The primary and secondary target for the hypernuclear experiment at PANDA

S. Bleser¹, F. Iazzi², M. Martinez Rojo¹, J. Pochodzalla³, A. Sanchez Lorente¹, and M. Steinen¹

¹Helmholtz-Institut Mainz, Germany; ²Politecnico di Torino and INFN, Sez. di Torino, Italy; ³Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, Germany

Gamma spectroscopy of double \( \Lambda \) hypernuclei will be one of the main topics addressed by the PANDA experiment at the FAIR facility at Darmstadt. For this project a dedicated hypernuclear detector setup will be installed. In addition to the general purpose of the PANDA detector it consists of a primary nuclear target for the production of \( \Xi^- + \Xi^- \) pairs, a secondary active target for the formation of hypernuclei and the identification of associated weak decay pions as well as a germanium detector array to perform high precision \( \gamma \) spectroscopy.

The primary reactions \( \bar{p} \) on a \( ^{12}_C \) nucleus were simulated in several runs of GiBUU calculations to get a realistic momentum distribution of the \( \Xi^- \). In the experiment a thin diamond filament will be used to produce those low momentum \( \Xi^- \). For the positioning of the primary filament target in the beam halo a stage with piezo motors for a two-dimensional motion was designed and is currently under construction, fig. 1. The mounting of five linear piezo motors equipped with targets guarantees an easy replacement in the case that a filament breaks. The specifications of the linear motors could be confirmed in experimental tests and their functionality in vacuum and after irradiation during a beam time at COSY in Jülich was validated.

In order to stop the \( \Xi^- \) hyperons and track pions from the decay of the produced double hypernuclei, the secondary target is composed as a compact structure of silicon microstrip detectors and absorber material. In the area of the sensor layers an absorber window is inserted to the target chamber which also serves as first volume to decelerate and stop the \( \Xi^- \), fig. 2. Stability and material tests were carried out for sheets of \( B_{4}C \) and \( CFC \) placed to a target chamber frame.

In order to optimize the geometry of the secondary target, the stopping probability of \( \Xi^- \) hyperons and the reconstruction accuracy of weak decay pions were studied in detailed simulations. The \( \Lambda \Lambda \) hypernuclei are created where the \( \Xi^- \) are stopped in the absorber volumes, fig. 3 (left). The momenta of the weak decay pions are reconstructed in the sensor layers. As one example the summed pion spectrum from the decay

\[
^{11}_{\Lambda\Lambda}B \rightarrow^{11}_{\Lambda}B + \pi^- \rightarrow^{11}_C + \pi_2 + \pi^- \quad (1)
\]

is shown in fig. 3 (right).

Figure 1: Vacuum chamber with target mechanics.

Figure 2: Arrangement of the secondary target layers in the \( x-y \) plane which is orthogonal to the beam direction.

Figure 3: Simulation results of \( \Xi \) stopping and \( \pi \) tracking.

The resolution for the higher and lower momentum is 6.7% and 10.7%, respectively. For a single pion a reconstruction efficiency of 58.6% was achieved.

---

Work supported by European Community Research Infrastructure Integrating Activity ‘Study of Strongly Interacting Matter’ HadronPhysics3 (SPHERE) under the FP7, GSI and HI Mainz.

bleser@kph.uni-mainz.de