AGS/RHIC

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***R**adiation*

***S**afety*

***C**ommittee*

Minutes of Radiation Safety Commitee of July 14, 2000

Polarized Proton Commissioning in RHIC

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Motivation: A brief commissioning run with polarized protons in RHIC has been proposed for review. The goal of this commissioning effort is to learn if any improvements are needed in the machine systems, which would require work during the upcoming shutdown to ensure a successful polarized proton program in RHIC next year.

The commissioning run is expected to have the following parameters:

1) Beam will be only in one of the RHIC rings at a time.
2) The bunch intensity will be less than 10^{11}/bunch.
3) One bunch is expected to be accelerated per cycle in both the Booster and AGS rings.
4) Four bunches are expected to be injected into RHIC.
5) The duration of the commissioning effort will last for about two weeks in RHIC.
6) Operations of polarized protons in the AGS and commissioning to the W dump may occur during heavy ion stores in RHIC.

The committee approved the Polarized proton commissioning. The approval is based on the discussion and conditions discussed below.

Jim Alessi provided the committee with description of the polarized proton intensity at the linac (attached). A conservative upper limit to the intensity is $3.4*10^{12}$ protons/pulse. This is 20-30 times lower than the high intensity source. The high intensity source will be RSC LOTO'ed off by two means **(Ck-booster-polarized protons-2000)**. The lock-out must be done upstream of the RFQ. In the future, dual hardwired interlocks should be considered for preventing the high intensity source. The Booster/AGS cannot accelerate the entire intensity of the high intensity source. The maximum possible beam using the polarized proton source that can be extracted may be only about five times lower than the high intensity source. This assumes $3*10^{12}$ protons per bunch and six bunches per AGS cycle. Therefore, planning should be based on a maximum fault intensity of $1.8*10^{13}$ protons per 3 sec cycle.

The startup requirements are divide into two logical groups. The first group has requirements that must be completed to transport the beam to areas where full intensity protons are allowed. The second set of requirements must be fulfilled before beam can be introduced to the w-line and RHIC.

Requirements for polarized protons to the up-stream U-line (to the 8 degree bend):

The fast switch for protons to heavy ions must be active and functionally checked. This switch, which allows full intensity protons to the V target, provided the 8 and 20 degree bends are off. **(Ck-booster-polarized protons-2000).**

The liaison physicists for the booster, AGS, and U-line must submit a new memo which states which chipmunks if any can be bypassed with the maximum fault level given above. **(Ck-booster, AGS, u-line-polarized protons-2000**) In addition, they should consider an appropriate check on the shielding, posting and radiation monitors. The booster, AGS, and upstream u-line were operated with full intensity protons immediately before the ion program to RHIC started.

The V target cave must be RSC LOTO'ed off. **(Ck-AGS, u-polarized protons-2000)**

A commissioning procedure for operating the beam switch and the linac beam stops should in place.

Before protons are taken past the 20-degree bend a fault study of the u-line dump must be conducted to verify the dump is still adequate for high-energy muons. **(Ck-U-line-polarized protons-2000)**

To transport beam past the 8 and 20 degree bends the following must be completed:

The UGE2,UGE3, and AtR chipmunks must be set to interlock at the lowest level, 2.5 mrem/hr. **(Ck-AtR-polarized protons-2000)**

There is concern that the present two chipmunks at Thompson road do not have sufficient coverage to protect the area. An analysis should be done to either demonstrate they are sufficient, need to be moved or additional chipmunks added. **(Ck-AtR-polarized protons-2000) .**.

The present uncontrolled portion over the X and Y arc including Thompson road will be posted as a controlled area. Thompson road will be appropriately barricaded to prevent traffic if possible. If it is not possible for Thompson road to be a controlled area the committee will re-examine the details.**(Ck-AtR-polarized protons-2000).** If one arc only is too be used, the size of the controlled area could be substantially reduced if the power supply for the other arc is RS LOTO'ed off

The main concern is the potential for escalation of the proton source to intensities not achievable with the heavy ion source. For the polarized proton commissioning one linac pulse will be injected into the booster and then into the AGS. There are no plans for multi-bunch injection or acceleration in the AGS. Thus the maximum beam fault for these planned operations is less than 10^{11} protons per cycle, with an expected cycle time of 3 seconds. It is not expected that the machine will operate 1200 cycles/hr but it will be assumed until procedures or interlocks are reviewed which limit the cycles per hour. The beam intensity is comparable to the present Au operations of approximately $1*10^9$ Au ions per cycle. However, both the number of bunches and the intensity per bunch can be increased. An upper limit of $2*10^{13}$ protons is possible using the polarized proton source.

It should be noted that the dose rate calculations for AtR and RHIC are based on nucleons and not heavy ions. The radiation hazards in the RHIC SAR are calculated for nucleons and then scaled for ions with the equivalent nucleon-GeV. The committee has accepted this conversion to be very reasonable for the type of beam faults expected. A substantial difference can exist for forward shields, which are shielding muons. This is a result of the higher momentum per particle creating a higher energy muon spectra. There are no locations in RHIC or AtR where this is a concern.

The following proton intensities were discussed:

1) The planned commissioning of 10^{11}/3 sec cycle or $1.2*10^{14}$ per hour.
2) Injection of $3*10^{12}$/3 sec. Cycle or $3.6*10^{15}$ per hour.
3) Six AGS bunches (10^{11} /bunch) giving $6*10^{11}$/3 sec cycle or $7.2*10^{14}$ per hour.
4) Six AGS bunches ($3*10^{12}$ /bunch) giving $1.8*10^{13}$/3 sec cycle or $2*10^{16}$ per hour.

The estimated levels for a DBA fault on Thompson road for $3*10^{13}$ protons/sec is reported in AD/RHIC/RD-83 as 282 rem/hr or about 78 mrem/sec. A chipmunk located within the main does peak would terminate the fault within 1 second. This estimate used an extra factor of 2 in the quality factor for design of the facility. In addition, the comparison of RHIC fault studies to estimates show that there was approximately a factor of 2 overestimate in the potential dose rate. Therefore, the committee will use the DBA number of 70 rem/hr for $3*10^{13}$ protons/sec.

The potential levels over the RHIC Injection arcs for the fault intensities discussed above are:

Fault	dose/cycle	dose/hour
DBA	58 mrem	70 rem/hr
1	0.19 mrem	233 mrem/hr
2	5.7 mrem	6.8 rem/hr
3	1.14 mrem	1.4 rem/hr
4	11 mrem	14 rem/hr

The committee was not presented with the specific details on how intensity excursions are to be avoided. Some methods such as those requiring operator intervention may not terminate the fault in one cycle. Several intensity reduction methods were suggested. One method was to sound an alarm for the operators to respond to if the current transformers in the AGS ring detected more than $5*10^{11}$ nucleons/cycle. Another method used in the past is to limit the width of the linac chopper pulse. A sub-committee needs to review the final methods chosen. **(Ck-AtR-polarized protons-2000)**. After initial operations a re-examination of the maximum beam the polarized source can deliver to the AGS can be made if the above estimates are overly conservative.

A commissioning procedure must be exist which ensure that the OSL for RHIC are not violated. . **(Ck-AtR-polarized protons-2000)**