Mini-review of the DC, October 14 1995 (DC Meeting, Oak Ridge)

November 30, 1995

The mini-review consisted of presentations by Vladimir Samsonov (PNPI) concerning the physical and mechanical aspects of the DC design. Craig Sangster (LLNL) reviewed the status of the front-end electronics design and results from the 1995 test beam runs. Here we briefly review what was discussed and what action items are appropriate.

I. DC Mechanical

Frame The DC has a single large exterior frame which houses electronics in each curved arc and gas feeds in the straight end pieces. Mechanical stresses have been thoroughly simulated for a 15 mm thick Ti version and a 25 mm thick Al version of the frame. Both versions require the C-fiber strut which is now finalized as part of the design. Neither version would require re-tensioning the wires after full assembly. Choice of material instead rests upon other considerations. Here I list briefly a comparison of the characteristics of Al metal vs. Ti metal. Ti metal is as strong as steel, but 45% lighter. It is 60% heavier than Al (Al=2.7 g/cm^3, Ti=4.5 g/cm^3). At room temperature, the thermal conductivity of Ti is 8.5% that of Al (20 W/mK vs 235 W/mK), and its electrical resistivity is 15.8 times higher than Al (42 $\mu\Omega$-cm vs 2.65 $\mu\Omega$-cm). Al has a linear expansion coefficient which is 3 times higher than Ti (25×10^{-6}/K vs 8.5×10^{-6}/K).

1. **Material Cost** Since the construction will take place in Russia, the Ti solution (surprisingly) has the better price.

2. **Weight** The Ti is solution is slightly lighter overall since its thickness is less (25 mm in the main part vs. 15 mm).

3. **Electrical & Thermal conductivity** Inherenty, Al has better electrical conductivity (10$\times$) and thermal conductivity (15$\times$). An Al frame could easily be used directly as a ground point, while the Ti frame might require a ground bus be added. A 100 cm^2 Ti bar (roughly equal to the cross section of the inner "wirefacing" surface of an arc) has an equivalent electrical resistance to a 4 cm^2 Cu rod. The total metal within an arc is more than this and could be sufficient for grounding purposes.

   A brief calculation of the thermal heat transfer shows that neither the Al frame nor the Ti frame will be a sufficient heat conductor if the cooling water were only applied at the bottom straight bar. Thus, coolant must travel the arc and then the difference in electronics temp is small enough that this is not a serious issue. (note in preparation from TKH to the tracking group).

4. **Thermal Expansion** Under a 10 degree temp change, a 4 meter length of Ti will expand by 34 microns. Al will expand by 100 microns.

5. **Ease of Machining (remachining)** The Godfather is not an expert in machining Ti metal. According to descriptions I have received, if necessary, a person with hand tools could drill and tap a hole in Ti with similar level difficulty as known for stainless steel.

ACTION ITEM: The present decision favors the Ti option. This choice should be fully evaluated via the above criteria on the next stage prototype. Calculations of heat transfer should be verified and tests of grounding capability made.

Gas Seal The gas seal of the chamber is quite complex. On the front and back faces of the chamber large windows will be stretched and sealed. At the corners, a seal must be made between the exterior frame arcs and ends. Additionally, signals and HV are feed through the side arcs using flexible kapton jumpers. These are sealed against rubber. ACTION ITEM: The integrity of the seal and possibly has contamination should be investigated and quantified on the existing prototypes. A ppm level water monitor should be used during the next test beam run as a method of quantifying leaks (this item can be borrowed from the RICH group).

Alignment Complete simulations of the alignment precision needs of the DC have been made. The predictions for the precision of not only wire manufacture, but individual wire position measurements exceed what is necessary to carry out the physics program. ACTION ITEM: In the presently quoted tolerances are met, no further action would be necessary.

Wire Split The procedure for breaking the wire in the middle using a kapton strip has been demonstrated. The kapton is quite light and the solder layer (quoted as only 25 microns) is quite thin. Although some tests have been made, more are requested. ACTION ITEM: Test the strength of the solder joint and report upon the success rate of making the joint after production of the next prototype.

II. HV

Configuration During the last test beam run, efficiency of the first and last wires of a single net was low. This contradicts results obtained earlier. The present theory maintains that the close proximity of the grounded window interferes with the electric field shape (demonstrated through GARFIELD calculations) and is the source of the problem. A new voltage configuration on the wires preceding and following the anodes may correct the situation. ACTION ITEM: Test the new HV configuration on the next prototype. The new prototype is already planned to have diode protection on its inputs.

Wire breakage The tracking group and this reviewer consider the possibility of wire breakage during operation to be small. However, in the present design, too many cells could be potentially lost if one high voltage were turned off. ACTION ITEM: An investigation of the benefit in flexibility and cost in complexity should be made of a system which could assert/de-assert HV to a single net by remote control. A system using optocouplers which allow a Li battery to open a normally closed relay is already under discussion in the tracking group.

III. Electronics

The electronics are well under control. The change in the next round will be an increased time constant in the shaping amplifier internal to the ASD-8 chip. This should result in an improved signal-to-noise which is anticipated to move the result on electronic noise from acceptable to solid. The cost could be in two-track resolution although present estimates predict that the device will still perform above PHENIX goals. ACTION ITEM: The two-track resolution should be investigated during the next test beam run. Slightly modified gas mixtures (a little slower) could be considered for fine-tuning the two track resolution if it is found to be worse than anticipated.