



$\Psi(3770)$ study w. central tracking @ PANDA cross-check

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on behalf of the Prof. Achim Denig's group

Determination of

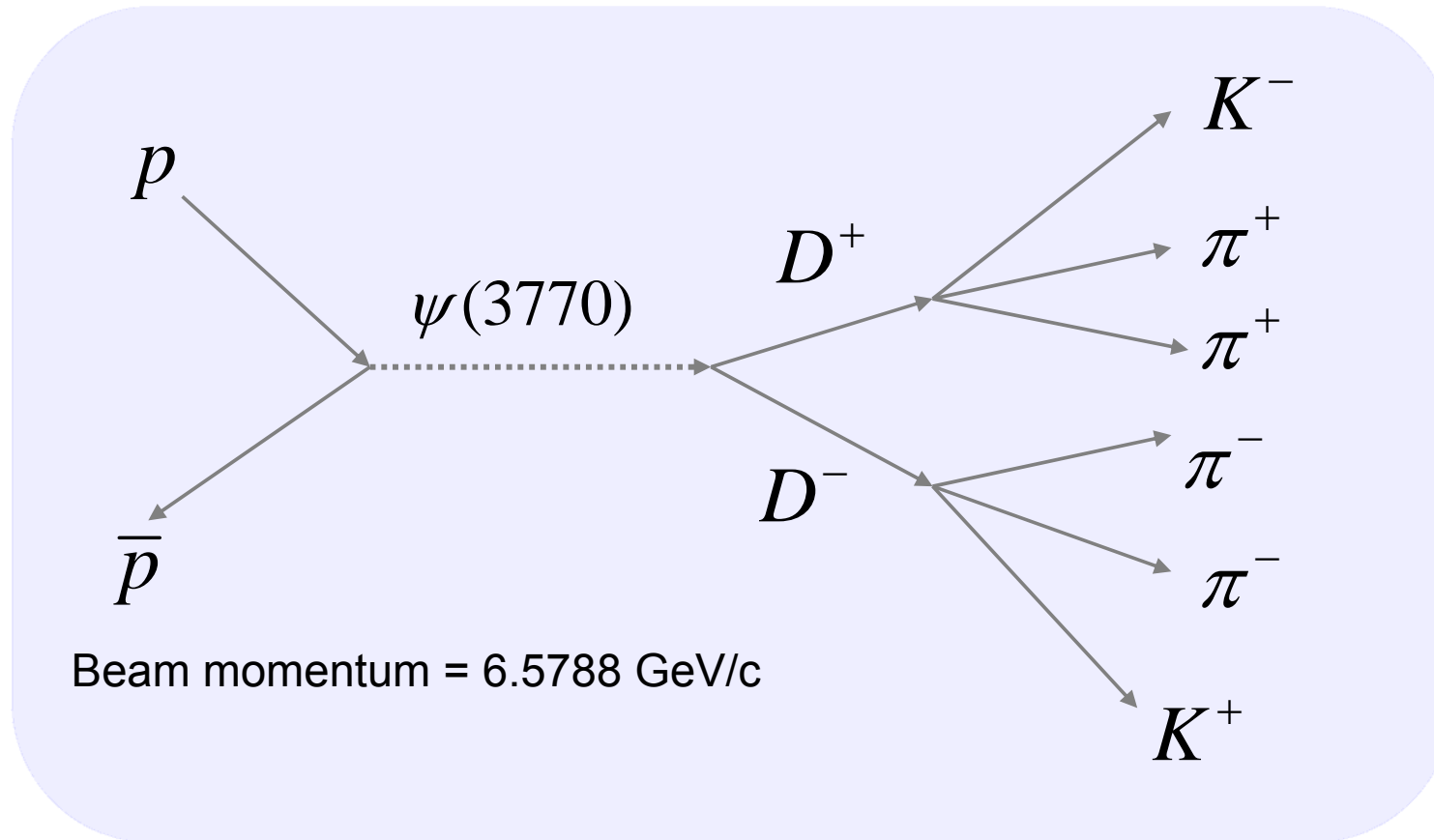
- global efficiency (acceptance)
- resolution of invariant mass and 4-momentum
- interaction and secondary vertex

in central tracking part (TPC vs STT mode)





Benchmark channel : $p\bar{p} \rightarrow \psi(3770) \rightarrow D^+D^- \rightarrow K^-\pi^+\pi^+K^+\pi^-\pi^-$

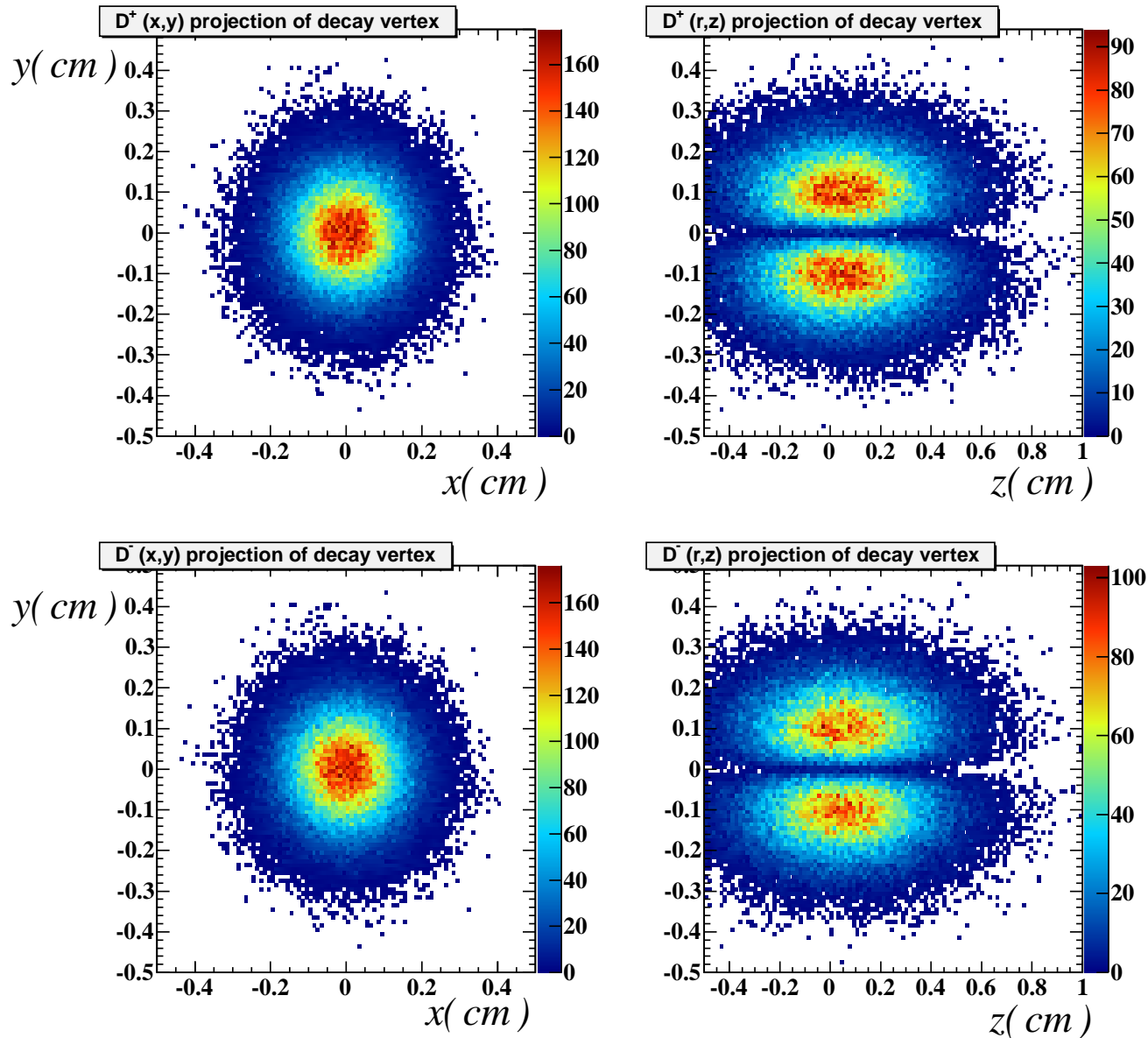


MC simulation on the PandaGrid : Alien(analysis) and MonaRisa(monitoring)

- TPC mode : run984 (pandaroot ver. august11)
- STT mode : run934oldnocu (pandaroot ver. july11)



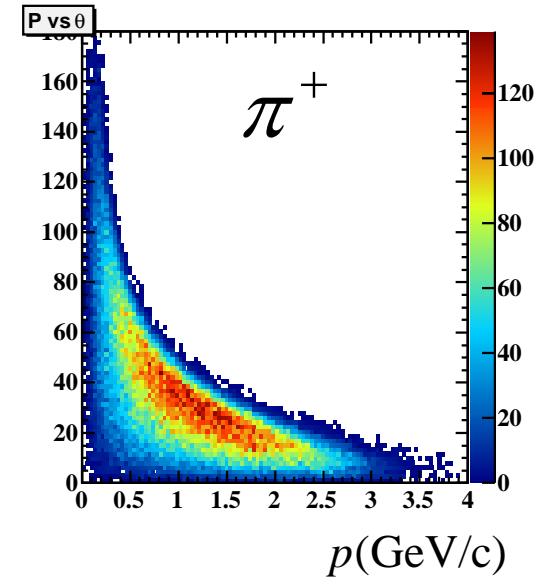
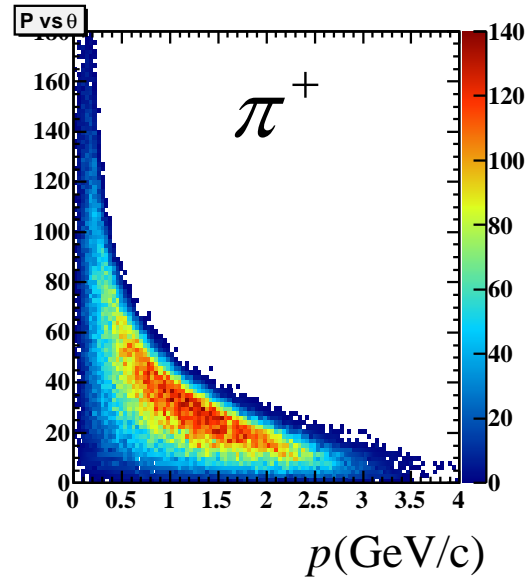
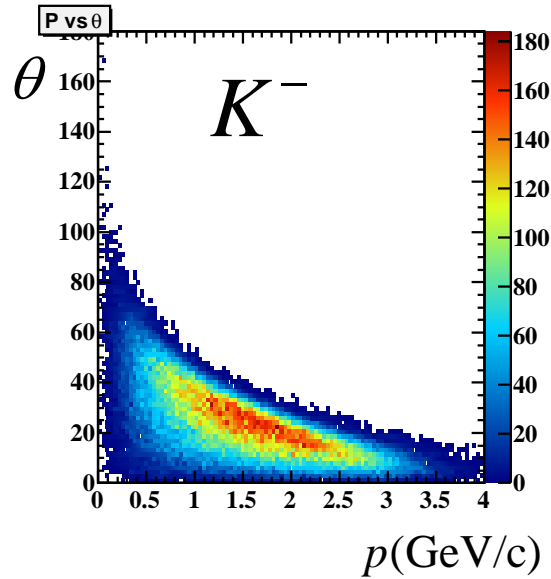
- Generated $\psi(3770)$ event : smeared vertex distribution of D^+ and D^-



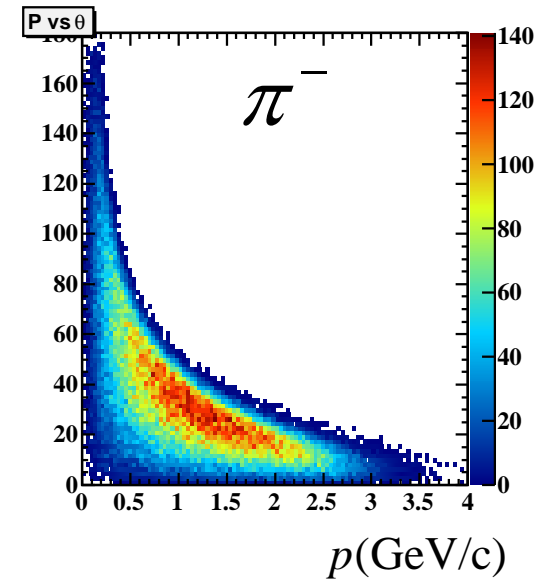
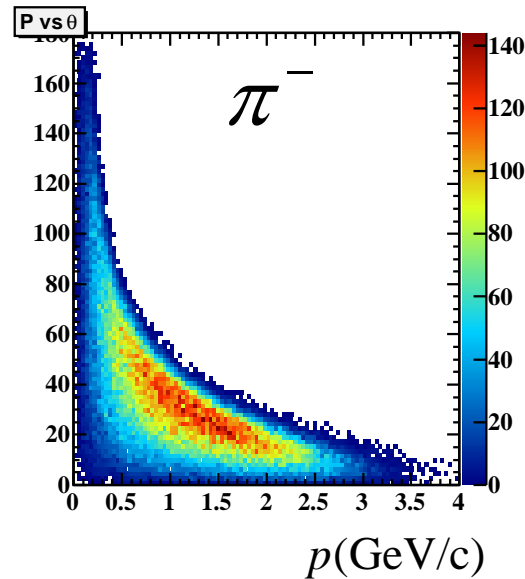
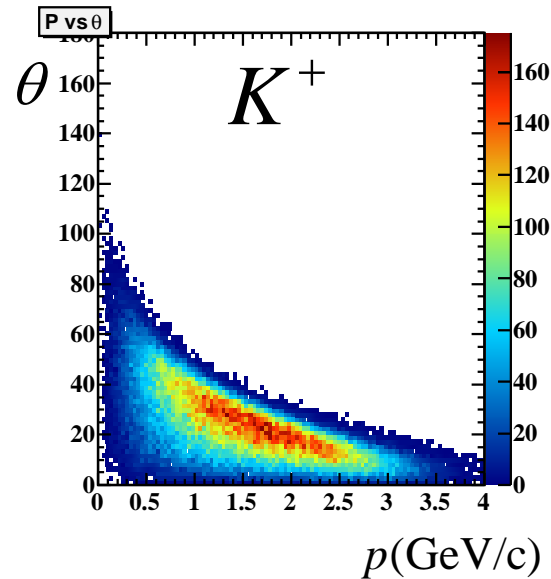


- Generated $\psi(3770)$ event : Momentum and Theta distribution for D^+ and D^- decay
only interested in the events with acceptance of the central tracker

D^+



D^-

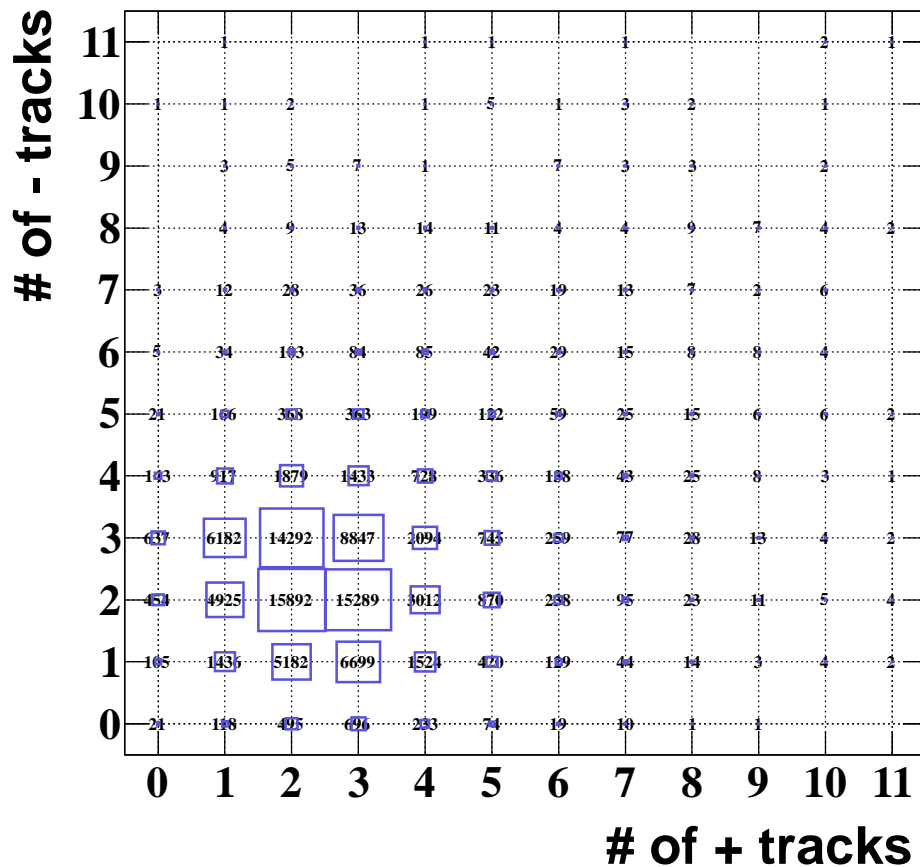




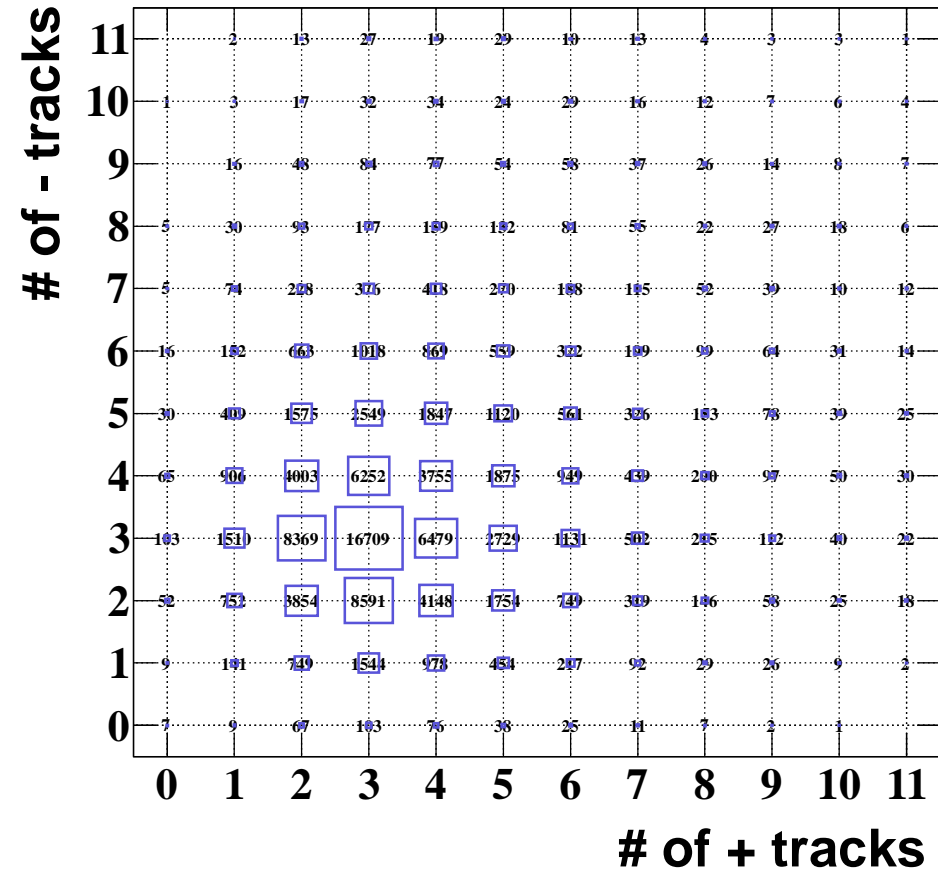
Event selection I

Reconstruction of charged tracks by TPC and STT :
required at least 3 positive and 3 negative tracks.

TPC(run984) : 99000 evt.



STT(run934oldnocu) : 98000 evt.

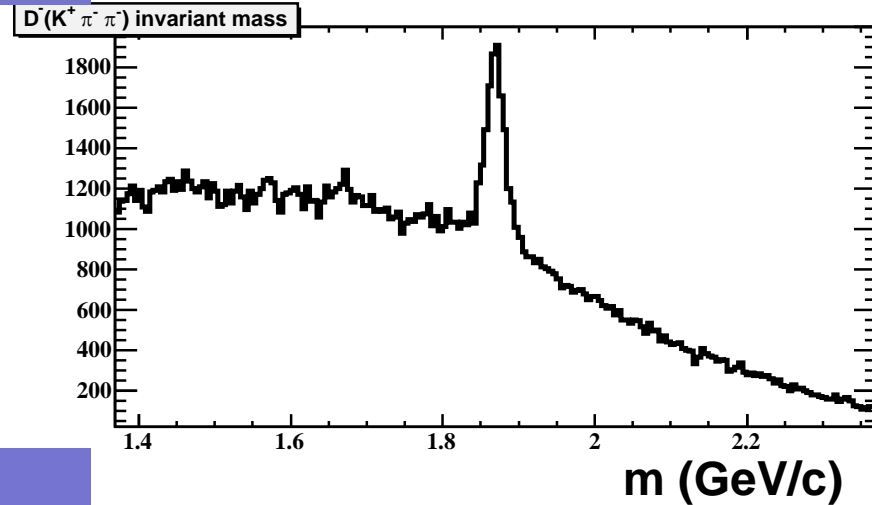
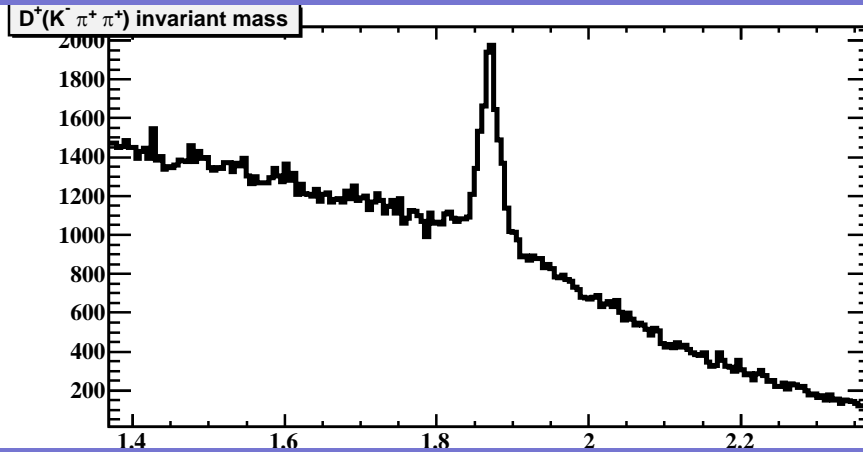




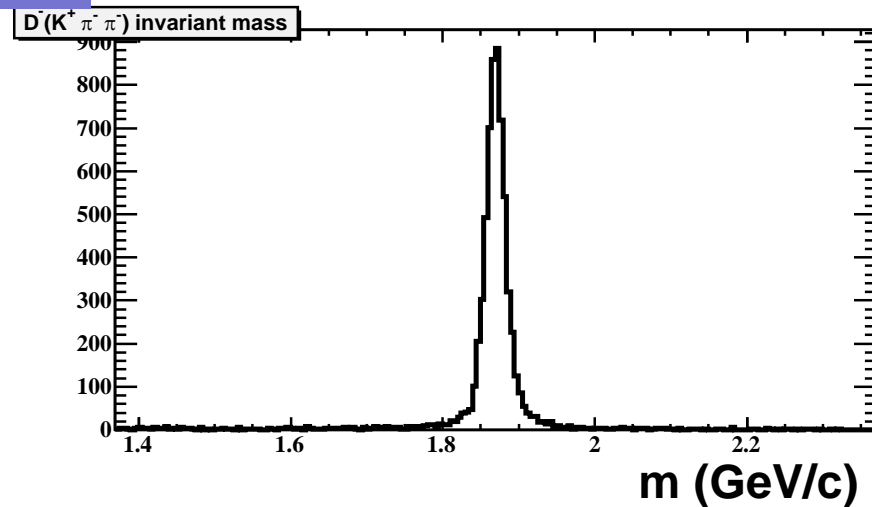
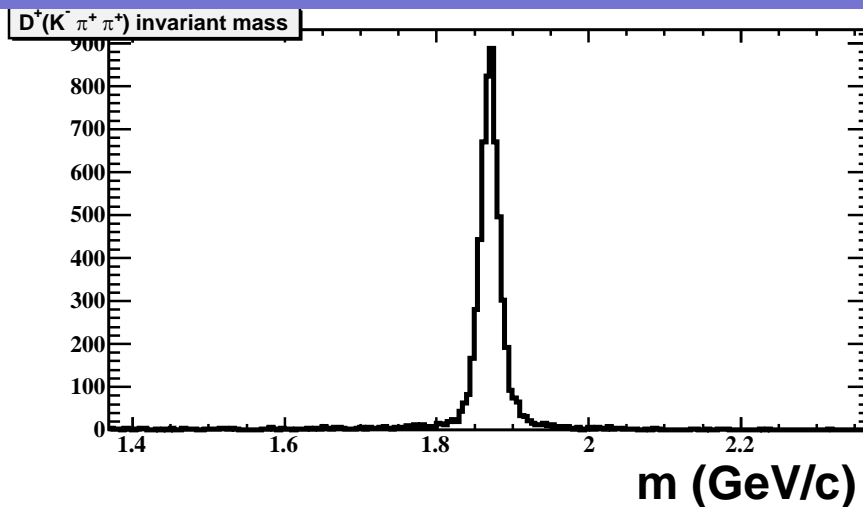
Event selection II

- MC true matching with kaon id=321 and pion id=211 (no index matching)

TPC mode : D+ and D- reconstruction



TPC mode : MC true matched D+ and D-

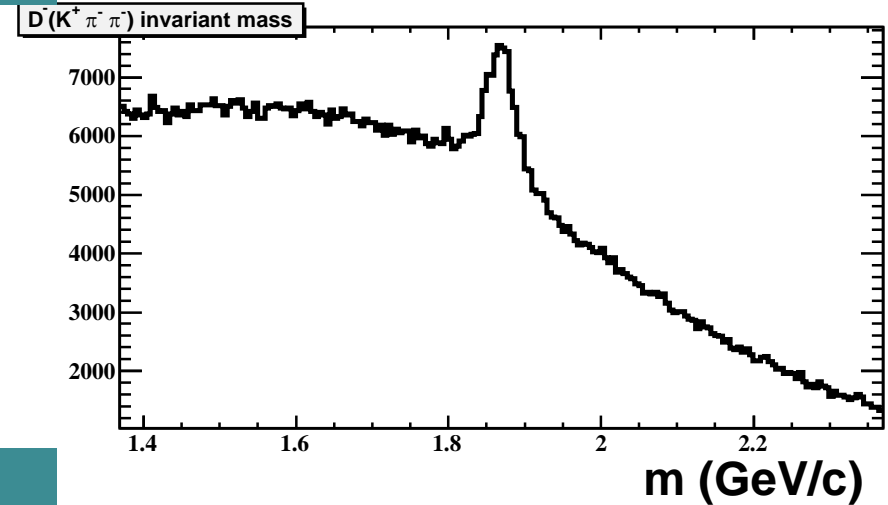
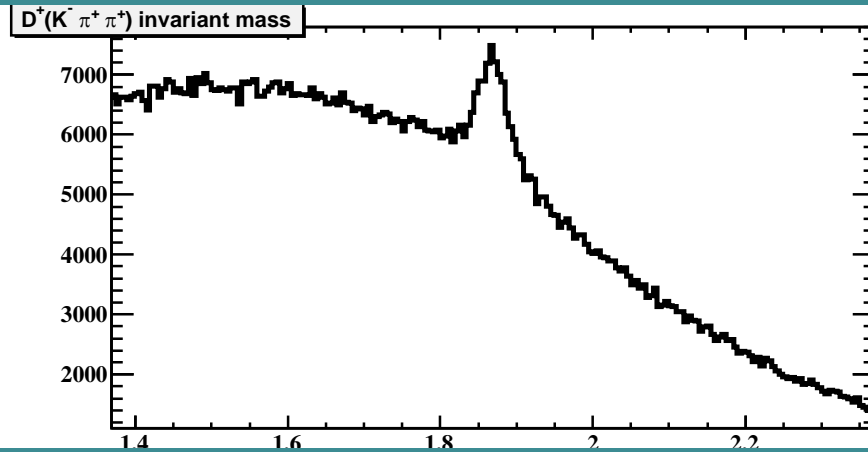




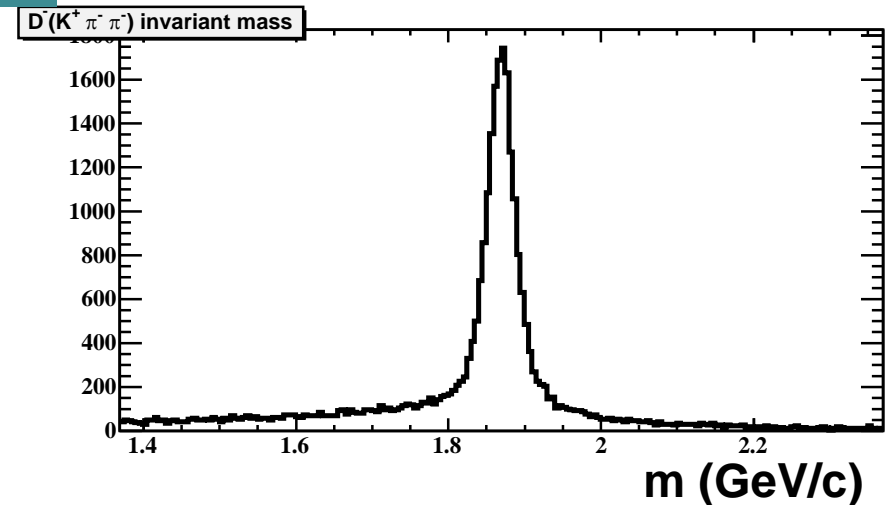
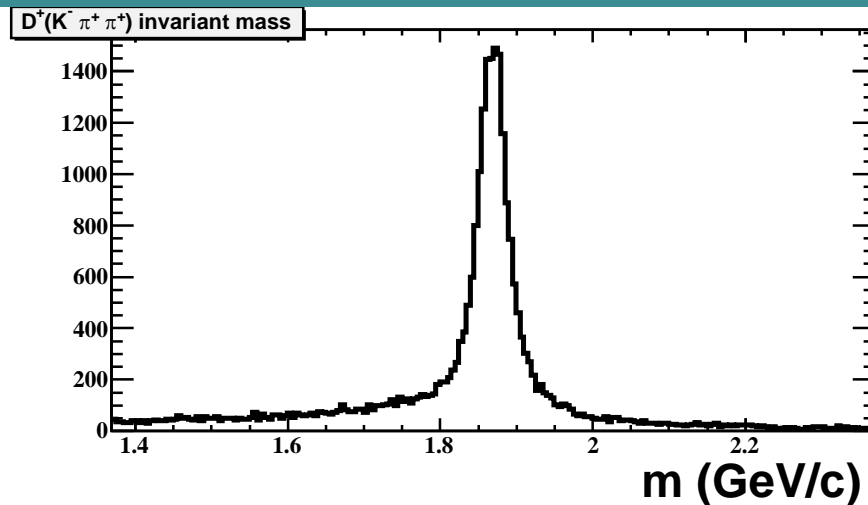
Event selection II

- MC true matching with kaon id=321 and pion id=211 (no index matching)

STT mode : D+ and D- reconstruction



STT mode : MC true matched D+ and D-

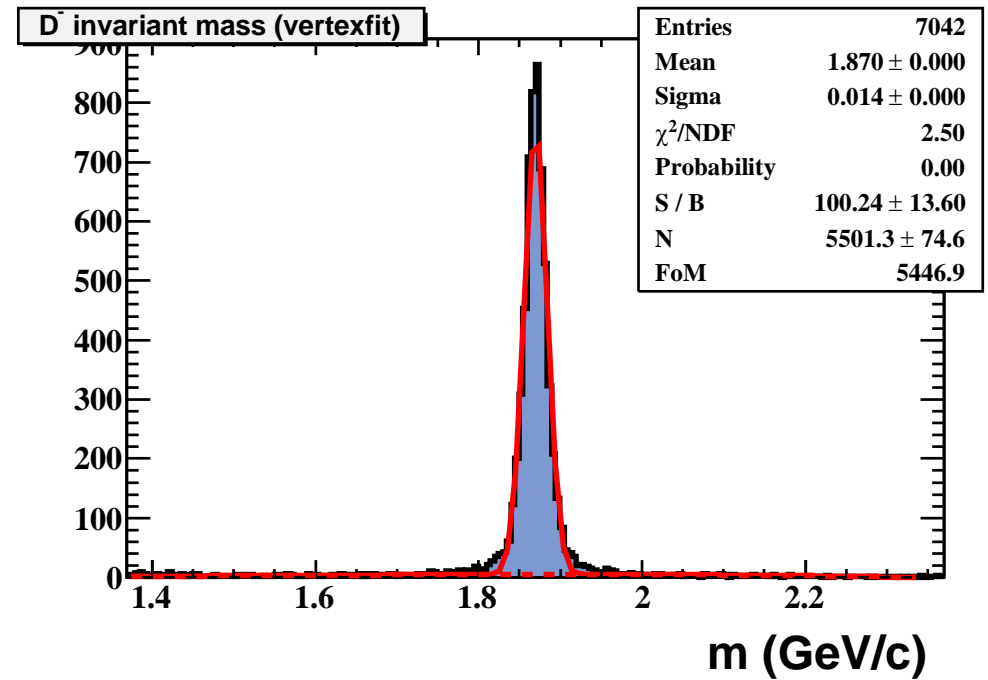
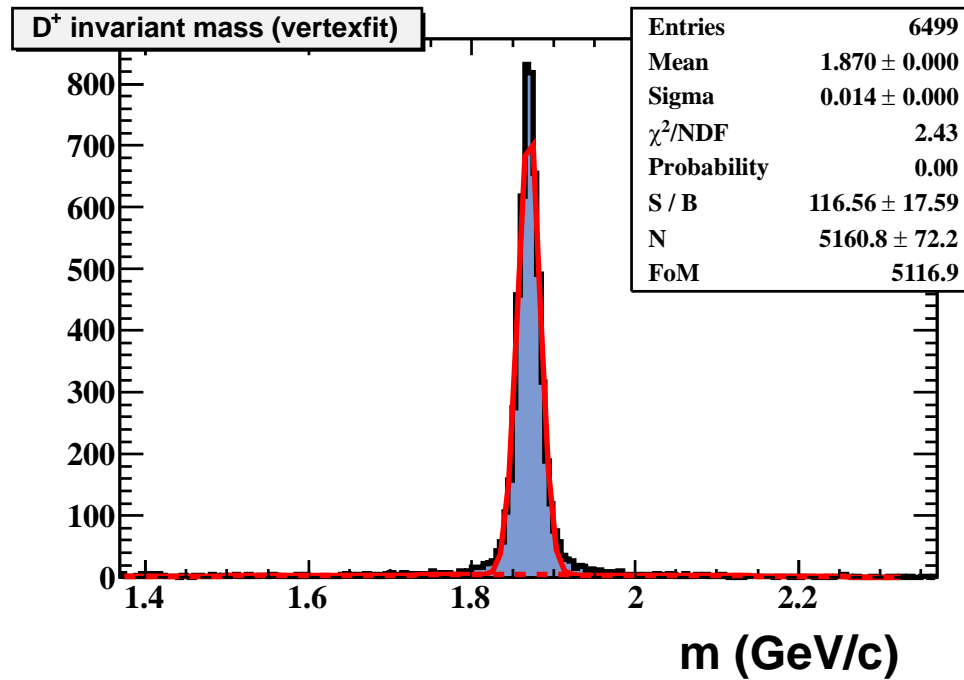




Event selection III

- MC true matching with kaon id=321 and pion id=211 (no index matching)
- 1 D⁺ and D⁻ candidate in 1 event, is identified from PndKinVertex fit with best probability
- mass window $1.8093 < m_D < 1.9293$ GeV

TPC mode : Fitted D⁺ and D⁻

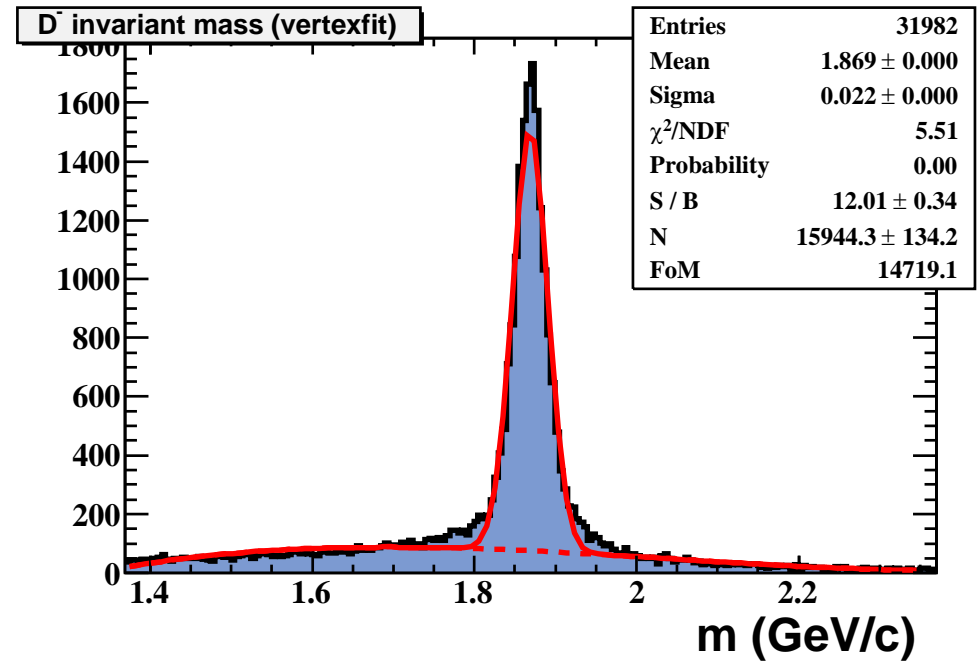
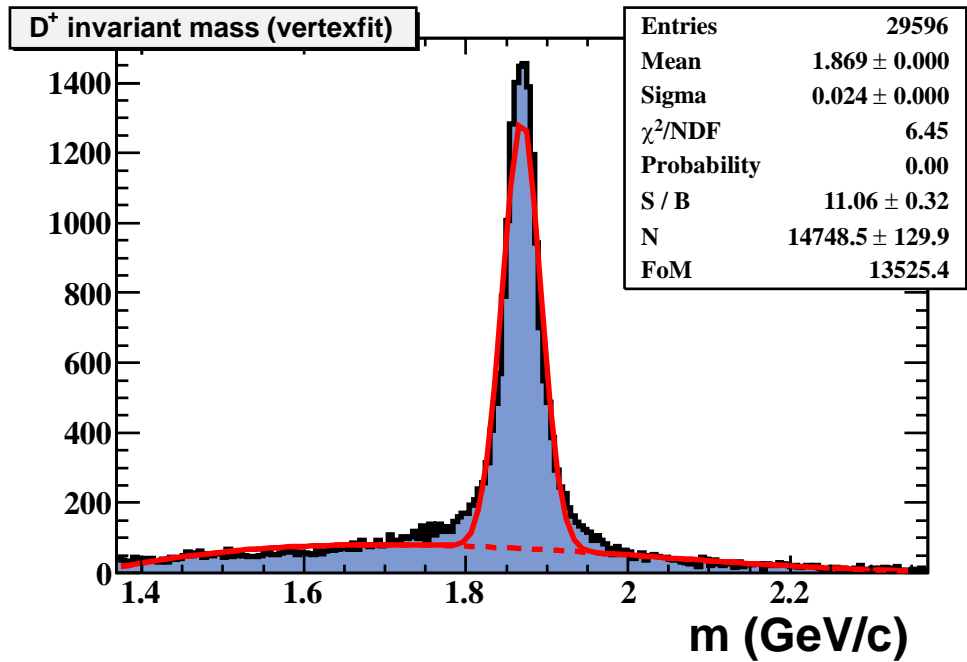




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STT mode : Fitted D⁺ and D⁻

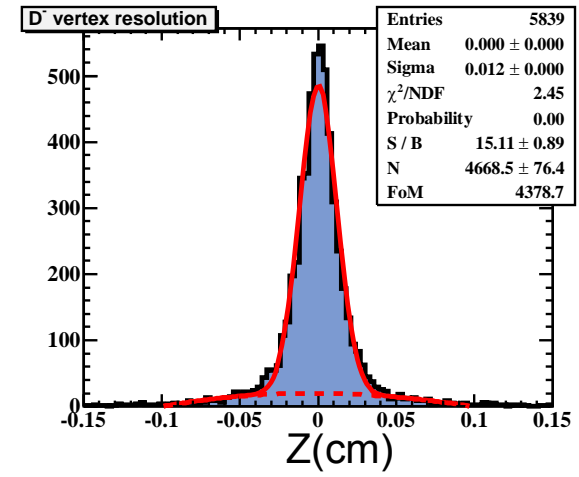
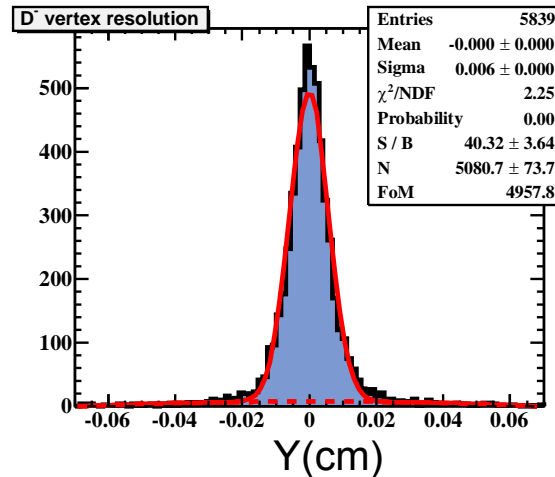
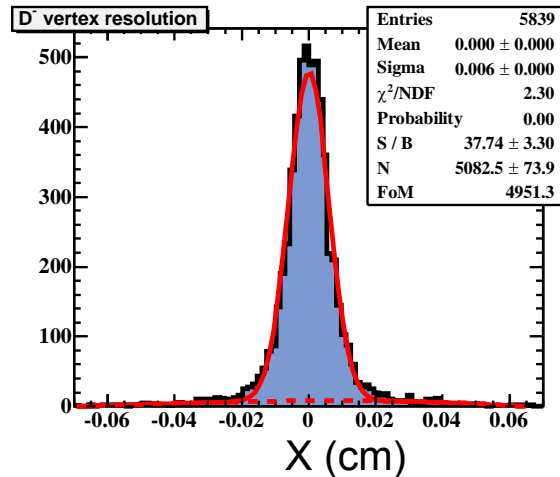
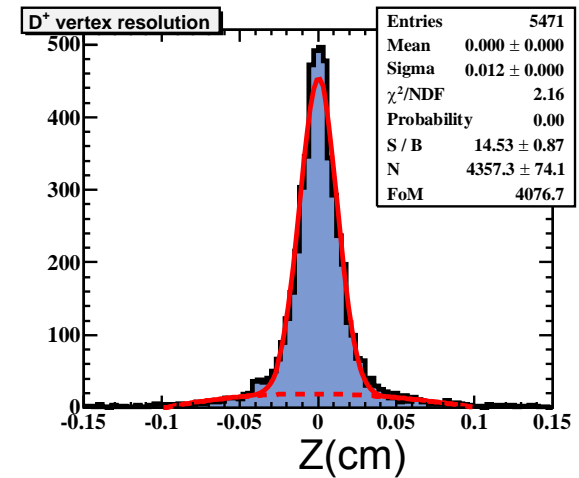
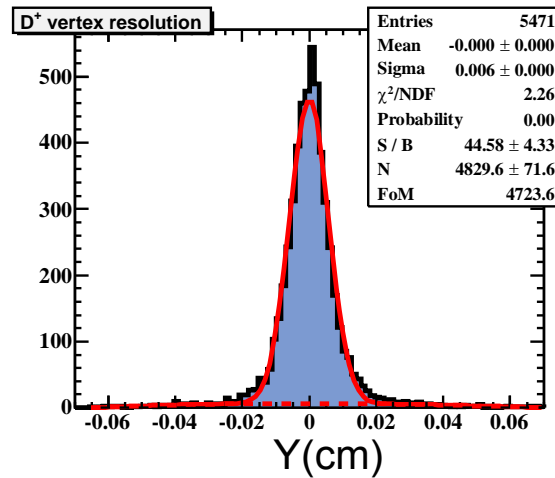
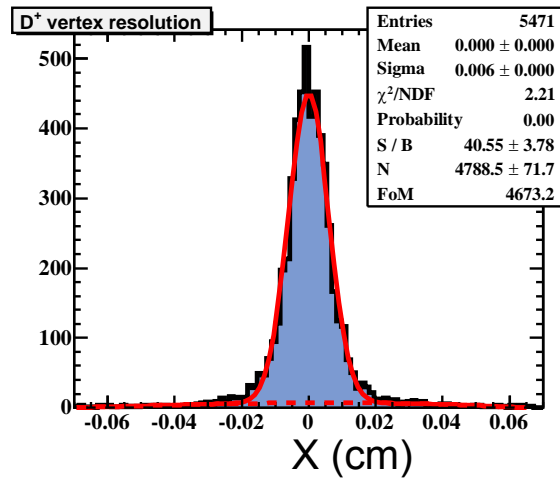




Event selection III

- Vertex position within mass window $1.8093 < m_D < 1.9293$ GeV

TPC mode : Vertex resolution

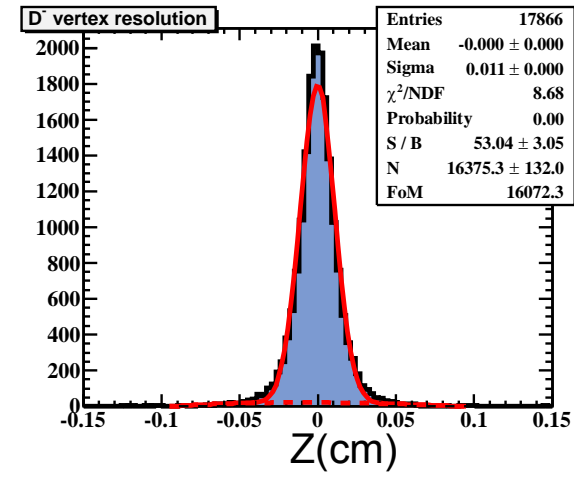
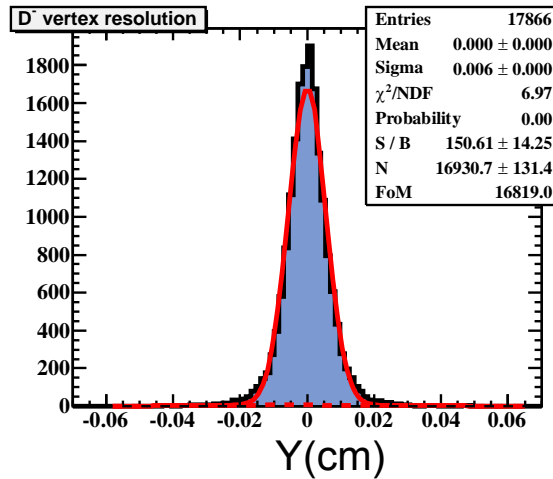
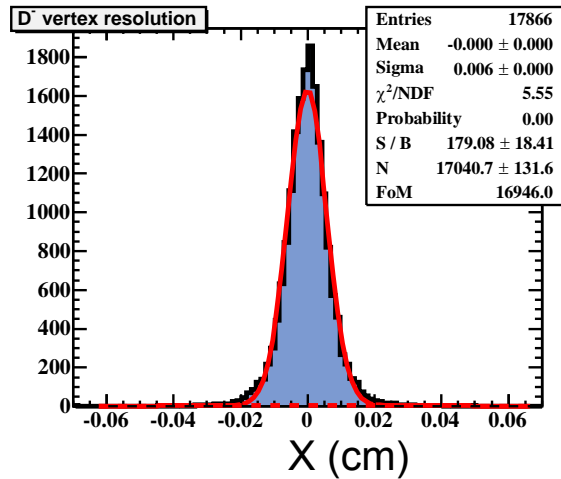
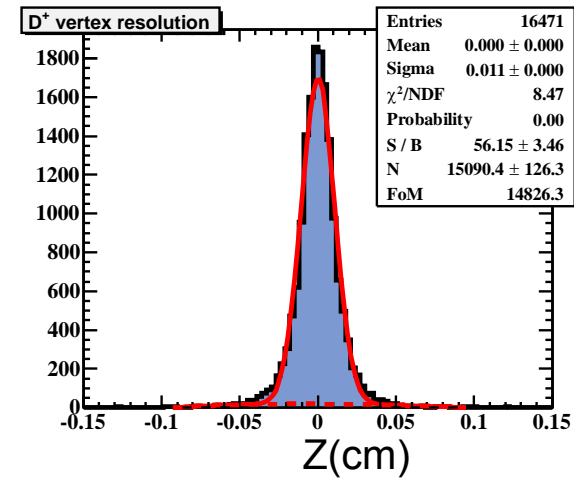
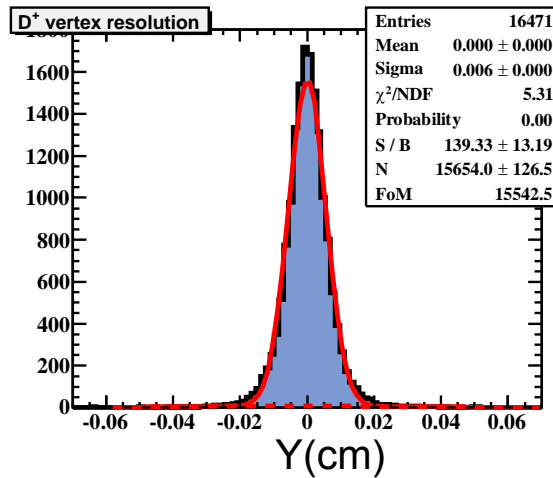
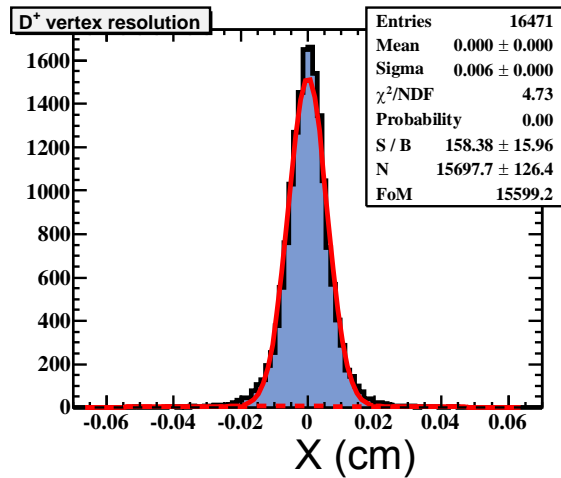




Event selection III

- Vertex position within mass window $1.8093 < m_D < 1.9293$ GeV

STT mode : Vertex resolution

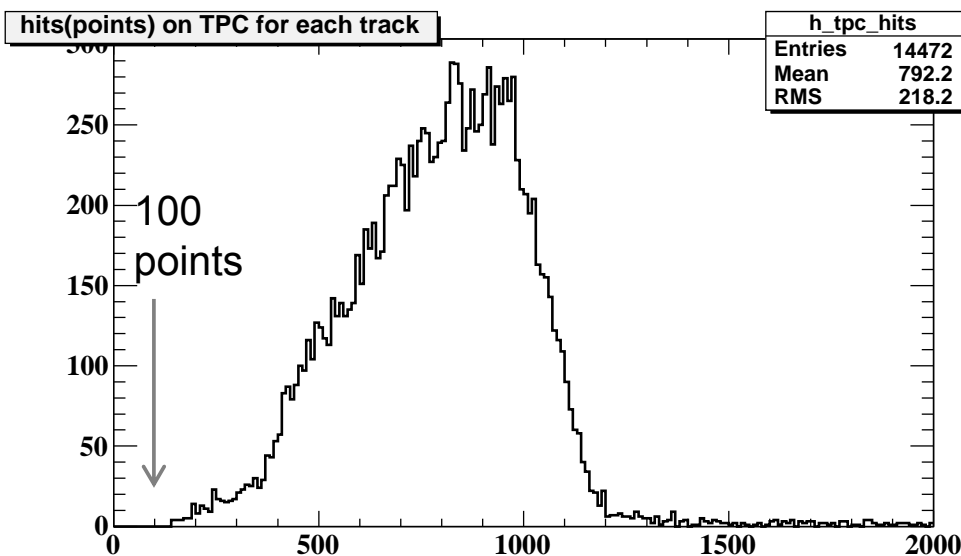




Event selection for $\psi(3770)$

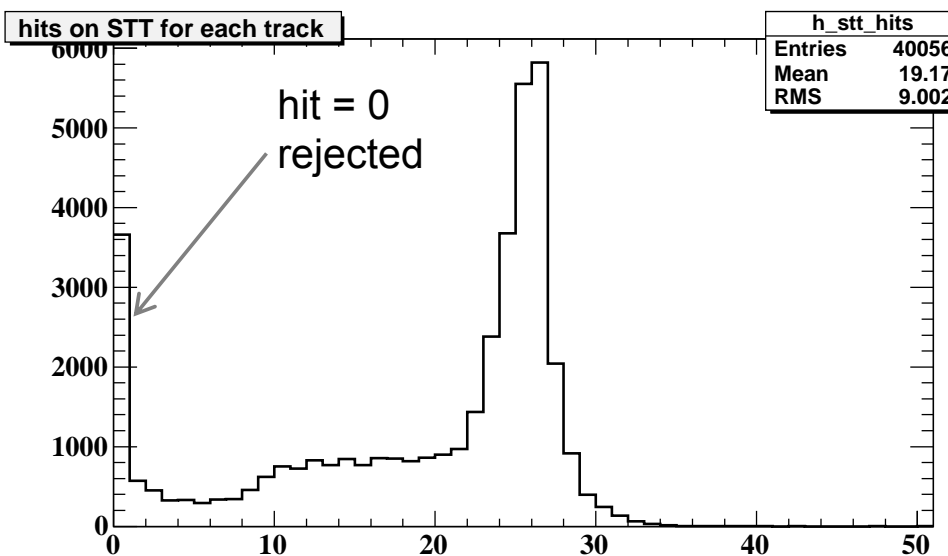
- combined D+ and D- to $\psi(3770)$
- only 1 best candidate of $\psi(3770)$ in 1 event, identified by highest probability (chi2) from vertex fit
- hit in the fiducial volume required to compare both detectors in same level
 - STT must have at least 1 hit in the volume
 - TPC have more than 100 hits(points) which corresponds to 7.5cm track length

TPC points



No effect : All tracks have more than 100 points in final $\psi(3770)$ sample

STT hits

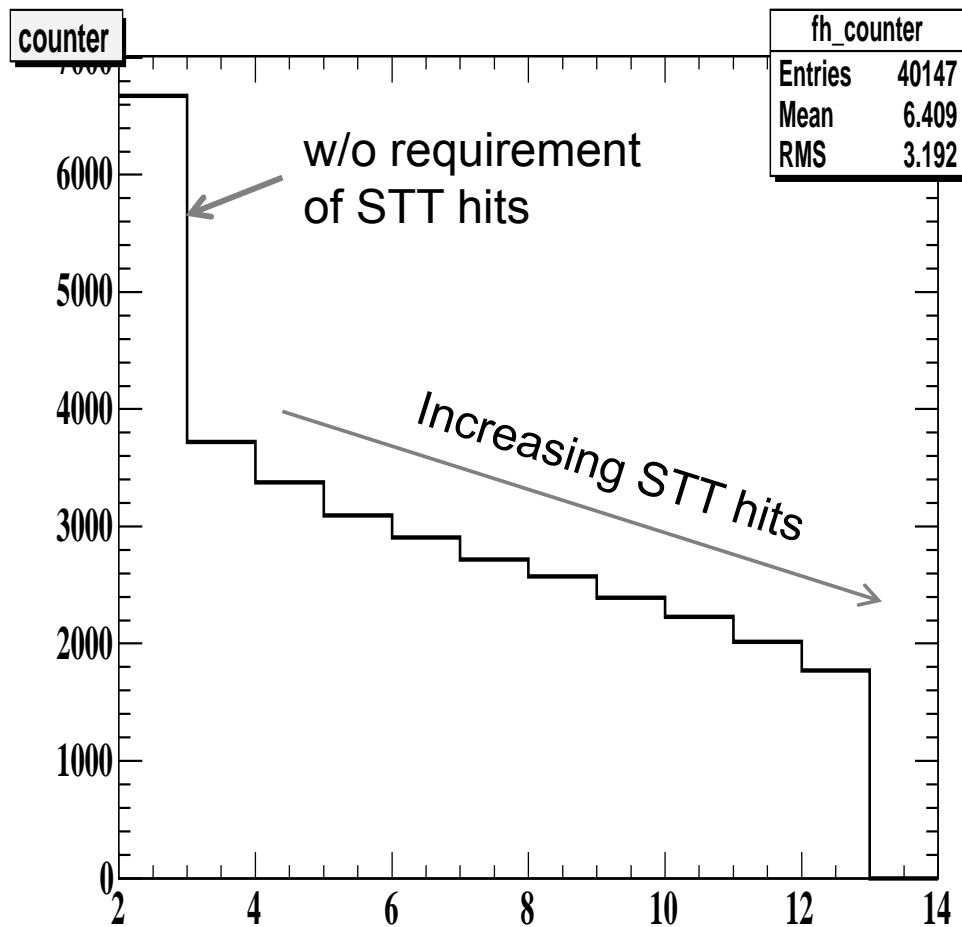


50% events have no STT hits (pure GEM, MVD)



Dependence of rec. efficiency on the STT hits

- apply the cut (STT hits \geq #) on each individual track i.e., for all 6 track candidates



Cut	Evt. (98000)	Glo.eff.
stt hits \geq 0	6676	6.8 %
stt hits \geq 1	3720	3.8 %
stt hits \geq 2	3373	3.4 %
stt hits \geq 3	3091	3.2 %
stt hits \geq 4	2904	3.0 %
stt hits \geq 5	2717	2.8 %
stt hits \geq 6	2573	2.6 %
stt hits \geq 7	2391	2.4 %
stt hits \geq 8	2226	2.3 %
stt hits \geq 9	2014	2.1 %
stt hits \geq 10	1774	1.8 %

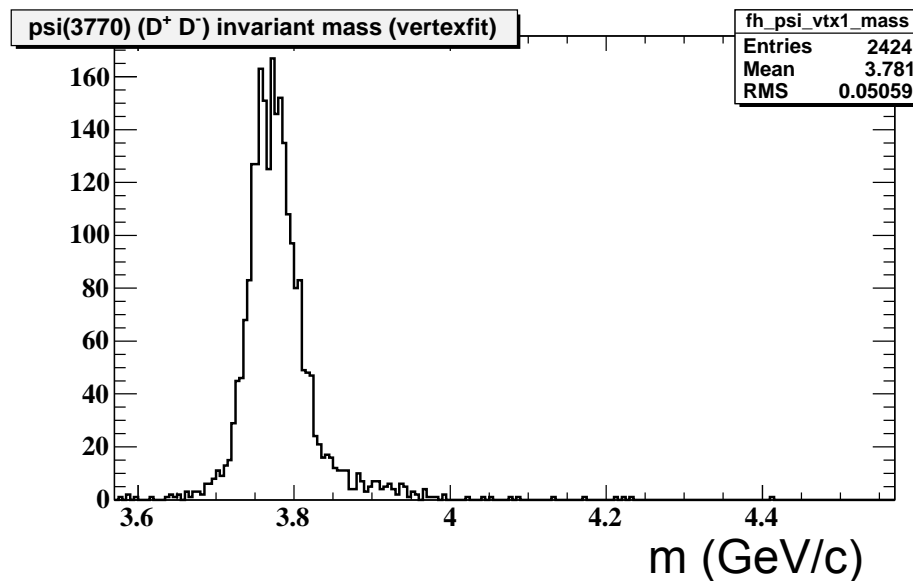




Event selection for Psi(3770)

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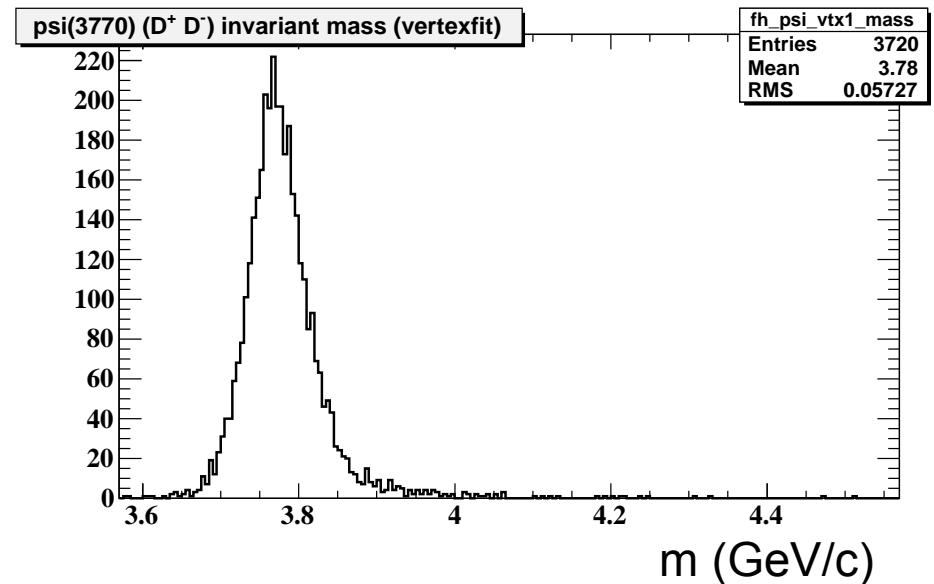
TPC Ψ mass distribution



Global efficiency

$$\varepsilon = \text{rec.} / \text{gen.} = 2424 / 99\text{K} \\ = 2.5 \%$$

STT Ψ mass distribution



Global efficiency

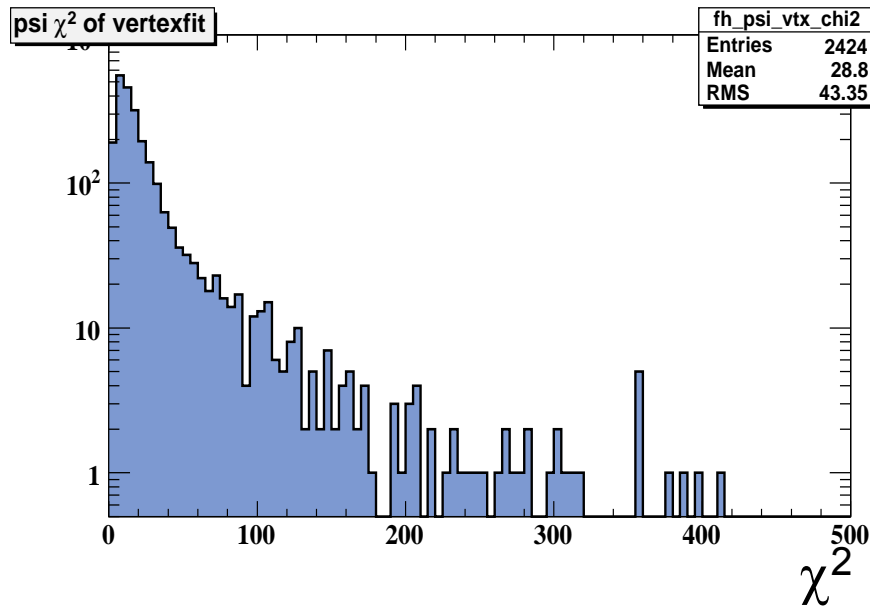
$$\varepsilon = \text{rec.} / \text{gen.} = 3720 / 98\text{K} \\ = 3.8 \%$$



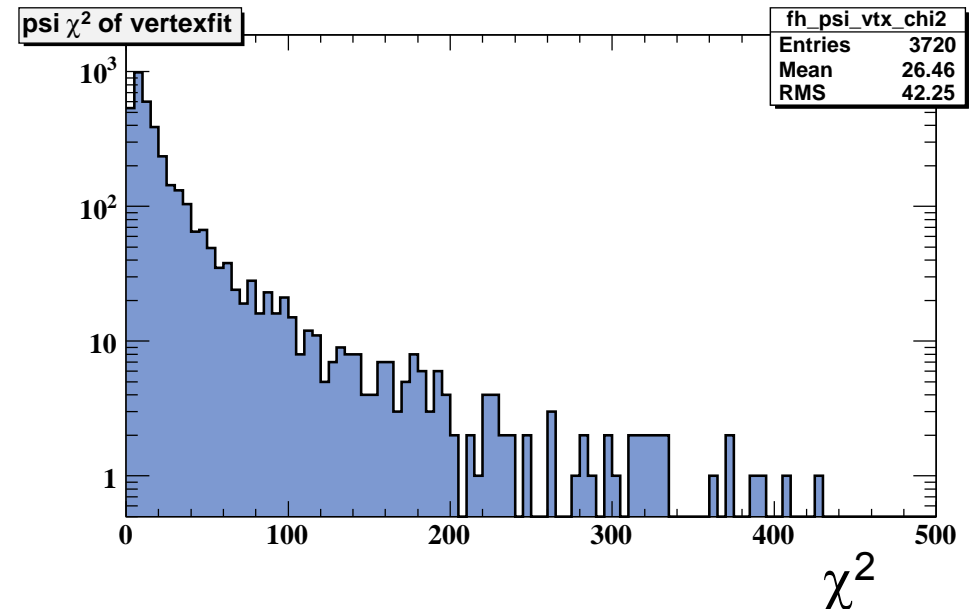
Event selection for Psi(3770)

- combined D+ and D- to psi(3770)
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TPC Ψ vertex fit : χ^2 distribution



STT Ψ vertex fit : χ^2 distribution

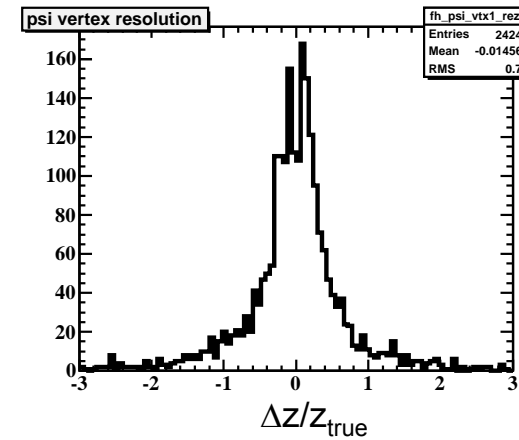
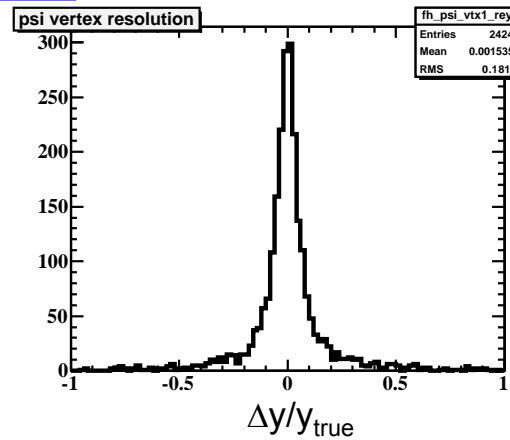
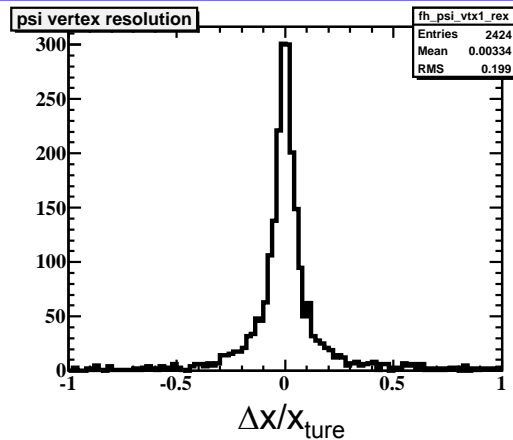




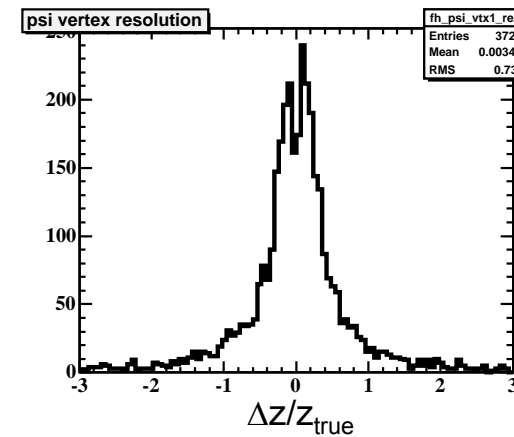
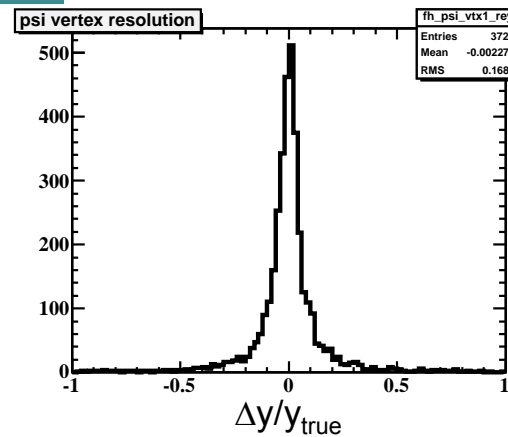
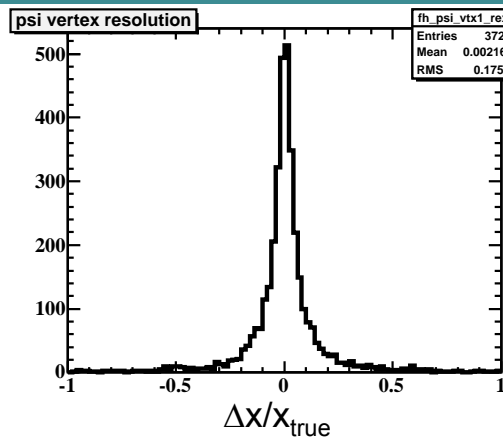
Event selection for Psi(3770)

- combined D+ and D- to psi(3770)
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TPC : Ψ vertex resolution



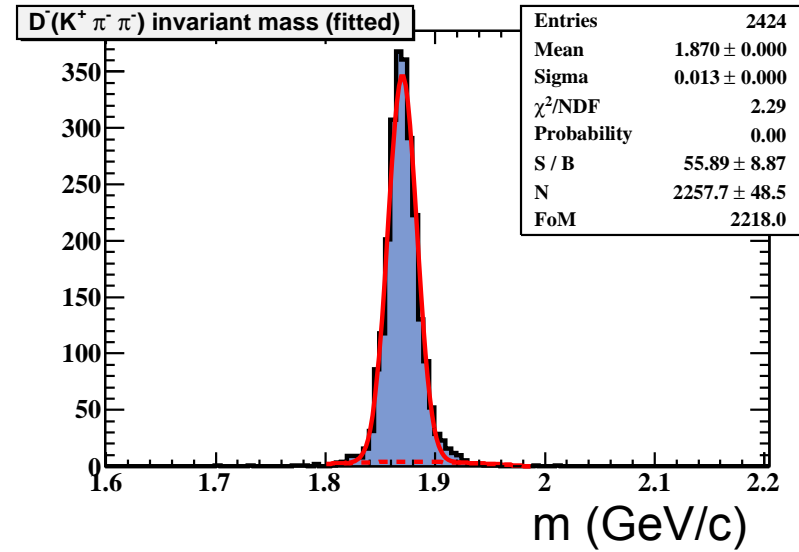
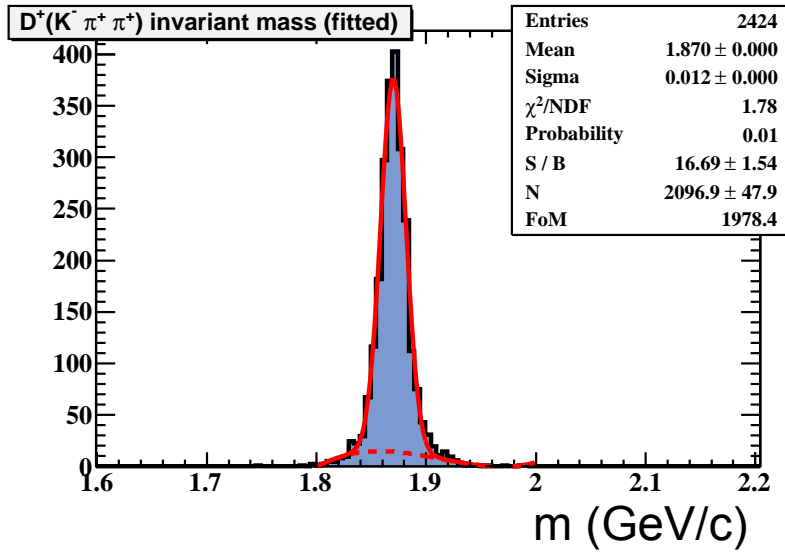
STT : Ψ vertex resolution



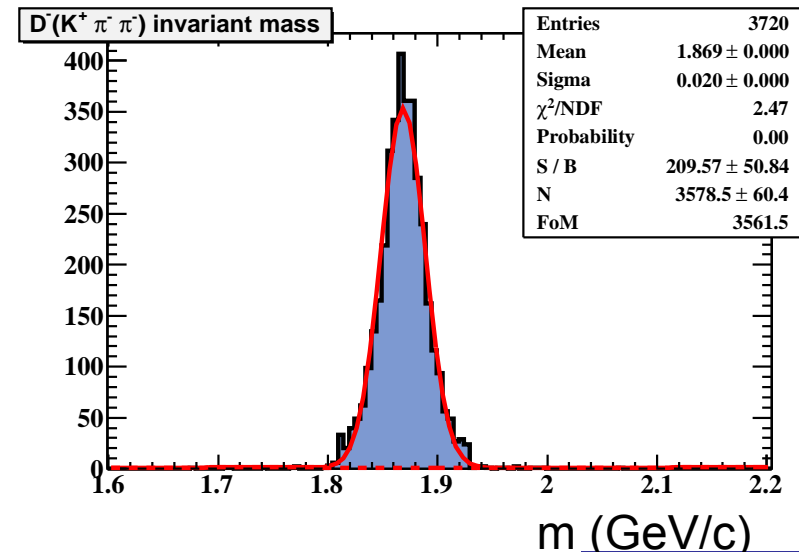
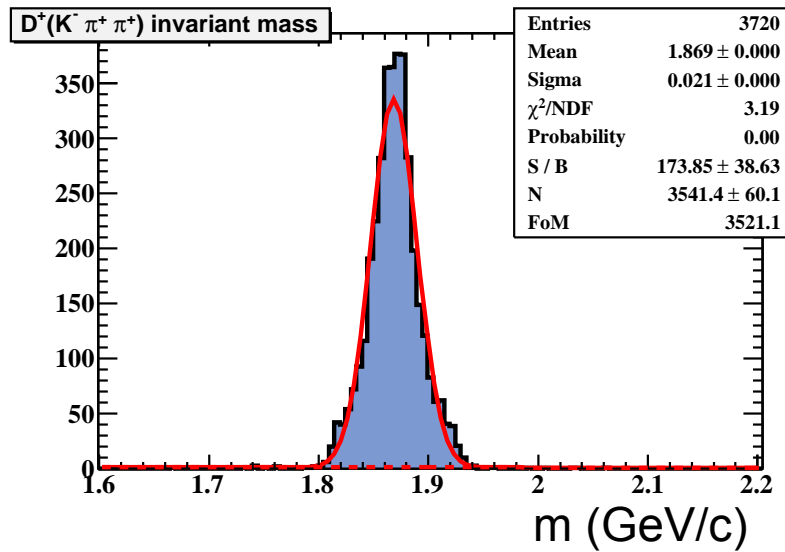


Event selection for Psi(3770)

TPC : D+ and D- after psi selection and psi vertex fit



STT : D+ and D- after psi selection and psi vertex fit

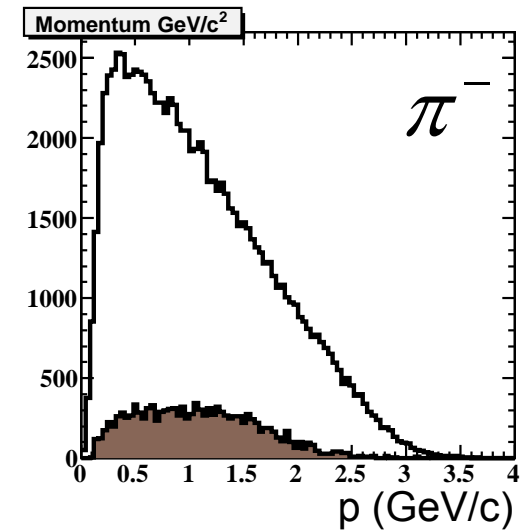
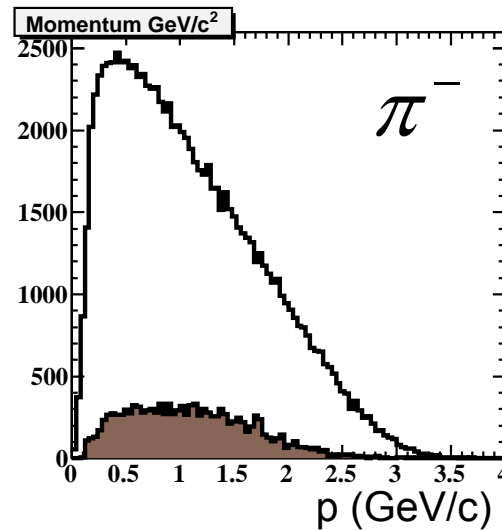
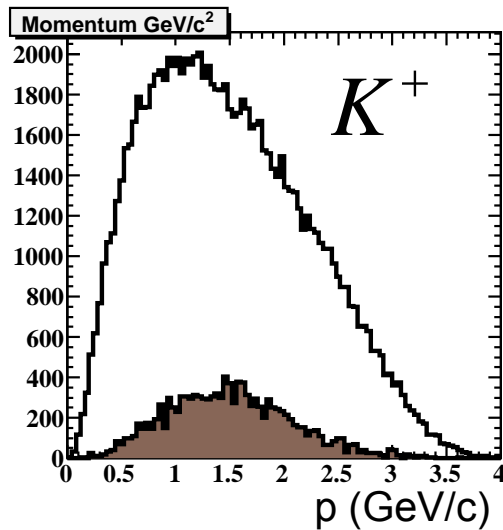
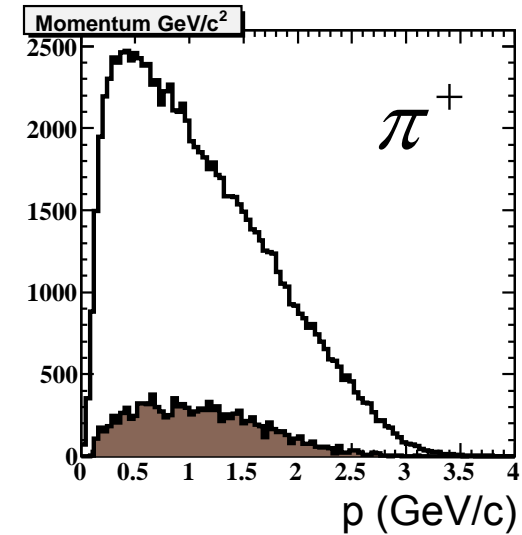
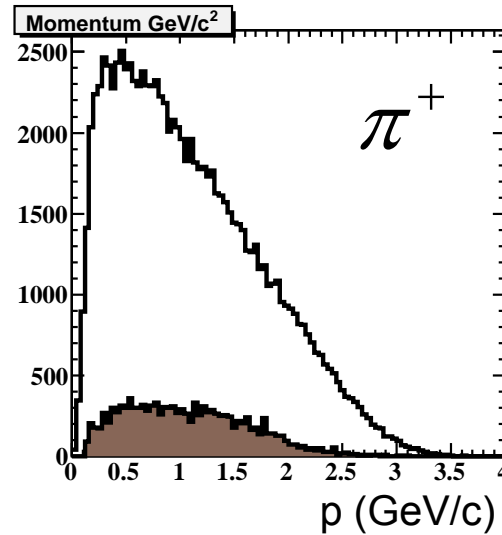
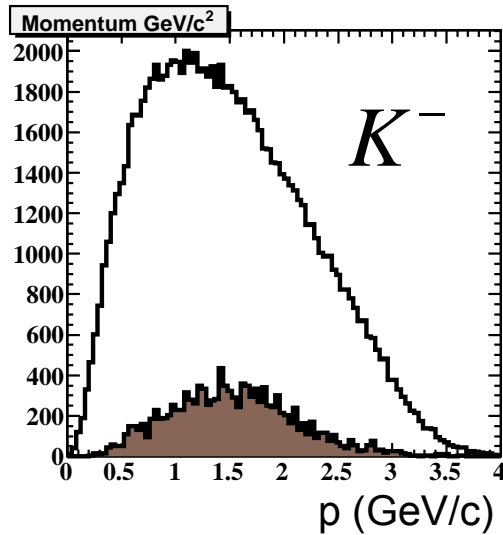




Event selection for Psi(3770)

- psi(3770) momentum : generated vs reconstructed (rec. scaled by factor 5)

TPC mode : momentum p

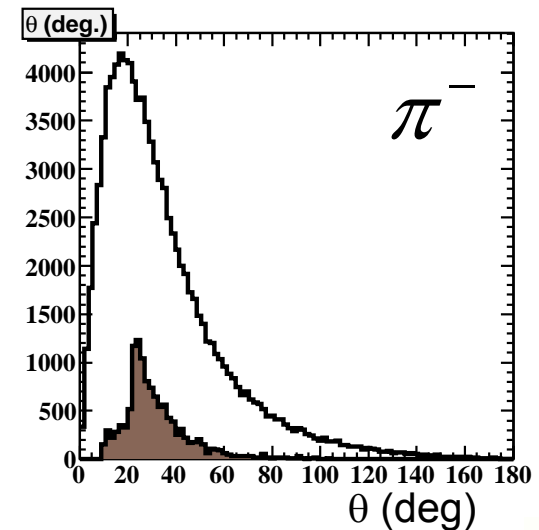
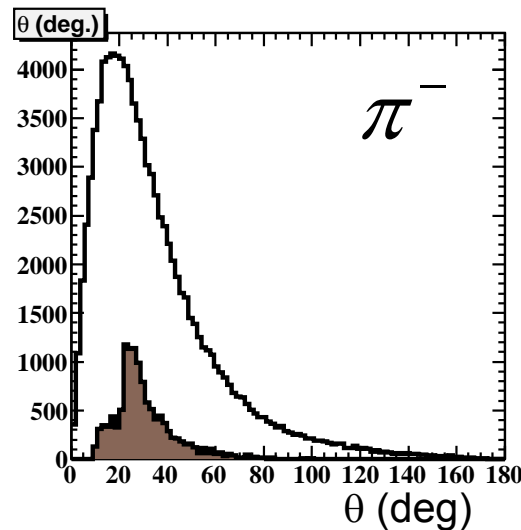
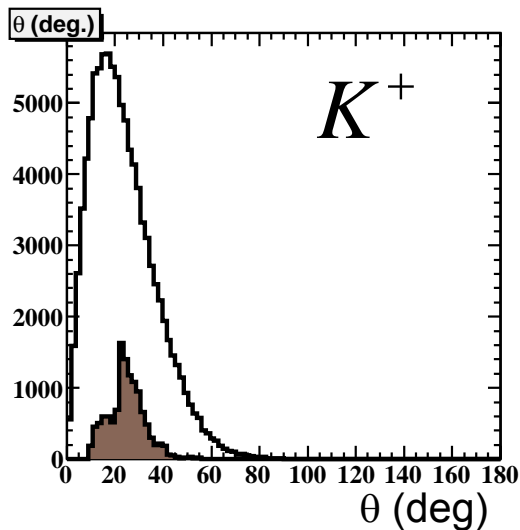
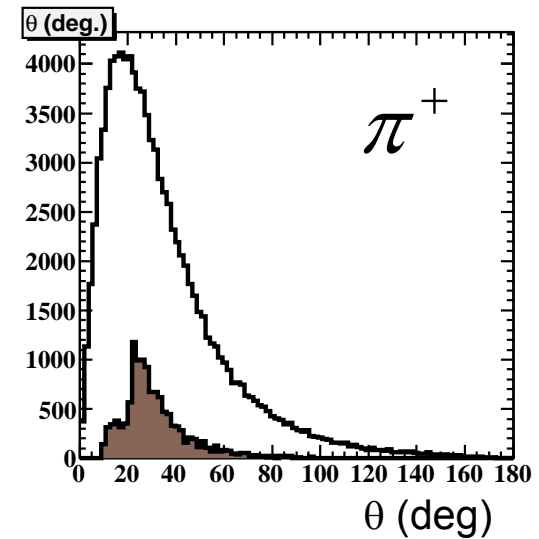
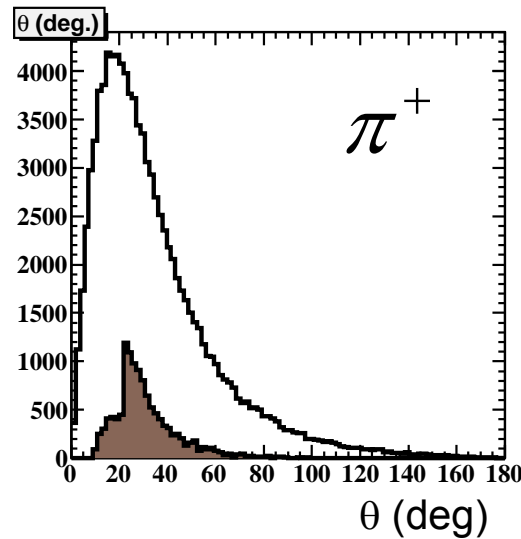
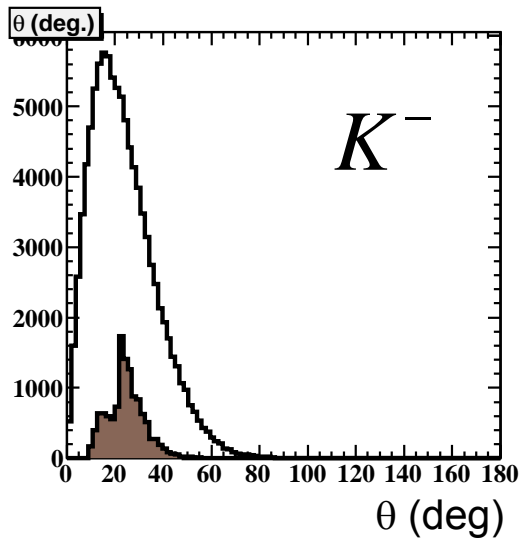




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- psi(3770) momentum : generated vs reconstructed (rec. scaled by factor 5)

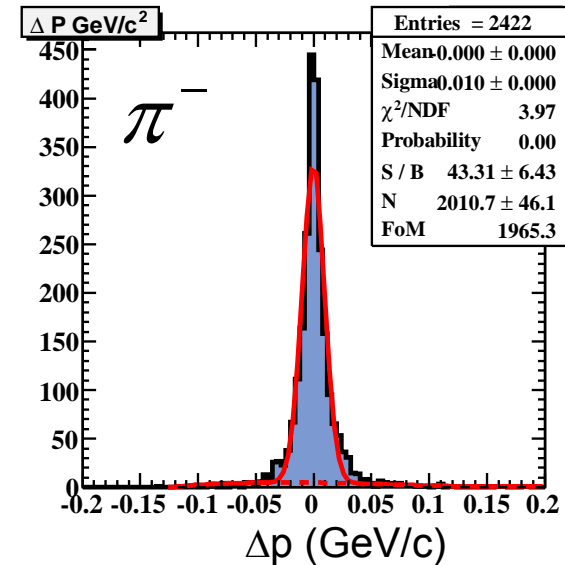
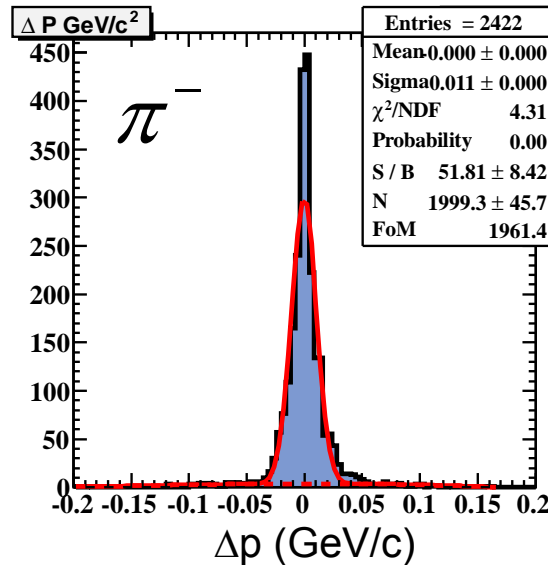
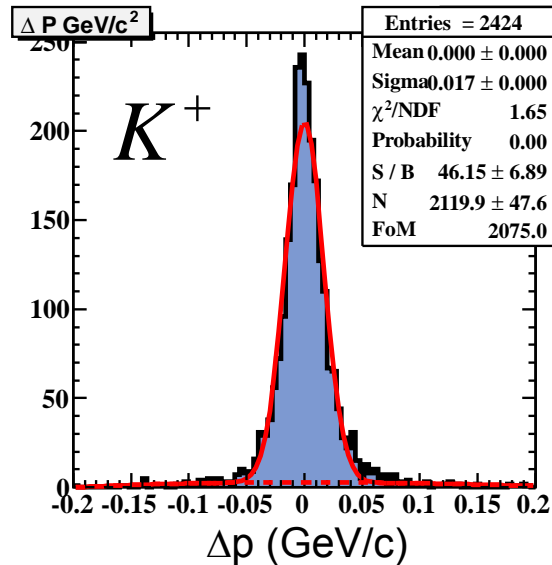
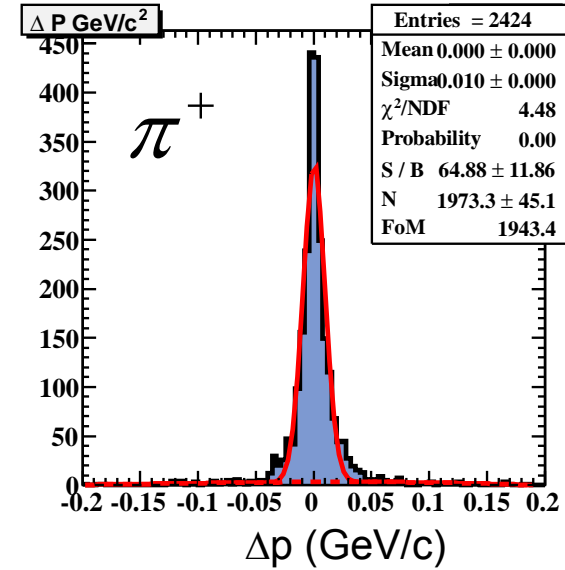
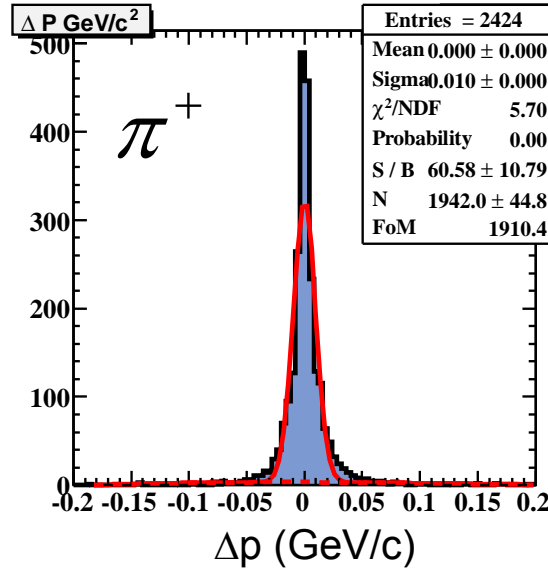
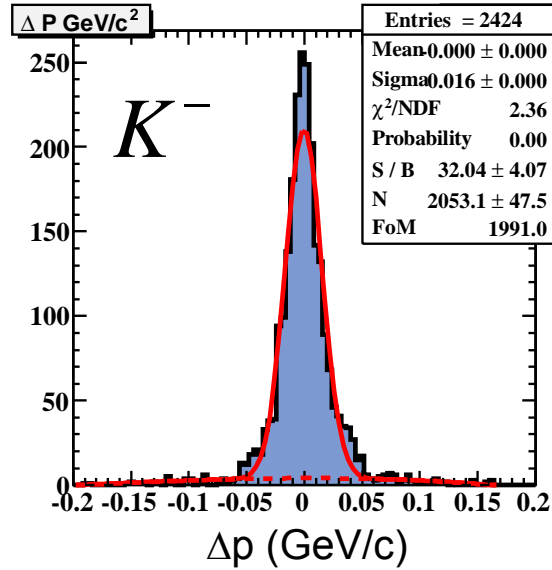
TPC mode : theta θ





Event selection for Psi(3770)

TPC mode : momentum resolution

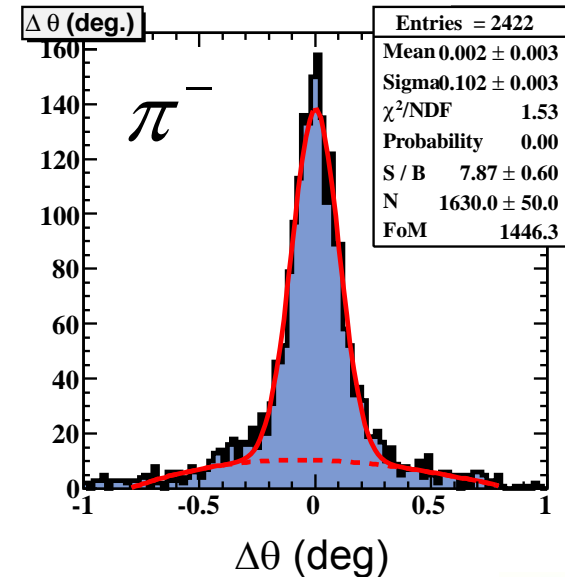
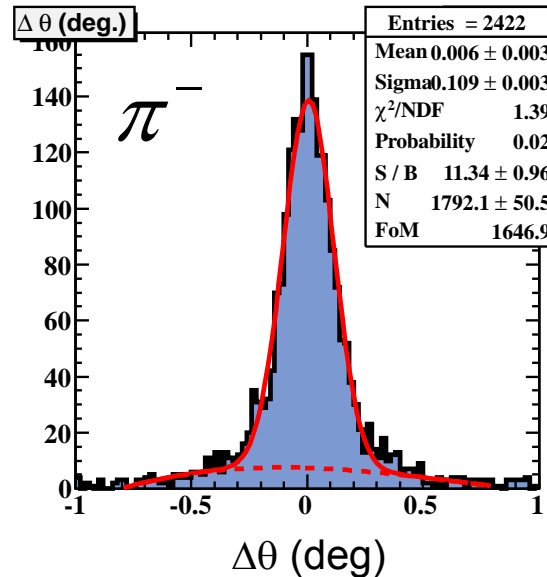
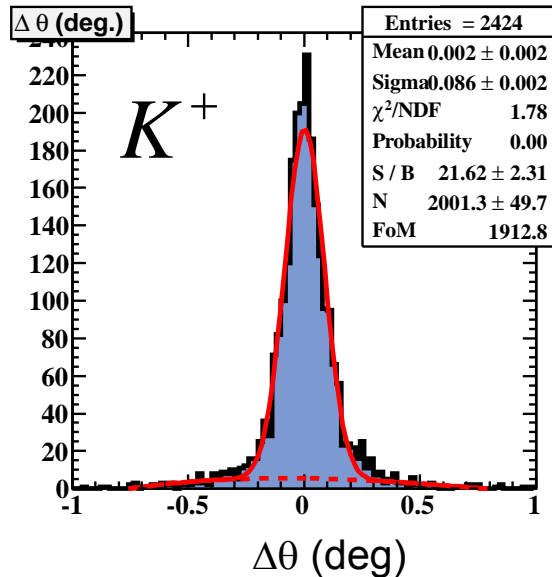
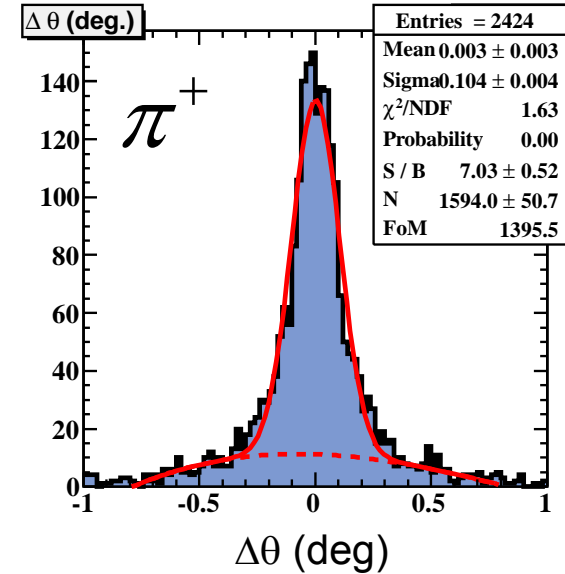
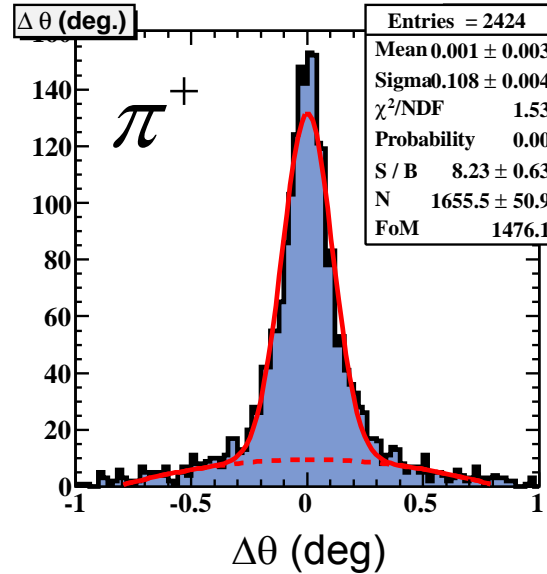
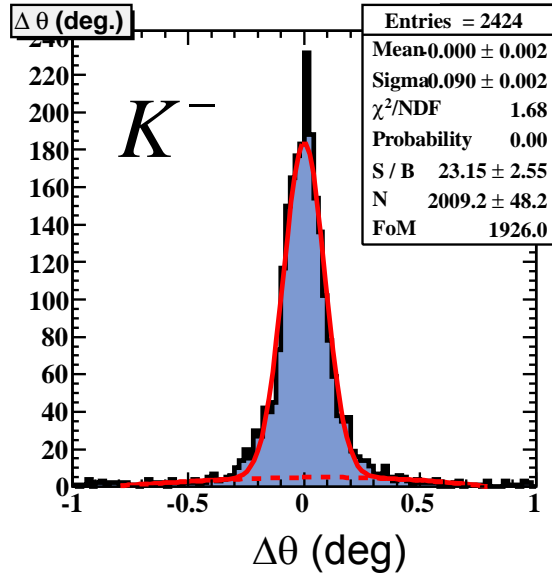


final data sample and additional true MC "index" matching



Event selection for Psi(3770)

TPC mode : theta resolution



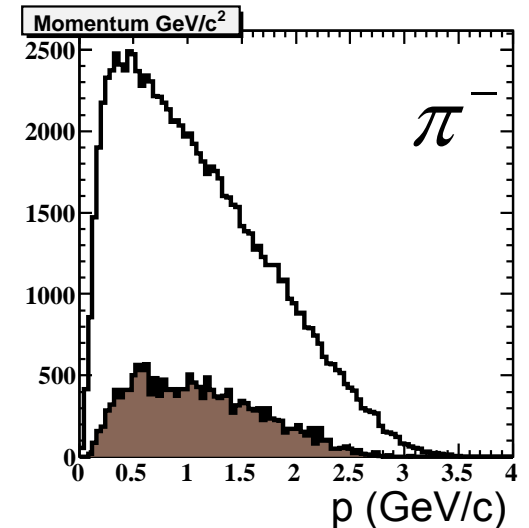
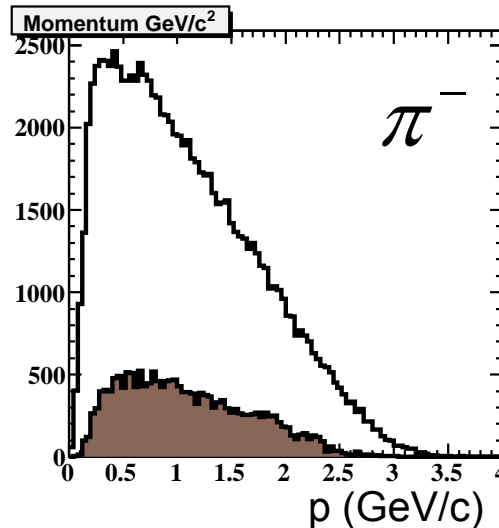
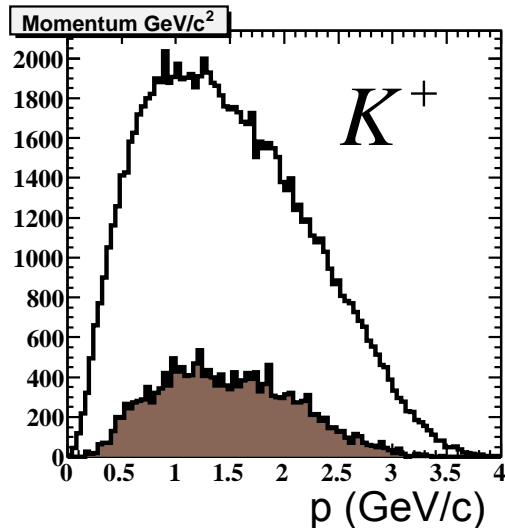
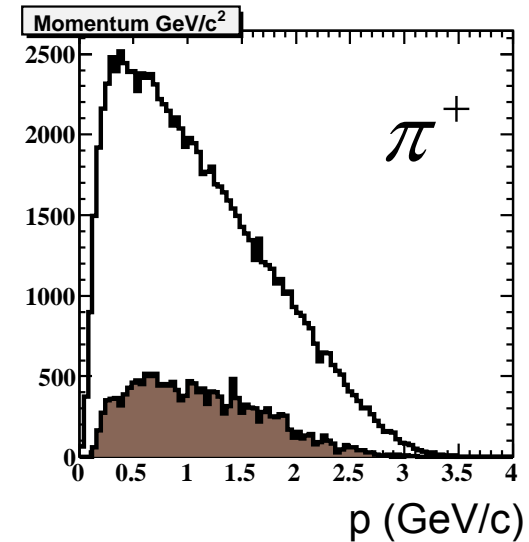
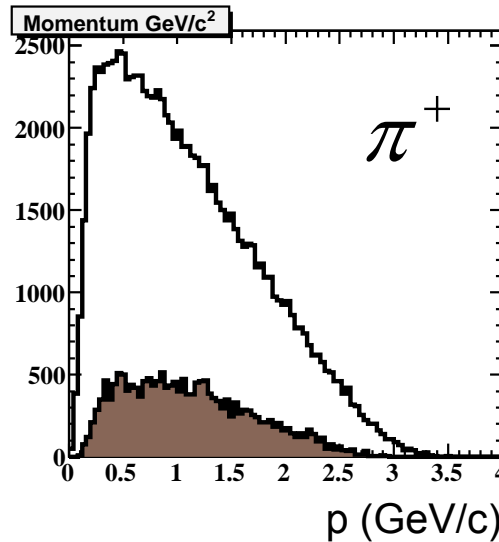
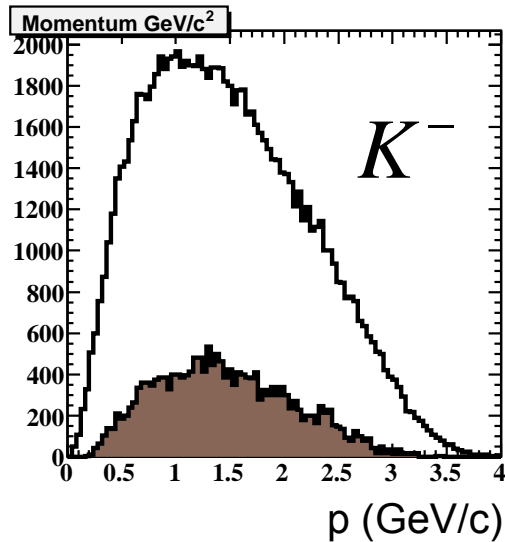
final data sample and additional true MC "index" matching



Event selection for Psi(3770)

- psi(3770) momentum : generated vs reconstructed (rec. scaled by factor 5)

STT mode : momentum p

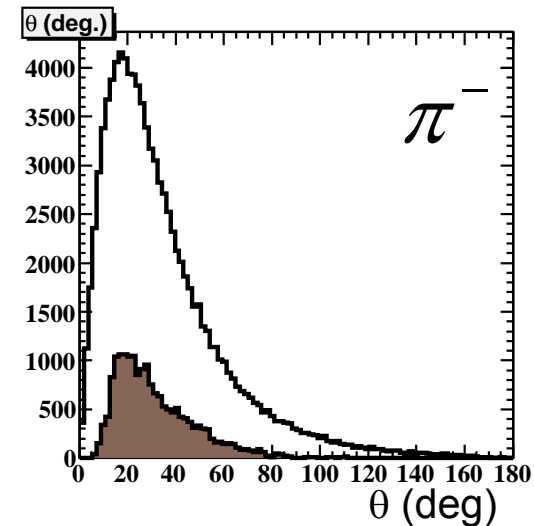
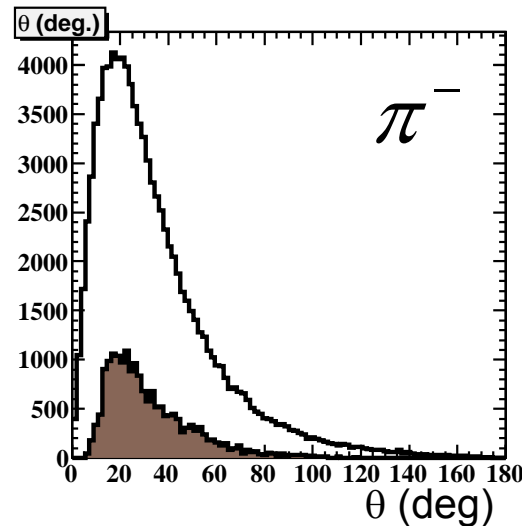
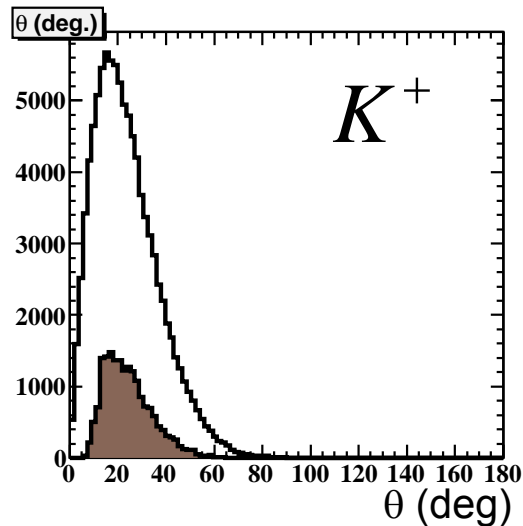
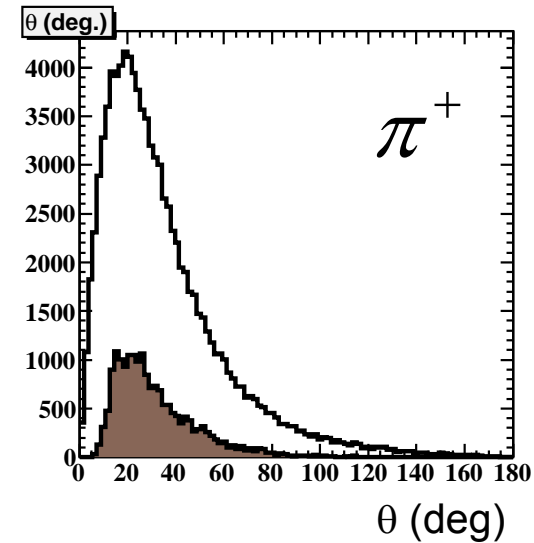
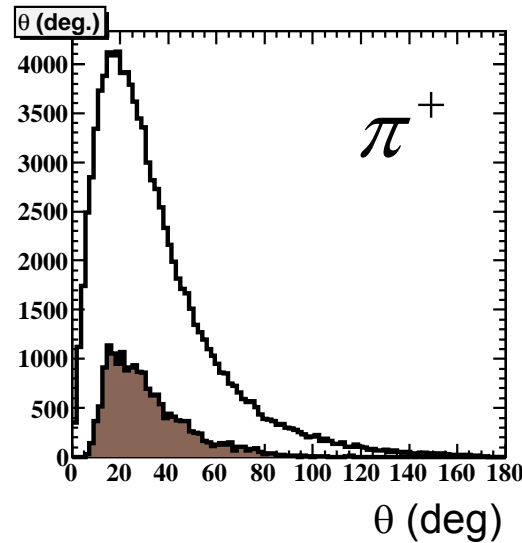
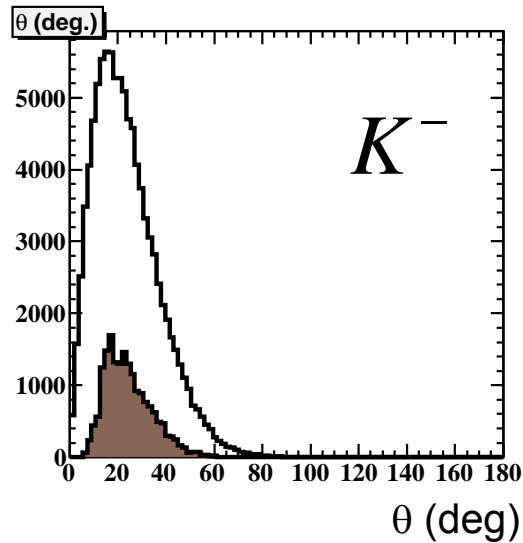




Event selection for Psi(3770)

- psi(3770) momentum : generated vs reconstructed (rec. scaled by factor 5)

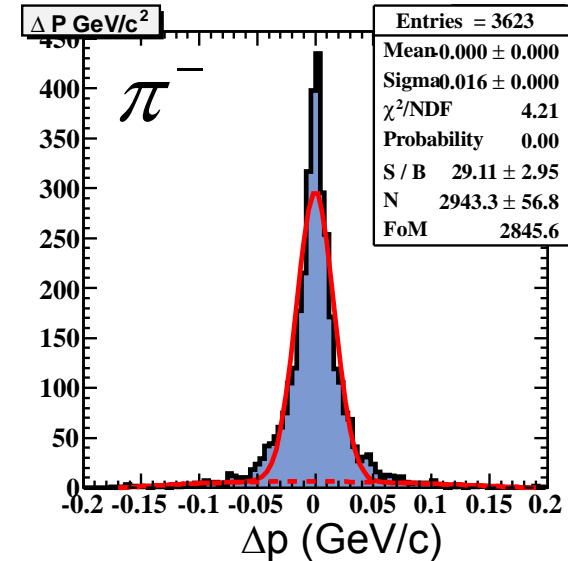
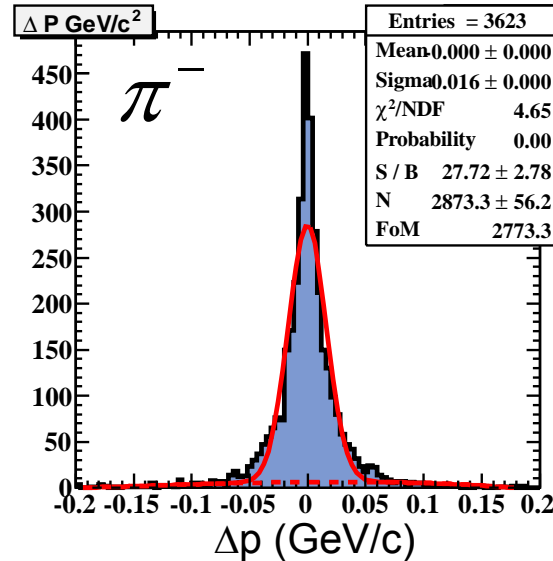
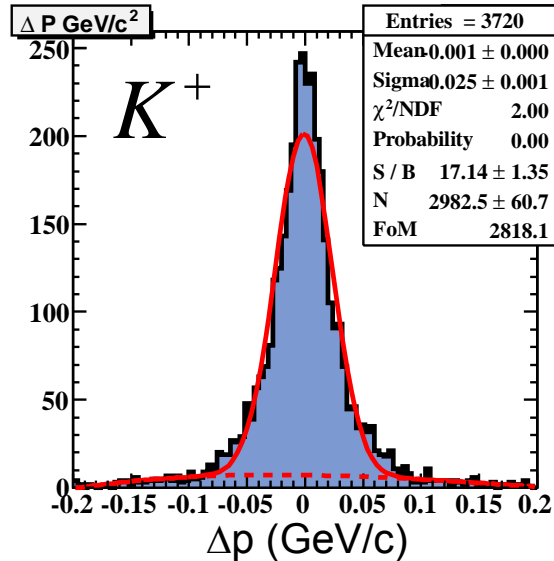
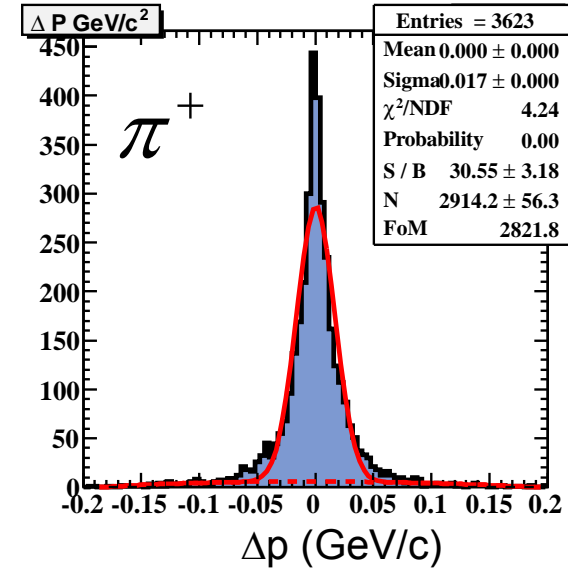
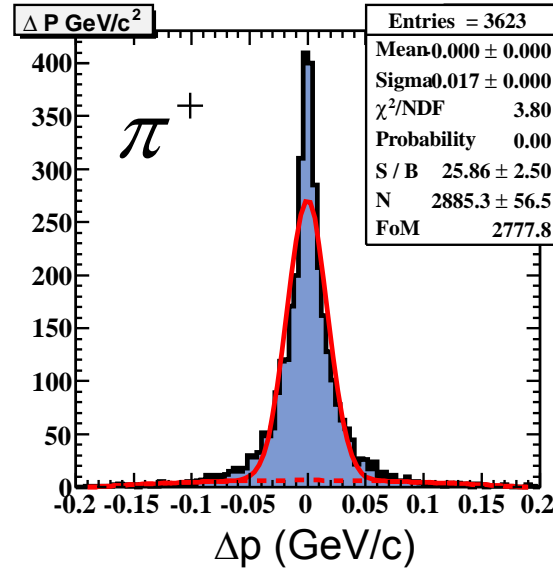
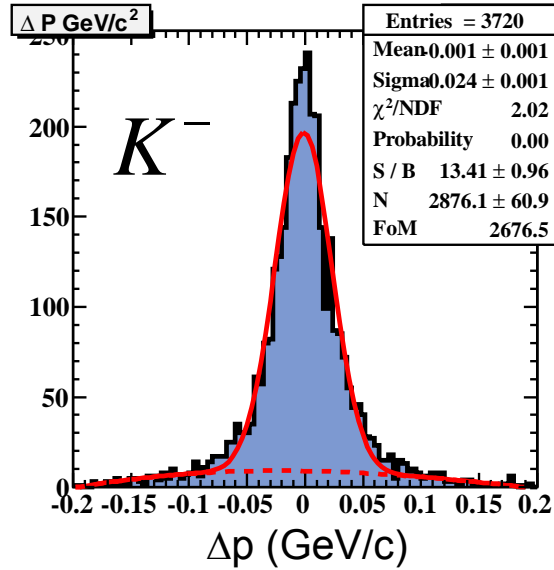
STT mode : theta θ





Event selection for Psi(3770)

STT mode : momentum resolution

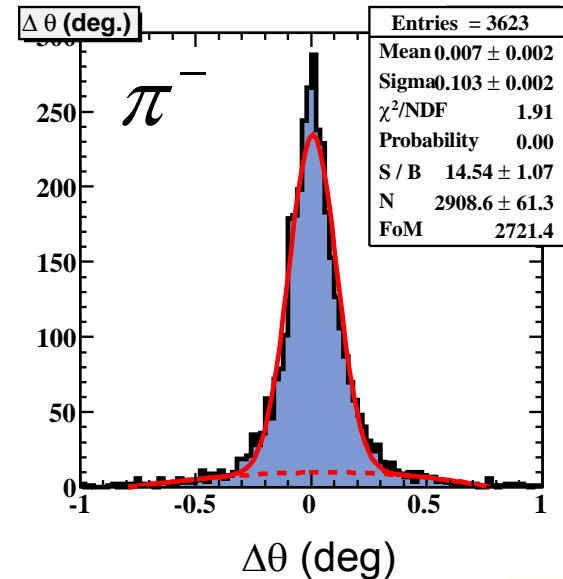
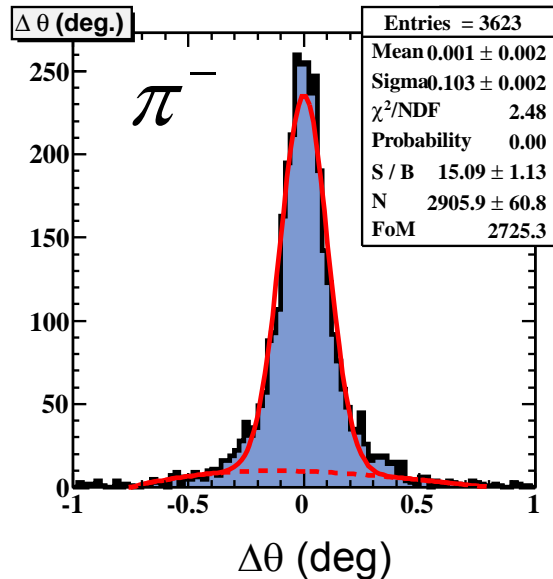
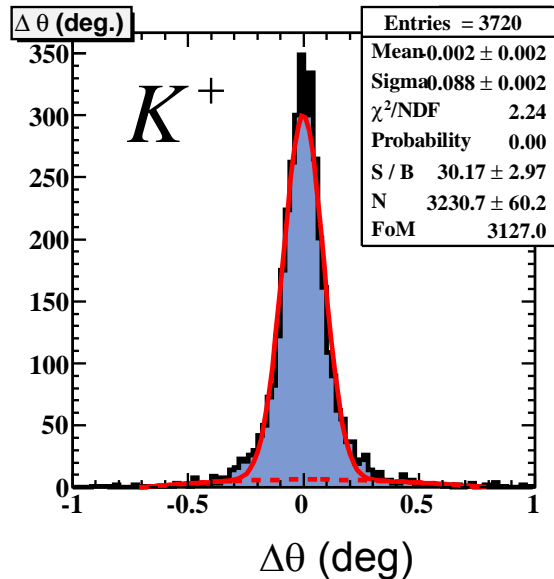
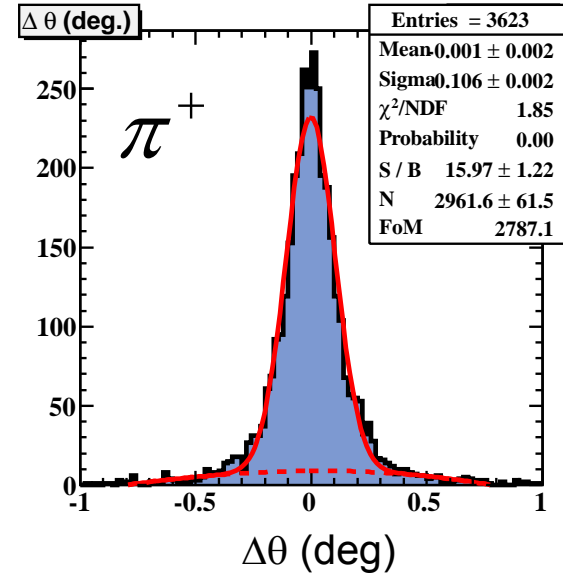
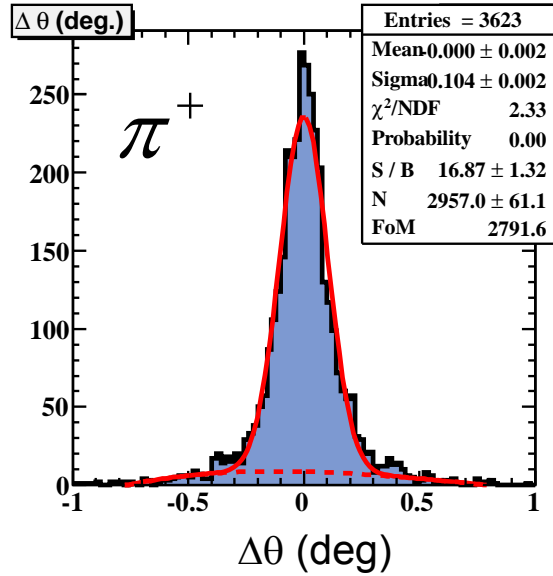
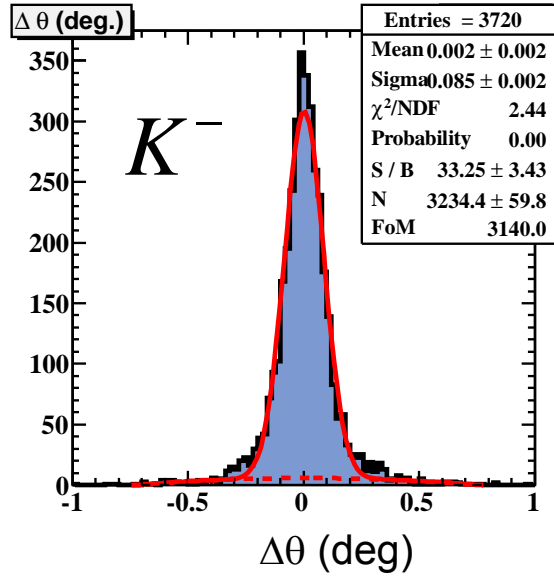


final data sample and additional true MC "index" matching



Event selection for Psi(3770)

STT mode : theta resolution



final data sample and additional true MC "index" matching



Cross check of ψ (3770) benchmark channel

Marius' method : best candidate from χ^2 approach : $\chi^2 < 18$
 mass window of D meson : 10 MeV/c
 D reconstruction \rightarrow D vertex fit \rightarrow ψ reconstruction
 \rightarrow 4C fitting for D \rightarrow found D vertex and mass from fitted D

Donghee's method : best candidate from probability : corresponds $\chi^2 < 14$
 mass window of D meson : 12 MeV/c
 D reconstruction \rightarrow D vertex fit \rightarrow ψ reconstruction
 \rightarrow ψ vertex fitting \rightarrow found D from fitted ψ

	TPC		STT	
	Marius	Donghee	Marius	Donghee
global efficiency. ε	2.3 %	2.5 %	3.8 %	3.8 %
D $^\pm$ vertex resol. x,y	57.5 (μm)	60 (μm)	56 (μm)	60 (μm)
D $^\pm$ vertex resolution z	121.1 (μm)	120 (μm)	106 (μm)	110 (μm)
D $^\pm$ mass resolution	10.3 (MeV/c)	12 (MeV/c)	14.3 (MeV/c)	21 (MeV/c)





General message from psi benchmark study : good performance for both tracker

Comparison of ψ (3770) benchmark channel with TPC and STT

	TPC	STT
global efficiency. ϵ	2.5 %	3.8 %
D^\pm vertex resolution X,Y(μm)	60 (μm)	60 (μm)
D^\pm vertex resolution Z (μm)	120 (μm)	110 (μm)
D^\pm mass resolution	13 (MeV/c)	21 (MeV/c)
$\psi(3770)$ vertex resolution $\Delta x/x, \Delta y/y$	~ 0.06 ($\Delta_{x,y} = 150\mu\text{m}$)	~ 0.06 ($\Delta_{x,y} = 150\mu\text{m}$) †
$\psi(3770)$ vertex resolution $\Delta z/z$	~ 0.22 ($\Delta z = 1.1\text{mm}$)	~ 0.22 ($\Delta z = 1.1\text{mm}$)
$\psi(3770)$ mass resolution	~ 80 (MeV/c)	~ 100 (MeV/c)
K^\pm p momentum resolution	17 (MeV/c)	25 (MeV/c)
K^\pm θ theta resolution	0.090 (deg)	0.088 (deg) ‡
π^\pm p momentum resolution	11 (MeV/c)	17 (MeV/c)
π^\pm θ theta resolution	0.109 (deg)	0.106 (deg)

† Converting from relative to Δ for $\psi(3770)$ vertex resolution :

$\Delta x, \Delta y$ @ $x,y=0.25\text{cm}$; Δz @ $z=0.5\text{cm}$

‡ 0.1 deg = 1.745 (mrad)

