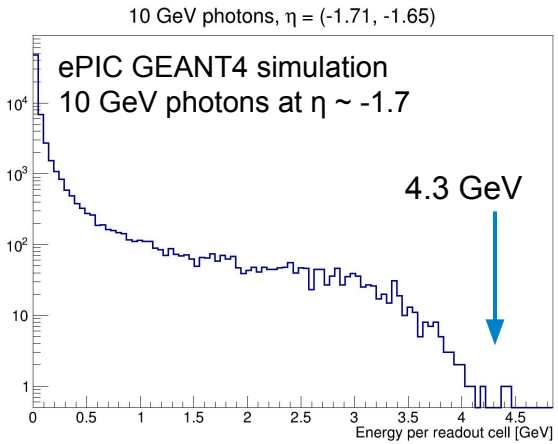
Pixel Size and Number of Pixels

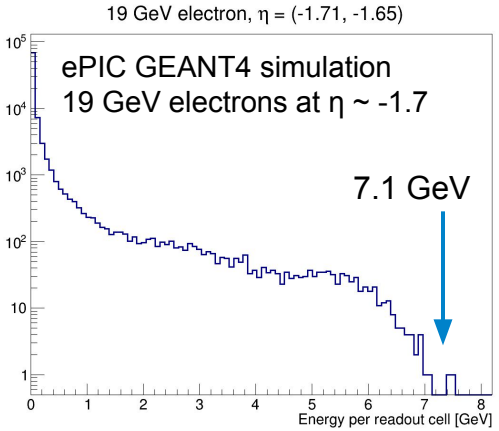
Defined by photoelectron statistics and energy range to be measured

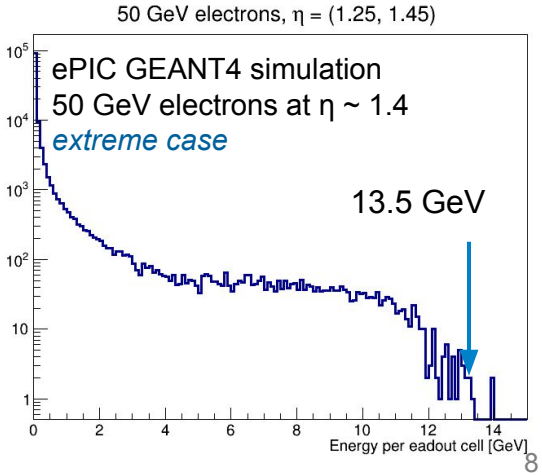
Energy measurement ranges in BECal:

- *Shall provide photon measurements up to 10 GeV* (F-DET-ECAL-BAR.2) *and down to 100 MeV* (F-DET-ECAL.9)
- *Shall provide electron ID up to 50 GeV and down to 1 GeV and below* (F-DET-ECAL-BAR.1)
  - Electron energy measurement needed for e/π separation only (straightforward at high energies)
- Reasonable performance for MIPs needed for calibration and for muon ID

Largest energy deposit occurs for particles at large η (steep angle) where the pathlength in a cell is maximal and the attenuation is minimal.







Photoelectron statistics

From our 2023 Hall D tests using GlueX SiPMs and double-clad Kuraray fibers: **1000 phe/GeV** per side for showers at the center of the Baby BCAL prototype

- Corrected for attenuation: **1077 phe/GeV*** per side

We can scale these results for the **ePIC Barrel ECal*:**

- x 1.5 factor improvement in **SiPM photon detection efficiency**
- x 1.16 factor to account for **better optical coupling**
- x 0.69 reduction accounting for **single-clad** Kuraray fibers

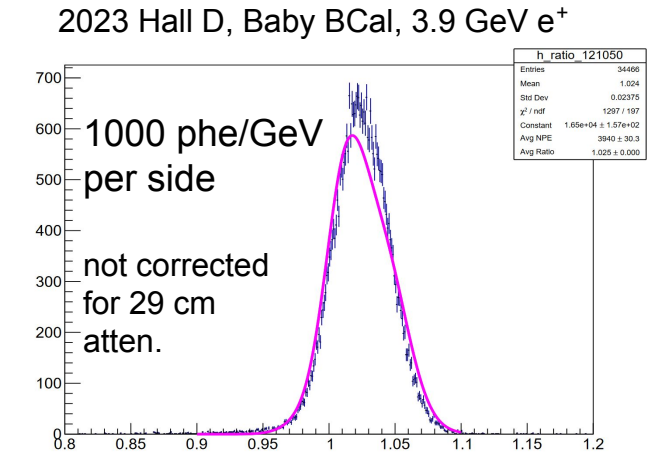
This gives ~ **1239 phe/GeV** per side (fully corrected for attenuation)

- **10 GeV ɣ at η ~ -1.7:** 5560 phe → **9.8 % max SiPM occupancy**
- **19 GeV e^- at η ~ -1.7:** 9181 phe → **16.1 % max SiPM occupancy**
- **50 GeV e^- at η ~ 1.4 (most extreme case):** 17456 phe → **30.1% max SiPM occupancy**

Well below the region where large nonlinearities in the SiPM response are expected in almost all cases.

Small non-linear effects possible for some ultra-high energy electrons, which is acceptable (e-π separation straightforward).

* See backup slide for the attenuation length measurement and extraction of those factors



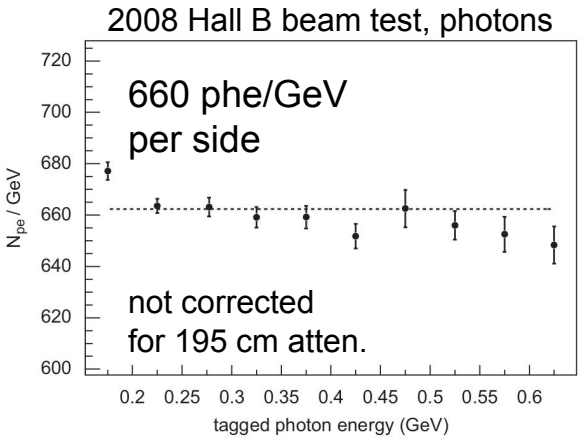


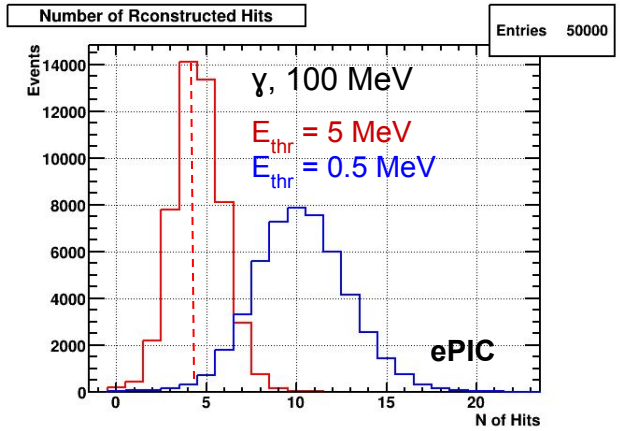
Fig. 16. The number of photoelectrons per GeV per end of the BCAL module is shown as a function of energy. A one parameter fit is plotted (dashed line). For more details see the text.

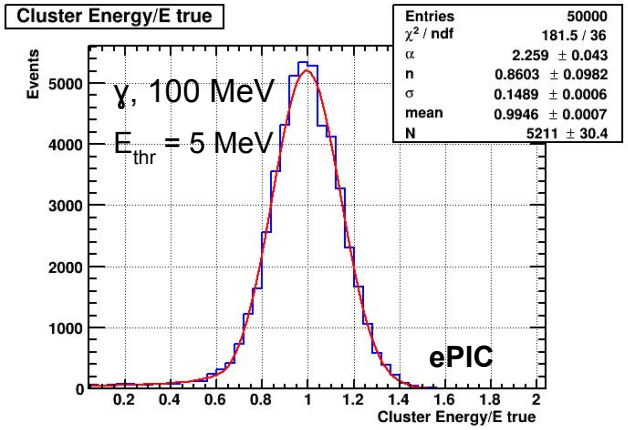
Low energy performance

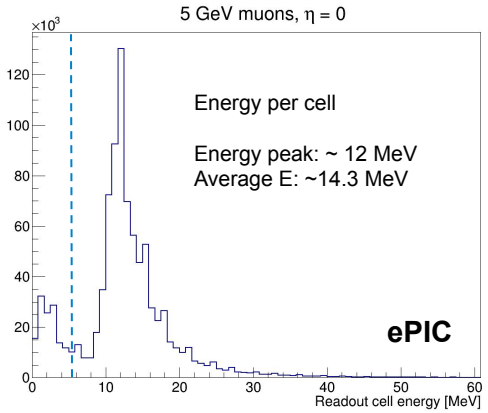
GlueX capabilities (NIM, A 896 (2018) 24-42):

- Cluster/shower threshold is **100 MeV nominal** (down to 50 MeV for some analyses, with mostly 2-3 cells per event only). Low energy detection threshold studied also with Michel electrons.
- Capability of **measuring MIPs**.
- Readout channel threshold **~ 17 MeV** (note: GlueX sums cells radially with the scheme 1-2-3-4)

Results from full ePIC GEANT4 simulation: 5 MeV threshold per channel







Extreme case - MIPs at η = 0:
Energy per cell = 12 MeV (peak) ➡ 15-16 phe at η = 0 ➡ ~ 7-8 phe per side (factor ~ 2 from atten. loss, assuming single-clad Kuraray fibers)

Low-energy measurements favor a larger PDE, matches well with 50μm pixel pitch SiPMs