Instrumentation for μ and K_L indentification at Super Flavor Factories

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Prototype Data Analysis and Simulation

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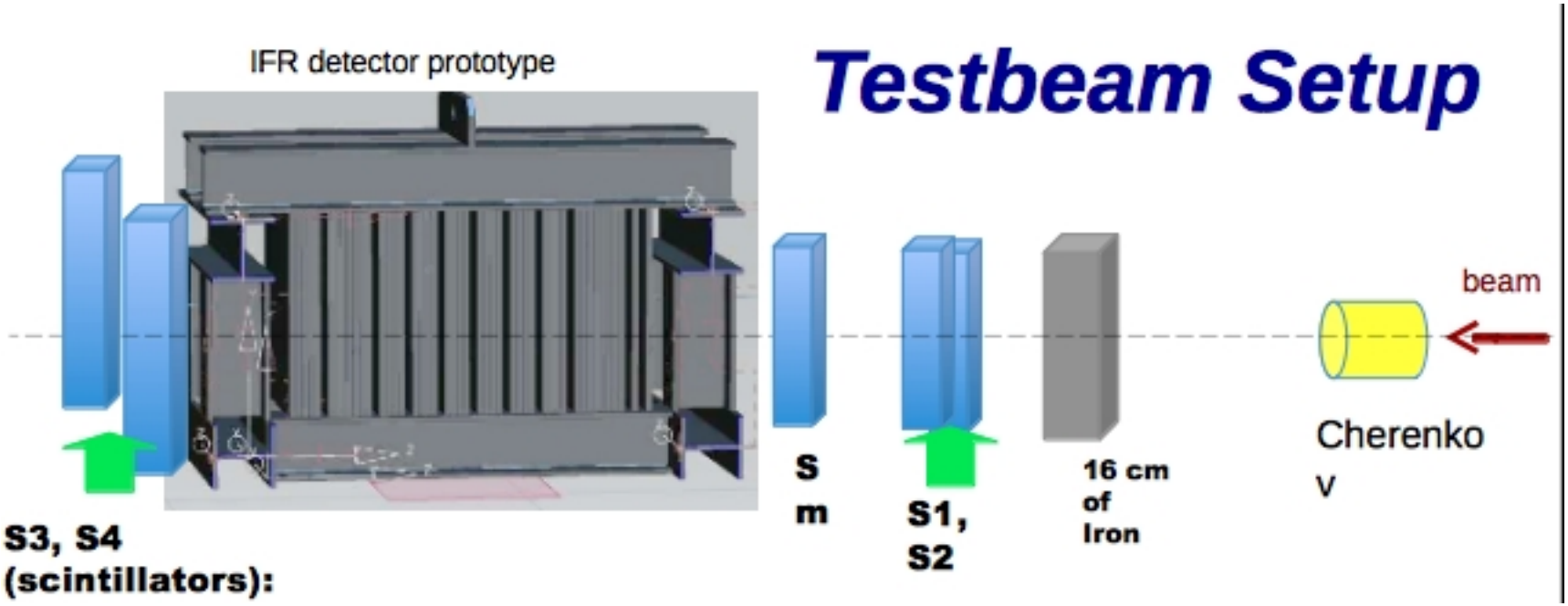
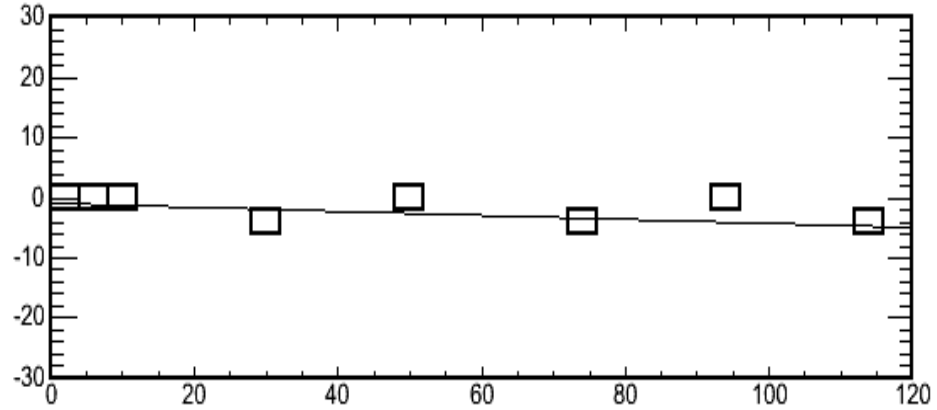
Prototype: FNAL-2012 setup

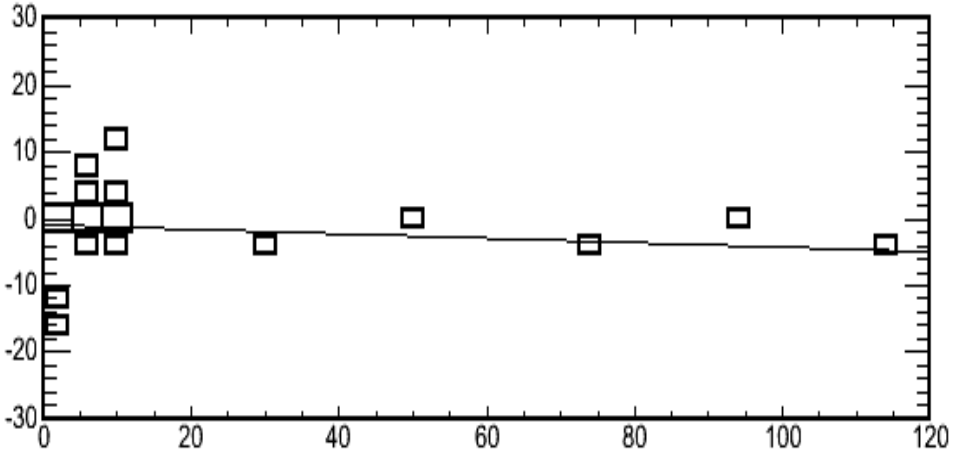


- Main improvement respect to 2010/2011 setup: muon and pions selected chancing N_2 pression
- Further scintillator before the prototype: Sm
  - Muons: S1 && S2 && Sm && $C_1(p_\mu)$ && !C_e
  - Pions: S1 && S2 && Sm && $C_1(p_\pi)$ && !C_e

Prototype data: "tipical" events

Muon candidate: 6 GeV

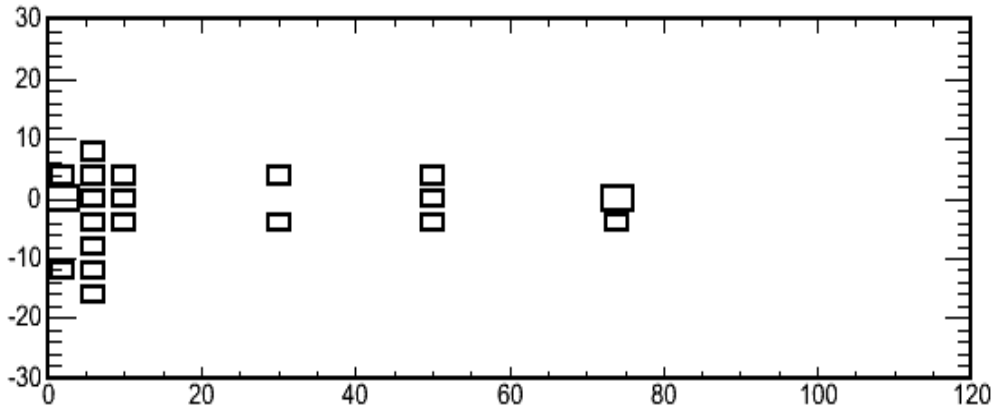


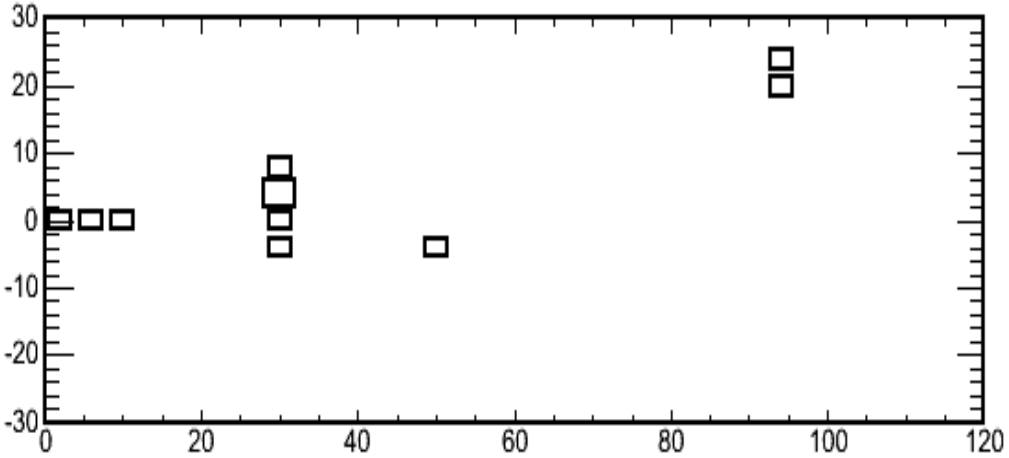


Y coordinate

Layer z [cm]

Pion candidate: 6 GeV





Layer z [cm]

Software

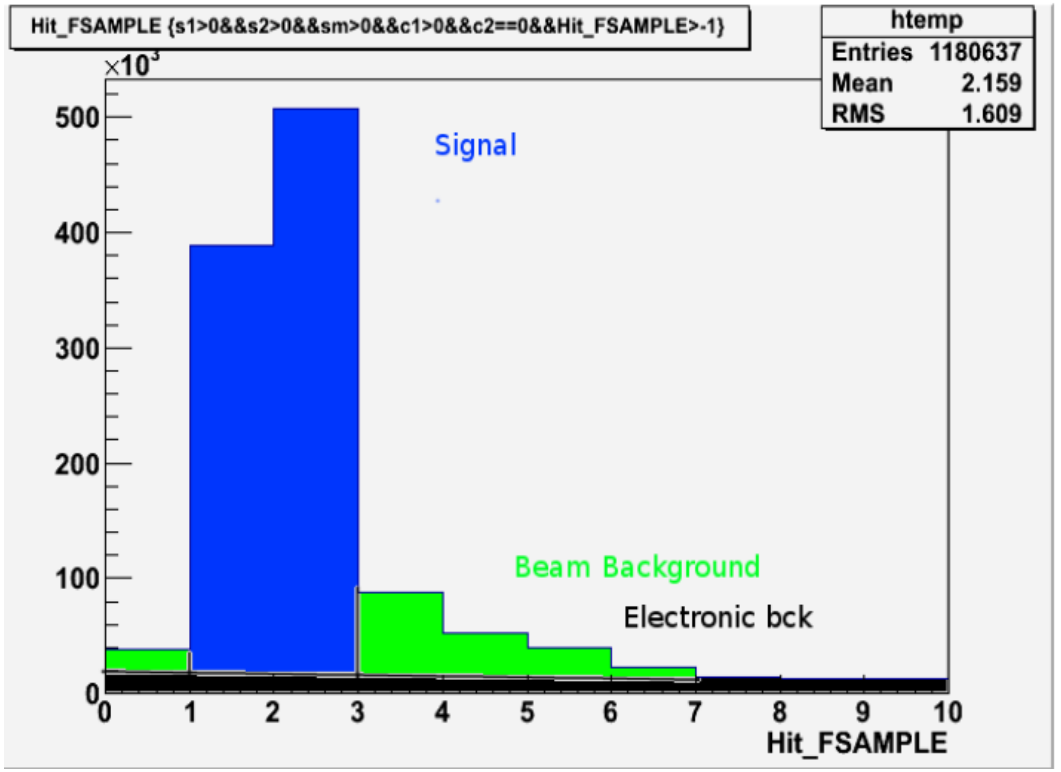
- **IfrRootCode**
  - Software for the digitization/reconstruction
  - Originally developed to work with the SuperB geometry, updated to analysis the data of the prototype:
    - Both data and MC
- Use the standard **Bruno** to produce MC events with the prototype geometry (or any other geometry)

Many developments in IfrRootCode

- To have reasonable data/MC agreement, we tune the digitization of the simulated data
  - Adding noise
  - Simulate the different layer efficiencies
  - Merge of tracks
- Use the cleanest and understandable sample (muons at 8GeV) to define the level of noise and the cuts on the digitization

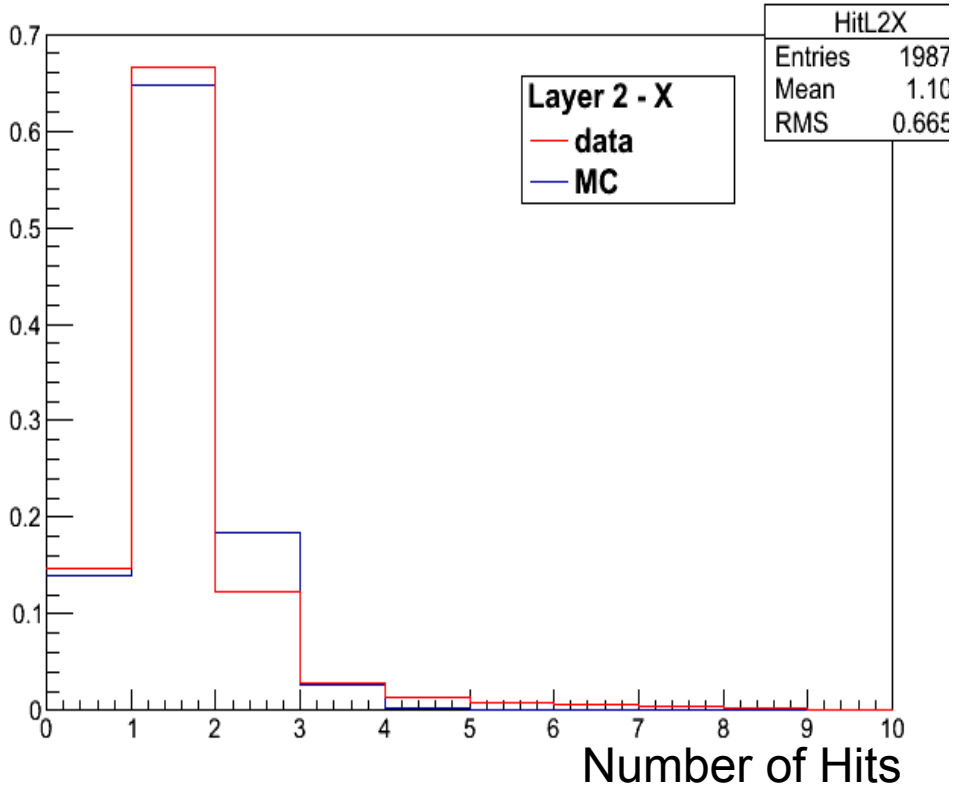
Backgrounds: electronics (and beam related)

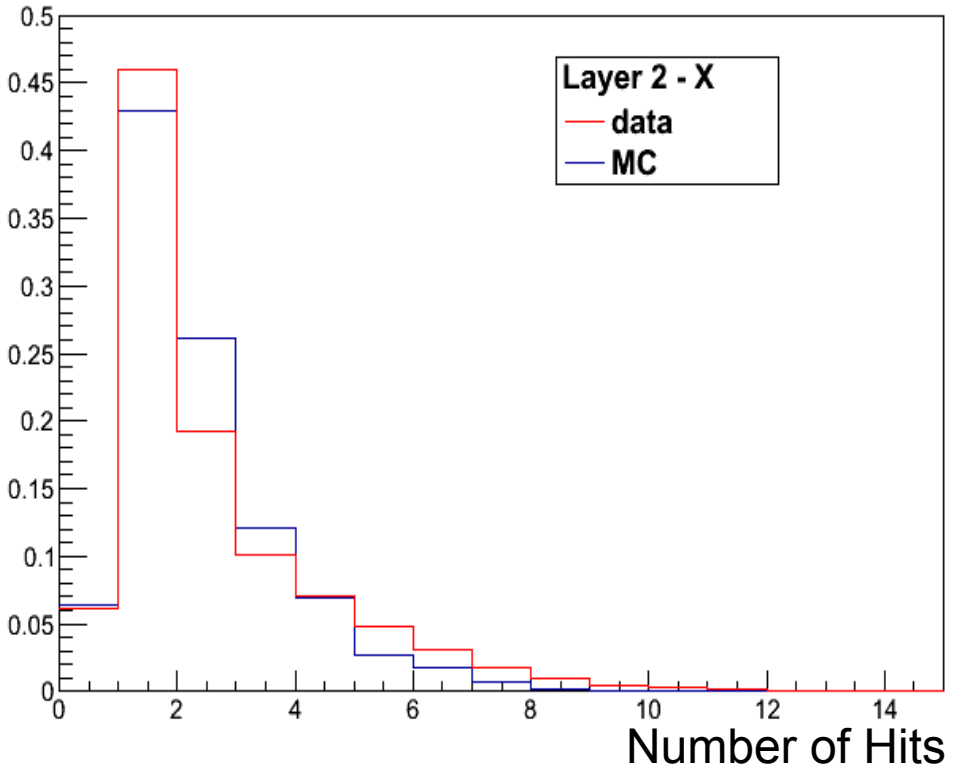
- Muons identified with the Cherenkov:
  - S1 && S2 && Sm && C1 && !C2
- Use the FSAMPLE 7,8,9 to evaluate the noise due to the electronics
- Hits for FSAMPLE=0,3,4,5,6 is assumed to be dominated by the beam related bkg



Layer efficiency

- Adjust the cut on the total release energy in a scint-bar:
  - Cut applied using 8GeV-muons and tests on pions at 8 GeV
  - Choose Layer by layer different energy cut

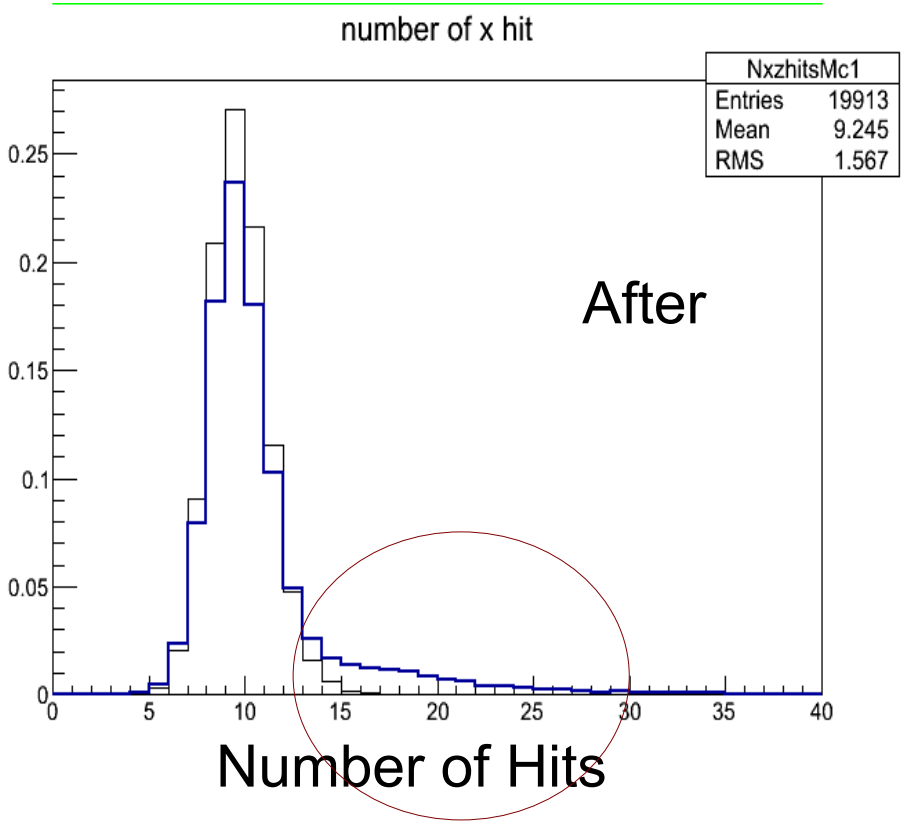


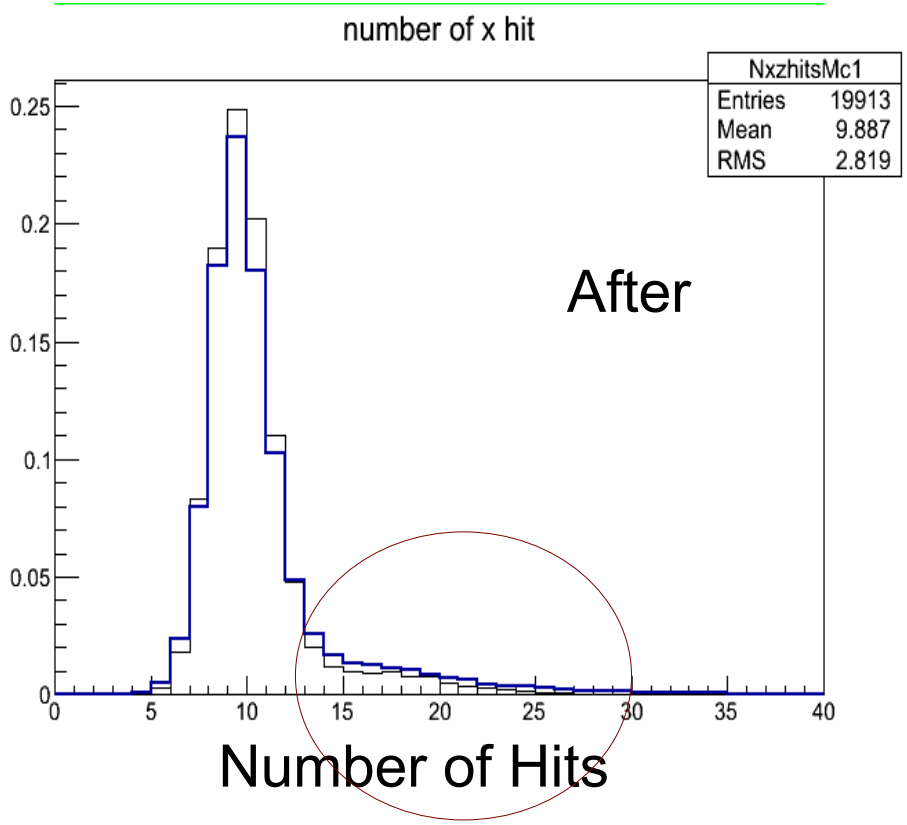


The tuning work very well to reproduce the bulk of the distribution
... summing togheter all the layers: tail still not simulated properly

Track merging: multiple tracks x event

- Added hits from pions in the muon sample to try to reproduce the tails
  - With 10% of contamination we have very good agreement in the total number of hits

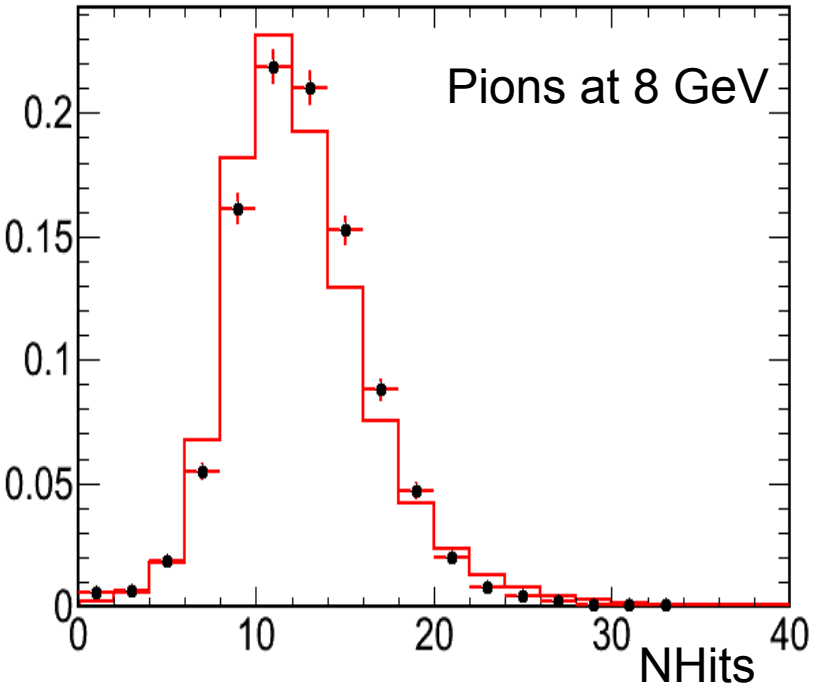




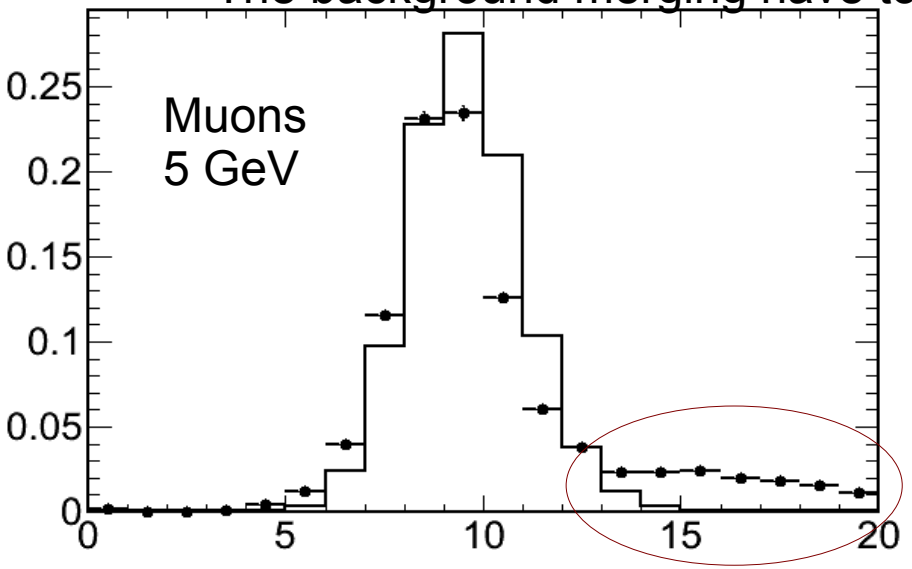
Events with multi-tracks have to be considered in these studies: consistent with the FNAL beam composition given by CALICE

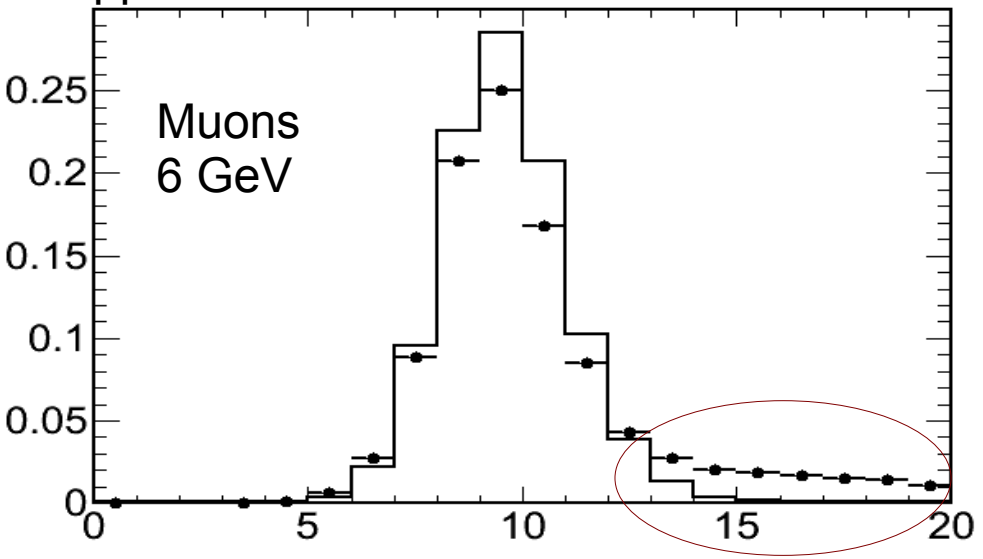
Some other Data/MC comparison

After all corretions applied using the muons at 8 GeV, the 8 GeV-Pions are simulated well!

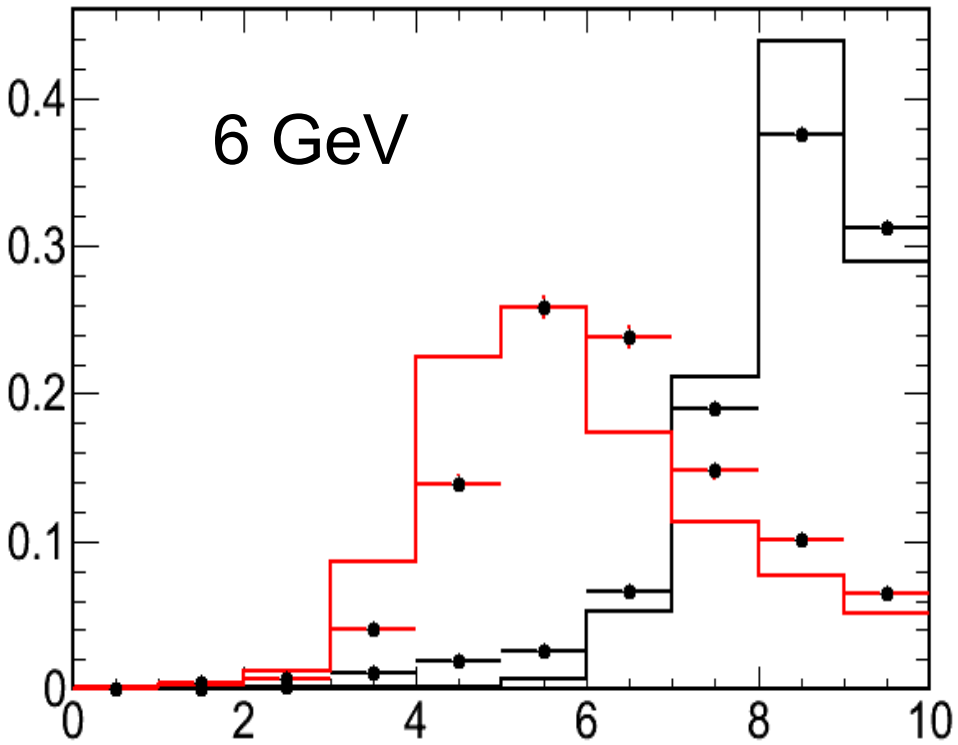


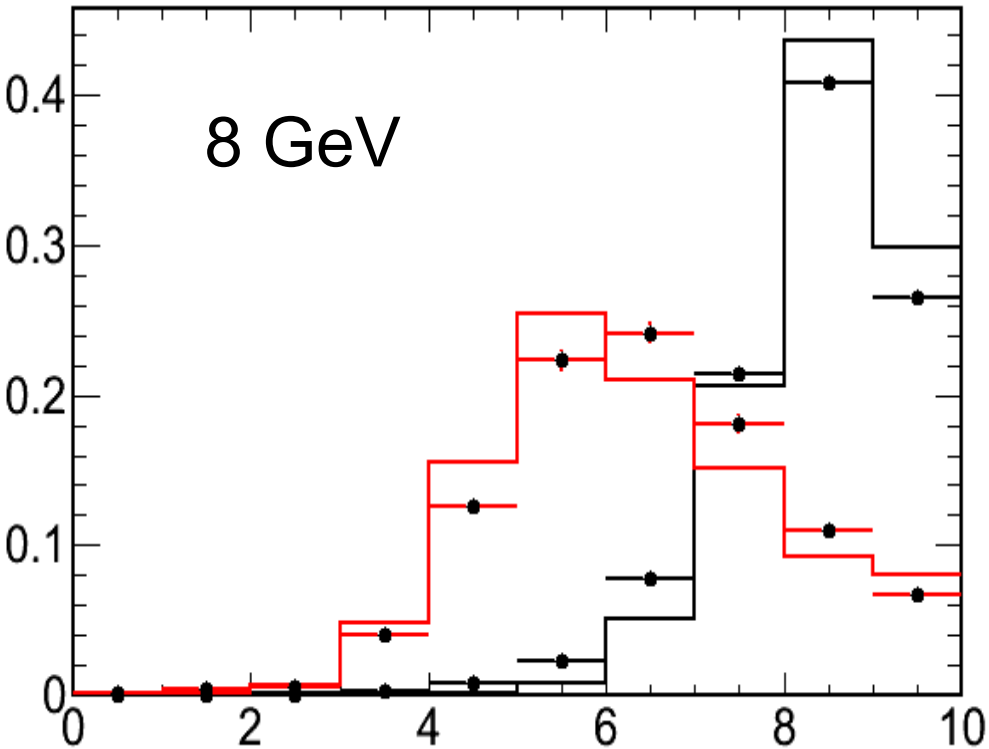
The background merging have to be applied also at 5 and 6 GeV





. . . an other variable



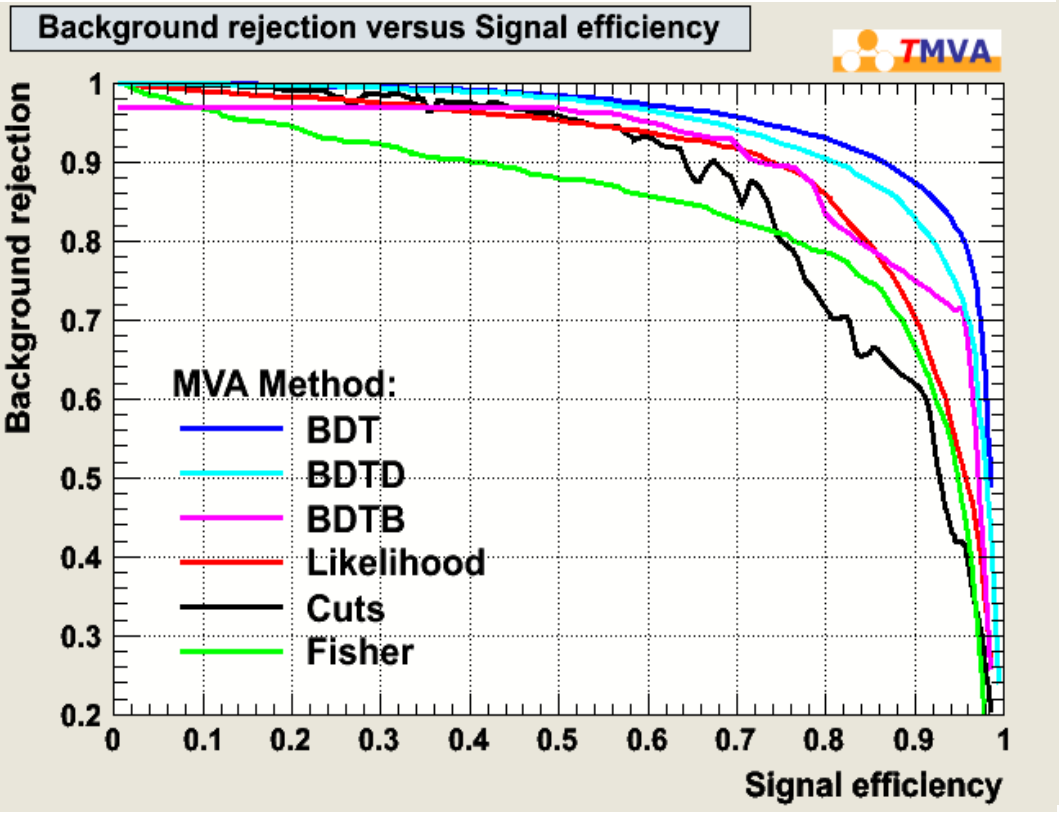


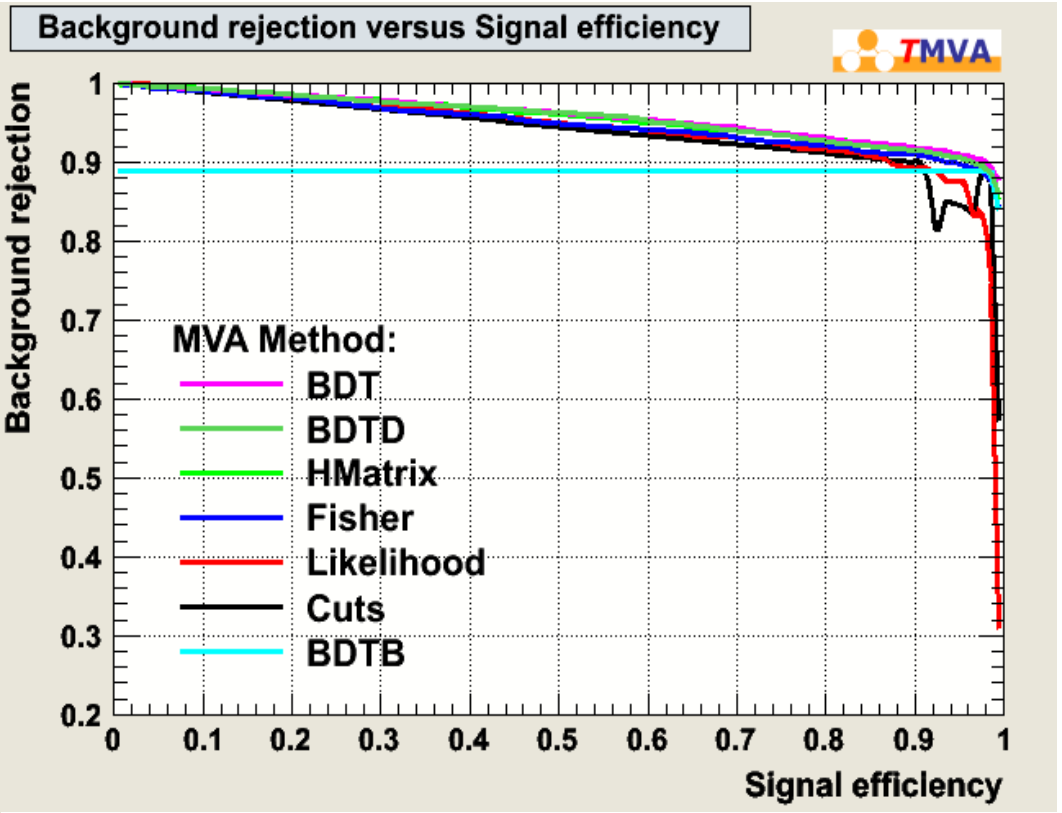
Without background merging

Despite these small differencies at 8 GeV
Try to compare the overall data/MC
Performance . . .

Muon select from data and MC

- Training multivariable selectors, at 8 GeV
- Use many inputs: #hits/#layers/tracking parameters
  - No surprisingly: data/MC response looks very different





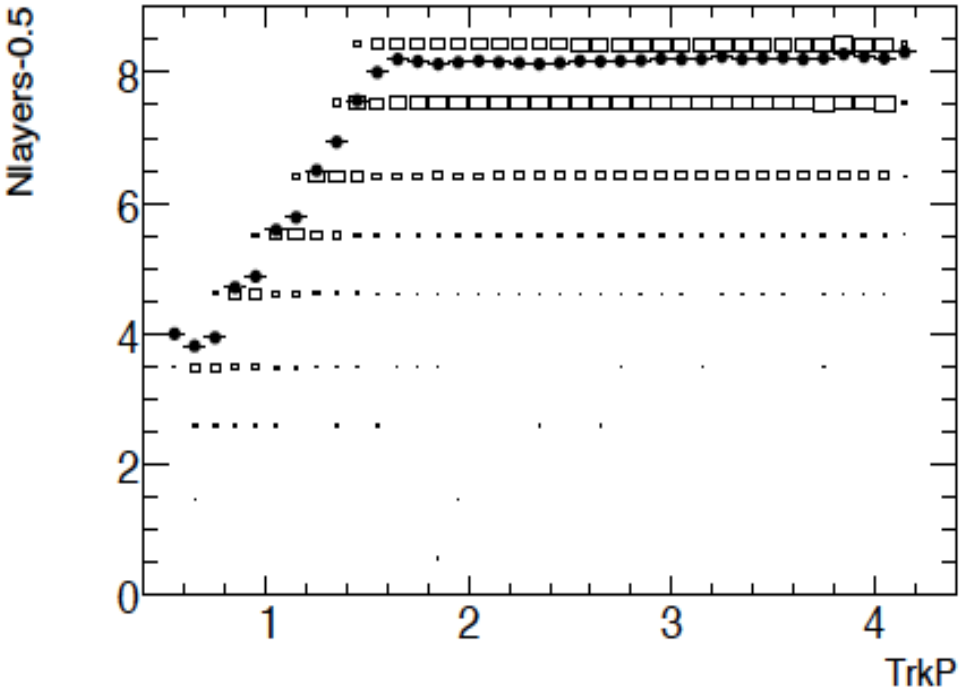
At lower energy even worse

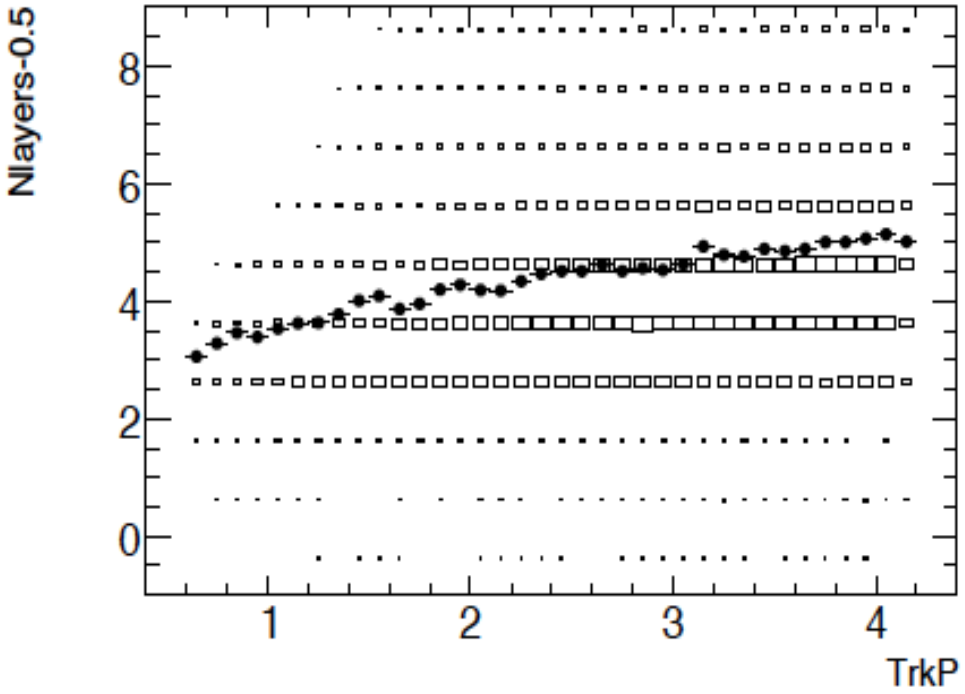
To summarize the status...

- We still are working to understand the data
  - With the data and beam informations we have I am not sure we will come to a fully understand of the muon-identification performances using only the data in time for the TDR
- We know the noise is important and we learn that the multiple tracks / event are important
  - But we assume the added tracks are pions (reasonable), but could be everything: positions, protons!
  - The situation at 8 GeV is reasonable under control, other energy points are less clear!

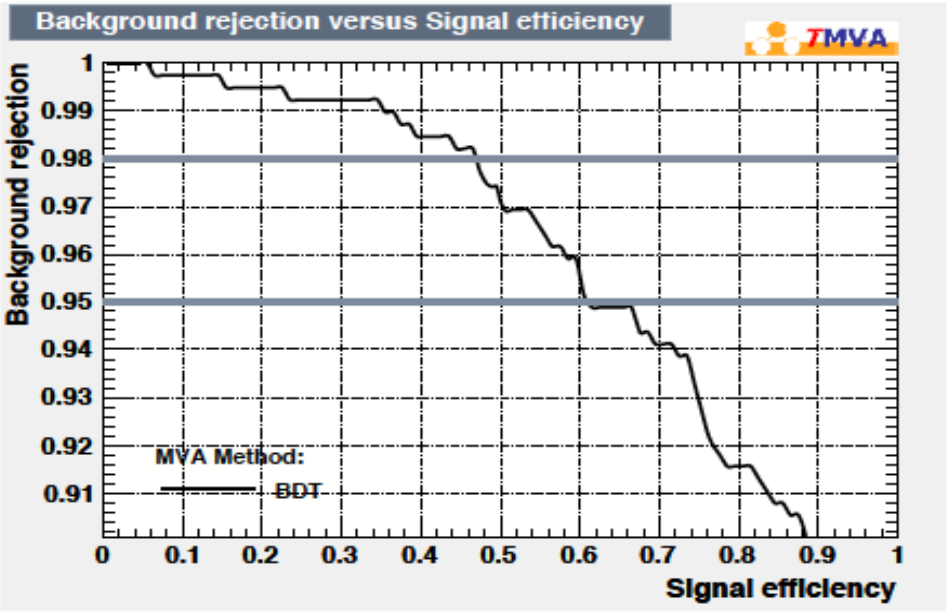
For the TDR...

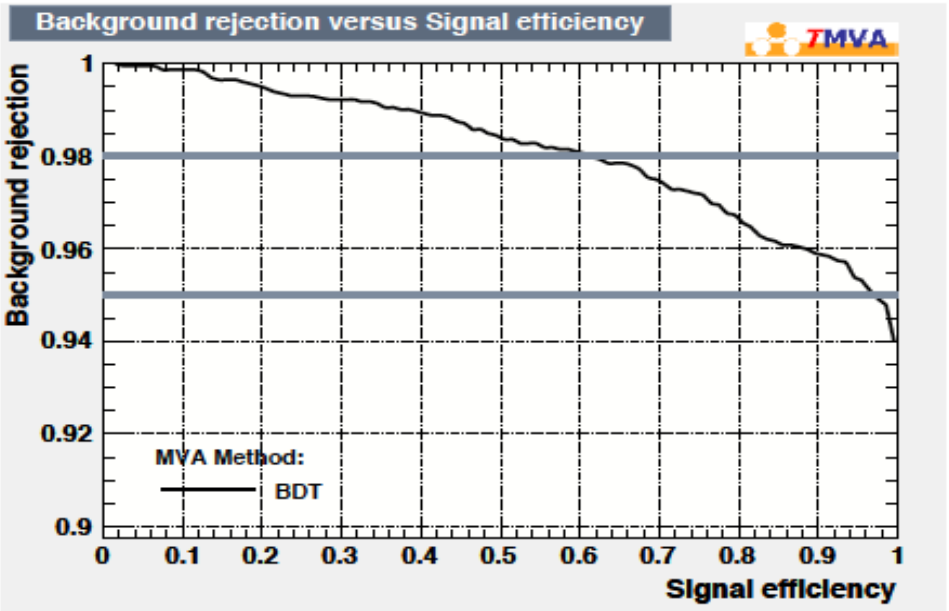
- We are confident that the calibration procedure is properly done
  - We assume an average layer efficiency
- Fully rely on the MC in a large range of energy, between 0 and 4 GeV
  - For the time being using the prototype geometry with pions and muons fired closer (2.5m) to the prototype!
  - For the final TDR we'll use the SuperB geometry



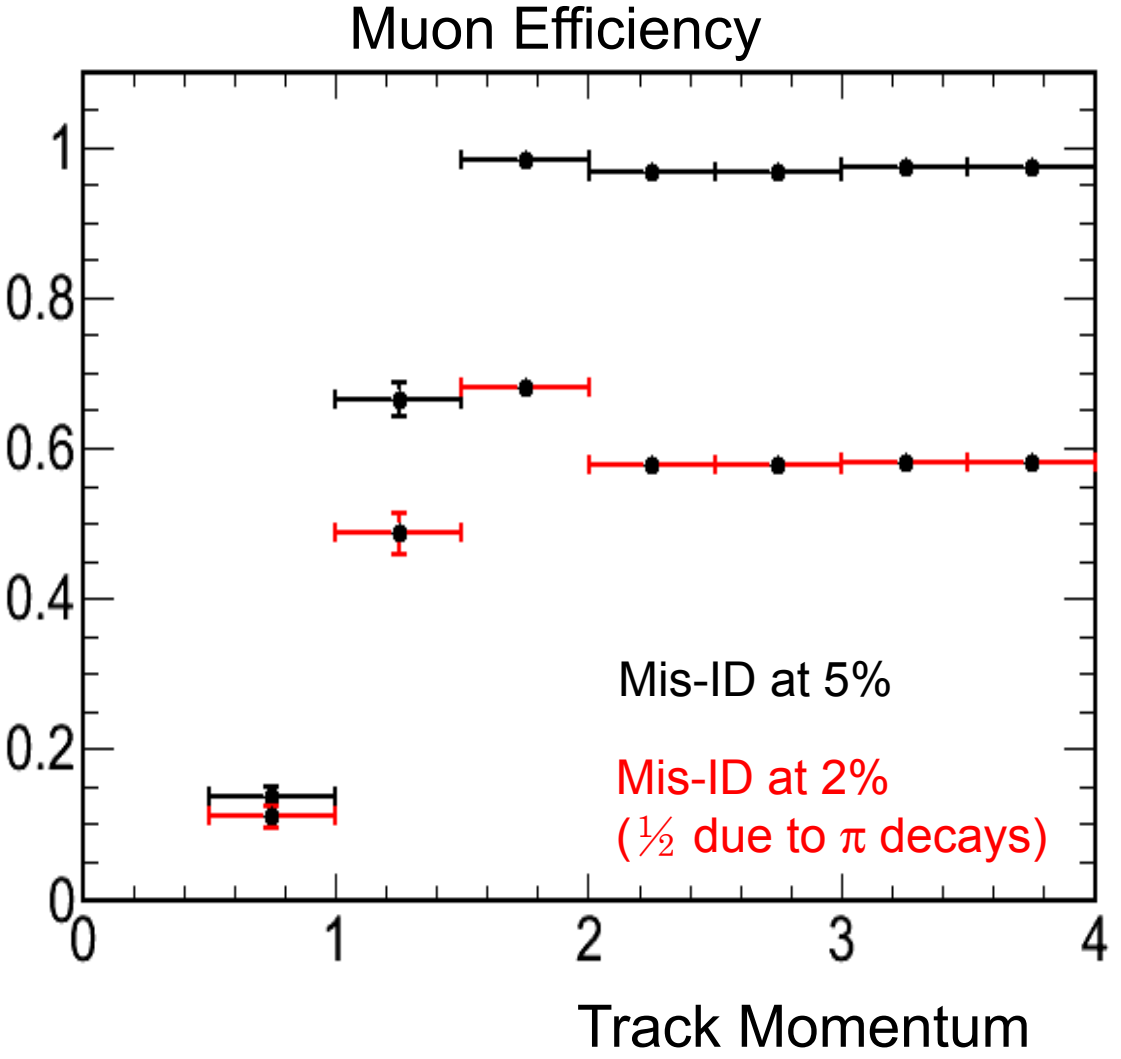


Informations we will have in the TDR





BDT optimized in bins of P, muon Efficiency



Agenda for the Parallel Sections

- Two sessions: Parallel I: Software, Simulation, Data Analysis
  - Thursday: 14:00 15:45
  - Friday: 9:00 10:45
- All the times will be devoted to discussion/work
  - Studies needed for the TDR and future
  - Data analysis: how to further clean the sample?
    - Pattern recognition to associate correct hits to muon tracks?
    - Use the first 2-3 layers as further selection elements
  - Detector performances: with the superB full detector
    - Test that the digitization and clasterization developed for the prototype work also with the superB geometry
  - Background studies:
    - evaluate the impact on the overall performance
  - Klong: preliminary studies are available
    - need to understand the effect of the background and the geometry