

Hall C line at 22 GeV (FFA)
Jay Benesch
6 February 2023

Abstract

The initial Hall C line work discussed in TN-22-016 is brought to completion. Details are found in the accompanying spreadsheet and optim file. The dipole settings are not perfect: the Pivot location is off by -1.33 mm in X and 0.06 mm in Z. Nothing that correctors can't handle, but annoying. Arc quadrupole setting are based on the 1.9 m dispersion arc optics provided by Alex Bogacz.

Magnets

One new quadrupole type is required: QRP, a 52 cm long quad with the QR profile and same maximum gradient per cm of length. This is used at 3C04 in addition to locations where the focusing is nominally needed as 3C04 is used with qsUtility to measure beam properties. The harp is moved to the 3C06 girder to get greater throw. PSS equipment was moved downstream by one girder to allow this. I have not examined cooling options for the QRP.

The new Lambertson is discussed in TN-22-041. Center plate is thicker so the C beam must be lower coming out of the transport recombiner. The dispersion from the Lambertson is closed via a new 180 cm dipole, detailed in an accompanying TN. The eight arc dipoles are discussed in TN-21-051. The new 180 cm dipoles were designed for use in the Compton chicane as there would have been no space for its detectors if the 200 cm dipoles previously contemplated had been used. The 2.62 cm vertical chicane at the end of the line uses the existing BEs.

ME should check the layout with the new, wider dipoles to ensure I didn't hit the tunnel wall. FFB magnet locations must be determined after this layout is done. Shorter FFB magnets may be required. Shorter BPM assemblies are required; those have been designed for the MOLLER beam line. The harps at 3C12 were removed: no space available. No thought has been given to synchrotron light monitors or interferometers.

Fast raster requires 100 A to provide 6 mm square at the pivot with two pair of coils. It is my understanding that the existing coils can accept 100 A. MOLLER requires ~80 A so JLab will gain experience with higher power circuits well before the upgrade.

Initial Conditions

Energy 22 GeV, dp/p 0.1%
 $\beta_X = \beta_Y = 20$ m as usual
 $\alpha_X = \alpha_Y = 0$ as usual
geometric emittanceX $3.6E-7$ cm, twice what Kirsten calculates for the perfect FFA arcs
geometric emittanceY $1.8E-7$ cm as the ratio is typically 2:1 x:y and no calculation has been done
initial dispersion and its derivative zero

Plots

The plots on the following pages end at $S=145$ m, just beyond the Pivot which is at $S=144.6$ m

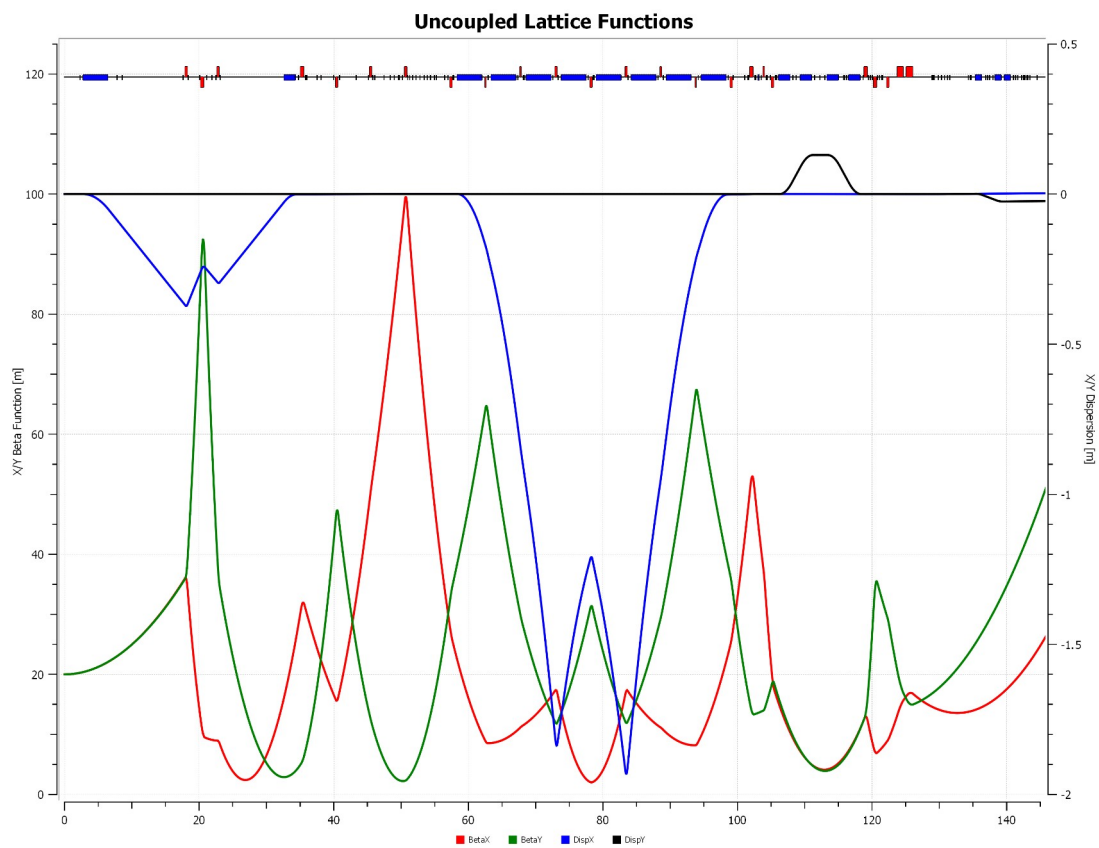


Figure 1. Lattice functions

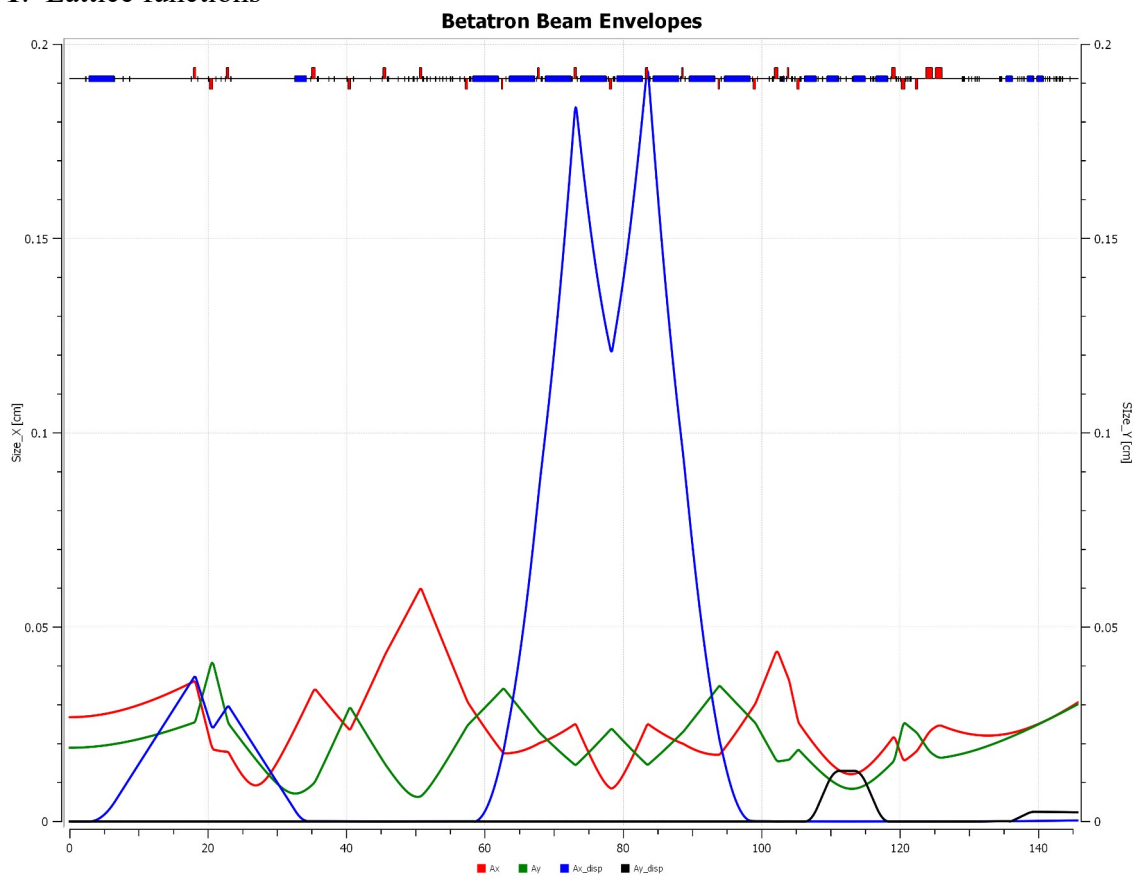


Figure 2. Beam envelopes with initial conditions specified on page 1

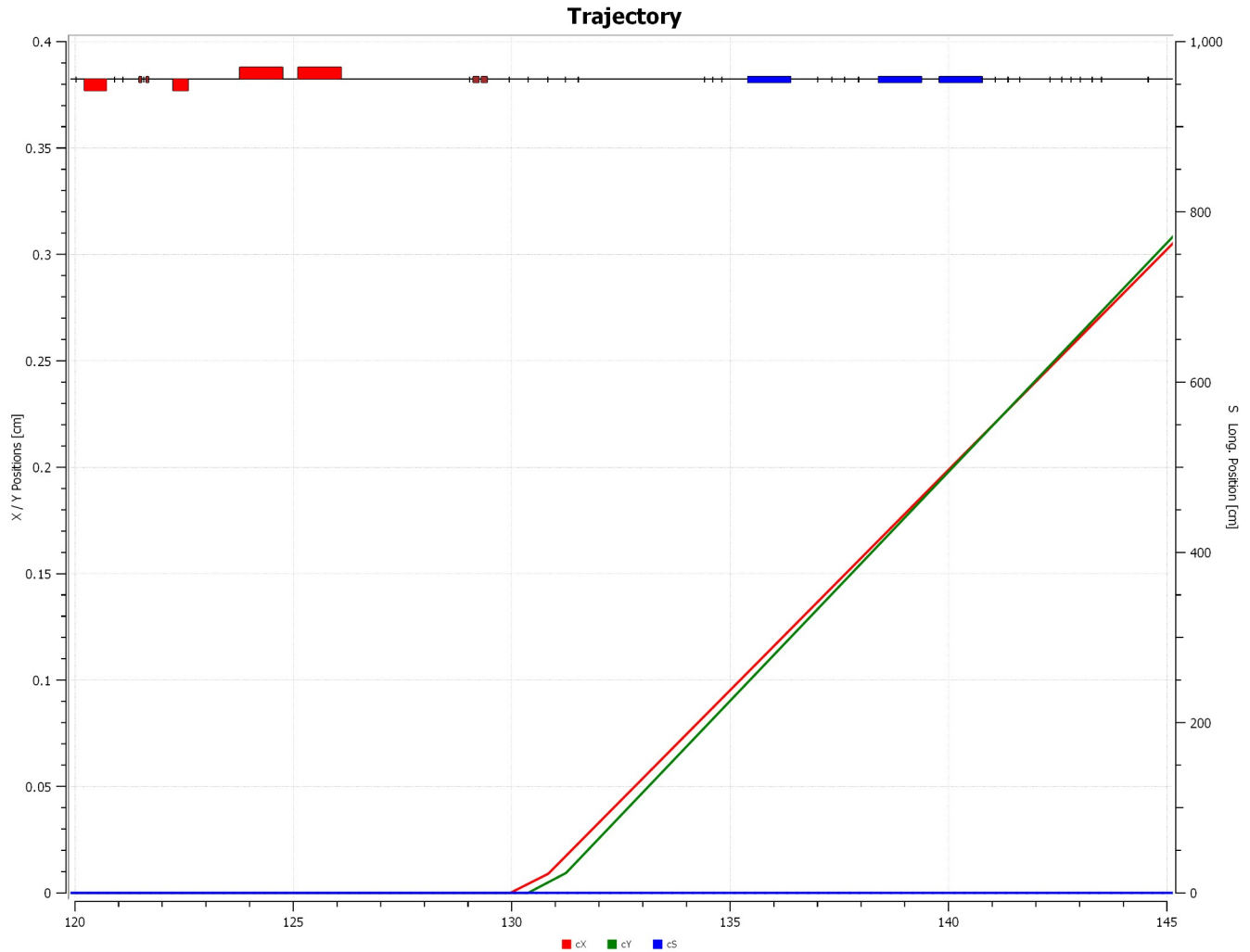


Figure 3. Raster providing 6 mm square at pivot 94 A in horizontal coils, 98 A in vertical coils

Conclusions

A viable redesign of the Hall C beam line has been completed. Fine tuning will be required, including a closer look at diagnostics and vacuum valves. Per Optim, about 54 MeV is lost to synchrotron radiation. The arc S is ~40 m and maximum current at 22 GeV ~40 uA so the power on the vacuum vessel wall is ~54 W/m. Cooling hasn't been considered.

This line will be used as the basis for the Hall A line up to the start of its Compton polarimeter. The 180 cm dipoles will be used there as well.