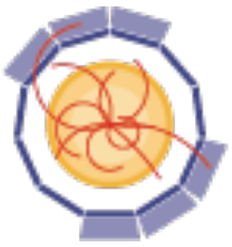


Advanced Particle Flow

- **Development of advanced particle flow and pattern recognition algorithms in PandoraPFA**
- **Application to LHC, LC and neutrino experiments**

J. S. Marshall, 1 February 2016

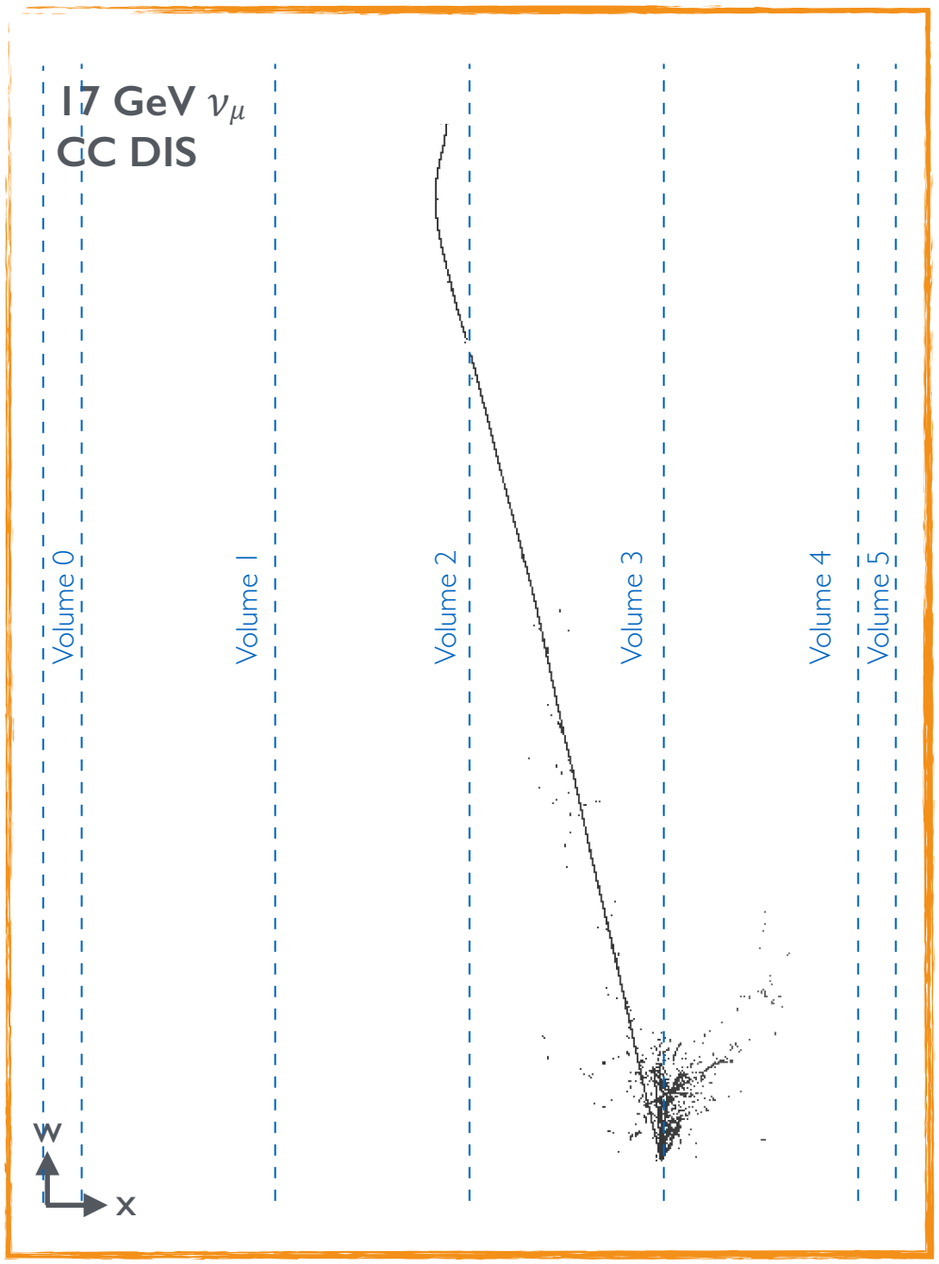
Pandora for MicroBooNE

The Pandora team has been busy in Collaboration Meetings!
First stop: MicroBooNE Collaboration meeting in Bern, Switzerland (19-21 January 2017)

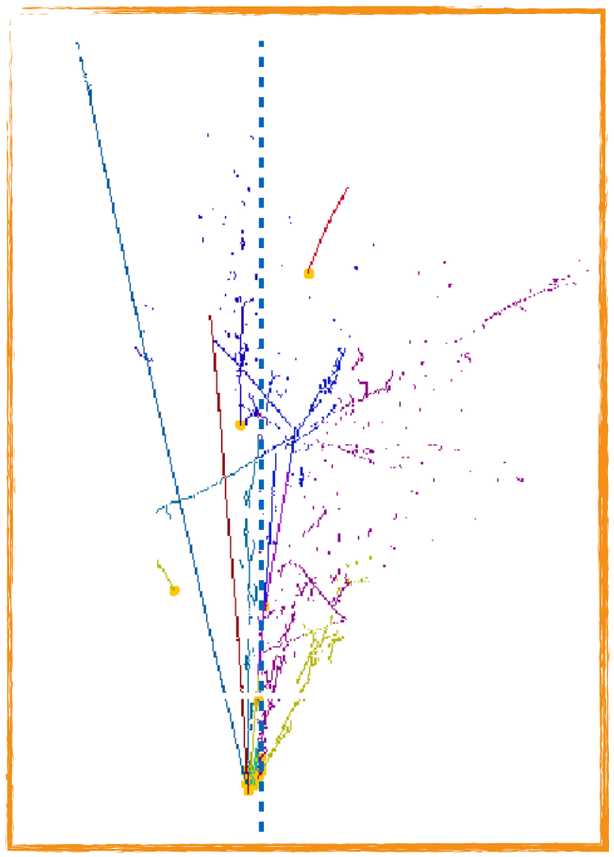
- Presented the most recent pattern recognition performance metrics, highlighting improvements in:
  - Vertexing (new algs for vertex creation and selection)
  - Shower completeness (new sliding cones fits to "generously" collect shower fragments far away)
  - Track/Shower ID (address the tension between pattern recognition for track vs. shower topologies)
- Next step: formal MicroBooNE Pandora publication based on the public technical note available **here**

Pandora for DUNE

The Pandora team has been busy in Collaboration Meetings!
Second stop: DUNE Collaboration week at CERN, Geneva Switzerland (23-27 January 2017)



Zoom in to reco particles →



DUNE vs. MicroBooNE (some key PatRec issues):

Beam spectrum: typically higher neutrino energies at DUNE, with rather different event topologies.

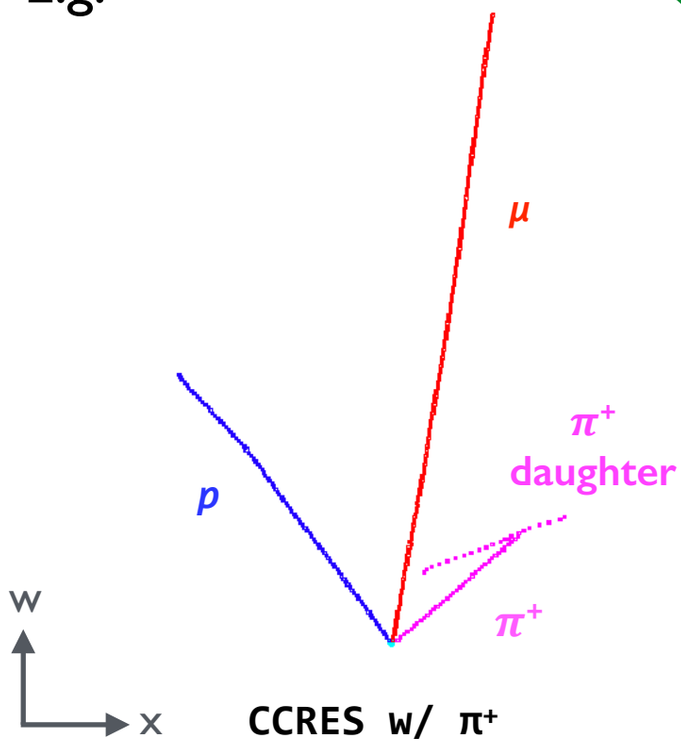
DUNE detectors comprise multiple "drift volumes": regions with common drift direction, wire pitches and angles.

Some all-new software challenges, but no cosmic-ray backgrounds!

Pandora for DUNE10kt

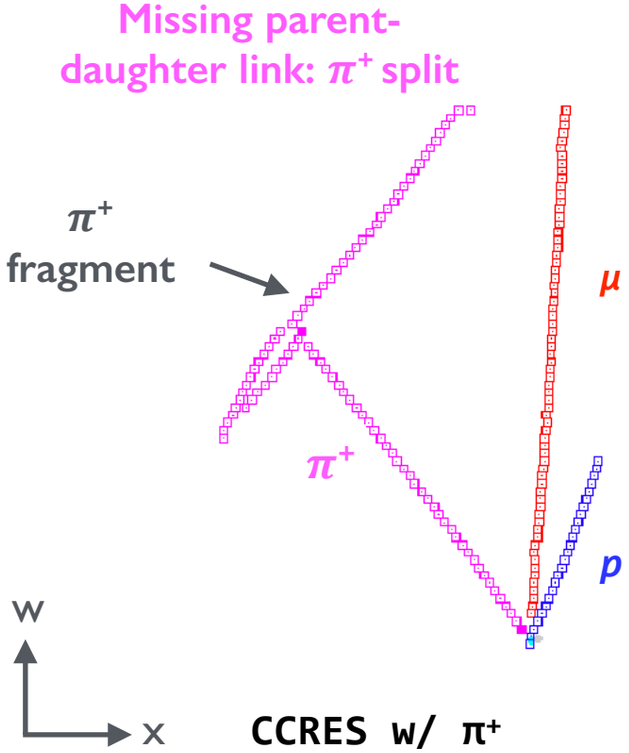
- **Most LAr TPC alg development and validation has been in a MicroBooNE context**
  - Last week, gave flavour of how Pandora performs for dune10kt model (w/o any retuning)
- **Presented fraction of events deemed "correct" by Pandora performance metrics:**
  - Well-defined (see MicroBooNE public note); ***very strict*** assessment of pattern recognition
  - Consider exclusive final-states where all true particles pass simple quality cuts (e.g. nHits)
  - Correct means exactly one reco primary particle is matched to each true primary particle

E.g. ✓



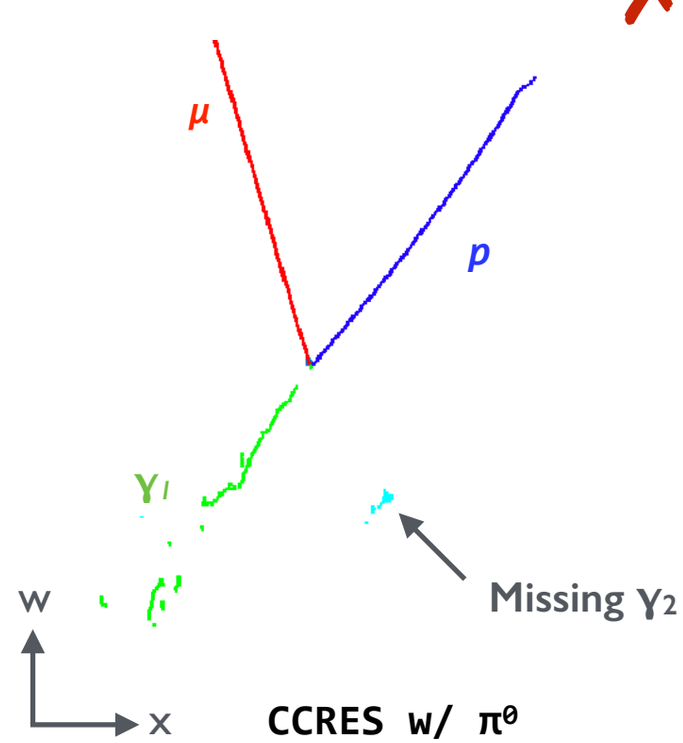
CCRES w/ π+

✗



CCRES w/ π+

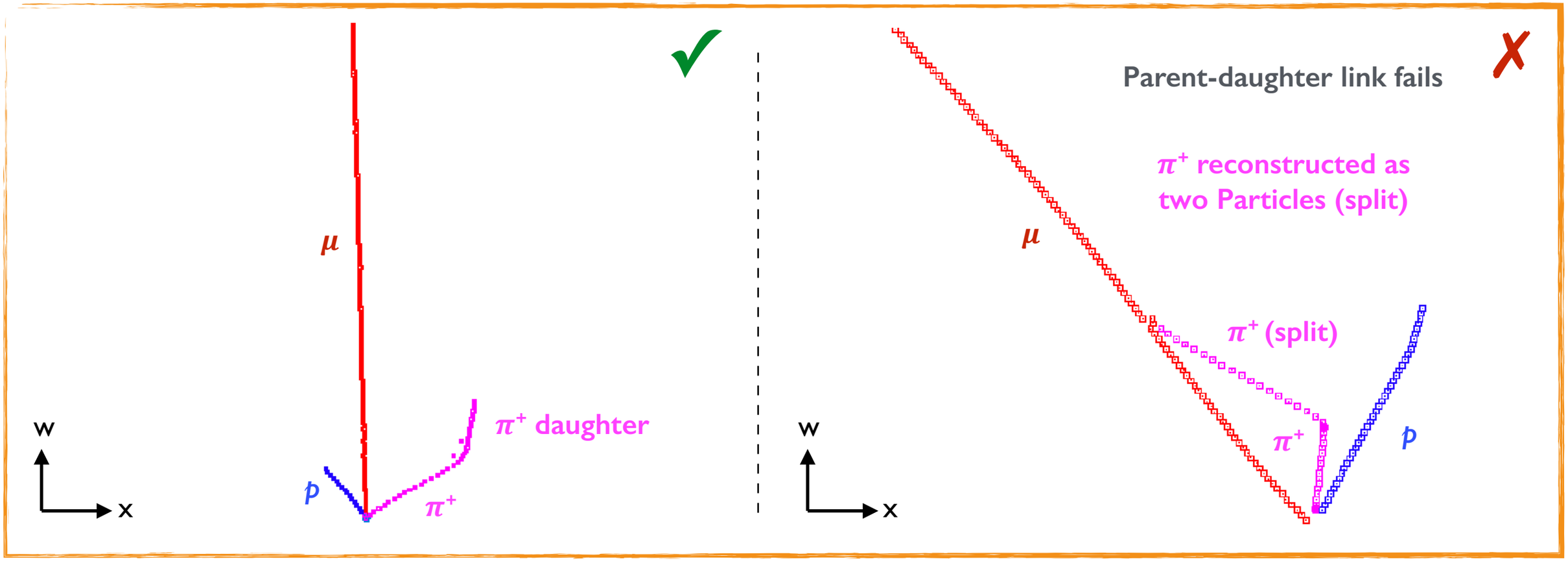
✗



CCRES w/ π0

E.g. Pandora for DUNE10kt

CC RES: $\nu_\mu + N \rightarrow X + p + \pi^+ + \mu^-$ π^+ often has complex hierarchy of daughter particles



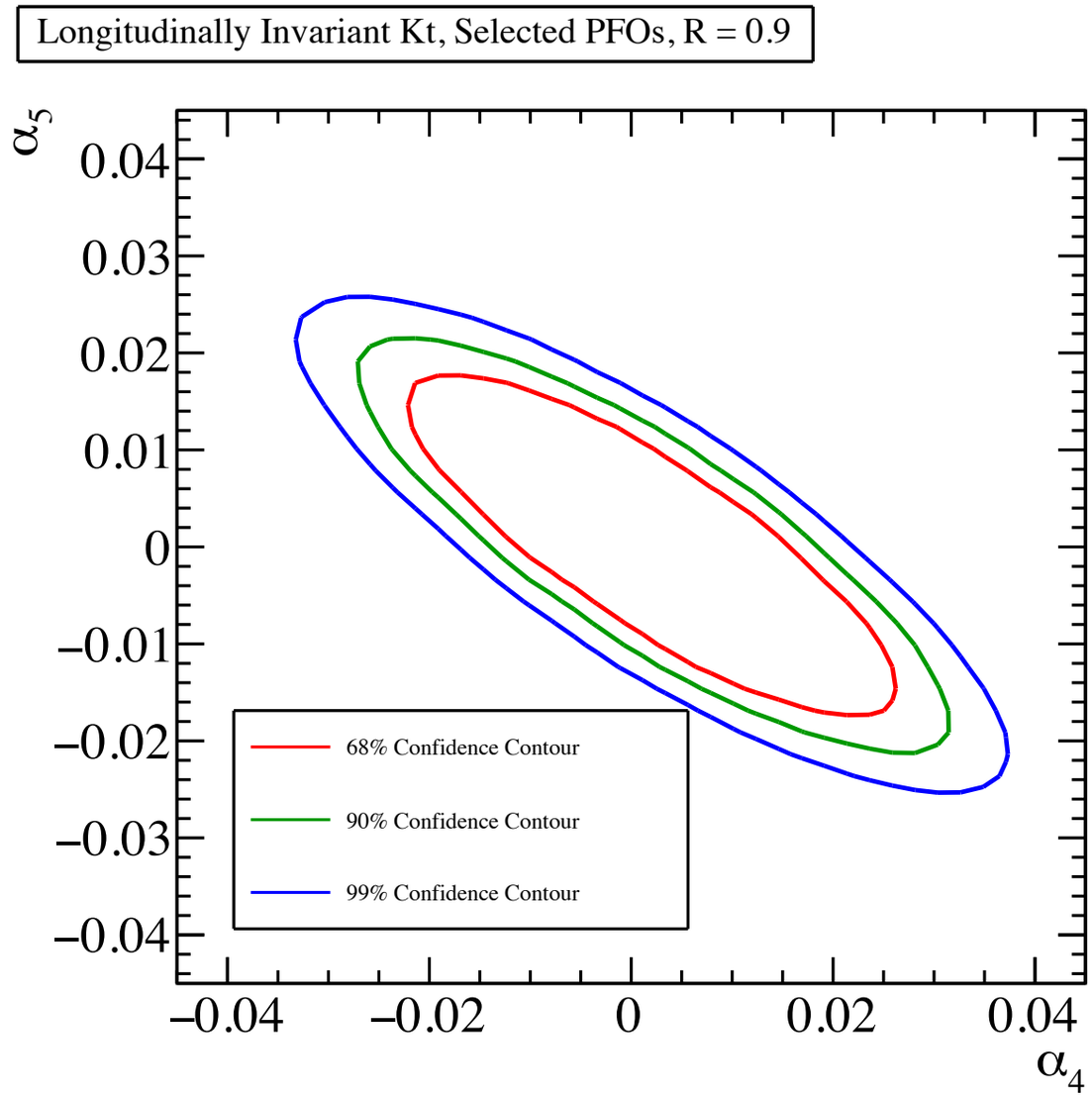
#Matched Particles	0	1	2	3+
μ	$(1.6 \pm 0.1)\%$	$(96.6 \pm 0.2)\%$	$(1.7 \pm 0.1)\%$	$(0.1 \pm 0.0)\%$
p	$(8.5 \pm 0.3)\%$	$(85.3 \pm 0.4)\%$	$(5.8 \pm 0.3)\%$	$(0.4 \pm 0.1)\%$
π^+	$(9.0 \pm 0.3)\%$	$(80.9 \pm 0.4)\%$	$(9.5 \pm 0.3)\%$	$(0.5 \pm 0.1)\%$

8,416 events **Fraction of "correct" events: 69.3%** **Examine many other exclusive final states**

ILC and CLIC

Work done by S. Green:

- Examine sensitivity of CLIC to anomalous gauge couplings, alpha4 and alpha5 at 1.4TeV.
- Include signal final state ννqqqq, as well as all relevant backgrounds.
- Next step: consider systematics.
  - Quantify how uncertainties (e.g. cross-sections for beam-related backgrounds) affect result.



CLIC Simulation, Preliminary

Advanced Particle Flow: CERN, LLR

- Ongoing progress with topics previously discussed.