Hall D Forward Drift Chamber Prototype Test Plan

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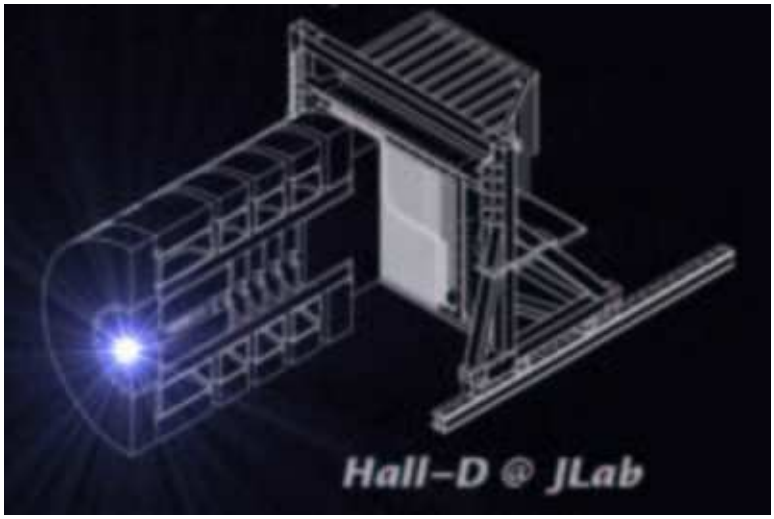

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Abstract

This document represents a compendium of information regarding the Hall D Forward Drift Chamber prototype. It also includes a test plan for the full slate of studies for the prototype. The different studies planned are discussed along with the steps required to carry them out. This document is expected to evolve and expand as the test plan is carried out and the detector design work continues. Errors and omissions should be sent to the author at carman@jlab.org.

1 Introduction

Fig. 1 is a schematic representation of the proposed HALL D detector. This facility is being optimized in its design to study photon-nucleon interactions leading to final states where multiple charged and/or neutral particles can be present. The detector consists of a large superconducting solenoid magnet whose inner volume is filled with a target, tracking chambers, and calorimeters. The magnet is employed to bend charged particles emerging from the beam-target interaction region into helical paths. By reconstructing the trajectories of these charged particles via the use of tracking chambers as they move through the detector, their momenta can be accurately determined. The calorimeters are used to determine the energy of both charged and neutral particles. The solenoid will be followed by further "downstream" detector systems used to measure the energies of the scattered particles to aid in particle identification. This hermetic system will allow for complete reconstruction of the final states of the photon-nucleon interaction. The superconducting solenoid magnet was originally part of the LASS spectrometer at SLAC and was later moved to LANL for the MEGA experiment.

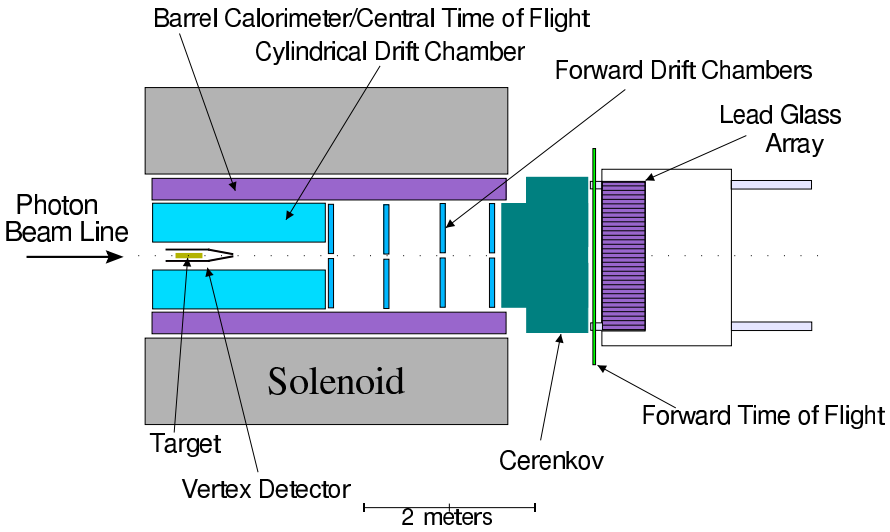


Figure 1: Schematic overview of the HALL D detector. The main detector subsystems, including the solenoid magnet, the calorimeters, and the elements of the drift chamber tracking system are identified.

Within the solenoid, the Forward Drift Chambers (FDCs) represent the main system for charged-particle track reconstruction between the target region and the downstream detector systems [1]. In the current detector design, the FDCs include four separate sets of disk-shaped planar drift chambers to measure the momenta of all charged particles emerging from the target at angles of up to 30° relative to the photon beam line. Each set of the four FDCs is envisioned to be identical.

The basic FDC drift package is a plane of wires with 150 μm spatial resolution between two planes of cathode strips. By charge interpolation of the electron avalanche image charge in the cathode strip readout, spatial resolutions at the cathode planes are expected of roughly 100 μm. The strips are arranged in a U and V geometry with respect to the wires (at $\pm 45°$),

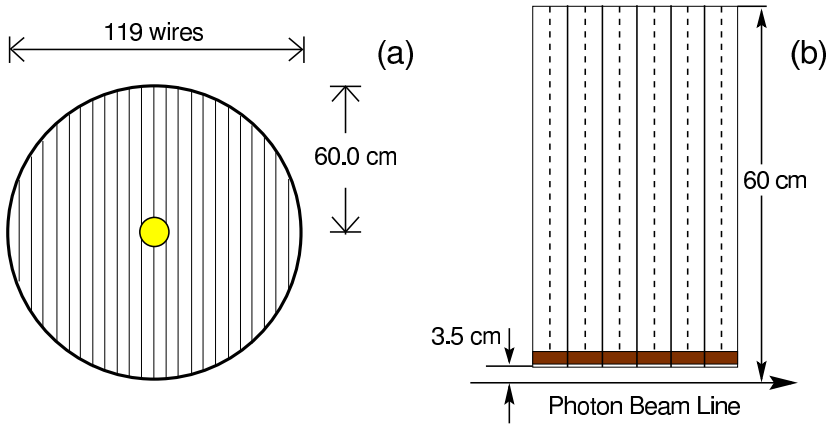


Figure 2: Schematic views from the front (a) and side (b) of a single FDC package. In (a) the wires are schematically indicated as the vertical lines. In (b) is shown a side view of the upper half of an FDC package with the wire planes shown as the dashed lines.

allowing the reconstruction of a 3–D space point from each hit. The chambers are arranged in packages of six to provide a small track segment to facilitate later linking of tracks. Given the number of spiraling tracks, it is critical that these chamber packages not only provide good spatial resolution but also reasonable direction information.

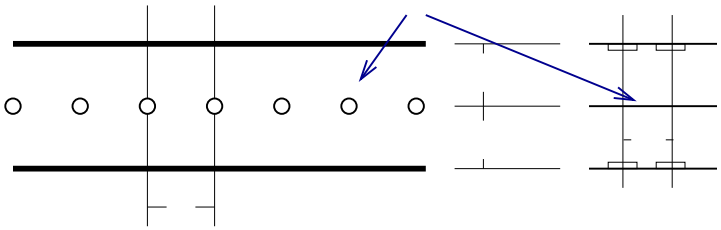
The basic chamber element is a disk of outer radius 60.0 cm, where the wires are strung as chords across the chamber as shown in Fig. 2(a). With a 1.0 cm wire spacing, each chamber will contain 119 wires. In addition, there will be an equal number of cathode strips on each face. This leads to 357 channels per chamber element. Fig. 2(b) shows the six chamber elements in side view forming one FDC package, leading to about 2150 channels per package. Adjacent chamber elements will be rotated by 60° with respect to each other to improve the overall resolution. The wires that cross through the beam line will be deadened out to a radius of about 3.5 cm to reduce the otherwise unmanageable rates.

The primary development issues associated with the FDCs that must be addressed are factors affecting the intrinsic resolution of the chambers, along with the mechanical and electronics layout. The goal is to construct a tracking detector that meets the required design specifications and has a long life time, a uniform and predictable response, a high efficiency, and is serviceable in case of component failure.

2 Cathode Strip Chambers

The material in this section borrows heavily from the following references:

- ATLAS Technical Design Report Chapter 6, June 1997.
- H. Fenker *et al.*, "Precision Interpolating Pad Chambers", NIM A **367**, 285 (1999).
- PHENIX Collaboration, PHENIX Internal Note PN125.

2.1 Introduction

Cathode strip chambers (CSCs) are typically multiwire proportional chambers (MWPCs) with a symmetric drift cell in which the anode-cathode spacing d is equal to the anode wire pitch S (see Fig. 3).