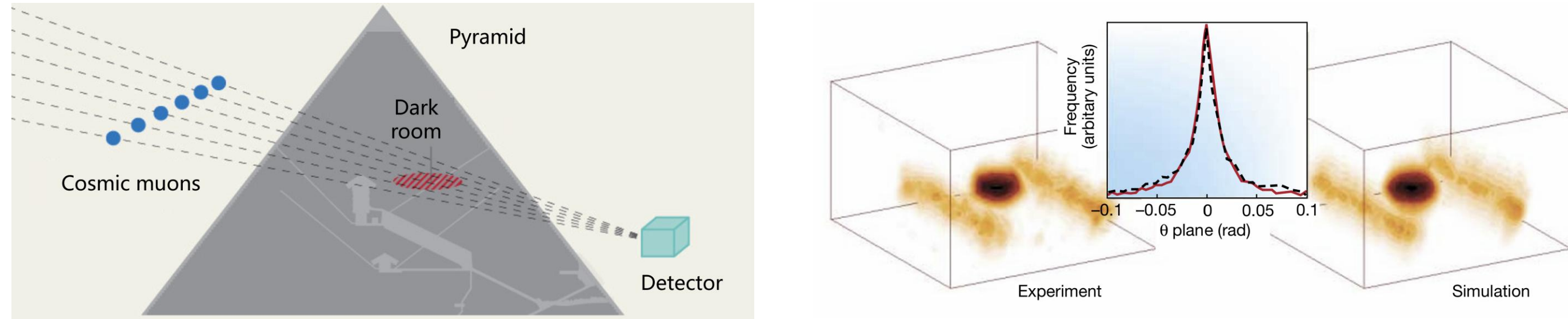


# Simulation research for the SHINE accelerator muography experiment



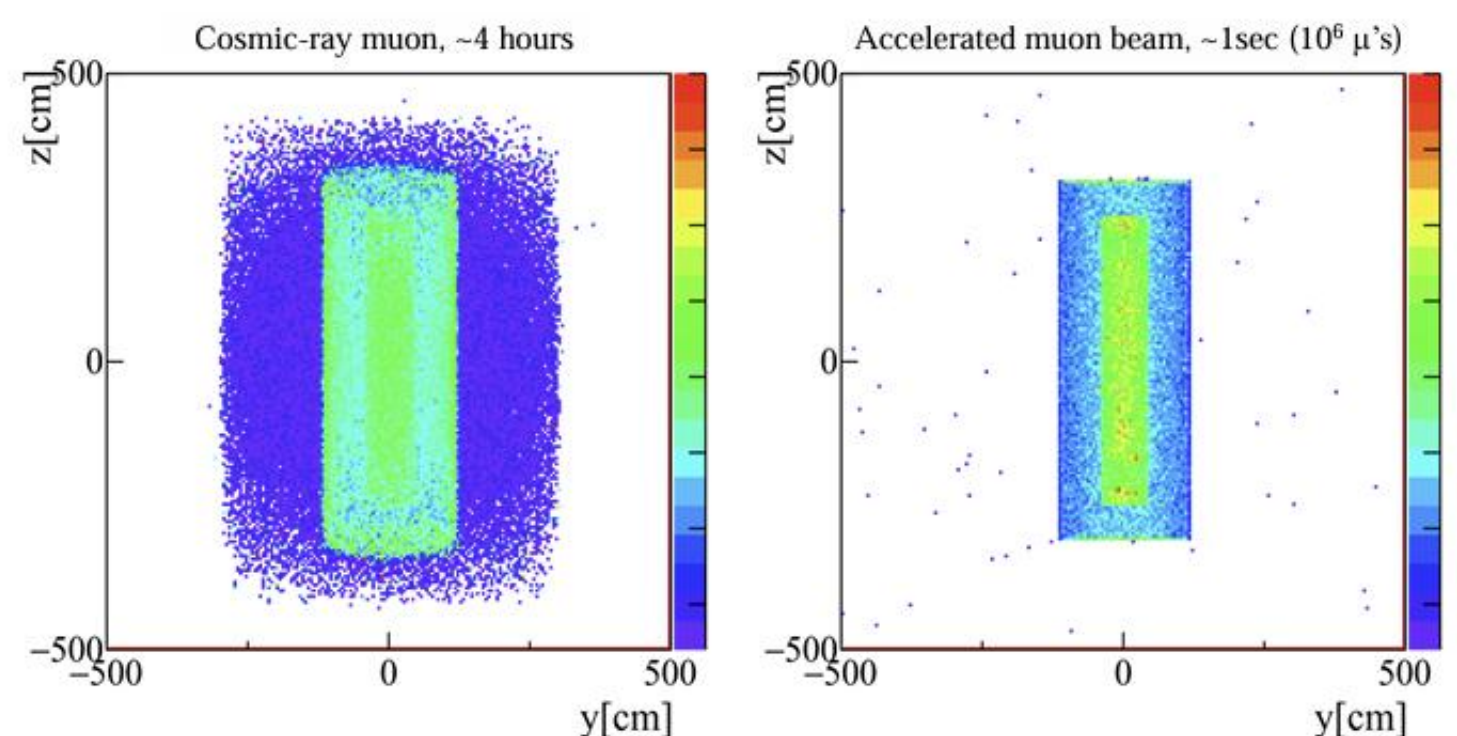
## Why accelerator muography?

- Muography utilizing cosmic-ray muons is a useful technique for imaging large, dense objects due to the high penetration capability of cosmic muons.



Muon radiography of large-scale object [1] Scattering tomography of High-Z object [2]

- However, the flux of cosmic-ray muons is relatively low, particularly in the horizontal direction, which necessitates long exposure times to obtain high-quality images.

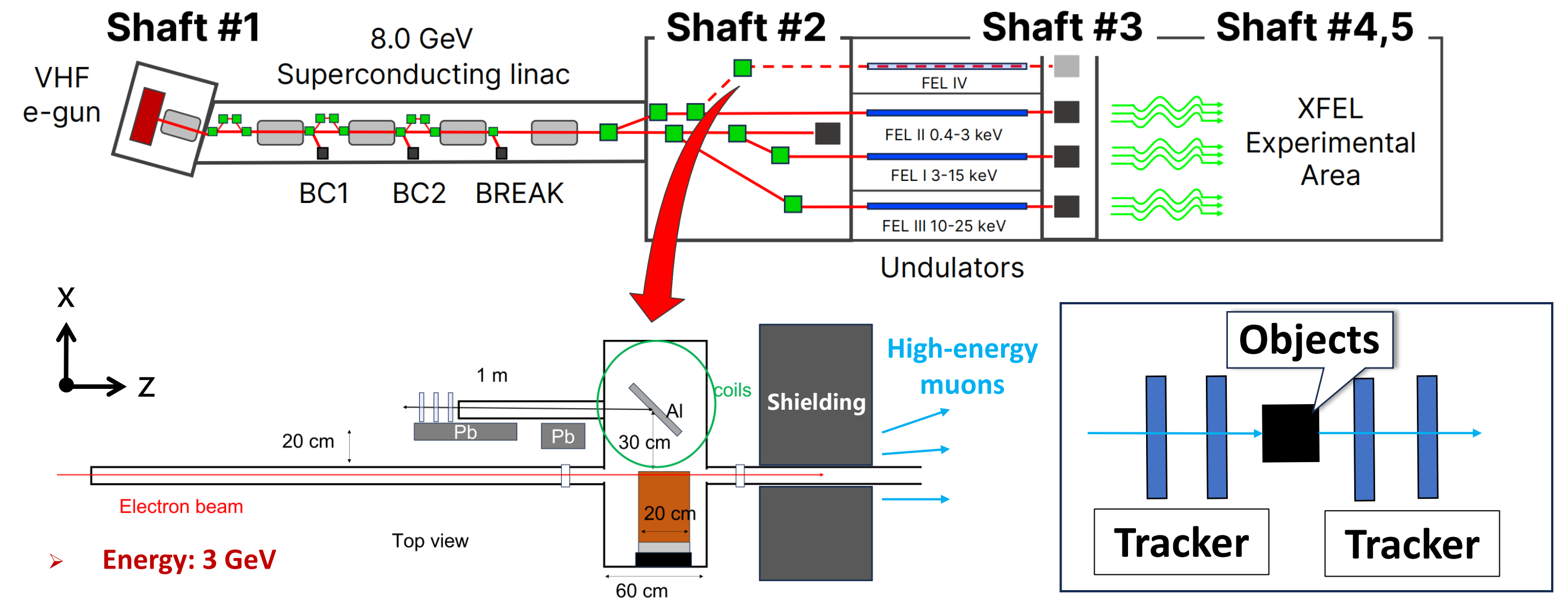


Simulated images using cosmic muons(left) and accelerator muons(right) for same object [3]

- High-intensity accelerator-based muon sources enable faster and more efficient imaging.
- The controllable energy and direction of accelerator-produced muons broaden the potential applications of muography [4].

## SHINE accelerator muography

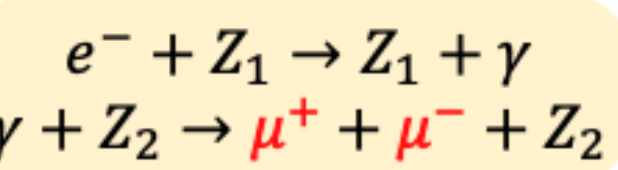
- The SHINE facility, designed to generate X-rays using a high-energy electron beam [5], and it can provide us accelerator muon source in shaft #2 [6].



- Energy: 3 GeV
- Charge: 50 pC /Bunch
- Repetition rate: 50 Hz

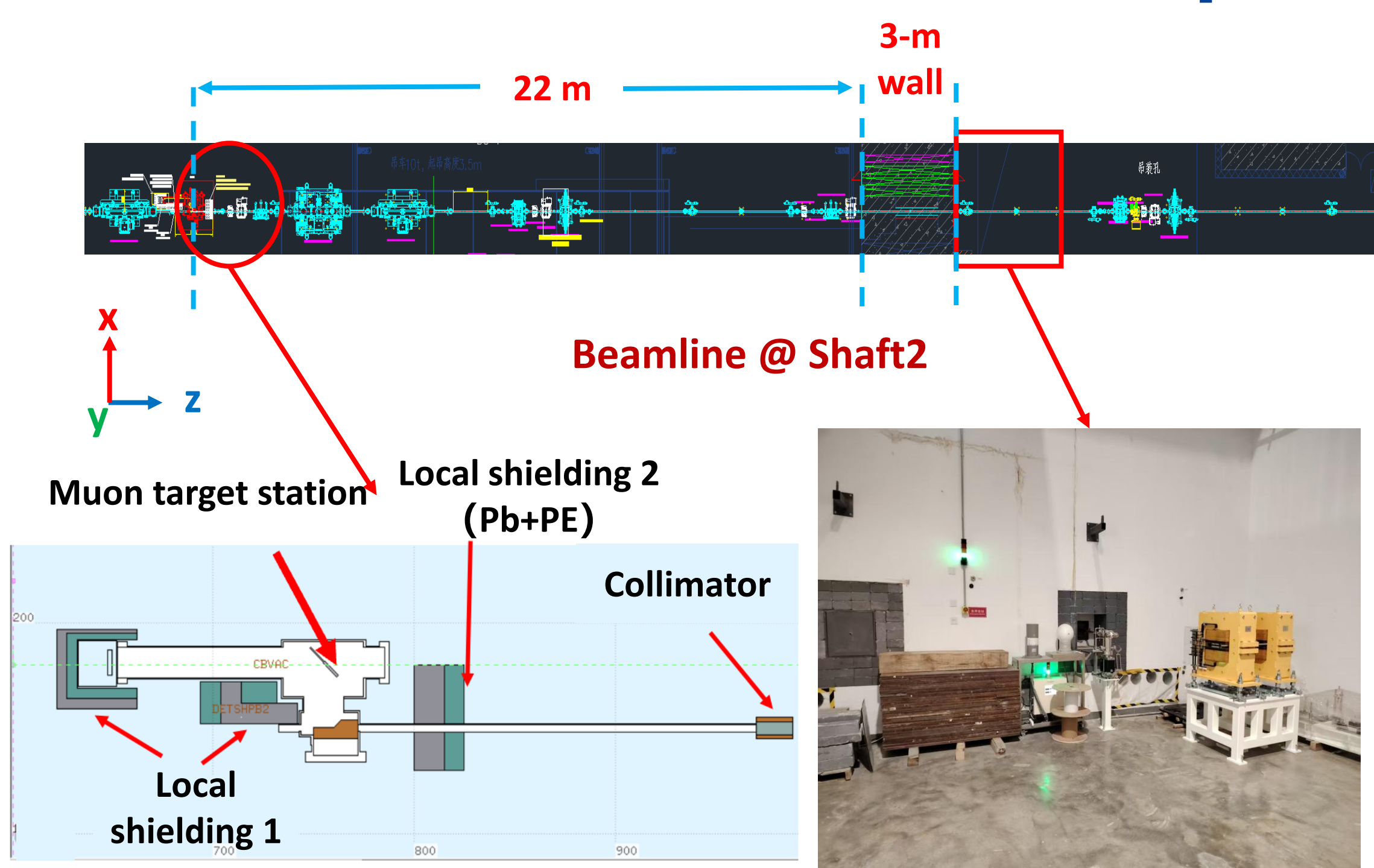
Electron-on-Target [7]

Bethe-Heitler process

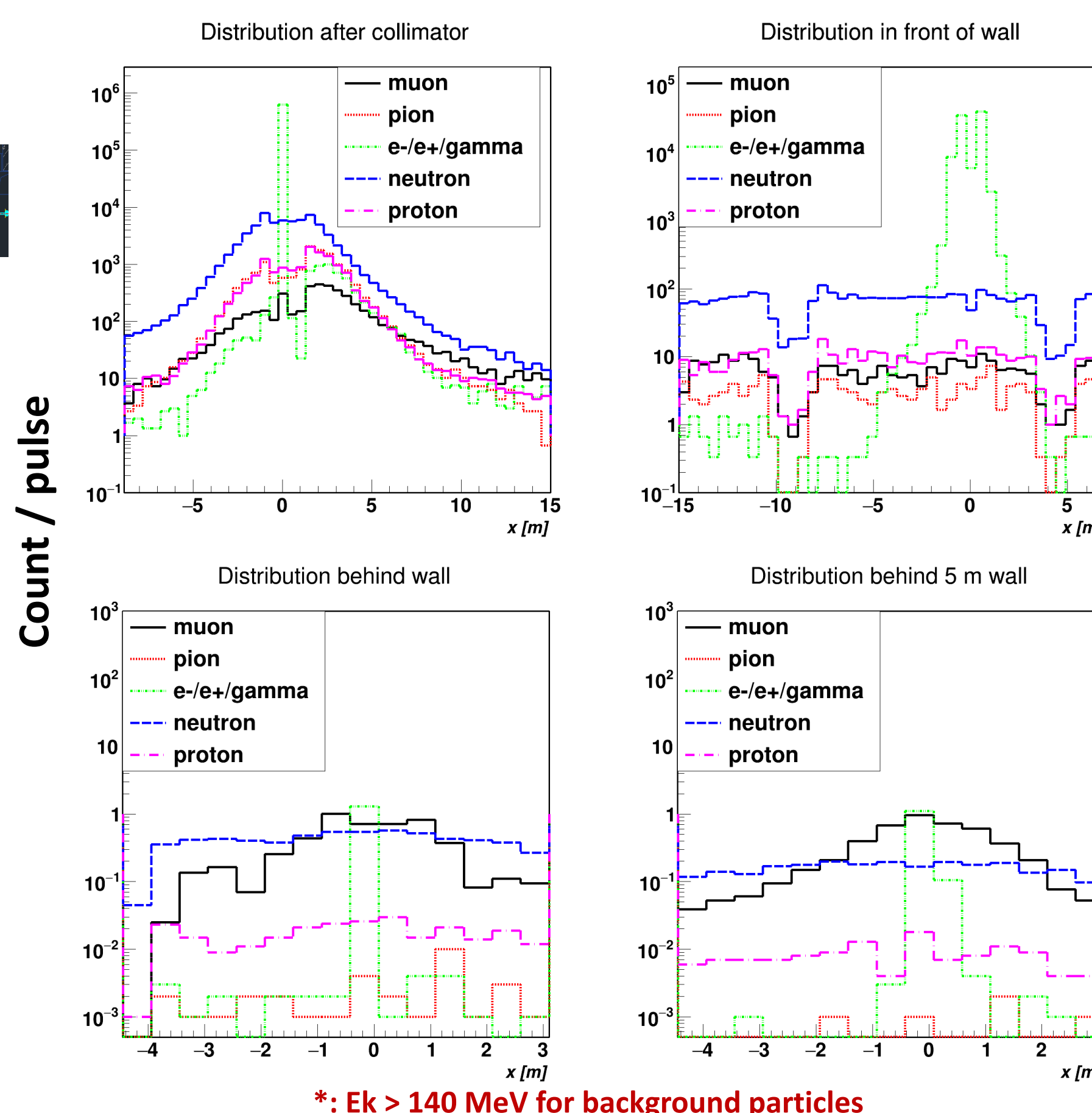


- High-energy muons can be generated by the interaction of the SHINE high-energy electron beam with the target.
- SHINE muography project will use high-energy muons for accelerator muography research.

## Experiment site & muon distribution



- There has less background particles and low muon flux behind the wall. It is suitable for muography experiment



\*:  $E_k > 140$  MeV for background particles

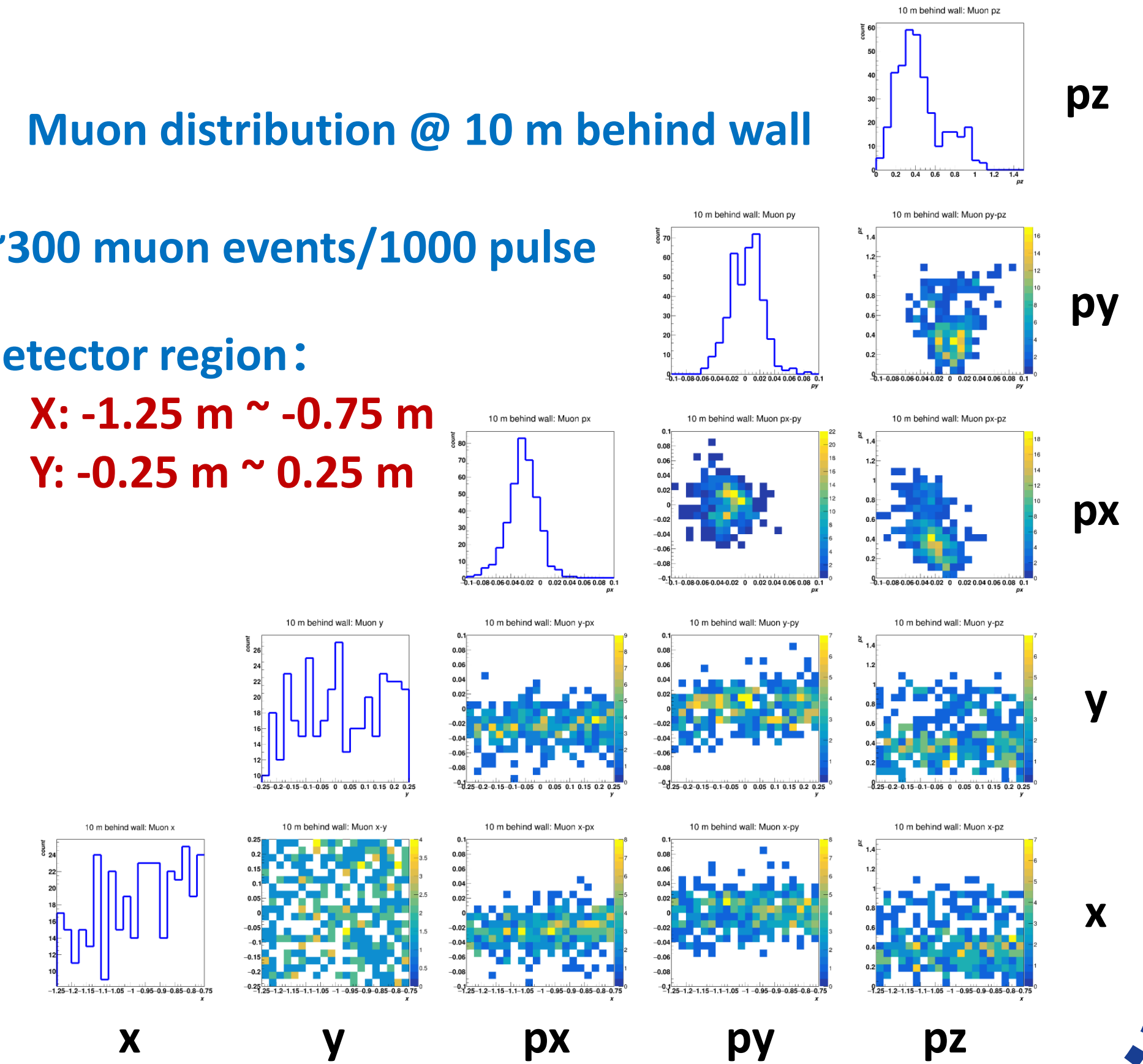
Muon distribution @ 10 m behind wall

~300 muon events/1000 pulse

Detector region:

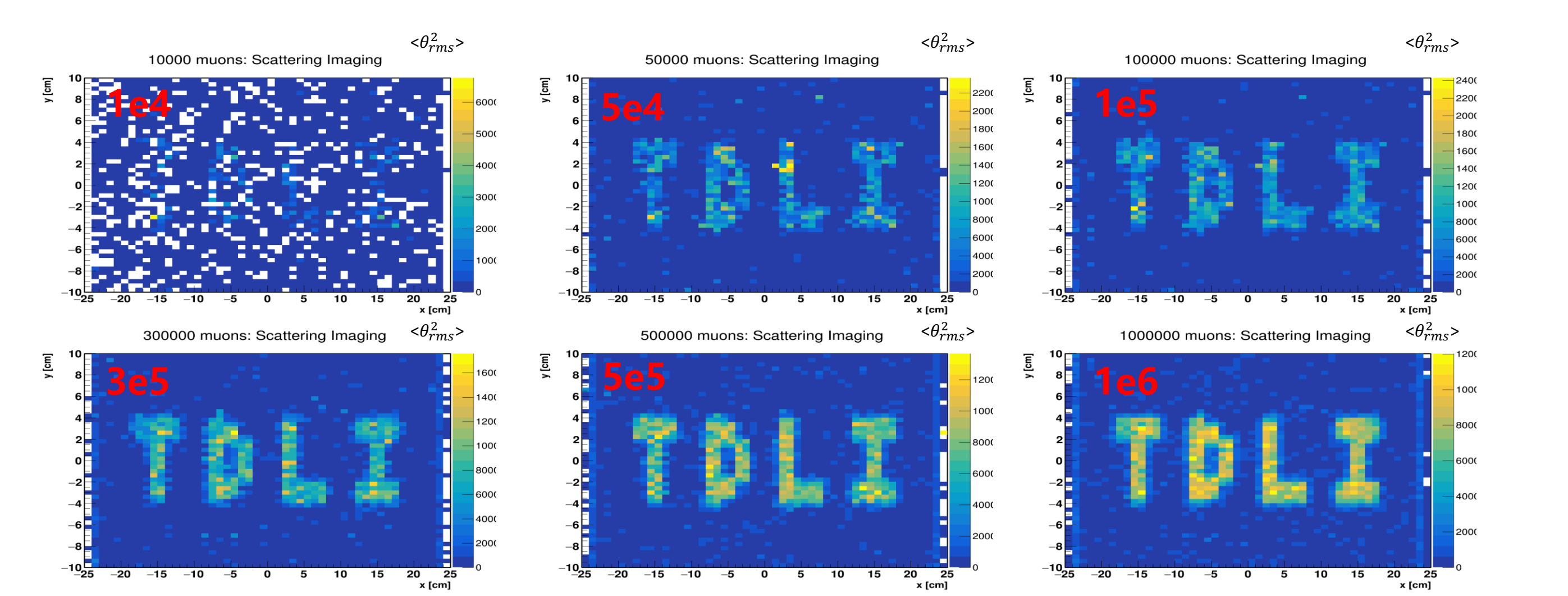
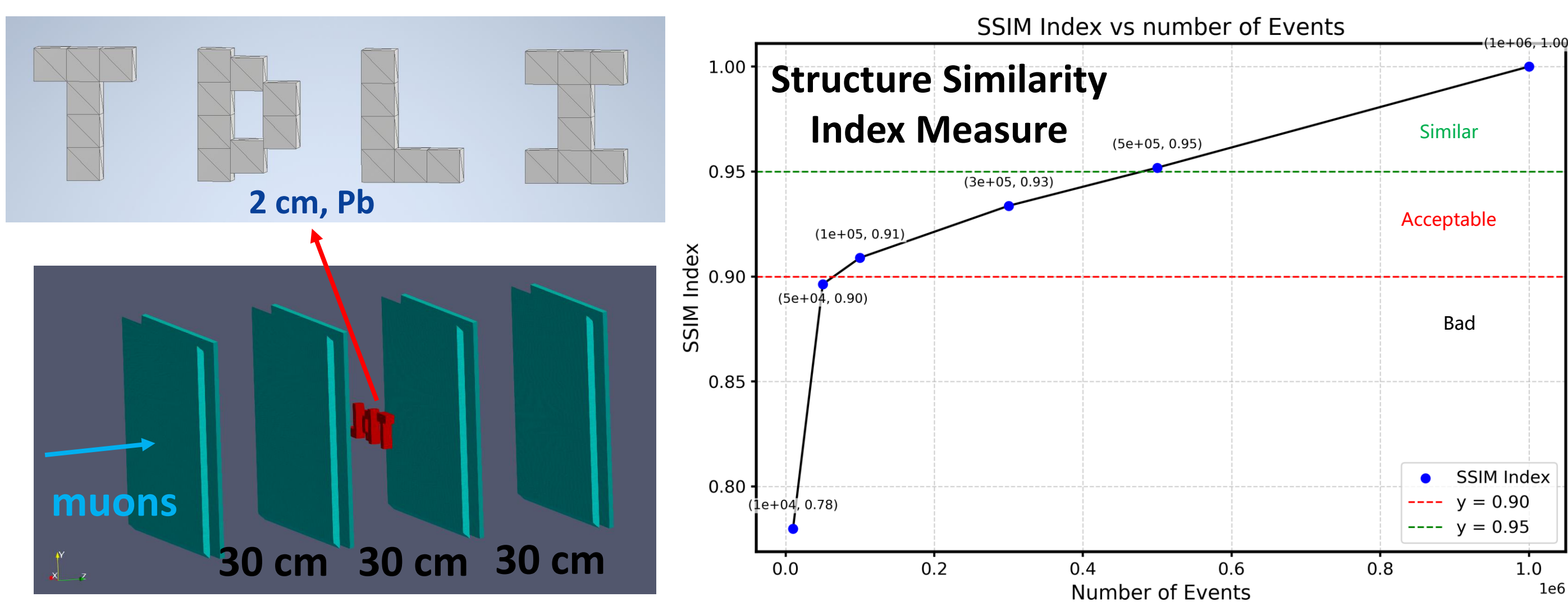
X: -1.25 m ~ -0.75 m

Y: -0.25 m ~ 0.25 m



## Muography simulation results

- Using muon distribution @ 10 m behind wall and 4-layers trackers, the muography results changed with events number is obtained.



Imaging results with the number of effective muon events

- More than 100,000 effective muon events are required for a good imaging results. It requires about 2-hours data taking time for 0.3 muons/pulse.

## Equipment for muography

- The equipment for SHINE muography experiment has been designed, and the scheme of data taking is determined.



Detectors and support framework

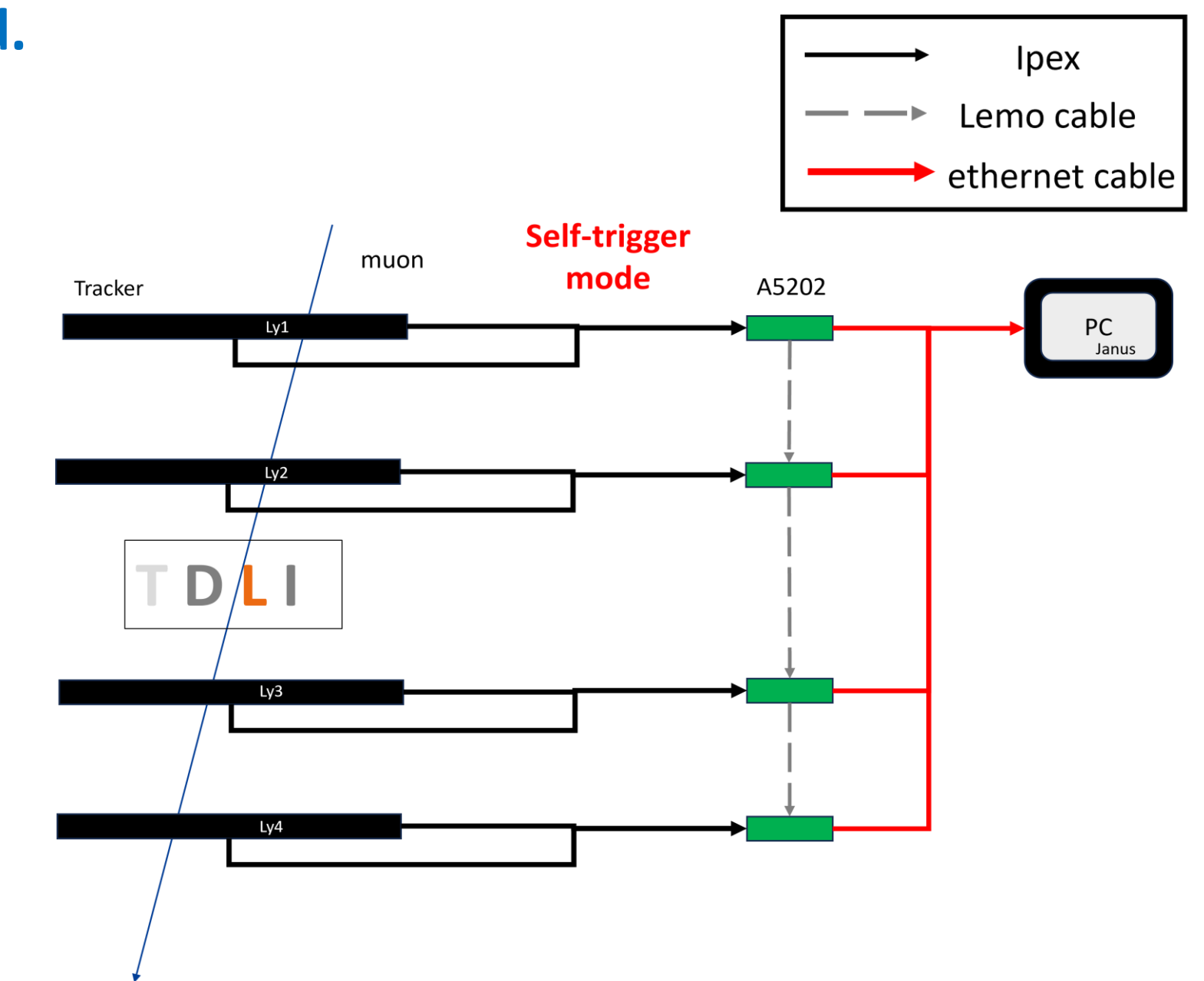


Diagram of data taking system

- The energy calibration of plastic scintillators is in progress.

## Conclusion

- Current muography based on cosmic-ray muons is limited by low flux, whereas accelerator-based muography allows for significantly faster imaging.
- By utilizing the electron beam at SHINE, an accelerator muon source can be realized for this research.
- The experiment location is determined to be behind the wall.
- The uography simulation results confirm the required events number and data taking time for experiment.

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