Opportunities for Pandora and Wire-Cell

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WARWICK
THE UNIVERSITY OF WARWICK

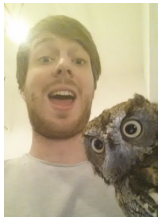
The Pandora project and team

PandoraPFA

- An STFC project: Stage 1 Oct 2019-Mar 2024; Stage 2 now running Apr 2024 - end 2027/28
- Planning for subsequent phase already underway; includes more physics exploitation of software
- Predominantly funded for DUNE, with some PDRA and student funding for SBN

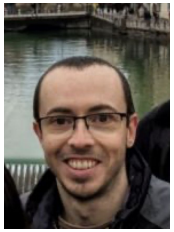
John Marshall

Andy Blake



Dom Brailsford

Leigh Whitehead



Andy Chappell

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Ryan Cross

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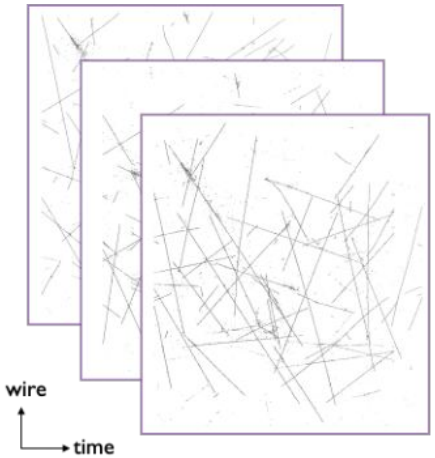
Pandora's multi-algorithm approach

- Many logical steps (> 100 algorithms) to go from input hits to 3D hierarchies
- Build different techniques, including deep learning, and physics and detector knowledge in the pattern recognition algorithms



2D pattern recognition

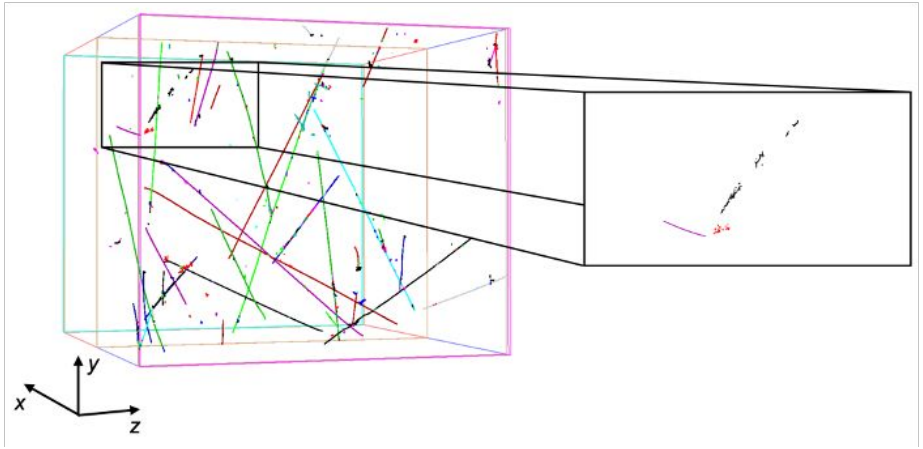
2D → 3D matching

Vertex finding

3D algorithms

Hierarchy building

Track/shower ID



Two very different, excellent reconstruction paradigms

Pandora	Wire-Cell
Build 2D clusters View matching 3D reco	Wire signal matching 3D hits 3D reco

Common steps, e.g. Vertex finding, Space point construction
Common interests, e.g. AI/ML/DL

Together they comprise the bulk of all LArTPC pattern recognition code that has been applied to/proven on real data

Common needs

- Many LAr-TPC experiments, analysers and reconstruction challenges, and relatively few reconstruction developers
- Train/support a large user base
- Recruit from outside the core team
- Build two-way bridge between reconstruction and analysis
- Tune algorithms for analysis
- Support bespoke needs from experiments/real data

(...while satisfying funding agencies about return on their investment!)

Strong motivation to find synergies/work together

Different Implementations

- Both external to ART/LArSoft
- By design, codebase implemented within external toolkits
- Some of our algorithms are similar, but…
  - Different inputs (wire/ticks vs hits x/z)
  - Different underlying classes, and different codebase

What can be shared?

- Easier example: ML algorithms (or at least architecture)
- Harder example: cluster growing in Pandora
- Mapping internal representation of objects to common output

  Sharing algorithms would rely on interfaces on both sides

How to collaborate?

- Sharing algorithms
- Cross-collaborative work for validation benchmarking/comparison framework
  - Understand strengths and differences to enhance both paradigms
- Common set of I/O training data very useful to integrate more AI/ML techniques
  - Can share the same trained models
  - Challenges related to how we represent hits (e.g. need both write recob hits)

How to collaborate? (2)

- Opportunity to run Pandora and Wire-Cell alongside each other to enhance a total reconstruction
  - Pandora and Wire-Cell may be sensitive to different topologies
  - Can combine selected samples to boost physics sensitivity
  - Can combine per-event outputs together to get PID, energy reco, etc.
- Can feed each other's outputs in input
  - Pandora could benefit from using in early pattern recognition the relationships between hits across views from Wirecell 3D hits
- Write to common LArSoft objects?
- Common slicing procedure?