“Simulations of the Injection Line into the KURRI FFAG

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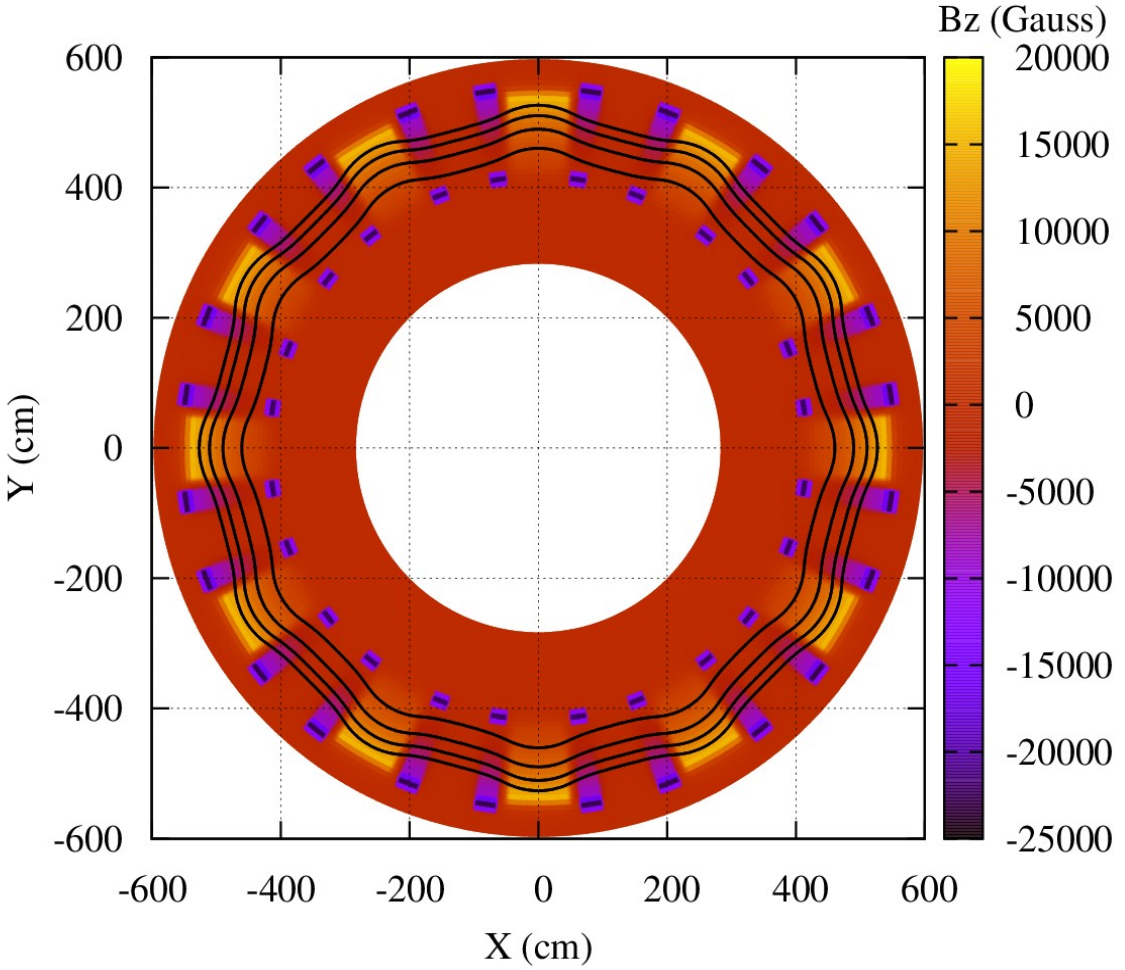
Field map of the main ring:

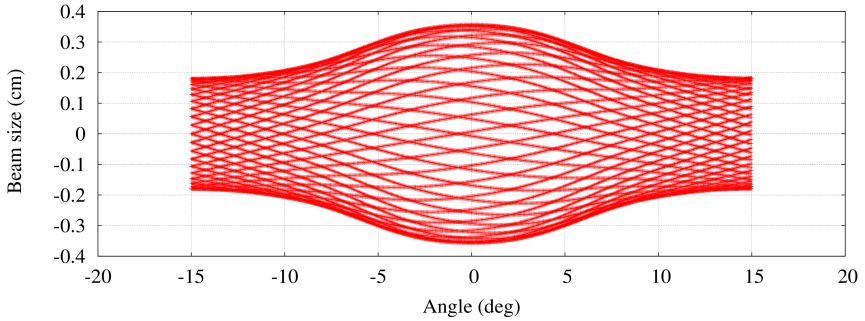
- Tracking results:

  closed orbits obtained by ensuring the symmetry of the field experienced on each trajectory, from entrance to exit of the cell.
- Injection @ 11 MeV
- Extraction @ 160 MeV

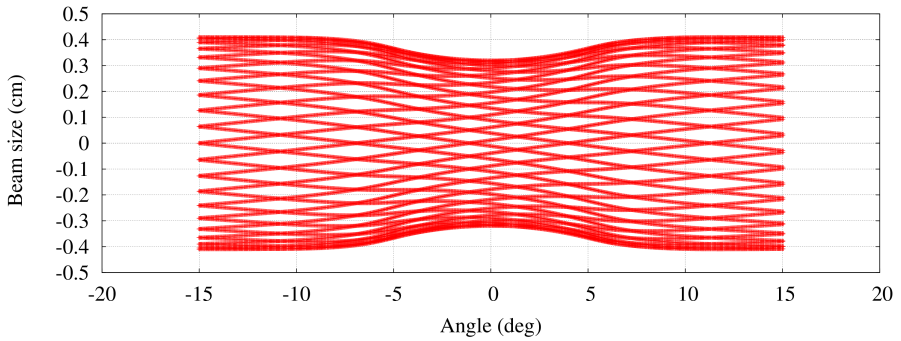


Beam envelope

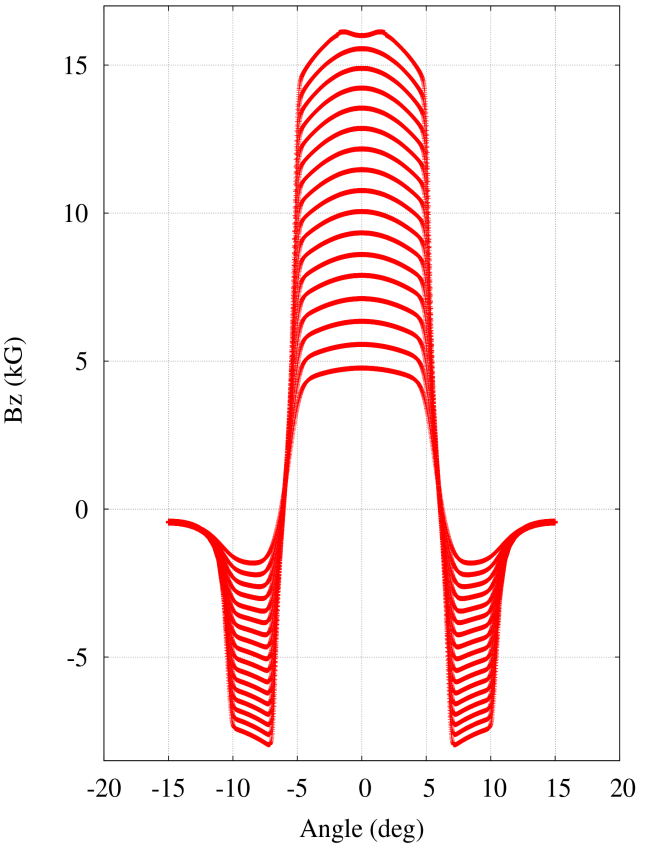
- Field experienced along each closed orbit

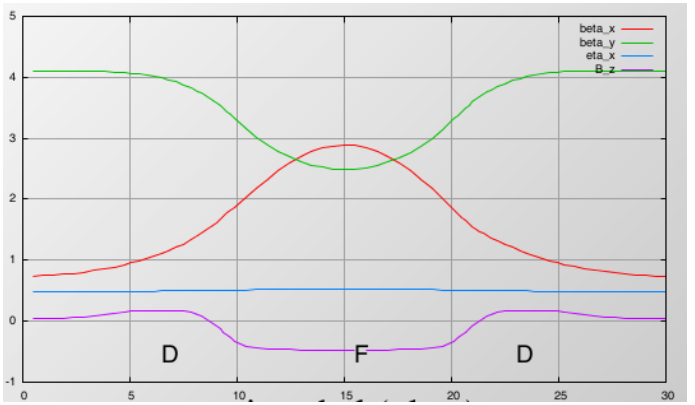


Horizontal beam envelope



Vertical beam envelope





Betatron functions at crucial locations

Location	β_x (m)	α_x(m)	β_y (m)	α_x(m)
Straight section (θ = 0 deg)	0.7414	0	4.0979	0
Center of the hill	2.8703	0	2.4869	0
Foil	2.8586	-0.1185	2.4901	0.2313

For backward tracking, the sign of the α has to be changed.

Injection into the main ring

- Backward tracking from the location of the foil.
- The field map is formatted in such a way that we start tracking from the location of the foil: Θ = 14.5 deg, R=460.146cm

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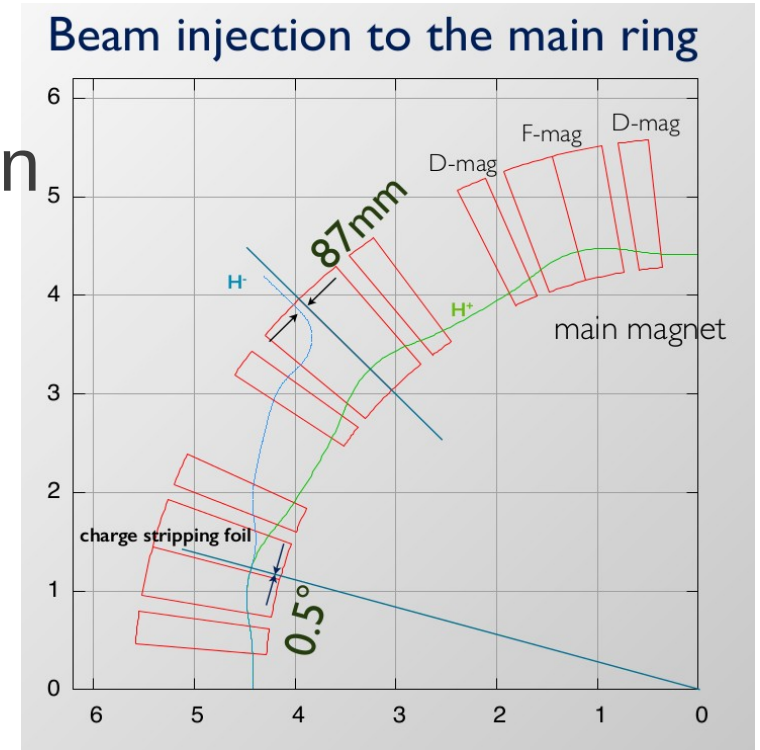
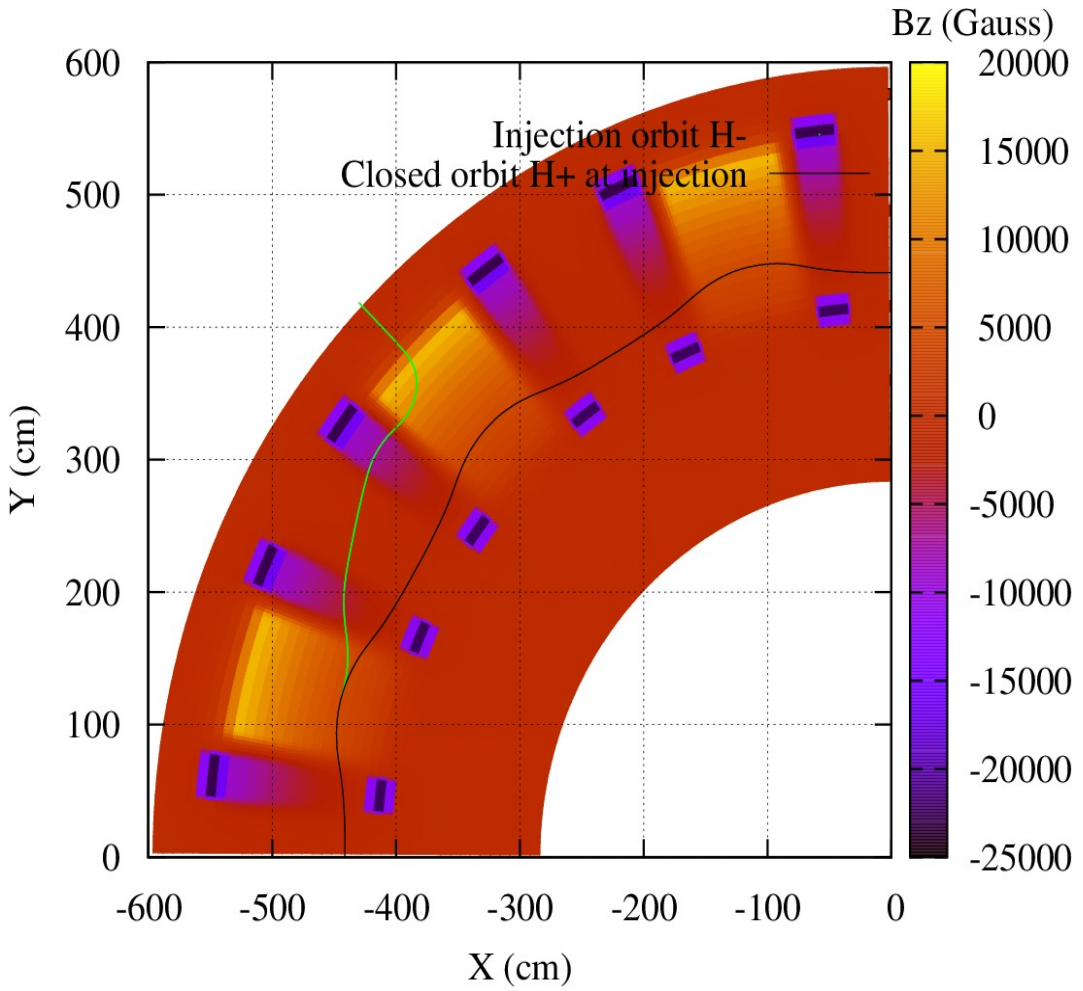




Injection line (green) for the H- ions into the ring

Dispersion:

- In order to measure the dispersion function at the location of the foil, the idea is to change the magnet strength instead of changing the momentum of the particle (by tuning the current of the magnet):

  With Zgoubi, we verified that changing the momentum by +1% is equivalent to changing the magnet strength by -1% (and vice versa).

- The dispersion function was computed at the location of the foil: D=0.5795m (periodic solution).
- Then, transporting the particle from the injection line, the new foil position is determined.

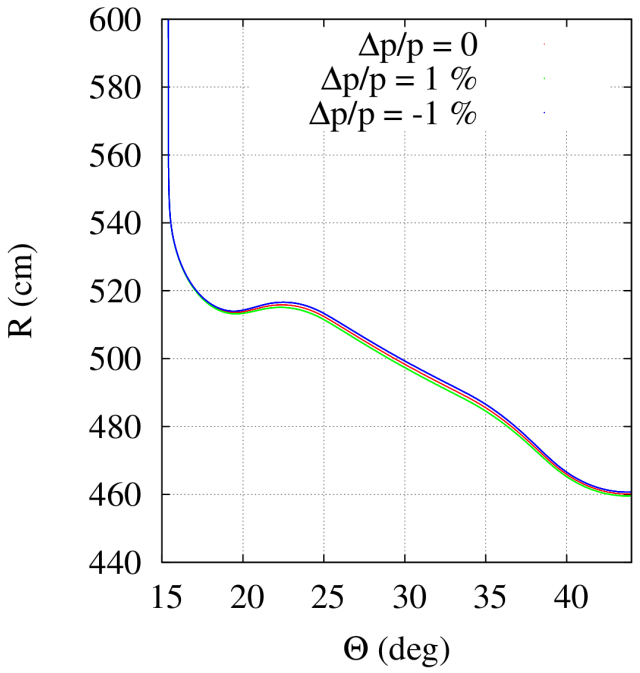
Dispersion

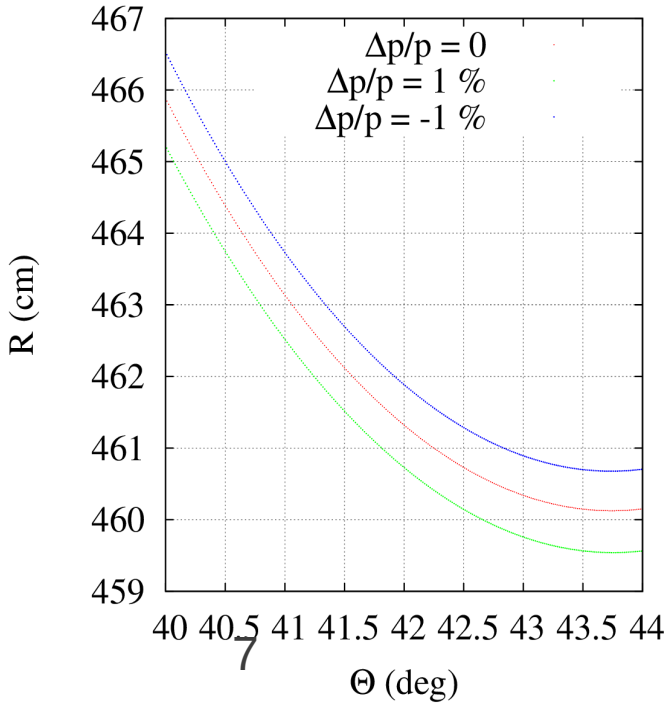
Momentum change ($\Delta p/p$)	Expected values (D. $\Delta p/p$)	Zgoubi results (ΔR)
+1%	0.579 cm	0.572 cm
-1%	0.579 cm	0.563 cm

$$\Delta R = r_2 - r_1 = r_1 \times ((\frac{(B\rho)_2}{(B\rho)_1})^{\frac{1}{1+k}} - 1) = 0.5326 \text{ cm}$$

Scaling FFAG

where $\frac{(B\rho)_2}{(B\rho)_1} = (\frac{r_2}{r_1})^{k+1}$, with $\frac{(B\rho)_2}{(B\rho)_1} = \frac{p_{+1\%}}{p_{inj}} = \frac{145.5598}{144.1187} = 1.01$



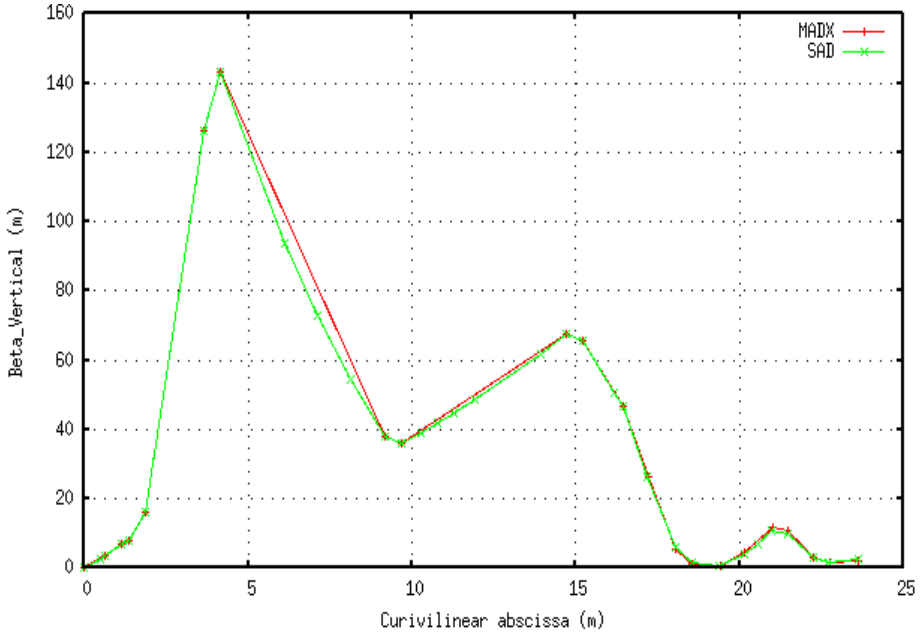


- Assumed that the initial D=D'=0 which is not correct!

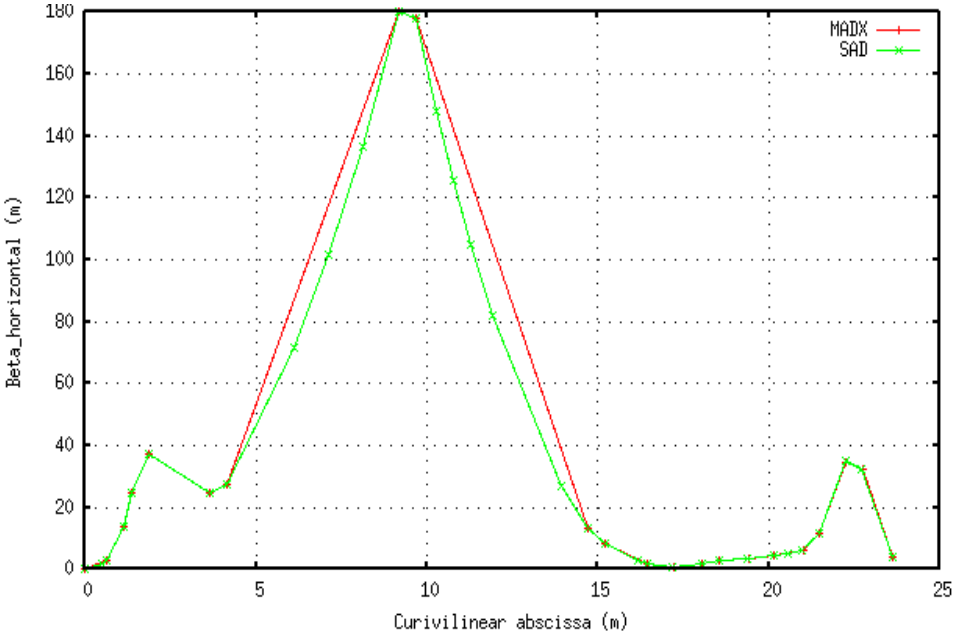
- The dispersion has to be computed from some point where the value is zero. The injection line has to be modelled!

Injection line: MADX vs SAD

- 8 Quadrupoles, 2 Bending magnets, 2 horizontal steering magnets, 2 vertical steering magnets.



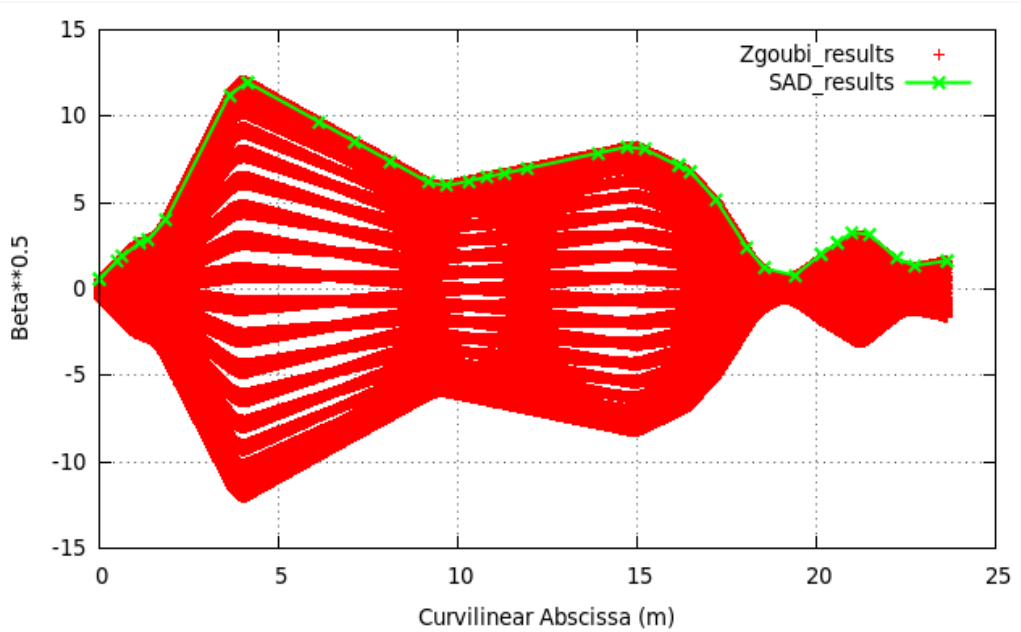
Vertical betatron function



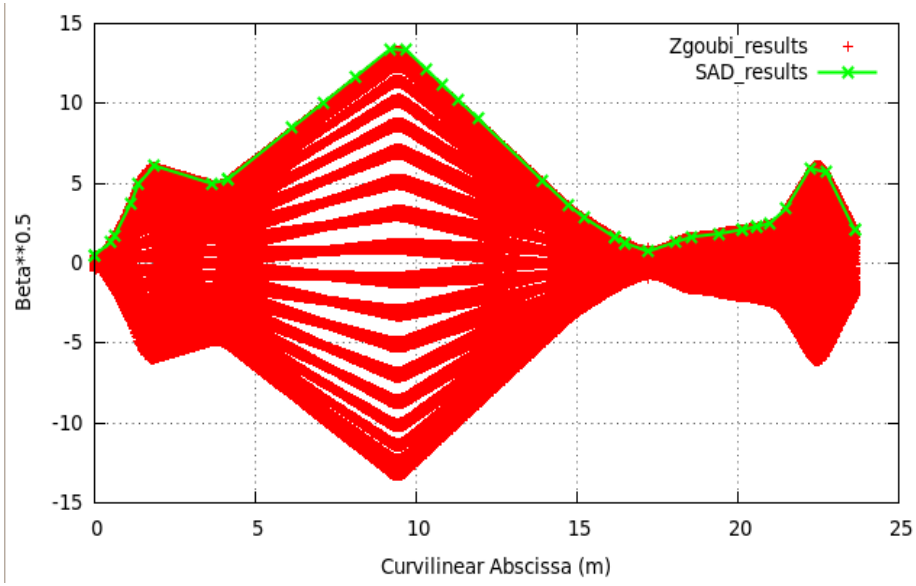
Horizontal betatron function

Injection line: Zgoubi vs SAD

- No fringe field except for the two bending magnets.

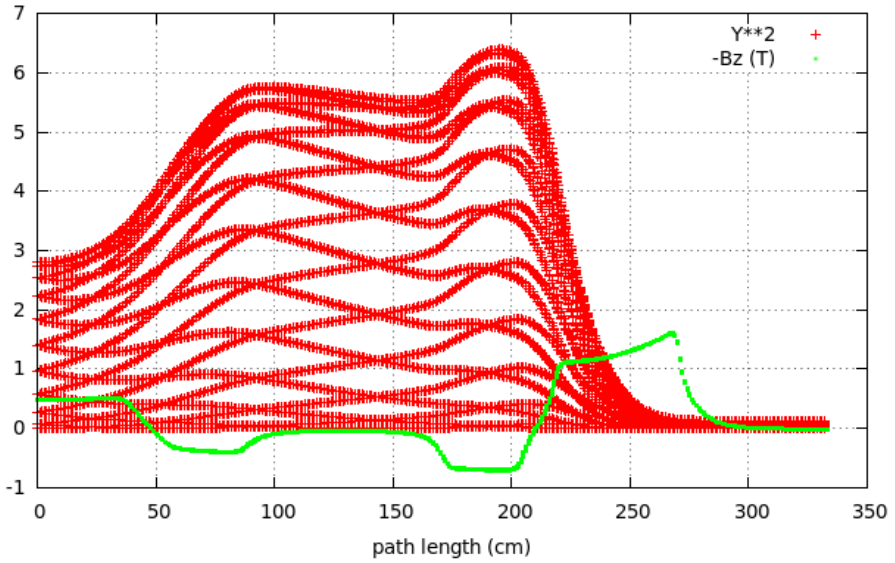


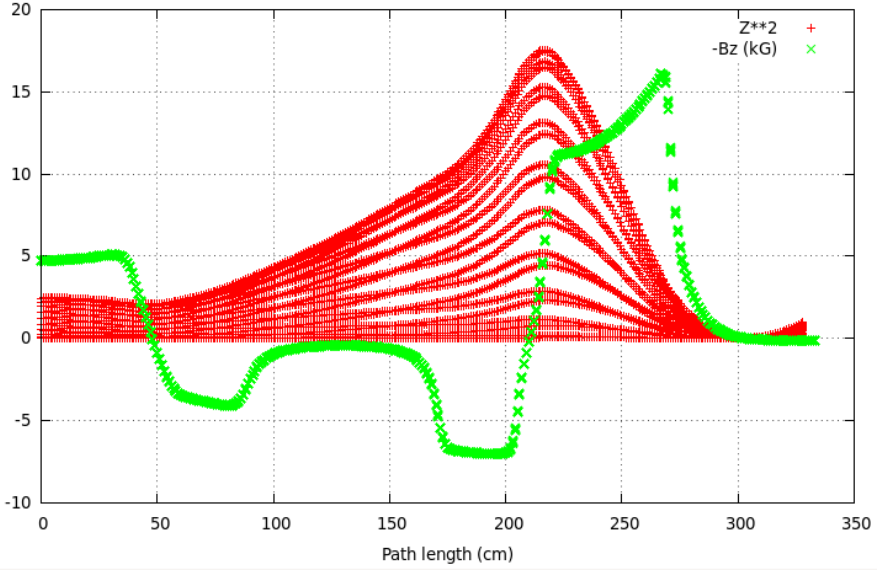
Vertical beam envelope



Horizontal beam envelope

Beam envelope from backward tracking:





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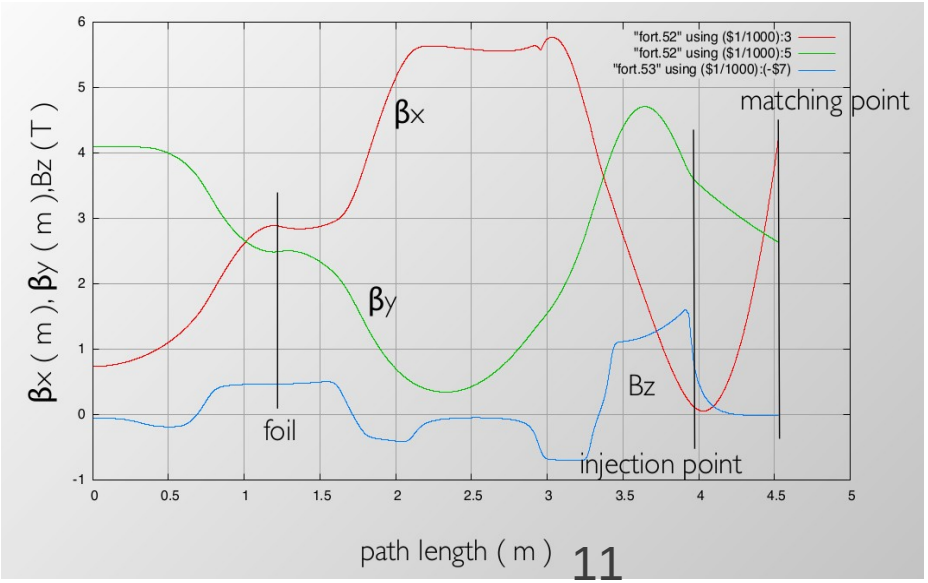

- The same field map?
- “ TOSCA map f810 d1020.dat”
- Need to check more