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BNL STATUS AND PLANS*

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Abstract - The present status and future plans for the Alternating Gradient Synchrotron are presented. The operating modes, accelerator improvement program, Booster synchrotron status, Stretcher ring proposal, and higher intensity options are described.

For the past few years, the Alternating Gradient Synchrotron, AGS, has been undergoing both a renaissance in its physics program as well as its accelerator operations and physical plant. The past physics accomplishments as exemplified by three Nobel Prizes; J/ψ discovery (1976), CP violation (1980), and two neutrinos (1988) are hopefully the prologue to the future physics accomplishments and prizes that may come from experiments that are presently searching for such processes such as rare kaon decays, oscillation of neutrino states, the formation of the quark-gluon plasma, etc. The AGS experimental program presently has a user community of ≈ 600 physicists, of which 350 are conducting high energy physics experiments and 250 are active in relativistic heavy ion physics research. They are engaged in 35 different experiments. This diversity of the physics at the AGS is in no small part due to the multitude of different operating modes available. The AGS provides protons in three different modes; slow extraction (e.g., 1. 5 x 10^{13} protons/2.5 sec., 50% duty factor), fast extraction (e.g., 1.6 x 10^{13} protons/1.2 sec., 2.7 microsecond pulse), single bunch extraction (one bunch of 1.2 x 10^{12} protons + either slow or fast extraction). Polarized protons have been accelerated to 22 GeV/c with a polarization of 50% at an intensity of 2 x 10^{10} protons/2.5 sec. (see Fig. 1). Ions up to silicon have been accelerated to 14.5 GeV/amu with intensities of from 10^9 - 10^{10}/2.5 sec. and a 50% duty factor.

Presently, the single largest construction effort at BNL is the Booster. It is being built to satisfy three needs of the AGS physics program. On the proton side, the aim is to increase the AGS injection energy from 200 MeV to 1.5 GeV and thus increase the accelerated beam intensity by a factor of 4 to 6 x 10^{13} protons per pulse. For

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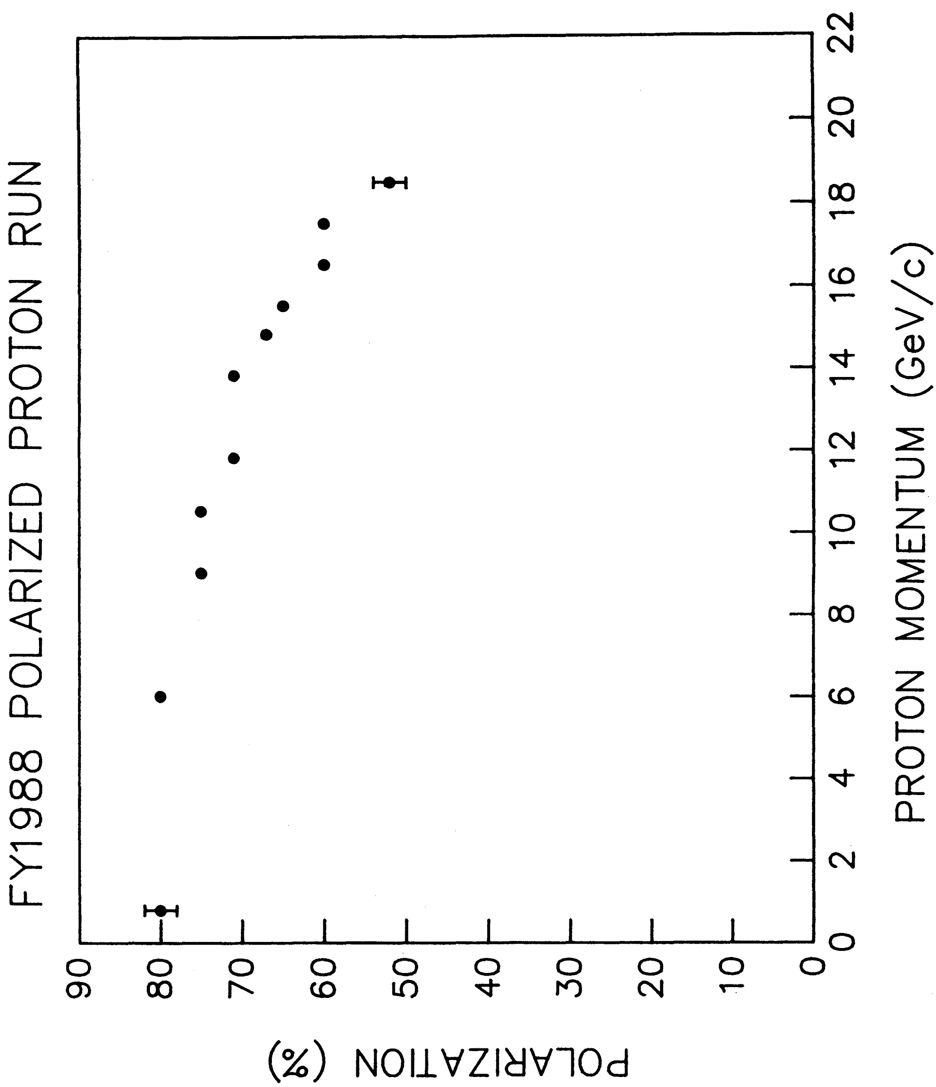

FIGURE 1 AGS proton beam polarization.

polarized protons, the Booster will accumulate 20 linac pulses and thus increase the intensity to 4 x 10^{11} polarized protons per pulse. For heavy ions, the Booster will allow for the acceleration of all ion species in the AGS by injecting fully stripped ions. This is essential for both the AGS fixed target program and the Relativistic Heavy Ion Collider (RHIC). The details of the Booster are described by W.T. Weng and of RHIC by H. Hahn elsewhere in these proceedings.

The AGS is presently undergoing an upgrade of its major subsystems so as to be ready for the new Booster Injector. All the major systems, including a new RFQ preinjector, a 10^{-9} Torr vacuum system, a new set of radiofrequency power amplifiers, a new control system, etc., are underway or completed. The major objective is for the AGS to accelerate and extract 6 x 10^{13} protons per pulse with less than 0.5% beam loss. To accomplish this the injection energy is being raised from 200 MeV to 1.5 GeV, a gamma transition jump system and VHF dilution radiofrequency cavity are being installed as well as new low field and high field programmable correction magnet systems, transverse damper system, and a programmable motor generator control system. With the completion of these and other projects, the AGS will then be able to accelerate 5 microamperes of 30 GeV protons with minimal losses. We expect to be completed with these upgrades, except for the radiofrequency amplifiers, prior to the start of Booster commissioning. This will then provide the AGS physics program with 5 microamperes of protons (50% duty factor), 0.1 microamperes of polarized protons and all ion species from hydrogen to uranium at energies above 10 GeV/amu.

The completion of the Booster in 1991 is the first step in a systematic and stepwise approach to providing a high intensity source of 30 GeV protons for the physics community. The next step beyond the Booster is to build a Stretcher ring that would then provide a 10 microampere, 100% duty factor beam. The Stretcher, has been designed and presented to the Department of Energy for their consideration.

At present, the AGS both accelerates and runs at a magnetic flattop for slow extraction. With the elimination of the flattop the AGS would cycle at least a factor of two faster (as is done for the neutrino physics single turn extraction program) and thus accelerate two times as many protons. The AGS would then fast extract into the

Stretcher where the beam would rapidly debunch and then the protons would be extracted CW out of the Stretcher onto the experimental area targets. In addition to this doubling of both the intensity and the macroscopic duty factor, an important feature is the virtual elimination of the present microscopic instantaneous intensity fluctuations which presently vary by a factor of 2 - 3.

The AGS Stretcher is a machine that is of a racetrack configuration equal in circumference to the AGS (807.12 m) using conventional iron and copper magnets and a lattice consisting of two long straight sections to provide for very efficient single turn injection from the AGS and subsequent slow extraction to the existing experimental areas. (See Figs. 2 - 4.)[1] The beam transfer systems and the machine lattice have also been designed to preserve the vertical polarization of polarized protons. The Stretcher has been designed to operate as a CW dispenser of protons, polarized protons, and heavy ions at the AGS extraction energy, up to 30 GeV. The AGS will cycle at a maximum repetition rate of 0.8 Hz and inject 12 bunches in a single turn over a period of 2.7 microseconds. As beam is injected into the Stretcher, the leftover nonresonating beam in the Stretcher is fast extracted onto a beam dump. The injected beam will then debunch in 10 - 20 milliseconds, where upon the third order resonance slow extraction system is enabled. This process is then repeated at the AGS cycling rate. The details of the Stretcher are described elsewhere in these proceedings by H. Foelsche.

With the completion of the Stretcher, the AGS will provide 10 microamperes of protons at 100% duty factor. The next question is what could be the ultimate potential of this facility. We believe that 50 microamperes is obtainable. This could be accomplished in several ways. But assuming the 30 GeV AGS is not replaced, then we would consider the introduction of the Post Booster (2.8 → 9.3 GeV) and a Collector (9.3 GeV). (See Fig. 5.) This scheme has been described in detail elsewhere.[2] Basically, the scheme is to operate the Booster and Post Booster at the Linac 10 Hz repetition rate, increase the AGS space charge limit with the introduction of the Post Booster, and match to the maximum AGS repetition rate of 2.5 Hz from the 10 Hz input of the preinjectors with the Collector. The Linac, operating at 10 Hz, would inject the Booster and then accelerate to

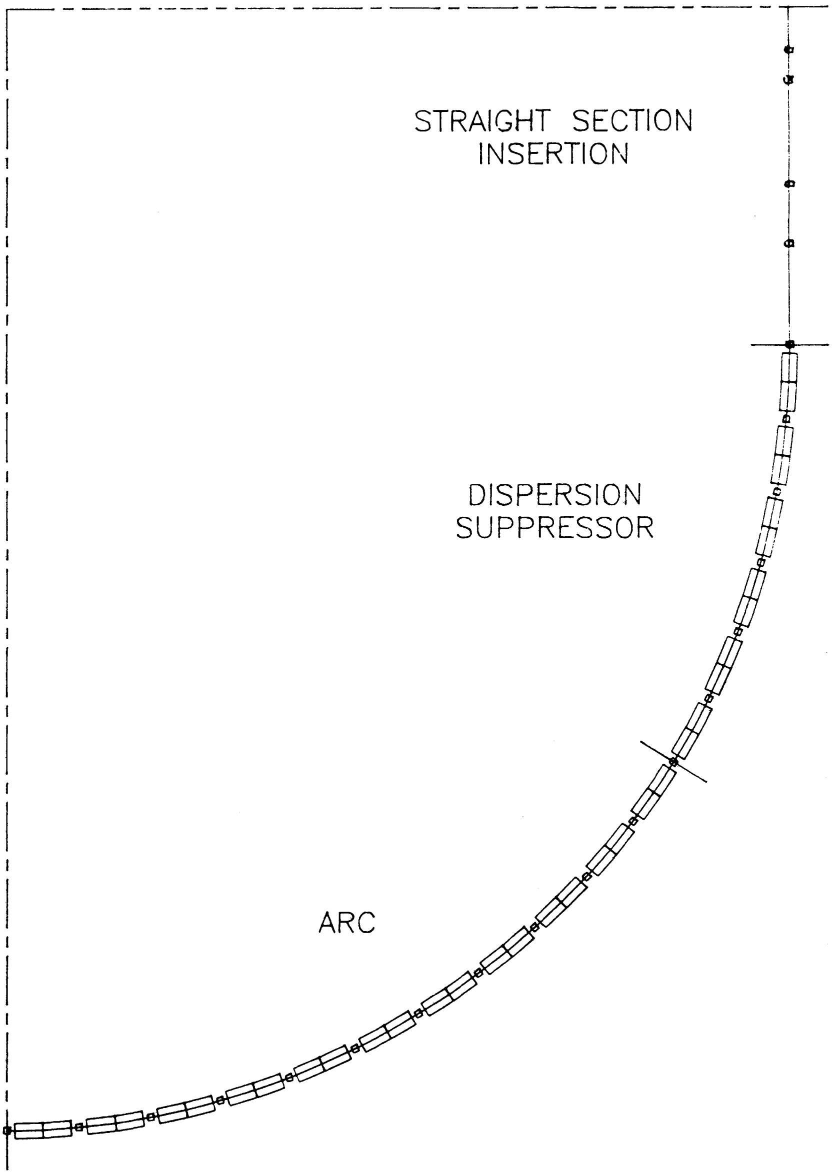

FIGURE 2 Stretcher quadrant.

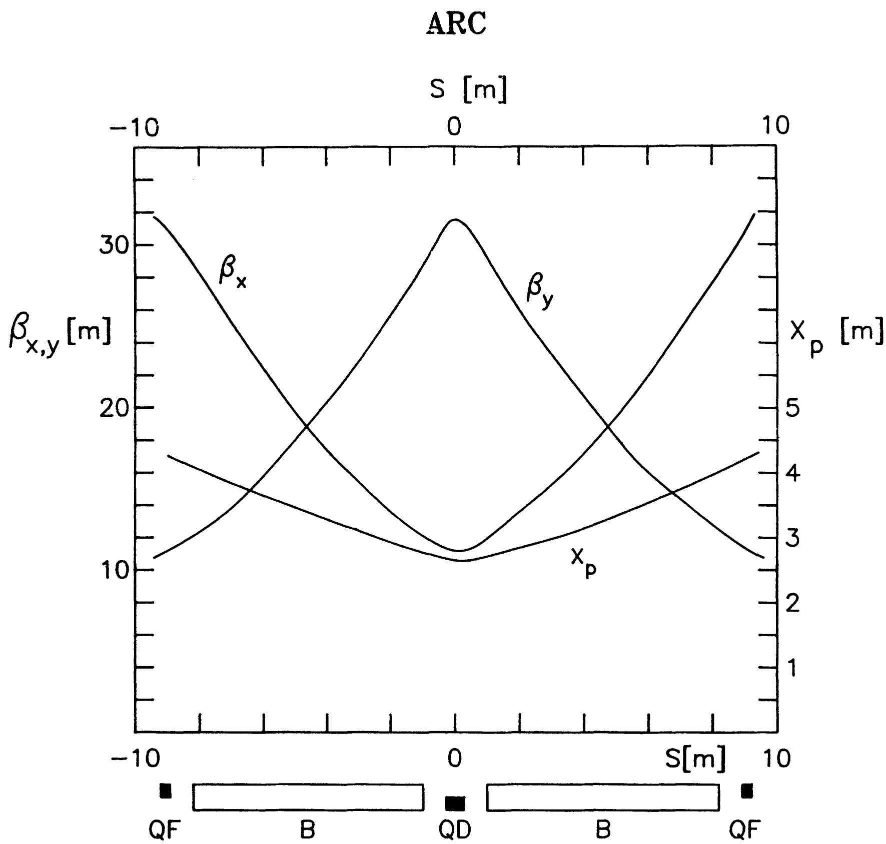

FIGURE 3 Betatron functions of Arc Cell.

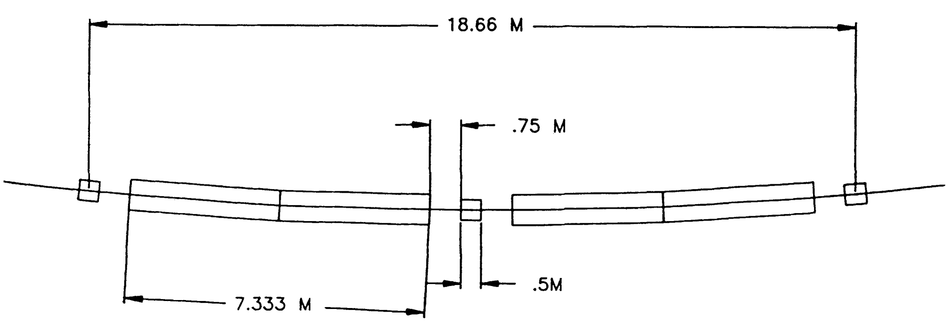

FIGURE 4 Stretcher cell.

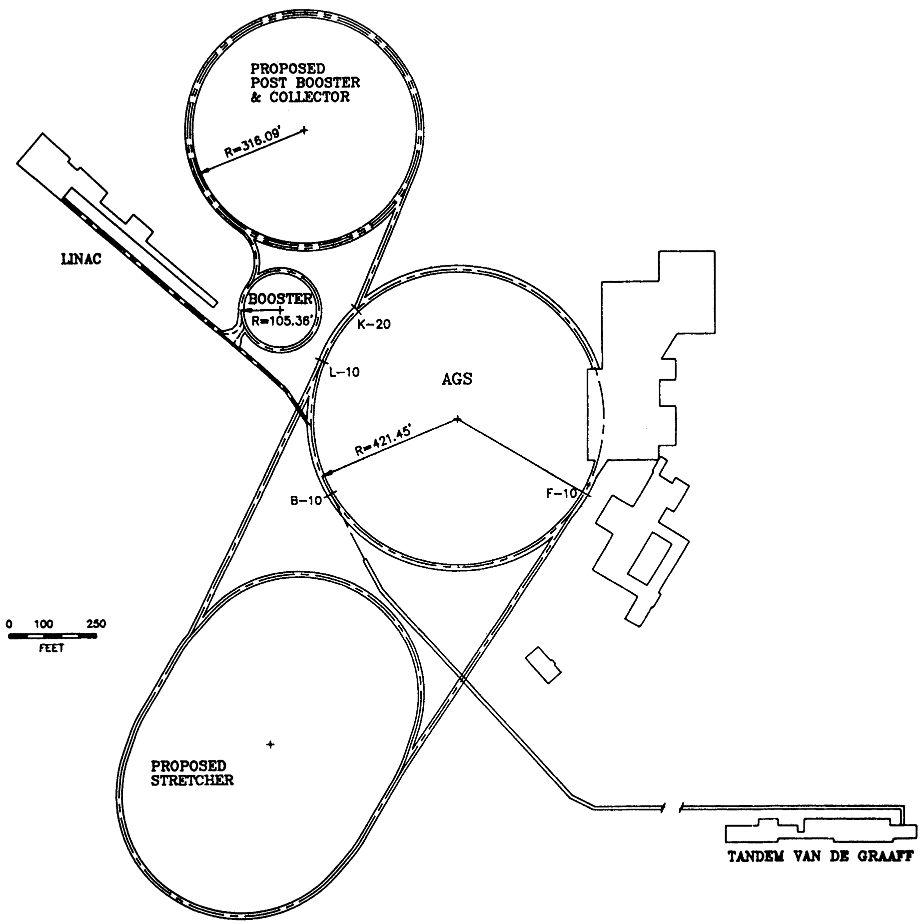

FIGURE 5 AGS II facility.

2.8 GeV at a 10 Hz repetition rate. The Booster has been designed, but not powered, to operate in this mode. The Booster would then inject the Post Booster which would accelerate to 9.3 GeV at a 10 Hz repetition rate. The Post Booster would inject four pulses into the Collector, which in turn would be injected into the AGS at 9.3 GeV (above transition energy). The AGS would accelerate to 30 GeV at a 2.5 Hz repetition rate. The AGS would then fast extract into the Stretcher which would slow extract 50 microamperes of proton current (see Fig. 6).

We have sketched out one of several possibilities for the evolution of the AGS complex into the next generation of a high intensity hadron facility. We believe that the most responsible scenario must of course minimize the cost but also the downtime to the ongoing physics program. With this stepwise approach, beginning with the Booster and then leading to the Stretcher, etc., one can reevaluate the effort and the physics merit for each new initiative.

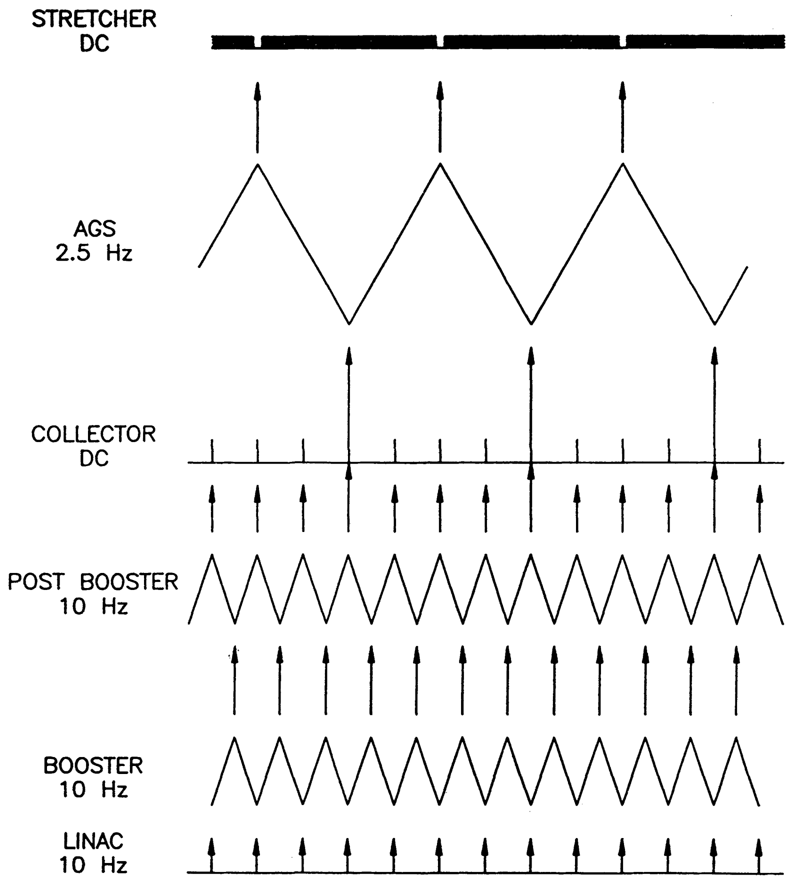

FIGURE 6 AGS II operating cycle.

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2. A High Intensity Hadron Facility, AGS II. Y.Y. Lee, D.I. Lowenstein. Proc. Workshop on Glueballs, Hybrids, and Exotic Hadrons, Brookhaven National Laboratory, August 29 - September 1, 1988, AIP Conf. Proc., Ed. S-U. Chung, 185, 185-192 (1989).