

# Control System

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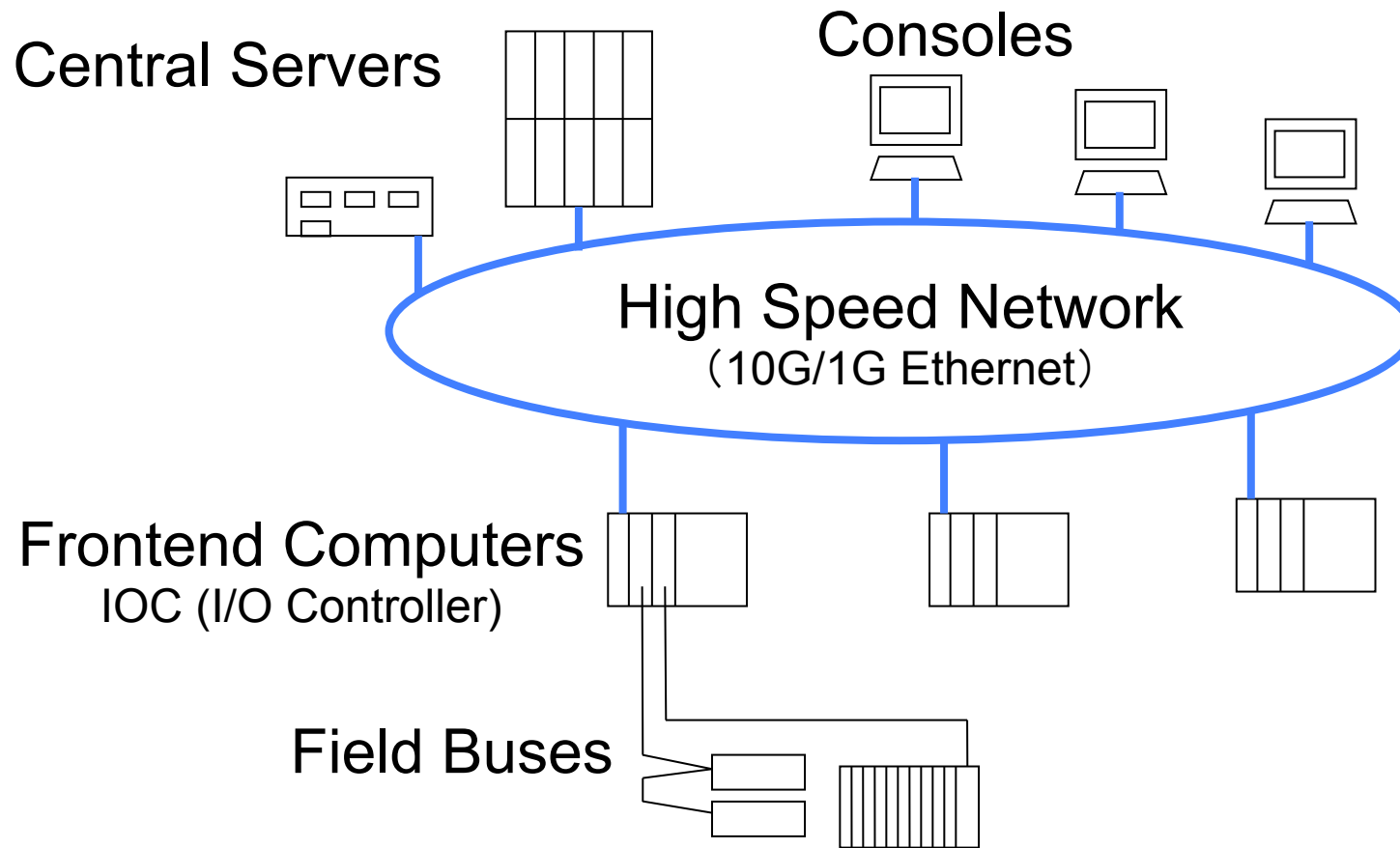
# Outline

- Overview
- Central Server Computers
- Network
- IOC (Input/Output Controller)
- Field Buses
- Bucket Selection System
- Beam Abort System
- Other Issues

# Overview of KEKB Control System (Software)

- EPICS based --- Distributed System
  - **EPICS** (Experimental Physics and Industrial Control System) is a toolkit to construct control systems
  - 2 layer model
    - OPI (Operation Interface) --- operation programs on central servers
    - IOC (I/O Controller) --- equipment controls on frontend computers
  - CA (Channel Access)
    - Communication protocol over network
    - Key technology of EPICS
- Operation Programs in Scripting Languages
  - Quick and Flexible Development
  - With EPICS-CA, GUI (tk)
  - **SAD Script** (developed at KEK)
  - **Python**

# Overview of KEKB Control System (Hardware)



# Central Server Computers

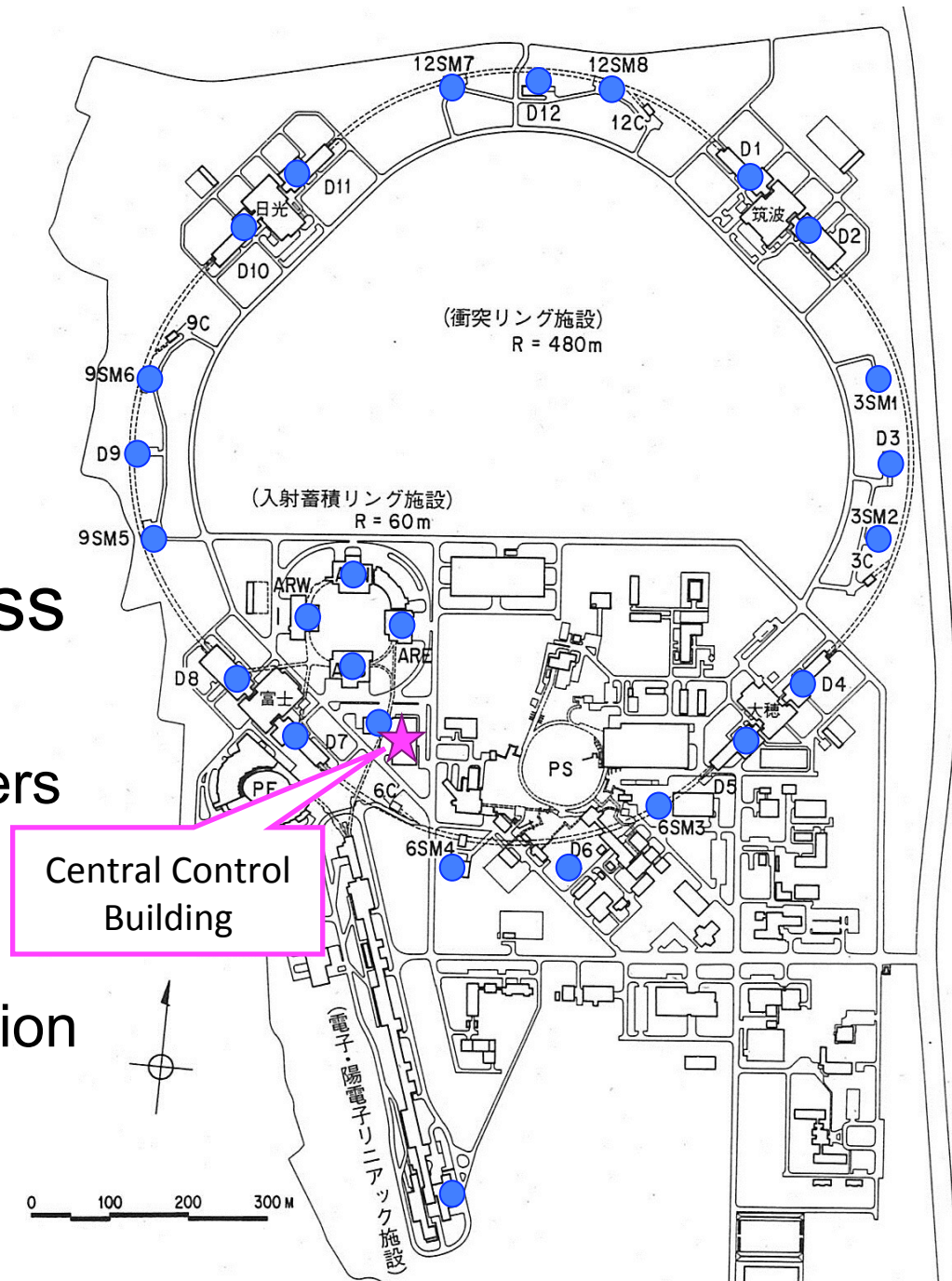
- Control Servers --- Managed by Control Group
  - Dedicated for KEKB Control / Operation
  - Currently consists of
    - Rack Mount Servers
      - 2 HP-UX
      - 1 Linux
    - Blade Servers
      - 14 Linux
- SAD Computers (SAD Cluster) --- Managed by SAD Group
  - Originally for SAD Simulations
  - Later intensively used for KEKB Operation
  - Not only for KEKB but also for other Projects (**Many user accounts !**)
  - Currently consists of
    - 1 Alpha/Tru64
    - 5 Macintosh
    - 5 Free BSD

# Network

Star Configuration between  
Central Control Building  
and  
26 Local Control Rooms

- Upgrade in Progress

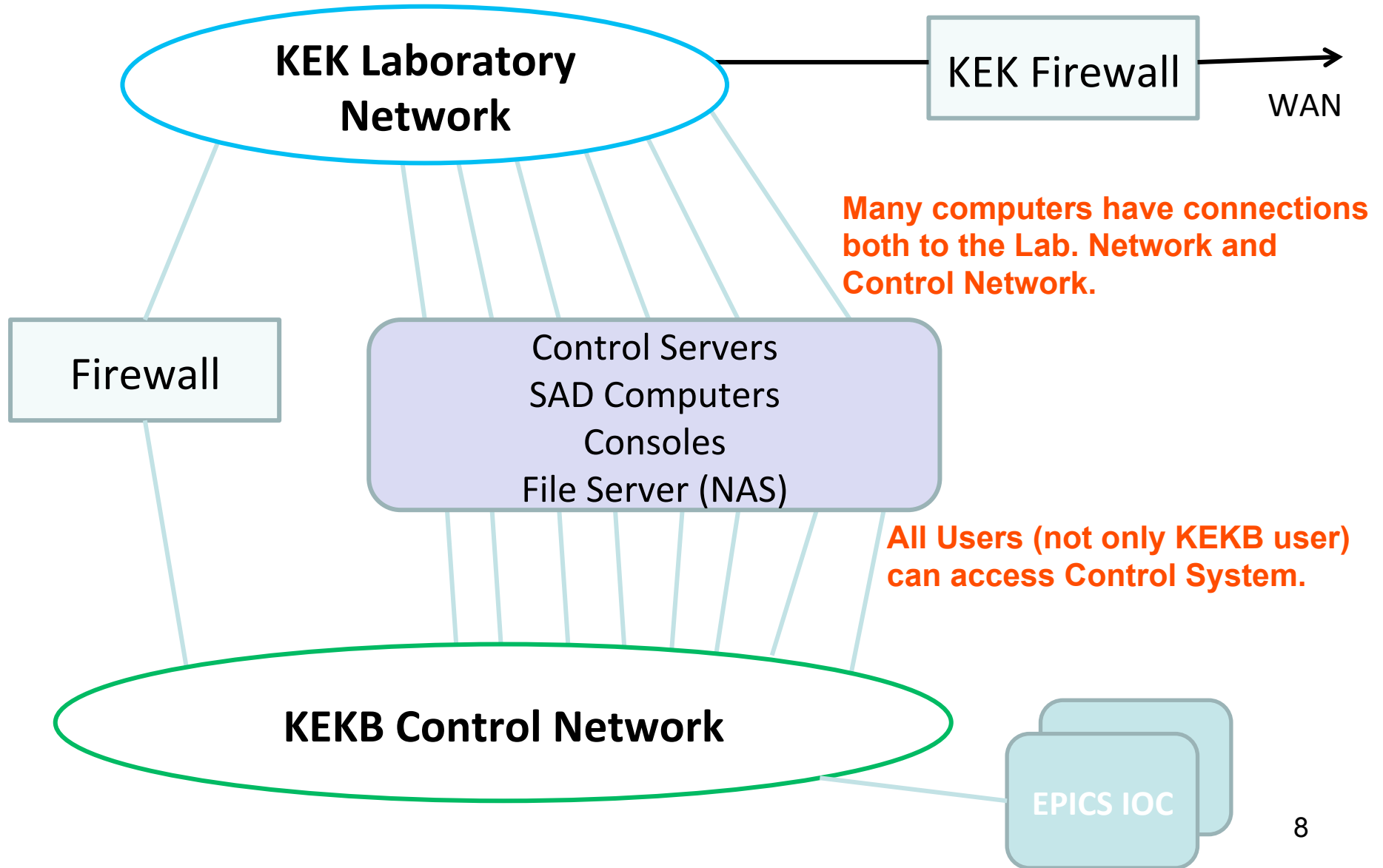
- 10G/1G bps Ethernet
- Additional Optical Fibers
- Central core switch
  - Catalyst 6509E
- Redundant Configuration
- VLAN



**Optical fiber cabling for SuperKEKB is on going.**

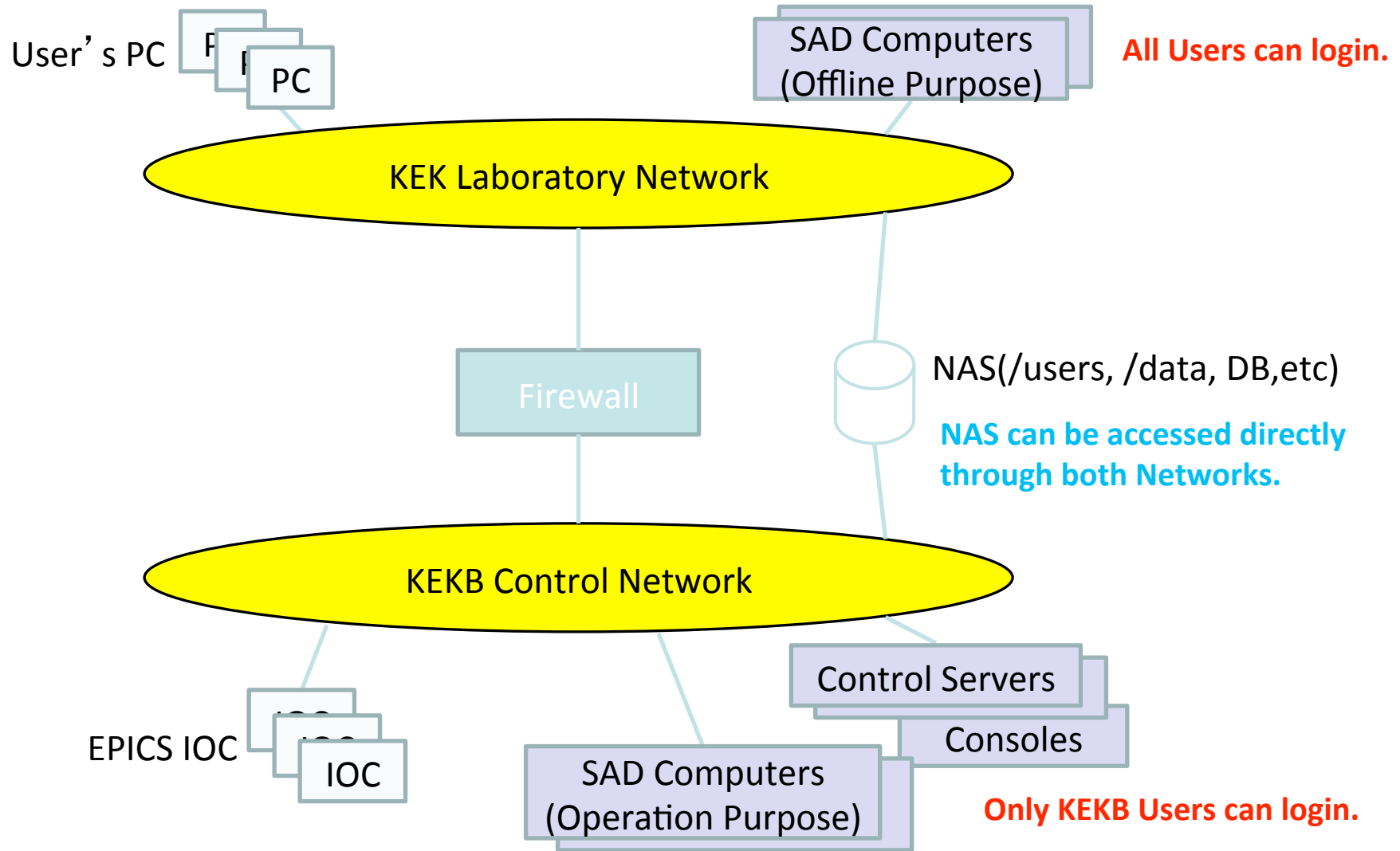


# Network --- Current Configuration





# Network --- New Configuration Plan



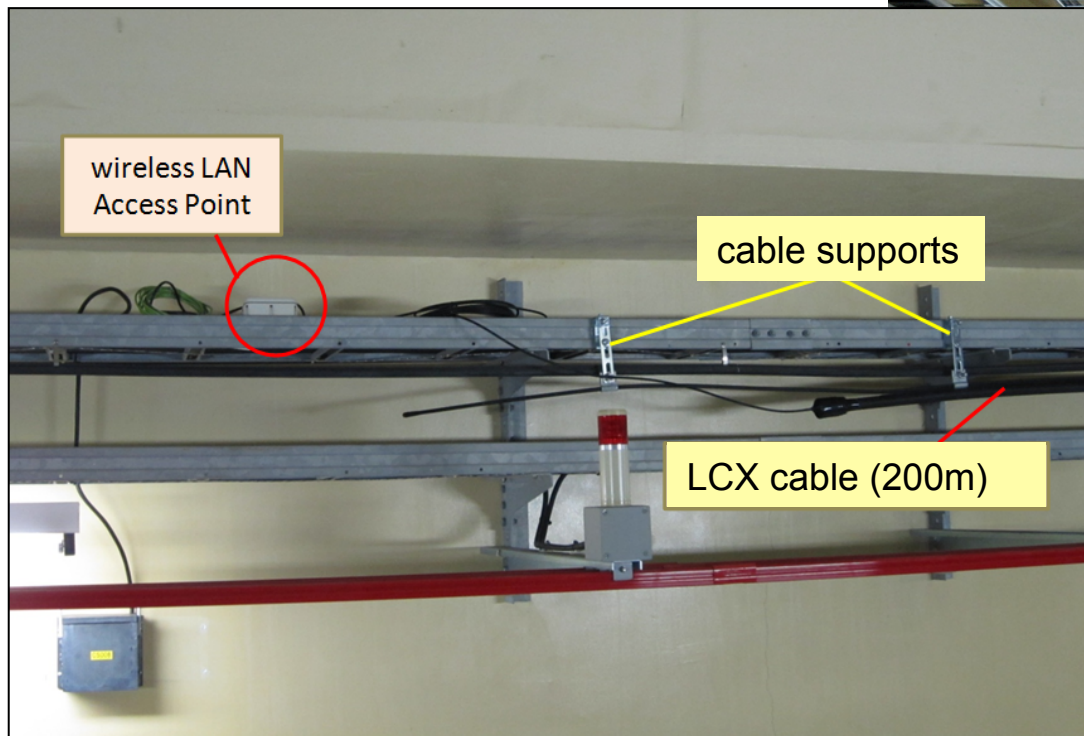
All of SAD Computers and Control Servers share same home directory.

# Network --- Wireless LAN

- Partially installed in KEKB
- Widely Deployed in SuperKEKB
  - Required to be available in the construction phase (before T=0)
  - In the Accelerator Tunnel
    - LCX cable (Leaky Coaxial cable) for Arc Sections
    - Collinear antenna for Straight Sections
  - In the Local Control Rooms and Power Stations
    - Collinear antenna
  - Both Linac and KEKB Wireless Networks are managed in a unified manner.

# Wireless LAN using LCX cable

Prototype Test of LCX cable



# Wireless LAN

- Installation in progress right now !



The 16 LCX cable drums have delivered to KEK the last month.





**They were unpacked the last week,  
and ...**



**Just installed to  
the KEKB beam-line yesterday.**

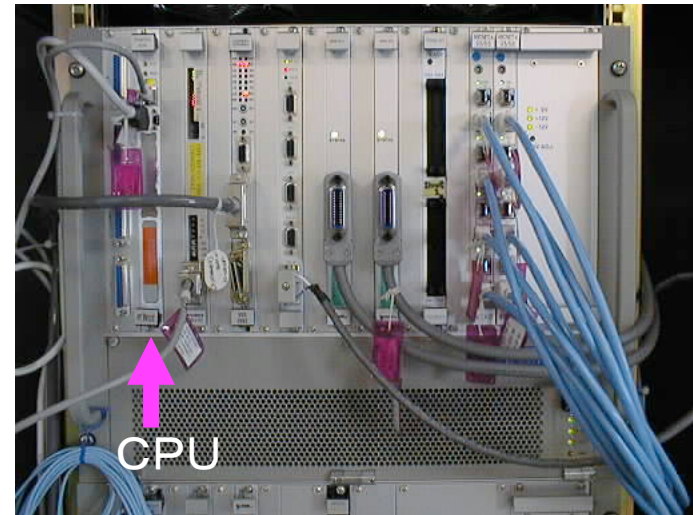


Now under construction.



# IOC (Input/Output Controller)

- VME/VxWorks IOC
  - Widely used in KEKB
  - Continue to use also in SuperKEKB
  - CPU upgrade
    - Force PPC750 → MVME5500
- PLC/Linux IOC
  - Yokogawa FAM3 series PLC
  - Embedded EPICS



CPU Module  
F3RP61

I/O Modules 16



# F3RP61 (e-RT3 2.0)

Linux 2.6.24

PPC 533MHz

128Mbyte RAM

100BaseTx x 2

USB

IEEE1394

Serial

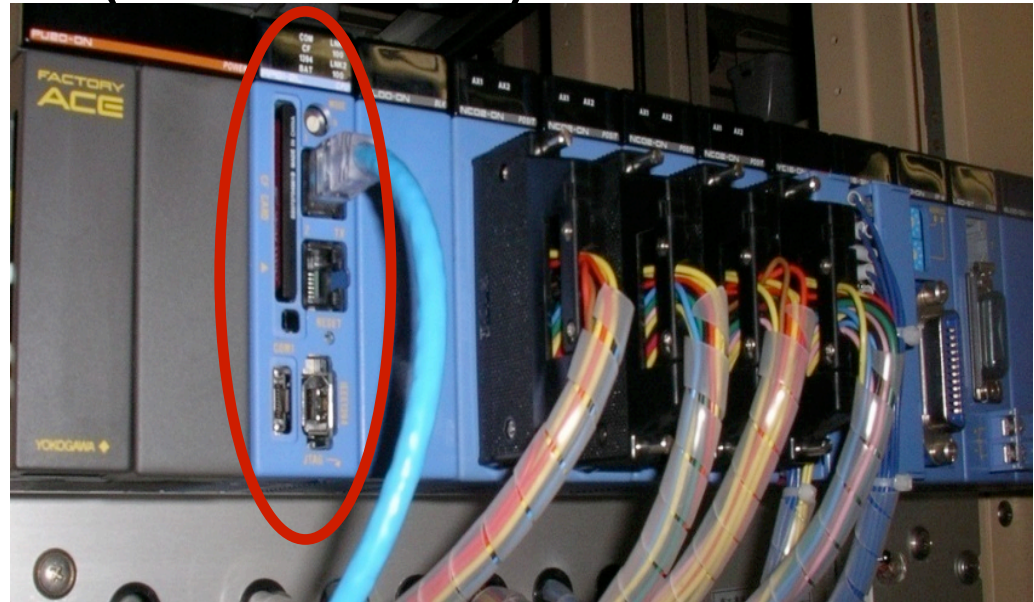
PCI

I/O Bus for FAM3 Module Interface

can access to mature FAM3 I/O Modules

Can be combined with conventional ladder CPU

Software development environment (ELDK)



KEKB Beam mask controller



# F3RP61 in SuperKEKB

construction in progress ...

- Vacuum Control
- LLRF (used with MicroTCA system)
- Interface to the Personnel Protection System
- Embedded in Large Magnet Power Supply
  - Digital feed back control for high current stability
- Beam Mask Control
- Pulsed Q-Magnet Control

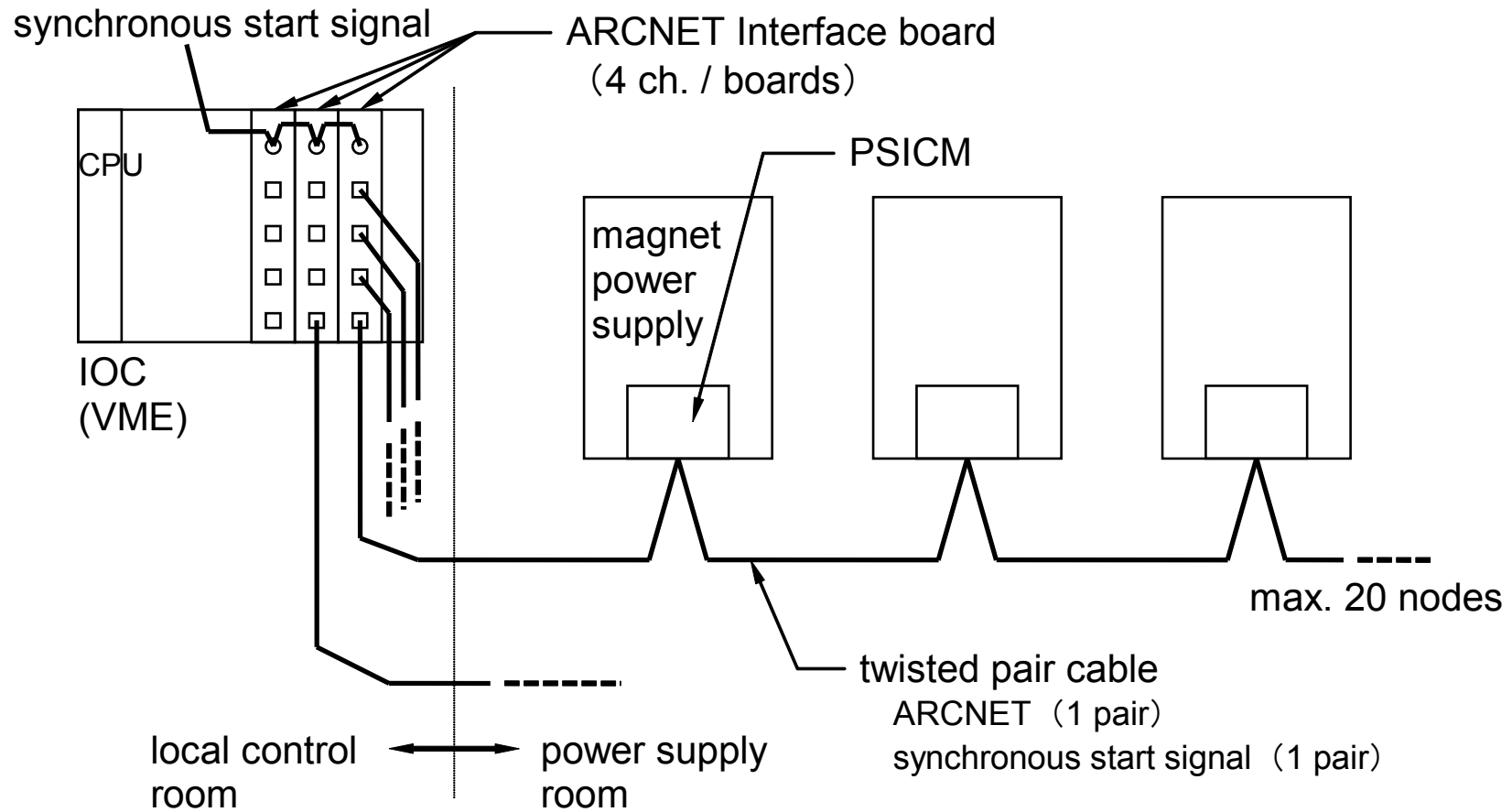
and more ...

- RF Power Supply Control
- Tilting Support (SX Magnet) Control

# Field Buses

- CAMAC --- Too old (>25 years old)
  - Replacement in progress
    - PLC (Embedded EPICS) or other Embedded EPICS Systems
- Serial (Asynchronous)
- GP-IB
  - Widely used
- Ethernet
  - Widely used
- VXI/MXI
  - For BPM
- ARCNET
  - For Magnet Power Supply

# ARCNET and Magnet Power Supply

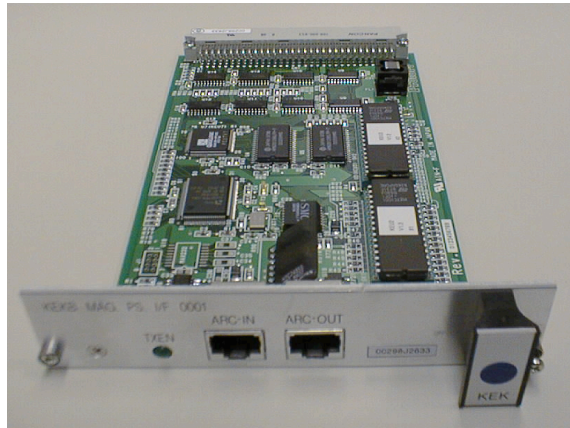


# Version up of the interface for Magnet Power Supply

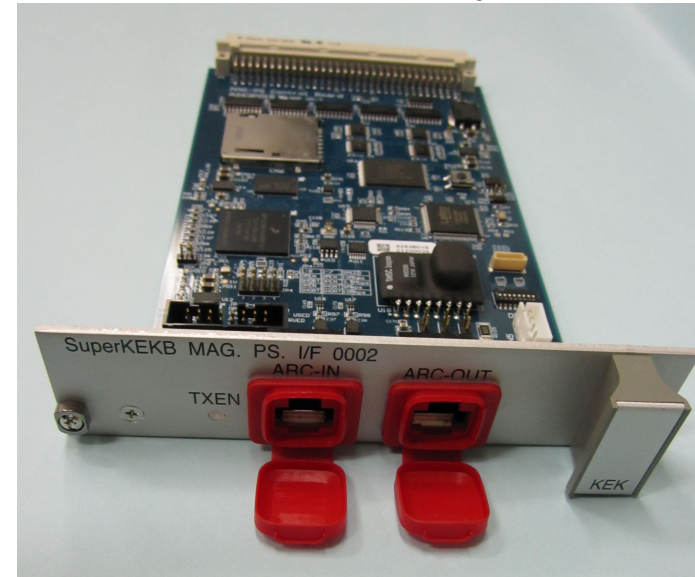
- PSICM (Power Supply Interface Controller Module)
  - Interface/Controller card plugged in power supply
    - Microprocessor is embedded
    - ARCNET controller and driver
    - Timing signal input to start synchronous ramping
  - New version of PSICM
    - Support high speed communication (10/5/2.5Mbps)
    - Support high resolution Power Supply (24/20/18/16bits DAC)
    - Fully compatible to the current version for the Magnet PS
    - Redundant timing signals
    - More reliable connectors

# New Version of PSICM

Old Version



New Version (Prototype)



Connector Protection against dust is available. (option)



# Bucket Selection System

- Complicated Task for positron injection
  - Damping Ring

- Start Designing

- Expansion of delay time,  $500\mu\text{s} \Rightarrow 2\text{ms}$
  - Phase shift for RF at 2<sup>nd</sup> half of Linac

Discussion with related groups is important.

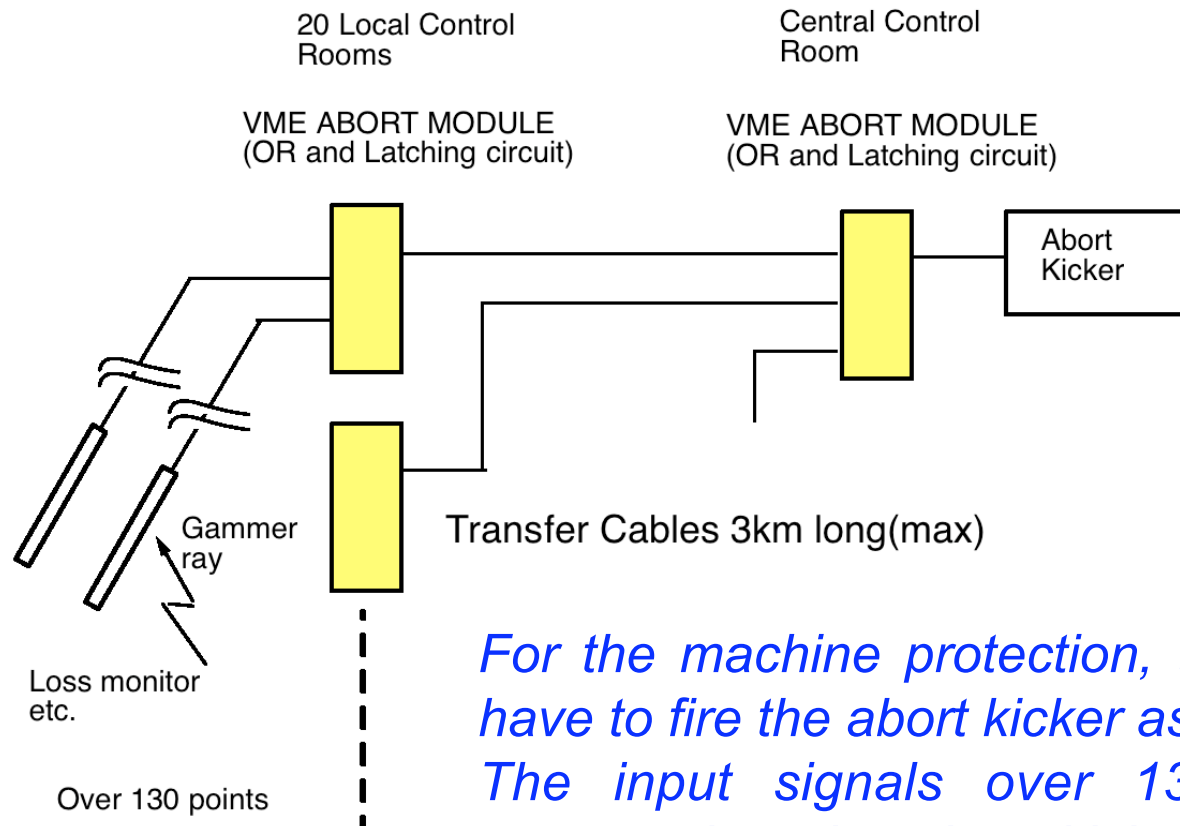
Linac Control Group / RF Group / Operation Group

- Test and Evaluation of modules

- Reflective Memory Module: VMIVME-5655
  - Event System Module: EVG, EVR

# Beam Abort System

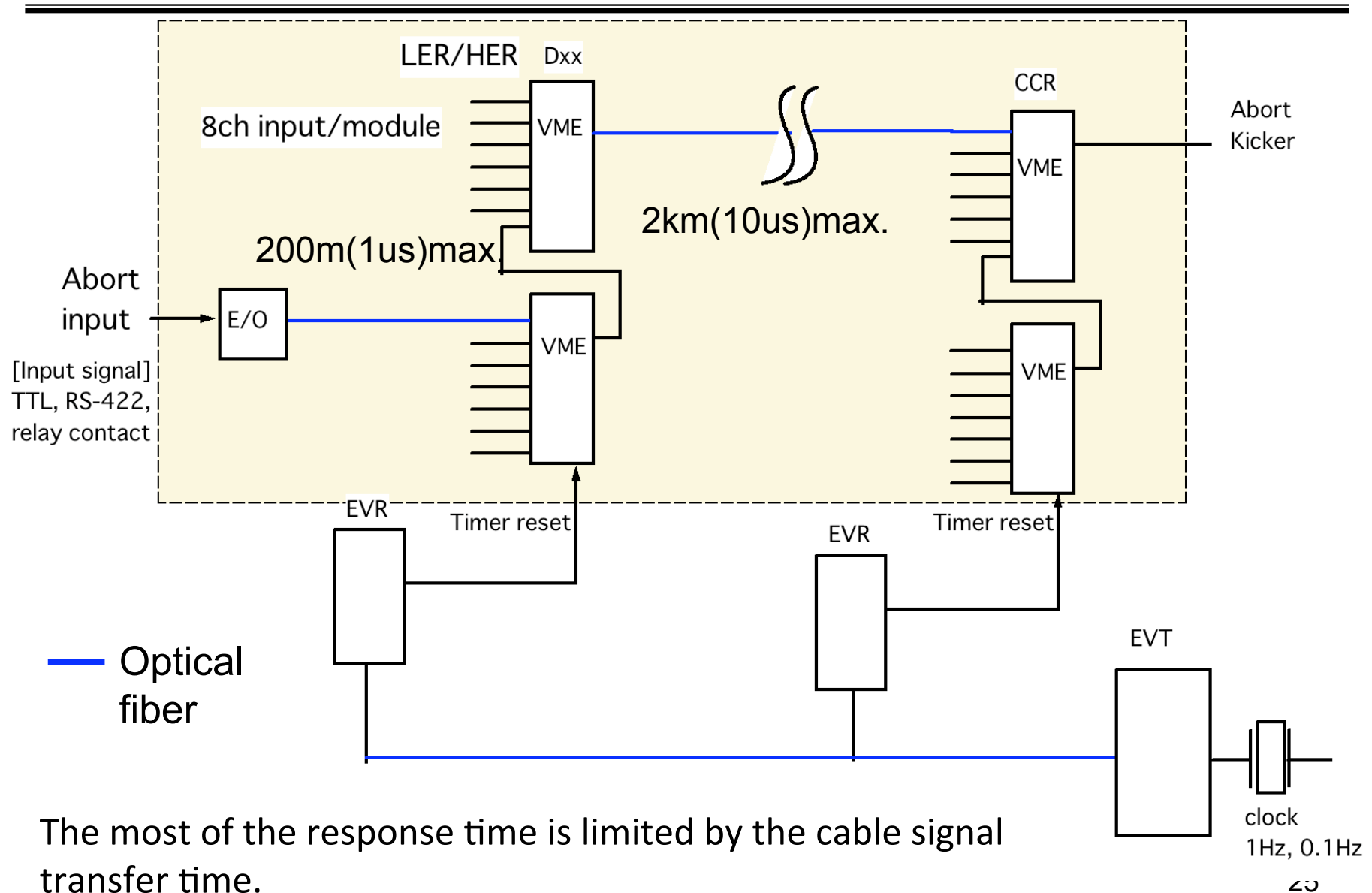
T. Naito, A. Akiyama



*For the machine protection, the beam abort system have to fire the abort kicker as soon as possible. The input signals over 130 points are directly converted to the abort kicker trigger signal through the star connected optical fibers without any delay except for the cable delay. The response time of system is less than 20us from the input to the beam abort.*



# System configuration of the beam abort



# *Improvement from the KEKB abort system*

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## **1. Response time from the input to the beam abort**

*100us -> 20us. Previous system used low pass filters for the noise reduction, which increased the response time.*

## **2. Optical fiber connection**

*Three kinds of signals(TTL, RS422, Relay contact) convert to optical signals to avoid the electrical noise. Control group maintains the signal transfer quality.*

## **3. Time stamp**

*In the most of the case, the beam abort are not only one input signal but also many dependent signals. To find out the source of the beam abort, the time stamp function is added to the VME-AM, which can store the time of the abort signal with 0.1us resolution.*

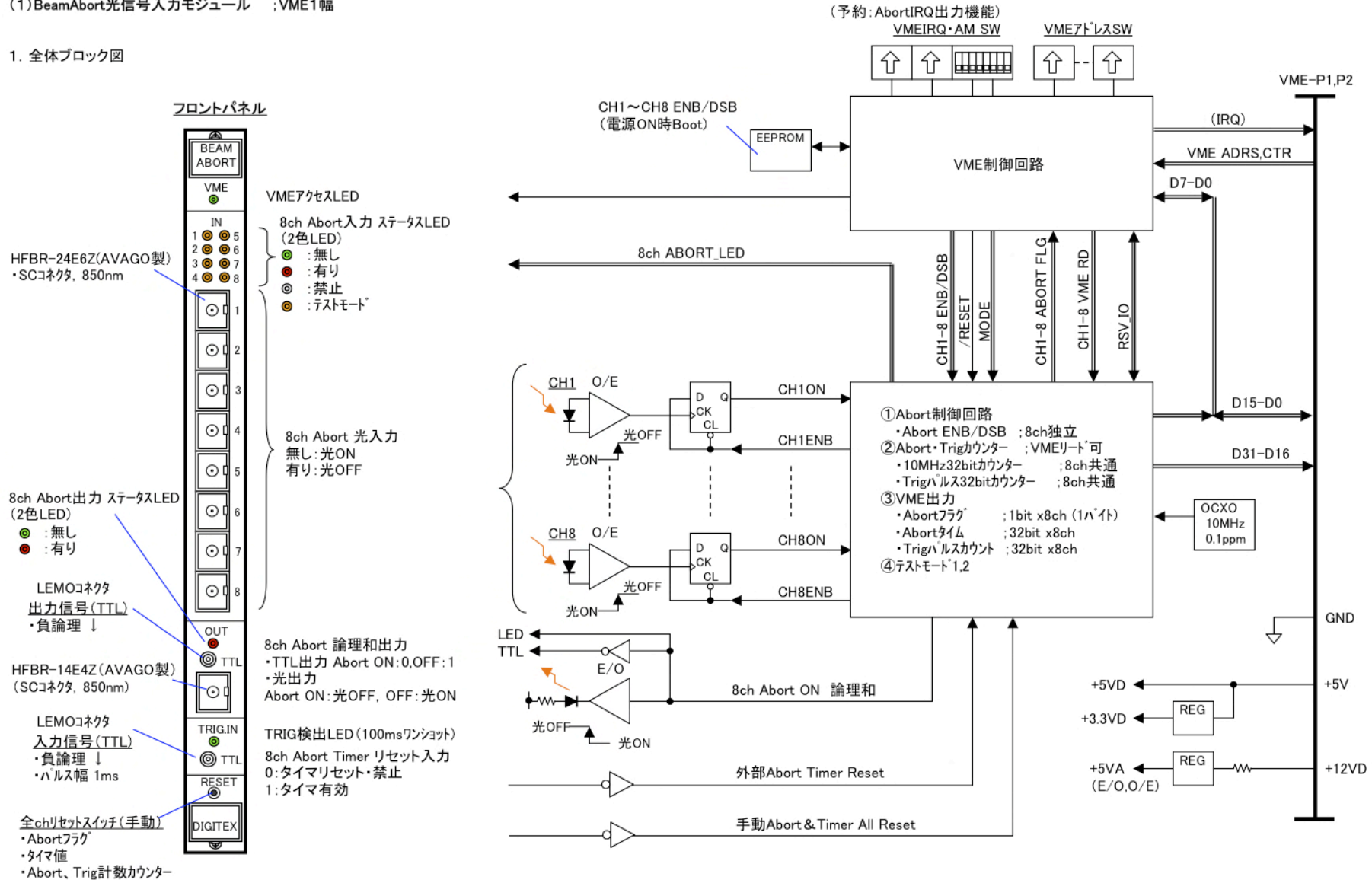
## **4. System check**

*To increase the reliability of this system, the system check function is installed to the VME-AM.*

# VME-AbortModule(VME-AM)

(1) BeamAbort光信号入力モジュール ; VME1幅

## 1. 全体ブロック図



# Other Issues

- Operation Consoles
  - Start designing
    - Choice of the console terminals
    - Layout of the Central Control Room
- EPICS Standard Tools
  - CSS (Control System Studio)
    - Evaluation, Customize, Deployment
- Operation Log
  - “Zlog” : Zope based web application
- EPICS Training
  - Training Course
  - Training Materials

# Man Power

- There are still many things to do.
- Toward T=0, more and more software developments increase.
  - More Outsourcing (?)
- KEKB Control Members
  - T. T. Nakamura
    - Magnet Control, Database, Python, Archiver, ...
  - M. Iwasaki
    - Network, Server Computers, Interface to Belle II, ...
  - H. Kaji
    - Timing, Bucket Selection, Wire Scanner Control, ...
  - A. Akiyama
    - VME, PSICM/ARCNET, Embedded Controller, ...
  - J-I. Odagiri
    - PLC/F3RP61, Vacuum Control, RF Control, ...
  - T. Naito (Not full time)
    - Beam Abort System
- We need new young people !

Thank you !

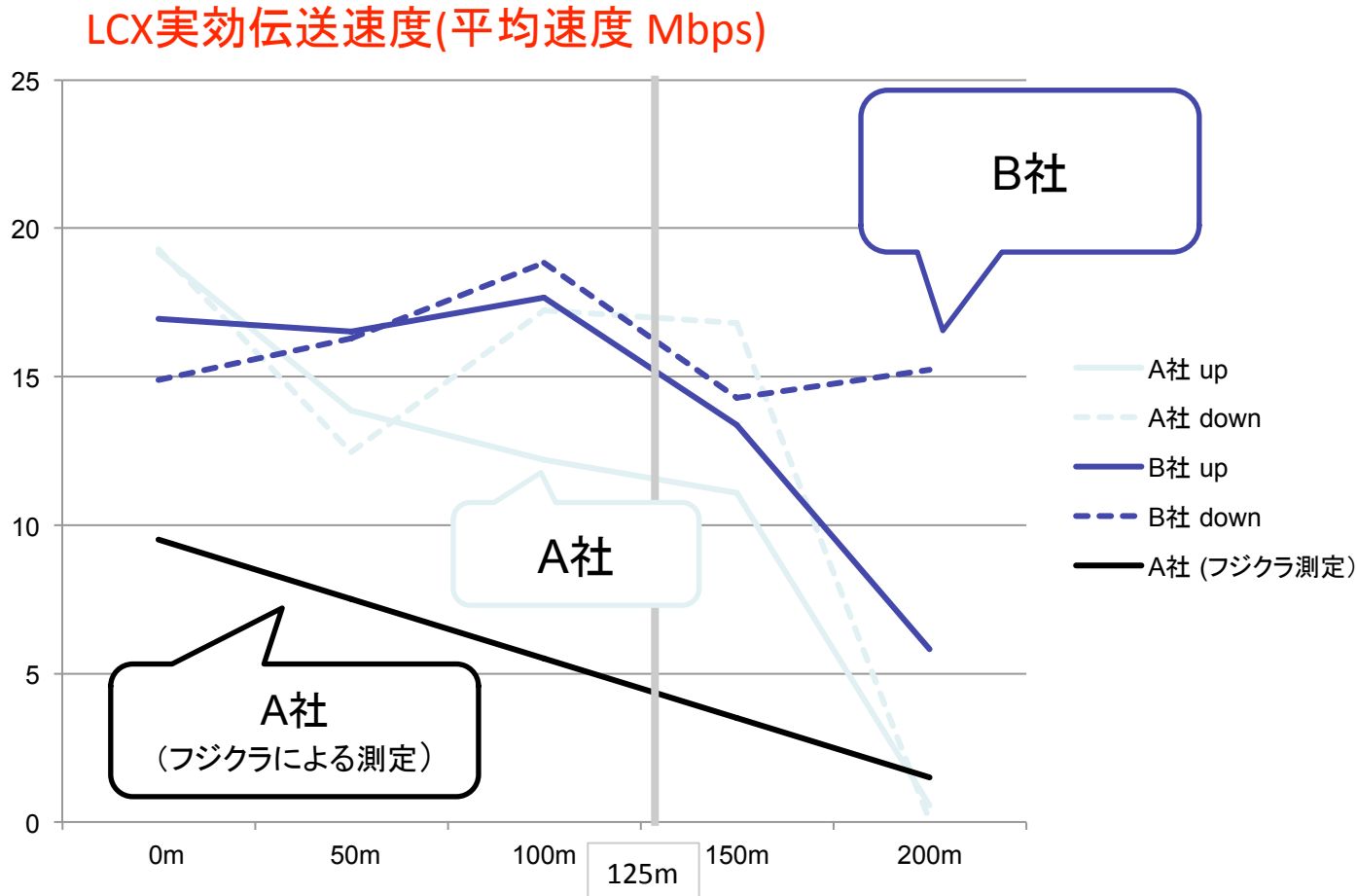


backup



# ネットワーク速度測定結果

3) 既設AP(A社)とB社製APとの比較 (制御netに接続せず、localで測定)



Localの測定だと、A社製APとB社製 APの差は少ない

# ネットワーク速度測定結果

## 4) 既設AP(A社)とB社製APとの比較 (制御netに接続したとき)

