Design and Status of the SuperKEKB Accelerator Control System

M. Iwasaki (KEK) for the SuperKEKB accelerator control group
SuperKEKB project

SuperKEKB → Upgrade of the KEKB B-factory experiment in Japan
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SuperKEKB $\rightarrow$ Upgrade of the KEKB B-factory experiment in Japan
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KEKB accelerator
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More than 1ab⁻¹ data / 11 years
The world highest luminosity

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X40 higher luminosity
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KEKB to SuperKEKB

• KEKB operation finished in 2010 June.
• SuperKEKB operation will start from 2015 Jan.

Currently under construction
KEKB to SuperKEKB

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Currently under construction
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
- Frontend Computers
  - IOC (I/O Controller)
- Field Buses
- Consoles
- Accelerator Components

~10,000 components

# signals to control \(\rightarrow\) ~200,000
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**

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J. Odagiri et al., MOCOBAB02
Many kinds of fieldbus in SuperKEKB
Ethernet, GP-IB, serial, VXI/MXI (for BPM), ARCNET (for magnet power supply) ...

We have developed the magnet power supply interface controller module (PSICM)

We upgrade PSICM for SuperKEKB
- Faster data transfer rate
- Support 24, 20, 18-bit DAC
- Redundant timing signal input
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

CSS installed users PCs can be remotely access to the database
For real-time / historical / trend monitoring
SuperKEKB Control Network System

Star network topology

Main network switch is located at the SuperKEKB CTL room

Connecting the SuperKEKB CTL room and 26 sub CTL rooms, where network switches are located.

Upgrade in Progress

- 10GbE/1GbE switches
- Additional optical cables for the redundant network configuration
- New network configuration
- Wireless LAN installation into the whole SuperKEKB accelerator area

M. Iwasaki et al., THPPC009
New Network Configuration

New configuration from this summer

All computers in the acc. control network don’t directly connect to the KEK laboratory network

→ Enhance the security

M. Iwasaki et al., THPPC009
For SuperKEKB Beamline construction, we install Wireless LAN system into the whole tunnel area.

Leak Coaxial (LCX) antenna and Access Point at the arc section.

M. Iwasaki et al., THPPC009
Timing System for positron injection

In SuperKEKB, we construct the positron Damping Ring. Positron injection timing scheme become complicated.

To account for DR, new timing system for $e^+$ injection is required.

H. Kaji et al., THCOCA04
K. Furukawa et al., FRCOBAB04
We have developed the faster response Beam Abort System for SuperKEKB E/O conversion, optical cable to transfer the signal, remove low-pass filters → **Response time improved from 100µs to 20µs**
Renovation of the computing room

Before the renovation
Renovation of the computing room

This summer, we removed old server racks, old panel board cabinets, power and signal cables.
Renovation of the computing room

Now under installation of the server racks
Summary

Upgrade of the accelerator control system for SuperKEKB is in progress

Currently preparing for the 1st SuperKEKB operation in 2015 January

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

J. Odagiri et al., MOCOBAB02, “Integration of PLC with EPICS IOC for SuperKEKB Control System”
T. T. Nakamura et al., TUPPC089, “Upgrade of the Power Supply Interface Controller Module for SuperKEKB”
H. Kaji et al., THCOCA04, “Upgrade of Event Timing System at SuperKEKB”
M. Iwasaki et al., THPPC009, “Design and Status of the SuperKEKB Accelerator Control Network System”
K. Furukawa et al., FRCOBAB04 “Beam Feedback System Challenges at SuperKEKB Injector Linac”
Back Up
To get x40 higher luminosity

KEKB to SuperKEKB

How to upgrade

- Replace short dipoles with longer ones (LER)
- Redesign the lattices of HER & LER to squeeze the emittance
- Add / modify RF systems for higher beam current
- New superconducting/permanent final focusing quads near the IP
- New beam pipe & bellows
- New positron target / capture section
- TiN-coated beam pipe with antechambers
- Damping ring
- Low emittance gun
- Low emittance electrons to inject
- Low emittance positrons to inject

New IR

Colliding bunches

Positron source

Belle II

New positron target / capture section
## SuperKEKB Schedule

|----------|------|------|------|------|------|------|------|---|

### KEKB operation
- Optics design
- Dismantling KEKB
- Fabrication and tests of MR components
- TiN coating & baking of beam pipes
- Install, assembly and set-up
- MR buildings construction
- Reinforce electricity and cooling facility
- Fabricate QCS-L
- Fabricate QCS-R
- Detector upgrade to Belle II
- Belle roll out

### SuperKEKB-MR(LER&HER) construction
- Cool down in beam line
- Roll in
- Roll out

### SuperKEKB commissioning
- Phase 1: w/o QCS w/o Belle II
- Phase 2: w/ QCS w/ Belle II (no VX D)
- Phase 3: w/ full Belle II
- DR commissioning during phase 1
- Reinvest RF, vac, etc. for higher beam current
- VX D install

### SuperKEKB-DR construction
- Optics design
- Fabrication and tests of DR components
- DR tunnel construction
- DR buildings construction
- Electricity and cooling system
- Install, assembly and set-up
The Event Timing System is configured mainly with...
- VME-EVG-230
- VME-EVR-230RF

Two layers of EVGs are configured at Main Trigger Station.

Local devices along with Linac beam line are controlled by EVRs.

The SINAP modules will be installed at Damping Ring.