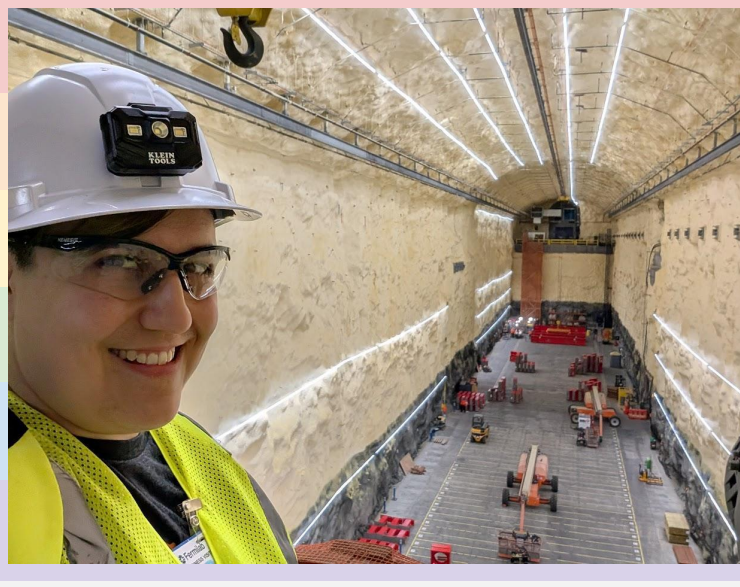
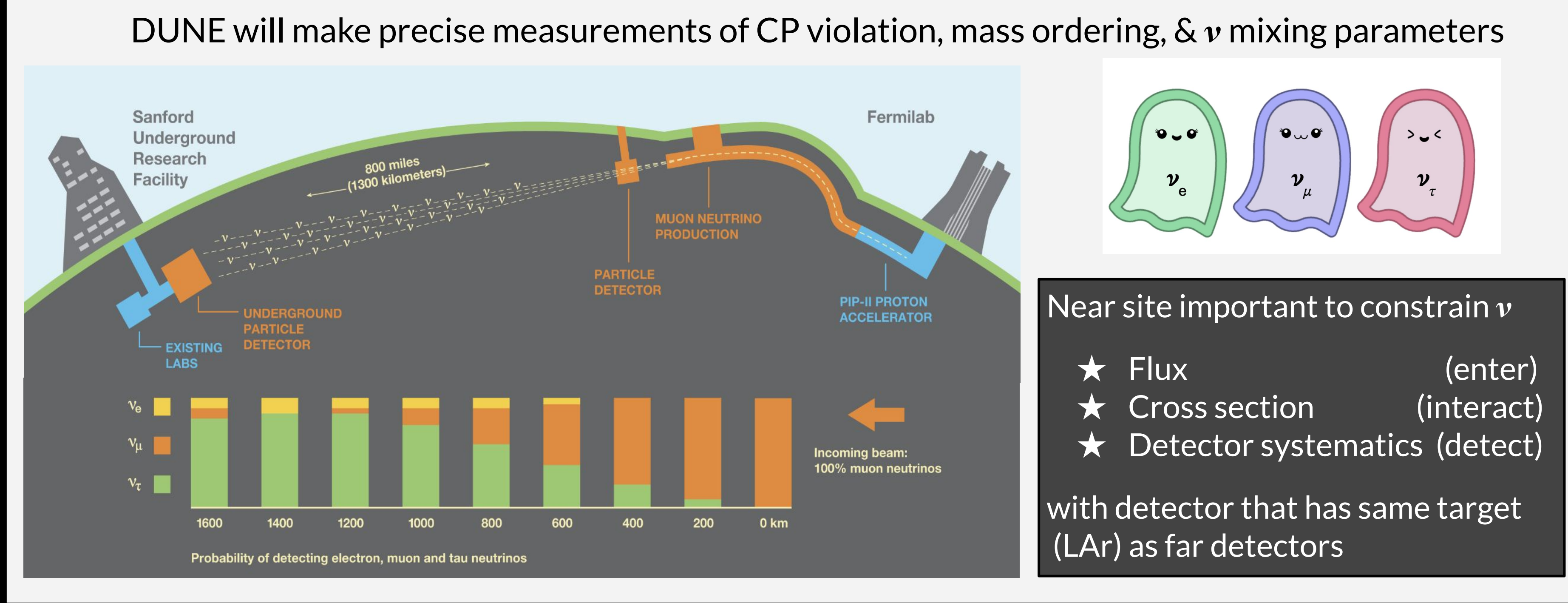


# Track Matching during Reconstruction using Graph Neural Networks Across DUNE's Near Detectors

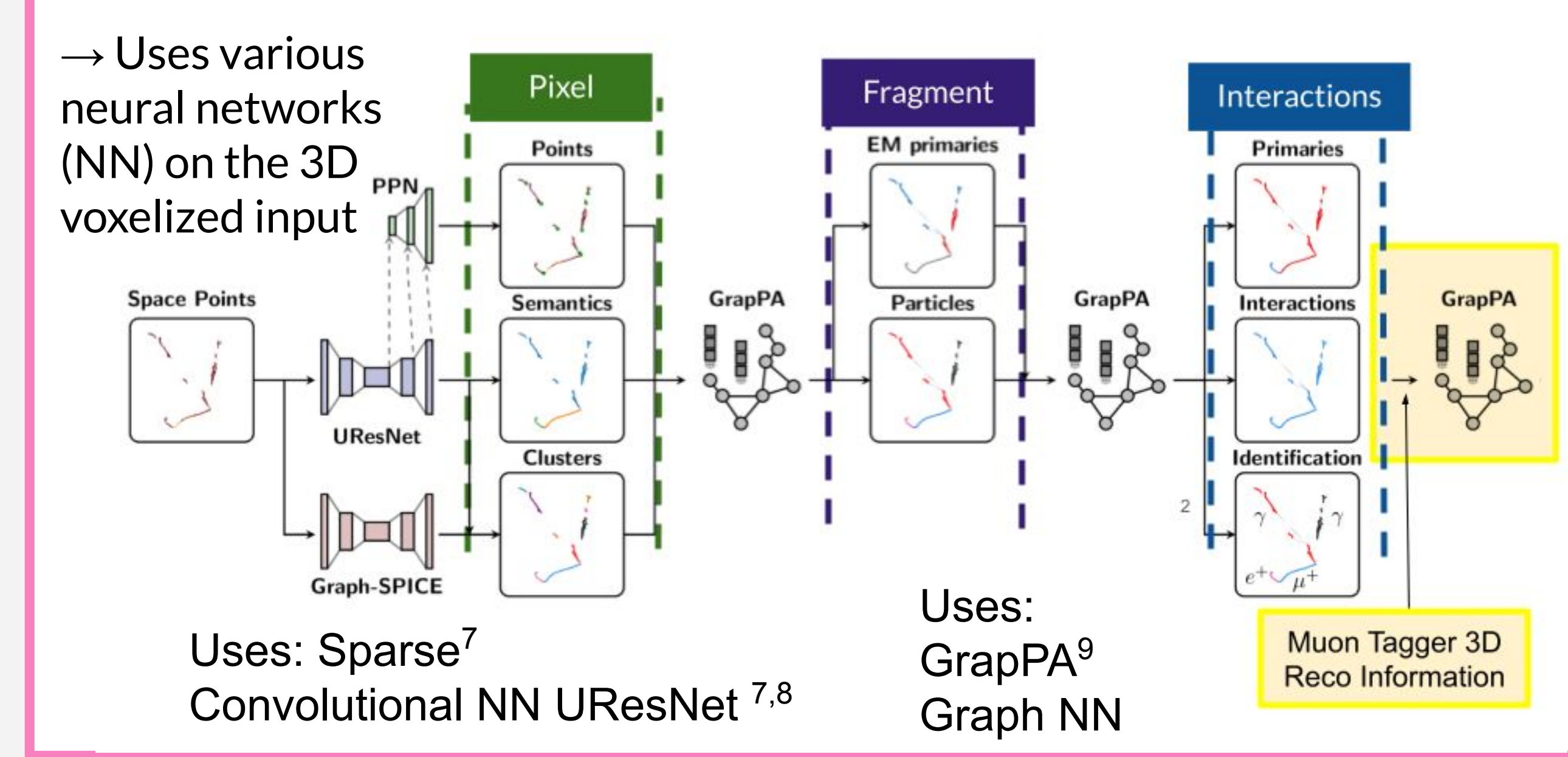
Jessie Micallef (she/they)  
on behalf of the DUNE collaboration  
jessie.micallef@tufts.edu



## Plan for DUNE<sup>1</sup>'s Intense $\nu$ Pileup at Near Site



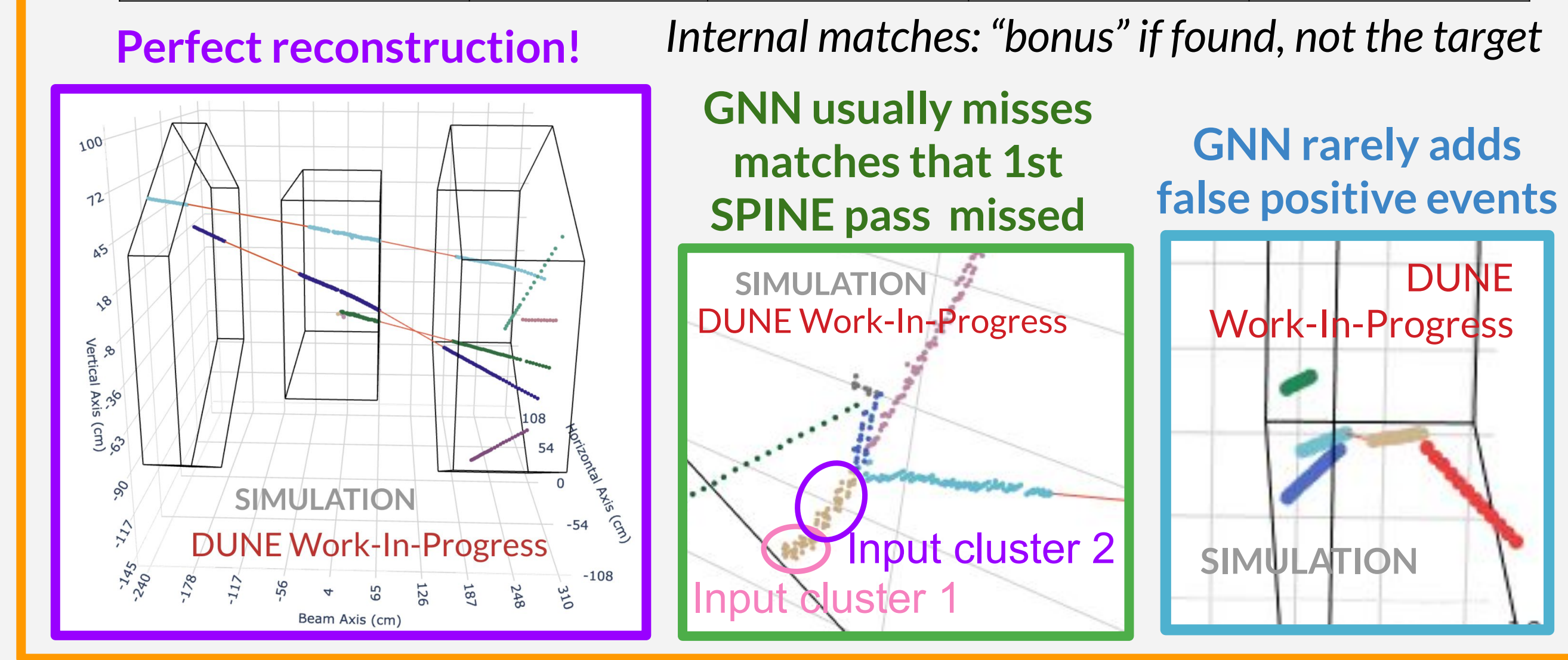
## Integrating into SPINE<sup>6</sup> Reconstruction



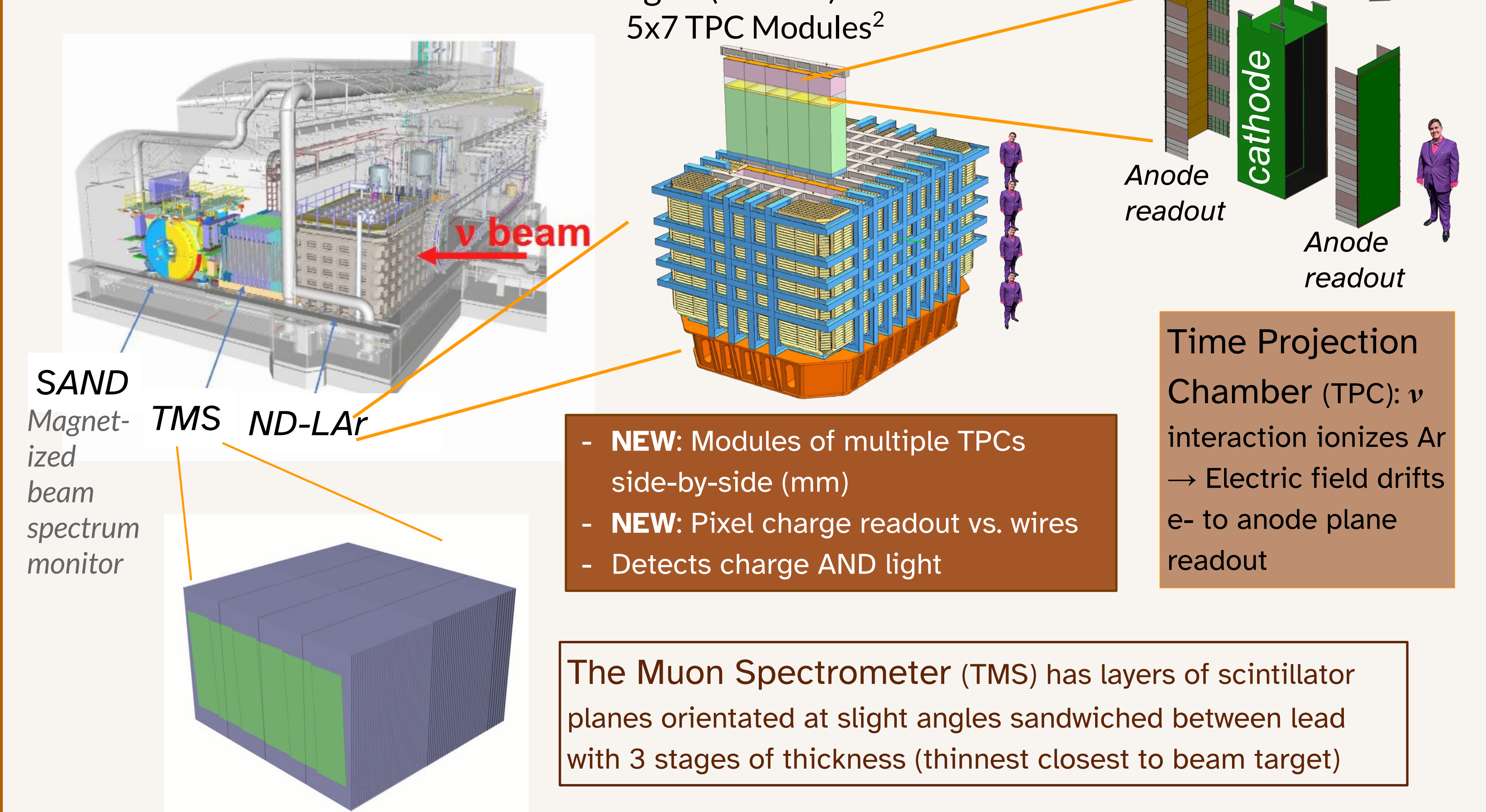
## GNN Performance on ND Prototypes

Network is identifying main target matches (Mx2 to 2x2) well!

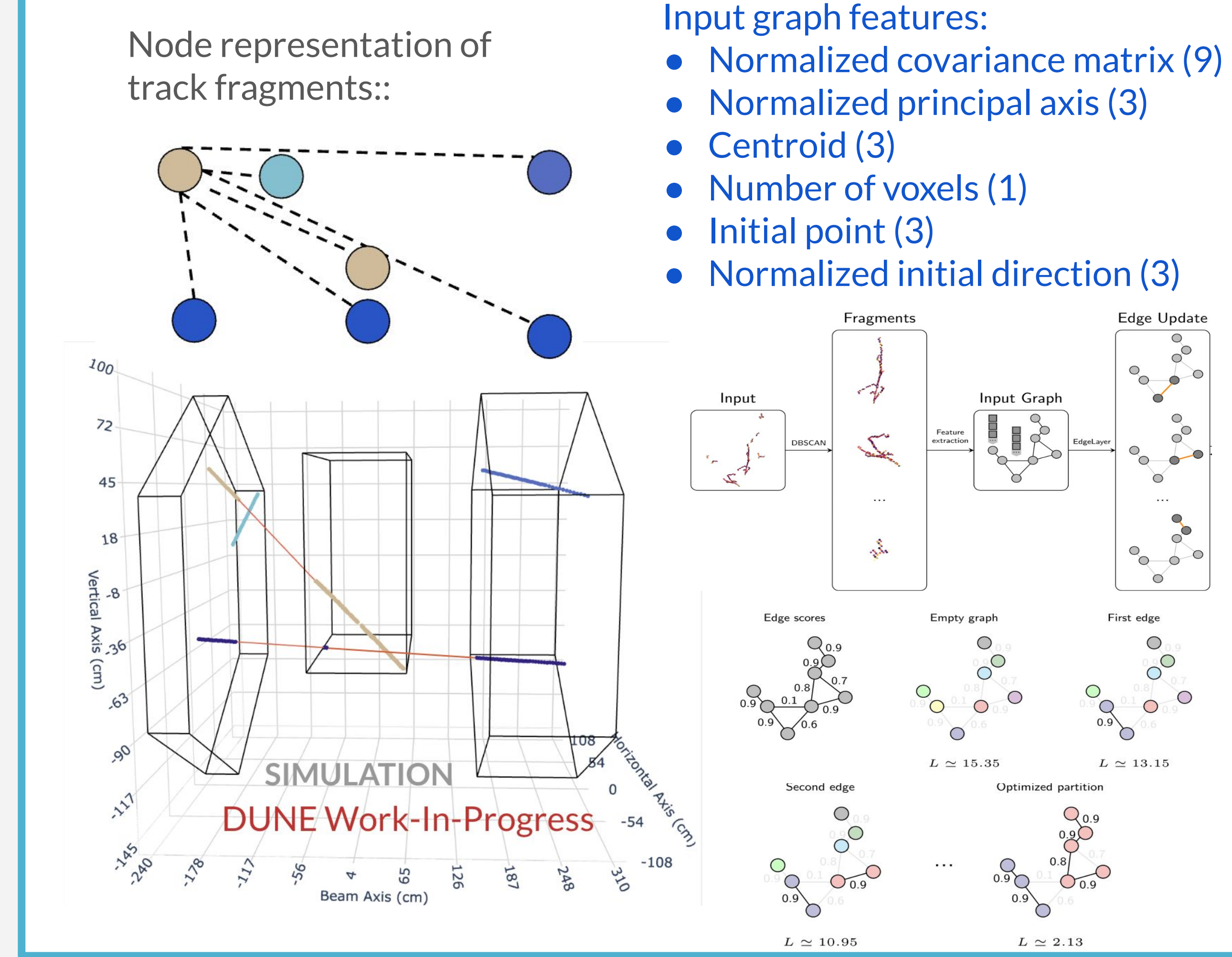
Connection	Colloquial	Mx2 to 2x2	2x2 to 2x2	Mx2 to Mx2
True Positive	Got it 🎯	5,569	88	43
False Negative	Missed it	237	138	195
False Positive	Faked it	340	28	11



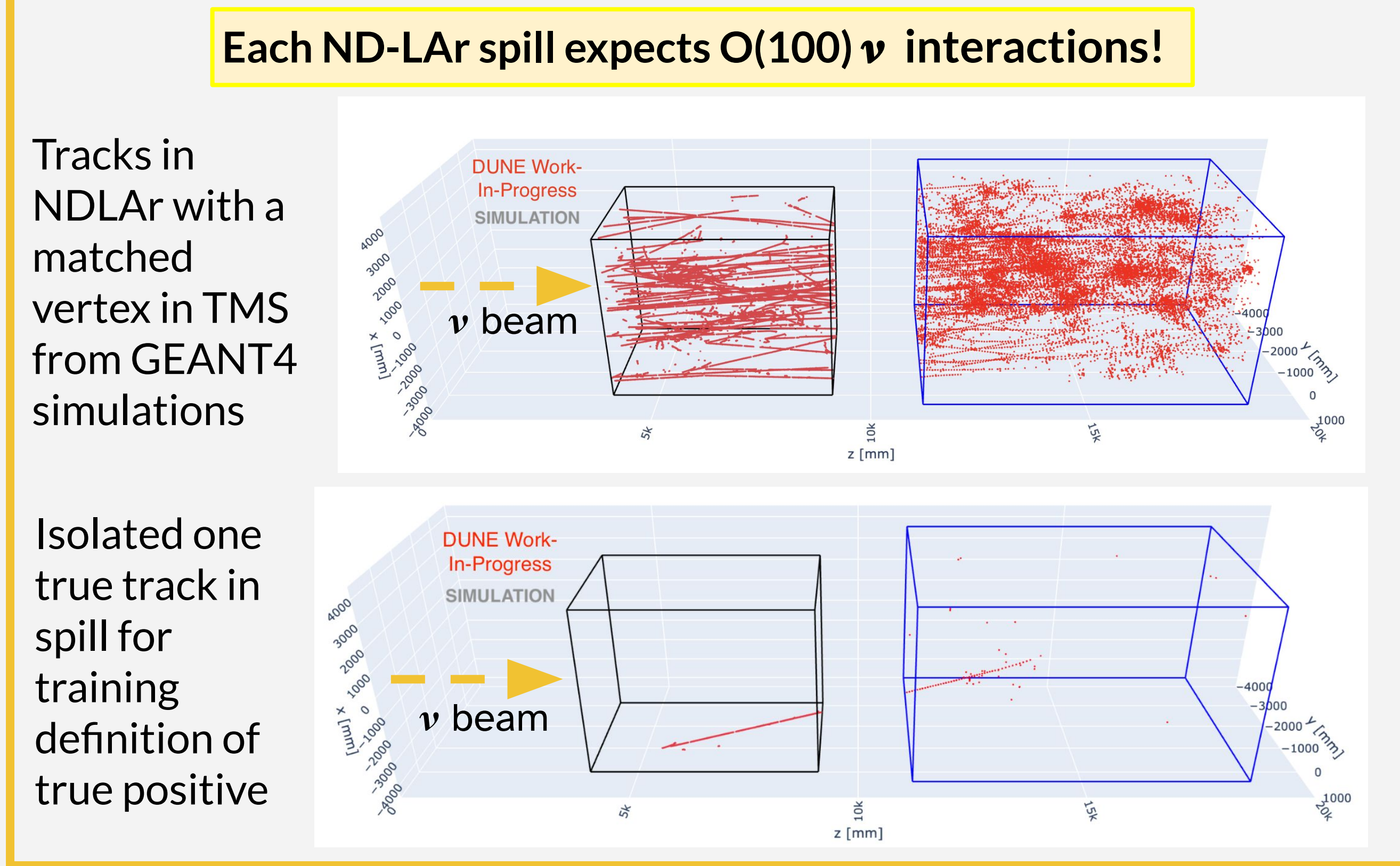
## DUNE Near Detectors



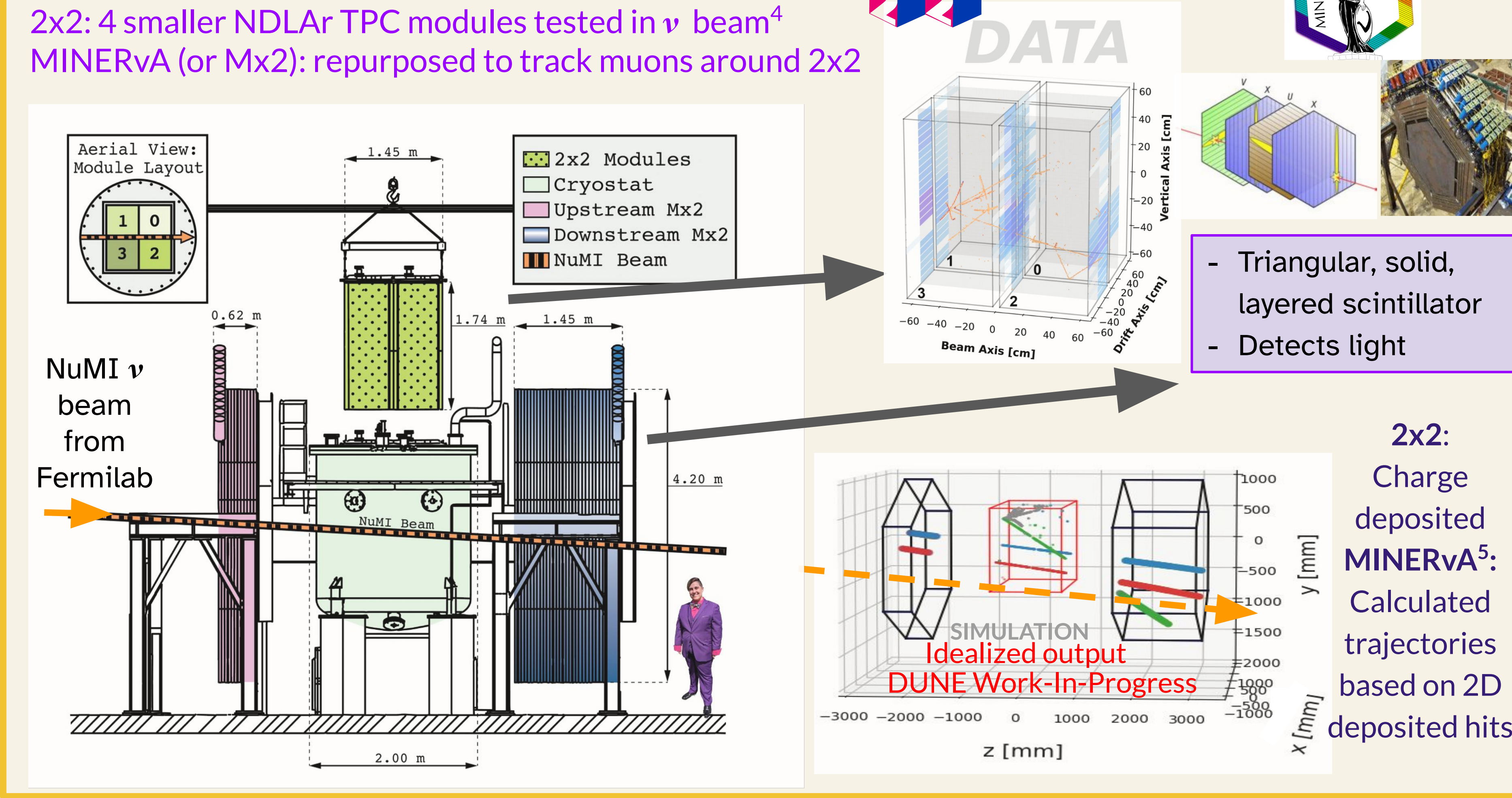
## Graph NN Architecture GrapPA<sup>9</sup>



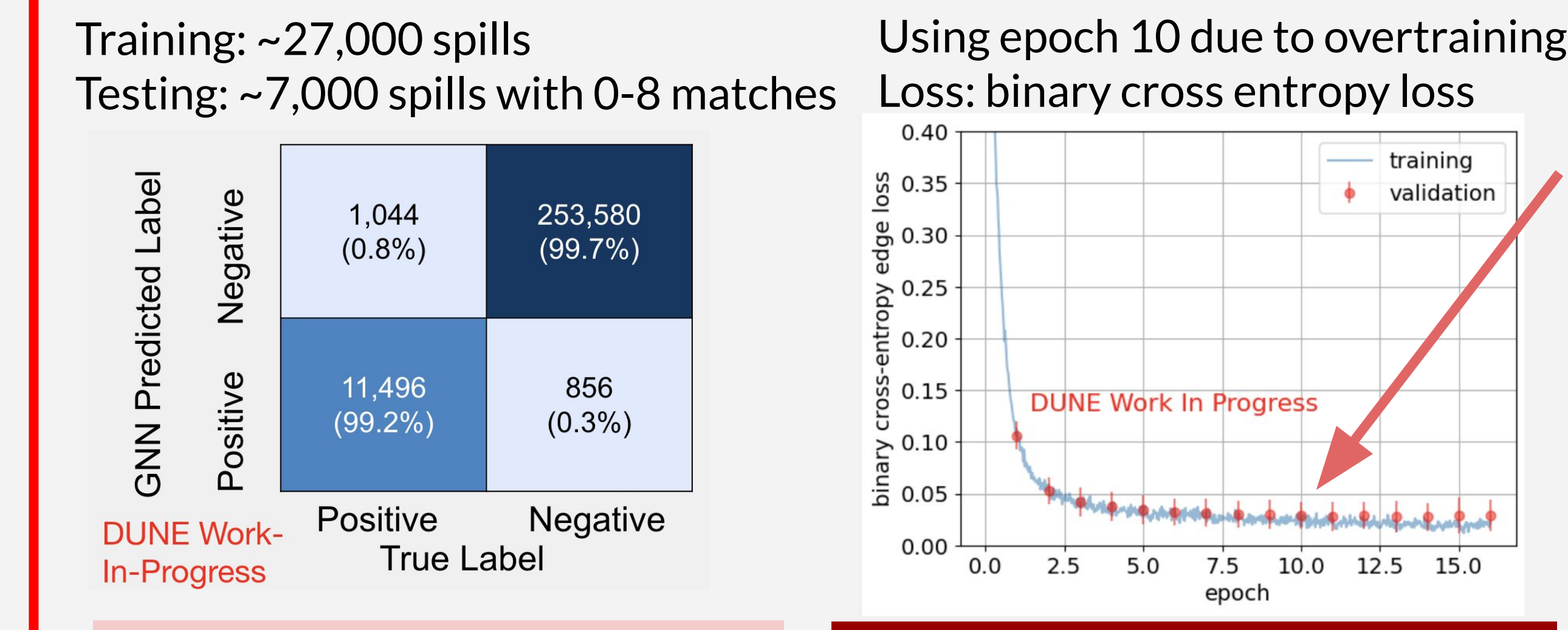
## Scaling up to ND-LAr + TMS



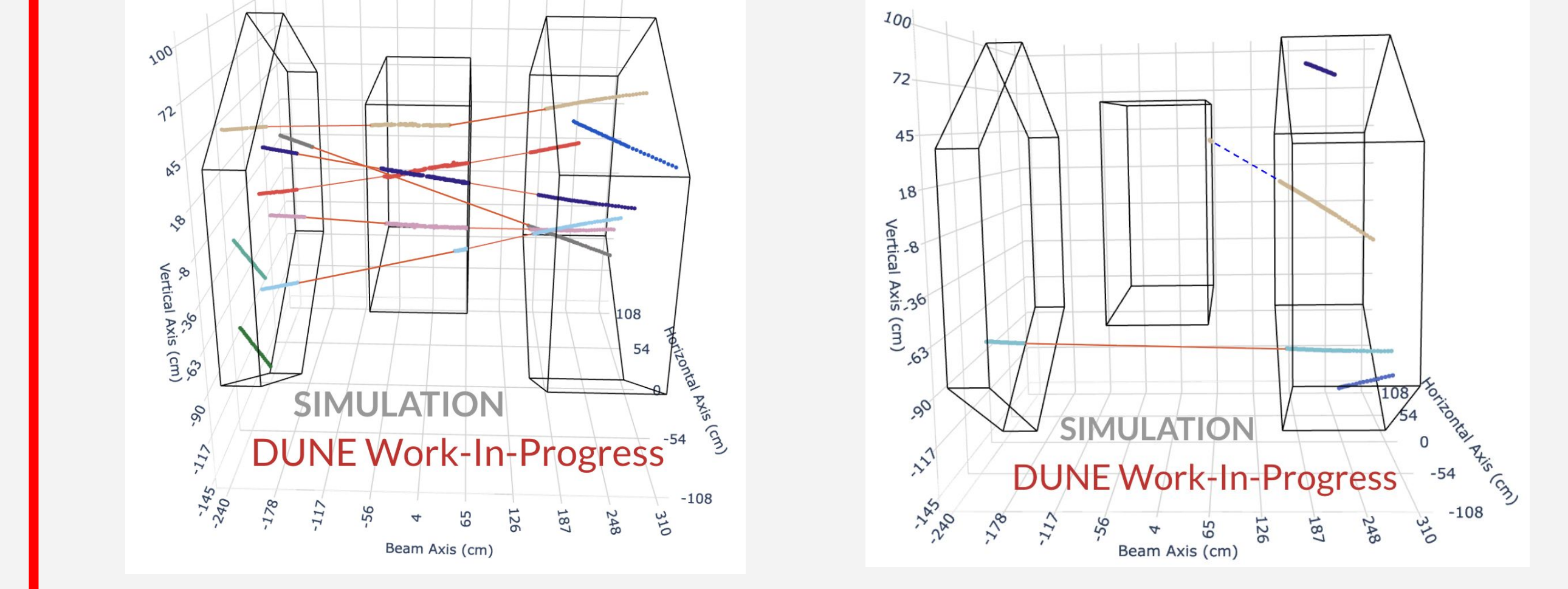
## 2x2 Prototype Demonstrator<sup>3</sup>



## Matching ND Prototype Detectors



## Four True Positive Matches! One False Negative by GNN



## Conclusion

- + 2x2 Prototype is great testing ground!
  - o GNN matching tracks well
  - o 5 days of real data to test GNN
- + Full scale ND LAr + TMS will have...
  - o Some same challenges
  - o Additional challenges due to the beam intensity
- + So far, traditional SPINE has handled the scale up well
  - o Stay tuned to see if track matching will also!

## References

[1] - DUNE. [2020 JINST 15 T08008](#).

[2] - DUNE. [Instruments 2021, 5\(4\), 31](#).

[3] - DUNE. [Instruments 2026, 10\(1\), 18](#).

[4] - DUNE. [Instruments 2024, 8\(3\), 41](#).

[5] - MINERVA. [Nucl.Inst.Meth.A743 \(2014\) 130](#).

[6] - <https://github.com/DeepLearnPhysics/spine>

[7] - Laura Dominé, Kazuhiro Terao. [PhysRevD \(102\) 012005](#).

[8] - Laura Dominé, et al. [Phys Rev D \(104\) 032004](#).

[9] - François Drielsma, et al. [PhysRevD. 104. 072004](#).

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