Particle Separation with PandoraPFA in the AHCAL

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CALICE Collaboration Meeting Everywhere

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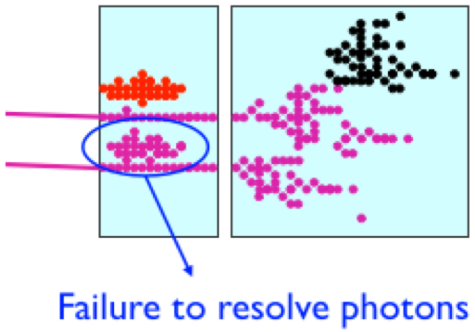
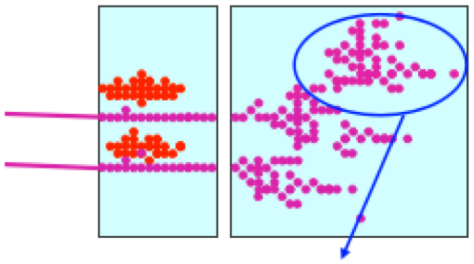
Particle Separation Study with TB Data

- Study particle separation performance with large prototype data
  - Track : information from wire chambers
  - Neutral event : initial track removal
  - Two-particle event : event merging

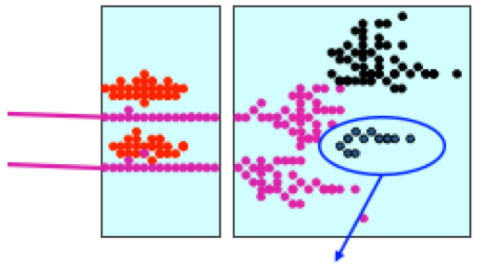
- AHCAL standalone performance
- Compare with GEANT4 to validate simulation



Failure to resolve photons



Failure to resolve neutral hadrons



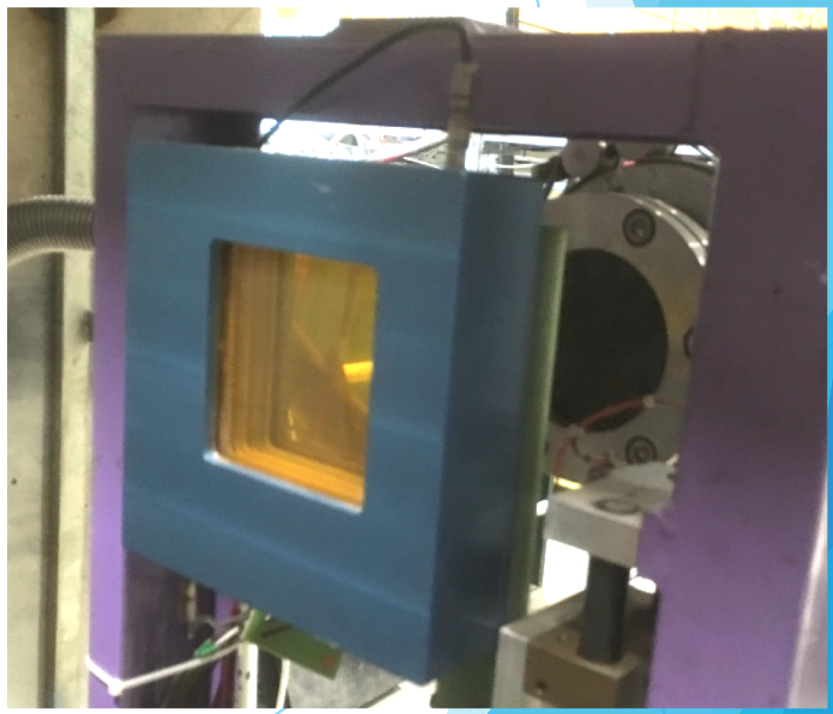
Reconstruct fragments as separate neutral hadrons

C13-04-22.4, p.305-315

Delay Wire Chamber

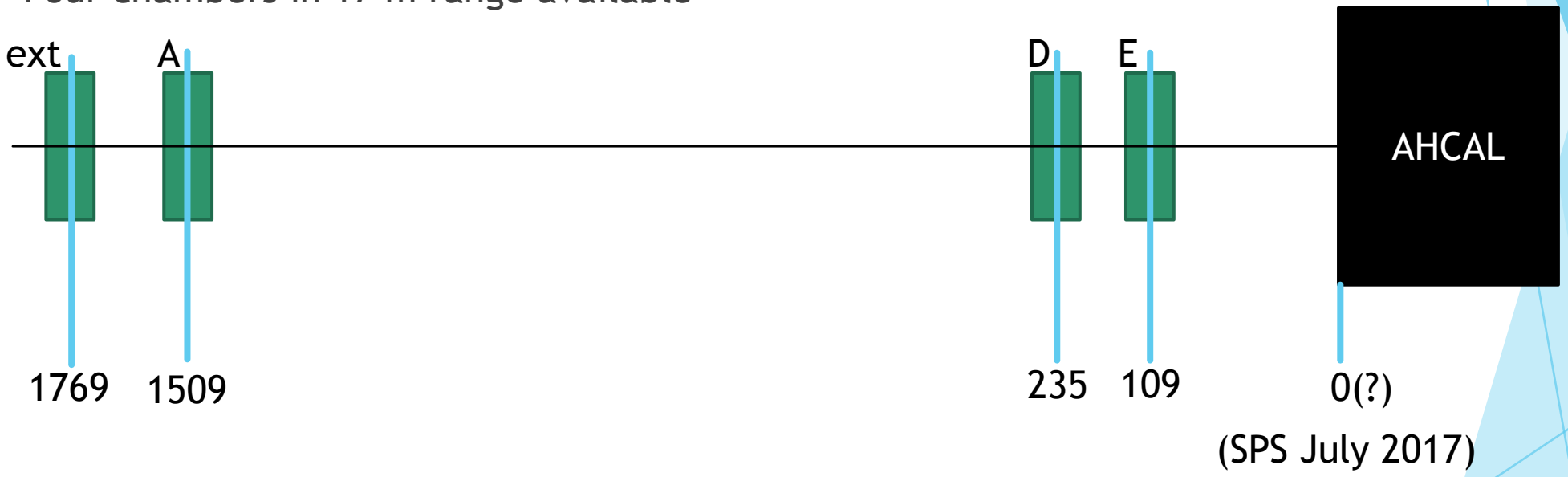
- For beam tracking, we had four wire chambers in front of the detector

- 100 x 100 mm^2 chamber with wire readout
- Hit position is readout as TDC
- Four channels for each chamber: up, down, left, right
- Hit position is reconstructed as
  - x = (left – right) * slope + offset
  - y = (down – up) * slope + offset
- Position resolution of ~600 um



Delay Wire Chamber Geometry

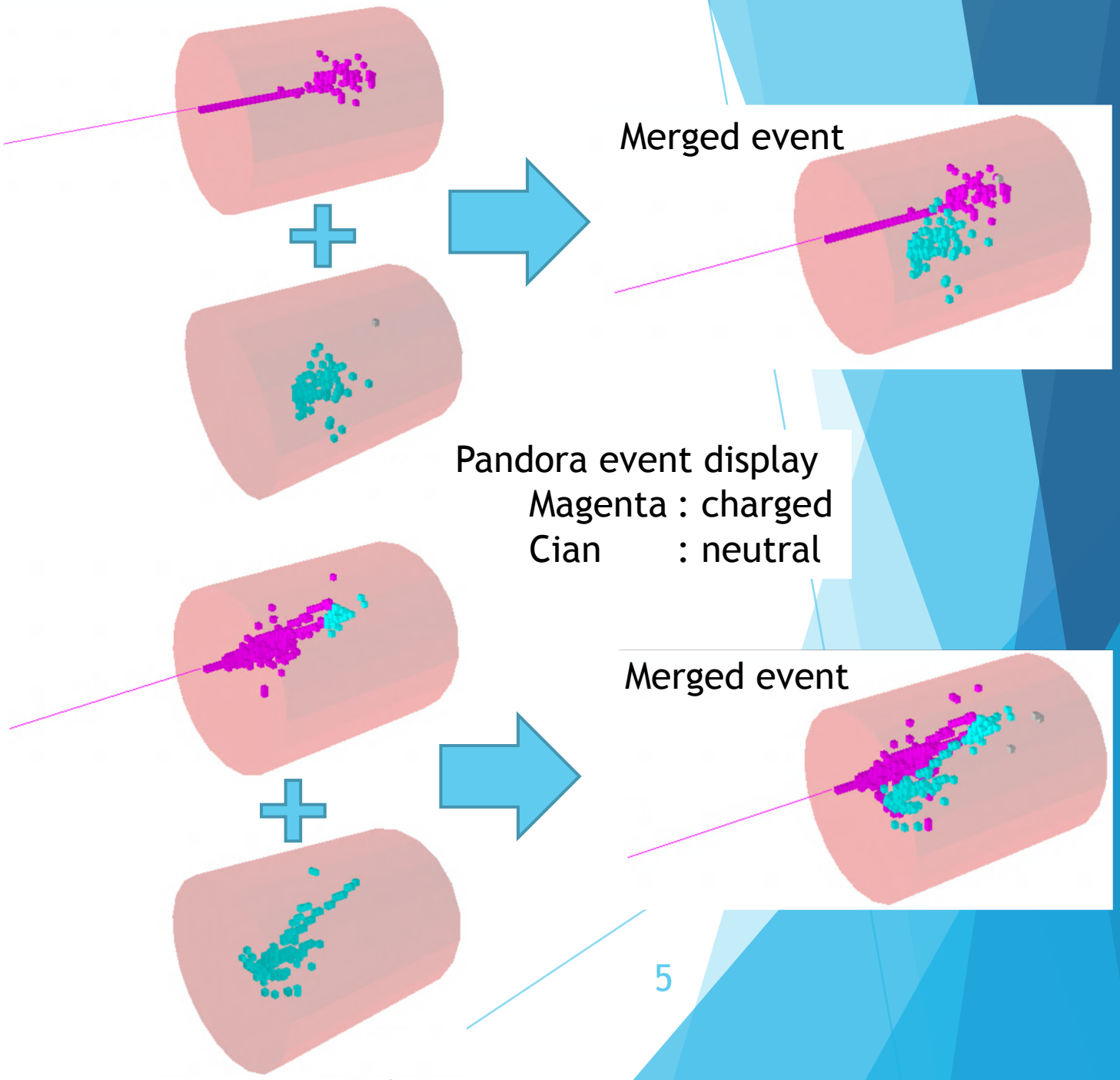
- Four chambers in 17 m range available



- Expecting sub mm position resolution at AHCAL
- Calibrated x and y positions of chambers using 160 GeV pion beam

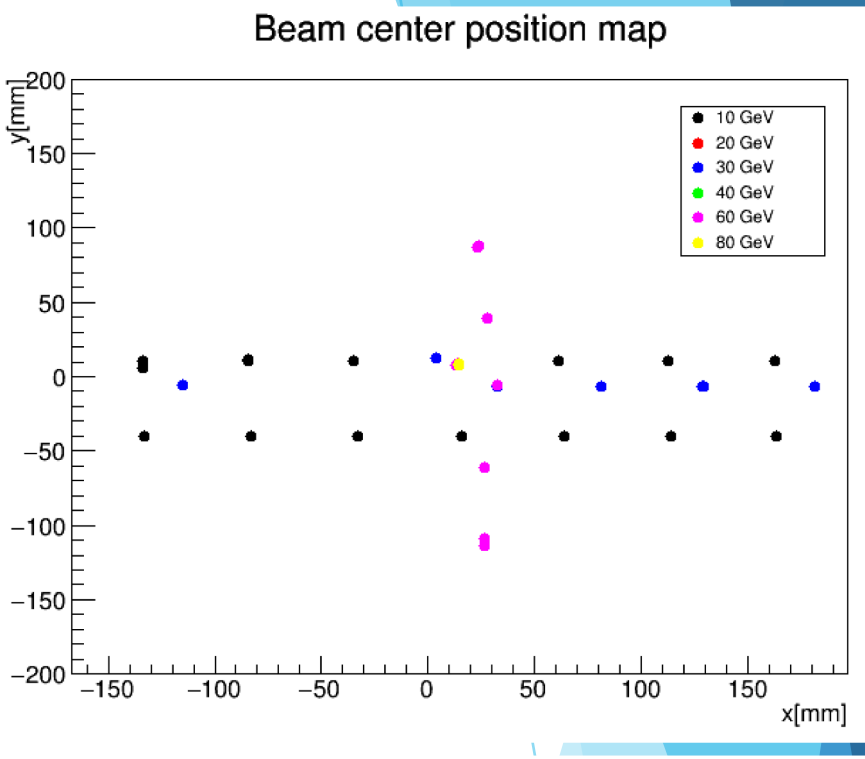
Shower Merging

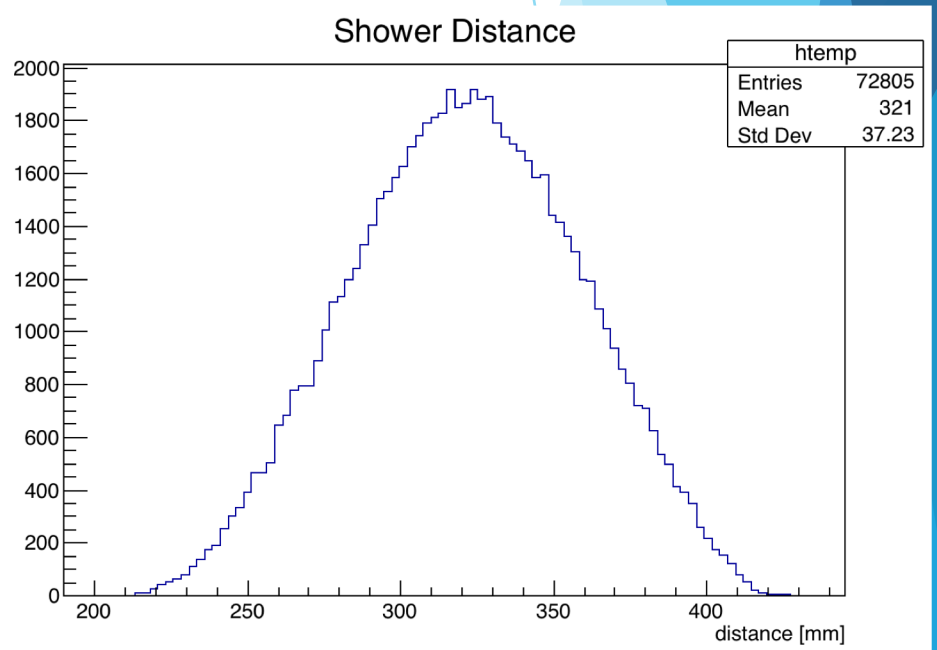
- Existing overlaying processor
  - Aims to overlay BG events
  - Randomly pick BG event to overlay
  - Overwrite existing collection
- New features required
  - Event position shifter
  - Keep original collections
  - Each hit stores information which shower they came from
  - 0.5 MIP applied after merging



Particle Separation

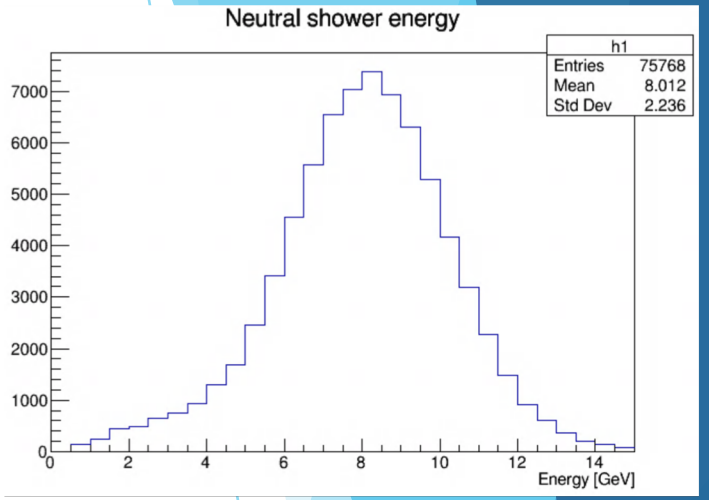
- 10 GeV (pseudo-)neutral shower reconstruction
  - Alone
  - Next to 30 GeV charged hadron
- Event merger : used existing one
  - No shifter, no afterwards threshold
  - Picked two events with distant center positions
  - Shower distance vary from event to event
  - Took mean distance as representative

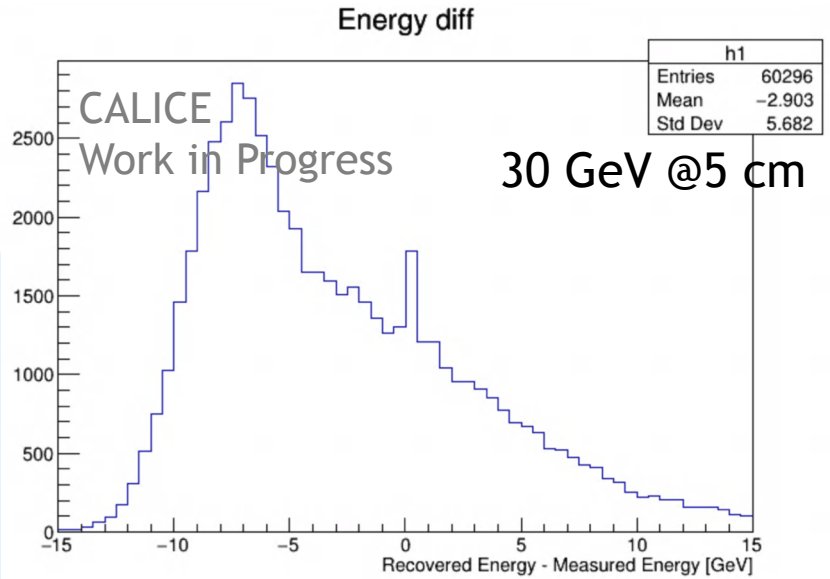


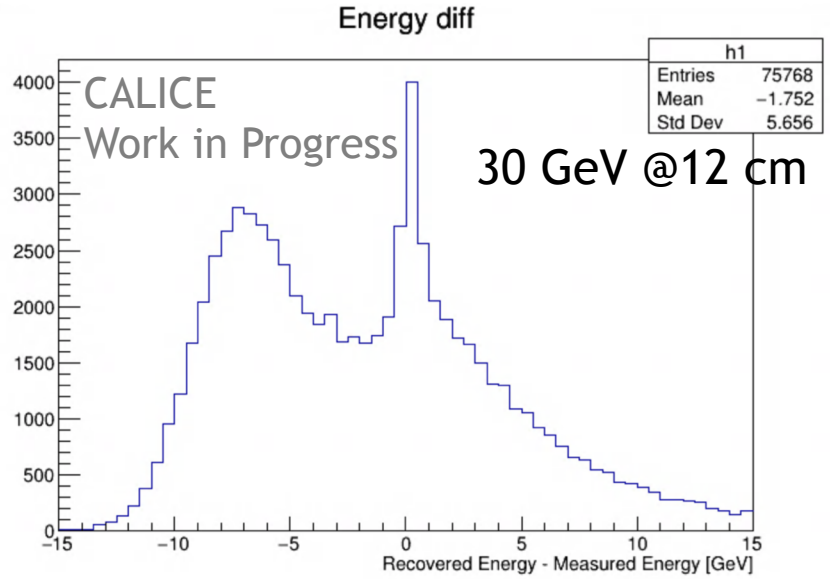


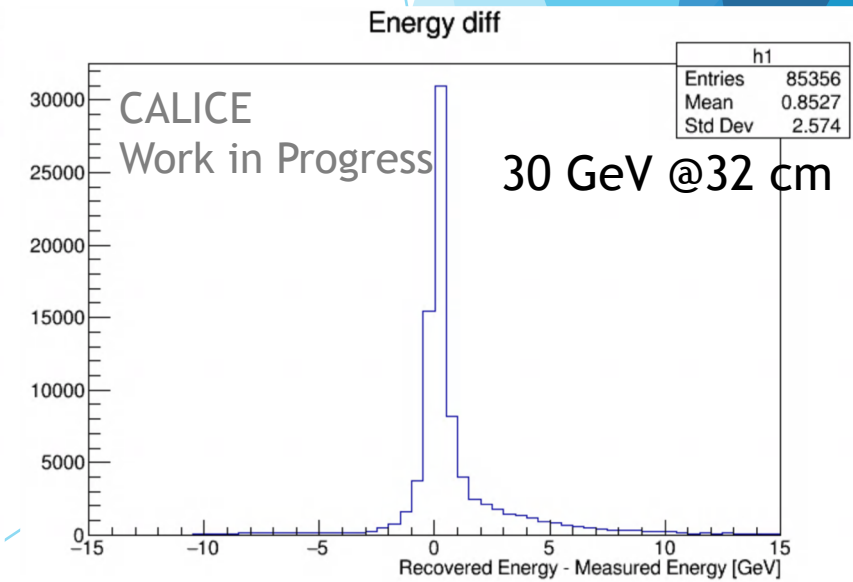
Energy Correction Errors

- (Energy reconstructed beside charged hadron) – (Energy reconstructed alone) measured for different distances
- Typical bump around -7 GeV
  - Events where most of hits in neutral shower classified to charged
    - Peak of neutral shower energy is @7-8 GeV



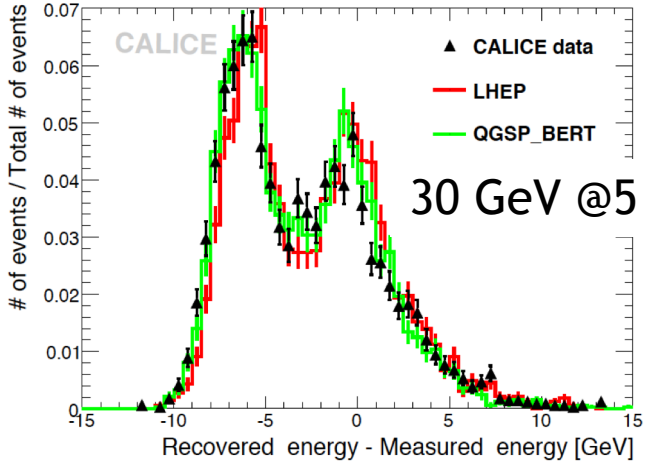




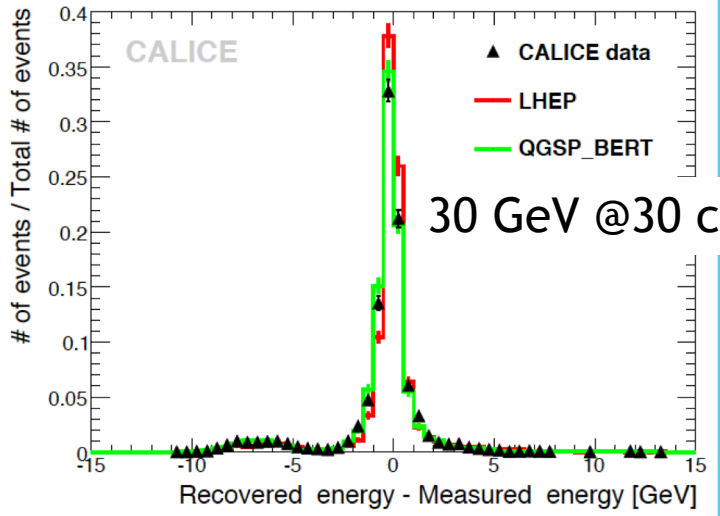


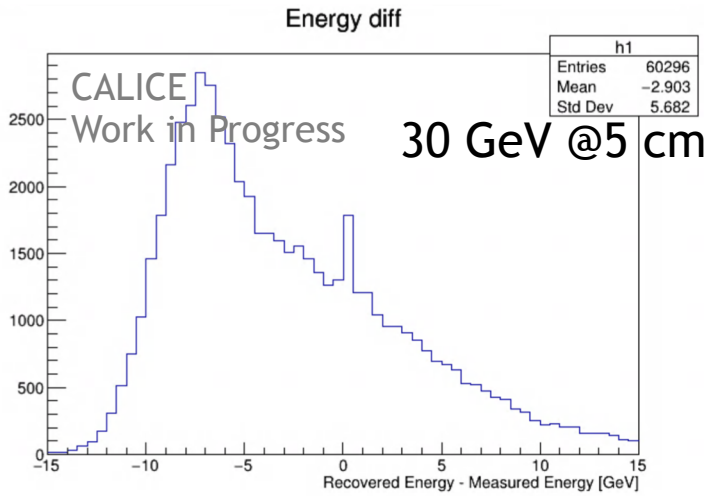
Comparison to Previous Study

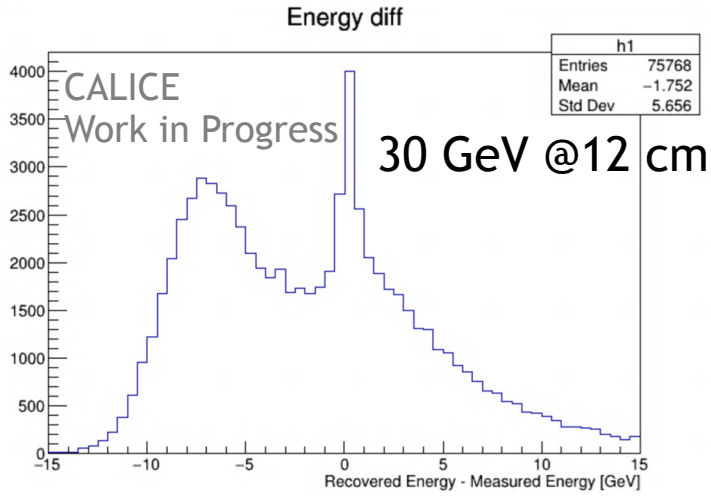
Previous prototype study JINST 6 P07005

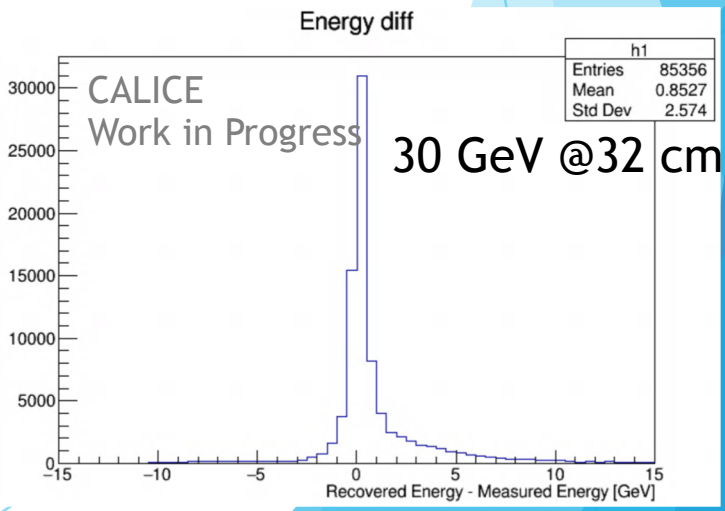


- Wider tail
- Larger confusion
  -> need further optimization of clustering parameters

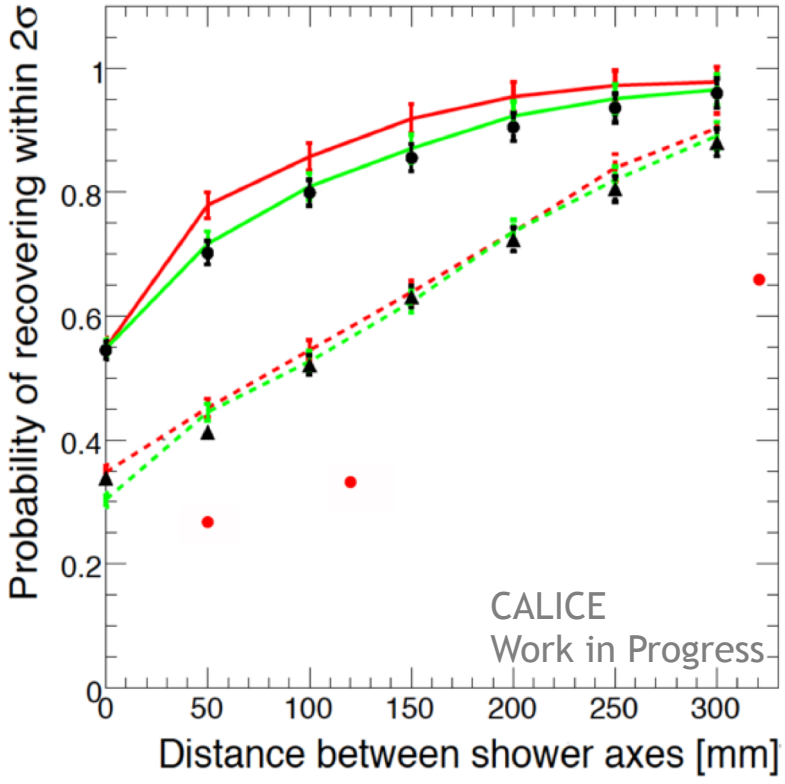


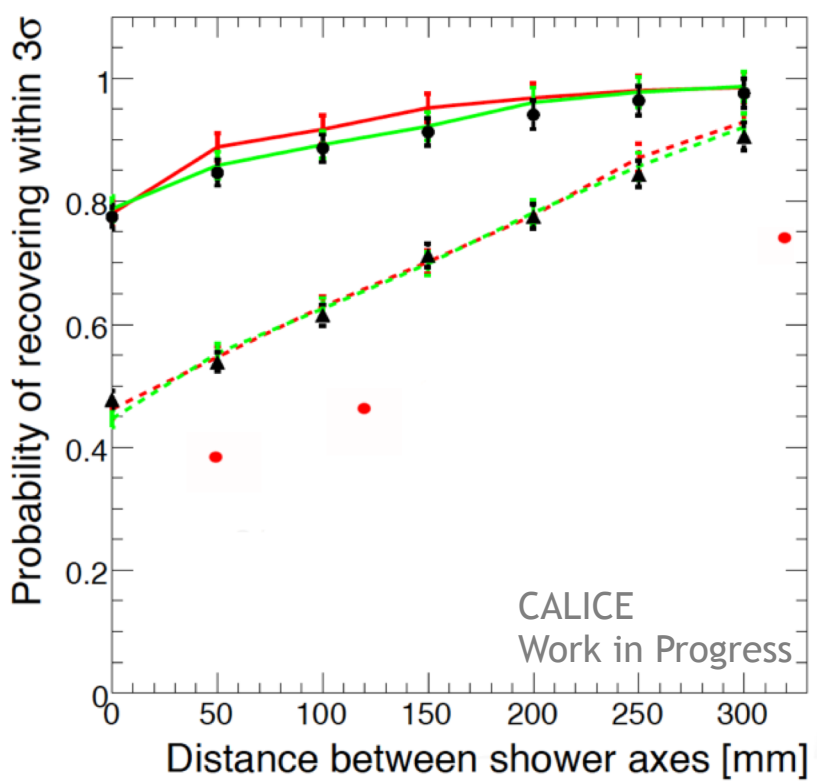






Separation Efficiency





Physics prototype

10-GeV track	30-GeV track
CALICE data	CALICE data
LHEP	LHEP
QGSP_BERT	QGSP_BERT

- 30-GeV track data

Summary

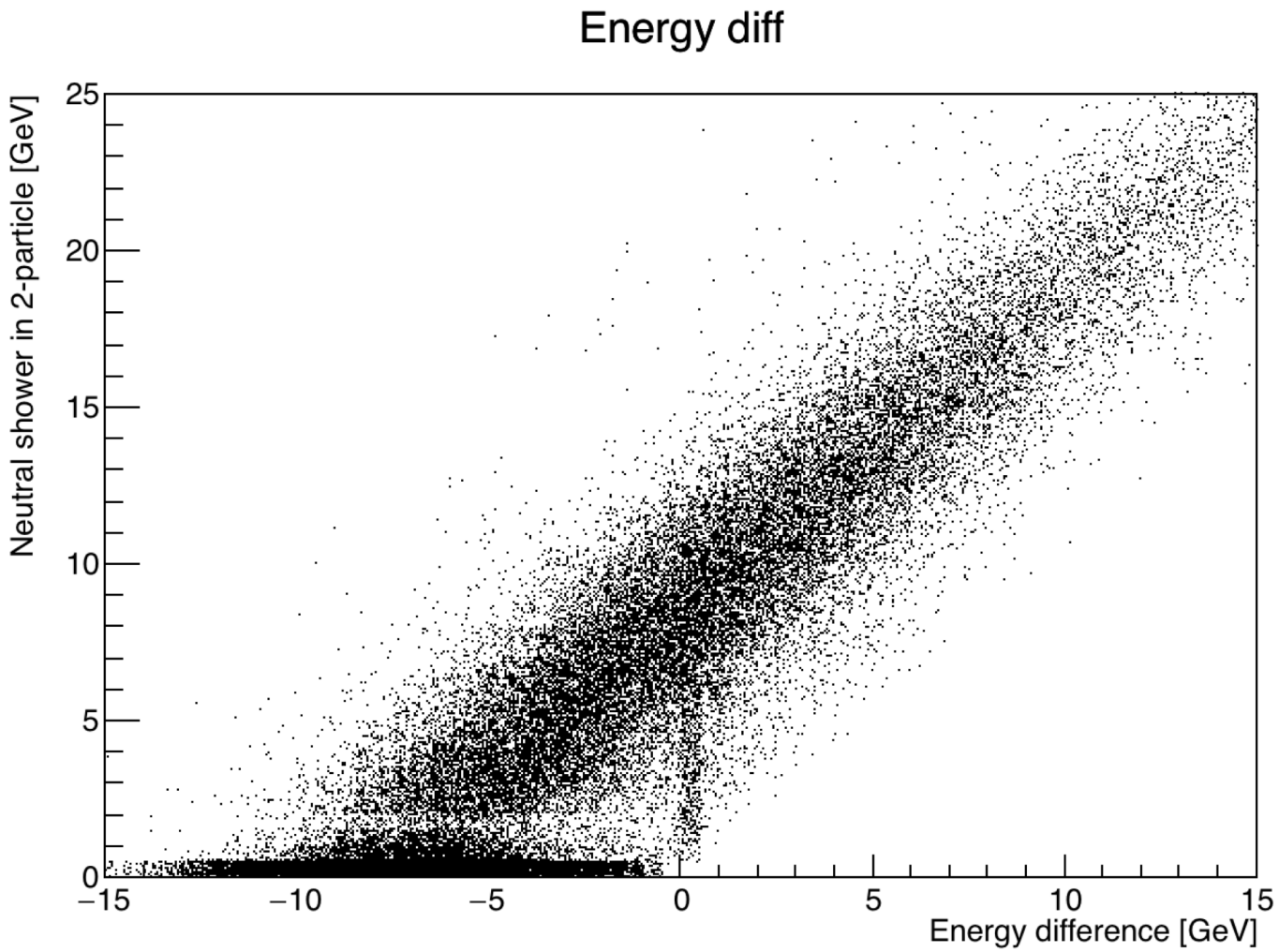
- Performance of particle separation is crucial for the Particle Flow Algorithm
- Tools for sample event creation has almost been done
  - Algorithm to generate pseudo-neutral particle by removing the initial track from charged shower is developed
  - Overlaying two showers and adding track information are almost done
- PFA studies ongoing
  - Shower profile study with one particle events
  - Particle separation study with merged charged+neutral showers
    - Preliminary study on energy reconstruction for overlaid particle
    - Not yet reaching the previous results
      - Proper event selection, careful calibration and optimization
      - Study with simulated data in pararrel

Prospects

- Separation study with various conditions
  - Energy reconstruction, separation efficiency
  - Shower energy, distance, depth
- Validation of GEANT4 simulation
- Simulation study with full detector setup : Vertex, Tracking, ECAL, HCAL …
  - Two hadron separation
  - Photon + Hadron separation (ECAL + HCAL combined)
- Further improvement of the clustering algorithm to be done

Backup

7 GeV Bump


Energy diff
Neutral shower in 2-particle [GeV]
25
20
15
10
5
0
−15
−10
−5
0
5
10
15
Energy difference [GeV]