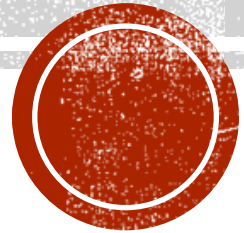
bHCAL Meeting – Neutron Calibration Update



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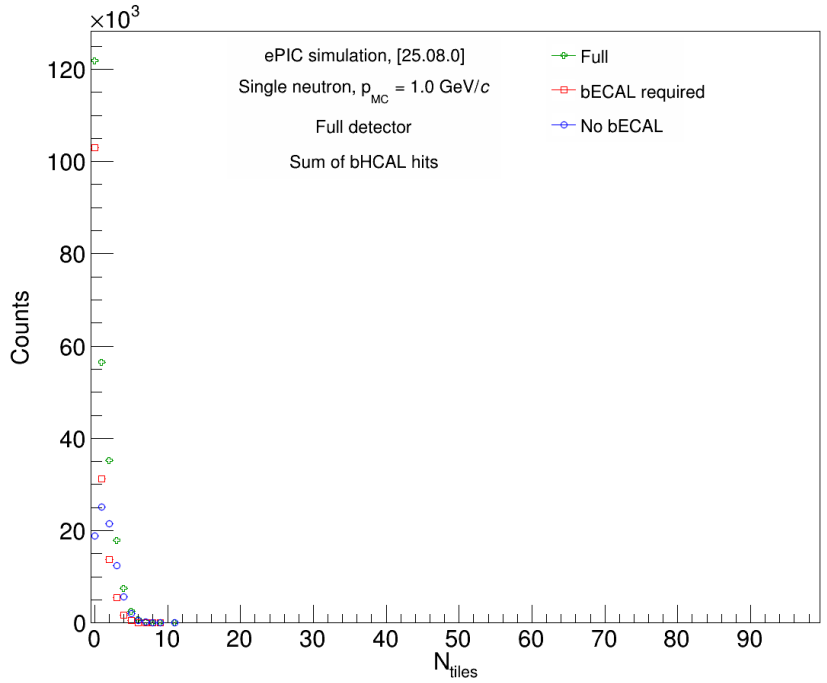
11/14/2025

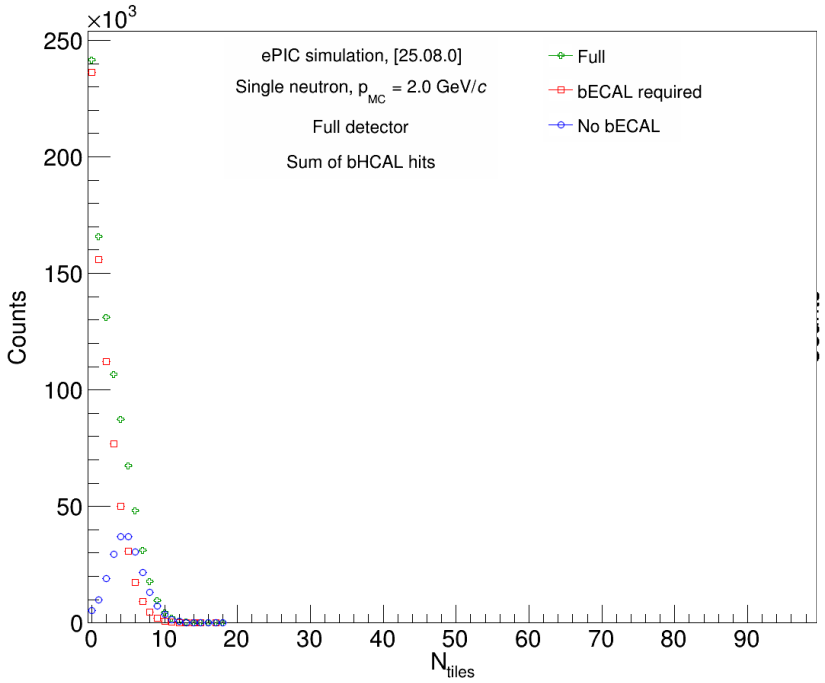
OVERVIEW

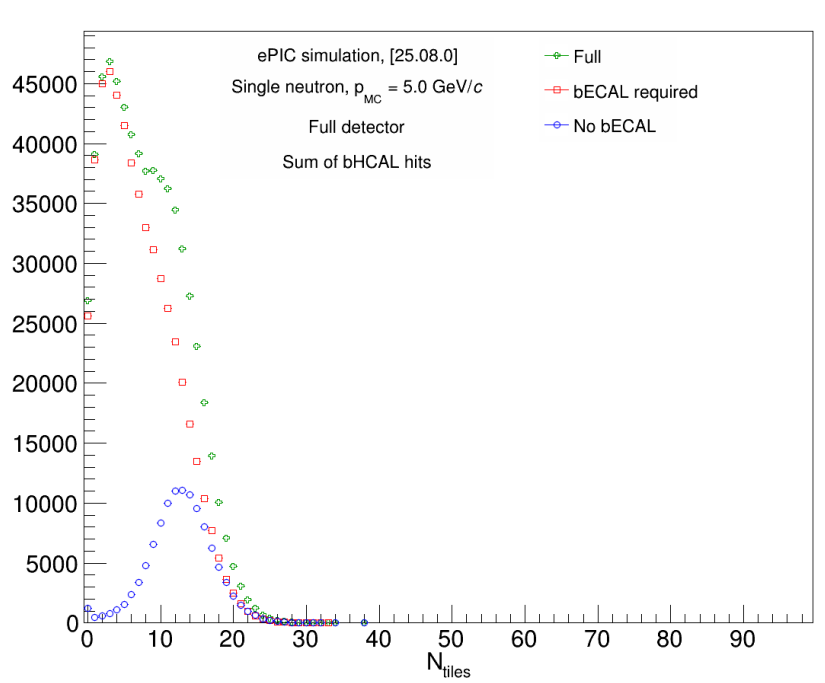
- First look at various energy deposition parameters in bECAL and bHCAL:
  - Number tiles with signal in bHCAL
  - Hits in layers of bECAL (SciFi layers only)
  - Shower size in bHCAL in $\Delta\eta$ vs. $\Delta\phi$
  - CellID mapping for bHCAL
    - For future manual clustering

NUMBER OF TILES WITH SIGNAL IN bHCAL

- Number of tiles with non-zero energy deposition in bHCAL
  - Three MC neutron momenta
  - Linear scale
  - Green – all hits, Red – require hits in bECAL, Blue – require no hits in bECAL

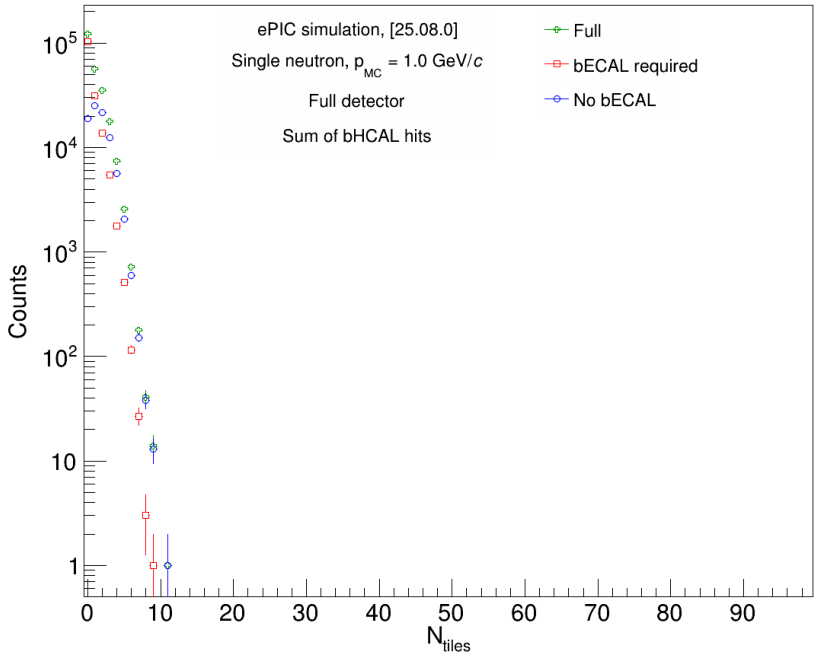


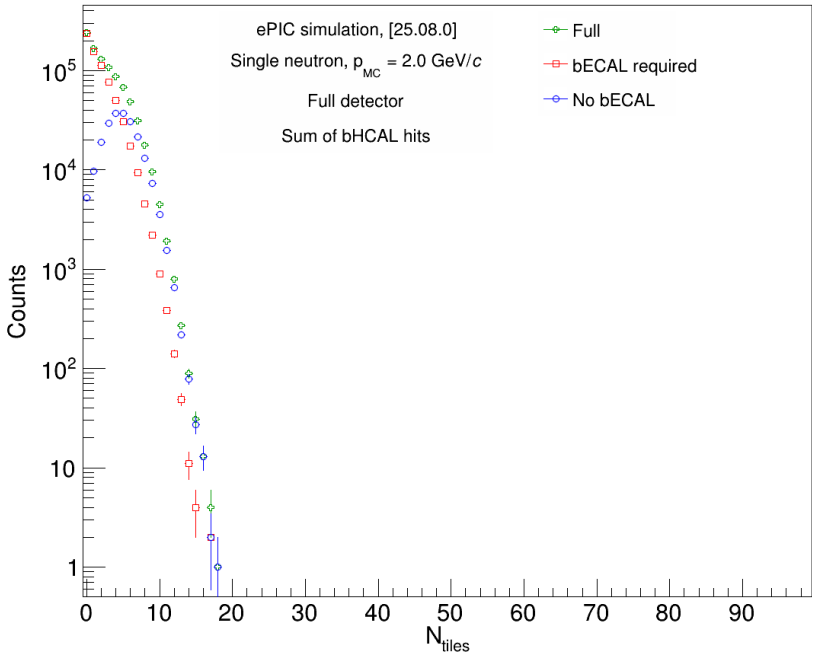


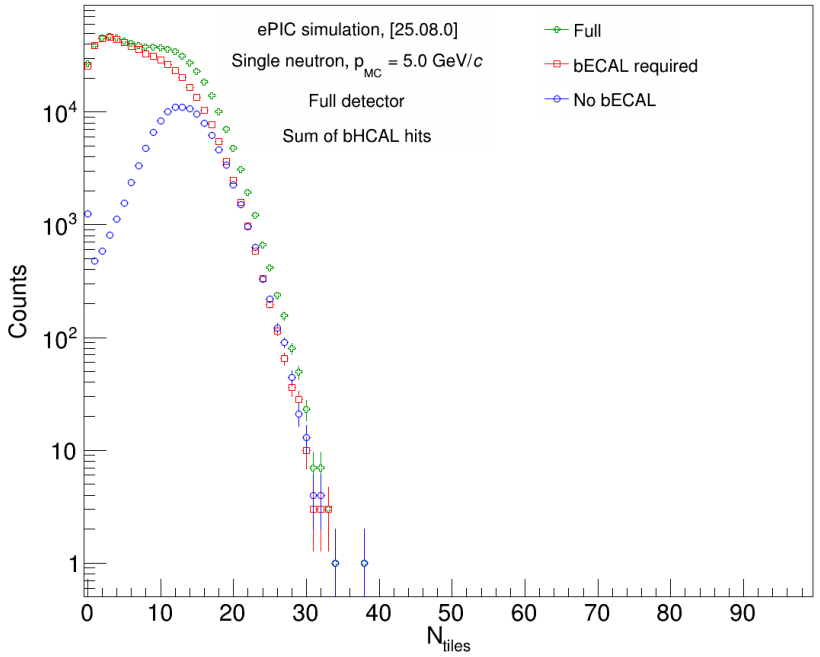


NUMBER OF HIT TILES IN bHCAL

- Number of tiles with signal in bHCAL
  - Three MC neutron momenta
  - Log-scale
  - Green – all hits, Red – require hits in bECAL, Blue – require no hits in bECAL

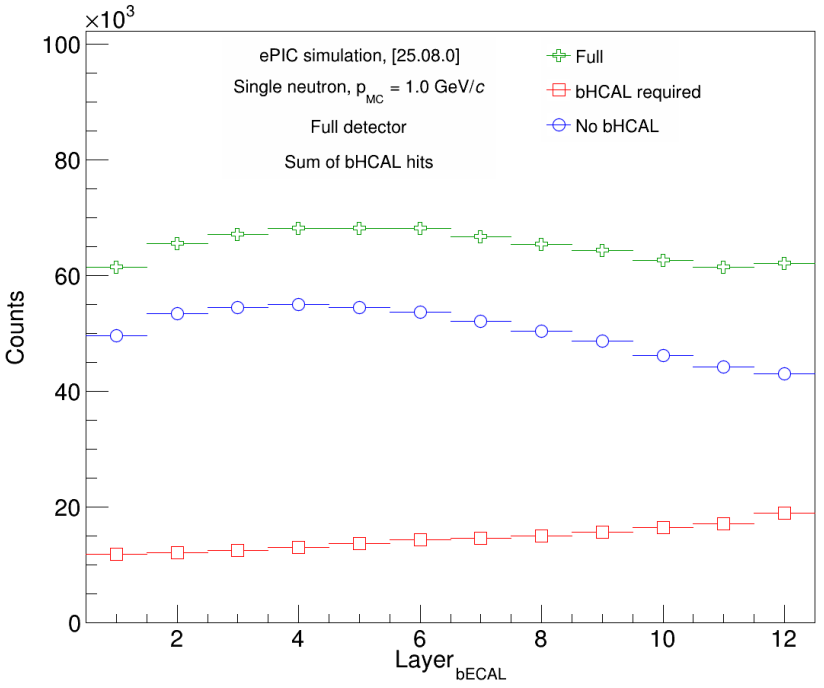


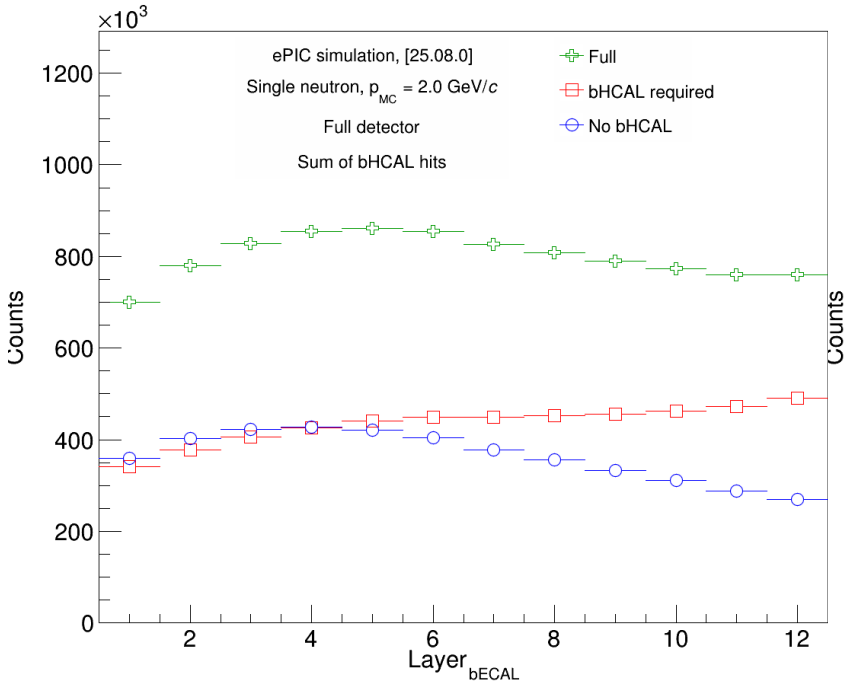


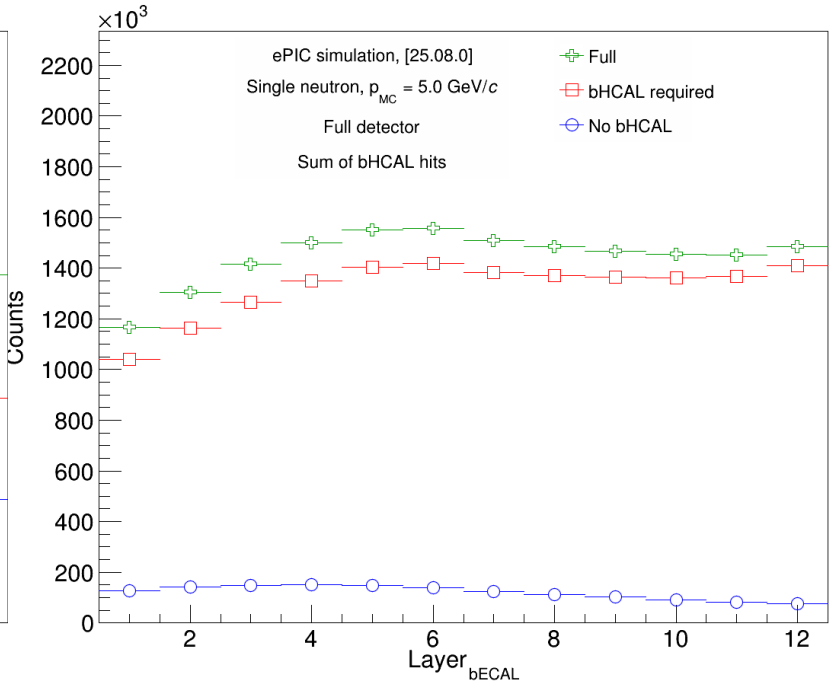


HITS IN LAYERS OF bECAL

- Hits recorded by individual SciFi layers of bECAL
  - All layers with signal
  - Three MC neutron momenta
  - Green – all hits, Red – require hits in bHCAL, Blue – require no hits in bHCAL



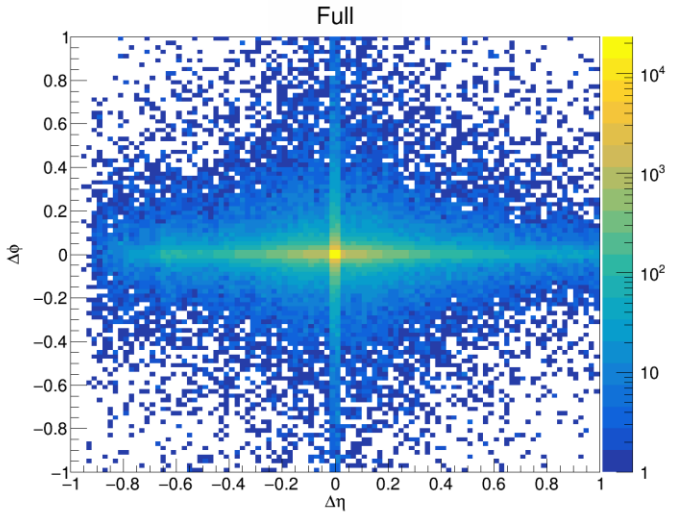


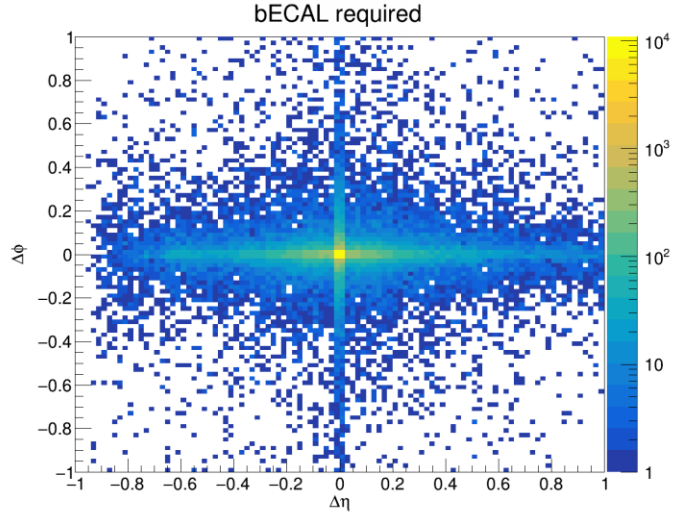


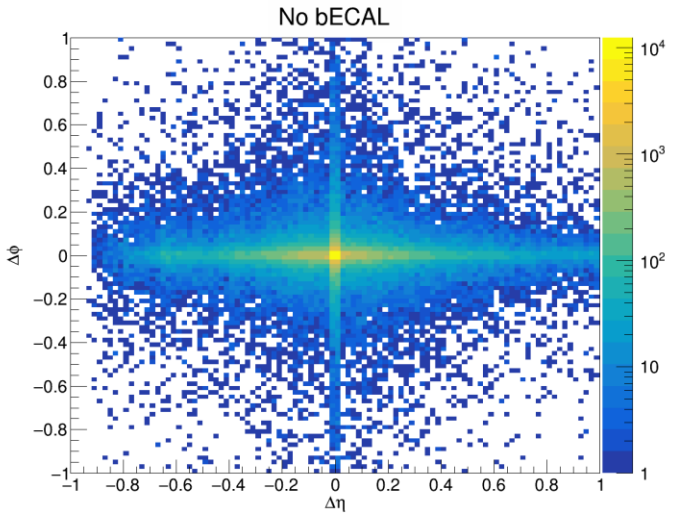
SHOWER TRANSVERSE SIZE IN bHCAL

- Transverse size of shower in bHCAL
  - MC neutron momentum: $1\ \mathrm{GeV}/c$
  - (top left) All hits
  - (top right) Require hits in bECAL
  - (bottom left) Require no hits in bECAL

- $\Delta\eta = \frac{\eta_i - \bar{\eta}}{\bar{\eta}}, \bar{\eta} = \frac{\sum_i \eta_i E_i}{\sum_i E_i}$
  - Index i is for individual tiles with energy deposition E_i at η_i
  - Same method for $\Delta\phi$







ePIC simulation, [25.08.0]
Single neutron, p_{MC} = 1.0 GeV/c
Full detector
Sum of bHCAL hits

SHOWER TRANSVERSE SIZE IN bHCAL

- Transverse size of shower in bHCAL
  - MC neutron momentum: $2\ \mathrm{GeV}/c$
  - (top left) All hits
  - (top right) Require hits in bECAL
  - (bottom left) Require no hits in bECAL

- $\Delta\eta = \frac{\eta_i - \bar{\eta}}{\bar{\eta}}, \bar{\eta} = \frac{\sum_i \eta_i E_i}{\sum_i E_i}$
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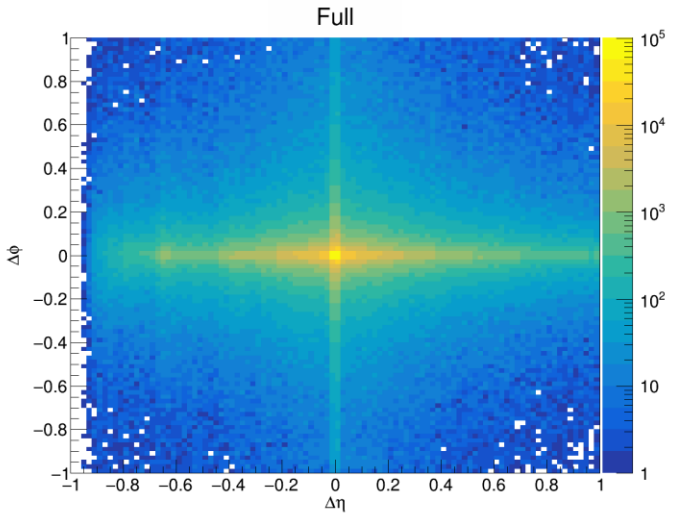

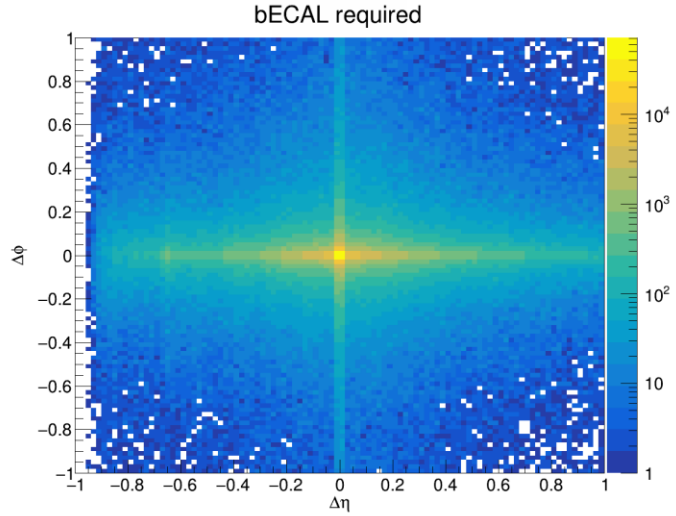

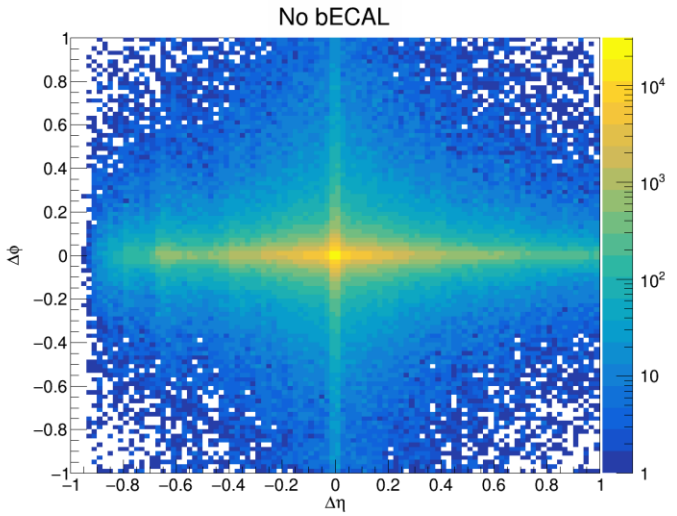

ePIC simulation, [25.08.0]
Single neutron, p_{MC} = 2.0 GeV/c
Full detector
Sum of bHCAL hits

SHOWER TRANSVERSE SIZE IN bHCAL

- Transverse size of shower in bHCAL
  - MC neutron momentum: $5\ \mathrm{GeV}/c$
  - (top left) All hits
  - (top right) Require hits in bECAL
  - (bottom left) Require no hits in bECAL

- $\Delta\eta = \frac{\eta_i - \bar{\eta}}{\bar{\eta}}, \bar{\eta} = \frac{\sum_i \eta_i E_i}{\sum_i E_i}$
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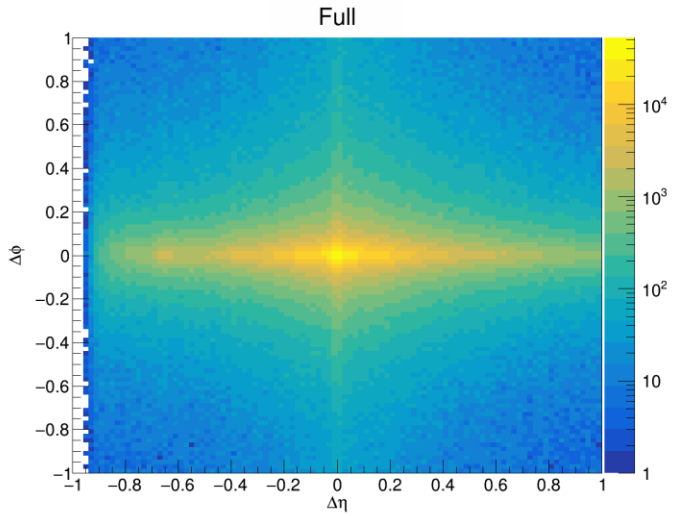
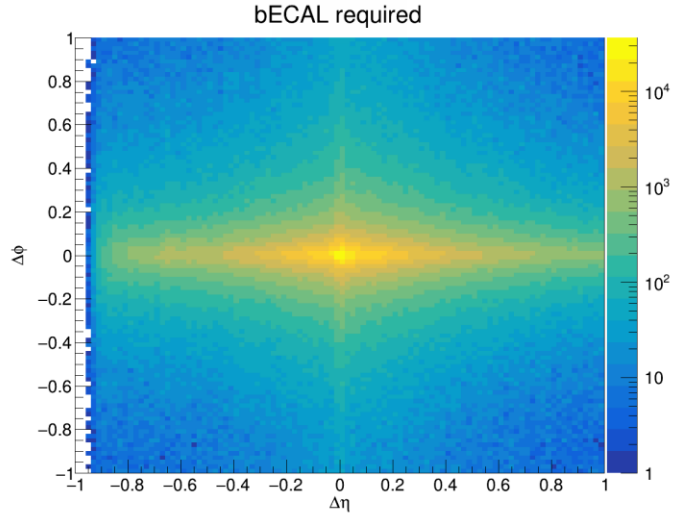
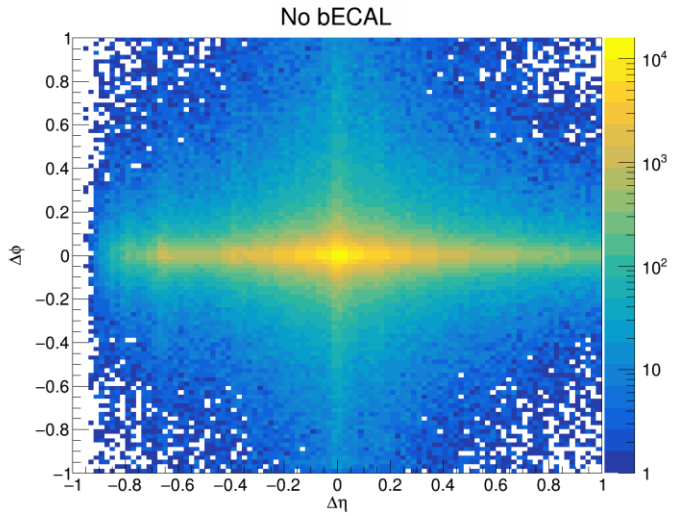


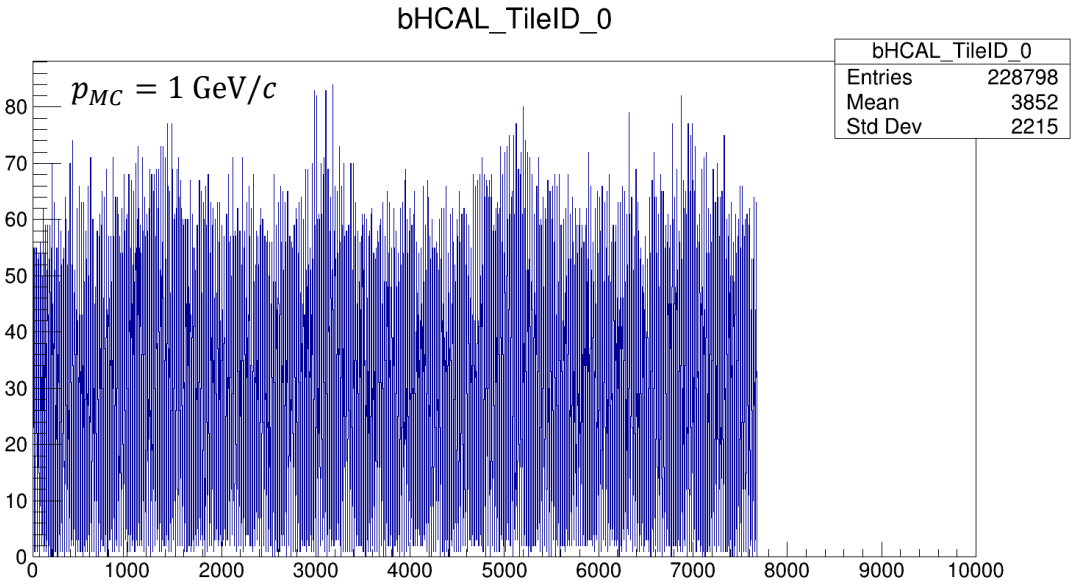


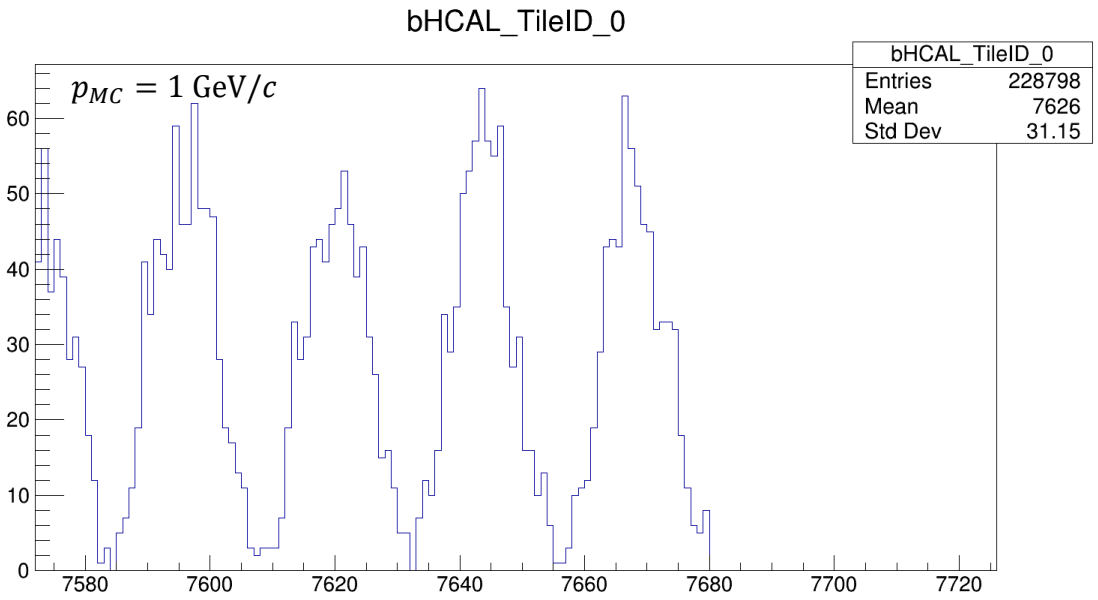


ePIC simulation, [25.08.0]
Single neutron, p_{MC} = 5.0 GeV/c
Full detector
Sum of bHCAL hits

CELL ID MAPPING IN bHCAL

- One goal is to perform manual clustering
  - Need simple tile map
- Problem: Information in EICRecon output not easily usable
  - CellIDs have some form of encoding, so they are not simply tile indices starting at 0 or 1
  - Figured out manual translation of CellID from EICRecon to custom TileID
- (top) TileIDs for bHCAL calculated from CellID in full range
- (bottom) Same, but zoomed at large TileID values
  - Mapping seems to work – maximum TileID is 7680, which is the total number of bHCAL tiles
- Individual bumps should be profiles in z (η) for one row of tiles at given ϕ





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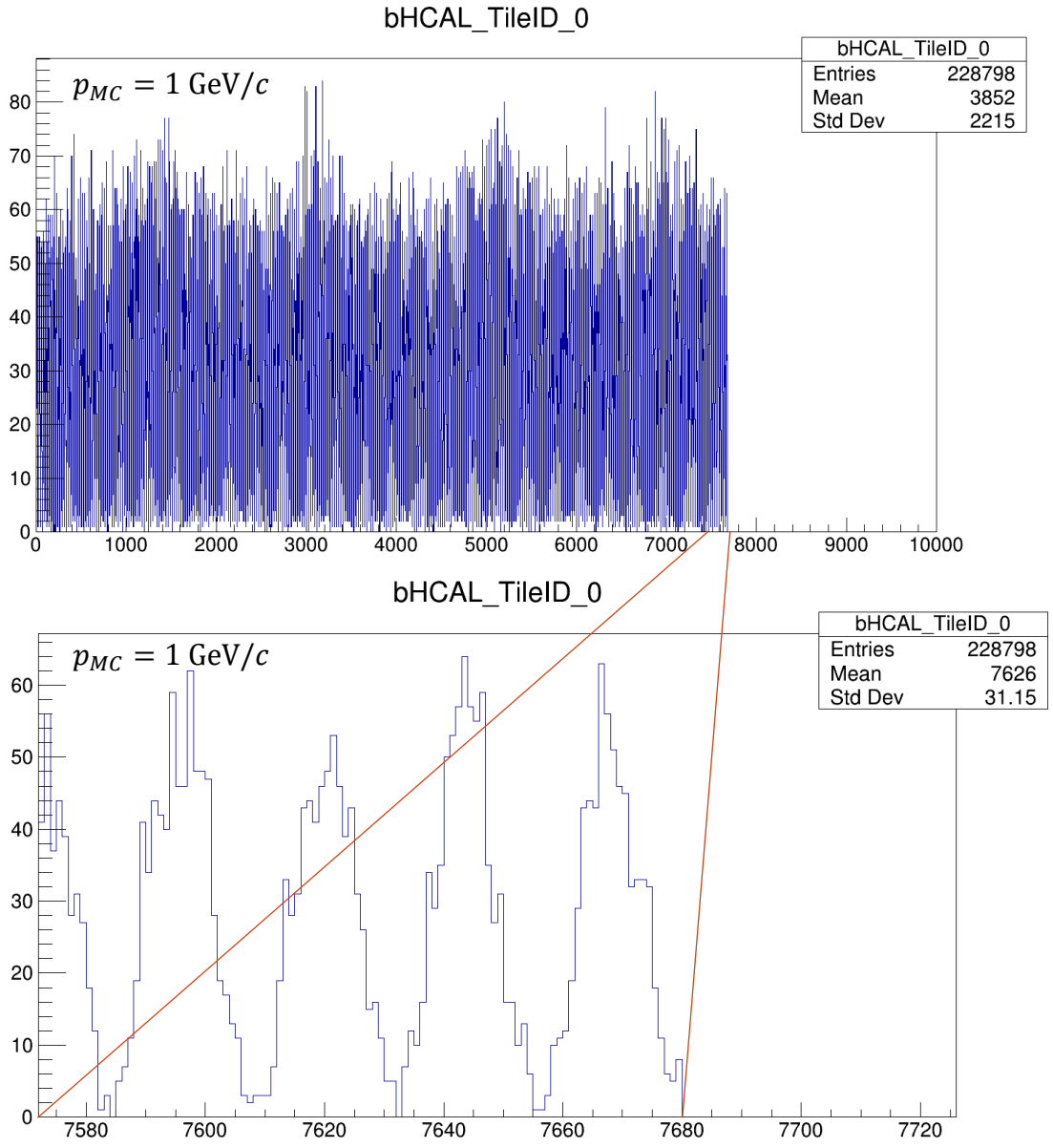

SUMMARY AND OUTLOOK

- First look at shower profile in both longitudinal and transverse direction
- Can see distinct features depending on different requirements on energy deposition in bECAL and bHCAL
  - How this can be used needs to be determined
- Have working bHCAL tile mapping that can be used for manual clustering

- Outlook:
  - Cross-check of TileID mapping
  - Continue with this study in more detail
    - First layer with signal in bECAL
    - Relationship between first layer in bECAL and cluster size in bHCAL
    - Manual clustering in bHCAL
      - Use transverse cluster size information event-by-event