5-OCT-2010 == PhotoCathode Godparent Review Summary

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The committee recognizes the tremendous amount of progress that has been made since the last review in February. Considerable knowledge and experience on photocathode fabrication and operation has been acquired by the team members. The first choice remains M3Sb (M: K Na Cs) cathodes, which lack a fundamental knowledge of their basic properties due to their more complicated structure and due to the fact that their tuning was probably done from more empirical approaches than from fundamental principles. It is very important that the Burle equipment be commissioned and that cathodes of sufficient quality are produced at ANL as soon as possible. Demonstration of scalability is also a high priority. For possible new semiconductor materials such as InGaN and GaAs, the basic physics behind band structure and its bending, surface activation techniques, possible optimization of photocathode absorption by antireflection/good transmission through the window/thickness/engineered doping is well understood to the limits of present knowledge available in the literature.

In order to provide a more meaningful assessment of the potential benefit of the techniques presented, it is essential to be provided a ranked list of tests that can characterize the photocathode properties. Specifically, it was unclear which of these diagnostic tools are applicable to fundamental understanding versus process control.

We recognize that both delivering a working 8" x 8" photocathode and publication of the findings, pertinent to understanding of the fabrication process and underlying physics, is crucial.

As there is a tradeoff in the space for deliverables, we suggest the utility of these characterization tools be prioritized in terms of their applicability to the following ranked figures of merit.

1. Scalability
2. Q.E.
3. Stability
4. Lifetime
5. Uniformity

Our brief assessment of the current state of the 4 effort tracks presented:

- **UC Berkeley SSL** – appears to be on track
- **Wash U** – the committee recommends since the a-InGaN looks promising that ANL resources be made available for characterizing the samples with respect to the metrics above. Modest requests for M&S should be considered by the management.
- **ANL Growth Facility** – getting practice with 4" PC growth is essential. While the proposed next steps look promising, the details need to be clarified.
- **ANL Characterization Facility** – we endorse completing the design and fabrication of the vacuum transfer system that is compatible with the existing growth and characterization systems at Argonne. This exploits the interest overlap between involved groups in a way that can rapidly lead to publishable results. Addition of new capabilities should be contingent upon

first exploiting the existing capabilities and be better defined in terms of the metrics presented above.

In general, multialkali photocathodes are established technology. Nevertheless, the scalability to an 8 inch format and the cost effectiveness of this process and its uniformity are crucial to the success of the program. This is probably the most challenging aspect of a large format PMT. Rapid developments over last 6 months indicate that we should be on the right track to reach the goal of mastering the technological details necessary for a large area PMT. However, if we plan to produce the cathodes at ANL we should start on that process as early as possible. It will be very important to ensure we are at least close to a sealable device with acceptable quantum efficiency (probably on a small format scale, with no MCPs installed in the device produced with only photocathodes used in a "photodiode" mode) at the new ANL facility. It will take quite some time to learn the nuances of photocathode production. Therefore if there is any possibility to speed up the facility commissioning and first processing attempts, we strongly advocate that they be undertaken at this stage of the program.