# The IFR test beam simulation based on SuperB Full Sim framework

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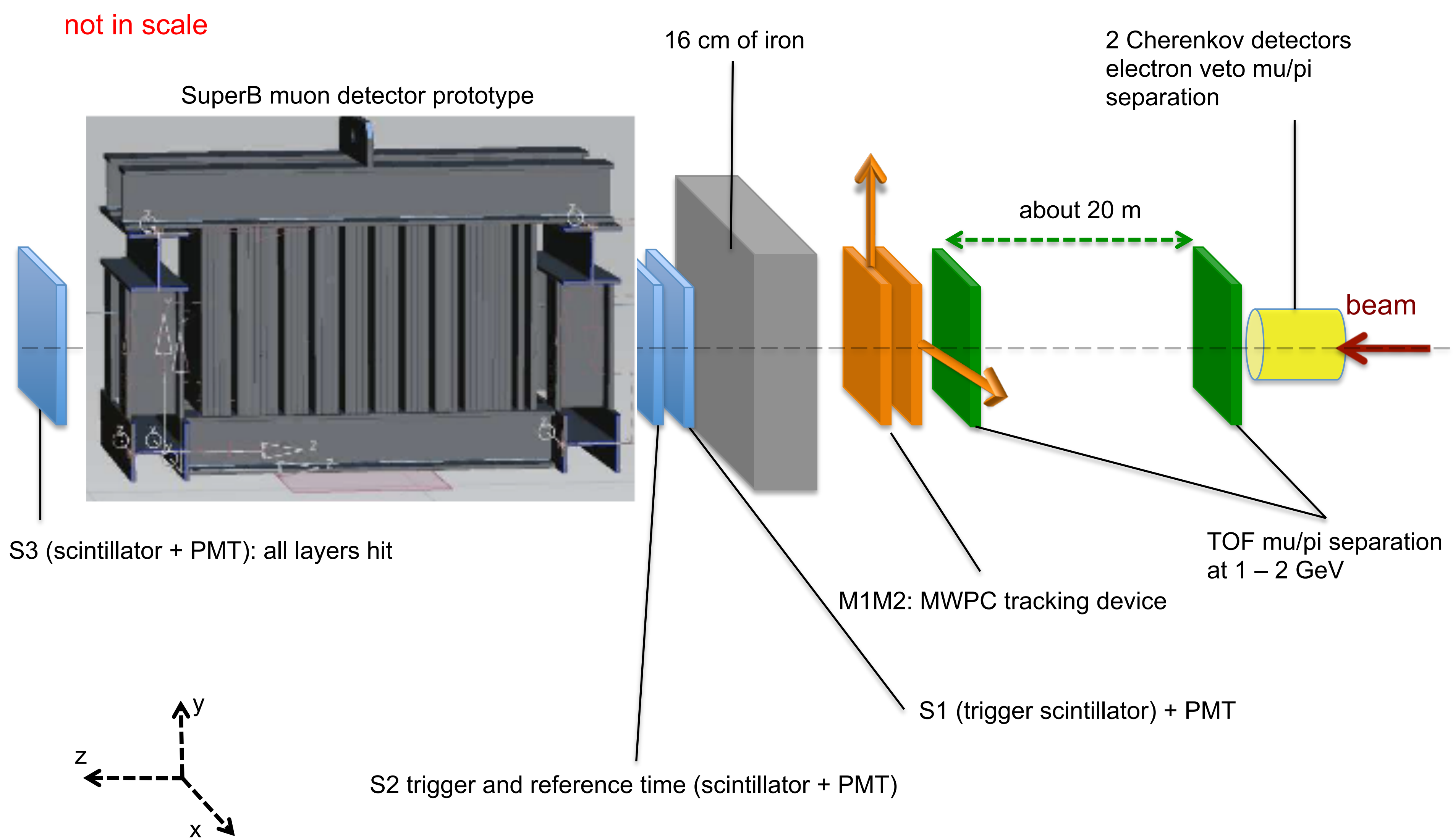
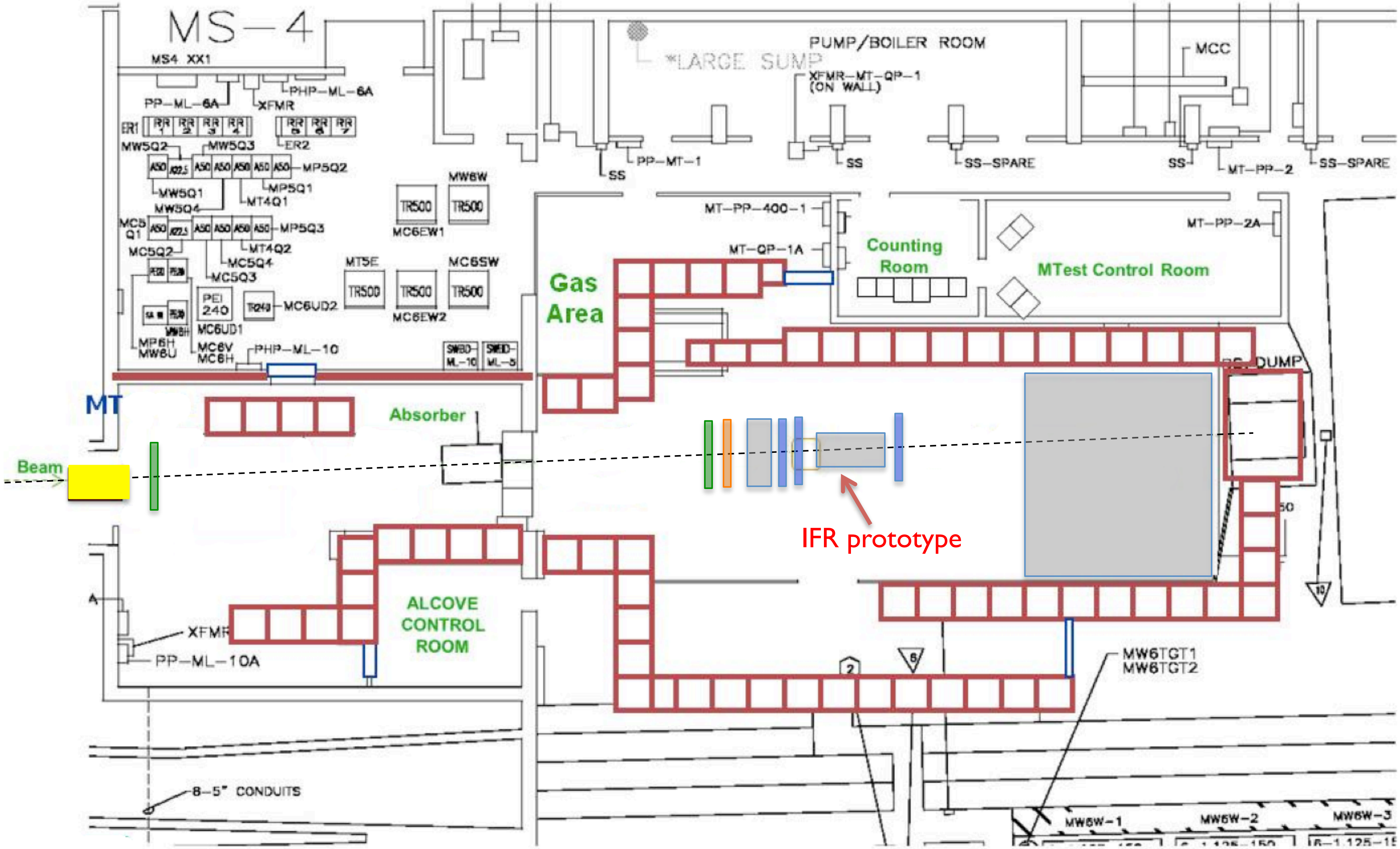
# Outline

- The IFR beam test
- The beam test simulation
- Few example of data analysis
- Summary, conclusions and whish list

# The experimental setup



# MTest Beamline Instrumentation




= Facility Motion Table

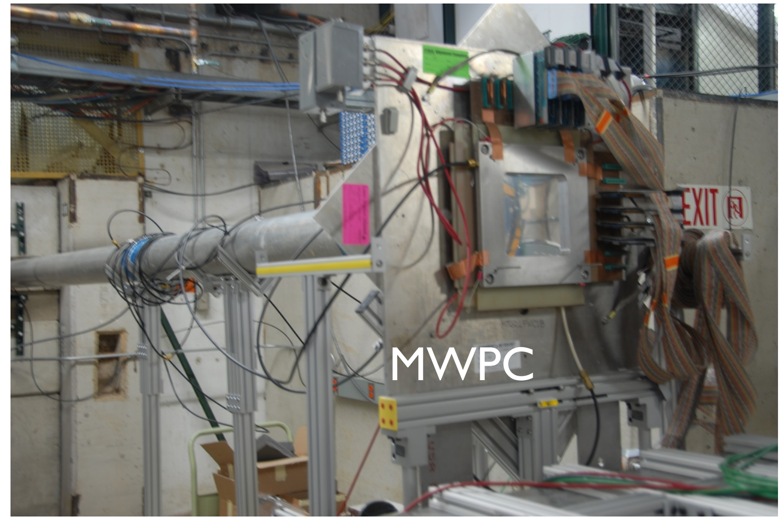
Cerenkov

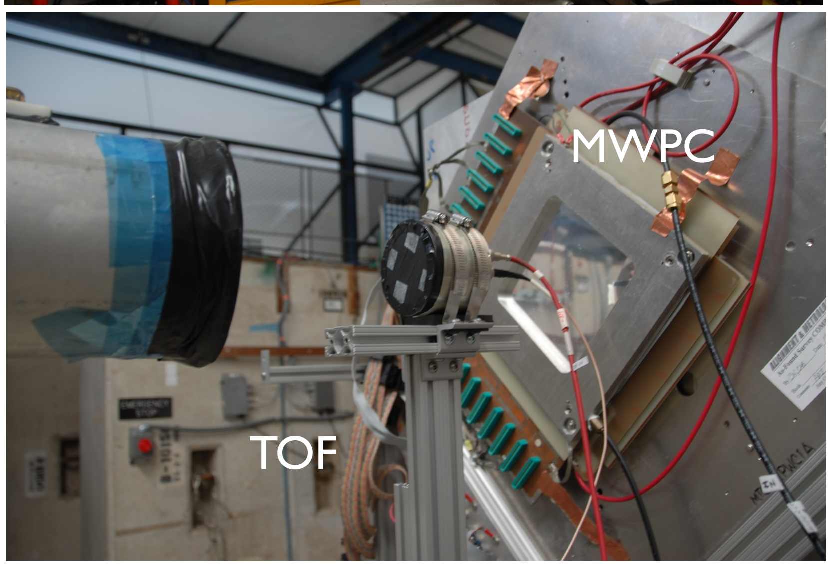
MWPC

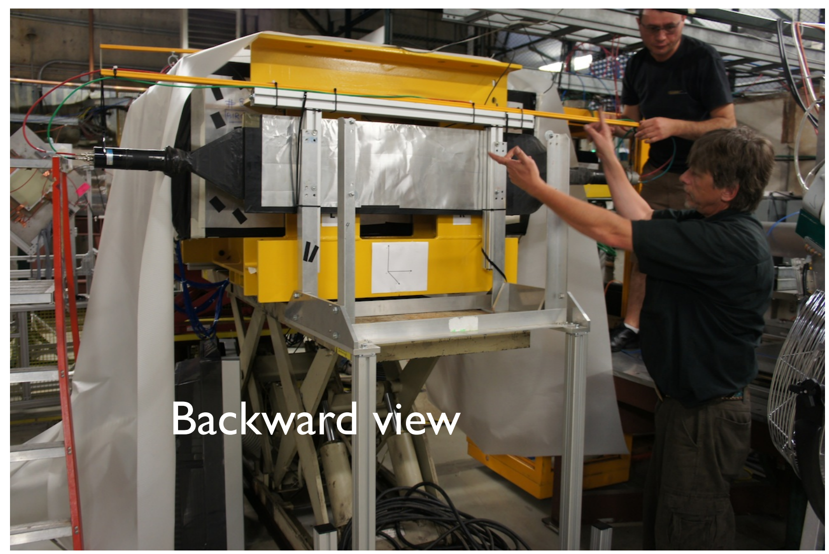
TOF

PMTs

# To have an idea

# Muon identification goal

- Muon/Pion separation on real data;
  - Check hadronic shower models on Monte Carlo;
  - Define a model for Detector Response (Digitization);
  - Both aspects important for Detector Geometry optimization and for future SuperB simulation;

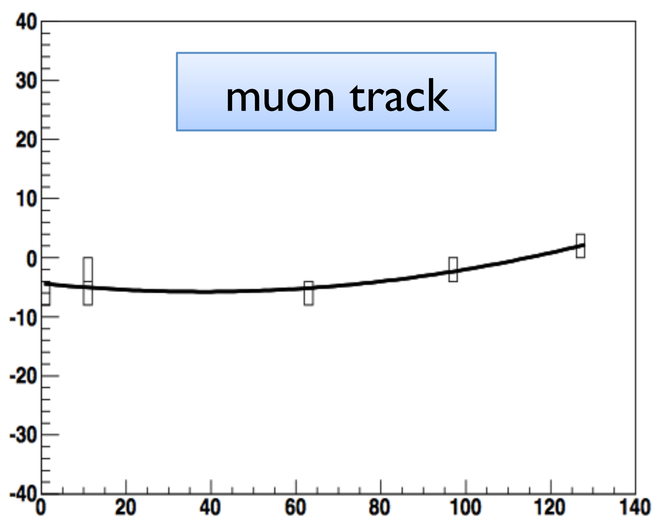
- Hadronic shower tails are crucial to define:
  - The total amount of material;
  - The optimal segmentation;

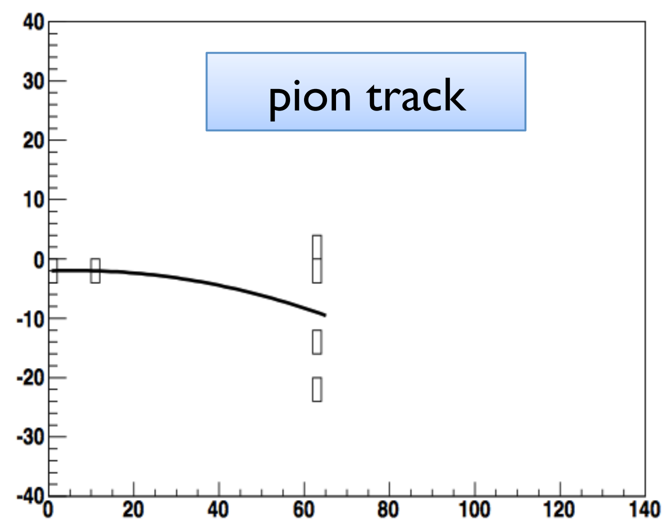
- Many studies on the shower development available above 10 GeV (CALICE), few old studies available in the "GeV" regime;

- The analysis of the prototype requires close interplay with simulation.

# Muon identification 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 the backward scintillators;

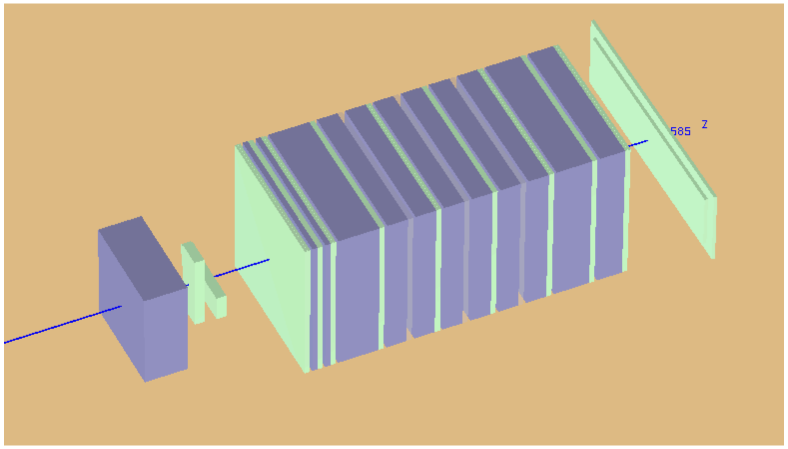


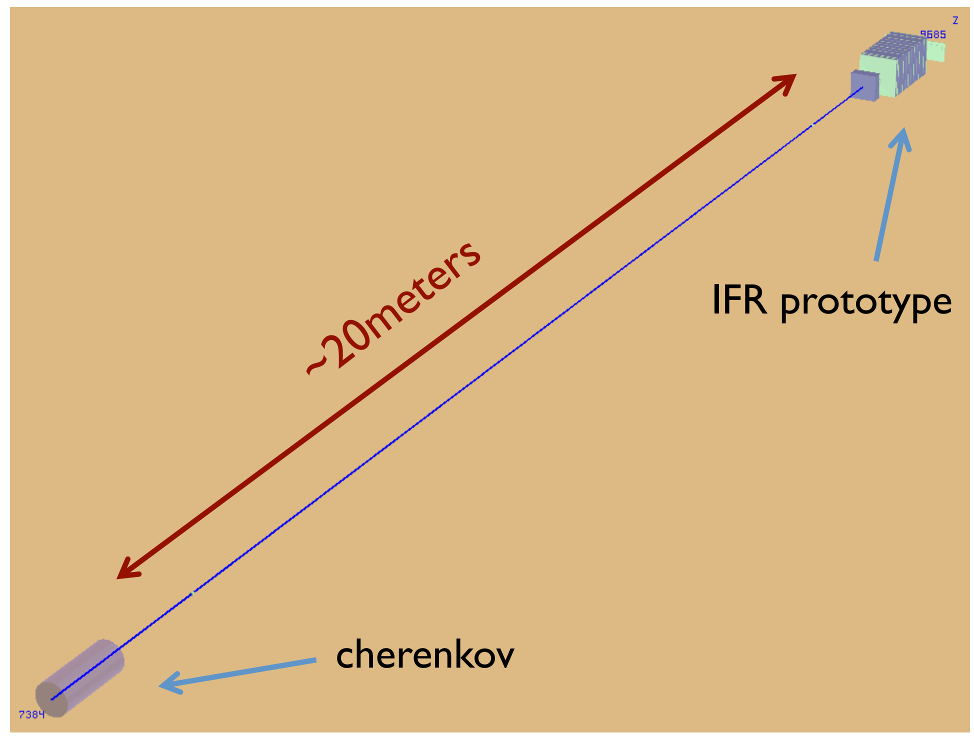
# Using Full Sim framework

- Completely removed the SuperB detector and final focus.
- Redefine the existing IFR FWD endcap volume and replace its geometry with the test beam setup.
- Use Bruno out of the box to shot single particles (muons, pions, electrons), manage the particle evolution and store ghit information.

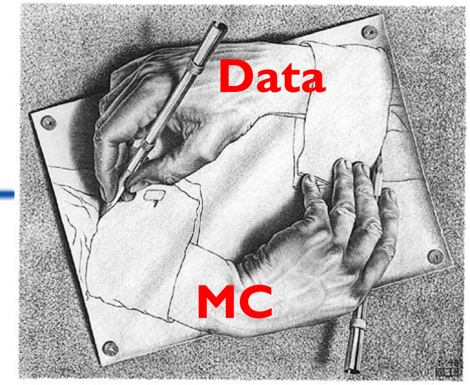
# Test beam setup description




A detailed description of the beam test setup has been done to perform reliable Monte Carlo studies.
Bruno Full Sim package has been used as framework.

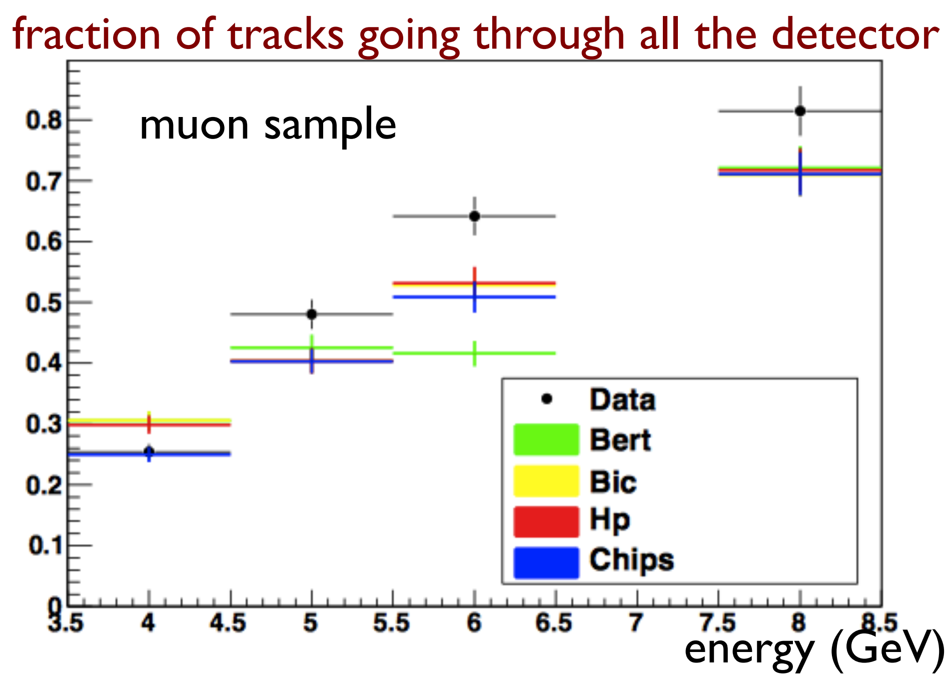


# Data-MC comparison




- Two ways interaction Data-MC
  - MC is used to understand detector acceptance and to study beam contamination;
  - Data are use to tune the MC hadronic shower description

- Generated samples of mu, pi, $e^{\pm}$
- Four different Physics lists used in the MC;
- Beam composition studies in progress.



# DT/MC studies: Reduced $\chi^2$ for different MC lists

- Estimate the contamination of pions in muon sample using a shape fit to LastLayer for different energies;
- Use reduced $\chi^2$ as discriminant variable to choose the MC list with the better agreement with data;
- CHIPS seems to match the data better then other MC list

| $c^2$/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 |

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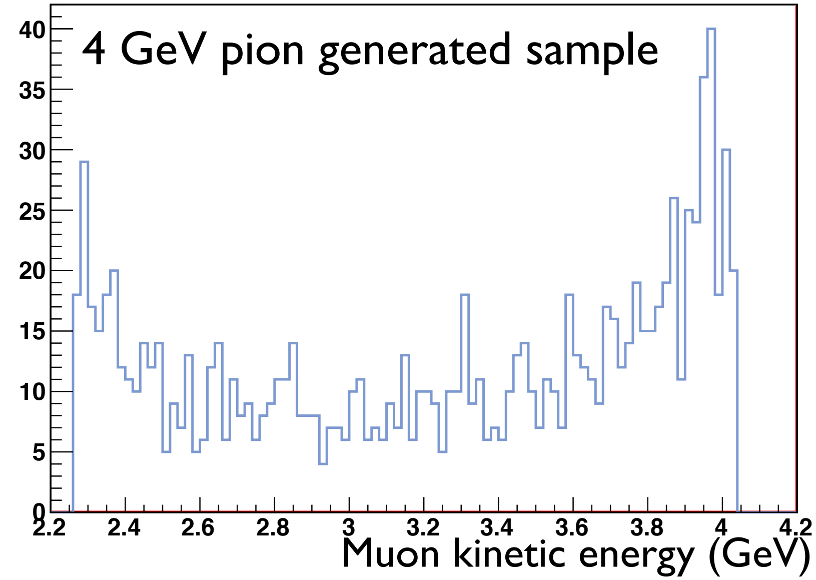
# Pions decay

The momentum selecting magnet is placed ~70 meters upstream the Cherenkov counter.

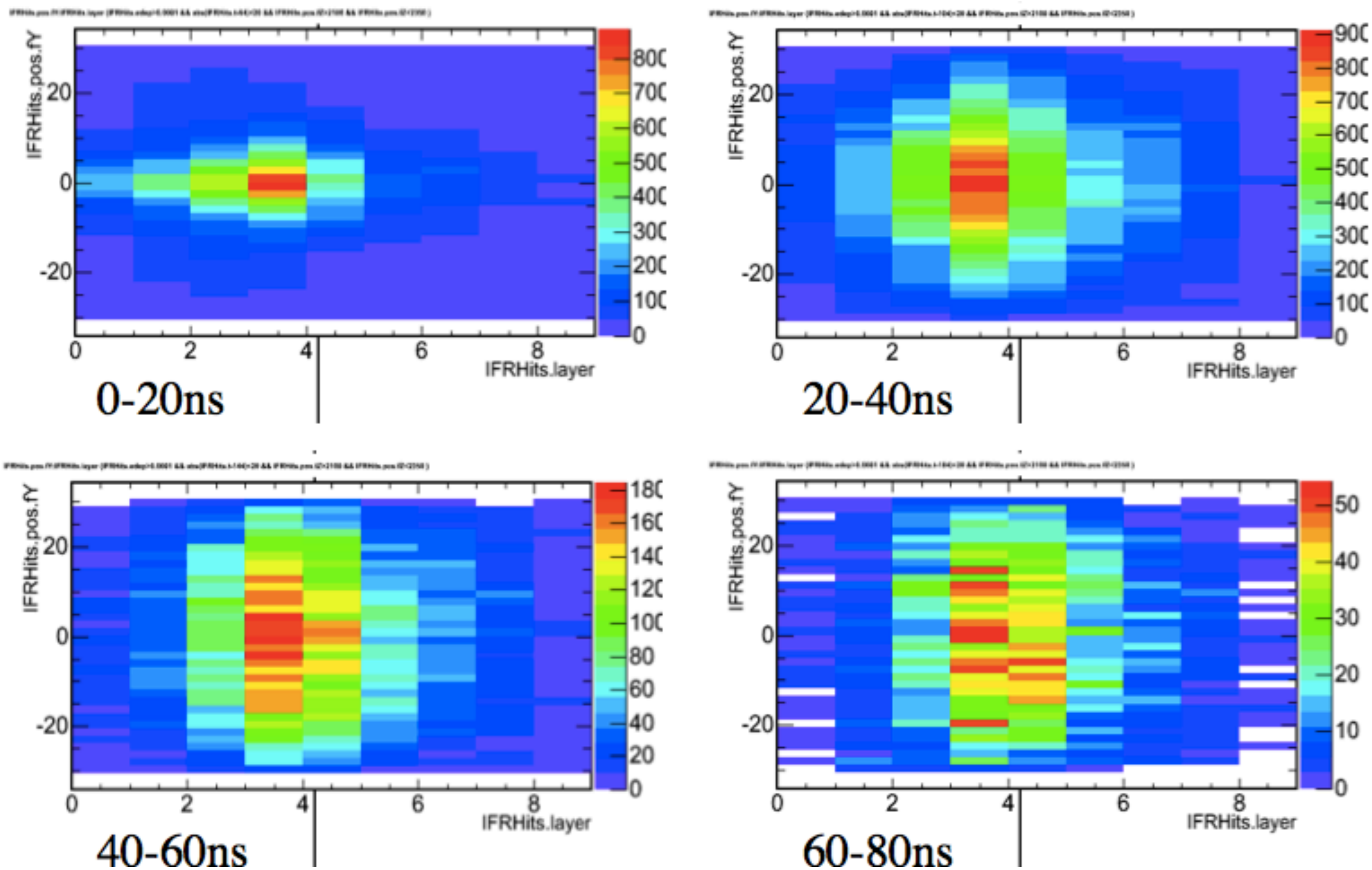
A fraction of the pions decays in fly into muons and a fraction of those muons reach the Cherenkov with wrong momentum being identified as a pion.

This feature has been implemented in the MC simulation and the results are summarized in this table




| Energy | Pions at Crk | Muons at Crk | Muon Energy |
|---|---|---|---|
| 1 GeV | 30% | 5% | 0.5 – 1 GeV |
| 2 GeV | 50% | 9% | 1 – 2 GeV |
| 4 GeV | 72% | 10% | 2 – 4 GeV |
| 6 GeV | 80% | 11% | 3.5 – 6 GeV |
| 8 GeV | 85% | 11% | 4.5 – 8 GeV |

# Time development for 8 GeV pions




**25% of hits have time > 20 ns**

# Summary, conclusions and…

- Using Bruno was the obvious solution for our test beam simulation.
- The framework worked fine so far (with some workaround)
- The hard part it the analysis, in particular the interplay between data and MC.

# Whish list

- We don’t have particular needs in terms of code development.
- We are happy with the current version (but no objection to further development) and we are more focused on the background analysis (see Valentina’s talk at the background session) and prototype studies.
- The main part of our coding effort is done on the IfrRootCode package we are using for event reconstruction.
- A tool to merge different sources of background and to have a “collection” of Background events to be added to the single particle would be useful.