Φ production in pp@158 GeV, 12E002 production and MC

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Introduction

- The goal is to obtain Φ multiplicities in pp collisions for available energies

- Analysis is meant to be done by means of invariant mass spectra fits in the Φ→K+K- decay channel (which includes about 50% of all Φ's produced)

- NA49 published results for pp, pPb @ 158 GeV, as well as PbPb at 20, 30, 40, 80, 158 GeV.

- First I will obtain results for pp@158GeV to cross check with NA49

- Analysis done on FULL target runs from /castor/cern.ch/na61/09/prod/12E002/mSHOE

- MC (VENUS and EPOS)
  
  /castor/cern.ch/na61/MC/Releases/v2r7-1c_slc5/rec/GEANT3/p_LH_158/EPOS_GCALOR/all_on/REFORM/gpc_on/miniSHOE/

  /castor/cern.ch/na61/MC/Releases/v2r7-1c_slc5/rec/GEANT3/p_LH_158/VENUS_GCALOR/all_on/REFORM/gpc_on/miniSHOE/
Fig. 2. (a) Transverse-mass distributions of $\phi$-mesons (averaged over rapidity) for Pb+Pb (3.0 < $y$ < 3.8) and p+p (2.9 < $y$ < 4.4). (b) Rapidity distributions of $\phi$-mesons for Pb+Pb and p+p. Full symbols represent measured points, open ones are reflected at midrapidity ($\nu_{cm} = 2.9$).

Fig. 3. $\phi/\pi$ ratio measured for Pb+Pb in comparison with p+p data (NA49 and previous work [18]) as a function of the square of the center-of-mass energy per nucleon pair $\pi$ yields in p+p were taken from [21].

Produced particles, e.g., pions and kaons. From a fit with a Gaussian ($dn/dy \propto \exp(-(y - y_{cm})^2/2\sigma_y^2)$) one obtains for the widths $\sigma_y = 0.89 \pm 0.06$ (p+p) and 1.22 ± 0.16 (Pb+Pb). This difference is remarkable in view of the fact that the shape of the distributions of charged pions and kaons is very similar in both reactions (e.g., $\sigma_y(\pi) = 1.5$ [4]).

By integrating the fit functions discussed before over the whole kinematical range one obtains for the total average $\phi$-multiplicities
- for p+p (inelastic): $\langle \phi \rangle = 0.012 \pm 0.0015$,
- for Pb+Pb (central): $\langle \phi \rangle = 7.6 \pm 1.1$.

The error estimates include contributions from statis-
Fig. 4. (a) Multiplicity dependence of the $\phi/\pi$ ratio in p+p. The cross-section weighted average is indicated by the horizontal dashed line. (b) Centrality dependence of the $\phi/\pi$ ratio in the forward hemisphere in $p+Pb$ normalized to the average $p+p$ value. The minimum-bias value is indicated by the horizontal dashed line. Vertical dashed lines indicate bin sizes in the abscissa.
Data
Event cuts

- T2 trigger
- BPD3 and other in the successful beam fit
- fitted vertex present, with status=0, and $-600 \text{ cm} < Z < -560 \text{ cm}$
Track cuts for Kaon candidates

- Bx,By < 4cm
- accept tracks in a +/- 5% band around Kaon Bethe-Bloch curve; below area between black curves is accepted as Kaons
Simple estimation in full phase space

- Fit with Lorentzian+const to get approximate number of $\Phi$'s $\approx 5000$
Binning (2D based on NA49 2x1D binning)
Conclusion for data analysis

- Need to optimise cuts to preserve as much statistics as possible, with low S/B ratio.
- dE/dx cut has to be based on fits to dE/dx distributions, to allow for correction of Kaon loss due to the cut.
- However above reduces the available phase space of Kaons. Maybe the bend-like approach fine, and Kaon loss correction could be calculated differently?
- Need to get event mixing running to obtain background distribution for subtraction.
- Need to define proper binning.
MC
Phi availability in MC

- Information about mother resonances is not propagated to daughters, so one cannot directly select kaons that come from (the same) phi.

- It turned out, however, that both EPOS and VENUS produce phi without mass distribution, so one can make an indirect selection by demanding very narrow window on the invariant mass of the pair of simulated kaons (see next slide).
Window chosen to cover phi mass from both generators (2 different values), but even with such a window contamination of non-phi kaons is less than 1%.

Invariant mass of generator level kaon pairs
Generator level pt distributions (divided by number of entries)

EPOS

VENUS
Generator level pt distributions conclusion

- Background histograms have about 10 times more entries that signal ones.
- VENUS has harder spectrum than EPOS. Also the signal kaon pair spectrum is harder than the background one in VENUS, while it is opposite for EPOS.
- Looking at the spectra, there is no way to make a phase space cut to increase S/B ration.
Generator level rapidity distributions (divided by number of entries)

EPOS

VENUS

Are these diffractive events?
Generator level rapidity distributions conclusion

- Does the VENUS contain diffractive events while EPOS don't?
- Kaons coming from phi decay have the same rapidity distribution as the phi.
Matching tracks to kaons from phi

- Each reconstructed MC track has a list of matched simulated vertex tracks.
- For a given rec. track, select a sim. vertex track with the highest number of common points.
- If the selected sim. vertex track is a kaon (according to ID), the rec. track is said to be matched to sim. kaon
- Pair of rec. tracks, opposite sign, is formed.
- It is considered Φ->K+K- decay if both tracks match to sim kaons from phi according to the window in sim. kaon invariant mass.
Distributions for reconstructed MC tracks

**EPOS**

**VENUS**

Width only due to detector effects, and it is similar to the natural width of phi!
phi Sim vs Rec

curves show phi with tracks selected using the matching and window in m_inv
Conclusion for MC analysis

- Current MC may be used to validate analysis methods.
- Would be good to have (at least toy) PID variables in MC, to make validation including PID cuts.
- Would be good to have physical phi mass distribution in MC along with decay history to select directly kaons from phi.
- Need to make acceptance study (flatly distributed phi decaying to kaons?).