

It's **HEP** to be **SMART**

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Milano-Bicocca University

Introduction



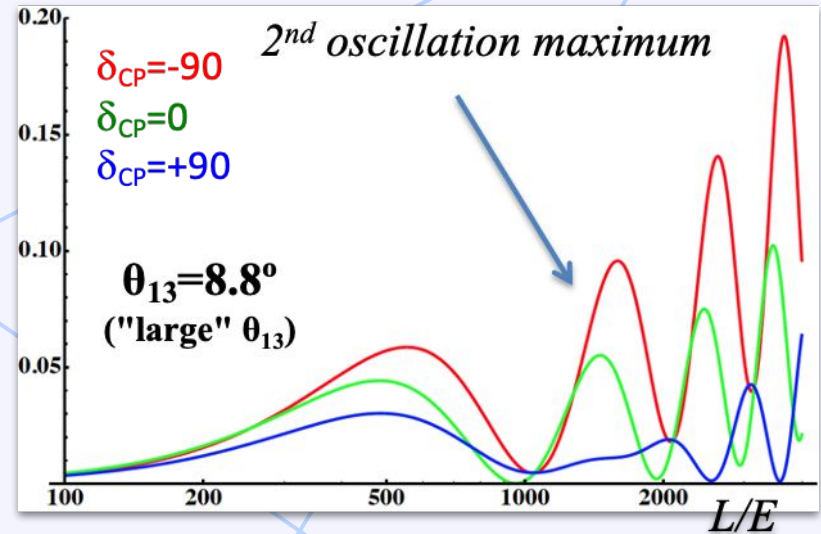
ML in HEP go brrrr

1. Event reconstruction for the ESS ν SB+
2. Calibration of the ALICE TPC

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

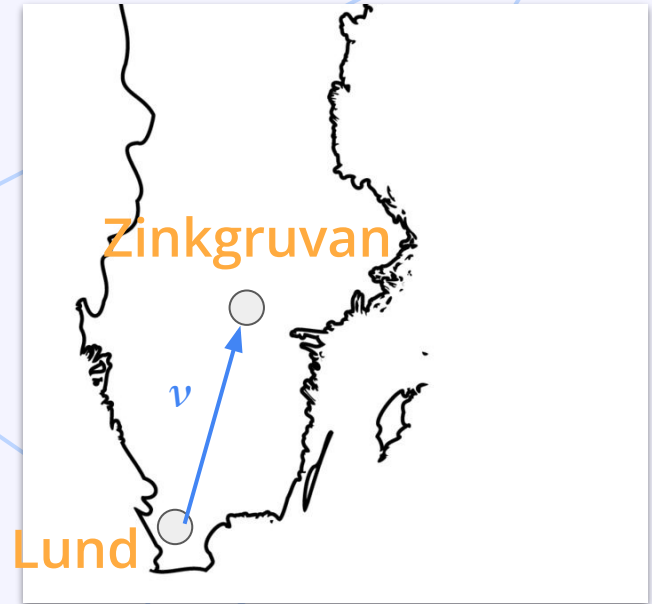
ESS ν SB+: Measuring leptonic δ_{CP} in a mine in Sweden

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

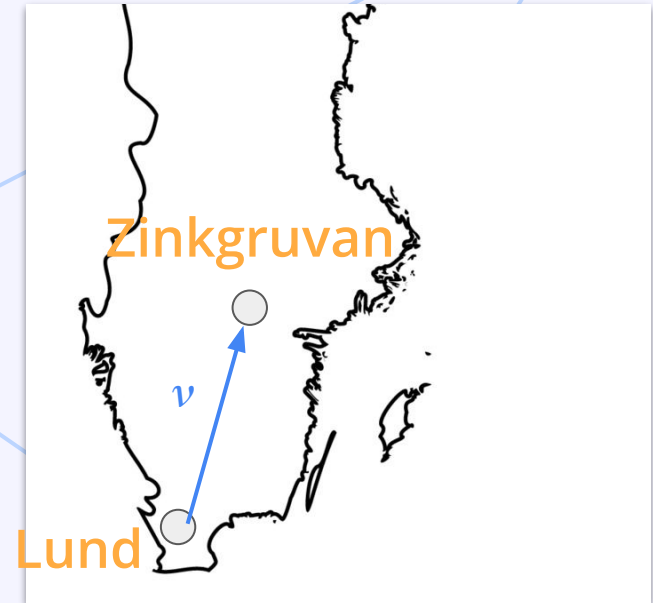
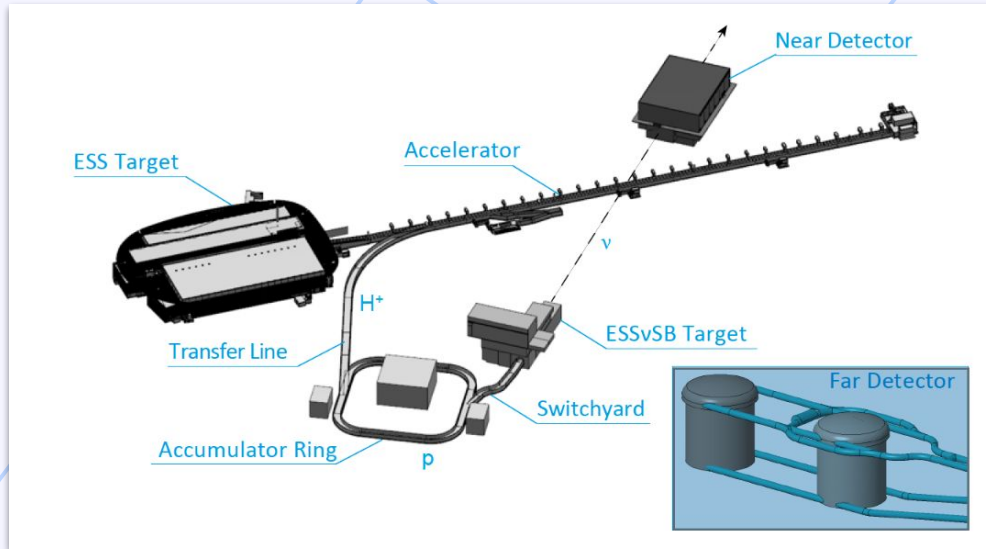


ESS ν SB+: Measuring leptonic δ_{CP} in a mine in Sweden

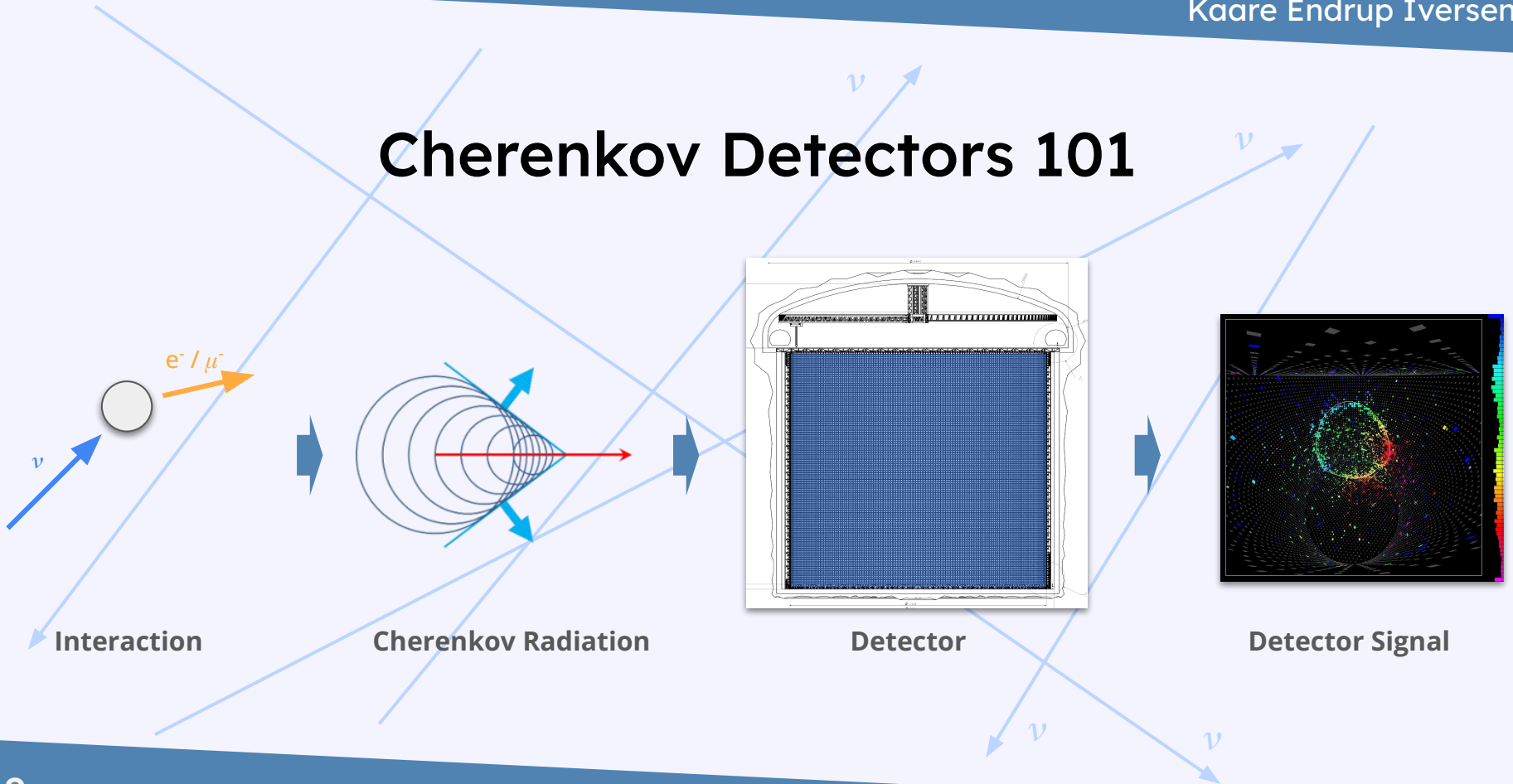
- CP-violation term more influential at 2nd maximum
- Great distance requires more intensive beam
- We can get that at ESS!



ESS ν SB+: Measuring leptonic δ_{CP} in a mine in Sweden



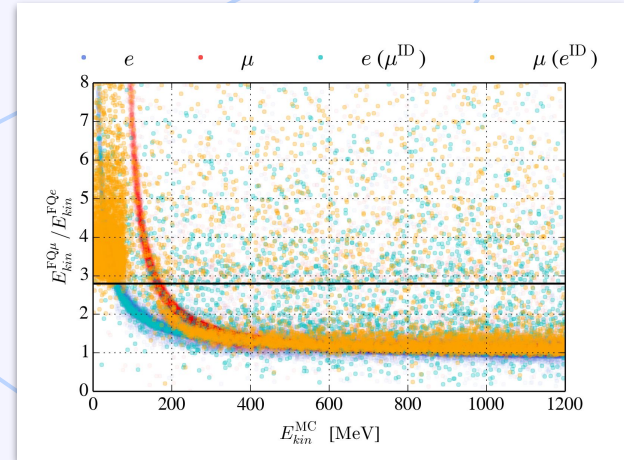
Cherenkov Detectors 101



GNNs for Flavour Classification

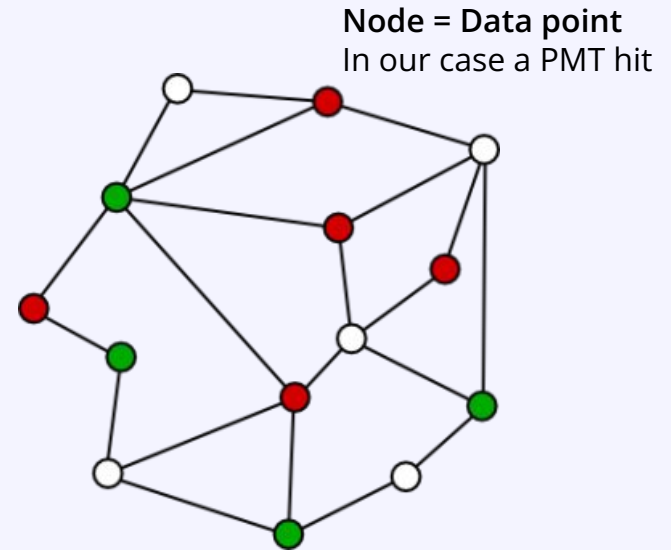
Current LLH-based methods are:

- Slow
- Inflexible
- Require cuts

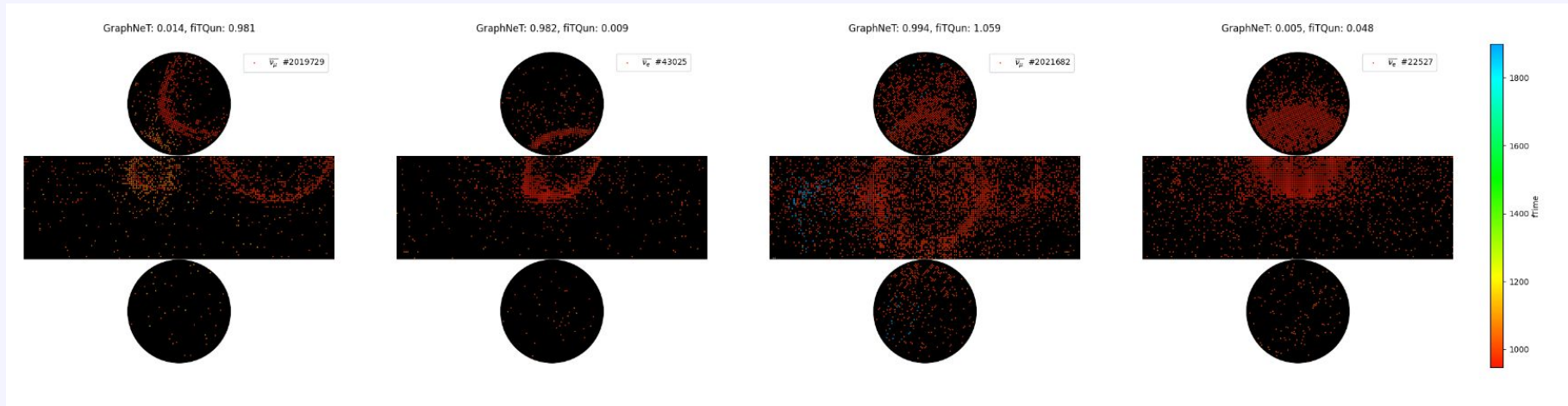


GNNs for Flavour Classification

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



GNNs for Flavour Classification



GNN > LLH

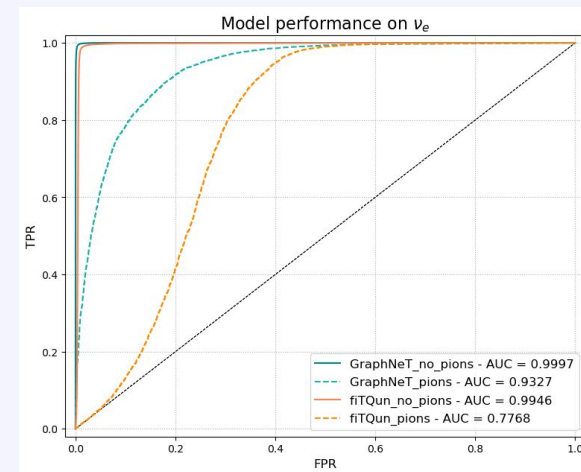
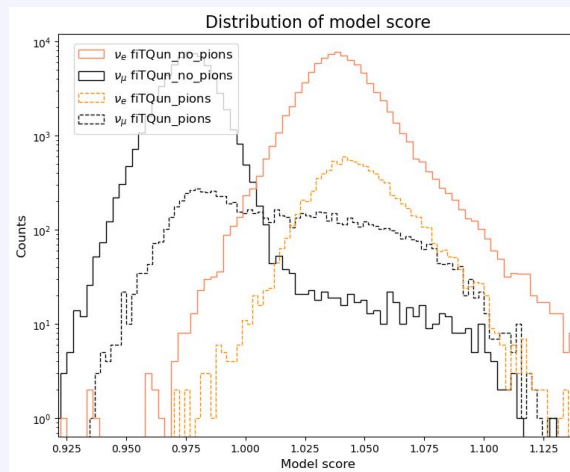
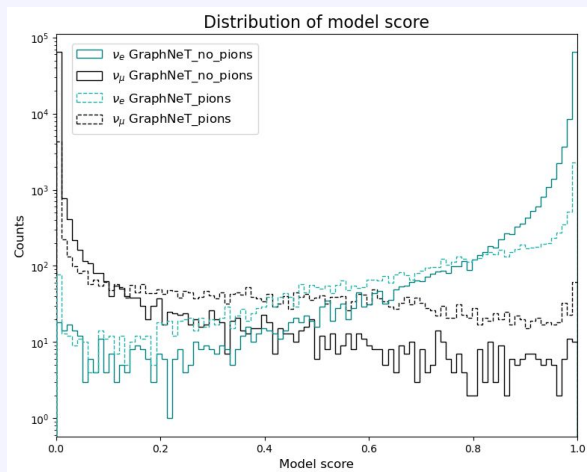
LLH > GNN

Both wrong

Both correct

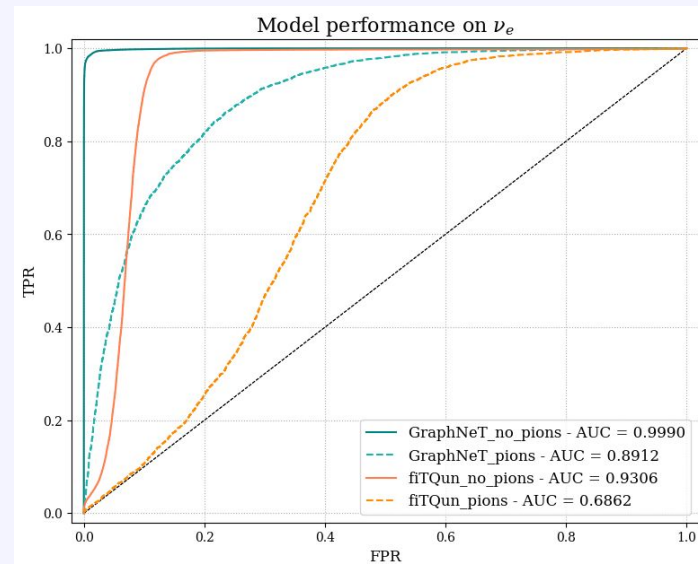
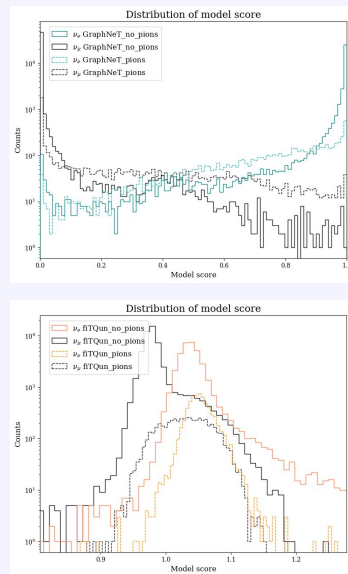
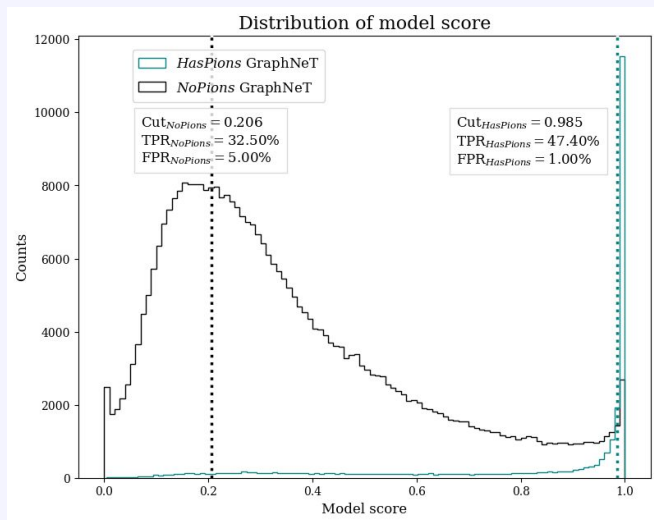
GNNs for Flavour Classification

Split by Pion production



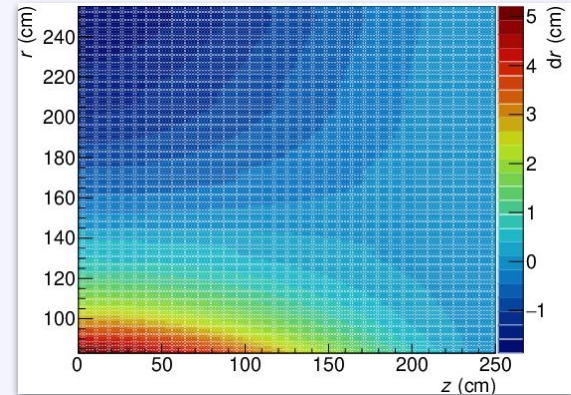
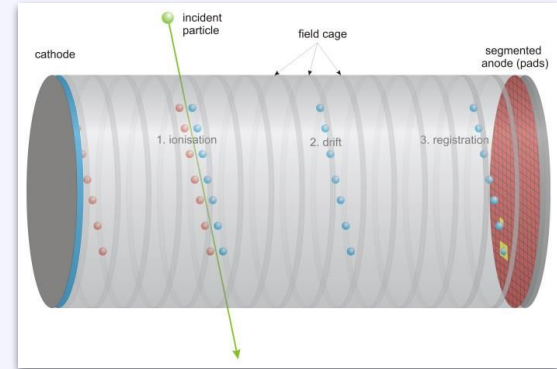
GNNs for Flavour Classification

Split by Pion production



ML Correction of Space Charge Distortions in the ALICE TPC

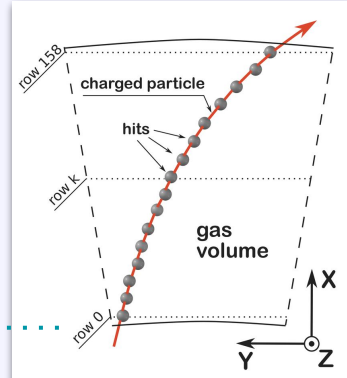
- Due to charge build up, we get **space charge distortions**
- Can be accounted for with traditional methods, but **computationally expensive**
- A task possibly **well-suited for ML**



TPC Space Charge Distortions

CURRENT

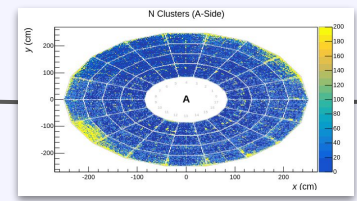
$(y, z, \sin(\varphi), \tan(\lambda), q/p_T)$



Final track

PROPOSED

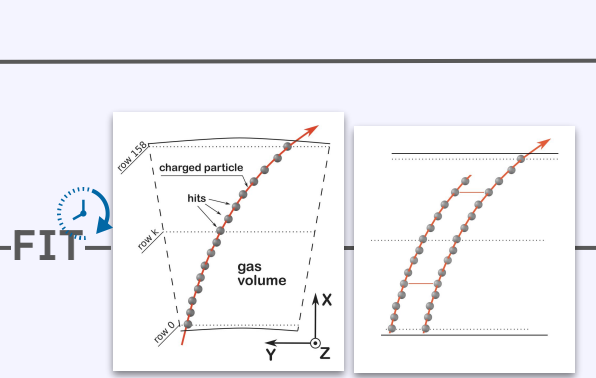
Recalibrated clusters



FIT



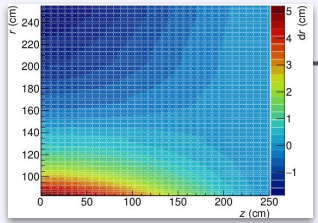
NN



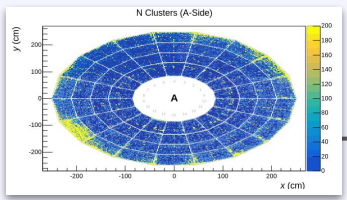
Initial track

Z-shift

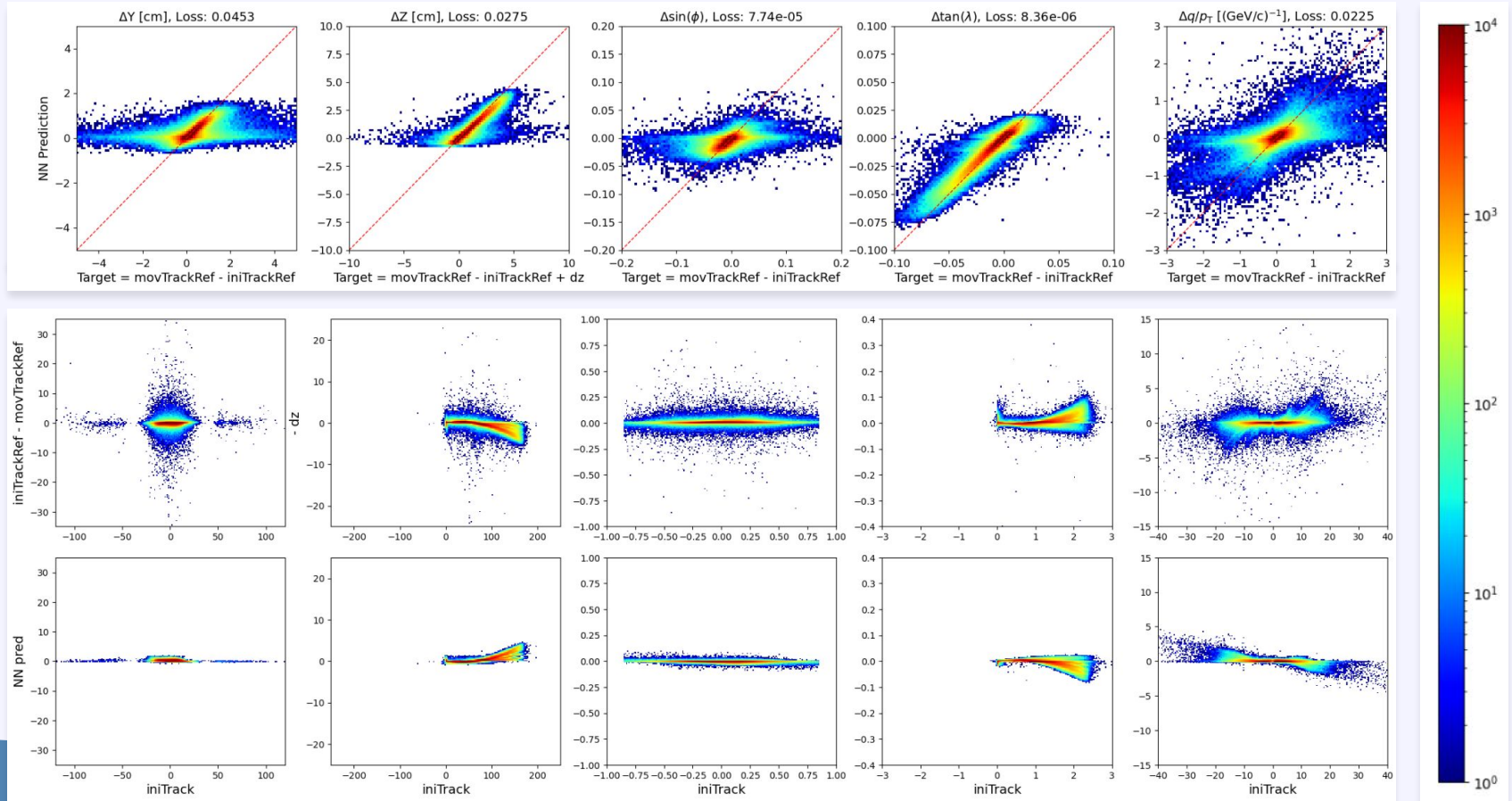
FIT



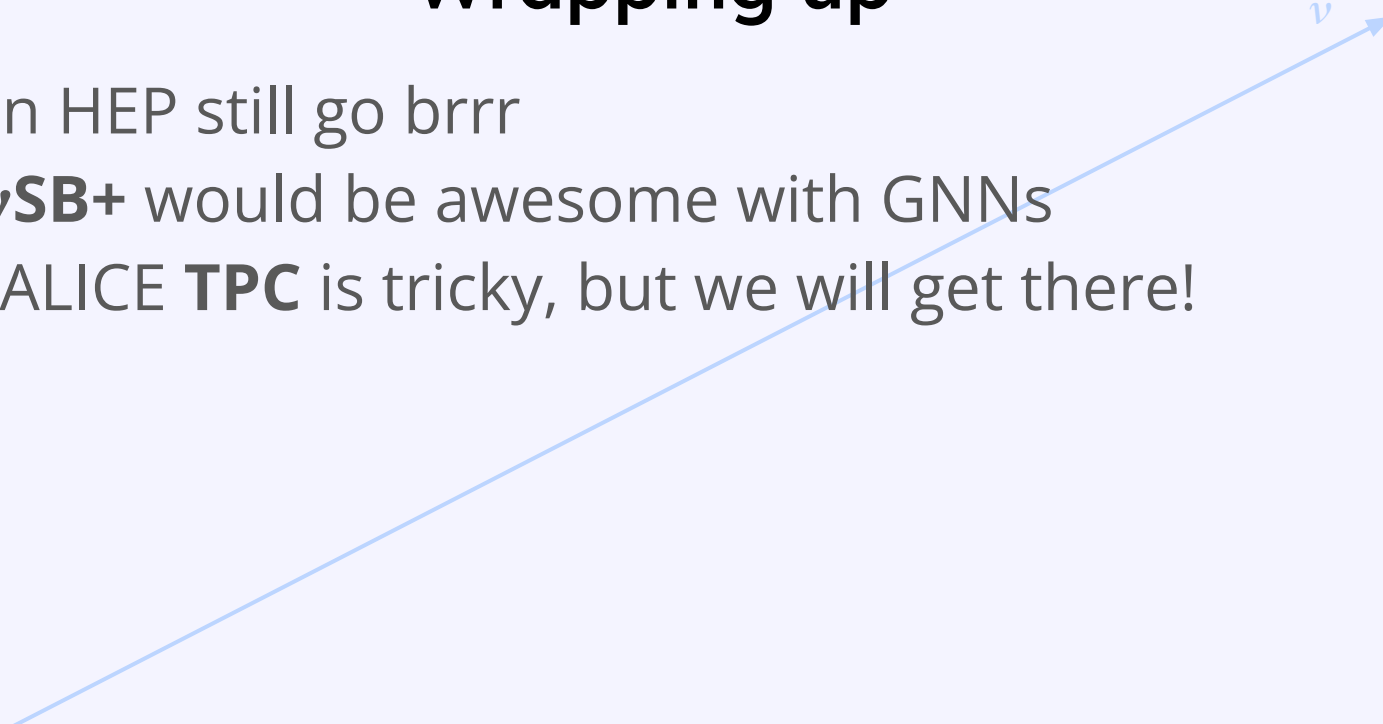
Correction maps



TPC Clusters



Wrapping up

- **ML** in HEP still go brrr
 - **ESSvSB+** would be awesome with GNNs
 - The ALICE **TPC** is tricky, but we will get there!
- 

Wrapping up

- **ML** in HEP still go hand in hand
- **ESSvSB+** would benefit from GNNs
- The ALICE **TPC** is still get there!



Thank you