

## Memo

*date:* January 31, 2011

*to:* RSC

*from:* D. Beavis 

*subject:* Estimates of Yearly Muon Dose from RHIC

The estimates for muon dose at the site boundary can be found in Appendix 18 of the RHIC SAD. The heavy ions beams are too low in energy to create muons that penetrate the RHIC shield and propagate to the site boundary or distance site buildings. The muon dose depends on the proton energy and intensity. The RHIC Project used a proton energy of 250 GeV and an estimated maximum of  $1.3 \times 10^{16}$  protons per year in a single ring.

### Increases in Proton Intensity

Intensity increases for protons are being planned for RHIC. Previous proton operations have been used as a guide to propose<sup>1</sup> that a typical 14 week proton run would have a less than  $2.5 \times 10^{16}$  protons per year in each ring. This provides a simple scaling factor of 1.92.

The muon sources listed in appendix 18 are the Limiting Aperture Collimators (LACs), the beam dumps, and the 10 O'clock intersection. The LACs were assumed to be on opposite side of 12 O'clock. The project located them on opposite sides of 10 O'clock. The distance to the North site boundary is smaller than from 12 O'clock to the West boundary creating a correction factor of  $(890\text{m}/670\text{m})^2 = 1.77$  for the LAC estimate. The muons generated by scraping at the 8 O'clock intersection will combine with the LAC muons, but this irrelevant as the muons from the scraping at 8 O'clock (or other IRs) is small.

The updated estimate for yearly dose for muons at the site boundary is:

Source	Old estimate (mrem/yr)	Updated estimate (mrem/yr)
Blue beam Dump	0.15-0.42	0.29-0.86
Blue LAC	0.07-0.36	0.24-1.22
Blue scraping at 8 O'clock	0.012	0.02

The off-site dose due to muons is well below the regulatory and BNL limits.

The muons from the yellow LAC may be directed at building 958 and/or building 914. The map being used for the present estimates is not accurate enough to determine the exact trajectory. However, the estimated yearly dose is 0.2-1.0 mrem/year. These are BNL buildings and occupancy factors would reduce these numbers by at least a factor of 4. The on-site dose due to muons from RHIC is well below the DOE and BNL standards.

### References

1. W. Fischer Private communication, August 26, 2010. This estimate is based on 500 fills with  $5 \times 10^{13}$  protons per ring.