HiLumi LHC Local Chromatic Correction

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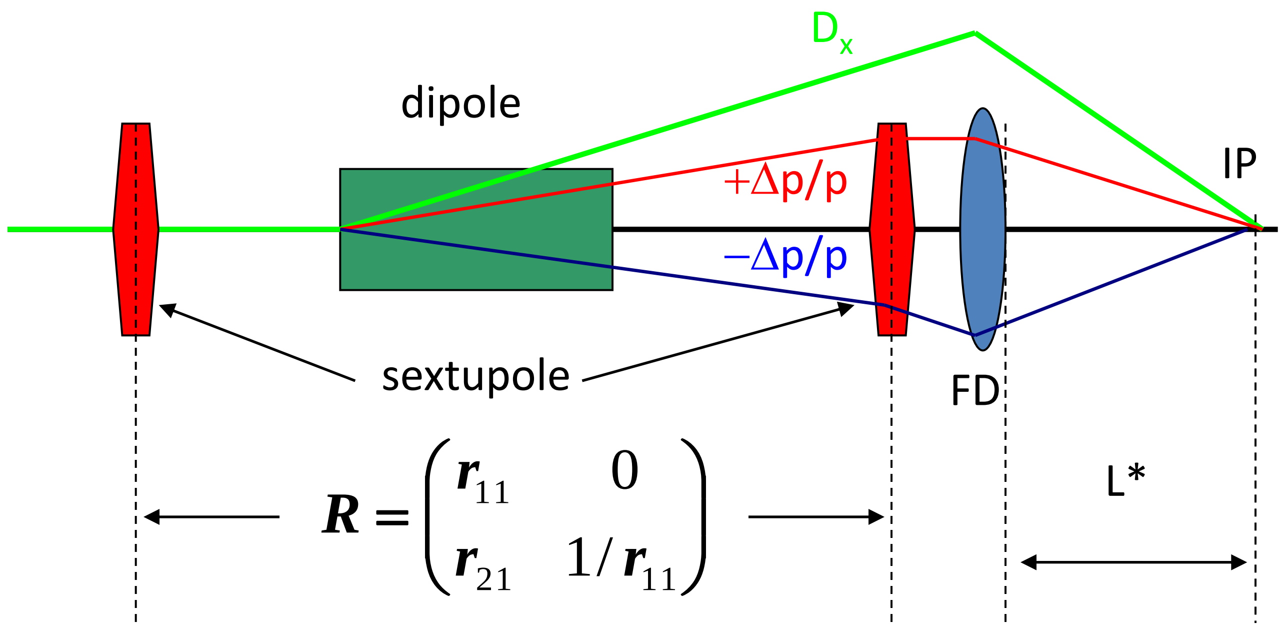
Outline

- Local chromatic correction principle
- Local chromatic correction for HiLumi LHC
- First attempt
- Low β^* lattices
- Next steps

Local chromatic correction principle



$$R = \begin{pmatrix} r_{11} & 0 \\ r_{21} & 1/r_{11} \end{pmatrix}$$

A bend upstream from the FD creates dispersion in the FD.

Sextupoles interleaved with the FD cancel the chromaticity.

Geometric aberrations of the FD sextupoles are cancelled with sextupoles, in phase with them, and located upstream from the bend.

Practically there are two sextupoles in the final focalization for the chromaticity correction and 2 or more compensation sextupoles.

Local chromatic correction for HiLumi LHC

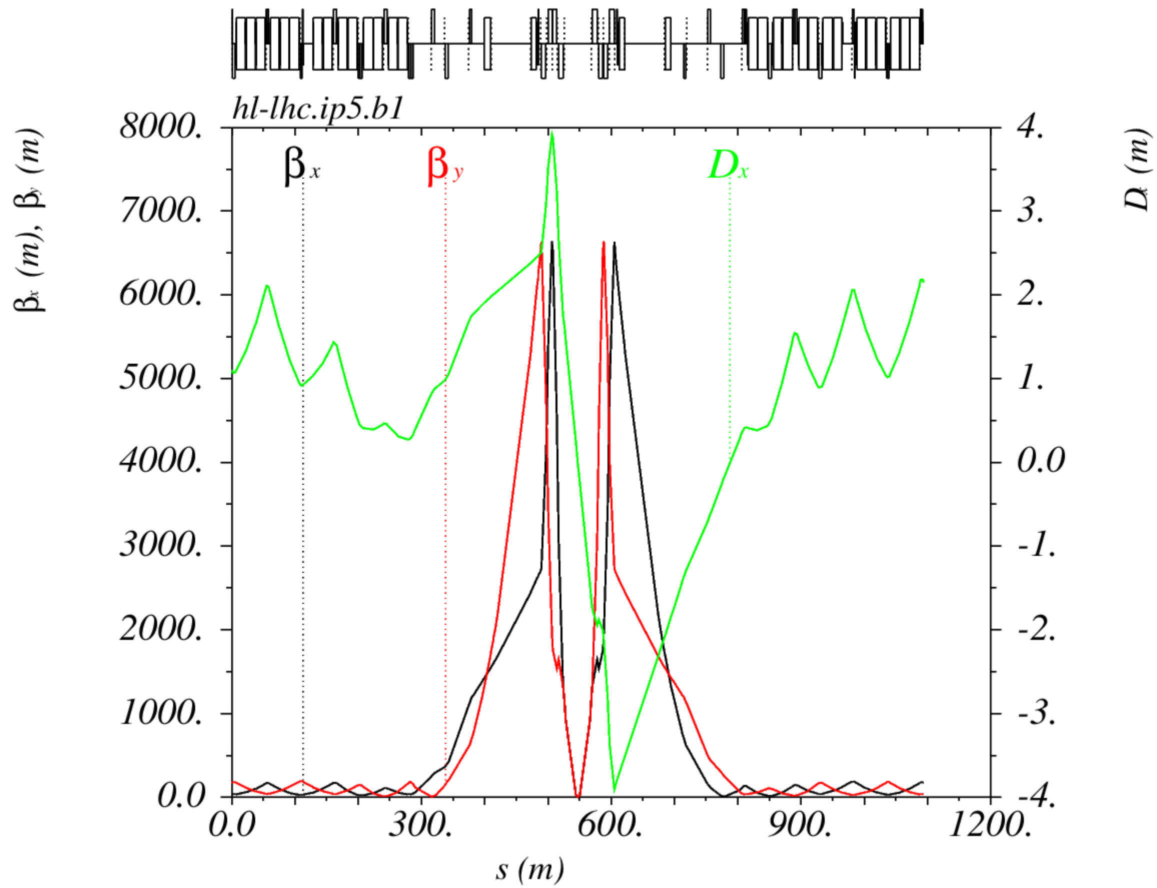
- The ATS scheme remains the main solution.
  - We plan to use the 170 T/m lattice with triplet and new QP before Q7.
- Local chromatic correction is conceived within the framework of the ATS scheme and could be an alternative.
  - No bend between the IP and the triplet.
  - Available for β^*=0.15m.
  - High β at crab cavity.
  - The chromaticity correction of the ATS scheme is considered.
- Appropriate locations (accordingly with the optics) for the compensation sextupoles were the main issue.

Local correction attempt

The sextupoles near the IP are used to correct partially the chromaticities, which mitigates the sextupole strengths in the arcs (“strong”).

We use a lattice with β*=0.4 m for the tests:

- The constraint on the derivative of the dispersion at IP is removed and we took the lattice with maximum dispersion in the triplet.
- We put two thin sextupoles in the triplet. One is located between Q2 and Q3, the other is after Q3. Inverting the sign between L and R.



Local correction attempt

We cancel about half the natural chromaticities by the local sextupoles in IR1 and IR5.

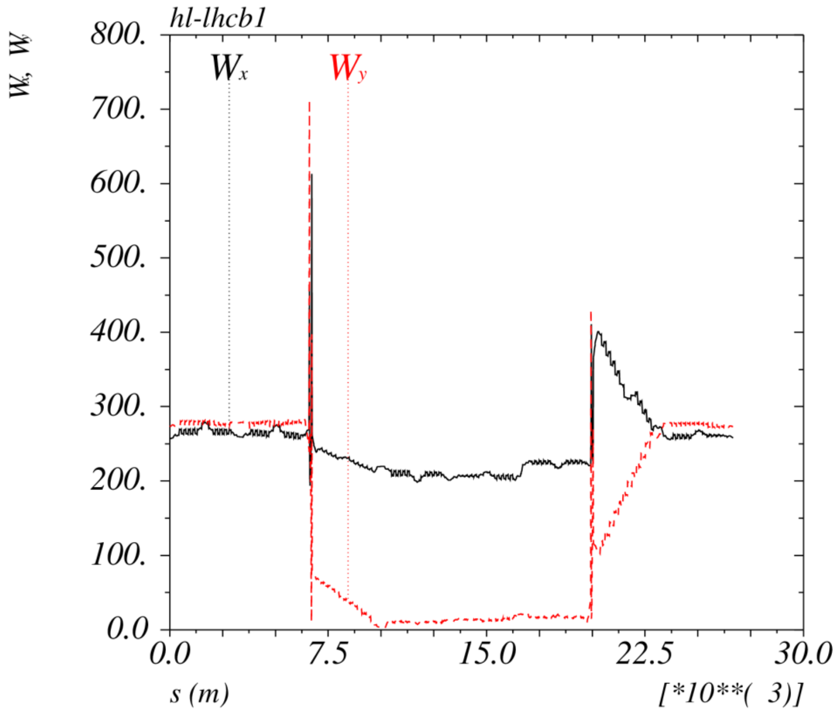
Local sextupole integrated strengths :
s1b1 = 0.03026 1/m^2
s2b1 =-0.02976 1/m^2

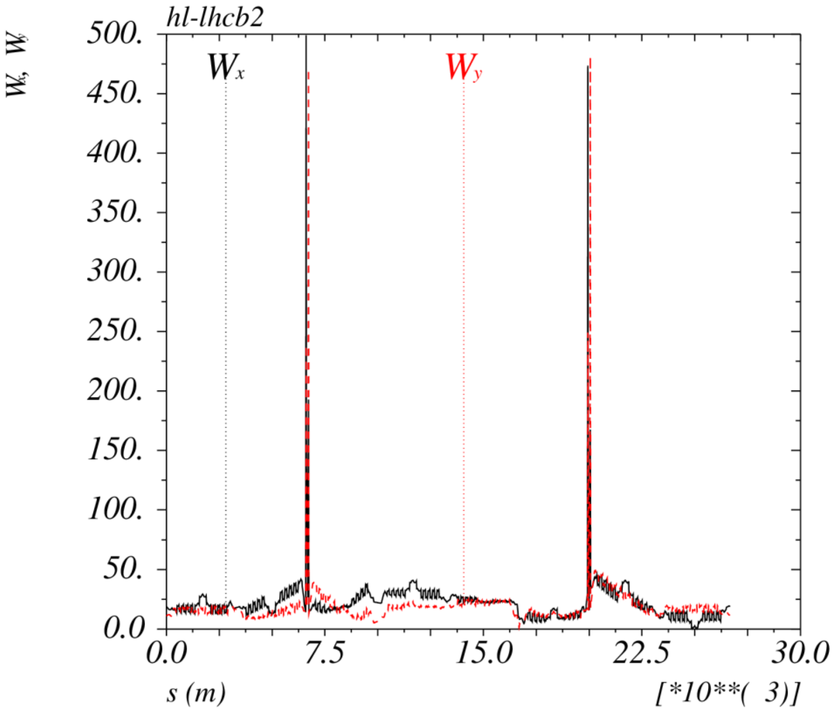
Sextupole	w/o local sext	w local sext
KSF1.A81B1	0.24433	0.61987E-01
KSF1.A12B1	0.23003	0.17267
KSF1.A45B1	0.24849	0.66106E-01
KSF1.A56B1	0.24163	0.20968E-01
KSD2.A81B1	-0.38888	-0.10138
KSD2.A12B1	-0.37468	-0.28173
KSD2.A45B1	-0.39605	-0.10830
KSD2.A56B1	-0.39322	-0.35507E-01

Local correction attempt

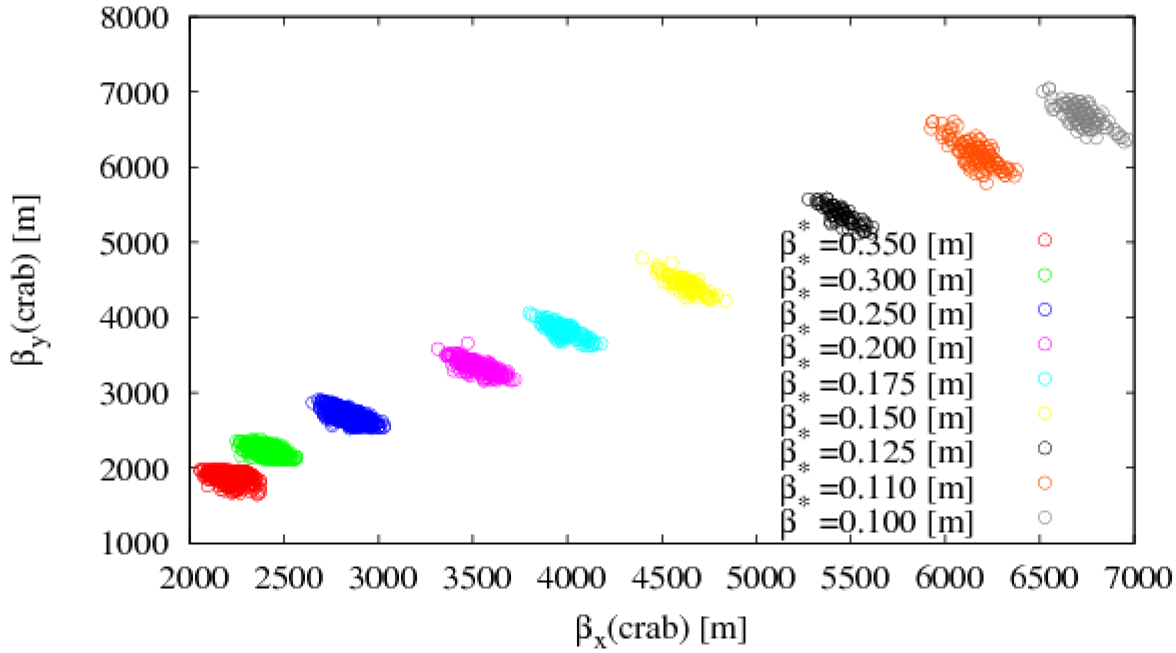
But…

- inverting the sign of the local sextupole ⇒ no geometric aberration compensation
- bad Montague functions in the arc and other sections for beam 1



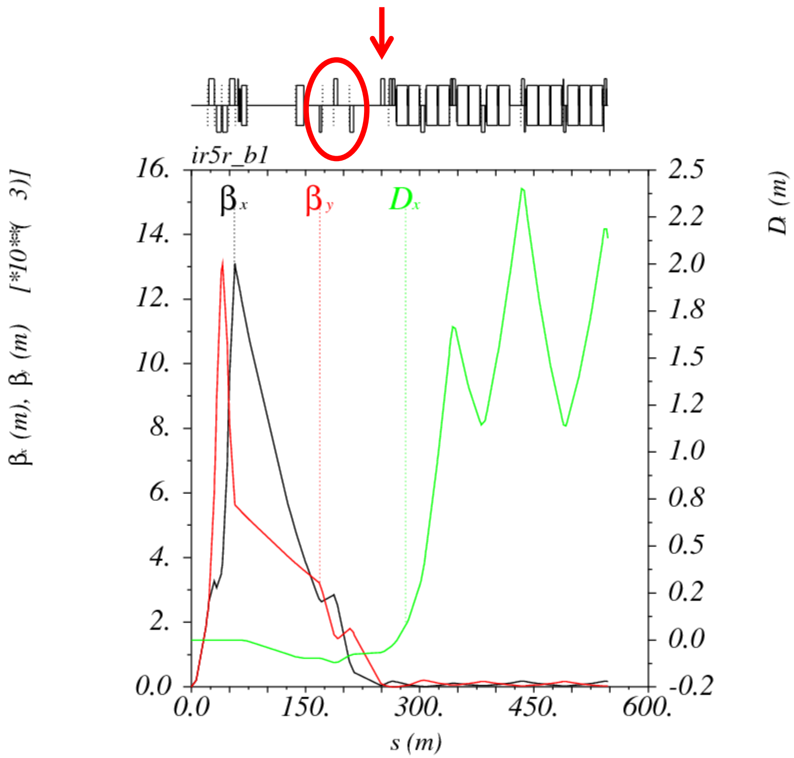


Low β* lattices

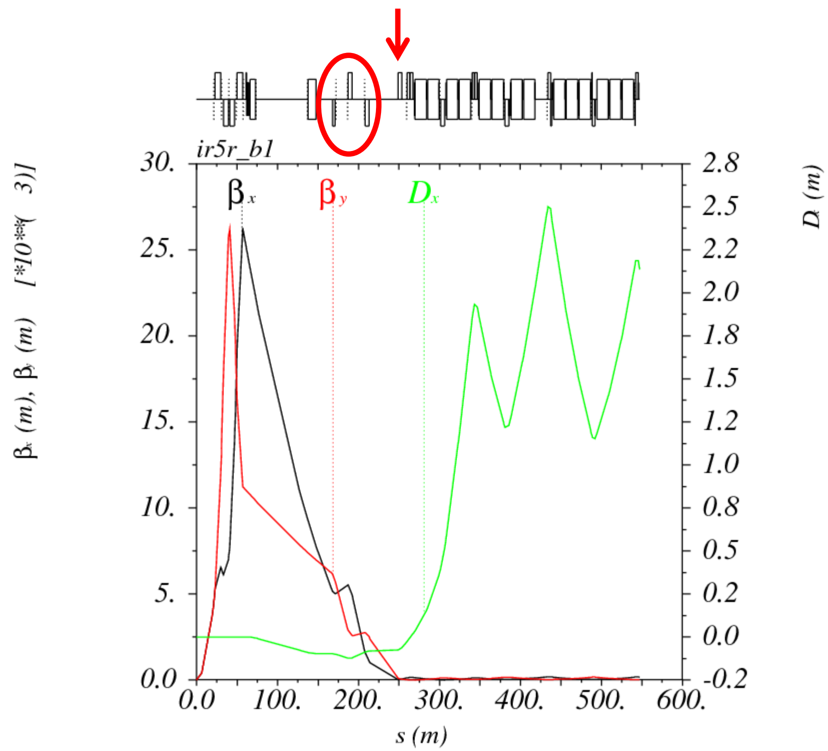


We search for low β* lattices with large $\beta_x \cong \beta_y$ at the crab cavity.
The triplet is different for each solution.

Optical functions



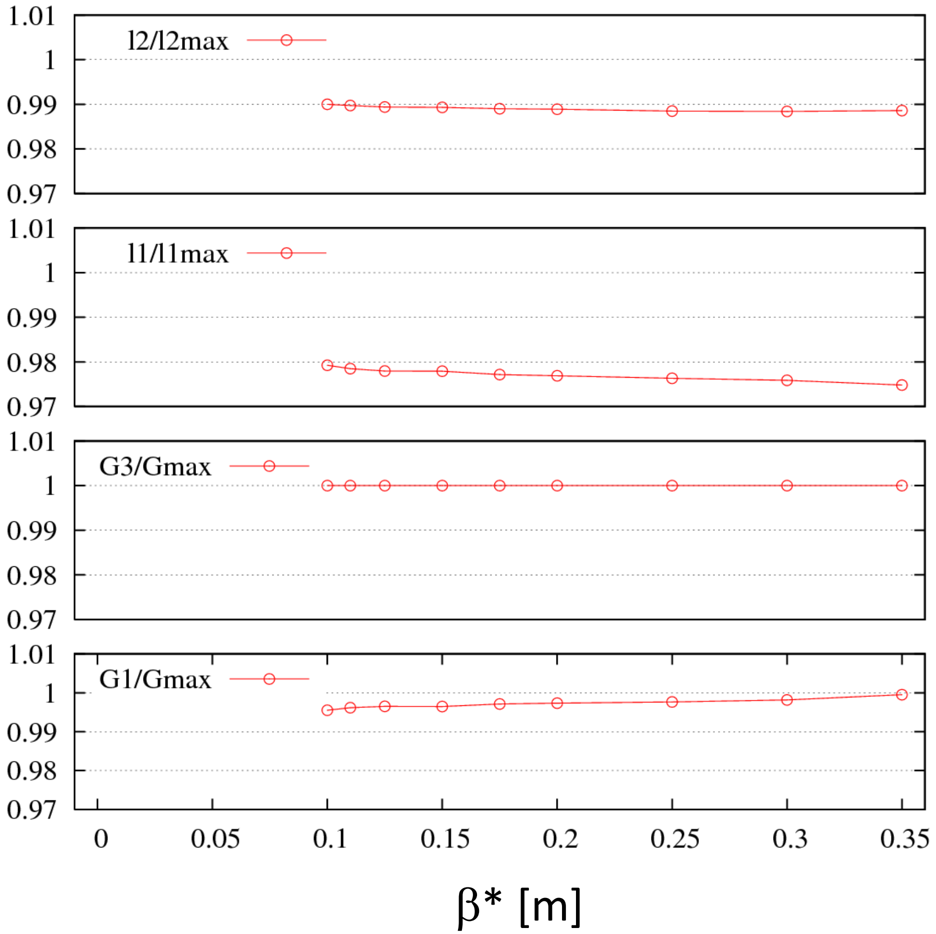
β^* =0.20 [m]



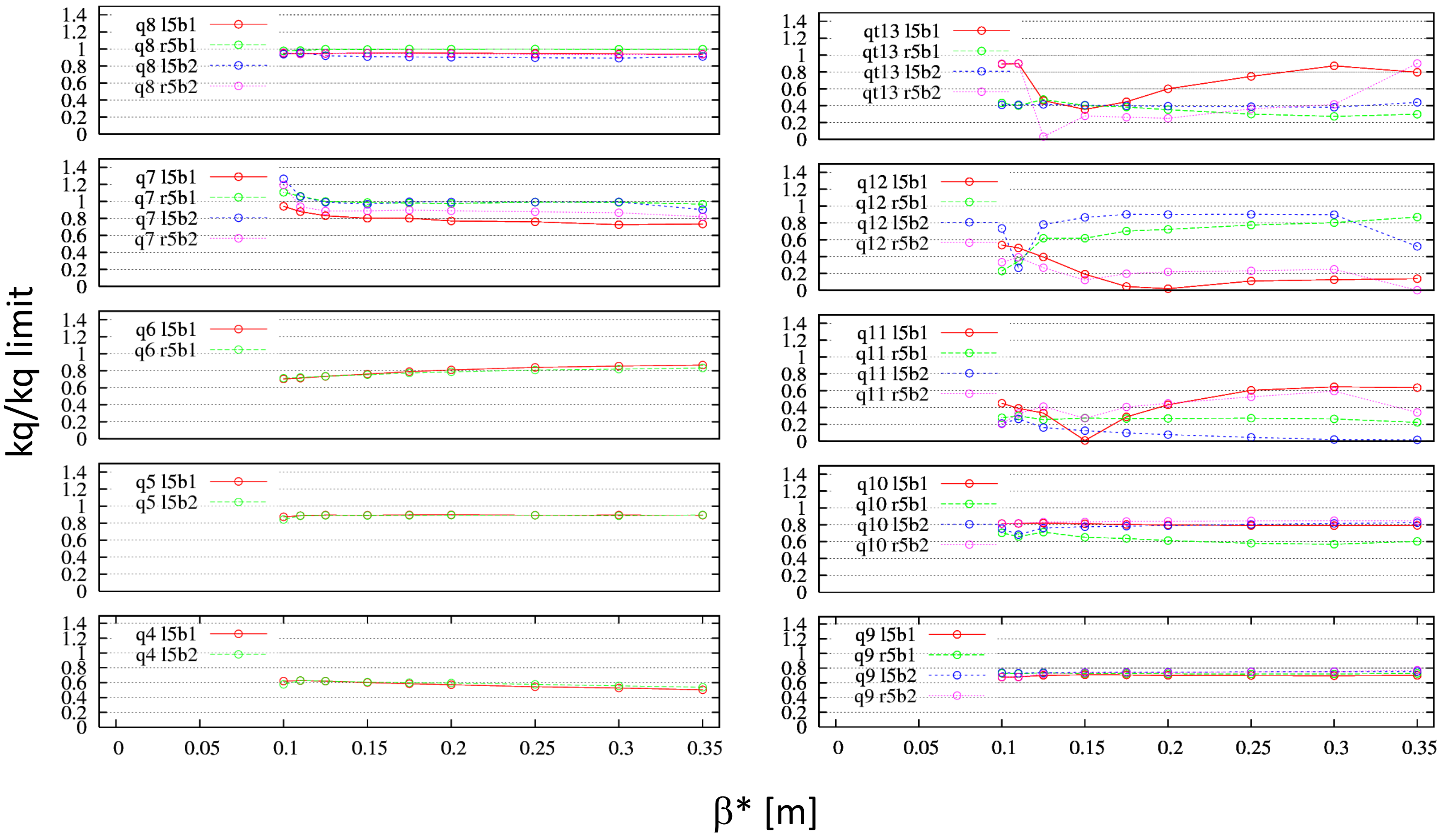
β^* =0.10 [m]

Triplet parameters

The strength and length variations of the quadrupole triplet remain small.



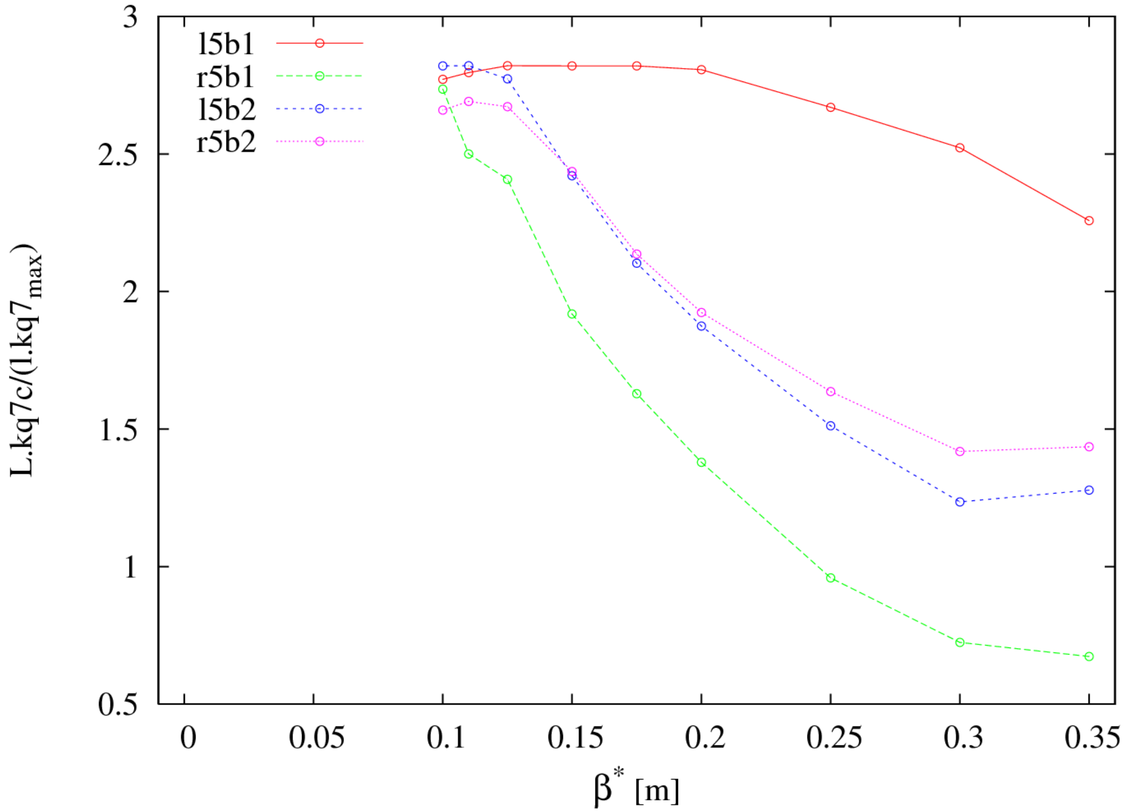
Quadrupole strengths



Added quadrupole strength

The integrated strength of the added quadrupole is larger than the maximum integrated strength of q7.

It becomes about 2.8 times larger from β*=0.2 m.



Next steps

- Choose one lattice, minimum QP strengths, with β^*=0.15 m (0.10 m ?)
- Match “realistic” dispersion in the IR.
- Find the places to insert “realistic” local sextupoles (1, 2 or more), taking into account the geometric aberration compensation.