

General Experimental Technologies for SHINE FEL-II: Commissioning Readiness and System Integration Progress

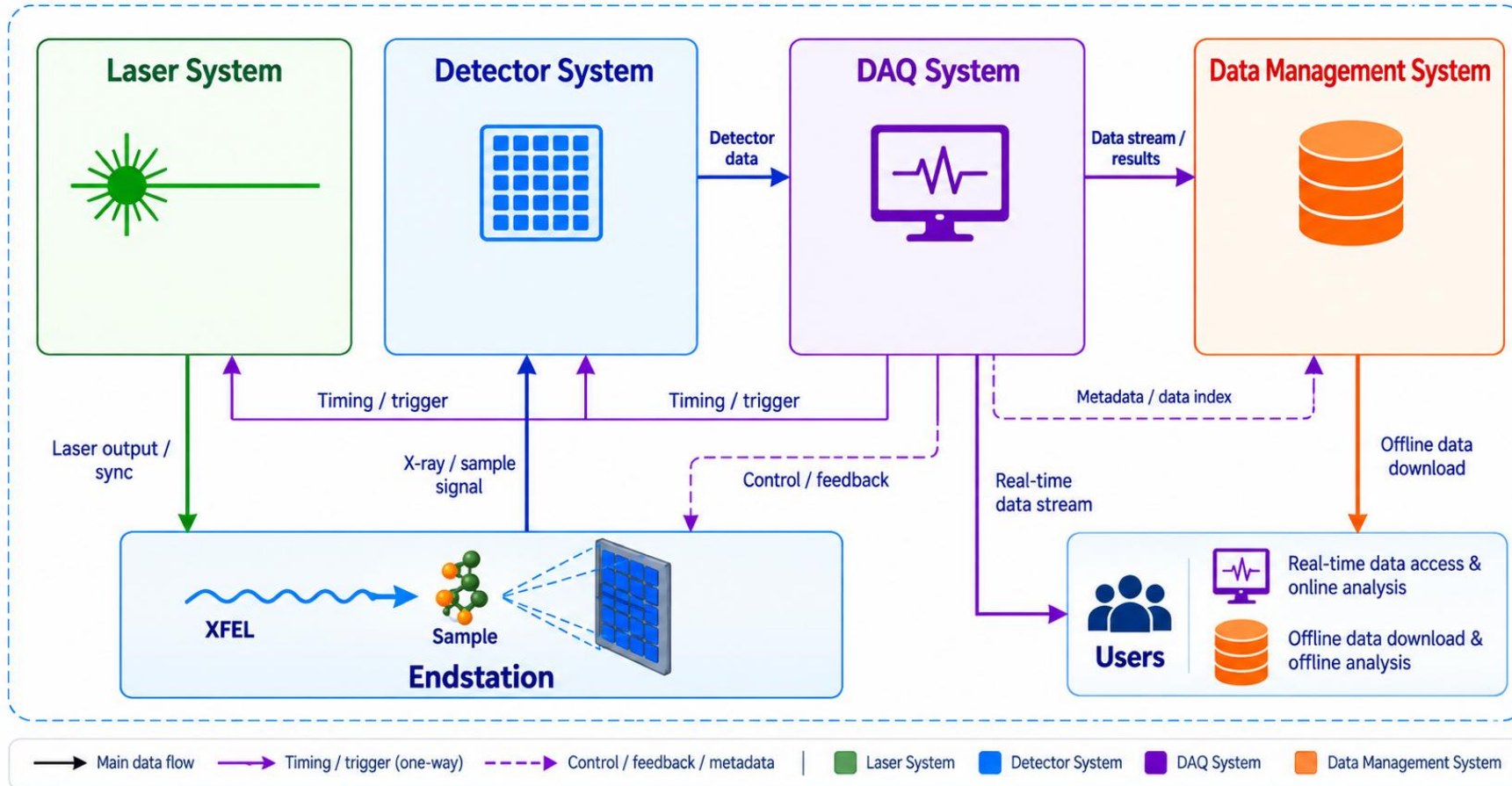
Ping Huai

Department of General Experiment Technologies

October 20, 2026

Integrated Experimental Technology Framework

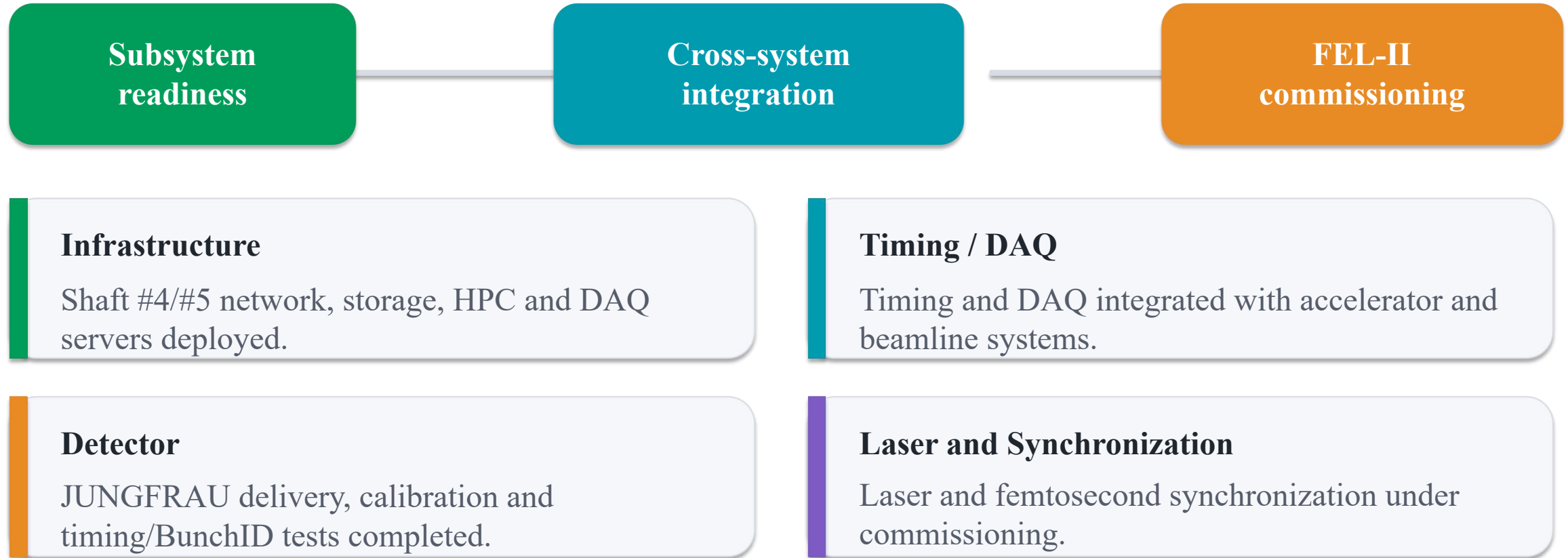
Department of General Experimental Technology



The value of General Experimental Technologies is the verified end-to-end chain:
laser → pump-probe experiment → detector → timing/DAQ → data.

From Delivery to Commissioning

2026 objective: from separate subsystem delivery to an integrated FEL-II commissioning platform.



Since the April TAC, the emphasis has shifted from “components completed” to “interfaces validated”.

Overall Commissioning Readiness

Data infrastructure

Integrated and tested network, storage, DM with DAQ

DAQ

Integrated and tested AMO/SES tests & beamline diagnostics integration

Timing

Integrated and tested Joint tests with accelerator timing; stable operation

Optical Laser

Integration in progress AMO/SES test platform and delivery plan for other endstations

Synchronization

Tested Shaft #2–#4 phase-stabilized link demonstrated

Detector

Lab-validated/Ready for installation JF4M/JF500K calibration and timing tests completed

Green indicates ready or already integrated;
orange indicates partly ready or awaiting final on-site integration.

1. Optical Laser Systems for Endstations

SES is the first on-site commissioning platform; commercial systems for other end-stations scheduled for delivery by the end of December, 2026.



**Self-developed high-repetition-rate laser
for SES**



**Commercial laser: LC CB3-29W, 1030 nm
/ 100 kHz / 29 W**

On-site commissioning of the SES laser platform is under way.

Femtosecond Synchronization System

~ 0.4 fs

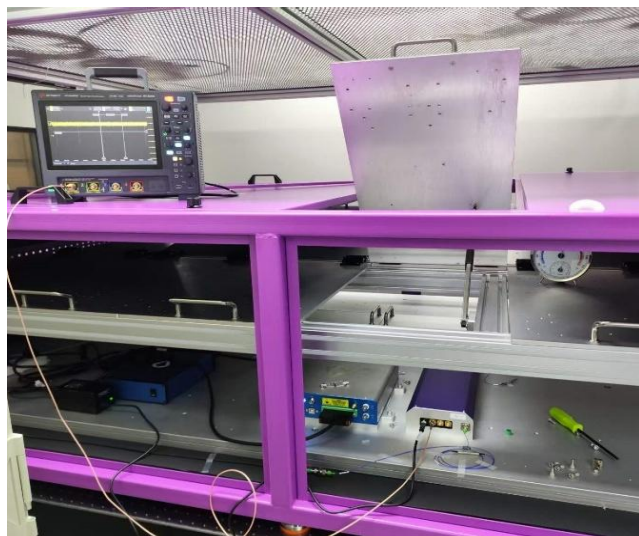
integrated jitter RMS
[1 Hz, 10 MHz]

Commissioning progress

TSP design, fabrication, installation and commissioning completed.

Shaft #2—#4 fiber phase-stabilized link installed and commissioned.

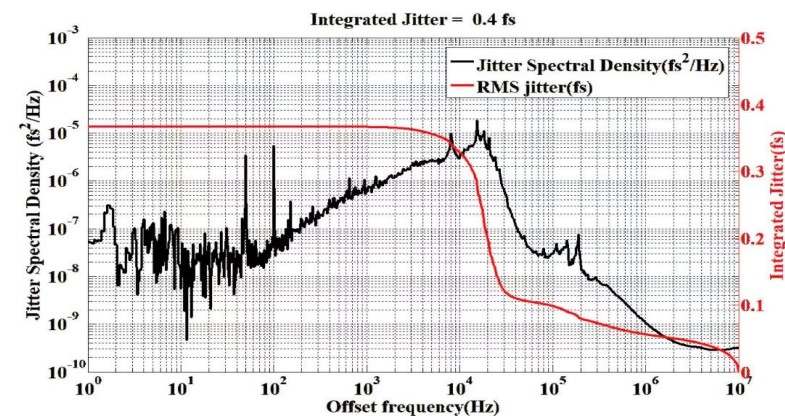
Shaft #4 OMO synchronized with the Shaft #2 OMO.



**TSP for synchronization
devices**



Electronics

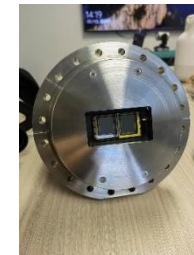


Integrated jitter result

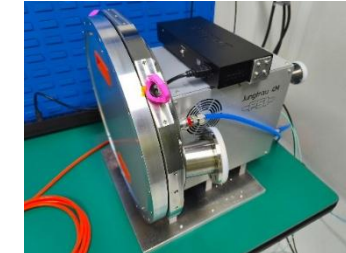
2. Detectors for Endstations

1 × JF4M
4 × JF500K
arrived at SHINE

CMOS
customized dual-sensor
detector for SSS



Dhyana XF400BSI-DS



JF4M



JF500K

JUNGFRAU detectors : high dynamic range and high frame rate for FEL-I CDS and HSS.
CMOS : FEL-II SSS

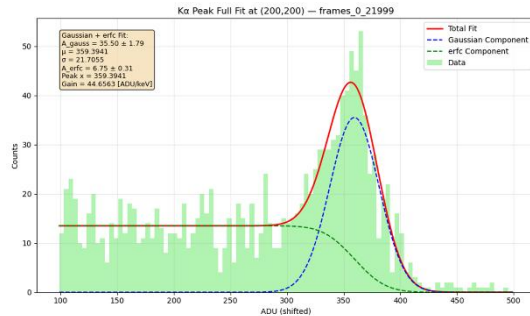
Endstation	Detector	Pixel	Array	Frame rate	Environment
CDS	Hybrid (JUNGFRAU)	75 μm	4M $\times$ 2	2.2 kHz	$\leq 10^{-5}$ mbar
HSS	Hybrid (JUNGFRAU)	75 μm	500K $\times$ 2	2.2 kHz	In air
SSS	CMOS	6.5 μm	4M $\times$ 2	40 Hz	10^{-8} mbar

Jungfrau Detector Readiness

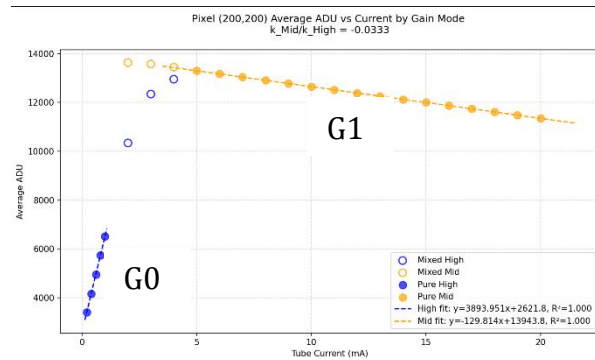
Calibration
established

Trigger & BunchID
verified

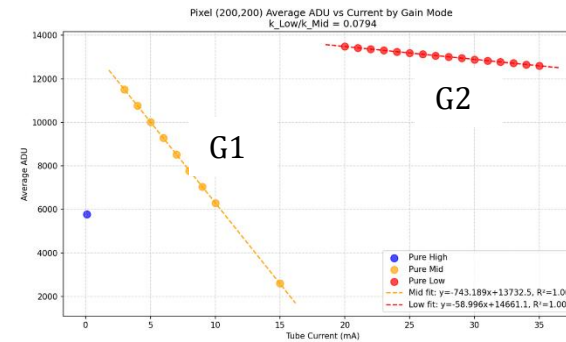
Ready for on-line
installation



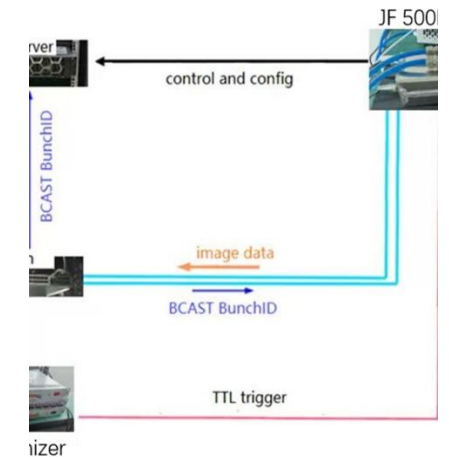
Cu K α spectrum
recorded by JF



X-ray intensity scan covering
G0 and G1



X-ray intensity scan covering
G1 and G2



JF4M test setup

Result: 1 × JF4M and 2 × JF500K are fully characterized and ready for on-line installation.

3、 Timing & DAQ Progress Since April 2026

All FEL-II timing has been deployed; FEL-I timing optical fibers & switches have been installed.



12 DAQ programs have been deployed, including 3 company-developed diagnostics programs integrated into the SHINE DAQ framework.

FEL-II DAQ Integration Status

Beamline Diagnostics

45 / 53

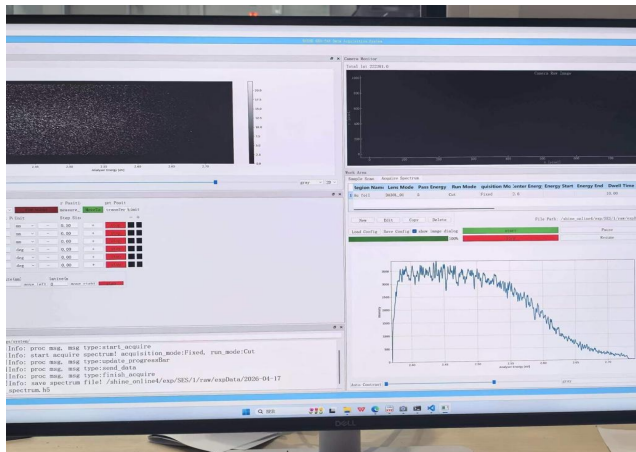
beamline devices
completed
timing-DAQ
integration

Endstation DAQ

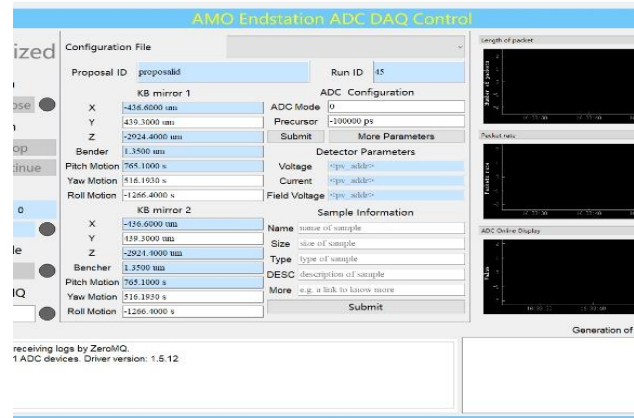
SES is online; AMO TDC has
been tested online; SSS and HSS
development is progressing.

Remaining devices

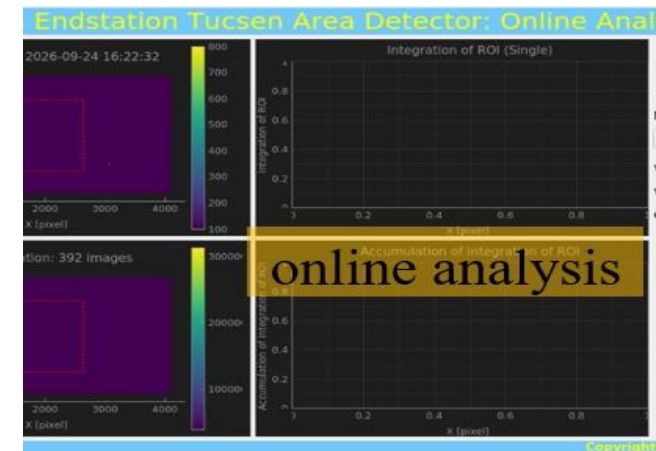
7 not required for Phase-I
commissioning; 1 under on-site
installation.



SES



AMO

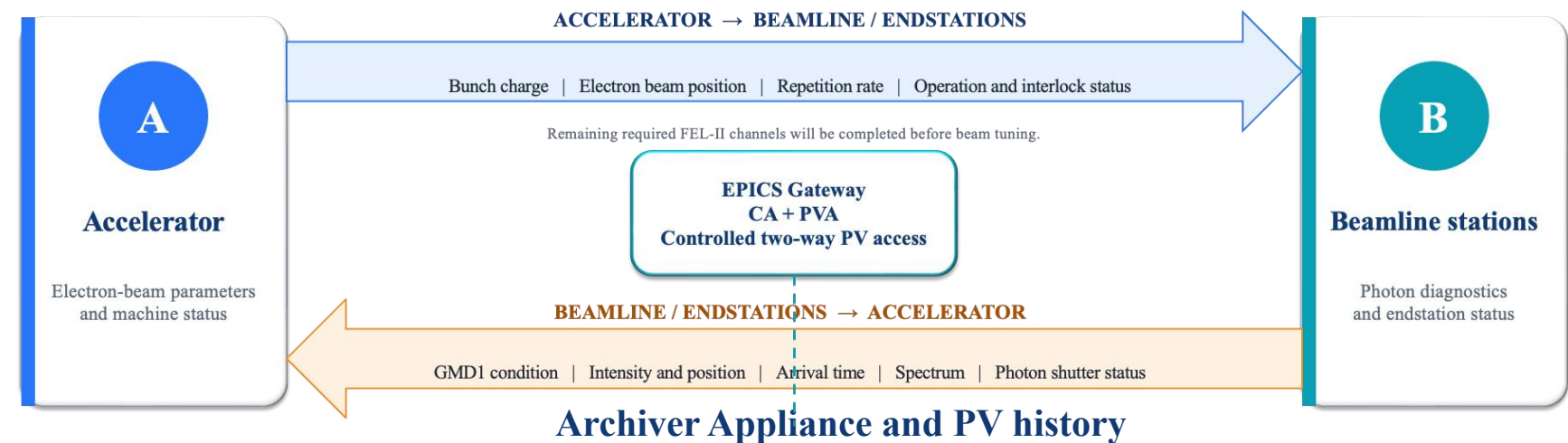


SSS

Key commissioning issues resolved: high-speed data writes to online GPFS storage and electromagnetic interference on timing trigger lines.

Accelerator–Beamline Diagnostic Parameter Exchange

Bidirectional EPICS PV exchange provides machine and photon diagnostics required for joint commissioning.



No.	Parameter	PV / Status	Unit
1	Electron energy	Not yet available	GeV
2	Electron energy jitter	Not yet available	—
3	Bunch charge	AC-LA-EXT4-BLCT01:CH2_Q	pC
4	Electron beam position	AC-UN-FEL2-BL-CBPM-CELL34-EBPM_X AC-UN-FEL2-BL-CBPM-CELL34-EBPM_Y	μm
5	Photon energy	Not yet available	keV
6	Photon energy and bandwidth	Not yet available	—
7	Accelerator repetition rate	AC-UN-FEL2-TIM-REP-RATE AC-UN-FEL1-TIM-REP-RATE	Hz
8	Accelerator operating status	Interlock status: AC-LA-INJ1-MPS:MPS00:COMLASSHUPMT AC-LA-INJ1-MPS:MPS00:TIMING_PERMIT_TO_DRIVER_LASER AC-LA-INJ1-MPS:MPS00:DEVLASSHUPMT AC-LA-INJ1-MPS:MPS00:DEV_DRI_LASER_AOM_PMT AC-LA-INJ1-MPS:MPS00:FPGA:OPERATIONMODE_I AC-LA-INJ1-MPS:MPS00:FPGA:REPETITIONMODE_I AC-LA-INJ1-MPS:MPS00:LASERMODE_SET Operating mode: Already sent to the beamline stations via hardware signals. Photon polarization: Not yet available	—
9	FEL pulse duration	Not yet available	fs
10	Vacuum pressure at the undulator exit	Please clarify which vacuum reading is required.	Pa

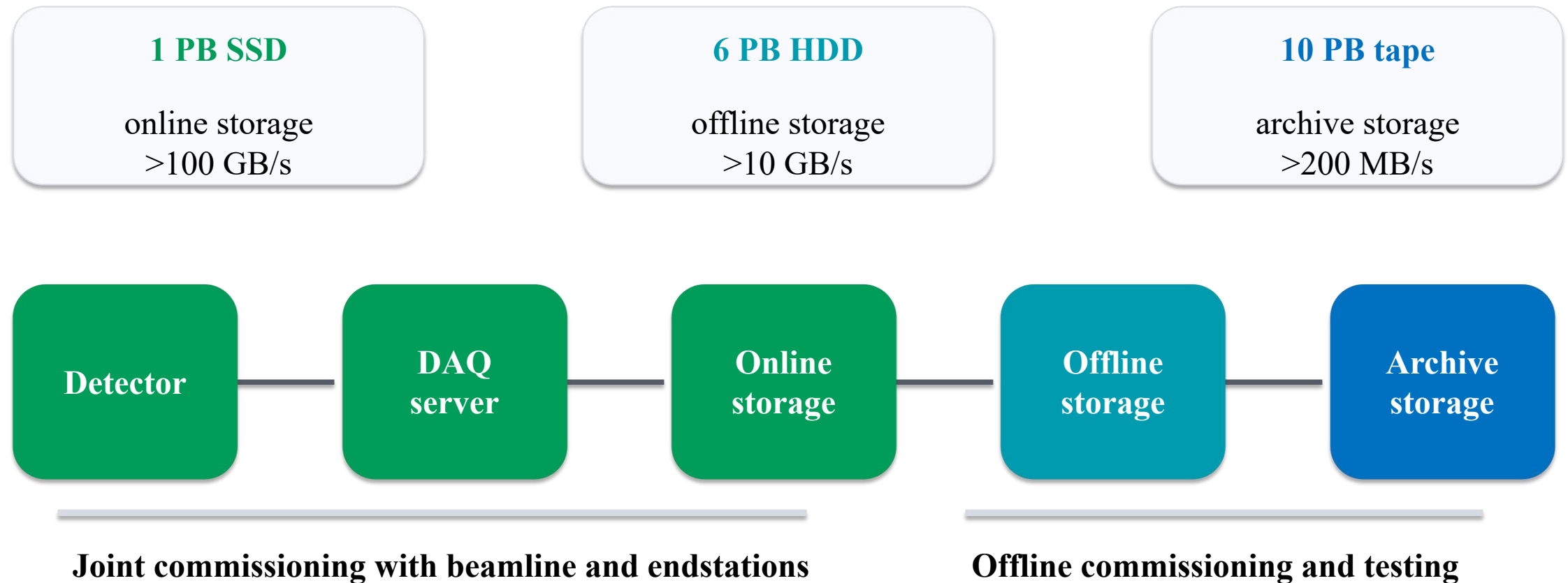
Accelerator PVs Required by the Beamline Stations

No.	Parameter	PV / Status	Unit
1	GMD1 pressure	Provided	torr
2	GMD1 gas type	Provided	—
3	GMD1 voltage	BE_FEL2_PDS:XGMD1_plusHvRead BE_FEL2_PDS:HAMPS1_plusHvRead BE_FEL2_PDS:HAMPS1_V_minusHvRead BE_FEL2_PDS:HAMPS1_L_minusHvRead	V
4	GMD1 intensity	BE-FEL2-GMD1:ADC-1:CARD1LIGHT	μJ
5	GMD1 position	BE-FEL2-GMD1:ADC-1:CARD1OFFSETX BE-FEL2-GMD1:ADC-1:CARD1OFFSEY	μm
6	Arrival time	PAM-AMO: BE-FEL2_PAM_AMO:ML:FS-RESULT PAM-SES: Not yet available	fs
7	Spectrum	BE-FEL2-PDS:PES:Card1Channel1EnergyData BE-FEL2-PDS:PES:Card2Channel1EnergyData BE-FEL2-PDS:PES:Card3Channel1EnergyData BE-FEL2-PDS:PES:Card4Channel1EnergyData	—
8	Photon shutter status	Provided	—

Beamline PVs Required by the Accelerator

4. Data Infrastructure for FEL-II Commissioning SHINE

Core infrastructure is now in place for FEL-II commissioning: Shaft #4/#5 network, online storage, online HPC and DAQ servers.



Progress of Joint Network Commissioning

Acceptance completed

FEL-II Beamline Diagnostics
FEL-II SES / AMO

In progress

FEL-I HSS / CDS
FEL-II SSS

Network deployment and commissioning

60+
switches
deployed

50+
OPI / IOC
commissioned

10+
endstation
clients

Deployed over Shaft 3, endstations in Shaft 4 and Tunnel 3-4 in July 2026.

Network setup for Shaft 5 and Tunnel 4-5 is planned before the end of 2026.

Commissioning scope: Control / Equipment / DAQ IP configuration • AD domain • Online storage

Control Switch Equipment Switch DAQ Switch

End-to-End Workflow Validation

Data management software has been validated with the SES TAP workflow, and is ready for joint commissioning with the DAQ system of the rest endstations.

- SES TAP experimental Data Acquisition → Event building → Data transfer → Metadata registration and storage → Display and preview on the Data Portal web page
- Modules of the software run stably during commissioning and meet expectations.

Please login and select proposal ID

Proposal ID: 2025-SHINE-AMO-000002

Username: amo

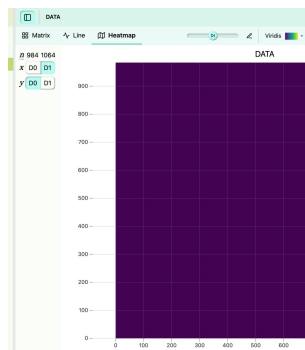
Password: ●●●●●●

Login

Start Experiment

Click "Start Experiment" to enter DAQ GUI

experiment login /
proposal selection



SES-TAP DAQ

Dataset Name	Acquire Time	Contact	Contact Email	Size
SES_TAP_2025_0001	2025-05-07 04:55:41	xm, admin		4.07MB
SES_TAP_2025_0002	2025-05-07 04:55:41	xm, admin		4.07MB

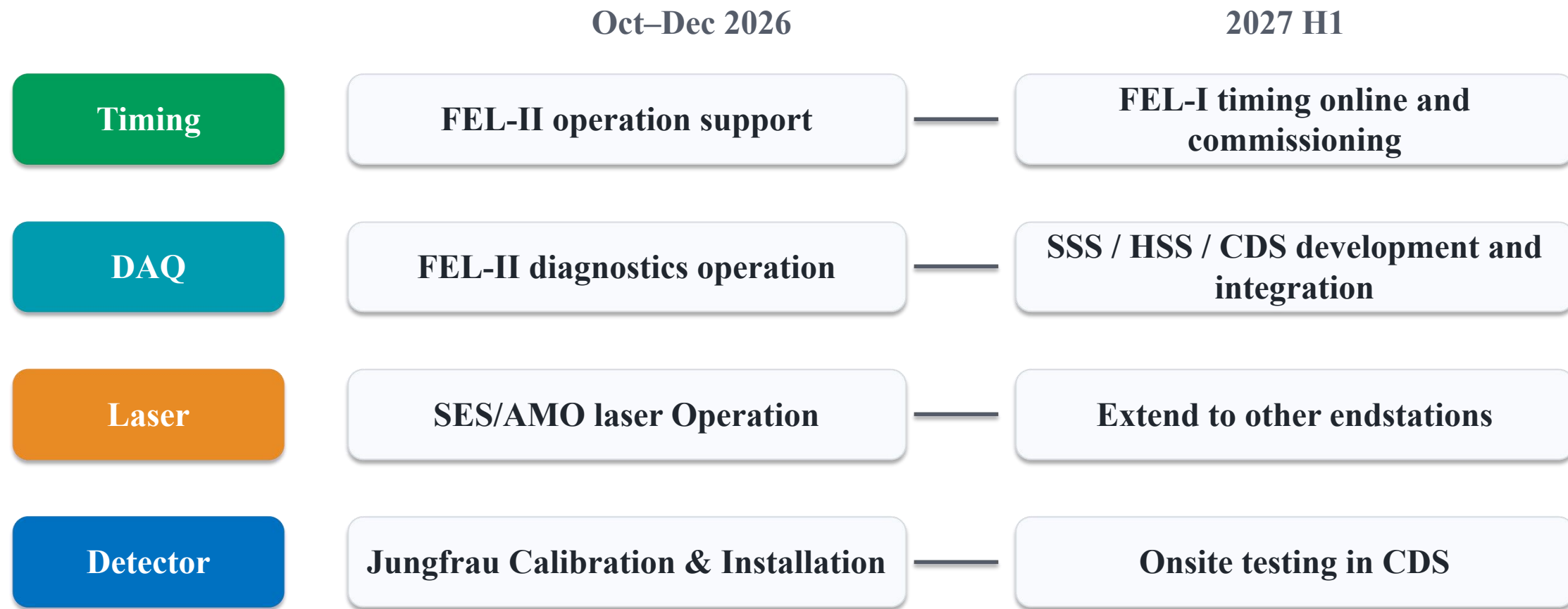
File Name	Data Size	Save Time	Storage Path
2025_05_07_10_55_36_450_runid_1_spectrum.h5	4.07MB	2025-05-07 04:55:41	/SHINE-data-offline/leg/SES/2025-SHINE-SES-0000_05_07_10_55_36_450_runid_1_spectrum.h5
2025_05_07_10_55_36_450_runid_1_spectrum-master.h5	54.29KB	2025-05-07 04:55:45	/SHINE-data-offline/leg/SES/2025-SHINE-SES-0000_05_07_10_55_36_450_runid_1_spectrum-master.h5



data-management interface

Next Commissioning Plan

The detailed schedule remains aligned with the April TAC baseline; the next phase focuses on stable integrated operation.



Primary objective: convert validated interfaces into stable, repeatable commissioning workflows.

Challenges, Risks and Mitigation

Synchronization stability

- Challenge: Long-term timing stability under commissioning conditions
- Mitigation: Continuous monitoring, feedback optimization and staged joint tests with accelerator timing

High data throughput

- Challenge: Sustained data flow from detector to DAQ to online storage
- Mitigation: Staged validation of the online/offline/archive chain and GPFS/server optimization

Multi-system integration

- Challenge: Coupling among timing, DAQ, data management and endstations
- Mitigation: Interface-by-interface commissioning and integrated rehearsals before beam operation

100 kHz reliability

- Challenge: Stable operation under high repetition rate
- Mitigation: Progressive soak tests, operational monitoring and issue tracking during commissioning

Summary

1

FEL-II support infrastructure is deployed and integrated.

Timing, DAQ, online storage and data-management workflows have completed system-level integration and joint testing.

2

Key experimental technologies are entering commissioning.

Laser synchronization has achieved ~ 0.4 fs integrated jitter; JUNGFRAU detectors have completed calibration and timing/BunchID tests.

3

The project has shifted to integrated commissioning.

The next focus is FEL-II beam commissioning, endstation integration and FEL-I deployment.

The details will be presented in the dedicated session.

Acknowledgement

This report was prepared with contributions from the following colleagues and teams:

Department of General Experimental Technology

Dr. J.M. Jiang, Dr. C.C. Yin, Dr. W.J. Shi, Dr. T.Y. Wang and other colleagues

In collaboration with

Dr. Y.B. Yan and Dr. G.H. Chen from the Division of Accelerator;
Dr. J.H. Chen, Dr. Y. Wang, Dr. X.C. Wang and Dr. M.X. Wang and other colleagues from the Division of Beamline and Endstation



Thank you for your attention!

