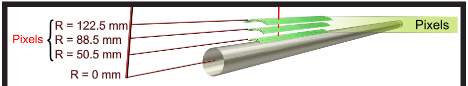
Neural network based cluster reconstruction in the ATLAS pixel detector

Introduction

- The ATLAS silicon pixel detector determines the position of passing charged particles
- Consisting of 80.4 million pixels in total of which $\sim 90\,\%$ are $50\ \mu m \times 400\ \mu m$



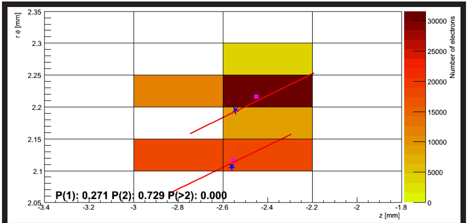
Schematic of the ATLAS Pixel barrel with its three layers being crossed by one high-energy particle

- In a densely populated track environment (e.g. a jet) two or more particles might deposit charge in adjacent pixels whereby shared clusters are produced

$\rightarrow$ A **neural network (NN) algorithm** is developed to determine a **more precise cluster position** and improve the **two-particle separation**. It addresses the issue of non-linear correlations between the variables

Method

- Results of the NN algorithm:
  - Estimation of the number of charged particles per cluster
  - For each of the estimated number of particles, the position with its uncertainty is determined in two dimensions

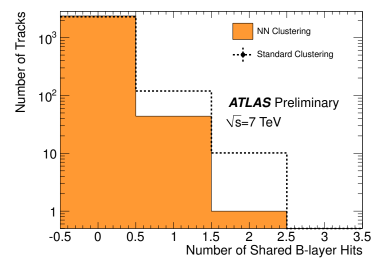


A cluster shown with the particle's true positions (pink marker) and their true directions (red line). Additionally, the NN probabilities for the particle multiplicity (lower left corner) and the estimated positions (blue marker) are displayed.

Results

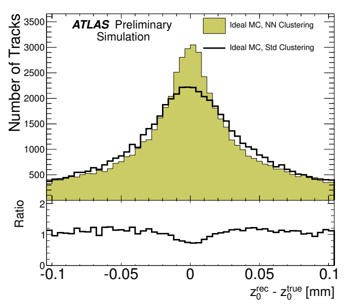
Hit Performance

- The amount of **shared hits on-track** (hits associated to multiple tracks) **decreases** strongly in the innermost layer with NN clustering as shown in the figure below



The number of shared hits on-track in the innermost Pixel layer reconstructed with and without the NN-based clustering for tracks with p_T>100 GeV of a $t\bar{t}$ sample

Tracking Performance



Simulated longitudinal impact parameter resolution with and without NN-based clustering for tracks with p_T>100 GeV

Conclusion

- The NN algorithm **significantly improves tracking performance** for physics analysis