

**Subject: ERL Shielding Imperfections (seams) and Changes to Penetrations**

**Present:** D. Beavis, C. Schaefer, C. Theisen, D. Phillips, E. Lessard, E.T. Lessard, M. Fedurin, K. Yip, and D. Kayran

Calculations for ERL shielding contained in two memorandums were reviewed. The memorandums discussed shielding imperfections not contained in previous analysis. These imperfections are seams<sup>1</sup> where shielding blocks interface to each other in the single layer design. In addition, the shielding for cryogenics ports and laser port penetrations have been changed and are detailed in the same memorandum. The radiation calculations for seams created by the interface between the roof beams and the wall blocks with the use of shims are presented in another memorandum<sup>2</sup>.

A Powerpoint presentation<sup>3</sup> was used to guide the discussion and provides some of the figures and results from the documents. It was noted that some of the calculations use approximations to allow computation of the dose in a reasonable amount of computer time.

Steel plates have been used to decrease the gap for many of the seams to as small as possible. Plates of steel 0.8 mm thick (or thicker), six inches wide, and six to 12 inches long were used to reduce the size of the gap between shielding blocks. The range of gaps sizes was caused by not forming a level base for the shielding blocks and imperfections to the blocks themselves. The concrete floor in the ERL area is not of the quality of most of the Building 912 concrete floor. The steel shims were placed into the gaps on both sides of the wall below a height of nine feet. Seams in the outer wall that also have a second interior wall may not have had the seams filled with steel.

It is possible to cover the seams with a layer of Pb or steel. In some locations cable tray of other utilities may hinder such an effort for a localized region. Shielding can be placed either on the

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<sup>1</sup> D. Beavis, "ERL Shielding Holes, Seams, and Penetrations for 3.5 MeV", May 27, 2014; [http://www.c-ad.bnl.gov/esfd/RSC/Memos/ERL\\_Holes\\_5\\_27\\_14.pdf](http://www.c-ad.bnl.gov/esfd/RSC/Memos/ERL_Holes_5_27_14.pdf)

<sup>2</sup> D. Beavis, "ERL Roof Shims", June 19, 2014; [http://www.c-ad.bnl.gov/esfd/RSC/Memos/ERL\\_6\\_19\\_14.pdf](http://www.c-ad.bnl.gov/esfd/RSC/Memos/ERL_6_19_14.pdf)

<sup>3</sup> D. Beavis, [ERL Shielding Imperfections, Seams, and Roof Shims](#), June 25, 2014;

inside or outside of the shield wall<sup>4</sup>. The discussion of the best approach continued through the meeting.

The committee recommended that if levels were reasonable for low power beam fault studies that the best approach would be to ensure that the array of radiation detectors properly limited the dose to personnel outside the seams and penetrations. This requires a staged approach to beam commissioning, which is already planned. This applies both to the gun to dump and the ERL ring operation with the five-cell cavity.

**ATS-ERL-Kayran&Beavis-August 01, 2014 Phased approach to ensure radiation detectors protect personnel from imperfections.**

The roof beams over the north labyrinth form a seam across the two walls and the labyrinth. A layer of Pb bricks were placed along the outer portion of the seam on the concrete ledge. It was noted that there may be a few small sections where unistruct or other items prevented the layer of PB from being added. The dose rate from electrons he was not accounted for and should be added. This is expected to be completed in a short time so put in the check-off database.

**CK-ERL-Beavis&Karol-July 15, 2014 -900: Provide dose from electron Bremsstrahlung for end wall seam.**

The cryogenics ports were discussed. The details and possible non-uniformity of the dose around the vent pipe was discussed. Options to place a small shield around the pipes was rejected. It was decided not to add shielding but to use the radiation detectors to provided protection.

After the meeting the radiation monitor (NMO174) between two ports was move to be almost centered on the vent pipe. This should provide sensitivity to a large range of beam fault conditions.

**This will be tracked to completion as part of the comprehensive fault study review. Beam Fault studies should determine if another monitor is needed to protect from beam faults that are not seen by NMO174.** Such a fault may occur in the upstream end of the gun transport where the radiation directed towards NMO174 is blocked by a large shield block. The scrapers may be a good target for this study.

The dose rate out the new laser port 30 cm from the wall is estimated to be 10 mrads/hr for a continuous beam loss of 100 Watts. The note did not make it clear if this included the dose from electrons. This should be clarified, although the dose rate is expected to be acceptable for low power tests and beam fault studies.

**CK-ERL-July 15,2014-Beavis- 901:Clarify the laser port dose in the memo.**

The committee decided to wait until there are some low power beam test results before deciding if it was suitable to leave the wood shims in place for the long term. The high Z of steel may cause more Bremsstrahlung and neutrons at high energy then it removes. A study should

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<sup>4</sup> On the east wall this is not possible due to the utility support building and the Klystron power supply building.

examine the interplay between the use of low Z materials versus higher Z materials for the shims. Most emphasis in the analysis so far has been focused on the risks related to the gun energy.

**ATS-Beavis&Lessard-Oct. 1, 2014-Examine the best material to use for ERL roof shims.**

The radiation protect for the facility may consider the fact that the gun and dump will only be used at the ERL for about 1.5 years in an intermittent mode. Present planning calls for the gun and beam dump to be moved to RHIC for the LEReC project. Therefore means to provide protect may not need to be as rigorous as those that will be used by a 20 year facility. Although , one must also consider if the facility is used for other radiation sources.

There was discussion on determining the possible limiting conditions on beam loss for the escalation for the MCI. As an example, studies can be conducted to determine the duration of a local beam fault before a hole is burned through the beam pipe. The committee is happy to consider such limitations on the maximum possible beam fault.

No de-rating of the equivalent dose has been used due to the small size of the area of the radiation escaping through these narrow seams. RCD has suggested that this is the best approach and there was general agreement on the committee. If necessary, we may apply de-rating for areas such as the roof where there was no occupancy expected.

Preventing possible exposure on the roofs is an issue. The engineers thought that putting a fence on the 912 roof would not be an easy job to accomplish. With the high dose rates but small exposure area possible on the building roof the committee recommends that all access points to the entire Building 912 roof be posted for a work permit required. At present the VTF can create small doses rates on the building roof and ERL may be able to create substantial dose rates on the building roof over ERL and 912 roof adjacent to it under fault conditions. ATFII is in the early planning stages and may consider a single layer shielding roof for cost control.

**ATS-Cirnigliaro&Beavis-August 1, 2014—Work permits and posting of building 912 roof access points.**

A meeting will be setup soon to discuss the layout of the ERL chipmunks. Two chipmunks, NMO181 and NMO182, have been added internally to the shielding. The intent is to leave them in place or move them until the shielding, penetrations, and imperfections are understood.

The one mega-Watt waveguide was also change in design where heavy concrete was replaced by steel near the port. This is on the prints but the dose rates for beam faults are expected to be lower than those provided in earlier documentation.

**CK-ERL-Beavis-July 15-Update expected dose for one megawatt waveguide port.**

Note added after the meeting. Consolidate all open beam fault study items in ATS or the check-off database into one ATS item for review of the beam fault studies. Based on the results the review will establish an administrative limit pending any required improvements to the shielding and radiation detectors. If necessary the limit will be established with hardware.

**ATS-ERL-Beavis&Karol-Oct. 1, 2014→ Review of a comprehensive set of beam to dump beam fault studies.**

The following check-off list data items have been closed and are covered by this ATS item:

- Ck-501 Fault study 50 kW port
- Ck-833 Dose protection provided by chipmunks
- Ck-837 Fault study vertical chicane.
- Ck-839 Fault study laser port with floor loss
- Ck-840 Use a vacuum valve for a beam fault

CC:

- RSC minutes file
- RSC
- Attendees
- I. Ben-Zvi
- T. Blydenburgh
- D. Passarello