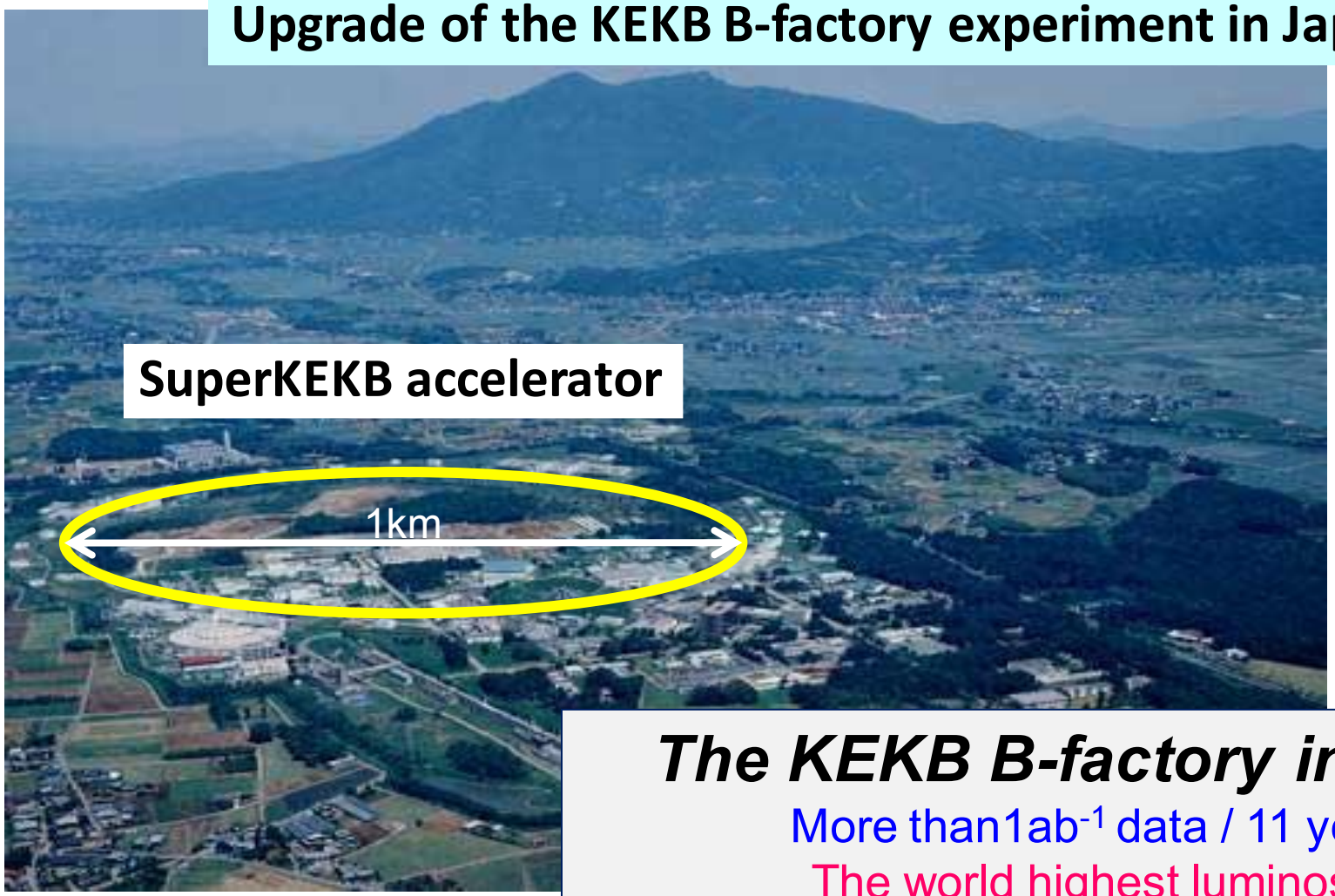
The Construction Status of the SuperKEKB Control System

The SuperKEKB accelerator control group

SuperKEKB project

Upgrade of the KEKB B-factory experiment in Japan



The KEKB B-factory in Japan

More than1ab^{-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

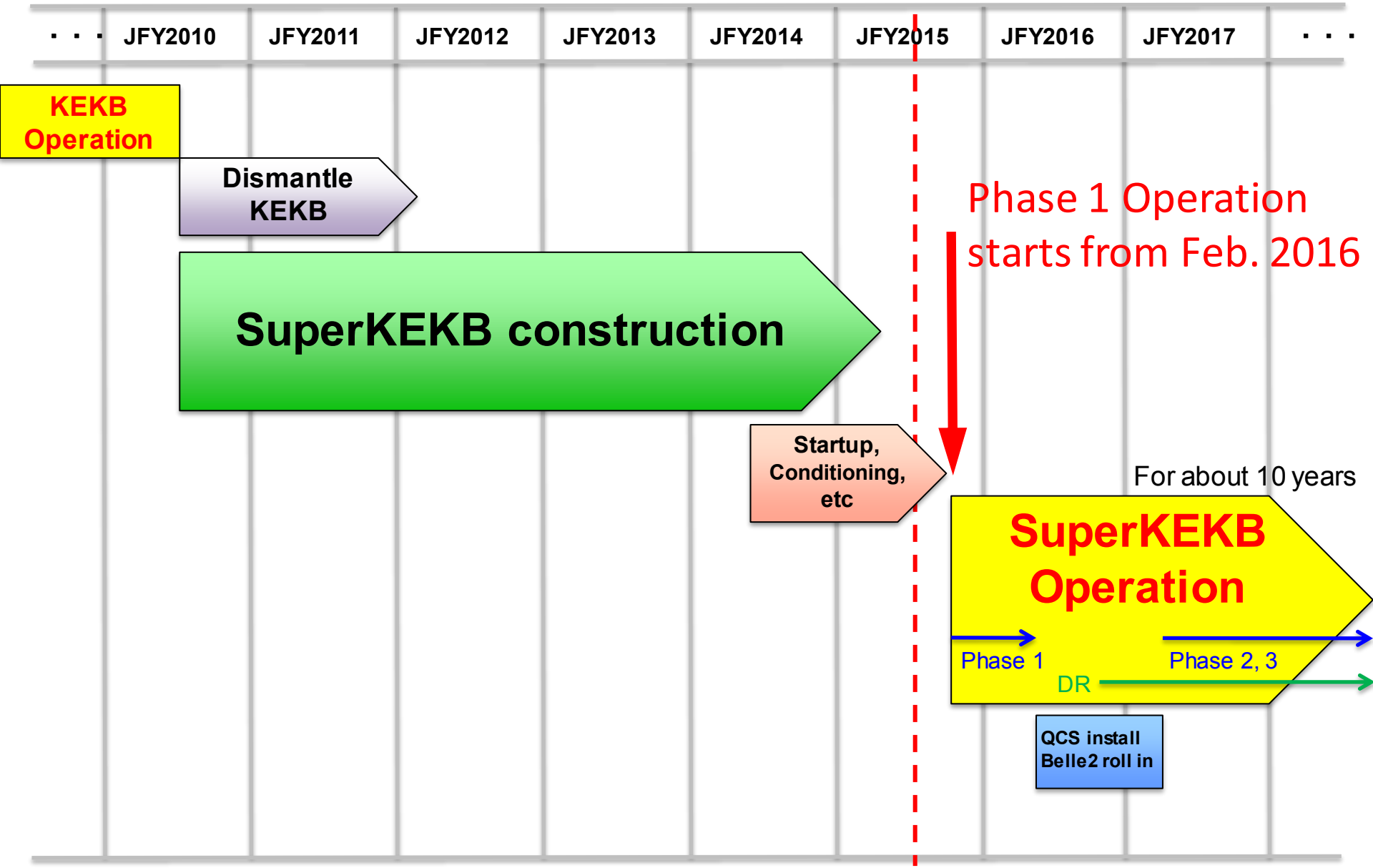
M.Masuzawa

KEKB to SuperKEKB

SuperKEKB and BelleII
as of 2015 Oct.

SuperKEKB master schedule

K. Akai



I. Construction toward the Phase 1 Operation

SuperKEKB Control System

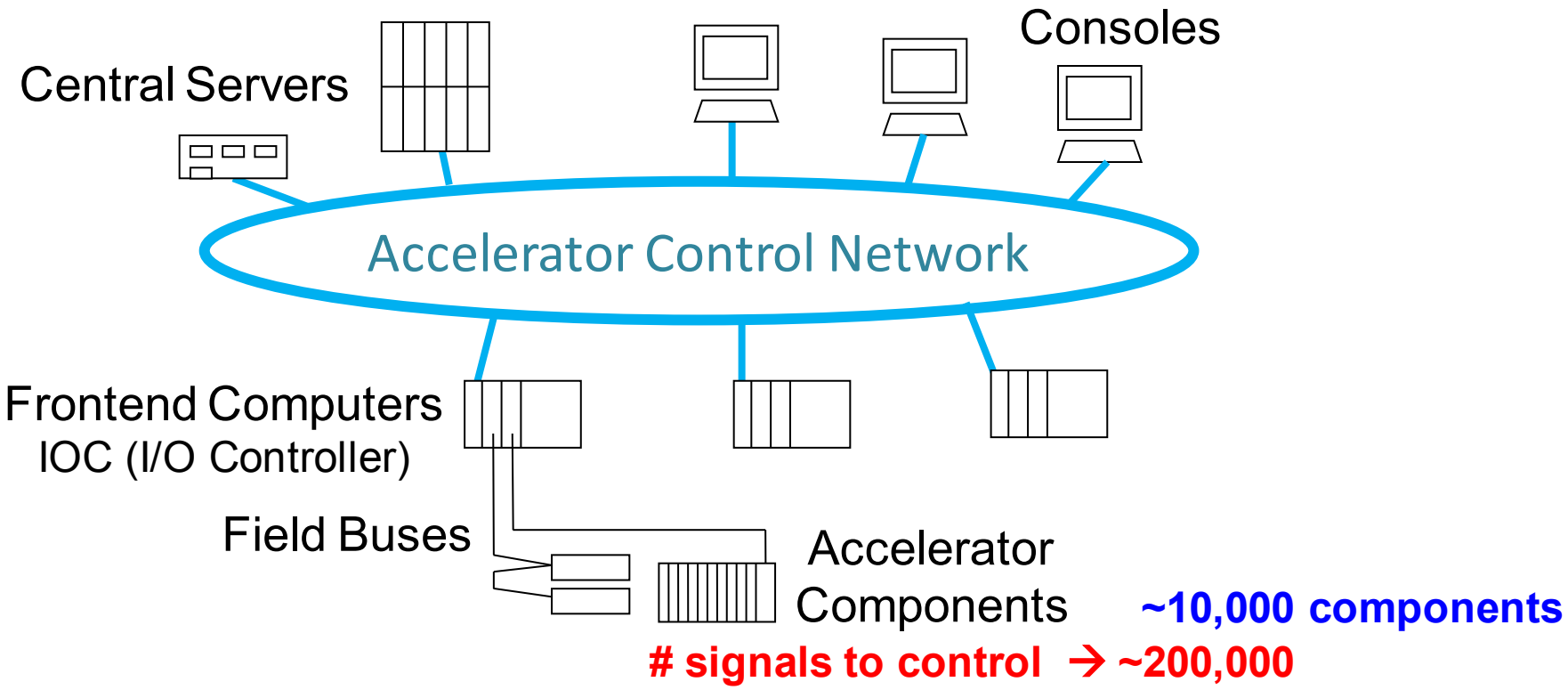
- **EPICS is used as the main software to control the accelerator**

  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



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)**

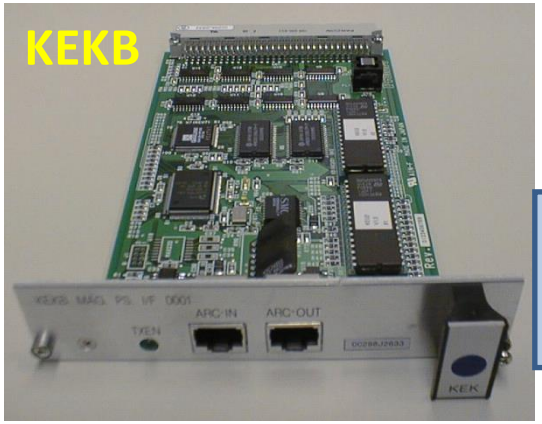
J. Odagiri et al

Magnet Control

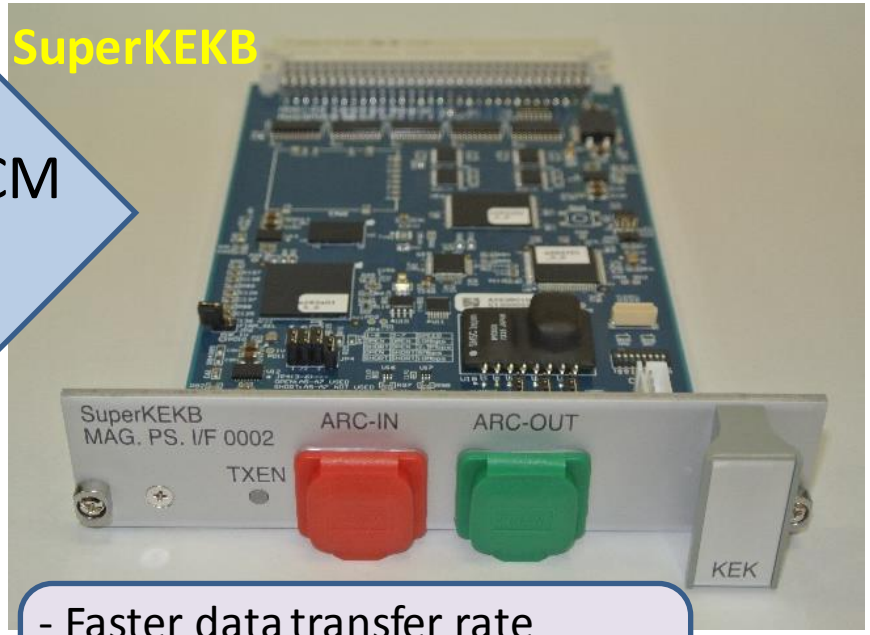
Many kinds of fieldbus in SuperKEKB

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 upgrade PSICM for SuperKEKB



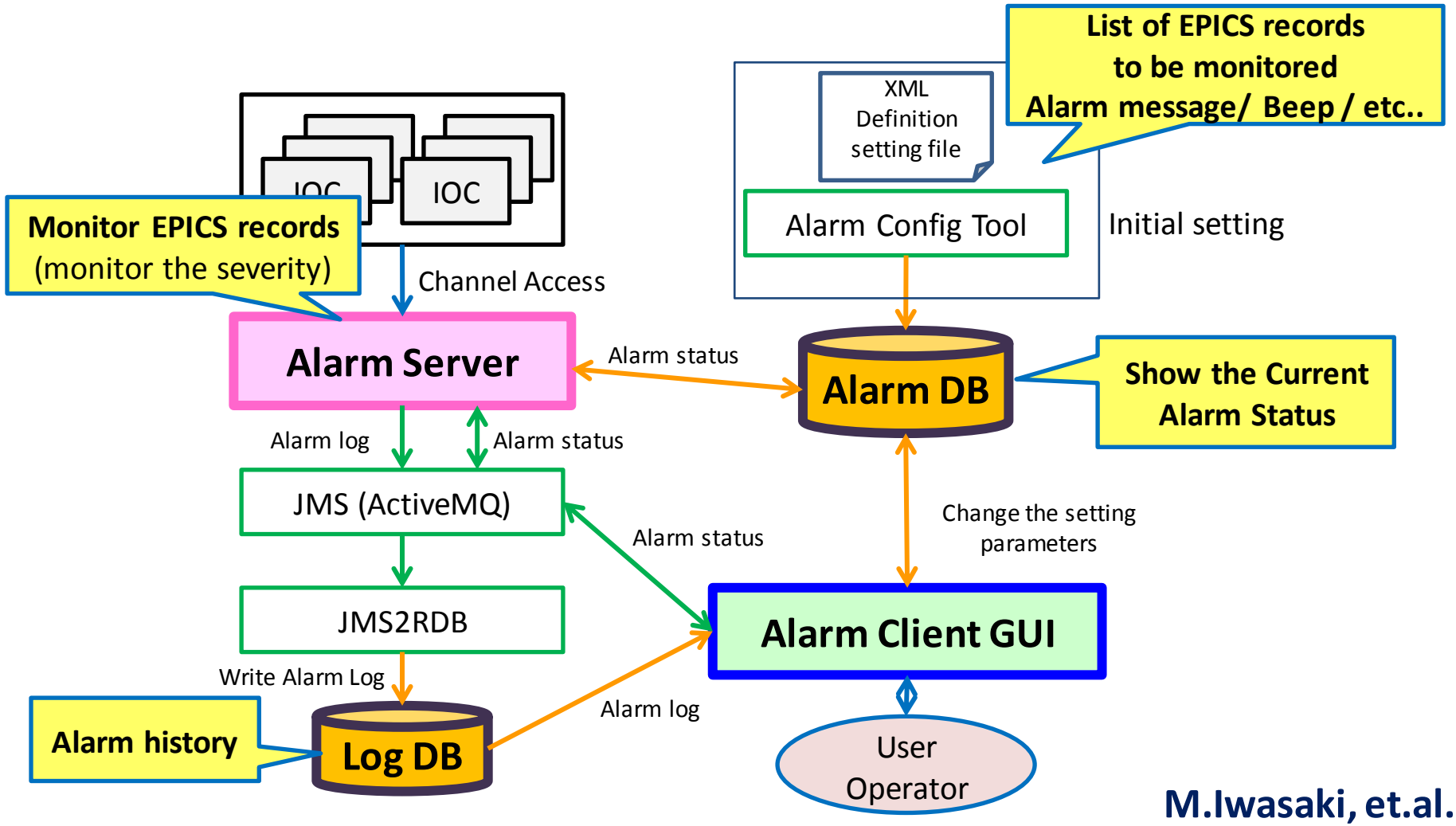
- Faster data transfer rate
- Support 24, 20, 18-bit DAC
- Redundant timing signal input

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**.

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.*



M.Iwasaki, et.al.

New Alarm system for SuperKEKB

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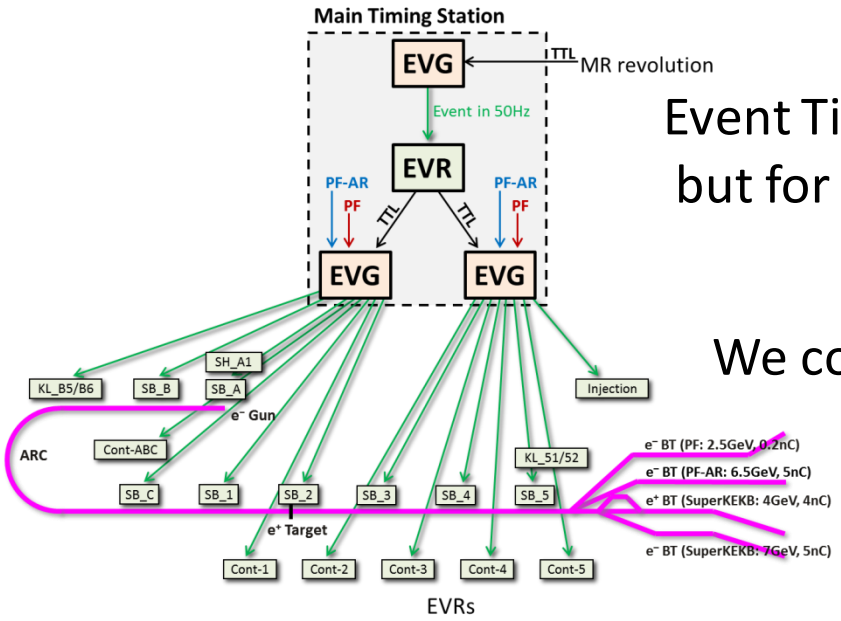
To apply the CSS-based alarm system to SuperKEKB

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

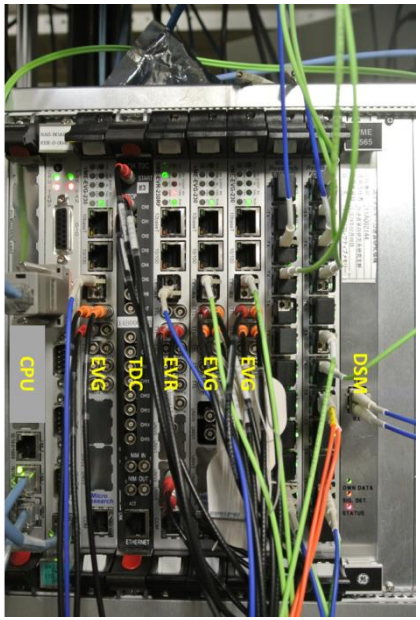
M.Iwasaki, et.al.

Event Timing System



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

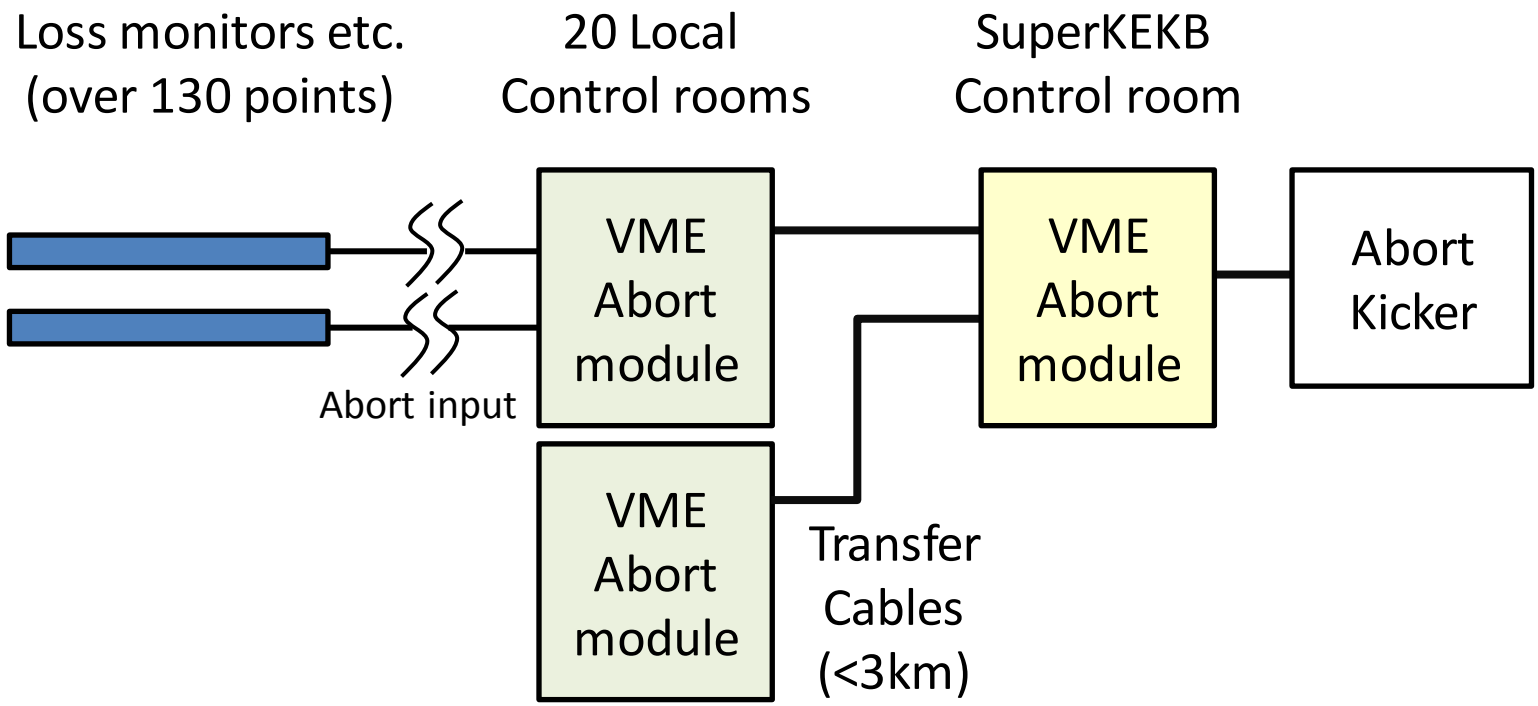
"New Event Timing System for Damping Ring at SuperKEKB."

Abort Trigger System

We have developed the faster response Abort Trigger System for SuperKEKB

E/O conversion, optical cable to transfer the signal, remove low-pass filters

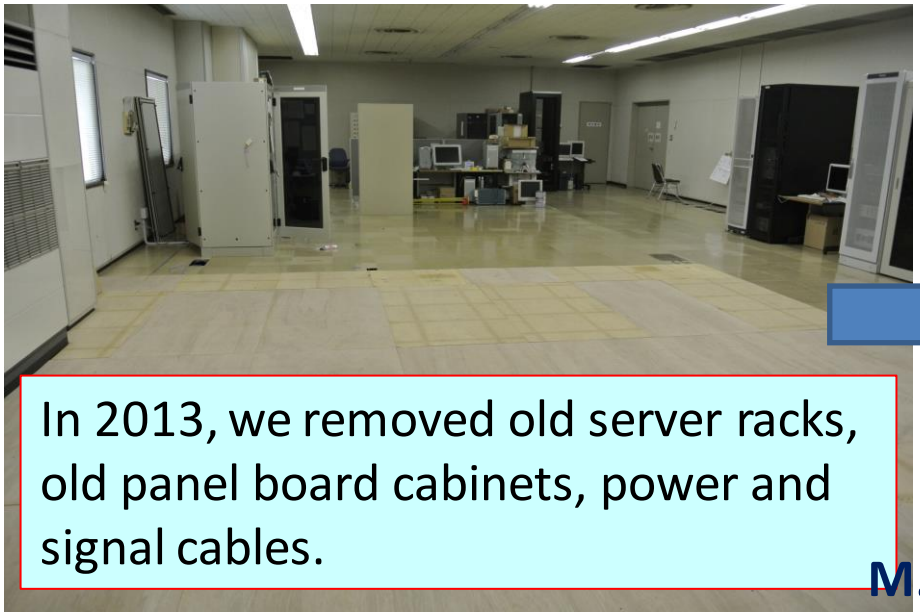
→ **Response time improved from 100μs to 20μs**



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

S. Sasaki et.al., MOPGF141

Renovation of the computing/control room



In 2013, we removed old server racks, old panel board cabinets, power and signal cables.

New server racks in the computing room

M.Iwasaki, et.al.

In 2014, we removed old desks

New Control Room

S.Sasaki, et.al.

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

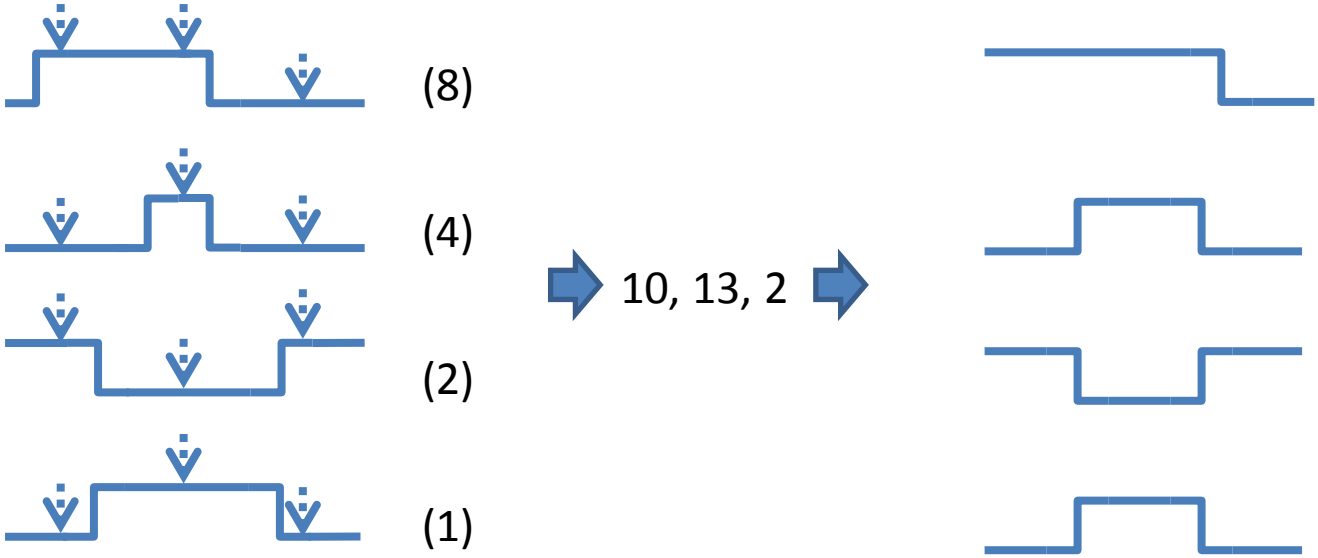
- The interlock signal between SuperKEKB and Belle II is important for the high luminosity operation.
  - VME-FPGA board has been developed collaborating with Spring-8
- R&D of the Data Archiving System
  - Collaborating with Linac Control Group, J-PARC Control Group and EPICS Collaboration

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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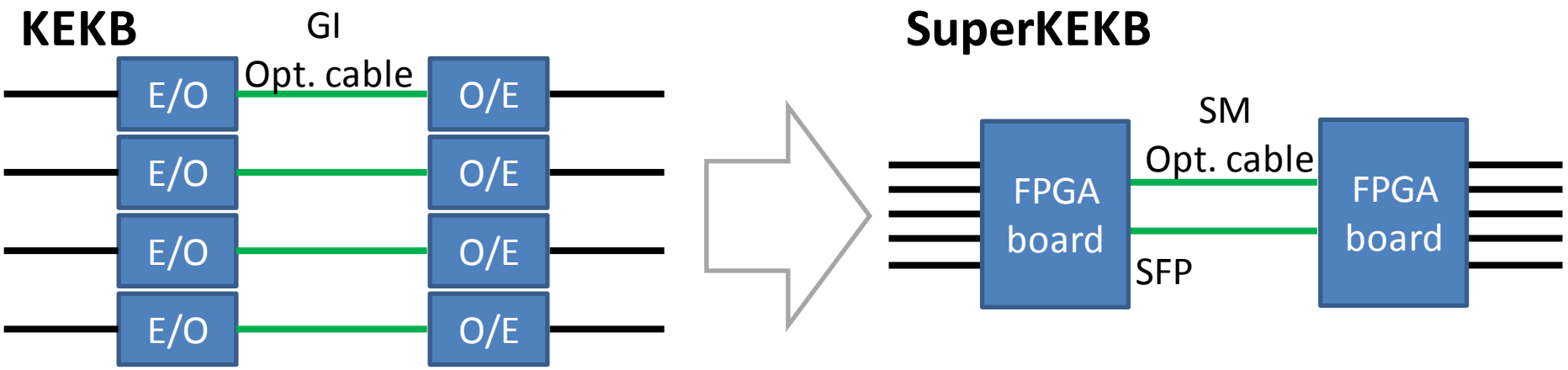


# of optical cables = # of signal

# of optical cables = 2

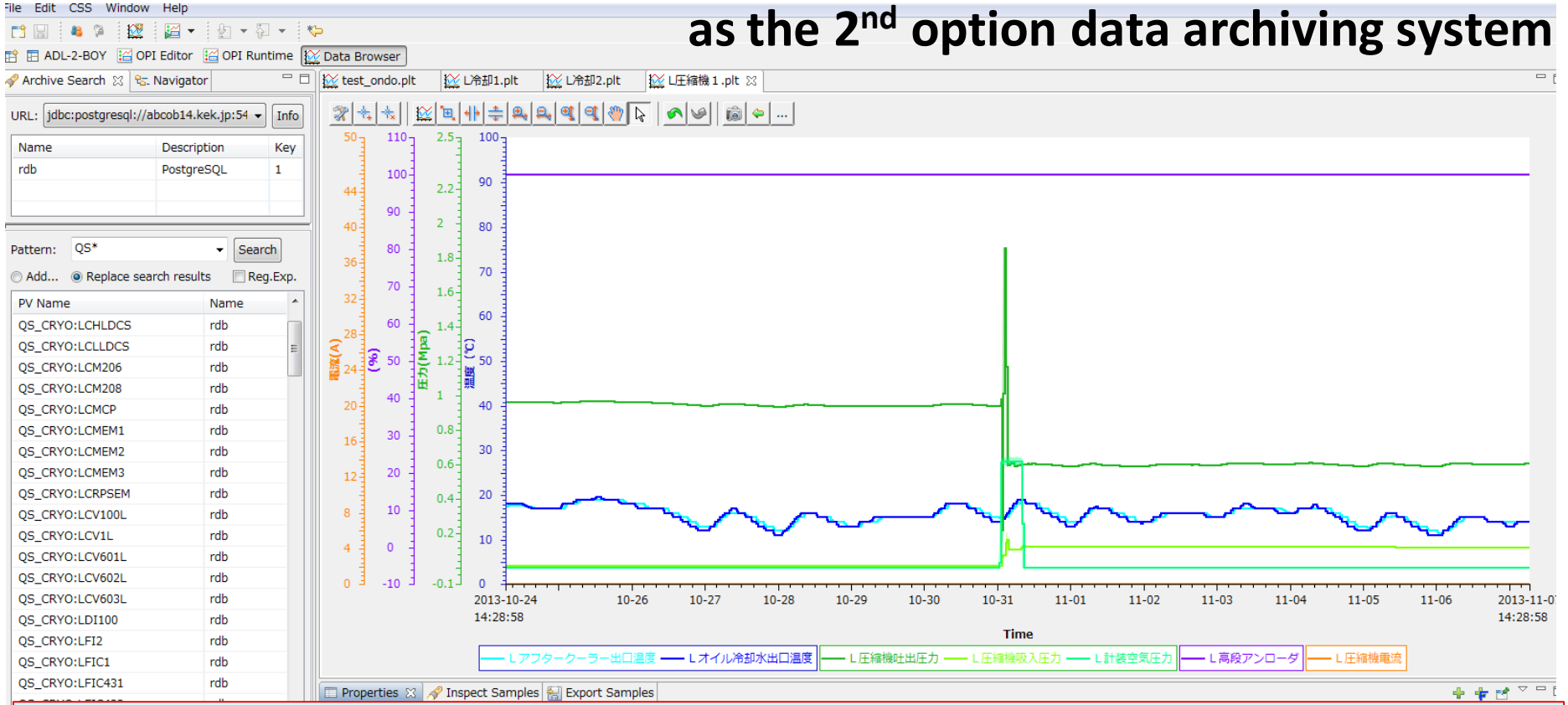
We also apply the VME-FPGA board to the signal transfer of soft abort request, beam gate control, QCS quench detection, … for SuperKEKB

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

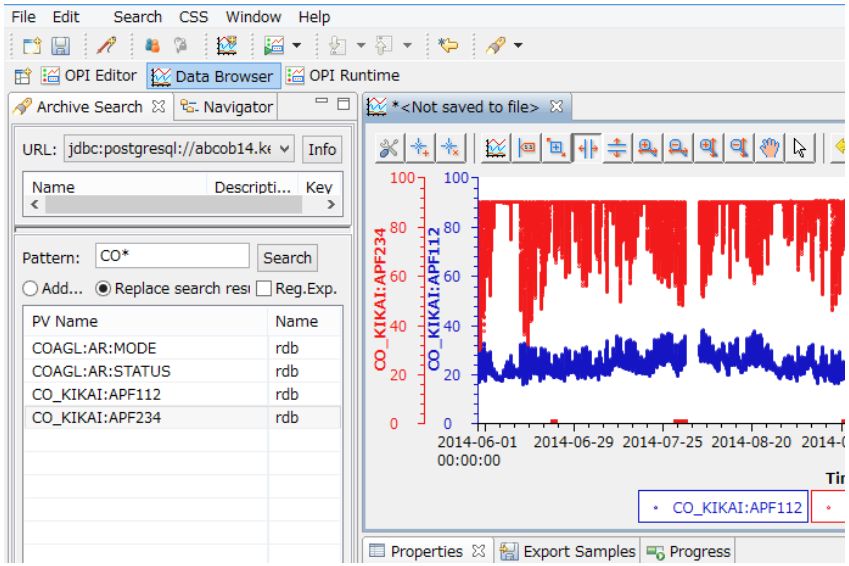


We accumulate the vacuum system (from 2015) & the QCS cryogenic system (from 2014) data with the new CSS archiver + PostgreSQL

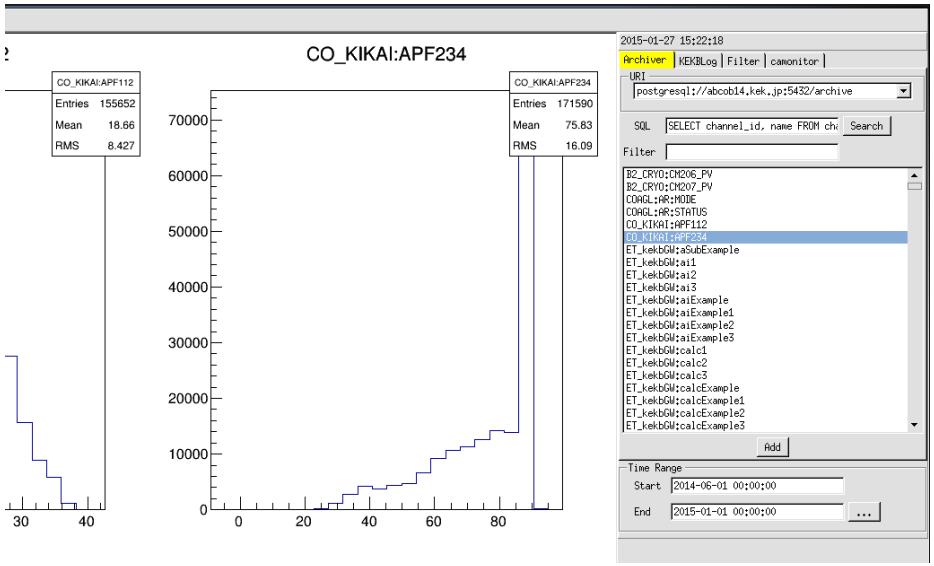
→ Store ~10,000 points every 1-10 seconds.

Data Archiving System

Data Browser based on CSS



Data Browser based on ROOT



User's PC with CSS or data browser based on ROOT can remotely access to the PostgreSQL server for real-time / historical / trend monitoring

M.Iwasaki, et.al.

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"

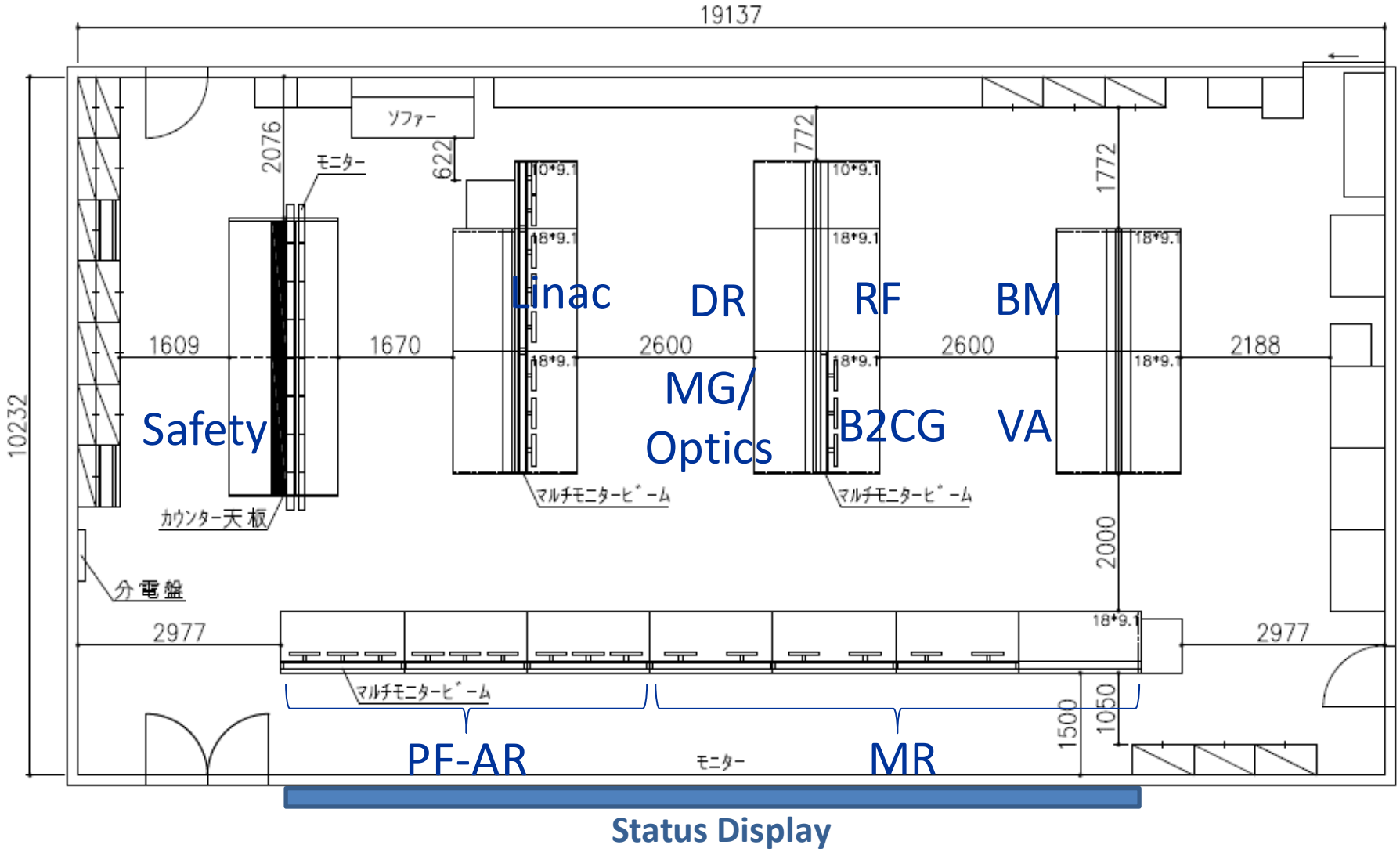
T. T. Nakamura et al., WEPGF085,
"The Construction of the SuperKEKB Magnet Control System"

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.