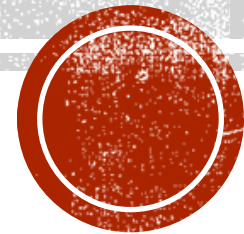


bHCAL Meeting — Neutron Calibration Update

Jan Vanek

University of New Hampshire

04/03/2026



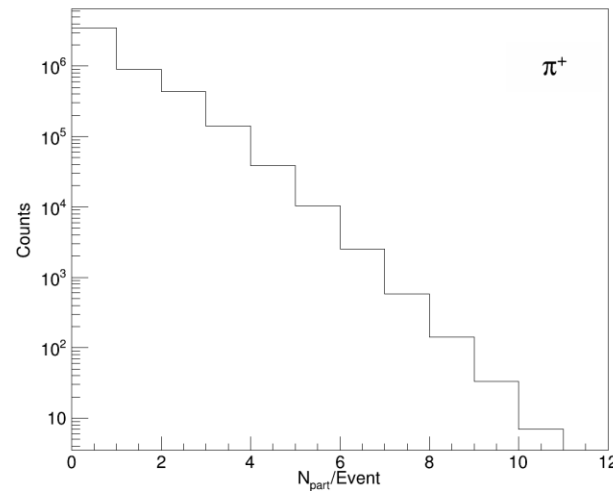
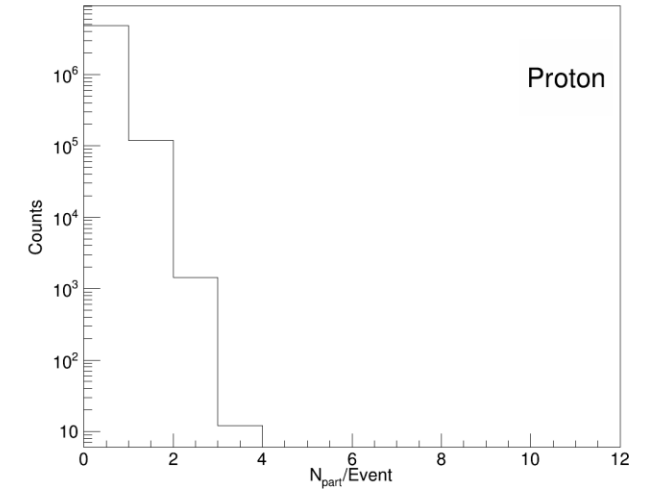
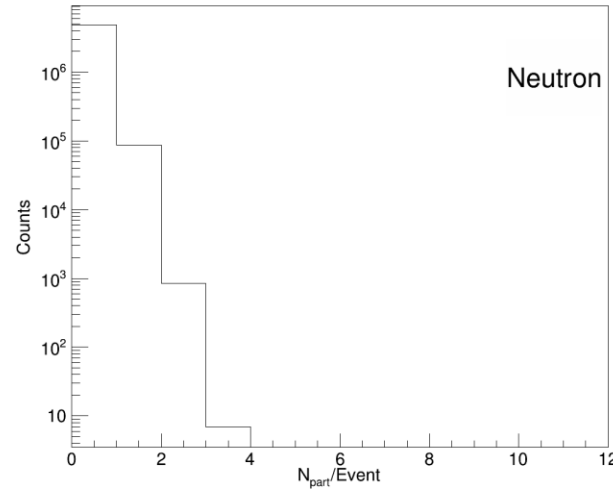
OVERVIEW

- Hadron (n, p, π^+) momentum distributions from physics simulations
 - To determine primary energy/momentum of interest for calibrations
- Updated to Method 2 calibration
 - New initial estimate of parameter B and subsequent scan around that value
 - Will be used also for more advanced manual calibrations
- Geometry of bHCAL chimney sectors

MOMENTUM DISTRIBUTIONS IN PHYSICS EVENTS

NUMBER OF HADRONS PER EVENT

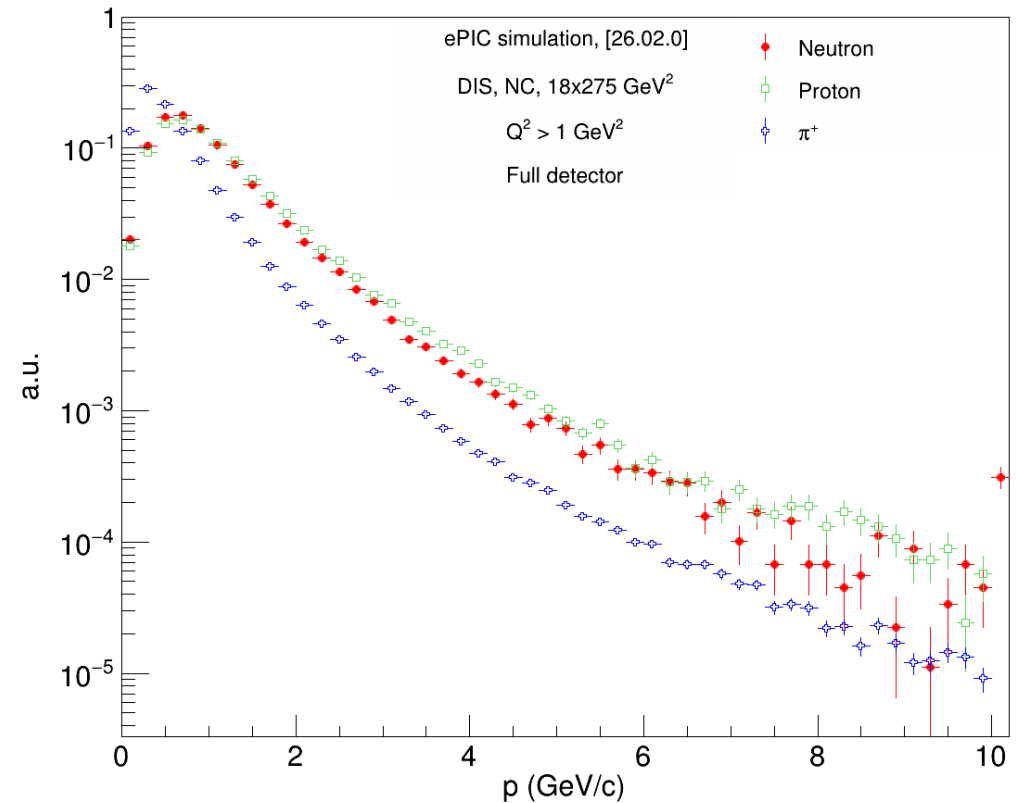
- Number of hadrons per event
 - DIS NC from [26.02.0] campaign $18 \times 275 \text{ GeV}^2$, $Q^2 > 1 \text{ GeV}^2$
 - To have idea about bHCAL occupancy for each hadron



ePIC simulation, [26.02.0]
DIS, NC, $18 \times 275 \text{ GeV}^2$
 $Q^2 > 1 \text{ GeV}^2$
Full detector

HADRON MOMENTUM DISTRIBUTIONS

- Hadron momentum distributions
 - DIS NC from [26.02.0] campaign 18x275 GeV², $Q^2 > 1$ GeV²
 - Normalized to unity
- Protons and neutrons peaked around 1 GeV/c



UPDATED METHOD 2 CALIBRATION

MANUAL CALIBRATION METHOD

- Method 2 calibration

- $E_{calib} = A(E_{EMCAL} + BE_{bHCAL})$
- Plot $(E_{EMCAL} + BE_{bHCAL})/E_{par,MC}$
 - First find B for which the distribution above has the smallest σ/μ
 - A is set as $1/\text{mean}$ of the distribution with optimal B

- **Old approach:**

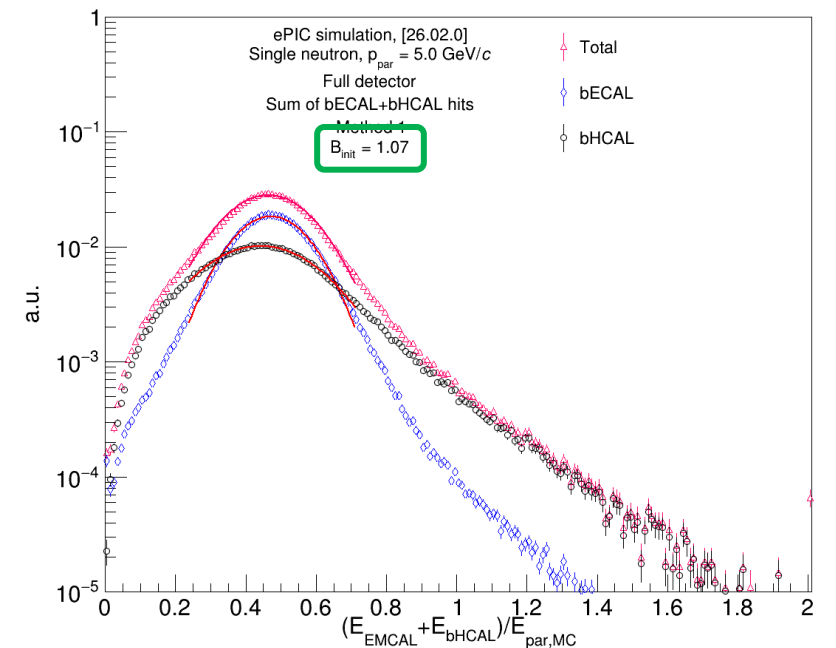
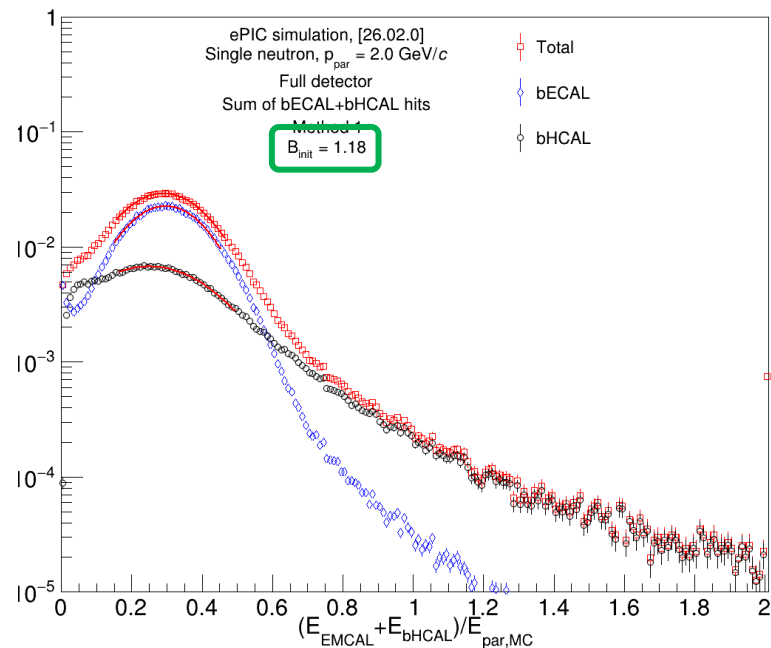
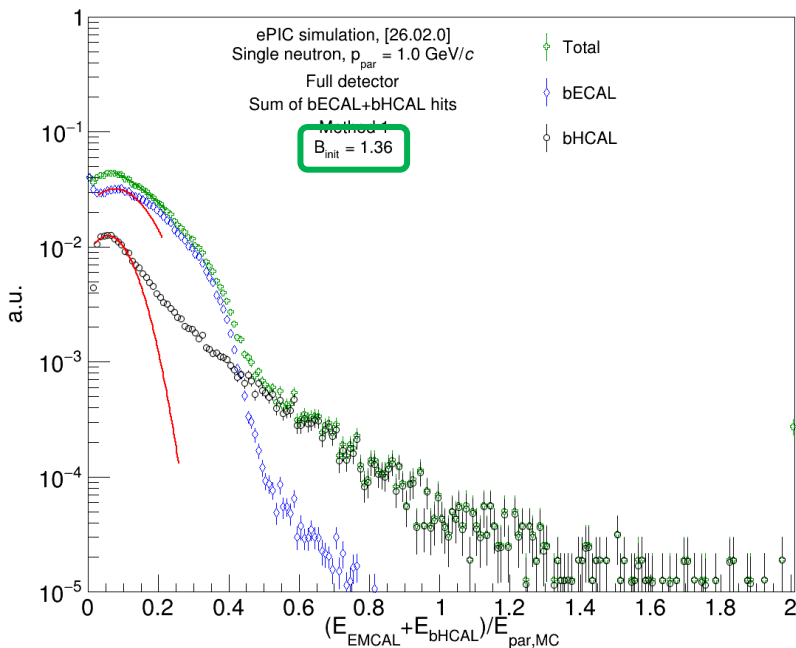
- Scan B in manually selected range with no external input

- **New approach:**

- Determine initial value of B based on contributions from bECAL and bHCAL to the total calibration distributions (details follow)
- Scan around the initial estimate to find final value of B

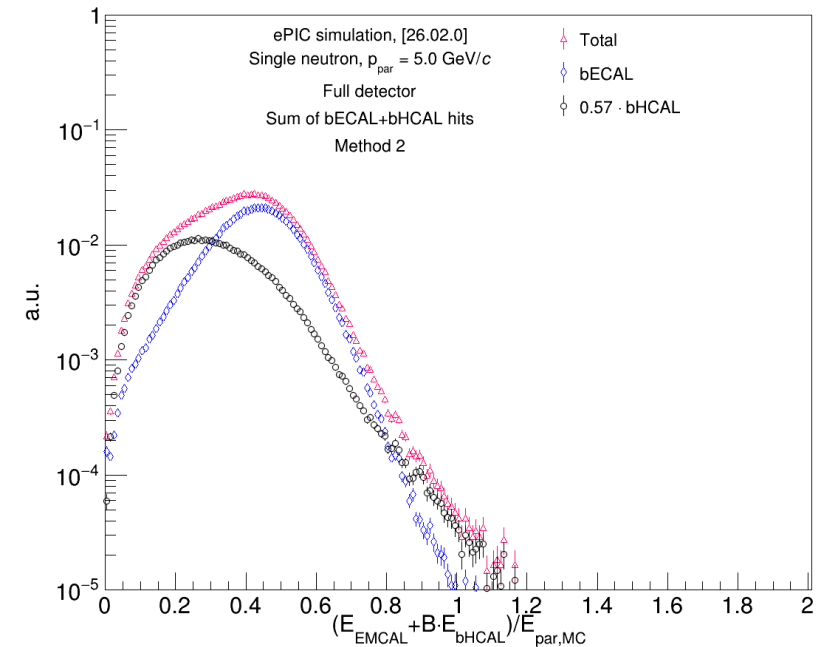
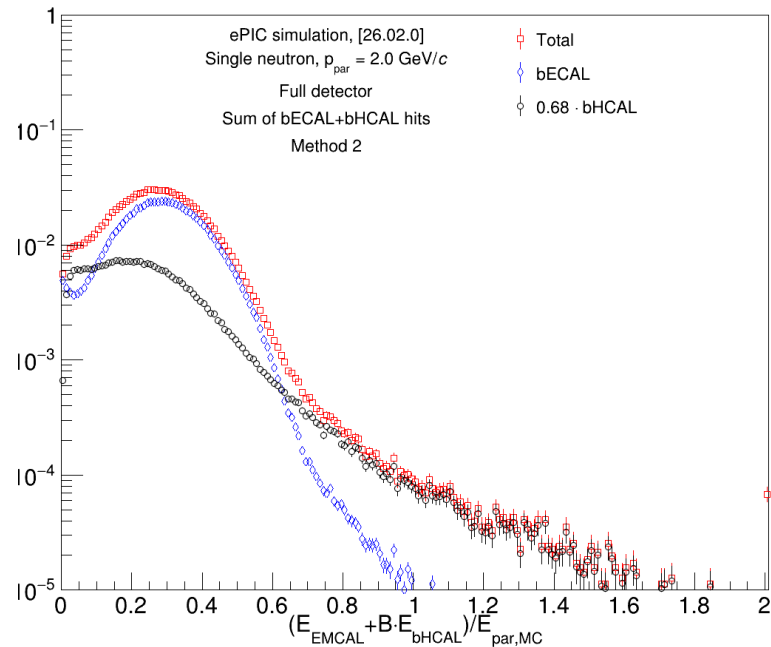
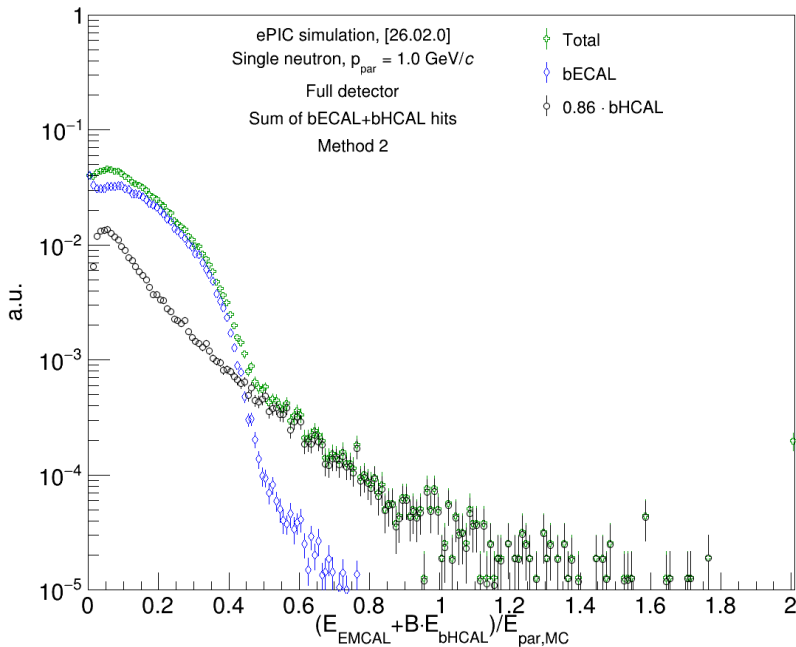
INITIAL B PARAMETER ESTIMATION

- Fit contributions from bECAL and BHCAL to calibration distribution when $B = 1$
- Initial value of B is based on means of the two contributions:
 - $B_{init} = \frac{\mu_{bECAL}}{\mu_{bHCAL}}$
- Different neutron momenta
 - (left) 1 GeV/c, (middle) 2 GeV/c, (right) 5 GeV/c



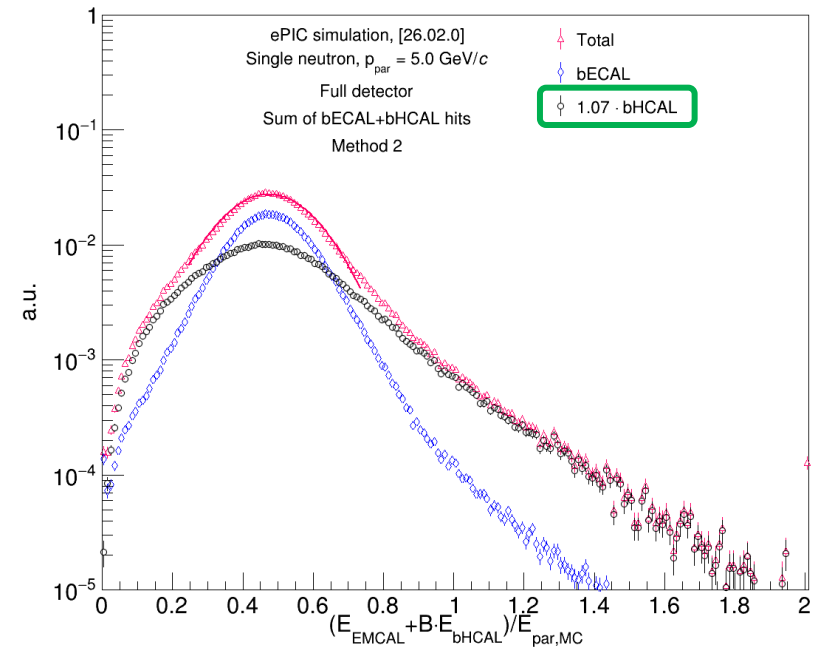
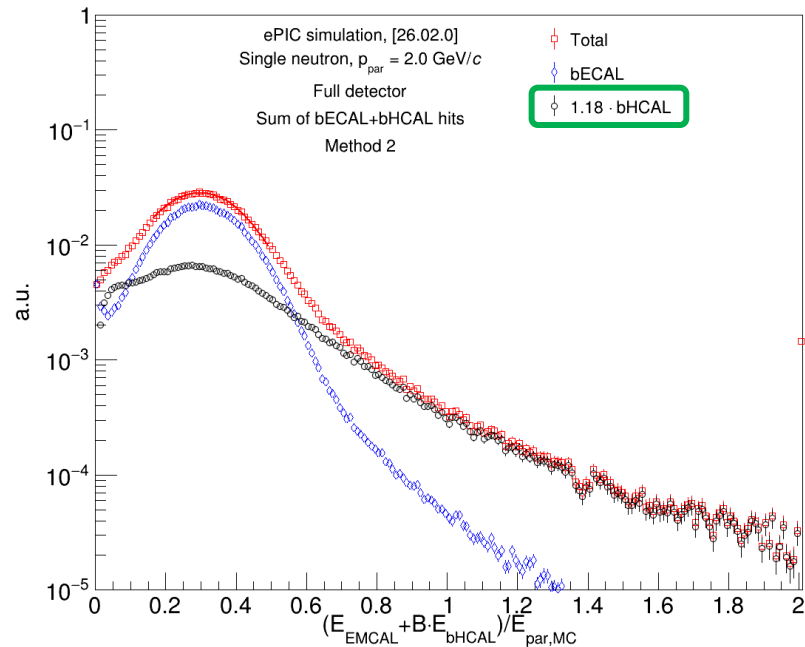
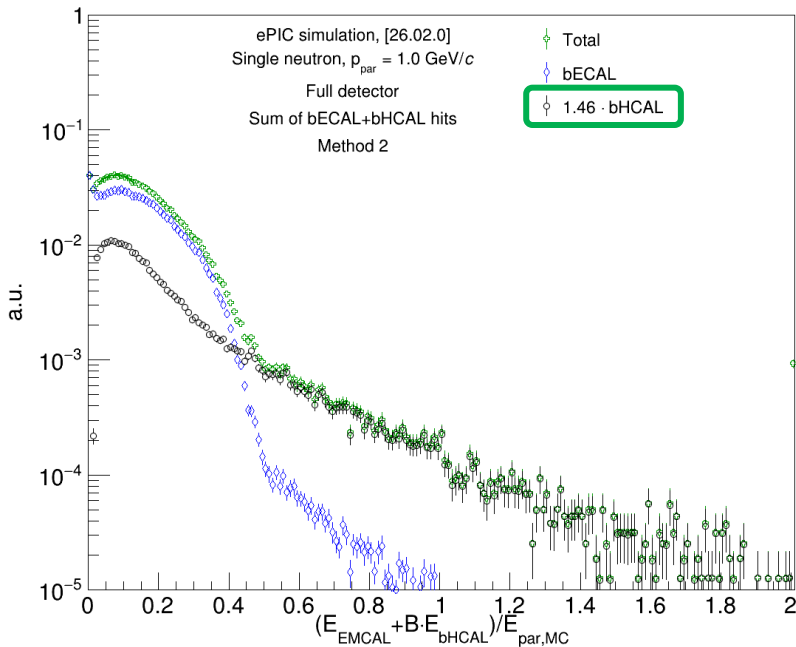
B PARAMETER SCAN

- Scan of B parameter is done in ± 0.5 around the initial estimate from previous step
 - 10 scan points
- First scan point
- Different neutron momenta
 - (left) 1 GeV/c, (middle) 2 GeV/c, (left) 5 GeV/c



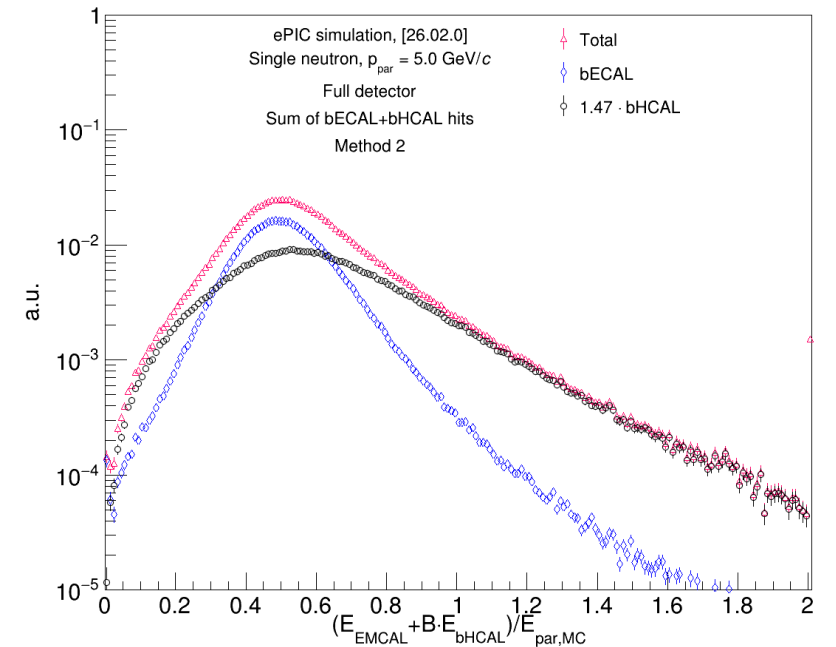
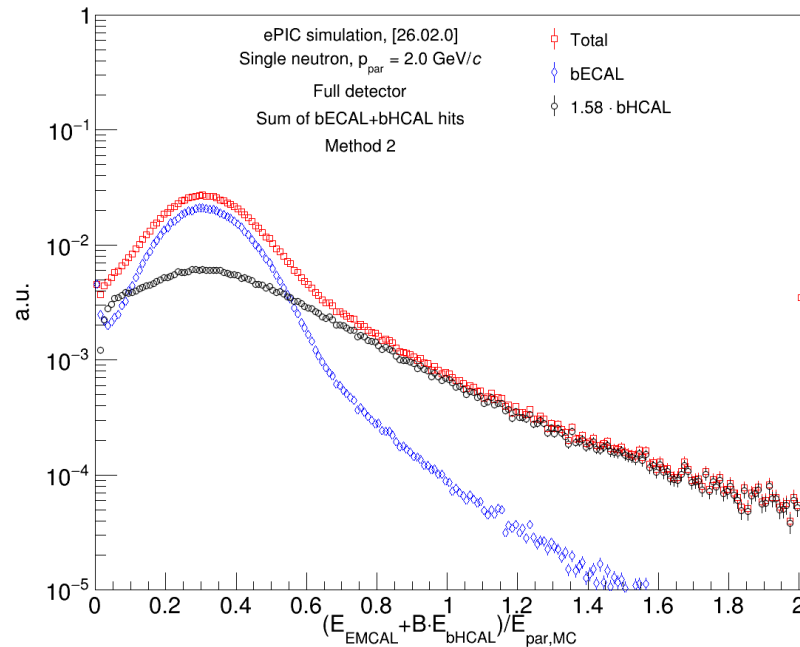
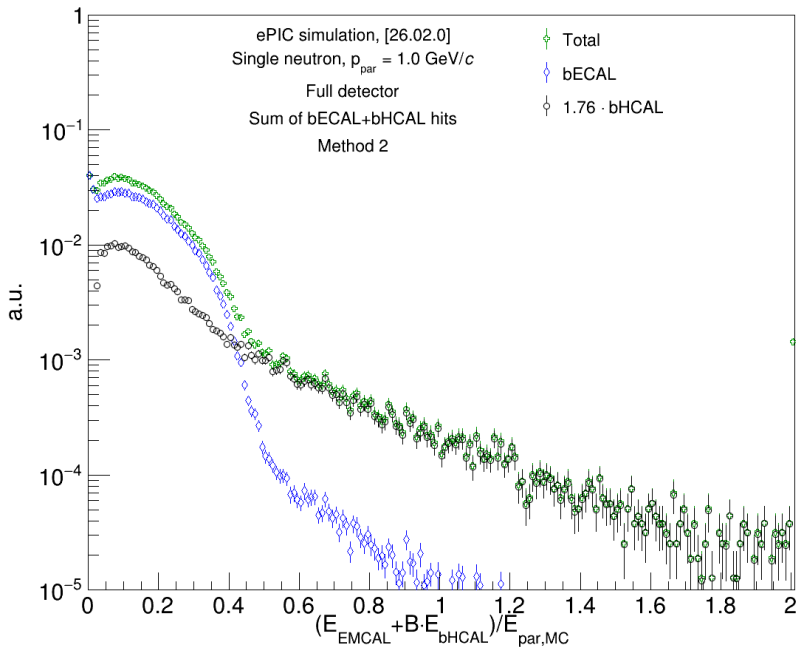
B PARAMETER SCAN

- Scan of B parameter is done in ± 0.5 around the initial estimate from previous step
 - 10 scan points
- Optimal B parameter
- Different neutron momenta
 - (left) 1 GeV/c, (middle) 2 GeV/c, (left) 5 GeV/c



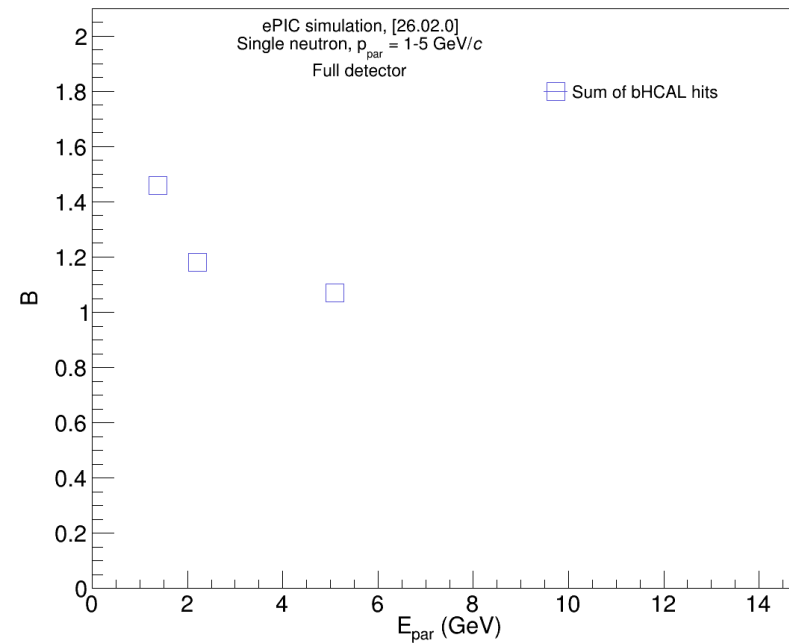
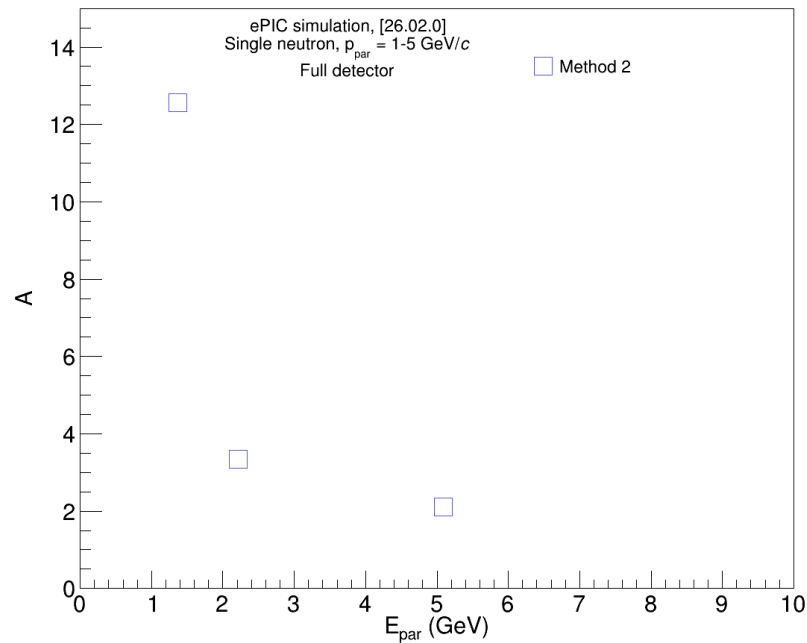
B PARAMETER SCAN

- Scan of B parameter is done in ± 0.5 around the initial estimate from previous step
 - 10 scan points
- Last scan point
- Different neutron momenta
 - (left) 1 GeV/c, (middle) 2 GeV/c, (left) 5 GeV/c



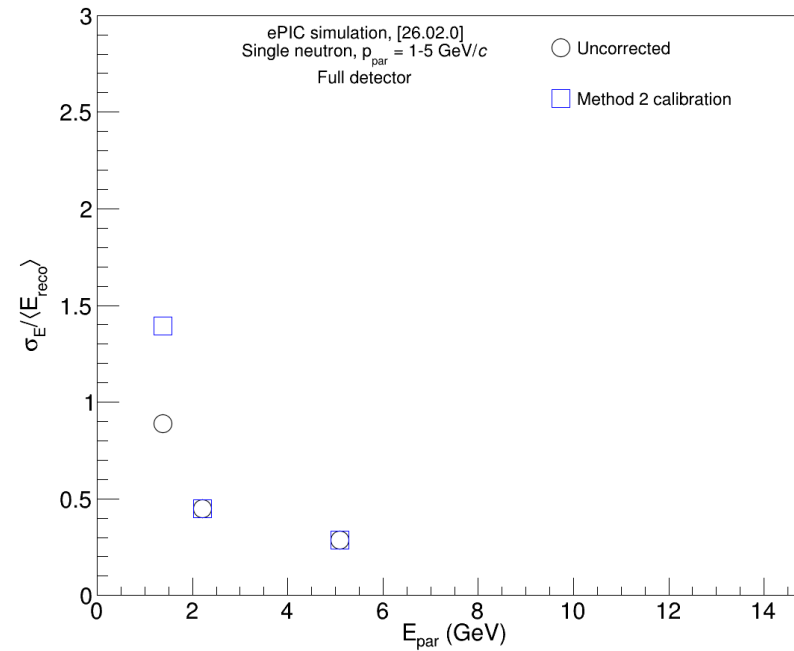
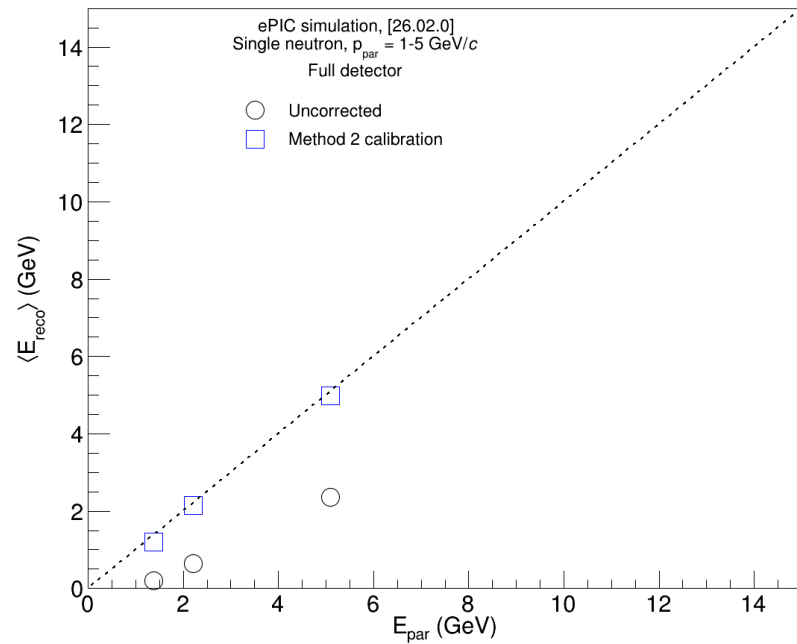
CALIBRATION PARAMETERS

- Method 2 calibration parameters
 - (left) Parameter A
 - (right) Parameter B



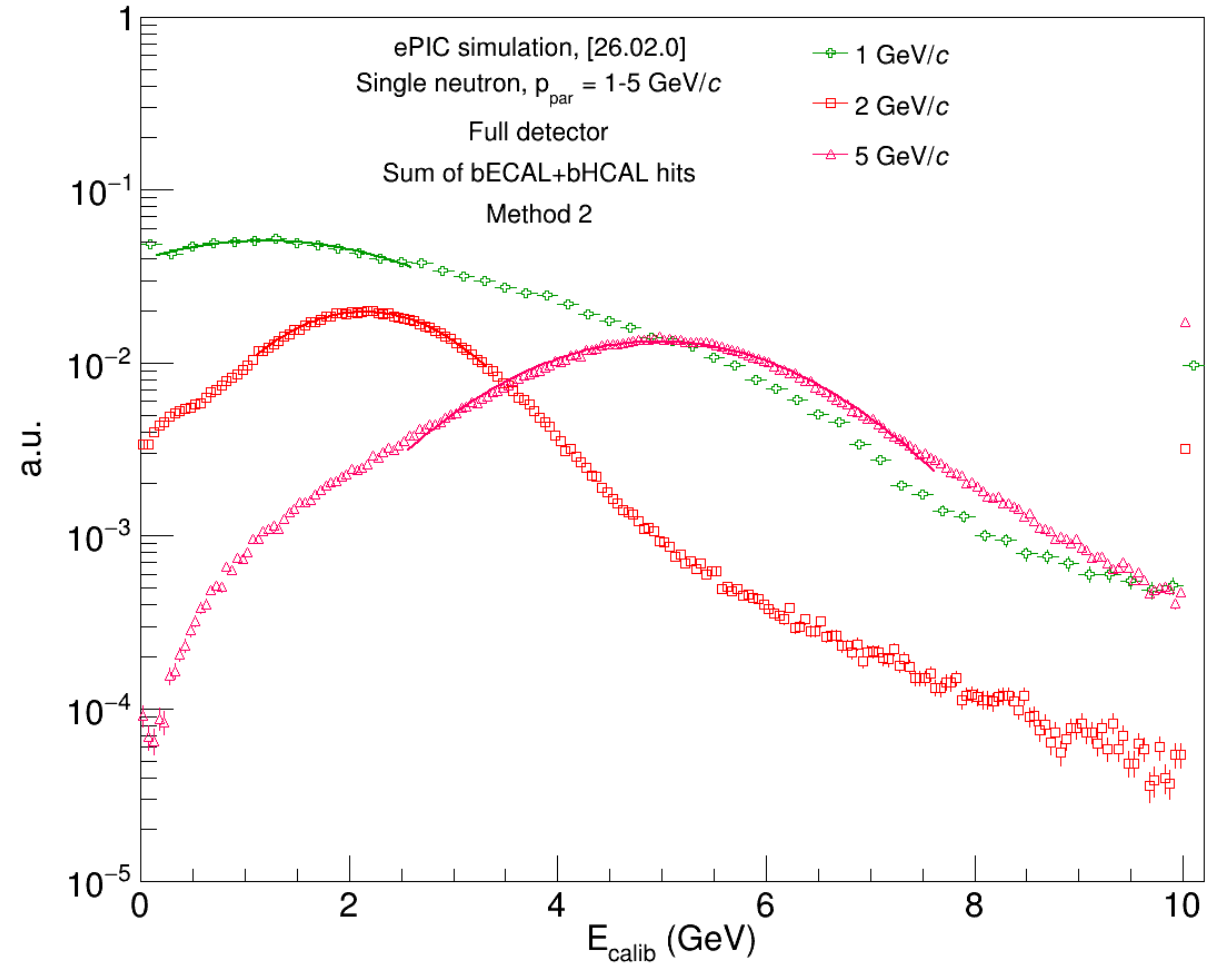
CALIBRATION RESULT

- Method 2 calibration parameters
 - (left) Calibrated vs. uncalibrated energy
 - (right) Energy resolution



CALIBRATED DISTRIBUTIONS

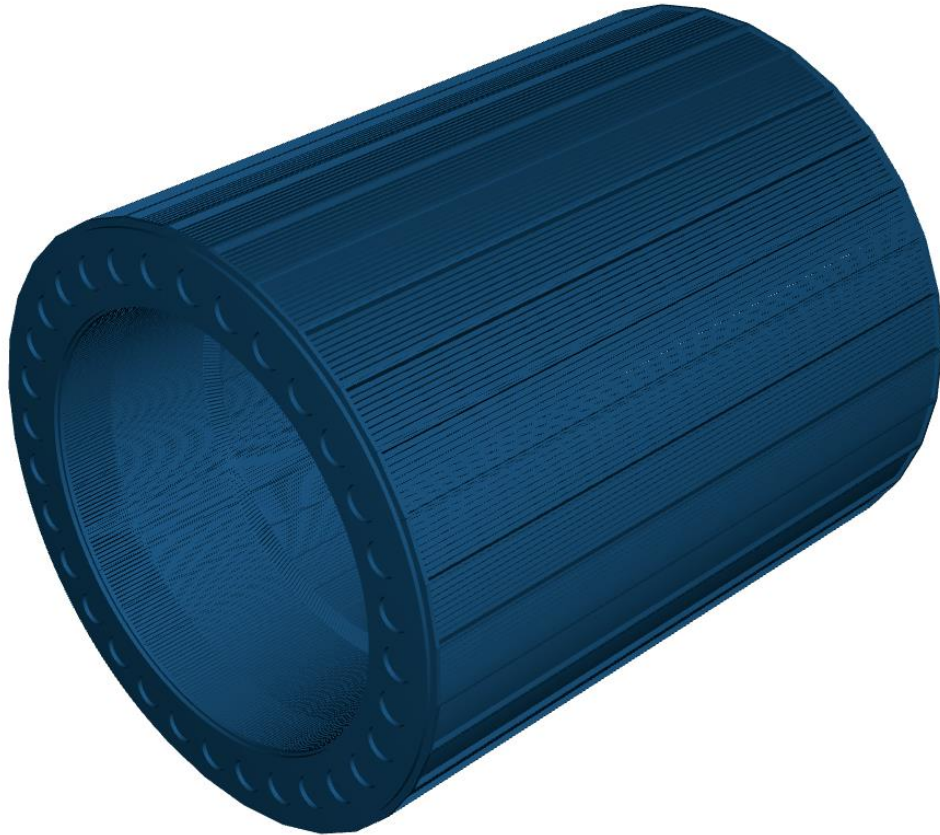
- Calibrated energy distributions of neutrons
- Initial estimate of parameter B appears to be working well
 - This method will be used for more advanced calibration procedure



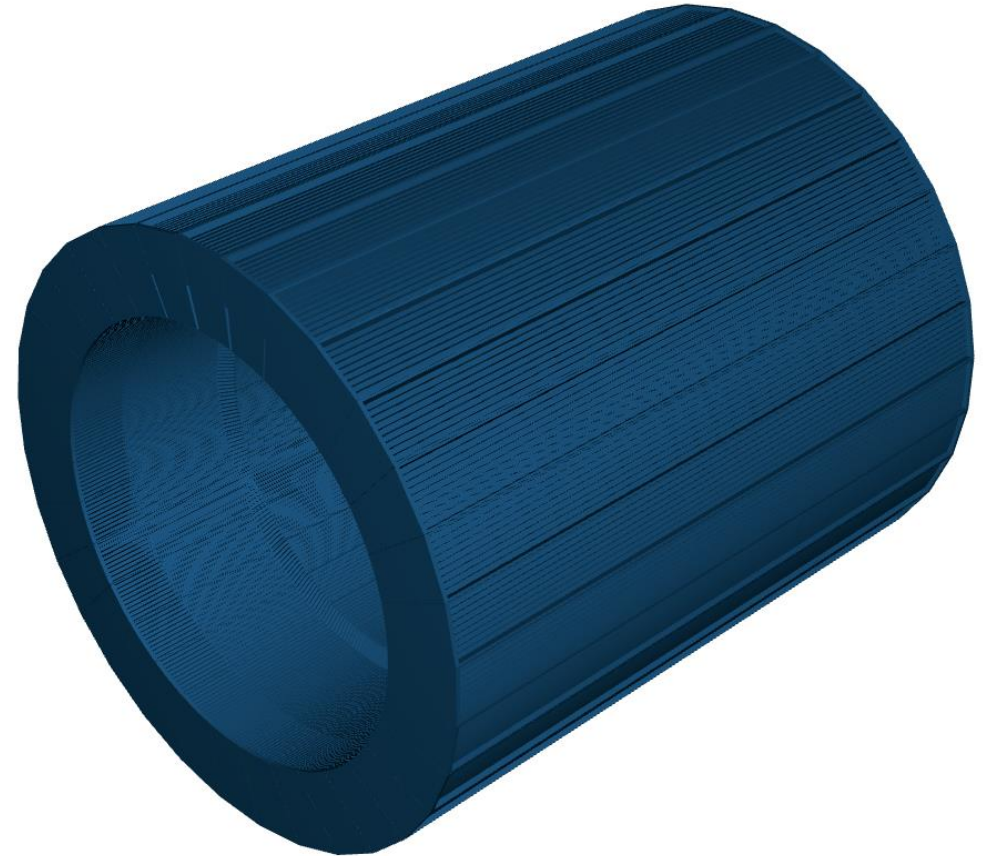
CHIMNEY SECTOR GEOMETRY

FULL bHCAL GEOMETRY

Full bHCAL geometry

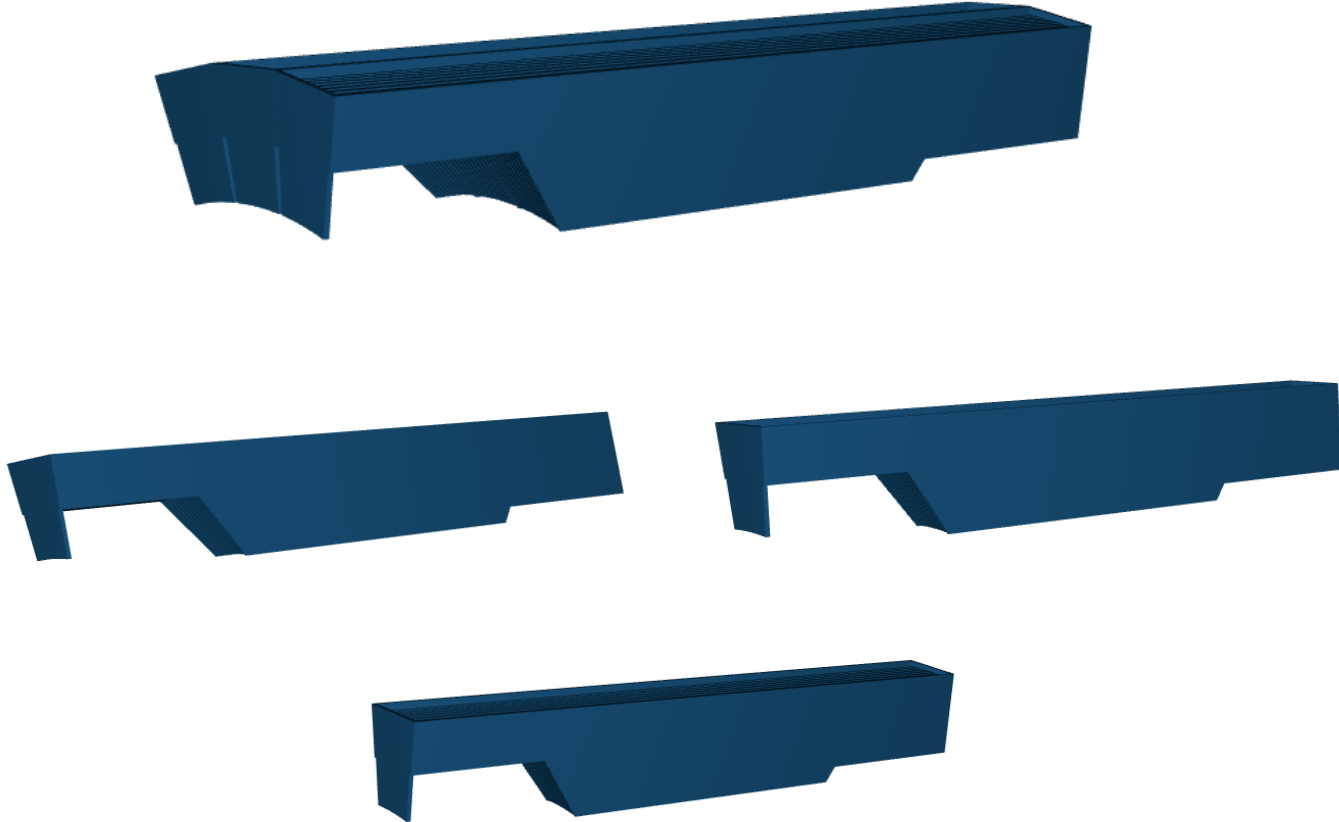


Full bHCAL geometry without end-rings

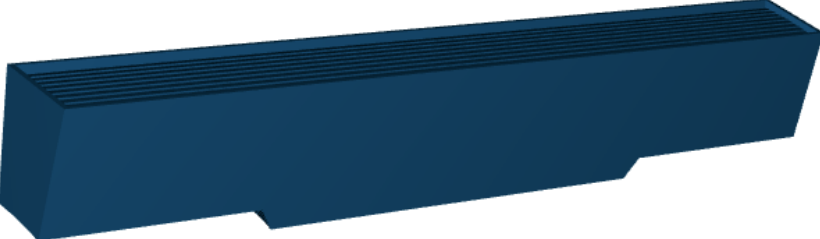


CHIMNEY SECTORS

Chimney sectors

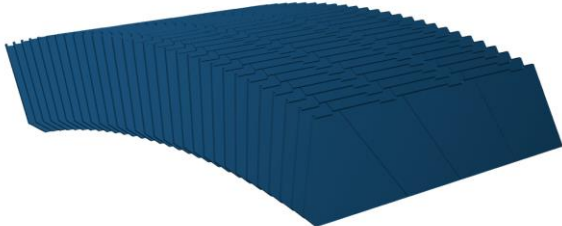


One regular sector

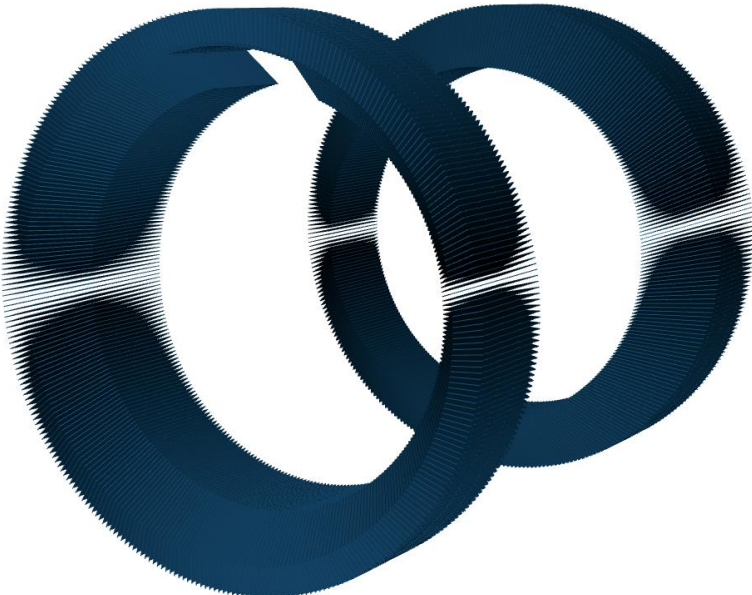


CHIMNEY TILES

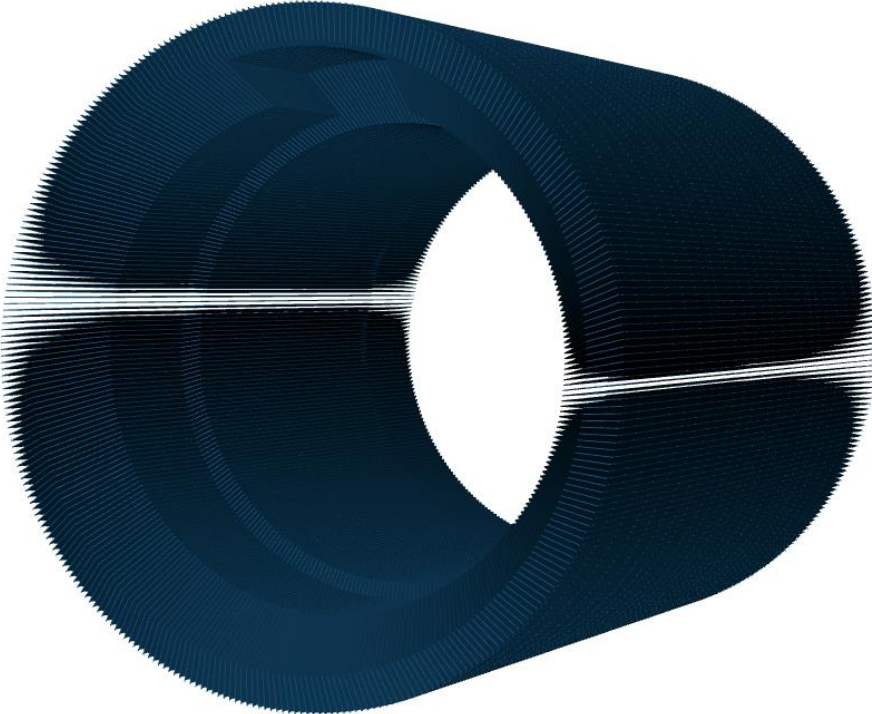
Chimney tiles



Four outer tile rings

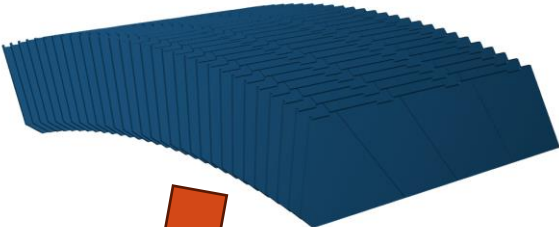


All bHCAL tiles

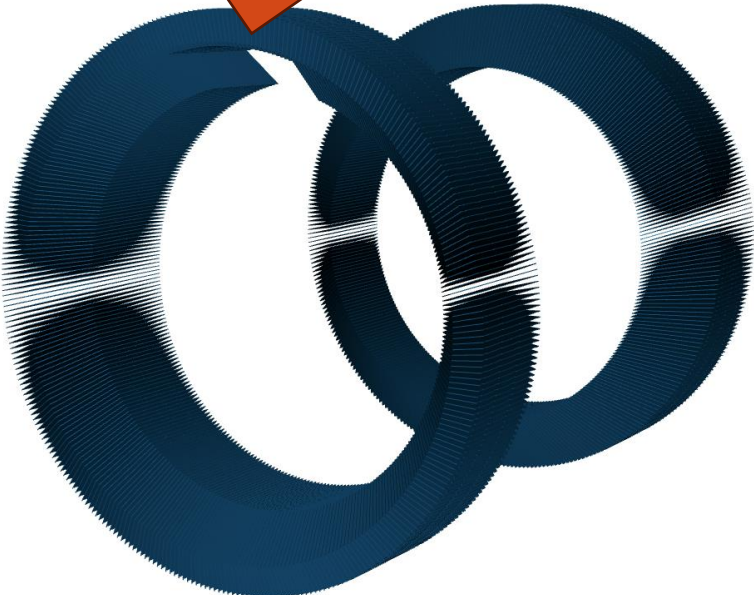


CHIMNEY TILES

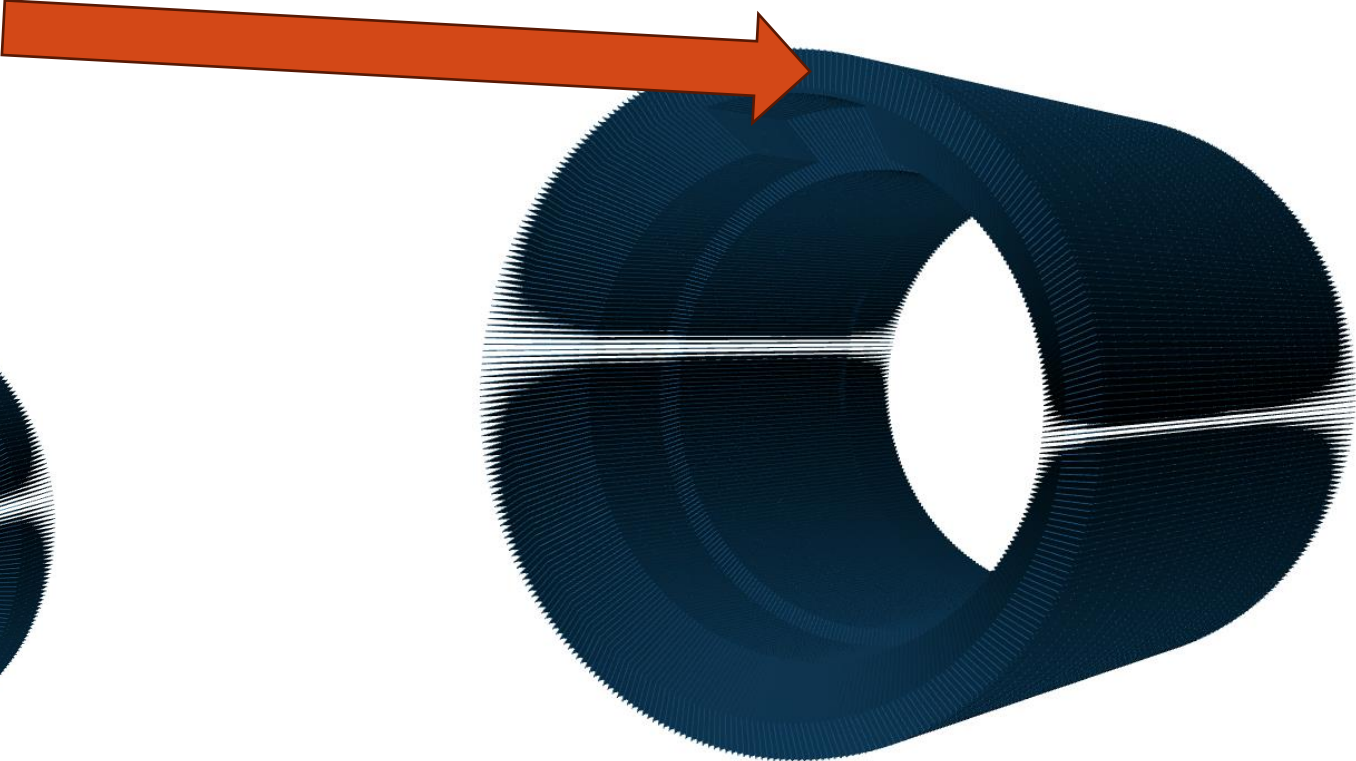
Chimney tiles



Four outer tile rings



All bHCAL tiles



SUMMARY

- Neutron and proton momentum distributions peak around $1 \text{ GeV}/c$
- Implemented new method to estimate initial value parameter B in Method 2
 - Appears to be working well
 - This method will be used for more advanced calibration procedure
- Investigated current bHCAL geometry with focus on chimney sectors

THANK YOU FOR ATTENTION