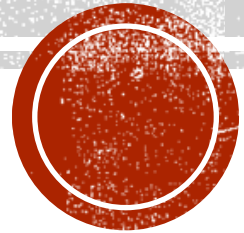
bHCAL Meeting – Neutron Calibration Update



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11/07/2025

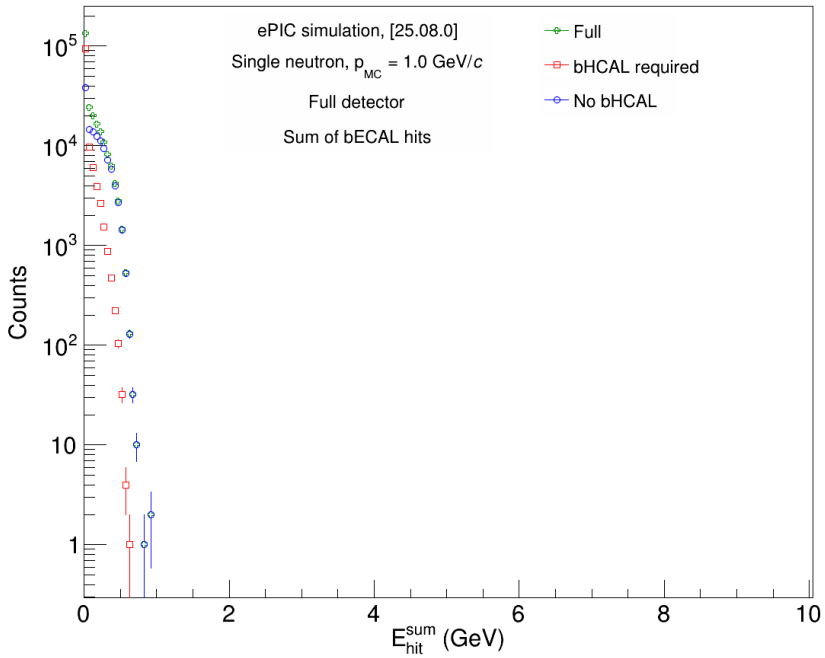
OVERVIEW

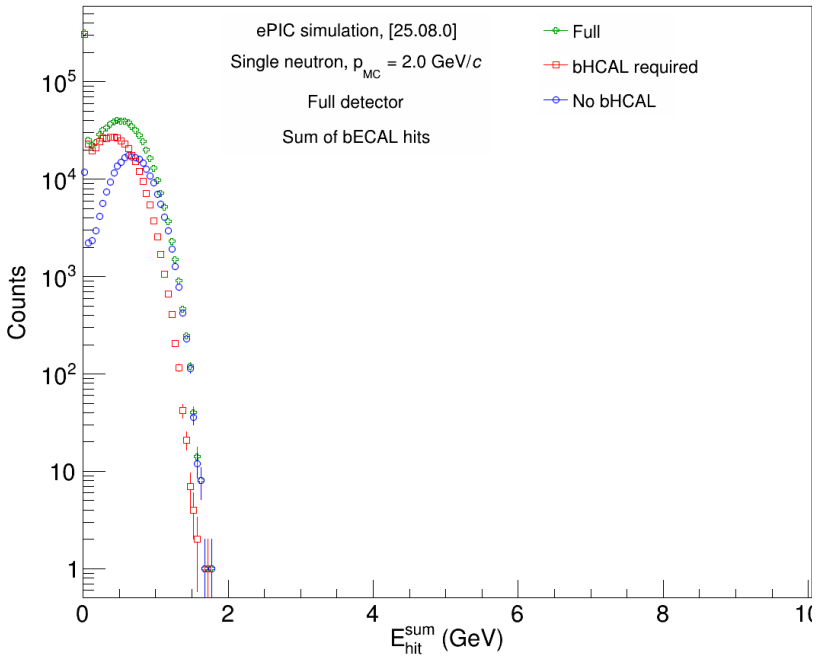
- Energy deposition in bECAL and bHCAL
  - Different combinations of energy deposition requirement in bECAL and bHCAL
  - Summary of plots produced for review last week

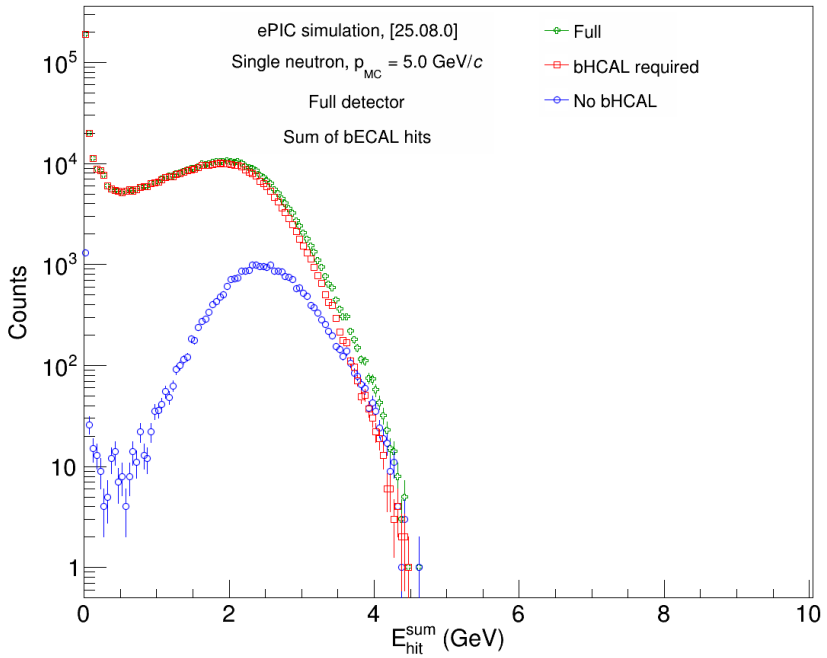
- Outlook
  - Possible future studies for manual calibrations
    - Based on discussions during preparation for the review

ENERGY DEPOSITION IN bECAL

- Uncorrected energy distribution for hits in bECAL for single neutrons at various MC momenta
  - Values in the legend are MC neutron momenta
  - Energy from **sum of individual hits**
  - Green – all hits, Red – require hits in bHCAL, Blue – require no hits in bHCAL

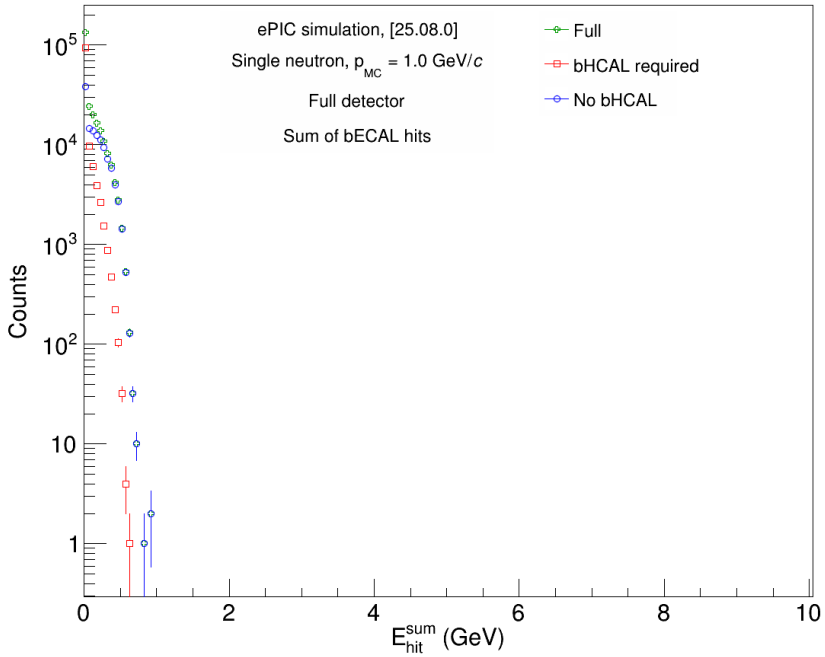


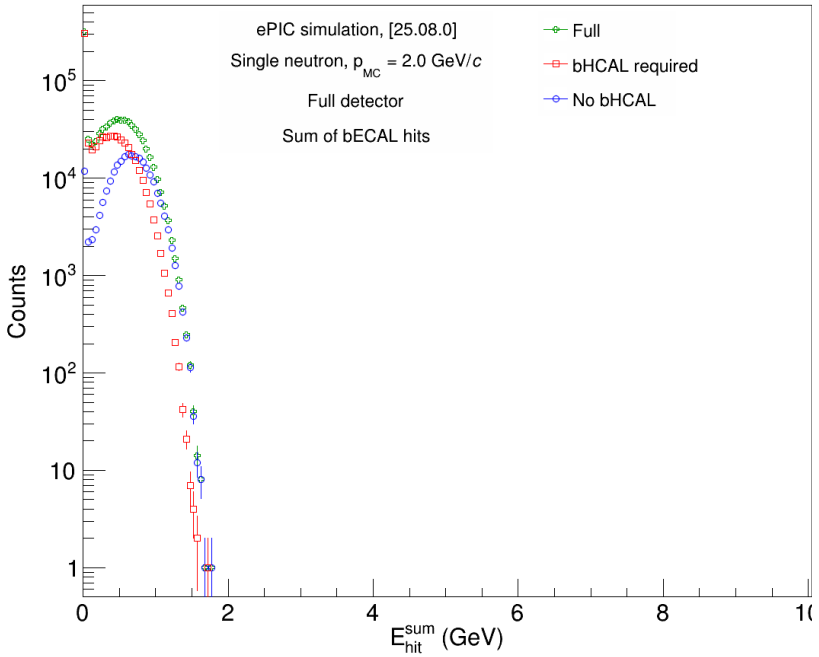


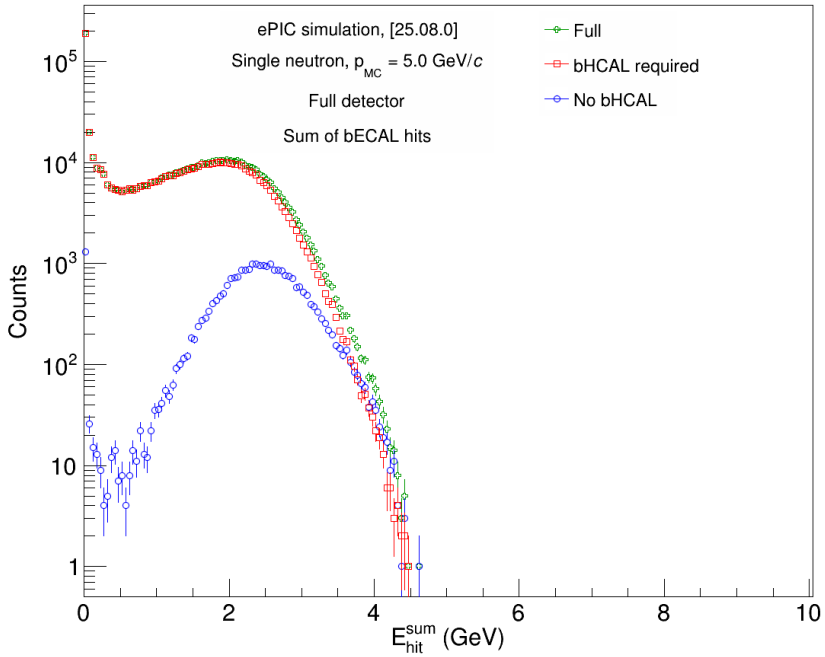


ENERGY DEPOSITION IN bECAL

- Key observations:
  - 1 GeV/c: Majority of neutrons detected by bECAL don't have signal in bHCAL
    - Expected – shower is short, so when it starts in bECAL, it's likely that nothing reaches bHCAL
  - 2 GeV/c: More substantial contribution of showers that reach both bECAL and bHCAL – longer shower
  - 5 GeV/c: Majority of showers that start in bECAL also reach bHCAL – even longer shower







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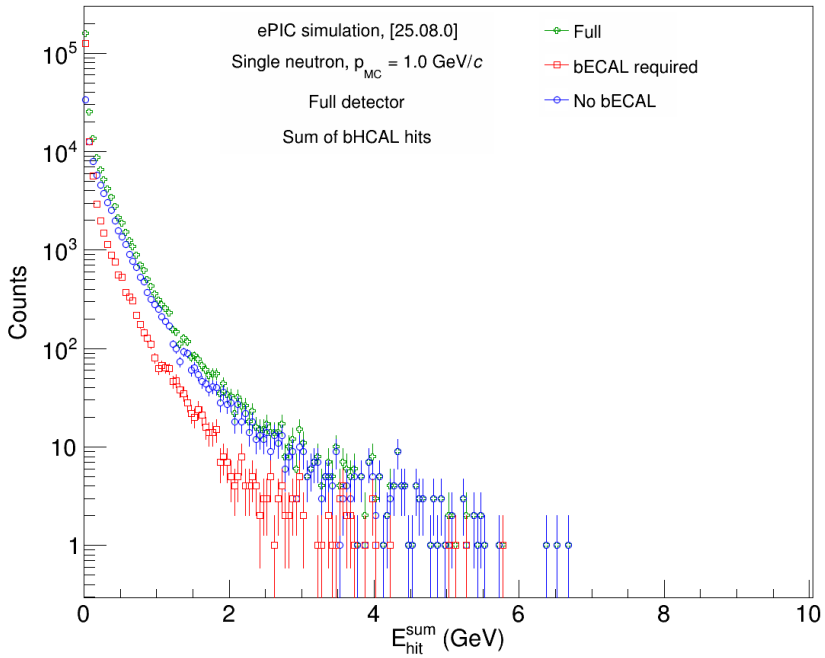

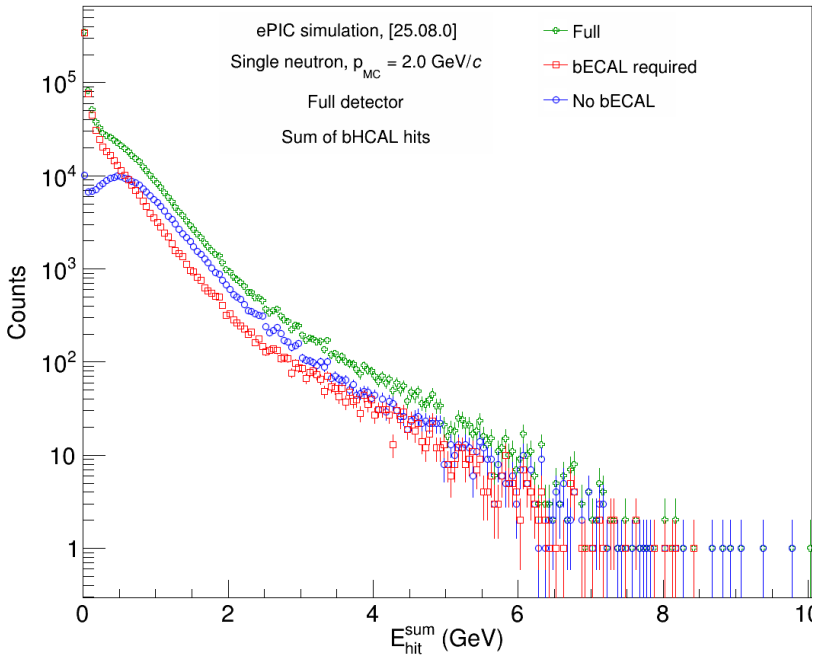

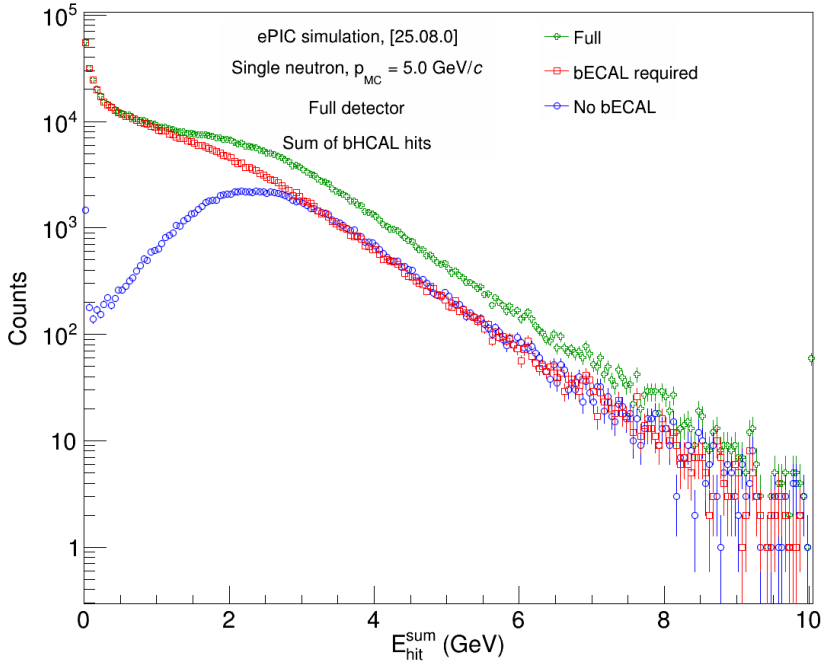

ENERGY DEPOSITION IN bHCAL

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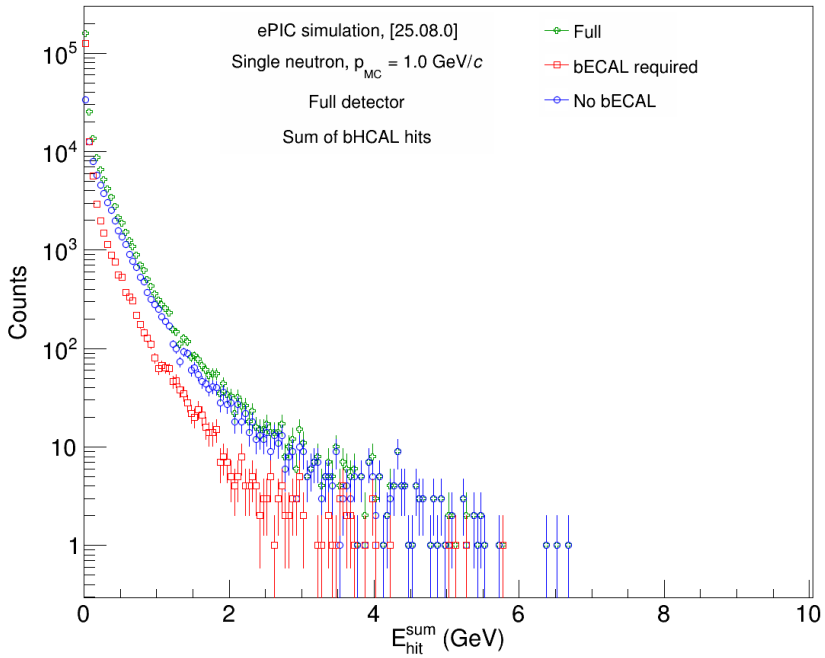
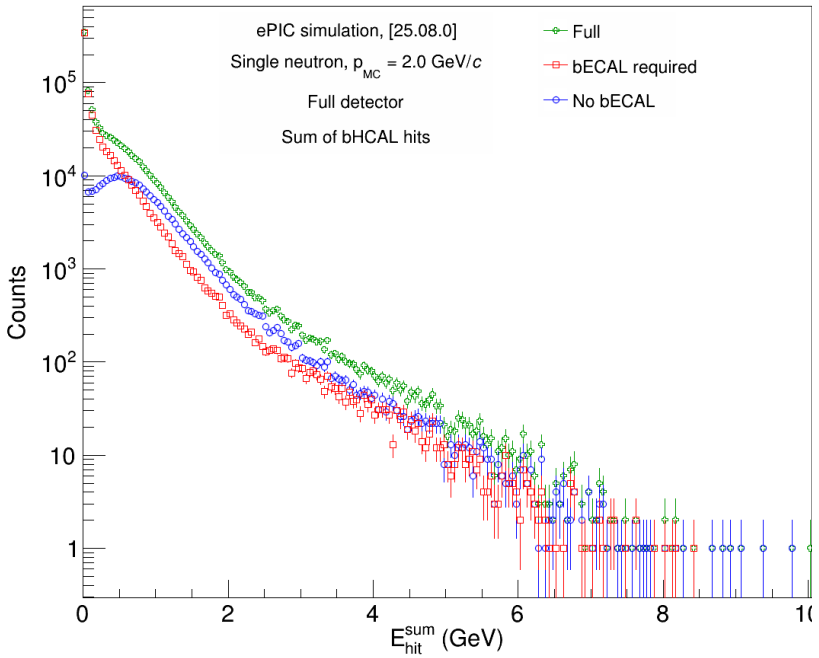
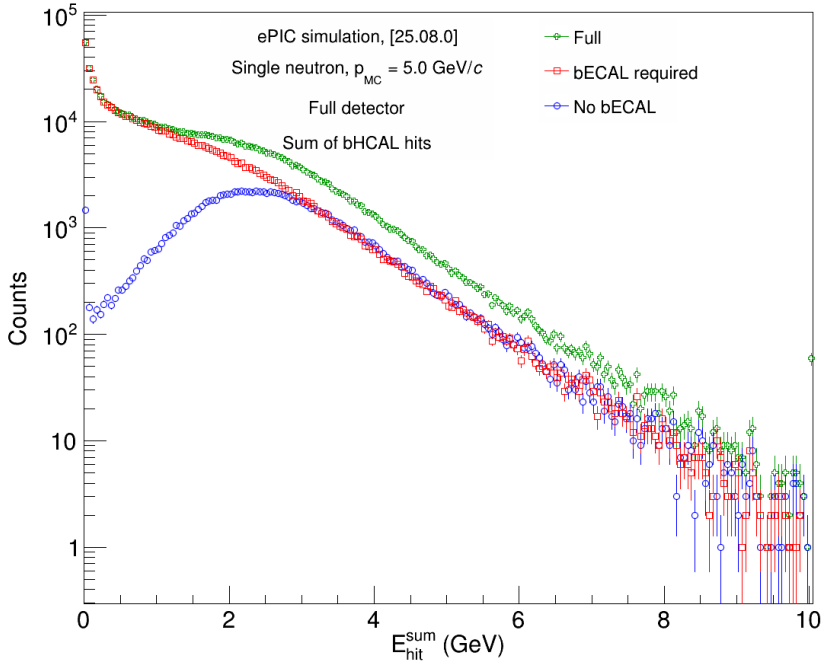
  - 2 GeV/c: More substantial contribution of showers that reach both bECAL and bHCAL – longer shower
  - 5 GeV/c: Many showers that reach bHCAL originate in bECAL – even longer shower







SUMMARY

- Energy deposition in bECAL and bHCAL appears to be consistent with expectation
  - Lower neutron energy – shorter shower – more localized energy deposition
  - Higher neutron energy – longer shower – energy deposition spread out to both detectors

- Main issues/concerns:
  - Substantial part of shower energy lost in the magnet
    - Potential problem for any energy
    - Appears most significant for low energies ($1\ \mathrm{GeV}/c$) as many such neutrons loose all/majority of energy in the magnet
  - Difficult to make "proper" manual calibration
    - Unknown missing energy from the magnet
    - How do we calibrate without directly using the MC energy of neutron and use just information from bECAL and bHCAL?
      - Current manual method works for simple case with known thrown neutron energy
      - What do we do for continuous neutron spectrum and only using detector information?

OUTLOOK

- More detailed study of shower evolution in bECAL and bHCAL
  - Ratio of energy deposition in bECAL and bHCAL
    - Similar to current simple calibration
  - Add information on size of shower
    - Number of hits, cluster size
  - Estimate energy loss in the magnet

- Make magnet sensitive volume in simulation
  - Directly retrieve the energy deposited in the magnet
  - Requires adding a new branch to EICRecon output

- Open questions about role of sampling fractions in current simulation

- More suggestions?

THANK YOU FOR ATTENTION