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A LARGE ACCEPTANCE DETECTOR FOR ELECTROMAGNETIC NUCLEAR PHYSICS AT CEBAF

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ABSTRACT

At CEBAF a large acceptance magnetic detector is planned for the investigation of electromagnetic nuclear reactions. The detector will be used to investigate multiple particle final states with high efficiency and to achieve sufficient count rate in cases of limited luminosity.

In addition to experiments that require high resolution magnetic spectrometers (with relatively small solid angles) there are two important classes of experiments at CEBAF that can only be performed with (or will at least benefit from) a large acceptance detector (LAD):

1. The detection of multiple particle final states, like in the photo- (or electro-) excitation of the nucleon resonances in both elementary and nuclear production ($\gamma N \rightarrow N^* \rightarrow \pi\pi N$, $\gamma D \rightarrow \Delta\Delta \rightarrow NN\pi\pi$, $\gamma A \rightarrow \pi NX$, $\gamma A \rightarrow NNX$).
2. Measurements at limited luminosity. The limitation can be due to the target (e.g. polarized target with low radiation resistance, active targets for the detection of low range recoils) or due to the beam (e.g. all experiments using a tagged bremsstrahlung or other secondary beams independent of the number of particles in the final state).

The physics program results in the following requirements for a general purpose large acceptance detector:

1. Homogeneous coverage of a large angular and momentum range for charged particles (magnetic analysis), photons (total absorption counters) and neutrons.
2. Good energy and angular resolution (for all particles).
3. Good particle identification properties.
4. No transverse magnetic field at the beam axis (to avoid sweeping (e^+,e^-) pairs into the detector).
5. Large field free space around the target to allow for the installation of complicated targets (cryogenic, polarized, track sensitive, etc.) or auxilliary equipment (nucleon polarimeter, γ-converter).

5. Particle identification. The combination of momentum and time-of-flight is used for the identification of charged particles. Pions and kaons can be separated up to 1.5 GeV/c, kaons and protons up to 2.5 GeV/c. π/μ and μ/e separation can be achieved by using the pulse height in the shower counter in addition.

The performance of the LAD can be predicted using Monte-Carlo methods to generate multiple particle final states and to test particle tracking and reconstruction. As an example, the probability to reconstruct the complete $\pi^+\pi^-p$ final state from the F35(1975) $\rightarrow$ $\pi^+\pi^-p$ decay has been found to be 30% (most of the events are lost because one of the 3 particles hits a coil).

The LAD will occupy the lightly shielded end station B. In addition to low intensity electron and photon beams, it can also be used for experiments with secondary kaon, pion and muon beams. The LAD is complimentary to the high resolution magnetic spectrometers: by using the standard spectrometers for high luminosity and the LAD for low luminosity experiments a wide range physics phenomena can be covered at CEBAF.

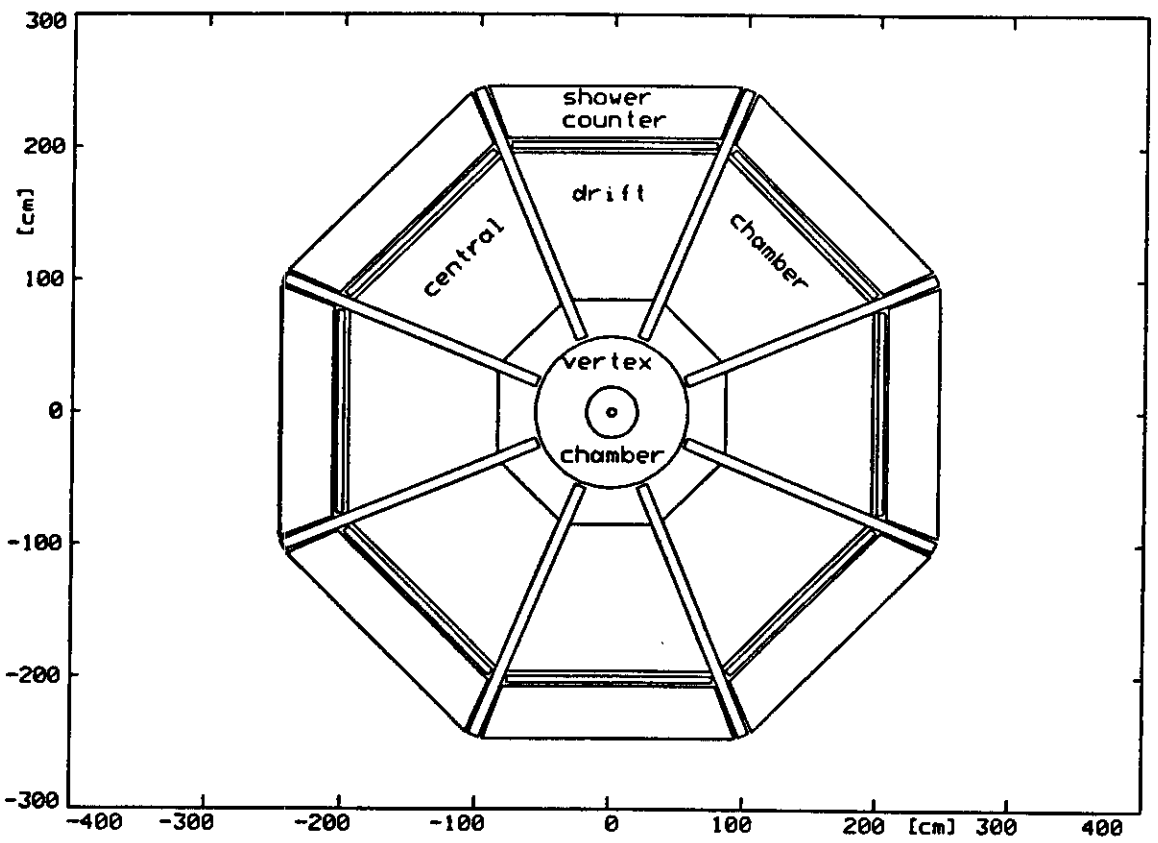

Figure 1: View of the toroidal detector in the direction of the beam