γ

CONF-880695--5

European Particle Accelerator Conf., Rome, Italy, 6/7-11/88.

BNL--41333

DE88 011621

STATUS OF THE AGS UPGRADE PROJECT*

Th. Sluyters
AGS Department, Brookhaven National Laboratory
Associated Universities, Inc., Upton, NY 11973 USA

Introduction

The upgrade of BNL's Alternating Gradient Synchrotron progresses parallel with the construction of the 1.5 GeV Booster with a view to completion of its major components in 1991. The initial goals of the upgrade program are: to prepare the AGS ring for acceleration of at least 5 x 10^{13} protons per pulse, to accelerate heavy ions up to gold, to accelerate polarized protons in the 10^{12}–10^{13} intensity range, and to improve the reliability and flexibility of the present machine operation. Figure 1 shows the AGS complex as it will operate in 1991.

There are several major systems in the AGS complex which have to be upgraded in order to accelerate the higher intensity beams and heavier ions. These systems are: the RFQ preinjector, the rf cavities, the vacuum, the transverse dampers, the correction magnets, extraction equipment, and the Siemens main magnet power supply. Additional major projects, which will keep the ring activation within "acceptable" limits despite a four-fold increase in beam intensity, are a fast beam chopper, a gamma-

Fast Beam Chopper

The application of a fast beam chopper was inspired by the construction of the 750 keV Radio Frequency Quadrupole preinjector (RFQ).[1] Presently the acceleration cycle begins with a capture process in which essentially a continuous 200 MeV beam is captured into the stable phase rf buckets, losing at least 20-25% of the injected beam in the AGS ring, increasing significantly the irradiation of the machine.

With the installation of the new 750 keV RFQ preinjector (see below), it is possible to reject the lost part of the beam before entering the RFQ at low energy (35 keV) by the use of an rf chopper synchronized with the AGS rf system. An rf chopper can prepare bunches with adjustable width and phasing, on a nanosecond time scale, that are suitable for direct injection into the stable rf buckets in the AGS or later on into the Booster. This device has been constructed and tested. It will be installed with the new preinjector in the AGS during the summer of 1988.[2]

acceptable limits despite a four-fold increase in beam intensity, are a fast beam chopper, a gamma-transition jump system, and a high frequency dilution cavity. These last projects have received high priority because they benefit as well the present operation of the AGS.

the summer of 1988.

750 keV RFQ Preinjector

The obsolete 750 keV Cockcroft-Walton will be replaced by a more reliable and low maintenance

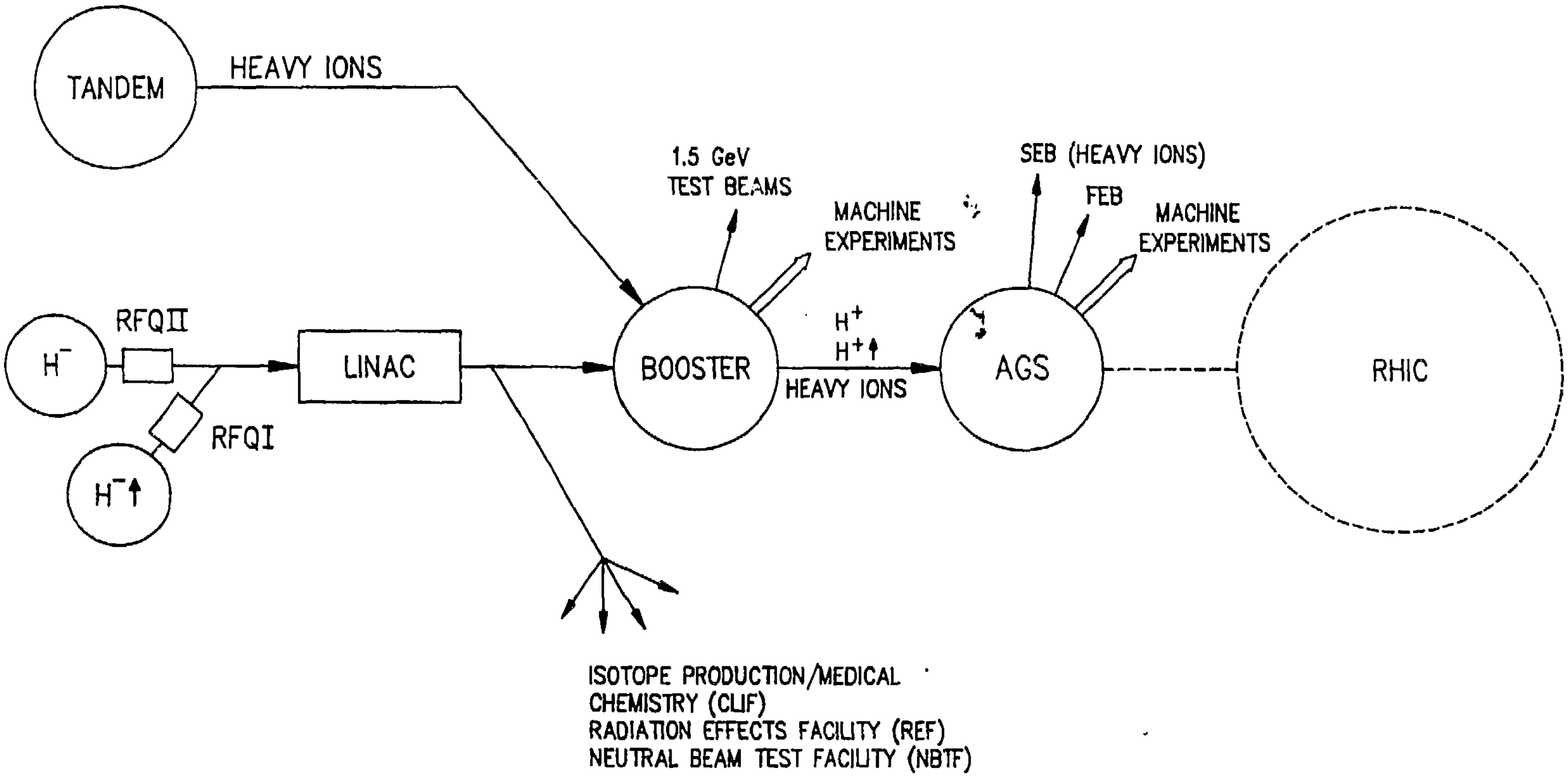

Figure 1. The AGS Complex in 1991.

*Work performed under the auspices of the U.S. Department of Energy.

750 keV Radio Frequency Quadrupole (constructed by Lawrence Berkeley Laboratory). The new preinjector is equipped with a rotationally symmetric magnetron source, fast beam diagnostics, and the fast beam chopper, which will remove undesirable beam between AGS bunches that are otherwise dumped in the AGS ring. The new preinjector will be installed in the summer of 1988 in the 200 MeV Linac.[3]

Gamma-Transition System

Significant beam loss occurs when the beam passes the unstable gamma-transition region at 8.4 GeV. In order to eliminate these losses, two complementary systems are under construction; namely, a fast quadrupole jump scheme and a high frequency rf dilution cavity (see below). The quadrupole scheme consists of three fast pulsed quadrupole doublets equally distributed in five-foot straight sections around the ring. This transition jump will decrease by a factor of one hundred the amount of time the beam presently spends in the unstable region. Such a system is expected to avoid beam losses during transition up to intensities of $2\text{-}3 \times 10^{13}$ protons per pulse. This project is now underway and the system will be installed during 1989.

High Frequency Dilution RF Cavity

A device which will control the beam losses at selected times before and/or after the AGS transition energy is the high frequency (93 MHz) dilution rf cavity. The injected power will produce controlled bunch filamentation and area dilution in longitudinal phase space. This new cavity and its

RF Cavities

The existing accelerating rf cavities were built in order to accelerate beams of 10^{13} particles per pulse. This system operates successfully and has supported intensities as high as 2×10^{13}. In order to reduce beam loading at higher intensities, the power amplifiers have to be rebuilt and located in the ring. The electrical drive system has to be improved, and the monitoring system has to be updated.

Polarized H^- Source

In the Advanced Source Development Group, an effort is underway to improve the output of polarized proton beams. The operational polarized H^- source presently produces beams of the order of 30 μA. Currents one order of magnitude higher will significantly affect the operation and use of polarized ion beams in the AGS as well as RHIC. Individual sections of a new polarized source have been successfully tested, in particular, the hydrogen dissociator. It is expected that implementation of this new dissociator with the operating source will significantly enhance the polarized beam intensity up to levels of hundreds of microamperes. This source, together with multi-pulse accumulation in the Booster, may well realize the acceleration of $10^{12}\text{-}10^{13}$ polarized protons per pulse in the AGS and RHIC.

Other improvement projects in progress are improved modulation of the Siemens main magnet power supply with more versatile cycle generation, more trolled bunch filamentation and area dilution in longitudinal phase space. This new cavity and its PIN-diode switch is being constructed and will be installed at the end of this year.[4]

Transverse Dampers

For higher intensity operation, the present transverse feedback system is inadequate. A new broadband 100 MHz feedback system is under construction to control the resistive wall instability, to suppress coherent oscillations arising from any beam injection error with the Booster, and to suppress possible bunch-to-bunch instability coupled with higher intensity operation. The scheme chosen is a hybrid between the CERN and FNAL booster system.[5] The sum and difference signals from single bunch pick-up electrodes are used to produce the level of the kick accomplished by a pair of strip lines.

Vacuum Upgrade

Over the last ten years on average, the vacuum system of the AGS has operated in the low 10^{-7} Torr pressure range. In order to minimize electron capture during heavy ion acceleration and for stable, high intensity proton beam operation, pressures in the 10^{-9} Torr range are required. In addition, we aim toward a low maintenance, radiation hardened, all-metal vacuum system. Basically, the program consists of reduction in the magnitude of outgassing from the existing vacuum chambers and increasing the size of the ion pumps. The program includes rework and/or replacement of practically all vacuum chambers, new vacuum clamps and seals (to be implemented, together with the new computerized vacuum control system, this summer), new ion pumps, all-metal valves, etc. The new system will be implemented during the long summer shutdown in 1990.

improved modulation of the Siemens main magnet power supply with more versatile cycle generation, more versatile power supplies for the low and high field correction system (highly accurate regulated monopolar and bipolar power supplies are on order), modernization of the computer controls system using Apollo workstations and new device controllers, upgrade of the present internal beam catcher, modernization of beam diagnostics, and finally a general AGS overhaul of the basic service equipment.

The AGS Upgrade Project, underway since 1985, has already begun to benefit the operational reliability of the AGS.

References

1. J.M. Brennan, private communication.
2. J.M. Brennan, A Fast Chopper for Programmed Population of the Longitudinal Phase Space of the AGS Booster, this proceedings.
3. J. Alessi, The New AGS H^- RFQ Preinjector, this proceedings.
4. J.M. Brennan, A High Harmonic Cavity for Controlled Longitudinal Phase Space Dilution in the AGS, this proceedings.
5. C. Carter, et al., Transverse Feedback System for CERN PS Booster, IEEE Trans. Nucl Sci. NS-28, 2270 (1981); E. Higgins, et al., The Fermilab Transverse Instability Active Damping System, IEEE Trans Nucl Sci., NS-22, 1473 (1975).