F3RP61-based Embedded IOCs for Accelerator Controls at KEK

Kazuro Furukawa

< kazuro . furukawa @ kek . jp >

For KEKB and Linac Control Groups

Jun.10.2009.
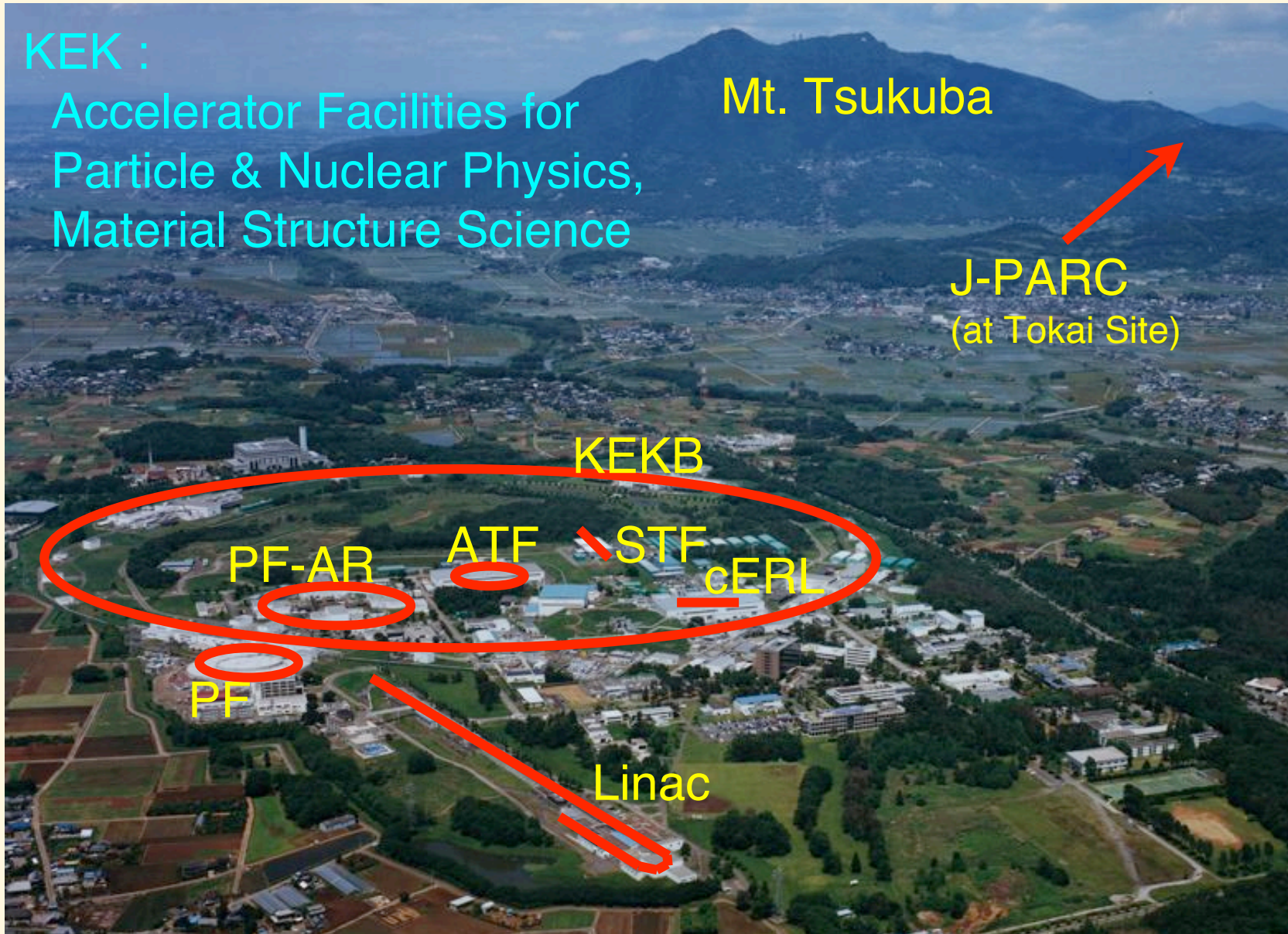
KEK :
Accelerator Facilities for
Particle & Nuclear Physics,
Material Structure Science

Mt. Tsukuba

J-PARC
(at Tokai Site)

KEKB

ATF   STF

PF-AR   cERL

PF

Linac

(Initial) PLC usage at KEK

◆ **At e⁻/e⁺ Linac**

❖ **We enforced that all the new controllers should be connected over IP/Ethernet since 1993 (instead of other field networks)**

❖ **PLC was much cost-effective compared with VME**

¤ **if the speed requirement allows**

❖ **Products from OMRON, Mitsubishi, Yokogawa, etc. were installed**

¤ **Only Yokogawa (FAM3) remained and others were removed, because maintenance capability over network was better**

◆ **Ladder software downloadable over IP/Ethernet, etc.**

◆ **(Recently Mitsubishi also added that feature)**

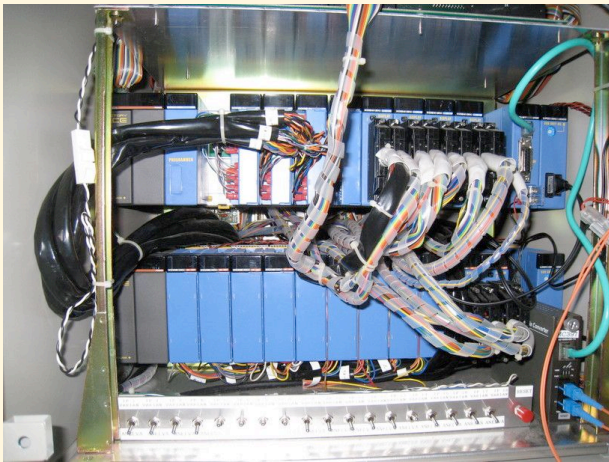❖ **170 PLCs (with Ethernet) used for RF, Magnets, Vacuum, (Safety), etc**

◆ **At J-PARC**

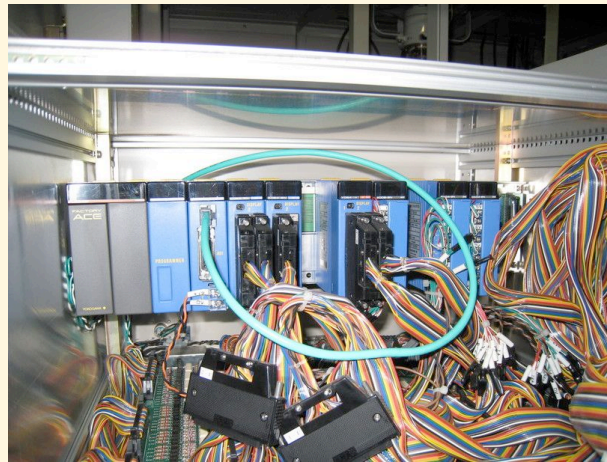❖ **Many installations with the same reasons as e-Linac**

◆ **At KEKB**

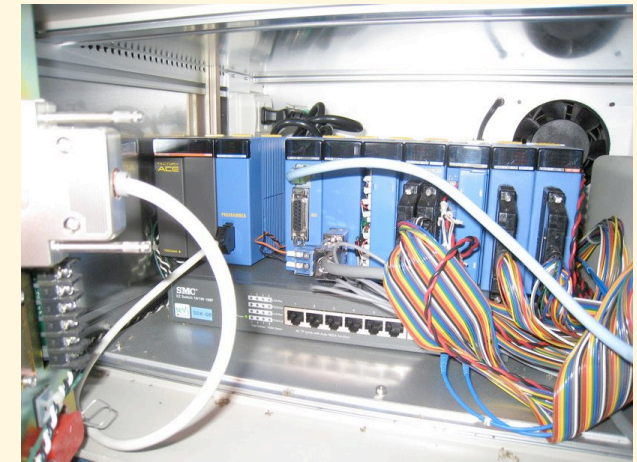❖ **Used indirectly at many devices, over serial or GPIB links**
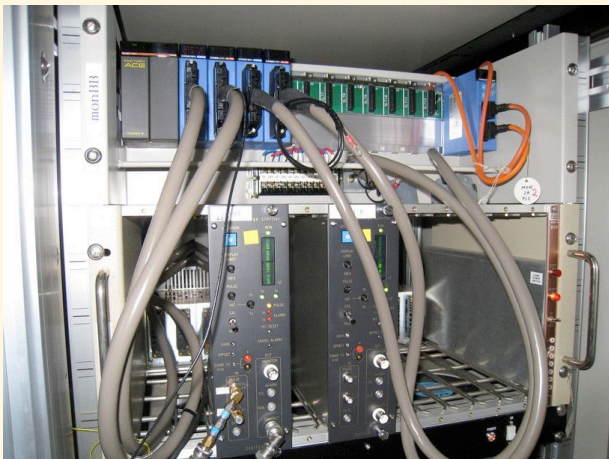
◆ **Even custom hardware modules can be designed (I/O Open)**

Vacuum Controller Internal

Magnet Controller Internal

RF Controller Internal

Safety Controller

Touch Panel Display for RF

Software management with PLCs

◆**Ideal at the beginning**

❖**Separate software development at control group, at equipment group, or at industrial company**

❖**Later, integration test with IP/Ethernet**

◆**Logic management, however**

❖**Same logics could be placed at ladder software, in EPICS database/sequencer (or in high-level applications)**

◆**Speed requirement**

❖**Closed loop over Ethernet was slow, sometimes un-reliable**

❖**Interrupts were possible, but slow and complicated**

◆**Thus, hoped to run EPICS on PLC**

EPICS on PLC

◆**VxWorks CPU was available on PLC (Yokogawa, Mitsubishi)**

  ¤ **Besides normal sequence / ladder CPU**

◆**Yokogawa starts to provide Linux (2.6) on PLC CPU (F3RP61)**

  ❖**Brave enough to choose open source environment**

    ¤ **We negotiate with Yokogawa to remove any license issues**

  ❖**Odagiri/KEK, Uchiyama/SHI-RIKEN, Yamada/KEK made much effort to realize EPICS implementation, (but no need for asynchronous records)**

  ❖**Takuya-Nakamura/MSC-KEK, et al, tailored the environment for KEKB**

    ¤ **Procserv, pcmon, NFS, …**

◆**Four F3RP61-based IOCs are used in KEKB operation**

  ❖**Three since September 2008, and another later, four in total**

  ❖**Beam mask controllers and Pulsed-quad controllers**

  ❖**No trouble at all, they run more than 8 months**

◆**~20 new IOCs are also used in J-PARC operation now**

F3RP61 (e-RT3 2.0)

Linux 2.6.24

PPC 533MHz

128Mbyte RAM

100BaseTx x2

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
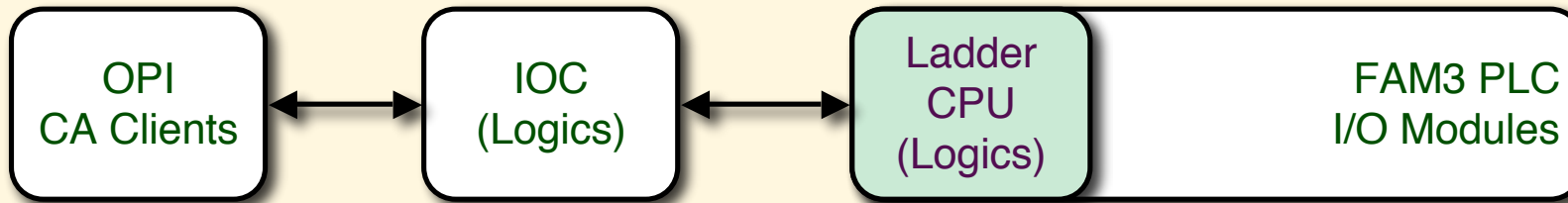
Software development environment (ELDK)
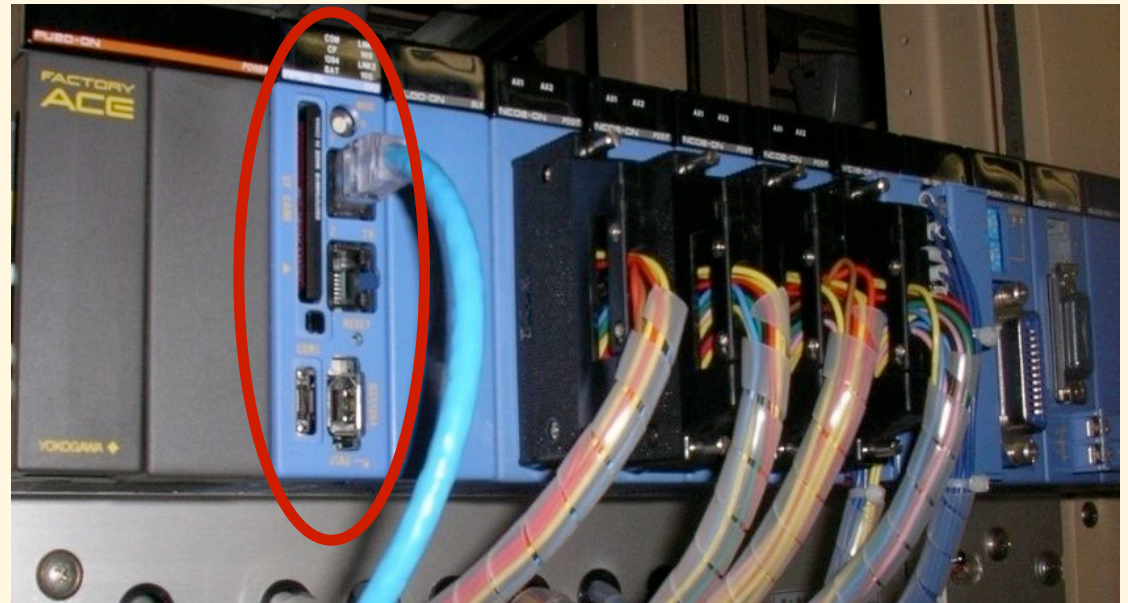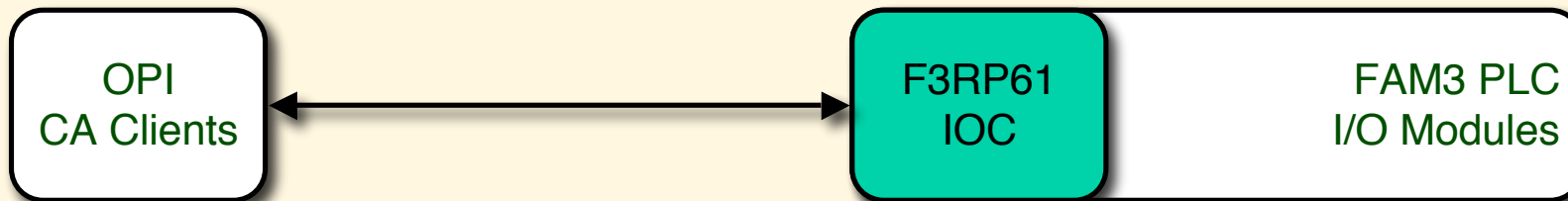

KEKB Beam mask controller

Simple Usage under EPICS
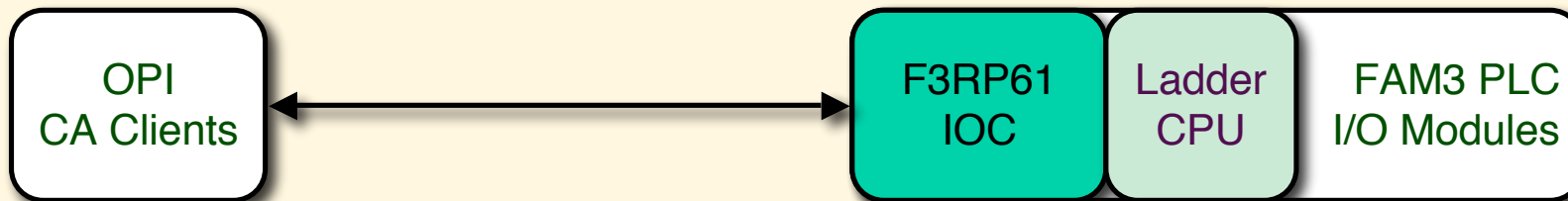
Conventional PLC usage   with asynchronous access

| OPI CA Clients | ◄──► | IOC (Logics) | ◄──► | Ladder CPU (Logics) | FAM3 PLC I/O Modules |

PLC usage with F3RP61   with only synchronous access and maybe with sequencer

| OPI CA Clients | ◄──► | F3RP61 IOC | FAM3 PLC I/O Modules |

If necessary, we can combine

| OPI CA Clients | ◄──► | F3RP61 IOC | Ladder CPU | FAM3 PLC I/O Modules |

Device Support

◆**No need for asynchronous access**
  ❖**Direct access to all I/O modules**

◆**Can access to registers on ladder CPU**
  ❖**If necessary**

◆**Interrupts also possible**

◆**Logics can be database links or sequencers**

◆**Did extend the number of EPICS developers**

◆**Source code and documents**
  ❖**http://www-linac.kek.jp/cont/epics/f3rp61/**

  ❖**Local development, PREEMPT_RT realtime (Yamada, et al)**

Other EPICS Development Activities at KEK

◆ **By A. Akiyama, et al**
  ❖ **Embedded IOC on FPGA-based controller**

◆ **By M. Satoh, et al**
  ❖ **Embedded IOC on oscilloscopes**

◆ **By A. Kazakov, et al**
  ❖ **Redundant IOC (RIOC with OSI supports)**
  ❖ **Redundant caGateway**
  ❖ **ATCA IOC with HPI/SAF support for RIOC**
    ✦ **ATCA for STF/ILC-LLRF and μTCA for ERL-LLRF**
  ❖ **Automatic test system environment**

◆ **By K. Zagar, et al**
  ❖ **Wireshark protocol analyzer for CA**

◆ **By K. Furukawa, et al**
  ❖ **Event-based fast control system**
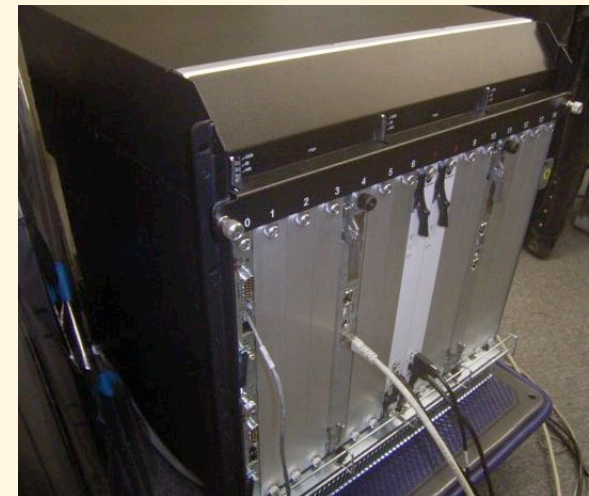
Summary

◆**Many PLC systems are used at KEK**

◆**PLC-embedded IOCs simplified the EPICS control architecture at KEK**

◆**FAM3-RP61 will replace some of VME IOCs**
❖**RP61s behave like VME with embedded IOC and IO open modules**

Thank you