Collider-Accelerator Department

BROOKHAVEN NATIONAL LABORATORY

Building 911B – P.O. Box 5000
Upton, NY 11973-5000
Phone 631 344 7124
Fax 631 344 5568
beavis@bnl.gov
www.bnl.gov

managed by Brookhaven Science Associates
for the U.S. Department of Energy

Memo

date: *October 1, 2012*

Updated: *October 5, 2012*

to: *RSC*

from: *D. Beavis*

subject: *Mis-Steering for First ATF 20 Degree Dipole*

This note will examine the issue of mis-steering in the first 20° dipole at ATF. The methods discussed in previous notes and in the ATF SAD are used. The main beam transport dipoles are designed to bend the beam 20 degrees. The 50 Ampere limit of the power supplies for the magnets allows the dipoles to bend 90 MeV electrons 20 degrees[1].

The ability for a magnet to bend the beam also requires that the aperture of the magnet is sufficient to allow the bend. This condition will be ignored, but makes the calculation conservative for lower energies. The return yoke on the side of the magnet is at least 3.2 cm of iron. The first dipole can bend a 20 MeV electron beam 90 degrees. The amount of shielding is least in this direction. At 90 degrees there is 5.1 cm Pb and 3.2 cm Fe. The concrete wall is 120 cm of light concrete. For 60 nano-Amperes of electrons at 20 MeV the beam power is 1.2 W rather than 5.1 W. **The dose rate outside the light concrete would be 2.3 mrads/hr for such a fault.** This is expected to be conservative and the trajectory in the magnet is probably not possible. It is not expected that such a fault could occur for one hour and the ATF has difficulty[2] with beam below 30 MeV.

The potential dose rate at 45degrees was also examined for a beam energy at 40 MeV with 60 nano-C. The wall appears to be a combination of light concrete and heavy in the forward direction. For this calculation it will be assumed to be light concrete. **The dose rate was estimated to be 1.1 mrads/hr just downstream of the transition in the concrete shielding.** At angles between 45 and 20 degrees the increase in effective shielding due to the angle the beam crosses the shielding and the layer of Pb bricks become 4 inches thick instead of 2 inches substantially decreasing the dose outside the shield.

At angles less than 20° the beam faults could produce radiation into the experimental area. Angles which are less than 20° are first shadowed by the Pb shielding around the collimator and then the quadrupole Pb. These two shields are sufficiently long to shield the forward photon radiation. As the angle is decreased further the quadrupole shield can be missed but then the shielding distributed downstream of D1 provides at least 4 inches of lead. There is also a mixture of light and heavy concrete. It will be treated as light concrete with a thickness of 210 cm. and a

total distance of approximately 7 meters. A dose rate in the experimental area is estimated to be 0.2 mrad/hr for 5.1 W of 85 MeV beam. This is expected to be conservative.

A simulation of the beam dump[4] in the experimental area was used to estimate the potential photon dose at the mezzanine above the dipole. If there is no Pb above the area that the mis-steered beam strikes then the dose rate above the mezzanine floor could be 10 mrads/hr. This is a crude scaling. There does appear to be four inch thick lead distributed over the loss points but the exact location is difficult to determine. Most likely it provides substantial reduction[5] for the gammas.

Neutrons are less copiously produced. With 1 meter of concrete the dose rate at a meter for 5.1 W of electrons striking Pb would be 0.6 mrem/hr.

There is a proposal to begin operations at nearly 1/40th of the beam power used in this note.

Conclusion

It is concluded that mis-steering the beam with the magnet does not represent an undue risk for exposure. With the additional low power restrictions for initial operations the dose external to the shield is nearly negligible.

Recommendations

A fault study at 40 MeV with mis-steering is suggested to verify that the numbers are conservative and provide documentation of the results.

The dumping of the beam into the Pb should be checked at zero degrees.

References

1. Private communication.
2. Private communication.
3. In the first version the heavy concrete was mistaken to be poly.
4. The simulation was for the beam dump in beam line 2 and the note has not been written yet.
5. Four inches would reduce the photon dose by almost a factor of 100 if it is covering the source.