Updates on K_S^0 analysis (feed down correction outside PV)

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SPD collaboration meeting
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Selection criteria

PV and 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.

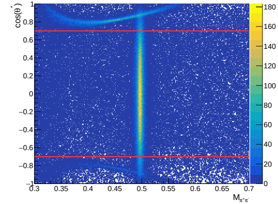
Kinematical cuts:

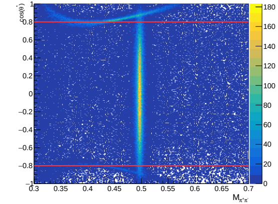
1. $\theta_{coll} < 0.03$ rad for K^0. This cut selects V^0 events the momentum looking at the PV.
2. $Dist = \sqrt{(x_{SV} - x_{PV})^2 + (y_{SV} - y_{PV})^2 + (z_{SV} - z_{PV})^2}$.
   This cut selects V^0 which decay close to PV. $Dist > 0.7$ cm for K^0_S.
3. Helicity angle ($|cos\theta^*| \leqslant 0.8$) for K^0_S
   (this cut previous meeting is $|cos\theta^*| \leqslant 0.7$ at 26 December 2024).

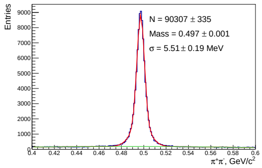
Helicity angle ($|cos\theta^*| \leqslant 0.8$) for K_S^0 at SPD

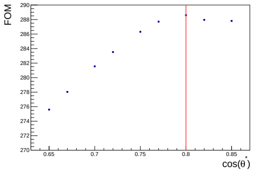
26 December 2023

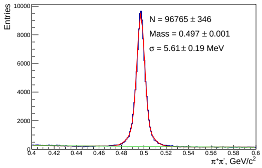
In current analysis







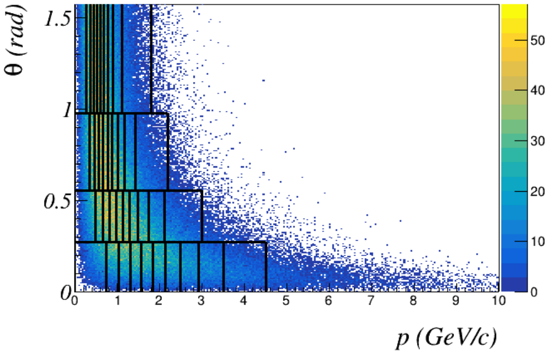




$|cos\theta^*| \leqslant 0.7$

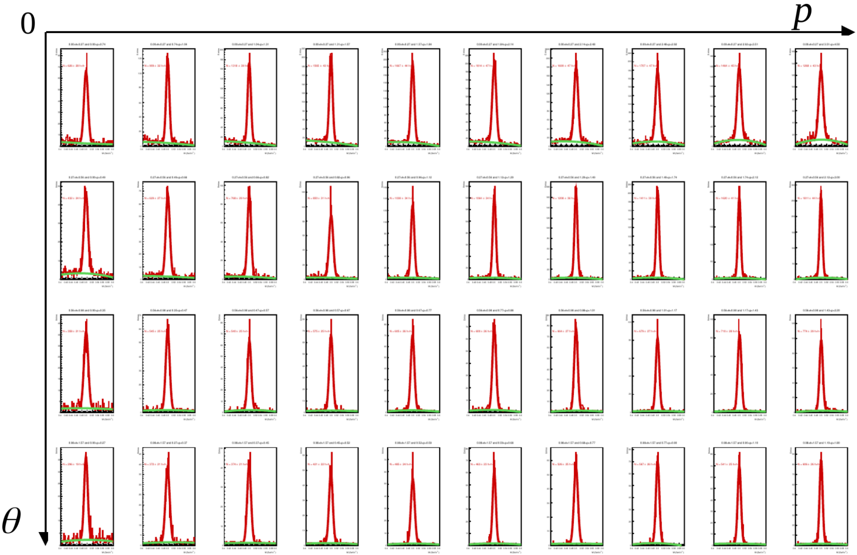
$|cos\theta^*| \leqslant 0.8$

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_S^0 in bins ($n_{bin}^{\theta} = 4, n_{bin}^{p} = 10$).

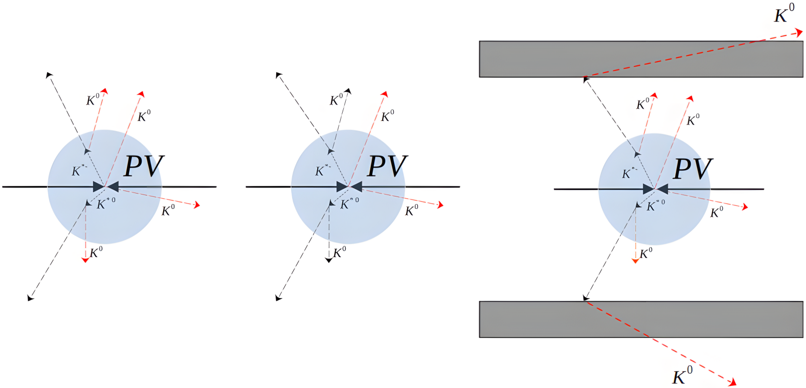
Distributions of the K_S^0 candidates with all cuts



Feed down correction in PV and outside PV

In previous analysis

In current analysis



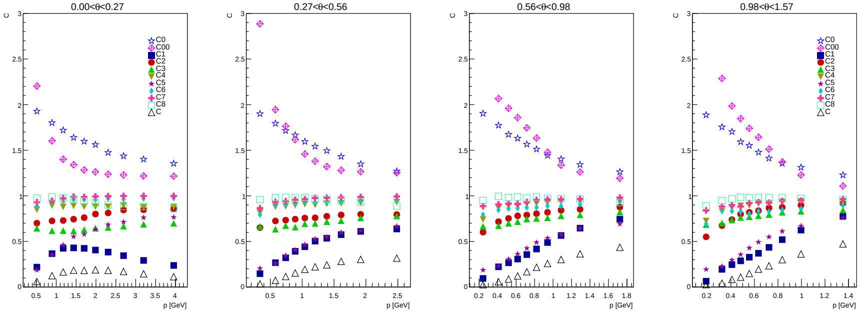
$N(K^0_{true} inPV)$ $\quad N(K^0_{true,direct} inPV)$ $\quad N(K^0_{true}(all))$

$$C0 = \frac{N(K^0_{true} inPV)}{N(K^0_{true,direct} inPV)} \qquad C00 = \frac{N(K^0_{true}(all))}{N(K^0_{true} inPV)}$$

Factorization of the MC correction

$$C = \frac{N(RD)}{N(true)} = C0 * C00 * C1 * C2 * C3 * C4 * C5 * C6 * C7 * C8$$

$C0 = \frac{N(K^0_{true} inPV)}{N(K^0_{true,direct} inPV)}$ – feed down in PV $\quad C00 = \frac{N(K^0_{true}(all))}{N(K^0_{true} inPV)}$ – feed down correction outside PV

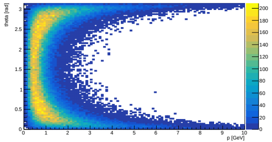


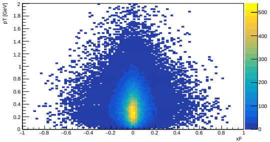
$C1 = \frac{N(3hits)}{N(K^0_{true}(all))}$ $\quad C2 = \frac{N(\chi^2/NDF_{tr1,2}<6)}{N(3hits)}$ $\quad C3 = \frac{N(\chi^2_{V0}<2.0)}{N(\chi^2/NDF_{tr1,2}<6)}$ $\quad C4 = \frac{N(\chi^2_{tr1,2} toPV>10)}{N(\chi^2_{V0}<2.0)}$

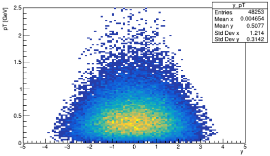
$C5 = \frac{N(convergency==1)}{N(\chi^2_{tr1,2} toPV>10)}$ $\quad C6 = \frac{N(\theta_{coll}<0.03)}{N(convergency==1)}$ $\quad C7 = \frac{N(Dist>0.7)}{N(\theta_{coll}<0.03)}$ $\quad C8 = \frac{N(|cos\theta^*|\leqslant 0.7)}{N(Dist>0.7)}$

The selected V^0 candidates are plated in (p,θ), (x_F, p_T) and (η, p_T) phase space

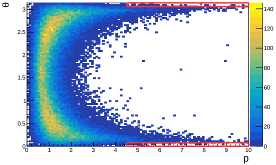
Pure Pythia 8 (true), K_S^0: new

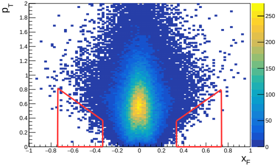


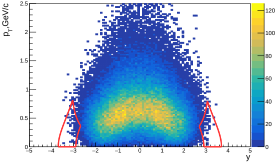




Reconstruction data (RD): new







θ - polar angle
p - total momentum

p_T - transverse momentum
x_F - Feynman variable

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

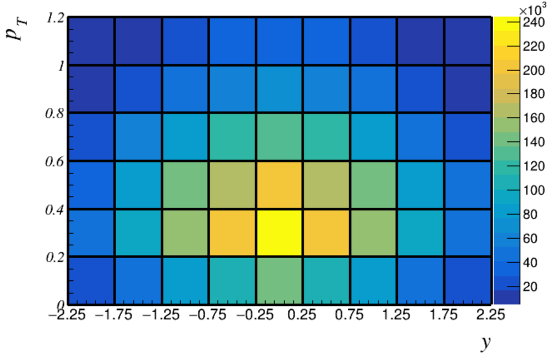
p_T - transverse momentum
y - rapidity

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

Binning

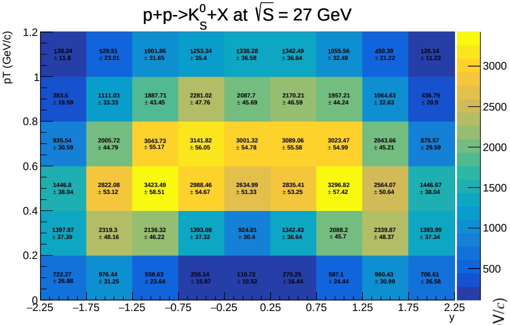
NA61/SHINE: -1.75< y <2.25 and 0< p_T <1.75 ($n_{bin}^{p_T} = 6, n_{bin}^{y} = 8$)

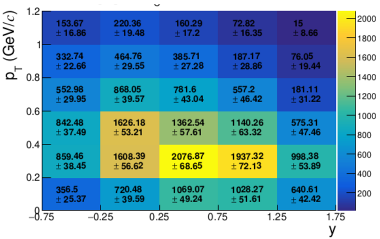
In current analysis: -2.25< y <2.25 and 0< p_T <1.2. ($n_{bin}^{p_T} = 6, n_{bin}^{y} = 9$)



- K_S^0 meson production in inelastic p+p interactions at 31, 40 and 80 GeV/c beam momentum measured by NA61/SHINE at the CERN SPS. arXiv:2106.07535, Submitted on 26 Feb 2024.
- K_S^0 meson production in inelastic p+p interactions at 158 GeV/c beam momentum measured by NA61/SHINE at the CERN SPS. Eur. Phys. J. C 82 no. 1, (2022) 96.

Uncorrected bin-by-bin multiplicities of K_S^0 with their statistical uncertainties





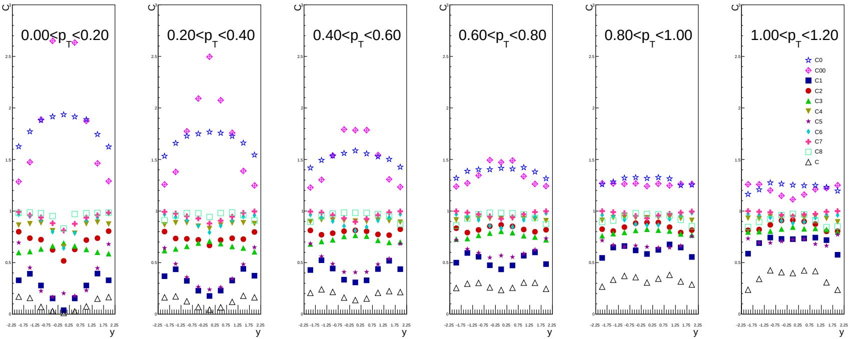
The NA61/SHINE Collaboration ($\sqrt{S}$ = 12,3 GeV)

Factorization of the MC correction

$$C = \frac{N(RD)}{N(true)} = C0 * C00 * C1 * C2 * C3 * C4 * C5 * C6 * C7 * C8$$

$C0 = \frac{N(K^0_{true} inPV)}{N(K^0_{true,direct} inPV)}$ – feed down in PV

$C00 = \frac{N(K^0_{true}(all))}{N(K^0_{true} inPV)}$ – feed down correction outside PV



$C1 = \frac{N(3hits)}{N(K^0_{true}(all))}$

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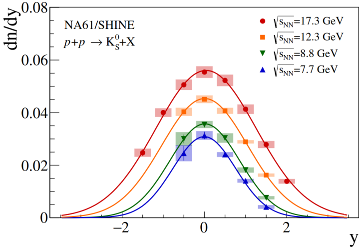
$C7 = \frac{N(Dist>0.7)}{N(\theta_{coll}<0.03)}$

$C8 = \frac{N(|cos\theta^*|\leqslant 0.7)}{N(Dist>0.7)}$

Conclusion and TODO

1. Analysis of the K_S^0 reconstruction efficiency was performed.
2. MC correction was factorized.
3. Next step is obtain double-differential distributions in transverse momentum and rapidity.



Thank you for your attention.