Persint

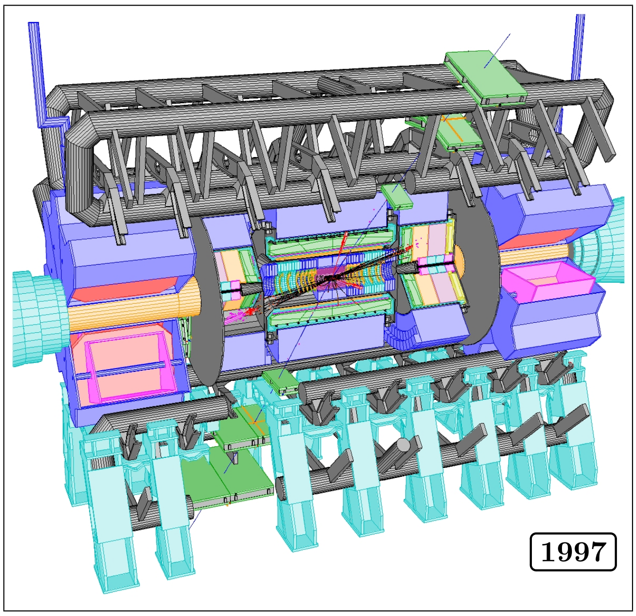
Event Display for ATLAS

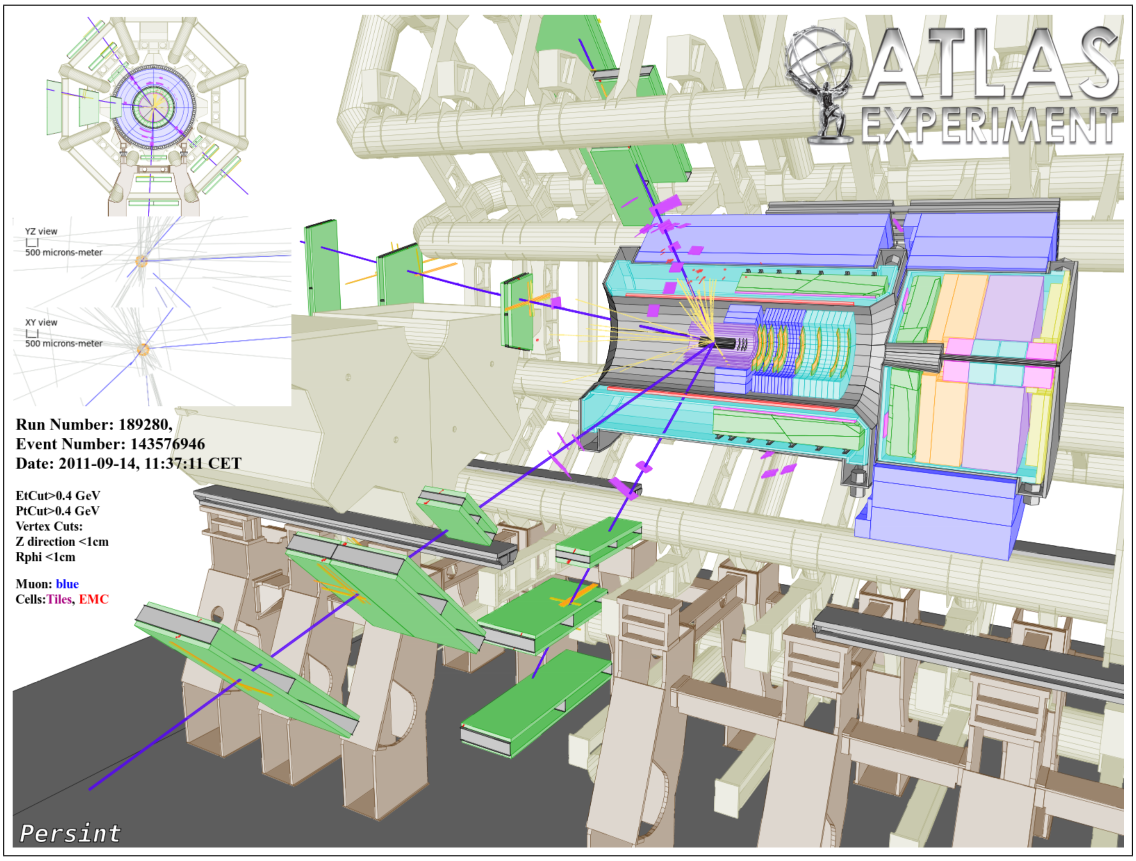
User's Manual and Tutorial

(*Version 6.0* September 16, 2014)

Abstract

This document is a "User's Guide and tutorial" for the *PERSINT* interactive detector, magnetic field, and event visualization program developed for the ATLAS collaboration [1]. The program is well suited for event scanning and for analyzing complicated events in their most intricate detail.





2012

$H \rightarrow \mu\mu\mu\mu$ candidate event of invariant mass 124.6 GeV, from the 2011 dataset.

This paper is dedicated to the memory of *Marc Virchaux* (1953-2004), the author of this software.

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History

Date	***Version***	***Comments***	***Persint version***
30/10/2009	V-4.0.3	Draft version (incomplete)	Persint-00-01-24
15/01/2010	V-4.1	First complete version	Persint-00-01-41
19/03/2010	V-4.2	Computation of invariant masses + minor corrections	Persint-00-01-46
09/04/2010	V-4.3	- Export as `.ps` and `.pdf` - New feature: *Save Special...*: Compare geometries - Improved Captions	Persint-00-01-53
19/06/2010	V-4.3.1	- Study of geometry and material - Improved labels and captions - Display vertices; 2 track shapes: *ribbon*, *cylinder* - Display magnetic field map	Persint-00-01-63
19/08/2010	V-4.3.2	- A-lines (alignment) downloaded for each event - Histogram of $d0$ distribution - Spinbox added for easy numerical settings	Persint-00-01-68
22/10/2010	V-4.3.3	- Modified interface with MuonBoy - Fully implement "Preferences" menu - Python script available in `/Persint-00-02-●●/example` for generating an `OutMboyView` file from `ESD`s - Updated TRT description - Download magnetic field maps from the Internet	Persint-00-01-75
29/01/2011	V-4.4	Direct access to User Manual Clean up field maps + Display Muonboy error messages Histogram of integral $\int Bdl$ Full-screen mode + Edit color of selected volumes Select particular sectors for display in an event	Persint-00-01-83
09/03/2011	V-4.5	Added 1D plots of magnetic field Redesign track selection user interface Multi-user installation Appendix B rewritten (Installation) Optional disabling of Log console	Persint-00-01-92
15/04/2011	V-4.6	Selection of solenoidal field map Redesign *Generate Muons* window 1D plots of $\int Bdl$	Persint-00-01-98
14/10/2011	V-4.7	Added German and Italian versions of GUI Map of X_0; map of "expected number of stations" Export map data as ASCII file; switch lin/log scale Additional AGDD/XML shapes	Persint-00-02-27

Date	***Version***	***Comments***	***Persint version***
27/01/2012	V-5.0	Define sectors to be displayed in an event Display only MDT chamber with adjustable minimum number of hits *Event* tool bar modified with added features Display of $jets$, $E_t\,miss$, and $RoI's$ (under development)	Persint-00-02-41
12/06/2012	V-5.1	Display of $jets$ and $E_t\,miss$ implemented $RoI's$ (under development)	Persint-00-02-54
31/08/2012	V-5.2	Miscellaneous improvements $RoI's$ (still under development)	Persint-00-02-58
21/06/2013	V-5.3	Add new MDT chambers: BME, BOE (J. Meyer)	Persint-00-02-66
02/12/2013	V-5.4	Various updates and fixes (X_0 map, ...)	Persint-00-02-69
16/09/2014	V-6.0	Elevator chambers. New small wheels (*J. Meyer*). *ROOT* format for magetic field maps (*M. Morii*)	Persint-00-02-74

The pdf version of this manual can be found at:
https://twiki.cern.ch/twiki/pub/Atlas/Persint2Wiki/PERSINT2_Manual.pdf
[CERN Twiki password required]
or
http://irfu.cea.fr/Images/astImg/3113/PERSINT2_Manual.pdf
[No password required]

Contents

List of Figures

Introduction

Persint [1] is an interactive visualization program developed for ATLAS. The program has been operational for many years and was used for:

- Designing the muon spectrometer
- Debugging the successive detector layouts, in particular resolving volume clashes in the GeoModel
- Optimizing the reconstruction software
- Analysing cosmic ray data in the commissioning phase
- Analysing collision events (data and Monte Carlo)

The new version described in this manual retains all the functionalities of the original package [2] and features a modern graphic user interface (GUI) and an easy to use file management system. The new interface, which uses the *Qt* library from *Trolltech*, makes it easy to interact with objects or applications.

Persint has many remarkable features, which can be used to visualize events in their most intricate detail. It is currently running on Linux , Mac OS and Windows operating systems and is interfaced with *ATHENA*, the general framework for data analysis in ATLAS. The package is being used with simulated events and with real data: cosmic ray events and events from collisions.

Persint is particularly well suited for understanding complicated events, when the visual representation of the detector's response becomes crucial.

1 Main features of *Persint*

The *Persint* program is designed for the three-dimensional representation of objects. It visualizes detector geometries using an interface with AMDB [2], an ASCII file containing the primary numbers used to build the muon spectrometer geometry. It also accesses AGDD [3], an XML-based geometry description language for the Atlas generic detector, mainly concerned with the inert material in the spectrometer. *Persint* interfaces with a variety of independent applications, in a fully interactive way. These applications include visualization of active detectors, inactive material, and the magnetic field map, as well as the detection of volume clashes, the display of event hits from files of physics events (simulated or data). It is possible to display events reconstructed with any reconstruction program active in *ATHENA*. Furthermore it is also possible to interactively run the embedded muon reconstruction program *MuonBoy*, and display the results.

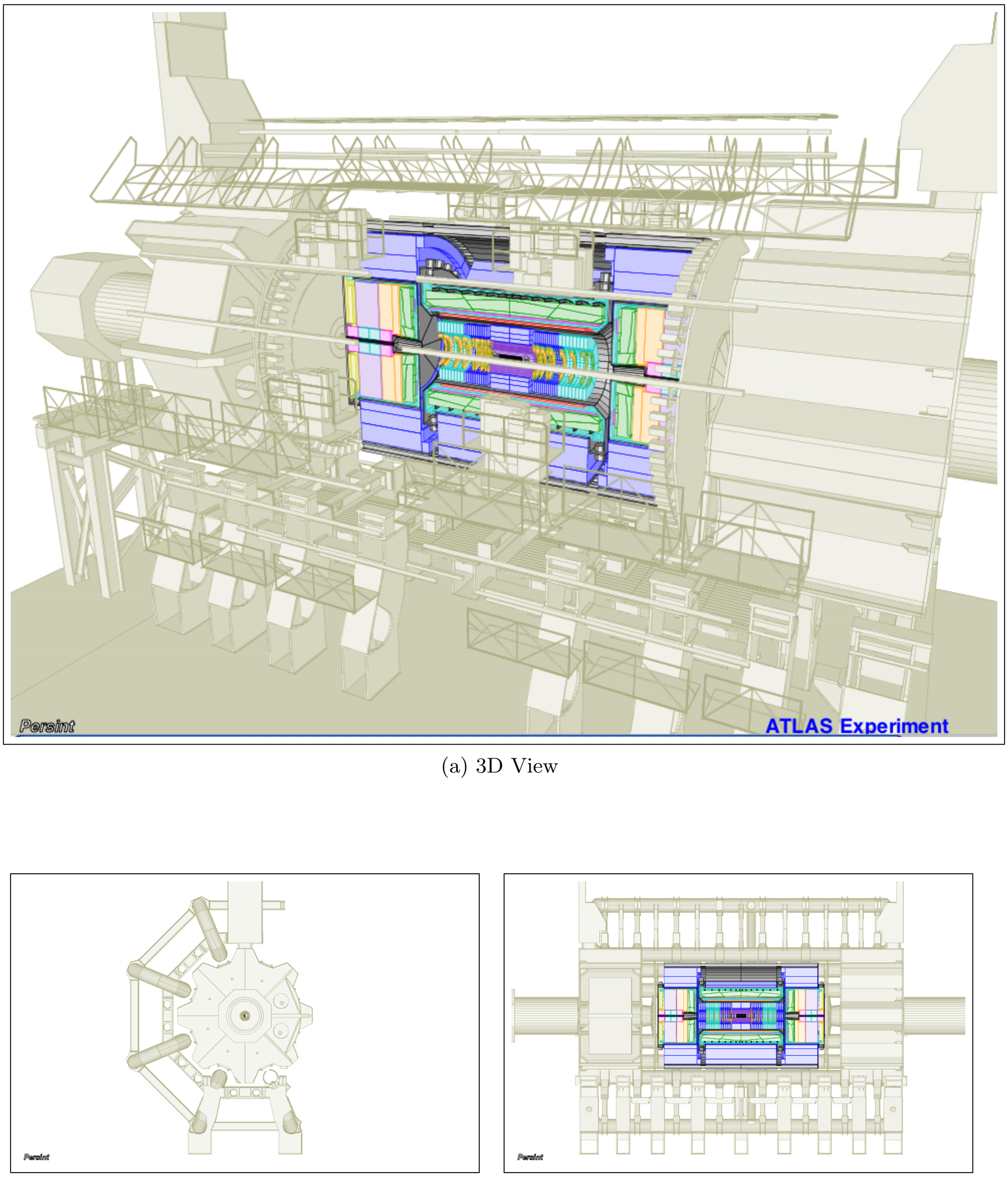
For spatial navigation, one can set the desired perspective for the 3D-view and display 2D-projections along various axes (Fig. 1). It is possible to change the viewpoint in order to best visualize the desired region, to displace the viewed objects with operations like translation, rotation and zoom.

The remarkable features offered by *Persint* are:

- 3-dimentional representation of objects in full volumes or "wire mode" using the computation of hidden faces
- Spatial navigation with real time displacements
- Focal length adjustment, from isometry to wide angle
- Displays can be exported as `.png, .jpg, .bmp`, or `.svg` files.
- Highlight of volume edges; adjustable light intensity on volume faces

[1] *Persint*: PERSpectively INTeractive
[2] Atlas Muon Data Base
[3] Atlas Generic Detector Description

- Detection of clashing volumes and highlight of intersections
- Boolean volume operations (addition, subtraction, intersection).
- Interfaces with numerous applications:
  . Display magnetic field map and field integrals; generate & track muons in mag. field
  . Distribution of material along tracks
  . Vertex display; Invariant mass calculation
  . Display of jets and missing E_T vector



(a) 3D View

(b) 2D Z-View

(c) 2D X-View

Figure 1: Various views of a *Persint* display

2 Architecture

Persint has been in use since 1995 and is written in Fortran90 . The core code contains everything needed to parse, store transiently and generate volumes from standard XML files. Analytic calculations determine volumes with hidden faces, provide the detection of clashes, can highlight volume intersections and supports boolean volume operations.

A second layer of C^{++} wraping classes provides the liaison between the core program and the graphic interface. This layer is made of classes encapsulating the calls to Fortran routines.

The third component is the Qt/C^{++} Graphic User Interface (GUI) .

Persint is a stand-alone package which uses ASCII event files as input:

1. The ASCII event files can be produced by *ATHENA* from raw data, with proper setting of the “properties”. In this case, the full potential of *Persint* can be used, including the interactive reconstruction of tracks with the embedded *Muonboy* reconstruction package. However, results from any *ATHENA* reconstruction package can be chosen for display (*Muonboy, Staco, Moore, Muid*, . . .) [1].

2. These ASCII files may also be produced from ESDs, using a “procedure” in *ATHENA* (Appendix G.2). In this case, events can be displayed but the interactive reconstruction of tracks cannot be performed.

Details of the design architecture can be found in Appendix A and in [5].

3 Installation on supported platforms

The necessary total disk space for installing *Persint* is less than 200 Mbytes. The following platforms may be used (see details in Appendix B, figure 131):

- **Ubuntu**
- **Scientific Linux**
- **Mac OS X**
- **Fedora**
- **Debian**
- **CentOS** (Ubuntu)
- **Cygwin**, the Linux-like environment tested with Windows 7
- **CernVM** via VirtualBox 4.0 (Ubuntu and Mac OS X)

Detailed instructions for installation and requirements for dependencies are given in Appendix B. An abridged HTML version of this user’s manual is available at:

https://twiki.cern.ch/twiki/bin/view/Atlas/Persint2Wiki

Up to date information on releases, installation and dependencies can be found there.

[1] *Muonboy, Staco, Moore, Muid* are computer programs for muon track reconstruction in Atlas.

4 Starting *Persint*

- To start *Persint* under Linux, launch the program with the *Persint* icon on the desktop [1].
- Under Mac OS, launch the *Persint.app* application placed in the *Application* folder at installation time [2].

In the pop-up window, choose the language: *English*, *French*, *German*, or *Italian*.

Upon launching *Persint*, the default AMDB geometry file is loaded automatically. It is located in the directory *Persint-00-02-••/AmdcData/share*, where *Persint-00-02-••* is the persint working directory [3]

Then a window is displayed which prompts you to restore (or not) the view which is automatically saved when closing the previous session (answer *Yes* or *No*).
When launching *Persint* for the very first time (there is no “previous session”), answer *Yes* in order to display the default view (*Zmumu4023.p2vf*) which is created at installation time in the directory *Persint-00-02-••/example.* [a]

[a] When running the preloaded *Persint* on lxplus at CERN for the first time, there is no default view available.

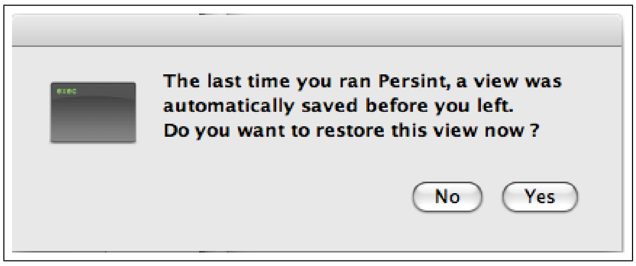
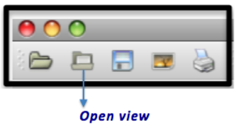


Figure 2 shows this default display in which labels have been added to indicate the location of the various tool bars and windows. The display also contains a simulated di-muon event which has been superimposed. How this is done is explained in section 6.3.

It is always possible to retrieve the original view (or any view which was saved as a `.p2vf` file). This is done in the following way:

Click on the *Open view* icon of the *File* tool bar. Select and open either the default file `Zmumu4023.p2vf` [4], or any saved `.p2vf` file.



Open view. . .

- The program's version number can be seen in the *About* item in the *Help* menu (or in the *persint* menu in Mac OS). The latest version is *Persint-00-02-74.* [5]
  Upon starting *Persint*, if your version is not up to date, a warning will tell you so and invite you to make the update.
- When loading the simulated event, you may be warned to use the appropriate geometry file. Answer Yes to load the suggested file (see page 24, figure 9a).

[1] Under Linux, this icon is created on the desktop at installation time.

[2] Under Mac OS, an alias can be conveniently placed *e.g.* on the *Desktop* or in the *Dock*.
It can also be launched from the *Terminal* by typing `./start_persint.sh` in the *persint* working directory: *Persint-00-02-••*.

[3] *Persint-00-02-••* is the evolving version number of *Persint*, e.g. *Persint-00-02-74*.

[4] `Zmumu4023.p2vf` is located in the `Persint-00-02-••/ example` directory.

[5] Check for the latest version at: `https://twiki.cern.ch/twiki/bin/view/Atlas/Persint2Wiki`.
As the version will evolve with time, the version number is given as *Persint-00-02-••* in this document.

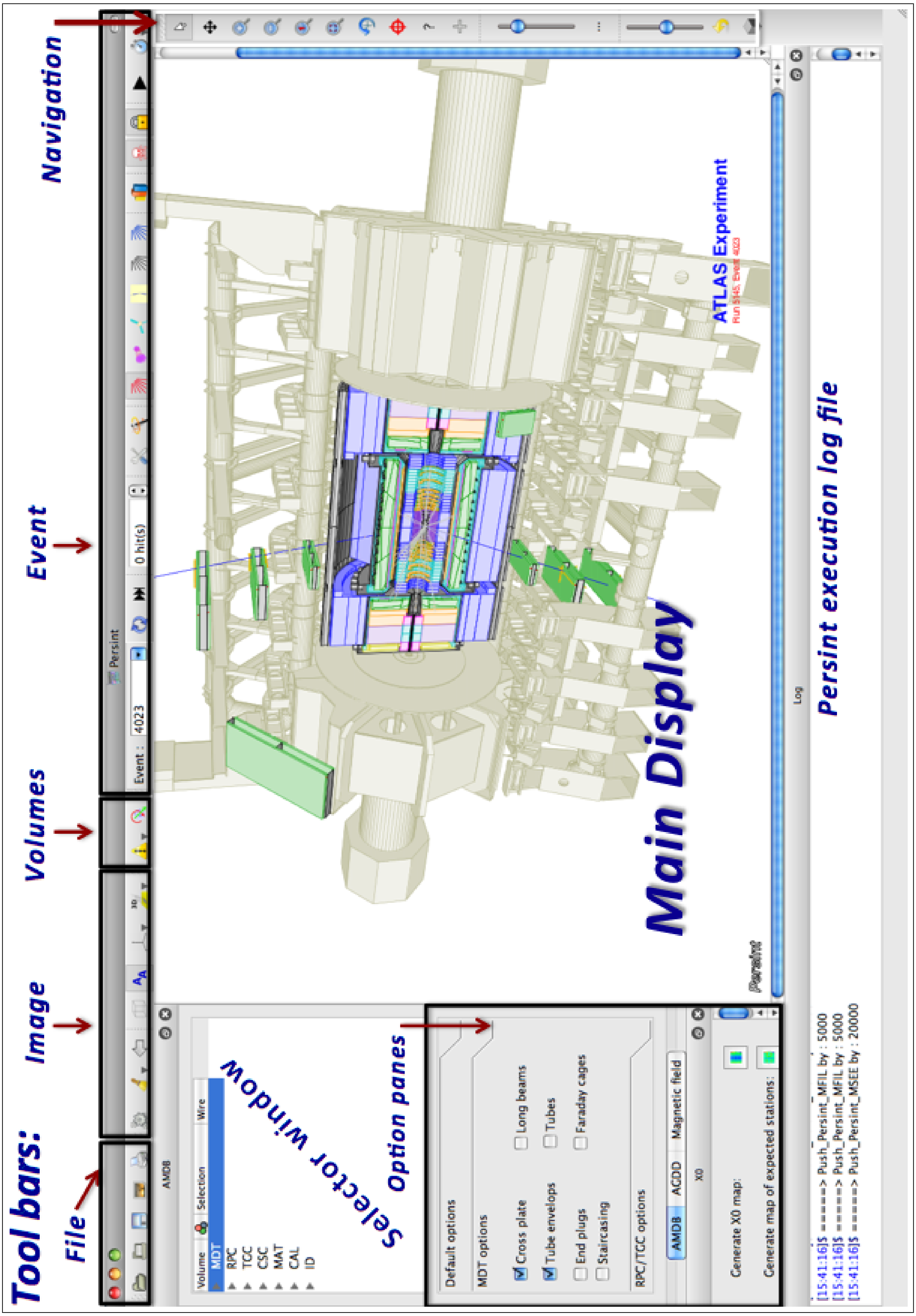


Figure 2: Layout of the *Persint* display window

5 The Graphic User Interface

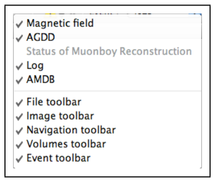
Figure 2 shows the *Persint* window once the program has been launched.

5.1 Items of the Graphic User Interface

A detailed description of menus and tool bars available in the Graphic User Interface is given in Appendix E.

- At the top are the menus: File, Image, Navigation, Volumes, Events, Tools, Window and Help. The persint menu is specific to Mac OS).
  These menus give access to the various operations one can perform.

- The most common operations (but not all) are also available through ***Tool bars*** which appear just below the menus, as repeatedly shown in Appendix E.
  The user can choose which tool bars to display. A `right-click` on any displayed tool bar will produce a pop-up list from which items can be enabled or disabled.
  The ***Navigation tool bar*** has been placed on the right hand side [1] by the user. It has a number of functions (represented by icons) which allow changing the aspect of the main display in many ways.



List of tool bars

- The large window at the left, the ***Selector window***, is used for selecting detector volumes.

  1. The *AMDB* interface allows interactive access to the geometrical data bases of the *amdb_simrec* type [3] and concerns not only detector volumes like muon chambers, calorimeters and trackers, but also magnets, feet, and shielding.
  2. The *AGDD* interface allows interactive access to data bases of the ATLAS Generic Detector Description type [4] [8]. The AGDD interface is used to display the inert material in ATLAS.
  3. The *Magnetic Field* interface provides a fully interactive 3D visualization of the Magnetic Field. The use of this interface will be described in section 9.7.
  4. The *X0* interface provides a full η, φ map of the amount of material traversed by a particle originating from the interaction point. The use of this interface will be described in section 9.8.

- The detector and event ***Main display*** window occupies the largest area of the display. When saving or exporting a view, it is the content of this main display window which is saved.
  The *Main display* can be modified in size by dragging the lower right corner. Also, by `right-clicking` on the title bar of the window, a number of functions appear in a pop-up window, which you are invited to test. [2]
  This ***Main display*** window can be made "Full screen" by using the appropriate item in the *Window* menu, or the short cut by typing the letter F (lower case). To exit the full screen mode, type F again.

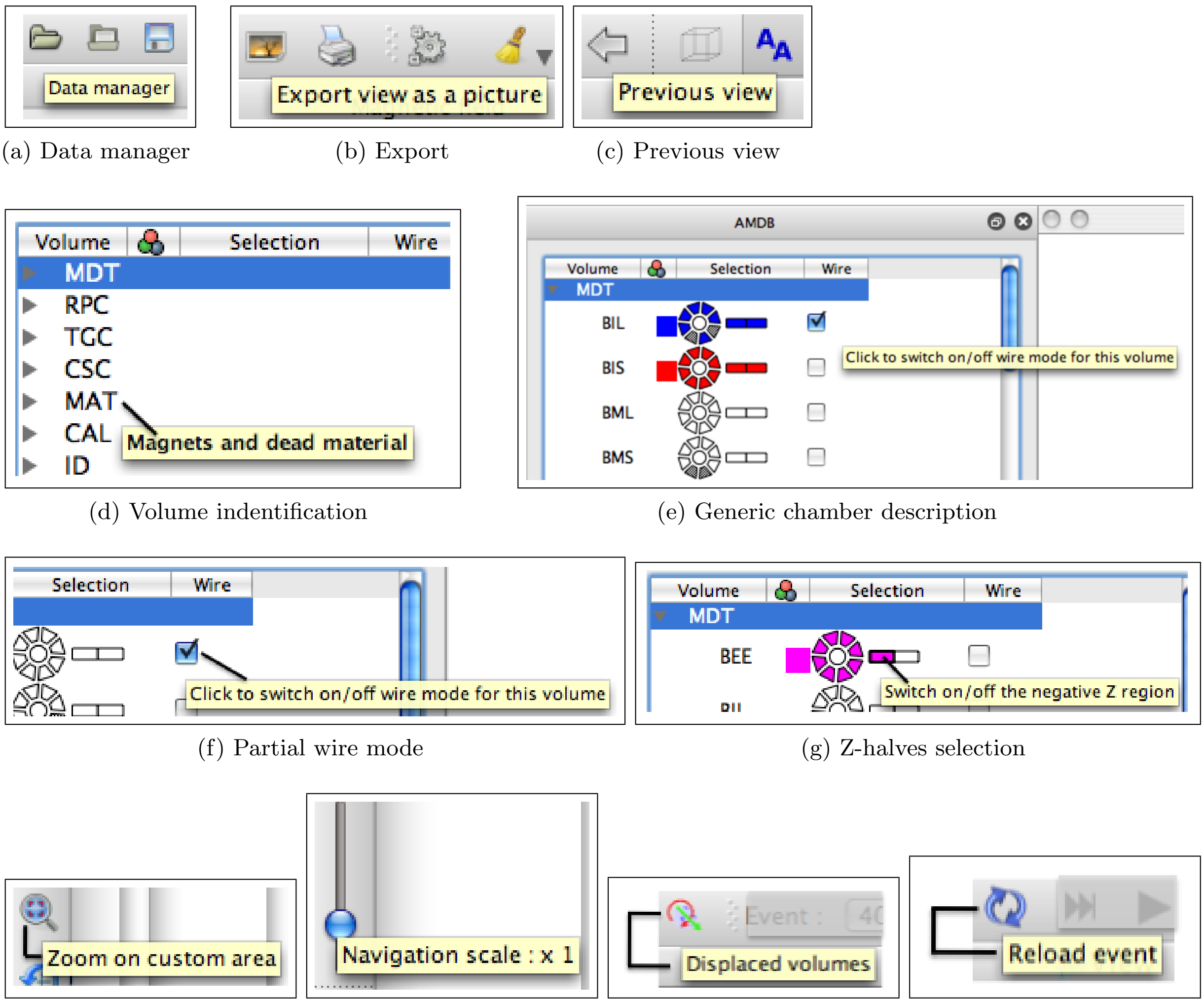
Actions on Main display

- Finally, the *Log* window can be opened in the *Window* menu (Appendix E.7) and shows comments about the successive operations when running *Persint*.

[1] Any tool bar can be placed to a preferred location by the user.
[2] This pop-up menu also appears when `right-clicking` on the title bar of the *Histogram of hit calorimeter cells* window (section 11.3.3).

5.2 Online help

The location on the screen and the size of all these windows may be changed by the user. Online information about the functions of the icons is provided in an information box which appears when the curser is positioned on any icon. Some examples are shown in figure 3.



(a) Data manager (b) Export (c) Previous view

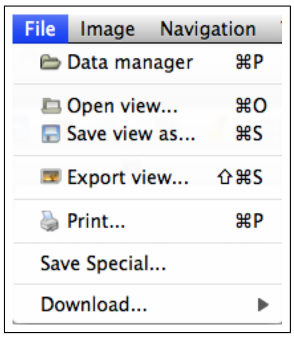
(d) Volume indentification (e) Generic chamber description

(f) Partial wire mode (g) Z-halves selection

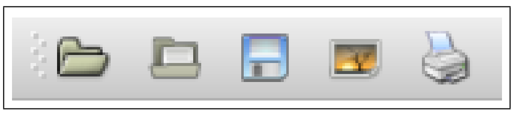
(h) Customized zoom (i) Navigation scale (j) Displaced volumes (k) Reload event

Figure 3: Examples of online information boxes, when positioning the curser over an icon.

5.3 Toolbars or Menus ?



In the following tutorial, we will mostly use the tool bars, although using actions in the menus may be preferred by some users.



6 Exercise 1: Setting the stage

In this section, we will start using *Persint* and explore it's most basic features as well as the main functions proposed by the interface. It is assumed that the installation was successful and that the necessary dependencies are satisfied (see Appendix B).

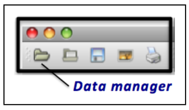
6.1 Necessary files

For proper initialization of certain applications, the program loads several databases and input files. It is possible to load any database during running time, but it is of interest to load default files, so that the program can initialize its applications when they are launched for the first time. Default files are stored, at installation time, in the `Persint-00-02-••` directory .
This section (6.1) provides information about the files needed for running *Persint*, and no action is needed at this time. You may however want to create two directories for storing various files generated when operating *Persint*, for example:

The *persint_export_files* directory (or any other name) for storing files generated by the *Export view* function of the *File* tool bar (see section 6.4, item 2). These are files for presentations and publications.

The *persint_working_files* directory (or any other name) for saving *Persint*-specific files. These are files which you may want to save when interrupting your work until your next session with *Persint*.

6.1.1 *Detector description and magnetic field*



Data manager

6.1.1 *Persint* uses several files which concern the detector description and the magnetic field map . At installation time, they are placed in the directory `Persint-00-02-••`[1] and can be loaded by clicking on the *Data manager* icon of the *File* tool bar. In the pop-up window (Figs. 4, 5, and 8) load the necessary files as follows[2]:

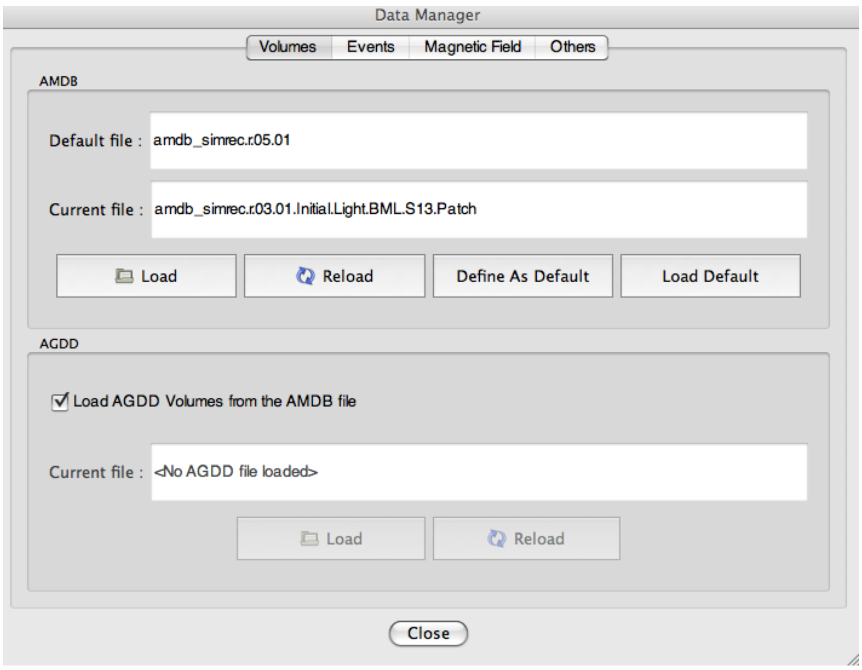


Figure 4: *Volume* tab: Choosing *AMDB* and *AGDD* files

[1]Created at installation time and named according to the *Persint* version in use. Check for the latest version at: `https://twiki.cern.ch/twiki/bin/view/Atlas/Persint2Wiki`

[2]When all the files are chosen, click on Close.

1. The *AMDB* file (of the `amdb_simrec.xxx` type) from which the detector volume can be displayed is loaded from the ***Volumes*** tab (Fig. 4). When clicking on [Load], the files in the directory `Persint-00-02-••/amdcData/share` are made available. [1] For this tutorial, we will load the *Default file* by clicking on [Load Default] and checking the box: "*Load AGDD Volumes from the AMDB file*".
   The two other buttons are used to [Reload] the current `AMDB` file or [Define as Default] the *Current file*.

2. The magnetic field files are loaded from the ***Magnetic Field*** tab (Fig. 5). The magnetic field map can be chosen for both the muon spectrometer (toroid) and the inner detector (solenoid). Click on [Modify...], and the *Magnetic field wizard* proposes several possible actions, first for the spectrometer (toroidal) field map (Fig. 6a).

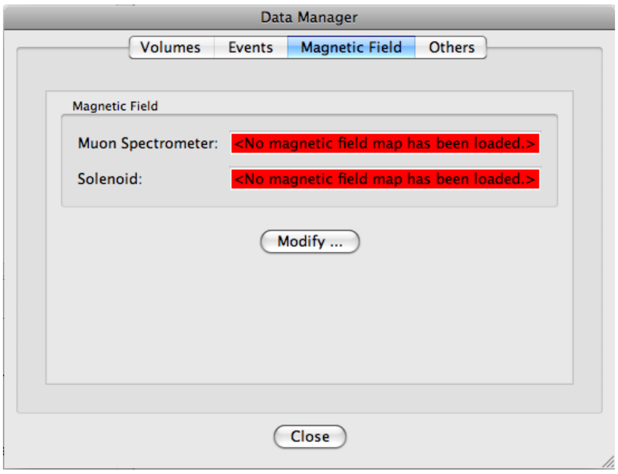


Figure 5: *Magnetic field* tab

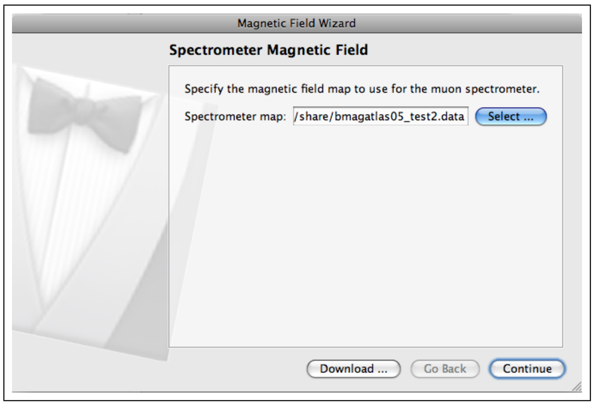
   - [Continue] to load the default map initially proposed [2] or chosen with one of the two following actions:
   - [Select...] to choose from the maps proposed in the `Persint-00-02-••/BFieldData/share` directory
   - [Download...] to download additional files from a CERN repository to the `Persint-00-02-••/BFieldData/share` directory

   Clicking the [Continue] button will load the chosen *spectrometer field map*, and will prompt two options for the *solenoid field map* (Fig. 6b):
   i) *Use the theoretical map* calculated from Biot-Savart;
   ii) *Use the measured map* which needs to be [Select...]ed or [Download...]ed.

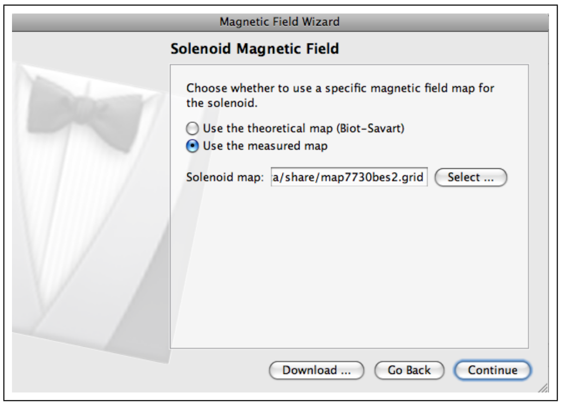
   Finally you are asked if the field maps you just loaded should be your future *default maps* (Fig. 7).

3. Event files are loaded from the ***Events*** tab (Fig. 8). When clicking on [Load], the files in the directory `Persint-00-02-••/ example` are made available. Event files can be loaded from other directories.
   The bottom part of the window shows the *Data cards* file, which is used for the interactive reconstruction of tracks within *Persint*. Here again, the default file `Muonboy_collision_cards` was chosen with [Load Default].

[1]The content of this directory is shown in Appendix D.2, Figure 133a.
[2]When running *Persint* on lxplus at CERN for the first time, there is no *default map* available.



(a) Spectrometer



(b) Solenoid

Figure 6: *Magnetic field wizard*

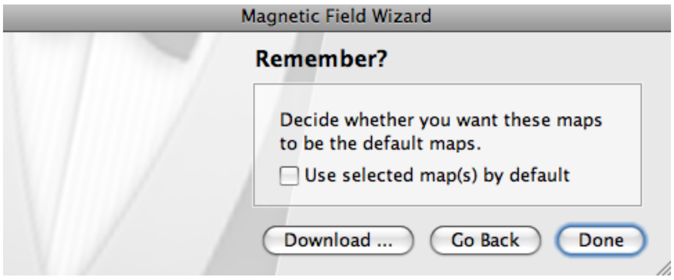


Figure 7: *Magnetic field wizard*: set map(s) as default ?

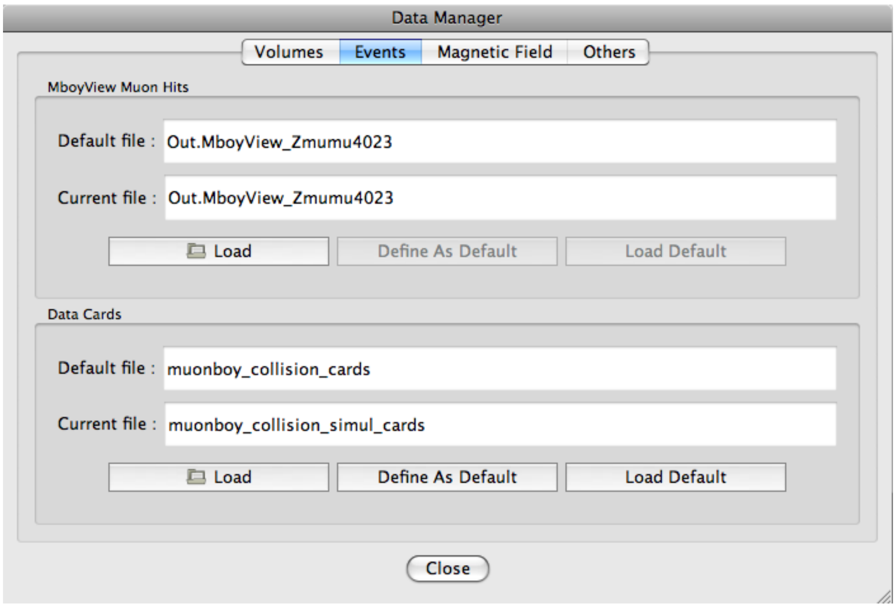


Figure 8: Choosing the *Event* file

6.1.2 *"Example" files for Event 4023*

For the purpose of this exercise (Exercise 1), three more working files were placed in the directory `Persint-00-02-••/example`[1] during installation of *Persint*. They concern Event 4023 of a $Z \rightarrow \mu^+\mu^-$ simulation:

1. *Zmumu4023.p2vf*: **Detector description** file.

   This file was produced to embed Event 4023 in a detector layout, and is only an example. You may want to build and display your own "visible" detector, save it as a `.p2vf` file and use it as a template for displaying events (see 6.4, item 1; and 7.4).

2. *Out.MboyView_Zmumu4023*: **Event file**.

   This *Event file* is an `ASCII` file produced by *ATHENA* when the "properties" are properly set. It contains the event *Zmumu4023* with all information necessary for viewing in *Persint*: parameters for hits, tracks, calorimeter clusters, reconstruction, and simulation of this Monte Carlo event.
   Persint can also use event files produced from ESDs, as explained in Appendix G.2.

3. *Zmumu4023.p2ts*: **Track parameter** file.

   This file contains the track parameters applied to the event to be displayed. The file is produced within the *Set track parameters* window where parameters such as momentum and energy thresholds, as well as the color code are set (see section 6.3, item 6, and figure 10). The parameters can be saved from the *Set track parameters* window as a `.p2ts` file to a directory of your choice.

4. *`.p2gm` files*: Parameters of **generated muon tracks**.

   The usage of this type of *Persint* file is described in 7.1.

No action is required at this stage, except to check that these files are present in the proper directory. All these files will be used in this tutorial as "Default files" .

6.2 Interfaces to applications

The *Persint* display window gives direct access to a series of applications through dedicated interfaces. They will be described and used throughout this tutorial.

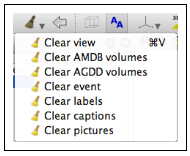
- the AMDB Interface
- the AGDD Interface
- the reconstruction and Event display Interface
- the Track parameters interface
- the Muon Track Generation Interface
- the Magnetic Field Interface

[1] The way to access these files will be explained as we go along.

6.3 Displaying detector layouts and events (Exercise 1 starts here).

1. Start *Persint* (see section 4).

2. Clear the view in the main display.

   Clear

   Use the *Clear* icon in the *Image* tool bar and choose *Clear view* in the proposed menu (or click directly on the "brush" in the icon). With this scrolling menu one can make a selective clearing of `AMDB` or `AGDD` volumes, event hits [1], labels [2] captions or pictures [3].

3. Display detector volumes.

   The desired detector volumes can be displayed using the *Selector window*, the operation of which will be detailed in sections 7.2. For the present exercise, we will load the "Default file" which was prepared when studying the `Zmumu4023` event:

   Open view...

   Click on the *Open view* icon of the *File* tool bar. Choose and open the file `Zmumu4023.p2vf` in `Persint-00-02-●●/example` of your working directory. The detector volumes are displayed [4], as shown in figure 2.

4. Load a $Z \to \mu^+\mu^-$ event in the following way.

   Click on the *Data manager* icon in the *File* tool bar. In the pop-up window, go to the *Events* tab (Fig. 8) and click on [Load Default] to load the "Default file" `Out.MboyView _Zmumu4023` which becomes the "Current file". Close the *Data manager* window.

   The *Event* file contains information concerning the geometry to be used. It may happen that a warning is issued, which prompts you to load the expected geometry file and/or the magnetic field files, as shown in figure 9. Answer [Yes] to load the expected files. It is possible to answer [No], in case one wants to use files different from the default files (*e.g.* a misaligned geometry or an different magnetic field). Furthermore, any given file available in the `Persint-00-02-●●/AmdcData/share` directory (see App. D.2, figure 133a) can be loaded from within the *Volumes* tab of the *Data manager* window.

(a) About the geometry file (b) About the magnetic field file

Figure 9: Warnings issued by *Persint*.


Next event

Click on the *Next event* icon of the *Event* tool bar: the muon chambers which are hit by reconstructed tracks are displayed.

[1] Event hits are treated in section 10.2.
[2] Labels are treated in section 9.1.2.
[3] Captions and pictures are treated in section 6.5.
[4] The selected detector volumes can be identified by looking at the AMDB and AGDD panes in the *Selector window*.

5. Display the event.[1]

   Click on the *Simulation tracks* icon of the *Event* tool bar: the muon tracks from the simulation are displayed. Erase these tracks by clicking again on that icon.

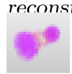
   Simulation tracks

   Click on the *Athena reconstruction* icon of the *Event* tool bar: only reconstructed tracks are displayed along with the associated segments in the chambers. Keep these tracks. [The segments and tracks can be erased by clicking again on that icon].

   Athena reconstruction

   Click on the *Hit calorimeter cells* icon of the *Event* tool bar: the calorimeter hits of the event are displayed. Keep these hits on display. [The hits can be erased by clicking again on that icon].

   Hit calorimeter cells

6. Make track and cluster selection.

   Click on the *Set track parameters* icon of the *Event* toll bar. In the pop-up window (Fig. 10) one can choose physics objects, and define some of their parameters. The usage of this facility is straightforward: items can be selected and momentum (p_T) or energy (E or E_T) thresholds can be set. It is possible to choose the *color*, the track *shape* (ribbon or cylinder), the track and segment *width*, display the scattering centers used by the reconstruction program, and define cuts on the impact parameters ($d0$, $z0$) of tracks.
   A detailed description of the *Set track parameters* window is given in Appendix E.5.1, where all the parameters are shown, in each of the five tabs.

   Set track parameters

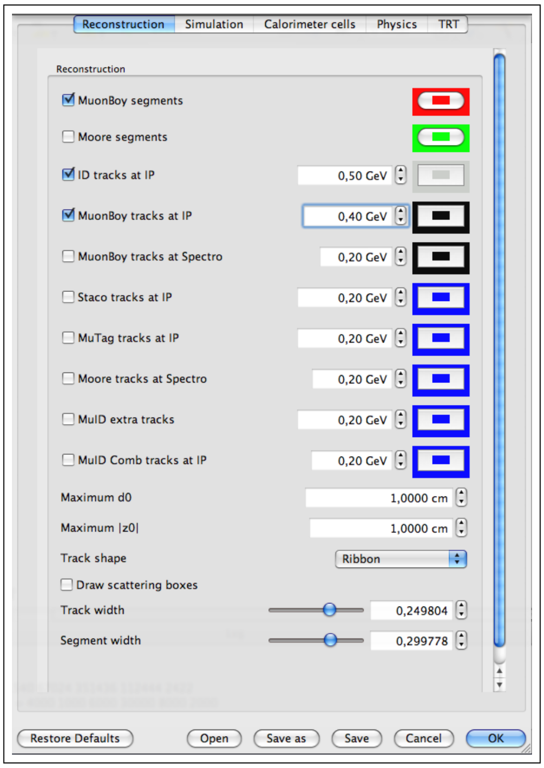


Figure 10: *Set track parameters* window. The parameters shown here (for the *Reconstruction* tab) are those of the predefined parameters of file `Zmumu4023.p2ts` mentioned below. See Appendix E.5.1 for the content of all 5 tabs.

[1]The result of the actions described below depend on the status of the *Set track parameters* window (see item 6).

For this exercise, we will use a pre-defined set of parameters by loading a file prepared beforehand, which is relevant to the event under study: in the pop-up window, click on the [Open] box, and in the `Persint-00-02-••/example` directory choose the file `Zmumu4023.p2ts`. Close the window by clicking on [OK]. To complete the loading of this "track parameter" file (`Zmumu4023.p2ts`), click on the *Compute* icon [1] of the *File* tool bar. The parameters from this file are then displayed in the *Set track parameters* window (Fig. 10). The resulting view is shown in figure 11.

Compute

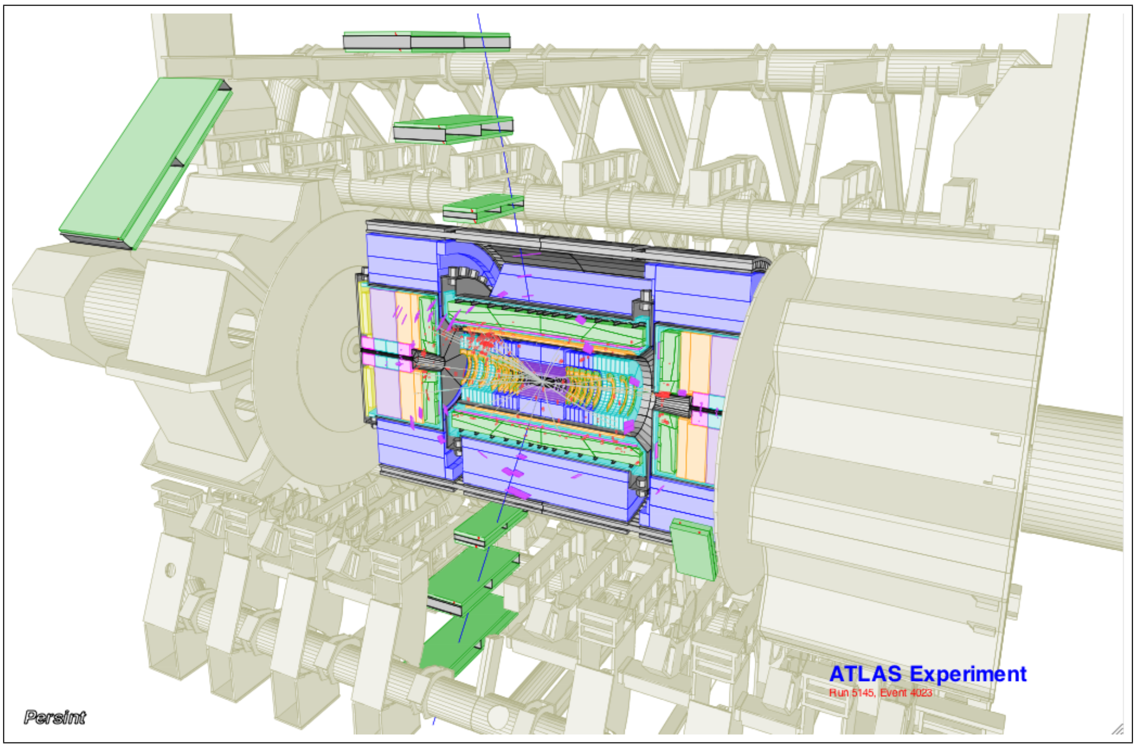
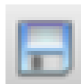


Figure 11: Resulting display of the exercise in section 6.3

6.4 Save, Export, and Print views



Save view as...

Open view...

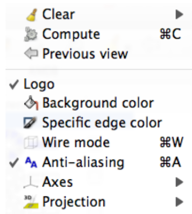
Export...

1. Save.
   By clicking on the *Save view as* icon in the *File* tool bar the view displayed in the main display can be saved as a `.p2vf` file to the directory of your choice, *e.g.* *Persint_working_files*. This file (*e.g.* `exercise1.p2vf`) can be retrieved for later use in *Persint* via the *Open view* icon.

2. Export.
   By clicking on the *Export...* icon in the *File* tool bar the view displayed in the main display can be exported to the directory of your choice, *e.g.* *persint_export_files*. There is a choice among several formats: `.png`, `.jpg`, `.bmp` for matrix graphics or `.svg`, `.ps`, `.pdf` for vector graphics. These files can be used in publications and presentations [2].
   Note that the background color of the display can be chosen with the *Background color* function of the *Image* menu. The grey background in figure 21d illustrates

[1]The *Compute* icon is one of the most used functions. Whenever in doubt about the status of a display, clicking on this icon will compute the most recent requests for viewing.

[2]The inserted *Captions*, *Labels*, and *Pictures* are saved with the display.

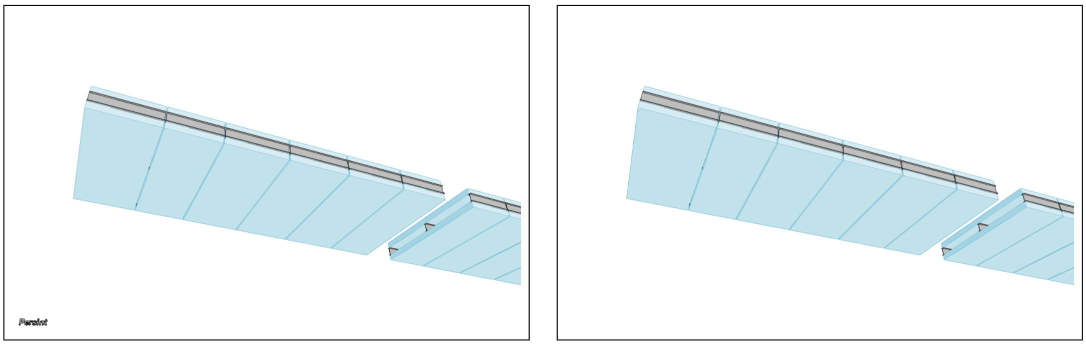


Specific edge color & Anti-aliasing

this feature.

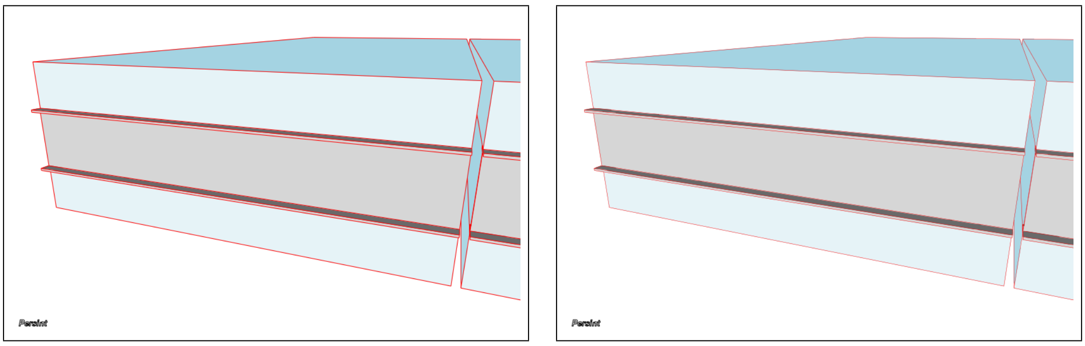
The edges of volumes can be highlighted with the *Specific edge color* function of the *Image* menu. Figure 12 shows a display without (a) and with (b) the *Specific edge color* being enabled (with the "red color").

The effect of the *Anti-aliasing* function aimed at smoothing the edges is shown in figure 13.



(a) Without specific edge color; with *Persint* logo (b) With specific edge color (red); without *Persint* logo

Figure 12: The *Specific edge color* function and *Persint* logo of the *Image* menu.



(a) Without Anti-aliasing (b) With Anti-aliasing

Figure 13: The *Anti-aliasing* function of the *Image* menu.
Because the printer performs its own optimization, the effect of *Anti-aliasing* shown here is less apparent than on a computer screen.

3. Print.
   It is straightforward to use the *Print* icon in the *File* tool bar for printing the view of the main display.

Print

4. Save special. . .
   This function allows for comparison between two geometries. In particular, it makes it possible to use a geometry from a file `amdb_simrec` different from the file expected from an event file. Invoking the *Save special. . .* function produces the following action:

- The current view is saved as a `.p2vf` macro file named `compare_persint_views.p2vf` into the `$HOME/.persint` directory.
- The current view is also saved as a `.png` image file named `persint-view-000.png` into the same directory.

If a `compare_persint_views.p2vf` file already exists because of a previous use of the *Save special ...* function, a warning is issued which asks you if the existing file should be loaded.

- If the answer is [No], the `compare_persint_views.p2vf` file is overwritten and the active display remains unchanged.
- If the answer is [Yes], the existing `compare_persint _views.p2vf` file is loaded and displayed, and stays unchanged in the `$HOME/.persint` directory.

In both cases, the view is saved as an image in the same directory with the name `persint-view-001.png` [1].

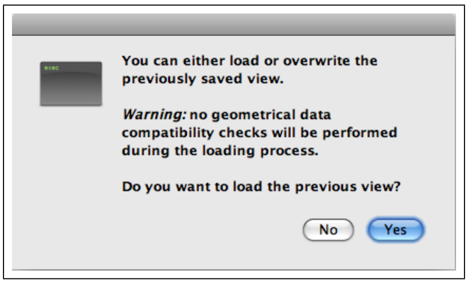


Figure 14: Warning issued when using the *Save special...* function

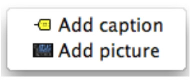
The use of the *Save special...* function is illustrated in section 9.3.

6.5 Dressing the display with captions, logos, and pictures

The *Export* function in the *Image* menu is used to make displays available for presentations and publications. It is possible to insert captions, logos, and figures in the displays, as described below.

1. The *Persint* logo.
   The *Persint* logo can be shown/hidden by checking/un-checking the function *Logo* in the *Image* menu. The result can be seen in figure 12a (with the *Persint* logo in the bottom-left corner) and figure 12b (without the *Persint* logo), and also in figure 31a.

2. *Add Caption.*
   A caption can be inserted in the following way: position the cursor at a chosen location in the display window and `right-click`. In the pop-up list choose *Add caption*. The text of the default caption can be edited as in figure 15 by adding text anywhere.
   The editing is done line by line and the text format can be chosen with the options provided:



Caption/picture

[1] The view number is incremented for each subsequent use of the *Save special...* function. If needed, the files can be deleted from the directory.

`Insert special character`: the special character palette appears when clicking on the [Ω] box; characters are inserted in the text bar at the bottom with a "*double-click*"; when the text is composed, click on [OK] to make it appear in the caption. Special characters include the greek alphabet, arrows, etc.

`Other available functions` (icons, from left to right):
Load caption from...
Save caption as...
Add event information (Run#, Event#, Time stamp)
Clear the entire text of the caption

Add caption icons

`Font:` By clicking on the *Font* box, the font and font size can be chosen.

`Vertical alignment:` text can be normal, ^{superscript} or $_{subscript}$.

`Foreground:` The *Foreground* box lets you choose the color of the font.

`Background:` Checking the *Background* box provides the background color of selected text in the caption.

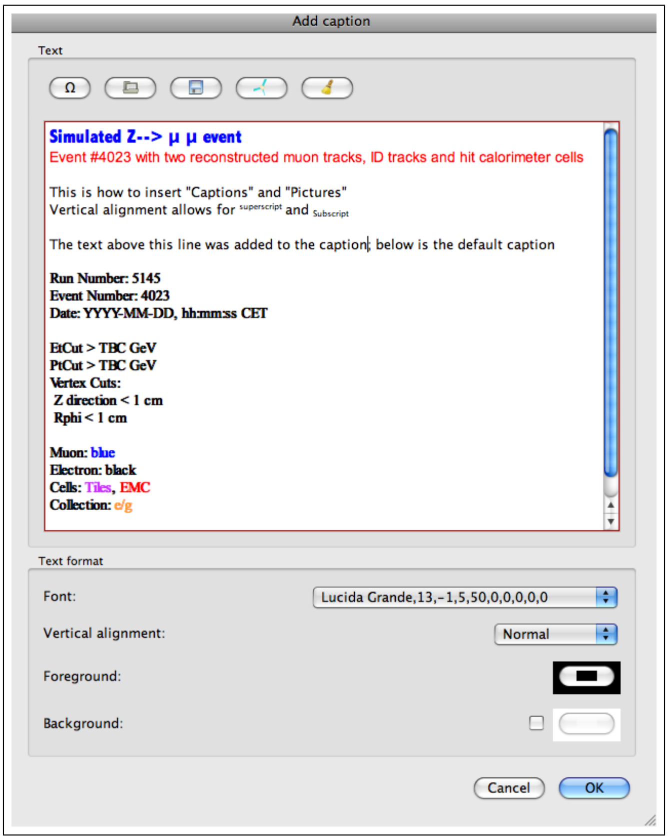
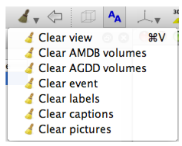


Figure 15: *Add caption* window. The last 3 paragraphs are the *Default* caption when an Event is displayed

When opening a new *Add Caption* window, the previously entered text is displayed, ready for modifications. The following actions can be taken:



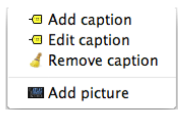
Clear captions

- *Remove caption*:

  Use the *Clear captions* function of the *Clear* icon;

  or `Right-click` on the caption and choose *Remove caption* from the list.

- *Export*
  Captions are saved when using the function *Export view as a picture*.

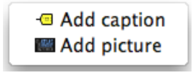


Actions on captions

- *Save view as a .p2vf file*: the captions are saved with this function, and can be retrieved with the `.p2vf` file.
- *Edit caption*
  Captions can be edited by `Right-clicking` on the caption and choosing *Edit caption* from the menu.

The location of captions cannot be changed; if their location is not adequate, they need to be removed and redone. [1]

3. *Add picture.*
Various logos or ad-hoc pictures can be inserted in a *Persint* display: position the cursor at a chosen location in the display window and `right-click`. In the pop-up list choose *Add picture* and choose from the proposed list (Fig. 16).



Caption/picture

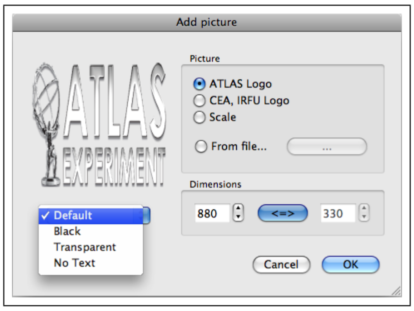


Figure 16: *Add picture* window

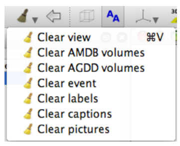
(a) Default (b) Black (c) Transparent (d) No text

Figure 17: The four flavors of the ATLAS logos.

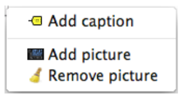
The *ATLAS* logo exists in four flavors: `default`, `black`, `transparent`, and `without text`. They are shown in figure 17. It is also possible to load any picture from an existing file with *From file ...*.
Finally, the size of the inserted picture can be adjusted with the *Dimensions* parameters in two ways: keeping the original aspect ratio <=> or with independent `x,y` dimensions >=<.

Note two features of the *Add Caption* and *Add picture* functions:

- The location of pictures (logos) cannot be changed; if their location is not adequate, they need to be removed and redone.
- The *Clear captions* or *Clear pictures* functions of the *Clear* menu offer two options: erase all the captions or pictures or erase only the last. Another way of removing one particular caption or picture, is to use the *Remove caption* or *Remove picture* in the menu which appears when `right-clicking` on the item to be removed.



Clear captions



Remove picture

[1] But remember that the text of the deleted caption is saved and appears when a new caption is added.

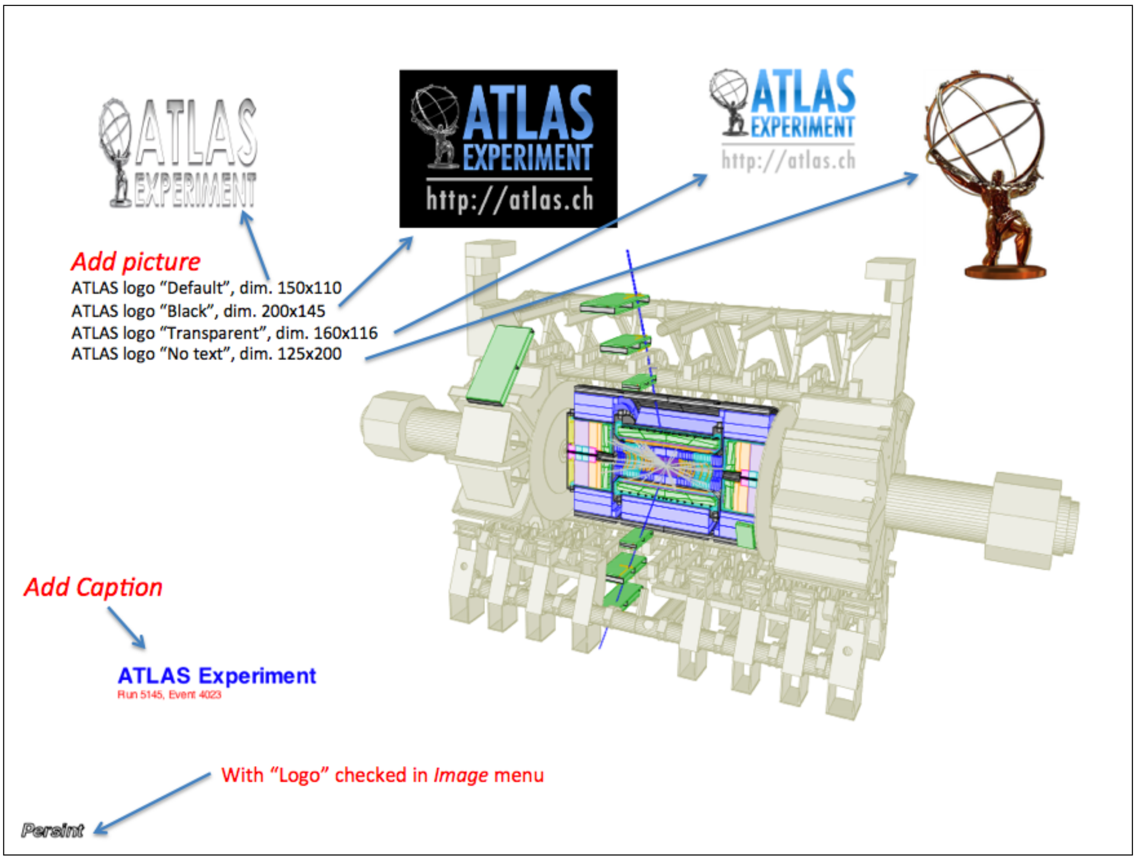
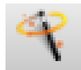


Figure 18: Examples of inserting various captions, logos and pictures in a display.

7 Exercise 2: Muon tracks in your own layout

In this exercise, we will create a custom made event from scratch. By following the instructions, you should obtain the displays shown in figures 21d and 22b with possible minor differences due to your choice of colors or navigation.
We want to start with an empty main display window: Start *Persint* and do not load the saved file, by answering No to the question in the pop-up window (page 16). If you answered Yes, use the *Clear* icon in the *Image* tool bar to clear the view in the main display.

7.1 Generate muon tracks at the IP



Generate muon tracks

In the *Event* tool bar, click on the *Generate muon tracks* icon. In the pop-up window (Fig. 19), click on the + Add muon box four times. Fill in the parameters of the generated four muons, for example:

1. $\eta = 0.30$; $\varphi = 90°$; $P_t = 1\,000\ GeV$; $Xv = Yv = Zv = 0$
2. $\eta = 0.30$; $\varphi = 90°$; $P_t = 100\ GeV$; $Xv = Yv = Zv = 0$
3. $\eta = 0.30$; $\varphi = 90°$; $P_t = 4\ GeV$; $Xv = Yv = Zv = 0$
4. $\eta = 0.30$; $\varphi = 90°$; $P_t = -4\ GeV$; $Xv = Yv = Zv = 0$

This is done by double-clicking on the value to be edited and using the spinbox which opens. Values can also be entered via the keyboard.
The muon momentum can be set either with P_t or P. The $->$ box is used in the following way:

- P_t $->$ P means that only P_t can be edited, P being calculated accordingly. Furthermore if one changes the value of η, P_t is kept fixed and P is recalculated.
- P_t $<-$ P means that only P can be edited, P_t being calculated accordingly. Furthermore if one changes the value of η, P is kept fixed and P_t is recalculated.

The electric charge of a generated muon is determined by the sign of the Pt or P momentum: *e.g.* track # 4 has negative charge.

Click on OK. The four tracks originating from the interaction point (IP) are displayed: whereas the 100 GeV and 1 000 Gev tracks appear as straight and superposed, the two 4 GeV tracks show clear opposite curvatures in the magnetic field.

Let's delete the 1 000 GeV track by selection the appropriate line number and clicking on the − Remove muon box. The pop-up window now looks like figure 19. You may want to choose specific colors for the tracks.
For future use, save the *generated muon* parameters as a `.p2gm` file by clicking on the Save box inside the *Generate muon tracks* window. You may want to use your *persint_working_files* directory as a destination.

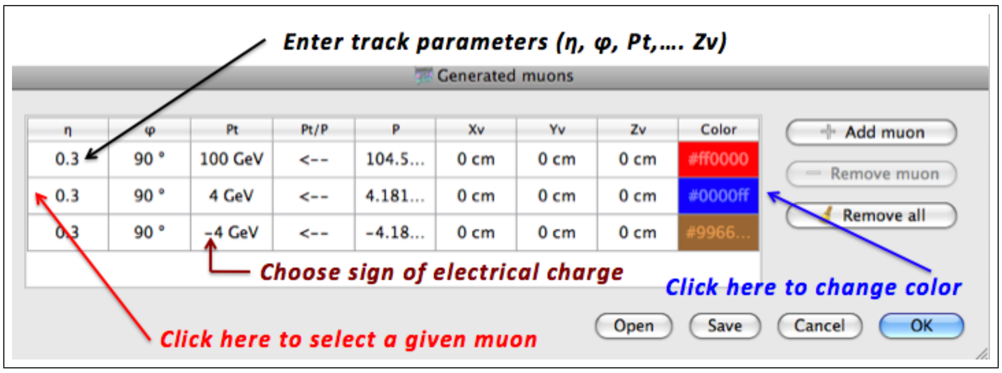
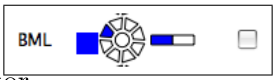


Figure 19: Pop-up window for muon track generation

7.2 Display the detector using the AMDB interface

The *Selector window* (Figs. 2, 21, and 22) gives access to the *AMDB* interface to select the detector volumes to be displayed by clicking on the relevant pictogram. [1] The layout of this window is determined by the two approximate symmetries of the muon spectrometer:

- The 8-fold symmetry with respect to φ of the toroids and the muon chambers in terms of *Large* and *Small* sectors. Thus the octant wheel selector.



- The symmetry between $Z \geq 0$ and $Z \leq 0$ regions. Thus the Z-halves selector.

Clicking in the center of a "wheel" selects all sectors of a given detector. Clicking again in the center erases that selection. Sectors can be selected individually by clicking in the corresponding box, but only adjacent sectors can be displayed in this way. Figure 20 shows the functioning of the selector.

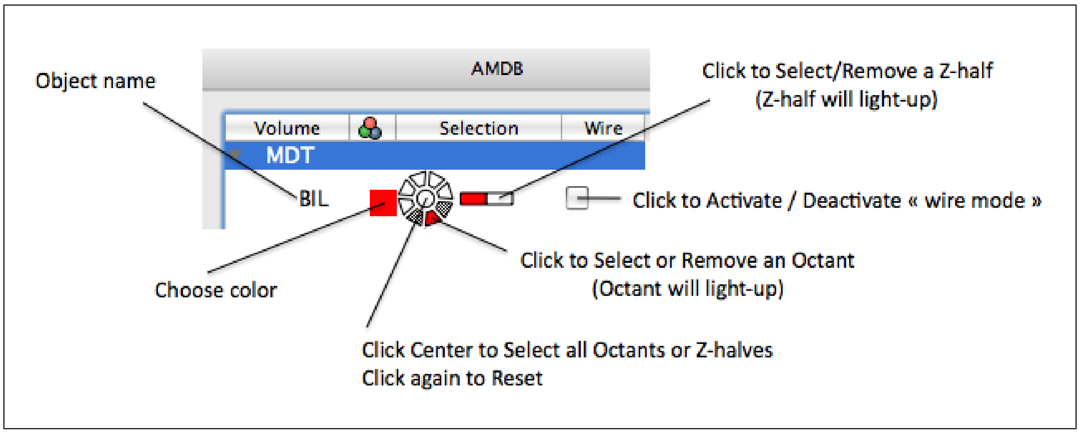


Figure 20: Illustration of the working of the Octant and Z-half selectors

7.2.1 *Draw* `MDT` *muon chambers*

Compute

In the *Selector window*, click on the `MDT` triangle and then in the center of each of the `BIL`, `BML` and `BOL` "wheels". Click on the *Compute* icon in the *Image* tool bar to display the view.
Now we want to simplify the view by choosing the `BIL`, `BML` and `BOL` chambers of the upper (Phi=90°) sector:

Click on the center of each wheel (followed by a click on *Compute*) to erase the view

Click in the corresponding sector of each "wheel", as shown in figure 21a

Click again on the *Compute* icon to display the modified view

The box at the left of the wheel allows you to choose your preferred color, if the default color is not suitable. You may want to try a "pastel" color and click again on the *Compute* icon to display the modified view.
The Wire" box lets you choose between the *full* or *wire* modes. (sections 7.7.3 and 9.6).

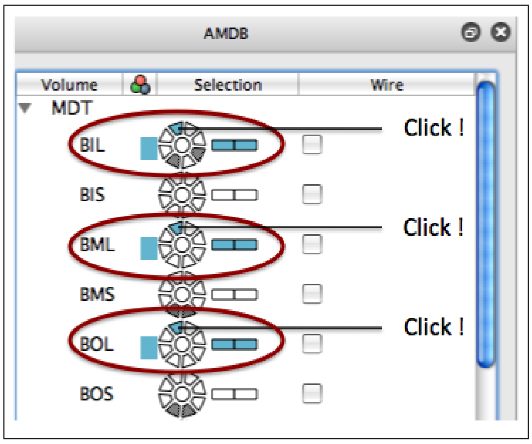
7.2.2 *Draw* `RPC` *muon chambers*

Click on the `RPC` triangle and choose the `BML` and `BOL` chambers of the upper (Phi=90°) sector by clicking on the corresponding sector of each "wheel", as shown in figure 21b. Click on the *Compute* icon to display the modified view. Again, you may want to choose a color.

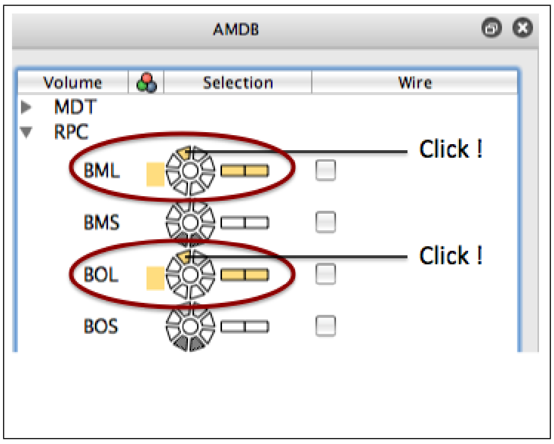
[1]The *AGDD* interface is described in section 7.5.

7.2.3 *Draw Inner Detector*

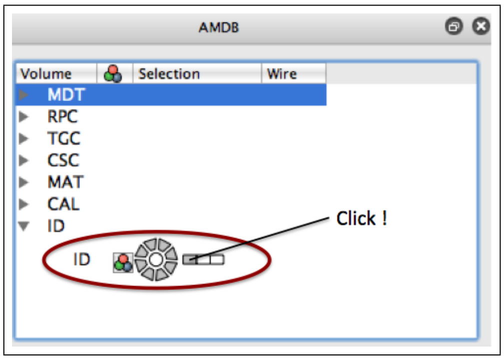
In the *Selector window*, click on the `ID` triangle. Click in the left-most third of the horizontal box, as shown in figure 21c, to select all sectors located at $Z < 0$ [1]. Here we have kept the default color. The view which has been composed appears in the *Main Display* window and resembles figure 21d. Note that it is possible to click the *Compute* icon only once, after having made all selections in succession.



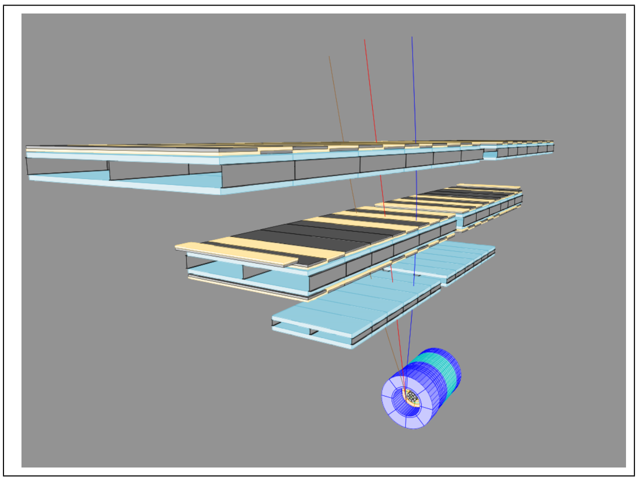
(a) Selection of `MDT` chambers



(b) Selection of `RPC` chambers



(c) Selection of the Inner detector (`ID`)

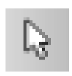


(d) Resulting display. Note the background color (see section 6.4, item 2, page 26)

Figure 21: Illustration of the operations (a,b,c) resulting in the display shown in (d). The selections are highlighted inside a red ellipse.

7.2.4 *Optimizing the view: a first try at navigation*

It is appropriate, at this time, to have a preview of the *Navigation* tool (Fig. 2) in order to place the view at the center of the display, with the proper magnification. To do this, we use the *Navigation* tool bar, in particular the *Default mode* which is the 'magic wand" used most often.



Default mode

Click on the *Default mode* icon of the *Navigation* tool bar.

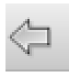
[1] To check if this horizontal box corresponds indeed to $Z < 0$, display the axes of the ATLAS coordinate system by clicking on the *Axes* icon of the *Image* tool bar and choose *e.g.* *Huge axes* in the menu. When done, erase the axes by choosing *No axes*. The coordinate axes are shown in figures 25, 67b, 68, and 69a.

1. Drag the view to the middle of the display with the right button of the mouse pushed down. The displacements can be in any direction in the display.
2. Rotate the central wheel of the mouse to zoom-in or zoom-out, so that the view occupies the whole display.
3. The left button of the mouse is used to rotate the view in 3-dimentional space.

The detailed description of the *Navigation* tool bar is in section 8 and Appendix E.3.

7.2.5 *Starting anew*

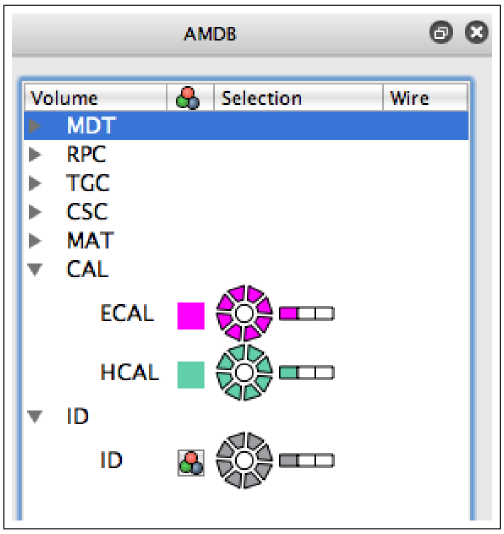
In case the result of an operation (navigation, addition of volumes, etc.) is not satisfactory, the *Previous view* icon allows you to retrieve the view which was displayed before the latest *Compute* step. Up to $\sim$ 100 previous steps can be retrieved.



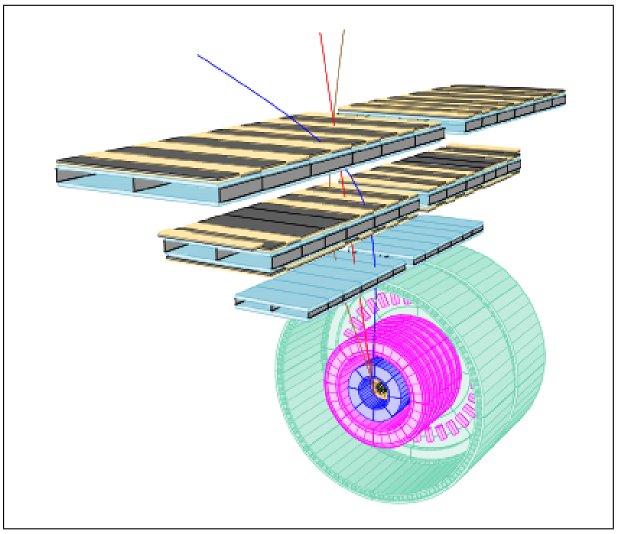
Previous view

7.3 Place the calorimeters

In the *Selector window*, click on the `CAL` triangle and click successively on items in the `ECAL` and `HCAL` lines. Make the selections shown in figure 22a: select the left-most rectangle to display the $Z < 0$ part of the calorimeters and choose the colors. The resulting display is shown in figure 22b.



(a) Selection of `ECAL` and `HCAL`



(b) Resulting display. Note that, contrary to figure 21d, the background color has been set to "white" in the *Image / Background color* menu

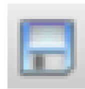
Figure 22: Additional selections (a) resulting in the display shown in (b).

Comparing figure 21d and figure 22b, one notices that when the material of the calorimeters is included (Fig. 22b), the two low momentum tracks, generated with 4 GeV at the IP, are bent more by the magnetic field, because of the energy loss in the calorimeters ($\simeq 3$ GeV on average) is now taken into account. [1]

[1]The energy loss is taken into account as soon as one element of the calorimeter is chosen in the *Selector window* even if the track does not cross the element which is displayed, as in figure 22b.

7.4 Save files for future use

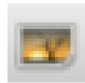
Let us suppose you must now interrupt your work.
In order to be able to retrieve, at any time, the view displayed in figure 22b, save it as a `.p2vf` file to a directory of your choice (e.g. *persint-working-files*, as suggested in section 6.1). This is done with the *Save view as* icon of the *File* tool bar.



Save view as...

The saved view, *e.g.* `exercise2.p2vf`, only contains the detector volumes. It is necessary to also save the generated muons as a `.p2gm` file from within the pop-up menu of figure 19. If not already done, open the *Muon generation* pop-up window and save the parameters by clicking on the Save box. You may again choose the *persint-working-files* directory to store the saved `exercise2.p2gm` file.

You may also want to export the view in order to use it for a presentation: use the *Export* icon of the *File* tool bar to save it, e.g., as *my-presentation.png* to the *persint-export-files* directory.



Export...

7.5 Place inert material using the AGDD interface

With the AGDD pane in the *Selector* window, one selects the inert material to be displayed [1]. In figure 23, we have displayed one of the two endcap toroids, the rail assembly, and the saddle for the barrel calorimeters.
Selections in the AGDD pane can be made at several levels of detail, according to the tree structure which is provided.

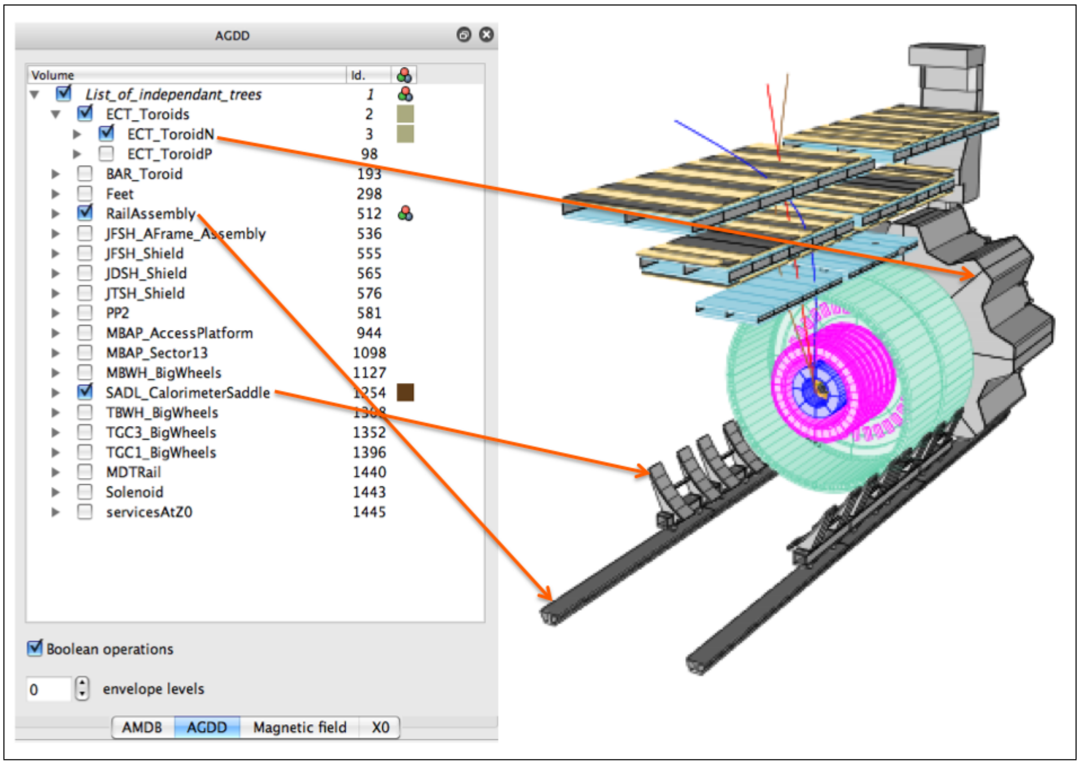


Figure 23: Selections made in the AGDD pane to obtain the modified display.

7.6 The *Dead material* function

The *Dead material* function is used for taking into account dead material traversed by tracks, even when the material is not selected for display.

[1] Calorimeters (`ECAL`, `HCAL`) and the inner detector (`ID`) are accessed with the *AMDB* pane.

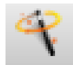
7.6.1 *Preparing the working view*

If you resume work with a new session of *Persint*, you want to display the view of figure 22b. When starting *Persint* anew, the view which was in use in the previous session is reloaded, provided you answer [Yes] in the initial pop-up window (Figure on page 16). This is because the current view is automatically saved when quitting *Persint*. In any case, the view may be retrieved since it was saved as `exercise2.p2vf` in section 7.4 by clicking on the *Open view* icon. Using the window which opens, choose the file `exercise2.p2vf` in the *persint-working-files* directory and click on [Open].

Open view...

You must also load the file containing the generated muon tracks which was saved as `exercise2.p2gm`.

> Click on the *Generate muon tracks* icon and, in the *Muon generation* window, click on the [open] box to retrieve the `exercise2.p2gm` file saved in your *persint- export-files* directory. [1]



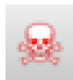
Generate muon tracks

If necessary, click on the *Compute* icon. Figure 22b should now be displayed.

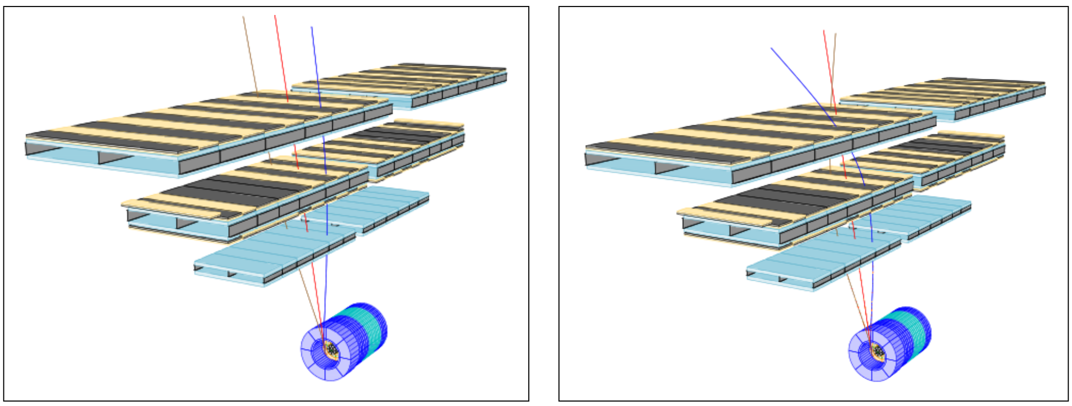
Compute

7.6.2 *Use of the Dead material function*

We now have figure 22b as working display, with the detectors and the 3 generated muon tracks. Note the visible curvature of the 4 GeV tracks, as they loose energy in crossing the calorimeters.
We will now remove the calorimeters from the display: in the `AMDB` pane of the *Selector* window, in the `CAL` arborescence deselect `ECAL` and `HCAL` by clicking in the center of the two wheels (see Fig. 22a). When hitting the *Compute* icon of the *Image* menu, the tracks now appear less curved, *i.e.* without the energy loss.
The energy loss can however be restored by clicking on the *Use all dead matter* icon of the *Events* menu. With this icon one can switch to displaying the muons with or without energy loss, even though the calorimeters are not shown in the display. This feature comes in handy for showing realistic muon tracks when material must be ommitted for clarity of the view.



Use all dead matter



(a) Muon tracks without energy loss in dead matter (b) Muon tracks with energy loss in dead matter

Figure 24: Display of figure 22b, but where the calorimeters are not selected for display. *Use displayed dead matter only* has been selected in a), *Use all dead matter* in b).

[1] If this file was not saved, it is easy to generate the muon tracks again, as indicated in section 7.1.

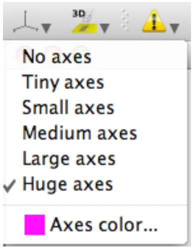
7.7 Look at the event in detail

In this section, we will continue work with figure 22b. If necessary, restore that view as shown in section 7.6.1. We will look at the ATLAS coordinate system, produce a projected view, and finally zoom-in to look at the MDT tubes in detail.

7.7.1 *Show ATLAS coordinate system*

The ATLAS coordinate system is shown in Appendix C (Fig. 132).

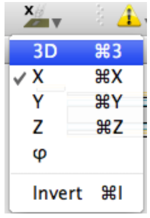
1. Click on the arrow of the *Axes* icon and choose *Huge axes*.
2. Click on the arrow of the *Projection* icon and choose *Invert*.
   The view is inverted with respect to the Z axis.
   Go back to the original orientation by repeating the *Invert* operation.
3. Erase the axes by clicking on the *Axes* icon again and choose *No axes*.



Axes

7.7.2 *View the event in the X-projection*

Click on the arrow in the *Projection* icon and choose *X*.
A projection perpendicular to the X-axis is displayed, in the (Y, Z) plane (Fig. 25).



Projection

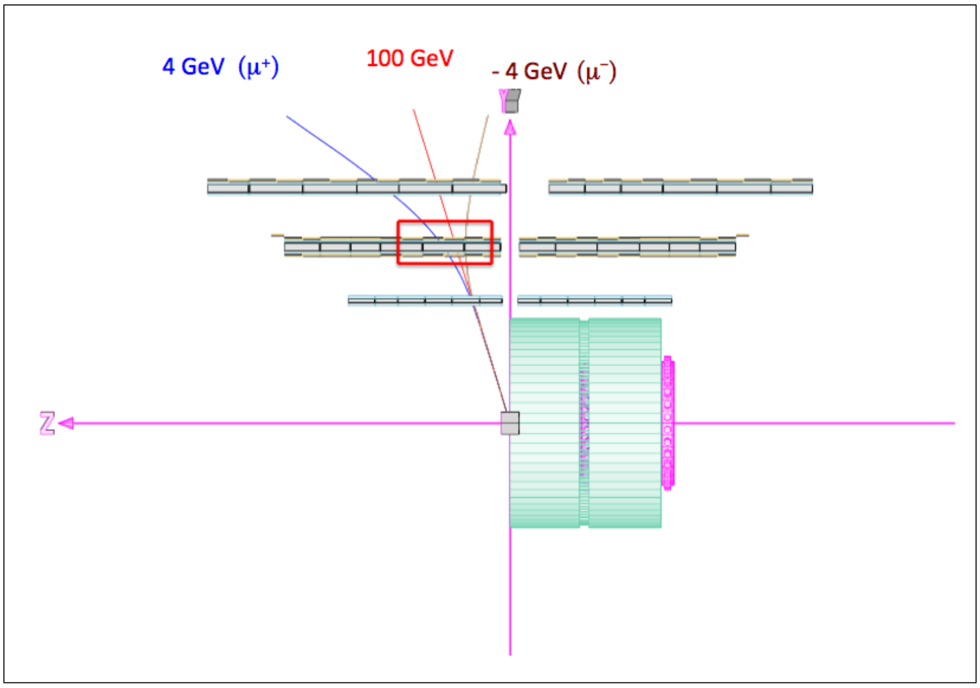
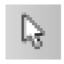


Figure 25: Resulting X-view from manipulations in section 7.7.2. The energy labels have been added by hand. See section 9.1.2 for labels generated by *Persint*.

7.7.3 Zoom-in on muon chambers



Default mode

1. Select the *Default mode* in the *Navigation* tool bar and, with the "wheel" ("central button") of the mouse pushed down, select a region in the `BML` chamber including the two tracks as shown by the red rectangle in figure 25.

2. In the *Selector window*, choose the ``` ``MDT options'' ``` tab and check the boxes as shown in figure 26a.
   Choose the ``` ``RPC options'' ``` tab and check the boxes as shown in figure 26b.

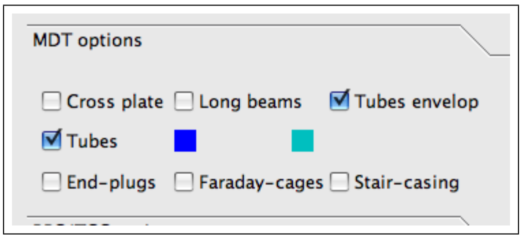
3. Click on the *Compute* icon.

4. Note that the selections can be made to produce displays in the *solid* or *wire* modes.

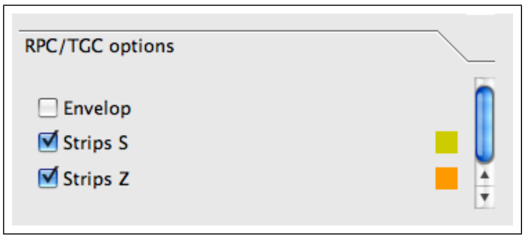
    means: item displayed in solid mode

    means: item displayed in wire mode

    means: item not displayed



(a) Selected *MDT options*



(b) Selected *RPC options*

Figure 26: Selections made in the *Option tabs* in the *Selector window*

A view similar to figure 27 should be displayed. It shows the three generated muon tracks crossing the two layers of MDT tubes and RPC Z-strips, in the BML station [1] . The two colors of the tubes alternate every 8 tubes (for easier tube identification) and can be chosen in the ``` ``MDT options'' ``` of the *Selector window* (Fig. 26a.). The red open squares represent the centers of multiple scattering used by the program.

The display in figure 27 can again be saved as a `.p2vf` file into one of your working directories (use the *Save view* icon). It can be retrieved with the *Open view* icon. The same is true for the generated tracks: they can be saved as a `.p2gm` file and retrieved by opening this file inside the *Muon generation* window opened with the *Generate muon tracks* icon (see section 7.6.1).

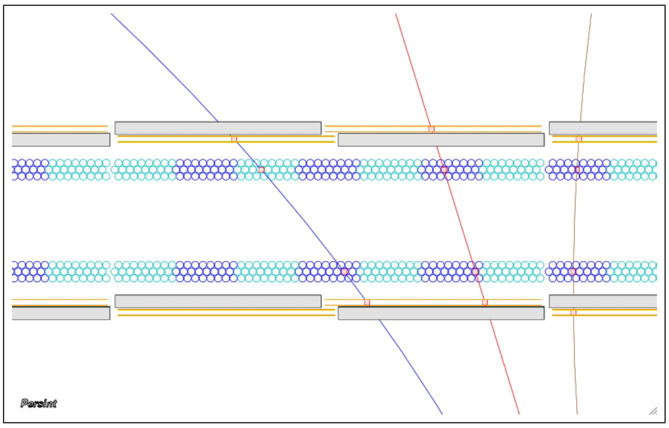
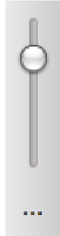


Figure 27: Resulting X-view from manipulations in section 7.7.3.

[1] A detector station is the mechanical entity holding several layers of detector planes. For example, a BML MDT station is made of two triplets of drift tubes (see fig. 27).

8 Exercise 3: Practicing *Navigation*

The interface to the various graphics applications of *Persint* is provided by the *Navigation tool bar* on the right hand side of the display (Fig. 2 and Appendix E.3). Its functions allow spatial navigation and modifications of the visualization properties.



Navigation scale

The desired perspective is obtained by changing the viewing point and the viewed point, by changing the focal length of the observer eye. The view may be rotated, displaced, enlarged or made smaller (Zoom). For *Zoom in/out* and *Rotation*, the amplitude of movements can be chosen with the *Navigation scale* gauge.

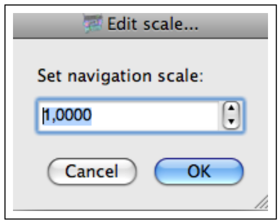


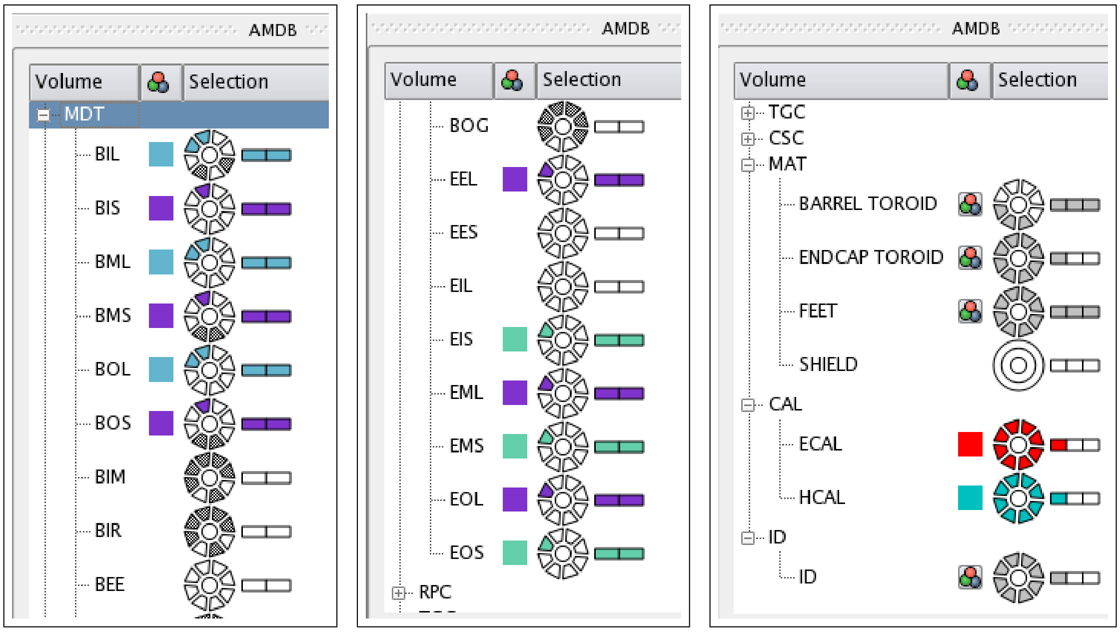
Figure 28: The scale can be changed by moving the cursor or by opening the *spinbox* with a click on the three dots (...), and setting the scale with the keyboard. The default value of 1.0000 is displayed.

8.1 Preparing the working view

In this section, we will learn to use the spatial navigation tools and start with the view which was saved as `exercise2.p2vf` in the previous exercise (section 7.4, Fig. 22b).

Start the *Persint* application and click on the *Open view* icon of the *File* tool bar. Load the `exercise2.p2vf` file, from the *persint_working_files* directory. The view of figure 22b is now displayed.

Open view...



(a) Barrel MDTchambers (b) Endcap MDTchambers (c) Selection of toroid coils and feet

Figure 29: Additional choices made in the *Selector window* to display the muon spectrometer

From the *Selector window*, add a second adjacent large sector and one adjacent sector of small MDT chambers (fig. 29a) and a few endcap MDT chambers (Fig. 29b). Check the result by clicking on the *Compute* icon. Three barrel toroid coils [1], one of the endcap toroids, as well as the detector feet are added when the selection shown in figure 29c are made[2]. When clicking on the *Compute* icon, the view of figure 30 is displayed.

[1]The toroids can be displayed in much more detail using the `AGDD` pane of the *Selector window*.
[2]Note the selections of `HCAL`, `ECAL`, and `ID` associated with the selections already made in exercise 2.

Before starting with the navigation, save the view for future use: click on the *Save view as* icon and save the view as `Exercise3.p2vf` into the *Persint_working_files* directory.

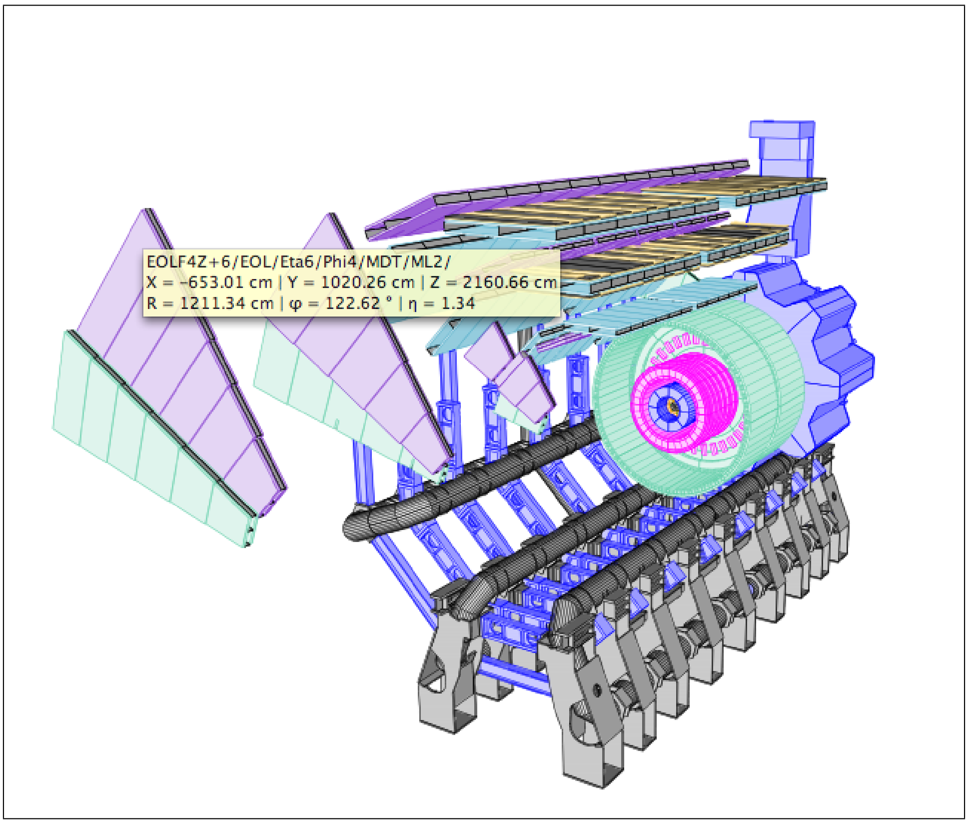
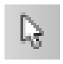


Figure 30: Detector layout resulting from the additional selections made in Exercise 3. The information box is obtained by positioning the cursor on the chosen volume `EOLF4Z+6` (see section 9.1.1).

8.2 The *Default mode*: a magic wand



Default mode

The *Default mode* is the most powerful function of the *Navigation tool bar*. With this icon selected, all three buttons of the mouse can be used to perform the most frequent navigation actions, as we have already seen in section 7.2.4.

1. The **left button** of the mouse is used to rotate the view in 3-dimentional space. Keep the left button pushed down and move the cursor anywhere inside the display. Start with simple movements, *e.g.* horizontal, vertical, and then use more complex movements. The actions and results are very much intuitive.

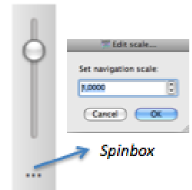
2. Rotate the **central wheel** of the mouse to zoom-in or zoom-out. Practice by making successive reverse zooms to the view.

3. With the **right button** of the mouse pushed down, the view can be translated in any direction inside the display.

4. By pushing the **central wheel** down (without rotating it), one selects a rectangular zone to be zoomed, as already exercised in section 7.7.3 (Fig. 25). This action is called *Zoom on custom area*.

5. By pushing and releasing the right button of the mouse on any detector volume, a pop-up menu is displayed from which various operations on the volumes can be performed. These operations include moving volumes, adding labels, captions, or pictures, and are described in section 9.

Note that the amplitude of the first two actions (rotation and Zoom in/out) can be tuned with the *Navigation scale*. Remember that the scale can also be set with the *Spinbox* accessible with a click on the [...] of the *Navigation scale* icon.

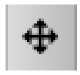


Navigation scale

8.3 Single functions

The 5 functions described below can all be performed with the *Default mode* icon (the magic wand) and are in fact redundant. However, when repeating the same action many times, it may be advantageous to use a single function.

1. Translation
   Activate the *Translation* icon and use the left button of the mouse to translate the view in any direction.


Translation

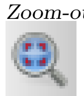
2. Zoom-in
   Activate the *Zoom-in* icon and click on the left button to zoom-in on the view.


Zoom-in

3. Zoom-out
   Activate the *Zoom-out* icon and click on the left button to zoom-out on the view.


Zoom-out

4. Zoom on custom area
   Activate this icon and use the left button to select a region (red rectangle). When the button is released, the zoom of the selected rectangle is performed.


Zoom on custom area

5. Rotation
   Activate this icon and use the left button to rotate the view around the center point of the display, with the appropriate movements of the cursor.


Rotation

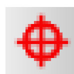
8.4 More functions

The remaining functions of the *Navigation* tool bar are:

1. Initial Zoom
   Activate the *Initial zoom* icon with the left button to retrieve the original zoom parameters. Note that if this function is used on a projected view (*e.g.* X-view), the *Initial zoom* action brings back the 3-D view.

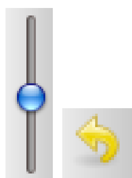

Initial zoom

2. Set center
   Selecting the *Set center* icon and then clicking on a given volume centers the view on that volume [1]. The point around which a view is rotated is chosen in this way.


Set center

3. Navigation scale
   As already mentioned, with this function it possible to change the amplitude of two navigation actions: *Rotation* and *Zoom in/out*.

4. Focal length
   The nominal focal length is 35 mm. It can be changed with the cursor of the *Focal length* icon, and set back to the nominal value with the *Reset focal length* icon.

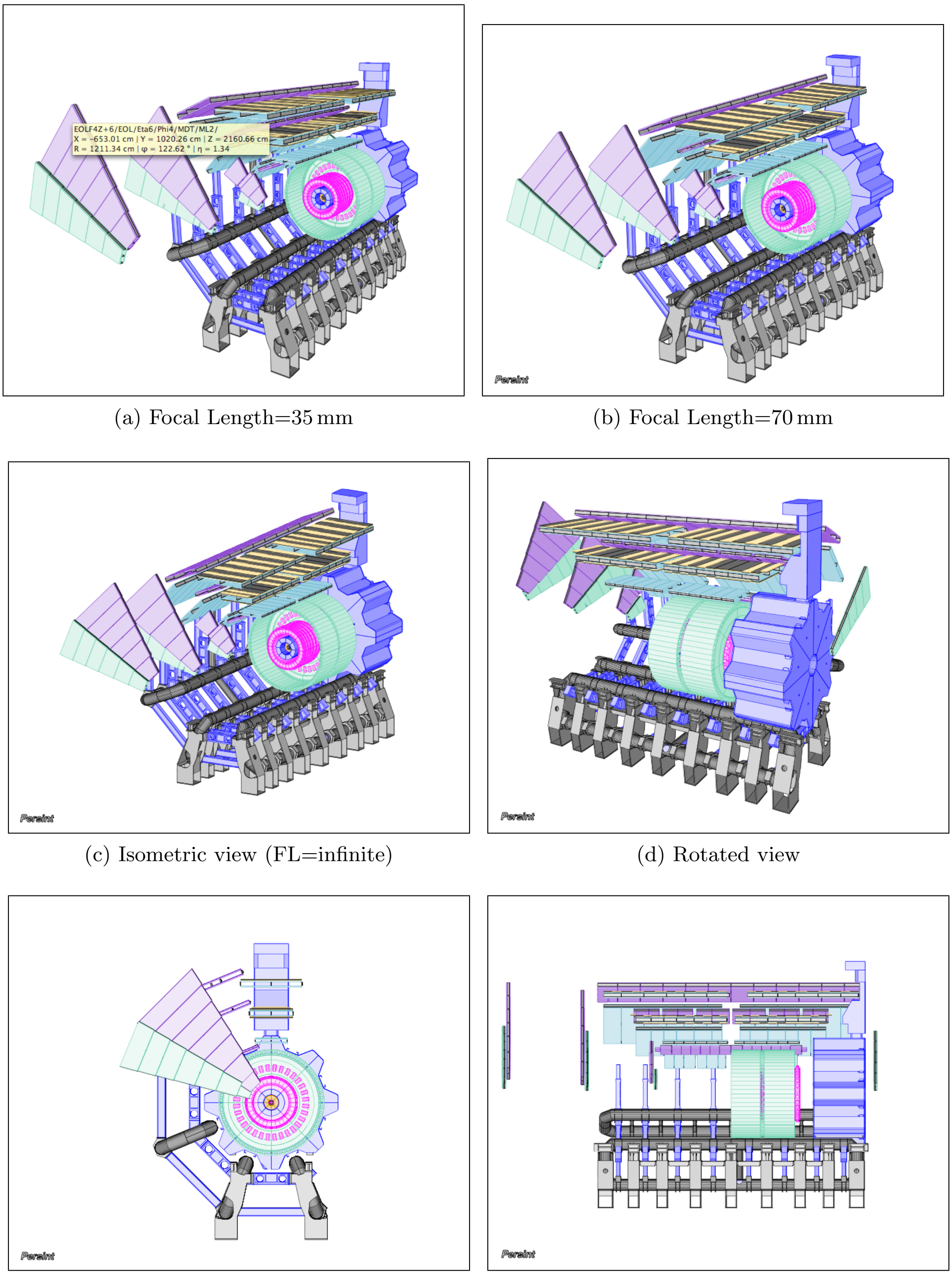

Focal length and Reset icons

5. Isometric view
   By clicking on this icon, one produces an isometric view (infinite focal length). To return to the previous focal length, click on the icon again.


Isometric view

Some results of using these functions are shown in figure 31, where the same volumes are shown with different perspectives.

[1]This action is more efficient (faster) than using the *Translation* function.



(a) Focal Length=35 mm

(b) Focal Length=70 mm

(c) Isometric view (FL=infinite)

(d) Rotated view

(e) Z projection

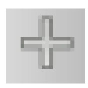
(f) X projection

Figure 31: Defining the viewing perspective

The two remaining functions will be explained in the next exercise (Section 9).

1. Volume information
2. Selection mode

Volume information



Selection mode

9 Exercise 4: Exploring more features

Open view. . .

We start with the view saved at the end of exercise 3. Click on the *Open view* icon and open the file `Exercise3.p2vf` from your *Persint_working_files* directory. This should display the view of figure 30.

9.1 Volume information labels

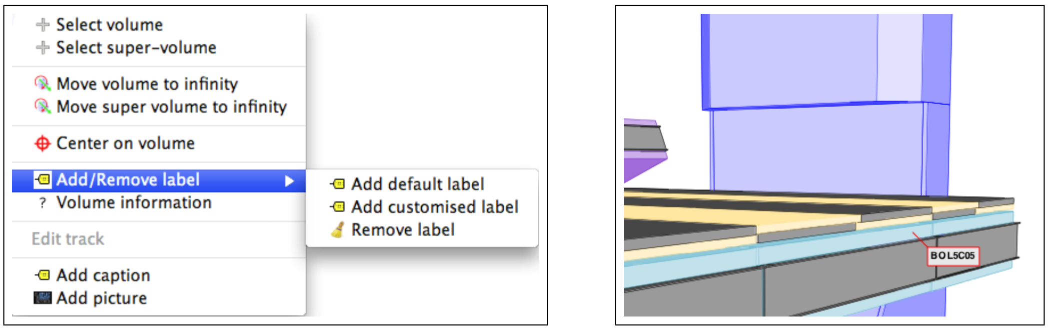
9.1.1 *Volume identification with information boxes*

You will have noticed that by positioning the cursor on a volume, an information box is shown which displays the identity of the volume and its geometrical parameters. It is a convenient feature to identify any volume in the layout.

9.1.2 *Label maker*

When saving displays to be used for publications or presentations, it is useful to be able to also display the volume parameters (volume identification, position, . . .) and an explanatory text. This is achieved with a feature which makes labels, as explained below. [1]

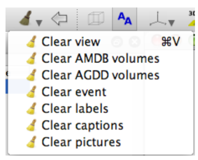
1. ***Default labels***
   By `right-clicking` on a volume (in this case a MDT chamber) [2] and releasing the button, one produces the pop- up window of figure 32a. Choose [Add/Remove label] / [Add default label] to obtain the default label which displays the "Hardware name" of the chosen muon chamber (BOL5C05) [3], as shown in figure 32b. If the geometry file does not provide the "Hardware name" the "Software name" is displayed.



(a) Pop-up window when `right-clicking` on a volume in the *Display window*.

(b) Default label for a MDT chamber

Figure 32: Making a *Default label*



labels

Reload event

   To remove the default label, repeat the operation by `right-clicking` on the same volume and choose [Remove label]. The *Clear labels* function of the *Image* menu clears <u>all</u> labels in the display. The *Reload event* function has the same effect.

2. ***Customized labels***
   The label can be customized by clicking [Add customised label] (figure 32a). In the window which opens (Fig. 33), the complete *Volume information* appears and room for *Additional text* is provided.

[1] Labels are saved when using the *Export View. . .* and *Save view as .p2vf file. . .* functions.
[2] Track labels are obtained with the same procedure, by clicking on the tracks (Fig 64 in section 10.5).
[3] BOL: **B**arrel **O**uter **L**arge chamber; 5: 5^{th} chamber from $|Z|=0$; C side $(Z<0)$ [A side $(Z>0]$; 05: sector number. **See reference [6] for conventions on chamber numbering.**

The *Customized label* has 5 lines of information:

(a) Hardware name of the chamber (EOL6A07)
(b) Software name of the chamber.
(c) X,Y,Z coordinates of the cursor.
(d) R, φ, η coordinates of the cursor.
(e) Magnetic field (B_x, B_y, B_z)

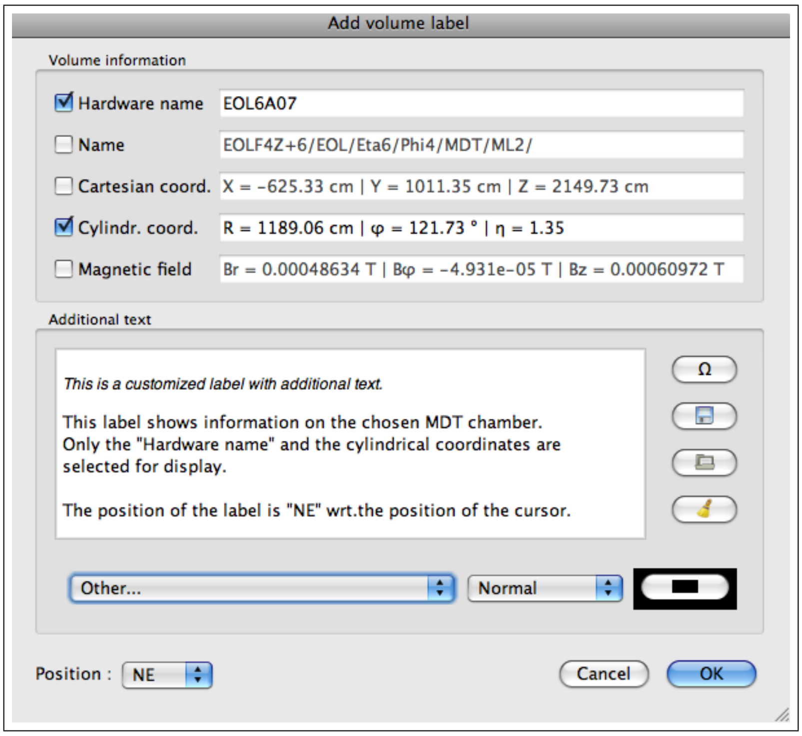


Figure 33: Pop-up window when choosing *Customised label* in the window of figure 32a.

It is possible to place the label at four different positions with respect to the cursor position (SE, SW, NW, NE). Click on OK, after having chosen “NE”; the customized label of figure 34 appears in the NE position.

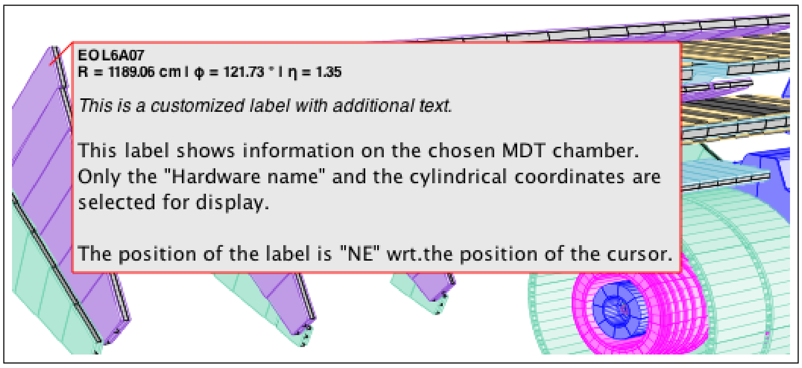
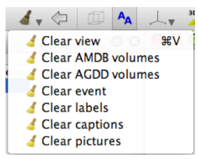


Figure 34: Custom label for an endcap MDT chamber

To remove the customized label, repeat the operation by `right-clicking` on the same volume and choosing Remove label. The *Clear labels* function clears all labels in the display. The *Reload event* function has the same effect, if indeed an event is displayed.

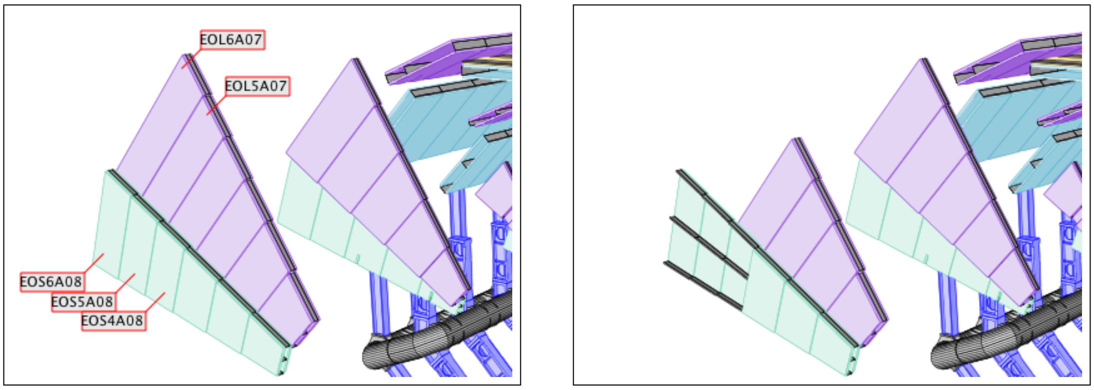


Clear labels

Reload event

9.2 Hide/Displace volumes or super-volumes

There are several ways to remove a volume or super-volume from the display. Technically this is done by setting the coordinates of a volume to very high values, thus the term “Move to infinity” used in the relevant functions.



(a) Partial display of the initial layout of endcap chambers

(b) Partial display after the hiding of 3 volumes and 2 super volumes

Figure 35: Hiding volumes and super volumes

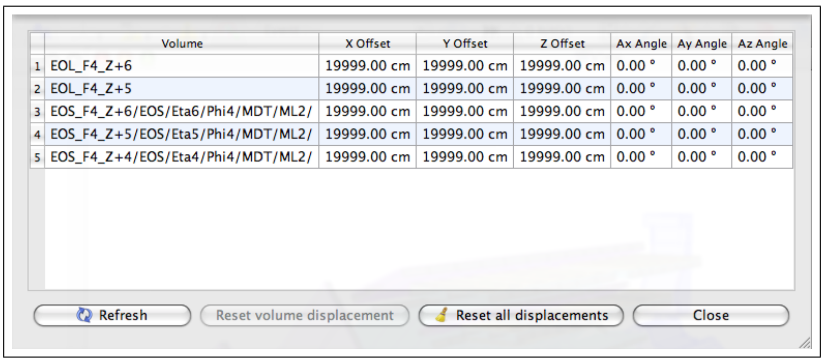
9.2.1 *Hide volumes*

The simplest way to hide a volume is to `right-click` on a volume, release the button and choose [Move volume to infinity] or [Move super volume to infinity] in the pop-up window (Fig. 32a). In the following example, we proceed to hide MDT endcap chambers: 3 volumes and 2 super modules in two neighboring sector. The procedure is simply repeated for each chosen volume (5 operations). Figure 35 shows a partial display of the initial layout and the result of the hiding. [1]

In order to restore the initial layout, simply click on *Displaced volumes* of the *Volumes* menu. In the pop-up window (Fig. 36), choose [Reset all the displacements] and click on [Close] : the initial view is restored.

Displaced volumes

It is also possible to individually select the volumes to be returned to the display by selecting each volume in the pop-up window (Fig. 36) and clicking on [Reset volume displacement] . The action takes place when the [Close] box it clicked on.



	Volume	X Offset	Y Offset	Z Offset	Ax Angle	Ay Angle	Az Angle
1	EOL_F4_Z+6	19999.00 cm	19999.00 cm	19999.00 cm	0.00 °	0.00 °	0.00 °
2	EOL_F4_Z+5	19999.00 cm	19999.00 cm	19999.00 cm	0.00 °	0.00 °	0.00 °
3	EOS_F4_Z+6/EOS/Eta6/Phi4/MDT/ML2/	19999.00 cm	19999.00 cm	19999.00 cm	0.00 °	0.00 °	0.00 °
4	EOS_F4_Z+5/EOS/Eta5/Phi4/MDT/ML2/	19999.00 cm	19999.00 cm	19999.00 cm	0.00 °	0.00 °	0.00 °
5	EOS_F4_Z+4/EOS/Eta4/Phi4/MDT/ML2/	19999.00 cm	19999.00 cm	19999.00 cm	0.00 °	0.00 °	0.00 °

Figure 36: Pop-up window showing displaced volumes

[1] The labels in figure 35a are produced as explained in section 9.1.2

9.2.2 *Hiding volumes, the fast way with Selection mode*

Selection mode

If a number of volumes or super volumes must be hidden, there is a fast and efficient way to do so with the *Selection mode* of the *Navigation* tool bar.

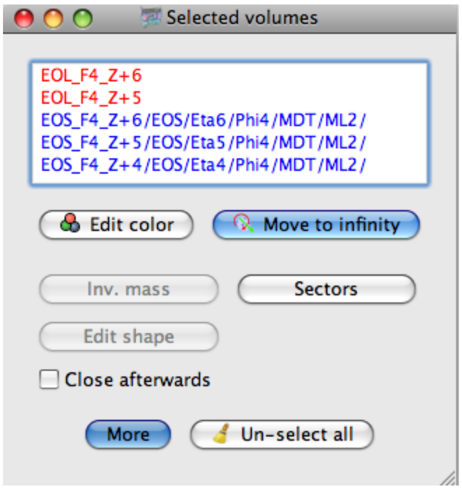


Figure 37: *Selected volumes* window

Click on the *Selection mode* icon of the *Navigation* tool bar and click on the volumes or super volumes to be displaced. The list of selected items appears in the *Selected volumes* pop-up window, shown in figure 37.

A `left-click` selects a volume (in blue).

A `right-click` selects a super volume (in red).

Use the Move to infinity button to hide the (super) volumes listed in the window. Note that volumes to be hidden can also be selected using the functions available in the window shown in figure 32a. This window is obtained by `right-clicking` on a volume, the *Default mode* being selected in the Navigation tool bar. In this case, the list of volumes to be hidden is made by choosing *Select volume* or *Select super volume*. The color of all selected volumes and super volumes can be changed with the *Edit color* button. *Un-select all*, can be used to clear the entire list. With the *Sectors* button, one makes a selection of sectors (see also 10.3). The *More* button gives access to two more functions concerning "ATHENA reconstructed tracks": *Inv. mass* (see 11.1.3) and *Edit shape* (see 11.1.1 and 11.1.3).

9.2.3 *Displacements of volumes*

Volume information

It is possible to change the display parameters of volumes by selecting the *Volume information* icon in the Navigation tool bar and clicking on the volume to be altered.

This opens the *Modify volume* window shown in figure 38.

The functions used most often are:

1. Selecting a volume or super volume by clicking on the appropriate button.
2. Changing the color of the volume/super volume.
3. Hiding volume/super volume (*i.e.* "Move to infinity"), a function already performed by other means (section 9.2.1).

Click on OK to view the changes made to the selected volume.

The two other features (Translation and Rotation) were used extensively during the design of the muon spectrometer and during the commissioning phase with cosmic rays. The development of the reconstruction software also benefited from this tool.

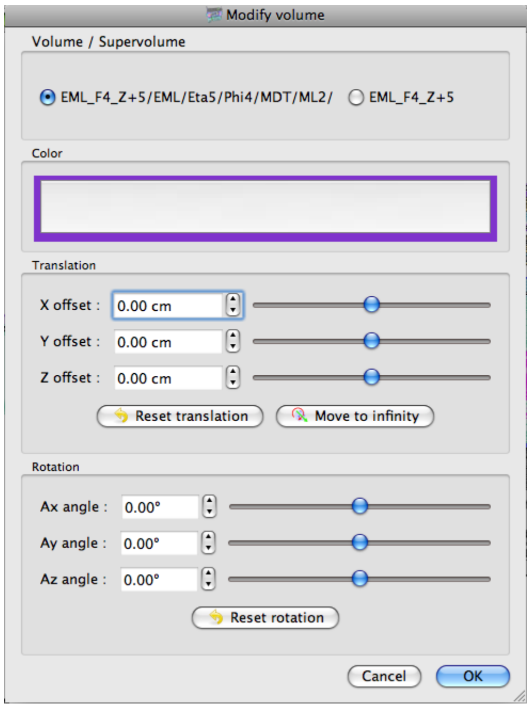


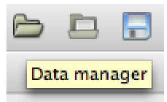
Figure 38: *Modify volume* window

9.3 Compare geometries

The comparison of displays obtained with different geometries can be performed with the *Save special...* function described in section 6.4. Below are two figures which illustrate its use. They were obtained with two different geometries of the supporting structure of ATLAS (the "feet"). The following exercise is done with a pre-loaded `.p2vf` file located in the directory *Persint-00-02-●●/example*. It can be repeated with any other `.p2vf` file of your choice.

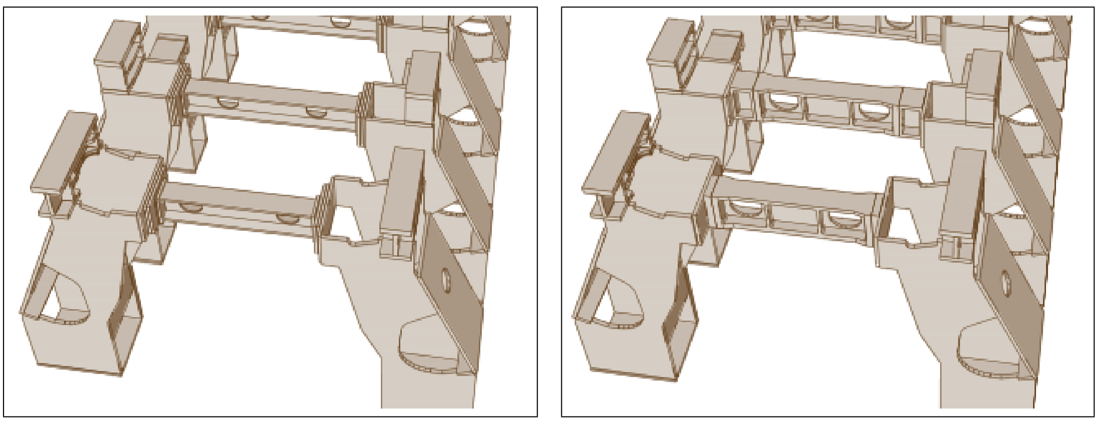
Open view...

1. First, using the *Open view* function, we display the feet structure by loading the relevant file `compare_persint_views.p2vf`, located in the directory *Persint-00-02-●●/ example* . The expected geometry is `amdb_simrec.r.04.01` and should be loaded by choosing [Yes] in the warning box. This geometry file is located in the `Persint-00-02-●●/ AmdcData/share` directory.
   When the ATLAS "feet" are displayed, we perform a zoom to get figure 39a. By using the *Save special...* function of the *File* menu and answering [No] to the prompt, the `.p2vf` file is saved into the `$HOME/.persint` directory and an image file *persint-view-000.png* is written into the same directory.



2. We now change the geometry description. Click on the *Data manager* icon of the *File menu* and choose the *Volumes* tab. Click on [Load] and choose the new geometry file `amdb_simrec.r.03.01.Initial.Light.EIL.BML.S13.Patch`.[1] Close the *Data manager* window. We now want to load the `compare_persint_views.p2vf` file again to display it with the new geometry. Proceed as above, using the *Open view* function. Answer [No] in the warning box in order to use the new geometry, and not the geometry expected by the `.p2vf` file. Ignore the `AGDD` warning. Perform a zoom to obtain figure 39b. Use the *Save special...* function of the *File* menu again, answer [No] to the prompt, and the new display is saved as *persint-view-001.png* into the `$HOME/.persint` directory.

3. These two `.png` images are now available for comparisons. Toggling between the two images, *persint-view-000.png* and *persint-view-001.png* shows the differences: there is less material in the first.



(a) First feet geometry (b) Second feet geometry

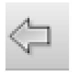
Figure 39: Two "feet geometries" to be compared.

[1]Geometry files of the `amdc _simrec` type are available in the `Persint-00-02-●●/AmdcData/share` directory.

9.4 Detect volume clashes

This feature was used extensively during the building of the geometry files (GeoModel). It is not commonly used, except by developers of geometry data bases. For completeness, its functioning is explained below.

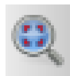
We continue working with the display of figure 35a, which should be the current view. If not, you can use one of the following three methods to get this view back:



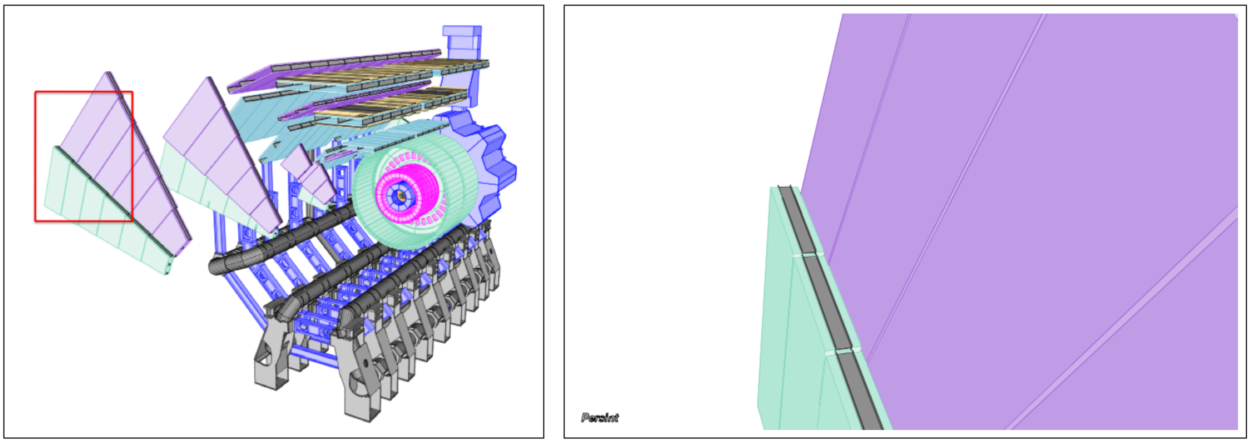
Previous view

- Use the *Previous view* function of the *Image* tool bar once or several times.
- In the pop-up window of *Displaced volumes* (Fig. 36) click on [Reset all the displacements] and then on [Close].
- If the view has been saved, as indicated in section 8.1, use the *Open view* function to load the saved `Exercise3.p2vf` file.

We now want to displace a volume to produce a clash between two volumes.
In the active display (Fig. 40a), zoom on the area shown in red by using the *Zoom on custom area* of the navigation tool bar. We obtain figure 40b.



Zoom on custom area

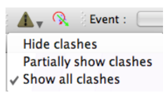


(a) Starting display (same as Fig. 30) (b) Detailed view of end cap MDT chambers after zoom

Figure 40: Displays used for detecting clashes

1. `Right-click` on the EOL chamber [1] (the violet volume) and choose *Volume information* in the pop-up window [2].
2. In the *Modify volume* window, select the *Supervolume* `EOL_F4_Z+6` and set the *Ax angle* to 6 degrees, as shown in figure 41a. After performing a *Zoom*, we obtain figure 41b.
3. To identify the clashes resulting from the rotation, click on *Clashes* in the *Volumes* menu (down arrow) and check *Show all clashes*.
   Click on the *Clashes* triangle to open the *Clashes* window which lists the 5 pairs of volumes which present a clash (Fig. 42a).
   The list of clashes can be saved as a `.txt` file with [Export], or stored for future comparisons within *Persint* with the [Store] box. The default name is `"Backup no.1"`.

Volume information

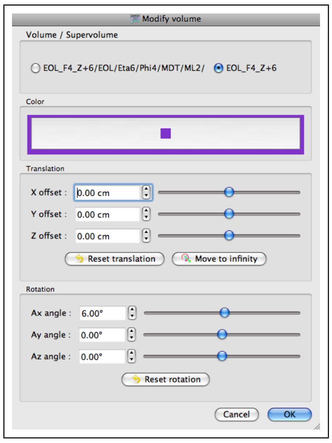


Clashes

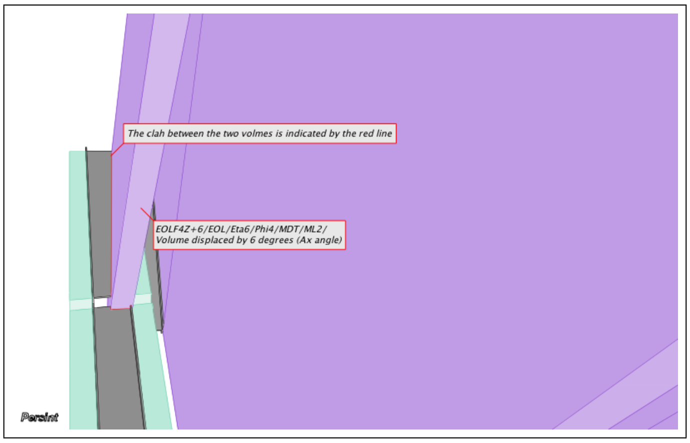
Clashes

[1] Remember that a volume can be identified by positioning the cursor on it, in order to activate the information box (see section 9.1.1).

[2] Alternatively, you can select *Volume information* in the Navigation tool bar, and click on the volume.



(a) *Modify volume* window for rotating chambers



(b) BOL volume displaced by 6°; the clashes are in red

Figure 41: Rotate EOL chamber by 6°

4. We now change the rotation of the same EOL chamber to 3° (instead of 6°) by changing the value in the *Modify volume* window of figure 41a.

   After having closed the window with OK, click on the *Clashes* triangle to display again the clashing volumes: only two clashes are left.

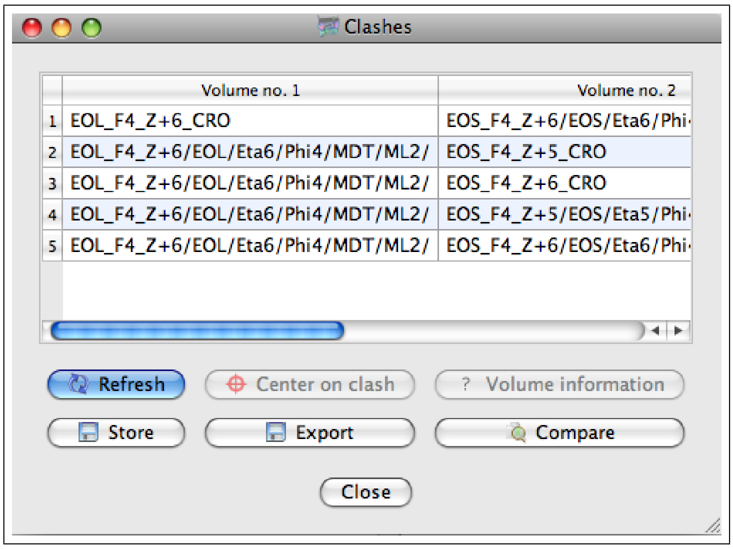
   

   Clashes

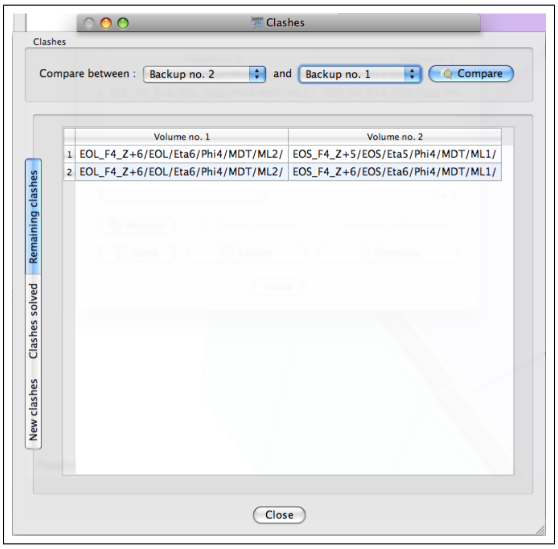
   Again, the list of clashes can be saved as a `.txt` file with the Export box, or stored for future comparisons within *Persint* with the Store box. This time the default name is `"Backup no.2"`.

5. Finally, we can compare the two stored geometries. In the *Clashes* window, click on the Compare box. In the window which appears (Fig. 42b), select the two stored files `"Backup no.2"` and `"Backup no.1"` and click on Compare.

   Use the tabs on the left hand side to perform the comparisons:
   Remaining Clashes Solved Clashes New Clashes



(a) *Clashes* window when EOL is rotated by 6 degrees.



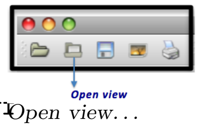
(b) *Result of comparing clashes*

Figure 42: Compare clashes for two geometries

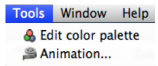
9.5 Animation

It is possible to produce an animation of a displayed view. Parameters such as amplitudes of rotation and zoom, number of iterations can be chosen. The generated frames can be used as input for video software.

You may use any view made with *Persint*, but for simplicity, we start with the view of figure 30. Choose the function *Open view* of the *Image* menu. Open the file `Exercise3.p2vi` in the directory *Persint_working_files* where it was saved in section 8.1.



Open view. . .



Animation

Choose *Animation* in the *Tools* menu. In the *Generating animation* window which opens (figure 43), choose the parameters, *e.g.* those indicated in the caption below.

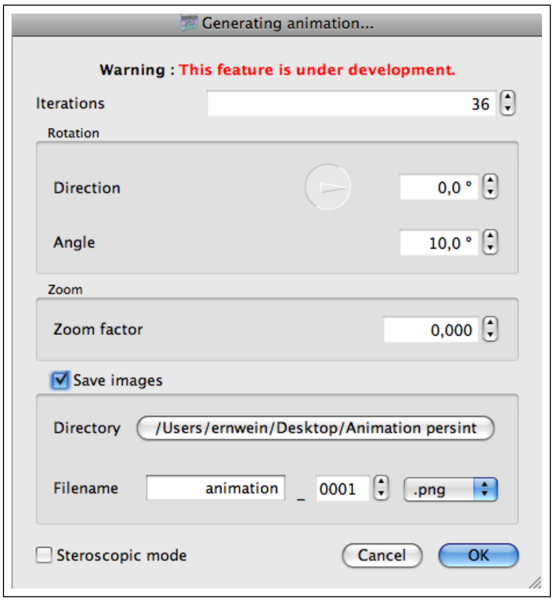


Figure 43:
The parameters are:
- Number of steps (iterations)
- The parameters of the motion (Direction and angle of rotation; Zoom factor)

Options:
- Save images
If the generated frames are to be saved, check the *Save images* box (the default is "no save"), choose the Directory, the filename and the format (extension `.png`, `.bmp` or `.jpg`)
- Stereoscopic mode

Clicking on the OK box will start the animation. With the parameters chosen (Fig. 43), the view rotates in 36 steps of 10 degrees, for a complete revolution.

The *Save images* box having been checked, 36 files are saved in the specified directory for future use by video software. With the *Stereoscopic mode* enabled, the number of saved frames would be doubled.

9.6 Wire mode

The wire mode exists in two flavors:

1. Global Wire Mode.

   In the *Wire mode*, the program bypasses the time-consuming computation of hidden faces and volume intersections. This results in a much faster processing of the view for display and optimal fluidity in the displacements.
   It can therefore be advantageous to switch to the wire mode when making complex navigations, and go back to the full volume display when finished.

Wire mode

2. Partial Wire Mode.

   By checking the appropriate box in the "Wire" column in the *Selector window*, groups of volumes can be displayed in the full or in the wire mode. This function is used to make certain volumes "transparent" in order to get a view "inside" the detector.

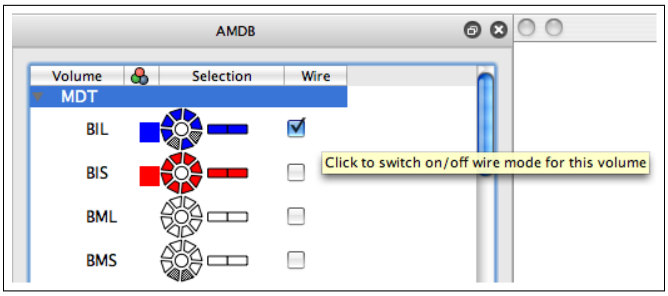


Figure 44: Partial *Wire Mode* switched on.

   The partial wire mode can also be chosen in the "MDT options" and "RPC/TGC options" panes (see Fig. 26).

9.7 Magnetic Field Interface

The *Magnetic Filed* interface provides a fully interactive 3D visualization of the magnetic field. This application is coupled to a set of subroutines that read the field database and compute the field at any given point.

9.7.1 Loading a Magnetic Field file

The muon spectrometer magnetic field map is loaded from the *Magnetic field* tab of the *Data manager* window (Fig. 5). Instruction are given in section 6.1.1, item 2, page 21. Click on [Modify. . .], and the *Magnetic field wizard* proposes several possible actions, first for the spectrometer (toroidal) field map (Fig. 6a):

- [Continue] to load the default map initially proposed [1] or chosen as follows:
- [Select. . .] to choose from maps proposed in `Persint-00-02-••/BFieldData/share`
- [Download. . .] to download additional files from a CERN repository to the `Persint-00-02-••/BFieldData/share` directory

Clicking the [Continue] button will load the chosen *spectrometer field map*, and will prompt two options for the *solenoid field map* (Fig. 6b):
i) *Use the muon spectrometer map for the solenoid map* [2] ;
ii) *Use a specific map* which needs to be [Select. . .]ed or [Download. . .]ed.

Finally you are asked if the field maps you just loaded should be your future *default maps* (Fig. 7).

[1] When running *Persint* on lxplus at CERN for the first time, there is no *default map* available.
[2] All spectrometer field maps contain a generic description of the solenoid field in the inner detector region

9.7.2 Display B-field lines

The magnetic field interface is launched in the following way: in the *Selector window* open the *Magnetic field* pane (Fig. 45a) and check the *Display magnetic field* box.

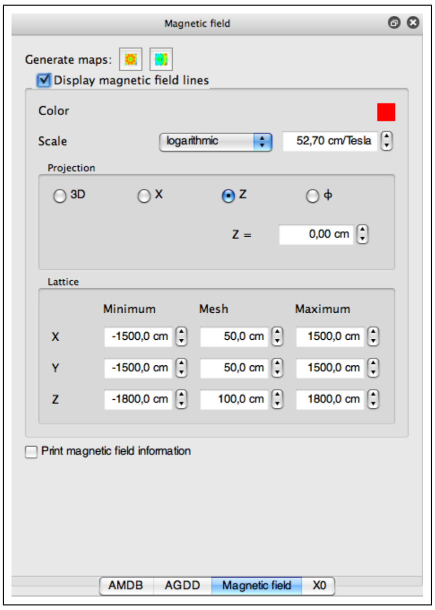
The field is visualized by means of arrows located at a series of lattice points. The direction and length of the arrow corresponds to to the direction and magnitude of the magnetic field. The field display can be customized with the following choices:

- Color of the arrows
- Linear or logarithmic scale
- 3D or projections, at x, y, or z positions
- Lattice for field display

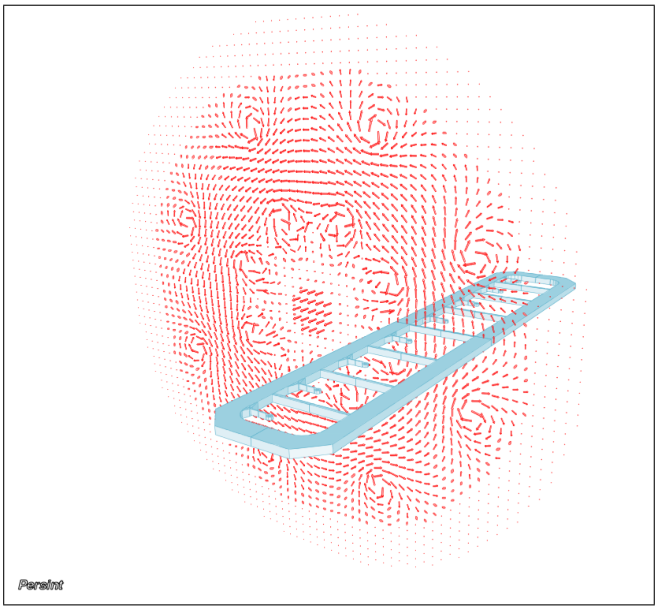
The vector field can be built either in a very localized region or over large distances.

Compute

Once all properties of the field visualization are defined, the display is obtained by clicking on the *Compute* icon.
Finally, elements of the Magnet system can be visualized through the AGDD pane of the *Selector* window. Figure 45 shows an example of a display of the magnetic field where one element of the cold mass of a barrel coil is shown.



(a) Chosen display parameters



(b) Display of field lines

Figure 45: Example of magnetic field lines displayed with a barrel toroid cold mass, selected with the AGDD interface. The parameters in (a) are used to obtain display (b).

9.7.3 Display B-field maps

- ***B-field map***

  The Magnetic field map can be displayed by clicking on the first (left) button of the *Generate maps* box in the *Magnetic Filed* pane of the *Selector window* (Fig. 45a) [1]. The *Select options for map* window opens and the parameters can be chosen in the three available panes (Fig. 46):

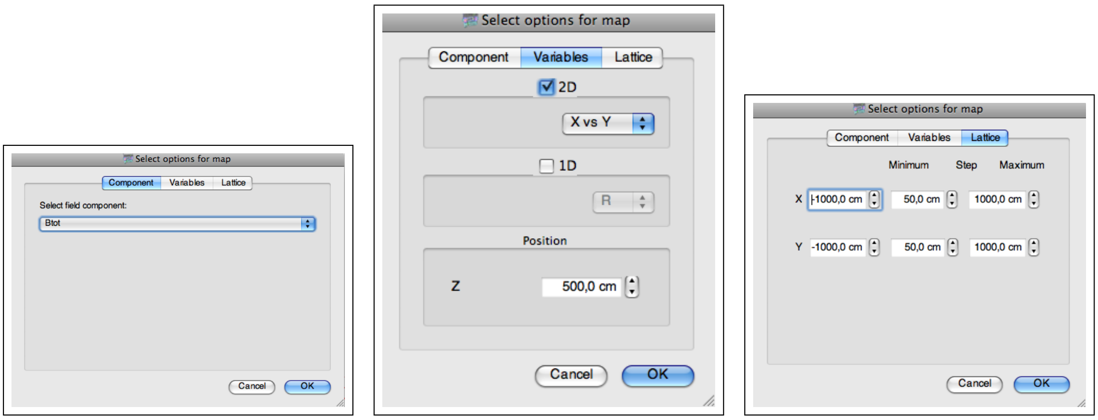
  – Field Component ($B_r, B_\phi, B_x, B_y, B_z, B_{tot}$) as well as various field gradients (derivatives): $\nabla B_x, \nabla B_y, \nabla B_z$ and 9 specific derivatives: $\frac{\partial B_i}{\partial u_j}$ $(i, j = x, y, z)$

  – The Variables to be displayed in 2D plots ($X vs.Y, X vs.Z, Y vs.Z$) and the value (position) of the 3^{rd} coordinate; or 1D plots (R, ϕ, Z, X, Y);

  – In the Lattice pane one can select the range of the axes and the step (Fig. 46c).

  When all the parameters are set, click on one of the OK buttons.
  Figure 47 shows the 2D field map.
  Several other field maps may be added to the display by using Add map. Each map can be saved with a choice of formats (`.png`, `.eps`, `.pdf`, etc.)

  The magnetic field file used (`bmagatlas05_test2`) is one of the files available [2] in the *Magnetic field* pane of the *Data manager* window (see 6.1.1, and figure 5).



(a) Field component (b) Variable(s) to be displayed (c) Lattice

Figure 46: Selecting options and variables for displaying the $2D$ field map.

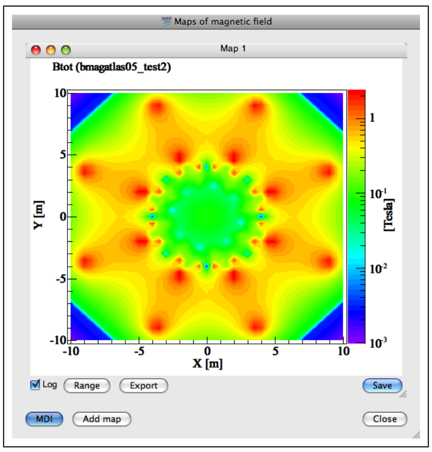
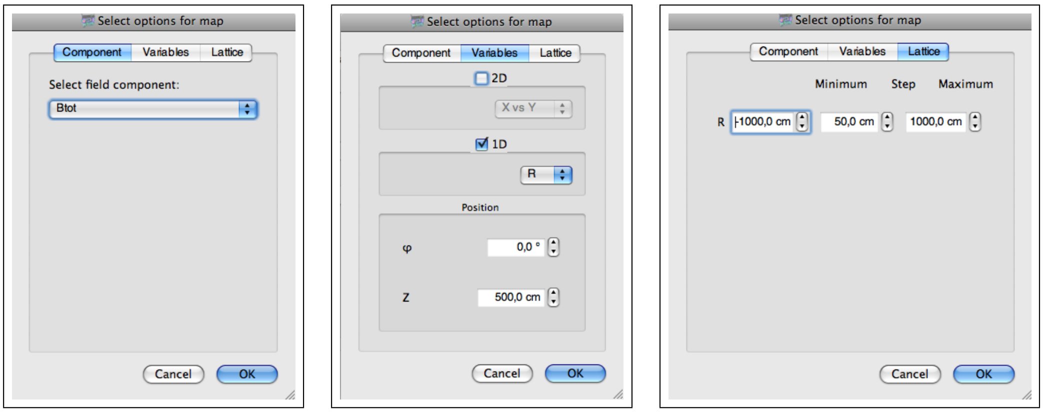


Figure 47:
$2D$ display of B_{tot} in the $X - Y$ plane at $Z = 500cm$. The corresponding selections are shown in figure 46. Units are $Tesla$ and m.

[1] An alternative is to use the *Tools* menu: *Tools/Histograms.../ Map of magnetic field* (see Appendix E.6).

[2] Additional field maps can be made available through the *Download...* button in the *Data manager* window (see 6.1.1, item 2, page 20); or by choosing *Download...* in the *File* menu (Appendix E.1).

The magnetic field can also be illustrated as 1D plots. With the selections shown in figure 48, the total field B_{tot} is shown as a function of R in figure 49 (Map 1).



(a) Component (b) Variables (c) Lattice

Figure 48: Selections for 1D plot of the magnetic field.

The field of the central solenoid magnet can be added, as shown in figure 49 (Map 2), with the following selections (made in the panes of figure 48):

Component= B_z; **Variable**= Z, at $\varphi = R = 0$; **Lattice**: $Z \in [-300, 300]cm$.

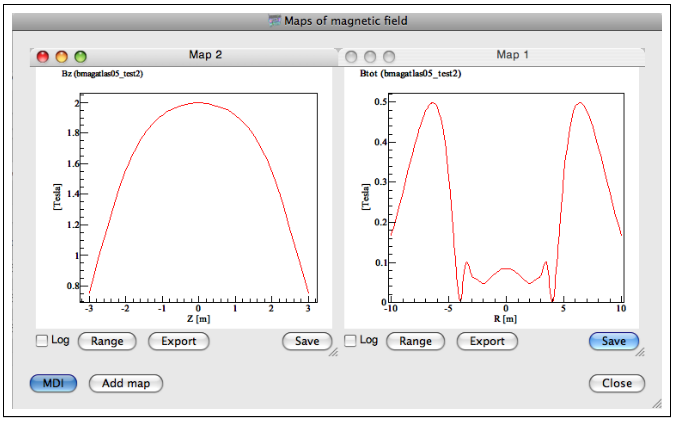


Figure 49: Units are *Tesla* and *m*.
Map 1: 1*D* display of B_{tot} as a function of R at $Z = 5\ m$, $\varphi = 0$.
Map 2: display of B_z as a function of Z at $R = 0$, $\varphi = 0$.

With the MDI [1] button, the display can be arranged to show each map separately, using the tabs, as shown in figure 50.

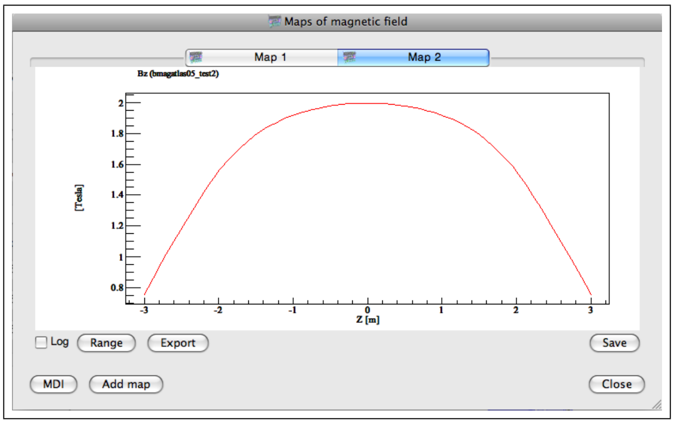
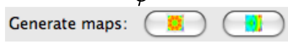
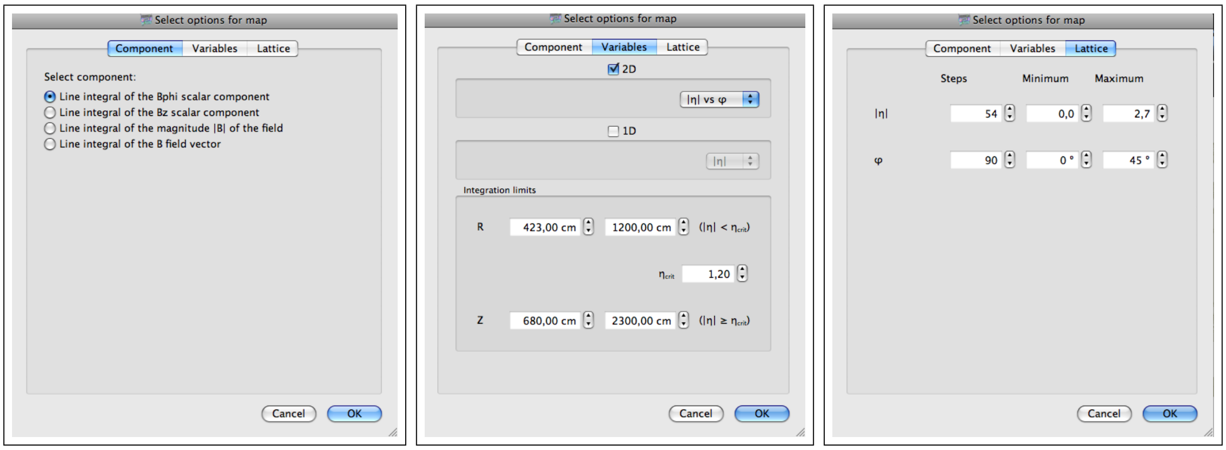


Figure 50: Same as figure 49, but in `MDI` mode, showing one plot at a time in separate tabs.

[1] Multiple Document Interface

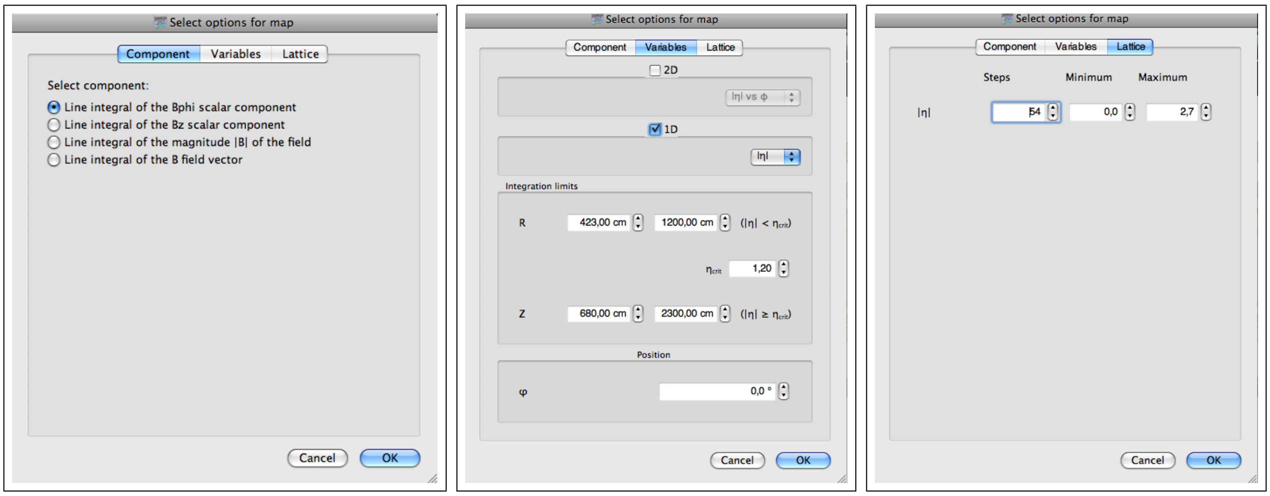
- ***Integral B-field map*** ($\int Bdl$)
  The integral field can be displayed by clicking on the second (right) button of the *Generate maps* box in the *Magnetic Filed* pane[1]. First, choose the component in the *Component* tab (Fig. 51a), then check "*2D*" in the *Variables* tab (Fig. 51b) and finally choose the lattice in the *Lattice* tab (Fig. 51c). The line integral of the B_φ scalar component is shown in Fig. 53a.
  

  An example of selections made to obtain a 1D plot of $\int Bdl$ is shown in figure 52, and the resulting plot in figure 53b.



(a) Select *Component* (b) Select *Variable* and integration limits (c) Select *Lattice* for 2D plot

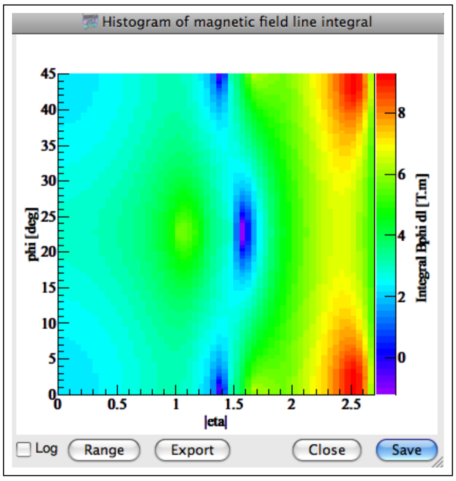
Figure 51: Map of the field integral $\int Bdl$. The unit is *Tesla.m*



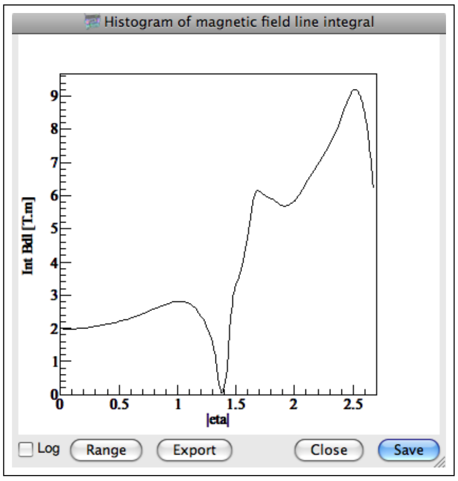
(a) Select *Component* (b) Select *Variable* and integration limits (c) Select *Lattice* for 1D plot

Figure 52: 1D display of $\int Bdl$ as a function of η

[1]OR: Use the *Tools* menu: *Tools/Histograms...* ***Map of field line integral***.



(a) 2-D $(\eta - \varphi)$ map of $\int Bdl$



(b) 1-D plot of $\int Bdl$ as a function of η

Figure 53: Display of $\int Bdl$

- ***Field gradients***
  This feature is destined for special studies by advanced users. Figure 54 shows various field gradients in the context of the 2013-2014 upgrade studies. The field gradient to be displayed is chosen in the selection window (Fig.46a)

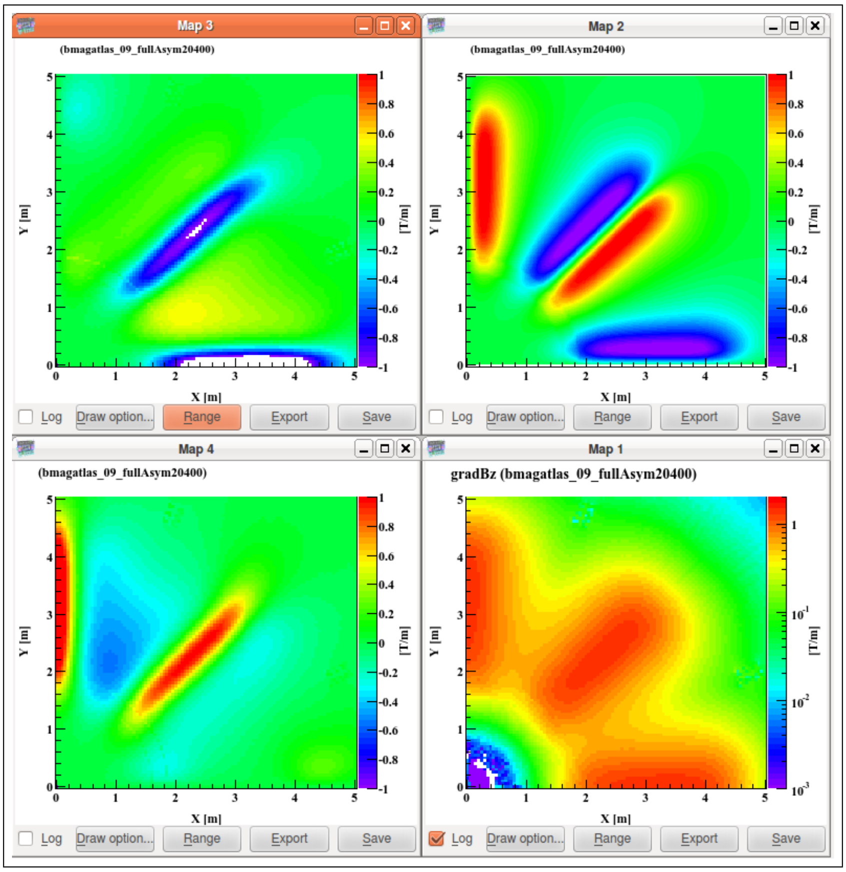
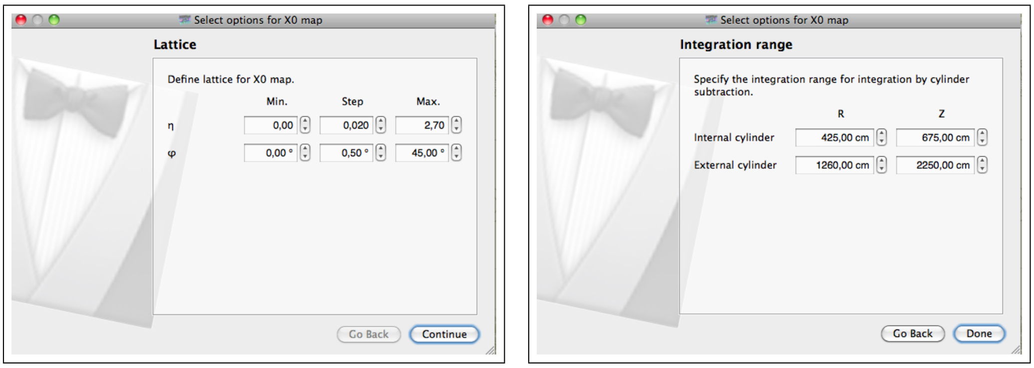


Figure 54: Display of magnetic field gradients: $\frac{\partial B_z}{\partial x}$, $\frac{\partial B_z}{\partial y}$, $\frac{\partial B_z}{\partial z}$, top left, top right and bottom left respectiveley. Bottom right shows the divergence $\nabla Bz = \frac{\partial B_z}{\partial x} + \frac{\partial B_z}{\partial y} + \frac{\partial B_z}{\partial z}$.

9.8 X_0 map: Distribution of material

The amount of material (in units of radiation length X_0) along any chosen direction from the interaction point can be displayed in the following way.
In the *Option pane* of the *Selector window* (Fig. 2), choose the X_0 tab [1], and hit the *Generate X_0 Map* button [2].
In the *Select options for X_0 Map* window (Fig. 55a), the direction (η, φ) can be chosen. After hitting the Continue button, the next step invites you to chose the integration range $(R,\ Z)$ (Fig. 55b). After hitting the Done button, the resulting map is shown in figure 56. The regions with high quantities of material because of the magnet coils are clearly visible (in warm colors): at $\varphi = 22.5°$ for the barrel region and at $\varphi = 0°$ and $45°$ in the forward region ($\eta > 1.5$).



(a) Choose the direction (b) Choose the integration range

Figure 55: Options for Map of X_0.
The two successive windows *Select options for X_0 Map* allow to choose the direction (η, φ) (a), as well as the integration range $(R,\ Z)$ (b). The amount of material - in units of X_0 - is calculated.

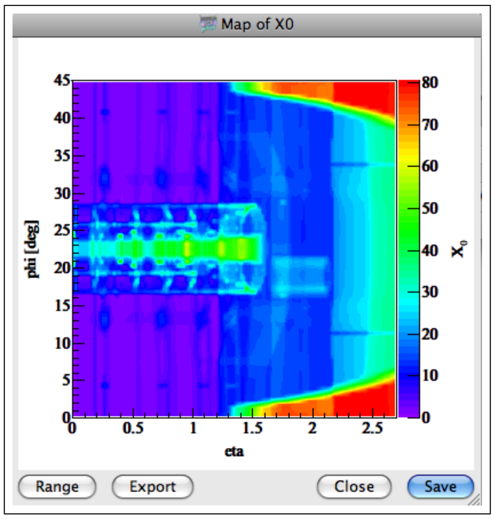


Figure 56: Resulting map of X_0.
Two dimentional (η, φ) Map of X_0. At the right, the color scale for the amount of material is expressed in units of radiation lengths (X_0).

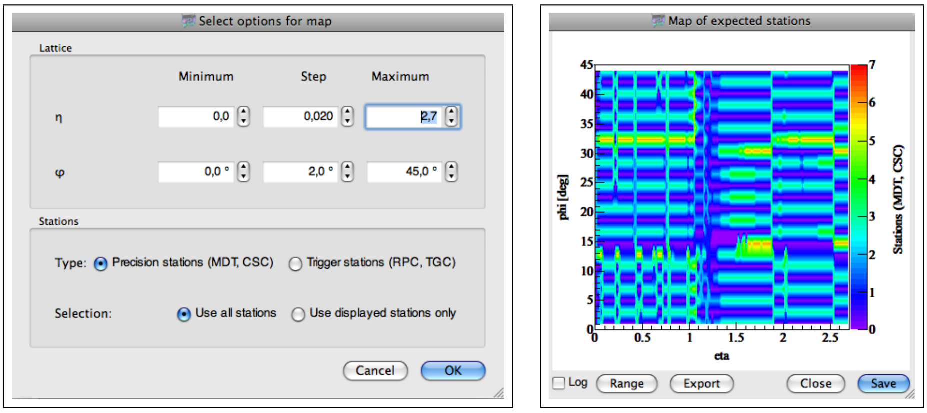
[1] You may have to open the X_0 tab by checking X_0 in the Windows menu
[2] OR: Use the *Tools* menu: *Tools/Histograms. . .* ***Map of*** X_0.

9.9 Map of the expected number of crossed muon stations

Ideally, the number of detector stations crossed by a muon is at least 3. There are regions in the spectrometer where this is not the case: *e.g.* in the transition region between barrel and endcap (around $\mid \eta \mid \simeq 1.2$), where a muon crosses fewer stations; and also at regular azimuthal angles. The tool described below makes it possible to determine the number of stations at any given η and φ.
The map is obtained by generating straight tracks from the *IP* and propagating them through the spectrometer, counting the number of chambers on the trajectory.

In the *Tools* menu, choose *Histograms. . . / Map of expected stations* button[1]. In the pop-up window *"Select options for map"*, make the following selections shown in figure 57a:

- **Lattice**: choose the desired η, φ ranges
- **Type** : select precision stations (MDT+CSC) or trigger stations (RPC+TGC)
- **Selection** : use *all stations* in the spectrometer or *only the stations being displayed*



(a) Choose the options for the display

(b) Map of *Number of expected stations*

Figure 57: Number of expected stations.
a) Options for displaying the map: η and φ ranges, type of chambers, selection of chambers.
b) Two dimentional (η, φ) map of *Number of expected stations*. At the right, the color scale for the number of stations.

Clicking on OK, produces the map of figure 57b. The regions where only one station or none are crossed can be clearly identified (blue *resp.* purple).
There are also a few rare regions where the number of expected stations exceeds 3, as indicated by the regions in yellow.
By using the selection *Use displayed stations only* in figure 57a, it is possible to restrict the map to the stations displayed in an event.

In any of the resulting maps (Figs. 47, 49, 50, 46b, 52c, 56, 57b,), several actions are possible with the tabs at the bottom of the display:

- **Range** : Set the range of the color scale for the plotted quantity .
- **Export** : Saves the map as an `ASCII` file (`.dat` format).
- **Save** : Saves the map as a picture with a choice of formats (`.png, .eps, .pdf`, etc.).
- **Close** window without saving or exporting.

[1]OR: In the *Option pane* of the *Selector window* (Fig. 2), choose the X_0 tab, and hit the *Generate map of expected stations* button

10 Exercise 5: ATLAS Physics Events (1)

10.1 Input files

10.1.1 Files loaded by the user

Persint allows the reading of event hit files and the visualization of these hits. It is also possible to reconstruct the event interactively [1]. All this is done with the help of the *Events* menu (Appendix E.5).

To display event hits, the following files must be loaded:

1. A geometrical data base of the "`amdb_simrec.xxx`" type.
2. An input Event file containing the hits of the "`OutMboyView_yyy`" type. The structure of this `ASCII` file is given in Appendix D.3.6, and an example Event file in Appendix D.3.7.

The interactive reconstruction of events requires the loading of two additional files.

1. The *Magnetic field* file
2. The user's directives in the form of "*Data cards*"

All these files are available through the *Data manager* icon of the *File* tool bar. For details, refer to section 6.1.1, figures 4, 5, 8, and Appendix D, figure 133a. As already mentioned, these files are loaded, if available, in the working directory. The program checks if the correct files are loaded. If there is a discrepency between the loaded geometry file and the event hit file [2], a warning is issued and the correct file(s) can be loaded (see section 6.3, item 4, and figure 9 on page 24).
The user may change these input files at any time during the running of *Persint*.

10.1.2 Event dependent files

The geometry file of the "`amdb_simrec.xxx`" type which is loaded at the beginning of a session represent the nominal geometry corresponding to the event file in use. The actual geometry, which represents the state of the detector at any given moment, must be used. Using a port [3] to a CERN data base, these files are invoked for each event displayed with *Persint* according to its *time stamp*.

→ The `"missing"` file indicates the detector parts or channels which are inoperative for a given event.

→ The `"Corr"` file provides the alignment parameters (A lines) and deformation parameters (B lines) of the precision chambers.

[1] The interactive reconstruction is using the interface with the Muonboy reconstruction program.

[2] The event hits file "`OutMboyView_yyy`" indicates the required geometry file in its header (Appendix D.3.7)). The file "`Persint-00-02-●●/PersintData/AtlasNode_AmdcFile_MagFieldFile.txt`" indicates the magnetic field file needed for a given geometry file (Fig. 133b).

[3] To get automatic access to these files, open the port with the following command:
`ssh -D 3128 lxplus.cern.ch`

10.2 Display physics events (Exercise 5 starts here)

Clear

For this exercise, we start from scratch; after starting *Persint*, we erase the display window with the *Clear* button of the *Image* tool bar.
Then we load the necessary files with the *Data manager* icon of the *File* tool bar:

- An `amdb_simrec.xxx` geometry file in the *Volumes* tab (Fig. 4).
  Check the box "*Load AGDD Volumes from the AMDB file*"
- A magnetic field file in the *Magnetic Field* tab (Fig. 5).
- The (default) Muon hits file in the *Events* tab (Fig. 8).
  Answer "*Yes*" if you are invited to load the "expected" *AMDB* file (see figure 9). Choose the magnetic field map (Fig. 9b) corresponding to the default Event file (answer "*Yes*"). Finally, load the appropriate Data Cards file `Muonboy_collision _simul_cards`, for a simulated event.

Next event

- To display the event of the default Event file (*Out.MboyView_Zmumu4023*)[1] click on the *Next event* icon of the *Event* tool bar. The muon chambers which contain hits (and only those chambers) are displayed.

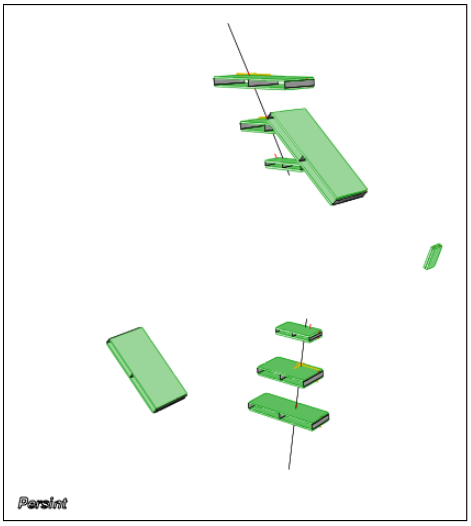
Athena-reconstruction

- To display the reconstructed tracks, click on the *Athena reconstruction* icon of the *Event* tool bar. A second click will remove the tracks.

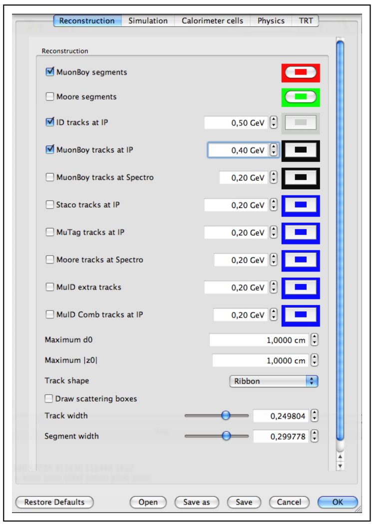
Simulation-tracks

- The *Simulated tracks* icon can be used to visualize generated tracks. A second click will remove those tracks.

- The muon chambers belonging to the event can be hidden by un-selecting *Chambers* in the *Event* menu.



(a) Display of Event 4023 showing tracks and the chambers containing hits



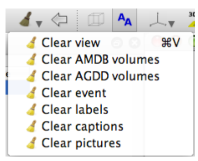
(b) The *Set track parameters* window

Figure 58: Display of Event 4023 resulting from the selections made.

After having used some functions of the *Navigation* tool bar to change the aspect of the display, figure 58a shows the event with the two muon tracks and the chambers which contain hits.

Set track parameters

Many different reconstructed objects can be displayed; they are selected in the *Set track parameters* window (Fig. 58)[2] available through the corresponding icon.
For instance, one can choose to display tracks reconstructed by Muonboy or Moore, Staco or Muid etc. . .
Besides these objects specific to the muon system, it is possible to visualize objects relevant to the calorimeters (cells) and Inner Detector (tracks). These displays will be discussed in section 11.3.



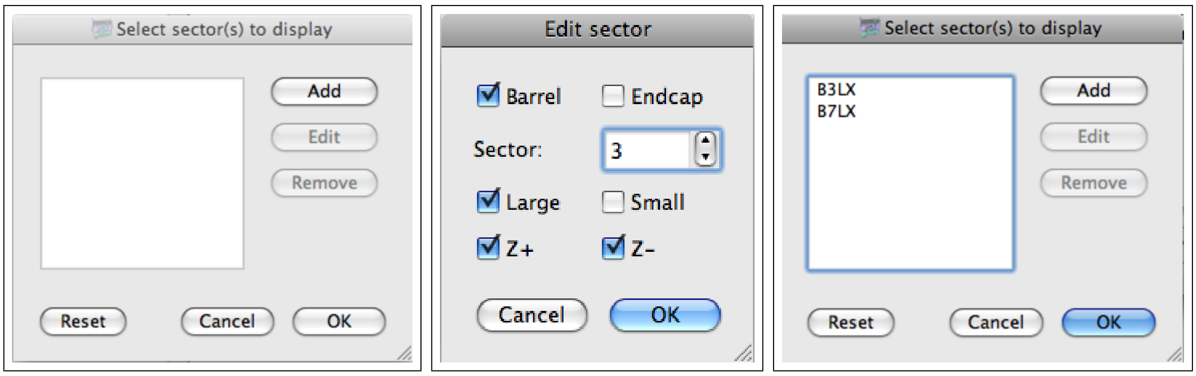
Clear event

Note that the *Event* can be erased from the display with the *Clear event* function.

[1]The file "*Out.MboyView_Zmumu4023*" used in this tutorial contains only one event.
[2]See also figure 136 in Appendix E.5.1.

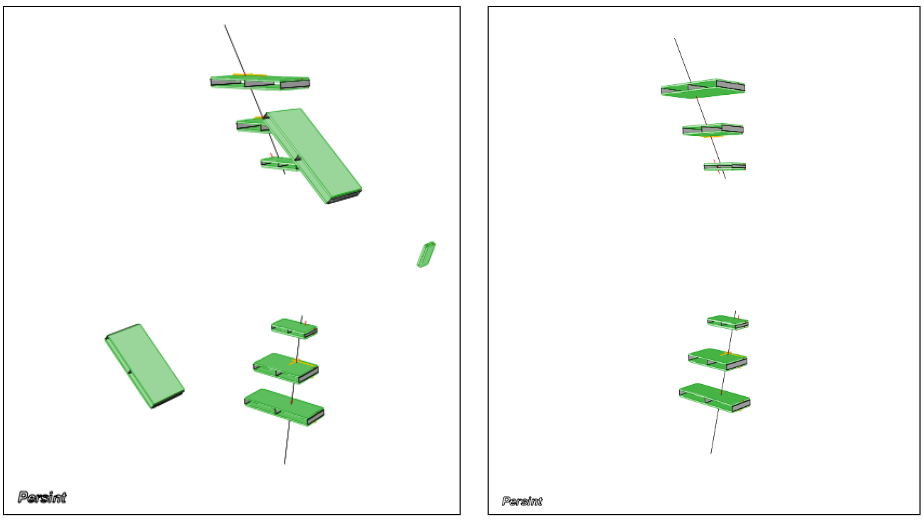
10.3 Select Sectors to be displayed

Because all chambers with hits are displayed in an event, the display may become crawded. Although this is not the case for the current event 4023, we will nonetheless clear the display of the chambers which do not have a reconstructed track.
First we identify the sectors of interest: by moving the cursor over the 6 chambers which contain the two reconstructed tracks, we find that the two sectors concerned are sectors 3 and 7, as indicated by the chamber labels. The goal is now to only display those sectors 3 and 7.
To do this, we use the function *Select Sectors...* of the *Events* menu. In the window which appears, we choose the sectors we want to display, by using the [Add] button shown in figure 59a. In the pop-up window, make the selections to display sectors 3, as shown in figure 59b; repeat the operation for sector 7. It is also necessary to select other options such as *Barrel/endcap, Large/Small, Z+-*. Upon clicking on [OK], the selection is displayed in the *Select sector(s)* window (Fig.59c). Clicking once more on [OK] will produce the event display of figure 59 where only sectors 3 and 7 are displayed.



(a) Select sector(s) window (b) Edit sector(s) window (c) Selections made

Figure 59: How to select the sectors to be displayed in an event.

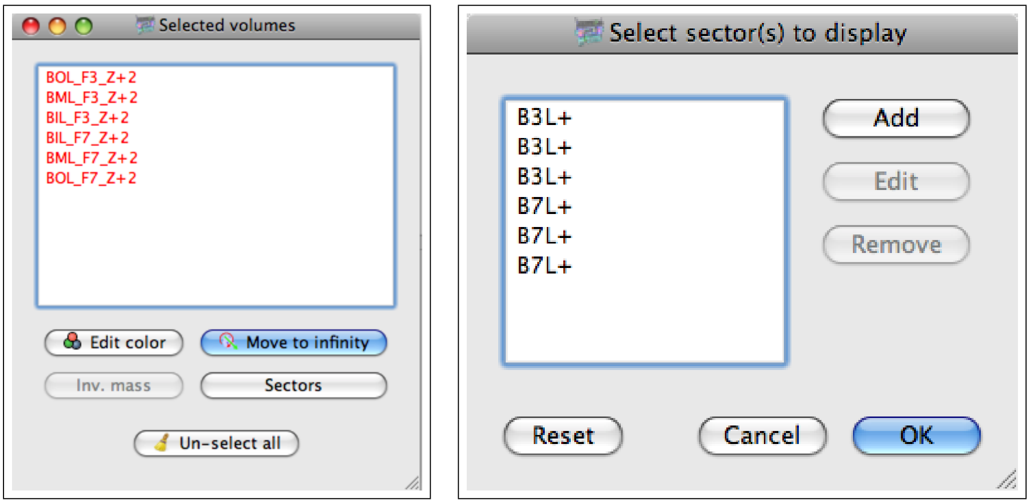


(a) Display of Event 4023 showing all chambers containing hits (b) Display of Event 4023 showing only chambers in sectors 3 and 7

Figure 60: Event 4023, display (2), resulting from the selection of two sectors.

The selection of sectors remains active until another selection is made in the *Select sector(s)* window or until one restores the entire display, using the Reset button of that window. Note that figures 60a (default) and 60b correspond to the selections of figures 59a and 59c, respectively.

There is an alternate and faster way to select the sectors to be displayed. Instead of using *Select sectors...* of the *Events* menu and enter the sector numbers into the *Edit sector* window (Fig. 59b), select the volumes directly in the following way:
Starting with figure 60a, `Right-click` in succession on the volumes which one wants to display and choose each time *Select Super-volume*. When done, the *Selected volumes* window (Fig. 61a) shows the list of volumes. Hit the *Sectors* button and check the list in the *Select sector(s)* window (Fig. 61b).

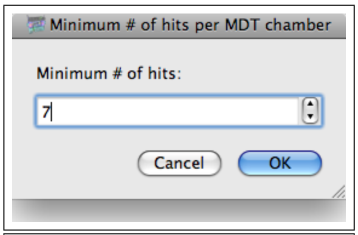


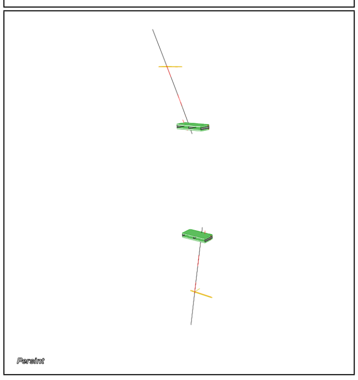
(a) Selected volumes window (b) Select sector(s) window

Figure 61: Alternate method for selecting sectors for display

Finally hitting OK produces again figure 60b, with only sectors 3 and 7 displayed.

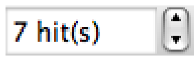
10.4 Select minimum number of hits





It is possible to restrict the display to MDT chambers which contain at least a specified ”*Minimum number of hits*”. In the simulated event of figure 60, the inner stations have 8 possible hits, whereas the middle and outer stations have 6 possible hits. In the *Events* menu, choose *Minimum number of hits...*. In the pop-up window (Top figure) set the minimum # of hits to 7. After clicking on OK, only the inner chambers are displayed (Bottom figure).

A faster way to set the minimum number of hits is to use the spinbox *n Hit(s)* in the *Event* tool bar (see figure 2 and appendix E.5).



Spinbox

10.5 Dressing the event

It is often convenient to "dress" the event with surrounding detectors in order to get a sense of orientation in ATLAS. This is particularly true for displays destined for presentations or publication. One can add the detector elements useful for orientation and change the aspect of the display at will. To do this, we use the *Selector window* and the *Navigation* tool bar as explained in section 7.

Open view...

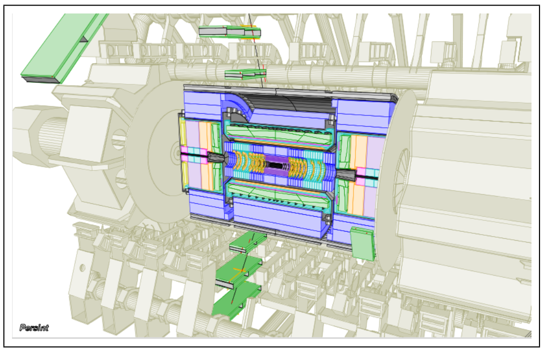
For this exercise, we will again load the predefined detector file for this event: click on the *Open view* icon of the *File* tool bar and select `Zmumu4023.p2vf` in the directory *Persint-00-02-••/example*. The display now resembles figure 62a.

Wire mode

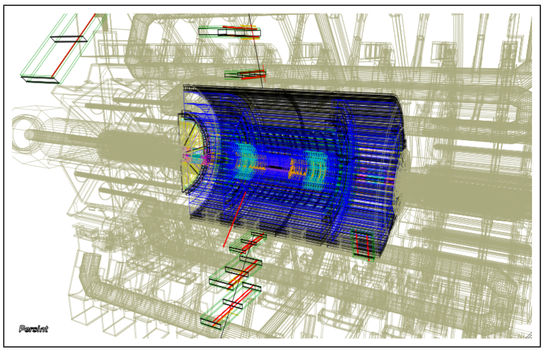
We want first to change the aspect of the display. In order to ensure fast processing of each action and to get optimal fluidity in the displacements, we turn to the global *Wire mode* (see section 9.6, item 1) by clicking on the relevant icon in the *Image* tool bar. The display of figure 62b is obtained.

We now *Zoom-out* and *Rotate* the view using the navigation tool bar as explained in section 8 to obtain a display resembling figure 62c.

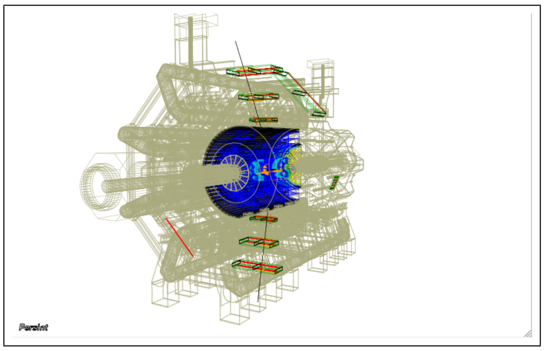
To obtain the display in full volume mode, we click again on the *Wire mode* icon to obtain figure 62d.



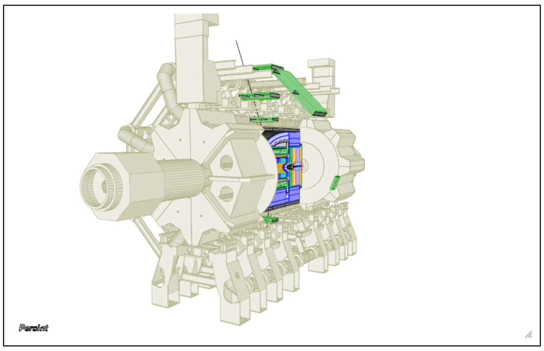
(a) Event 4023 dressed with the default file `Zmumu4023.p2vf`



(b) Event 4023 in Wire mode



(c) Event 4023 rotated and after Zoom-out

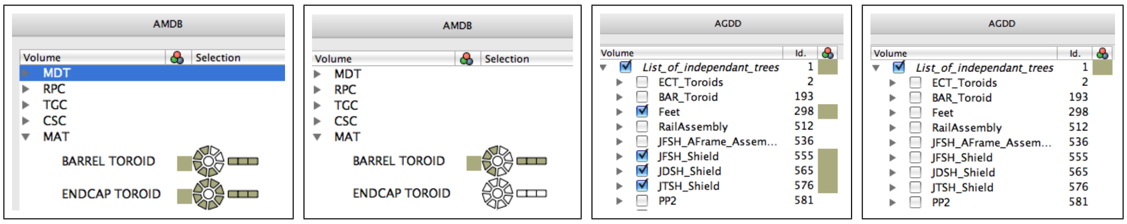


(d) Event 4023 in full display mode

Figure 62: Display of Event 4023 resulting from the selections made.

In this view, the event itself is partially hidden. To remedy this, we will drop some elements of the detector to be displayed. First we remove the endcap toroids by unchecking the relevant item in the AMDB tab of the *Selector window* and we also remove the lower coil of the barrel toroid by selecting the four left-most coils. Remember that

the color of the detector items (*e.g.* the barrel toroid) can be chosen in this pane. These modifications are indicated in figure 63b.
We now remove the feet and the shielding by making the appropriate selection in the AGDD pane of the *Selector window*, as indicated in figure 63d.

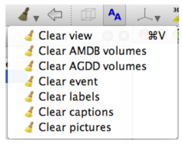


(a) Initial status (b) Modified status (c) Initial status (d) Modified status

Figure 63: Modifications made in the *Selector window*.

After the selections have been made, click on the *Compute* icon of the *Image* tool bar. A view similar to figure 64 is displayed.
To return to the bare event display (without the "dressing"), use elements of the *Clear view* function to remove AMDB and AGDD volumes.

Compute



Clear view

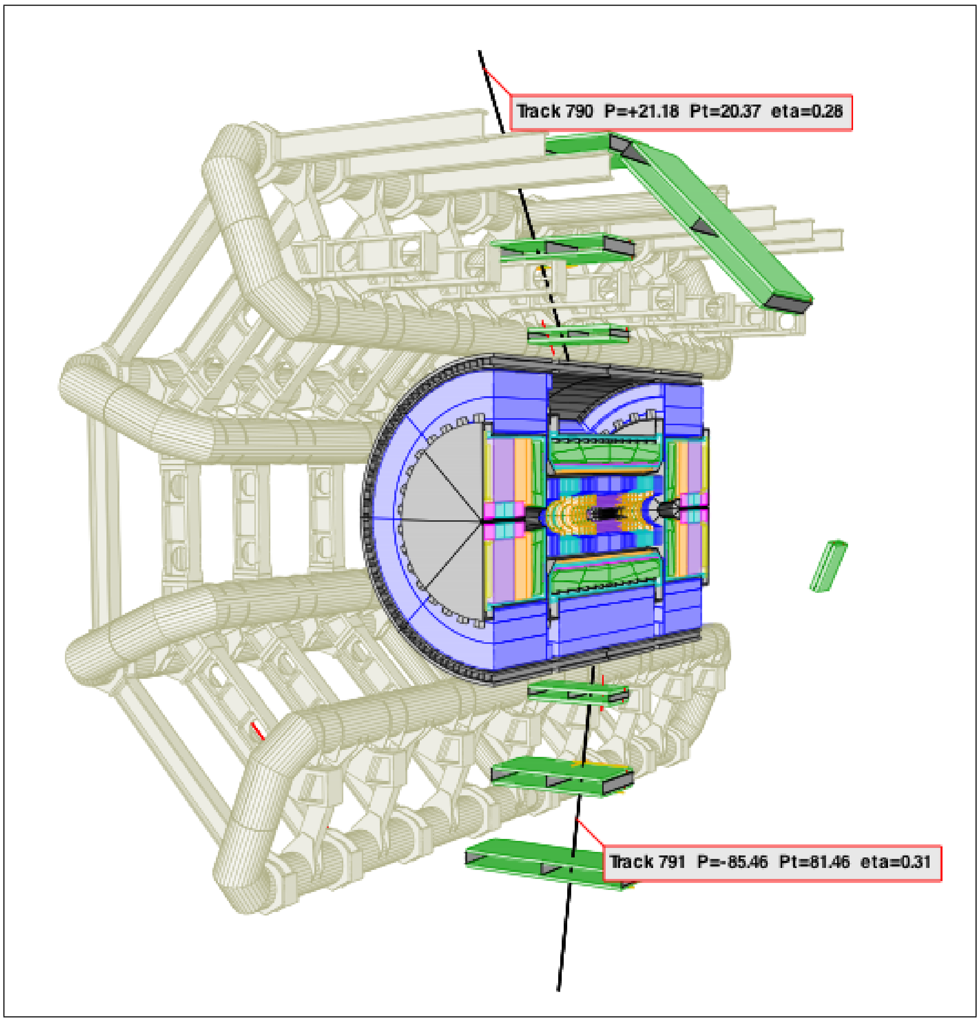
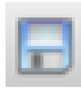


Figure 64: Display resulting from the modifications made to the selected detector elements. Track labels were produced as indicated in section 9.1.2.

10.6 Save the view

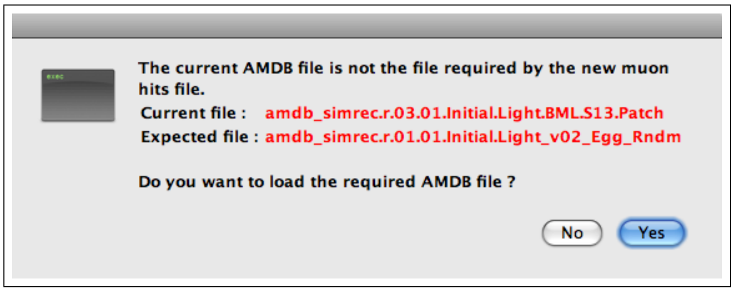


Save view as...

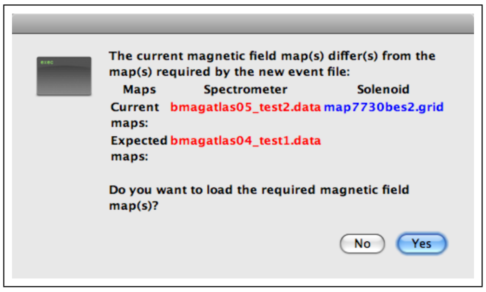
By clicking on the *Save view as* icon in the *File* tool bar the view displayed in the main display can be saved as a `.p2vf` file to the directory of your choice, *e.g.* *Persint_working_files*. This file (*e.g.* `exercise5.p2vf`) can be retrieved for later use in *Persint* via the *Open view* icon.
The view can also be exported or printed as explained in section 6.4.

10.7 Changing the event file

We now want to use a different event file. In the *File* menu (or tool bar), choose *Data manager* and then the *Event* tab and click on [Load]. Choose the file "`Out.MboyView_Top_evts_5`" of the *Persint-00-02-••/example* directory. *Persint* issues a warning and invites you to load the appropriate geometry file (Fig. 65a): answer [Yes] in order to load the correct file. A second warning is issued (Fig. 65b) which invites you to load the appropriate magnetic field file. Again, answer [Yes].[1] The loading of the appropriate files takes several seconds.



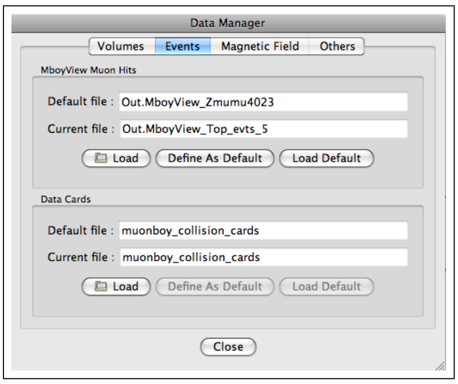
(a) AMDB geometry file



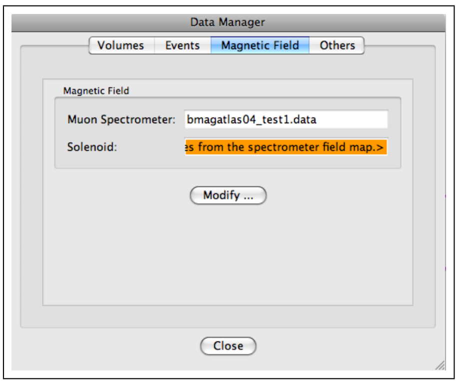
(b) Magnetic field file

Figure 65: Warnings issued by *Persint* about loading the proper files.

The panes *Events* and *Magnetic field* now display the current files which are used, and also the default files (Fig. 66).[2]



(a) Event file



(b) Magnetic field file

Figure 66: "Default" files and "Current" files being used by *Persint*.

[1] It is possible to use geometry and field files different from the recommended files, by answering [No]. This may be needed in special cases.

[2] Note that the current file can be defined as the default file by clicking on [Define as Default].

10.8 Scanning events

Persint is well adapted for scanning events. To illustrate how the scanning works, we shall load a file which contains many events (unlike *Out.MboyView_Zmumu4023* which has only one event).

In the *Event* tab of the *Data manager* window (Fig. 8), click on Load in the *Muon hits file* part. In the pop-up window, choose `Out.MboyView_1` in the *Persint-00-02-••/example* directory, a file of simulated single muon events. Depending on the previously loaded event file, two consecutive warnings, similar to figure 65, are issued about geometry and magnetic field files. Choose the suggested files by answering Yes. Close the *Data manager* window.

10.8.1 *Manual scanning*


Next event

Click on *Next event* to display the first event of the file.
The event number is # 3998 and is displayed in the *Event number* scale of the *Event* tool bar.

Event number scale

Click on *Next event* to display the following event.
The details of the event visualization can be defined using a series of functions of the *Events* menu (*e.g.* Athena reconstruction, Hit calorimeter cells, Strips, Tubes etc.) [1].

Any event can be chosen directly from the *Event number* scale. It can also be entered with the keyboard.
The *Reload event* icon is used to load the current event again.


Reload event

10.8.2 *Automatic scanning*


Start autoscan
Autoscan speed

The scanning can be performed automatically with the *Start autoscan* icon.
The *Autoscan speed* icon makes it possible to choose the time between events (1, 2, 5, 10, 20, or 30 seconds). The change of speed can be made "on the fly".

If one wants to work with a given event, the automatic scanning can be interrupted with the *Start autoscan* icon which has now changed aspect (*Stop autoscan*).


Stop autoscan

10.8.3 *Visualization properties*

By default, each visualization of a new event is done from a predefined perspective. However, when scanning events, it may be convenient to retain the current (modified from the default) visualization properties. This is done with the *Store visualization properties* icon.


Store visualization properties

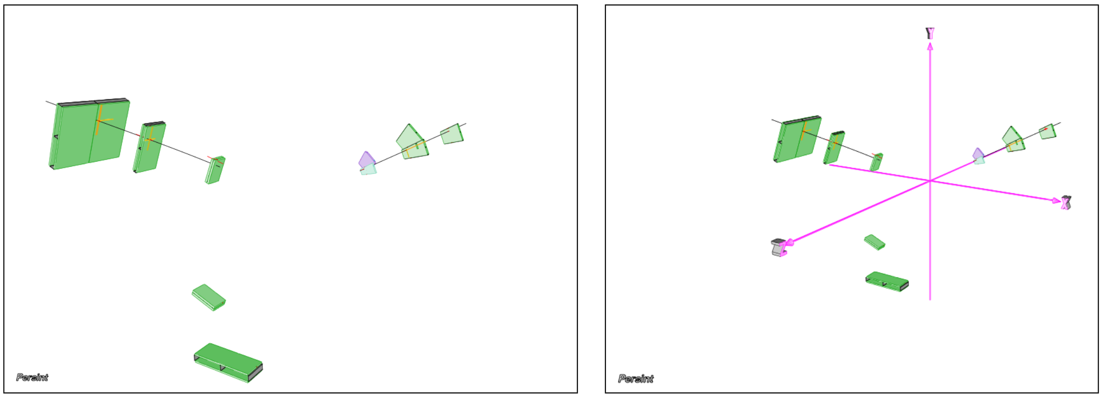
To illustrate this feature, we go back to the first event (#3998) of the loaded event file by choosing the event number in the *Event number* scale. Display the reconstructed tracks using the *Athena reconstruction* icon (Fig. 67a).


Athena-reconstruction

Now we use the navigation tools to change the visualization properties. First we zoom-out and display the ATLAS coordinate axes by choosing *Huge axes* in the *Axes* menu (Fig. 67b).


Axes

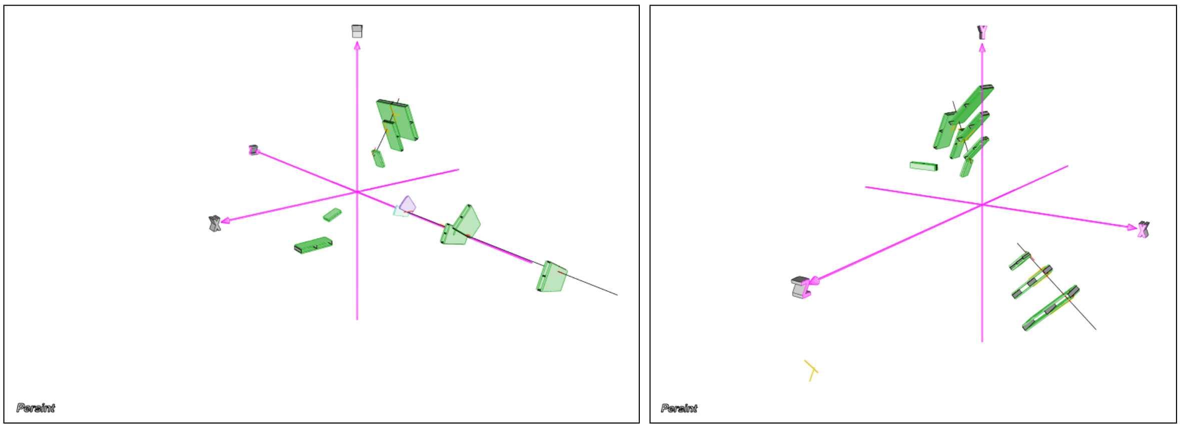
[1] See Appendix E.5



(a) Event 3998: initial default visualization properties (b) Event 3998: after zoom-out and with axes

Figure 67: Various views of Event 3998

Let's rotate the view to obtain figure 68a. We assume that the *Store visualization properties* icon is enabled. Clicking on the *Next event* icon will display event #3999 with the stored visualization properties (*i.e.* the rotated view). These parameters are used until the *Store visualization properties* icon is disabled and the next event #4000 is displayed (Fig. 68b).



(a) Event 3998: after rotation (b) Event 4000: Back to initial visualization properties

Figure 68: Events 3998 & 4000

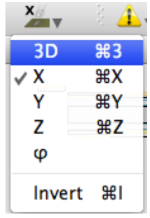
This feature of changing the visualization parameters can be used "on the fly" in the *Autoscan* mode.

10.8.4 *Using 2D projections*

For scanning purposes, it may be useful to use a two-dimentional projected view of the events:

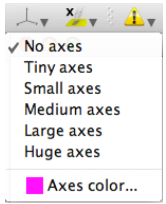
Stop autoscan

- Stop the autoscan with a click on the *Stop Autoscan* icon.



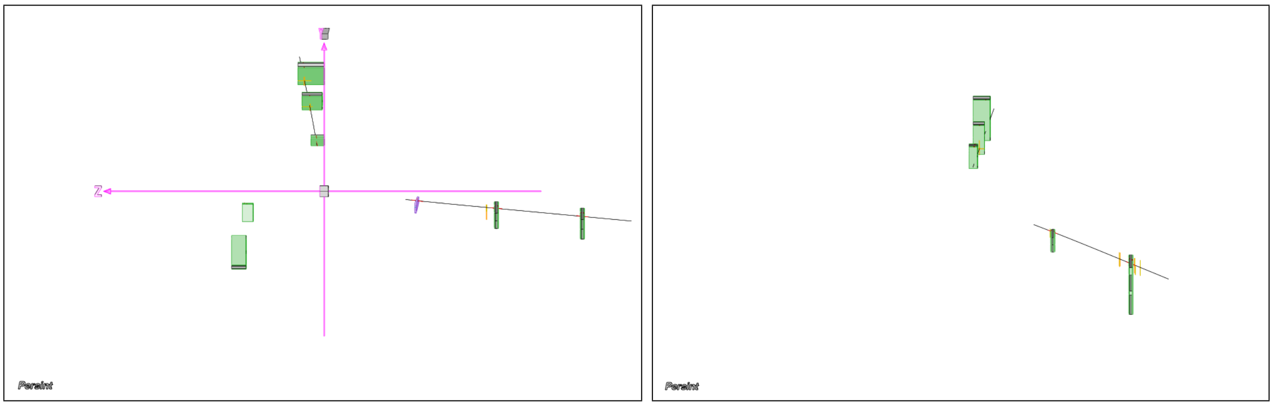
Projection

- Display the X-projection by clicking on the appropriate item of the *Projection* menu.
- Resume the automatic scanning with the *Start autoscan* function. All events are now displayed in the X-projection until the *Store visualization properties* function is disabled to return to the initial 3D view, or the *Stop autoscan* function is used to end the automatic scanning.



Axes

Figure 69 shows two events captured during the automatic scanning with the X-projection enabled. Note that the display of the axes can be disabled at any time by choosing *No axes* in the *Axes* menu.



(a) With coordinate axes displayed (b) Without Coordinate axes

Figure 69: X-projection of scanned events

11 Exercise 6: ATLAS Physics events (2)

In this exercise, we will examine more features provided by the *Events* menu. They concern the data from the muon spectrometer, the calorimeters, and the Inner Detector.

Remember that it may be convenient to save the display as a `.p2vf` file (*e.g.* in your *Persint_working_files* directory) if you must interrupt your work. This is done with the *Save view as* function, as explained in section 6.4.

Save view as...

11.1 Muon spectrometer data

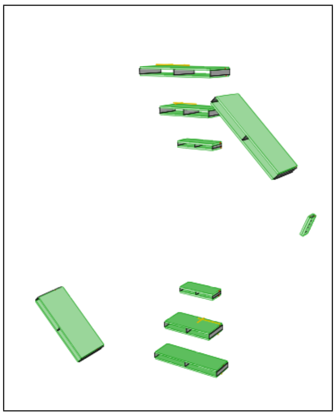
Again, as in exercise 5, we start from scratch. After starting *Persint*, we erase the display window with the *Clear* button of the *Image* tool bar.

Clear

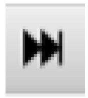
Then we load the necessary files with the *Data manager* icon of the *File* tool bar:

- An `amdb_simrec.xxx` geometry file in the *Volumes* tab (Fig. 4). Check the box "*Load AGDD Volumes from the AMDB file*"
- A magnetic field file in the *Magnetic Field* tab (Fig. 5).
- The (default) Muon hits file in the *Events* tab (Fig. 8).

  Answer Yes if you are invited to load the "expected" *AMDB* file (see section 6.3, item 4 and figure 9). Furthermore, you are invited to choose the magnetic field map (Fig. 9b) corresponding to the default Event file (answer Yes). Finally, load also the (default) Data Cards file which is needed for interactive muon reconstruction with *Muonboy*.



To display the event of the default Event file (*Out.MboyView_Zmumu4023*) [a] click on the *Next event* icon of the *Event* tool bar. The muon chambers which contain hits (and only those) are displayed in the figure to the left.



Next event

[a] The file "*Out.MboyView_Zmumu4023*" used in this tutorial contains only one event.

11.1.1 *ATHENA* reconstructed segments and tracks

Now we want to display the reconstructed tracks in the muon spectrometer.

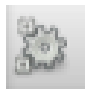
1. First we choose the parameters of the tracks to be displayed by opening the *Set track parameters* window. We replace the default values by the following:

Set track parameters

   - For now, we only are concerned with the first pane (*Reconstruction*).
   - Check "Muonboy segments" (or Moore segments)
   - Check "Muonboy tracks at spectro" (or Moore segments)
   - Select the "Track shape": *Ribbon, Crossed ribbons*, or *Cylinder*
   - Set "Track width" to the desired value

   The resulting *Set track parameters* window is shown in figure 70a.

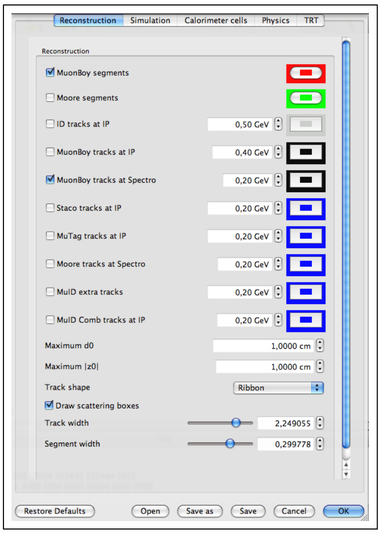
   Close the window by clicking on OK, then click on the *Compute* icon.



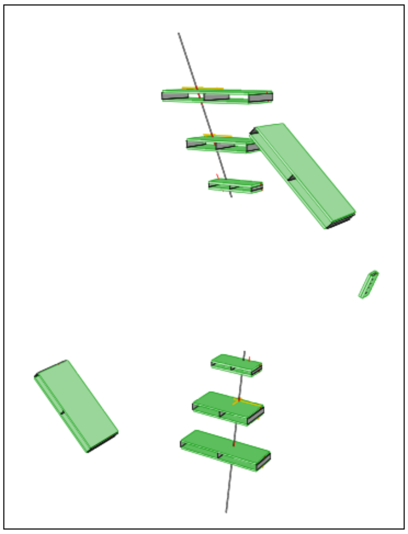
Compute

   To visualize the reconstructed tracks, click on the *Athena reconstruction* icon and obtain figure 70b.

Athena-reconstruction

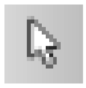


(a) Selections made in the *Set track parameters* window



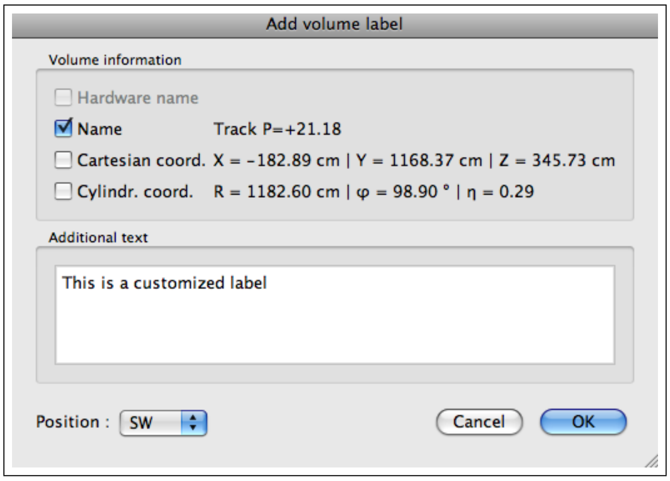
(b) Display of reconstructed Muonboy tracks

Figure 70: Event 4023 (first pass)

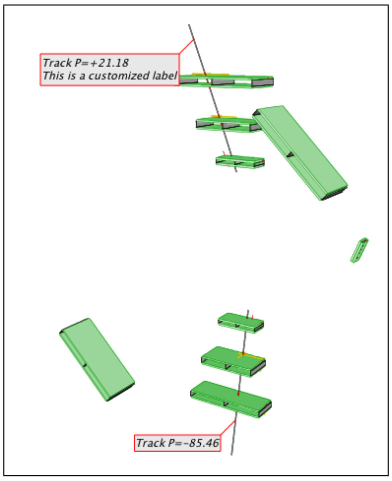


Default mode

2. We will now label the tracks. Select the *Default mode* in the *Navigation* tool bar. Move the cursor over the first track, `right-click` and choose *Add cutomized label*. In the pop-up window, un-check the two coordinate boxes and choose the SW position (Fig. 71a). Click on OK .
   Repeat this operation for the second track to obtain figure 71b.
   The labels indicate the charges and momenta (in GeV/c) of the reconstructed tracks.

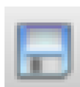


(a) Selections made in the *Set track parameters* window



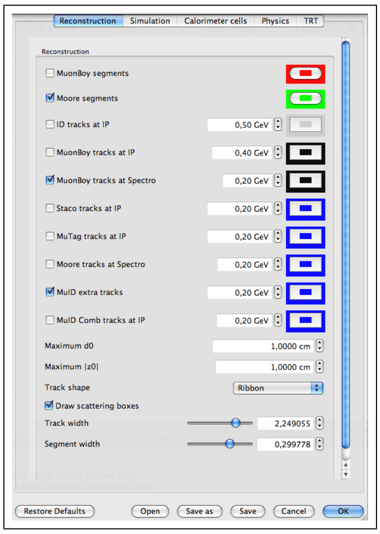
(b) Display of reconstructed tracks with labels

Figure 71: Event 4023 (second pass)

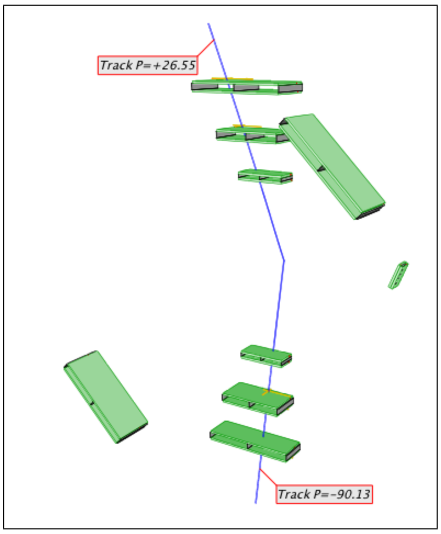


Save view as. . .

3. We may want to save the display into the directory (*Persint_working_files*) as a `.p2vf` file, for future use with *Persint*, using the *Save view as ...* function.
   Remember that the *Export view as ...* can be used for saving the display for presentations as a (*e.g.* .jpg) file, with the possibility of adding captions, logos or pictures (see sections 6.4 and 6.5).



(a) Selections made in the *Set track parameters* window

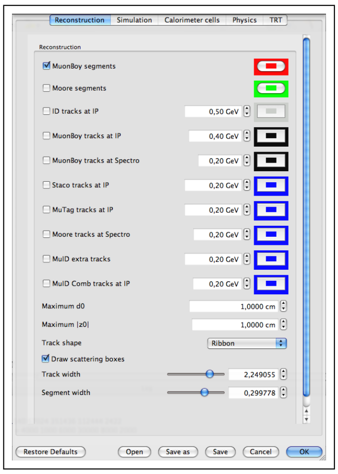


(b) Display of reconstructed MuID tracks

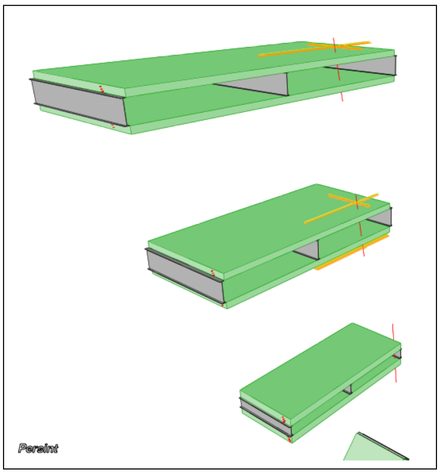
Figure 72: Event 4023 (third pass)

4. As can be seen in the *Set track parameters* window, one can choose other objects to be displayed. For example, the choices: "*Moore segments*" and "*MuID extra tracks*" shown in figure 72a result in figure 72b, once the customized labels have been added as before.

5. Instead of showing the tracks, one can choose to display only the segments. To do this, open the *Set track parameters* window and select only the Muonboy or Moore segment box (or both), as shown in figure 73a. We look now at the upper triplet of detector stations. After rotating the display and zooming-in, we obtain figure 73b.



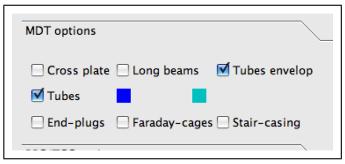
(a) Selecting segments in the *Set track parameters* window



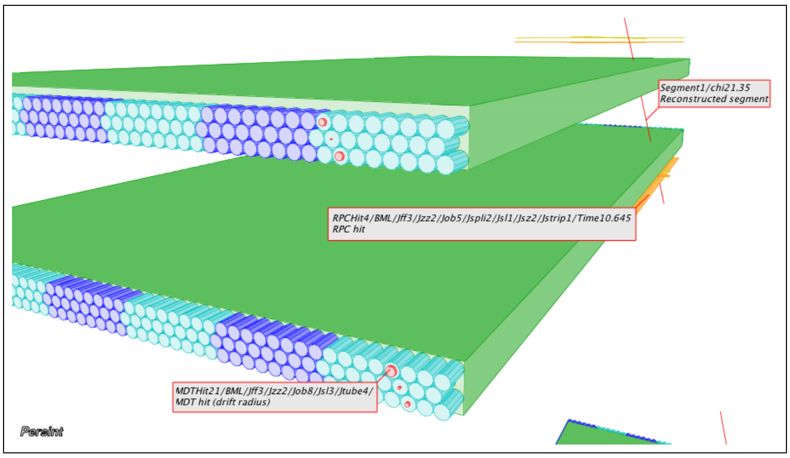
(b) Display of reconstructed segments (in red)

Figure 73: Event 4023 (fourth pass)

6. We now choose different settings of the "MDT options" shown in figure **??**, we rotate the view, and we zoom-in on the `BML` chambers with the *Zoom on custom area* function discussed in section 8.3, item 4. We obtain figure **??**, where one recognizes the hit MDT tubes (in red), the active RPC strips (in yellow) and the reconstructed segment (in red). The labels have been added as explained in section 9.1.2.



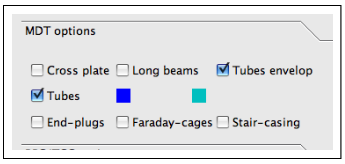
(a) Selecting MDT options in the *Options* pane



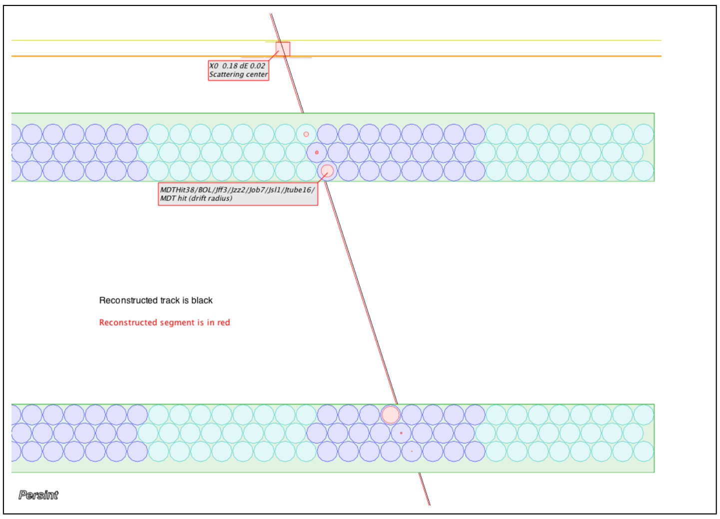
(b) Display obtained with the settings shown in figure 74a

Figure 74: Event 4023 (fifth pass)

7. We choose now the X-projection in the *Image* menu. In the *Set track parameters* window, make the selection shown in figure 70a (Reconstructed segments and tracks). The MDT options are again shown in figure 75a. After zooming, we obtain figure 75b where labels (section 9.1.2) and a caption (section 6.5) have been added. The red square is the location of a scattering center along the reconstructed track. Multiple scattering is computed at that location, using the track momentum and the average amount of surrounding material.



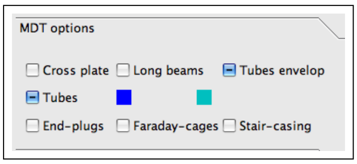
(a) Selecting MDT options in the *Options* pane



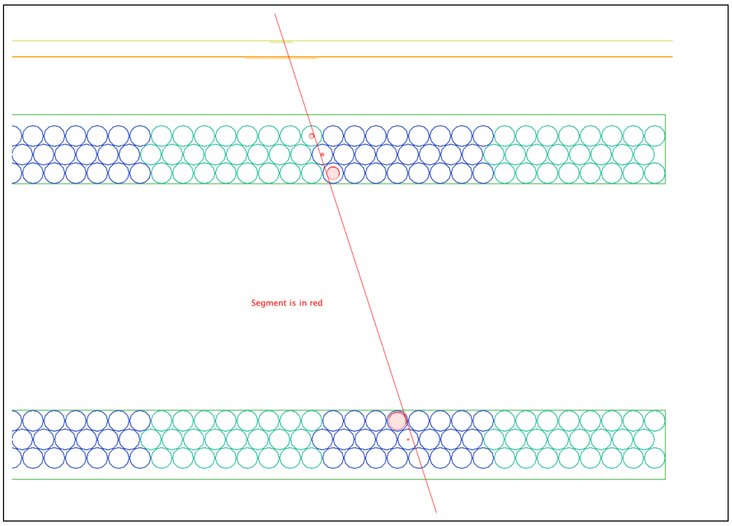
(b) X-projection of reconstructed tracks with the settings shown in figures 70a and 75a

Figure 75: Event 4023: Zoomed X-projection with reconstructed tracks

8. Finally, selecting segments instead of tracks in the *Set track parameters* window, according to figure 73a, and choosing the MDT options of figure 76a, we obtain the display of figure 76b.



(a) Selecting MDT options in the *Options* pane



(b) X-projection of reconstructed segments with the settings shown in figures 73a and 76a

Figure 76: Event 4023: Zoomed X-projection with reconstructed segments

11.1.2 *Simulated muon tracks*

This exercise is only valid for simulated events !

Clear

- Start with an empty main display by using the *Clear view* function.

Reload event

- Load the previous event again (Event 4023) with the *Reload event* function.

Set track parameters

- Open the *Set track parameters* window and make the following additional selections: *Generate tracks at IP* and *Only muons* so as to obtain the overall selections of figure 77b.
- Click on OK to close the window.

Compute

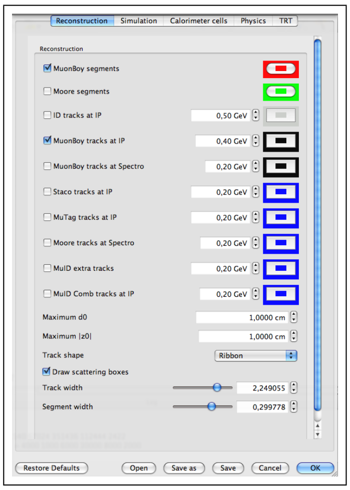
- Validate the selections by clicking on the *Compute* icon.

Simulation tracks

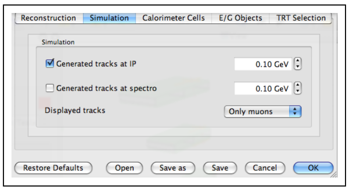
- To visualize the generated tracks, click on the *Simulation tracks* icon. The simulated tracks appear (from the IP).

Athena reconstruction

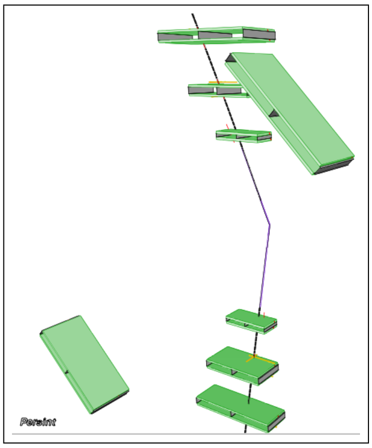
- Click on the *Athena reconstruction* icon and the reconstructed tracks appear superimposed on the simulated tracks, as expected for a successful reconstruction (Fig. 77c).



(a) Selections in the *Set track parameters* window (Reconstruction)



(b) Selections in the *Set track parameters* window (Simulation)

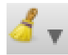


(c) Display of simulated and reconstructed tracks

Figure 77: Event 4023 (sixth pass)

11.1.3 *Reconstructed muon tracks and invariant mass*

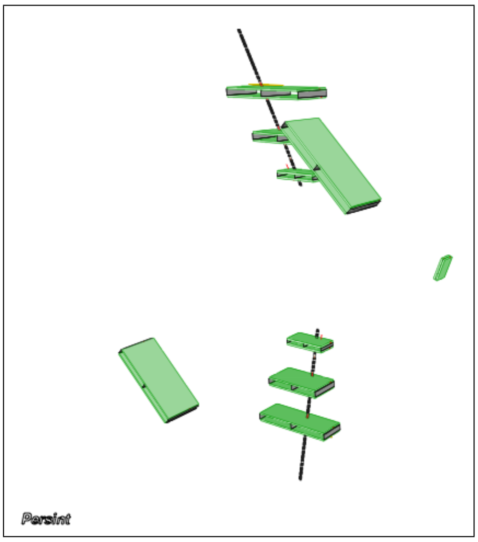
As seen in 11.1.2, the reconstructed tracks are visualized with the *Athena reconstruction* icon (Figure 77c). It is possible to compute the invariant mass of two reconstructed muon tracks in the following way.


Clear

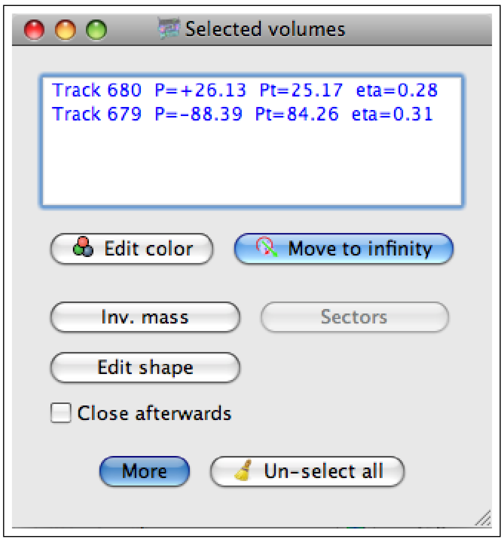

Reload event


Athena reconstruction

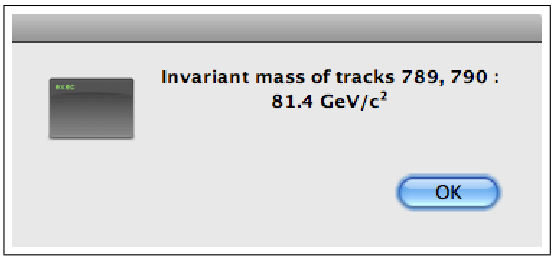
- Start with an empty main display by using the *Clear view* function.
- Load the previous event again (Event 4023) with the *Reload event* function.
- Click on the *Athena reconstruction* icon and the two reconstructed tracks appear. (Fig. 78a).
- Select the two tracks by clicking in turn on each track, so that their parameters appear on two lines in the *Selected volumes* window (Fig. 78b).
  It may be necessary to increase the width of the tracks in order to make the selections easily. The track width can be increased *e.g.* to 8, in the *Set track parameters* window (Appendix E.5.1).



(a) Reconstructed tracks



(b) Selected tracks in the *Selected volumes* window



(c) Calculated invariant mass

Figure 78: Invariant mass of two reconstructed muon tracks

- Click on Inv. mass to compute the invariant mass of the selected muon tracks. The result is shown in figure 78c.

11.1.4 *Interactive reconstruction with Muonboy*

We start again with Event 4023 of the `Out.MboyView_Zmumu4023` file. Make sure all necessary files are loaded by using the *Data manager* windows. In particular the *Magnetic field* file and the *Data cards* file need to be loaded as indicated in figures 5 and 8 on pages 21- 22. Use the default files for this exercise. Click on the *Muonboy interactive reconstruction* icon. Two reconstructed candidate tracks are displayed.

Muonboy interactive reconstruction

We now make a customized label for each candidate (see section 9.1.2) and obtain figure 79.

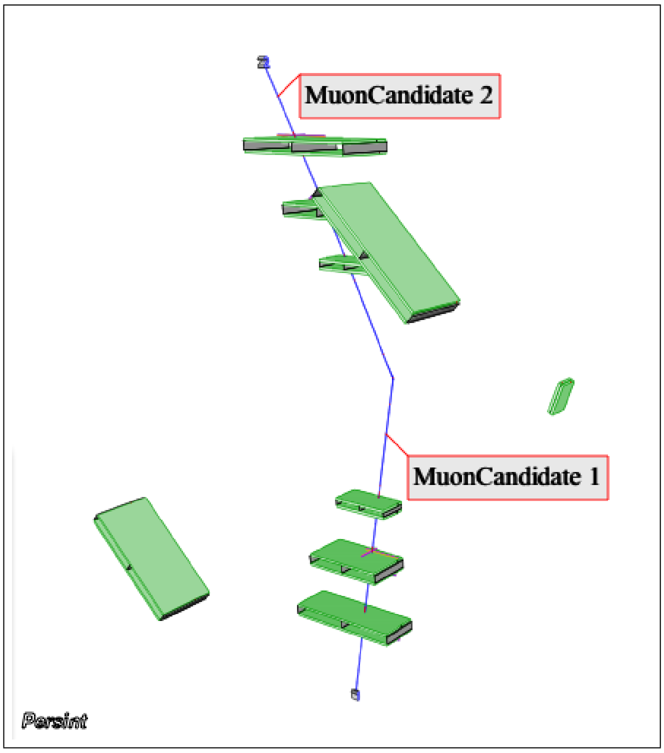


Figure 79: Display of two candidate tracks

For each candidate track which is displayed, the *Muonboy* pane at the bottom left of the *Persint* display shows the characteristics as seen in figure 80. This pane also shows a warning if no muon could be reconstructed. [1]

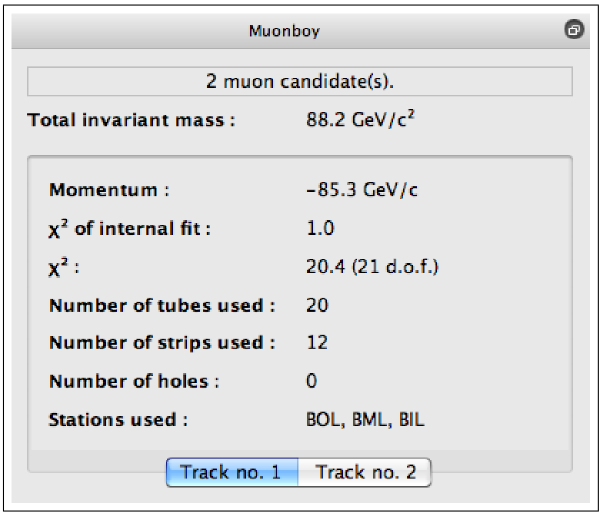
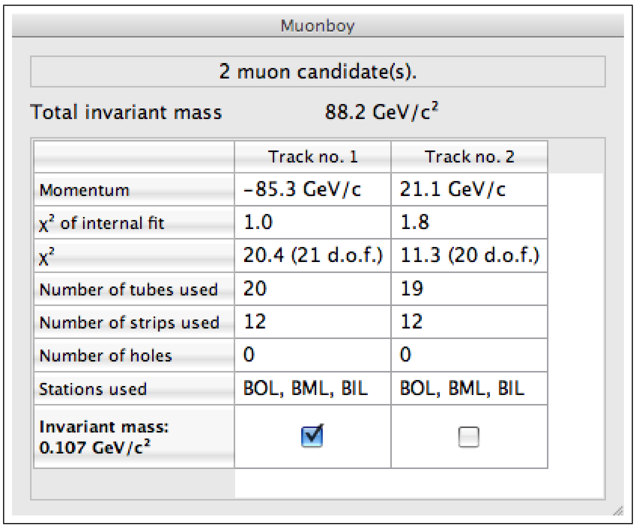


Figure 80: The parameters of each muon candidate are shown in the *Muonboy* pane. They include the signed momenta of reconstructed muons, the track fitting parameters, and the invariant mass of a muon pair.

In the *Muonboy* window, the total invariant mass of all reconstructed muons is displayed.

[1] *e.g.* an explicit message is issued if data such as alignment parameters of the A-lines are missing.

A table containing the parameters of all reconstructed muons can be obtained by clicking on the icon at the right hand side of the title bar, which makes it a floating window. When this table (Fig. 81) is displayed, a `right-click` on the content will offer the *Copy to clipboard* function which can be used to save the reconstruction data in a text file.


Muonboy

2 muon candidate(s).

Total invariant mass 88.2 GeV/c²

	Track no. 1	Track no. 2
Momentum	-85.3 GeV/c	21.1 GeV/c
χ^2 of internal fit	1.0	1.8
χ^2	20.4 (21 d.o.f.)	11.3 (20 d.o.f.)
Number of tubes used	20	19
Number of strips used	12	12
Number of holes	0	0
Stations used	BOL, BML, BIL	BOL, BML, BIL
Invariant mass: 0.107 GeV/c²	☑	☐

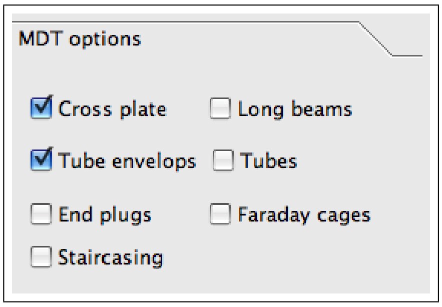
Figure 81: The *Muonboy* window, with a table of all reconstructed muons. The total invariant mass is given at the top, the invariant mass of the chosen muon(s) at the bottom. The *Copy to clipboard* function is obtained by `righ-clicking` on the table.

The boxes at the bottom of the window make it possible to calculate the invariant mass of any number of muons by making the appropriate selections. In figure 81 with one box checked, the invariant mass is the muon mass. Again, the table may be copied to the clipboard and saved.

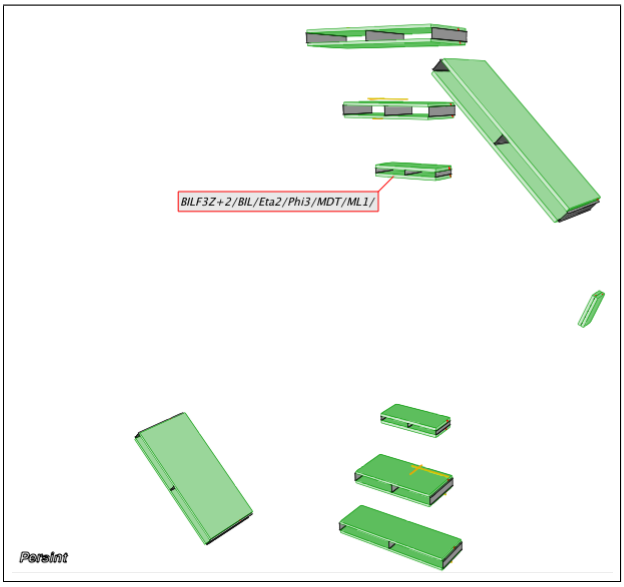
11.1.5 *Color code for MDT hits*

The interactive reconstruction can be used to look at the reconstruction process in detail. We start again with Event 4023 of the `Out.MboyView_Zmumu4023` file. Make sure all necessary files are loaded by using the *Data manager* windows. In particular the *Data cards* file and *Magnetic field* file need to be loaded as indicated in figures 5 and 8 on pages 21 and 22. Use the default files for this exercise.

With the nominal MDT options (Fig. 82a), we obtain the display of figure 82b.



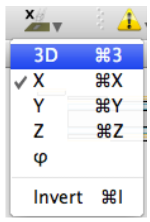
(a) Nominal MDT options



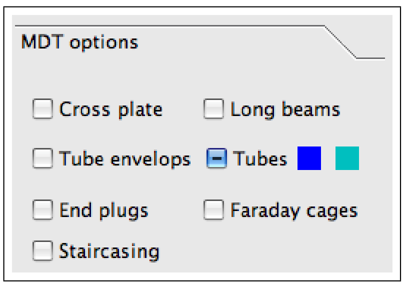
(b) Event 4023

Figure 82: Event 4023 without reconstruction

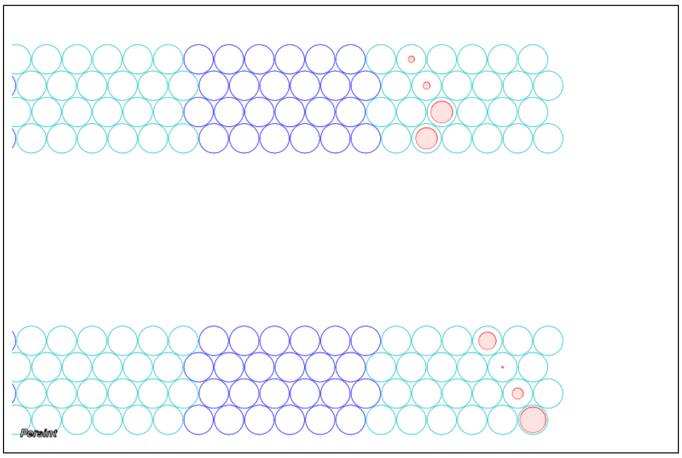
We now choose the X-projection with the *Projection* menu, and zoom on the BIL chamber indicated by a label to obtain figure 83b which uses the MDT options of figure 83a.



Projection



(a) MDT options



(b) MDT hits before reconstruction (red)

Figure 83: Event 4023: Detail of BIL chamber in the X-projection

Muonboy interactive reconstruction

The reconstructed track is obtained by clicking on the *Muonboy interactive reconstruction* icon (Fig. 84).

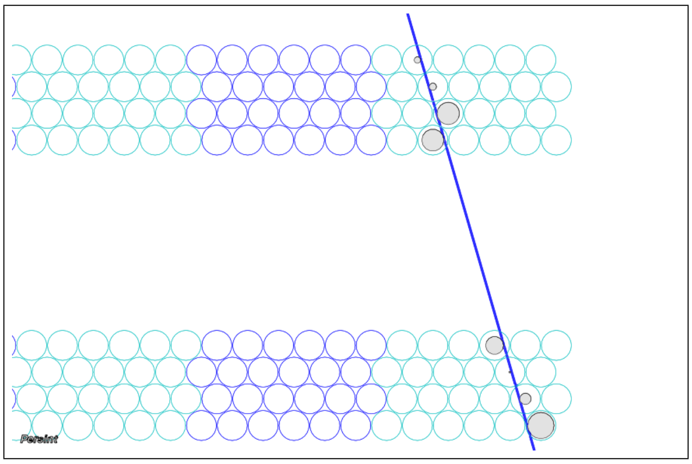


Figure 84: MDT hits after reconstruction (black)

The color code for MDT hits is the following: black hits are those selected by the pattern recognition, red hits do not belong to a track (all hits are selected by the pattern reconstruction in figure 84).

The interactive reconstruction can be used to act on the event characteristics to understand which role they play. For instance, a hit MDT tube or a RPC strip can be removed with the *Move volumes to infinity* (see section 9.2). Then, when re-running the reconstruction algorithm, the removed tube or strip will not be taken into acccount.

11.2 Inner Detector data and Vertex display

The primary vertex as well as secondary vertices are available for display. Histograms of primary vertices can also be produced.
The primary vertex is obtained by a fit of all reconstructed Inner Detector tracks. Likewise, the secondary vertices are obtained from an analysis of the ID tracks.
The default settings in the *ATHENA* job options produce the primary vertex candidate in the *Persint* event file `OUT.MboyView_xxx`, as seen in Appendix D.3.7: the line `VTX` appears seven lines before `END EVT` line.
To obtain the secondary vertices in `OUT.MboyView_xxx`, the proper job options need to be chosen when running the reconstruction programs in *ATHENA*.

11.2.1 Vertex display

Clear

Reload event

- Start with an empty main display by using the *Clear view* function.
- Load the previous event again (Event 4023) with the *Reload event* function.
- To best illustrate this function which displays the vertex, we will first display the Inner Detector tracks:
  Open the *Set track parameters* window and make the selections shown in figure 85. In particular, check the "ID tracks at IP" box.[1]

Set track parameters

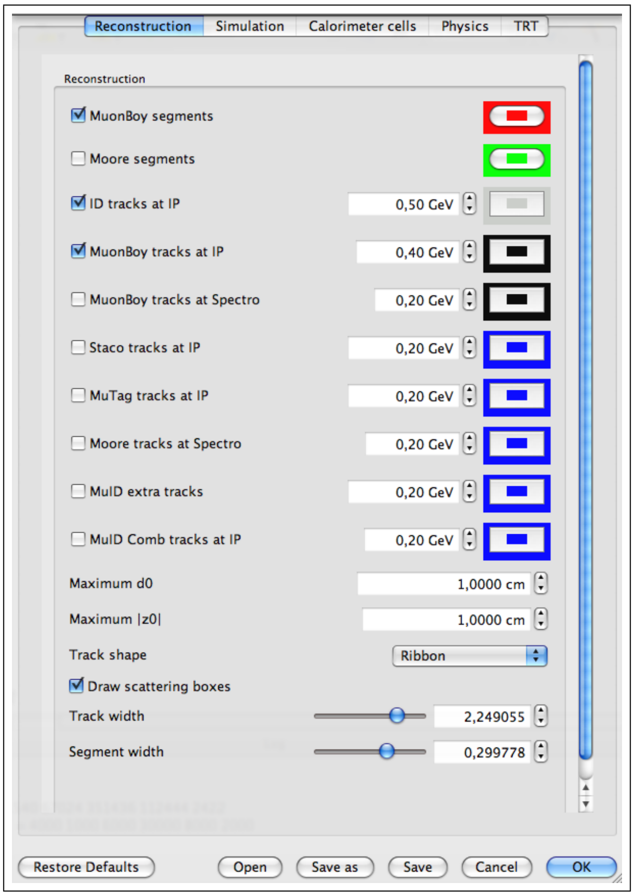


Figure 85: Selection made in the *Set track parameters* window to display Inner Detector tracks at the IP.

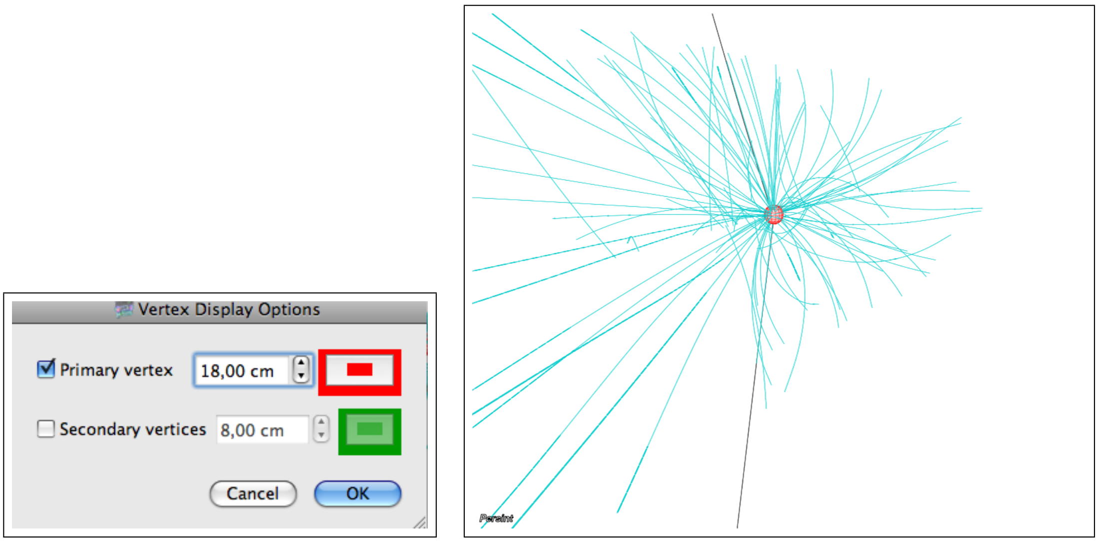
[1]Note that it is not necessary to display the Inner Detector tracks in order to display the primary vertex.

- Click on OK to close the window.
- Validate the selections by clicking on the *Compute* icon.

Compute

- Click on the *Display vertex candidates* icon of the event tool bar.
  In the window which opens, choose the Vertex display options: check the *Primary vertex* box and choose the size and color of the sphere which represents the primary vertex.

Display vertex candidates



(a) *Vertex Display Options*

(b) Display of Inner Detector (blue) and muon (black) tracks, and the primary vertex in red.

Figure 86: Display primary vertex.

- Click on OK to close the window.
- Zoom on the vertex region and obtain figure 86, with the Primary vertex displayed.

11.2.2 Histogram of $d0$ (primary vertex)

A histogram of the primary vertex candidates in an event is obtained by clicking on the item *Histogram of d0 distribution* in the *Events* menu (See Appendix E.5). The histogram can be saved in various formats [.png, .gif, .ps, .eps, .pdf, .C (ROOT macro)].

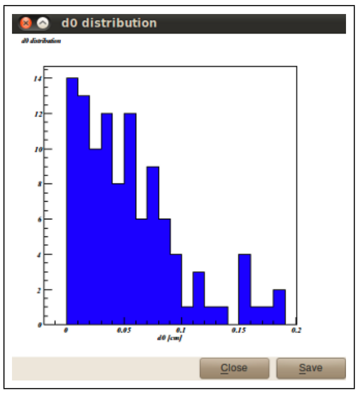


Figure 87: Histogram of $d0$: distribution of primary vertex candidates for a 7 TeV collision event.
Each Inner Detector track has an associated $d0$.
(Run 155678, Event 13304729)

11.3 Calorimeter data

11.3.1 *Display calorimeter hits*

Clear

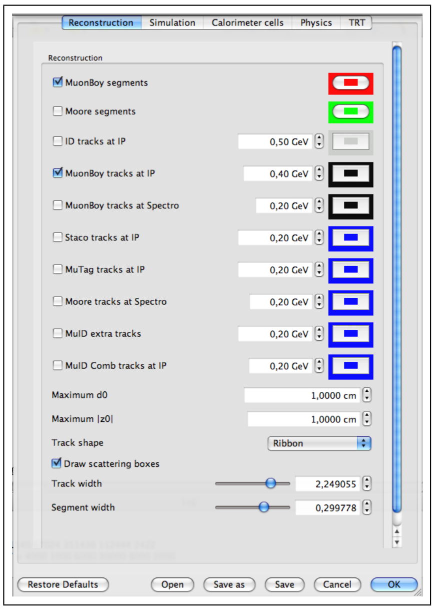
- Start with an empty main display by using the *Clear view* function.

Reload event

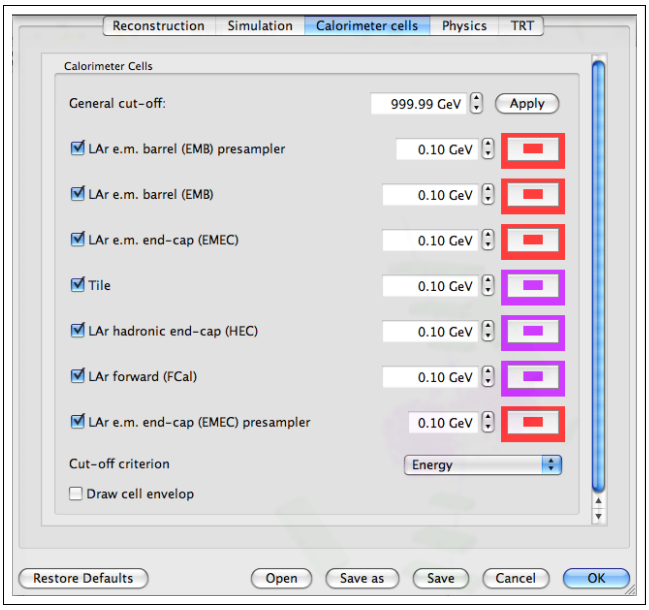
- Load the previous event again (Event 4023) with the *Reload event* function.

Set track parameters

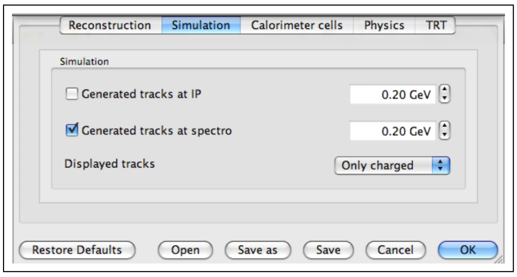
- Open the *Set track parameters* window and choose, in each of the four tabs, the values shown in figure 88. Make sure to select *Energy* as Cut-off criterion in the *Calorimeter cells* tab.



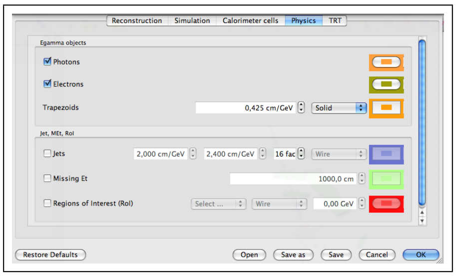
(a) Selections for *Reconstruction*



(b) Selections for *Calorimeter cells*



(c) Selections for *Simulation*



(d) Selections for *Physics objects*

Figure 88: Selection made to obtain the display of figure 89

- Click on OK to close the window.

Compute

- Validate the selections by clicking on the *Compute* icon.

Athena reconstruction

- To visualize the reconstructed muon tracks, click on the *Athena reconstruction* icon.

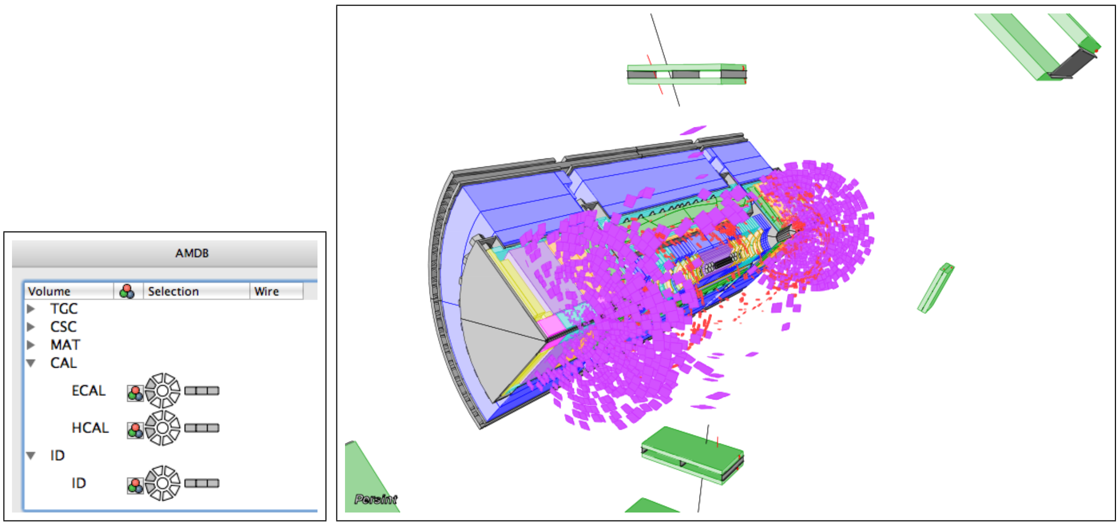
Hit calorimeter cells

- To visualize the calorimeter cells which have a signal, click on the *Hit calorimeter cells* icon.
- To dress the display with some detectors, make the selections in the AMDB pane of the *Selector window*, as shown in figure 89a.

Figure 89b is the result of these these selections and shows the reconstructed muon tracks, the calorimeter cells with hits and two sectors of the calorimeters and inner detector.

Save view as. . .

This display may now be saved for future use: click on the *Save view as. . .* icon and save the file as `exercise6-Calo-low-thresholds.p2vf` in your *Persint_working_files* directory.



(a) AMDB selection pane (b) Calorimeter hits (low thresholds)

Figure 89: Display of event 4023 with two reconstructed muon tracks, and hit calorimeter cells: electromagnetic liquid argon in red, [hadronic Tile, endcap, and forward c alorimeters] in purple

11.3.2 *Display calorimeter hits with increased thresholds*

1. **Display bare calorimeter hits**

   Starting with the display of figure 89b [1], we now change the thresholds for displaying calorimeter hits, as they were set very low in the default settings.

Set track parameters

   Open the *Set track parameters* window and change the values according to figure 90. Note that the thresholds may be set for *Energy* or *Transverse energy*. Instead of setting the parameters by hand, you may load the prepared *Track parameter* file which we already used in section 6.1.2, item 3. Click on Open and select `Zmumu4023.p2ts` in the *Persint-00-02-••/example* directory. Click on OK and then on the *Compute* icon. Activate the *Athena reconstruction* and *Hit calorimeter cells* icons to obtain the display of figure 91.

C ute

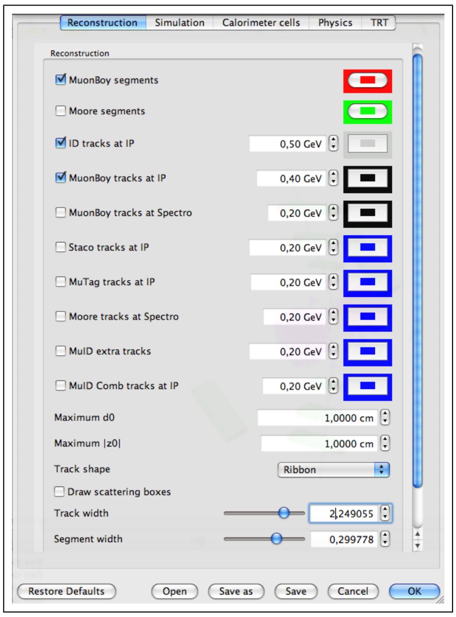
Athena reconstruction

Hit calorimeter cells

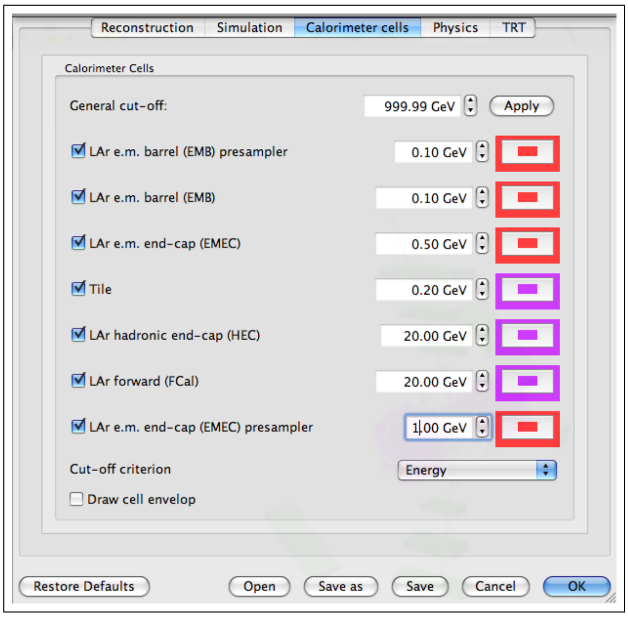
   Note that the dressing with calorimeter and Inner detector sectors has been removed by clicking in the center of the three wheels of figure 89a.

   Note also that since the "*ID tracks at IP*" box is checked with a 0.5 GeV/c threshold (Fig. 90), Inner detector tracks are displayed as well.

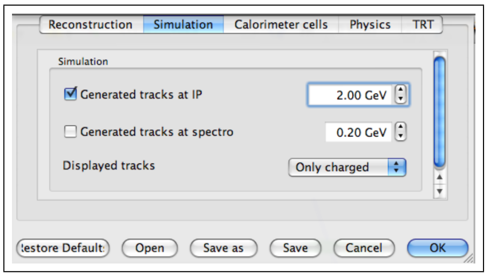
[1] In case the work was interrupted, remember that the display was saved as a `.p2vf` file.



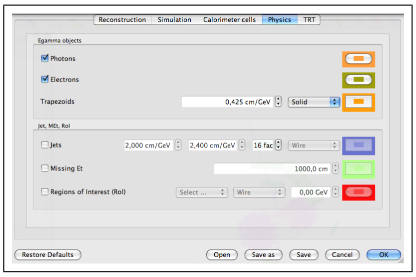
(a) Selections for *Reconstruction*



(b) Selections for *Calorimeter cells*



(c) Selections for *Simulation*



(d) Selections for *Physics objects*

Figure 90: Selection made to obtain the display of figure 91

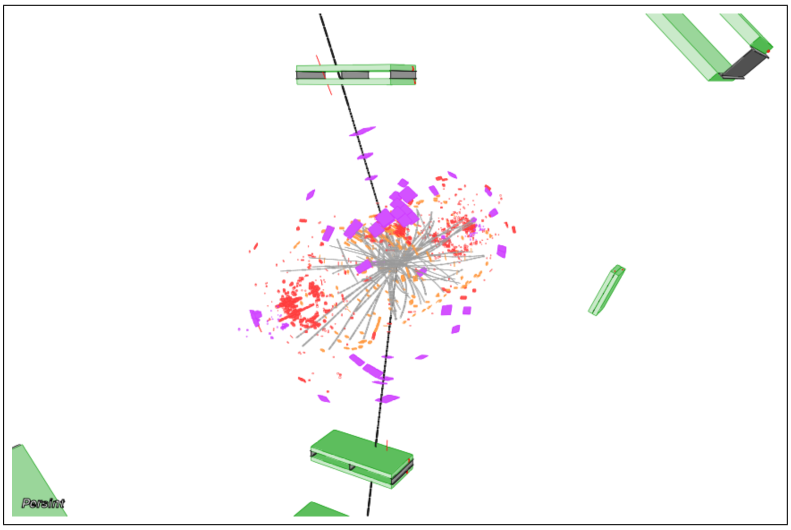


Figure 91: Display of event 4023 with increased thresholds for calorimeter hits: essentially 2 *GeV* in forward calorimeters. Reconstructed Inner detector tracks are also displayed

2. **Display calorimeter hits inside cell envelopes**

   In the *Set track parameters* window (Calorimeter Cells), check the *Draw cell envelope* box and increase the threshold of *"LAr e.m. end-cap (EMEC)"* to 0.5 *GeV*, and to 2 *GeV* for "HEC" and "FCal" (Fig. 92). Save the selections as a `.p2ts` file with the Save box of the *Set track parameters* window.

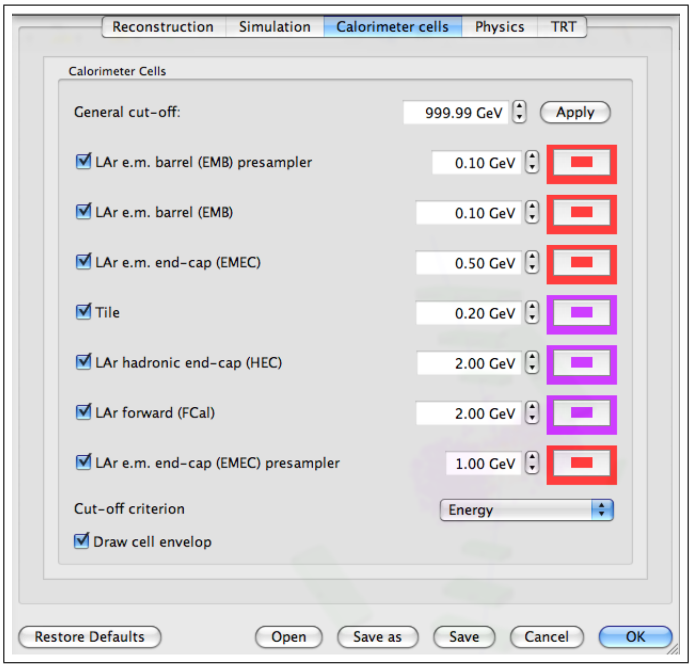


Figure 92: Selection of thresholds and cell envelopes to obtain the display of figure 93

After making an X-projection and after some zooming, we obtain the display of figure 93.

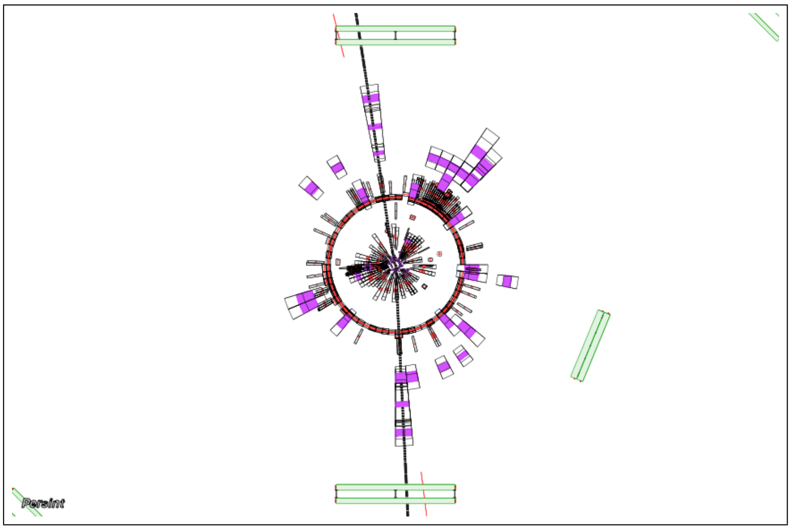


Figure 93: Display of event 4023 (X-projection) with increased thresholds for calorimeter hits shown within cell envelopes

11.3.3 *Histogram of calorimeter hits*

Note that the use of the *Histogram* facility requires that the dependency for *QtROOT* be satisfied (see Appendix B).
We start again with Event 4023 of the `Out.MboyView_Zmumu4023` file.
Open the *Set track parameters* window and choose [Restore defaults]. Once the event is displayed, click on the *Histogram of hit calorimeter cells* (also available in the *Tools* menu). The histogram is displayed in figure 94 and shows the cell energy as a function of *Eta* (Pseudo rapidity η) and *Phi* (Azimutal angle ϕ).

Histogram of . . .

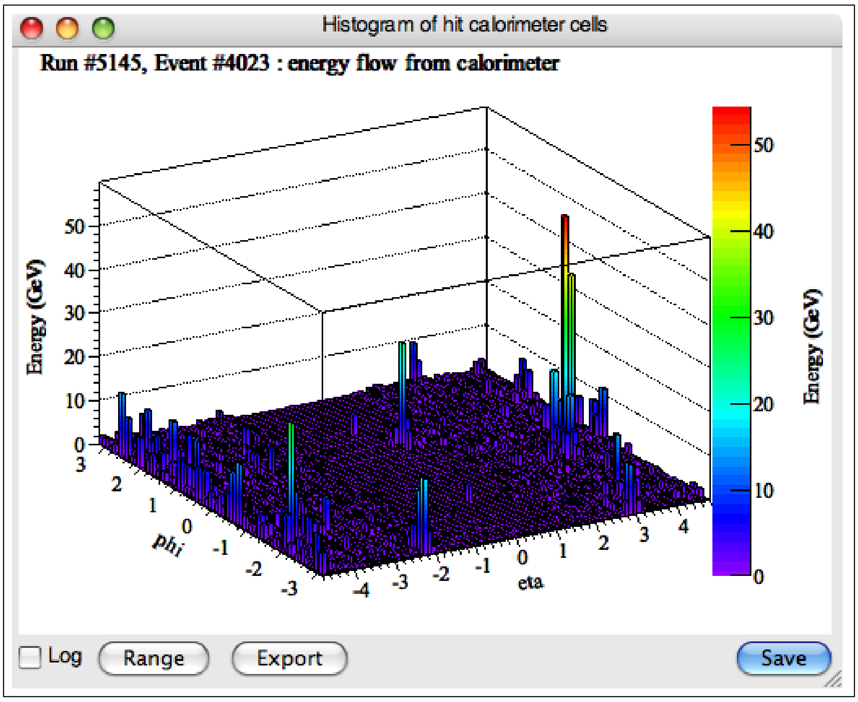


Figure 94: Histogram of hit calorimeter cells (low thresholds)

We now increase the thresholds of the cell energy in the *Set track parameters* window as shown in figure 95.

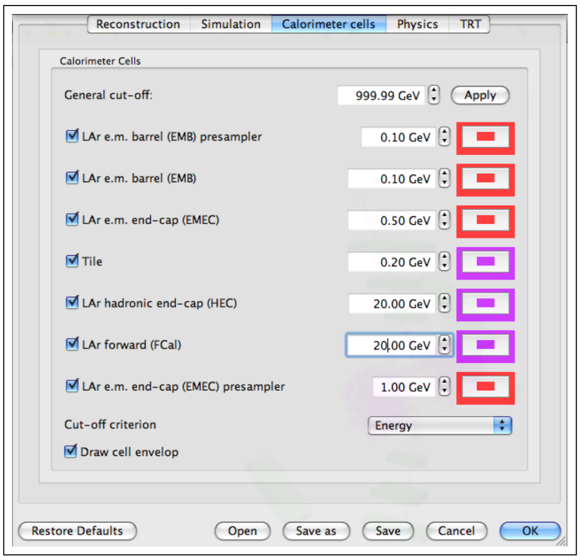


Figure 95: Selection of high thresholds in the *Set track parameters* window: energy thresholds of LAr HEC and FCal have been set to 20 *GeV*.

Compute

To display the modified histogram, close the *Set track parameters* window by clicking on the OK box and then on the *Compute* icon.

Histogram of . . .

Finally, clicking on the *Histogram of hit calorimeter cells* icon two times, displays the modified histogram (Fig. 96).

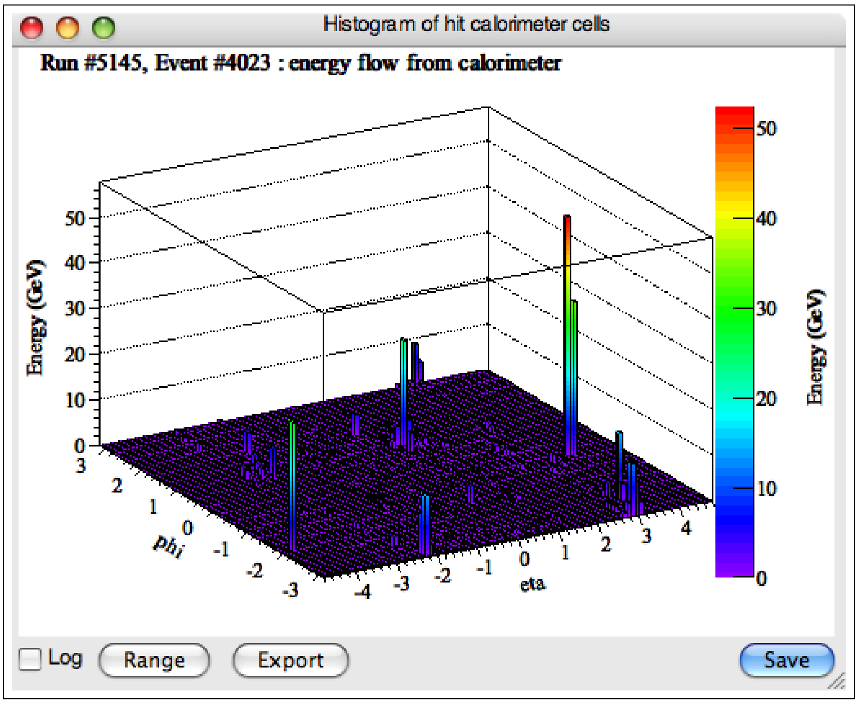
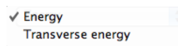


Figure 96: Histogram of hit calorimeter cells (high thresholds)



Cut-off criterion

Note that calorimeter cell thresholds may be set according to *Energy* or *Transverse energy*. The selection is made via the *Cut-off criterion* box in the *Set track parameters* window.

Aspect of histogram

The histogram can be resized or displaced at will by using the pop-up window obtained by `right-clicking` on the title bar of the histogram window.
With *Maximize*, the histogram will occupy the entire area of the Main display.
With *Minimize*, the histogram is reduced to a "tab" at the bottom of the display, and can be retrieved with *Restore*.
Just as with previous maps (9.7.3, 9.8, and 9.9), the histogram can be exported as an `ASCII` file (`.dat` format) with the Export button.

The histogram can be saved by clicking on the Save box. A number of formats are proposed, as shown in figure 97.

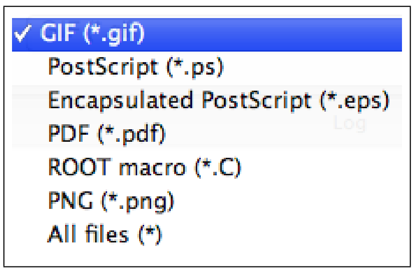


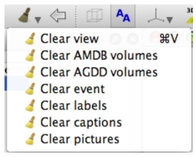
Figure 97:
File formats proposed when saving the *Histogram of hit calorimeter cells*

Note that, when scanning events (see section 10.8), the histogram is automatically refreshed when a new event is displayed.

11.4 Physics objects

11.4.1 Jets

Reconstructed jets can be shown as labels placed on calorimeter cells.
We will use a real event from data collected in 2011. First clear the display by clicking on *Clear view* in the *Clear* icon menu.



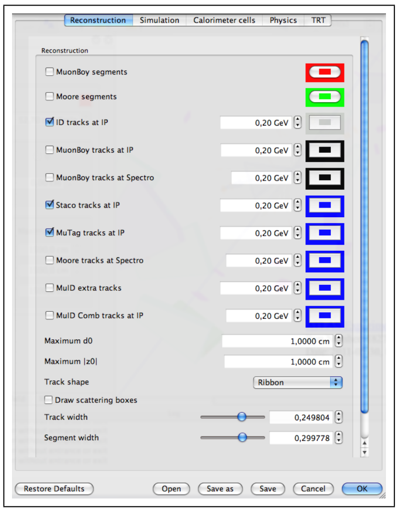
Clear view

Open the *Data manager* window and load the file `Out.MboyView-74566644-1` from the `Persint-00-02-●●/example` directory. Answer "Yes" to the suggestion to load the proper geometry file.
Open the *Set track parameters* window and click on *Restore defaults*. This will result in the parameters to be set according to figure 98 which shows the parameters for *Reconstruction*, *Calorimeter cells*, and *Physics*. In particular, use the *Physics* window (Fig. 98c) to set the parameters for displaying the jets:

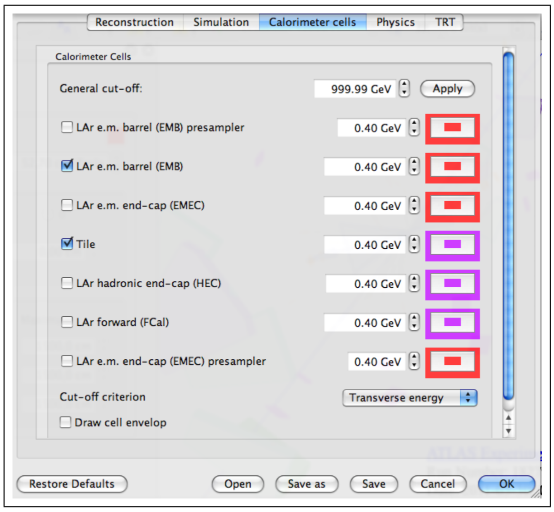
- check the *Jets* box
- set the scale (in cm/GeV) for the jet cone (box 1)
- set the scale (in cm/GeV) of the arrow of the jet axis (box 2)
- choose the number of faces of the jet cone
- choose the *wire* or *solid* mode for the jet cone

Click on *OK* and then on the *Compute* icon[1].

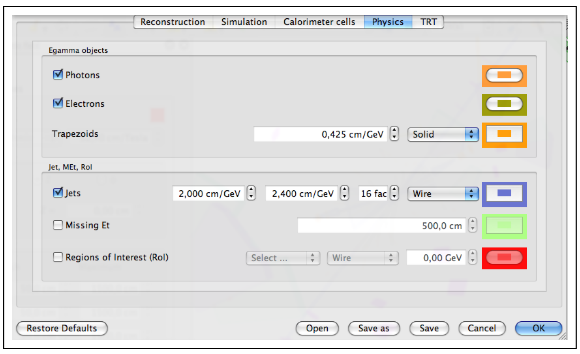

Compute



(a) Selections for *Reconstruction*



(b) Selections for *Calorimeter cells*



(c) Selections for *Physics* objects

Figure 98: Selection made for displaying jets in event 74 566 644 (Fig. 99).

[1] Remeber that it is usually necessary to click on the *Compute* icon after closing the *Set track parameters* window.

Add the default caption by `right-clicking` on an empty space of the display.
Add default labels by `right-clicking` on one of the jet axes and one of the jets cones.
The result is shown in figure 99.
Note that the size (scale) of the jet cones and jet arrows, as well as the color (blue in figure 99) can easily be modified in the *Set track parameters* window, *Physics* tab.

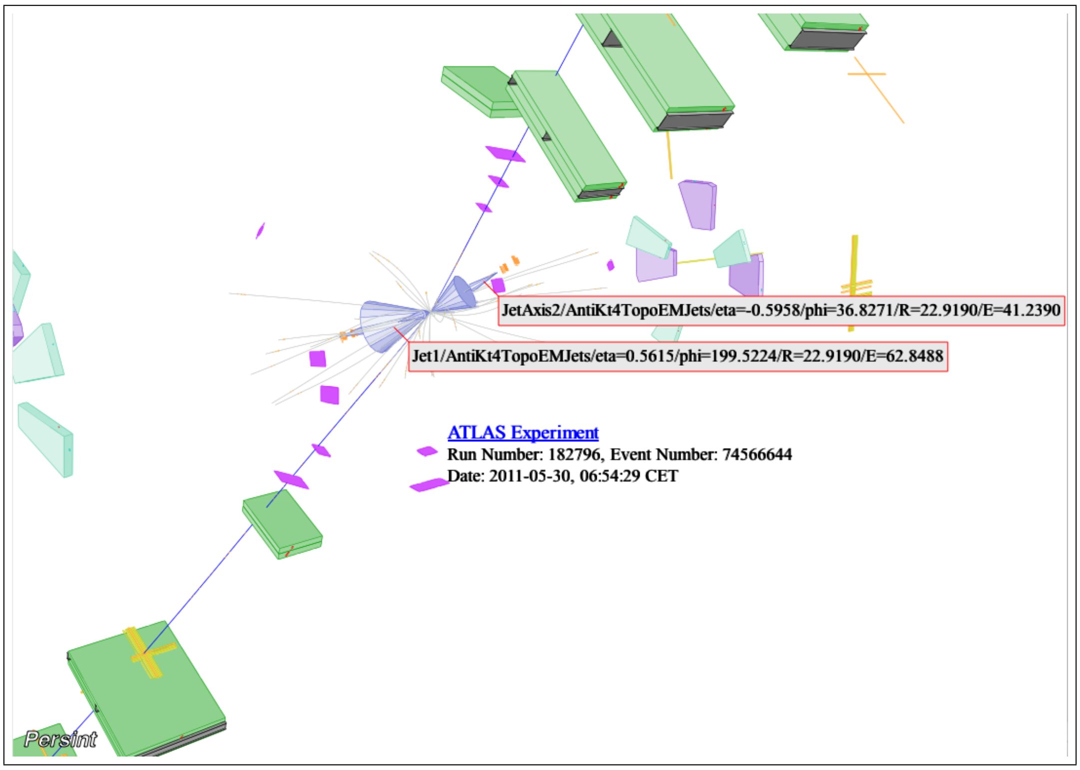


Figure 99: Display of an event from 2011 data where the "jet" feature is illustrated.

11.4.2 Missing E_T

A vector representing the calculated missing transverse energy (missing E_T) can be drawn in the following way:
Click on the *Set track parameters* icon in the *Events* tool bar (or use the *Events* menu), and go to the *Physics* tab. Check the *Missing E_T* box, and hit the *Compute* icon. Note that the legnth of the arrow does not reflect the size of missing E_T, but is determined by the value (in cm) given in the spin box in the Missing E_T line of the *Set track parameters* window. The color of the arrow (green in figure 100) can be chosen in the *Set track parameters* window, *Physics* tab (Fig. 98c).
The value of the Missing E_T can be looked up in the information box which appears when placing the cirsor on the arrow. The same information appears if one inserts a "label" by `right-clicking` on the Missing E_T arrow. Note that the value of the Missing E_T corresponds to the variable `MET_RefFinal`.
Figure 100 shows the same event with the Missing E_T arrow.
Another illustration of the "Missing E_T" feature can be found in figure 125.

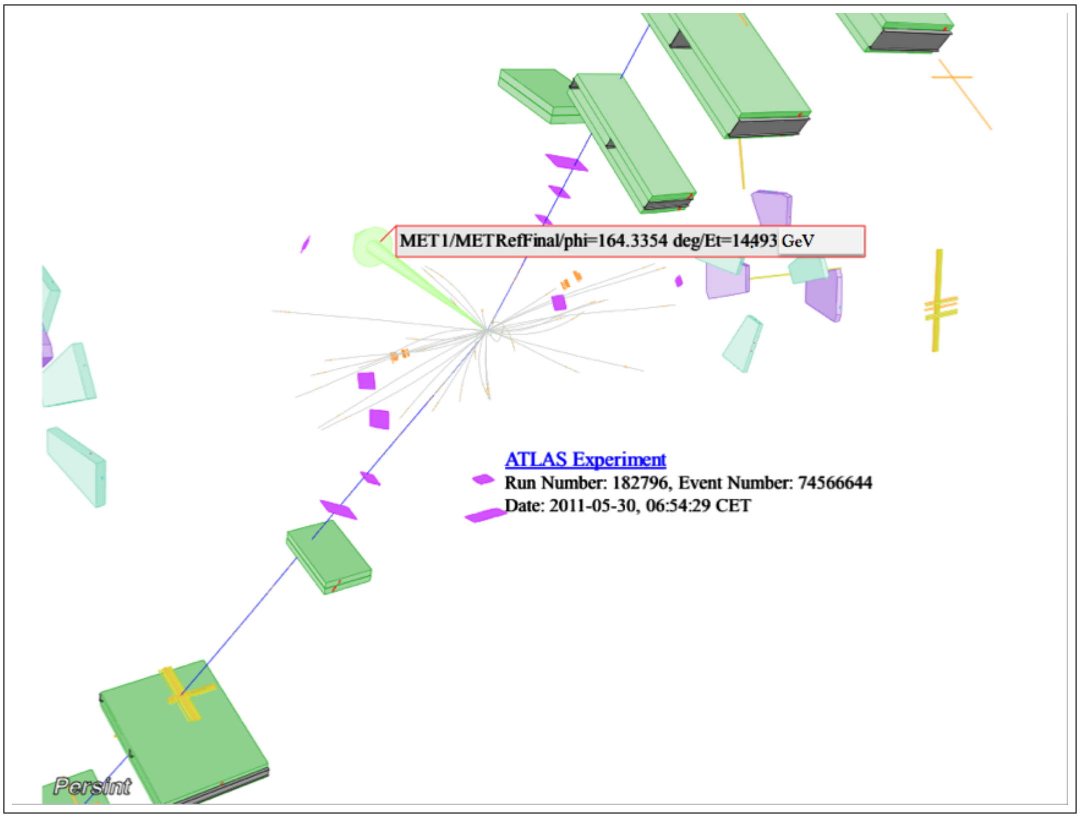


Figure 100: Display of the same event where the "Missing E_T" feature is illustrated.

11.4.3 RoI (Regions of Interest from trigger)

Under development

12 *Persint*: a versatile tool

12.1 An analysis tool

Many features of *Persint* can be used for illustrating the properties of the muon spectrometer. For example, the *Generate muon tracks* function is a convenient tool for studying the behavior of muons in the spectrometer. In the early collision data of 2009, a charge asymmetry of low energy muons was spotted in the forward regions.

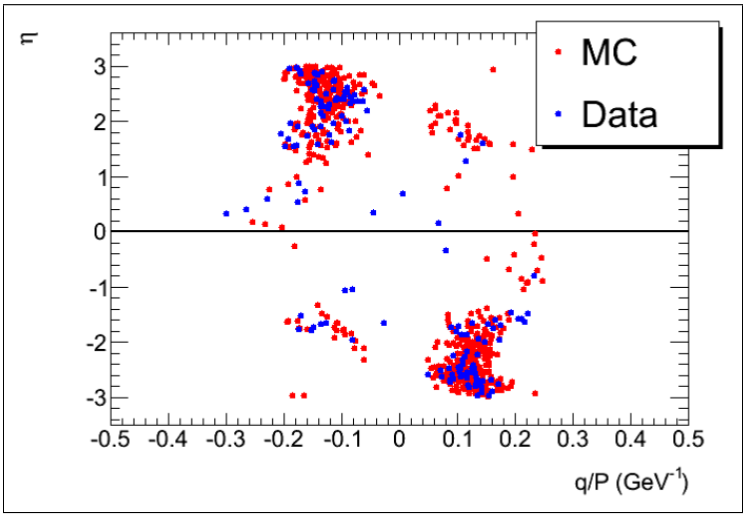


Figure 101: Scatter plot showing the μ^-/μ^+ asymmetry: μ^- are more numerous in the $\eta > 0$ region, whereas μ^+ are more numerous in the $\eta < 0$ region. This is true for 900 *GeV* collision data and Monte Carlo events.

The effect has its explanation in a rather subtle acceptance property of the spectrometer for positively and negatively charged muons. *Persint* was used to illustrate this behavior [7].

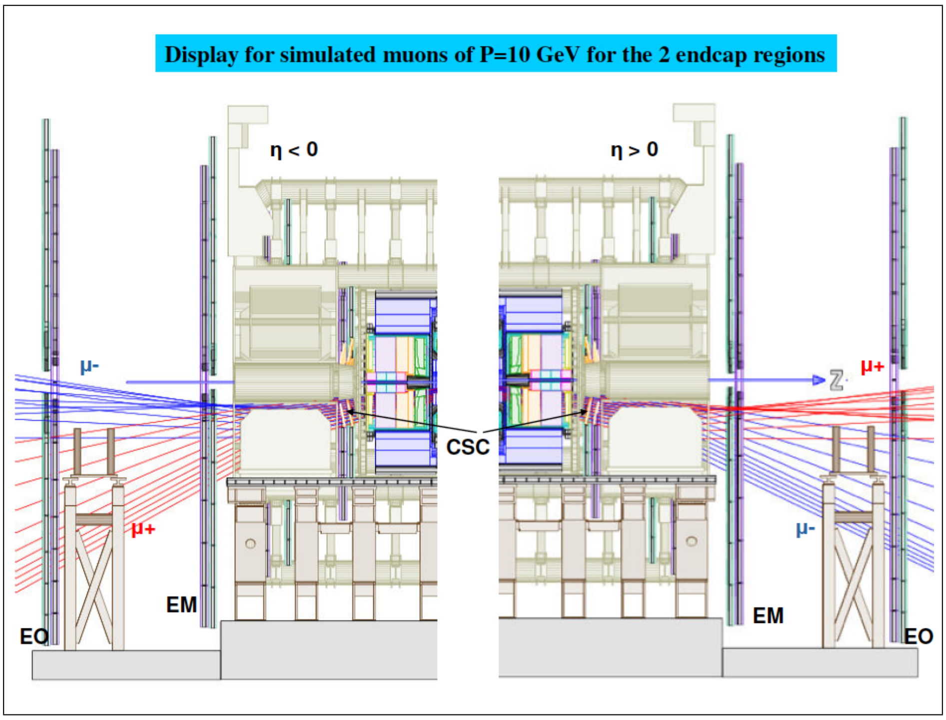
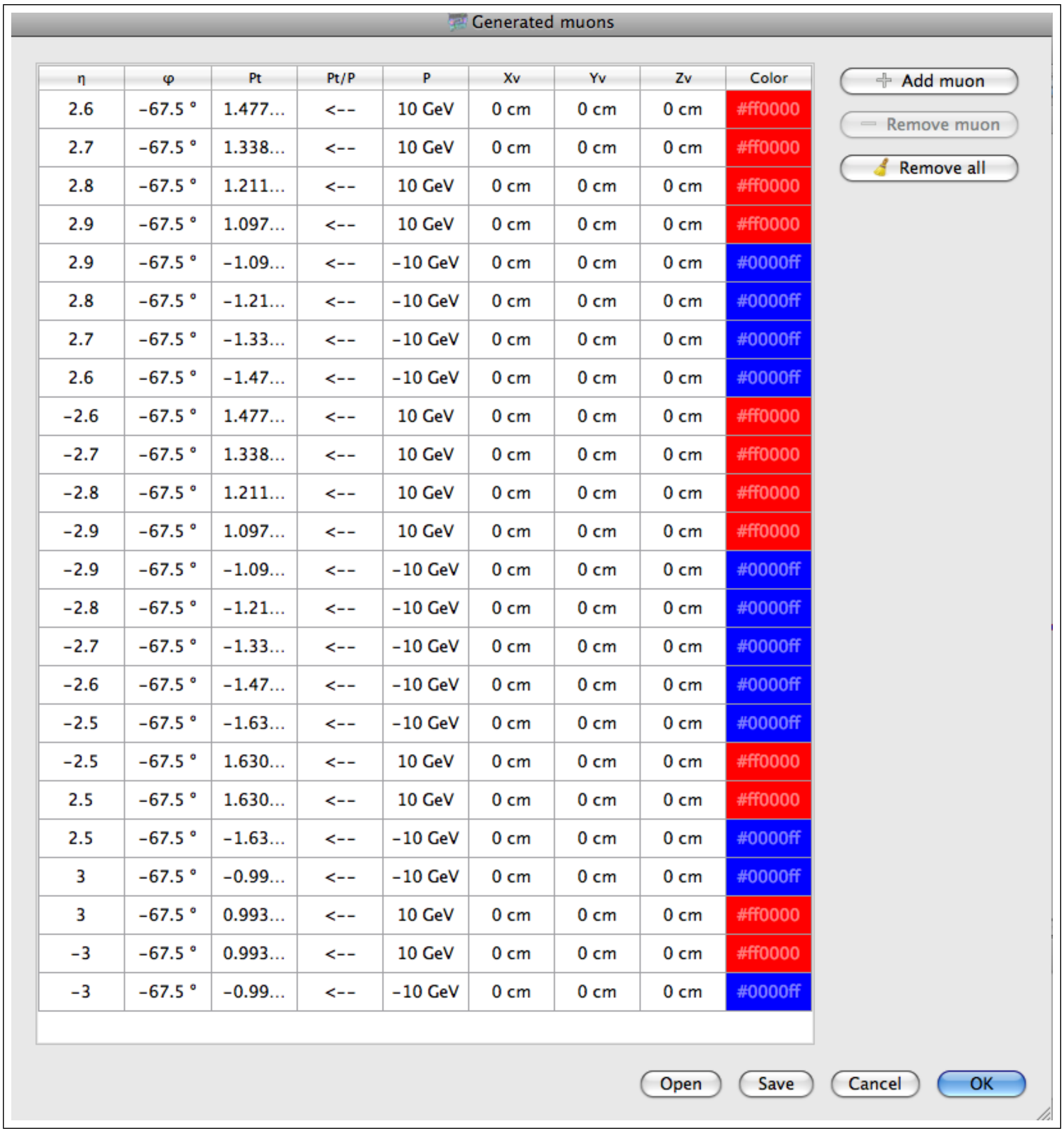


Figure 102: Illustration of the charge asymmetry of forward low energy muons in 900 *GeV* collision data. The intricate acceptance effect is illustrated with generated positive (red) and negative (blue) muons in the forward regions.

The muons of figure 102 have been generated with the parameters shown in the *Generate muon tracks* window of figure 103: $P = 10\ GeV$ and $\mid \eta \mid \in [2.5, 3.0]$



η	φ	Pt	Pt/P	P	Xv	Yv	Zv	Color
2.6	-67.5 °	1.477...	<--	10 GeV	0 cm	0 cm	0 cm	#ff0000
2.7	-67.5 °	1.338...	<--	10 GeV	0 cm	0 cm	0 cm	#ff0000
2.8	-67.5 °	1.211...	<--	10 GeV	0 cm	0 cm	0 cm	#ff0000
2.9	-67.5 °	1.097...	<--	10 GeV	0 cm	0 cm	0 cm	#ff0000
2.9	-67.5 °	-1.09...	<--	-10 GeV	0 cm	0 cm	0 cm	#0000ff
2.8	-67.5 °	-1.21...	<--	-10 GeV	0 cm	0 cm	0 cm	#0000ff
2.7	-67.5 °	-1.33...	<--	-10 GeV	0 cm	0 cm	0 cm	#0000ff
2.6	-67.5 °	-1.47...	<--	-10 GeV	0 cm	0 cm	0 cm	#0000ff
-2.6	-67.5 °	1.477...	<--	10 GeV	0 cm	0 cm	0 cm	#ff0000
-2.7	-67.5 °	1.338...	<--	10 GeV	0 cm	0 cm	0 cm	#ff0000
-2.8	-67.5 °	1.211...	<--	10 GeV	0 cm	0 cm	0 cm	#ff0000
-2.9	-67.5 °	1.097...	<--	10 GeV	0 cm	0 cm	0 cm	#ff0000
-2.9	-67.5 °	-1.09...	<--	-10 GeV	0 cm	0 cm	0 cm	#0000ff
-2.8	-67.5 °	-1.21...	<--	-10 GeV	0 cm	0 cm	0 cm	#0000ff
-2.7	-67.5 °	-1.33...	<--	-10 GeV	0 cm	0 cm	0 cm	#0000ff
-2.6	-67.5 °	-1.47...	<--	-10 GeV	0 cm	0 cm	0 cm	#0000ff
-2.5	-67.5 °	-1.63...	<--	-10 GeV	0 cm	0 cm	0 cm	#0000ff
-2.5	-67.5 °	1.630...	<--	10 GeV	0 cm	0 cm	0 cm	#ff0000
2.5	-67.5 °	1.630...	<--	10 GeV	0 cm	0 cm	0 cm	#ff0000
2.5	-67.5 °	-1.63...	<--	-10 GeV	0 cm	0 cm	0 cm	#0000ff
3	-67.5 °	-0.99...	<--	-10 GeV	0 cm	0 cm	0 cm	#0000ff
3	-67.5 °	0.993...	<--	10 GeV	0 cm	0 cm	0 cm	#ff0000
-3	-67.5 °	0.993...	<--	10 GeV	0 cm	0 cm	0 cm	#ff0000
-3	-67.5 °	-0.99...	<--	-10 GeV	0 cm	0 cm	0 cm	#0000ff

Figure 103: List of muon tracks generated in figure 102. Muons of momentum $P = 10\ GeV$ have been generated at the IP and propagated through the calorimeters, using the *Generate muon tracks* function (section 7.1)

12.2 Study of the geometry and dead material

Persint has been used to optimize the muon spectrometer throughout the design phase. At present it is the tool with which the most recent layout and the dead material content of ATLAS support structures are being introduced into the geometry description used by the reconstruction software.
As an example, the latest barrel toroid cryotube structure has been introduced into the geometry. With this study using *Persint* the primary numbers entering the geometry data base have been updated.[1]

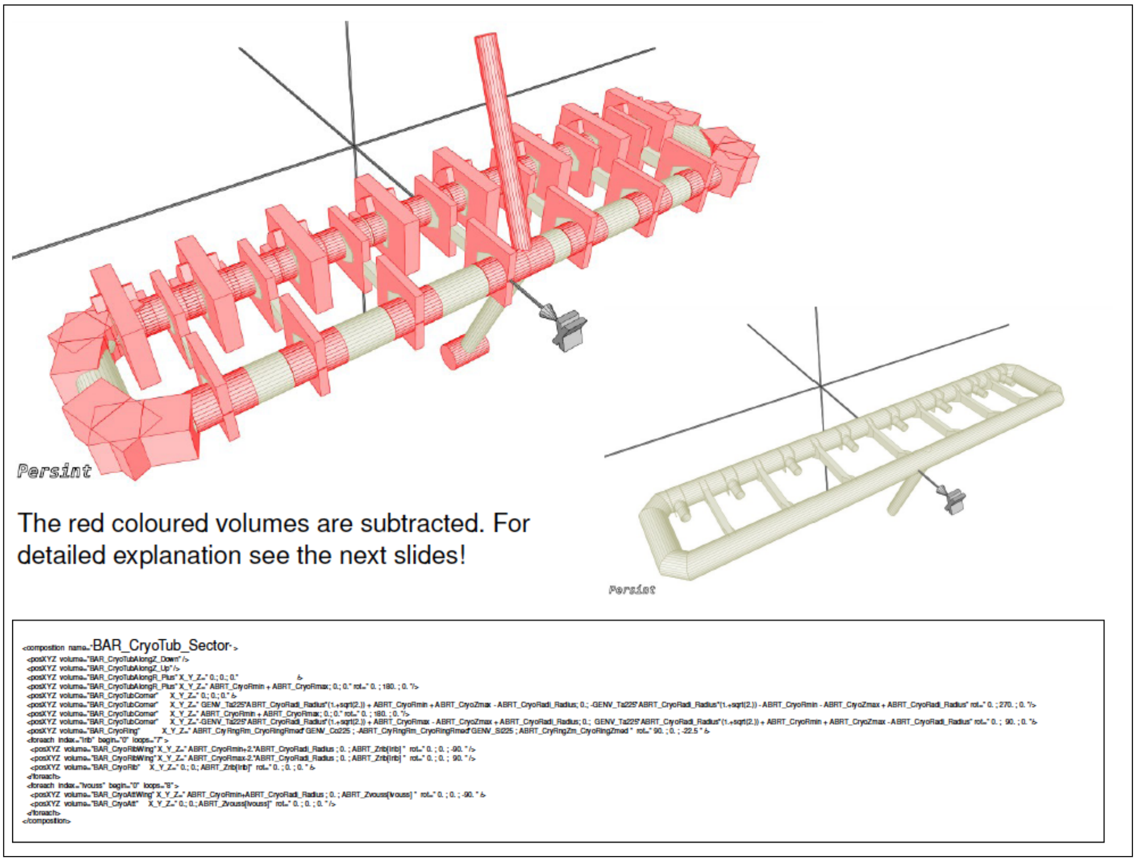
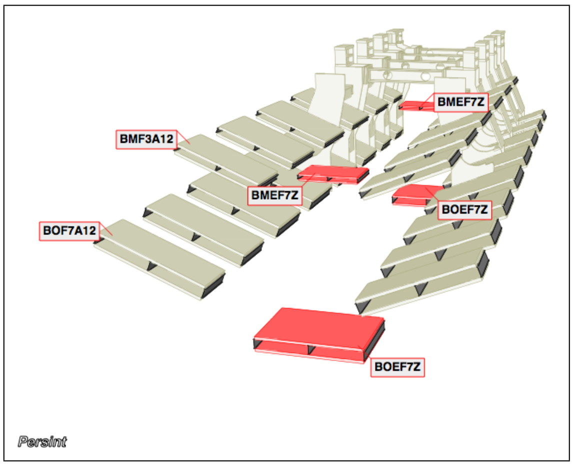


Figure 104: Using *Persint* for the geometry description: the modified volumes are visualized and the primary numbers are entered into the data base.

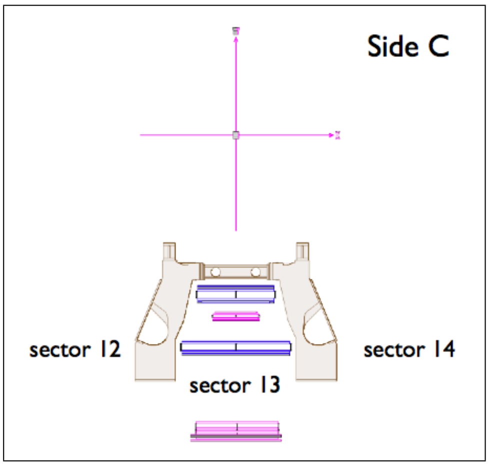
[1]The *GEOMODEL* in particular uses these primary numbers.

12.3 New MDT chambers: layout and geometrical acceptance

During the long shut down of 2013-2014, additional MDT chambers (so called "*Elevator chambers*") are being installed in the barrel part of the muon spectrometer. The goal is to cover areas in the feet region (Sector 13) where the original layout has acceptance holes. Figure 105 shows the location of the new MDT chambers.
The layout is implemented in the geometry data base and is checked with *Persint*. In particular, the geometrical acceptance is verified by reconstructing muon tracks with the built in reconstruction program *Muonboy*.
Persint is the only tool available for these studies as a stand alone software package and is used to display the new chambers in their environment, resolve geometrical clashes and reconstruct tracks using the new geometry data base. The standard ATLAS software is not capable of such flexibility and rapid response.



(a) 3D view



(b) Z view

Figure 105: Layout of the new MDT chambers (BME and BOE)

Figure 106 shows the new BME and BOE chambers and illustrates how they close the holes in the MDT coverage. Generated tracks with the momentum and direction indicated in the box are shown in red. Some tracks which cross two stations (BIL and [BML or BOL]) are now crossing one additional MDT chamber.

Note the tilted RPC chamber in the BOE station on the left. The tilt is needed because of an obstacle in the floor structure. This particular geometry is implemented in the latest `AMDB` data base so that in *Persint* the built in *Muonboy* program is able to reconstruct tracks crossing this station, even though the RPC chamber is tilted and the station is outside the standard ATLAS GEANT4 fiducial volume. The reconstructed track is shown in figure 107[1].

[1] Some illustrations are taken from a presentation by Vasiliki Kouskoura (Muon Software Meeting, June 6, 2013):
https://indico.cern.ch/getFile.py/access?contribId=9&resId=0&materialId=slides&confId=256006

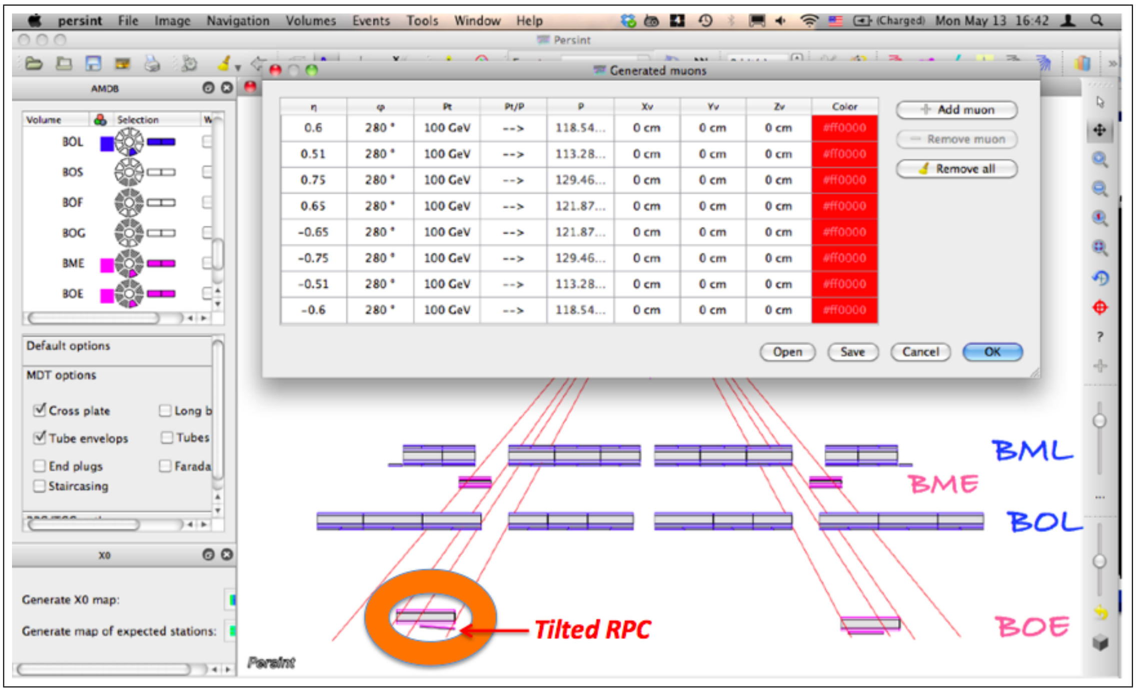


Figure 106: The new MDT chambers in *Persint*.

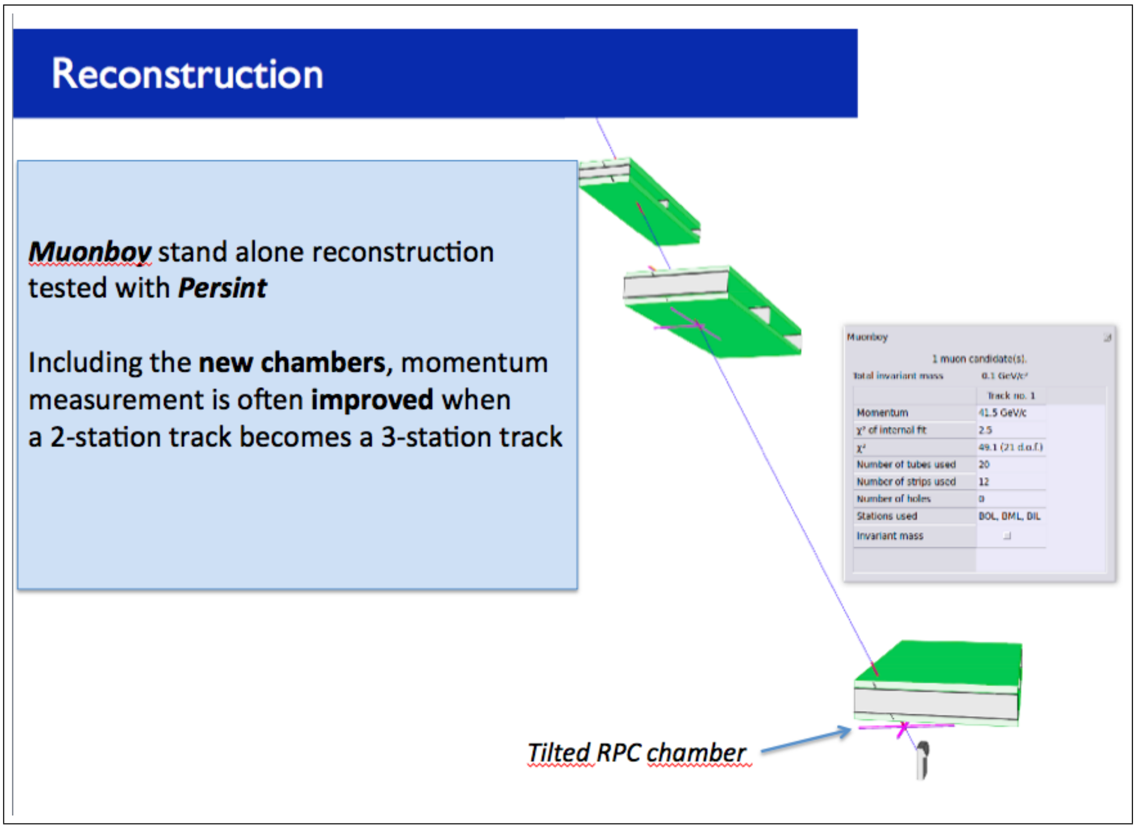


Figure 107: Reconstructed muon in the new MDT chambers, using *Persint* and *Muonboy*.

12.4 ATLAS Upgrade studies: New Small Wheel

PERSINT was used during the 2013-2014 shutdown to check the geometry (`AMDB` primary numbers) of the new small wheel Micromegas chambers. Several checks and improvements have been made. These studies were only possible with *PERSINT* because it is a standalone program which is not hindered by the rigid data base structure in *ATHENA*. The turnaround is fast enough to be efficient and useful for such studies.

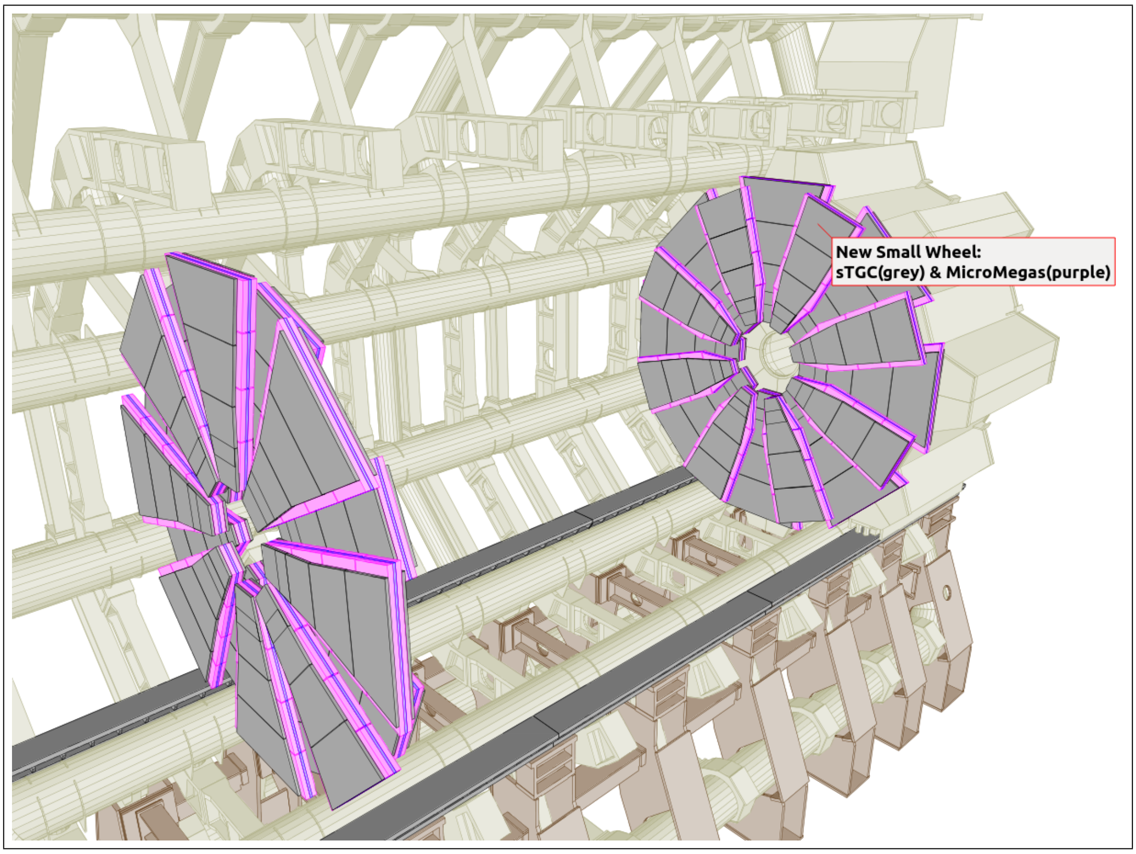


Figure 108: Layout including the New Small Weels:
the sTGC's are in grey, the MicroMegas detectors in purple

13 Selected event displays

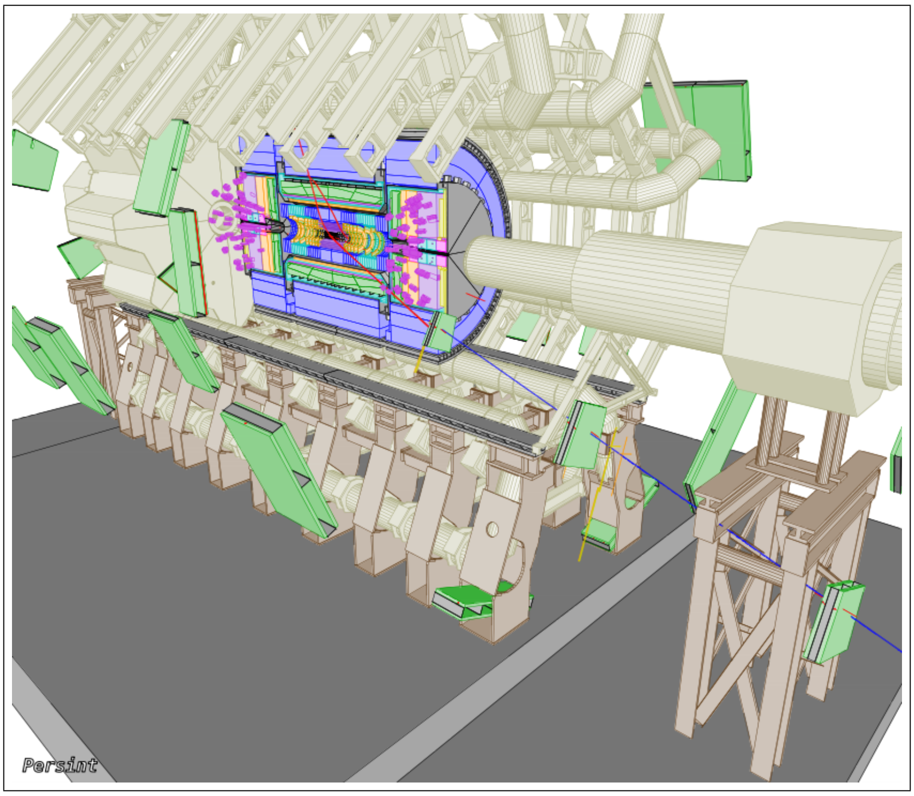


Figure 109: *Min Bias* event in 900 *GeV* data: Run 141749, Event 113661. (December, 2009)

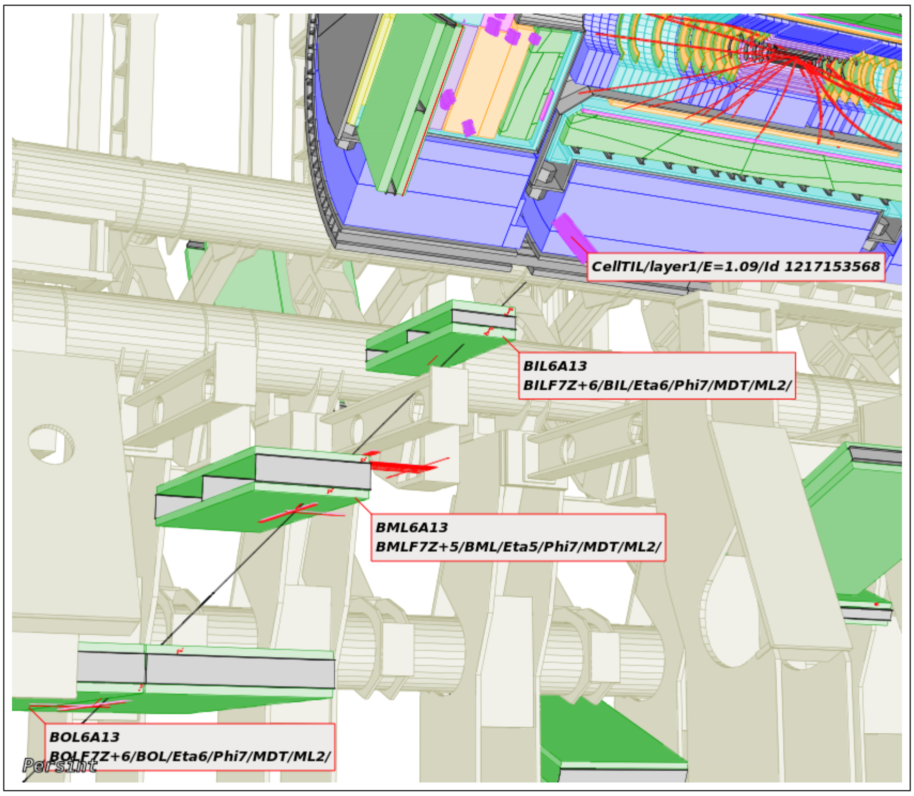


Figure 110: *Min Bias* event in 900 *GeV* data: Run 141749, Event 171059. (December, 2009)

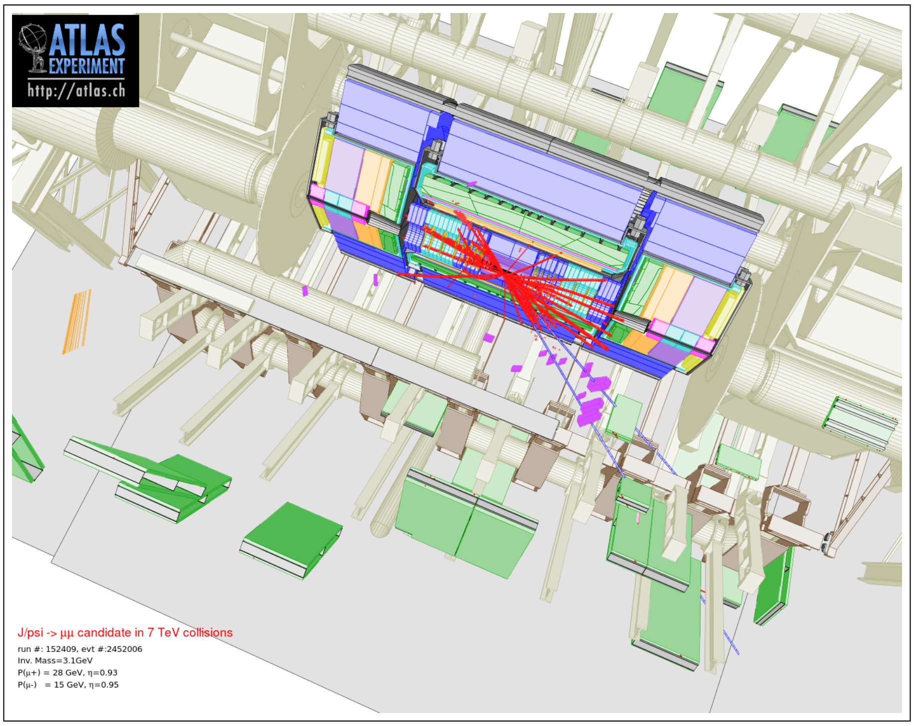


Figure 111: A $J/\Psi \to \mu\mu$ candidate in the 7 TeV collision data of 2010.

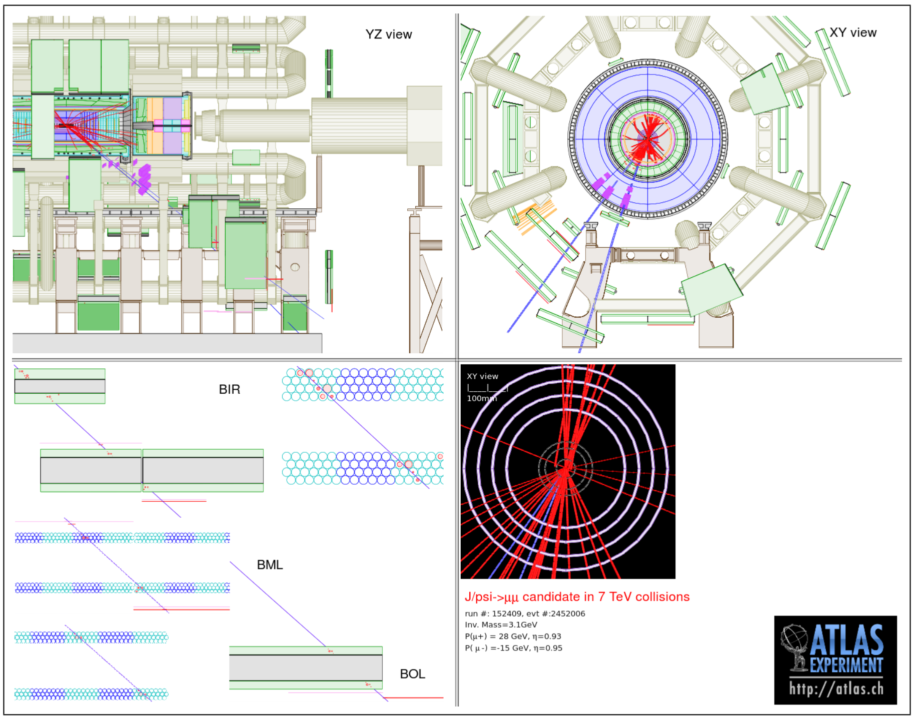


Figure 112: The same $J/\Psi \to \mu\mu$: in 2D projections and details of track reconstruction.

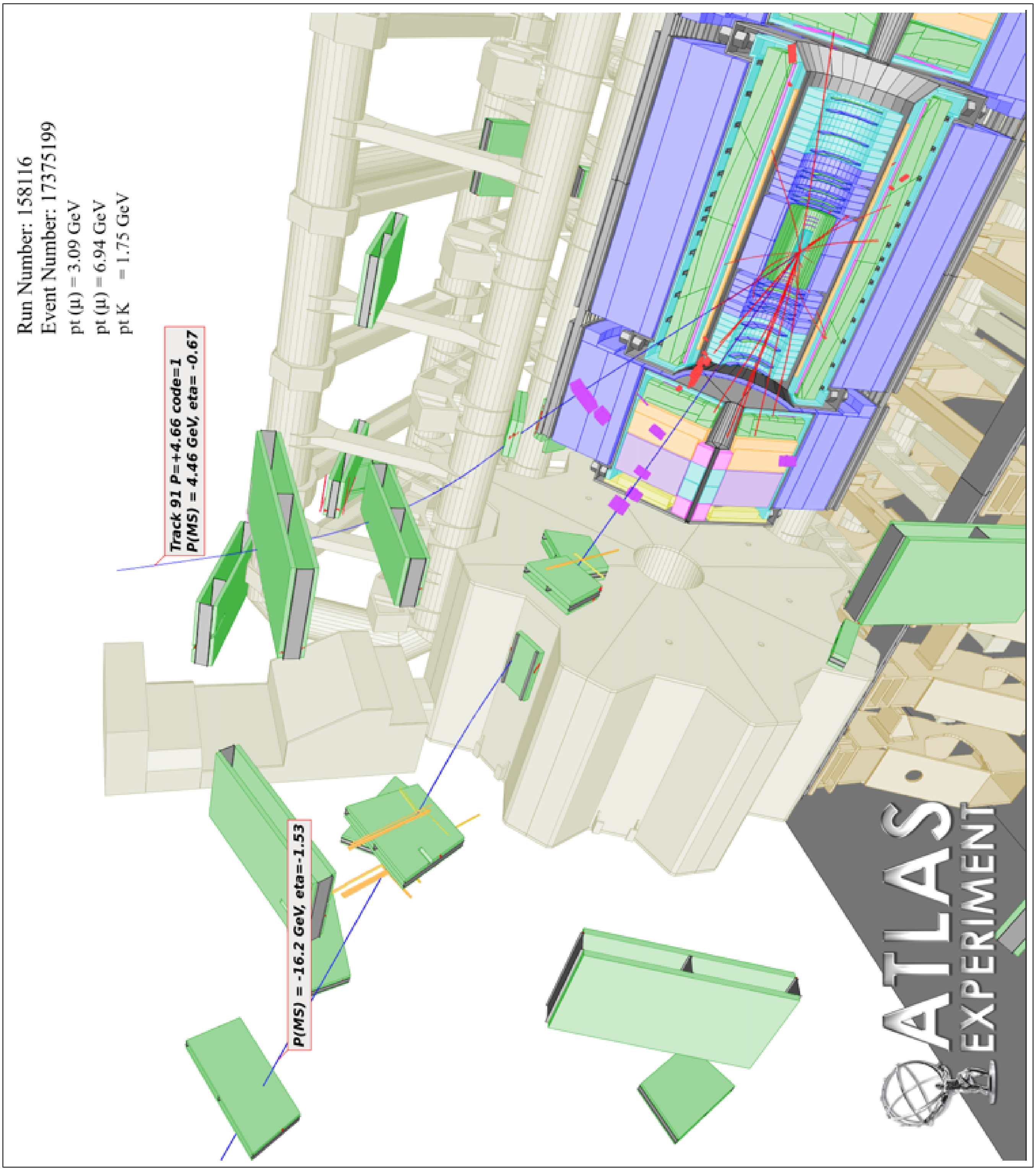


Figure 113: A second $J/\Psi \to \mu\mu$ candidate in the 7 TeV collision data of 2010.

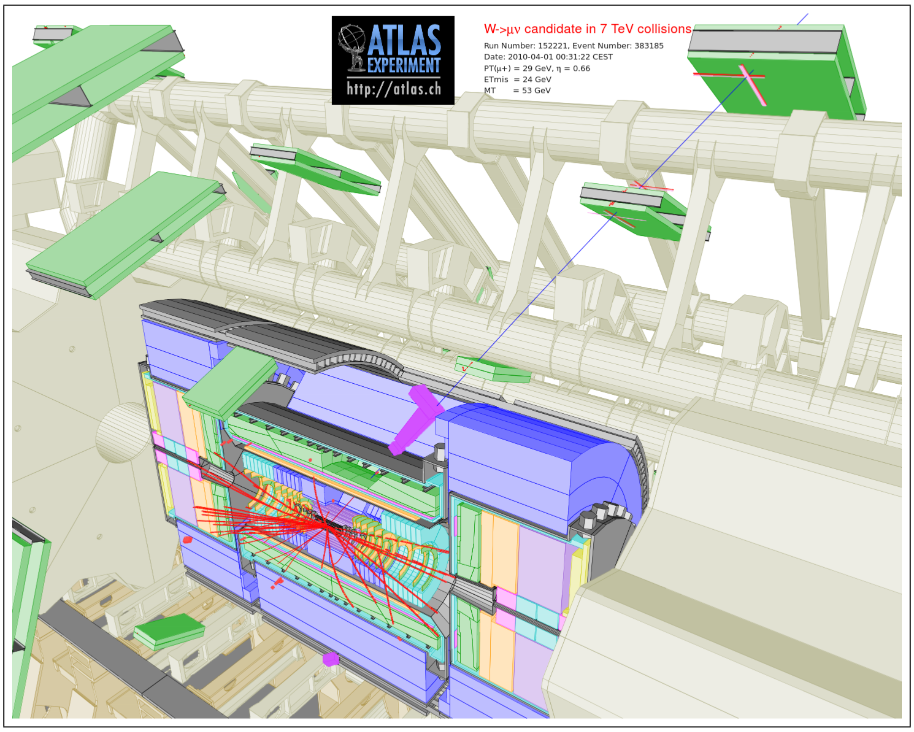


Figure 114: A $W \to \mu\nu$ candidate in the 7 TeV collision data of 2010.

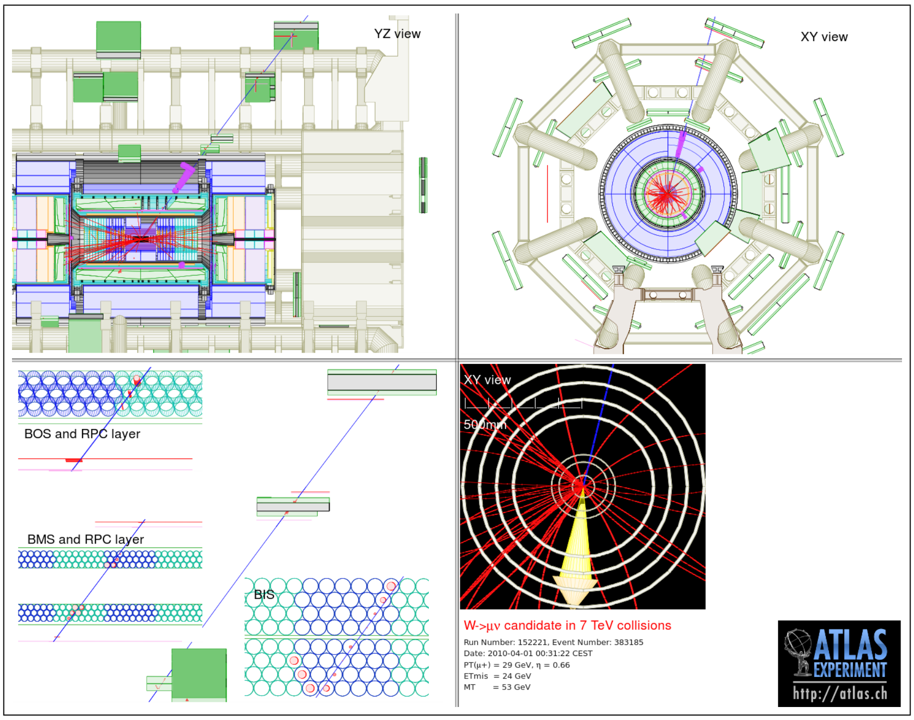


Figure 115: The same $W \to \mu\nu$ candidate: in 2D projections and details of track reconstruction.

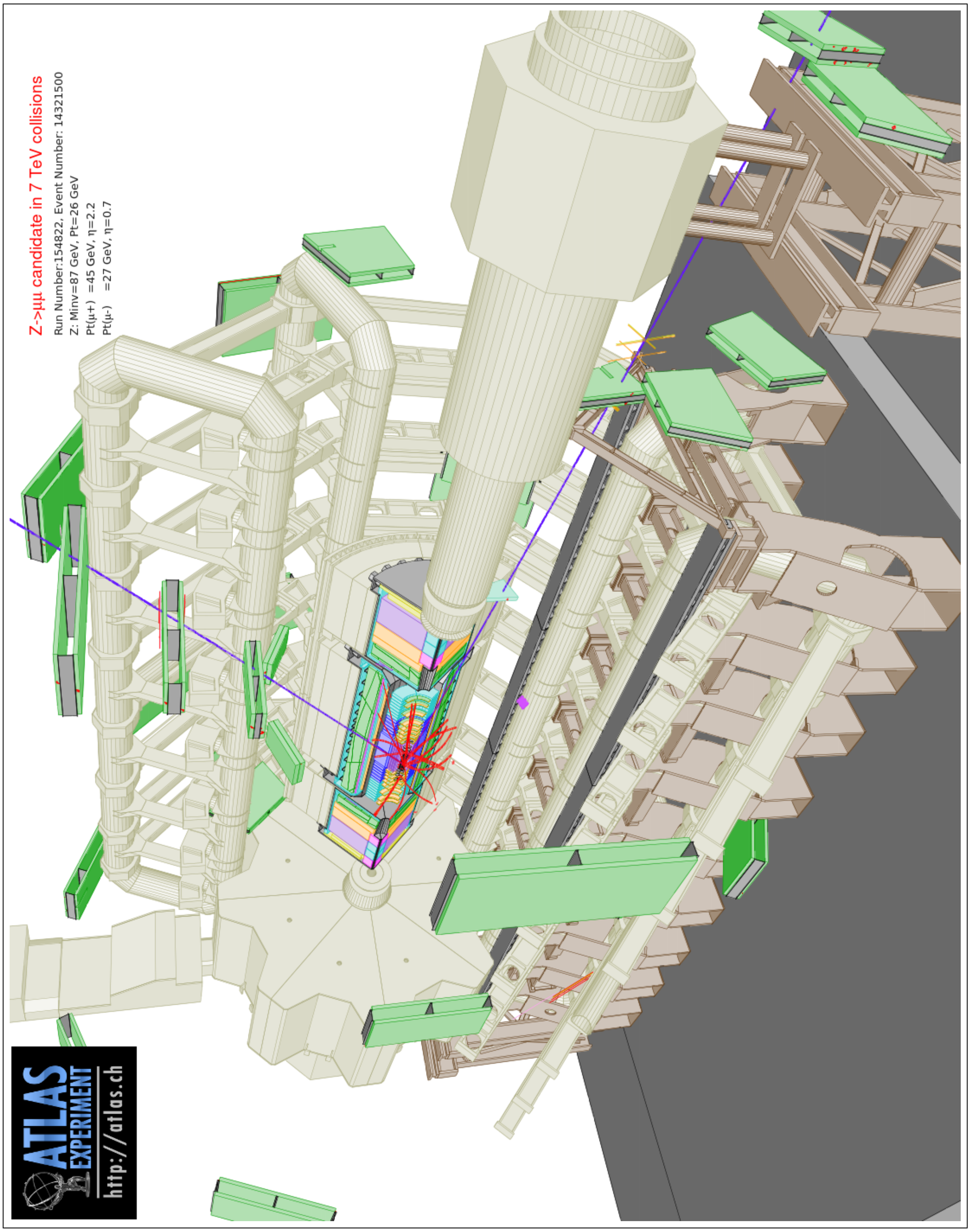


Figure 116: A $Z \to \mu\mu$ candidate in the 7 TeV collision data of 2010.

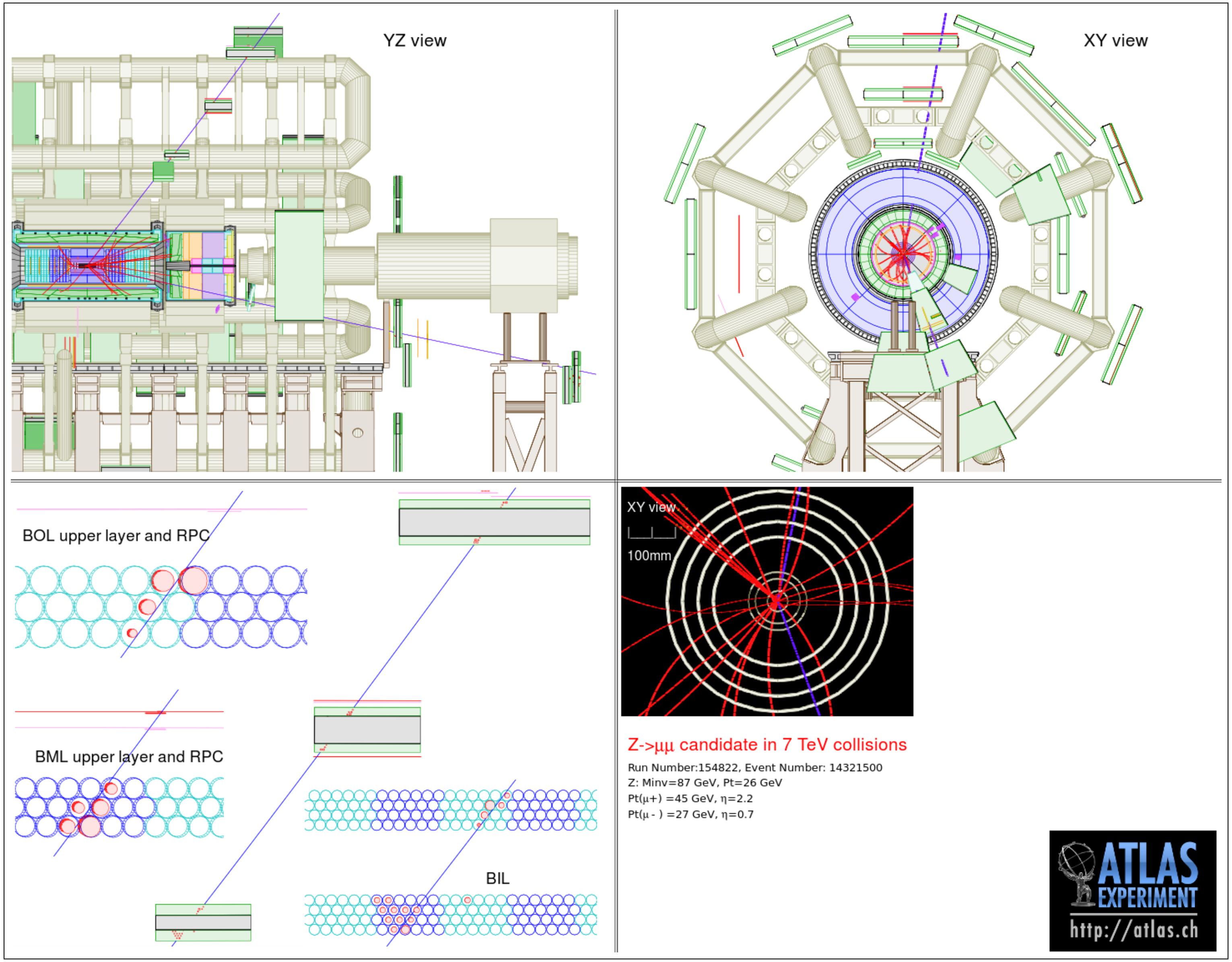


Figure 117: The same $Z \to \mu\mu$: in 2D projections and details of track reconstruction.

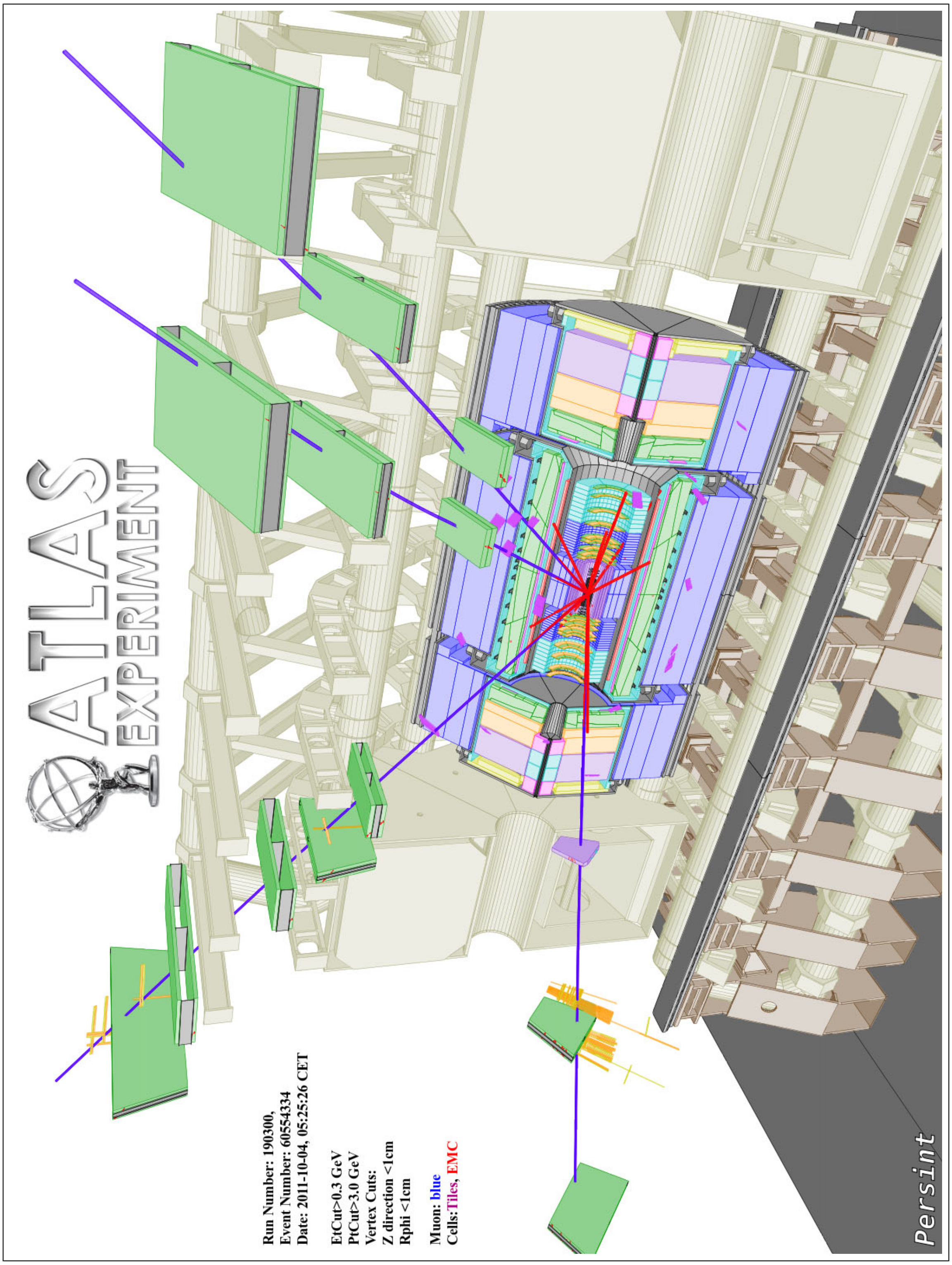


Figure 118: ZZ candidate event ($Z \to \mu\mu$). Run 190300; Event 60554334. (04-10-2011)

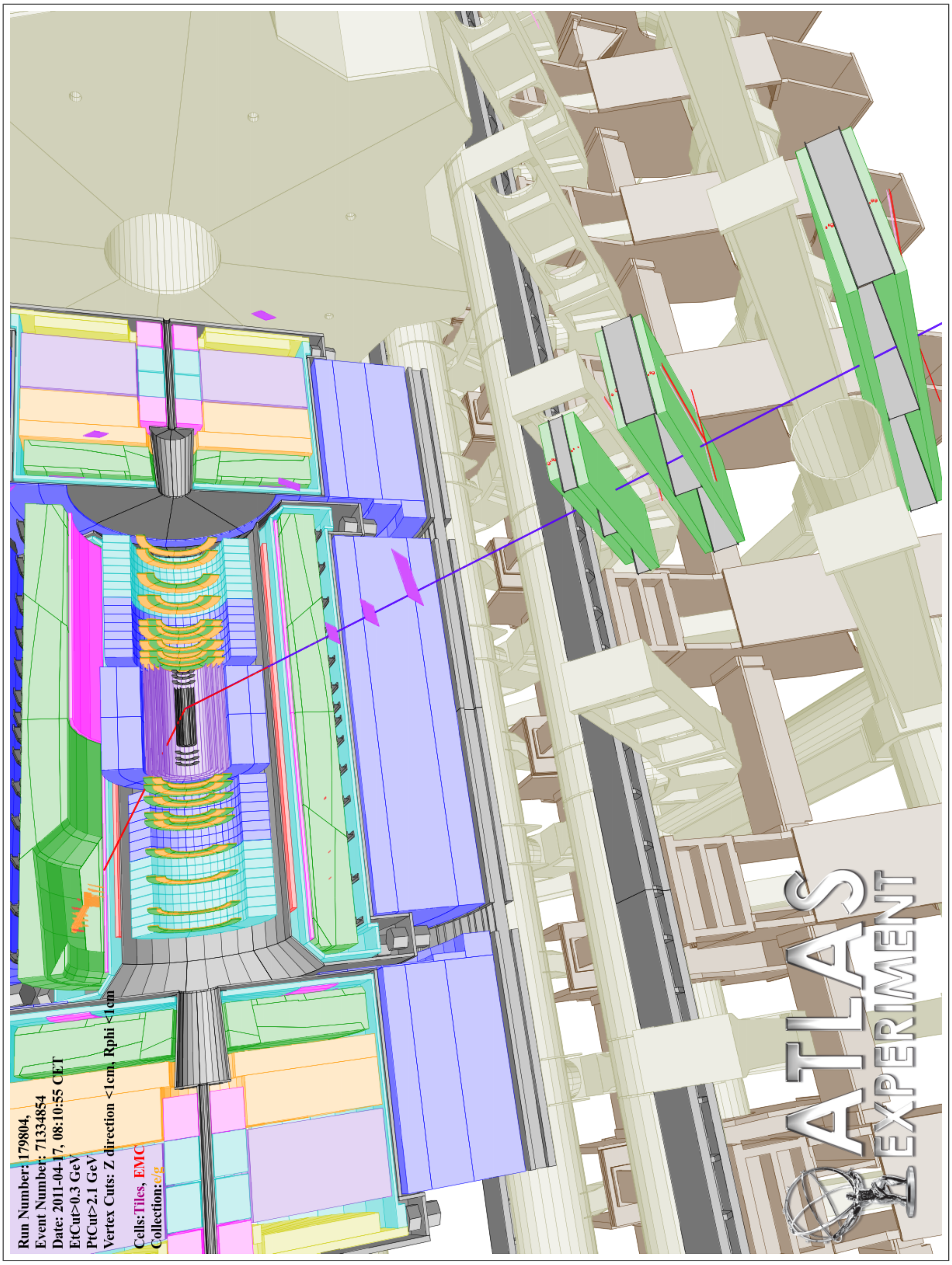


Figure 119: $e\mu$ event with the highest $e\mu$ invariant mass: 662 GeV. Run 179804; Event 71334854. (17-04-2011)

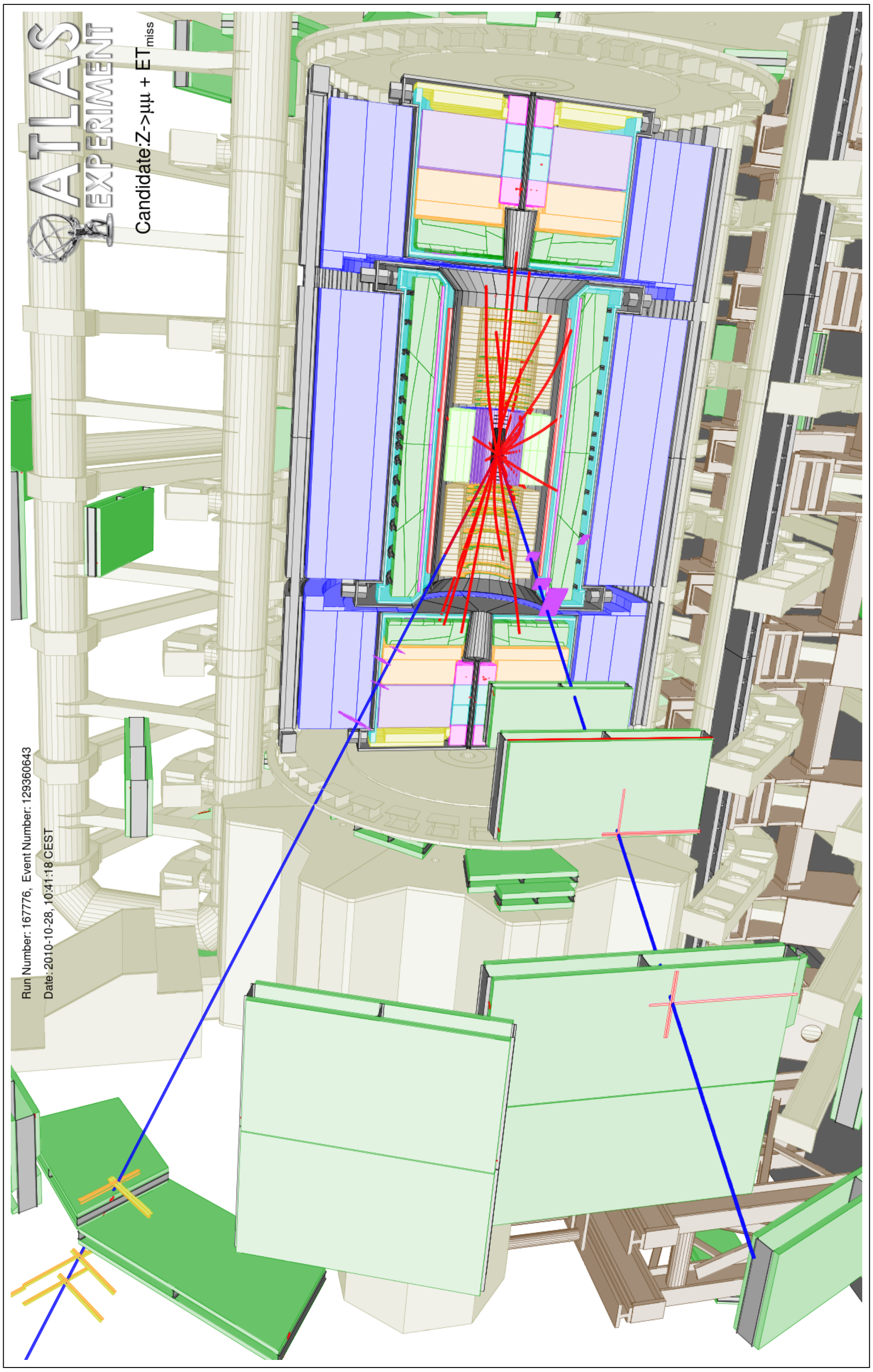


Figure 120: Candidate event $Z \rightarrow \mu\mu + Et_{miss}$. Run 167776; Event 129360643. (28-10-2010)

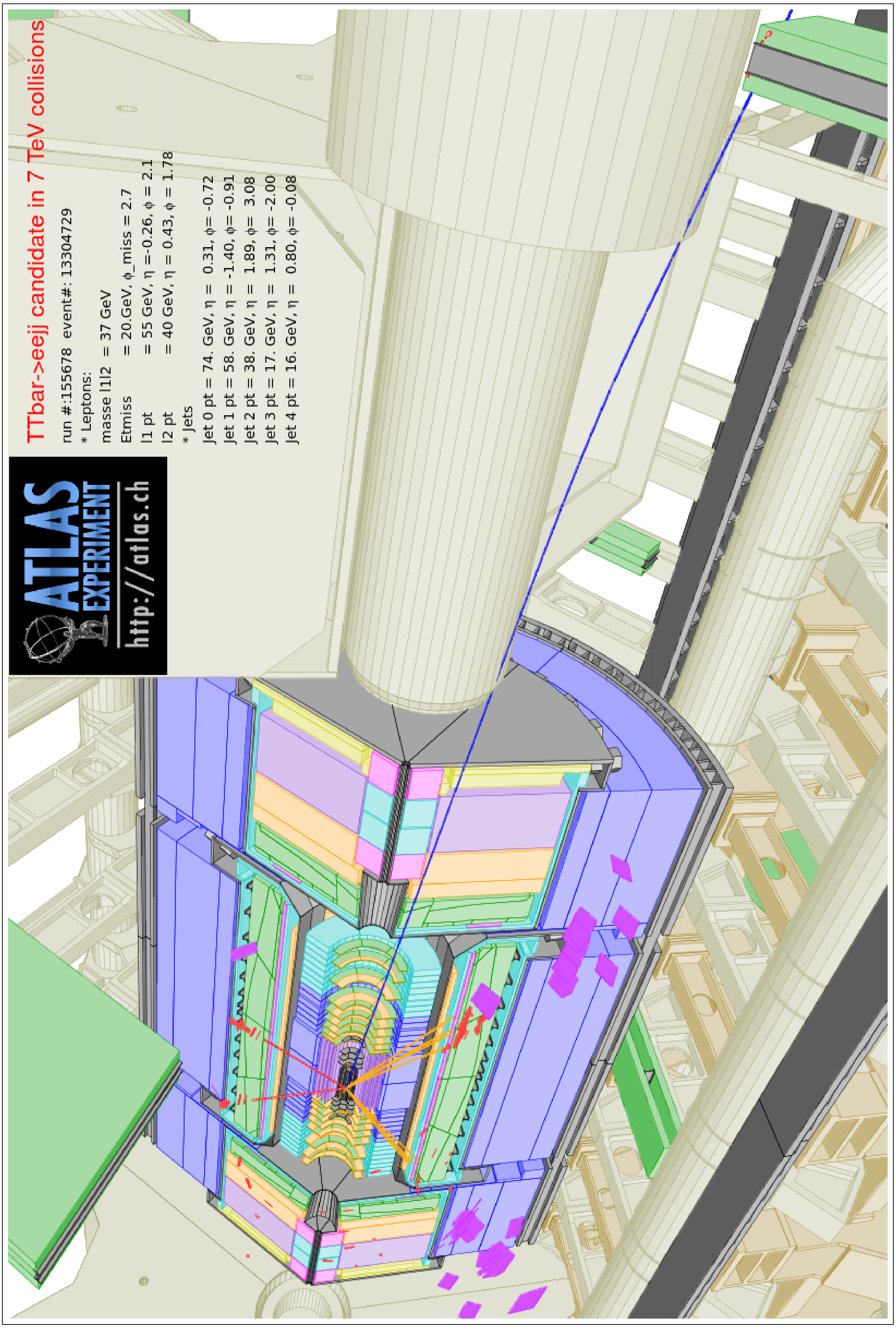


Figure 121: $t\bar{t} \to eejj$ Run 155678; Event 13304729.

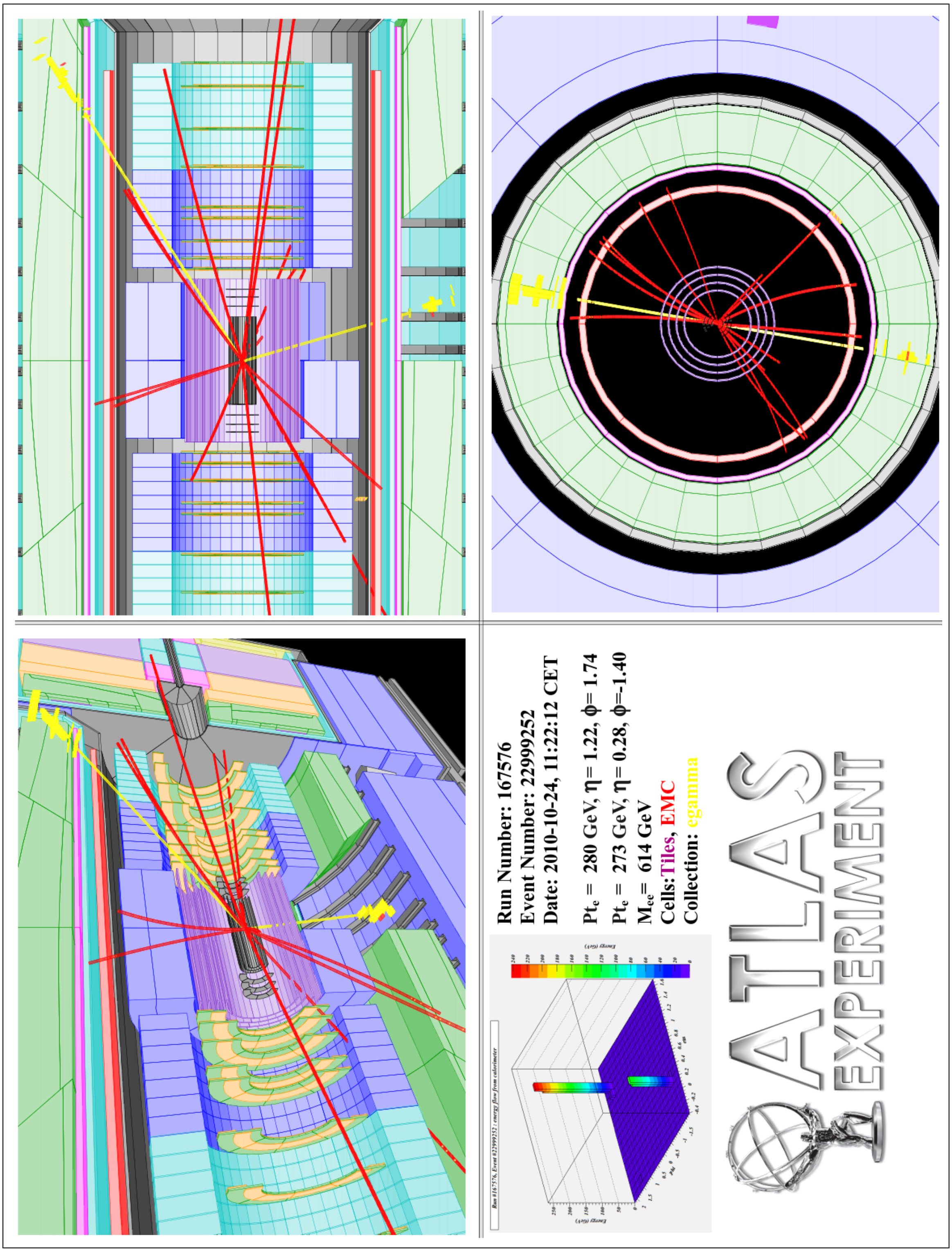


Figure 122: Candidate event $Z' \to ee$. Run 167576; Event 22999252.

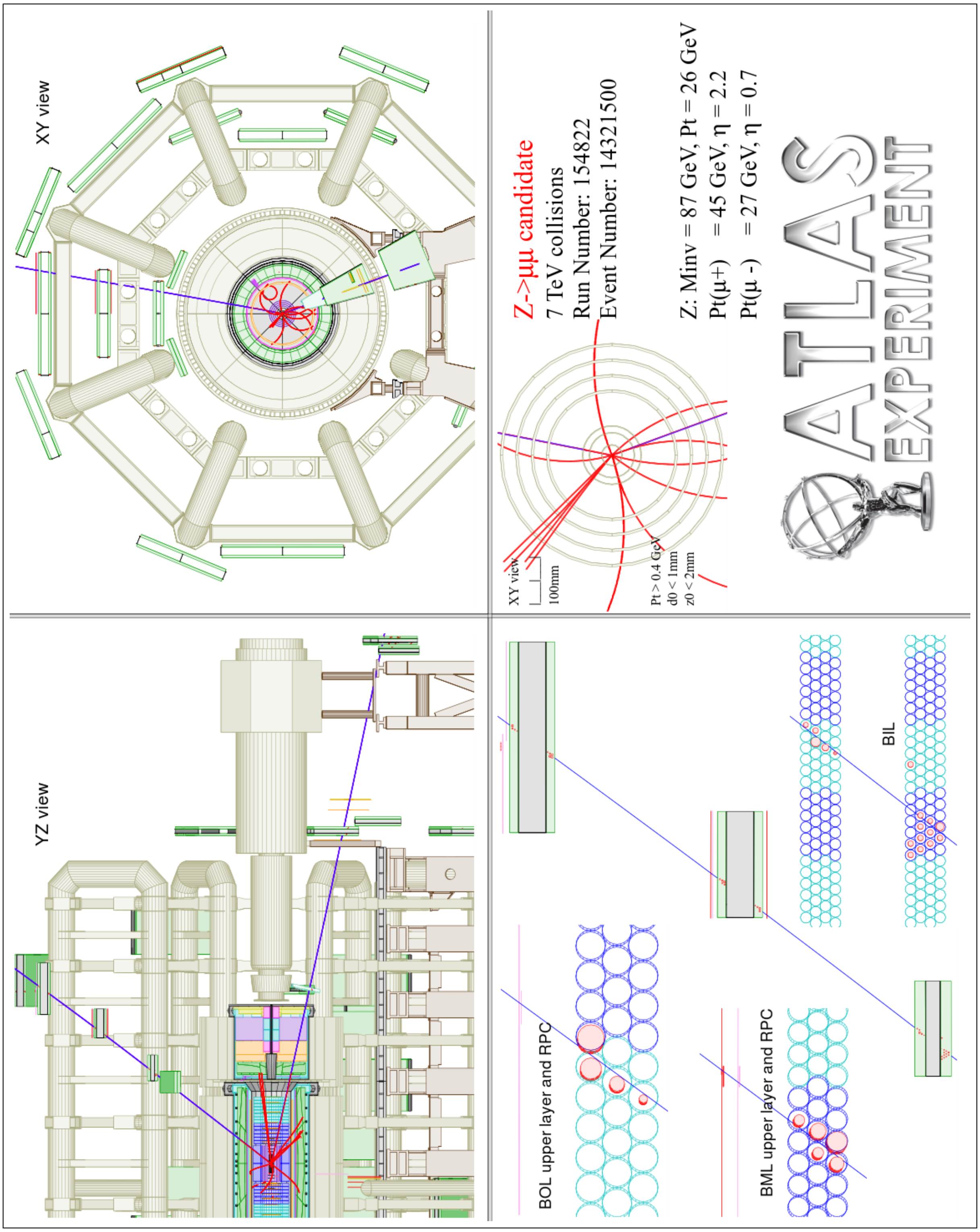


Figure 123: Candidate event $Z \to \mu\mu$. Run 154822; Event 14121500.

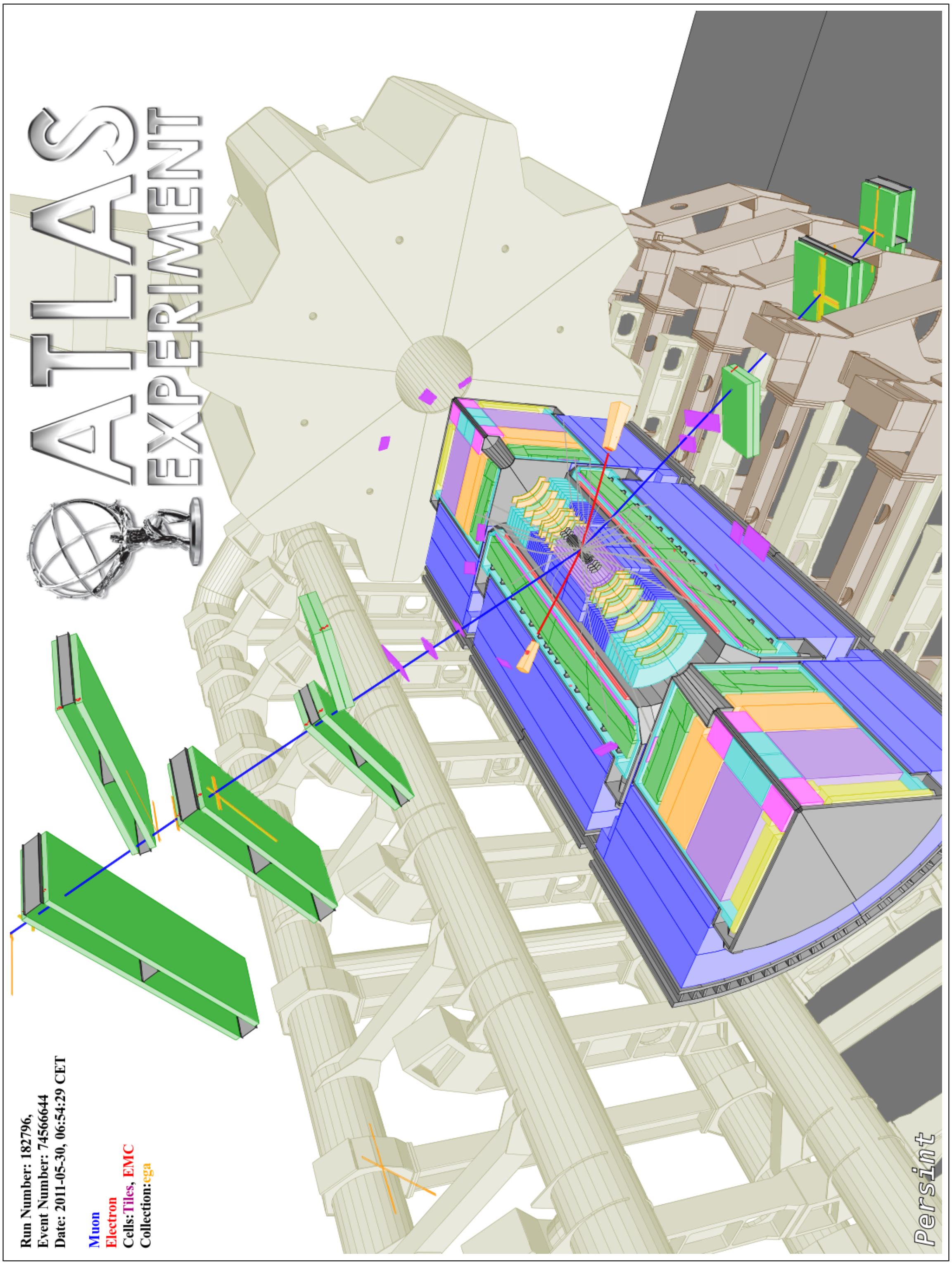


Figure 124: Candidate event $H \to ee\mu\mu$. $M(ee\mu\mu) = 124.3GeV$. Run 182796; Event 74566644. (30-05-2011)

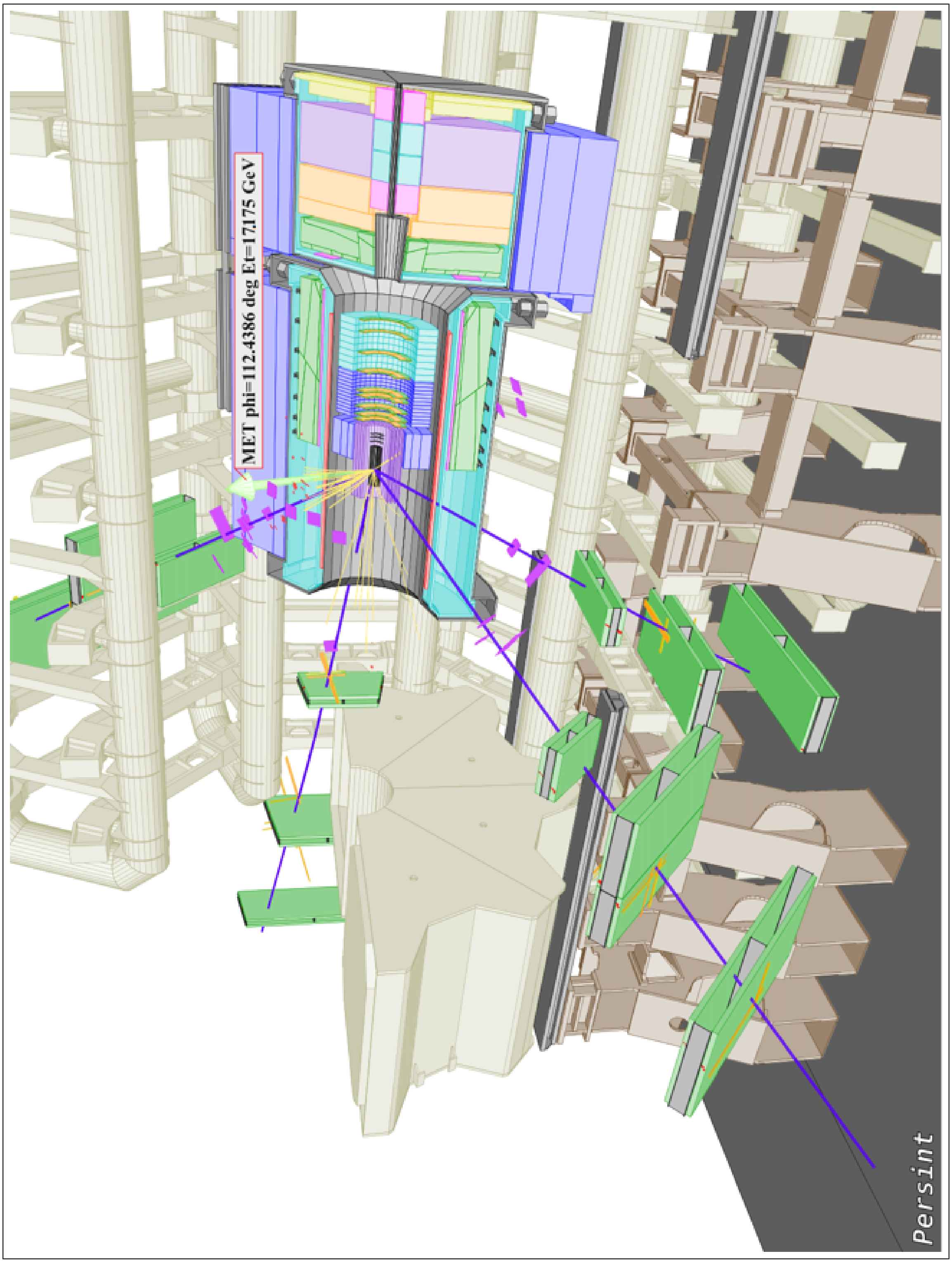


Figure 125: Candidate event $H \to \mu\mu\mu\mu$ with Et_{miss} as a green arrow. $M(\mu\mu\mu\mu) = 124.6GeV$. Run 189280; Event 143576946. (14-09-2011)

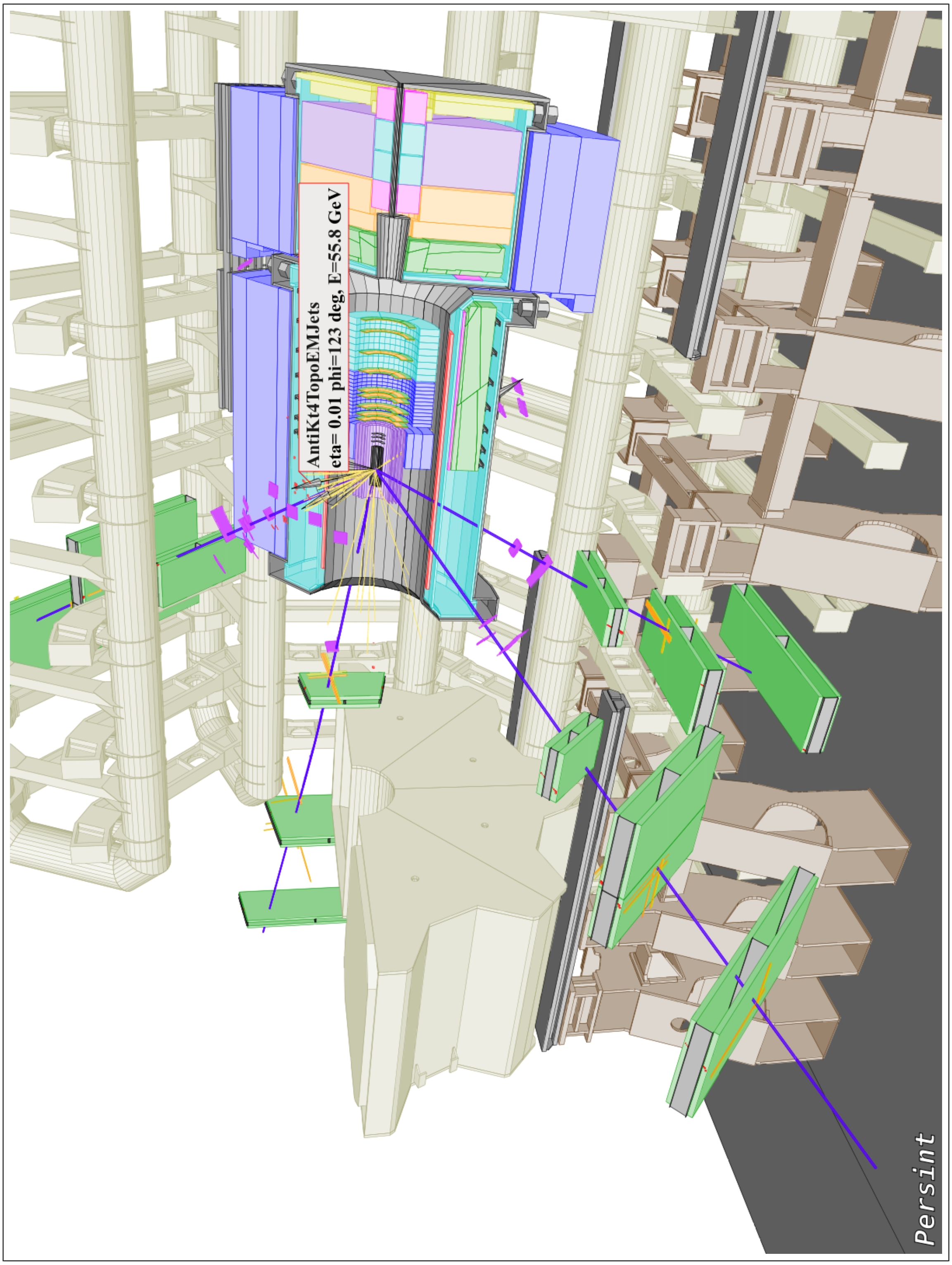


Figure 126: The same candidate event $H \rightarrow \mu\mu\mu\mu$ with jets shown as grey arrows. $M(\mu\mu\mu\mu) = 124.6 GeV$. Run 189280; Event 143576946. (14-09-2011)

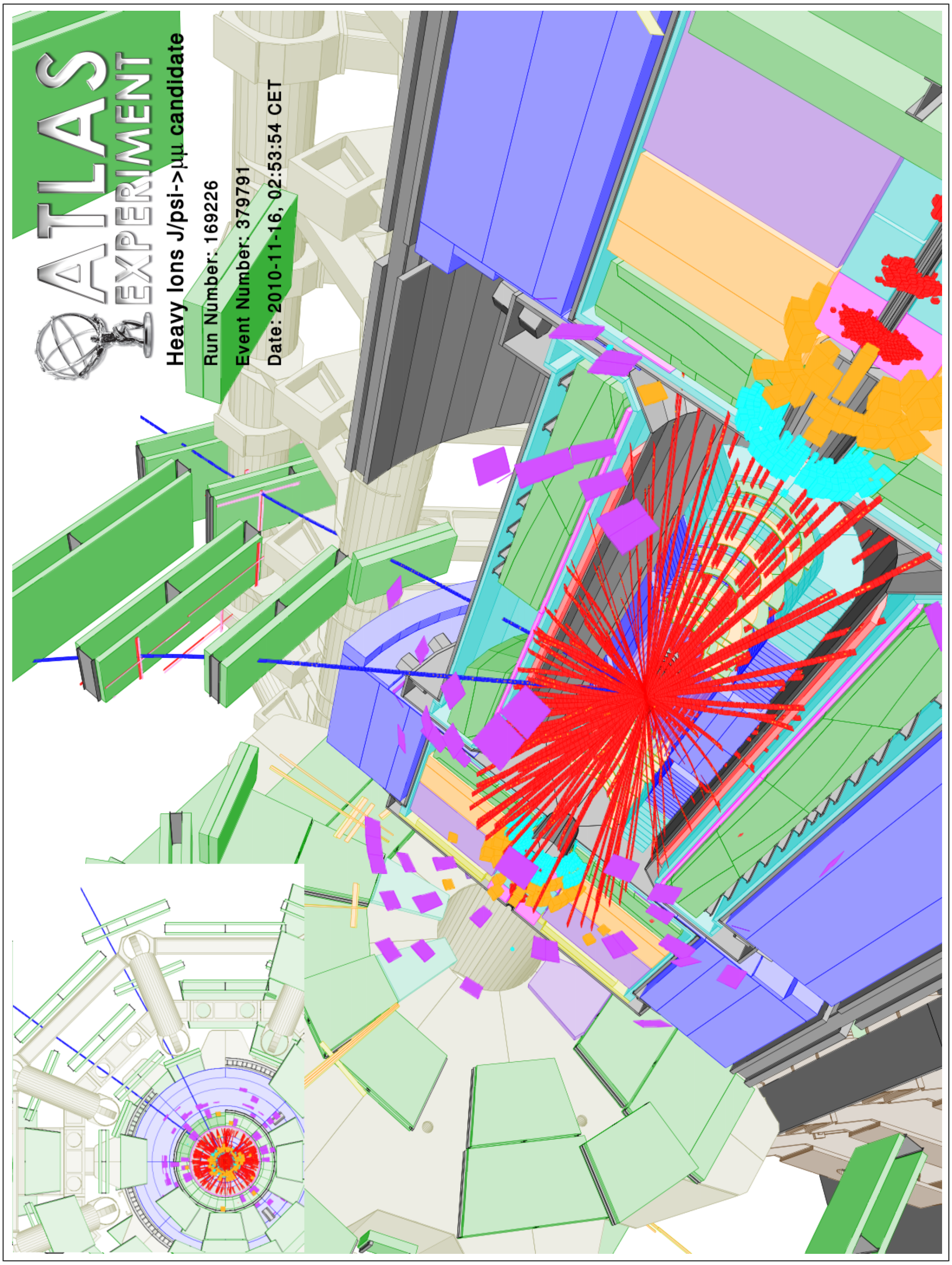


Figure 127: Candidate $J/\psi \to \mu\mu$ in Heavy Ion collisions. Run 169226; Event 379791.

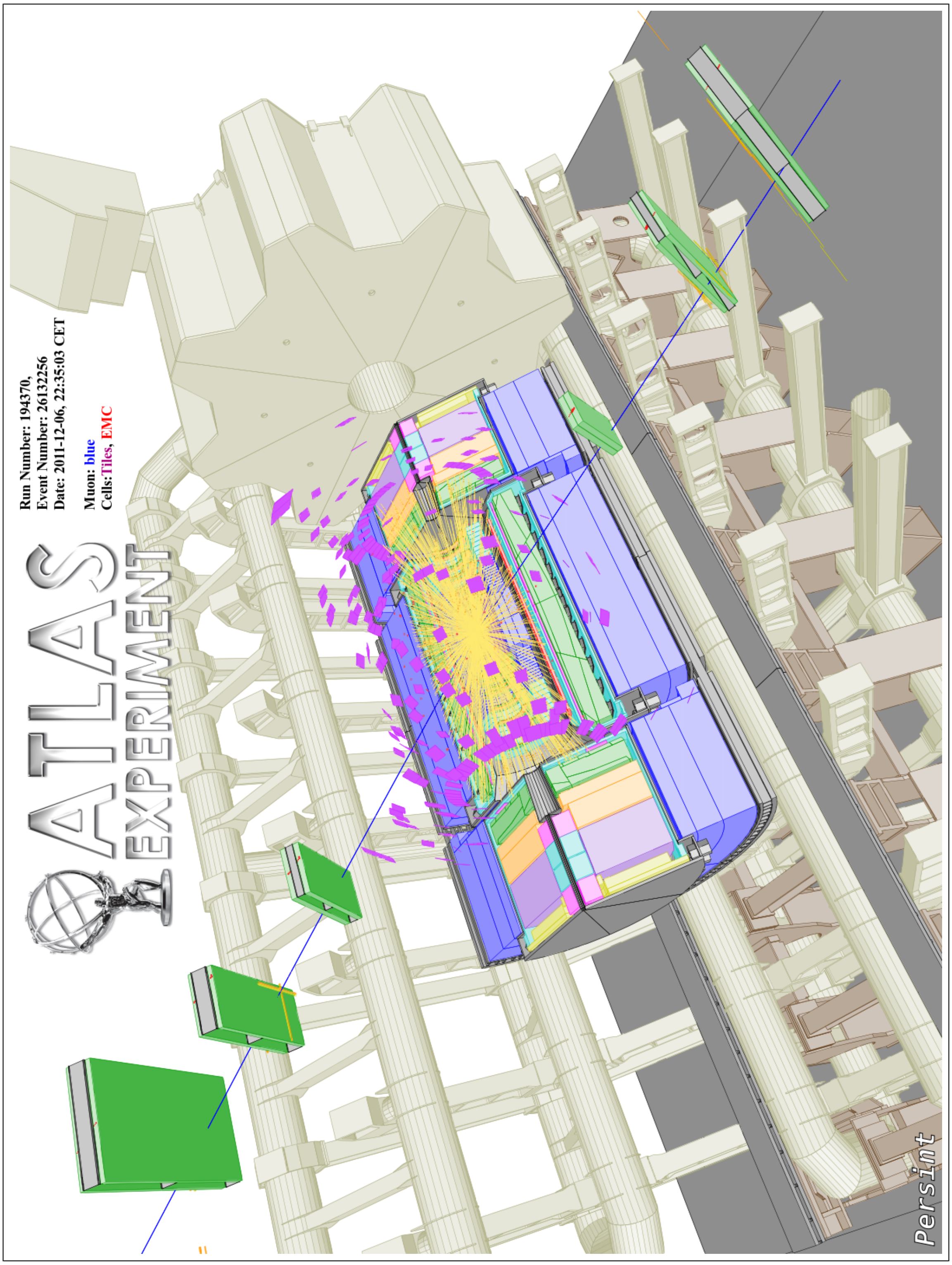


Figure 128: Heavy Ion collision $Z \to \mu\mu$ + ??. Run 194370; Event 16132256. (06-12-2011)

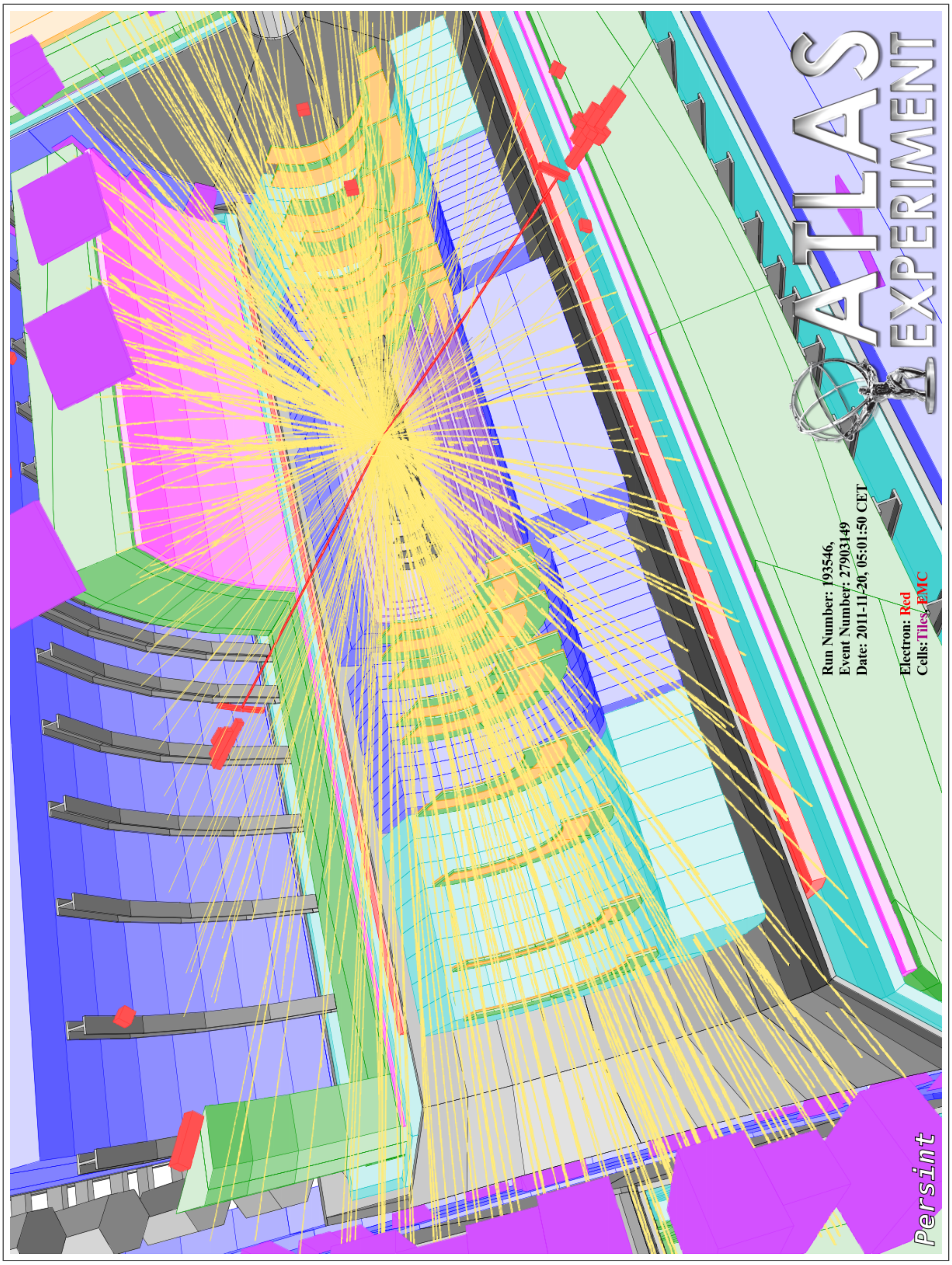


Figure 129: Heavy Ion collision $Z \to ee$ + ??. Run 193546; Event 27903149. (20-11-2011)

14 Useful hints

1. *Compute*
   The effect of the *Compute* icon is to make all computations necessary to display an event, after changes have been made to the parameters.
   Actionning *Compute* is not always necessary:

   > For example, after closing the *Set track parameters* window by clicking on OK, it is necessary to validate further with *Compute*. On the contrary, after closing the *Generate muon tracks* window with OK, it is not necessary to use *Compute*.
   > There is no general rule for using the *Compute* action. When in doubt, it is always prudent to use it.

2. Interrupt/resume your work
   It is important to realize that it is possible to interrupt and resume your work at any time. In case *Persint* cannot be left idle during the pause, you can save the files used by the program as specific `ASCII` files. The relevant files (described in Appendix D) are:

   - The `.p2vf` file
     It contains everything necessary [1] for displaying the current view of the *Main display* (see section 6.4, item 1). The file is saved with the *Save view as...* icon, and retrieved with the *Open view* icon.

Save view as...

Open view

   - The `.p2gm` file
     This file contains the parameters of the tracks generated with the *Generate muon tracks* icon (section 7.1). The file is saved from within the *Generate muon tracks* window by clicking on the Save box.
   - The `.p2ts` file
     This file contains the parameters of the *Set track parameters* window (Appendix E.5.1). These parameters define the objects chosen for display in an event (Tracks, segments, MDT, RPC, ID hits, calorimeter hits, electrons, photons, etc.), as well as their energy or momentum thresholds. The file is saved from within the *Set track parameters* window by clicking on the Save as... box [2].

3. *Previous view*
   When modifying the aspect of a view with the navigation tools, is is sometimes difficult and time consuming to go back to a previous display which seemed satisfactory. The *Previous view* icon makes it possible to retrieve up to $\sim$ 100 displays backwards.

Previous view

[1] Labels and captions are saved but pictures (*e.g.* the ATLAS logo) are not.
[2] The Save box saves the file and makes it the default file.

15 APPENDICES

A Architecture

Persint, the detector and event display for the ATLAS muon spectrometer originally conceived by Marc Virchaux, now has a new Graphical User Interface developped with *Qt*. This appendix gives a short description on how the software source code is organized.

- **Software development philosophy**

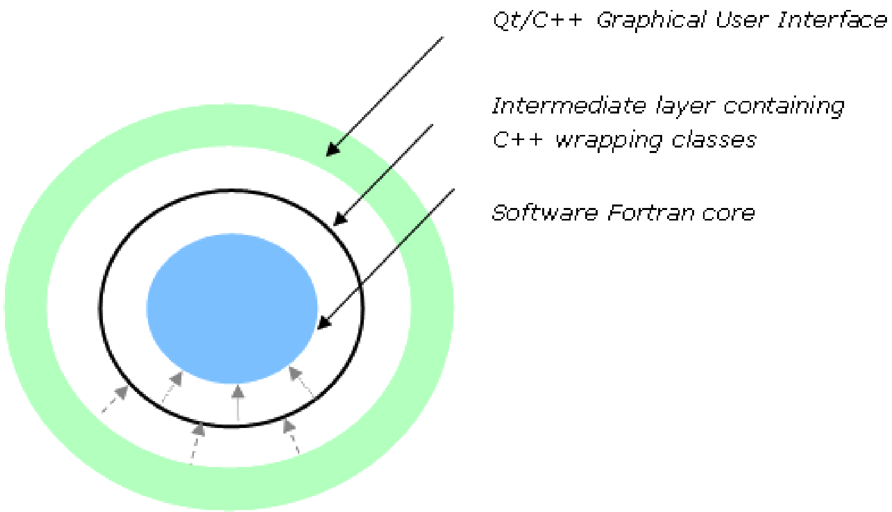


Figure 130: Architecture of the *Persint* source code

As shown in figure 130, the source code is divided into 3 distinct parts :

1. The core corresponds to Fortran code, e.g. algorithms for computing hidden faces, routines for reading input files, and so forth...
2. The "wrapping" layer, written in C^{++}, is a communication layer between the program core and the graphical interface. It is made of classes encapsulating the calls to Fortran routines.
3. The C^{++} code for the Graphical User Interface (GUI).

Thus, there is no direct call to Fortran core routines from the GUI as they are only called by the wrapping layer. Wrapper classes are organized by topics, e.g. one for views, one for AMDB volumes, etc...

- **File organization**
  Most source files created for the new interface are located in one of the following three directories :

1. *PersintCore/persint2_core*
   This directory contains all Fortran routines called by the "wrapping" layer. Most of theses routines have been written specifically for the new GUI and are code fragments extracted from the initial HIGZ- based version of Persint. Like wrapper classes, these routines are organized by topics. For example, all methods dealing with AMDB volumes are gathered in file *wrap_amdb.FF90*. Moreover, each routine name is prefixed with a string identifying its topic :

AMDB volume related routines start with "AMDB_", etc. ... Files whose name does not start with "*wrap_*" only contain routines called from other Fortran routines, not directly from the wrapper classes.

2. *Persint2Core*
   This directory contains C^{++} header (.h) and source (.cpp) files respectively defining and implementing all wrapper classes. Each wrapper class in this directory is associated with a Fortran file in the *PersintCore/persint2_core* directory. The only constructor in each of these classes has the "protected" attribute, so that the only way to actually instantiate a wrapper class - and to access its methods - is by creating a derived class. These wrapper classes have been implemented so that, whenever possible, they use standard C^{++} libraries rather than *Qt*- specific tools. This directory also contains classes required by the GUI but without calls to Fortran routines (e.g.: *ColorF, persint::Colors, FCString, ...*).

3. *PersintGui*
   This directory contains all *Qt* classes developped for the new interface. Files with *.ui* extension are XML files created with the *Qt* designer and describing widgets. They should be edited with the designer-qt4 executable. The directory also contains *.h* and *.cpp* files implementing classes derived from *Qt* widgets. These classes inherit from wrapper classes as is necessary for interacting with the core of the application. For instance, the *persint::AmdcVolumeTree* class inherits from the *persint::Amdb* wrapper class in order to be able to access functions related to AMDB volumes. Files ending with *_moc.cxx* or *_ui.h* are generated automatically by *Qt* tools during compilation and should not be edited by hand.

- **Sample ASCII files**
  The various files used by *Persint* are listed and described in Appendix D. They include files which contain all the information about geometry, detector description, magnetic field, events, track parameters, generated muons, etc.

B Installation and dependencies

This chapter is included in the manual for reference and for completeness.

However, for ***up-to-date instructions*** and **easy installation**, consult the **Twiki page**
https://twiki.cern.ch/twiki/bin/view/Atlas/Persint2Wiki
and use ***copy-paste*** operations.

The latest release of *Persint* is : **Persint-00-02-74**. This version number is used throughout these instructions. Check for the latest version at the link indicated above. Earlier releases can be found at:
http://atlas.web.cern.ch/Atlas/GROUPS/MUON/Persint/releases/

The running of *Persint* is dependent on a number of libraries which need to be installed beforehand. Satisfying these dependencies involves procedures which depend on the platform. On the contrary, the installation of *Persint* proper is common to all platforms. The complete procedures [1] are described below for reference. Bugs, comments, installation problems, or questions can be reported to :
https://groups.cern.ch/group/atlas-sw-persint-support/default.aspx

B.1 Suported platforms

Persint is developed under the latest **Ubuntu** release. We also make sure it runs at CERN on **lxplus** machines as well as under **Fedora**. We provide best effort support for **Mac OS X**.

History of Persint installation tests

Platform					Persint	
OS	Release	Arch.	C++ compiler	Qt	Release	Notes
Ubuntu	Utopic (14.10)	amd64/i386	GCC 4.8.2	4.8.6	00-02-72	
	Trusty LTS (14.04)	amd64/i386	GCC 4.8.2	4.8.6	00-02-73	
	Saucy (13.10)	amd64/i386	GCC 4.8.1	4.8.4	00-02-70	
	Raring (13.04)	amd64/i386	GCC 4.7.2	4.8.3	00-02-69	
	Quantal (12.10)	amd64/i386	GCC 4.7.2	4.8.3	00-02-69	
	Precise LTS (12.04)	amd64/i386	GCC 4.6.3	4.8.1	00-02-69	
	Oneiric (11.10)	amd64/i386	GCC 4.6.1	4.7.4	00-02-69	
	Natty (11.04)	amd64/i386	GCC 4.5.2	4.7.2	00-02-69	
	Maverick (10.10)	amd64/i386	GCC 4.4.5	4.7.0	00-02-69	
	Lucid LTS (10.04)	amd64/i386	GCC 4.4.3	4.6.2	00-02-31	
	Hardy LTS (8.04)	amd64/i386	GCC 4.2.3	4.3.4	00-02-27	
Scientific Linux Cern	Carbon (6.4)	x86_64	GCC 4.7	4.8.4	00-02-72	lxplus
Mac OS X	Mavericks (10.9.3)	x86_64	LLVM 5.1	4.8.6	00-02-73	
	Mountain Lion (10.8.4)	x86_64	GCC 4.7.3	4.8.5	00-02-68	
	Snow Leopard (10.6.8)	x86_64	GCC 4.2.1	4.8.4	00-02-65	
Fedora	Beefy Miracle (17)	i386	GCC 4.7.0	4.8.2	00-02-57	VirtualBox 4.1 on Mac OS X
Debian	Squeeze (6.0)	x86_64	GCC 4.4.5	4.6.3	00-02-57	VirtualBox 4.1 on Ubuntu
CentOS	6.3	x86_64	GCC 4.4.6	4.6.2	00-02-57	VirtualBox 4.1 on Ubuntu
	5.7	i386	GCC 4.1.2	4.7.4	00-02-27	VirtualBox 4.0 on Ubuntu
Cygwin	1.7	i686	GCC 4.5.3	4.5.3	00-02-48	Tested under Windows 7

Figure 131: History of *Persint* installation

[1] When updating to a new version of *Persint*, it is usually sufficient to do only the installation without repeating the part concerning dependencies.

B.2 Installation

B.2.1 Tarball *(default procedure)*

Download and install the complete source tarball (15 MB).
In the following, *-00-02-●●* is the evolving version number of *Persint*, *e.g. Persint-00-02-74*

```
wget http://atlasinfo.cern.ch/Atlas/GROUPS/MUON/Persint/releases/00.02.●●/
    src/Persint-00-02-●●.tar.gz

tar xvfz Persint-00-02-●●.tar.gz

cd Persint-00-02-●●

./configure

make -j3

./start_persint.sh
```

Warning: the above instructions assume ***all dependencies*** are satisfied.

B.2.2 svn

Download code from source repository and install, as follows.

After configuring subversion, checkout the *Persint* source code. From the *Persint* directory, run the `bootstrap.sh` script to download other required Atlas software components. You can then start compilation with "make".
After you are done, simply run the `.start_persint.sh` script, that will set your library and binary paths and run the program.

```
export SVNROOT=svn+ssh://svn.cern.ch/reps/atlasoff

svn co $SVNROOT/graphics/Persint/tags/Persint-00-02-●● Persint-00-02-●●

cd Persint-00-02-●●

./bootstrap.sh

make -j3

./start_persint.sh
```

Warning:

- The above instructions assume **all dependencies** are satisfied.
- **Subversion configuration**: if your local username is different from your lxplus username, you may need to specify the latter in your `$HOME/.ssh/config` file.
  For details, see:
  https://twiki.cern.ch/twiki/bin/viewauth/Atlas/SoftwareDevelopmentWorkBookSVN.

B.2.3 Ubuntu package

Persint is available as an **Ubuntu** package on a dedicated repository [1]. However, this package provides a version of *Persint* without histograms (because `ROOT` is no longer available as an Ubuntu package). To benefit from histograms, you need to install *Persint* by hand.
The procedure below can be found at:
http://sizun.web.cern.ch/sizun/persint/ubuntu.html.

[1] http://atlas-samusog.web.cern.ch/atlas-samusog/muonboy/persint/jobOptions.html

Persint on Ubuntu

To install Persint on *ubuntu*, follow the following steps:

1. Add the repository containing the *persint* package to the package manager's list of available repositories:
   - Edit the */etc/apt/sources.list* file (with administrative privileges, e.g. `gksudo gedit /etc/apt/sources.list`) and add this line:

     ```
     deb http://sizun.web.cern.ch/sizun/ubuntu <ubuntu_version> contrib
     ```

     Replace <*ubuntu_version*> with the version of ubuntu you are using (i.e. *utopic*, *trusty*, *saucy*, *raring*, *quantal*, *precise*, *oneiric*, *natty*, *maverick*, *lucid* or *hardy*).
     You may want to run `lsb_release --codename --short` to find out which it is.
2. Add to the package manager's list of trusted keys the GPG key used to digitally sign the *persint* package:

   ```
   sudo apt-key adv --recv-keys --keyserver keyserver.ubuntu.com 25DB4A9D
   ```

   In case the `keyserver.ubuntu.com` key server fails to respond, you may try one of the following servers: `pgp.mit.edu`, `keys.gnupg.net`, `wwwkeys.ch.pgp.net`.
3. Update the list of available packages:

   ```
   sudo apt-get update
   ```

4. Install the *persint* package:

   ```
   sudo apt-get install persint
   ```

   You should then be able to start Persint via the `Applications > Science` or `Applications > Education` menu panel (depending on your *ubuntu* release).

Support

- Mailing list: atlas-sw-persint-support

Notes

- Packages are now only provided for release *trusty* (14.04 LTS) and later.
- For other distributions, platforms, installation methods or versions of Persint, please refer to the official Persint page.
- This repository is not always updated as frequently as the official Persint repository.

Creation: December 3rd, 2009. Last modification: June 23rd, 2014.

B.2.4 Pre-installed lxplus version

If you have an account on the **lxplus** network, you can run a version of *Persint* pre-installed on `AFS`, though it might be a little slower.

Run the pre-installed version of *Persint* on lxplus:

```
ssh -X lxplus.cern.ch
```

```
\ln -sf /afs/cern.ch/atlas/www/GROUPS/MUON/Persint/releases/00.02.••/slc5-x86_64-gcc34/
    share/ Persint/start_persint.sh
```

```
./start_persint.sh
```

B.3 Dependencies

Persint no longer requires either `CERNLIB, HIGZ` or `LAPACK`.

B.3.1 Mandatory requirements

1. **Install C^{++} compiler**

   - **Ubuntu**

     ```
     sudo apt-get install g++
     ```

   - **Mac OS X**
     After installing MacPorts (see B.4.1):

     ```
     sudo port install gcc46
     ```

   - **Fedora**
     With administrative privileges (su command), execute the following command line:

`yum install gcc-c++`

- **Debian**

  `sudo apt-get install g++`

- **CentOS 5/6**
  With administrative privileges (su command), execute the following command line:

  `yum install gcc-c++`

- **CernVM**
  After installing OpenAFS:

  `source /afs/cern.ch/sw/lcg/external/gcc/4.3/‘uname -m‘-slc5/setup.sh`

- **Cygwin**
  Update your Cygwin installation by running the `setup.exe` program to install the following package:

  `gcc4-g++`

2. **Install a fortran compiler**

- **Ubuntu**

  `sudo apt-get install gfortran`

- **Mac OS X**
  After installing MacPorts:

  `sudo port install gcc46`

  `sudo ln -s /opt/local/bin/gfortran-mp-4.6 /opt/local/bin/gfortran`

- **Fedora**
  With administrative privileges (su command), execute the following command line:

  `yum install gcc-gfortran`

- **Debian**

  `sudo apt-get install gfortran`

- **CentOS 5/6**
  With administrative privileges (su command), execute the following command line:

  `yum install gcc-gfortran`

- **Cygwin**
  Update your Cygwin installation by running the setup.exe program to install the following package:

  `gcc4-fortran`

3. **Install other standard utilities: *wget*, *make*, *perl*, *pkg-config*, *head*, *sed***

- **Mac OS X**
  After installing MacPorts :

  `sudo port install wget pkgconfig`

  `export PKG_CONFIG_PATH=/opt/local/lib/pkgconfig;`

  You might want to add `PKG_CONFIG_PATH` to your login script.

- **Fedora**
  With administrative privileges (su command), execute the following command line:

  `yum install wget pkgconfig xterm perl`

- **Debian**

```
sudo apt-get install make pkg-config
```

- **CentOS 5/6**
  With administrative privileges (su command), execute the following command line:

  ```
  yum install wget pkgconfig xterm perl make
  ```

- **Cygwin**
  Update your Cygwin installation by running the `setup.exe` program to install the following package:

  ```
  wget make sed tar pkg-config
  ```

4. **Install Qt**
   Persint requires Nokia's ***Qt*** framework (≥4.3.4).

- **Ubuntu**

  ```
  sudo apt-get install libqt4-dev
  ```

- **Mac OS X**
  After installing MacPorts :

  ```
  sudo port install qt4-mac +debug
  ```

  This may take a while...

- **Fedora**
  With administrative privileges (su command), execute the following command line:

  ```
  yum install qt-devel
  ```

- **Debian**

  ```
  sudo apt-get install libqt4-dev
  ```

- **CentOS 5**
  The release of Qt (4.2) provided by the qt4-devel CentOS 5 package is too old for Persint. Hence, Qt needs to be installed from source. Set the PKG_CONFIG_PATH variable appropriately to indicate to Persint the location of Qt.

- **CentOS 6**
  With administrative privileges (su command), execute the following command line:

  ```
  yum install qt-devel
  ```

- **Cygwin**
  Update your Cygwin installation by running the `setup.exe` program to install the following package:

  ```
  qt4-devel-tools libQtCore4-devel libQtGui4-devel libQtTest4-devel libQtNetwork4-devel
  ```

- **CernVM**
  After installing OpenAFS, add the path of Qt on AFS to the `PKG_CONFIG_PATH` variable:

  ```
  export PKG_CONFIG_PATH=/afs/cern.ch/sw/lcg/external/qt/4.6.3/
     `uname -m`-slc5-gcc43-opt/lib/pkgconfig/:$PKG_CONFIG_PATH
  ```

- **Scientific Linux Cern**
  The release of Qt (4.2) provided by the qt4-devel SLC5 package is too old for *Persint*. Hence, Qt needs to be installed from source.

  – lxplus
    The location of the Qt library on AFS will be automatically taken care of by the *Persint* makefile and the start up script.

- Non-lxplus machine with access to CERN AFS directories
  Qt is installed in the /afs/cern.ch/sw/lcg/external/qt/ directory. Choose the appropriate version and add the path of the lib/pkgconfig subdirectory to your `PKG_CONFIG_PATH` environment variable.
- Standalone machines
  Download and install Qt from `source`. If you do not install it into a standard location, add the path of the lib/pkgconfig subdirectory to your `PKG_CONFIG_PATH` environment variable.

B.3.2 Optional features

Install QtROOT. QtRoot is a Qt plugin of ROOT, used to display ROOT histograms within the Qt interface. The version of QtROOT you install should be compatible with your version of the Qt4 library.

1. **General instructions**

   - Method 1
     The simplest way to get QtROOT is to install ROOT with the –enable-qt flag. You first need to install Qt and pkg-config to allow the ROOT configure script to find Qt. Then :

     ```
     wget ftp://root.cern.ch/root/root_v5.30.00.source.tar.gz
     tar xvfz root_v5.30.00.source.tar.gz
     cd root
     export QTDIR=`pkg-config --variable=prefix QtCore`
     ./configure --enable-qt --prefix=<PREFIX> --etcdir=<PREFIX>/etc
     make
     make install
     ```

   - Method 2
     To install the latest QtRoot module, you will need to use the official `INSTALL_QTROOT.sh` script and to follow these instructions. This method is for experts of Unix only. After installing `Qt` and `pkg-config`, you will have to download the `INSTALL_QTROOT.sh` script and patch the script before running it:

     ```
     wget http://root.bnl.gov/QtRoot/INSTALL_QTROOT.sh
     wget http://atlas.web.cern.ch/Atlas/GROUPS/MUON/Persint/releases/
        INSTALL_QTROOT.sh.patch
     patch < INSTALL_QTROOT.sh.patch
     chmod u+x INSTALL_QTROOT.sh
     export QTDIR=`pkg-config --variable=prefix QtCore`
     .  ./INSTALL_QTROOT.sh
     The existing version of Qt package has been found under QTDIR=
     Do you want to use it?  (yes/no) yes
     Do you want to proceed?  (yes/no) yes
     Do you want to install COIN3D also?  (yes/no) no
     ```

     After installation is complete, you need to run the QtRoot setup script:

     ```
     ./set_environment.sh
     ```

     You might want to add this command to your login script.

2. **Ubuntu**
   In Ubuntu releases 8.10 (Intrepid), 9.04 (Jaunty), 10.04 (Lucid) and 10.10 (Maverick), QtRoot is directly available as an Ubuntu package :

```
sudo apt-get install root-plugin-qt libroot-dev
```

For other releases, follow general instructions above, but set the QTDIR variable by hand to:

```
export QTDIR=/usr/share/qt4
```

3. **Mac OS X**
After installing MacPorts, install the qt_mac variant of the root port:

```
yum install qt-devel
```

4. **Fedora**
With administrative privileges (su command), execute the following command line:

```
yum install root-gui-qt root-physics
```

5. **CernVM**
After installing OpenAFS:

```
source /afs/cern.ch/sw/lcg/app/releases/
    ROOT/5.30.00/‘uname -m‘-slc5-gcc43-opt/root/bin/thisroot.sh
```

Install SOCI library. *Persint* uses the SOCI library for access to the ATLAS Oracle databases, to download extra geometry files. This feature is **really optional**.

1. Install the Oracle Database Instant Client software development kit.

   - **Ubuntu**

     (a) Go to the Oracle download page, in the *Instant client* section and select the appropriate platform. Download the Instant Client Basic RPM package and the Instant Client SDK RPM package. You will need to create a (free) Oracle user account an to accept the license agreement.

     (b) Convert the RPM packages into debian packages :

     ```
     sudo apt-get -y install alien
     sudo alien -d oracle-instantclient-basic-<version>-<platform>.rpm
        oracle-instantclient-basic-<version>-<platform>.rpm
     ```

     (c) Install the generated debian packages and their dependency *libaio* :

     ```
     sudo dpkg -i oracle-instantclient-basic-<version>-<platform>.deb oracle-
        instantclient-basic-<version>-<platform>.deb
     sudo apt-get -y install libaio1
     ```

     (d) Define some environment variables to notify Persint of Oracle's location:

     ```
     export ORACLE_LIBDIR=/usr/lib/oracle/<version>/client/lib;
     export ORACLE_INCDIR=/usr/include/oracle/<version>/client;
     ```

     (The exact name of the installation directories will depend on your platform.)

   - **Mac OS X**

     – Install the *oracle-instantclient* port:

     ```
     sudo port install oracle-instantclient
     ```

     Make sure you download the actual zip files and not an HTML error page (accept the license agreement first, and use the left mouse button).

     (a) Delete intermediate files created by the failed building process and create a directory
     `/opt/local/var/macports/distfiles/oracle-instantclient`:

```
sudo port clean --all oracle-instantclient
sudo port selfupdate
sudo mkdir -p /opt/local/var/macports/distfiles/oracle-instantclient
```

(b) Go to the Oracle download page, register, download manually the packages
`instantclient-basic-10.2.0.4.0-macosx-x64.zip`
and
`instantclient-sdk-10.2.0.4.0-macosx-x64.zip`
and place them into the newly created directory:
`/opt/local/var/macports/distfiles/oracle-instantclient`

```
sudo mv instantclient-*.zip /opt/local/var/macports/distfiles/
 oracle-instantclient/
```

Make sure you download the actual zip files and not an HTML error page (accept the license agreement first, and use the left mouse button).

(c) Install the downloaded packages

```
sudo port install oracle-instantclient
```

– Define some environment variables to notify *Persint* of Oracle's location:

- **Scientific Linux Cern**
  On a SLC machine with access to CERN AFS directories:

```
export ORACLE_INCDIR=/afs/cern.ch/atlas/www/GROUPS/MUON/Persint/releases/
   opt/oracle/instantclient10_1/sdk/include;
export ORACLE_LIBDIR=/afs/cern.ch/atlas/www/GROUPS/MUON/Persint/releases/
   opt/oracle/instantclient10_1;
```

2. Install the SOCI C^{++} Database Access library.

- **General intructions**

```
wget http://downloads.sourceforge.net/soci/soci-3.0.0.tar.gz
wget http://downloads.sourceforge.net/soci/soci-3.0.0.tar.gz
tar xvfz soci-3.0.0.tar.gz
\rm soci-3.0.0.tar.gz
cd soci-3.0.0
wget http://atlas.web.cern.ch/Atlas/GROUPS/MUON/Persint/releases/soci-3.0.0.patch
patch -p1 < soci-3.0.0.patch
./configure --include-prefix=<PREFIX>/include --lib-prefix=<PREFIX>/lib
   --oracle-include=$ORACLE_INCDIR --oracle-lib=$ORACLE_LIBDIR
make
make install
```

Where <PREFIX> is the installation path of your choice. You might encounter an error if the version of your Oracle client is recent as SOCI expects version 10. Just patch the SOCI source code before compilation :

```
sed -i 's;nnz10;nnz<version>;g' build/unix/build-oracle.tcl
sed -i 's;nnz10;nnz<version>;g' src/backends/oracle/test/Makefile.basic
```

Inform *Persint* of the library's location with an environment variable :

```
export SOCI_HOME=<PREFIX>;
```

- **Scientific Linux Cern** On a SLC machine with access to CERN AFS directories:

```
export SOCI_HOME=/afs/cern.ch/atlas/www/GROUPS/MUON/Persint/releases/opt;
```

B.4 Platform-specific instructions

B.4.1 Mac OS X

1. **Installing MacPorts**
   To install the required dependencies, you might want to install MacPorts.

   (a) First install, if not already done, Apple's Xcode tools from Mac OS X installation DVD or from Apple's site

   (b) Download and install the MacPorts software distribution package

   (c) Update the list of available ports:

   ```
   sudo port selfupdate
   ```

2. **Updating MacPorts ports**

   ```
   sudo port selfupdate
   sudo port upgrade outdated
   ```

B.4.2 CernVM

1. **Installing CernVM**

   - VirtualBox (https://www.virtualbox.org/wiki/Downloads)
   - http://cernvm.cern.ch/portal/downloads
   - CernVM (https://twiki.cern.ch/twiki/bin/viewauth/Atlas/CernVM)
   - CernVMGuideSoftwareInstall (https://twiki.cern.ch/twiki/bin/viewauth/Atlas/CernVMGuideSoftwareInstall)

2. **Installing OpenAFS**

   - See CernVM *release notes* (http://cernvm.cern.ch/portal/release_2.4.0)
   - Do:

     ```
     sudo conary update group-openafs-client openafs openafs-client
     sudo conary update kernel-module-openafs-‘uname -r‘
     sudo mkdir -p /afs
     echo cern.ch > /tmp/ThisCell
     sudo cp /tmp/ThisCell /usr/vice/etc/ThisCell
     ```

     After reboot, AFS should be mounted under /afs. To authenticate use the *kinit* command.

3. **Installing binary distribution of *Persint***

   - Install AFS and authenticate with *kinit*
   - Download, install and setup binary kit

     ```
     wget http://atlas.web.cern.ch/Atlas/GROUPS/MUON/Persint/releases/00.02.57/
        Persint-00-02-••-cernvm-‘uname -m‘-gcc43-qt463.tar.gz
     tar xvfz Persint-00-02-••-cernvm-‘uname -m‘-gcc43-qt463.tar.gz
     cd Persint-00-02-••
     source install_cernvm.sh
     ./start_persint.sh
     ```

B.4.3 Cygwin

1. **Installing Cygwin under Windows 7**
   Install Cygwin by running `setup.exe`.

   - In addition to the packages listed in the dependencies, select the following packages required to connect to an X server:

     ```
     xorg-server xinit
     ```

   - Before starting *Persint* (using the `start_persint.sh` script), connect to a Cygwin/X server by typing *startxwin* from the Cygwin shell.

C ATLAS coordinate system

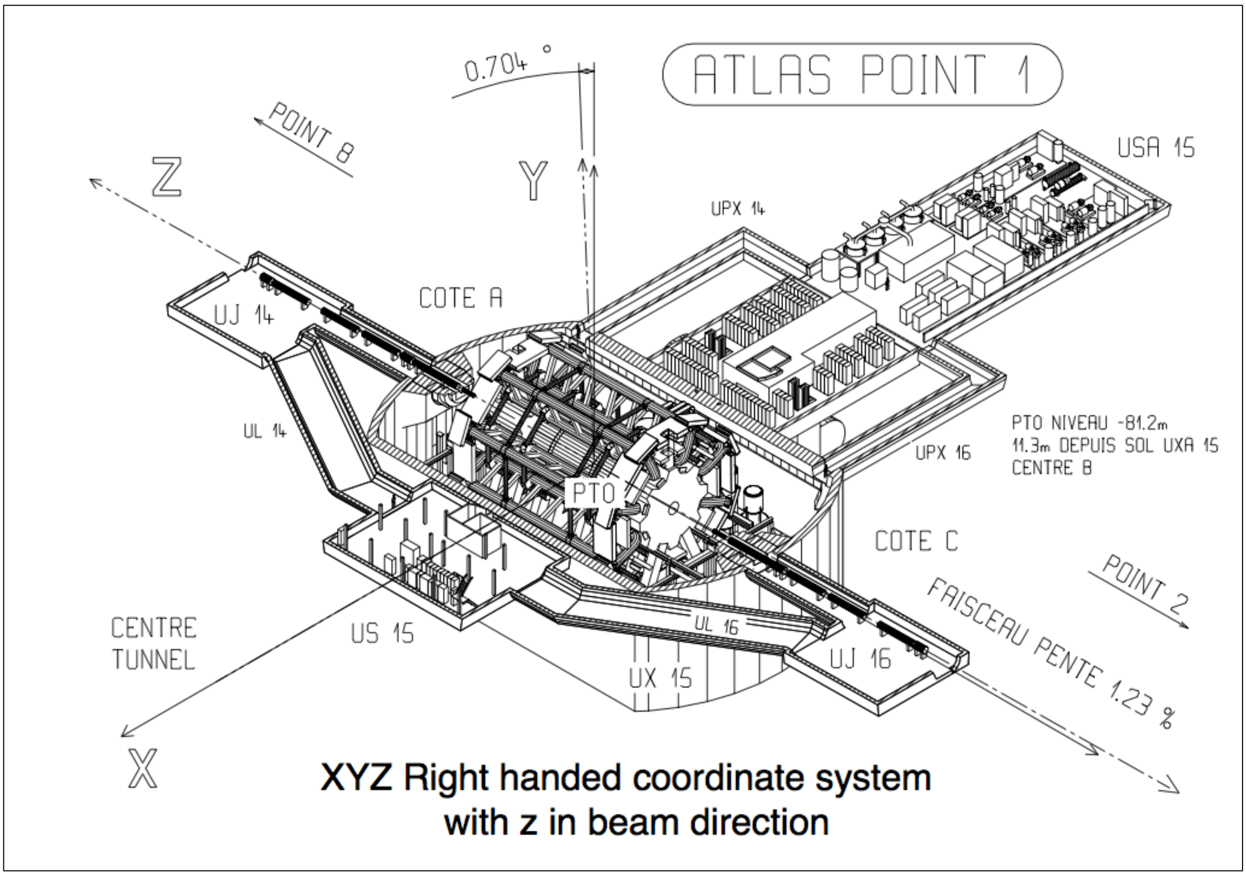


Figure 132: ATLAS coordinate system.

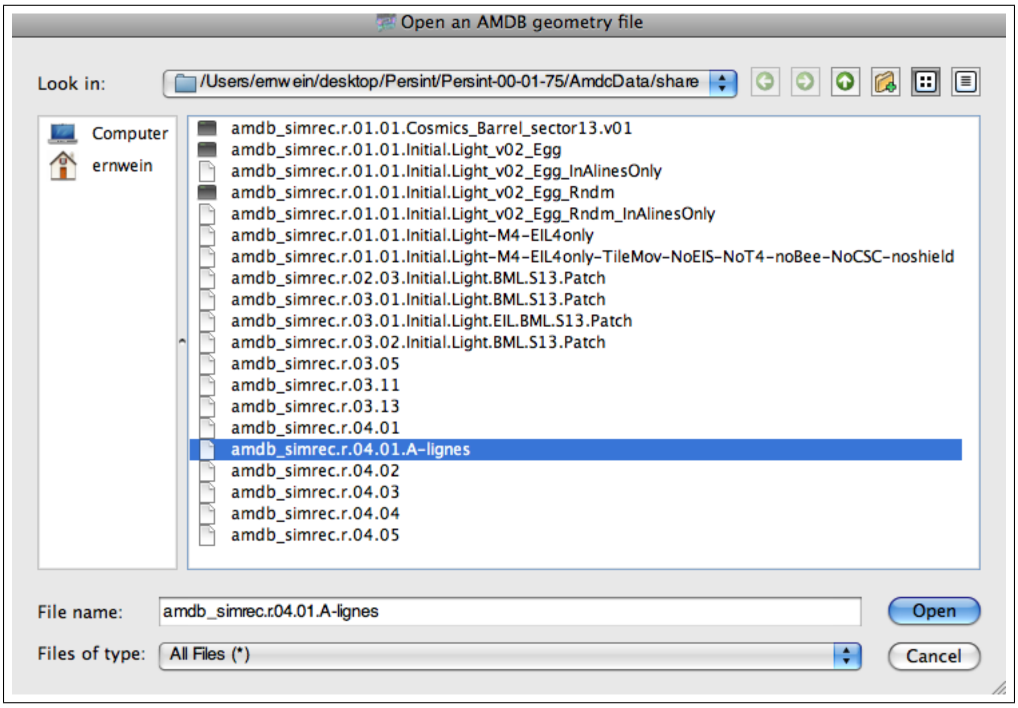
D Files used in *Persint*

D.1 File formats

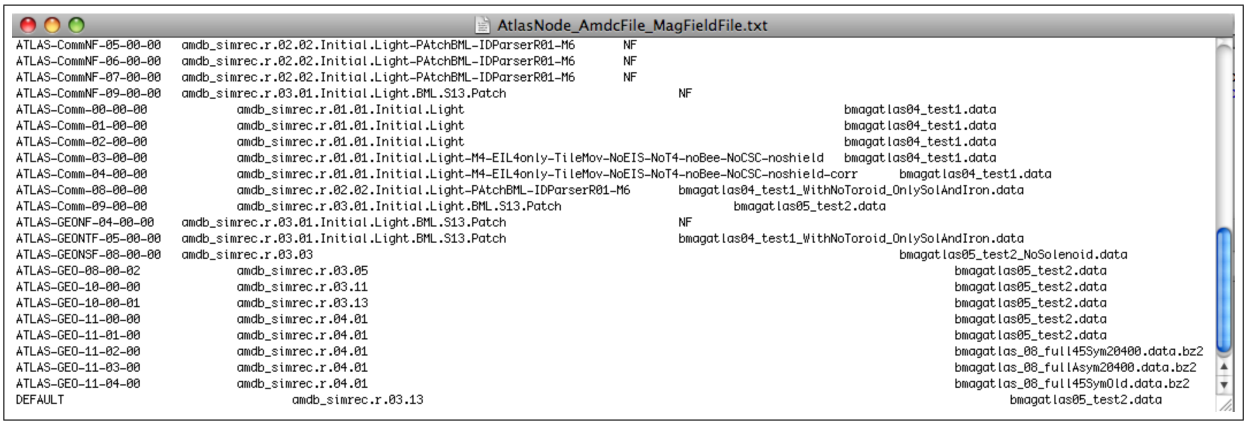
Several types of files are encountered when using *Persint*. Most are specific to *Persint*, except the "exported" files used for presentations and publications.

File extension	***Description***	***Default directory***	***Comments***
`.p2vf`	Detector description file.	Persint-00-02-●● /example	Produced by *Persint* with the *Save view as* function of the *File* menu. Retrieved with the *Open view* function. (Section 6.3, item 3)
`.p2ts`	Track parameter file for displaying an event	Persint-00-02-●● /example	Produced with *Save* or *Save as*, retrieved with *Open* in the *Set track parameters* window. (Section 6.3, item 6)
`.p2gm`	Generated muon parameter file	Persint-00-02-●● /example	Produced with the *Save* action, retrieved with the *Open* action in the *Generate muon tracks* window. (Section 7.1, Figure 19)
`amdb_simrec.xxx`	Detector geometry file ("primary numbers")	Persint-00-02-●● /amdcData/share	Loaded from the *Volumes* tab of the *Data manager* window. (Section 6.1.1, item 1; figure **??**)
`Bmagatlas.data`	Magnetic field file	Persint-00-02-●● /BFieldData/share	Loaded from the *Magnetic Field* tab of the *Data manager* window. (Section 6.1.1, item 2; figure **??**)
`Out.MboyView_yyy`	Reconstructed event file	Persint-00-02-●● /example	ASCII file produced by *ATHENA*. (Section 6.1.1, item 3, figure **??** and Section 6.1.2, item 2)
`.png`, `.jpg`, `.bmp` `.svg`, `.ps`, `.pdf`	File containing the *Persint* Main Display	User's choice	Produced by *Persint* with the *Export* function of the *File* menu. (Section 6.4)
`.dat`	ASCII file	User's choice	Produced by the *Export* function in the various maps available in the *Tools* menu

D.2 Directories for *Persint* files



(a) Available geometry files in `Persint/AmdcData/share`. This window is prompted when clicking *Load* in the *Data manager* window (*Volumes* tab) of figure 4.



```
AtlasNode_AmdcFile_MagFieldFile.txt
ATLAS-CommNF-05-00-00   amdb_simrec.r.02.02.Initial.Light-PAtchBML-IDParserR01-M6       NF
ATLAS-CommNF-06-00-00   amdb_simrec.r.02.02.Initial.Light-PAtchBML-IDParserR01-M6       NF
ATLAS-CommNF-07-00-00   amdb_simrec.r.02.02.Initial.Light-PAtchBML-IDParserR01-M6       NF
ATLAS-CommNF-09-00-00   amdb_simrec.r.03.01.Initial.Light.BML.S13.Patch                         NF
ATLAS-Comm-00-00-00             amdb_simrec.r.01.01.Initial.Light                                                       bmagatlas04_test1.data
ATLAS-Comm-01-00-00             amdb_simrec.r.01.01.Initial.Light                                                       bmagatlas04_test1.data
ATLAS-Comm-02-00-00             amdb_simrec.r.01.01.Initial.Light                                                       bmagatlas04_test1.data
ATLAS-Comm-03-00-00             amdb_simrec.r.01.01.Initial.Light-M4-EIL4only-TileMov-NoEIS-NoT4-noBee-NoCSC-noshield   bmagatlas04_test1.data
ATLAS-Comm-04-00-00             amdb_simrec.r.01.01.Initial.Light-M4-EIL4only-TileMov-NoEIS-NoT4-noBee-NoCSC-noshield-corr      bmagatlas04_test1.data
ATLAS-Comm-08-00-00             amdb_simrec.r.02.02.Initial.Light-PAtchBML-IDParserR01-M6       bmagatlas04_test1_WithNoToroid_OnlySolAndIron.data
ATLAS-Comm-09-00-00             amdb_simrec.r.03.01.Initial.Light.BML.S13.Patch                         bmagatlas05_test2.data
ATLAS-GEONF-04-00-00    amdb_simrec.r.03.01.Initial.Light.BML.S13.Patch                         NF
ATLAS-GEONTF-05-00-00   amdb_simrec.r.03.01.Initial.Light.BML.S13.Patch                         bmagatlas04_test1_WithNoToroid_OnlySolAndIron.data
ATLAS-GEONSF-08-00-00   amdb_simrec.r.03.03                                                             bmagatlas05_test2_NoSolenoid.data
ATLAS-GEO-08-00-02              amdb_simrec.r.03.05                                                             bmagatlas05_test2.data
ATLAS-GEO-10-00-00              amdb_simrec.r.03.11                                                             bmagatlas05_test2.data
ATLAS-GEO-10-00-01              amdb_simrec.r.03.13                                                             bmagatlas05_test2.data
ATLAS-GEO-11-00-00              amdb_simrec.r.04.01                                                             bmagatlas05_test2.data
ATLAS-GEO-11-01-00              amdb_simrec.r.04.01                                                             bmagatlas05_test2.data
ATLAS-GEO-11-02-00              amdb_simrec.r.04.01                                                             bmagatlas_08_full45Sym20400.data.bz2
ATLAS-GEO-11-03-00              amdb_simrec.r.04.01                                                             bmagatlas_08_fullAsym20400.data.bz2
ATLAS-GEO-11-04-00              amdb_simrec.r.04.01                                                             bmagatlas_08_full45SymOld.data.bz2
DEFAULT                                 amdb_simrec.r.03.13                                                             bmagatlas05_test2.data
```

(b) Part of the file "`Persint-00-02-••/PersintData/AtlasNode_AmdcFile_MagFieldFile.txt`": Correspondence between geometry and magnetic field files

Figure 133: Details of some files used by *Persint*.

D.3 File description

D.3.1 .p2vf

```
[ColorPalette]
1\red=0
1\green=0
1\blue=0
.
.
20\green=255
20\blue=127
size=20

[Files]
AMDBfile=amdb_simrec.r.03.01.Initial.Light.BML.S13.Patch

[AMDBTree]
MAT\BARREL\sectorsSelected=@Variant(\0\0\0\r\0\0\0\b|)
MAT\BARREL\ZRegionSelected=@Variant(\0\0\0\r\0\0\0\x3\a)
MAT\BARREL\colorIndex=19
MAT\ENDCAP\sectorsSelected=@Variant(\0\0\0\r\0\0\0\b\xff)
MAT\ENDCAP\ZRegionSelected=@Variant(\0\0\0\r\0\0\0\x3\a)
MAT\ENDCAP\colorIndex=19
MAT\HCAL\sectorsSelected=@Variant(\0\0\0\r\0\0\0\b<)
MAT\HCAL\ZRegionSelected=@Variant(\0\0\0\r\0\0\0\x3\a)
MAT\HCAL\colorIndex=-1
MAT\ECAL\sectorsSelected=@Variant(\0\0\0\r\0\0\0\b<)
MAT\ECAL\ZRegionSelected=@Variant(\0\0\0\r\0\0\0\x3\a)
MAT\ECAL\colorIndex=-1
MAT\ID\sectorsSelected=@Variant(\0\0\0\r\0\0\0\b<)
MAT\ID\ZRegionSelected=@Variant(\0\0\0\r\0\0\0\x3\a)
MAT\ID\colorIndex=-1
OptionsMDT\crossBars=2
OptionsMDT\longBeams=0
OptionsMDT\envelop=2
OptionsMDT\tubes=0
OptionsMDT\endPlugs=0
OptionsMDT\faradayCages=0
OptionsMDT\stairCasing=0
OptionsRPCTGC\envelop=2
OptionsRPCTGC\stripsS=0
OptionsRPCTGC\stripsZ=0

[AGDDv002]
Vis\1\branchName=List_of_independant_trees
Vis\2\branchName=ECT_Toroids
.
.
Colors\1\branchName=List_of_independant_trees
Colors\1\colorIndex=19
Colors\size=1
Options\booleanMode=false
Options\envelopeLevel=2

[ViewParameters]
focal=35
isometricView=0
XO=-0.723623859990529
YO=-20.7343174935221
ZO=-59.5720362668364
XA=2184.99982896372
YA=1111.63360827307
ZA=630.705081840161
projection=0
WireModeOn=false

[MovedVolumes]
1\volumeName=SADL_Gusset_Plate/Iron/
1\superFlag=1
1\xOffset=9999
1\yOffset=9999
1\zOffset=9999
1\xAngle=0
.
.
62\volumeName=oAttWing74900001
62\superFlag=1
62\xOffset=19999
62\yOffset=19999
62\zOffset=19999
62\xAngle=0
62\yAngle=0
62\zAngle=0
size=62

[Labels]
size=0
```

D.3.2 .p2ts

```
[simulation]
parameters\Gen_trk_at_IP\checked=0
parameters\Gen_trk_at_IP\value=0.1
parameters\Gen_trk_at_spectro\checked=1
parameters\Gen_trk_at_spectro\value=0.1
options\simul\value=1

[reconstruction]
parameters\Mboy_Seg\checked=1
parameters\Mboy_Seg\red=1
parameters\Mboy_Seg\green=0
parameters\Mboy_Seg\blue=0
parameters\Moore_Seg\checked=0
parameters\Moore_Seg\red=0
parameters\Moore_Seg\green=1
parameters\Moore_Seg\blue=0
parameters\ID_trk_at_IP\checked=0
.
parameters\Mboy_trk_at_IP\checked=0
.
parameters\Mboy_trk_at_spectro\blue=0
parameters\Staco_trk_at_IP\checked=0
.
parameters\MuTag_trk_at_IP\checked=0
.
parameters\Moore_trk_at_spectro\checked=0
.
parameters\MuID_Extra._trk\checked=0
.
parameters\MuIDcomb_trk_at_IP%20\checked=0
.
options\matter\value=1
options\width\value=1.71

[calorimeterCells]
parameters\barrel_presampler\checked=1
.
parameters\barrel_lar_em\checked=1
.
parameters\endcap_lar_em\checked=1
.
parameters\tile\checked=1
.
parameters\endcap_lar_hadr\checked=1
.
parameters\very_forward_lar\checked=1
.
parameters\endcap_presampler\checked=1
parameters\endcap_presampler\value=0.1
parameters\endcap_presampler\red=1
parameters\endcap_presampler\green=0.2
parameters\endcap_presampler\blue=0.2
options\envelop\value=0

[EgamaObjects]
parameters\Photons\checked=1
parameters\Photons\red=1
parameters\Photons\green=0.6
parameters\Photons\blue=0.2
parameters\Electrons\checked=1
parameters\Electrons\red=0.6
parameters\Electrons\green=0.6
parameters\Electrons\blue=0

[TRT]
parameters\bra\checked=0
parameters\bra\min=6
parameters\bra\max=50
options\braphi\value=32
parameters\brc\checked=0
parameters\brc\min=6
parameters\brc\max=50
options\brcphi\value=32
parameters\eca\checked=0
parameters\eca\min=6
parameters\eca\max=50
options\ecaphi\value=32
parameters\ecc\checked=0
parameters\ecc\min=6
parameters\ecc\max=50
options\eccphi\value=32
options\allenvelop\value=0
```

D.3.3 .p2gm

```
[Muons]
1\track=1.2, 90, 100, true, 0, 0, 0
1\color=@Variant(\0\0\0\x43\x1\xff\xff\xff\xff\0\0\0\0\0\0)
2\track=1.2, 0, 100, true, 0, 0, 0
2\color=@Variant(\0\0\0\x43\x1\xff\xff\0\0\0\0\xff\xff\0\0)
3\track=1.2, 0, 10, true, 0, 0, 0
3\color=@Variant(\0\0\0\x43\x1\xff\xff\0\0\xff\xff\0\0\0\0)
size=3
```

D.3.4 amdb_simrec.xxx

```
********************************************************************************
*
* NAME (16 Char.) of this AMDB_SIMREC data base  (ATLAS Muon Layout version R) :
*
*
* ****************
* ****************
N R.03 01
*       .Initial.Light.BML.S13.Patch
*       BIS 1,2,4,5,6 without supports
*       BML Old numbering
*       EIL mv by 20m to avoid clashes in GeoModel/G4
*       NO EEL, EES
* ****************
* ****************
*
* COMMENTS :
*    Final Layout R
*    R.03 01
*          Huge corrections From Stefania Spagnolo on RPC orientation
*          all corrections appear with comments "*"
*          Update on RPC and cutouts
*          -BMS 2 5, 6 , 7 (cutouts)
*          -BOF
*          -BOG
*          -W RPC 7
*          -add W DED 3
*          Update XML part for Andrea converter
*          -saddle
*          -PP2
*          -passerel/platforms
*          -ECT_Cryo7SidTemp suppress composition replace by a rotation
*          -many ";" + other correction in Patch Panel.
*    R.02 03
*      corrections From Andrea Dell'Acqua about ";" and TGCSupport
*                       Without symetry convention to build TGC support
*      CSC position corrected
*    R.02 02
*           ID Patch Panels PP2 (not at the correct position)
*           Muon Barrel Access Platforms
*           Feet Struts
*           Access Platform Sector 13
*           MDT Big Wheel
*           Calorimeter Saddle
*           TGC support (not at the correct position)
*           BOL Support
*           Mobylette: Cyclomoteur
*
*    R.02 01:
*           Pierre-Franois
*       new 1 BIM with HV <-> RO inverted
*       new 6 BIR with HV <-> RO inverted + correction 75mm
*            BIS8 bad position
*     BML sector 13 add hole corresponding to elevator place
* 12345 -> 12367
*            BOG bad position
*            Stefania
*    BMF1,BMF2,BMF3 LB2->LB1
*                 BOG1,BOG2,BOG4,BOG5 RPC size
*    W PRC8, RPC17
*            Florian
*   BOS2,BOS3,BOF1->BOF8 1868->1853 (+3mm? should be checked)
```

```
*                 BOS1 CRO est a -2656mm
*        CRV est a  1050mm
*      : Same Dead Matter as R.01.01
*    initially based on q.02_test8
*    R.01 01 BOG positions from ATLM____0034 Version AG (Layout R sector 12) based on Feet as installed
*            EOL/EOS positions in Z according to Layout R Version AG
*            BOG 6 RO/HV swapped from ATLM____0041 Version AG (Layout R sector 14)
*            BOL sector 13 positions z+40 mm after elevator shaft according to Layout R Version AF
*            AGDD-XML section : correction to JDSH_TUBEleng, JDSH_PLUGleng
*                               variable names follow DB conventions
*                               implementation of ECT Service Tower
*            correction to EEL sector 9
*            positions of stations located at Z<0 not mirrored following 30.035 wire pitch
*            dz of BOG cutouts following 30.035 wire pitch
*            BOL 3,6,7 swap dz of RPC and DED (stations not mirrored)
*
*
********************************************************************************
*
* VERSION NUMBER (Integer I5) of this AMDB_SIMREC data base (Default is 0)
*
* *****
* *****
V     7
* *****
* *****
*
*
********************************************************************************
*
* The lines which start with the character  D  correspond to the
*                                           *****
*
* DEFINITION OF THE DIFFERENT STATIONS
*
* The station  Typ It  is formed of  No  different objects (or multi-layers).
*             ********              ****
*
* Within a station, the relative postion of each object is given by
*  dx ,  dy  and  dz , the local reference frame (x,y,z) being
* ****  ****     ****
* the same one as in V.Chaloupka Data Base.
*
*
*   ---------------> Typ It : Identify the station type.
*   |
*   |     -------------> No : Number of objects forming the station.
*   |     |
*   |     |  And, for each object :
*   |     |
*   |     |    -----------> dx, dy, dz : Relative position of the object.
*   |     |    |
*   |     |    |      -------> Io : Object serial number in the station.
*   |     |    |      |
*   |     |    |      |  -------> Tec : Type of technology used for the object.
*   |     |    |      |  |
*   |     |    |      |  |  -------> Iw : Inner structure type index.
*   |     |    |      |  |  |
*   |     |    |      |  |  | --------> Isplit_x : Number of sections in x
*   |     |    |      |  |  | |                    for RPC's (1 if missing).
*   |     |    |      |  |  | | ------> Isplit_y : Number of sections in y
*   |     |    |      |  |  | | |                  for RPC's (1 if missing).
*   |     |    |      |  |  | | |
*   |     |    |      |  |  | | | ----> Ishape : Type of geometrical shape
```

```
*   |     |    |      |  |  | | | |     missing
*   |     |    |      |  |  | | | |      or 0 --> trapezoidal (or rectangular)
*   |     |    |      |  |  | | | |         1 --> "T" shaped
*   |     |    |      |  |  | | | |         2 --> "Diamond" shape (CSC)
*   |     |    |      |  |  | | | |         3 --> rotated trapezoids (TGC)
*   |     |    |      |  |  | | | |
*   |     |    |      |  |  | | | |   -----> Width_xS, Width_xL, Length_y,
*   |     |    |      |  |  | | | |   |      Excent., Dead1, Dead2 :
*   |     |    |      |  |  | | | |   |      Dimensions of the object
*   |     |    |      |  |  | | | |   |      (See figures).
*   |     |    |      |  |  | | | |   |
* XXX-X   X    |      |  |  | | | |   |
*XXXXX--XXXXX--XXXXX  X XXX X X X X XXXXXX--XXXXXX--XXXXXX--XXXXX--XXXXX--XXXXX
*XXXXX--XXXXX--XXXXX  X XXX X X X X XXXXXX--XXXXXX--XXXXXX--XXXXX--XXXXX--XXXXX
* .....
*
*
*
********************************************************************************
*
* The lines which start with the character  C  correspond to the
*                                          *****
*
* DEFINITION OF THE CUT-OUTs IN THE STATIONS
*
* The cut-out  Icut  in the station  Typ It  is formed of  Nocut
*            ******               ********             *******
* different sub-cuts in the various objects (or multi-layers) of
* this station.
*
*
*   -------------> Typ It : Identify the station type.
*   |
*   |   ------------> Icut : Cut-out index
*   |   |
*   |   | -------------> Nocut : Number of sub-cuts in the station.
*   |   | |
*   |   | |  And, for each sub-cut :
*   |   | |
*   |   | | --------------> dx, dy : Relative position of the sub-cut.
*   |   | | |
*   |   | | |         -------> Io : Serial number of the object in which
*   |   | | |         |             the sub-cut is made.
*   |   | | |         |
*   |   | | |         |              -----> Width_xS, Width_xL, Length_y,
*   |   | | |         |              |      Excent.
*   |   | | |         |              |      Dimensions of the sub-cut
*   |   | | |         |              |                         (see figures).
* XXX-X X X |         |              |
*XXXXX--XXXXX         X             XXXXXX--XXXXXX--XXXXXX--XXXXX
*XXXXX--XXXXX         X             XXXXXX--XXXXXX--XXXXXX--XXXXX
* .....
*
*
*
*-- Definition of stations -----------------------------------------------------
* Typ I  No
*   s      z      t  Io Tec i x y m   W_xS    W_xL    L_y     Ex     D1     D2     D3
*******       *******   ***  **  **       ********        *******       *******
*      *******       **    **  **  ********        ********       *******       *******
*
*
*-- Definition of BIL stations -------------------------------------------------
* Typ I  No
```

```
*  dx      dy      dz   Io Tec i x y s  W_xS     W_xL     L_y     Ex     D1      D2
* ...
D BIL 1   7
   0.      0.      0.    1 MDT 1       2671.5  2671.5 1081.261  0.    55.      0.
-1280.     0.   123.07 2 CHV 1          6.0      6.0 1081.261  0.     0.      0.
   0.      0.   123.07 3 CMI 1          6.0      6.0 1081.261  0.     0.      0.
1280.      0.   123.07 4 CRO 1          6.0      6.0 1081.261  0.     0.      0.
   0.    215.   170.57 5 LB  1       2620.0  2620.0     50.    0.     0.      0.
   0.    815.   170.57 6 LB  1       2620.0  2620.0     50.    0.     0.      0.
   0.      0.   293.07 7 MDT 2       2671.5  2671.5 1081.261  0.    55.      0.
D BIL 2   7
   0.      0.      0.    1 MDT 1       2671.5  2671.5  901.051  0.    55.      0.
```

and so on ...

towards end of file ...

```
   <mposPhi volume="rail1"  ncopy="8"  Phi0="-14.35" R_Z="10040;-6000" impliedRot="false" />
   <mposPhi volume="rail2"  ncopy="8"  Phi0="14.35"  R_Z="10040;-6000" impliedRot="false" />
</composition>

</section>


<section name       = "Solenoid"
         version    = "1.1"
         date       = "22 11 1962"
         author     = "laurent"
         top_volume = "Solenoid">

<!--
      *************************************************************
      ***                  Solenoid                            ****
      *************************************************************
-->

<tubs   name="tubs_hole"      material="Azur"   Rio_Z="1200;1300;5000" />
<composition name="Solenoid">
   <posXYZ volume="tubs_hole"      X_Y_Z=" 0 ; 0 ; 0"  />
</composition>
</section>

<section name       = "Eta0Services"
         version    = "1.1"
         date       = "22 11 1962"
         author     = "laurent"
         top_volume = "Eta0Services">
<cons   name="cons_angle" material="Orange" Rio1_Rio2_Z="4500;9000;4500;9000;300" profile="-14;28"    />

<composition  name="servicesAtZ0" >
  <mposPhi  volume="cons_angle" Phi0="45"  ncopy="8" >
  </mposPhi>
</composition>

</section>

</AGDD>
X ----------------------------------------------------------------------------------------
*
*
*
End
```

D.3.5 Bmagatlas

```
B-3D-R.1    ATLM dtb => atlm01p
    8      5.80  20500.00  20500.00
   30    4      1.28      5.78     492.20     985.30    1241.00     137.90
    1    4      1.25      4.30
   32
    122.46
    498.57
    825.04
   1256.16
     96.00
     96.00
    80    99    0.785398185
 0.000000000 0.006000000 0.008500000 0.009000000 0.011000000 0.013900000
 0.017238000 0.019000000 0.022000000 0.024070000 0.027379000 0.030670000
 0.035531000 0.043423000 0.052974000 0.064359000 0.078351000 0.115947000
 0.168554000 0.231067000 0.285960000 0.325066000 0.341732000 0.349282000
 0.356406000 0.359997000 0.364267000 0.368445000 0.370000000 0.372000000
 0.374908000 0.378033000 0.379500000 0.380000000 0.381000000 0.382000000
 0.384113000 0.388406000 0.392699000 0.396685000 0.398699000 0.400670000
 0.401699000 0.402500000 0.403760000 0.404000000 0.405199000 0.406800000
 0.409937000 0.411699000 0.414699000 0.416769000 0.420078000 0.428230000
 0.445673000 0.471050000 0.508646000 0.561253000 0.623766000 0.678659000
 0.699990000 0.717765000 0.729584000 0.734431000 0.738464000 0.741981000
 0.745518000 0.749105000 0.752696000 0.756966000 0.761144000 0.762699000
 0.764699000 0.767607000 0.770732000 0.772699000 0.774699000 0.776812000
 0.781105000 0.785398000
      0.0000     38.0000     72.0000    100.0000    124.0000    145.0000
    492.0000    516.0000    543.0000    566.0000    636.0000    723.0000
    764.2500    791.7500    805.2619    812.8077    816.0000    818.0000
```

and so on ...

towards end of file ...


```
Cy;zJzEzNzOzv=yYP+2+1z+zwztzozmzjzhzf=xJ6=yZ1!2z8!2z7z6zaz5!2z7z6!2z7!4z6z5z6g.=
xrWy;=y6jyedPzu=z2m*2!5y;y,y:y,!2yZyXyWyV!2ySyQ!2yRySyVyXy.yL=-2Cy;zJzEzNzOzv=yY
P+2+1z+zwztzozmzjzhzf=xJb=yZ1!2z8z7z6z7zaz5!2z7z6!2z7!5z6z5g:=xrLy;=y;O*1=xQAzm=
z2ny;*1y;*1y;y:y;y,y:y,y.!2yY!2yV!2ySyQ!2yRySyVyXy.yL=-2Cy;zJzEzNzOzv=yYP+2+1z+z
wztzozmzjzhzf=xJi=yZ1z8z7z8z6z7zaz5!4z7z6z7z6z5!2z6z5hO=xrz*1=xYnystZzi=z2n*1y;*
1!3y;y:y,y:y,y.!2yY!2yV!2ySyQ!2yRySyVyXy.yL=-2Cy;zJzEzNzOzv=yYP+2+1z+zwztzozmzjz
hzf=xJq=yZOz9!4z7zaz5z8z6!3z7!4z6z5z6h2QO*3=xUezj=z2n*2!4y;y:y,y;!2y.!2yY!2yV!2y
SyQ!2yRySyVyXy.yL=-2Cy;zJzEzNzOzv=yYP+2+1z+zwztzozmzjzhzf=xJx=yZO!2z8!3z7zaz6!2z
7z6!2z7z6z7z5!2z6z5h6=xqUz1NzyML1zm=z2oy;*1y;*1y;y:y;y.y;!2y.yZyXyWyU!2ySyQ!2yRy
SyVyXy.yL=-2Cy;zJzEzNzOzv=yYP+2+1z+zwztzozmzjzhzf=xJ)=yZO!2z8!3z7zaz6!2z7z6z8z6z
7!3z6!2z5ha=xq-*1=y;O*1=xV)zq=z2o*1y;*1!3y;y:y,y:y,!2yZyXyWyUyTyRyQ!2yRySyVyXy.y
L=-2Cy;zJzEzNzOzv=yYP+2+1z+zwztzozmzjzhzf=xJD=yZO!2z8!3z7zaz6!5z7!4z6z5z6hd=xqk*
1-xz3,Xzt=z2o*2!4y;y:y,y:y,!2yZyXyWyUyTyRyQ!2yRySyVyXy.yL=-2Cy;zJzEzNzOzv=yYP+2+
1z+zwztzozmzjzhzf=xJF=yZOz8z7z8!2z7zaz6!5z7!5z6z5hfPQ*3=xVNzv=z2py;*1y;*1y;!2y:y
,y:y,!2yZyXyWyUyTyRyQ!2yRySyVyXy.yL
```

D.3.6 Description of the *Out.MboyView* ASCII event file readable by PERSINT

```
Here is an example of an event file. The first word of each line is a keyword which has to start
on the first column : only the first 3 letters are mandatory, and usually case sensitive.
The first part of the file contains global parameters which are optionnal.
GEO geometry : if present, it should be the first line and contains info on the geometry to be
used, i.e. ATLAS-DC3-05.
RTpara integer allows to set the RT relations which will be used for MDT.
   0 default, the RT will be explicitely given for each MDT of each event using the RS lines
     which will be described later.
   > 0 will use our "home-made" parametrization done on the first cosmic runs.
   < 0 a constant value (equals to the abs of the given value, divided by 100) in cm will be used.
     For nice displays, -120 is a good choice.
Then for each event,
NEW EVT eventNumber runNumber AmdcAthenaFlag CosmicFlag
AmdcAthenaFlag : hits are identified by the Amdc (0) or Athena identifiers (1 = default).
CosmicFlag : 0 if standard (collision) or 1 if cosmic
HIT numberMDThits numberRPChits numberTGChits number CSChits
MDT BIL i1 i2 i3 i4 i5 X Y Z DriftTime ADCcount Particle TDCcount digitID
i1 to i5 are the Athena idenfiers of the given tube/station
X Y Z are the positions of the middle of the tube. If unknow, put 0. 0. 0. and they will be
computed by Amdc.
RPC BML i1 i2 i3 i4 i5 i6 i7 i8 X Y Z Particle digitID time
i1 to i8 are the Athena identifiers of the given strip/station
X Y Z are the positions of the middle of the strip. If unknow, put 0. 0. 0. and they will be
computed by Amdc.
END EVT last line of the event.
In addition to the muon information, we can add calorimeter or tracking information in these
files. Starting with the calorimeter cells, the format is
CAL TYP radius eta phi layer Energy(MeV) deta dphi dr dx dy dz
TYP indicates the type of calorimeter. It must be one of the following 3 characters words :
PSB(PreSamplerBarrel), EMB(largEmBarrel), EME(largEmEndcap), TIL(tile), HEC(largHadronicEndcap), FCA(veryForwardEndcap)
or PSE(PreSamplerEndcap)
radius, eta and phi give the position of the center of the cell
deta, dphi, dr, dx, dy, dz give the size of the cell. The parameters used are (dx, dy, dz)
for FCA, (deta, dphi, dr) for PSB, EMB and TIL and (deta, dphi, dz) for EME, HEC and PSE.
The parameters not used may be arbitrary.
Example :
CAL EME 615.1562 -2.5600 0.2495 1 722.0 0.1000 0.0982 0.0000 0.0000 0.0000 224.1685 740294660

For Egamma Objects the format is :

CAL EgammaContainerLocation X Y Z Px Py Pz E eta phi Charge
electromagnetic objects are dumped if : //(isEM & 0x7FF)==0 means all cuts except TRT
X,Y,Z are the track intercept at the perigee, Px,Py,Pz are the gtrack momentum at the perigee
for neutral particles, X,Y,Z and Px,Py,Pz are set to 0
E, eta, Phi are the cluster energy, pseudo-rapidity and azimuth respectively
Example :
EGA egammaCollection 0.001 -0.035 -11.853 -50455.172 -792.320 -49976.254 73027.702 -0.882 -3.117 -1

For Trackparticle and Trk::Track Objects the format is :

TRK TrackParticle TrackParticleContainerLocation dummy X Y Z Px Py Pz Charge PDG_Code
the track representation is the perigee one
Examples
TRK McEventCollection TruthEvent dummy 0.009 0.006 23.258 -1400.825 2469.821 -6805.638 1 211

TRK CombinedMuon MboyESDMuonContainer dummy 2.488 -82.009 -591.075 -1125.241 -34.143 -7849.847 -1 0

TRK TrackRecord MuonEntryLayerFilter dummy -50.110 -52.002 -6740.000 -8.635 1.688 -125.547 -1 11

TRK CombinedMuon StacoCombinedMuonContainer dummy 0.000 0.001 84.526 31681.809 -12270.981 37905.569 1 0

TRK CombinedMuon MuidCombinedMuonContainer dummy 0.002 0.005 84.522 31454.320 -12184.459 37634.866 1 0

TRK CombinedMuon MuidExtrCombinedMuonContainer dummy -7.415 -19.176 94.293 32445.334 -12545.980 38727.635 1 0

TRK TrkTrack Tracks KalmanFitter 0.012 0.002 83.630 103.873 -670.289 -3445.807 1 0

TRK TrkTrack ConvertedMBoyMuonSpectroOnlyTracks Muonboy 4021.170 -1375.752 4822.313 28616.934 -9429.886 33776.897 1 0

TRK TrkTrack ConvertedMooreTracks MooreLegacyCnv 4133.017 -1699.972 5078.248 30054.322 -11982.251 36321.348 1 0

Description
```

```
TRK McEventCollection TruthEvent are the generated tracks. They are drawn inside the tracker (except for muons).

TRK TrackRecord MuonEntryLayerFilter are the generated tracks at the spectrometer entrance.
They are drawn starting from the surface defining this spectrometer entrance.

TRK TrkTrack ConvertedMBoyMuonSpectroOnlyTracks are the Muonboy tracks, drawn inside the spectro.

TRK CombinedMuon MboyESDMuonContainer are the Muonboy tracks, back-propagated to the interaction point.

TRK TrkTrack Tracks are the tracks from the Inner Detector.

TRK CombinedMuon StacoCombinedMuonContainer describe the Staco tracks, i.e. combination of InDet and Spectro tracks.

For Segment Objects the format is :

SEG MuonSegment TrkSegmentCollectionLocation X Y Z Dx Dy Dz Chi2
X,Y,Z are the segment position (global frame)
Dx,Dy,Dz the segment direction
Chi2 the segment Chi-squared
Example :
SEG MuonSegment ConvertedMBoySegments -7271.419 -5869.373 -14294.539 -0.114541 -0.096927 -0.988679 8.2018
```

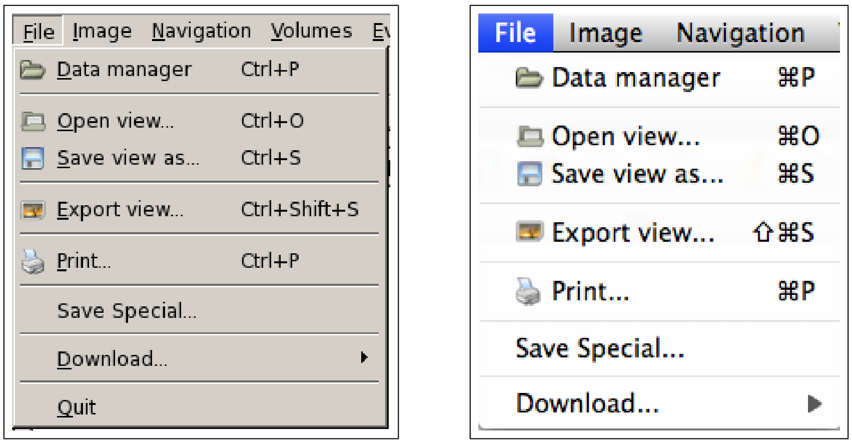
D.3.7 Out.MboyView_Zmumu4023

```
GEO ATLAS-GEO-02-01-00
NEW EVT 4023 5145 1 0
HIT 44 36 0 0 0
MDT  BIL  2  3  1  1  1         0.000  4770.927  1280.035    0.000    101   6     1737     0     1
MDT  BIL  2  3  1  2  2         0.000  4796.939  1295.052    0.000     88   6     1224     1     1
MDT  BIL  2  3  1  3  2         0.000  4822.950  1310.070    0.000    161   6     1098     2     1
MDT  BIL  2  3  1  4  3         0.000  4848.961  1325.087    0.000     90   6     1385     3     1
MDT  BIL  2  3  2  1  5         0.000  5048.997  1385.157    0.000    145   6     1539     4     1
MDT  BIL  2  3  2  2  4         0.000  5075.009  1370.140    0.000     85   6     1552     5     1
MDT  BIL  2  3  2  3  5         0.000  5101.020  1385.157    0.000    116   6     1162     6     1
MDT  BIL  2  3  2  4  5         0.000  5127.031  1400.175    0.000    147   6     1152     7     1
MDT  BIL  2  7  1  1  7        -0.000 -4770.927  1460.245    0.000     83   6     1571     8     1
MDT  BIL  2  7  1  2  7        -0.000 -4796.939  1445.227    0.000     88   6     1574     9     1
MDT  BIL  2  7  1  3  7        -0.000 -4822.950  1460.245    0.000    107   6     1188    10     1
MDT  BIL  2  7  1  4  8        -0.000 -4848.961  1475.262    0.000     90   6     1112    11     1
MDT  BIL  2  7  2  1 10        -0.000 -5048.997  1535.332    0.000    108   6     1098    12     1
MDT  BIL  2  7  2  2 10        -0.000 -5075.009  1550.350    0.000    146   6     1205    13     1
MDT  BIL  2  7  2  3 11        -0.000 -5101.020  1565.367    0.000     83   6     1613    14     1
MDT  BIL  2  7  2  4 10        -0.000 -5127.031  1550.350    0.000     80   6     1532    15     1
MDT  BIS -7  8  1  3  6      4176.601 -1730.005 -6070.210    0.000    129   6     1326    16     1
MDT  BIS -7  8  2  4 23      4306.481 -1783.803 -6580.805    0.000     94   6     1958    17     1
MDT  BML  2  3  1  1  3         0.000  6913.457  1925.087    0.000    103   6     1179    18     1
MDT  BML  2  3  1  2  3         0.000  6939.469  1940.105    0.000    133   6     1134    19     1
MDT  BML  2  3  1  3  4         0.000  6965.480  1955.122    0.000     83   6     1426    20     1
MDT  BML  2  3  2  1  7         0.000  7312.517  2045.227    0.000    106   6     1302    21     1
MDT  BML  2  3  2  2  7         0.000  7338.529  2060.245    0.000     66   6     1096    22     1
MDT  BML  2  3  2  3  8         0.000  7364.540  2075.262    0.000    104   6     1250    23     1
MDT  BML  2  7  1  1 10        -0.000 -6913.457  2135.332    0.000     94   6     1504    24     1
MDT  BML  2  7  1  2  9        -0.000 -6939.469  2120.315    0.000    101   6     1653    25     1
MDT  BML  2  7  1  3 10        -0.000 -6965.480  2135.332    0.000    120   6     1220    26     1
MDT  BML  2  7  2  1 14        -0.000 -7312.517  2255.472    0.000    116   6     1237    27     1
MDT  BML  2  7  2  2 14        -0.000 -7338.529  2270.490    0.000     83   6     1683    28     1
MDT  BML  2  7  2  3 14        -0.000 -7364.540  2255.472    0.000    116   6     1475    29     1
MDT  BOL  2  3  1  1 12         0.000  9274.457  2675.402    0.000     98   6     1084    30     1
MDT  BOL  2  3  1  2 12         0.000  9300.469  2690.420    0.000    110   6     1126    31     1
MDT  BOL  2  3  1  3 13         0.000  9326.480  2705.437    0.000     64   6     1700    32     1
MDT  BOL  2  3  2  1 16         0.000  9673.517  2795.542    0.000     99   6     1418    33     1
MDT  BOL  2  3  2  2 16         0.000  9699.529  2810.560    0.000     97   6     1152    34     1
MDT  BOL  2  3  2  3 17         0.000  9725.540  2825.577    0.000    106   6     1178    35     1
MDT  BOL  2  7  1  1 18        -0.000 -9274.457  2855.612    0.000    127   6     1185    36     1
MDT  BOL  2  7  1  2 18        -0.000 -9300.469  2870.630    0.000    126   6     1148    37     1
MDT  BOL  2  7  1  3 19        -0.000 -9326.480  2885.647    0.000     96   6     1441    38     1
MDT  BOL  2  7  2  1 22        -0.000 -9673.517  2975.752    0.000    107   6     1323    39     1
MDT  BOL  2  7  2  2 22        -0.000 -9699.529  2990.770    0.000     75   6     1096    40     1
MDT  BOL  2  7  2  3 23        -0.000 -9725.540  3005.787    0.000    111   6     1257    41     1
MDT  BOL  4  2  2  2  4      6858.603  6858.603  6330.140    0.000     98   6     1650    42     1
MDT  BOL  4  6  1  1 23     -6558.031 -6558.031  6885.787    0.000     95   6     1961    43     1
RPC  BML  2  3  1  1  2  1  0  2  -860.000   6808.790   1900.750               6    44    31.250
RPC  BML  2  3  1  1  2  1  0  3  -860.000   6808.790   1927.250               6    45    31.250
RPC  BML  2  3  1  1  2  1  0  1  -860.000   6808.790   1874.250               6    46    34.375
RPC  BML  2  3  1  1  2  2  0  2  -860.000   6831.090   1900.750               6    47    31.250
RPC  BML  2  3  1  1  2  2  0  3  -860.000   6831.090   1927.250               6    48    31.250
RPC  BML  2  3  1  1  2  1  1 41 -1086.100   6808.790   2285.000               6    49    25.000
RPC  BML  2  3  1  1  2  1  1 40 -1059.500   6808.790   2285.000               6    50    31.250
RPC  BML  2  3  1  1  2  2  1 41 -1086.100   6831.090   2285.000               6    51    28.125
RPC  BML  2  3  2  1  2  1  0 10  -860.000   7486.900   2112.750               6    52    31.250
RPC  BML  2  3  2  1  2  2  0 10  -860.000   7509.200   2112.750               6    53    31.250
RPC  BML  2  3  2  1  2  1  1 44 -1165.900   7486.900   2285.000               6    54    34.375
RPC  BML  2  3  2  1  2  1  1 45 -1192.500   7486.900   2285.000               6    55    34.375
RPC  BML  2  3  2  1  2  2  1 45 -1192.500   7509.200   2285.000               6    56    34.375
RPC  BML  2  7  1  1  2  1  0  9   860.000  -6808.790   2086.250               6    57    34.375
RPC  BML  2  7  1  1  2  2  0 10   860.000  -6831.090   2112.750               6    58    31.250
RPC  BML  2  7  1  1  2  2  0  9   860.000  -6831.090   2086.250               6    59    34.375
RPC  BML  2  7  1  1  2  1  1 12   314.700  -6808.790   2285.000               6    60    28.125
RPC  BML  2  7  1  1  2  1  1 13   341.300  -6808.790   2285.000               6    61    31.250
RPC  BML  2  7  1  1  2  2  1 13   341.300  -6831.090   2285.000               6    62    28.125
RPC  BML  2  7  2  1  2  1  0 17   860.000  -7486.900   2298.250               6    63    34.375
RPC  BML  2  7  2  1  2  2  0 17   860.000  -7509.200   2298.250               6    64    37.500
RPC  BML  2  7  2  1  2  1  1 14   367.900  -7486.900   2285.000               6    65    31.250
RPC  BML  2  7  2  1  2  2  1 14   367.900  -7509.200   2285.000               6    66    34.375
RPC  BOL  2  3  1  1  2  1  0 15 -1212.500   9835.400   2834.000               6    67    40.625
RPC  BOL  2  3  1  1  2  1  0 16 -1212.500   9835.400   2868.000               6    68    43.750
RPC  BOL  2  3  1  1  2  1  0 17 -1212.500   9835.400   2902.000               6    69    43.750
RPC  BOL  2  3  1  1  2  2  0 16 -1212.500   9857.700   2868.000               6    70    43.750
RPC  BOL  2  3  1  1  2  1  1 51 -1528.550   9835.400   2885.000               6    71    40.625
RPC  BOL  2  3  1  1  2  1  1 52 -1558.650   9835.400   2885.000               6    72    40.625
RPC  BOL  2  3  1  1  2  1  1 54 -1618.850   9835.400   2885.000               6    73    40.625
RPC  BOL  2  3  1  1  2  1  1 53 -1588.750   9835.400   2885.000               6    74    43.750
RPC  BOL  2  3  1  1  2  2  1 52 -1558.650   9857.700   2885.000               6    75    40.625
RPC  BOL  2  7  1  1  2  1  0 23  1212.500  -9835.400   3023.150               6    76    50.000
RPC  BOL  2  7  1  1  2  2  0 24  1212.500  -9857.700   3053.450               6    77    50.000
RPC  BOL  2  7  1  1  2  1  1 16   475.050  -9835.400   2705.000               6    78    37.500
RPC  BOL  2  7  1  1  2  2  1 16   475.050  -9857.700   2705.000               6    79    40.625
RS3      0  -1308.750   4770.927   1280.035  1.0000000  0.0000000  0.0000000     12    222.625     12.860     12.854     12.846     12.838     12.830
RS3      1  -1308.750   4796.939   1295.052  1.0000000  0.0000000  0.0000000     12    222.625      5.662      5.646      5.628      5.608      5.587
RS3      2  -1308.750   4822.950   1310.070  1.0000000  0.0000000  0.0000000     12    222.625      1.356      1.324      1.289      1.261      1.239
RS3      3  -1308.750   4848.961   1325.087  1.0000000  0.0000000  0.0000000     12    222.625      8.765      8.752      8.740      8.729      8.718

                                   and so on ...

RS3     43  -4822.968  -8293.094   6885.787 -0.7071068  0.7071068  0.0000000     21    236.262     14.548     14.546     14.543     14.541     14.538
TRK TrackRecord MuonEntryLayerFilter  dummy       26.231      31.511    -5169.224      0.120      -7.474    -239.587   1     -11
TRK TrackRecord MuonEntryLayerFilter  dummy       34.158     -22.677     4018.539    -37.150      33.002     325.454   1     211
TRK TrackRecord MuonEntryLayerFilter  dummy      303.879    1107.051     -881.413    275.440    -195.088    -130.474   1     211
TRK TrackRecord MuonEntryLayerFilter  dummy       26.442      31.334     3931.646   -265.210    -166.037    1465.477  -1    -211
TRK TrackRecord MuonEntryLayerFilter  dummy      -19.992      77.941    -6750.000     18.730      99.074   -7258.469  -1    -211
TRK TrackRecord MuonEntryLayerFilter  dummy       -0.584      40.996    -4986.499     -3.045      -9.014    -114.564   1     -11
```

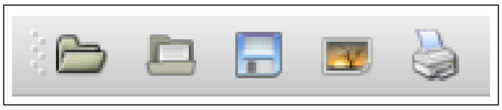
```
TRK TrackRecord MuonEntryLayerFilter  dummy        19.337       36.153     -4880.334       11.948      -29.038      -142.377   1      -11
TRK TrackRecord MuonEntryLayerFilter  dummy        -3.994       40.805     -5043.736      -13.777       -7.566      -159.787  -1       11
TRK TrackRecord MuonEntryLayerFilter  dummy         5.694       40.603     -5154.146       -2.102      -44.098      -604.135   1      -11
TRK TrackRecord Muo00.02.nEntryLayerFilter  dummy         0.281       40.999     -5648.321        0.957      -13.118      -193.964  -1       11
TRK TrackRecord MuonEntryLayerFilter  dummy       688.370     -918.723      2261.243     -229.182      -66.157       376.339   1      211
TRK TrackRecord MuonEntryLayerFilter  dummy         4.389       54.630      6750.000       -7.909      485.134     63057.680  -1     -211
TRK TrackRecord MuonEntryLayerFilter  dummy        40.997        0.510      3480.941     -305.727     -539.746      1183.440   1     2212
TRK TrackRecord MuonEntryLayerFilter  dummy       -10.345      -51.670     -6750.000     -192.807     -783.343    -95296.601  -1     -211
TRK TrackRecord MuonEntryLayerFilter  dummy        -2.909       40.897     -4784.081      210.335     -339.444     -2224.941   1     2212
TRK TrackRecord MuonEntryLayerFilter  dummy       -25.355       61.174     -6750.000     -600.697     1353.510   -154378.164   1      211
TRK TrackRecord MuonEntryLayerFilter  dummy       -12.254      -65.734     -6750.000     -207.946    -1240.695   -121680.794   1      211
TRK TrackRecord MuonEntryLayerFilter  dummy      -677.366     4196.687      1128.050    -3174.049    20625.379      5930.249   1      -13
TRK TrackRecord MuonEntryLayerFilter  dummy       215.236    -4245.547      1281.801     3628.730   -75960.679     24125.117  -1       13
TRK McEventCollection  TruthEvent  dummy        1.503        2.503      -67.259        1.503        2.503      -67.259     1149.462     -2204.148    216907.812
TRK McEventCollection  TruthEvent  dummy        1.503        2.503      -67.259        1.503        2.503      -67.259    -1054.058      -829.331   -310323.094
TRK McEventCollection  TruthEvent  dummy        1.503        2.503      -67.259        1.503        2.503      -67.259   -20725.680    -55372.098     56198.594
TRK McEventCollection  TruthEvent  dummy        1.503        2.503      -67.259        1.503        2.503      -67.259    40281.672     -1251.868    -47630.750
TRK McEventCollection  TruthEvent  dummy        1.503        2.503      -67.259        1.503        2.503      -67.259    -1087.246    -55982.418     32977.281
TRK McEventCollection  TruthEvent  dummy        1.503        2.503      -67.259        0.000        0.000        0.000     3688.245    -81230.836     25813.461
TRK McEventCollection  TruthEvent  dummy        1.503        2.503      -67.259        0.000        0.000        0.000    -4775.492     25248.418      7163.820
TRK McEventCollection  TruthEvent  dummy        1.503        2.503      -67.259        1.503        2.503      -67.259    -1087.246    -55982.418     32977.281
TRK McEventCollection  TruthEvent  dummy        1.503        2.503      -67.259        0.000        0.000        0.000     3595.597    -79488.586     25240.912
TRK McEventCollection  TruthEvent  dummy        1.503        2.503      -67.259        0.000        0.000        0.000    -4775.216     25246.961      7163.415
TRK McEventCollection  TruthEvent  dummy        1.503        2.503      -67.259        1.503        2.503      -67.259    39219.113     56356.379     60462.516
TRK McEventCollection  TruthEvent  dummy        1.503        2.503      -67.259        1.503        2.503      -67.259     -934.032      2752.398     10946.362

                                                   and so on ...


CAL TIL  1646.0000     1.5104    -1.0308    0        113.0     0.2000     0.0982   181.0000     0.0000     0.0000     8.0000 1284329264
CAL TIL  1646.0000     1.5104    -0.8345    0        225.2     0.2000     0.0982   181.0000     0.0000     0.0000     8.0000 1284362032
CAL TIL  2066.0000     1.3098    -0.7363    0        611.2     0.2000     0.0982   239.0000     0.0000     0.0000     8.0000 1284377904
CAL TIL  1646.0000     1.5104    -0.3436    0        115.2     0.2000     0.0982   181.0000     0.0000     0.0000     8.0000 1284443952
TRK CombinedMuon MboyESDMuonContainer  dummy       -15.153       -2.748      -73.463    -4127.595    22763.613     6537.681   1       0
TRK CombinedMuon MboyESDMuonContainer  dummy         5.662        0.232      -69.260     3476.724   -84711.070    26957.698  -1       0
TRK CombinedMuon StacoCombinedMuonContainer  dummy         1.595        0.072      -66.480     3823.643   -84175.569    26698.228  -1       0
TRK CombinedMuon StacoCombinedMuonContainer  dummy         1.922        0.364      -67.822    -4684.434    24730.417     7015.255   1       0
TRK CombinedMuon MuidCombinedMuonContainer  dummy         1.596        0.072      -66.480     3795.742   -83572.482    26507.004  -1       0
TRK CombinedMuon MuidCombinedMuonContainer  dummy         1.919        0.363      -67.827    -4789.944    25295.987     7176.314   1       0
TRK CombinedMuon MuGirlCombinedMuonContainer  dummy         1.919        0.363      -67.804    -4780.355    25244.324     7156.335   1       0
TRK CombinedMuon MuGirlCombinedMuonContainer  dummy         1.597        0.073      -66.453     3780.566   -83257.069    26385.272  -1       0
TRK CombinedMuon MuGirlCombinedMuonContainer  dummy         1.597        0.073      -66.453     3780.566   -83257.069    26385.272  -1       0
TRK CombinedMuon MuidExtrCombinedMuonContainer  dummy        14.491        0.578      -69.406     3423.688   -85821.615    27312.401  -1       0
TRK CombinedMuon MuidExtrCombinedMuonContainer  dummy        36.455        6.768      -71.602    -4663.056    25116.948     7215.593   1       0
TRK TrkTrack Tracks GlobalChi2Fitter       -0.362        2.231      -75.922    -1906.348     -309.684    -8717.668  -1       0
TRK TrkTrack Tracks GlobalChi2Fitter        0.729       -0.213      -65.348     -170.245     -583.032      381.741  -1       0
TRK TrkTrack Tracks GlobalChi2Fitter       -0.245        2.386      -74.900    -7773.899     -799.400   -34786.180   1       0
TRK TrkTrack Tracks GlobalChi2Fitter       -0.925        0.690      -56.395     -326.254     -437.493     1835.077  -1       0
TRK TrkTrack Tracks GlobalChi2Fitter        0.433       -0.023      -64.817      -35.997     -690.686     1287.463  -1       0
TRK TrkTrack Tracks GlobalChi2Fitter       -0.170        0.118      -69.815    16145.576    23291.786    24952.900   1       0

                                                   and so on ...
towards end of file ...


TRK TrkTrack Tracks GlobalChi2Fitter      -11.839       11.872     -541.449      545.862      544.334     -492.060  -1       0
TRK TrkTrack ConvertedMBoyMuonSpectroOnlyTracks Muonboy      -663.671     4197.861     1128.441    -3158.298    20126.521     5786.598   1       0
TRK TrkTrack ConvertedMBoyMuonSpectroOnlyTracks Muonboy       210.489    -4244.784     1281.564     3915.525   -81367.942    25839.576  -1       0
VTX VxPrimaryCandidate       1.4989       2.5093     -67.2314
SEG MuonSegment ConvertedMBoySegments     -1129.503     7138.999     1999.174    -0.148683     0.944727     0.292205       1.3543
SEG MuonSegment ConvertedMBoySegments       350.289    -7138.999     2195.211     0.046998    -0.953258     0.298479       0.3012
SEG MuonSegment ConvertedMBoySegments     -1506.562     9499.999     2748.712    -0.149175     0.940661     0.304800       2.2791
SEG MuonSegment ConvertedMBoySegments       458.330    -9499.999     2929.664     0.046037    -0.954235     0.295492       2.6723
SEG MuonSegment ConvertedMBoySegments     -1230.750     4948.979     1345.019    -0.232330     0.934226     0.270637       0.4230
SEG MuonSegment ConvertedMBoySegments       615.375    -4948.979     1505.046     0.117707    -0.946624     0.300082       0.3672
END EVT
```

E Menu items

E.1 *File* menu



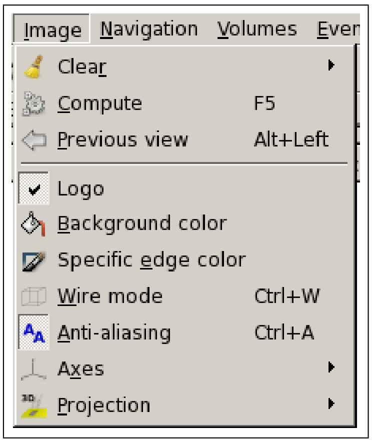
(a) Linux style (b) Mac OS style



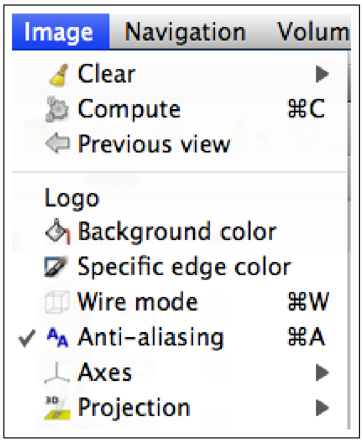
Item name	***Action***
Data manager	Load various files: *Volumes, Events, Magnetic field and others*
Open view ...	Open a *Persint* `.p2vf` file for display
Save view as ...	Save view as a *Persint* `.p2vf` file
Export view ...	Export (save) view as a local file (`.png`, `.jpg`, `.bmp`, `.svg`)
Save special...	To compare geometries (sections 6.4, and 9.3)
Print	Print current view
Download ...	- Download geometry files from Oracle data base at CERN - Download data from Trac server (Not yet available) - Download additional field maps from: https://atlas.web.cern.ch/Atlas/GROUPS/MUON/magfield/Fieldmap
Quit	Quit *Persint* (for Linux only) [1]

[1] In Mac OS, use "Quit" in the ***persint*** menu (section E.8).

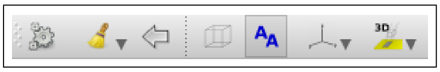
E.2 *Image* menu



(a) Linux style



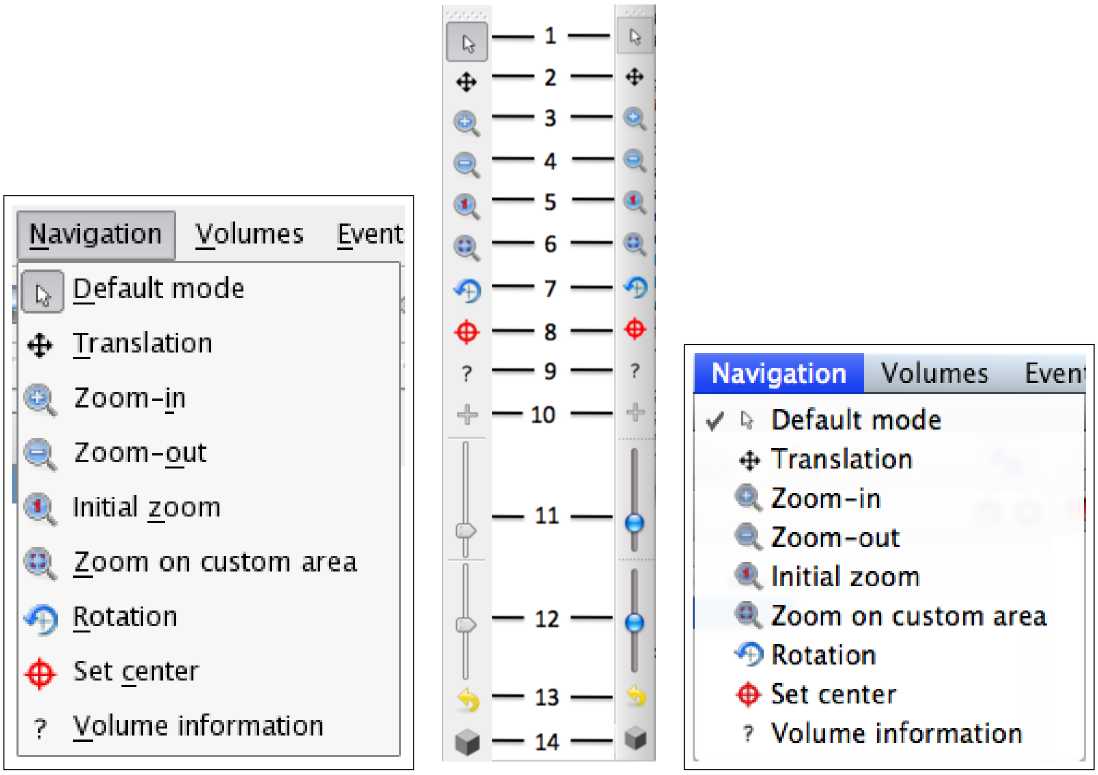
(b) Mac OS style



Item name	*Action*
Clear	Several options: - Clear view (completely); one can also use the "Brush" - Partial clear of AMDB or AGDD volumes - Clear event: clears the event hits and associated chambers - Clear labels: clears all labels in the display. - Clear captions: clears all captions in the display. - Clear pictures (logos): clears all pictures in the display.
Compute	Make the calculation to display the newly defined view
Previous view	Display the view defined by the previous "Compute" action. Up to 10 backward steps are possible
Logo [1]	Display or hide the *Persint* logo at the bottom left of the display.
Background color [1]	Choose the background color of the main display window
Specific edge color [1]	Define the color of volume edges in the display
Wire mode	Switch the Wire mode on/off for all the displayed volumes
Anti-aliasing	Provide smooth volume edges
Axes	Display the ATLAS coordinate system in various styles
Projection	Display 3D views or 2D projections; makes axes inversion

[1]Not present as an icon in the default tool bar.

E.3 *Navigation* menu



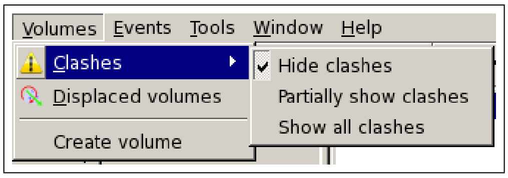
(a) Linux style (d) Mac OS style

#	*Item name*	*Action*
1	**Default mode**	All purpose function to perform *Rotation, Translation, Zoom-in/out, Zoom on custom area* (see section 8.2)
2	**Translation**	Translate the view in any direction
3	**Zoom-in** [1]	Zoom-in by moving the viewing point forward, to enlarge the view
4	**Zoom-out** [1]	Zoom-out by moving the viewing point backwards, to reduce the view
5	**Initial zoom**	Retrieve the original viewing parameters
6	**Zoom on custom area**	Define the region to be enlarged
7	**Rotation** [1]	Rotate view around center point of display
8	**Set center**	Center view on a point chosen with the cursor
9	**Volume information**	Open the *Modify volume* window to choose volume parameters: `Color, Hide, Translation, Rotation`
10	**Selection mode** [2]	Select a series of volumes to be hidden
11	**Navigation scale** [2]	Set the amplitude of the following navigation actions: `Rotation, Zoom-in/out`
12	**Focal length** [2]	Set the focal length of the viewing.
13	**Reset focal length** [2]	Reset focal length to nominal value (35 mm)
14	**Isometric view** [2]	Set/reset parameters for isometric viewing (infinite focal length).

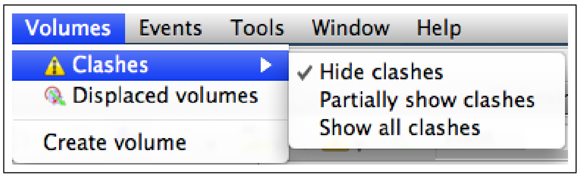
[1] The amplitude of these actions is controlled by the displacement of the cursor in the *Navigation scale* gauge

[2] These five items of the *Navigation* tool bar are NOT in the Menu.

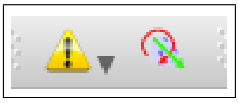
E.4 *Volumes* menu



(a) Linux style



(b) Mac OS style



Item name	***Action***
Clashes	Show/Hide intersections of clashing volumes (for debugging geometry)
Displaced volumes	Show and edit list of displaced volumes ("*Move to infinity*")
Create volumes	Draw many types of volumes, *e.g.* dead matter, using the `AGDD XML` description

Displaced volumes window

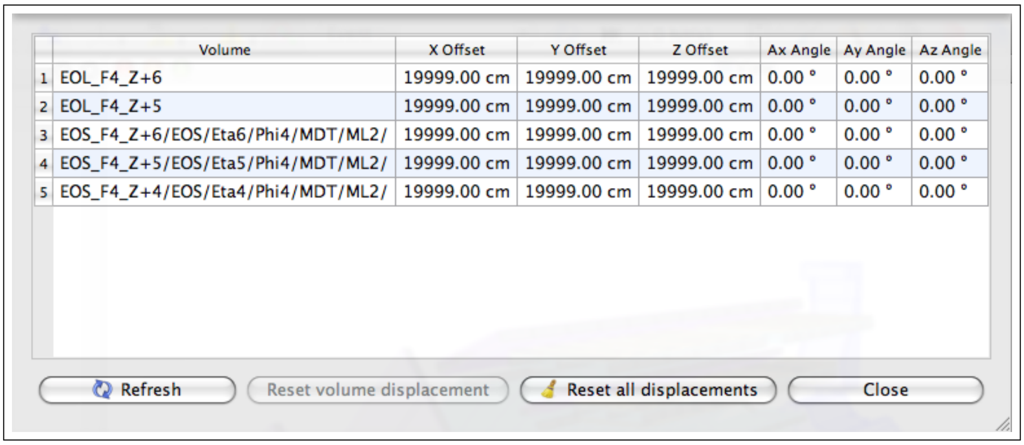


Figure 134: Volumes can be displaced in the X, Y, Z directions and/or rotated. The volumes shown in this window are "hidden" or *Moved to infinity*: $X = Y = Z =$ 19999.00 cm. (section 9.2)

Create volume window

The *Create volume* function is used to draw many types of volumes. The function is embedded in *Persint* and is used, for example, to display the dead matter structures of ATLAS. It uses the `AGDD XML` description.
The `xml` structure of the AGDD file is given below in E.4.1, and the subroutine used to create volumes is shown in E.4.2.

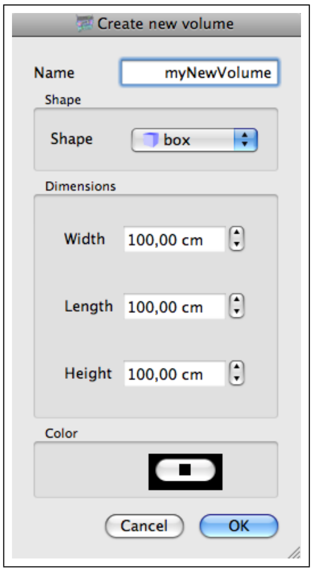


Figure 135: With the *Create volume* function it is possible to draw one volume at a time with chosen dimensions and color. The available shapes are:
– Box (width, length, height)
– Sphere (diameter, # of facets)
– Cone (diameter, height, # of facets)
– Frame (Diameter, length, height, thickness)

Examples of various `AGDD XML` volumes can be found in [8], where the *ATHENA* package *AGDD2Geo* is presented in connexion with the `AGDD XML` structure.
A summary list of the `AGDD` volume types described in [8] is given below:

- Cube
- Tube
- Pyramid
- Cylinder
- Chain
- Polygons
- Combined volumes
- Merged volumes
- Subtracted volumes
- Extruded volumes

As an example, the following paragraph shows the xml description of AGDD files.

E.4.1 xml description of AGDD files

```
<?xml version="1.0"?>
<!DOCTYPE AGDD SYSTEM "AGDD.dtd" >

<AGDD>

<section name       = "Solids"
         version    = "1.1"
         date       = "29 August 2002"
         author     = "Marc Virchaux"
         top_volume = "TEST">

<defaults   unit_length="mm"   />
<box    name="box"            material="Green"    X_Y_Z="500;200;800"   />
<trd    name="trd"            material="Blue"     Xmp_Ymp_Z=" 300 ; 30 ; 200 ; 80 ;
800 "            />
<trd    name="trd_tilt_1"     material="Red"      Xmp_Ymp_Z=" 300 30 200  80
800"  side_tilts="15 -15" />
<trd    name="trd_tilt_2"     material="Orange"   Xmp_Ymp_Z=" 300 30 200  80
800"  side_tilts="22.5  7.5" />
<trd    name="trd_incli"      material="Yellow"   Xmp_Ymp_Z=" 300 30 200  80
800"                        inclination="15 30" />
<trd    name="trd_incli_tilt" material="Purple"   Xmp_Ymp_Z=" 300 30 200  80
800"  side_tilts="-7.5 15"  inclination="5 -30" />
<tubs   name="tubs_full"      material="Azur"     Rio_Z=" 0 100 800"
nbPhi="100"        />
<tubs   name="tubs_full2"     material="Azur"     Rio_Z=" 0 100 800"
nbPhi="10"         />
<tubs   name="tubs_hole"      material="Yellow"   Rio_Z="50 100 800"      />
<tubs   name="tubs_angle"     material="Red"      Rio_Z="50 100 800"
profile="30 180"    />
<cons   name="cons_full"      material="Blue"     Rio1_Rio2_Z="0 ; 0;100;140;
800"                  />
<cons   name="cons_hole"      material="Green"    Rio1_Rio2_Z="50 90 100 140
800"                  />
<cons   name="cons_angle"     material="Orange"   Rio1_Rio2_Z="50 150 50 150
80" profile="60  90"    />
<elipso name="elipso"         material="Purple"   radiusXYZ=" 150 ; 200 ; 400 "
nbPhi="6"          />
<gvxysx name="gvxysx"         material="Azur"     dZ="230."
          X=" 50. 115. 115.  20.  20.  10.   10.   60.   60."
          Y="  0.  65. 165. 270. 600. 630. 1050. 1060. 1110."   />
<gvxy   name="gvxy"           material="Orange"   dZ="330."  >
  <gvxy_point  X_Y=" -60.0    0.0"  />
  <gvxy_point  X_Y="  50.0    0.0"  />
  <gvxy_point  X_Y=" 115.0   65.0"  />
  <gvxy_point  X_Y=" 115.0  165.0"  />
  <gvxy_point  X_Y="  20.0  270.0"  />
  <gvxy_point  X_Y="  20.0  600.0"  />
  <gvxy_point  X_Y="  10.0  630.0"  />
  <gvxy_point  X_Y="  10.0 1050.0"  />
  <gvxy_point  X_Y="  60.0 1060.0"  />
  <gvxy_point  X_Y="  60.0 1110.0"  />
  <gvxy_point  X_Y=" -60.0 1110.0"  />
  <gvxy_point  X_Y=" -60.0  600.0"  />
  <gvxy_point  X_Y=" -10.0  550.0"  />
  <gvxy_point  X_Y=" -10.0  450.0"  />
  <gvxy_point  X_Y=" -60.0  400.0"  />
  <gvxy_point  X_Y=" -60.0  300.0"  />
  <gvxy_point  X_Y=" -10.0  250.0"  />
  <gvxy_point  X_Y=" -10.0  150.0"  />
  <gvxy_point  X_Y=" -60.0  100.0"  />
</gvxy>
<gvxysxy  name="gvxysxy"     material="Black"   dZ="100."  >
  <gvxy_point  X_Y=" 120.0   80.0"  />
  <gvxy_point  X_Y=" 200.0  200.0"  />
  <gvxy_point  X_Y="  20.0  100.0"  />
</gvxysxy>
<pcon   name="pcon"          material="Black"  >
  <polyplane  Rio_Z="100 150  400" />
  <polyplane  Rio_Z="100 110  280" />
  <polyplane  Rio_Z=" 25  75   50" />
  <polyplane  Rio_Z=" 25 165 -200" />
  <polyplane  Rio_Z=" 50 140 -400" />
</pcon>

<composition name="TEST">
   <posXYZ volume="box"            X_Y_Z=" 700  800   400"  />
   <posXYZ volume="trd"            X_Y_Z="-800  500     0"  />
   <posXYZ volume="trd_tilt_1"     X_Y_Z="-800  800     0"  />
   <posXYZ volume="trd_tilt_2"     X_Y_Z="-800  200     0"  />
   <posXYZ volume="trd_incli_tilt" X_Y_Z="-800 -100     0"  />
   <posXYZ volume="trd_incli"      X_Y_Z="-200  200     0"  />
   <posXYZ volume="tubs_full"      X_Y_Z=" 200 -200     0"  />
   <posXYZ volume="tubs_full2"     X_Y_Z="   0    0     0"  />
   <posXYZ volume="tubs_hole"      X_Y_Z=" 500 -320     0"  />
```

```
   <posXYZ volume="tubs_angle"     X_Y_Z=" 600 -620    0"  />
   <posXYZ volume="cons_full"      X_Y_Z="-200 -200    0"  />
   <posXYZ volume="cons_hole"      X_Y_Z="-500 -500    0"  />
   <posXYZ volume="cons_angle"     X_Y_Z=" 800 -100    0"  />
   <posXYZ volume="pcon"           X_Y_Z=" 550  700    0"  />
   <posXYZ volume="snake"          X_Y_Z="   0 -800   50"  />
   <posXYZ volume="snake_nphi"     X_Y_Z="   0 -800 -400"  />
   <posXYZ volume="gvxysx"         X_Y_Z="-300  350    0"  />
   <posXYZ volume="gvxy"           X_Y_Z=" 100  350    0"  />
   <posXYZ volume="gvxysxy"        X_Y_Z="-900 -800    0"  />
   <posXYZ volume="elipso"        X_Y_Z="  500  200    0"  />
</composition>

</section>


<section name       = "Solids"
         version    = "1.1"
         date       = "29 August 2002"
         author     = "Marc Virchaux"
         top_volume = "TESTtruc">

<composition name="TESTtruc ">
   <posXYZ volume="box"            X_Y_Z="-700 -800  -400"  />
   <posXYZ volume="trd"            X_Y_Z=" 800 -500    0"  />
</composition>

</section>

<section name       = "Solids"
         version    = "1.1"
         date       = "29 August 2002"
         author     = "Marc Virchaux"
         top_volume = "TESTtruc2">

<box    name="box2"            material="Gray"    X_Y_Z="100;200;800"
                 />
<trd    name="trd2"            material="black"     Xmp_Ymp_Z=" 300 ; 30 ; 200 ; 80 ;
800 "             />

<composition name="TESTtruc2">
   <posXYZ volume="box2"           X_Y_Z=" 700  800   400"  />
   <posXYZ volume="trd2"           X_Y_Z="-800  500    0"  />
</composition>

</section>


<section name       = "AllBazard"
         version    = "1.1"
         date       = "29 August 2002"
         author     = "Marc Virchaux"
         top_volume = "all">

<composition name="All">
   <posXYZ volume="TEST" X_Y_Z=" 0  0   0"  />
   <posXYZ volume="TESTtruc" X_Y_Z=" 0  0   0"  />
   <posXYZ volume="TESTtruc2" X_Y_Z=" 0  0   0"  />
</composition>



</AGDD>
```

E.4.2 Subroutine used for creating volumes

```
%%
 SUBROUTINE Init_AGDD_Xml
 IMPLICIT NONE
!
!>> Initialisation : Description of the AGDD xml format !!!
!
   Nb_xml_ele = 0
!
!>> 1 ------------------------------------------------------------------
   CALL ADD_XML_ELE('section')
!                  *********
   CALL ADD_XML_ATT('name                ','A         ','Atlas     ')
   CALL ADD_XML_ATT('version             ','A         ','1.1       ')
   CALL ADD_XML_ATT('date                ','A         ','#         ')
   CALL ADD_XML_ATT('author              ','A         ','#         ')
   CALL ADD_XML_ATT('top_volume          ','A         ','none      ')
!
!>> 2 ------------------------------------------------------------------
   CALL ADD_XML_ELE('var')
!                  *****
   CALL ADD_XML_ATT('name                ','A         ','#         ')
   CALL ADD_XML_ATT('value               ','R         ','0.        ')
   Iel0_xml_varia = Nb_xml_ele
!>> 3 ------------------------------------------------------------------
   CALL ADD_XML_ELE('array')
!                  *******
   CALL ADD_XML_ATT('name                ','A         ','#         ')
   CALL ADD_XML_ATT('values              ','79R       ','#         ')
!>> 4 ------------------------------------------------------------------
   CALL ADD_XML_ELE('table')
!                  *******
   CALL ADD_XML_ATT('name                ','A         ','#         ')
!>> 5 ------------------------------------------------------------------
   CALL ADD_XML_ELE('defaults')
!                  **********
   CALL ADD_XML_ATT('unit_length         ','A         ','mm        ')
   CALL ADD_XML_ATT('unit_angle          ','A         ','deg       ')
!-----------------------------------------------------------------------
   Iel1_xml_varia = Nb_xml_ele
!
!>> 6 ------------------------------------------------------------------
   CALL ADD_XML_ELE('solid')                                       ! Obsolete !
!                  *******                                         ! Obsolete !
   CALL ADD_XML_ATT('name                ','A         ','#         ') ! Obsolete !
   CALL ADD_XML_ATT('material            ','A         ','air       ') ! Obsolete !
   CALL ADD_XML_ATT('shape               ','A         ','#         ') ! Obsolete !
   CALL ADD_XML_ATT('dim                 ','7R        ','#         ') ! Obsolete !
   CALL ADD_XML_ATT('innerstruct         ','A         ','none      ') ! Obsolete !
   CALL ADD_XML_ATT('unit_length         ','A         ','default   ') ! Obsolete !
   CALL ADD_XML_ATT('unit_angle          ','A         ','default   ') ! Obsolete !
   Iel0_xml_solid = Nb_xml_ele
!>> 7 ------------------------------------------------------------------
   CALL ADD_XML_ELE('box')
!                  *****
   CALL ADD_XML_ATT('name                ','A         ','#         ')
   CALL ADD_XML_ATT('material            ','A         ','air       ')
   CALL ADD_XML_ATT('parameters          ','A         ','none      ')
   CALL ADD_XML_ATT('sensitive           ','A         ','false     ')
   CALL ADD_XML_ATT('X_Y_Z               ','3R        ','#         ')
   CALL ADD_XML_ATT('unit_length         ','A         ','default   ')
   CALL ADD_XML_ATT('unit_angle          ','A         ','default   ')
!>> 8 ------------------------------------------------------------------
   CALL ADD_XML_ELE('trd')
!                  *****
   CALL ADD_XML_ATT('name                ','A         ','#         ')
   CALL ADD_XML_ATT('material            ','A         ','air       ')
   CALL ADD_XML_ATT('parameters          ','A         ','none      ')
   CALL ADD_XML_ATT('sensitive           ','A         ','false     ')
   CALL ADD_XML_ATT('Xmp_Ymp_Z           ','5R        ','#         ')
   CALL ADD_XML_ATT('inclination         ','2R        ','0. 0.     ')
   CALL ADD_XML_ATT('side_tilts          ','2R        ','0. 0.     ')
   CALL ADD_XML_ATT('unit_length         ','A         ','default   ')
   CALL ADD_XML_ATT('unit_angle          ','A         ','default   ')
!>> 9 ------------------------------------------------------------------
   CALL ADD_XML_ELE('tubs')
!                  ******
   CALL ADD_XML_ATT('name                ','A         ','#         ')
   CALL ADD_XML_ATT('material            ','A         ','air       ')
   CALL ADD_XML_ATT('parameters          ','A         ','none      ')
   CALL ADD_XML_ATT('sensitive           ','A         ','false     ')
   CALL ADD_XML_ATT('Rio_Z               ','3R        ','#         ')
   CALL ADD_XML_ATT('profile             ','2R        ','0. 360.   ')
   CALL ADD_XML_ATT('nbPhi               ','I         ','0         ')
   CALL ADD_XML_ATT('unit_length         ','A         ','default   ')
   CALL ADD_XML_ATT('unit_angle          ','A         ','default   ')
!>> 10 -----------------------------------------------------------------
   CALL ADD_XML_ELE('cons')
!                  ******
   CALL ADD_XML_ATT('name                ','A         ','#         ')
   CALL ADD_XML_ATT('material            ','A         ','air       ')
   CALL ADD_XML_ATT('parameters          ','A         ','none      ')
   CALL ADD_XML_ATT('sensitive           ','A         ','false     ')
   CALL ADD_XML_ATT('Rio1_Rio2_Z         ','5R        ','#         ')
   CALL ADD_XML_ATT('profile             ','2R        ','0. 360.   ')
   CALL ADD_XML_ATT('nbPhi               ','I         ','0         ')
   CALL ADD_XML_ATT('unit_length         ','A         ','default   ')
   CALL ADD_XML_ATT('unit_angle          ','A         ','default   ')
!>> 11 -----------------------------------------------------------------
   CALL ADD_XML_ELE('pcon')
!                  ******
   CALL ADD_XML_ATT('name                ','A         ','#         ')
   CALL ADD_XML_ATT('material            ','A         ','air       ')
   CALL ADD_XML_ATT('parameters          ','A         ','none      ')
   CALL ADD_XML_ATT('sensitive           ','A         ','false     ')
   CALL ADD_XML_ATT('profile             ','2R        ','0. 360.   ')
   CALL ADD_XML_ATT('nbPhi               ','I         ','0         ')
   CALL ADD_XML_ATT('unit_length         ','A         ','default   ')
   CALL ADD_XML_ATT('unit_angle          ','A         ','default   ')
!>> 12 -----------------------------------------------------------------
   CALL ADD_XML_ELE('trtmodule')
!                  ***********
   CALL ADD_XML_ATT('name                ','A         ','#         ')
   CALL ADD_XML_ATT('material            ','A         ','air       ')
   CALL ADD_XML_ATT('parameters          ','A         ','none      ')
   CALL ADD_XML_ATT('sensitive           ','A         ','false     ')
   CALL ADD_XML_ATT('Bh1_B2_Z            ','4R        ','#         ')
```

```
      CALL ADD_XML_ATT(’unit_length         ’,’A         ’,’default   ’)
      CALL ADD_XML_ATT(’unit_angle          ’,’A         ’,’default   ’)
!>> 13 -----------------------------------------------------------------
      CALL ADD_XML_ELE(’gvxy’)
!                      ******
      CALL ADD_XML_ATT(’name                ’,’A         ’,’#         ’)
      CALL ADD_XML_ATT(’material            ’,’A         ’,’air       ’)
      CALL ADD_XML_ATT(’parameters          ’,’A         ’,’none      ’)
      CALL ADD_XML_ATT(’sensitive           ’,’A         ’,’false     ’)
      CALL ADD_XML_ATT(’X                   ’,’79R       ’,’0.        ’)
      CALL ADD_XML_ATT(’Y                   ’,’79R       ’,’0.        ’)
      CALL ADD_XML_ATT(’dZ                  ’,’R         ’,’#         ’)
      CALL ADD_XML_ATT(’unit_length         ’,’A         ’,’default   ’)
      CALL ADD_XML_ATT(’unit_angle          ’,’A         ’,’default   ’)
!>> 14 -----------------------------------------------------------------
      CALL ADD_XML_ELE(’gvxysx’)
!                      ********
      CALL ADD_XML_ATT(’name                ’,’A         ’,’#         ’)
      CALL ADD_XML_ATT(’material            ’,’A         ’,’air       ’)
      CALL ADD_XML_ATT(’parameters          ’,’A         ’,’none      ’)
      CALL ADD_XML_ATT(’sensitive           ’,’A         ’,’false     ’)
      CALL ADD_XML_ATT(’X                   ’,’79R       ’,’0.        ’)
      CALL ADD_XML_ATT(’Y                   ’,’79R       ’,’0.        ’)
      CALL ADD_XML_ATT(’dZ                  ’,’R         ’,’#         ’)
      CALL ADD_XML_ATT(’unit_length         ’,’A         ’,’default   ’)
      CALL ADD_XML_ATT(’unit_angle          ’,’A         ’,’default   ’)
!>> 15 -----------------------------------------------------------------
      CALL ADD_XML_ELE(’gvxysxy’)
!                      *********
      CALL ADD_XML_ATT(’name                ’,’A         ’,’#         ’)
      CALL ADD_XML_ATT(’material            ’,’A         ’,’air       ’)
      CALL ADD_XML_ATT(’parameters          ’,’A         ’,’none      ’)
      CALL ADD_XML_ATT(’sensitive           ’,’A         ’,’false     ’)
      CALL ADD_XML_ATT(’X                   ’,’79R       ’,’0.        ’)
      CALL ADD_XML_ATT(’Y                   ’,’79R       ’,’0.        ’)
      CALL ADD_XML_ATT(’dZ                  ’,’R         ’,’#         ’)
      CALL ADD_XML_ATT(’unit_length         ’,’A         ’,’default   ’)
      CALL ADD_XML_ATT(’unit_angle          ’,’A         ’,’default   ’)
!>> 16 -----------------------------------------------------------------
      CALL ADD_XML_ELE(’snake’)
!                      *******
      CALL ADD_XML_ATT(’name                ’,’A         ’,’#         ’)
      CALL ADD_XML_ATT(’material            ’,’A         ’,’air       ’)
      CALL ADD_XML_ATT(’radius              ’,’R         ’,’#         ’)
      CALL ADD_XML_ATT(’Phi0                ’,’R         ’,’0.        ’)
      CALL ADD_XML_ATT(’nbPhi               ’,’I         ’,’0         ’)
      CALL ADD_XML_ATT(’unit_length         ’,’A         ’,’default   ’)
      CALL ADD_XML_ATT(’unit_angle          ’,’A         ’,’default   ’)
!>> 17 -----------------------------------------------------------------
      CALL ADD_XML_ELE(’elipso’)
!                      ********
      CALL ADD_XML_ATT(’name                ’,’A         ’,’#         ’)
      CALL ADD_XML_ATT(’material            ’,’A         ’,’air       ’)
      CALL ADD_XML_ATT(’radiusXYZ           ’,’3R        ’,’#         ’)
      CALL ADD_XML_ATT(’nbPhi               ’,’I         ’,’0         ’)
      CALL ADD_XML_ATT(’nbTheta             ’,’I         ’,’0         ’)
      CALL ADD_XML_ATT(’unit_length         ’,’A         ’,’default   ’)
      CALL ADD_XML_ATT(’unit_angle          ’,’A         ’,’default   ’)
!>> 18 -----------------------------------------------------------------
      CALL ADD_XML_ELE(’gcylrz’)
!                      ********
      CALL ADD_XML_ATT(’name                ’,’A         ’,’#         ’)
      CALL ADD_XML_ATT(’material            ’,’A         ’,’air       ’)
      CALL ADD_XML_ATT(’parameters          ’,’A         ’,’none      ’)
      CALL ADD_XML_ATT(’sensitive           ’,’A         ’,’false     ’)
      CALL ADD_XML_ATT(’Phi0                ’,’R         ’,’0.        ’)
      CALL ADD_XML_ATT(’dPhi                ’,’R         ’,’#         ’)
      CALL ADD_XML_ATT(’nbPhi               ’,’I         ’,’6         ’)
      CALL ADD_XML_ATT(’unit_length         ’,’A         ’,’default   ’)
      CALL ADD_XML_ATT(’unit_angle          ’,’A         ’,’default   ’)
!>> 19 -----------------------------------------------------------------
      CALL ADD_XML_ELE(’gslice’)
!                      *******
      CALL ADD_XML_ATT(’name                ’,’A         ’,’#         ’)
      CALL ADD_XML_ATT(’material            ’,’A         ’,’air       ’)
      CALL ADD_XML_ATT(’unit_length         ’,’A         ’,’default   ’)
      CALL ADD_XML_ATT(’unit_angle          ’,’A         ’,’default   ’)
!>> 20 -----------------------------------------------------------------
      CALL ADD_XML_ELE(’elcyl’)
!                      *******
      CALL ADD_XML_ATT(’name                ’,’A         ’,’#         ’)
      CALL ADD_XML_ATT(’material            ’,’A         ’,’air       ’)
      CALL ADD_XML_ATT(’parameters          ’,’A         ’,’none      ’)
      CALL ADD_XML_ATT(’sensitive           ’,’A         ’,’false     ’)
      CALL ADD_XML_ATT(’RXio_RYio_Z         ’,’5R        ’,’#         ’)
      CALL ADD_XML_ATT(’profile             ’,’2R        ’,’0. 360.   ’)
      CALL ADD_XML_ATT(’nbPhi               ’,’I         ’,’0         ’)
      CALL ADD_XML_ATT(’unit_length         ’,’A         ’,’default   ’)
      CALL ADD_XML_ATT(’unit_angle          ’,’A         ’,’default   ’)
!-----------------------------------------------------------------------
      Iel1_xml_solid = Nb_xml_ele
!
!>> 21 -----------------------------------------------------------------
      CALL ADD_XML_ELE(’MDT_Chamber’)
!                      *************
      CALL ADD_XML_ATT(’ShortWidth          ’,’R         ’,’#         ’)
      CALL ADD_XML_ATT(’LongWidth           ’,’R         ’,’#         ’)
      CALL ADD_XML_ATT(’Length              ’,’R         ’,’#         ’)
      CALL ADD_XML_ATT(’UpperMultilayer     ’,’Aref      ’,’#         ’)
      CALL ADD_XML_ATT(’LowerMultilayer     ’,’Aref      ’,’#         ’)
      CALL ADD_XML_ATT(’Spacer              ’,’Aref      ’,’#         ’)
      CALL ADD_XML_ATT(’unit_length         ’,’A         ’,’default   ’)
      Iel0_xml_cmpac = Nb_xml_ele
!>> 22 -----------------------------------------------------------------
      CALL ADD_XML_ELE(’MDT_Multilayer’)
!                      ****************
      CALL ADD_XML_ATT(’nLayers             ’,’I         ’,’#         ’)
      CALL ADD_XML_ATT(’nTubesPerStep       ’,’I         ’,’#         ’)
      CALL ADD_XML_ATT(’Tube                ’,’Aref      ’,’#         ’)
      CALL ADD_XML_ATT(’Support             ’,’Aref      ’,’#         ’)
      CALL ADD_XML_ATT(’unit_length         ’,’A         ’,’default   ’)
!>> 23 -----------------------------------------------------------------
      CALL ADD_XML_ELE(’MDT_Spacer’)
!                      ************
      CALL ADD_XML_ATT(’Height              ’,’R         ’,’#         ’)
      CALL ADD_XML_ATT(’C_Channel           ’,’Aref      ’,’#         ’)
      CALL ADD_XML_ATT(’unit_length         ’,’A         ’,’default   ’)
!>> 24 -----------------------------------------------------------------
```

```
   CALL ADD_XML_ELE('MDT_Tube')
!                  *********
   CALL ADD_XML_ATT('InnerRadius         ','R         ','#         ')
   CALL ADD_XML_ATT('OuterRadius         ','R         ','#         ')
   CALL ADD_XML_ATT('ShellMaterial       ','A         ','#         ')
   CALL ADD_XML_ATT('GasMaterial         ','A         ','#         ')
   CALL ADD_XML_ATT('Plug                ','Aref      ','#         ')
   CALL ADD_XML_ATT('unit_length         ','A         ','default   ')
!>> 25 ---------------------------------------------------------------------
   CALL ADD_XML_ELE('MDT_Support')
!                  ************
   CALL ADD_XML_ATT('Thickness           ','R         ','#         ')
   CALL ADD_XML_ATT('Material            ','A         ','#         ')
   CALL ADD_XML_ATT('unit_length         ','A         ','default   ')
!>> 26 ---------------------------------------------------------------------
   CALL ADD_XML_ELE('MDT_C_Channel')
!                  **************
   CALL ADD_XML_ATT('Width               ','R         ','#         ')
   CALL ADD_XML_ATT('Thickness           ','R         ','#         ')
   CALL ADD_XML_ATT('Material            ','A         ','#         ')
   CALL ADD_XML_ATT('unit_length         ','A         ','default   ')
!>> 27 ---------------------------------------------------------------------
   CALL ADD_XML_ELE('MDT_TubePlug')
!                  *************
   CALL ADD_XML_ATT('Length              ','R         ','#         ')
   CALL ADD_XML_ATT('Material            ','A         ','#         ')
   CALL ADD_XML_ATT('unit_length         ','A         ','default   ')
!>> 28 ---------------------------------------------------------------------
   CALL ADD_XML_ELE('compact')
!                  ********
   CALL ADD_XML_ATT('name                ','A         ','#         ')
   CALL ADD_XML_ATT('envelope            ','Aref      ','none      ')
!--------------------------------------------------------------------------
   Iel1_xml_cmpac = Nb_xml_ele
!
!>> 29 ---------------------------------------------------------------------
   CALL ADD_XML_ELE('composition')
!                  ************
   CALL ADD_XML_ATT('name                ','A         ','#         ')
   CALL ADD_XML_ATT('envelope            ','Aref      ','none      ')
   CALL ADD_XML_ATT('parameters          ','A         ','none      ')
   Iel0_xml_compo = Nb_xml_ele
   Iel1_xml_compo = Nb_xml_ele
!>> 30 ---------------------------------------------------------------------
   CALL ADD_XML_ELE('stackX')
!                  ********
   CALL ADD_XML_ATT('name                ','A         ','#         ')
   CALL ADD_XML_ATT('envelope            ','Aref      ','none      ')
   CALL ADD_XML_ATT('parameters          ','A         ','none      ')
   CALL ADD_XML_ATT('origin              ','A         ','atStart   ')
   Iel0_xml_stack = Nb_xml_ele
!>> 31 ---------------------------------------------------------------------
   CALL ADD_XML_ELE('stackY')
!                  ********
   CALL ADD_XML_ATT('name                ','A         ','#         ')
   CALL ADD_XML_ATT('envelope            ','Aref      ','none      ')
   CALL ADD_XML_ATT('parameters          ','A         ','none      ')
   CALL ADD_XML_ATT('origin              ','A         ','atStart   ')
!>> 32 ---------------------------------------------------------------------
   CALL ADD_XML_ELE('stackZ')
!                  ********
   CALL ADD_XML_ATT('name                ','A         ','#         ')
   CALL ADD_XML_ATT('envelope            ','Aref      ','none      ')
   CALL ADD_XML_ATT('parameters          ','A         ','none      ')
   CALL ADD_XML_ATT('origin              ','A         ','atStart   ')
!--------------------------------------------------------------------------
   Iel1_xml_stack = Nb_xml_ele
!
!>> 33 ---------------------------------------------------------------------
   CALL ADD_XML_ELE('union')
!                  *******
   CALL ADD_XML_ATT('name                ','A         ','#         ')
   CALL ADD_XML_ATT('ref_volume          ','Aref      ','none      ') ! Obsolete !
   CALL ADD_XML_ATT('parameters          ','A         ','none      ')
   Iel0_xml_bool = Nb_xml_ele
!>> 34 ---------------------------------------------------------------------
   CALL ADD_XML_ELE('intersection')
!                  **************
   CALL ADD_XML_ATT('name                ','A         ','#         ')
   CALL ADD_XML_ATT('ref_volume          ','Aref      ','none      ') ! Obsolete !
   CALL ADD_XML_ATT('parameters          ','A         ','none      ')
!>> 35 ---------------------------------------------------------------------
   CALL ADD_XML_ELE('subtraction')
!                  *************
   CALL ADD_XML_ATT('name                ','A         ','#         ')
   CALL ADD_XML_ATT('ref_volume          ','Aref      ','none      ') ! Obsolete !
   CALL ADD_XML_ATT('parameters          ','A         ','none      ')
!--------------------------------------------------------------------------
      Iel1_xml_bool = Nb_xml_ele
!
!>> 36 ---------------------------------------------------------------------
   CALL ADD_XML_ELE('posXYZ')
!                  ********
   CALL ADD_XML_ATT('volume              ','Aref      ','#         ')
   CALL ADD_XML_ATT('X_Y_Z               ','3R        ','0. 0. 0.  ')
   CALL ADD_XML_ATT('rot                 ','3R        ','0. 0. 0.  ')
   CALL ADD_XML_ATT('sym                 ','A         ','none      ')
   CALL ADD_XML_ATT('index               ','3I        ','0 0 0     ') ! Obsolete !
   CALL ADD_XML_ATT('unit_length         ','A         ','default   ')
   CALL ADD_XML_ATT('unit_angle          ','A         ','default   ')
   CALL ADD_XML_ATT('rotMat      ','9R','0. 0. 0. 0. 0. 0. 0. 0. 0.')
   Iel0_xml_sipos = Nb_xml_ele
!>> 37 ---------------------------------------------------------------------
   CALL ADD_XML_ELE('posRPhiZ')
!                  **********
   CALL ADD_XML_ATT('volume              ','Aref      ','#         ')
   CALL ADD_XML_ATT('R_Phi_Z             ','3R        ','0. 0. 0.  ')
   CALL ADD_XML_ATT('S                   ','R         ','0.        ')
   CALL ADD_XML_ATT('impliedRot          ','A         ','true      ')
   CALL ADD_XML_ATT('rot                 ','3R        ','0. 0. 0.  ')
   CALL ADD_XML_ATT('sym                 ','A         ','none      ')
   CALL ADD_XML_ATT('index               ','3I        ','0 0 0     ') ! Obsolete !
   CALL ADD_XML_ATT('unit_length         ','A         ','default   ')
   CALL ADD_XML_ATT('unit_angle          ','A         ','default   ')
   CALL ADD_XML_ATT('rotMat      ','9R','0. 0. 0. 0. 0. 0. 0. 0. 0.')
!>> 38 ---------------------------------------------------------------------
   CALL ADD_XML_ELE('axisPos')
!                  *********
```

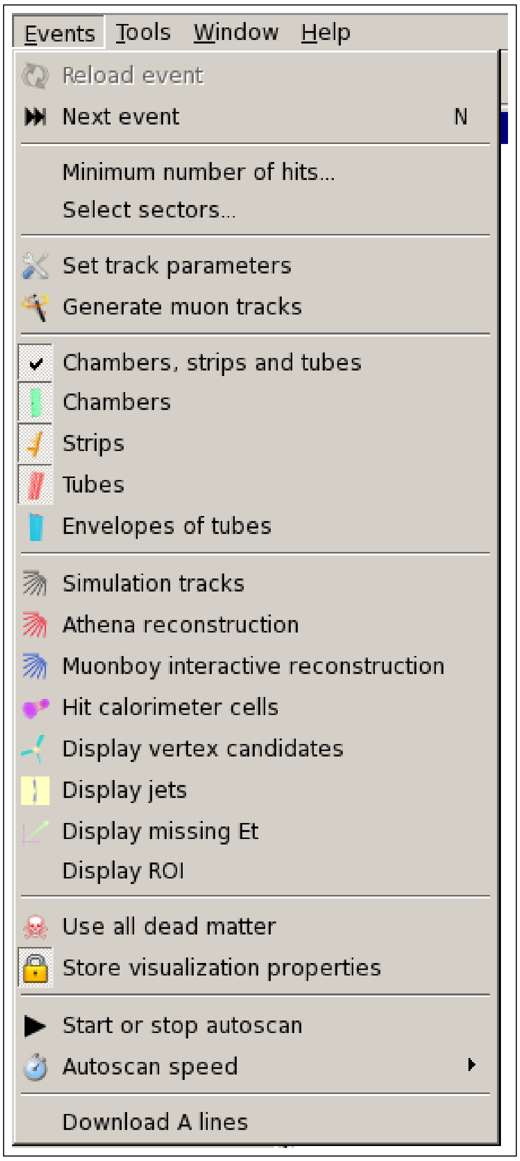
```
  CALL ADD_XML_ATT('volume            ','Aref     ','#        ')
  CALL ADD_XML_ATT('dX                ','R        ','0.       ')
  CALL ADD_XML_ATT('dY                ','R        ','0.       ')
  CALL ADD_XML_ATT('dZ                ','R        ','0.       ')
  CALL ADD_XML_ATT('gap               ','R        ','0.       ')
  CALL ADD_XML_ATT('shift             ','R        ','0.       ')
  CALL ADD_XML_ATT('rotation          ','R        ','0.       ')
  CALL ADD_XML_ATT('unit_length       ','A        ','default  ')
  CALL ADD_XML_ATT('unit_angle        ','A        ','default  ')
!-----------------------------------------------------------------------
     Iel1_xml_sipos = Nb_xml_ele
!
!>> 39 -----------------------------------------------------------------
  CALL ADD_XML_ELE('mposZ')
!                   *******
  CALL ADD_XML_ATT('volume            ','Aref     ','#        ')
  CALL ADD_XML_ATT('ncopy             ','I        ','#        ')
  CALL ADD_XML_ATT('Z0                ','R        ','0.       ')
  CALL ADD_XML_ATT('dZ                ','R        ','#        ')
  CALL ADD_XML_ATT('X_Y               ','2R       ','0. 0.    ')
  CALL ADD_XML_ATT('R_Phi             ','2R       ','0. 0.    ')
  CALL ADD_XML_ATT('S                 ','R        ','0.       ')
  CALL ADD_XML_ATT('rot               ','3R       ','0. 0. 0. ')
  CALL ADD_XML_ATT('sym               ','A        ','none     ')
  CALL ADD_XML_ATT('index             ','3I       ','0 0 0    ') ! Obsolete !
  CALL ADD_XML_ATT('indexstep         ','I        ','1        ') ! Obsolete !
  CALL ADD_XML_ATT('unit_length       ','A        ','default  ')
  CALL ADD_XML_ATT('unit_angle        ','A        ','default  ')
  CALL ADD_XML_ATT('rotMat      ','9R','0. 0. 0. 0. 0. 0. 0. 0. 0.')
  Iel0_xml_mupos = Nb_xml_ele
!>> 40 -----------------------------------------------------------------
  CALL ADD_XML_ELE('mposR')
!                   *******
  CALL ADD_XML_ATT('volume            ','Aref     ','#        ')
  CALL ADD_XML_ATT('ncopy             ','I        ','#        ')
  CALL ADD_XML_ATT('R0                ','R        ','0.       ')
  CALL ADD_XML_ATT('dR                ','R        ','#        ')
  CALL ADD_XML_ATT('Z_Phi             ','2R       ','0. 0.    ')
  CALL ADD_XML_ATT('S                 ','R        ','0.       ')
  CALL ADD_XML_ATT('rot               ','3R       ','0. 0. 0. ')
  CALL ADD_XML_ATT('sym               ','A        ','none     ')
  CALL ADD_XML_ATT('index             ','3I       ','0 0 0    ') ! Obsolete !
  CALL ADD_XML_ATT('indexstep         ','I        ','1        ') ! Obsolete !
  CALL ADD_XML_ATT('unit_length       ','A        ','default  ')
  CALL ADD_XML_ATT('unit_angle        ','A        ','default  ')
  CALL ADD_XML_ATT('rotMat      ','9R','0. 0. 0. 0. 0. 0. 0. 0. 0.')
!>> 41 -----------------------------------------------------------------
  CALL ADD_XML_ELE('mposPhi')
!                   *********
  CALL ADD_XML_ATT('volume            ','Aref     ','#        ')
  CALL ADD_XML_ATT('ncopy             ','I        ','#        ')
  CALL ADD_XML_ATT('Phi0              ','R        ','0.       ')
  CALL ADD_XML_ATT('dPhi              ','R        ','0.       ')
  CALL ADD_XML_ATT('R_Z               ','2R       ','0. 0.    ')
  CALL ADD_XML_ATT('S                 ','R        ','0.       ')
  CALL ADD_XML_ATT('impliedRot        ','A        ','true     ')
  CALL ADD_XML_ATT('rot               ','3R       ','0. 0. 0. ')
  CALL ADD_XML_ATT('sym               ','A        ','none     ')
  CALL ADD_XML_ATT('index             ','3I       ','0 0 0    ') ! Obsolete !
```

```
  CALL ADD_XML_ATT('indexstep         ','I        ','1        ') ! Obsolete !
  CALL ADD_XML_ATT('unit_length       ','A        ','default  ')
  CALL ADD_XML_ATT('unit_angle        ','A        ','default  ')
  CALL ADD_XML_ATT('rotMat      ','9R','0. 0. 0. 0. 0. 0. 0. 0. 0.')
!>> 42 -----------------------------------------------------------------
  CALL ADD_XML_ELE('mposWedge')
!                   ***********
  CALL ADD_XML_ATT('volume            ','Aref     ','#        ')
  CALL ADD_XML_ATT('wedge_number      ','I        ','#        ')
  CALL ADD_XML_ATT('sectors           ','80I      ','#        ')
  CALL ADD_XML_ATT('Phi0              ','R        ','0.       ')
  CALL ADD_XML_ATT('dPhi              ','R        ','0.       ') ! ???
  CALL ADD_XML_ATT('R_Z               ','2R       ','0. 0.    ')
  CALL ADD_XML_ATT('S                 ','R        ','0.       ')
  CALL ADD_XML_ATT('impliedRot        ','A        ','true     ')
  CALL ADD_XML_ATT('rot               ','3R       ','0. 0. 0. ')
  CALL ADD_XML_ATT('sym               ','A        ','none     ')
  CALL ADD_XML_ATT('unit_length       ','A        ','default  ')
  CALL ADD_XML_ATT('unit_angle        ','A        ','default  ')
  CALL ADD_XML_ATT('rotMat      ','9R','0. 0. 0. 0. 0. 0. 0. 0. 0.')
!>> 43 -----------------------------------------------------------------
  CALL ADD_XML_ELE('mposX')
!                   *******
  CALL ADD_XML_ATT('volume            ','Aref     ','#        ')
  CALL ADD_XML_ATT('ncopy             ','I        ','#        ')
  CALL ADD_XML_ATT('X0                ','R        ','0.       ')
  CALL ADD_XML_ATT('dX                ','R        ','#        ')
  CALL ADD_XML_ATT('Y_Z               ','2R       ','0. 0.    ')
  CALL ADD_XML_ATT('rot               ','3R       ','0. 0. 0. ')
  CALL ADD_XML_ATT('sym               ','A        ','none     ')
  CALL ADD_XML_ATT('unit_length       ','A        ','default  ')
  CALL ADD_XML_ATT('unit_angle        ','A        ','default  ')
  CALL ADD_XML_ATT('rotMat      ','9R','0. 0. 0. 0. 0. 0. 0. 0. 0.')
!>> 44 -----------------------------------------------------------------
  CALL ADD_XML_ELE('mposY')
!                   *******
  CALL ADD_XML_ATT('volume            ','Aref     ','#        ')
  CALL ADD_XML_ATT('ncopy             ','I        ','#        ')
  CALL ADD_XML_ATT('Y0                ','R        ','0.       ')
  CALL ADD_XML_ATT('dY                ','R        ','#        ')
  CALL ADD_XML_ATT('Z_X               ','2R       ','0. 0.    ')
  CALL ADD_XML_ATT('rot               ','3R       ','0. 0. 0. ')
  CALL ADD_XML_ATT('sym               ','A        ','none     ')
  CALL ADD_XML_ATT('unit_length       ','A        ','default  ')
  CALL ADD_XML_ATT('unit_angle        ','A        ','default  ')
  CALL ADD_XML_ATT('rotMat      ','9R','0. 0. 0. 0. 0. 0. 0. 0. 0.')
!>> 45 -----------------------------------------------------------------
  CALL ADD_XML_ELE('axisMPos')
!                   **********
  CALL ADD_XML_ATT('volume            ','Aref     ','#        ')
  CALL ADD_XML_ATT('ncopy             ','I        ','#        ')
  CALL ADD_XML_ATT('dX                ','R        ','0.       ')
  CALL ADD_XML_ATT('dY                ','R        ','0.       ')
  CALL ADD_XML_ATT('dZ                ','R        ','0.       ')
  CALL ADD_XML_ATT('gap0              ','R        ','0.       ')
  CALL ADD_XML_ATT('gap               ','R        ','0.       ')
  CALL ADD_XML_ATT('shift0            ','R        ','0.       ')
  CALL ADD_XML_ATT('shift             ','R        ','0.       ')
  CALL ADD_XML_ATT('rotation          ','R        ','0.       ')
```

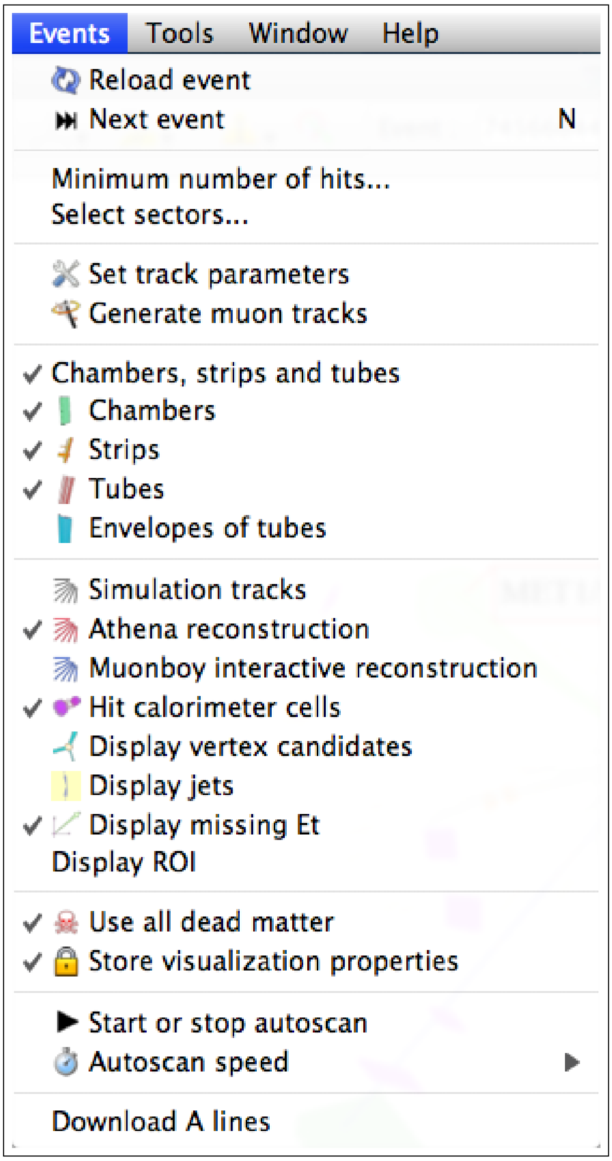
```
   CALL ADD_XML_ATT('unit_length          ','A         ','default   ')
   CALL ADD_XML_ATT('unit_angle           ','A         ','default   ')
!-----------------------------------------------------------------------
   Iel1_xml_mupos = Nb_xml_ele
!
!>> 46 -----------------------------------------------------------------
   CALL ADD_XML_ELE('foreach')
!                  *********
   CALL ADD_XML_ATT('index                ','A         ','#         ')
   CALL ADD_XML_ATT('begin                ','R         ','0.        ')
   CALL ADD_XML_ATT('step                 ','R         ','1.        ')
   CALL ADD_XML_ATT('loops                ','I         ','#         ')
   CALL ADD_XML_ATT('when                 ','I         ','1         ')
   Iel0_xml_forea = Nb_xml_ele
!
!>> 47 -----------------------------------------------------------------
   CALL ADD_XML_ELE('volume')
!                  ********
   CALL ADD_XML_ATT('name                 ','A         ','#         ')
   Iel0_xml_volum = Nb_xml_ele
!
!>> 48 -----------------------------------------------------------------
   CALL ADD_XML_ELE('identifier')
!                  ************
   CALL ADD_XML_ATT('field                ','A         ','#         ')
   CALL ADD_XML_ATT('value                ','I         ','0         ')
   CALL ADD_XML_ATT('step                 ','I         ','0         ')
   Iel0_xml_ident = Nb_xml_ele
!>> 49 -----------------------------------------------------------------
   CALL ADD_XML_ELE('layer')
!                  *******
   CALL ADD_XML_ATT('field                ','A         ','layer     ')
   CALL ADD_XML_ATT('value                ','I         ','0         ')
   CALL ADD_XML_ATT('step                 ','I         ','0         ')
!>> 50 -----------------------------------------------------------------
   CALL ADD_XML_ELE('ring')
!                  ******
   CALL ADD_XML_ATT('field                ','A         ','ring      ')
   CALL ADD_XML_ATT('value                ','I         ','0         ')
   CALL ADD_XML_ATT('step                 ','I         ','0         ')
!>> 51 -----------------------------------------------------------------
   CALL ADD_XML_ELE('sector')
!                  ********
   CALL ADD_XML_ATT('field                ','A         ','sector    ')
   CALL ADD_XML_ATT('value                ','I         ','0         ')
   CALL ADD_XML_ATT('step                 ','I         ','0         ')
!-----------------------------------------------------------------------
   Iel1_xml_ident = Nb_xml_ele
!
!>> 52 -----------------------------------------------------------------
   CALL ADD_XML_ELE('polyplane')
!                  ***********
   CALL ADD_XML_ATT('Rio_Z                ','3R        ','#         ')
!>> 53 -----------------------------------------------------------------
   CALL ADD_XML_ELE('snake_point')
!                  *************
   CALL ADD_XML_ATT('X_Y_Z                ','3R        ','#         ')
!>> 54 -----------------------------------------------------------------
   CALL ADD_XML_ELE('gvxy_point')
!                  ************
   CALL ADD_XML_ATT('X_Y                  ','2R        ','#         ')
!>> 55 -----------------------------------------------------------------
   CALL ADD_XML_ELE('gcylrz_point')
!                  **************
   CALL ADD_XML_ATT('R_Z                  ','2R        ','#         ')
!>> 56 -----------------------------------------------------------------
   CALL ADD_XML_ELE('gslice_new')
!                  ************
   CALL ADD_XML_ATT('Z                    ','R         ','#         ')
!>> 57 -----------------------------------------------------------------
   CALL ADD_XML_ELE('gslice_point')
!                  **************
   CALL ADD_XML_ATT('X_Y                  ','2R        ','#         ')
!>> 58 -----------------------------------------------------------------
   CALL ADD_XML_ELE('row')
!                  *****
   CALL ADD_XML_ATT('values               ','79R       ','#         ')
!-----------------------------------------------------------------------
!
!>> 59 -----------------------------------------------------------------
   CALL ADD_XML_ELE('parameters')
!                  ************
   CALL ADD_XML_ATT('name                 ','A         ','#         ')
   CALL ADD_XML_ATT('type                 ','A         ','none      ')
!>> 60 -----------------------------------------------------------------
   CALL ADD_XML_ELE('real')
!                  ******
   CALL ADD_XML_ATT('name                 ','A         ','#         ')
   CALL ADD_XML_ATT('value                ','R         ','0.        ')
   CALL ADD_XML_ATT('unit                 ','A         ','mm        ')
   CALL ADD_XML_ATT('comment              ','A         ','none      ')
!-----------------------------------------------------------------------
!
!>> 61 -----------------------------------------------------------------
   CALL ADD_XML_ELE('SiDigit')
!                  *********
   CALL ADD_XML_ATT('id                   ','A         ','no_id     ')
   CALL ADD_XML_ATT('kine                 ','I         ','0         ')
   CALL ADD_XML_ATT('type                 ','A         ','pixel     ')
   CALL ADD_XML_ATT('dir                  ','A         ','barrel    ')
   CALL ADD_XML_ATT('phi                  ','R         ','0.        ')
   CALL ADD_XML_ATT('rho                  ','R         ','0.        ')
   CALL ADD_XML_ATT('z                    ','R         ','0.        ')
   CALL ADD_XML_ATT('top_x                ','R         ','0.        ')
   CALL ADD_XML_ATT('top_y                ','R         ','0.        ')
   CALL ADD_XML_ATT('top_z                ','R         ','0.        ')
   CALL ADD_XML_ATT('bottom_x             ','R         ','0.        ')
   CALL ADD_XML_ATT('bottom_y             ','R         ','0.        ')
   CALL ADD_XML_ATT('bottom_z             ','R         ','0.        ')
   Iel0_xml_digit = Nb_xml_ele
!>> 62 -----------------------------------------------------------------
   CALL ADD_XML_ELE('StripCluster')
!                  **************
   CALL ADD_XML_ATT('id                   ','A         ','no_id     ')
   CALL ADD_XML_ATT('kine                 ','I         ','0         ')
   CALL ADD_XML_ATT('type                 ','A         ','pixel     ')
   CALL ADD_XML_ATT('phi                  ','R         ','0.        ')
   CALL ADD_XML_ATT('rho                  ','R         ','0.        ')
```

```
   CALL ADD_XML_ATT('z                   ','R         ','0.        ')
   CALL ADD_XML_ATT('d_rphi              ','R         ','0.        ')
   CALL ADD_XML_ATT('d_rz                ','R         ','0.        ')
   CALL ADD_XML_ATT('length              ','R         ','0.        ')
   CALL ADD_XML_ATT('pitch               ','R         ','0.        ')
   CALL ADD_XML_ATT('thickness           ','R         ','0.        ')
   CALL ADD_XML_ATT('sin_stereo          ','R         ','0.        ')
   CALL ADD_XML_ATT('sin_tilt            ','R         ','0.        ')
!>> 63 ------------------------------------------------------------------
   CALL ADD_XML_ELE('TRTDigit')
!                   *********
   CALL ADD_XML_ATT('id                  ','A         ','no_id     ')
   CALL ADD_XML_ATT('kine                ','I         ','0         ')
   CALL ADD_XML_ATT('dir                 ','A         ','barrel    ')
   CALL ADD_XML_ATT('above_threshold     ','A         ','false     ')
   CALL ADD_XML_ATT('drift               ','R         ','0.        ')
   CALL ADD_XML_ATT('phi                 ','R         ','0.        ')
   CALL ADD_XML_ATT('zrho                ','R         ','0.        ')
   CALL ADD_XML_ATT('min                 ','R         ','0.        ')
   CALL ADD_XML_ATT('max                 ','R         ','0.        ')
!>> 64 ------------------------------------------------------------------
   CALL ADD_XML_ELE('TruthTrack')
!                   ************
   CALL ADD_XML_ATT('particle            ','A         ','?         ')
   CALL ADD_XML_ATT('kine                ','I         ','0         ')
   CALL ADD_XML_ATT('rep                 ','A         ','vertex    ')
   CALL ADD_XML_ATT('charge              ','I         ','0         ')
   CALL ADD_XML_ATT('eta                 ','R         ','0.        ')
   CALL ADD_XML_ATT('phi                 ','R         ','0.        ')
   CALL ADD_XML_ATT('pt                  ','R         ','0.        ')
   CALL ADD_XML_ATT('v_phi               ','R         ','0.        ')
   CALL ADD_XML_ATT('v_rho               ','R         ','0.        ')
   CALL ADD_XML_ATT('v_z                 ','R         ','0.        ')
!-----------------------------------------------------------------------
   Iel1_xml_digit = Nb_xml_ele
!
!>> Specify the hierarchy of the identifiers ---------------------------
   CALL ADD_XML_IND('sector')
   CALL ADD_XML_IND('ring')
   CALL ADD_XML_IND('multilayer')
   CALL ADD_XML_IND('layer')
   CALL ADD_XML_IND('strip')
   CALL ADD_XML_IND('tube')
!-----------------------------------------------------------------------
!
%
```

E.5 *Events* menu



(a) Linux style

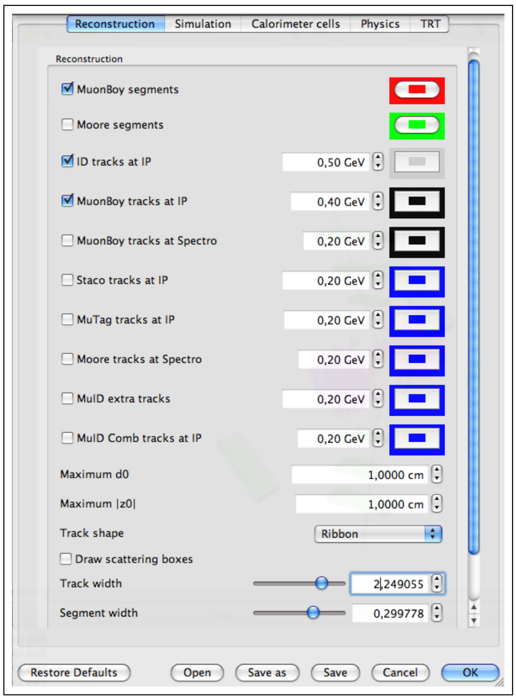


(b) Mac OS style

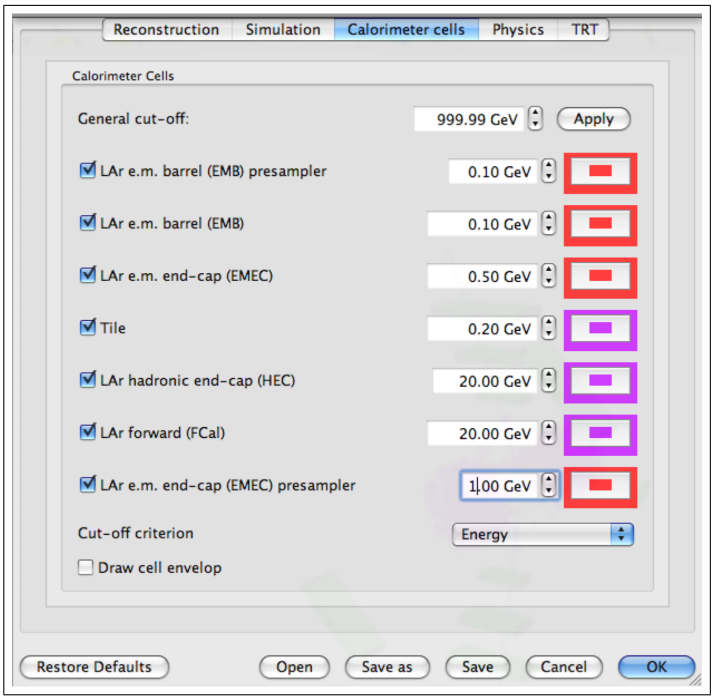
Item name	***Action***
Reload event [1]	Load current event again
Next event	Display next event of the active *Event* file
Minimum number of hits...	Minimum # of hits required for a MDT chamber to be displayed
Select Sectors...	Select sectors for displaying chambers with hits in an event
Set track parameters	Open window (Fig. 10) where the objects to be displayed are chosen and their parameters set
Generate muon tracks	Generate muon tracks at the IP. The vertex position, φ, η, and P_t can be chosen (and the color !)
Chambers, strips and tubes [2]	Display/Hide chambers, trips and tubes "in one stroke"
Chambers [2]	Display/Hide the entire chamber
Strips [2]	Display/Hide RPC strips
Tubes [2]	Display/Hide MDT tubes
Envelopes of tubes[2]	Display/Hide the tube envelopes
Simulation tracks	Display simulation tracks
Athena reconstruction	Display tracks reconstructed by *ATHENA*
Muonboy interactive reconstruction	Use the embedded MuonBoy program to ineractively reconstruct segments and tracks
Hit calorimeter cells	Display the hit cells of the calorimeters
Display vertex candidates	Display primary vertex candidates of the current event
Display jets	Display jets
Missing E_T	Draw Missing E_T arrow
Display RoI	Display Regions of Interest (under development)
Use all dead matter	Choose to use ALL dead matter or only DISPLAYED dead matter when computing track momentum with energy loss
Store visualization properties	Store viewing parameters from one event to the next, when scanning an event file
Start autoscan	Display successive events in regular time intervals
Autoscan speed	Set the time interval between two consecutive event displays (1, 2, 5, 10, 20, or 30 seconds)
Download A lines [2]	Download A-lines for each event from the ATLAS data base

[1] Active only if an event is displayed.
[2] Not present as an icon in the default tool bar.

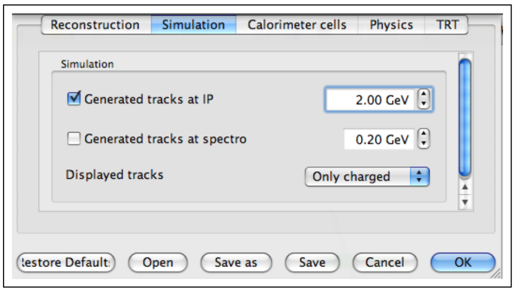
E.5.1 *Set track parameters* window



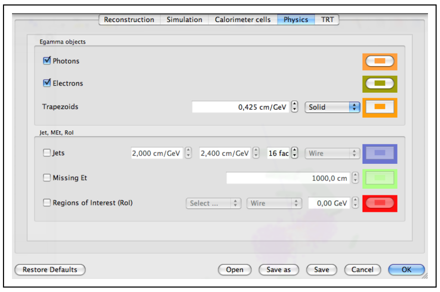
(a) Selections for *Reconstruction*



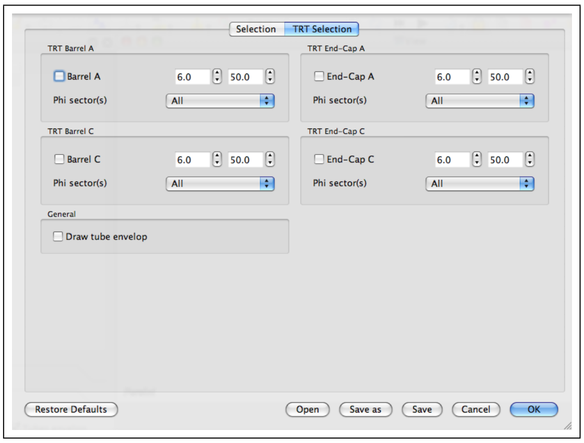
(b) Selections for *Calorimeter cells*



(c) Selections for *Simulation*



(d) Selections for *Physics* objects



(e) Selections specific to the TRT detector

Figure 136: The two panes in the *Set track parameters* window (**Mac OS style**). Thresholds can be set for track momentum and calorimeter cell energy (both in GeV). The selections in the TRT pane concern cuts on timing.

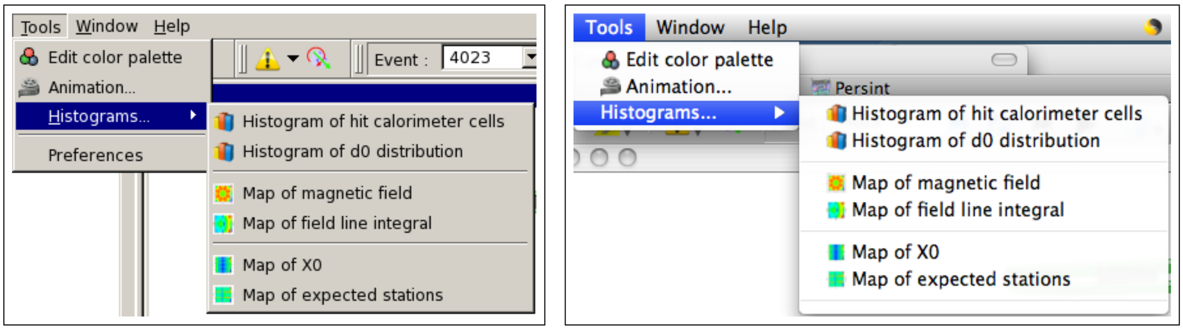
Parameter	***Description***
Reconstruction	
Muonboy segments	Choose color
Moore segments	Choose color
ID tracks at IP	Pt threshold in GeV/c; choose color
Muonboy tracks at IP	Pt threshold in GeV/c; choose color
Muonboy tracks at Spectrometer	Pt threshold in GeV/c; choose color
Staco tracks at IP	Pt threshold in GeV/c; choose color
MuTag tracks at IP	Pt threshold in GeV/c; choose color
Moore tracks at Spectrometer	Pt threshold in GeV/c; choose color
MuID extra tracks	Pt threshold in GeV/c; choose color
MuID Combined tracks at IP	Pt threshold in GeV/c; choose color
Maximum |d0|	Maximum allowed track impact parameter (x,y plane)
Maximum |z0|	Maximum allowed track impact parameter (z direction)
Track shape	Choose shape of the track: *Ribbon*, *Crossed ribbons*, or *Cylinder*
Jets	Choose parameters for displaying jet cones and jet arrows
Missing E_T	Choose parameters for displaying the Missing E_T arrow
Regions of Interest (RoI)	Choose parameters for displaying the RoIs (Under deveolpment)
Draw scattering boxes	Scattering centers used in the reconstruction are shown (or hidden)
Track width	Can be adjusted with ruler or spinbox
Segment width	Can be adjusted with ruler or spinbox
Simulation	
Generated tracks at IP	Pt threshold in GeV/c
Generated tracks at Spectro	Pt threshold in GeV/c
Displayed tracks	Only muons; only charged; only neutrals; all tracks
Calorimeter cells	
General threshold	General threshold on E or E_T for all calorimeter cells, in GeV/c^2
LAr e.m. barrel presampler	E or E_T threshold in GeV/c^2; choose color
LAr e.m. barrel	E or E_T threshold in tower (GeV/c^2); choose color
LAr e.m. end-cap (EMEC)	E or E_T threshold in GeV/c^2; choose color
Tile calorimeter	E or E_T threshold in GeV/c^2; choose color
LAr hadronic end-cap (HEC)	E or E_T threshold in GeV/c^2; choose color
LAr forward (FCAL)	E or E_T threshold in GeV/c^2; choose color
Cut-off criterion	Choose E or E_T threshold
Draw cell envelope	

Parameter	***Description***
Physics objects	
Photons	Display or hide photons
Electrons	Display or hide electrons
TRT	
TRT barrel A and C	- Cuts on "time over threshold" - Choose Phi sectors (1-32)
TRT End-Cap A and C	- Cuts on "time over threshold" - Choose Phi sectors (1-32)
Draw tube envelope	Draw or hide

Action box	***What it does***
Restore defaults	Sets parameters back to default values
Open	Open any `.p2ts` file containing saved parameters from previous work
Save as	Save parameter file with the name of your choice to any directory
Save	Save modified parameter file with the same name to the same directory
Cancel	Cancel operation and leave parameter file unchanged
OK	Validates parameter file; to take effect, this validation must be followed by the *Compute* action; the file is not automatically saved

E.6 *Tools* menu

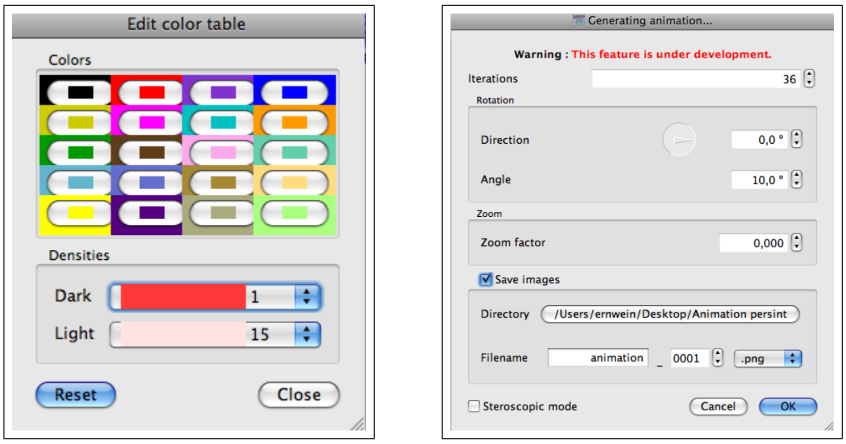
There is no default tool bar for this menu.



(a) Linux style (b) Mac OS style

Item name	***Action***
Edit color palette	Opens the *Edit color table* window, where the colors as well as the color density can be chosen
Animation ...	Opens the *Generating animation* window, where parameters which control the animation can be chosen
Preferences ... [1]	Set preferences for saving track parameters, magnetic field display, show warnings for reconstruction errors, disable Log console, as well as network parameters for access to CERN data bases
Histogram ... [2]	There are 6 types of histograms/maps available: calorimeter cells, vertex (d0), magnetic field, field integral, X_0, expected # of stations

Edit color palette and **Animation** windows:

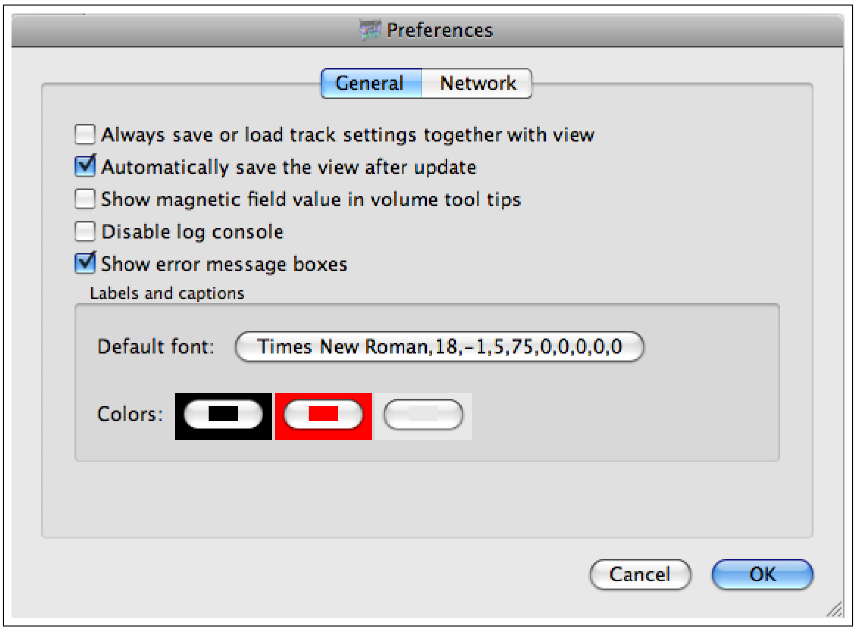


(a) Edit color palette (b) Generating animation

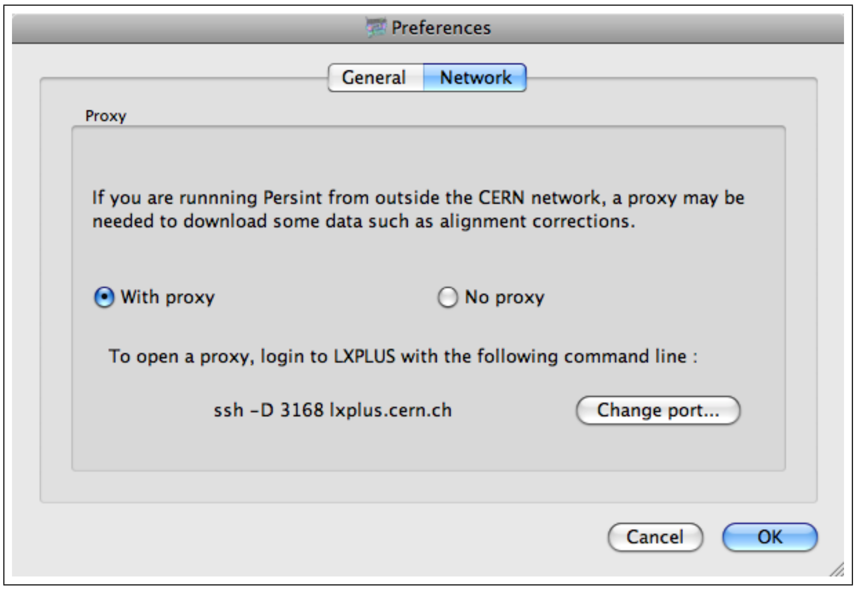
Figure 137: Layout of the windows for *"Editing the color palette"* (a), and *"Generating animation"* (b).

[1] In the case of a *Mac OS* environment, the ***Preferences*** function is found in the ***Persint*** menu.
[2] With *Linux*, ***Create histogram*** is also found in the ***Tools*** menu, provided *QtRoot* is installed.

Preferences windows:



(a) "General" Preferences

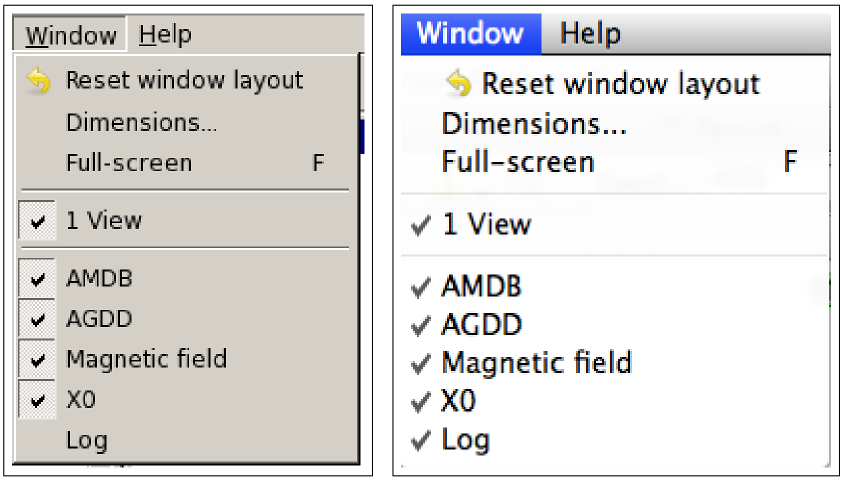


(b) "Network" Preferences

Figure 138: The setting of ***Preferences*** (to be found in the *Persint* menu for the Mac OS environement):
a) **General** for saving track settings with view, update/no-update of view, showing magnetic field in volume information boxes, disabling/enabling Log console and warning messages for reconstruction errors
b) **Network** for choosing a "*proxy*" when downloading from a CERN server (*e.g.* alignment constants)

E.7 *Window* menu

There is no default tool bar for this menu.

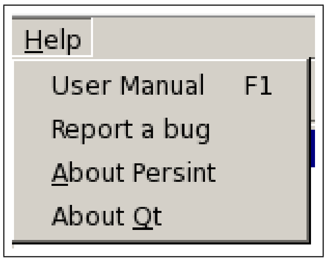


(a) Linux style (b) Mac OS style

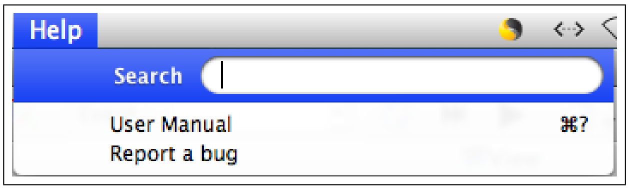
Item name	***Action***
Reset window layout	Set the default layout of the *Persint* display
Dimensions	Set image canvas size
Full-screen	Makes the Main display full-screen; as a shortcut, type *F* (lower case) to enter or quit full-screen mode
1 View	
AMDB	Enable the AMDB *Selector* window
AMDB (v1)	Enable a previous version of the AGDD *Selector* window
AGDD	Enable the AGDD *Selector* window
X_0	Enable the X_0 window (amount of material)
Log	Enable the *Log* window

E.8 *Help* menu

There is no default tool bar for this menu.



(a) Linux style



(b) Mac OS style

Item name	***Action***

Linux style	
User Manual	Opens the *Persint* User Manual in your web browser
Report a bug	Prompts to your mailer with the destination mail address: *atlas-sw-persint-support@cern.ch*
About Persint [1]	Open information window about *Persint*; the version number is found here
About Qt [1]	Open information window about *Qt*

Mac OS style	
Search	Search for commonly used functions
User Manual	Opens the *Persint* User Manual in your web browser (27 Mo pdf)
Report a bug	Prompts to your mailer with the destination mail address: *atlas-sw-persint-support@cern.ch*

[1] In the *Mac OS* environment, ***About Persint*** and ***About Qt*** are found in the ***Persint*** menu (see section E.9)

E.9 *persint* menu (Mac OS only)

There is no default tool bar for this menu.

(a) Mac OS style

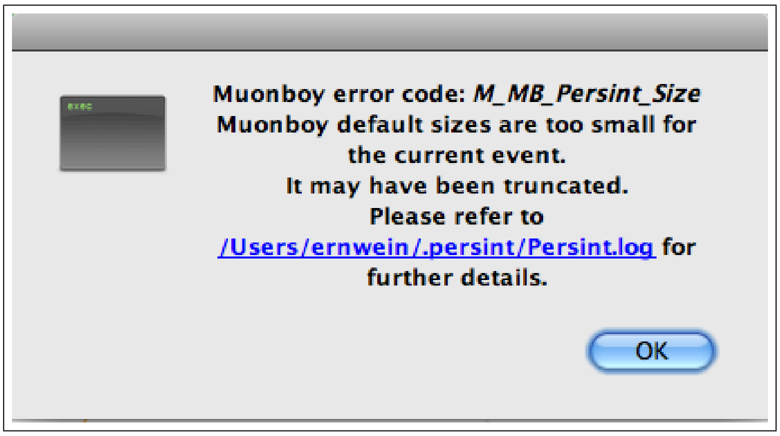
Item name	***Action***
About Persint	Open information window about *Persint*; the version number is found here
About Qt	Open information window about *Qt*
Preferences . . .[1]	Set preferences for saving track parameters, magnetic field display, show warnings for reconstruction errors, disable Log console, as well as network parameters for access to CERN data bases
. . .	
Quit Persint[1]	

[1]In the Linux environment, ***Preferences*** is found in the ***Tools*** menu (see section E.6 where the two Preferences windows are shown), and ***Quit*** is found in the ***File*** menu (section E.1)

E.10 *Warning messages*

On various occasions, *Persint* encounters an error which is reported in a message like those shown below.
Note that for these messages to appear, the *Show errors* box should be checked in the *Preferences* window (see figure 138a, page 163).

(a) Failed download of alignment corrections



(b) Event too big for Muonboy reconstruction with standard settings

F Right-click

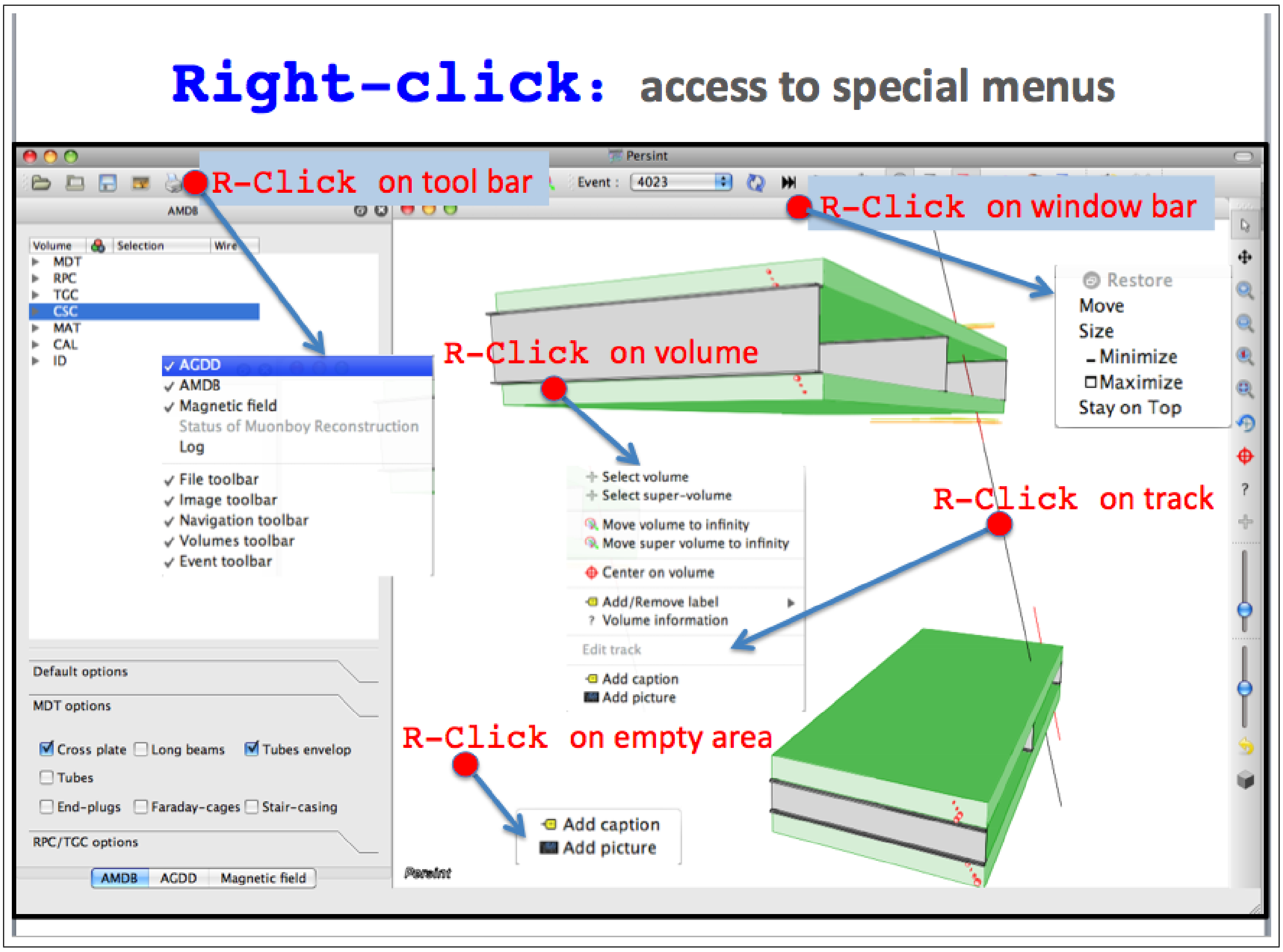


Figure 139: Special menus available through `Right- click` on various areas of the *Persint* display

.

The special menu which appears depends on the location of the cursor when `right-clicking`. In the case of a reconstructed track, there is a menu item called *Edit track* illustrated in figure 140.
R_{max} and Z_{max} (both in *cm*) define the cylinder, centered on the IP, which contains the track.

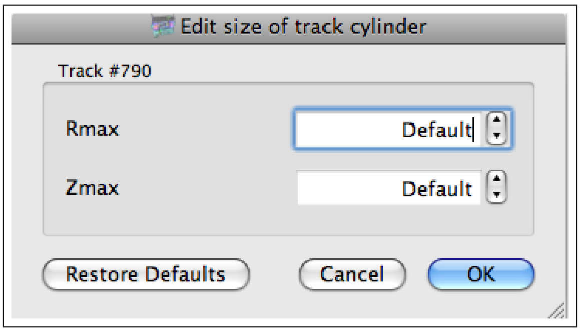


Figure 140: Window which opens when clicking on *Edit track* in the special menu obtained with a `right-click` on a track

.

G Producing *Event files* for *Persint* in *ATHENA*

ASCII *Event files* for input to *Persint* (`Out.MboyView_xxx`) are produced in *ATHENA* from raw data. These files contain all coded information needed to display the reconstructed objects. It is possible to display tracks reconstructed by the various reconstruction packages (*e.g. MuonBoy*, *Staco*, *Moore*, *MuID*, ...) by selecting the appropriate objects in the window described in figure 10 (*Set track parameters*).

G.1 Event files from raw data

Inside *ATHENA* , *Event files* for *Persint* are produced by the *MboyView* package via the *doPersint* flag in *RecExCommon*:

```
doPersint=true
```

It is possible to make a selection of events to be included in the *Event file* by using the following parameters in the *PITHON* file used for running *ATHENA*:

```
# Event Selection:  EvtSelectionType and EvtSelectionThreshold
#     = 1 view without Selection
#     = 2 view only for evts Nber of Tracks .le.  EvtSelectionThreshold
#     = 3 view only for evts Nber of Tracks .ge.  EvtSelectionThreshold
#     = 4 view only for evts Nber of Tracks .eq.  EvtSelectionThreshold
# GenEvent Selection:  GenEvtSelectionType and GenEvtSelectionEta<Min/Max>
#     = 1 view without Selection
#     = 2 view only for evts with at least a gen track with
#         GenEvtSelectionEtaMin<abs(eta)<GenEvtSelectionEtaMax

if doPersint:

    MboyView = Algorithm( "MboyView" )
    MboyView.EvtSelectionType = 1
    MboyView.EvtSelectionThreshold = 0
    MboyView.GenEvtSelectionType = 2
    MboyView.GenEvtSelectionEtaMin = 0.
    MboyView.GenEvtSelectionEtaMax = 2.7
```

The information to be included in the *Events* for *Persint* can be chosen as follows (0=no; 1=yes):

```
if doPersint:

     MboyView = Algorithm( "MboyView" )
     MboyView.ViewDigits = 1        # dump the spectrometer digits
     MboyView.ViewCalo = 0          # dump the calorimeter cells
     MboyView.ViewMcEventCollection = 1    # dump the truth info
     MboyView.ViewTrackRecordCollection = 1 # dump the TrackRecord
     #      (i.e.  truth info at the spectrometer entrance)
     MboyView.TrackRecordCollectionLocationForGenEventSelectionList =
     [ "MuonEntryLayerFilter" ]
     MboyView.TrackRecordCollectionLocationForGenEventSelectionList +=
     [ "MuonEntryRecordFilter" ]
```

G.2 Event files from ESDs or dESDs

The ASCII input file for *Persint* (`Out.MboyView_xxx`) can also be produced from ESD files.

G.2.1 *Procedure*

- Set up *ATHENA* release 15.6.3 or higher. You may follow instructions given in: https://twiki.cern.ch/twiki/bin/view/Atlas/WorkBook, in particular in sections: *Getting an Account*, *Setting up your Account*, *Running Athena HelloWorld*.

- Get a *job options* file.
  A generic *job options* file (`MboyViewESD.py`) is located in the directory `Persint-00-02-●●/example`.
  It is also available as an attachment to the following Twiki page [the file is listed in the next section (G.2.3)]:
  https://twiki.cern.ch/twiki/bin/view/Atlas/PersintDumpESD
  You may want to edit the *job options* file for geometry and conditions tags associated with your ESD file.

- Finally, execute the following command:
  `athena MboyViewESD.py -c 'inputFileList=["/path/to/ESD/file"]'`
  where */path/to/ESD/file* is "comme son nom l'indique".

This will create a file `MboyView` which can be read by *Persint*.

G.2.2 *Limitations*

The method described above does not re-run the reconstruction but only dumps the values already available in the ESD file. The advantage of this method is its speed. However, in the ESD file, only the TDC counts of MDT hits are stored, and not the radius returned by the RT calibration service.
An approximate radius is thus associated with MDT hits, in the following way:

1. If the MDT hit is associated with a Muonboy segment, the calibrated radius is saved in the segment and this is what is returned in the ASCII dump

2. If the MDT hit is not associated with any segment, its radius is set to 7.5 mm

This last approximation makes the ASCII dump suitable for display, but not suitable for *Muonboy interactive reconstruction* in Persint.

Muonboy interactive reconstruction

In future versions of this tool, a better radius determination may be included.

G.2.3 *ATHENA job options* file, an example: `MboyViewESD.py`

```
#-----------------------------------------------------------------------
# Configure the input file, in a way compatible with auto-configuration
#-----------------------------------------------------------------------
from AthenaCommon.AthenaCommonFlags import athenaCommonFlags
athenaCommonFlags.FilesInput = inputFileList

#-----------------------------------------------------------------------
# Include the RecExCommon flags, to force trigger the auto-configuration
#-----------------------------------------------------------------------
```

```
include('RecExCond/RecExCommon_flags.py')

#--------------------------------------------------------------
# Load POOL support
#--------------------------------------------------------------
import AthenaPoolCnvSvc.ReadAthenaPool
from AthenaCommon.AppMgr import ServiceMgr as svcMgr
from AthenaCommon.AppMgr import ToolSvc as toolSvc

from AthenaCommon.AlgSequence import AlgSequence
topSequence = AlgSequence()

from AthenaCommon.AlgSequence import AthSequencer
selectionSequence = AthSequencer("selectionSequence")

#--------------------------------------------------------------
# Event related parameters
#--------------------------------------------------------------
# theApp.EvtMax = 100

#--------------------------------------------------------------
# GeoModel stuff
#--------------------------------------------------------------
from AthenaCommon.GlobalFlags import GlobalFlags
from AthenaCommon.DetFlags import DetFlags
DetFlags.ID_setOn()
DetFlags.Calo_setOn()
DetFlags.Muon_setOn()

# GeoModel initialisation
from AtlasGeoModel import SetGeometryVersion
from AtlasGeoModel import GeoModelInit

#--------------------------------------------------------------
# Set output level threshold (2=DEBUG, 3=INFO, 4=WARNING, 5=ERROR, 6=FATAL )
#--------------------------------------------------------------
MessageSvc = Service( "MessageSvc" )
MessageSvc.OutputLevel = 3

#-------------------------------------------------------------------------------
# Define the input collection
#-------------------------------------------------------------------------------
svcMgr.EventSelector.InputCollections = athenaCommonFlags.FilesInput()

#-------------------------------------------------------------------------------
# Optionally add to selectionSequence any private alg that selects the
# events to be dumped in Out.MboyView
#-------------------------------------------------------------------------------
# from PFMuonAnalysis.PFMuonAnalysisConf import CosmicMuonAnalysis
# selectionSequence += CosmicMuonAnalysis("CosmicMuonAnalysis")

#-------------------------------------------------------------------------------
```

```
# Configure the MboyView algs
#-------------------------------------------------------------------------------
from MboyView.MboyViewConf import MboyViewDigiMaker
selectionSequence += MboyViewDigiMaker("MboyViewDigiMaker")
selectionSequence.MboyViewDigiMaker.ApproximateRsLine = True

from MboyView.MboyViewConf import MboyView
selectionSequence += MboyView("MboyView")
selectionSequence.MboyView.SwitchOff = 0
selectionSequence.MboyView.ViewDigits                 = 1
selectionSequence.MboyView.ViewTrackRecordCollection  = 1
selectionSequence.MboyView.ViewCombinedMuonContainer  = 1
selectionSequence.MboyView.ViewTrackParticleContainer = 1
selectionSequence.MboyView.ViewTrkTrackCollection     = 1
selectionSequence.MboyView.ViewTrkSegmentCollection   = 1
selectionSequence.MboyView.ViewMcEventCollection      = 1
selectionSequence.MboyView.ViewEgammaContainer        = 1

topSequence += selectionSequence

# AthenaEventLoopMgr = Service( "AthenaEventLoopMgr" )
# AthenaEventLoopMgr.OutputLevel = WARNING
```

Index

References

[1] *Persint* was originally developed and maintained by the Saclay Muon Software Group: *L. Chevalier, F. Gaillot, J.-F. Laporte, A.Ouraou, D. Pomarède, P. Sizun. M. Virchaux* (1953-2004) was the principal developer.

[2] The *Persint* visualization program for the ATLAS experiment, *D. Pomarède, M. Virchaux*: Conference for Computing in High Energy and Nuclear Physics, La Jolla, California, March 24-29, 2003. (arXiv: cs/0305057v1, 29 May 2003)

[3] AMDB documentation:
L. Chevalier et al., ATLAS Internal Note, ATL-MUON-97-148 (1997). "http://muondoc.web.cern.ch/muondoc/Software/DetectorDescription/amdbdoc/amdbmanual.ps"

[4] M. Virchaux et al., ATLAS Internal Note ATL-MUON-97-198 (1997).

[5] "http://atlas.web.cern.ch/Atlas/GROUPS/MUON/Persint/releases/doc/index.html"
and: "Rapport de stage F. Gaillot et documentation for developers"

[6] Section 5.6 in the AMDB Documentation:
"http://muondoc.web.cern.ch/muondoc/Software/DetectorDescription/amdbdoc/amdbmanual.ps"

[7] ATL-COM-PHYS-2010-045
http://cdsweb.cern.ch/record/1236325/files/ATL-COM-PHYS-2010-045.pdf

[8] Jochen Meyer,
"https://cdsweb.cern.ch/record/1456446"

Acknowledgments

Jochen Meyer has written a guide to the `AGDD XML` dead material files, and operations on volumes. He added code for new volumes (*e.g.* elevator chambers) and for the geometry of the New Small Wheel. He also used Persint to test tracks reconstructed with the embedded Muonboy program.
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