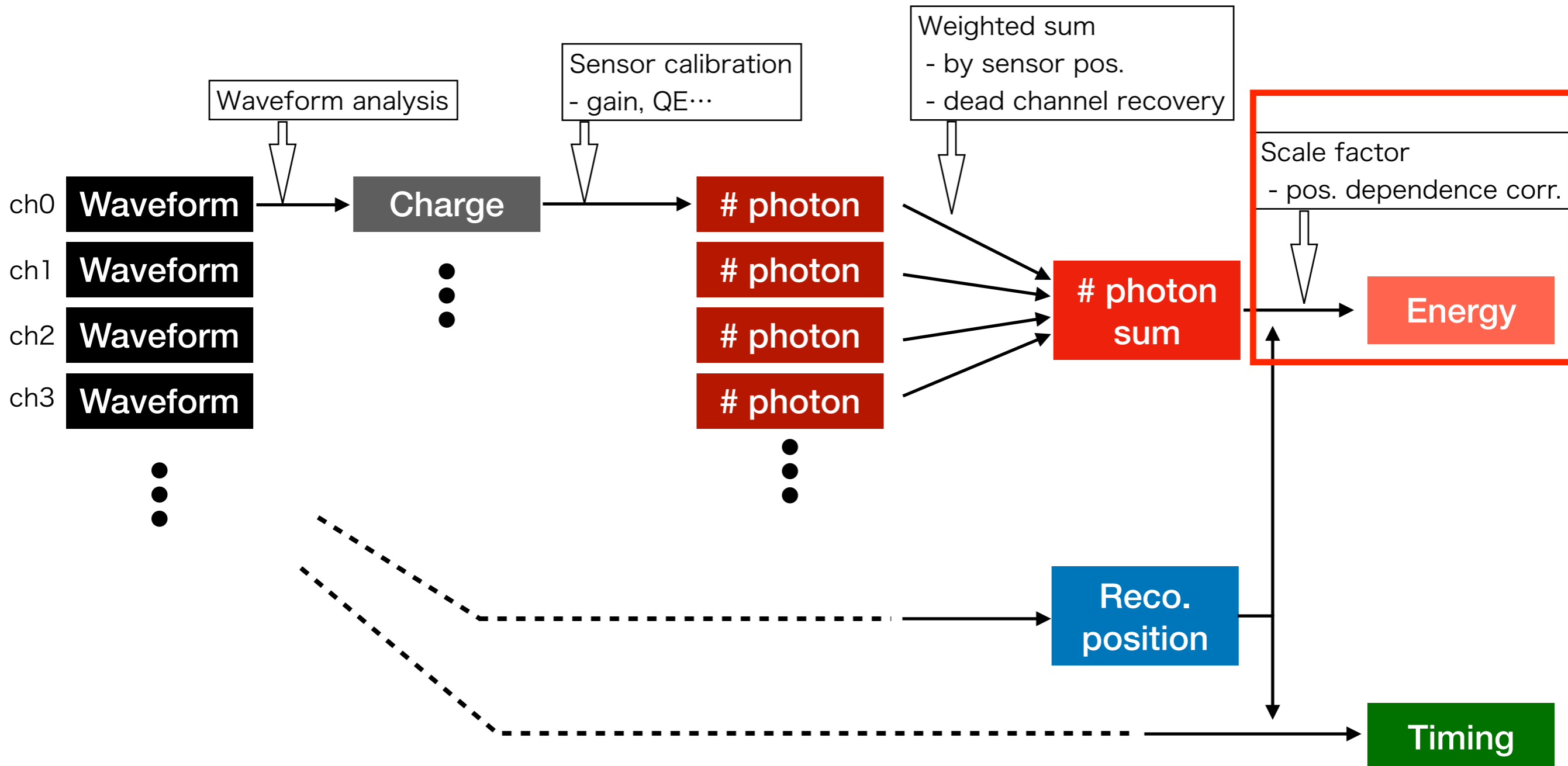


Calibration of XEC

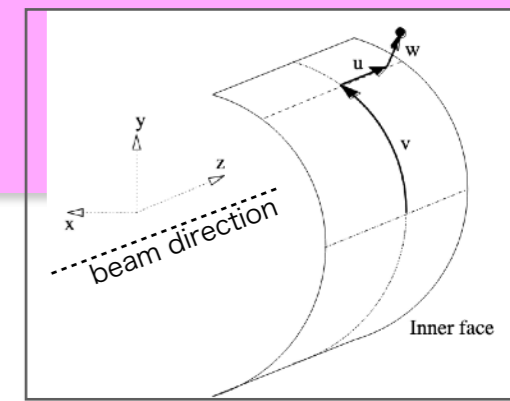
- Gamma-ray with 17.6 MeV
- Cosmic-ray

Analysis schematic of the LXe detector

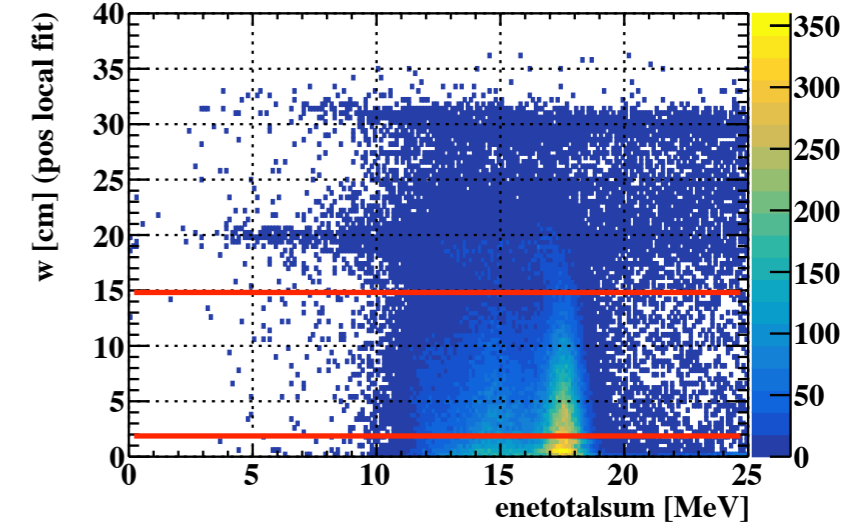
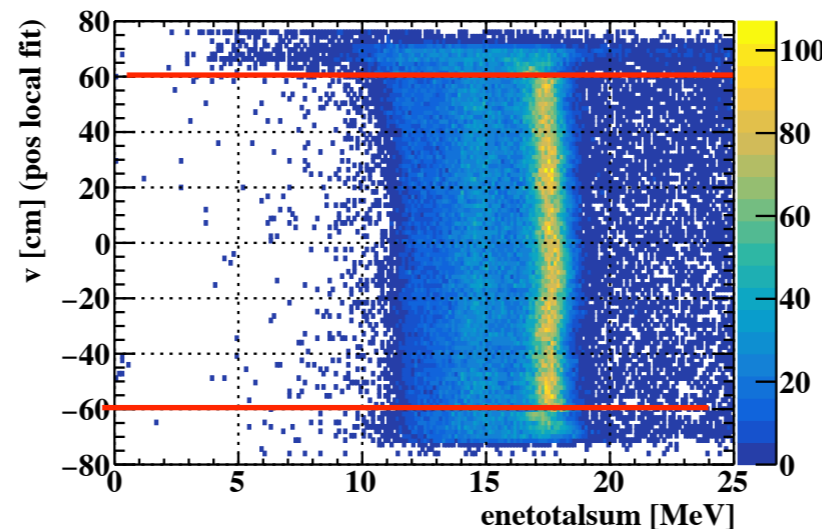
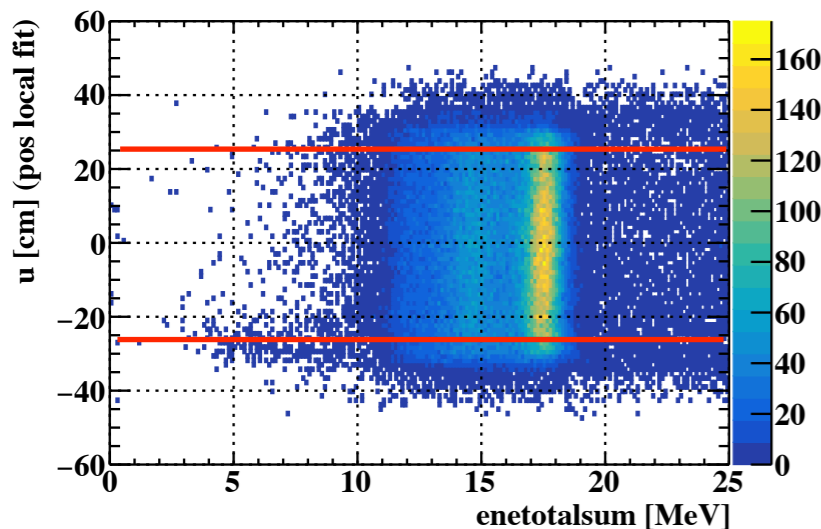
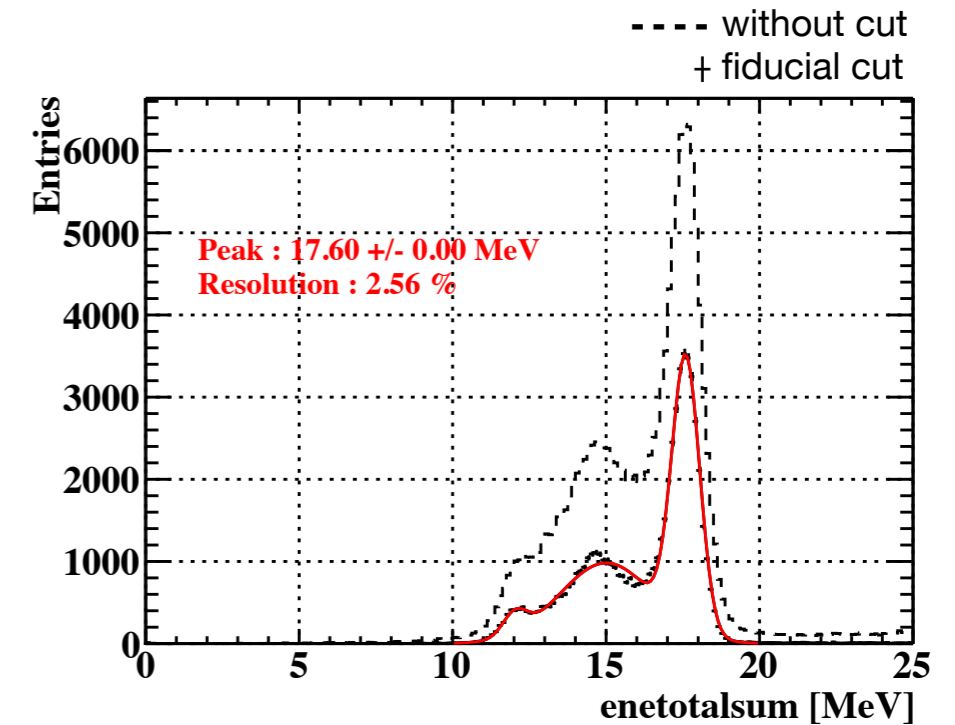
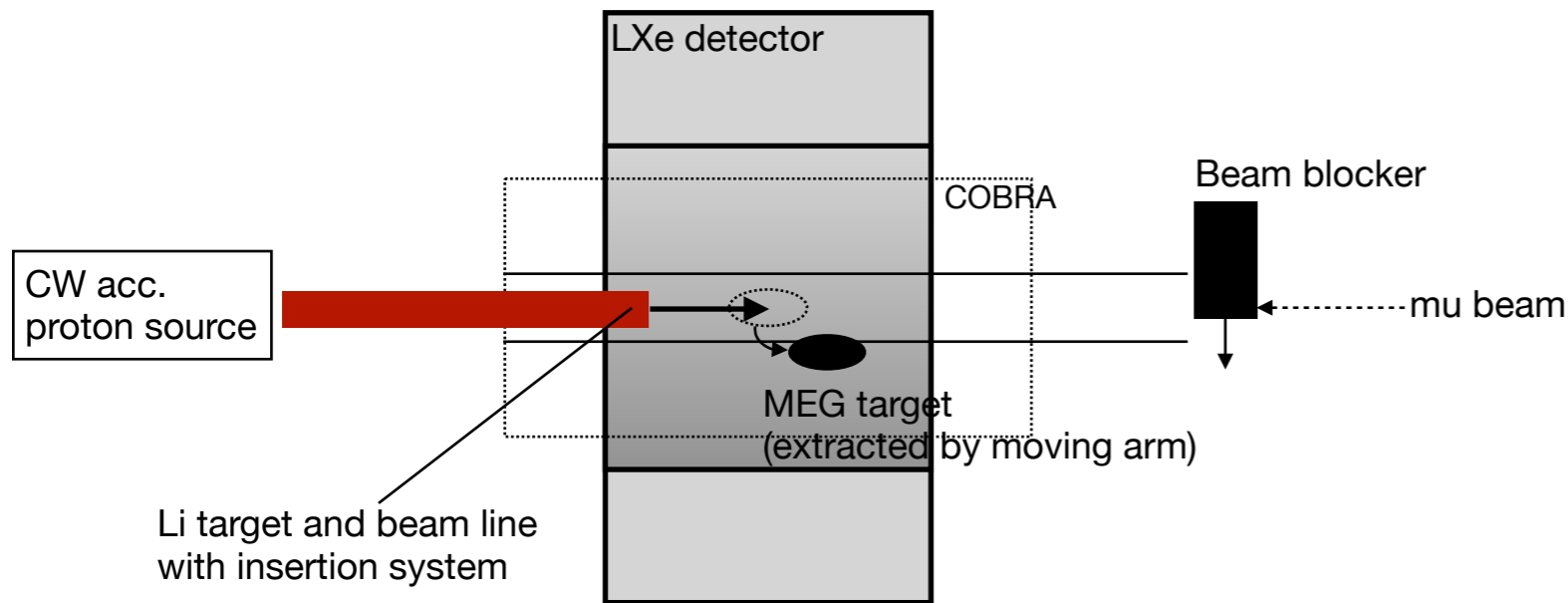
- Schematic of Analysis of the LXe detector
 - Finally, energy, position and timing of gamma-ray event are reconstructed
 - Pileup gamma-ray rejection is also applied in the LXe analysis



Energy Calibration using 17.6 MeV Gamma

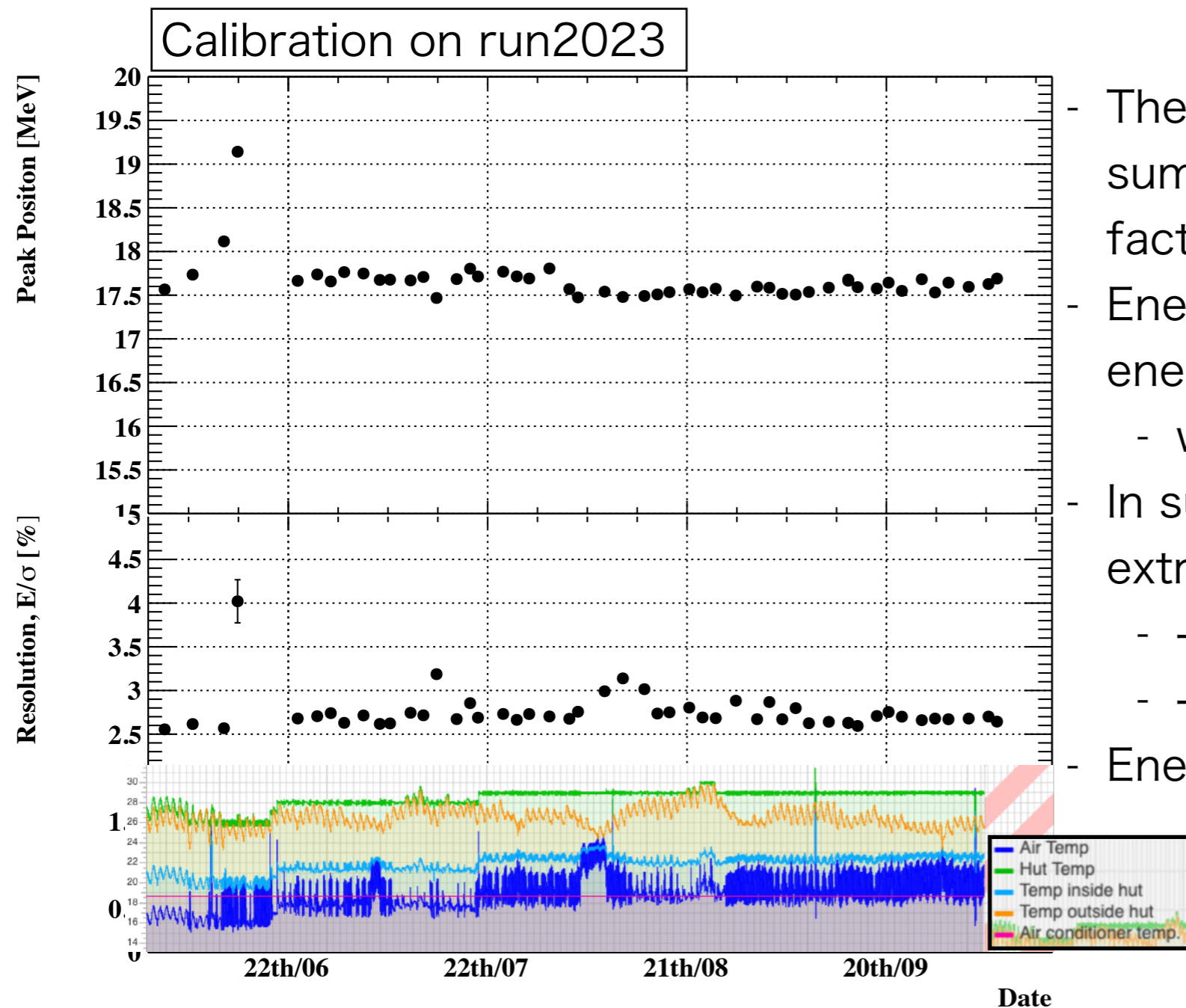


- Energy scale factor by mono-energy gamma-ray
 - using ${}^7\text{Li}(p, \gamma){}^8\text{Be}$ reaction to obtain 17.6 MeV gamma-ray
 - proton is accelerated by CW accelerator
 - This calibration is done three times per week (~30min/set)



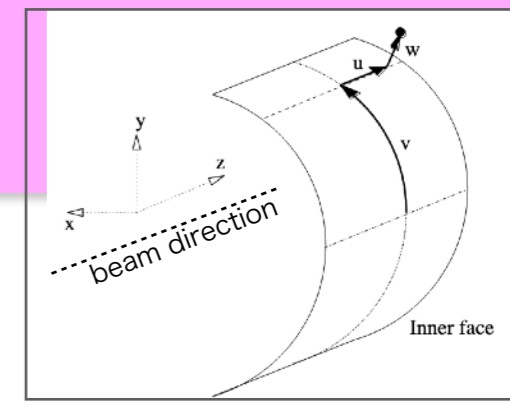
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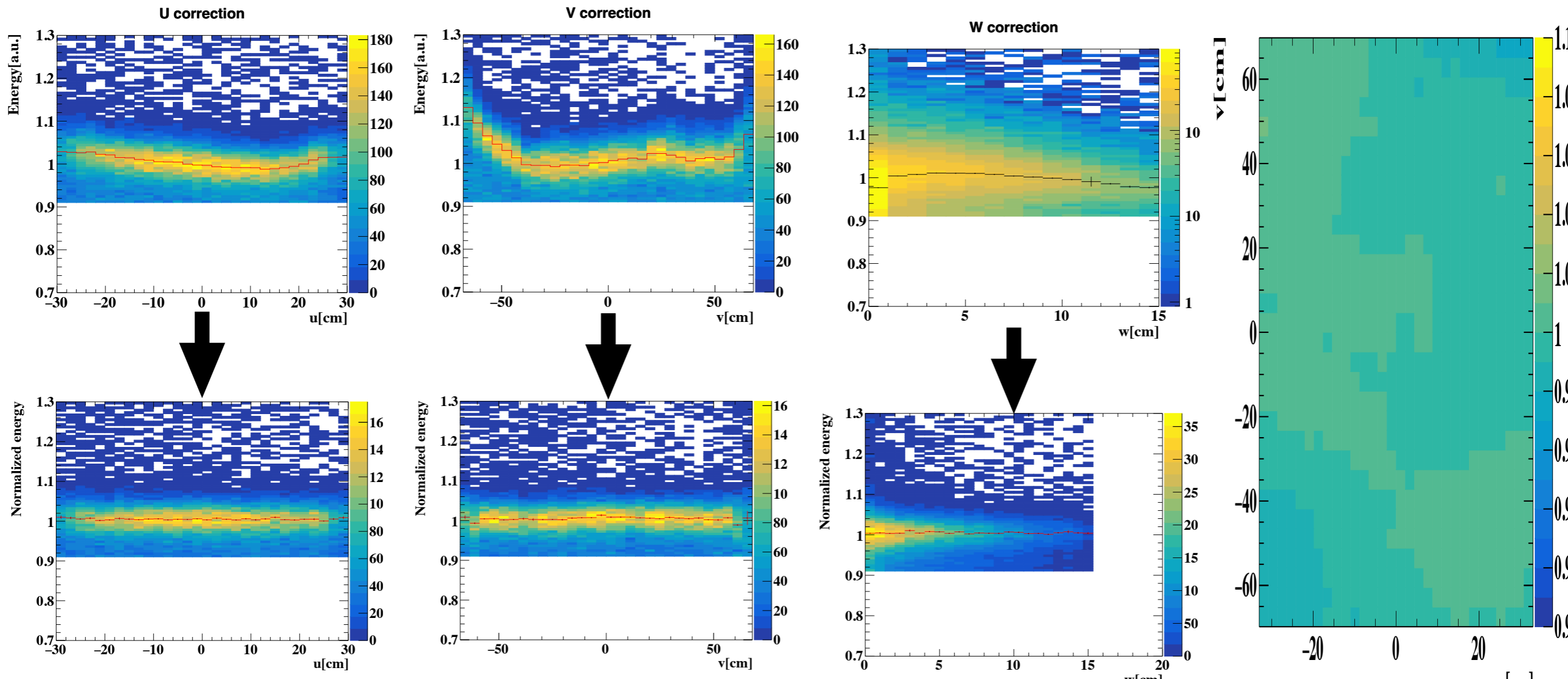


- The peak position of weighted #photon sum distribution is used to calculate scale factor (#photon sum \rightarrow energy)
- Energy scale stability is evaluated from energy scale history (left figure)
 - within 0.2 MeV (~1%) for later part
- In summer days, there are some extremely hot days in the PSI
 - \rightarrow hut temperature was unstable
 - \rightarrow noise situation became worse
- Energy resolution : ~2.5% @17.6MeV

Energy Calibration using 17.6 MeV Gamma

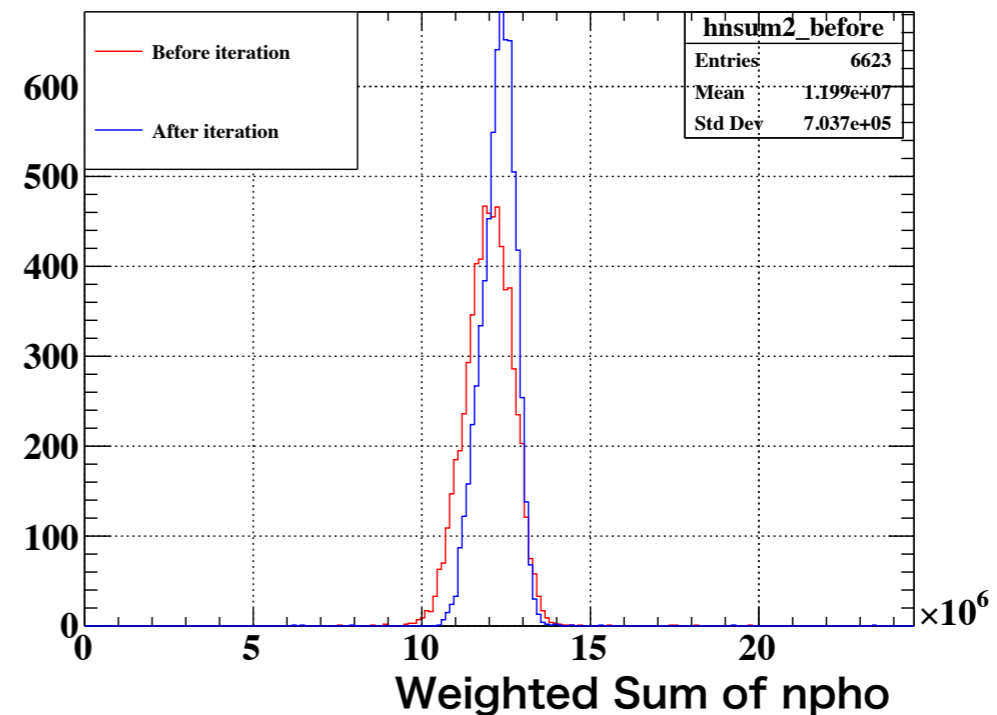
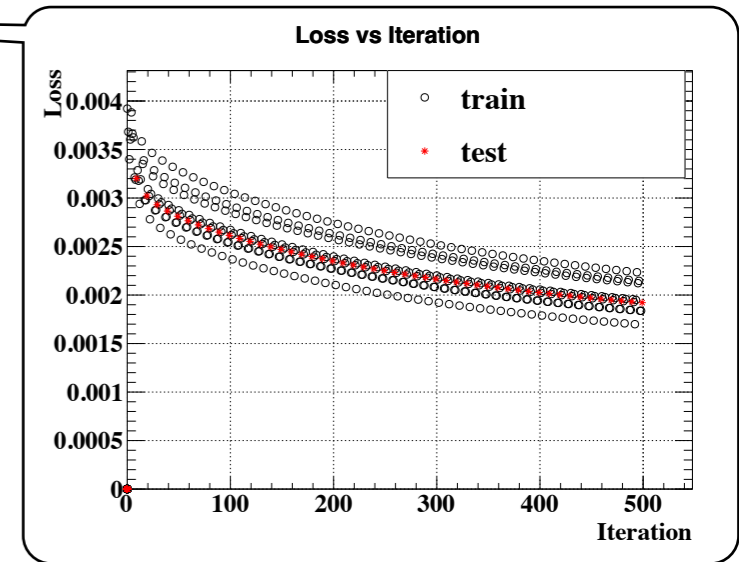
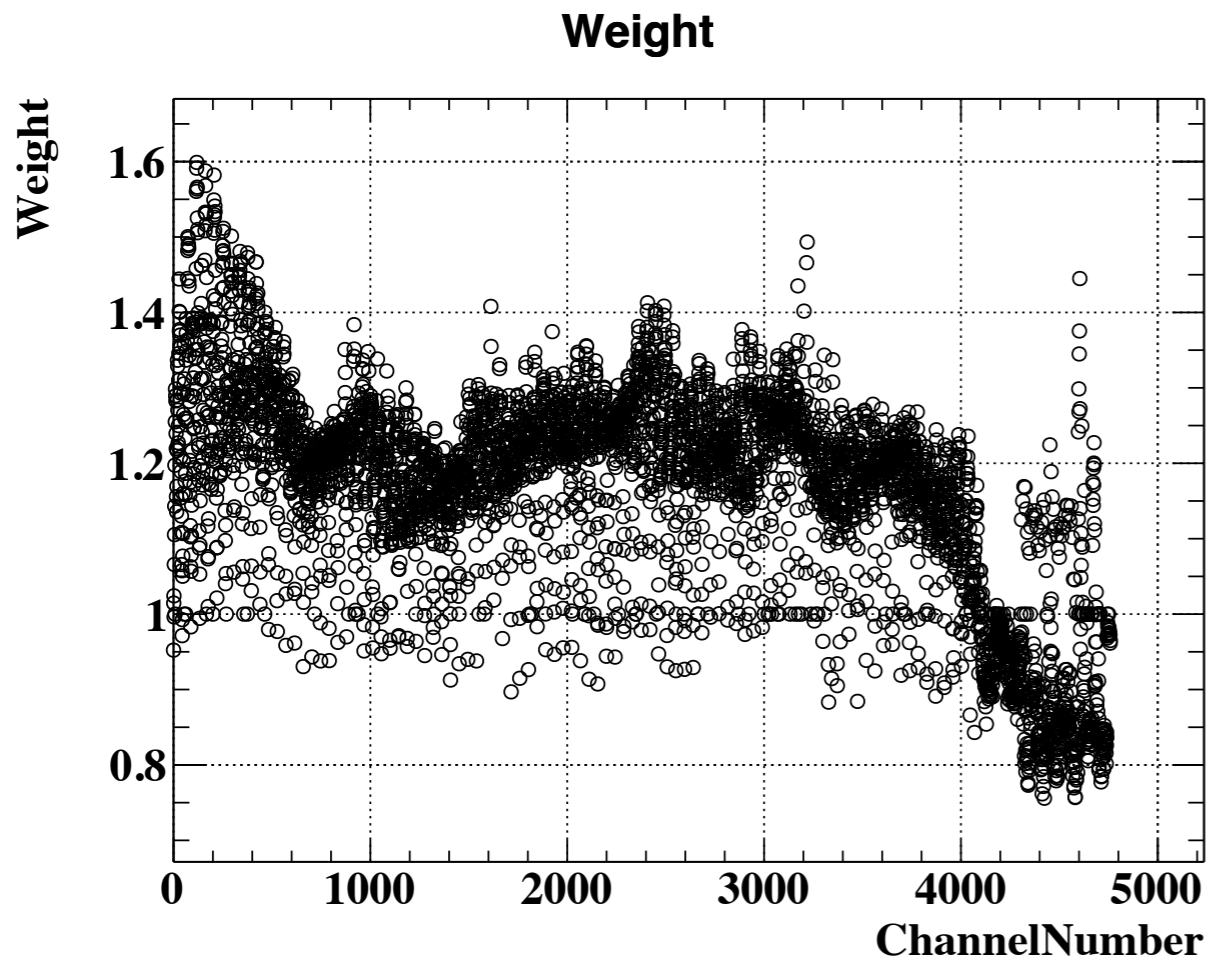


- Non-uniformity correction
 - using 17.6 MeV gamma-ray events to obtain correction table for non-uniformity during run time
 - First, the correction factor for 1-D (for u , v , w each) is calculated
 - Then, 2-D correction table (u, v plane) is calculated
 - Finally further correction for depth is applied with 3x8 uv sections



Trigger improvement : using 17.6 MeV Gamma

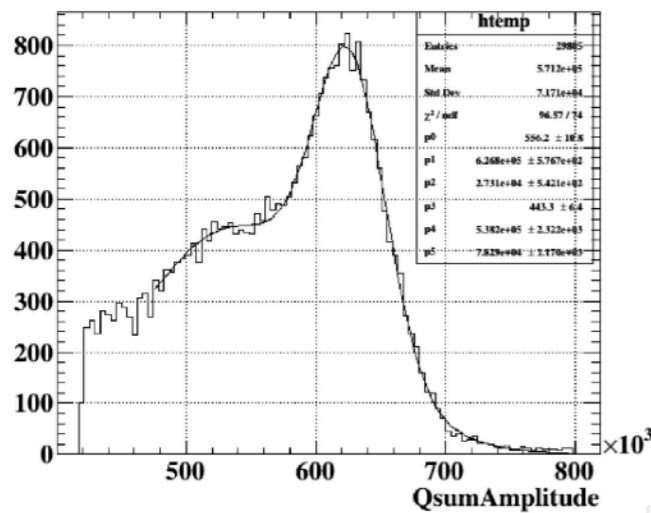
- Trigger rate was suppressed due to non-uniformity of LXe detector in 2022
 - threshold cannot be higher enough to reject BG without dropping signal
 - **Optimization of trigger weight sensor by sensor** is adopted to improve uniformity (since 2021)
 - Calculating “weight factor” to make “loss” to be minimize for each sensor



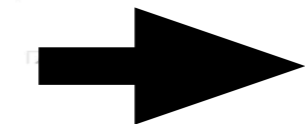
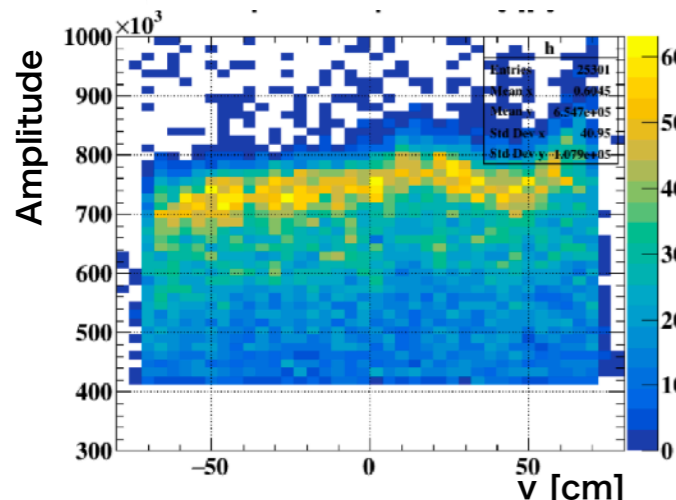
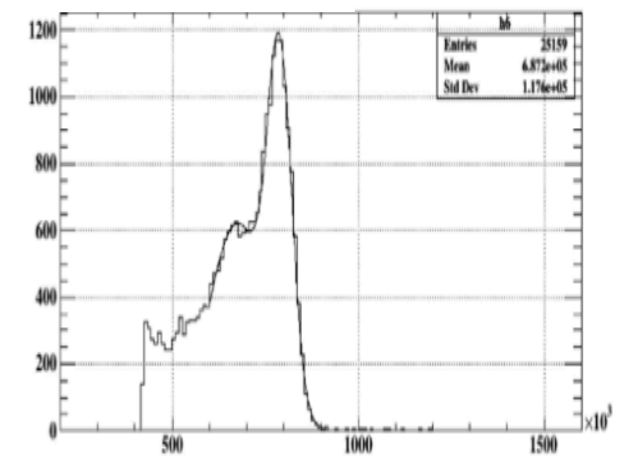
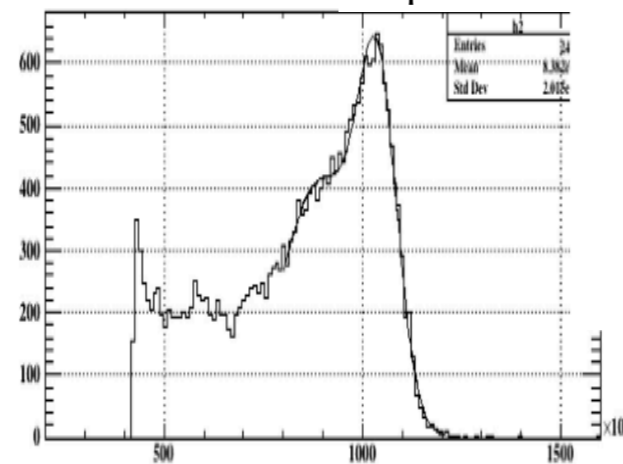
Trigger improvement : using 17.6 MeV Gamma

- Trigger rate was suppressed due to non-uniformity of LXe detector in 2022
 - threshold cannot be higher enough to reject BG without dropping signal
 - **Optimization of trigger weight sensor by sensor** is adopted to improve uniformity (since 2021)
 - crosstalk and after pulse of MPPC are also considered on trigger side since 2023 -> uniformity of online charge is much improved

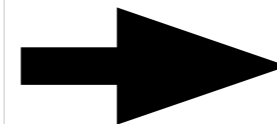
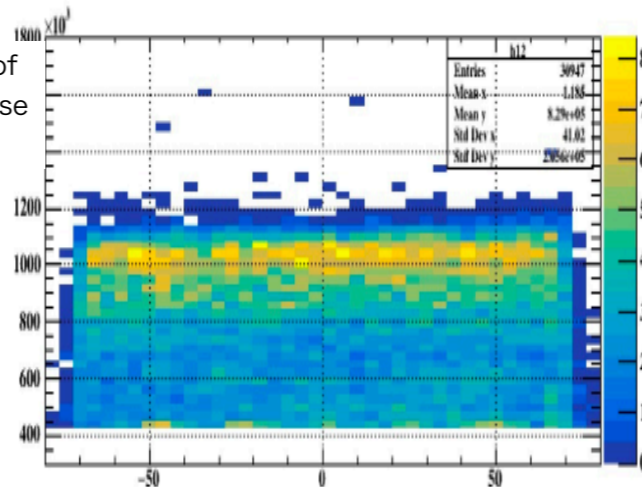
previous method



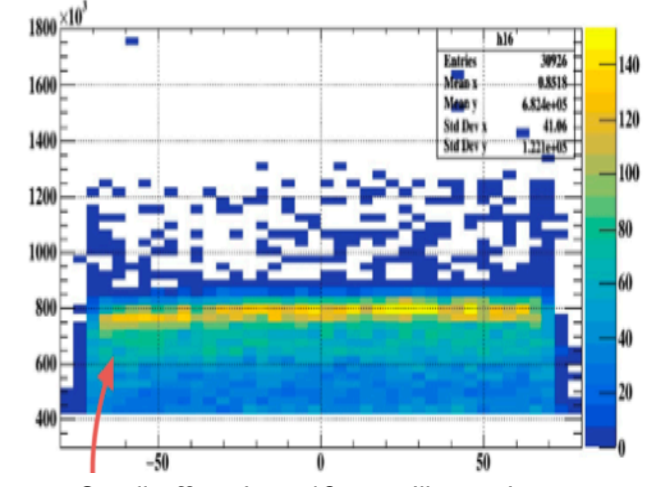
Improved method in 2023 run



Introduce the effect of Crosstalk & After pulse on online charge



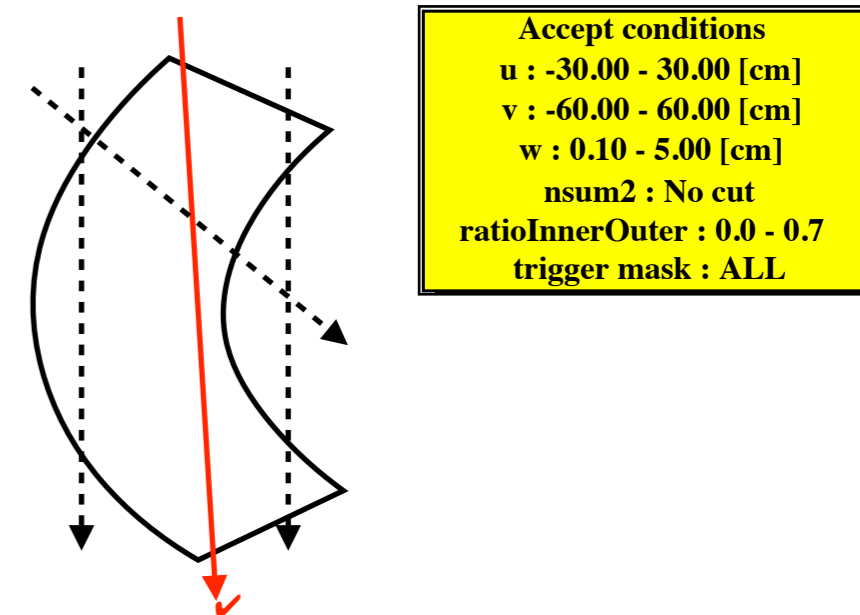
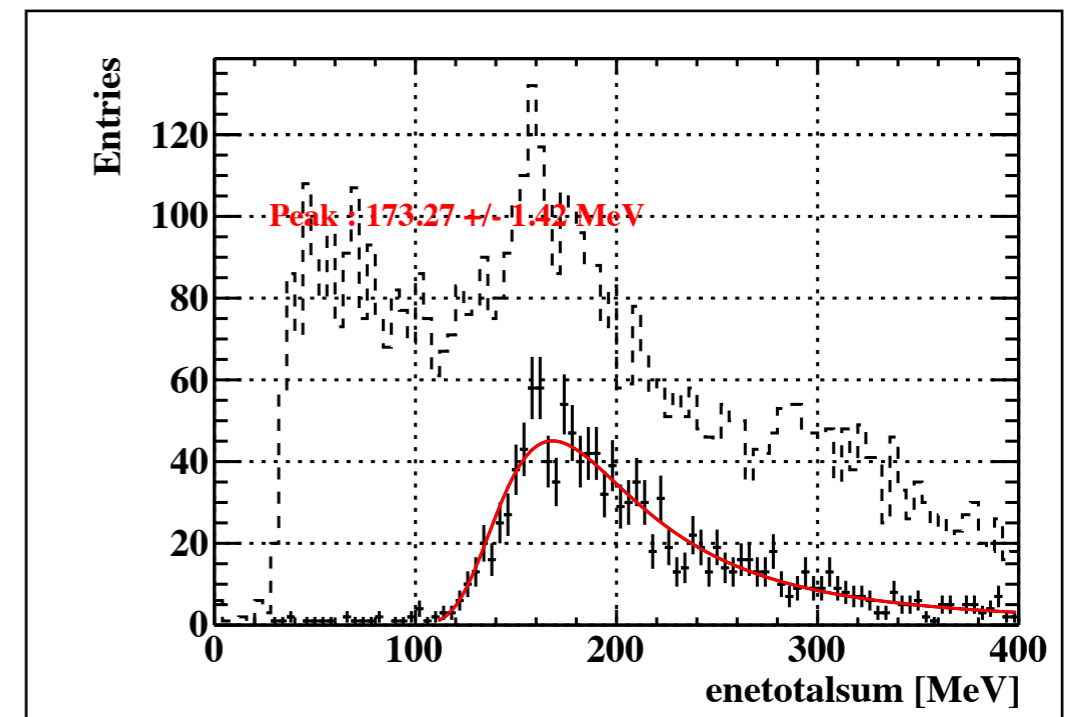
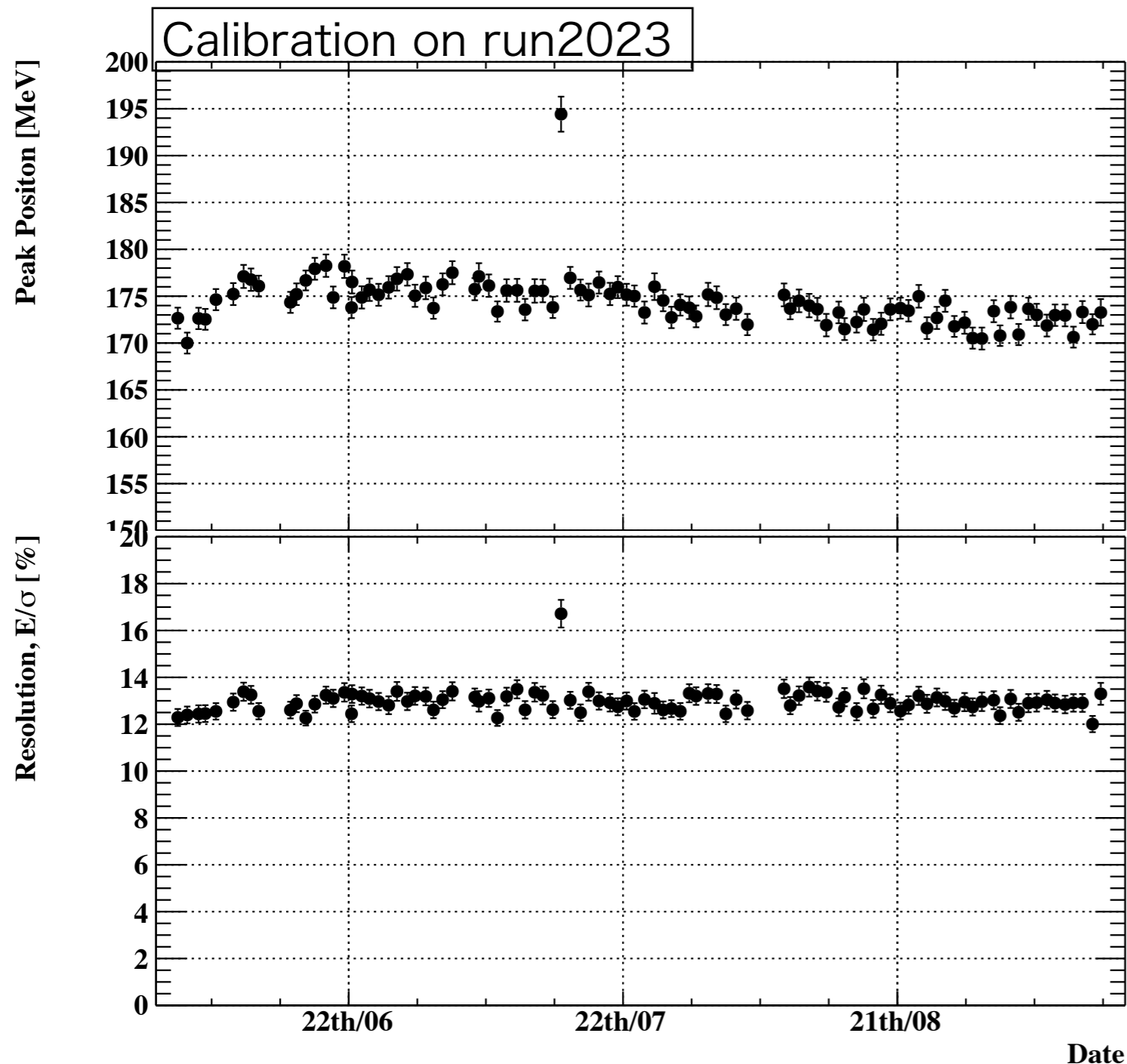
Further tuning



Small effect in v<40cm still remains

Energy Calibration using Cosmic-ray

- Cosmic run is taken everyday to monitor the energy scale of the XEC
- It can be taken with/without beam and even in CEX (calibration) period
- The energy scale history by cosmic event (and also CW event) will be precisely re-calculated for physics analysis to reconstruct the energy scale



Energy Calibration : for physics analysis

- The energy scale history by cosmic event (and also CW event) will be precisely re-calculated for physics analysis to reconstruct the energy scale
- The status of calibration for **2022** data with rough sensor calibrations
- The energy scale fluctuate in $\sim 2\%$ level
 - There are a lot of room for improvement
- Currently further precise sensor calib. is ongoing with improved noise reduction

