**C-AD**

**Radiation**

**Safety** Minutes of the Subcommittee Meeting of Sept. 5 & 20, 2012

**Committee**

Issued: Oct. 17, 2012

**Subject: ERL Low Power Test**

**Present 9/5/12:** D. Beavis, A. Etkin, R. Karol, N. Kling, D. Phillips, B. van Kuik, I. Ben-Zvi, M. Minty, P Sampson, A. Zaltsman, B. Sheehy. P. Sullivan, C. Theisen, T. Seda. L. Hammons, C. Montag, J. Dai, W. Xu, A. Zaltsman, and D. Kayran

**Present 9/20/12:** D. Beavis, A. Etkin, R. Karol, B. van Kuik, H. Kahnhauser, C. Theisen, C. Montag, and J. Sandberg

The ERL would like to conduct a series of simple low power tests before the ARR has been conducted to verify that accelerator is ready to operate. To conduct the limited low power tests the Department has requested that the RSC review the plans for the test and make recommendations that would provide for safe low power operation. The Department would need to request an exemption of the Accelerator Order. The exemption requires review by the Laboratory Environmental Safety and Health Committee (LESHC), which will make a recommendation to the ALD for ES&H and the DOE Area Office.

The exemption request is using Paragraph 3.c.(2) of the Accelerator Order, DOE Order 420.2C. This is implemented in the Accelerator Safety Subject Area[1] of the SBMS. An initial draft of the request[2] was provided. The exemption request was not reviewed at this meeting but will be at the next. The materials were not distributed well enough in advance to provide members with sufficient time to review. A meeting will be scheduled next week to make final recommendations. This meeting will provide for an overall introduction.

The low power test is considered critical for this import R&D work at ERL. It is also important in the advancement of projects such as electron ions colliders including eRHIC. However, the committee must ensure that the Department has had proper internal reviews so that it does not take on too much risk.

**Description**

I. Ben-Zvi made a presentation[3] of the plans for the low power test. The test will be conducted in two phases. The first phase will have the electron beam from the gun be

transported into a Faraday Cup located close to the gun. The beam will not be bent into the vertical chicane. The second phase will have the electron beam transported to a G5 dump which will be located in a straight section downstream of the five-cell cavity. The cavity can be used to accelerate the beam to energies up to about 23 MeV.

The gun is expected to be commissioned in December. The initial goal for the gun is to achieve an energy of a least 1 MeV and increase to a desired energy of 2.5 MeV. The initial power for the gun is expected to be 25 micro-Watts. The power of the beam from the gun is expected to eventually reach approximately 1 W during the two phases. The facility design was based on a continuous loss of the gun beam of 1000 W, although the as built configuration has not been compared to the initial configuration[4] used in the analysis.

Preceding the low power beam tests will be a Cold Emission Test (CET) of the gun. This should provide some initial radiation surveys external to the shielding for x-rays emanating from the gun area (with no beam). The CET will be conducted as an RGD, and under all the C-AD RSC requirements.

**Gun Beam to faraday Cup.**

It is suggested that the first dipole be RS LOTOed during the first phase of the testing. This will prevent any possible deflection of the beam. **The external dose from a fixed source along the beam line or at the Faraday cup for 70 Watts at 2.5 MeV is less than 0.3 mrem/hr if the shadow shield does not protect the exterior area.**
The calculation uses broad beam TVLs and is expected to be conservative.

**Recommendations:**

1. RS LOTO first dipole. **(CK-ERL-fy2103-821)**
2. Place alarm level for chipmunks at 5 mrem/hr. **(CK-ERL-fy2103-822)**
3. Escalate alarm levels as surveys demonstrate the adjacent areas are properly protected. **(CK-ERL-fy2103-823)**
4. Post area around the shielding as a Controlled Area- TLD required. **(CK-ERL-fy2103-824)**
5. Provide temporary posting to keep unauthorized people away until area surveys are complete. **(CK-ERL-fy2103-825)**

**Gun to G5 dump**

The second phase of the test has the low energy beam transported to the G5 dump. The beam will be transported through the five-cell cavity and at some point will be accelerated to 20-23 MeV. Any dipole along the transport must be evaluated for being all potential energies.

The vertical chicane has four vertical bends. The first bend is 15 degrees down followed by $30^o$ up, the $30^o$ down, and then $15^o$ up. Each dipole has a power supply that can deliver 10 amps. A clear statement of the bending power of each will need to be provided

to the committee. It was noted that they are intended to run at 80-90 percent of the maximum current. The committee recommended that C. Montag and D. Kayran report back to the RSC on the optics elements.

The horizontal bending dipoles will be RS LOTOed to prevent beam from being directed towards the side walls, except for possible beam fault studies. The vertical bends in the chicane could direct the beam to the roof. The committee requested that Kin Y. examine the issue of beam directly striking the roof shielding for an estimate of the dose on the shielding roof and the building roof. The calculation has been completed[5] and will be reviewed at the next meeting.

The experiment will limit the beam current with a series of software and hardware controls including the duty factor. There was substantial discussion on the methods the experiment employ for the administrative controls. They should provide a document clearly stating how this is conducted, controlled, and authorized. A limited number of personnel will be authorized to change the administrative controls and its software. The work will be performed under the ERL conduct of operations. Operations procedures will have the operator monitor the beam power and take appropriate action if the beam power exceeds the limits for the test. The controls are not of the rigor that the committee typically uses to prevent several factors of ten intensity excursion. The ACS will utilize either the present interlocking chipmunks or the interior non-interlocking chipmunk to provide the appropriate level of assurance that radiation levels outside the shielding do not become a concern. This may include changing the two monitor chipmunks to become interlocking. A specific proposal will be presented by R. Karol and D. Beavis at the next meeting.

The committee requested that J. Sandberg and C. Theisen examine the effort to upgrade the two non-interlocking chipmunks to interlocking. After the meeting A. Etkin suggested that these two chipmunks be tied into adjacent interlocking chipmunks. They already have separate readout and this technique would require a small effort, although not usually considered acceptable for a permanent installation. It is expected that the full committee will approve this short term method for implementing the chipmunk interlocks on these two chipmunks.

The transport to the dump should be divided into two sub-phases. After delivery of 1-3.5 MeV beam to the dump a survey shall be conducted with controlled and stable conditions. In addition, at least one fault study shall be conducted at the chicane. RCTs are expected to be at the area for the initial tuning.

The low power tests are expected to operate for up to one week per month for several months. After initial surveys the expected occupancy of adjacent areas should be considered in conjunction with the “routine” low power testing. The low power gun test may require from 100 to 1000 hours of operation to provide the necessary understanding of the gun operation.

The dose rate outside the shielding has been estimated[6] for 25 MeV beam on the G5 beam dump. **For 70 watts at 25 MeV the dose rate in the isleway by the power supply building will be 0.004 mrads/hr.**

**Recommendations:**

1. Consideration of the effectiveness of the configuration for all phase must be considered. For example, an operator may decide to not transport the beam to the G5 dump but to take it to the Faraday cup. If this is to be allowed then the ACS must protect against the faults. **(CK-ERL-FY13-826)**
2. RS LOTO the dipole after the five-cell cavity. **(CK-ERL-FY13-827)**
3. The beam will go through the vertical chicane between the gun and the five-cell cavity. Review the analysis of dose on the shielding roof and the building roof submitted by Kin Y. **(CK-ERL-FY13-828)**
4. There is no access allowed for the shielding top. **(CK-ERL-FY13-829)**
5. The Project should provide a table of maximum bends at a set energy. This should be accurate to 5%. If necessary consider upper current limits on the dipole power supplies. **(CK-ERL-FY13-830)**
6. The Project should provide the maximum expected quad steering from a single quadrupole or a set of quadrupoles. **(CK-ERL-FY13-831)**
7. Provide the administrative means to limit beam power (current) and control changes. **(CK-ERL-FY13-832)**
8. A detailed plan for limiting the dose outside the shielding using the chipmunks must be documented. **(CK-ERL-FY13-833)**
9. Documentation on optical element performance. **(CK-ERL-FY13-834)**
10. Establish a maximum amount of time for low power testing before an ARR is performed. A ninety-day duration for low power testing has been proposed. **(CK-ERL-FY13-835)**
11. Crane cab must be prevented from being over the roof shielding. **(CK-ERL-FY13-836)**
12. Fault study at the chicane and others as appropriate. **(CK-ERL-FY13-837)**

**References**


1. https://sbms.bnl.gov/sbmsearch/subjarea/40/40_SA.cfm?parentID=40
2. E.T. Lessard ,"Exemption request for Low power Testing of ERL SC Gun and 5-Cell Cavity", August 30, 2012
3. I. Ben-Zvi PowerPoint presentation, Sept. 5, 2012;
4. D. Beavis memorandum, " Dose rate Estimates for ERL Penetrations ", March 28, 2008, http://www.c-ad.bnl.gov/esfd/RSC/Memos/ERL-Penetrations3.pdf
5. Kin Yip, "Radiation due to 3.5 MeV Electron Beam", Oct. 1, 2012, http://www.c-ad.bnl.gov/esfd/RSC/Memos/Kin_Radiation_MeV_10_1_12.pdf
6. D. Beavis memorandum, "G5 Beam Dump Simulation", Jan. 12, 2012; http://www.c-ad.bnl.gov/esfd/RSC/Memos/G5%20Beam%20Dump%20Simulation.pdf

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