

# **Threshold Fluctuations in ALPIDE**

**Abstract & Overview of Cluster Size Study for ATHIC 2025**

**Yongjun Choi (PNU) / 12th Nov. 2024**

Combined ITS2-WP2/ITS3-WP1: ITS simulation and reconstruction

# Abstract for ATHIC2025



- Asian Triangle Heavy-Ion Conference (Page: <https://indico.cern.ch/event/1424442/>)
  - It is the only Asian international conference in Heavy-Ion physics.
  - The conference has been held every two years since it was first hosted in South Korea in 2006.
- Date: 13th - 16th January 2025
- Conference Venue: Mayfair Palm Beach Resort, Gopalpur-On-Sea, Berhampur, Odisha, India.

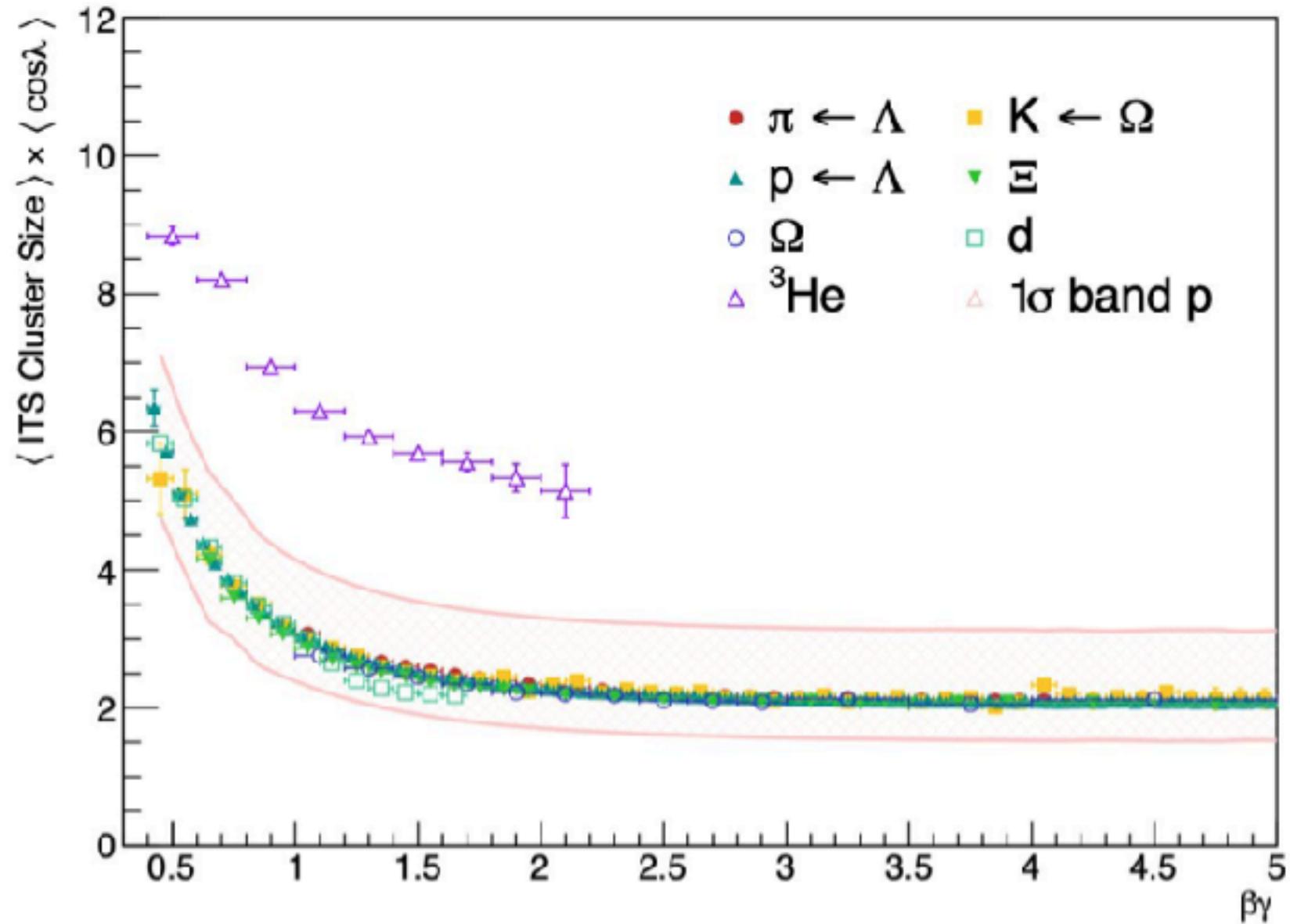


Abstract (Deadline: 15th November 2024)

- Title: Study pixel cluster produced by  $^{241}\text{Am}$  radioactive source in the ALPIDE pixel chip
- Author: Yongjun Choi, Kyungrim Woo, Minjae Kwon, Sungwoon Choi, In-Kwon Yoo
- Content: The ALPIDE is a Monolithic Active Pixel Sensor used in the ALICE Inner Tracking System installed during LS2 of the LHC and currently being operated in pp and Pb-Pb collisions. In ALPIDE, electron-hole pairs are produced by the energy loss caused by incident charged particles, and the electrons are collected by the pixel diodes. The cluster size, the number of pixels fired by each incident particle, indicates how widely the electrons are spread out and how many pixels responded to them over the threshold. The cluster size distribution provides, therefore, the information on the incident particle trajectory and energy loss. In this presentation, the cluster size distribution produced from  $^{241}\text{Am}$  alpha source will be shown at various collimator sizes and alpha particle energies, and the response of the ALPIDE chip will be discussed.

# Motivation of Cluster Size Study

- From Giorgio's slide (9th Sep. 2024)

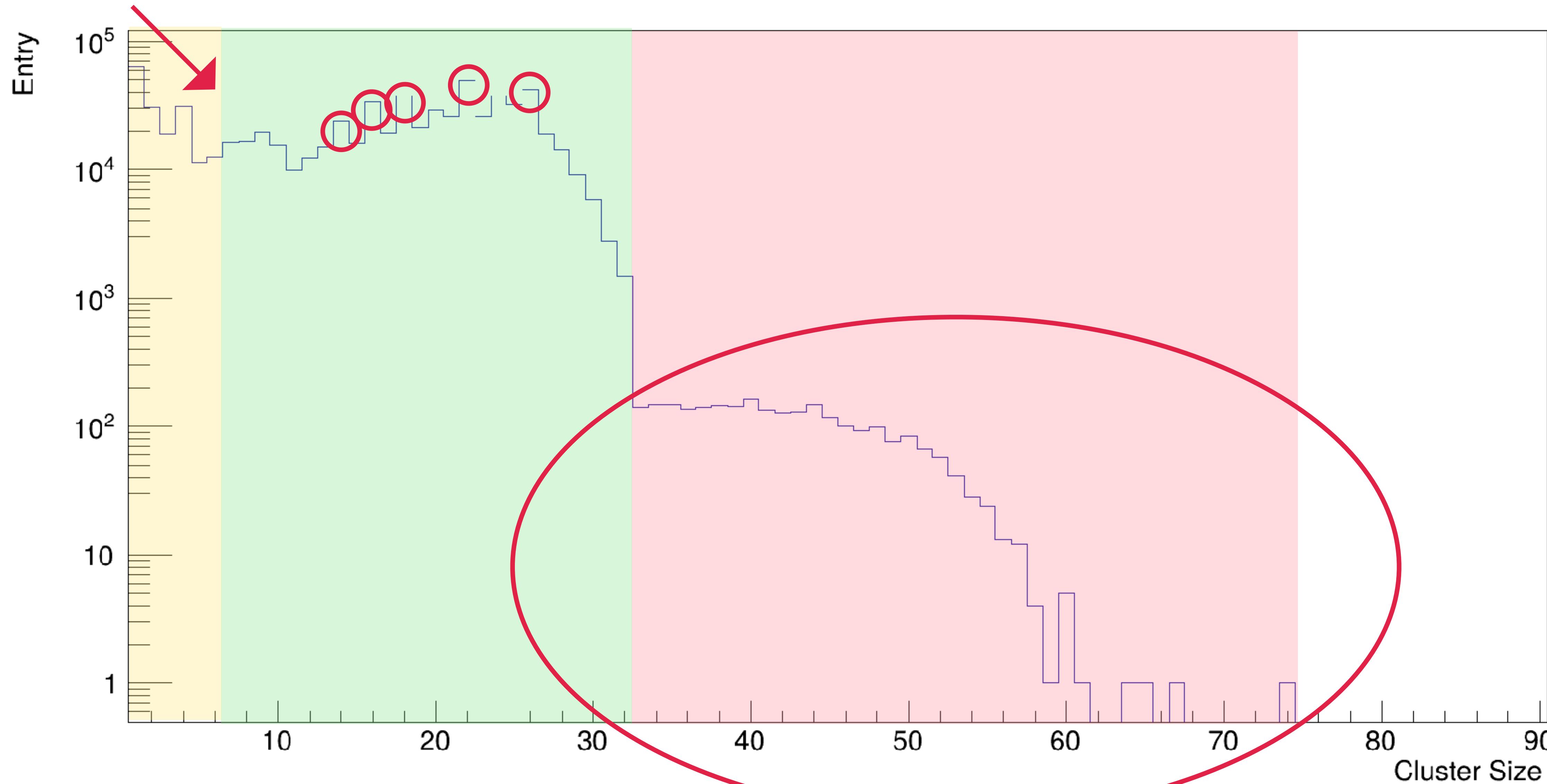


$$-\left\langle \frac{dE}{dx} \right\rangle = \frac{4\pi}{m_e c^2} \times \frac{n z^2}{\beta^2} \times \left( \frac{e^2}{4\pi \epsilon_0} \right)^2 \times \left[ \ln \left( \frac{2m_e c^2 \beta^2}{I \times (1 - \beta^2)} \right) - \beta^2 \right]$$
$$\text{Cluster Size} = [1] \times \beta^{-[4]} \times \left[ [2] - \beta^{[4]} - \ln \left[ (\beta\gamma)^{-[5]} + [3] \right] \right]$$

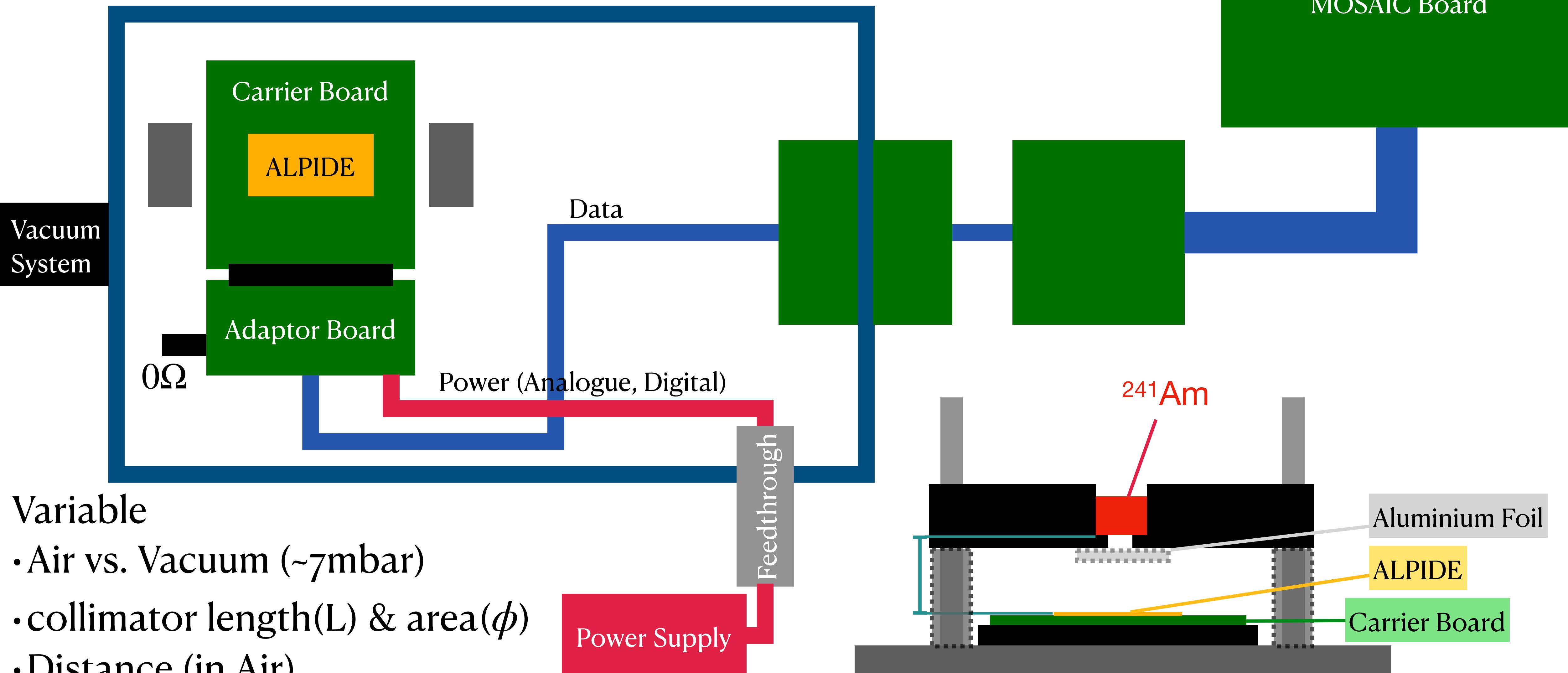
- The cluster size follows Bethe-Bloch formula
- (In high momentum), {Cluster Size}  $\propto$  {Energy Loss}
- Purpose: Check in case of the low  $\beta\gamma$ 
  - $^{241}\text{Am}$  =  $\alpha$  source ( $\beta\gamma_\alpha = 0.0015$ )

# Motivation of Cluster Size Study

Cluster Size



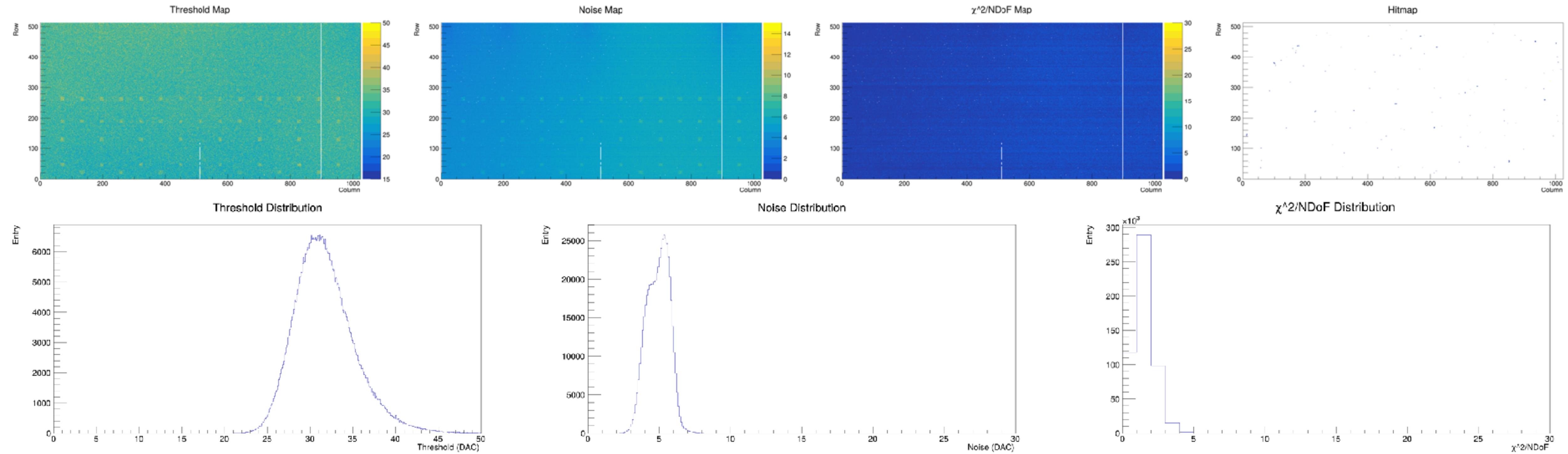
# Experimental Set-up



# Procedure

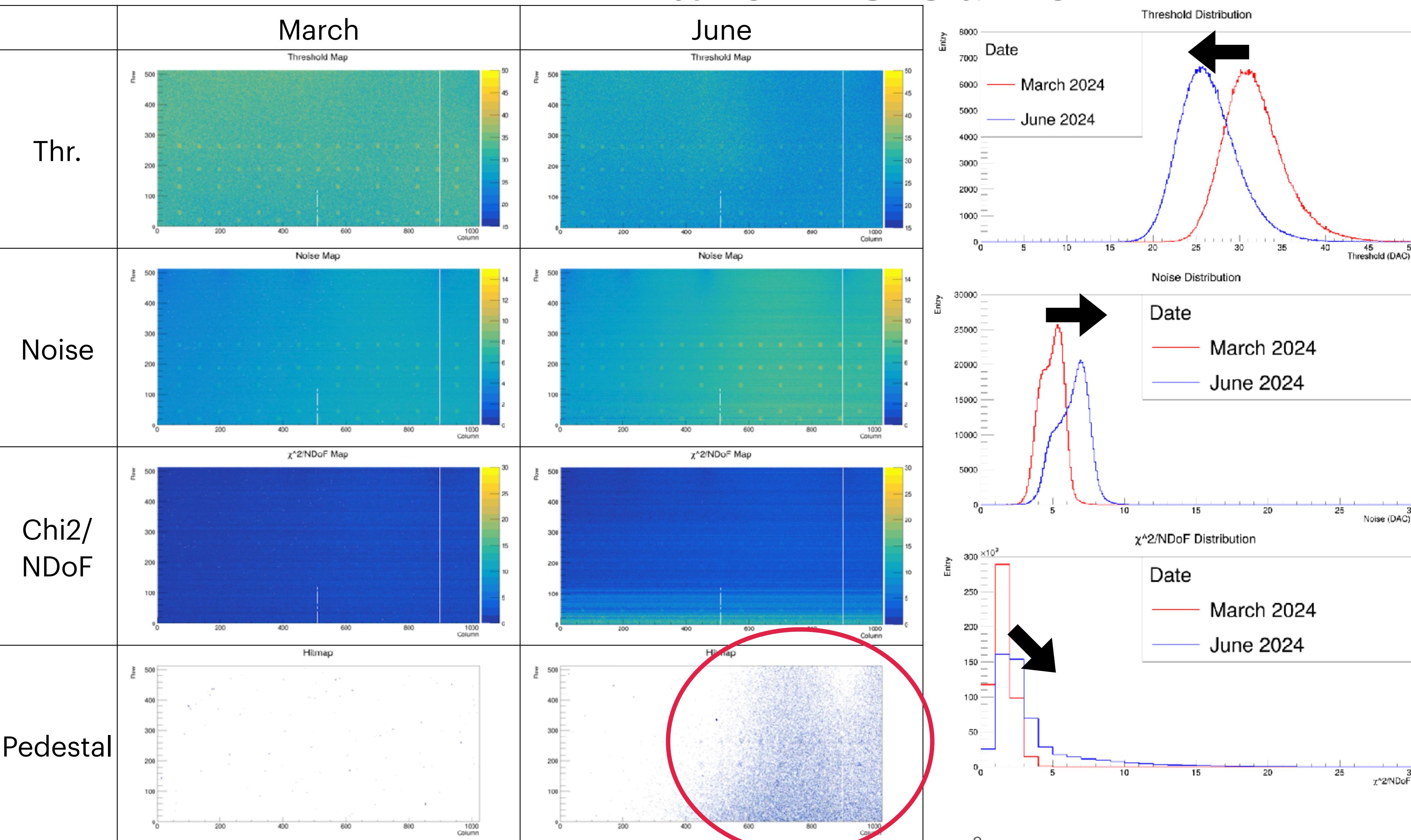
1. Pre-Test
  1. Light shielding
  2. Test FIFO
  3. Monitor Threshold and Pedestal
2. Measurement from Am241 (Activity: 4.1 kBq)  $\rightarrow \alpha + \gamma$
3. Measurement from Am241 with shielding  $\rightarrow \gamma$  only
  - Vacuum (7 mbar) / Air
  - Collimator Length(L) [mm]: 1 / 3 / 7 / 20
  - Collimator Radius( $\phi$ ) [mm]: 1 / 2 / 3 / 4 / 7

# T854192 25T 02/4C(Bronze) Threshold and Pedestal (14 Mar. 2024)

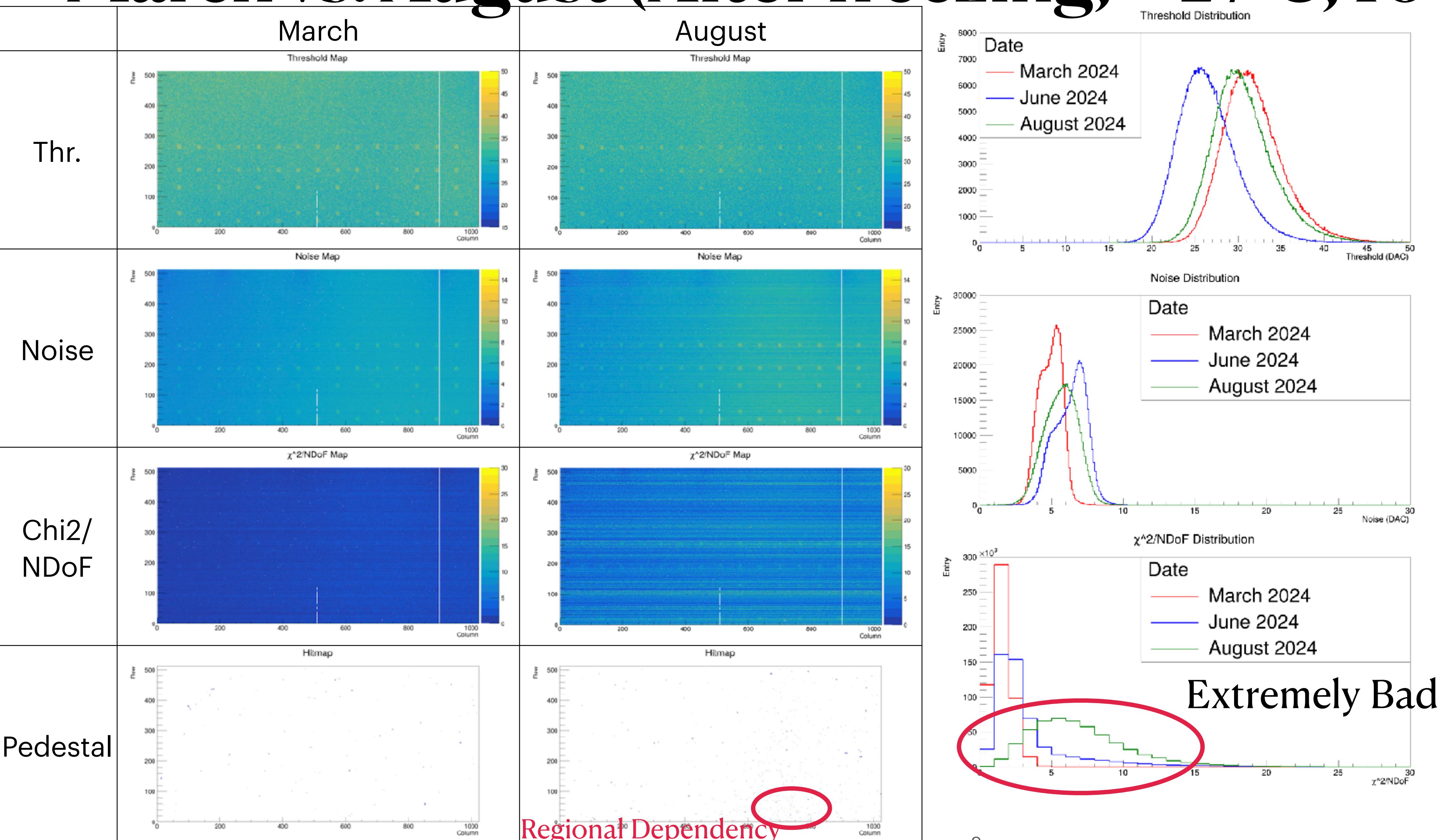


- Uniform in Threshold, Noise and  $\chi^2/\text{NDoF}$
- The hot pixel → masked

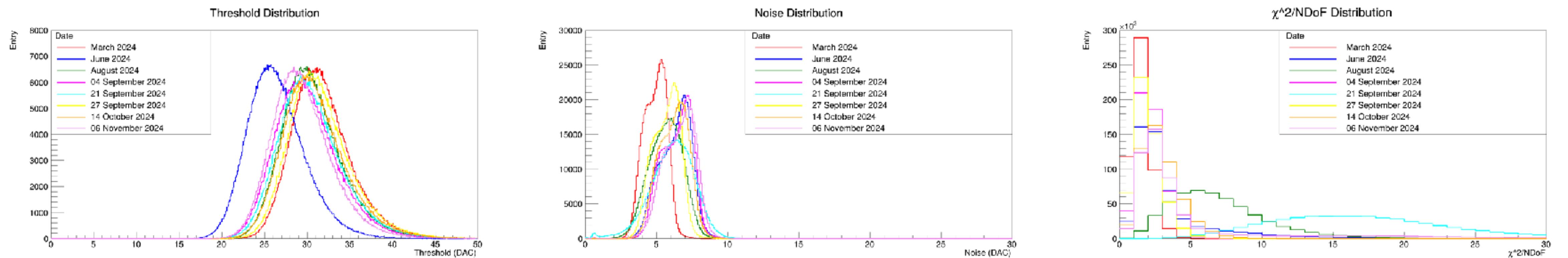
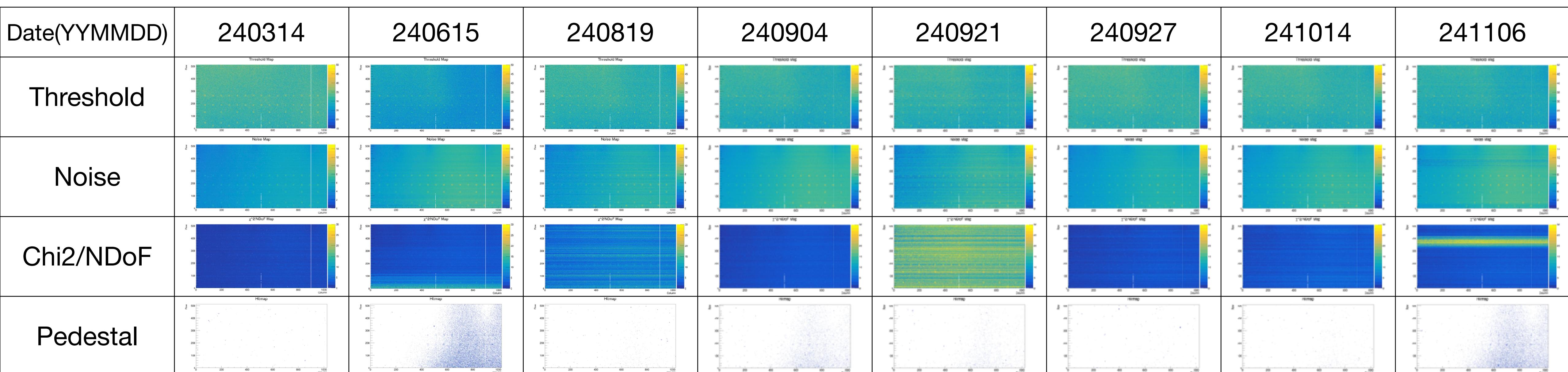
# March vs. June



# March vs. August (After freezing, -27°C, 10 days)

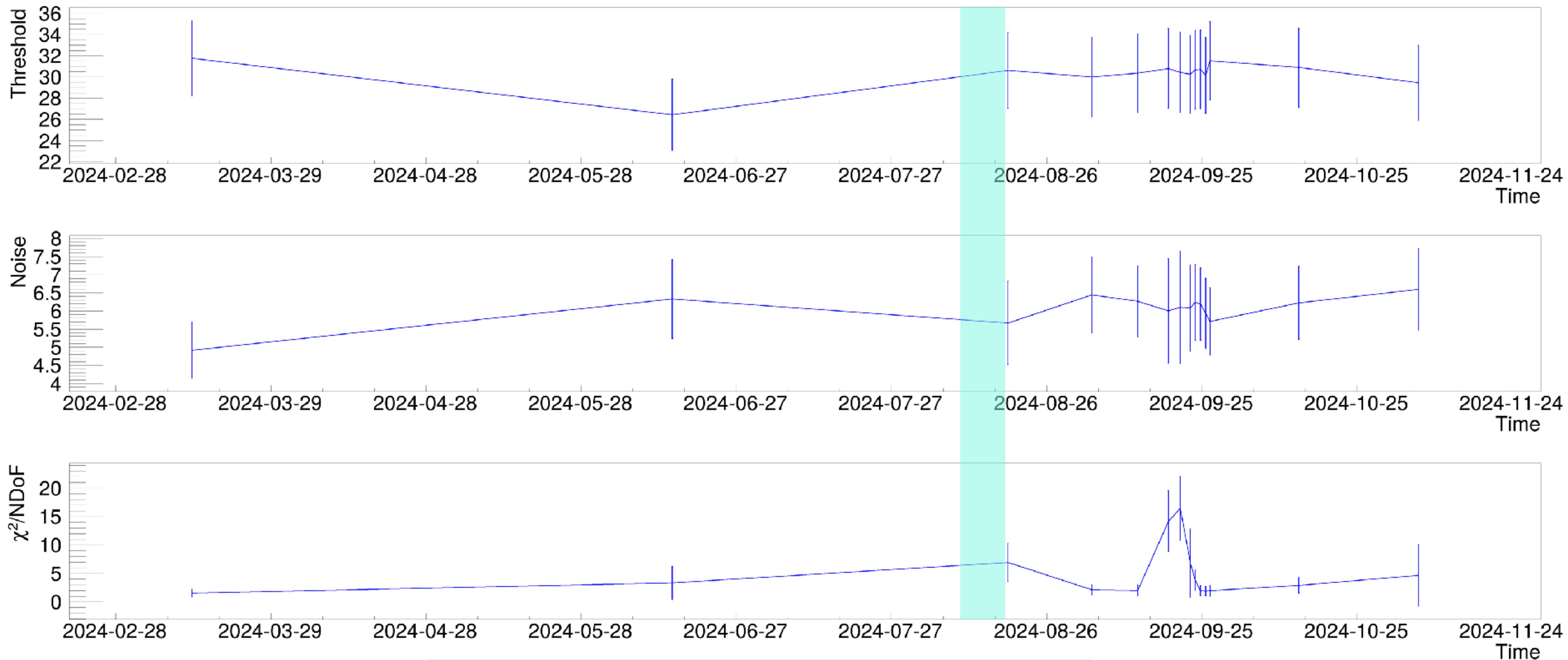


# T854192 25T 02/4C(Bronze) Threshold and Pedestal



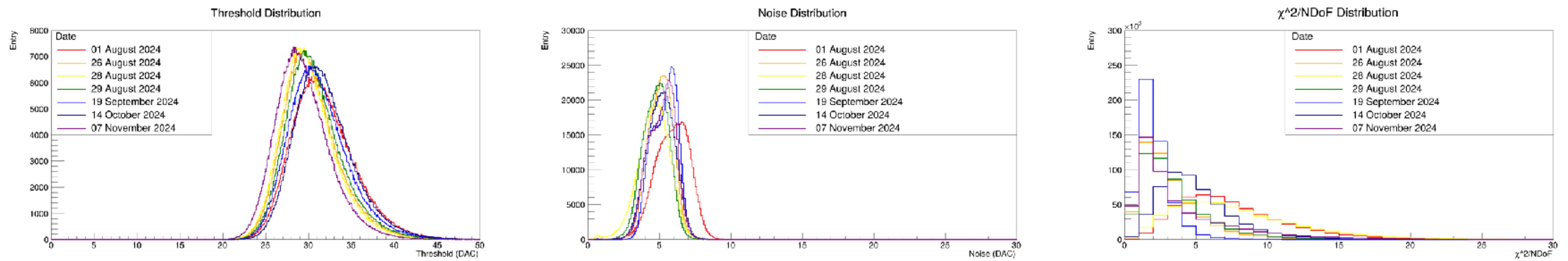
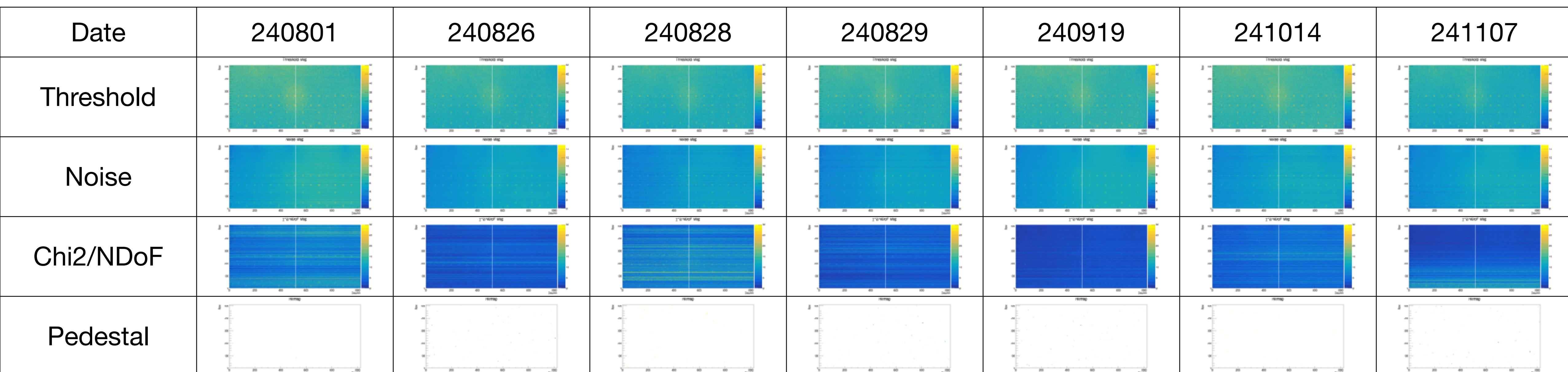
- Threshold & pedestal is changed randomly.
- Bad to use!

# T854192 25T 02/4C(Bronze) Threshold Timeline



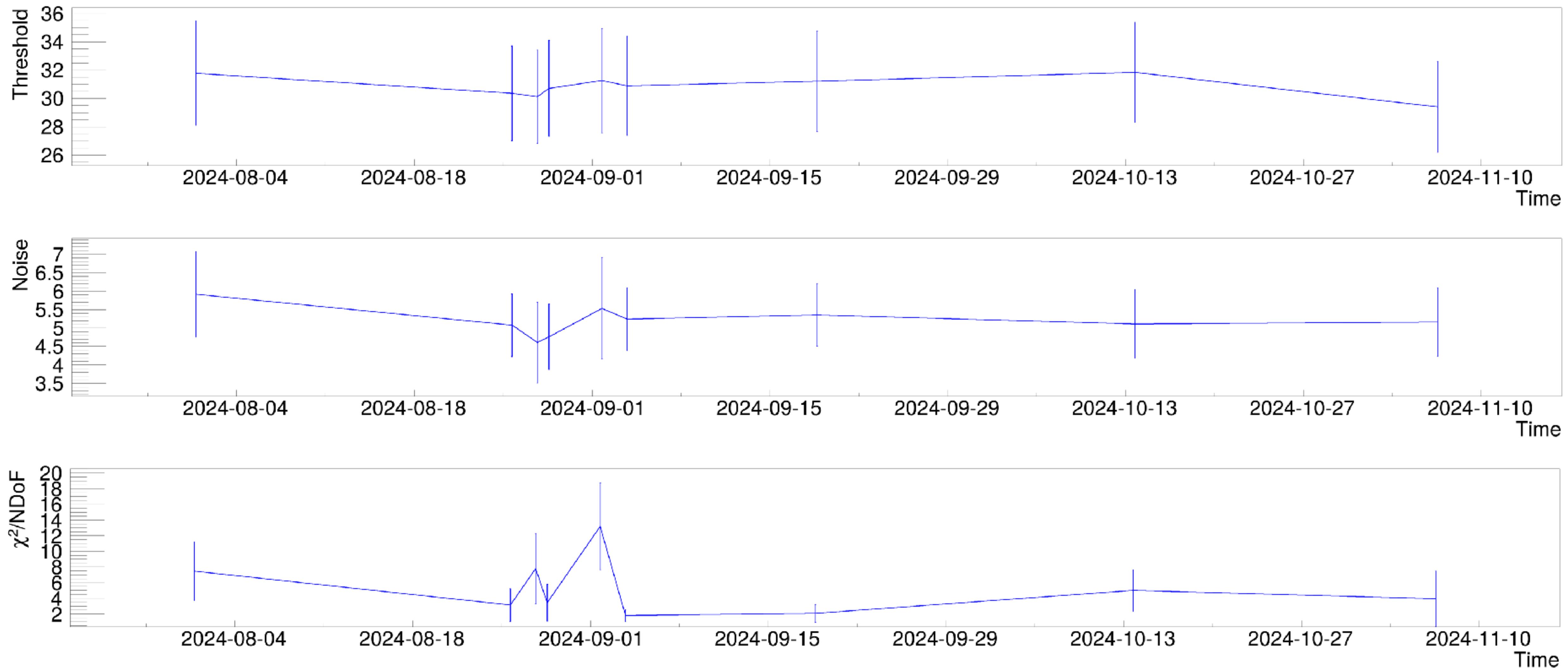
Stored in Refrigerator (-27°C, 10 days)

# T968874W 12T-C5(Silver) Threshold and Pedestal



- Threshold & Noise,  $\chi^2/\text{NDoF} \rightarrow$  Fluctuated
- Few Pedestal  $\rightarrow$  Good to use in experiment!

# T968874W 12T-C5(Silver) Threshold Timeline



# Conclusion & Outlook

- Fluctuation in Threshold, Noise &  $\chi^2/\text{NDoF}$ 
  - Monitoring threshold is needed.
- Experiment with Silver ALPIDE -> OK!
- (Cluster size distribution) total entry check with collimators (by 15th Nov. 2024)
- Cluster Shape Study (by 30th Nov. 2024)

Thank you for listening.