

# Control system renewal for efficient operation of RIKEN 18 GHz electron cyclotron resonance ion source<sup>†</sup>

A. Uchiyama,<sup>\*1</sup> K. Ozeki,<sup>\*1</sup> Y. Higurashi,<sup>\*1</sup> M. Kidera,<sup>\*1</sup> M. Komiyama,<sup>\*1</sup> and T. Nakagawa<sup>\*1</sup>

The RIKEN 18 GHz electron cyclotron resonance ion source (18 GHz ECRIS)<sup>1)</sup> is used as an external ion source at the RIBF accelerator complex to produce an intense beam of medium-mass heavy ions. In the RIBF control system, Experimental Physics and Industrial Control System (EPICS) is adapted in order to integrate controllers for operation of power supplies of the magnet, vacuum systems, beam diagnostic system, etc.<sup>2)</sup> However, a non-EPICS-based system has hardwired controllers, and it is used in the 18 GHz ECRIS control system as an independent system. For this reason, an unintegrated control system between the ECRIS and the RIBF accelerator complex causes inefficient cross-operation. For efficient operation of the 18 GHz ECRIS, the control system should be upgraded by a remote control system with EPICS.

Rapid development of the renewal method is necessary because the 18 GHz ECRIS is used for both RIBF injection and standalone experiments at the RILAC. Therefore, we use the 28 GHz SC-ECRIS control system technology<sup>3)</sup> for constructing the 18 GHz ECRIS control system. The control system features are used to adapt the programmable logic controllers (PLCs) to embedded EPICS technology and construct superior client systems. The 18 GHz ECRIS control system includes several types of distributed systems for remote control and Ethernet services. For control of the main devices (e.g., gas valves, 18 GHz ECRIS rod position), a Yokogawa F3RP61-2L module, which acts as an EPICS input/output controller (IOC), is combined with FA-M3 PLCs.<sup>4)</sup> A beam diagnostic system (e.g., Faraday cup, beam profile monitor) is constructed with the EPICS using Linux-based IOCs connected with N-DIMs, which are the original Ethernet-based control devices at the RIKEN Nishina Center.<sup>5)</sup> The negatively biased disk and the oven system are placed in the high-voltage terminal. For components installed at the locations, it is necessary to provide insulation between the controller and components. Consequently, an FA LINK (proprietary specification, Yokogawa Electric Corporation) and optical fibers are adopted for connection with the high-voltage stage (See Fig. 1).

For the software, basic components, such as a data archiver, and a GUI-based operator interface, are implemented as well as RIBF control system. The operational log system<sup>6)</sup> is also adopted for the 18 GHz ECRIS control system. By completely logging 18 GHz

ECRIS operations, for example gas valve and rod position operations, the operational logs can support the generation of ion beams, because the logged data can be used to develop an ion beam.

The 18 GHz ECRIS system can be operated without serious problems. Especially, we successfully achieved stable <sup>48</sup>Ca beams<sup>7)8)</sup> in 2015 using this renewal control system, because a more sensitive operation, for example fine tuning of the MIVOC<sup>9)</sup> temperature and micro-oven<sup>10)</sup> voltage, is possible, which was not the case with the old hardwired control system.

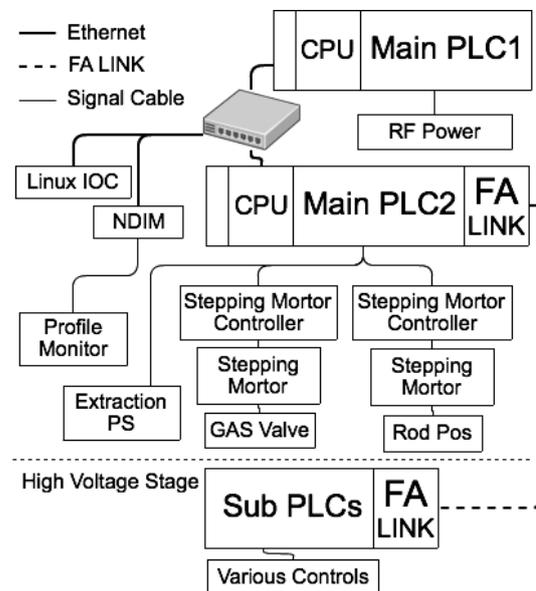


Fig. 1. Outline of the hardware for this renewal system.

## References

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<sup>\*1</sup> RIKEN Nishina Center