

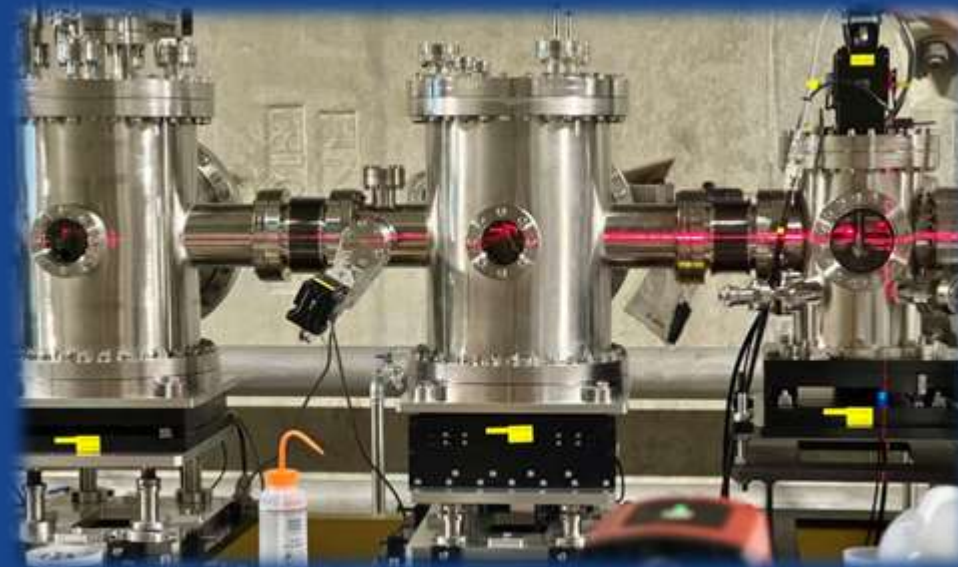
SHINE TECHNICAL ADVISORY COMMITTEE MEETING · OCTOBER 2026

Recent progress of pulse energy and position diagnosis in SHINE project

X-ray gas monitor detector (XGMD) & huge-aperture multipliers (HAMPs)

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SHINE

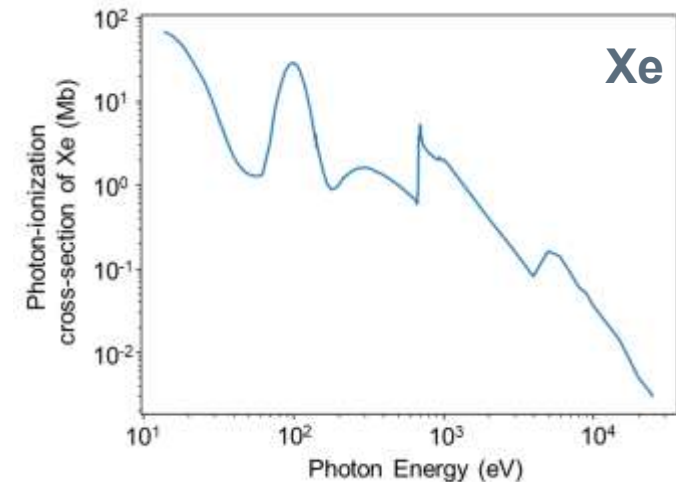
Energy and angle vary pulse to pulse.
Each pulse needs an intensity reference.

USED FOR

- ✓ Normalise endstation data
- ✓ Beam path monitoring and feedback
- ✓ Accelerator lasing state monitoring

Challenge:

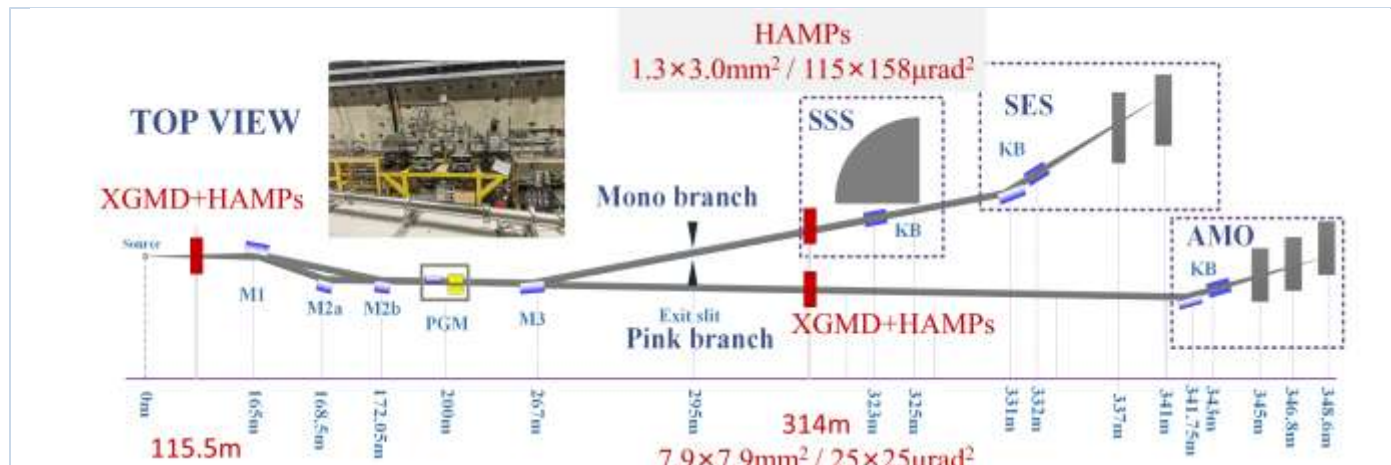
Much lower cross-section in HX range



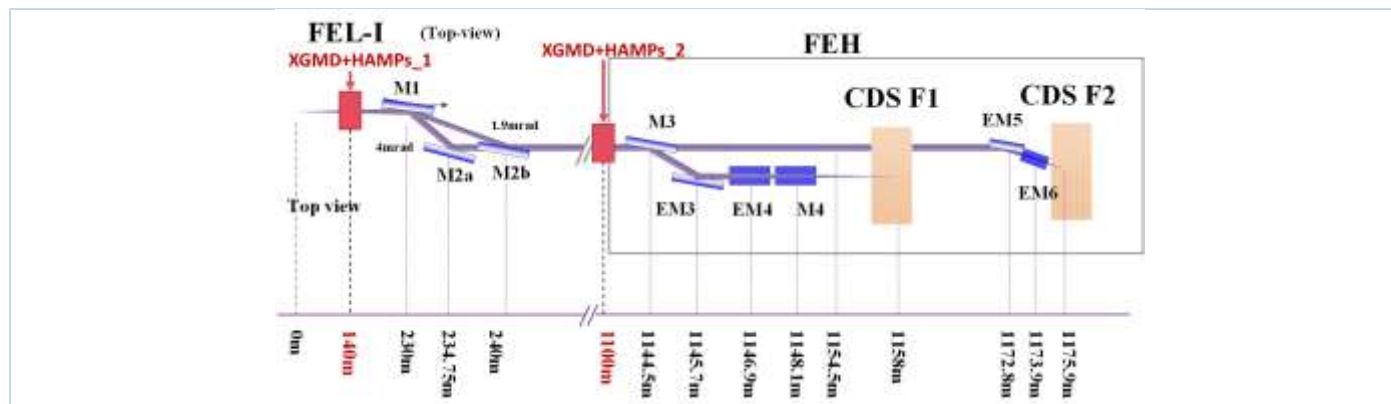
ENERGY
 $\leq 10\%$

POSITION
 $\leq 10\%$

RATE, UP TO
1 MHz



FEL-II layout.



FEL-I layout.

FEL-II**3 sets:**

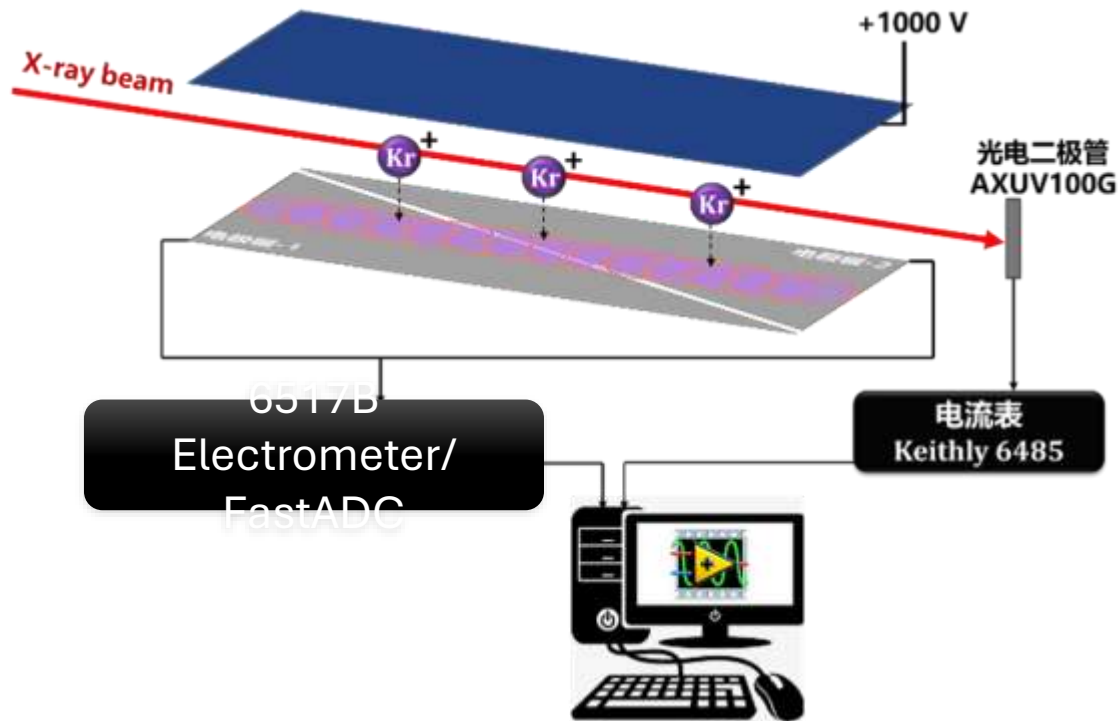
115.5 m, + pink & mono at 314 m

FEL-I**2 sets:**

140 m and 1100 m

FUNCTIONS

- Energy and position monitoring
- Monitoring of BL reflectivity
- Beam path feedback



X-rays ionise the gas. The bias collects the ions, and the current follows the photon flux.

Xe, Kr or Ar at 5×10^{-4} Torr.

CALIBRATION CHAIN

1 Photons per pulse



2 $k = I / \Phi$
 7.52×10^{-23} C/photon



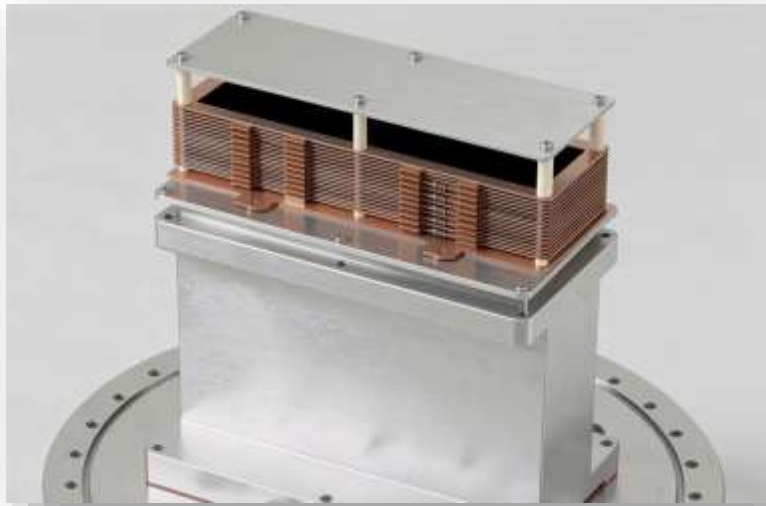
3 Charge Q_{acc}



4 Fast ADC $\int V dt$



5 $N_i = \int V_i dt / (A \cdot k)$

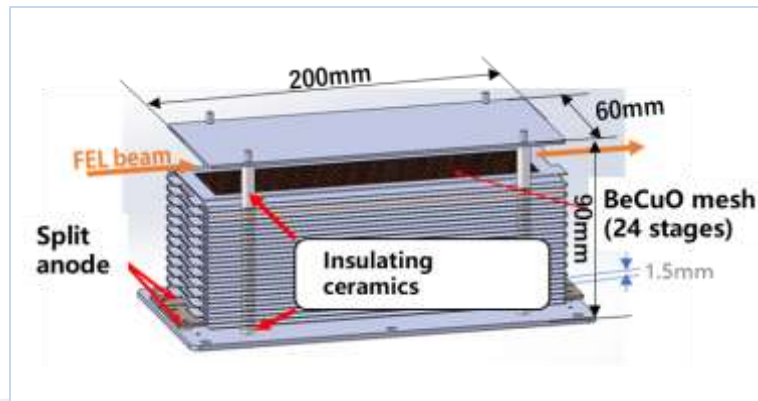


Length	200 mm
Stages	24 CuBeO grids
Voltage	0 ~ 10 kV
Max gain	5E4 at 7 kV
Position	split anode
Pumping	5 orders, $\Phi 10$ mm
Adjustment	XY ± 10 mm



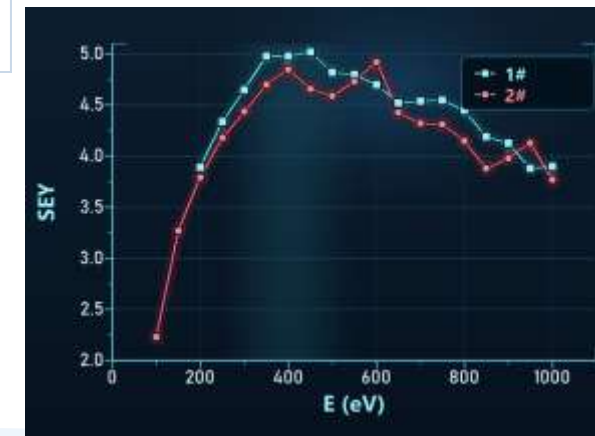
CuBeO grids.

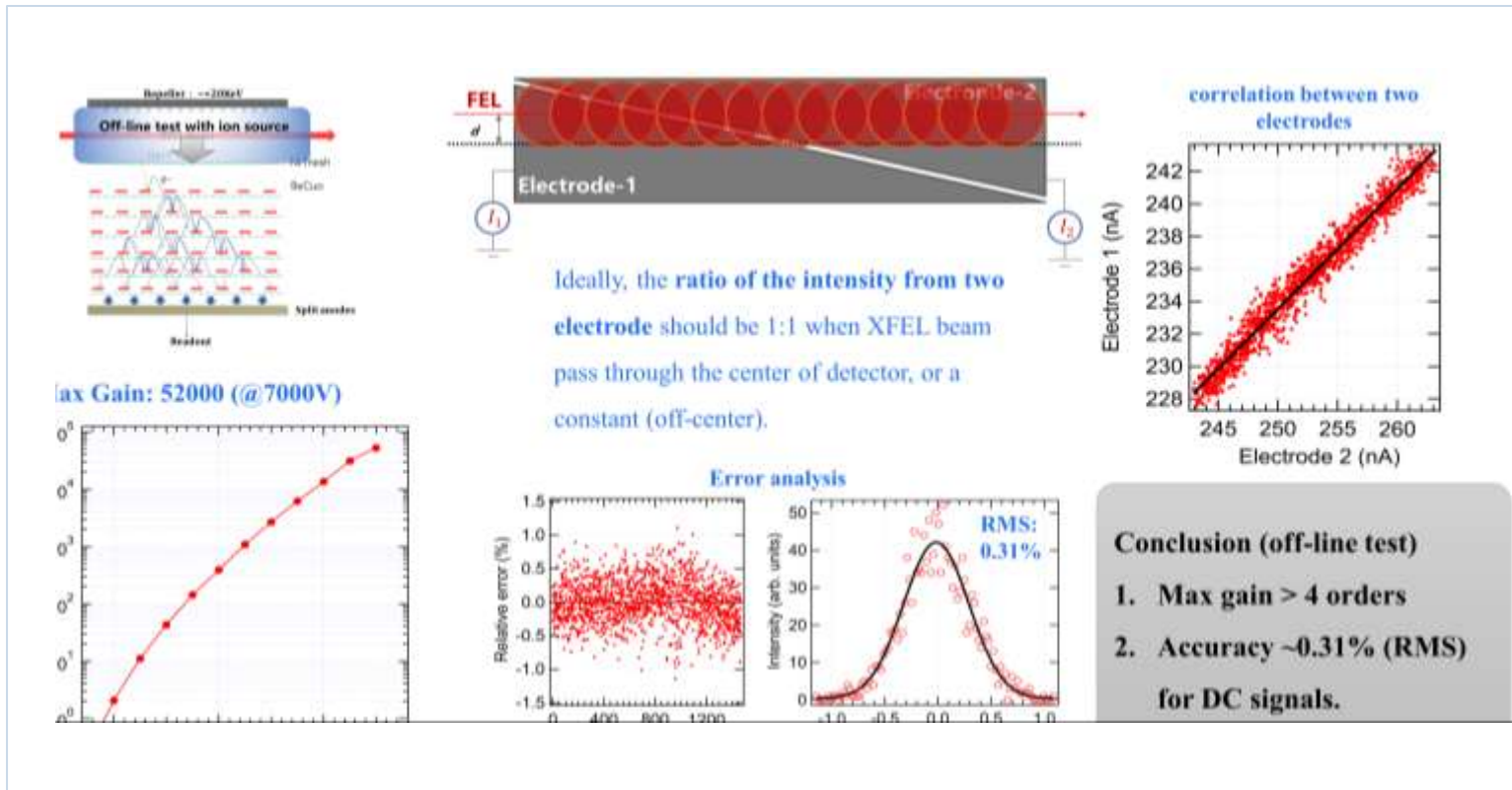
Maximum emission rate:
4.8 ~ 5.0 @ 400V



Split anode for the beam position.

$$\text{Position: } d = (H/2) \cdot (I_1 - I_2) / (I_1 + I_2)$$





Ion-source test bench.

MEASURED

MAXIMUM GAIN

$\sim 5.2E4$

at 7 kV, $\geq$ four orders

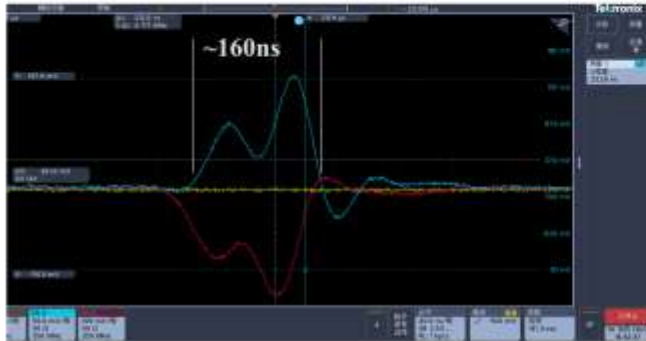
ANODE SELF-CORRELATION

0.31%

RMS on a DC signal

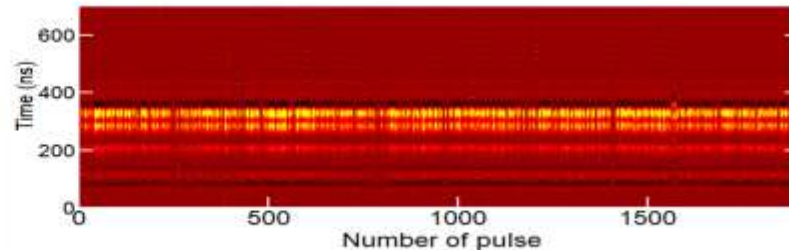
An off-axis beam gives a constant ratio between the two anode signals.

The duration ~160ns (capable for high repetition)
incident XFEL: 13.5 nm (92eV), 25Hz)



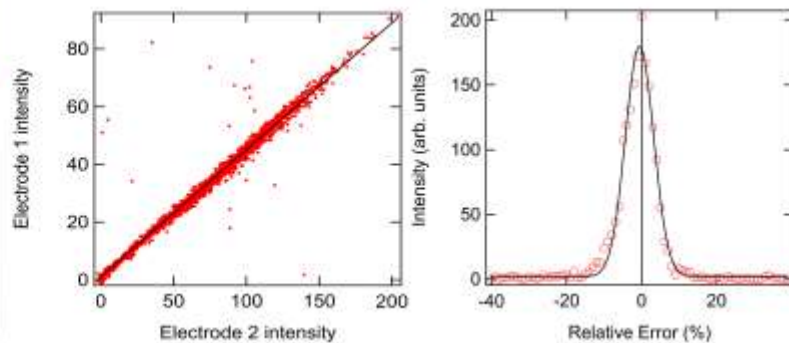
Conclusion of on-line test:

- Time duration of each multiplied pulsed signal: **160ns** --> capable for high repetition ($\geq 100\text{kHz}$);
- Accuracy test for pulsed signal: **3.8% (RMS)**, fulfill the commissioning specifications.



correlation between two electrodes

Relative error: 3.8%(RMS)



BEAM

13.5 nm, 25 Hz

SIGNAL DURATION

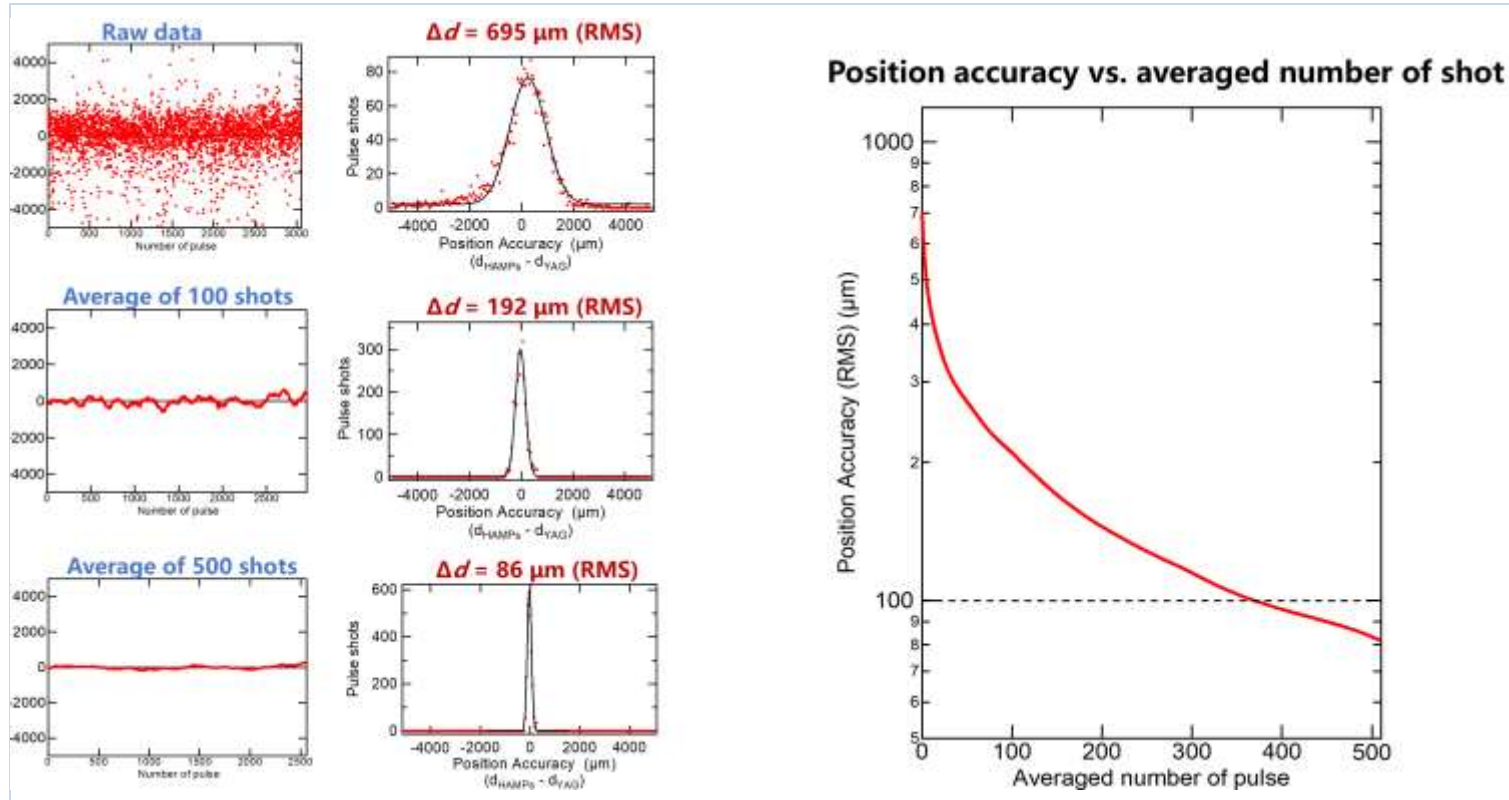
$\approx 160 \text{ ns}$
high repetition rate

SINGLE-PULSE ENERGY

3.8%
RMS, target 10%

Matches the EuroXFEL result.

Waveform, fast-ADC acquisition and anode correlation.



HAMPs against the YAG screen.

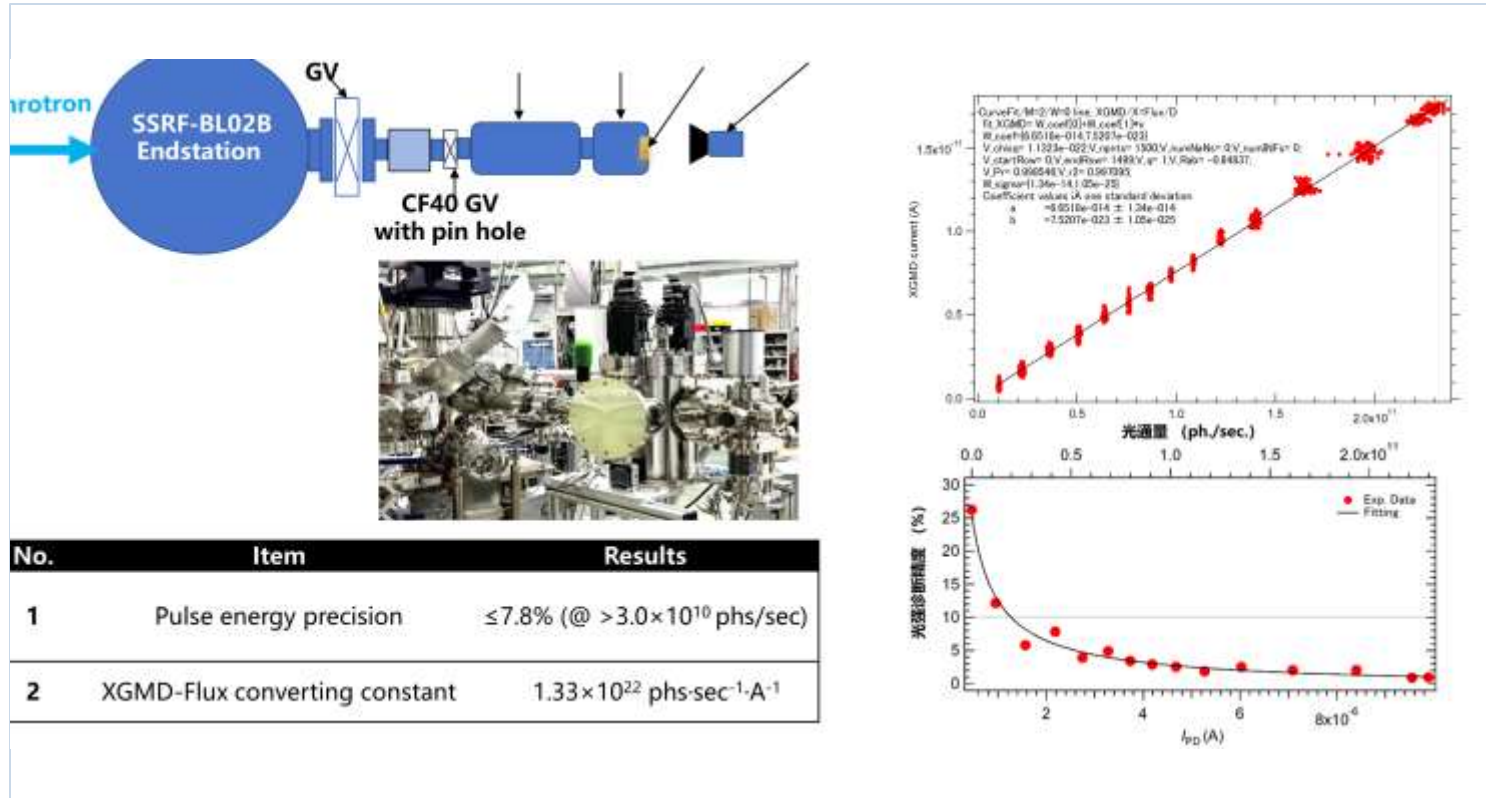
POSITION RMS

Raw data
695 μm

100 shots
192 μm

500 shots
86 μm

0.7 mm single-shot. Within
10% of spot size.



RESULTS

k	7.52×10^{-23} C/photon
Flux constant	1.33×10^{22} ph/s/A
Intensity accuracy	7.8%

Current-to-flux fit and accuracy.

Synchrotron gives absolute flux, the FEL gives per-pulse intensity.

SIGNAL PATH

Detector and HV

4–7 kV bias

**Fast ADC, PXIe**

8 channels, 1 GS/s

**FPGA per-pulse**

baseline and integral

**EPICS and storage**

10 Gbps link

HARDWARE

Digitizer

PXIe-X1073

Sampling

1 GSPS

Resolution

16 bit

Bandwidth

DC–300 MHz

Channels

4 per card

Host

x86, 4 TB

Remote access of 8- axes
through EPICS network.



RESULTS

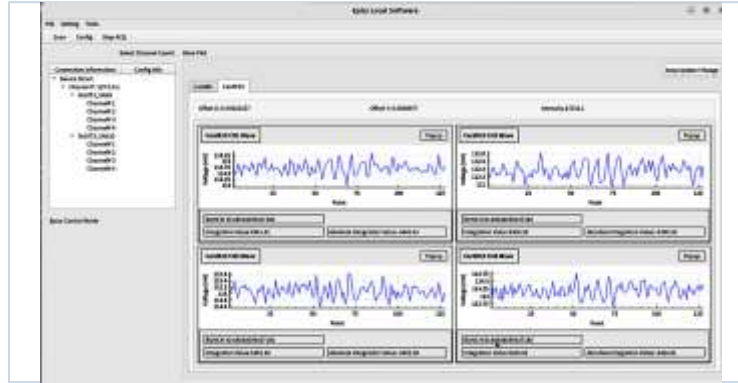
Chamber, 4 axes	1000 μm step, limits OK
XGMD plates, 4 axes	100 μm step, OK
Devices tested	FEL-II 115 m, 314m(pink&mono)

All axes reached their limits and returned correct values.

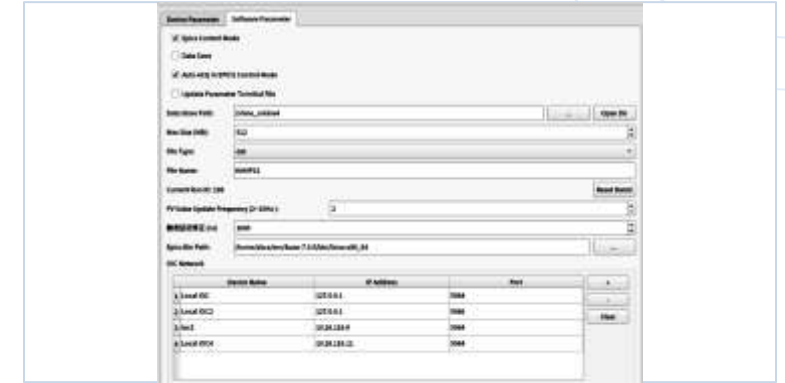
Remote access of Fast ADC (IOC program)



Digitizer setting



Multi-channels acquisition with bunch ID



Storage path

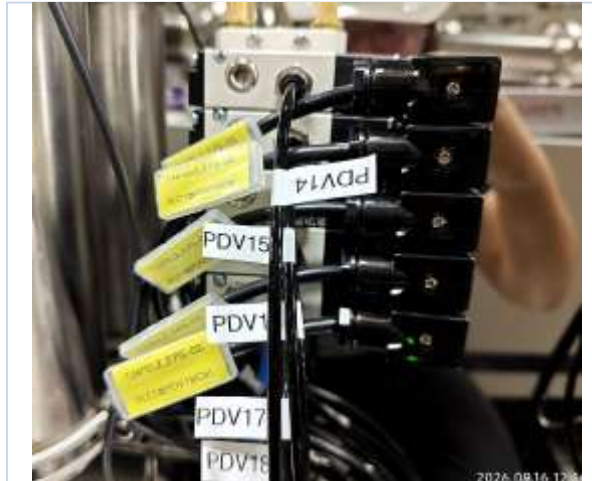
Acquisition	128 ns, 50 mV, delay 0–512 ns
Bunch ID	8 channels aligned
Storage	/shine_online4, continuous ID
Remote restart	IOC back in ~30 s

Remote control of gas inlets:

- Gas type (Ar, Kr, Xe...)
- Set working pressure



Gas branches



Selection valves

RESULTS

Item	Measured	Pass
Base vacuum	2.5×10^{-8} Torr	Yes
Dosing pressure	5.00×10^{-4} Torr	Yes
Upstream	1.2×10^{-8} Torr	Yes
Downstream	9.92×10^{-9} Torr	Yes

Kr to Ne switching verified through EPICS.

The devices do not block the beam, so they run in parallel with the optics.

Beam conditions	200 eV, 10 μ J, 10 Hz
Gas configuration	Kr at 5×10^{-4} mbar
Detector alignment	On beam path $\rightarrow$ equal anode signals
Energy accuracy	two-anode correlation, $\leq 10\%$
Position accuracy	multi-pulse average

6 days, in parallel with the other diagnostics.

RISK 01**Sensitive to air**

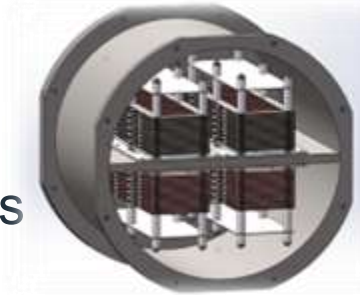
Air exposure degrades the multiplier.

Solutions:

Vacuum storage containers

Mount only when pumping is ready

Dry-nitrogen vent only

**RISK 02****High-rate data volume**

Correlation test between different device in high repetition condition

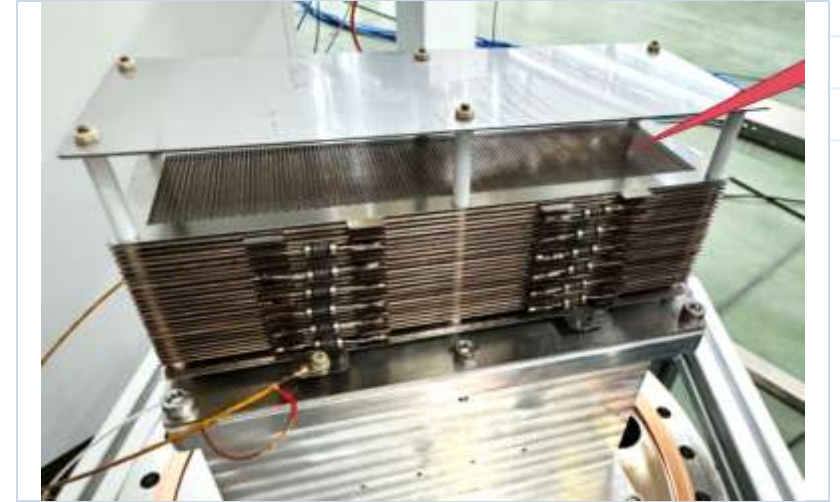
Solutions:

Still working with DAQ group and supply company...



- ✓ XGMD+HAMPs for FEL-II accepted; FEL-I assembled and tested.
- ✓ Energy accuracy 3.8% RMS (single pulse)
- ✓ Position 695 μm raw (single pulse), 86 μm after 500 shots
- ✓ **Remote access of FastADC, motors, gas inlets, ready to use**

Next: phase I beam commissioning and cross-device correlation



HAMPs module in the tunnel

**Thank you for your
attention.**