First Look at Hall A Beam Line at 22 GeV (FFA)
Jay Benesch
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Summary

The Hall C beam line of TN-23-009 was adapted to Hall A. The lines are identical through the first dipole of the Compton chicane except for signs of the dipoles and beam height. The greater length of the Hall A Compton system allowed for 18.5 cm vertical offset versus 13 cm in C. The remainder of the line began as the MOLLER beam line. Major modifications needed in the Moller polarimeter to deal with higher energy put the end point at the usual pivot. The polarimeter design herein is a placeholder informed by a brief discussion with Don Jones. As in Hall C, the dipole settings are not quite right (at few Gauss level) so the beam is a few mm off nominal at the dump face. It is expected that this will be corrected when the design is revisited if the FFA project becomes real.

Discussion

The majority of the beam line is identical to that discussed in the Hall C TN. Since the first nineteen quads are the same no robustness check was done. Beta functions are shown in Figure 1.

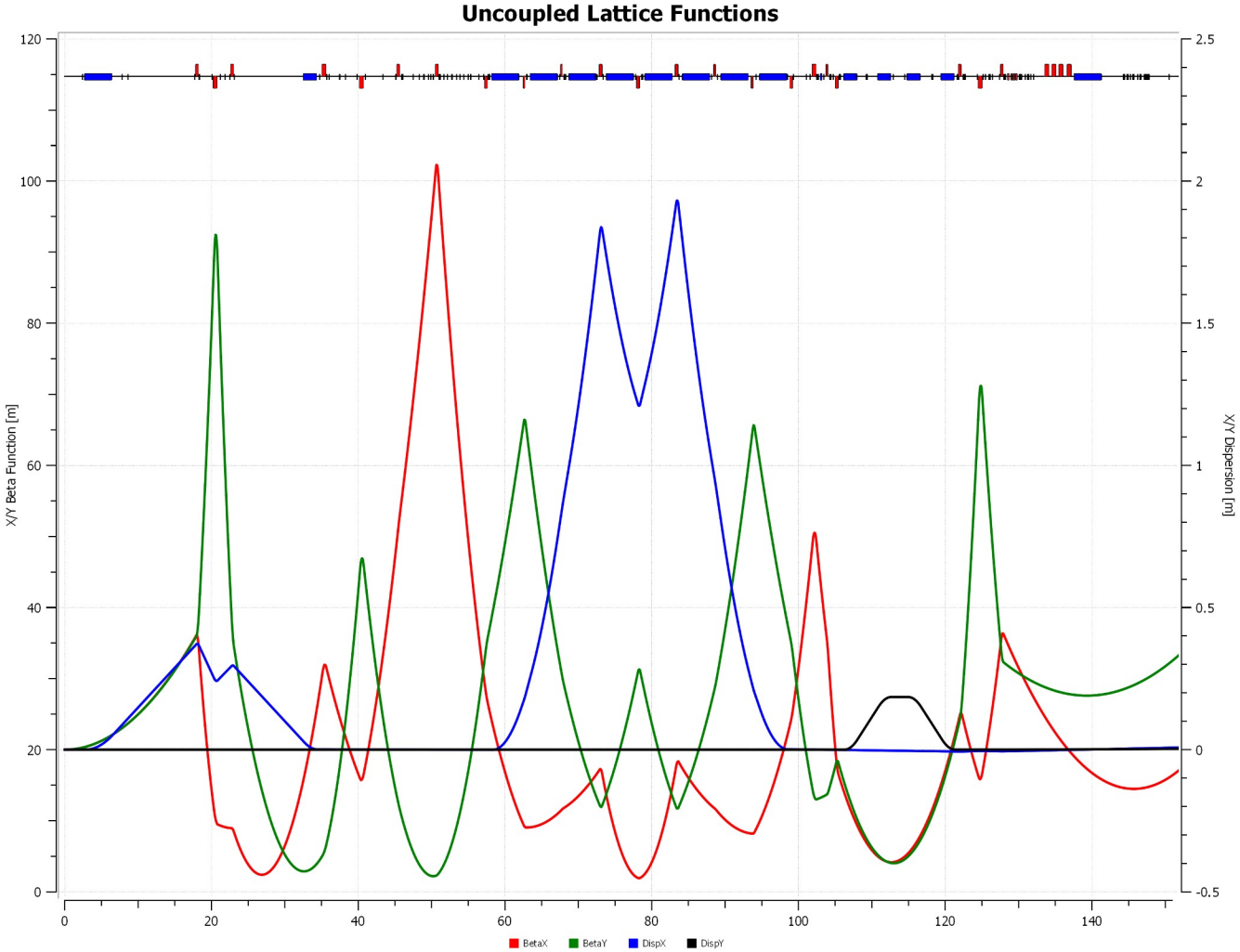

Figure 1. Beta functions and dispersion to 151 m; pivot is at 150.55 m

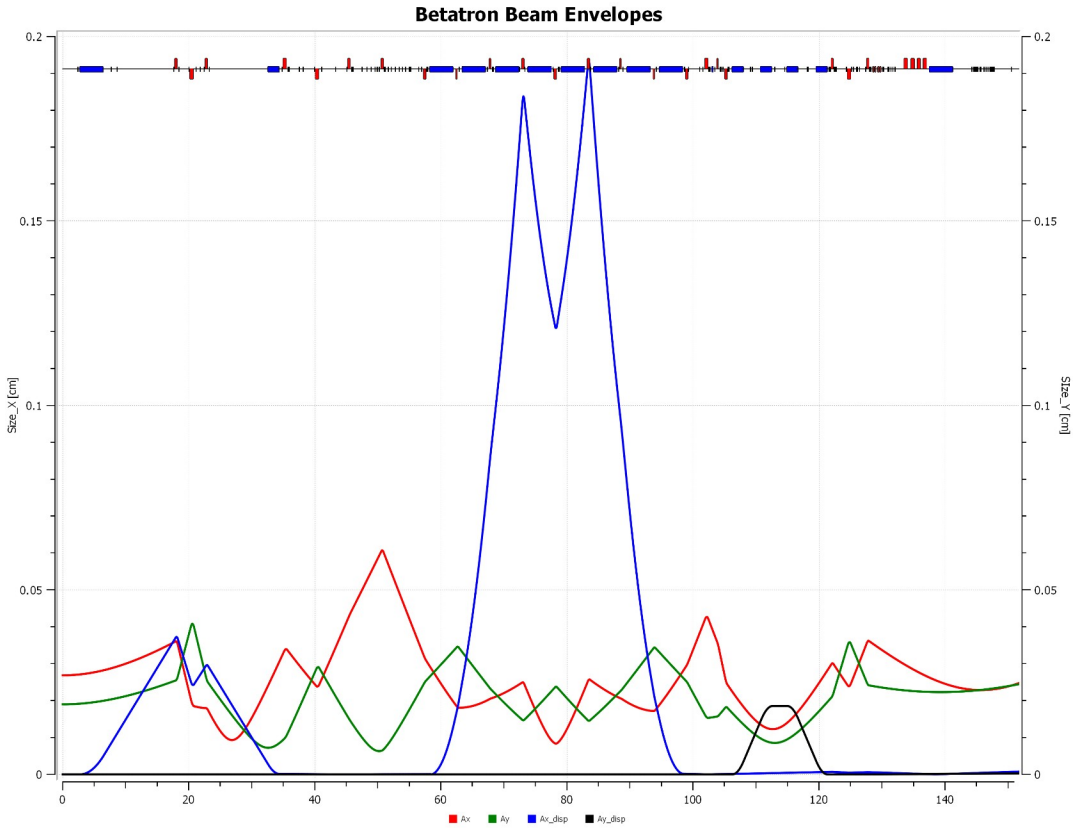

Figure 2. Beam is large in middle of arc due to 1.9 m peak dispersion and dp/p 0.1%

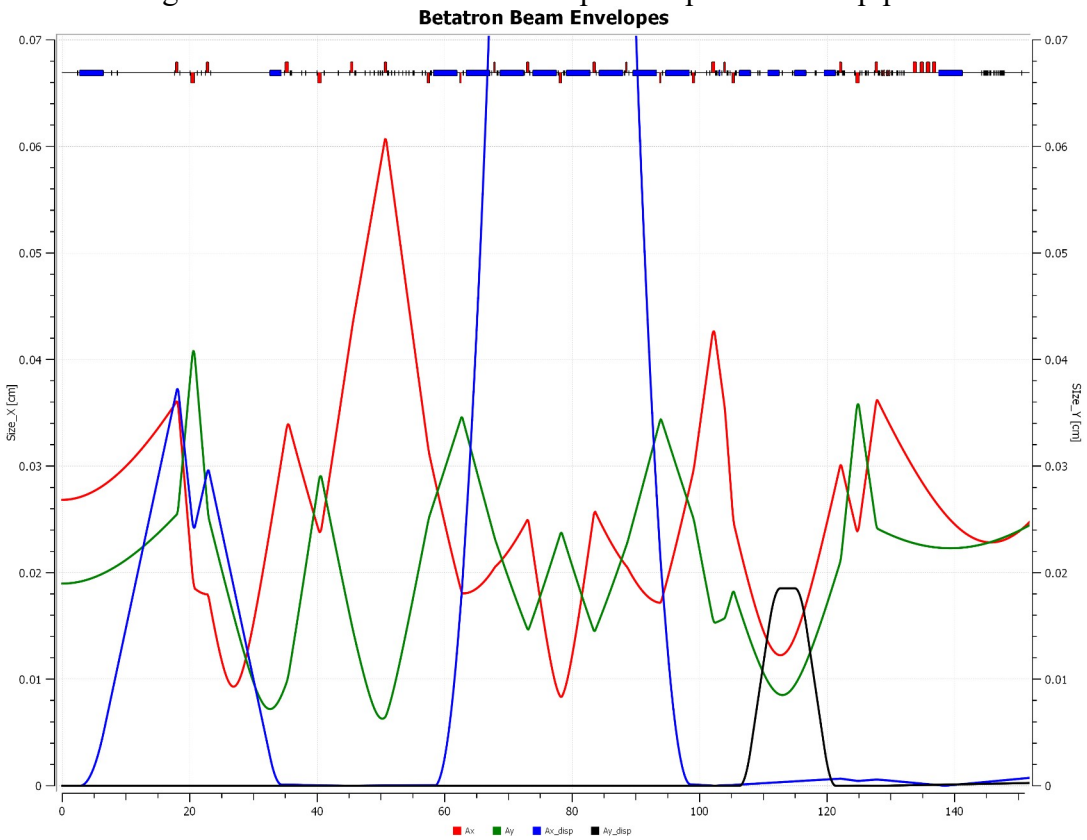

Figure 3. Same as Figure 2 except vertical scale altered to better show that vertical sigma in Compton chicane is ~250 microns due to the 18.5 cm dispersion in quadrature with beta function.

Each drift in the quad triplet was increased by 50 cm as the pivot is the design point, not the MOLLER target position. The drift between the exit of the Compton chicane and the start of the first girder in the triplet was increased 20 cm. The second raster girder was restored; 52 A is needed in each of the four coils for a 5 mm square at the pivot. Assuming a 150 cm diameter scattering chamber on the pivot, there remains almost two meters of un-assigned space after the last diagnostic element in this lattice. The diagnostic elements on the beamline after the Moller polarimeter may be moved downstream.

The Moller polarimeter in 2023 has three quads of one type and one of a fourth. Per Don Jones, the required focusing more than doubles. In TN-20-044 I show the design of an improved 104 mm ID quadrupole at 35.56 cm length, the same as the three. This design will meet the expected need if extended to 50 cm steel length. Drifts of 50 cm between the quads were imposed to moderate coupling between them. The polarimeter dipole is 161 cm long now and deflects the unscattered beam modestly due to shielding steel saturation. A new dipole, likely of the Lambertson type, will have to be designed. 380 cm is allocated in the lattice. This should be long enough that the unscattered beam will not be deflected. The polarimeter target is moved upstream 100 cm from the present location, 70 cm from the MOLLER location.

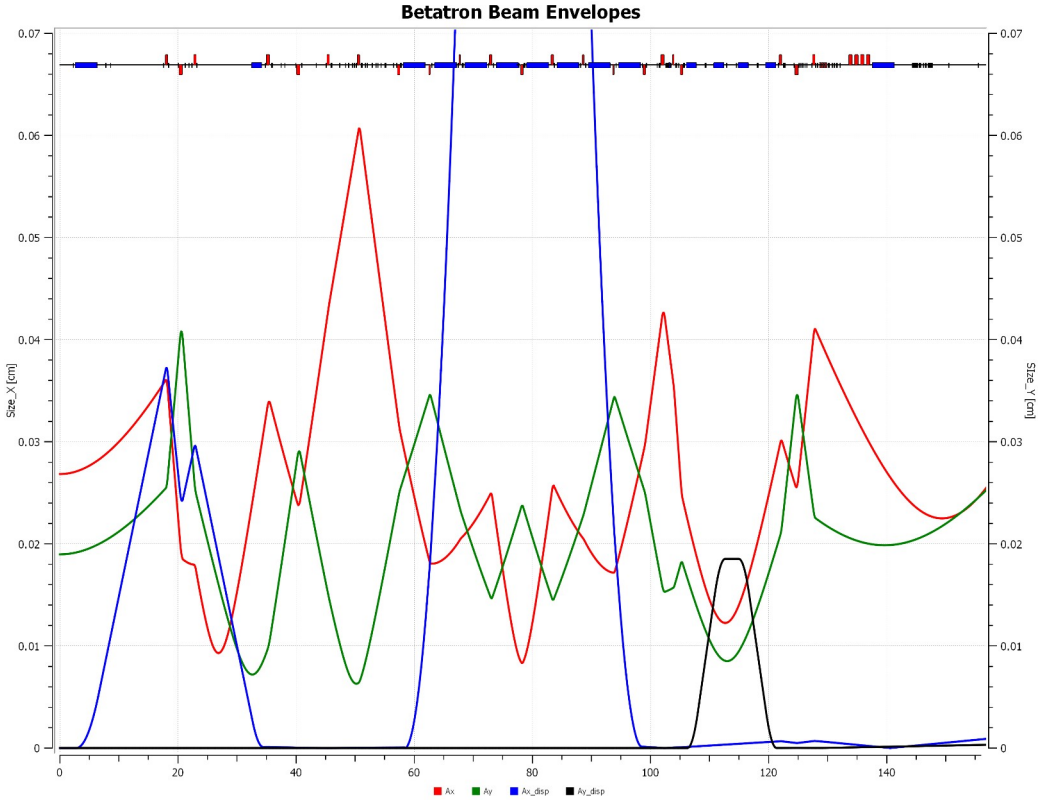

Figure 4. Twiss parameters matched 5 m downstream of pivot, approximate location of SoLID target. This has a slightly smaller spot at the pivot than in Fig. 3. Optimization goal zero alphas in Figure 3.

Conclusion

A viable conceptual design for the A beam line has been completed. The Moller polarimeter needs further definition by system experts but it is believed that sufficient space has been allocated. FEM models of 50 cm steel length by 104 mm ID quads and the polarimeter dipole must be created. Details are in the accompanying Optim and spreadsheet files. Beam height is 6.2 mm below present value due to the new Lambertson. If spectrometers mounted to the pivot are used, a small vertical chicane will be needed. If only large installations after the pivot, as expected, this won't be an issue.