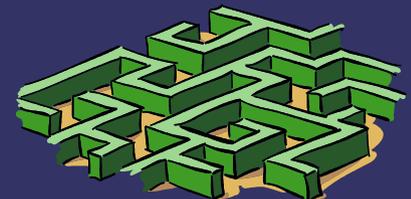


J-PARC Controls *- High Level Applications -*

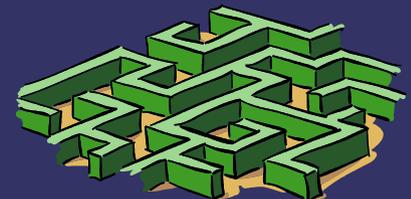
J-PARC controls group
Noboru Yamamoto

For ATAC08/EPICS collaboration meeting



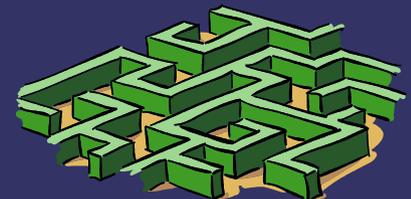
Recommendations from ATAC 2007

- ➔ *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.*



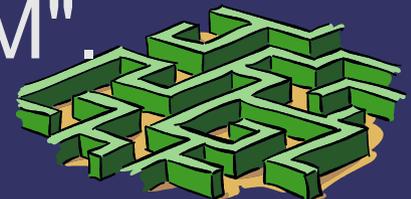
Overview

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

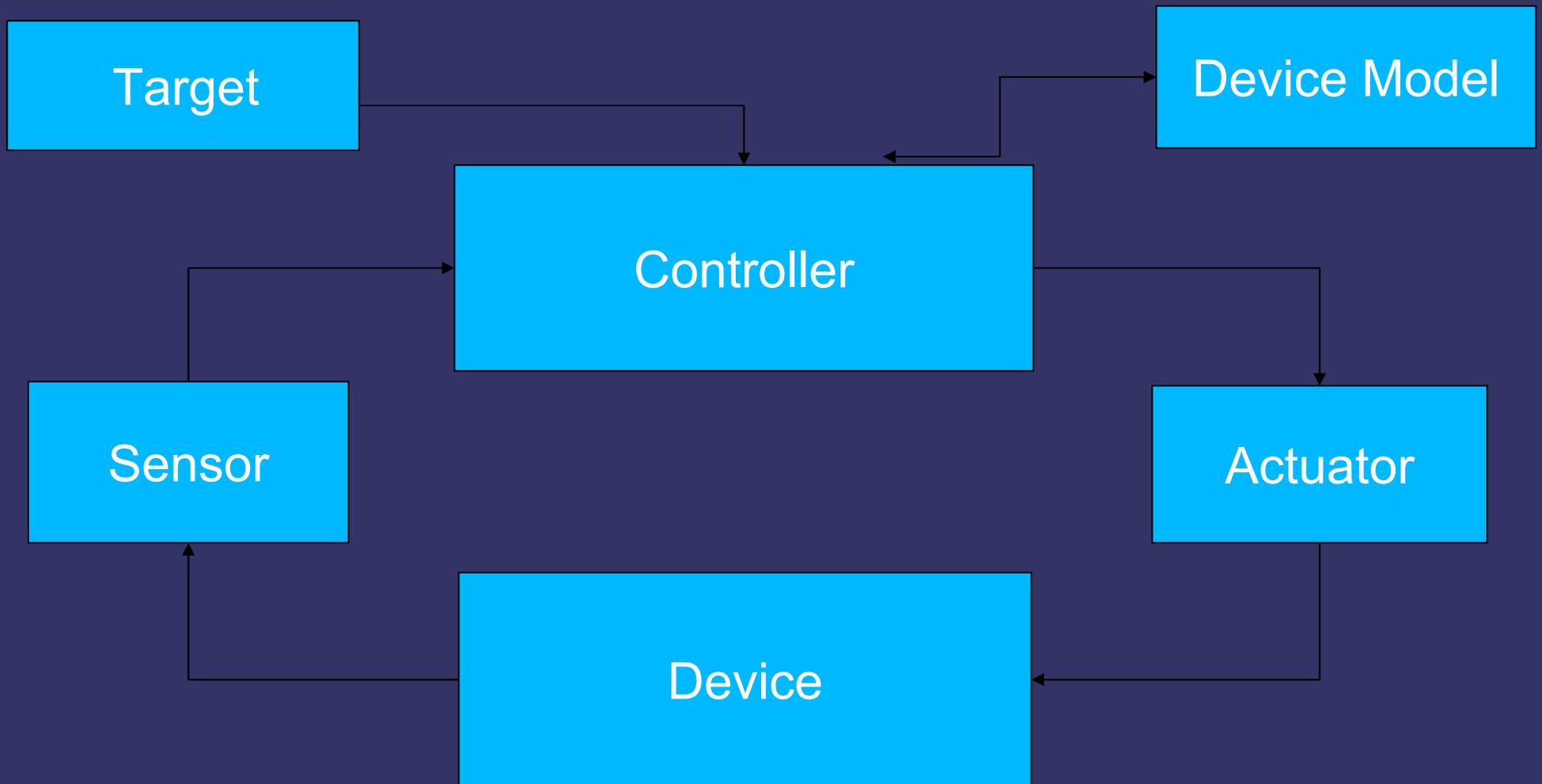


From Accelerator(Device) Controls to Beam controls

- ⇒ 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".



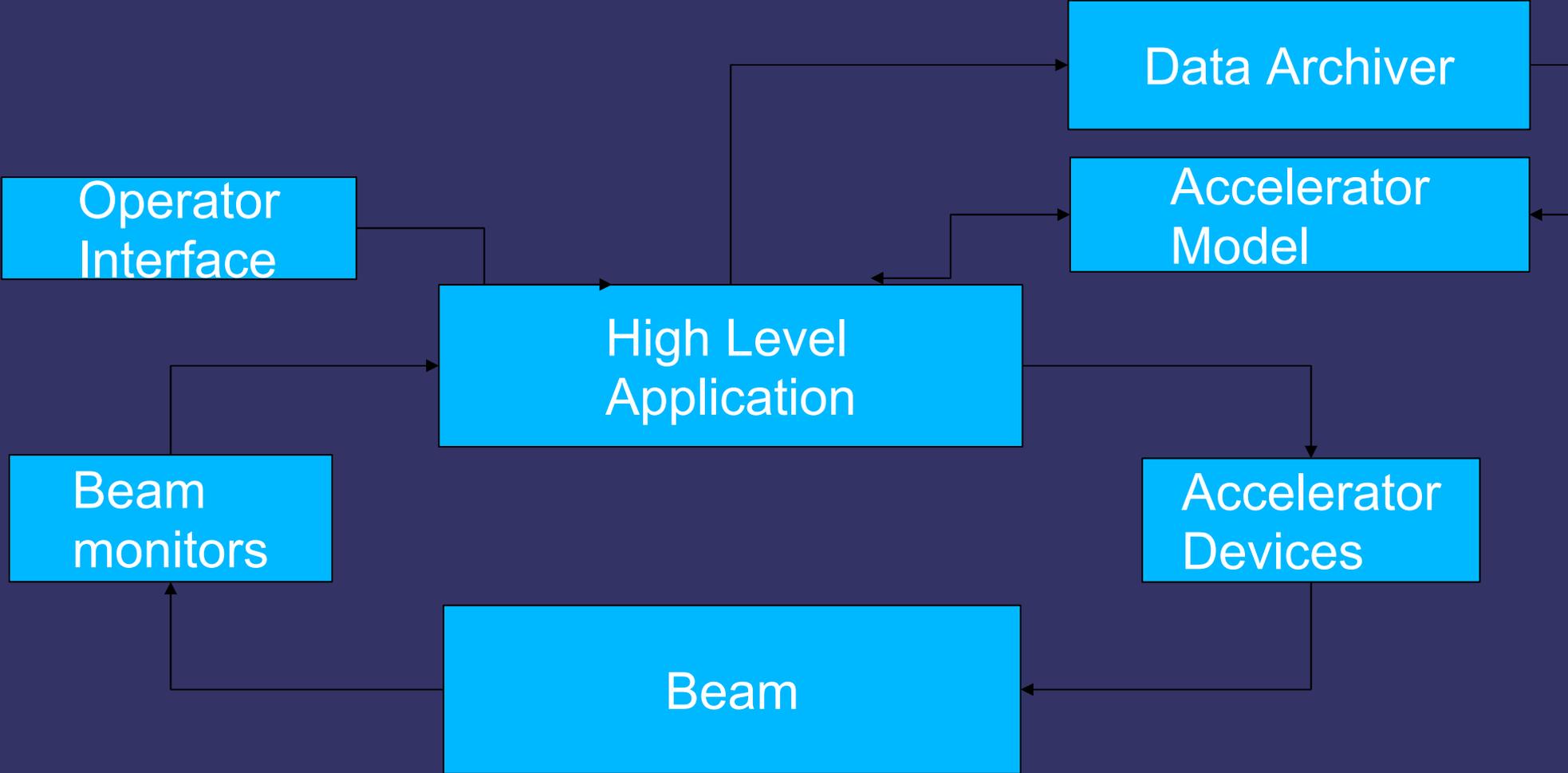
Accelerator(Device)Controls



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

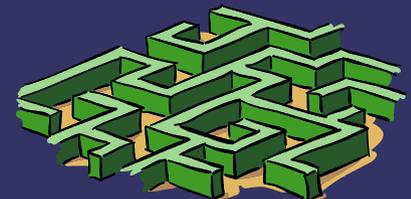
- ⇒ HLA developers
 - Most of HLA are written by the commissioning group members
 - or under the guidance of the commissioning group
 - RCS and 50GeV teams works closely and will be able to share software/ knowledge of HLA.
 - semi-regular meeting with Prof. Oide (KEKB/SAD) and RCS/50GeV team.
- ⇒ Controls 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

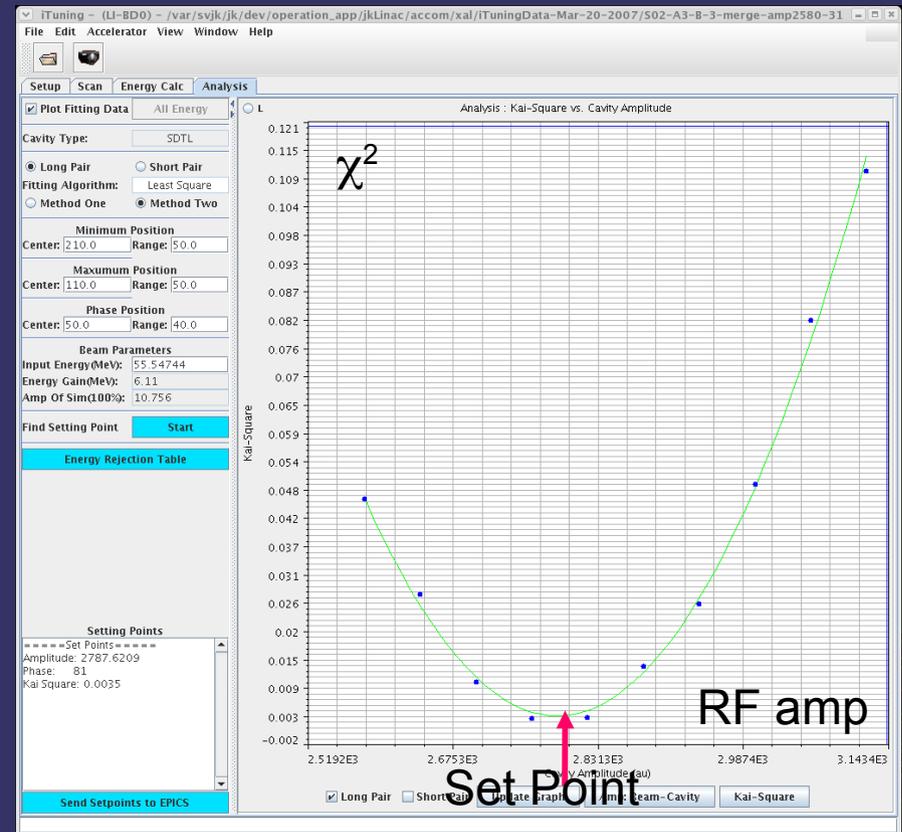
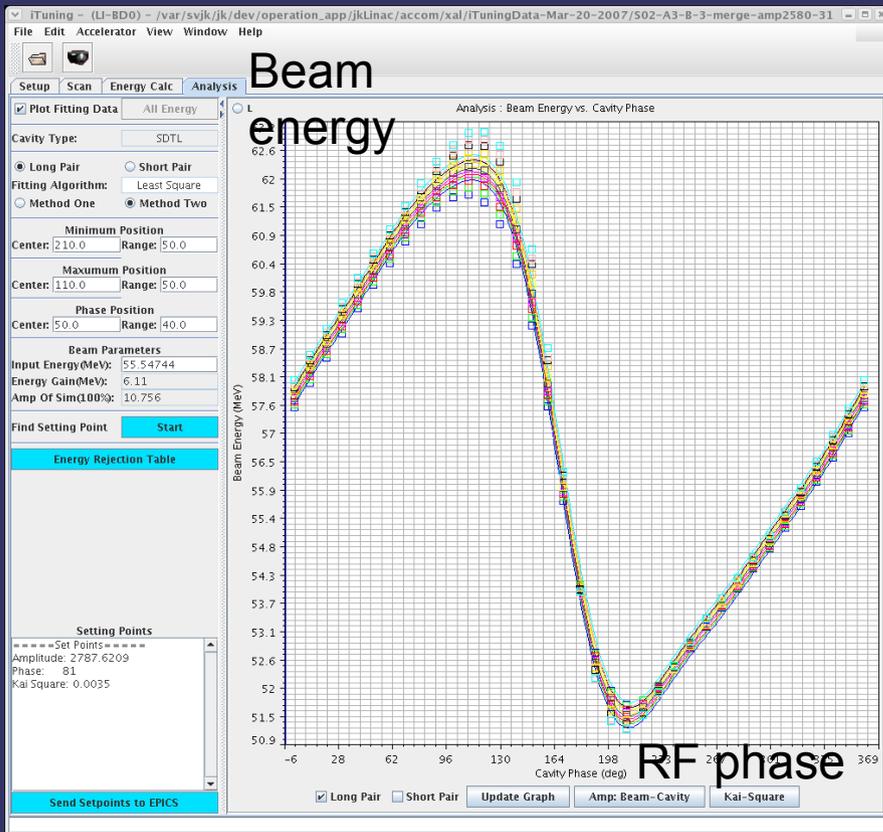


RF Tuning

- 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

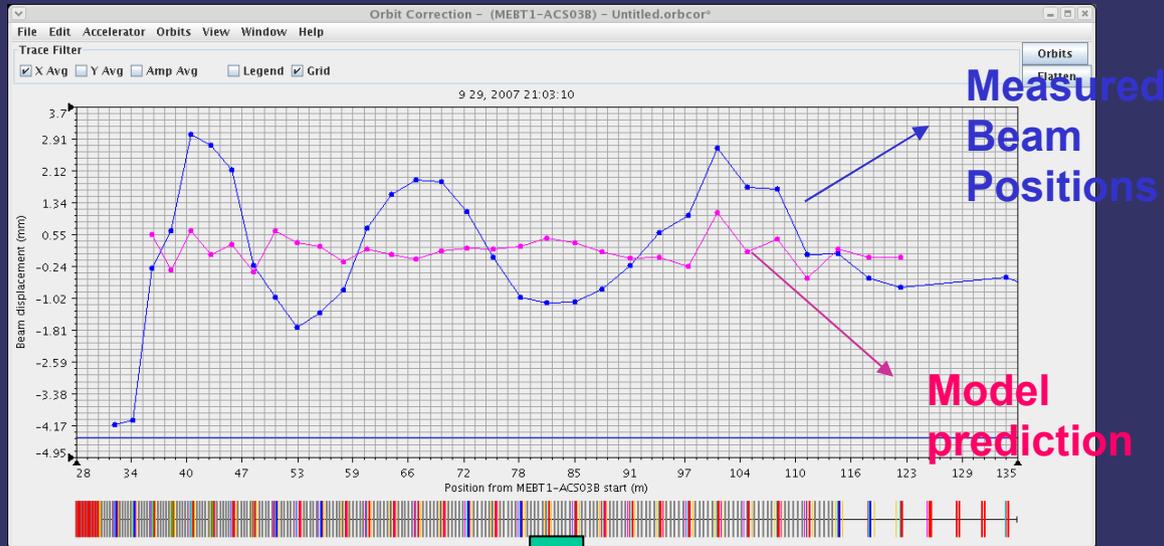
Fit to PARMILA model

χ^2 vs. RF amplitude

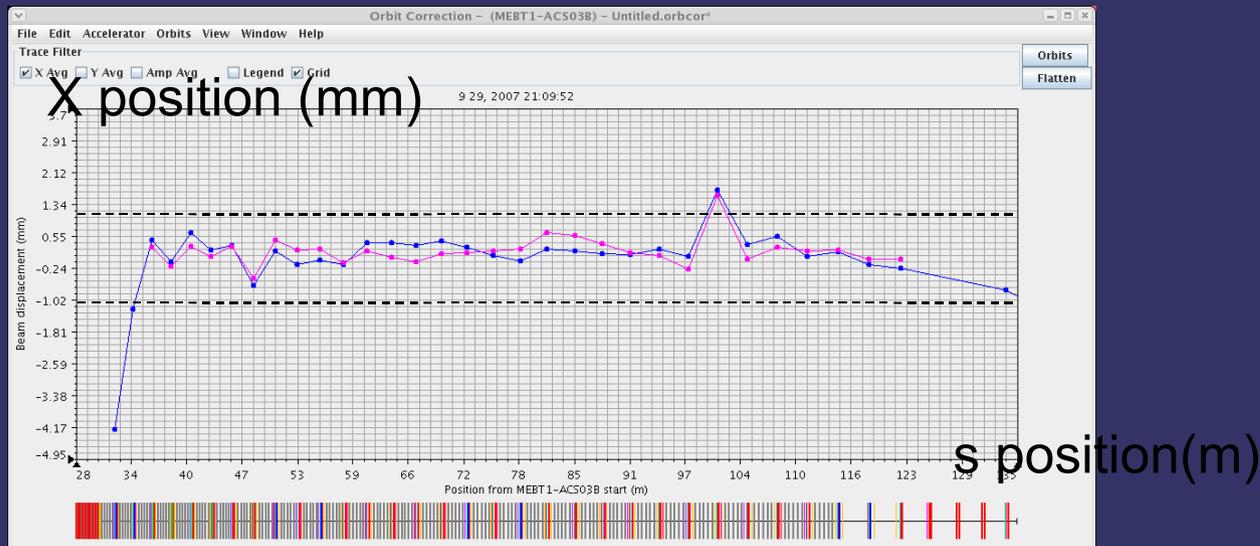


Orbit Correction

Before correction (SDTL)

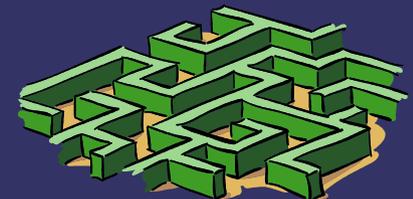


After correction



- Beam orbit correction with steering magnets
- Based on JCE
- Whole LINAC corrections can be finished within 1 hour

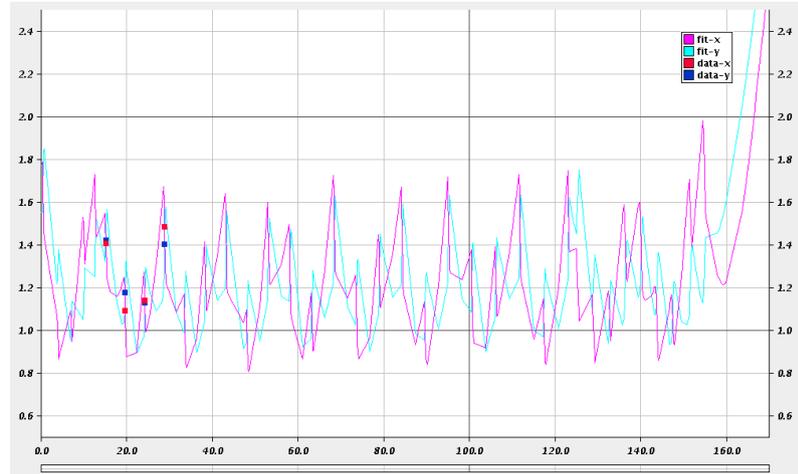
- Orbit deviations within 1mm



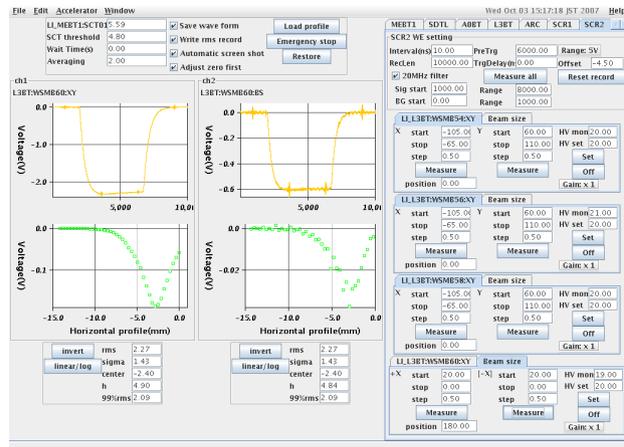
Transverse matching

Beam envelope (A0BT-L3BT)

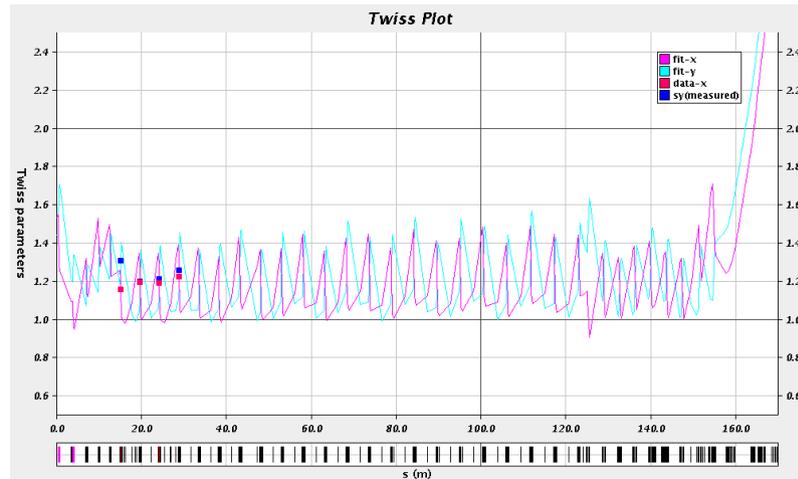
- Beam profile measurements with wire scanners
- Tuning of upstream QMs
- Mismatch factor $< 5\%$ after matching.
- Tuning done in 1~2 hour per section



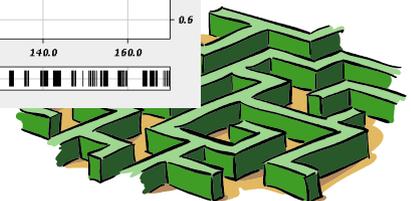
Before correction



WS measurement panel



After correction



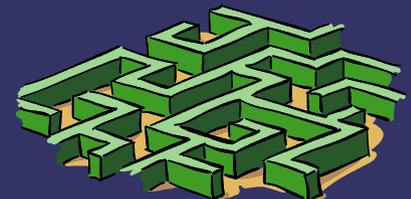
JCE and SAD

⇒ JCE

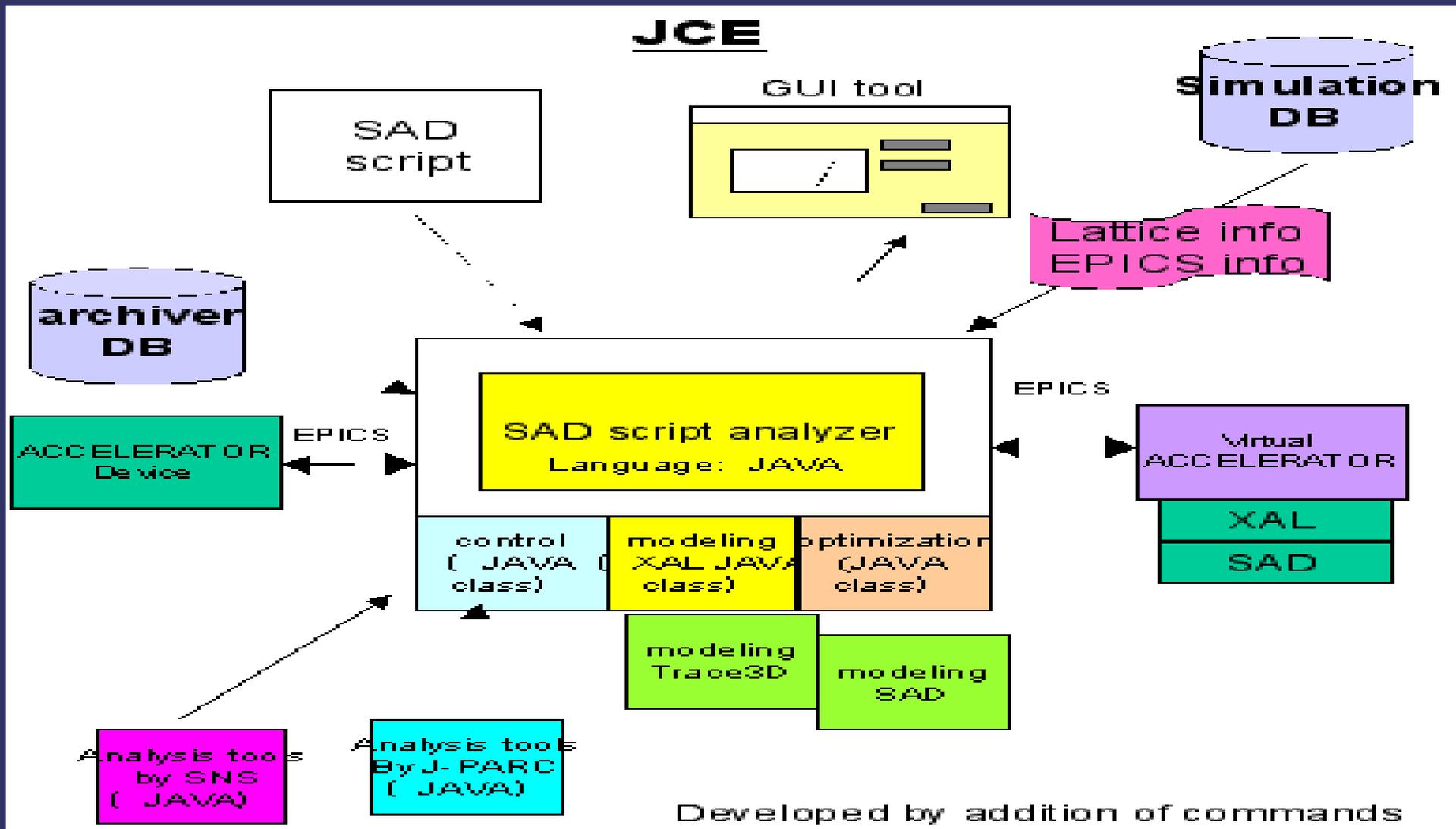
- scripting language compatible with SAD
- Written in Java
- XAL and Trace 3D as accelerator Model
- GUI widgets set based on XAL/java
 - Framework compatible with KEKBFrame
- JCA/CAJ library access.
- Developed for J-PARC

⇒ 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.



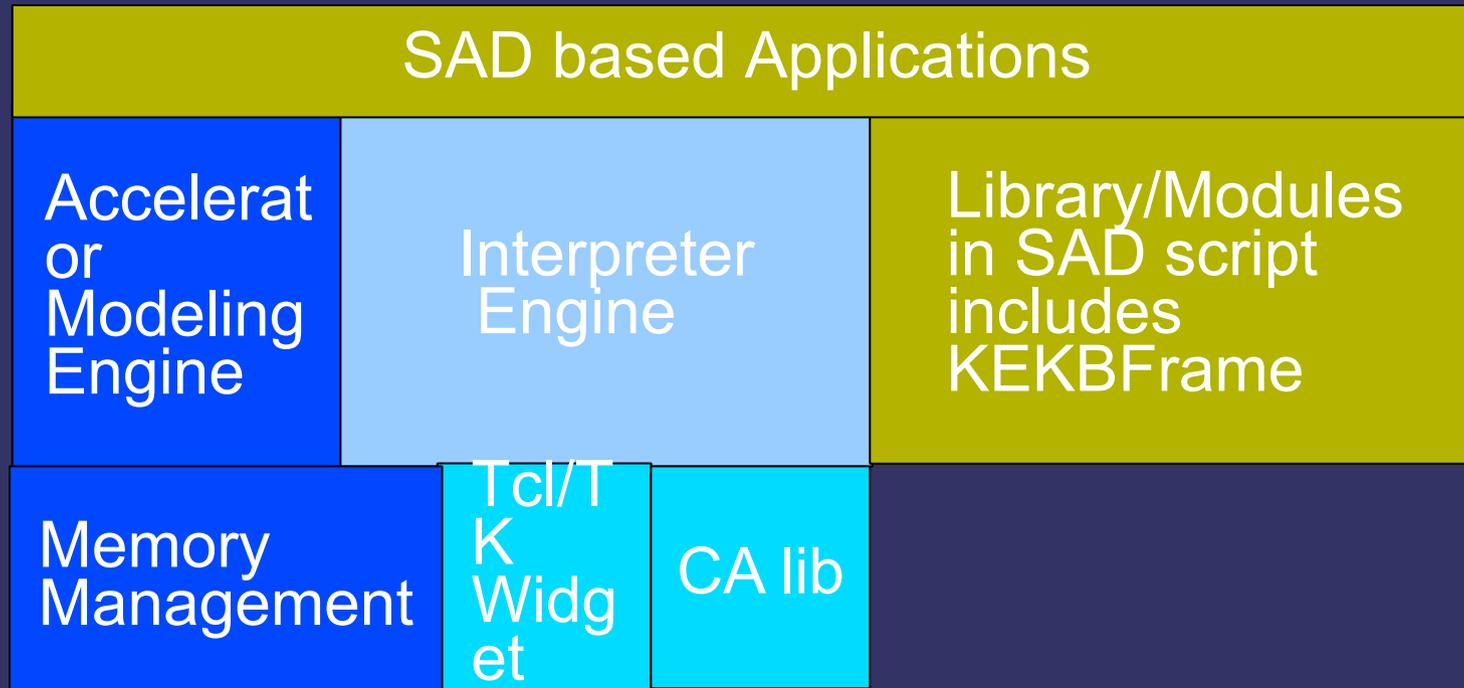
JCE:Java commissioning Environment



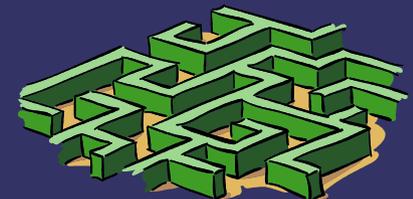
“JCE:A Java commissioning Environment” by H. Sako, 2006



SAD

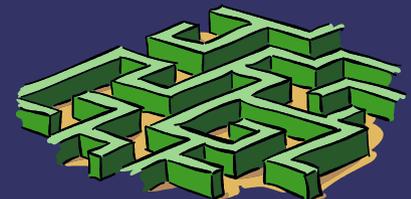


- mostly Written in Fortran(f77/gfortran/Intel fc)
-



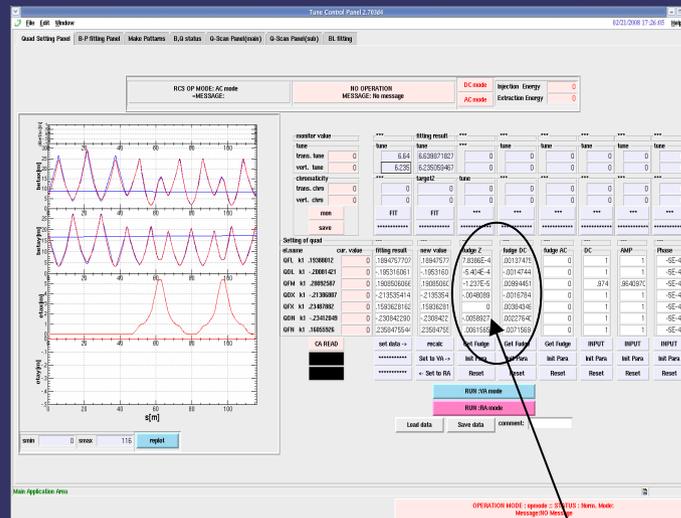
High Level Applications at RCS

- ⇒ 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
- ⇒



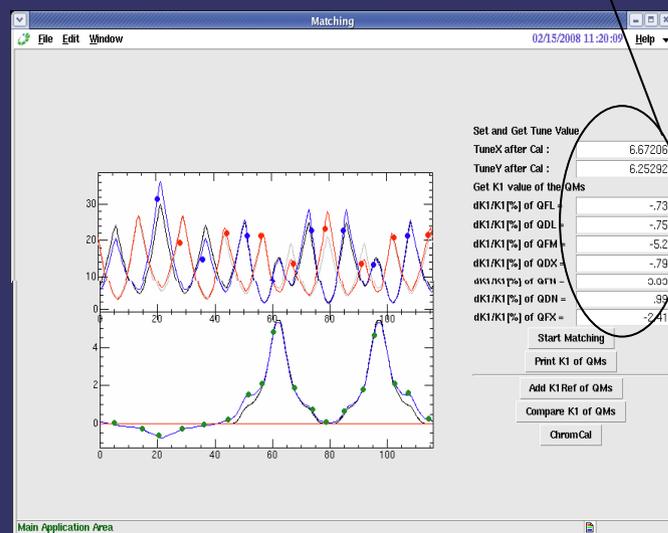
B,Q control and optics correction

B,Q control panel
model fitting : SAD



Set & Meas. Correction
(Fudge factor)

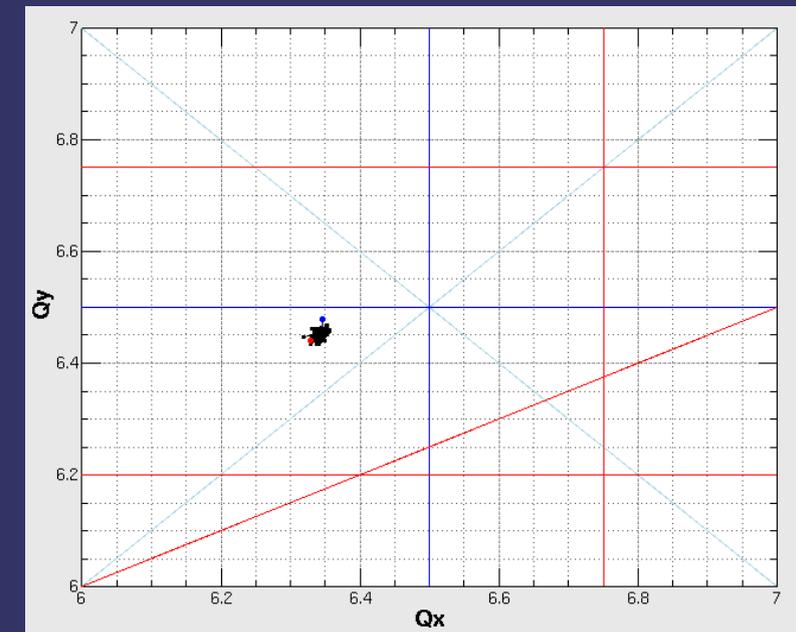
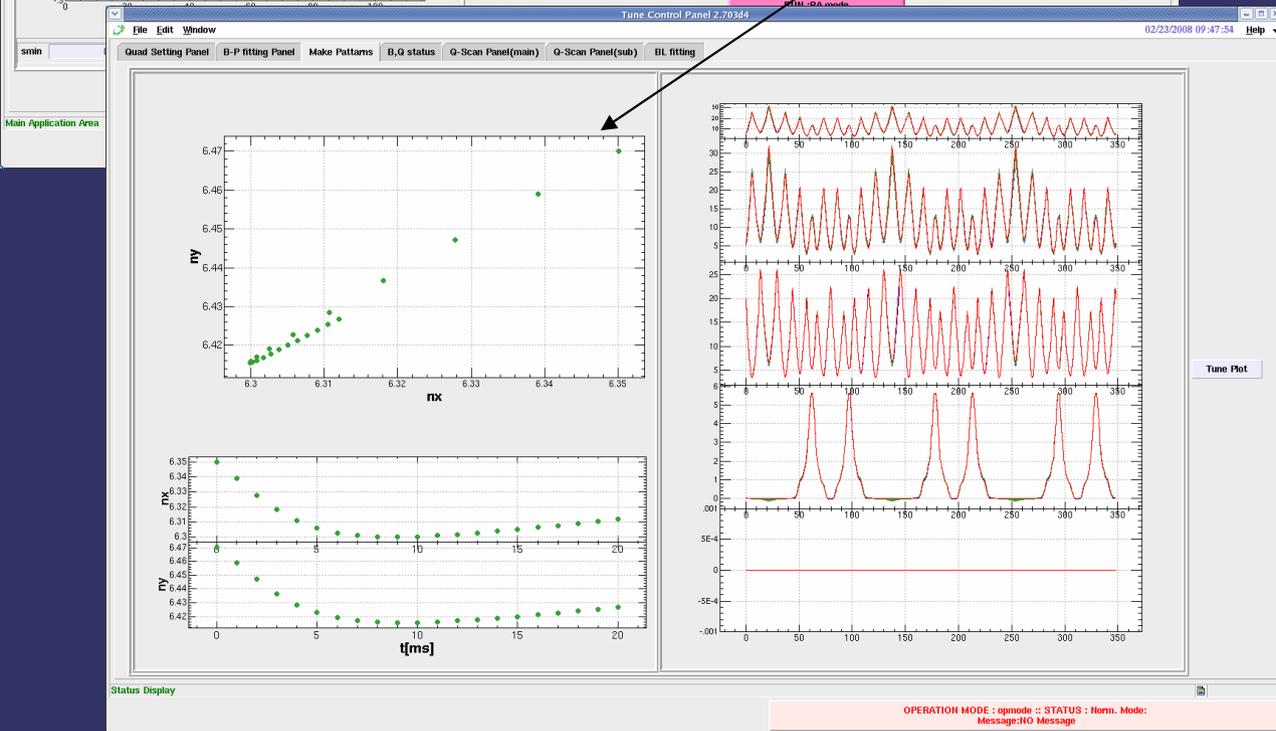
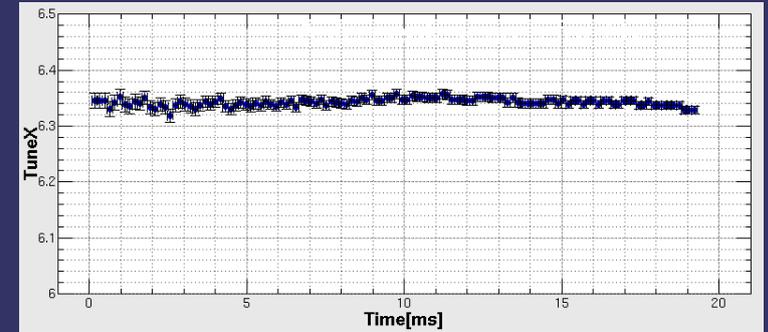
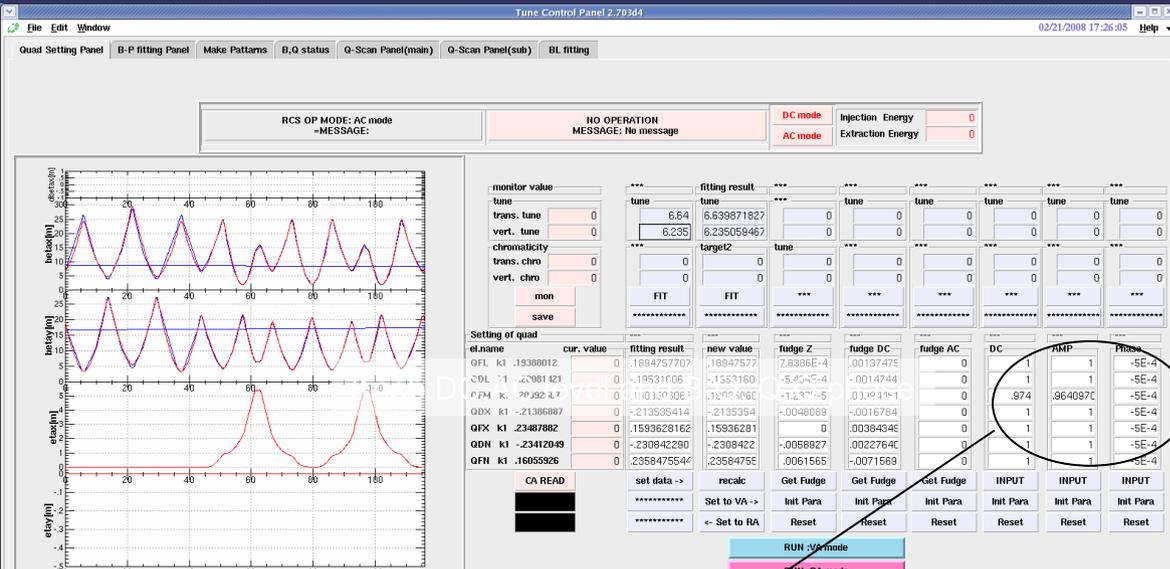
Optics measurement and
correction panel



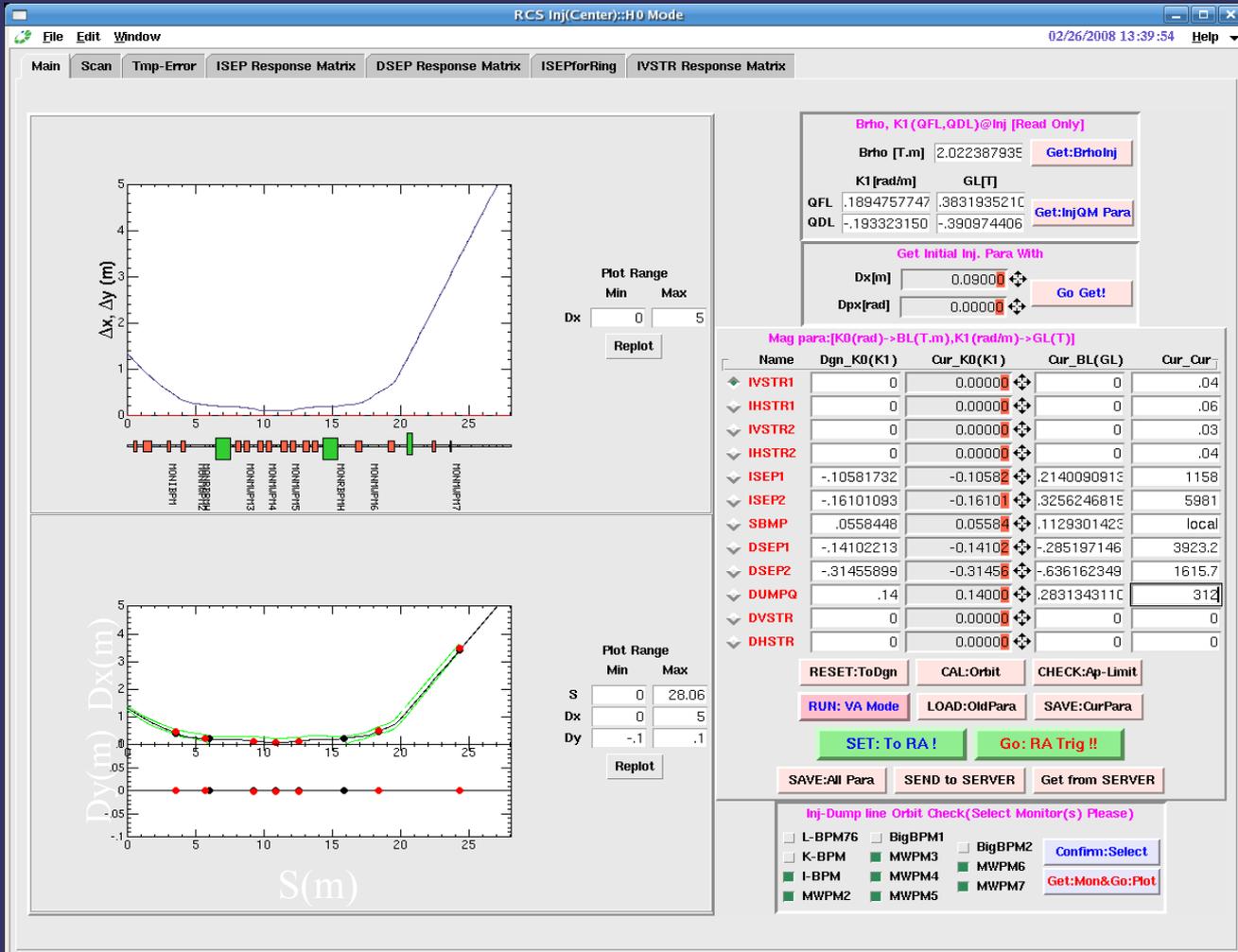
Fudge factor



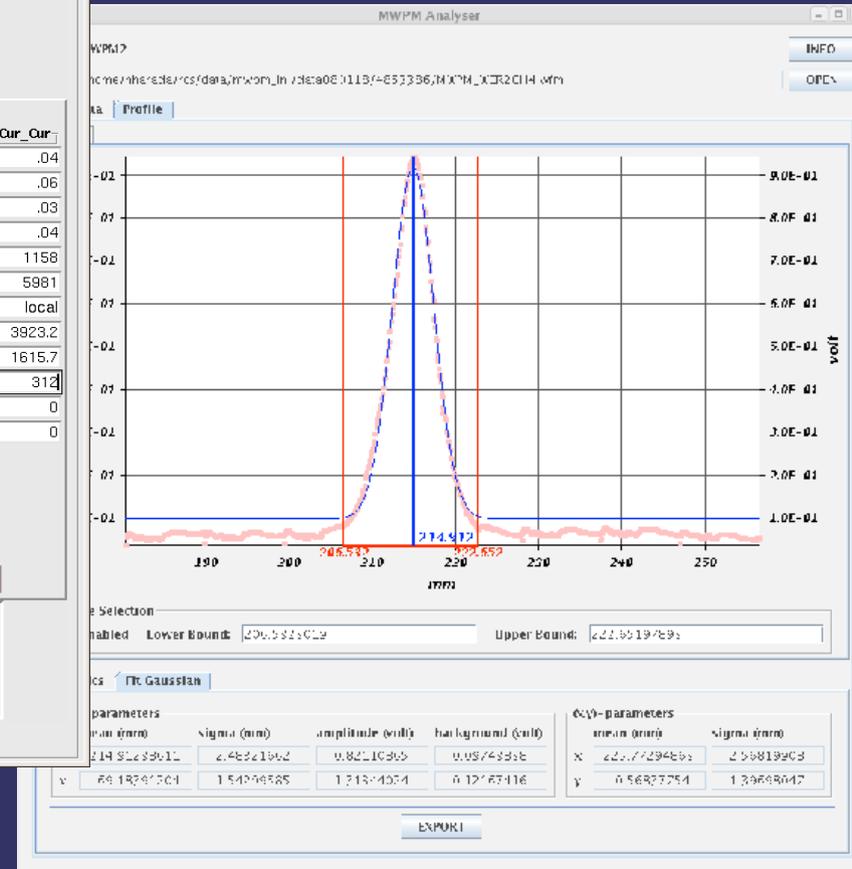
Tune correction and dynamic tune control



Injection control panel



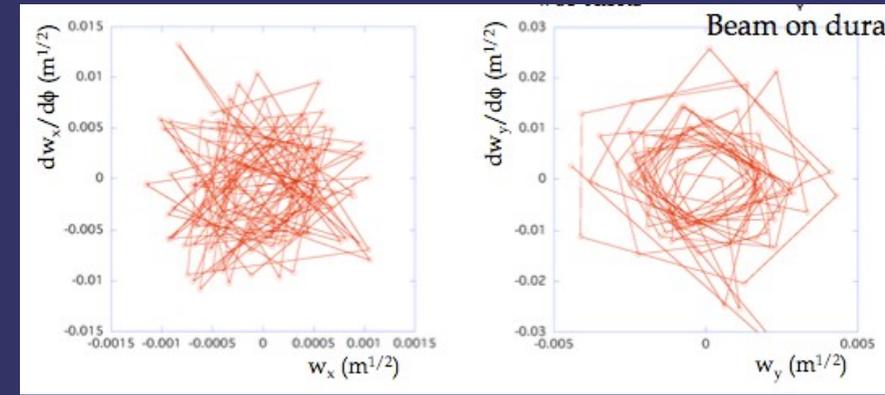
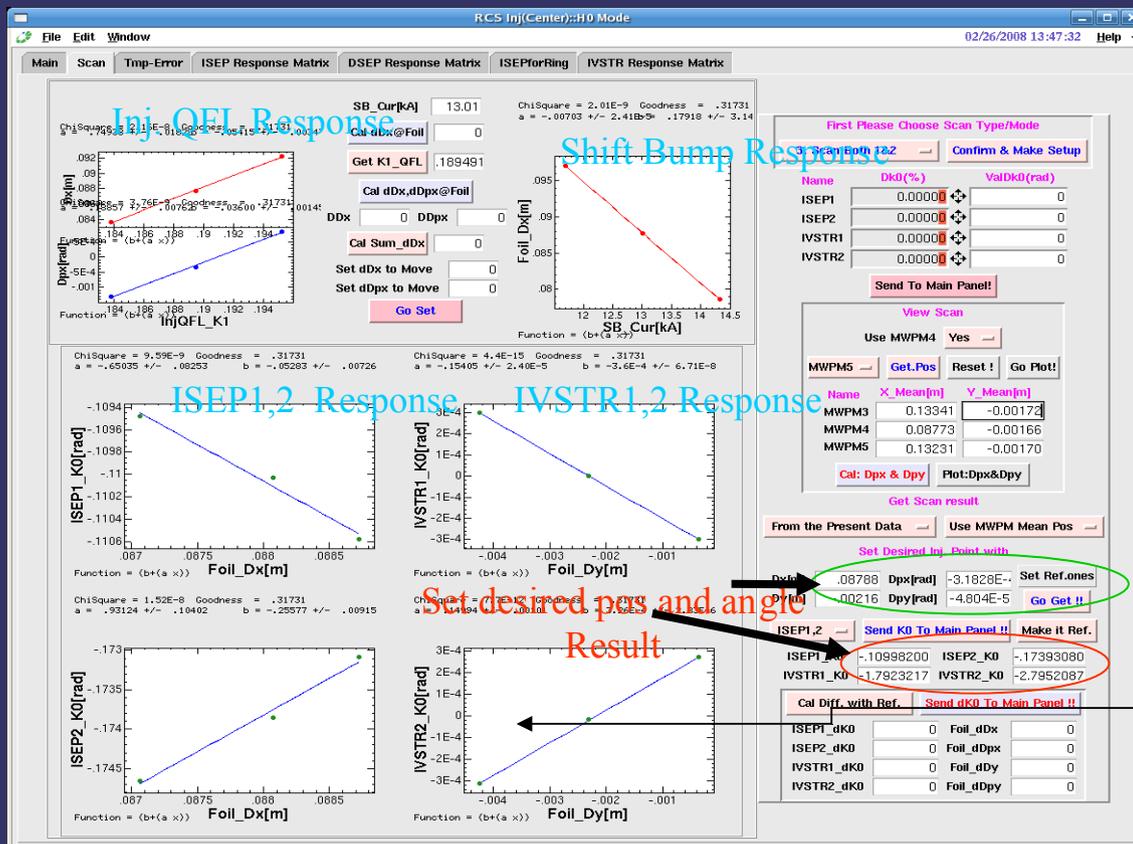
RCS Injection OPI Main Panel
for Parameter set and Orbit Monitor



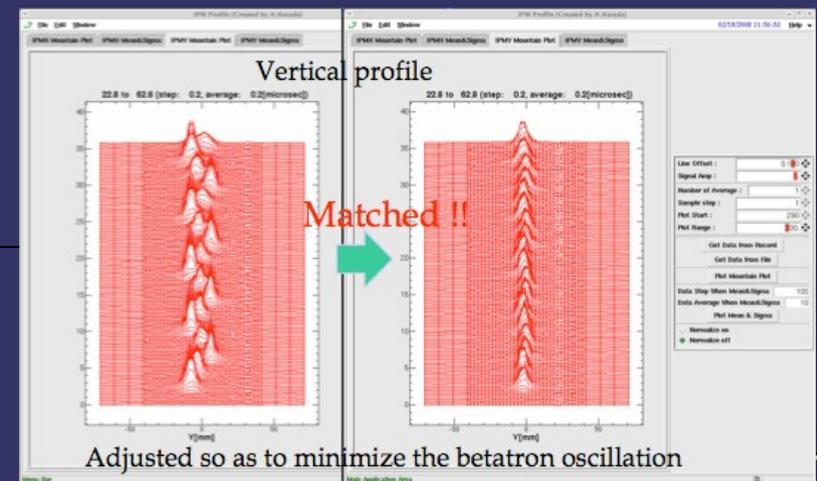
Injection beam profile(measured)

Injection control panel (correction)

RCS Inj OPI for Orbit Control using measured Response Matrix



phase space plot



Adjusted so as to minimize the betatron oscillation

Beam profile

Orbit correction

Optics measurement and analysis panel(1a)

-COD correction

BPM Information

Beam_Tag	325038006
S_Tag	8482270
MR_Tag	2
Beam_Type	54
RCS_Tag	56501
RCS_Type	54
Time	3409783273.00000
msec	856
Data_Tag	1

Select Time (0-20):

CODX Amp:

CODY Amp:

Cal of Twiss Parameters

Control of CaMen@BPMCOD

- start
- stop
- Start&Stop
- On Flag
- Off Flag
- Select the Plotted BPMID
- Select Auto Save Mode
- Add ReferenceCOD
- Add CompareCOD

BPM0101 BPM0502 BPM1001 BPM1402 BPM1901 BPM2302

BPM0102 BPM0601 BPM1002 BPM1501 BPM1902 BPM2301

BPM0201 BPM0602 BPM1101 BPM1502 BPM2001 BPM2402

BPM0202 BPM0701 BPM1102 BPM1601 BPM2002 BPM2501

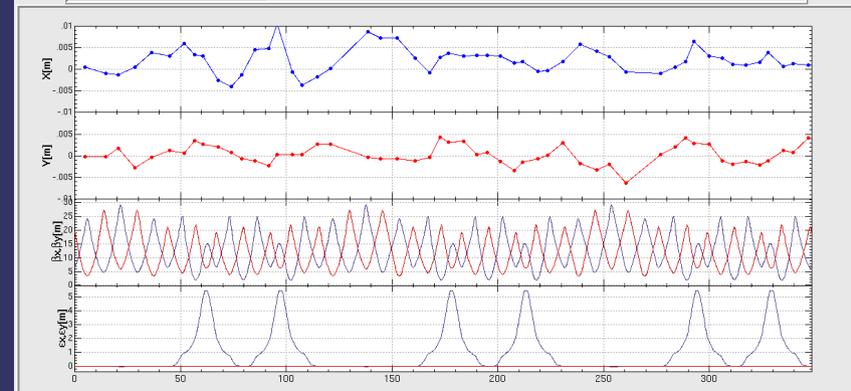
BPM0301 BPM0702 BPM1201 BPM1602 BPM2101 BPM2502

BPM0302 BPM0801 BPM1202 BPM1701 BPM2102 BPM2601

BPM0401 BPM0802 BPM1301 BPM1702 BPM2201 BPM2602

BPM0402 BPM0901 BPM1302 BPM1801 BPM2202 BPM2701

BPM0501 BPM0902 BPM1401 BPM1802 BPM2301 BPM2702



BPM Information

Beam_Tag	326094206
S_Tag	8484824
MR_Tag	2
Beam_Type	54
RCS_Tag	61571
RCS_Type	54
Time	3409793480
msec	39
Data_Tag	71

Select Time (0-20):

CODX Amp:

CODY Amp:

Cal of Twiss Parameters

Control of CaMen@BPMCOD

- start
- stop
- Start&Stop
- On Flag
- Off Flag
- Select the Plotted BPMID
- Select Auto Save Mode
- Add ReferenceCOD
- Add CompareCOD

BPM0101 BPM0502 BPM1001 BPM1402 BPM1901 BPM2302

BPM0102 BPM0601 BPM1002 BPM1501 BPM1902 BPM2301

BPM0201 BPM0602 BPM1101 BPM1502 BPM2001 BPM2402

BPM0202 BPM0701 BPM1102 BPM1601 BPM2002 BPM2501

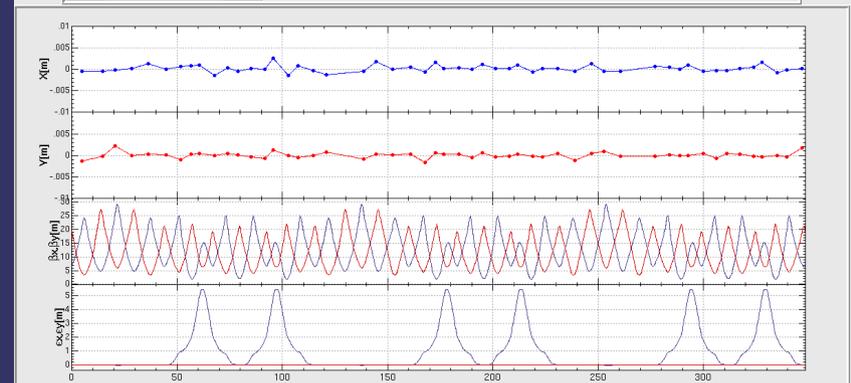
BPM0301 BPM0702 BPM1201 BPM1602 BPM2101 BPM2502

BPM0302 BPM0801 BPM1202 BPM1701 BPM2102 BPM2601

BPM0401 BPM0802 BPM1301 BPM1702 BPM2201 BPM2602

BPM0402 BPM0901 BPM1302 BPM1801 BPM2202 BPM2701

BPM0501 BPM0902 BPM1401 BPM1802 BPM2301 BPM2702



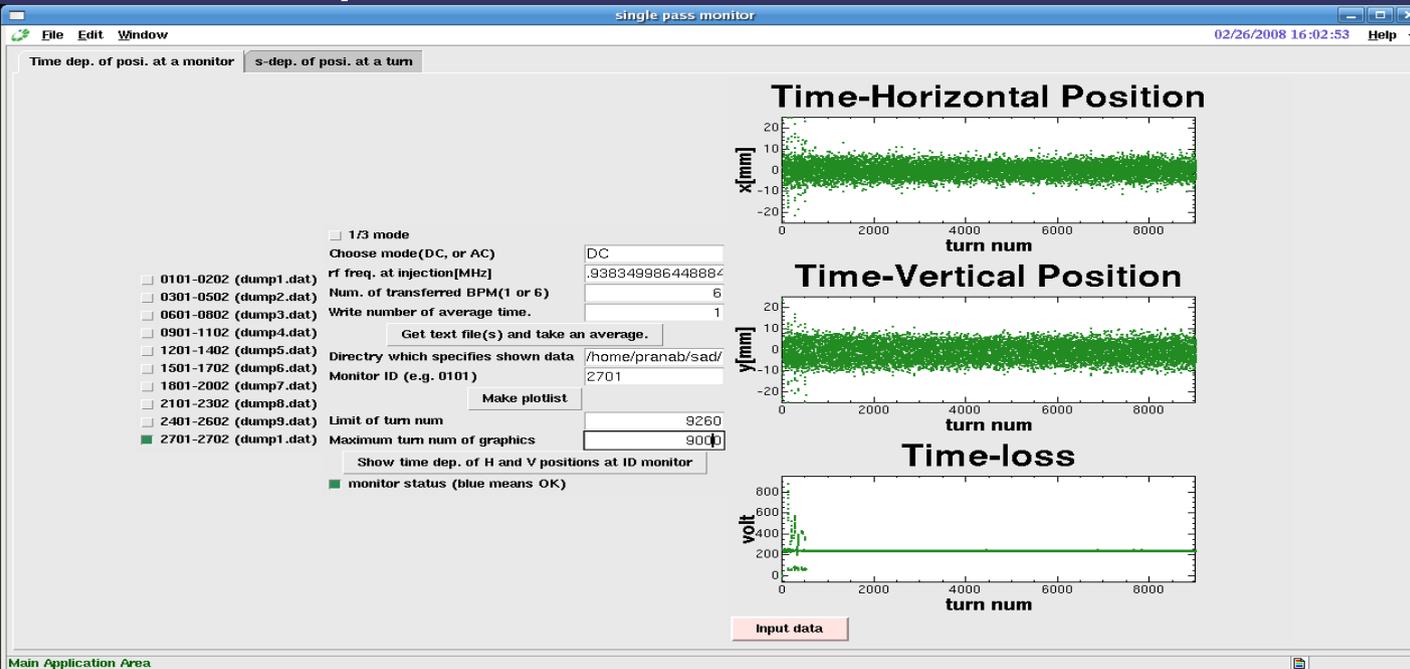
COD correction panel

COD

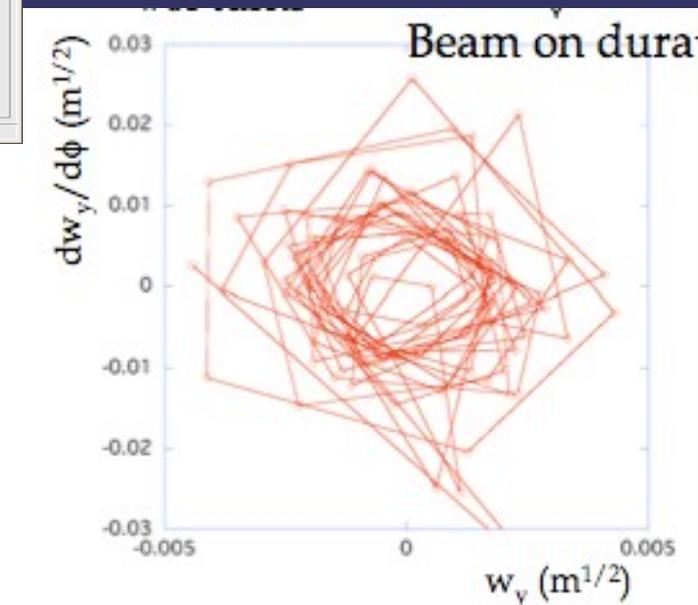
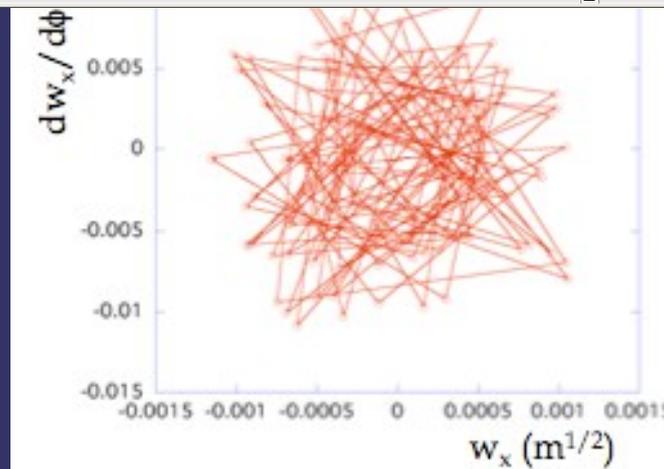


Optics measurement and analysis panel(1b)

-one pass measurement



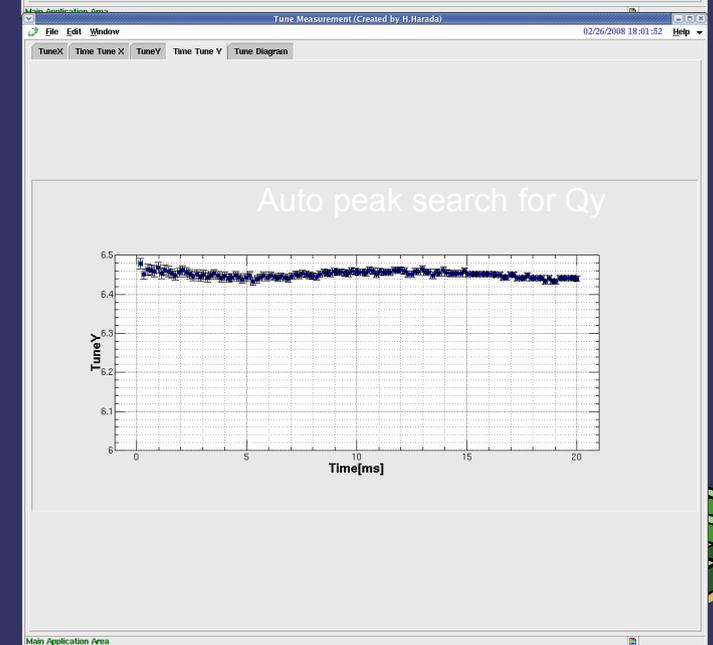
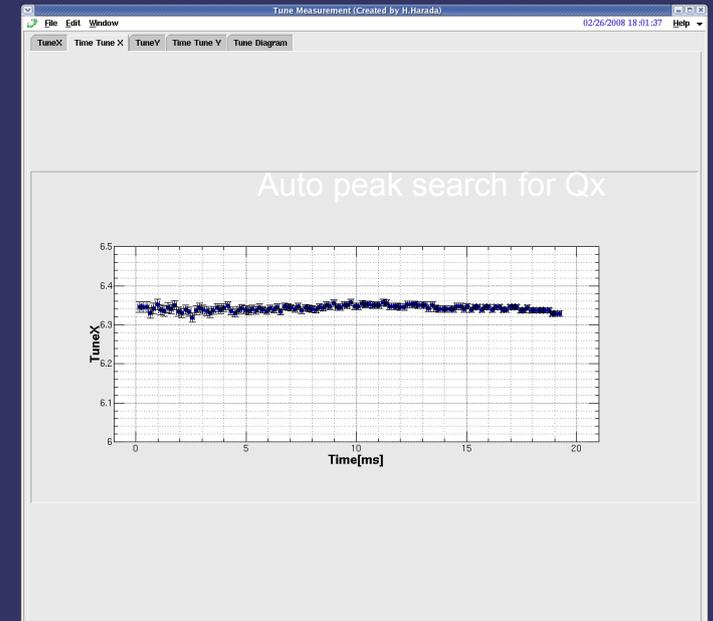
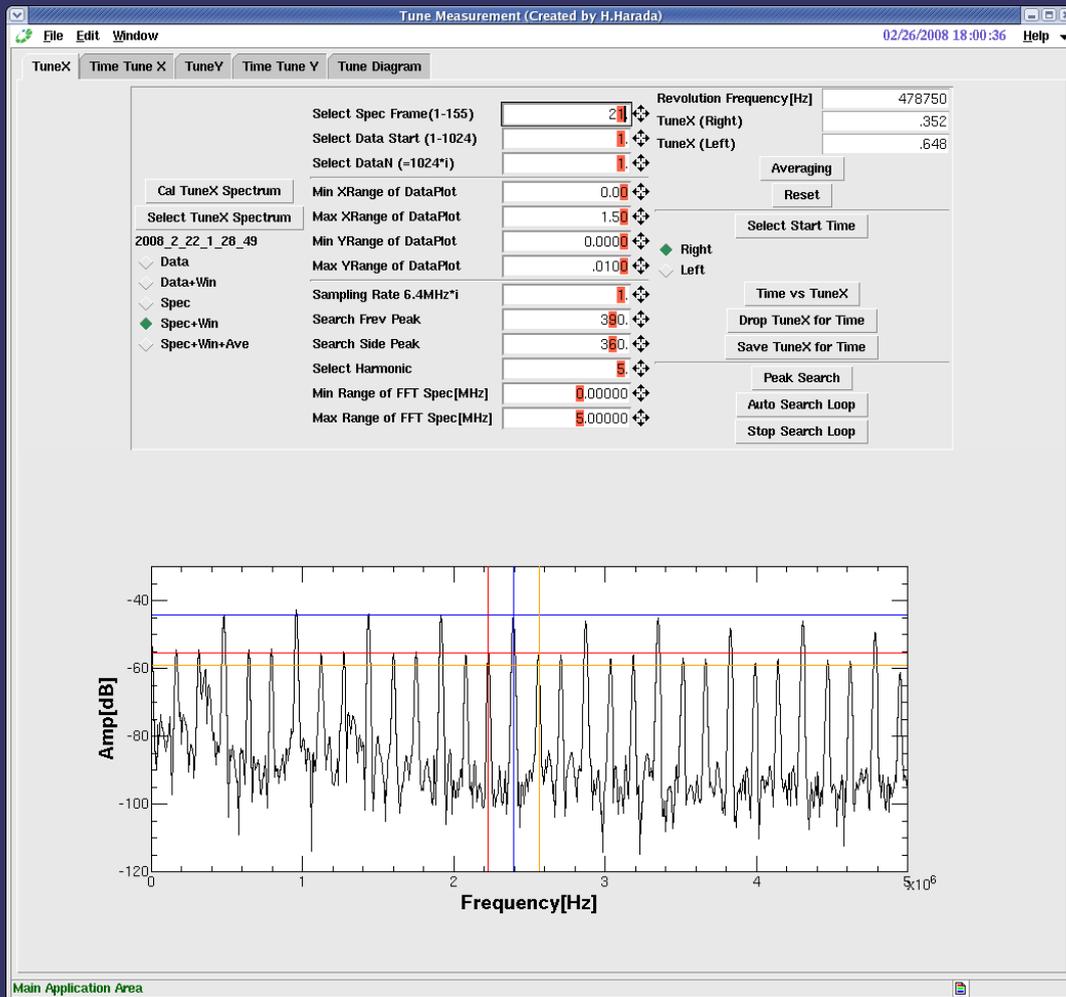
one pass orbit



phase space plot

Optics measurement and analysis panel(2)

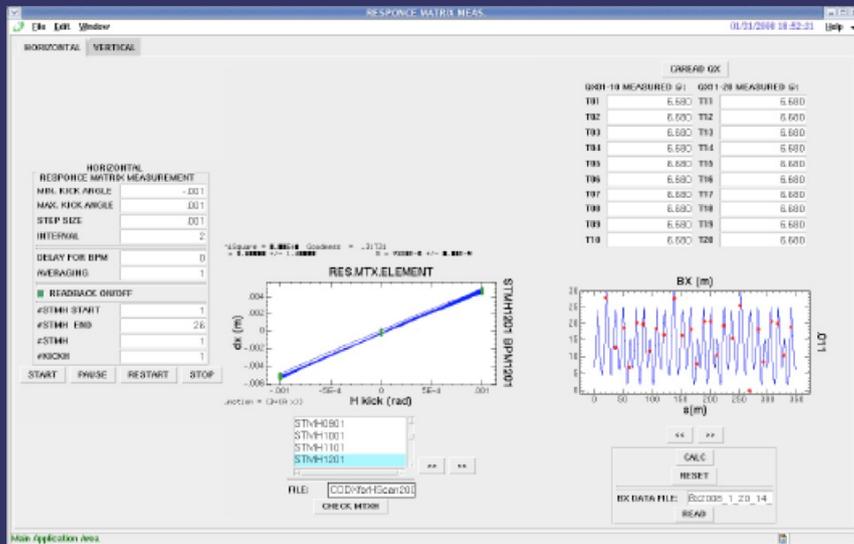
-tune measurement



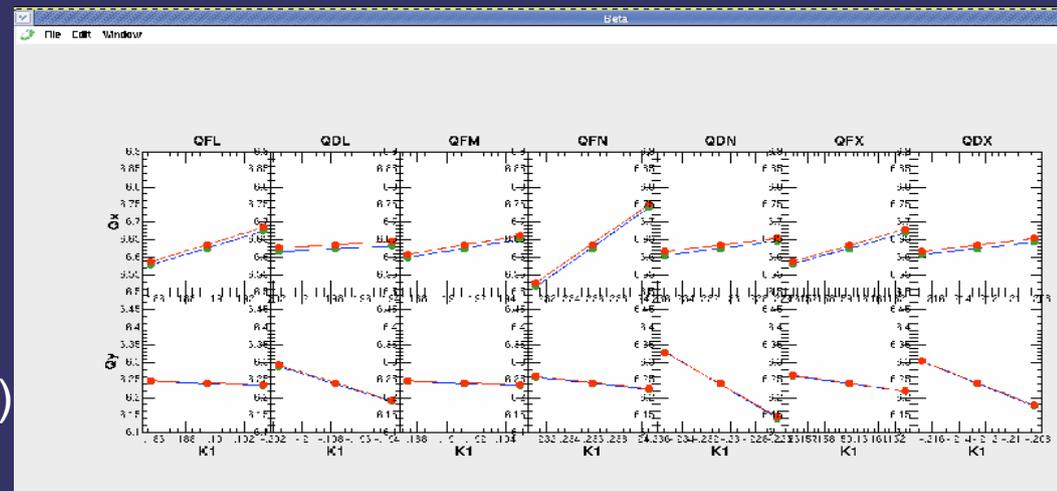
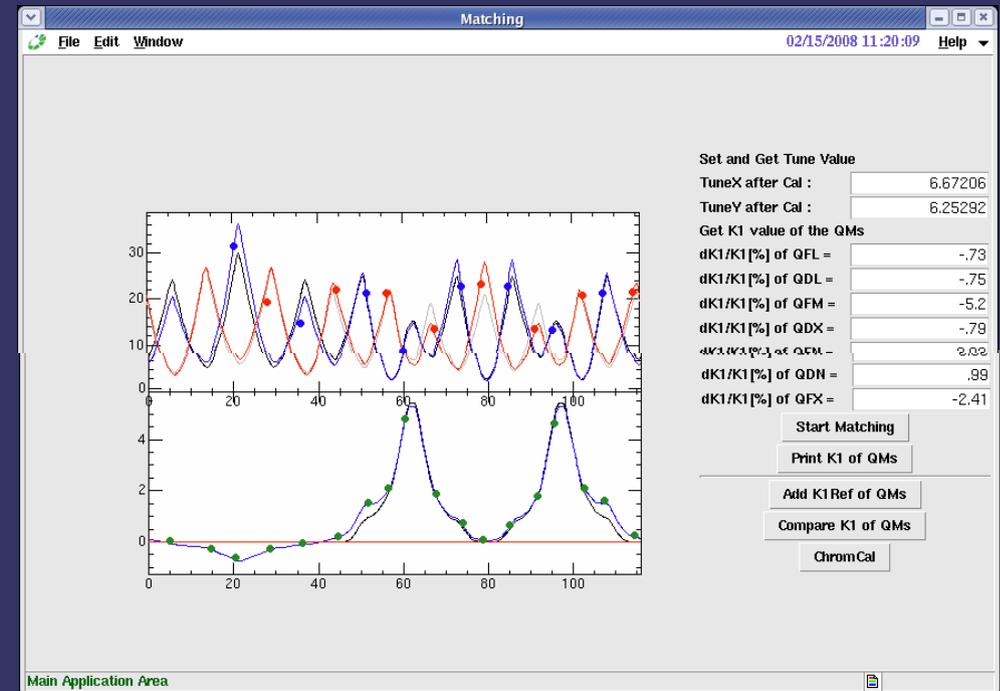
Optics measurement and analysis panel(3)

-beta function measurement

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



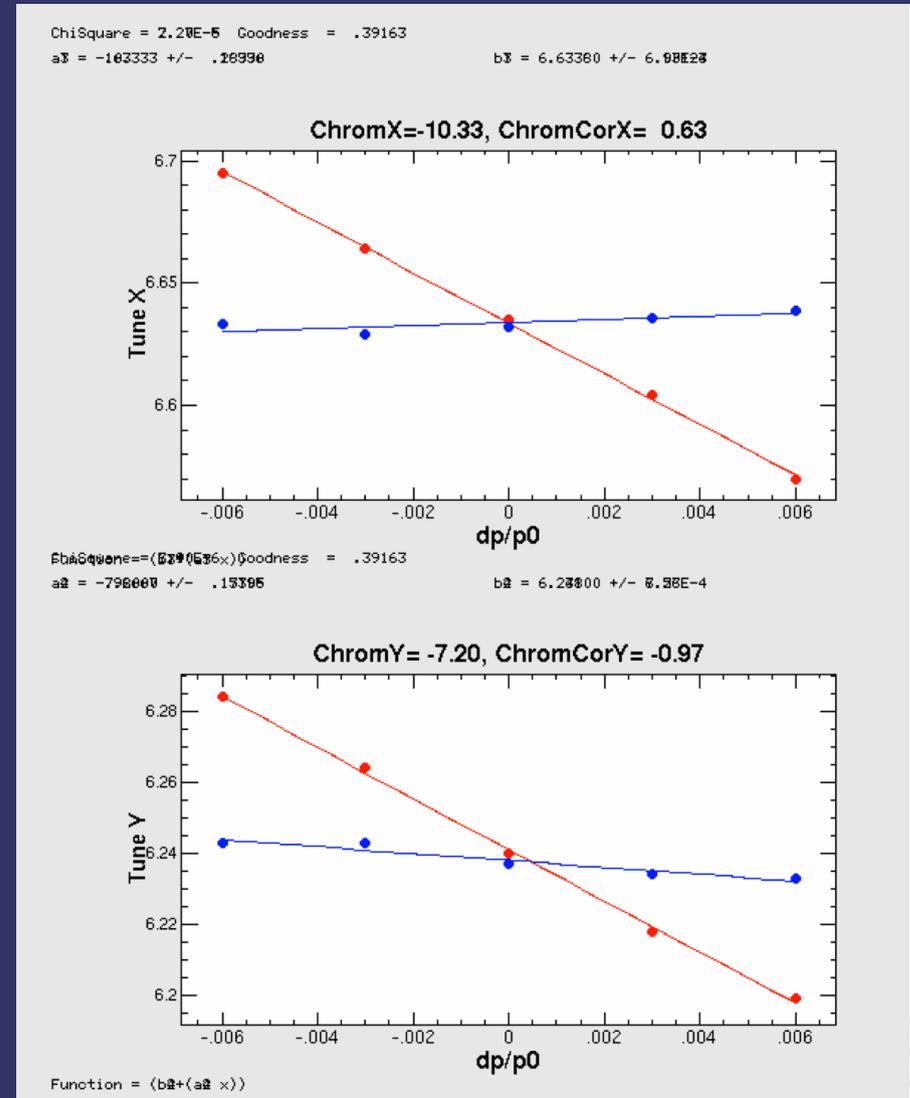
- ② Knob: Quad magnets(B,Q control panel)
- Monitor: tune monitor(tune measurement panel)



Optics measurement and analysis panel(4)

-Chromaticity measurement

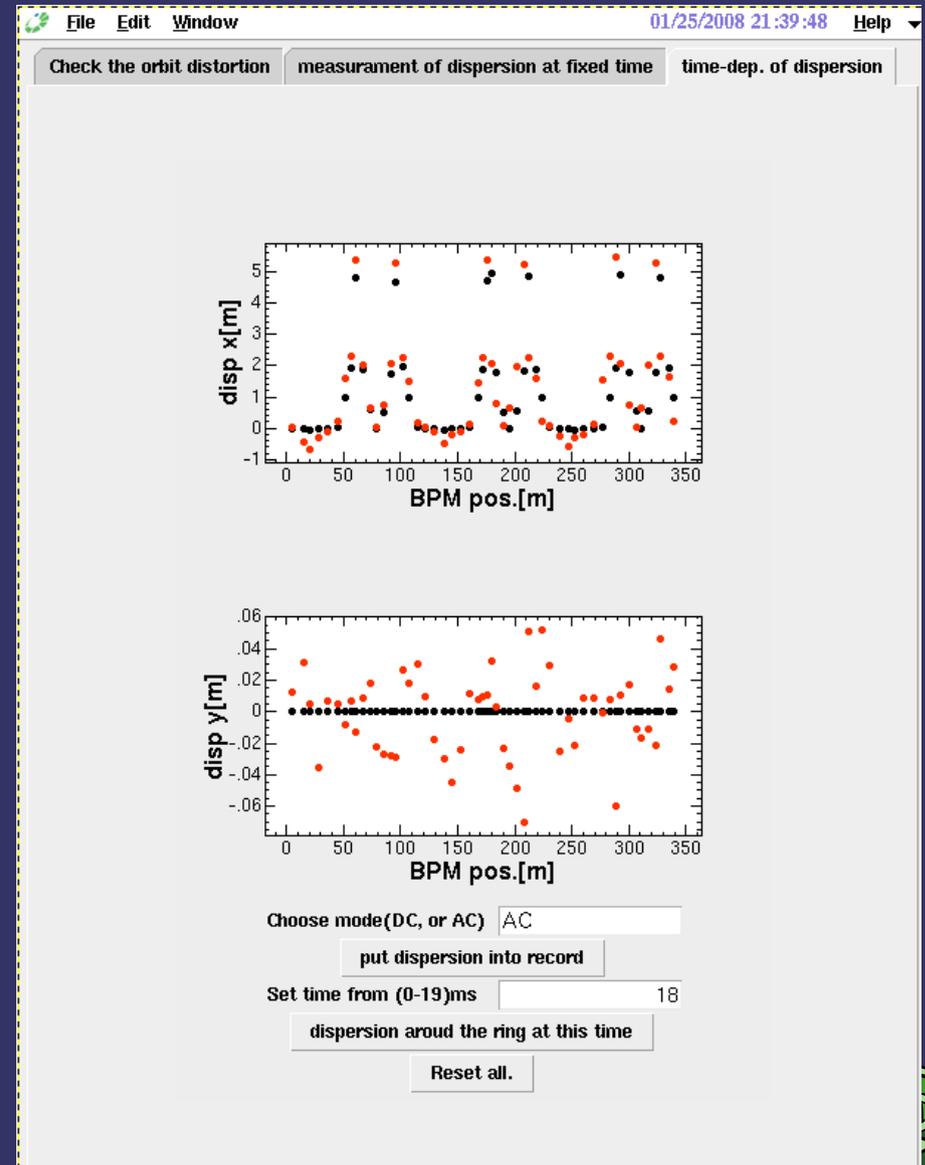
- ➔ Measurement
 - Knob: RF frequency
 - Monitor: tune monitor
- ➔ Correction
 - Knob: Sextupole magnets



Optics measurement and analysis panel(4)

-Dispersion measurement

- ➔ Knob: RF frequency
- ➔ Monitor: BPM

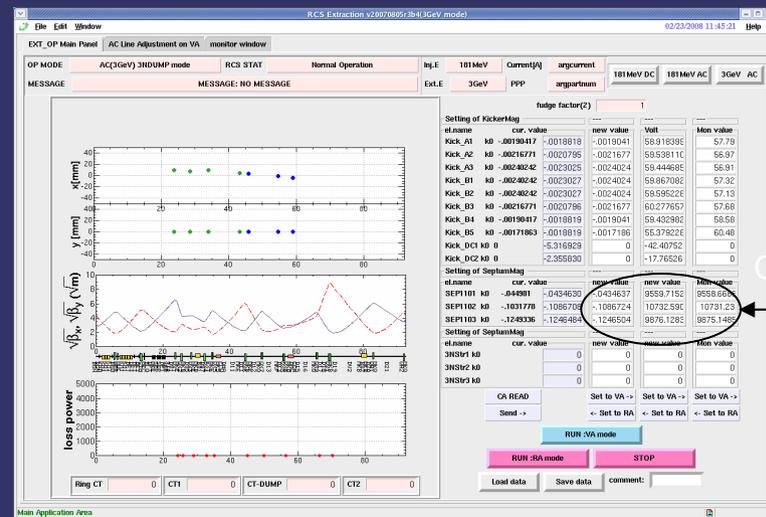


Extraction orbit control

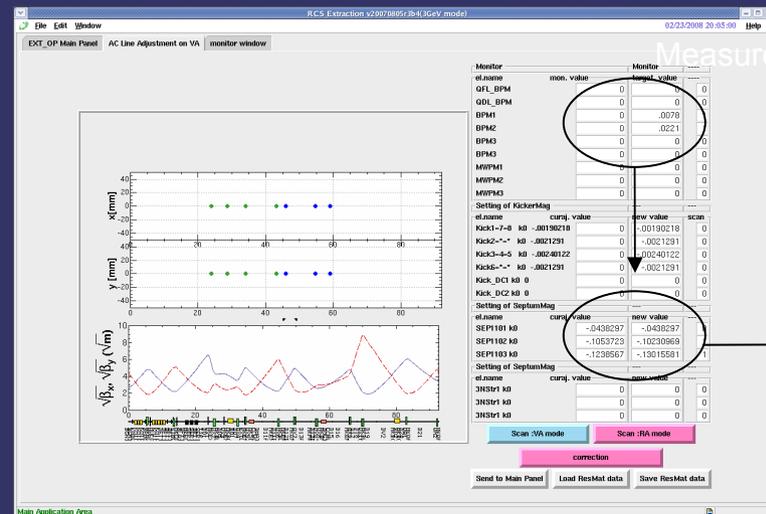
Extraction orbit control panel knob: 8 kicker magnets
3 septum magnets

Set & Meas. Correction (Fudge factor)

orbit measurement and correction panel



Corrected k0

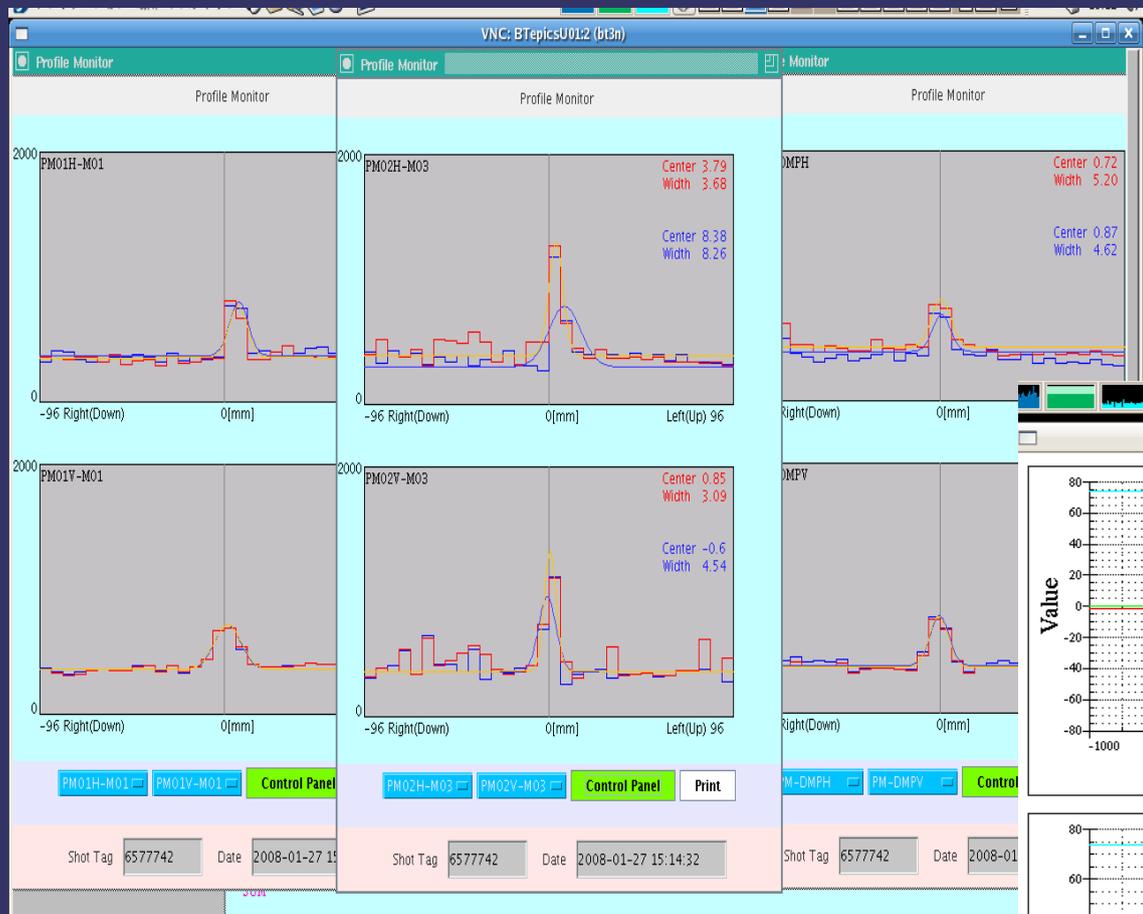


Measured displacement

dk0

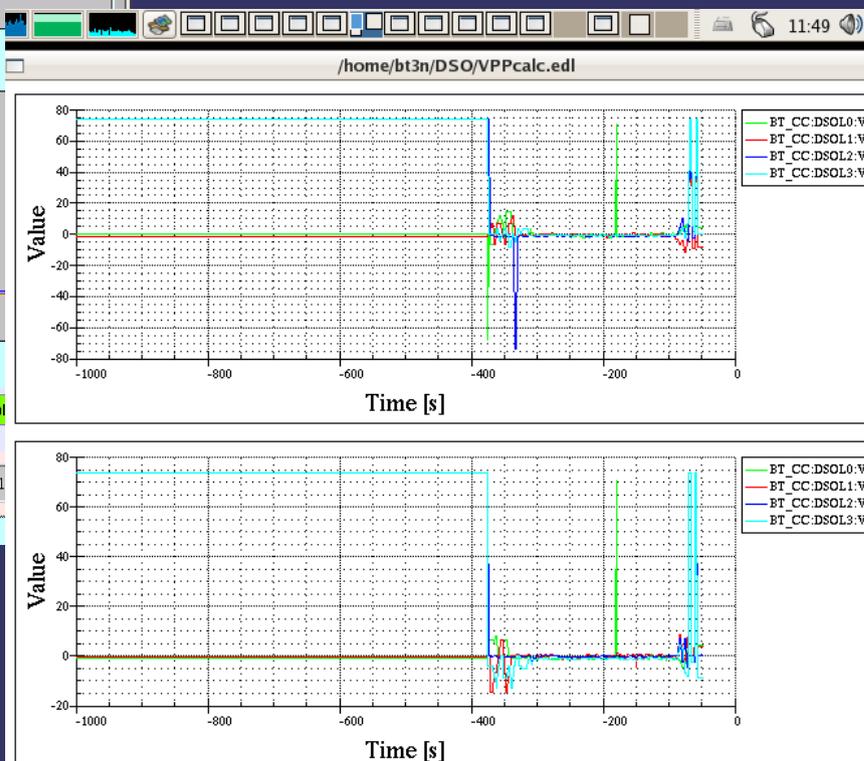


Extracted beam measurement



Beam profile

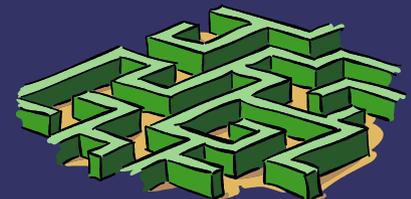
Beam position



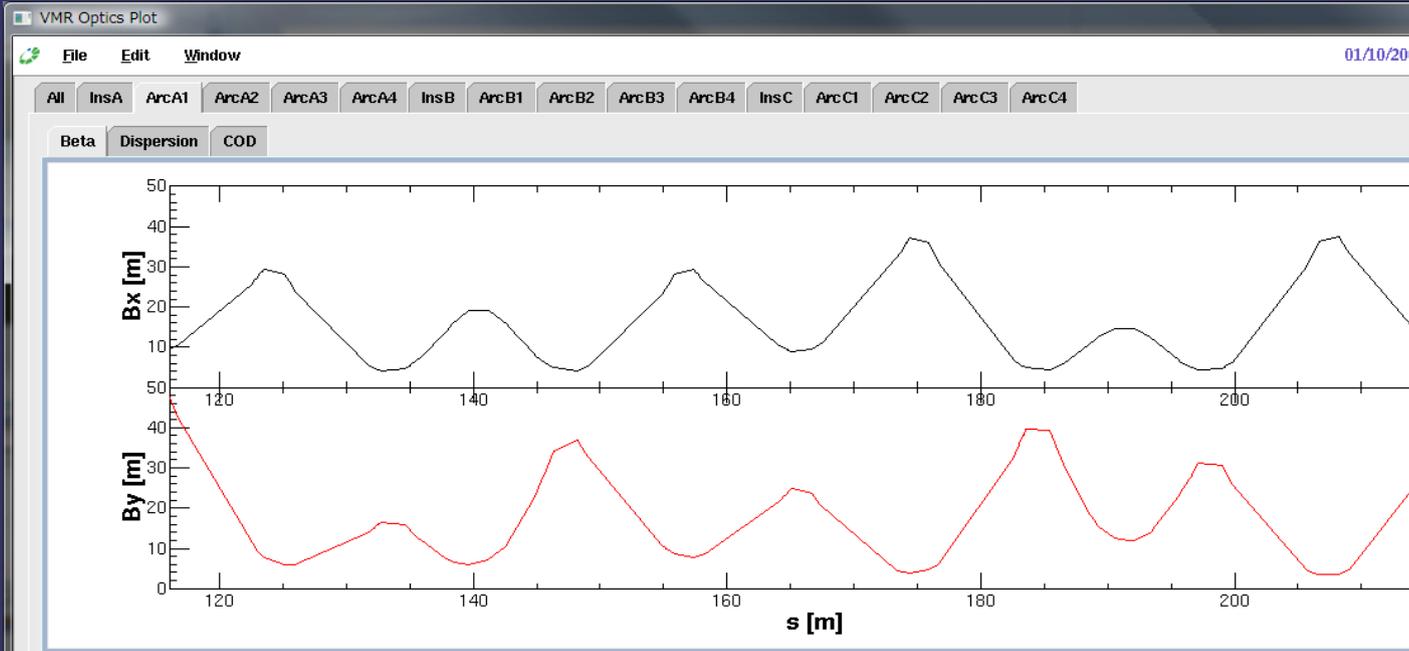
High Level Applications for 50GeV Ring

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

.....

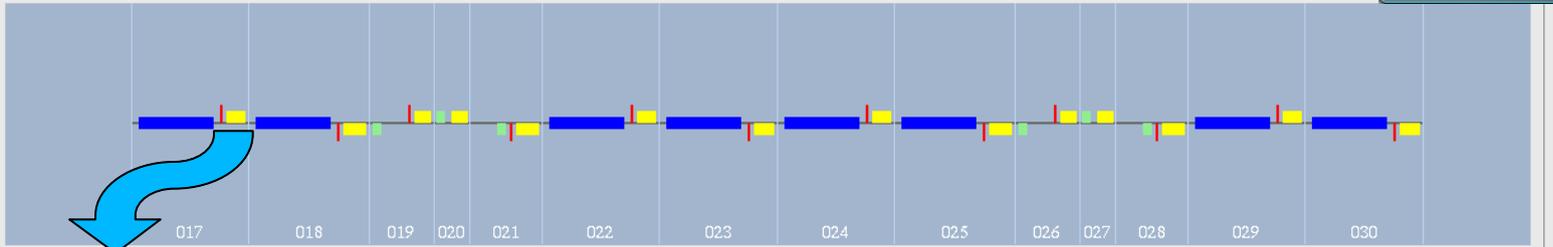


Sample application for MR Optics control



The VMR Optics Control window displays a list of parameters for the Virtual Main Ring Optics Control. The window includes a menu bar (File, Edit, Window, Help) and a status bar showing the date '01/10/2008 09:39:45'. The parameters are organized into two columns: 'Set Parameters' and 'Setting Read Back'. Each parameter has a numerical value and a control knob. The status bar at the bottom indicates 'VMROptCont on localhost:33.0'.

Parameter	Set Parameters	Setting Read Back
Tune-H	22.48	22.43
Tune-V	20.82	20.42
BMN	0.06541666700	0.065316667000
QFS	0.124051887362	0.124051887362
QDS	-0.178586182257	-0.178586182257
QFT	0.140434350581	0.140434350581
QFP	0.074018259567	0.074018259567
QDT	-0.150799415324	-0.150799415324
QFR	0.178604518381	0.178604518381
QDR	-0.170130281541	-0.170130281541
QDX	-0.168259422338	-0.168259422338
QFN	0.159204785118	0.159204785118
QDN	-0.188172968498	-0.188172968498
QFX	0.132578859481	0.132578859481
SFA	0.541650142500	0.541650142500
SDA	-0.442082104322	-0.442082104322
SDB	-0.442082104322	-0.442082104322

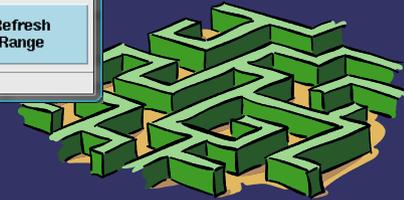


The QFN017 control window displays parameters for adjusting the K value of QFN017. The window includes a menu bar (File, Edit, Window, Help) and a status bar showing the date '01/10/2008 09:57:16'. The parameters are:

- Adjust K value of QFN017
- Main Power Supply for QFN Family: 0.1592
- AUX Power Supply for QFN017: 0.0000

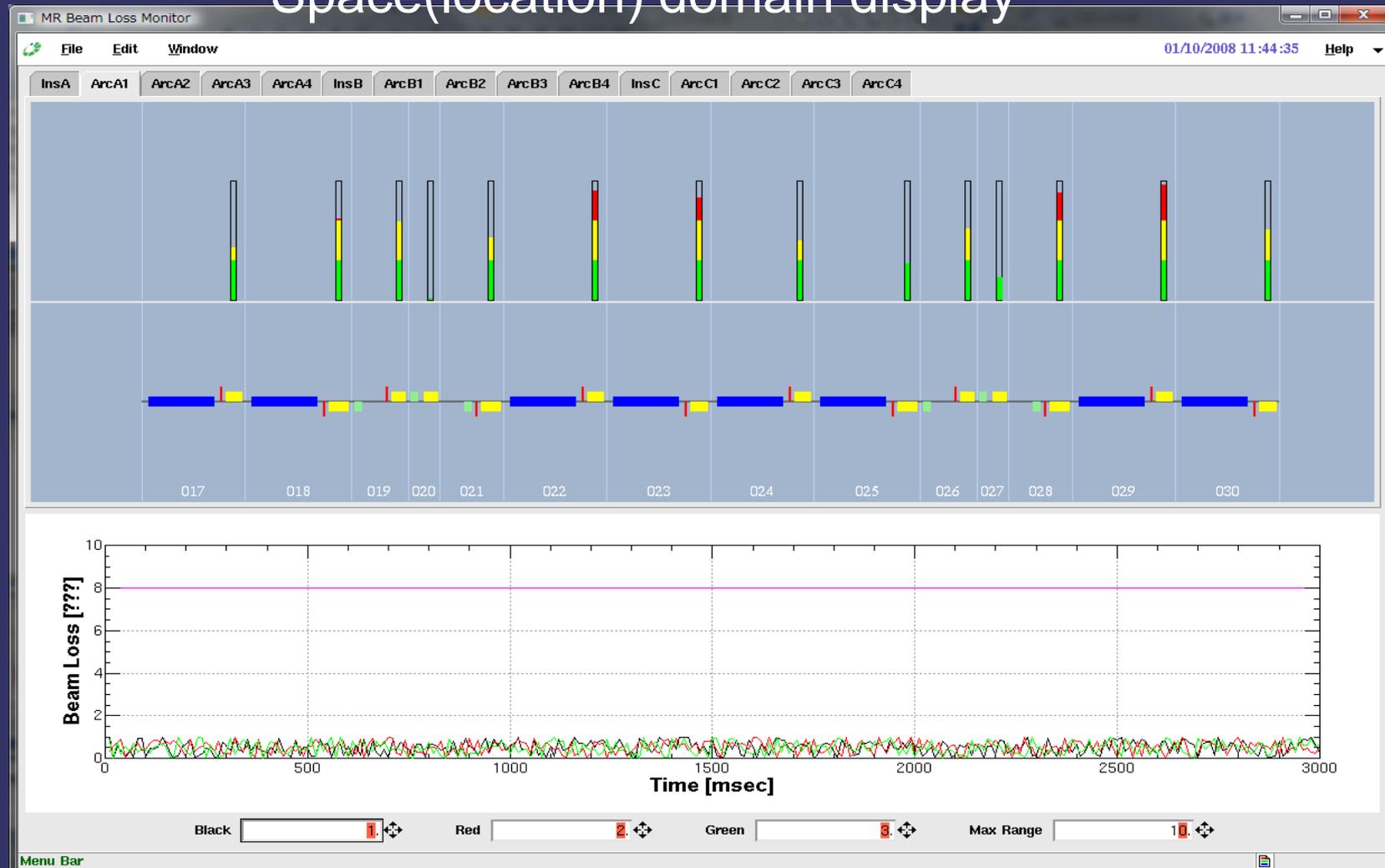
The range control window displays parameters for adjusting the ranges of the beamline elements. The window includes a menu bar (File, Edit, Window, Help) and a status bar showing the date '01/10/2008 09:57:16'. The parameters are:

- Ex Range: Max 4.00, Min -2.00
- Ey Range: Max 4.00, Min -2.00
- Dx Range: Max 5.00, Min -1.00
- Dy Range: Max 5.00, Min -1.00

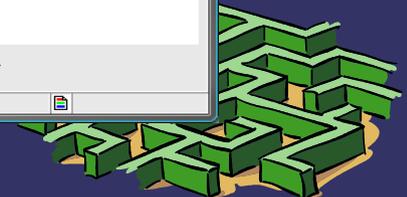


Sample Application for MR Beam Loss monitor display

Space(location) domain display

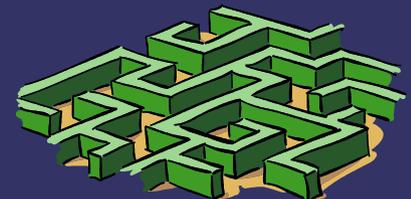


Time domain display



Summary

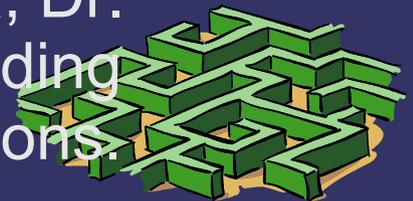
- ➔ Useful High level applications are already developed for LINAC and RCS commissioning.
 - It also means Base Device Controls works nicely.
- ➔ Prototype applications for MR were developed.
- ➔ Controls group working closely with commissioning group members.



Acknowledgement

To all members of J-PARC controls group

and Special thanks to Dr. Sako, Dr. Noda, Dr. Harada, Dr. Hotchi and Dr. Takano for providing pictures of these applications.



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