Central Tracker Benchmark: $\bar{p}p \longrightarrow n(\pi^+\pi^-)$ (n=1,2)

Elisa Fioravanti

INFN Ferrara

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Outline

- Kinematics of the reaction
- Data simulation
- Analysis
  - $\bar{p}p \longrightarrow \pi^+\pi^-$
  - $\bar{p}p \longrightarrow \pi^+\pi^-\pi^+\pi^-$
- Outlook

Kinematics of the reaction

Multipion analysis is relevant for Central Tracker study in order to compare the two detector setup. In particular the interesting figures of merit are:

- Invariant mass resolution of $\pi^+\pi^-$ and $\pi^+\pi^-\pi^+\pi^-$
- Reconstruction efficiency of $\bar{p}p \longrightarrow \pi^+\pi^-$ and $\bar{p}p \longrightarrow \pi^+\pi^-\pi^+\pi^-$
- Single pion tracks resolution

Energy in the center of mass system: 3.07 GeV; p_z=4.0 GeV

Cross section reference from: V. Flaminio, CERN-HERA 84-01:
- $\bar{p}p \longrightarrow \pi^+\pi^-$: σ=0.007 mb at $E_{CM} = 3.07$ GeV
- $\bar{p}p \longrightarrow \pi^+\pi^-\pi^+\pi^-$: σ=0.43 mb at $E_{CM} = 2.954$ GeV

Data simulation

- Event generation is performed with EvtGen event generator using PHSP decay model
- MonteCarlo simulation, digitalization and reconstruction is performed within pandaroot framework
- PID is based on MonteCarlo Truth information
- 100.000 events were produced on the grid with STT and TPC (no event mixing).

Analysis

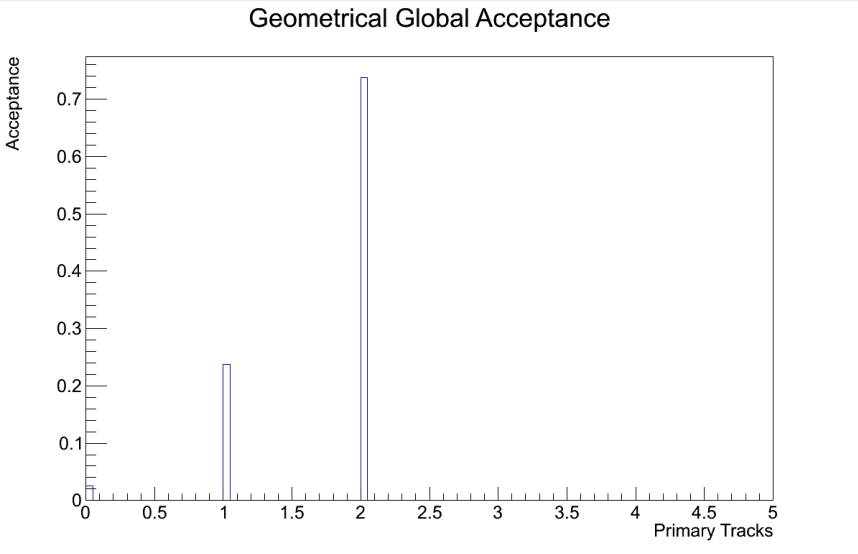
- Analysis is performed with rho package
- No background suppression is studies
- Events with 2.07 GeV $< m(\pi^+\pi^-) <$ 4.07 GeV are selected
- Events with 2.57 GeV $< m(\pi^+\pi^-\pi^+\pi^-) <$ 3.57 GeV are selected
- Vertex fit is performed and best candidate in each event is selected by minimal χ^2

$$\bar{p}p \longrightarrow \pi^+\pi^-$$

Geometrical acceptance

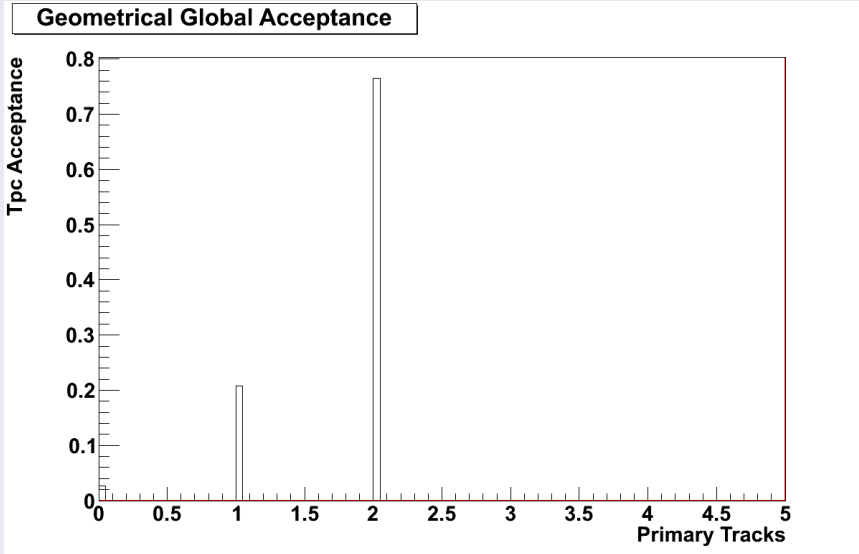
Estimation is done based on MonteCarlo simulation. Track is considered to be within acceptance of detector if it creates at least one MonteCarlo hit.

STT



Geometrical STT acceptance: 74%

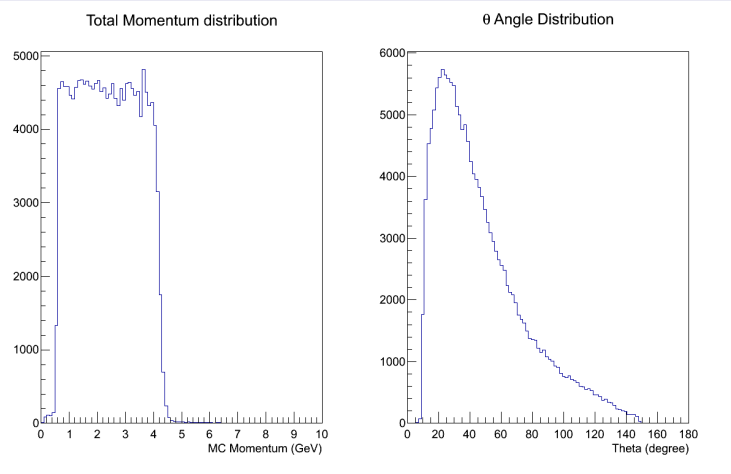
TPC

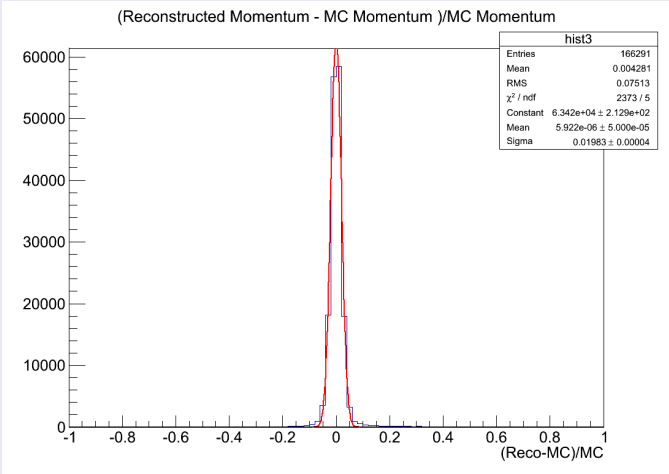


Geometrical TPC acceptance: 77%

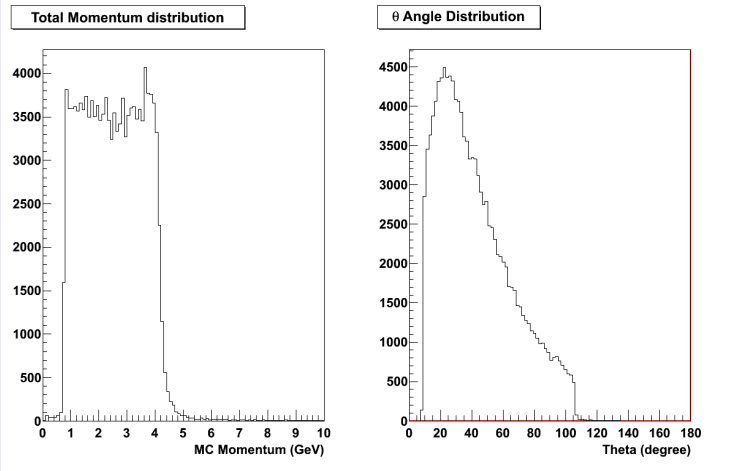
Single pion track reconstruction

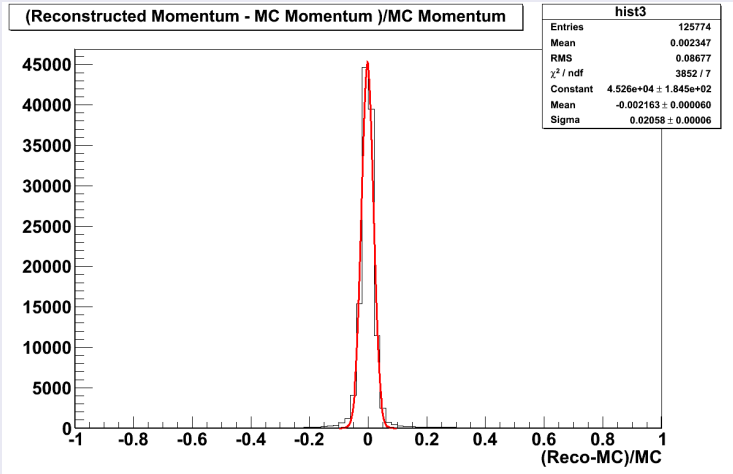
STT





TPC

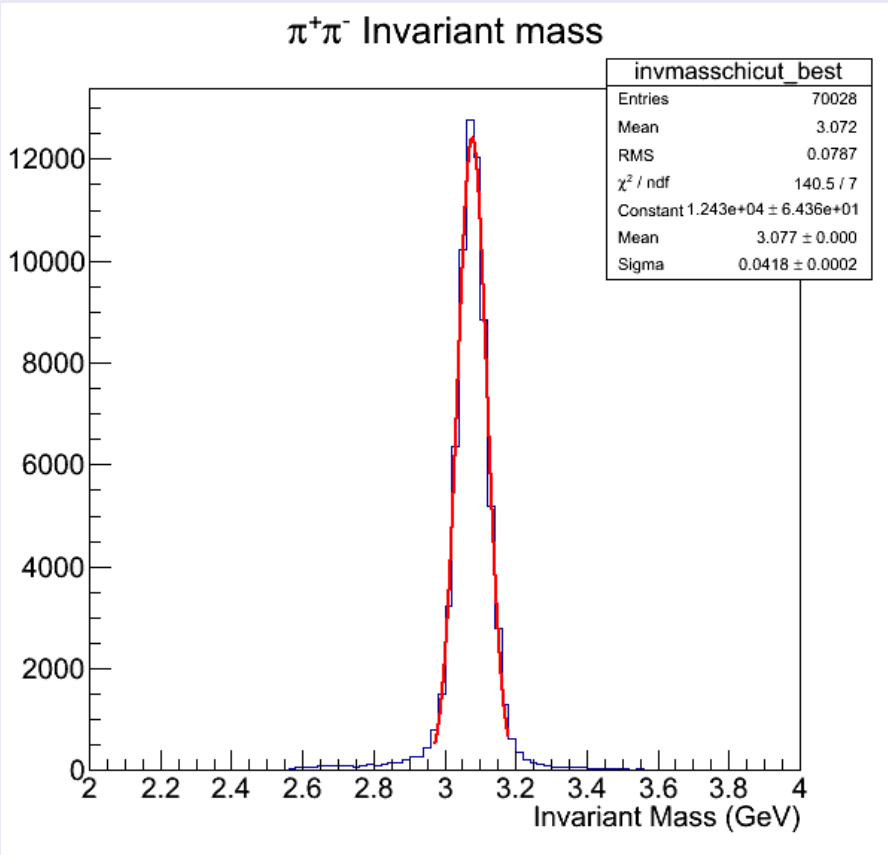




Single pion track resolution: STT 2.0% - TPC 2.1%

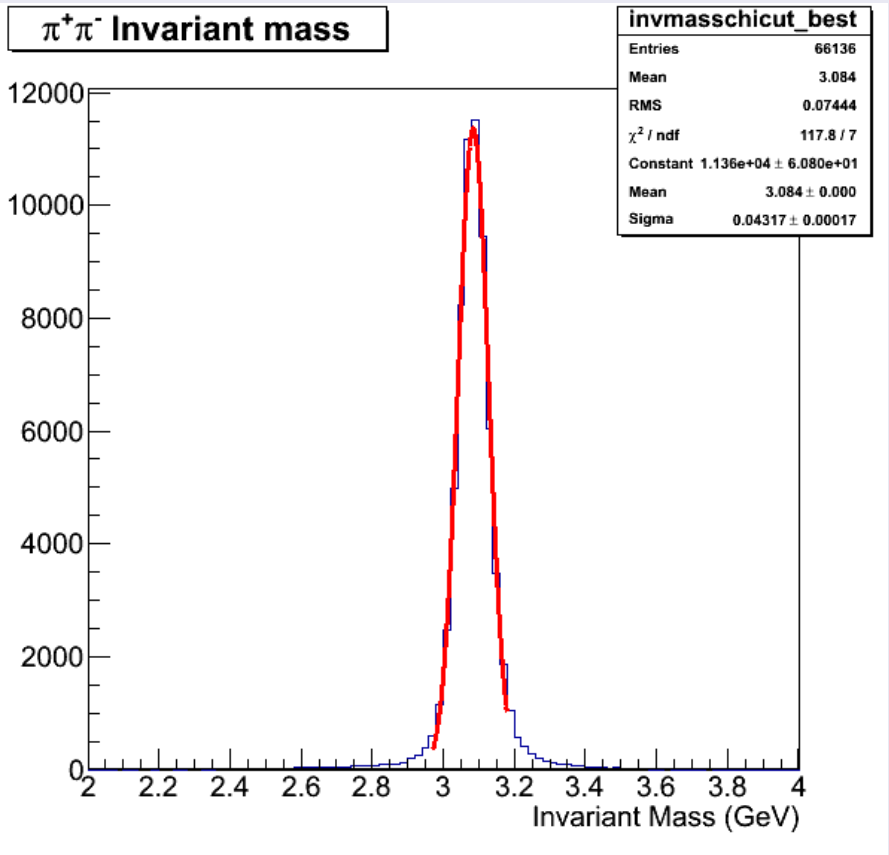
Invariant mass distribution

STT



Resolution: 41.8±0.2 MeV
Efficiency (70.4±0.3)%

TPC



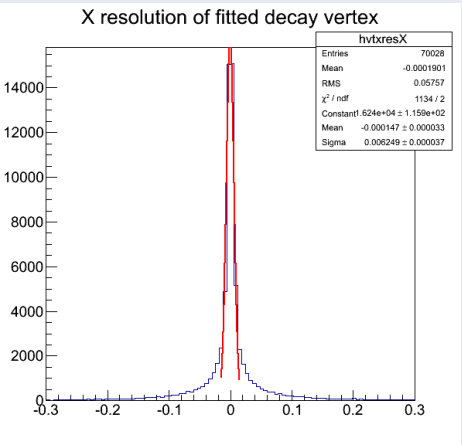
Resolution: 43.2±0.2 MeV
Efficiency (70.7±0.3)%

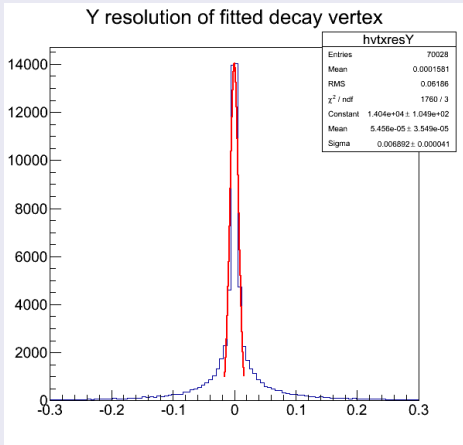
Efficiency=Number of reconstructed events/ number of generated events.

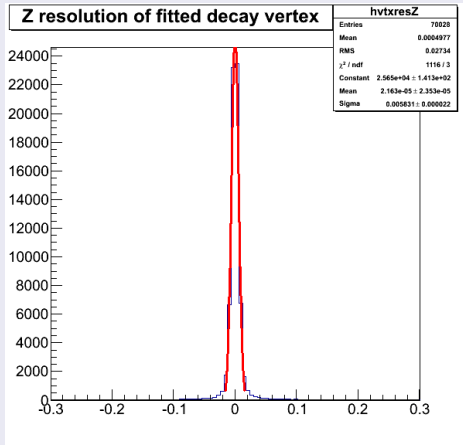
This results are obtained with different cuts/requirements on the minimal track lengths in the STT/TPC

Vertex resolution

STT

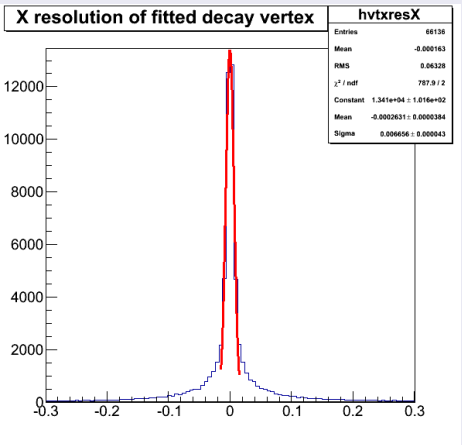


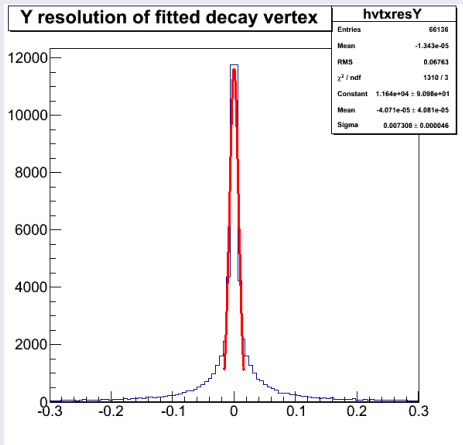


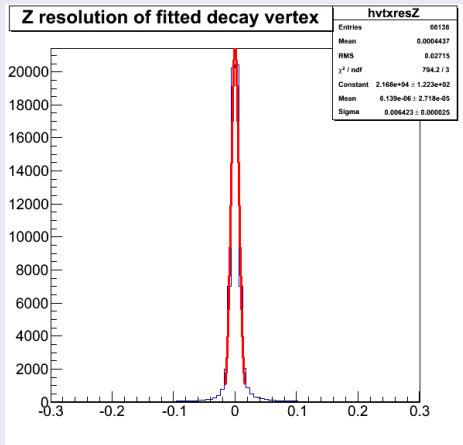


σ_x :62.5 μm; σ_y :68.9 μm; σ_z :58.3 μm;

TPC



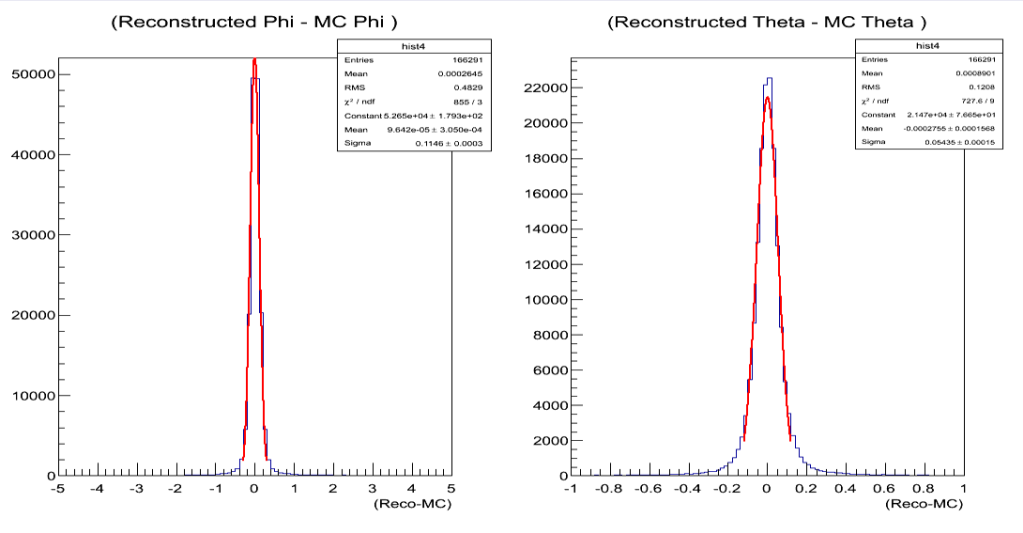




σ_x :66.6 μm; σ_y :73.1 μm; σ_z :64.2 μm;

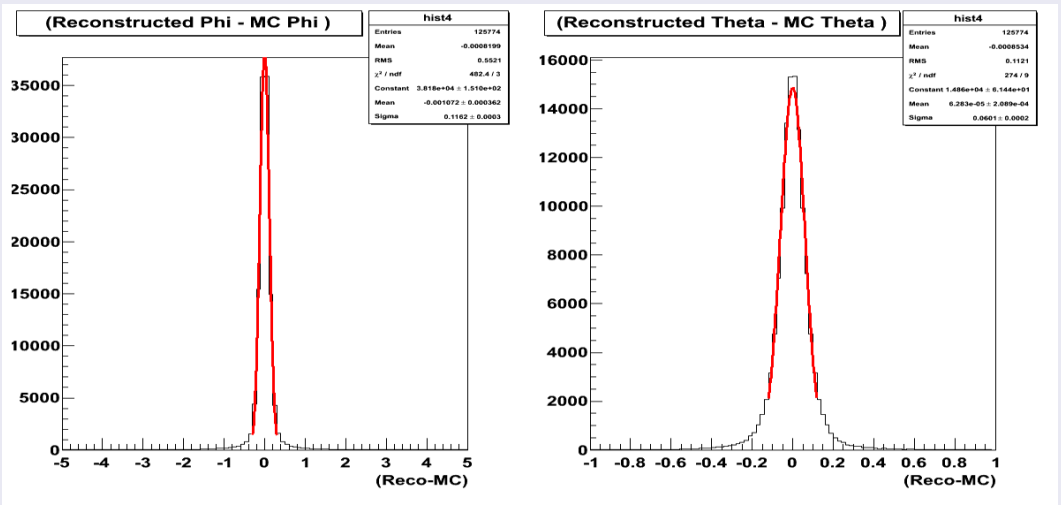
θ, ϕ resolution

STT



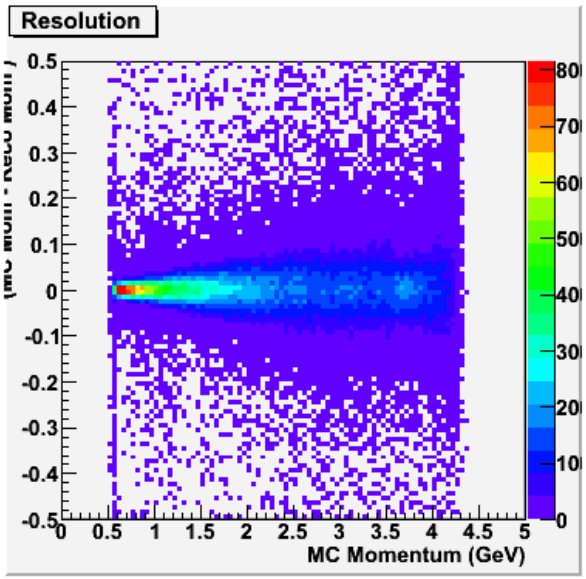
$\sigma(\theta)$=0.115°; $\sigma(\phi)$=0.054°

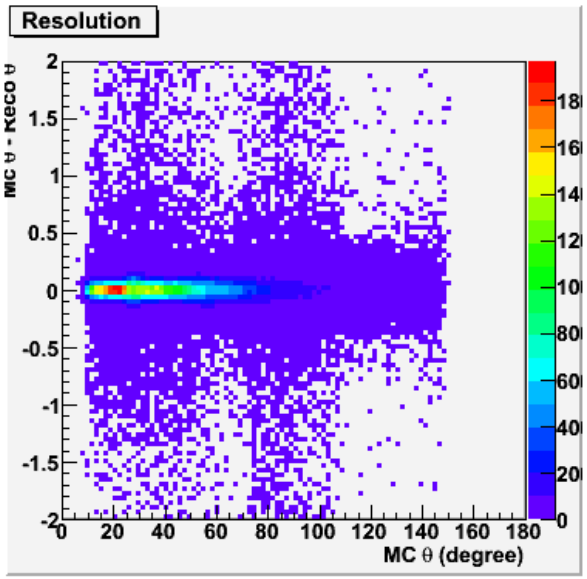
TPC

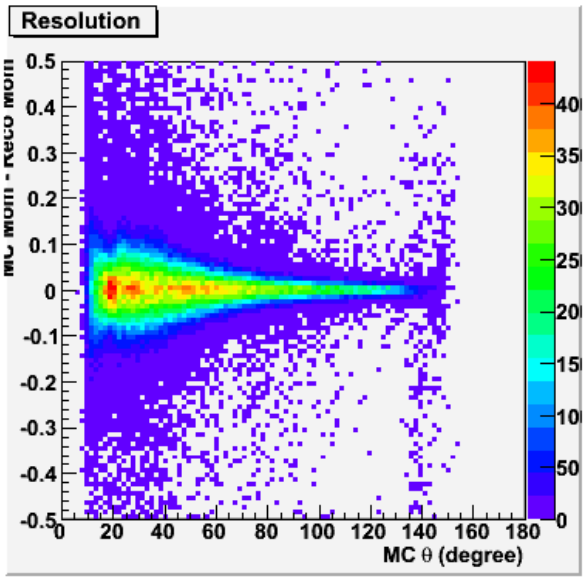


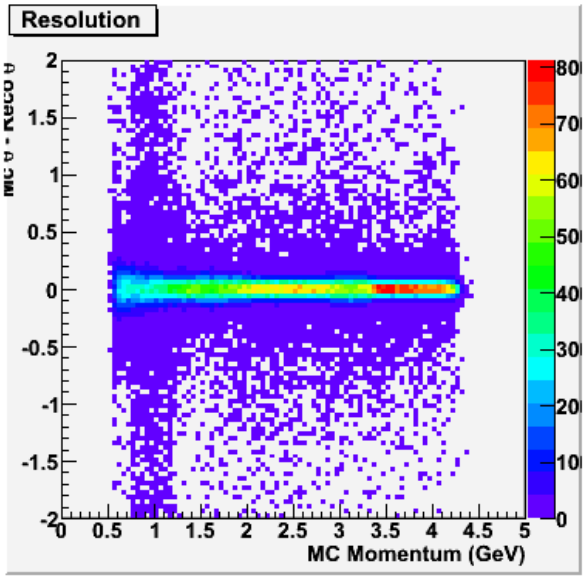
$\sigma(\theta)$=0.118°; $\sigma(\phi)$=0.060°

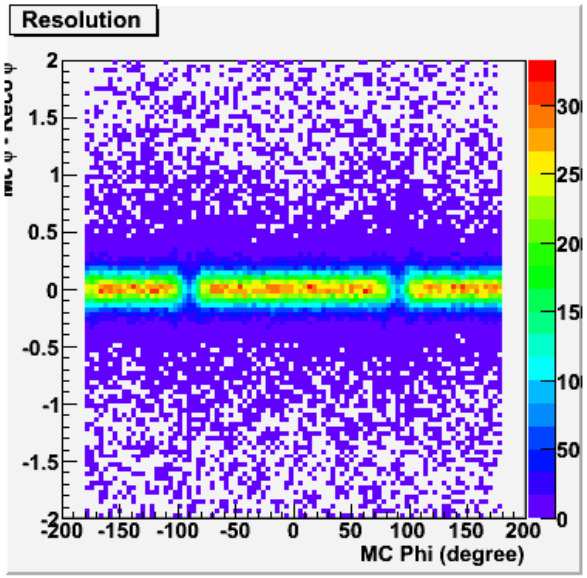
STT - Resolution



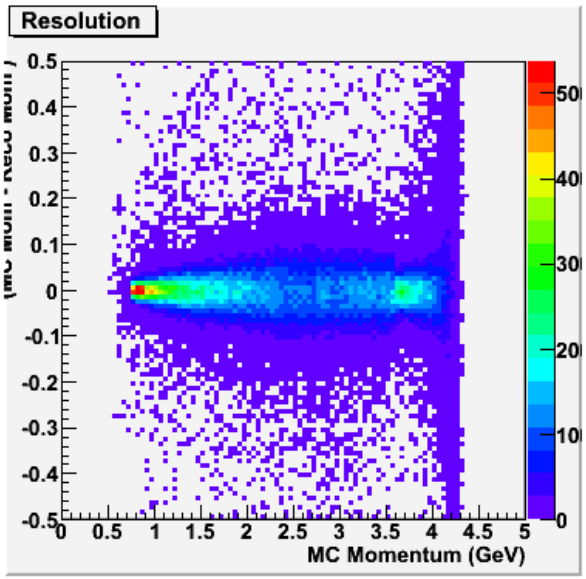


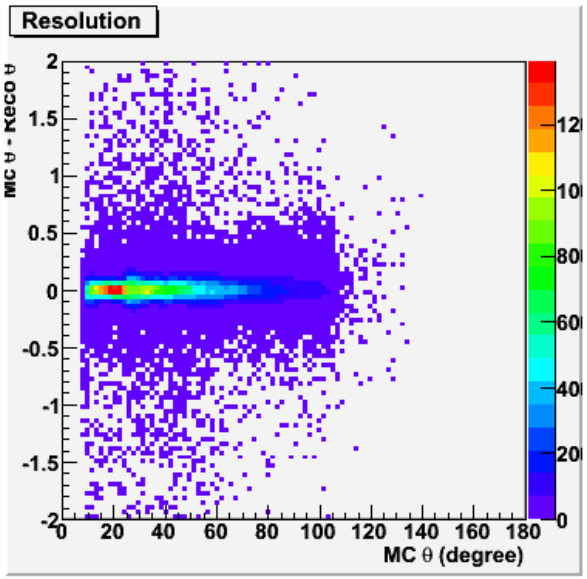


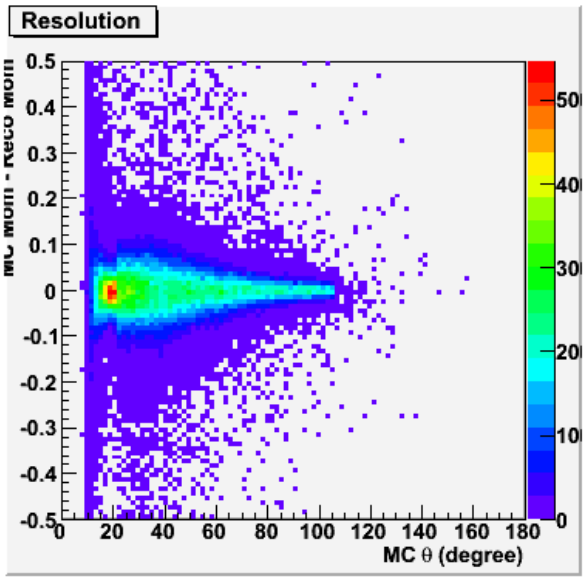


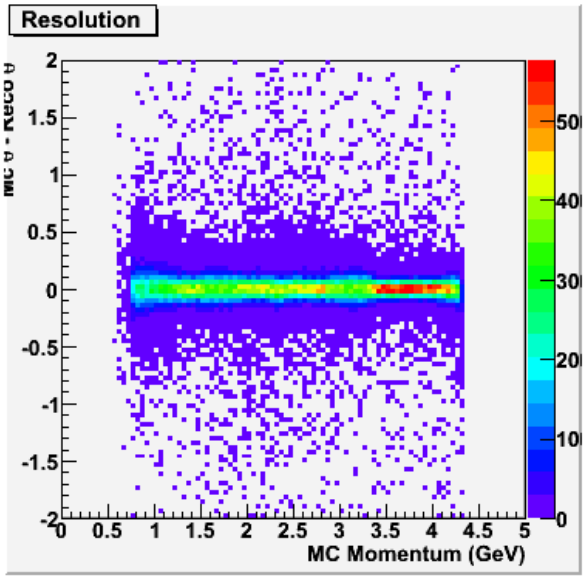


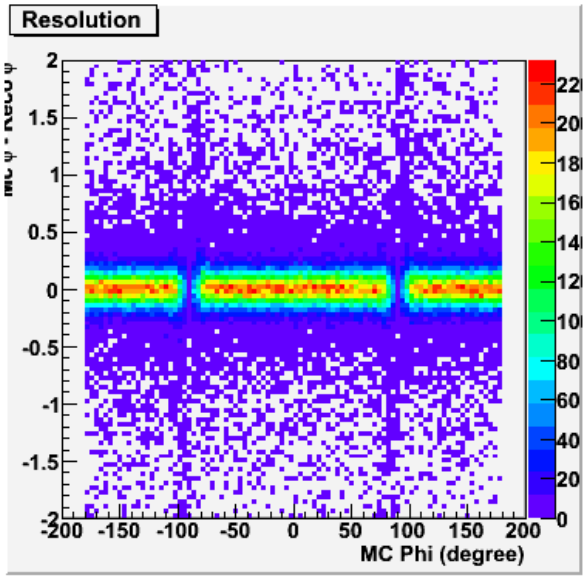
TPC - Resolution









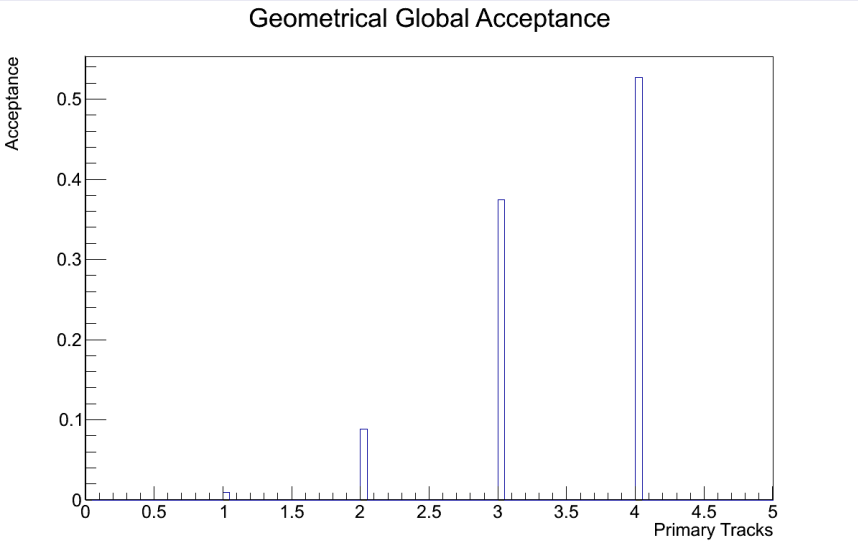


$$\bar{p}p \longrightarrow \pi^+\pi^-\pi^+\pi^-$$

Geometrical acceptance

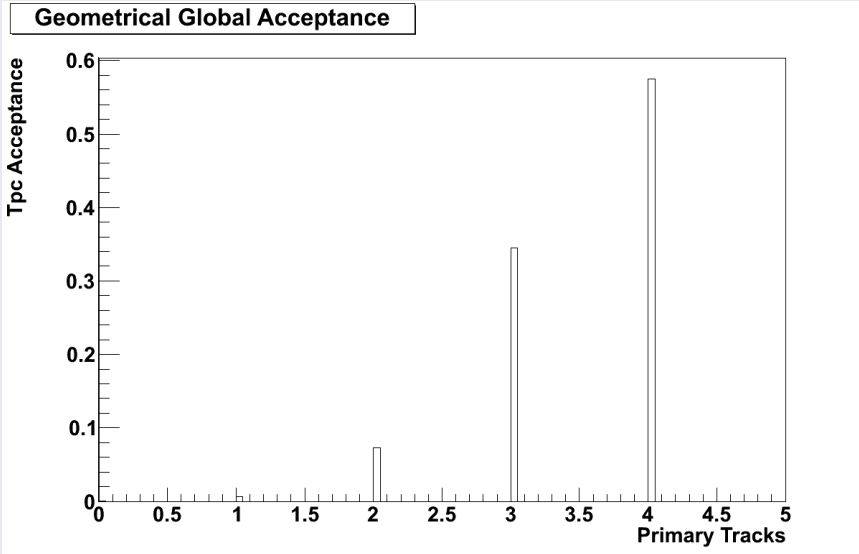
Estimation is done based on MonteCarlo simulation. Track is considered to be within acceptance of detector if it creates at least one MonteCarlo hit.

STT



Geometrical STT acceptance: 52%

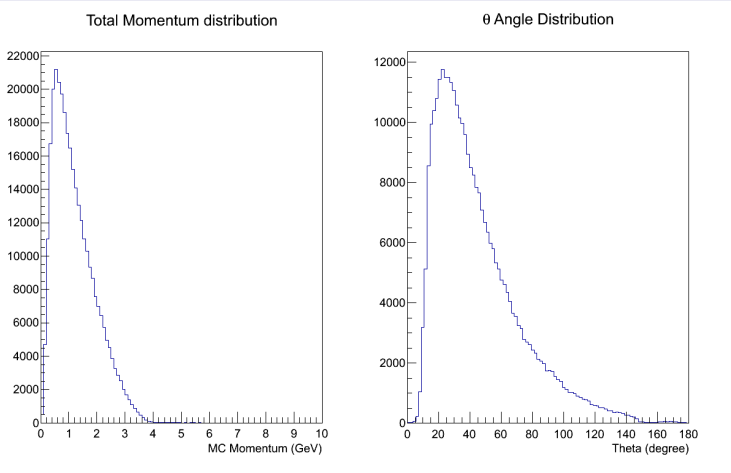
TPC

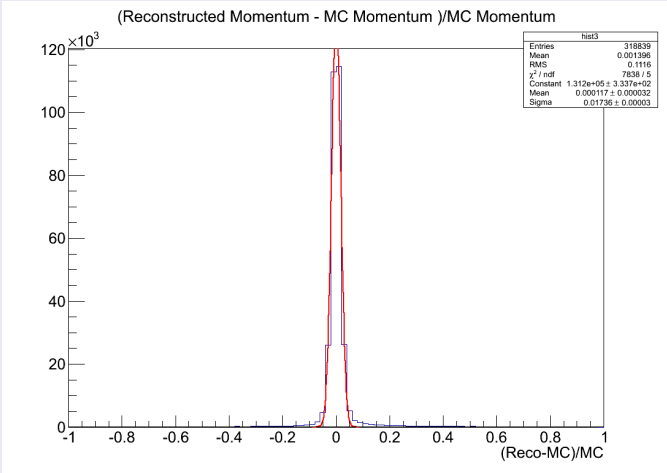


Geometrical TPC acceptance: 58%

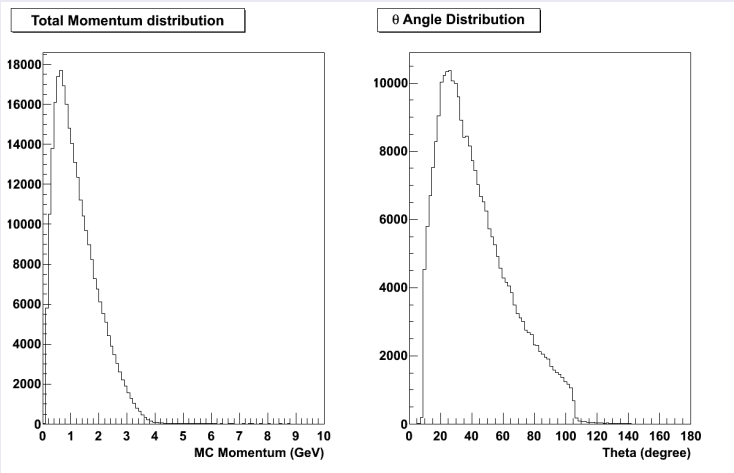
Single pion track reconstruction

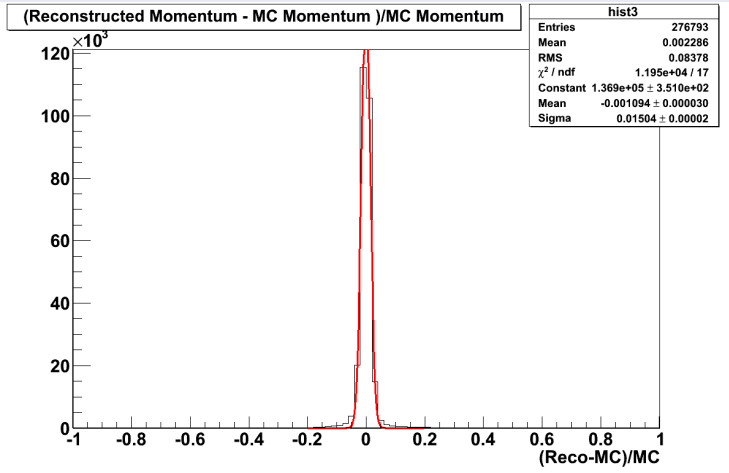
STT





TPC

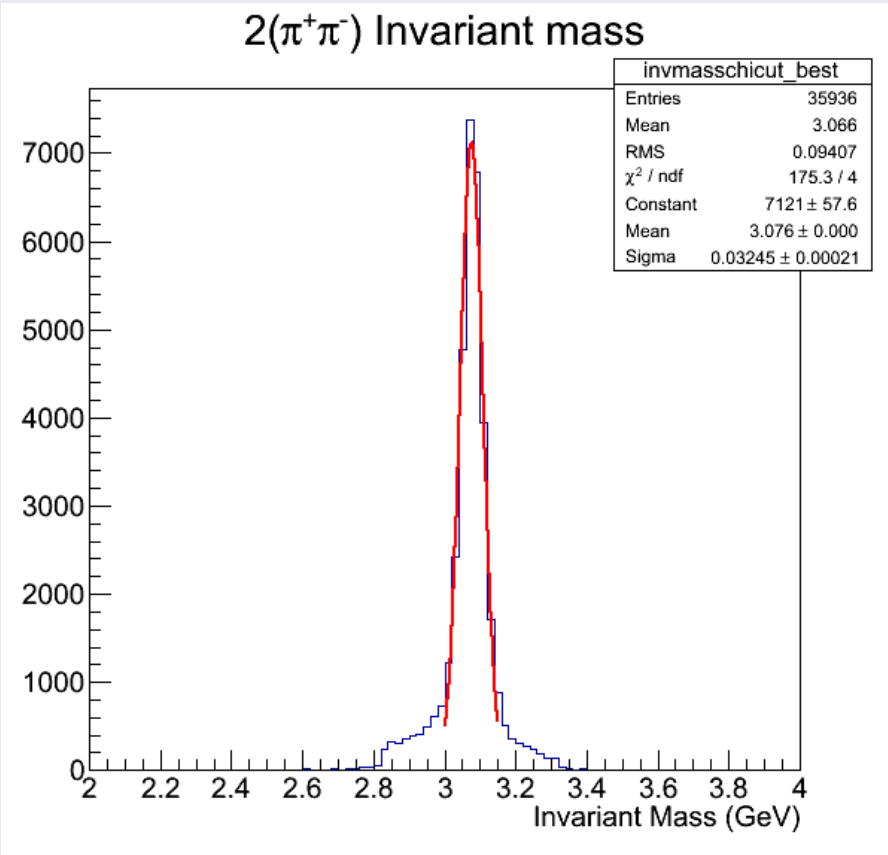




Single pion track resolution: STT 1.7% - TPC 1.5%

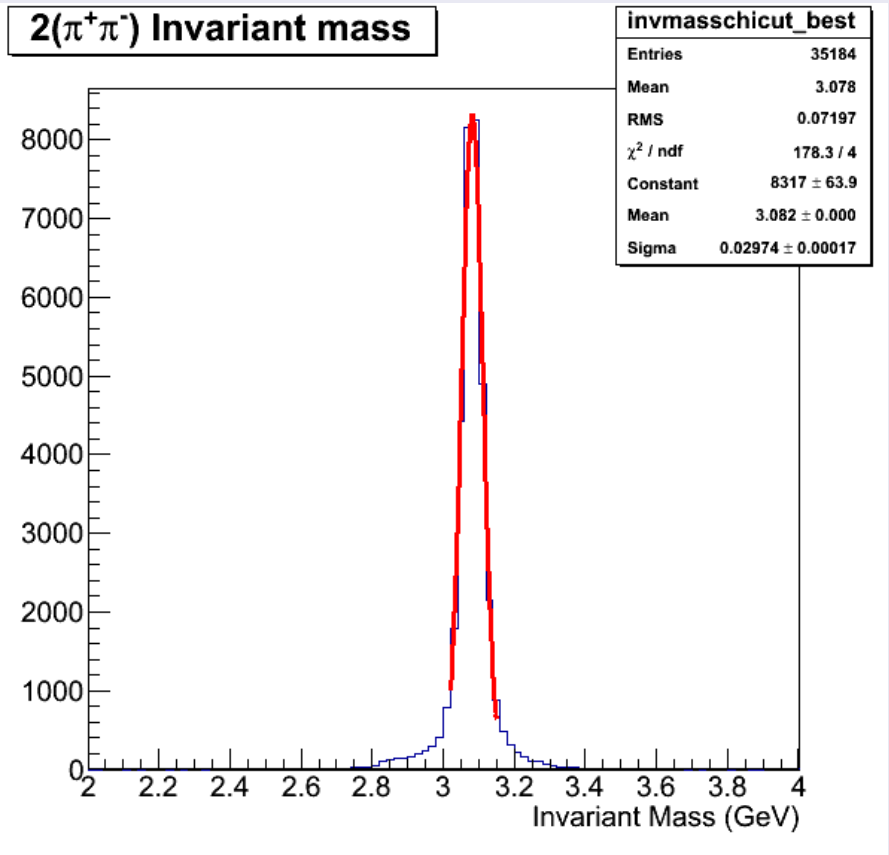
Invariant mass distribution

STT



Resolution: 32.5±0.2 MeV
Efficiency (35.9±0.2)%

TPC



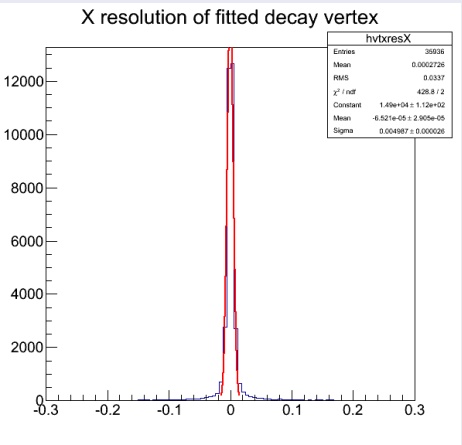
Resolution: 29.7±0.2 MeV
Efficiency (35.2±0.2)%

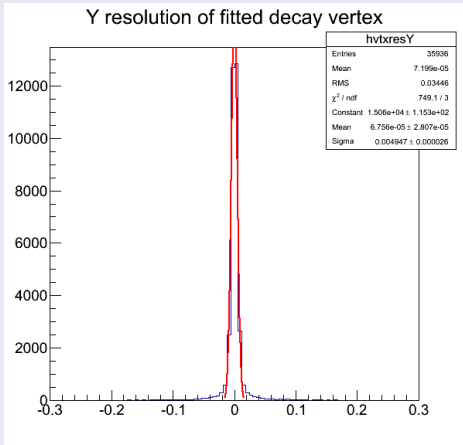
Efficiency=Number of reconstructed events/ number of generated events.

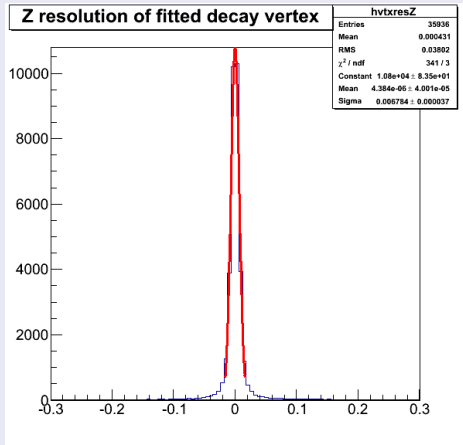
This results are obtained with different cuts/requirements on the minimal track lengths in the STT/TPC

Vertex resolution

STT

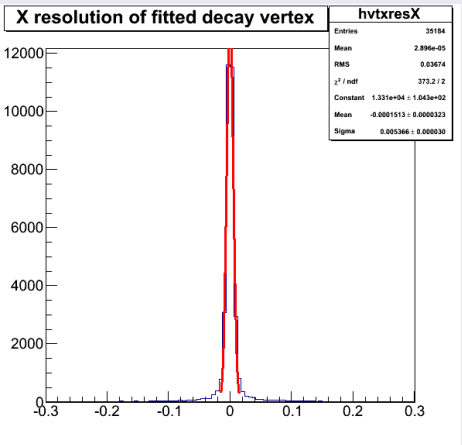


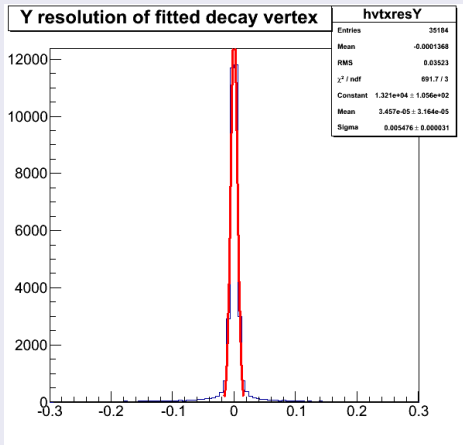


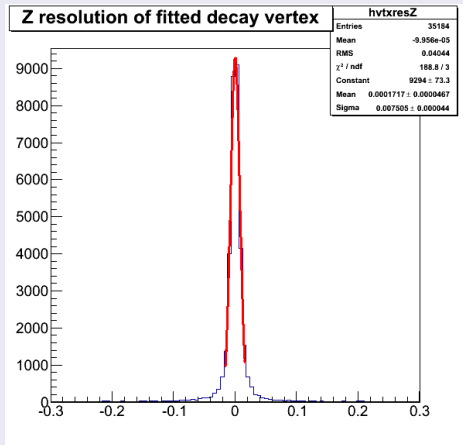


σ_x :49.9 μm; σ_y :49.5 μm; σ_z :67.8 μm;

TPC



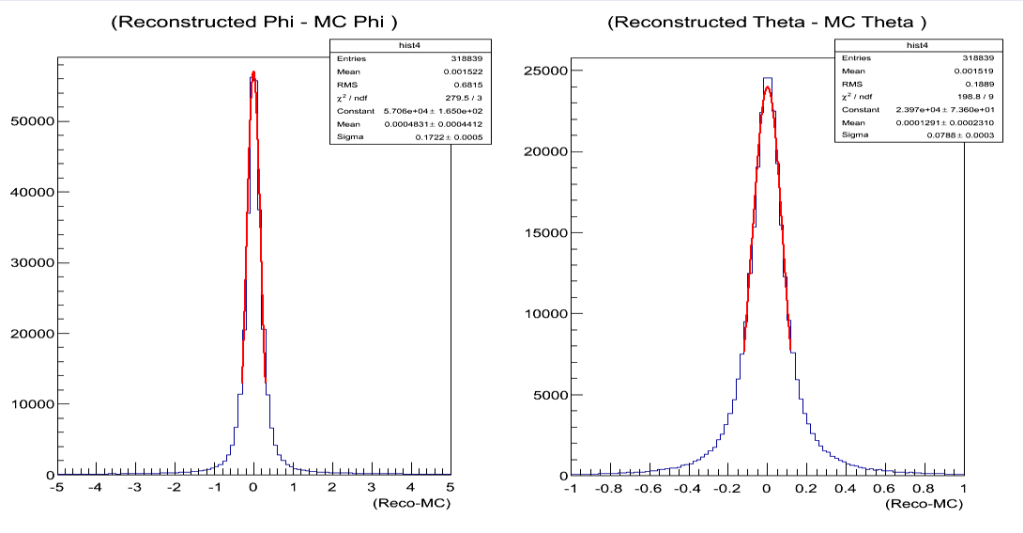




σ_x :53.7 μm; σ_y :54.8 μm; σ_z :75.1 μm;

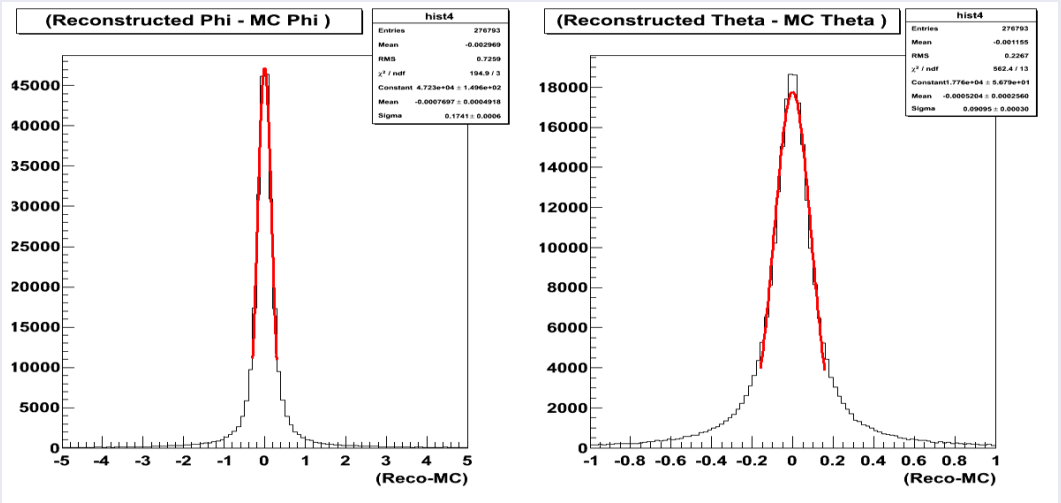
θ, ϕ resolution

STT



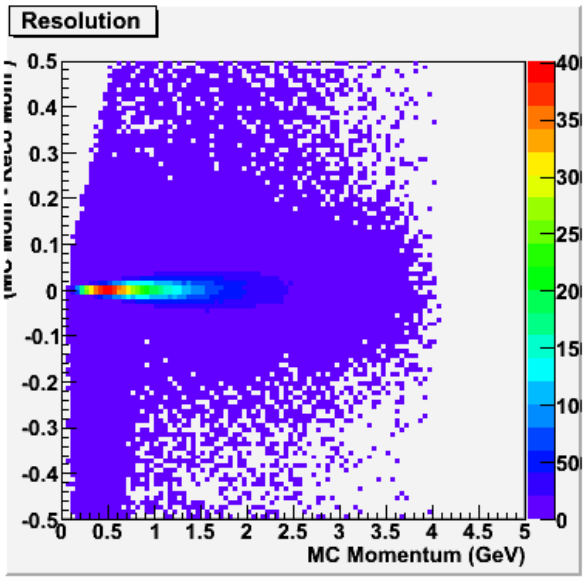
$\sigma(\theta)$=0.172°; $\sigma(\phi)$=0.079°

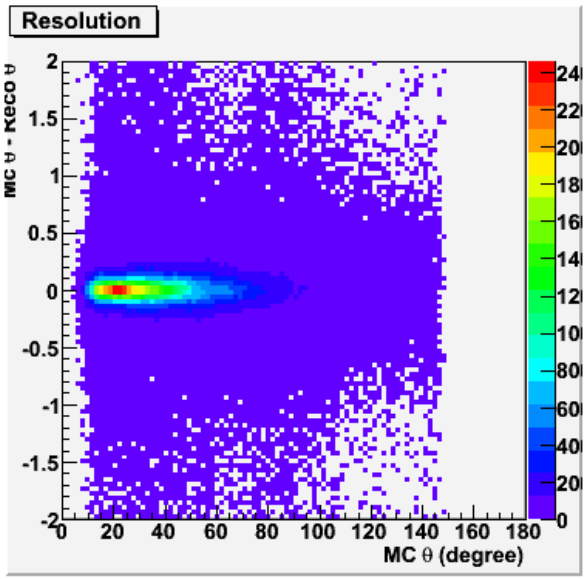
TPC

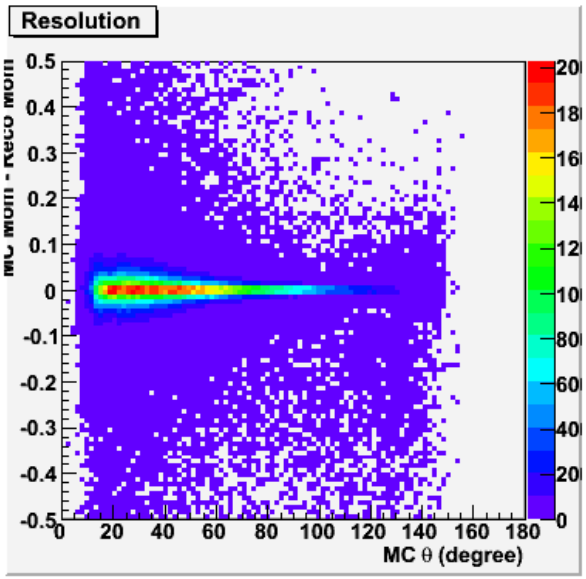


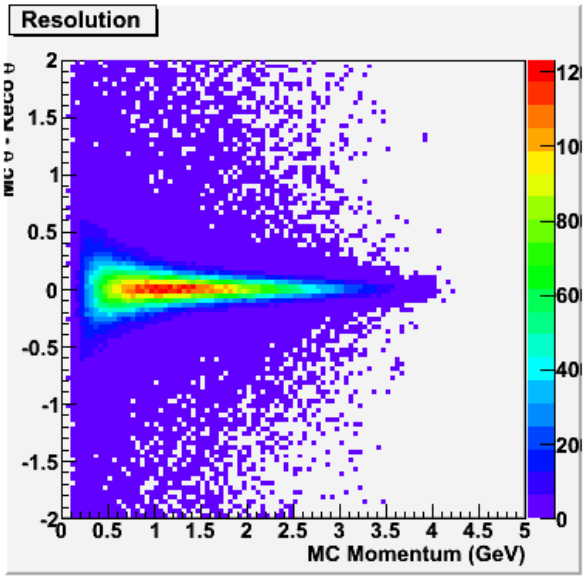
$\sigma(\theta)$=0.171°; $\sigma(\phi)$=0.091°

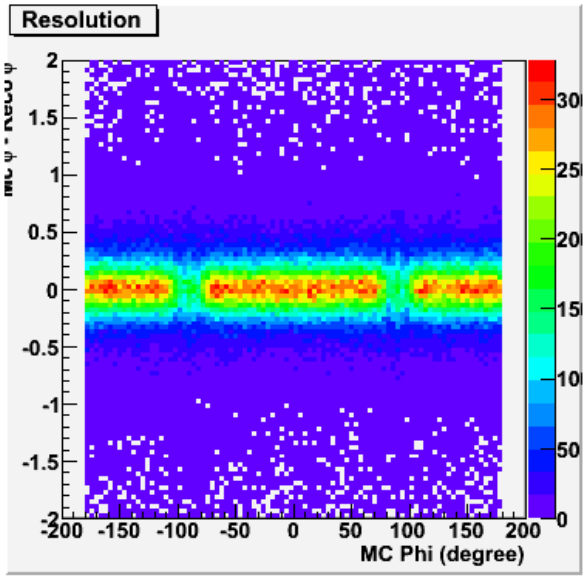
STT - Resolution



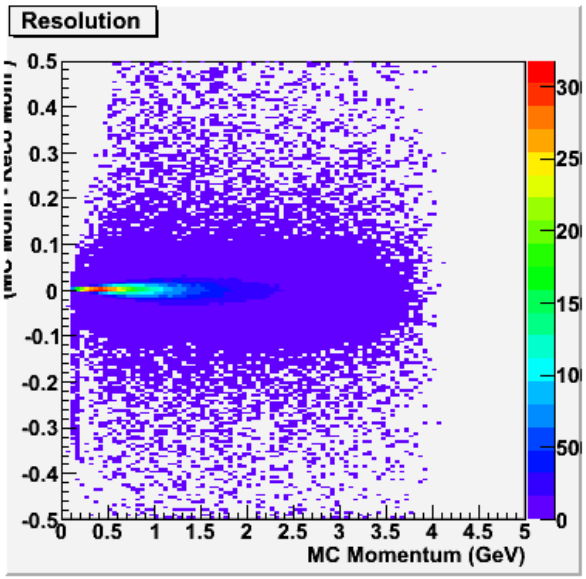


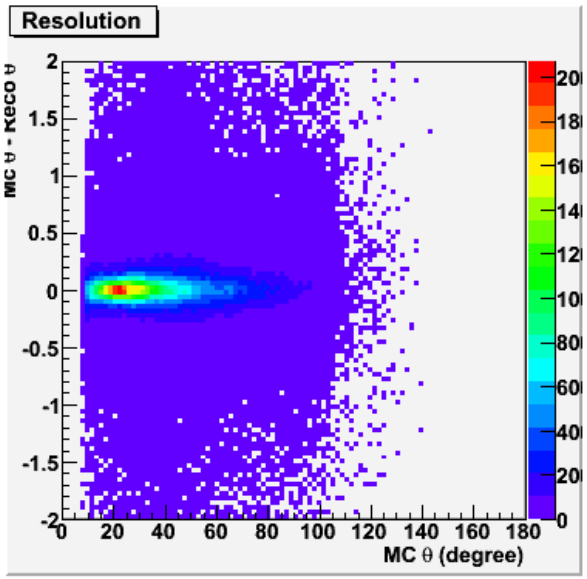


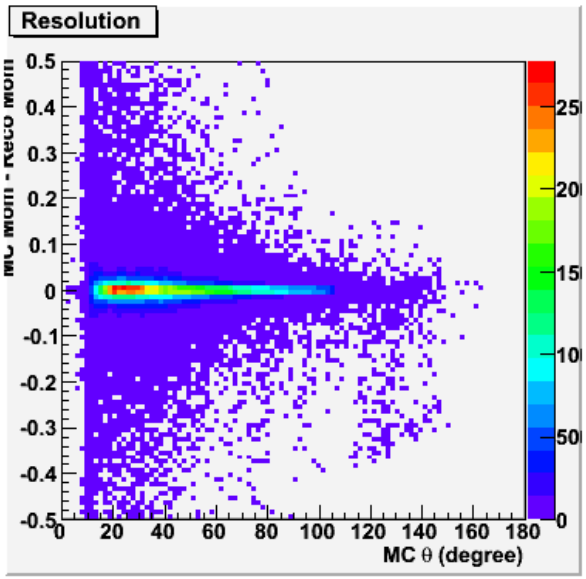


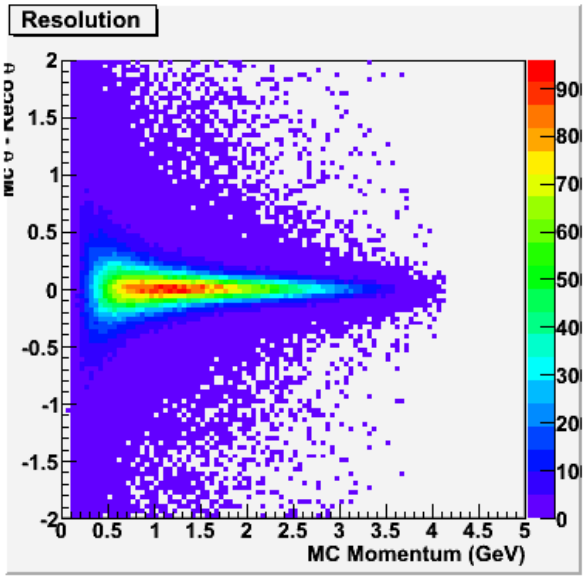


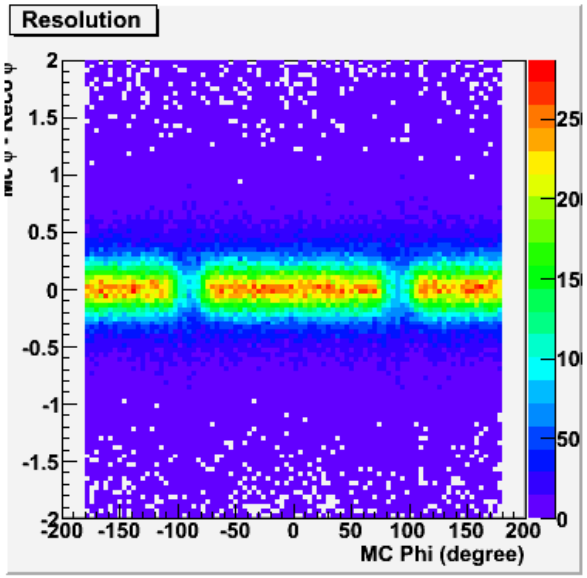
TPC - Resolution











Outlook

For the studied benchmark channel both Central Tracker options offer a good overall performance.

	$\bar{p}p \rightarrow \pi^+\pi^-$		$\bar{p}p \rightarrow \pi^+\pi^-\pi^+\pi^-$	
	STT	TPC	STT	TPC
Acceptance	74%	77%	52%	58%
Single track resolution	2.0%	2.1%	1.7%	1.5%
Invariant mass resolution	41.8 MeV	43.2 MeV	32.5 MeV	29.7 MeV
Invariant mass efficiency	70.4%	70.7%	35.9%	35.2%
Vertex: X resolution	62.5 μm	66.6 μm	49.9 μm	53.7 μm
Vertex: Y resolution	68.9 μm	73.1 μm	49.5 μm	54.8 μm
Vertex: Z resolution	58.2 μm	64.2 μm	67.8 μm	75.1 μm

THANKS FOR YOUR ATTENTION