Charged Particle Beam Optics
for the Proposed
Irradiation Physics Area
at
Fermilab

Jason St. John
Adam Watts
External Beams Department
2018.08.10

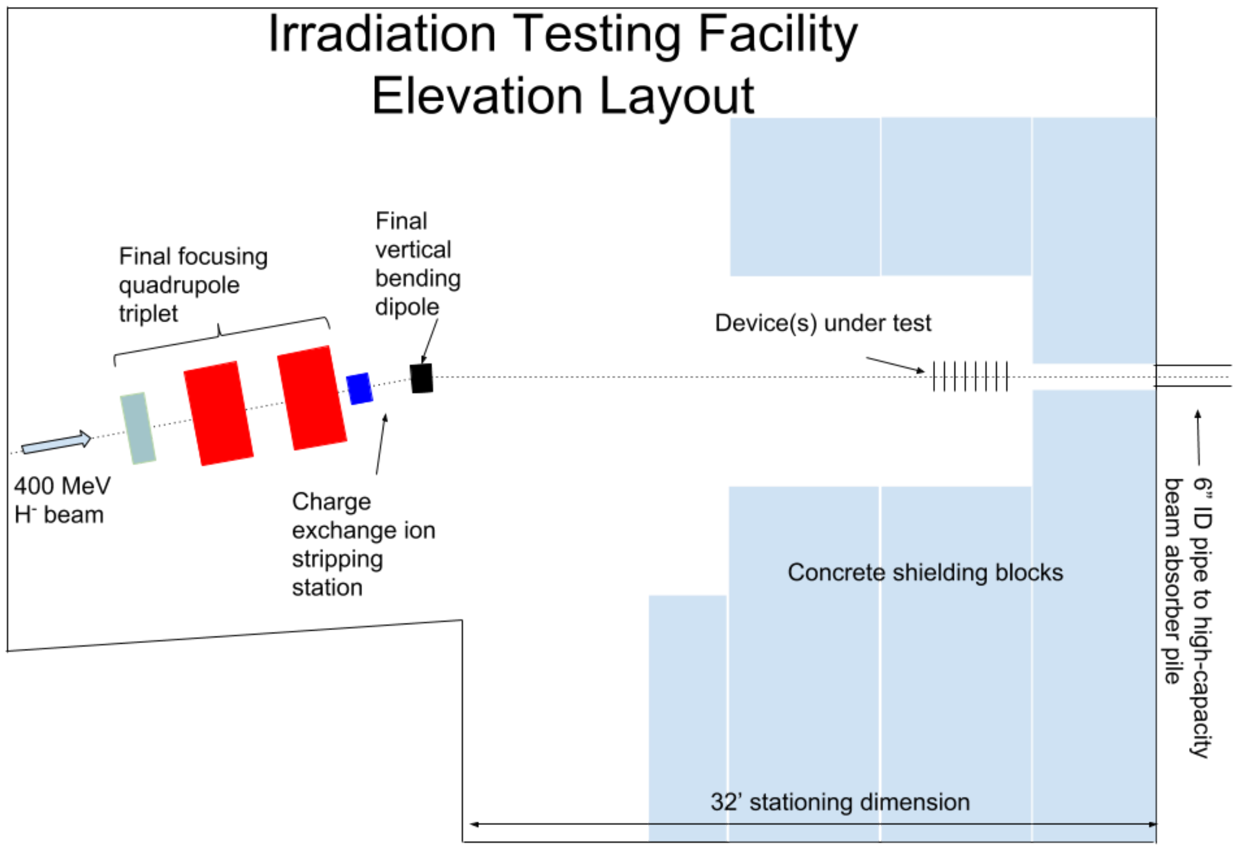

Fig. 0. Elevation diagram of the Irradiation Physics Area.

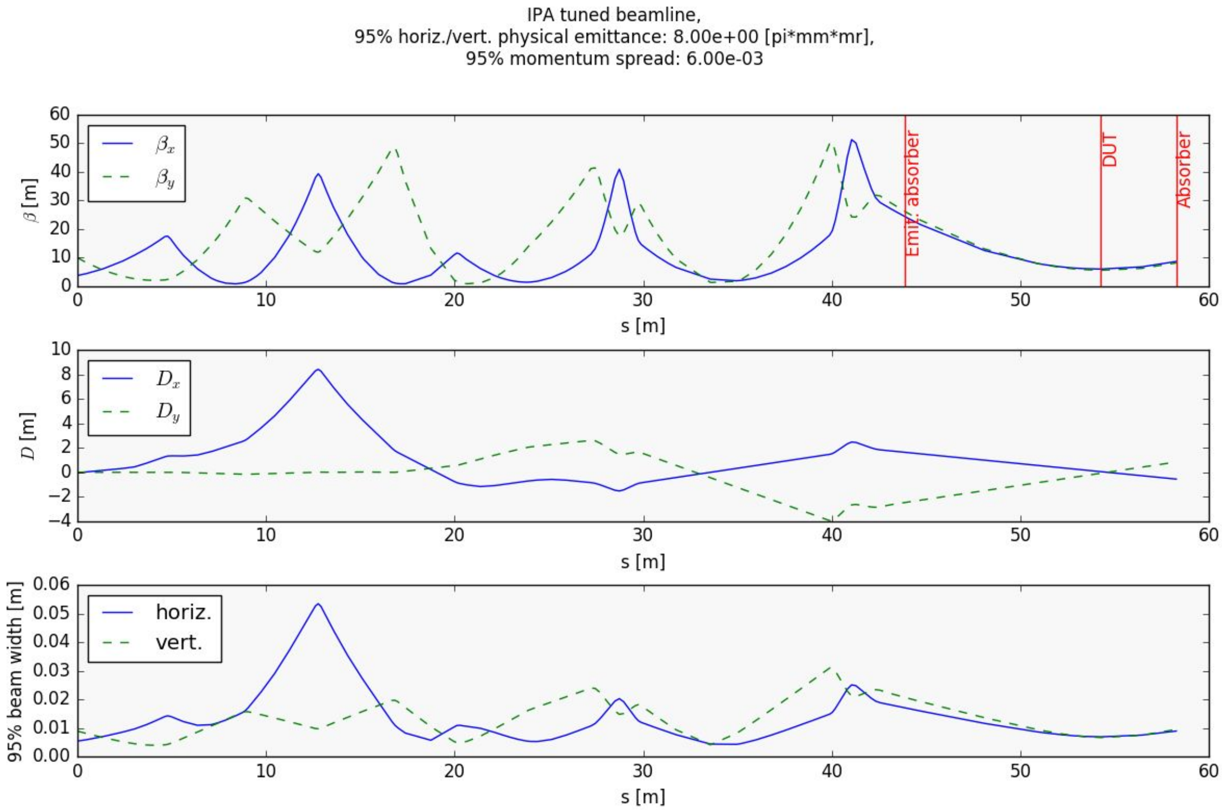

Fig. 1: Irradiation Physics Area beam line from kicker magnet extraction to the material core of the final absorber. [Top] Transverse beta functions showing the approximate positions of the original MuCool Test Area absorber. [Middle] Dispersion functions. [Bottom] 95% physical beam width taking 2-sigma emittance of 8 microns. The MADX[1] deck can be found appended to this note. The stationing of the front face of the final absorber is taken to be 58.25 m. For a target placed 4 m before this (3 m of absorber wall, 1 m of shielding wall), the target would be at z=54.25 m.

Introduction

This document explores the possibility of cleanly transporting 400 MeV H^- from the Linac into the Irradiation Physics Area (IPA) enclosure, where it passes through a thin scattering target and on into the final absorber. Figure 0 shows the elevation view of the proposed facility. The passage of the beam through the target will give rise to emittance dilution via multiple scattering (see [2]) as well low-energy secondary particles (see [3]) which are not treated here.

A tune for this beam line was found in MAD-X[1] using Initial beam parameters are taken to be $\beta_{x,y}$ = 3.691, 9.767 (m) and $\alpha_{x,y}$ = 0.403, -0.822 with the deck and command files appended to this note. Beam diameter was constrained to 1 cm full width at 95% containment at the proposed DUT stationing, four meters upstream of the front face of the final absorber. This beam diameter is within the original design envelope of the MuCool Testing Area (MTA). A table of currents for the quadrupole magnets is given in Table 1, showing comparison of this tune to a typical set of values from MTA operation and to the maximum current available from each magnet's power supply.

<u>Quadrupole currents</u>

Using , we convert the tune detailed and linked above to expected currents. These are presented in Table 1

Magnet	Model	1 cm Ø tune [A]	Typical in MTA [A]	Maximum (A)
UQ1		26.27	26	50
UQ2		-16.71	-18	50
UQ3		28.15	29	50
UQ4		-23.48	-23	50
UQ5		36.84	33	50
UQ6		-5.24	-11	50
UQ7	SQA	-75.04	-76	220
UQ8	SQA	139.68	140	220
UQ9	TQT	-31.14	-30	50
UQ10	TQT	-31.97	-30	50
UQ11	SQA	107.98	102	220
UQ12	SQA	-34.09	-34	220

Table 1: Quadrupole magnet currents for the calculated tune, compared to typical values from MTA operation.

References

[1] L. Deniau, “MAD-X -- Methodological Accelerator Design”. Copyright CERN, Geneva 1990.
[2] J. St. John, “Multiple Scattering from Thin Targets for the Proposed Irradiation Physics Area” July 2018. https://beamdocs.fnal.gov/AD-public/DocDB/ShowDocument?docid=6324
[3] J. St. John, “A Study of Prompt and Residual Radiation in the Proposed Irradiation Physics Area” May 2018. http://beamdocs.fnal.gov/AD-public/DocDB/ShowDocument?docid=6339