FFA for Stage 2: Design and Tracking

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ISIS, RAL, STFC

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FFA ring parameters

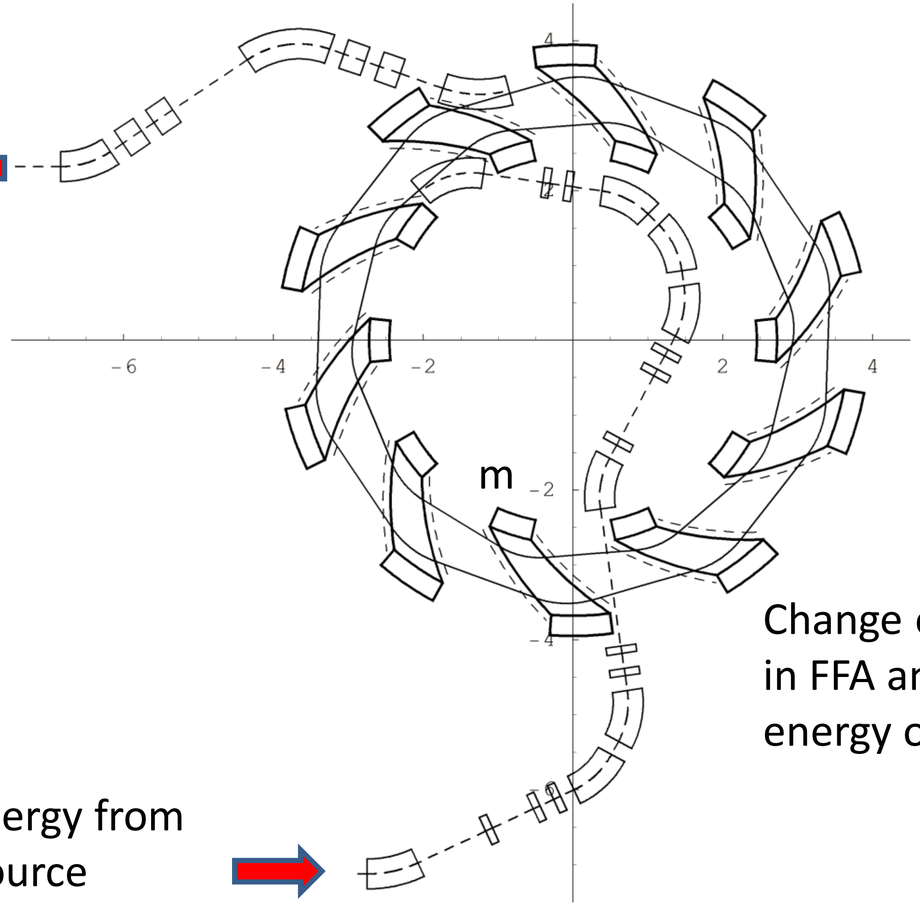
- 10-cell ring spiral scaling FFA
- Proton max acceleration range (15 - 127 MeV)
- Geometrical field index k=5.3
- Logarithmic spiral angle 48.7 deg.
- Min, max radii (2.92 m, 3.48 m) (~60 cm excursion)
- Maximum B field 1.4 T
- Packing factor p_f=0.34
- Proton RF frequency 2.89 – 6.48 MHz (h=1)
- Transverse tunes (2.83, 1.22)
- Bunch intensity ~10^8 protons/ bunch

Variable extraction energy

Variable extraction energy from FFA within 1 s (20-125 MeV) at fixed geometry

+

pulse by pulse variation with kicker could be implemented



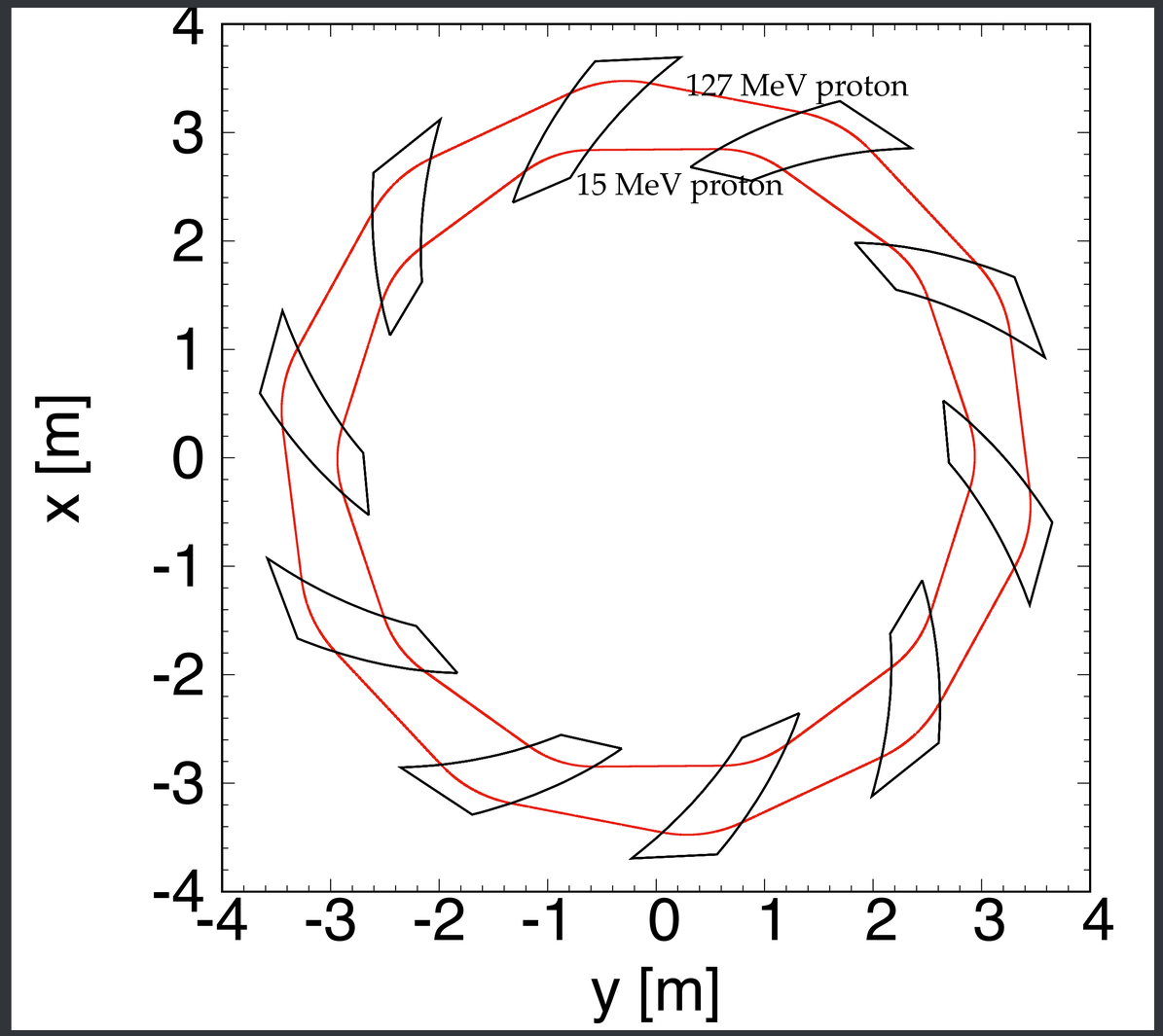
Change of the value of magnetic field in FFA and transfer lines for a specific energy operation (laminated magnets)

Variable input energy from the Laser Source (multiple ions are possible)

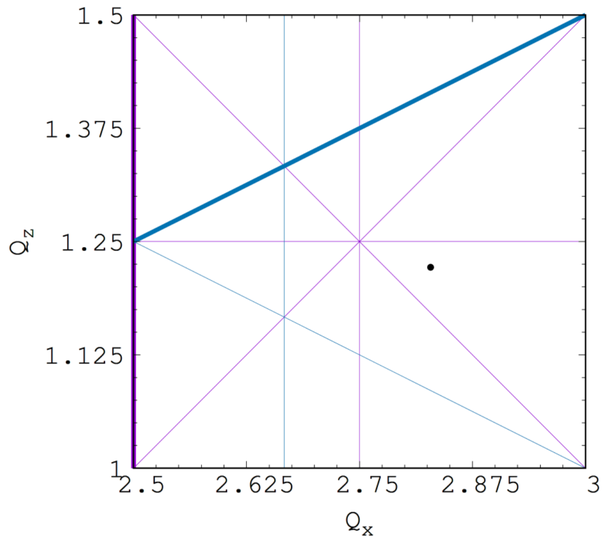
Contents

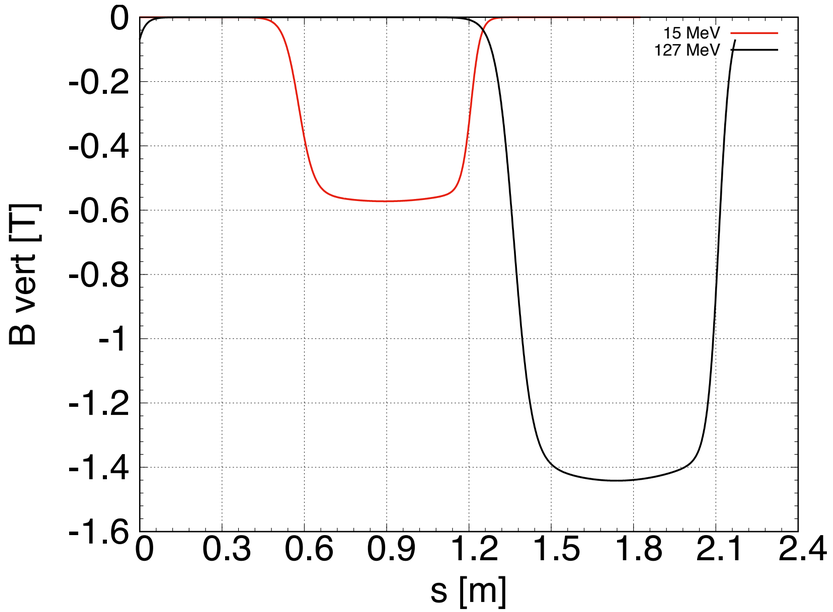
Tracking

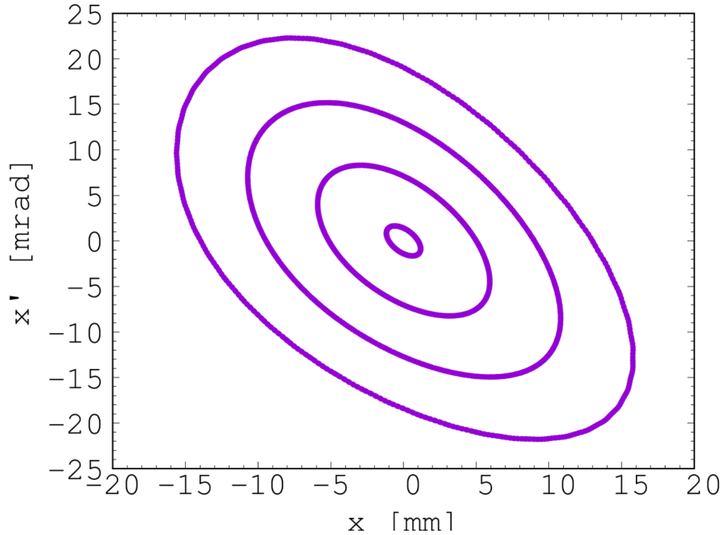
- Performed in FixField code
- Includes non-linearities, fringe fields
- Single particle tracking
- No space charge

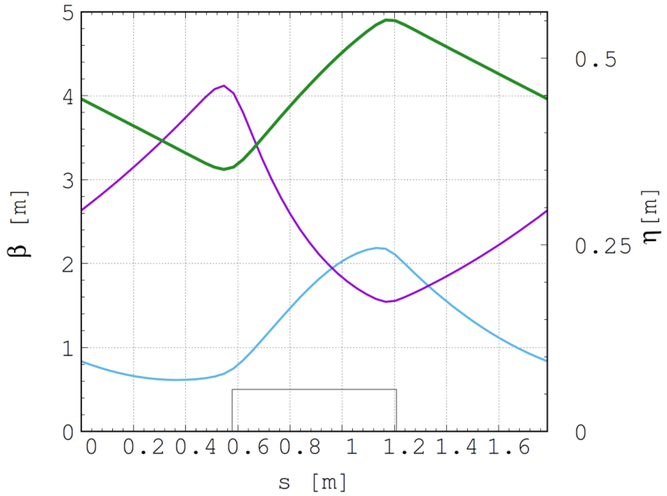


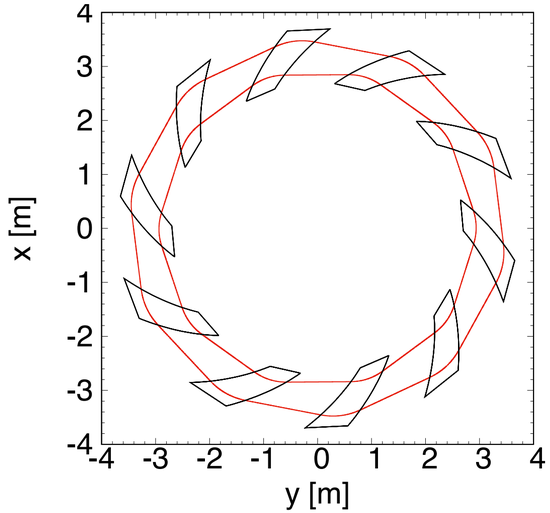
Tracking - Optics - DA

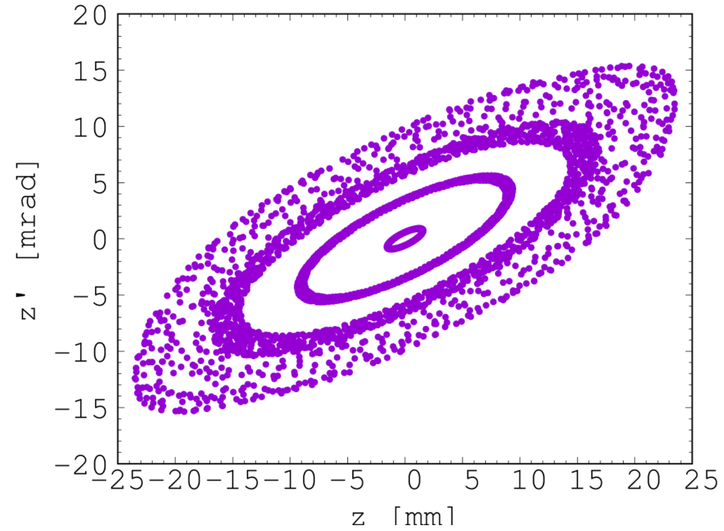












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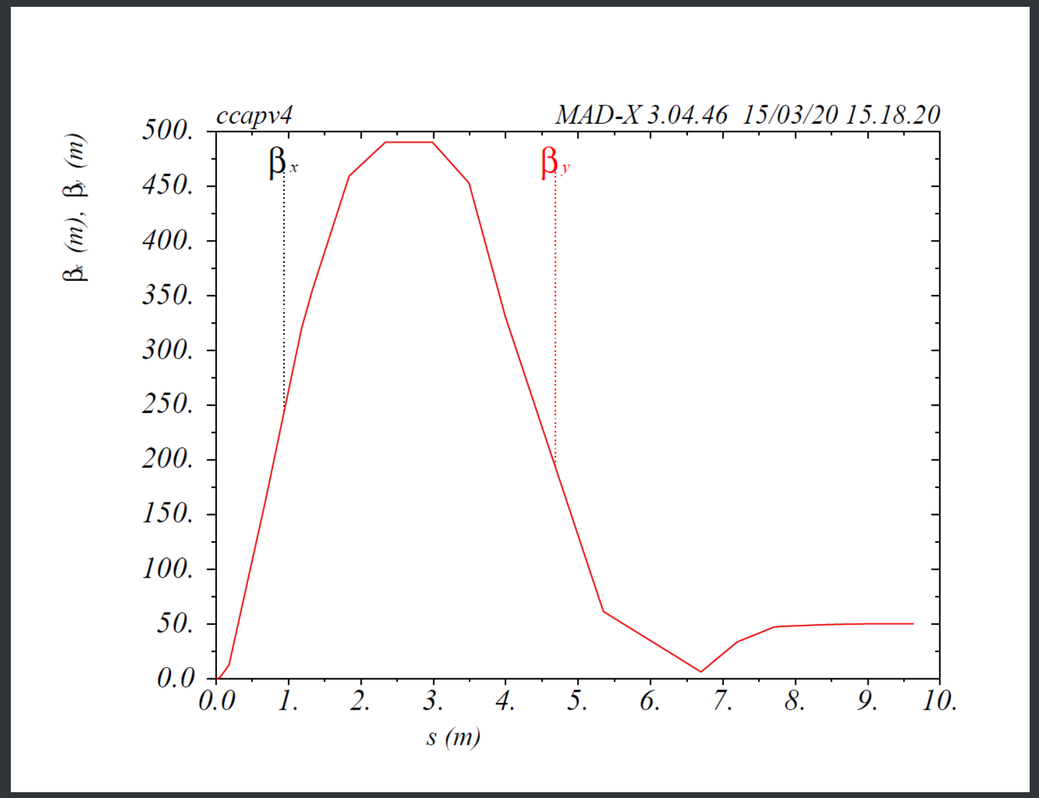
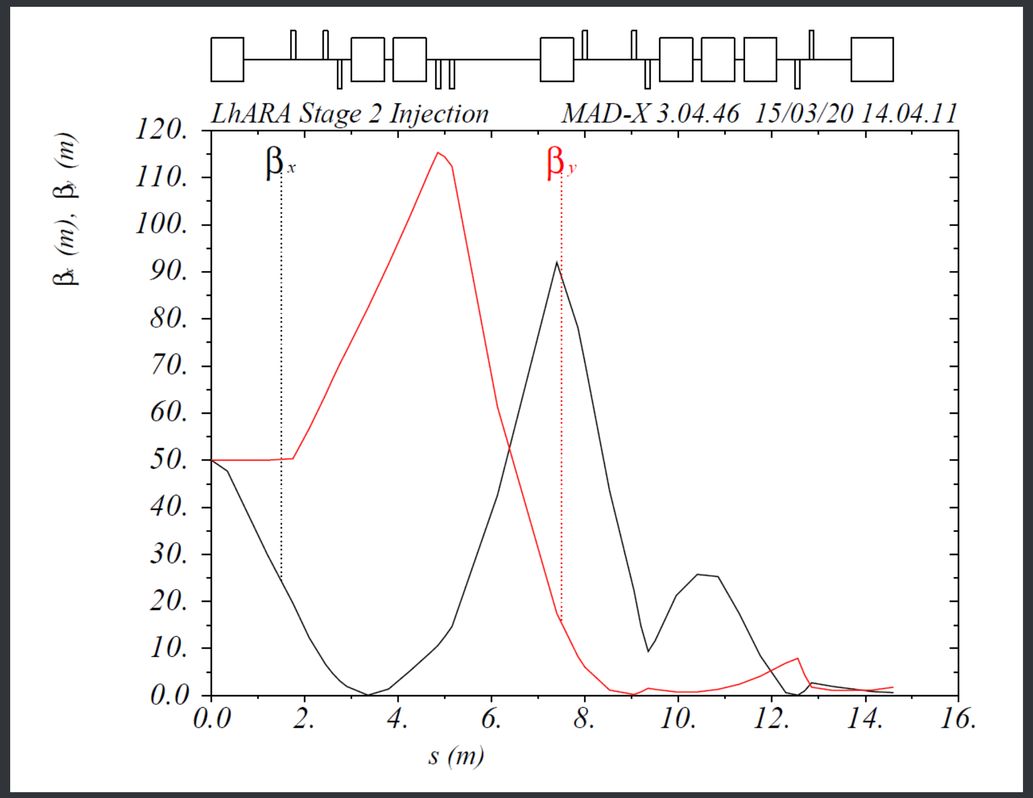
Injection optics

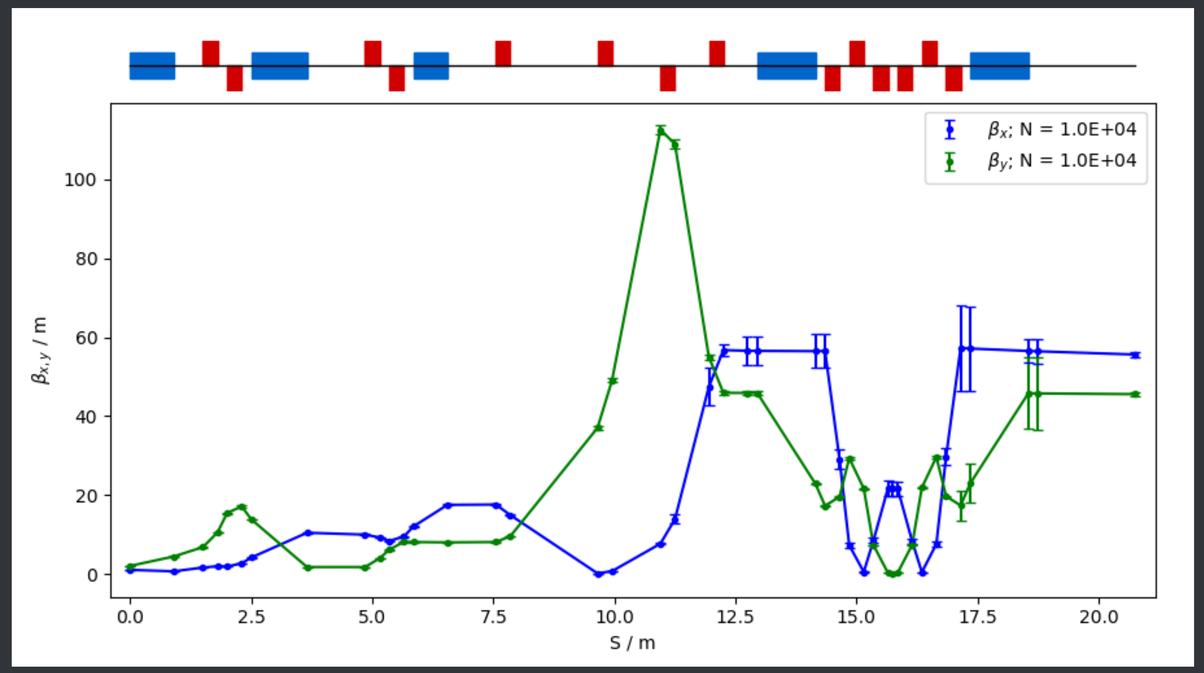


- Stage 1 is tuned to match the injection line
- Focus point changes location and requires a dedicated collimation system
- Focusing can be realised with normal conducting solenoids

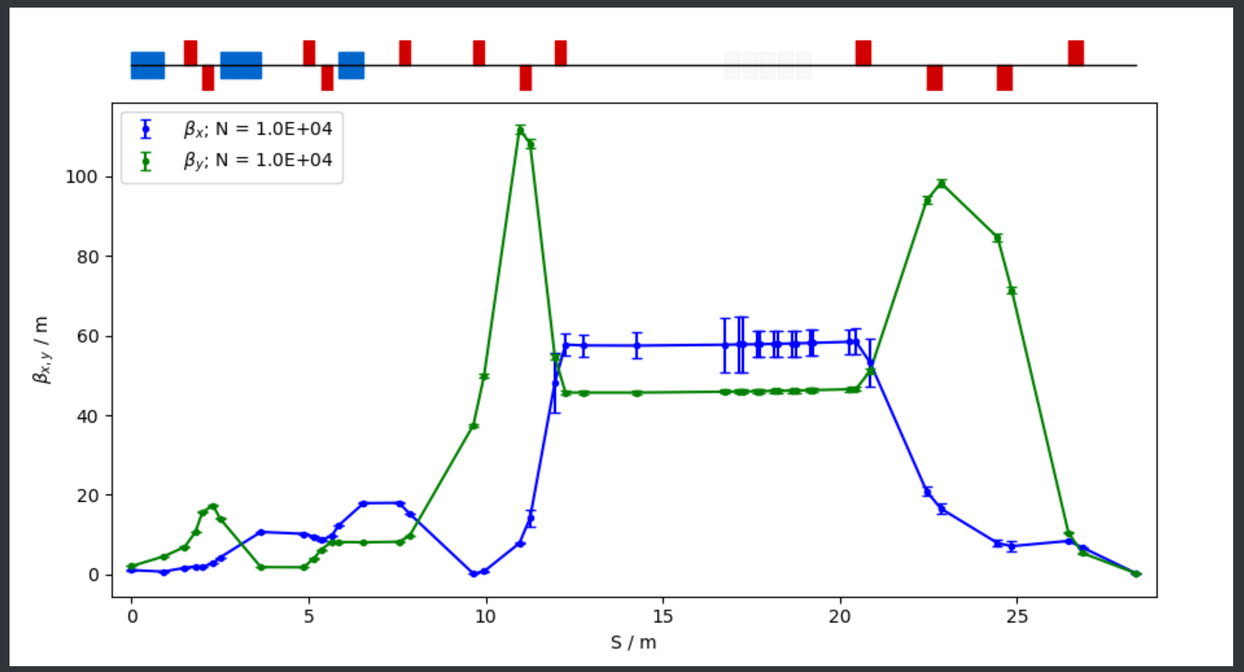


Optics from the switching dipole to the injection septum has been designed

Extraction optics



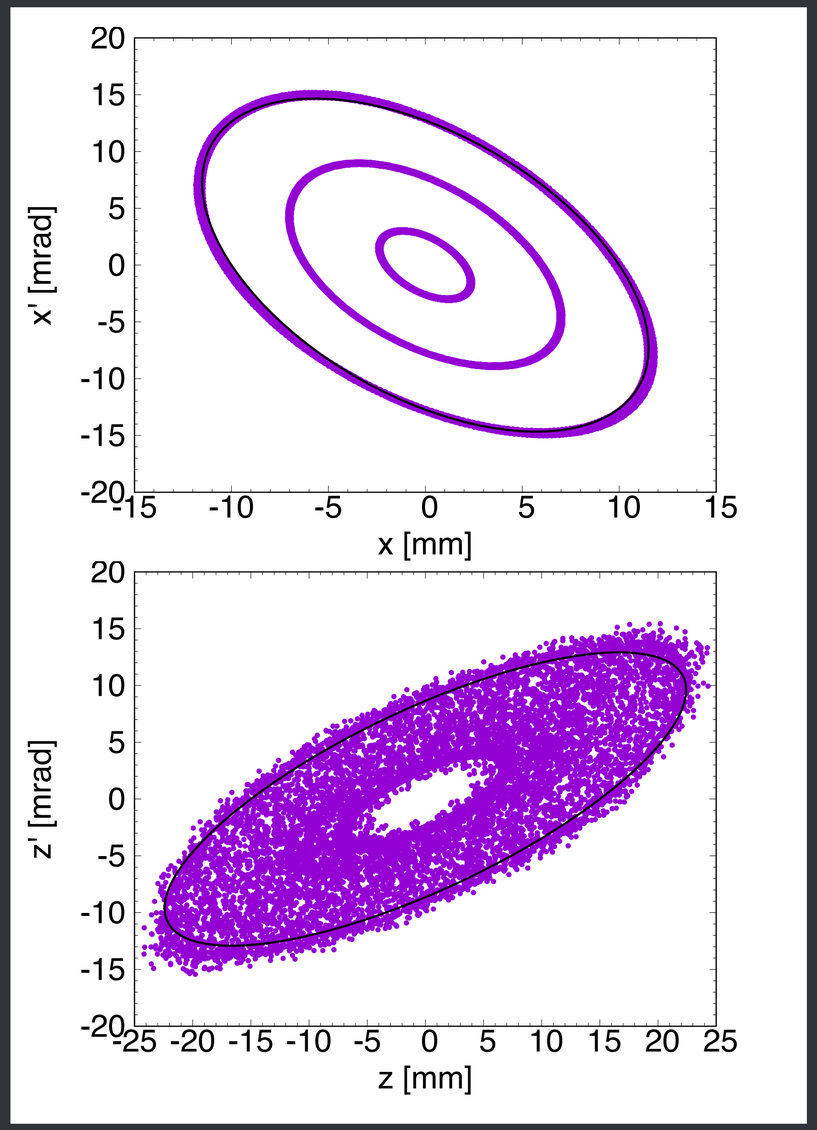
Optics for Stage 2 in-vitro end station, the arc optics scaled from the Stage 1



Optics for Stage 2 in-vivo end station, a dedicated final focus has been designed

Third order resonance extraction

- Horizontal tune is moved at extraction energy to 3rd order non-systematic resonance (3Qx=8)
- Tracking without error shows good acceptance



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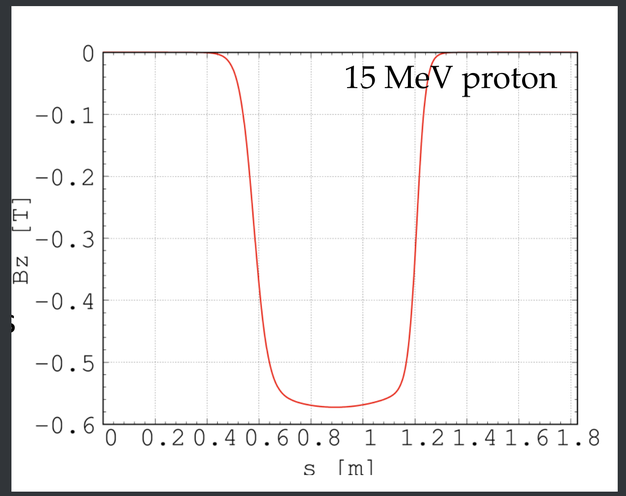
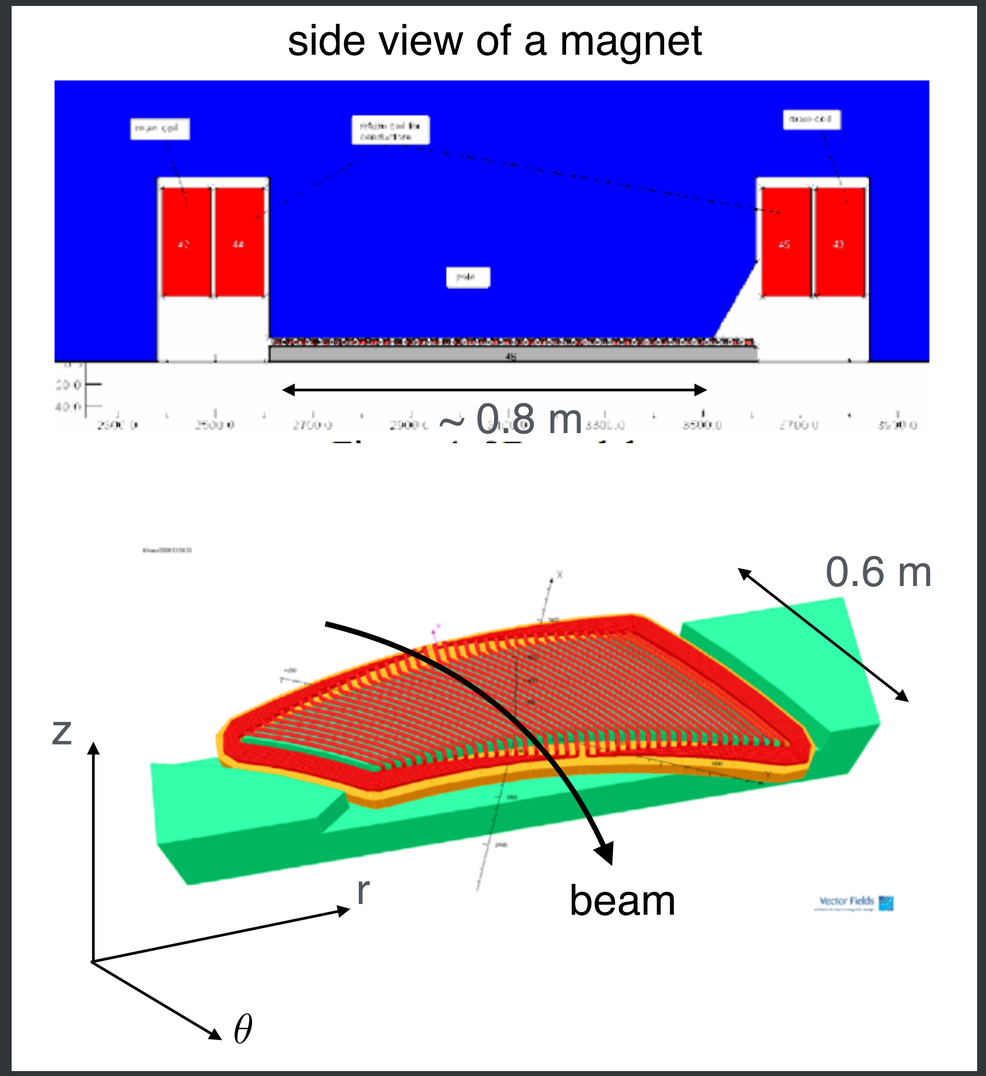
FFA main magnets specifications

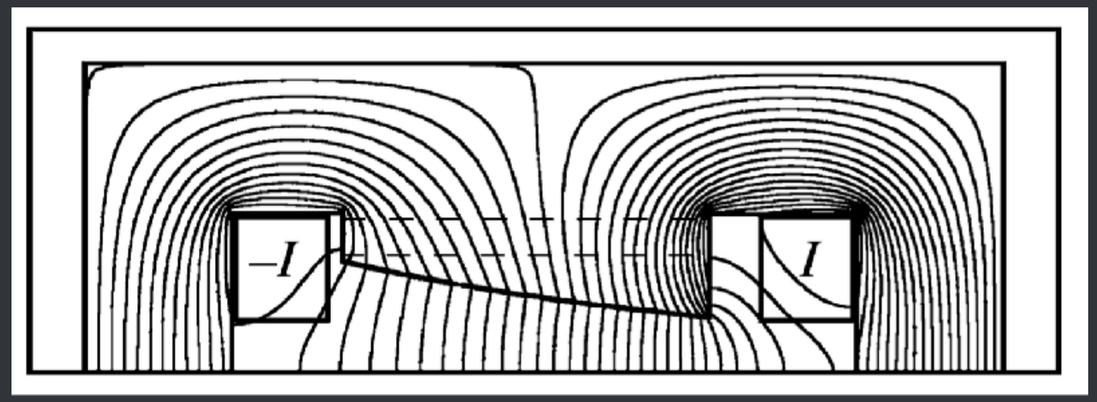
structure	Spiral singlet
aperture	~ 0.6 m
gap height	50 ~ 200 mm
length	0.6 m
field strength	1.4 T max.
spiral angle	48 deg
field index k	5.3



$$B_z = B_0 \left(\frac{r}{r_0}\right)^k F(\theta) \qquad k = \frac{r}{B_z}\frac{dB_z}{dr}$$

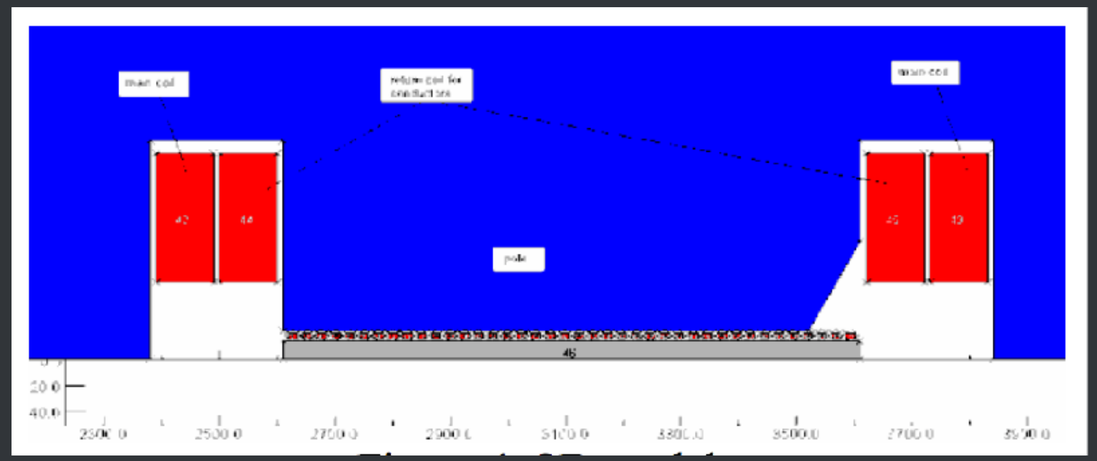


Magnets manufacturing options

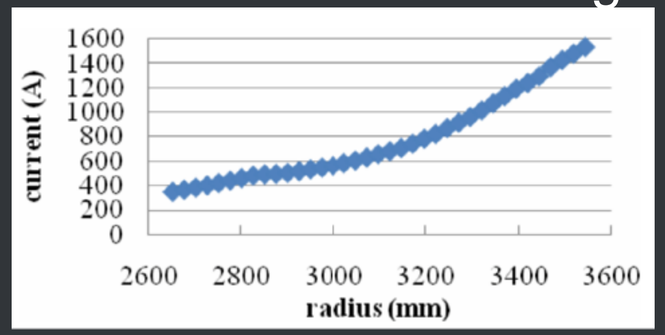


A) change gap height along radius

Ref. D. Neuveglise, et al, Proc of PAC09 (2009) 5002.



B) current distribution along r



$$B_z = B_0 \left(\frac{r}{r_0}\right)^k F(\theta) \qquad k = \frac{r}{B_z}\frac{dB_z}{dr}$$

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Summary

- Conceptual design of Stage 2 in good shape
- Good performance of the cost-effective FFA lattice in terms of optics and dynamic aperture
- Injection and extraction designed and look feasible
- Remaining R&D essentially focused on main magnets