

# Observation of the Resonance $\Sigma(1385)$ in the $p + CH_2/CD_2@3.5$ GeV with the FOPI Spectrometer $\diamond$

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We have performed an experiment in November 2005 with the FOPI spectrometer at GSI, measuring the reaction  $p + CH_2/CD_2@3.5$  GeV. The  $\Lambda$  and the  $K_S^0$  produced in these collisions are identified using the FOPI Central Drift Chamber (CDC) and in the forward tracking device Helitron. The neutral strange particles are reconstructed via their decay into charge particles:  $\Lambda \rightarrow p + \pi^-$  (BR=64%) and  $K_S^0 \rightarrow \pi^+ + \pi^-$  (BR=69%).

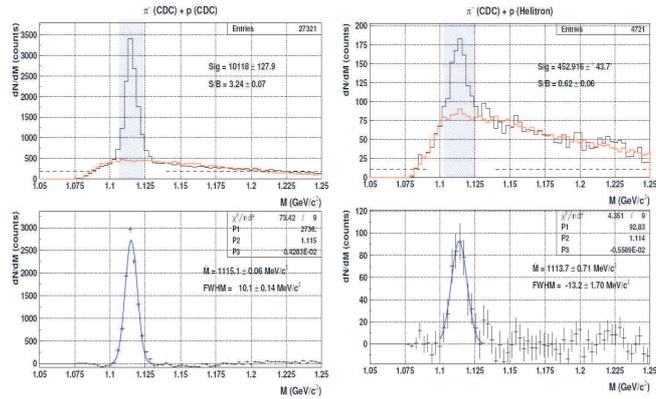


Fig. 1: Invariant mass spectrum of  $p$  and  $\pi^-$  reconstructed in the CDC (left) and where the  $\pi^-$  is reconstructed in the CDC and the proton in the forward Helitron distribution obtained combining particles from different events (combinatorial background). The lower panel shows the spectrum after the subtraction of the combinatorial background where only the  $\Lambda$  peak is visible.

The reconstruction of the secondary vertex is done in the x-y plane and the particles are selected applying a cut on the distance of the decay vertex from the primary interaction vertex. Fig. 1 (left) shows the invariant mass spectrum of  $p$  and  $\pi^-$  where both particles are reconstructed in the CDC(left) and where the  $\pi^-$  is reconstructed in the CDC and the  $p$  in the Helitron distribution obtained combining particles from different events (combinatorial background). The lower panel shows the spectrum after the subtraction of the combinatorial background where only the  $\Lambda$  signal at  $1.115\text{GeV}/c^2$  is visible. The total statistics collected amount to about 10000 counts for  $\Lambda$  and 5000 for  $K_S^0$  and correspond to a signal to background ratio of 5.6 and 7 respectively for the applied cuts. The signal to background ratio for the  $\Lambda$  reconstructed in the forward direction is much worse (0.62) and this particles have not been used to reconstruct the  $\Sigma$  resonance. This statistics is collected in a phase space region which angular coverage goes from  $30^\circ$  to  $135^\circ$  in the laboratory and in this region

one can combine the  $\Lambda$  hyperons with a proton or a  $\pi^-$ . The invariant mass of  $\Lambda-p$  combination can be used to look for the exotic state  $ppK^-$ , but the statistics is too low to find any hints. The situation is different for the  $\Lambda-\pi^-$  distribution, where a signal with a significance of 8.7 is visible at about  $1383\text{MeV}/c^2$  with a width of  $40\text{MeV}/c^2$ , as it is shown in fig 2. This peak corresponds to the  $\Sigma^0(1385)$  resonance and in the same figure a signal excess in the higher mass region is also visible, that could be interpreted as the presence of higher  $\Sigma$  resonances.

From the simulation of the  $ppK^-$  signal a ratio  $ppK^-/\Lambda$  of about  $7 \cdot 10^{-4}$  is obtained and this translate into 20 counts expected in the CDC acceptance region. On the other hand the reaction kinematic is such that the decay products of the  $ppK^-$  state tend to fly in the low polar angle region. This region of the phase space doesn't correspond to a good vertex resolution for the FOPI detector and hence new tracking devices are currently developed for the future experiments.

The analysis of the  $\Sigma(1385)$  resonance is anyway a useful cross-check to test the  $\Lambda-X$  correlation analysis and it can be used as a reference to compare the production probability of the kaon-bound state.

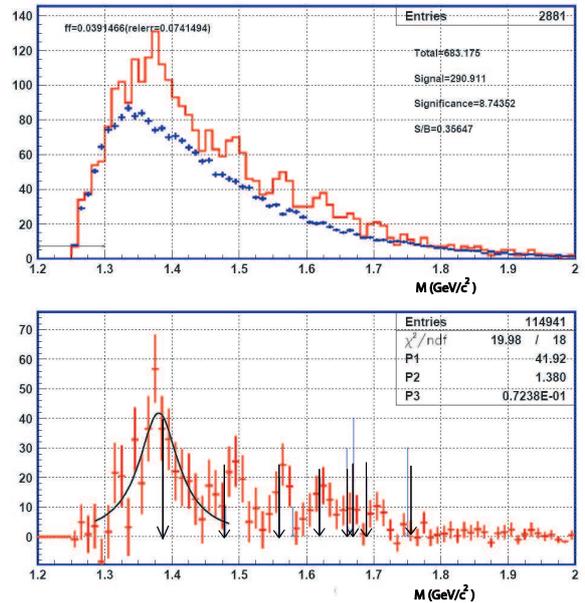


Fig. 2: (left)  $\Lambda-p$  invariant mass distribution. In the upper plane the signal (black curve) is shown together with the combinatorial background (red curve). In the lower panel signal is shown after the background subtraction. (Right)  $\Lambda-\pi^-$  invariant mass distribution.