FDC Geometry and Channel Count

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Abstract

This note presents a preliminary description of the FDC geometry needed for HDGeant.

The following description of the FDC geometry and channel count is still tentative because we are still working on the mechanical drawings and optimizing the package design. In particular the design of the boards containing the preamp chips is not sufficiently mature to add to the Monte Carlo.

The Forward Drift Chamber detector array consists of four packages of 6 chambers, each chamber consisting of a wire plane flanked on either side by cathode planes divided into strips. One chamber unit consists of a support frame, a cathode plane, a wire plane inside a 1 cm thick gas volume, another cathode plane, and another support frame. Adjacent layers are electrically separated from each other by a 25 micron layer of conducting material such as aluminized Mylar (density = 1.39 g/cm^3). The various layers are illustrated in figure 1. The wires are attached to a 5 mm thick G10/FR4 frame (density = 1.7 g/cm^3). In the current design the outer radius of the frame is 60 cm and the inner radius is 52.4 cm. Both dimensions are likely to change as the design matures. The outer radius is determined by the inner radius of the BCAL (65 cm) and the dimensions of the rails and likely cable configuration from a drawing generated by Ravi Anumagalla (figure 2). There are 96 sense wires (20 μm diameter gold-plated Tungsten) and 97 field wires (100 μm

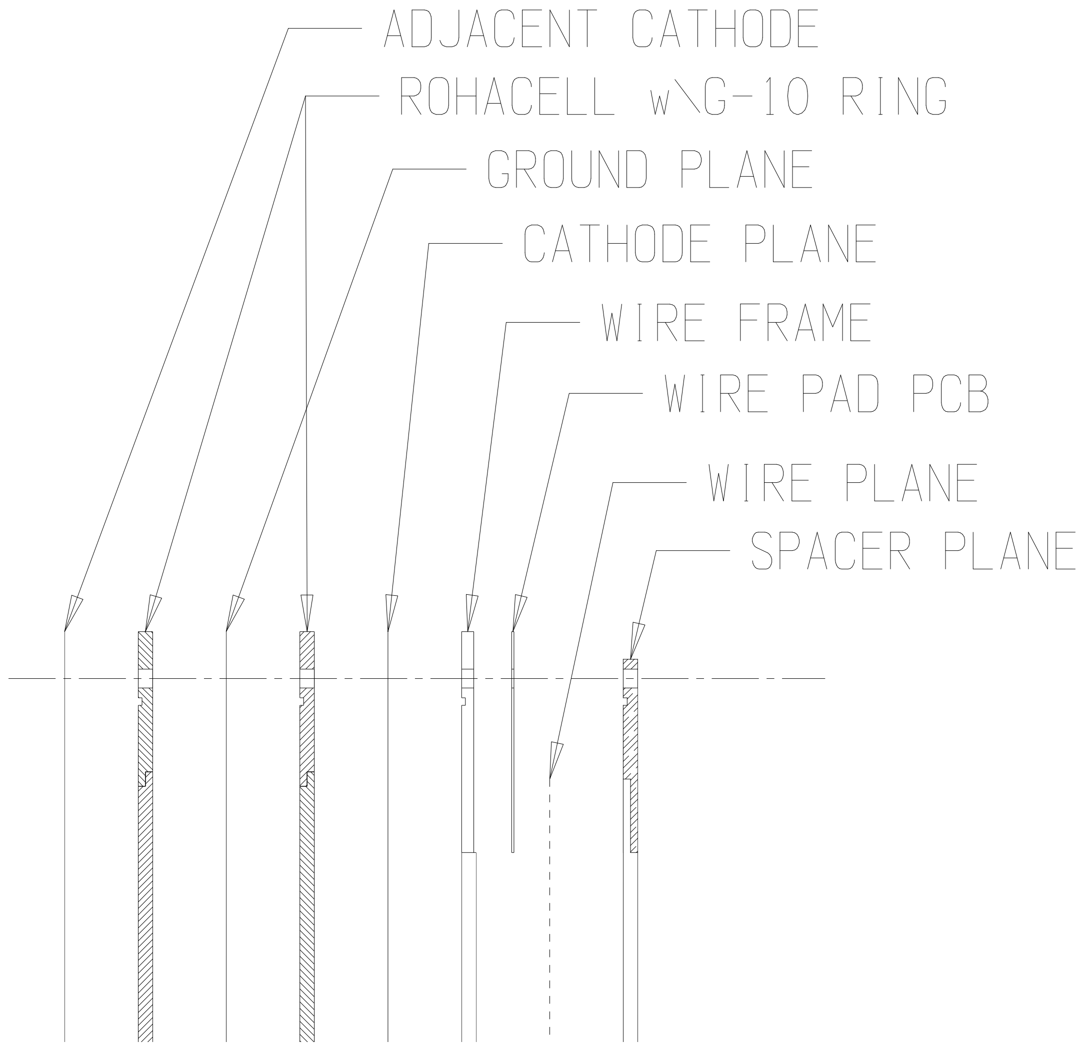

Figure 1: Components of an FDC unit.

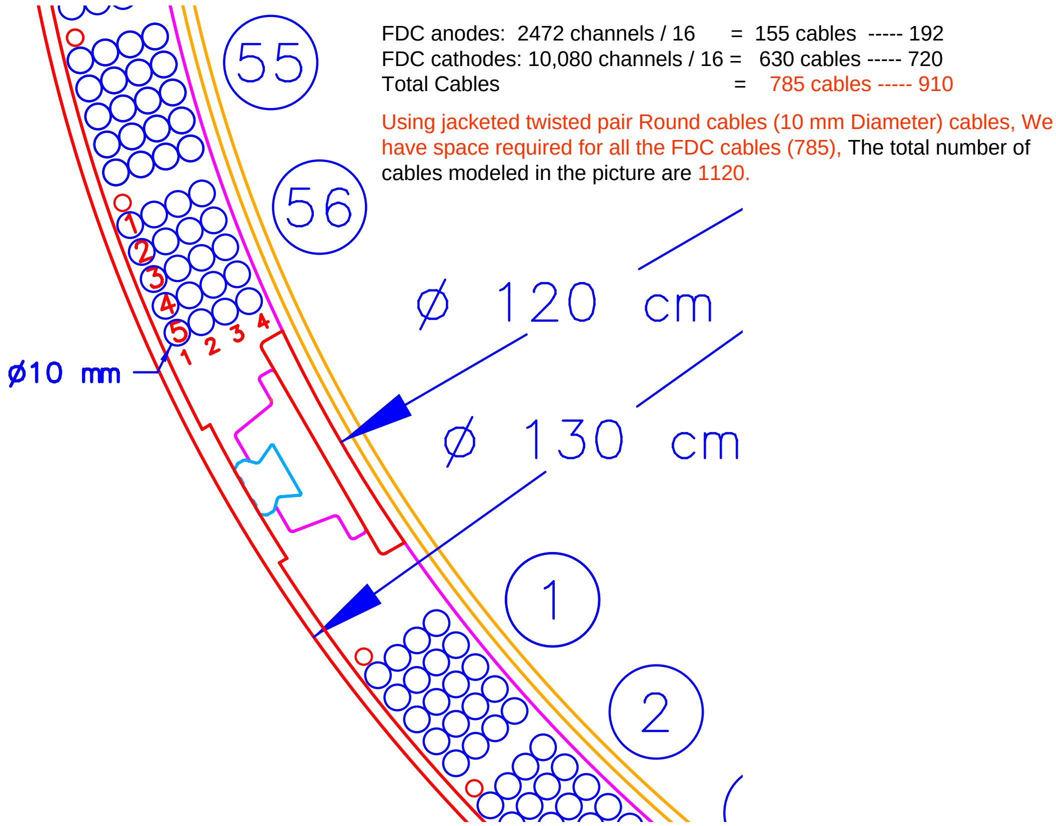

Figure 2: Region between outer radius of FDC and inner radius of BCAL.

diameter gold-plated Aluminum) per wire plane. The region within a radius of 3.5 cm from the nominal beam line is inactive: the wires will most likely be slightly thickened in this region to kill the gain. A 5 mm thick spacer of G10/FR4 separates the wire plane from the adjacent cathode plane. The cathode planes are 50 μm thick layers of Kapton (density = 1.42 g/cm^3) covered by a 5 μm layer of copper (density = 8.96 g/cm^3). There are 192 strips per cathode plane. The strips are at $\pm 45^\circ$ with respect to the wires (90° with respect to each other) in a given chamber. The cathode planes are attached with on the order of 25 μm of epoxy (density$\sim$1 g/cm^3) to 5 mm thick G10/FR4 support rings with roughly the same dimensions (inner radius $\sim$54.8 cm) as the wire support rings. The entrance and exit windows for each package are currently envisioned to be the first and last ground planes.

We are considering a couple of ways to maintain the separation between the wire and cathode planes. One possible solution (shown in figure 1) is to use 5 mm thick layers of Rohacell, a low density foam (0.032 g/cm^3), within the active radius of the detector. We need MC studies to determine if we can afford this extra material.

We estimate that we will need $\sim$ 720 thirty-four-conductor cables, each of which will likely be shielded ribbon cable with a round ($\sim$1 cm diameter) profile. We also need 24 cables for HV, each of which will most likely be multi-conductor cable with a round ($\sim$1 cm diameter) profile.

The first unit in a package has wires oriented in the vertical direction. The second has the wires oriented at $+60^\circ$ with respect to the vertical direction. The third has the wires oriented at -60° with respect to the vertical direction. The pattern repeats.

The position of each of the packages along the z-direction will need to be optimized. In Ravi's current drawings, the first package starts at 227 cm from the origin (the center of the target is at 65 cm from the origin) and the fourth package ends at 403 cm. The packages are evenly spaced with respect to each other.

Two rails for positioning/supporting the FDC packages need to be added to the detector model. We will also need support bars between the packages and are considering stainless steel frames on the outside of each package. These would be say 2 mm thick with inner radius 53.6 cm and outer radius 60 cm. The support bars could be modeled as carbon fiber rods with 1 cm diameter.

In order to simplify the detector model in HDGeant I suggest ignoring the details of the support rings and implementing an annulus composed of

G10 of thickness 12 cm, outer radius 60 cm, inner radius 53.6 cm (splitting the difference between the wire frames and the cathode plane frames) for each package. For the electronics I suggest an annulus of inner radius 60 cm, outer radius 61 cm, width 12 cm, composed of a mixture of silicon and G10. The simplest thing to do for the cables is to implement a set of rings with an appropriate composite of plastic (for the cables) and air (for the volume around the cables). Each package needs 180 signal cables. The first ring would have an inner radius of 61 cm, an outer radius of 62 cm, and cover the length between the upstream entrance of the first package to the downstream exit of the fourth package; the second would have an inner radius of 62 cm, an outer radius of 63 cm, and extend from the upstream entrance of package 2 to the downstream exit of package four; and so on. Sketches of the proposed simplified geometry are shown in figure 3.

For the cathode layers I suggest a mixture of 25 micron epoxy (1.0 g/cm^3), 50 micron Kapton, 5 micron Copper. For the ground planes: 25 micron Mylar + 25 micron epoxy. For the electronics region: 59.5% plastic (polyester?), 26.1% FR-4, 14.4% Silicon by mass (based on 50 mils $\times$ 1 cm $\times$ 1 cm Silicon for the ASICS, 62 mils for the preamp boards, and 4.8 cm $\times$ 0.6 cm $\times$ 0.7 cm for the connectors; obviously this is a crude approximation). About 89% of the volume is air. For the cables: 33% Copper, 67% PVC (ρ=1.32 g/cm^3, C_2H_3Cl) by mass. About 52% of the volume is air.

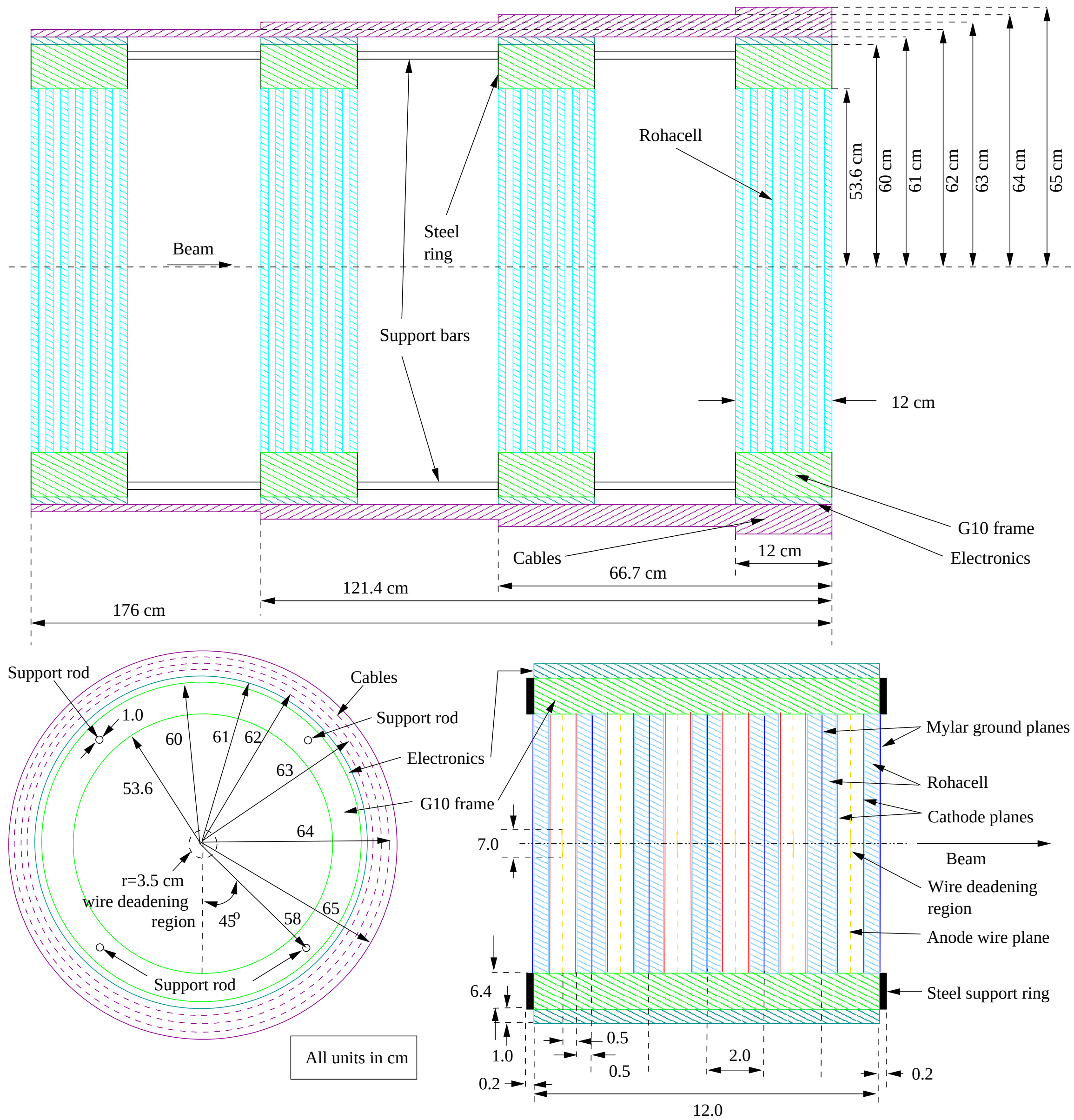

Figure 3: Simplified FDC geometry (not to scale).