Subject: Upgrade Items for RHIC and AtR


The committee discussed issues related to the future increase in the RHIC storage energy and the future increased transfer intensities to RHIC via AtR.

Increased Proton Energy

The department has requested that the risks related to exposure due to increasing the proton beam energy to 300 GeV be considered.

The committee recommends that the Department proceed with its plans to commission higher energy proton beams in RHIC with the restrictions discussed below.

The committee used reference 1 as the basis for the discussion of increasing the proton energy from 250 GeV to a maximum of 300 GeV. The remaining issue for an energy increase is the leakage of muons from the collimators and beam dumps. The worst case yearly doses at the site boundary are given in the table below.

<table>
<thead>
<tr>
<th>Source</th>
<th>RHIC SAD mrem/yr</th>
<th>Intensity Upgrade mrem/yr</th>
<th>Energy and intensity upgrade mrem/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue beam dump</td>
<td>0.15-0.42</td>
<td>0.13-1.5</td>
<td>1.2-5.9</td>
</tr>
<tr>
<td>Blue collimator</td>
<td>0.13-0.7</td>
<td>0.3-0.9</td>
<td>1.2-3.5</td>
</tr>
</tbody>
</table>

The yellow beam dump and collimator have lower values at the site boundary. The primary uncertainty in the scaling calculation is the path length of magnet material that the muons travel through. The estimates are based on 2345 full energy proton fills per year. RHIC has never approached this number. The risk of off-site exposure is considered low and well below the standards. However, the committee would like the more detailed
Monte Carlo calculations for both the beam dump and the collimator to be completed before routine operations at higher energy are recommended.

Commissioning proton beam energies above 250GeV will be considered on a case-by-case basis. The committee suggests that the following be done for commissioning efforts:

Complete the details Monte Carlo calculations for the beam dump and collimator. These calculations should consider how well the magnetic fields need to be represented. (CK-RHIC-protons-FY2012-779).

The total beam used for commissioning tests on the blue beam dump or collimator should not exceed 10% of the integrated intensity discussed above. (CK-RHIC-protons-FY2012-780).

The commissioning review should consider the merits of using the yellow beam for single beam commissioning. The distance to the site boundary for the yellow beam dump is greater than the blue beam dump resulting in lower potential off-site dose. The yellow collimator points at the south site boundary and is not an issue for off-site dose. (CK-RHIC-protons-FY2012-781).

A simple analysis indicates\(^2\) that the amount of proton beam scrapped on the collimators is a higher percentage of the total stored beam than assumed by the RHIC Project. The RHIC Project assumed that less than 2% of the proton beam would be lost on the primary collimators. An upper limit based on ring beam current data is 15% or a factor of 7.5 times higher. The RHIC project assumed that half the ring losses would be at the collimator and half distributed around the ring. This could reduce the factor of 7.5 to 3.75. The potential muon dose at the site boundary from the blue collimator could be in the range of 10-20 mrem/year with the upgrades. Although this does not exceed the DOE requirements it exceeds the present BNL limit of 5mrem/yr per facility. The committee recommends that either a more accurate number be extracted from the existing instrumentation or that a measurement of the percentage of proton beam scrapped on the collimators be made during the next proton run. (CK-RHIC-protons-FY2012-782).

The BNL limit of 5mrem/yr per facility for dose off-site is based on the DOE limit of 100 mrem/yr and 20 operating facilities. It is noted that there are no other facilities at BNL that can contribute dose at the locations relevant for the muons from RHIC.

**AtR with Increased Transfer Intensity**

The increased bunch intensity in RHIC will be a direct result of increasing the bunch intensity transferred to RHIC from AtR. The energy of the beam will not be increased. The AGS delivery cycles will remain the same, which is one bunch of protons per AGS cycle and 4 bunches of ions per AGS cycle.
The potential exposure to personnel on Thompson Road over the AtR-X&Y arcs was discussed in the RSC meeting of Nov. 18, 2008. The dose for various full beam faults was discussed in that meeting and is updated in the table below.

### Full beam loss

<table>
<thead>
<tr>
<th>Fault duration</th>
<th>Present dose (mrem)</th>
<th>Upgrade dose (mrem)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Au-1 cycle</td>
<td>0.12</td>
<td>0.26</td>
</tr>
<tr>
<td>Au-1 RHIC fill</td>
<td>3.6</td>
<td>7.3</td>
</tr>
<tr>
<td>Au-1 hr³</td>
<td>144</td>
<td>234</td>
</tr>
<tr>
<td>Protons-1 cycle</td>
<td>0.03</td>
<td>0.07</td>
</tr>
<tr>
<td>Protons-1 RHIC fill</td>
<td>3.6</td>
<td>7.3</td>
</tr>
<tr>
<td>Protons 1-hr³</td>
<td>36</td>
<td>59</td>
</tr>
</tbody>
</table>

Support divisions within the department find that having Thompson Road open during RHIC operations is very convenient. Thompson Road is presently an Uncontrolled Area. The areas adjacent to Thompson Road that are over the X and Y arcs are posted as Controlled Areas. It would be convenient if Thompson Road could remain an Uncontrolled Area. Based on the tables above it does not appear likely the people using Thompson Road would receive more than 20 mrem in a beam fault. The present TLD data demonstrate that the chronic dose on Thompson Road is at background. The committee **did not recommend increased transfer intensities until the following are examined:**

- Review the alarms for beam losses in AtR. *(CK-U-FY2012-783).*
- Review the dose footprint in a fault to the location of the radiation monitors to determine how effective they limit dose. This is more an issue for the X arc. *(CK-U-FY2012-784).* The completion of these items will enable the committee to determine the appropriate posting for Thompson Road.

The committee discussed the incorporation of the B15 dual transformer interlock into the new AGS interlock logic that is being developed for the replacement of the ACS relay system with PLCs. These transformers prevent high intensity pulses from the AGS being extracted into AtR. They have been reviewed in the past with the expectation of shutting the beam off before it is extracted or only allowing at most one pulse out of the machine.

The AGS beam intensities of $10^{14}$ protons per second are based on operating conditions that are not used when the AGS operates for RHIC running. A more credible upper limit of the beam intensity for one bunch per cycle will be generated for the committee. It will be used as part of the review for interlocking the AGS on large beam pulses. *(CK-AGS-protons-FY2012-785).*

Several options were discussed on the incorporation of the transformer interlocks. Concerns were expressed about using the AGS beam permit system and on interlocking large magnets off. The approach for the new interlock will be reviewed at a future meeting. *(CK-AGS-protons-FY2012-786).*
References

3) The present numbers were based on 1200 cycles in an hour and the upgraded numbers are based on 900 cycles per hour.

CC:
Present
RSC
RSC RHIC file
RSC AtR file
RSC Minutes file
W. Fischer
A. Dress