

η_c analysis for Central Tracking selection

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Kinematics of the reaction

Relevance for CT study: reaction is a decay of ground state of charmonium η_c with charged tracks in the whole acceptance range of CT in wide range of momenta. Reconstruction of η_c via narrow ϕ resonances provide good perspectives for background suppression.

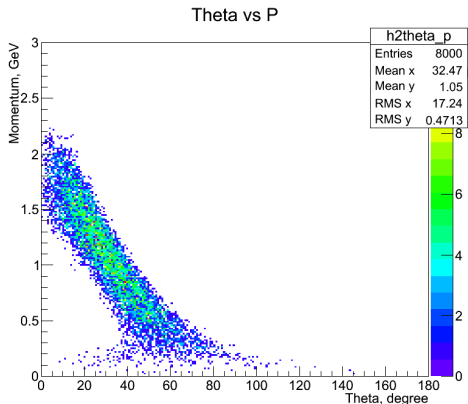
$$p\bar{p} \rightarrow \eta_c \rightarrow \phi\phi \rightarrow K^+K^-K^+K^-,$$

$$BR(\eta_c \rightarrow \phi\phi) = 2.7 \cdot 10^{-3}$$

$$BR(\phi \rightarrow K^+K^-) = 48.9\%$$

$$E_{CM} = 2980 \text{ MeV},$$

$$p_z = 3677 \text{ MeV}$$



- Event generation is performed with EvtGen event generator using SVV_HELAMP decay model
- Monte Carlo simulation, digitization and reconstruction is performed within pandaroot framework
- PID is based on MonteCarlo Truth information
- 100000 events were produced on the grid with STT and TPC (no event mixing)

Figures of merit

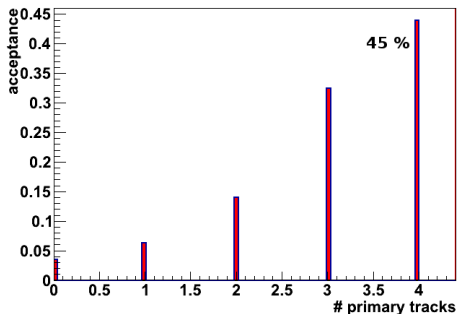
- Efficiency of η_c reconstruction
- Resolution of the reconstructed invariant mass for both η_c and ϕ .

- Analysis is performed with rho package
- No background suppression is studied
- Charged candidates with opposite charge are combined to ϕ candidate with ϕ mass preselection $1.02 \pm 0.1 \text{ GeV}$
- Vertex fit is performed and best η_c candidate in each event is selected by minimal χ^2 .
- Events with ϕ candidate within mass window:
 $1.00 \text{ GeV} < m(K + K^-) < 1.04 \text{ GeV}$ are selected
- η_c is considered as reconstructed if it falls into mass window $[2.90; 3.06] \text{ GeV}$

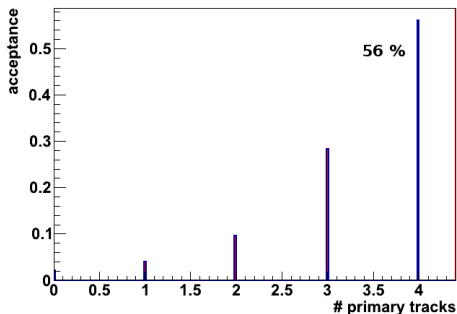
Geometrical acceptance

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

STT

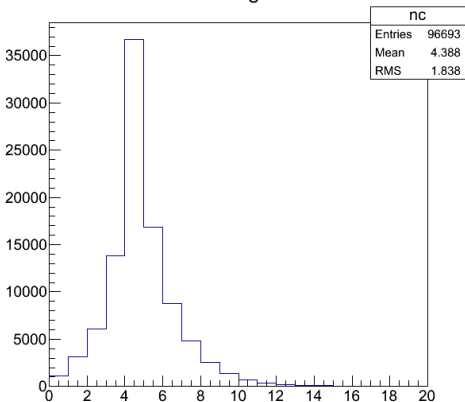


TPC



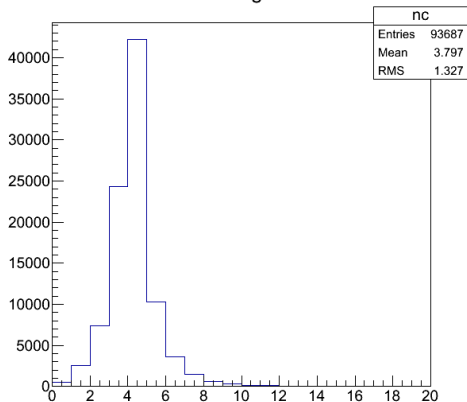
Number of reconstructed charged tracks

STT
n charged



75% ≥ 4 tracks

TPC
n charged

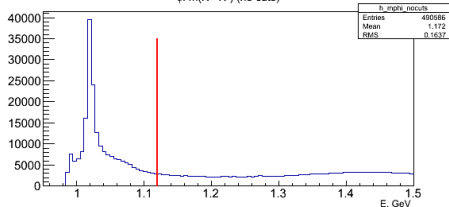


63% ≥ 4 tracks

Invariant mass (Preselection on ϕ mass in a wide window)

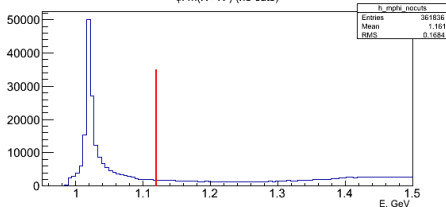
STT

$\phi: m(K^+ K^-)$ (no cuts)

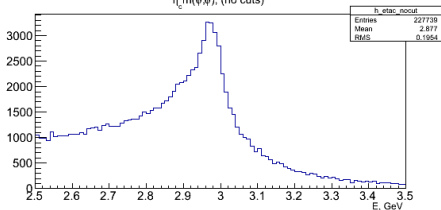


TPC

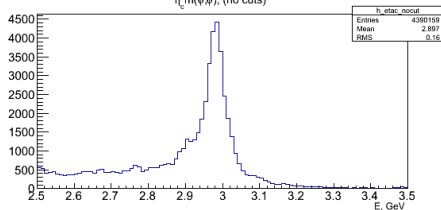
$\phi: m(K^+ K^-)$ (no cuts)



$\eta_c m(\phi\phi)$, (no cuts)



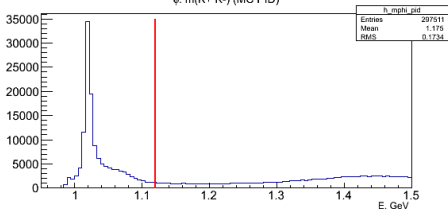
$\eta_c m(\phi\phi)$, (no cuts)



Monte Carlo based PID

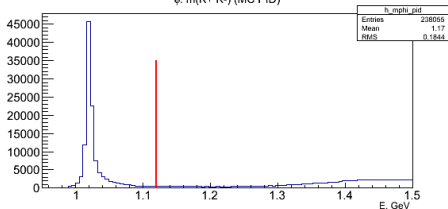
STT

ϕ : $m(K+K^-)$ (MC PID)

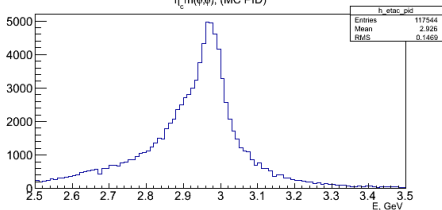


TPC

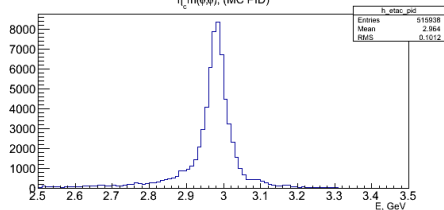
ϕ : $m(K+K^-)$ (MC PID)



η_c $m(\phi,\phi)$ (MC PID)



η_c $m(\phi,\phi)$ (MC PID)

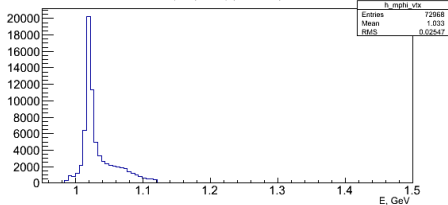


Combinatorial background is significantly reduced for both cases

Best candidate from vertex fit

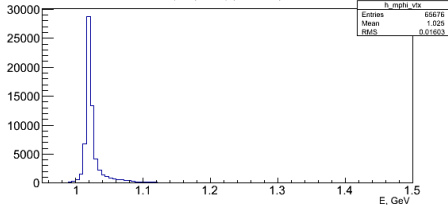
STT

ϕ : $m(K^+ K^-)$ (Vertex fit)

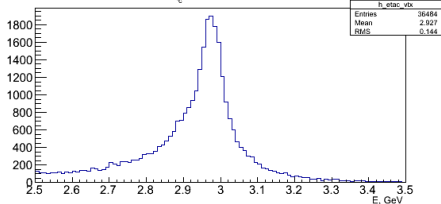


TPC

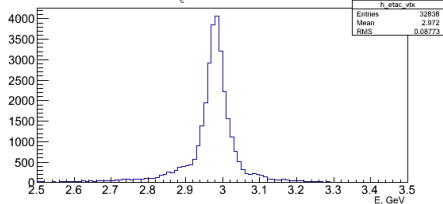
ϕ : $m(K^+ K^-)$ (Vertex fit)



$\eta_c m(\phi, \phi)$, Vertex fit



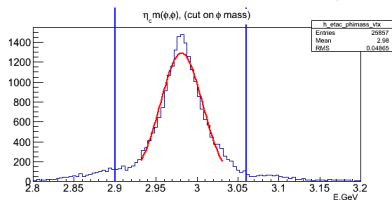
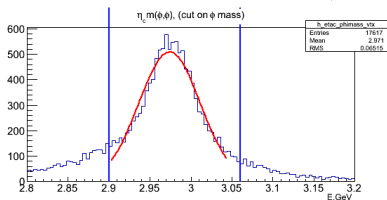
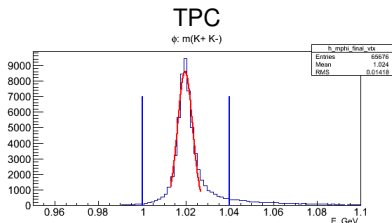
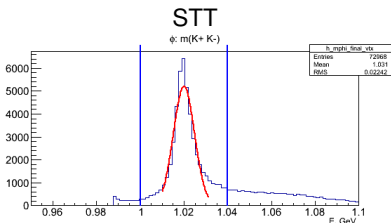
$\eta_c m(\phi, \phi)$, Vertex fit



Two step peak fit:

- First fit with a gaus and extraction of μ, σ
- Second fit with a gaus in the range $[\mu-1.6*\sigma, \mu+1.6*\sigma]$ to extract peak width σ_2

Cut on invariant mass

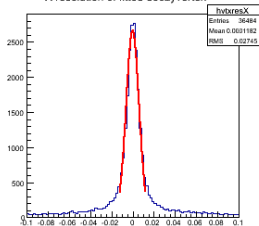


- $\sigma(\phi) = 4.83 \pm 0.02$ MeV
- $\sigma(\eta_c) = 37.4 \pm 0.2$ MeV
- $\varepsilon_{\#} = 12.2 \pm 0.2\%$ or $27.1 \pm 0.3\%$ within detector acceptance

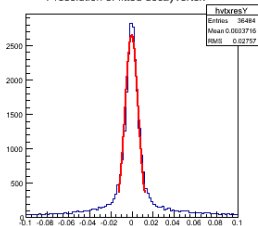
- $\sigma(\phi) = 3.36 \pm 0.02$ MeV
- $\sigma(\eta_c) = 25.8 \pm 0.1$ MeV
- $\varepsilon_{\#} = 23.8 \pm 0.2\%$ or $42.5 \pm 0.3\%$ within detector acceptance

Vertex resolution (STT)

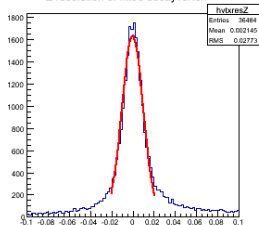
X resolution of fitted decayvertex



Y resolution of fitted decayvertex



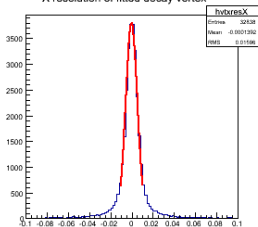
Z resolution of fitted decayvertex



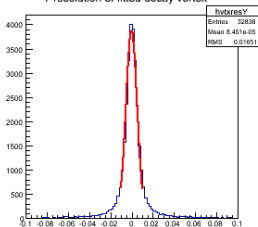
$$\sigma_x = 60.7 \mu m, \sigma_y = 61.6 \mu m, \sigma_z = 99.8 \mu m$$

Vertex resolution (TPC)

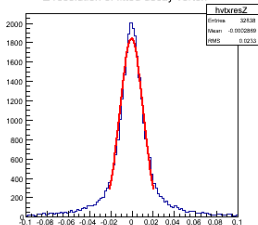
X resolution of fitted decay vertex



Y resolution of fitted decay vertex



Z resolution of fitted decay vertex

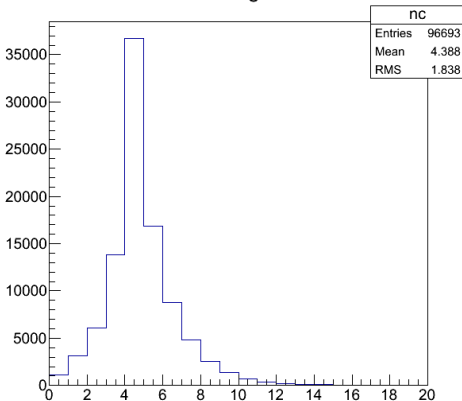


$$\sigma_x = 54.8\mu m, \sigma_y = 52.6\mu m, \sigma_z = 108.2\mu m$$

Comparison of STT results with/without cleanup code

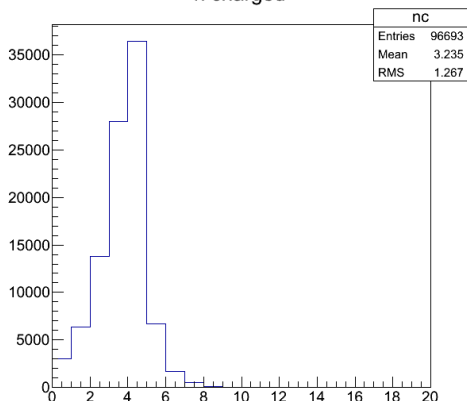
Number of reconstructed charged tracks

STT
n charged



75% ≥ 4 tracks

STT cleanup
n charged

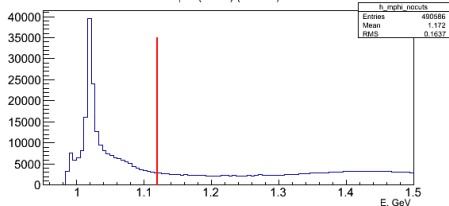


47 % ≥ 4 tracks

Invariant mass (Preselection on ϕ mass in a wide window)

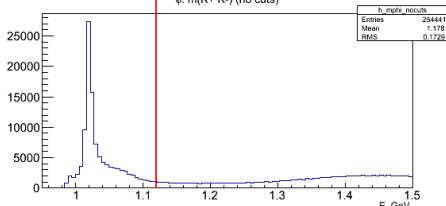
STT

$\phi: m(K^+ K^-)$ (no cuts)

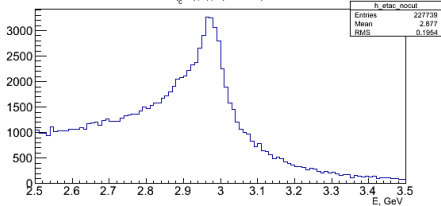


STT cleanup

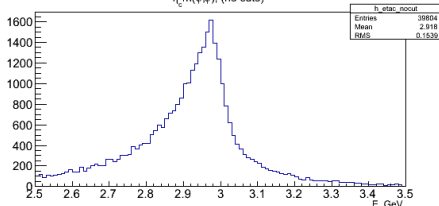
$\phi: m(K^+ K^-)$ (no cuts)



$\eta_c m(\phi, \phi)$ (no cuts)



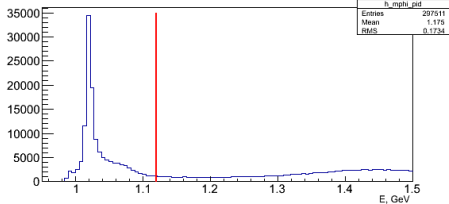
$\eta_c m(\phi, \phi)$ (no cuts)



Monte Carlo based PID

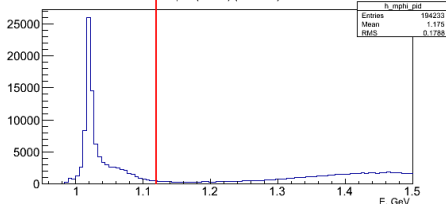
STT

ϕ : m(K+ K-) (MC PID)

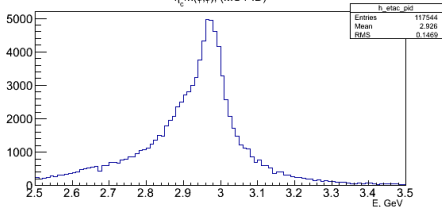


STT cleanup

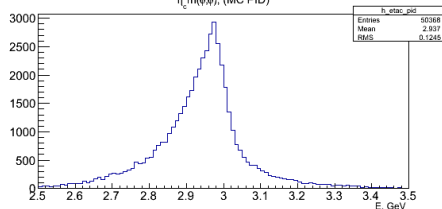
ϕ : m(K+ K-) (MC PID)



η_c : m(ϕ , ϕ) (MC PID)



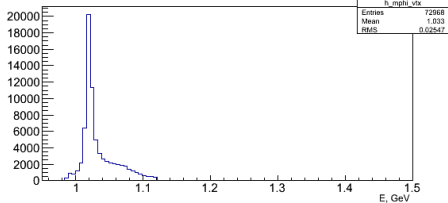
η_c : m(ϕ , ϕ) (MC PID)



Best candidate from vertex fit

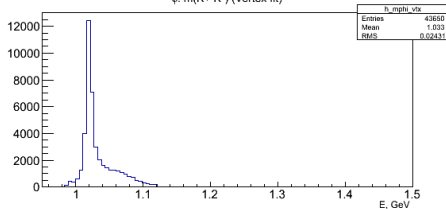
STT

$\phi: m(K^+ K^-)$ (Vertex fit)

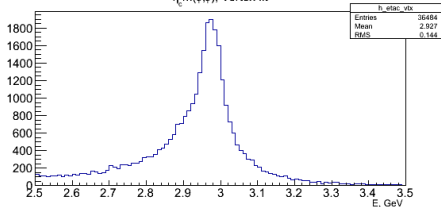


STT cleanup

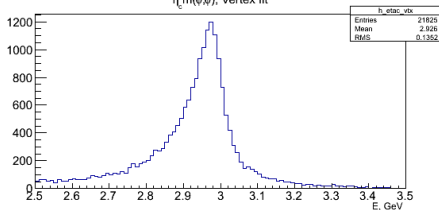
$\phi: m(K^+ K^-)$ (Vertex fit)



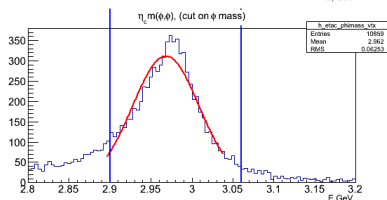
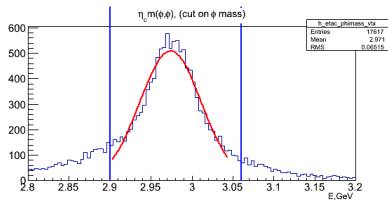
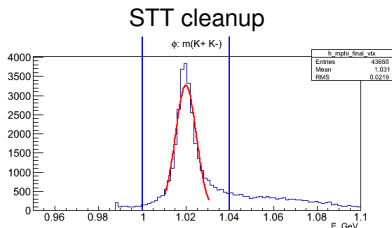
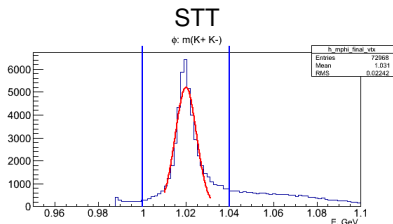
$\eta_c m(\phi, \phi)$, Vertex fit



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Cut on invariant mass



- $\sigma(\phi) = 4.83 \pm 0.02$ MeV
- $\sigma(\eta_c) = 37.4 \pm 0.2$ MeV
- $\varepsilon_{ff} = 12.2 \pm 0.2\%$ or $27.1 \pm 0.3\%$ within detector acceptance

- $\sigma(\phi) = 4.75 \pm 0.04$ MeV
- $\sigma(\eta_c) = 40.5 \pm 0.7$ MeV
- $\varepsilon_{ff} = 7.8 \pm 0.1\%$ or $17.3 \pm 0.3\%$ within detector acceptance