

# What goes on in the corner of the corner office?

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Doctoral student, ALICE group

PhD Day, spring 2024  
Division of Particle and Nuclear Physics

What  
of



corner  
e?

# Introduction



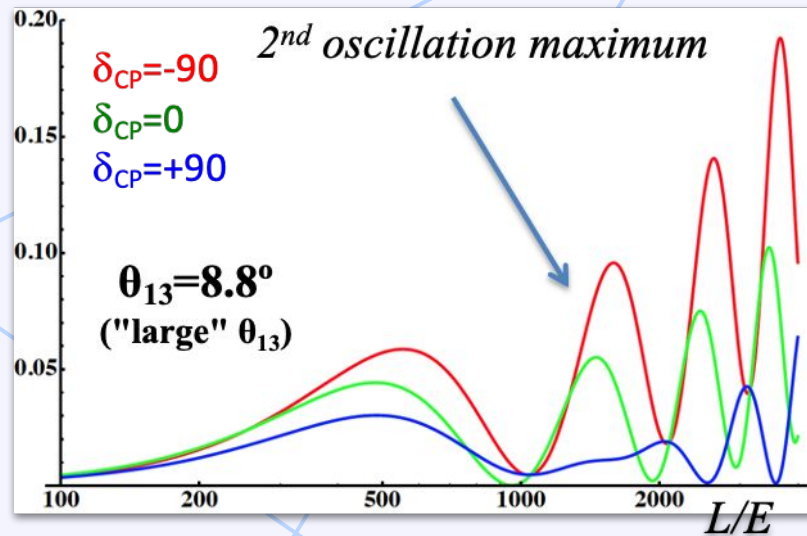
# Main theme: ML in HEP

1. Event reconstruction for the ESS $\nu$ SB+
2. Calibration of the ALICE TPC

# GNNs for Flavour Classification for $ESS_{\nu SB+}$

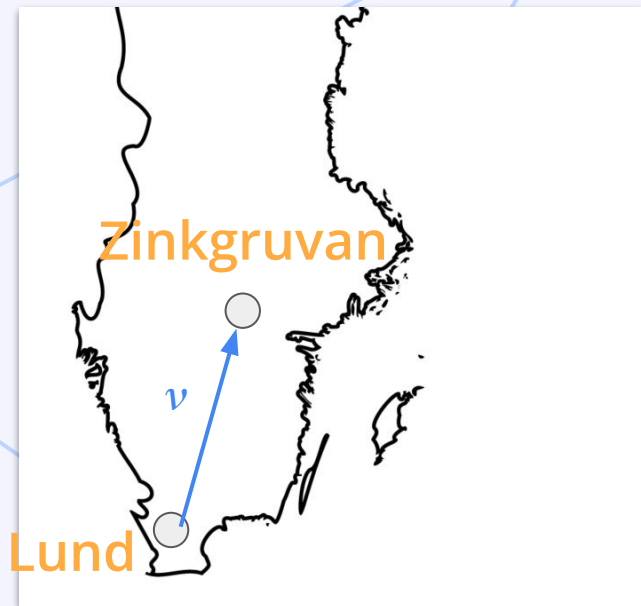
## ESS $\nu$ SB+: Measuring leptonic $\delta_{CP}$ in a mine in Sweden

- CP-violation term more influential at 2nd maximum
- Great distance requires more intensive beam

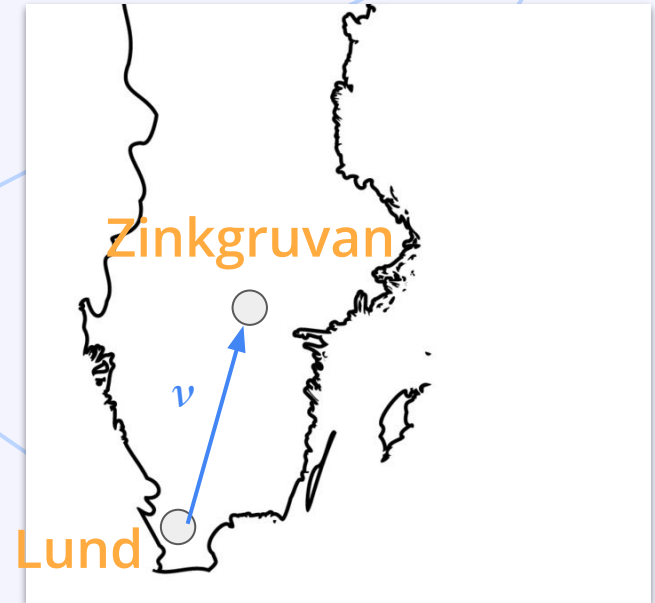
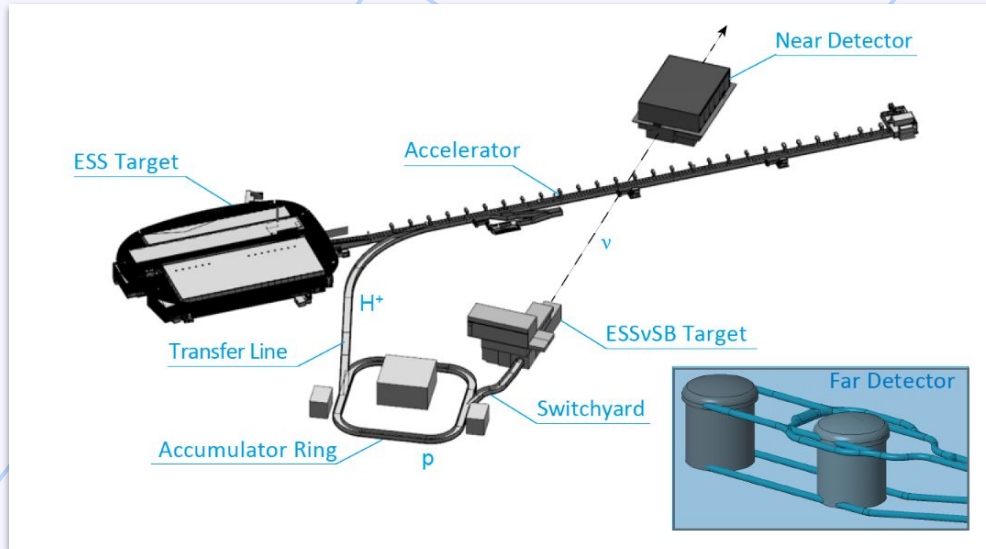


## ESS $\nu$ SB+: Measuring leptonic $\delta_{CP}$ in a mine in Sweden

- CP-violation term more influential at 2nd maximum
- Great distance requires more intensive beam
- We can get that at ESS!

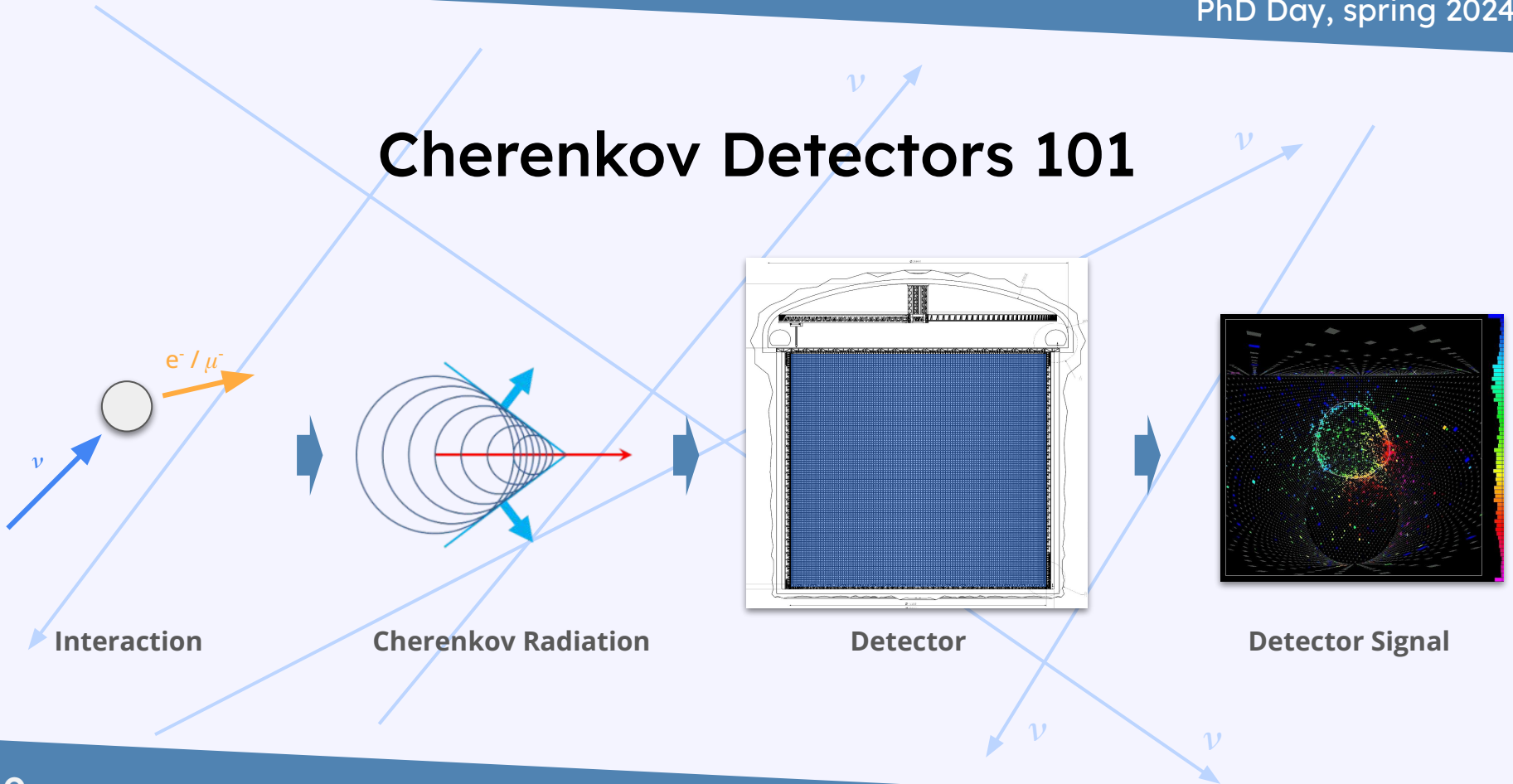


# ESS $\nu$ SB+: Measuring leptonic $\delta_{CP}$ in a mine in Sweden





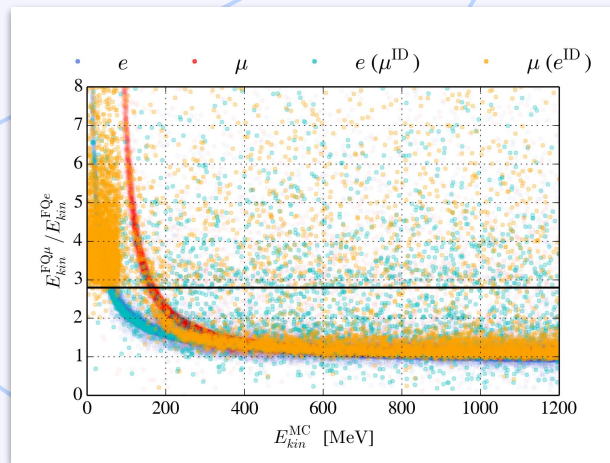
# Cherenkov Detectors 101



# GNNs for Flavour Classification

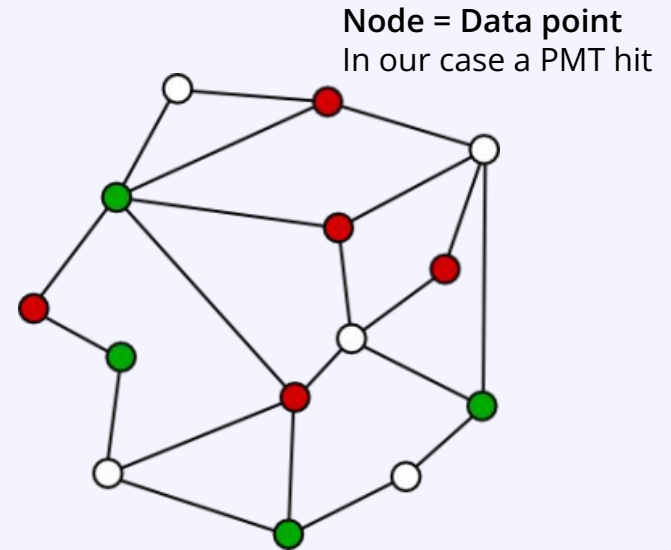
Current LLH-based methods are:

- Slow
- Inflexible
- Require cuts

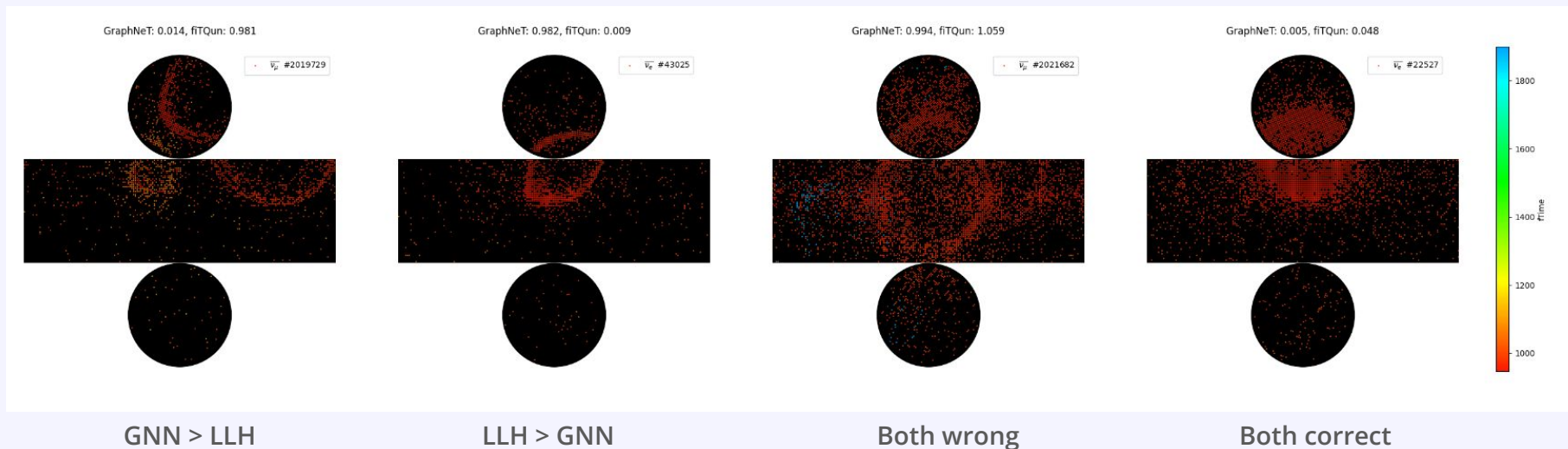


# GNNs for Flavour Classification

- Graph: Event
- Node: PMT hit
- A node has features like xyz, time, charge
- Graph is updated through message passing

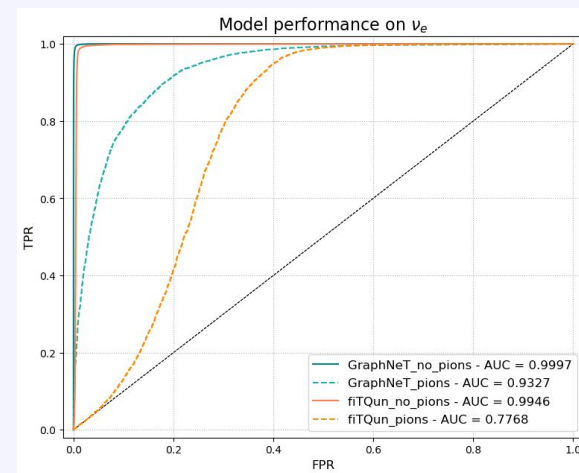
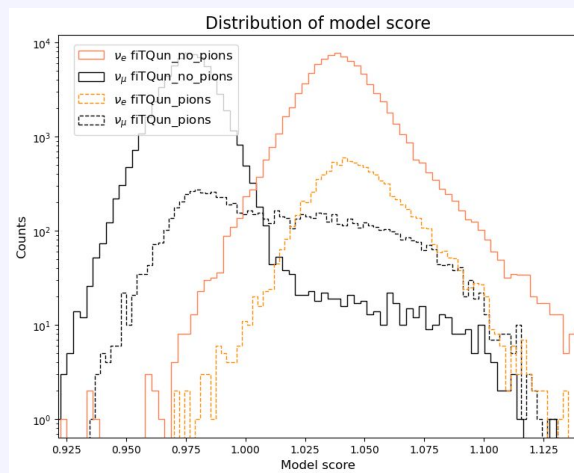
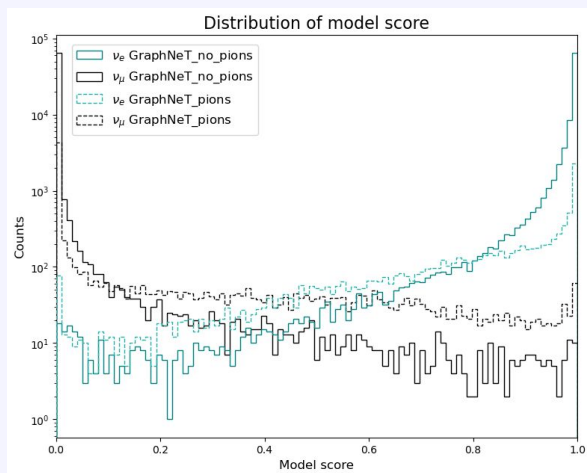


# GNNs for Flavour Classification



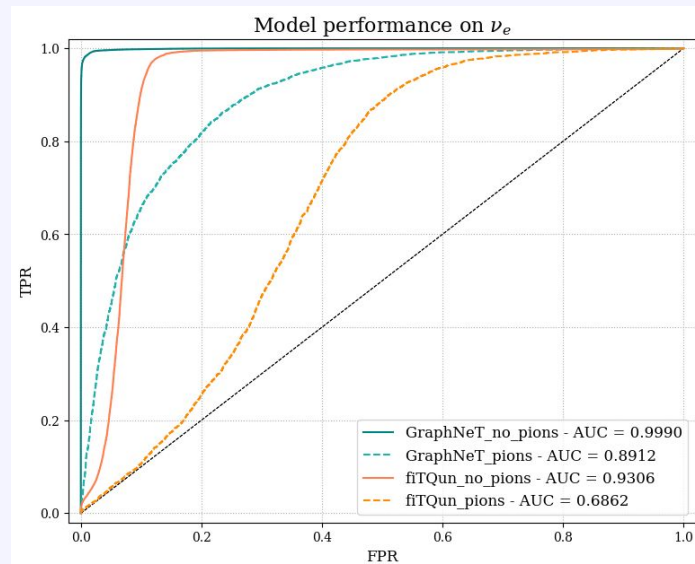
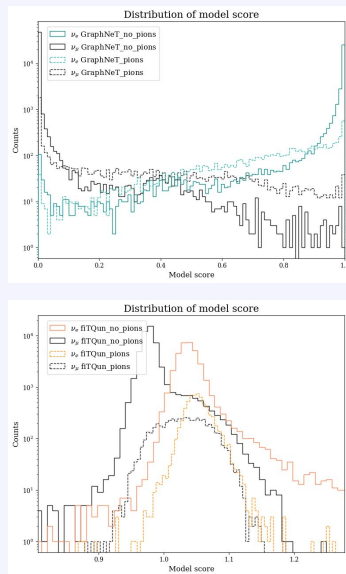
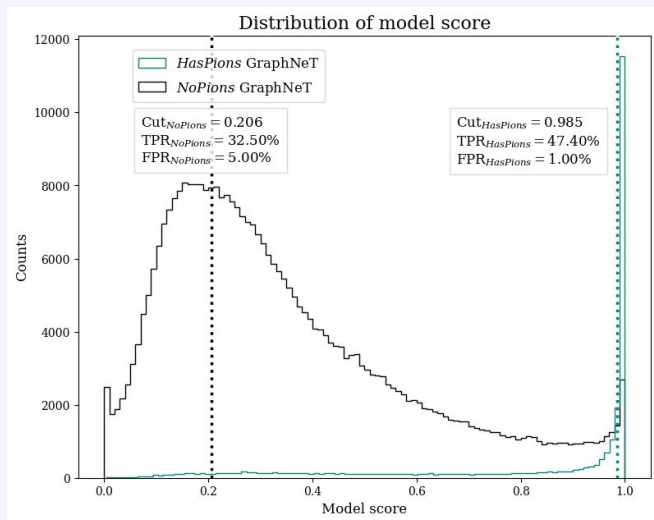
# GNNs for Flavour Classification

Split by Pion production



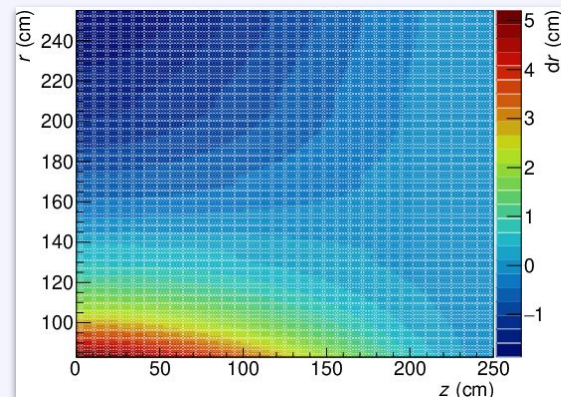
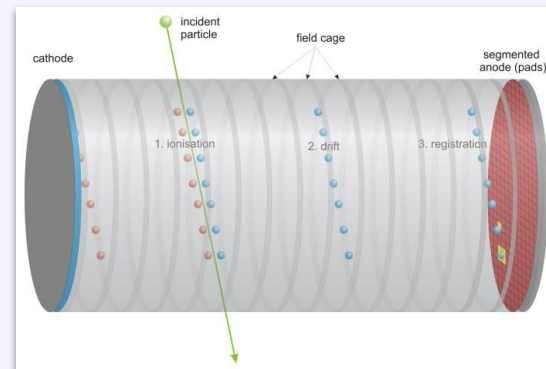
# GNNs for Flavour Classification

Split by Pion production



# ML Correction of Space Charge Distortions in the ALICE TPC

- Due to charge build up, we get **space charge distortions**
- Can be accounted for with traditional methods, but **computationally expensive**
- A task possibly **well-suited for ML**

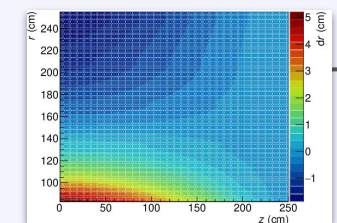




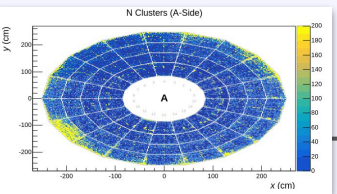
# TPC Space Charge Distortions

CURRENT

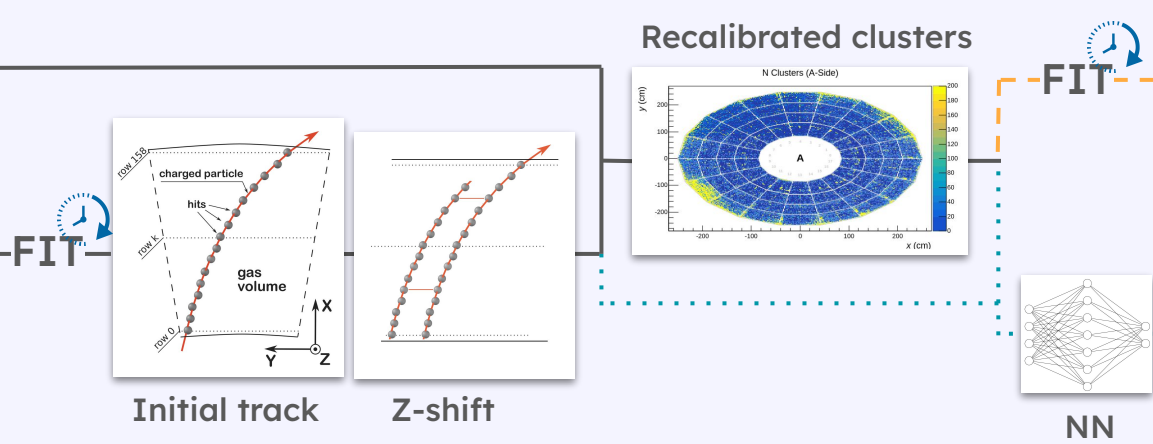
$(y, z, \sin(\varphi), \tan(\lambda), q/p_T)$



Correction maps



TPC Clusters



Initial track

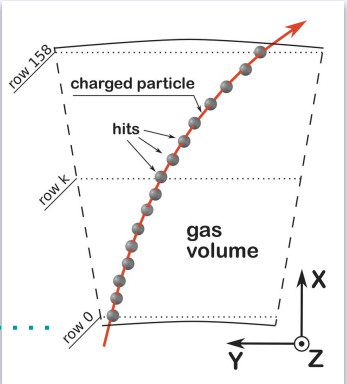
Z-shift

Recalibrated clusters

FIT

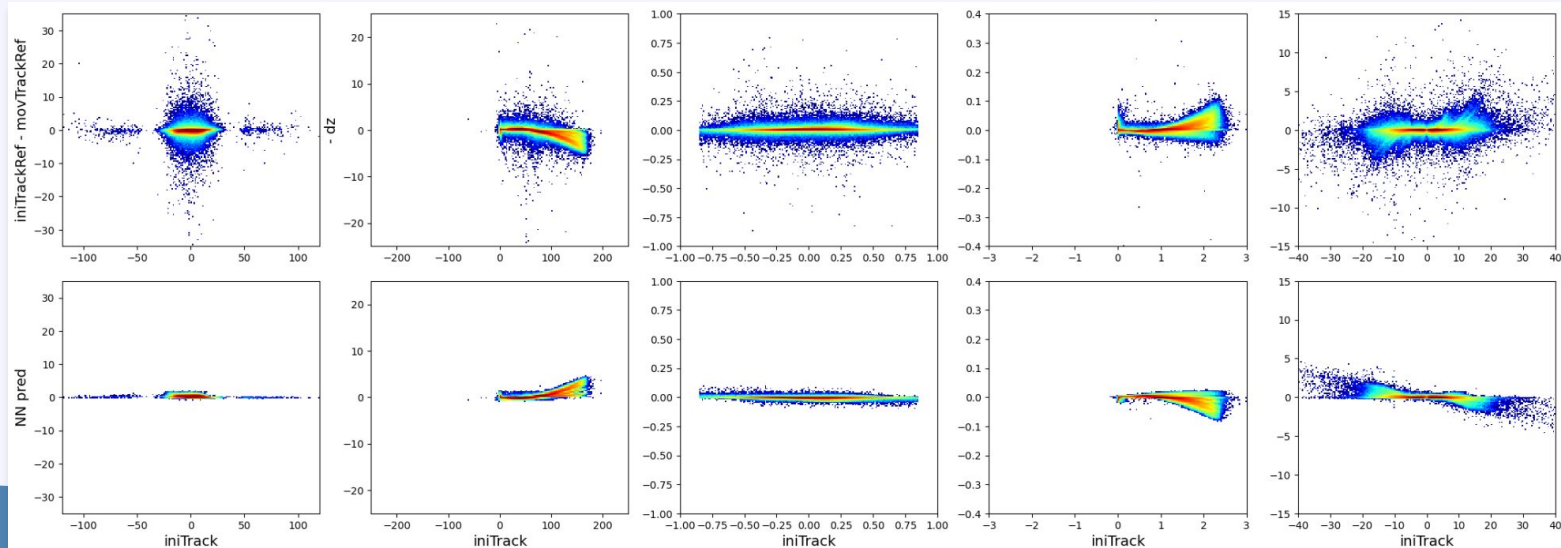
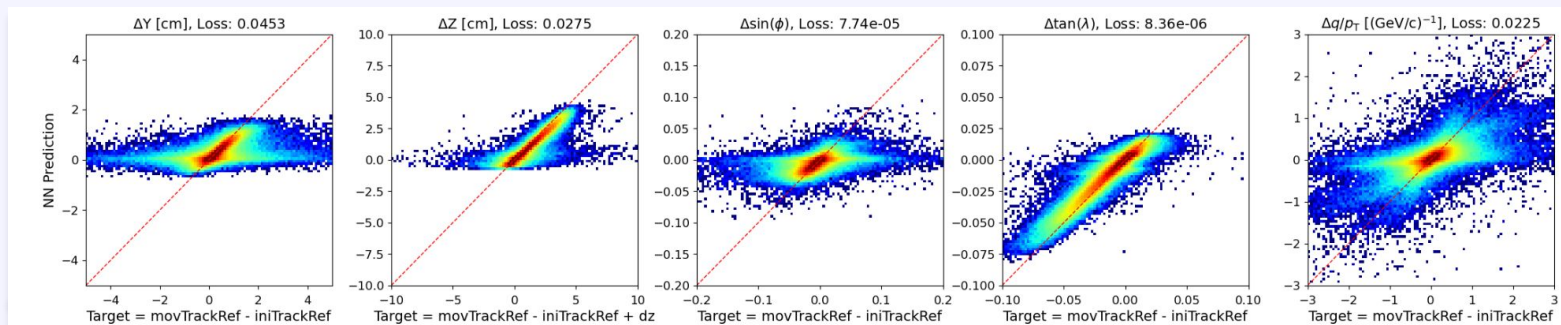


NN

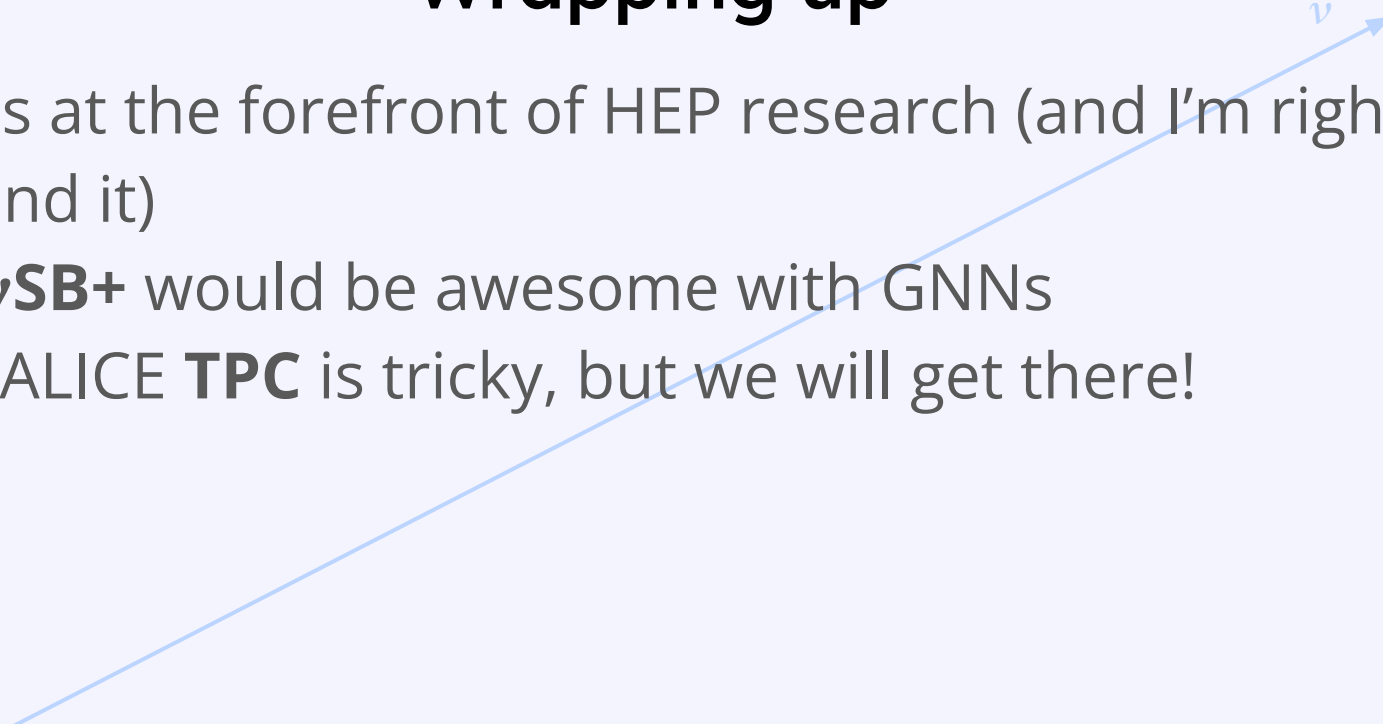


Final track

PROPOSED



## Wrapping up

- **ML** is at the forefront of HEP research (and I'm right behind it)
  - **ESS $\nu$ SB+** would be awesome with GNNs
  - The ALICE **TPC** is tricky, but we will get there!
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## Wrapping up

- **ML** is at the forefront of research (and I'm right behind it)
- **ESSvSB+** would benefit from GNNs
- The ALICE **TPC** is still getting there!



**Thank you**