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Cherenkov counter for the G^0 backward angle measurements

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Abstract. The G^0 program consists of a set of parity violation experiments performed at Jefferson Lab (Va, USA) dedicated to the determination of the strange quark contribution to the charge and magnetization distributions of the nucleon [1]. This paper describes the final design of the Cherenkov counter used to reject the significant charged background of the G^0 backward angle measurements.

PACS. 29.40.Ka Cherenkov detectors

1 Introduction

The main focus of the G^0 experiment is to measure the neutral weak form factors G_E^Z and G_M^Z of the nucleon, over a large momentum transfer range. This will allow us to determine the strange quark contributions to the charge and magnetization densities of the nucleon. For this purpose, parity-violating asymmetries in elastic e-p scattering have already been measured at forward angles over the Q^2 range 0.1-1 $(GeV/c)^2$, and will be measured at backward angles for Q^2 values of 0.3, 0.5 and 0.8 $(GeV/c)^2$. At backward angles we also measure quasi-elastic scattering from a LD_2 target to extract precisely the axial form factor [1]. However, negatively charged pions, as well as their decay products (μ^-), will produce a significant background to the elastic and quasi-elastic rates detected by the G^0 spectrometer. Aerogel Cherenkov counters afford the best π/e discrimination at these energies and allow implementation in the current G^0 setup. LPSC Grenoble has designed and constructed half of the 8 Cherenkov counters needed.

2 The aerogel Cerenkov counter

The aerogel refractive index ($n = 1.03$) was fixed by the momentum distributions of the background. It should be less than $1/\beta$, but as large as possible to maximize light yield. The aerogel was supplied by Matsuhita Electric Works in the format of tiles (113x113x10 mm^3). The geometry of the counter and the necessary number of photomultipliers (PMT) was studied by using simulations [2] (Geant, Litrani) and validated with measurements made on a prototype. To allow the mounting of the aerogel in France and a safe transportation to Jlab, the Cerenkov box (see Fig. 1) is composed of two parts. The first part is the aerogel radiator which is 5 cm thick, and the second one is the lightbox itself. To ensure the best photon collection

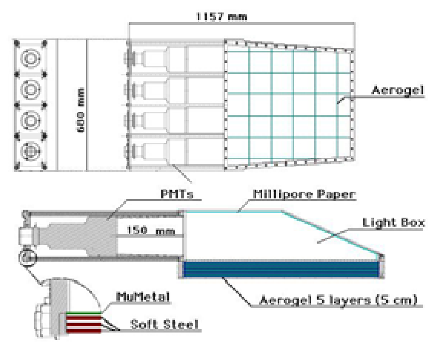

Fig. 1. Cherenkov design and magnetic shielding

using 4 PMTs, the inner parts of these two boxes are covered by three layers of diffuse reflecting paper (Millipore). The XP4572b 5 inch tubes (Photonis) are very sensitive to magnetic fields. As they will be located in the fringe field of the G^0 magnet (4.4 mT in the axial direction and 11 mT in the transverse one), efficient magnetic shielding is needed. The design finally retained after tests at the LCMI Laboratory in Grenoble is made of three layers of 2 mm soft iron separated by 2 mm of air, and one layer of 0.8 mm of μ-metal. During these tests, one had to find the best compromise (light yield and field) for the positioning of the tubes inside the shielding. It was found that a back-off of 15 cm was sufficient. The 4 Cerenkov counters have been also successfully tested with cosmic rays and typical total numbers of 8 photoelectrons were measured with a collection time lower than 25 ns.

References

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