

# GEP ECal performance and energy calibration

**Jhih-Ying Su**

**University of Massachusetts, Amherst**

# ECal energy calibration

- Calibration is done by obtaining reasonable E/p distribution of the scattered electrons.
- The electron energy comes from ECal PMT signals with proper gain coefficients.
- GEM tracking allows for precise proton angular reconstruction, which eventually reconstruct the momentum of electrons.
- This method is similarly applied for HCal, but more complicated as HCal is a sampling calorimeter.

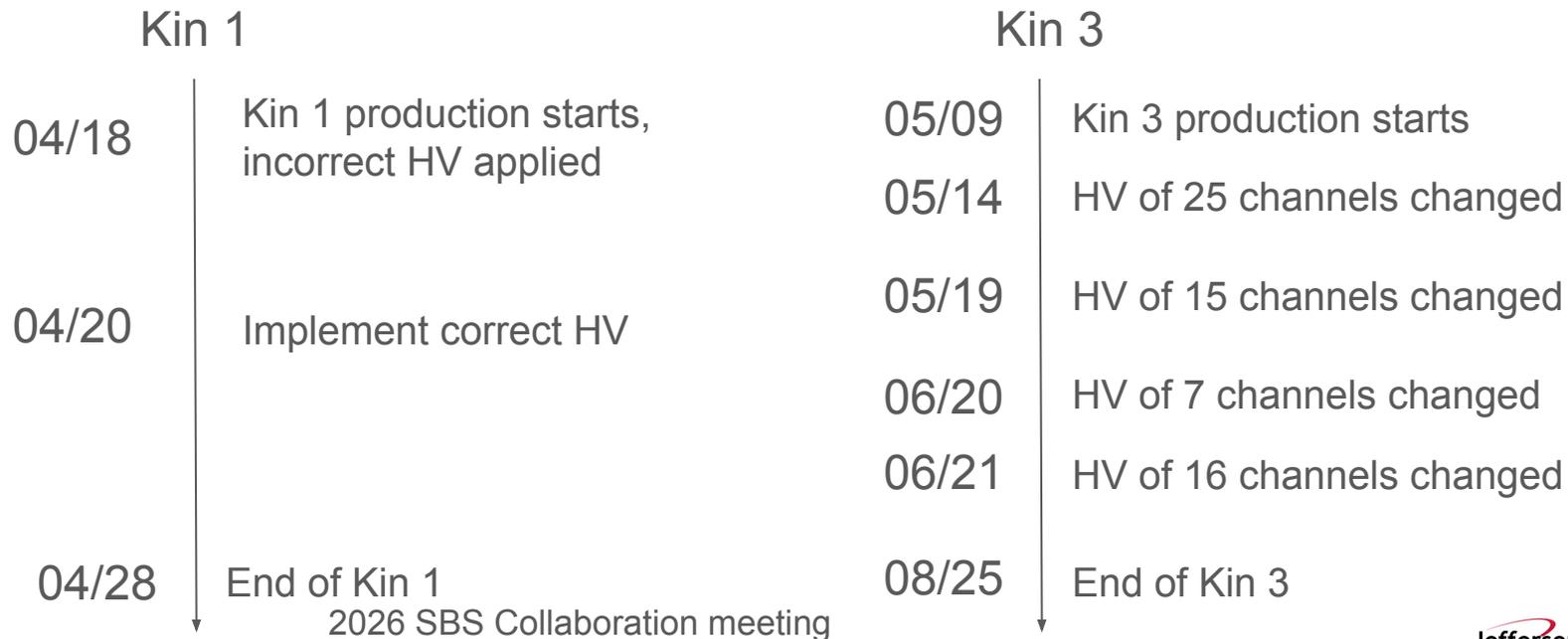
$$\theta_e = 2 \tan^{-1} \left( \frac{M_p}{M_p + E_{beam}} \frac{1}{\tan(\theta_p)} \right)$$

$$\phi_e = -\phi_p$$

$$p_e = \frac{E_{beam}}{1 + \frac{E_{beam}}{M_p} (1 - \cos(\theta_e))}$$

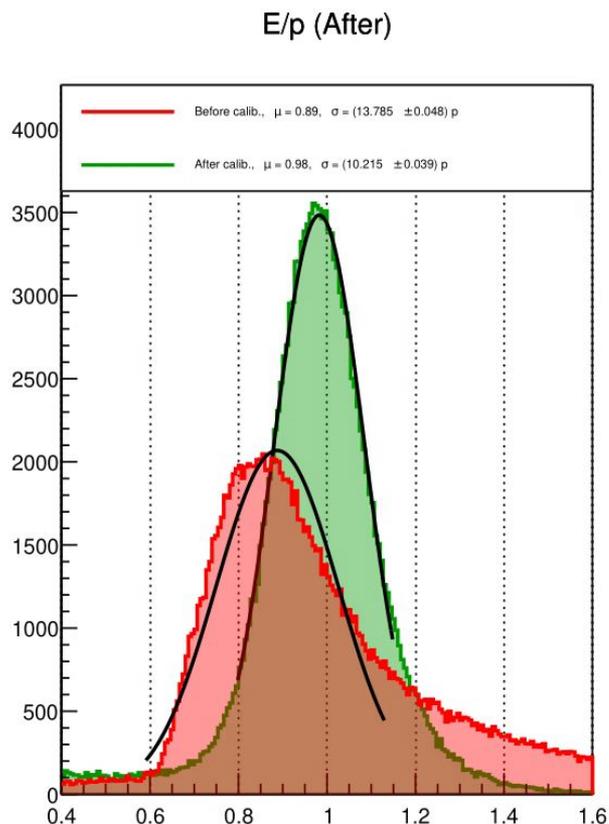
# Different HV periods in Kin1 and Kin3

- During the experiment, it was a challenge to optimize the performance of ECal by applying the HV in a reasonable range, and obtaining the appropriate gain coefficients for each channel. With massive amounts of channels HV being changed, it's necessary to separate the runs in periods.

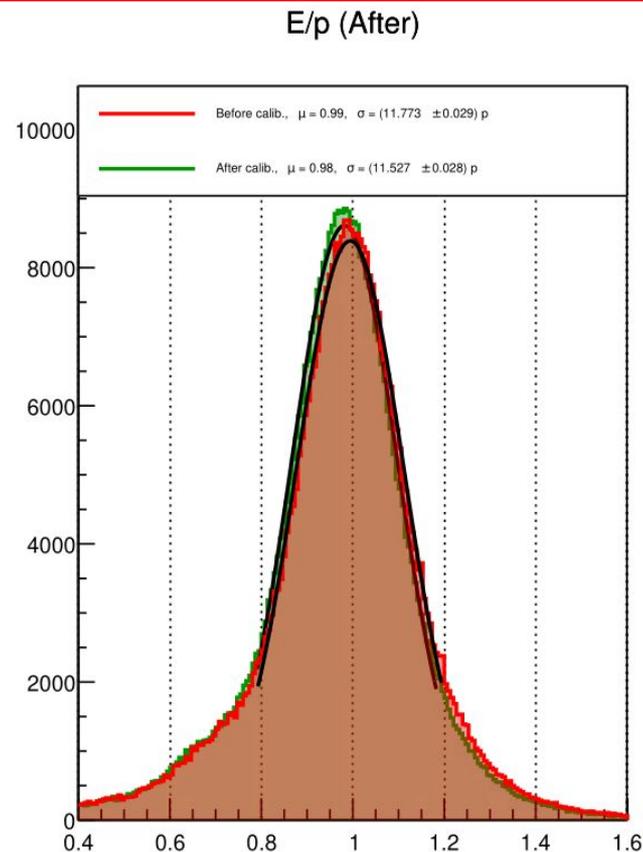


# Calibration results in Kin 1

- The red curve and the green curve are E/p before and after calibration, respectively. Both incorrect and correct HV periods in Kin 1 are well calibrated, with the resolution  $\sim 11\%$ .



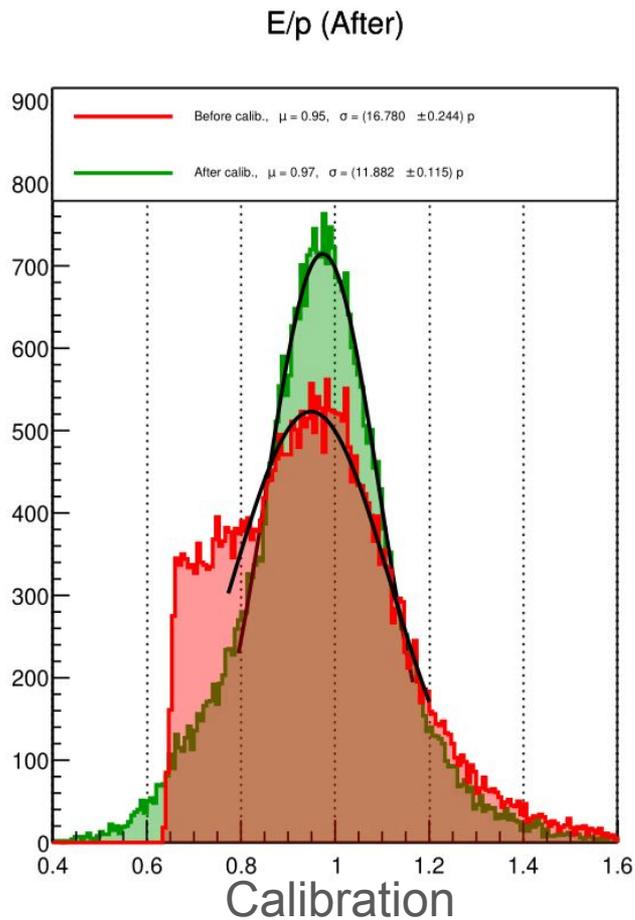
Wrong HV period  
2026 SBS Collaboration meeting



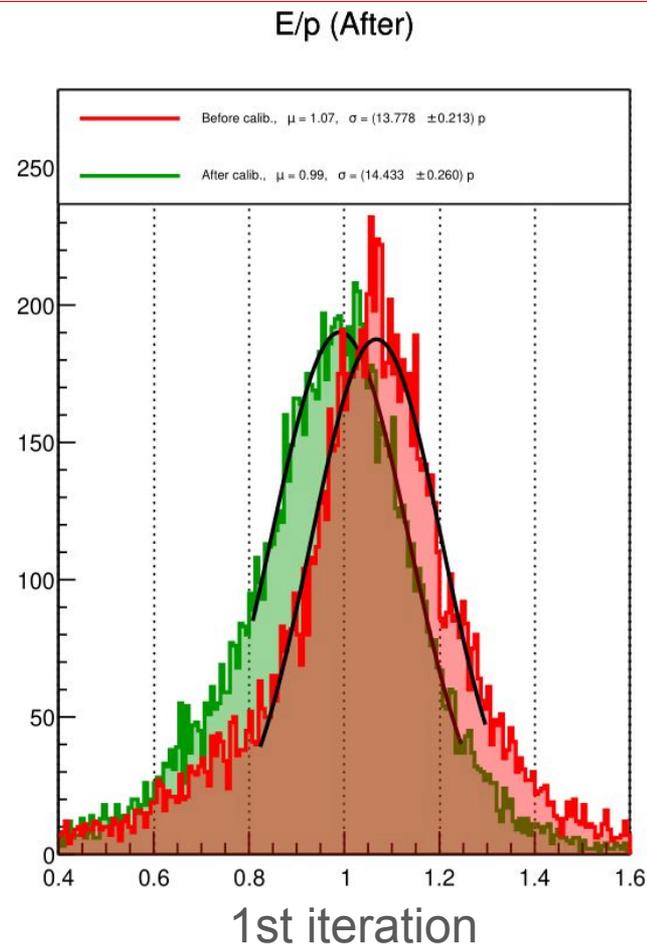
Correct HV period

# Calibration results in Kin 3

- For Kin 3 we reach the resolution  $\sim 12\%$ , while in our first iteration  $E/p$  is not centered near 1 due to the ineffectiveness of calibration near the dead channels.



Jih-Ying Su @ SBS Collaboration meeting

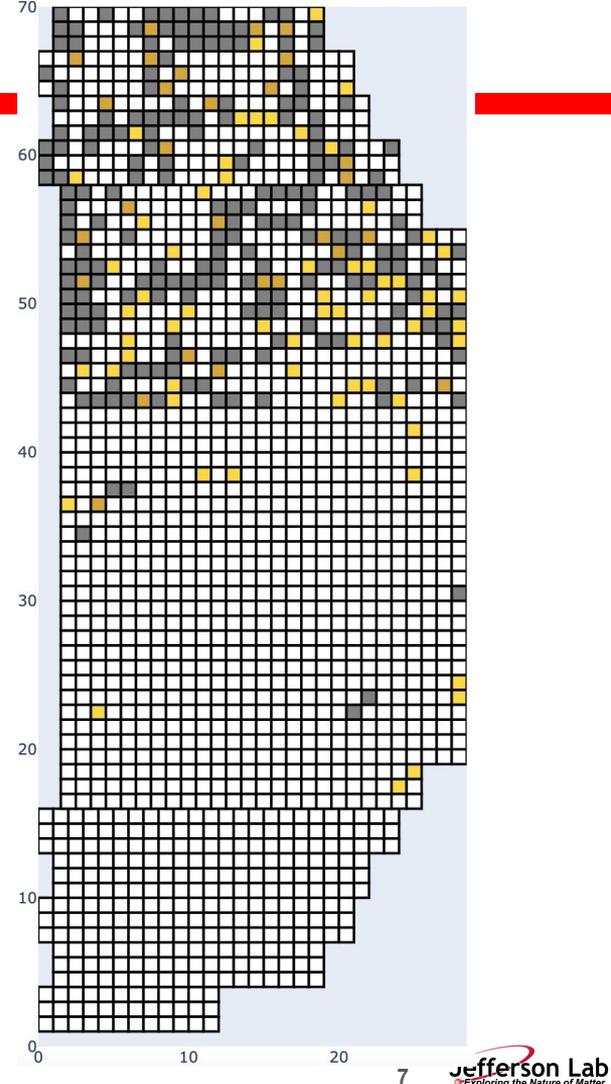


# Next step of calibration work

- Do the calibration with higher events per block, find out the channels that have fewer events or unreasonable gain coefficients. We will apply the old gain coefficients for those blocks as they are not correctly calibrated.
- Several iterations are needed until we are satisfied with the result.

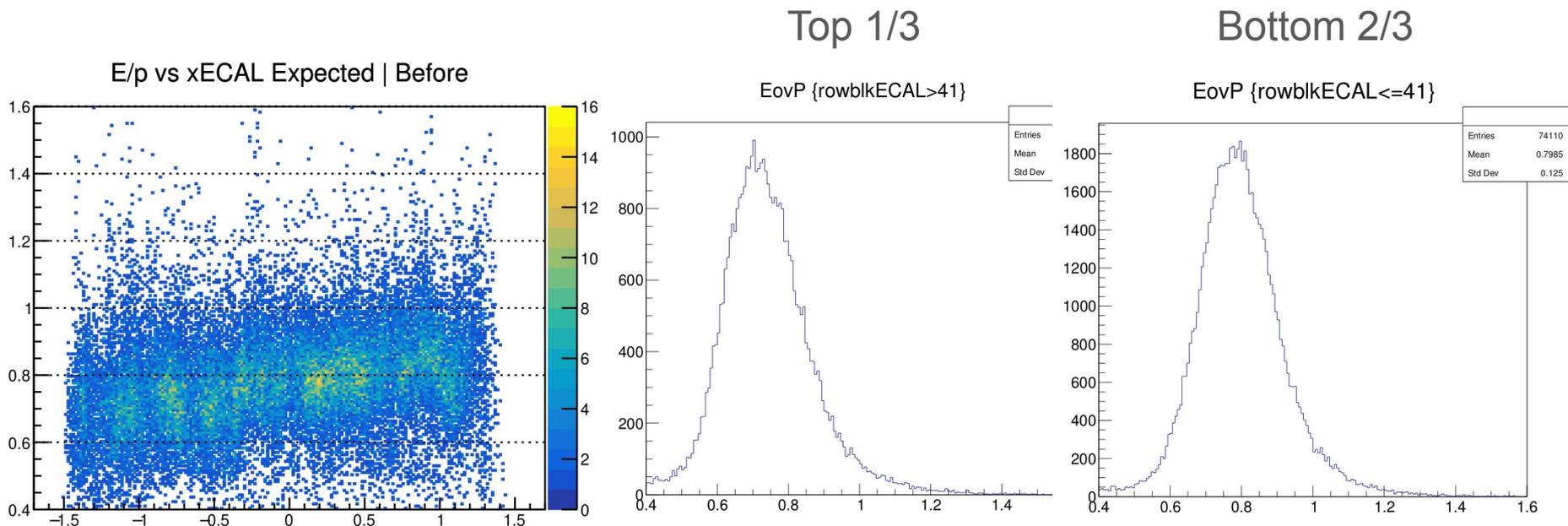
# Darkening of ECal top 1/3

- The top  $\frac{1}{3}$  (row 43-69) of ECal showed a lot darkening and loose light guides.
- The bottom  $\frac{2}{3}$  had few failures.
- Yellow and orange signify levels of crystal darkening.
- Gray represents a loose light guide.
- It is significant to figure out when this happened as the performance of the PMTs would be different, which means we need to divide our periods of calibration based on the time of darkening.



# Identify the timing of light shedding

- By looking at the E/p distribution, it is obvious that the top 1/3 of ECal is significantly lower.



# Tentative conclusion to the darkening of ECal

- The E/p distributions show that we probably have the glue joint darkening at the upper  $\frac{1}{3}$  of ECal at the beginning of Kin 1, while this is not a final conclusion
- We are able to have only 2 HV periods (3 if include the commissioning period) in Kin 1 and 5 HV periods in Kin 3, without the necessity to create more periods of ECal energy calibration for ECal darkening

# Summary

- ECal energy calibration is in good progress, although several iterations are needed to achieve the expected performance.
- An investigation on ECal darkening has been done with a preliminary conclusion that this happened before the beginning of the experiment.

**Thank you!**