

Explorations of Mt. Qixing using Muography



高能與強場物理研究中心
CENTER FOR HIGH ENERGY AND
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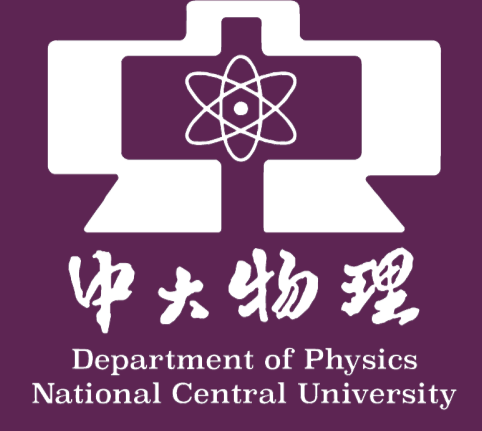


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Introduction

The NCU-AS muography project started in 2021 with the Amuping experiment and relocated to Mt. Qixing in late 2025. The first observatory has operated stably since December 2025, while a second is under construction. We aim to perform 1D density measurements and cross-checks using the first two stations, with 2D imaging planned for the third. Featuring complex geology and geothermal resources, Mt. Qixing is a key target in the Taiwan Earth science community.

The NCU-AS Muography Exp.

- Core target: To establish an end-to-end muography technical pipeline in Taiwan.
- Passed experiments: Amuping&Daxi in Taoyuan, Taiwan.
- Current experiment: Mt. Qixing in Taipei, Taiwan.
 - Resolve the 3D density distribution of Mt. Qixing

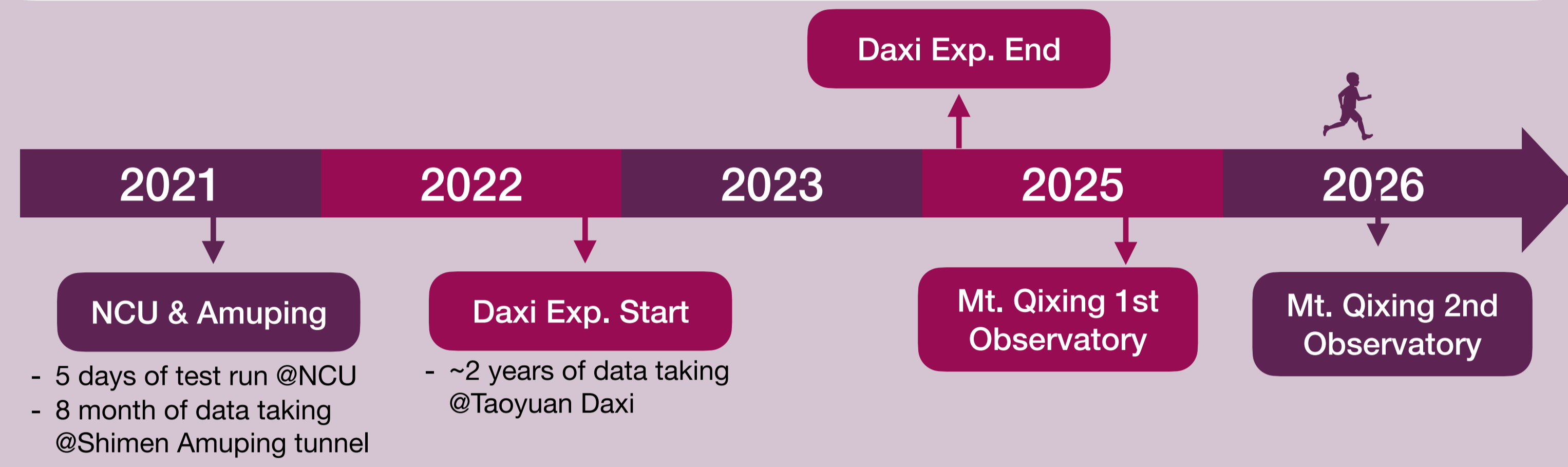


Fig.1 Time line of the past experiments conducted by the NCU-AS team.

NCU-AS Muon Tracker

- SiPM coupled scintillator tracking detector
- FPGA-based DAQ system
- Muon Tracking Board(MTB): Tracking unit composed of FPGA, HV board and 16 SiPM modules.
- Three generations of detector was developed.



Fig.2 MTB unit

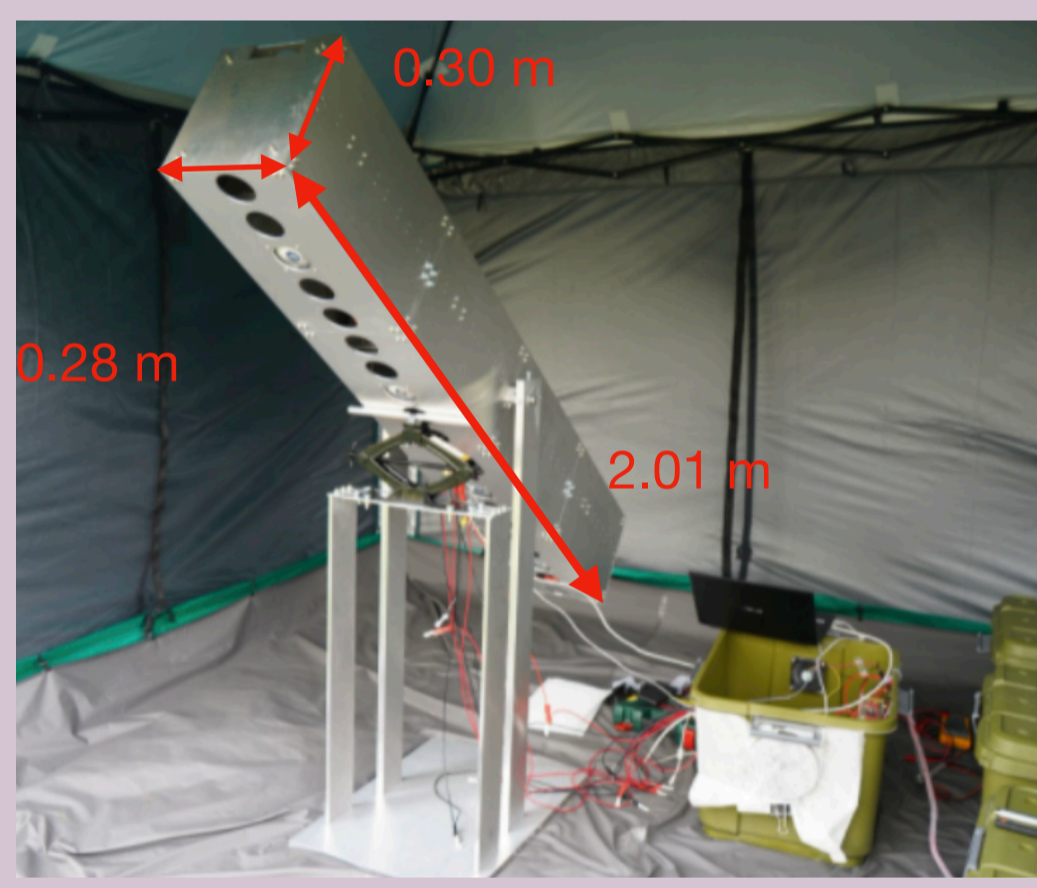


Fig.3 V1 Detector

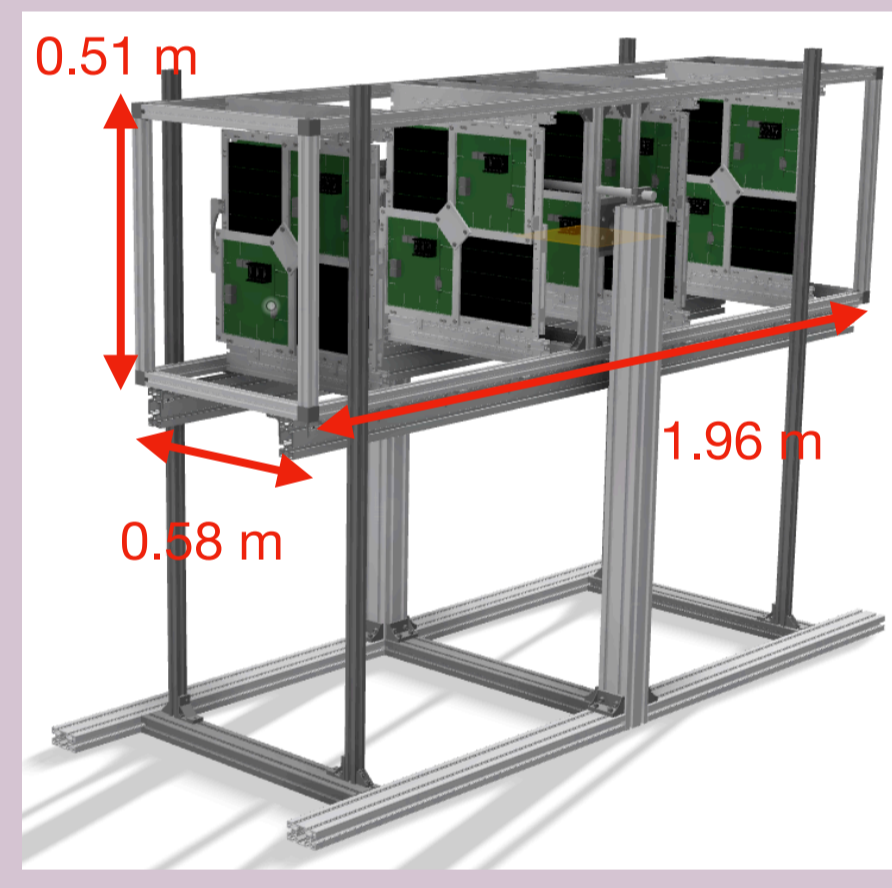


Fig.4 V2 Detector

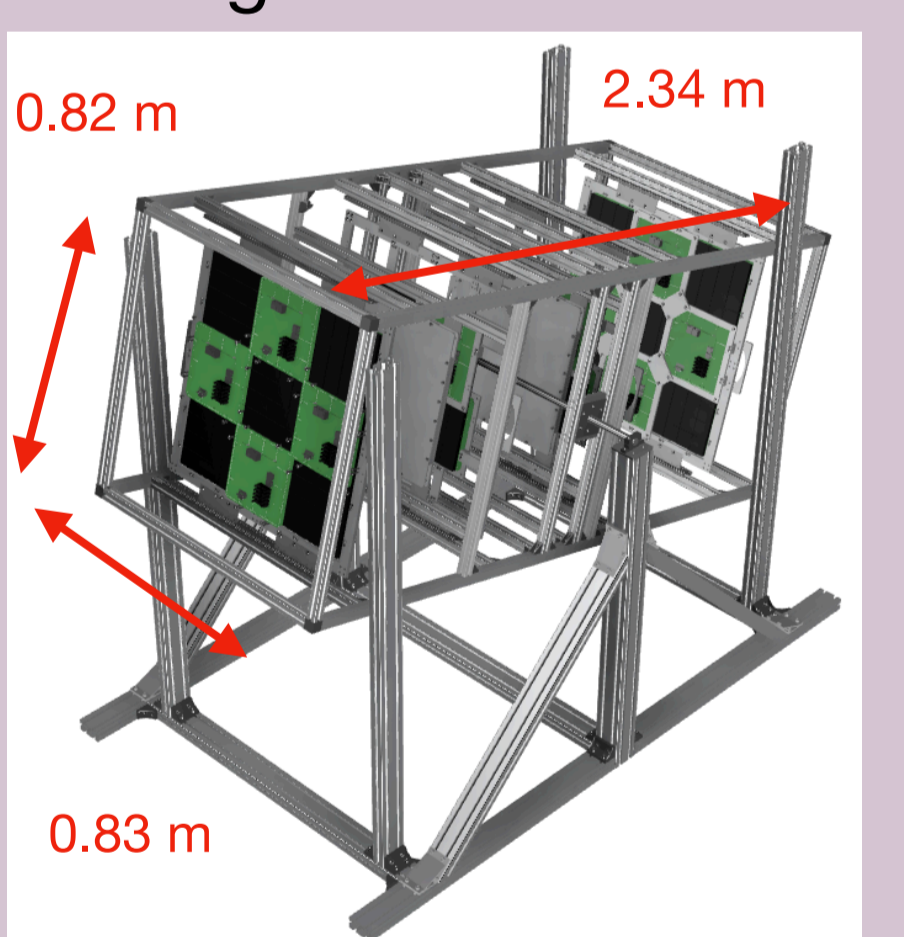


Fig.5 V3 Detector

	V1	V2	V3
Experiment	Amuping	Daxi/Mt. Qixing	Calibration
# of channels	64	256	416
Angle of view	$\pm 7.59^\circ$	$\pm 14.93^\circ$	$\pm 21.80^\circ$

Table.1 Comparison between 3 generations of detector

The 1st Observatory

- Southeast side of the Mt. Qixing.
- An FRP shelter with diameter 3.5m and height 2.8m.
- Measurement range: Mostly cover the Mt. Qixing.
- Limitation: Back-shielding due to Mt. Xiaoguanjin
- Preliminary results are fit with other geophysics measurement-> See Phay's poster(Poster #11)

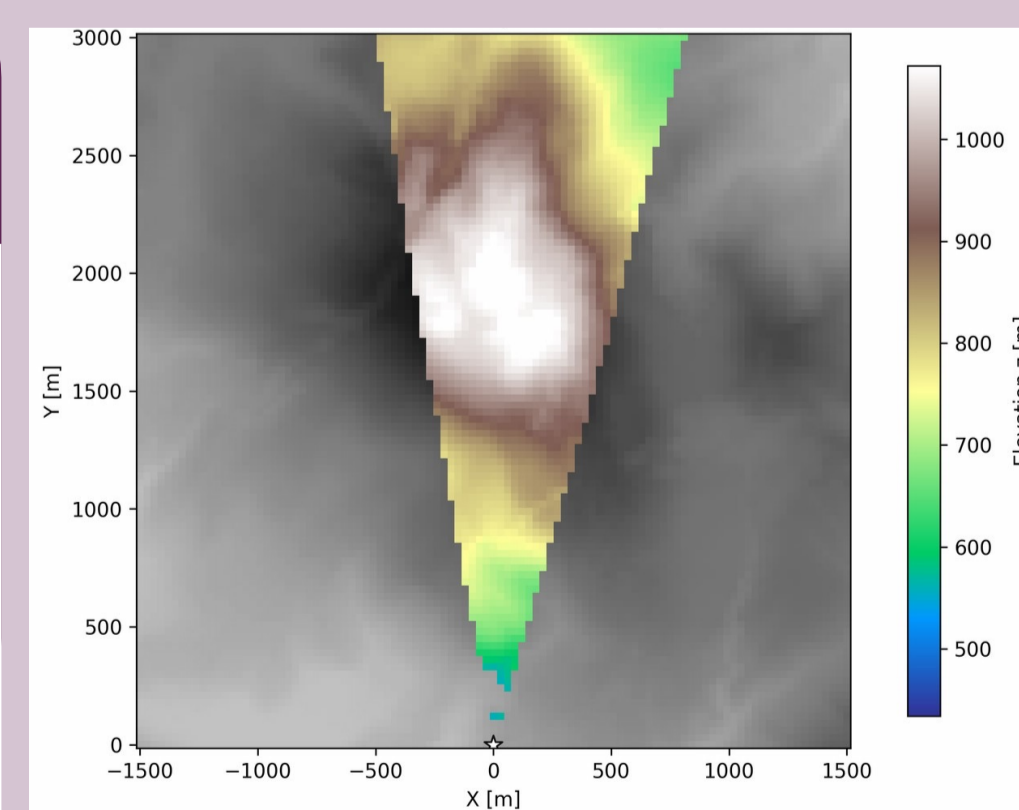


Fig.6 The observatory #1



Fig.7 The observatory #1



Fig.8 Inner view of the observatory #1

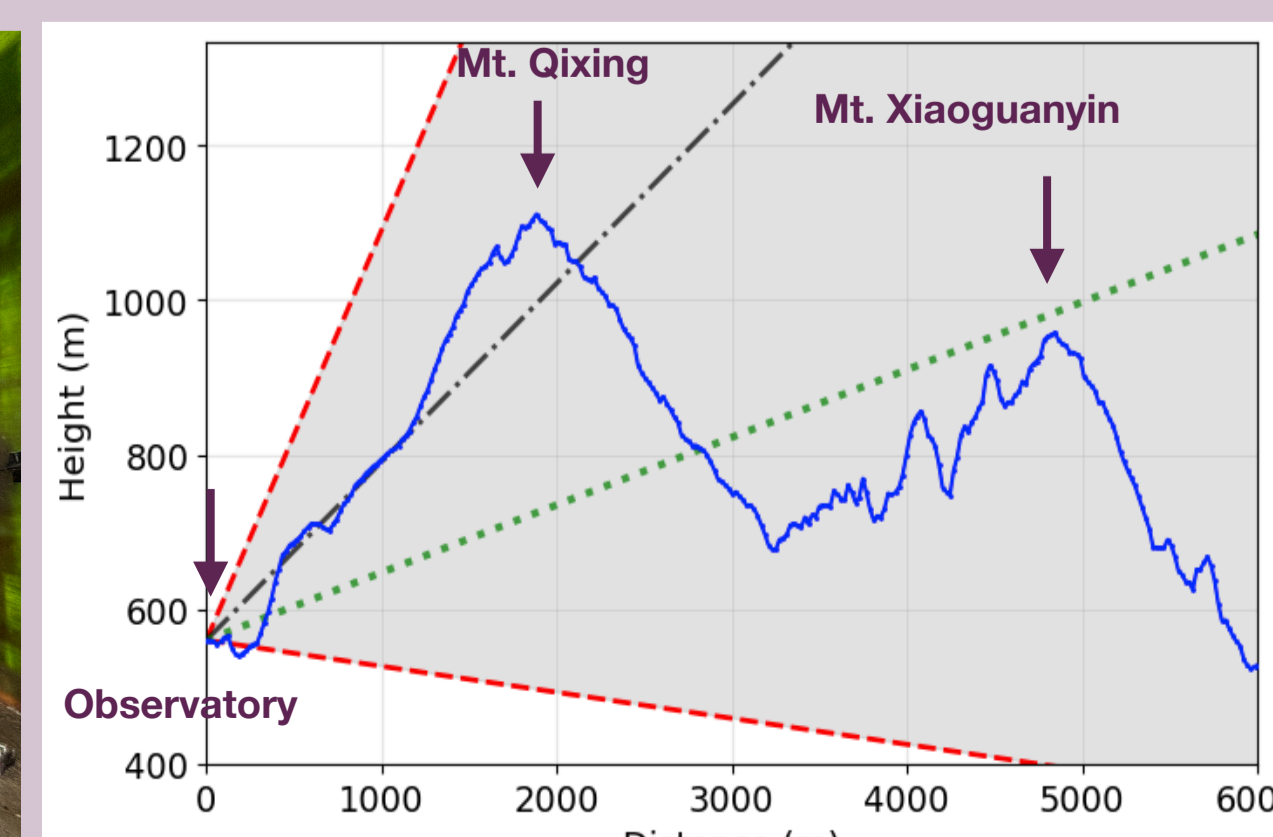


Fig.9 Terrain profile between Mt. Qixing and observatory #1

The 2nd Observatory

- Location: Xiaoguanjhan -> The opposite of the first observatory.
- Target: To crosscheck the result of the first observatory.
- Detector improvement:
 - Better Time-of-Flight(ToF) by extending the gap of each layer to 50cm.
 - Larger angle of view
- No back-shielding due to other mountain.
- Expected to be launched at the end of June.

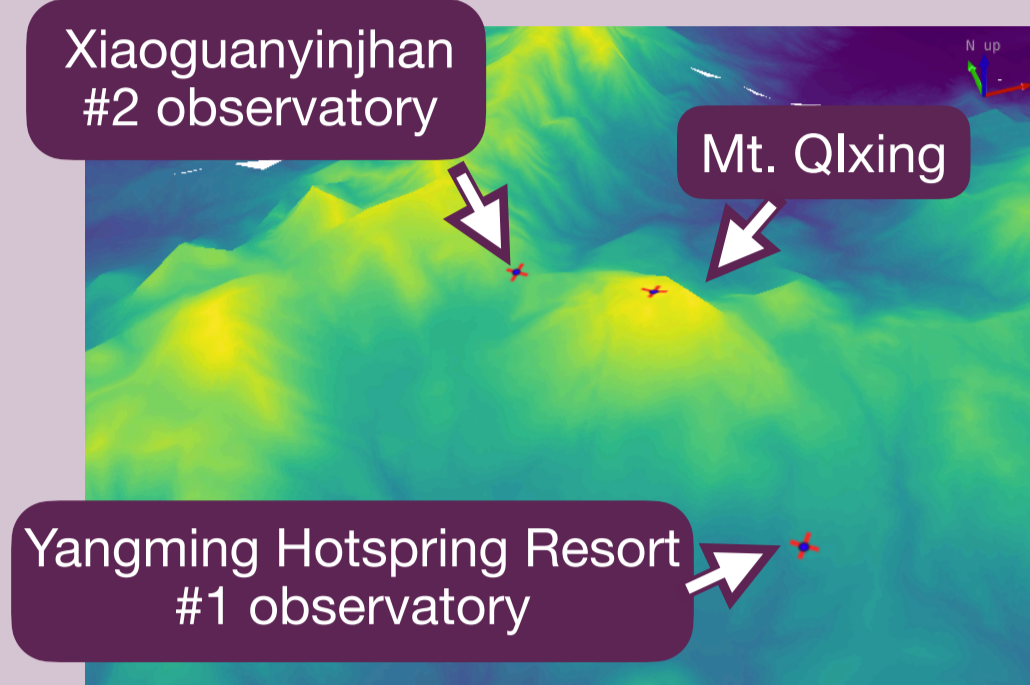


Fig.10 Locations of the two observatories



Fig.11 Assembling V3 Detector

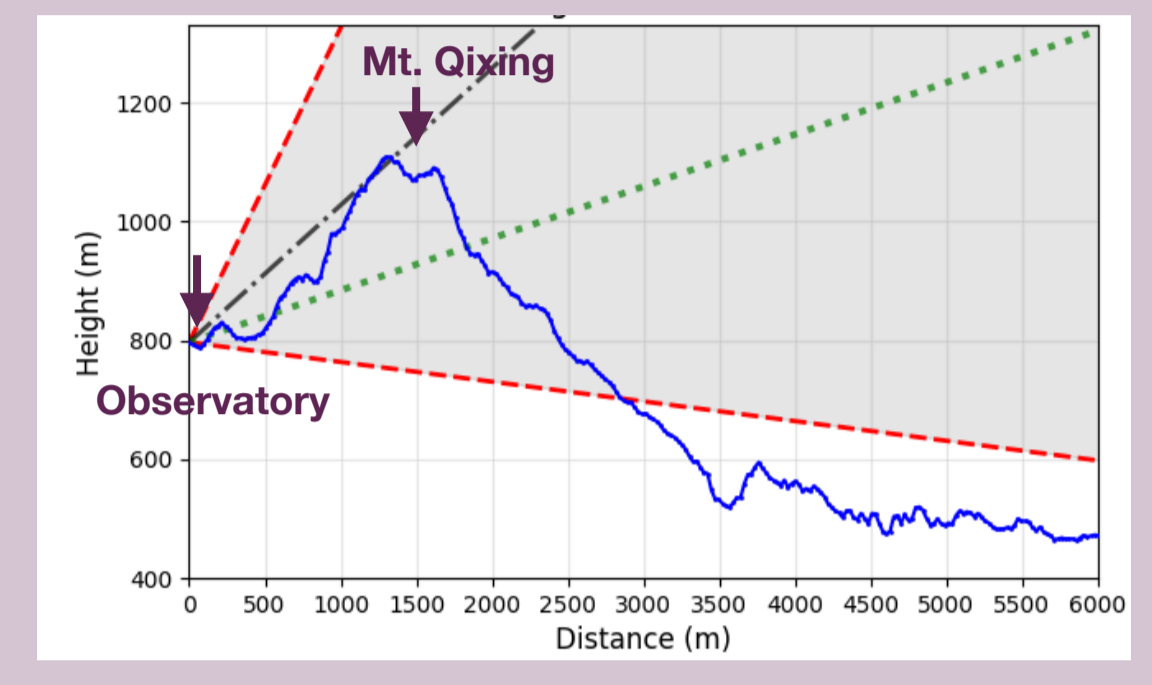


Fig.12 Terrain profile between Mt. Qixing and observatory #2

Detector Performance & Monitoring

- Efficiencies measurement: All above 94% detection efficiency.
- Measured by a tower-like arrangement of MTBs.
- Time over threshold(TOT) calibration:
 - Ensuring same signal response for each SiPM module.
 - Modify operating voltages to set all TOT to about 1600 ns.
- Auto-monitoring framework:
 - Automatically analyzed hit level and TOT of each channel daily.
 - Results are sent to users via discord daily.



Fig.13 Setup of efficiency measurement

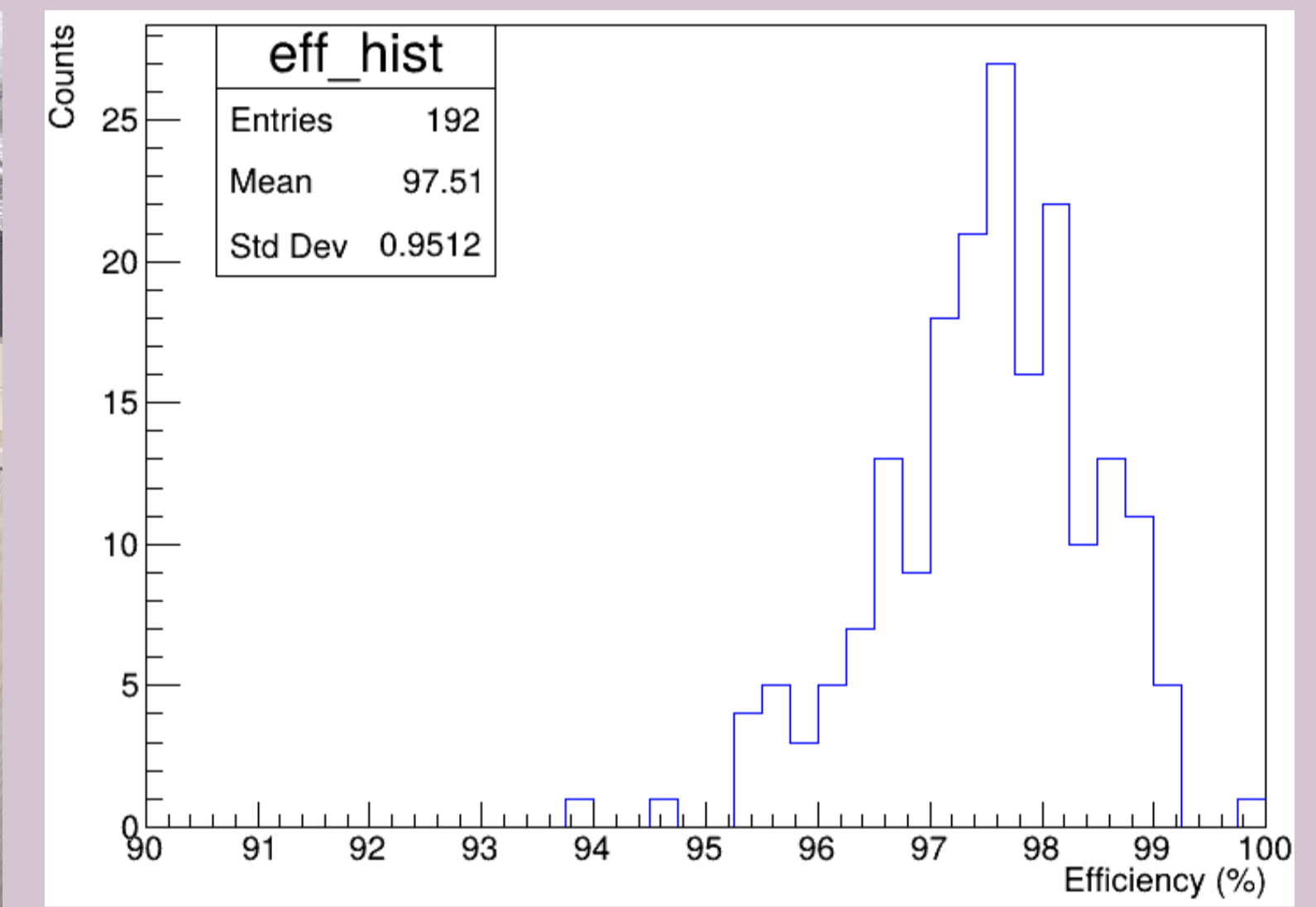


Fig.14 Efficiency distribution for the V1 detector

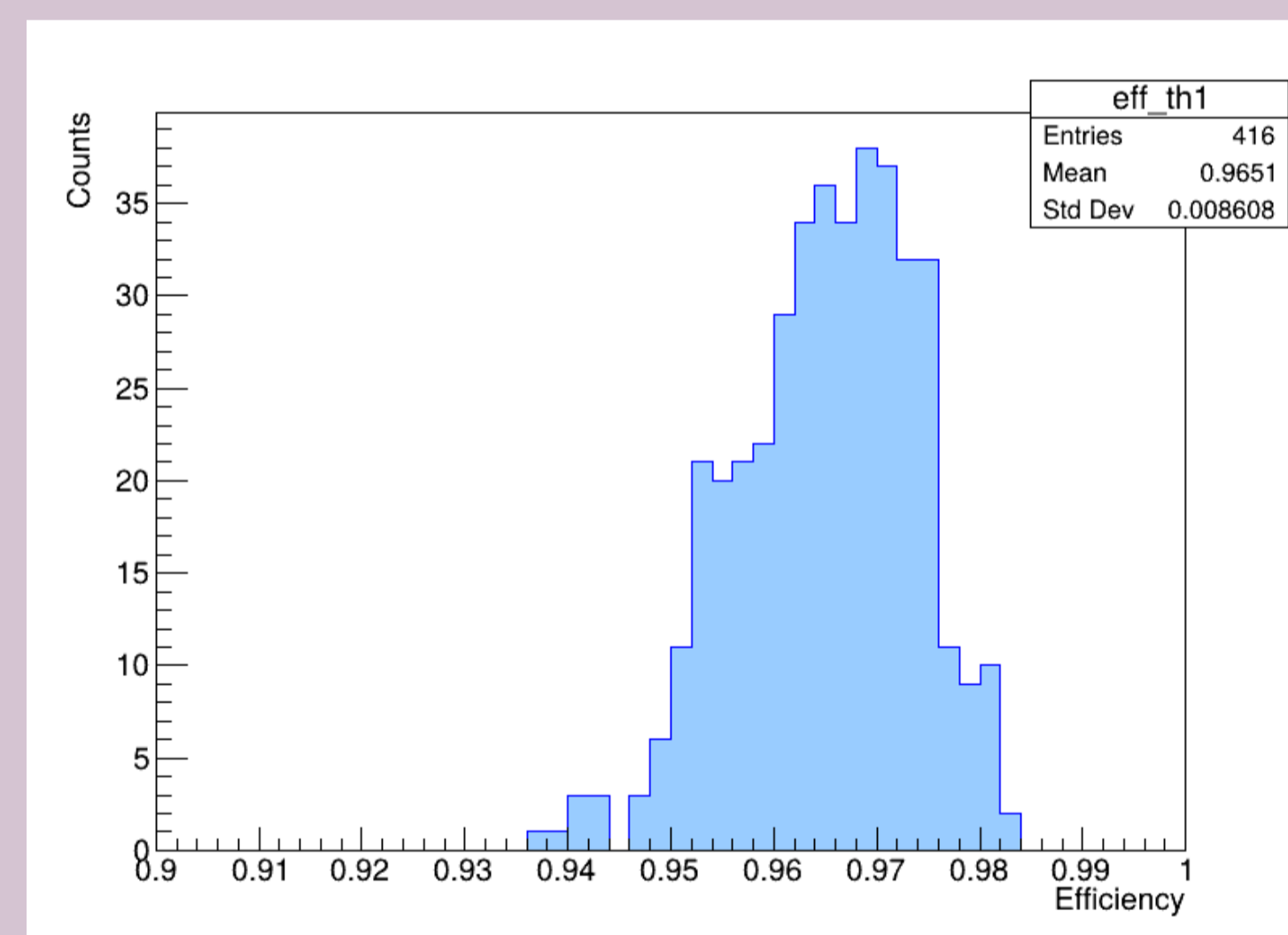


Fig.15 Efficiency distribution for the V2 detector

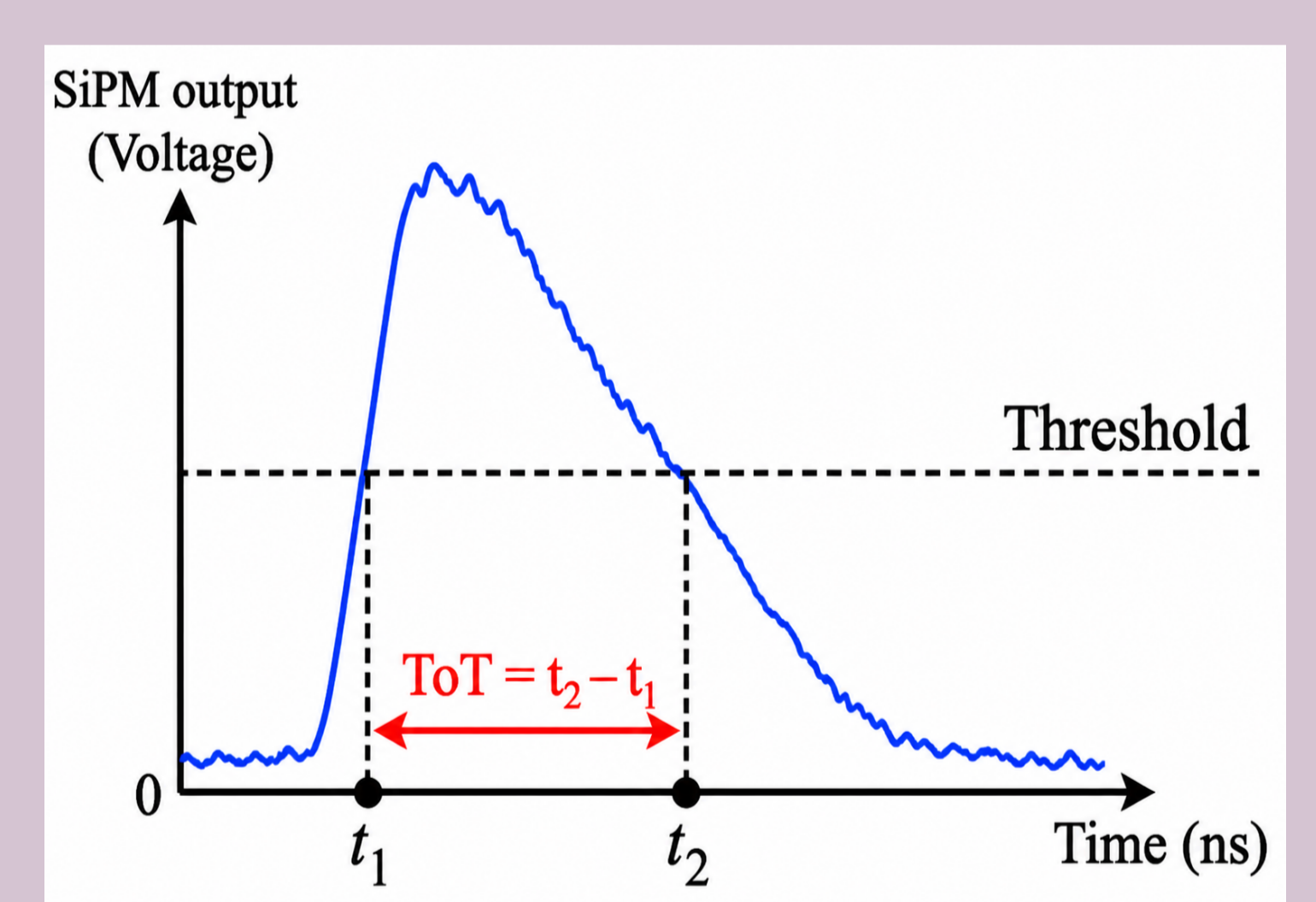


Fig.16 Time Over Threshold definition and SiPM waveform

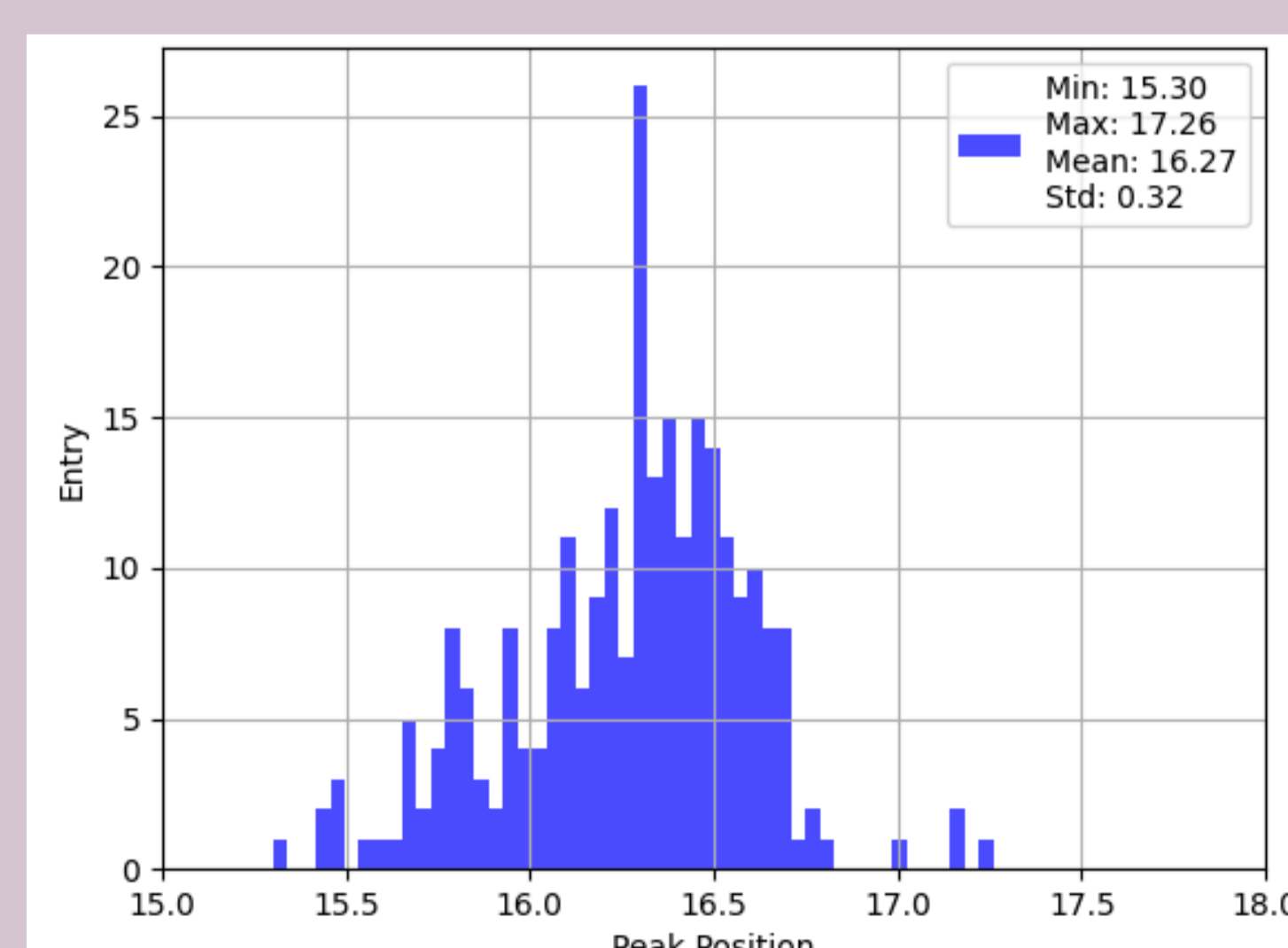


Fig.17 TOT distribution for the V2 detector

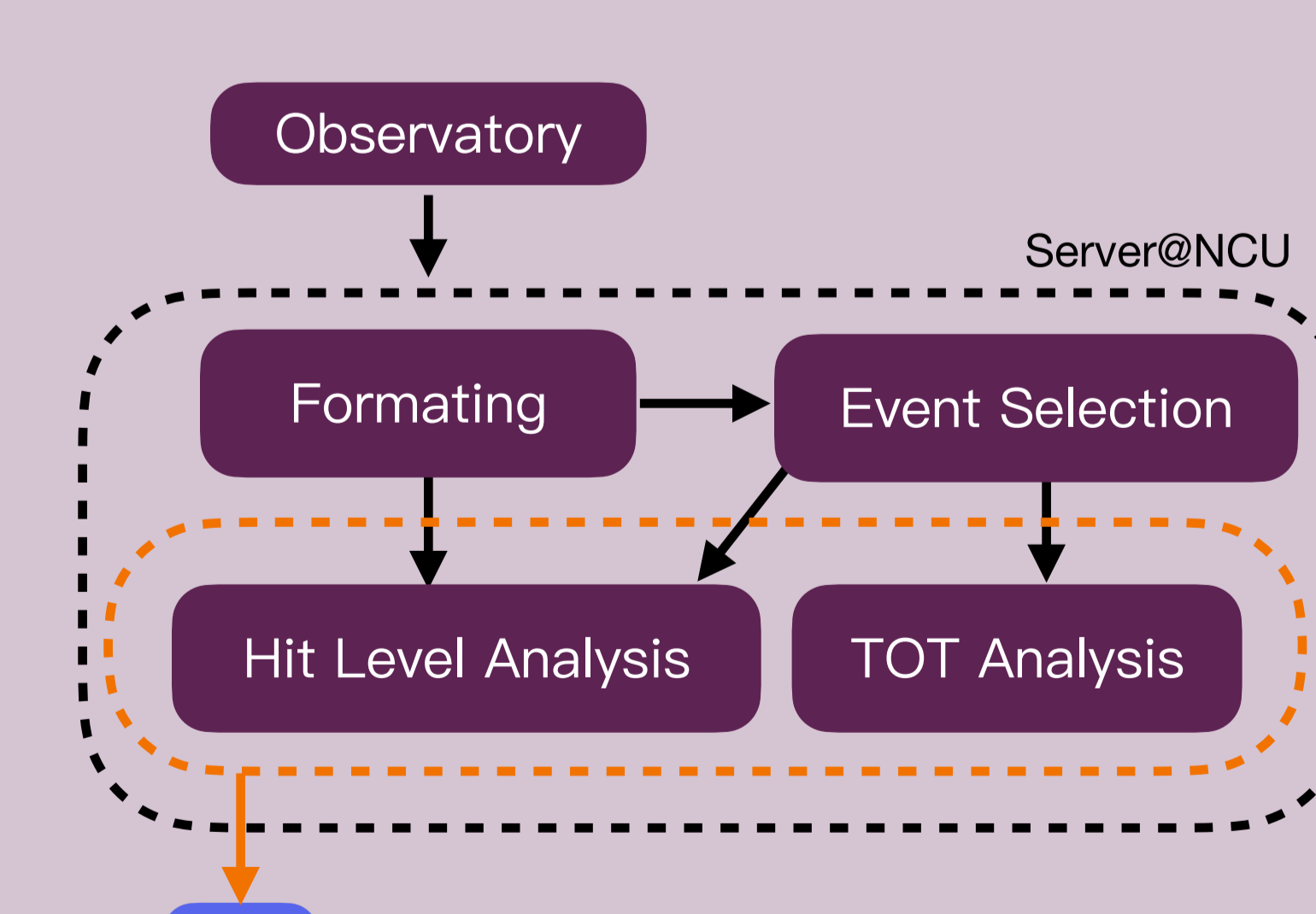


Fig.18 Structure of the auto-monitoring framework

Summary

- Previous NCU-AS muography experiment: Amuping and Daxi
- The project relocated to Mt. Qixing in Nov. 2025.
- Three generations of scintillator-coupled SiPM trackers have been developed.
- The 2nd observatory is under preparation; the 3rd is slated for operation in 2027.
- An auto-monitoring framework was develop to help remote monitoring.