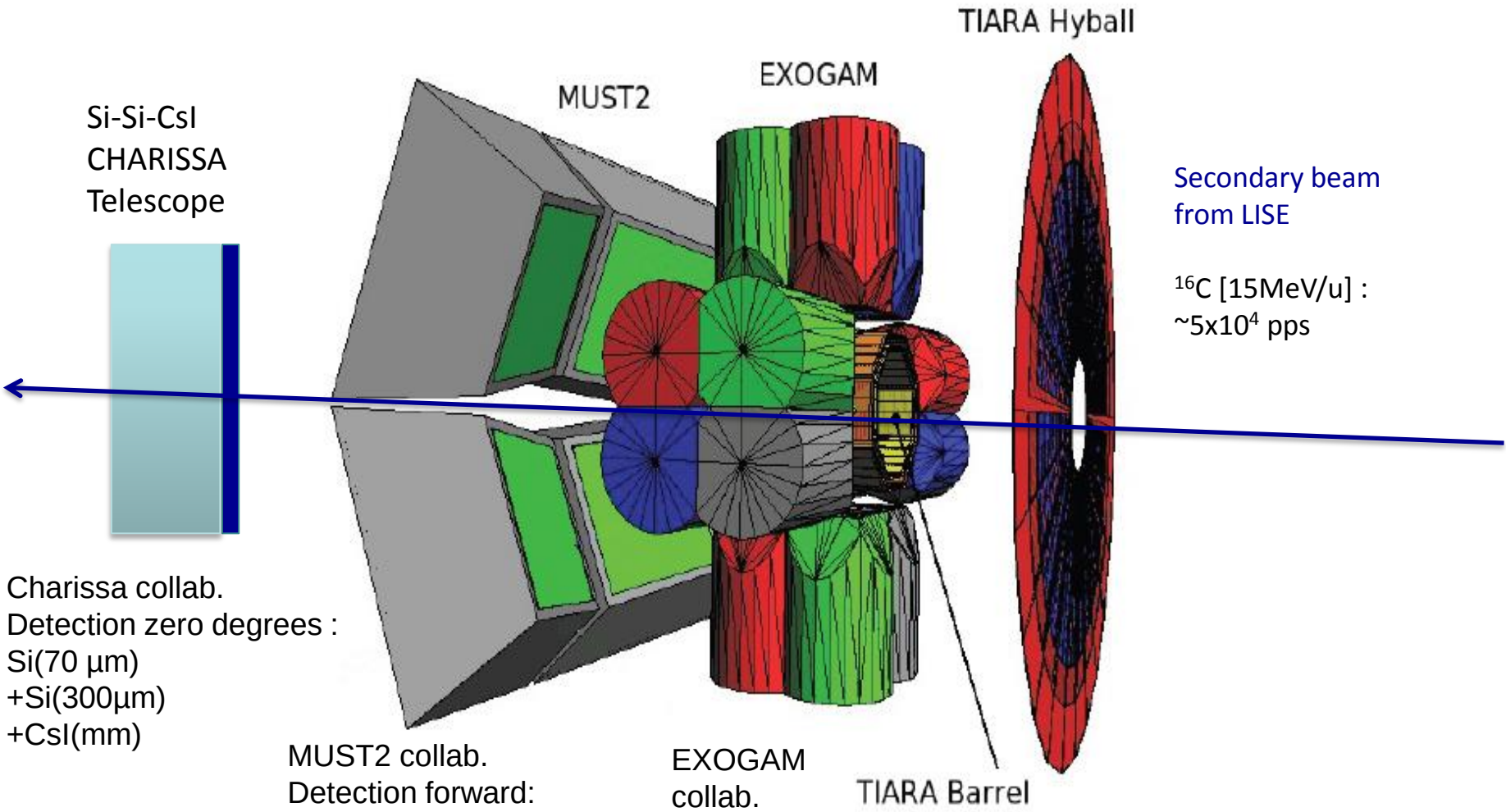
# MUST2 transfer experiments proposed to the GANIL PAC (Nov 11, Oct 2012).

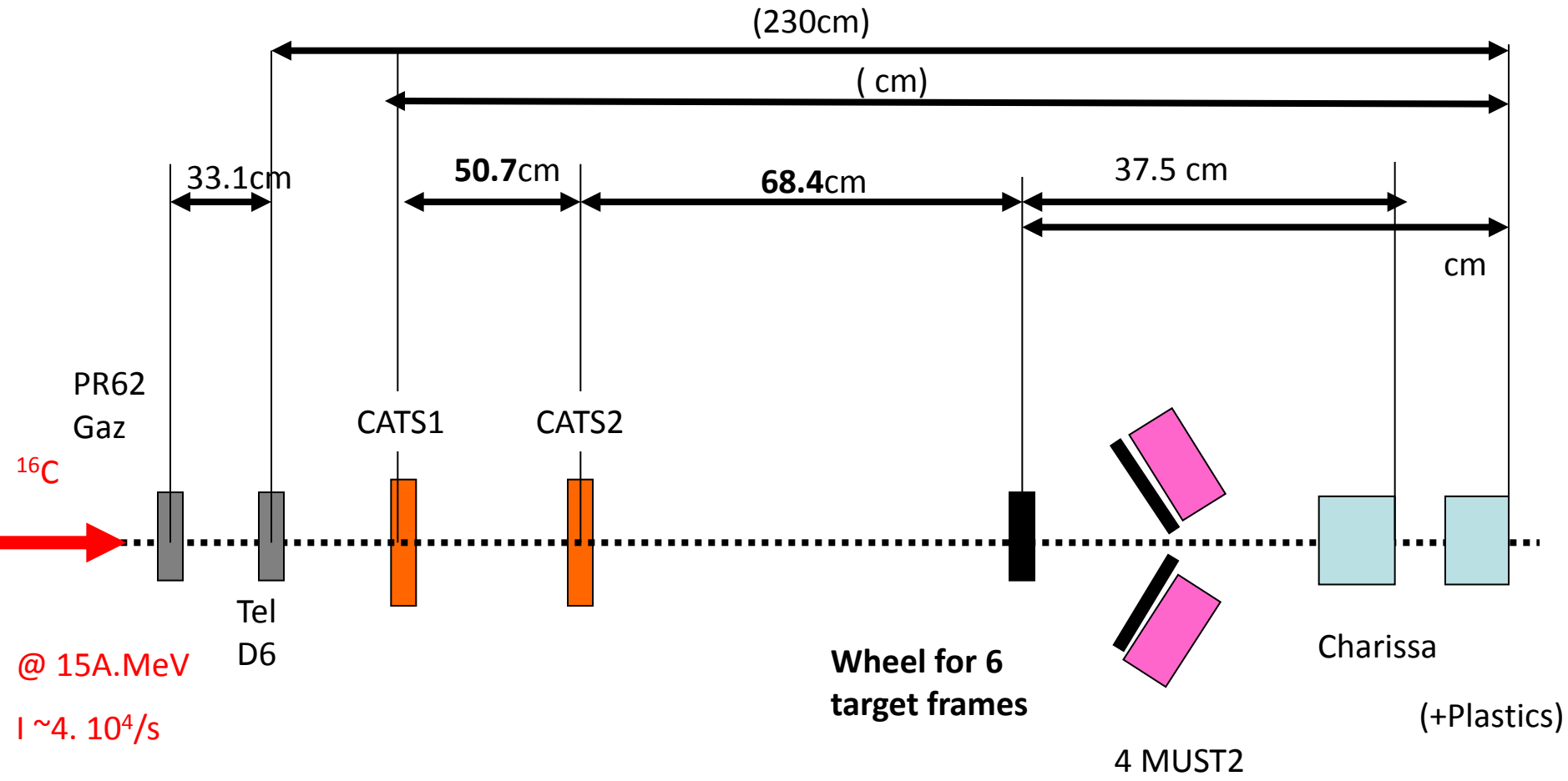
**E628** B. Fernandez (Univ. **Santiago de Compostela**), W. Catford (Surrey) *et al.* ***PAC 2010, 18UT***
**E644** M. Assié (**IPNO**), E.C. Pollacco (**SPhN**), W Catford (Surrey) *et al.* **, *38 UT***
**E657** A. Corsi (**SPhN**), S. Péru (**DAM/SPN**), et al. ***PAC 2012, 24 UT***

| EFFECT | Reaction /Energy | Exp. conditions set-up<br>LISE D6 area +2 BTDs (CATS) |
|---|---|---|
| E628<br>Spectroscopy of $^{17}$C : Location of the 0d3/2 Strength in the Neutron-Rich Carbon Isotopes | $^{16}$C(d,p) $^{17}$C<br>15 MeV/n | Backward Tiara (Hyball, Barrel)<br>Forward 4 MUST2 (Si /CsI)<br>+ 4 EXOGAM clovers<br>Charissa Si- CsI |
| E644<br>Study of the n-p pairing through 2-nucleon transfer reactions (Pair transfer to investigate the neutron-proton pairing in the f7/2 shell) | $^{48}$Cr(p,$^{3}$He) (d,$^{4}$He)<br>$^{56}$Ni(p,$^{3}$He) (d,$^{4}$He)<br>30 MeV/n | Backward Tiara (Hyball, Barrel)<br>Forward 4 MUST2<br>+ 4 EXOGAM clovers<br>+Charissa DE (Si) +Plastics |
| E657 Nuclear shape evolution in Se and shape coexistence by identifying a possible low-lying excited $0^{+}_{2}$ state, and measuring its excitation energy | $^{72}$Se(p,t) $^{70}$Se<br>36MeV/n<br>*Next : $^{68}$Ge(p,t) $^{66}$Ge*<br>36MeV/n | LISE / 4 MUST2 + BTDs<br>+ 4 Exogam clovers<br>+LaBr3 +SiLi |

# Experimental Set-Up



# Configuration for transfer reactions using CATS+MUST2+TIARA in D6 area

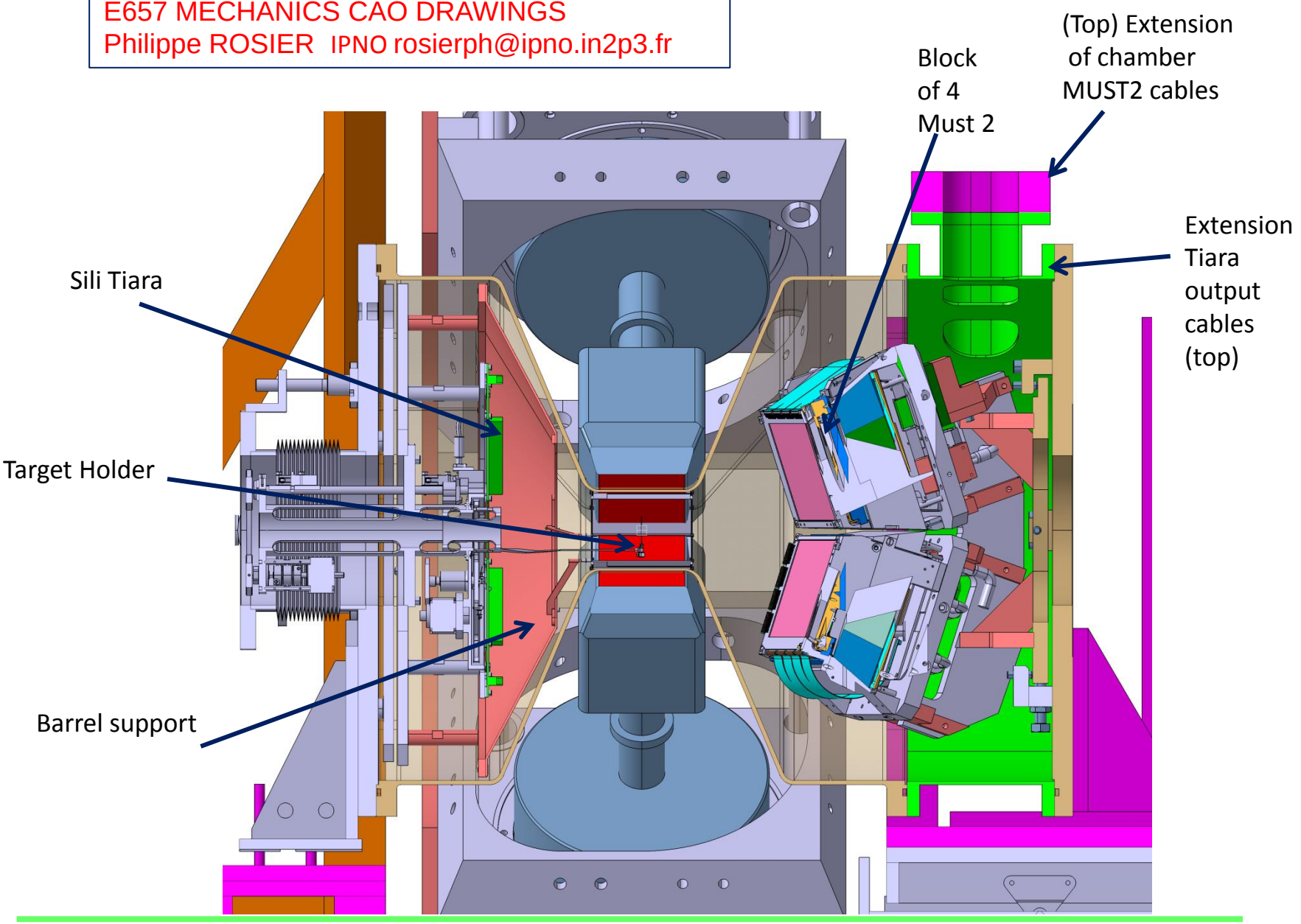



Tous les TRIGGERS FAG 150/s ; CATS ~ 4.4 $10^4$/s
Divisions 1000 (Cats1, Cats2, Charissa) , Exogam 100
Reaction target $CD_2$ 2 mg/cm$^2$

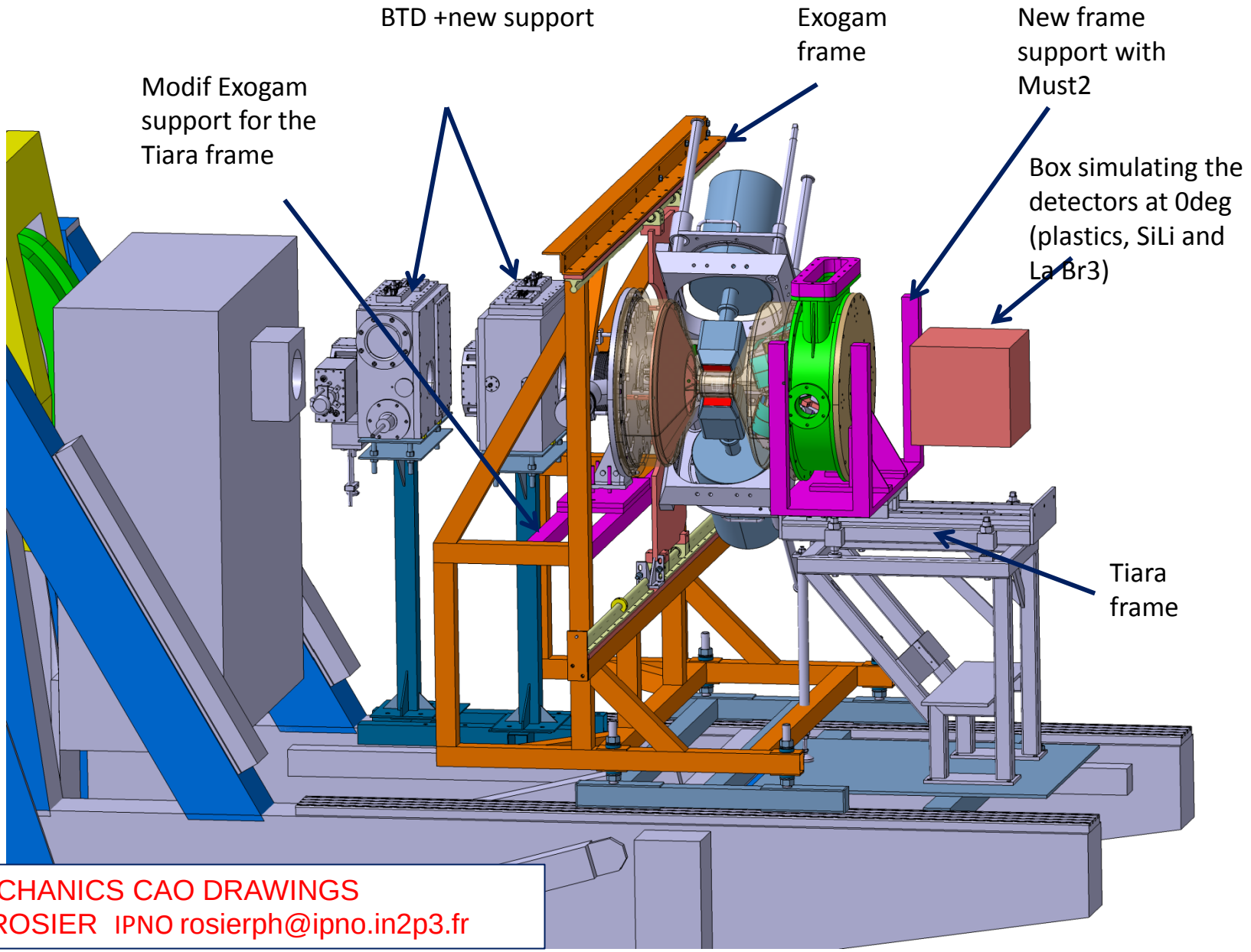
MUST2 : 4 telescopes

# Reaction chamber TIARA +MUST2

E657 MECHANICS CAO DRAWINGS
Philippe ROSIER IPNO rosierph@ipno.in2p3.fr



# Reaction chamber TIARA +MUST2




E657 MECHANICS CAO DRAWINGS
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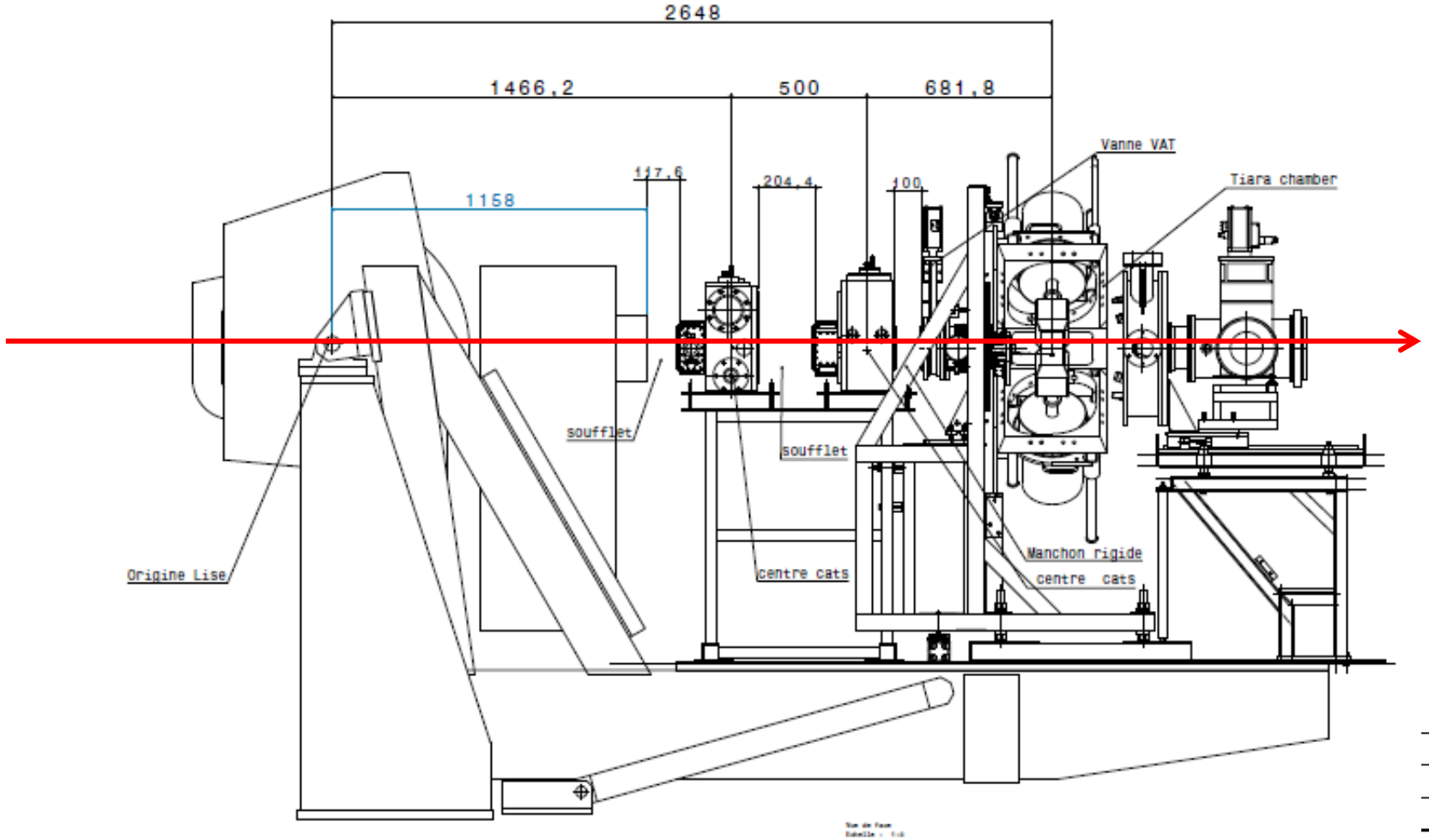
# General view of the LISE D6 line




Modifications October 2013
E657 MECHANICS CAO DRAWINGS
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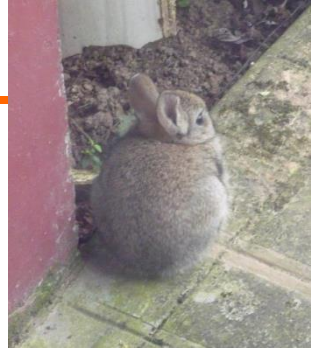
| | | | | |
|---|---|---|---|---|
| N° ensemble | Date | Dessiné par | Vérifié par | Logiciel |
| | | | | CATIA V5 |

SERVICE RECHERCHE ET DEVELOPPEMENT DETECTEURS
INSTITUT DE PHYSIQUE NUCLEAIRE - 91406 ORSAY CEDEX

**MUST 2**
position des BTD et cible
Manips E644 E657 E628

PROJET/ sous projet
243 E 03
N°PLAN 1/1

# TIARA-MUST2 in D6 - E628 summary $^{16}C(d,p)^{17}C$, (d,t)



$^{A}Z(d,p)\ ^{A+1}Z$ → Identif in Charissa

→ BACKWARD in TIARA

Gammas in EXOGAM
to separate bound states

(d,t)
(d,alpha)

→ FORWARD in MUST2

Reactions channels in MUST2: (d,t), (d,$^{4}$He)
-Tritons and $^{4}$He stop in the DSSD of MUST2, identified by E-TOF
-(d,$^{3}$He) → $^{3}$He can be identified via ΔE-E plot
NB: $^{16}$C from (d,d') (2+)

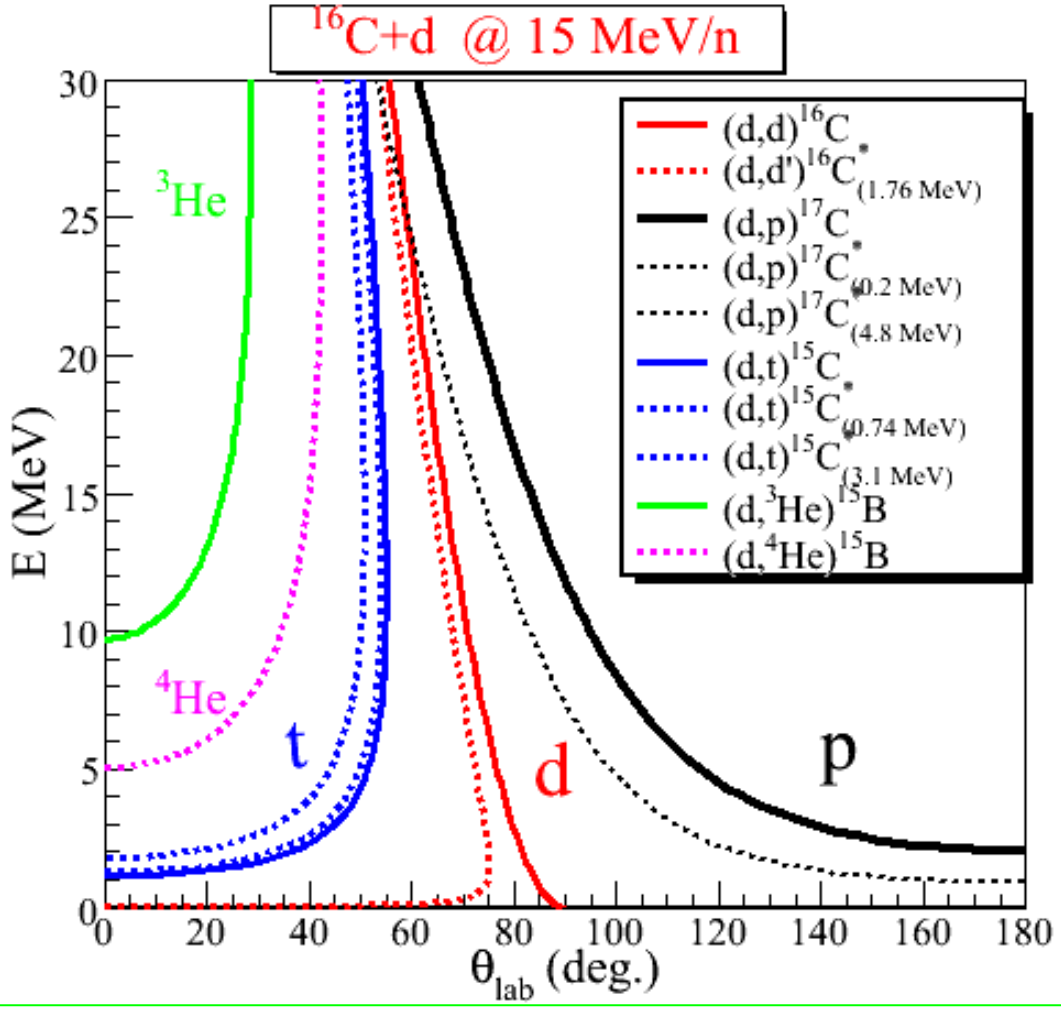
TIARA+MUST2 experiment on D6 E628 – Tuesday 4th March to Monday 10th March 18UT

Primary beam $^{18}$O at 50 A.MeV (I=6µAe increasing to 8µA ) on production target $^{9}$Be of LISE
Production of the secondary beam $^{16}$C at 15A.MeV
Production target 9Be 2mm; wedge 2mm.
Measured intensity ~4.4 $10^{4}$pps for 6µA of 1ary beam.

[NB: beam production and measurements in this mass region have been performed;
LISE++ predictions found to be reliable for beam $^{16}$C .]
Identification telescope E-DE D4/D6 // D6: Chio DE-TOF
(Residual contaminants can be eliminated by TOF)

Beam purity > 99% ; purified with the LISE spectrometer and the Wien filter

# FULL KINEMATICS

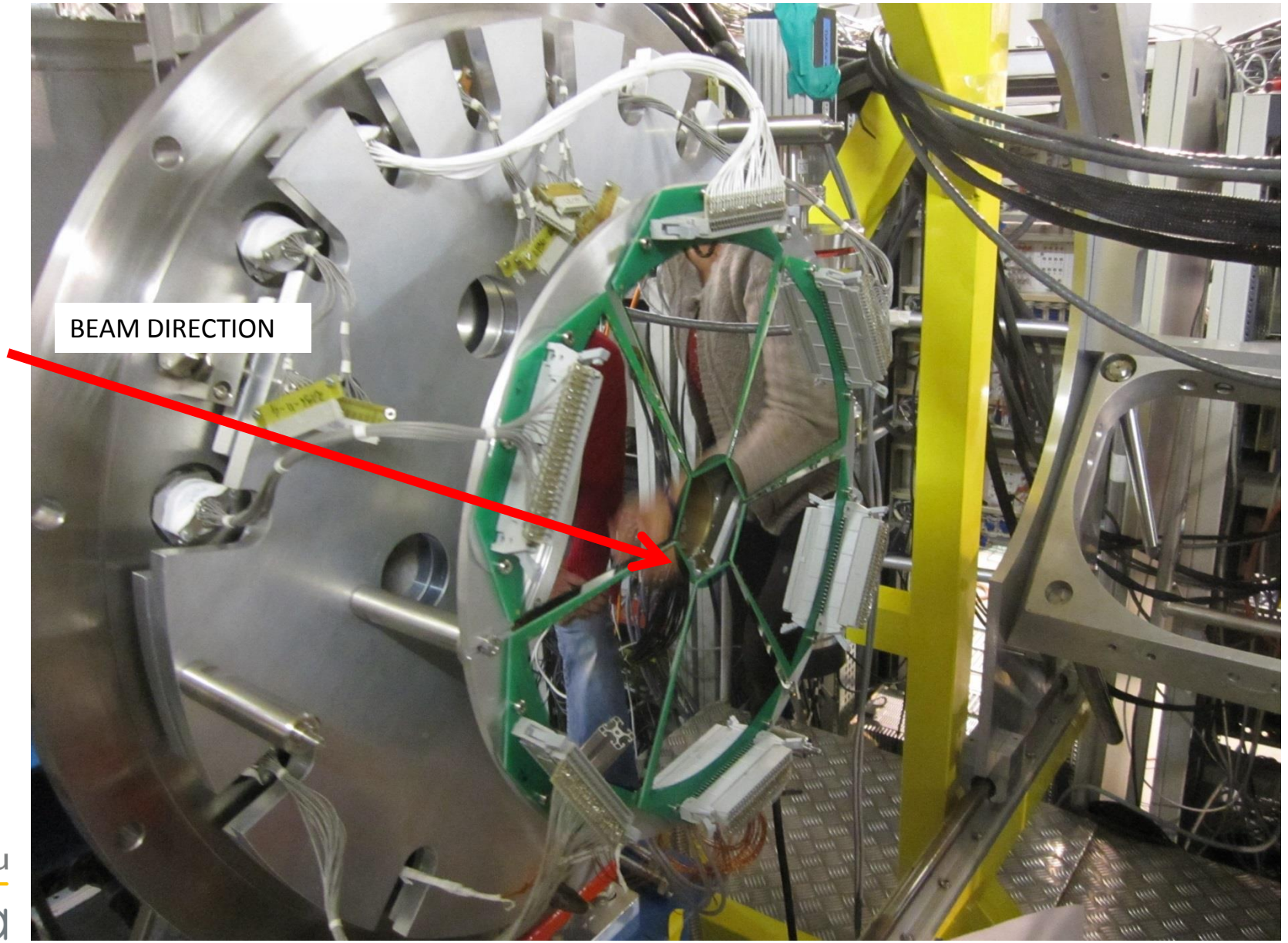



+To locate for the first time the unbound 3/2+ levels in $^{17}$C that carry the single-particle strength of the 0d3/2 orbital. New information related to the emergence of N=16

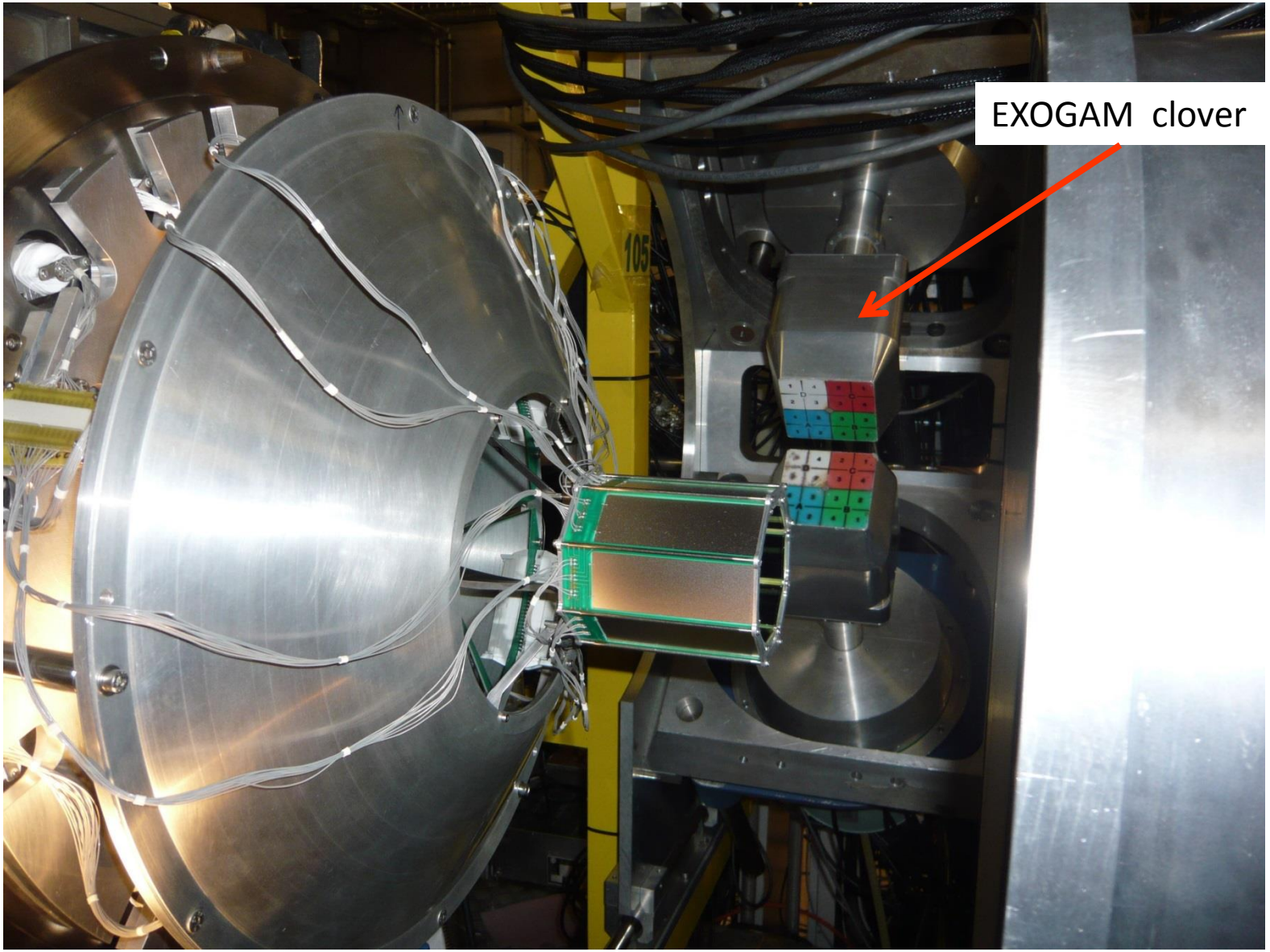
+ To measure the angular momentum for bound states (separated using gamma-rays in coincidence with particles) . New information related to N=14

+ To investigate the population of the $^{16}$C ground state.

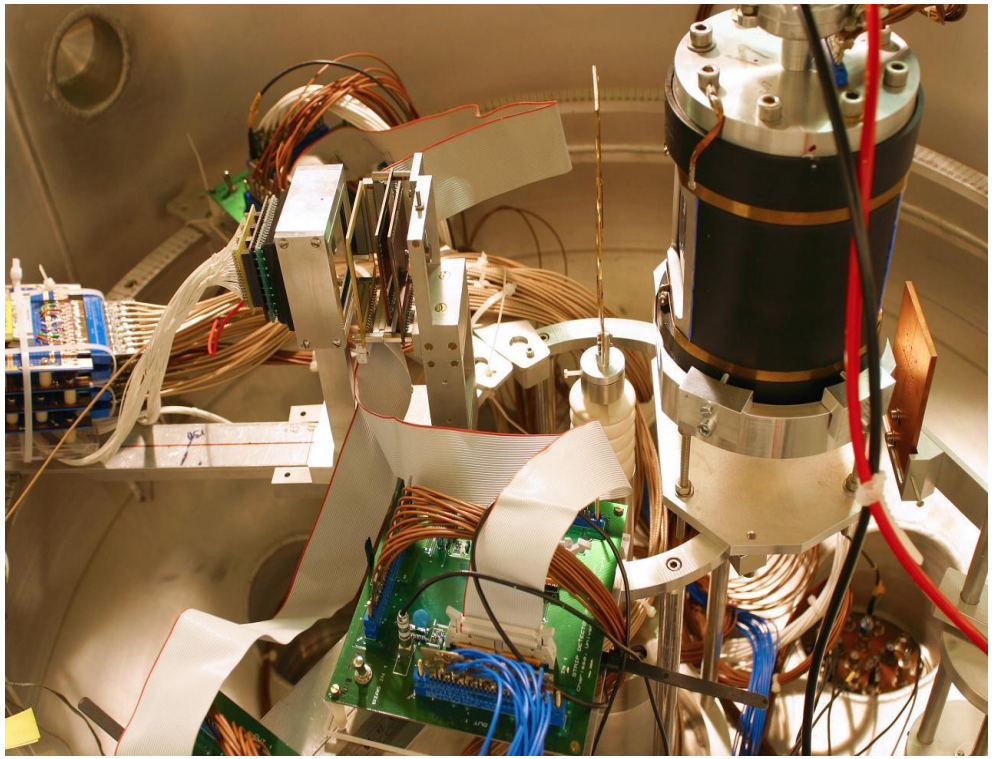
# Hyball detector



# TIARA Barrel



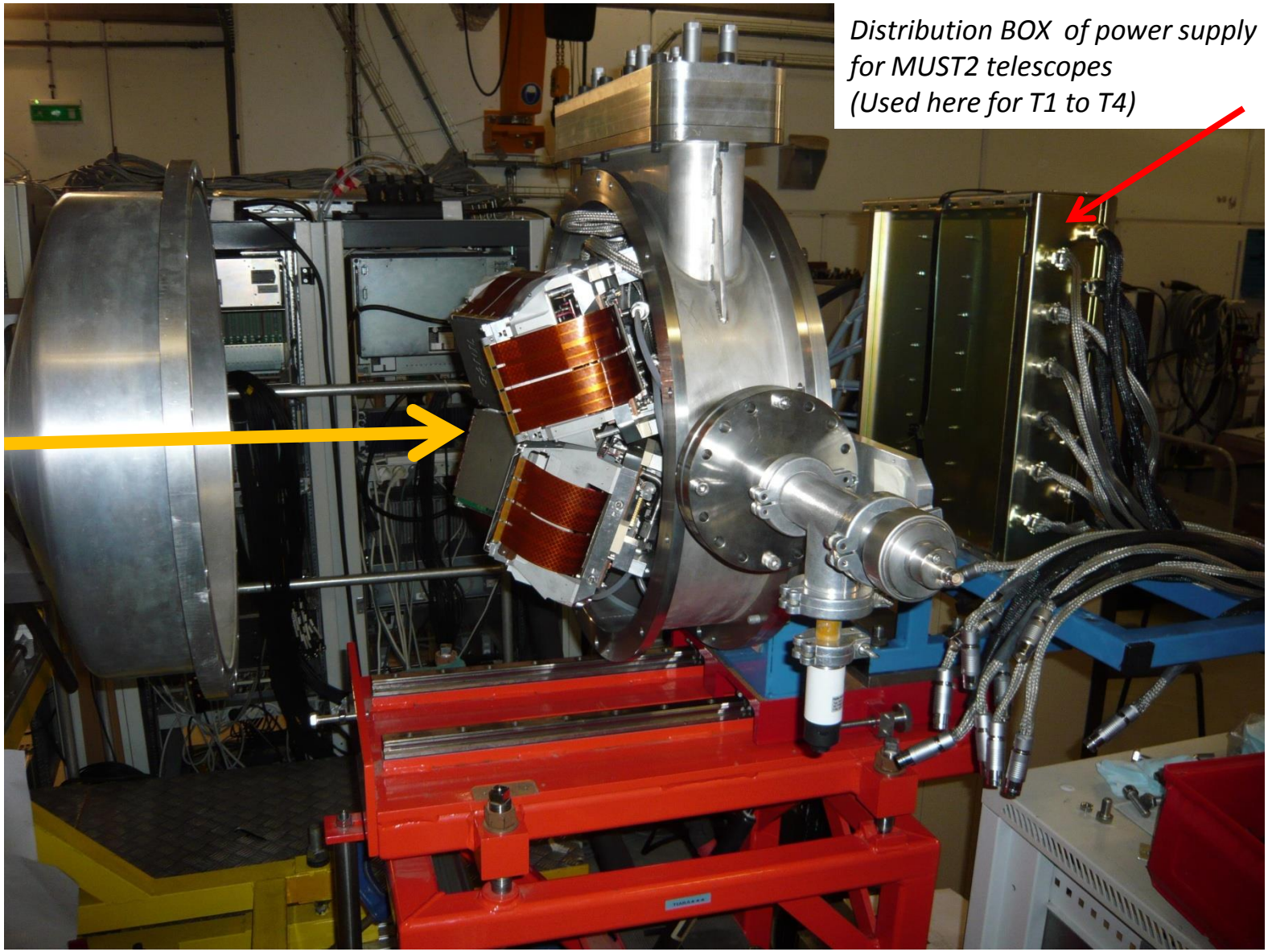
# Detection zero degrees : Si(70 um)+Si(300um)+CsI(mm)



**Slide from CHARISSA collaboration**

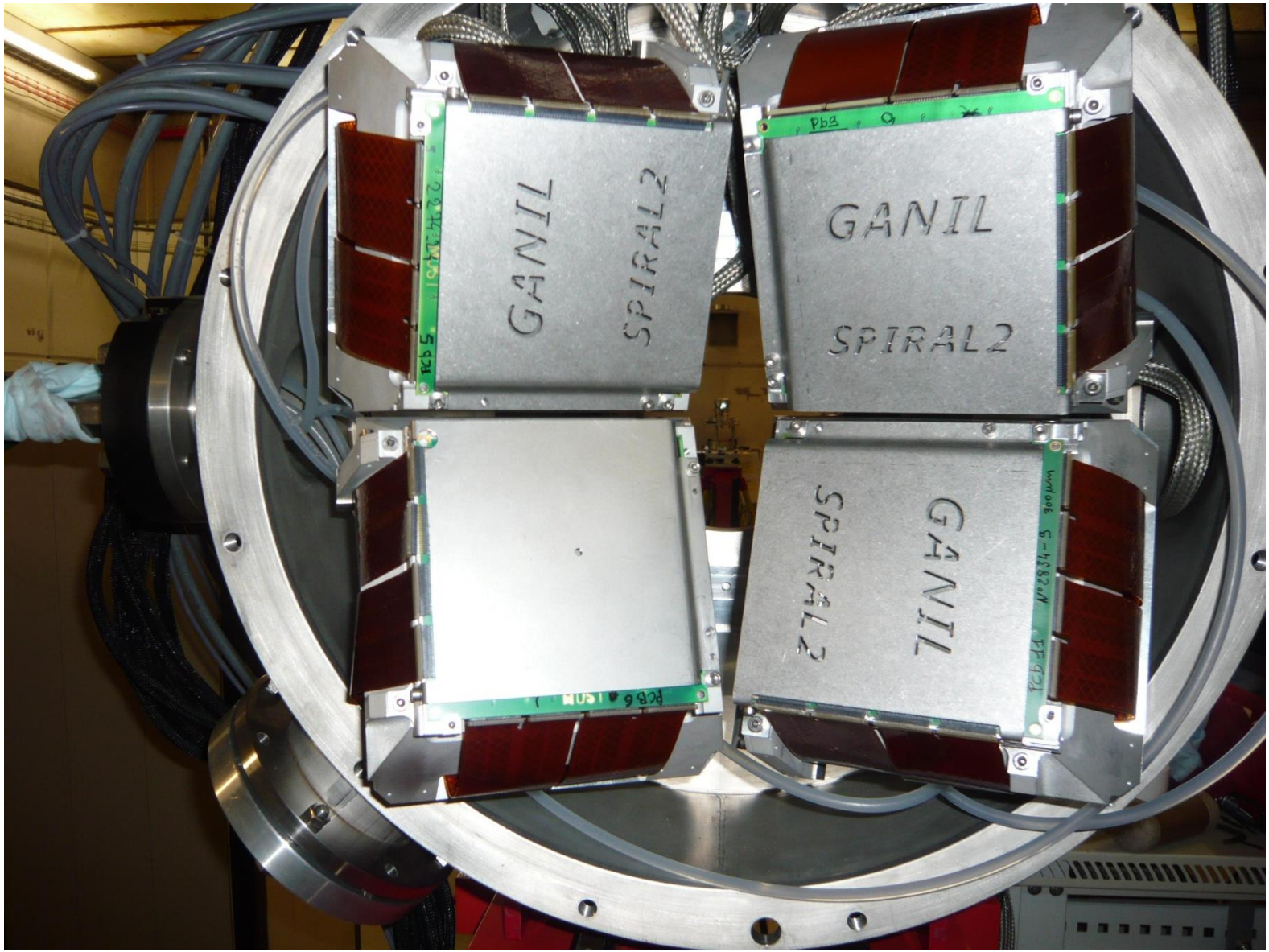
**Radiation Damage.**
**Fluence = I(4.10e4 pps)*5) days*24*3600=1.7 10e10 p/cm2**
**Stopping power ($^{16}$C)= 2000 MeV.cm-1**
**Stopping power (alpha)= 1500 MeV cm-1**
**Stopping power (137Cs)= 97000 MeV cm-1**
**Limits (from Knoll book) = 10e8 (fission fragments), 10e11 (alpha particles).**
**TO reduce the total fluence on the telescope :**
**BEAM stopper and divide the measurement in two parts.**

# MUST2 - D6 area – (setup –tests-22 November 2013)

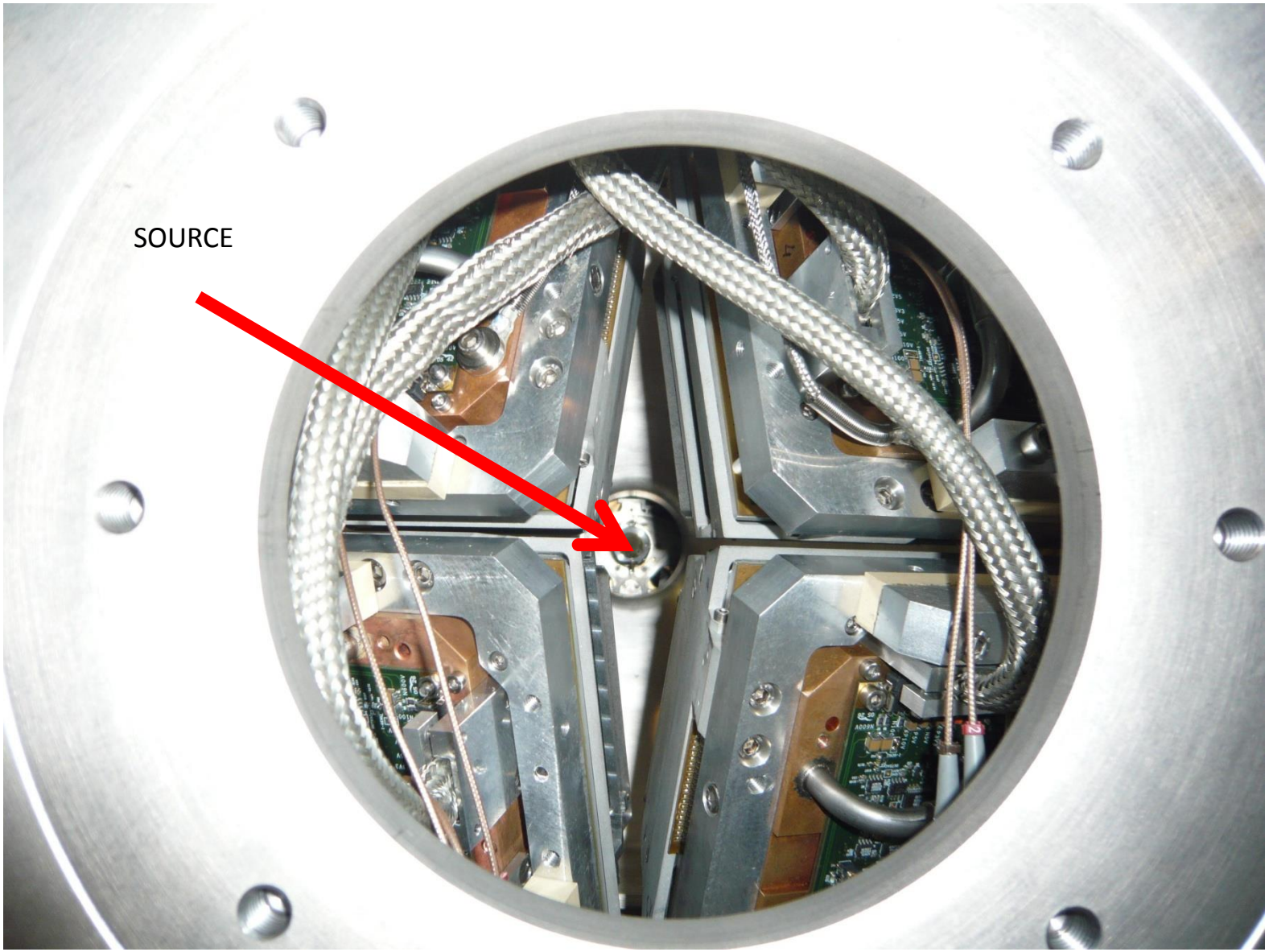


*Distribution BOX of power supply for MUST2 telescopes (Used here for T1 to T4)*

# MUST2 settings in nov 2013

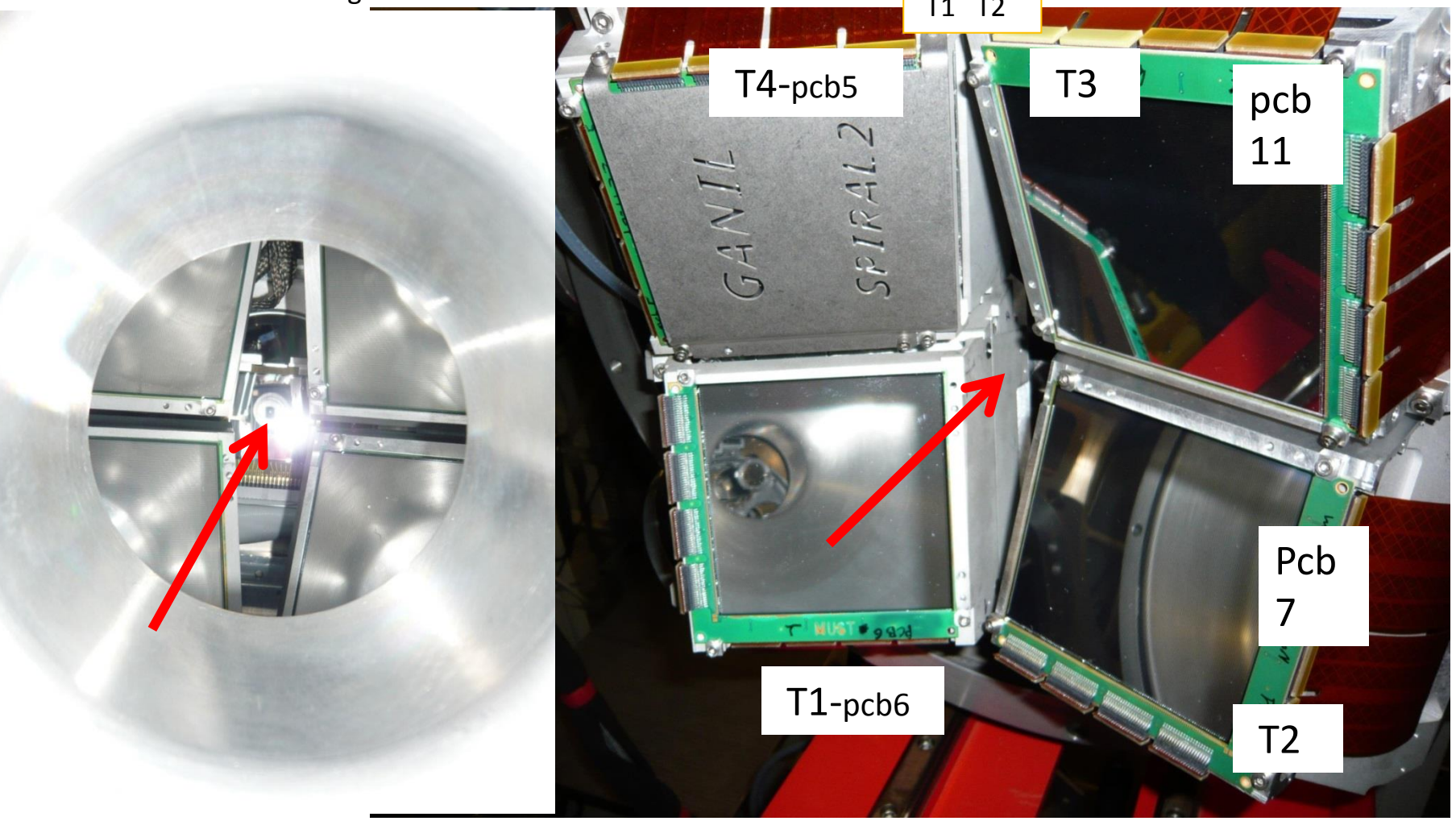


# Back of MUST2 telescopes seen from the reaction chamber flange

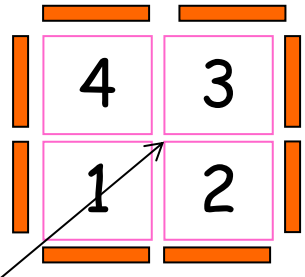


# MUST2 Configuration in the reaction chamber for E628

View of the MUST2 from target location




Nov 2013 Test en source alpha 3 pics GT288 –
241Am 244Cm 239Pu 2989 Bq au 22/06/2007




Si-strip Telescopes
2 stages DSSD+CsI
MM1 to MM4:

128 X and Y strips ;
Energy and time for each ;
CsI divided into 16 pads
per telescope
DAS Configuration for MUVI
Threshold discri on Strips
XE and YE set to 400 keV
CsI : threshold set to 2.6 MeV,
Shaping time 3µs Gain : 0.6 pF

TAC range (each strip) 600 ns

128 X 1 / 1 Y 128

| | | | |
|---|---|---|---|
| 4 | 5 | 9 | 13 |
| 3 | 6 | 10 | 14 |
| 2 | 7 | 11 | 15 |
| 1 | 8 | 12 | 16 |

128 Y 1 / 1 X 128

| | | | |
|---|---|---|---|
| 1 | 2 | 3 | 4 |
| 8 | 7 | 6 | 5 |
| 12 | 11 | 10 | 9 |
| 16 | 15 | 14 | 13 |

T4 T3
T1 T2

1 X 128 / 1 Y 128

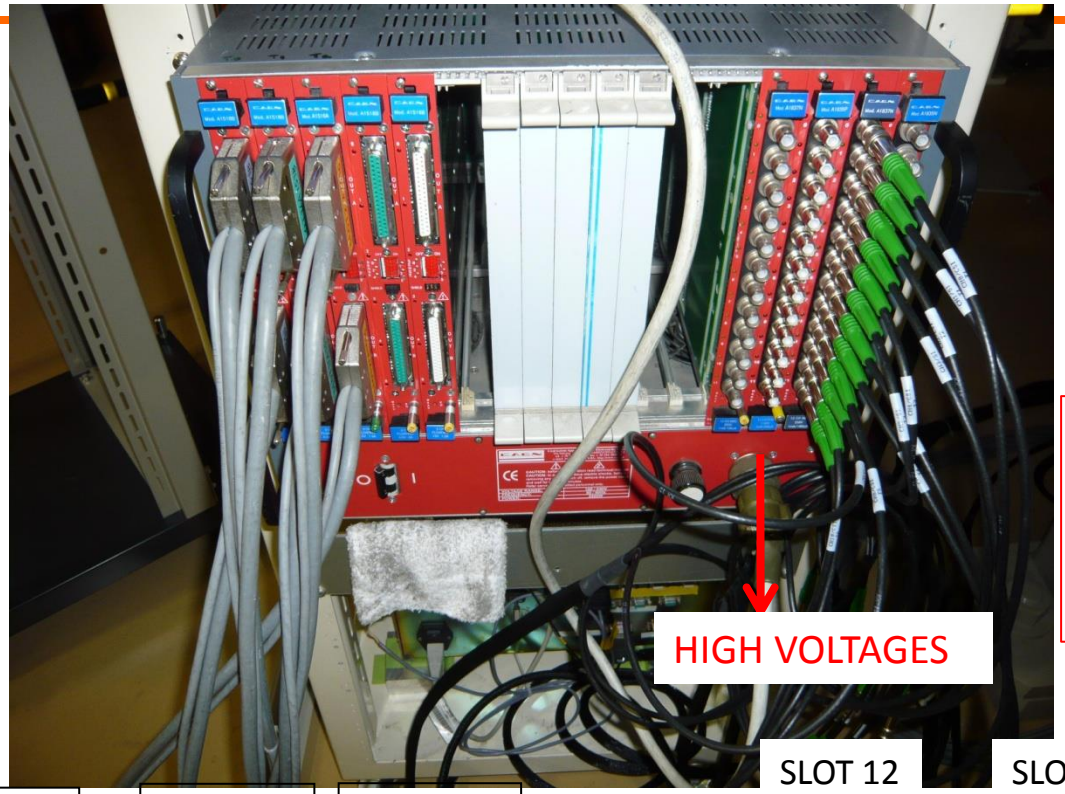
| | | | |
|---|---|---|---|
| 13 | 14 | 15 | 16 |
| 9 | 10 | 11 | 12 |
| 5 | 6 | 7 | 8 |
| 4 | 3 | 2 | 1 |

1 X 128 / 1 Y 128

| | | | |
|---|---|---|---|
| 16 | 12 | 8 | 1 |
| 15 | 11 | 7 | 2 |
| 14 | 10 | 6 | 3 |
| 13 | 9 | 5 | 4 |

# Power supply CAEN SY1527 USUAL FULL configuration for 8 telescopes LOW/ HIGH VOLTAGES

SY1527 max number
of boards per crate 16
19 " wide
depth 720 mm
8U-high
Euro-mechanics rack




SLOT 14
A1837N
12ch.

A1837N
-250V/1mA
(100µA)
-50V( CsI),
-100V (Si)

SLOT 0
A1518B
OUT A
3X +2.5V

OUT B
3X -2.5V

SLOT 1
A1518B
OUT A
3X +2.5V

OUT B
3X -2.5V

SLOT 2
A1516A
OUT A
1X +3.3 V
2X -5V

OUT B
2X +5V
1X +10V

SLOT 3
A1518B
"1"
3X +2.5V

"2"
3X -2.5V

SLOT 4
A1518B
"3"
2X -5V
1X +3.3 V

"4"
2X +5V
1X +10V

SLOT 12
A1837N
12ch.

SLOT 13
A1835P
12ch

A1835P
+1.5kV /7mA
(200µA)
+HT Sili Julich
(Not used)

Distribution box T1 to T6

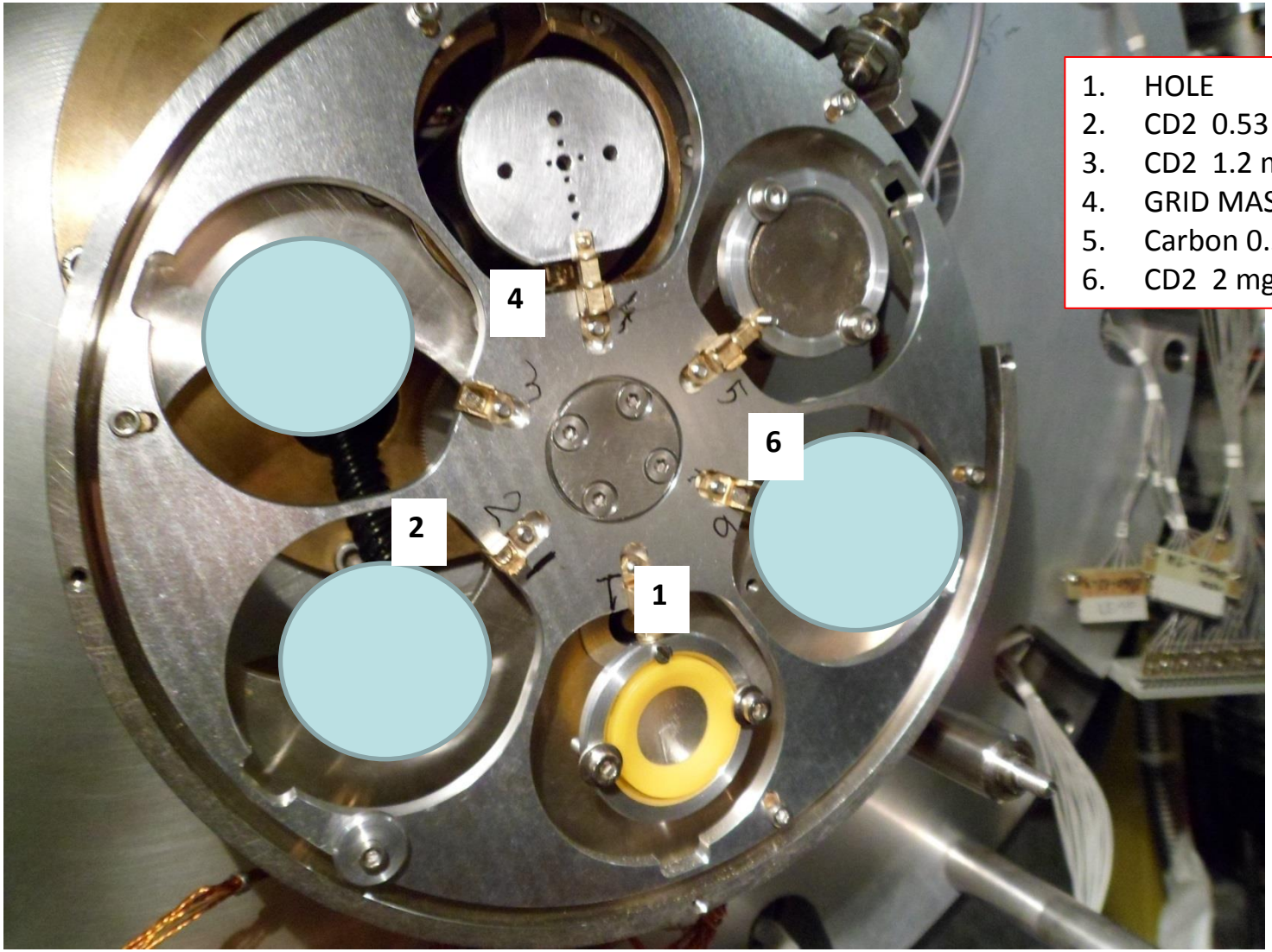
*Distribution box T7 to T8 (T9,…T12)*

# Power supply Modules CAEN HIGH VOLTAGE

**Red: 4 MUST2**
**purple TIARA**

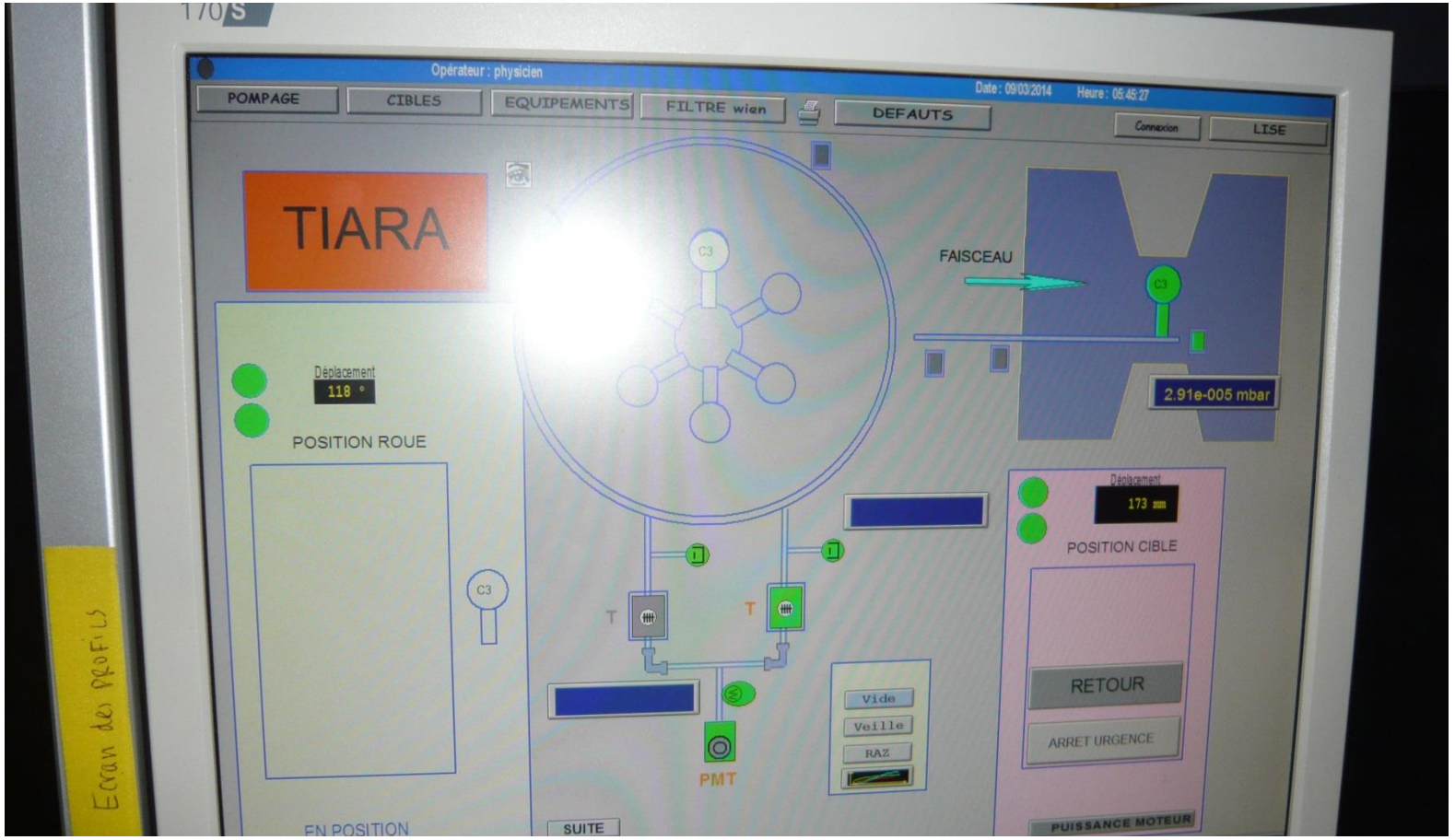
| SLOT | Slot /board 10 | Slot /board 11 | Slot /board 12 | Slot 13 | Slot 14 |
|---|---|---|---|---|---|
| Module | A1737 | A1737 | A1835P | A1837N | A1837N |
| | -HT | -HT | +HT | | -50V (CsI), -100V(Si) |
| | (Io=5µA) | (Io=5µA) | +1.5kV/7mA(200µA) | -250V/1mA (100µA) | -250V/1mA(100µA) |
| Ch0 | **IB1 50V** 0.3 | **OB5 150V** 1.2 | **CATS 1 640 V IOset =2µA ( I < 0.2)** | | CsI/T1 50V |
| Ch1 | IB2 **50V** 0.0 | **OB6 150V** 0.6 | **CATS 2 640 V IOset =2µA (I < 0.2 )** | | T1 Si DSSD 80 |
| Ch2 | IB3 **50V** 0.0 | **OB7 150V** 1.3 | | | T2 CsI 50V |
| Ch3 | IB4 **50V** 0.1 | **OB8 150V** 1.2 | | | T2 Si DSSD 70V |
| Ch4 | IB5 **50V** 0.0 | **W1 50V** 1.2 | | | T3 CsI 50V |
| Ch5 | IB6 **50V** 0.6 | **W2 50V** 1.2 | | | T3 Si DSSD 80V |
| Ch6 | IB7 **50V** 0.1 | **VOID** | | | T4 CsI |
| Ch7 | IB8 **50V** 0.0 | **W4 50V** 0.3 | | | T4 Si DSSD 80V |
| Ch8 | OB1 1**50V** 0.7 | **W5 50V** 1.2 | | | |
| Ch9 | OB2 **150V** 1.1 | VOID | | | |
| Ch10 | OB3 **150V** 4.2 | VOID | DE Charissa 28V (5µA) 0.7 | | CsICharissa 45V( I=3µA) 0.7 |
| Ch11 | OB4 **150V** 1.6 | **W3 50V** 0.1 | E Charissa 131V (10µA) 3.0 | | W6 50V (Io=5µA) 0.4 |

# TARGET WHEEL OF 6 TARGET SLOTS




1. HOLE
2. CD2 0.53 mg/cm$^2$
3. CD2 1.2 mg/cm$^2$
4. GRID MASK
5. Carbon 0.52 mg/cm$^2$
6. CD2 2 mg/cm$^2$

***Wheel of 6 target slots: See Automate on the LISE PC >>> MENU >> TARGETS → select TIARA TARGET***



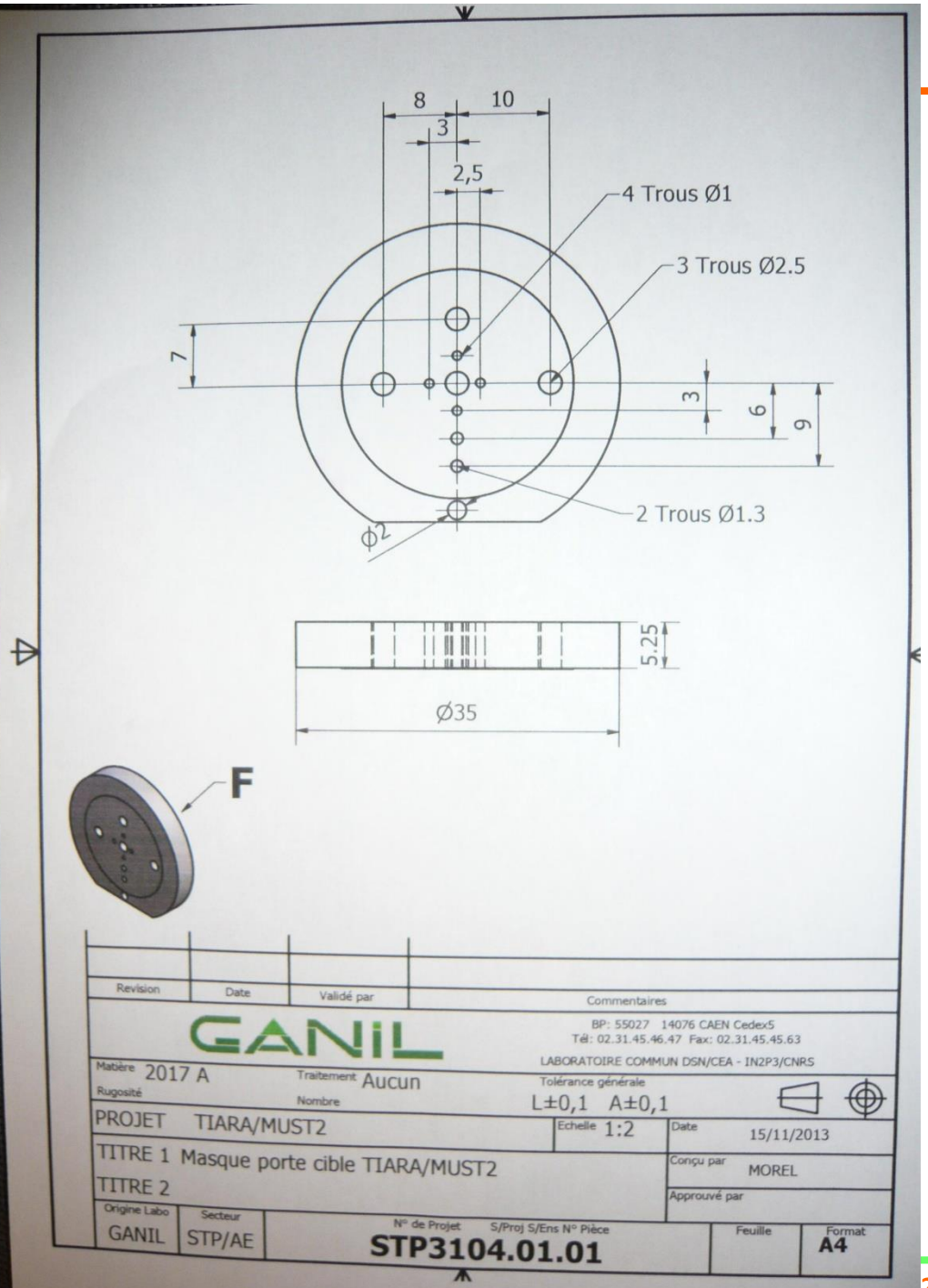

After removing the target already positioned, there is a sequence of operations:

Rotation of the wheel (POISITION ROUE) to the desired position of target; translation to move the arm to the central target position (POSITION CIBLE). Before any operation you need to click on the frame « MOTEUR »

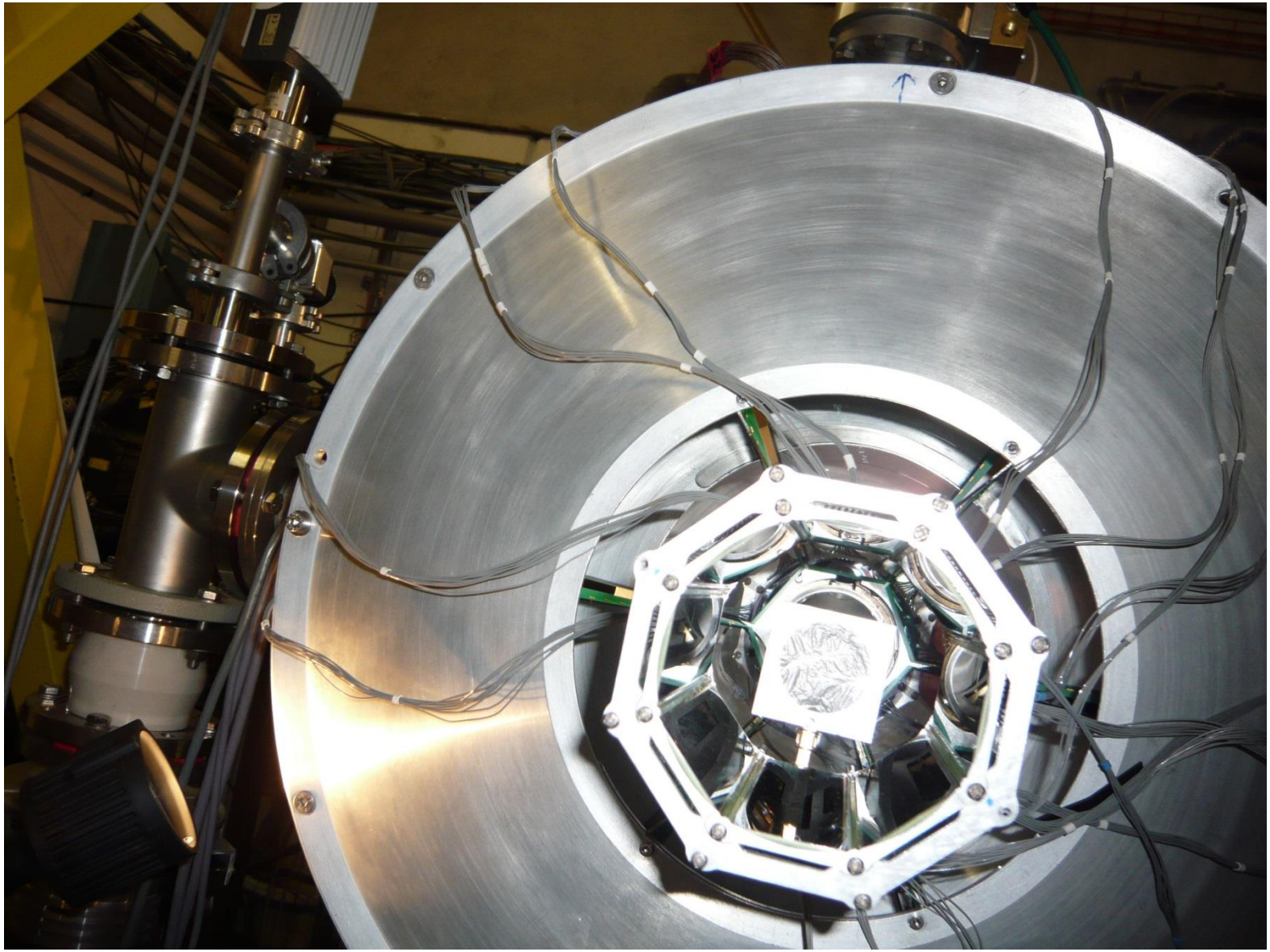
NB: the translation of the target frame towards the final position (172 mm) is done at a (slow) velocity of nearly 1 mm/s

# Masque-cible

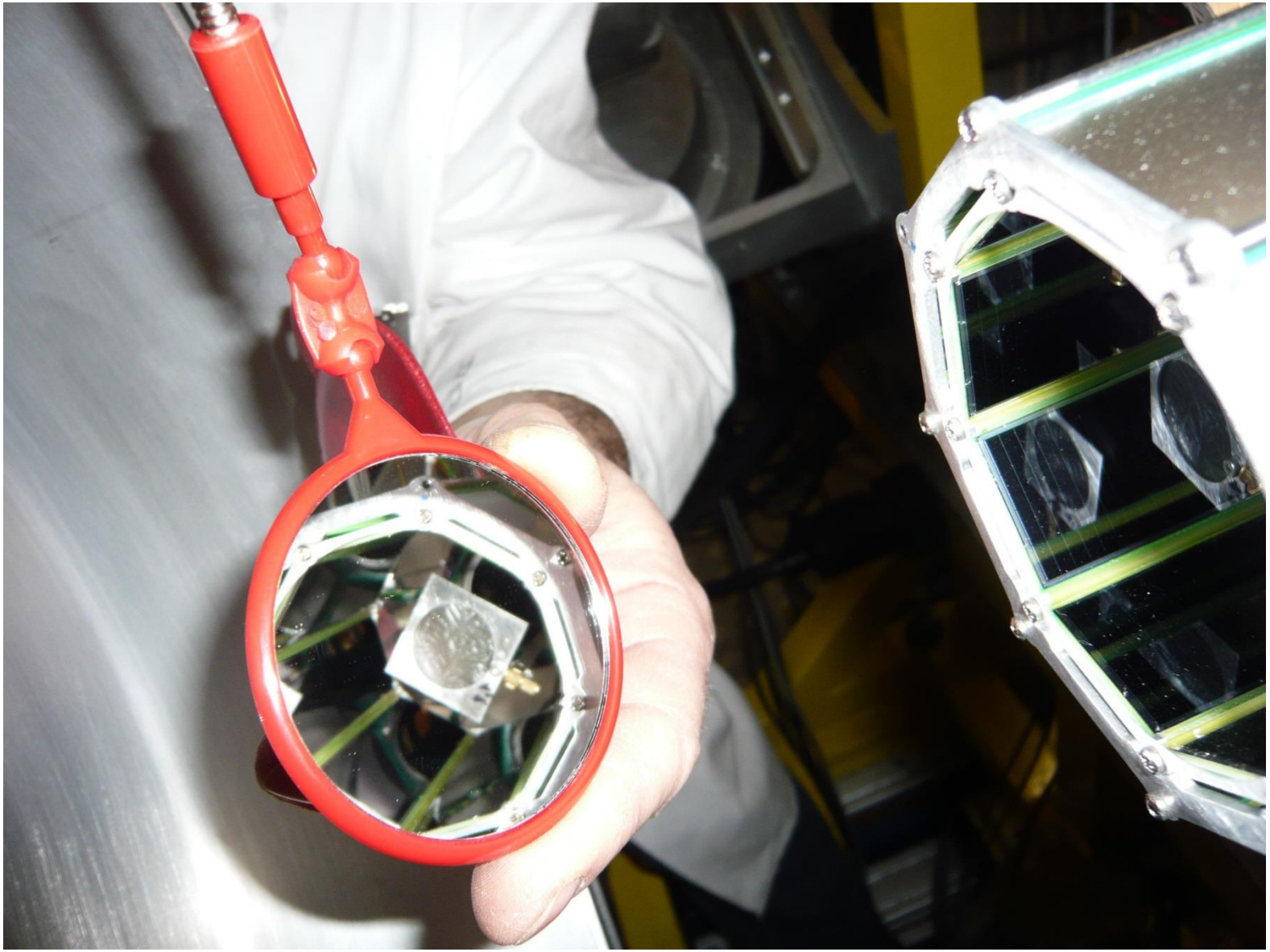
Dessin et fabrication : Vincent Morel



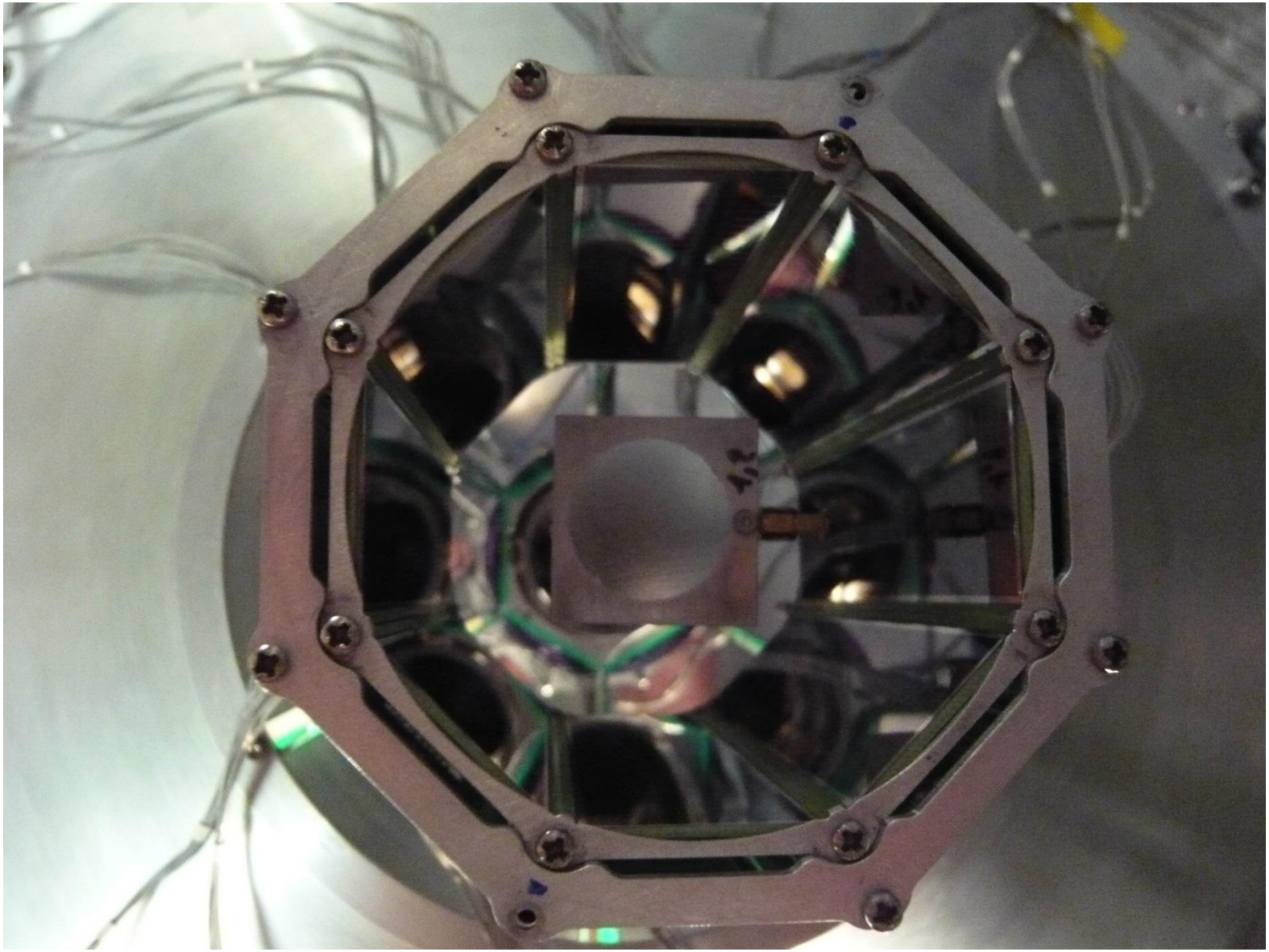

# Opening of the TIARA chamber – Monday 10th March



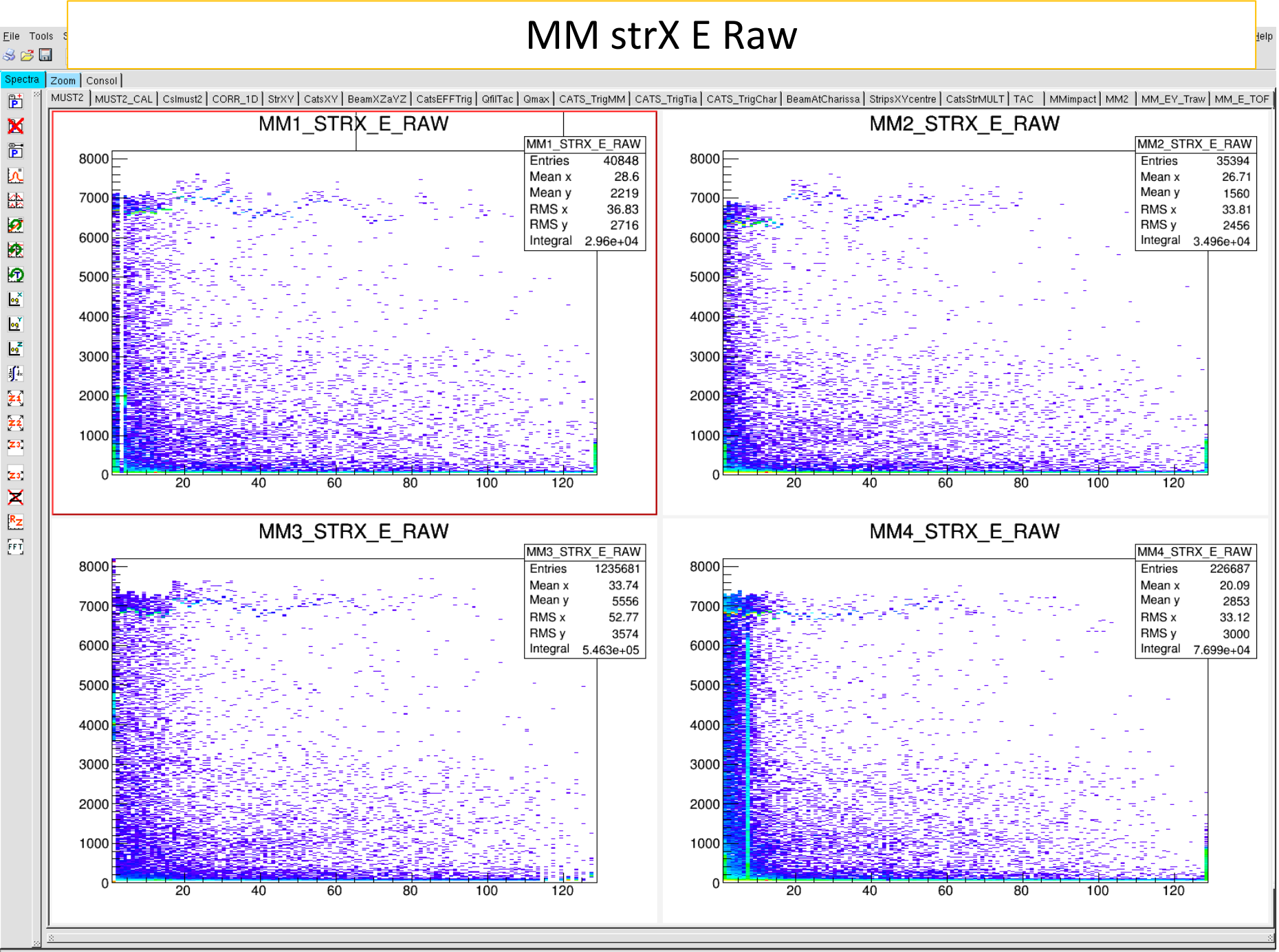
# Opening of the TIARA chamber – Monday 10th – View of the CD2 target



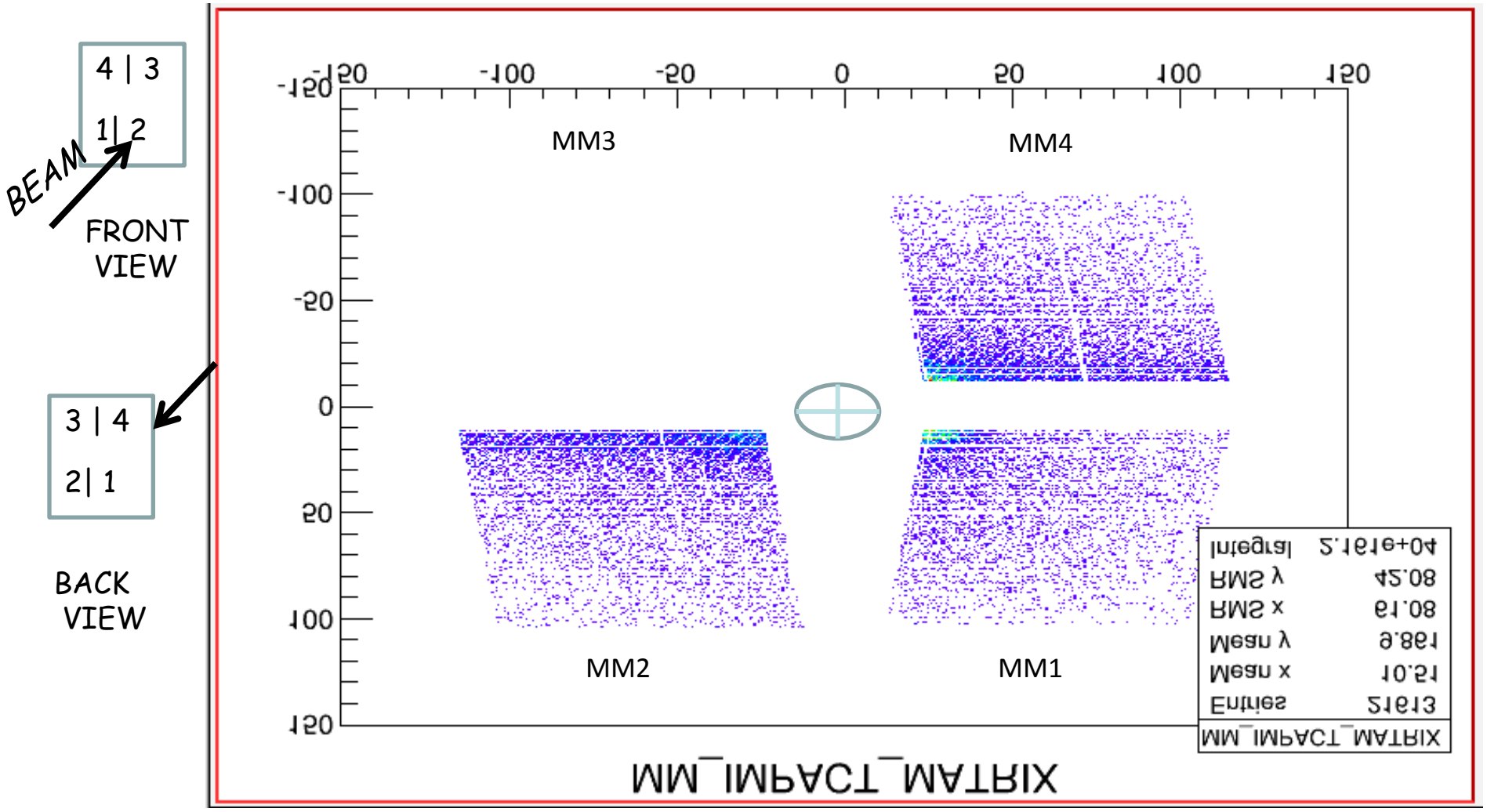
# Visualization of the CD2 target 1.2 mg/cm$^2$ inside the Barrel



# MM strX E Raw

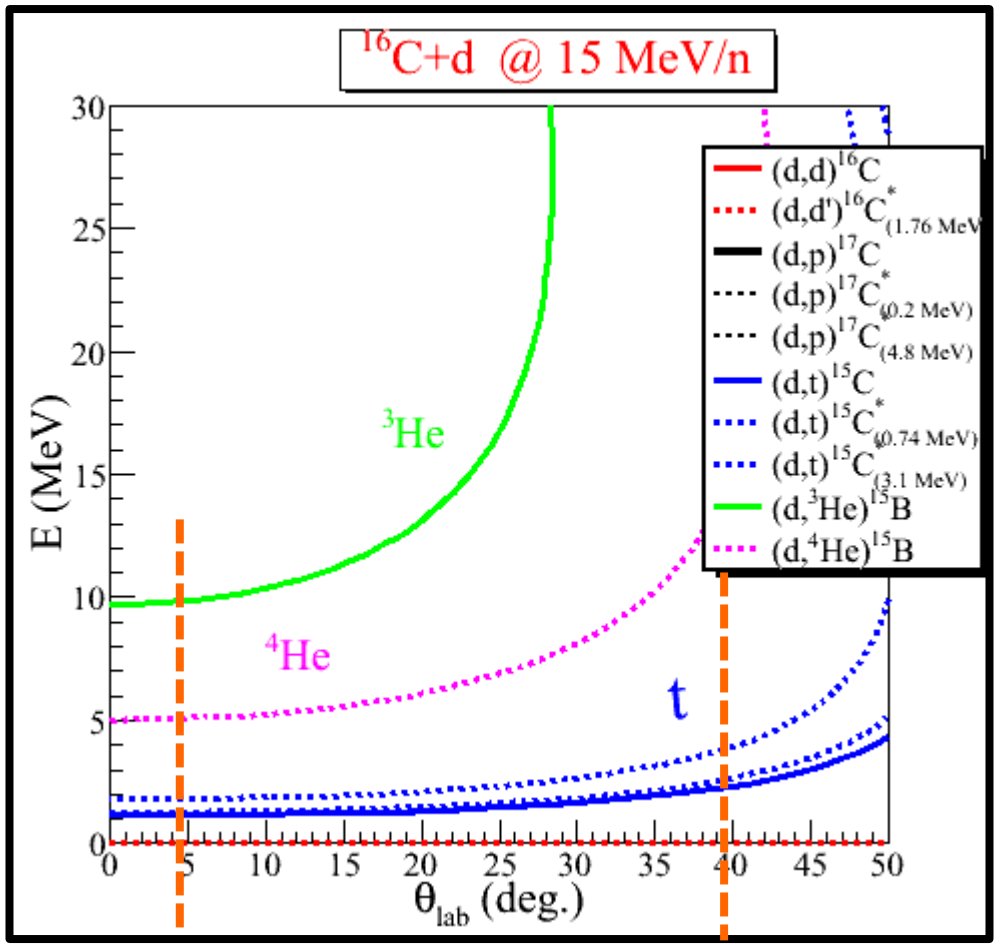

File Tools
Help
Spectra Zoom Consol
MUST2 MUST2_CAL CsImust2 CORR_1D StrXY CatsXY BeamXZaYZ CatsEFFTrig QfilTac Qmax CATS_TrigMM CATS_TrigTia CATS_TrigChar BeamAtCharissa StripsXYcentre CatsStrMULT TAC MMimpact MM2 MM_EY_Traw MM_E_TOF
MM1_STRX_E_RAW
MM1_STRX_E_RAW
Entries 40848
Mean x 28.6
Mean y 2219
RMS x 36.83
RMS y 2716
Integral 2.96e+04
MM2_STRX_E_RAW
MM2_STRX_E_RAW
Entries 35394
Mean x 26.71
Mean y 1560
RMS x 33.81
RMS y 2456
Integral 3.496e+04
MM3_STRX_E_RAW
MM3_STRX_E_RAW
Entries 1235681
Mean x 33.74
Mean y 5556
RMS x 52.77
RMS y 3574
Integral 5.463e+05
MM4_STRX_E_RAW
MM4_STRX_E_RAW
Entries 226687
Mean x 20.09
Mean y 2853
RMS x 33.12
RMS y 3000
Integral 7.699e+04

# IMPACT Run 1299 (view at the back of the MUST2 array)




We had problem with the Csi pads of Tel 3 (the MufeeY card n°3)

# KINEMATICS covered by MUST2



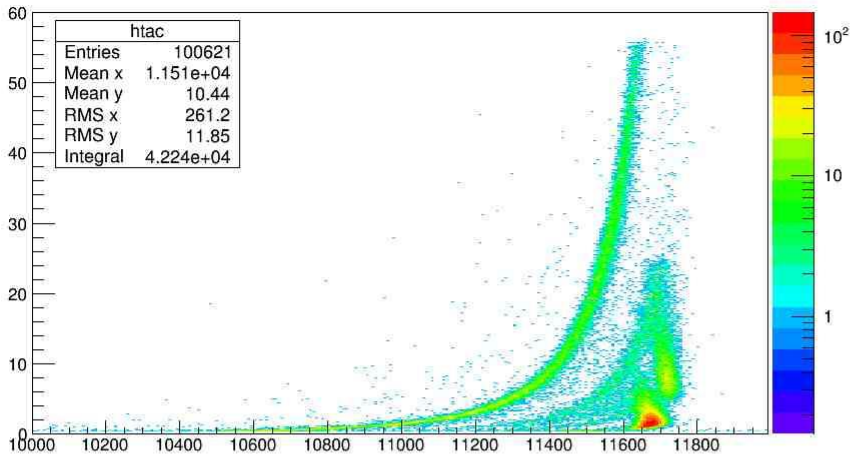

Coverage 5 to 40 deg.

Protons of E ≤ 6 MeV
d of E ≤ 9 MeV
t of E ≤ 10 MeV
3He E ≤ 22 MeV
4He E ≤ 25 MeV
are stopped
in the DSSD 300µm
of MUST2

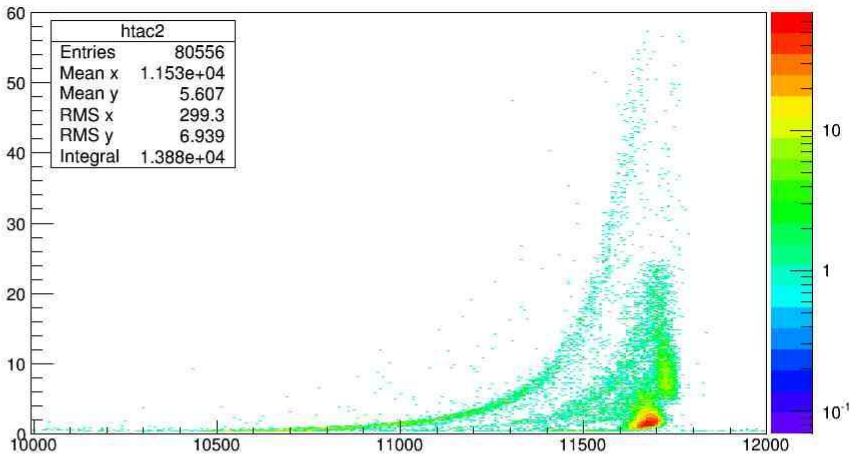
→the tritons and 4He
for the reactions
of interest are stopped
In the DSSD
theywill be identified
and selected in the
E-TOF spectra

# MUST2 PID Estrips %TOF runs 1352-1358

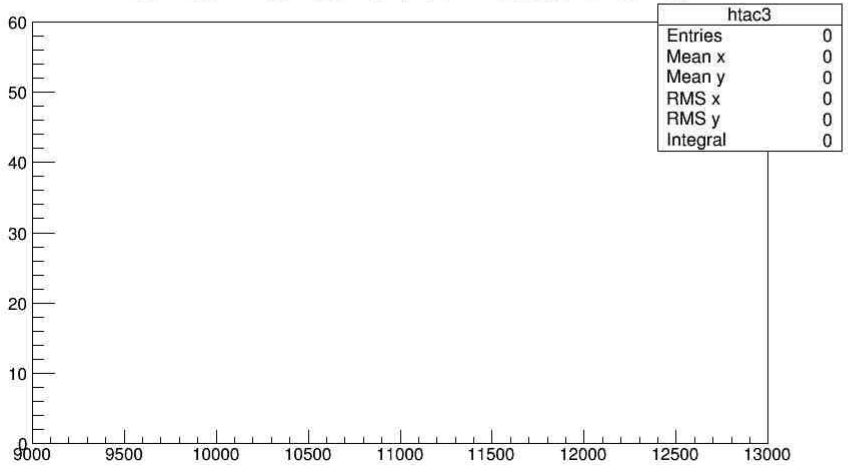
MUST2.Si_E:TAC_MM_CATS1 {MUST2.TelescopeNumber==1}



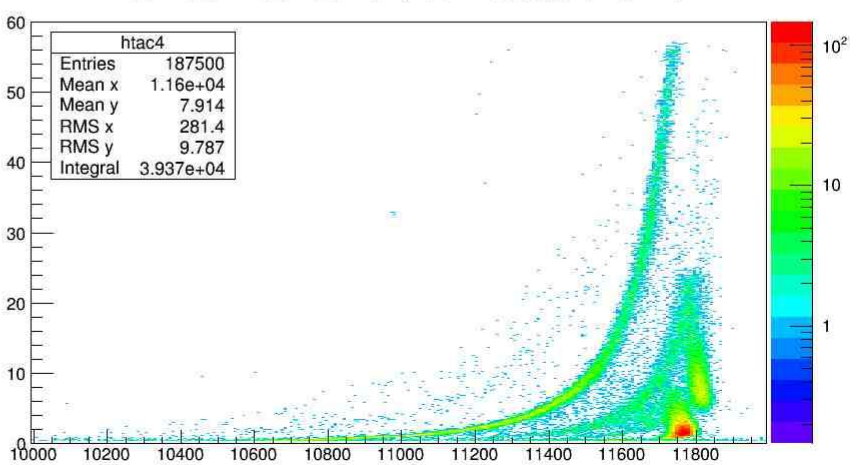

MUST2.Si_E:TAC_MM_CATS1 {MUST2.TelescopeNumber==2}



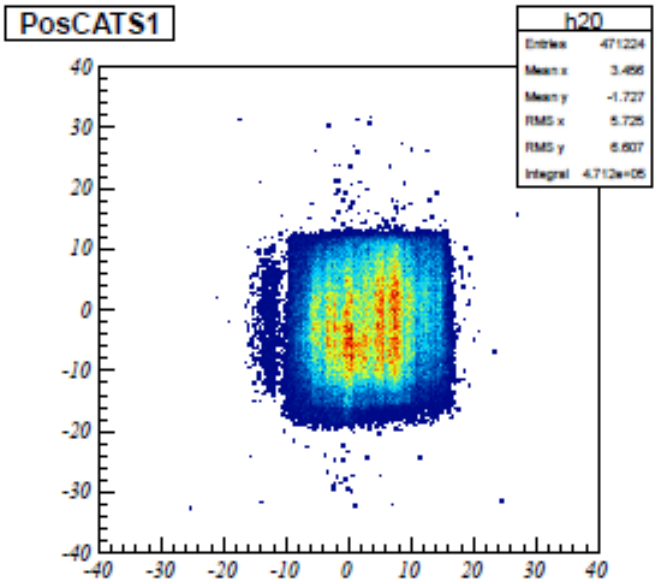

MUST2.Si_E:TAC_MM_CATS1 {MUST2.TelescopeNumber==3}

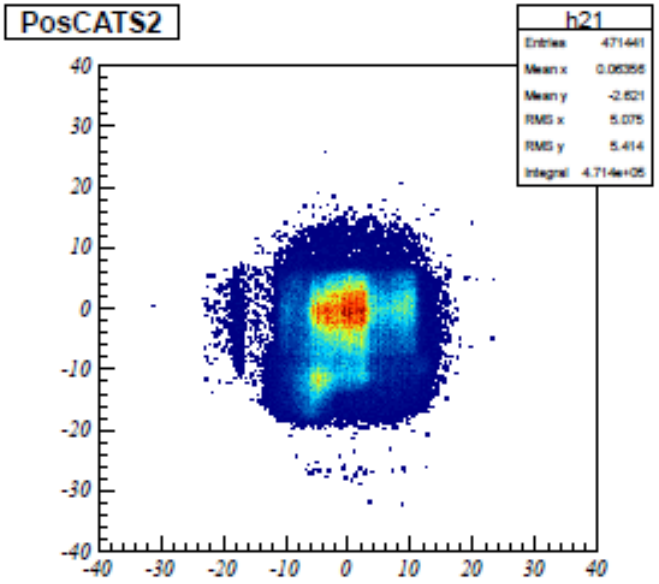



MUST2.Si_E:TAC_MM_CATS1 {MUST2.TelescopeNumber==4}

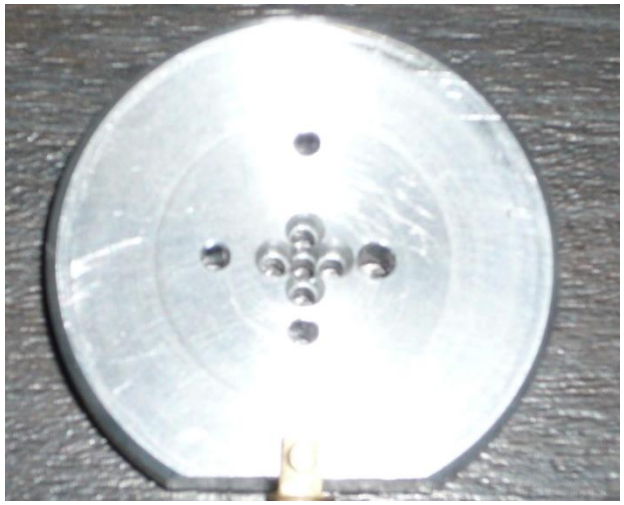


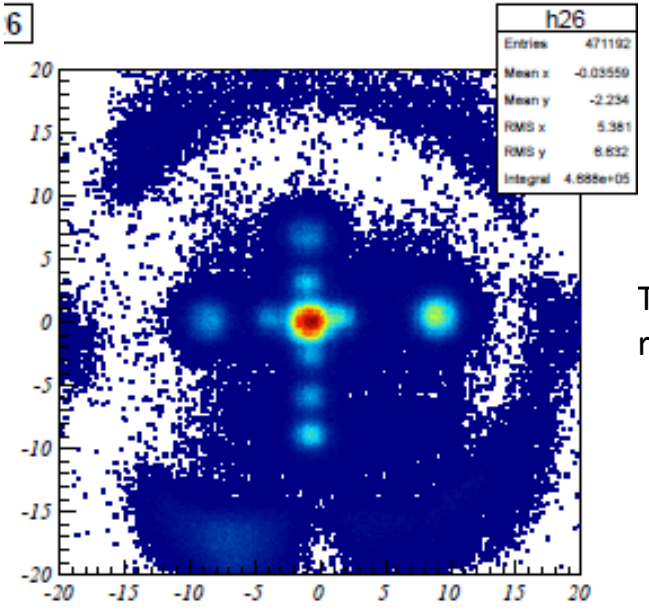
# Beam profile and reconstruction from CATS 1 and CATS2




TESTS DEC 2013 Run 1067 Mask –grid at target position

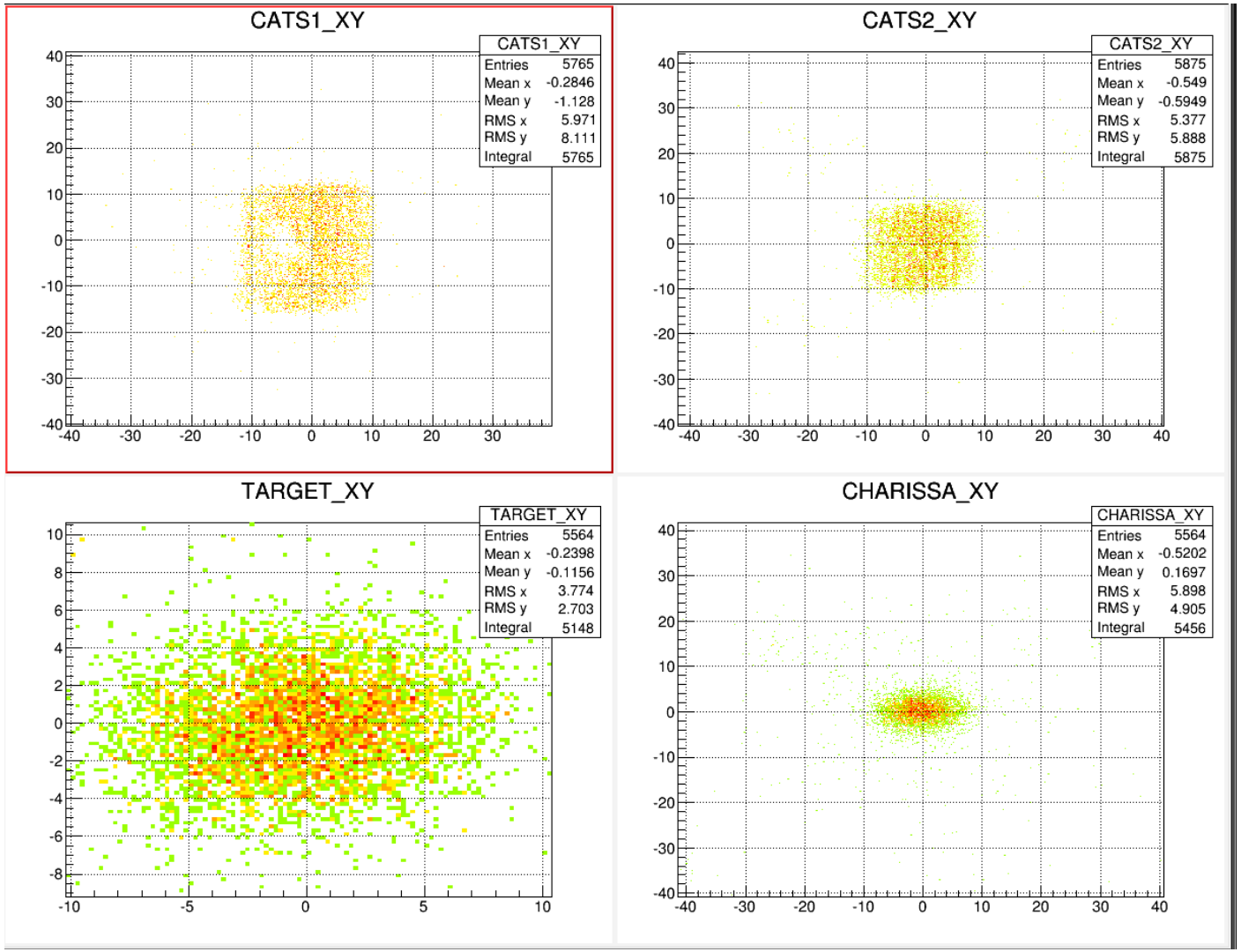




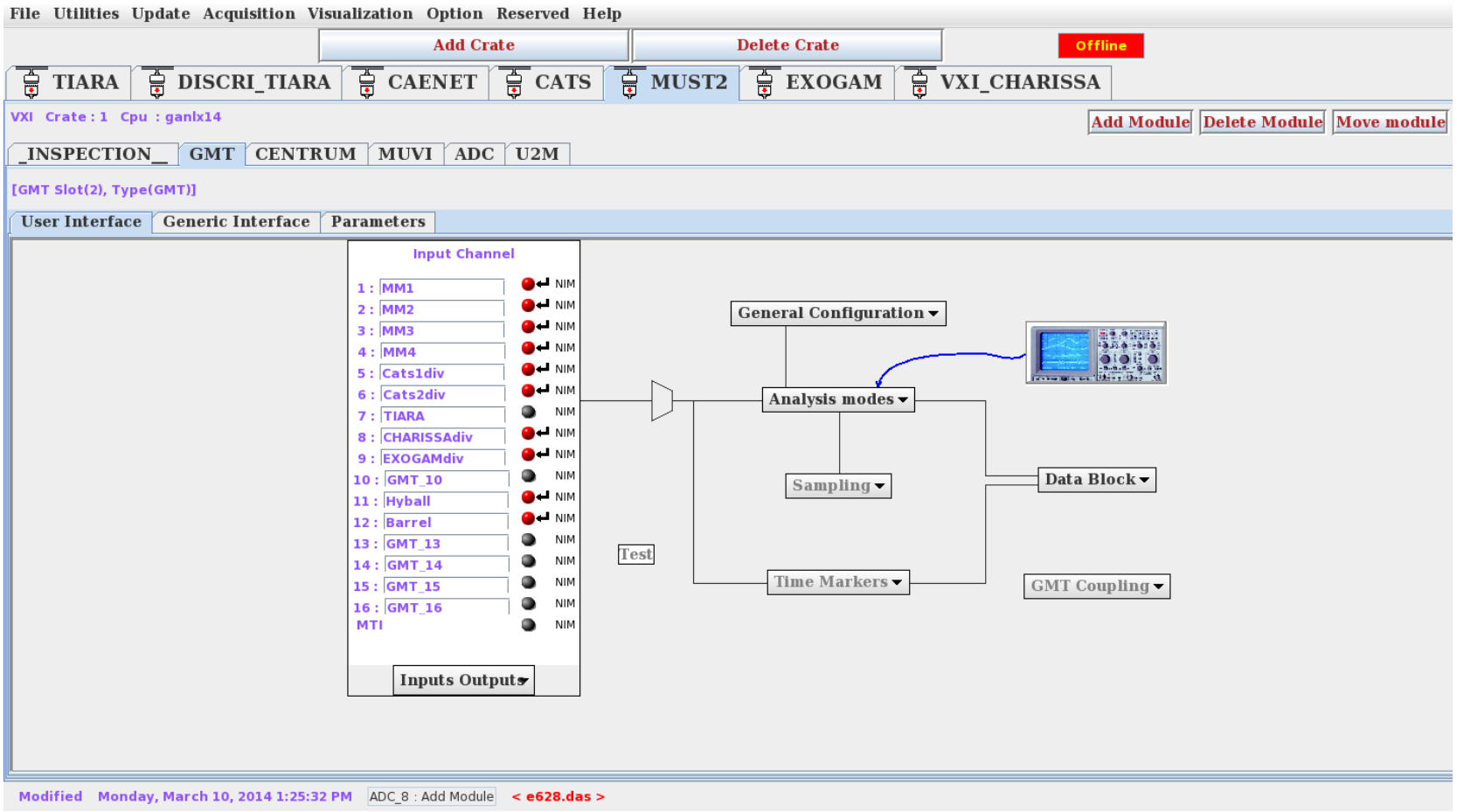

TARGET reconstruction

# Beam profile

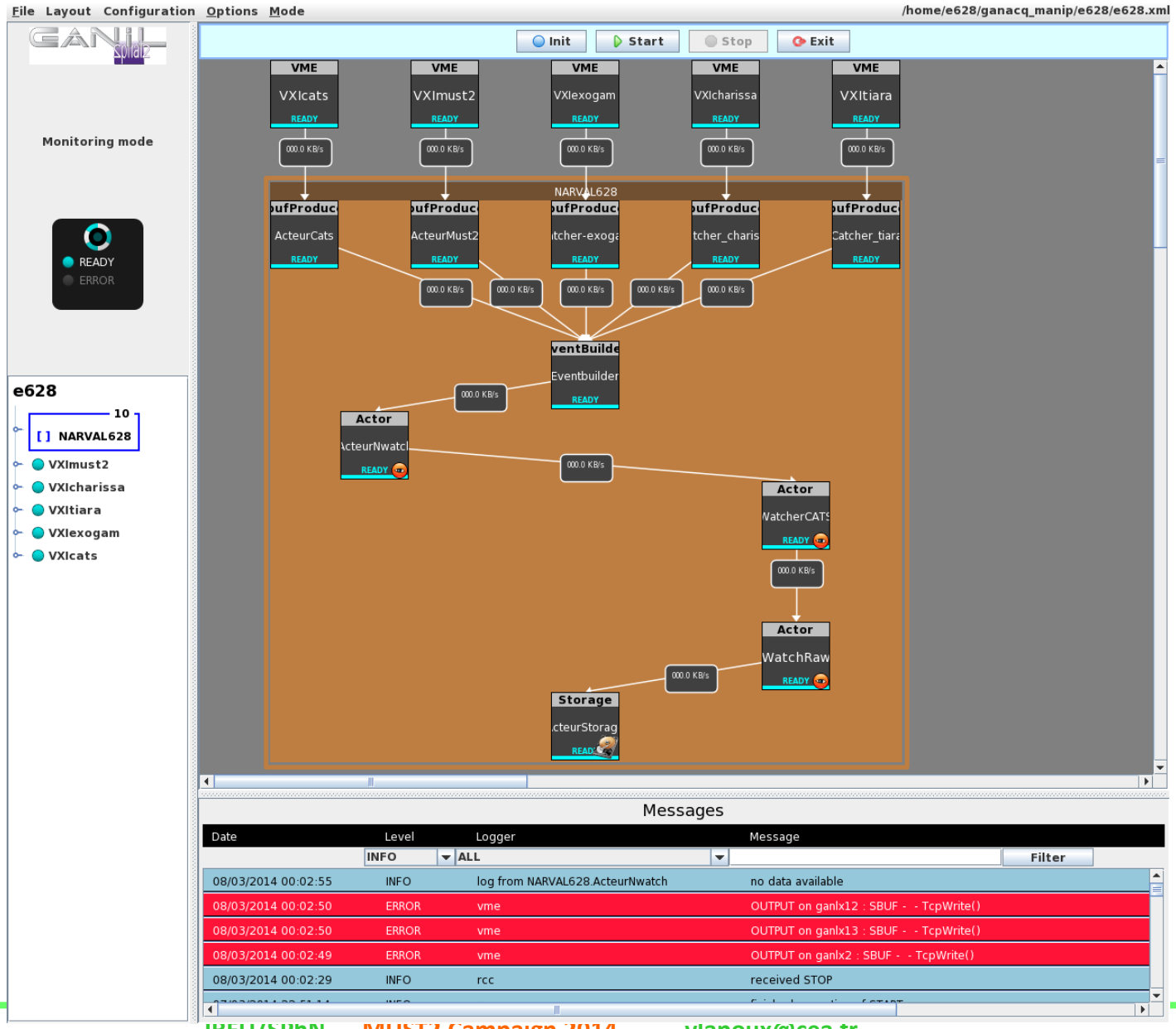
10 March Optimization of the beam intensity at I ~ 9µA
CATS1 and CATS 2 ~6 10**4 /s



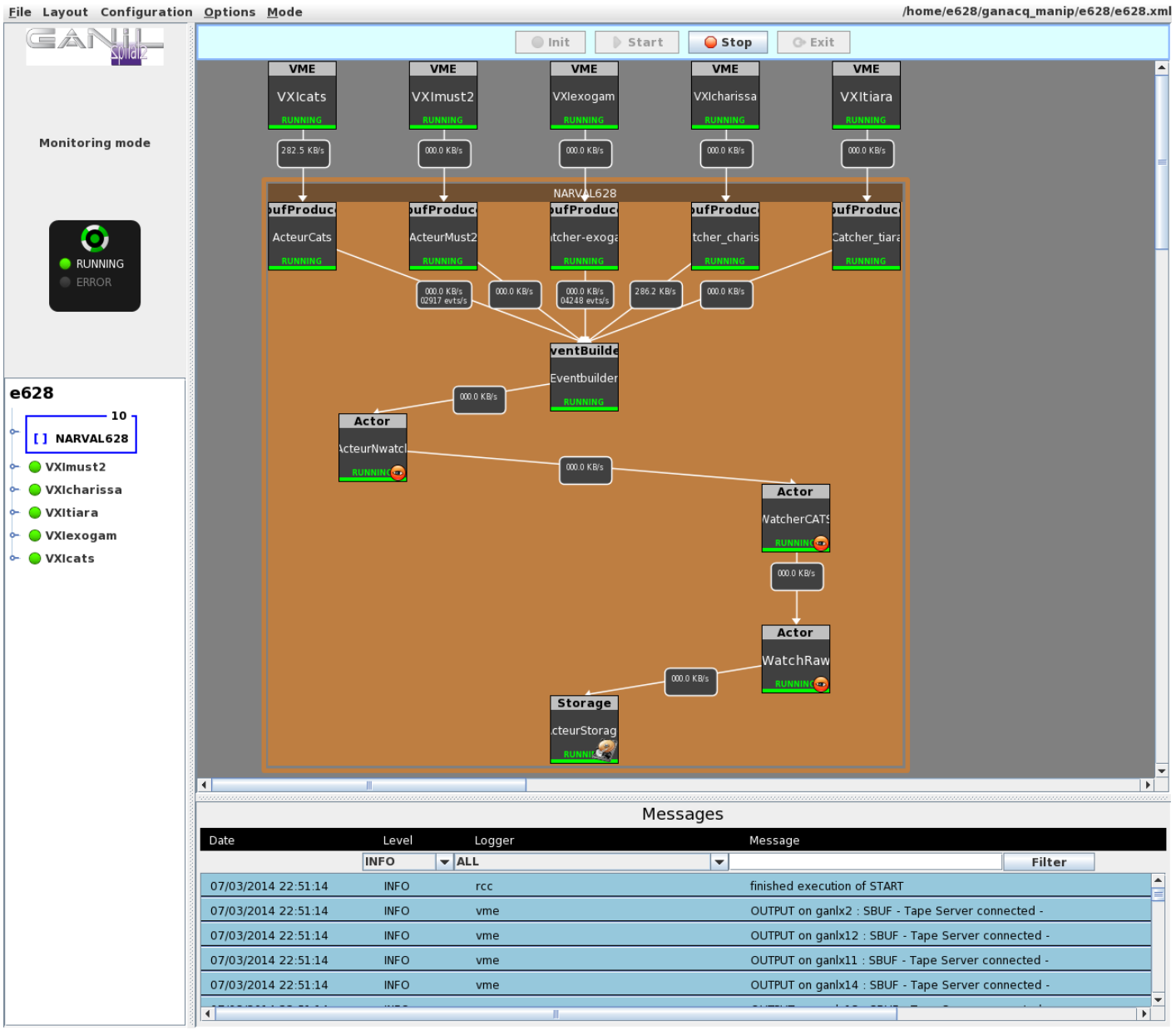
# Ganil Master Trigger E628



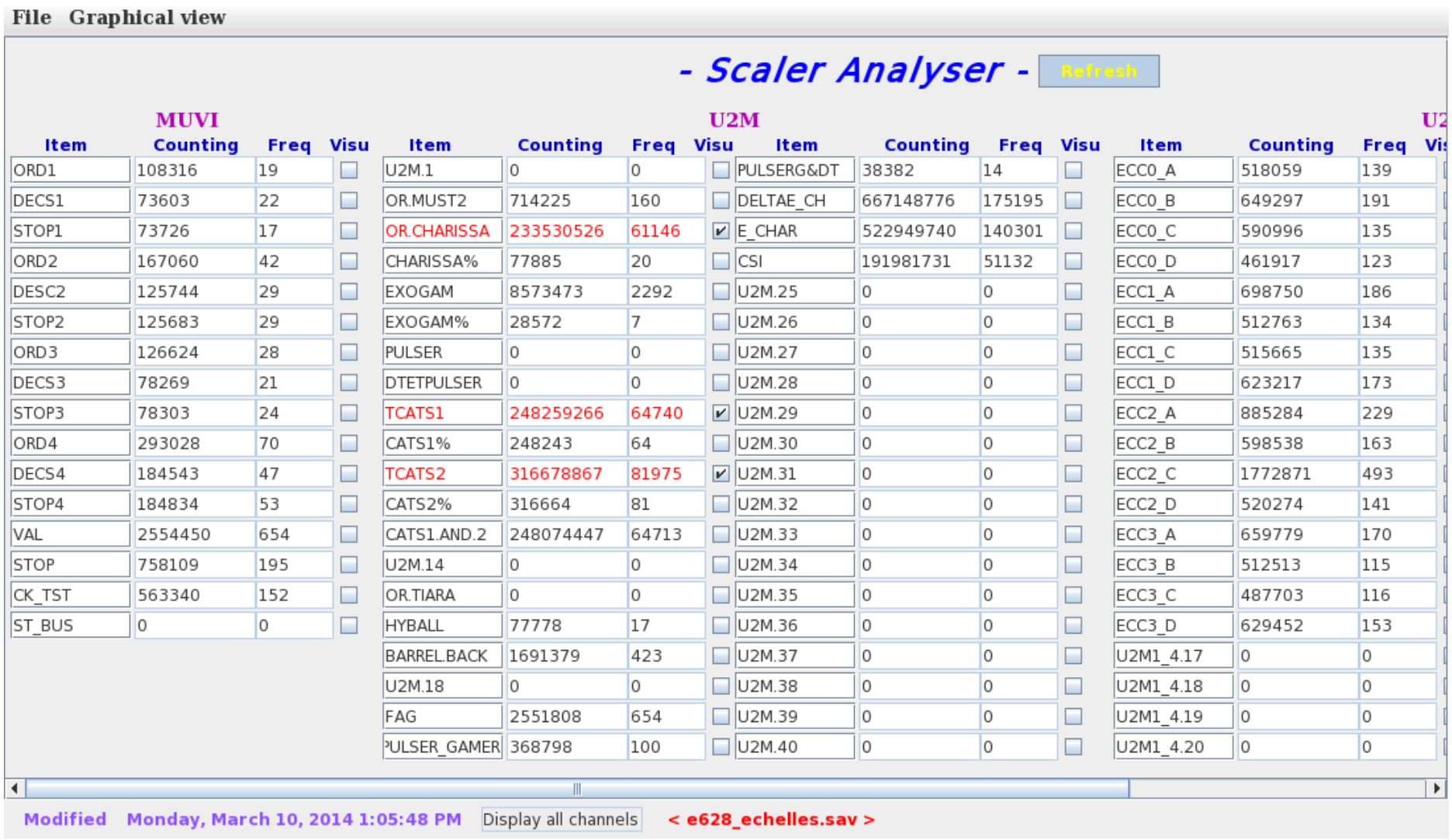
# Narval RUN CONTROL E628 STOP- READY



# Narval RUN CONTROL E628 -START



# Scalers Run 1375 10 March



File Graphical view

- Scaler Analyser - Refresh

MUVI

| Item | Counting | Freq | Visu |
|---|---|---|---|
| ORD1 | 108316 | 19 | ☐ |
| DECS1 | 73603 | 22 | ☐ |
| STOP1 | 73726 | 17 | ☐ |
| ORD2 | 167060 | 42 | ☐ |
| DESC2 | 125744 | 29 | ☐ |
| STOP2 | 125683 | 29 | ☐ |
| ORD3 | 126624 | 28 | ☐ |
| DECS3 | 78269 | 21 | ☐ |
| STOP3 | 78303 | 24 | ☐ |
| ORD4 | 293028 | 70 | ☐ |
| DECS4 | 184543 | 47 | ☐ |
| STOP4 | 184834 | 53 | ☐ |
| VAL | 2554450 | 654 | ☐ |
| STOP | 758109 | 195 | ☐ |
| CK_TST | 563340 | 152 | ☐ |
| ST_BUS | 0 | 0 | ☐ |

U2M

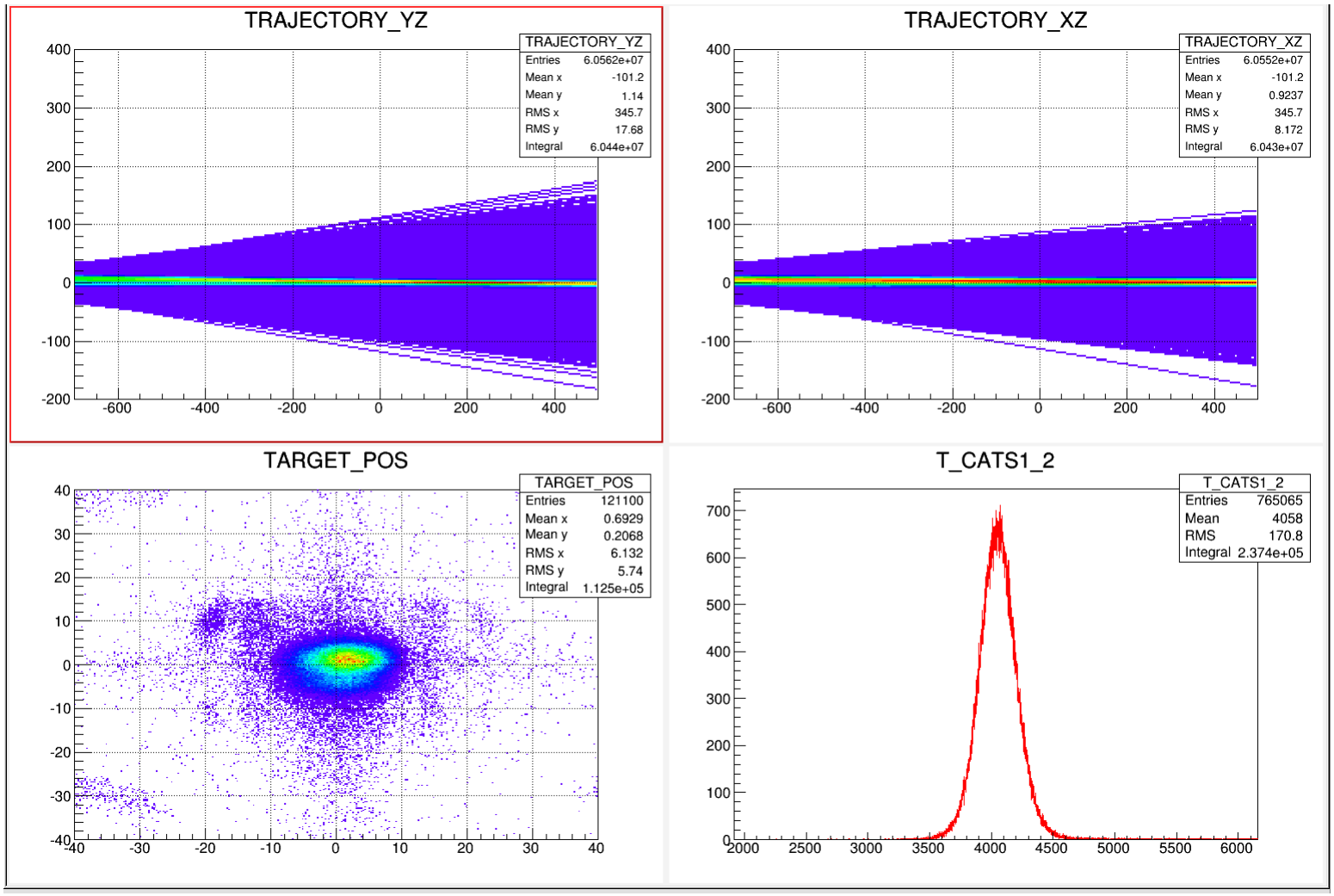
| Item | Counting | Freq | Visu |
|---|---|---|---|
| U2M.1 | 0 | 0 | ☐ |
| OR.MUST2 | 714225 | 160 | ☐ |
| OR.CHARISSA | 233530526 | 61146 | ☑ |
| CHARISSA% | 77885 | 20 | ☐ |
| EXOGAM | 8573473 | 2292 | ☐ |
| EXOGAM% | 28572 | 7 | ☐ |
| PULSER | 0 | 0 | ☐ |
| DTETPULSER | 0 | 0 | ☐ |
| TCATS1 | 248259266 | 64740 | ☑ |
| CATS1% | 248243 | 64 | ☐ |
| TCATS2 | 316678867 | 81975 | ☑ |
| CATS2% | 316664 | 81 | ☐ |
| CATS1.AND.2 | 248074447 | 64713 | ☐ |
| U2M.14 | 0 | 0 | ☐ |
| OR.TIARA | 0 | 0 | ☐ |
| HYBALL | 77778 | 17 | ☐ |
| BARREL.BACK | 1691379 | 423 | ☐ |
| U2M.18 | 0 | 0 | ☐ |
| FAG | 2551808 | 654 | ☐ |
| ?ULSER_GAMER | 368798 | 100 | ☐ |

| Item | Counting | Freq | Visu |
|---|---|---|---|
| PULSERG&DT | 38382 | 14 | ☐ |
| DELTAE_CH | 667148776 | 175195 | ☐ |
| E_CHAR | 522949740 | 140301 | ☐ |
| CSI | 191981731 | 51132 | ☐ |
| U2M.25 | 0 | 0 | ☐ |
| U2M.26 | 0 | 0 | ☐ |
| U2M.27 | 0 | 0 | ☐ |
| U2M.28 | 0 | 0 | ☐ |
| U2M.29 | 0 | 0 | ☐ |
| U2M.30 | 0 | 0 | ☐ |
| U2M.31 | 0 | 0 | ☐ |
| U2M.32 | 0 | 0 | ☐ |
| U2M.33 | 0 | 0 | ☐ |
| U2M.34 | 0 | 0 | ☐ |
| U2M.35 | 0 | 0 | ☐ |
| U2M.36 | 0 | 0 | ☐ |
| U2M.37 | 0 | 0 | ☐ |
| U2M.38 | 0 | 0 | ☐ |
| U2M.39 | 0 | 0 | ☐ |
| U2M.40 | 0 | 0 | ☐ |

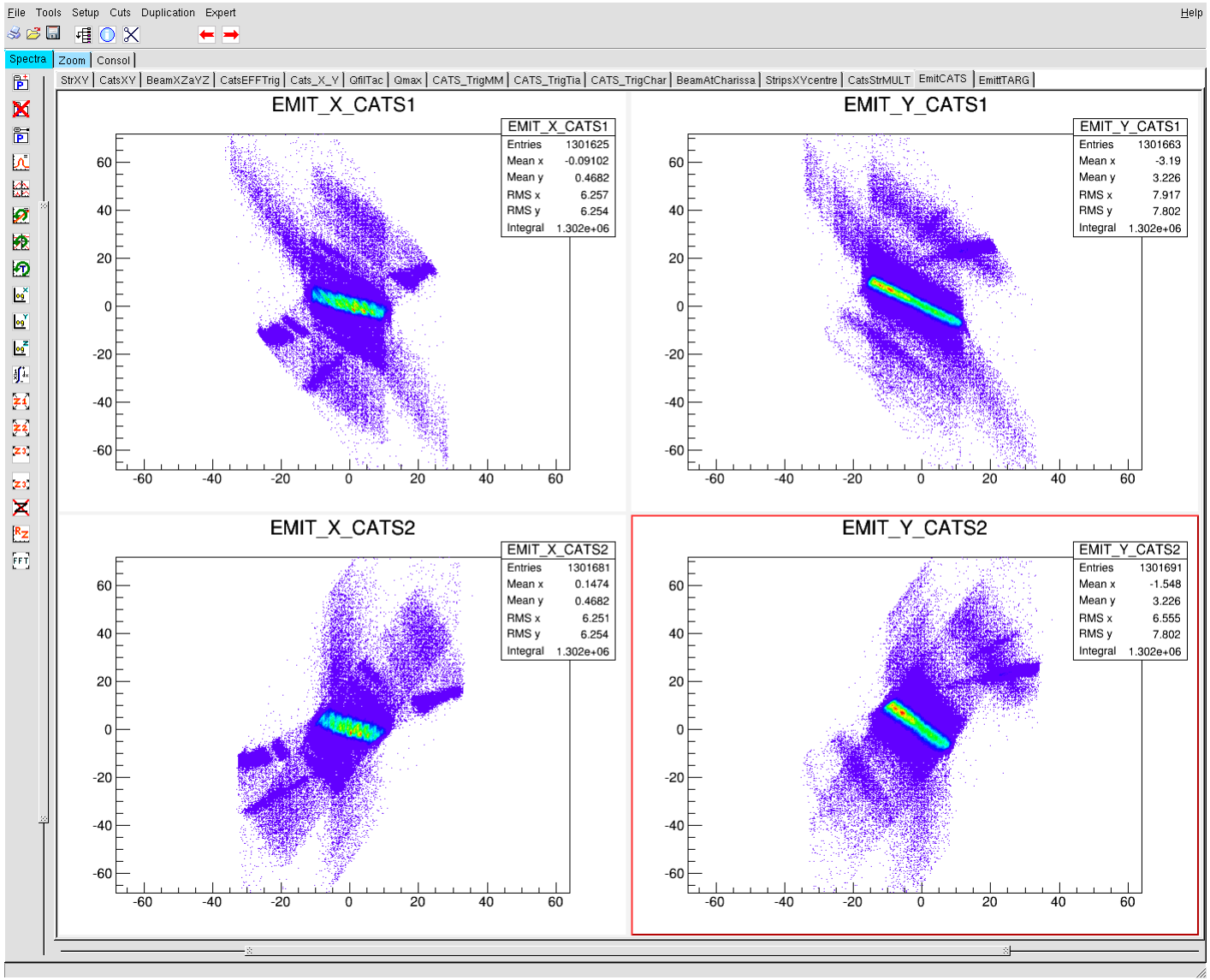
| Item | Counting | Freq | Vis |
|---|---|---|---|
| ECC0_A | 518059 | 139 | |
| ECC0_B | 649297 | 191 | |
| ECC0_C | 590996 | 135 | |
| ECC0_D | 461917 | 123 | |
| ECC1_A | 698750 | 186 | |
| ECC1_B | 512763 | 134 | |
| ECC1_C | 515665 | 135 | |
| ECC1_D | 623217 | 173 | |
| ECC2_A | 885284 | 229 | |
| ECC2_B | 598538 | 163 | |
| ECC2_C | 1772871 | 493 | |
| ECC2_D | 520274 | 141 | |
| ECC3_A | 659779 | 170 | |
| ECC3_B | 512513 | 115 | |
| ECC3_C | 487703 | 116 | |
| ECC3_D | 629452 | 153 | |
| U2M1_4.17 | 0 | 0 | |
| U2M1_4.18 | 0 | 0 | |
| U2M1_4.19 | 0 | 0 | |
| U2M1_4.20 | 0 | 0 | |

Modified Monday, March 10, 2014 1:05:48 PM Display all channels < e628_echelles.sav >

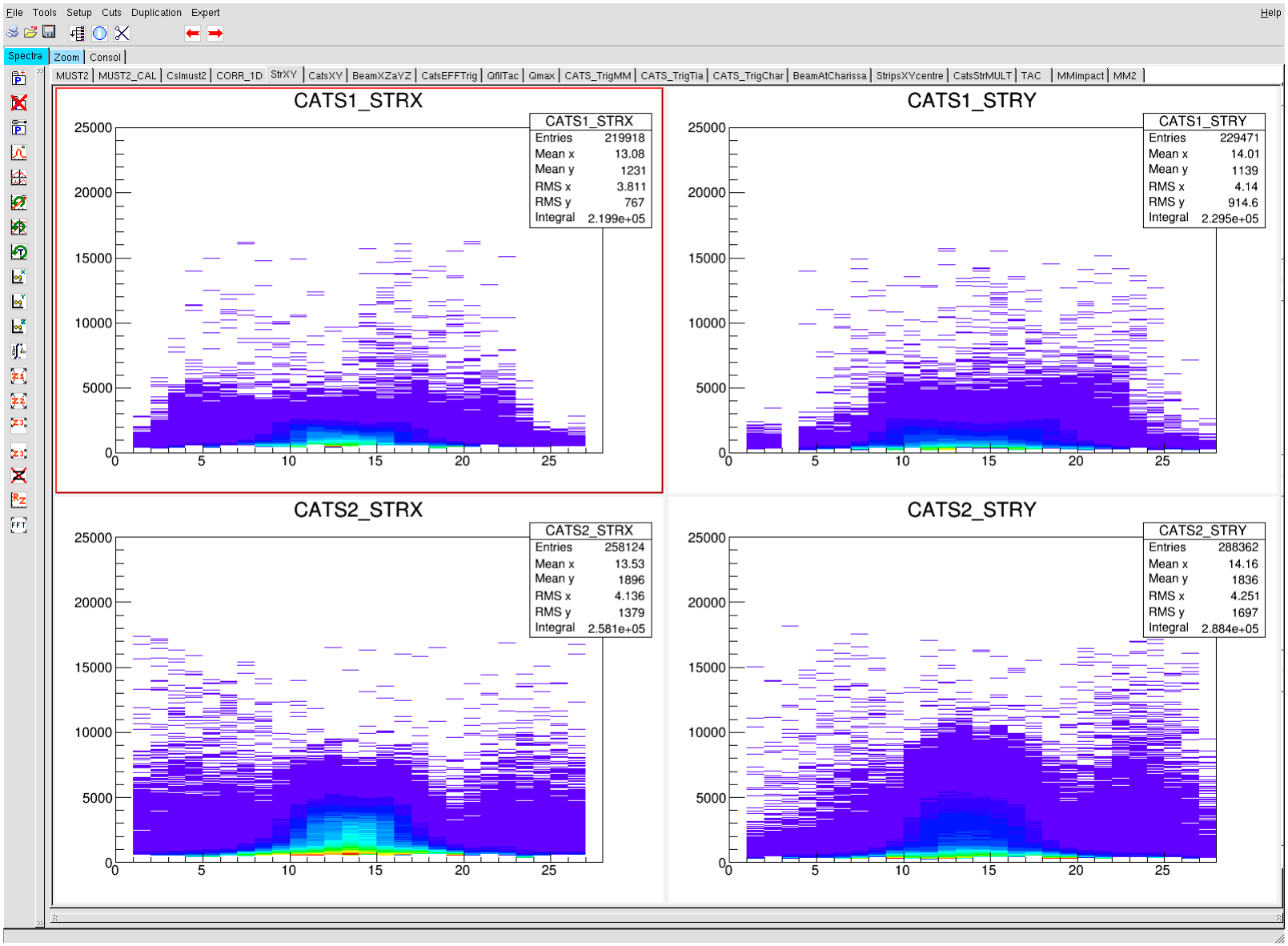
# CATS profile run 1375  10 March



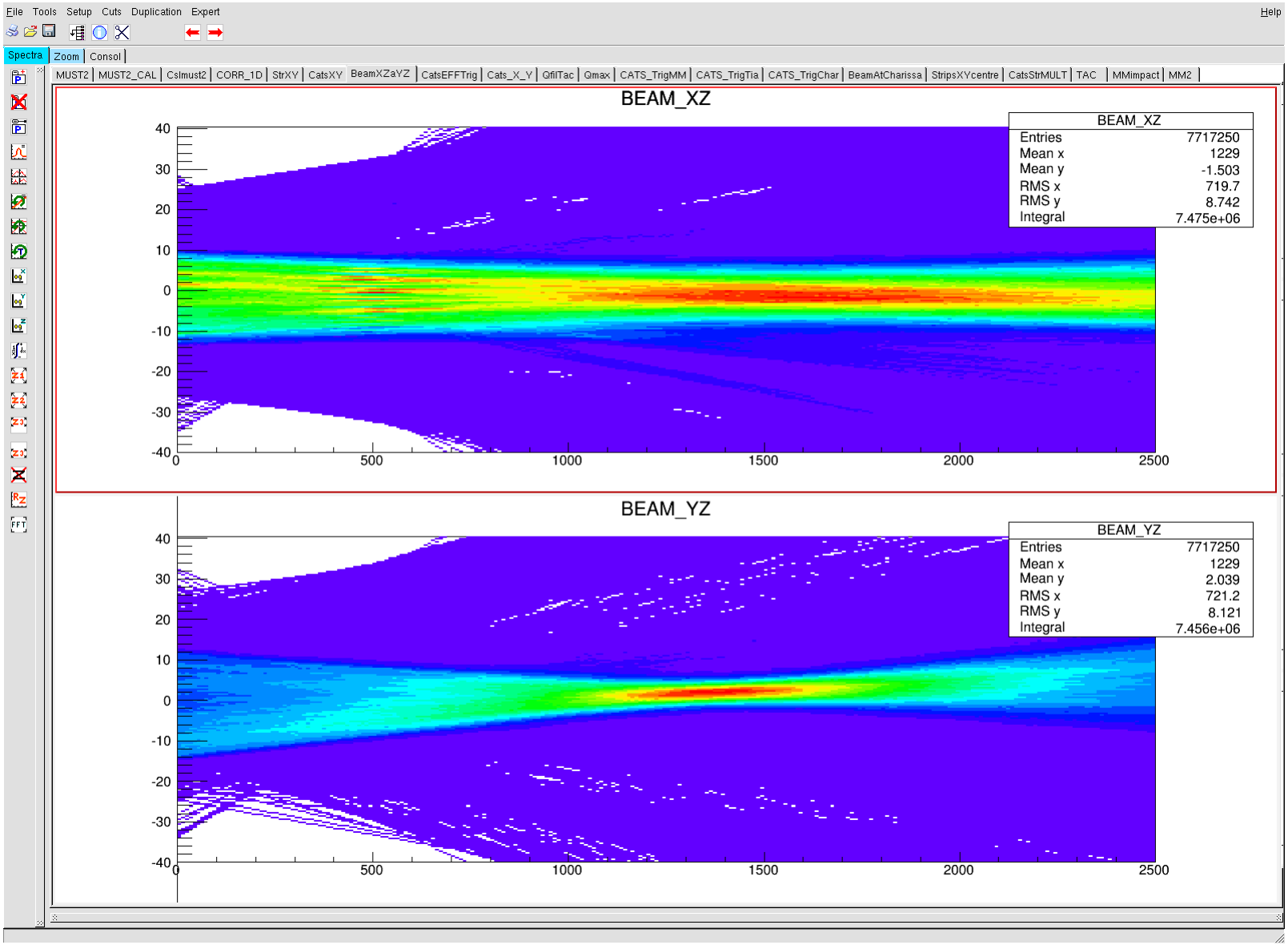
# Emittance (Run 1337) CATS 1, CATS2 Theta (mrad) % mm



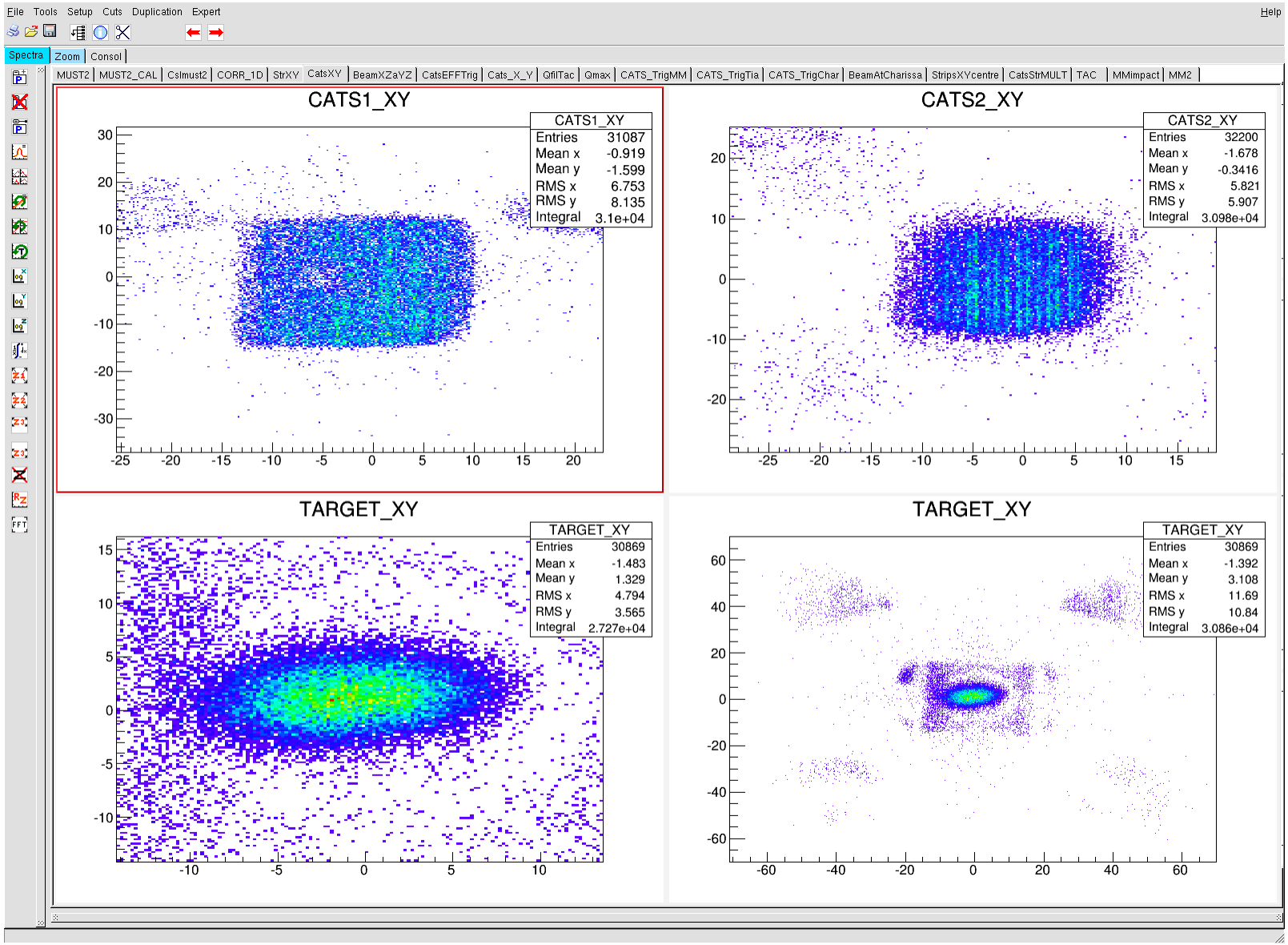
# TYPICAL RUN (1299) and SPECTRA - strips XY CATS



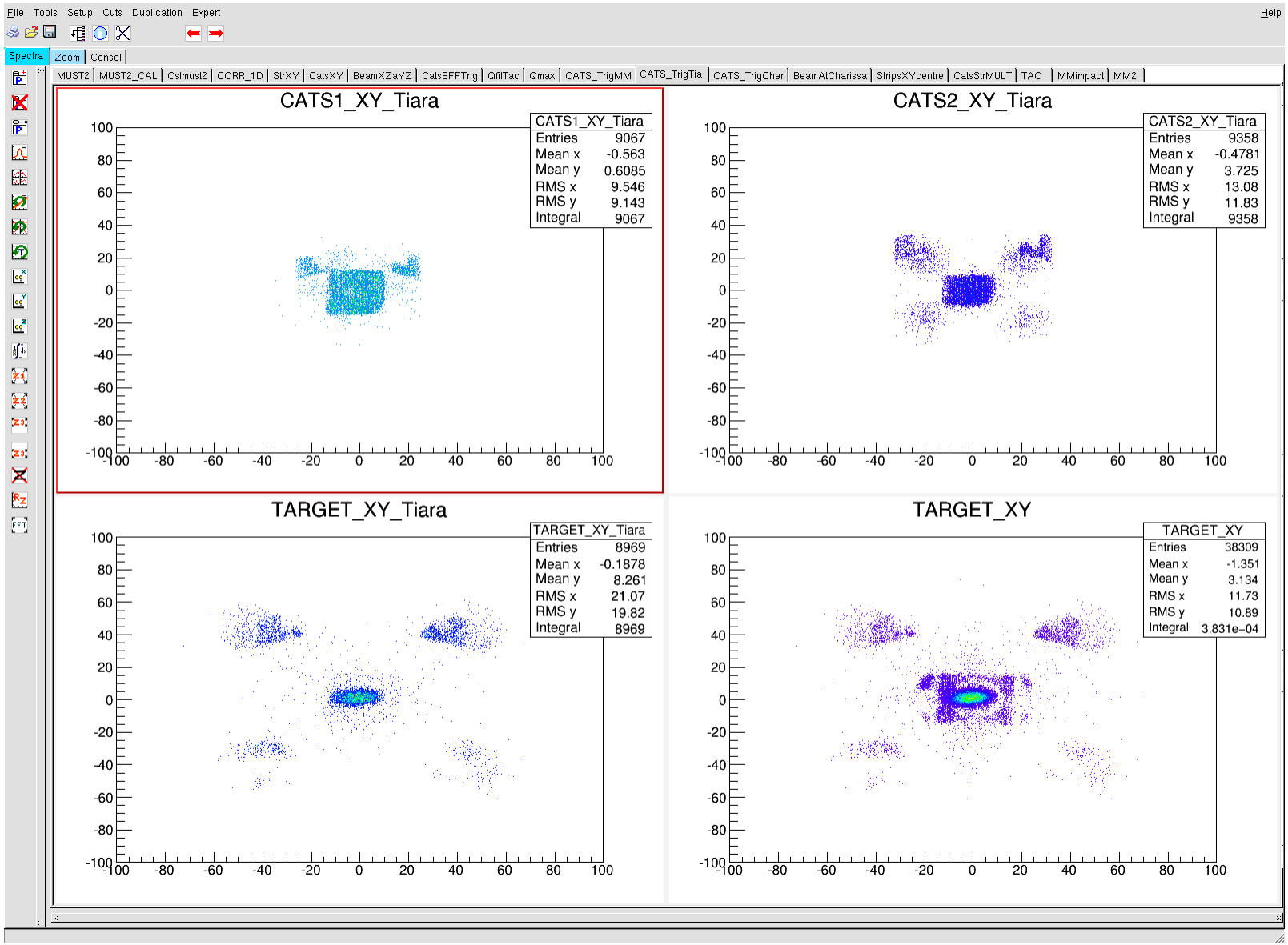
# TYPICAL RUN (1299) and SPECTRA - CATS Beam focalisation



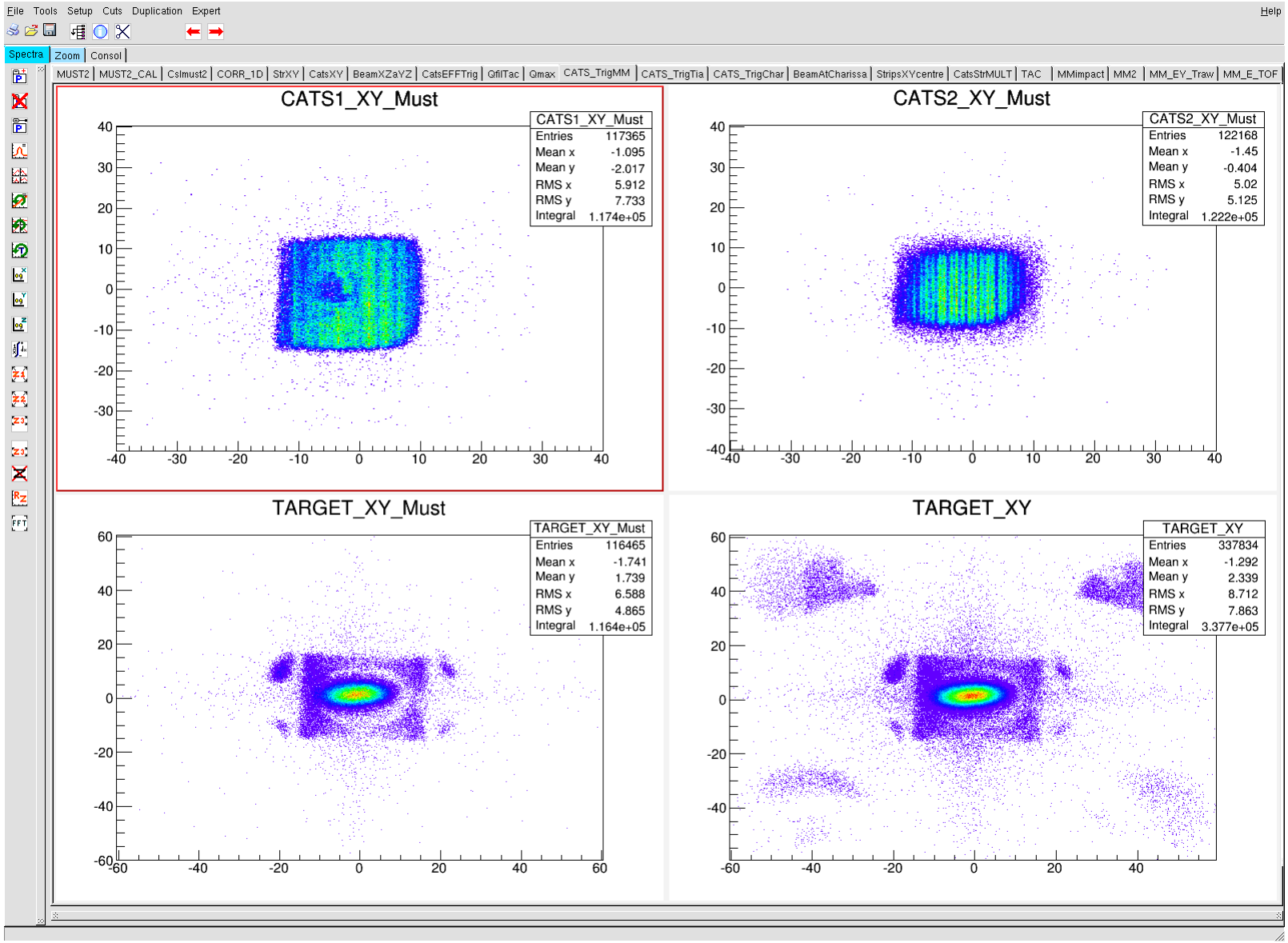
# TYPICAL RUN (1299) and SPECTRA - CATS – All triggers



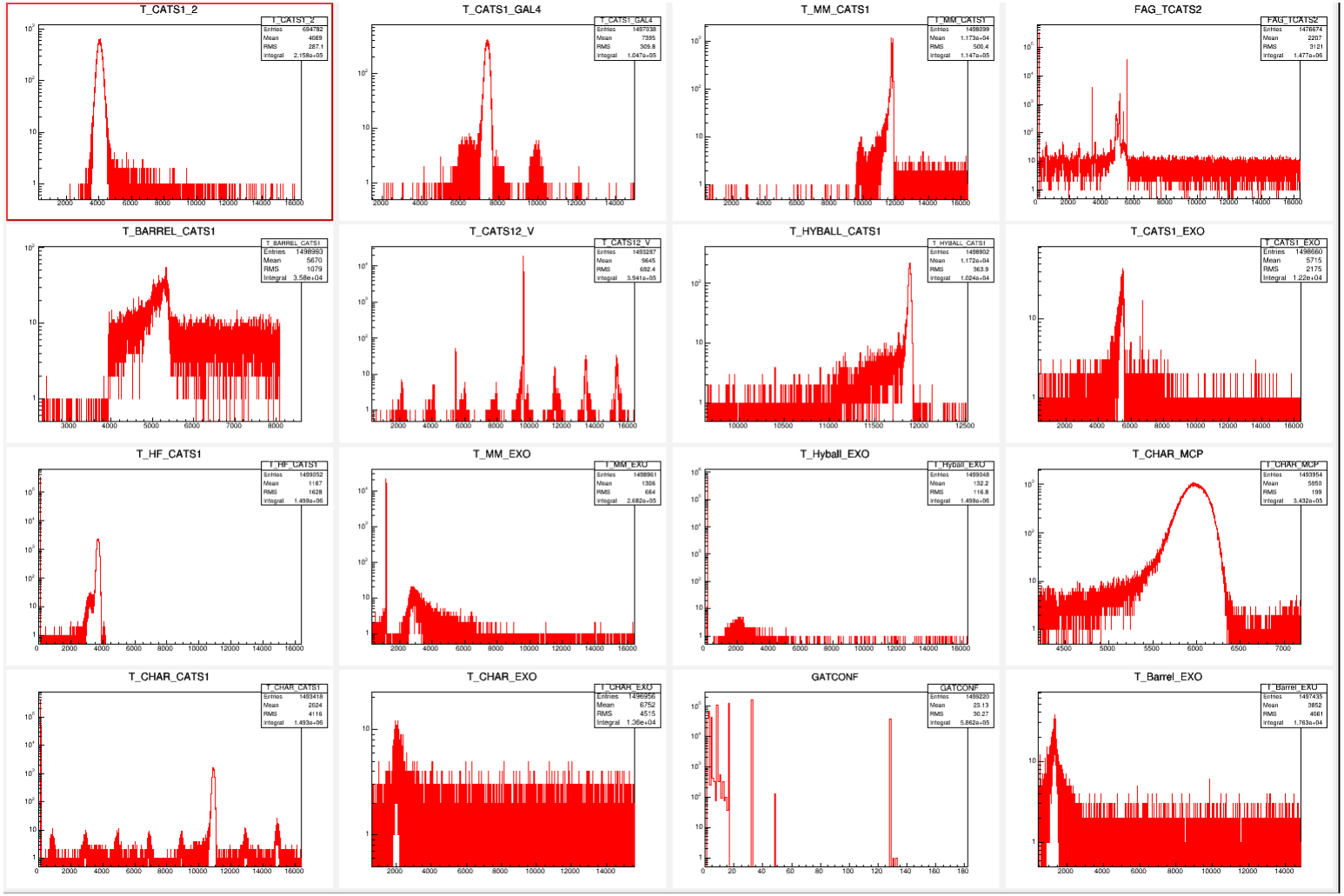
# TYPICAL RUN (1299) and SPECTRA - CATS-Trigger TIARA



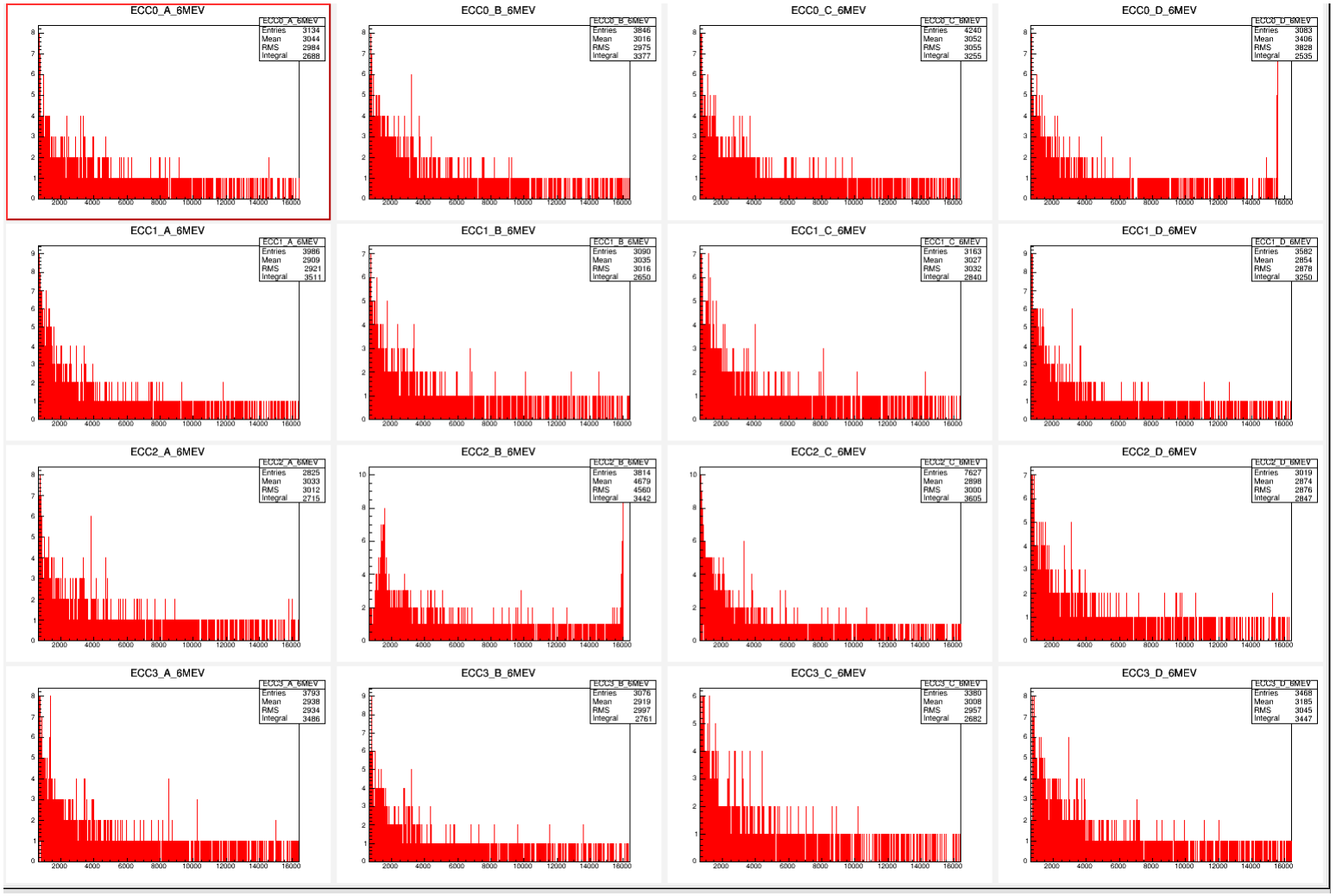
# TYPICAL RUN (1299) and SPECTRA - CATS- Trigger MUST2



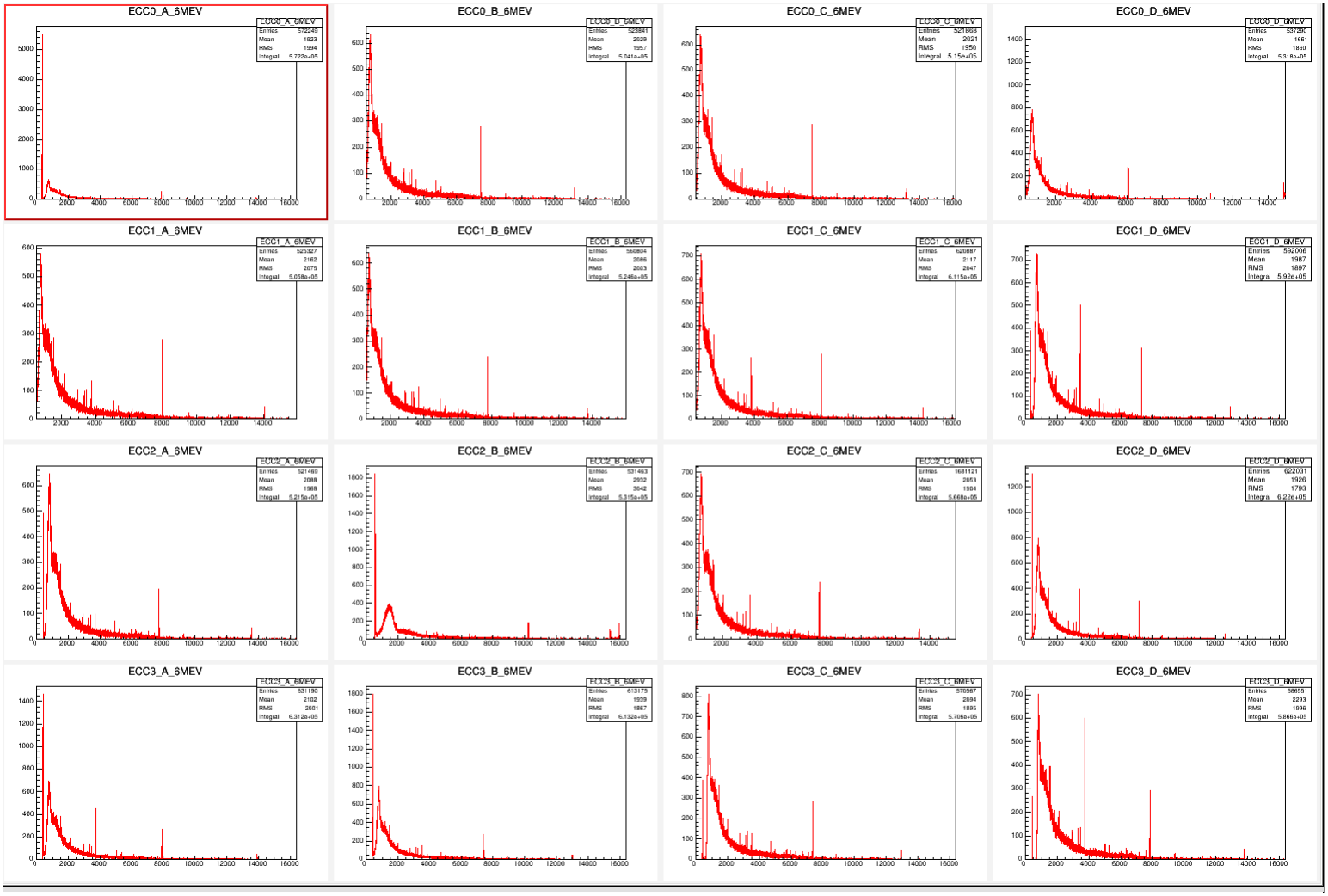
# TYPICAL RUN 1375- TAC SPECTRA -10 March



# TYPICAL RUN 1375 – EXOGAM SPECTRA -10 March

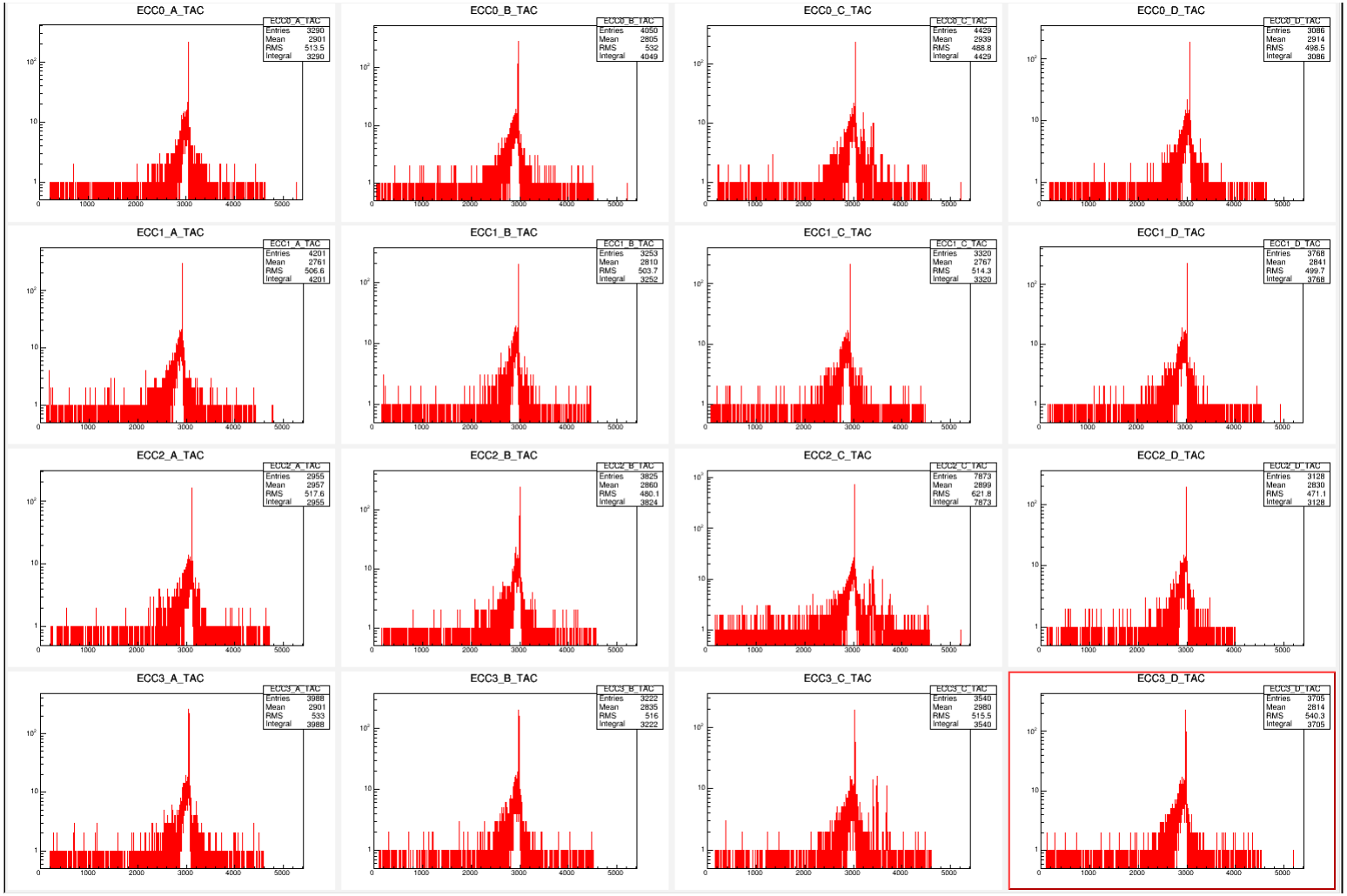


# TYPICAL RUN 1375- EXOGAM SPECTRA

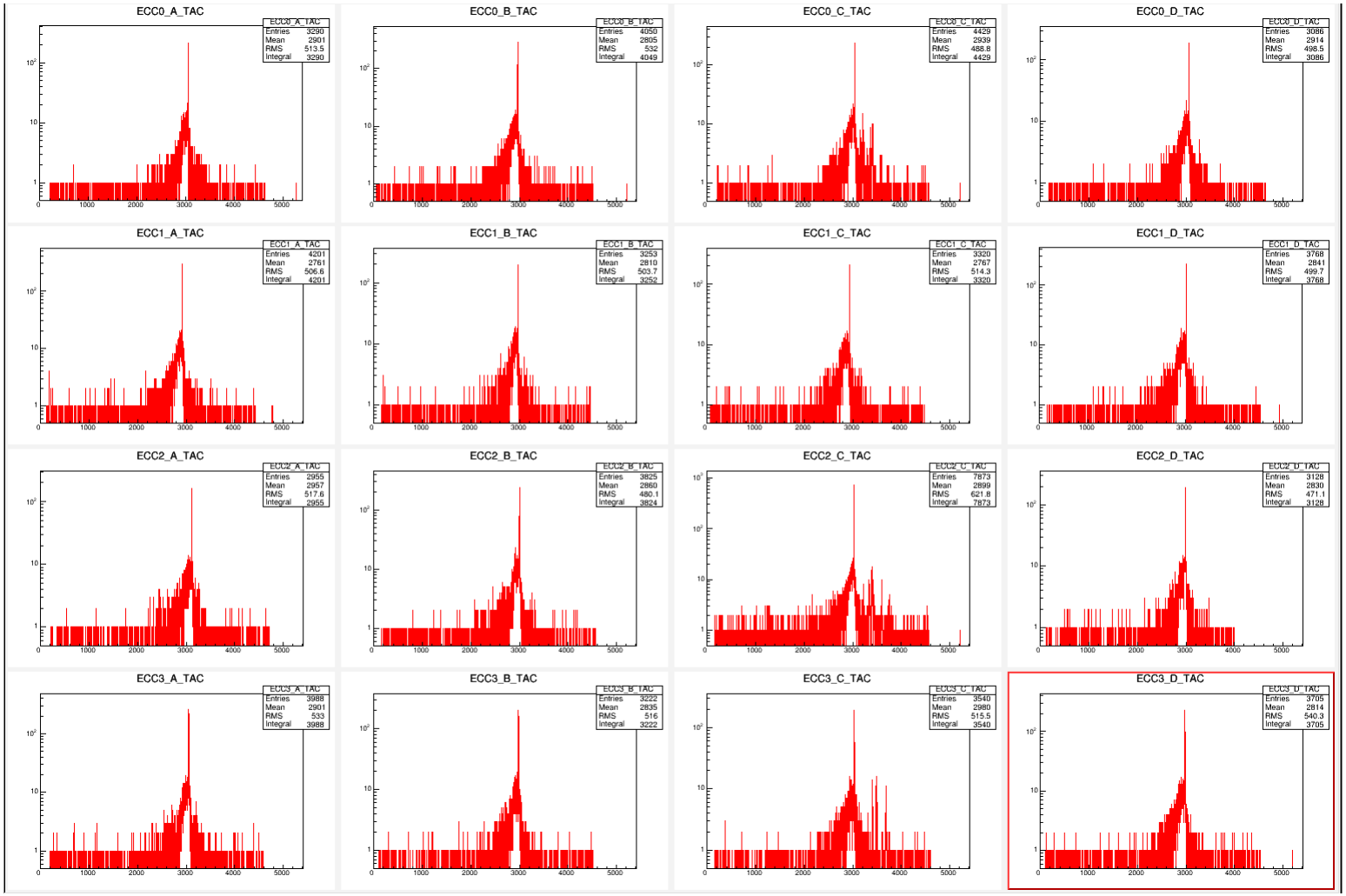


# TYPICAL RUN 1375- EXOGAM SPECTRA

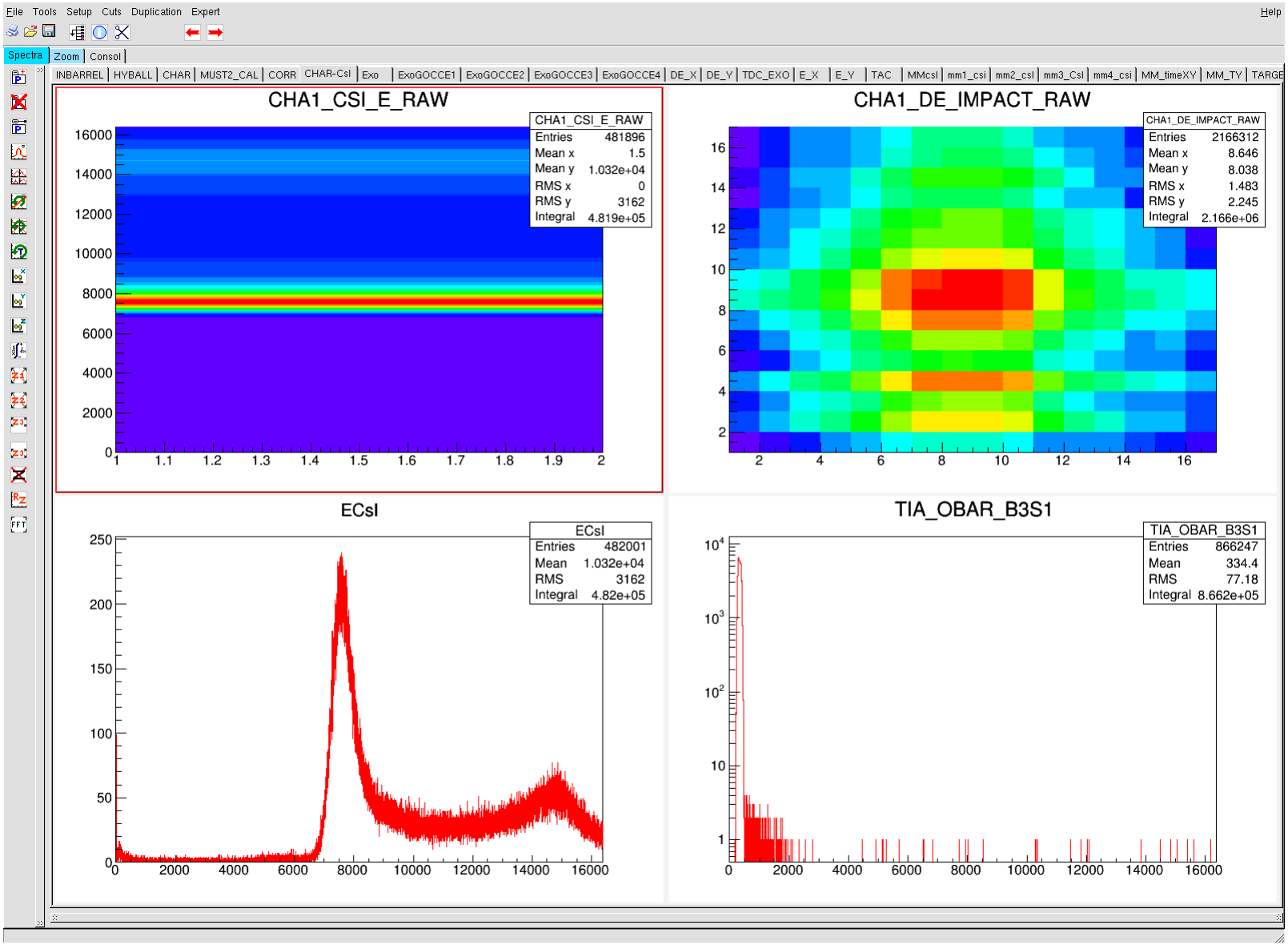
# TYPICAL RUN 1375 - EXOGAM SPECTRA



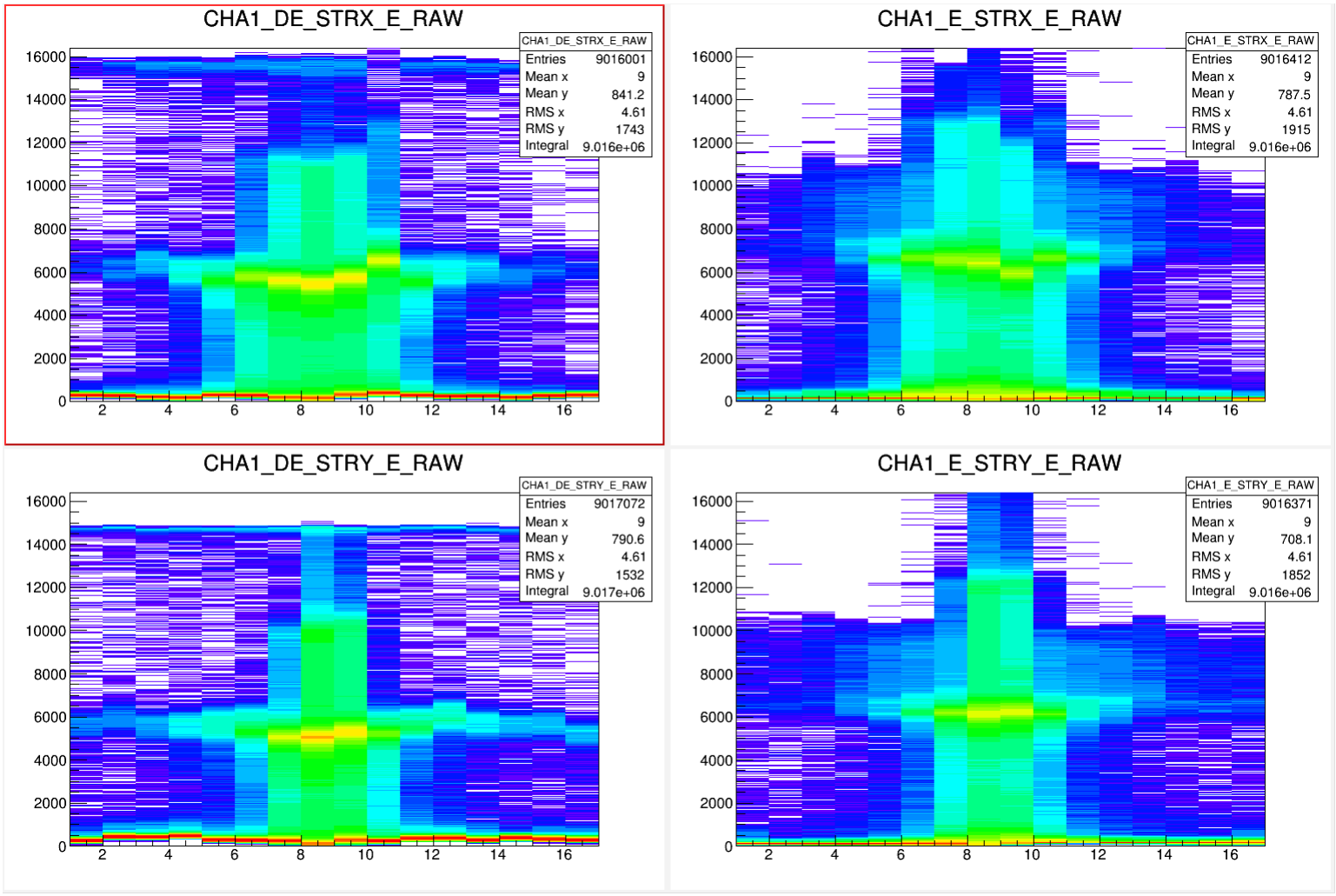
# TYPICAL RUN 1375 - EXOGAM SPECTRA



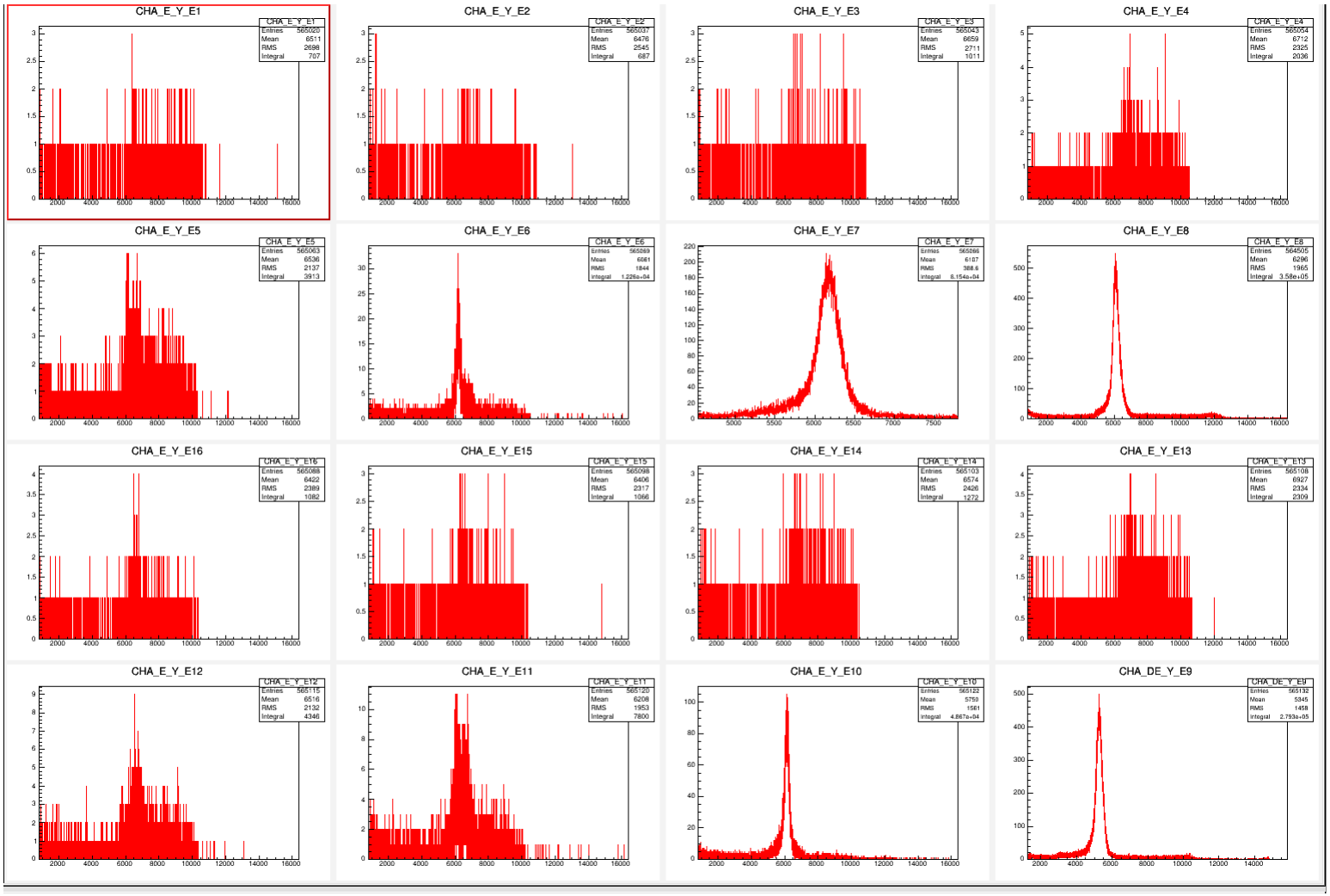
# TYPICAL RUN 1375- Charissa Spectra



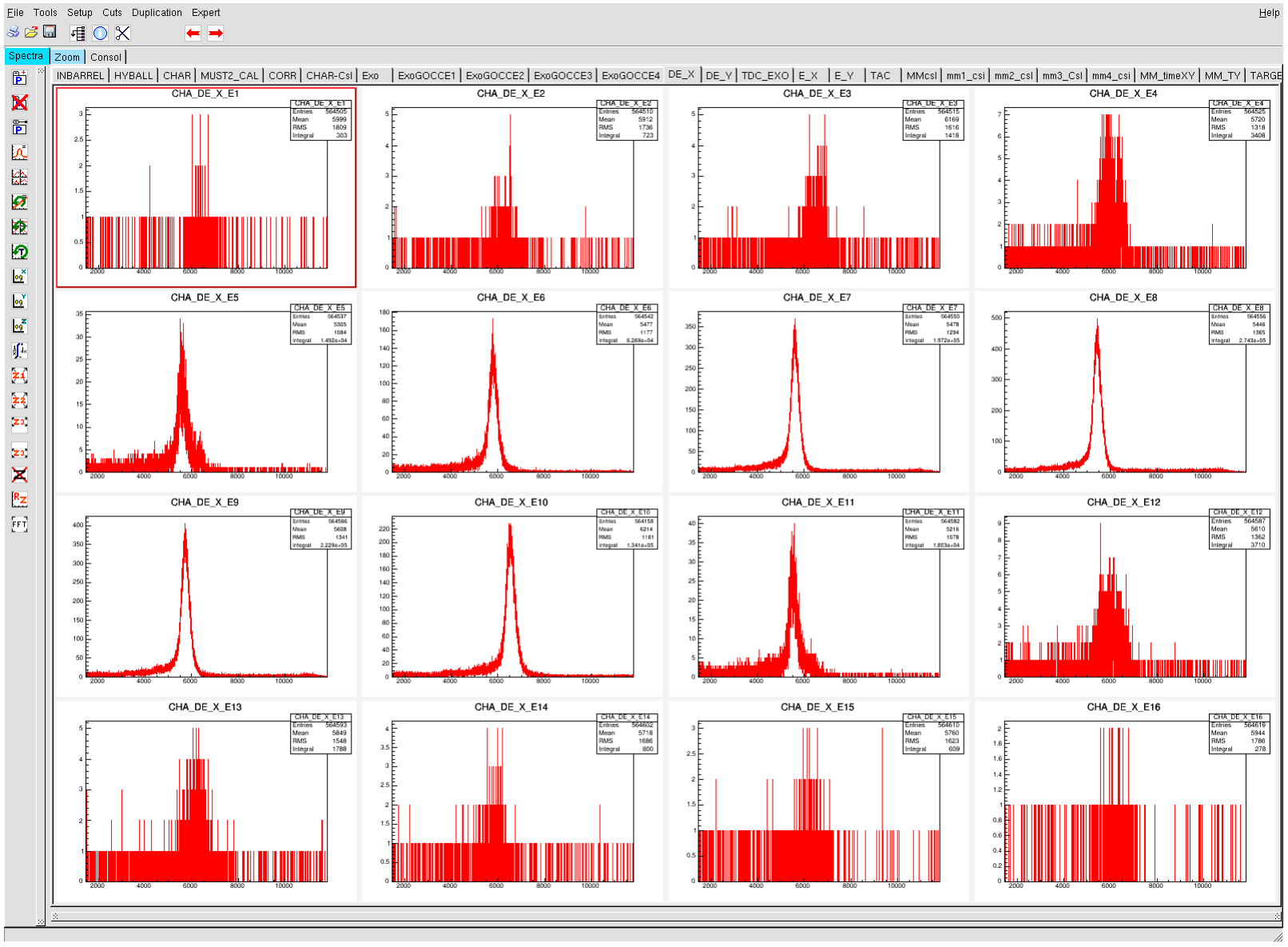
# TYPICAL RUN 1375 -Charissa SPECTRA



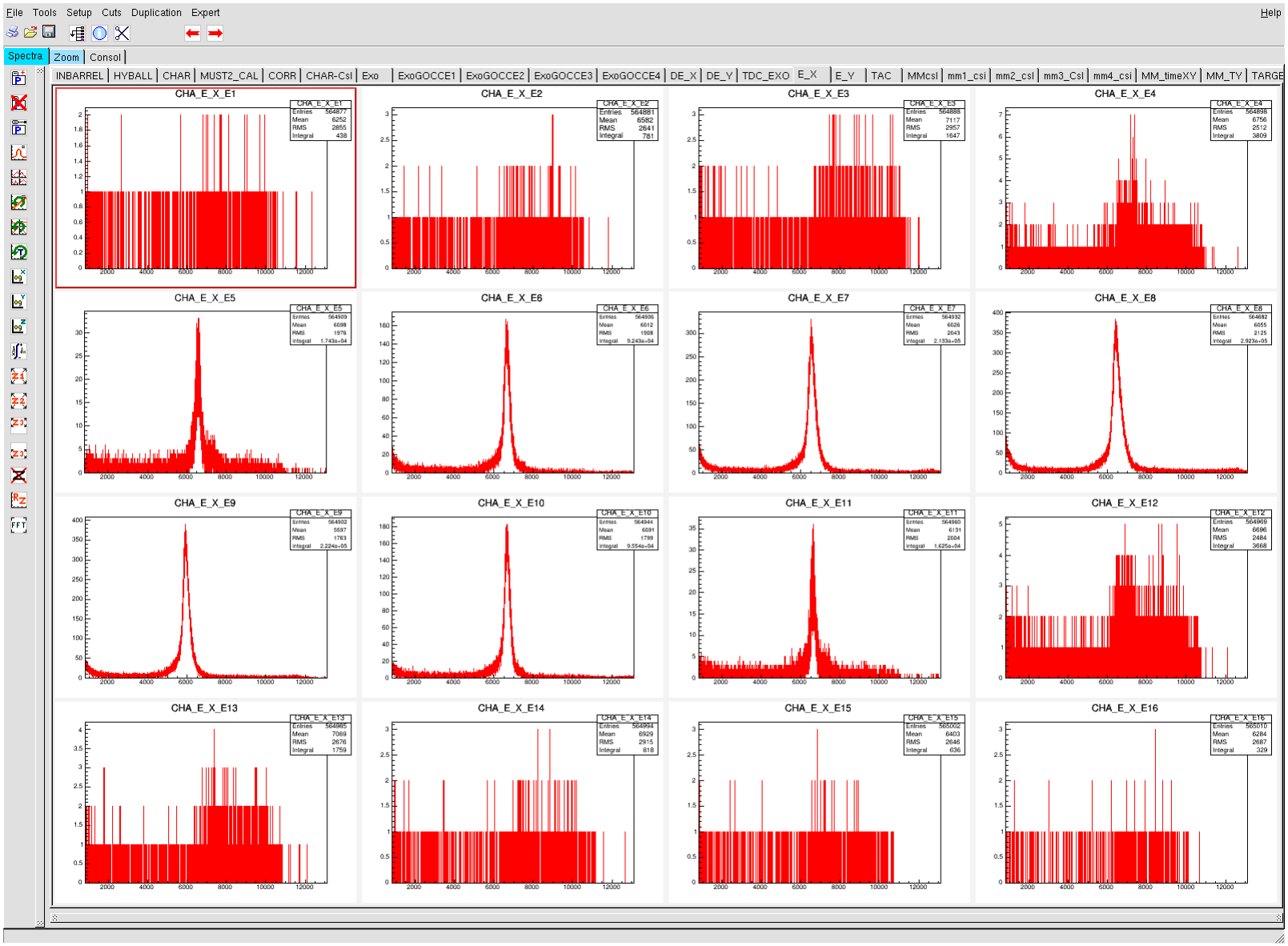
# TYPICAL RUN 1375 - Charissa SPECTRA



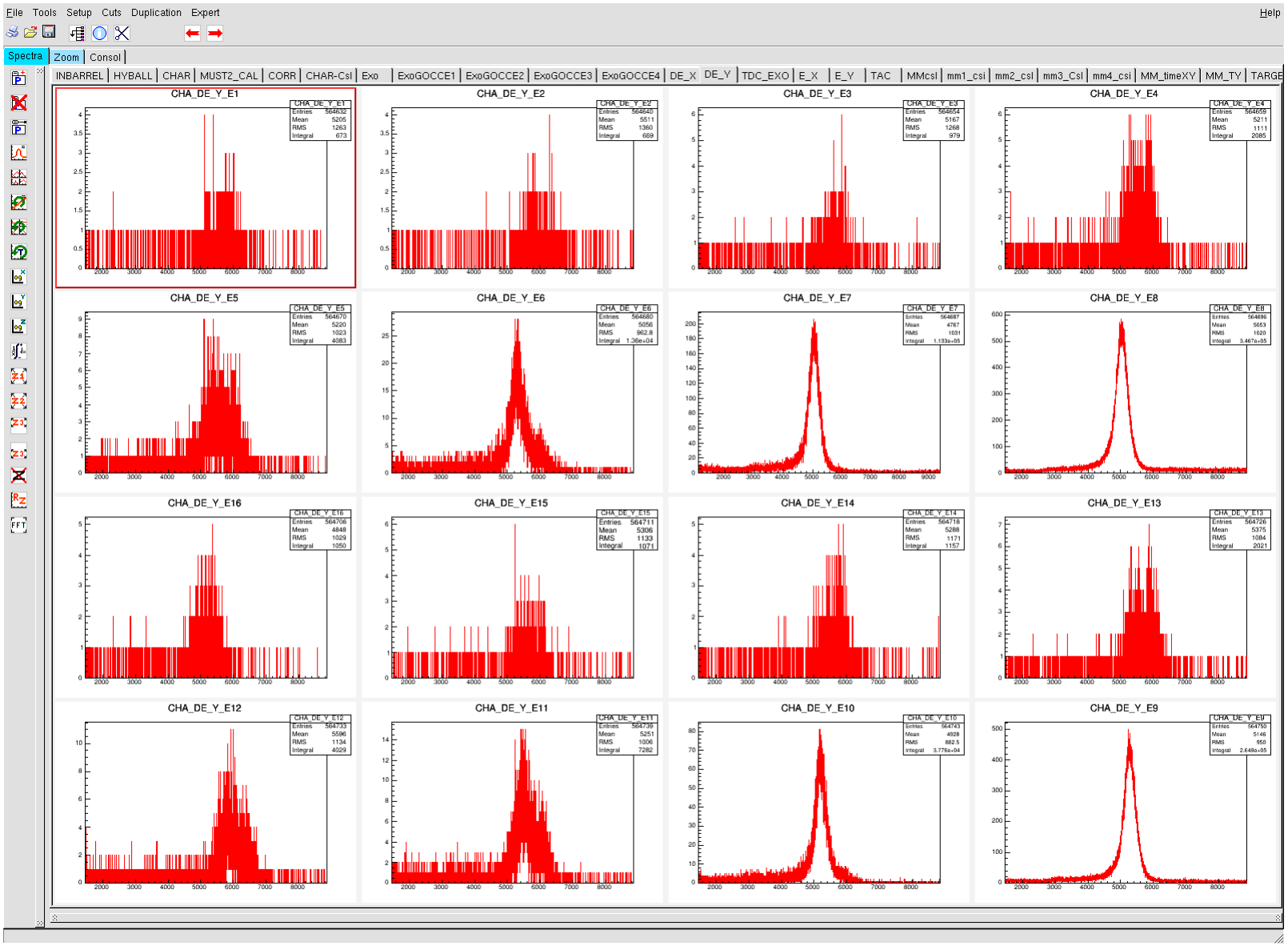
# TYPICAL RUN 1375 - Charissa Spectra



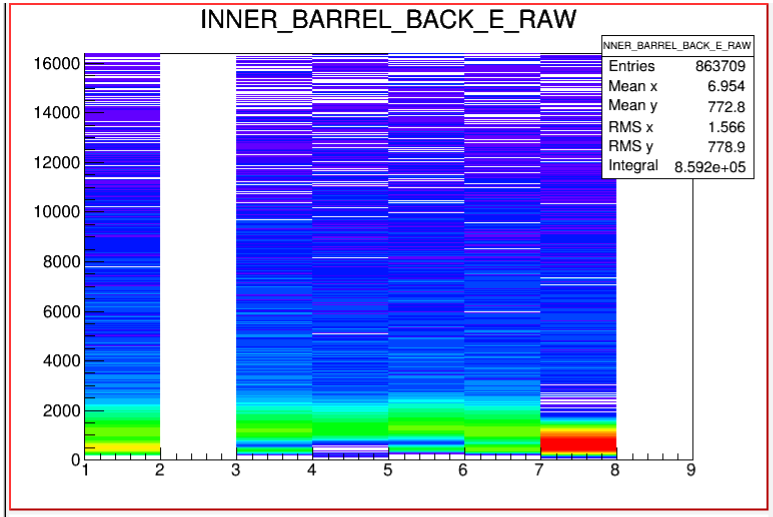
# TYPICAL RUN 1375 - Charissa Spectra

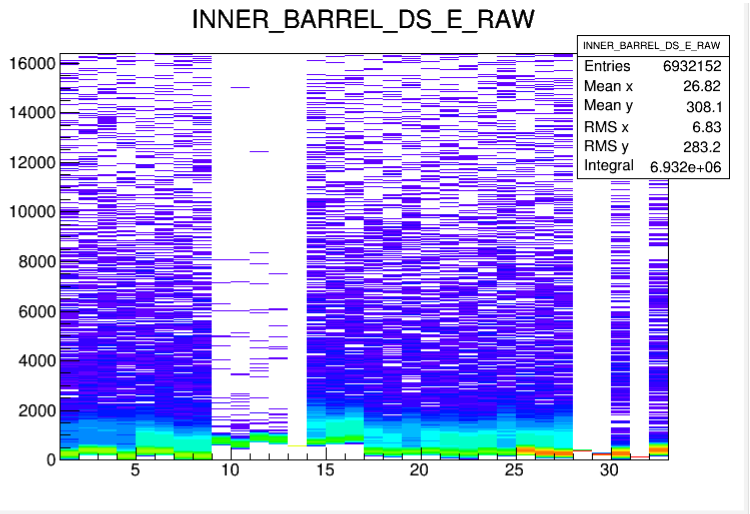


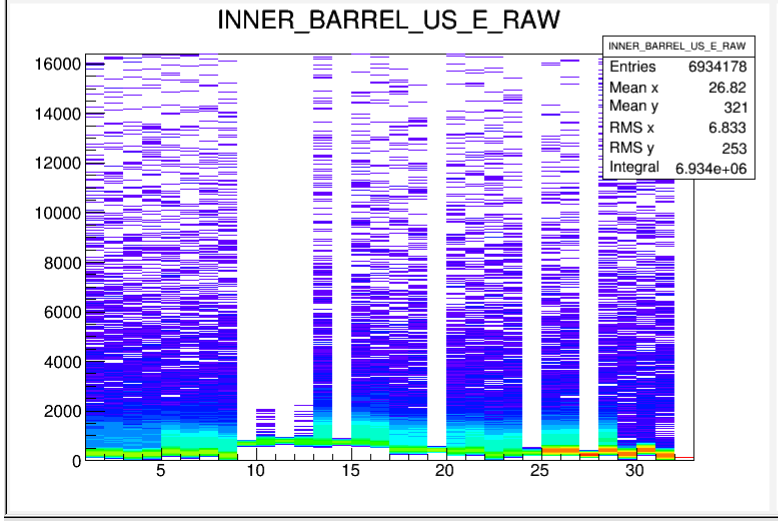
# TYPICAL RUN 1375- Charissa Spectra

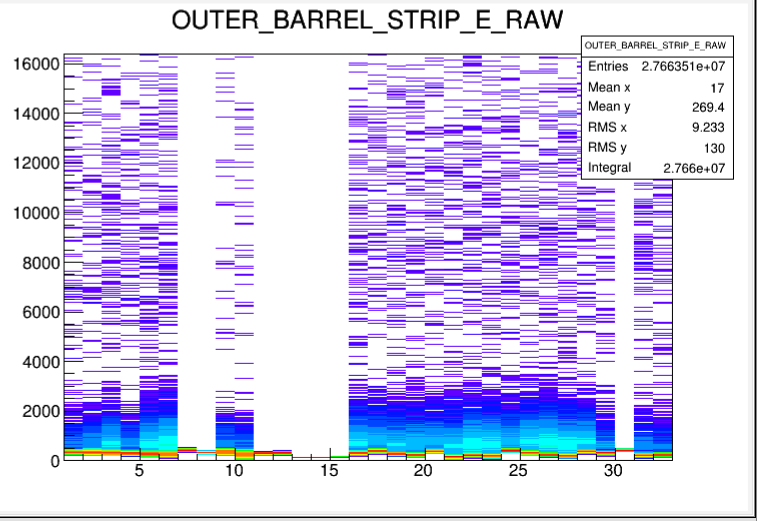


# TYPICAL RUN 1375- TIARA Barrel SPECTRA

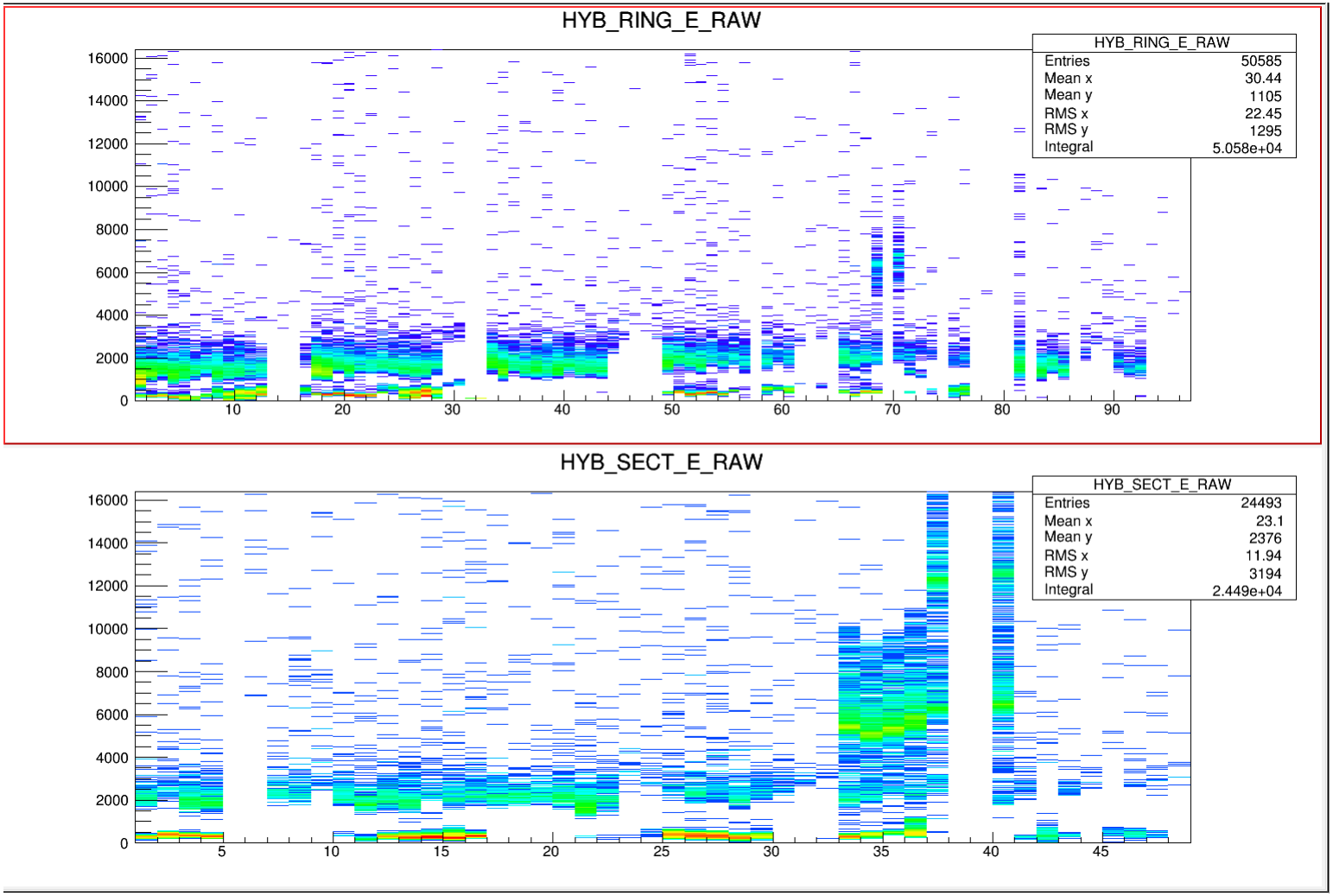


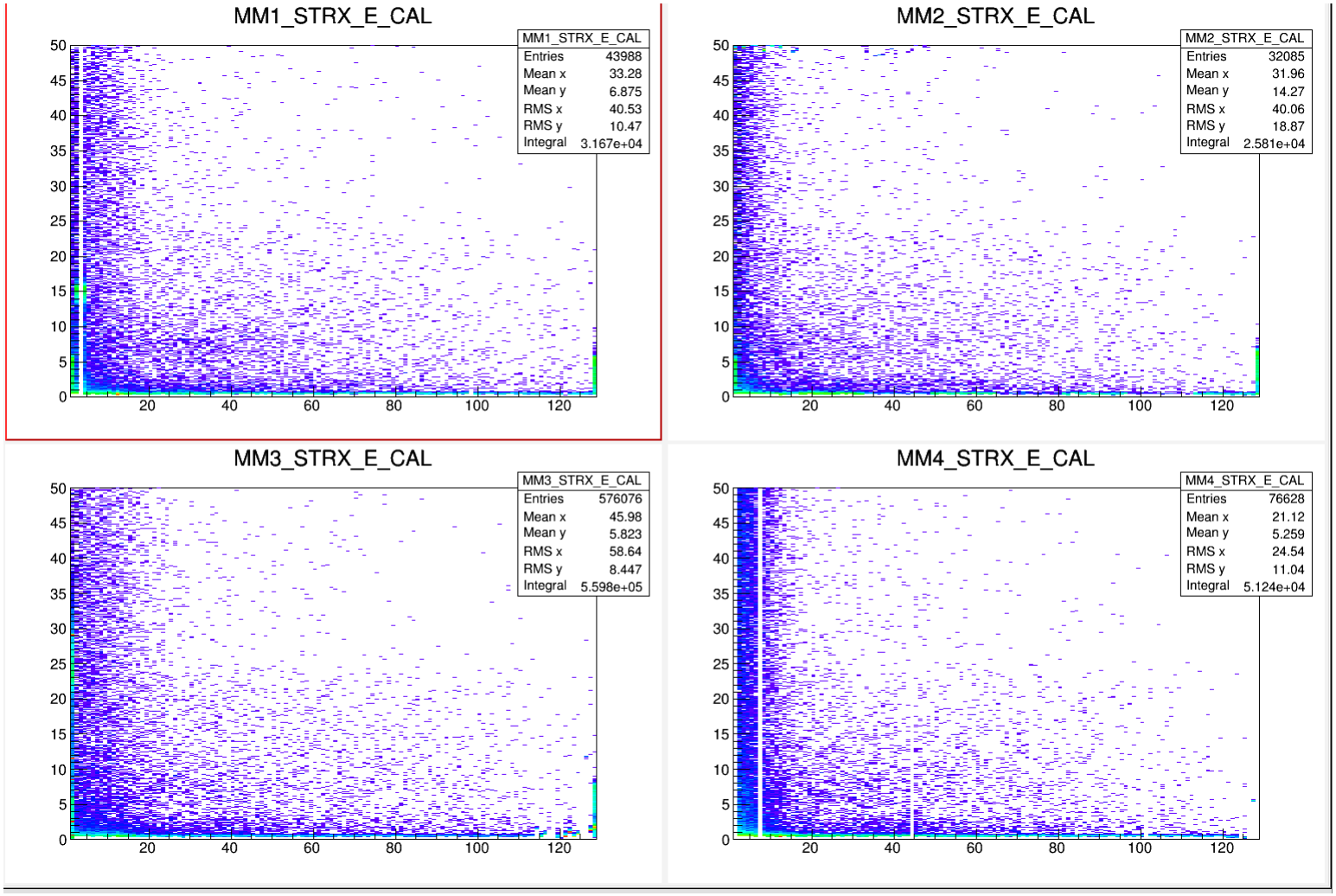



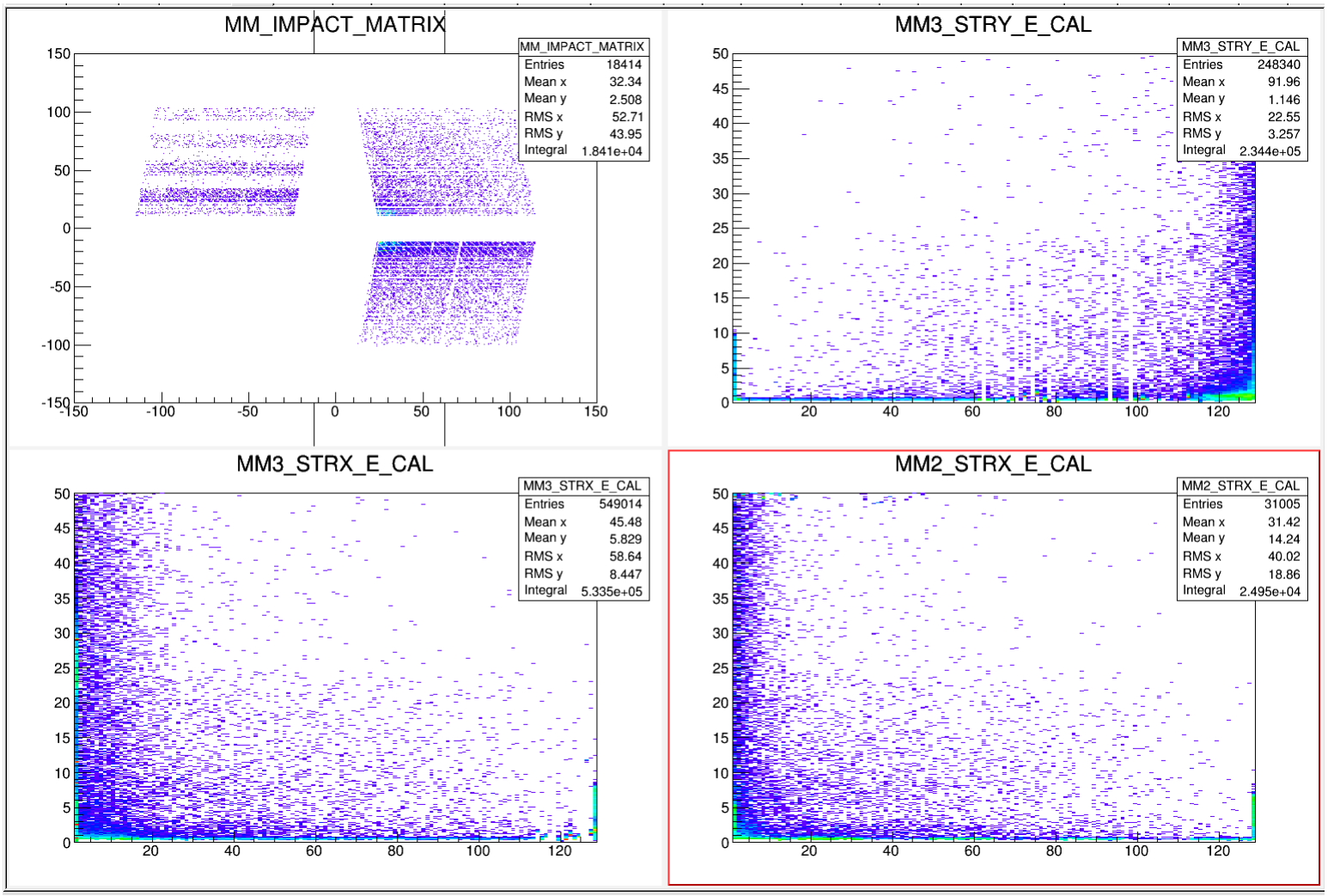
# TYPICAL RUN 1375 TIARA Hyball SPECTRA - 10 March



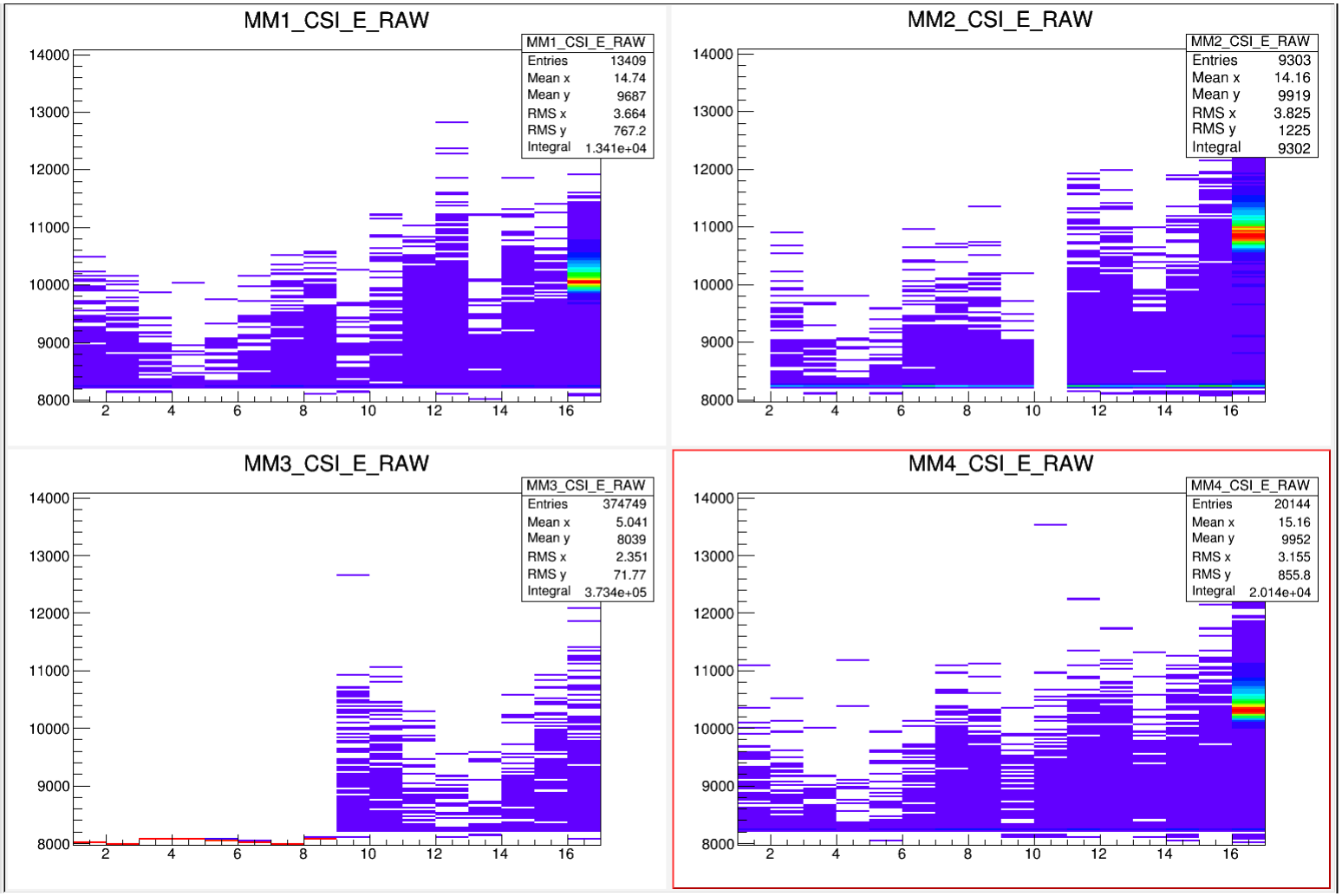
# TYPICAL RUN 1375 – MUST2 SPECTRA



# TYPICAL RUN 1375 – MUST SPECTRA – 10 March



# TYPICAL RUN 1375– MUST2 SPECTRA 10 March



# TYPICAL RUN 1375 – MUST2 SPECTRA -10 March