Comparison of K^0_S production in Pythia and FTF at $\sqrt{S}$=10 GeV.

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SPD Physics & MC meeting
19/02/2025

Event and track selection

Event sample

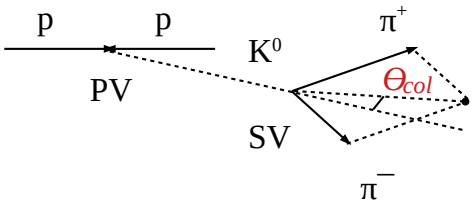
SpdRoot 4.1.7
Generation№1: FTF (p+p) at $\sqrt{S}$=10 GeV.
Generation№2: Pythia 8, (p+p) at $\sqrt{S}$=10 GeV, SoftQCD(MB).

4 000 000 events

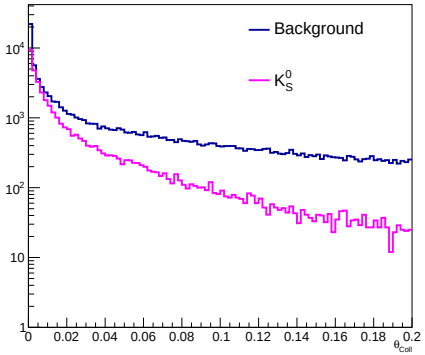
V0 selection:

1. The primary vertex coordinates has a gaussian smearing with $\sigma_z = 30$ cm, $\sigma_x = \sigma_y = 0.1$ cm,
2. Daughters = K^0(-211, 211),Λ(2212,-211),$\bar{\Lambda}$(-2212, 211);
   Bg = (321,-321), (-321,211), (321,-211).
3. For track selection: minimum Its hits = 0;
   total minimum hits = 3.
4. The track candidates were required to be well-fitted and to have a track fit χ^2 over the number of degrees of freedom less than 6 ($\chi^2/NDF < 6$).
5. Minimum χ^2_{V0} track to PV is less than 2.
6. Track extrapolation χ^2 is more than 10.
7. Track fit is converged.

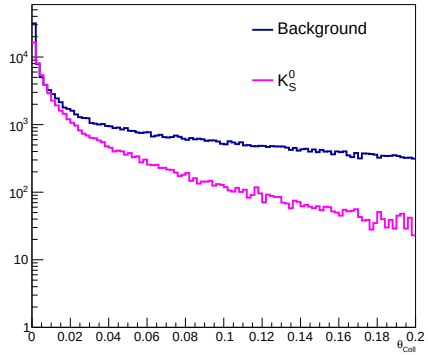
The collinearity cut

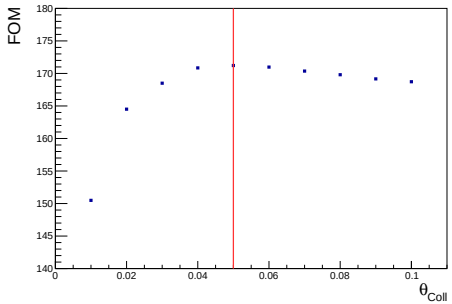


FTF

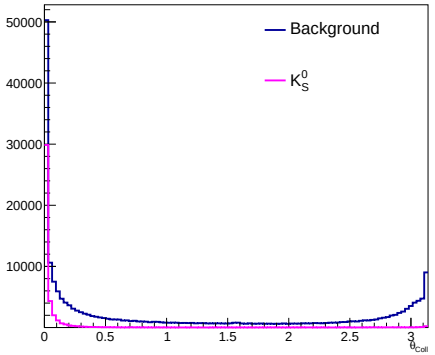


Pythia 8

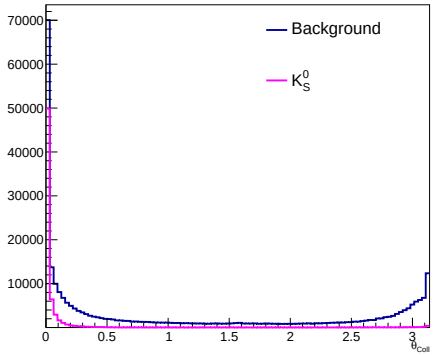




$$FOM = \frac{N_{sig}}{\sqrt{N_{sig}+N_{bg}}}$$



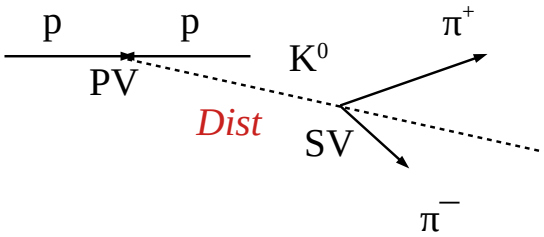
θ_{coll} <0.045



θ_{coll}<0.05

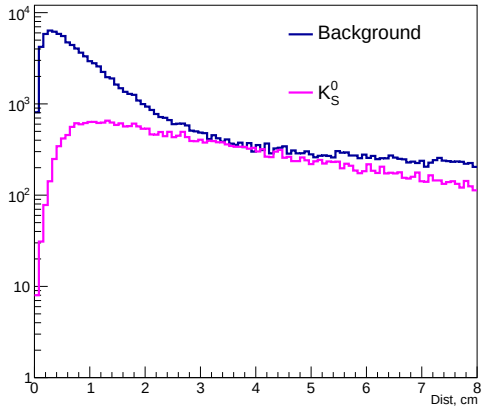
This cut selects V^0 events the momentum looking at the PV.
$\theta_{coll} < 0.05$ rad for K^0_S at $\sqrt{S}$=10 GeV (θ_{coll} <0.03 rad for K^0 at $\sqrt{S}$=27 GeV).

Distance between PV and SV (V0 vertex)

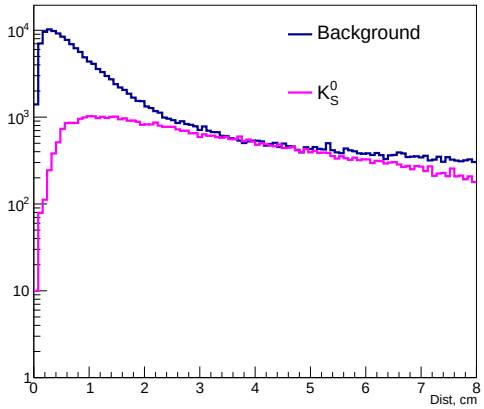


$$Dist = \sqrt{(x_{SV} - x_{PV})^2 + (y_{SV} - y_{PV})^2 + (z_{SV} - z_{PV})^2}$$

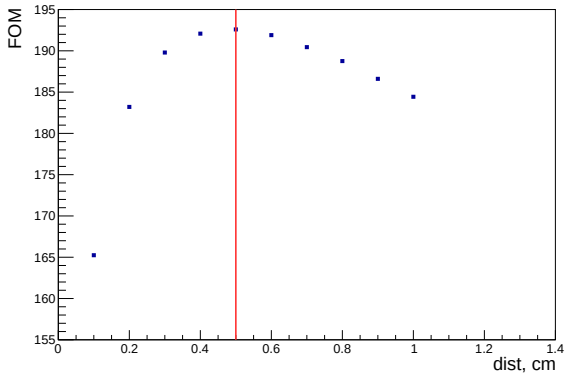
FTF



Pythia8



Pythia8 and FTF: *Dist* >0.5 cm

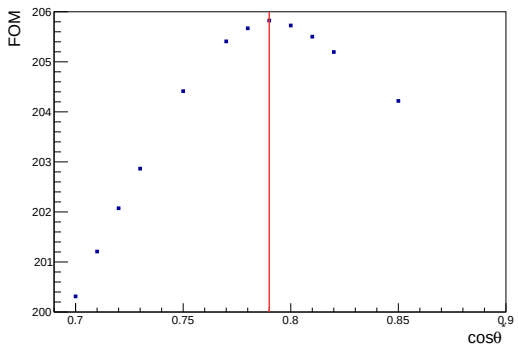


This cut selects V^0 which decay close to PV.

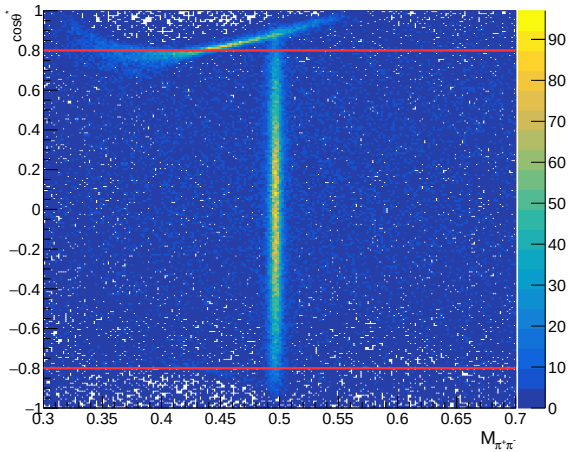
Dist > 0.5 cm for K^0 at $\sqrt{S}$=10 GeV ($Dist > 0.7$ cm for K^0 at $\sqrt{S}$=27 GeV).

Cuts is helicity angle for selestions K^0_S

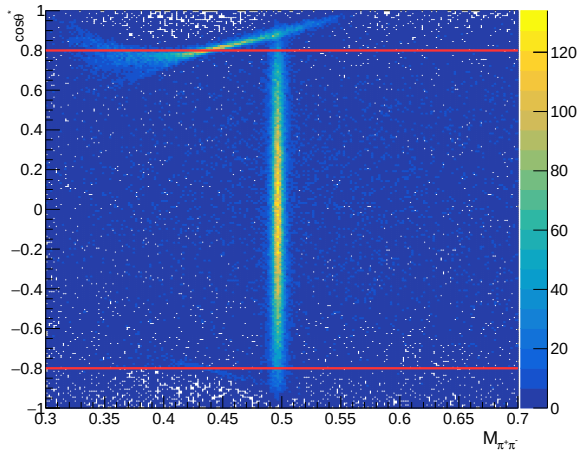
A cut on the "helicity angle θ^* ", defined as the angle between the π^+ momentum vector in the K^0_S, rest frame and the K^0_S fligth direction, was used to remove the Λ and $\bar{\Lambda}$ contamination.



FTF



Pythia 8



$$FOM = \frac{N_{sig}}{\sqrt{N_{sig}+N_{bg}}}$$

$|cos\theta^*| \leqslant 0.78$

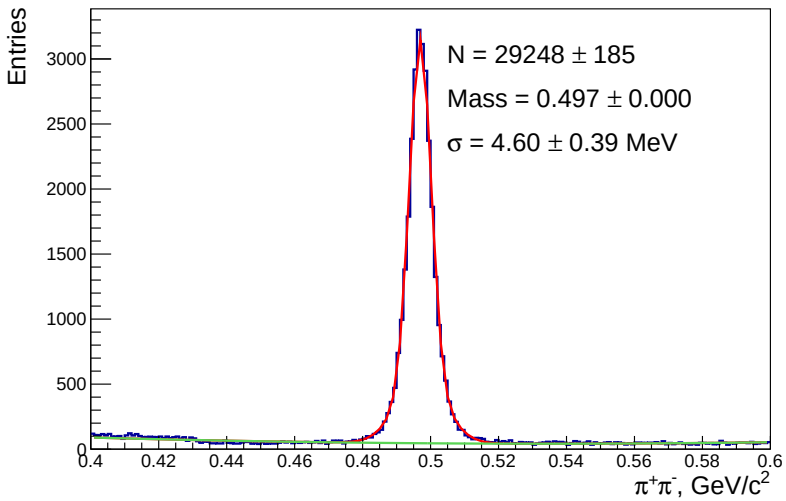
$|cos\theta^*| \leqslant 0.79$

$|cos\theta^*| \leqslant 0.80$ for K^0 at $\sqrt{S}$=10 GeV ($|cos\theta^*| \leqslant 0.80$ for K^0_S at $\sqrt{S}$=27 GeV).

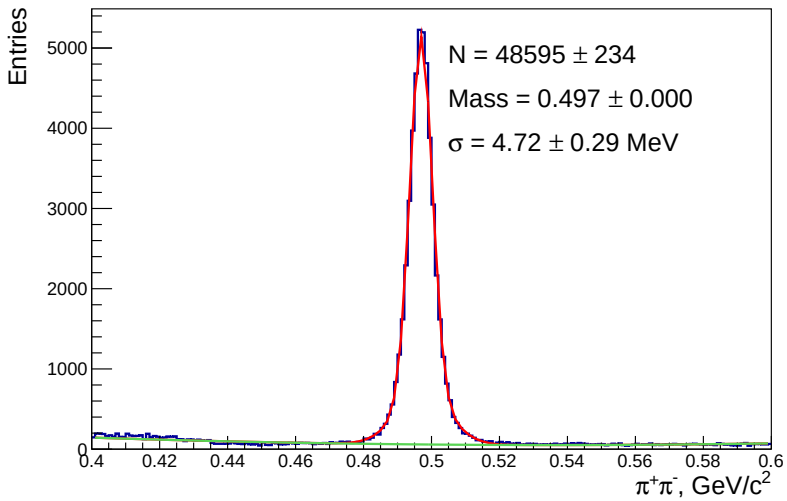
Invariant mass of K^0 for FTF and Pythia8 after all cuts

$4 \cdot 10^6$ events

FTF



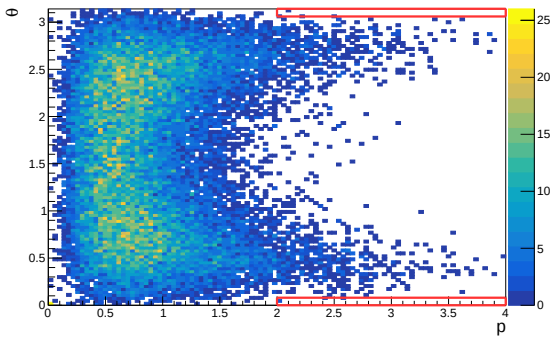
Pythia8

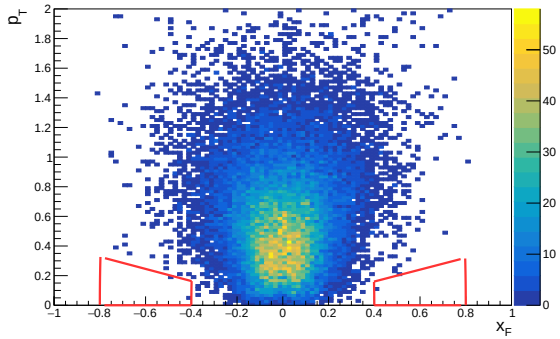


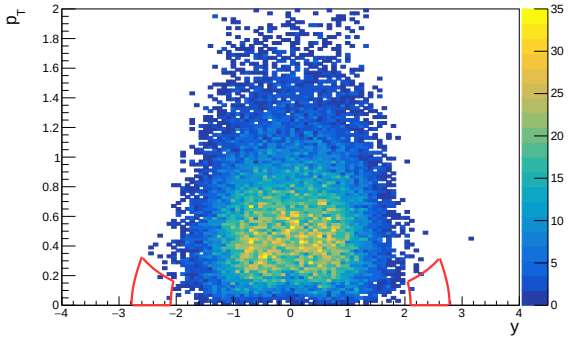
The shape of the K^0_S signal was parametrized by double Gaussian and background was parametrized by the second order polynomial.

Pythia and FTF $\sqrt{S}$=10 GeV, K^0 $\pm 2\sigma$

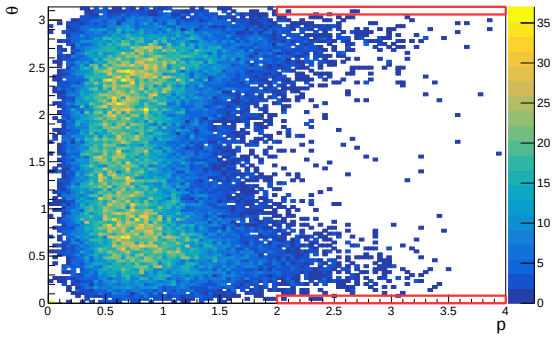
Reconstruction data, FTF:



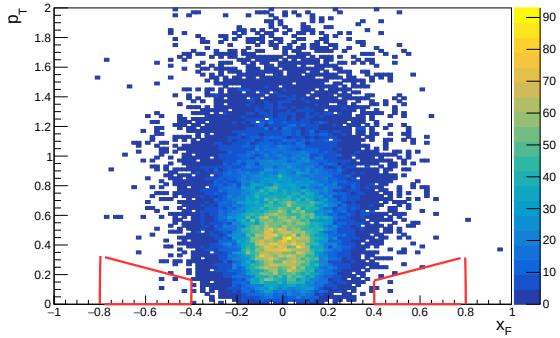




Reconstruction data, Pythia 8:

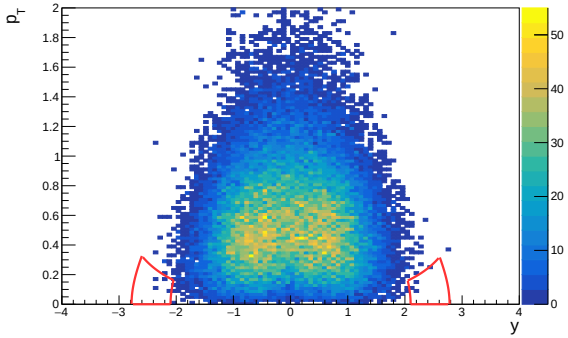


θ - polar angle
p - total momentum



p_T - transverse momentum
x_F - Feynman variable

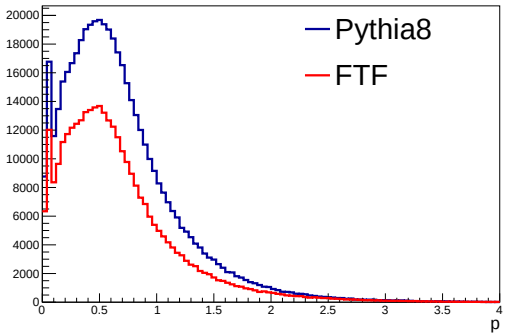
$$x_F = \frac{2p_T}{\sqrt{S}}$$

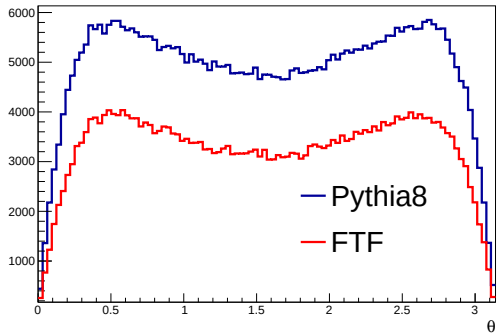


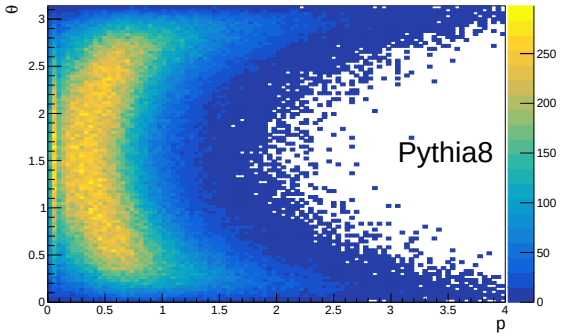
p_T - transverse momentum
y - rapidity

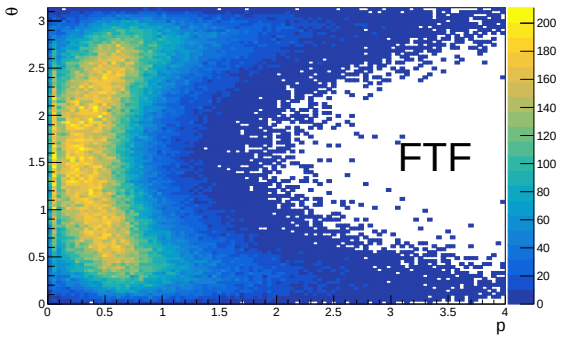
$$y = \frac{1}{2} \ln \frac{\sqrt{p^2+m^2}+p\cos\theta}{\sqrt{p^2+m^2}-p\cos\theta}$$

Distributions of p and θ for Pythia8 and FTF $\sqrt{S}$=10 GeV (true)

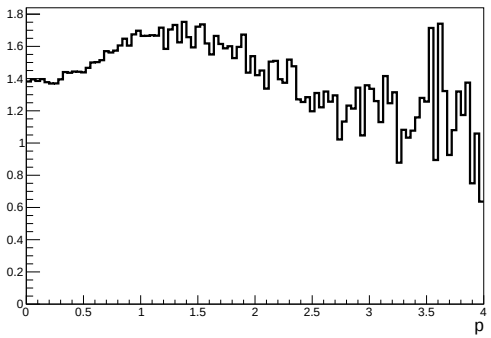




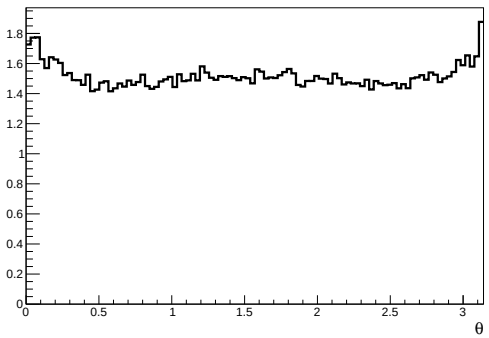




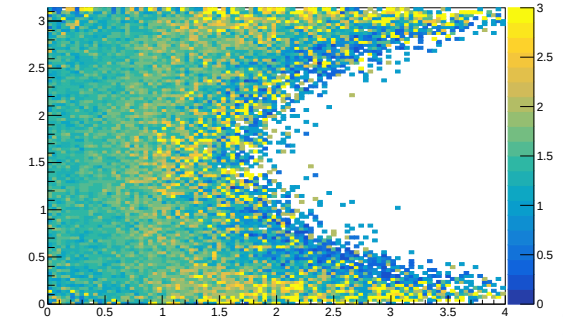
Pythia8/FTF



Pythia8/FTF

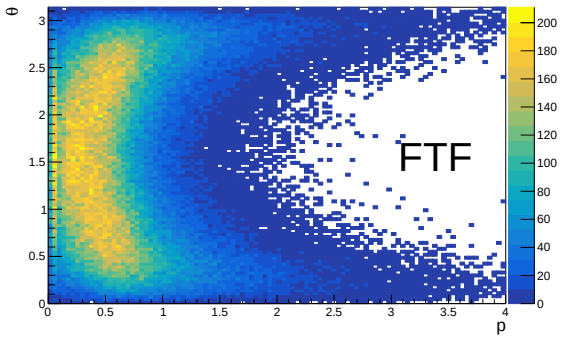


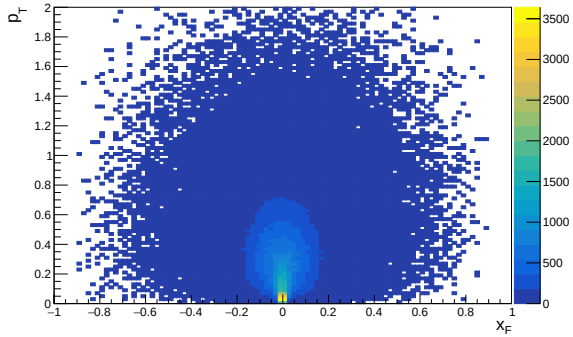
Pythia8/FTF

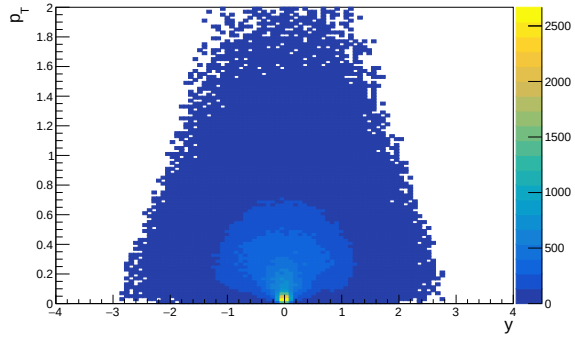


(p, θ), (x_F, p_T) and (y, p_T) phase space at $\sqrt{S}$=10 GeV(true)

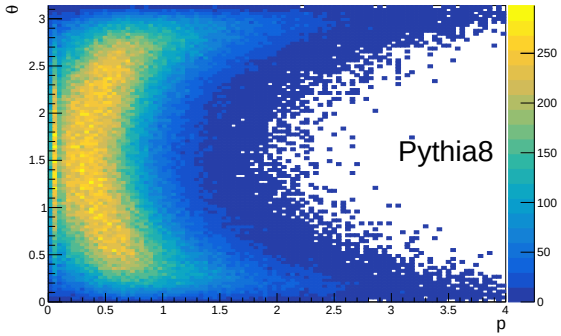
Pure FTF (true), K^0_S:







Pure Pythia 8 (true), K^0_S:



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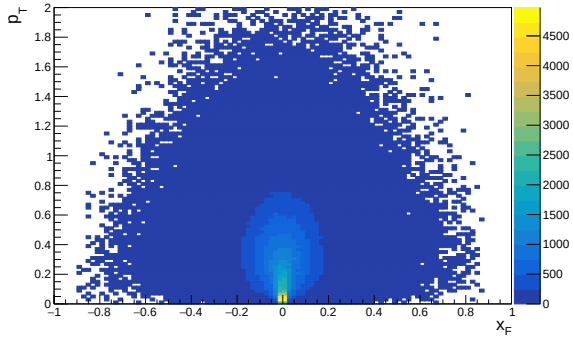
p - total momentum



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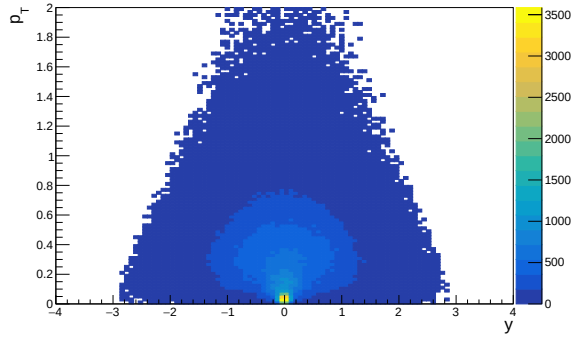
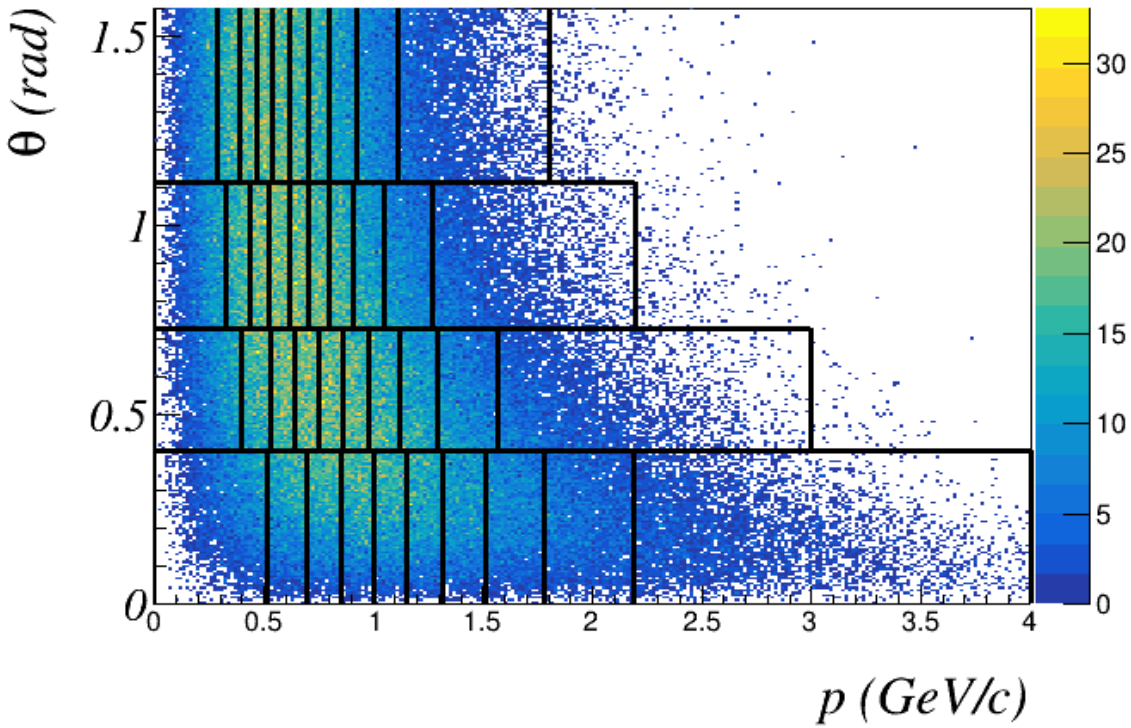
$$x_F = \frac{2p_T}{\sqrt{S}}$$



p_T - transverse momentum
y - rapidity

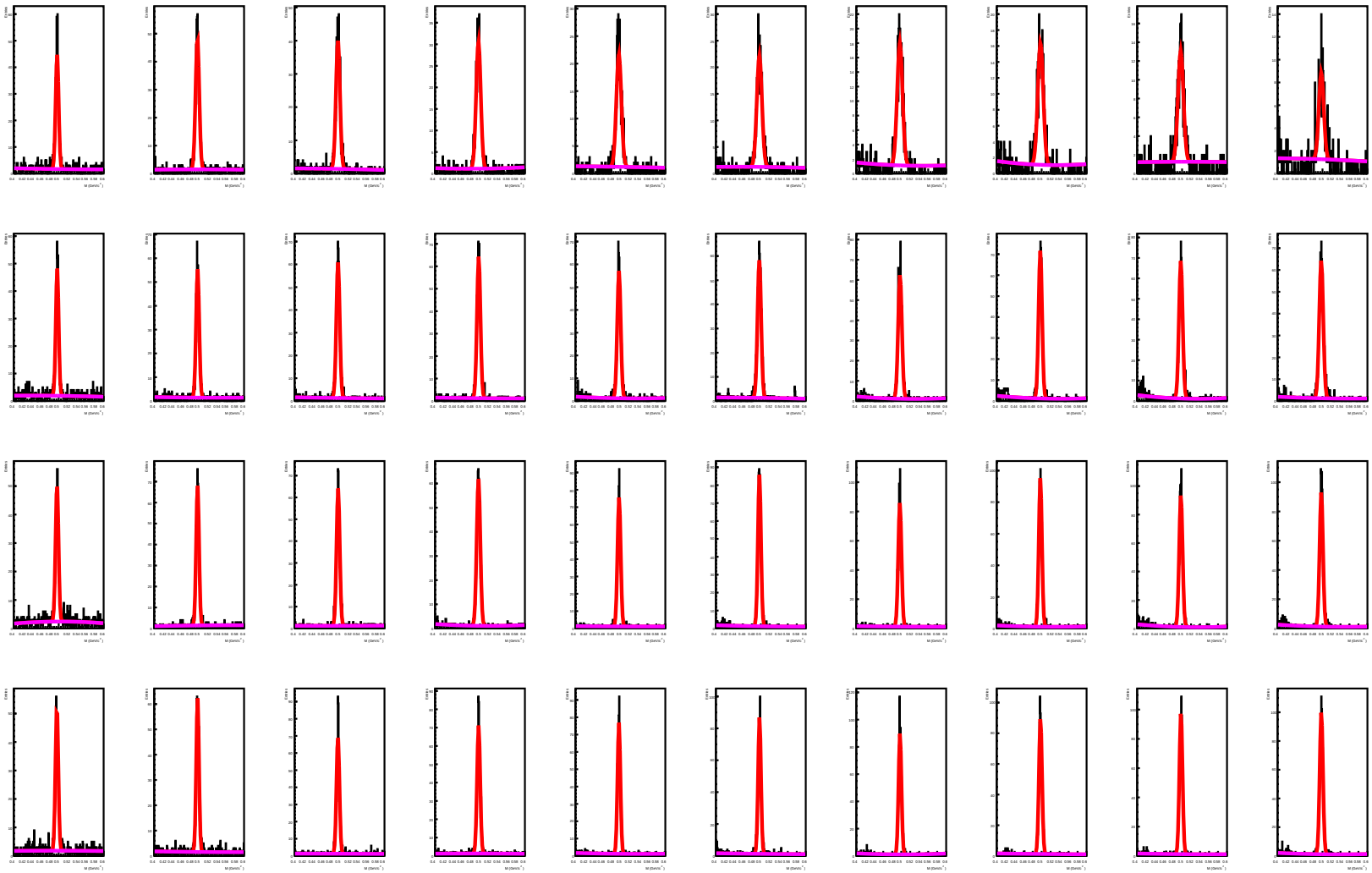
$$y = \frac{1}{2} \ln \frac{\sqrt{p^2+m^2}+p\cos\theta}{\sqrt{p^2+m^2}-p\cos\theta}$$

Binning



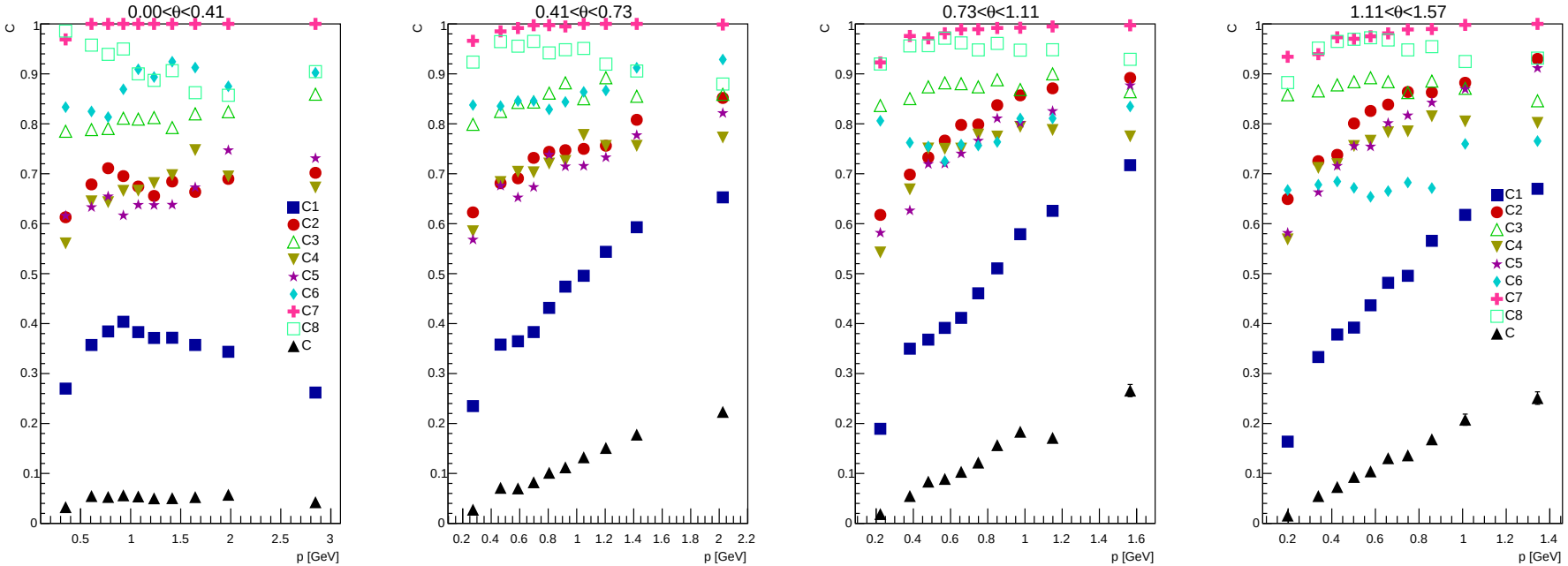
The choice of the binning scheme is obtained from distribution of K^0 simulated in Pythia 8. It was done to have the similar number of K^0 in bins ($n^{\theta}_{bin} = 4, n^{p}_{bin} = 10$).

Distributions of the K_S^0 candidates with all cuts in the binning scheme



FTF (Factorization of the MC correction)

$$C = \frac{N(RD)}{N(K^0_{true}(all))} = C1 * C2 * C3 * C4 * C5 * C6 * C7 * C8$$

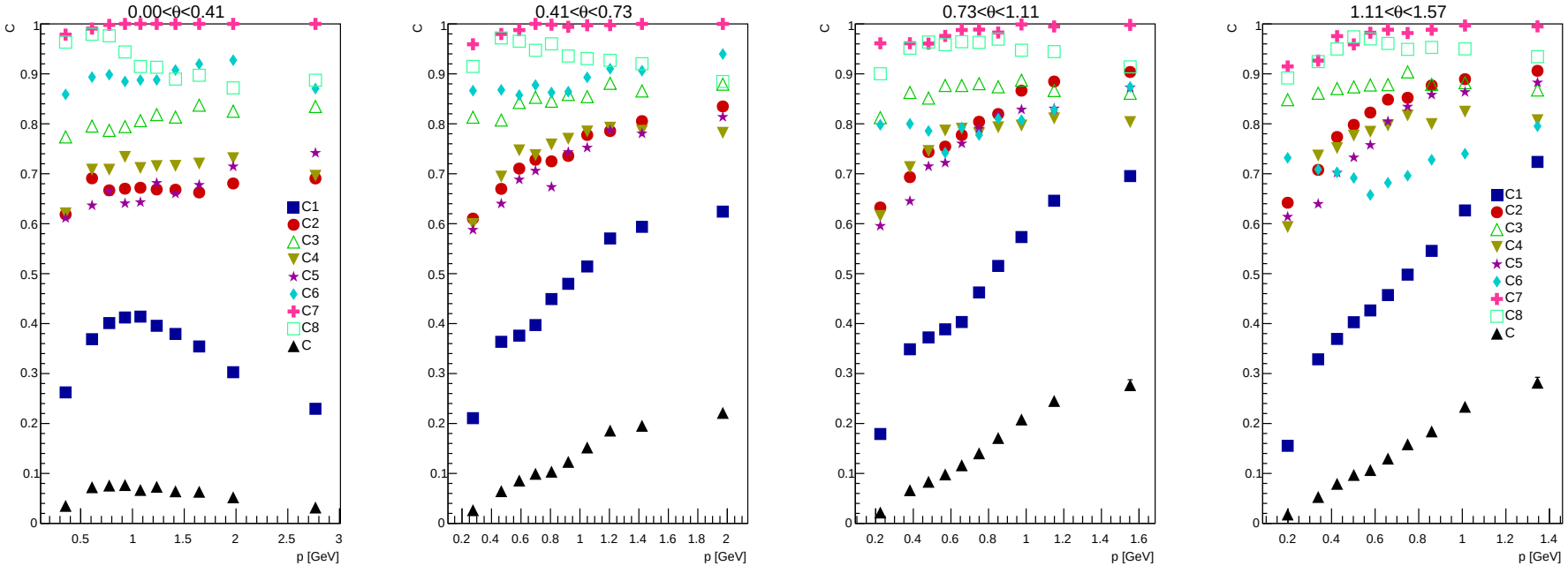


$$C1 = \frac{N(3hits)}{N(K^0_{true}(all))} \qquad C2 = \frac{N(\chi^2/NDF_{tr1,2}<6)}{N(3hits)} \qquad C3 = \frac{N(\chi^2_{V0}<2.0)}{N(\chi^2/NDF_{tr1,2}<6)} \qquad C4 = \frac{N(\chi^2_{tr1,2}{}^{toPV}>10)}{N(\chi^2_{V0}<2.0)}$$

$$C5 = \frac{N(convergency==1)}{N(\chi^2_{tr1,2}{}^{toPV}>10)} \qquad C6 = \frac{N(\theta_{coll}<0.03)}{N(convergency==1)} \qquad C7 = \frac{N(Dist>0.7)}{N(\theta_{coll}<0.03)} \qquad C8 = \frac{N(|cos\theta^*|\leqslant 0.7)}{N(Dist>0.7)}$$

Pythia 8 (Factorization of the MC correction)

$$C = \frac{N(RD)}{N(K^0_{true}(all))} = C1 * C2 * C3 * C4 * C5 * C6 * C7 * C8$$



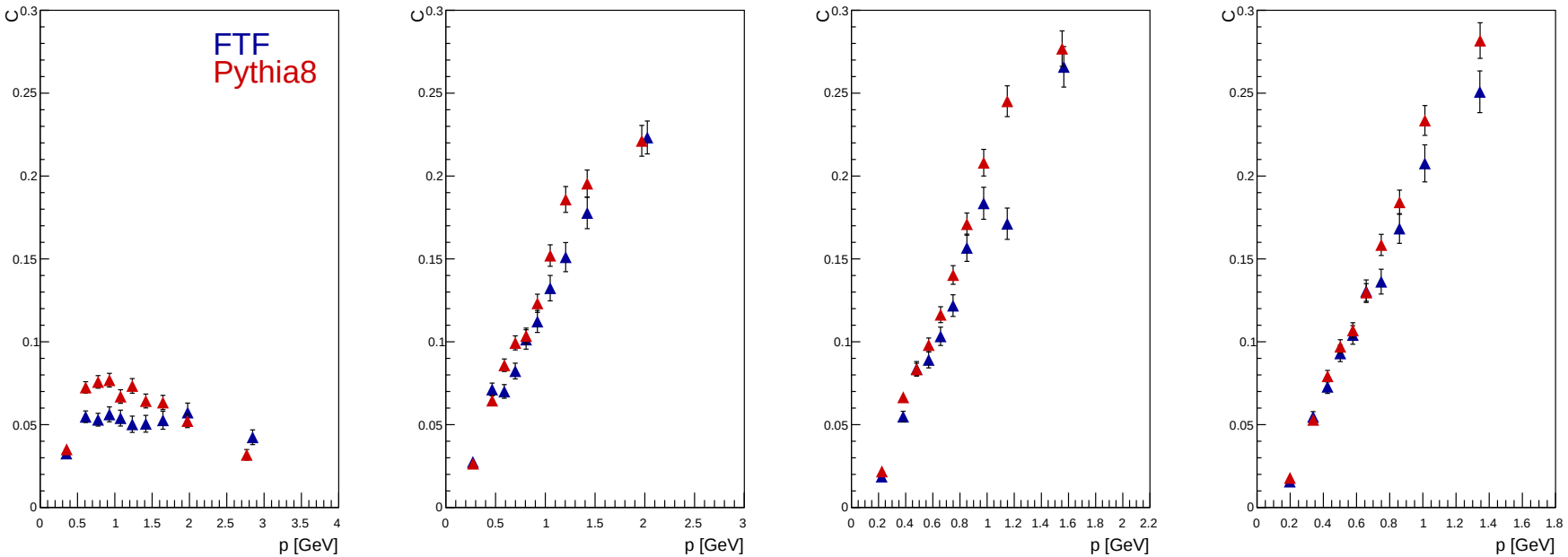
$$C1 = \frac{N(3hits)}{N(K^0_{true}(all))} \qquad C2 = \frac{N(\chi^2/NDF_{tr1,2}<6)}{N(3hits)} \qquad C3 = \frac{N(\chi^2_{V0}<2.0)}{N(\chi^2/NDF_{tr1,2}<6)} \qquad C4 = \frac{N(\chi^2_{tr1,2}toPV>10)}{N(\chi^2_{V0}<2.0)}$$

$$C5 = \frac{N(convergency==1)}{N(\chi^2_{tr1,2}toPV>10)} \qquad C6 = \frac{N(\theta_{coll}<0.03)}{N(convergency==1)} \qquad C7 = \frac{N(Dist>0.7)}{N(\theta_{coll}<0.03)} \qquad C8 = \frac{N(|cos\theta^*|\leqslant 0.7)}{N(Dist>0.7)}$$

Comparison of total reconstruction efficiency for FTF and Pythia8

$$C = \frac{N(RD)}{N(K^0_{true}(all))}$$

$0 < \theta < 0.41$ $0.41 < \theta < 0.73$ $0.73 < \theta < 1.11$ $1.11 < \theta < 1.57$



Conclusion and TO DO

1. Analysis of the K_S^0 reconstruction efficiency for different generators (Pythia8 and FTF) was performed.
2. There are no difference in K_S^0 reconstruction efficiency as function of momentum and theta.
3. Next step: Calculate reconstruction efficiency of the K_S^0 at $\sqrt{S}$=5 GeV. And compare reconstruction efficiency at different energies $\sqrt{S}$=5, 10, 27 GeV.

Thank you for your attention.