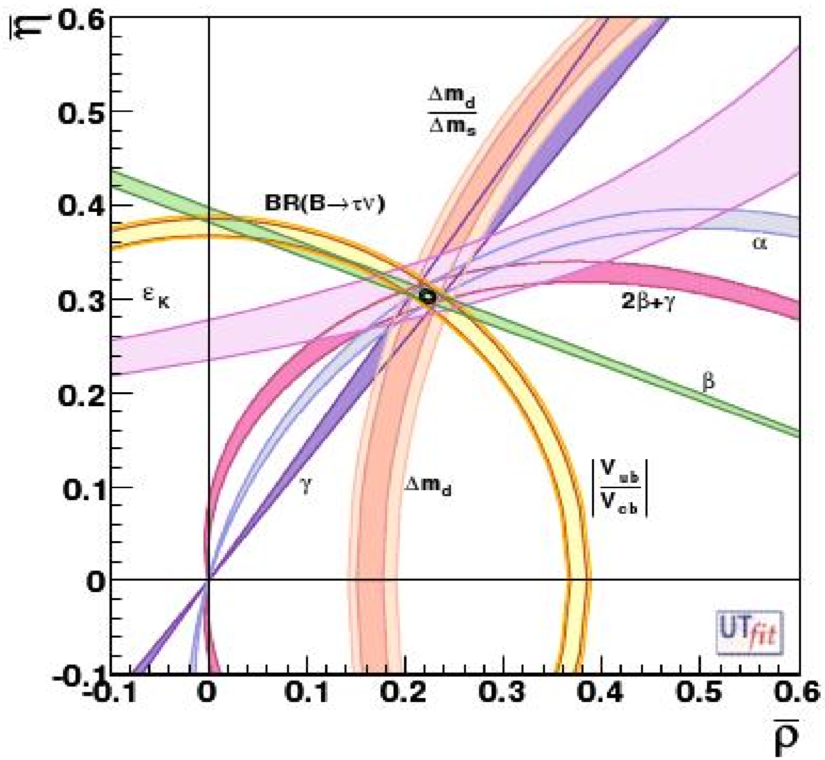
XVII SuperB Workshop , Elba, 31 May 2011

Result from Test Beam: reconstruction and muon ID



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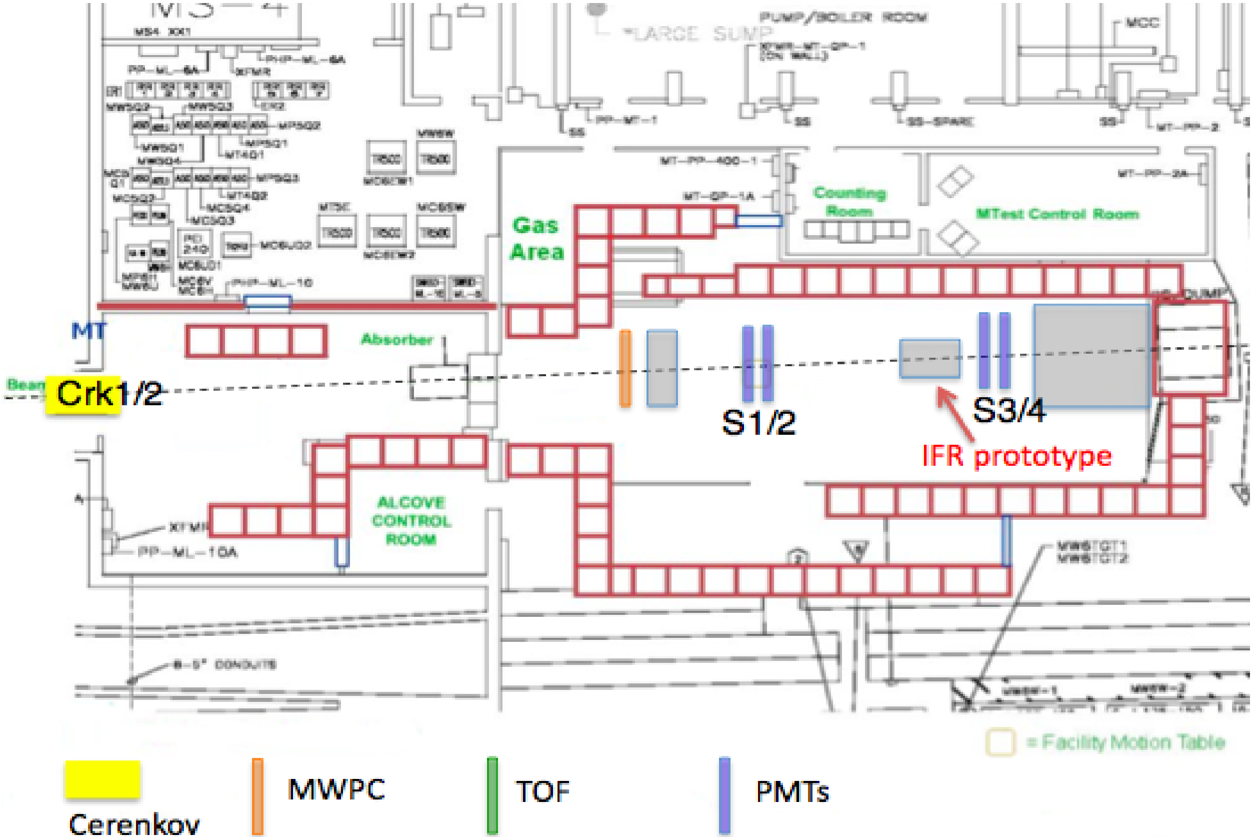
Outline

- Goal;
- Layout;
- Strategy;
- New Tracker;
  - X,Y hits;
  - $\sigma_{X,Y}$;
  - Total and average number of hits;
  - Total fitted track length;
- Data-MC comparison;
- Muon sample contamination;
- Conclusions.

Prototype Data Analysis: Goal

- Muon/Pion separation on real data;
  - Check hadronic shower models (QGSB_BERT, QGSB_HP, FTF_BIC, CHIPS);
  - Define a model for Detector Response (Digitization);
  - Both aspects important for Detector Geometry optimization and for future SuperB full simulation;
- Hadronic shower tails are crucial to define:
  - The total amount of material;
  - The optimal segmentation;
- Many studies on the shower development available above 10 GeV (CALICE), few old studies available in the “GeV” regime;
- The analysis of the prototype requires close interplay with simulation.

Prototype Data Analysis: Layout



- Scintillator $S_{1\text{-}2}$ used to select events
- Scintillator $S_{3\text{-}4}$ used to evaluate the leak per track
- For the time being: Analyze only BIRO channels TDC will follow

Selection

$$\mu \Rightarrow S1 \times S2 \times \overline{C}_e \times C_\mu$$

$$\pi \Rightarrow S1 \times S2 \times \overline{C}_e \times \overline{C}_\mu$$

Distance between Crk1/2 and prototype is ~22m, the pion decays are an issue:

- 4 GeV: 8%
- 8 GeV: 4%

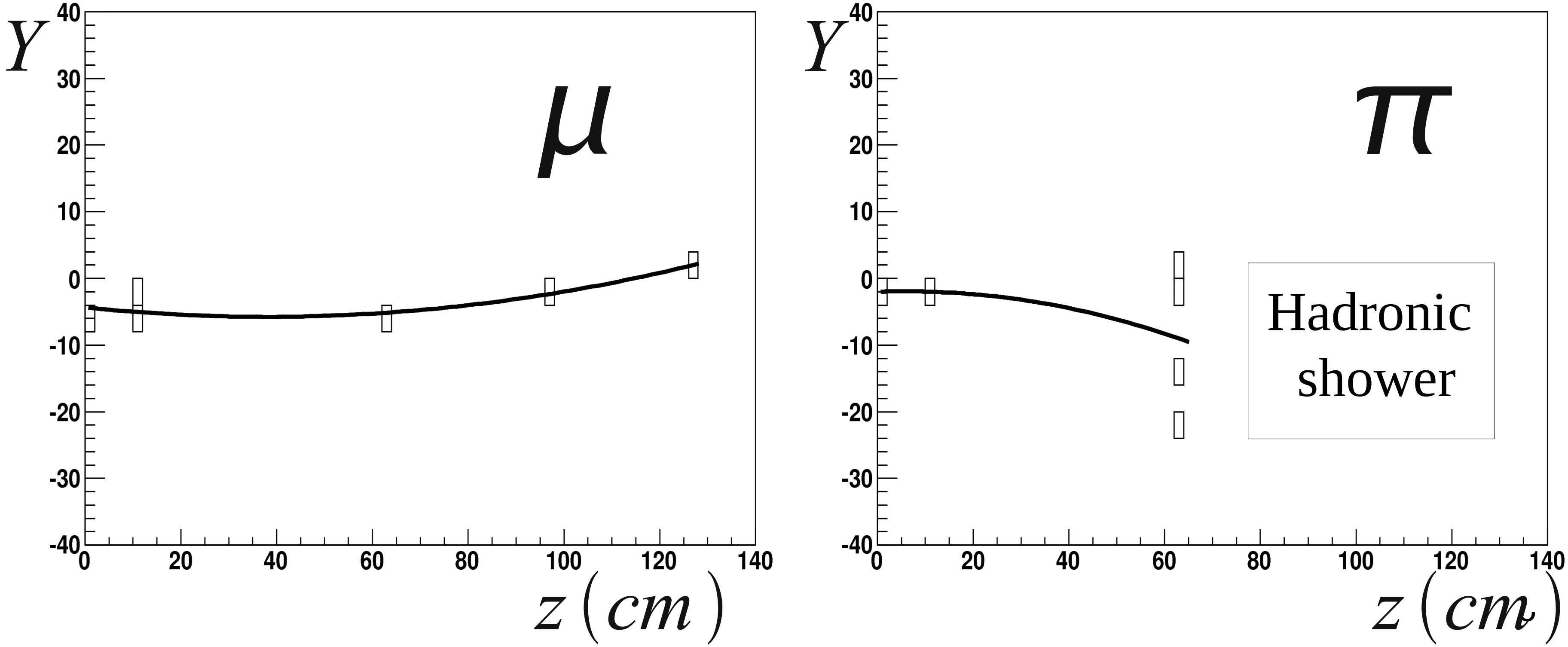
Simulation needed to subtract this component

Prototype Data Analysis: Strategy

- Total number of hits/layer and lateral size for pions, strongly related to the hadronic shower shape;
- Last layer is a quantitative clear measurable quantity related to the pion punch-through;
- Evaluate the hadronic shower leak using scintillator S_3-S_4;
- Time development of the signal in IFR for muons is in the sub-ns regime, and extend to 50ns and more for hadronic;
- **Analysis strategy:**
  - Reduce smearing due to the beam size (~10cm) using a quadratic fit to hits;
  - Quantitative studies on hadronic shower development cannot be done because of the rough longitudinal segmentation;
  - Comparison with detailed simulation of the Prototype setup.

New quadratic Tracker

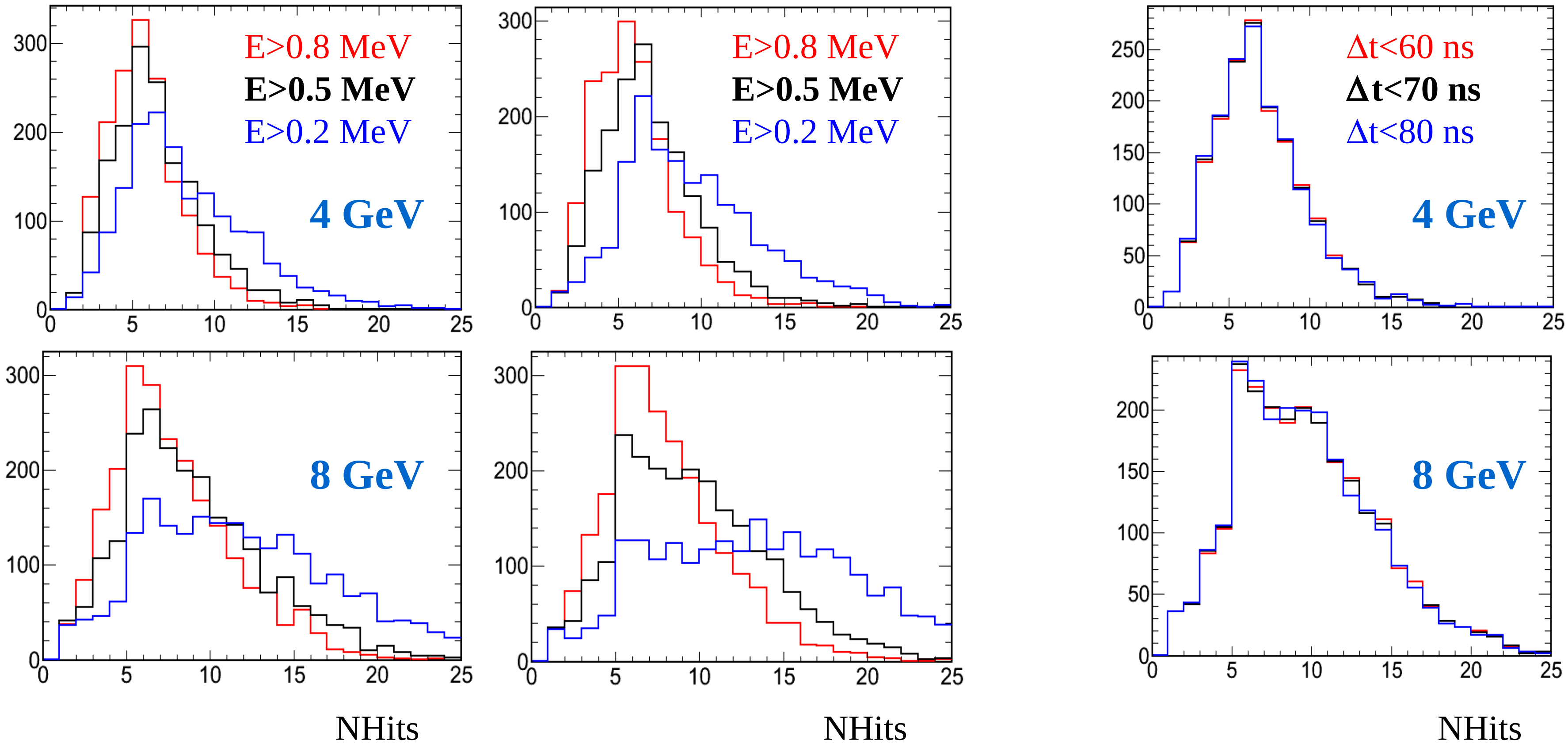
- Last Meeting:Track direction determined from hits collected in the first three layers(raw method);
- Performed a new tracker using a quadratic fit of the hits collected in the different layers;
- Multiple Scattering considered;



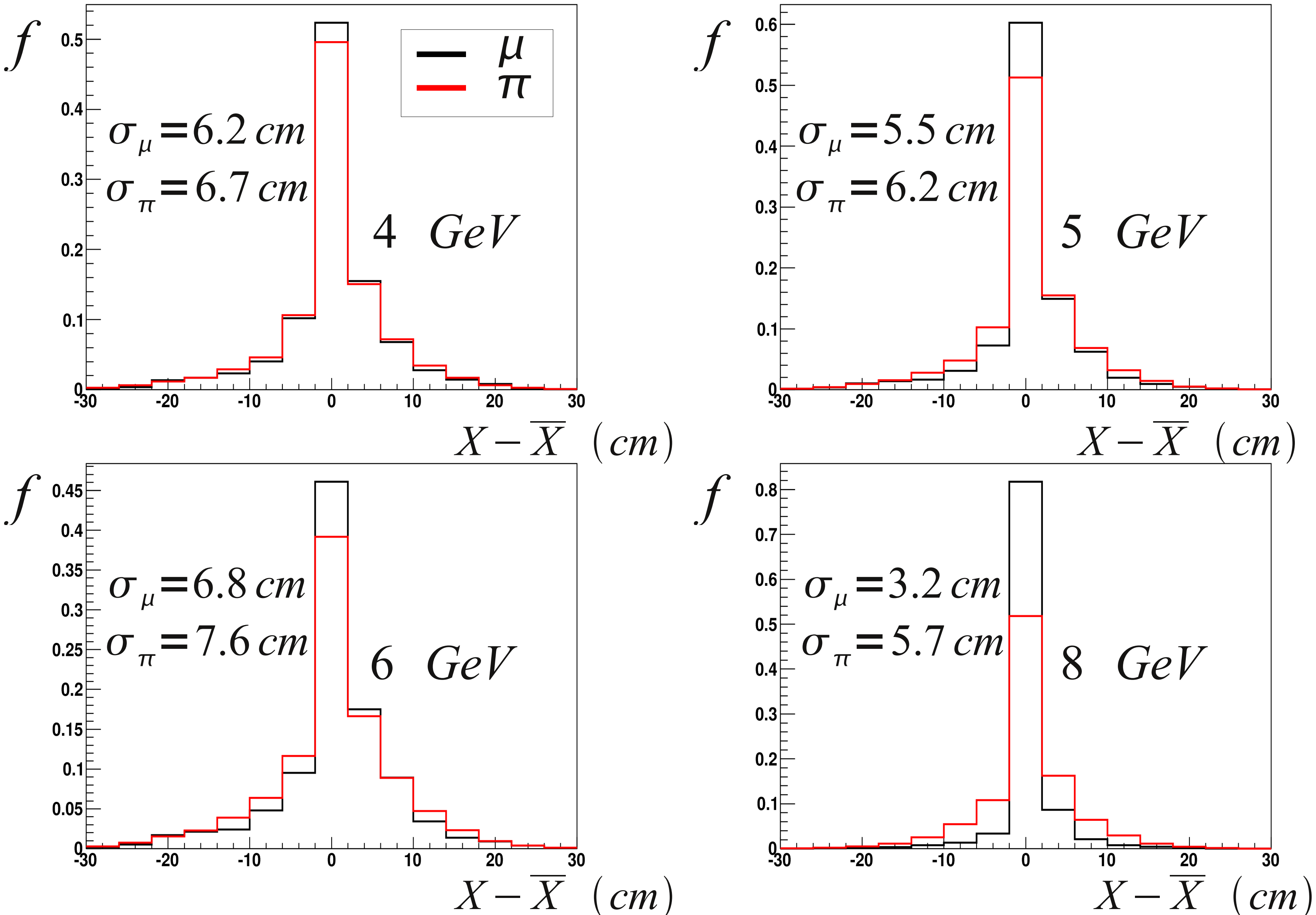
Digitization requirements

- Only BIRO channels have been analyzed;
- Digitization criteria:
  - Only gHits within the 70-ns (about 5 time samples) window after the Trigger given by scintillators S1 and S2 are considered;
  - Total energy released in the scintillator-bar > 0.5 MeV (¼ of a MIP, ~3.5 p.e.);

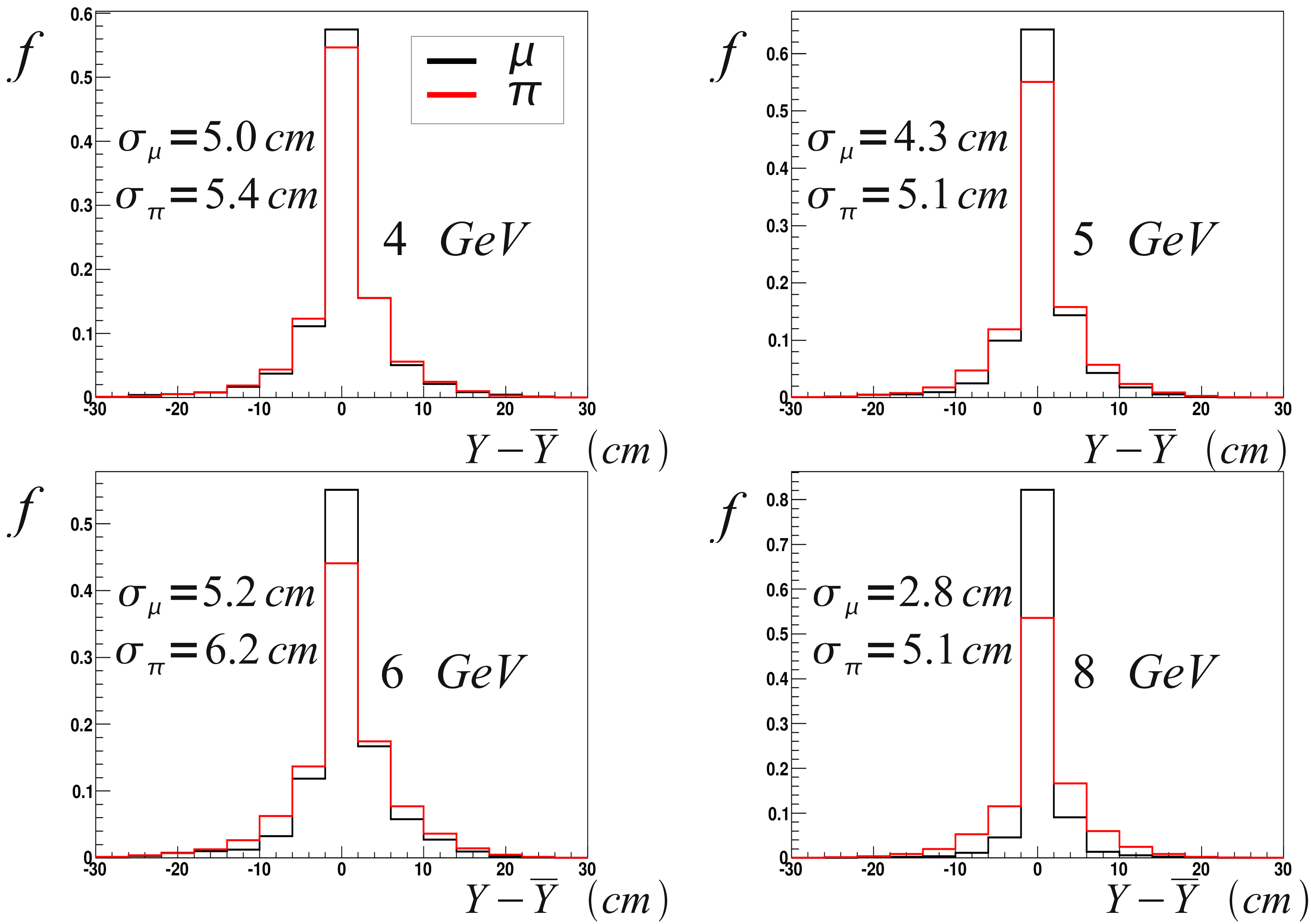
Pions - QGSP- BERT **Pions - QGSP- HP** **Pions - QGSP- HP**



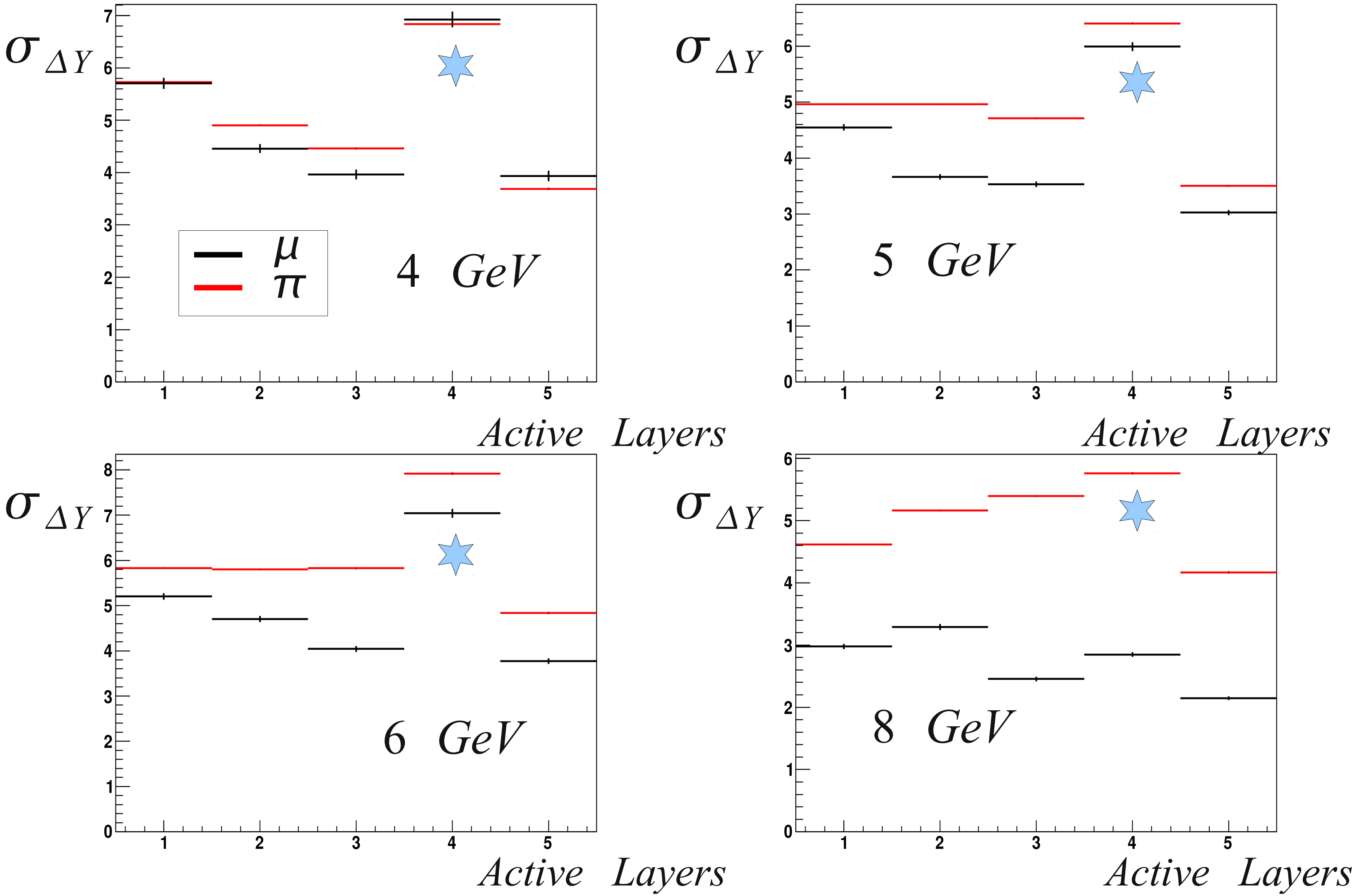
X as function of beam energy



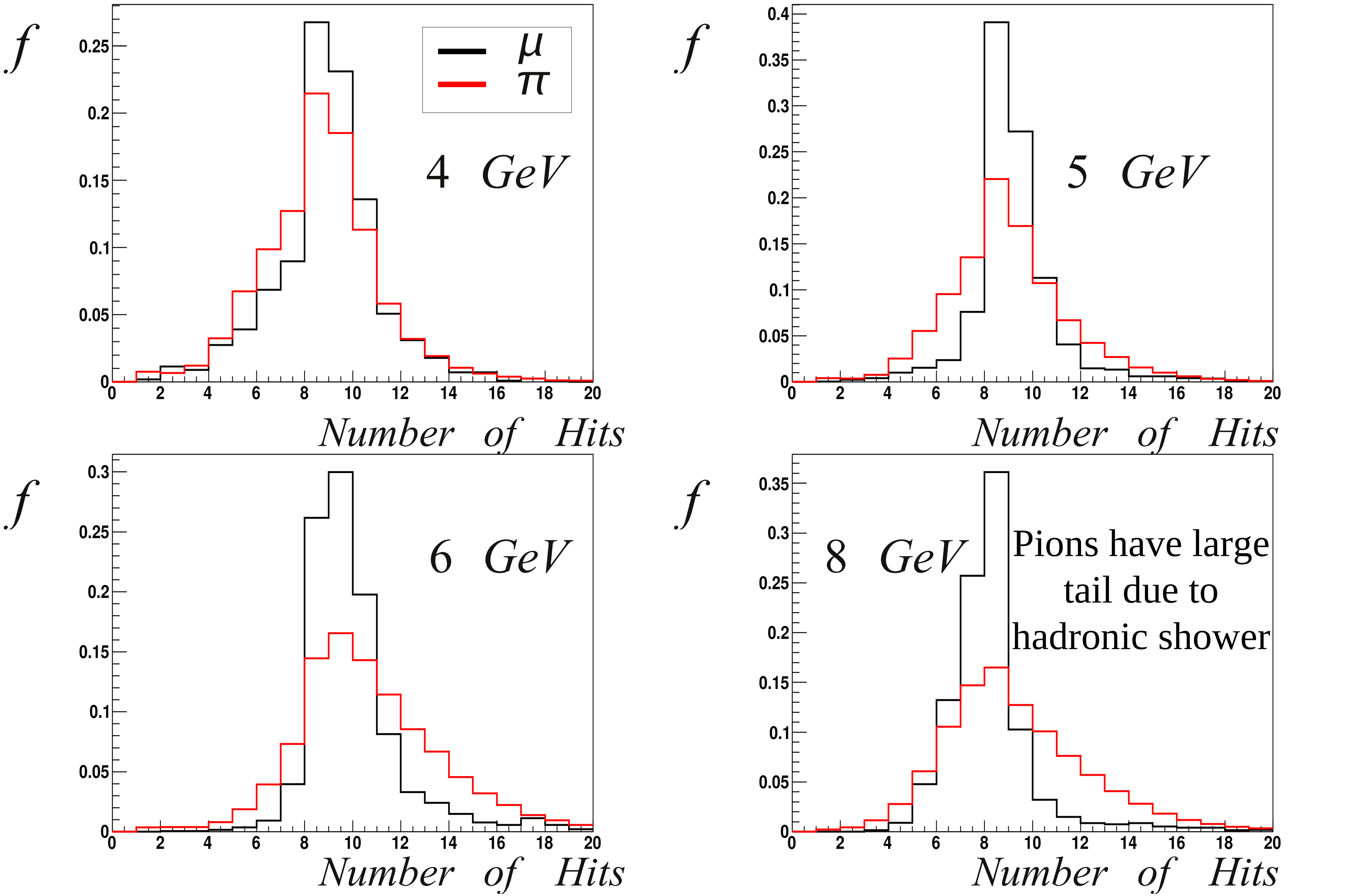
Y as function of beam energy



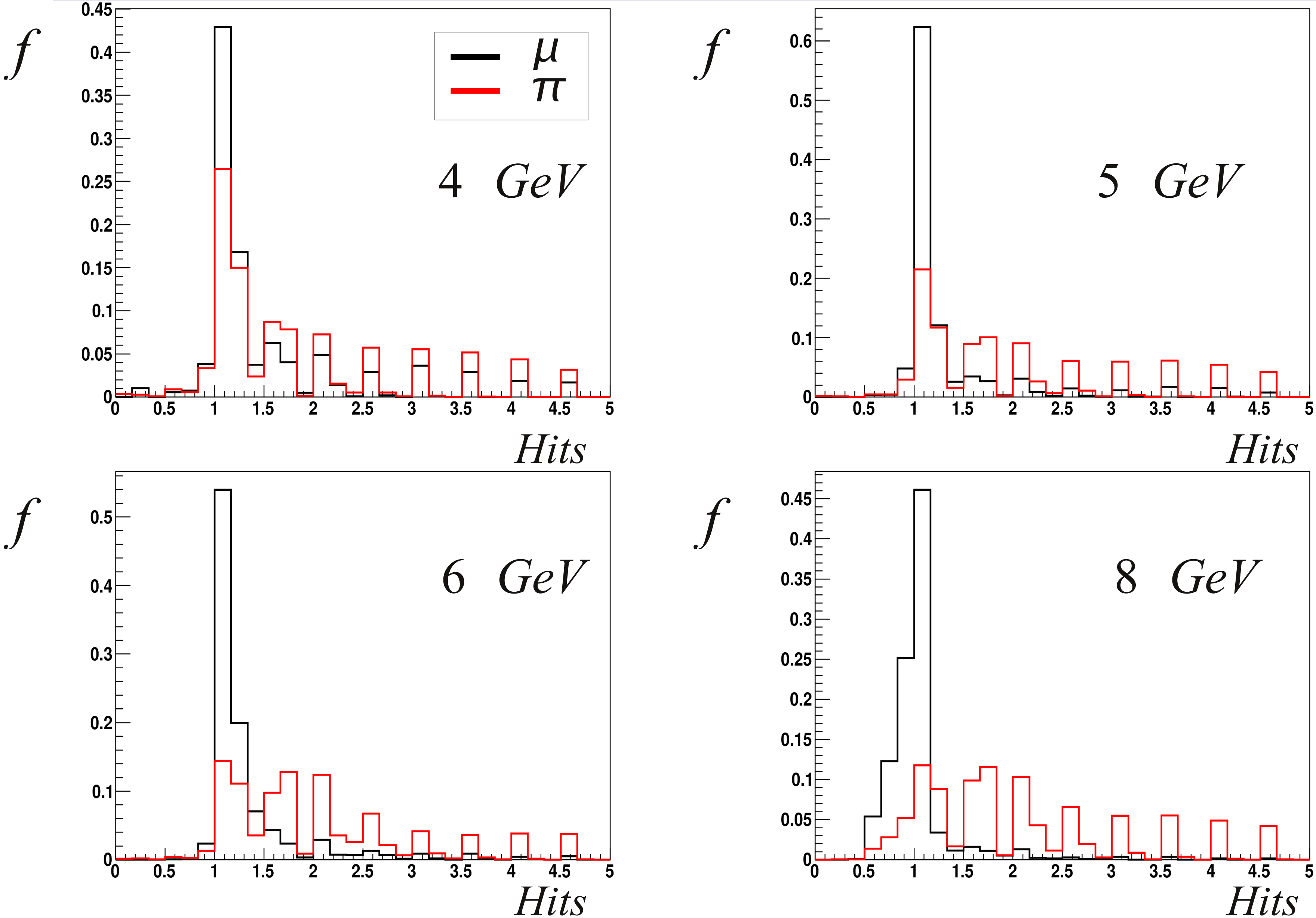
Lateral cluster size as function of the active layers



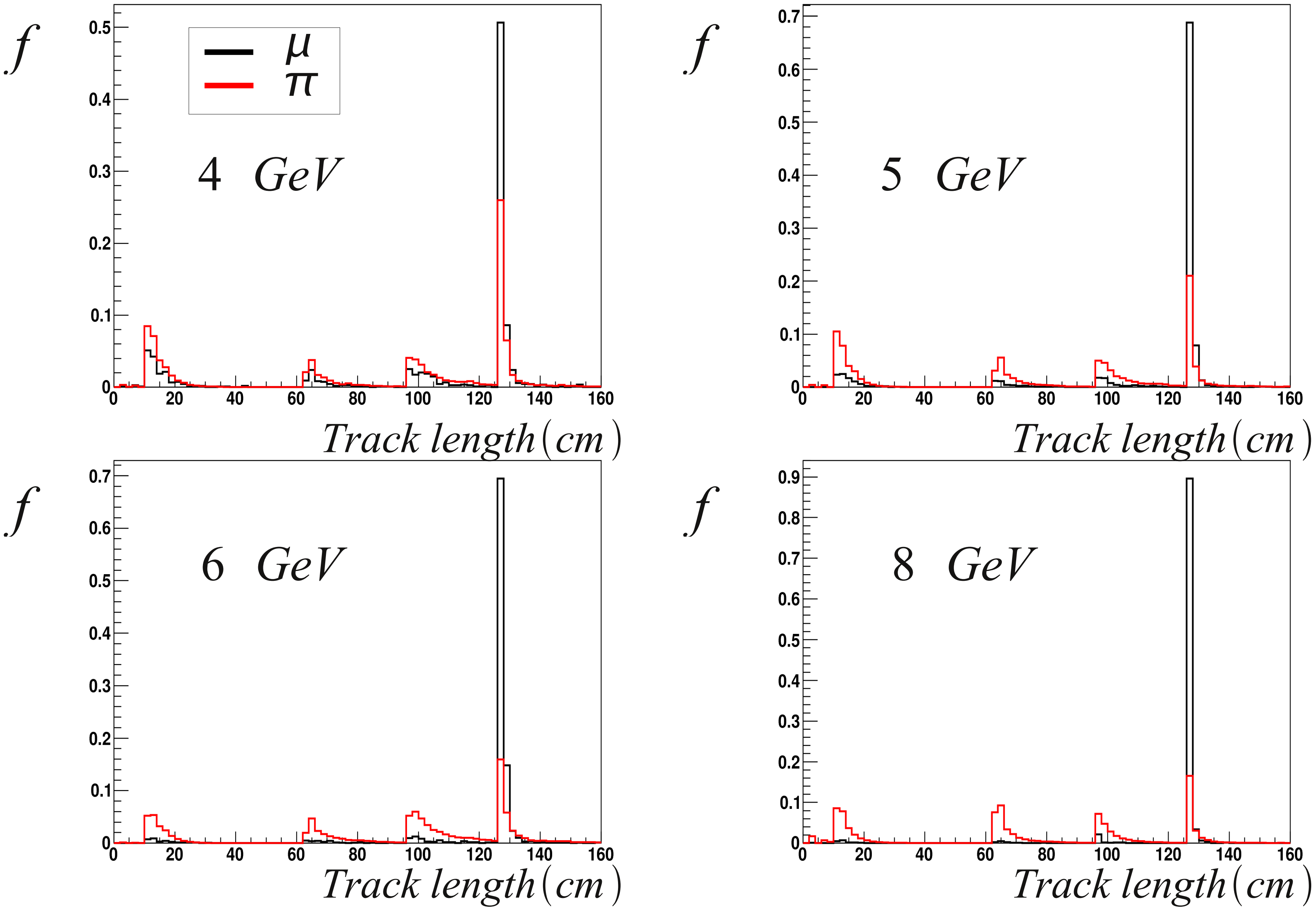
Total number of hits



Average number of hits

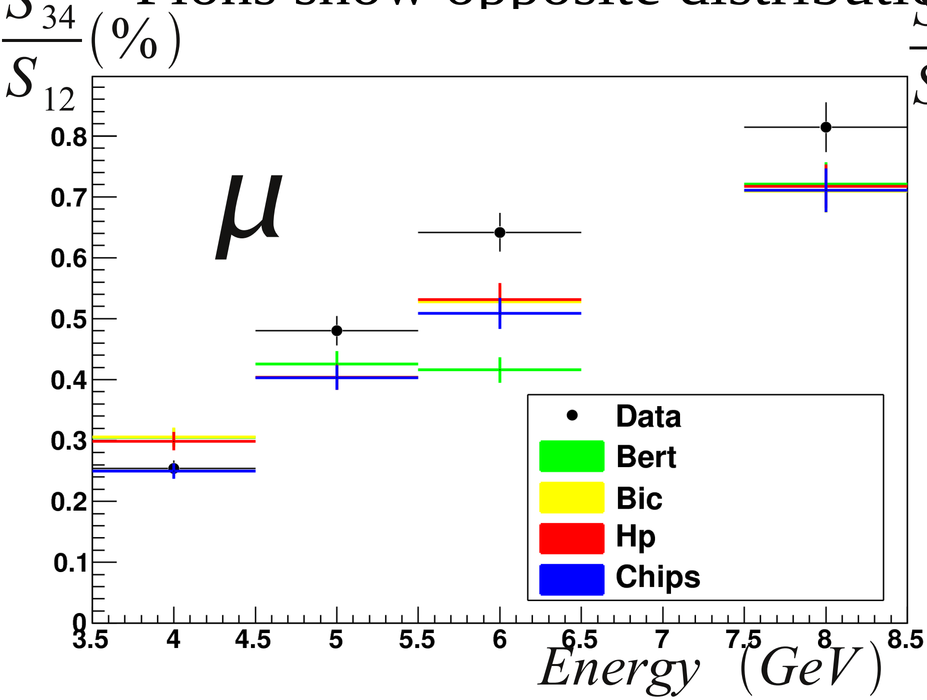


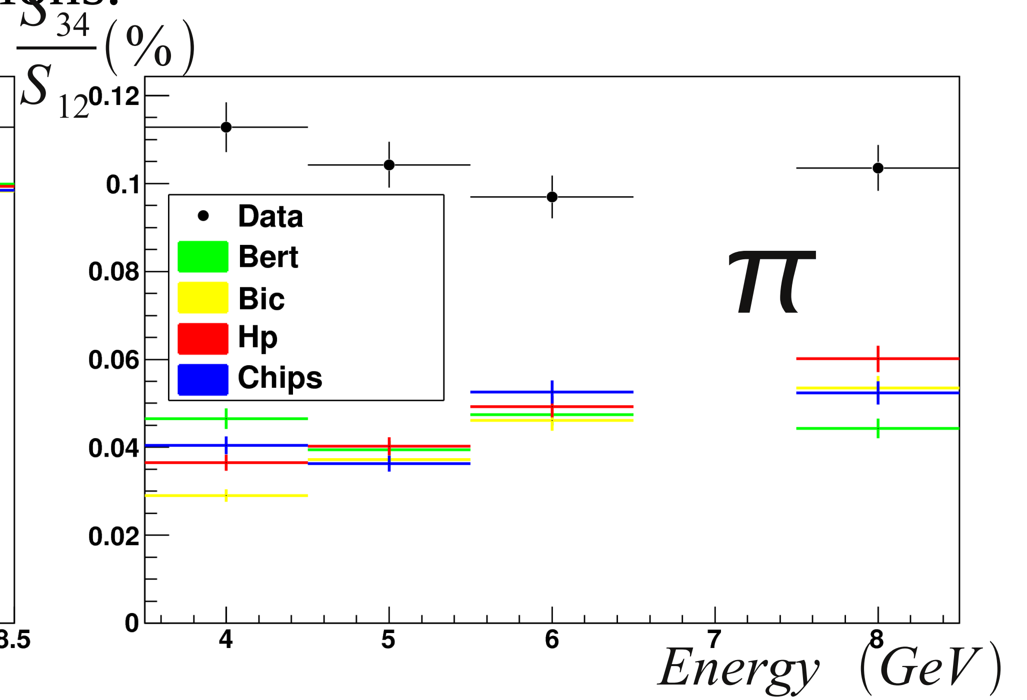
Total fitted track length



Data-MC Comparison

- Try to estimate the contamination of muons in pions sample and vice versa using MC;
- Implemented a simulation of the prototype: several information are missing (correct distances, scintillator dimensions, beam composition as function of the energy, Cerenkov efficiencies, ...) ;
- Four different Physics lists used in the MC;
- Muons fractions are quite compatible within errors;
- Pions show opposite distributions.



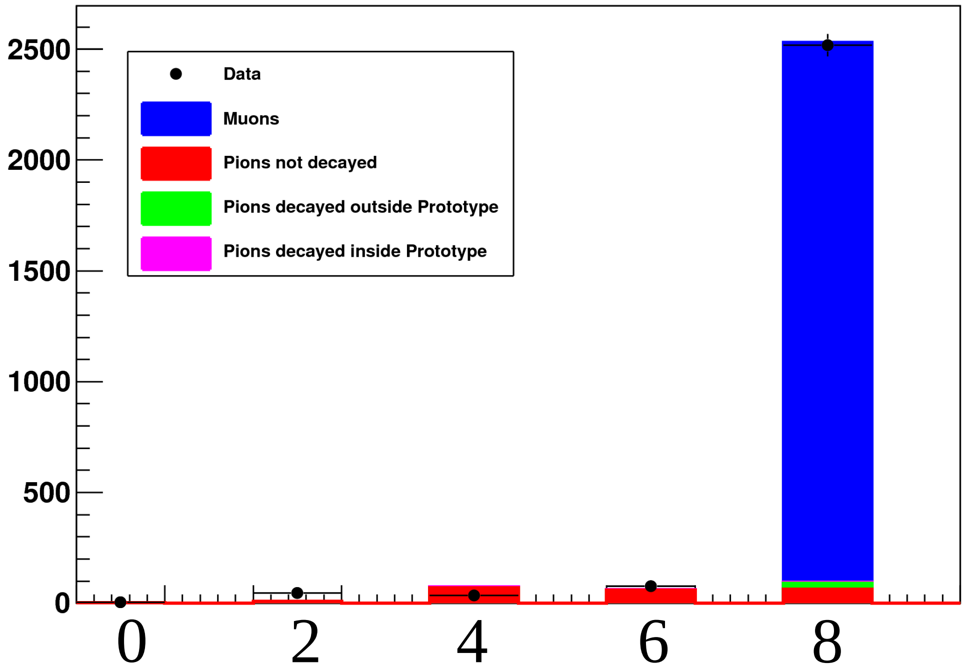


DT/MC studies: Reduced χ^2 for different MC lists

- Estimate the contamination of pions in muon sample using a shape fit to LastLayer for different energies;
- Use reduced χ^2 as discriminant variable to choose the MC list with the better agreement with data;

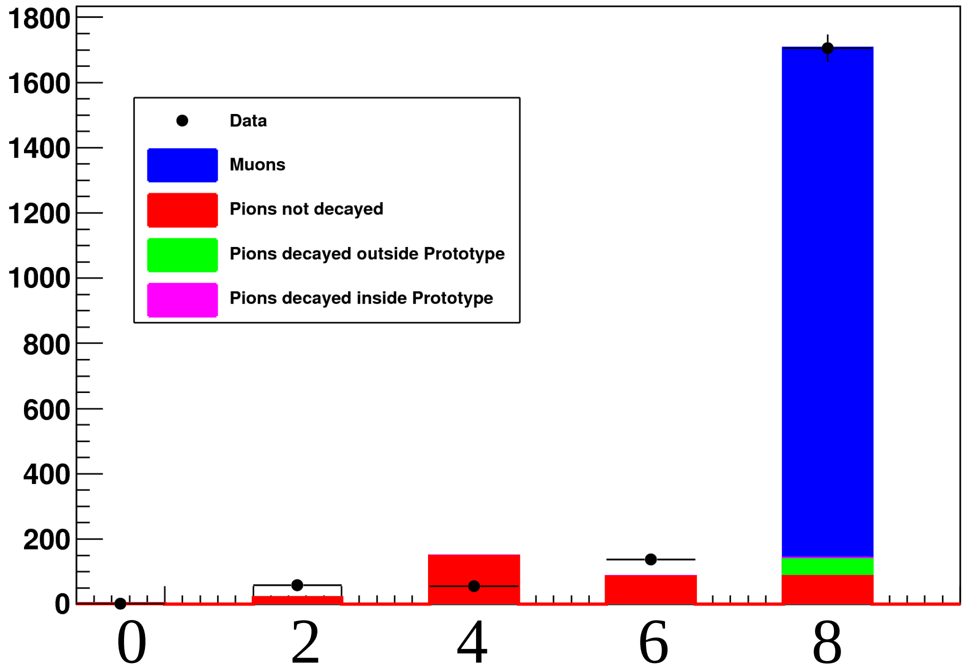
χ^2/NDoF	BERT	CHIPS	HP	BIC
4 GeV	50.7	33.2	58.8	49.4
5 GeV	61.6	43.8	61.1	58.1
6 GeV	18.8	14.2	17.8	18.5
8 GeV	10.1	11.3	9.3	9.4

- CHIPS seems to match the data better then other MC lists.



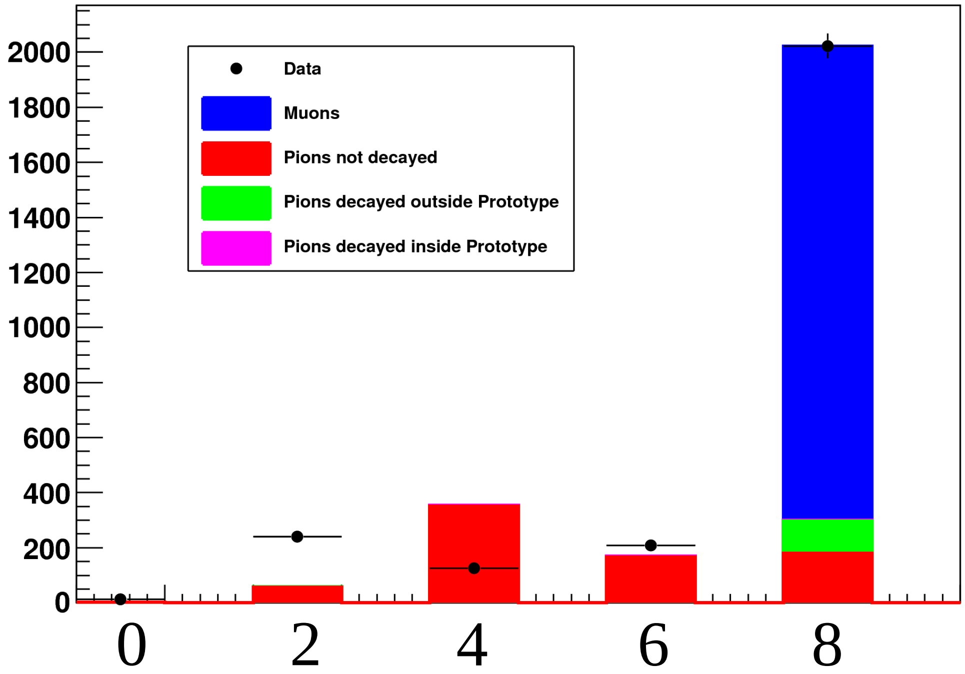
Muon Sample composition at 8 GeV (in percent)

8 GeV	BERT	CHIPS	HP	BIC
μ	91.9 ±9.5	92.1 ±1.5	91.0 ±10	91.6 ±11
π	8.1 ±0.9	7.9 ±1.0	9.0 ±1.0	8.4 ±1.0



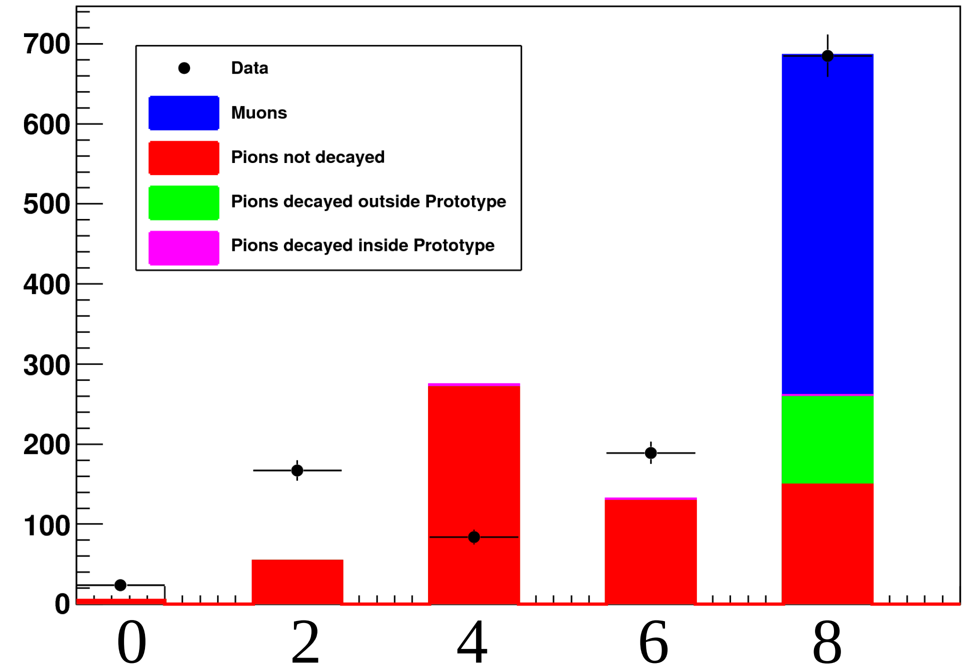
Muon Sample composition at 6 GeV (in percent)

6 GeV	BERT	CHIPS	HP	BIC
μ	80.7 ±8.3	79.9 ±6.9	81.7 ±8.1	79.9 ±6.9
π	19.3 ±2.0	20.1 ±1.7	18.3 ±1.8	20.1 ±1.7



Muon Sample composition at 5 GeV (in percent)

5 GeV	BERT	CHIPS	HP	BIC
μ	77.5 ±6.2	66.1 ±4.3	76.5 ±6.3	65.0 ±
π	22.5 ±1.8	33.9 ±2.2	23.5 ±1.9	35.0 ±



Muon Sample composition at 4 GeV (in percent)

4 GeV	BERT	CHIPS	HP	BIC
μ	36.8 ±	37.0 ±	38.9 ±	40.0 ±
π	63.2 ±	63.0 ±	61.1 ±	60.0 ±

Conclusions

- First study encouraging
  - Clear differences in lateral and longitudinal cluster shape in the muon and pion enriched samples;
- So far comparison with MC not clear because of:
  - Unknown beam composition and Cerenkov efficiencies;
  - Layout geometry not completely known.

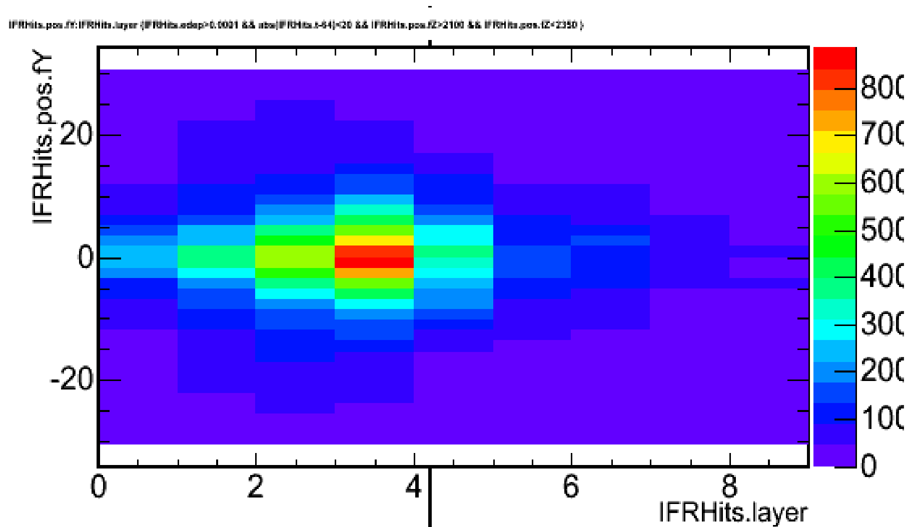
- To do, before July test beam
  - Look at TDC response;
  - Use Ferrara CR runs to understand timing response of prototype;
  - Compare “muon” selection using different configurations;
  - Final answers on geometry require tuned simulation:
    - Both digitization and Physics list need adjustments

Backup slides

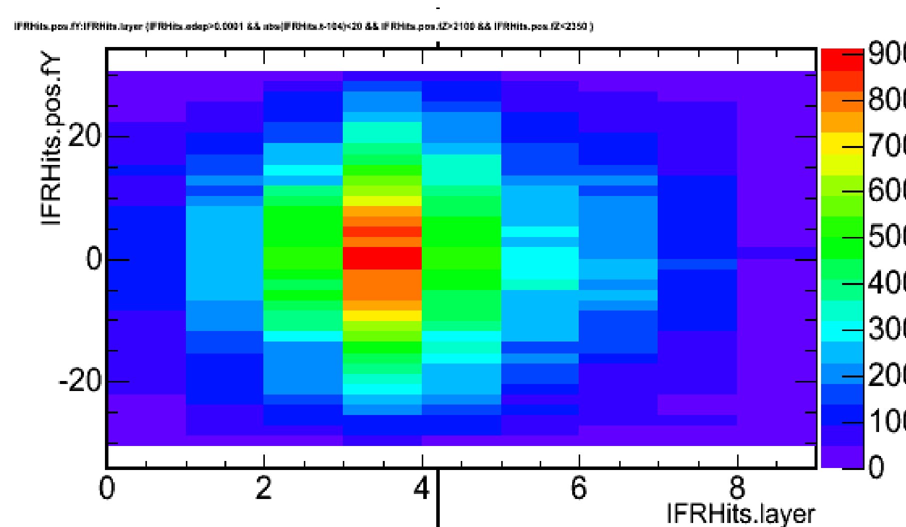
Prototype Data Analysis: Data

	Trig	N_{tot}	S_{1-2} μ	S_{1-2} π	S_{3-4} μ	S_{3-4} π
4 GeV	μ	35320	28,9%	16,2%	25,5%	12,6%
	μ+π	48420	2,4%	71,2%	25,4%	11,3%
5 GeV	μ	51113	40,3%	13,2%	43,9%	12,3%
	μ+π	118635	2,2%	78,8%	48,0%	10,4%
6 GeV	μ	51860	52,4%	6,8%	64,3%	13,7%
	μ+π	57342	3,4%	71,8%	52,7%	4,8%
8 GeV	μ	x	x	x	x	x
	μ+π	95326	2,8%	89,7%	81,4%	10,4%

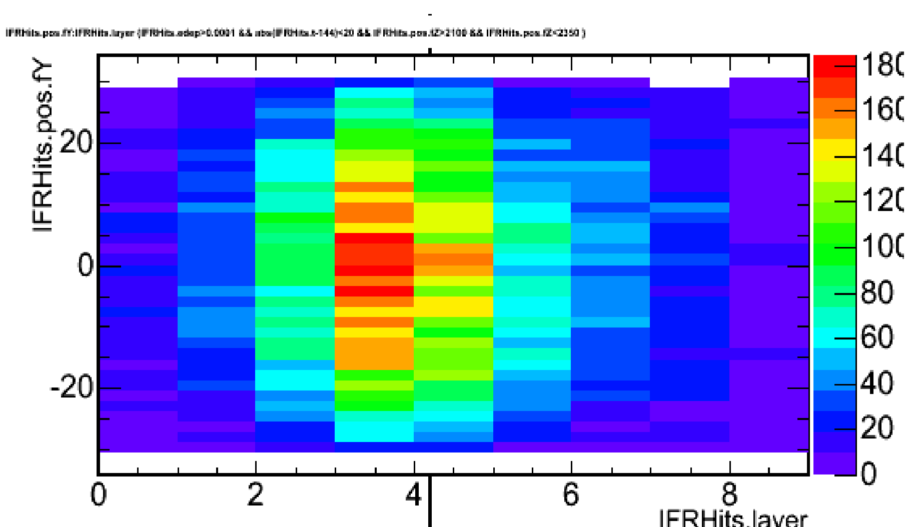
Simulation: Time development for 8 GeV π



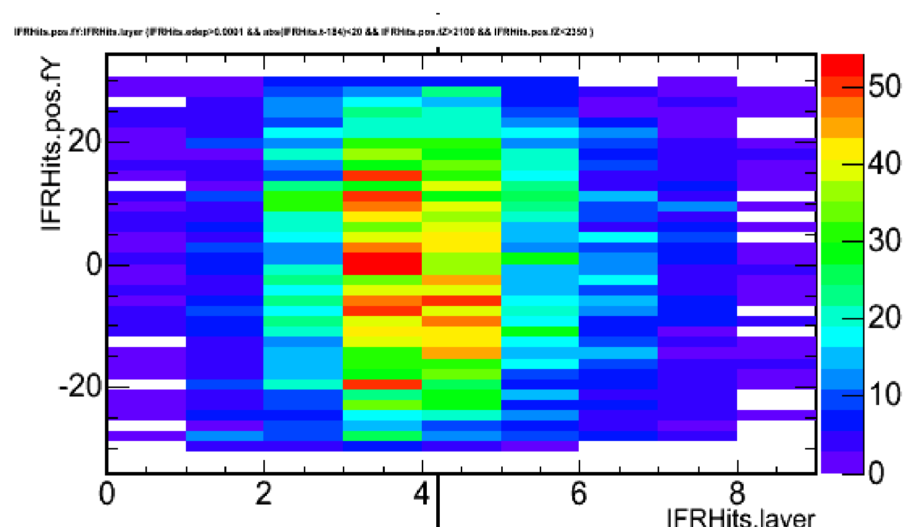
0-20ns



20-40ns



40-60ns



60-80ns

25% of hits have gTime>20 ns