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STATUS AND FUTURE PLANS FOR THE BNL POLARIZED H⁻ SOURCE*

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In 1982, when Haeberli described[1] the design and performance of his 3 μA polarized negative hydrogen source, he predicted that the colinear colliding beam source had the potential to produce H⁻ beam currents well in excess of 10 μA. The recently constructed AGS source, which is similar to Haeberli's system, has reached peak beam currents in excess of 25 μA, while operating in the pulsed mode. Standard operation of the AGS machine is 10 μA in beam pulses of 0.5 ms each two seconds. These "intense" beams have been achieved by cooling the atomic beam from room temperature to 110°K and by increasing the cesium ion current from 2-3 mA to the 10-15 mA level. Higher polarized beam currents are expected with relatively simple modifications in the design.

The source design is shown in Figures 1 and 2. Polarized hydrogen atoms are produced in a ground state atomic beam source (Figure 1) consisting of an rf dissociator, sextupoles and rf transition cavities. Subsequently the atoms pick up an electron

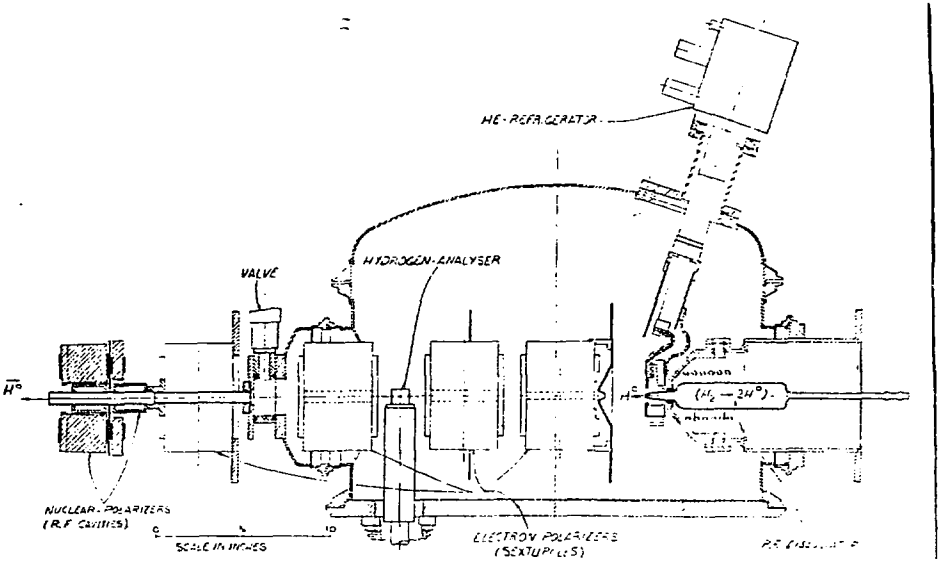

Figure 1 - The polarized atomic beam line.

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in the interaction region by charge exchange with a 45 keV Cs° beam moving in the opposite direction (Figure 2). The emerging polarized H⁻ ions are accelerated to 20 keV and removed from the source by a 90° electrostatic deflector.

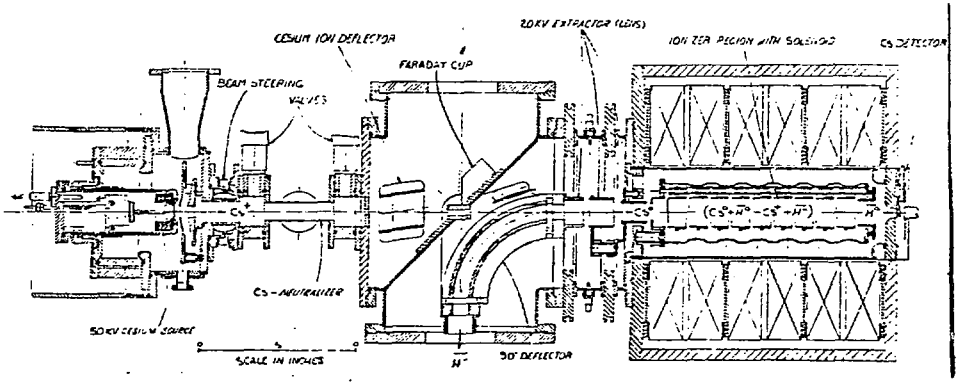

Figure 2 - The neutral cesium beam line with interaction region and polarized H⁻ extraction system.

The first main difference between the BNL design and the Wisconsin unit is that the BNL source is pulsed and has extra cooling at the front end (nozzle) of the rf dissociator. The cooling is by means of a closed cycle helium refrigerator. Velocity measurements revealed cooling of the atomic beam to only 110°K, limited by the design of the nozzle and the capacity of the refrigerator. The density of the cold atomic beam is a factor of two higher than a thermalized beam at room temperature. This increase in density can be explained qualitatively by the ratio of the atomic velocities $[v(300°)/v(110°) = 1.65]$ and the improved acceptance angle of the first sextupole magnet.

The other improvement responsible for the larger polarized beam currents is a new cesium source, whose design is based on surface ionization using curved porous tungsten.[3] A unique feature of this source is the operation of the porous tungsten in the pulsed mode rather than in the d.c. mode.[4] In between pulses cesium accumulates on the tungsten emission surface, so that only a low cesium flow rate (0.1 mg/hr) is required. This feature of short pulsed sources minimizes problems associated with Cs coating of electrodes and insulators, loading on power supplies, etc. It is possible to maintain a pulse shape with a relatively flat portion of at least the required 0.5 millisecond each two seconds (see Figure 3). The pulse shape is a sensitive function of the ionizer temperature (about 1000°C) and the Cs coverage of the

emitting surface at the start of the pulse. This coverage, a fraction of a monolayer, is adjusted by the temperature of the Cs boiler, which is usually less than 100°C.

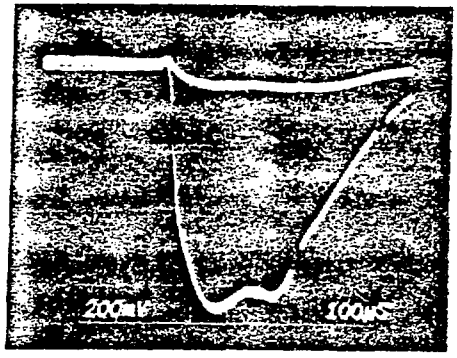

Figure 3 - The bottom trace is the polarized H^- beam. The top trace represents the unpolarized H^- beam, which has been recently reduced to much less than 7.5%.

Figure 4 shows the layout of the three-electrode cesium source. The 0.2 cm thick tungsten ionizer has a radius of 1.9 cm. The extraction gap can be adjusted with the source in operation. A mechanical swivel can steer the cesium beam into the collision chamber, which is located about 1 meter from the source. Figure 5 shows the details of the electrode geometry as well as its voltage pulsing scheme. This arrangement suppresses cesium ion emission in between pulses from the cesium ion emitter and backstreaming electrons from the beam line.

The emittance of the H^- beam was estimated in the vertical plane with a simple, two-slit, emittance detector located 0.5 m from the spherical inflector. The emittance for a 9 μA and 20 keV beam is 8.9 mm.mrad $\sqrt{\text{MeV}}$, a value very close to the emittance values measured more accurately by Haeberli for a 3 μA beam.[1]

The source is installed on the linac of the Alternating Gradient Synchrotron. Routine operation will start soon.

Further increase in beam intensity can be expected a) with increased cesium beam neutralization efficiency, which is presently only 40-50%, b) by more efficient cooling of the nozzle of the dissociator, c) by tapered design of the first sextupole magnet, and d) by improving the vacuum around the rf transition cavities.

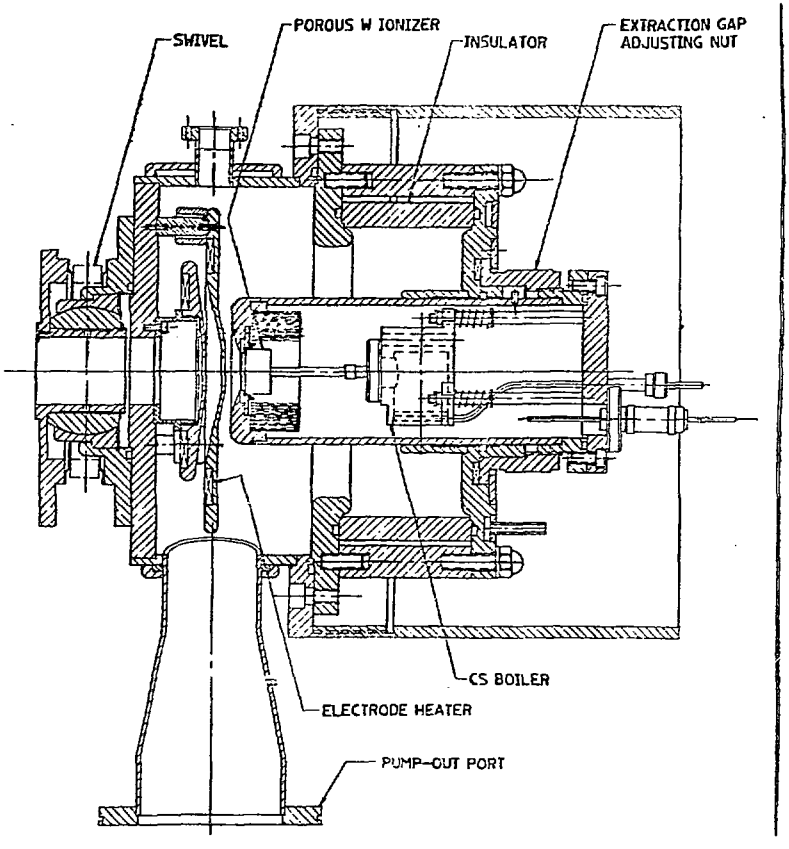

Figure 4 - The 10-15 mA cesium ion source.

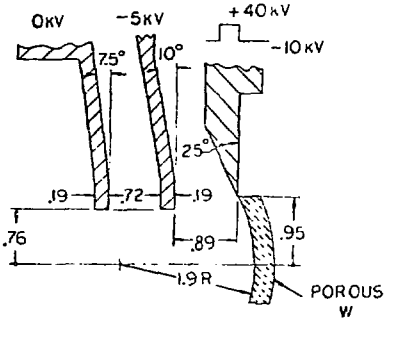

Figure 5 - The electrode geometry of the cesium ion source and its voltage pulsing scheme.

References

1. W. Haeberli, et al., Nucl. Instr. and Meth. 196 (1982), 319.
2. P.F. Schultz, E.F. Parker and J.J. Madsen, in Polarization Phenomena in Nuclear Physics, 1980; eds. G.G. Ohlsen, et al., AIP Conf. Proc. No. 69, Part 2 (Am. Inst. of Phys., NY, (1981), 909.
3. T. Wise and W. Haeberli, Ann Arbor, 1981, AIP Conf. Proceed. No. 80.
4. J. Alessi, Proc. Conf. on Low Energy Ions and Beams-3, Loughborough, U.K., 1983, to be published in Vacuum.

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