AGS Polarized Beam Facility*

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On February 23, 1984, 2 μA of polarized H^- was accelerated through the linac to 200 MeV with a polarization of 65%. 1 μA was injected into the AGS and acceleration attempts began. Several short tests were made until June 1984 when full time effort began. By June 26, the AGS polarized beam reached 13.8 GeV/c to eclipse the previous world's high energy of 12.75 GeV/c set at the Argonne ZGS some six years earlier. The polarized beam energy was raised to 16.5 GeV/c at which energy the decision was made to commence high energy physics running. By this time the accelerated beam intensity exceeded 10^{10} protons per pulse with about 40% polarization. The beam was extracted and two experiments began taking data.

Figure 1 is a layout of the AGS facility showing the specific new equipment necessary for polarized proton operation. In the injection line there is the polarized ion source, RFQ, 200 MeV polarimeter, and additional low intensity diagnostics and an additional buncher. In the AGS ring there are 96 correction dipoles, 12 fast rise time quadrupoles (one in each superperiod), and the internal polarimeter. In the extracted beam line area there is a high energy polarimeter to give an absolute measurement of beam polarization, using proton-proton elastic scattering.

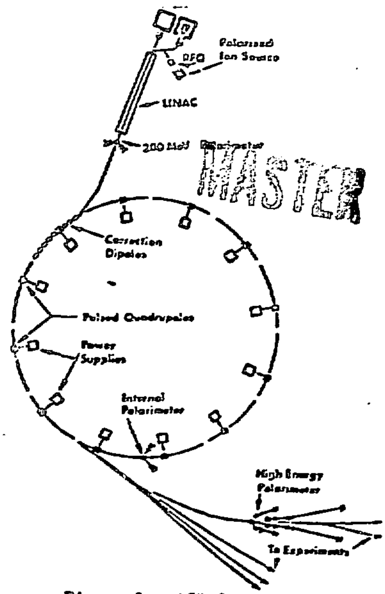

Figure 1 - AGS facility.

Fig. 1. AGS Facility

Among all the new equipment necessary, the H^- ion source, the RFQ linear accelerator, the pulsed quadrupoles and their power supplies, and the internal polarimeter were all novel devices requiring special attention. The H^- ion source uses Cs charge exchange ionization to produce polarized H^-. This source has produced 25 μA of H^- which is several times higher than previous sources of this kind. The RFQ came on the air with almost no difficulty and was the first in the world, by a few days, to be successfully coupled to an operating accelerator. The fast pulsed quadrupoles are ferrite magnets with a 2 μsec rise time and a dI/dt of 1.3 GA per second. The internal polarimeter target assembly uses a spooling 0.003" nylon filament as a target. It is flipped into and out of the beam with a flip speed and a spooling rate of about 1 meter per second.

As previously mentioned, two experiments took data during this first operating period. E-782 studied P-P elastic scattering in pure spin states, i.e., both the target and projectile particle spin states were specified in these measurements of spin-spin correlation. E-785 measured single spin asymmetry in inclusive reactions at high transverse momenta with the projectile proton polarized. These experiments will continue in the Fall of 1985 when we anticipate further physics experiments and an increase in polarized beam energy to above 20 GeV/c.

Figure 2 shows the AGS experimental area. Only beam lines D1 and C1 were used for the first experimental runs. All beam lines are capable of operating with polarized protons and there would appear to be space and time for many more experiments. Because the AGS has a vertical bend in its extraction system, the polarization of the extracted beam is different in each beam line as a function of energy. Figure 3 shows a graph of

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the calculations[1] where θ is the angle of the spin vector from the vertical. It is probably desirable that each experimental group includes a polarimeter in their beam line.

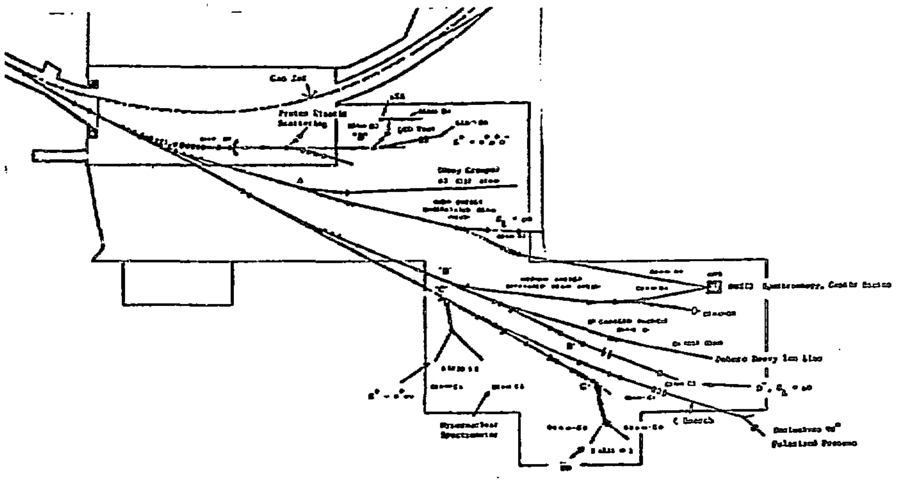

Fig. 2. AGS East Experimental Area.

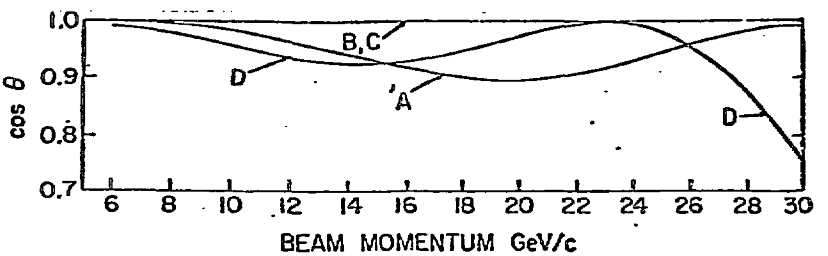

Fig. 3. Spin Precession in the AGS External Beam Lines.

One of the major difficulties in operating a polarized proton program is the lower intensity. The normal AGS program runs over 10^{13} protons per pulse and if polarized protons could approach this intensity, the entire program could be run with polarized protons. This would certainly lead to much more running time for these experiments. In an effort to achieve such a goal, a new source is being developed which hopefully will reach a milliampere of beam compared to the present 25 μA. The design is to make a very cold atomic hydrogen beam (a few °K) and to replace the present cesium charge exchange unit with a deuterium ring magnetron section. The deuterium charge exchange cross-section is a factor of 25 greater than Cs and a further gain would be expected from the colder atomic beam. The prototype is under test now. It is hoped that by this fall one will be able to start construction of an operating source of this type.

In addition to a new source, there is a proposal to build a 1.0 GeV Booster Synchrotron to inject into the AGS. This would not only raise the AGS space-charge limit for protons and extend the mass range of heavy ions which could be accelerated, but could also be used to accumulate up to 25 linac pulses of polarized protons.

References

1) G. Bunce, Informal Report BNL-29856, unpublished.

Acknowledgments

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