HIE-ISOLDE Commissioning Plan & Operation Software

D.Lanaia*, M.A. Fraser, D. Voulot

*The research project has been supported by Marie Curie Early Initial Training Fellowship of the European Community's Seventh programme under contract number (PITN-GA-2010-264330-CATHI)

HIE-ISOLDE Workshop 28-29th Nov 2013

Outline

- Introduction
- Timeline for commissioning
- Control System & Generic CERN Applications
  - 3 Tier Architecture
    - ✓ F.E.S.A. Class (Front End Software Architecture);
    - ✓ InCA (Injector Control Architecture);
  - TIMBER (Login and data monitoring)
- REX - ISOLDE's Software and Applications
  - REX EBIS and Trap
  - Working Set & Equipment Array
  - Beam Diagnostic Application
  - Mass & Energy Scan
- Specific applications for HIE-ISOLDE
  - Beam Diagnostic Concept
  - T.O.F. (Time of Flight)
  - HIE-Phase-Up
  - HIE-Converter
  - Setting Generator
- Conclusion

Introduction

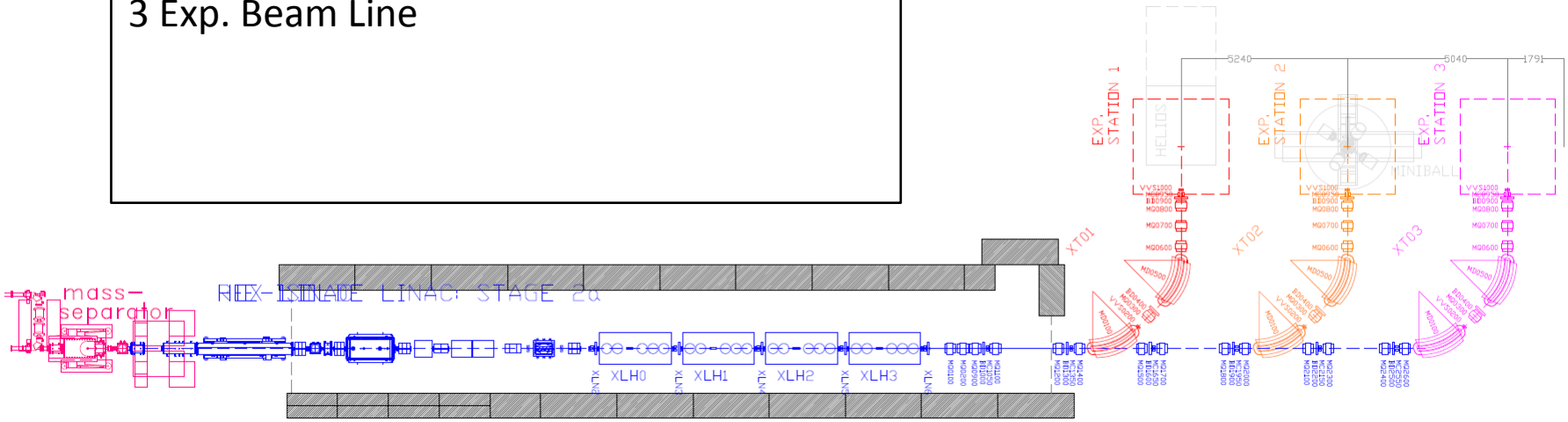
- **REX:** Post Accelerate Radioactive Ion Beam (RIB)
  - **RIB:** Weak and difficult to detect in standard diagnostic
  - **Scale:** Standard way of machine tuning

HIE ISOLDE Linac Stage1:

REX + 2 High β cryomodule
10 SC cavities
2 < A/q < 4.5
Max Energy > 5.5 MeV/u (A/q = 4.5)
Energy fully variable from 0.45 to 5.5 MeV/u
2 Exp. Beam Line 3rd as option

HIE ISOLDE Linac Stage2:

REX + 4 High β cryomodule
20 SC cavities
RFQ Buncher + IHS + 3 Seven Gap + 9 Gap
2 < A/q < 4.5
Max Energy ≈ 10 MeV/u (A/q = 4.5)
Energy fully variable from 0.45 to 10 MeV/u
3 Exp. Beam Line

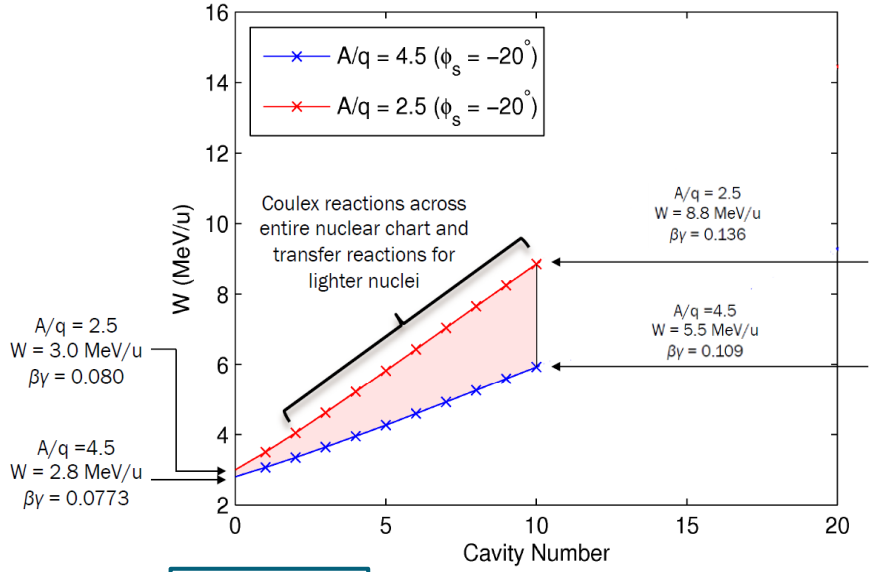


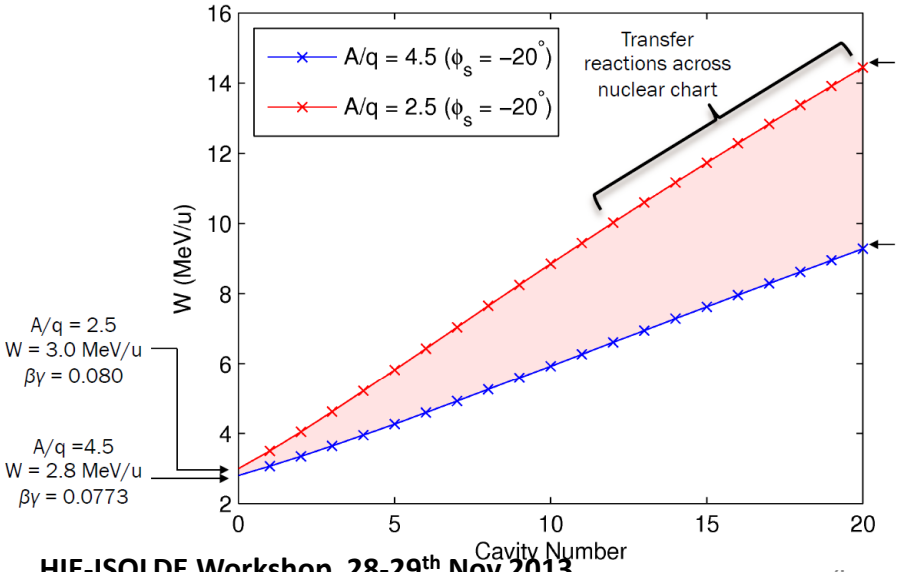
HIE-ISOLDE: Energy Performances

Energy Performances:

Stage 1:

A/q	Energy [MeV/u]
2	10.1
2.5	8.8
3	7.7
4	6.5
4.5	6.0

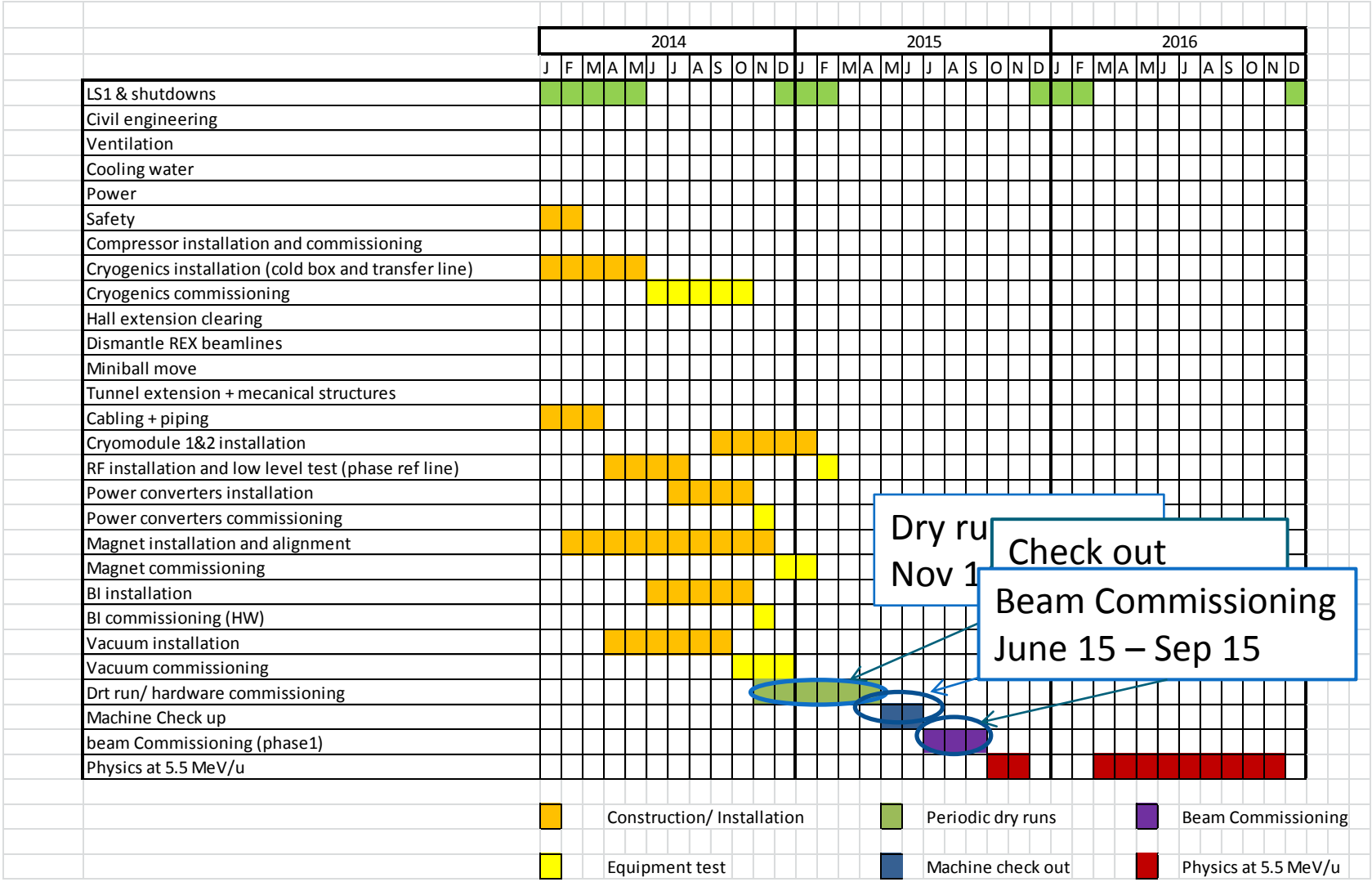




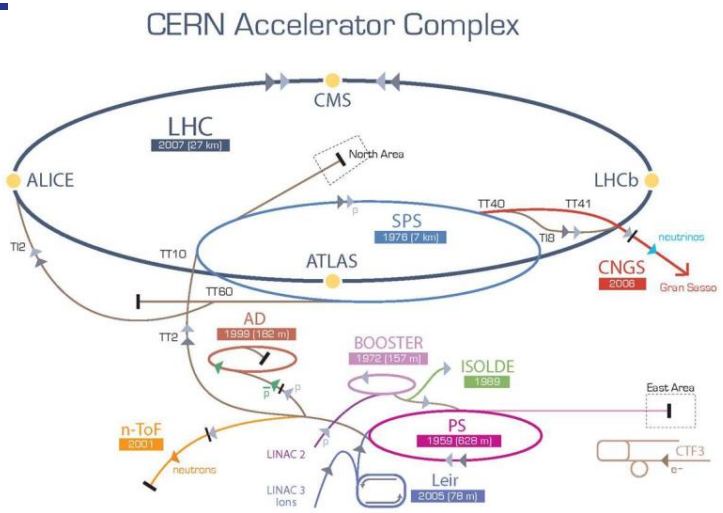
Stage 2:

A/q	Energy [MeV/u]
2	16.9
2.5	14.3
3	12.5
4	10.2
4.5	9.4

Time Line for Commissioning



CERN Control System



- CERN has an integrated **control infrastructure** deployed over **all** the CERN accelerator complex.
  - Advantages:
    - ✓ Many generic applications/tools
    - ✓ Support BE/CO
    - ✓ Portability
  - Boundary conditions:
    - ✓ Need to follow standard architecture
    - ✓ Programming: language Java

Controls Software Infrastructure

3-tier Architecture

Control Room Workstation

Java Based Protocol

System InCa Applications Server

Communication Middleware

F.E.C (Front End Computer)
- FESA Class
- Real Time Tasks

InCA (Injector Control Application):
- Reduce duplication
- Reduce Maintenance Cost
- Improve performances of the control system

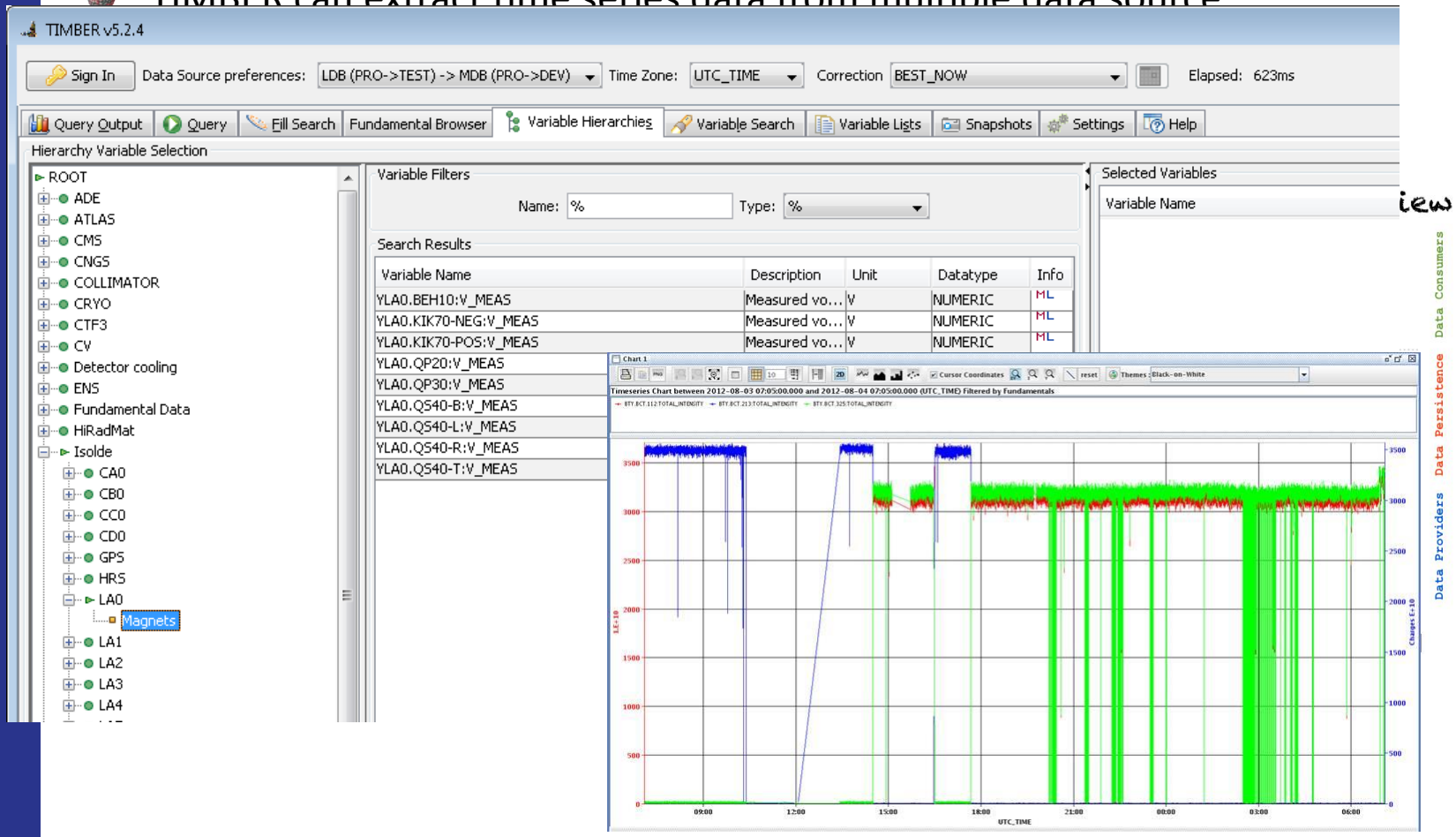
FESA in charge of:
- Hardware abstraction
- Real time control of equipment
- Runs on Front End Computer

Application Strategy for HIE ISOLDE

- HIE ISOLDE Applications will be fully integrated in the CERN control system
- Use of general tools developed for CERN
  - DIAMON
  - TIMBER
  - INSPECTOR
  - Working Set
- Use of existing application developed for REX-ISOLDE
  - Upgrade where needed
- Development of specific new application for HIE ISOLDE
  - Converter
  - Phase Up
  - Time of flight

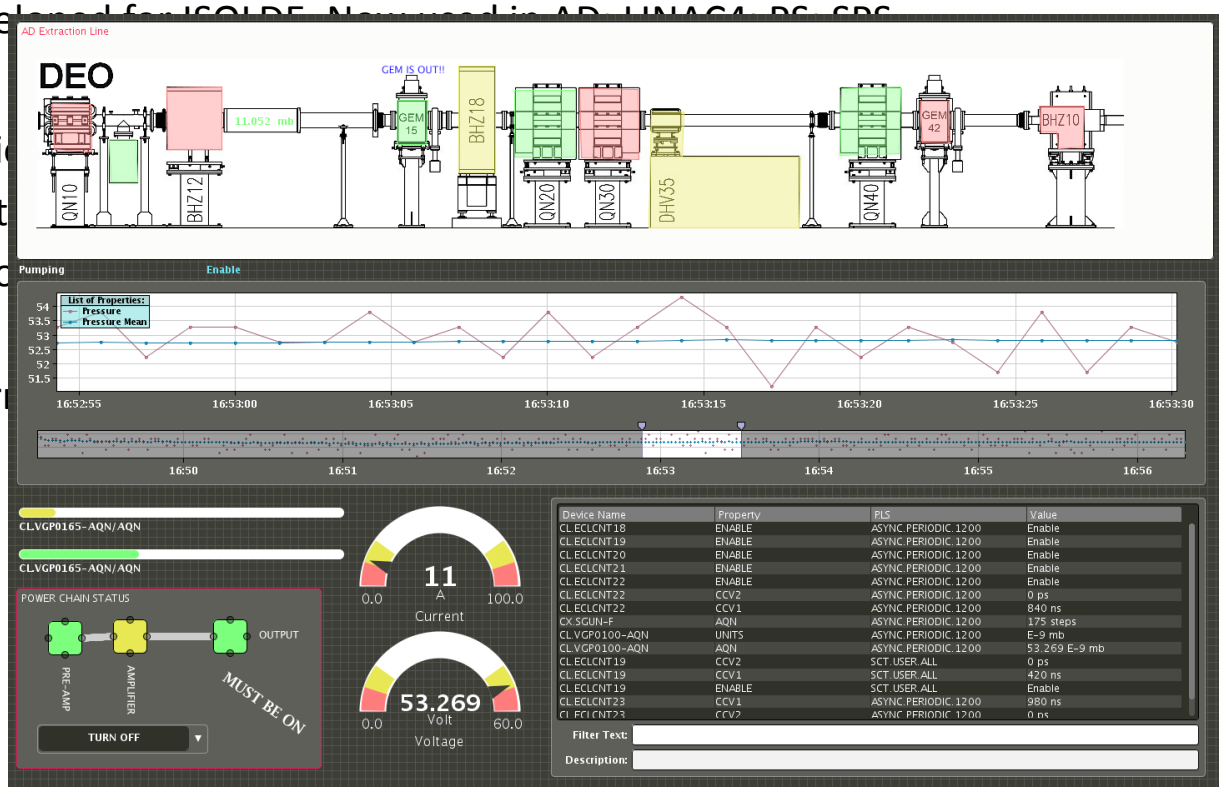
Timber: Login and data monitoring

- Developed for LHC
- TIMBER can extract time series data from multiple data source



Inspector: Integrate Synoptic

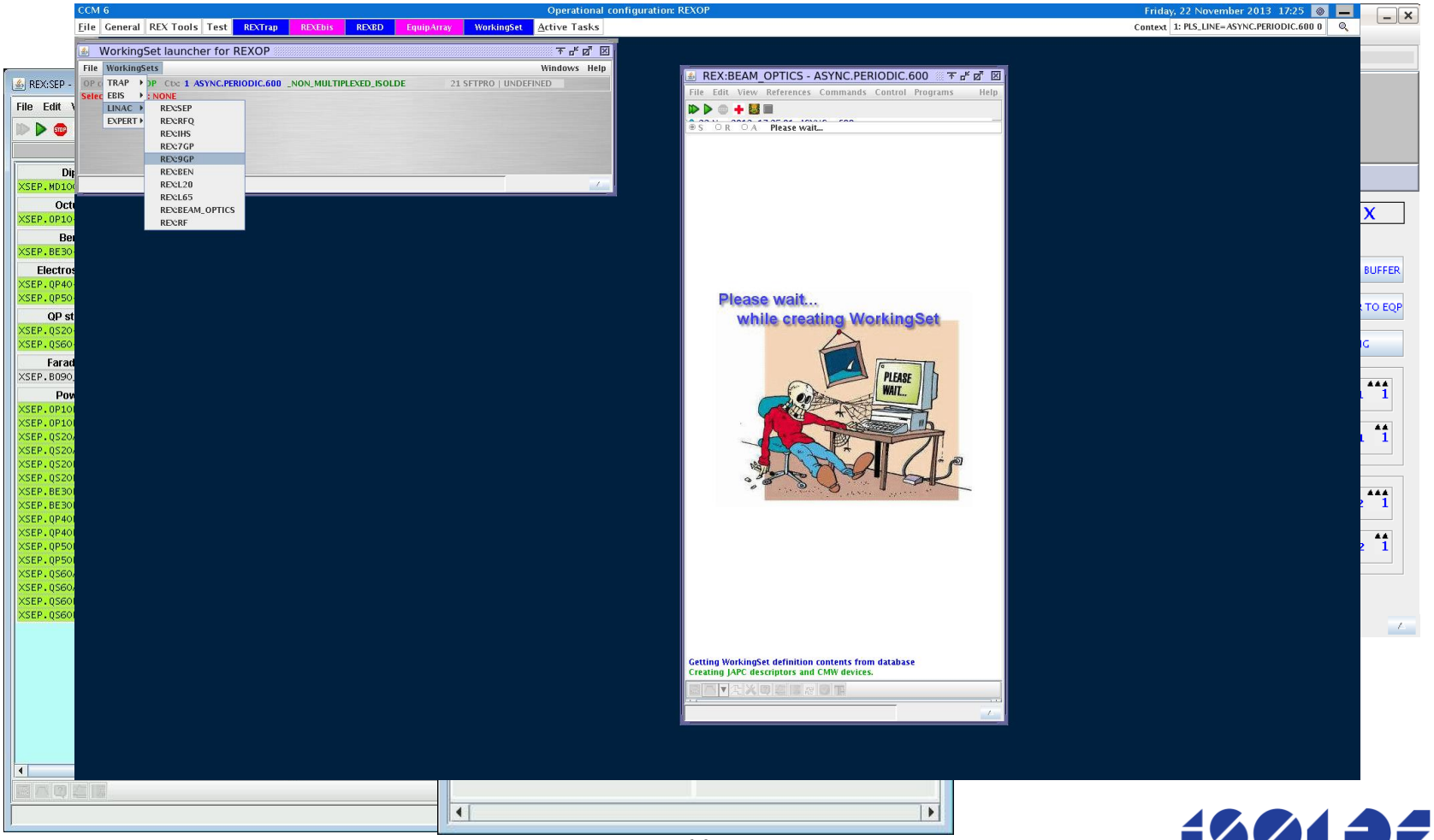
- What is it?
  - Graphical framework implemented in Java that allows to control and to monitor any CERN standard equipment.
  - Application deve[illegible]
- What it does:
  - - Rapid applicati[illegible]
  - - Device acquisit[illegible]
  - - Data elaboratic[illegible]
  - - Data logging
  - - Mail/SMS allar[illegible]



Courtesy of: M. Ferrari (BE-OP) & L. Bertrand (BE-OP)

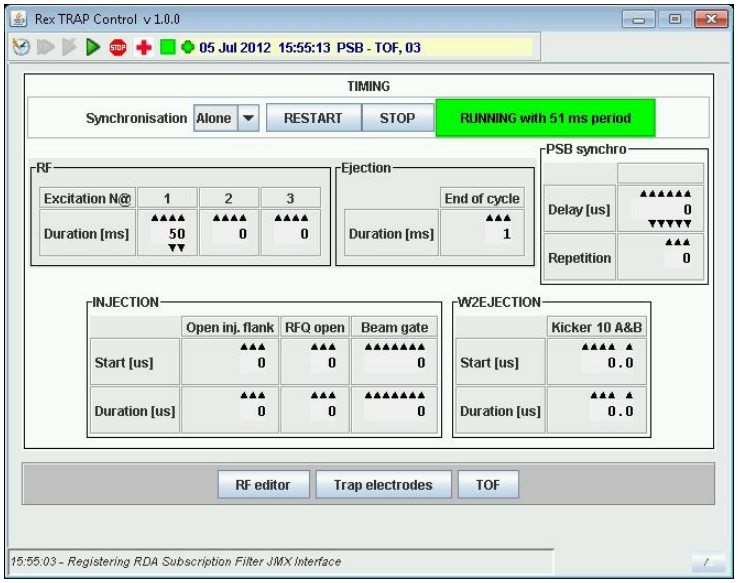
Working Set & Knobs, Equipment Array

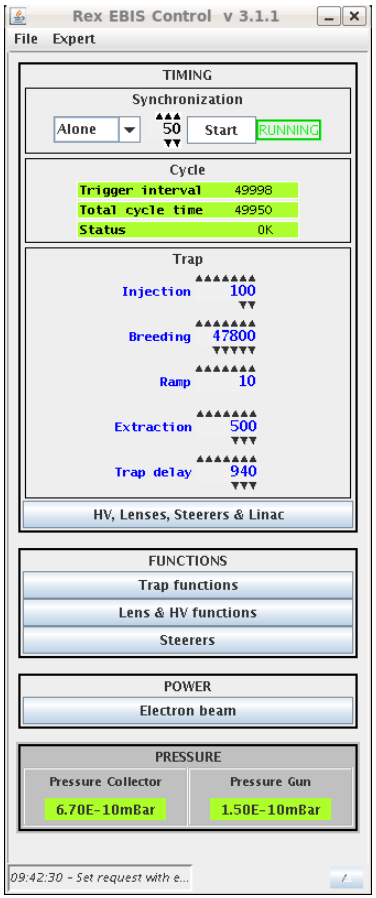
- The **Working Set**
  - group devices together so that generic applications for display acquisition and controls properties can be seen and controlled in a grouped way.

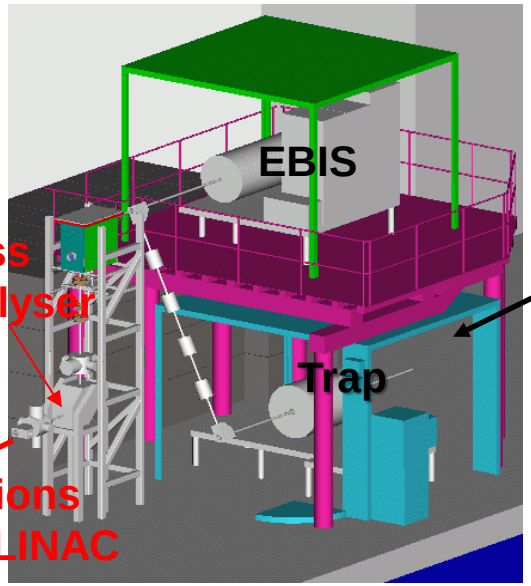


REX - ISOLDE Applications (EBIS & Trap)

Controls and display all REXEbis devices and time settings







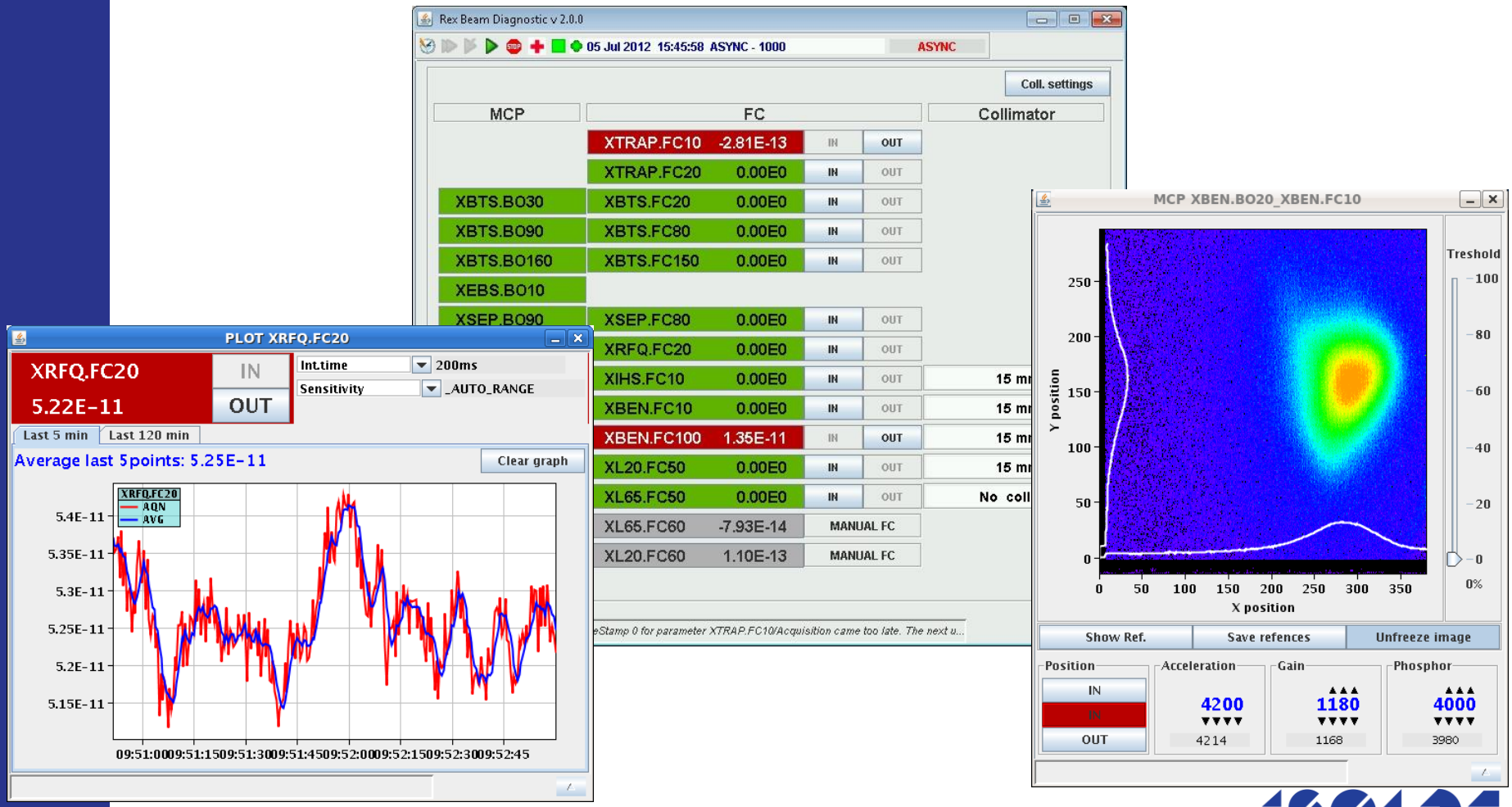
1⁺ ions from ISOLDE

Low energy part of ISOLDE

No change are foreseen for applications

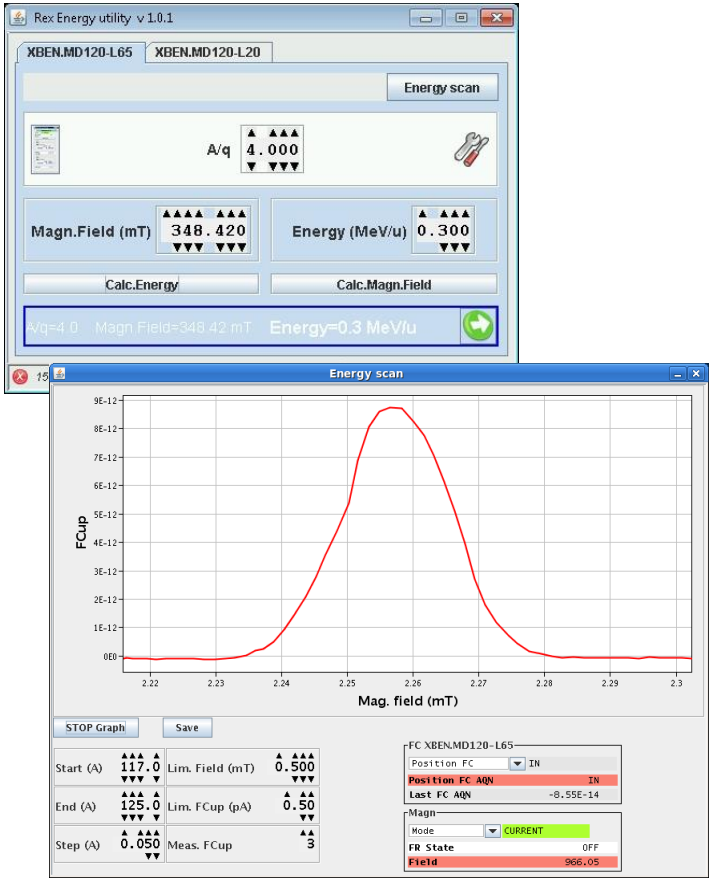
REX - ISOLDE Applications (Beam Instrumentation)

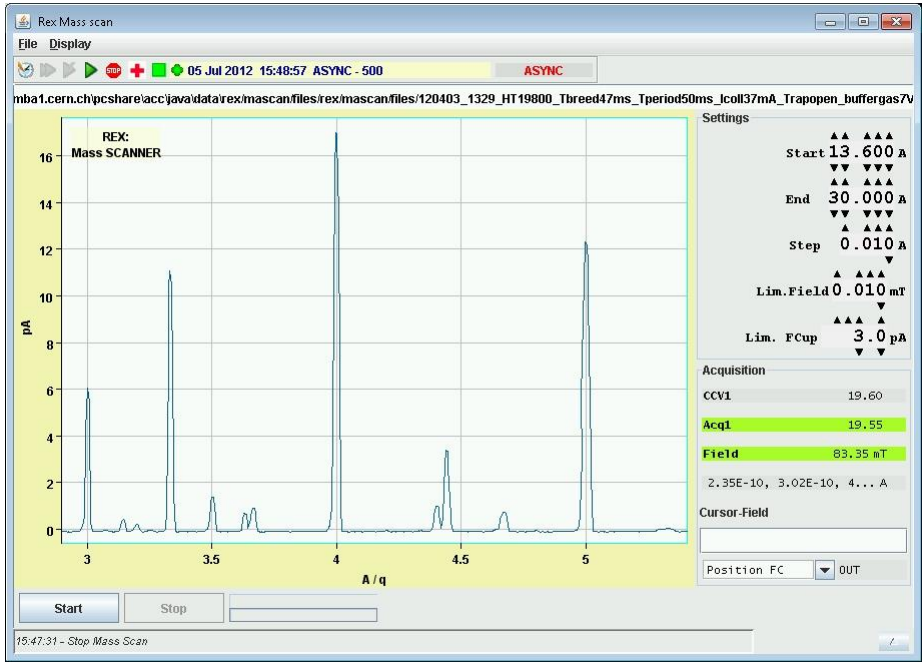
- **Mainly Faraday Cup Based + MCPs**



REX - ISOLDE Application (Utilities)

- **Mass Scan:** Identification of mass peaks and correct A/q selection before the REX - RFQ
- **Energy Scan:** Scan the field of the separator magnet after REX to find the energy

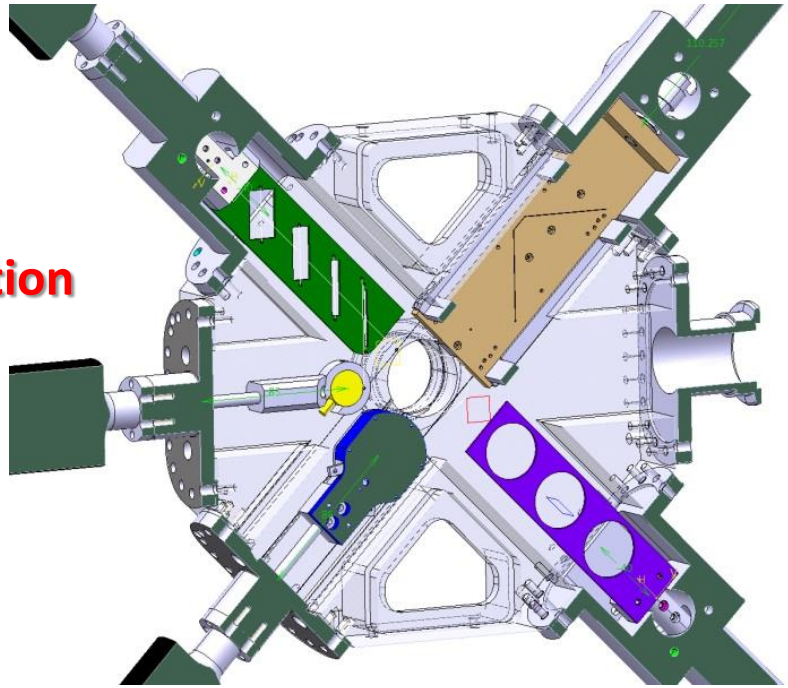




Application for HIE ISOLDE

- **Beam Diagnostics**
  - Beam Intensity and Transmission: Faraday Cup
  - Energy & Time Spectroscopy: Si detector
  - Transverse profile & position: Scanning Slit

Same Concept of the REX Beam Diagnostic Application



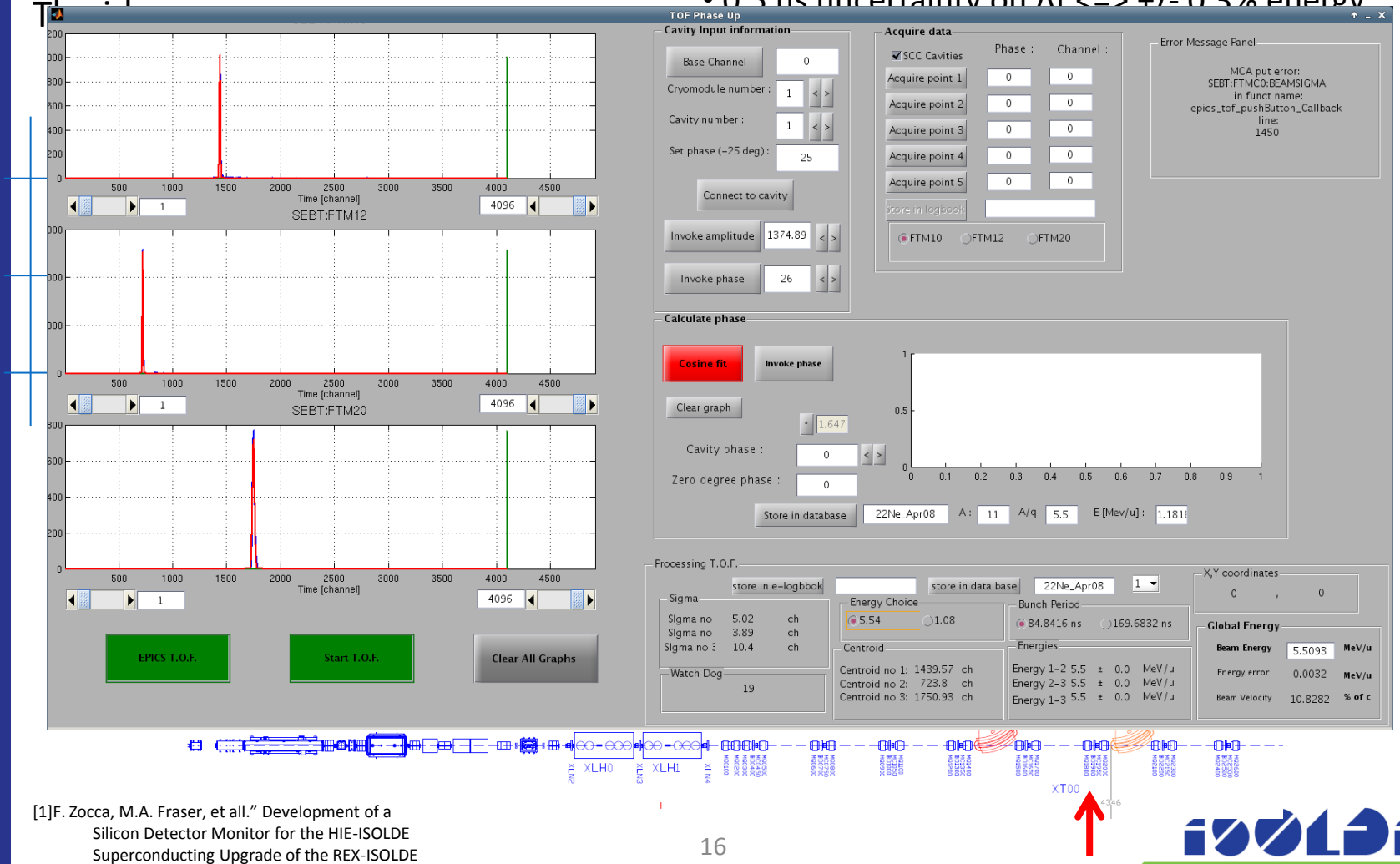
Detailed presentation by:

- **E.D. Cantero**
- **A. Garcia Sosa**

Application for HIE ISOLDE

T.O.F. System

- Get n from bender energy calibration (uncertainty on energy: few %)
- 0.5 ns uncertainty on Δt <=> +/- 0.3% energy

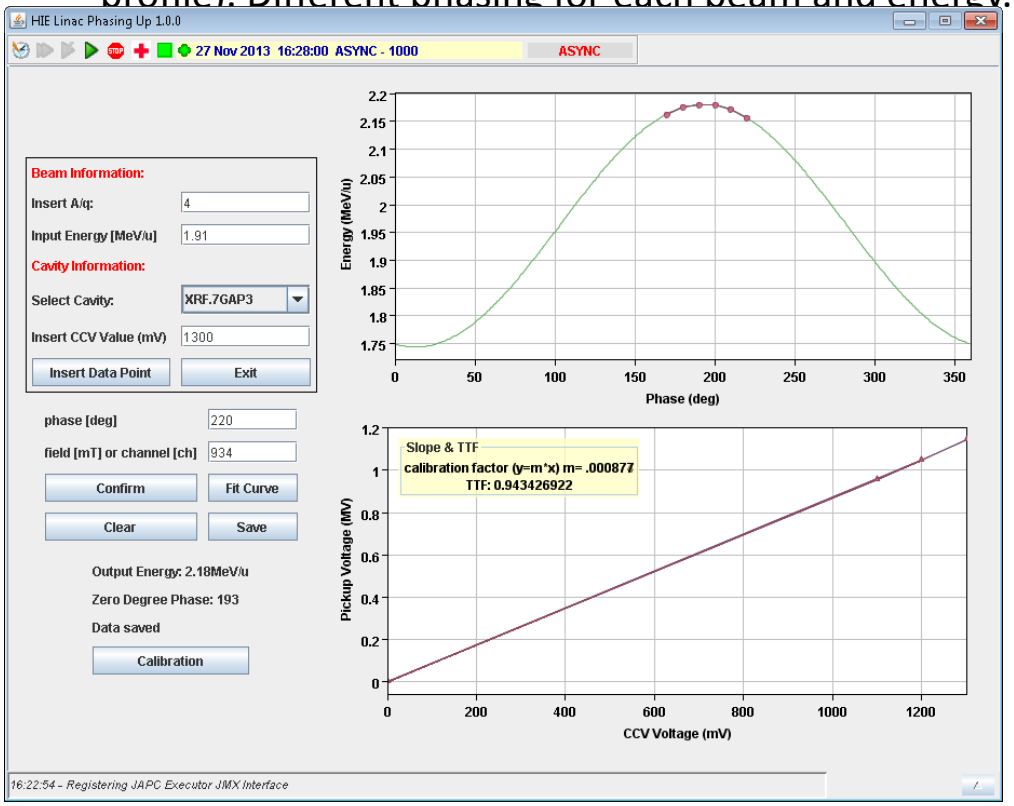


[1]F. Zocca, M.A. Fraser, et all.” Development of a Silicon Detector Monitor for the HIE-ISOLDE Superconducting Upgrade of the REX-ISOLDE Linac”, CERN-HIE-ISOLDE-PROJEJECT-Note-0008

Application for HIE ISOLDE

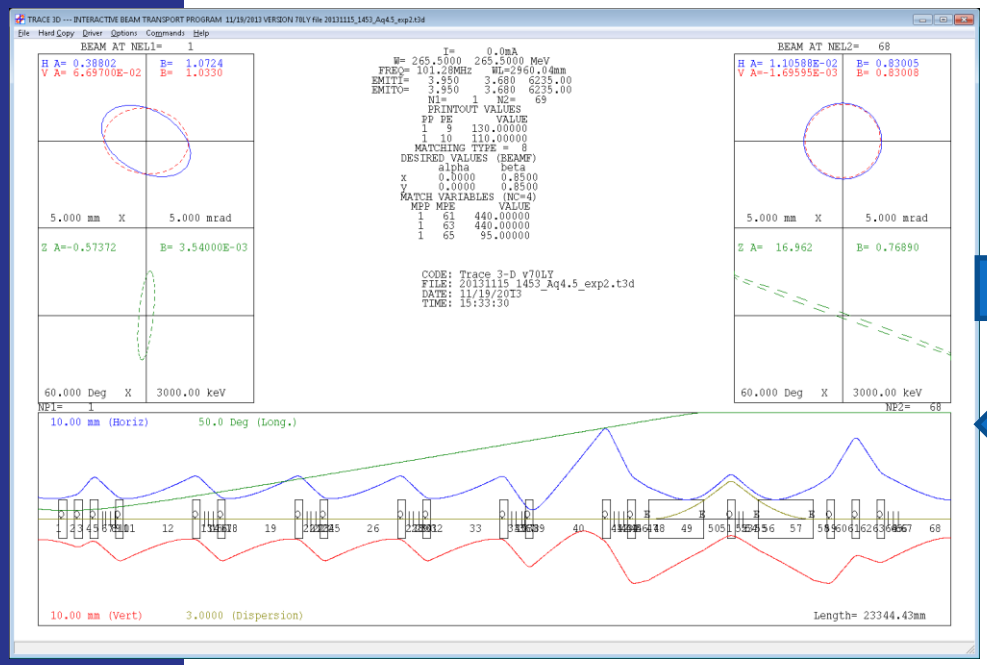
Cavity Phase Up

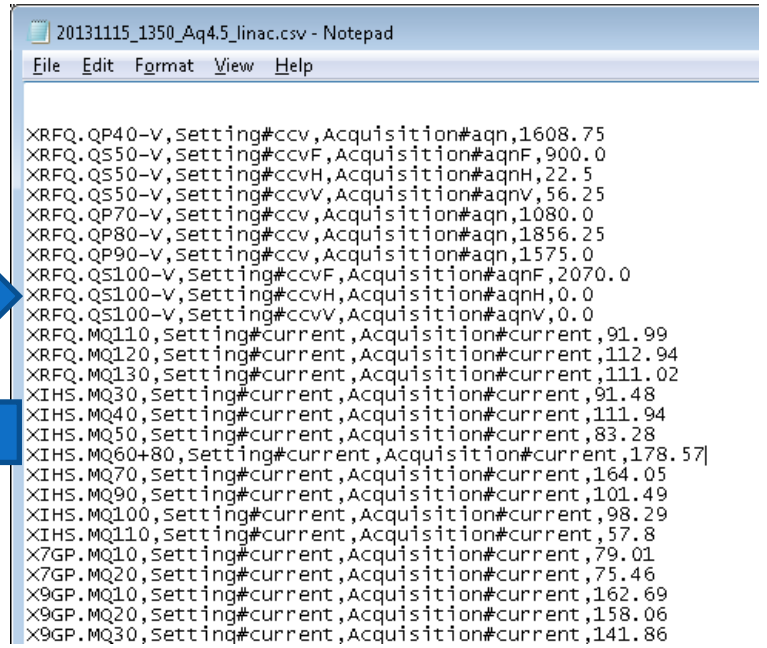
- **REX:** NC machine with fixed velocity profile. -> Phase-up check once per year at machine starts
- **HIE-ISOLDE:** SC machine -> 32 independently-phased cavities (variable velocity profile). Different phasing for each beam and energy.



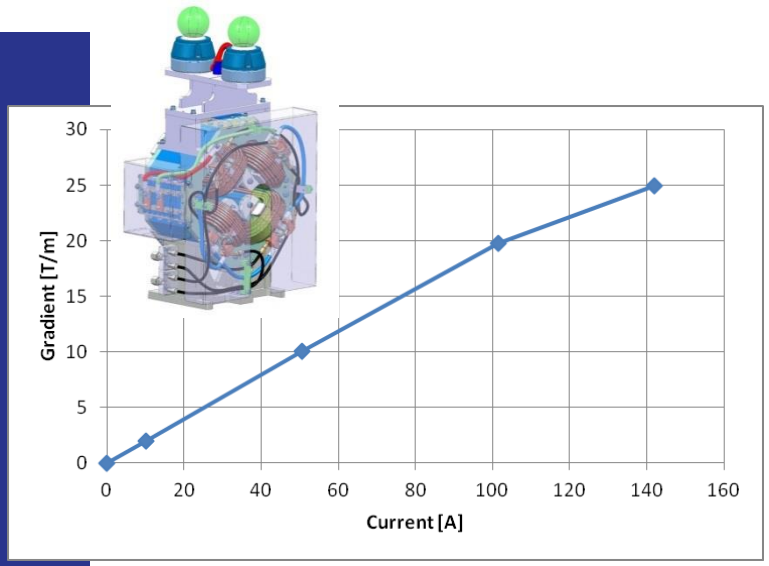
Application for HIE ISOLDE

- **HIE Converter:** Converts optics setting coming from Trace3D in Eq. Array format and vice versa.





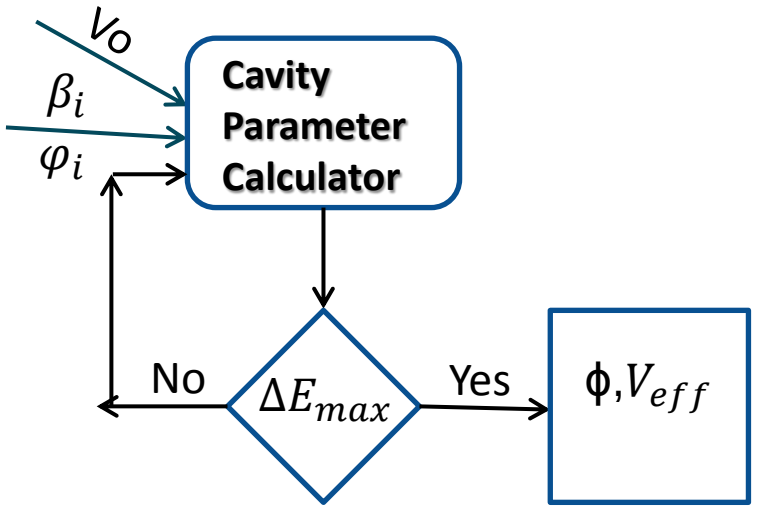
Application for HIE ISOLDE



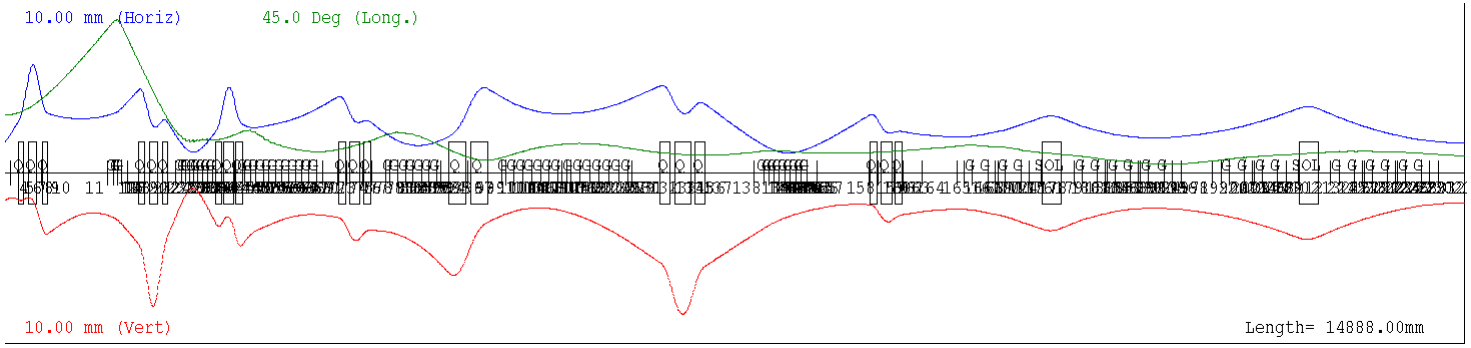
Magnetic Element: Calibration Curve

NC.RF: Fixed. Scaled with A/q

SC.RF: routine that optimize the phase in each gap



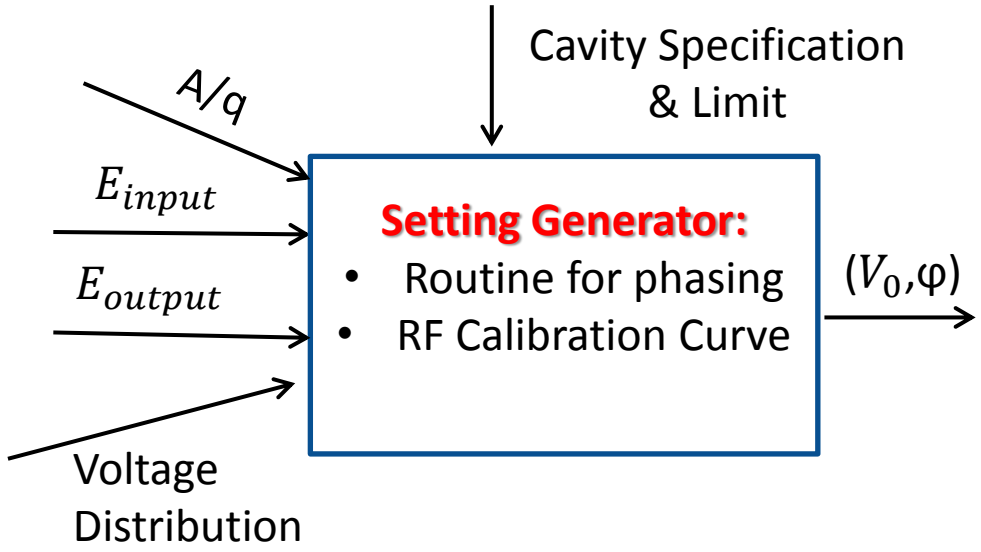
$$\Delta E = \frac{q}{A} V_0 \, TTF(\beta_i) \cos(\varphi)$$



Application for HIE ISOLDE

- **Setting Generator:** Generating SCRF setting from **few** beam input

Time Saving



Summary and Conclusion

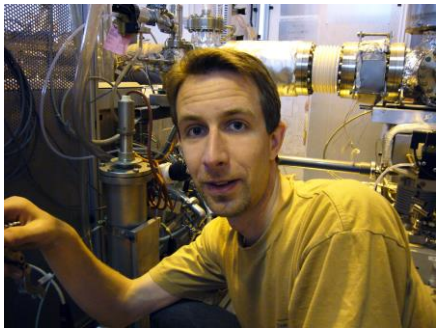
- **Beam Commissioning:** Foreseen in June 2015, last for 3 months
- **HIE - ISOLDE Control System:** Fully integrated with CERN system
  - InCA
  - DIAMON
  - TIMBER
- **HIE - ISOLDE Application:**
  - Keep the same concept of the ISOLDE one. ISOLDE Application will need to updated for the new devices
  - Minimize the need of new application
  - New Application have been developed and test have been performed at ISOLDE
  - Debug will be done as much as possible before beam commissioning
- **Next task:**
  - Implement the setting generator
  - Implement the T.O.F. application

Acknowledgments

- Special Thanks for help and support to:
  - Didier Voulot
  - Matthew Fraser
  - Emiliano Piselli
  - Miguel Lozano Benito
  - Erwin Siesling
  - Fredrik Wenander
  - Pascal Fernier
  - All the ISOLDE Team






Thank you for your attention