



中国散裂中子源
China Spallation Neutron Source



高能质子束实验终端
High-energy Proton-beam Experiment Station



Introduction and Prospects to the 1.6 GeV Proton Test Beam at CSNS



Author: Yuhang Guo, on behalf of HPES R&D Team

Institute of High Energy Physics, CAS

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**China is building its first
1.6 GeV proton test beam.**



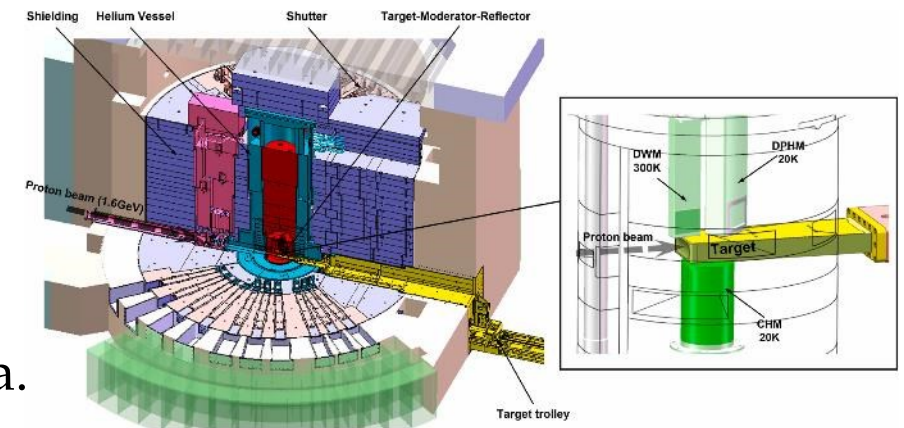
高能质子束实验终端

High-energy Proton-beam Experiment Station

Location of CSNS

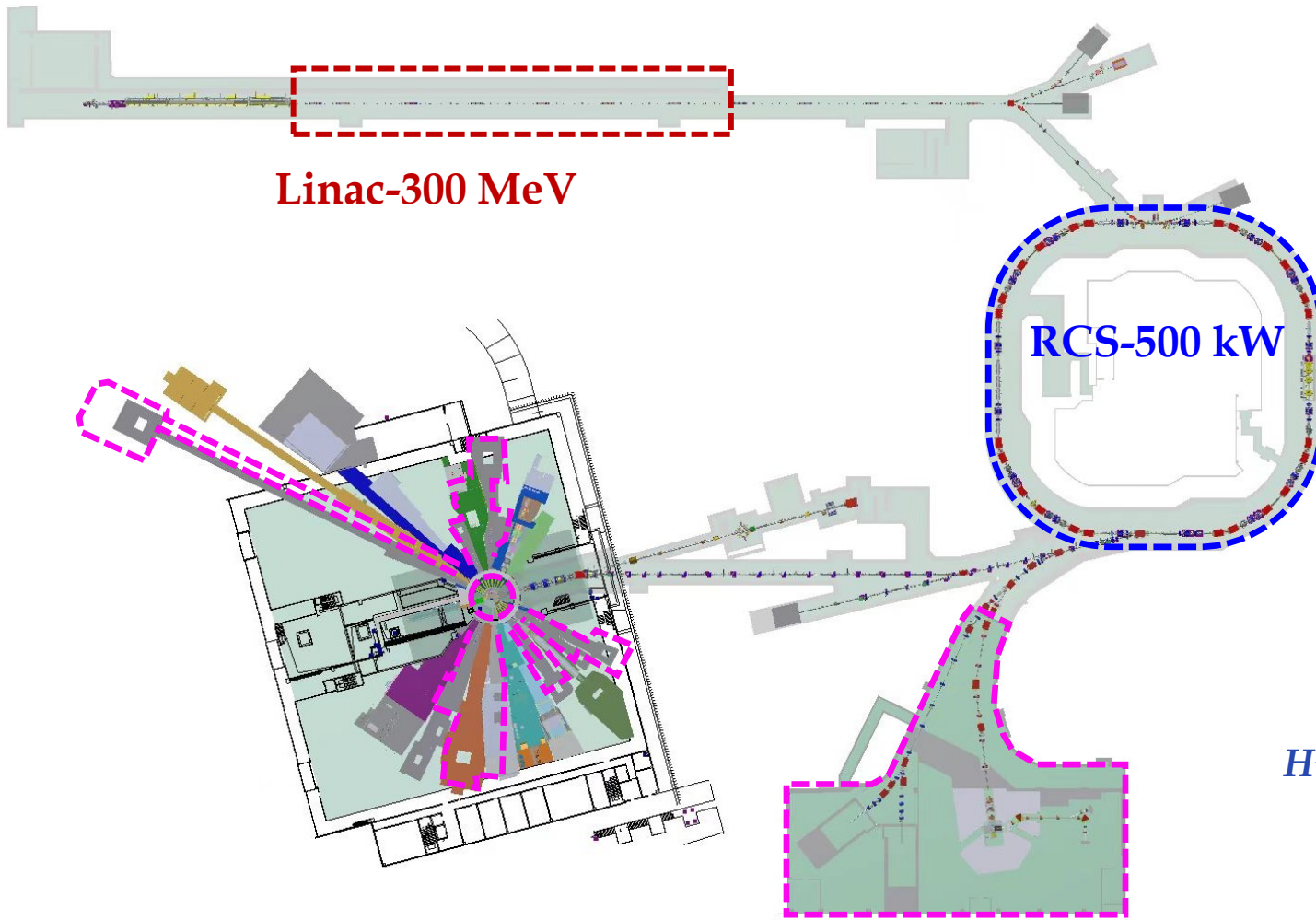


1.1 CSNS



- China Spallation Neutron Source (CSNS) @ Dongguan, China.
- Run since 2018, power: 185 kW.
- We are pushing the second phase of CSNS.

[DOI:10.1016/j.nima.2025.170431](https://doi.org/10.1016/j.nima.2025.170431)



➤ Improvement to CSNS:

- Linac energy 80 MeV → 300 MeV
- Beam power 185 kW → 300 kW
- 11 new neutron beam lines
- One Surface muon source
- One 1.6 GeV proton test beam

High-energy Proton-beam Experiment Station (HPES)

First beam delivery: 2029

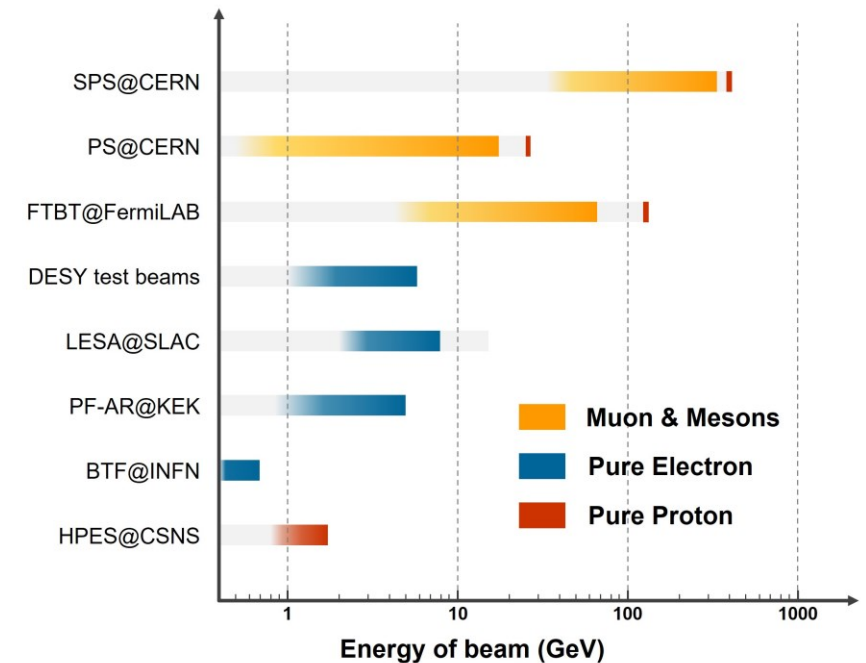
Neutron spectrometers and terminals-11 to be build

High-energy Proton-beam Experiment Station (HPES)

Bird view of HPES beam parameters

Parameters	Designed Values
Primary beam energy	1.6 GeV
Energy spread	<0.5% @ 1.6 GeV
Tunable energy range	0.8 – 1.6 GeV
Proton flux	10^3 - 10^8 p/s
General Macro-pulse frequency	25 Hz
Effective macro-pulse frequency	24 Hz
Macro-pulse length	1 ms
Interval of micro-pulse	410 ns

- ▮ **First** GeV-proton **test beam** in China.
- ▮ Flexible proton beam with flux tunable.
- ▮ Fill the absence of test beam resources in 1 GeV energy region.



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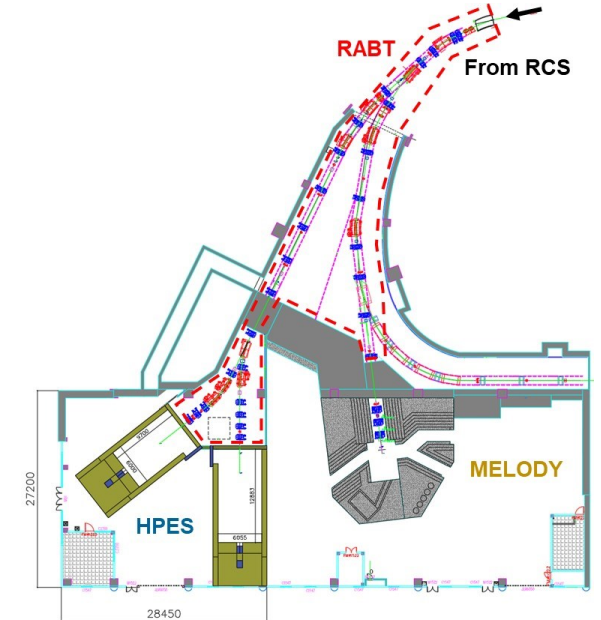
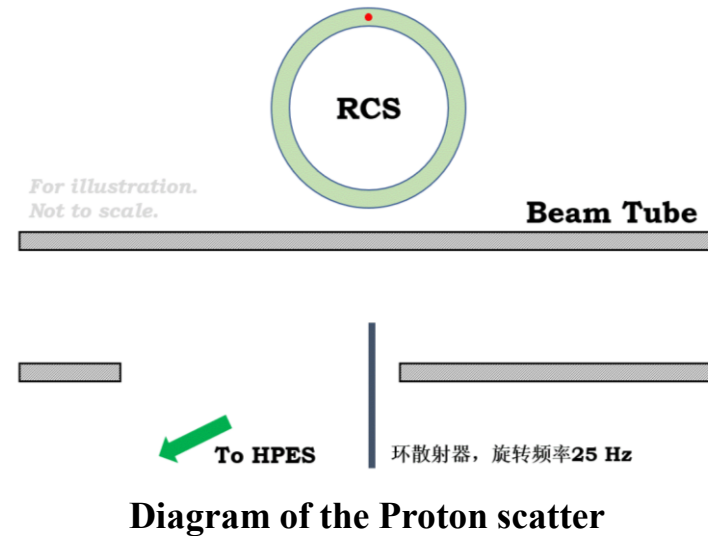
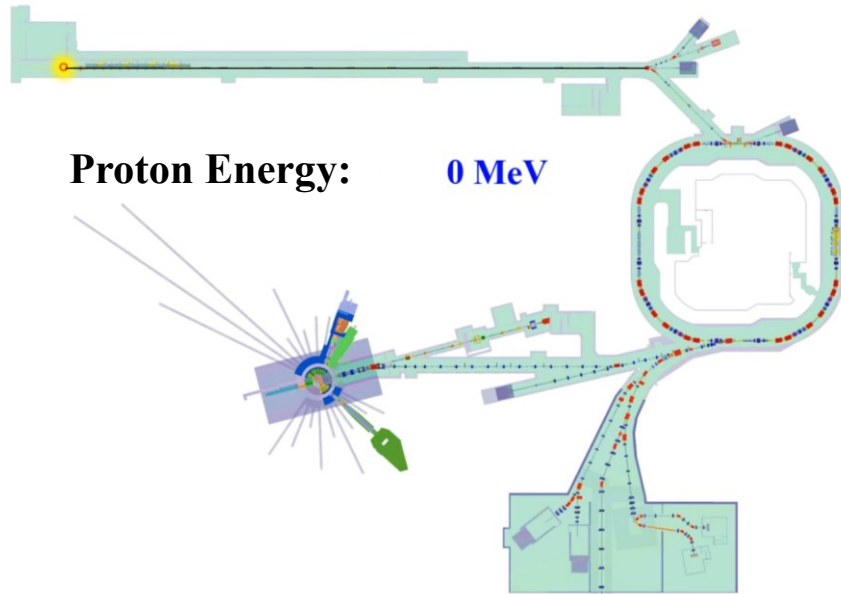
Devices in HPES Terminal



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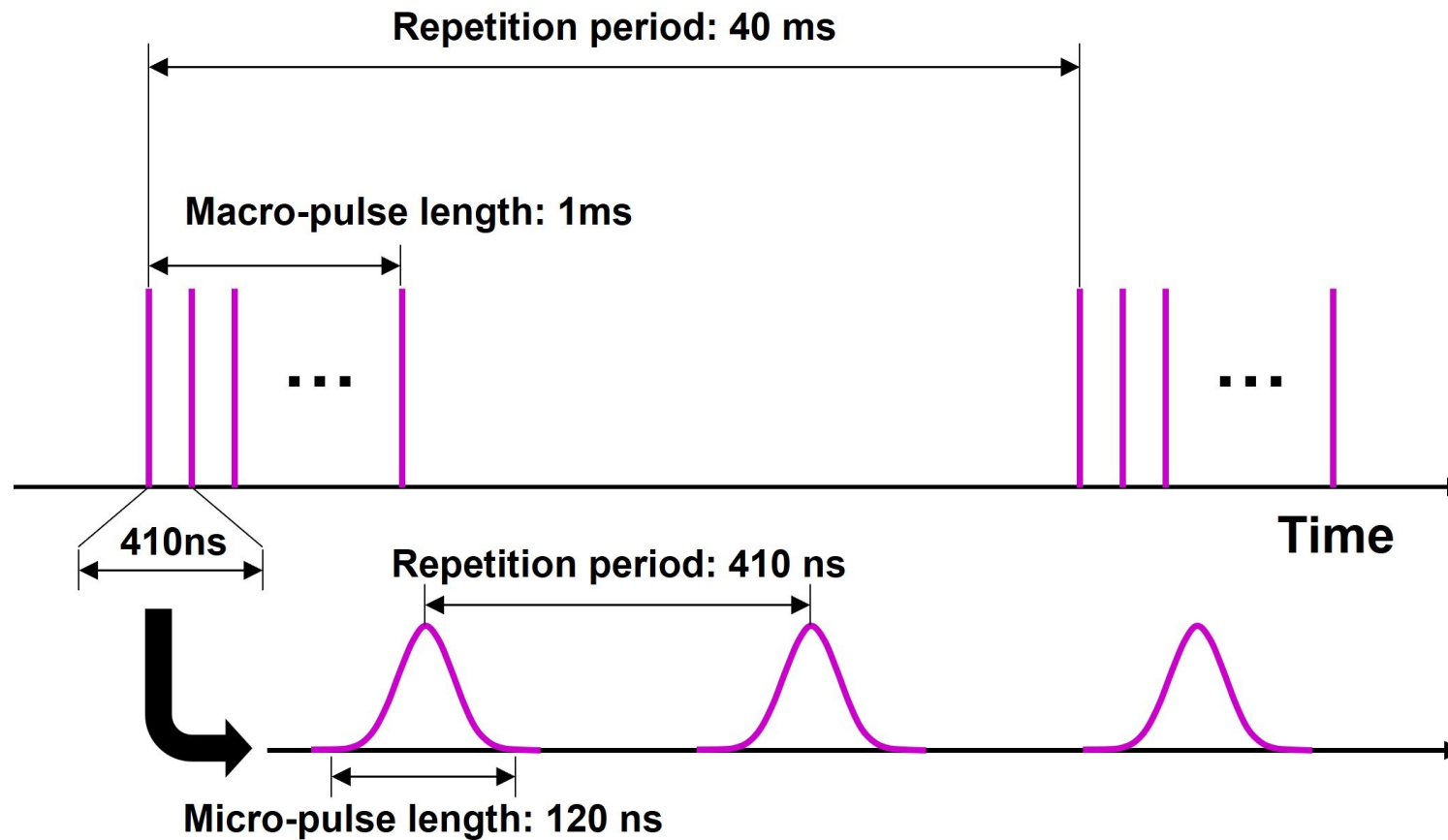
2.1 proton extraction



- The proton scatter foil rotates in 25 Hz, synchronous with beam in RCS.
- Foil will interact with beam halo when it arrives.
- Protons elastic scattering at 20 – 25 mrad will be extracted by a Lamberson Magnet.
- Extracted protons delivered by RABT to the **TWO** terminals of HPES.

DOI: [10.1103/PhysRevAccelBeams.27.070401](https://doi.org/10.1103/PhysRevAccelBeams.27.070401)

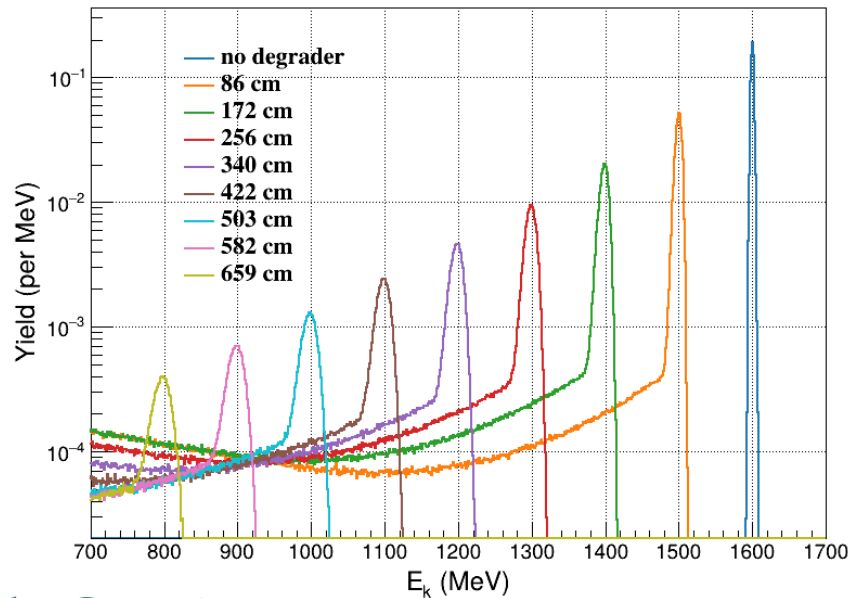
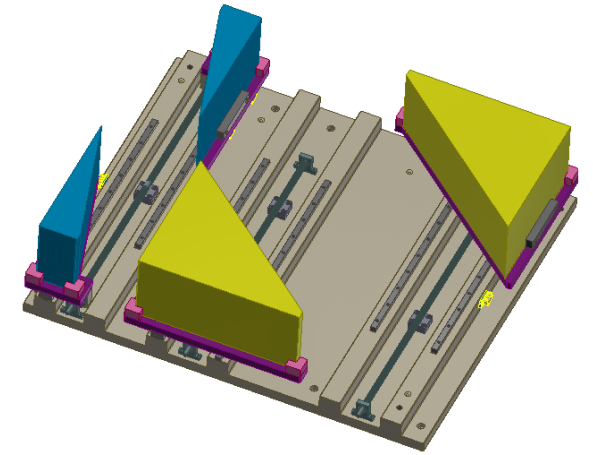
2.2 Time structure



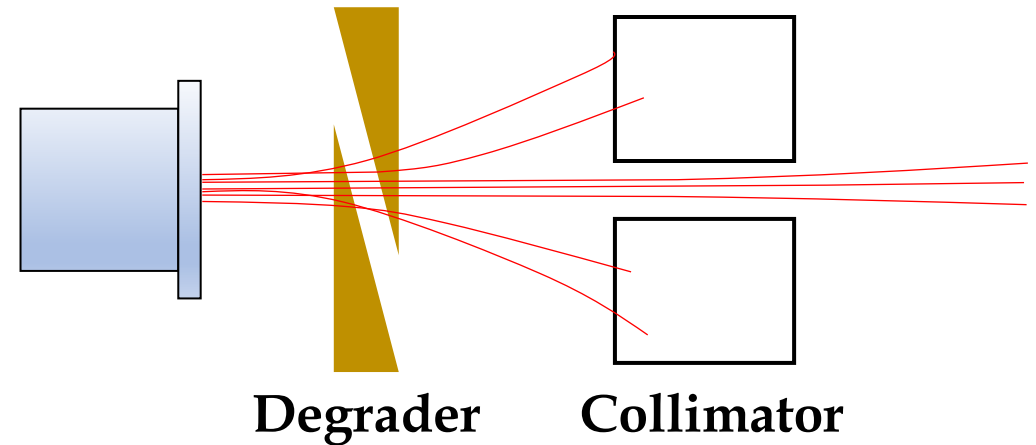
- Dual-hierarchy structure:
 - Macro pulse frequency 25 Hz (24 Hz effective)
 - Macro-pulse length 1 ms, with 39 ms interval.
 - Micro-pulse distributed in the macro-pulse.
 - Each micro-pulse width is 120 ns cycled by 410 ns.

2.3 Proton energy

- Energy of primary proton beam: 1.6 GeV.
- HPES uses a degrader to tuned beam energy.
- Continuous proton energy range: 0.8 – 1.6 GeV.

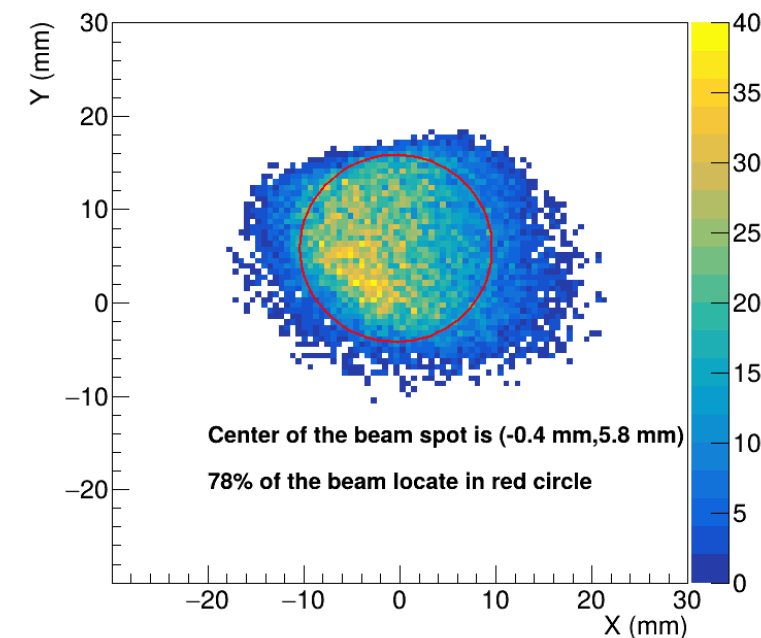
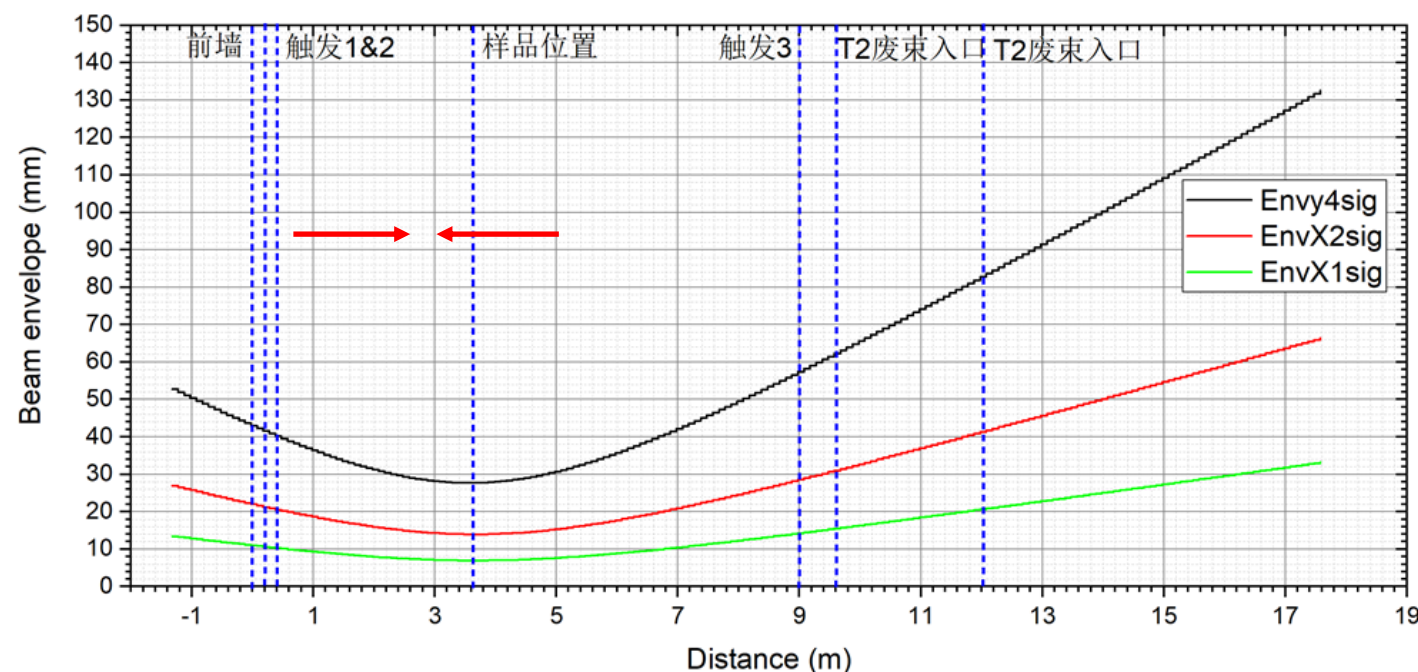


Simulated by Geant4



2.4 Proton flux and beam spot

- Proton flux and profile of HPES is tunable by collimator and scattering foil.
- Flux adjustable in 10^3 - 10^8 p/s.
- The beam spot adjustable in $10 \times 10 \text{ mm}^2 \sim 100 \times 100 \text{ mm}^2$.



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3. Devices in HPES Terminal



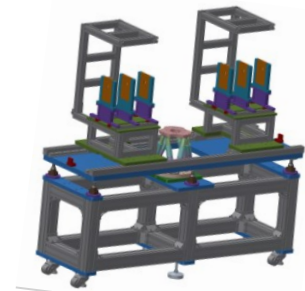
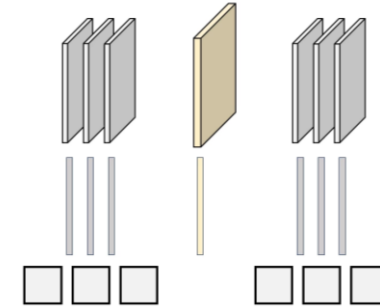
- HPES is equipped with 7 Detector In Terminal (DIT):
 - Reference DIT: providing reference information of the protons.
 - Statistic DIT: providing statistic information of the beam.

Devices		Usage
Reference DIT	HEPTel	Provide reference track of protons for tracker test, < 10μm
	LEMS	Provide reference energy of protons calorimeter test, 1% @ 1.6 GeV.
	FLASH	Provide reference to the time gate to the DUT, < 1ns.
Statistic DIT	PALET	Measure the profile of the extracted beam.
	PROUD	Measure the time structure of the extracted beam.
	BMOS	Monitor the flux of the extracted beam without interception.
	SEEM	

3.1 Reference DIT

TRACK

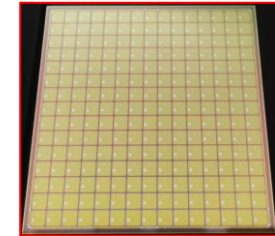
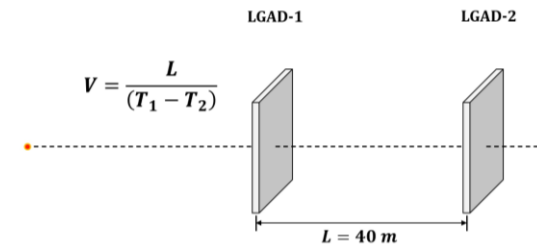
- An **EUDET**-type proton **telescope** equipped in HPES.
- 6 MIMOSA-28, DUT resolution reach < 10 μm .
- Telescope resolution is expected reach < 5 μm .
- We are also developing a telescope based on Jadepix. Prototype is under test at CERN East Area.



DOI:10.1007/s41365-024-01447-9

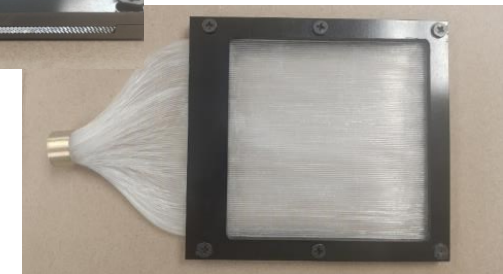
ENERGY

- A TOF spectrometer developed to measure energy.
- 2 LGAD, 40 m distance, E res. $\sim 1\%$ @1.6 GeV.
- LGAD pixels are bonded in parallel to reduce readout channels.
- Timing resolution of each ~ 100 ps.

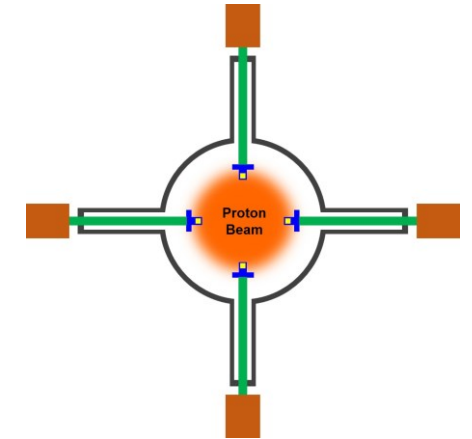
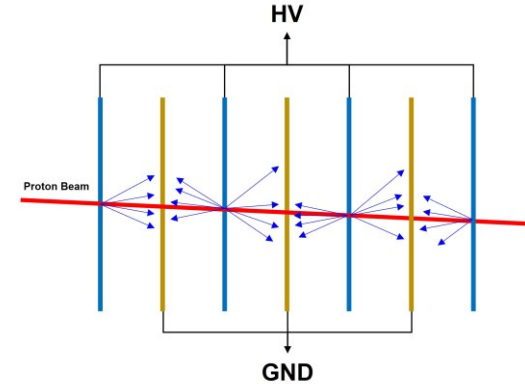
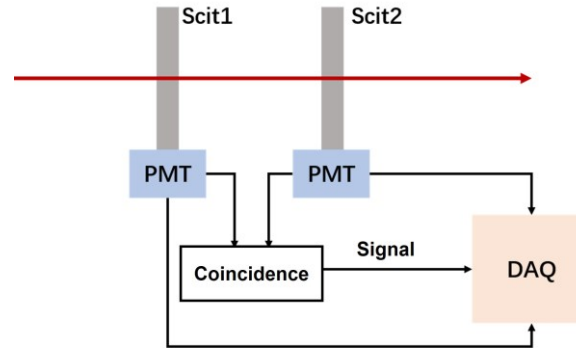
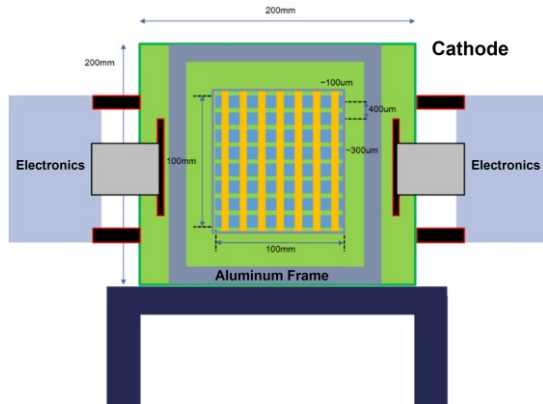


TIME

- A trigger device designed to provide time gate reference.
- Scintillator fiber coupled with PMT.
- Trigger time spread < 1 ns.
- Prototype have been tested at CERN North Area.



3.2 Statistic DIT



PALET

Profile Detector

Micromegas

Positioning Res. 0.3 mm

PROUD

Beam Structure Calibrator

Plastic Scintillator

Dyn. range $1-10^4$ p/pulse

SEEM

Flux Monitor

Aluminum Multiplier

Intensity $> 1E4$ p/s

BMOS

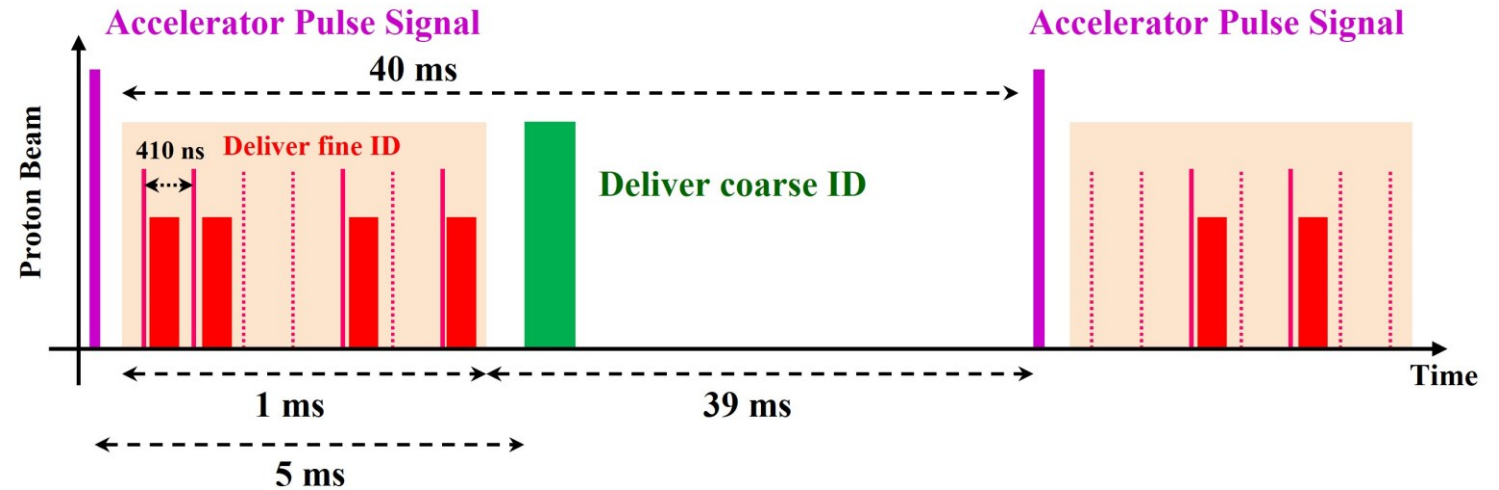
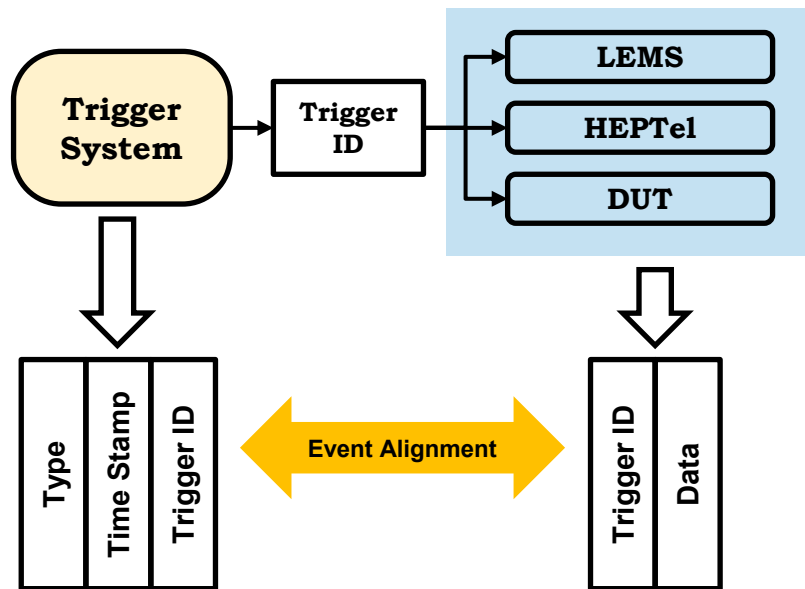
Flux Monitor

Silicon Carbide

Intensity $< 1E5$ p/s

3.3 Trigger Logic Unit

- Rigorous alignment proton by proton is required by tracker and calorimeter tests.
- A trigger logic unit has been designed in HPES **based on AIDA-2020 architecture**.
- Trigger ID will be fan out to DUT and DIT and packed in data as label of data alignment.
- Primary tests have been carried out in SPS.



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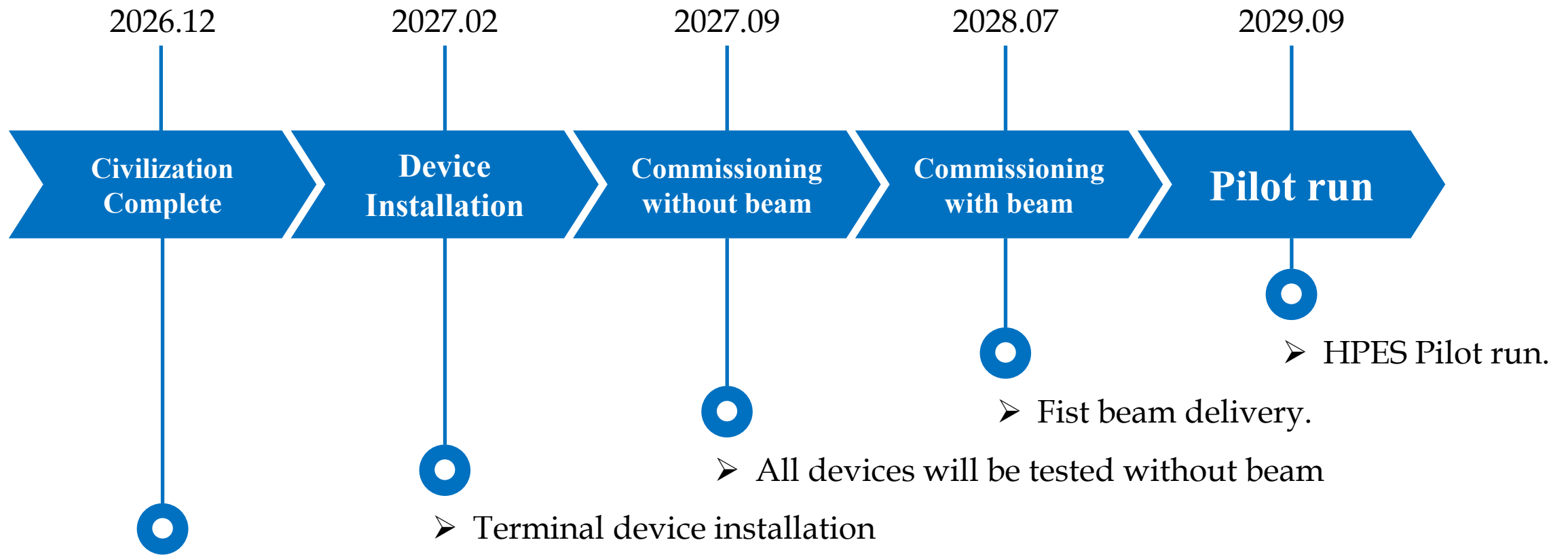
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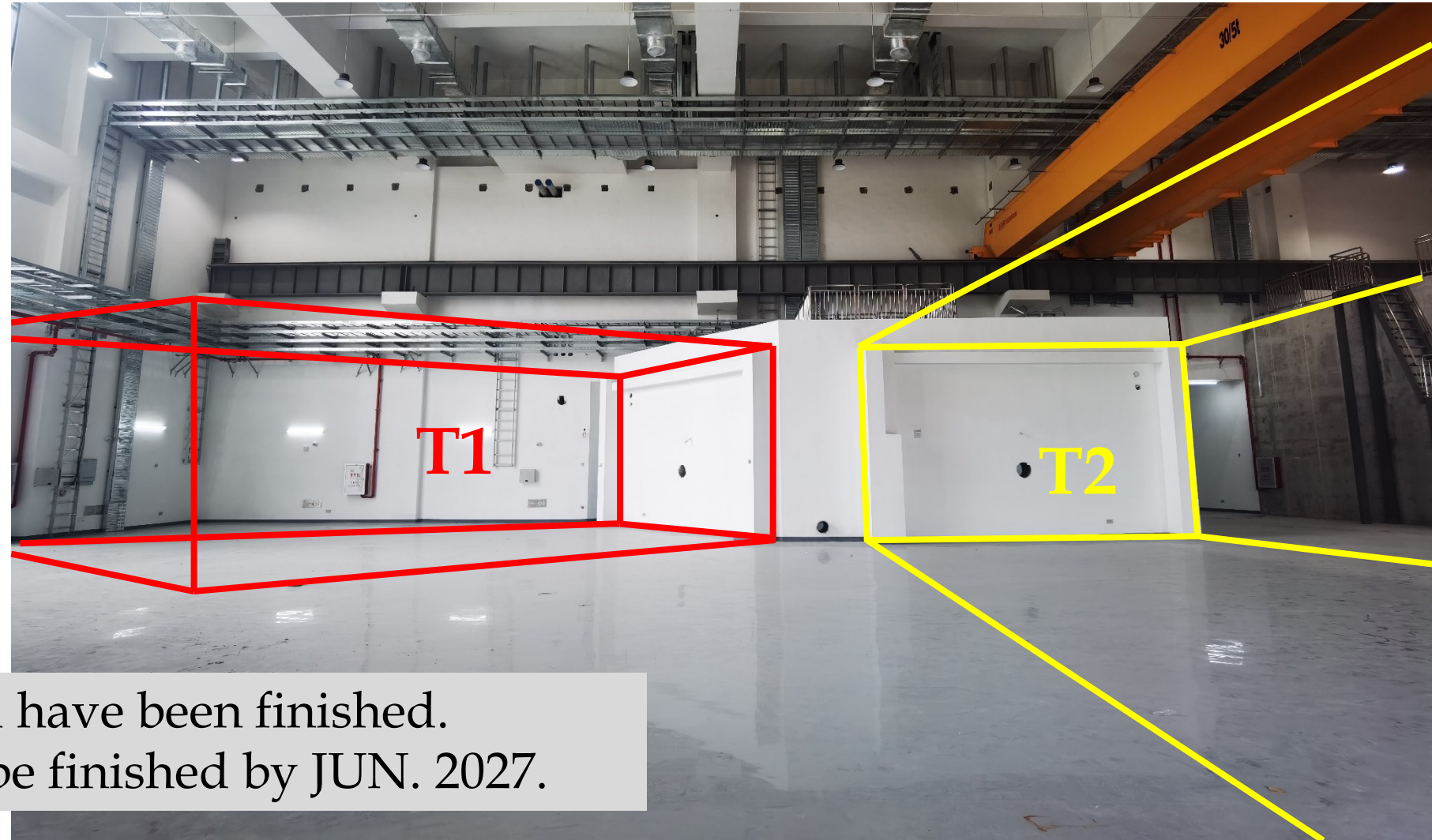
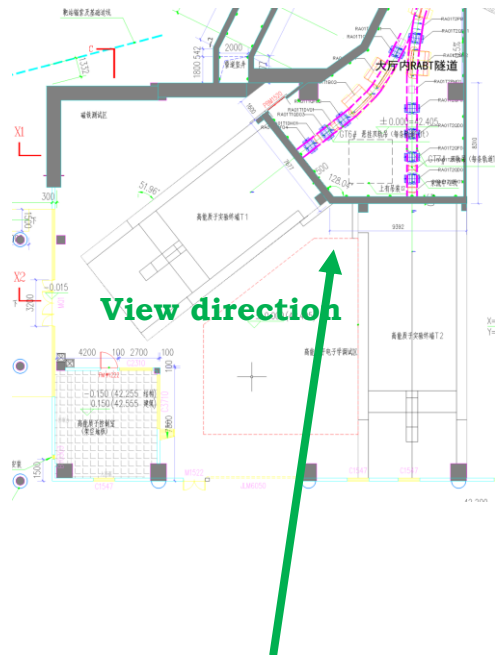
4.1 Milestone of HPES construction



- Construction of the experiment hall will be finished by summer this year.
- Devices installation will then start.

- ◆ The HPES is expected to delivery its first beam in 2029.
- ◆ More information will be updated in the future.

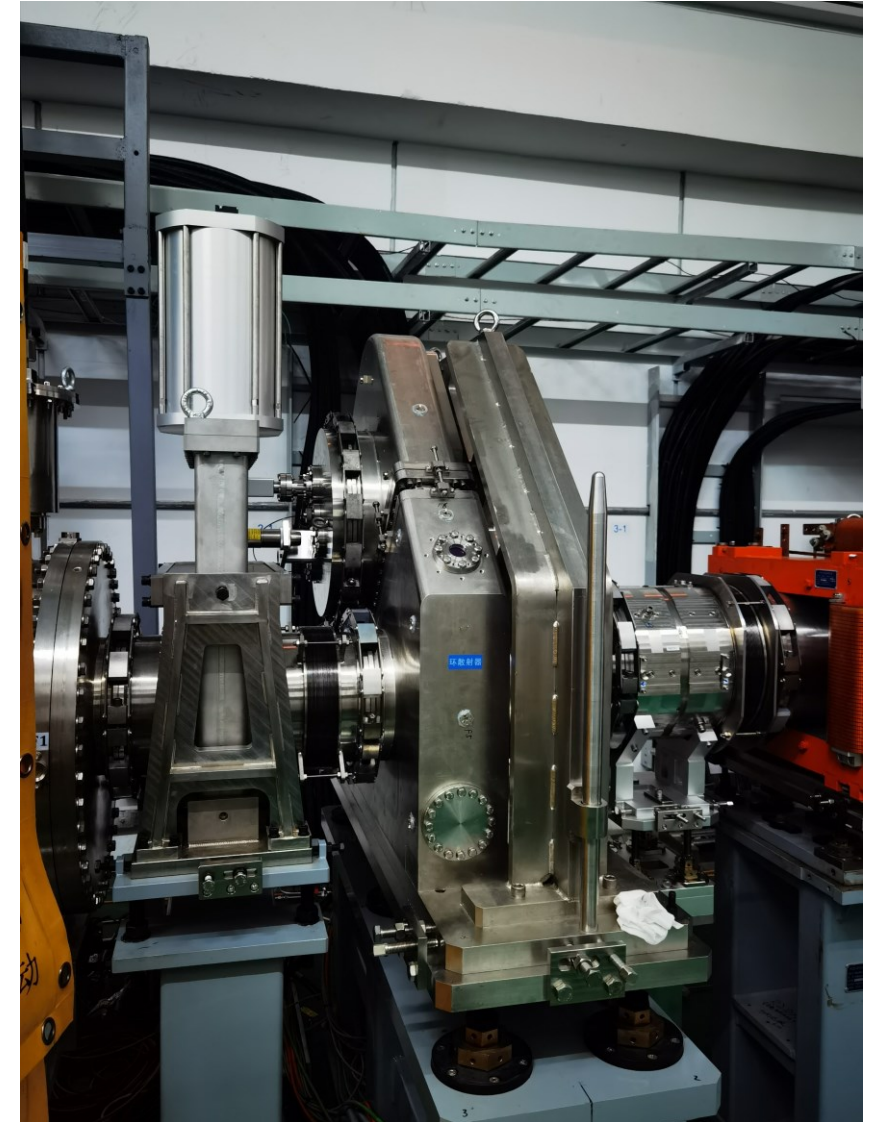
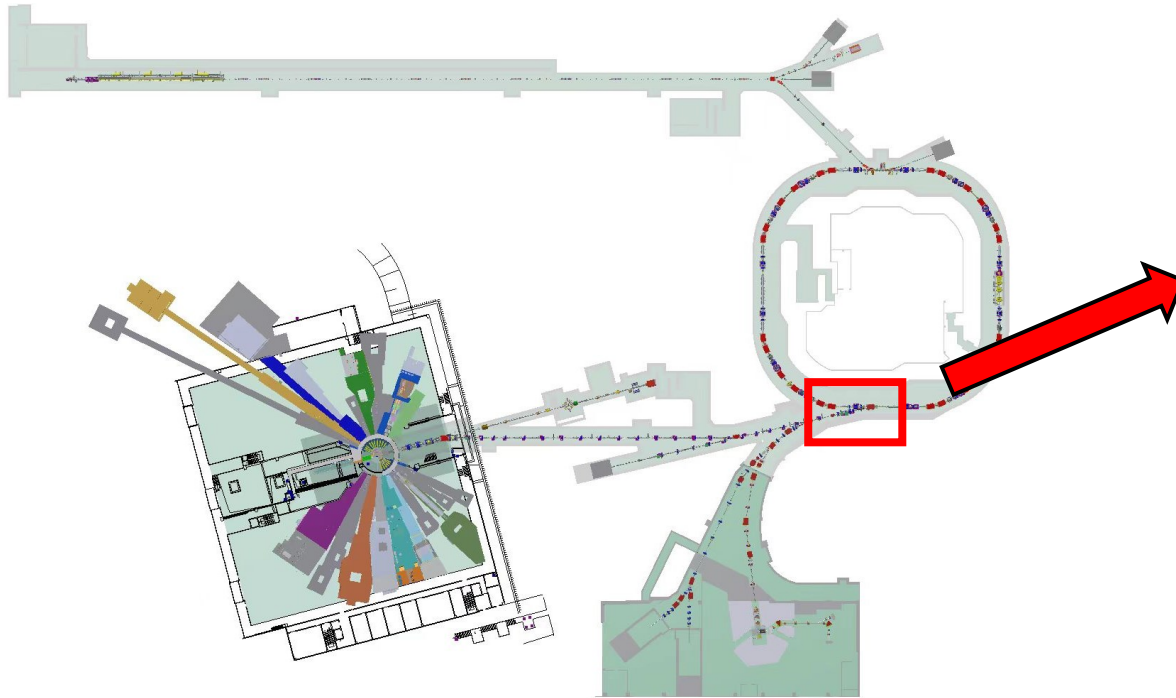
4.2 Recent progress of HPES



- Experiment hall have been finished.
- Terminals will be finished by JUN. 2027.

4.2 Recent progress of HPES

- The proton scatter has been installed on the RCS of CSNS.
- Currently, it is under tuning test.



4.3 Team of HPES



HPES will open to everyone. Welcome to contact with us if you are interested.



Director of HPES
JING Hantao / 敬罕涛
jinght@ihep.ac.cn



Team Coordinator
DONG Mingyi / 董明义
dongmy@ihep.ac.cn



Team Coordinator
FAN Ruirui / 樊瑞睿
fanrr@ihep.ac.cn



Beamline Physicist
GUO Yuhang / 郭宇航
guoyh@ihep.ac.cn



User Support
TAN Zhixin / 谭志新
tanzx@ihep.ac.cn

Device Physicist:

QIAN Sen/ 钱森
SHI Xin/ 史欣

LIANG Zhijun/ 梁志均
LI Qiang/ 李强

ZHANG Hongyu/ 章红宇
LV You/ 吕游

YI Han/ 易晗
LI Mengzhao/ 李梦朝

4.4 Summaries



- China's first proton test beam will be completed in 2029.
- Multiple DIT have been equipped with HPES in supporting the users:
 - Telescopes with resolution $< 10 \mu\text{m}$.
 - Proton energy spectrometer with res. 1% @ 1.6 GeV.
 - Trigger device with TLU for data alignment proton by proton.
- Beam extraction is under tuning.
- Post Doc. position is open. **We provide competitive salary.** Contact with us if you are interested.



Contact: Yuhang Guo

Phone: +86 18392181025

Email: guoyh@ihep.ac.cn

致谢



承蒙厚爱
感谢倾听
Thanks!