Report from the LAr Review

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This is the report from the mini-review of the LAr R&D work at FNAL. The review was held on January 26 2009 from 1-5pm. We received presentations on the following topics

Introduction - Liquid Argon Detectors related to Fermilab	S. Pordes
Materials Test System and Electronics Test Stand	S. Pordes
Some issues with a closed system	R. Andrews
Electronics Developments	C. Bromberg (MSU)
The 20 ton Purity Demonstration	R. Plunkett
Liquid Argon for Dark Matter Detectors	A. Sonnenschein

LAr TPC R&D

The committee believes that the R & D program currently underway is in the right direction for a step-wise progression towards large volume liquid argon TPC experiments. LAr is important to the lab as a potential detector technology for a large detector for the long baseline neutrino beam. It may offer the better detector technology at the DUSEL site, but also offers a way that FNAL could justify a Project X - long-baseline-beam to a surface detector in case the DUSEL lab does not work out.

The work at PAB appears to be making good progress and we encourage this to continue. We were impressed by the efforts to track down the condenser effects on the lifetime.

The progression to such a possibility needs the R&D on high-bandwidth low-cost low-noise electronics presented by Bromberg and confidence-building work on a LAr construction-style that can be scaled to very large detectors. We have the impression that MicroBooNE will have to be fairly conservative in construction, so that they can have high confidence of ending up with a working detector. So the LAPD test is very interesting because it will better allow testing of the cost-cutting approaches toward materials and techniques one will need to get to the very large detectors.

The LAPD endeavor is a good next step in the progression. The piping schematic and flow path features, pump, and filtering techniques, and operations (purge, fill, purify, stable operation) that will be explored are directly applicable to the larger experiments. The physical installation and set up seems very straightforward and mechanically feasible. The tank has a 30" port on the top which gives flexibility in testing and exploring additional ideas that will come undoubtedly up. For example a study of the slow convective fluid motion would be appropriate. We think it is important to understand the fluid motion's influence on the fine wires of a TPC. The fluid drag will impart a displacement and tensile forces that get very significant as the length between

wire supports increases. This flow could also affect the purity in one region of the tank versus another. Ways should be devised to try and measure the purity at different locations in the tank. Another test would be to attempt to measure the Nitrogen content of the Argon from a few vendors. Nitrogen does not cause problems for electron drift but it is an issue for light collection which is needed for triggering. The LAPD test should explore ways to remove the Nitrogen.

From the perspectives that (i) an R&D setup can provoke more questions to answer, which may take more time to investigate, and that (ii) the lab is squeezed for people now, so that doing LAPD may take longer than projected, and finally that (iii) LAPD once it achieves its objective of cleaning up LAr would be an interesting place to put test detector components, it would be much better to site it in a place were there is not a tight deadline to remove it. The investigation which resulted from the current test-stand showing that dripping condensate directly back into the vessel causes problems is a perfect illustration of this.

We recommend that PPD continue with the current support of this activity. It would be beneficial to try and get more scientists involved in this effort as this would allow more topics to be addressed in parallel. This is consistent with Pier's statement that more scientists need to get involved in intensity frontier projects at the lab.

LAr Dark Matter R&D

Our impressions of the dark matter R&D proposal are that (1) it is on an extremely interesting path for doing physics, (2) given the physics capabilities of MiniMAX it would seem that it perhaps rises to the level of being an experiment rather than R&D and (3) if there are resources for it, to the extent that it expands the LAr detector community it may also help moving toward a large LAr detector. Although this detector concept is the subject of an S4 NFS proposal we were given the impression that there is no R&D money available from NSF as the proposals submitted are not supposed to require any R&D, which is clearly not the case here. So the request is that FNAL fund the R&D.

However, we have a number of concerns with the R&D program that was described. Given the tight resources that the lab currently is under, we are concerned that embarking on this project may dilute and extend progress on other fronts. We think the manpower estimates given are low and the timeline for MiniMAX is rather optimistic. Successfully building an acrylic cryogenic vessel with the proper optical qualities and no thermal cracking or crazing would be a significant challenge that appeared to us to be taken somewhat lightly. Because the PMT's surround the vessel, undoubtedly a design goal will be to minimize light obstruction and maximize reflectivity in the internal components. This will add to the complexity of the internal electric field grids and wiring. Radio-purity concerns and cleaning requirement for all materials in the liquid argon is something that can expand the first pass estimates on time and costs.