The Upgrade of Pulsed Magnet Control System Using PXIe Devices at KEK LINAC

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Introduction

Currently the pulsed magnet control system (PMCS) at KEK electron positron injector LINAC 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 module responds to the trigger signal which is generated from the event receiver (EVR) and sets the current of the pulsed magnet. The readback value of the pulsed magnet is retrieved from the ADC module. Despite its long success, there still exists several problems for current PMCS. 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.
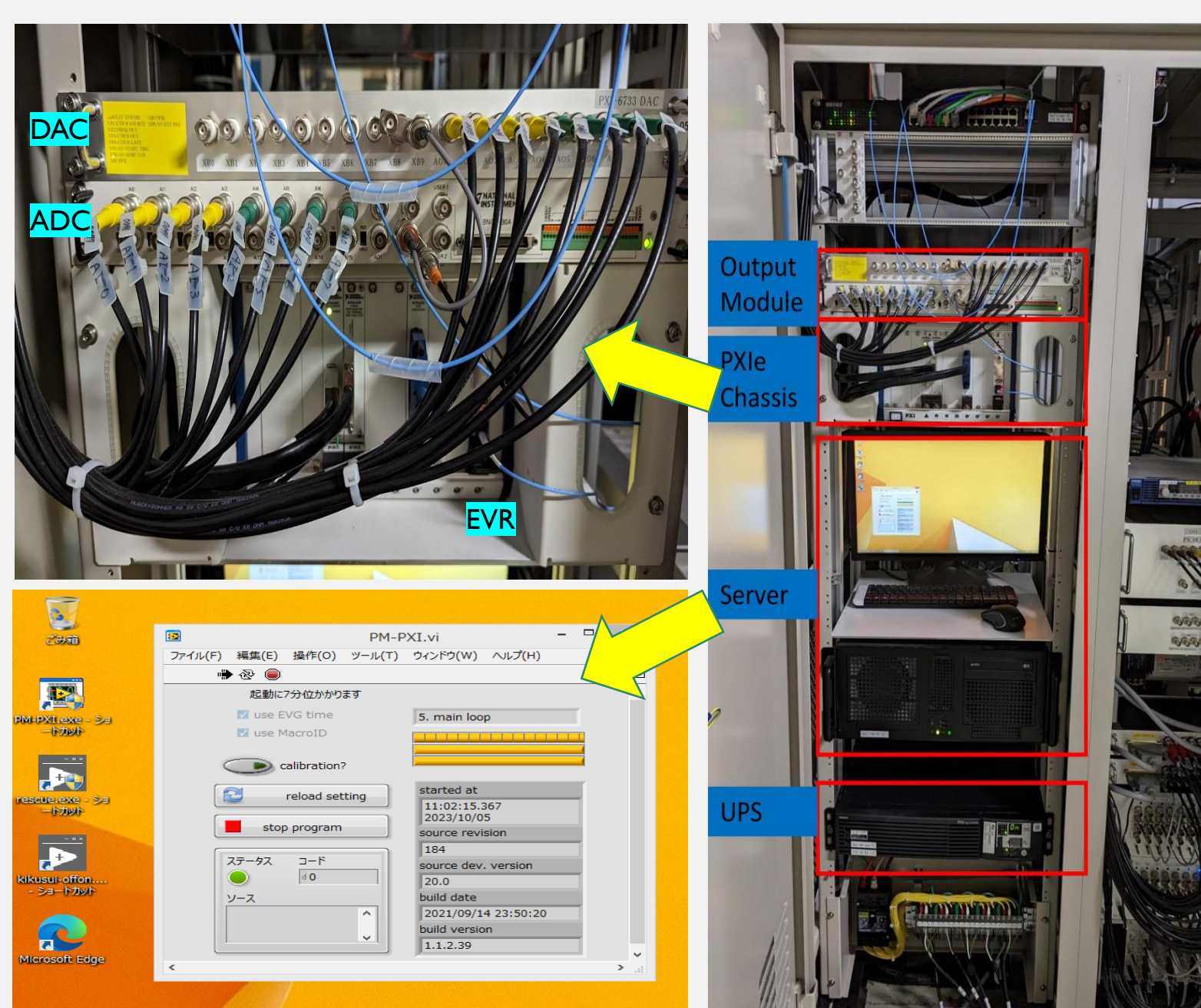
Current pulsed magnet control system
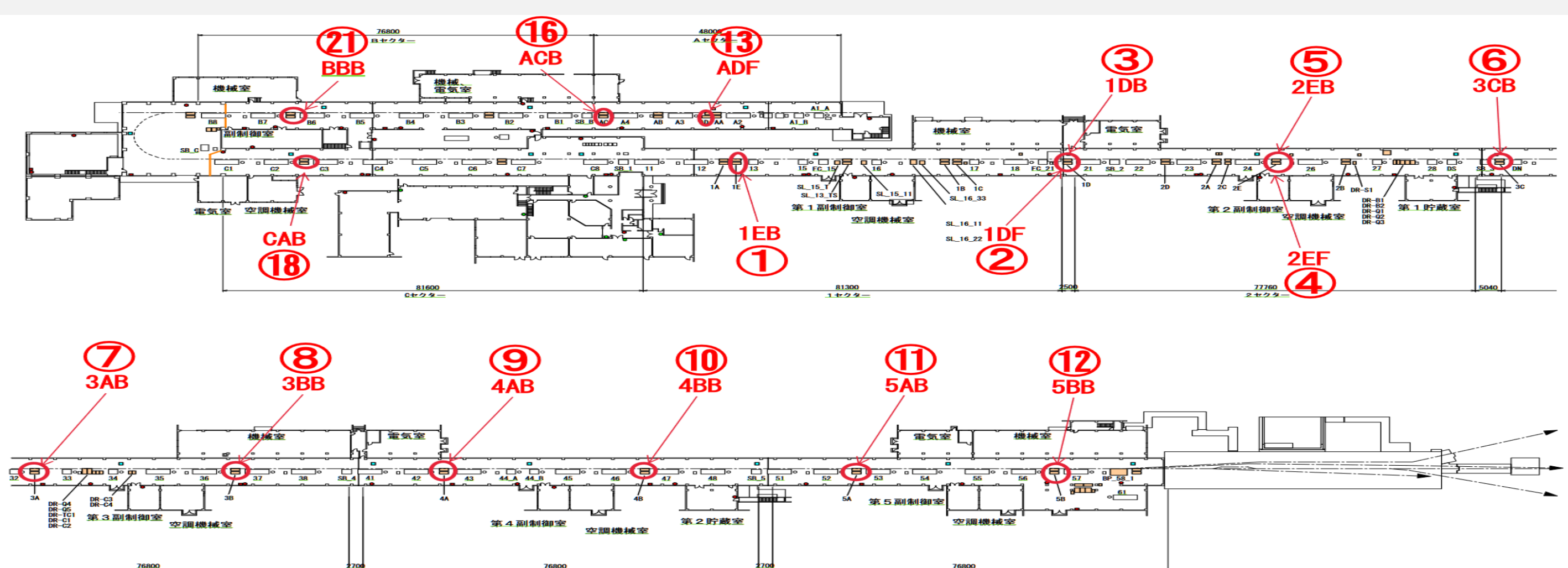
Location of pulsed magnet control units at LINAC

- 16 control units
- Up to 8 PM per unit
- 12 beam modes per PM
- 11 process variables per PM
- Trigger by EVR
- 50 Hz operation

PXIe chassis and modules

Windows 8.1 based Pulsed magnet control unit

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.

New System

- Same hardware (PXIe Chassis, NI modules, MRF EVR)
- RT IOC (using MCoreUtils) runs on Alma Linux with RT-kernel
- EPICS driver of NI modules based on NIDAQmx
- mrfioc2 with modification as EVR driver (use data buffer)
- iocStats with modification for monitoring
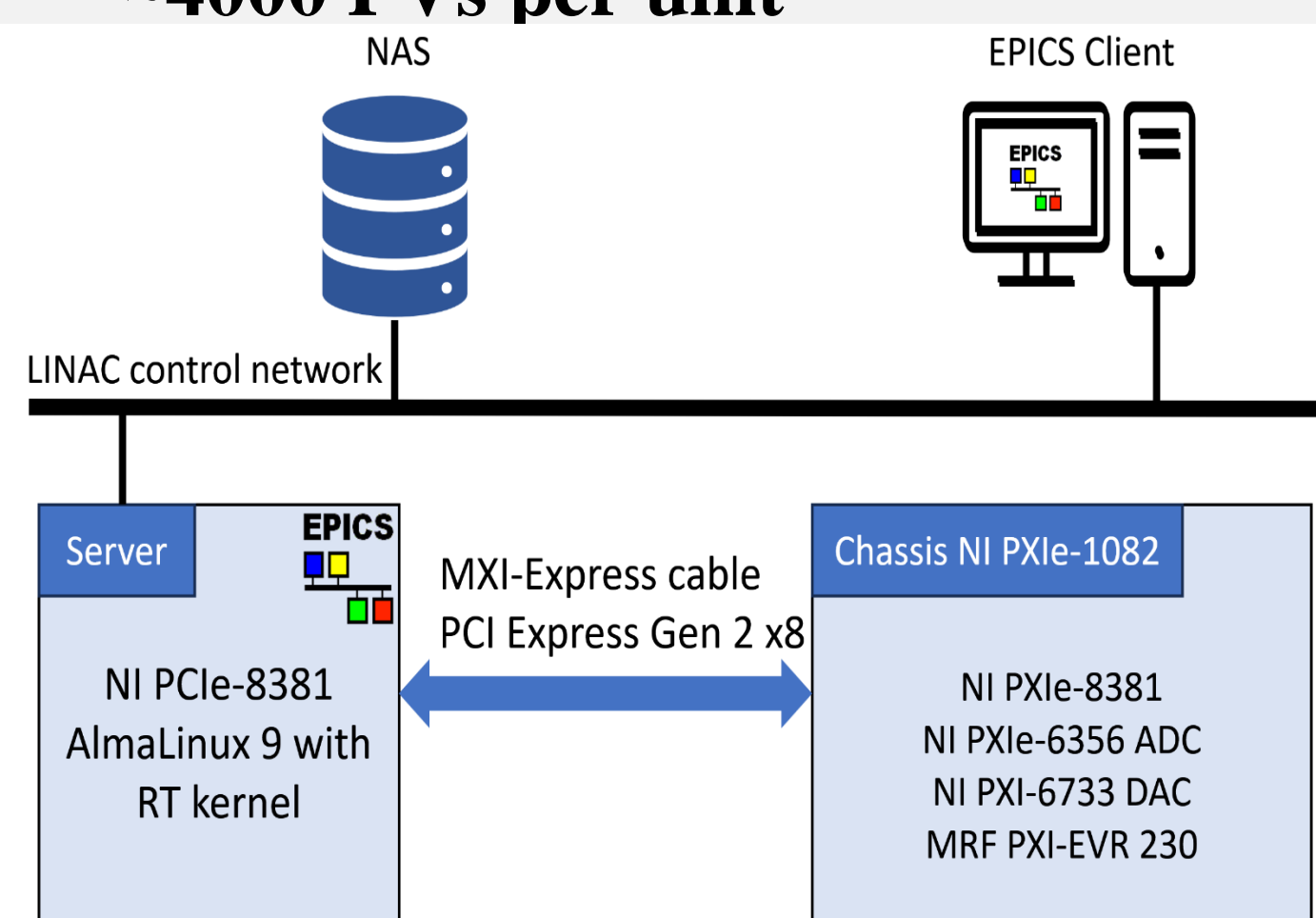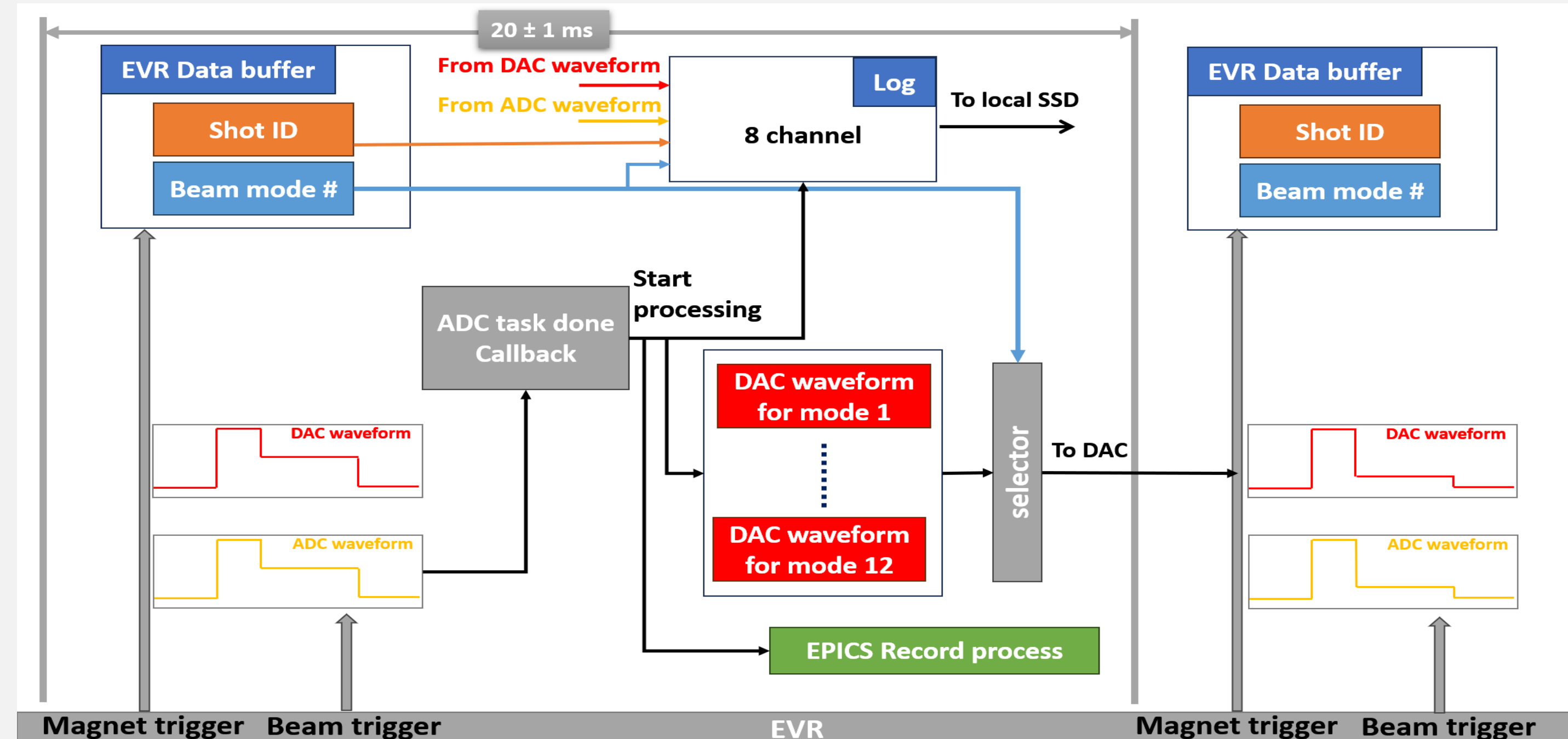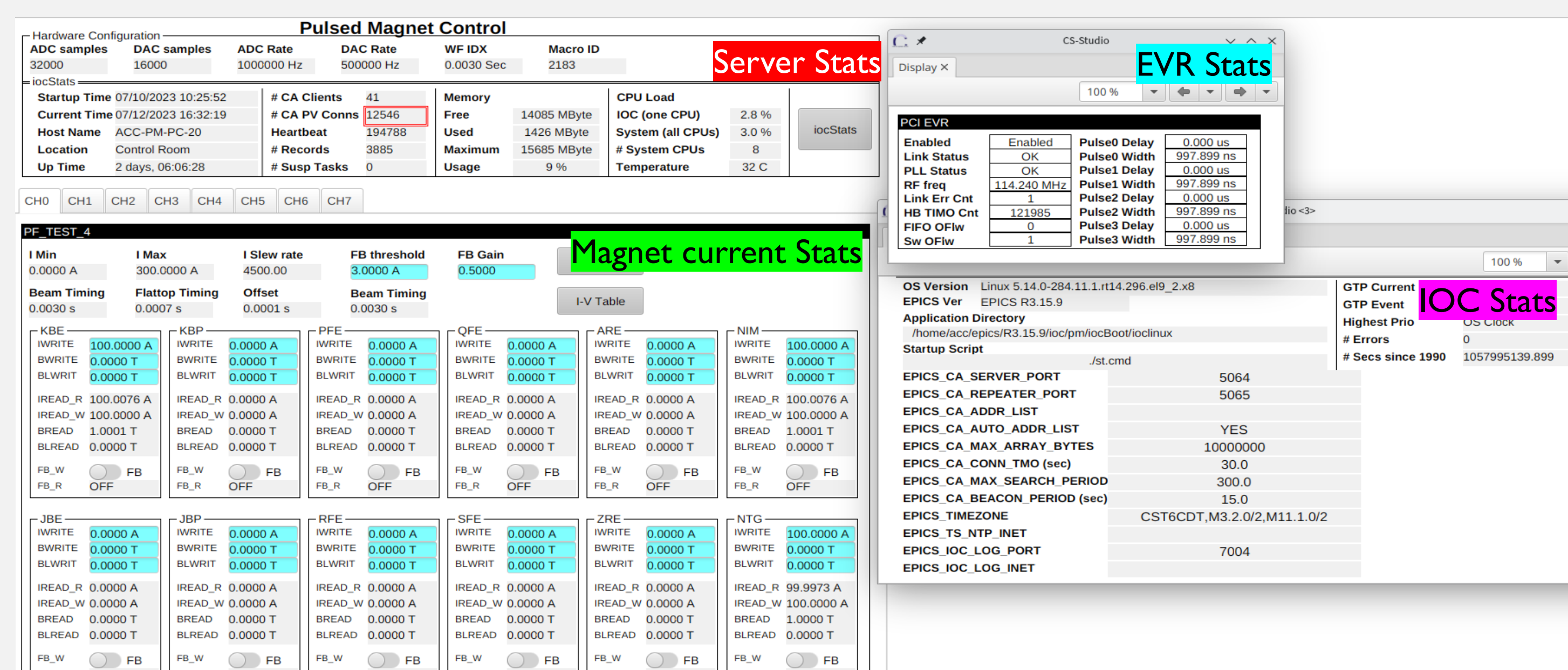- ~4000 PVs per unit

Diagram of new PMCS

Real time IOC

Data flow

An OPI to monitor the status of HW and IOC

Evaluation of new system

PF_TEST_5 KBE IREAD_R (8 Hours)

mean: 160.0001
stdev: 0.0141
max: 160.11
min: 159.935
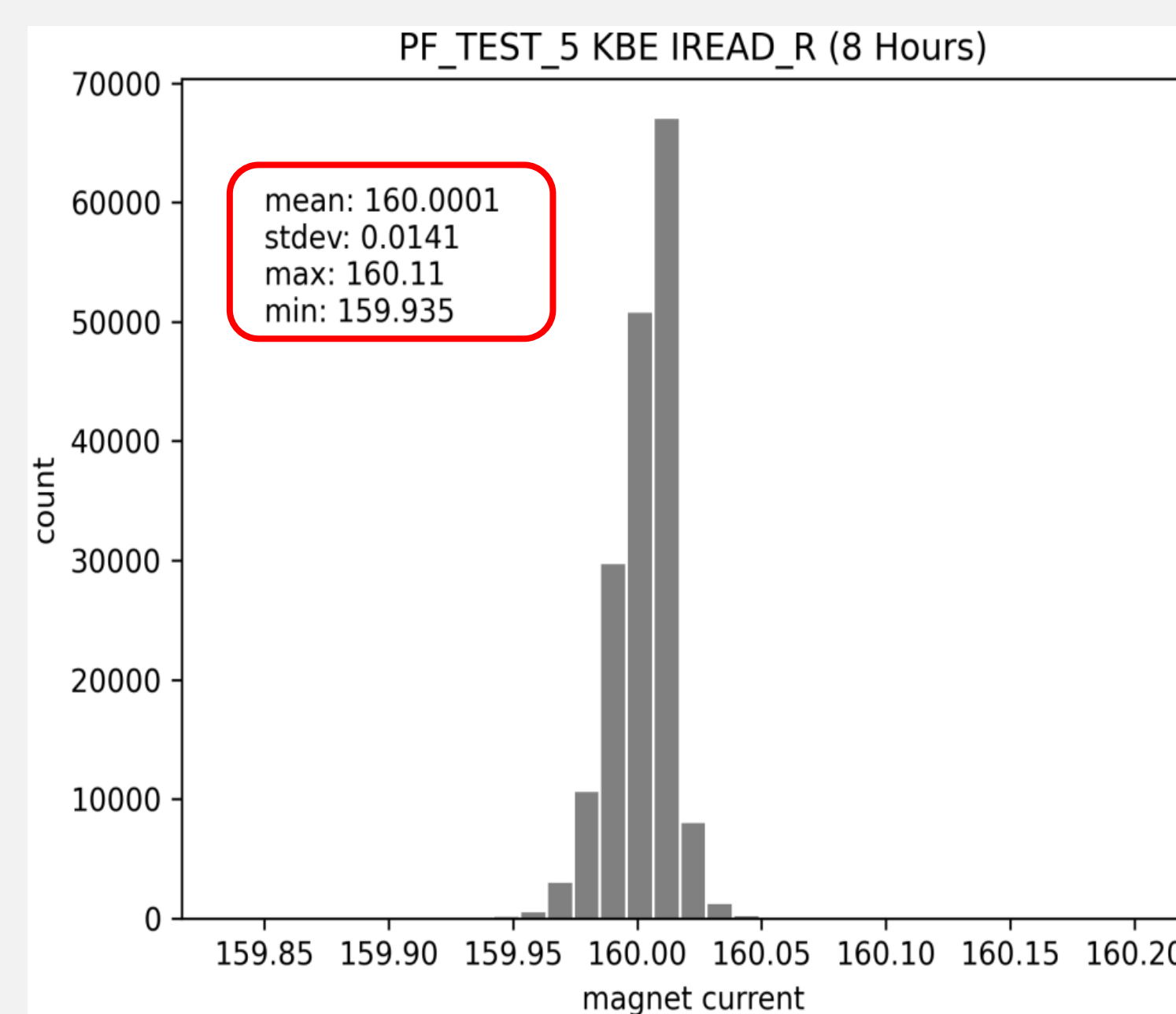
The measured magnet current result of a test magnet for 8 hours operation. The mean value and standard deviation of the current were 160 A and 0.0141 A, respectively. The relative stability is 88 ppm, corresponding to the level with the precedent measurement.

EVR Timestamp Problem

Latency of reading PXI EVR timestamp register
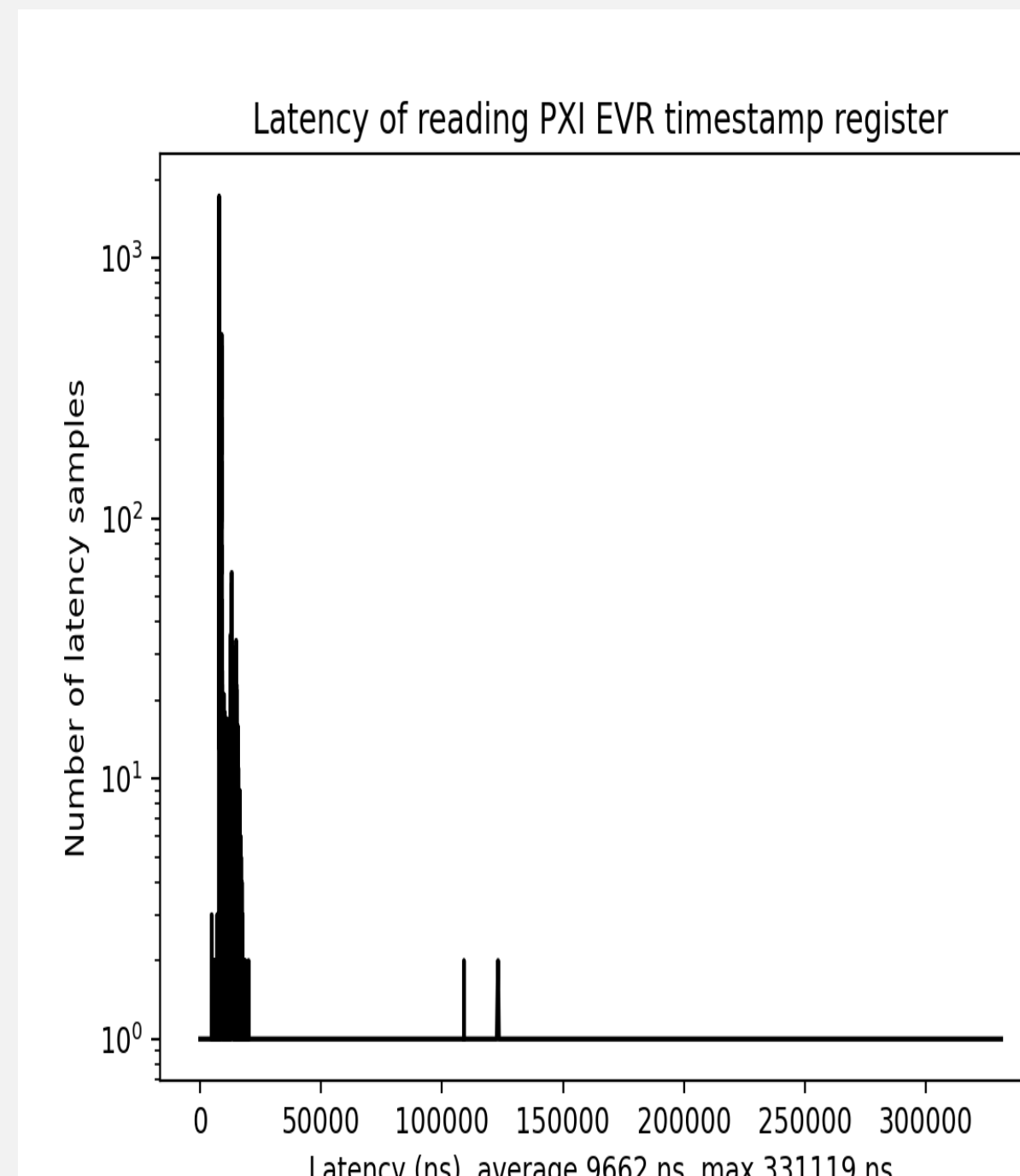
- IOC sometimes lost trigger during the test
- Reading timestamp from EVR usually takes ~10 us
- In worst case it takes 300 us
- ~300 PVs are process every 20 ms
- All those PVs read EVR to get timestamp by default which cause IOC unstable
- Solution: disable EVR as IOC time provider
- For special PV which needs EVR timestamp, set its TSE field

Outlook

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. One control unit will be replaced during 2023 fall operation.