HPS Response

to the DOE Office of High Energy Physics Report

on the Review of the Heavy Photon Search Test Run

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Heavy Photon Search Collaboration

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Introduction

This report summarizes the response of the Heavy Photon Search Collaboration to the report recently issued by the Office of High Energy Physics of the US Department of Energy following the review they conducted of the Heavy Photon Search Test Run experiment on March 1, 2011 at DOE Germantown.

Our response is organized in five sections. The first addresses the Executive Summary and Introduction and Background sections of the DOE report. The four sections following address in turn the reviewer's comments and recommendations for the four charge elements, scientific significance, technical readiness, cost and schedule, and cost and schedule contingency.

I. Executive Summary/Introduction and Background

Both the Executive Summary and the Introduction and Background sections of the report accurately reflected the information HPS had provided in its proposal and in the review, and the comments made by the reviewers during the course of the review. Detailed items in the executive summary are dealt with below, in our comments on the conclusions of the reviewers.

II. Scientific Significance.

We are gratified with the reviewer's assessment that the scientific merit of the HPS Test Run, and the full HPS, is high. The reviewer also noted that the experiment is "quite a worthwhile project", "if the full HPS experiment can really be done for ~$3M and if there is not a prospect of an experiment with similar sensitivity elsewhere…" The experiment can be done for ~$3M as we demonstrated under costs and schedules. The reviewer mentioned the "claims" from the Mainz experiment that they could cover the parameter space of our displaced vertex search. The Mainz group has not made a formal proposal for covering this region, nor has it made calculations of rates, backgrounds, or experimental reach expected in their approach to this measurement (which is very different from ours), nor do they plan to do this experiment in the next year. Their "claims" were in fact offered in the Heavy Boson Workshop at Jefferson Lab, and signaled their interest in extending their search into new territory with a new technique. They did not attempt to document their ability to carry out such a measurement with high sensitivity. At this time, there is not a believable prospect for another experiment elsewhere with reach or sensitivity comparable to HPS.

The reviewer commented that a null result over the region of interest would not "kill any of the popular theories." While this may be strictly true, owing to the limits of the HPS experimental reach, HPS could eliminate viable regions of parameter space for the "g-2 region", the "DAMA region", and those suggested by other particular theories. So HPS data could contribute to killing such hypotheses (or confirming them!). In the case of the g-2 region, assuming the heavy photon couples predominantly to e^+e^-, HPS can cover almost all the viable phase space if it succeeds in running at 1 GeV.

HPS certainly agrees with the reviewer that it should try to run at 1 GeV, and it is continuing its evaluation of the reach of such a run. Run time constraints at Jefferson Lab make it look very difficult to run at 1 GeV in 2012, however, and special machine provisions would be needed to run at 1 GeV in the 12 GeV era at CEBAF.

The reviewer for this section had no specific recommendations.

III. Technical Readiness

The reviewer notes that HPS is making good technical progress on the main technical challenges in the experiment (proximity of sensors and ecal modules to the beam, design and implementation of a trigger, and target design). The reviewer also notes that each of the technical items is low risk, since they make use of existing technology, with the possible exception of the FADC development for ecal readout and trigger, which is considered "low to moderate" risk. We agree with those assessments, and in fact are already considering a backup trigger system in case the FADC development is somewhat behind schedule.

The reviewer suggests rastering the beam on the target during the test run. This is something we had considered and rejected. Any rastering will change the beam position, perhaps just horizontally, but possibly both horizontally and vertically. Vertical motions cannot be tolerated because the silicon sensors are positioned so close to the beam that they constrain the beam position. Even horizontal motions are problematical if they are larger than the 200 μm beam spot, because they would violate the clearance required in passing the beam through the ecal vacuum chamber, and require rapid and highly accurate position monitoring. The plan to provide a beam which is small vertically and much larger horizontally has already been demonstrated in Hall B, and this beam perfectly suits the HPS Test Run, does not compromise resolution, and will not damage the target. We don't need rastering and rastering will introduce new complications, so we will stick to present plans.

The reviewer comments that since the test run has in some sense dual goals, both answering technical questions and getting physics answers, it is conceivable that the technical questions may not be fully and conclusively answered if the physics goals get in the way. As we tried to make clear in the proposal, our highest priority is to measure silicon sensor occupancies and trigger rates, so that we can remove the technical contingencies preventing approval of the full HPS run. Practically speaking, the apparatus is capable of such measurements well before it is ready to take high rate physics data, and occupancies and trigger rates must be under control before physics running is possible, so technical questions will be answered first in any case. We agree with the observation that we must at the same time establish that the silicon sensors and the ecal modules are sufficiently radiation hard to handle HPS operating conditions and are planning accordingly. Given the possibility that radiation damage to the sensors may be important, the reviewer suggests we include different sensor types in the Test Run setup, to see if radiation damage may be better mitigated with another design. We don't see this as a realistic option, because the schedule and the budgets are already tight. There is not time or money to invest in other sensors, adapt readout hybrids for multiple sensors, devise cooling strategies for other sensors, or even work out modified support fixtures for other sensors.

The review states, "It was not clear that the same silicon design would be reused in the 12 GeV full HPS run." To be clear, the same sensors and hybrids will be used in the full HPS, but the sensor mounting will be different, so the sensor modules (sensor + support + hybrid + cooling) of the test run will not be reused. The test run utilizes only 20 sensors, instead of the 120 sensors of the full run, and many of the procedures used to mount them will be reused in building the full HPS apparatus.

The review notes that variations in light output by the ecal crystals could well affect the trigger rates, and that it might be advantageous to use a light fiber monitoring system, room for which is not allotted in the ecal enclosure design. While we are skeptical that such a system is needed to monitor crystal light output, and while we expect to accomplish the needed monitoring with online data, we are planning to leave enough room to install light fibers in the ecal temperature enclosure. The calorimeter which used the crystals previously incorporated a light fiber system, and it is available to us.

The reviewer also noted that the enclosure is being designed by our Orsay collaborators, but that it will be built at Jefferson lab, and argues that this arrangement could lead to a significant cost increase and schedule risk. There are certainly disadvantages to having the left hand do the design, and the right hand the manufacture, but these disadvantages don't apply to the present case. Jefferson Lab has been closely collaborating with the Orsay group for some time, and has built a very successful calorimeter, the CLAS IC, with them. The left and right hands have been working together, successfully and efficiently, for some time.

We fully agree that the enclosure design and fabrication schedule be reviewed as soon as possible, and have already made progress in this direction at our recent Collaboration Meeting.

We also agree that the DAQ system presents a significant risk to our obtaining physics results from the test run apparatus, because so many elements need to be developed, including hardware, software, and firmware. Accordingly, we are focusing extra effort at coordinating, scheduling, and integrating the SLAC and JLAB DAQ systems. As the reviewer correctly notes, it is the physics goals, not the hardware proofs of principle, that are potentially at risk here.

No recommendations were made in this section.

IV. Cost and Schedule

The reviewer found that the HPS Test Run schedule was very tight, that it did not show float in many of the subsystem schedules, that milestones were not called out, and that availability of key components did not appear. All of these findings are accurate, and reflect the state of the HPS Test Run schedule at the time of the review. We had only a short time to prepare the HPS Test Run Proposal after the PAC approval, and were unable to complete the schedule in full detail for the review. Since the review, we have been updating the schedule, including at our recent Collaboration meeting, and are presently in the process of refining it, adding float where possible, establishing milestones in the various systems, and including availability of key components. The integration task is called out specifically as requiring a more detailed schedule, and we will see that it is added.

The reviewer states that despite the tight schedule, it is possible to prepare the HPS Test Run on time by instituting the necessary close control of task accomplishment and decision making. We are committed to making that happen, and will establish more formal project management to ensure that it does. In particular, the reviewer recommends that a single leader be named to oversee the test run and to coordinate and integrate all activities into a coherent whole. John Jaros will assume the role of Project Leader for the HPS Test Run, and will work very closely with Stepan Stepanyan and the subsystem leaders to fulfill those responsibilities.

The review states "the scheduling of beam time for the Test run remains as the largest single risk to the program." DOE's report on the review notes that HPS has already provided a document, "HPS Test Run Contingency Plan", which outlines how the HPS Test Run apparatus will be used even if no formal beam time is allotted during spring 2012 at Jefferson Lab. In fact, the critical test run goals can be accomplished by running parasitically with the experiment presently scheduled in Hall B, and adding a 1-2 week electron run at the end. If this is impossible, the HPS Test Run apparatus can be transported to the SLAC test beam, to make the measurements of occupancies and trigger rates needed to remove the PAC's contingencies.

V. Cost and Schedule Contingencies

Our reviewer expressed further concerns about the tightness of the schedule, and the fact that contingencies, though included, are perhaps on the small side, or in the case of "in-kind" contributions, not included at all. Again, there is a request for more detailed scheduling, including more detail and more float, identifying critical path items, and assigning contingencies to the "in-kind" items. As stated above, we appreciate this constructive criticism and have already begun producing more comprehensive schedules. We will explore possible contingencies for "in-kind" items.

The fact that JLAB has not guaranteed beam time for the HPS Test Run was presented as a serious concern, as it was in Section IV above. We believe that "The HPS Test Run Contingency Plan" fully addresses this concern, as stated above.

Another concern raised is the level of overlap of scientific personnel between HPS and APEX. This is not a problem. Scientific personnel on HPS are in fact very busy with developing hardware, software, simulation, and analysis for HPS. Their responsibilities on APEX have in the past included developing and building the APEX target, helping run shifts, and more recently in the case of one experimentalist and the three theorists, participating in the APEX analysis. These recent efforts have essentially no impact on the HPS construction schedule and have provided valuable education for the HPS crew. It is quite unlikely that APEX will run before the Summer 2012 shutdown, so we don't expect to have to run shifts on two experiments simultaneously during the next year, so the overlap of personnel will not negatively impact the HPS Test Run. Even if APEX were to run, we expect to be able to meet our obligations to both experiments.

The reviewer recommended appointing a Project Engineer in addition to the Project Leader mentioned in Section IV above. He also recommended identifying float in the subsystem schedules, including availability of contributed components in the schedule, and adding milestones to the schedule. As a $.75M project, HPS does not command enough resource to appoint a full time Project Engineer. However, we fully agree that the schedule is tight, that more detail, milestones, and float must be properly included in the schedule, and that a good deal of week by week oversight is required to complete the HPS Test Run in a timely way. Accordingly, we will establish a Project Team, consisting of the Project Leader, John Jaros, and Stepan Stepanyan, to share the Project Engineer's responsibilities of refining and monitoring the construction schedule and overseeing progress and plans on all fronts. It is natural and necessary to monitor activities at each of the labs separately since DOE is funding them independently and the major construction is rather equally divided between the two. Stepanyan will closely monitor work at JLAB, and Jaros work at SLAC. Several engineers are engaged at each of SLAC and JLAB whose advice and expertise will provide critical input to decisions made by the Project Team. Subsystem leaders will also contribute. The Project Leader will retain control of HPS contingency funds and ultimate responsibility for monitoring overall progress and plans and dealing with exigencies.