New options for the High-β optics

Status of the Atlas high-β optics for physics

- Required beam properties:

- β^*>2600 m, ϵ=1.0μm.rad.

– $\pi/2$ phase advance between the IP and the detector.

- Optics solution:

- β^*=2625 m.

- Half an integer less in tune in the vertical plane.

- To keep all the quadrupoles in the limit the polarity of Q4 had to be inverted on both sides of the IP. (LHC-Project-Report 770).

Status of the optics for injection

- Previous studies:

- Injection optics with β^*=200 m and Q4 with inverted polarity.

=>Impossible to separate the beams or have lower β^* while respecting the aperture, tune, and hardware constraints.

- Main issues:

- Compensate the loss in tune.
- Q4 with inverted polarity.
- No practical solution for injection.

=>Investigate new approaches.

New options concerning the tune

- Loose one whole integer in global tune by running the two high-β experiments.

$\Rightarrow$Possibility to compensate this loss with IR8 or IR2 (M. Aiba).

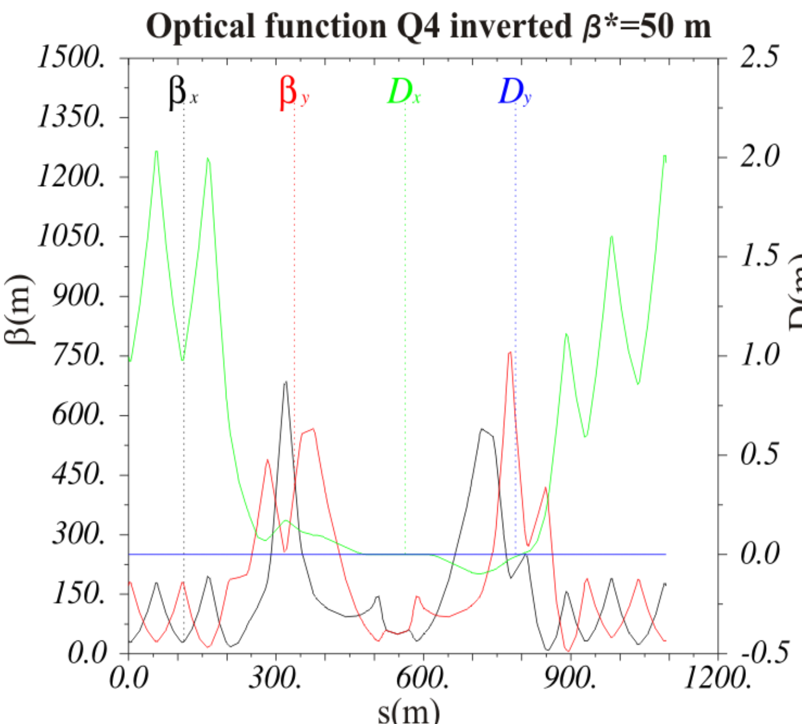
- Possible strategy:

Inject with the nominal optics and compensate the loss in tune with another IR.

$\Rightarrow$Still need to find a solution concerning the polarity of Q4.

Inject with the polarity of Q4 inverted

- New strategy:
- No constraints on the tune over the insertion.
- Start with the previous solution and go down step by step in β^* to see how far we can go.

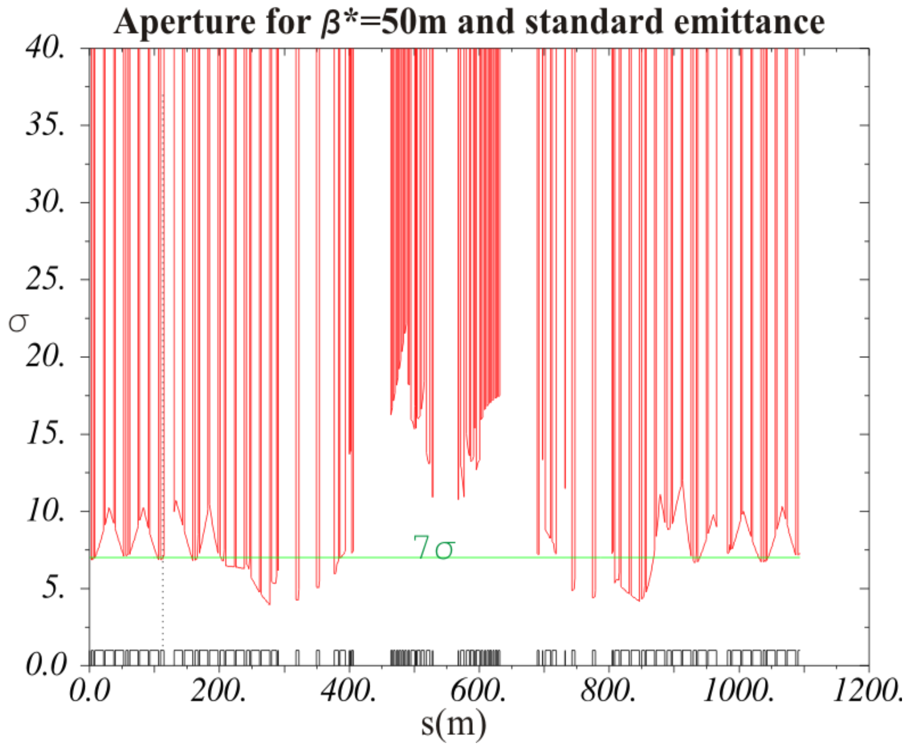


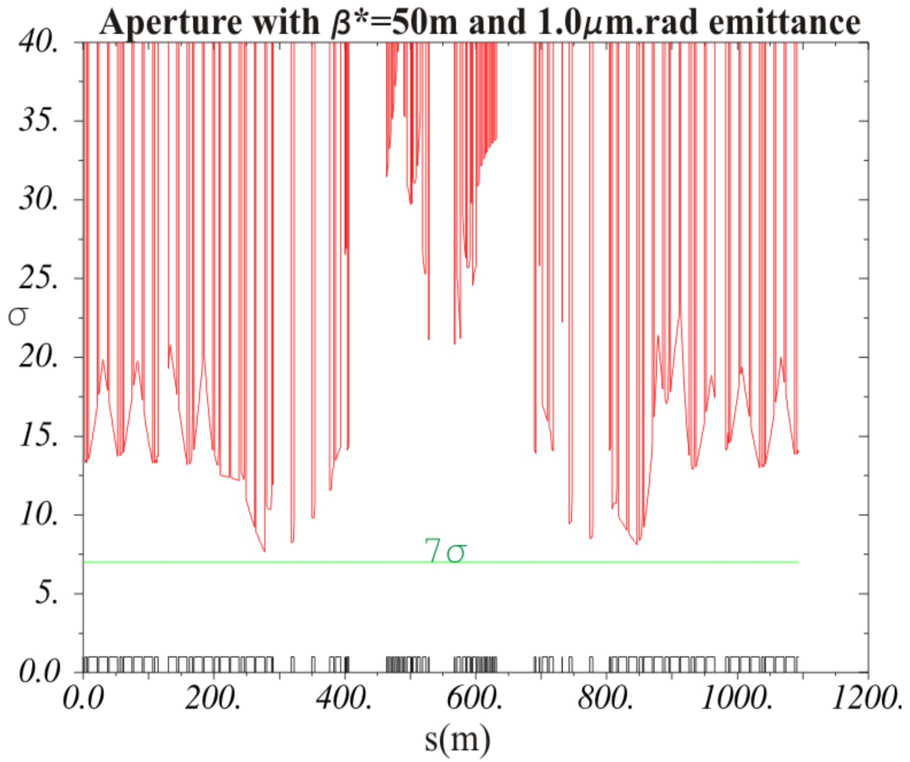
⇒Possible to go down to 50m while respecting aperture and hardware constraints for an emittance of 1.0μm.rad.

$\Delta\mu_x$=0.23

$\Delta\mu_y$=0.55

Aperture for different emittances





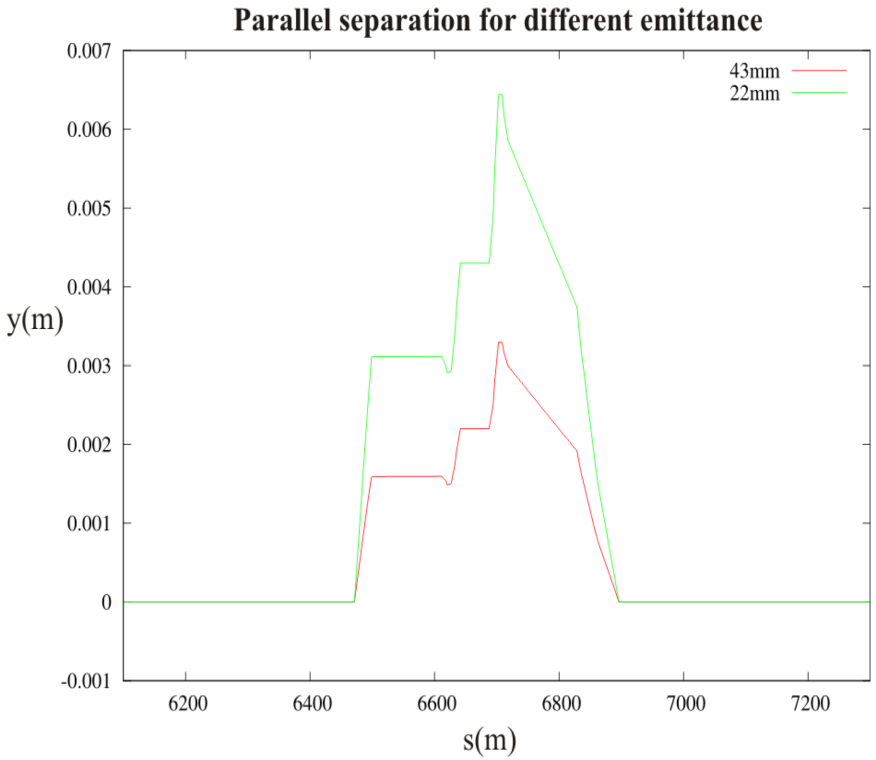
⇒The aperture constraint is only respected for the 1.0μm.rad emittance required for Atlas. With the standard emittance we have a minimum of 3.92σ.

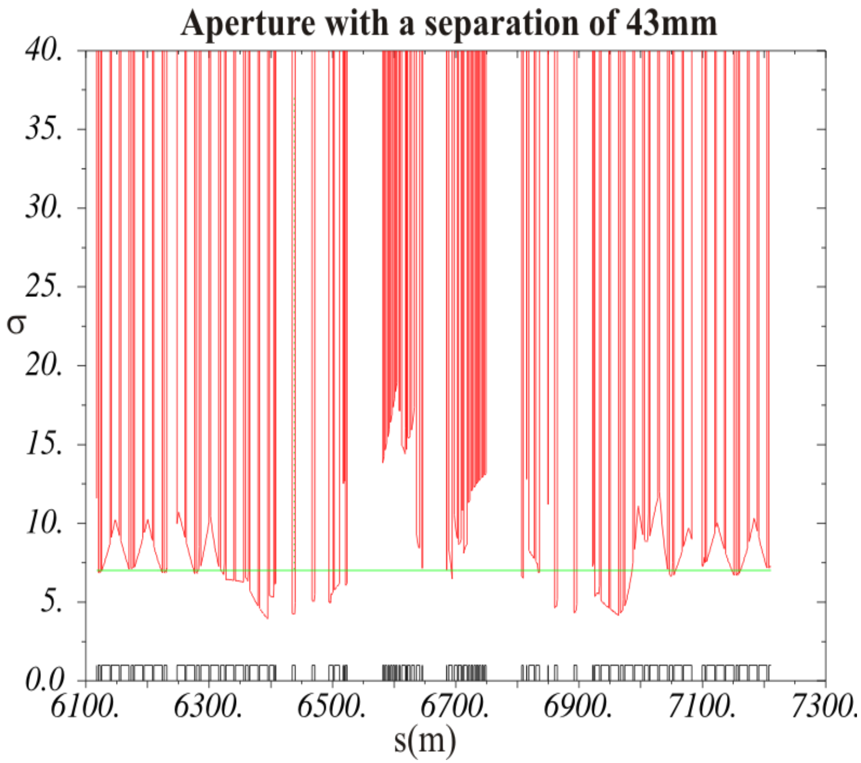
Separation

- We need 7σ separation. For $\beta^* = 50$ m we have:

$$\epsilon = 3.75\mu\text{m.rad} \Rightarrow 7\sigma = 4.3\text{mm}$$

$$\epsilon = 1.0\mu\text{m.rad} \Rightarrow 7\sigma = 2.2\text{mm}$$





Use the nominal injection

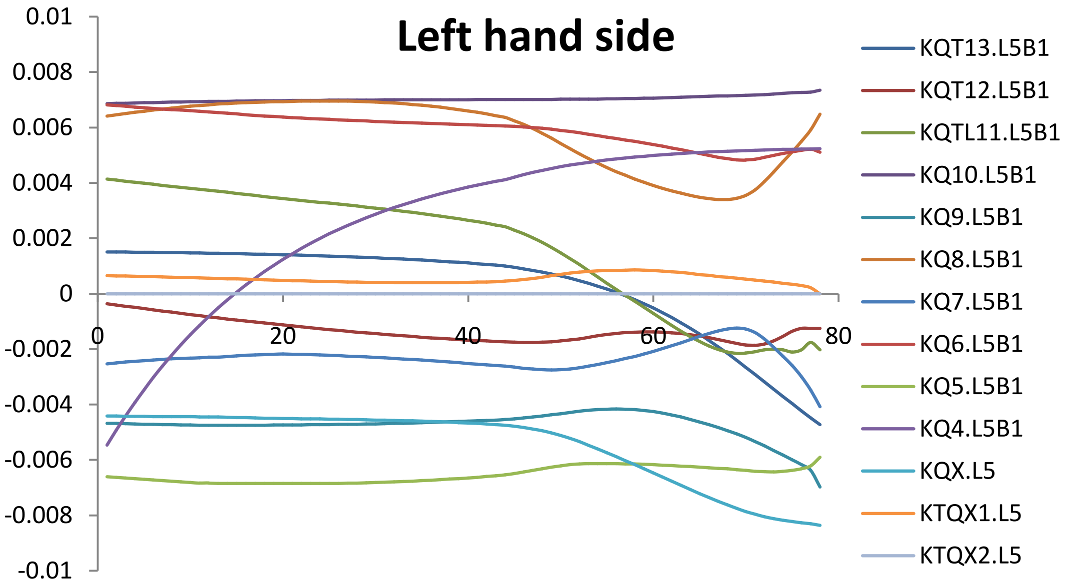
Using the nominal injection and ramp implies a change of polarities of the Q4 during the unsqueeze.

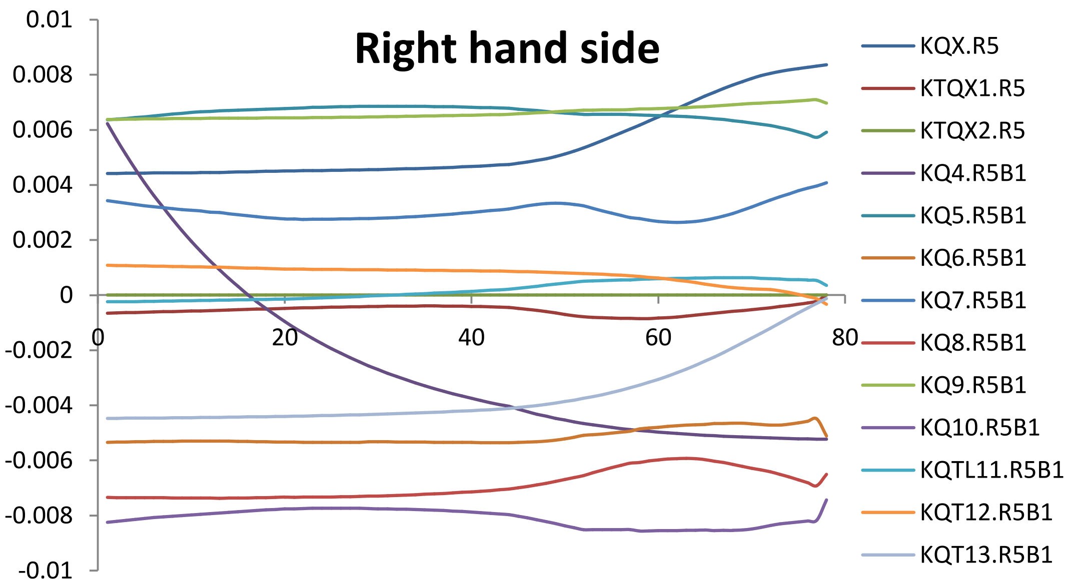
⇒Non negligible hardware changes.

⇒These changes could be conceivable but very expensive.(F.Bordry)

	Characteristics of Q4 during the unsqueeze					
	Injection 7TeV			High-Beta optics		
	k(m^-2)	I(A)	%Imax	k(m^-2)	I(A)	%Imax
Q4R	-0.00523	2796	76%	+0.00622	3330	91%
Q4L	+0.00523	2795	76%	-0.00546	2928	80%

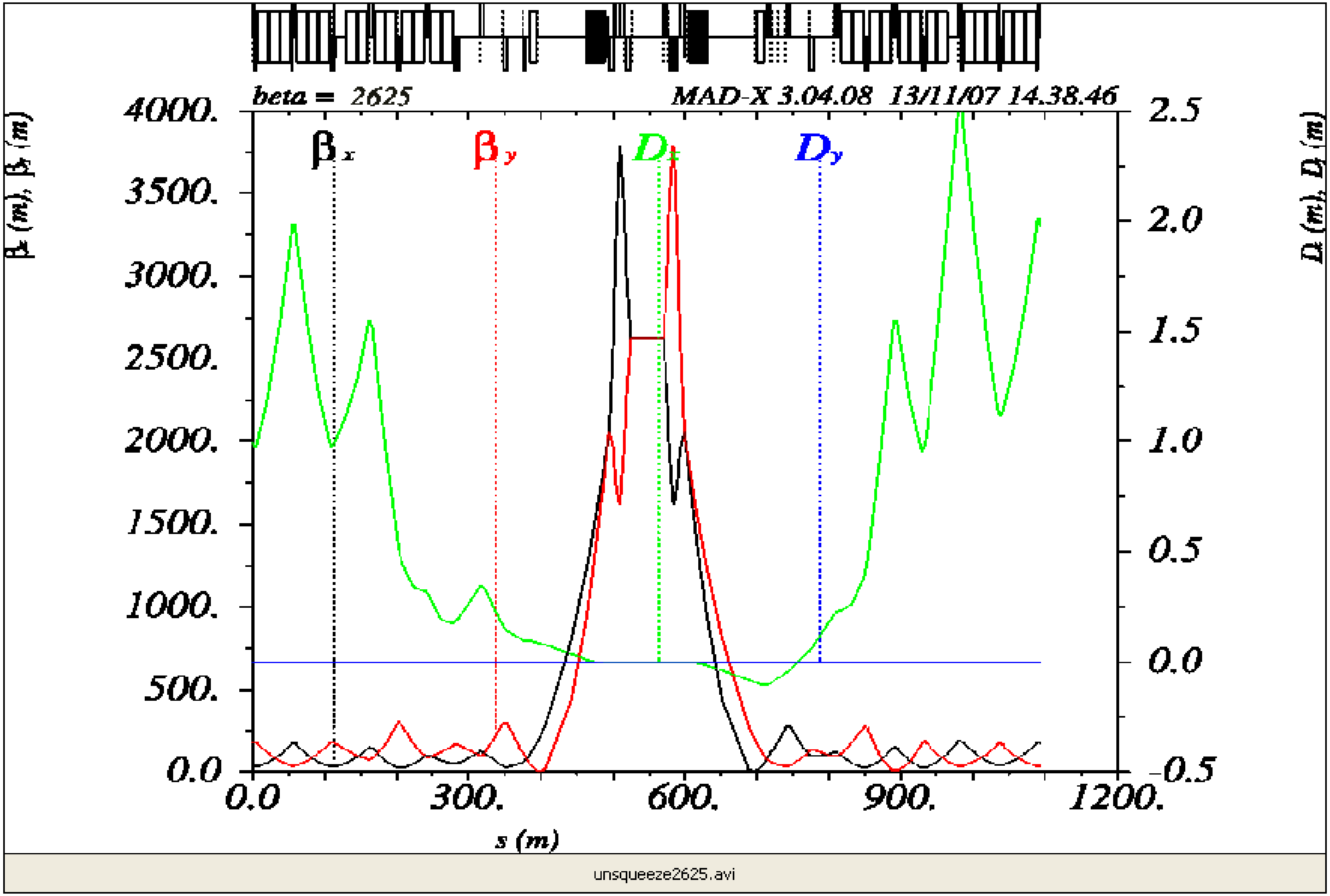
Unsqueeze from 17 m to 2625 m





- Squeeze from 2625 m to 17 m.
- Force Q4 to Change sign in the high-β region.
- Vary all the other quadrupoles as smoothly as possible.

Evolution of the optical functions during the unsqueeze



Summary

- Tune flexibility studies lead to new possible strategies concerning the high beta optics:

- Injecting with Q4 already inverted.

⇒Aperture issues.

⇒New injection and ramp

- Invert Q4 during the unsqueeze.

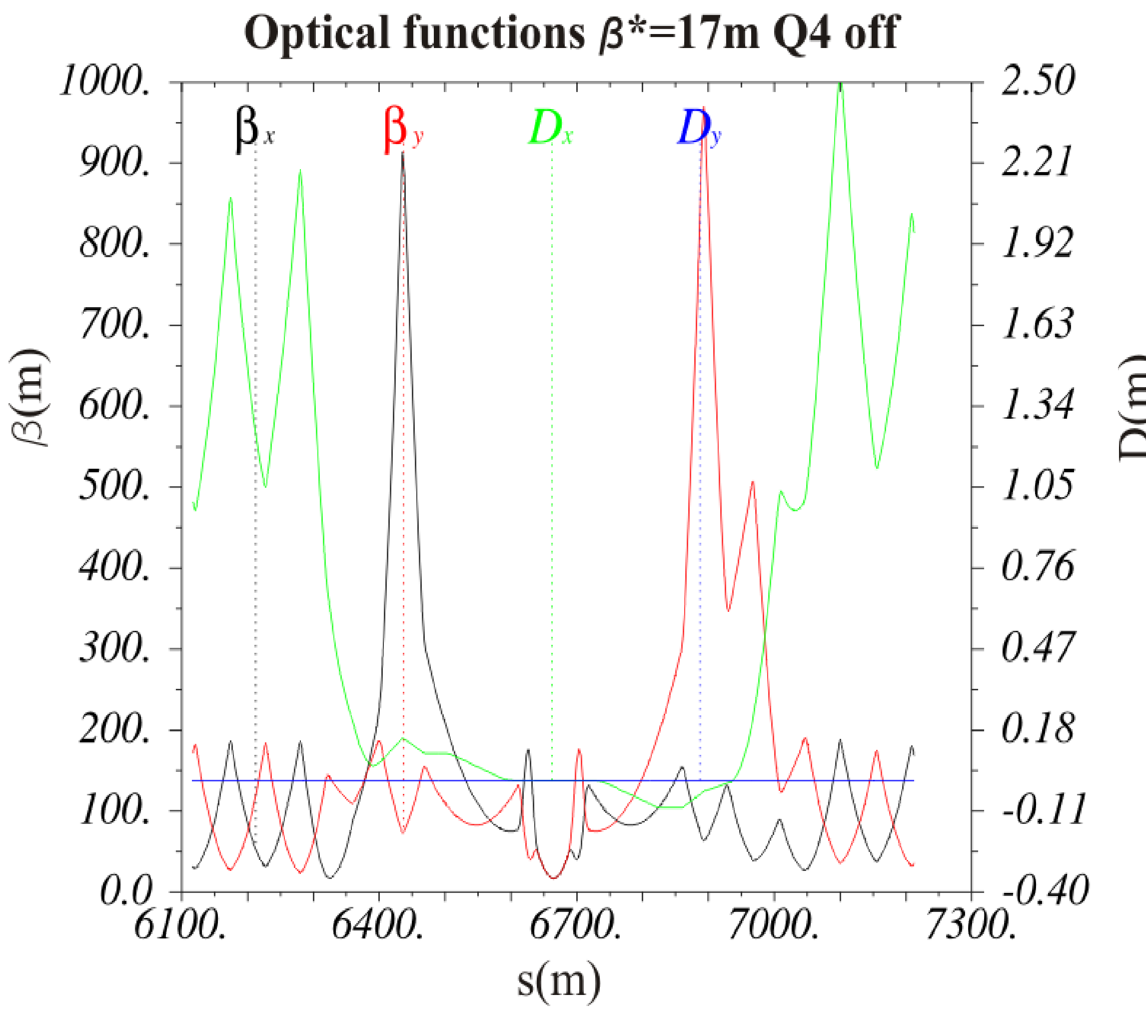
⇒Hardware changes needed.

⇒ All these studies have been made for the Atlas optics but could also apply for TOTEM.

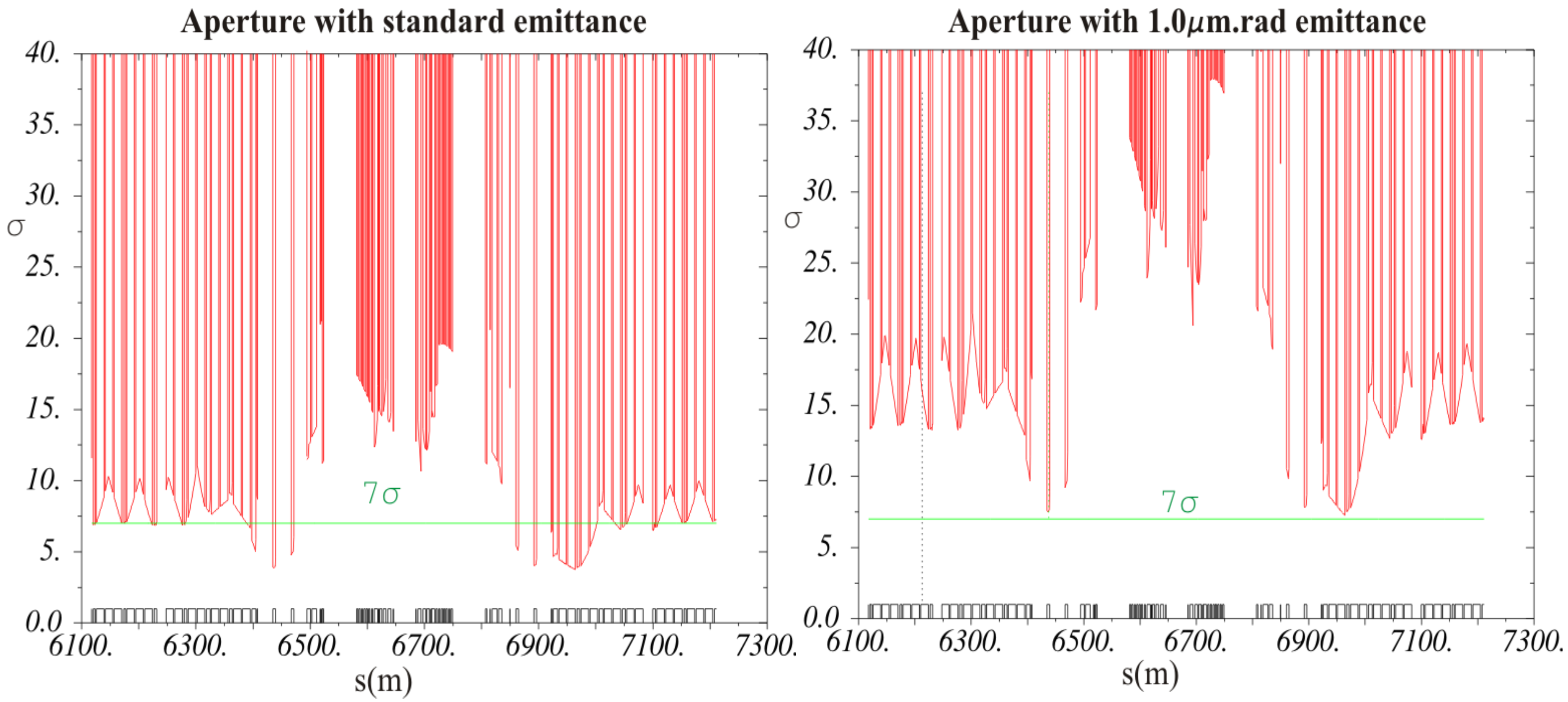
Injecting with Q4 turned off

One option could be to recable the Q4 before injecting and inject with both Q4 turned off.

⇒Peaks in Q6 will induce aperture issues.



Apertures with Q4 turned off



=>7σ constraint respected for 1.0μm.rad emittance (required by Atlas) but not for the standard emittance.