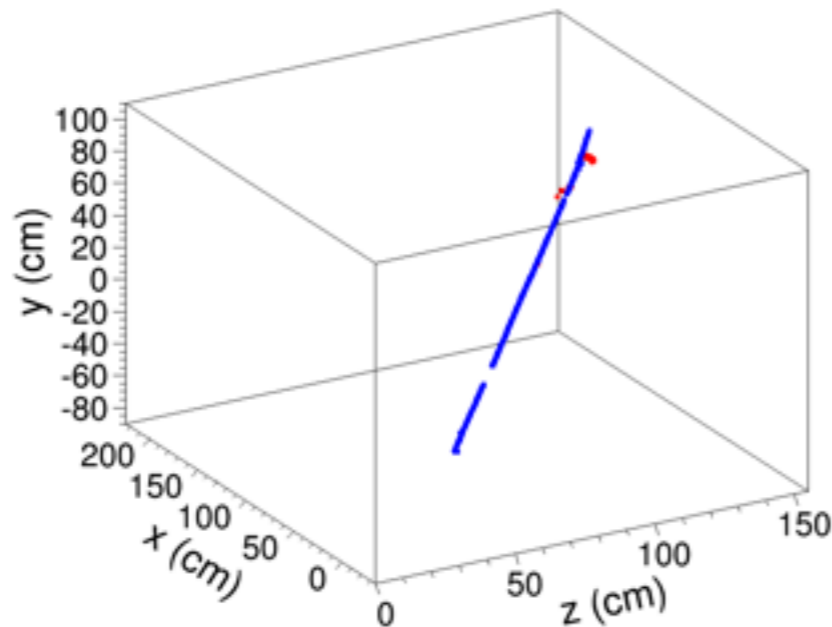


Reconstruction R&D for CERN Prototype



Andy Blake, Cambridge University
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Introduction

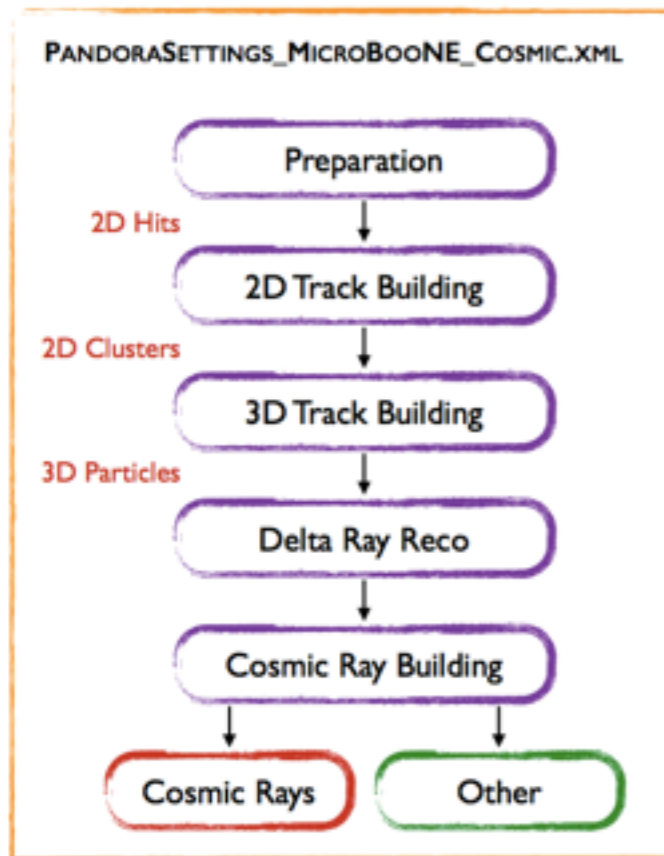
- **This talk given on behalf of Cambridge and Warwick groups.**
 - Mark Thomson, Gary Barker, John Marshall, Martin Haigh, AB et al.
- **Interested in reconstruction R&D for CERN prototype.**
 - Natural extension of current reconstruction effort on LBNE 35t etc.
 - Existing pattern recognition software (using Pandora & LArSoft) should already be applicable to CERN prototype.
 - Timescale for data-taking also fits in well with our plans to deliver high-level reconstruction tools for LBNF.
 - ☆ Warwick group are experts in high-level reconstruction!
- **This talk contains initial thoughts on reconstruction R&D.**
 - Will review current status of Pandora reconstruction effort.
 - Will offer tentative plans for work on CERN prototype.

Pandora

- **Pandora is a toolkit for developing pattern recognition algorithms in fine-grain detectors (applied to ILC/CLIC, LAr-TPC, ATLAS).**
- **Approach:**
 - Reconstruction philosophy:
“It’s easier to put things together than to break them apart”
 - We use a highly modular approach of many focused algorithms, each addressing a specific topology. Minimises mistakes.
 - Pandora provides a lightweight framework to support this approach. All core memory management is performed via the framework, keeping algorithms simple and efficient.
- **Development of LAr-TPC reconstruction algorithms has now reached an advanced stage (with many talks in LBNE DocDB).**
 - Pandora reconstruction runs in ART/LArSoft framework.
 - Reconstruction chains developed for neutrinos and cosmic-ray muons.
Inputs: 2D hits, Outputs: 3D particles
 - We currently support the MicroBooNE and LBNE 35t geometries.

Reconstruction Chains

Cosmic-ray chain



MicroBooNE
LBNE 35t

Neutrino chain



MicroBooNE
LBNE FD
[in progress]

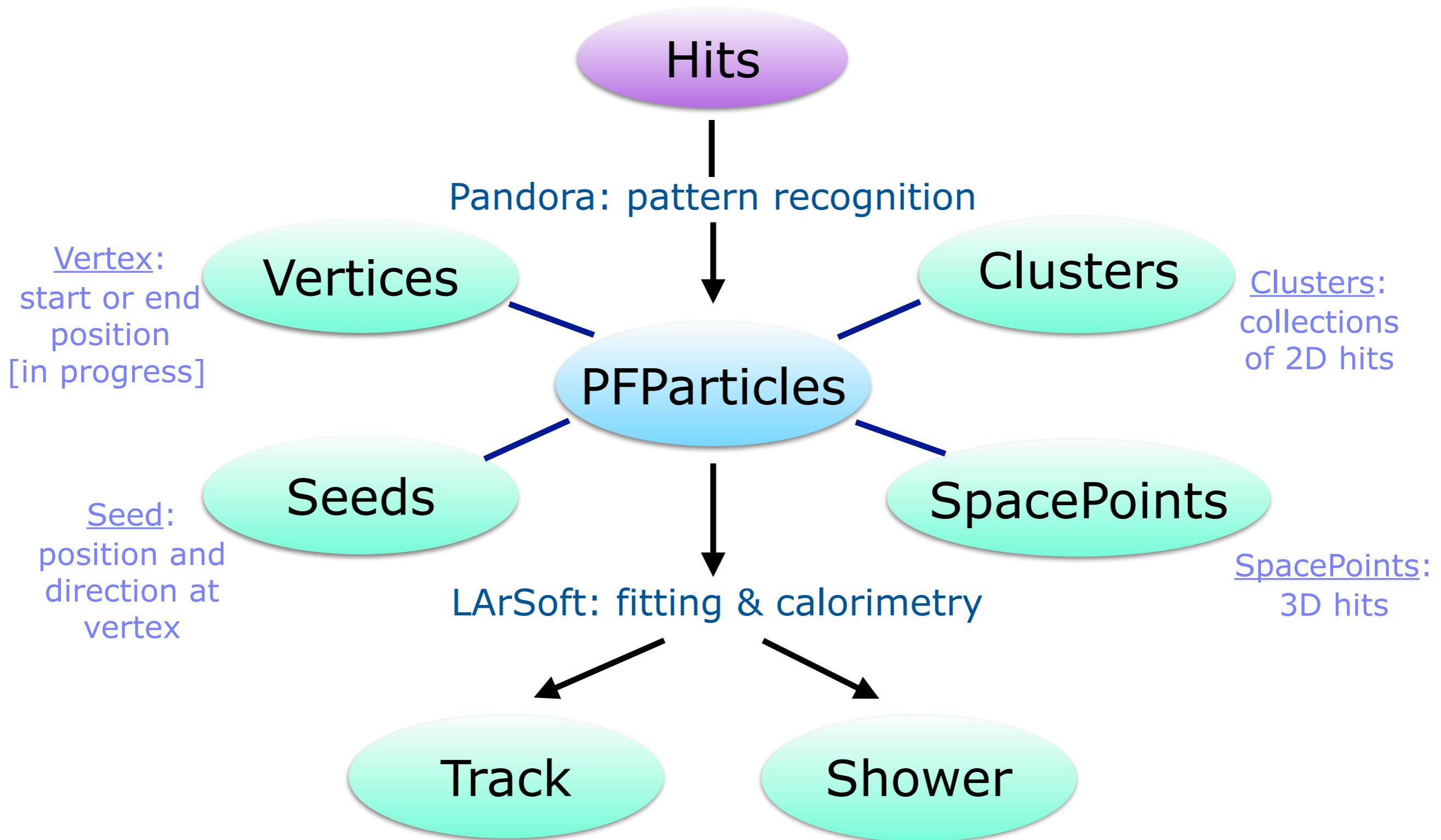
Other tools (in LArSoft)

Particle stitcher
(for multiple drift volumes)

Track builder
(Fits smooth trajectory
through track-like particles)

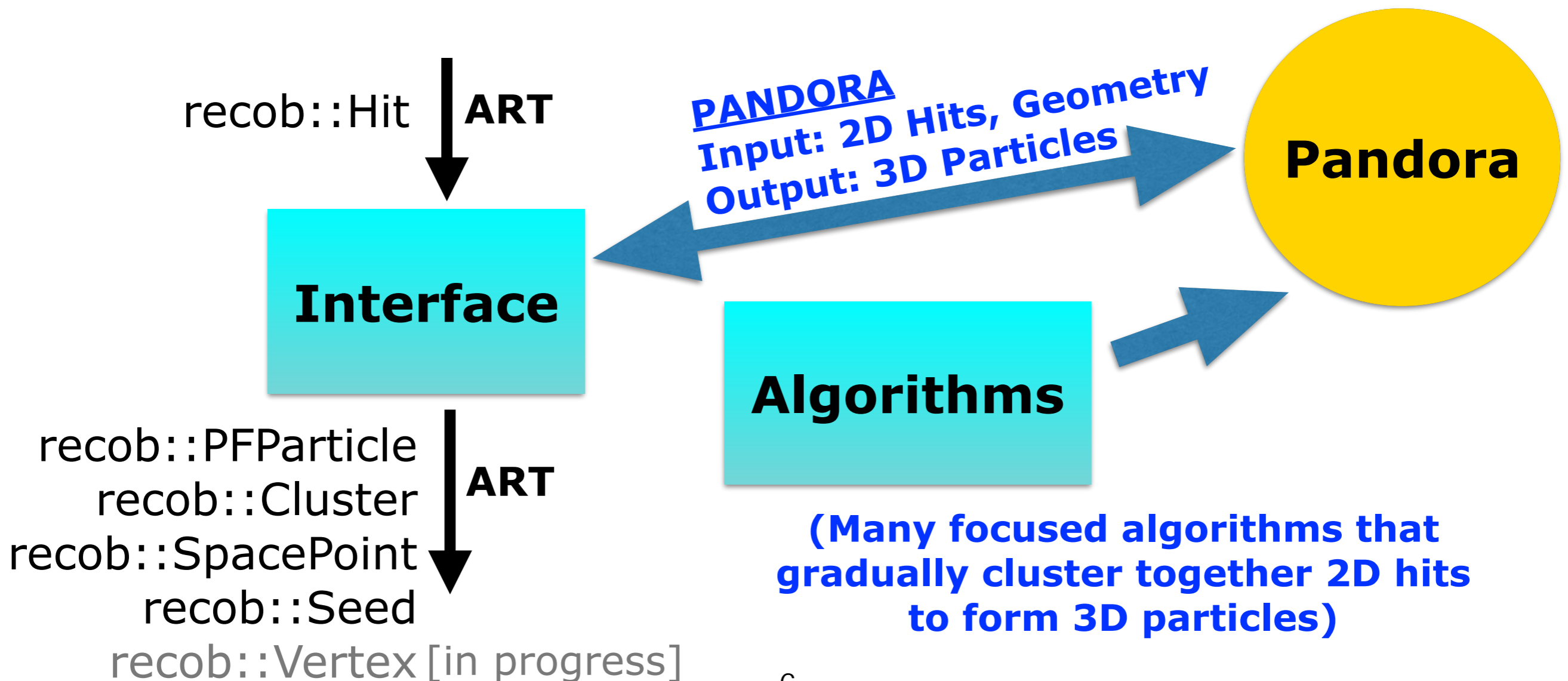
LAr-TPC pattern recognition currently comprises >50 algorithms

Reconstruction Outputs



Pandora in LArSoft

- LAr code committed to larpandora repository of LArSoft.
- Two packages:
 - LArPandoraInterface: ART Producer and Analysis Modules.
 - LArPandoraAlgorithms: All pattern recognition algorithms.

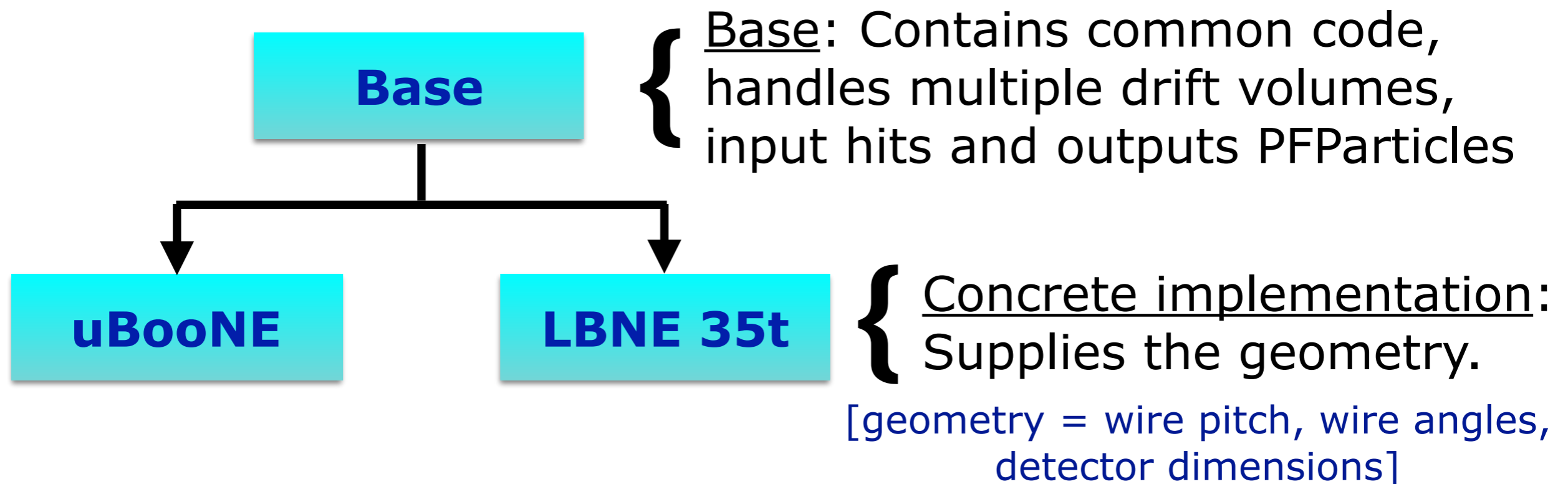


Pandora in LArSoft

- **Significant developments over past two months:**

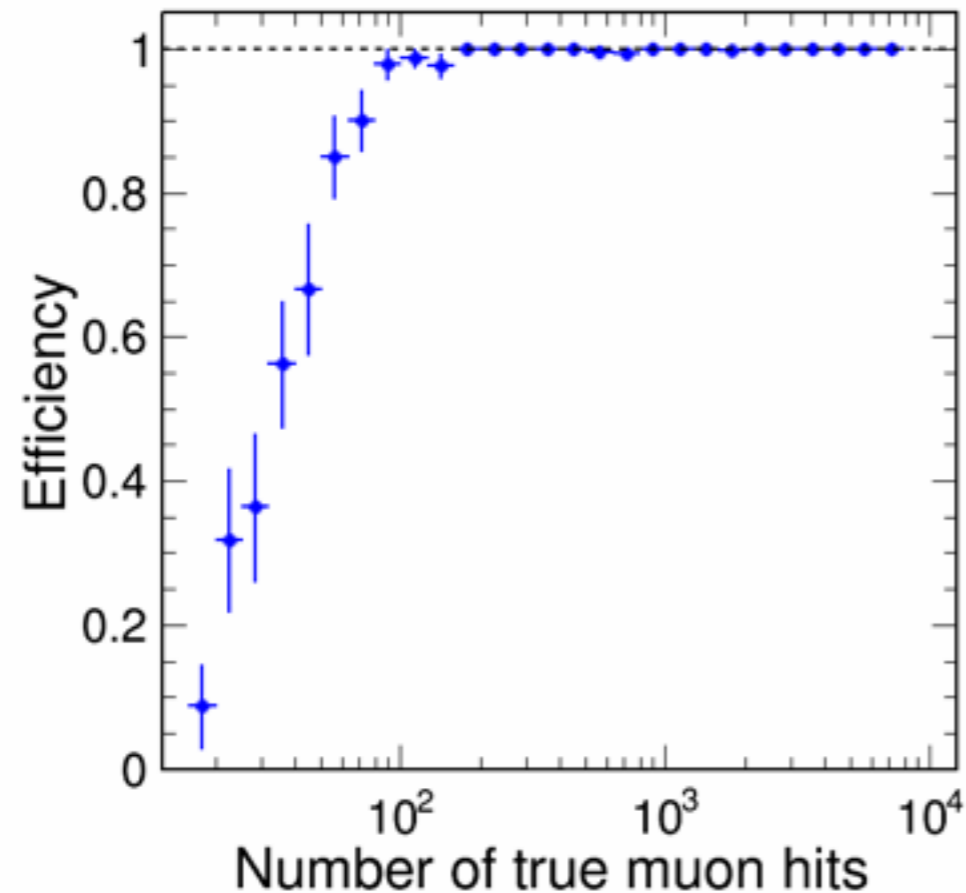
- Two-pass reconstruction chain for MicroBooNE (cosmic-ray, neutrino)
- Reconstruction of multiple drift volumes for LBNE
- Separate ART Producers for MicroBooNE and LBNE 35t

- **Current design of ART Producer Modules:**

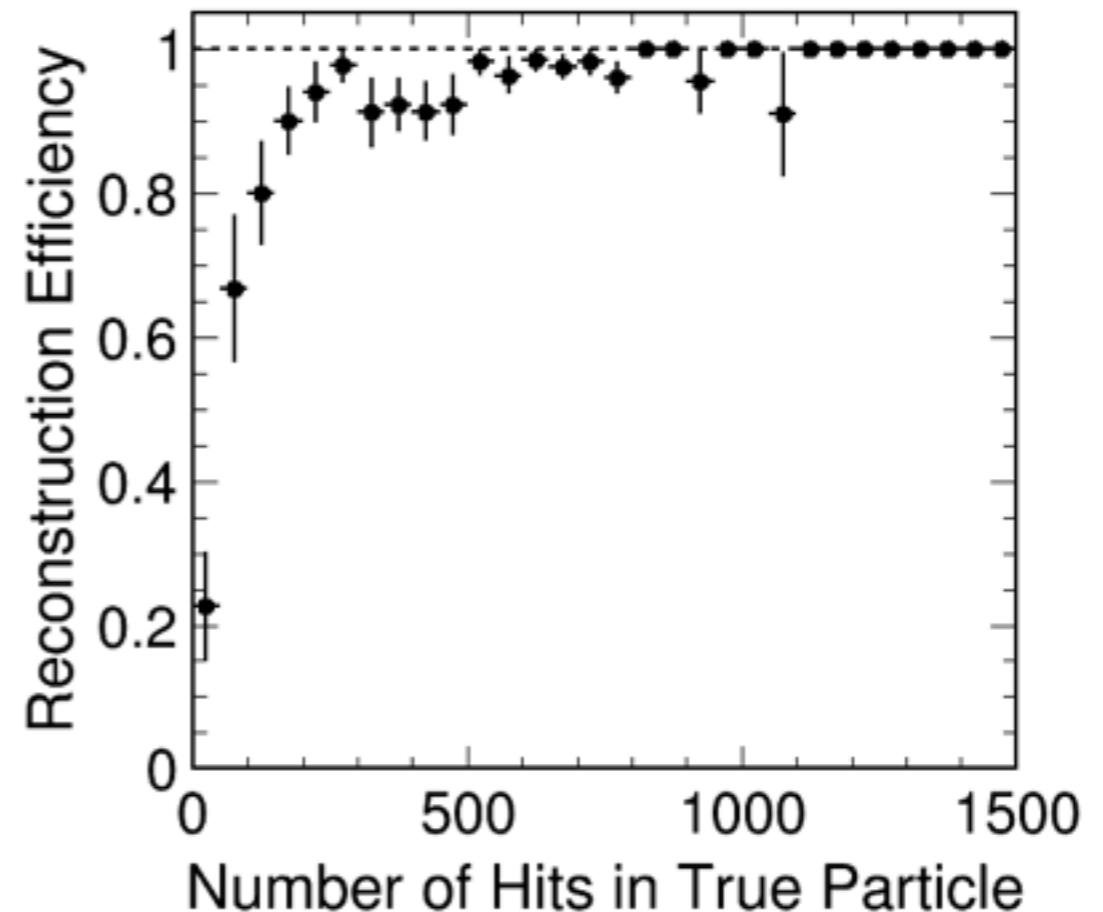


Performance

- e.g. Reconstruction efficiency:



Cosmic-ray muons,
MicroBooNE



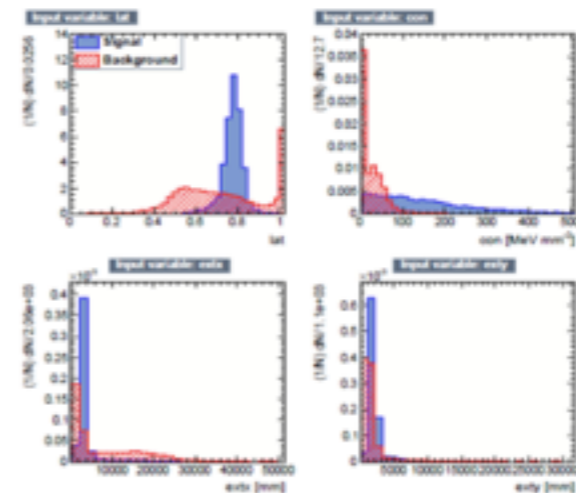
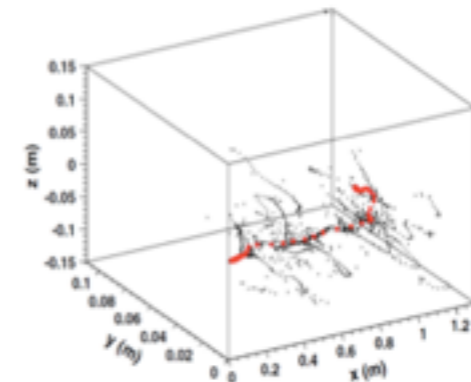
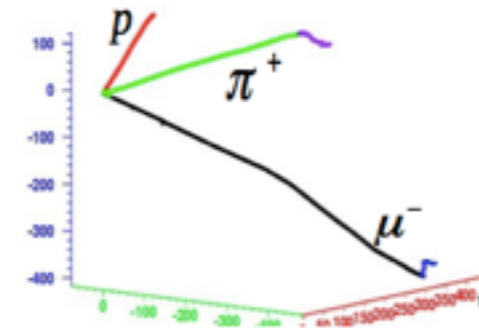
Cosmic-ray muons,
LBNE 35t
(Re-using MicroBooNE chain)

High-level Reconstruction

- **High-level tools developed for LBNO by Warwick group.**
 - In particular, particle identification.

Current tools:

- **Cellular automaton:** apply local rule to rank hits then consider all trajectories.
Eur. Phys. J. C73 2591 (2013)
- **Local Principle Curves:** principle axis analysis adapted to work in a local hit cloud.
Eur. Phys. J. C74 2832 (2014)
- **PID:** Emag vs hadronic shower discrimination via shower shape variables in multivariate analysis.
Eur. Phys. J. C73 2369 (2013)



- **Will implement tools for LBNE during first half of 2015.**

CERN Prototype

- **Initial thoughts...**
- **Data from CERN prototype will address many important reconstruction issues:**
 - Pattern recognition,
 - track fitting and momentum determination,
 - photon/electron separation,
 - π^0 reconstruction,
 - calorimetry for electromagnetic and hadronic showers,
 - etc.
- **Will also provide real data on detector performance:**
 - Acceptances and resolutions as a function of energy and angle.
 - Geometrical effects e.g. distortions, gaps between TPCs.
 - etc.
- **A gold-mine of measurements and studies related to reconstruction R&D ... all important for LBNF.**

Tentative Plans

- **Main efforts over next few months:**
 - Cambridge: continue to develop pattern recognition.
 - Warwick: adapt high-level reconstruction tools for LBNF.
- **Main focus will be 35t cosmic-ray reconstruction and FD neutrino reconstruction ... but efforts will definitely yield results that can be applied to CERN prototype.**
 - For example: simulation, reconstruction and characterisation of single-particle events in 35t and/or FD geometry.
 - ☆ Provide inputs to CERN prototype planning and proposal, based on full simulation and reconstruction.
[for now, "reconstruction" = pattern recognition]
 - Efforts may also advance to the stage where we can perform studies that motivate measurements, or address design issues.
- **Can easily create ART Producers for new geometries.**
[Assuming that software will be based on ART/LArSoft ?]

Summary

- **Interested in reconstruction R&D on CERN prototype.**
 - Natural extension of ongoing UK efforts.
- **Already have advanced reconstruction tools that can applied to R&D efforts.**
 - Will continue to develop pattern recognition algorithms in coming months, as well as adapting high-level tools.
 - Anticipate full reconstruction and particle identification in time for CERN prototype data-taking.
- **Our ongoing efforts will likely yield full-simulation single-particle studies - should be of interest.**
- **Depending on how efforts advance in coming year, could contribute physics and/or design studies to CERN prototype efforts.**
- **Those are my initial thoughts!**