3-Dimensional reconstruction in DUNE

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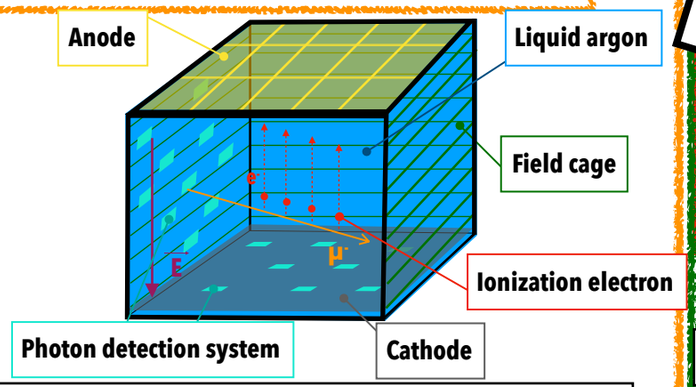
on behalf of the DUNE collaboration

2-view option for DUNE's Liquid argon TPC

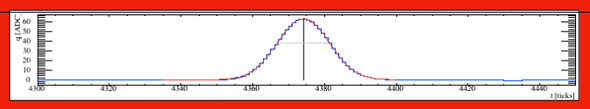


Charged particles pass through the argon **generating ionization electrons**. Electrons drift upwards vertically thanks to an electric field created by an anode and a cathode. Ionization signal is collected at the anode on **2 perpendicular readout views**. Scintillation light is collected by photomultipliers located on the cathode and the field cage.

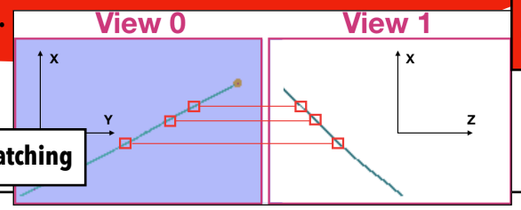
Pandora - A multi-algorithm reconstruction framework

INPUT

Charge vs Time » Pulse from one channel of one view → **One hit**



Prior to Pandora, the ionization signal is reconstructed into the so-called « hits ». **The (2D) hits collection of the event is the input of Pandora.**



2 - View-matching

Matching across the two views clusters coming from the same particle comparing clusters':

- **Topologies**
- **Collection times**
- **Charge content**

➡ **Creation of 3D clusters made of 3D hits.**

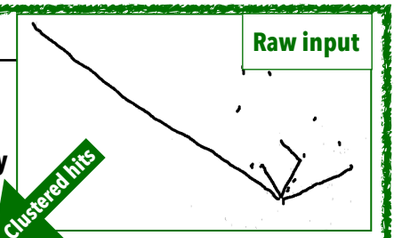
4 fundamental stages

1 - Clustering

Gathering together hits that belong to the same particle looking at:

- **Nearest neighbor**
- **Hits alignement and directionality**

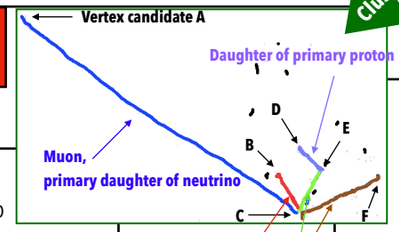
Two types of clusters can be formed: **Tracks** or **showers**



3 -Vertexing

Origin of each tracks – in this example corresponding to the location of the neutrino interaction.

➡ **Series of topological arguments depending on the nature of the events**: For neutrino events all tracks should point towards the vertex, for cosmic rays the vertex is the highest 3D hit of the track.



More details @arxiv:1708.03135

4 - Particle hierarchy

The particle hierarchy is the **genealogy of the event**. A Michel electron would be the daughter particle from the primary muon. Here the neutrino is the parent particle and its **primary daughters are determined as the tracks that emerge from the vertex**.

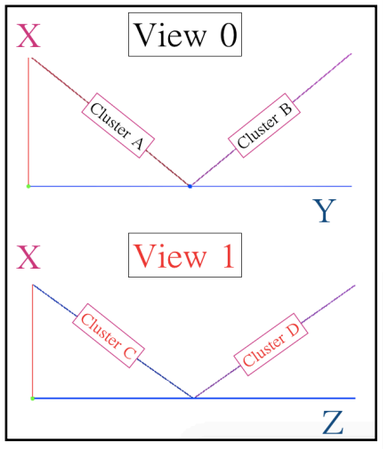
Focus on the view-matching step -> Calorimetric-matching algorithm

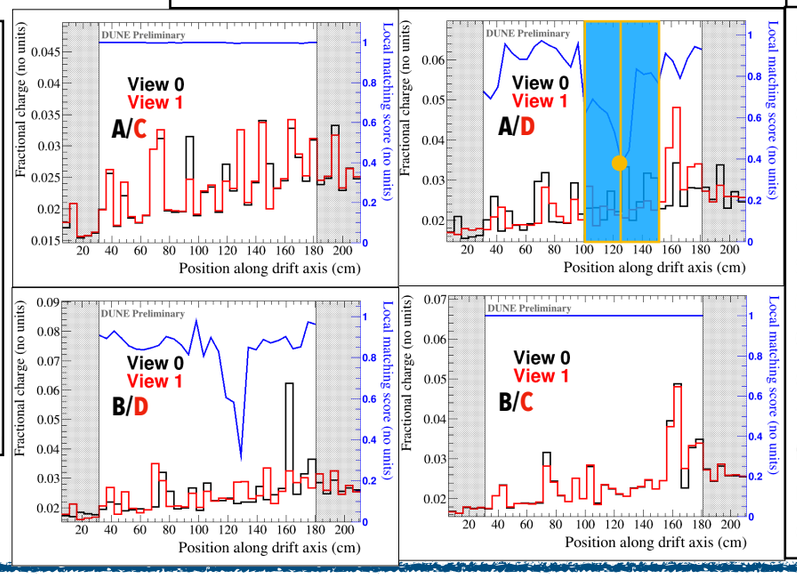
Principle

Here **two muons** are **simulated** with **symmetrical** directions.

✗ **Indistinguishable geometrically!**

➡ *Only charge information can help disentangle the situation!*



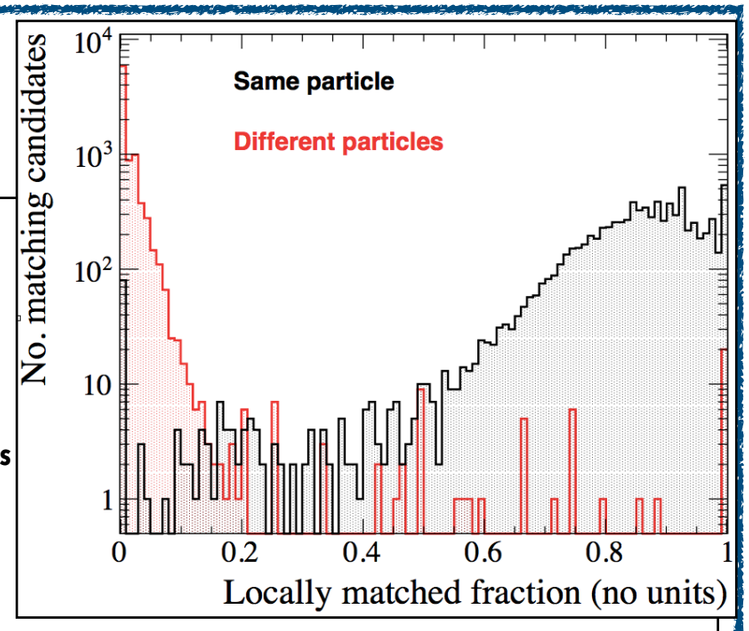


For each comparison the blue curve corresponds to the local correlation scores computed for every 11-bin wide subregions of the charge profile. The local correlation score is drawn at **the center (in X)** of **the subregion**. **Correlation score** is expected to be **very close to 1 when profiles are from the same particle** and random between 0 and 1 otherwise.

Performance

« Locally matched fraction »:
Fraction of local correlation scores that are above a threshold (0.99).

This method discriminates clusters coming from the same particle and those from different particles with great success!



➡ **Fewer than 0.5% of the comparisons between clusters from different particles result in a locally matched fraction above 0.4!**