Sep 19, 2012

Dear Photocathode Group Godparents,

The Photocathode group wishes to thank the Godparent Committee for their recommendations following the Photocathode Godparent Review of July 9, 2012. We have studied these comments carefully and list the response to the comments in detail below. By doing so, we hope to better document our position and plans for the future. Your comments on our work are appreciated.

Best regards,

Photocathode Group

**The comments and responses are listed in detail below:**

1. In the near-term, the large-chamber Photocathode deposition and hot-seal system at SSL will be the only viable way to make first-article 8" LAPPDs. Therefore this effort must be funded at a level sufficient to ensure that prototypes continue to be made available until either commercialization and/or the Single Tile Factory (STF) is a viable alternative.

**[Response]** Yes, the effort at SSL is the highest priority for funding. The SSL group has demonstrated an acceptable 8'' photocathode, and work is in progress to transfer this capability to the tank.

2. Beyond this, the committee notes that there was a clear lack of vision from the LAPPD project management on how resources should be allocated going forward. At this stage the committee notes that it makes little sense to discuss PC development plans in the abstract, since it will clearly be tied to the next stage of ANL-centered effort. Specific questions that the committee would like answered are:

a. The progress and experience gained with the chalice have been impressive; however how does this effort tie into what is needed next?

**[Response]** The experience of the chalice shows that the K-Cs-Sb can be made in large area even in the present not optimal condition. The efficiency depends on the plasma, contamination and a lot of other effects that we do not yet fully understand. The chalice work also demonstrates the requirement for development of instrumentation for control and measurement during deposition. The next step is to develop the protocol to shoot 3'' and 8'' photocathodes and assess the resources necessary to instrument the high vacuum system and for the management to secure it.

b. Can the PC component of the STF be developed separately (initially)?

**[Response]** Yes, this is the plan. The chamber is designed so that the cathode can be deposited and characterized in a separated chamber. However, we need a resource-loaded schedule to make the study

possible, with detailed specification of the actual internal deposition instrumentation. We need the assessment of schedule and resources.

c. What is the role of the STF if a vendor starts to make LAPPDs?
**[Response]** This is a question related to the STF. We refer you to the STF review. In short, the STF is a test facility and the vendor is the production line. Experience has shown over and over that it is crucial for the process of having a product be adopted by industry to have a parallel development system available at a national laboratory.

d. How will the cathode material for PMT production in the STF be downselected?
**[Response]** This is a misunderstanding. STF is an R&D facility. The default photocathode is a 25% QE KCs-Sb cathode. However, we will continue on improving the QE. Argonne is also part of the photocathode SBIR proposal with BNL and RMD cooperation to develop higher QE photocathode. As higher QE photocathode becomes available, we will try to implement it into the STF.

e. Are the resources available sufficient to bring the STF online? And by when?
**[Response]** This is a question for the STF review.

f. When will the responses to the STF review committee comments be available?
**[Response]** This is a question for the STF review.

3. The committee strongly recommends that a resource-loaded schedule for the STF be provided, so that the integration and viability of the PC program therein can be assessed.
**[Response]** Yes, we will work on the photocathode part. Also, this is a question for the STF review.

4. Progress with the chalice has been impressive. To obtain the full measure of repeatability and process control, we strongly recommend that additional instrumentation be added to this setup. In many cases these can be data loggers and sensors that can be moved or replicated on the modular STF system later.
**[Response]** This is the plan. Our group has started to investigate what additional sensors are needed for photocathode monitoring, how to implement them and how to read them out. We plan on having a fully instrumented photocathode growth chamber. Currently, the pressure unit can be read out directly, while the temperature read out needs some further investigation.

5. Since it is expected to take time to gain experience solving the problems of an 8" PC, we strongly recommend building this modular component first, and operating it initially independently (and with as much monitoring instrumentation as is feasible), to learn what it takes to make a 20% quantum efficiency PC in that environment. Wherever possible, lessons learned from the construction and operation of the

SSL chamber should be married to the valuable experience gained with the chalice operating on the Burle system. An adiabatic transfer of operations from the chalice to this new system is recommended.
**[Response]** This is the plan. The cathode effort suffers at the moment from a scarcity of personal: a commitment of people and resources is needed in order to define direction and priority.

6. As noted above, the intellectual leadership of the fundamental science component of the PC effort has moved to BNL. The committee realizes that it is ineffective to recommend collaboration in this effort without a clear leader at ANL. Therefore we recommend that such a person be identified at ANL and supported at a level to make collaboration on the fundamental science aspects of Photocathode development viable.
**[Response]** We are still considering what to do on this part; it will depend on the budget.

7. We reiterate that tighter coordination of the GaInN fabrication with measurement capabilities at ANL, perhaps through more regular visits by Daniel Leopold to the lab, is strongly encouraged.
**[Response]** We agree with the suggestion.

8. Given the intimacy of the packaging to the growth of a successful PC, going forward, it may make more sense to merge, or at least have this committee meet jointly with the hermetic packaging (and standing STF review?) committee.
**[Response]** For the next phase of the project there should be a single review, which addresses the project as one integral unit. Thus, we agree with the suggestion.