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POSSIBLE INJECTION LINES FOR H- INJECTION

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Some special ray tracing runs have been done using the BEAM code on the PDP-10 to examine two possible schemes for injecting H^- ions into the AGS.

Originally, the BEAM code provided options for using field tables suitable for 50 MeV injection, midfield around 12 GeV, and saturation around 33 GeV. None of these are exactly suitable for 200 MeV injection, but the midfield option is probably best and was therefore used for these runs.

The runs consist of 1) the closed orbit with suitable orbit bumps to hit the stripper foil, 2) a ray coming in from outside using the reverse bending in one or two magnets to hit the closed orbit found in 1), 3) the emittance ellipse parameters for matching, and 4) the momentum dispersion requirements.

The first type of run is a straightforward BEAM code option. The second run is usually done by exploiting the symmetry of the AGS lattice. For example, to determine how to inject a particle at A20 to hit the point (x, x') at B1, inject that particle at A9 with coordinates $(x, -x')$. It will give at A10 the correct position and opposite sign but numerically correct slope for the A20 injection. This ray can now be tried. The matrix for horizontal motion can be used to iterate to a better solution if the first result does not match the closed orbit with sufficient accuracy. During the ray trace, horizontal and vertical matrices are accumulated. These matrices are inverted, turned into three $\times$ three matrices and used to project back the (α,β,γ) of the AGS to the starting point of the ray trace. The momentum dispersion properties are determined by repeating processes 1) and 2) with momenta slightly different. In principle, the Δp used should be small but because of rather large round-off errors, etc. $\Delta p/p = 0.3\%$ was chosen.

The first case to be presented uses a large fraction of the existing transport and matching line. The exit angle from the inflector would be aimed steeply inward. The reverse bending in magnet B1 brings the ray onto a closed orbit which has been deformed inward by reversing the A13-B7 bumps. At straight section B1, the stripper foil converts the H^- ion to a proton exactly on the closed orbit. The inflector required for this solution will be significantly different than the existing one. It is thus not possible with the present inflector to quickly change back and forth between H^- and protons.

A second option consists of turning off the bending magnet just before the shield wall, allowing the beam to continue to a new bending magnet which bends the beam into A15. No inflector is required. The trajectory hits a stripper foil at A17. Two new orbit bumps and optics matching lenses are also required for this case. Its only advantage is the ease of switching between protons and H^-.

The beam transport optics have not been examined in either case. The tables below give all relevant optical parameters of the closed orbits and of the entering ray at A20 for case 1 and A15 for case 2. All coordinates are relative to the BEAM code system. Entrance conditions are relative to the longitudinal center of the relevant straight sections. In case 2, the ray traverses the fringing field of magnet A16. To test linearity for this situation, a family of rays on the boundary of a 1 π cm mrad ellipse as determined by the ellipse parameters was followed to A17. The curve resulting matched the desired ellipse close enough that the differences are barely perceptible on a hand plotted graph.

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Case 1 Orbit bump of 1923.2 gauss in. at A13 and 2894.9 gauss in. at B7

Orbit at B1		Input Ray at A20	
x =	-2.0234 in.	x =	2.0779
x' =	1.3488 mrad	x' =	-42.156 mrad
α_H =	0.3745	α_H =	11.6503
β_H =	862.23 in.	β_H =	3485.91 in.
α_V =	-0.2866	α_V =	-0.10433
β_V =	411.57 in.	β_V =	108.4 in.
$p\frac{dx}{dp}$ =	94.97 in.	$p\frac{dx}{dp}$ =	124.3 in.
$p\frac{dx'}{dp}$ =	-42.82 mrad	$p\frac{dx'}{dp}$ =	-272.9 mrad

Case 2 Orbit bump of 1933.3 gauss in. at A9 and 2839.2 gauss in. at B3

Closed Orbit at A17		Input Ray at A15	
x =	-2.0655 in.	x =	11.386 in.
x' =	0.5668 mrad	x' =	-93.754 mrad
α_H =	0.00133	α_H =	-0.094934
β_H =	888.723 in.	β_H =	1659.24 in.
α_V =	0.01212	α_V =	0.5883
β_V =	398.31 in.	β_V =	323.13 in.
$p\frac{dx}{dp}$ =	85.15 in.	$p\frac{dx}{dp}$ =	106.5 in.
$p\frac{dx'}{dp}$ =	26.44 mrad	$p\frac{dx'}{dp}$ =	63.17 mrad