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T.F. Kycia and M. Month

April 18, 1978

ACCELERATOR DEPARTMENT

BROOKHAVEN NATIONAL LABORATORY

UPTON, NEW YORK 11973

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ABSTRACT

A new method of injection into the AGS using a chopped H^- beam is proposed. Orbit control, control over the beam characteristics, and the implications for operating the rf system are considered.

One of the most fundamental aspects of accelerator operation is the matching of beams when transferred from one machine to another in the sequence which accelerates beam and accumulates charge. In general, the low energy initial stages are mismatched. For example, the use of a linac operating at a bunch frequency of 200 MHz is not well suited to the rf requirements of a circular accelerator such as the AGS, although tailoring the situation is undoubtedly not impossible. What is presently done is simply to accept the high frequency linac beam as if it were dc. Thus, at the initial stage a bunching operation is necessary. The capture process is rather complicated and the beam during this period is not entirely under control. Some of the points that complicate the capture process are:

- 1) It is a lossy process.
- 2) There is dilution of the beam phase space resulting from the beam mismatch.
- 3) There is no effective orbit control possible with the dc beam.
- 4) The rf system cannot operate with feedback and must be programmed - that is, it must function "blind". Furthermore, there must be a switchover to a feedback system in midstream, so to speak, adding even more complexity.
- 5) The ability to accurately fix the density of the beam, both transversely and longitudinally, is severely limited by the lack of control. The aperture is therefore not optimally utilized.

With these considerations, it seems clear that a technique which could overcome these uncertainties would indeed be desirable. The purpose of this report is to propose one.

The system we propose for injection into the AGS from the 200 MeV linac has the following steps:

- 1) From an H^- source, draw a current in the range 1 to 20 mA, so that the energy spread and transverse emittances are small. Their eventual values will be determined by the operating procedure rather than by the source. The transverse emittances will be fixed by the chosen H^- current, the target thickness and the amount of charge to be accumulated in the ring. The longitudinal phase space area (i.e. energy spread in the AGS) is given by the nature of the H^- current pulse structure as well as the voltage of the "waiting" rf system.
- 2) The pulse structure of the H^- beam can be created prior to the beam entering the linac. A pulsed beam deflector at rf frequencies can change the dc H^- beam to the desired chopped beam. A sequence of H^- pulses is thereby created with a given pulse length and given pulse frequency.
- 3) The H^- beam enters the AGS as a strip of beam filling a certain fraction of the circumference. As an example, take an rf system operating in the AGS on the fundamental harmonic. Such a capture rf system would be used to implement boxcar stacking for the 400 GeV ISABELLE rings. With a 70% injection duty cycle, this would imply an H^- beam with strips of length 3.3 μ sec at a frequency 210.4 kHz. If we wanted to inject into the 12th harmonic rf system with the same 70% filling, the strips would have to be of length 0.28 μ sec at a frequency 2.52 MHz.
- 4) With H^- injection, we can simply superimpose strips. To get 4×10^{12} protons injected requires 192 mA (at a bunching of 70%). Thus, for a 10 mA H^- beam and 95% stripping efficiency, we need about 20 turns, that is, 20 strips when operating at the fundamental rf frequency, or 240 strips with the AGS operating at the 12th harmonic.

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