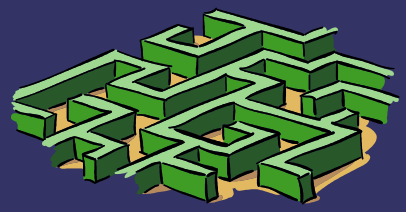
J-PARC Controls
- High Level Applications -

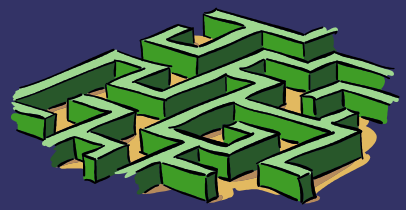
J-PARC controls group
Noboru Yamamoto

For ATAC08/EPICS collaboration meeting



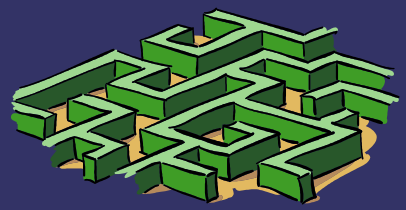
Recommendations from ATAC 2007

- *Based upon the commissioning plan presented, specify the high-level physics applications needed to carry out this plan and begin development of these applications as soon as possible.*
- *Management should review the staffing level of the controls group in parallel with the identification of needs implied by the above recommendations.*



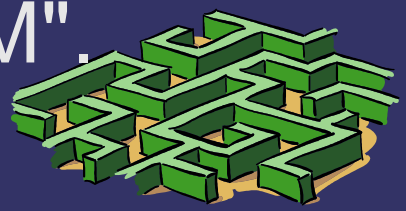
Overview

- From Accelerator Controls to Beam controls
- Development Environment of HLA
- High Level Application examples
  - LINAC
  - RCS
  - MR(prototype)

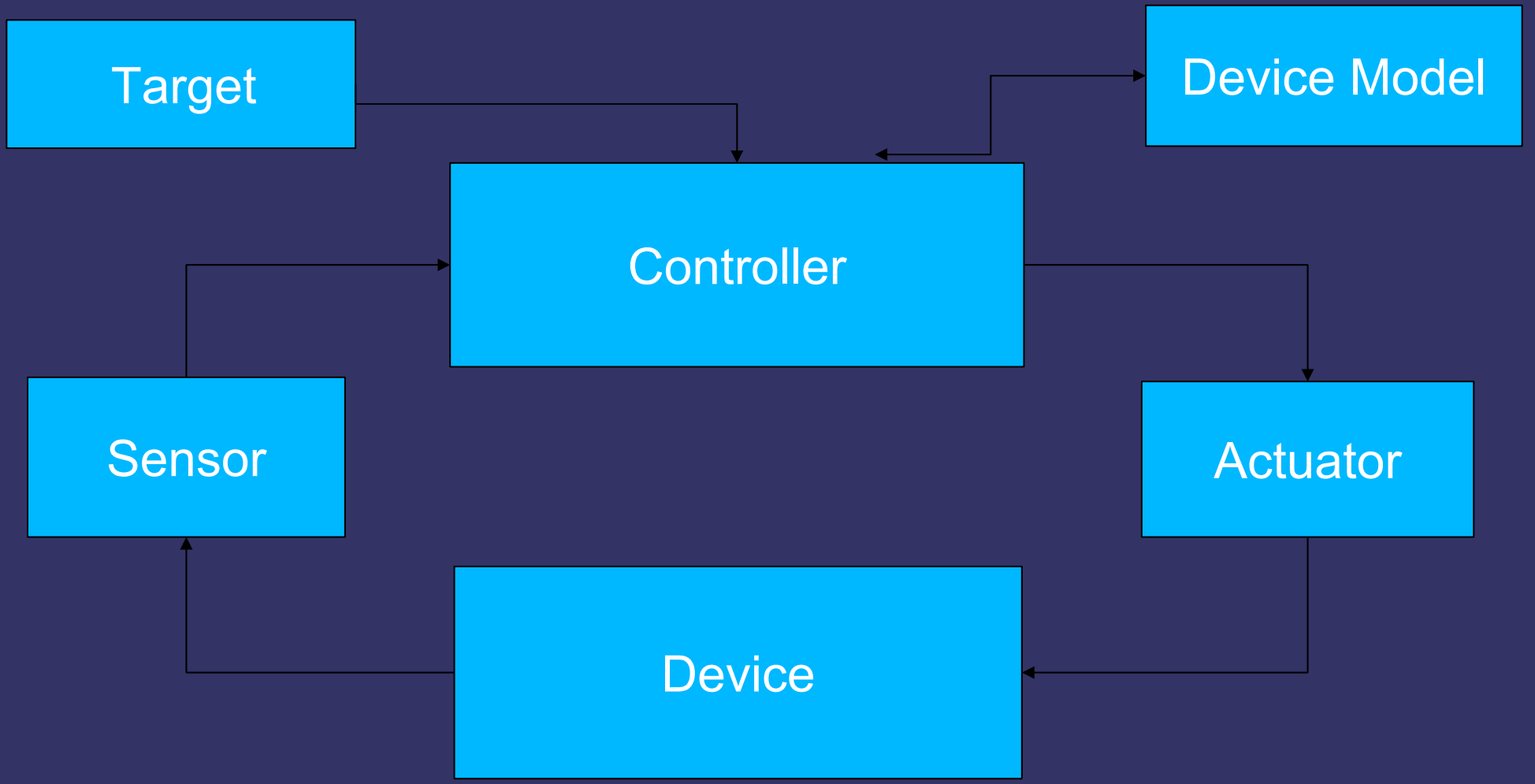


From Accelerator(Device) Controls to Beam controls

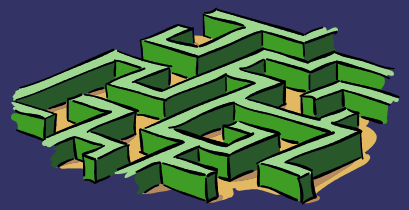
- Today's technology reduces the cost to develop a device control system for accelerators.
  - "Standard model" : Hardware
    - Distributed intelligent controllers.
    - Network
    - Servers
  - Tools/Frameworks: Software
    - EPICS
    - XAL
    - TANGO (ESRF and others)
    - MADOCA (Spring 8)
- Final Product of Accelerator is "BEAM".



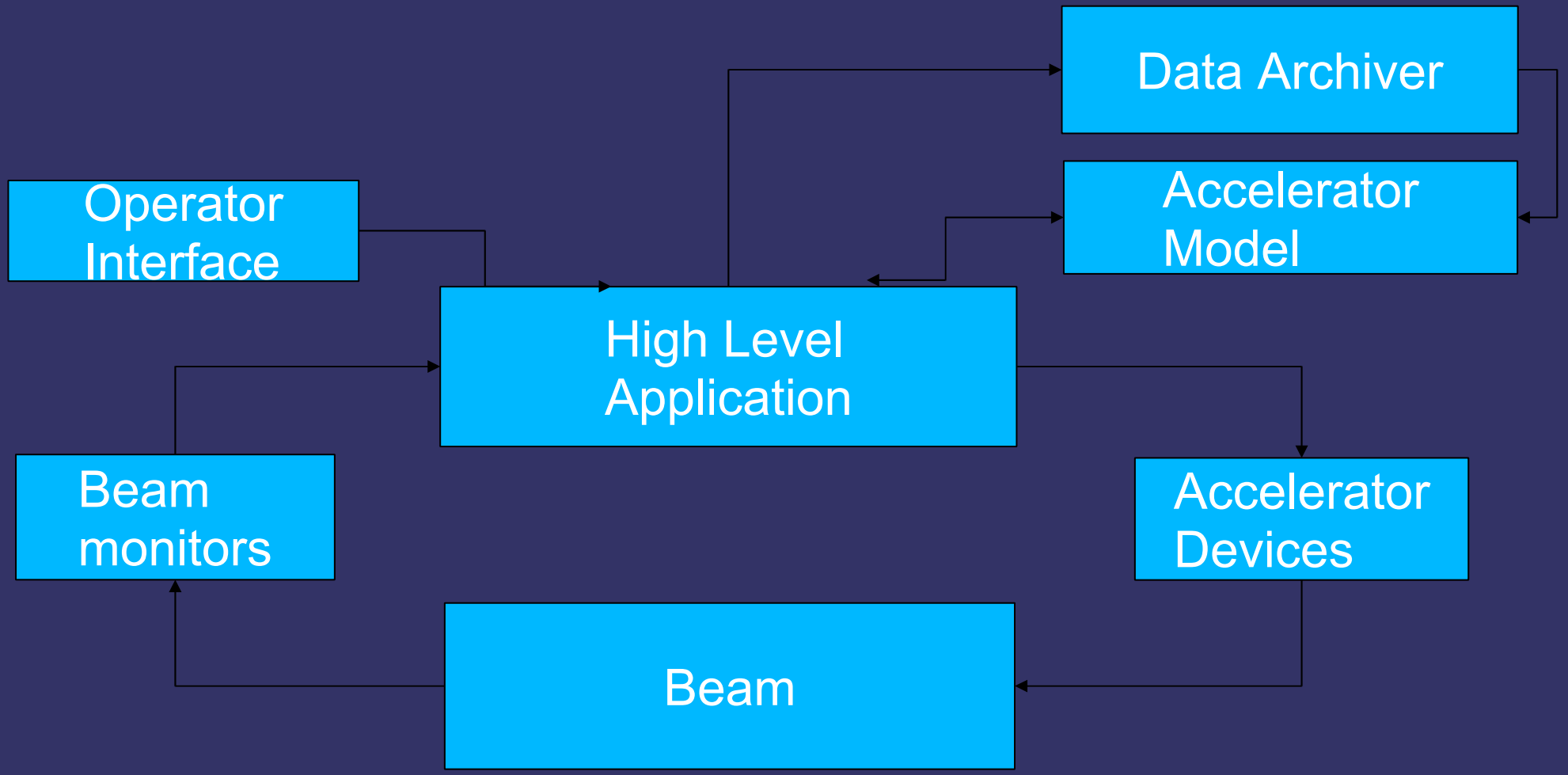
Accelerator(Device)Controls



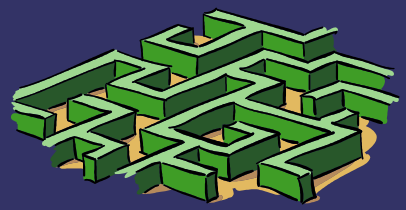
Schematic view of device control system



Beam Controls



Schematic view of Beam control system

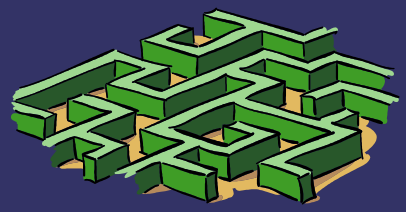


Development Environment of HLA

- Accelerator Models
  - XAL and Trace3D for LINAC
  - SAD for RCS and 50GeV Ring
- Programming Languages
  - Java with XAL/JCE
  - SAD script
  - Both languages support EPICS Channel Access and Graphical User Interface
- Data Archiver
  - RDB(PostgreSQL) based
  - Channel Archiver
- For generic applications Java/JCE and SAD are also used as well as medm/edm/python.

HLA Developers

- HLA developers
  - Most of HLA are written by the commissioning group members
  - or under the guidance of the commissioning group
    - RCS and 50GeV teams works closely and will be able to share software/ knowledge of HLA.
    - semi-regular meeting with Prof. Oide (KEKB/SAD) and RCS/50GeV team.
- Controls group is responsible to provide and maintain environment for HLA development.
  - EPICS and device controls
  - JCE/XAL
  - SAD
  - Data Archiver/Retriever

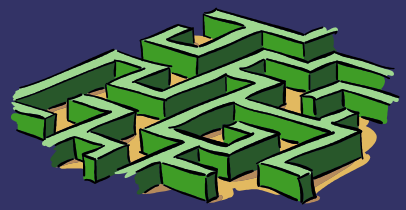


High Level Applications at LINAC

Applications developed/used for LINAC beam commissioning

- RF tuning
- Orbit correction
- Transverse matching
- Beam Based Alignment
- Beam energy analyser
- Save and Restore DB

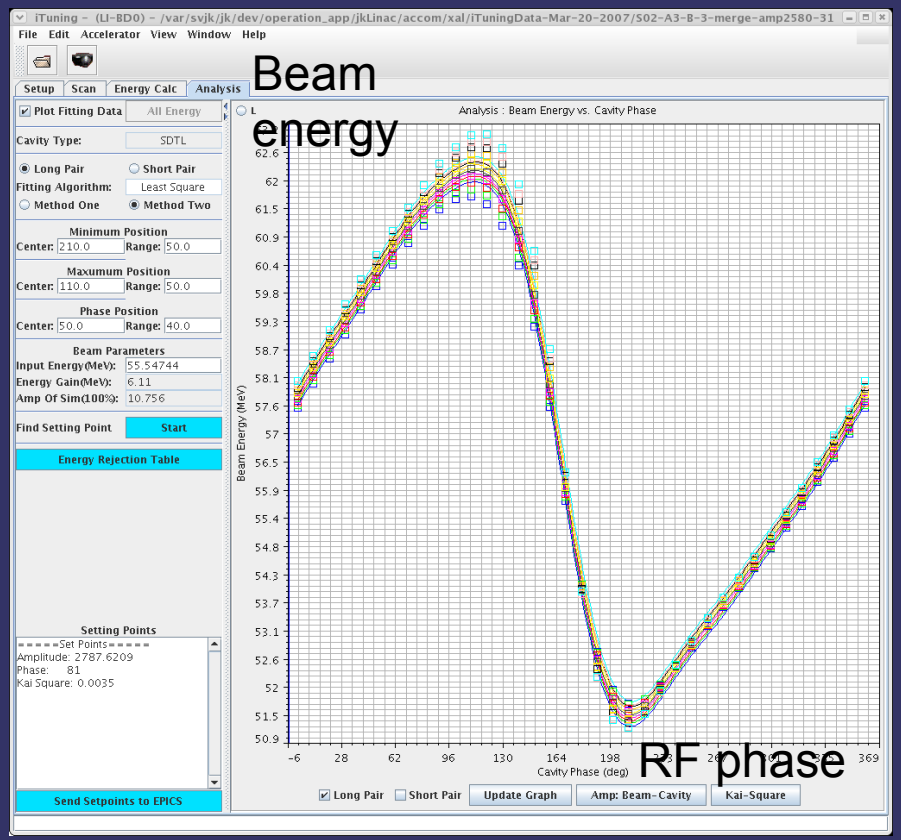
…Others



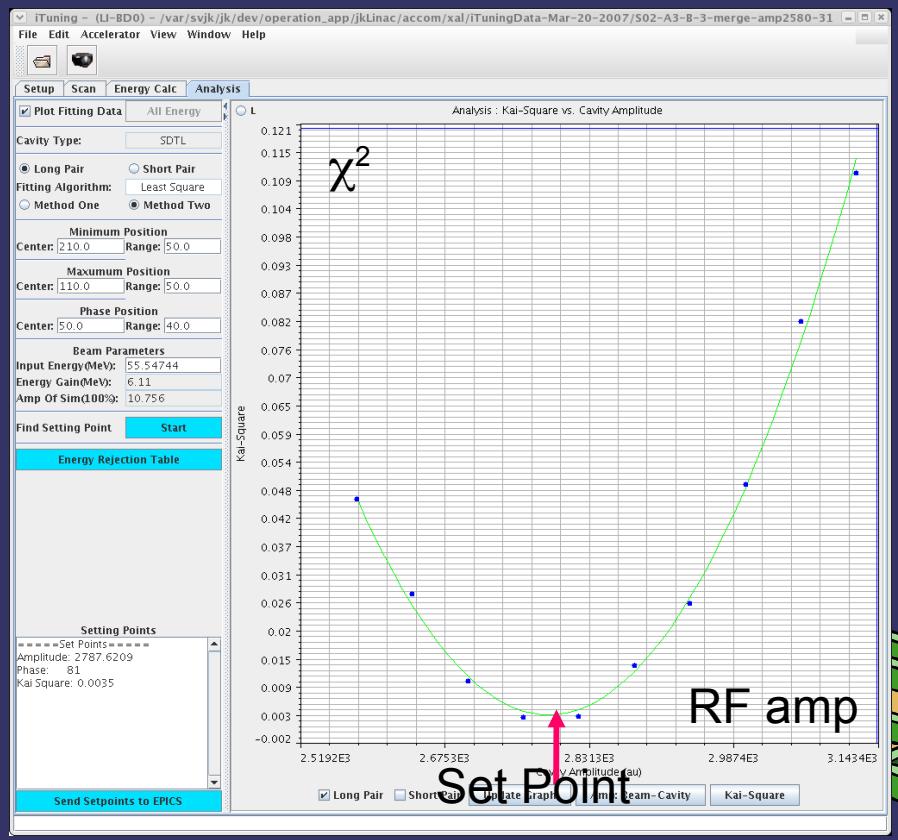
RF Tuning

- Scan of RF amplitude and phase
- Energy measurements with FCT pairs
- Determine RF amplitude and phase set points with a model
  - Whole procedure done within 1 hour per RF source

Fit to PARMILA model

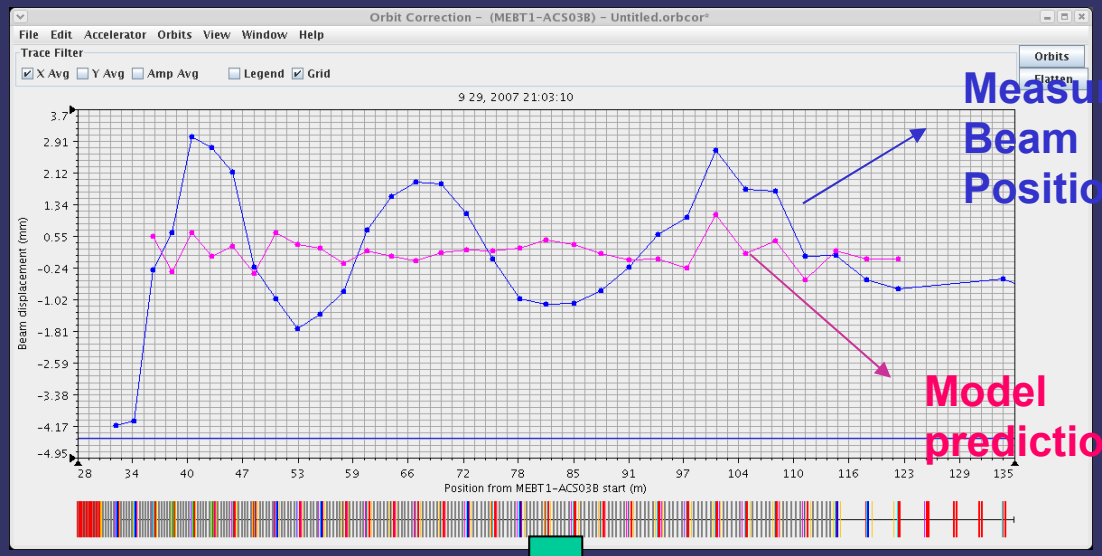


χ^2 vs. RF amplitude

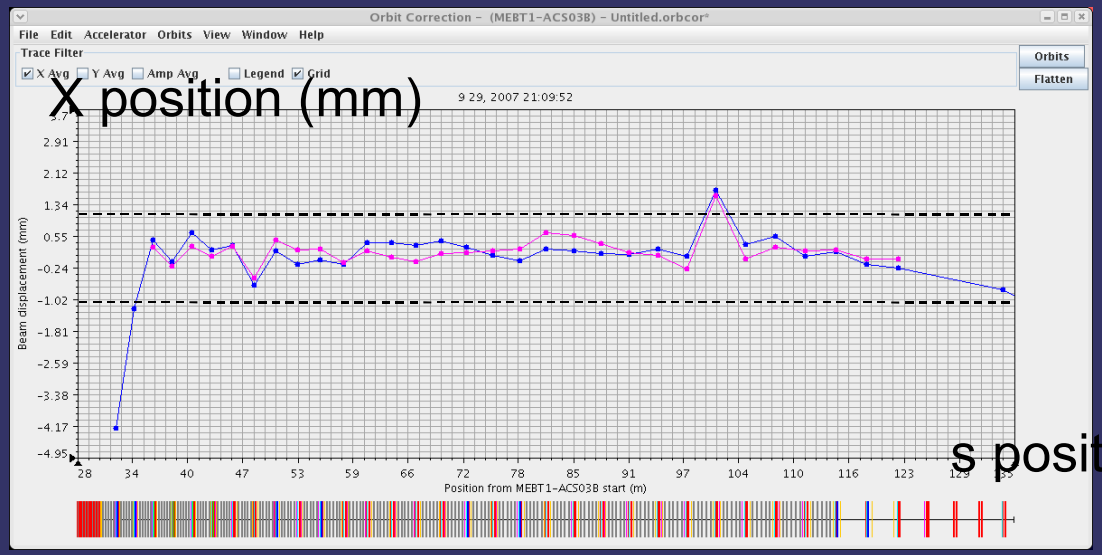


Orbit Correction

Before correction (SDTL)

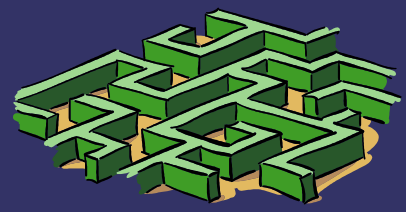


After correction



- Beam orbit correction with steering magnets
- Based on JCE
- Whole LINAC corrections can be finished within1 hour

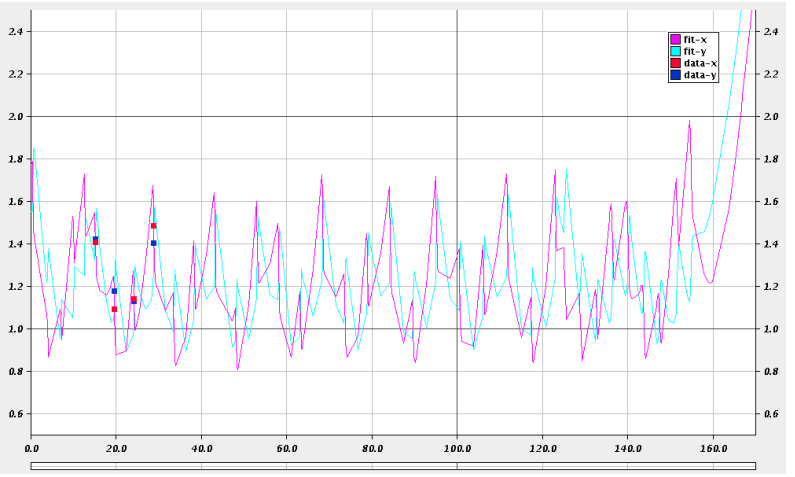
- Orbit deviations within 1mm



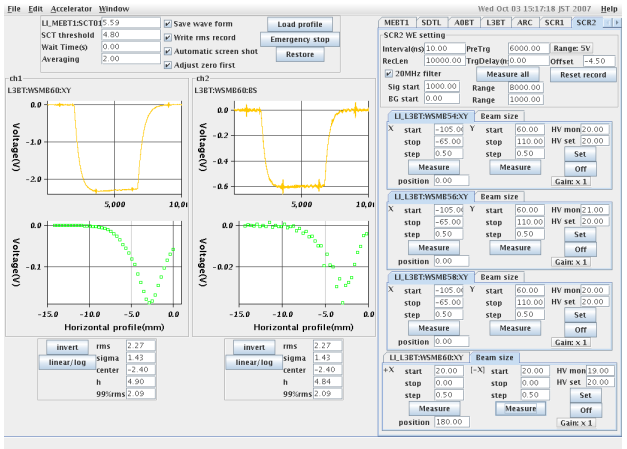
Transverse matching

- Beam profile measurements with wire scanners
- Tuning of upstream QMs
- Mismatch factor < 5% after matching.
- Tuning done in 1~2 hour per section

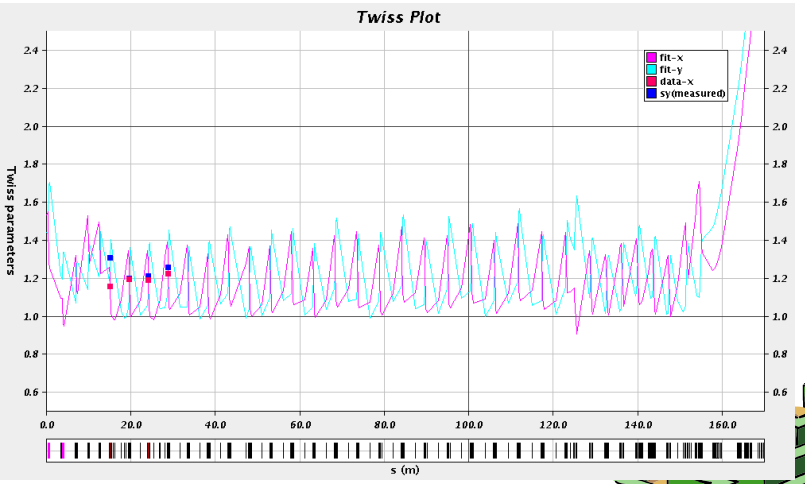
Beam envelope (A0BT-L3BT)



Before correction



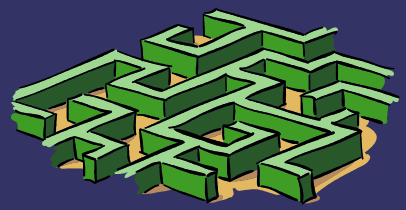
WS measurement panel



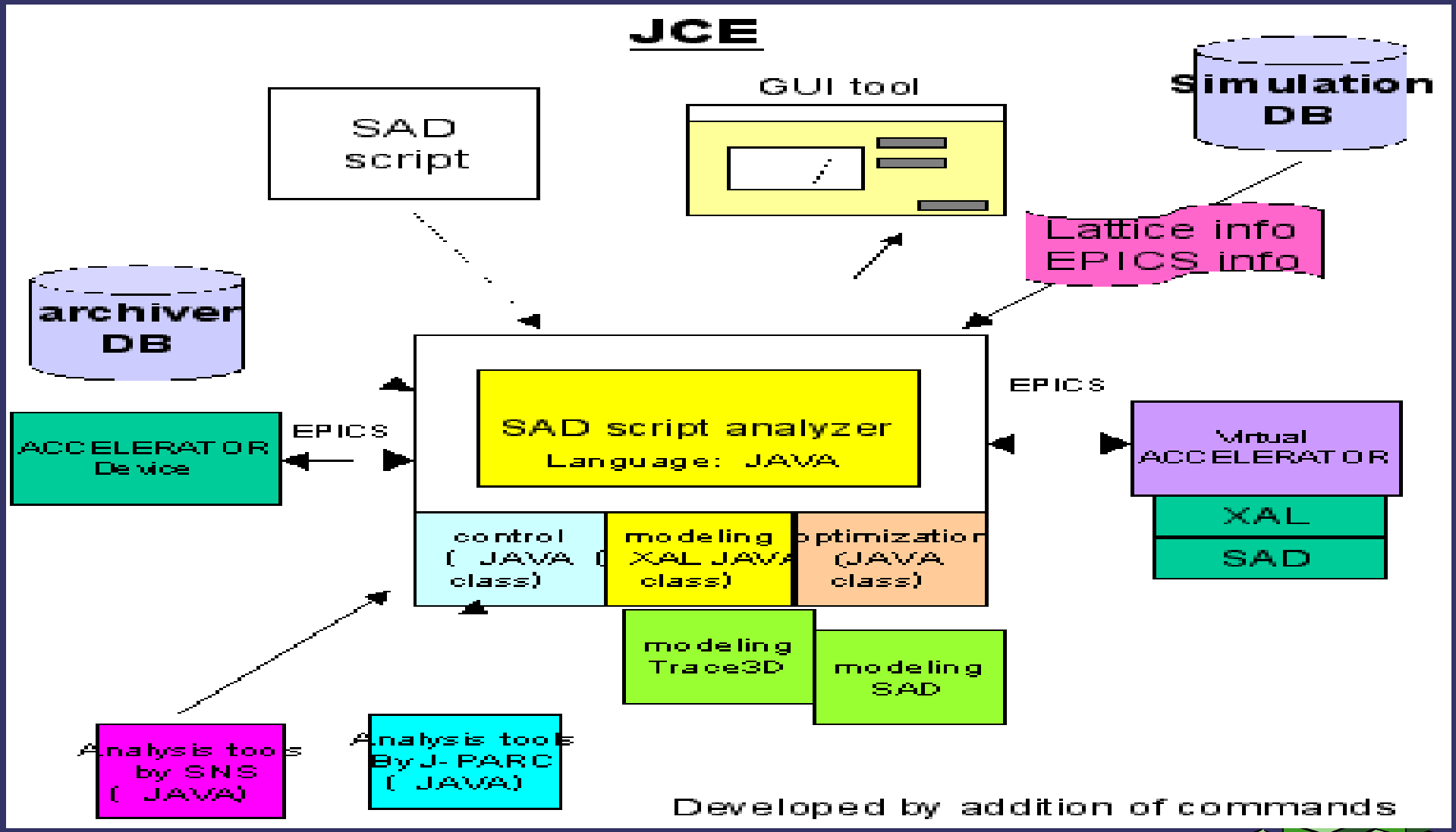
After correction

JCE and SAD

- JCE
  - scripting language compatible with SAD
  - Written in Java
  - XAL and Trace 3D as accelerator Model
  - GUI widgets set based on XAL/java
    - Framework compatible with KEKBFrame
  - JCA/CAJ library access.
  - Developed for J-PARC
- SAD
  - scripting language with syntax of Mathematica
  - Written in Fortran/C/C++
  - Custom Accelerator Modeling Engine
  - GUI widgets set based on Tcl/TK
    - KEKBFrame as GUI framework
  - CA library access
  - Intensively used in KEKB.

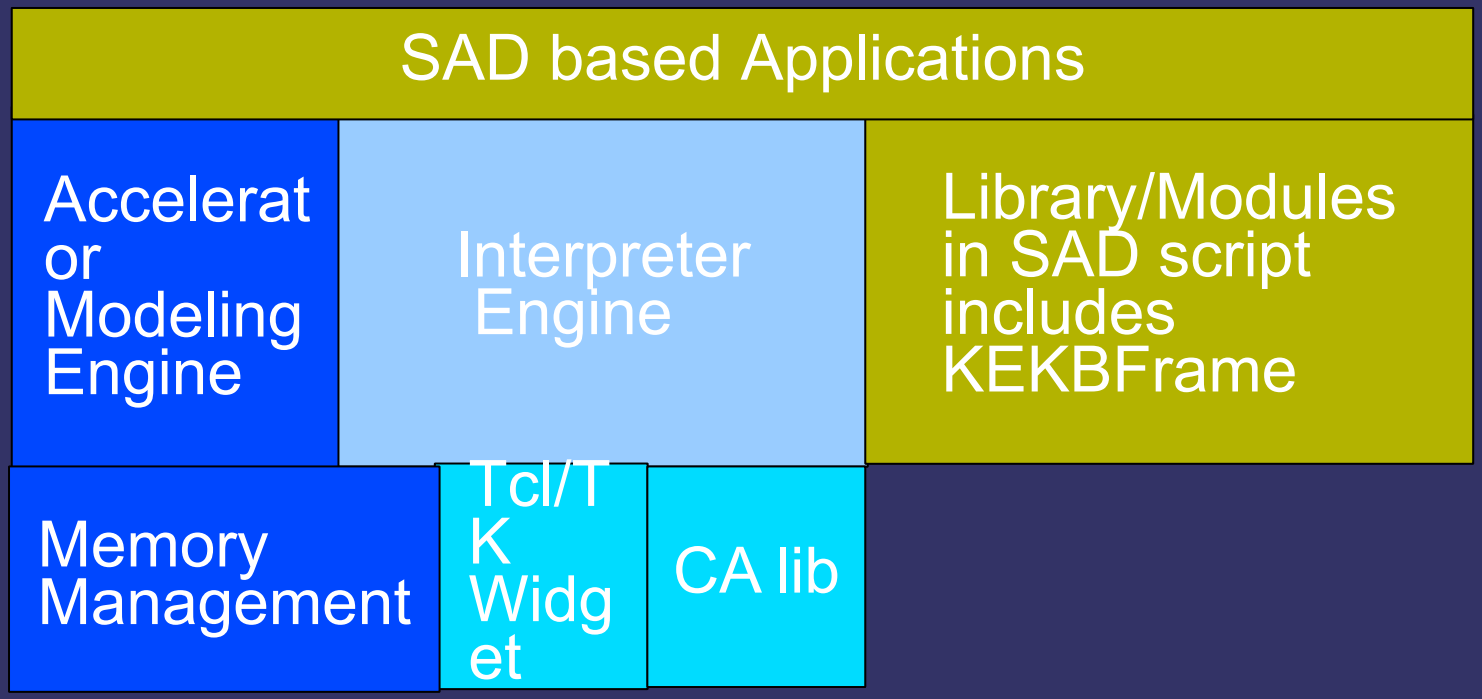


JCE:Java commissioning Environment

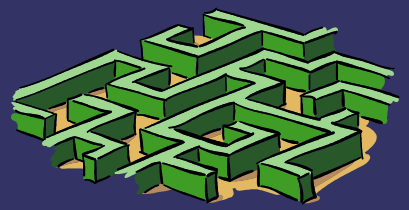


"JCE:A Java commissioning Environment" by H. Sako, 2006

SAD

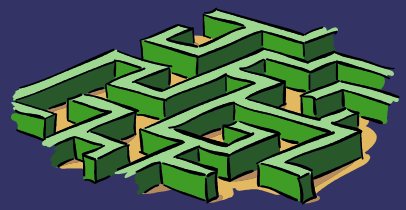


- mostly Written in Fortran(f77/gfortran/Intel fc)
-



High Level Applications at RCS

- B,Q control and optics correction
- Tune correction and dynamic tune control
- Injection control panel
- Injection orbit control
- Optics measurement and analysis
- Extraction orbit control
- Extracted beam measurement
  - 3NBT
- .....



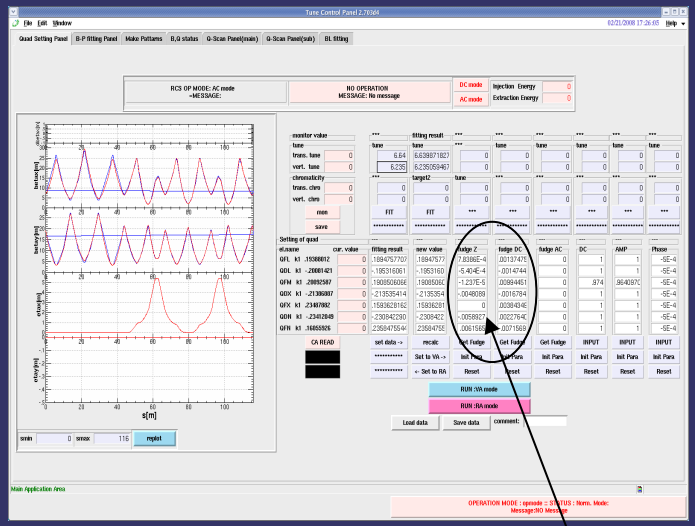
B,Q control and optics correction

B,Q control panel
model fitting : SAD

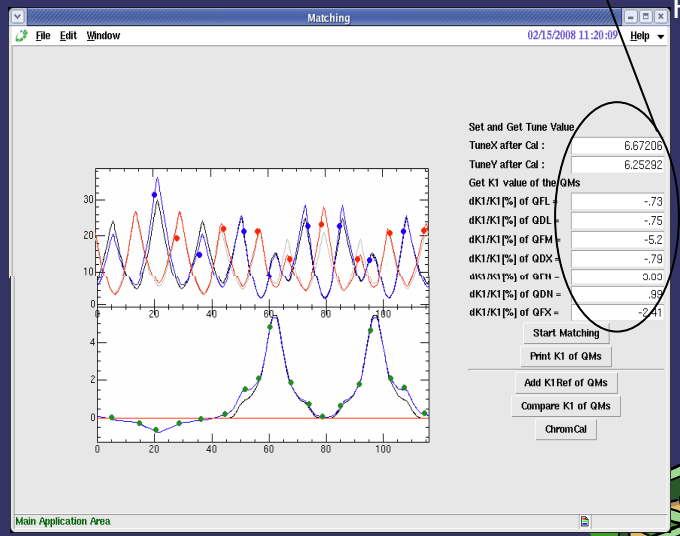
Set & Meas.

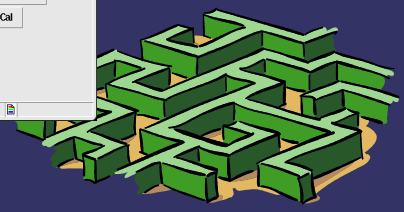
Correction
(Fudge factor)

Optics measurement and
correction panel

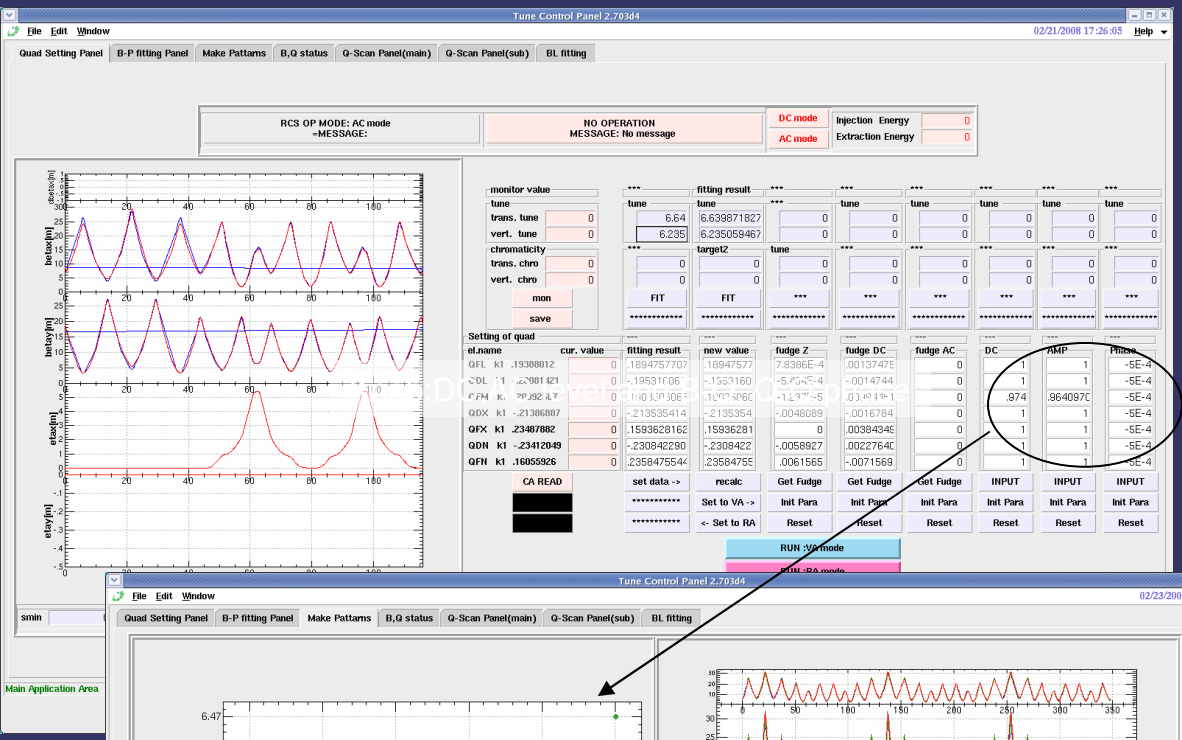


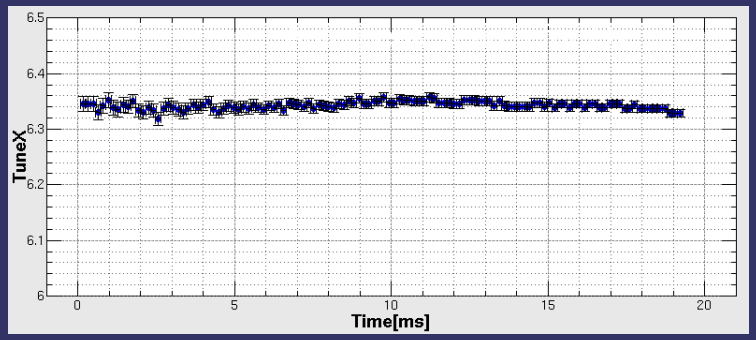
Fudge factor

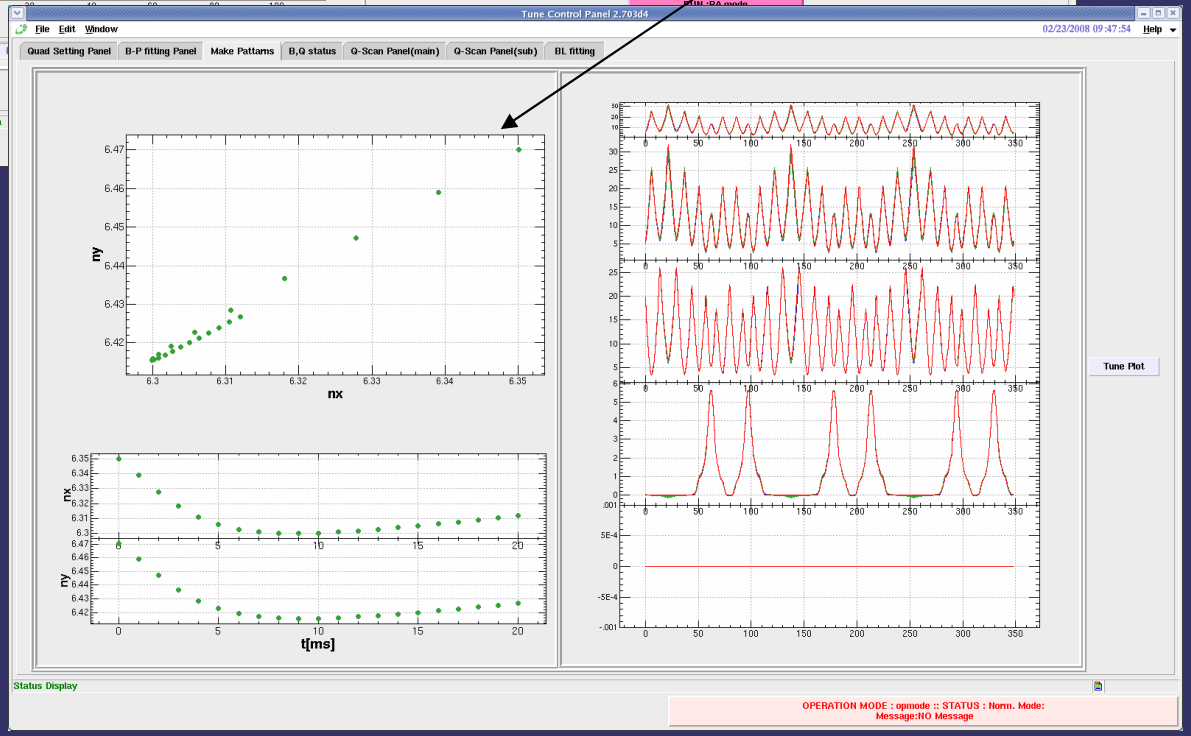


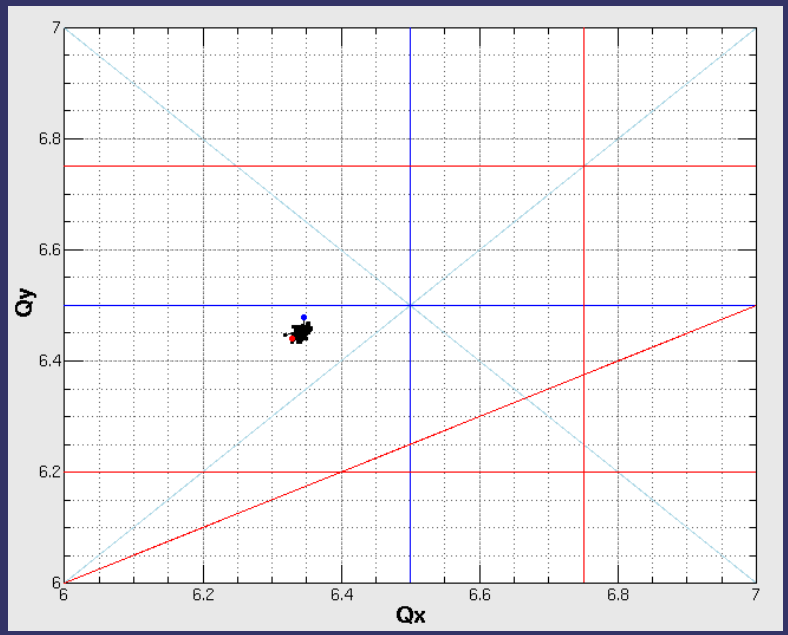


Tune correction and dynamic tune control

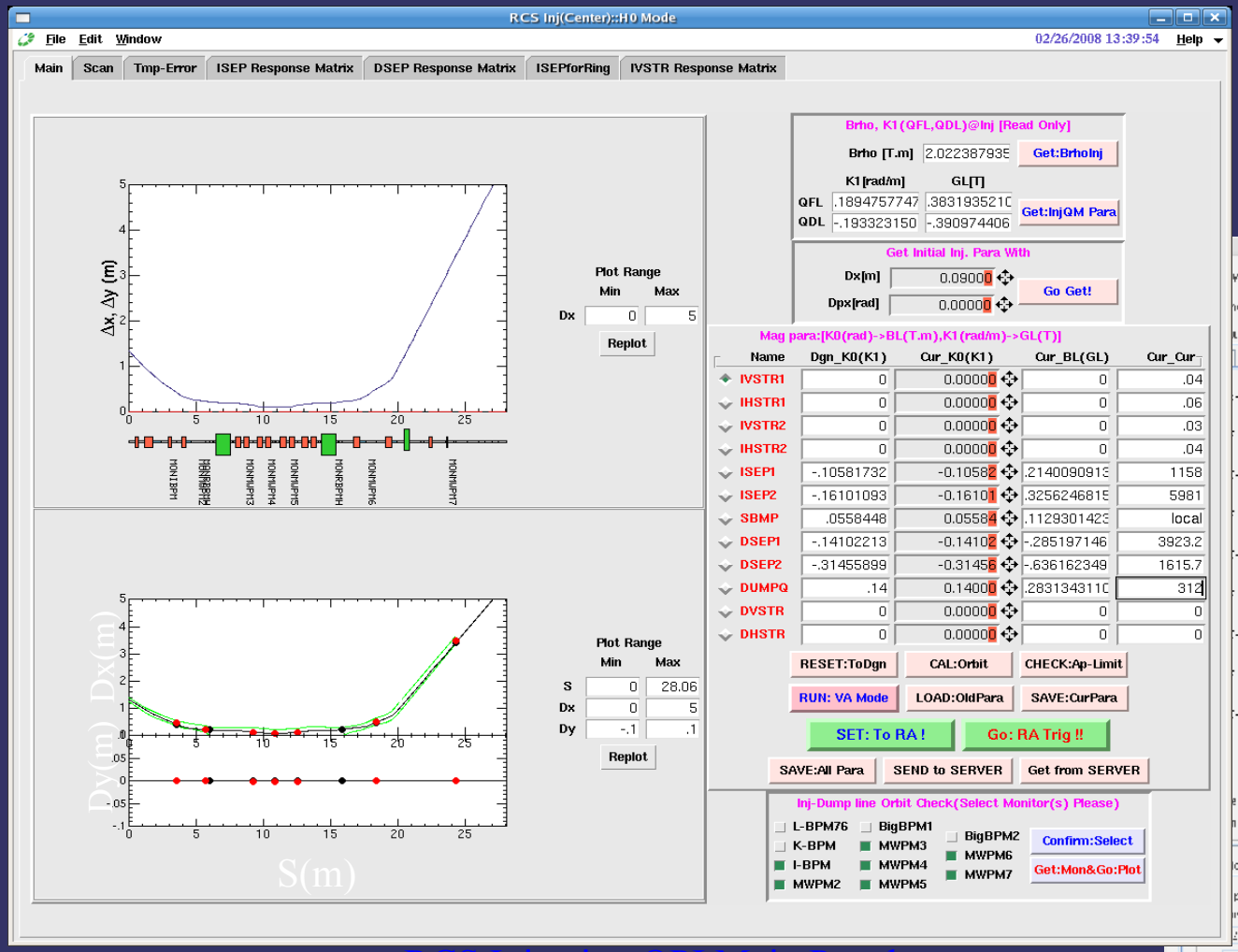




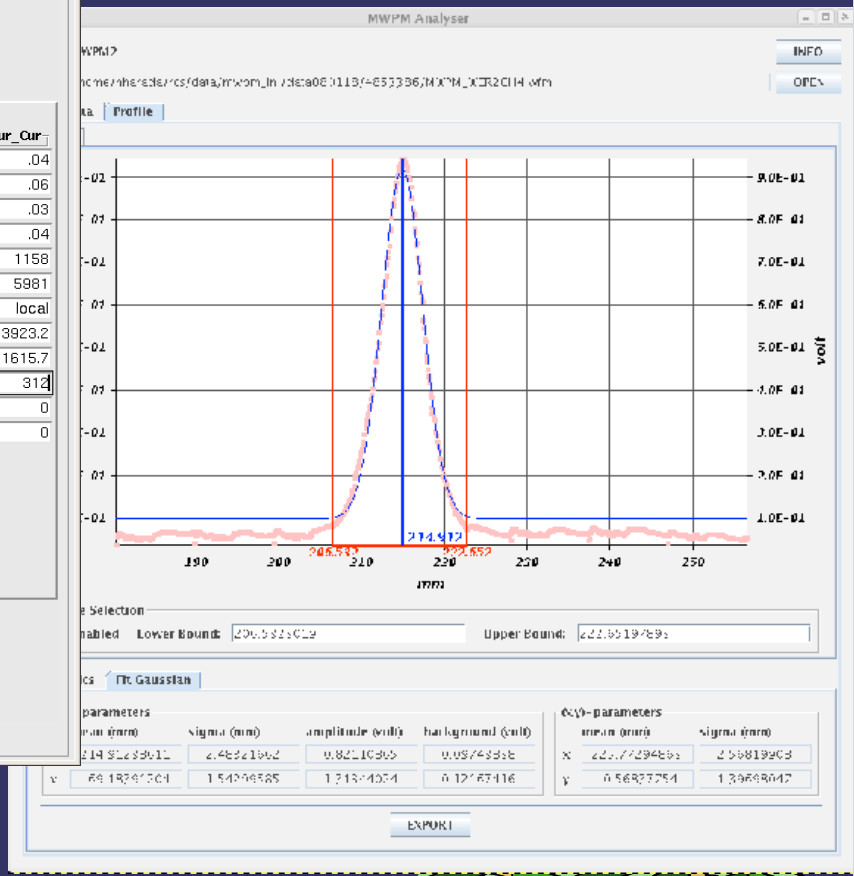




Injection control panel



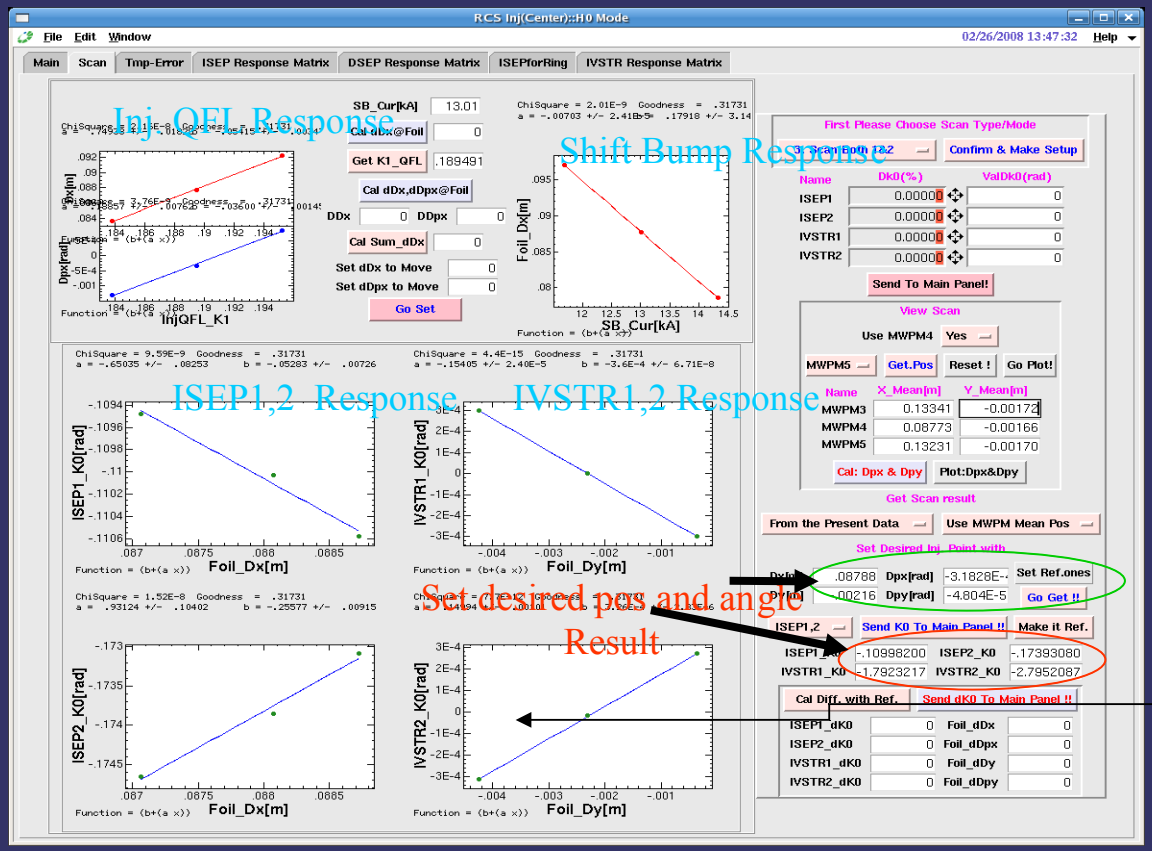
RCS Injection OPI Main Panel
for Parameter set and Orbit Monitor

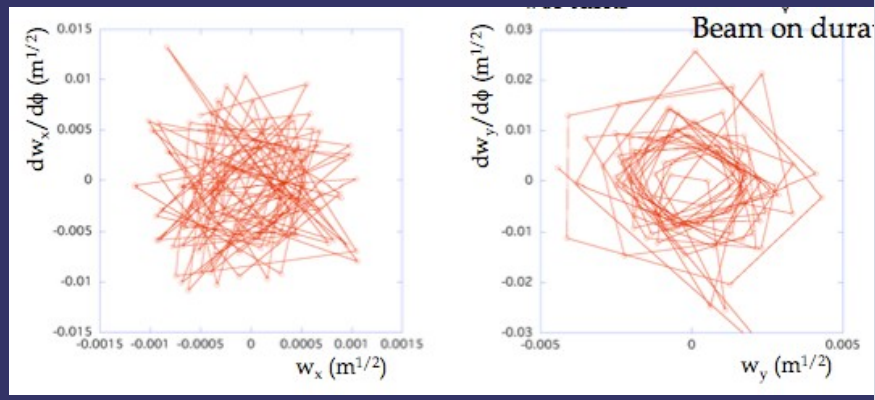


Injection beam profile(measured)

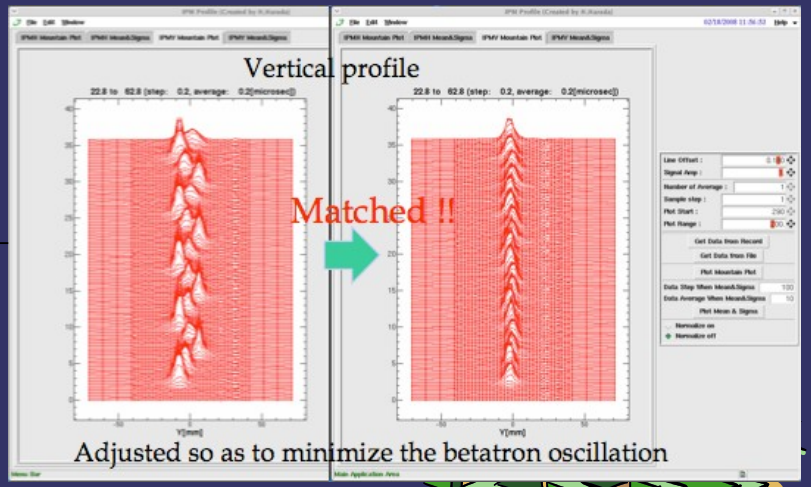
Injection control panel (correction)

RCS Inj OPI for Orbit Control
using measured Response Matrix





phase space plot

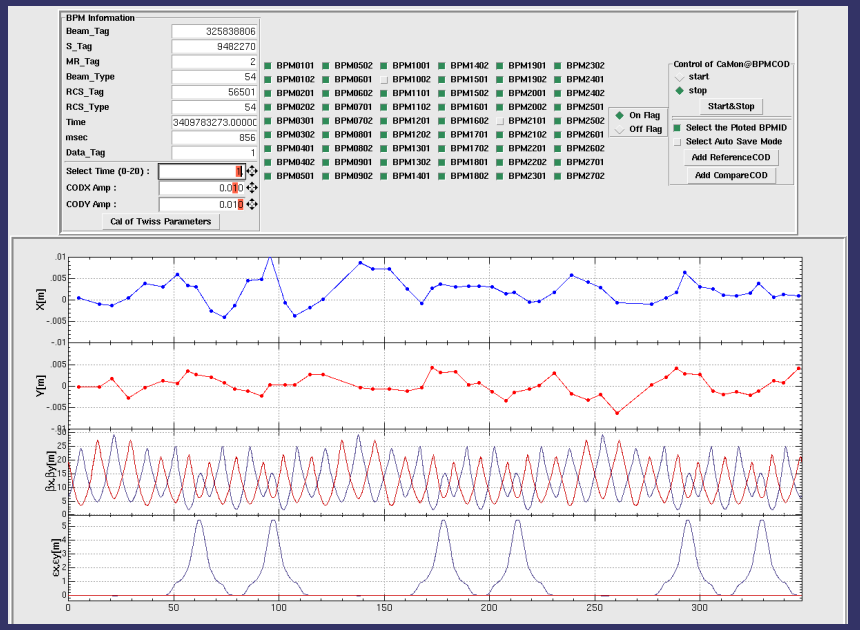


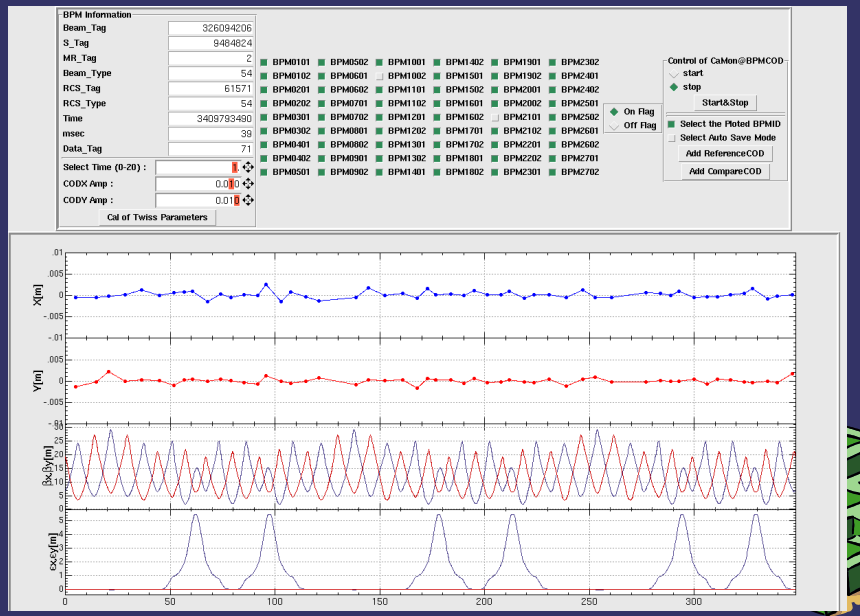
Beam profile

Orbit correction

Optics measurement and analysis panel(1a)

-COD correction



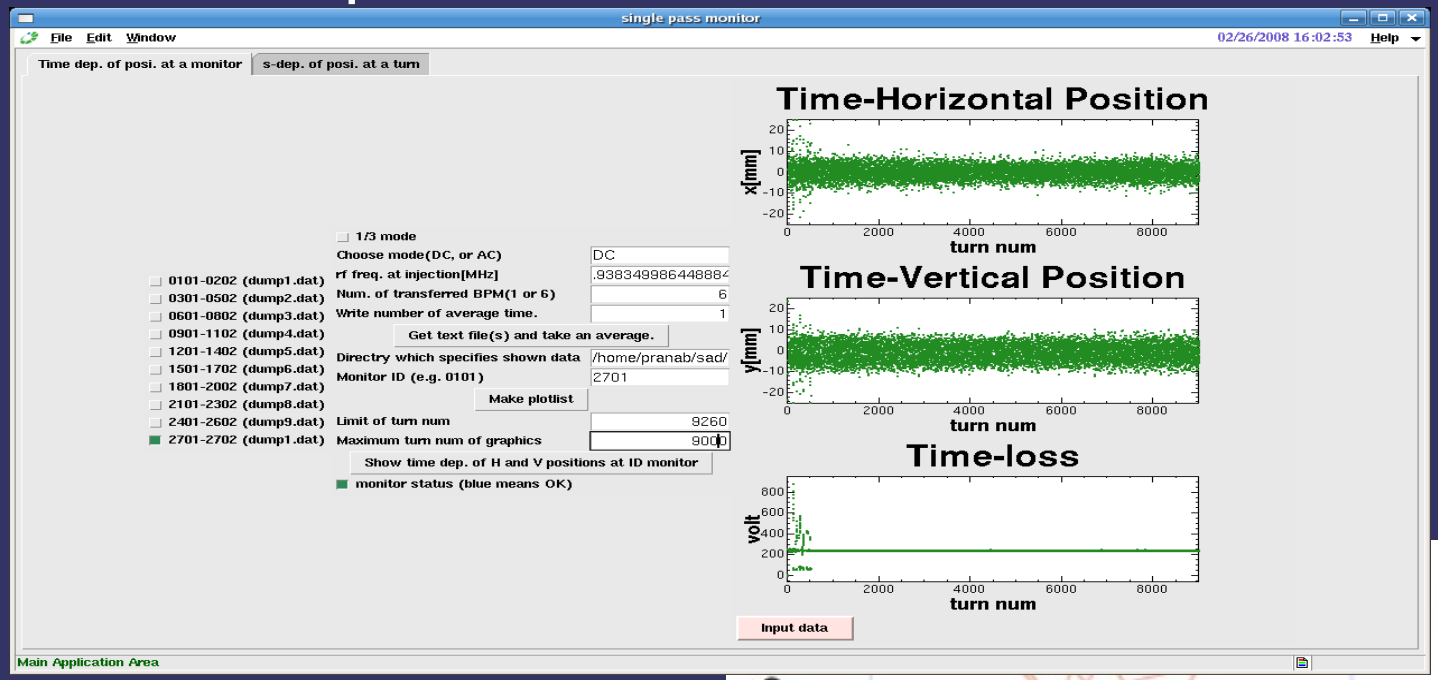


COD correction panel

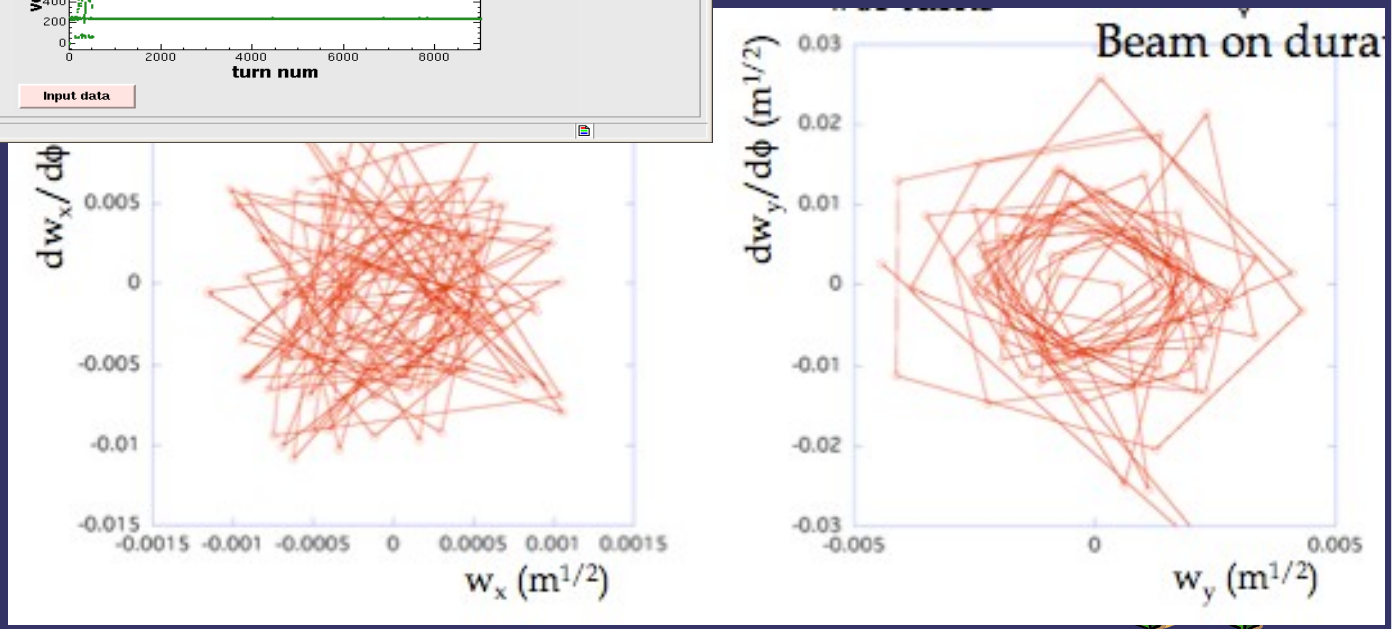
COD

Optics measurement and analysis panel(1b)

-one pass measurement



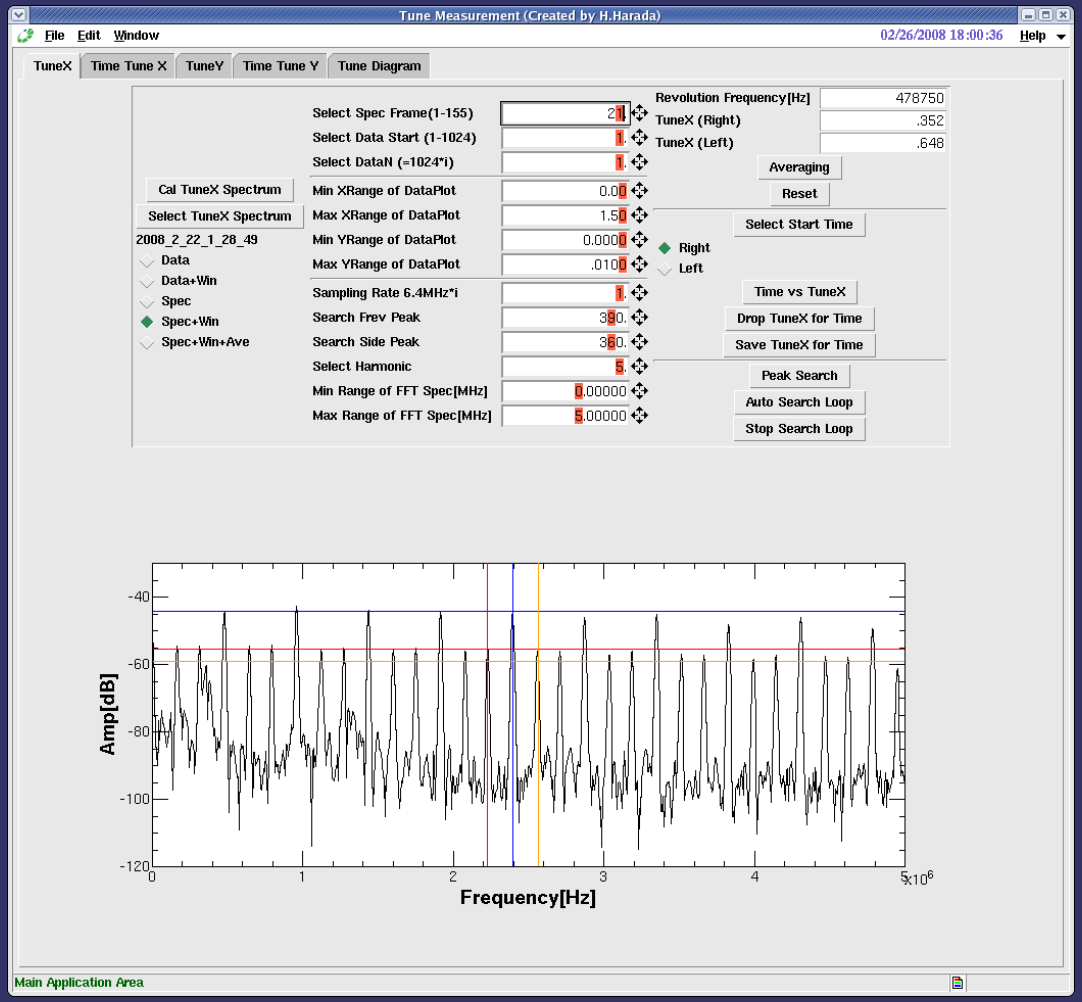
one pass orbit

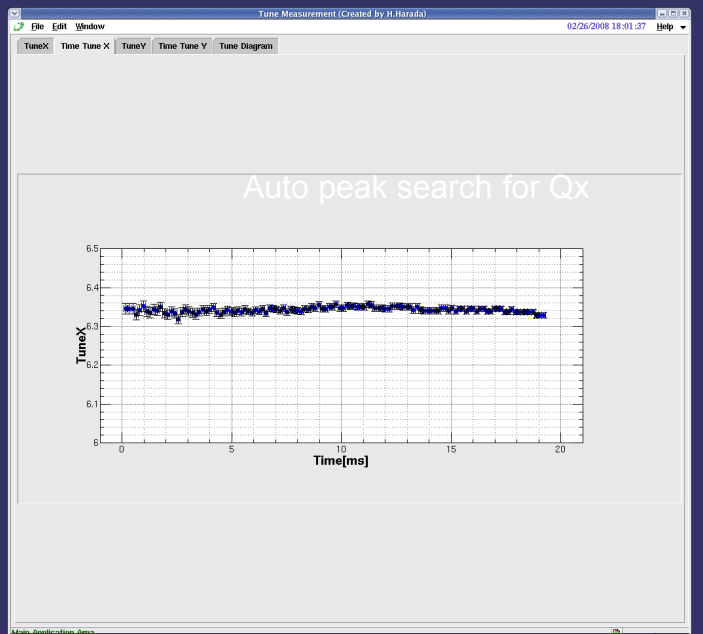


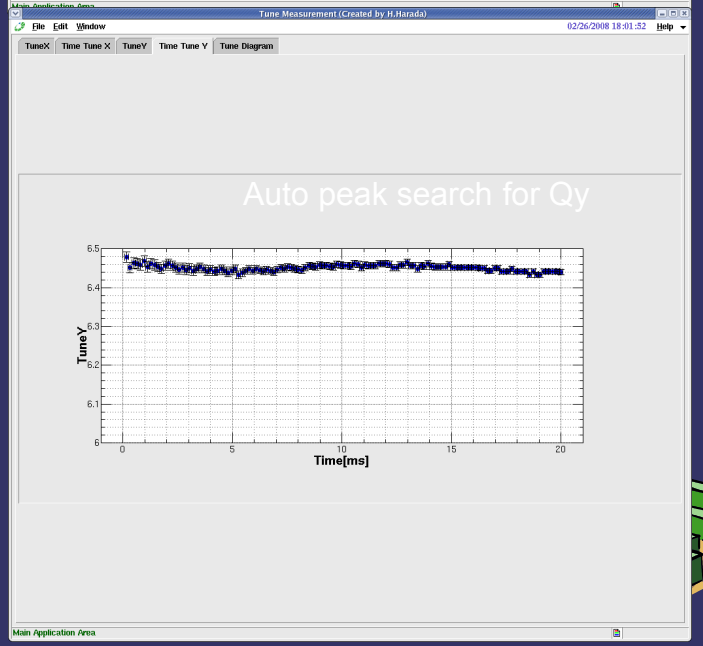
phase space plot

Optics measurement and analysis panel(2)

-tune measurement



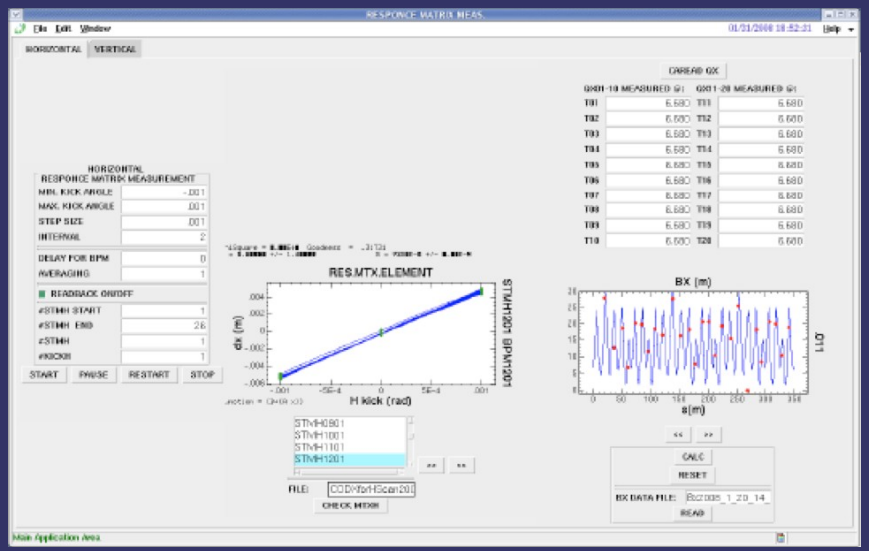


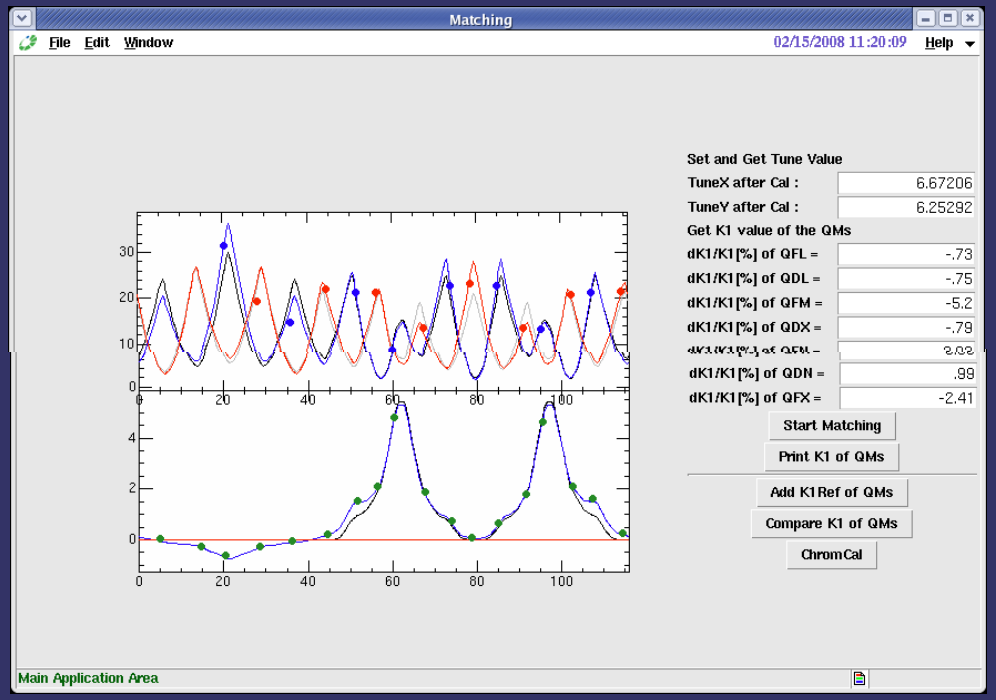


Optics measurement and analysis panel(3)

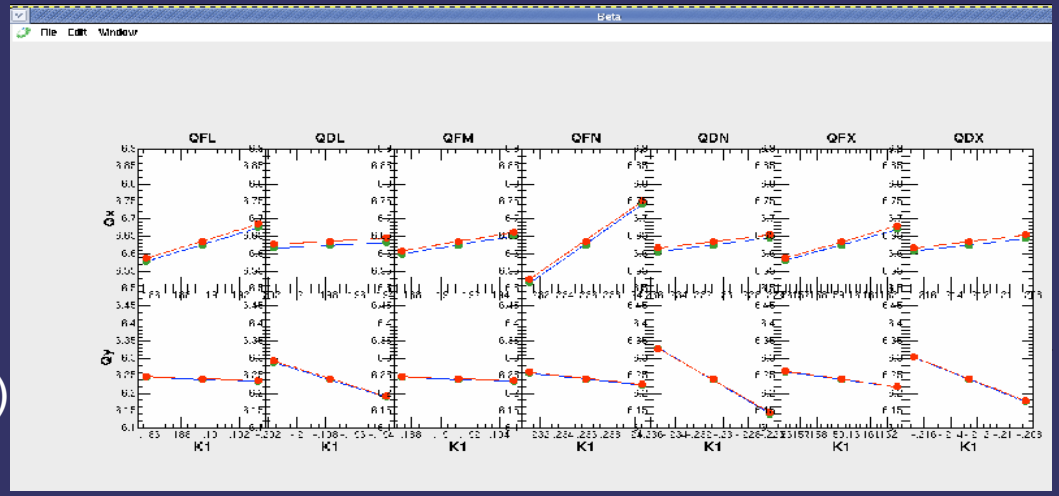
-beta function measurement

① Knob:
steering magnets (Auto Scan)
Monitor:
BPM





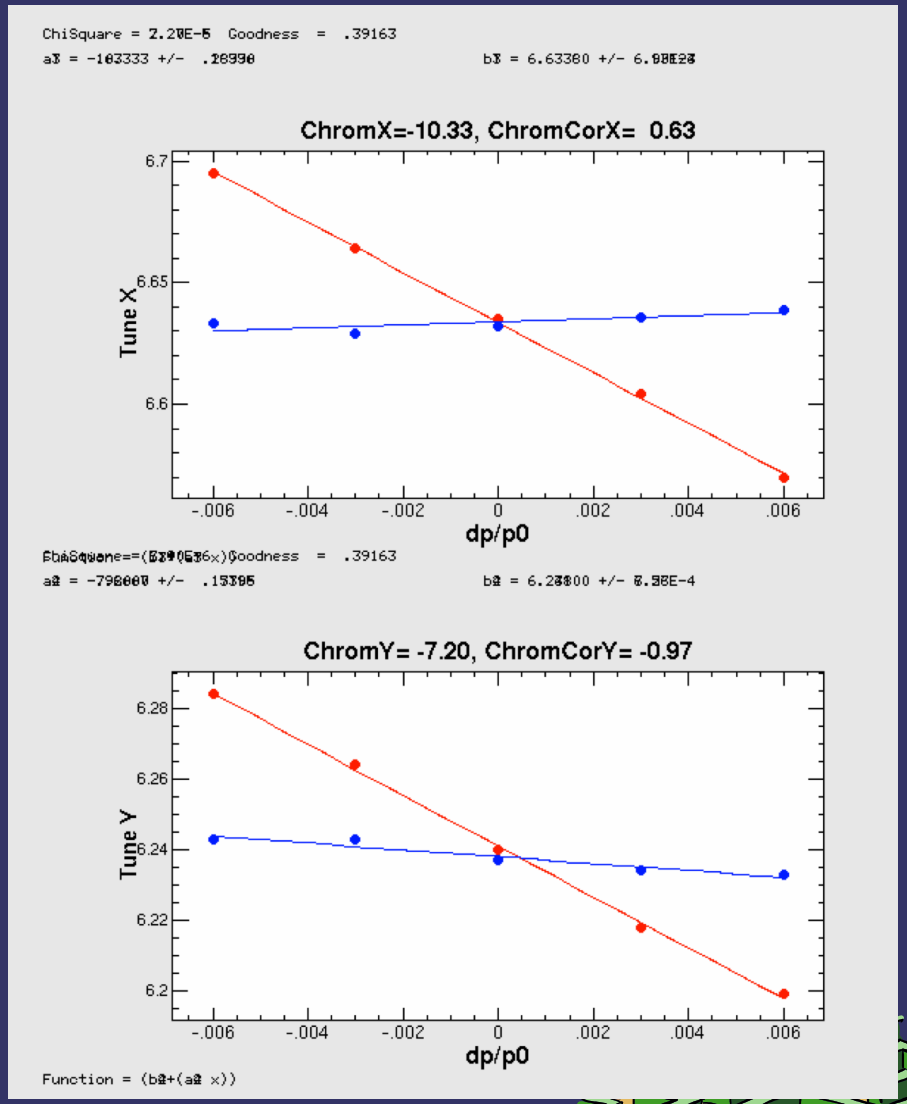
② Knob:
Quad magnets(B,Q control panel)
Monitor:
tune monitor(tune measurement panel)



Optics measurement and analysis panel(4)

-Chromaticity measurement

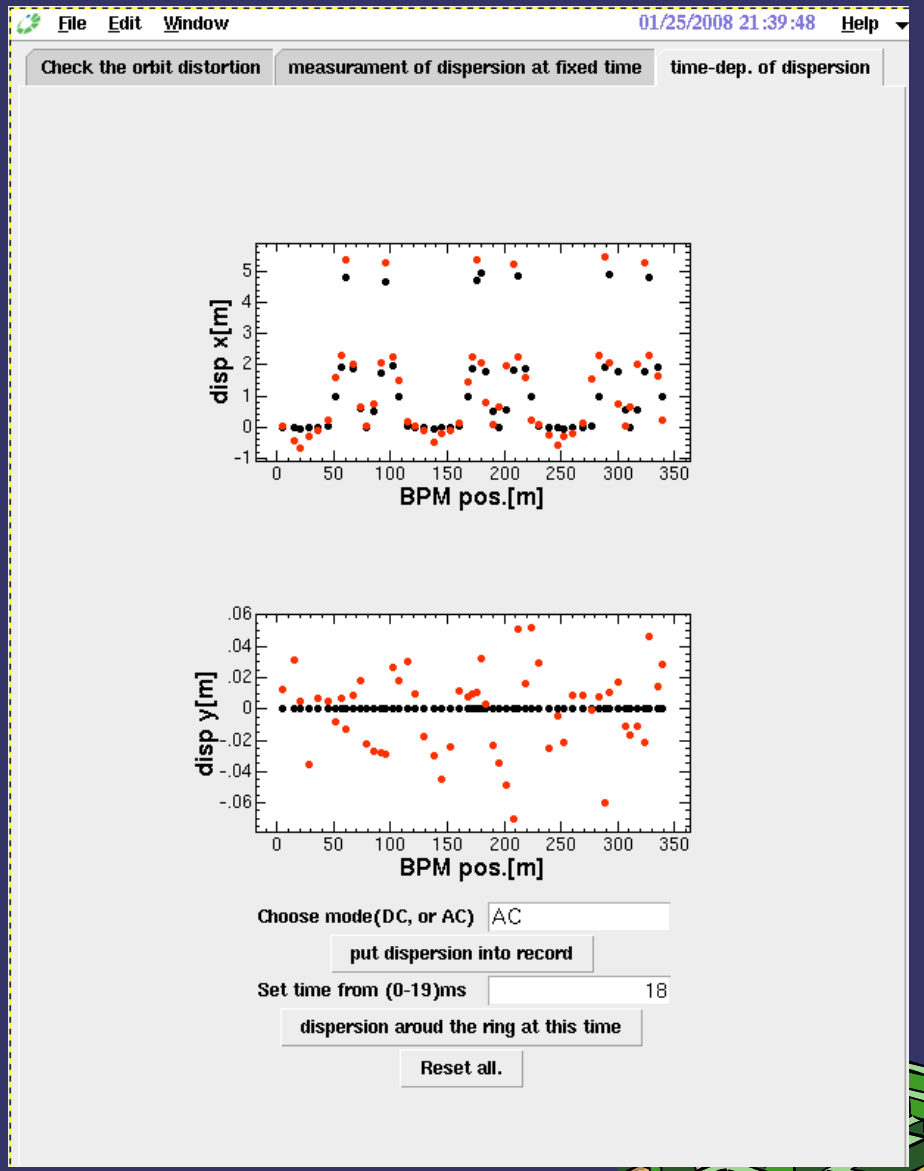
- Measurement
  - Knob: RF frequency
  - Monitor: tune monitor
- Correction
  - Knob: Sextupole magnets



Optics measurement and analysis panel(4)

-Dispersion measurement

- Knob: RF frequency
- Monitor: BPM

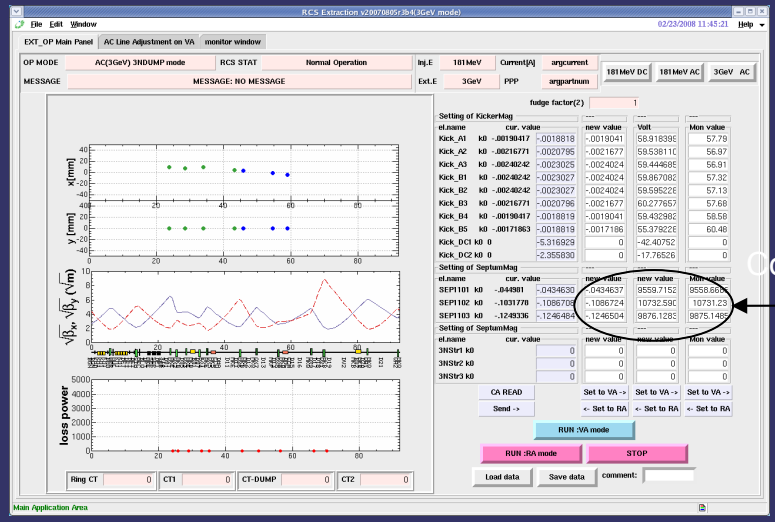


Extraction orbit control

Extraction orbit control panel
knob: 8 kicker magnets
3 septum magnets

Set & Meas. Correction
(Fudge factor)

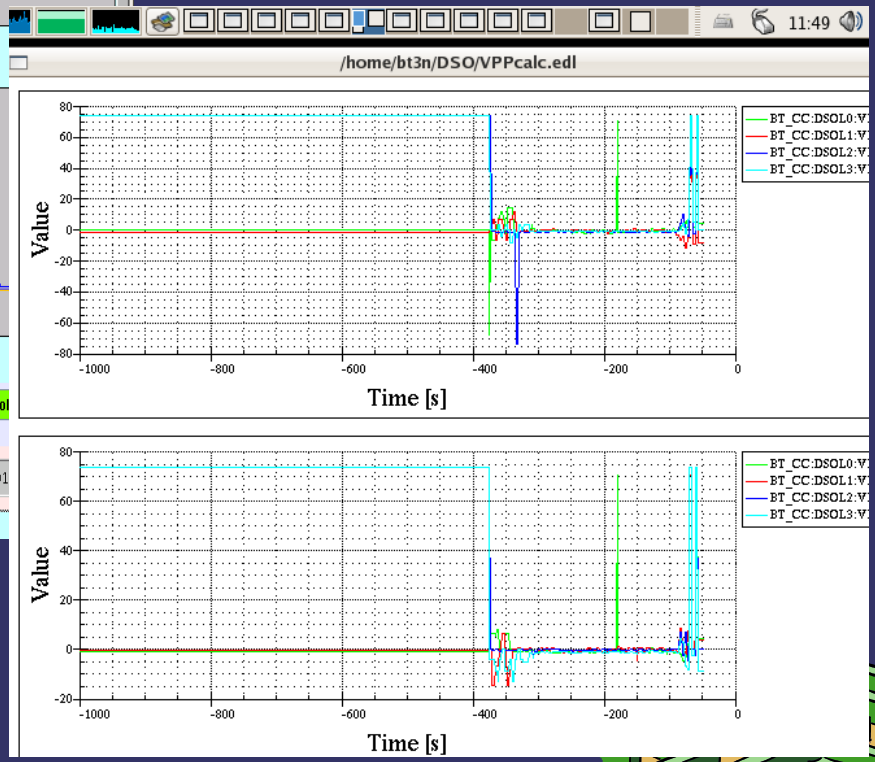
orbit measurement and
correction panel



Extracted beam measurement

Beam profile

Beam position

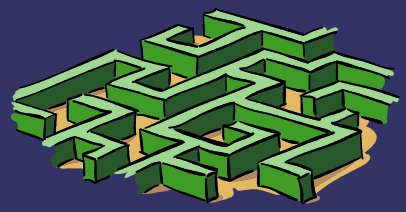


3NBT Gr

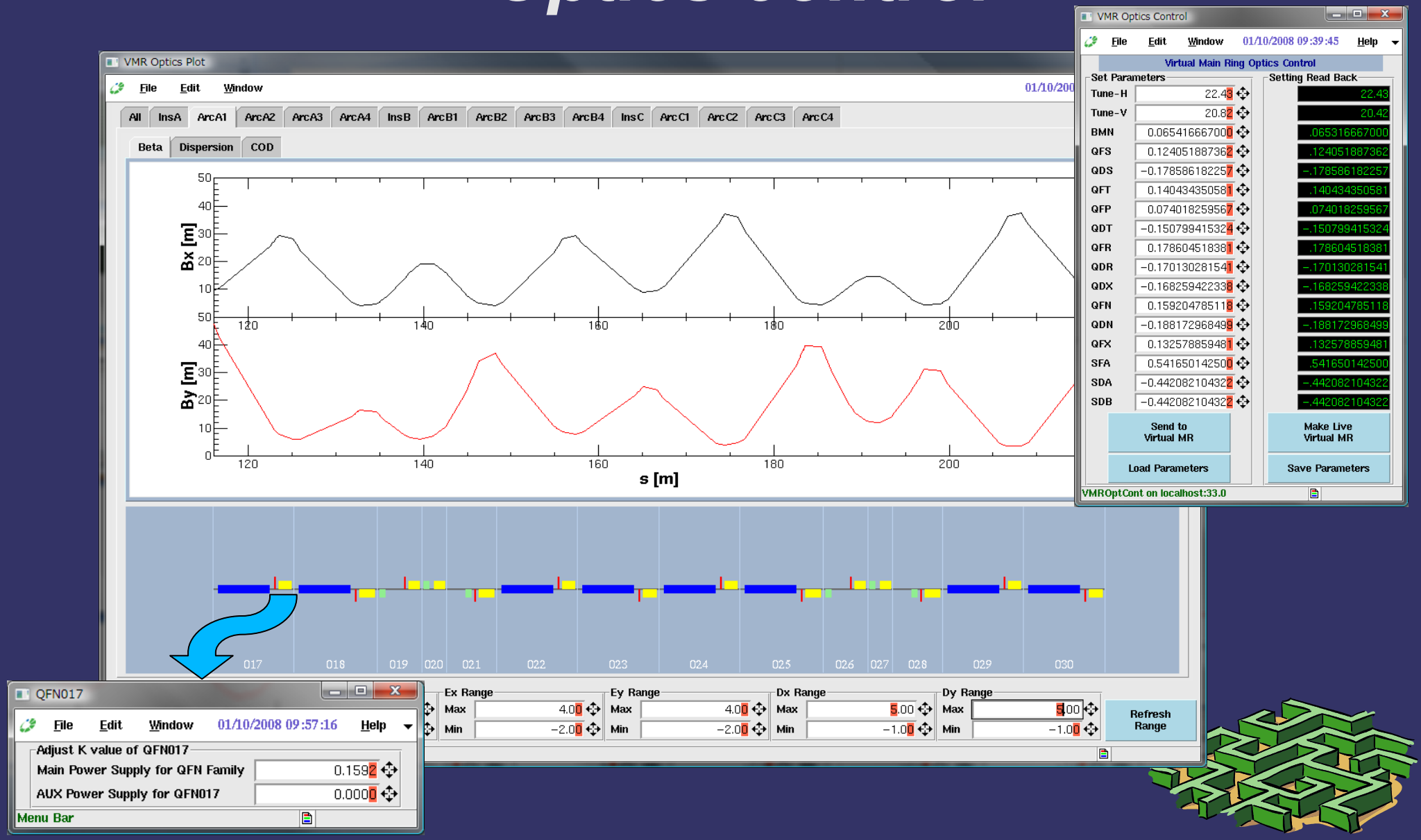
High Level Applications for 50GeV Ring

- Work closely to RCS commissioning team
- Develop several prototype applications for the ring operation.
  - Beam loss monitor display
  - Injection orbit control
  - Orbit correction

  .....

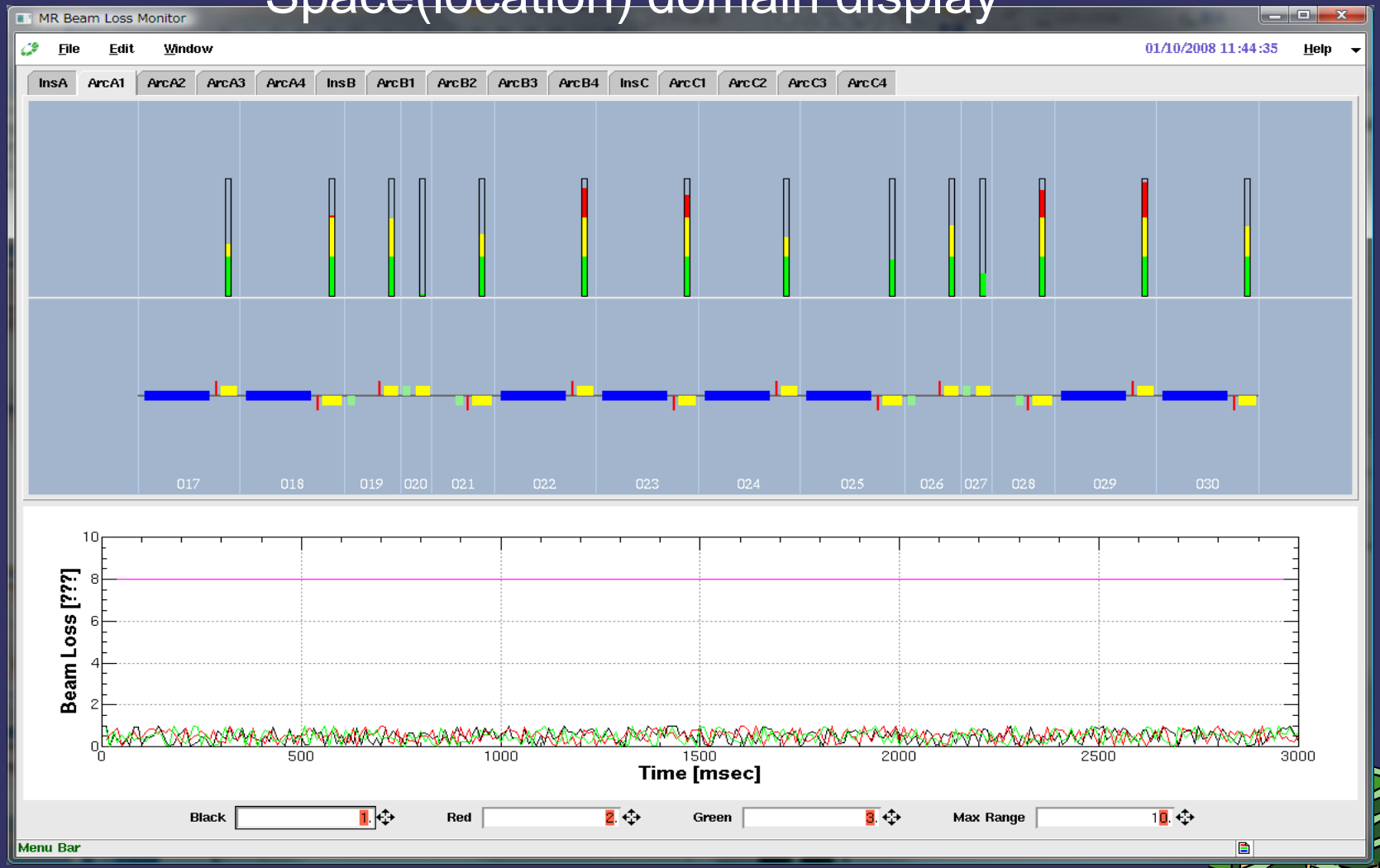


Sample application for MR Optics control



Sample Application for MR Beam Loss monitor display

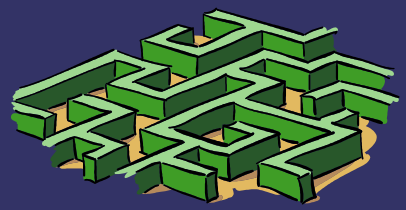
Space(location) domain display



Time domain display

Summary

- Useful High level applications are already developed for LINAC and RCS commissioning.
  - It also means Base Device Controls works nicely.
- Prototype applications for MR were developed.
- Controls group working closely with commissioning group members.



Acknowledgement

To all members of J-PARC controls group

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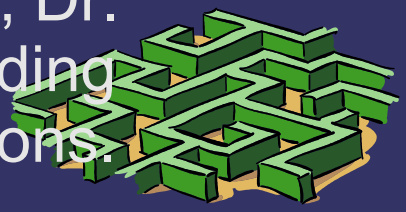

Picture of Atlas from http://www.yk.rim.or.jp/~tetsuyat/fan/fa7.jpg