



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

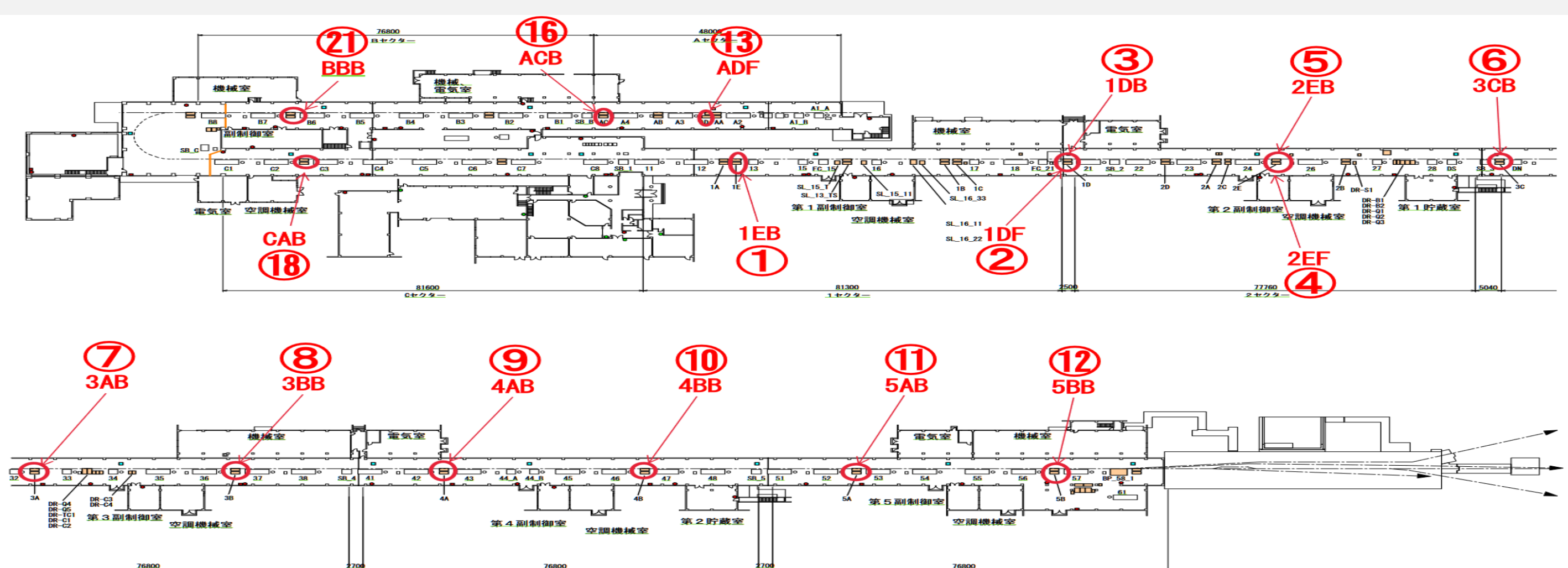
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Introduction

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

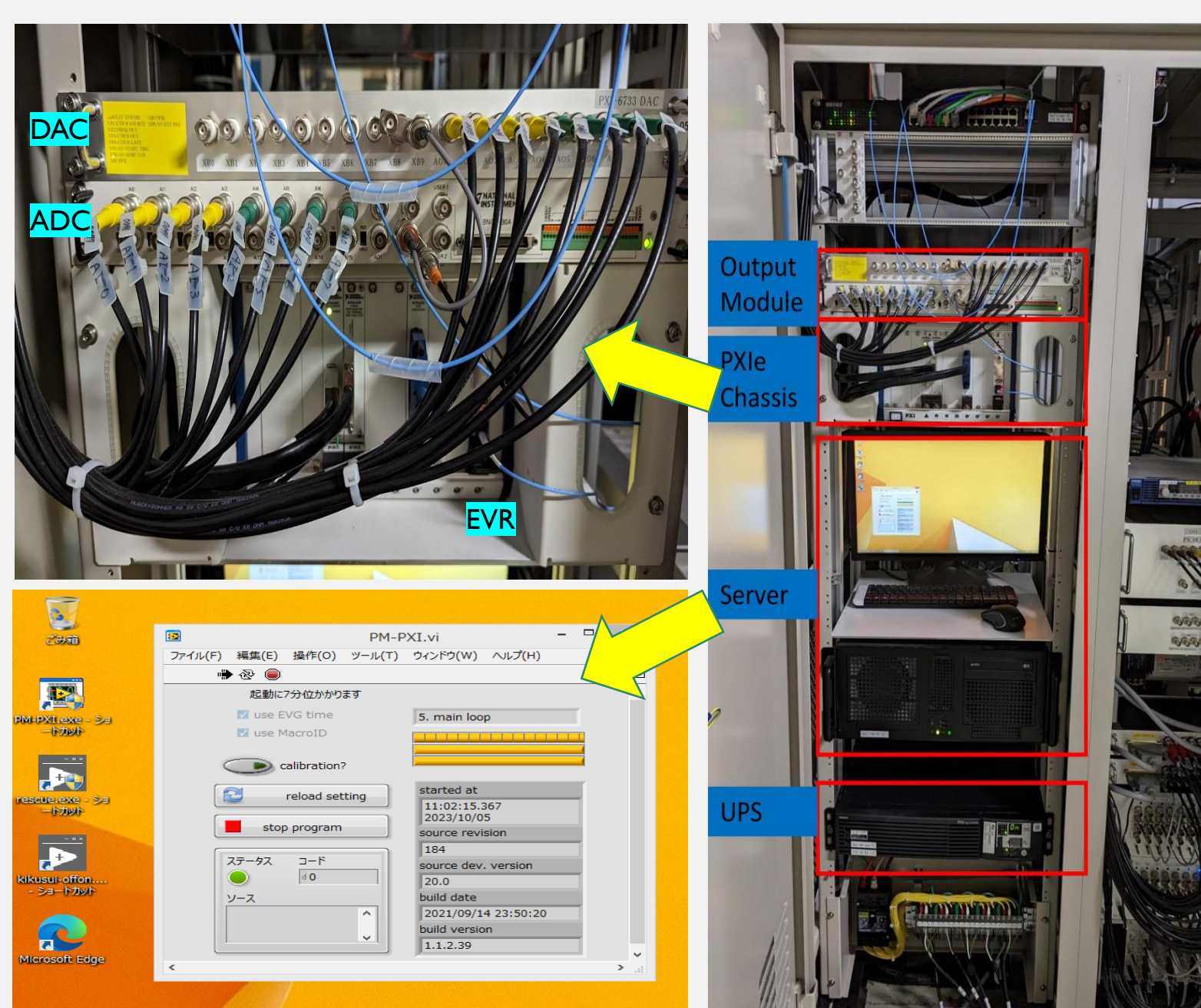


Location of pulsed magnet control units at LINAC

- 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

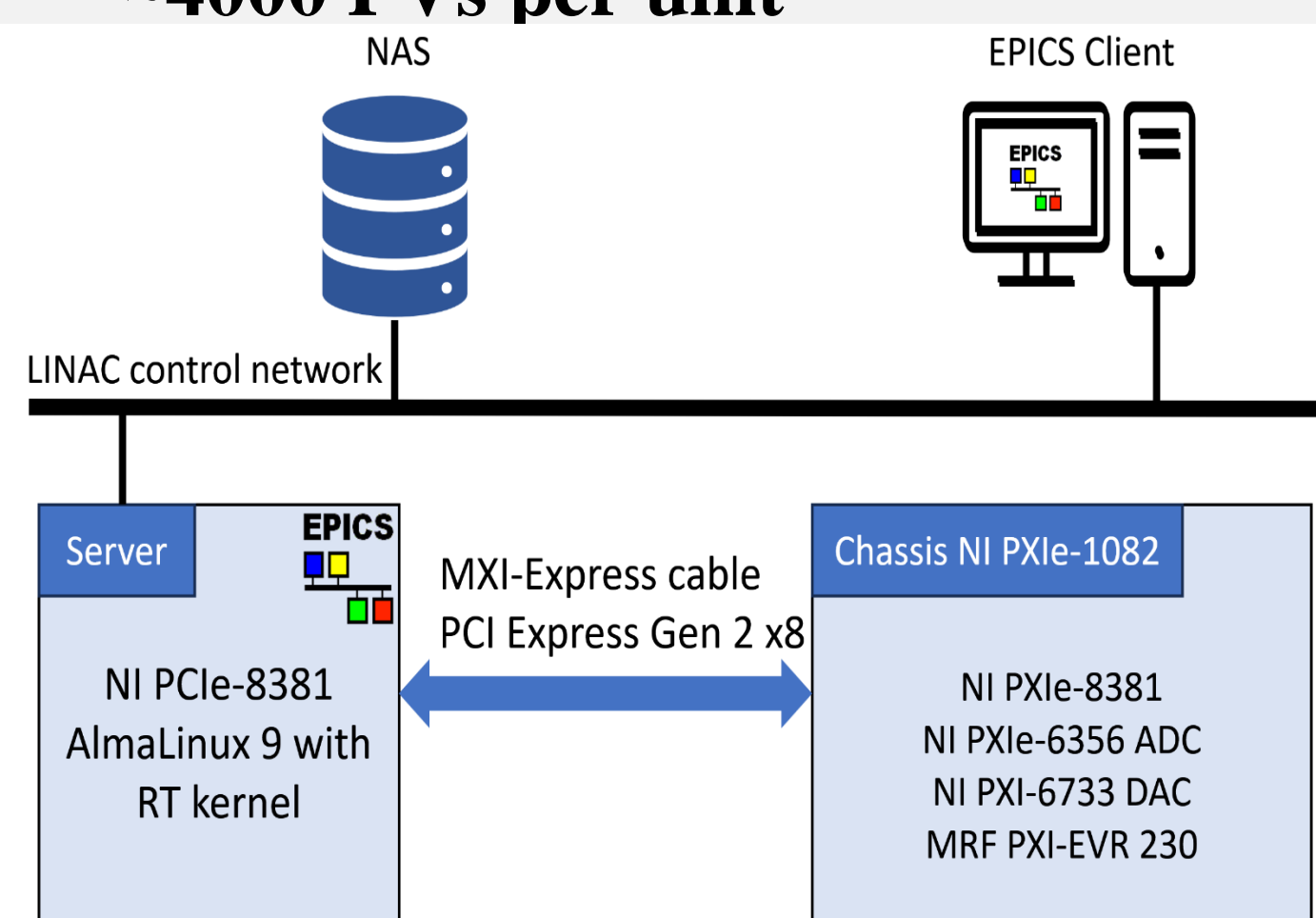
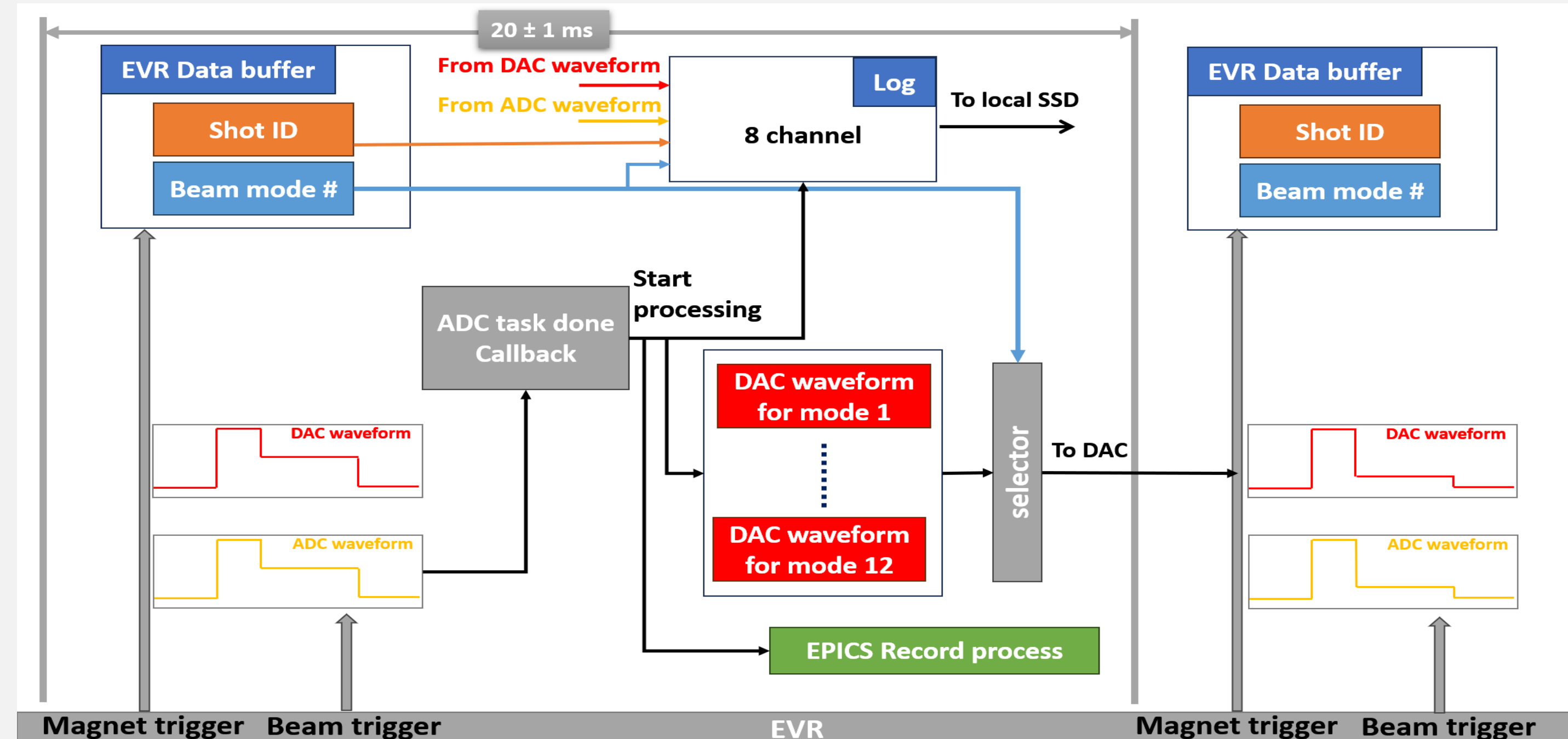


Diagram of new PMCS

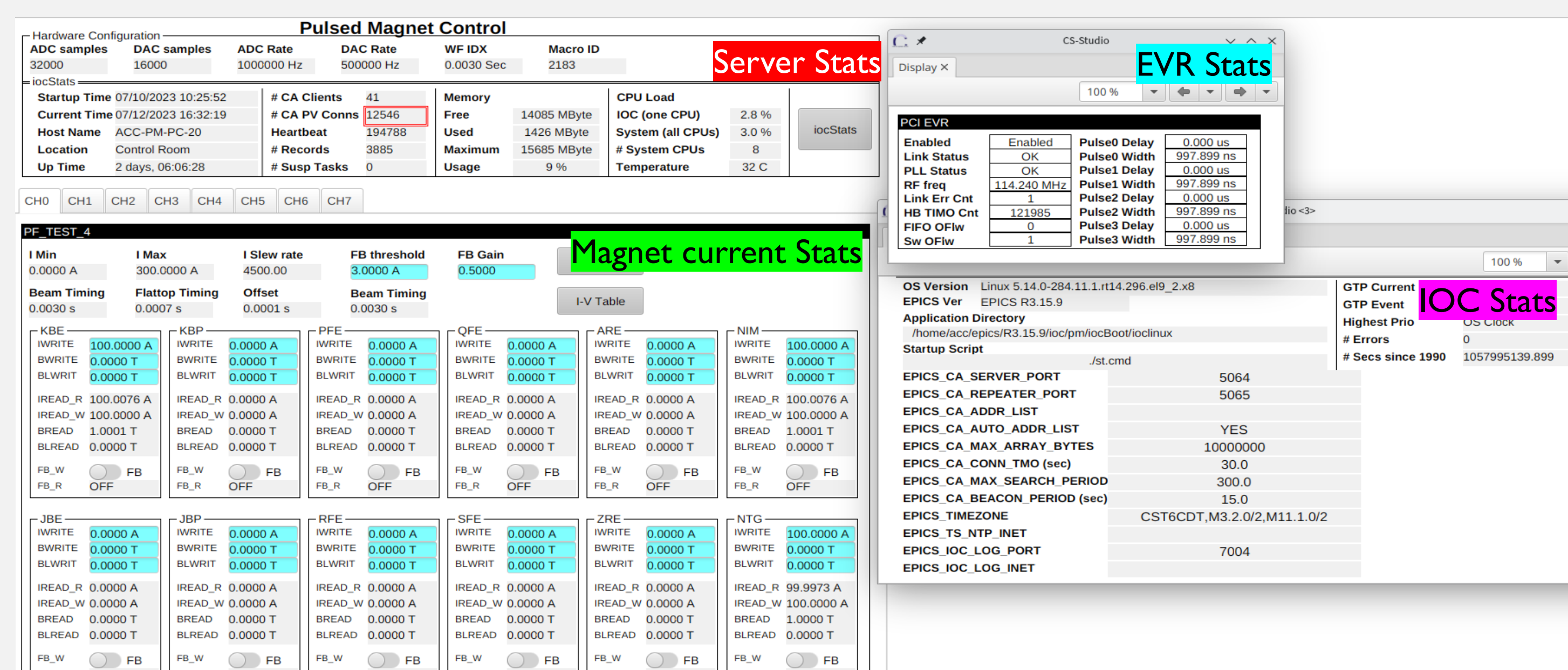
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epics> mcoreThreadShowAll
NAME          EPICS ID  LWP ID  OSIPRI  OSSPRI  STATE  POLICY  CPUSET
-----
_mrt_         0x224b6660 107731  0       0       OK     FIFO  1-7
_evrifd       0x224b6660 107733  10      10      OK     FIFO  1-7
EVRIFD        0x2306b20 107734  90      89      OK     FIFO  1-7
PCII5R0000:0f:0c 0x23380110 107735  98      97      OK     FIFO  1-7
dmLog         0x2573390 107740  10      10      OK     FIFO  1-7
taskwd        0x2ae9090 107741  10      10      OK     FIFO  1-7
tLaserQueue   0x2b19190 107742  76      69      OK     FIFO  1-7
cblow         0x257f630 107743  59      58      OK     FIFO  1-7
cbMedium      0x2b24490 107744  64      63      OK     FIFO  1-7
cbHigh        0x2b247b0 107745  71      70      OK     FIFO  1-7
dcbALink      0x2b21f90 107746  59      50      OK     FIFO  1-7
tLaserQueue   0x2b21f90 107747  58      57      OK     FIFO  1-7
scanOnce      0x2e63270 107752  67      66      OK     FIFO  1-7
scan-10       0x2e65e10 107753  65      64      OK     FIFO  1-7
scan-5        0x2e66060 107754  66      65      OK     FIFO  1-7
scan-2        0x2e662b0 107755  67      66      OK     FIFO  1-7
scan-1        0x2e66500 107756  68      67      OK     FIFO  1-7
scan-0-5      0x2e66750 107757  69      68      OK     FIFO  1-7
scan-0-2      0x2e669a0 107758  70      69      OK     FIFO  1-7
scan-0-1      0x2e66bf0 107759  71      70      OK     FIFO  1-7
CAS-TIP       0x2e6f190 107760  16      16      OK     FIFO  1-7
CAS-UDP       0x2e6f900 107761  12      12      OK     FIFO  1-7
CAS-ipcConn   0x2f01b10 107762  14      14      OK     FIFO  1-7
ipToAsLProxy 0x7fd40c018950 107765  10      10      OK     FIFO  1-7
tLaserQueue   0x7fd40c0190f0 107766  52      51      OK     FIFO  1-7
CAS-UDP       0x7fd40c0190f0 107767  54      53      OK     FIFO  1-7
CAS-event     0x7fd40c0609e0 107768  52      51      OK     FIFO  1-7
CAS-TIP       0x7fd3b000450 107846  18      18      OK     RR  1-3
CAS-client    0x7fd3b00047a0 107947  20      20      OK     RR  0,2
CAS-event     0x7fd3b000460 109933  18      18      OK     RR  1-3
CAS-client    0x7fd3b00050c0 109934  20      20      OK     RR  0,2
CAS-event     0x7fd3b0005780 112396  18      18      OK     RR  1-3
CAS-client    0x7fd3b00059e0 112397  20      20      OK     RR  0,2
    
```

Real time IOC

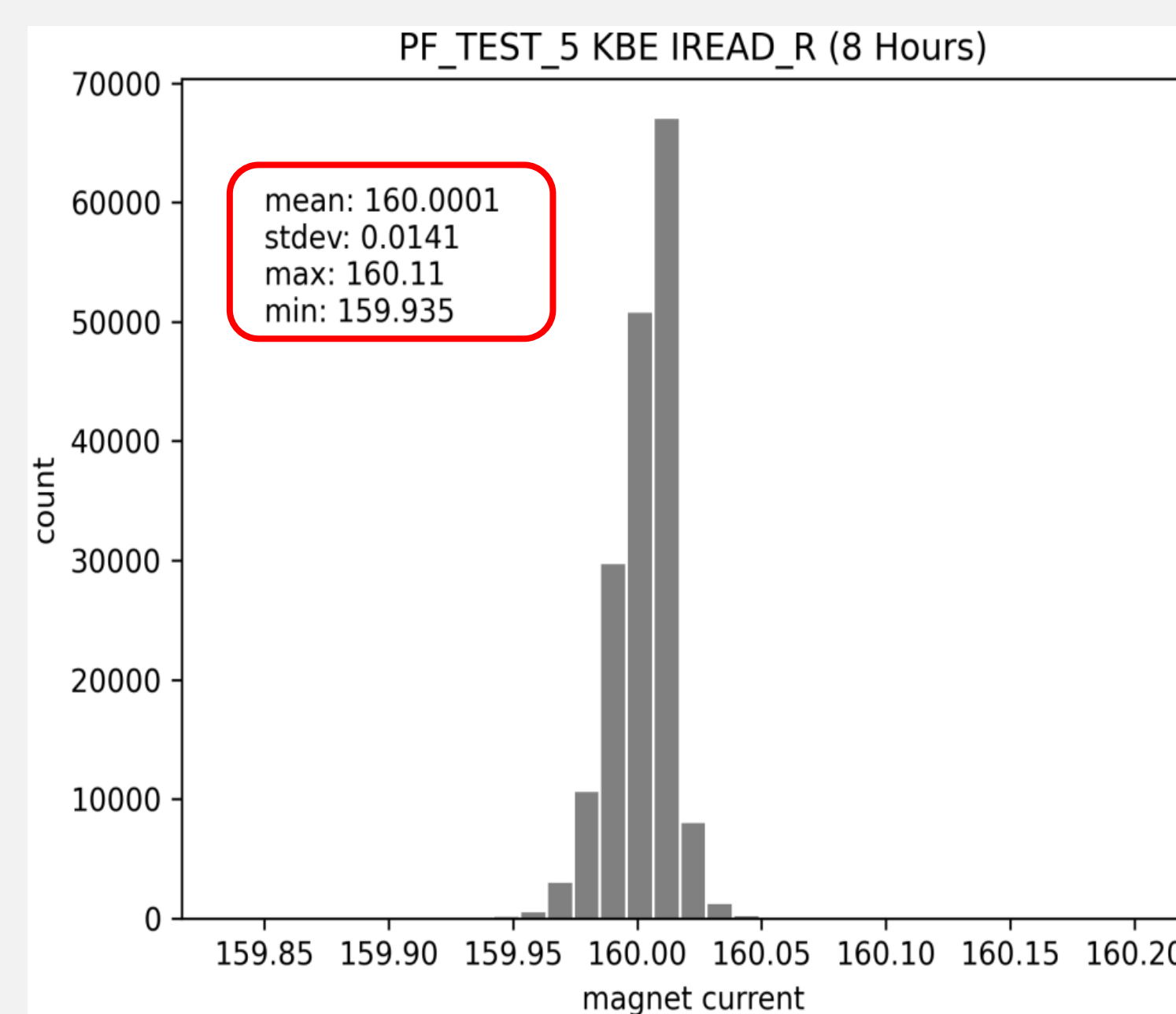


Data flow



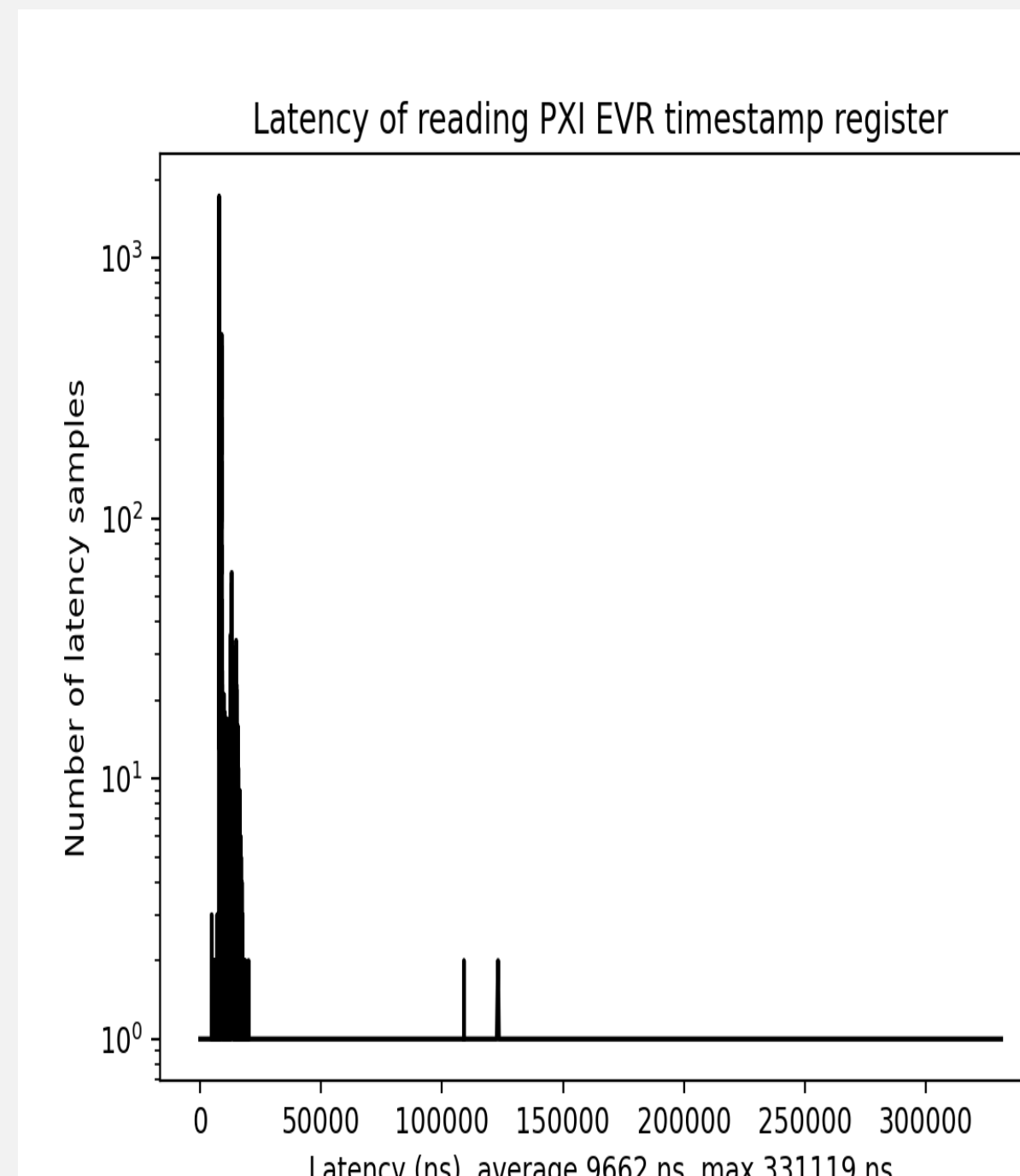
An OPI to monitor the status of HW and IOC

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.

EVR Timestamp Problem



- 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.