

DESIGN OF RELIABLE CONTROL WITH STAR-TOPOLOGY FIELDBUS COMMUNICATION FOR AN ELECTRON CYCLOTRON RESONANCE ION SOURCE AT RIBF



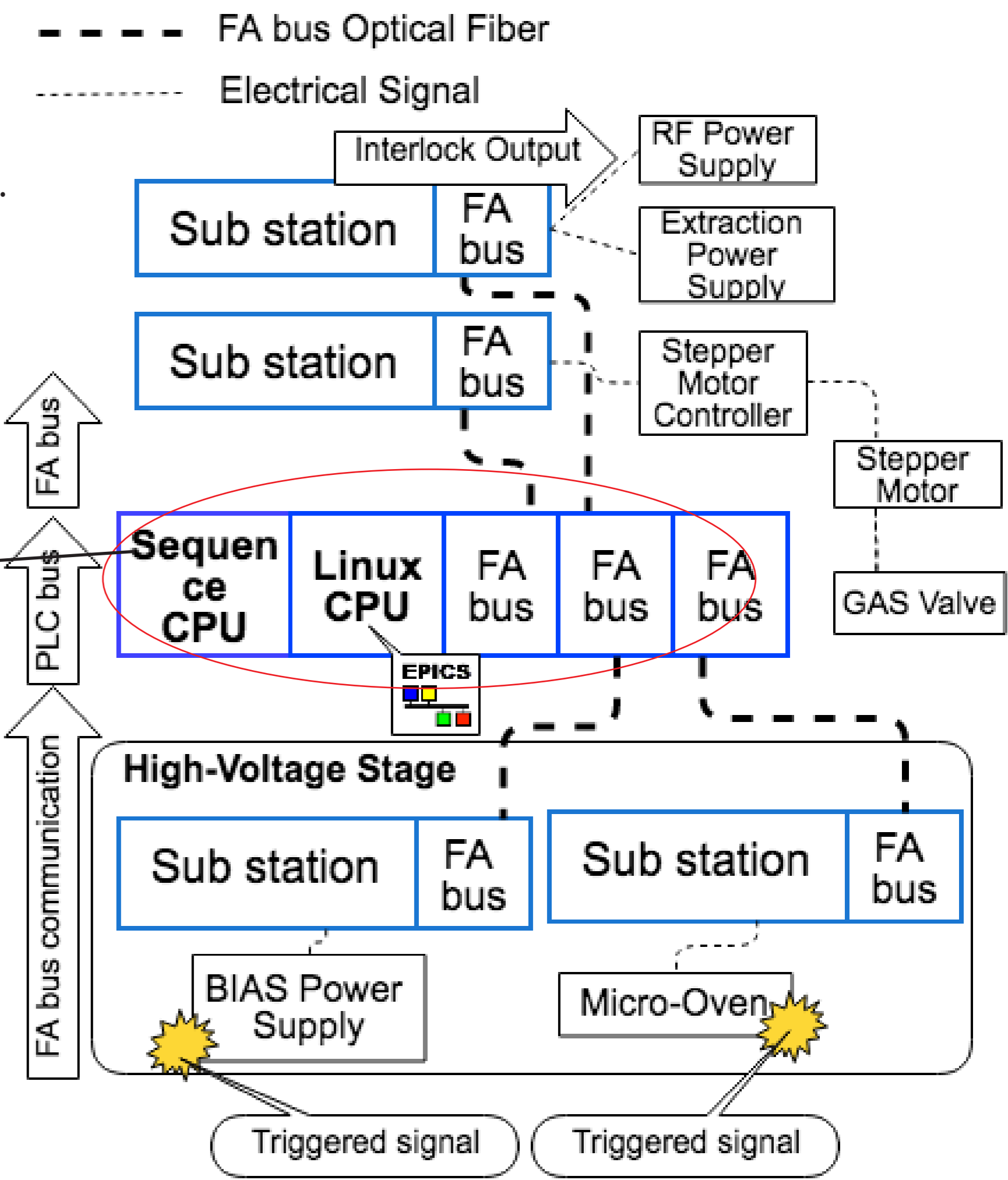
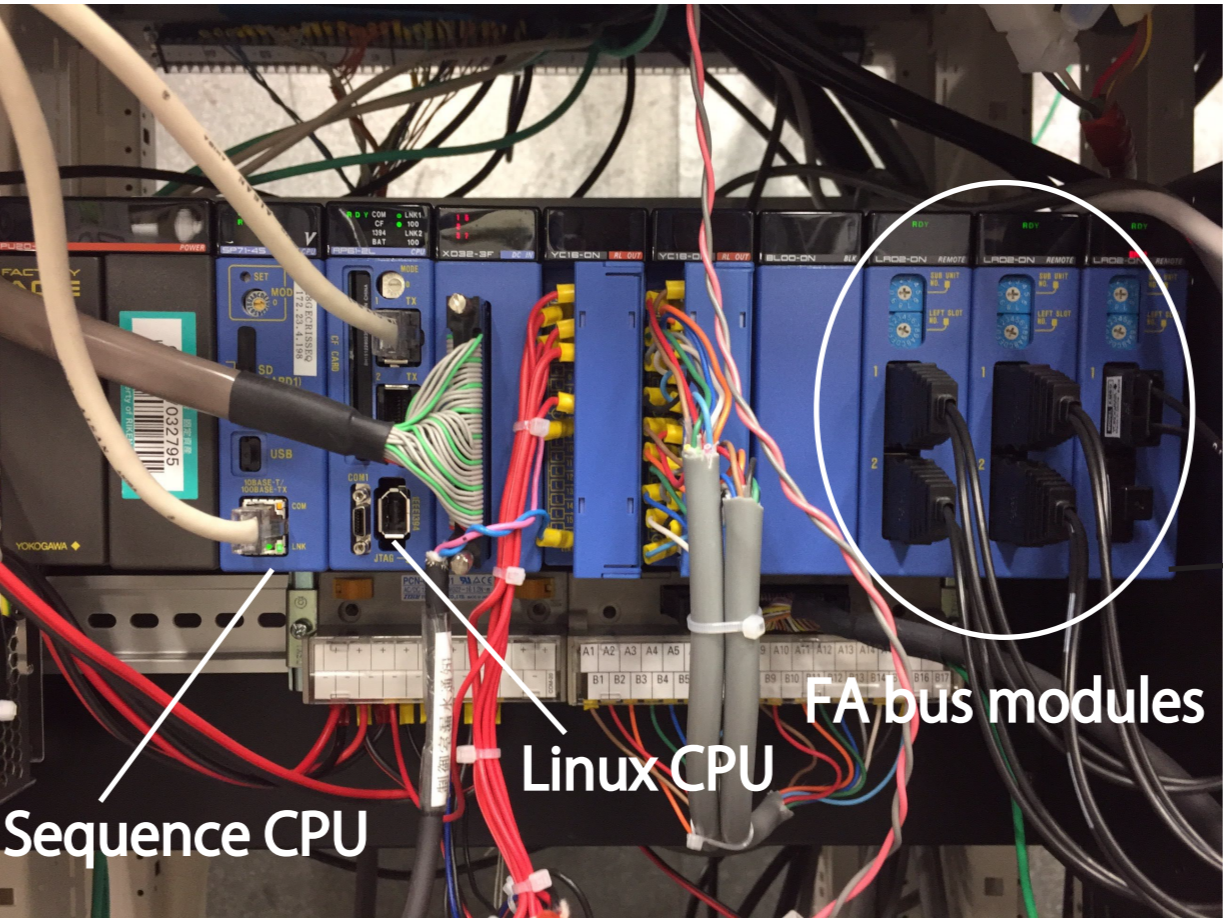
© A. Uchiyama#, T. Nagatomo, Y. Higurashi, J. Ohnishi, T. Nakagawa, M. Komiyama, N. Fukunishi (RIKEN Nishina Center)
H. Yamauchi, M. Tamura, K. Kaneko (SHI Accelerator Service, Ltd.)

Abstract

In the RIKEN Radioactive Isotope Beam Factory (RIBF) project, a superconducting linear accelerator has been implemented in order to enhance the beam energy necessary for promoting super-heavy element search experiments. A new 28-GHz electron cyclotron resonance ion source (ECRIS) has been installed upstream of it. Its control system has been planned to comprise the Yoko-gawa FA-M3V series, which is a programmable logic controller (PLC) with Experimental Physics and Industri-al Control System (EPICS) because basically the same control system has been successfully operated for our existing ECRIS control system. However, the existing ECRIS control system with PLCs has a disadvantage of low reliability for communications between PLC stations. In addition, higher expandability is required for the ion-source operation because some devices such as a power supply of oven method are changed depending on types of heavy ions. In the new system, we have designed the control system by utilizing a star-topology fieldbus for communications between the PLC stations to establish safety and expandability.

New SC-ECRIS Control System

- Yokogawa FA-M3V PLC and Linux CPU (F3RP61-2L) provides the operation service by using EPICS.
- New SC-ECRIS is constructed as clone with RIKEN 28-GHz SC-ECRIS**, so the control system should follow the current RIKEN 28-GHz SC-ECRIS control system.
- To solve the disadvantage of RIKEN 28-GHz SC-ECRIS control system, a new SC-ECRIS control system has been designed by implementing two different types of CPUs in the main PLC station.
- ※ First slot : Sequence CPU for interlock, Second slot : Linux CPU for EPICS IOC.**
- FA bus optical fibers are utilized for communication between Linux CPU and PLC substations on high-voltage stage.
- Interlock signal using EPICS CA is NOT reliability, so FA bus is utilized for interlock signal between main station and sub stations on high-voltage stage.

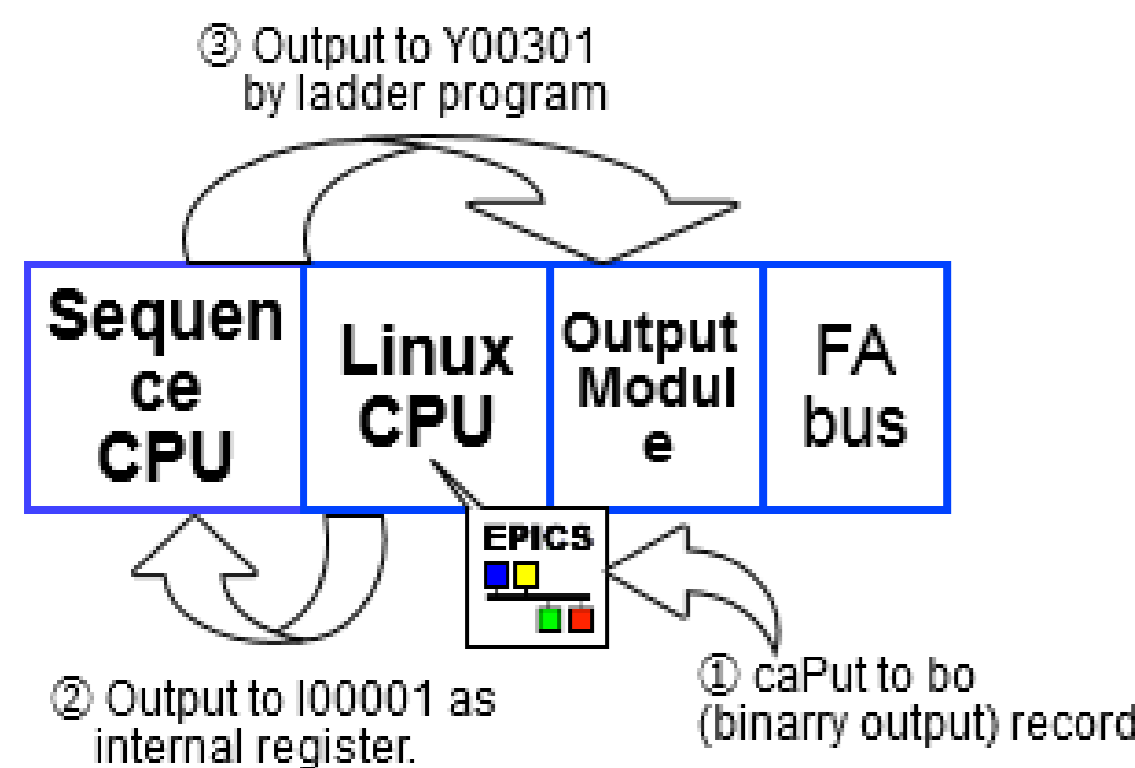


Type of interlock

- Human protection system
 - It has a mechanism to turn off the RF power and power supplies for high-voltage beam extraction when a person enters the ion source room.
 - ※ This interlock system utilizes the opening of doors and entrance information as the triggers.
 - ※ Alert system (warning light) is included in this system.
- Machine protection system
 - The system monitors the cooling water, vacuum condition, etc., and automatically stops the ion source and the devices constituting it, safely in case of abnormality.

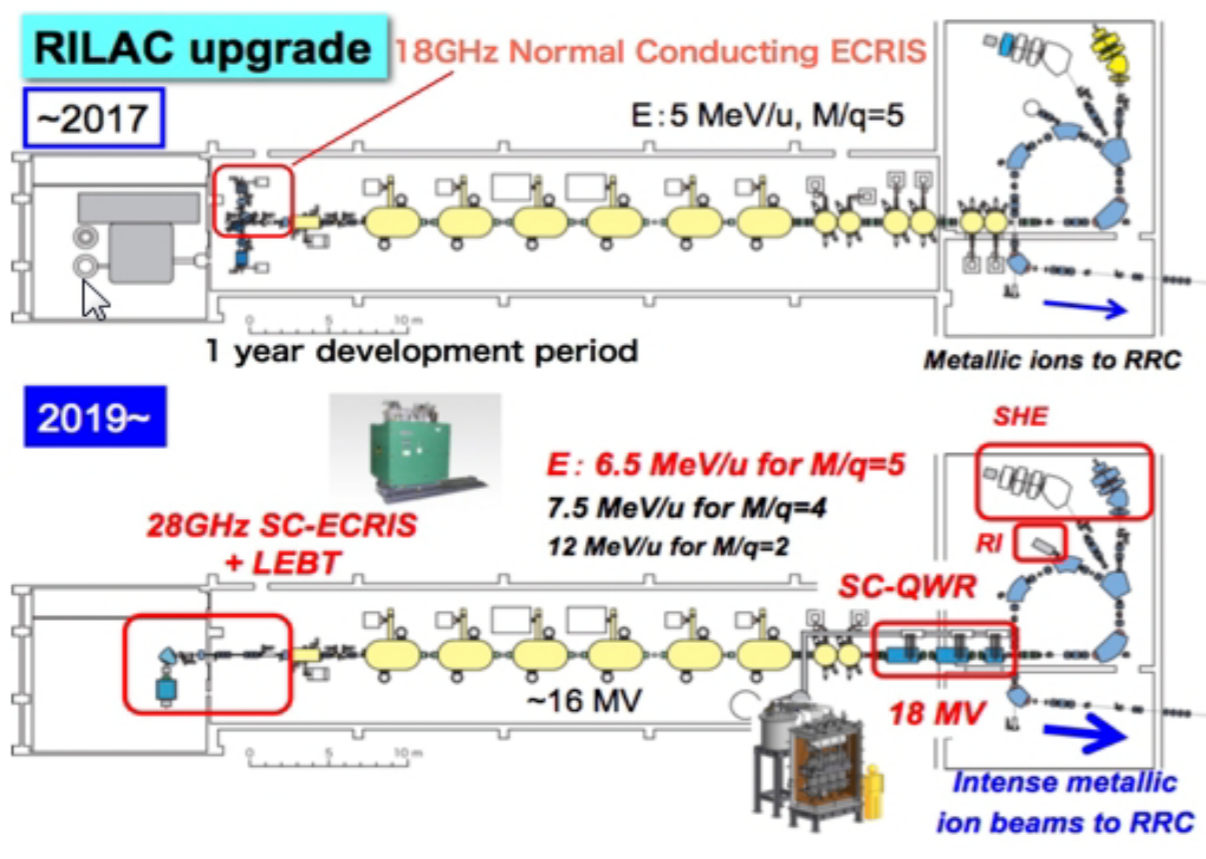


I/O sharing method

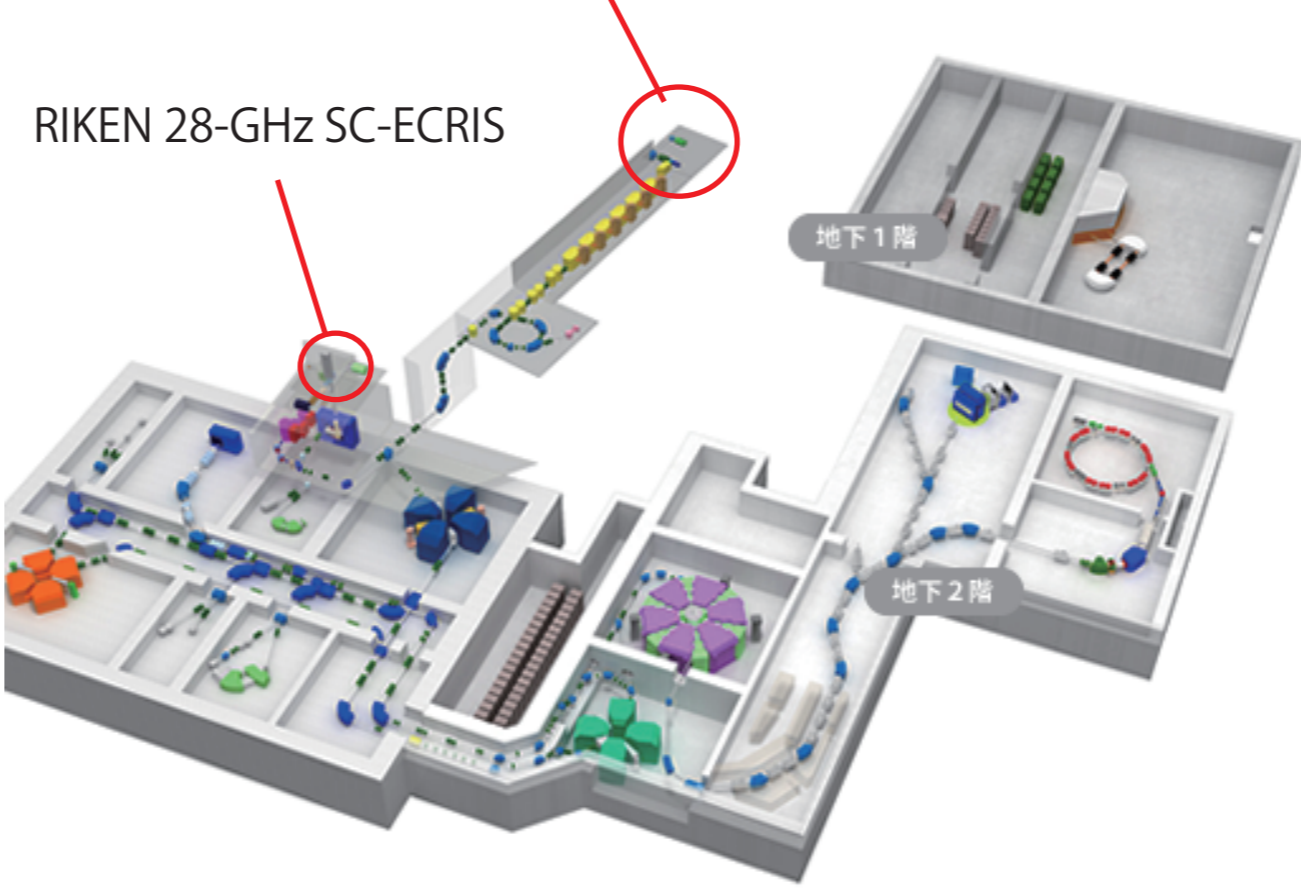


- The feature of the Yokogawa FA-M3V series is that, as a behavior when there are two CPUs, reading can be done from both CPUs unconditionally, but direct instructions to the output module adopt exclusive control.
- When performing output control from the EPICS IOC on the Linux PLC CPU, it will be realized via internal regis-ters of the sequence PLC CPU, for example, I00001.

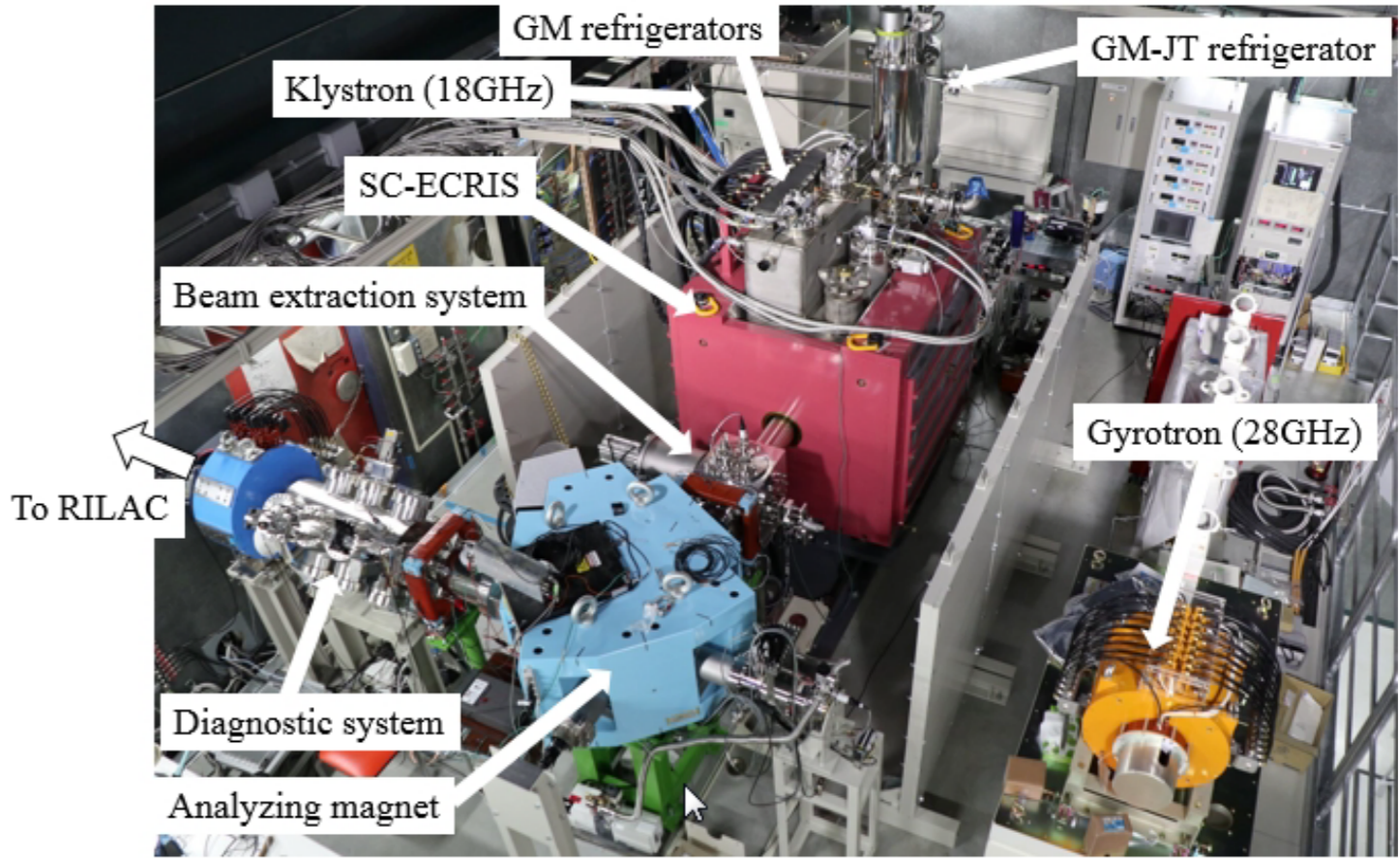
RIBF new project



New SC-ECRIS (clone of RIKEN 28-GHz SC-ECRIS) is here !



Photograph of new SC-ECRIS



RIKEN 28-GHz SC-ECRIS Control System

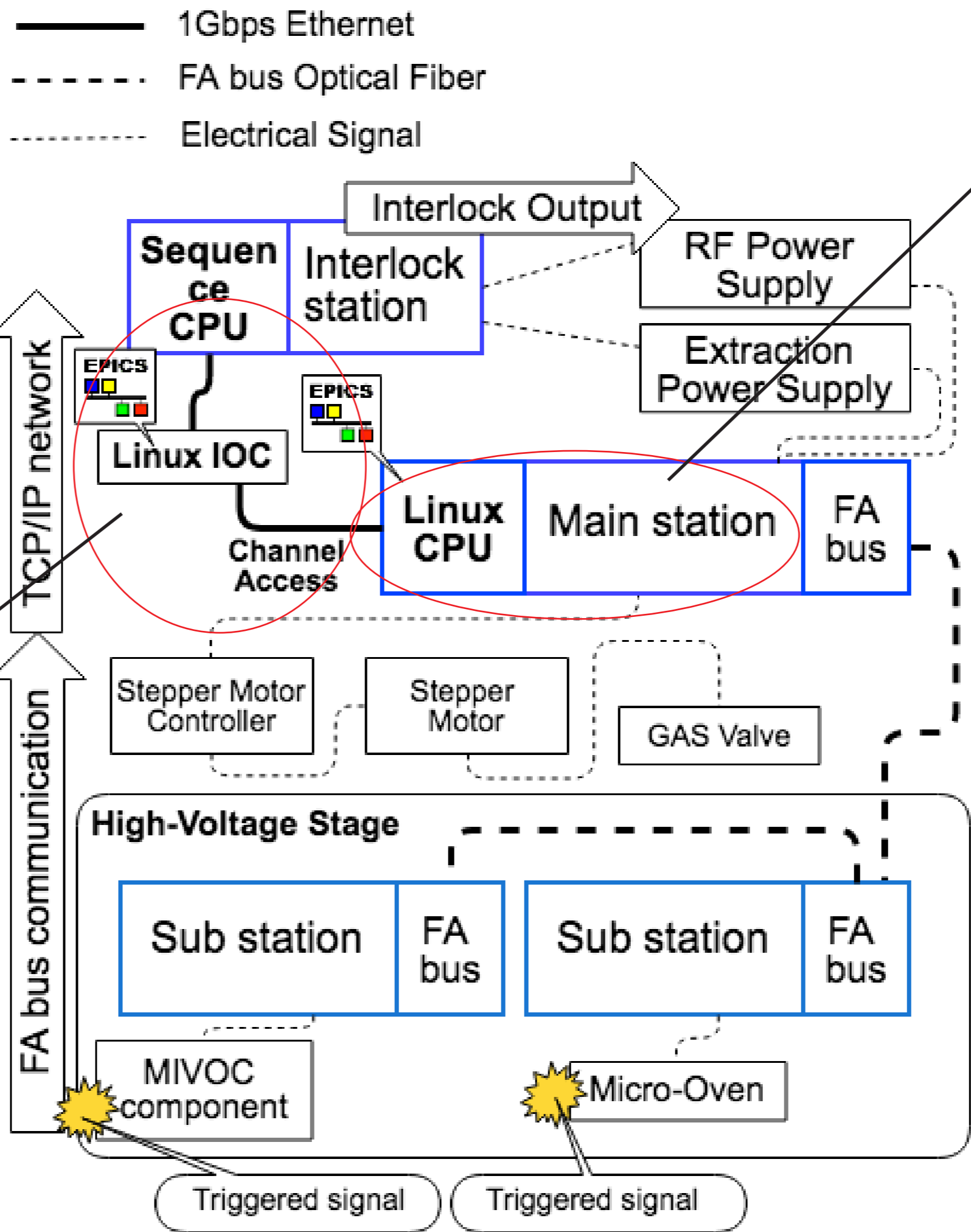
- Yokogawa FA-M3 series and Linux CPU provides the operation service by using EPICS.
- Another PLC with sequence CPU has been installed for interlock system.
- FA bus with optical fibers are utilized for communication between Linux CPU and PLC substations on high-voltage stage.

Disadvantage of RIKEN 28-GHz SC-ECRIS Control System

When using state information of the substation implemented in the high-voltage stage as an interlock signal, this system has the means to exchange signals only by the EPICS CA via the TCP/IP network. In general, the reliability of the CA-based interlock system is not high because of the failure of the network switch in the network route, the problem of slow signal transmission speed compared with the bus access, and the problem of reliability of the EPICS IOC.



New SC-ECRIS (RIKEN 28GHz-ECRIS clone) control system should be solved this disadvantage and construct.



PLC-based system with Linux CPU.
Implementation in 2009 for RIKEN 28GHz SCECRIS.

