BEAM COMMISSIONING SOFTWARE AND DATABASE FOR J-PARC LINAC

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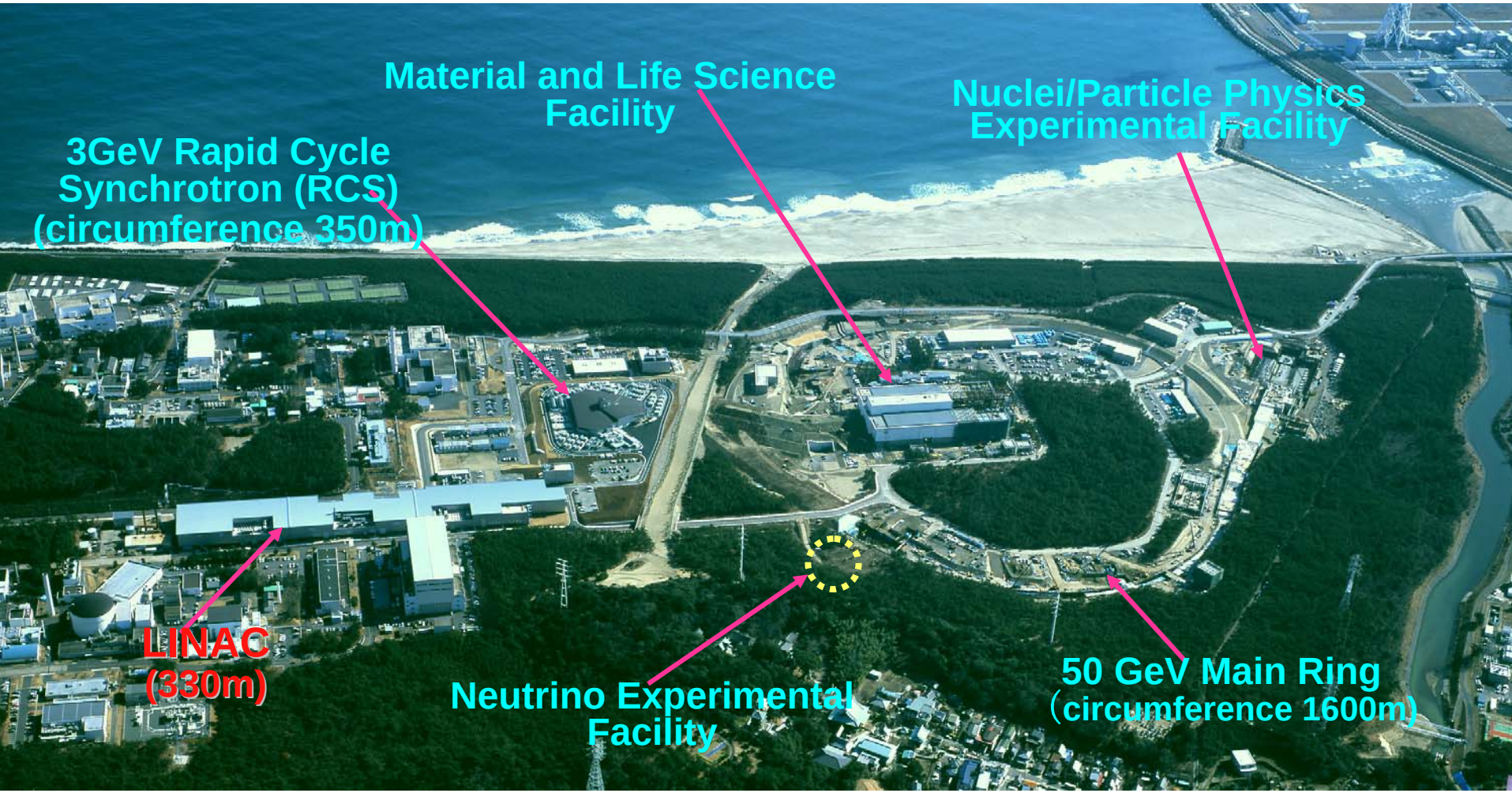
Outline

- Overview of commissioning software system
- Database
- High-Level Application frameworks
- Beam commissioning applications
- Conclusions

J-PARC Accelerator Complex



LINAC commissioning since Sep 2006

RCS commissioning started in Oct 2007

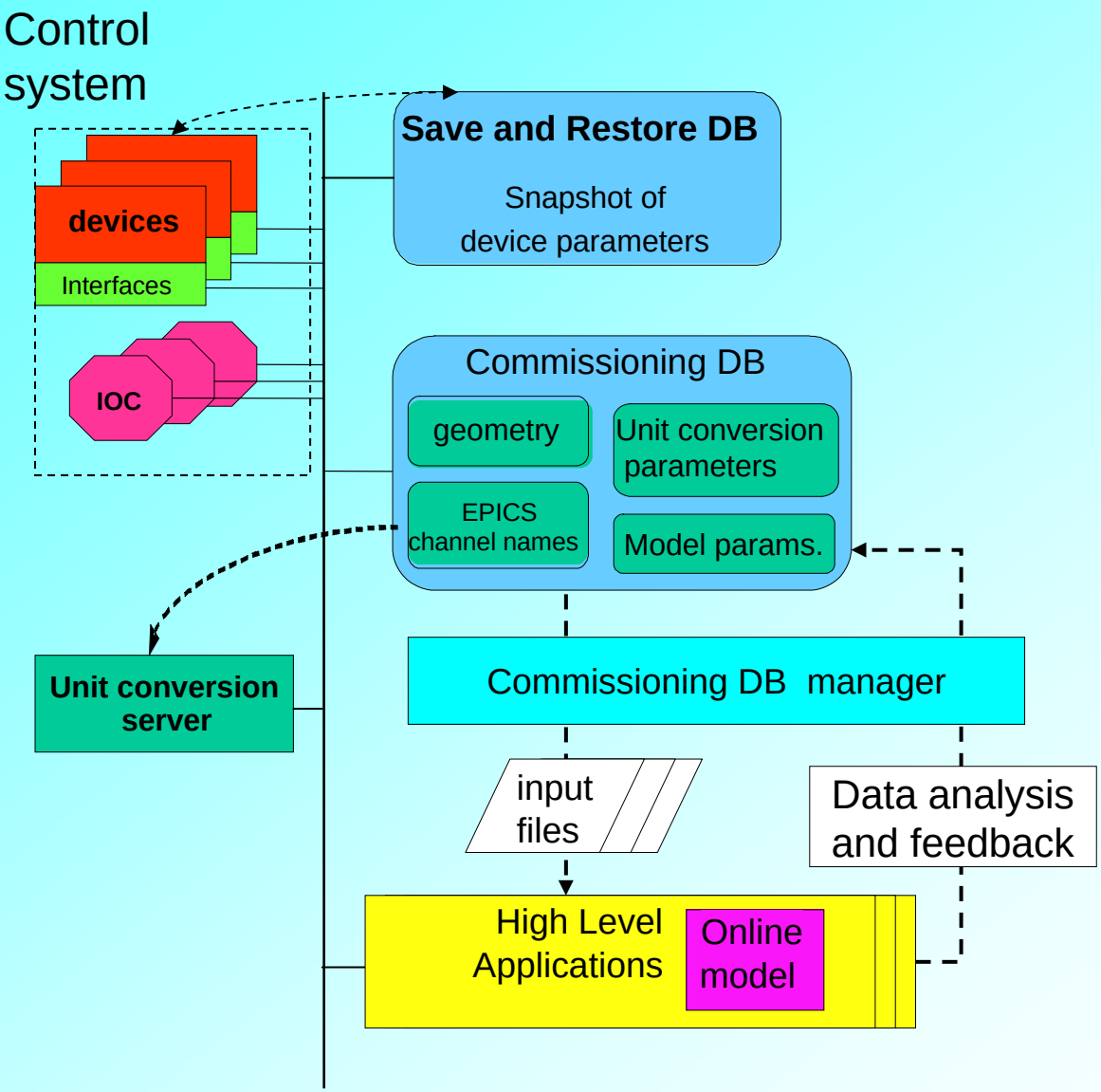
Design concepts of commissioning software system

- Large number of device channels at J-PARC LINAC
  - ~20k with beam monitors, magnets and RFs must be fully controlled
- Various settings of devices
  - Various beam destinations (4 dump lines, 1 transport line to RCS)
  - Energy 3~181 MeV (during RF tuning)

⇨ Central data source

  - Use of RDB
- Online model and device control
  - Should be closely connected
- Easy development and maintenance of applications
  - Java

Commissioning Software System



- Device Control
  - EPICS CA
    - JCA/CAJ
- Database
  - Commissioning DB
  - Save & Restore DB
- Unit Conversion Server
  - Physics records
- High Level Applications
  - JCE/XAL

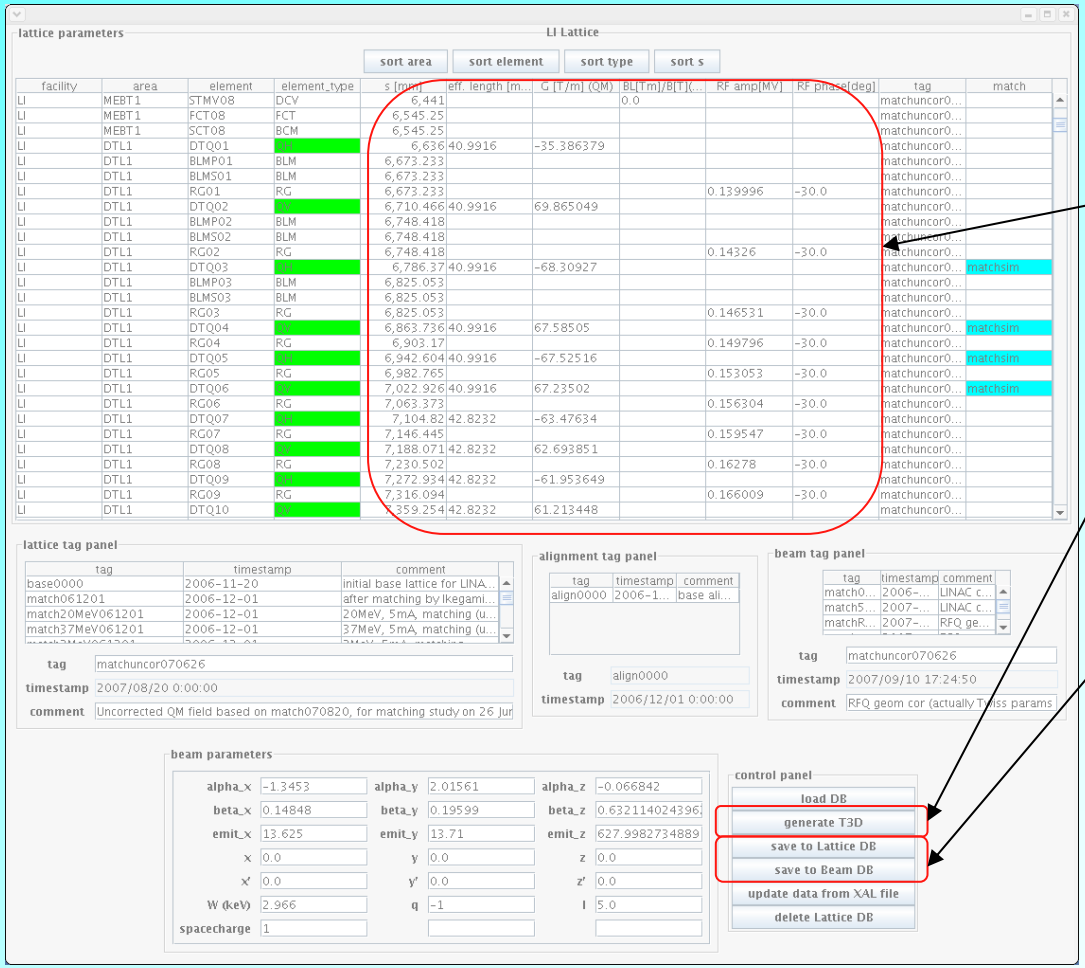
- Generation of input files for HLA
- Data analysis in commissioning and feedback for device parameters

Commissioning DB (CODB)

- Central data source for commissioning software and infrastructure
  - Geometry of beam-line devices
  - EPICS names
  - Device and beam modeling parameters
  - Unit conversion function parameters
  - Generation of input files for high level applications

- PostgreSQL
  - “The world’s most advanced open source DB”
  - Being improved rapidly (both performance and functionalities)

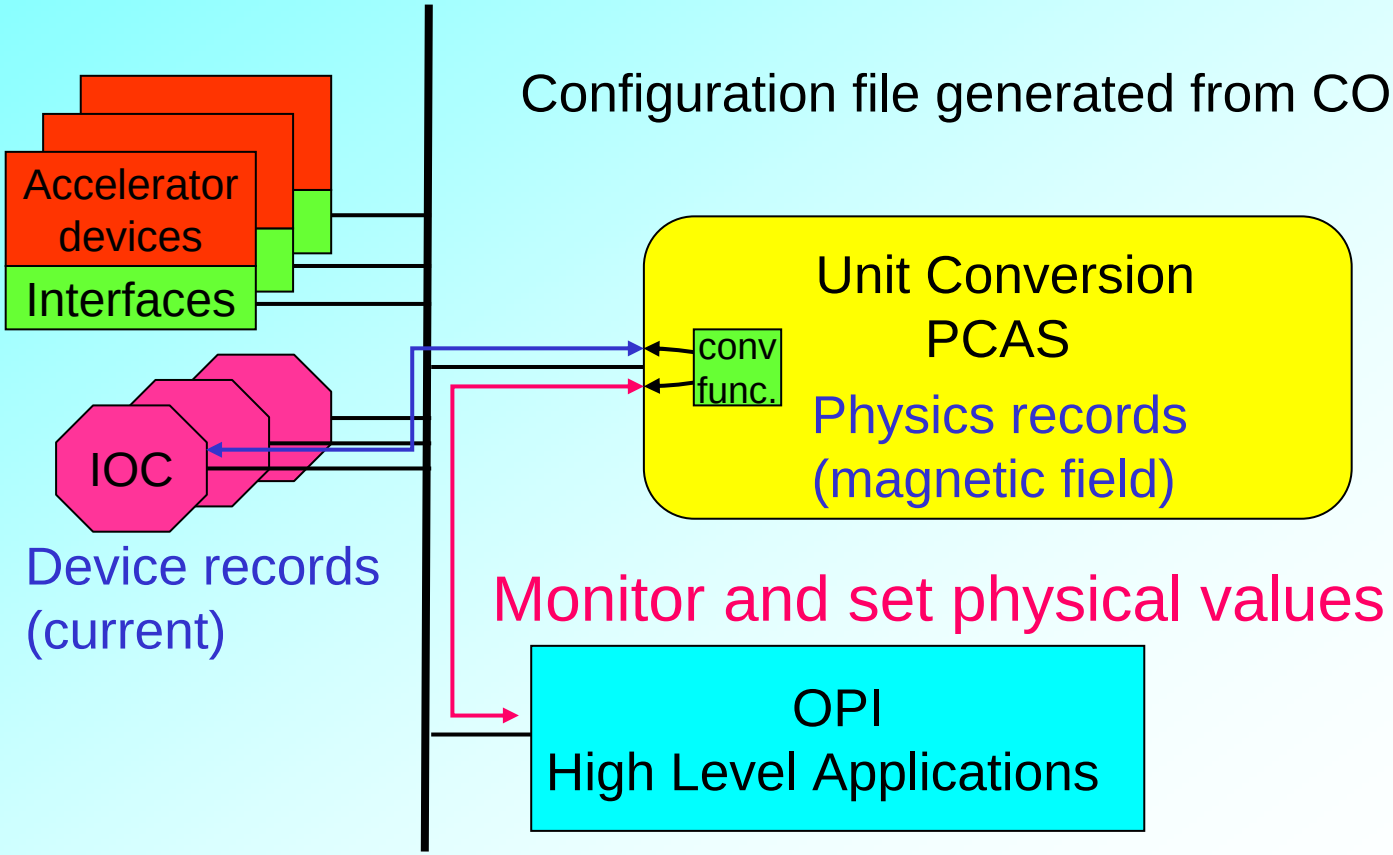
Commissioning DB Manager



- GUI for Commissioning DB
  - Geometry
  - Device parameters (e.g. magnetic field)
- Generation of XAL input files
- Save a data set with a tag and comments
  - Different beam settings
  - Corrected device parameters in the commissioning

Unit Conversion Server

- Provides physics records in connection to device records
  - Indispensable for efficient beam commissioning
- Portable Channel Access Server
- ~400 magnet power supplies
  - Conversion function : 3rd order polynomial (inverse function solved analytically)



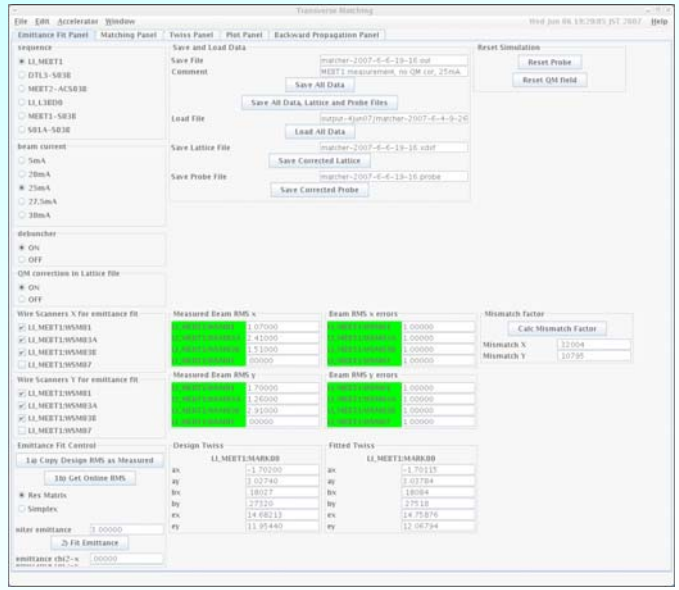
High level application frameworks

- JCE (Java Commissioning Environment)
  - Framework based on a SAD script language
  - Parser and core codes in Java
  - Quick development of applications
    - Beam diagnostics displays
    - Magnetic field set panel
    - Transverse matching
- XAL
  - Framework in Java developed at SNS
  - Developed for J-PARC
    - Beam envelope simulator
    - RF tuning
    - Orbit correction
    - Beam based alignment
    - Energy analyzer
    - Save and Restore DB
- JCE/XAL common functionalities
  - XAL input files
  - XAL online model
  - XAL wrapper class for JCA/CAJ

JCE script

```
Add->{KBFComponentFrame[
        Add-> {KBFGroup[Text->"Wire Scanners X for emittance fit
        Add-> {KBFCheckButton[Width->xwid,Variable:>awsx[1],Te
        Add-> {KBFCheckButton[Width->xwid,Variable:>awsx[2],Te
        Add-> {KBFCheckButton[Width->xwid,Variable:>awsx[3],Te
        Add-> {KBFCheckButton[Width->xwid,Variable:>awsx[4],Te
....
```

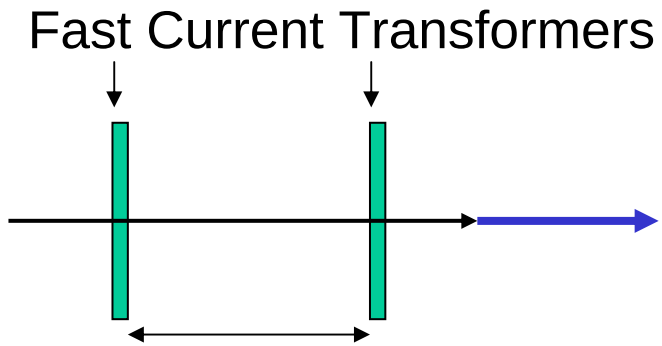
JCE application



Applications for J-PARC LINAC Commissioning

RF tuning application (XAL)

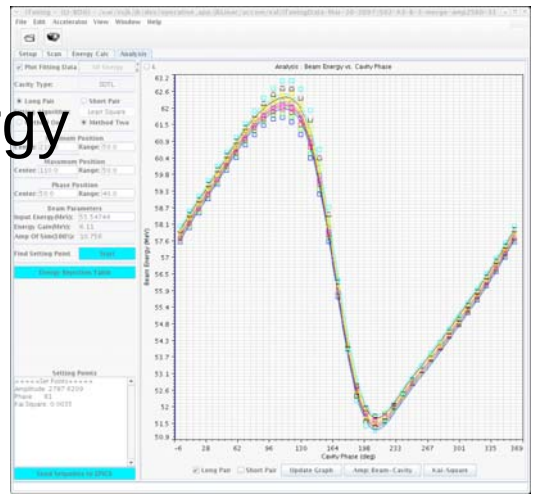
- Tune amplitude and phase of RF to accelerate beam to a designed energy by measuring time of flight of beam.

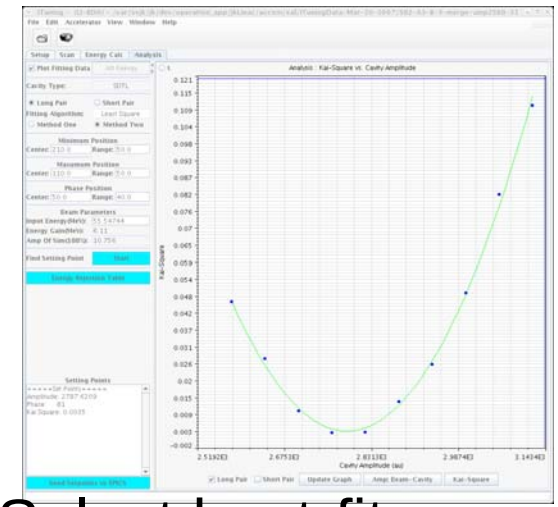


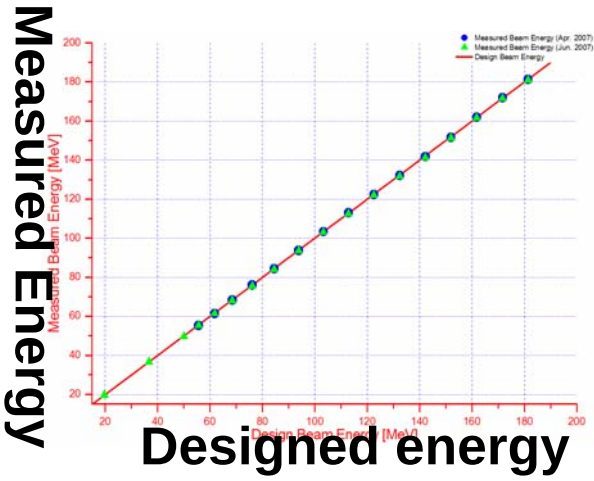
H^- Beam

Scan RF amplitude and phase

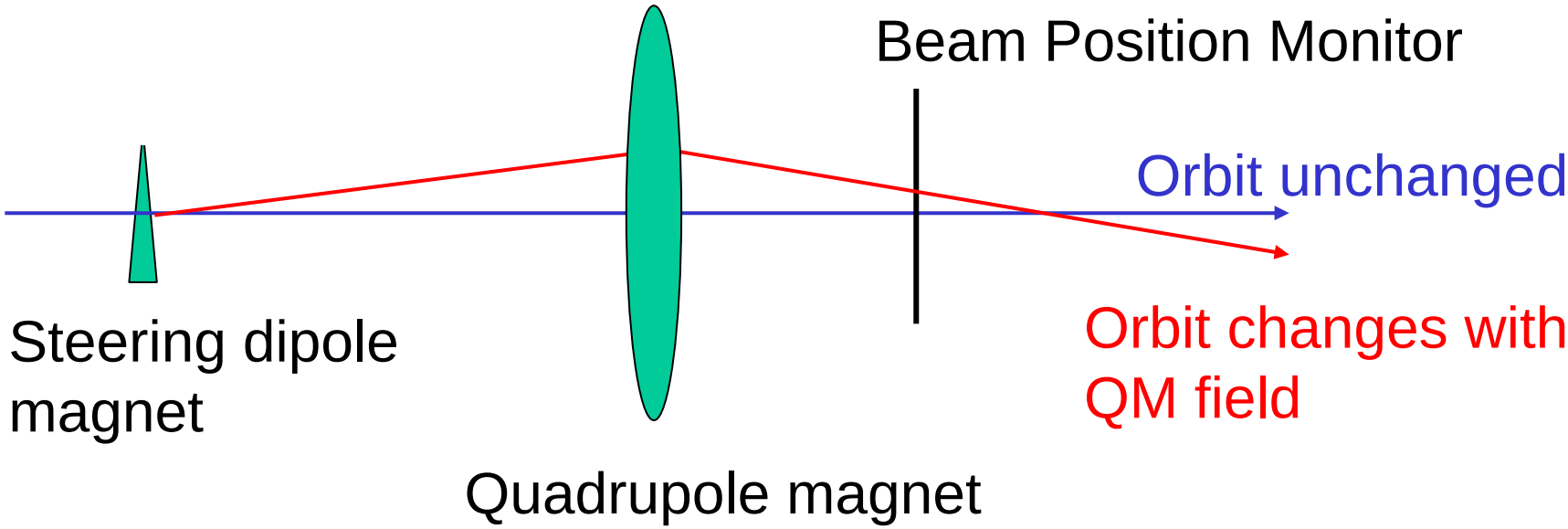
time of flight ⇨ Energy







Beam Based Alignment

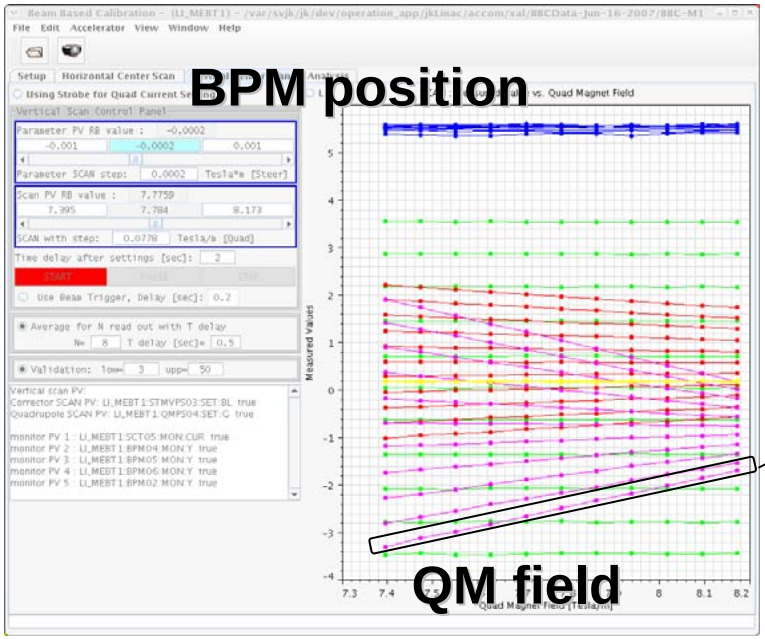


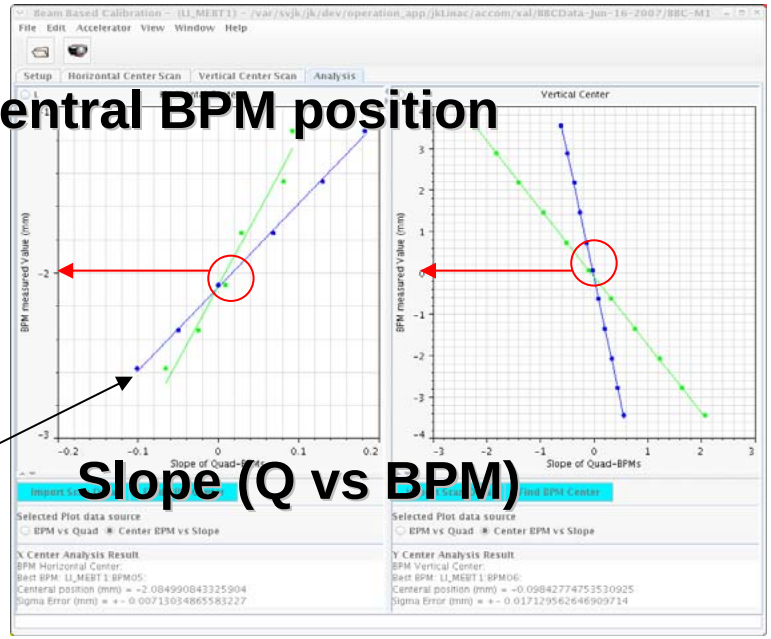
- Tune steering magnet so that the orbit passes through the center of a quadruple magnet

Beam Based Alignment application (XAL)

- Change QM and steering field and measure beam positions with BPM
- Find center of QM

MEBT1 BPM05

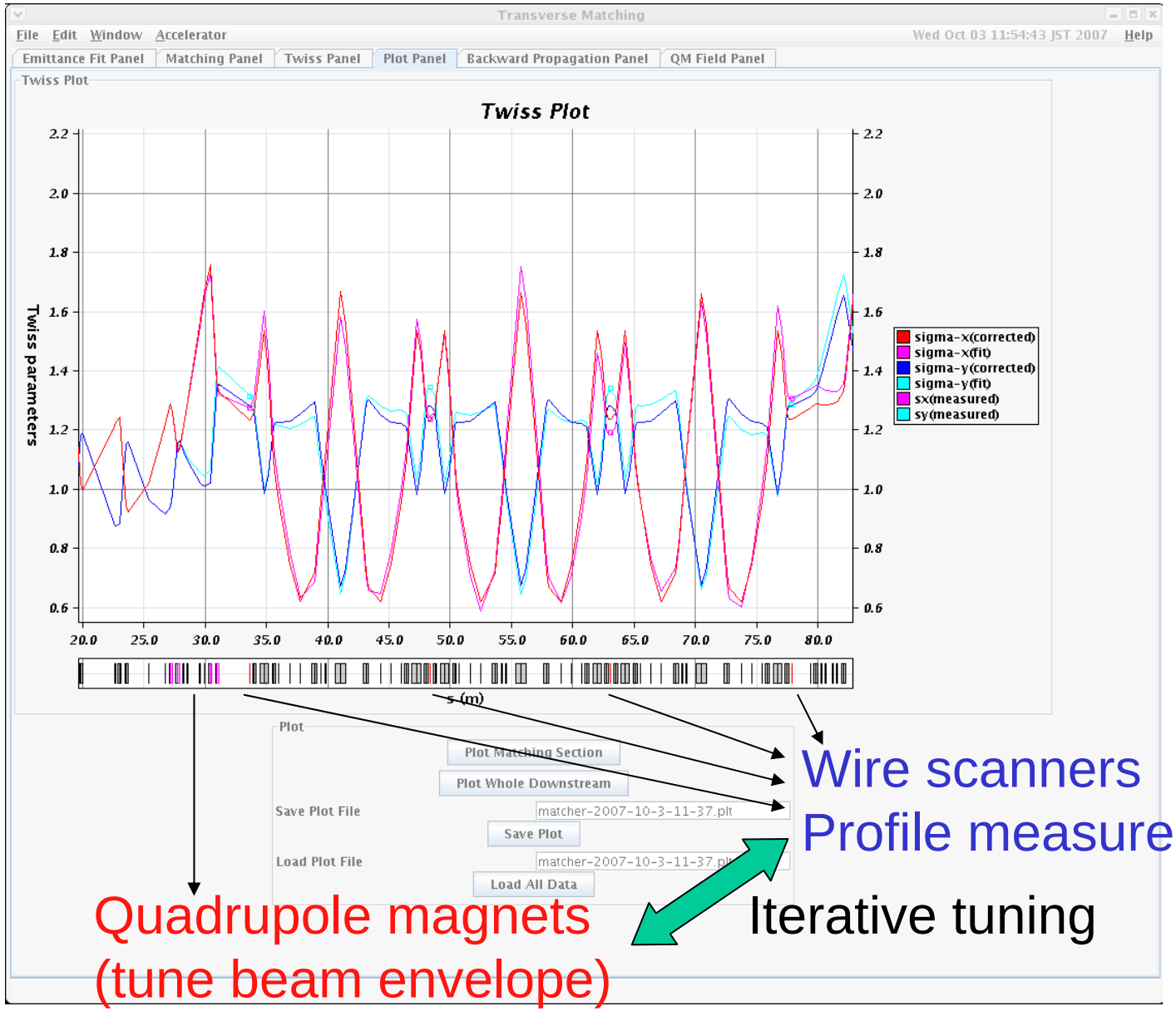




BPM positions vs QM field at each steering field

Central BPM positions vs steering slope (from left plot)

Transverse matching

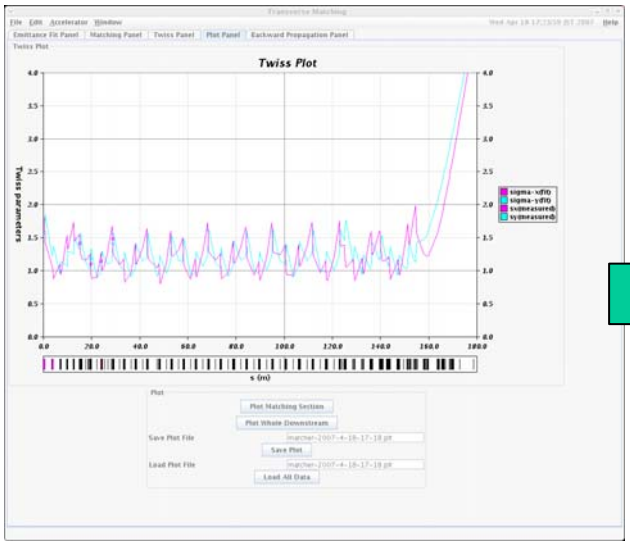


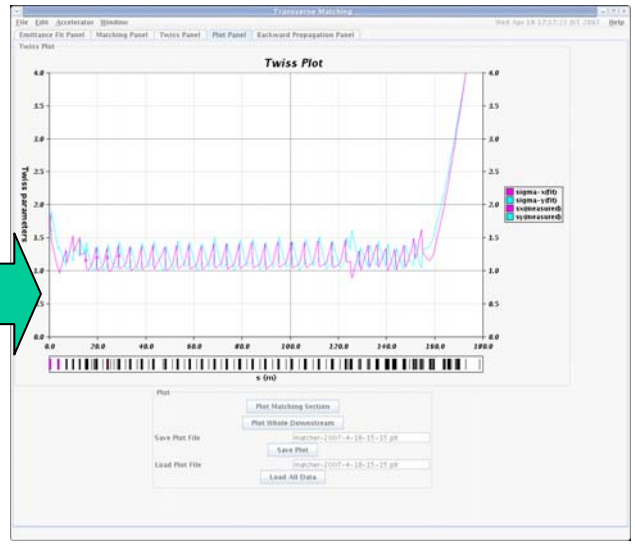
Transverse matching application (JCE)

WS measurement

QM tuning

- Measurement of beam profiles with wire scanners
- Optimize QM field for periodic beam envelope with Newton-Raphson method
- Mismatch factor of less than 5% achieved

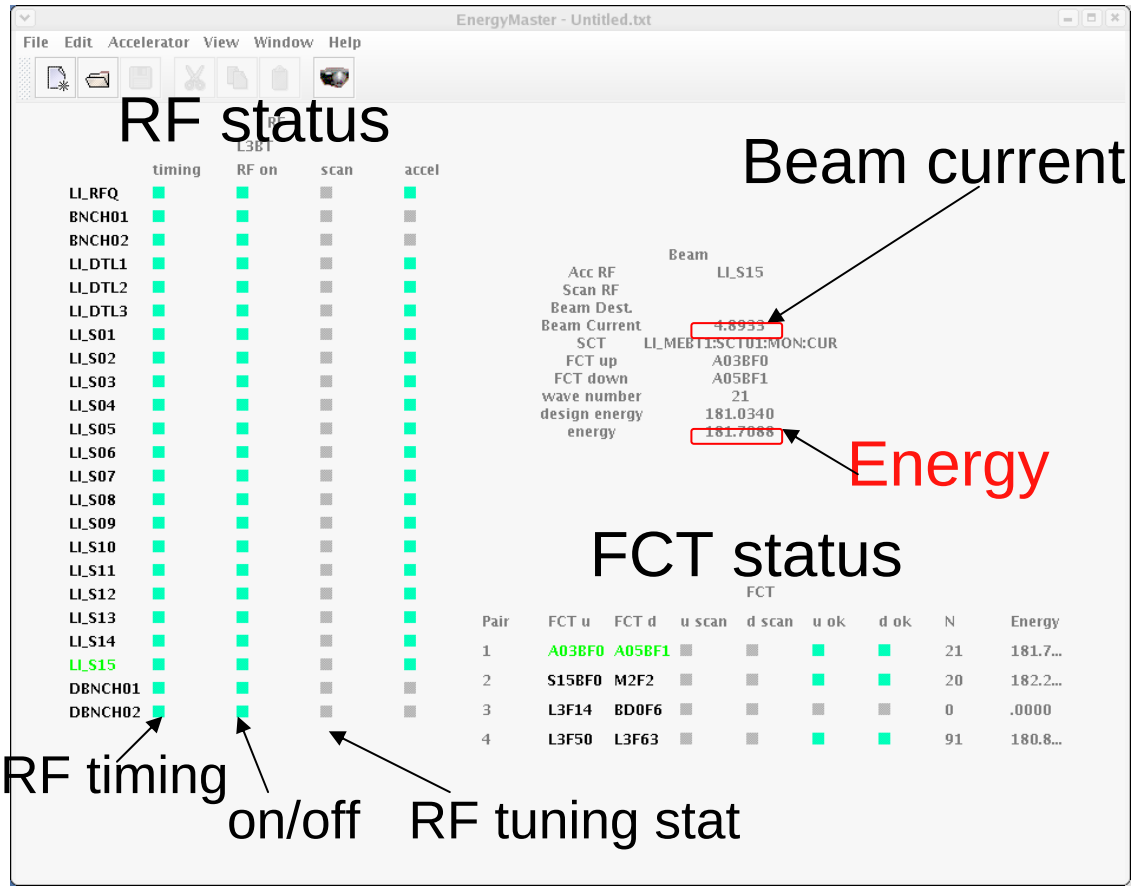




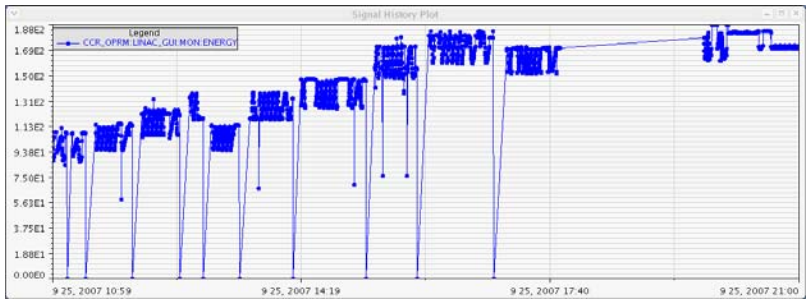
Before correction

After correction

Energy analysis application (XAL)



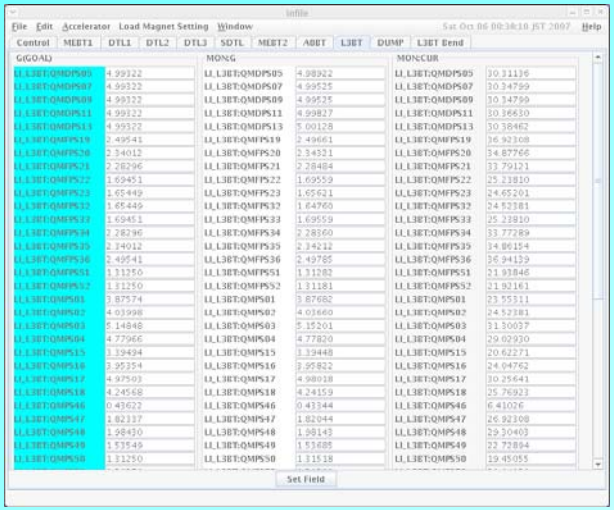
- Integrate all information for energy calculations
- Choose a proper FCT pair and calculate energy



Energy evolution during RF tuning

JCE applications

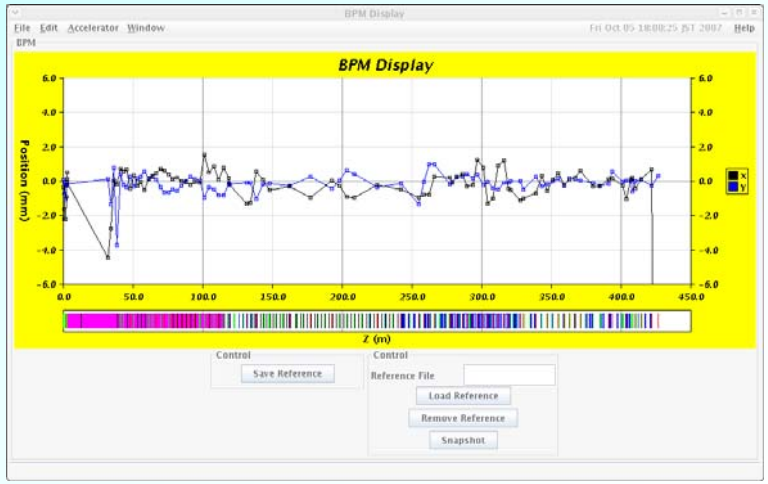
- Magnet field setter



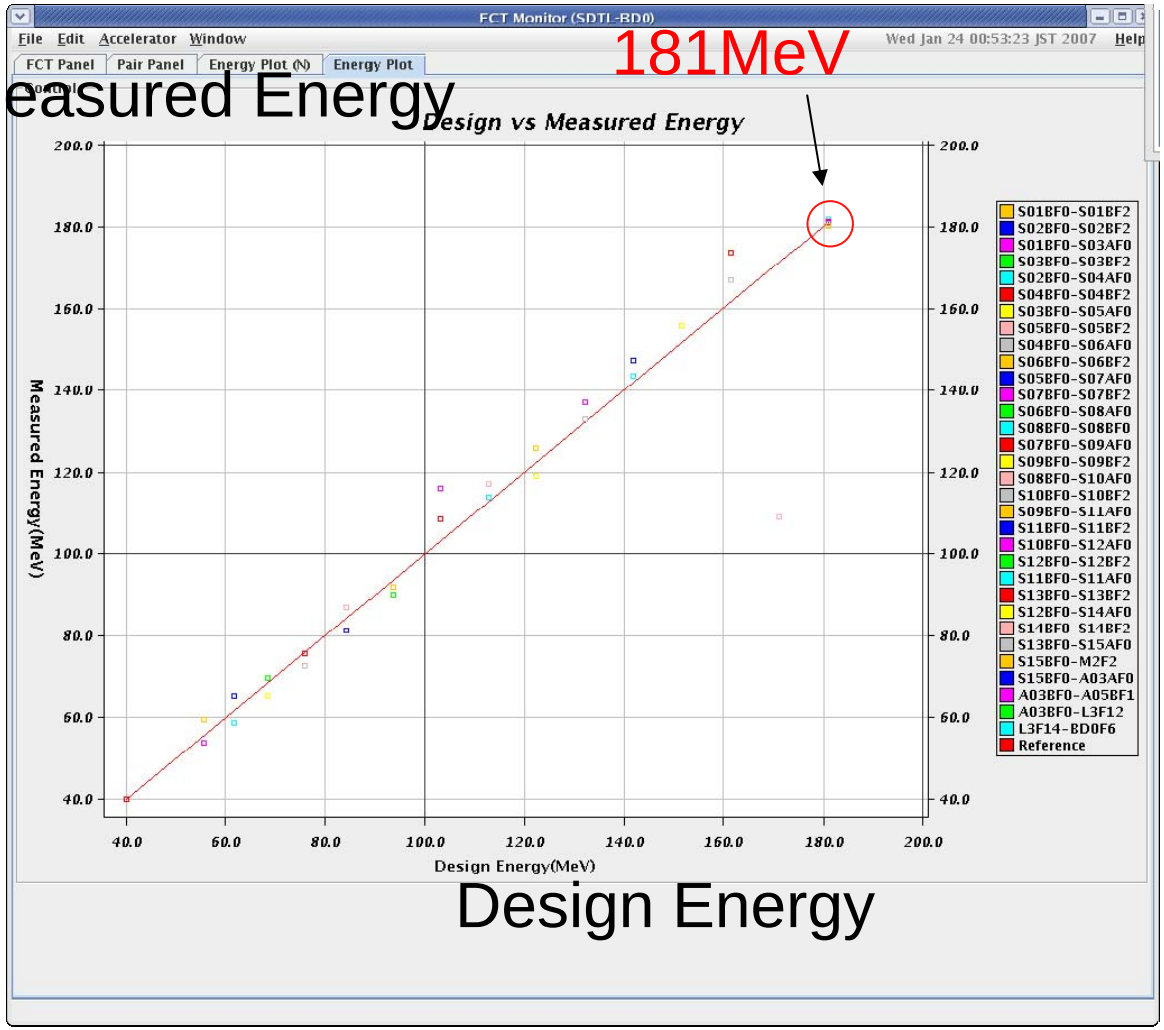
- Beam Loss monitor display

- Current monitor display

- Beam position monitor display

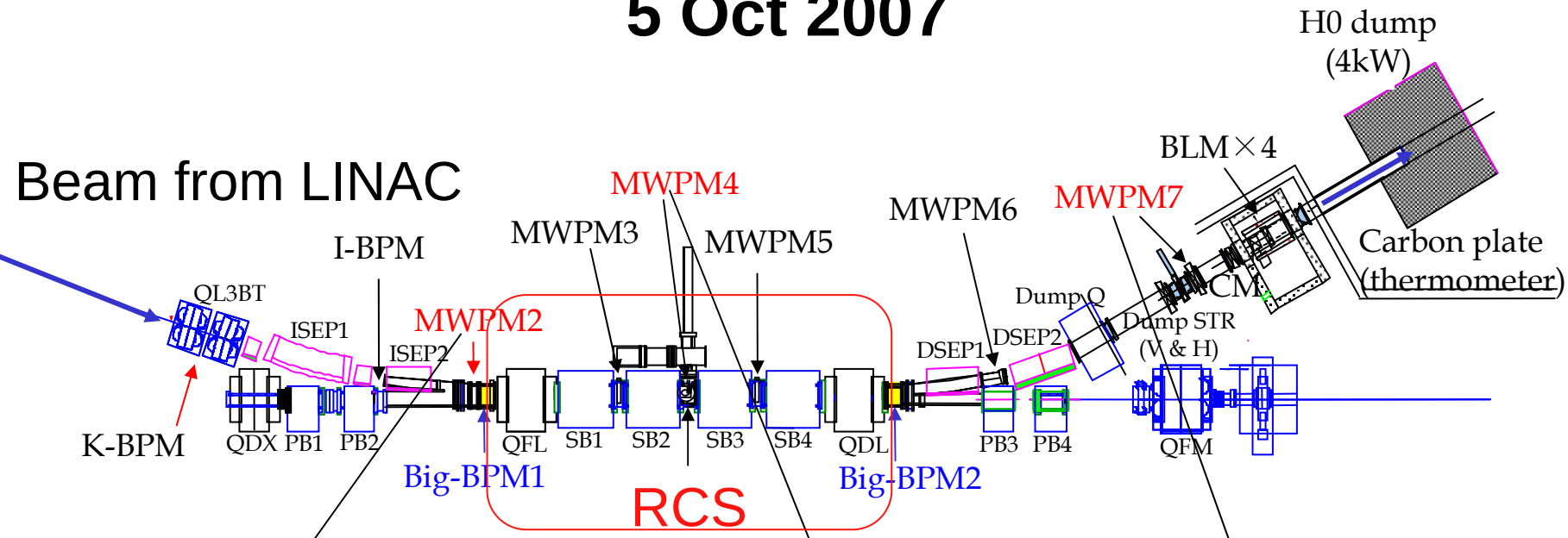


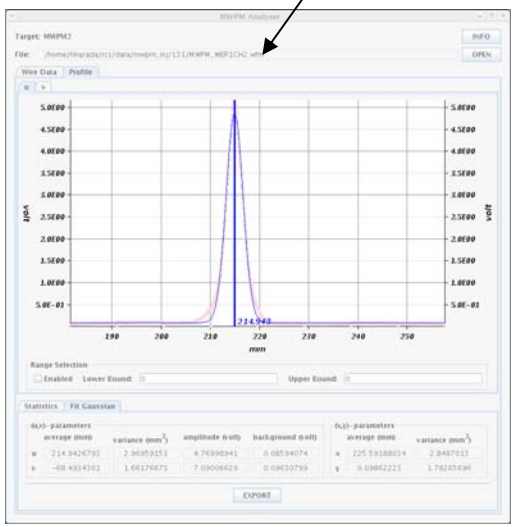
First acceleration to 181 MeV
24 Jan 2007

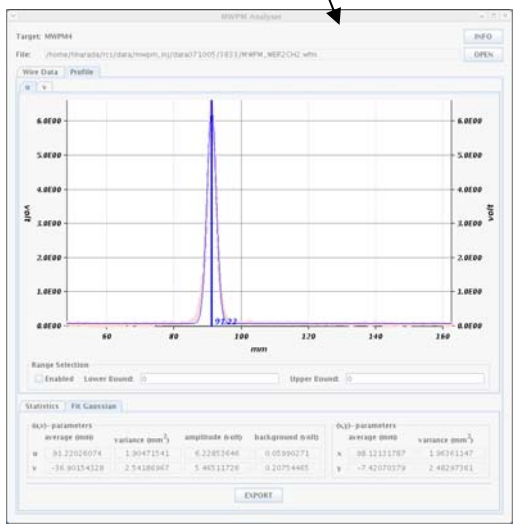


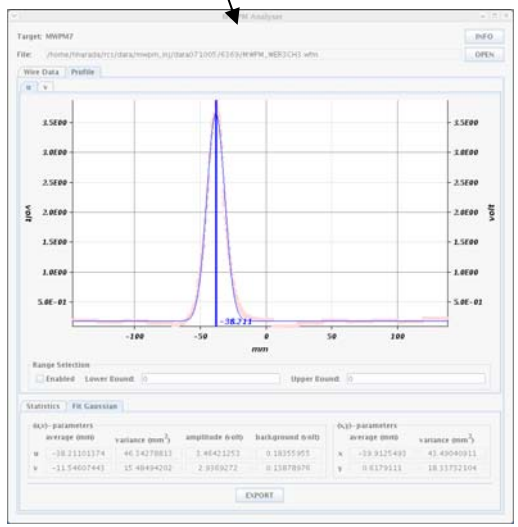
First acceleration to 181 MeV
24 Jan 2007

First Injection to RCS (H0 dump)
5 Oct 2007









Beam profiles measured by MWPMs

Conclusions and Outlook

- Commissioning software system developed and successfully applied to J-PARC LINAC
  - Commissioning DB
  - Unit conversion server
  - JCE and XAL
- Improvements for more efficient operation
  - Maintenance scheme of Commissioning DB
  - Development of Save and Restore DB


Thank you for your attention!
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2007 10 16