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A 25 μA Pulsed Polarized H^- Ion Source*

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A Haeberli-type pulsed polarized negative hydrogen source has been brought into operation at the BNL Alternating Gradient Synchrotron. It operates reliably at beam currents sometimes as high as 25 μA and 20 keV in beam pulses of 500 μsec with approximately 75% polarization. These beam intensities are about an order of magnitude higher than the original Haeberli source built at the University of Wisconsin. This improvement is caused by the higher densities of both the atomic hydrogen beam and the cesium beam, which are the basic ingredients in the charge exchange reaction

$$\vec{H} + Cs^{o} \rightarrow \vec{H}^{-} + Cs^{+}.$$

About half the beam (10-15 μA) is accelerated in the 200 MeV linac and injected into the AGS.

The source layout is shown in Figure 1 and Figure 2 (Reference 1 and 2). The polarized atomic hydrogen beam (Figure 1) is a conventional ground state atomic beam line with an rf disassociator. The atomic beam is thermalized to about 100°K by cooling the disassociator nozzle using a closed-loop helium refrigerator. The H_2 gas as well as the rf are pulsed. Four sextupoles provide an electron polarized beam, followed by two rf transition cavities giving alternating nuclear polarization on a pulse-to-pulse basis. The density of the H^{o} beam near the interaction region is estimated to be $2\text{-}3 \times 10^{11}$ atoms/cm^3.

The neutral cesium beam line (Figure 2) produces a 40 keV, 10-15 mA pulsed Cs^+ beam by surface ionization of cesium on a hot porous tungsten button. Between pulses the Cs source voltages are such that Cs^+ ions are captured on the surface until the opposite voltage is applied. This arrangement allows high cesium currents at low Cs oven temperatures (80°C) resulting in very low cesium consumption rates, which improves significantly its reliability and lifetime (Reference 3).

The cesium ion beam becomes neutralized in a cesium vapor neutralizer, which is pulsed by a magnetically operated flapper valve in the Cs supply line. The inside structure is made of a commercially available stainless steel mesh material, giving the proper wicking action. The geometry and dimensions as well as the temperature regulation of the outer flanges and main body are made such that most of the cesium returns to the reservoir. It has operated now for many months without maintenance.

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The neutral cesium beam (6-10 particle-mA reach the interaction region) and the polarized atomic hydrogen beam interact in a 30 cm long collision region. The H^- ions, produced by charge exchange with Cs°, are accelerated slightly toward the extraction end, where they are focused, accelerated, and deflected by a 90° electrostatic mirror into the transfer line of the 750 keV RFQ. The normalized emittance is about 0.065 π cm mrad at 20 keV with a polarization around 75% (measured at 200 MeV).

The source has operated reliably since December 1983. Computer control of all power supplies has resulted in very stable, reproducible operation. Beam intensities of 25 μA in beam pulses of 400 μsec or more have been obtained in particular soon after a new tungsten button is installed. The maintenance of the source, which is required about once every 10 days, usually consists of cleaning the electrodes of the cesium gun or replacing the button. The beam is restored within eight hours.

In the near future we expect an improvement in the intensity of the source by at least a factor of two. This will be achieved by the installation of a tapered first sextupole, an improved vacuum in the rf transition area and improved cooling of the nozzle of the H_2 dis-associator.

The availability of a H^- ion source in the milliampere range with an on/off polarization capability will revolutionize the operation of particle accelerators. Such an ion source has recently been proposed at BNL. Its principles are shown in Figure 3. The source consists of a low temperature (7°K) helium cooled atomic hydrogen beam with a density which is significantly higher than the present room temperature atomic beams ($\rho \div T^{-1/2}$). This beam is focused (by a permanent magnet doublet system) into the interaction region, where the polarized H° beam interacts with a low energy (200 eV) D^- beam ($\vec{H}^\circ + D^- \rightarrow \vec{H}^- + D^\circ$) producing polarized negative hydrogen ions. Beams well in excess of 1 mA are expected to be extracted from such a system.

The helium cooled test facility with its turbo and cryopumped vacuum system has been fabricated. The ring magnetron has been constructed and is undergoing initial testing.

References

1. W. Haeberli, et al., Nucl. Instrum. and Meth. 196 (1982), p. 319.

2. Th. Sluyters, J. Alessi and A. Kponou, AIP Conference Proceedings No. 111 (BNL 1983), p. 736.

3. J.G. Alessi, Vacuum 34, Nos. 1-2, 7 (1984).

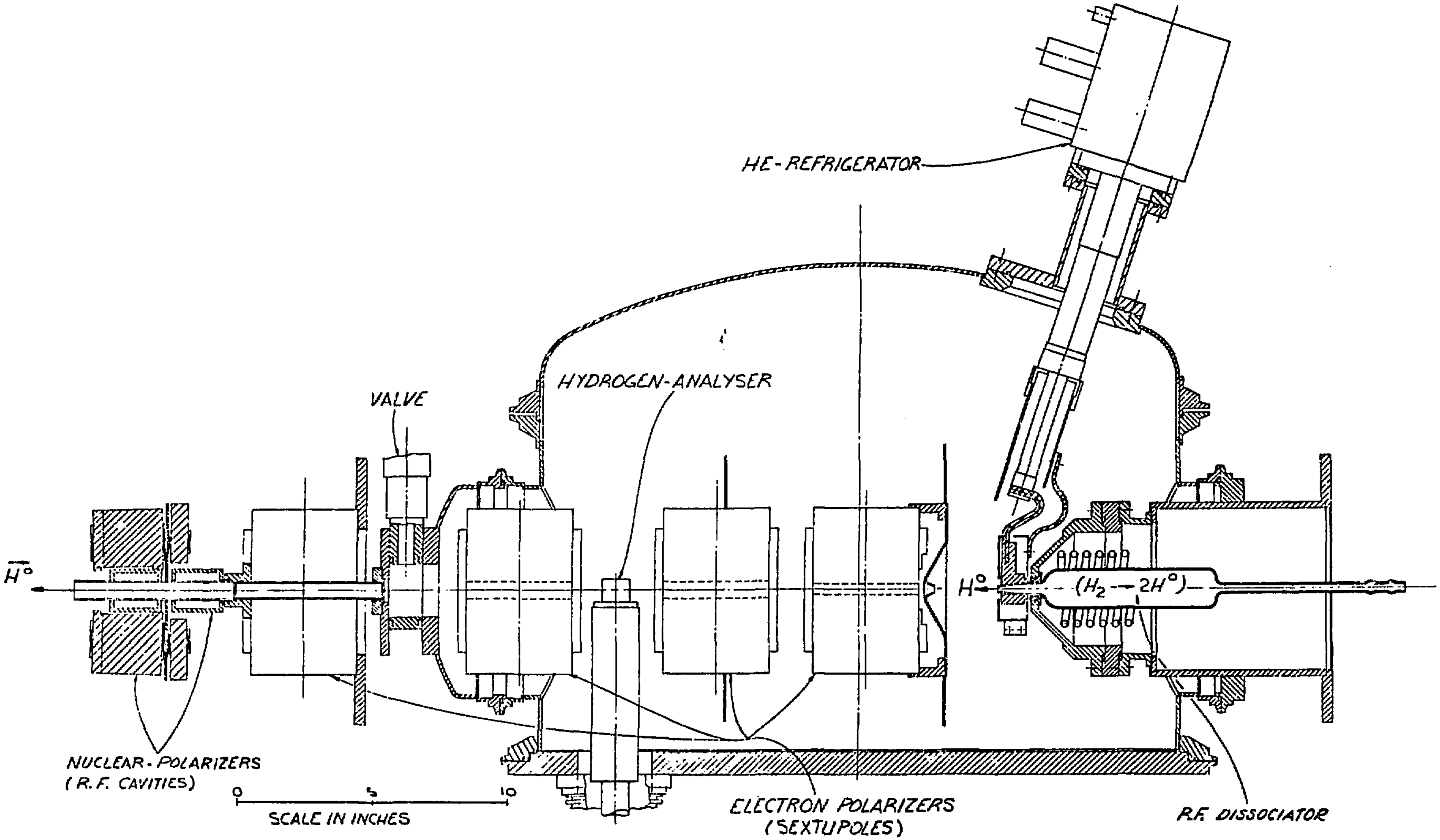

Figure 1 - The polarized atomic hydrogen beam line.

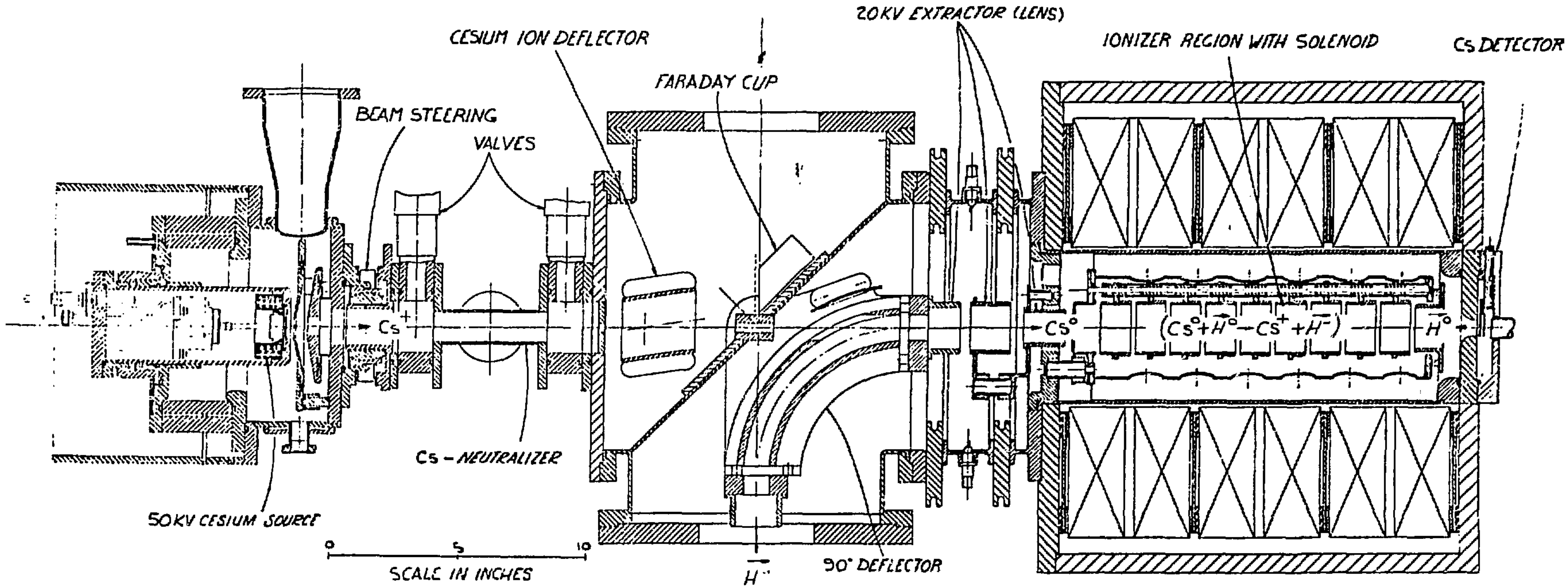

Figure 2 - The neutral cesium beam line with charge exchange collision chamber.

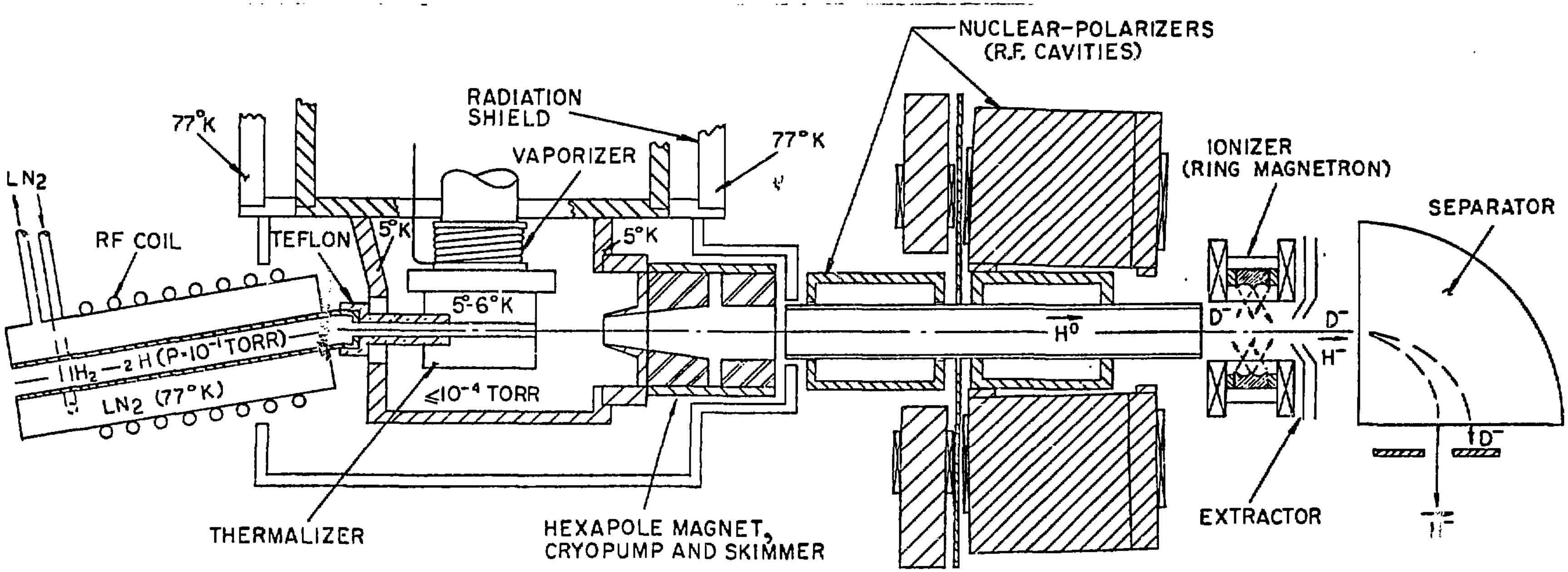

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Figure 3 - The next generation polarized negative ion source.