Low kaon identification using a TOF system at PANDA*

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Mandatory for the performance of hypernuclei physics at the $\overline{\mathrm{P}}$anda experiment, is the production of low momentum Ξ^- via the $\overline{p} + p \rightarrow \Xi^-\overline{\Xi}^+$ reaction(See ref. [1, 3]). Because the value of this cross section is likely 4 order of magnitude lower than the one corresponding to the $\overline{p} + p$ annihilation process, the background suppression plays an important role in the unique identification of hypernuclei. Moreover, the mayor part of the associated $\overline{\Xi}^+$ annihilates inside the residual target nucleus releasing in most cases two positive kaons. Theses kaons are emitted particularly into the forward region, providing with its identification a possibility to tag the production of Ξ^- hyperons. In the present work, we introduce a strategy to identify low momentum kaons via a TOF(Time of flight system) in combination with the tracking performance of the TPC detector at $\overline{\mathrm{P}}$ANDA. The TOF system consist of a scintillating fibers array and a cylindrical scintillator detector, which provide the start and stop time measurement respectively.

The TOF scintillator barrel at $\overline{\mathrm{P}}$anda consist of 16 slabs ($3\times0.5\times180$ cm) and it is place between the TPC and the DIRC detectors. The scintillating fibers array is placed upstream around the hypernuclear target. It consist of 1200 scintillating fibers(1. meter length) arranged into two rings parallel to the beam axis.

Kaons emitted from the annihilation of $\overline{\Xi}^+$ process, have typically a momentum of 500 MeV/c. The identification procedure consist in measuring the time of flight of particles track candidates crosssing the fibers array, the TPC and the scintillator barrel detector. With a magnetic field of 2 T only particles(kaons) above 300 MeV/c will fulfil this condition. Reducing the magnetic field to 1 T, the number of low momentum particles fulfilling the above condition is then larger. The mass of the particle is then reconstructed, making use of time of flight measurent, the track length and the momentum provided by the tracking algorithm.

The efficiency of the discussed low momentum kaon trigger has been tested by using a montecarlo simulation of the above mentioned detector setup(Fig. 1). The simulation revealed that for low momentum kaon identification the stop detector must provide a time resolution of < 100 ps, whereas the fiber detector has to provide the start time with a minimum resolution of about 400 ps.

Of course, the choice of start detector with a time resolution comparable to the one of the stop detector improves enormously the identification efficiency(See Fig. 2).

For instance, in the simulation of the hypernuclei signal(ref. [4], from 50000 produced Ξ^- + $\overline{\Xi}^+$ pairs, only 15000 Ξ^- leads to the hypernuclei formation. Taking into account the low kaon trigger under the conditions of 1 T magnetic field and a start time resolution of about 80 ps, one obtain an efficiency of the 25% which means a value of 3000 produced hypernuclei.

One can concludes that a background suppression strategy based on the identification of low momentum kaons is not enough as stand-alone method but it can be combined with other techniques discussed in previous reports(See [2]) providing better results.

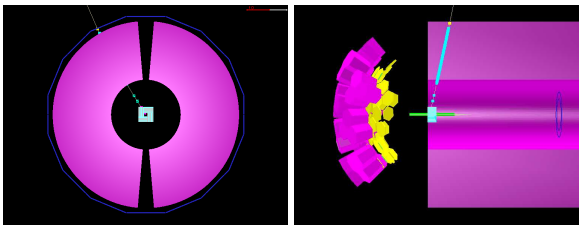

Figure 1: Left and right panel show respectively the X-Y and Y-Z view of the TOF system layout. In both cases a kaon track is denoted by its hits on the fibers array, TPC and TOF barrel.

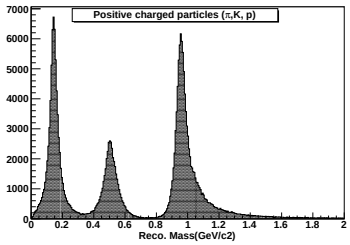

Figure 2: Mass reconstruction for positive charged pion, proton and kaons. The time resolution of TOF start and stop detector is 80 ps, the resolution of the reconstructed momentum and length is 1% and 3% respectively. The magnetic field value was reduced to 1 T to increase the detector acceptance.

References

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