Reconstruction Challenges In Large Volume Liquid Argon Detectors

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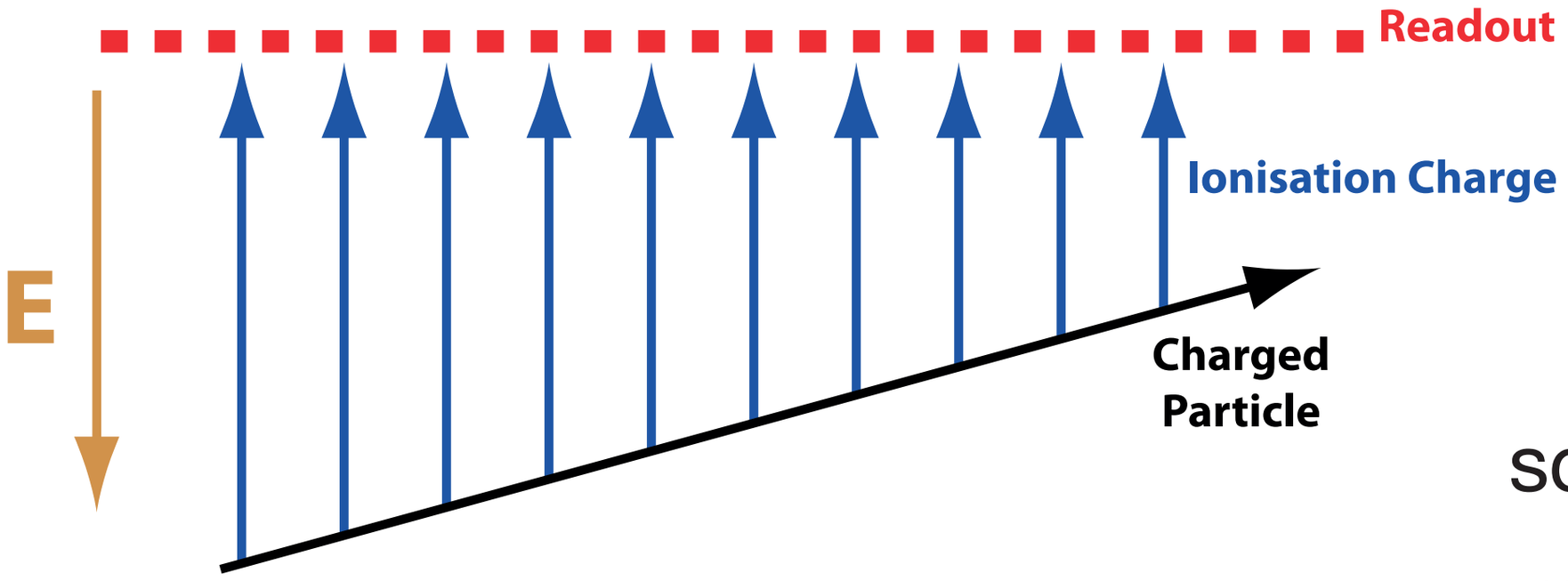
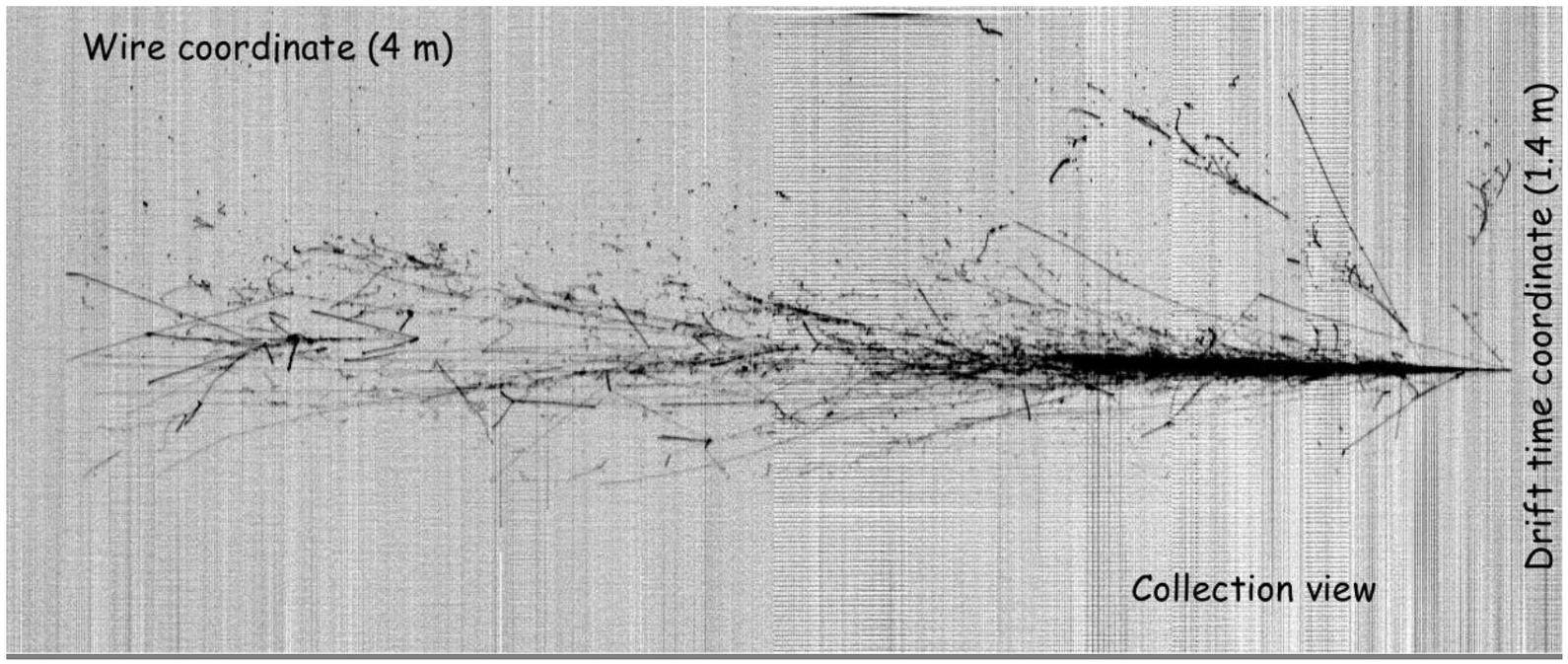
IoP NPPD 2011, Glasgow

THE UNIVERSITY OF WARWICK

Liquid Argon TPCs



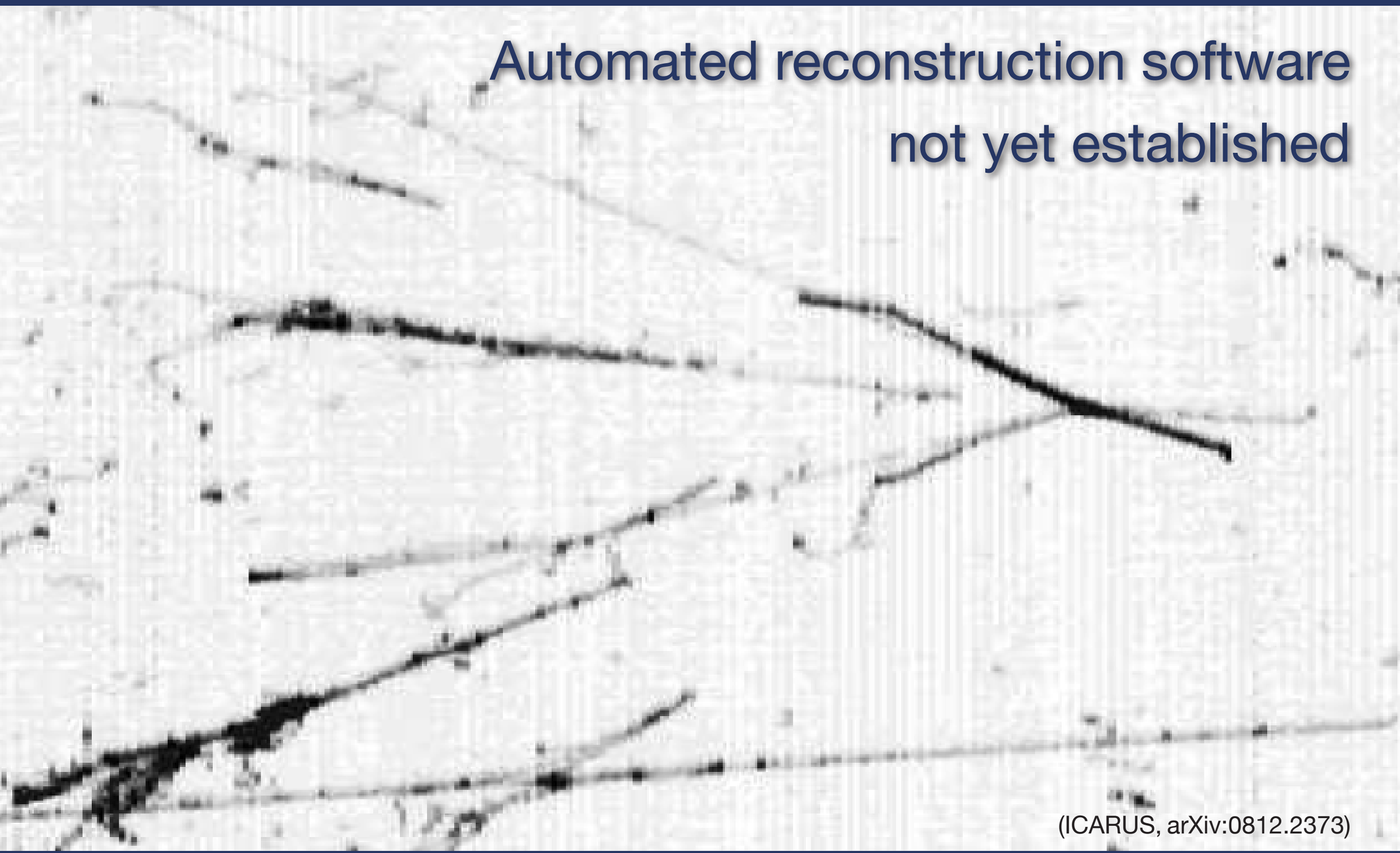


A. Guglielmi (ICARUS), Neutrino 2010

Detectors on scale of 100 kton required for next generation ν experiments

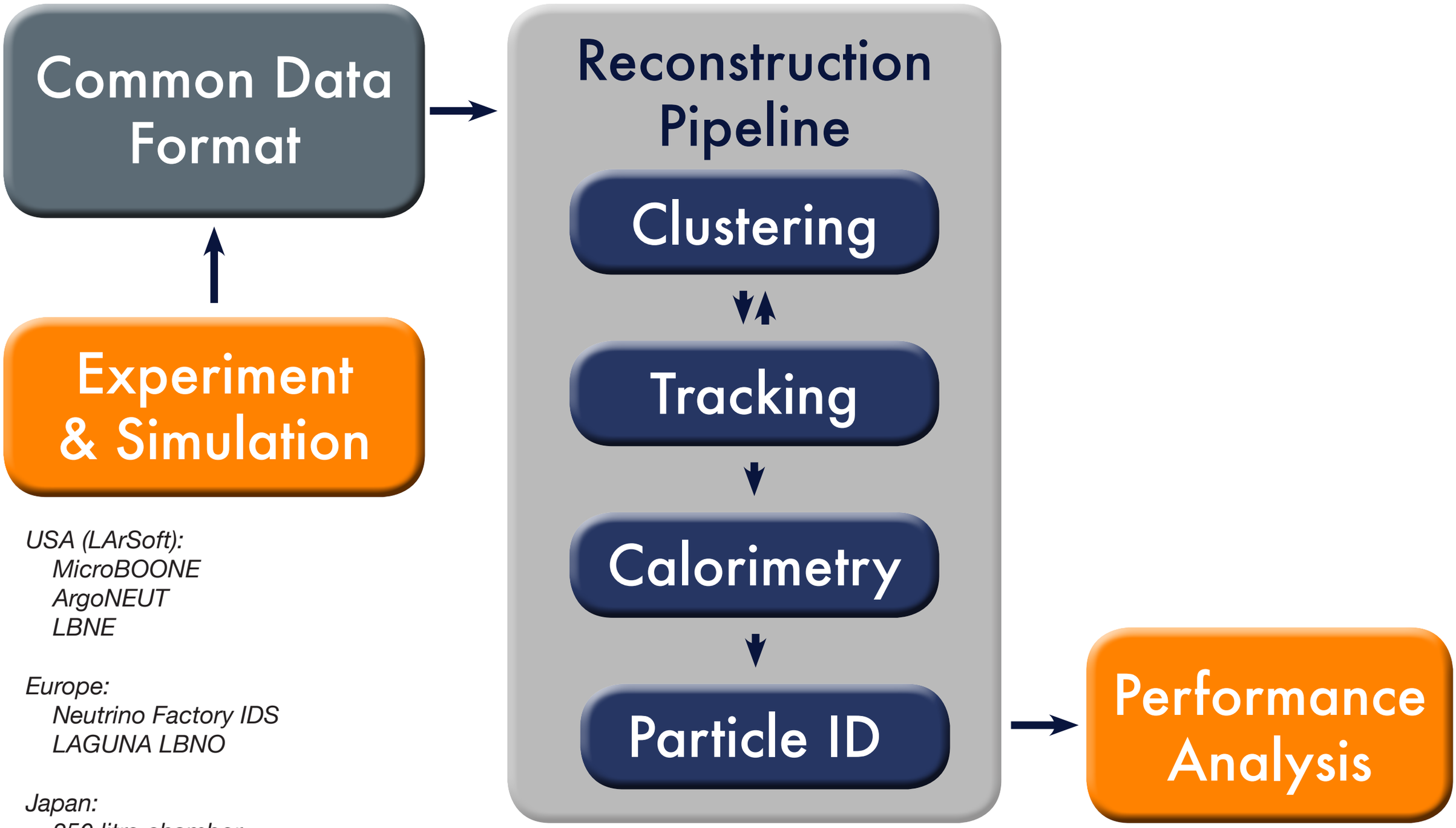
The Challenges

Automated reconstruction software not yet established



(ICARUS, arXiv:0812.2373)

The Road To Analysis



USA (LArSoft):
- *MicroBOONE*
- *ArgoNEUT*
- *LBNE*

Europe:
- *Neutrino Factory IDS*
- *LAGUNA LBNO*

Japan:
- *250 litre chamber*

Reconstruction Algorithms

Clustering

- DBSCAN
- OPTICS
- Cellular Automata

conservative clustering

Track Fitting

- Kalman Filter

Calorimetry

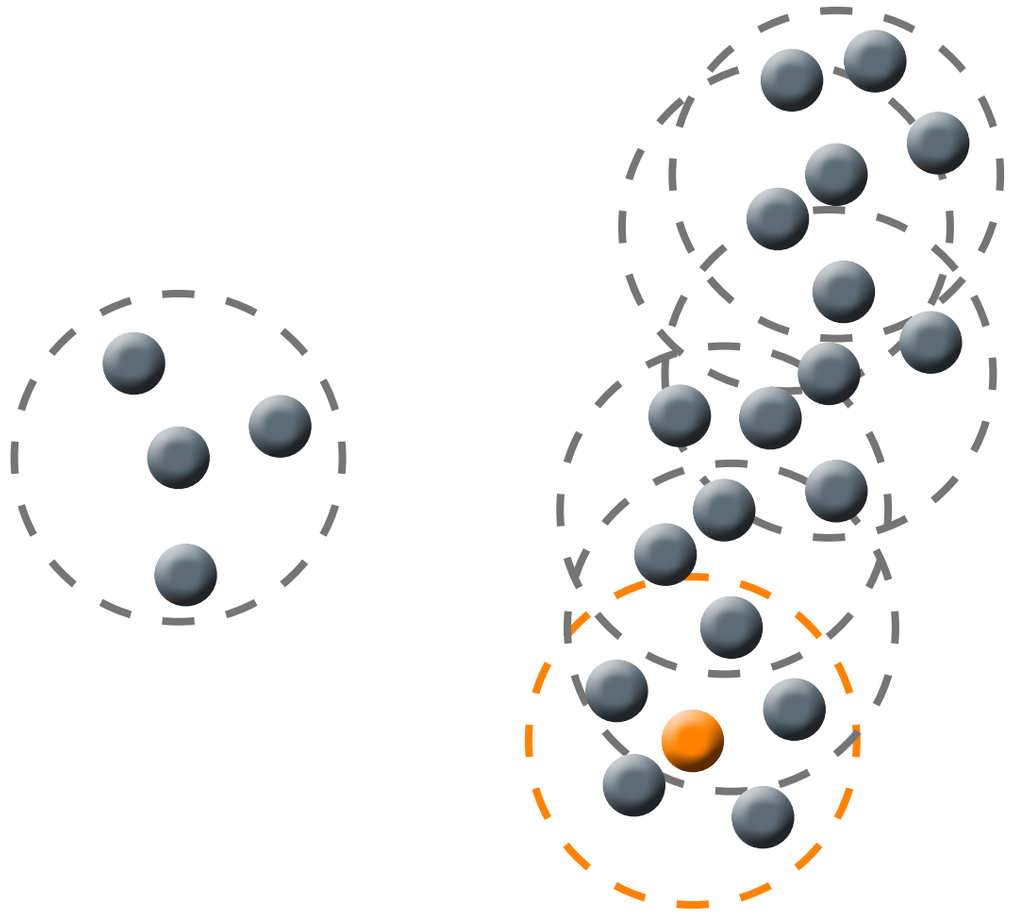
- Particle Flow

Feature Extraction

- Corner Finding

DBSCAN*

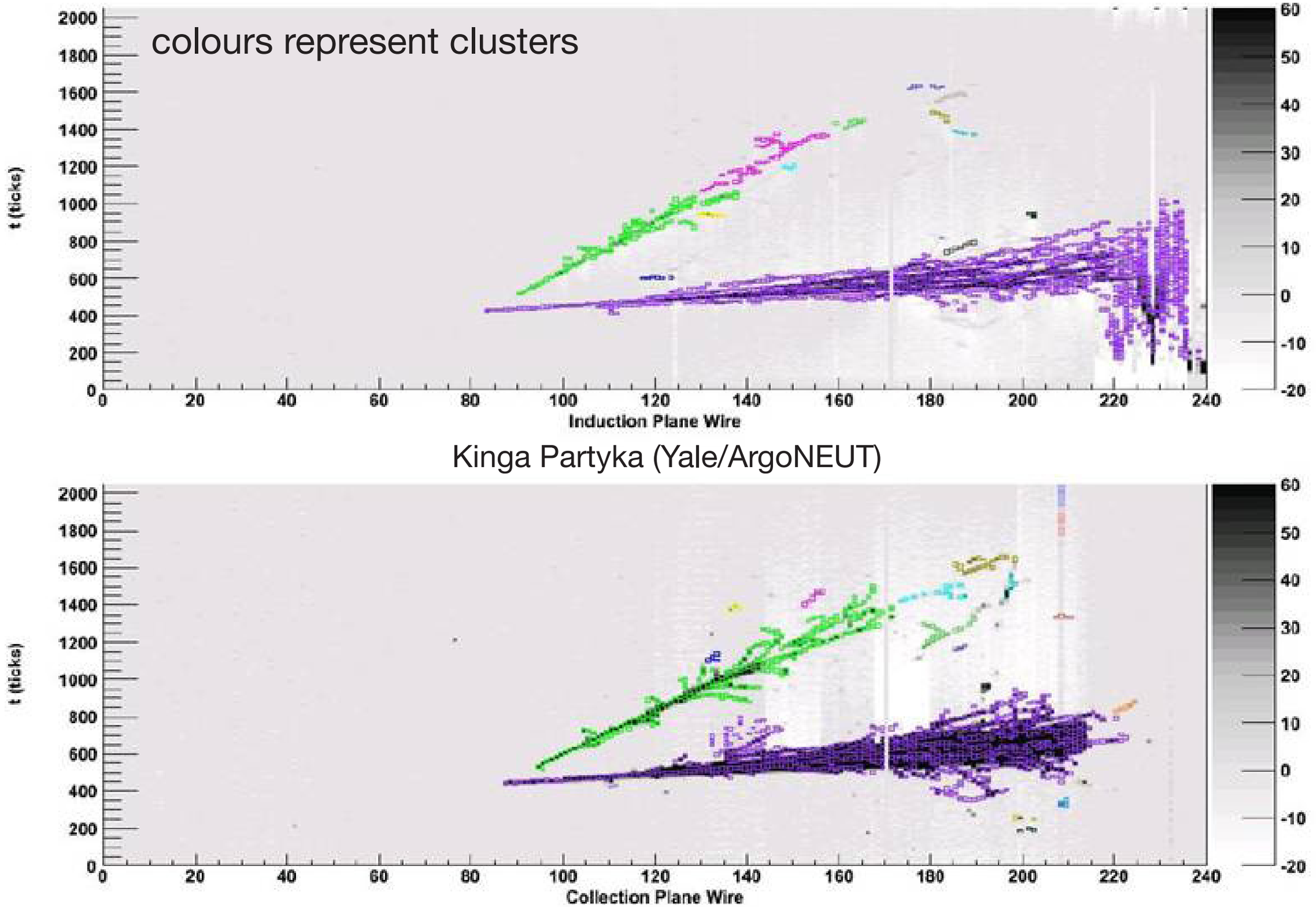
- Density based clustering
- Neighbourhood (radius ε) around a point must have $\geq N_{min}$ points
- Clusters formed from *density reachable* points



$N_{min} \geq 5$

*Sander et al., Data Mining & Knowledge Discovery 2, pp169–194 (1998)

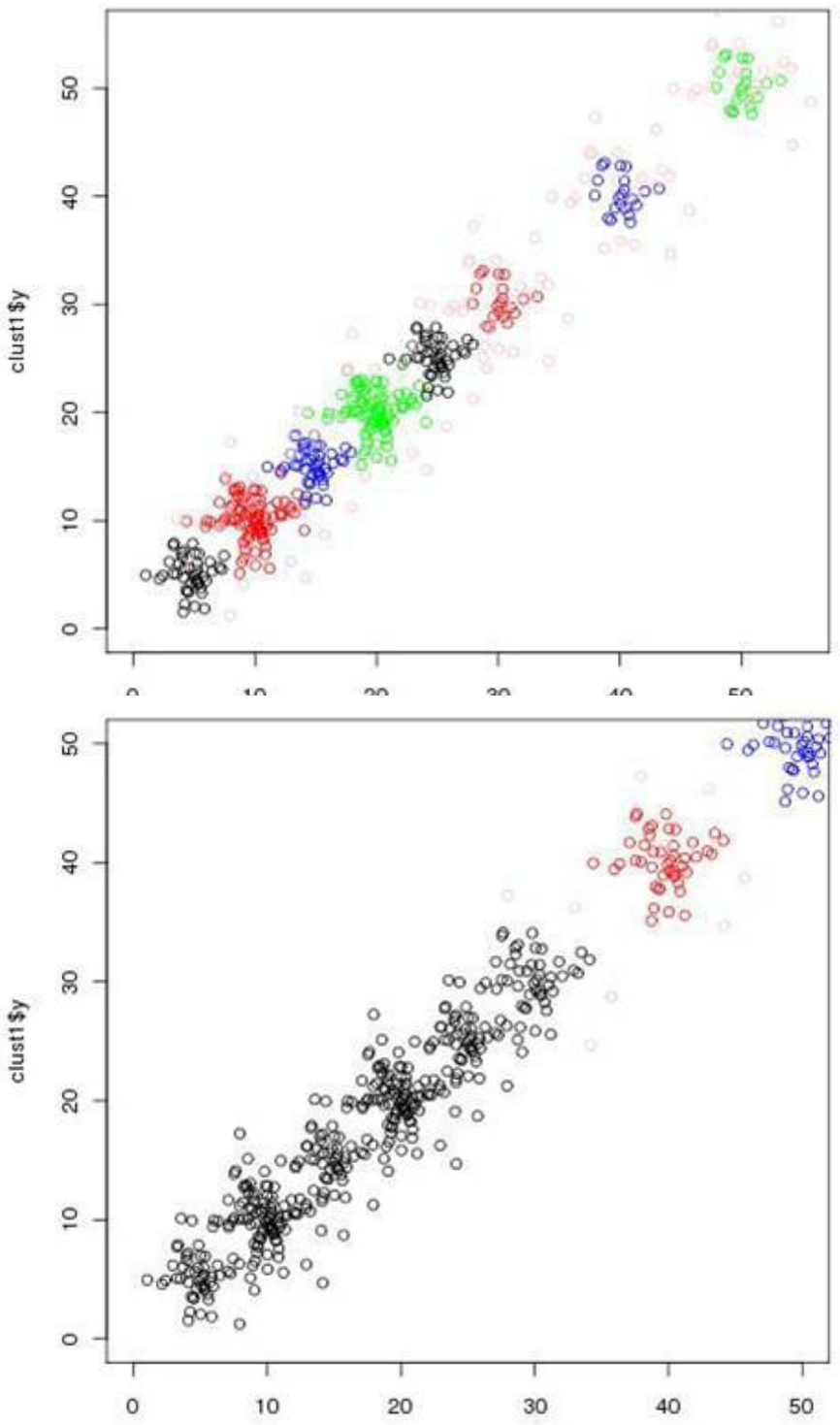
DBSCAN in ArgoNEUT



Kinga Partyka (Yale/ArgoNEUT)

OPTICS*

- Extension of DBSCAN

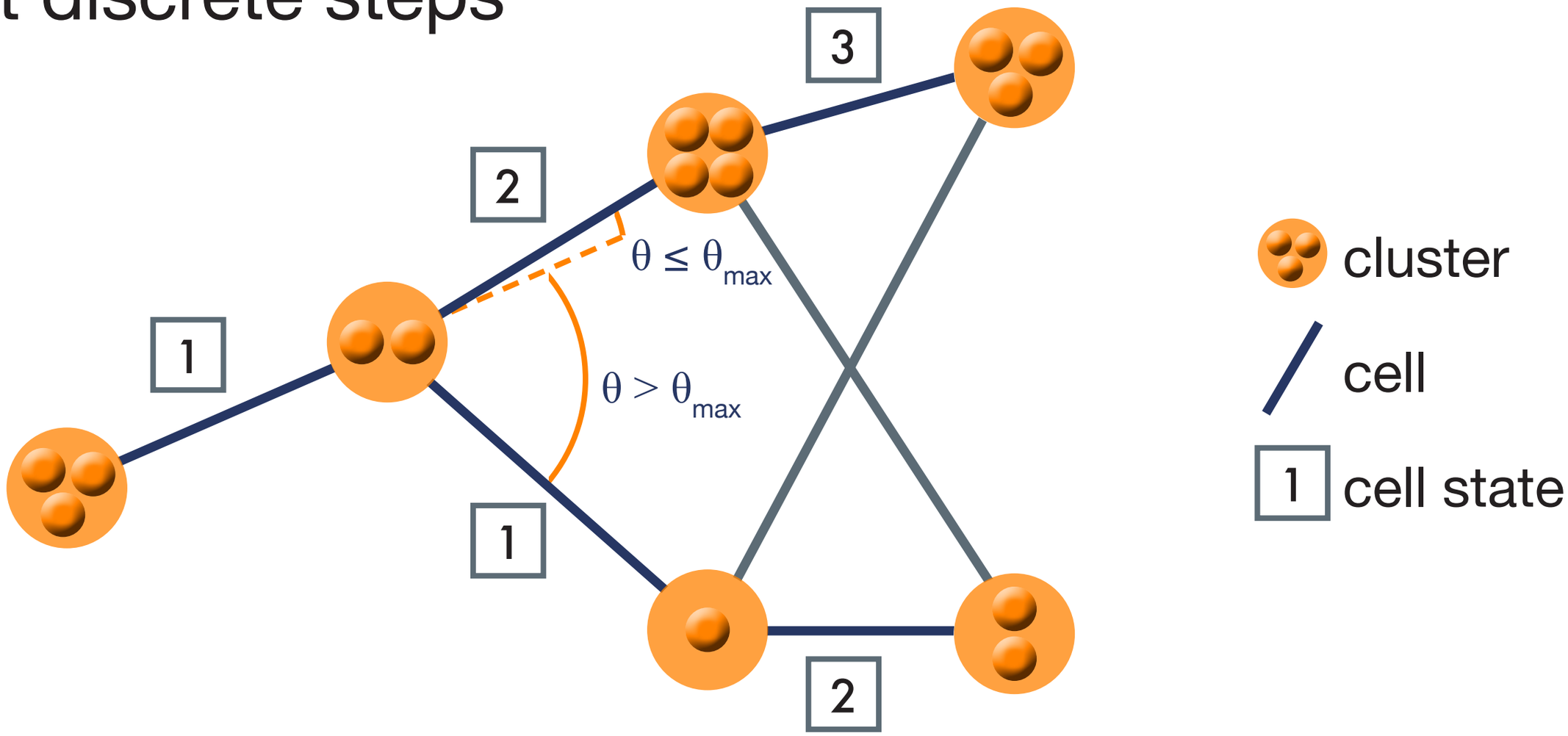


- Clusters on *all* scales of neighbourhood ε
- ε scale can be tuned to minimise overclustering

Ankerst et al., ACM SIGMOD Int. Conf. on Management of Data pp49–60 (1999)

Cellular Automata

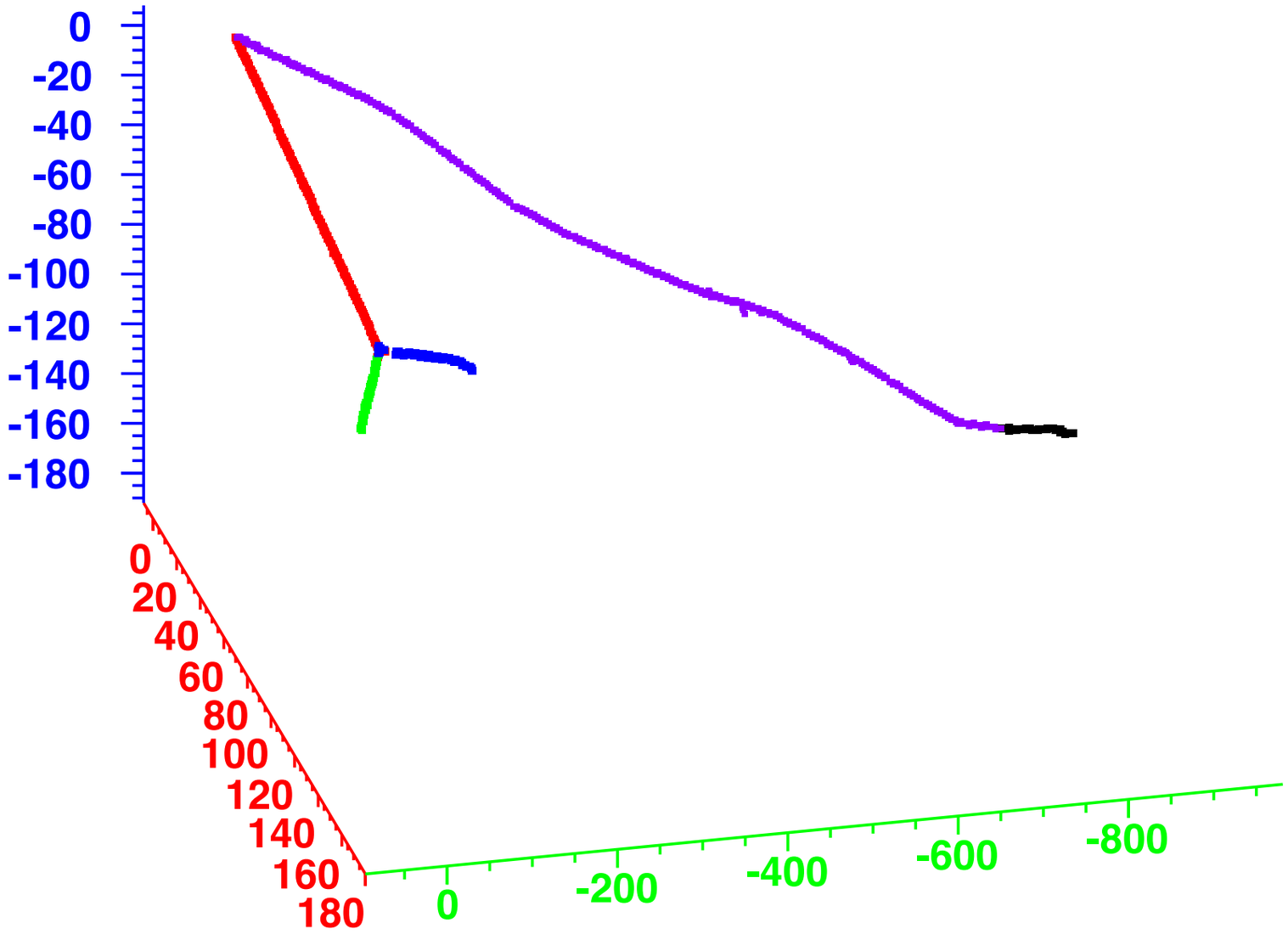
- Dynamical system with rules to update *local* state at discrete steps



Rule: Increment state if neighbours consistent with straight line determined by max. angle θ

Cellular Automata

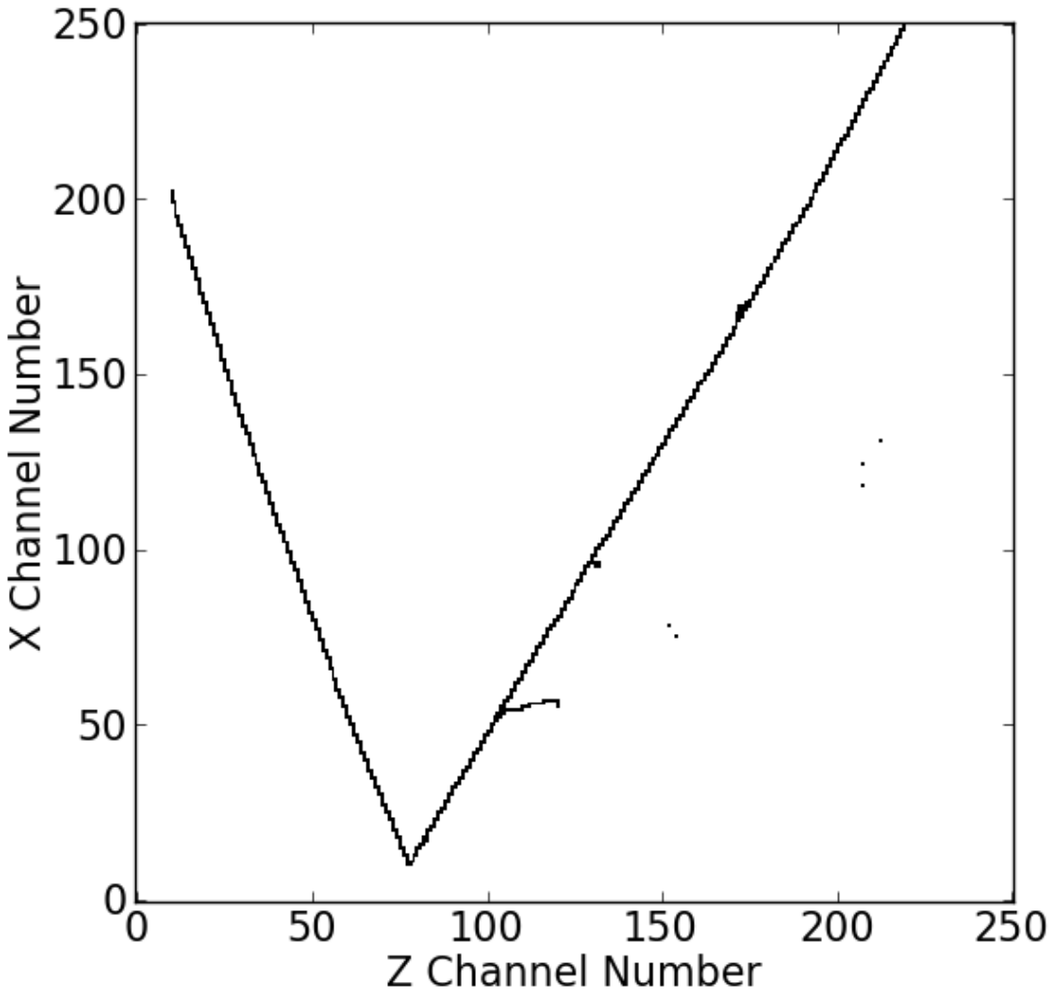
- CA applied to GENIE CCQE ν_μ interaction tracked through GEANT4

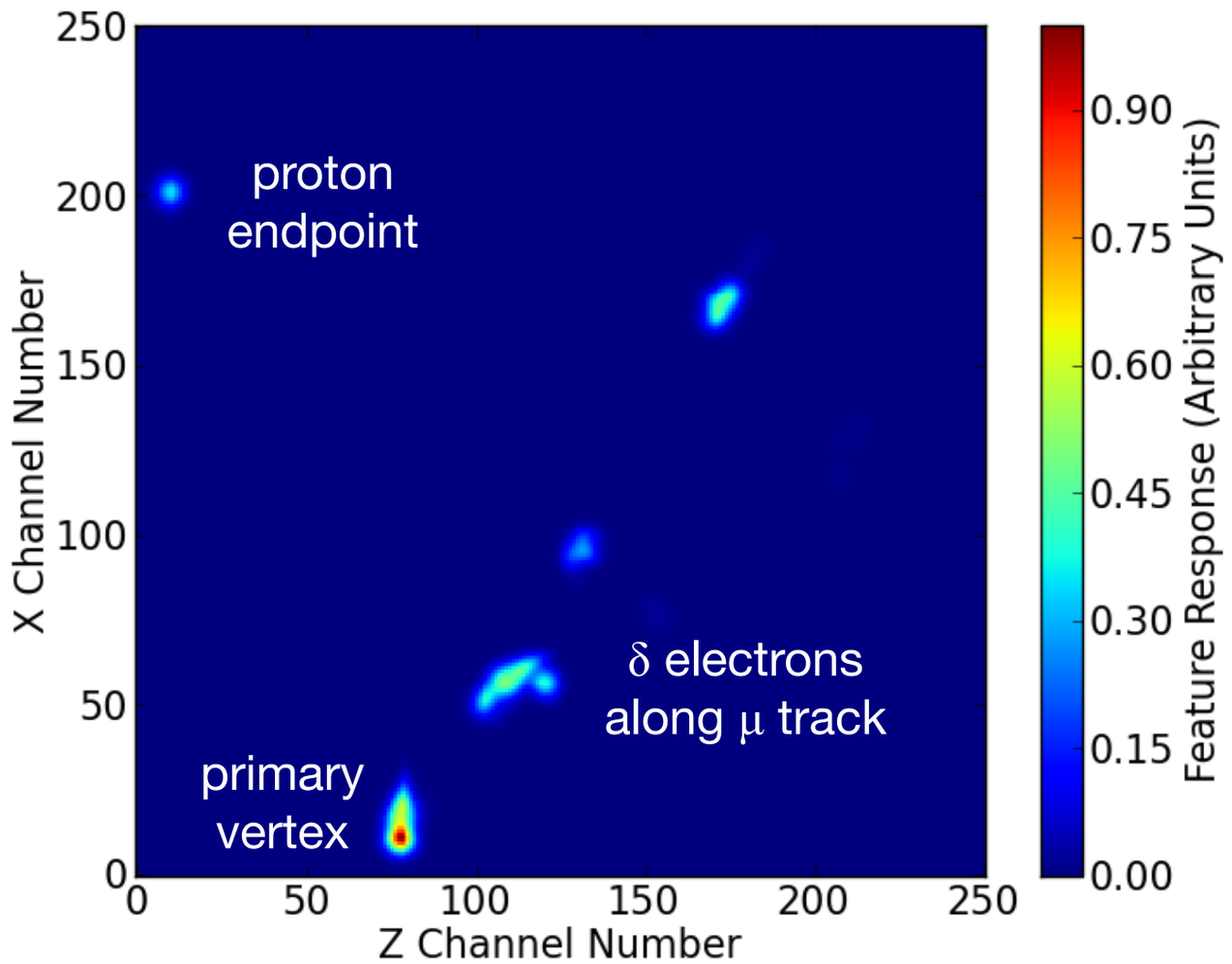


proton, muon, Michel electron, products of hadronic reinteraction of proton

Key Point Detection

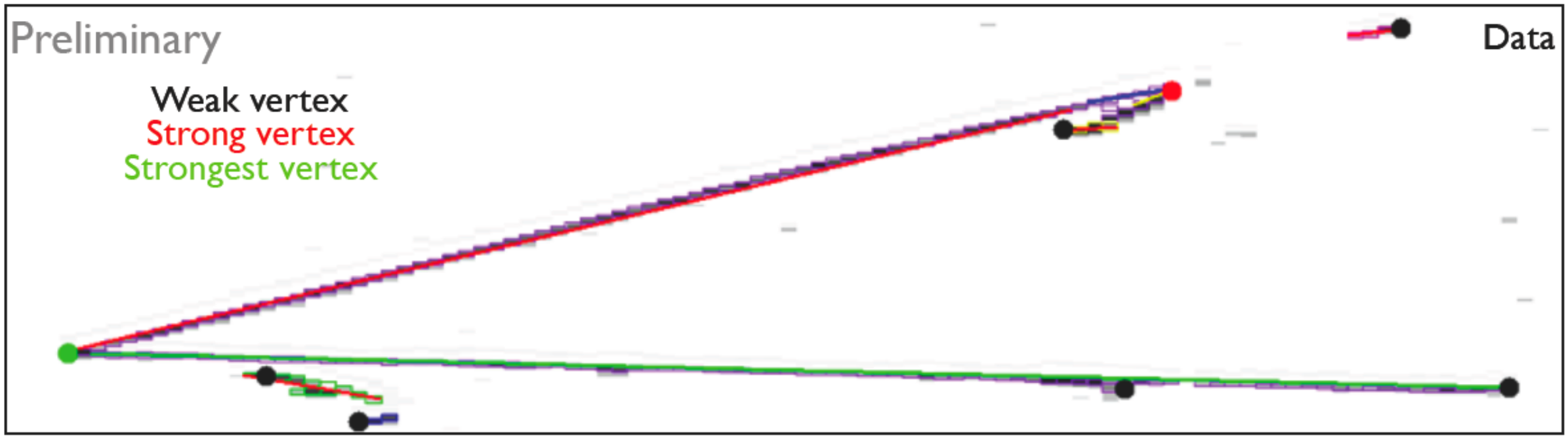
- Structure tensor of energy deposits can be used to identify *interest points*
- Foestner/Noble corner detection measure





B. Morgan, JINST 5(07) p7006 (2010)

Vertex Finding in ArgoNEUT



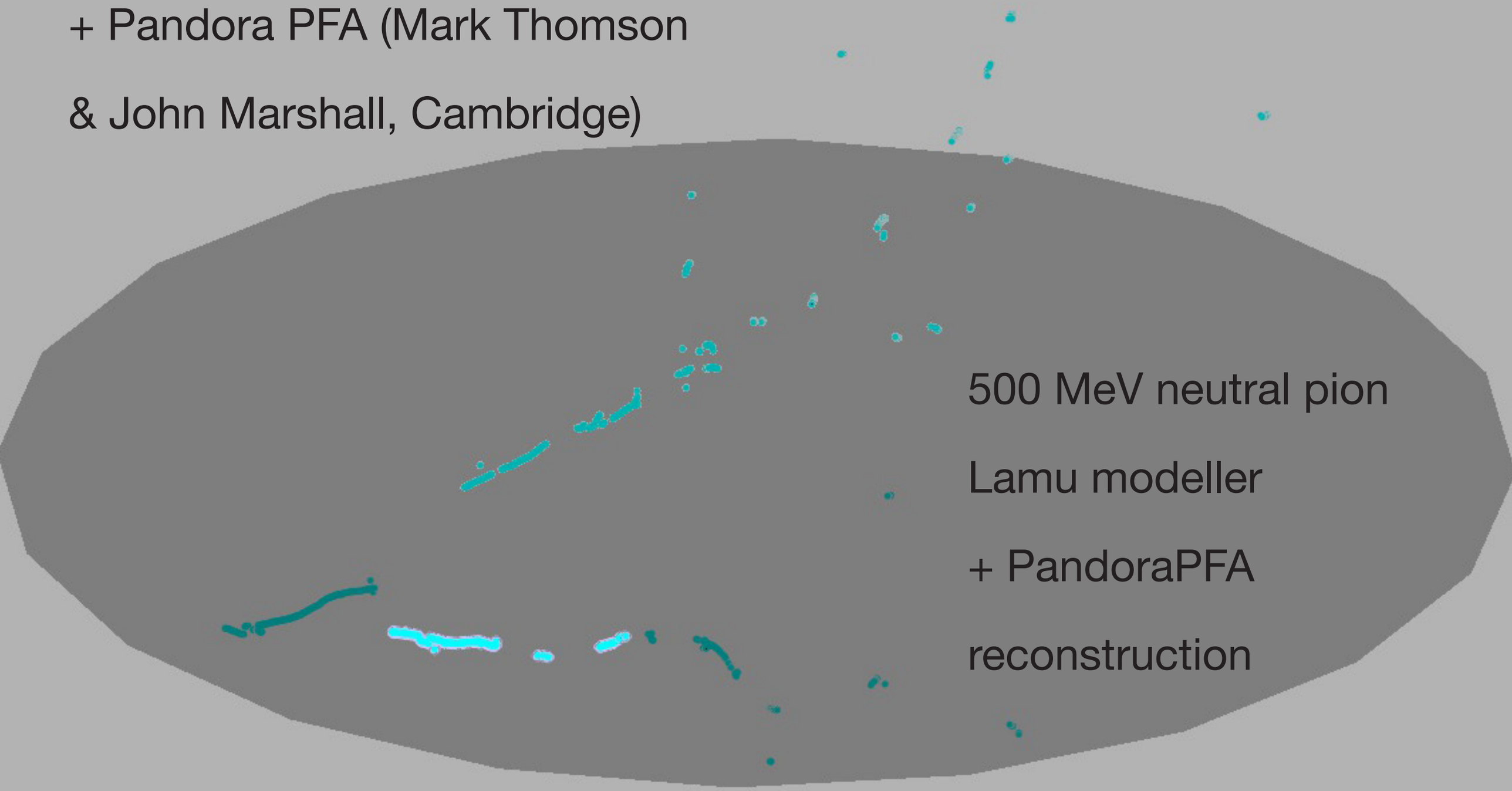
- Key point detection has been used to find vertices in ArgoNEUT events

Particle Flow Calorimetry

Latte simulation (Ben Morgan, Warwick)

+ Pandora PFA (Mark Thomson

& John Marshall, Cambridge)



500 MeV neutral pion

Lamu modeller

+ PandoraPFA

reconstruction

Do LAr-TPCs Dream of Electric Reconstruction?

- Reconstruction algorithms in development
- Key point finding critical for identifying features in ν interactions
- Focus reconstruction efforts towards phenomenology
- Warwick are contributing significantly to worldwide software efforts