Proposal for a new decay ring lattice

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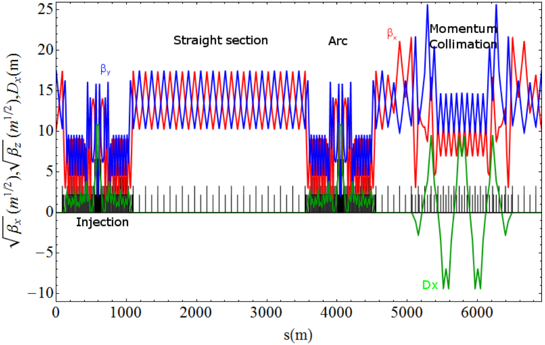
"Old" lattice



- The injection is located in the arc.
- Transition gamma: $\gamma_T \approx 27$.
- A larger value of the slipping factor η improves the collective effects.
- How to increase η and then to decrease γ_T?

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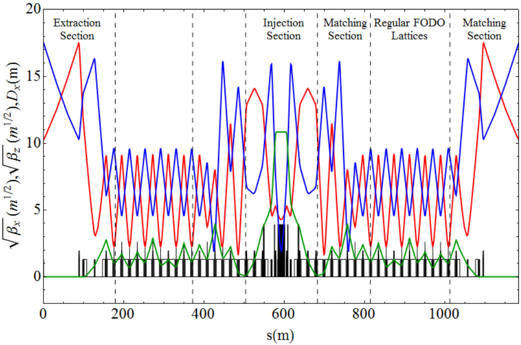

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How to increase the momentum compaction

The momentum compaction is defined by:

$$\alpha_P = \frac{1}{\gamma_T^2} = \frac{1}{L} \oint \frac{D_x(s)\, ds}{\rho}$$

L is the total length, D_x the horizontal dispersion and ρ the curvature radius. Several possibilities to increase α_P:

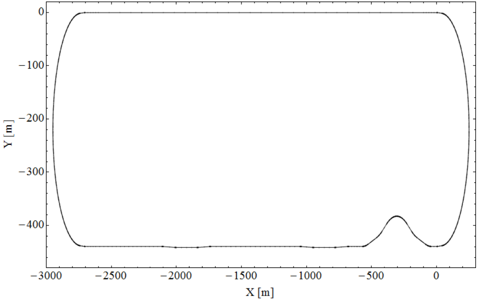
- Increase the average dispersion in the dipoles. It implies larger apertures. Not a large number of degrees of freedom. Difficult to have a significant change on the momentum compaction.
- Increase the integration length. The idea is a "wiggler" scheme: we alternate the sign of the curvature radius with the dispersion. The total length L stays the same but we have increased the integrate $\oint \frac{D_x(s)\, ds}{\rho}$.

An injection out of the arc

The second solutions seems the most promising.
The injection is out of the arcs.

- ☺ Simpler arcs: FODO lattices.
- ☺ More compact arcs: enlarged duty factor (39 %).
- ☹ More dipoles needed (208 against 172 before).

General:
Layout:



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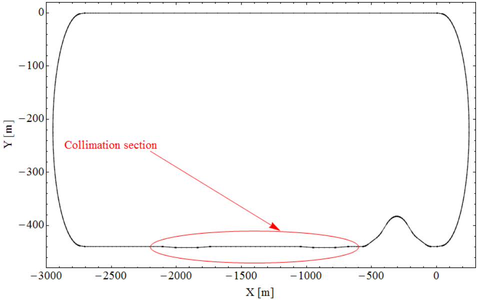

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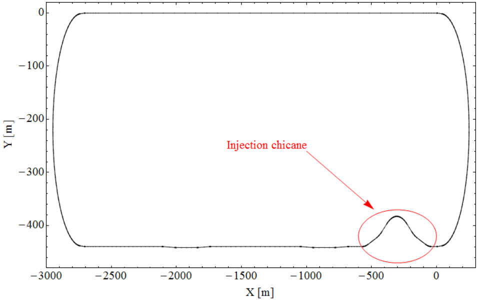

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Injection chicane:
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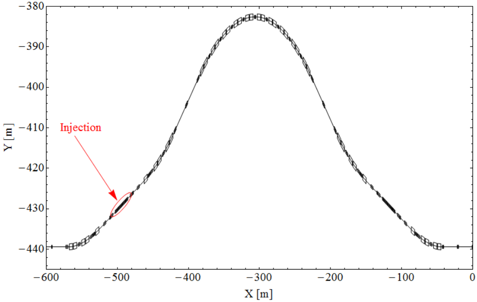
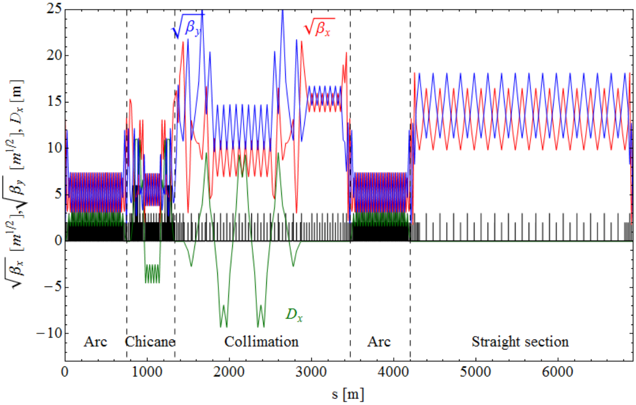
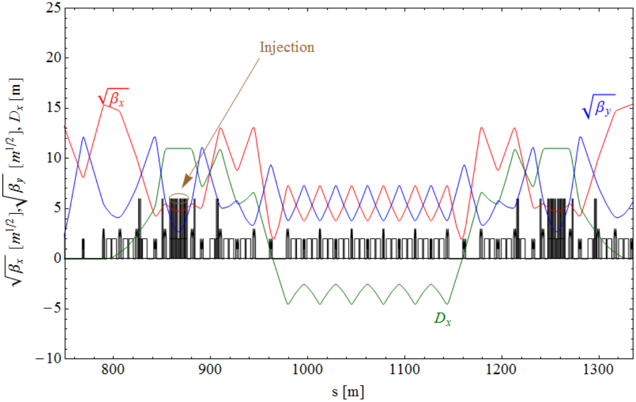


Optical functions in the decay ring



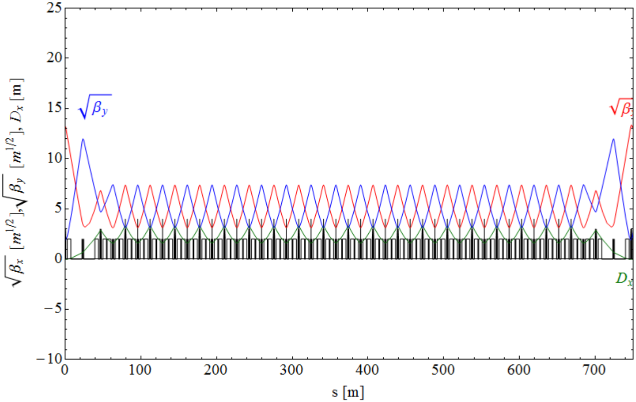
Straight section length: 2706 m (total length: 2200 π m).
7.46 T dipoles (for $^6He^{2+}$) with an angle of $\pi/84$ rad.

Optical functions in the injection chicane



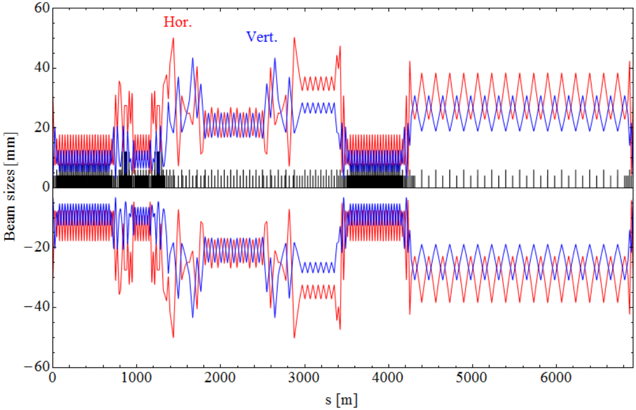
Dispersion at the center of the injection section:
11 m for $\beta_x = 22$ m.

Optical functions in the arcs



The phase advance by FODO lattice is $\pi/2$ in both planes, which enables to cancel some non linearities brought by the sextupoles. The dynamic aperture should be enlarged.

Beam sizes in the decay ring



Emittances:
$\epsilon_x = 0.15\pi$ mm.mrad and $\epsilon_y = 0.08\pi$ mm.mrad.
The beam is assumed to be collimated at $\delta = 2.5‰$ and the beam sizes are taken up to 6 σ.

Summary of the 1st order lattice

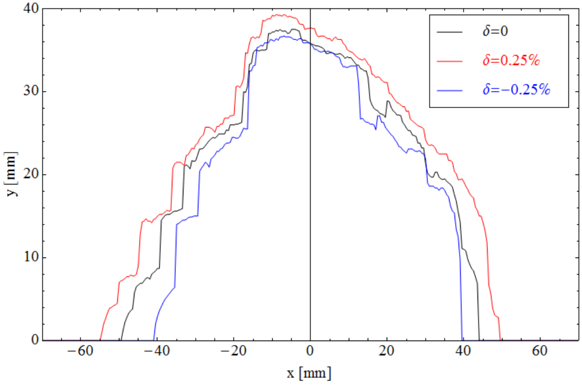
- The transition gamma γ_T for the new lattice is 18.7 (to compare with the old value of 27).
- The value of the average betatron functions are :
  $<\beta_x>=$ 125 m (against 134 m before)
  $<\beta_y>=$ 160 m (against 175 m before).
- The fractional part of the tune is kept equal to the one of the reference lattice. We have then:

$$Q_x = 22.228 \text{ and } Q_y = 19.16$$

- The arcs are more compact and much simpler.
- The beam sizes are similar to the reference lattice. The maximum beam size is before the collimation section.

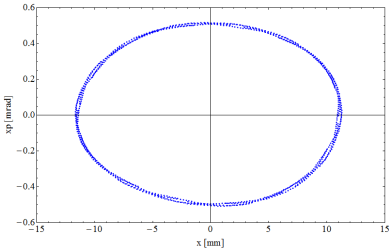
Dynamic aperture

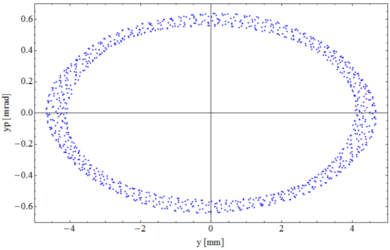
A big advantage of the new lattice is to have a very simple arc which enables to cancel the chromaticity with only two sextupole families by keeping a large dynamic aperture in the momentum range.



$\sigma_x = 1.83$ mm and $\sigma_y = 0.76$ mm.

Tracking at 6 σ_x, 6 σ_y and $\delta = 0$





The non linearities are well canceled in the arcs.
Small transfer between the horizontal and vertical planes.

Summary of the new lattice

- The transition gamma γ_T for the new lattice is 18.7. A significant decrease was then obtained
- A smaller transition gamma means more dipoles or a larger average dispersion (larger apertures). More studies are needed to see if a value of 15 is possible.
- The arcs are more compact and much simpler.
- The dynamic aperture stays very large. Small coupling between the planes.
- The beam sizes are similar to the reference lattice. The beam pipe radius should be about 6 cm.
- The optical properties of the new lattice seem to be very good.