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Polarized proton luminosity in RHIC

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Collider Accelerator Department

Brookhaven National Laboratory

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Polarized Proton Luminosity in RHIC

One of the three persuasive arguments in support of building the booster ring between the linac and AGS is that the ring can be used to accumulate polarized protons during the AGS cycle. An intensity increase in the AGS of a factor of 20 is anticipated for this. The purpose of this note is to remark that the booster compresses as well as accumulates.* This compression is a complication for AGS polarized proton physics where the beam will initially be accelerated in only 1/4 of the AGS circumference and it will be necessary to redistribute it before extraction to the experiments. However, for RHIC this compression is a blessing: the entire booster fill of polarized protons, accumulated over an appropriate time determined by the accumulation efficiency, will be compressed into 3 bunches (for normal proton acceleration) or fewer bunches (one bunch is used for heavy ion acceleration for RHIC). This increases the effective intensity of the polarized proton source by a factor of between 4-12, in addition to the accumulator factor of about 20. With this overall improvement factor of 80 to 200 for polarized protons in RHIC, the full proton design luminosity will be available for polarized proton experiments immediately with even the present polarized proton ion source.

The design numbers for protons in RHIC are 10^{11} protons/bunch and $L = 10^{31} cm^{-2} sec^{-1}$. The present polarized proton ion source provides $2x10^{10}$ protons per cycle at full AGS energy. A factor of 20 increase in intensity is assumed by accumulating over a 3 second cycle. The resulting $4x10^{11}$ protons would be compressed into 1-3 bunches in the booster, giving $1 - 4x10^{11}$ polarized protons per bunch. Improvements in the RHIC rf system and beam dump are required to give an order of magnitude increase in proton intensity and $L = 10^{33} cm^{-2} sec^{-1}$. If these changes are carried out, a luminosity of $L = 4x10^{32}$ would be available for experiments with polarized protons colliding with unpolarized protons (those experiments exploiting parity violation, such as W physics) with the present source. If

* Y.Y. Lee has noted this before, but its implications have, I think, been missed by many of us.

the polarized source intensity improves by a factor of 3† , $L = 10^{33}$ would be available for polarized proton experiments, with both beams polarized.

† J. Alessi heads an ongoing program on the source which anticipates greater than a factor of 10 increase in intensity.