Sampling fraction vs. nHCal geometry versions

Leszek Kosarzewski

The Ohio State University

nHCal DSC meeting 8.7.2025

THE OHIO STATE UNIVERSITY

Outline

1. Sampling fraction calculation method
2. Sampling fraction for different nHCal geometry versions

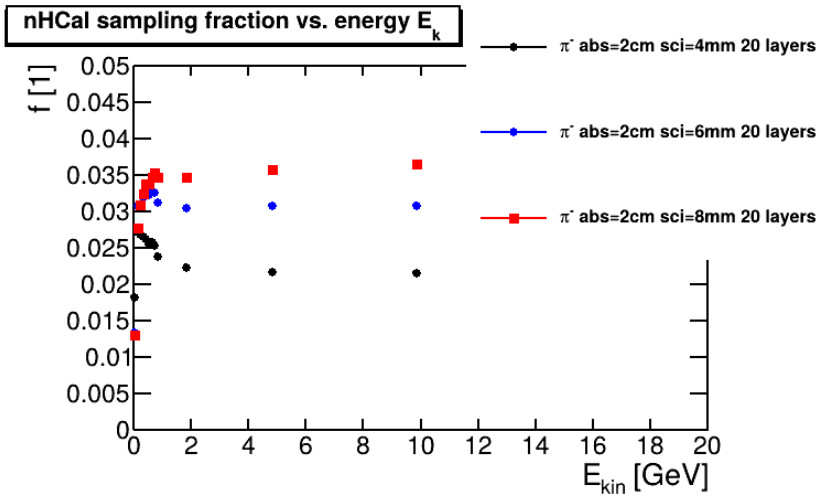
Sampling fraction calculation method

$$f_s = \frac{\sum E_{scint}}{E_k}$$

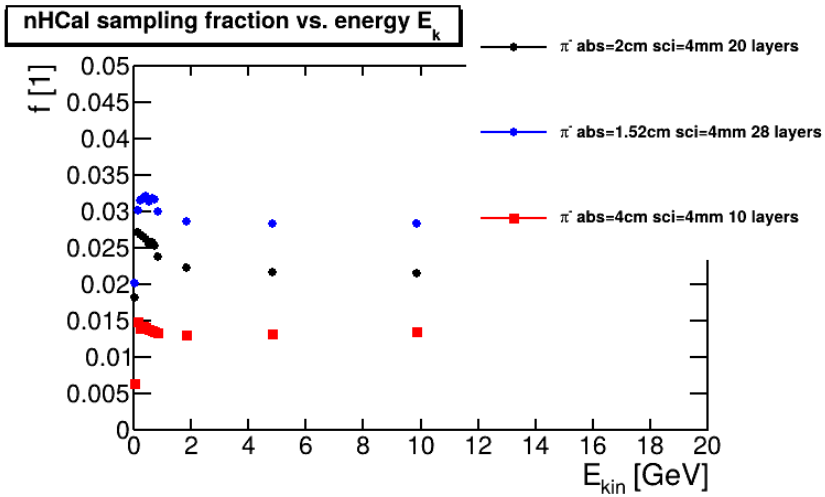
- Sampling fraction calculated by filling a TProfile with a ratio of sum of energy deposits in scintillator tiles E_{scint} over kinetic energy of incoming particle
- calculated for electrons and pions
- calculated e/h ratio
- made all geometry versions $5\times$ thicker ($\lambda/\lambda_0 > 10$)

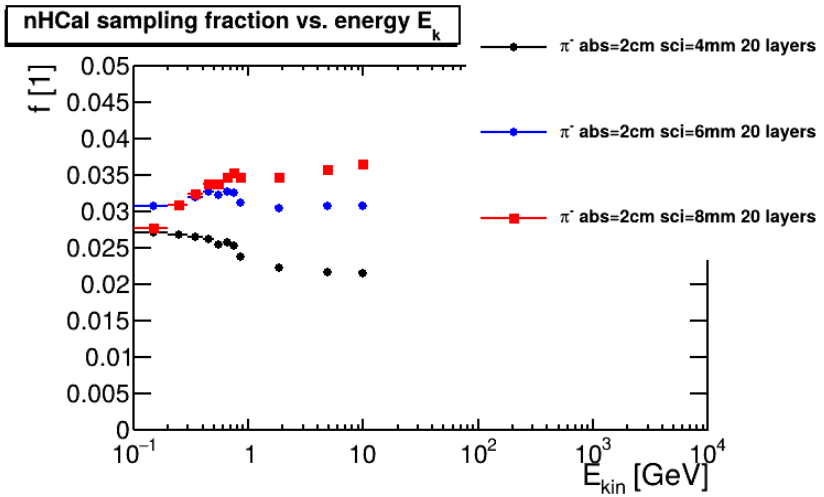
Sampling fraction vs. geometry - pions

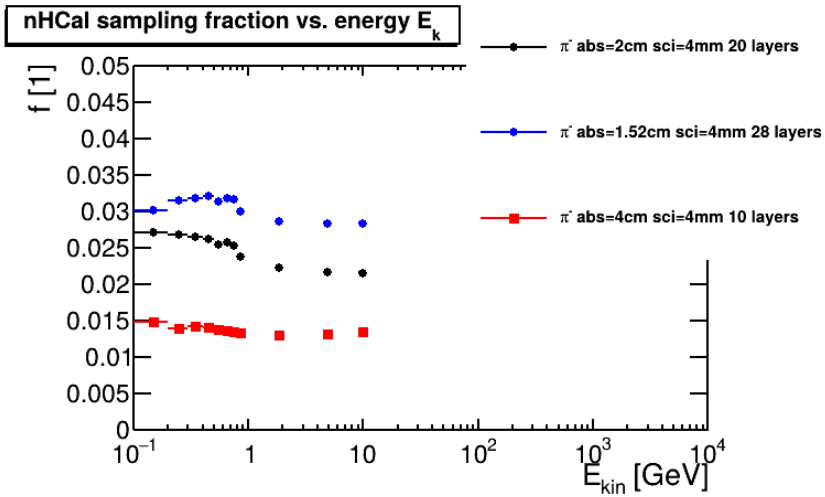
scintillator



absorber



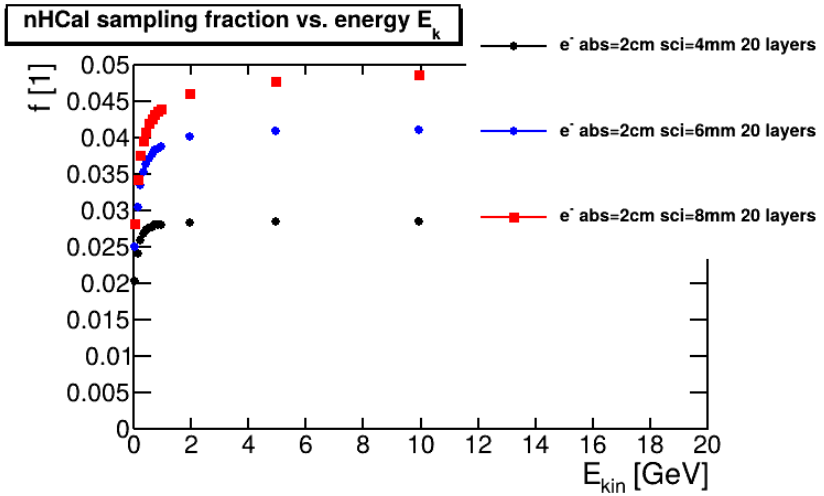




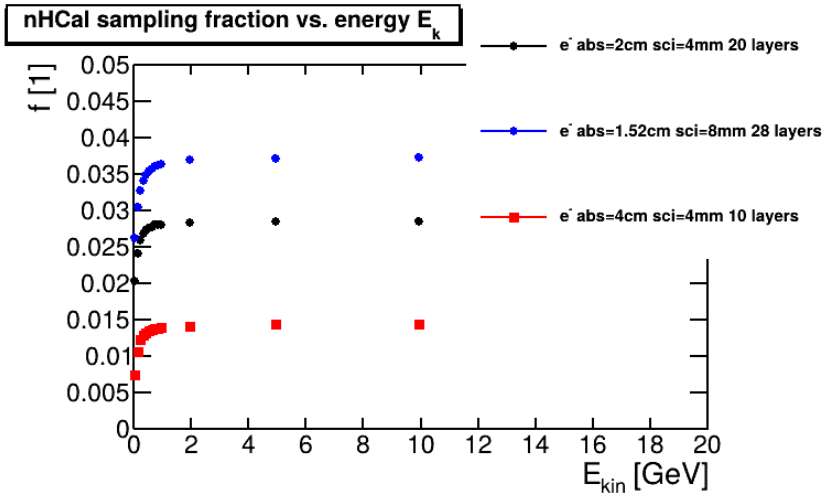
- The higher, the better in principle, but we need to look at the energy resolution too
- Higher sampling fraction can make e/h response off, but this can be compensated with ML software
- Sampling fraction is energy dependent, but we can assume only a single value in the reconstruction

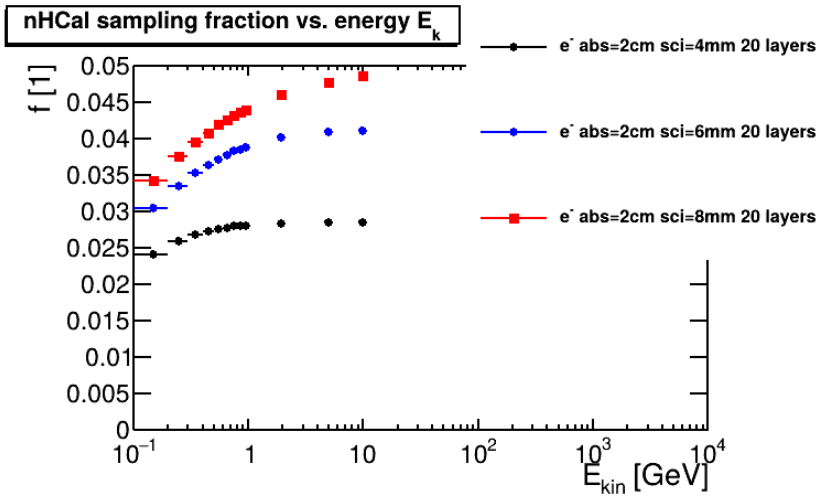
Sampling fraction vs. geometry - electrons

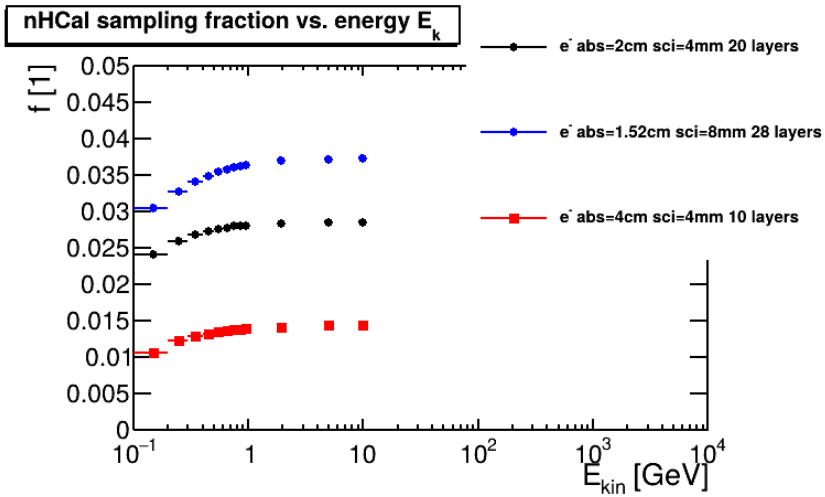
scintillator



absorber

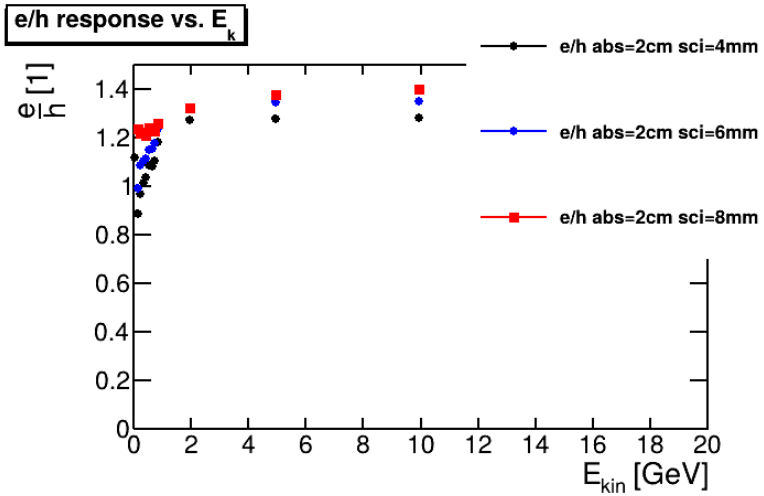




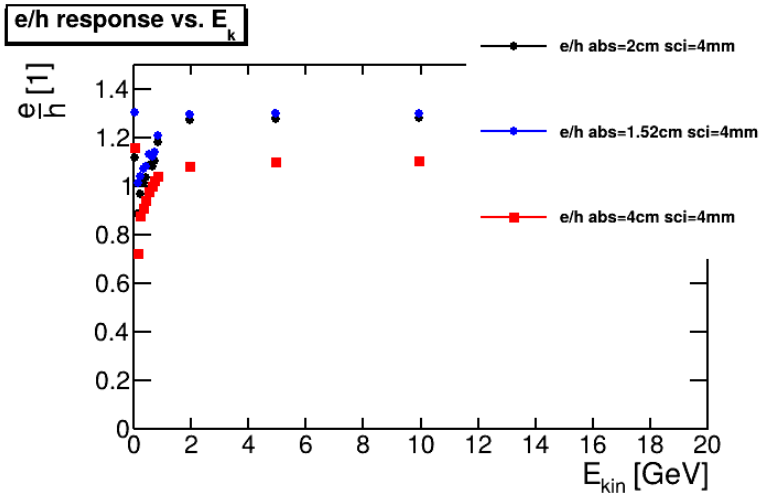


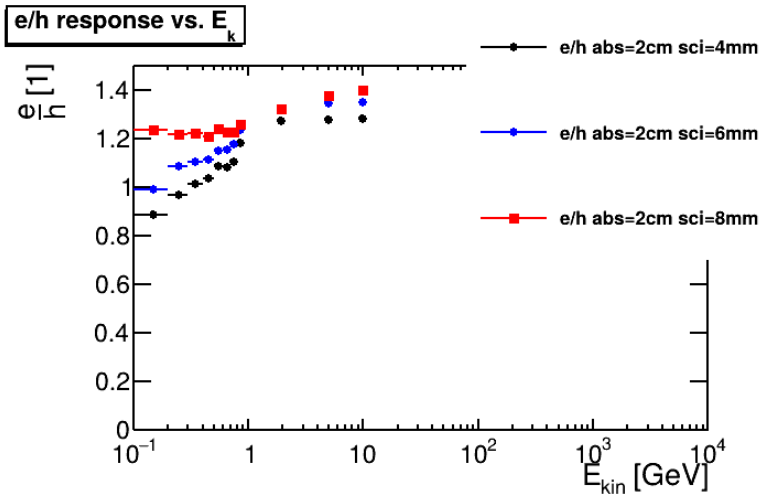
- Now larger than pions at high energy

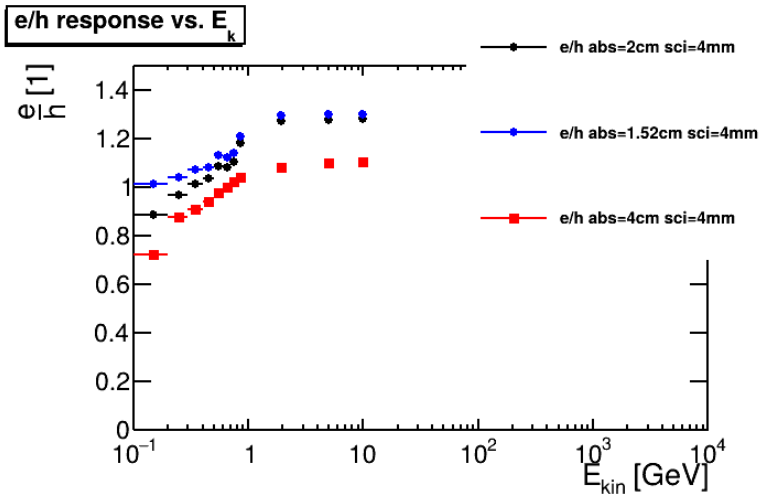
scintillator



absorber







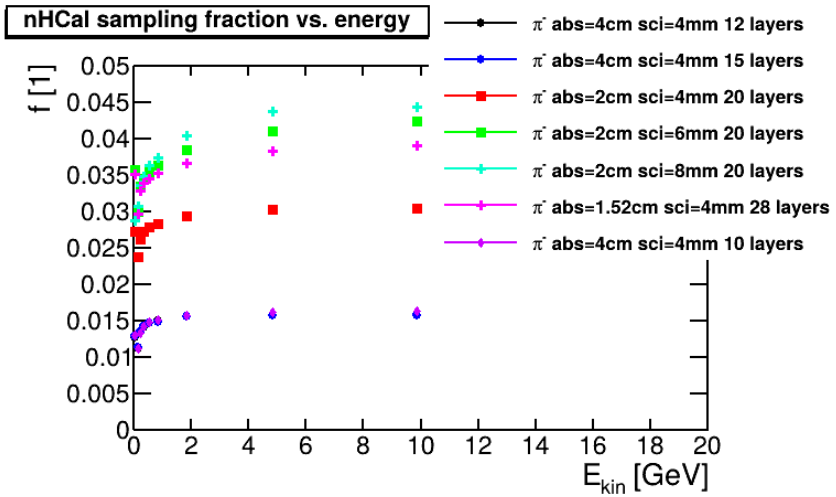
- Now larger than pions at high energy

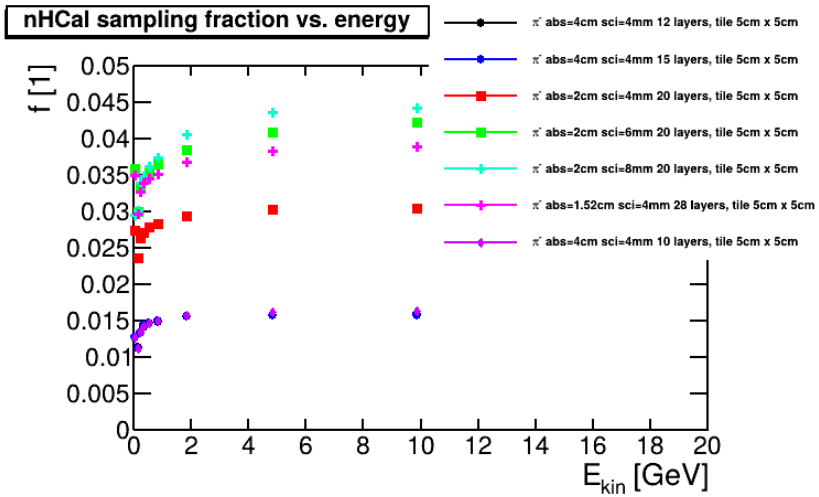
Summary

- Investigated sampling fraction for different geometry versions
- Which value to pick for eicrecon? (matching average E_k or value for flat region)
- e/h response calculated correctly: $e/h > 1$ at high energy
- This is the correct method vs. LFHCAL (all layers)
  - LFHCAL studies dependent on sampling fraction are most likely not correct (energy reco, ML, etc.)
    - 0.028 vs. 0.037 (eicrecon LFHCAL)

BACKUP

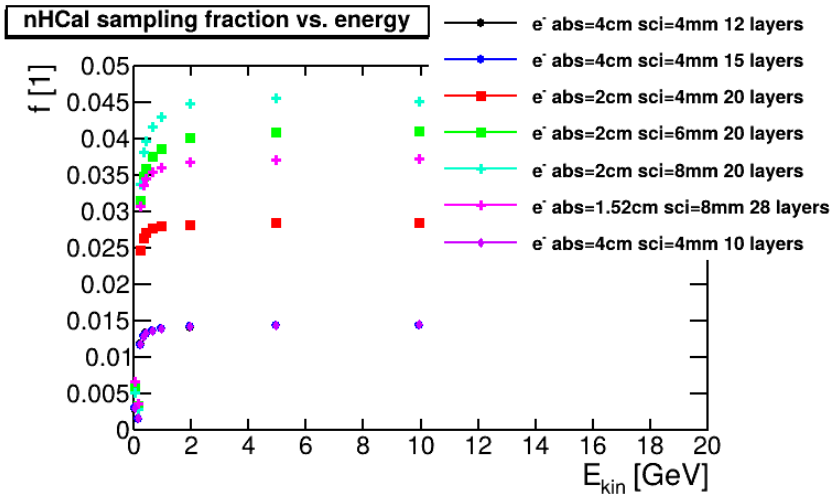
Sampling fraction vs. geometry - pions

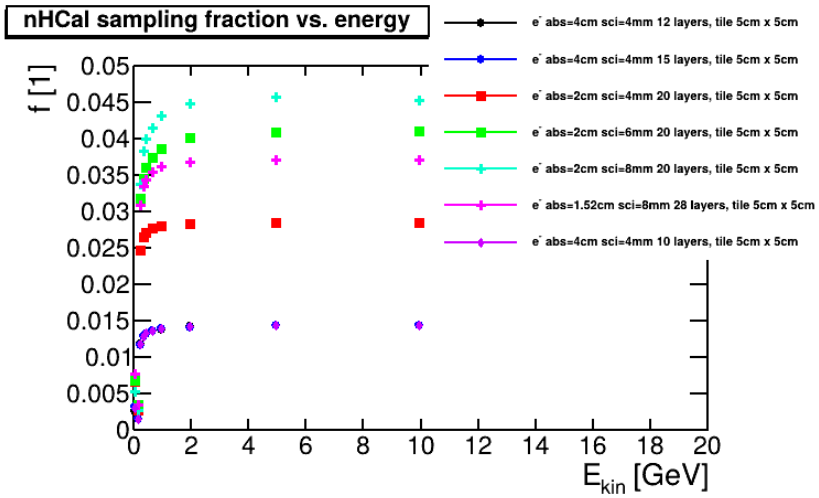




- Results behave as expected eg.: doubling scintillator doubles sampling fraction
- The higher, the better in principle, but we need to look at the energy resolution too
- Higher sampling fraction can make e/h response off, but this can be compensated with ML software
- Sampling fraction is energy dependent, but we can assume only a single value in the reconstruction

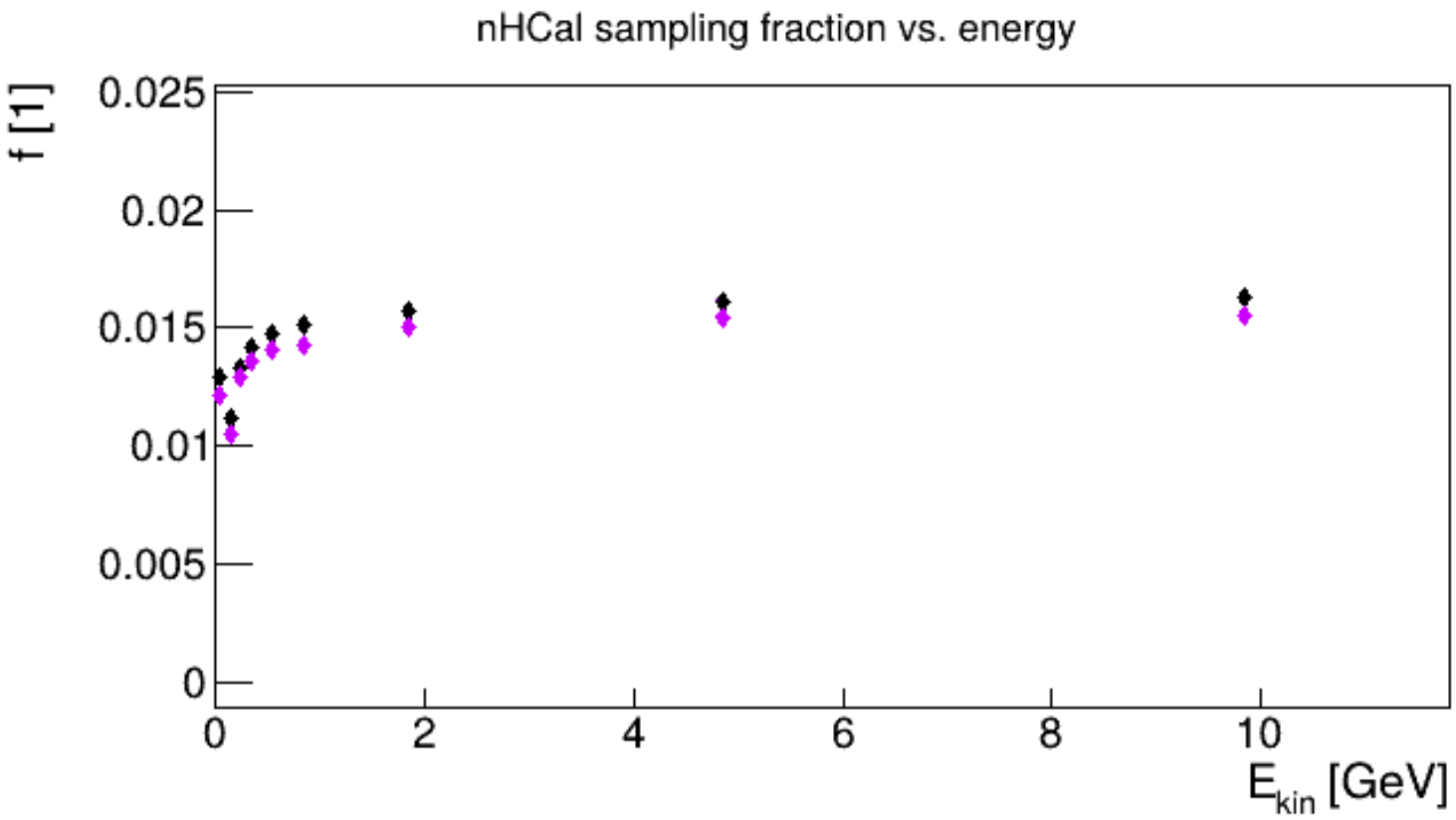
Sampling fraction vs. geometry - electrons





- Smaller than pion - this is strange
- Missing energy not taken into account (need correction!)
- Can refer to the original pion energy, but leakage!

Update from old StainlessSteel to SAE304



- Density updated from old StainlessSteel 8.3 $\mathrm{g/cm^3}$ to SAE 304 7.9 $\mathrm{g/cm^3}$ (5% change)
- Merged into main epic repository: `https://github.com/eic/epic/pull/885`
- Increases sampling fraction for default by 4.5% to 6% (low energy)