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Sketch of the Straw-Tube Tracking System for BCD at the SSC

We summarize a possible configuration of the BCD straw-tube tracker that is compatible with the volume indicated for this on the drawings of Ron Hoffman dated 3-9-90, titled 'BCD Central Detector Details.' This is a box of transverse size 180×180 cm^2, 600-cm long, with flares on each end at 30° to the beam. A top view of a portion of this volume is shown in my figure, along with a configuration of straw-tube superlayers in a concentric cylindrical geometry.

Some parameters of the model system are also given in the Table. There are 10 triplets of superlayers, each consisting of a layer of vertical straws, a layer of straws tilted at $\tan^{-1}(0.2)$ to the vertical, and a layer tilted at $-\tan^{-1}(0.2)$. If each superlayer is 10 straws thick, the total number of straws is 340,780.

For assembly purposes the straws are grouped into modules of never more than 68 straws along the wider edge of the module – about 30 cm assuming a straw diameter of 5 mm. There would then be about 640 modules.

The straws in the 'neck' of the detector volume are all 180-cm long (except those that would intercept the silicon tracker, which must be split; the accounting for this split does not appear in the Table). In the flared volume the straws are taken to be split at beam height, and vary in length from 100 to 155 cm.

The tilted superlayers present an interesting mechanical construction problem. The surface obtained on stringing tilted wires between circular patterns on two parallel end plates is a hyperboloid of revolution. This has a waist whose radius can be considerably smaller than that of end plates. Hence if we wish to surround the wires by tubes, the tubes would have to be flared. Thus we cannot actually construct the ideal hyperboloid out of straws. Instead I propose to build it out of modules each of which is a flat slab, and given an average tilt to match the hyperboloid as well as possible. This implies the cracks are inevitable. The Table includes a lower bound on the fraction of the area lost in the cracks; it is quite significant on the innermost superlayers where the radius is small.

Not shown is the edge problem for the tilted layers when they abut the vertical boundaries of the detector volume. This problem exists if we were to use rectangular rather than circular geometry for the detector, and is even more severe then...

We end with a few remarks possibly useful for the Facilities Requirements Report:

1. The chamber gas might be dimethylether – probably the most flammable/toxic of the gases under consideration. Each tube of 180-cm length has a volume of 35 cm^3, so a system of 340,000 straws has a gas volume of about 400 ft^3, not counting the gas volume of the manifolds. If the gas-changing time is 30 minutes, we would need 800 ft^3/hour = 4 bottles! As the gas might cost $500/bottle, there is a clear need for a gas recirculating/purifying system.
2. The electronics on the tube ends are anticipated to consume as much as 20 mWatt/channel = 7 KWatt for the whole system. Details of how this heat load will be dissipated do not exist. It is desired to operate the system at room temperature, or perhaps only slightly above 0°C. If the electrical power is provided at 5 volts, the total dc current is 1400 amps.
3. The chambers with operate at about 2 kV. Each straw may draw about 0.1 μamp at 10^{32} luminosity, implying an additional 0.2 kWatt heat load.
4. If we successfully implement our strategy of data-collection chips that drive fiber-optic cables, there may only be 2 or 3 cables per module, perhaps 2000 in all. Thus cooling ducts and gas distribution are likely to be more cumbersome than the electrical cabling.
5. The system-calibration technique is not certain at this time. It will not be a laser, as the tubes are opaque. It will probably not be radioactive sources. We are now considering a pulsed x-ray source.
6. The straw tubes are flammable even if the gas is not.
7. The straw modules are rather lightweight ($<$ 1 kg each??), but must still be aligned in some overall support system, not yet envisaged.