1 TRIUMF
2 UNIVERSITY OF WATERLOO
3 THE UNIVERSITY OF BRITISH COLUMBIA
ALPHA

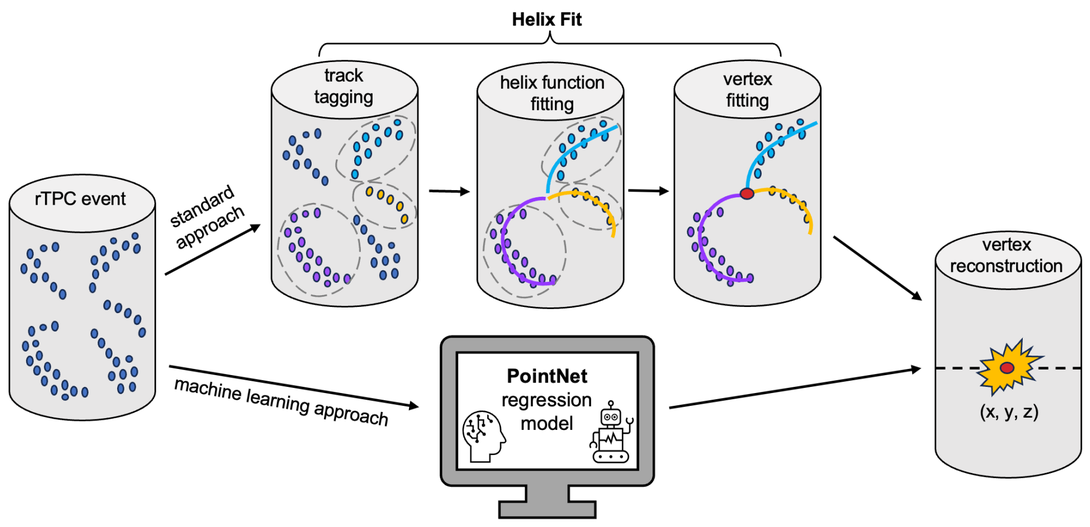
AI Meets Antimatter: Unveiling Antihydrogen Annihilations

Presenters: A. Ferreira (aferreira@triumf.ca)[1,2], M. Singh (msingh2@triumf.ca)[1,2]
Advisors: A. Capra [1], W. Fedorko [1], M. Fujiwara [1], L. Martin [1]
Other contributors: D. Duque Quiceno [1,3], A. Li [1,2], Y. Saito [1], G. Smith [1,3], A. Xu [1,3]

tinyurl.com/cap-congress-24

Intro

The ALPHA-g experiment at CERN aims to perform the first-ever direct measurement of the effect of gravity on antimatter, determining its weight to within 1% precision. Antiprotons annihilate on the trap wall and the annihilation products are detected by the rTPC. We are working on a new deep learning method based on PointNet to predict the position at which the annihilation happens and aim to improve upon the standard approach to annihilation position reconstruction.



Methods

1. Adapt PointNet model architecture to do regression instead of classification
2. Get 2.2 million simulated events
3. Preprocess data (e.g. subtract mean)
4. Train model to learn *z* vertex
5. Use new, unseen data to make sure the model generalizes well

Results

The main results so far on simulation compared the conventional method are:

- Improved resolution along *z*-axis
- Improved *z*-dependent bias

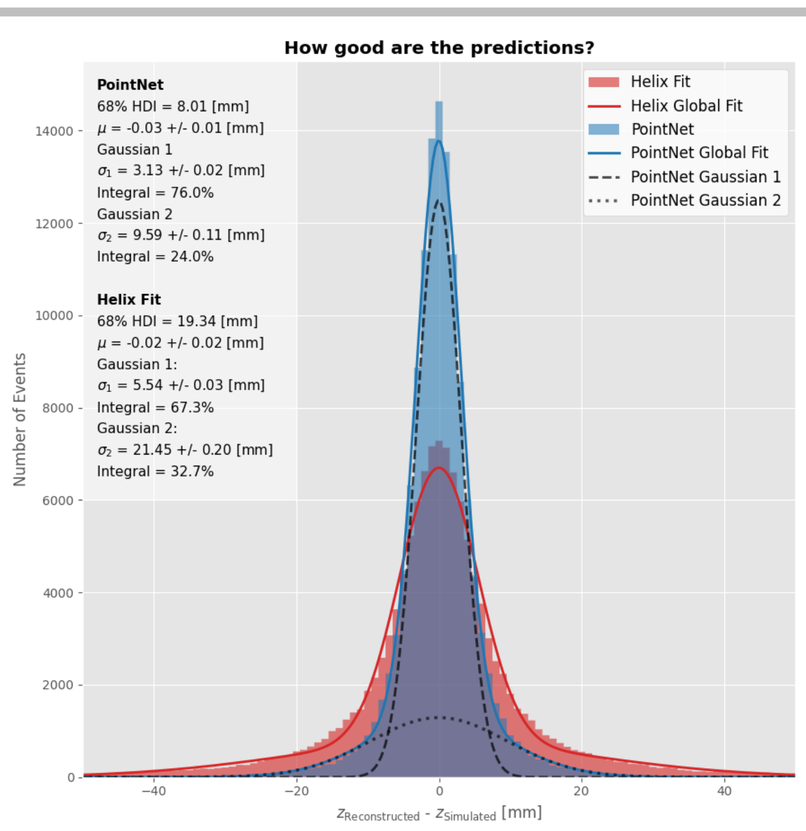
However, the standard method has been improving in the meantime as well

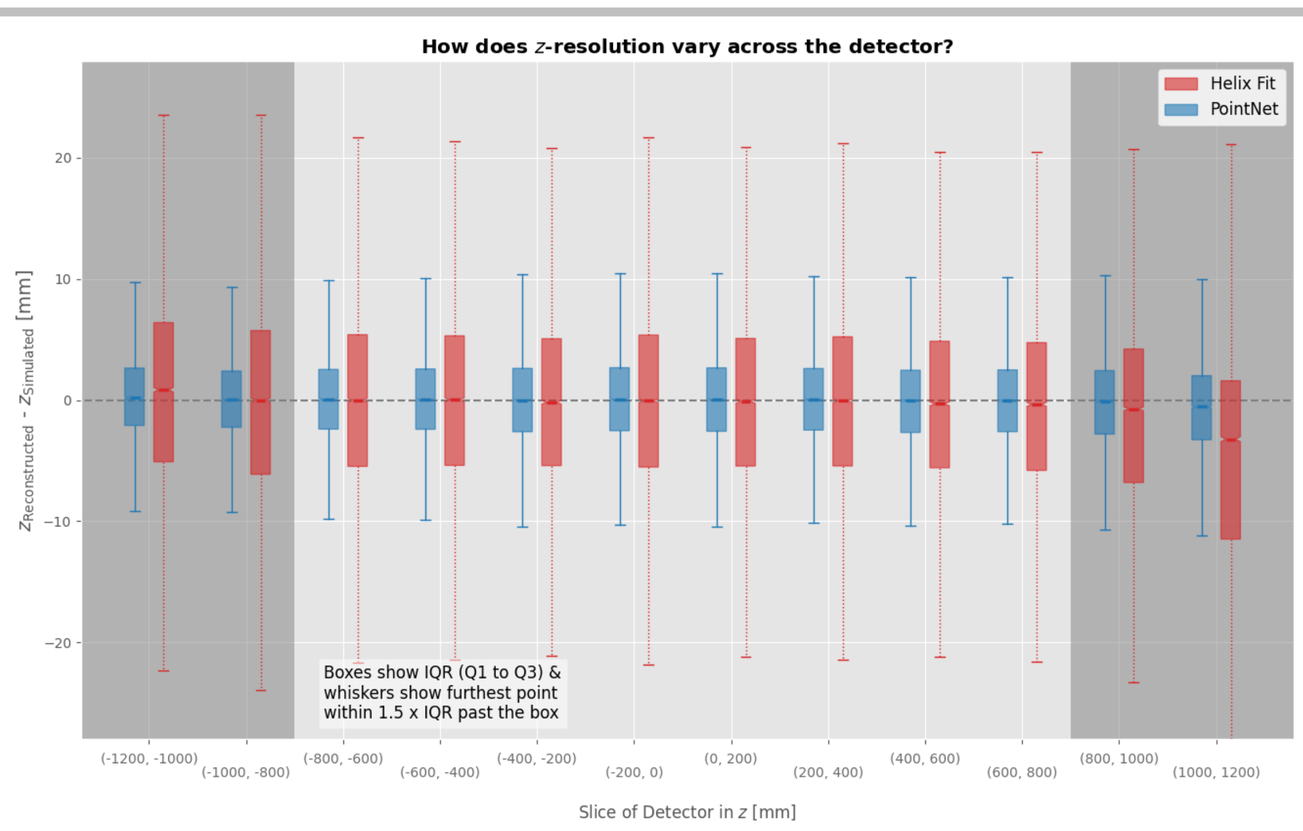
Next Steps

- Work on reproducibility and publication
- Test on real data
- Extend to predicting *x* and *y*
- Improve model (Point Transformer?)
- Explore other tasks such as uncertainty estimation or track segmentation

Resolution

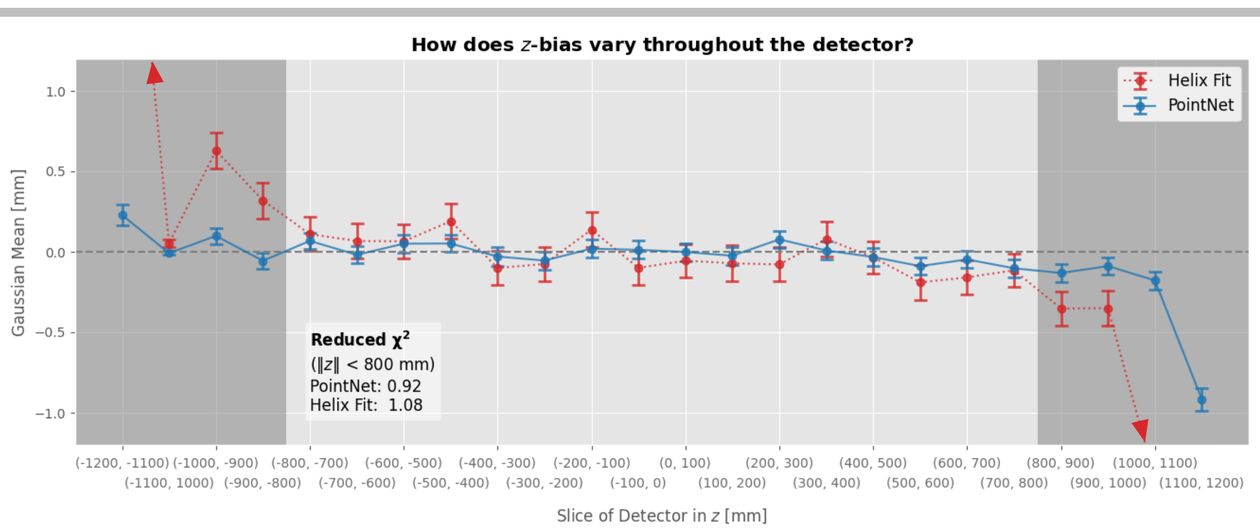
vertex reconstruction **precision**

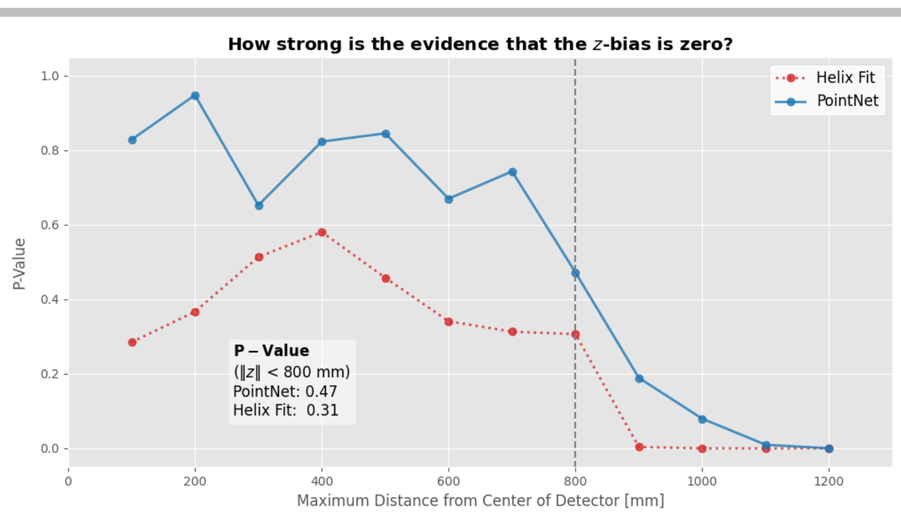




Bias

vertex reconstruction **accuracy**





The dataset used for the visualizations above contains 130k events that were not used for model training or selection

Discovery, accelerated