

Committee Report - 7/28/14
Heavy Photon Search (HPS) Experiment Readiness Review

- Beam delivered to Hall B
- HPS experiment

Committee Members:

Roger Carlini (chair, machine protection)
Vashek Vylet (radiation control)
Bert Manzlak (EHS & Q)
Dave Kausch (fire protection)
Mike Spata (accelerator operations)
Ronald Lipton (SVT)
Dave Mack (12 GeV, calorimetry)
Jennifer Williams (EHS & Q)
Hyekyoung Park (engineering)

Summary: Observations, Findings and Recommendations
Mapped onto Specific Committee Charges

Overview:

The committee was impressed with the very professional scientific collaboration, excellent presentations and level of documentation. The committee found no show stoppers, but the installation schedule for a fall run is very tight.

1. Are the HPS specific equipment, documentation and procedures to run the experiment in place and adequate? This includes demonstrated readiness for full rate capability and expedient analysis of the data.

The experiment apparatus is well defined and construction/installation is proceeding well, but the schedule is very tight to have everything ready for beam this fall. There are several concerns (detailed later in this report) concerning possible radiation damage issues with respect to the detectors and electronics. Ultimately the concerns expressed by the committee will have to be evaluated under operating conditions and therefore do not impact direction construction/installation activities for initial experiment commissioning.

2. Are the formal documentation requirements and reporting (run coordinator → shift leaders) procedures for running the experiment adequate, appropriate and complete (COO, ESAD, RSAD, ERG, OSP's, general equipment operation manuals, etc.)?

The reviewers are confident that all related EH&S documentation (COO, ESAD, RSAD and ERG) will be ready (most are already in excellent shape) and will meet

schedule due dates. The HPS collaboration deserves compliments for a very timely and proactive approach to radiation safety aspects.

3. Has the entire beamline, target, detector configuration been defined (including ownership, maintenance and control during beam operations)? Is all the necessary equipment installed and operable? If not, what are the completion/commissioning schedule and procedures?

The experiment configuration is well defined. A detailed construction, installation and commissioning plan exists with clear milestones identified. However, the time allocated for the activities seems short considering that the planned run is only on nights and weekends.

4. Are the anticipated beam emittance, halo characteristics and general stability likely to be within the required specification to perform this measurement?

Specifications “should be” within easy reach based on demonstrated previous CEBAF performance at 6 GeV. However, the HPS apparatus and experiment goals are not very fault tolerant with respect to significant beam loss and/or poor beam quality.

5. Has transmission of the primary beam and generated secondaries been evaluated for unexpected beam restrictions (e.g. too small of a beam pipe acting as a secondary target), background sources (e.g. large number of produced photons hitting the beam line) or paths (e.g. primary and/or secondary steering from a magnet fringe field)?

Yes, if accelerator performance is as anticipated the beam should meet the specified experiment requirements. However, this will be the first beam into Hall B since the accelerator upgrade and the removal of CLAS.

6. Are the radiation levels expected to be generated in the hall acceptable? Is any local shielding required to minimize the effects of radiation in the hall equipment?

The Rapid Access System will be offline during this experiment. Radiation simulations indicate that negligible dose is anticipated. Radiological impact will be at most equal to typical Hall B Experiments, likely quite lower.

7. Are the local shielding and the machine protection system required to minimize the effects of radiation in the HPS detector in place?

The Laboratory and collaboration should consider adding an FSD based on an error in beam position at the last two beam position monitors. Consider whether the system protecting the SVT from direct hit would benefit from a formal failure analysis, e.g. analyze safety rating/reliability of critical components and identify potential weak spots. Regarding possible radiation damage to electronics, consider use of passive dose integrators (OSL and optichromic), in addition to active radiation detectors. With 100 nA of beam current we can expect to have good BPM signals throughout

the beamline. Could consider implementing an energy lock based on the vertical dispersion in the Hall B ramp.

8. Have all the jobs that need to be done to mount the experiment/s been identified and defined adequately?

Yes, sufficient planning seems to be in place to get all of the systems installed for the experiment. However, the overall schedule is very tight with little (if any) float.

9. Have conflicts with the 12 GeV Upgrade in Hall B been examined and resolved?

The 6 GeV beam delivery procedure is under revision for the 12 GeV era in general and HPS in specific. Hot Checkout to be completed by September and the collaborators expect to be ready for beam in October. Running will be interleaved with CLAS 12 installation with running on night and weekends (see detailed discussion below).

10. Are the responsibilities for carrying out each job identified, and are the manpower and other resources necessary to complete them on time in place?

Reevaluate the schedule to validate that it is consistent with running only on nights and weekends (see detailed discussion below).

Closeout Report – HPS Readiness Review

July 02, 2014

The HPS experiment is entering a phase from the end of construction and assembly to the beginning commissioning with an expected beam operation period of a few weeks in November/December 2014. The experiment is overall in a good state, but significant installation activities still remain – and the schedule is very tight. Several critical items/tasks still to be accomplished between now and November/December 2014 to make the commissioning period under beam conditions a success.

Detailed Observations, Findings and Recommendations:

Required Documentation and Equipment Operation Procedures / Manuals:

The formal documentation COO, ESAD, RSAD, ERG, OSP's, and general equipment operation manuals are in good shape. The reviewers are confident that all related EH&S documentation (COO, ESAD, RSAD and ERG) will be ready and will meet schedule due dates. The collaboration has already been returned their ESAD with a few suggested edits by the committee. The RSAD is ready and adequate. The presentations at the time of the review satisfied any questions the committee concerning the basic experiment setup. The committee notes that the ERG safety document needs to be finalized so a firm schedule can be set in order for staff to start training for Hall B access. The reviewers suggest communication with the hall leader to begin the new Emergency Response Guidance (SAF 111) training with sufficient time to allow personnel time to acquire the training ... possibly, one month earlier than expected beam delivery.

Experiment Installation and Testing:

Structural soundness of the equipment installation: The size of magnets and girders in this experiment are relatively small compared to the hall A and B's typical equipment. Also the new installation is in the alcove where the beam line is low from the floor level. As long as the structural analysis has been done the committee does not see any issues. The layout is straight-forward and the committee believes the mechanical installation should be relatively simple. The SVT unit is mounted on a long rod which is cantilevered. I hope the structural study has been done with the thermal aspect as well since the SVT generates heat. Since it's inside a large vacuum chamber I suspect the vacuum pump will run nearby. The vibration should not affect its distance from the beam line.

This committee notes a concern from the earlier: “Heavy Photon Experiment engineering run DAQ/offline readiness review”: Committee: Graham Heyes (chair), Sandy Philpott, Chris Cuevas. Specifically, “One of the presentations focused on the new SVT readout hardware. This hardware is quite different from any existing DAQ system at JLab with the ROC code running processors embedded in the custom electronics rather than a commercial VME board. Running the ROC on the embedded ROCs may present

unforeseen issues. It is critical to get the new SVT readout hardware on site to give sufficient time for testing and integration with the rest of the DAQ. There are a lot of complex custom hardware components in the system, running the whole system together should be done soon.”

Initial Beam Conditioning / Radiation Backgrounds:

As noted earlier the RSAD is ready and adequate. Collaboration deserves compliments for a very timely and proactive approach to radiation safety aspects. Radiological impact will be at most equal to typical Hall B Experiments, likely quite lower. Consider whether the system protecting the SVT from direct hit would benefit from a formal failure analysis, e.g. analyze safety rating/reliability of critical components and identify potential weak spots. Regarding possible radiation damage to electronics, consider use of passive dose integrators (OSL and optichromic), in addition to active radiation detectors.

The 6 GeV beam delivery procedure is under revision for the 12 GeV era in general and HPS in specific. Hot Checkout to be completed by September and the collaborators expect to be ready for beam in October. Running will be interleaved with CLAS 12 installation with running on night and weekends. Specifications within easy reach based on demonstrated previous CEBAF performance at 6 GeV. Sufficient planning seems to be in place to get all of the systems installed for the experiment. The Rapid Access System will be offline during this experiment. Radiation simulations indicate that negligible dose is anticipated.

The present optics configuration allows for 1 mm of leakage dispersion in either plane. This needs to be revisited for this experiment. The use of the 2C04 harp to verify beam quality from CEBAF should be added to the procedure. The beam should be tuned to the nominal size at the Tagger Harp before sending beam into the Hall. Items for consideration during the Hall B Beam Delivery procedure revision should include: Adding an FSD based on an error in beam position at the last two beam position monitors. With 100 nA of beam current expect to have good BPM signals throughout the beamline. The collaboration should consider implementing an energy lock based on the vertical dispersion in the Hall B ramp. The committee suggests a re-evaluation the schedule to in order to validate that it is consistent with running only on nights and weekends. Control of all magnets along the beamline should be conducted from the MCC.

Detector Sub-systems:

The test run used a photon beam, while the experiment will use an electron beam. Backgrounds will be different and probably larger. The detectors are relatively rad-soft, so nearby areas should be monitored with scintillators and ion chambers. This will provide quick guidance for tuning and the possible need for additional shielding. It is worrisome to see that the front end board is so close to the radiator. In Hall C, we have had difficulties running ioc's above 10 mR/hr (and they are useless at 100 mR/hr). The collaboration is prepared to install x-ray filters if needed. The 0.5mm separation between

the edge of the SVT and the radiated primary beam suggests a tight spec is needed on residual dispersion. Otherwise, energy bumps in the machine will cause the beam to change position far faster than the orbit locks can keep the position constant. The computing requirements appear to be on the same scale as those for Hall D.

SVT – The SVT silicon detector will be operating in a radiation environment that is rather unique compared to most silicon-based. There will be a large electromagnetic and rather small neutron background. This leads to several concerns: The in-vacuum readout system uses commercial off the shelf electronics, which have not been qualified for the levels or mix of radiation present in the HPS experiment. There is the possibility of single event upset, single event latchup or total dose related failure when the experiment goes to high flux. Given the environment and lack of specific testing of these electronics this risk is hard to quantify. The risk is somewhat mitigated by the accessibility of the SVT system but severe problems with the Virtex 7 FPGAs will require a redesign. The primary danger to the SVT appears to be mis-steered beam, which could short out the detector diodes and fry the front-end electronics. This is mitigated by a 2 or 3 mm collimator located upstream of the target, and beam dump interlocks based on halo counters. The experiment expects to test the interlock systems as part of the commissioning utilizing wires that project toward the beam from each SVT assembly. These need to be thoroughly tested and understood. There may be other effects on the detectors due to uneven oxide charge distribution due to the steep fall of beam halo. The guard ring could provide additional information on beam halo if the current is separately monitored. The SVT system will be tested for several weeks at SLAC before delivery and at JLab for a similar period. Such an extended testing period is wise and provides some buffer period to solve possible problems. The relative ease of access to the SVT system also provides some flexibility to address problems after installation.

HPS / Experiment Commissioning/ Manpower / Operation “Shift” Task Lists:

A detailed construction, installation and commissioning plan has been developed with clear milestones identified. The time allocated for the activities seems short considering that the run is only on night and weekends. The collaboration is encouraged to be flexible to adjust their initial shift staffing consisting of a shift leader and shift person and thus only a two person shift setup.

Fire Protection Evaluation:

The fire safety aspects of the HPS experiment apparatus appear to be outstanding. The installed fire detection and suppression features of Experimental Hall B are adequate for the hazards this experiment introduces.

Key Issues & Recommendations:

1. The collaboration has developed a detailed construction, installation and commissioning plan with clear milestones identified. However, the time allocated for the activities seems short considering that the run is only on night and weekends. The collaboration is encouraged to be flexible to adjust (meaning increase) their initial shift staffing consisting of only a shift leader and shift person and thus only a two person shift setup. The committee suggests a re-evaluation of the schedule to in order to validate that it is consistent with running only on nights and weekends.
2. The committee recommends that the collaboration and laboratory consider allocating larger blocks of dedicated running time to the experiment if and whenever possible. This should improve productivity and allow a stronger concentration of expert manpower on site during data taking. It would also save a significant amount of travel (and the associated expense) incurred by the HPS offsite collaborators.
3. The present optics configuration allows for 1 mm of leakage dispersion in either plane. This needs to be revisited for this experiment (see detailed comments above). The collaboration should also consider implementing an energy lock based on the vertical dispersion in the Hall B ramp.
4. The primary danger to the SVT appears to be mis-steered beam, which could short out the detector diodes and damage the front-end electronics. This is mitigated by a 2 or 3 mm collimator located upstream of the target, and beam dump interlocks based on halo counters. The experiment expects to test the interlock systems as part of the commissioning utilizing wires that project toward the beam from each SVT assembly. This procedure needs to be thoroughly tested and understood.
5. The SVT silicon detector will be operating in a radiation environment that is rather unique compared to most silicon-based. There will be a large electromagnetic and rather small neutron background. This leads to several concerns: The in-vacuum readout system uses commercial off the shelf electronics, which have not been qualified for the levels or mix of radiation present in the HPS experiment. There is the possibility of single event upset, single event latchup or total dose related failure when the experiment goes to high flux.
6. The SVT system will be tested for several weeks at SLAC before delivery and at JLab for a similar period. The committee recommends that a detailed plan for having the SVT readout in place and tested should be produced with a full detector test, including SVT readout electronics (even if there is no SVT detector) taking place at least a month before beam. Such an extended testing period is wise

and provides some buffer period to solve possible problems. The relative ease of access to the SVT system also provides some flexibility to address problems after installation.

7. The computing requirements appear to be on the same scale as those for Hall D – which are significant.