Distributed control by EPICS for the SRILAC beam energy position monitoring system using LabVIEW†

T. Watanabe,[*1] A. Kamoshida,[*1,*2] A. Uchiyama,[*1] N. Fukunishi,[*1] R. Koyama,[*3] and K. Kaneko[*3]

For stable operation of the newly constructed Superconducting RIKEN Heavy-ion Linac (SRILAC), nondestructive and highly sensitive measurement using the beam energy and position monitor (BEPM) system is essential.[1,2] A great advantage of this system is that it can handle a time-chopped beam by synchronizing the measurement system with the beam chopping signal. Although the chopped beam intensity is of several electric nA, we can measure the beam position and energy to accuracies of ±0.1 mm and precision in the order of 10^{-4}, respectively.

These measurements and controls are programmed with LabVIEW. Further, by sharing these measured values, such as beam positions and beam energies, with a large-scale EPICS control system, it is easy to obtain the correlation of each relevant machine parameters in time series. A block diagram of the BEPMs and data-acquisition system is shown in Fig. 1. All the modules, including digitizers, multiplexers and a embedded controller, are integrated into a PXI express chassis. The signal process procedures are controlled using the LabVIEW 2020 graphical programming language, and the module drivers are supported by the National Instruments Corporation. The obtained data are shared using CA Lab, which is a user-friendly, lightweight, and high performance interface between the LabVIEW program language and the EPICS-based control system. It allows easy reading and writing of EPICS process variables (PVs). The PVs used by the BEPM system include analog inputs, wave-forms, and analog and binary outputs. The measurement results are displayed on a local remote desktop. Furthermore, once these data are saved to PVs, the Control System Studio (CSS), which is an Eclipse-based tool to operate a large-scale control system, can display the results anywhere in the control room.

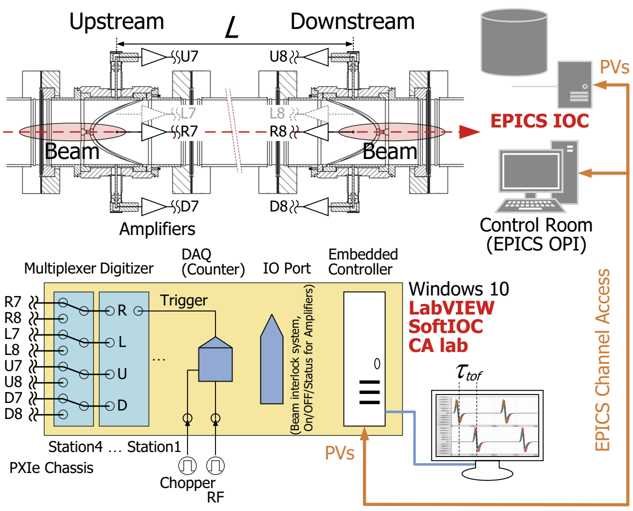

Fig. 1. Block diagram of the BEPMs and DAQ.

Figure 2 shows one example of the measured results, which presents the relationship between the beam position at BEPM 1 and the vacuum between the cryomodules of CM1 and CM2 when the $^{51}V^{13+}$ beam intensity is increased to 2.5 particle μA. Based on this measurement, we established that the vacuum rapidly became worse when the beam position shifted from −1 mm to −2 mm. Therefore, we changed the EPICS interlock system to start the beam attenuator automatically to prevent vacuum deterioration.

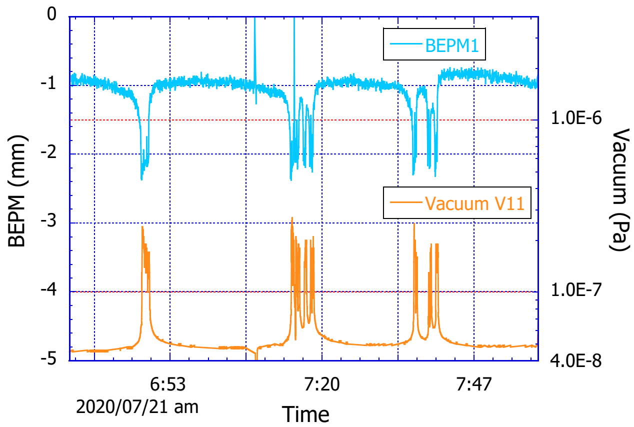

Fig. 2. Measured results showing the relationship between the beam position at BEPM 1 and the vacuum between cryomodules of CM1 and CM2.

We are currently working on measurement of the quadrupole moment to obtain the beam size, beam intensity from the bunched signal, and TOF using a lock-in amp technique.

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*1 RIKEN Nishina Center
*2 National Instruments Japan Corporation
*3 SHI Accelerator Service Ltd.

References
1) T. Watanabe *et al.*, Proc. the 18th Annual Meeting of Particle Accelerator Society of Japan, (Online, Aug. 2021), pp. 683–686.
2) T. Watanabe *et al.*, Proc. 2020 Int. Beam Instrumentation Conf. (IBIC2020), (Santos Brazil, Online, Sept. 2020), pp. 295–302.