# Using Sparse Convolutional Neural Networks in MicroBooNE

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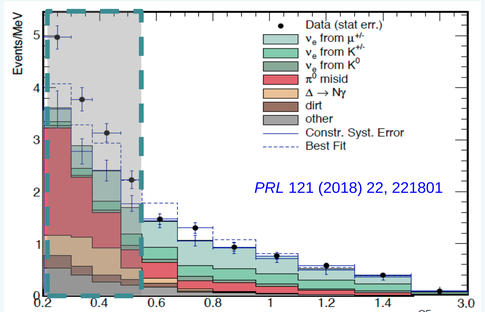
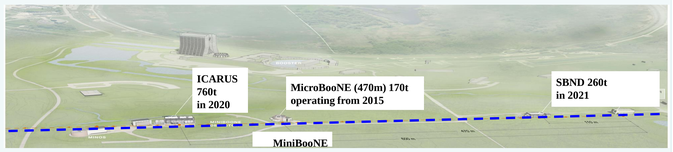
## Motivation

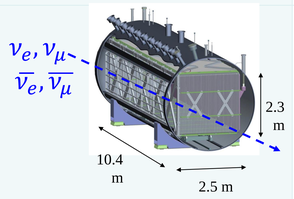
- MiniBooNE sees 4.5$\sigma$ $\nu_e$-like Low Energy Excess (LEE)
- Compatible with 3+1 model.
- Tension with other experiment
- Limited capability to distinguish e vs γ



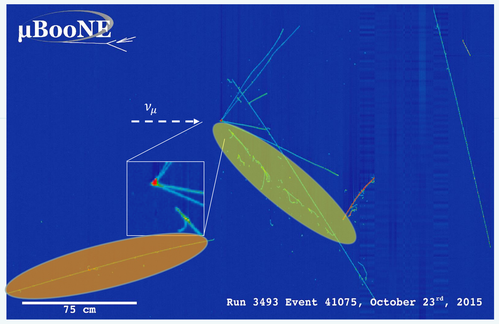

## The MicroBooNE Detector




- MicroBooNE
  - Same beam (BNB)
  - Similar baseline
  - LArTPC (85 tons of LAr active mass)
  - 3 planes of sense wires
- Goals
  - LEE search
  - Cross-section measurements
  - Detector physics (DUNE)

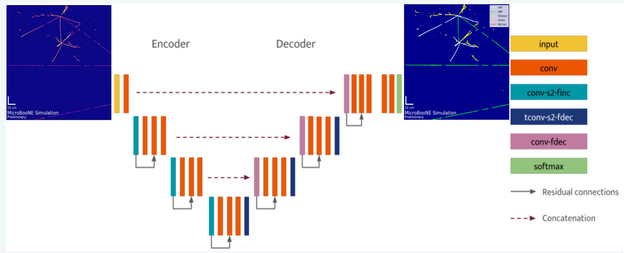



- **Dominated by CCQE 1L1P events**
  - 1e1p – signal
  - 1μ1p – constraining flux, systematics
- **Shower Vs Track** - Distinct topologies Semantic segmentation ( PRD 99 (2019) 9, 092001)
- **$\gamma, \pi^0$ Vs e** - Gap from vertex



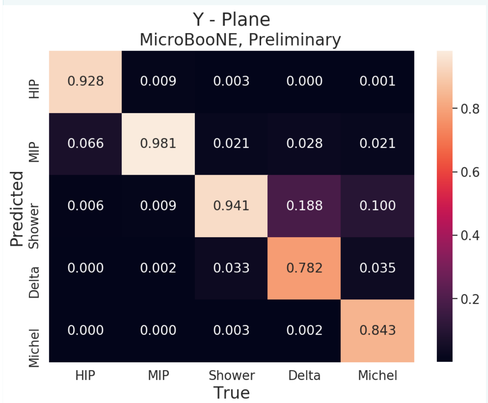

## SparseSSNet

- Sparse Submanifold Convolutional Network (CVPR.2018.00961)
- Prior training define mask (e.g., >0 pixels)
- Remove all masked pixels (~99.5%)
  - Reduce memory consumption (~1GB / image)
  - Reduce inference time (~0.5 sec / image)
  - Prevent dilation of sparse image
- Distinct model for each plane

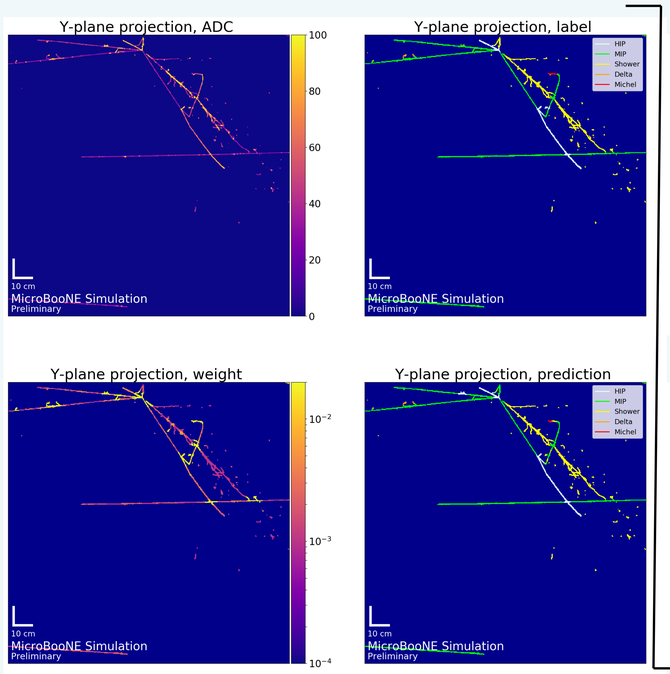



## Results:

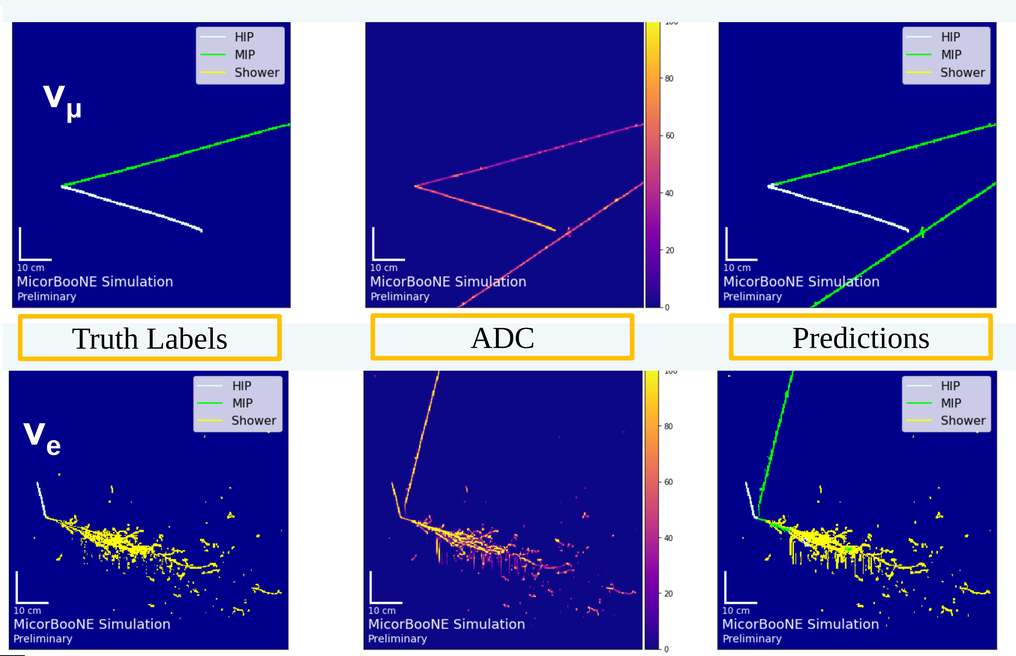
- Pixel-weight to prevent class imbalance
- Single hot labels: HIP, MIP, shower, delta, Michel




### Test sample




### ν interaction sample




## Summary

**SparseSSNet Improvements:**

Entire image instead of 64 crops.

Memory usage ~GB/full_image

Time ~0.5s/full_image (CPU)

Higher accuracy (~99%), No “dilation” of data

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