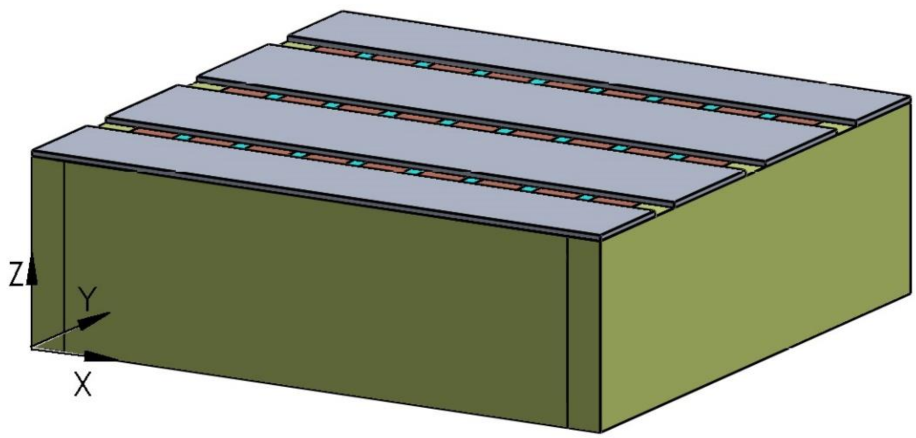
Heat Flow Mockup Information for Simulation
3/18/2015



Materials:

1. Copper (C11000):
    a. Thermal Conductivity: 388W/m-K
2. Cryogenic G-10 (G-10CR, MIL-I-24768/2):
    a. Thermal Conductivity* @88K:
        i. Parallel to fibers: 0.416W/m-K
        ii. Normal to fibers: 0.294W/m-K
3. Aluminum (AL 6061):
    a. Thermal Conductivity: 167W/m-K

*Note: The thermal conductivity of G-10CR varies in relation to the lay of the fibers within the G-10CR plate. In the mockup, Normal to the fibers refers to the thickness dimension of the plates; for the heater block this is in the Z-direction shown above, for the mockup walls, Normal direction would be perpendicular to the Z-direction.

Layout:

The mockup, shown above, is comprised of several main sections: the heater block (Forward Calorimeter side), the HEC plates, and the framework that holds the HEC and heater block in position. The whole mockup is immersed in liquid argon. This creates a setup that will be used to study the heat flow between the Forward Calorimeter and the HEC detectors. The following describes the mockup using the coordinate system shown above at the lower left corner of the mockup.

The framework of the mockup consists of four side walls of G-10CR, 100mm tall and 19.05mm thick. Outer dimensions of the mockup are 331mm in the X-direction and 313mm in the Y-direction. The walls are held in place using four 3mm thick aluminum brackets. The outer most aluminum brackets are 55mm wide, the inner two brackets are 72mm wide.

The aluminum plates also hold the nine copper plates that make up the HEC side of the mockup. These copper plates run perpendicular to the aluminum brackets. Each of the HEC plates has dimensions: 40mm tall, 25mm wide, and 275mm long, with an 8.5mm spacing between each plate. The two outer HEC plates are flush with the G-10CR walls. In the space between each plate is a hexcel spacer, with negligible volume, and static argon.

The Forward Calorimeter side of the mockup, or heater block (not shown in the picture above), is comprised of four plates sandwiched together. Each of the plates has an X-dimension of 292mm and Y-dimension of 274mm. Working from the bottom plate up, the first plate is made from G-10CR, and has a Z-dimension of 19.05mm (0.75in). The second plate is made from 4.064mm (5/32in) copper. Between these two plates is a heater layer that simulates the heat produced in the Forward Calorimeter, the copper plate helps evenly distribute the heat across the entire plate. The third plate is G-10CR, 9.525mm (0.375in) thick. The top most layer is an aluminum plate 8mm thick. This plate represents the outer shell of the Forward Calorimeter, and is closest to the HEC plates. There are two temperature probe layers in the heater block, the first is between the top of the copper plate and the bottom of the second G-10CR plate. The second temperature probe layer is between the top of the second G-10CR plate and the bottom of the Aluminum plate.

The heater block is held in place using machine screws passing through slots cut into the G-10CR walls. This creates an isolated liquid argon layer between the HEC plates and the Forward Calorimeter block. It is the heat transfer from the Forward Calorimeter side, through the liquid argon, to the HEC detector that is of interest to us. The optimal liquid argon gap size is 12mm, but can adjusted from 0mm to 20mm to represent the varying gap size that exists in the actual detector.

The entire mockup is submerged in a liquid argon bath. The construction allows for liquid argon to completely fill the gap between the Forward Calorimeter side and HEC side of the mockup, as well as the space between the individual HEC plates. The hexcel spacer between each HEC plate (not included in the simulation geometry) prevents the liquid argon in this region from forming convective cells therefore the liquid argon in this region can be treated as static. The 12mm gap between the Forward Calorimeter and HEC plates is free of any obstructions, allowing the heat transfer to form convective cells within this layer of liquid argon.