J-PARC Controls
- High Level Applications -

J-PARC controls group
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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)
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

Target -> Controller -> Device -> Actuator

Schematic view of device control system
Beam Controls

Operator Interface

Beam monitors

High Level Application

Beam

Data Archiver

Accelerator Model

Accelerator Devices

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

$\chi^2$ vs. RF amplitude
Orbit Correction

Before correction (SDTL)

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

After correction

- 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

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: A Java commissioning Environment

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

Accelerator Modeling Engine

Interpreter Engine

Library/Modules in SAD script includes KEKBFrame

Memory Management

Tcl/TK Widget

CA lib

- 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
- .....

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B,Q control and optics correction

B,Q control panel
Model fitting: SAD

Set & Meas. Correction (Fudge factor)

Optics measurement and correction panel
Tune correction and dynamic tune control
Injection control panel

RCS Injection DPI 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

Inj. QFL Response  Shift Bump Response

ISEP1,2 Response  IVSTR1,2 Response

Set desired pos and angle

Result

Orbit correction

phase space plot

Vertical profile

Matched!!

Adjusted so as to minimize the betatron oscillation
Optics measurement and analysis panel (1a) - COD correction

COD correction panel
Optics measurement and analysis panel (1b)
-one pass measurement

One pass orbit

Phase space plot
Optics measurement and analysis panel(2)
-tune measurement

Auto peak search for Qx

Auto peak search for Qy
**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

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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