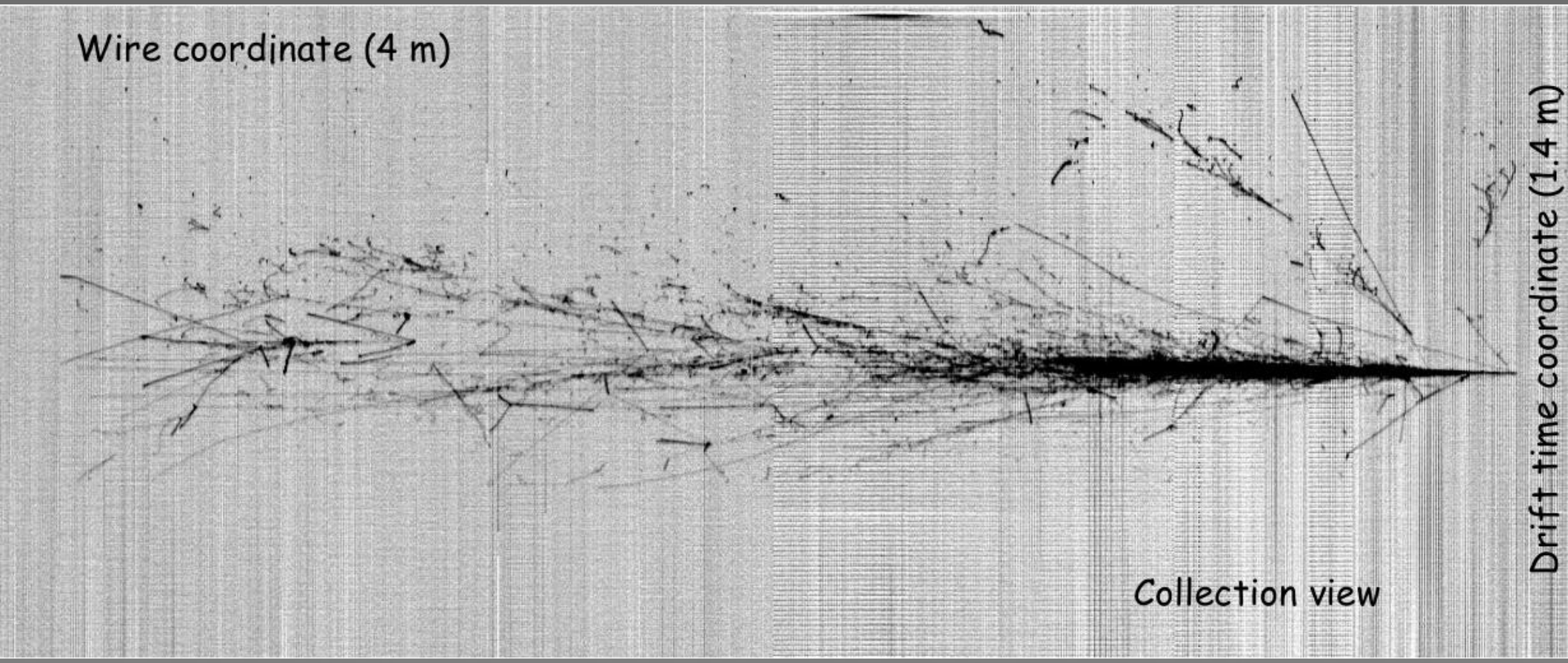
LAr-TPC Event Reconstruction

Ben Morgan

THE UNIVERSITY OF WARWICK

The Electronic Bubble Chamber



Alberto Guglielmi (ICARUS), Neutrino 2010:
http://indico.cern.ch/conferenceDisplay.py?confId=73981

Can LAr-TPCs realise their potential?

- Quantifying the physics performance requires software to reconstruct:
  - Particle energies.
  - Particle momenta.
  - Particle Type ID.
  - Interaction Vertices.
  - Anything else?

Automatic reconstruction software does not exist for liquid argon...

Beauty has a price...

Tracks AND Showers

Multiple Scattering

Where's the IP?

ICARUS,
arXiv:0812:2373

Latte

THE UNIVERSITY OF WARWICK

2011 – the year of automation?

LArSoft

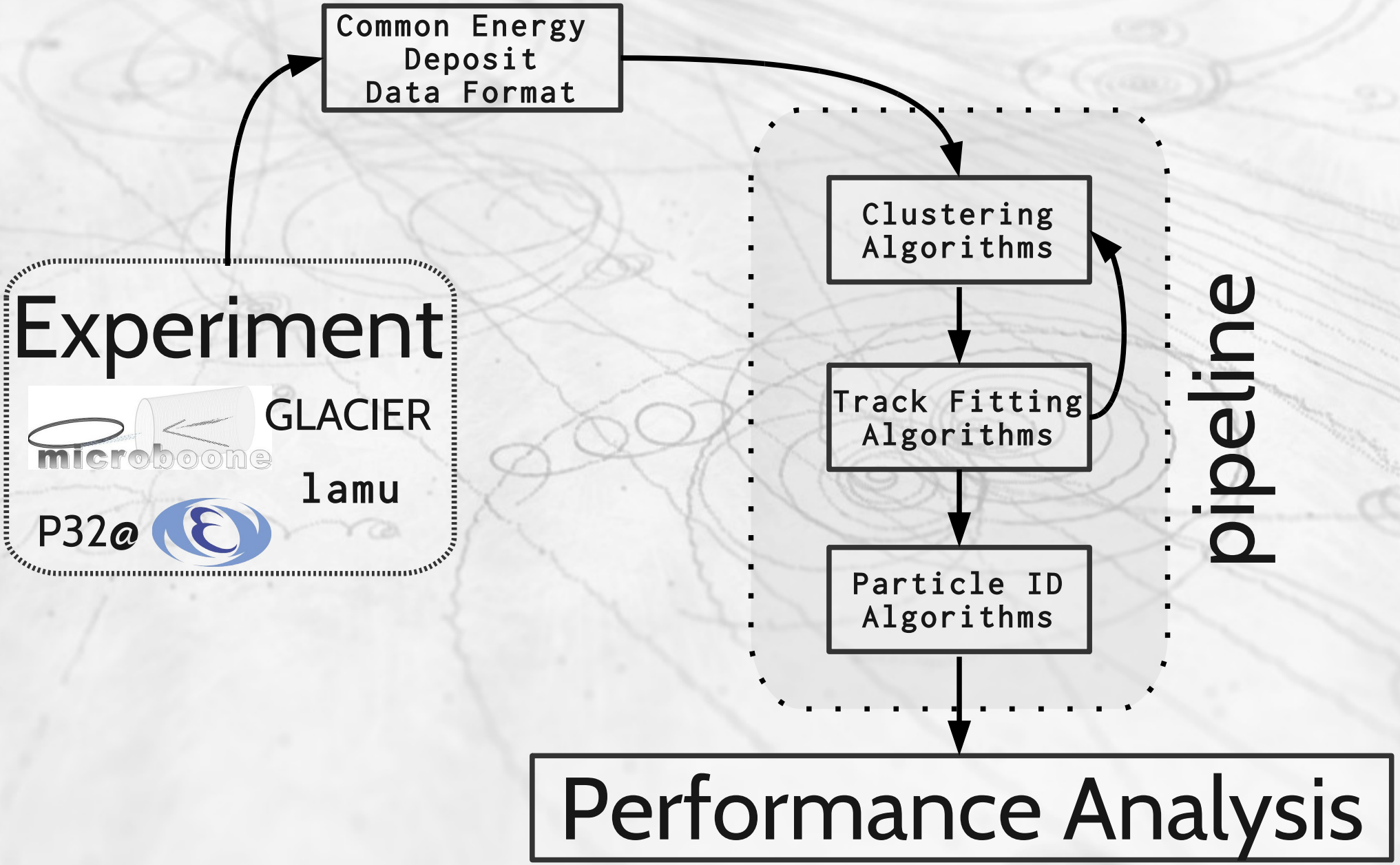
Fermilab

QScan

ETH

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

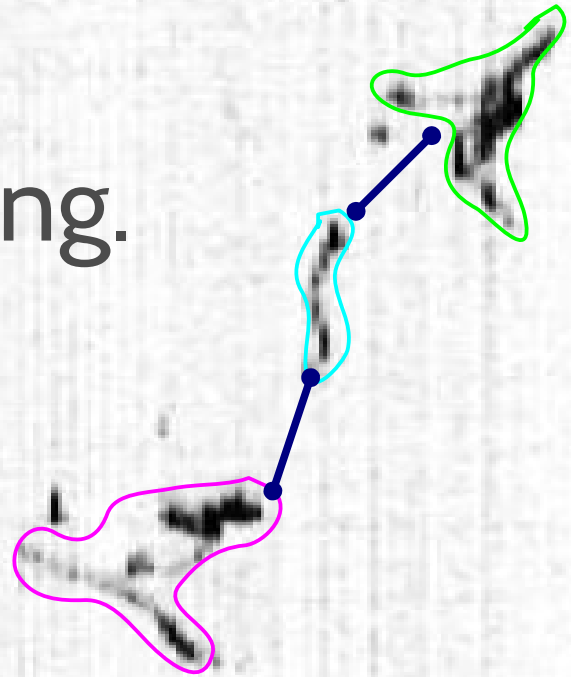
vertex finding
topological association
automation
particle ID
clustering
track fitting
e-pion separation
analysis


Common Energy Deposit Data Format
Experiment
GLACIER
microboone
lamu
P32@
Clustering Algorithms
Track Fitting Algorithms
Particle ID Algorithms
pipeline
Performance Analysis

Clustering Strategy

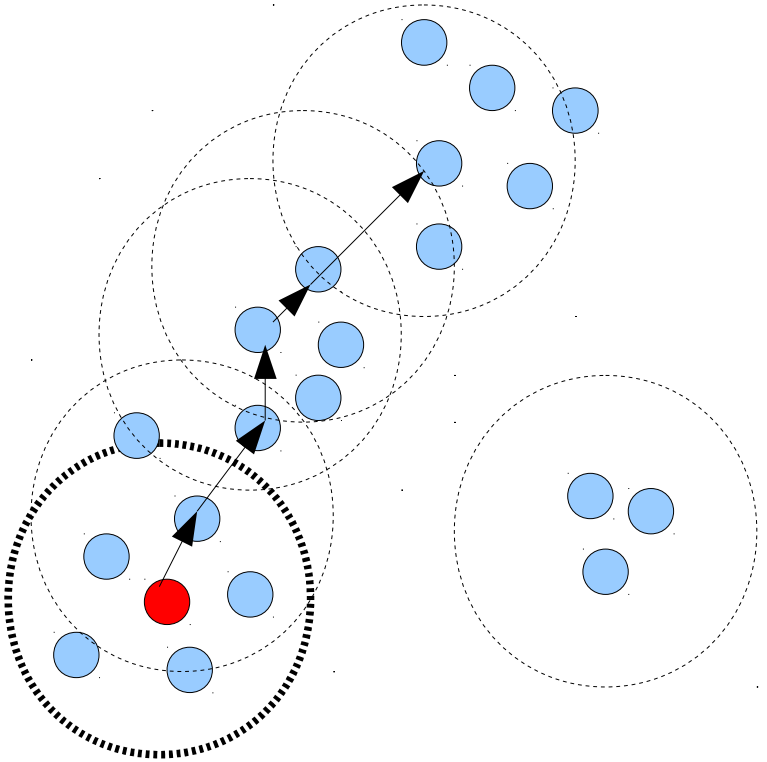
- Conservative algorithms.

- Topological merging.



DBSCAN* Algorithm

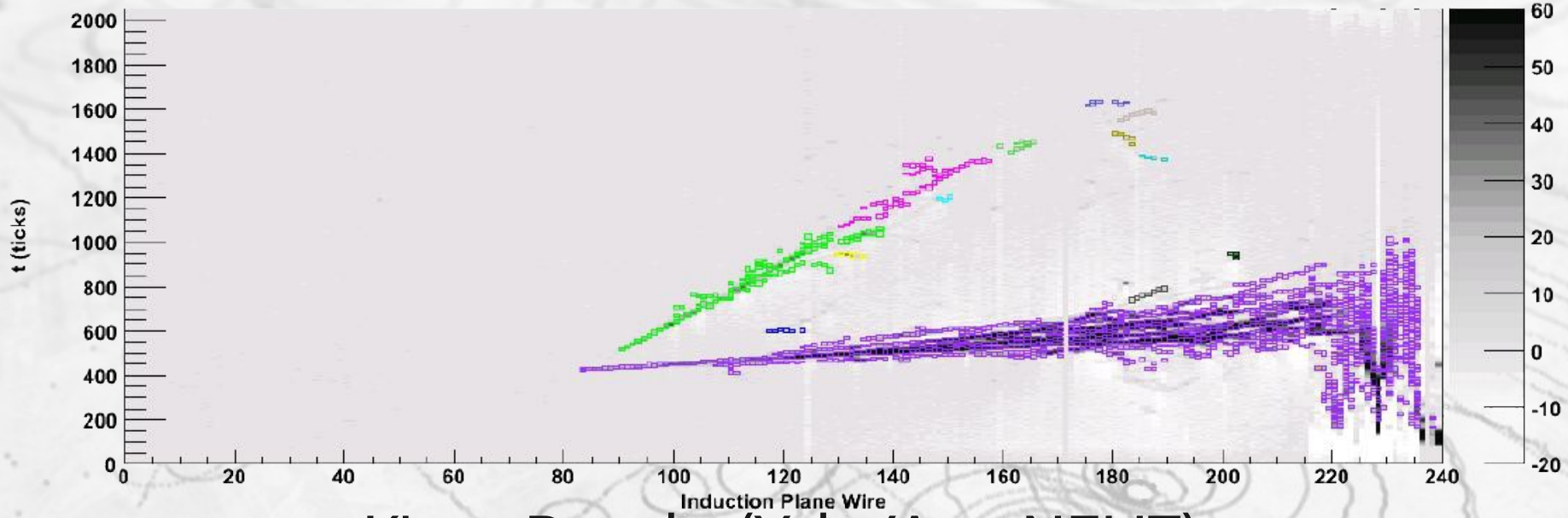
- Density based.
- Neighbourhood ε of a point must have >=N_{min} points.
- Clusters formed by **density reachable** points.



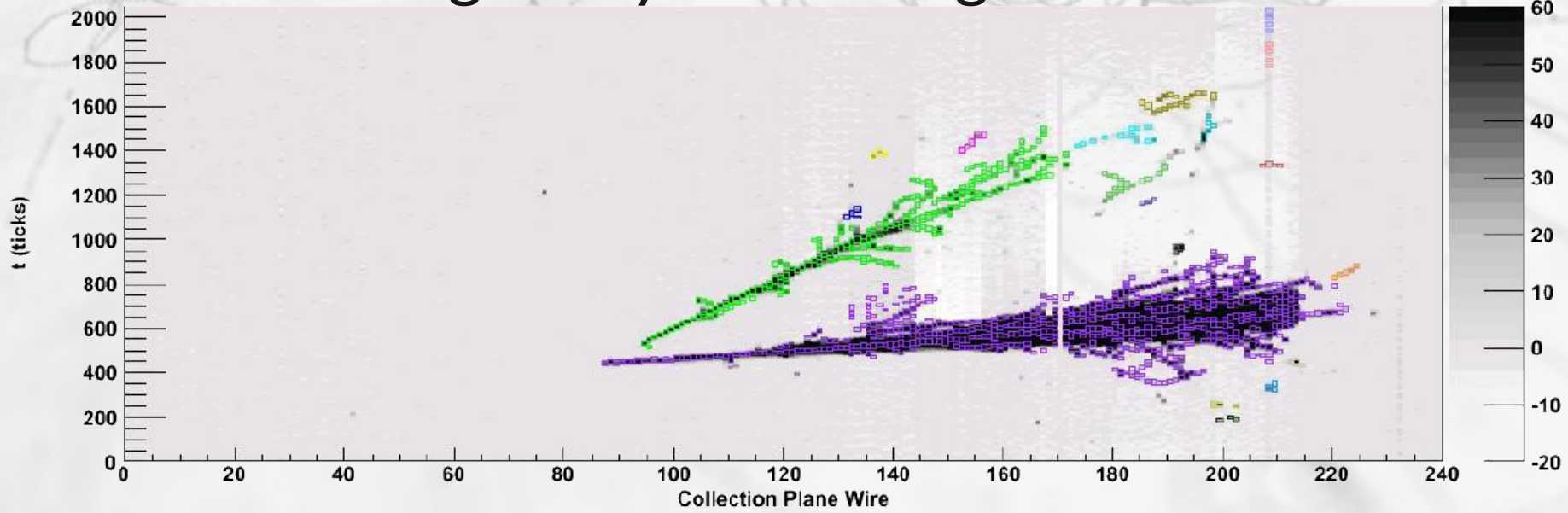
ε-Neighbourhood
N>=5

*Sander et al, Data Mining and Knowledge Discovery 2, pp169-194 (1998)

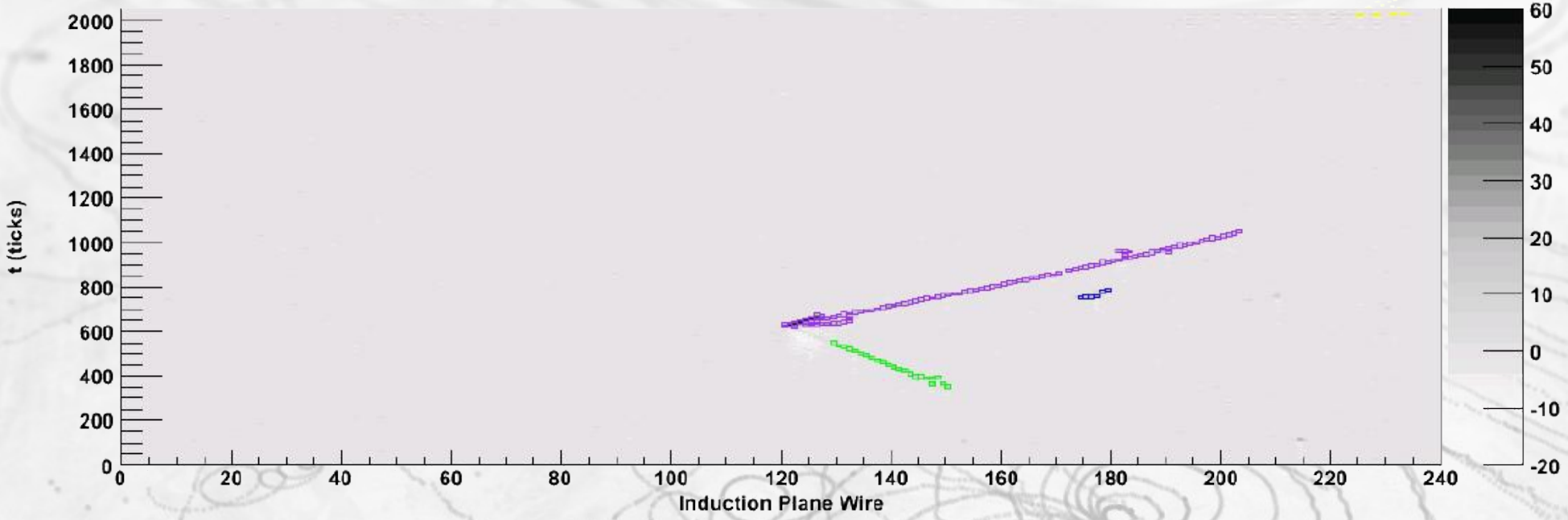
DBSCAN in ArgoNEUT



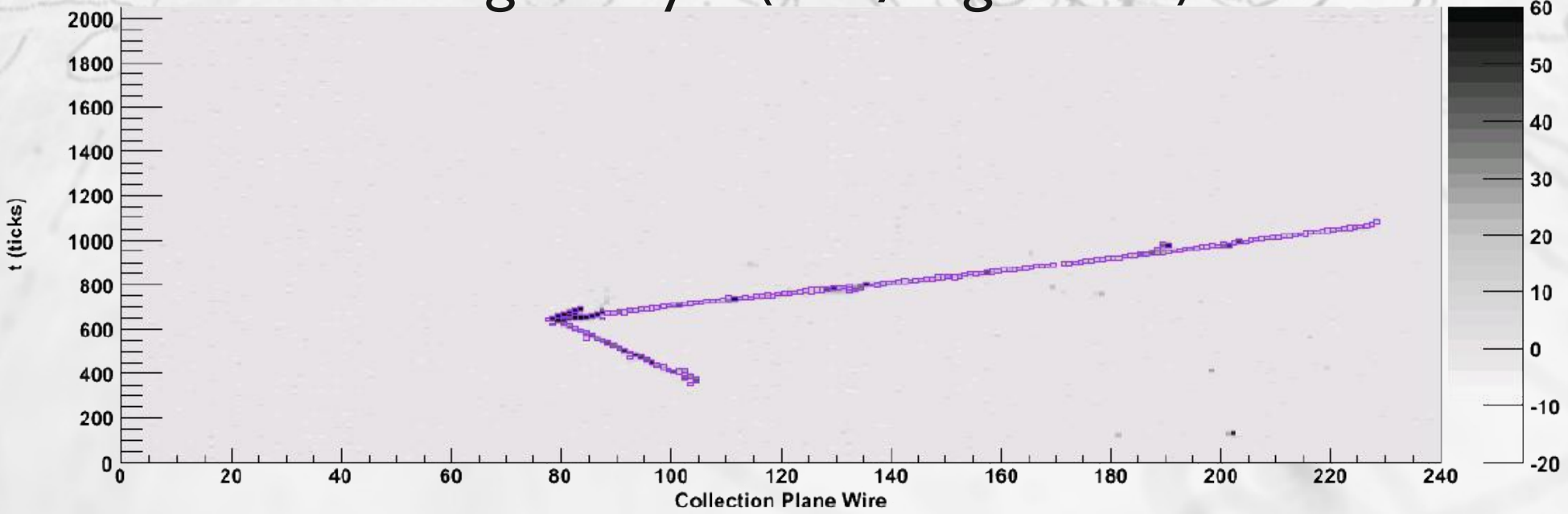
Kinga Partyka (Yale/ArgoNEUT)



DBSCAN can be too liberal...



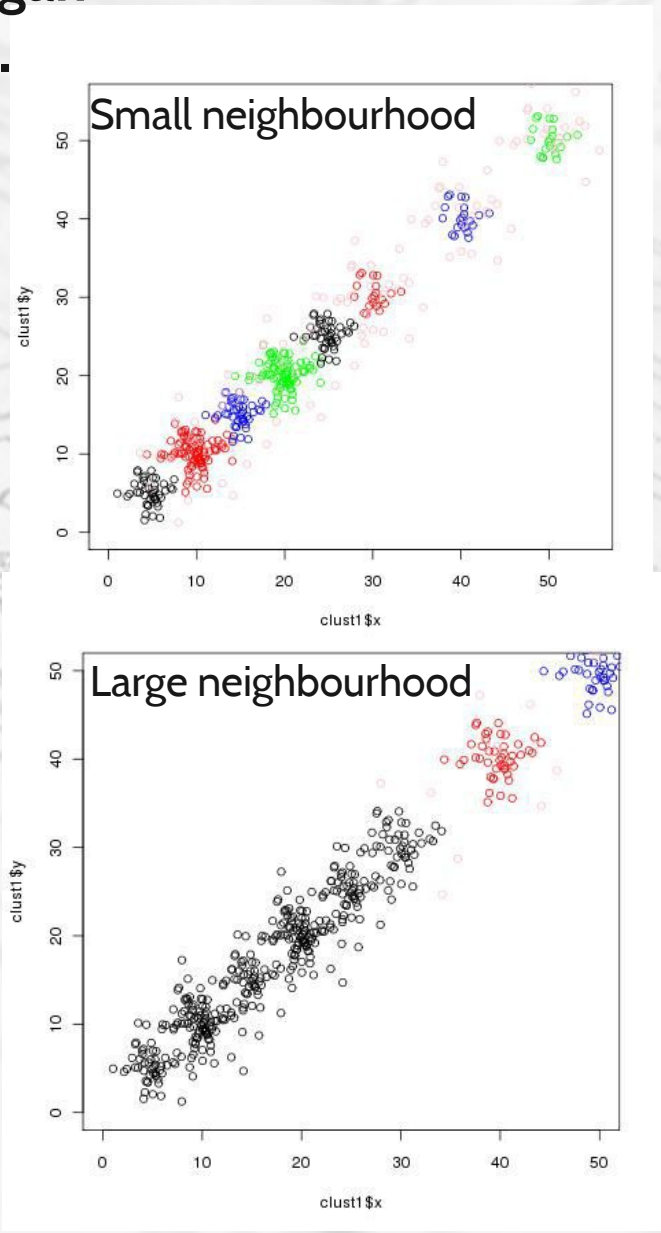
Kinga Partyka (Yale/ArgoNEUT)



OPTICS* Algorithm

Dan Roythorne, Ben Morgan
University of Warwick.

- Extension of DBSCAN.
- Measures clustering on all scales of neighbourhood ε.
- Tuning of ε-scale can be used to minimize overclustering.



*Ankerst et al, ACM SIGMOD Int Conf. on Management Of Data pp49-60 (1999)

Cellular Automata

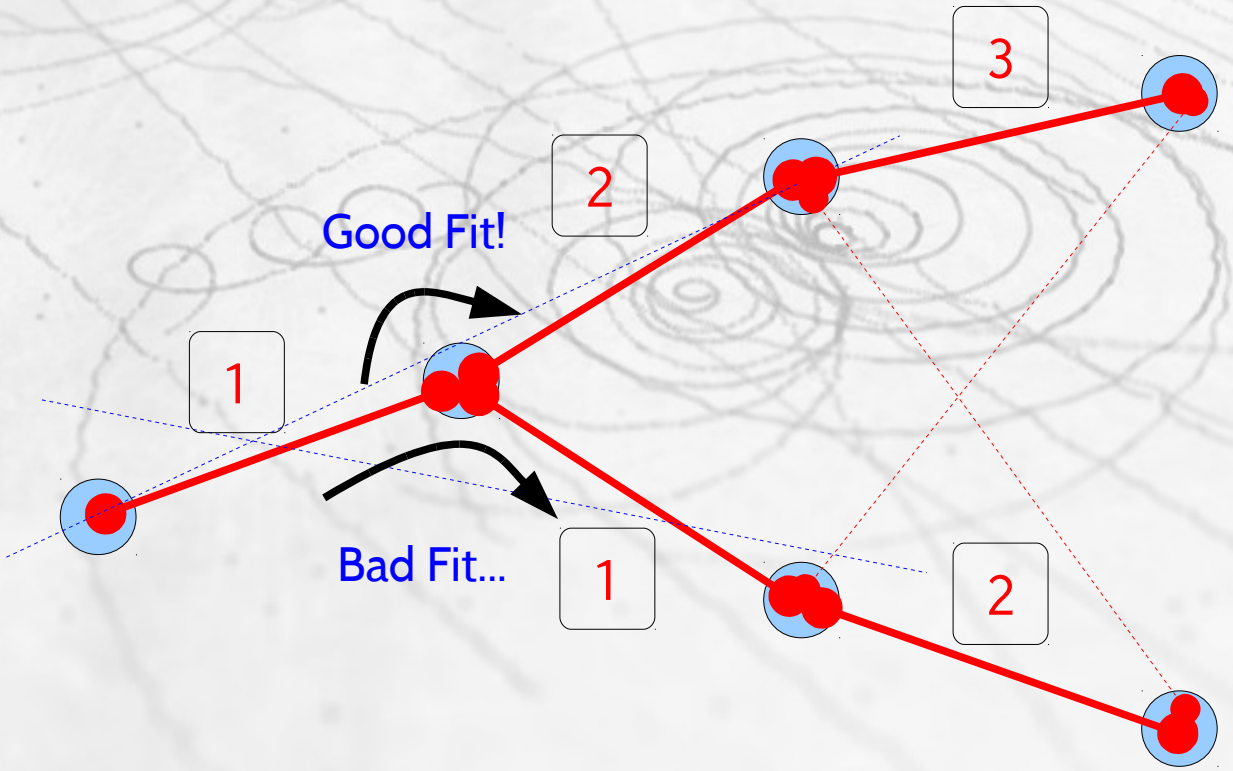
Andrew Bennieston
University of Warwick.

- Dynamical system with rules for update of local state at discrete steps.

CAT Cell

CAT Rule:
Increment state if neighbours fit a straight line

`CATState`



Particle Flow

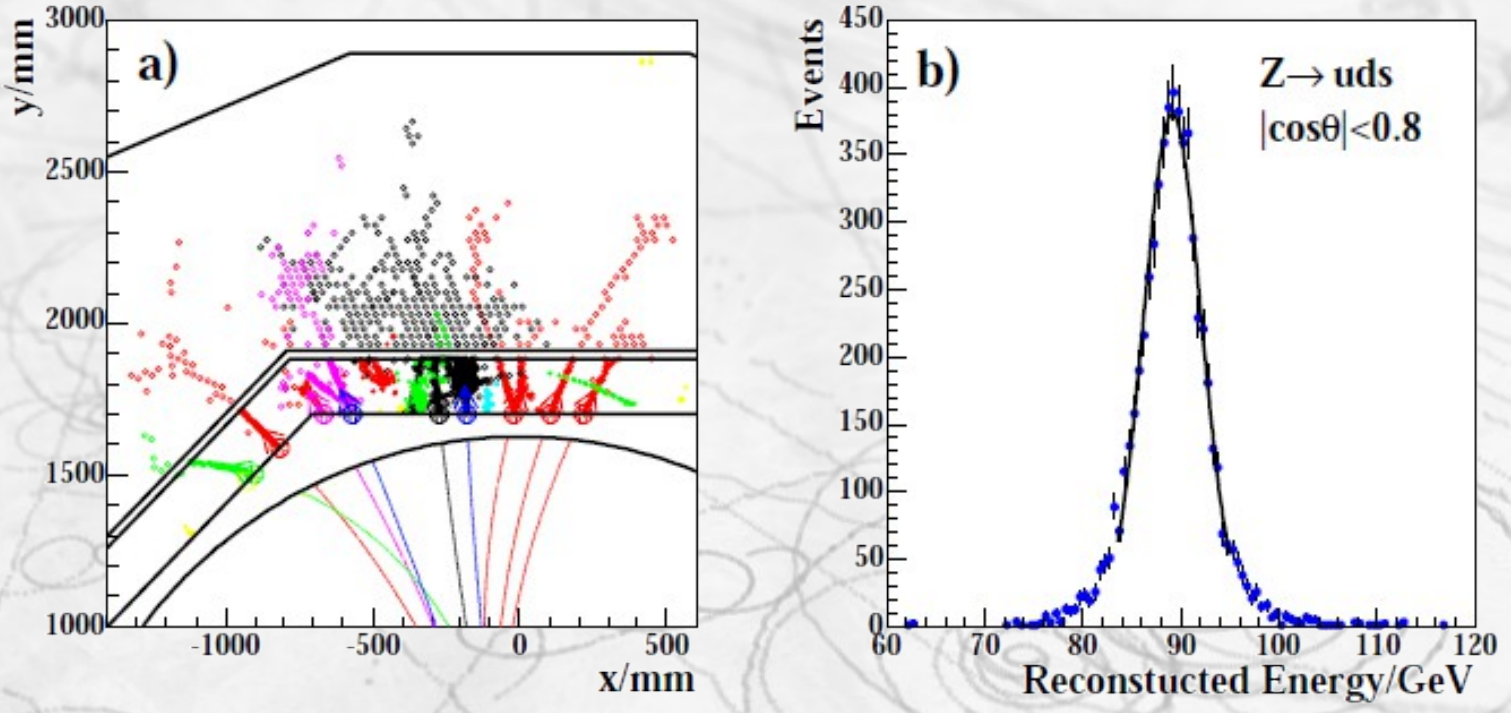
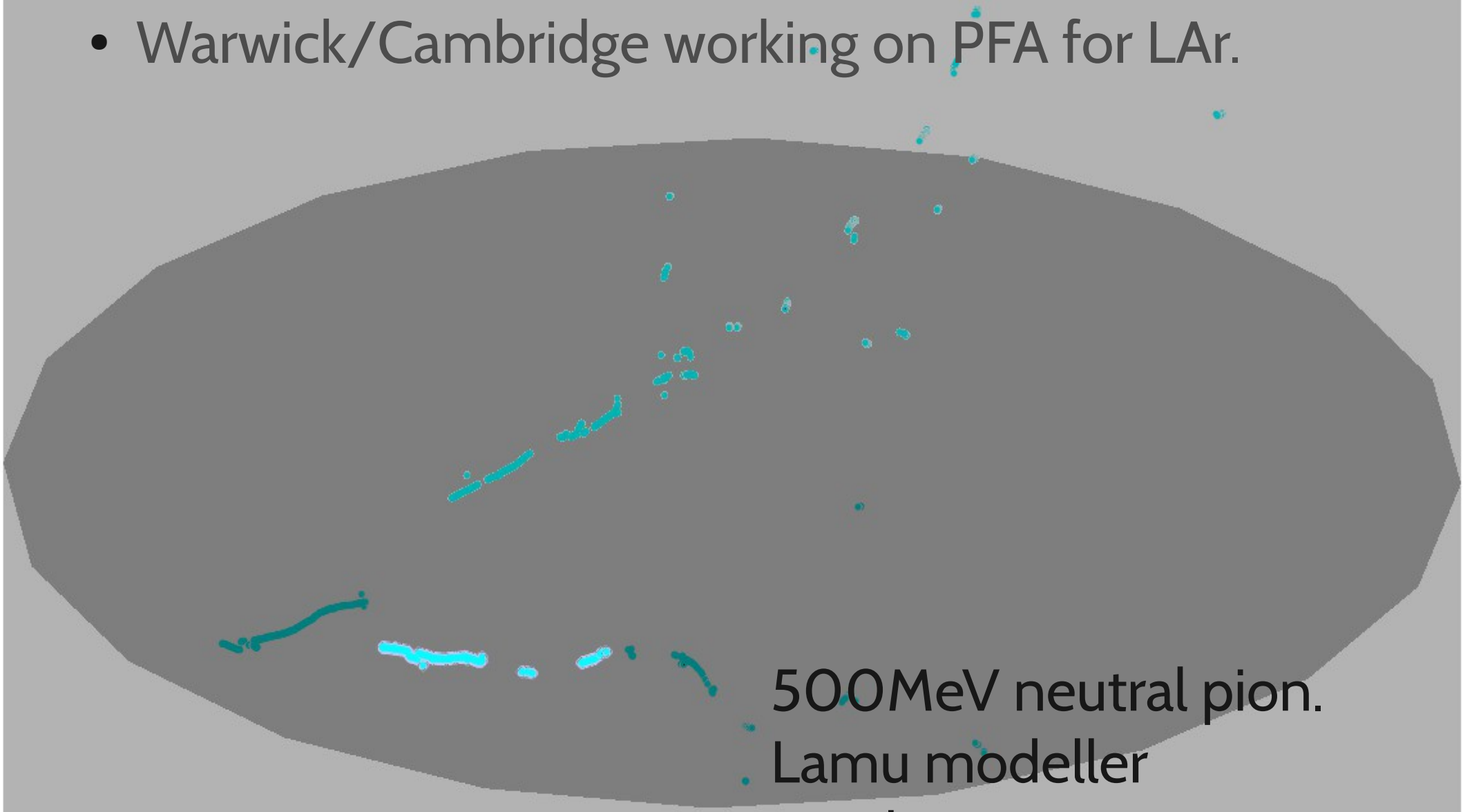


Figure 1: (a) An example of the particle flow reconstruction of a 100 GeV jet using the PandoraPFA algorithm; (b) the distribution of the total reconstructed jet energy in the decays of Z to light quarks (uds) at $\sqrt{s}$ = 91.2 GeV.

- ILC needs tracking calorimetry for jet resolution.
  - => Particle flow algorithms.
- PandoraPFA modular framework
  - Mark Thomson, John Marshall (Cambridge)

Latte + PandoraPFA

- Warwick/Cambridge working on PFA for LAr.

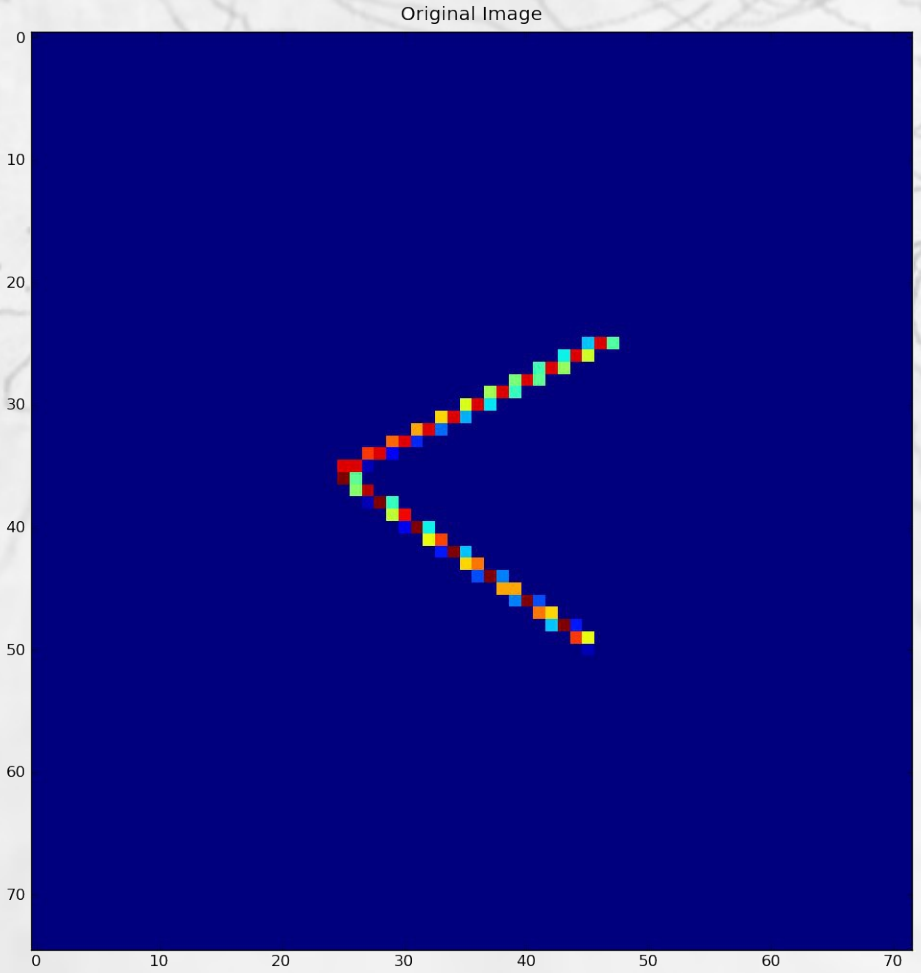


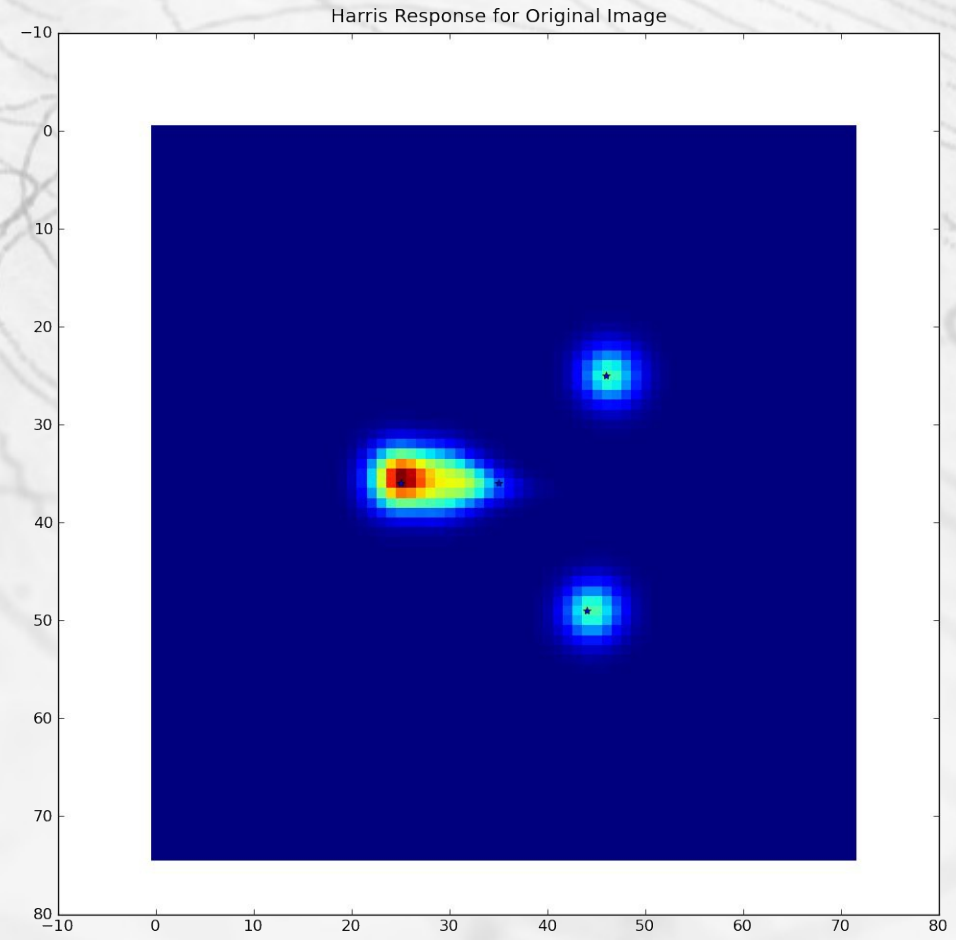
500MeV neutral pion.
Lamu modeller
PandoraPFA reconstruction

Key Point Detection

Ben Morgan
University of Warwick.

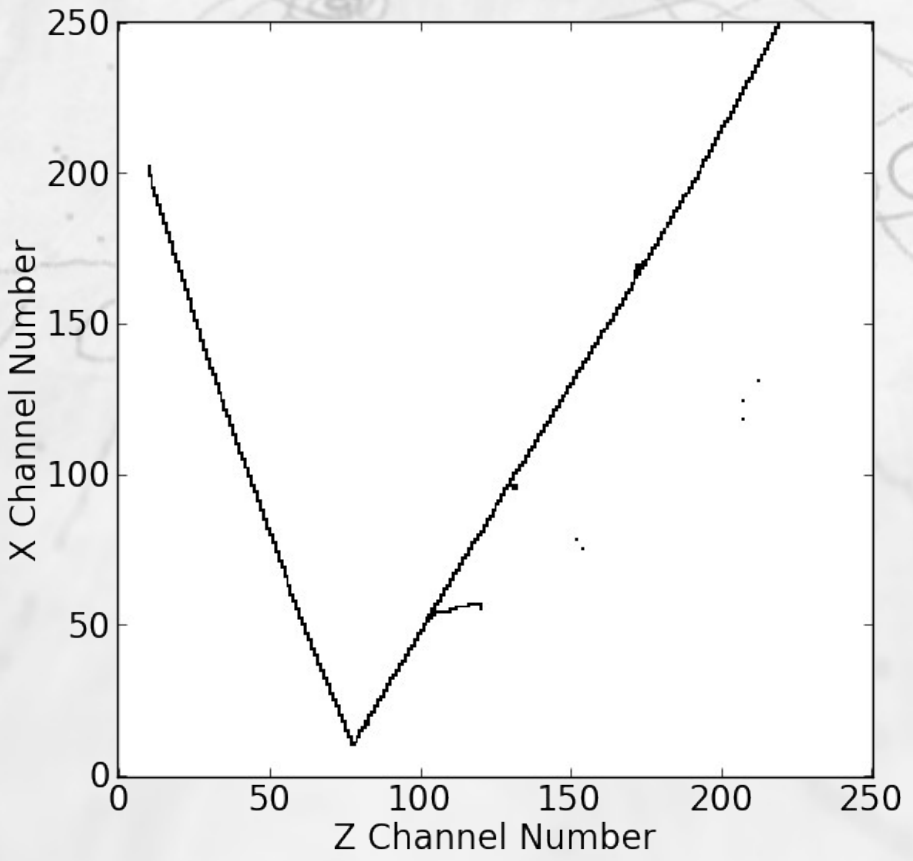
- Structure Tensor of energy deposits can identify points of interest.

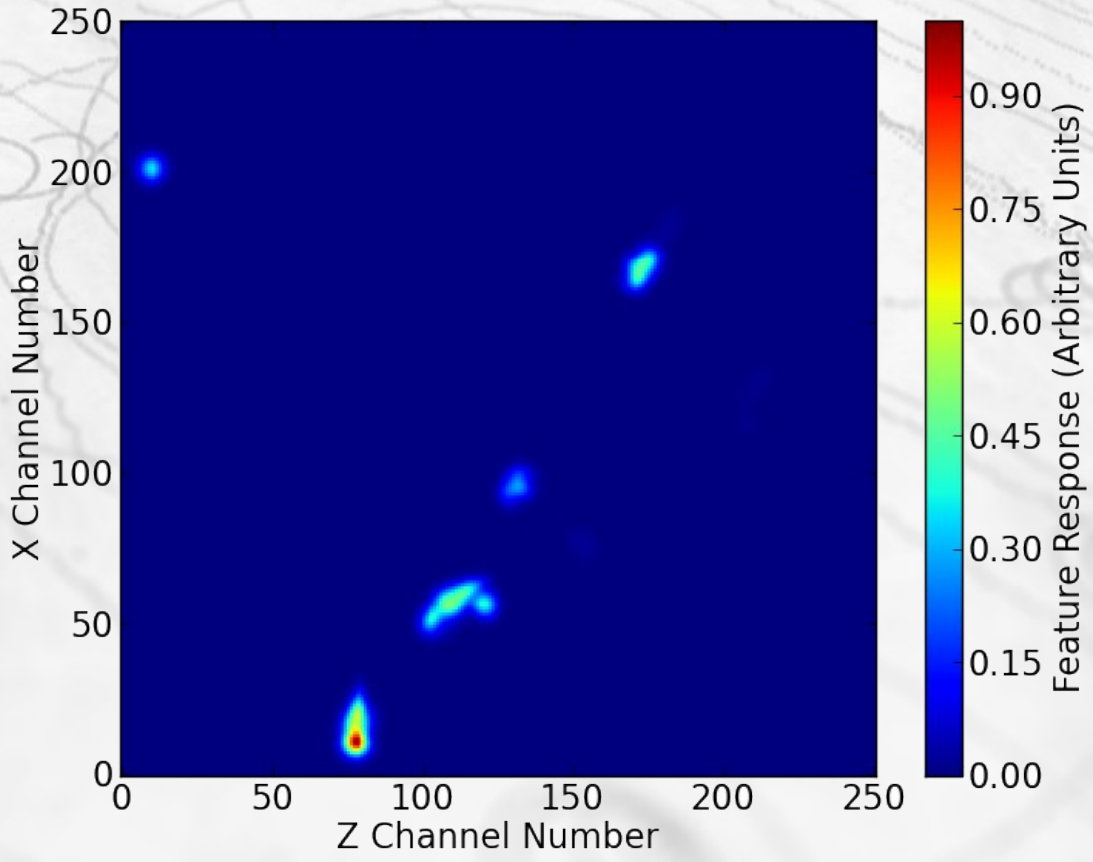




CCQE Vertex Detection

- Latte: Foestner/Noble Corner Detection Measure.
- Primary vertex identified with >85% efficiency.
  - **Ben Morgan, JINST 5(07), pp.7006 (2010)**





The Road to Performance.

- Focus Reconstruction efforts → Phenomenology.
- World collaboration and **teamwork** critical.
- **Warwick's experiment-independent software toolbox can help to unify efforts.**