

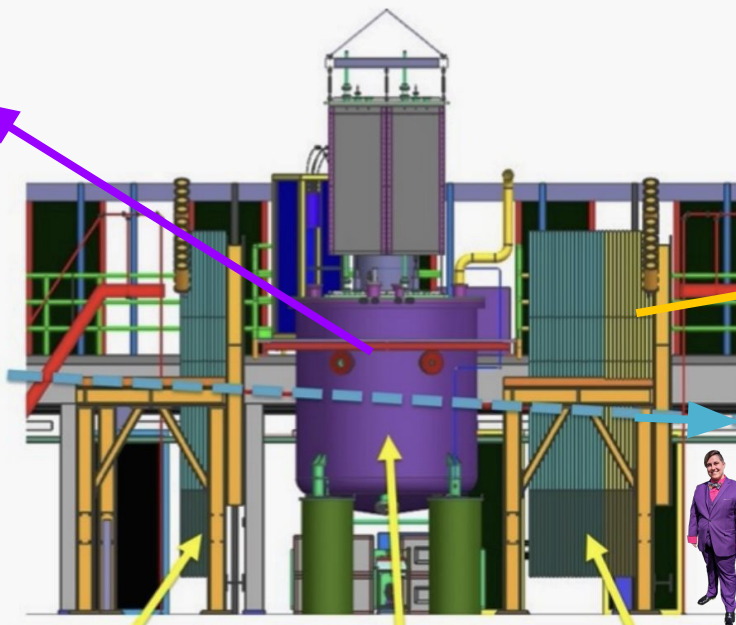
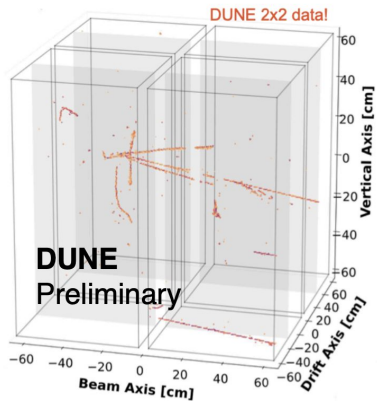
Track Matching Across Detectors: Reco SPINE 2x2 Matching + More?

Jessie Micallef (they/them), Daniel Xing
jessie.micallef@tufts.edu

3D from 2x2 vs 2D MINERvA Mx2



Inherently a 3D pixel readout

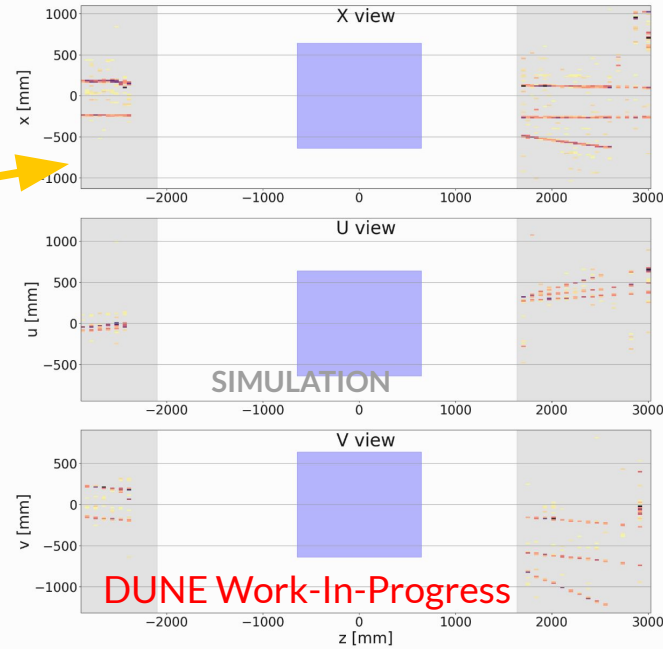


Upstream MINERvA

2x2 LArTPC

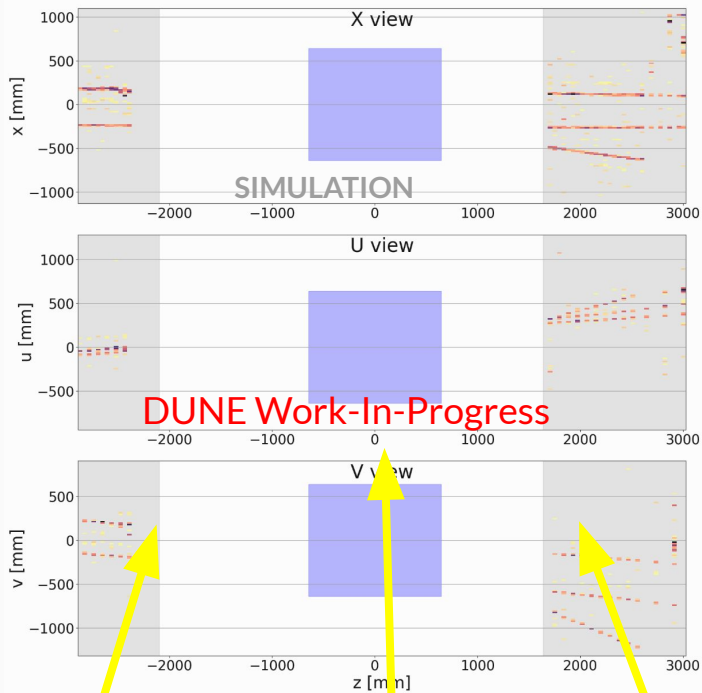
Downstream MINERvA

MINERvA: inherently a 2D output!



MINERvA Operations

Mx2 Track Segments

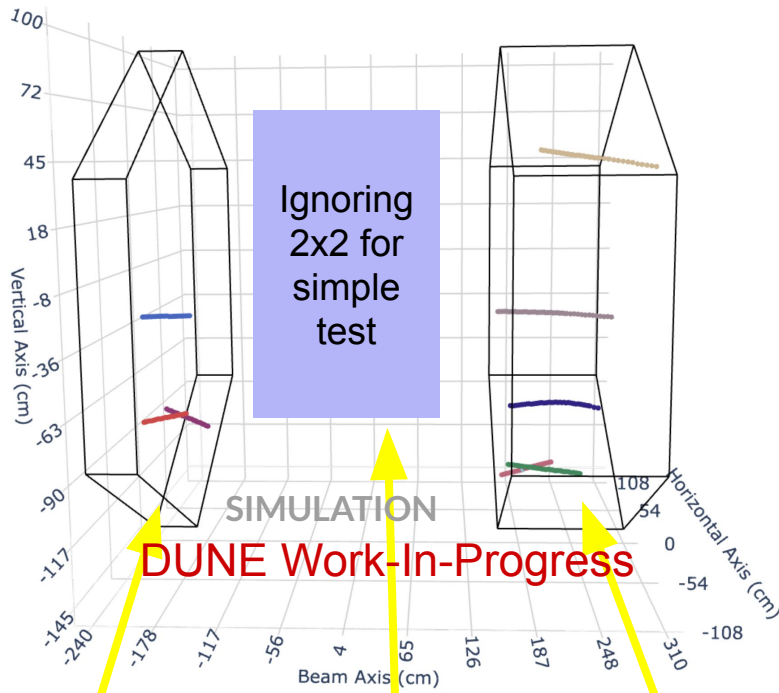


Traditional Track Reconstruction



Note: left & right are not the same particles

Colors indicate track segment



Upstream MINERvA

2x2 LAr with 4 TPCs

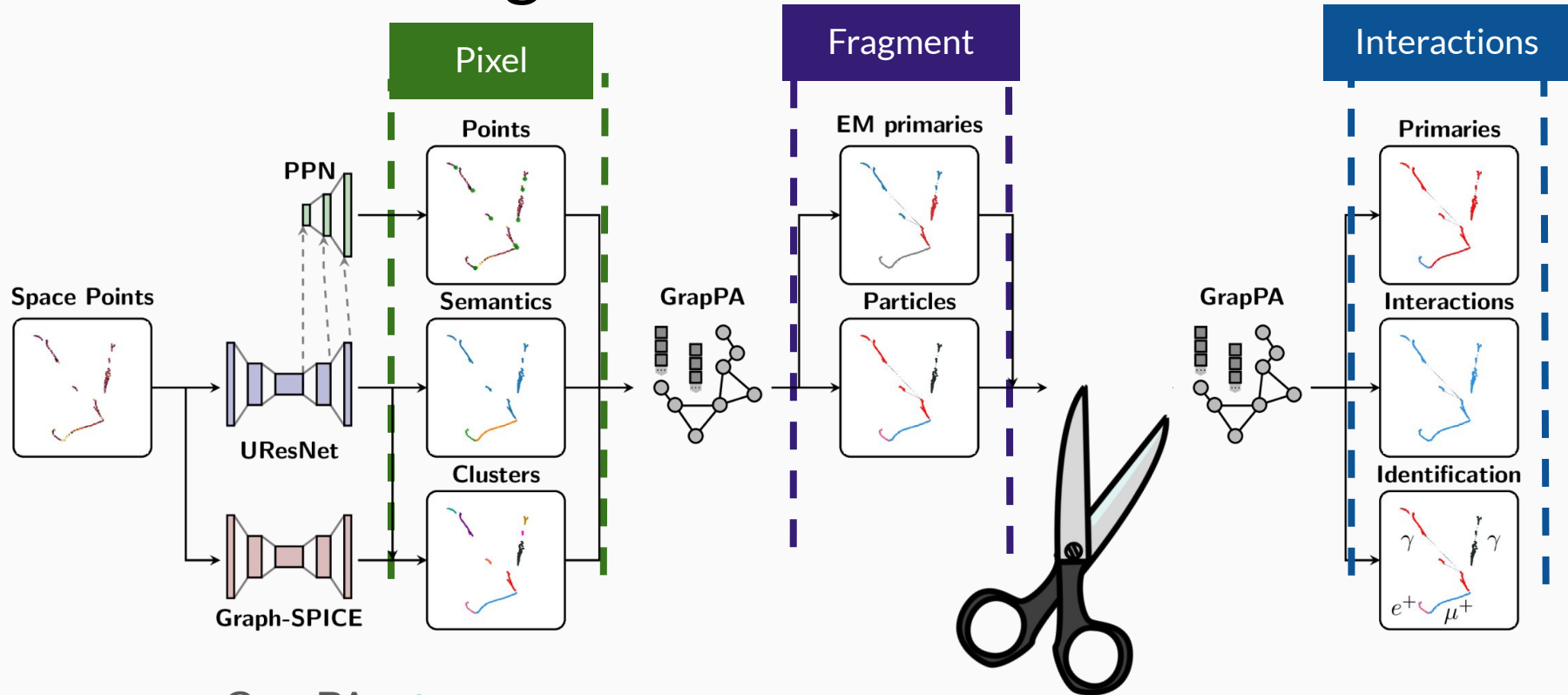
Downstream MINERvA

Upstream MINERvA

2x2 LAr with 4 TPCs

Downstream MINERvA

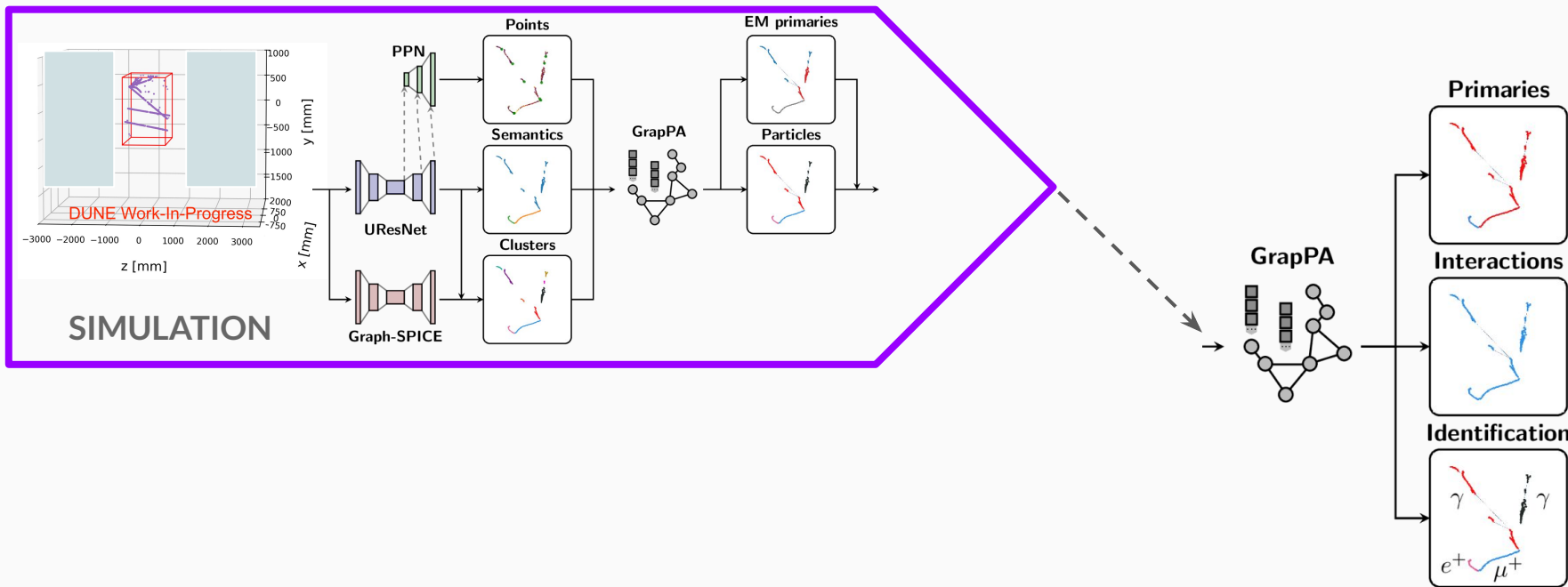
SPINE: Inserting Mx2



Grappa: [PhysRevD. 104. 072004](https://arxiv.org/abs/1907.072004)

Inserting Mx2

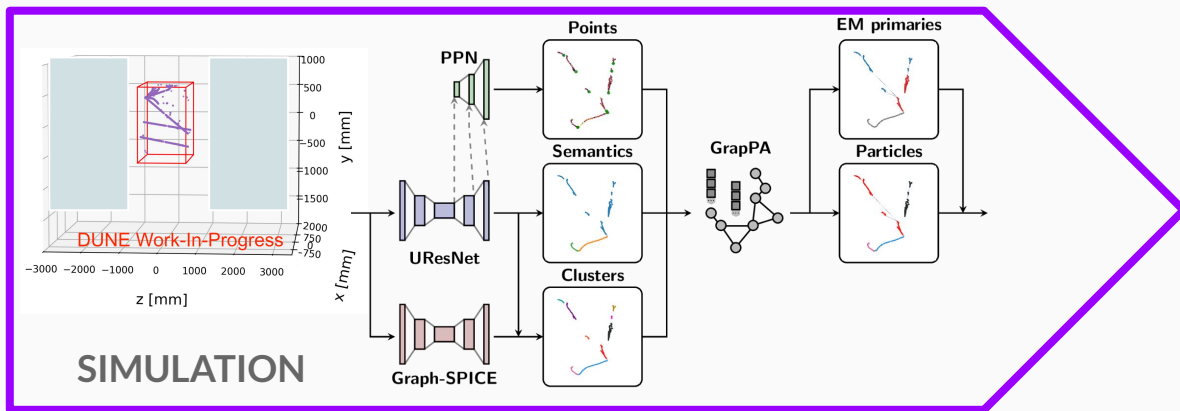
2x2



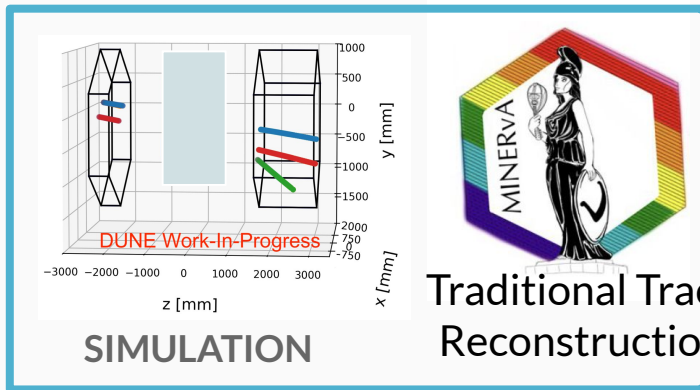
Grappa: [PhysRevD. 104.072004](https://arxiv.org/abs/1907.07204)

Inserting Mx2

2x2



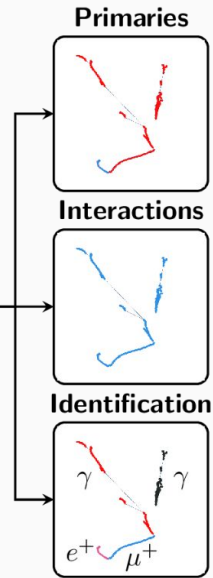
Mx2



Traditional Track Reconstruction

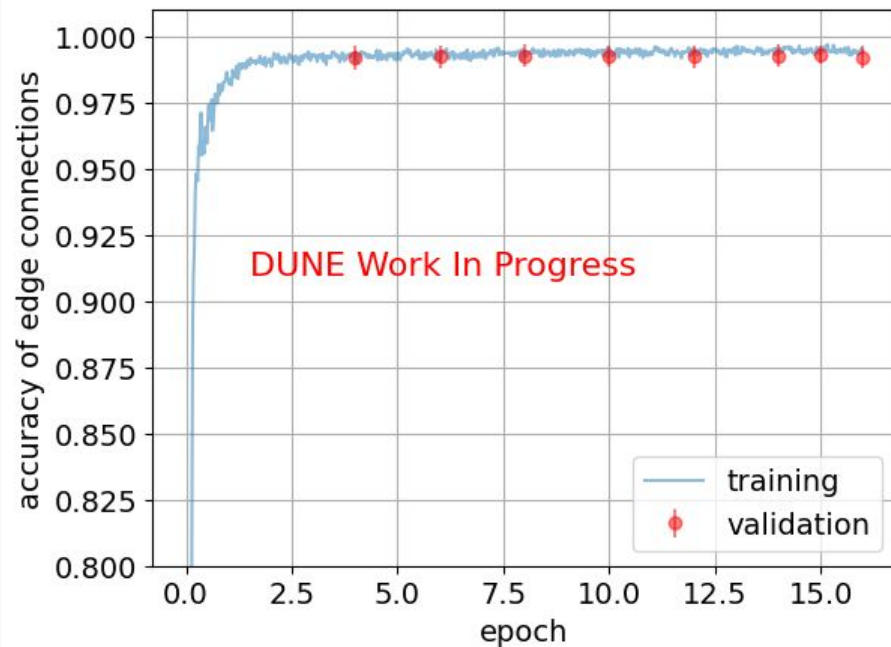
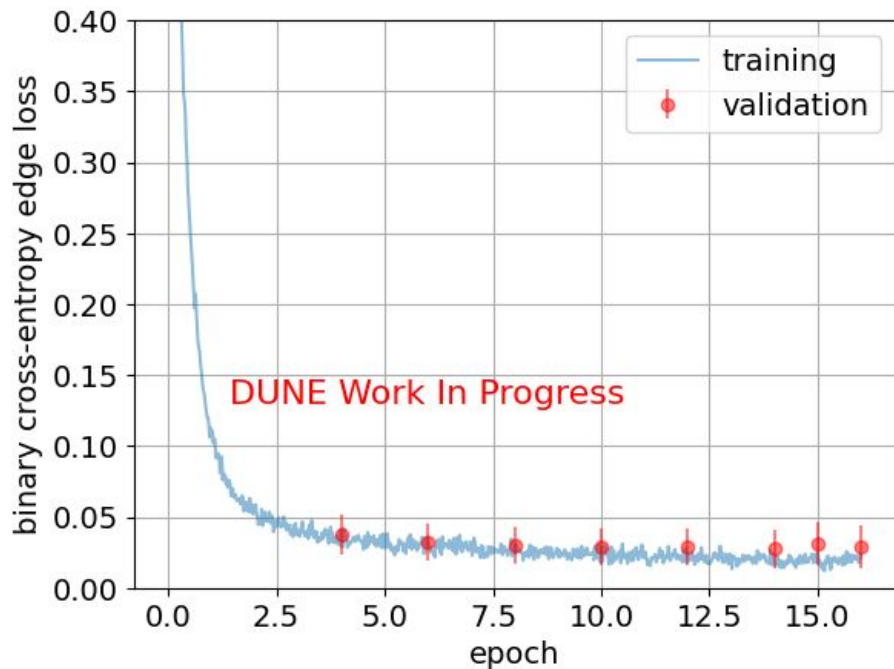
GrapPA: [PhysRevD. 104.072004](https://arxiv.org/abs/2007.12345)

GrapPA

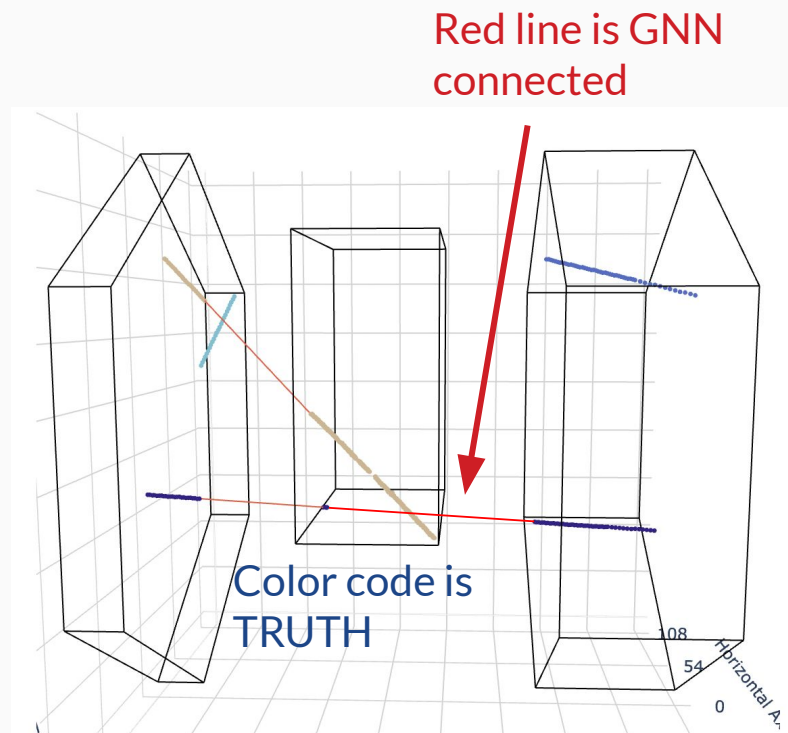
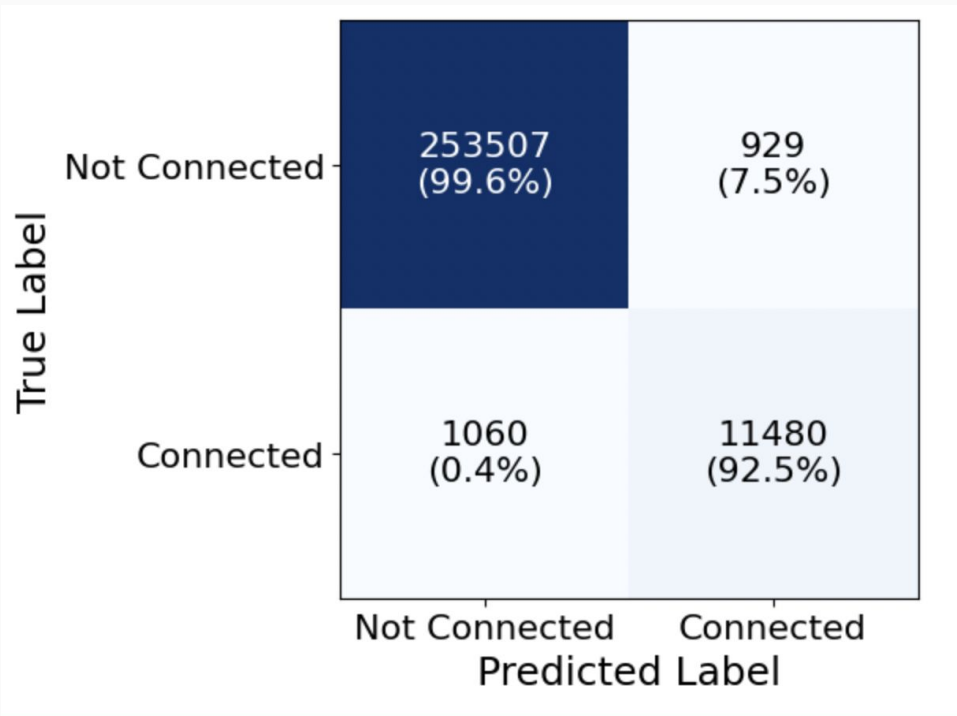


First Check: Trained with ~27k events

- MINERva Up + Downstream already connected via MINERva reco
- Some 2x2 fragments are not connected → taken mid SPINE reco currently

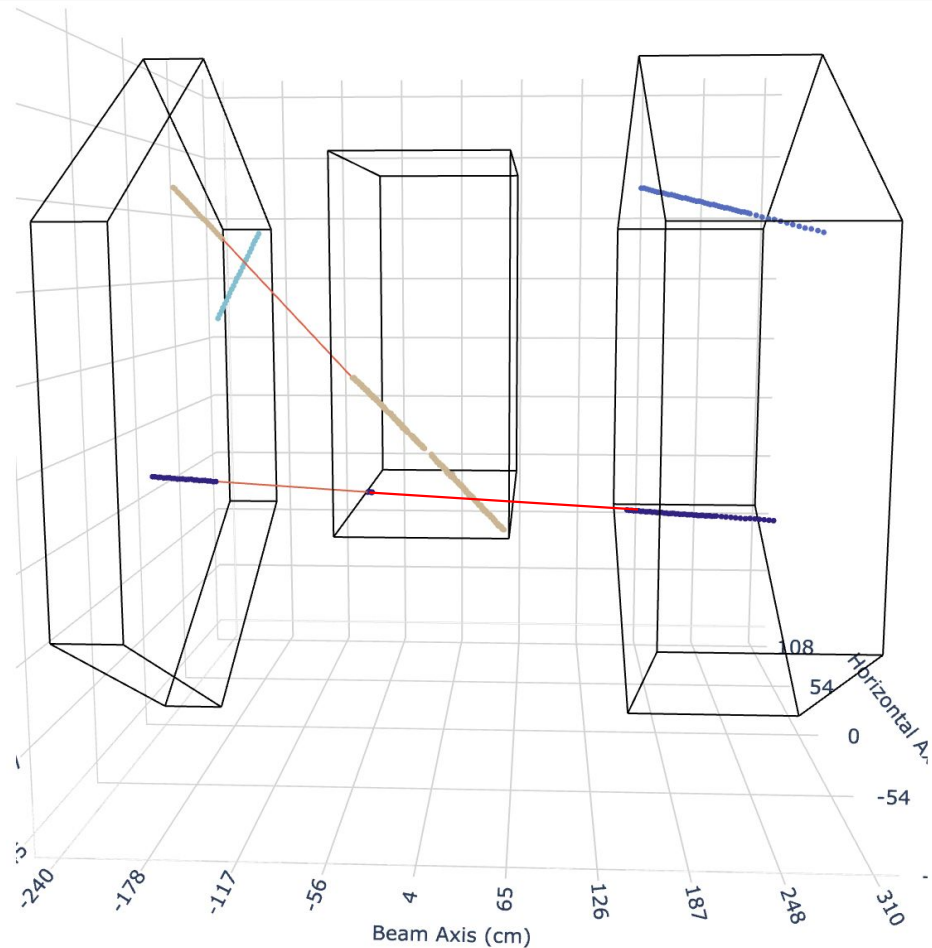


First Check: Tested with 6757 events



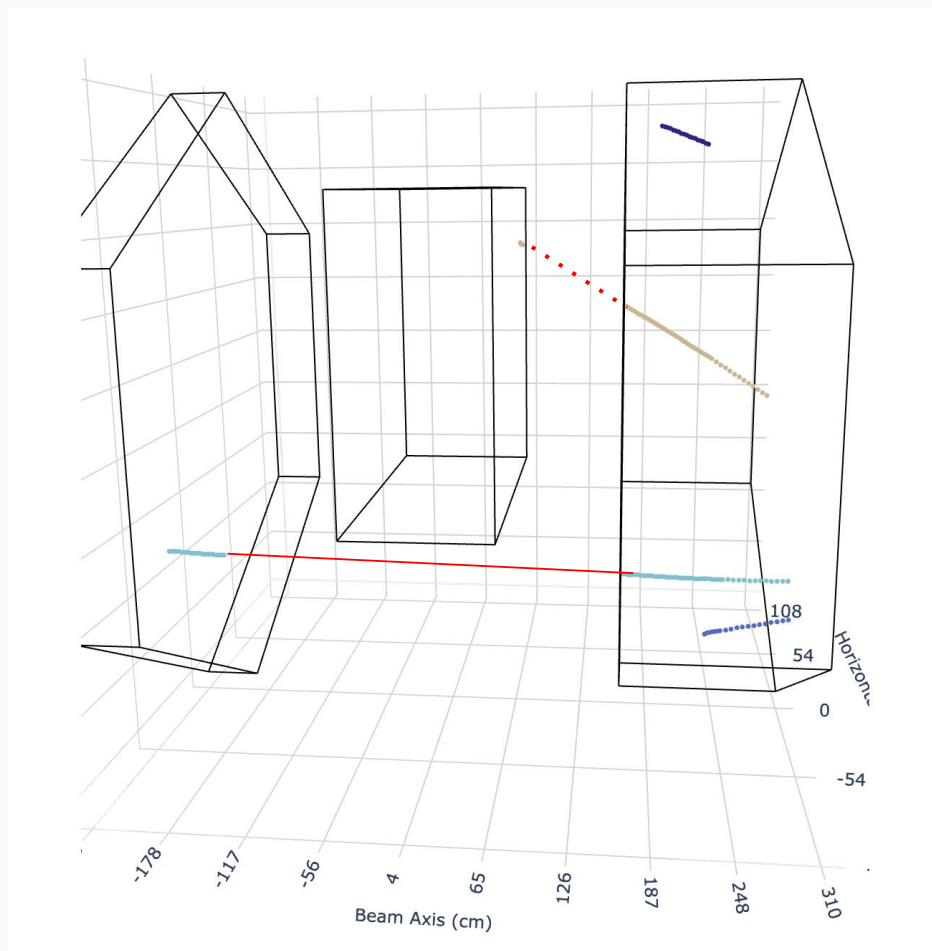
Correct Event

Doing well!



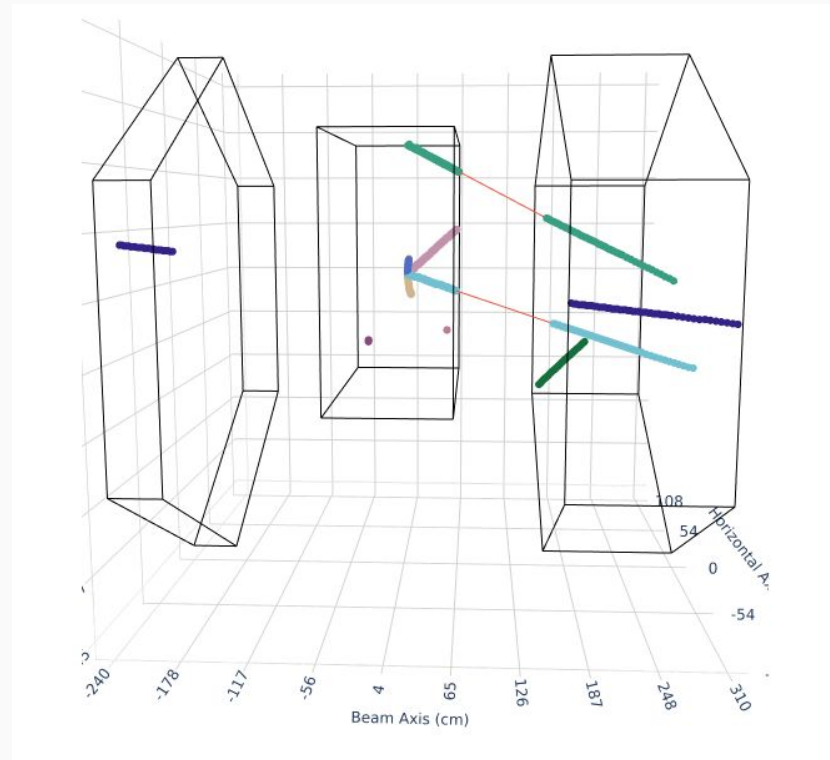
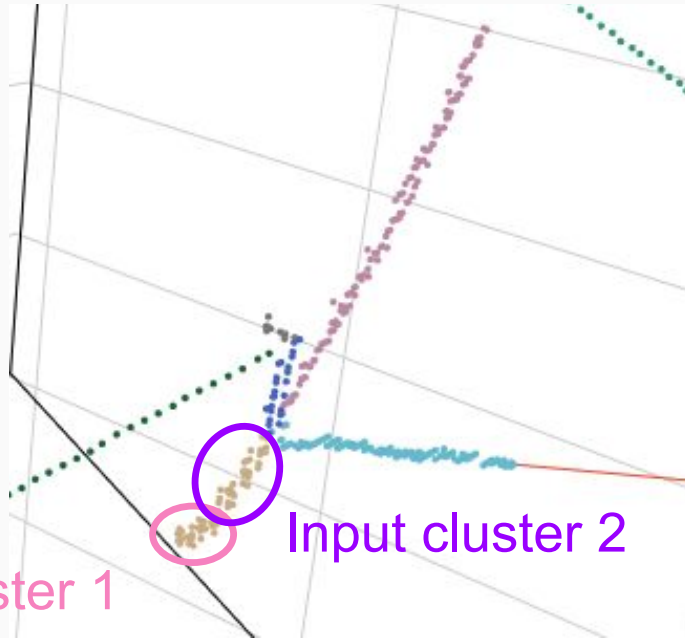
Missing Connection

Not surprising



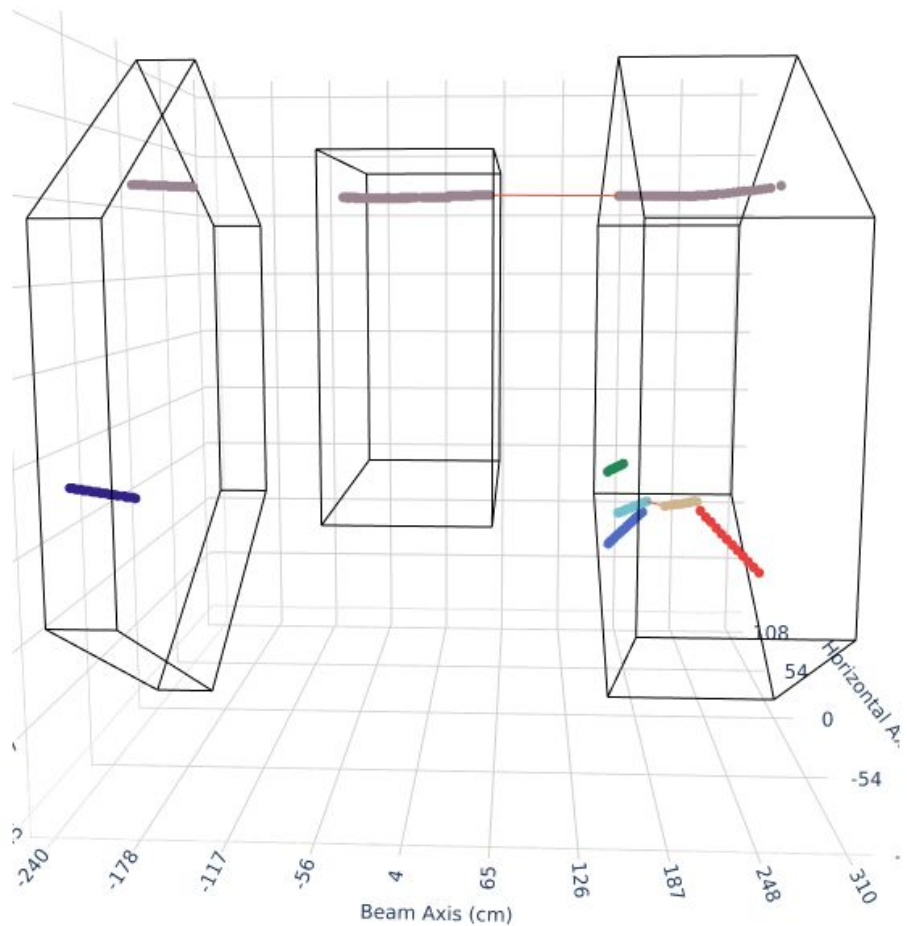
Missing Connection inside 2x2

Missing inside 2x2, looks easy but we currently skip local clustering



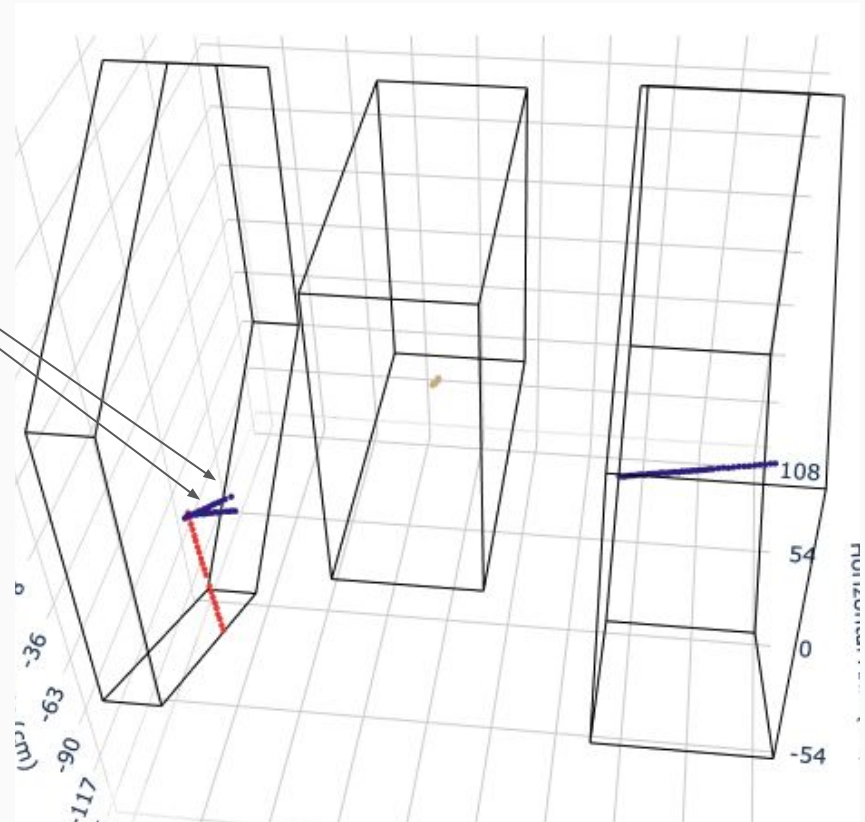
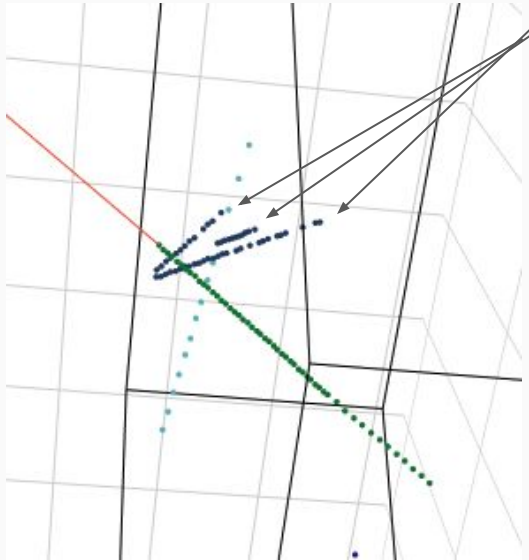
Extra Connection

Inside Mx2 connected,
needed for 2x2 though



Why does the network think MINERvA inner connections happen?

We tell it that it happens



First Check: Tested with 6757 events

volume_pair	correct_both	correct_one	missing	extra_both	extra_one	truth_total
2x2-2x2	46	6	186	25	25	238
2x2-minerva	5575	44	187	335	38	5806
minerva-minerva	87	14	125	56	34	226

Legend:

correct_both : true pair, GNN predicted both directions

correct_one : true pair, GNN predicted only one direction

missing : true pair, GNN predicted neither direction

extra_both : non-true pair, GNN predicted both directions

extra_one : non-true pair, GNN predicted one direction

truth_total : correct_both + correct_one + missing

First Check: Tested with \sim events

volume_pair	efficiency_full	efficiency_any	purity_directed
2x2-2x2	0.19327731092	0.21848739495	0.5664739884
2x2-minerva	0.96021357216	0.96779193937	0.9405141992!
minerva-minerva	0.3849557522	0.44690265486	0.5628742514!

Legend:

eff_full : correct_both / truth_total

eff_any : (correct_both + correct_one) / truth_total

purity : (2*cb + co) / (2*cb + co + 2*eb + eo)