

# Unsupervised Learning to Build Pretrained Models for the AT-TPC

Maya Wallach<sup>1</sup>, E. Villasana<sup>2</sup>, M.P. Kuchera<sup>2</sup>, R. Ramanujan<sup>2</sup>, Y. Ayyad<sup>3</sup>

<sup>1</sup>Michigan State University

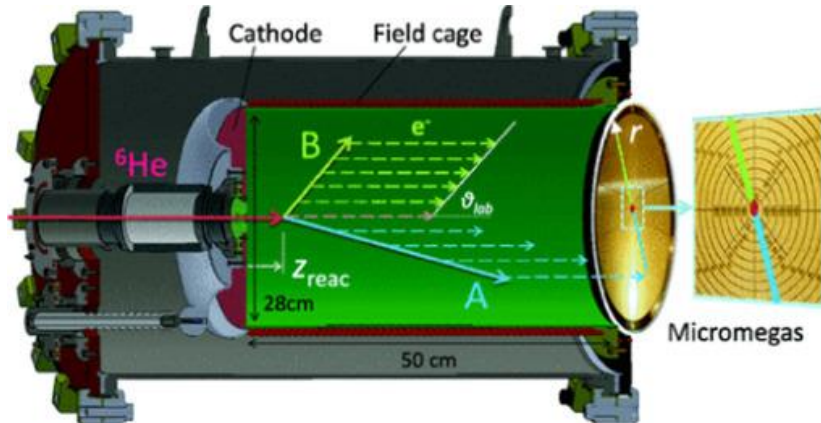
<sup>2</sup>Davidson College

<sup>3</sup>Universidad de Santiago de Compostela



# Background

- The Active Target Time Projection Chamber (AT-TPC) is a particle detector located at the Facility for Rare Isotope Beams at Michigan State University
- FRIB runs different beam/target combinations with different experimental setups approximately every two weeks.



<https://doi.org/10.1016/j.nima.2014.10.048>

# Motivation

- Supervised methods require labeling for the training set
- With constantly evolving experimental parameters, this requires retraining models for each experiment.

## Objective

We aim to build an unsupervised pretrained model that can be used for all upcoming experiments to accomplish various ML tasks

# Methods

- **PointNet:**

- The architecture operates on point cloud data
- Makes supervised, point-wise predictions



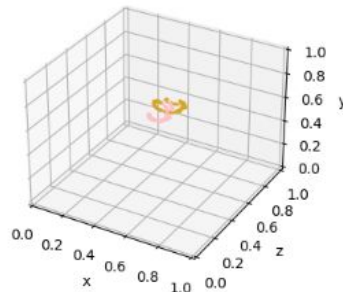
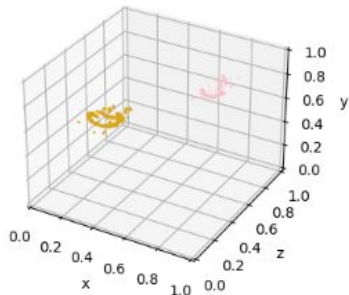
Input



Output

- **Unsupervised task:**

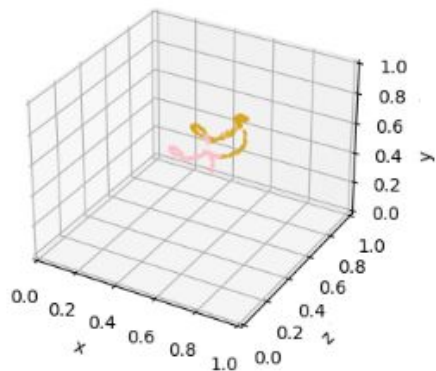
- a. Voxelize the data
- b. Translate the contents of each voxel to a different location (“scramble”)
- c. For each point in the scrambled event, the PointNet model attempts to predict its voxel of origin



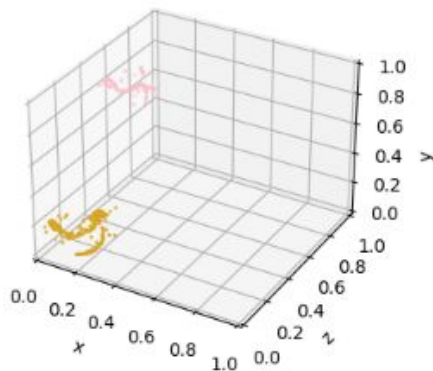
# Preliminary Results

$^{22}\text{Mg} + \alpha$ :

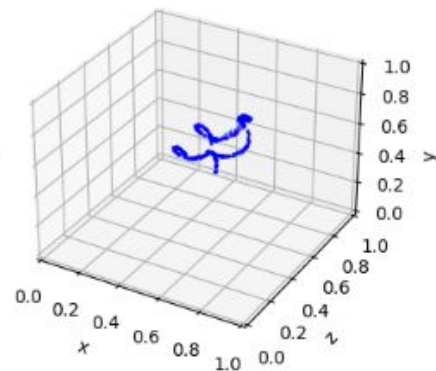
Event 1161 original



Event 1161 shuffled

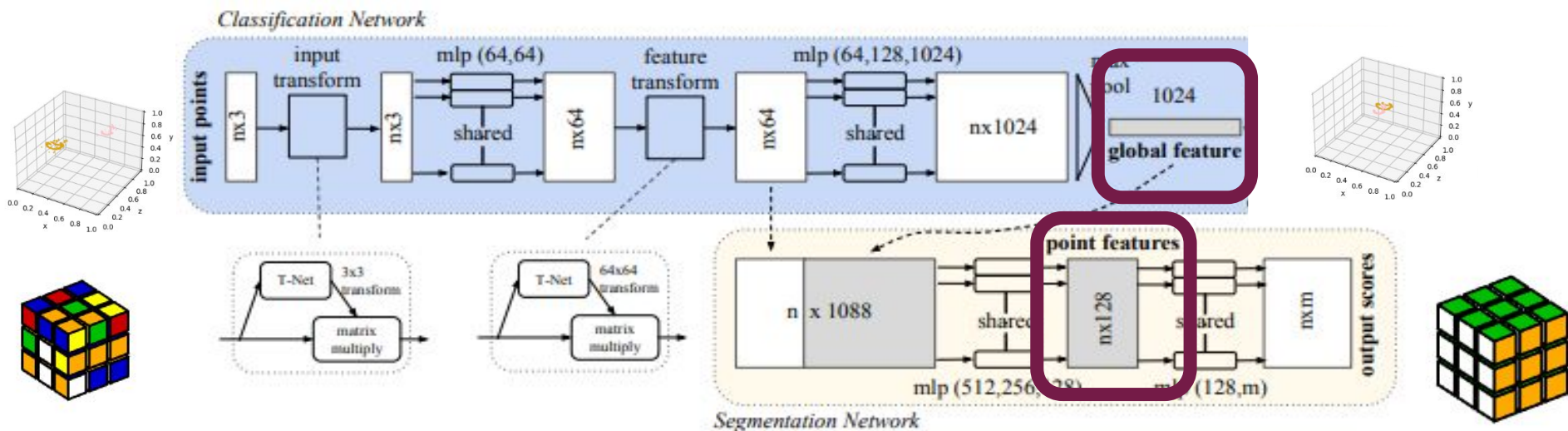


Event 1161 hits (blue)/misses (red)



# Project Goals

- Train on large amounts of unlabeled experimental data from various experiments
- We want to investigate the latent representations for event and track identification



Thank you!



# Point-cloud based ML

- PointNet:
  - The architecture operates on point cloud data and is permutation invariant
  - The model makes supervised point-wise predictions

