

The Development of Linux-based Pulsed Magnet Control System Using PXIe Devices at KEK LINAC

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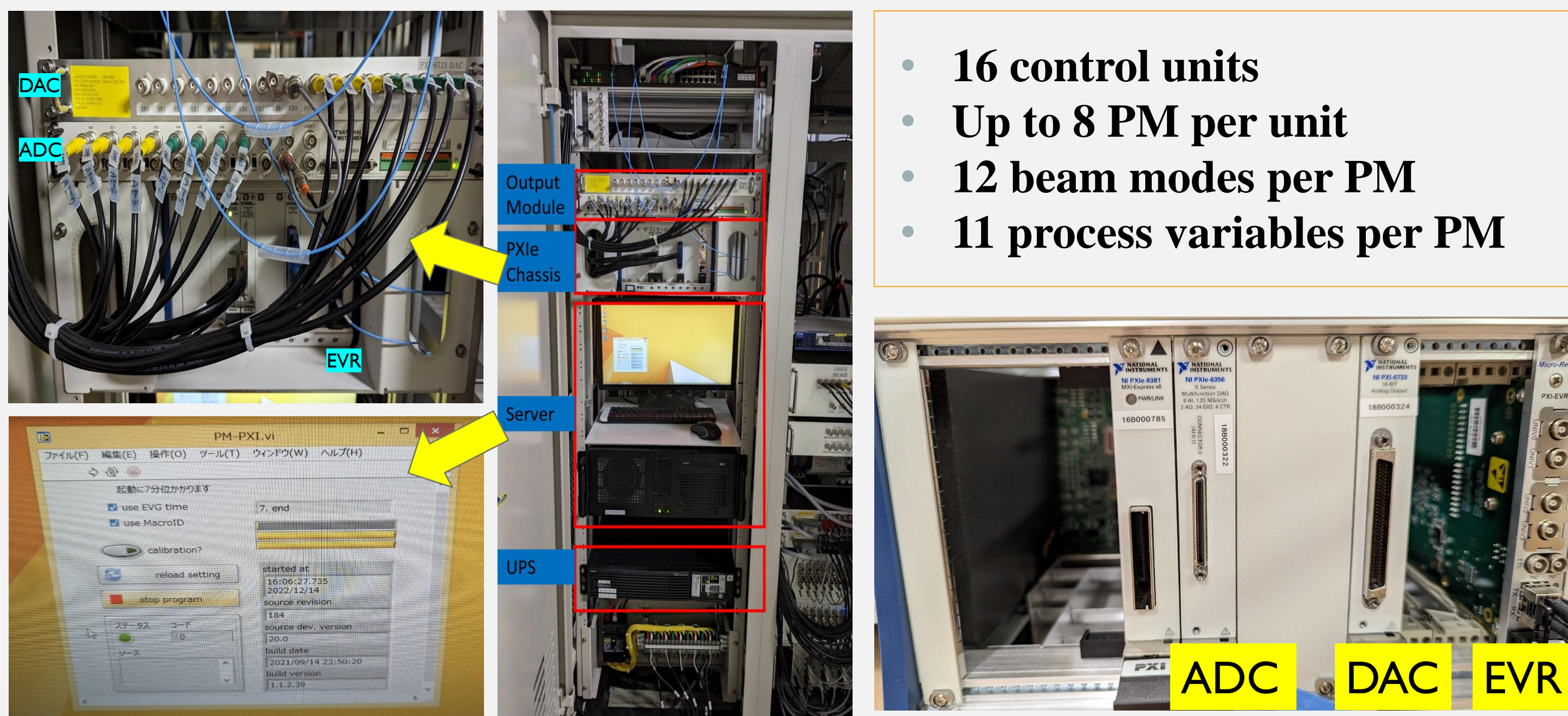
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Abstract

The pulsed magnet control system (PMCS) at KEK electron positron injector LINAC operates at every 20 ms to achieve simultaneous injection for four rings, a 2.5 GeV Photon Factory (PF), a 6.5 GeV PF-AR, a 4 GeV SuperKEKB lower energy ring (LER) and a 7 GeV SuperKEKB high energy ring (HER). The system consists of a control server that operates on the Windows 8.1 platform, in conjunction with a PXIe chassis equipped with a DAC, an ADC, and an event timing module. The PXIe DAC board responds to the trigger signal which is generated from the event receiver and sets the current of the pulsed magnet. The current readback value of the magnet is retrieved from the ADC module. Despite its long success, the PMCS has several problems in use. One is the discontinued support of Windows 8.1. Another key concern is the unsatisfactory long-term stability. To solve the problems, an upgraded system using real-time Linux to communicate with PXIe modules is adopted. The EPICS driver for PXIe devices is developed to integrate with the LINAC control system. The development of the new Linux-based PMCS is introduced in this work.

Current pulsed magnet control system



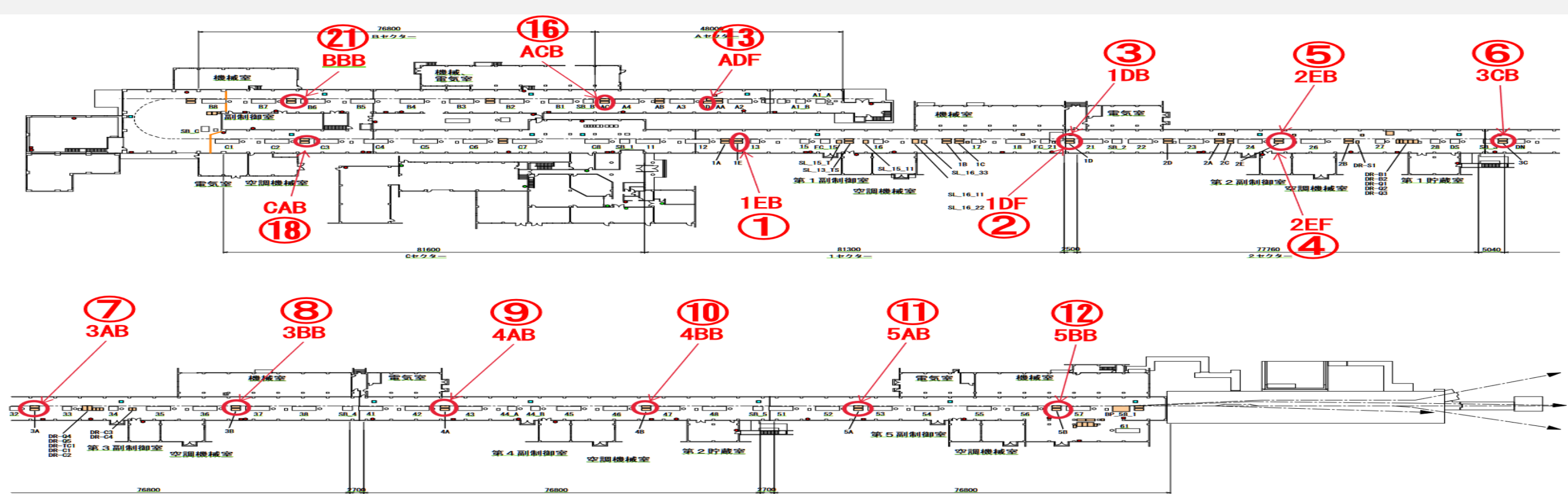
- 16 control units
- Up to 8 PM per unit
- 12 beam modes per PM
- 11 process variables per PM

Windows 8.1 based Pulsed magnet control unit

PXIe chassis and modules

Why upgrade?

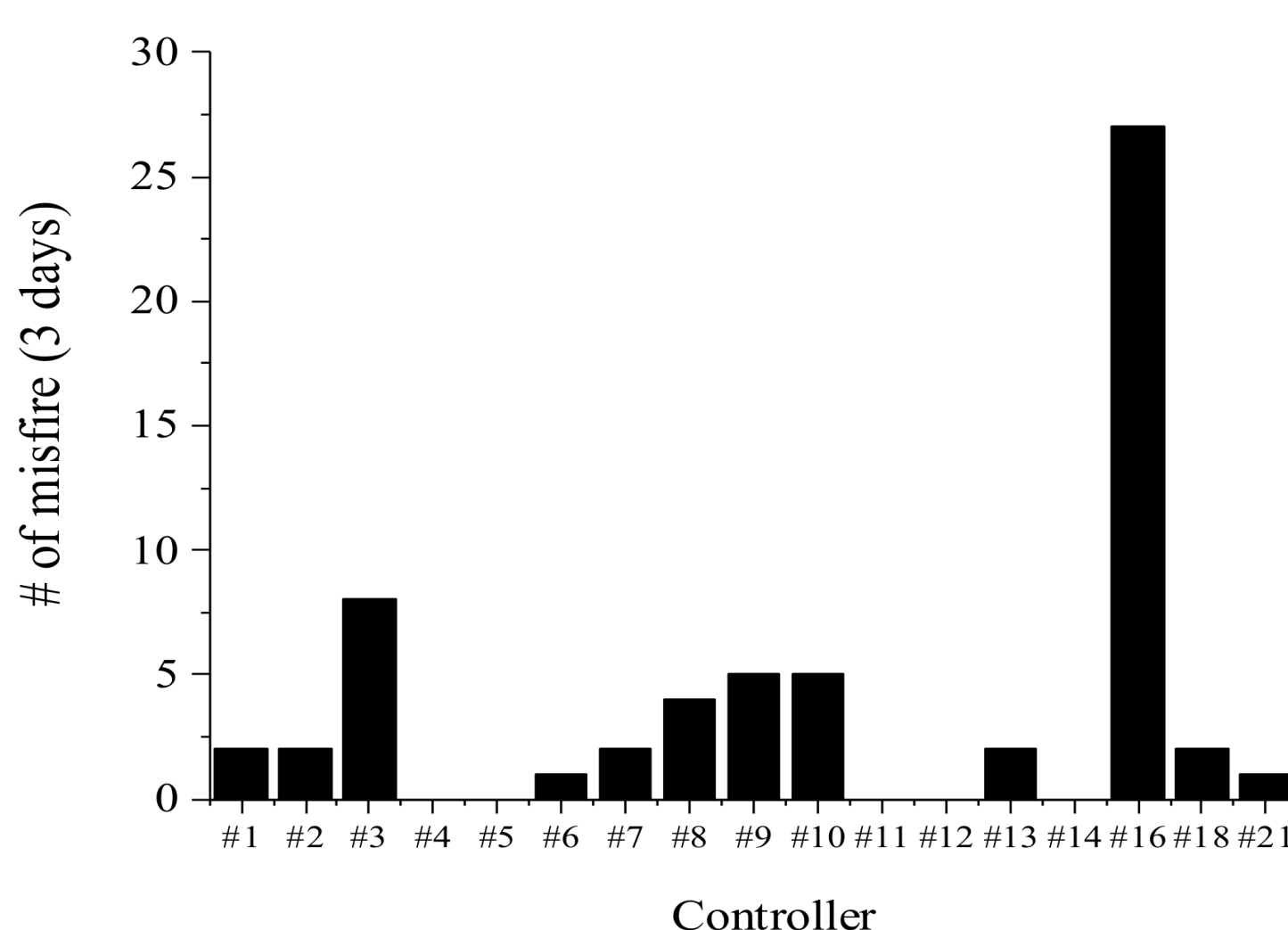
- Windows 8.1 is discontinued.
- The trigger dropping rate is high.
- System restart is required occasionally.
- The compatibility and performance issue of NI network shared variable.



Location of pulsed magnet control units at LINAC

4/9 (木) 18:00 ~ 4/12 (日) 18:00 (72 hours)

• # of pulsed magnet misfire events (operation units): 61
=> 1.2/day/unit (17/day/unit w/ old software)



Misfired events of pulsed magnet units during 2020 operation

- ACC-PM-PC-1 PF/PD/PX/PY_13_5-PX13_2-PX_12_2
- ACC-PM-PC-2 PX/PY_16_5-17_2-17_4
- ACC-PM-PC-3 PF/PD_17_4-PX/PY_18_2-PF/PD/PX/PY_18_4
- ACC-PM-PC-4 PX/PY_21_2-21_4-22_4
- ACC-PM-PC-5 FX/PY_24_4-26_4-PF/PD_28_4
- ACC-PM-PC-6 PF/PX/PY/PD_DC_4-32_4
- ACC-PM-PC-7 PF/PX/PY/PD_34_4
- ACC-PM-PC-8 PF/PX/PY/PD_36_4-38_4
- ACC-PM-PC-9 PF/PX/PY/PD_42_4-44_7
- ACC-PM-PC-10 PF/PX/PY/PD_46_4-48_8
- ACC-PM-PC-11 PF/PX/PY/PD_52_4-54_4
- ACC-PM-PC-12 PF/PX/PY/PD_56_4-58_4
- ACC-PM-PC-13 PB_AT_J1/J5-PX/PY_AT_22-PF/PD/PX/PY_A1_M
- ACC-PM-PC-16 PF/PD/PX/PY_A2_1-PF/PD/PX/PY_TEST_1
- ACC-PM-PC-18 PX/PY_R0_61-R0_63
- ACC-PM-PC-21 PX/PY_R0_01-R0_02

New System

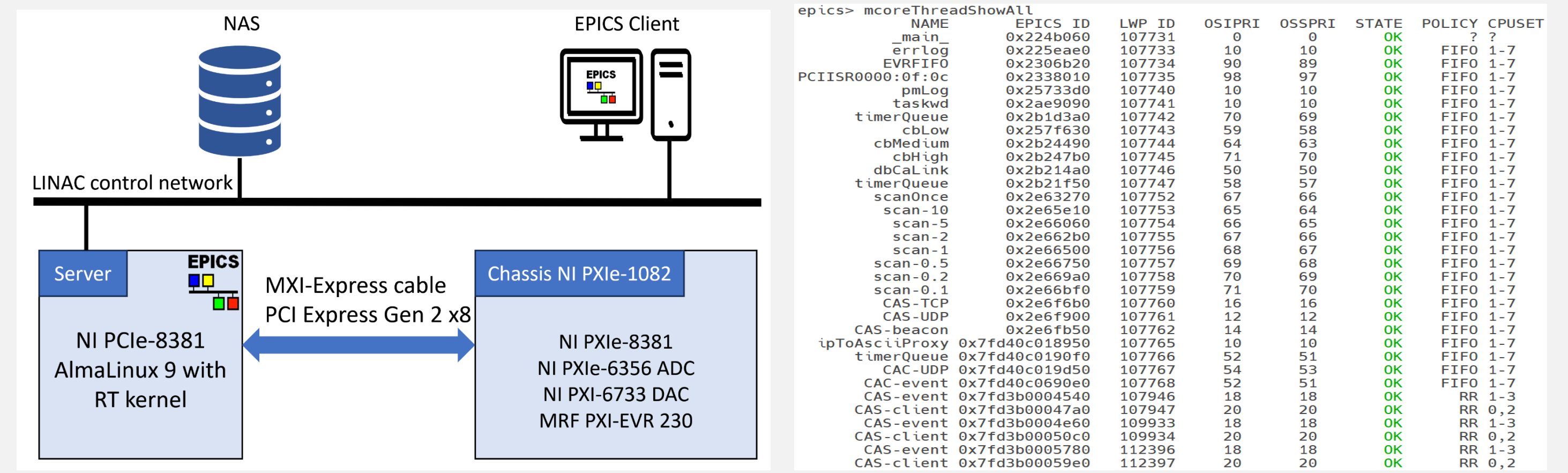
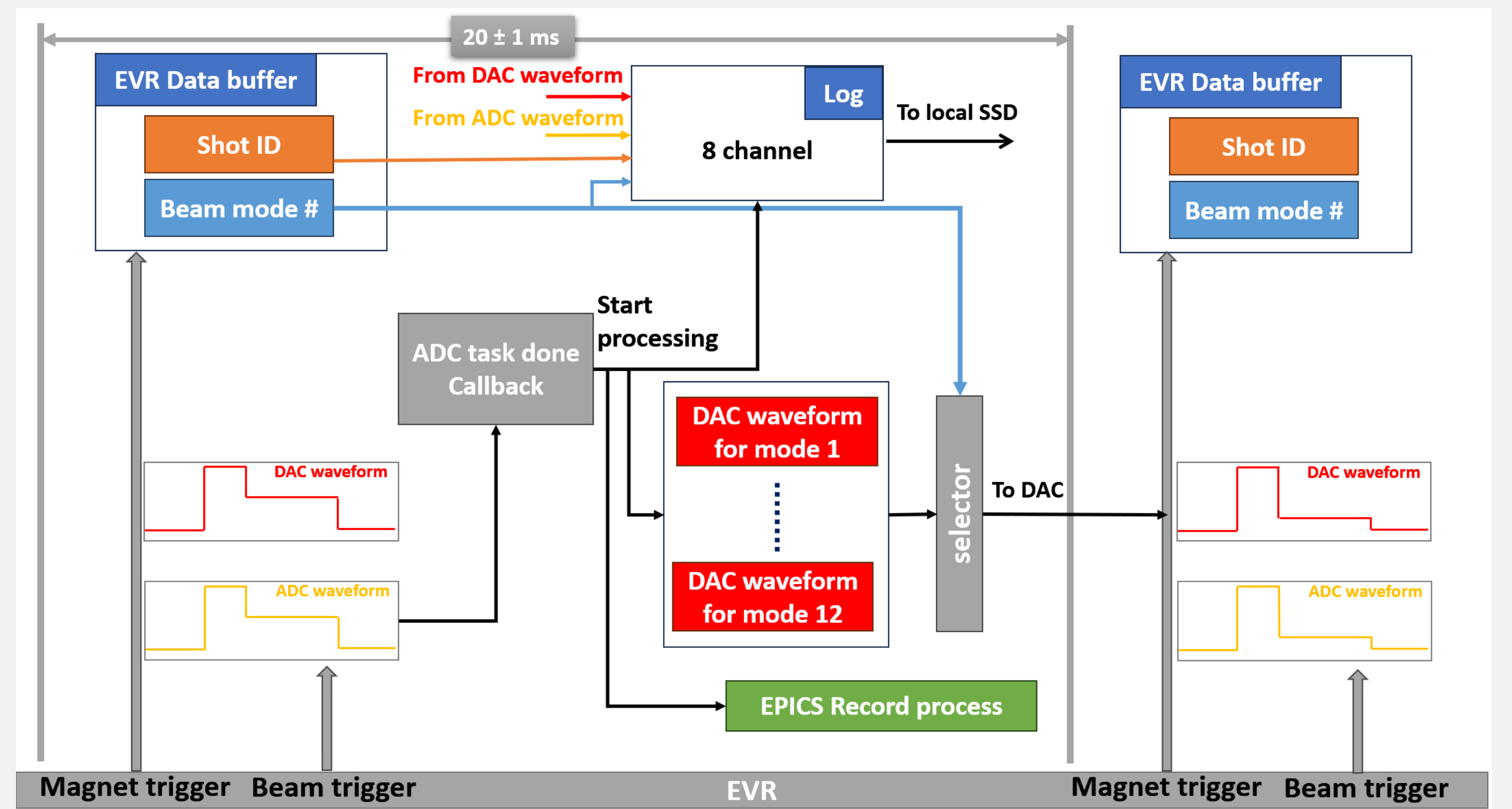
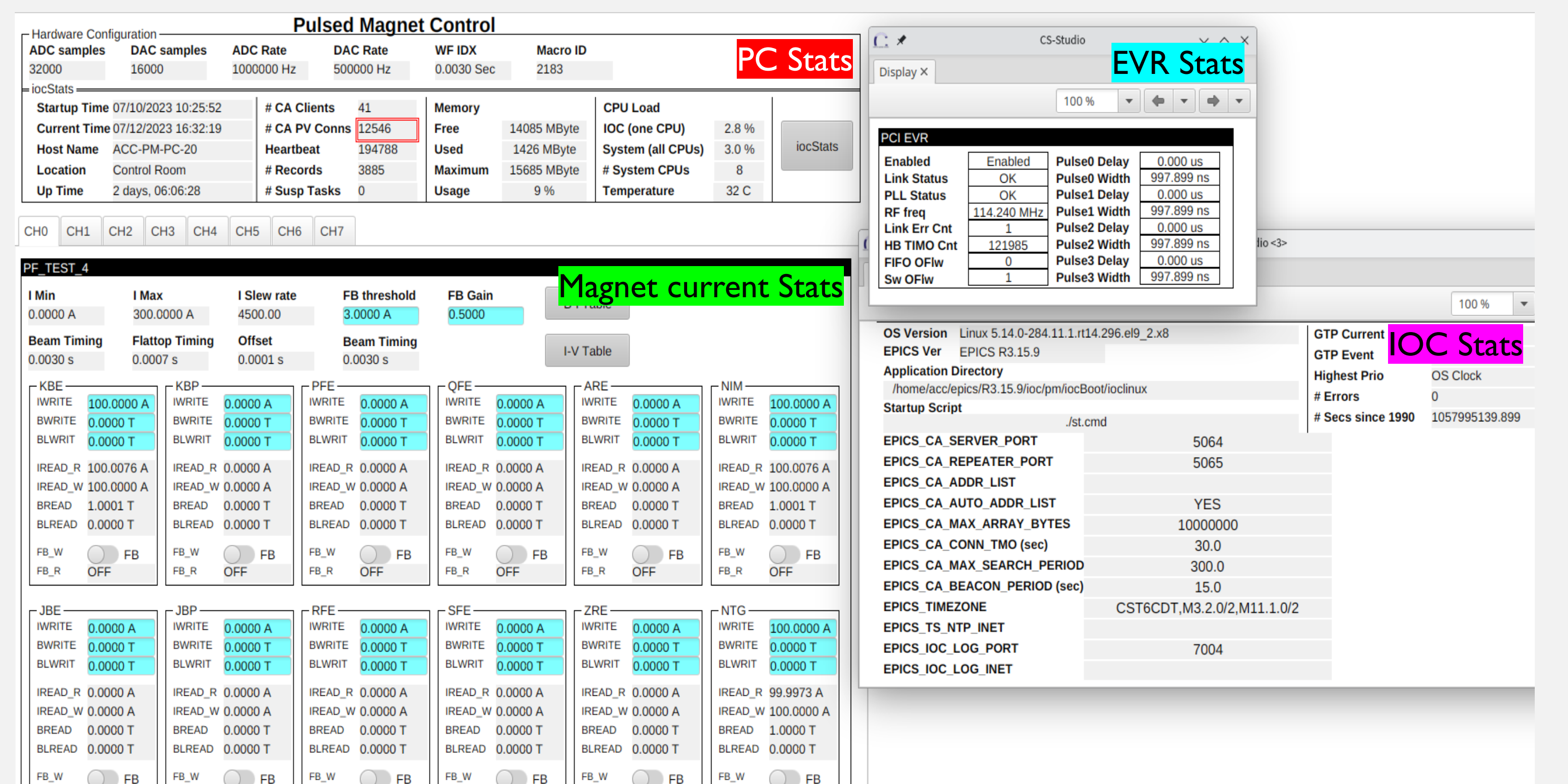


Diagram of new PMCS

Real time IOC

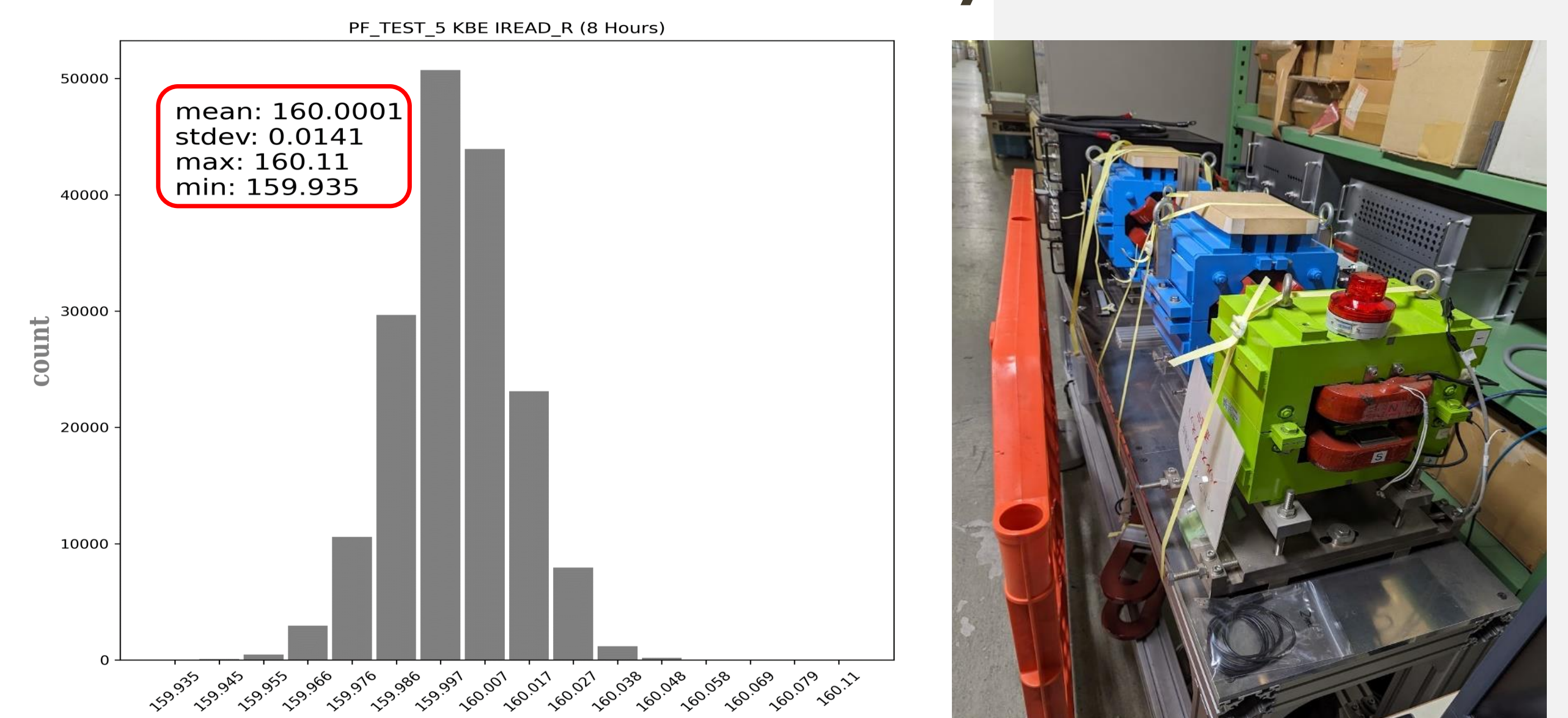


Data flow



An OPI to monitor the status of HW and IOC

Evaluation of new system



The measured magnet current result of a test magnet for 8 hours operation. The mean value and standard deviation of the current were 160 A and 0.0141 A, respectively. The relative stability is 88 ppm, corresponding to the level with the precedent measurement.

Conclusion

The pulsed magnet control system is upgraded from a Windows 8.1 based LabVIEW program to a non-proprietary operating system and software. We implement, test, validate and modify the control software under the PXIe platform while keeping the available hardware. The experiment shows both the performance and stability are satisfactory.