bHCAL Meeting – Neutron Calibration

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OVERVIEW

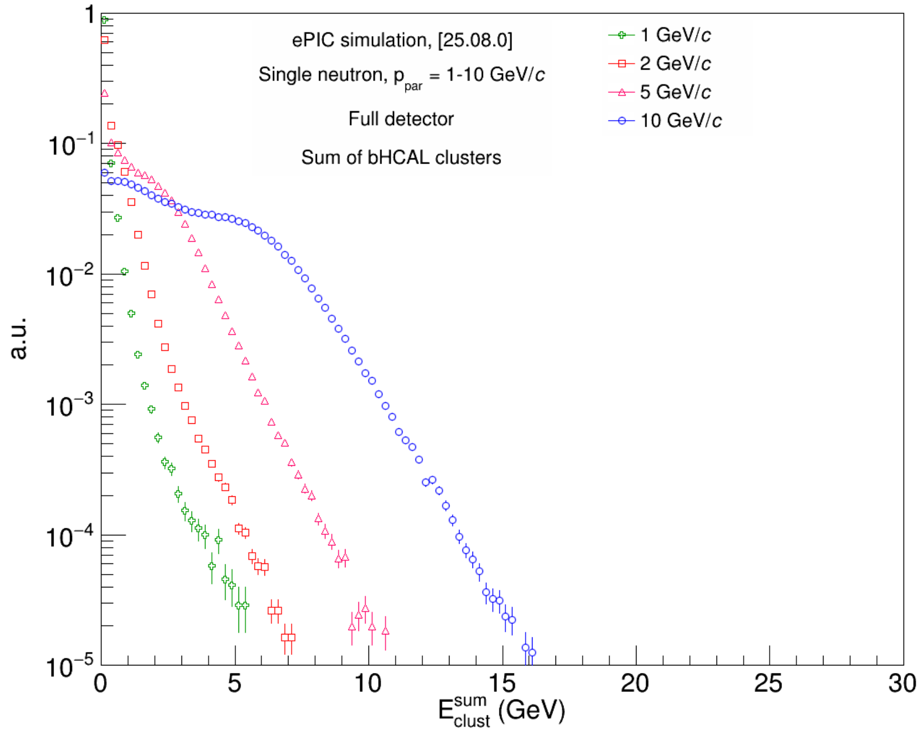
- Simple neutron calibration for bHCAL
  - Baseline calibrations to compare to more advanced ML methods
  - Two methods, as proposed by Derek

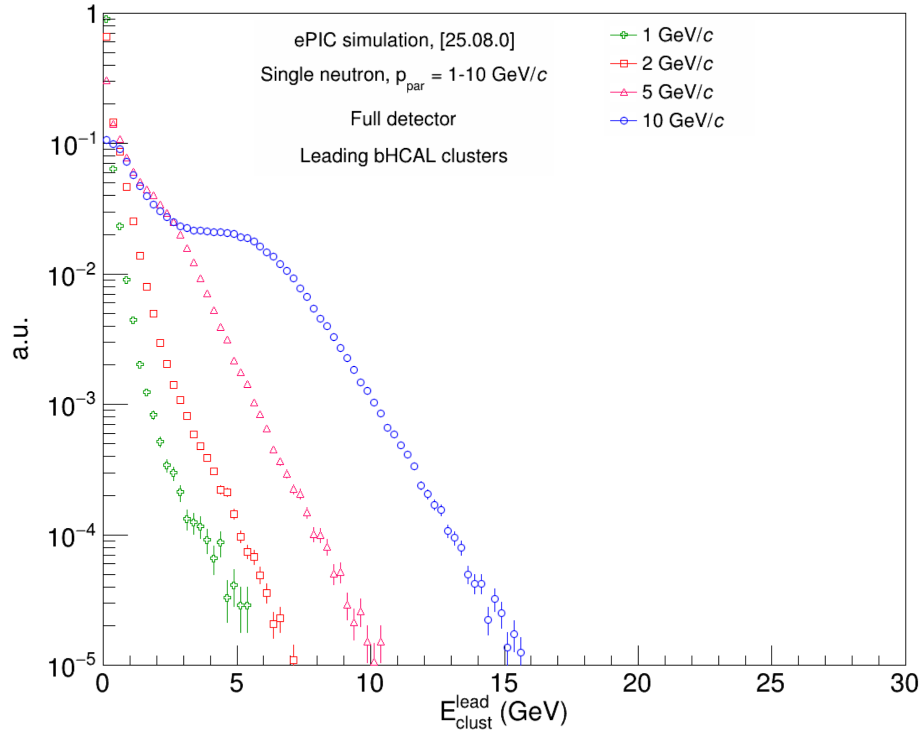
- Method 1
  - $E_{calib} = A(E_{EMCAL} + E_{bHCAL})$
  - Plot $(E_{EMCAL} + E_{bHCAL})/E_{par,MC}$
    - A is set as mean of this distribution

- Method 2
  - $E_{calib} = A(E_{EMCAL} + BE_{bHCAL})$
  - 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 mean of the distribution with optimal B

UNCORRECTED ENERGY DISTRIBUTIONS

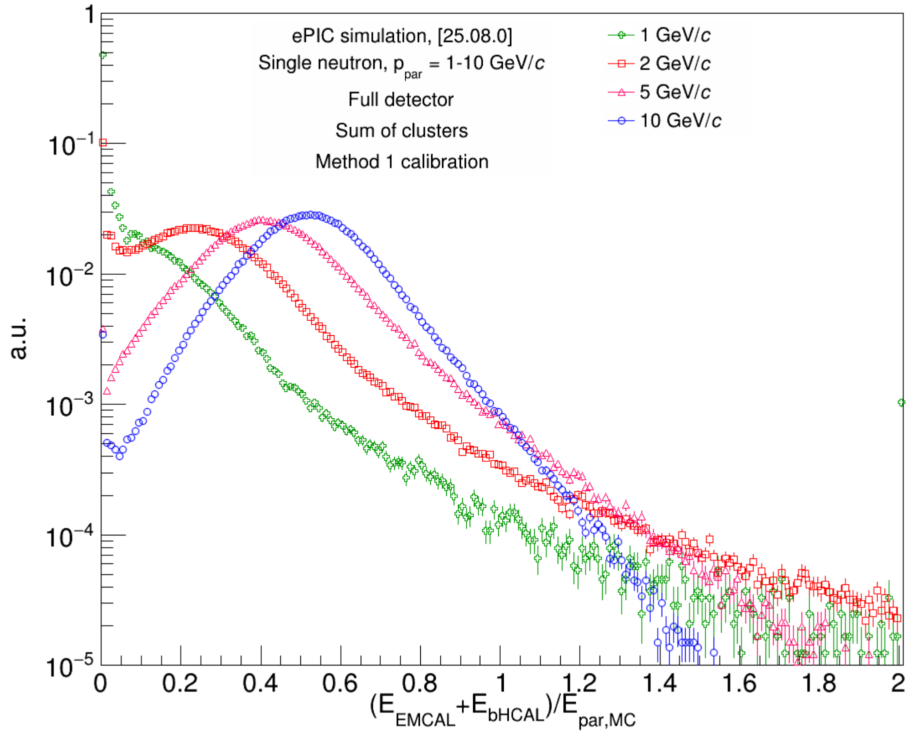
- Uncorrected energy distribution for clusters in bHCAL for single neutrons at various MC momenta
  - Values in the legend are MC neutron momenta
  - (left) Sum of all bHCAL clusters
  - (right) Leading clusters in bHCAL

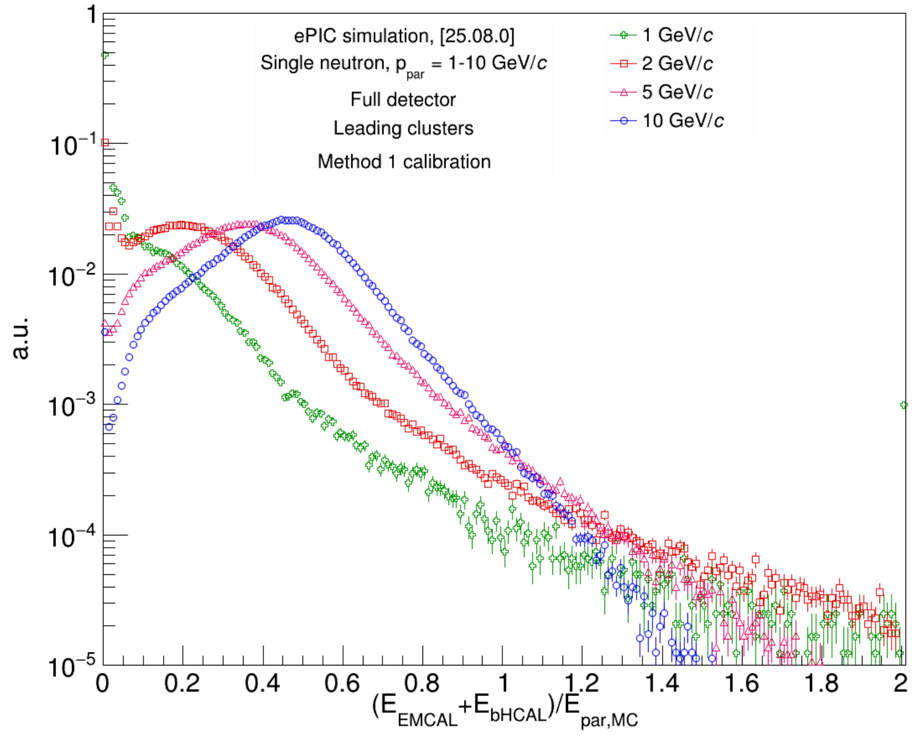




METHOD 1 CALIBRATION DISTRIBUTIONS

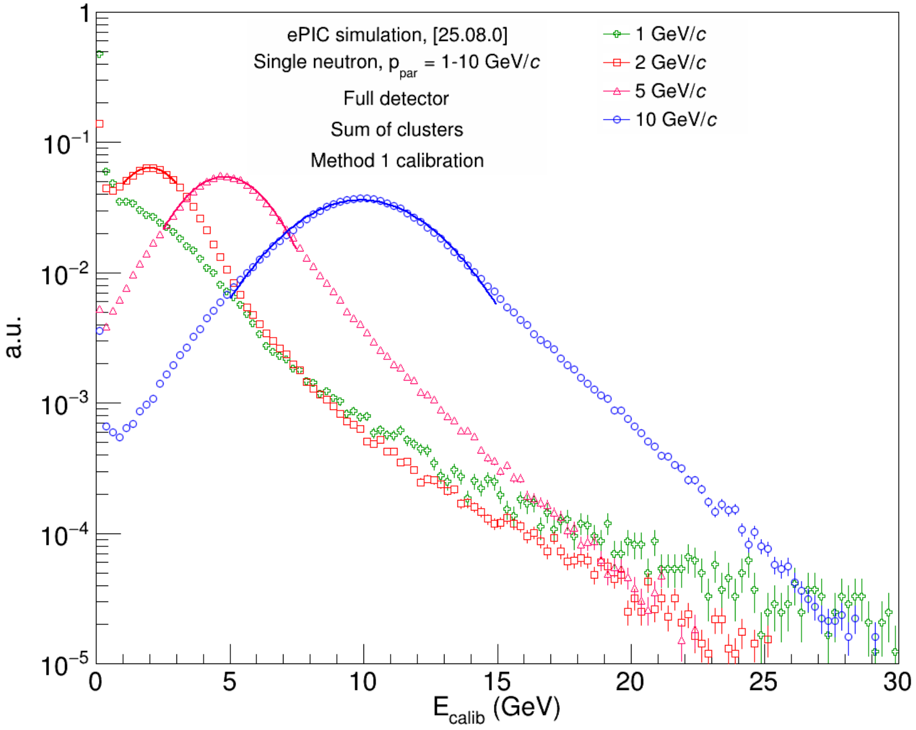
- Distributions used for calibration in Method 1
  - (left) Sum of all bHCAL clusters
  - (right) Leading clusters in bHCAL
  - Mean of distributions for calibration (parameter A) extracted from histogram stats
    - Works well, possibly can be improved with fitting

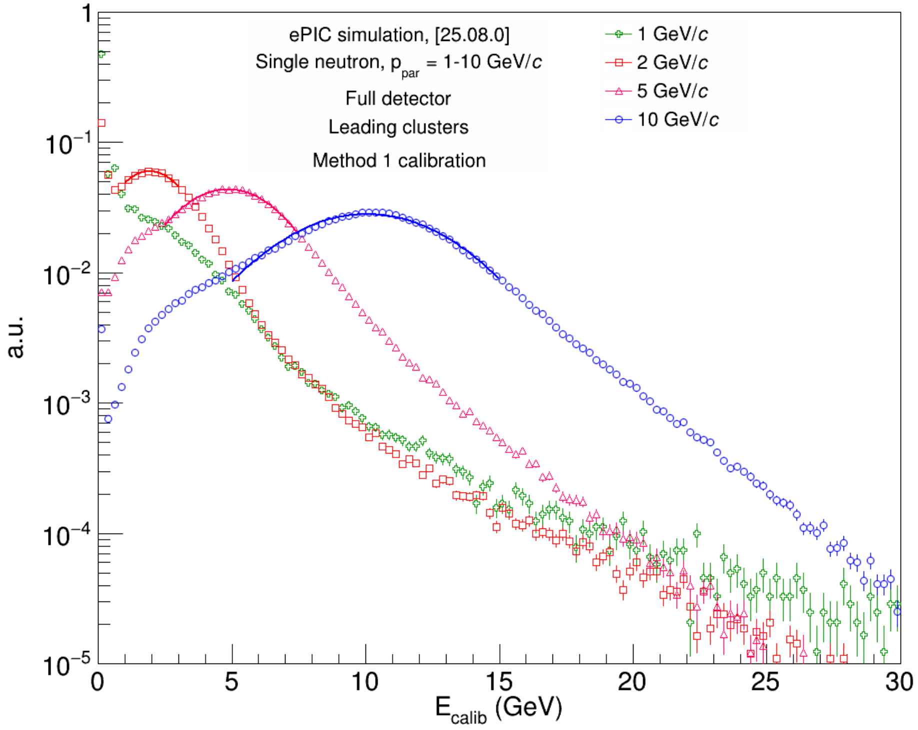




METHOD 1 CORRECTED ENERGY DISTRIBUTIONS

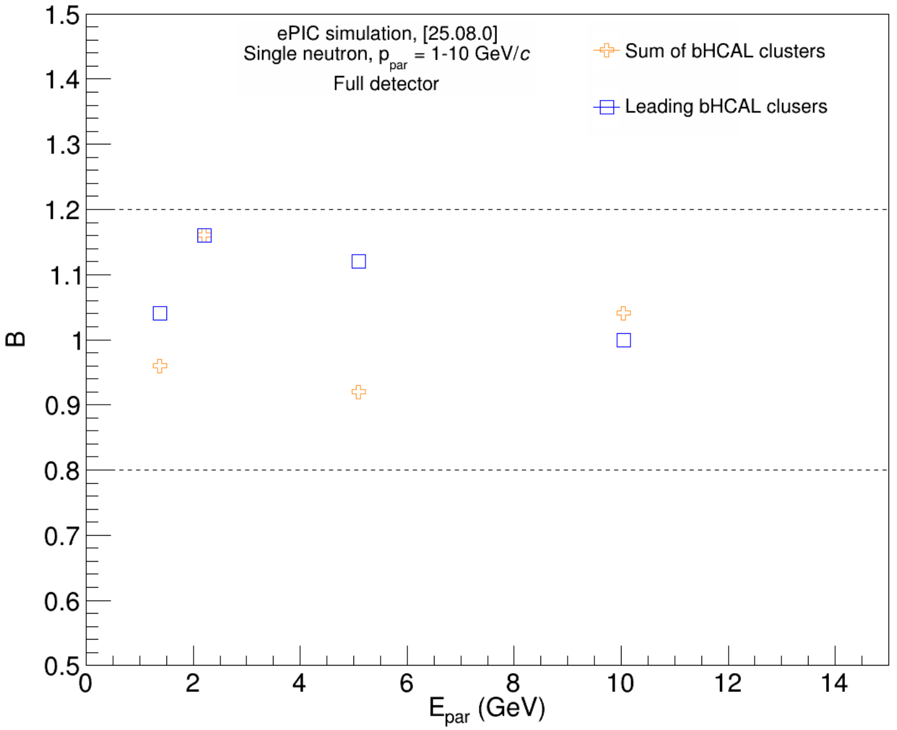
- Method 1 corrected energy distribution for clusters in bHCAL for single neutrons at various MC momenta
  - (left) Sum of all bHCAL clusters
  - (right) Leading clusters in bHCAL
  - All fits are Gaussian





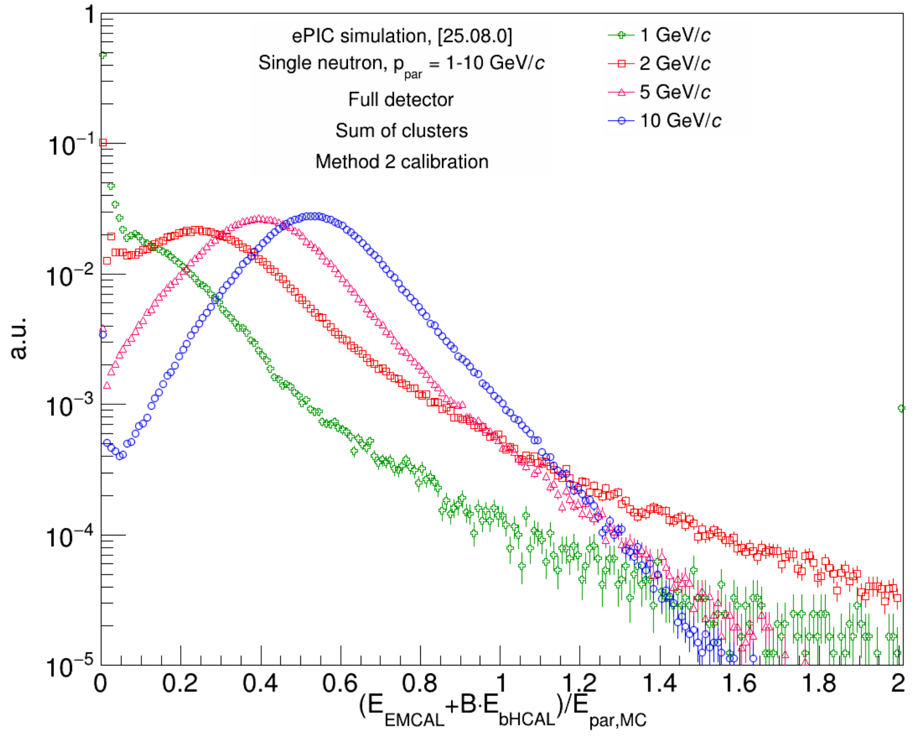
METHOD 2 – VALUES OF B PARAMETER

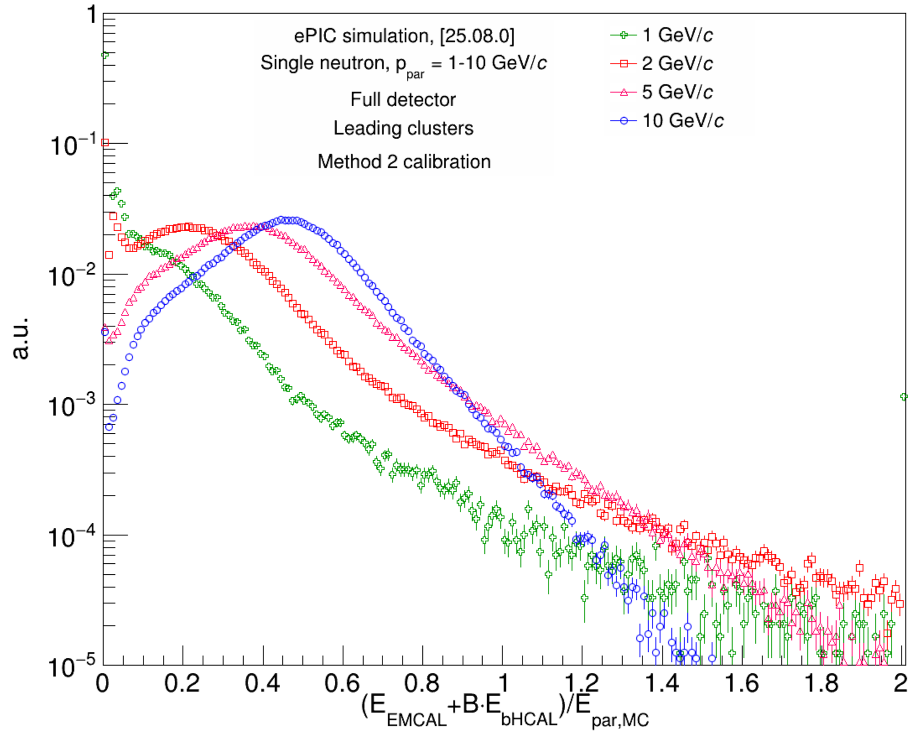
- Values of the parameter B used in calibration using Method 2
  - Parameter was varied "by hand" in range $(0.8,\ 1.2)$ with 10 steps
    - $B = 1$ is equivalent to Method 1
    - Variation range indicated by dashed lines
  - Each $E_{calib} = A(E_{EMCAL} + BE_{bHCAL})$ fitted with Gaussian to get σ/μ
    - Distribution corresponding to smallest σ/μ used for calibration (see next slide)



METHOD 2 CALIBRATION DISTRIBUTIONS

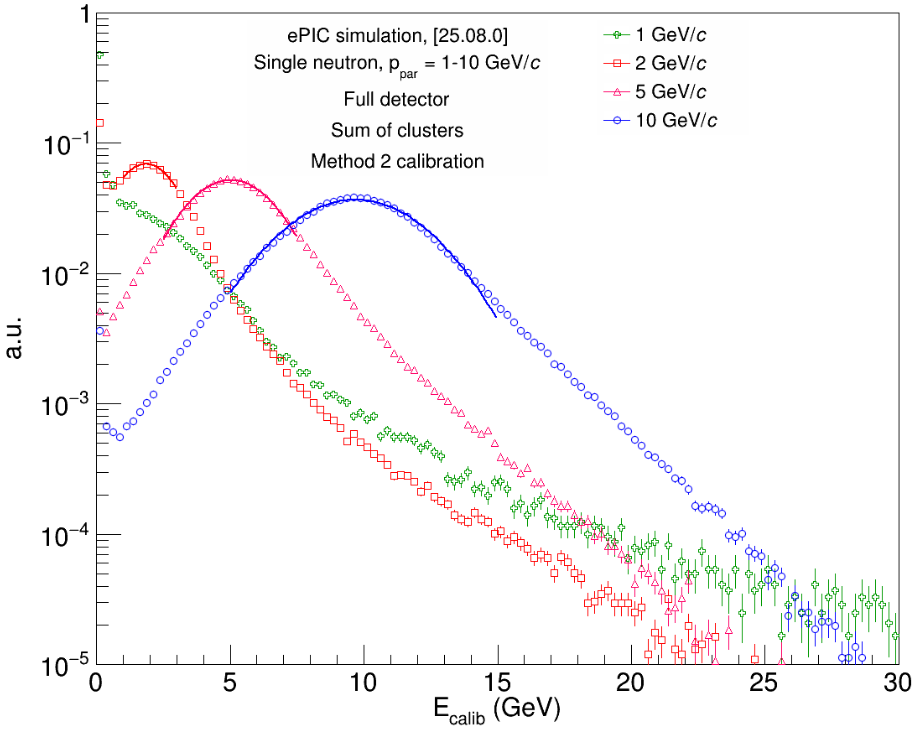
- Distributions used for calibration in Method 2 for optimal parameter B from previous slide
  - (left) Sum of all bHCAL clusters
  - (right) Leading clusters in bHCAL
  - Mean of distributions for calibration (parameter A) extracted from histogram stats

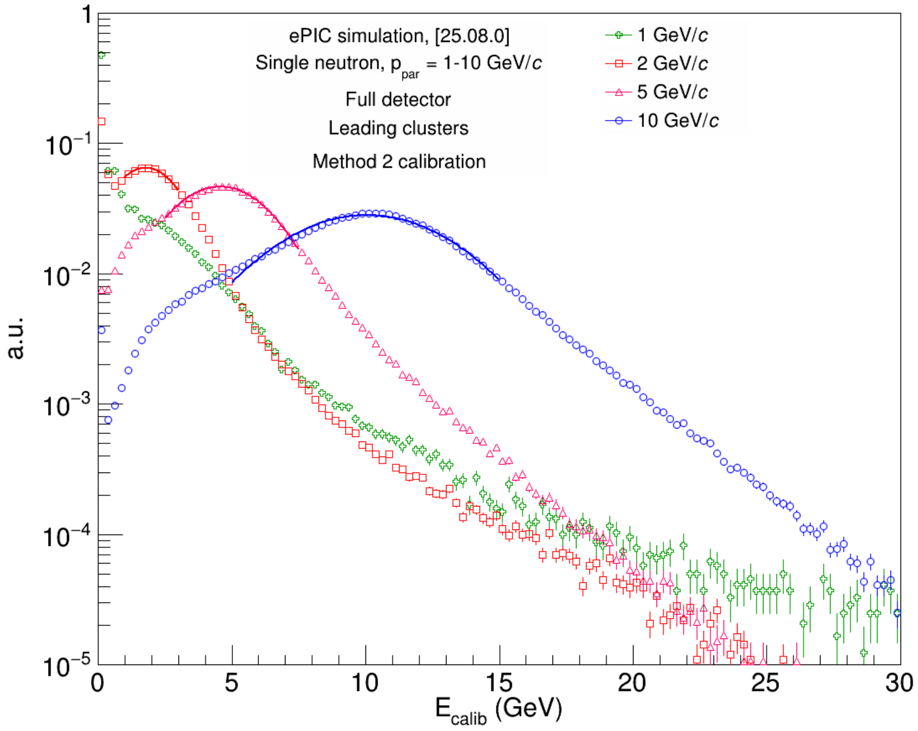




METHOD 2 CORRECTED ENERGY DISTRIBUTIONS

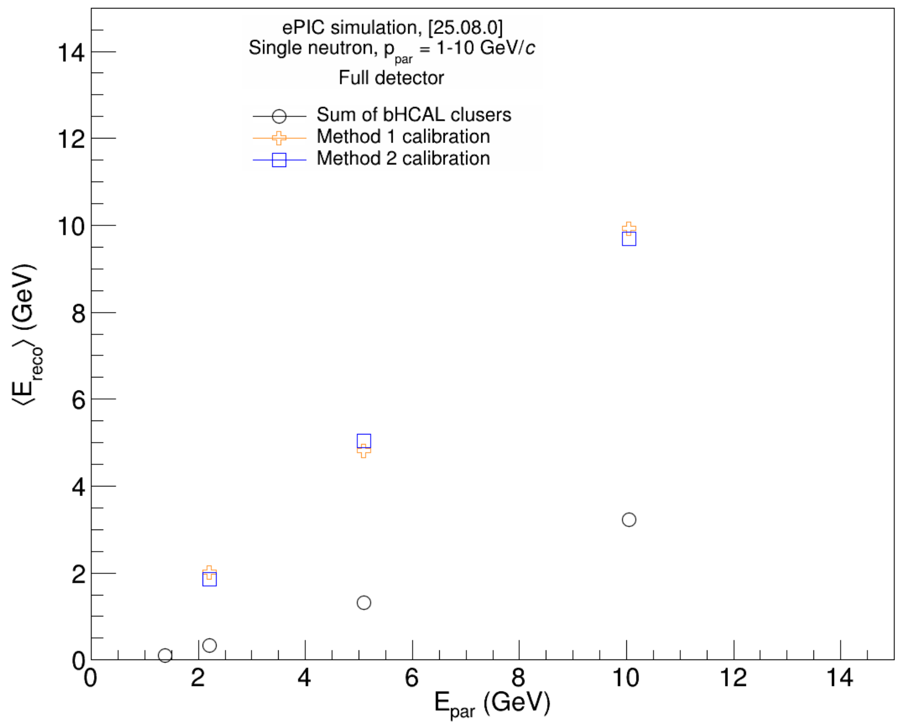
- Method 2 corrected energy distribution for clusters in bHCAL for single neutrons at various MC momenta
  - (left) Sum of all bHCAL clusters
  - (right) Leading clusters in bHCAL
  - All fits are Gaussian

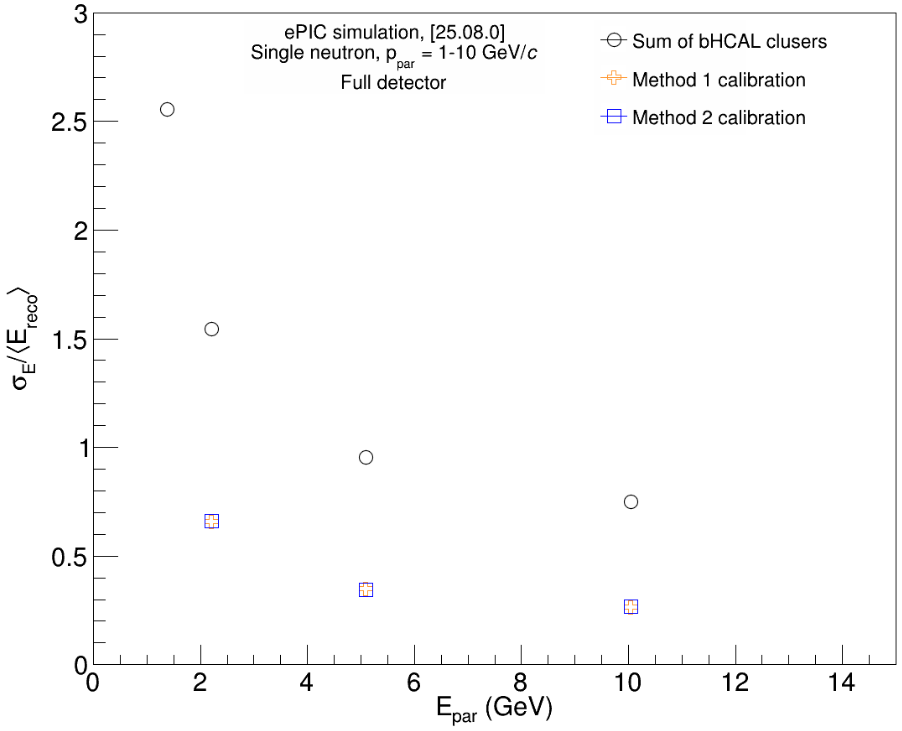




RESOLUTION FOR SUM OF CLUSTERS

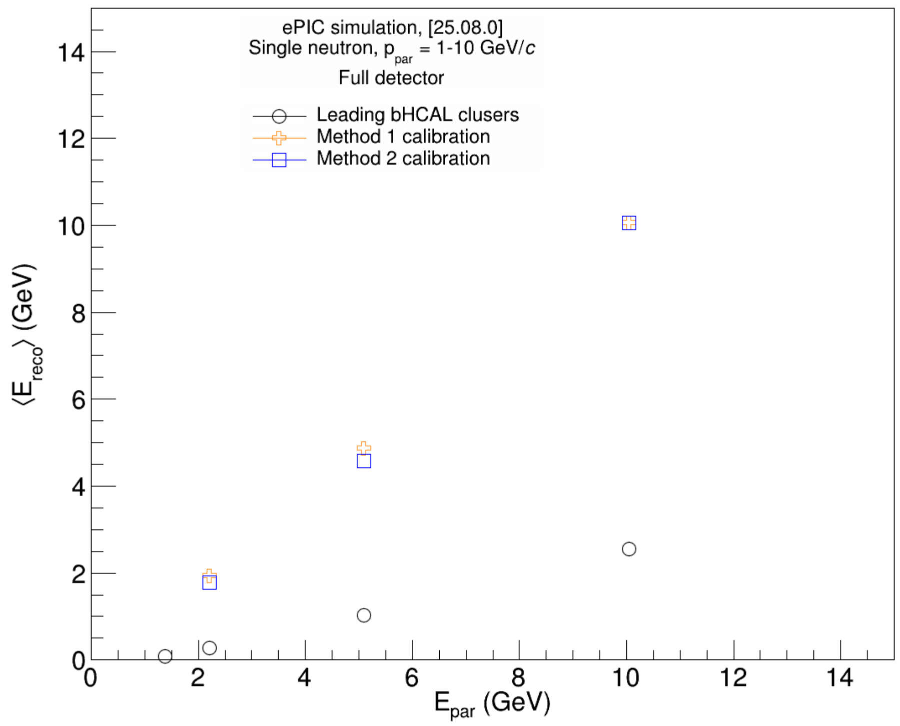
- Resolution for energy distributions from **sum of clusters**
  - Comparison for uncalibrated and the two calibration methods
  - (left) Mean reconstructed energy vs. MC energy of neutrons
  - (right) Energy resolution vs. MC energy of neutrons

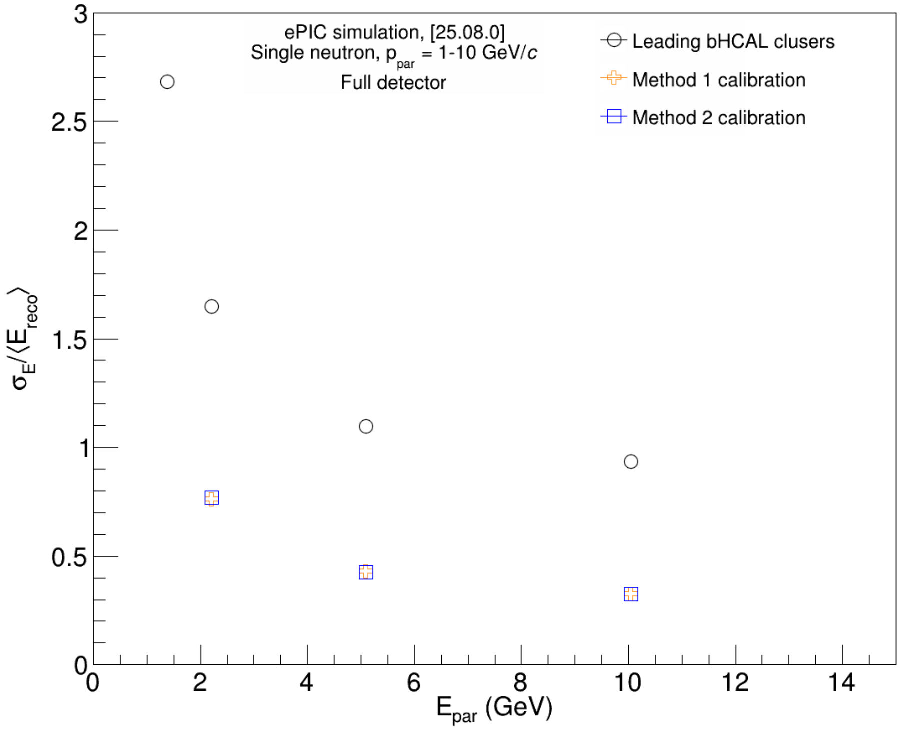




RESOLUTION FOR LEADING CLUSTERS

- Resolution for energy distributions from **leading clusters**
  - Comparison for uncalibrated and the two calibration methods
  - (left) Mean reconstructed energy vs. MC energy of neutrons
  - (right) Energy resolution vs. MC energy of neutrons





SUMMARY AND OUTLOOK

- Performed calibration of neutrons in bHCAL using two simple methods

- Both methods work reasonably well for neutrons above 2 GeV

- Both simple methods struggle with calibration below 2 GeV
  - Too many low energy hits in bHCAL and steeply falling spectra make it difficult to get clear peak
  - Potential good motivation for usage of ML that should perform much better

- Method 2 works similarly to Method 1
  - Method 2 does not seem to have major advantage over Method 1 in current implementation
  - With limited timeframe, could not perform more detailed scan of parameter B using more advanced tools like TMinuit

THANK YOU FOR ATTENTION