Acceptance and Resolution Studies for Forward Tracking Stations

11th December 2012
PANDA Collaboration Meeting

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INFN Ferrara

Forward Tracking EVO Meeting:

- 04/12/2012
- 15/11/2012
- (Next one: in January?)

Minutes available at the following link:

http://panda-wiki.gsi.de/cgi-bin/view/Tracking/FwdEvoMeetings

The working packages are divided in the following way (from the meeting of 15/11):

- Elisa Fioravanti, Isabella Garzia (Ferrara): Acceptance and resolution studies. Multipion analysis.
- Martin J. Galuska (Giessen): Pattern recognition
- J. Biernat (Crakow): Occupancy studies
- M. Jadhav (Julich): Study of compact design
- Himani Bhat (India): benchmark channel psi(4040)->D*D*->K+K+pi+pi-pi+pi-

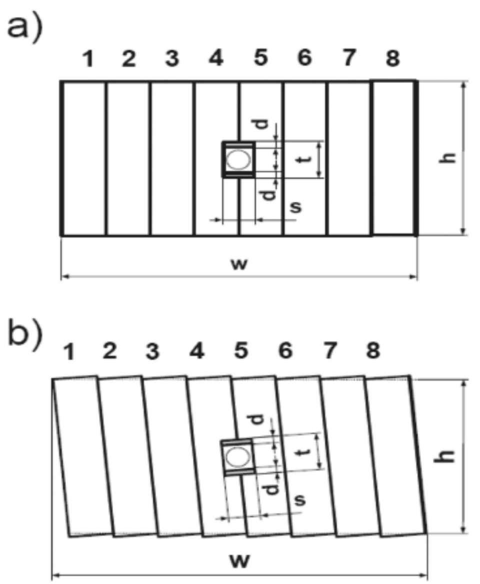
Outline

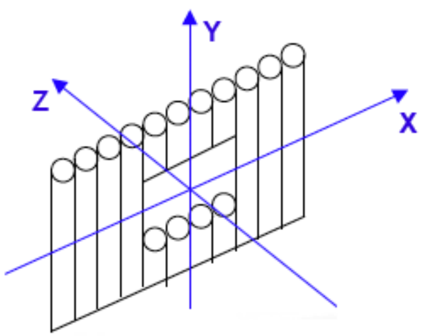
- Geometry configurations available
- Acceptance Studies
- Resolution Studies
- Plans

Tracking station	Double layer	Straw inclination	Number of modules (straws)	*z*-coordinate [mm]	Active area *w* [mm]	Active area *h* [mm]
FT1	1	0º	8 (2x128)	2954	1297.9	640
	2	+5º	8 (2x128)	3004	1358.8	640
	3	-5º	8 (2x128)	3054	1358.8	640
	4	0º	8 (2x128)	3104	1297.9	640
FT2	1	0º	8 (2x128)	3274	1297.9	640
	2	+5º	8 (2x128)	3324	1358.8	640
	3	-5º	8 (2x128)	3374	1358.8	640
	4	0º	8 (2x128)	3424	1297.9	640
FT3	1	0º	12 (2x192)	3945	1944.3	690.3
	2	+5º	12 (2x192)	4019.75	2013.2	703.4
	3	-5º	12 (2x192)	4165	2015.4	728.8
	4	0º	12 (2x192)	4239.75	1944.3	741.9
FT4	1	0º	12 (2x192)	4385	1944.3	767.3
	2	+5º	12 (2x192)	4459.75	2020.0	780.4
	3	-5º	12 (2x192)	4605	2022.2	805.8
	4	0º	12 (2x192)	4679.75	1944.3	818.9
FT5	1	0º	25 (2x400)	6075	4045.1	1180.0
	2	+5º	25 (2x400)	6125	4163.7	1180.0
	3	-5º	25 (2x400)	6175	4163.7	1180.0
	4	0º	25 (2x400)	6225	4045.1	1180.0
FT6	1	0º	37 (2x592)	7475	5984.3	1480.0
	2	+5º	37 (2x592)	7525	6136.6	1480.0
	3	-5º	37 (2x592)	7575	6136.6	1480.0
	4	0º	37 (2x592)	7625	5984.3	1480.0

Tracking station	Double layer	Straw affected by opening (split straws) 1st layer/2nd layer	*s* [mm]	*t* [mm]
FT1	1	59-70 / 59-70	116	172
	2	59-70 / 59-70	116	172
	3	59-70 / 59-70	116	172
	4	59-70 / 59-70	116	172
FT2	1	59-70 / 59-70	116	172
	2	59-70 / 59-70	116	172
	3	59-70 / 59-70	116	172
	4	59-70 / 59-70	116	172
FT3	1	91-102 / 91-102	116	166
	2	91-102 / 91-102	116	166
	3	91-102 / 91-102	116	166
	4	91-102 / 91-102	116	166
FT4	1	91-102 / 92-103	116	166
	2	91-102 / 92-103	116	166
	3	91-102 / 92-103	116	166
	4	91-102 / 92-103	116	166
FT5	1	197-215/ 197-215	187	238
	2	197-215 / 197-215	187	238
	3	197-215 / 197-215	187	238
	4	197-215 / 197-215	187	238
FT6	1	298-316 / 299-317	187	238
	2	298-316 / 299-317	187	238
	3	298-316 / 299-317	187	238
	4	298-316 / 299-317	187	238

- All the dimensions and distances were decided on December 2009.
- Simulation of all the tubes: 13056





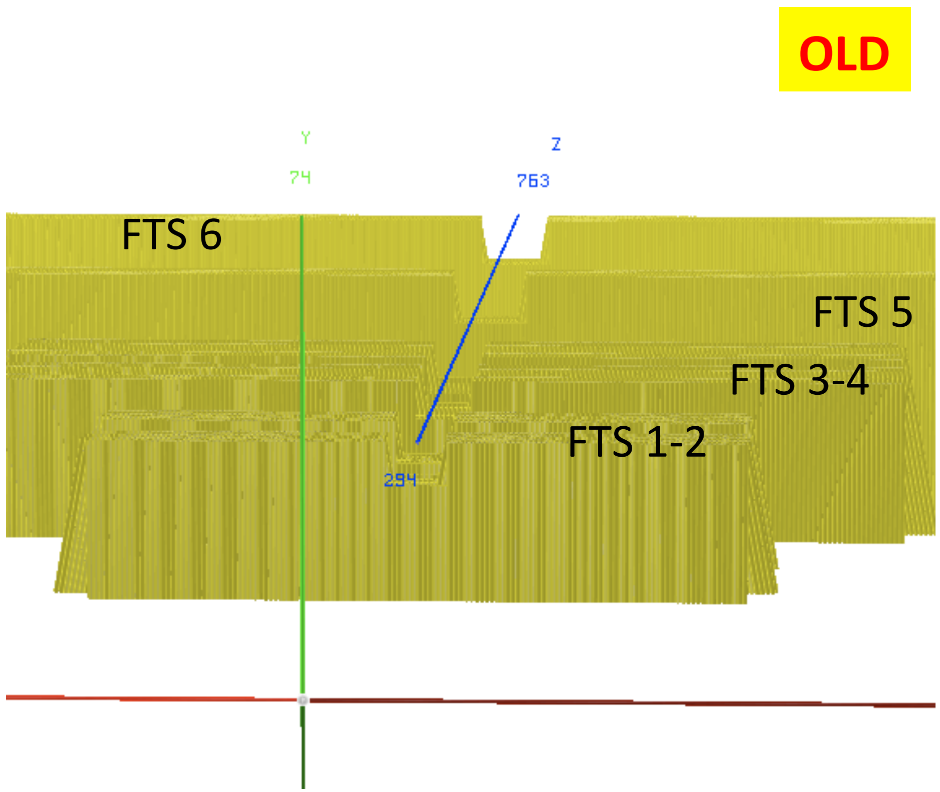
- 6 stations: two before, two inside, two after the dipole magnet.
- 4 double layers for each station: 24 double layers.
- For each double layers there are two planes. The double layers have different dimensions and distances.
- The second and the third double layers are inclined of ±5° (the central planes of each stations).
- The hole for the beam pipe is squared, inclined and different for each double layers

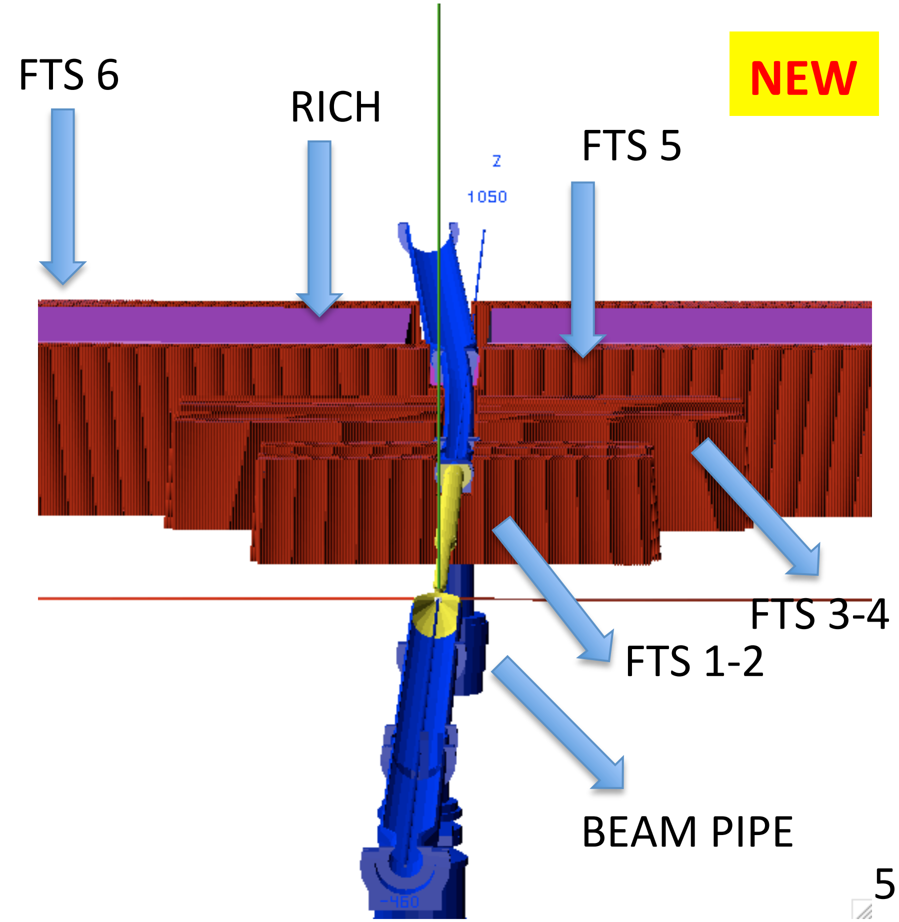
NEWS:

There were overlaps between FTS and beam pipe.

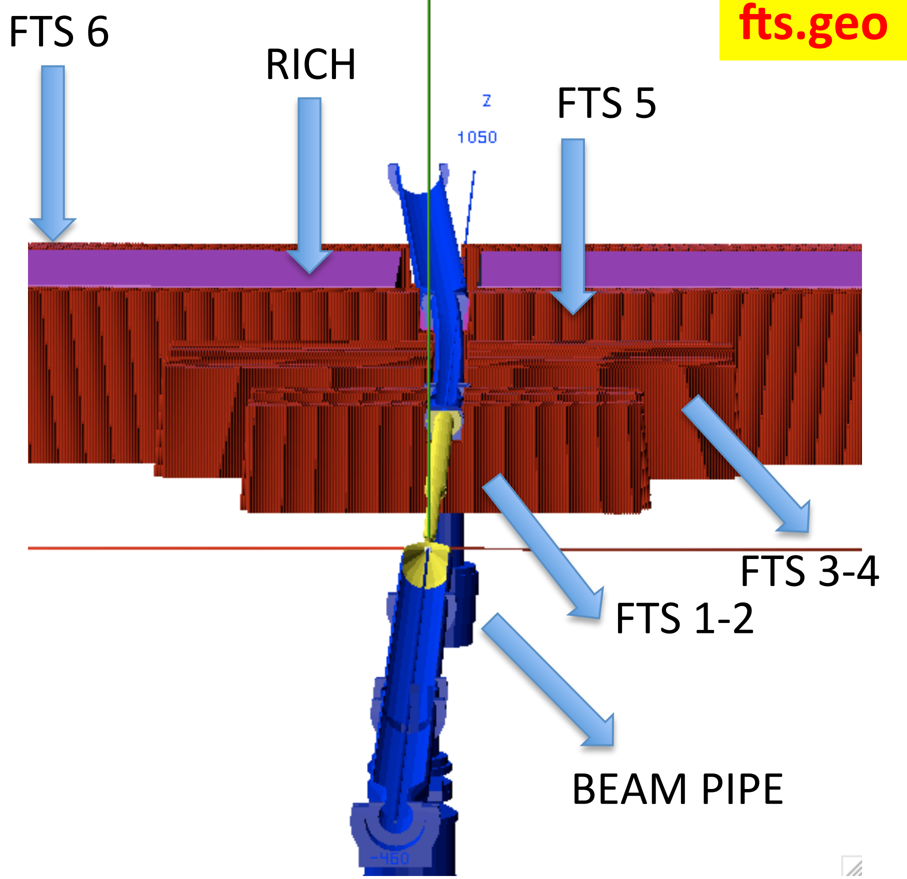
Now **the overlaps are solved** thanks to Isabella with the help of Paul Buehler.

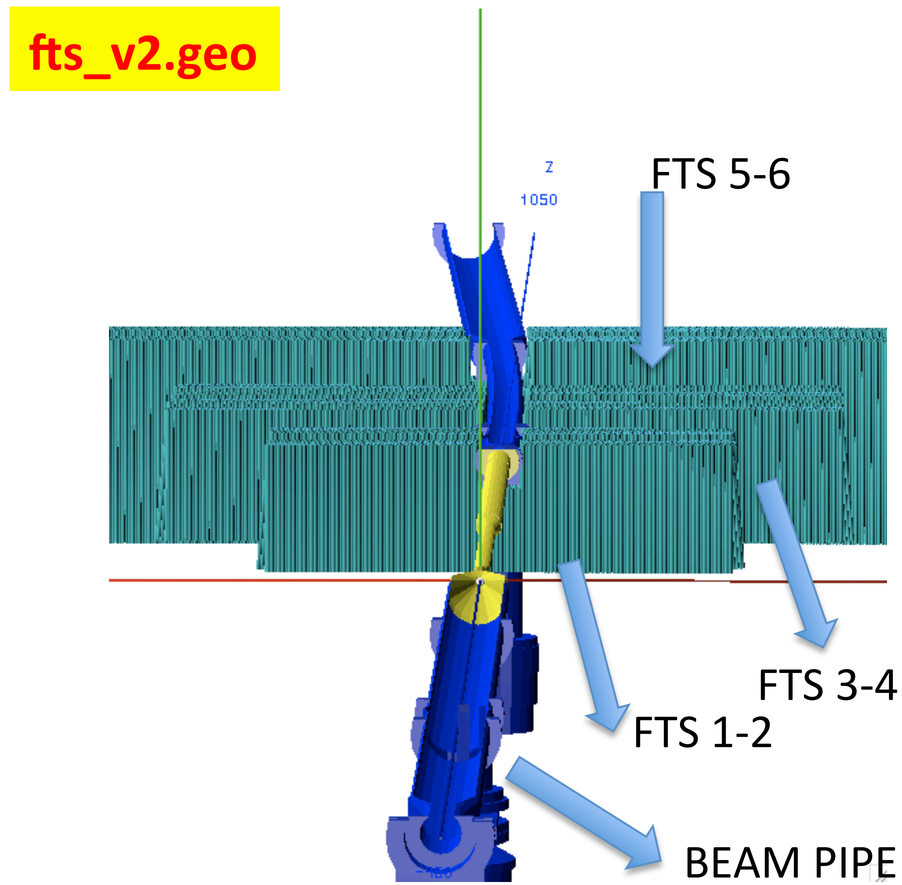
The holes for the beam pipe of the last two stations (FTS 5 and FTS 6) are shifted in order to introduce the **bending of the beam pipe**. (Beam pipe version: beampipe_201112.root**)**

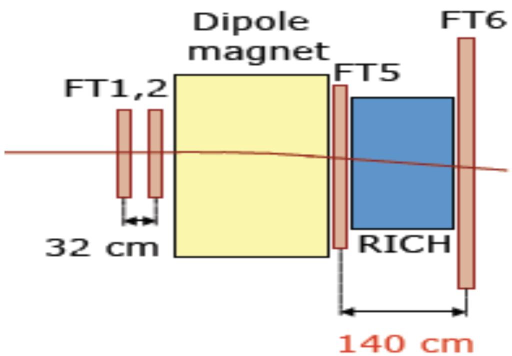


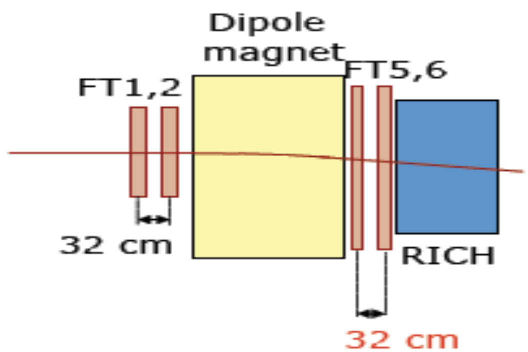


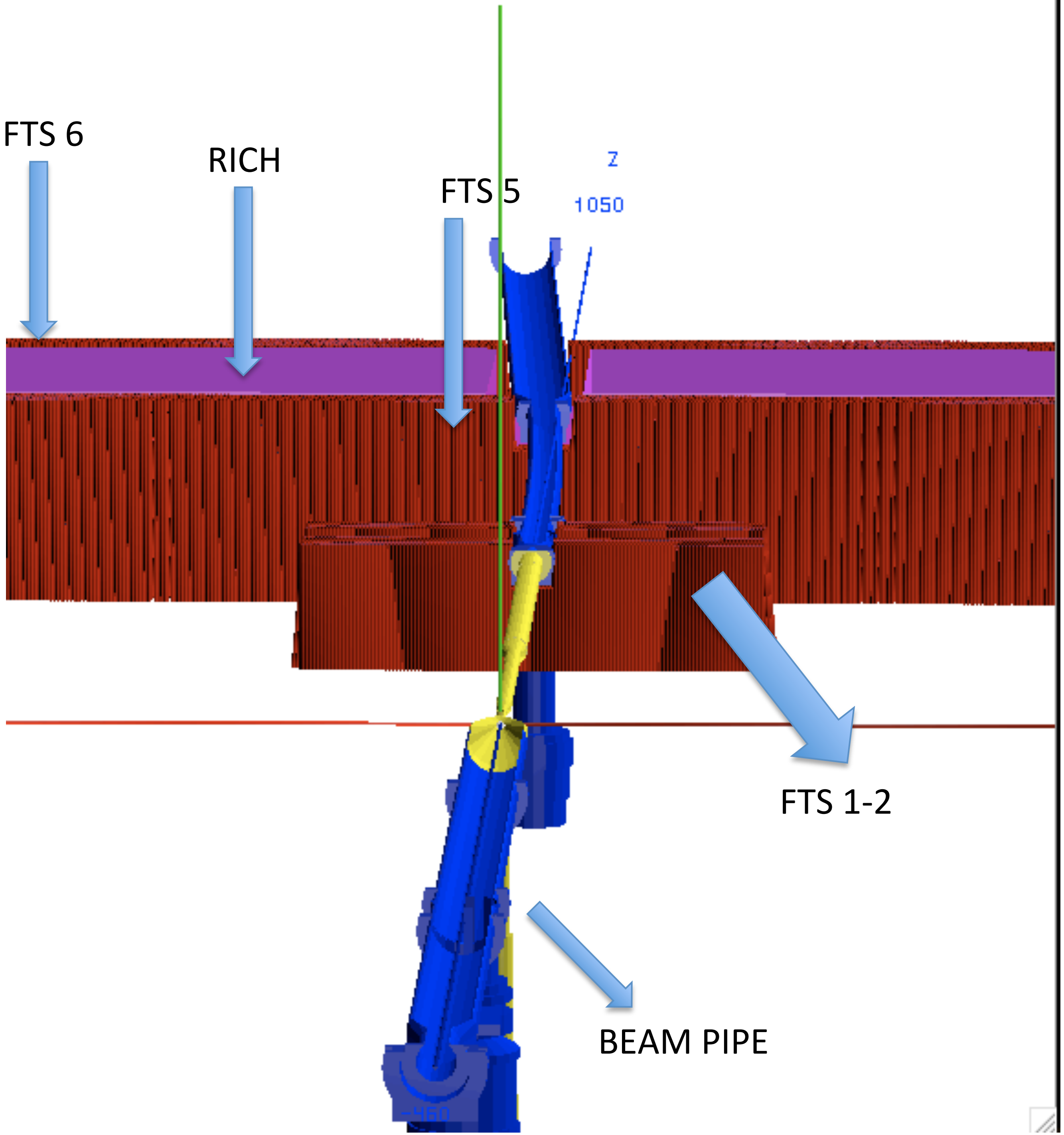
Three geometry configurations available











Fts_1256.geo

No FTS 3 and FTS 4:
No stations inside
The dipole

Acceptance Studies

Aim:

Study the x-y intensity distribution for muons at the z-position of tracking stations.
We want to re-do the same work done by Ola Wronska in 2009.

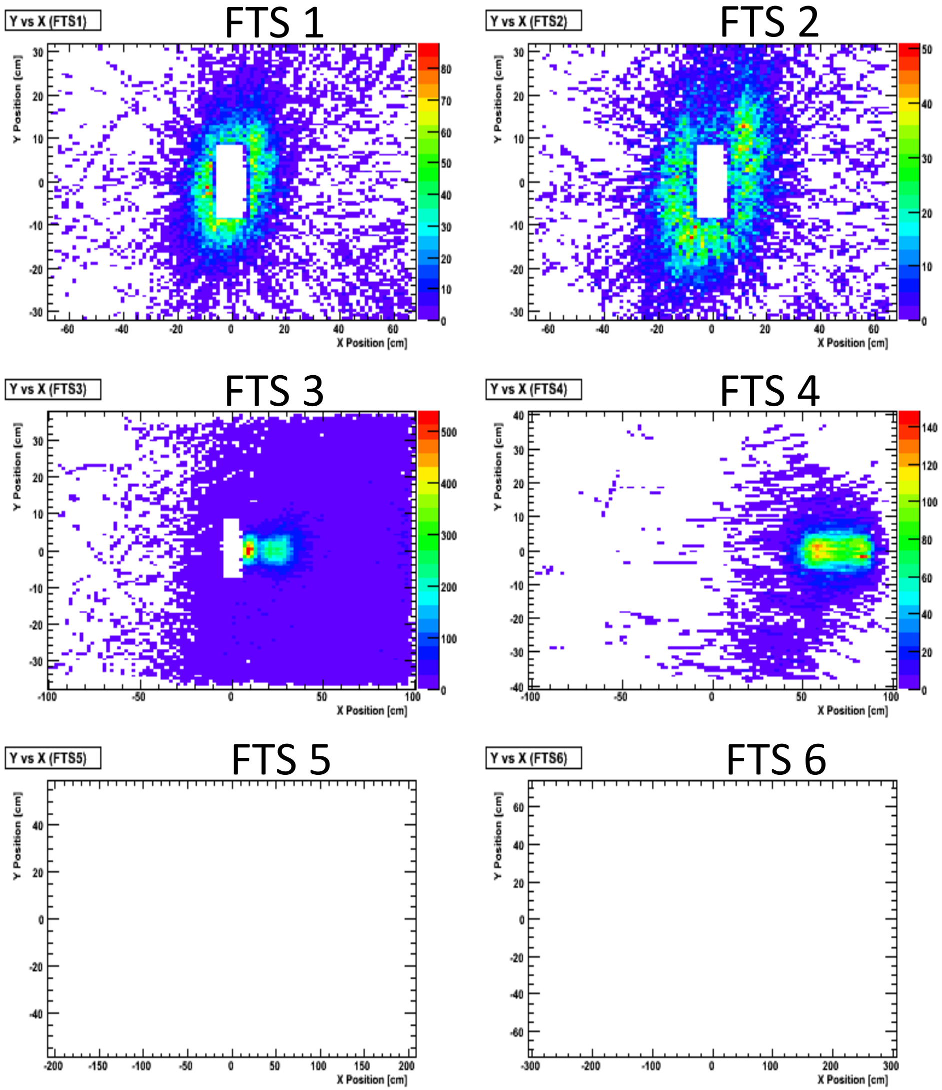
Strategy:

- BoxGenerator is used for the simulation
- 10.000 Muons simulated with different momentum:
  200 MeV, 500 MeV, 1 GeV, 2 GeV, 3 GeV, 4 GeV, 5 GeV
- Uniformly in phi: [0,360°]
- Uniformly in theta: [0.1,5°]
- Only primary tracks are selected
- Multiple scattering and energy losses included
- Detectors included: FTS and RICH
- Pandaroot Version 17805 (includes last geometry version of FTS and RICH. Last version of beam pipe)

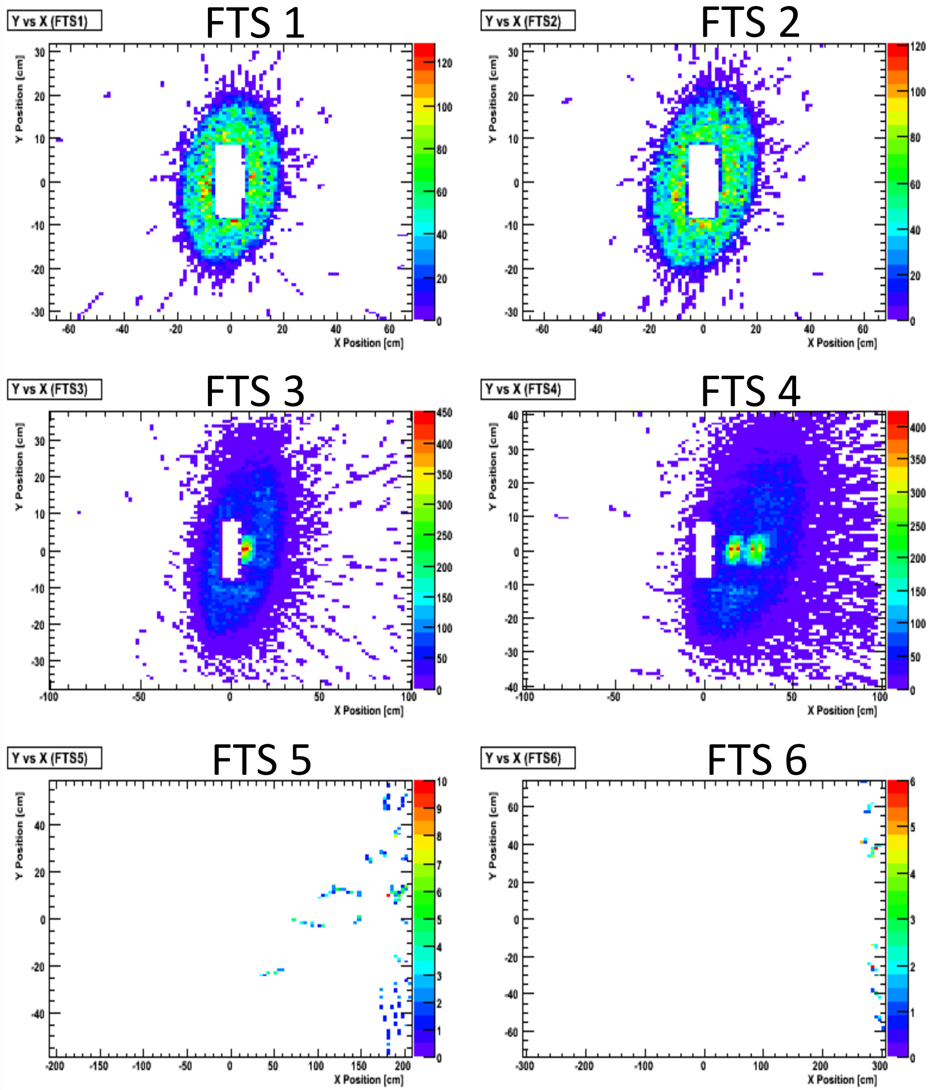
Geometry v1 (Rich between FTS 5 and FTS 6)

x: x stations dimensions
y: y stations dimensions

Muon momentum: 200 MeV



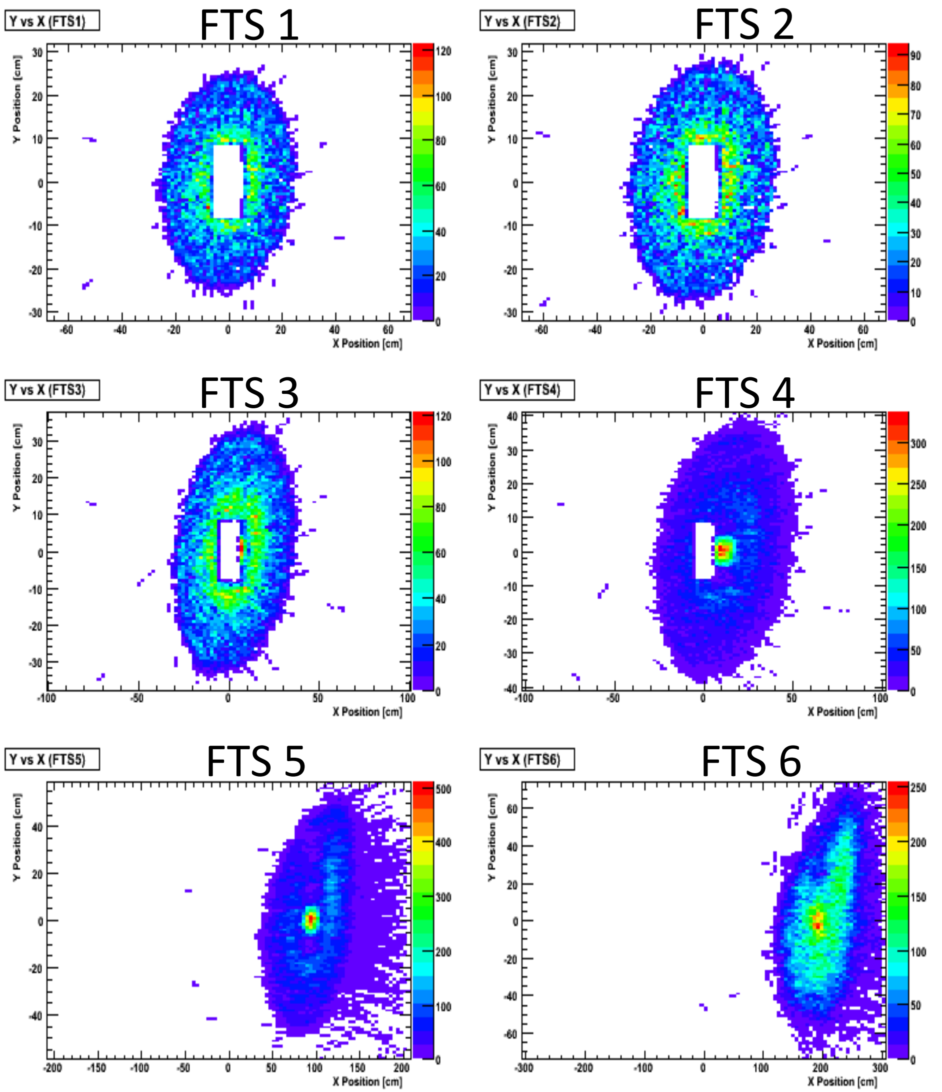
Muon momentum: 500 MeV



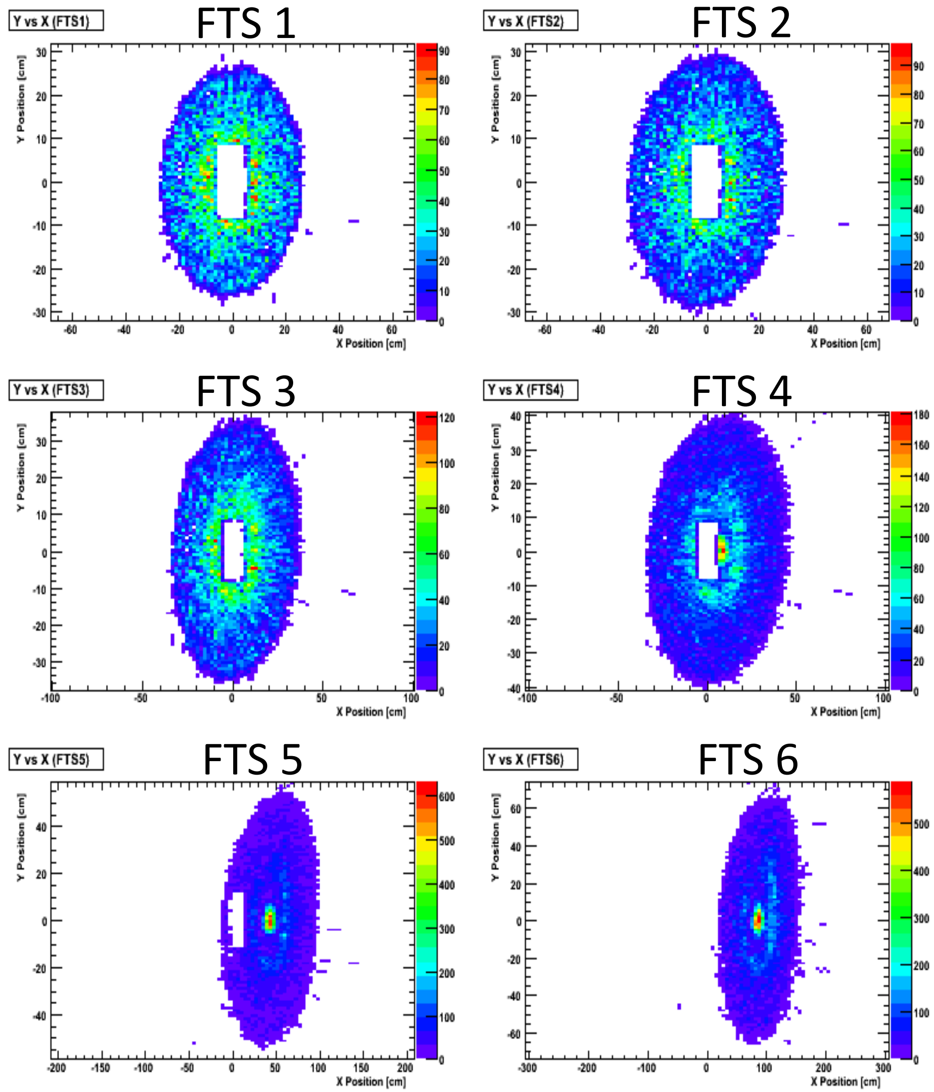
Geometry v1 (Rich between FTS 5 and FTS 6)

x: x stations dimensions
y: y stations dimensions

Muon momentum: 1 GeV



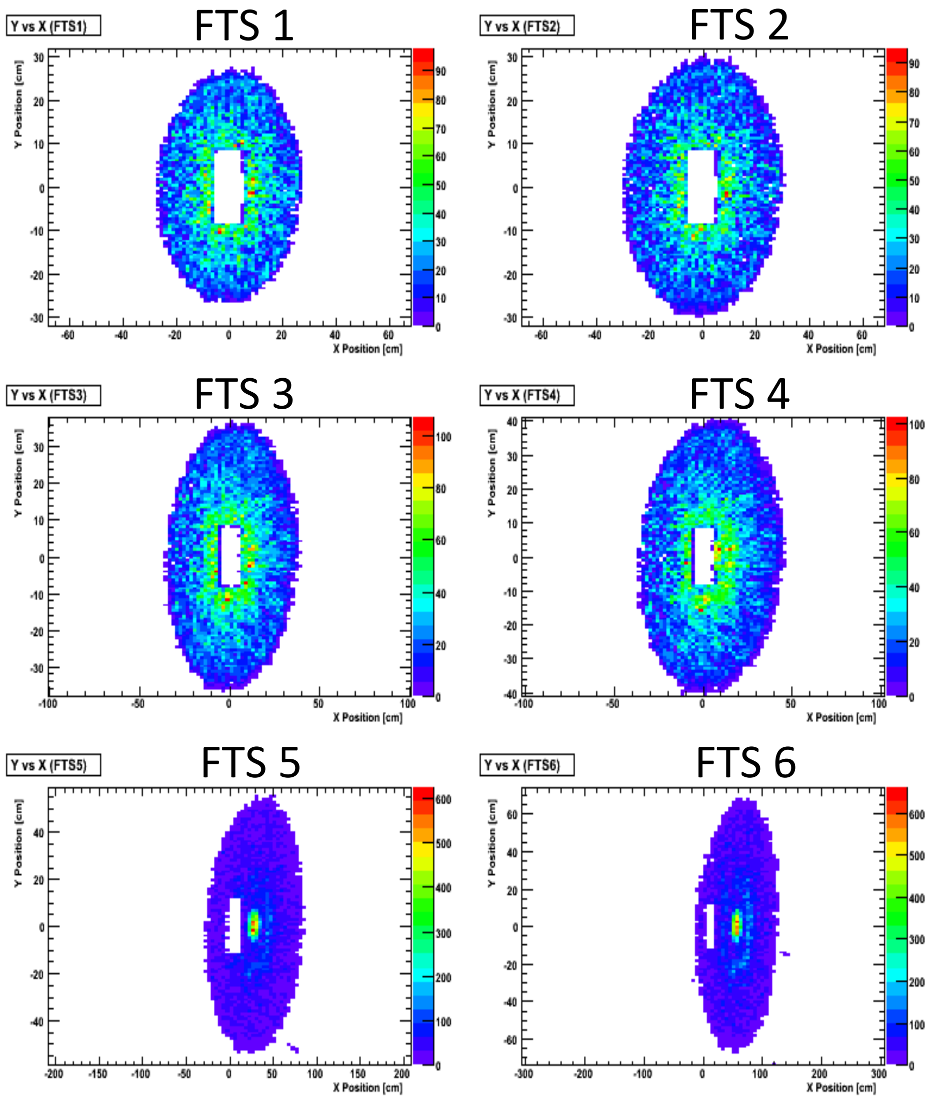
Muon momentum: 2 GeV



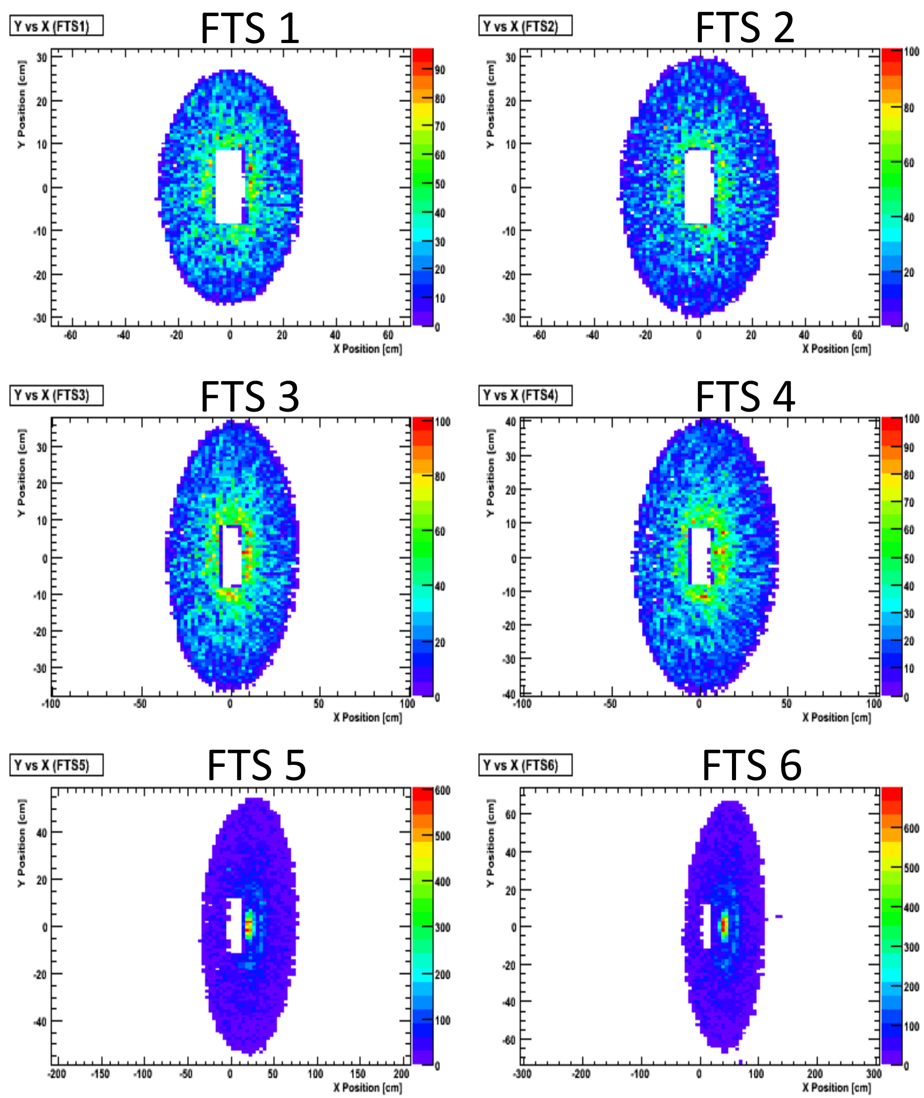
Geometry v1 (Rich between FTS 5 and FTS 6)

x: x stations dimensions
y: y stations dimensions

Muon momentum: 3 GeV



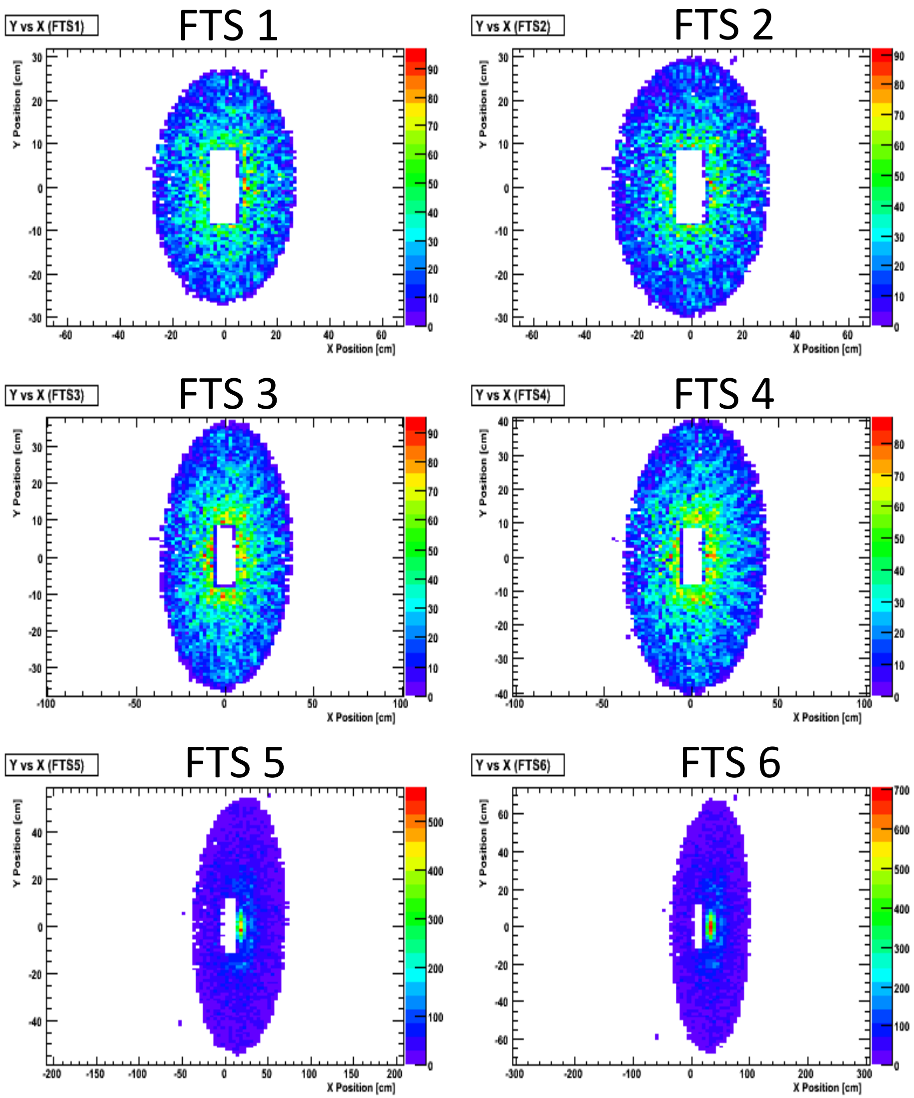
Muon momentum: 4 GeV



Geometry v1 (Rich between FTS 5 and FTS 6)

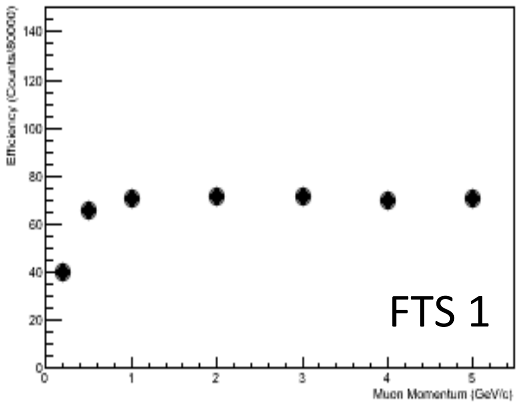
x: x stations dimensions
y: y stations dimensions

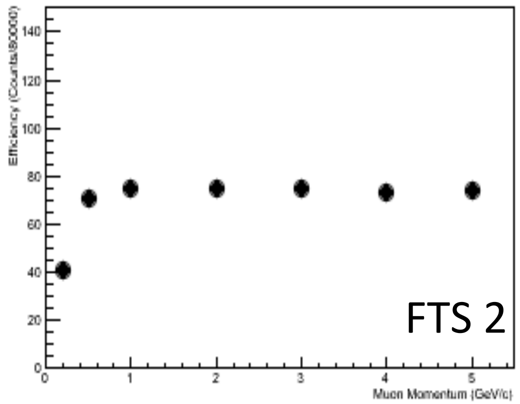
Muon momentum: 5 GeV



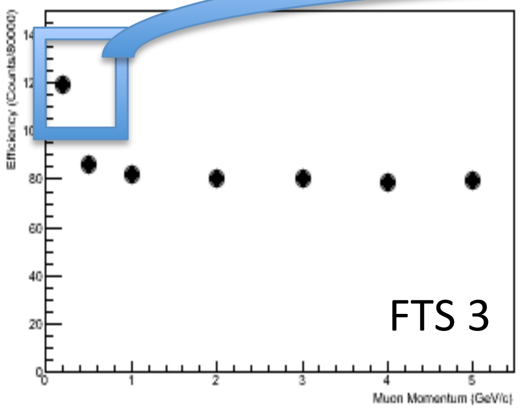
Geometry v1
(Rich between FTS 5 and FTS 6)

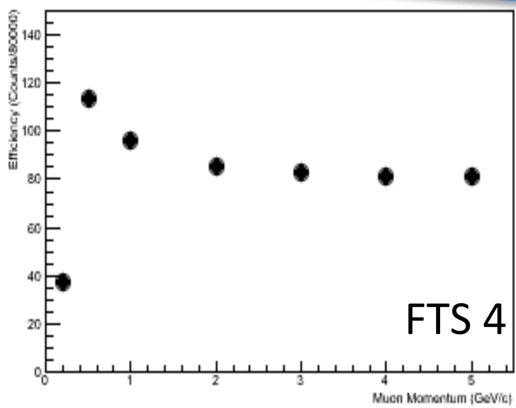
x axis: Muon Momentum
y axis: Efficiency [counts/(10000*8)]

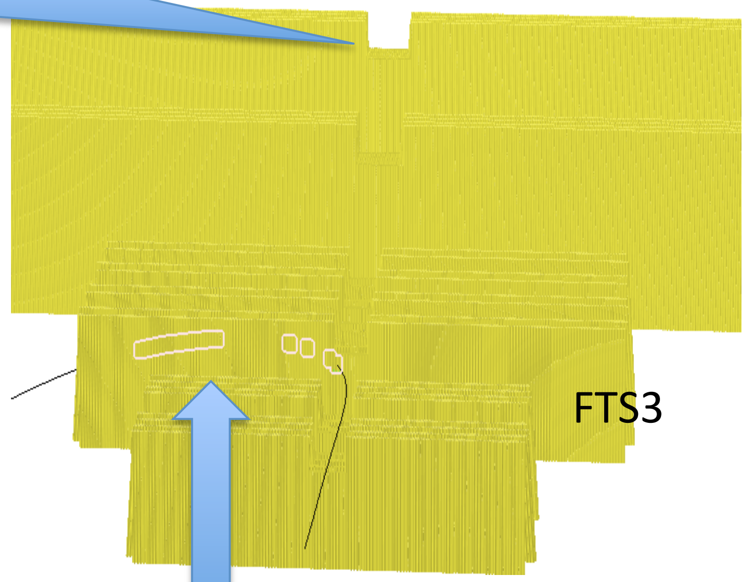


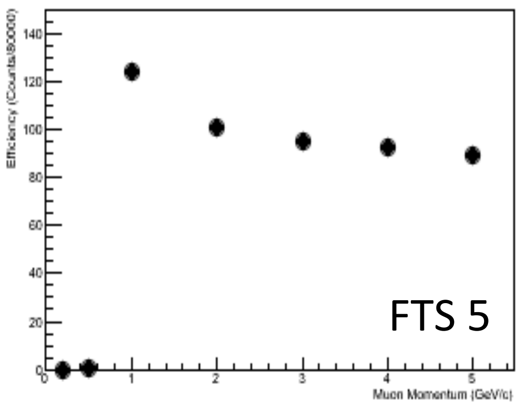


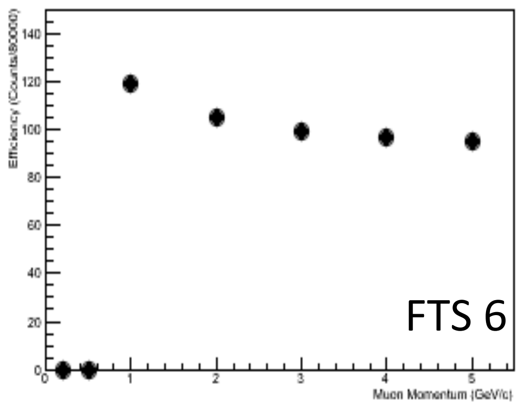
Why acceptance > 100% ?





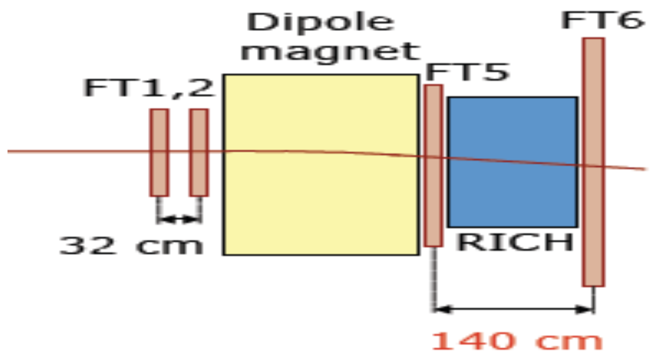


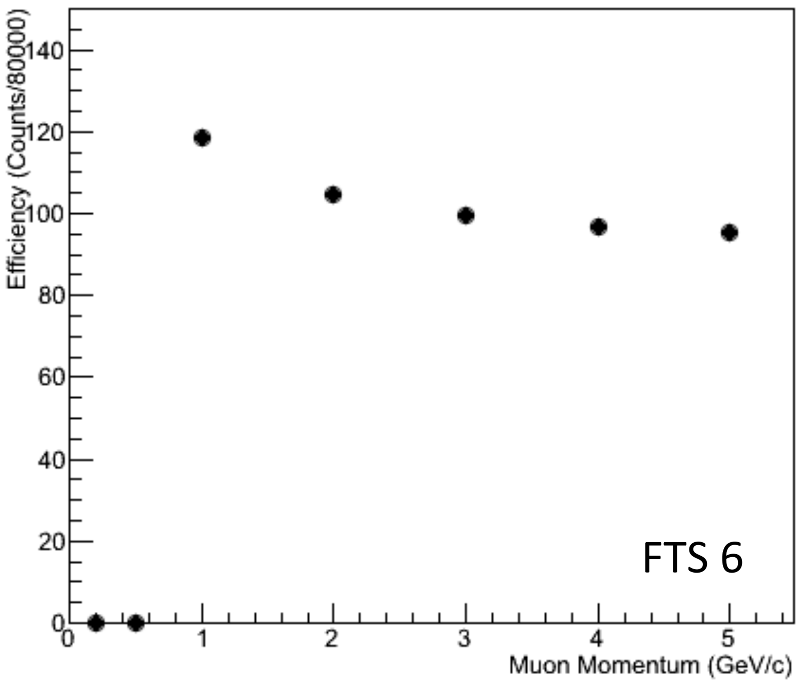




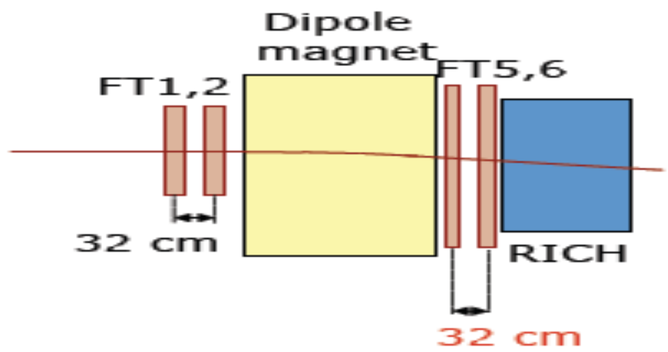
In the FTS 3 the trajectory
is bent by the magnetic field

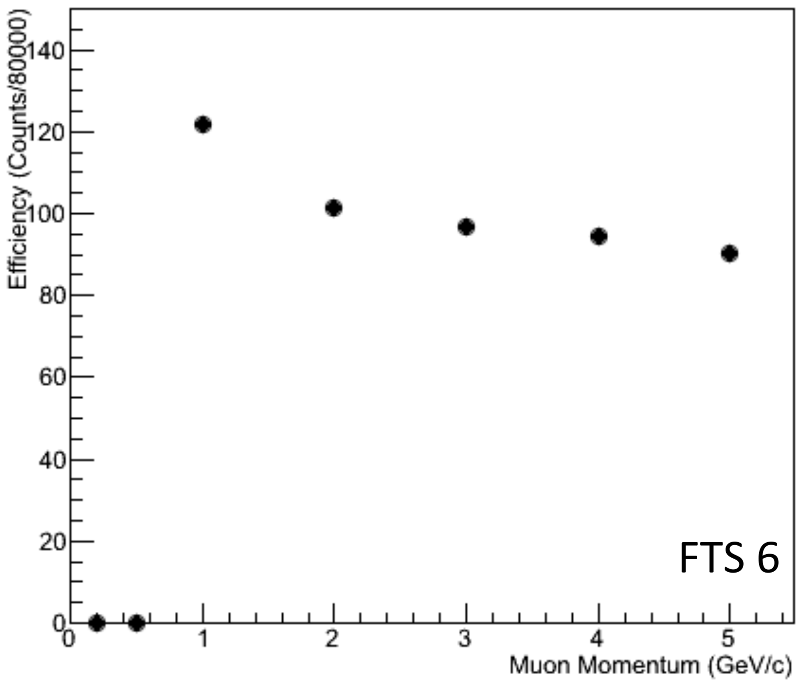
Geometry v1
(Rich between FTS 5 and FTS 6)





Geometry v2
(FTS 5 close to FTS 6)



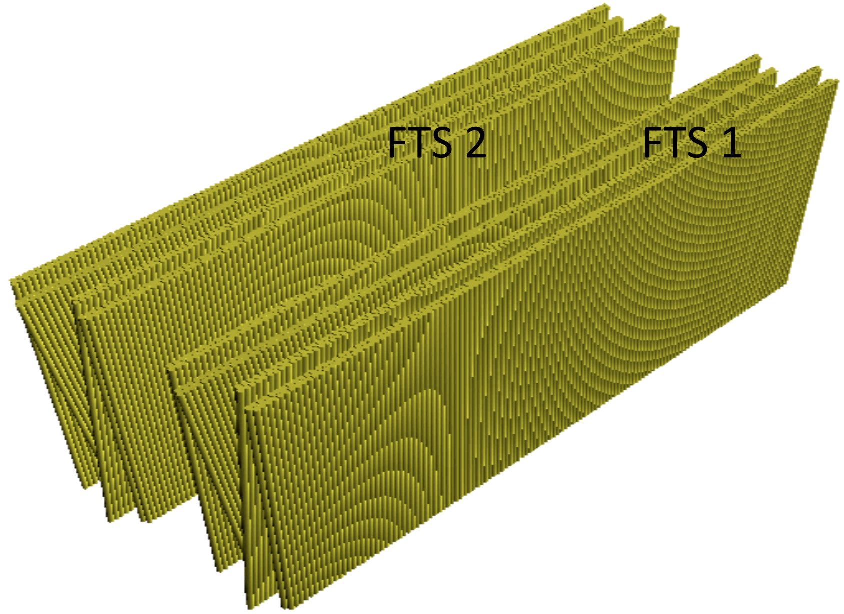


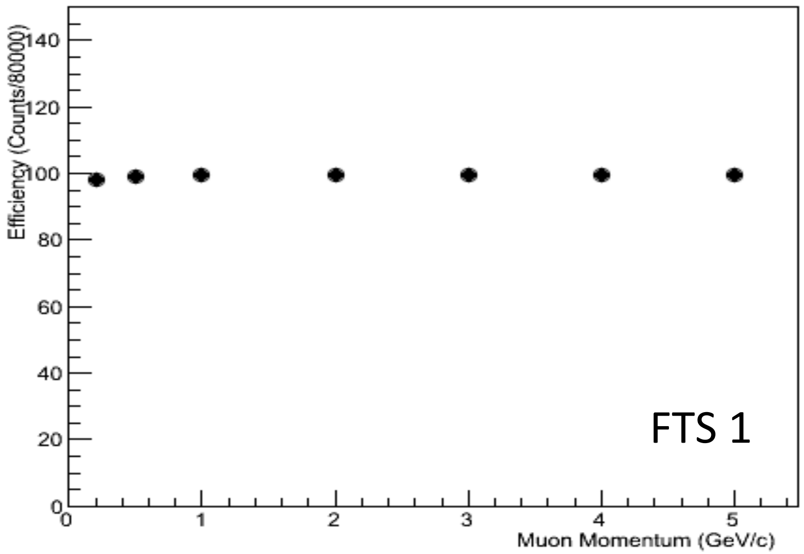
No big differences between the two geometry configurations.
Maximum difference:
With the geometry v2 we lose a 5% of hits for muon at 5 GeV/c

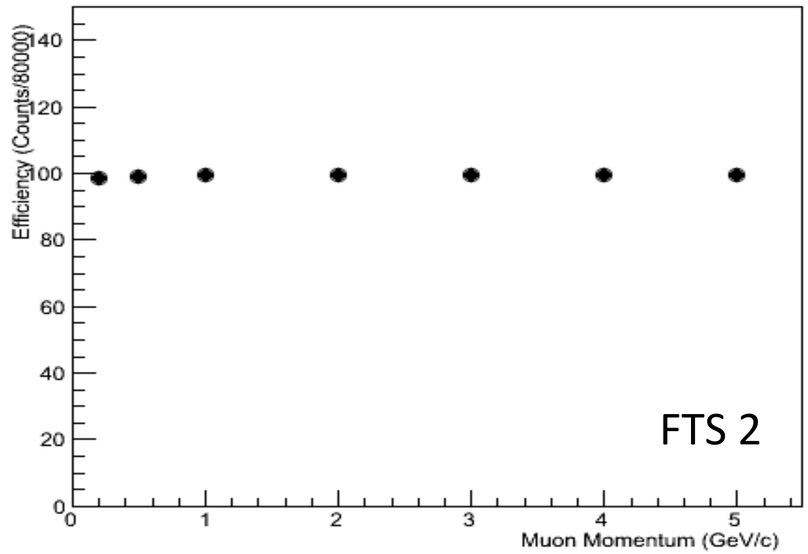
Our acceptance is around 70%
for **the first two stations**
(for momentum higher than 1 GeV)
Where we lose 30% of events?

From the figures of slides 6-9 we can see a loss of events in the **beam pipe.**

In order to check it, we implement a new version of the geometry where FTS 1 and FTS 2 have not the hole for the beam pipe.







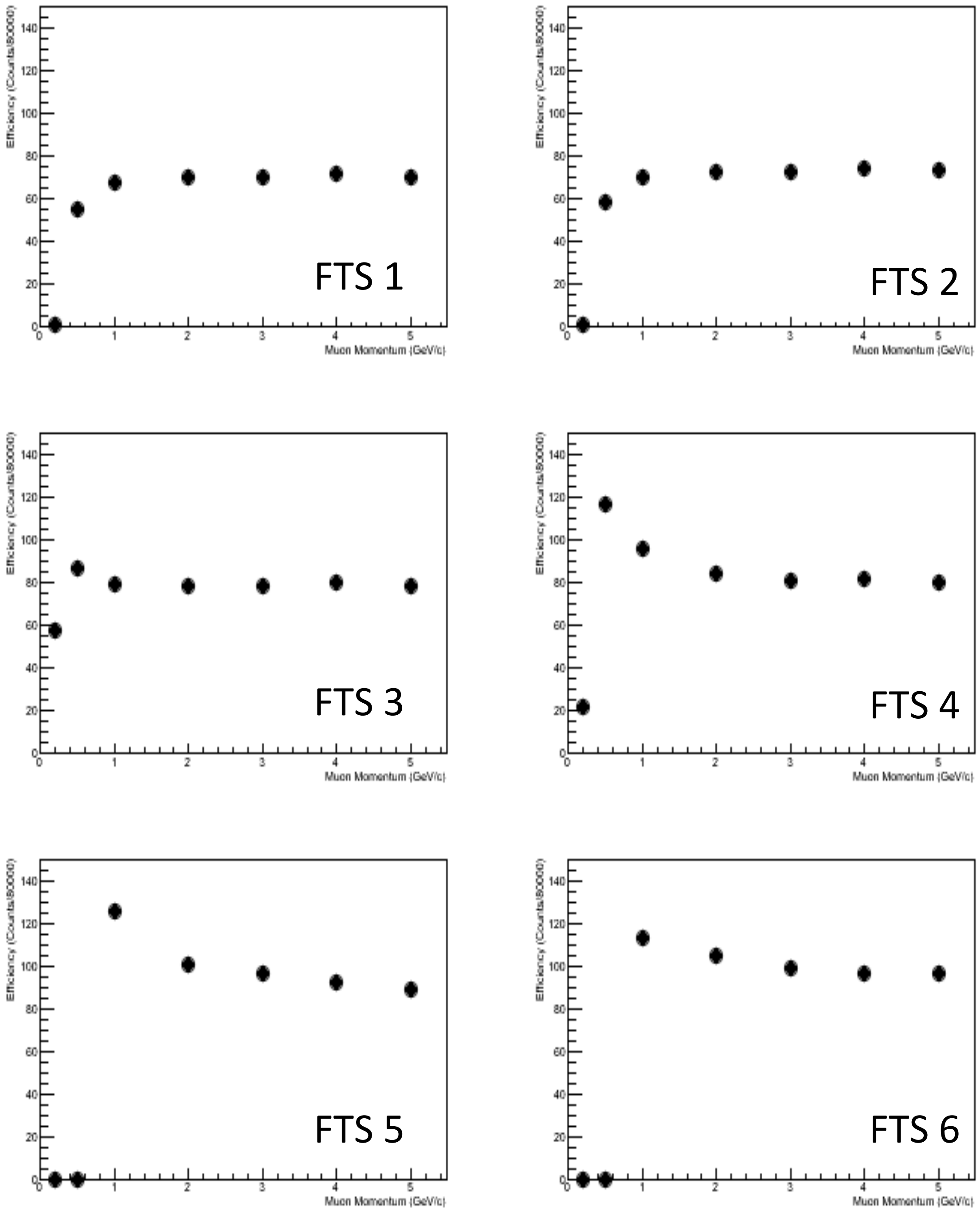
The acceptance with this configuration is around 100%.
So we lose around 30% of events in the hole of the beam pipe

Strategy:

- BoxGenerator is used for the simulation
- 10.000 Muons simulated with different momentum:
  200 MeV, 500 MeV, 1 GeV, 2 GeV, 3 GeV, 4 GeV, 5 GeV
- Uniformly in phi: [0,360°]
- Uniformly in theta: [0.1,5°]
- Only primary tracks are selected
- Energy losses included
- Detectors included: FTS and RICH
- Pandaroot Version 17805 (includes last geometry version of FTS and RICH. Last version of beam pipe)

How results are affected by the multiple scattering?

SIMULATION: MULTIPLE SCATTERING EXCLUDED



Geometry v1
(Rich between FTS 5 and FTS 6)

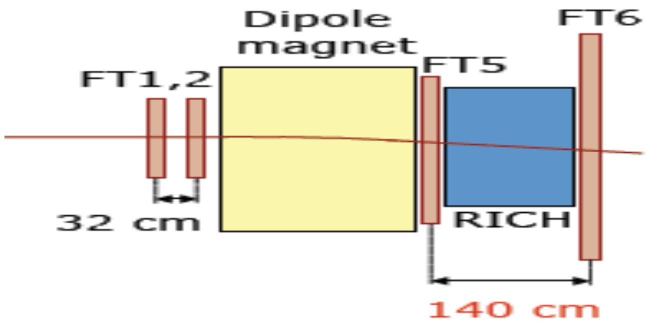
The number of hits decreases substantially for muons at 200 and 500 MeV, with respect to the simulation where the multiple scattering is included.

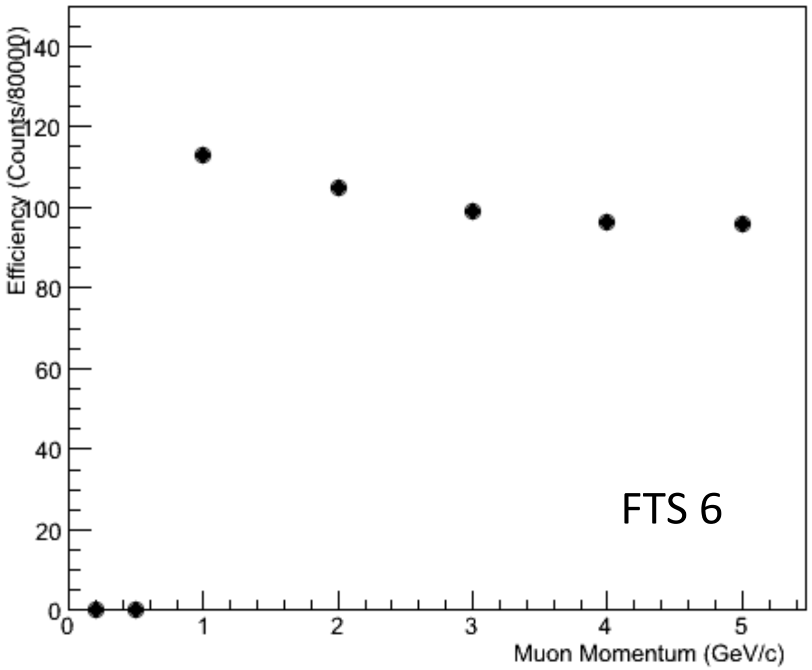
Instead, for higher muon's momentum, the situation is unchange.

So, the multiple scattering effect is more visibile at **low muon's momentum.**

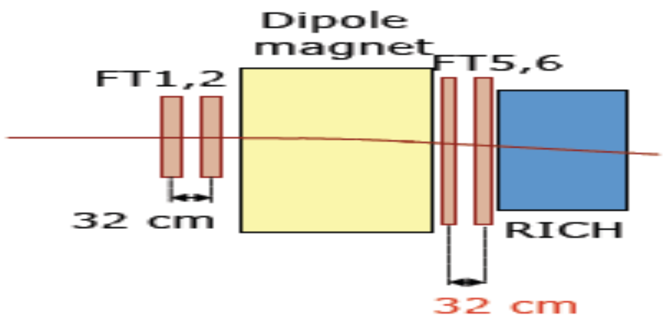
Since in our simulation we include only the geometry of FTS and of the beam pipe, we expect that muons make multiple scattering with the FTS tubes and with the beam pipe.

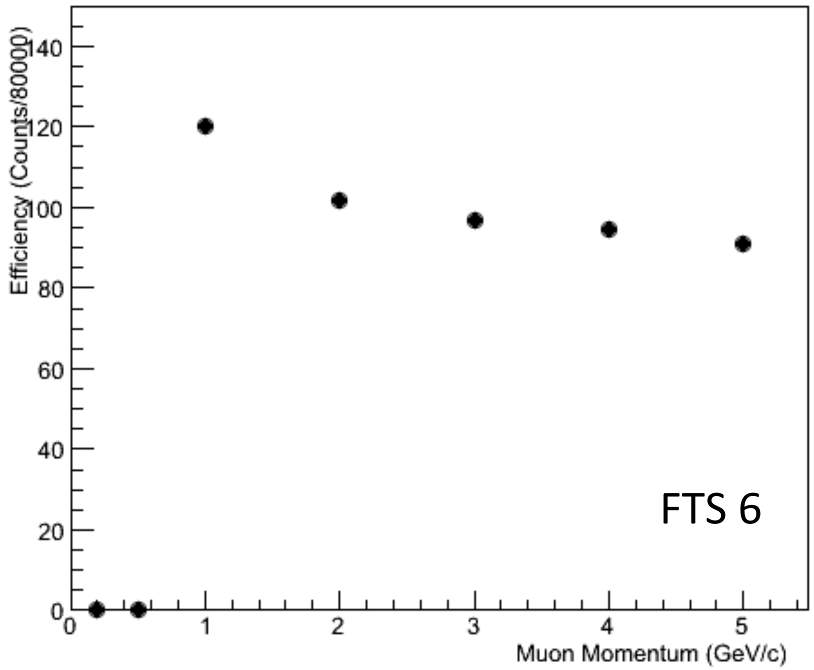
Geometry v1
(Rich between FTS 5 and FTS 6)





Geometry v2
(FTS 5 close to FTS 6)





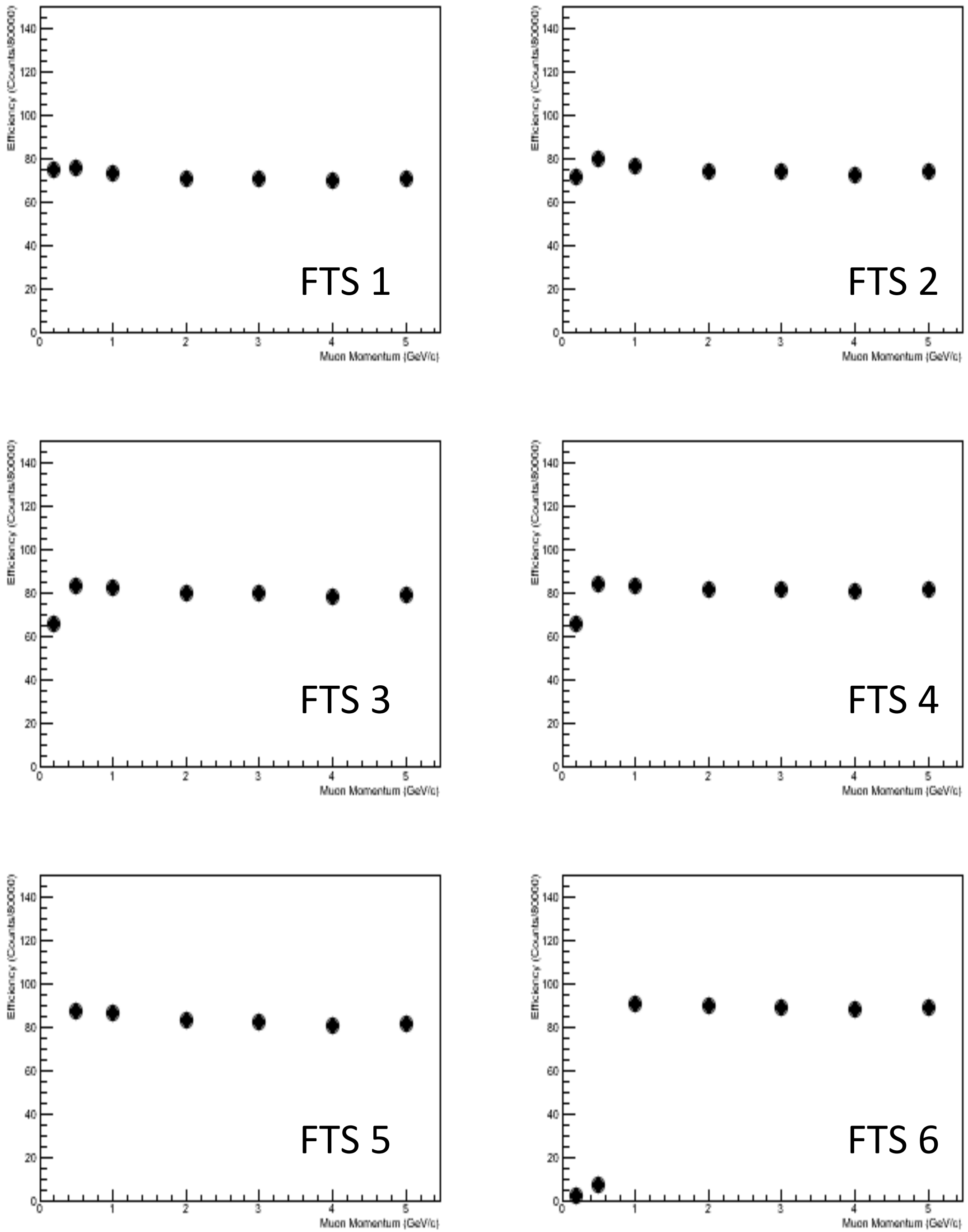
No big differences between the two geometry configurations.
Maximum difference:
With the geometry v2 we lose a 5% of hits for muon at 5 GeV/c

Strategy:

- BoxGenerator is used for the simulation
- 10.000 Muons simulated with different momentum:
  200 MeV, 500 MeV, 1 GeV, 2 GeV, 3 GeV, 4 GeV, 5 GeV
- Uniformly in phi: [0,360°]
- Uniformly in theta: [0.1,5°]
- Only primary tracks are selected
- Multiple scattering and energy losses included
- Detectors included: FTS and RICH
- Pandaroot Version 17805 (includes last geometry version of FTS and RICH. Last version of beam pipe)

How results are affected by the magnetic field?

SIMULATION: (DIPOLE AND SOLENOID) MAGNETIC FIELD OFF

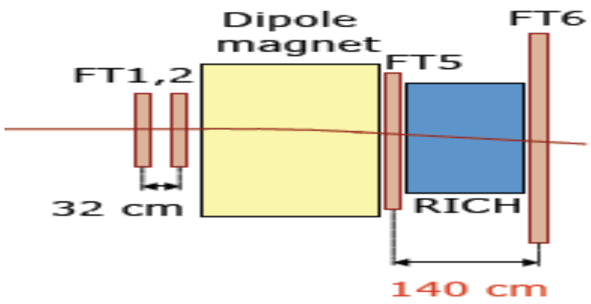


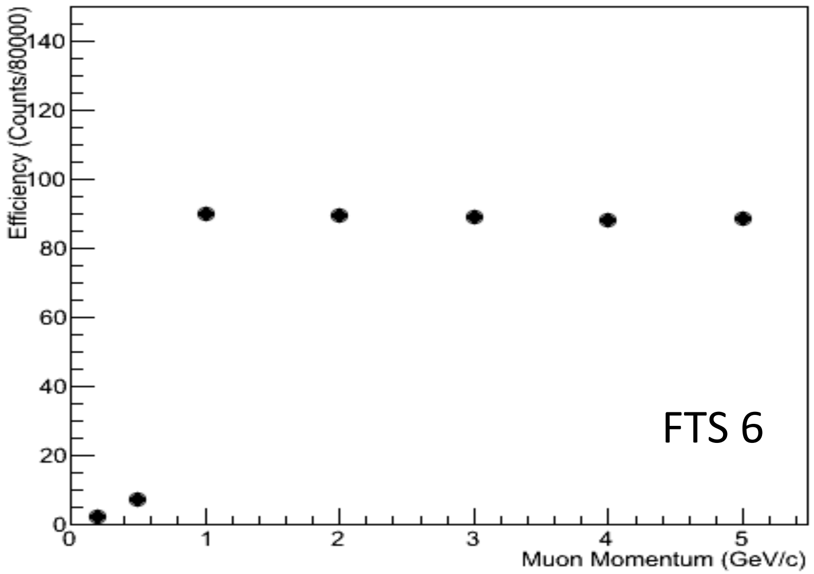
Geometry v1
(Rich between FTS 5 and FTS 6)

The number of hits increases substantially for muons at 200 and 500 MeV, for the first two stations, with respect to the simulation where the magnetic field is on.

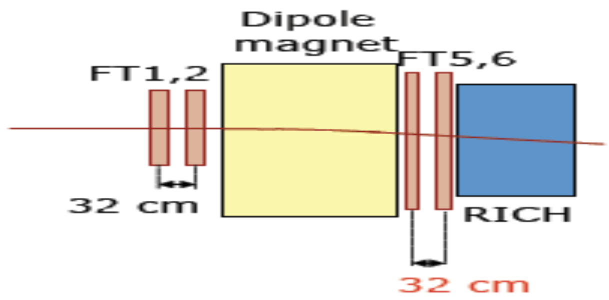
We **don't have anymore efficiency higher than 100%** (as shown at slide 10)

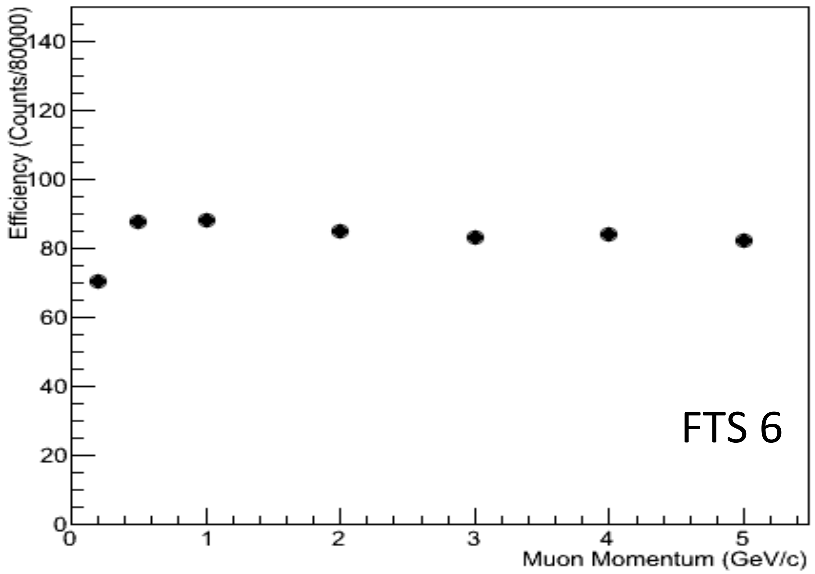
Geometry v1
(Rich between FTS 5 and FTS 6)





Geometry v2
(FTS 5 close to FTS 6)





The big difference is at very low muon's momentum (0.200 GeV/c and 0.500 GeV/c): in the first geometry configuration, the majority of muons are stopped inside the RICH and doesn't reach the last station.

For muon's higher momentum, with the geometry v2 configuration, we lose around 4% of events

Resolution Studies

Aim:

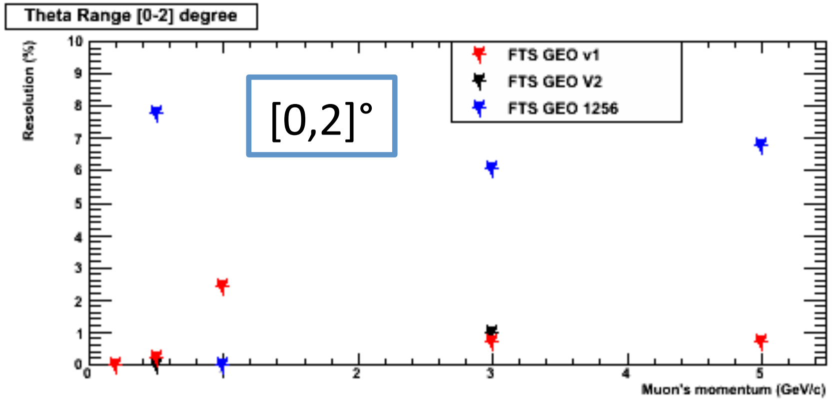
Study the momentum resolution for the forward tracking stations in this way:

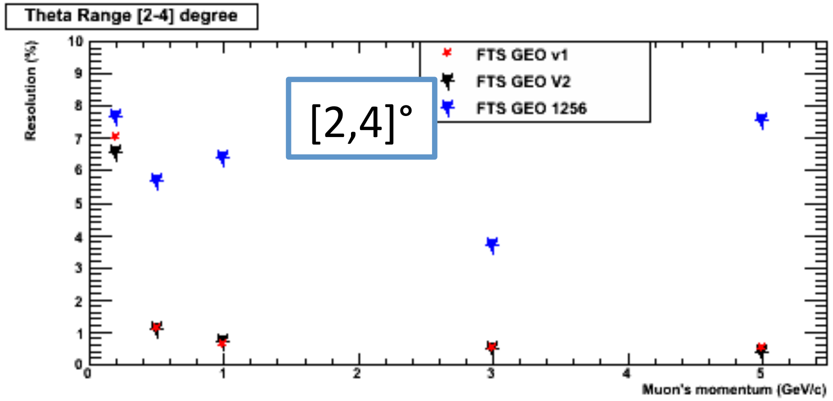
- Look at the variable “(Reconstructed Momentum – MC Momentum)/ MC Momentum”
- Fit the distribution and extract the sigma value.

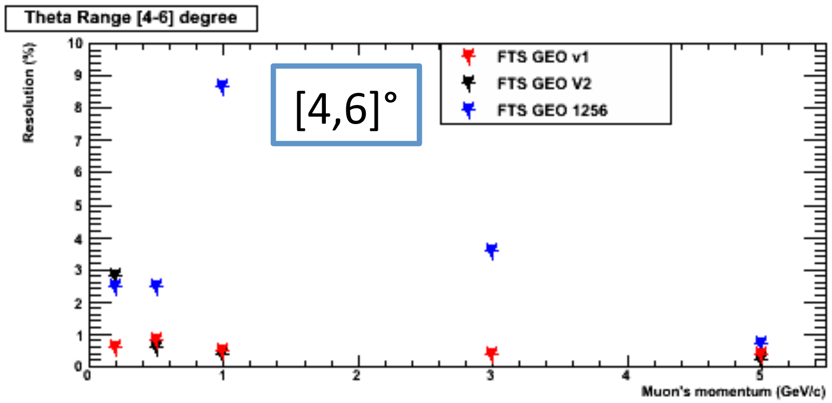
Strategy:

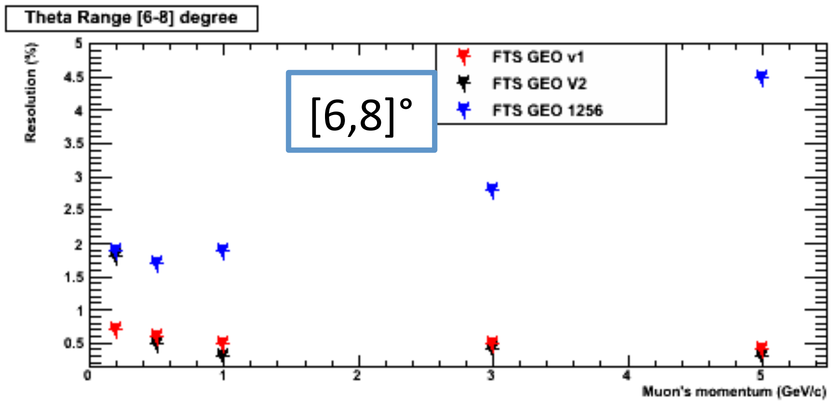
- BoxGenerator is used for the simulation
- 10.000 Muons simulated with different momentum:
  200 MeV, 500 MeV, 1 GeV, 3 GeV, 5 GeV
- Uniformly in phi: [0,360°]
- Uniformly in theta: [0,2°], [2,4]°, [4,6]°, [6,8]°, [8,10]°,
- Only primary tracks are selected
- Multiple scattering and energy losses included
- All Detectors included
- Only forward Tracks selected
- Pandaroot Version 17936

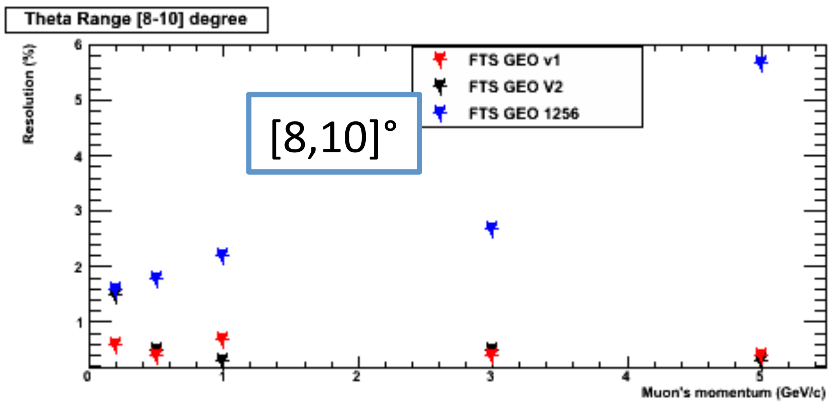
All the results combined together. X axis: Momentum; Y axis: Resolution (%)







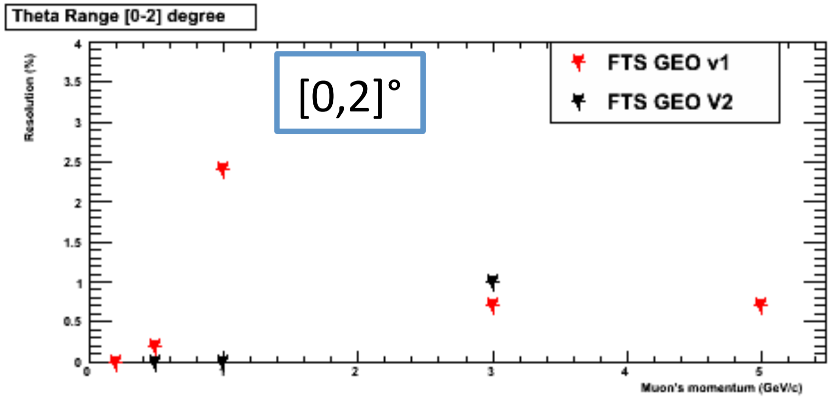


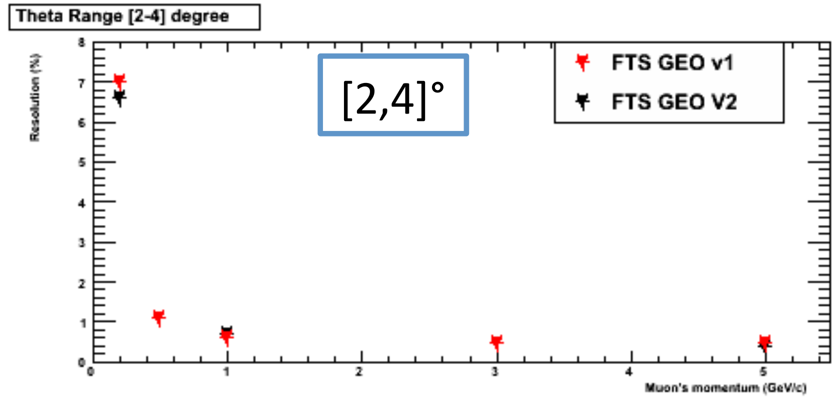


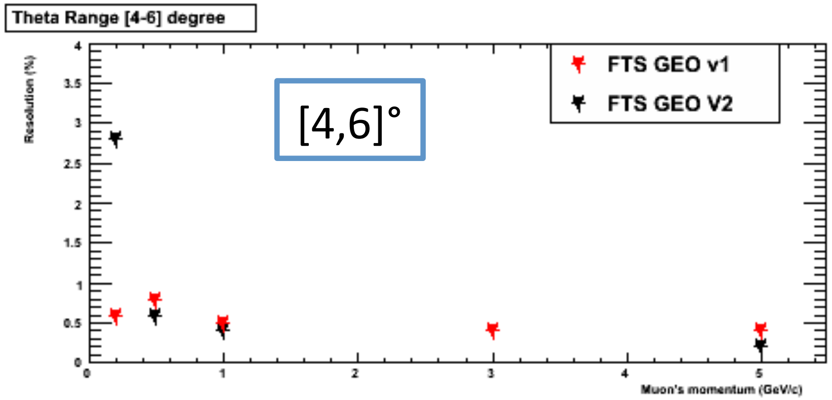
FTS GEO 1256 seems to give the worse resolution values than the other two geometry version, in particular for low momentum particle (i.e. lower than 3 GeV)

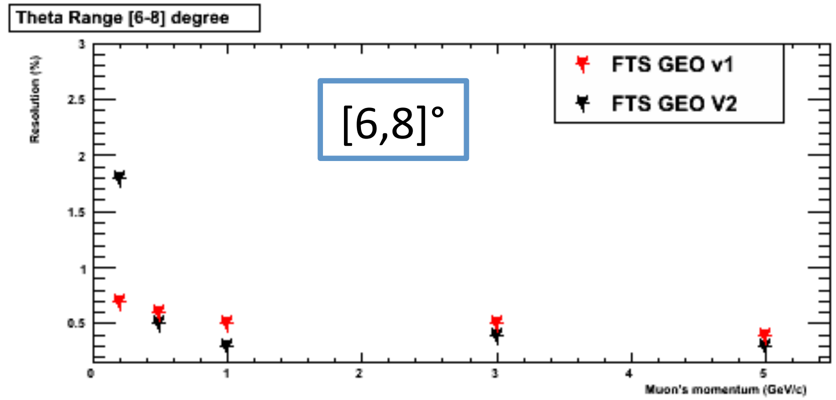
From this study seems that the **FTS3 and FTS4** (stations inside the dipole) **help us in the reconstruction of low momentum tracks.**

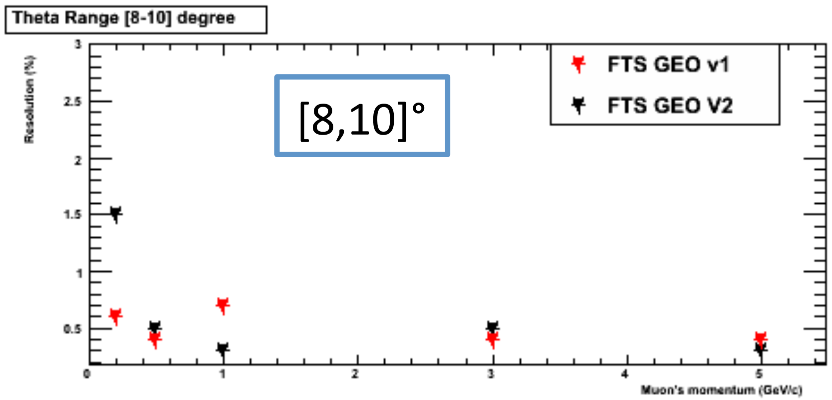
Zoom – Only geometry version 1 and 2 (RICH before, RICH after)











From this study the two geometry versions (V1 and V2) seem to be equivalent

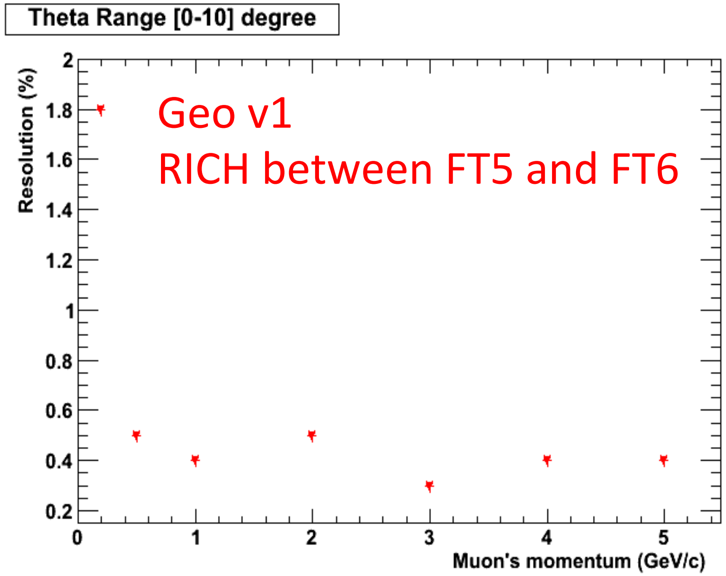
Aim:

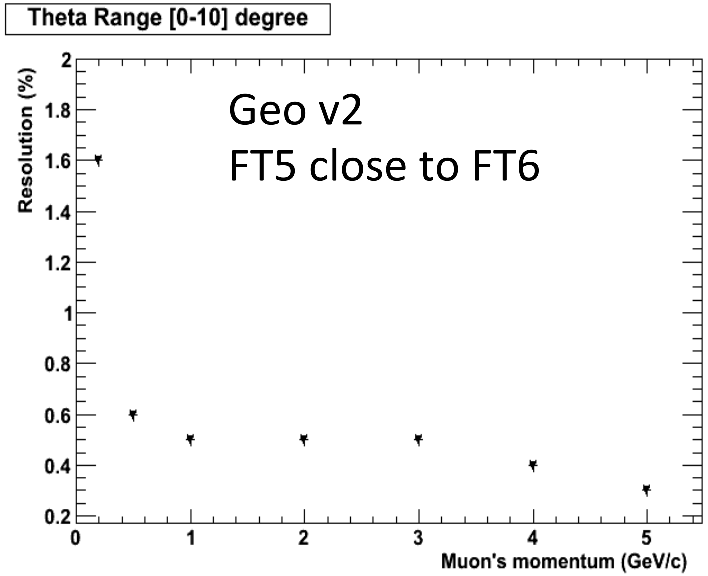
Study the momentum resolution for the forward tracking stations,
Looking at the variable "(Reconstructed Momentum – MC Momentum)/ MC Momentum"

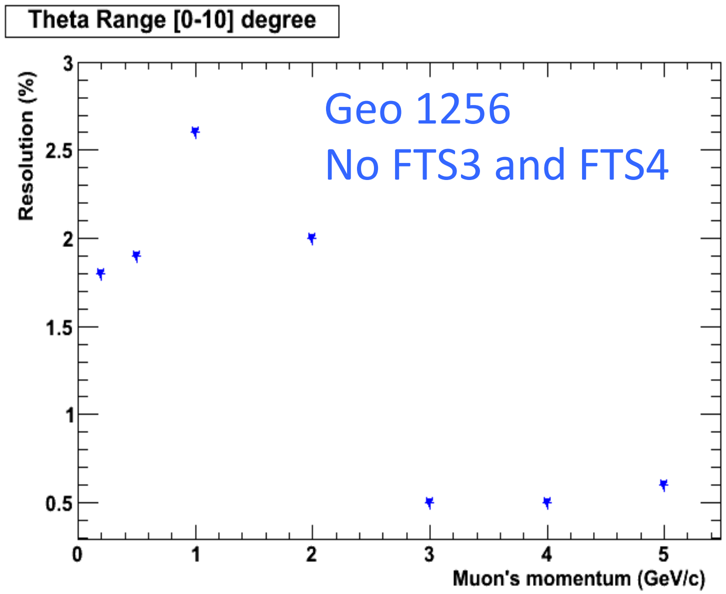
Strategy:

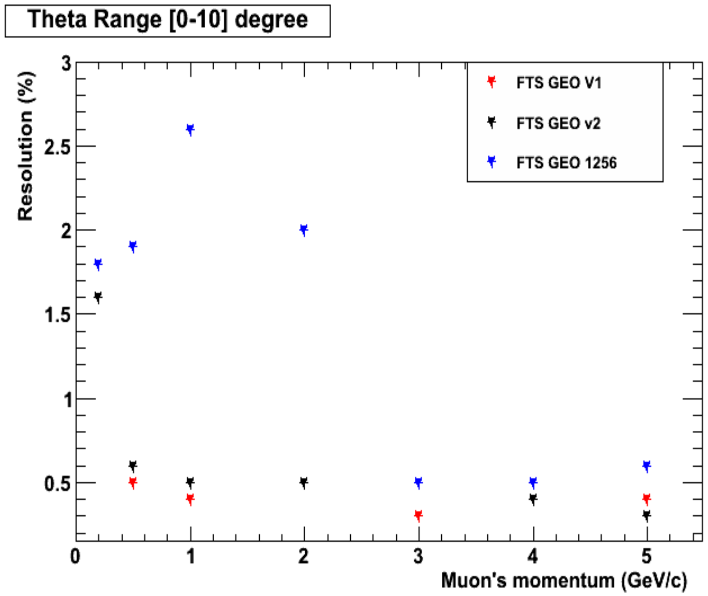
- BoxGenerator is used for the simulation
- 10.000 Muons simulated with different momentum:
  200 MeV, 500 MeV, 1 GeV, 2 GeV, 3 GeV, 4 GeV, 5 GeV
- Uniformly in phi: [0,360°]
- Only primary tracks are selected
- Multiple scattering and energy losses included
- All Detectors included
- Only forward Tracks selected
- Pandaroot Version 17936

Theta Range [0-10°]









FTS GEO 1256 seems to give the worse resolution values than the other two geometry version, in particular for low momentum particle (i.e. lower than 2 GeV)

From this study seems that the **FTS3 and FTS4** (stations inside the dipole) **help us in the reconstruction of low momentum tracks.**

For low momentum **FTS GEO V1** seems to give better resolution values,
Instead for high momentum the **GEO V1** and **GEO V2** seems to be equivalent

PLANS FOR FERRARA PANDA GROUP

1) Continue the resolution studies for:
- Only FTS in order to isolate the contamination in terms of resolution coming from MVD and GEM
- Different skew angles
- Different beam momentum (different field)
- ……

2) Thanks to Paul Buehler, we are running on the GRID pantip->2($\pi^+\pi^-$) benchmark channel. We hope to show you, as soon as possible, the results of this analysis with a large amount of data.

3) …..

THANKS FOR YOUR ATTENTION!

Merry Christmas
to everybody!