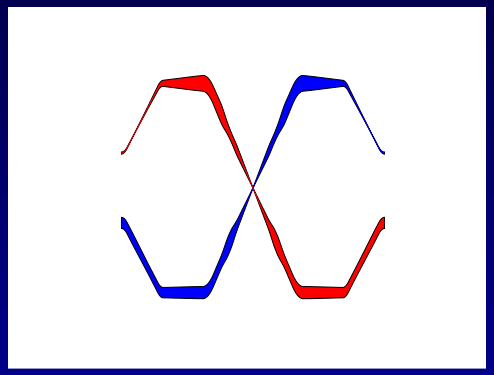
Crab cavity IR design with $\theta = 8$mrad

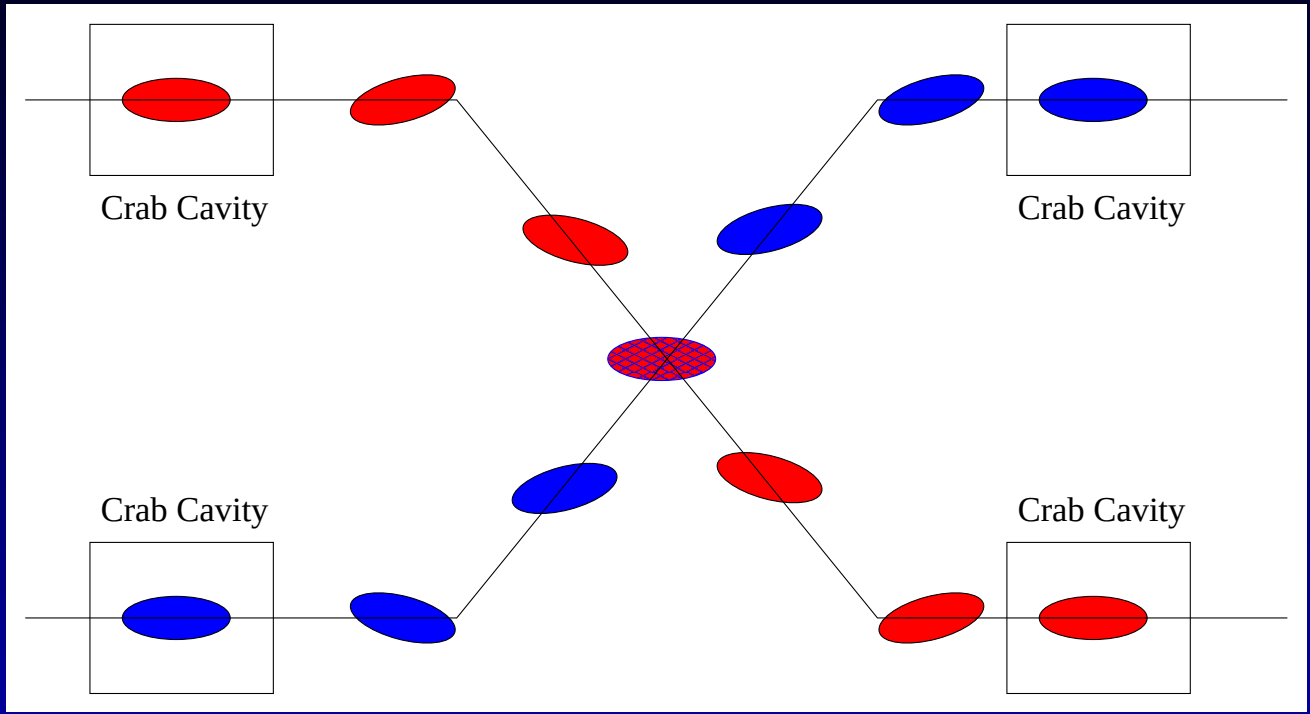


R. Tomás, R. Calaga, R. de Maria and F. Zimmermann

Thanks to: R. Gupta, T. Hayes, T. Risselada, T. Sen and J. Tuckmantel

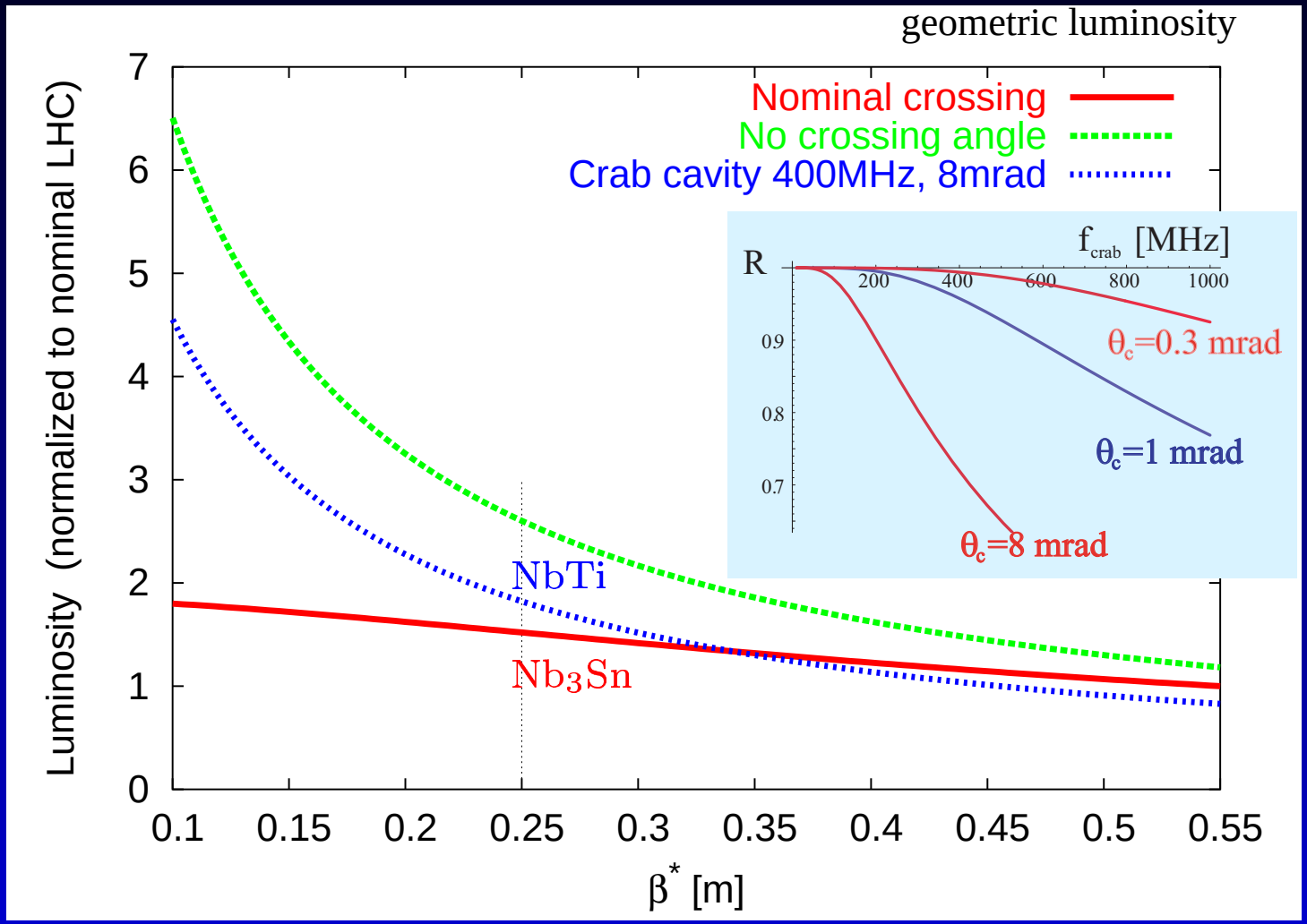
http://care-hhh.web.cern.ch/care-hhh/SuperLHC_IRoptics/IRoptics.html

Crab cavity scheme



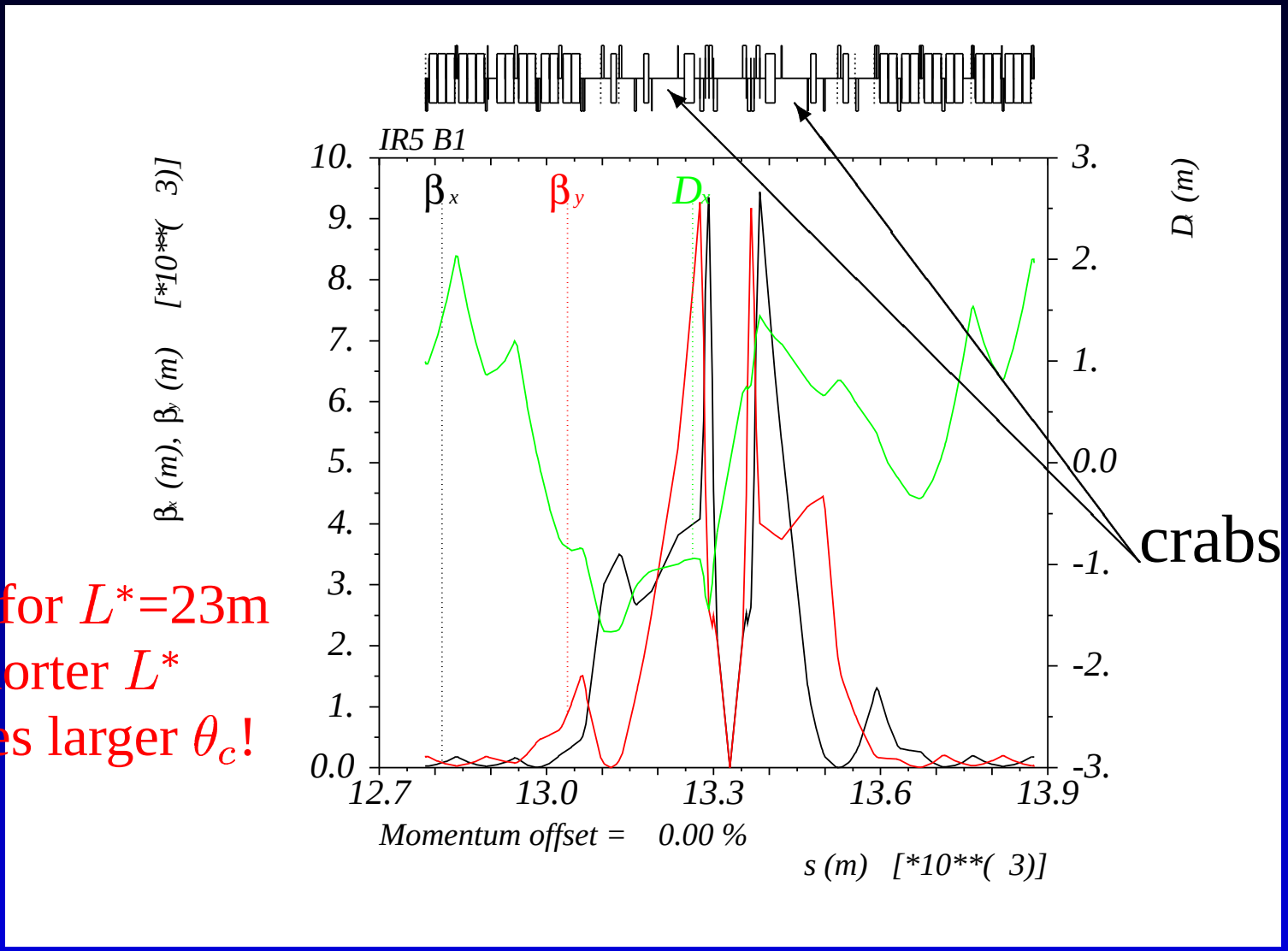
- Crabs restore crossing angle luminosity loss
- Beam-Beam long range effects become negligible
- Separate beam channels allow for smaller quads
- Crabs are big, can we fit them? $\rightarrow$ optics design
- RF noise problem?$\rightarrow$F. Caspers: "...feasible."

Luminosity scope



- Crab option gets factor 2 only from optics
- and we could aim at lower θ_c and lower β^*

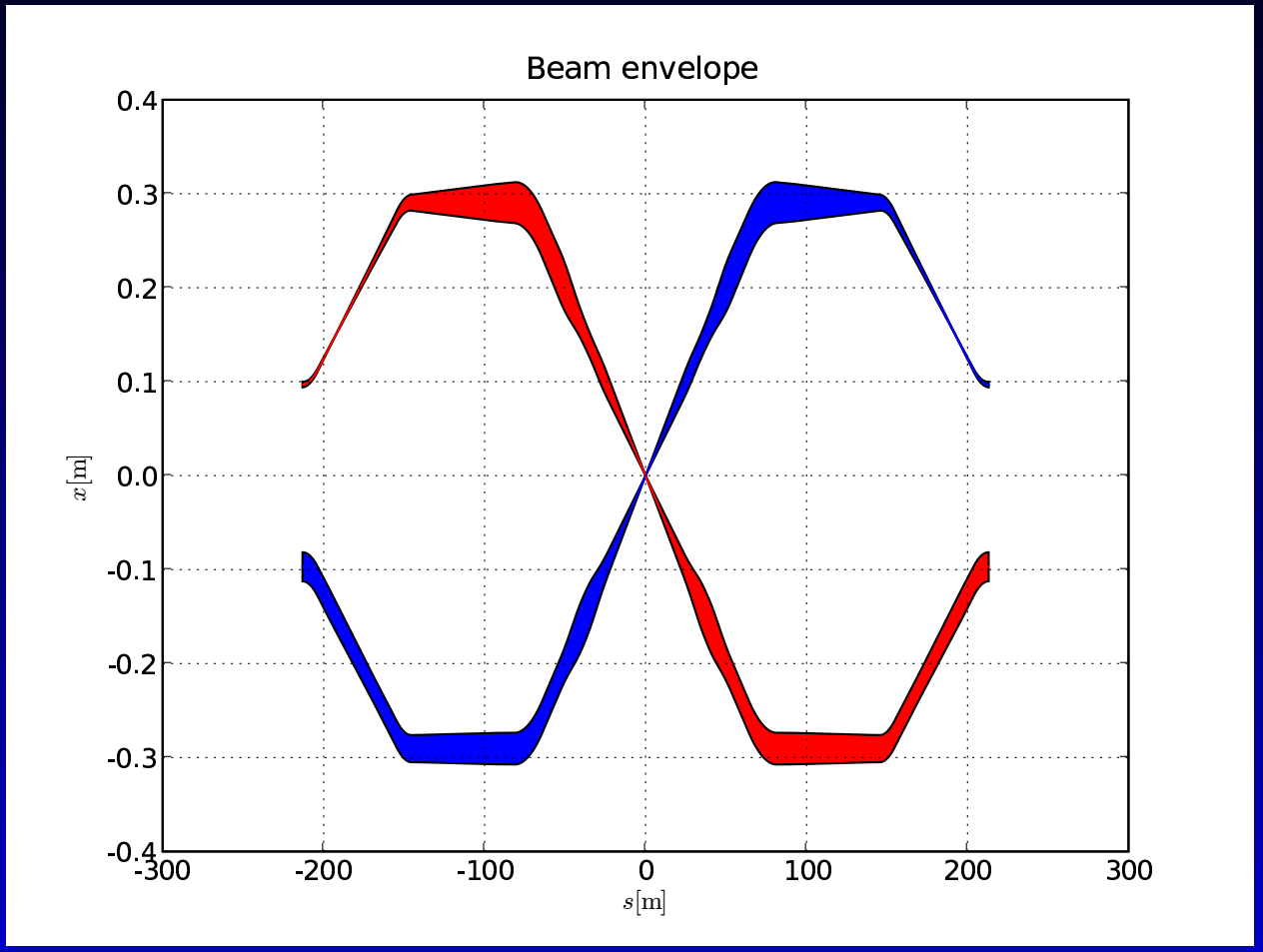
Optics for θ=8mrad, β^*=0.25m, L^*=23m



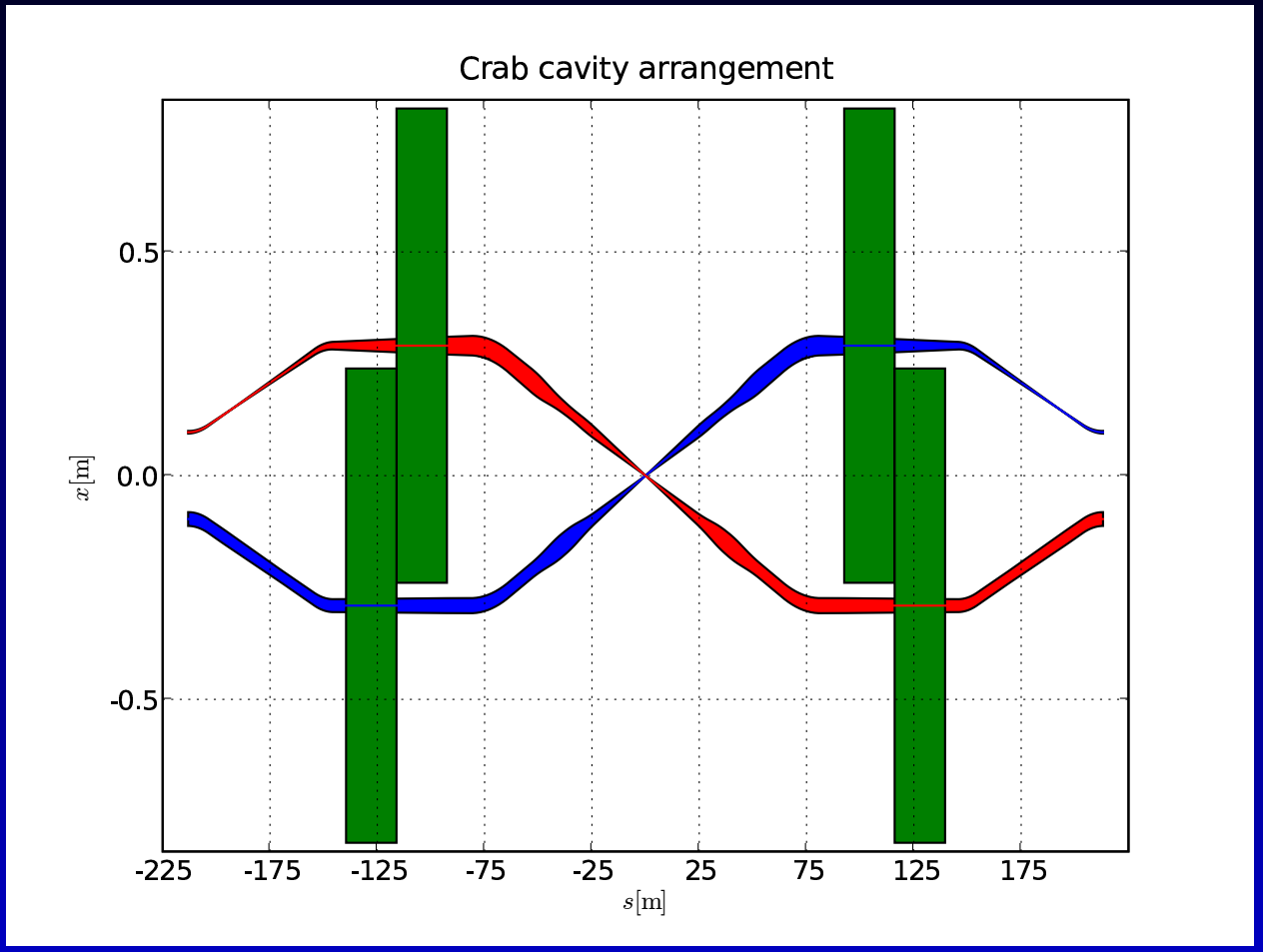
sorry for L^*=23m
but shorter L^*
implies larger θ_c!

- Extra quadrupoles and dipoles

Beam survey for θ=8mrad



Crab cavity arrangement



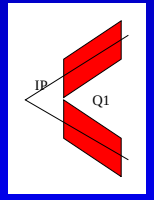
Using Rama's existing design with radius=0.53m

Available space per ring and per side $\approx$ 25m

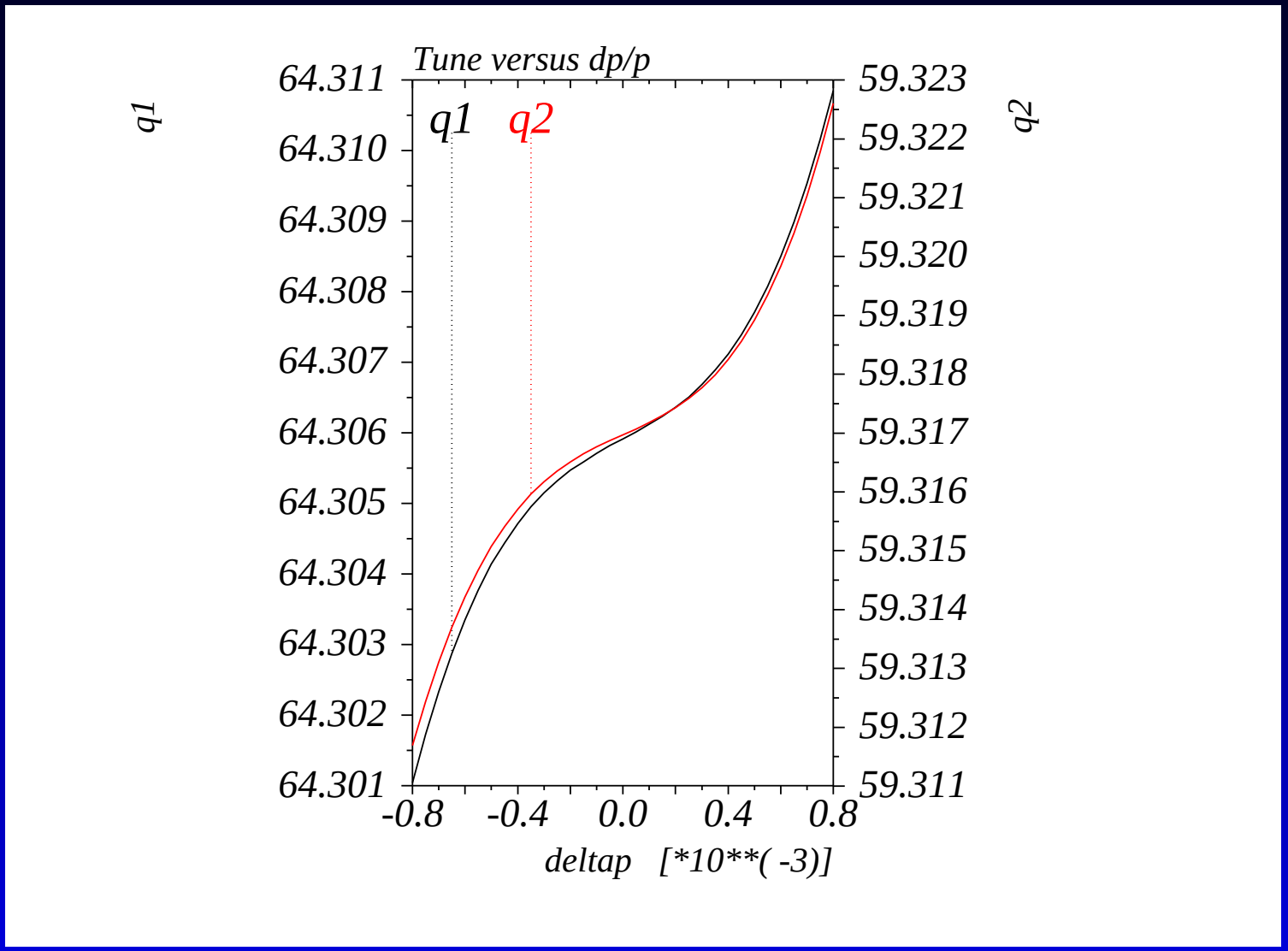
Magnet requirements

Magnet	Aperture [mm]	Gradient/Field	Length [m]
QX1	46	200 T/m	6.3
QX2	63	200 T/m	5.5
QX3	63	200 T/m	5.5
BXA	59	5.3 T	17.6
BXB	39	8.6 T	9.0
BXC	42	8.2 T	9.45

- Reasonable for existing technology (NbTi)
- Q1 design most difficult on the engineering part:

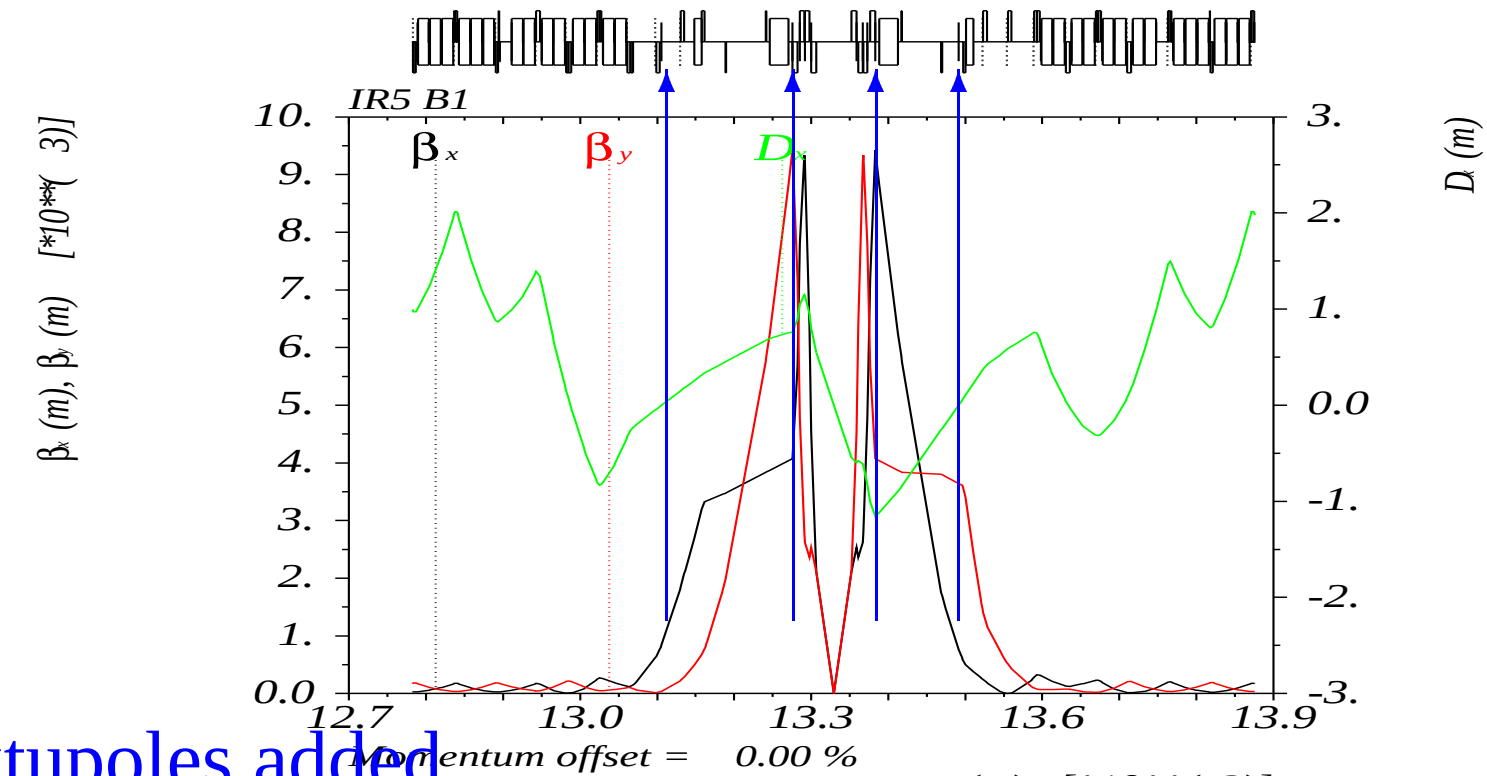


Chromaticity correction: Q' and Q" easy



- Lattice sextupoles at a max of 70% of their strength.

Local chromaticity correction?



4 sextupoles added
2 chromatic, 2 achromatic

in collaboration with P. Jarnhus

- Chromatic and geometric compensation unachievable: Inefficient scheme and 2nd order dispersion
- But we do not need this for the crab option!

Dynamic aperture

Using present LHC IR errors the DA is computed as:

Case	Dip err	Quad err	Both	Both/10
Crab cavity	1.5	7.0	1.5	12.5
T. Sen Quad first			4.5	14.0

- The large dipoles dominate DA
- Reasonable DA obtained by reducing errors by a factor of 10
- Field quality needs to be improved or dedicated correctors need to be used (true for all 'standard' options and easier for separate channels)

Conclusions

- An IR design that allocates space for crab cavities has been presented
- Factor of 2 in luminosity only from optics
- Magnet requirements within existing technology
- Chromaticity correction easy
- Long range beam-beam negligible (larger L)
- Dynamic aperture too small for LHC-like multipole errors
- Improvement of magnetic field quality or correction necessary (true for all 'standard' options)
- RF noise problem?$\rightarrow$F. Caspers: "...feasible."