

# HIGH PERFORMANCE GENERIC BEAM DIAGNOSTIC SIGNAL PROCESSOR FOR SHINE

WEP53

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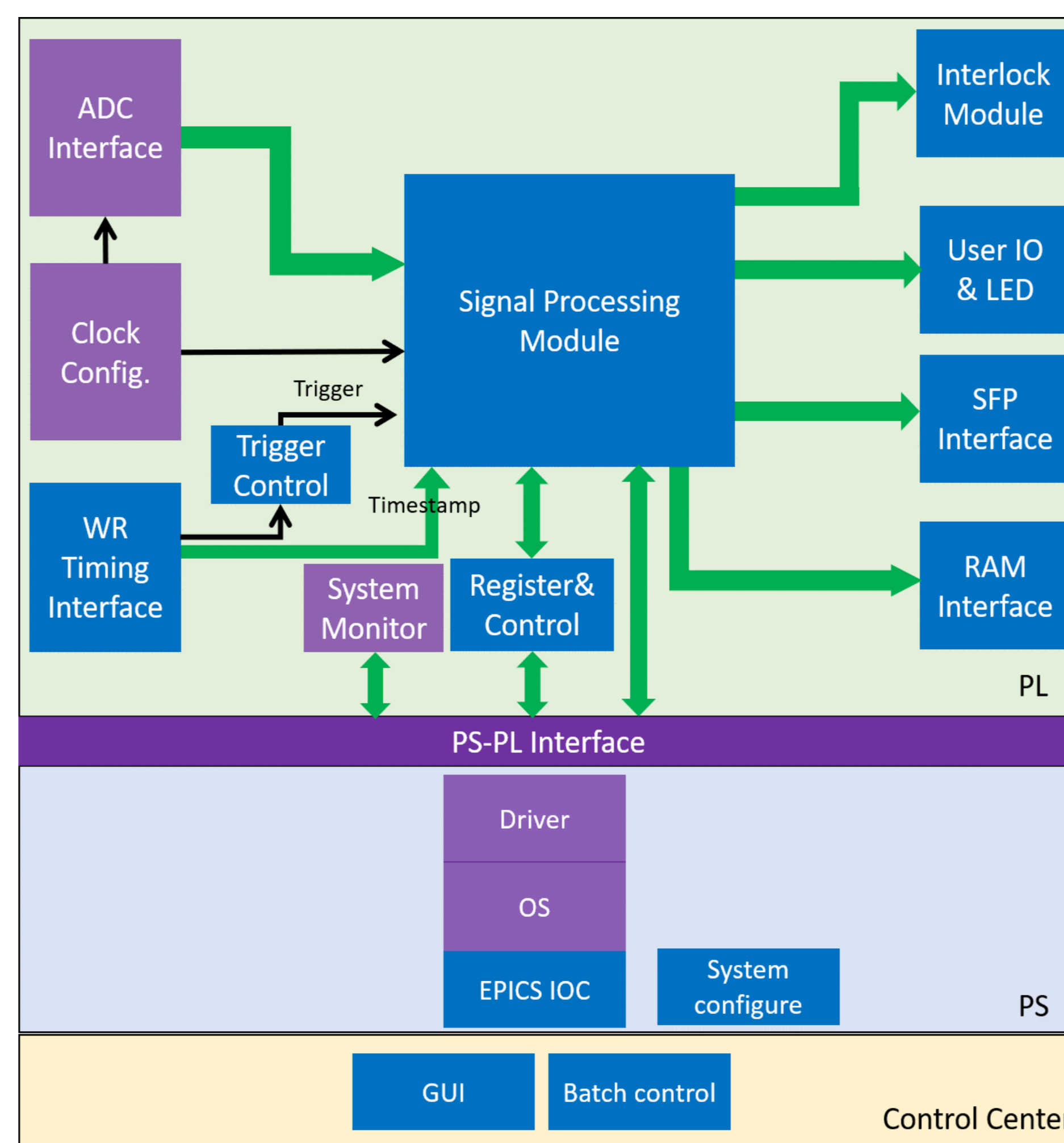
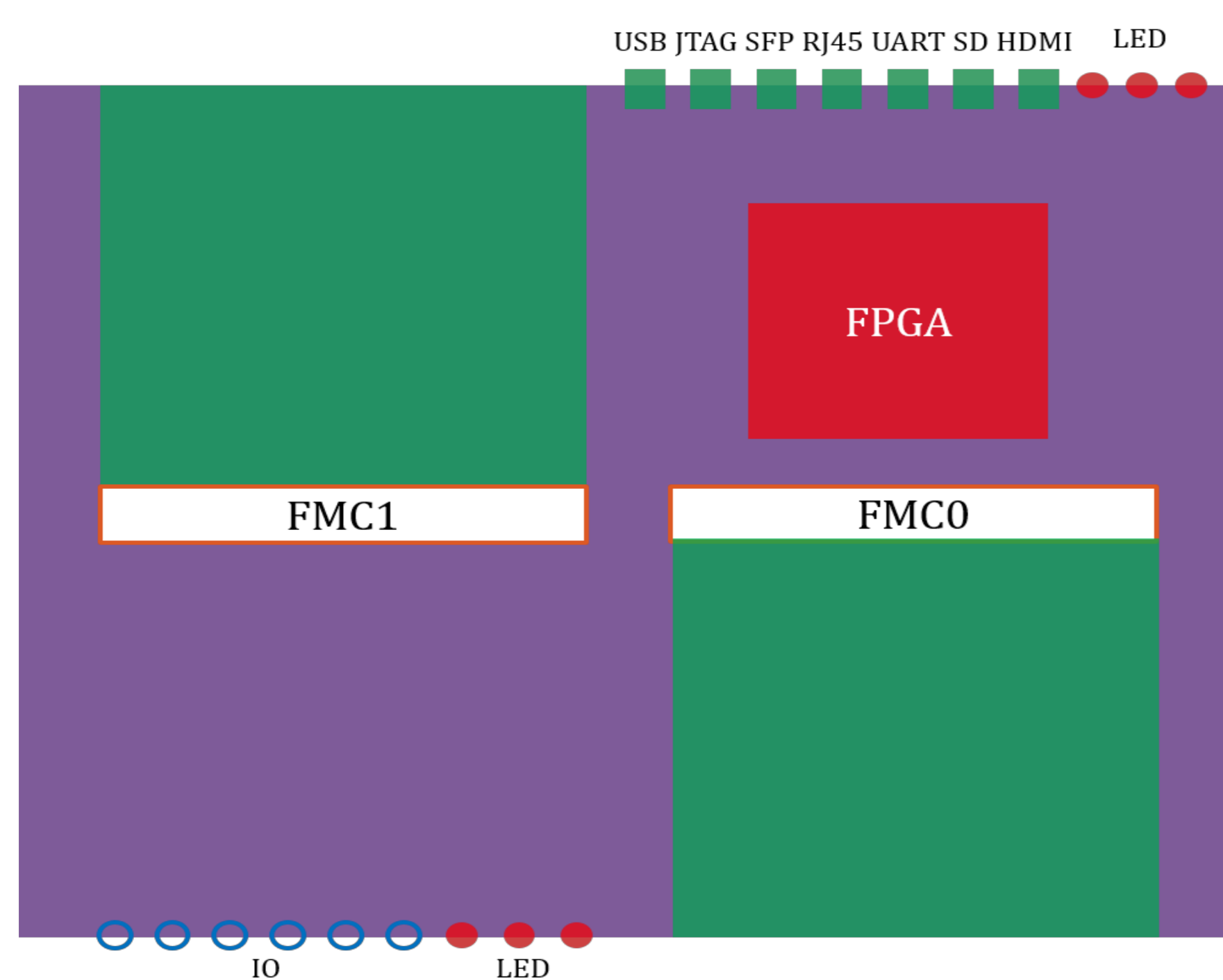
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## •Abstract

A generic signal processor has been developed for beam diagnostic system in SHINE. The stand-alone processor is used for the signal processing of stripline BPM, cavity BPM, cold button BPM, beam arrival measurement, bunch length measurement and other diagnostic systems. The main core is a SoC FPGA, which contains both quad-core ARM and FPGA on a chip. The ARM runs LINUX OS and EPICS IOC, and FPGA performs peripheral interfaces and high-speed real-time signal processing. An FMC carrier ADC board is mounted, which can sample 4 channels input signal with a maximum sampling rate of 1GSPS. The processor is equipped with a White Rabbit timing card, which can realize 1MHz high repetition rate synchronous measurement. Lab test results and on-line beam tests prove that the processor has high performance. This paper will introduce the processor development and applications on SHINE.

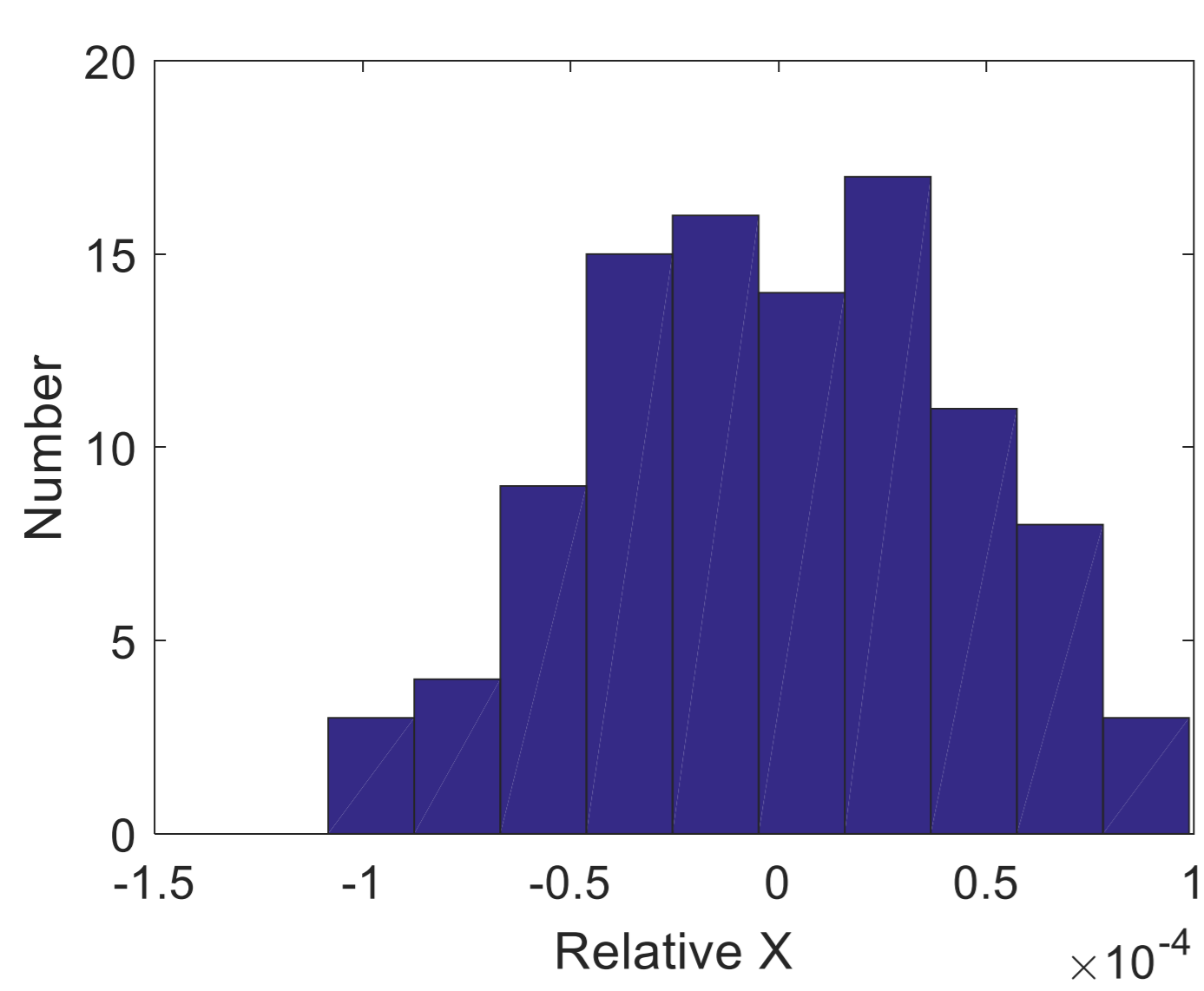
## •Generic beam diagnostic signal processor

The processor is designed as a 1U height standalone device. The core component is a Xilinx FPGA, an ADC daughter board connected through FMC HPC interface, and a White Rabbit timing (WRN) daughter board connected through FMC LPC interface.

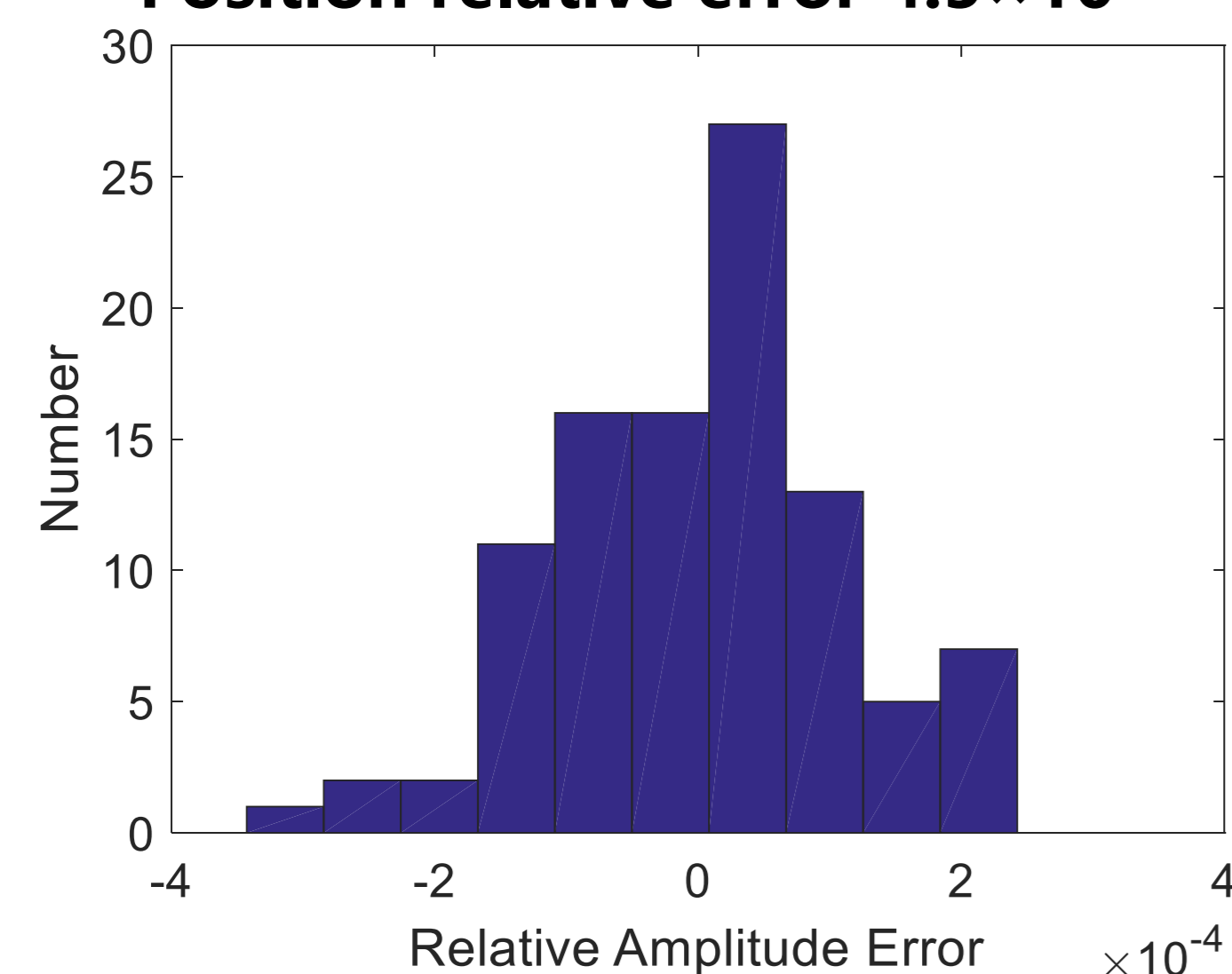


Parameters	value
Channels	4
ADC bits	14
ADC Bandwidth	2 GHz
Max ADC rate	1 GSPS
FPGA	Xilinx ZCU15EG
Clock	Ext./Int.
PL DDR4	8GB
PS DDR4	4GB
Trigger	WRN/Ext. SMA /Self/Period
Interlock	Lemo
Ethernet	2×RJ45
SFP	4, UDP&Aurora
Software	Linux/EPICS

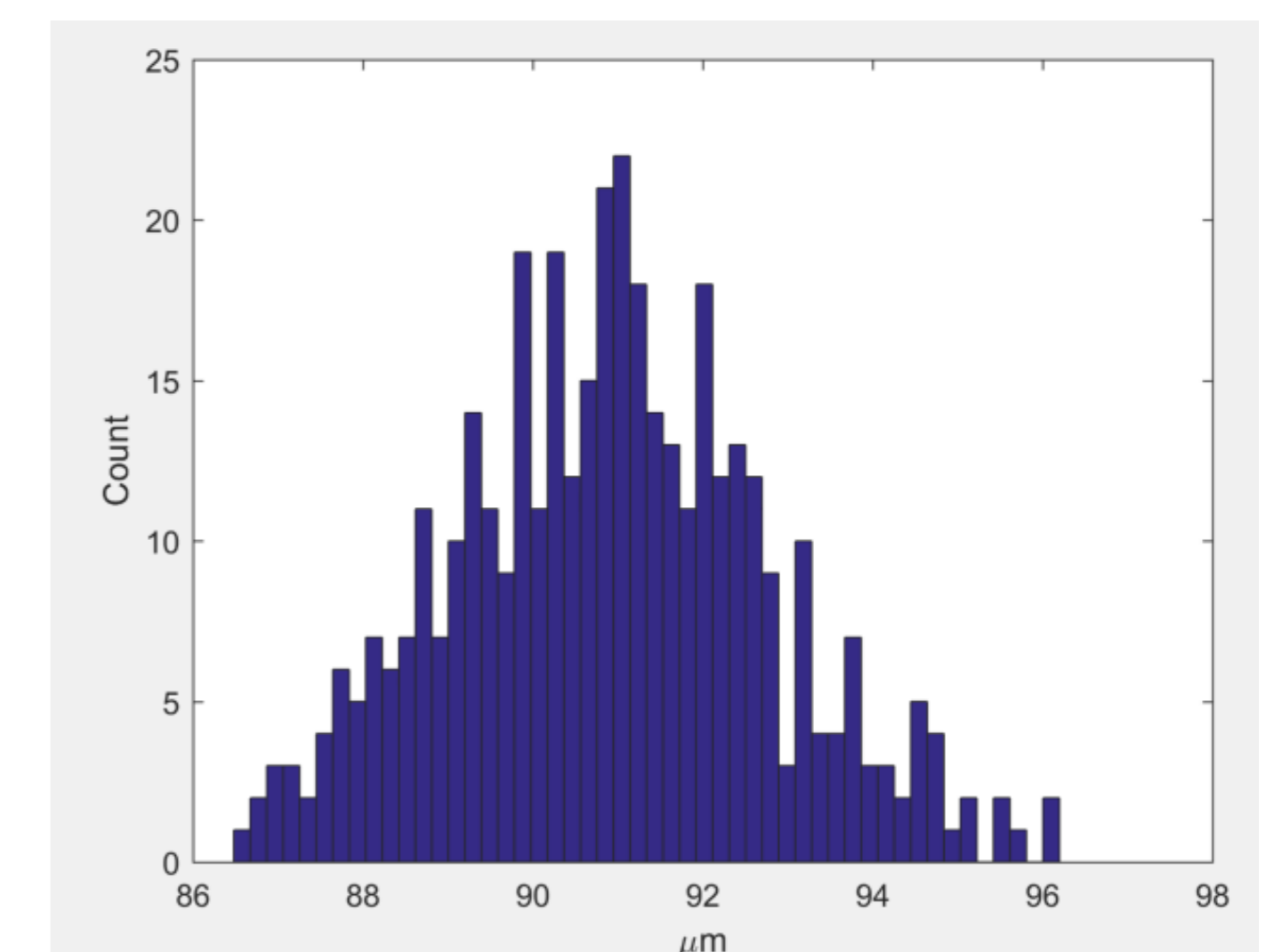
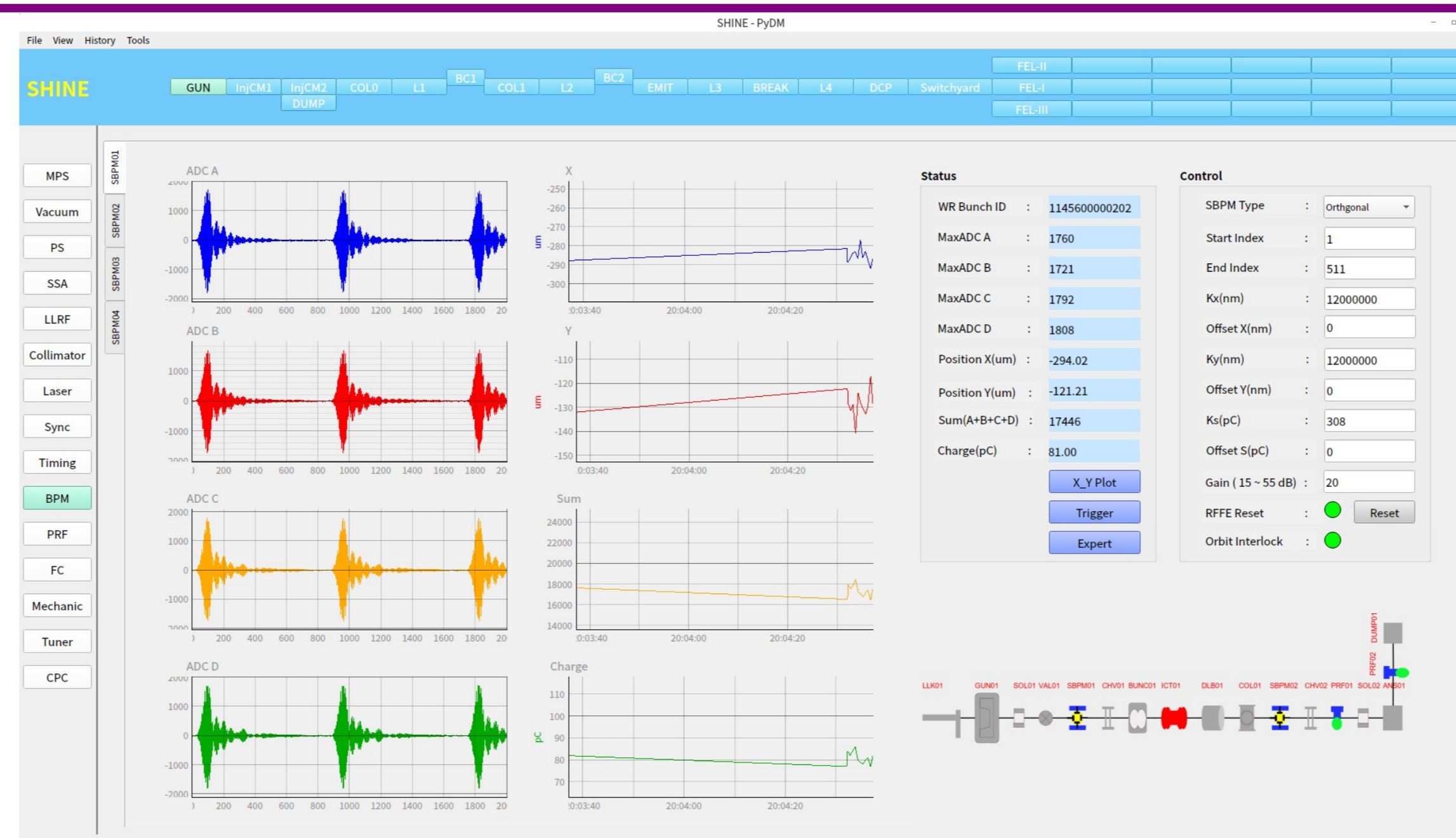
## •Application on SHINE and Performance evaluation



Position relative error  $4.5 \times 10^{-5}$



Amplitude relative error  $1.0 \times 10^{-4}$

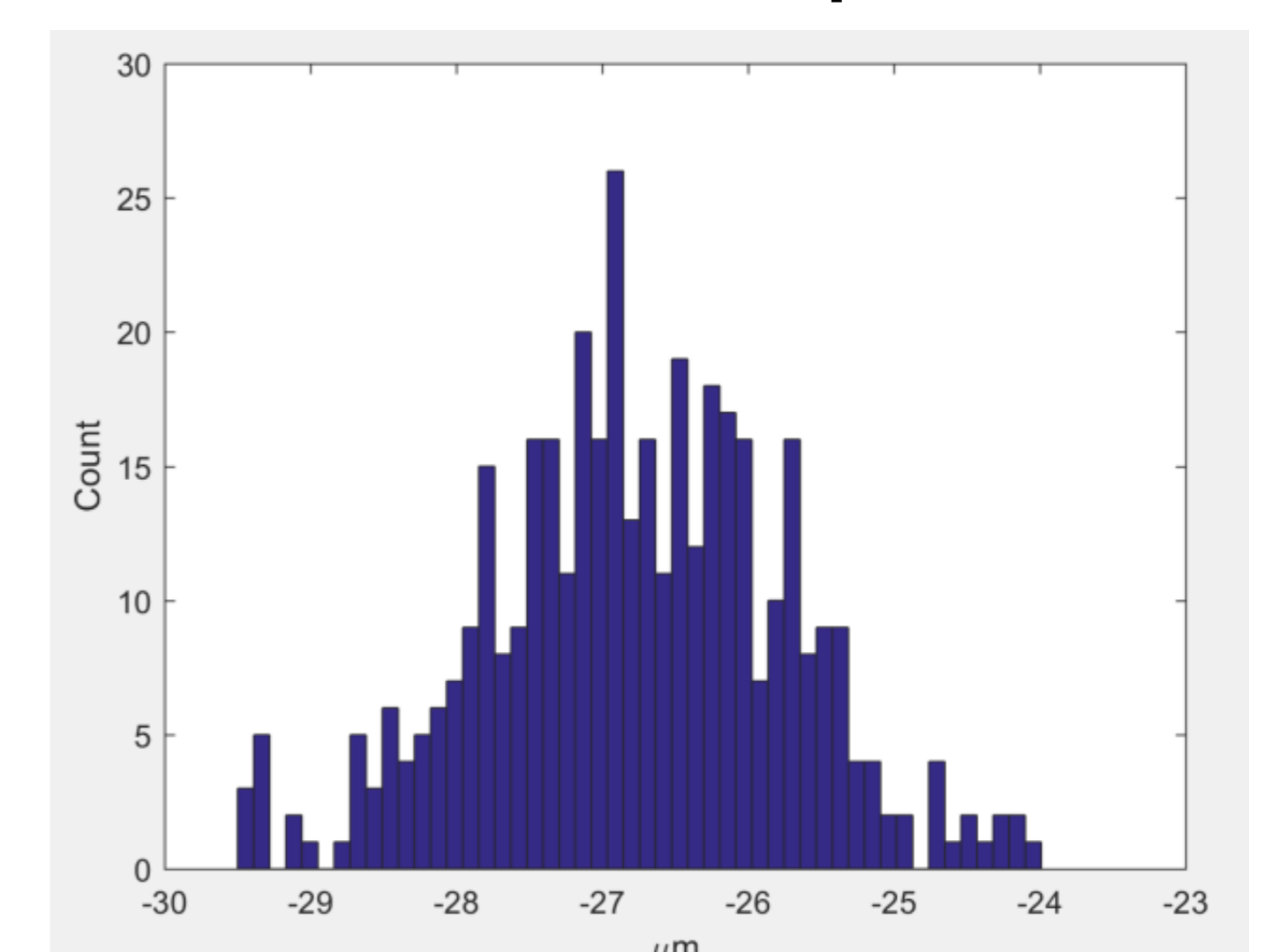


Front-end module + Processor resolution  $1.8 \mu\text{m}$



Confirm 1MHz beam rate

In October 2023, the processors were deployed in the injector section of SHINE.



Processor resolution  $1.0 \mu\text{m}$

## •Conclusion

We have completed the installation of the processors in the injector section and achieved their application. During beam commissioning, we have measured the first beam in SHINE and confirming a high repetition rate of 1 MHz. To date, 270 units have been delivered. This lays the groundwork for the next step in beam commissioning and testing. Next, we will proceed with installation and testing in other sections of SHINE.