

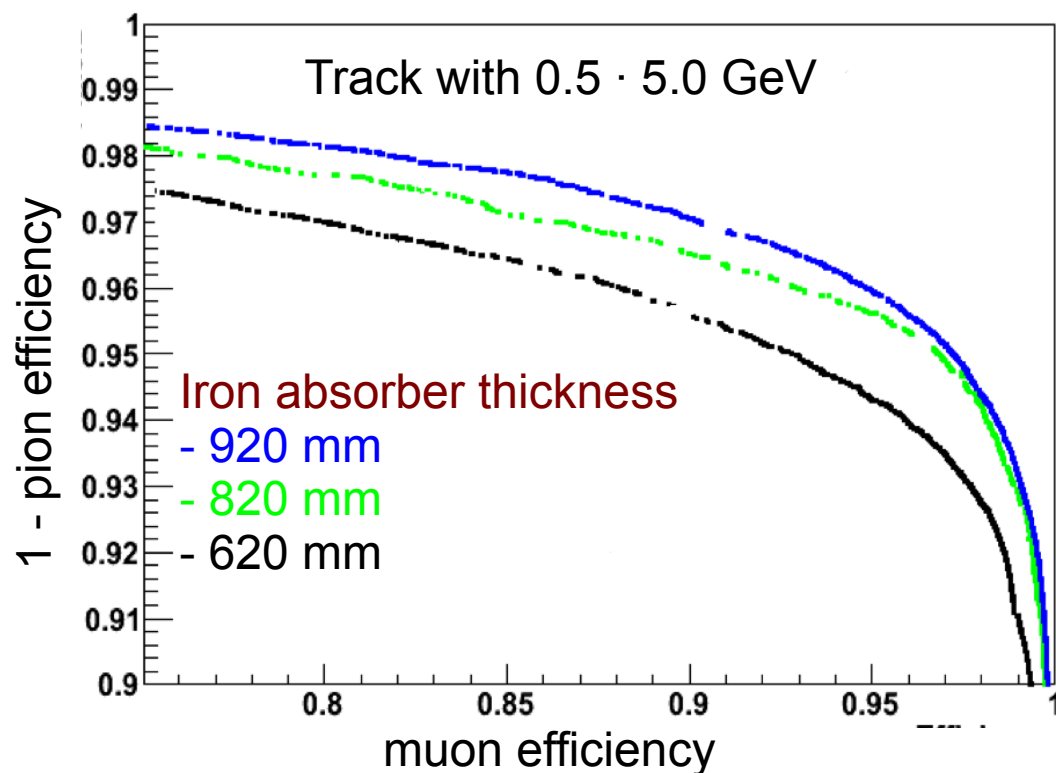
Beam Test Data Analysis

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Muon identification with the prototype

- Muon/Pion separation from Test Beam
 - Check hadronic shower models on Monte Carlo and define a detector response (Digitization)
 - Both aspects important for the Detector Geometry optimization and for future SuperB simulation
 - Many studies on hadron shower development available above 10 GeV (ex. CALICE), few old studies in the 'GeV' regime!



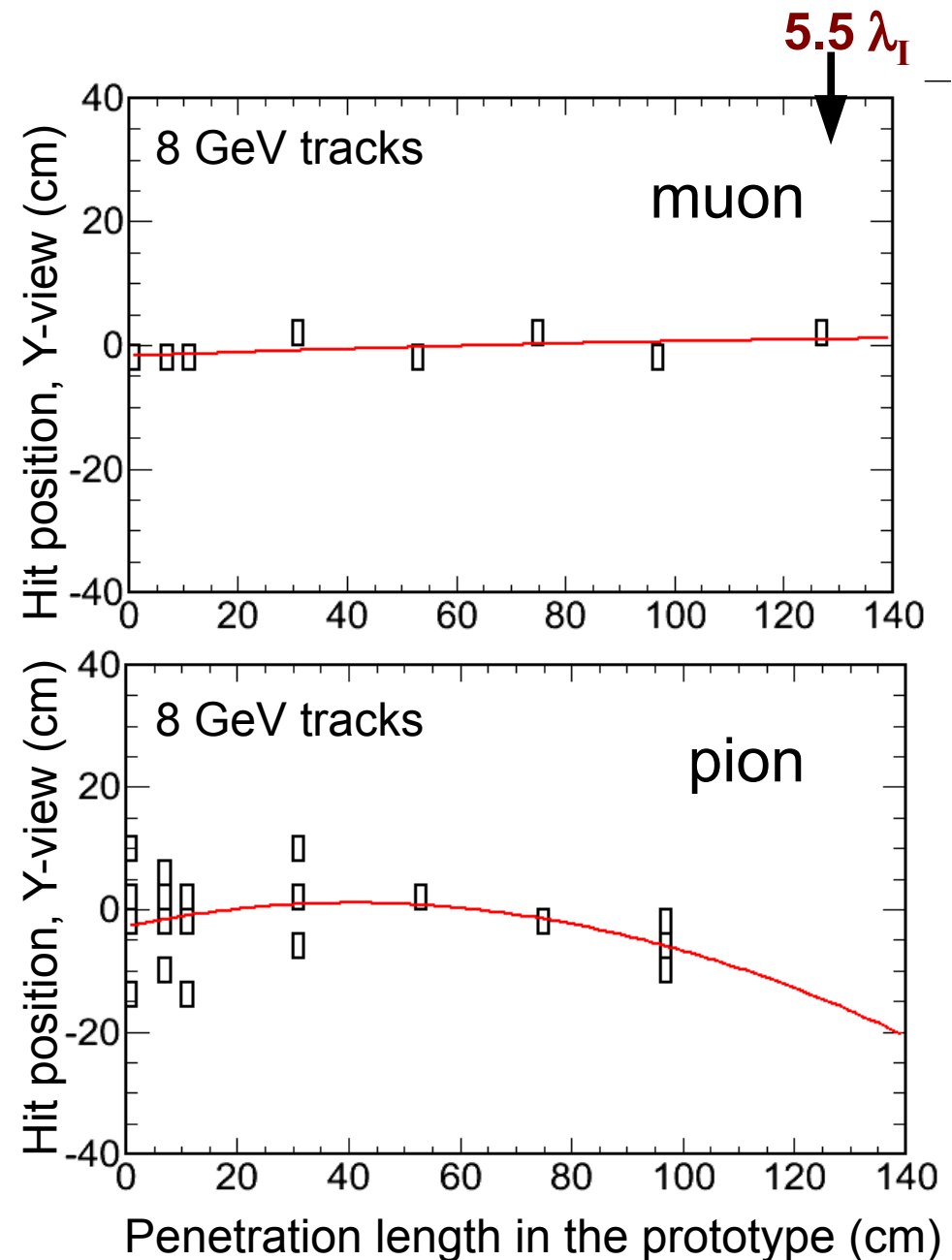
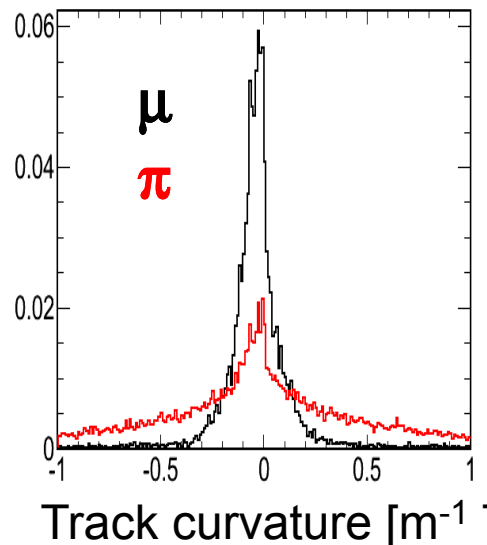
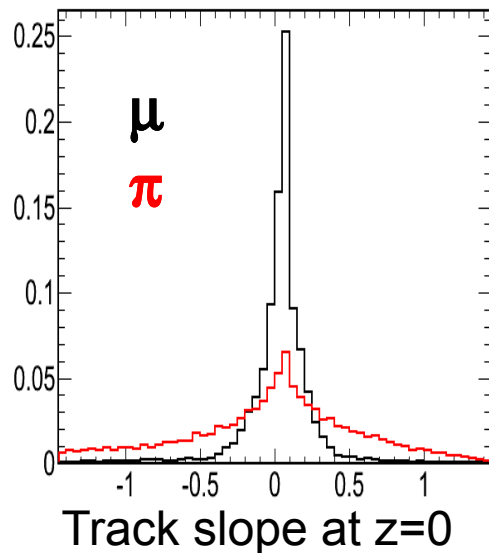
- Hadronic shower tails crucial to define:
 - Total amount of material
 - Optimal segmentation (8-9 layers ?)

Example of study performed with a GEANT4 simulation of the full SuperB Detector

→ Study will be repeated with IFR simulation tuned from data

Muon identification:

- We studied on data various quantity:
 - Hit multiplicity
 - Shower shape: transverse activity
 - Track length
 - χ^2 of a track fit performed on the BIRO readout, separately for X-view and Y-view.
- Model of track: simple quadratic function

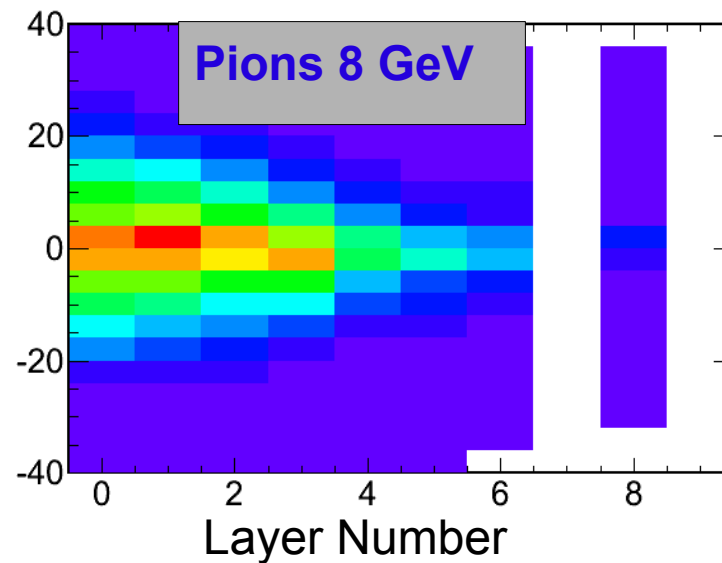
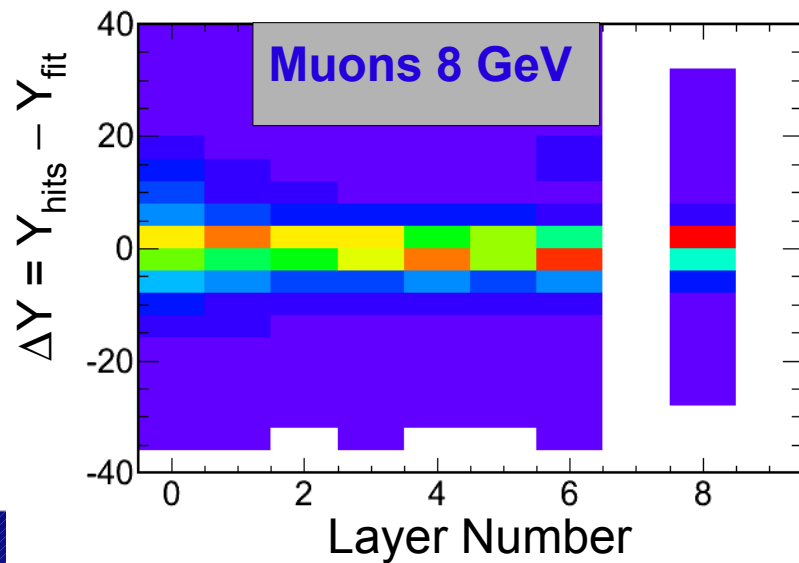
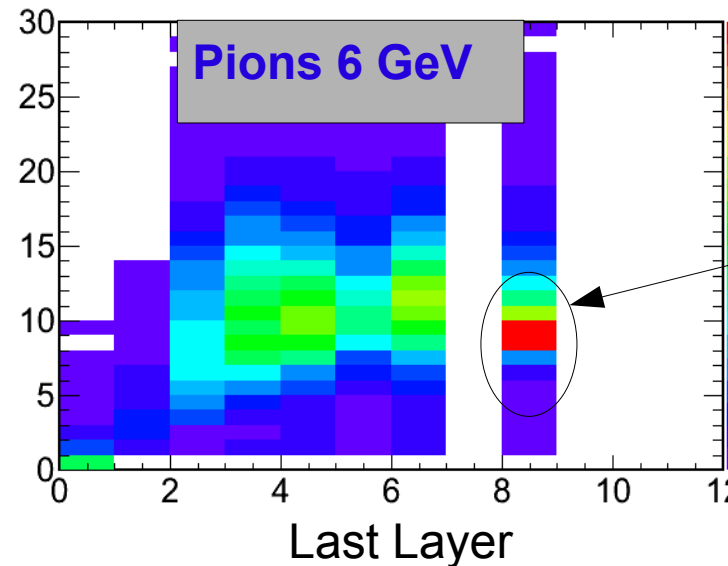
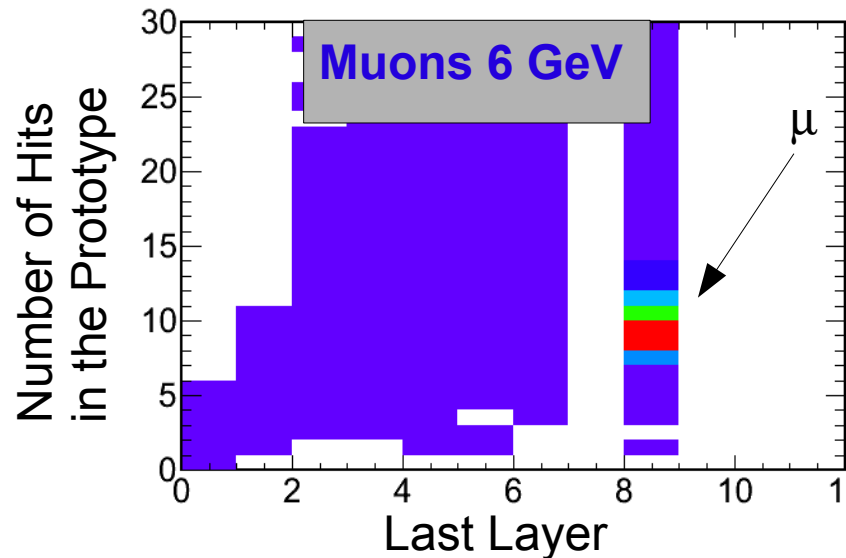


Hadron Shower Properties from Data

Muon trigger at 6 and 8 GeV is very clean!

Pions (not muons) and Muons shows clear signatures

Variable LastLayer
Is a clean measurement
of the π punch through
fraction

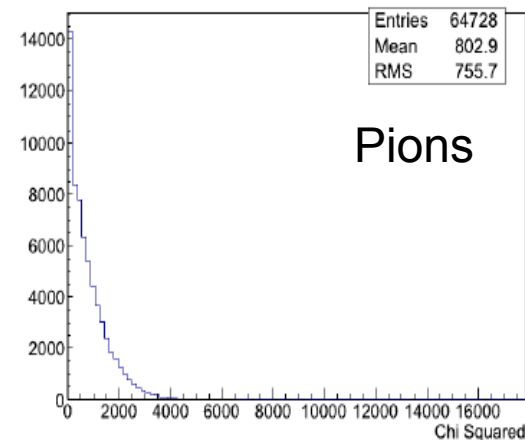
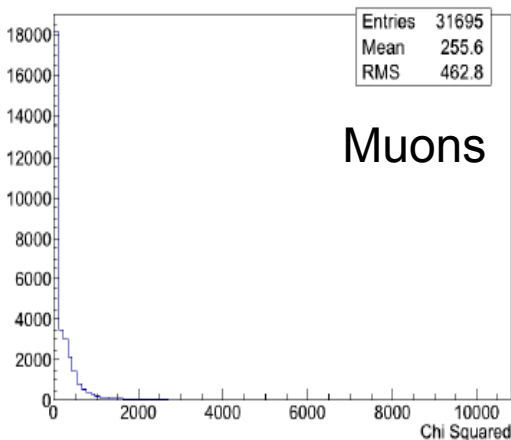
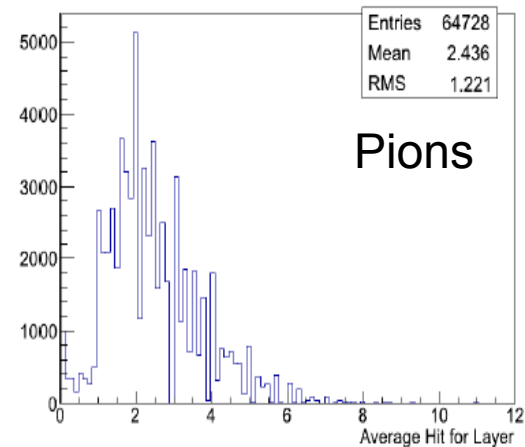
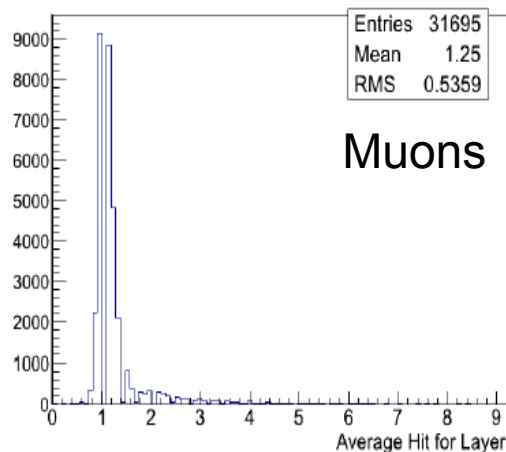


Contamination
from muons
(require MC)

Runs at lower
Energy require
More studies:
- large pion
contamination

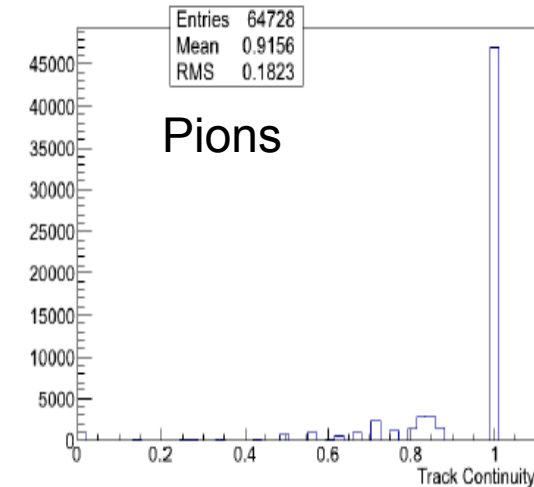
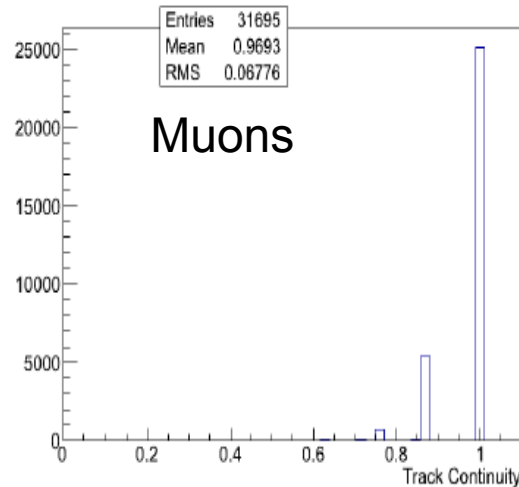
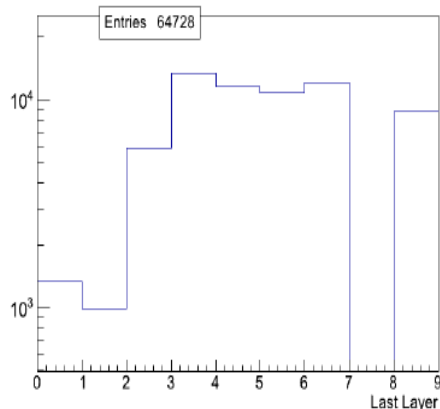
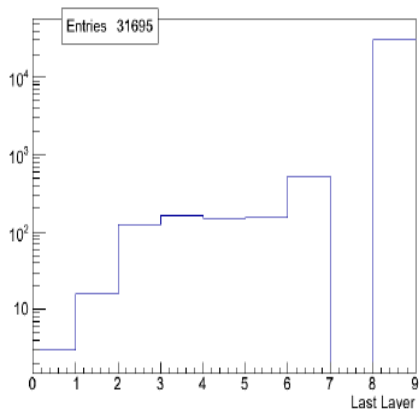
Muon Selector I

- Use the variables studied to implement a muon selector
 - Last Layer ($X_{\text{view}}, Y_{\text{view}}$)
 - #Hit/ActiveLayer ($X_{\text{view}}, Y_{\text{view}}$)
 - Track χ^2 ($X_{\text{view}}, Y_{\text{view}}$)
 - Track continuity ($X_{\text{view}}, Y_{\text{view}}$)



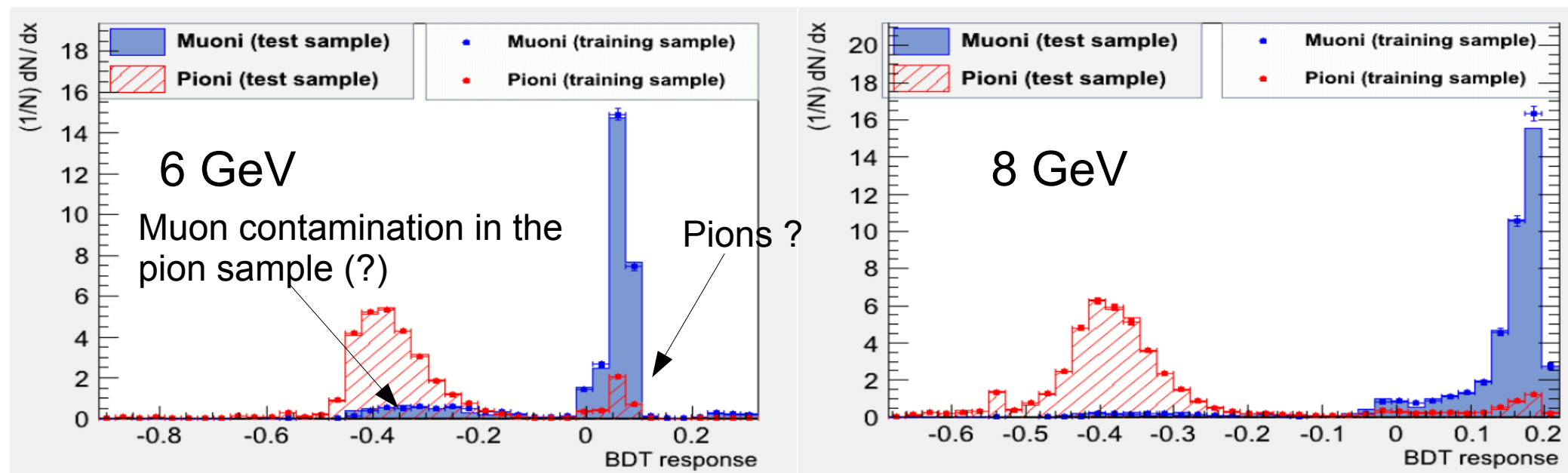
8 GeV Muons

8GeV Pions



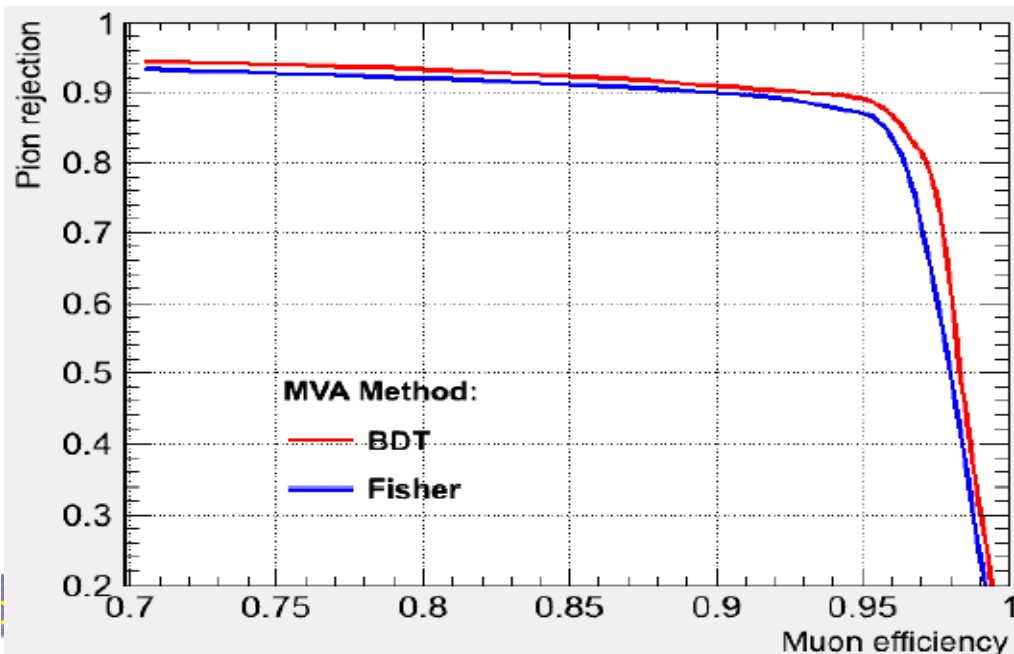
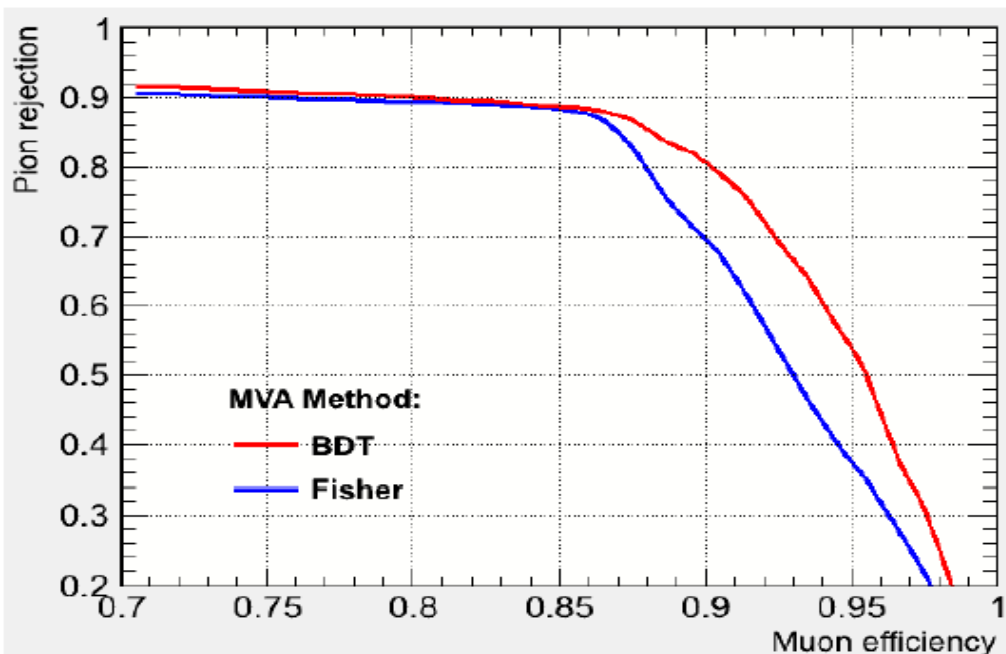
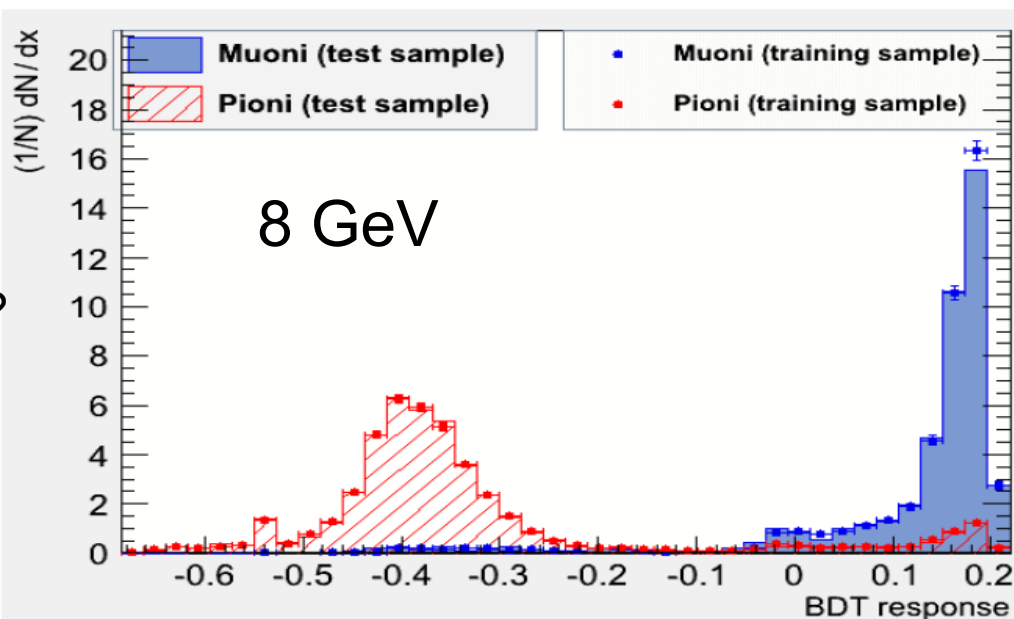
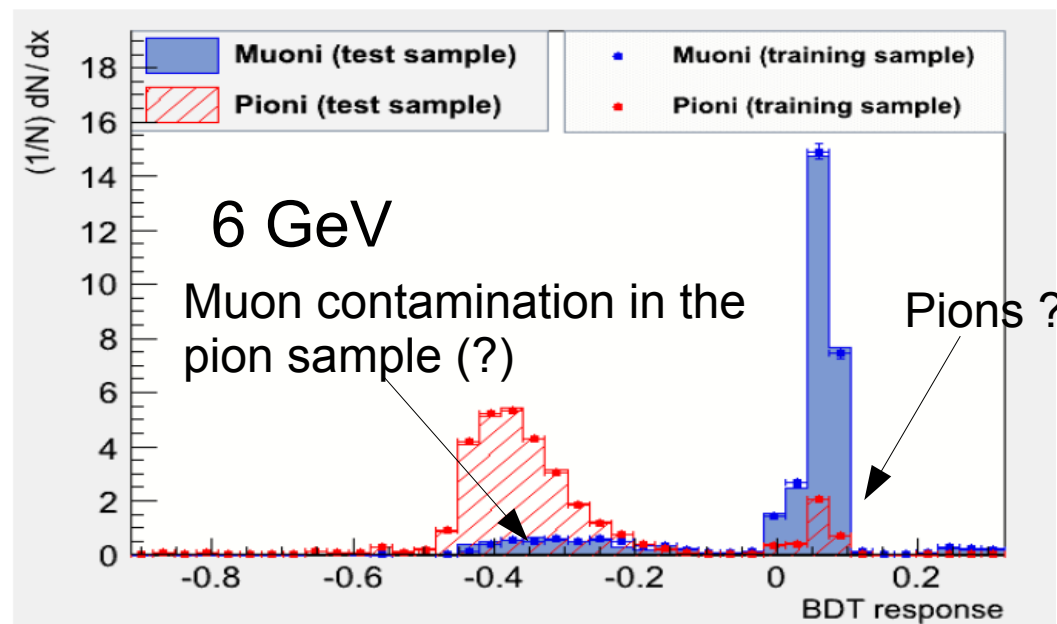
Muon Selector II

- Not easy variable correlations: use MultiVariate Analysis (TMVA)



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Further studies with the Prototype Data

- How the mu/pi separation change
 - if we kill randomly hits ? (noise)
 - Putting together two bars to simulate 8cm-scintillator-bars in one of the View?
 - Remove one layer from the data (layer 5 for example)?
- Strategy:
 - Touch the data accordingly, perform the optimization with the BDT and than compare the different configurations:
 - Cut on the BDT to have the same muon efficiency and compare the pion mis-identification
 - Caveat: the real efficiency are evaluated on a sample different from the sample used to train the BDT

- To simulate the presence of noise, we kill IFRHits randomly with a prob of 5%, 10%, 15%

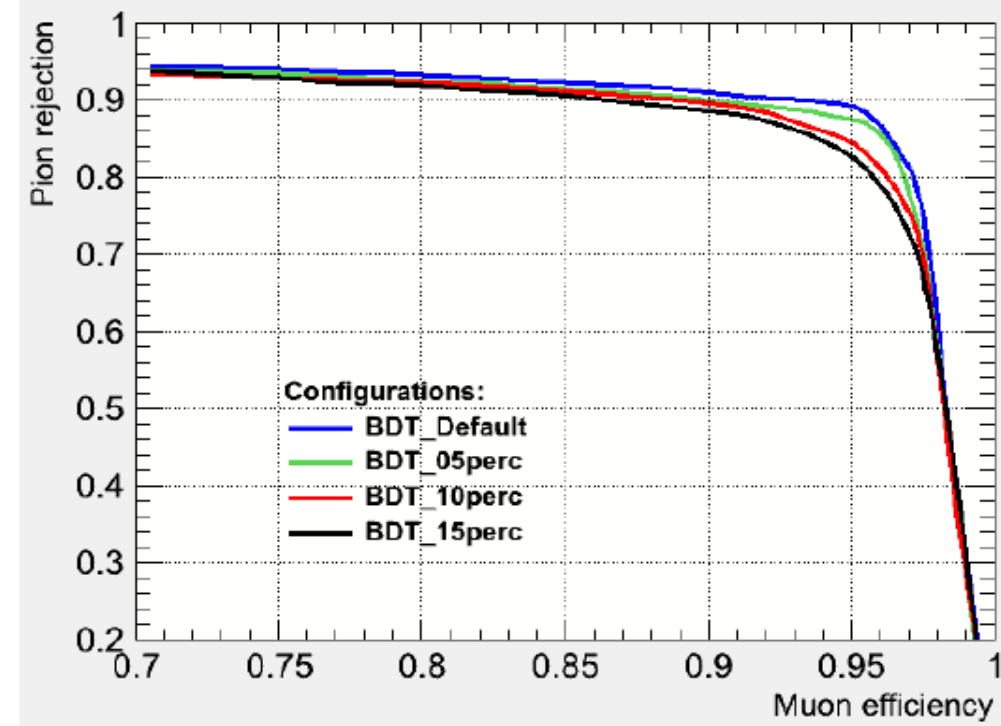
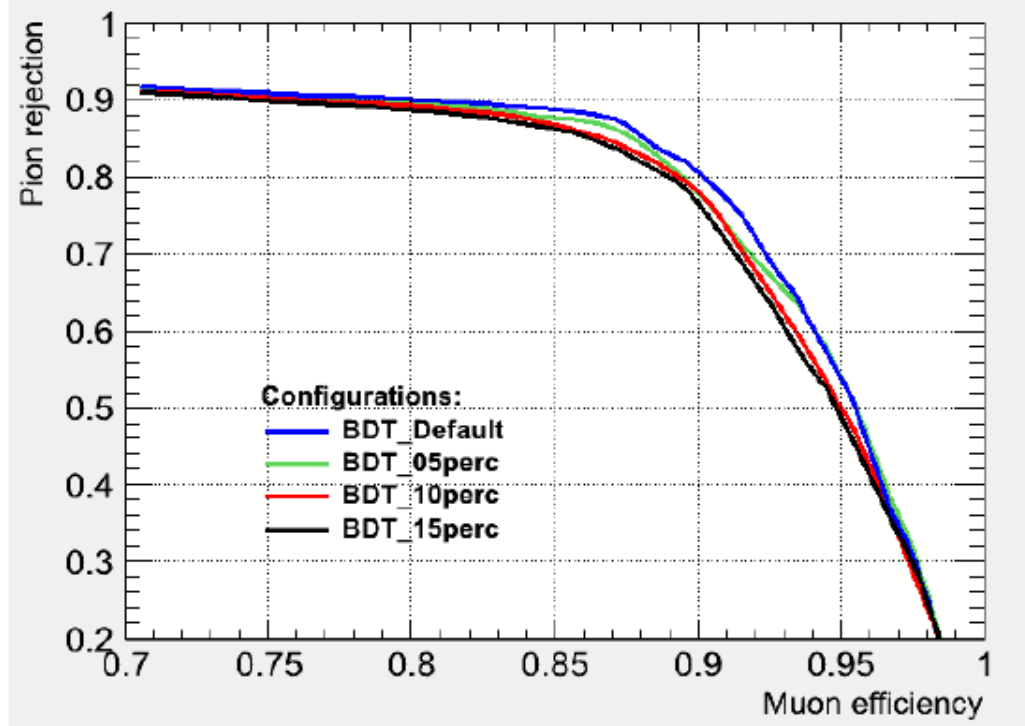


Tabella
Test

6 GeV N_2

8 GeV N_2

ϵ_π

ϵ_μ

ϵ_π

ϵ_μ

Default	40.9 ± 0.2	95.0 ± 0.2	9.9 ± 0.1	95.2 ± 0.1
ADet05	44.9 ± 0.2	95.7 ± 0.2	10.8 ± 0.1	96.1 ± 0.1
ADet10	49.7 ± 0.2	95.9 ± 0.2	13.4 ± 0.1	96.5 ± 0.1
ADet15	52.1 ± 0.2	96.0 ± 0.2	14.6 ± 0.1	96.2 ± 0.1

PRELIMINARY but,
Clearly the performances
degrade with the noise
increase (expected)

Further Studies: VERY PRELIMINARY

	6 GeV N_2		8 GeV N_2	
	ϵ_π	ϵ_μ	ϵ_π	ϵ_μ
Default	40.9 ± 0.2	95.0 ± 0.2	9.9 ± 0.1	95.2 ± 0.1
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8 cm bars (Xview)	46.7 ± 0.2	95.6 ± 0.2	9.9 ± 0.1	95.2 ± 0.1
NoLayer5y	47.7 ± 0.2	95.7 ± 0.2	10.1 ± 0.1	95.3 ± 0.1

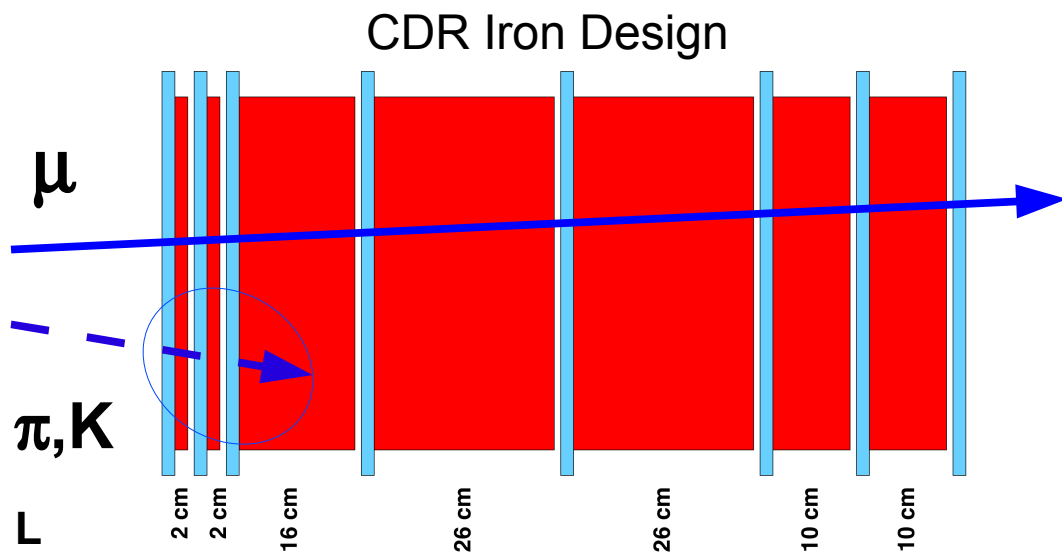


Conclusions

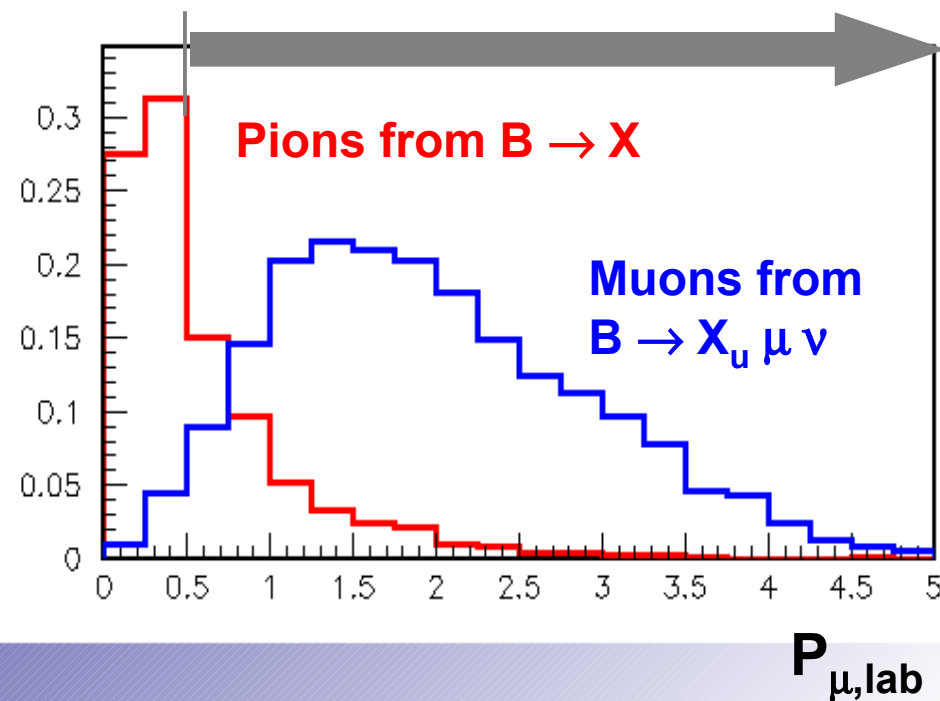
- At high moments (6, 8 GeV) sample of pion and muons are quite clean: Cherenkov performances are good
 - Contaminations are small but have to be evaluated, mainly the fraction of muons from pion decays after the Cherenkov: use MC simulation!
 - Goal: extract as much as we can from these data!
- Studies to understand the data at lower moments (1-4 GeV) are ongoing but I do not think we can use these data without:
 - Beam composition/Cherenkov efficiency/beam profile etc etc...
 - But some studies are still possible using the prototype itself to clean the samples
- Nevertheless we are ready to make quantitative Data/MC comparison at the studies energy
 - Tune the MC to optimize the amount of absorber, number of active layers, segmentation

BACKUP

IFR for μ and K_L detection

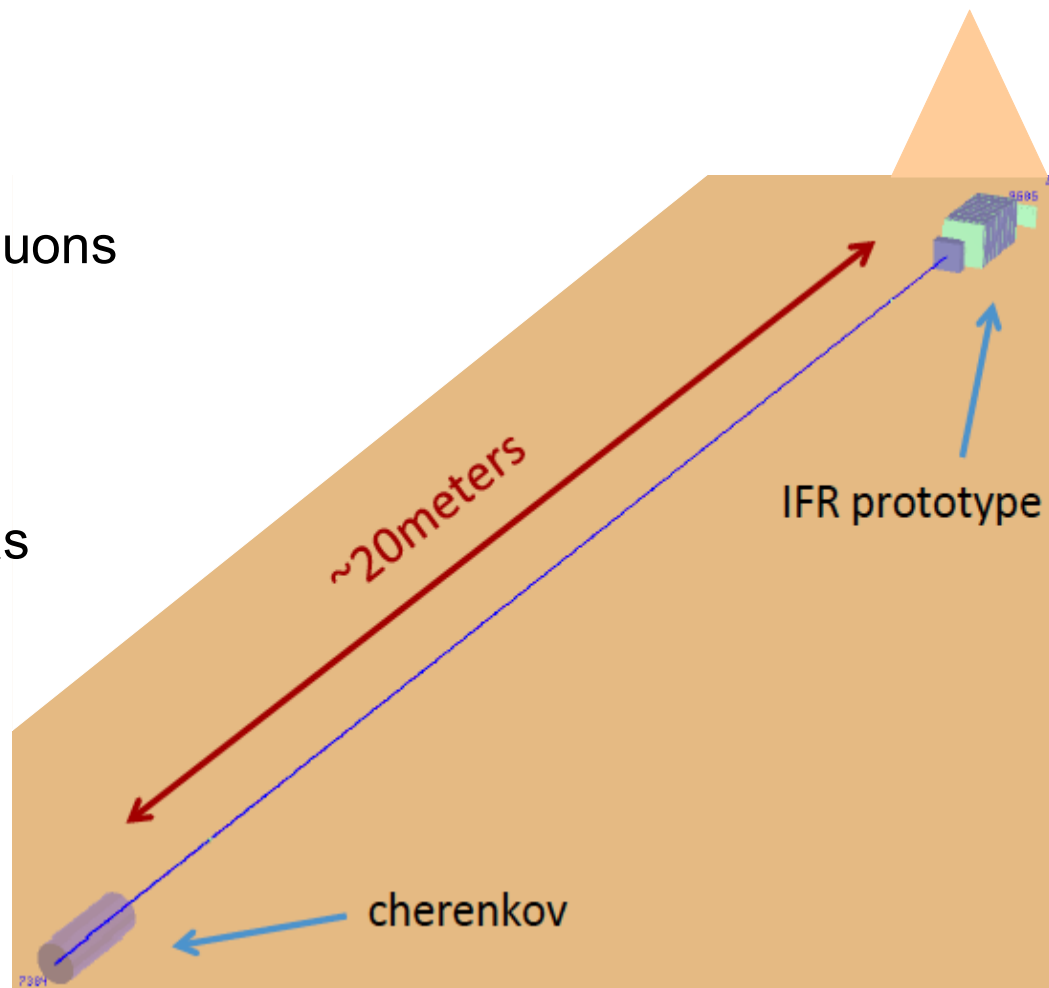
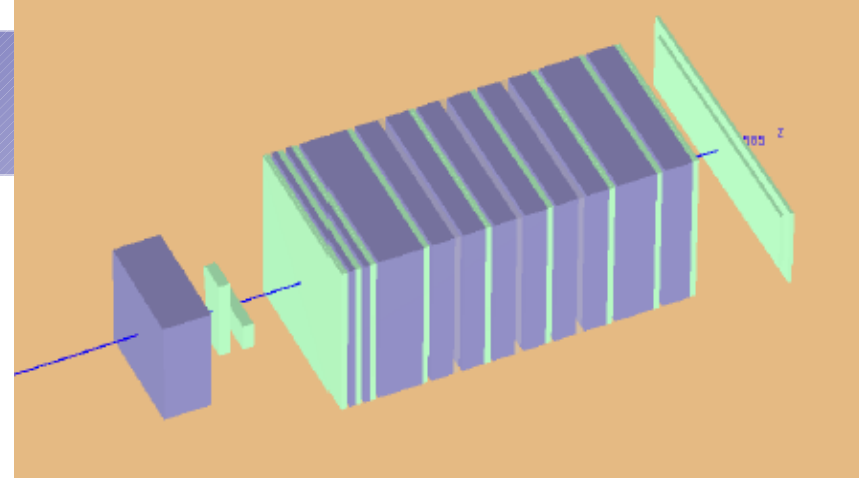


- Muon momentum in laboratory frame $< 5 \text{ GeV}/c$



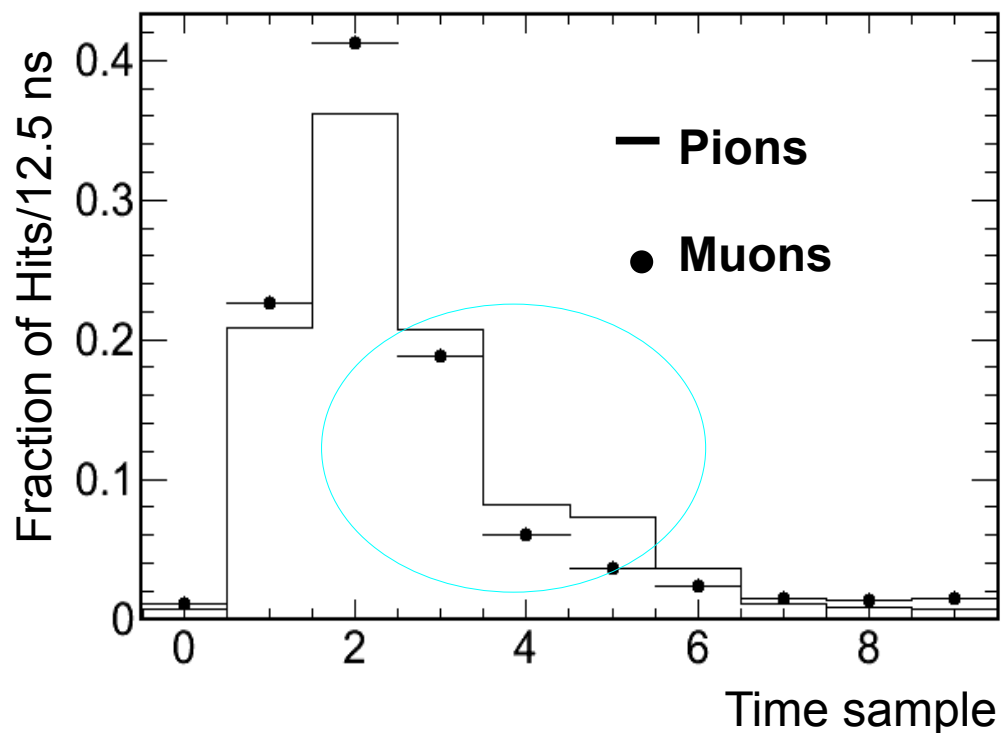
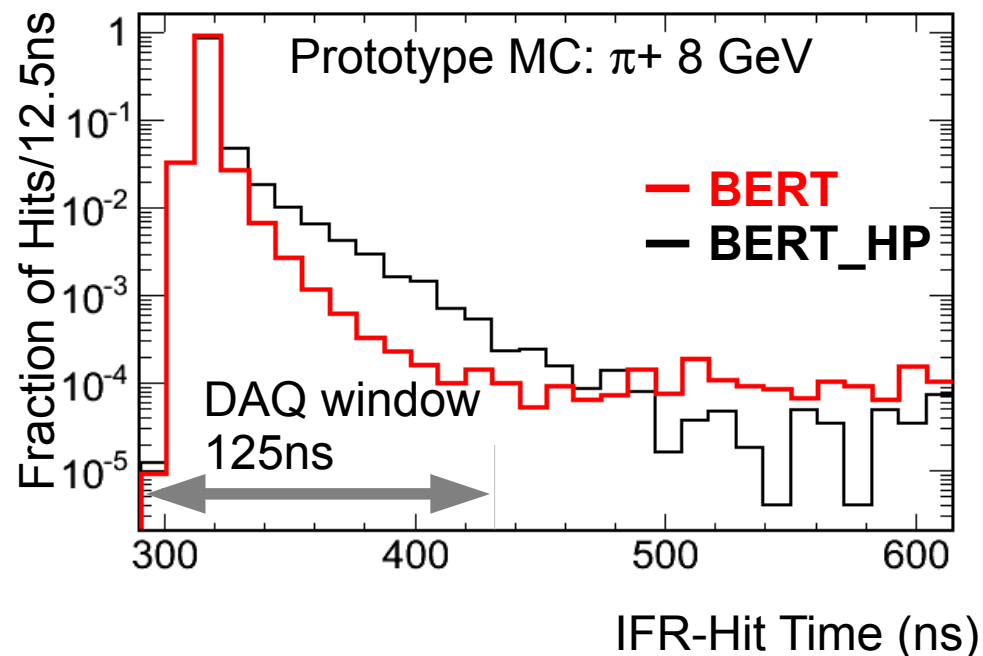
Prototype Simulation

- Simulation is crucial to understand the data
 - Muons contamination in the pions sample is crucial because affect the punch through probability
 - π decay after the Cherenkov
 - π decay gives under threshold muons not vetoed
 - Spectrometer is ~60m before the Cherenkov
 - Detailed simulation with GEANT4 has been implemented:
 - Fraction of pions that decay after C_μ
 - 4 GeV: 8%
 - 8 GeV: 4%



Hadron Shower development

- From simulation: time development of the signal in IFR for muons is in the sub-ns regime, and extend to 50ns and more for pion secondaries (more than 5%)
 - Hadronic showers in heavy metals are more complex processes: slow emission



- The Prototype Front End Electronics samples data in 10 bins of 12.5 ns
- Specific calibrations are needed to fully understand the data
- The MC show large discrepancies between different physics lists