Collider-Accelerator Department

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Memo

Date: *August 26, 2016*

To: *RSC, D. Kayran, D. Phillips, J. Tuozzolo, and A. Fedotov*

From: *D. Beavis*

Subject: *LEReC Gun Conditioning with Truck Door Shielding Removed*

The RSC meeting of April 15, 2016 discussed[1] some of the issues of the gun conditioning expected to occur this fall at IR2. After the meeting, members of the Project expressed a desire to use the truck door shielding or a portion of it for the gun conditioning tests. Since that time there is renewed interest to examine means to conduct the gun conditioning without putting the truck door shielding in place. This memorandum discusses several options for conducting gun conditioning without the truck door shielding.

The levels during conditioning are unknown at this time. An estimate of the upper limits of the x-rays production can be made. The gun will be conditioned to 0.5 MV. The power supply can provide a beam current of 100 mA when the cathode and gun are functioning well. For the sake of this estimate we will assume that 10% of this current can exist as field emission current inside the gun. The 10 kW of power would generate 10,000 R/hr at a meter[2]. Operation of the gun at this power level would most likely damage the gun and be prevented by machine protection systems as well as good operator practices and procedures.

The truck door after the first layer of shielding is at least 11 meters from the gun. This would reduce the dose rate at that location to 83,000 mrads/hr. During RHIC shutdown this would typically be an uncontrolled area. However, for such testing it would be posted as a Controlled Area and the posting for no elevated work would need to be in place during gun conditioning. To reduce the dose rate to 0.83 mrad/hr at the truck door there would need to be controls in place to reduce the dose rate by 10^{-5}.

NCRP 51 has curves for tenth-value layers for Pb, steel, and concrete[3]. From these curves a reduction of a factor of 10 (a TVL) would be accomplished by 1.1 cm of Pb. A Pb shield 2.1 inches thick would provide the required dose reduction. The transverse size of the shield needs to shadow the entire area[4] of the truck door where the concrete is missing. The truck door is 12 feet wide and approximately 12 feet high. If the Pb shield is placed 3 feet from the source of x-rays in

[1] RSC Meeting of April 16, 2016; http://www.c-ad.bnl.gov/esfd/RSC/Minutes/04_15_16Minutes.pdf
[2] D. Beavis, April 22, 2016; http://www.c-ad.bnl.gov/esfd/RSC/Memos/4_22_16_LEReC.pdf
[3] See figures E.12,E.13, and E.14 of NCRP 51.
[4] The width of the door that is not shadowed by at least 50 cm of IR concrete shielding needs to be shadowed by the Pb shield.

the gun then a shield would need to be 1/10 the size of the truck door or 1.2 feet by 1.2 feet. Since the source will have a variety of potential locations the shield must account for the extent of the source. Most likely this is somewhat larger than the anode and cathode sizes. The transverse size of the Pb shield would need to be 2-3 feet and the 2.1 inches thick discussed before.

If light concrete was used to attenuate the x-rays then 50 cm would be required. The thin blocks may meet this need but the issue of a single layer with cracks would need to be investigated.

The area interlocks would need to be satisfied to turn the gun on. This requires that a robust barrier be used at the truck door to prevent personnel from entering without using the PASS system at the gate, 2GE1.

The project needs to decide on what will best meet their needs and ask the RSC to review. I suggest:

1. Area outside posted as Controlled Area and no elevated work
2. A lockable barrier at the truck door which forces personnel to use gate 2GE1.
3. A properly sized Pb shield near the gun and locked in place.
4. If the Pb shield or the barrier needs to be moved then RS LOTO must be done to prevent the LEReC gun from operating.
5. Other x-ray source must be RS LOTOed off or their operation reviewed for the configuration.