Software developments and analysis in the ATLAS group

Software coordination

- Starting October 2021 G. Stavropoulos is appointed ATLAS muon software coordinator.

- Goal: Design, develop and maintain the ATLAS muon offline software all the way from DAQ byte-stream reading to muon reconstruction and identification.

- Muon software domain:
  - Data Access: Byte-stream Conversion - Cabling
  - Detector Description
  - Modelling of the Detector Response (Simulation, Digitization, ”Local” Reconstruction)
  - Track Reconstruction and Muon Identification
  - Conditions Database and Detector Control system
  - Detector Specific calibration procedures
  - Trigger
  - Offline Data Quality
  - Validation
- Various tasks ongoing in each of these areas.

An example: High radiation background in the New Small Wheel detector

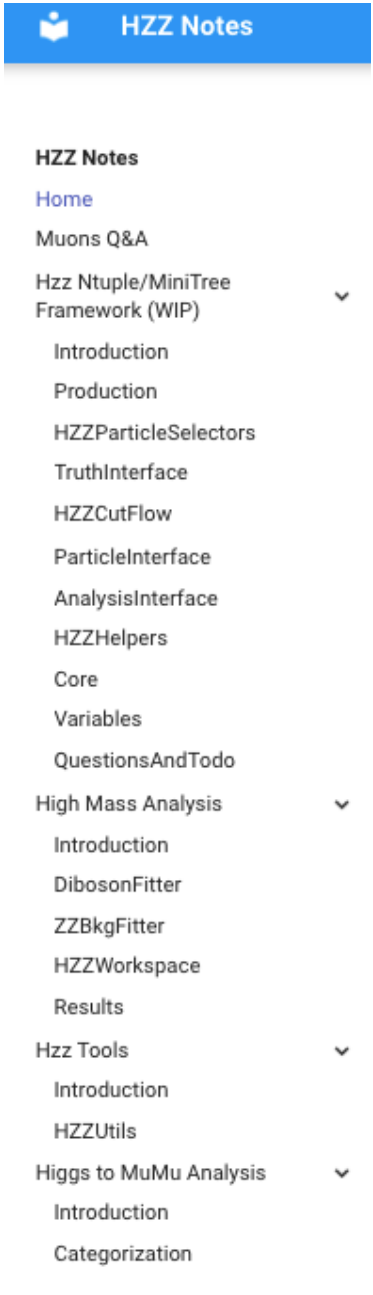
- The precise reconstruction of the trajectories of muons created in proton–proton (pp) collisions is a key ingredient in many of the physics processes.
- In order to reconstruct muon trajectories, ATLAS uses energy deposits from charged particles (hits) recorded in individual detector elements of the New Small Wheel (NSW) and applies clustering algorithms to them.
- The purpose of the clustering algorithms is to group together these energy deposits. Based on those groups of hits called clusters in a number of the layers of NSW, the associated track parameters can be estimated.
- Therefore, the performance in the reconstruction of these clusters heavily affects with the associated tracks.
- In the context of this task, we work with Micromegas clusters, which are a collection of strips (sensitive element of the Micromegas detector).

Description of the task

- Muons with high transverse momentum undergo radiative energy losses.
- These may produce hits near the muon track and 'spoil' the shape of the cluster in the NSW.
- Goal: In order to accurately find the hit positions of the muon track along the detector layers, we would like to identify these problematic clusters.
- We refer to:
  - Signal: Clusters with simulated hits from muons.
  - Background: Clusters with simulated hits from electrons, photons apart from muons.
- This is a classification task with a binary (two level) qualitative response (Y=1 for signal, Y=0 for background).
- Someone can explore a number of methods like Boosted decision trees, Random Forests, Support Vector Machines etc.

HZZ group activities

- Our group is taking part in the high mass H to ZZ analysis, where heavy particles that are predicted from many models beyond the Standard Model decay into diboson final states.
- We try to document everything as much as possible in the website below, since the packages that the group uses are enormous and this is really helpful for a newcomer.
- Website link: https://hzznotes.web.cern.ch/
- This is not something ordinary and HZZ conveners liked the effort, since anything similar doesn't exist and encouraged others to follow.
- We have added a dedicated section for the high mass analysis, where we comment on the packages and its methods/objects used along with results.



Tasks examples

- Signal shape parametrization: The top plot on the left shows a fit on the signal using the sum of a Crystal Ball function and a Gaussian function (6 parameters in total, same mean for both functions).

- Background shape parametrization: The bottom plot on the left shows a fit of a custom function for the parametrization of the background.