# Prototype aerogel Čerenkov counter for kaon/pion separation*

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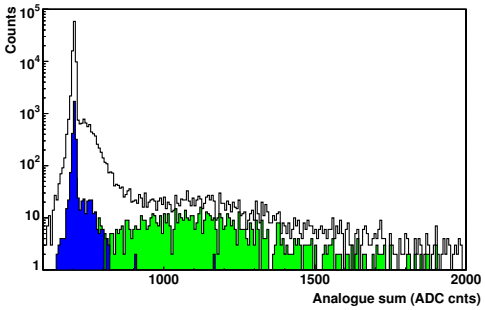


Figure 1: The analogue sum spectrum of both PMTs for events identified by the detector package of the spectrometer as pions (green) and protons (blue). The unshaded spectrum corresponds to all particles entering the Čerenkov counter. Protons were below the Čerenkov light emission threshold.

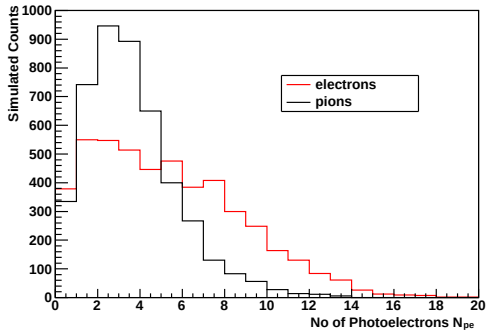


Figure 2: Simulated distribution of photoelectrons for the set-ups discussed in Table 2.

For hypernuclear experiments, which are currently performed at GSI (HypHI) or proposed for FAIR (PANDA) and for MAMI (A1), an unambiguous kaon identification is essential. An aerogel Čerenkov counter was designed for the KAOS spectrometer at the Mainz Microtron MAMI for the discrimination between kaons and pions of momenta $p \geq 1\mathrm{GeV}/c$.

Before the construction of the final detector a smaller prototype has been built, mounted inside the KAOS spectrometer, and tested. The prototype consisted of a $20\times10\times10$ cm$^3$ light collection box with a single layer of aerogel of active area $20 \times 10$ cm$^2$. The inner walls were covered by Millipore paper and the photons were detected by two 2" PMTs, attached on opposite sides. Different refractive indices and thicknesses of the aerogel, geometries of the light collection box (*e.g.* including or excluding mirrors) and momenta of the incoming particles were studied.

Table 1: Measured detection efficiencies, $\epsilon$, for electrons and pions at various momenta, $p$. In one set-up the light collection box included mirrors.

| $p$ (MeV/$c$) | particles | mirrors | $\epsilon$ (%) |
|---|---|---|---|
| 380–530 | electrons | no | 88 |
| 620 | pions | no | 90 |
| 480 | pions | yes | 65 |

Table 2: Mean number of photoelectrons measured with different set-ups and compared to simulations.

| $p$ (MeV/$c$) | particles | mirrors | $N_{\mathrm{pe}}^{\mathrm{exp}}$ | $N_{\mathrm{pe}}^{\mathrm{simul}}$ |
|---|---|---|---|---|
| 380-530 | electrons | no | 4.2 | 4.8 |
| 480 | pions | yes | 3.6 | 3.4 |

We used aerogel with $n = 1.07$ made by Chiba U., Japan, which provides separation of pions and kaons in the momentum range $p \approx 365$–$1300\,\mathrm{MeV}/c$ [1]. The detector was exposed to various particle types, such as electrons, pions and protons. In Fig. 1 a representative spectrum is shown for events identified by the detector package of the spectrometer as pions and protons.

The detection efficiency was determined by the ratio of events with a Čerenkov signal above a given detection threshold to the number of events reconstructed to be passing the volume of the counter. Results for different set-ups tested during several beam-times are shown in Table 1. When testing with pions, the prototype was rotated towards the incoming particle direction.

The performance of the prototype detector was also studied with the simulation package Litrani. The number of photoelectrons, $N_{\mathrm{pe}}$, predicted by the simulation was compared to number of photoelectrons seen in the actual experiments as shown in Table 2. The simulated distribution of photoelectrons for these set-ups is shown in Fig. 2.

Since the results from the experiments and the simulations are in fairly good agreement we can trust our simulations to predict and optimize the light yield of aerogel Čerenkov counters to be used in future hypernuclear experiments.

## References

[1] L. Debenjak *et al.*, GSI Scientific Report 2008, (2009) p. 253.

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