

HIE-ISOLDE Commissioning Plan & Operation Software

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

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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

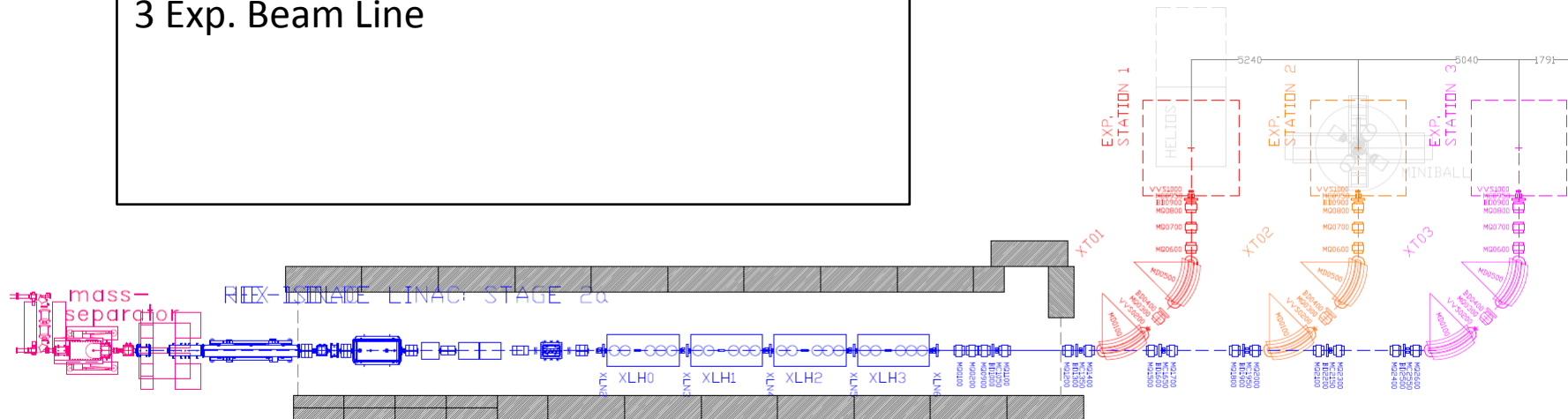
Introduction

- **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:

HIE ISOLDE Linac Stage2:

- REX + 2 High β cryomodule
- 10 SC cavities
- 20 SC cavities
- 2 $4A/q < 4.5$
- 2 $2A/q < 4.5$
- Max Energy > 5.5 MeV/u ($A/q = 4.5$)
- 0 Max Energy ~ 10 MeV/u ($A/q = 4.5$)
- Energy fully variable from 0.45 to 5.5 MeV/u ($A/q = 4.5$)
- 2 Energy fully variable from 0.45 to 10 MeV/u
- 3 Exp. Beam Line

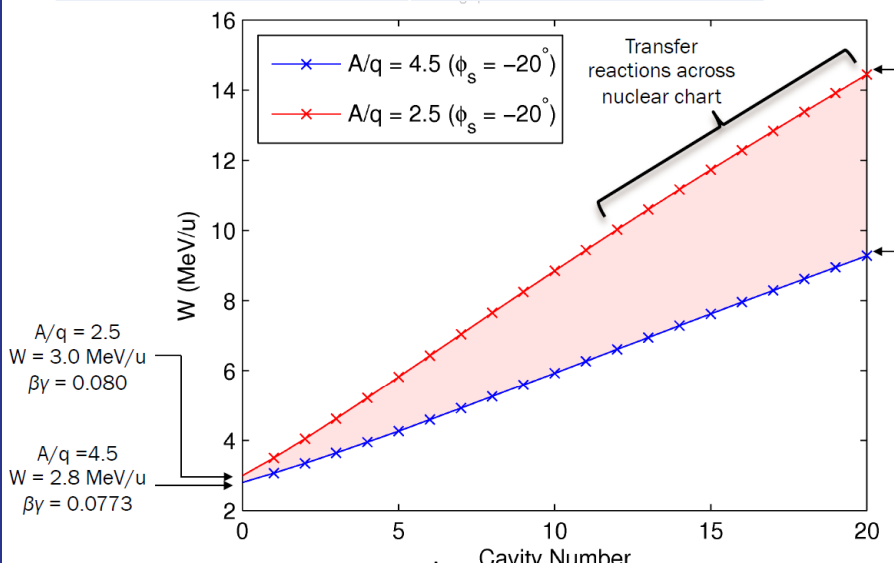
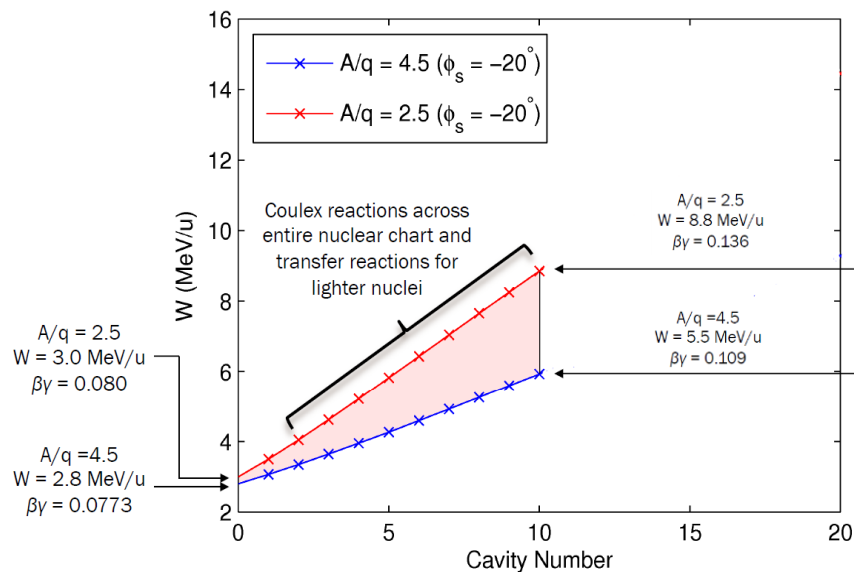


HIE-ISOLDE: Energy Performances

Energy Performances:

Stage 1:

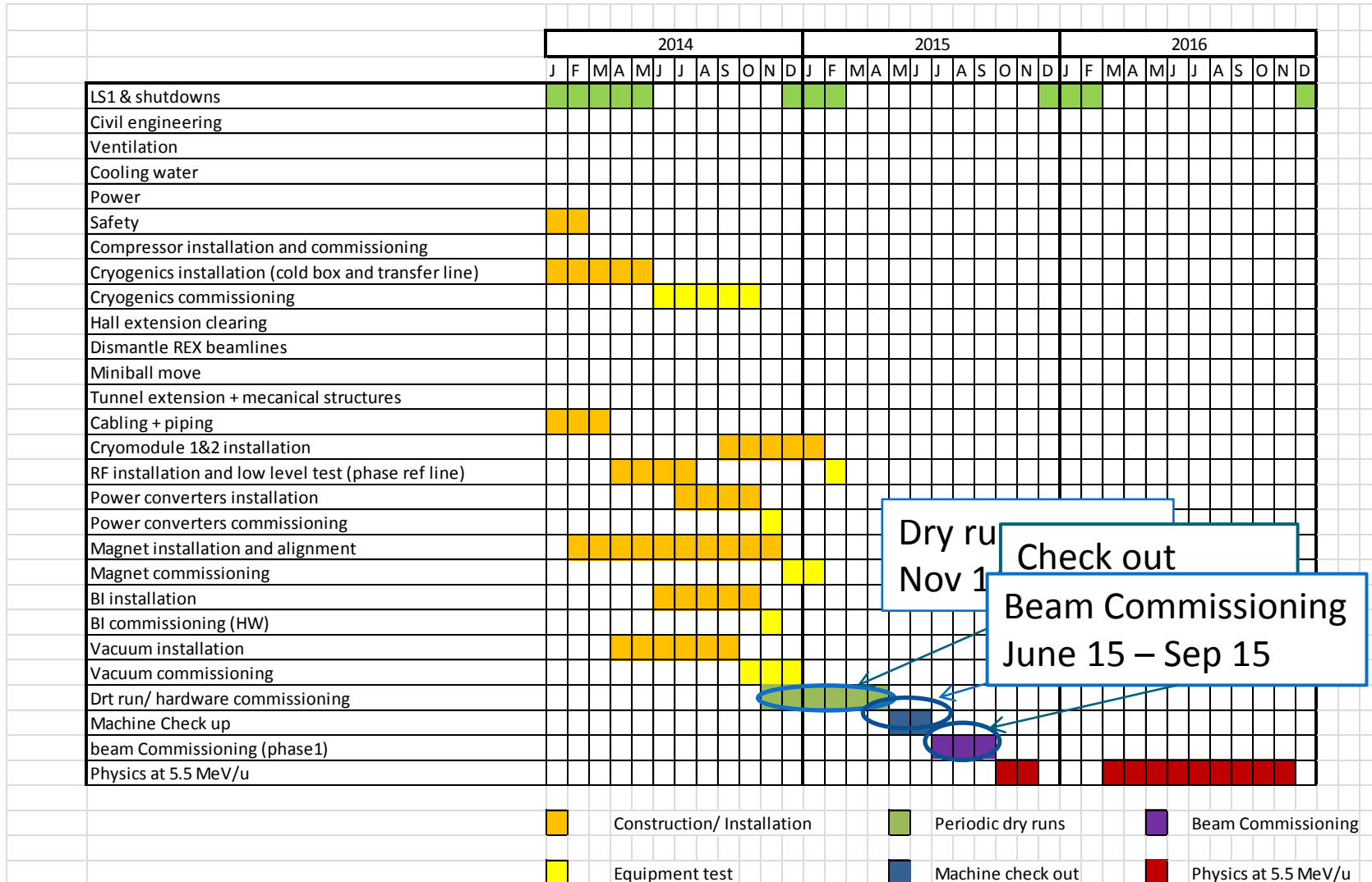
A/q	Energy [MeV/u]
2	10.1
2.5	8.8
3	7.7
4	6.5
4.5	6.0



Stage 2:

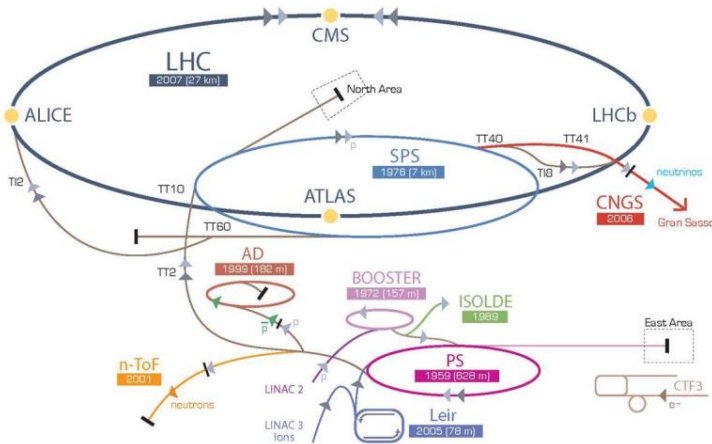
A/q	Energy [MeV/u]
2	16.9
2.5	14.3
3	12.5
4	10.2
4.5	9.4

Time Line for Commissioning



CERN Control System

CERN Accelerator Complex



CERN has an integrated **control infrastructure** deployed over **all** the CERN accelerator complex.

➤ Advantages:



- ✓ Many generic applications/tools
- ✓ Support BE/CO
- ✓ Portability

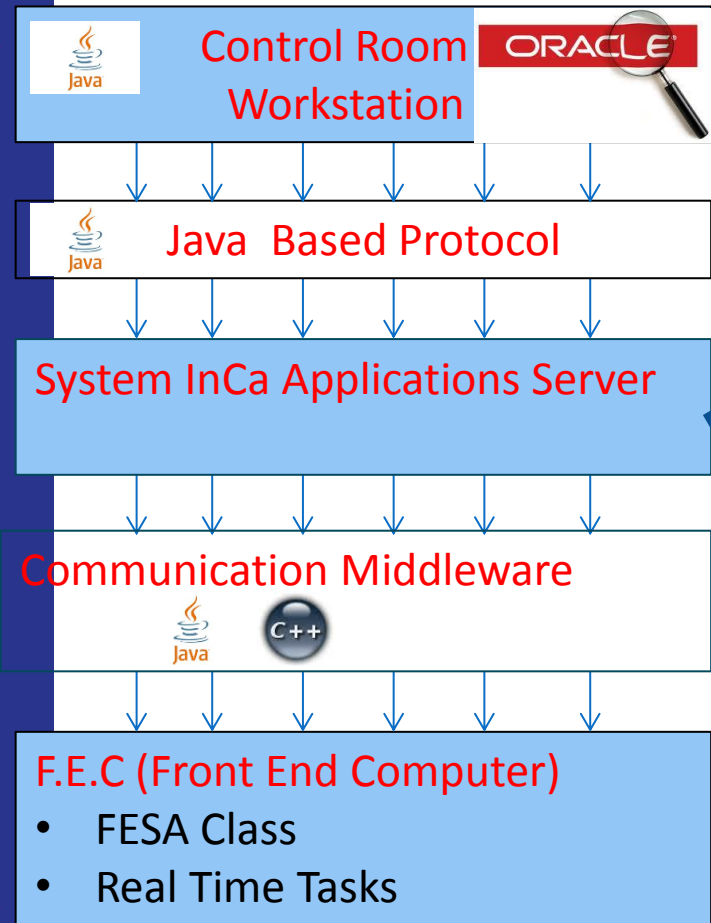
➤ Boundary conditions:



- ✓ Need to follow standard architecture
- ✓ Programming: language Java

Controls Software Infrastructure

3-tier Architecture




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

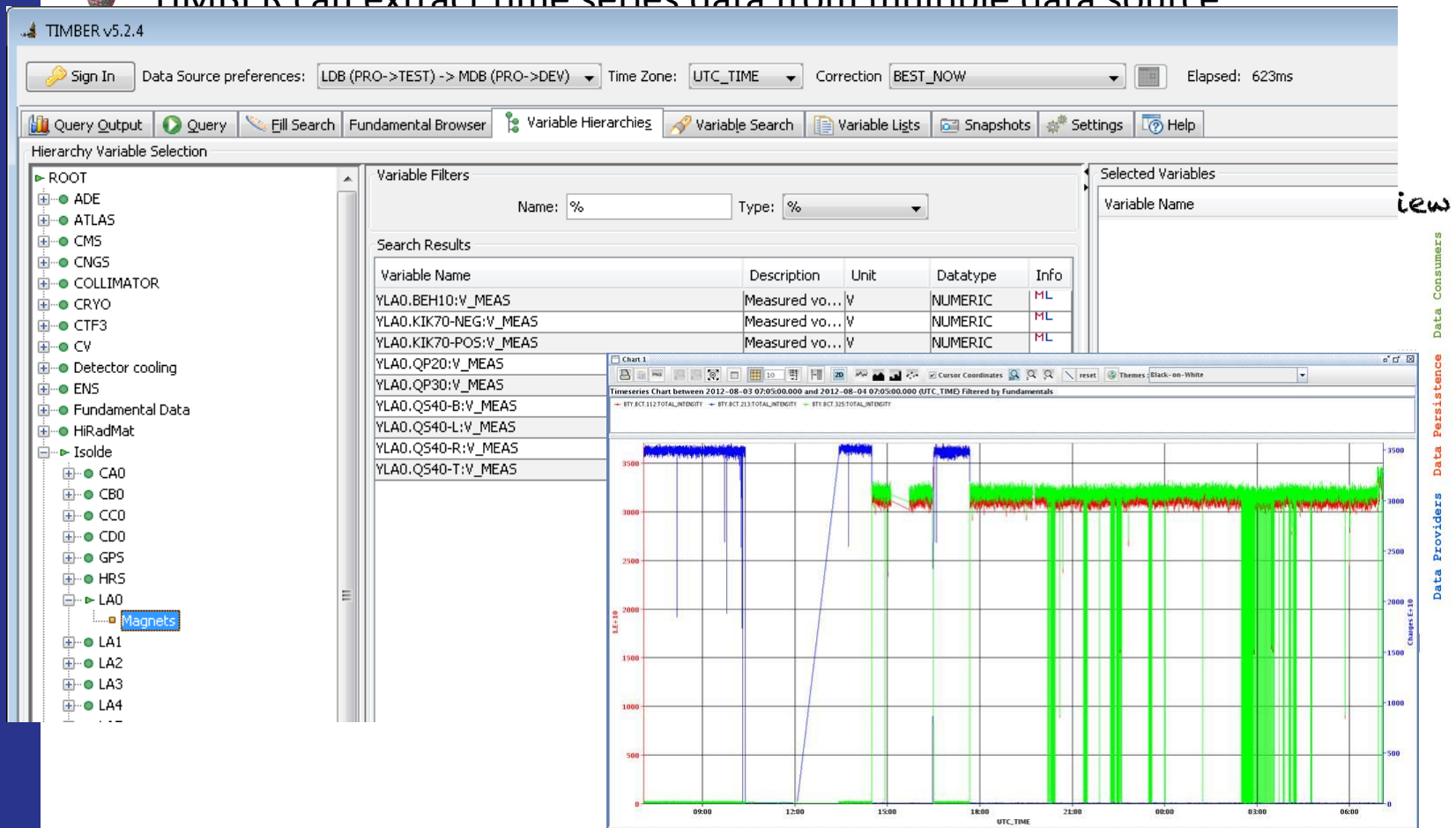


Application Strategy for HIE ISOLDE

- 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



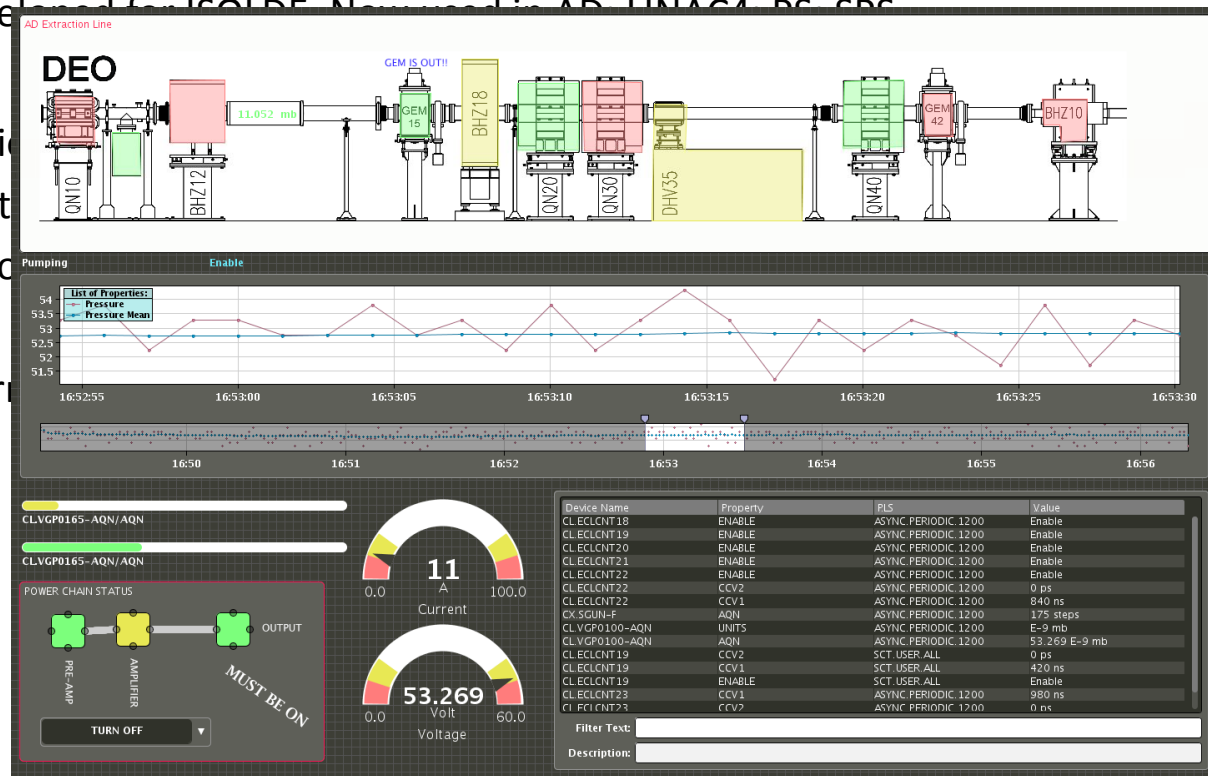
Inspector: Integrate Synoptic

What is it?

- Graphical framework implemented in Java that allows to control and to monitor any CERN standard equipment.
- Application developed for ISOLDE, Neutron Lin AC LINAC4, DC CRG

What it does:

- - Rapid application
- - Device acquisition
- - Data elaboration
- - Data logging
- - Mail/SMS alarm



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

Working Set & Knobs, Equipment Array

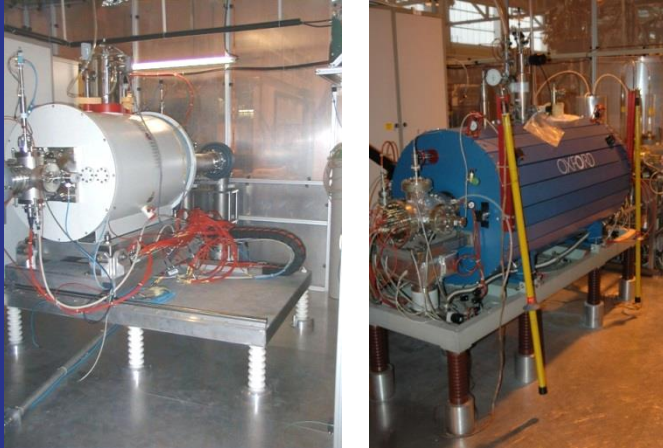
The Working Set

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

The screenshot displays the REXOP software interface. The main window is titled 'WorkingSet launcher for REXOP' and shows a list of devices under the 'Select' column, including 'NONE', 'LINAC', 'ERIS', 'REXCSEP', 'REXRFQ', 'REXCHS', 'REX7GP', 'REX9GP', 'REXCBEN', 'REXCL20', 'REXCL65', 'REXBEAM_OPTICS', and 'REXCRF'. A context menu is open over the 'REXBEAM_OPTICS' device. In the foreground, a 'Please wait...' dialog box is displayed, featuring a cartoon skeleton sitting at a desk with a computer monitor that says 'PLEASE WAIT...'. The dialog box contains the text 'Please wait... while creating WorkingSet' and a progress bar at the bottom with the text 'Getting WorkingSet definition contents from database' and 'Creating JAPC descriptors and CMW devices.' The background shows a list of equipment items such as 'XSEP_MD10', 'XSEP_OP10', 'XSEP_BE30', 'XSEP_QP40', 'XSEP_QP50', 'XSEP_QS20', 'XSEP_QS60', and 'XSEP_B090'.

REX - ISOLDE Applications (EBIS & Trap)

Controls and display all REXEbis devices and time settings



REX TRAP Control v 1.0.0
05 Jul 2012 15:55:13 PSB - TOF, 03

TIMING
Synchronisation: Alone | RESTART | STOP | **RUNNING with 51 ms period**

RF		Ejection		PSB synchro	
Excitation N@	1 2 3	End of cycle		Delay [us]	0
Duration [ms]	50 0 0	Duration [ms]	1	Repetition	0

INJECTION			W2EJECTION	
	Open inj. flank	RFQ open	Beam gate	Kicker 10 A&B
Start [us]	0	0	0	0.0
Duration [us]	0	0	0	0.0

Buttons: RF editor | Trap electrodes | TOF

15:55:03 - Registering RDA Subscription Filter JMX Interface

REX EBIS Control v 3.1.1
File Expert

TIMING
Synchronisation: Alone | Start: **RUNNING**

Cycle
Trigger interval: 49998
Total cycle time: 49950
Status: OK

Trap
Injection: 100
Breeding: 47800
Ramp: 10
Extraction: 500
Trap delay: 940

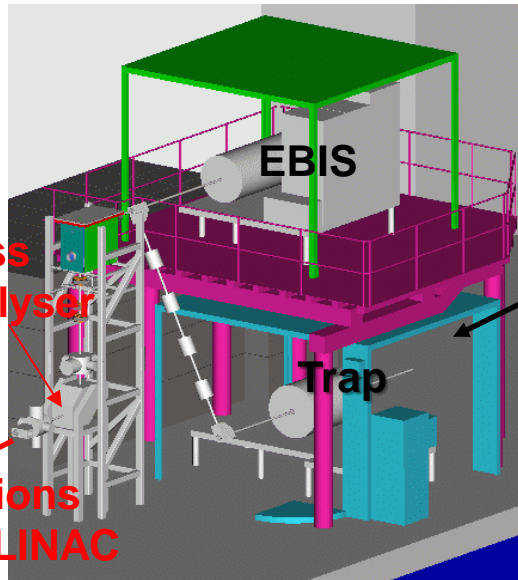
HV, Lenses, Steersers & Linac

FUNCTIONS
Trap functions
Lens & HV functions
Steersers

POWER
Electron beam

PRESSURE
Pressure Collector: 6.70E-10mBar
Pressure Gun: 1.50E-10mBar

09:42:30 - Set request with e...



Mass analyser

q⁺ ions to LINAC

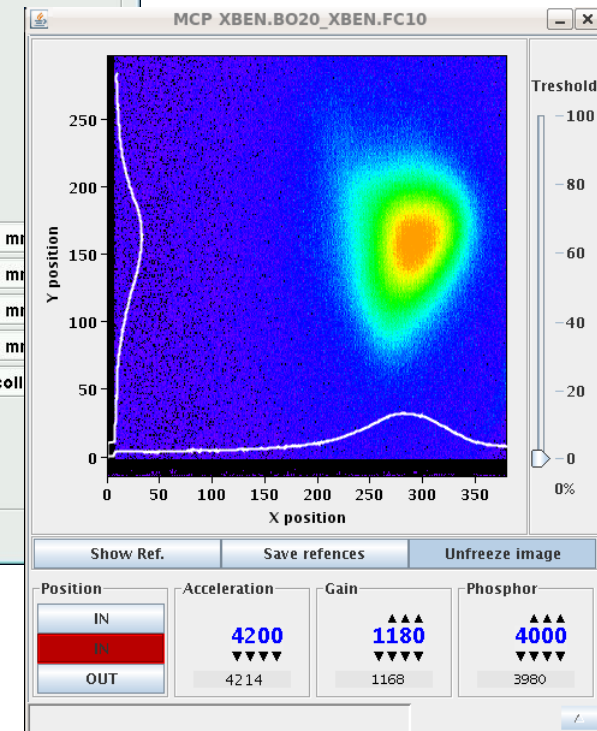
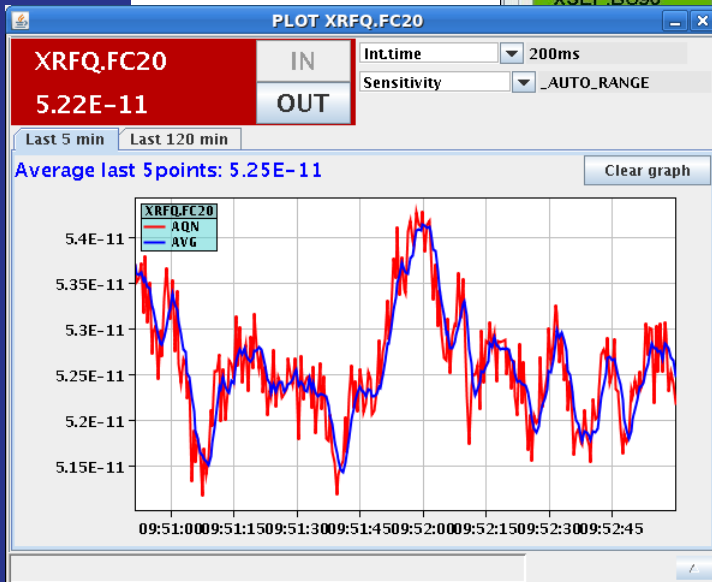
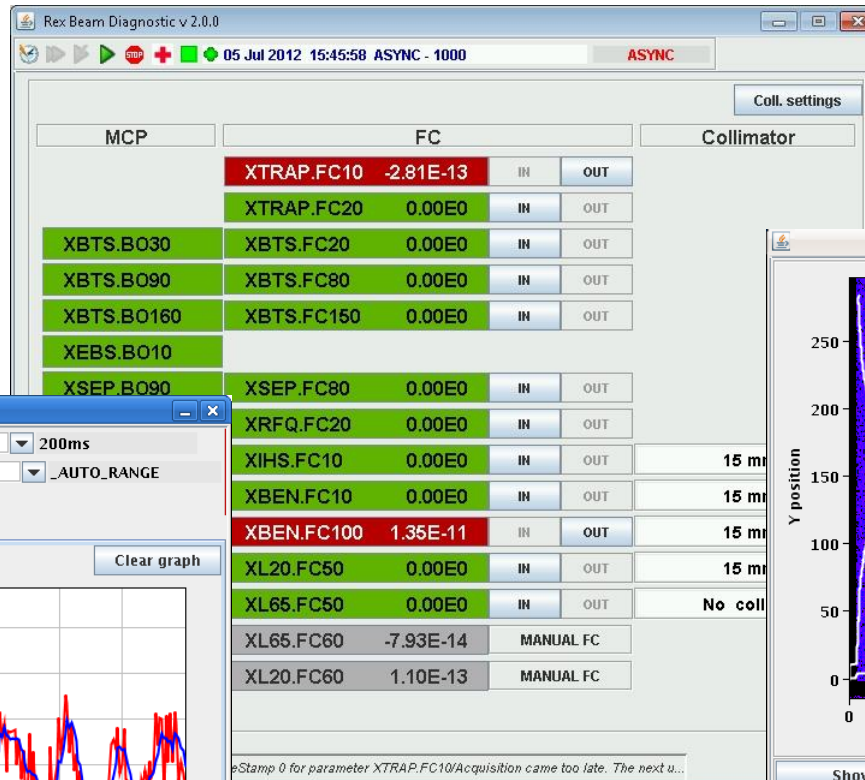
1⁺ ions from ISOLDE

Low energy part of ISOLDE

No change are foreseen for applications

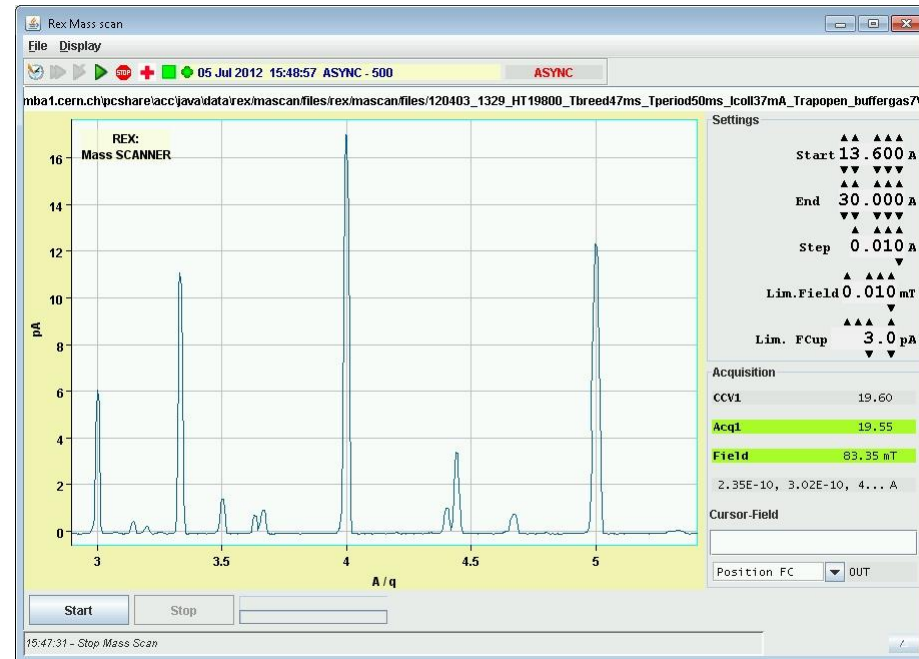
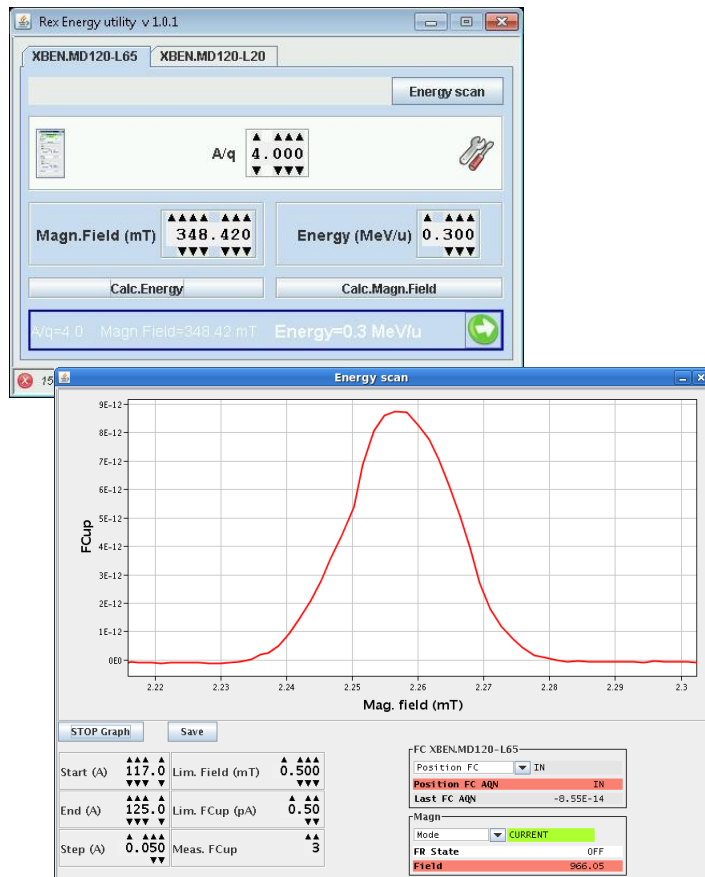
REX - ISOLDE Applications (Beam Instrumentation)

- 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**

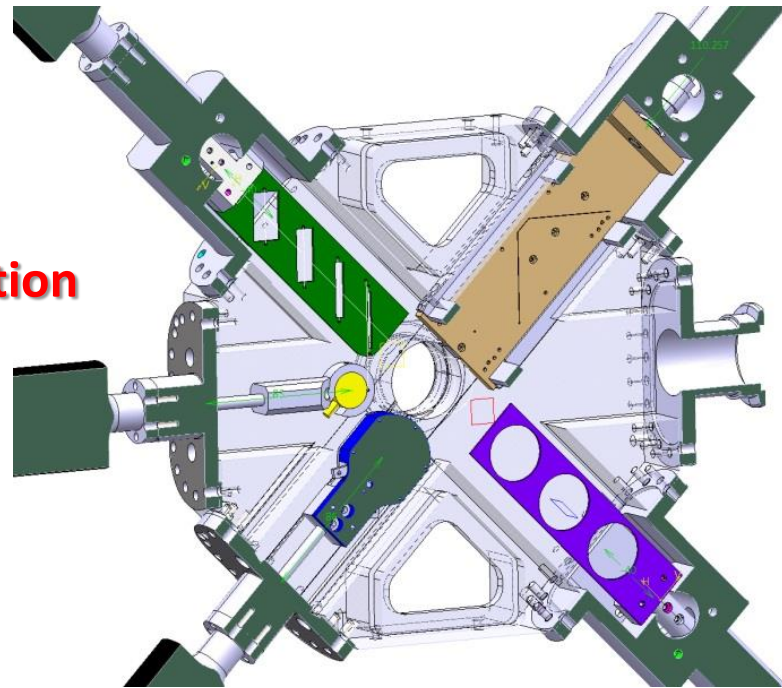
● **Beam Diagnostics**

- 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:

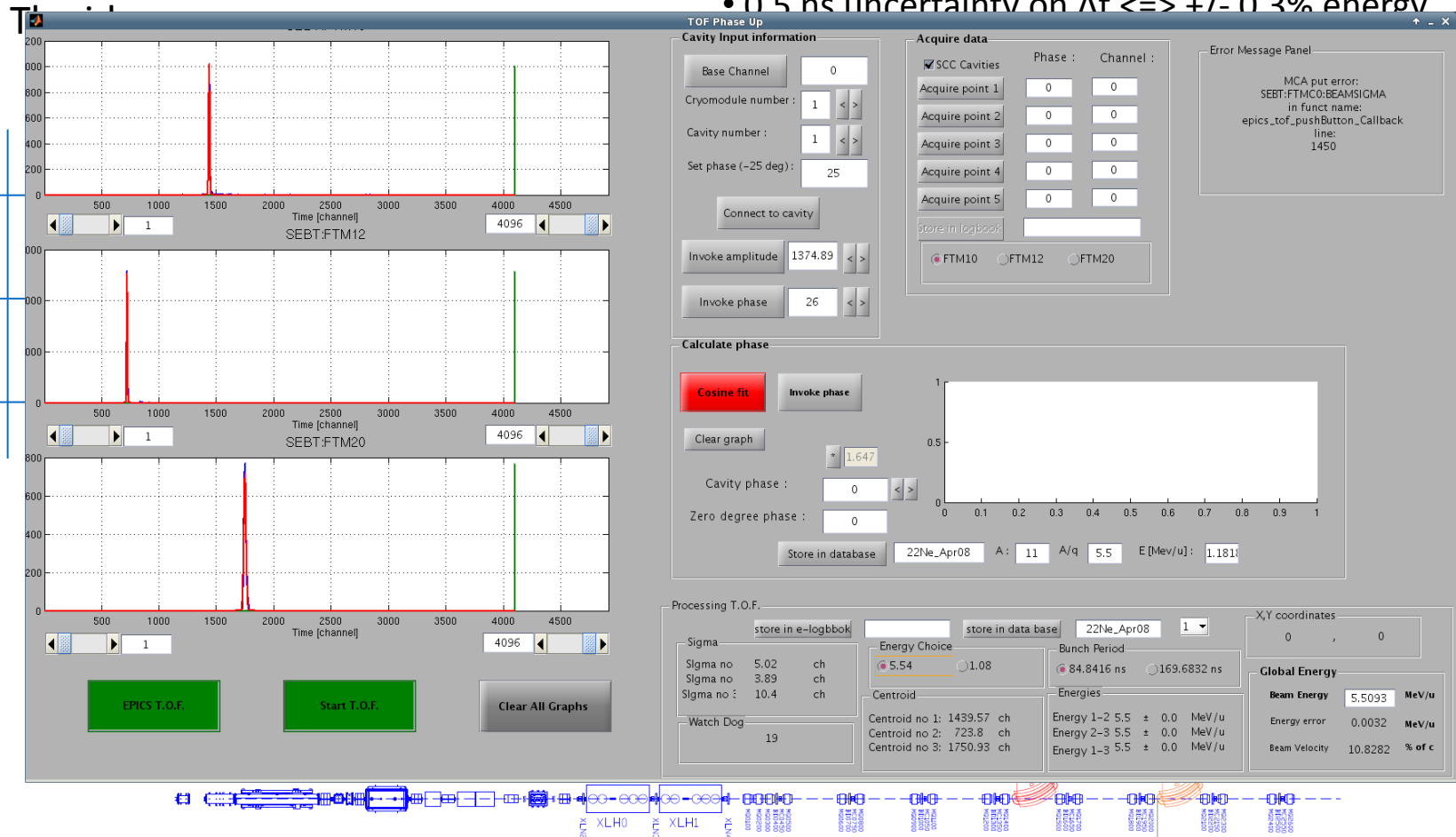
- E.D. Cantero
- A. Garcia Sosa



Application for HIE ISOLDE

T.O.F. System

- Get n from bender energy calibration (uncertainty on energy: few %)
- 0.5 ns uncertainty on $\Delta t \Leftrightarrow \pm 0.3\%$ energy

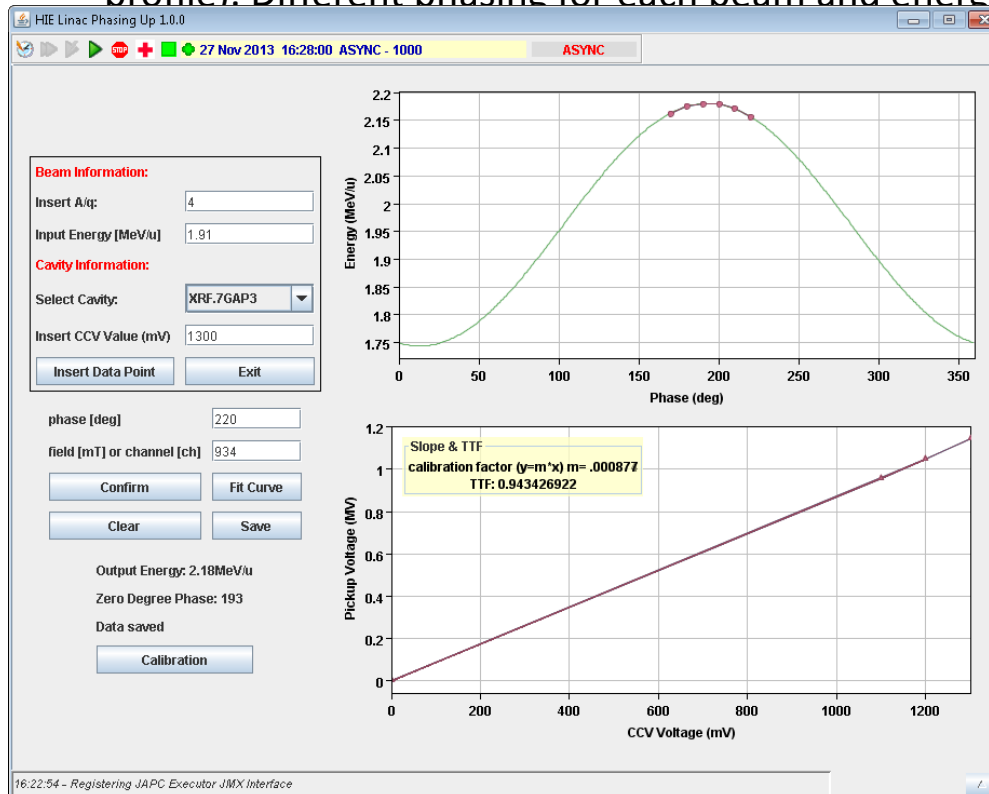


[1]F. Zocca, M.A. Fraser, et al." Development of a Silicon Detector Monitor for the HIE-ISOLDE Superconducting Upgrade of the REX-ISOLDE Linac", CERN-HIE-ISOLDE-PROJECT-Note-0008

Application for HIE ISOLDE

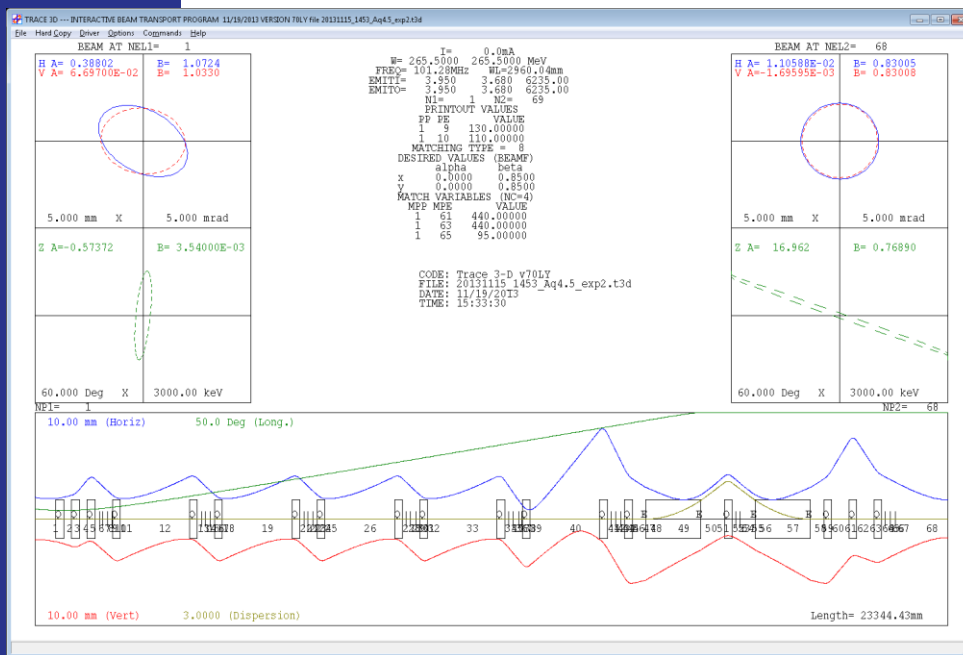
Cavity Phase Up

- **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

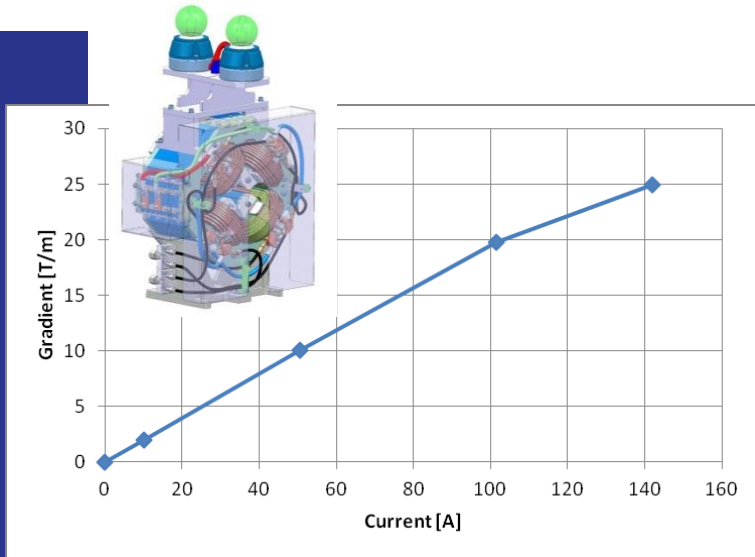
- **HIE Converter:** Converts optics setting coming from Trace3D in Eq. Array format and vice versa.



```
20131115_1350_Aq4.5_Linac.csv - Notepad
File Edit Format View Help

XRFQ.QP40-V,Setting#ccv,Acquisition#aqn,1608.75
XRFQ.QS50-V,Setting#ccvF,Acquisition#aqnF,900.0
XRFQ.QS50-V,Setting#ccvH,Acquisition#aqnH,22.5
XRFQ.QS50-V,Setting#ccvV,Acquisition#aqnV,56.25
XRFQ.QP70-V,Setting#ccv,Acquisition#aqn,1080.0
XRFQ.QP80-V,Setting#ccv,Acquisition#aqn,1856.25
XRFQ.QP90-V,Setting#ccv,Acquisition#aqn,1575.0
XRFQ.QS100-V,Setting#ccvF,Acquisition#aqnF,2070.0
XRFQ.QS100-V,Setting#ccvH,Acquisition#aqnH,0.0
XRFQ.QS100-V,Setting#ccvV,Acquisition#aqnV,0.0
XRFQ.MQ110,Setting#current,Acquisition#current,91.99
XRFQ.MQ120,Setting#current,Acquisition#current,112.94
XRFQ.MQ130,Setting#current,Acquisition#current,111.02
XIHS.MQ30,Setting#current,Acquisition#current,91.48
XIHS.MQ40,Setting#current,Acquisition#current,111.94
XIHS.MQ50,Setting#current,Acquisition#current,83.28
XIHS.MQ60+80,Setting#current,Acquisition#current,178.57]
XIHS.MQ70,Setting#current,Acquisition#current,164.05
XIHS.MQ90,Setting#current,Acquisition#current,101.49
XIHS.MQ100,Setting#current,Acquisition#current,98.29
XIHS.MQ110,Setting#current,Acquisition#current,57.8
X7GP.MQ10,Setting#current,Acquisition#current,79.01
X7GP.MQ20,Setting#current,Acquisition#current,75.46
X9GP.MQ10,Setting#current,Acquisition#current,162.69
X9GP.MQ20,Setting#current,Acquisition#current,158.06
X9GP.MQ30,Setting#current,Acquisition#current,141.86
```

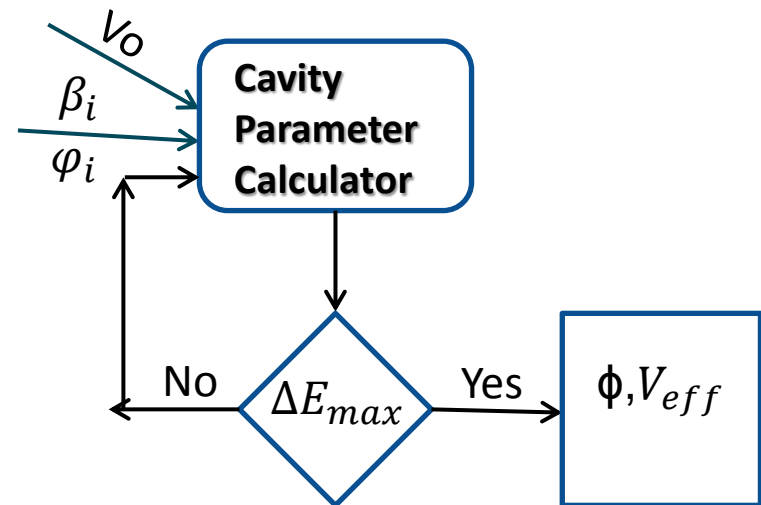
Application for **HIE ISOLDE**



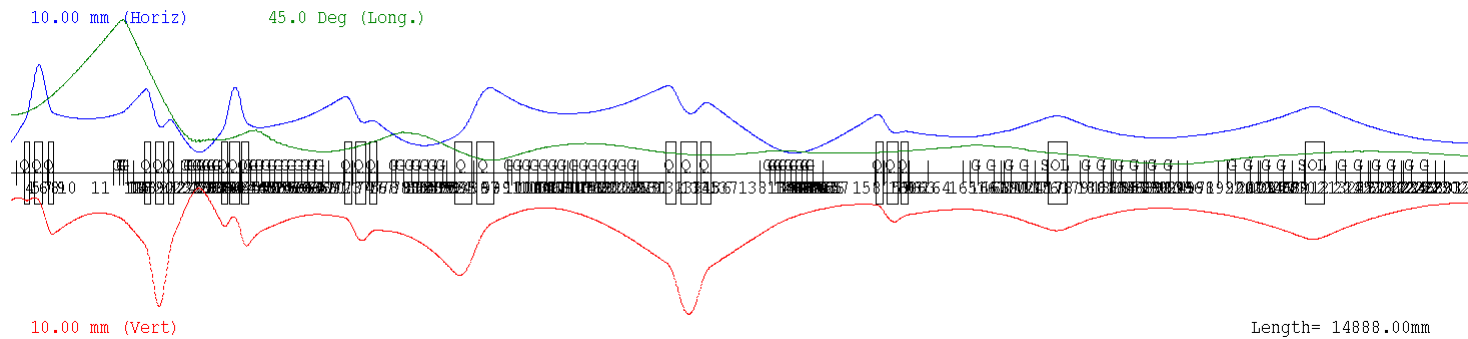
Magnetic Element: Calibration Curve

NC.RF: Fixed. Scaled with A/q

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



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

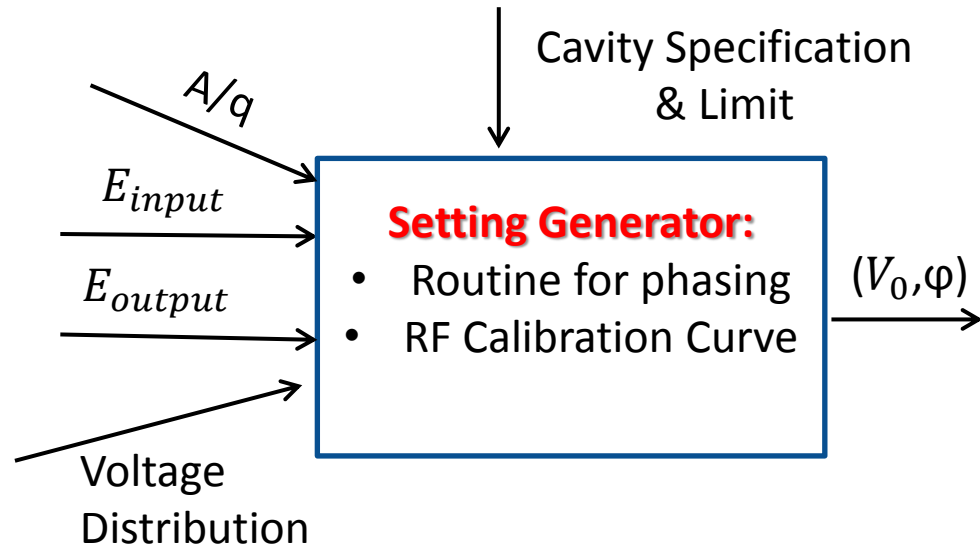


Application for **HIE ISOLDE**

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



Time Saving



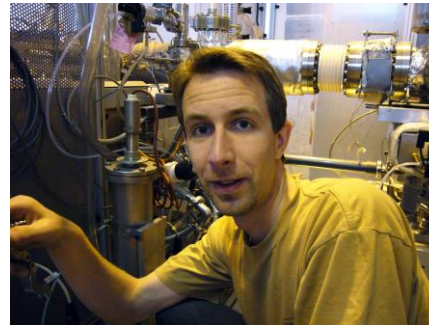
Summary and Conclusion

- **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 be 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
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- Erwin Siesling
- Fredrik Wenander
- Pascal Fernier
- All the ISOLDE Team



Thank you for your attention