Hi all,

Here are notes from Monday's LArDBT meeting 2012-04-02. Since the NSF proposal is due in a very short time, we plan to meet every Monday at 11:15 CT for the next 3 weeks (April 9, 16, 23). Meetings can be less frequent after then.

Attendees: Flavio Cavanna, Eric Church, Bonnie Fleming, Alan Hahn, Mike Kirby, Ornella Palamara, Jen Raaf, Brian Rebel, Andrzej Szelc, Tricia Vahle

Flavio and Ornella put together some thoughts on Phase 1 of the LArDBT plan, which is to put a slightly modified ArgoNeuT into the FTBF as soon as possible (i.e., by the time the beam comes back on next year). These are summarized below.

Phase 1 goals

- **Recombination**

Phase 1 would concentrate toward measuring the recombination processes induced by energy deposition of charged particles crossing the detector -- recombination subtracts a significant fraction of the released charge, and depends on local ionization density, so it must be corrected moving along the length of the track. This is something that has been discussed for many years as a necessary ingredient for full understanding of LArTPCs. It is crucial for calorimetry -- all tracks will need a significant correction factor to get the right amount of energy deposition across the track; if we don't know this with precision, we'll end up with a large error in the calorimetric reconstruction.

We're not starting from scratch -- there have been measurements in the past. However, these were done only with cosmics, where you must assume the type of particle crossing the detector. Statistics have been limited for highly ionizing particles like protons, and the assumption that these cosmic tracks were protons couldn't be verified. Thus, having a LArTPC in a test beam with known particle types and energies will be an important advancement in understanding. Other existing measurements include the T32 experiment at J-PARC, which used a test beam, but which had very coarse readout of the detector: a single collection plane with 1-cm wide readout strips separated by 1 cm each. The need now is to do a precision measurement. Also related, no one has yet looked at dE/dx deposition by kaons -- another area where we should be able to make measurements. T32 has collected test beam data with kaons, and analysis is in progress, but still subject to the coarse readout.

- **Electron/photon separation**

In a detector the size of ArgoNeuT (~90 cm long), we should be able to look at the beginnings of EM showers. Experimentally studying this is important for future applications of this technology. This will be studied first by MC simulation. Andrzej has made a nice first effort toward MC studies, and will continue to work on this. Any help is

appreciated. Also, he will compare with Kevin Yarritu (LANL), who has been doing similar studies for the LBNE near detector.

Phase 2 goals

This should be discussed in more detail during the next meeting, but here are some initial thoughts. Clearly many other ideas can/should be added to this, so please distribute other options, ideas, and comments to the list for discussion. The detector size will be informed by the requirements of studies we want to do.

- **EM and hadronic shower propagation**
  This requires a much bigger detector than phase 1 (~5-10 m long).

Other Discussion

Some questions concerning FTBF and necessary hardware modifications to ArgoNeuT were also discussed.

FTBF Site

- We confirmed that M-Center can receive tertiary beam
- The question of who decides/allocates the area in and access to M-Center: in previous discussions with Aria, we determined that she (as head of the FTBF) is very interested to see a dedicated cryo facility with a LArTPC placed in M-Center, and she showed us the available space there. Officially, we would need to write an MOU which then typically takes a few months to receive approval.
- Safety/ODH documentation: Brian said that there is now a dedicated cryo safety committee, so getting approval and documentation will not be as difficult as it was for ArgoNeuT or LAPD (for example).
- Cryo infrastructure: What is needed/what can be taken from LAPD or ArgoNeuT? Brian says that the LAPD filtration system has been claimed by the LBNE 35-ton prototype effort, and maybe it's better to steal the MicroBooNE idea/design of filter skids. Alan noted that we should make sure to only ask for what is necessary to keep costs down -- active filtration and pumping is essential for phase 2, but not necessarily for phase 1.
- How to get FNAL engineering/tech support for the cryo infrastructure: Brian noted that the division head is very much in favor of us doing this project, but since we don't know what the budget is yet, it's hard to say how difficult it will be to get support. LAPD went through a lessons-learned review, and this brought up the fact that we need a dedicated group of people working on this, but the direction of effort needs to be handed down from the division, and the availability comes down to what other projects need those resources as well. Alan noted that this will be part of the MOU (what FNAL contributes to the process).

Hardware modifications to ArgoNeuT

Some of these will make sense to be done by FNAL, some make more sense for university groups to do.

- PMTs

Reading out scintillation light by PMTs is an important aspect we need to stress. It will help very much in triggering. This will also require mods for mechanical support of the PMTs, side flange modifications as well as feedthroughs, readout electronics and HV.

- LAr recirculation (cryostat out/inlet lines, dewar, submersible pump, filter) & GAr recirculation (new filter insul.)

  These make sense for FNAL to work on
- Low X0 window in front flange(s), excluder for LAr dead layer, removable pre-shower material

This probably should be a 1/2-FNAL, 1/2-University effort because modifications to the flanges will require approval for safe operation under vacuum. We still don't have full understanding of whether this modification really needs to be done. Hopefully the answer will come out of Andrzej's MC studies.

- NanoBooNE TPC & signal feedthrough

Using the NanoBooNE TPC instead of ArgoNeuT TPC has large benefits (same number of planes, wire spacing, etc. as MicroBooNE) and is extremely relevant for future experiments, but is a rather ambitious goal. Bonnie & Mitch said that it's best to push for nanoboone, but have argoneut as the backup solution if necessary. Ornella noted that the recombination measurement is not related to the electronics; nanoboone is preferred, but if it's not feasible, then the measurement can also be done reasonably well with argoneut.

- Cold electronics

Where to get/what to use? Eric noted that the signal readout is very different for the argoneut and nanoboone options. He's not sure how the argoneut option would be developed (since Josh is gone, and Mitch may not have enough time to do this), and the nanoboone option has the benefit that Andrzej and Eric are already working on it for microboone.

MC studies

Andrzej has already done a significant amount of work on this, but a few remaining studies are greatly important.

The most urgent thing to answer: how (if possible) to extract photons from preshower to study electron/photon separation in the detector. In principle, putting 1 radiation length of material in the front of the detector will cause a significant fraction of electrons to make photons by bremsstrahlung, but the energy may be half the energy of the electrons. The angle should be within a few degrees (if the electrons are a few hundred MeV). Should be able to see one shower at the beginning, one delayed (gamma)... it would be nice to see if this idea can be supported by simulation. If so, then we'll want to test it experimentally in phase 1.