Hall D Beam Containment Proposal

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In the Following we list the active and passive safety devices that assure the primary electron beam reaches the diamond radiator and the electron dump. We believe these devices satisfy the Laboratory beam containment rules as well as the SLAC beam containment rules, where there are currently two "above ground" primary electron beams in operation. We would like the laboratory Radiation and Personnel Safety groups to evaluate this proposal to make sure they agree with our assessment. It may be that some of the active devices are not actually needed or that there are other devices which accomplish the same purpose.

1 Electron Beam on Diamond Radiator

1. There should be a beam current monitor near the exit from the linac which will turn off the beam if the current exceeds the Hall D requirement.

2. The bend string, which brings the beam up from the accelerator and back to horizontal, must be in series on the same power supply.

3. The bend string power supply should be equipped with a "meter relay" which shuts off the primary beam if the supply current varies by $\pm 10\%$ from its desired value.

4. Preceding the diamond radiator, there should be a small aperture protection collimator with a burn-through monitor and a beam-loss detector, such as an ion chamber, which will shut off the beam if it hits the protection collimator.

2 Electron beam on the dump

1. There should be a meter relay on the tagger magnet power supply to turn off the beam if the supply current varies by more than $\pm 10\%$ from its desired value.

2. There should be a beam current monitor set to a low threshold in the photon beam line just downstream from the tagger magnet which will shut off the primary beam if it detects a charged beam in the photon line.

3. Following the current monitor there should be a permanent magnet to bend a charged beam downward.

4. There should be small aperture protection collimators with burn-through-monitors on either side of the permanent magnet with ion chambers or other type of beam loss detectors near the protection collimators.

5. There should be a beam current monitor just upstream of the 60 KW electron dump. This current reading can be compared to the current reading at the exit of the accelerator and shut off the beam if the readings differ by more than a few percent.

3 Discussion

3.1 Permanent Magnets

A permanent magnet is available from FNAL. It is 4 m long with integral BL=8.2 kG.m, so a 12 GeV/c beam is bent down 20 mrad and will be 20 cm below the photon beam line at a distance of 10 m from the center of the magnet. If the magnet is positioned with the photon beam near the top pole, a 6 GeV/c beam will just clear the bottom pole. If the errant beam energy is less than 6 GeV, it will strike the bottom pole of the magnet and will be detected by the ion chamber located at the downbeam end of the permanent magnet. We propose having a 60 cm diameter vacuum pipe to the point 10 m downstream from the magnet where a block of iron would be placed in the ground to stop the errant beam before it is turned off. At the 10 m point, the photon vacuum pipe would be necked down to 10-15 cm diameter from that point to the photon collimator at the front of Hall D.

3.2 Photon flux monitors

Though not classified as a beam containment issue, there is also the possibility that a slightly missteered primary beam can hit the diamond radiator holder (or some object that has fallen into the beam) and cause a larger than normal photon flux into the photon collimator and Hall D. We propose that ion chambers (or other beam-loss detectors) be located near the photon collimator to turn off the beam if the loss rate is above the normal running threshold.

3.3 Sizing of shielding

In the current civil construction layouts, the shielding around buildings and collimators is sized for a 60 KW primary beam. The possibility has been raised that it should have been sized for a 1 MW beam. If that is the case, then additional earth will needed around the tagger and beam dump buildings and possibly over the tunnel coming up from the linac. However, we believe a credible accident might allow the full accelerator beam to be delivered to the electron dump before it is shut off by the fast shutdown system. The dumping of full power anywhere else would require multiple failures of the system. Therefore we assume that only the electron beam dump requires shielding for 1MW, and shielding for the rest of the construction needs to be sized for the accidental dumping of up to 60 KW.