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COLLABORATION IN SPIRAL2, LIPAC & ESS CONTROL SYSTEMS BASED ON EPICS

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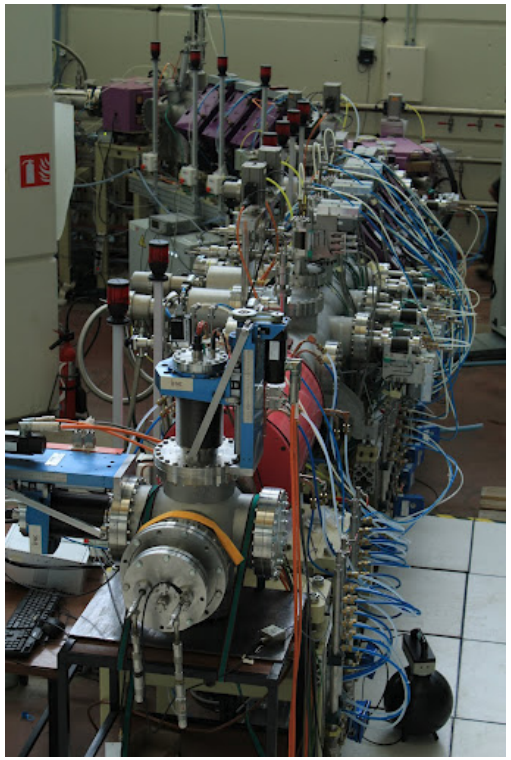


Irfu

OUTLINE

Some words about EPICS

Brief legacy with some Irfu EPICS projects

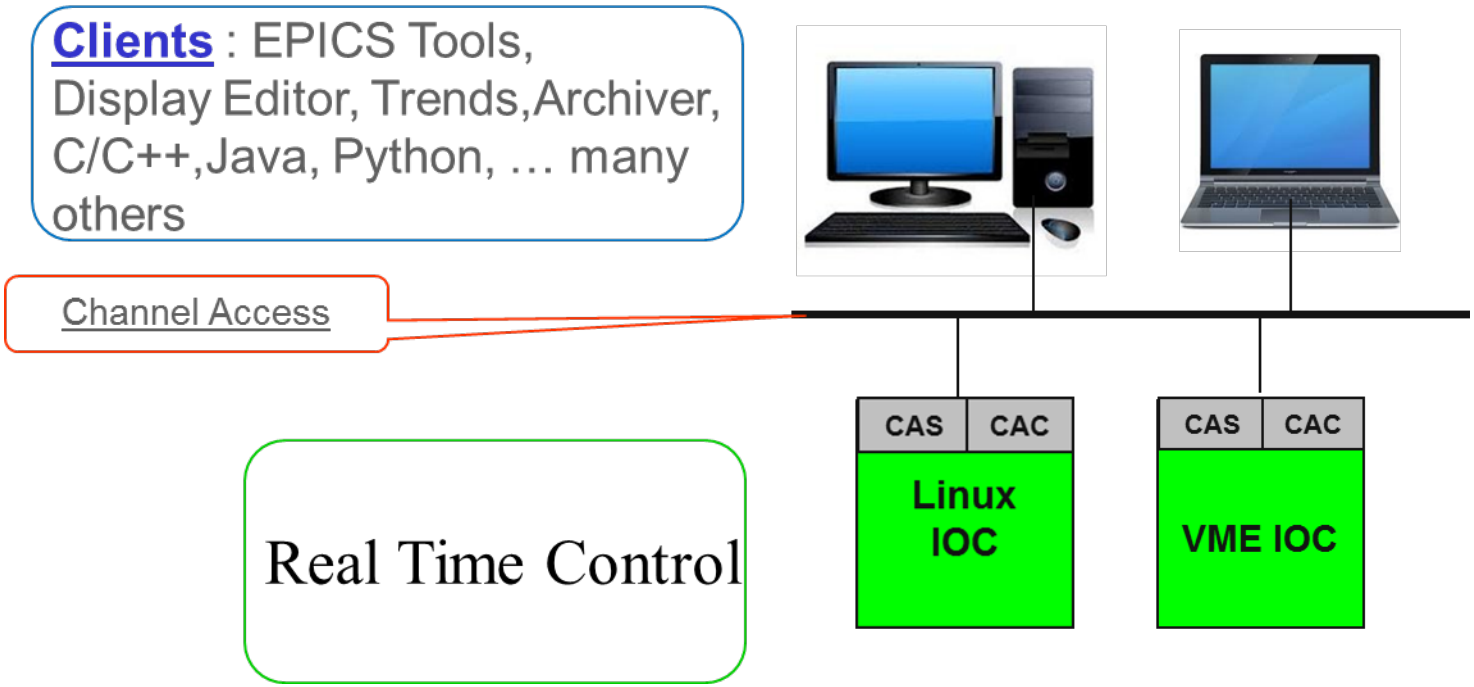
Our collaboration in Spiral2

Our collaboration in LIPAc

Our following collaboration in ESS

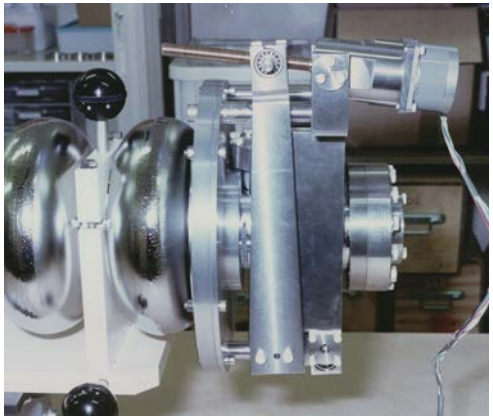
SOME WORDS ABOUT EPICS

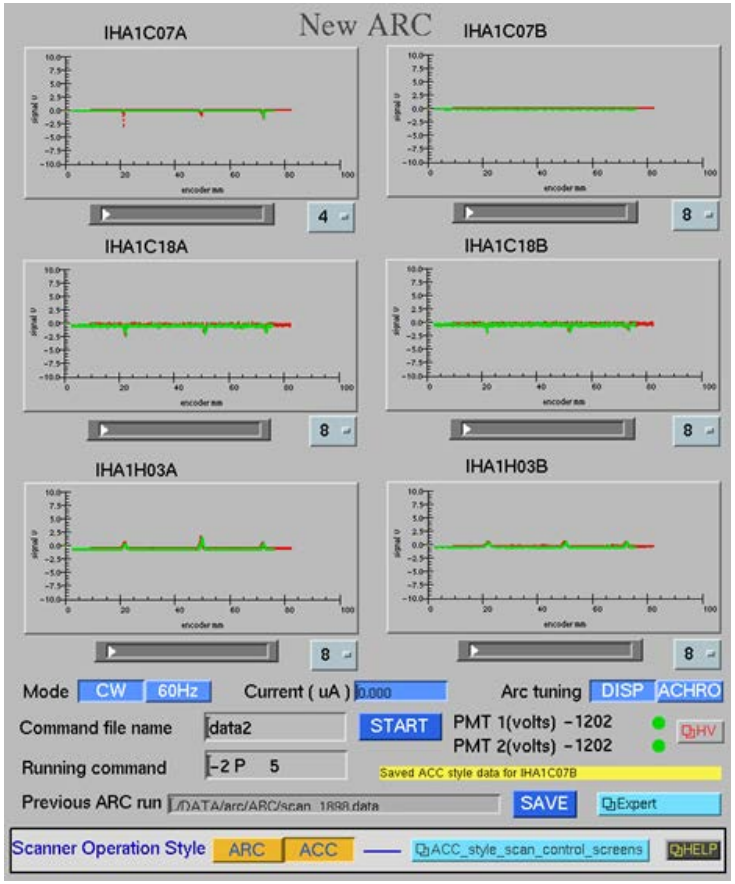
EPICS is a set of Open Source software tools, libraries and applications used worldwide to create control systems for particle accelerators, telescopes and large physics experiments.
Accelerators: SNS, SLAC, JLAB, Diamond, KEK and recently ITER & ESS



BRIEF LEGACY OF EPICS IN OUR INSTITUTE

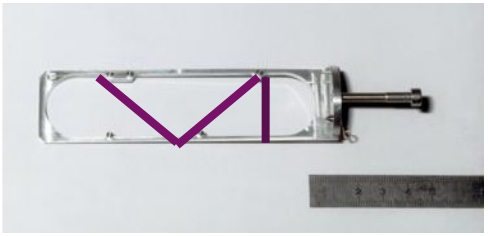
Started with EPICS in 1993 on TTF at Desy
TTF Injector, LLRF and some diagnostics





1996-1999 ARC energy measurement at Jlab, Hall A

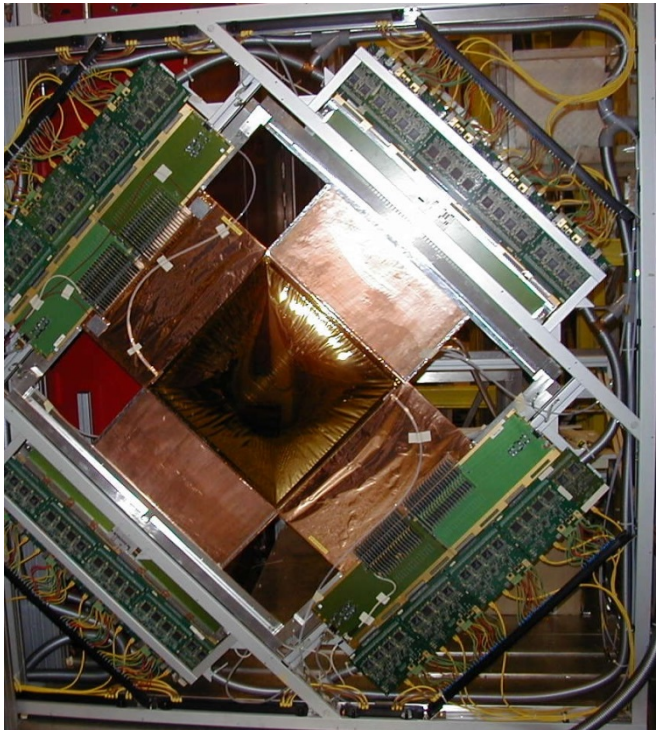
- Controls of wire scanners for the bend angle measurement
- Field integral measurement of the ARC



EPICS BETWEEN 2000-2005

4 EPICS VMEs on COMPASS at CERN

- Micromegas and drift chambers
- Quench data acquisition and slow control for the superconducting magnet



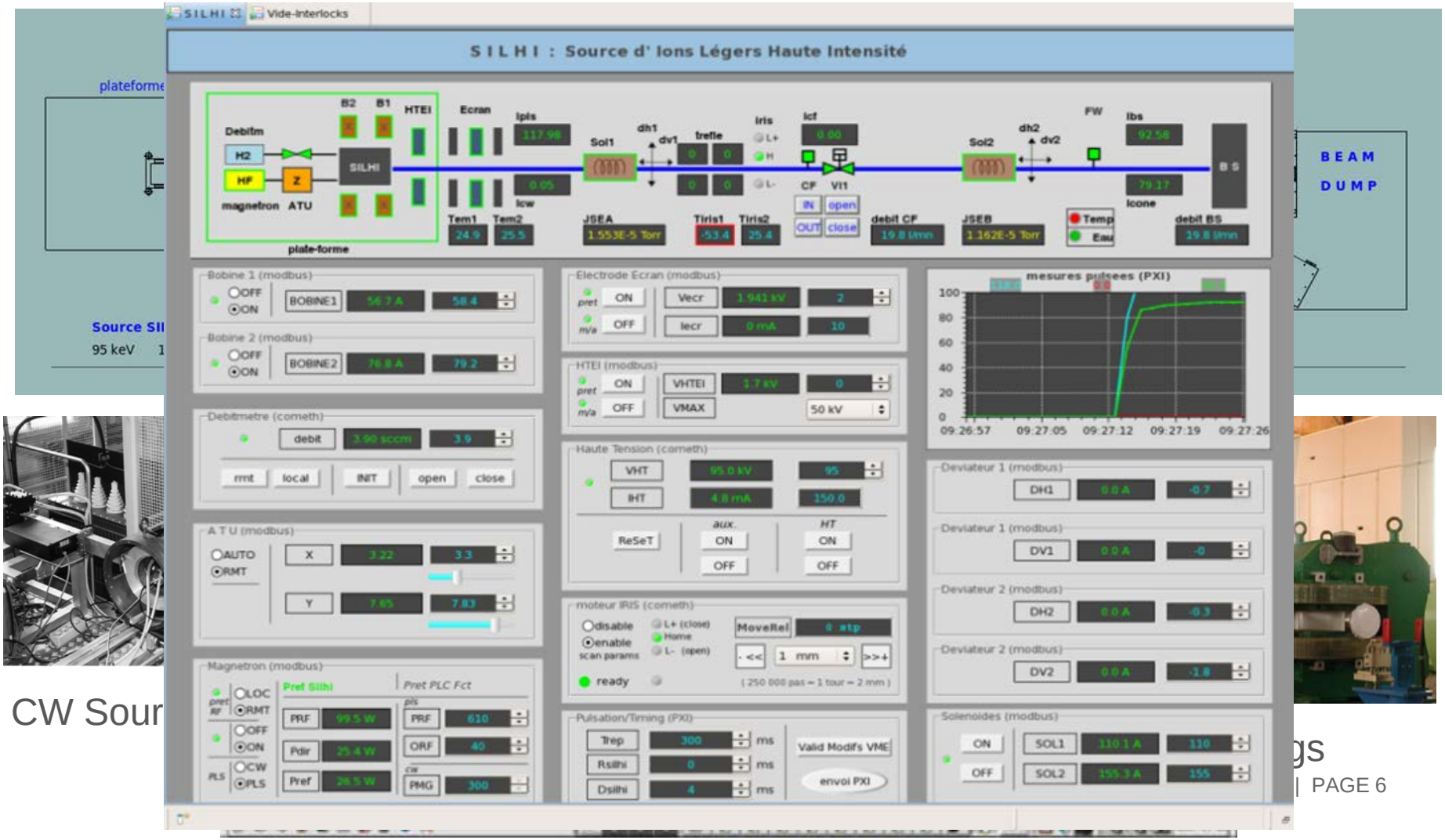
Ground Support equipment of MIRI imager (JWST)

- ESO software for IR detector
- EPICS for slow control

IPHI : AN HPPA PROTOTYPE INSTALLED AT SACLAY

IPHI (High Intensity Proton Injector) started in the 90's

HPPA : High Power Proton Accelerator



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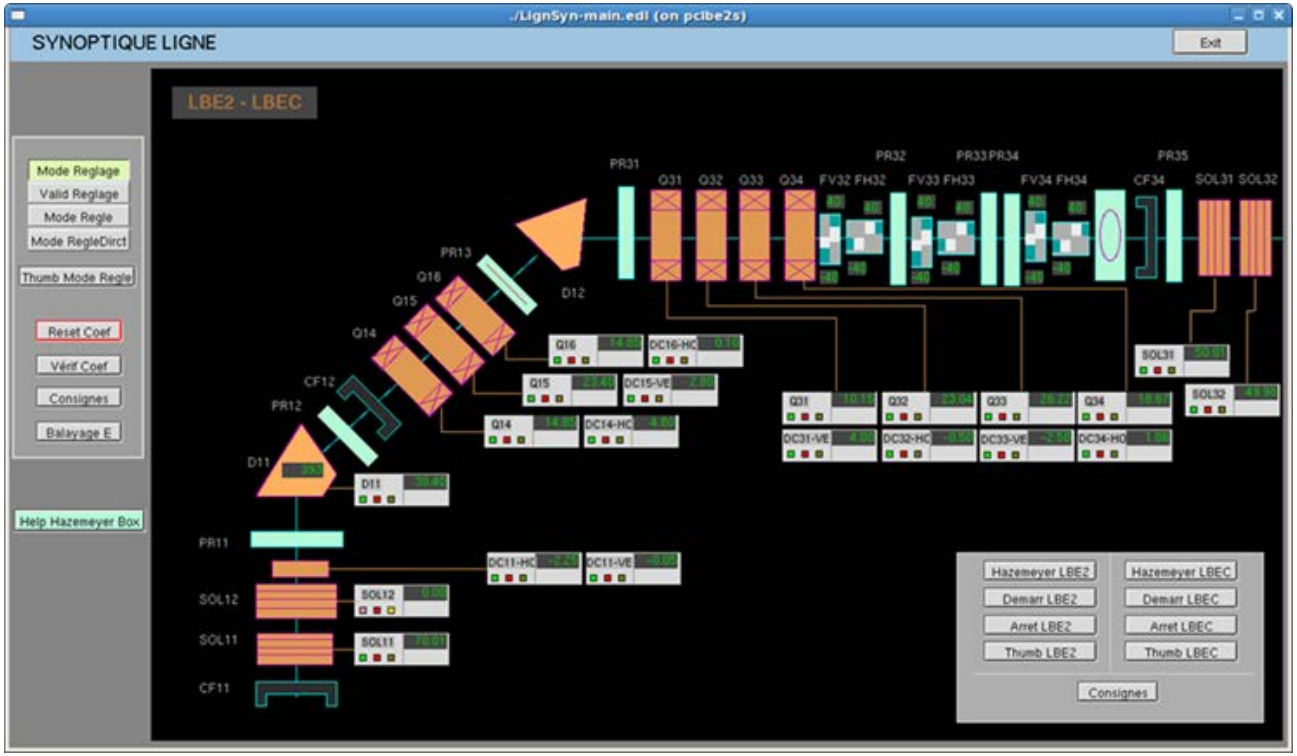
OUR COLLABORATION IN SPIRAL2: CONTEXT

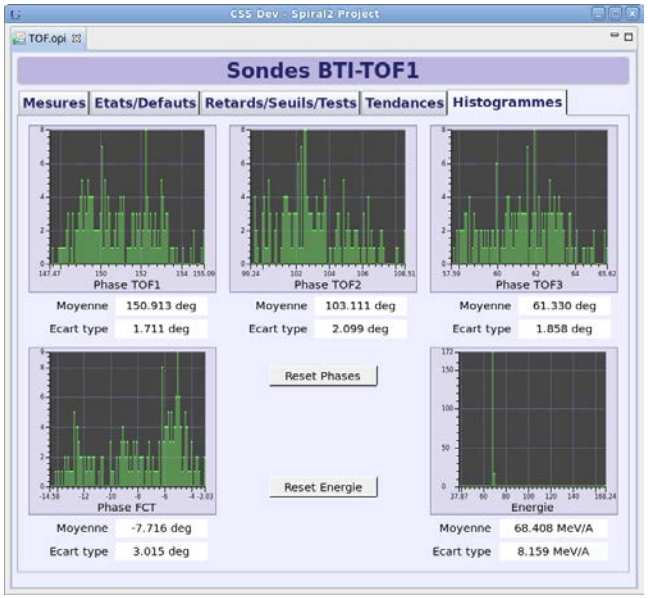
- The Spiral2 facility will be a new Rare Ion Beam facility for nuclear physics and astrophysics at Ganil in Normandy
- Spiral2 control system is under the responsibility of Ganil
- 3 French Labs, Ganil (Caen), IPHC (Strasbourg) and Irfu cooperate for the Spiral2 control system



IRFU CONTROL WORK-PACKAGES IN SPIRAL2

- the EPICS platform for the whole project
  - based on VME/VxWorks and Linux PCs
- CS of the injector (2 sources, 2 LEBTs, RFQ)
  - EPICS & PLCs
- some diagnostics controls
  - FC, ACCT/DCCT
  - Slits
  - Fast Current Transformers
  - Time of Flight
  - Agilent oscilloscope EPICS interface

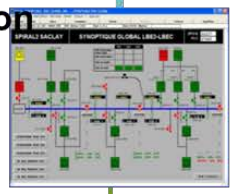
  for the Fast Faraday Cup
- LLRF control



SPIRAL2 LEBT CONTROL ARCHITECTURE

EPICS supervision

Muscade supervision for PLCs



Ethernet general network

Ethernet EPICS VME sub network

Ethernet PLC sub network

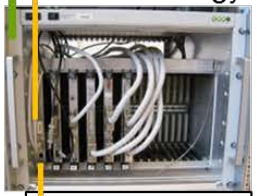
Interlock PLC

Vacuum PLC

Low Beam Energy

Source, CF, sem-grids

Common Low Beam Energy



CF, slits, sem-grids

Profibus DP

173 Input/Output

MKS gauges

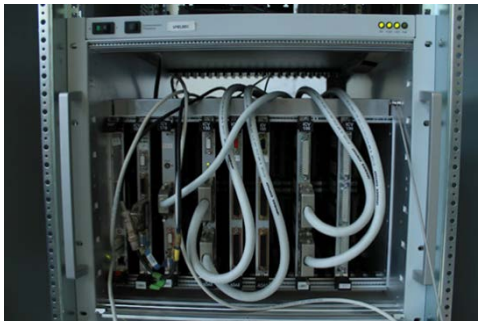
321 Input/Output

Hazemeyer Power Supplies

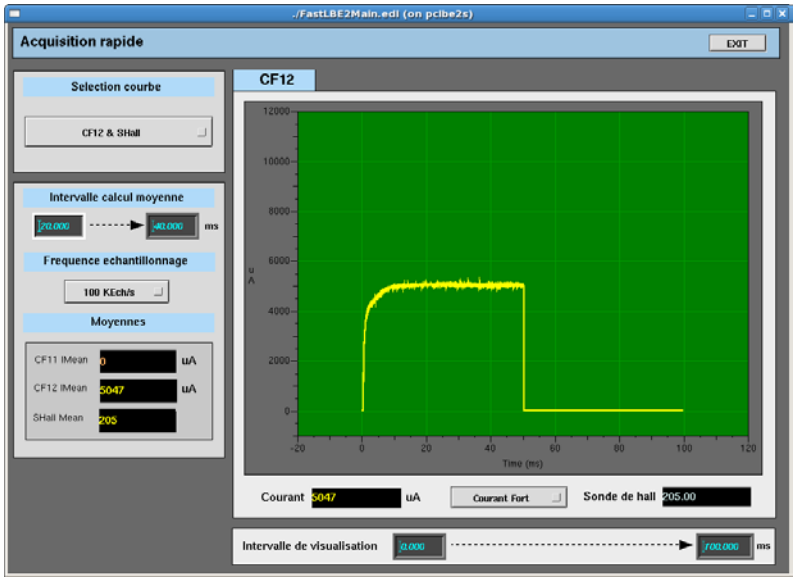
Hazemeyer Power Supplies

SPIRAL2 COMMON HARDWARE PLATFORM

- Emerson MVME 5500 CPU running VxWorks 6.9
- VME NEXEYA ADAS boards/EPICS drivers
  - ICV150: 32 ADCs, 16-bit resolution, 30 K samples/s
  - ICV714: 16 DACs, 12-bit resolution
  - ICV196: 96 binary I/O channels
  - **ICV108: a controller board with RAM 4 Mbytes, external trigger**
  - **ICV178: 8 ADCs, 16-bit resolution, 50 K Samples/s up to 1.2 M Samples/s**



EPICS driver developed for the synchronised intensity measurement (FC, ACCT, EMU) on Spiral2 and then used on other projects



COMMON EPICS SOFTWARE PLATFORM

- EPICS 3.14.12.4
- Homogeneous development was needed between the 3 labs to ease integration
  - Rules :
    - for naming files and global functions
    - for naming PVs
  - Development model used by each developer
    - Top directory topSP2
    - Application module template
    - IOC (VME/Linux) module template

SPIRAL2 DEUTERON SOURCE CONTROL

50 KV PS polarization plaft

30 KV PS, intermediate electrode

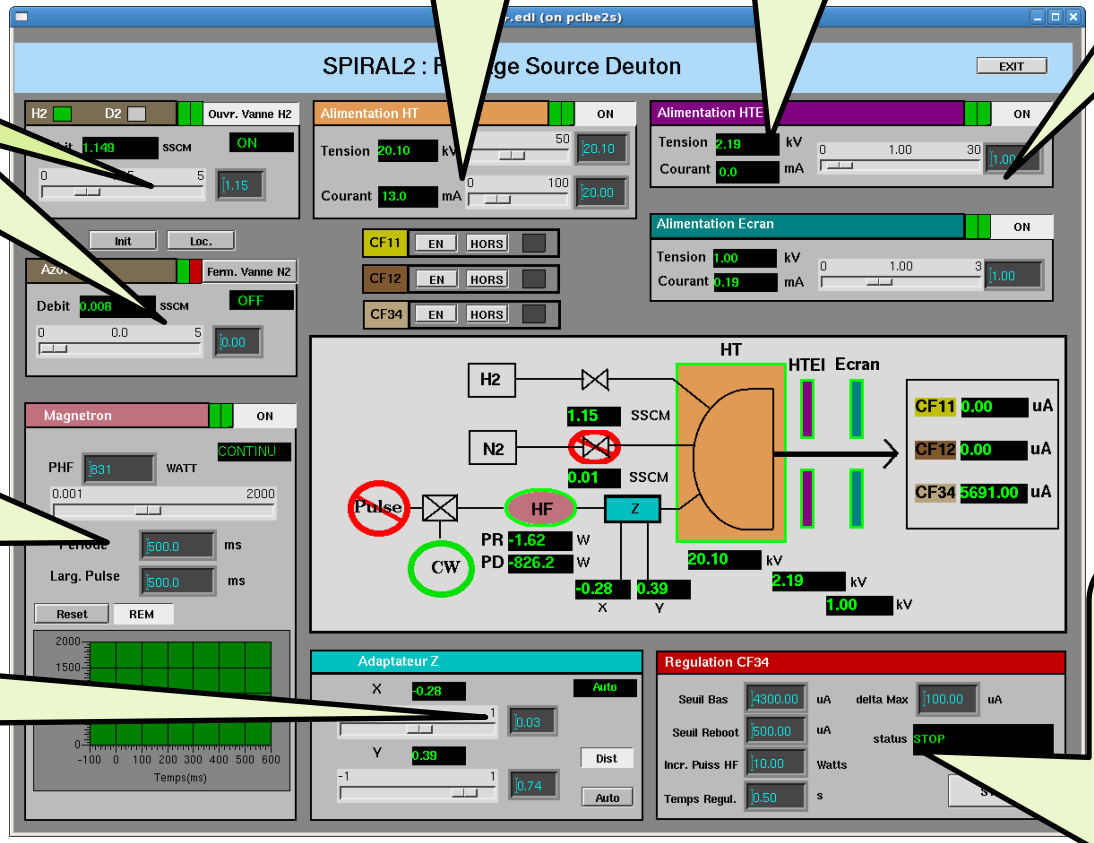
-3 KV PS repelling electrode

2 Flow controllers: Deuterium/Hydrogen & Nitrogen

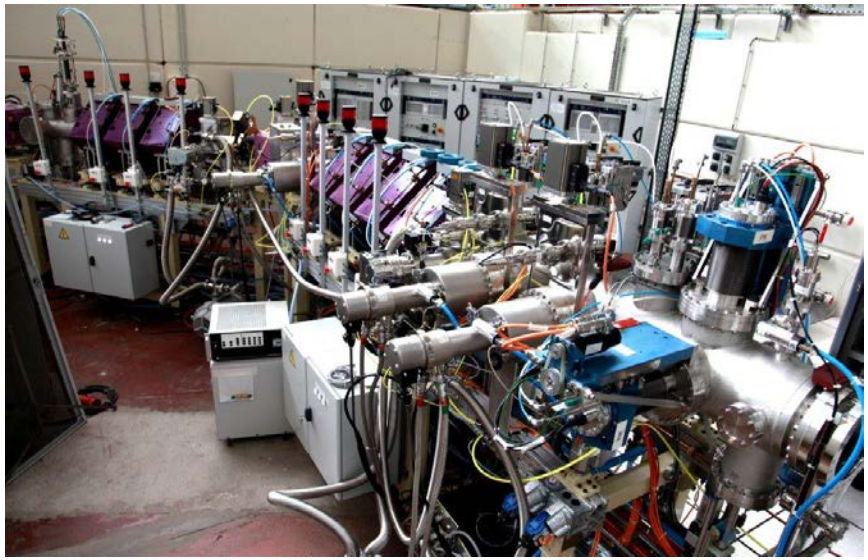
Agilent pulse generator & RF generator= magnetron

Automatic Tuning Unit= impedance adapter

SNL program for regulation based on the beam current reading



SPIRAL2 LEBT TESTED AT SACLAY



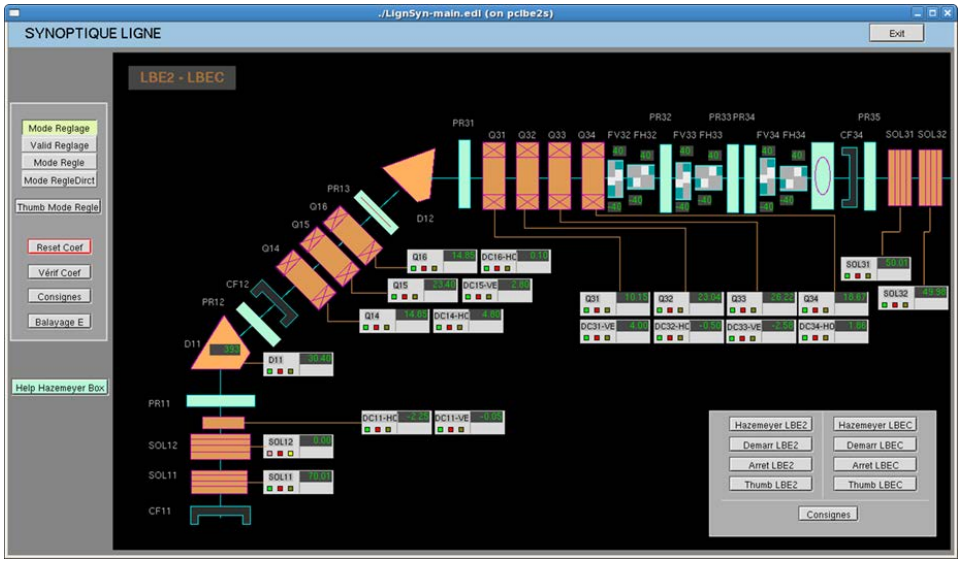
Controls of diagnostics & 20 Power Supplies

Diagnostics:

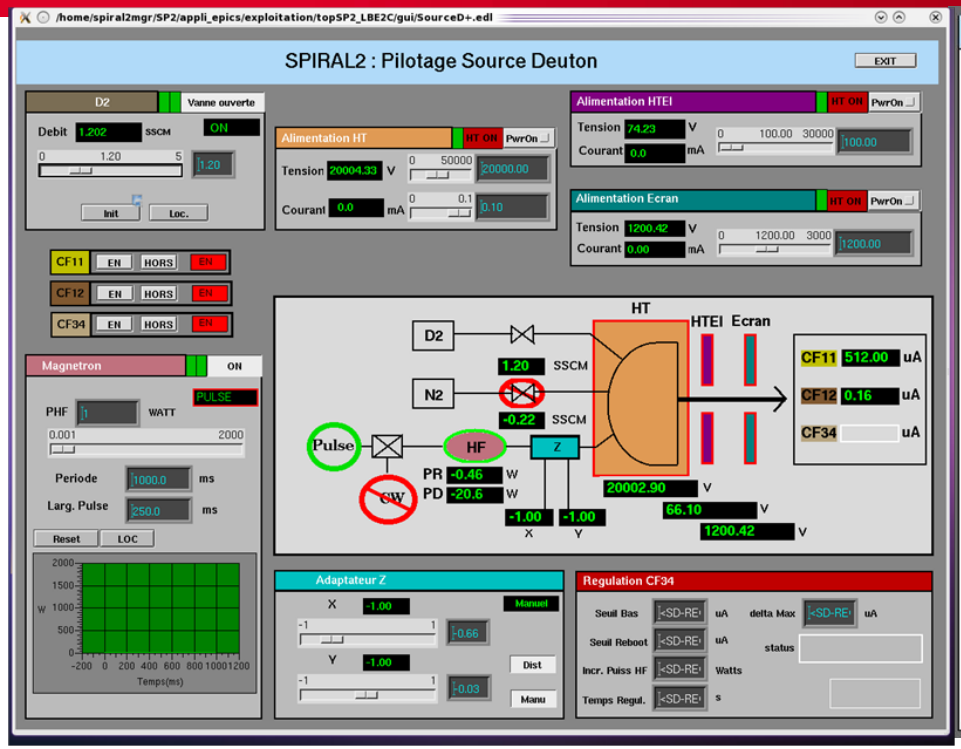
FC, ACCT & DCCT, SEM-grid harps (Ganil), Allison emittance-meters (IPHC), Slits => VME or Modbus/Tcp used

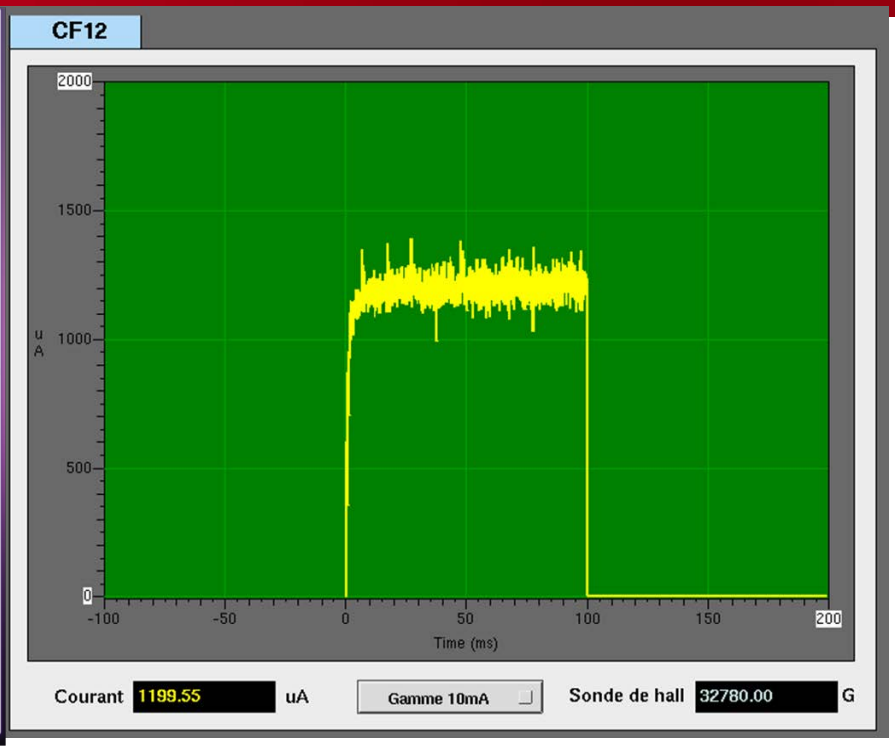
20 Hazemeyer Power Supplies :

- 2 dipoles
- 2 solenoids
- 7 quadrupoles
- 9 steerers
- Connected to Ethernet fieldbus & accessed via Modbus/TCP
- A common software interface (Ganil)



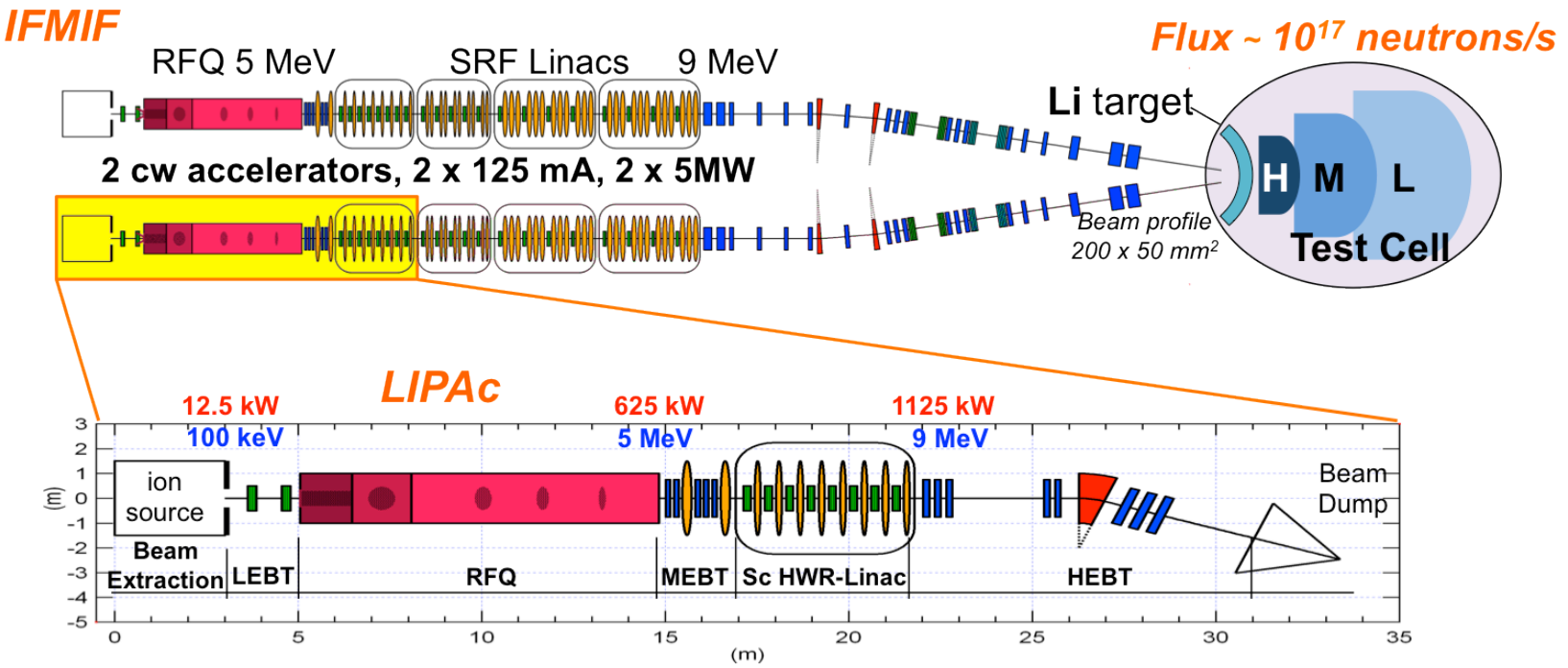
A FIRST BEAM AT GANIL FOR CHRISTMAS 2014





- Tests at Saclay and Grenoble stopped in May 2012
- Saclay LEBT control system was quickly reinstalled at Ganil just before Christmas 2014
- Intensity 1.2 mA measured on the Faraday Cup

CEA COLLABORATION IN LIPAC (IFMIF)



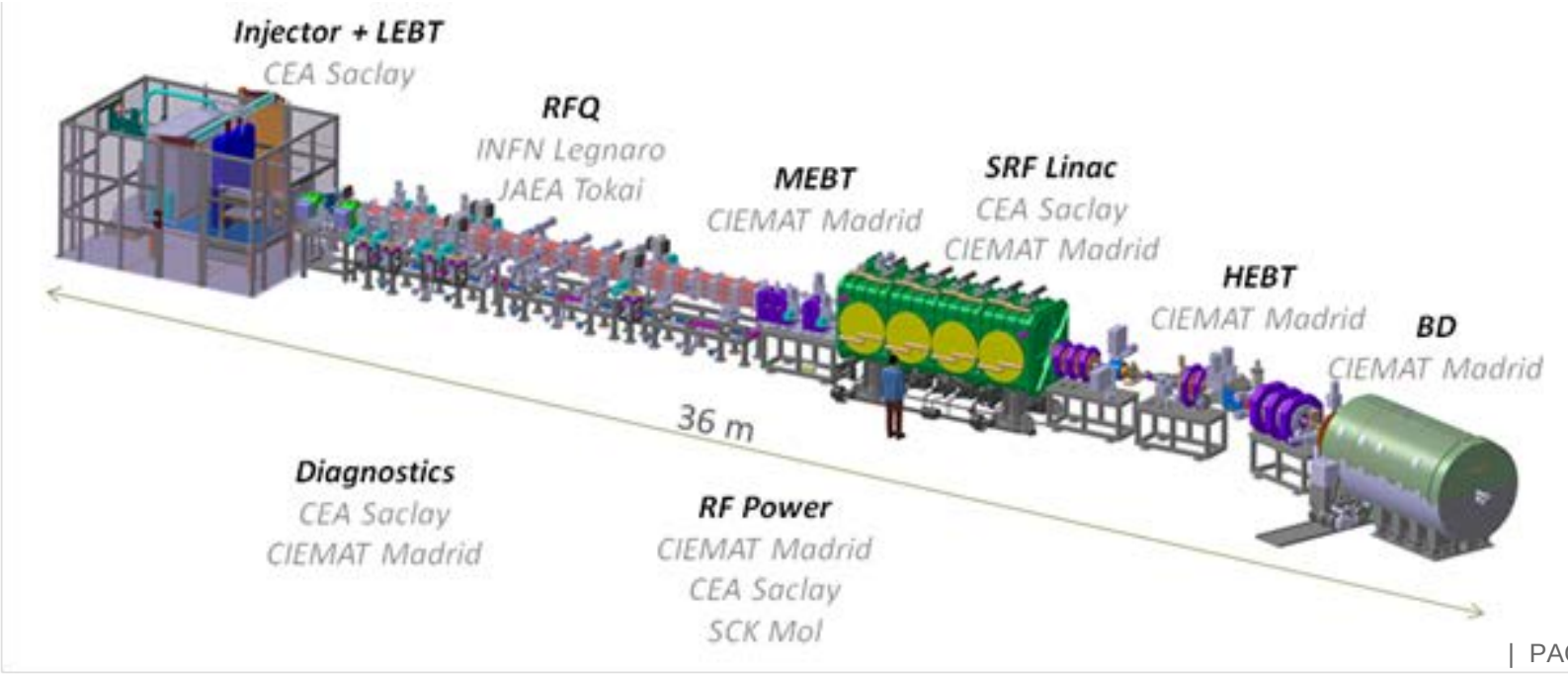
- IFMIF (International Fusion Materials Irradiation Facility) purpose: provide an accelerator based on a neutron source to produce high-energy neutrons (deuterons) at sufficient intensity and irradiation volume to qualify materials for fusion reactors

- A prototype LIPAc (Linear Ifmif Particle Accelerator) identical to the low energy section of IFMIF is being built to check the validity of the design before launching the IFMIF construction

LCSS SHARED BETWEEN 3 INSTITUTES

- LIPAc is developed under the Broader Approach for Fusion agreement between Europe and Japan. 3 European countries are involved: France, Italy and Spain and share the sub-systems

- The control system is split into different LCSs between Ciemat Madrid, INFN Legnaro and CEA Saclay



IRFU IN CHARGE OF TRANSVERSE COORDINATION

- Responsible for the general design and of the choice of solutions
- Check the compatibility of LCSs choices compared to the standard solutions
- Responsible for the acceptance tests through European LCSs

LCS	Institutes
Source & LEBT	CEA Irfu
RFQ	INFN Legnaro
MEBT	Ciemat Madrid
SRF Linac	Ciemat & CEA
Diagnostics	CEA & Ciemat
HEBT	Ciemat Madrid
Beam Dump	Ciemat Madrid
Coordination	CEA Irfu

LIPAC TRANSVERSE COORDINATION

- EPICS software platform
  - Identical to Spiral2 platforms (hardware & software)
  - With the same templates to use for development
- Guidelines for installation
- Guidelines for development
- Guidelines for naming
- Template LCS Acceptance Test
  - To be filled up and followed step by step during the acceptance

LCS ACCEPTANCE TESTS (1)

- Checking of the manuals
  - User manual
  - Maintenance manuals (one per device)
    - Design of software development
    - Hardware configuration
    - Scenarios to test controls

- Checking software installation
  - Start from scratch
  - The complete LCS software has to be reinstalled automatically if possible
  - Checking of the topIFMIF tree
  - Checking of the database records naming

} Scripts

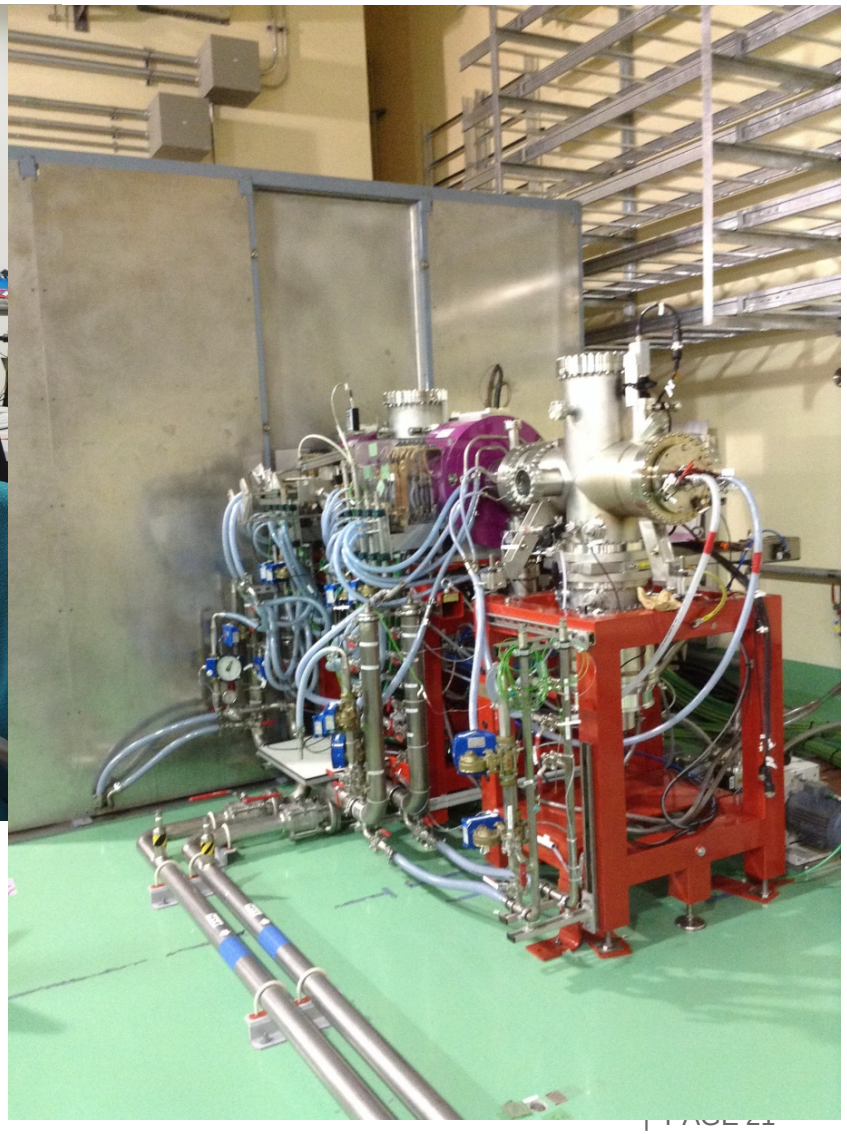
LCS ACCEPTANCE TESTS (2)

- Application module acceptance test
  - Checking scenarios adapted by the person/developers in charge of the LCS
- Release acceptance test
  - This phase concerns the test of the full system from the LCS user interface to the I/Os.
- Global acceptance test
  - All LCSs connected to the Rokkasho network and Central Control system

- **CEA diagnostics European LCS acceptance tests took place in May 2014**

- **Injector LCS acceptance at Rokkasho in November 2014**

LIPAC INJECTOR AT ROKKASHO



Control system tested October 1st-9th

First beam: November 4th
70keV/40mA 100ms 10%duty

ESS: COLLABORATION ON CS WORKPACKAGES

- EPICS chosen by ESS
- Proton source and LEBT with diagnostics controls to be tested at INFN/Catania in 2015
- RFQ and MEBT discussions in progress to define our scope about controls

CONCLUSION

- Experience of EPICS developers through Spiral2 and LIPAc facilitated our entrance into the ESS collaboration controls
  - Experience in injector controls
  - Experience in diagnostics controls
  - Our methods of work through different Laboratories
- Context different from Spiral2 or LIPAc
  - Standard platform designed and provided by ESS
  - Opportunity, to use more recent technologies
- Fall EPICS meeting (110 attendees) 21-23 October 2014

ACKNOWLEDGEMENTS

- To the complete control system teams:
- PLCs team (SIS/LDISC)
- Electrotech team (SIS/LEIGE) for their work designing racks & cabinets for the control system of Spiral2 Injector and LIPAc.