Updates to the ECAL endcaps geometry

Alessandro Ruggeri

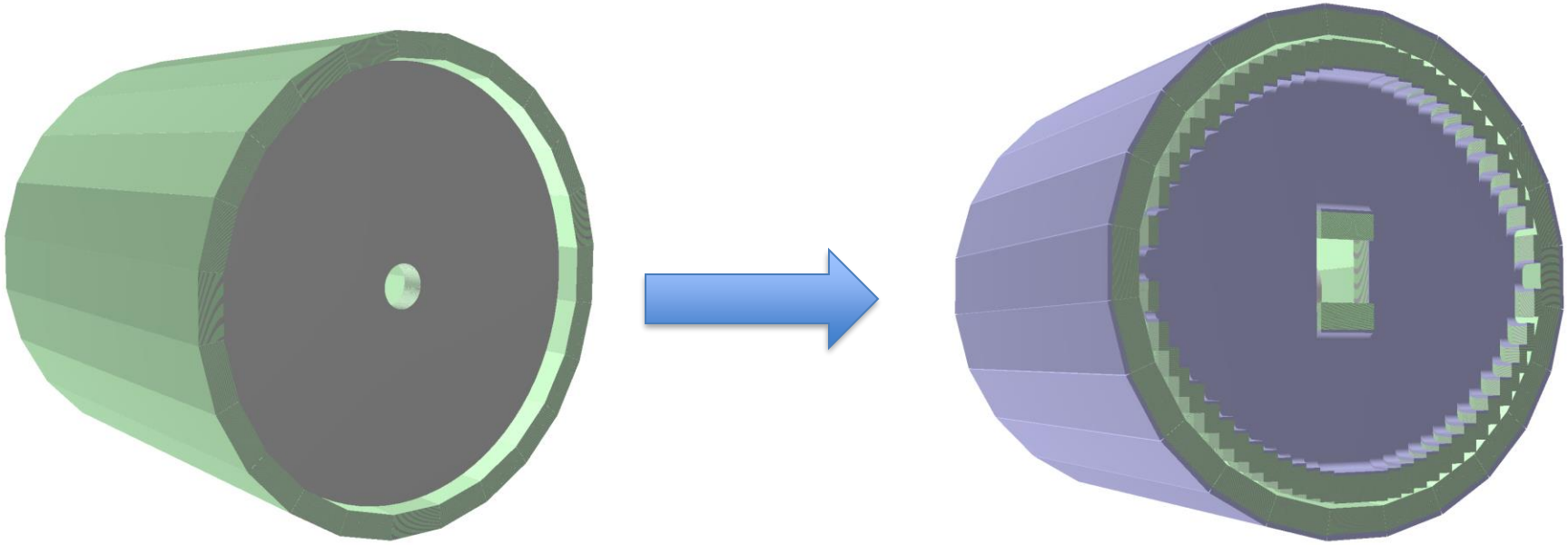
DUNE-Italia Collaboration Meeting, Ferrara

29/10/2024

INFN BOLOGNA
Istituto Nazionale di Fisica Nucleare
Sezione di Bologna

Updated endcap geometry

- Realistic geometry implemented by Paolo Gauzzi in dunendggd branch-18.
- Old geometry: disk-shaped endcaps with “virtual” modules
- New geometry: fully modelled endcap models and Al back-plates



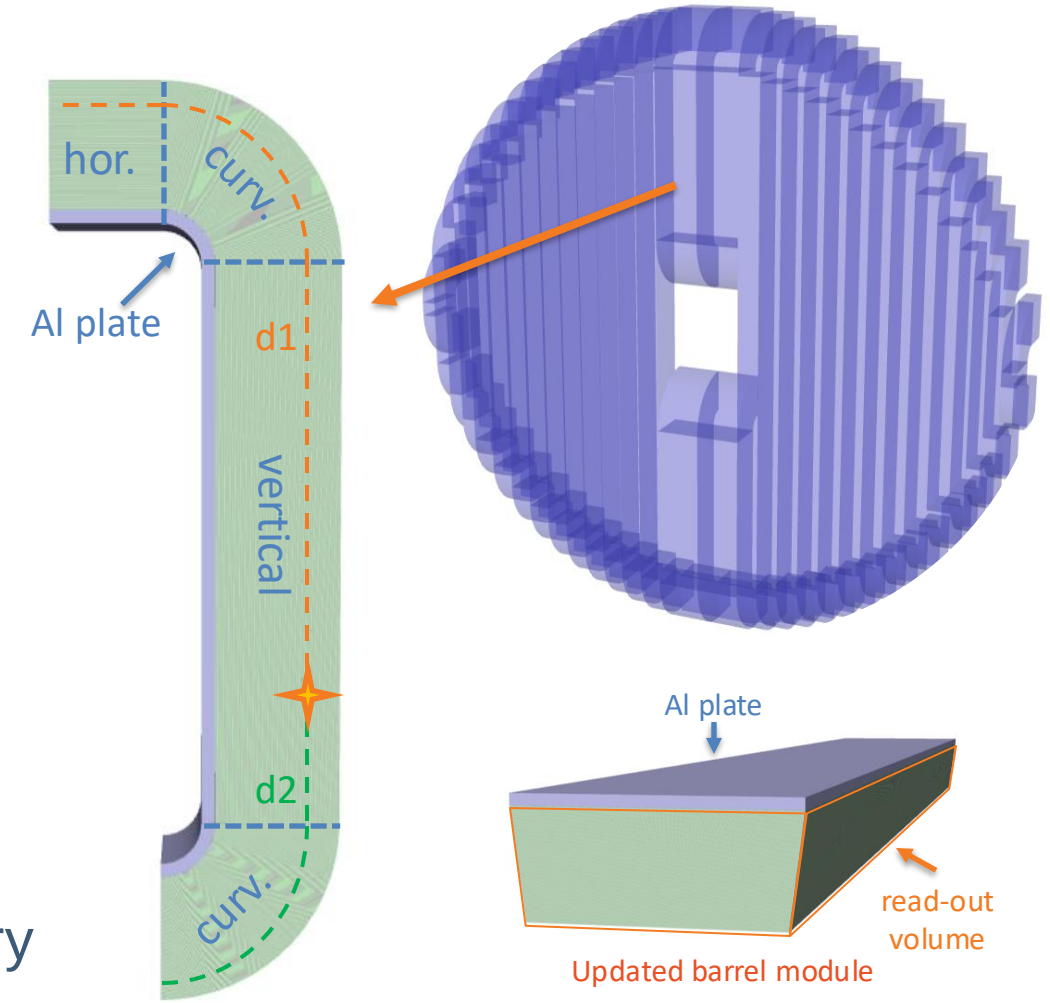
INFN BOLOGNA
Istituto Nazionale di Fisica Nucleare
Sezione di Bologna

DUNE

Updates to digitization

- New endcap modules:
  - composed of multiple sections
  - varying length and shape
  - Aluminium back-plate

- Cell finding and indexing in SANDGeoManager
- Path length to PMT (d1, d2) computation depends on the module geometry
- Hit reconstruction from TDCs in the new geometry



INFN BOLOGNA
Istituto Nazionale di Fisica Nucleare
Sezione di Bologna

DUNE

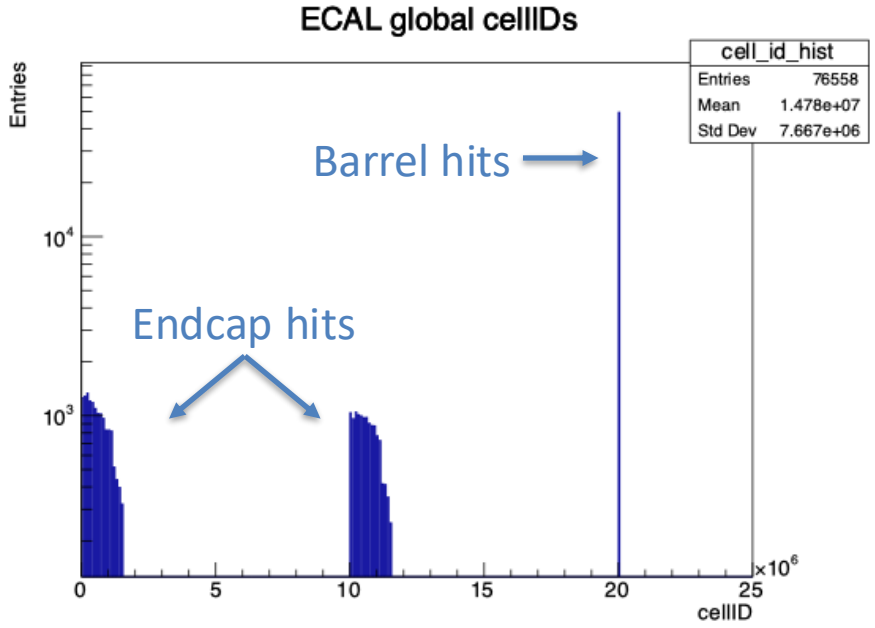
SANDGeoManager

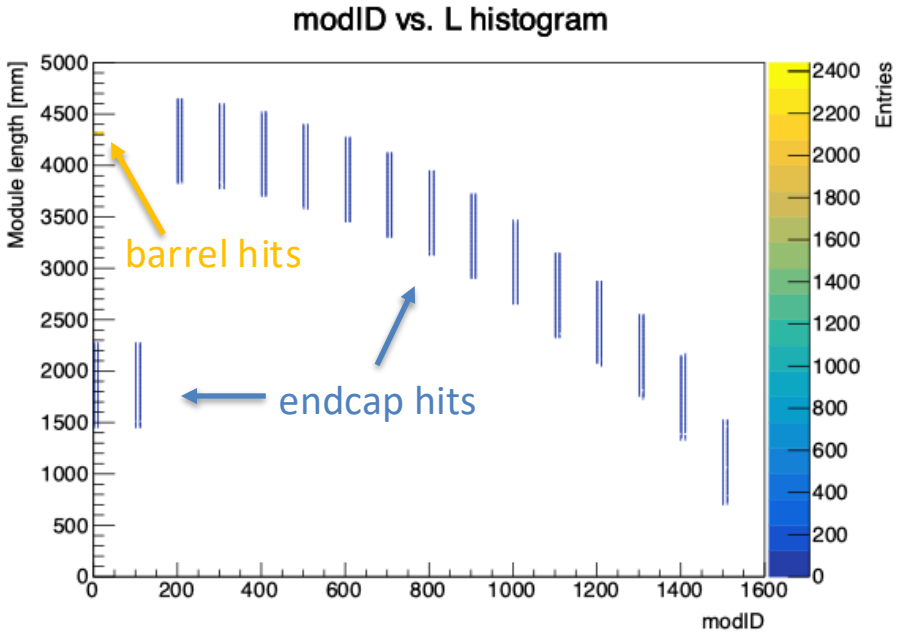
- Management of the SAND ECAL and tracker geometries
- Extracts relevant quantities of cells and tubes from the TGeoManager object:
  - encoding and decoding of IDs
  - positions, dimensions, etc…
- Accepts drift-chamber geometries thanks to V. Pia and G. Ingratta

- Modified ECAL manager and added new class to manage endcap cells
- ECAL cells path length computation and hit reconstruction
- Currently working on sandreco branch-20 → `20-update-sandgeomanager-for-the-ecal-endcap-modules`

Digitization checks

- sandreco digitization runs again from beginning to end
- Checked the new indexing and extraction of cell info
- Next step: hit position reconstruction from photo-signals





INFN BOLOGNA
Istituto Nazionale di Fisica Nucleare
Sezione di Bologna

DUNE

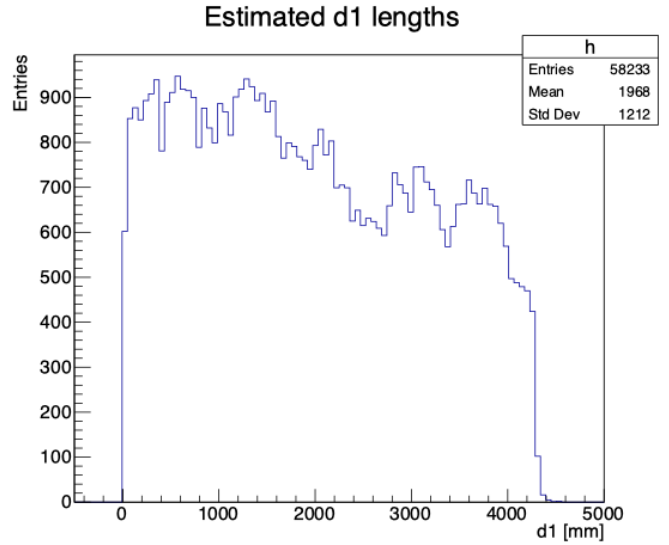
Hit position reconstruction

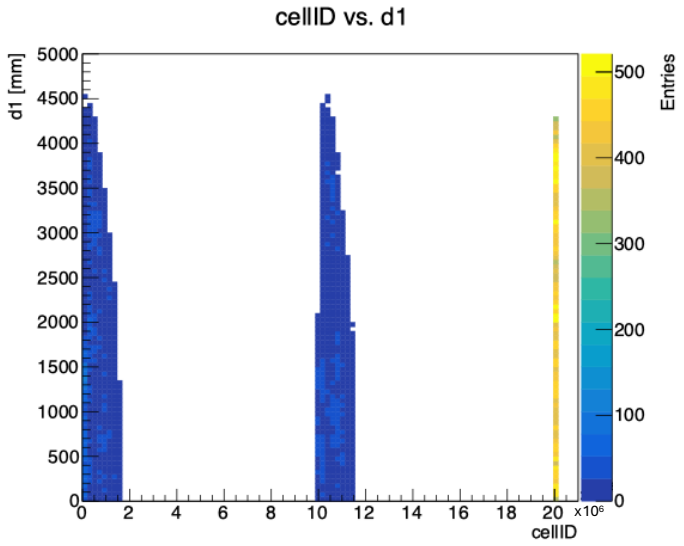
- Path length to a PMT given signal TDCs at both ends:

$$d_1 \simeq \frac{1}{2}(l_{cell} + v_{prop} \cdot \Delta_{TDC})$$

- Physical constraints: $0 < d1 < l_{cell}$
- Transversal coordinates are set as the cell centre

- Reconstructed hit position from d_1 given the cell geometry:
  1. Local coordinates corresponding to d_1
  2. Conversion to global coordinates



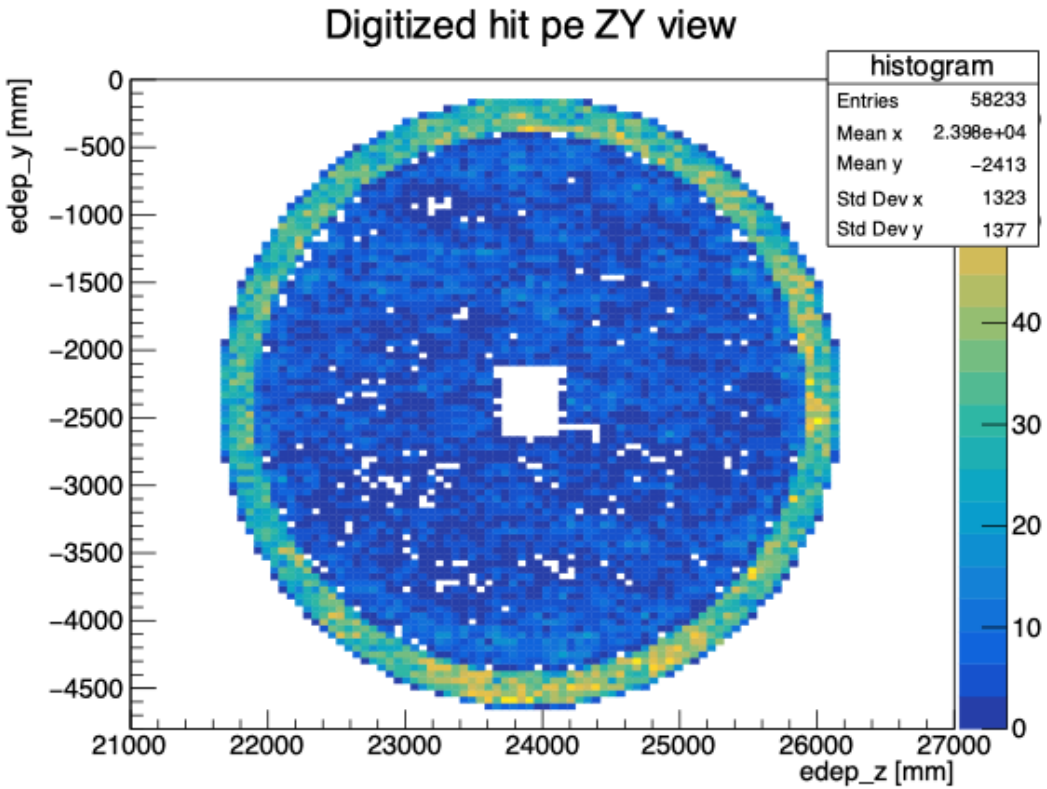


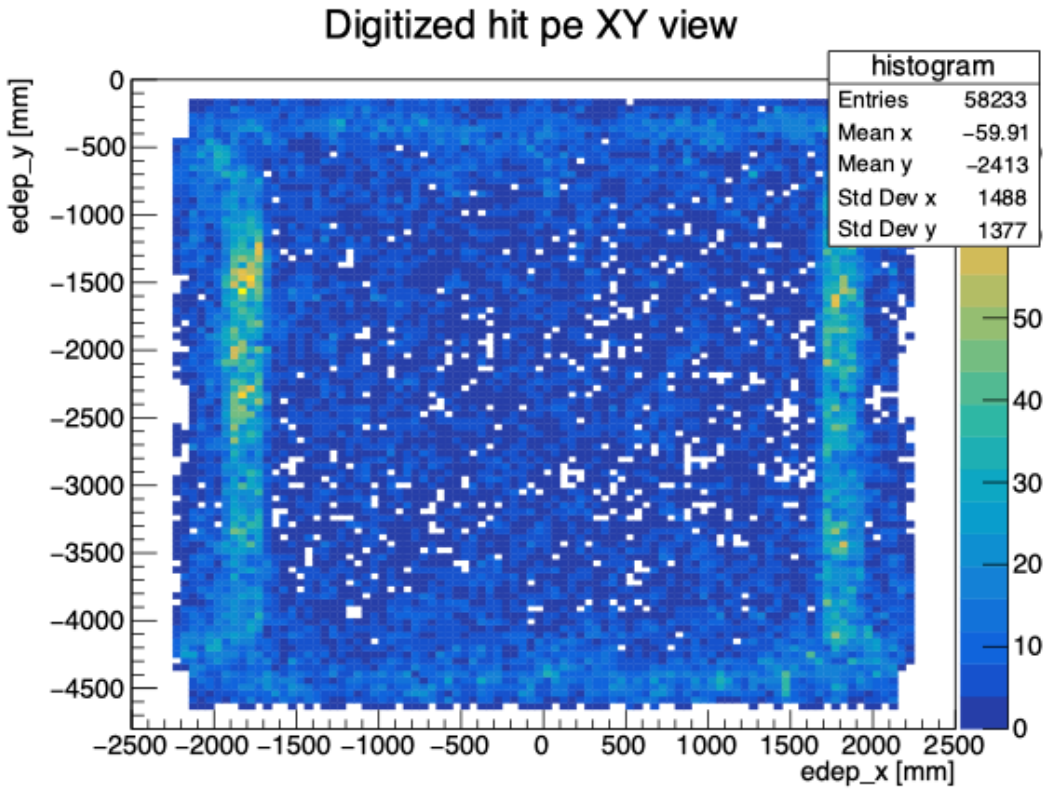
INFN BOLOGNA
Istituto Nazionale di Fisica Nucleare
Sezione di Bologna

DUNE

edepsim hit distribution

- Hits corresponding to the first available photo-electron in a pair of photo-signals.

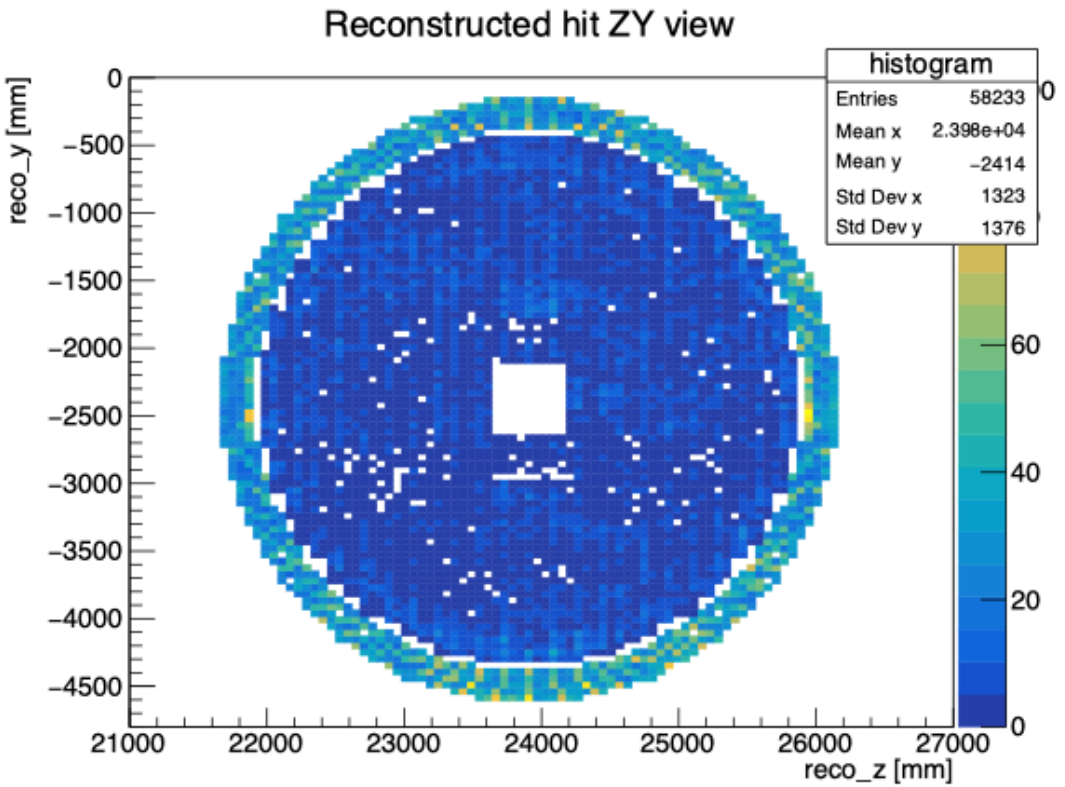


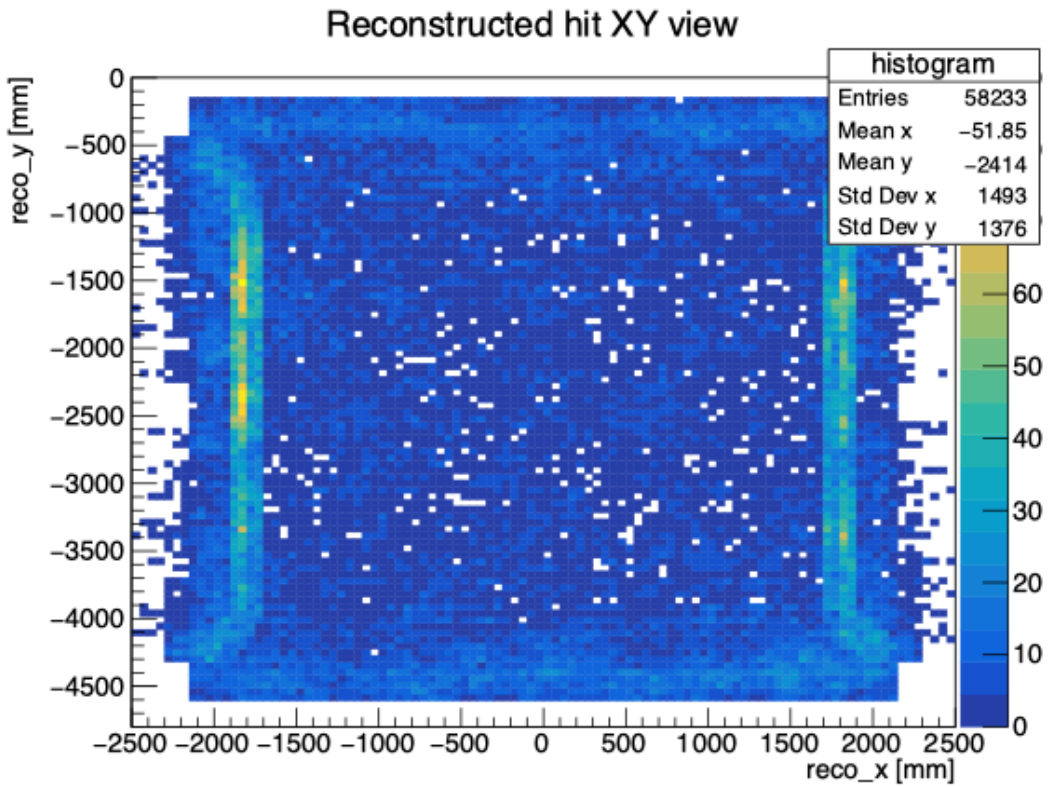


Istituto Nazionale di Fisica Nucleare Sezione di Bologna

Hit reconstruction

- Considering all photo-signal pairs in a cell → potential spurious matches

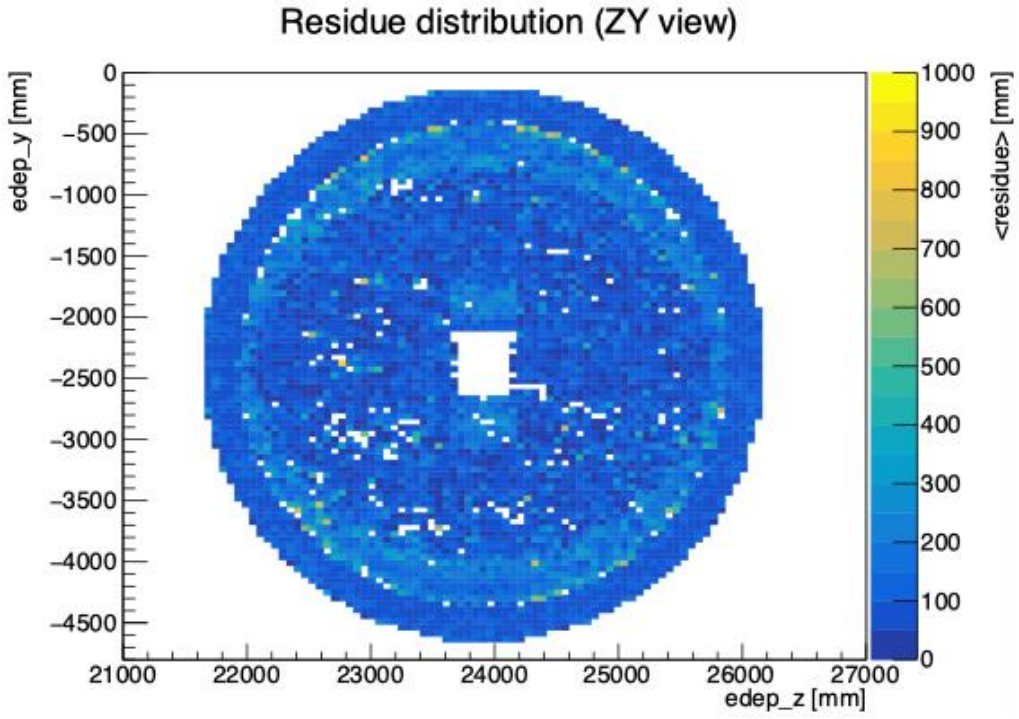


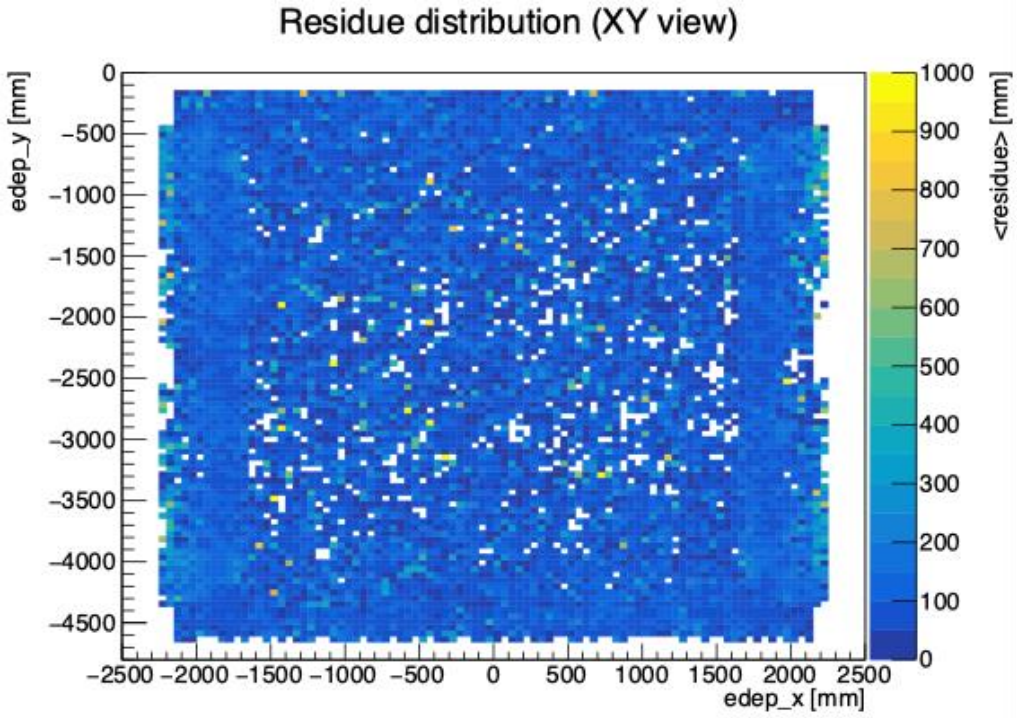


Istituto Nazionale di Fisica Nucleare Sezione di Bologna

Spatial distribution of the residues

- Average residue for each bin in edepsim-hit coordinates
- Reconstructed positions are consistent with edepsim once d_1 is constrained.



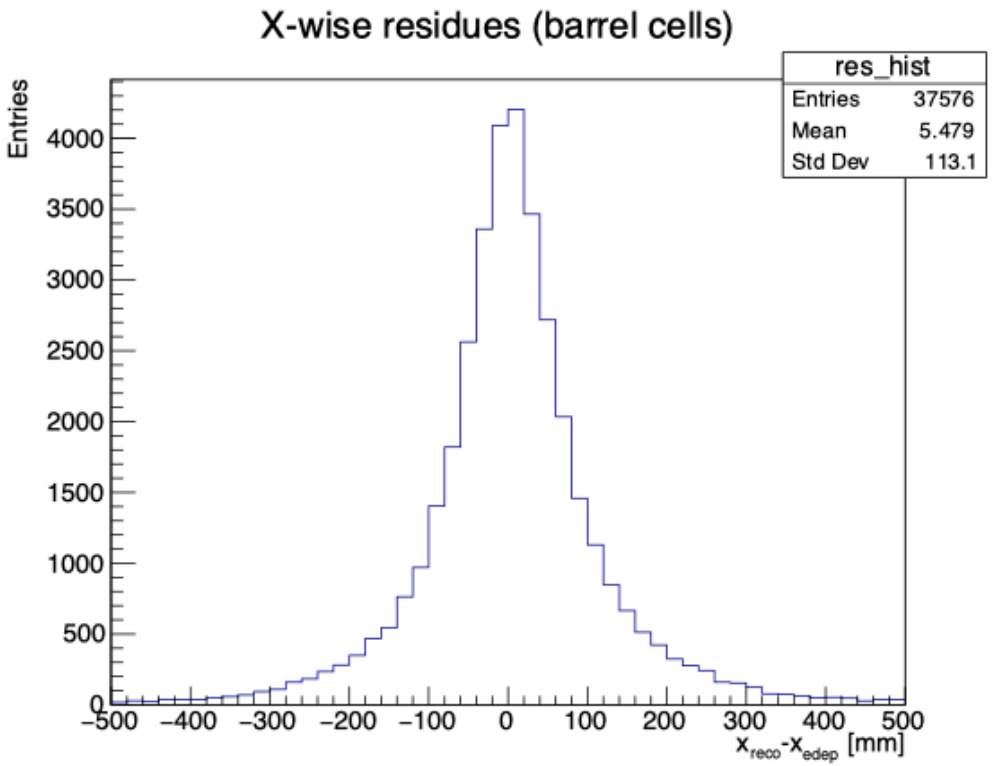


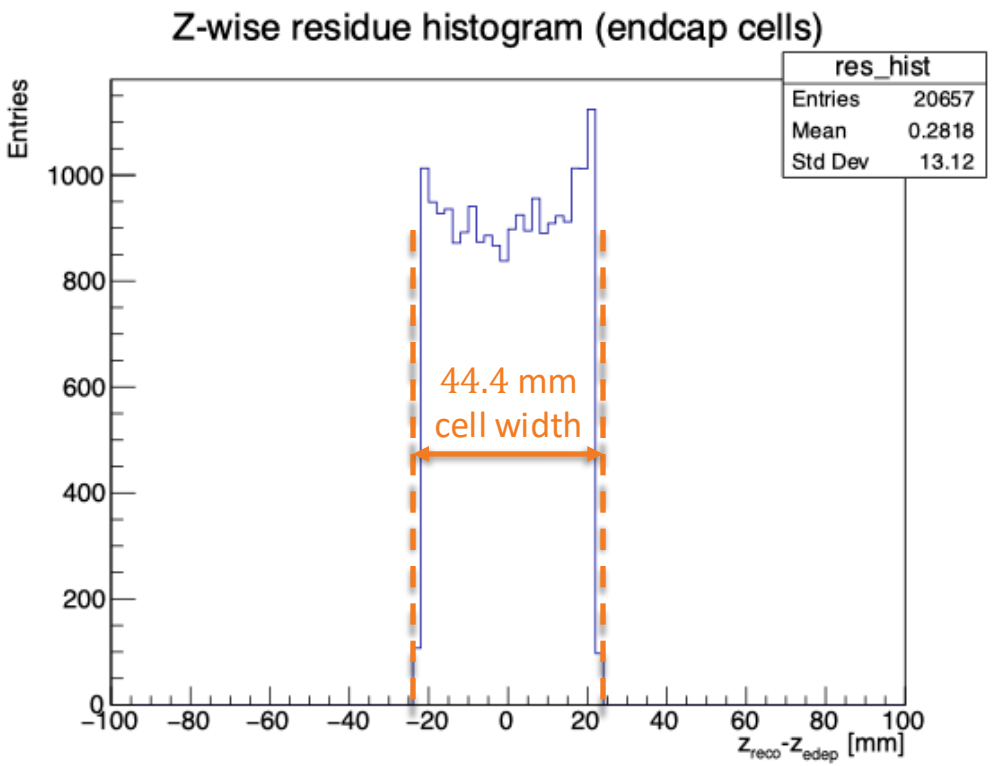
INFN BOLOGNA
Istituto Nazionale di Fisica Nucleare
Sezione di Bologna

DUNE

Direction-wise residues

- Direction-wise residues are consistent with the cell directions in barrel and endcaps





Conclusions and prospects

- In dunendggd: increased the size of the magnetized volume for ROOT node finding algorithm to work with the new endcap modules
  - resulting overlaps must be solved before merging branch-18
  - update strategy is to be decided

- In sandreco: merge with develop branch in the near future:
  - updated scintillation decay time
  - SANDGeoManager for drift-chamber geometries
- Waiting for a defined merge strategy for ECAL digitization