The Construction Status of the SuperKEKB Control System

The SuperKEKB accelerator control group
SuperKEKB project

Upgrade of the KEKB B-factory experiment in Japan

SuperKEKB accelerator

The KEKB B-factory in Japan
More than 1ab⁻¹ data / 11 years
The world highest luminosity
→ Will be upgraded to SuperKEKB
X40 higher luminosity
KEKB to SuperKEKB

- KEKB operation finished in 2010 June.
- SuperKEKB operation will start from 2016 Feb.

Currently under construction
KEKB to SuperKEKB

SuperKEKB and BelleII
as of 2015 Oct.
SuperKEKB master schedule

KEKB Operation

Dismantle KEKB

SuperKEKB construction

Startup, Conditioning, etc

Phase 1 Operation starts from Feb. 2016

For about 10 years

Phase 1

Phase 2, 3

DR

QCS install Belle2 roll in

I. Construction toward the Phase 1 Operation
SuperKEKB Control System

• EPICS is used as the main software to control the accelerator
  2 layer model
  • OPI (Operation Interface) --- operation programs on central servers
  • IOC (I/O Controller) --- equipment controls on frontend computers

• Scripting Languages are used for the operation programs
  SAD Script/Tk  Python/Tk  Tcl/Tk

Accelerator Control Network

Central Servers

Consoles

Frontend Computers

IOC (I/O Controller)

Field Buses

Accelerator Components

~10,000 components

# signals to control → ~200,000
IOC (I/O Controller)

• Most of the IOC in KEKB were VME-based with VxWorks.
• In SuperKEKB, PLC-based IOC with Linux are widely used.
  – Beam Monitors: Upgraded VME/VxWorks IOC
  – Magnet Power Supply: Upgraded VME/VxWorks IOC
  – Vacuum System: PLC/Linux IOC
  – RF (New LLRF System): μTCA/Linux IOC + PLC/Linux IOC
  – RF (Old LLRF system): VME/VxWorks IOC with CAMAC
  – BT (Septum, Kicker): PLC/Linux IOC
  – BT (Other devices): VME/VxWorks IOC (to be upgraded)
  – Abort Trigger System: New VME/VxWorks IOC
IOC (I/O Controller) for SuperKEKB

- VME/VxWorks IOC
- PLC/Linux IOC
  - Yokogawa FAM3 series
  - Linux running on the CPU module (F3RP61)
  - Install EPICS into the CPU module

Control the vacuum system, LLRF, beam collimators, etc.

- PC/Linux IOC (Soft IOC)

J. Odagiri et al
Magnet Control

Many kinds of fieldbus in SuperKEKB
Ethernet, GP-IB, serial, VXI/MXI (for BPM), ARCNET (for magnet power supply) ...

For the Magnet Control, we have developed the PSICM
(Power Supply Interface Controller Module)

We start with the combination of Old & New PSICM because of the limited budget.
426 New PSICM (out of 2162 Magnet PS in LER and HER) have been installed for the Phase 1 Operation.
New PSICM is fully backward compatible.

- Faster data transfer rate
- Support 24, 20, 18-bit DAC
- Redundant timing signal input

T. T. Nakamura et al., WEPGF085
New Alarm system for SuperKEKB

- In KEKB, we used SAD-based alarm system.
- In SuperKEKB, we construct the CSS-based alarm system.

Monitor EPICS records (monitor the severity)

Alarm Server

JMS (ActiveMQ)

JMS2RDB

Log DB

Alarm Client GUI

User Operator

Alarm history

List of EPICS records to be monitored
Alarm message/ Beep / etc..

Initial setting

Show the Current Alarm Status

Change the setting parameters

M.Iwasaki, et.al.
New Alarm system for SuperKEKB

- In KEKB, we used SAD-based alarm system.
- In SuperKEKB, we construct the CSS-based alarm system.

To apply the CSS-based alarm system to SuperKEKB

1) We must make sure that it stably operates under the several 10 thousands alarm points. (~25,000 in KEKB)
   → We did load tests, and confirm it works well.

2) We must develop the software tools to meet our accelerator operation system.
   → Currently on going
Event Timing System is not just for delivering triggers but for frequent switching of operation parameters.

We configured three EVG at Main Timing Station to satisfy complicated requirements to the SuperKEKB operation.

We have already succeeded the injections to two light source rings with new system and are waiting for the operation of SuperKEKB.

H. Kaji et al., WEC3O04

“New Event Timing System for Damping Ring at SuperKEKB.”
We have developed the faster response Abort Trigger System for SuperKEKB E/O conversion, optical cable to transfer the signal, remove low-pass filters → Response time improved from 100μs to 20μs

Loss monitors etc. (over 130 points) → 20 Local Control rooms → SuperKEKB Control room

Abort input → VME Abort module → Transfer Cables (<3km) → VME Abort module → Abort Kicker

The new system has been partially installed and has worked with the previous system

S. Sasaki et.al., MOPGF141
In 2013, we removed old server racks, old panel board cabinets, power and signal cables.

In 2014, we removed old desks

New server racks in the computing room

New Control Room
II. Collaborative R&D toward the Phase 2 and beyond

• The interlock signal between SuperKEKB and Belle II is important for the high luminosity operation.
  – VME-FPGA board has been developed collaborating with Spring-8

• R&D of the Data Archiving System
  – Collaborating with Linac Control Group, J-PARC Control Group and EPICS Collaboration
New Signal Transfer Scheme with FPGA

- In KEKB, we transfer the E/O converted signals via optical cables for the detector and accelerator communication (injection control, ...).
- For SuperKEKB we have developed the new signal transfer scheme using the VME-FPGA board which is developed for Spring-8.

Based on the sampling, parallel to serial, and serial to parallel conversion using the FPGA boards.

Revolution = 100KHz → Sampling rate higher than 1MHz is required

T.Abe (Spring-8), S.Sasaki, M.Iwasaki, A.Akiyama, M.Ikeno, M.Shoji
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KEKB

[Diagram: E/O, Opt. cable, O/E]

SuperKEKB

[Diagram: FPGA board, SM, Opt. cable, SFP]

# of optical cables = # of signal

# of optical cables = 2

We also apply the VME-FPGA board to the signal transfer of soft abort request, beam gate control, QCS quench detection, ... for SuperKEKB

T.Abe (Spring-8), S.Sasaki, M.Iwasaki, A.Akiyama, M.Ikeno, M.Shoji
Data Archiving System

- **KEKBLog** as a primary data archiving system (file based logging system)
- **CSS (Control System Studio)-based Archiver + PostgreSQL** as the 2nd option data archiving system

We accumulate the vacuum system (from 2015) & the QCS cryogenic system (from 2014) data with the new CSS archiver + PostgreSQL → Store ~10,000 points every 1-10 seconds.
User’s PC with CSS or data browser based on ROOT can remotely access to the PostgreSQL server for real-time / historical / trend monitoring
Summary

Upgrade of the accelerator control system for SuperKEKB is now in progress

Currently preparing for the 1st SuperKEKB operation in 2016 Feb.

Please also see the details of the accelerator control system upgrade in the following presentations

S. Sasaki et al., MOPGF141,
“Upgrade of Abort Trigger System for SuperKEKB”

T. T. Nakamura et al., WEPGF085,
“The Construction of the SuperKEKB Magnet Control System”

H. Kaji et al., WEC3O04,
“New Event Timing System for Damping Ring at SuperKEKB”
Back Up
Layout after the renovation

Everyone can directly watch the main accelerator status display.

S.Sasaki, et.al.