\( \Lambda \) production in 3.5 GeV energy p-p reactions at HADES* \\

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The understanding of a hyperon production in proton-proton reactions is important for a further understanding of strangeness interactions in nuclear matter and it has been studied by HADES at a beam energy of 3.5 GeV. To be able to compare the experimental results with theoretical predictions, resonant and non-resonant contributions to the total production spectrum have been considered, also employing several exclusive \( \Lambda \)-channel analyses from the same reaction. In particular the influence of intermediate resonances like \( \Sigma^+, \Delta^{++} \) or \( \text{N}^* \) to the inclusive \( \Lambda \) production has been considered. Pinning down all contributions will help in tuning transport models (GiBUU and UrQMD) as well will serve in the understanding of the production mechanism of \( \Lambda \) in proton-nucleus reactions. These result will also help to understand future measurements at SIS100 at FAIR.

The \( \Lambda \) baryon is reconstructed in HADES by its charged hadronic decay into a proton and a negative pion. These particles are measured using MDC gas chambers, arranged in four layers of a tracking device immersed in a toroidal magnetic field. Bending of the track in the magnetic field allows to reconstruct the momentum of the particle. This quantity, together with energy deposition of charged particle, are uniquely correlated for each particle species by the Bethe-Bloch equation, allowing for particle identification. Using Invariant Mass technique for combined proton and pion tracks, the mother particle is reconstructed. The primary vertex is reconstructed by intersecting the \( \Lambda \) track with all other tracks leaving the reaction region. The secondary decay vertex of the \( \Lambda \) is associated with the intersection of the proton and pion pairs used in the invariant mass analysis. By applying topological cuts on the secondary and primary vertexes, the misidentification background is reduced and the final yield results in 164 455 candidates with a signal to background ratio of 3.02 in a 3\( \sigma \) mass fit region (fig. 1).

![Fit of two gauss functions](image1.png)

**Figure 1:** Reconstructed \( \Lambda \) signal yield in pp reaction.

Experimental data have been corrected for the geometrical acceptance and reconstruction efficiency using a simulation model (Pluto) for the production of the contributing channels. The simulation model in this energy range is based on a resonant production model by Tsushima et al. \([1,2]\), where the largest fraction of the kaon production (associated with \( \Lambda \) production) goes through resonant channels (around 90\%, the rest goes via phase-space). Most of the considered channels were measured exclusively at HADES in the same reaction and published by the HADES collaboration \([3–6]\). A complementary PWA model incorporates results of Partial Wave Analysis by E. Epple \([6]\) for the \( \text{pK}^+ \Lambda \) channel.

![Figure 2: Comparison of experimental data to two models.](image2.png)

**Figure 2:** Comparison of experimental data to two models.

Results show good agreement of production yields in mid-rapidity region (fig. 2) but also higher yield of \( \Lambda \)s in back-rapidity region. This extra production was partially attributed to hyperon production in Kapton windows of the liquid Hydrogen target and is currently under investigation – further disagreement could imply that the UrQMD and GiBUU models need to be further tuned to be able to model the \( \Lambda \) production in p+p collisions at 3.5 GeV.

**References**

5. J. Siebenson, PhD thesis, TUM 2013

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