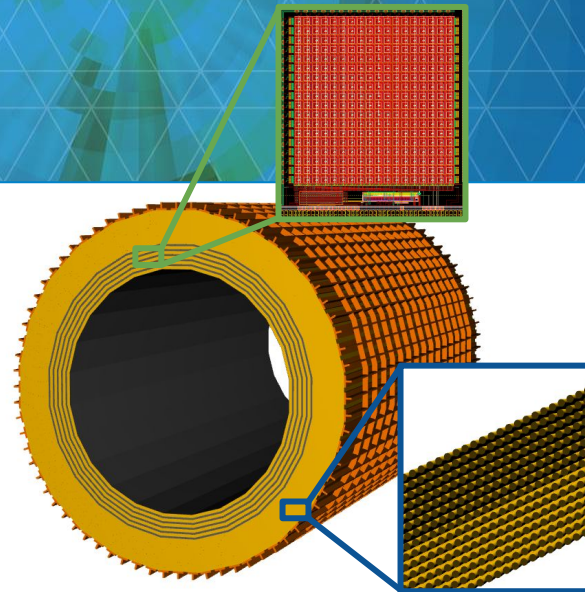


ePIC Collaboration Meeting
January 10, 2024

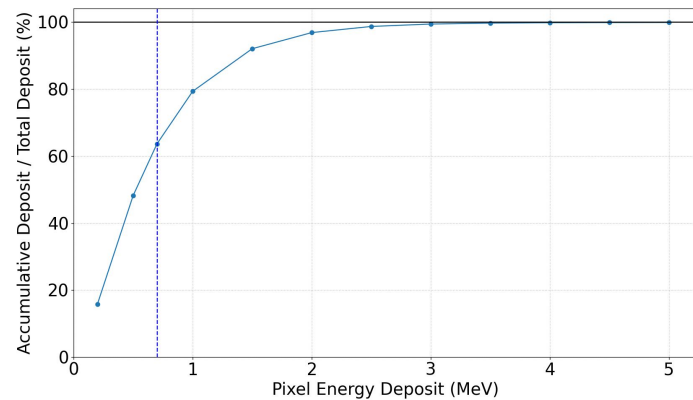
Barrel Imaging Calorimeter (BIC) **AstroPix Dynamic Range**



Maria Źurek
Argonne National Laboratory

AstroPix for ePIC

1. Low rates
 - a. The expected hit rate for **all imaging layers together** is well below $< 3 \times 10^7$ Hz
 - b. This translates to a maximum hit rate per tracker stave (1×10^8 chips) < 36 kHz
2. Dynamic range (see plot for 2 GeV electron) **~ 3 MeV**
3. **Zero suppression threshold of 20 keV** well suited for EIC electromagnetic showers
4. Low Ionization radiation dose and neutron flux
 - a. The maximum **ionizing radiation dose** < 1 **kRad/year** for the barrel region
 - b. Max neutron flux is at the order of **10^9 neutrons/cm² per year**
5. Timing requirement: 3.125 ns (v4) - **driven by 10 ns bunch** crossing



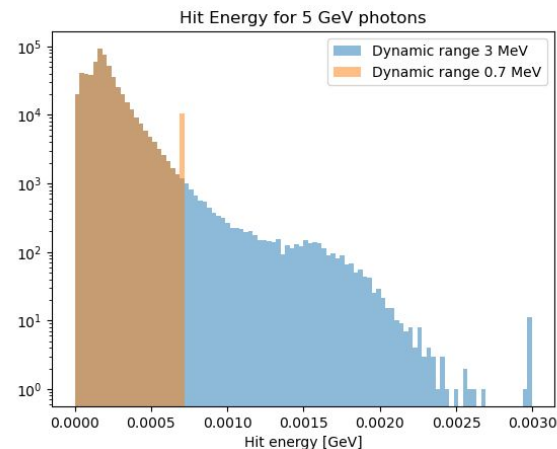
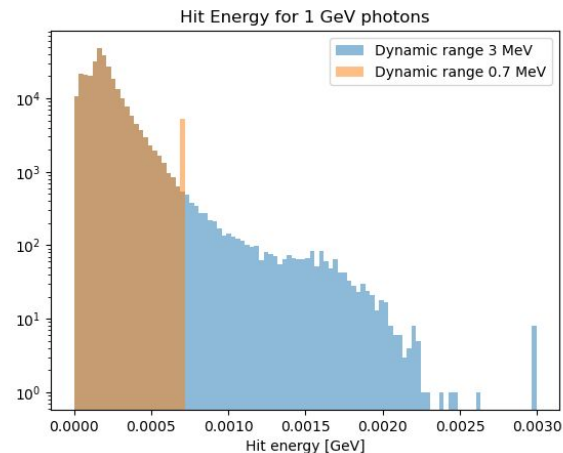
Accumulative energy deposit to the total energy deposit for 2 GeV electrons.

- About 63% of the energy deposit was made through hits with deposit < 700 keV
- hits with deposit < 3 MeV contribute to 99% of the total energy deposit

Dynamic Range Studies

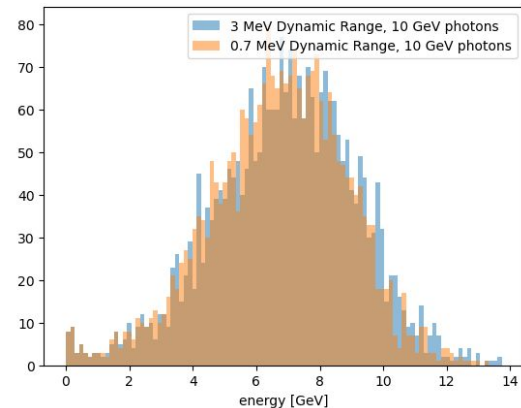
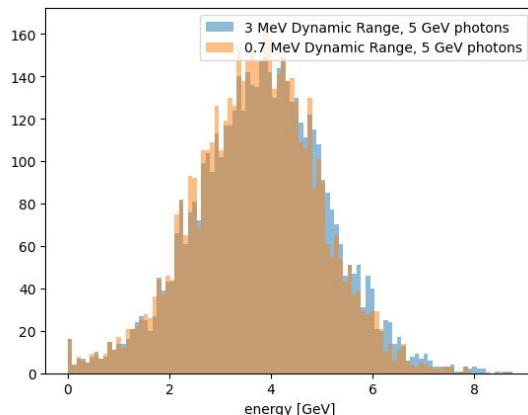
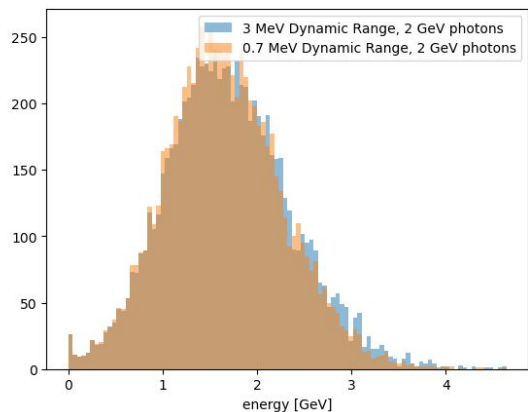
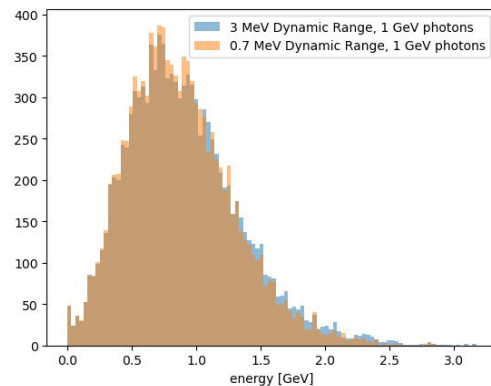
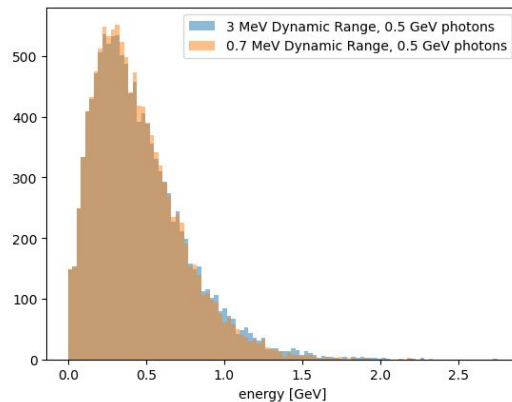
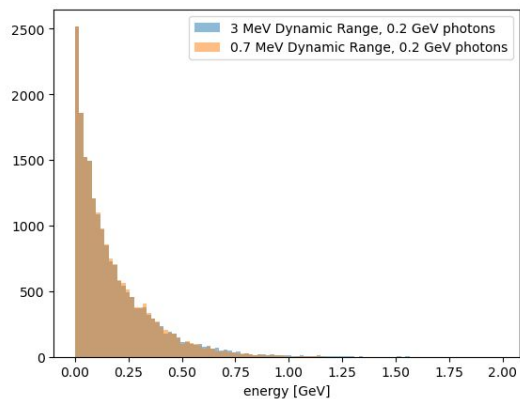
- Geometry: BIC with 4 AstroPix Layers, 23.12.0 production
- Particle: single photon, $\eta = (-1, 1)$
- Dynamic range studied: 3 MeV and 0.7 MeV
- Low E threshold: 0.015 MeV

- Sum of pixel (reco hits) studied with those two dynamic ranges
- If reco hit energy > 0.7 MeV, take 0.7 as the hit energy
- Impact on energy sum shape studied



Energy Deposit Studies

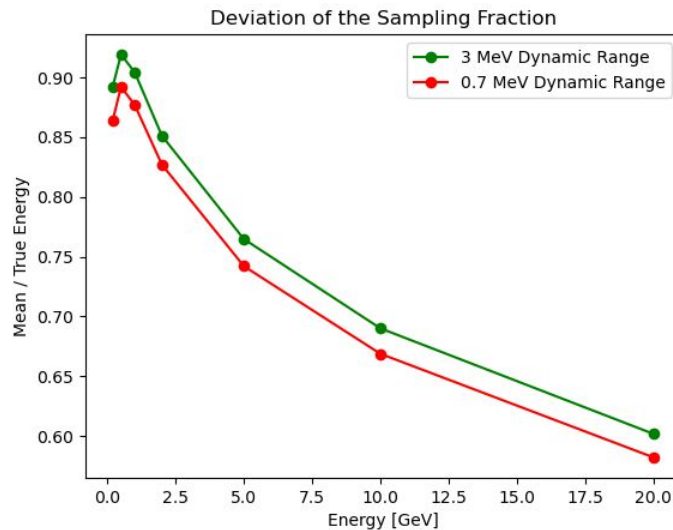
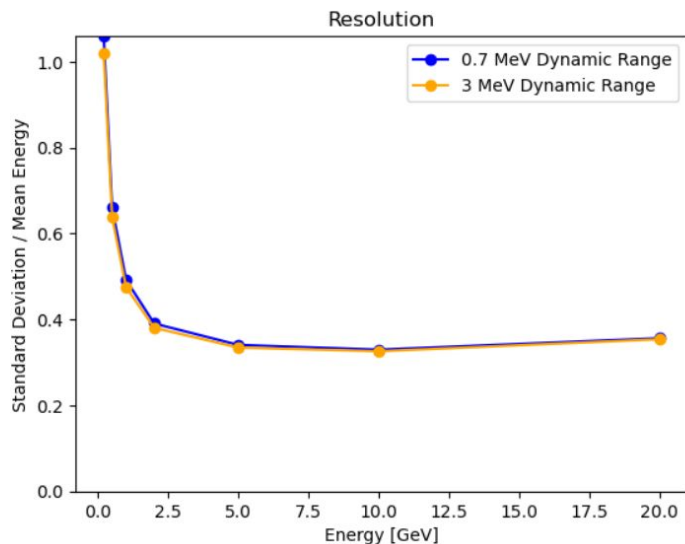
sampling fraction $\sim 0.46\%$ assumed



Energy Resolution and Energy Dependence

Energy resolution: Standard deviation plotted

- Non-gaussian, non-Crystal Ball shape
- Assuming perfect calibration (but! huge sampling fraction energy dependence)



1.5 times change from 20 GeV to 500 MeV

Summary

Change of the dynamic range (0.7 MeV to 3 MeV) do not have much impact on the overall energy resolution.

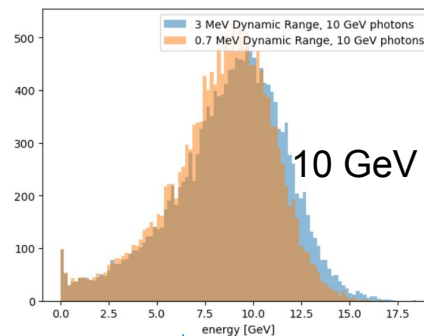
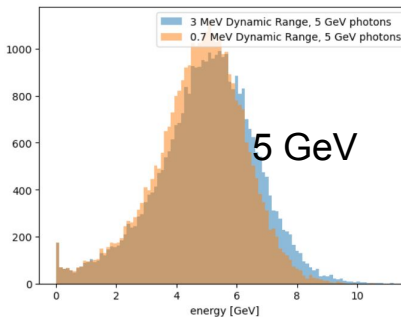
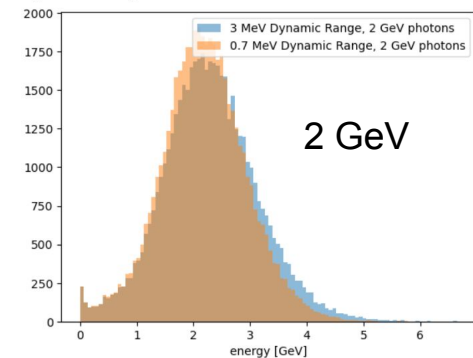
The resolution with 0.7 MeV Dynamic Range a bit worse, but the difference well beyond the effect of shower leakage, small sampling fraction, strong dependence of the sampling fraction of the energy.

Backup

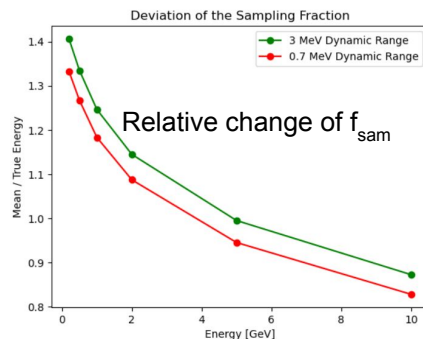
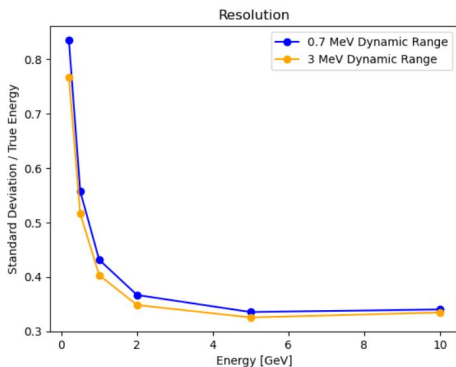
Energy resolution of AstroPix Layers

- Sampling fraction $\sim 0.5\%$
- Example Energy Lineshapes for photons at $\eta = 0$

with 6 AstroPix Layers and 3 MeV dynamic range



non-gaussian



strong dependence in this geometry

*Assuming perfect calibration (but! huge sampling fraction energy dependence)