Design of an Intense Polarized Atomic Jet for Use at RHIC

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As part of a project to calibrate the polarization of the RHIC proton beams we have undertaken the design of an atomic beam source. For this purpose we collected results from measurements on beam scattering, degree of dissociation, and velocity distribution. A computer program was written and compared to earlier programs to calculate the absolute atomic beam density for a given focussing magnet configuration and nozzle temperature. Comparison to programs that had been used earlier revealed a number of programming errors. Atomic beam optimization by gradient search was unsuccessful because of the large number of parameters and the existence of numerous local maxima. As an alternate approach, the atomic beam intensity was calculated for a very large number of randomly chosen magnet geometries. Initially the parameters defining the geometry were chosen within a rather wide range, which was then reduced in succession. In each of these steps, about 50,000 systems were calculated. Comparing the best 10 systems showed that they were rather similar. Finally a selected best system was fine-tuned by applying a gradient search code. This last step contributed only a small improvement. As a check on our calculations, we compared to atomic beam measurements made on the Wisconsin ABS and the recently constructed COSY source. In both cases the measured maximum output of the devices and the predictions of our calculations agree well. Although the maximum intensity agrees, the calculation appears to consistently over estimate the gas flow at which the maximum beam intensity is observed. The present calculations predict a beam intensity of 1.0×10^{17} atom/s into an 11mm aperture 290mm from the last magnet of the ABS. Collimation to 9mm reduces the output to 9×10^{16} atoms/s.