Optimization of the IR in SuperKEKB LER

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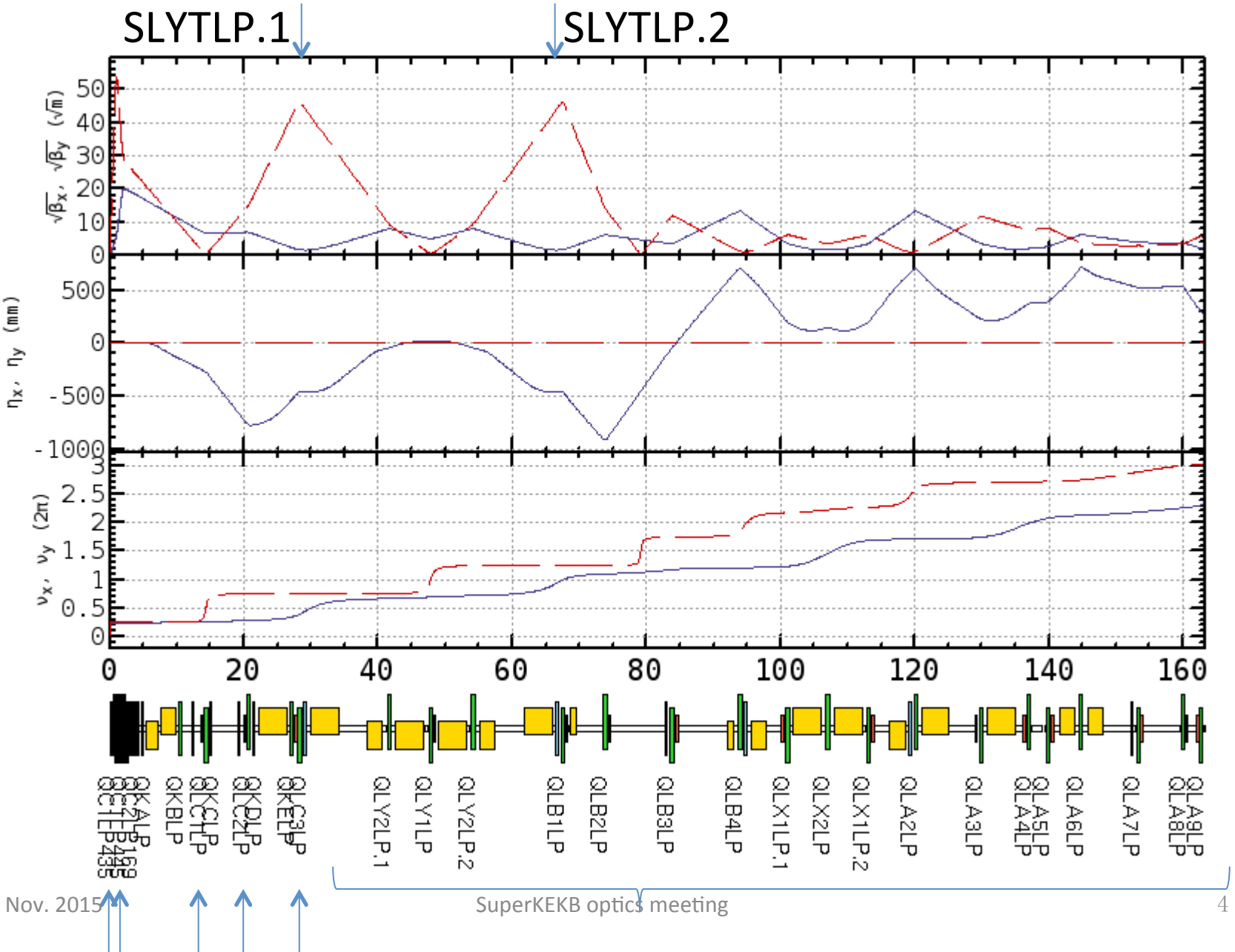
Plan of collaboration between CEPC and SuperKEKB

- Start with a simplified SuperKEKB lattice (By H. Sugimoto, w/o solenoid)
  - Try to re-optimize the IR nonlinearity
- With a realistic SuperKEKB lattice
  - Try to find a better solution combine the beam-beam, space charge and nonlinearity in lattice (I hope but long-term study)

Aberration in IR

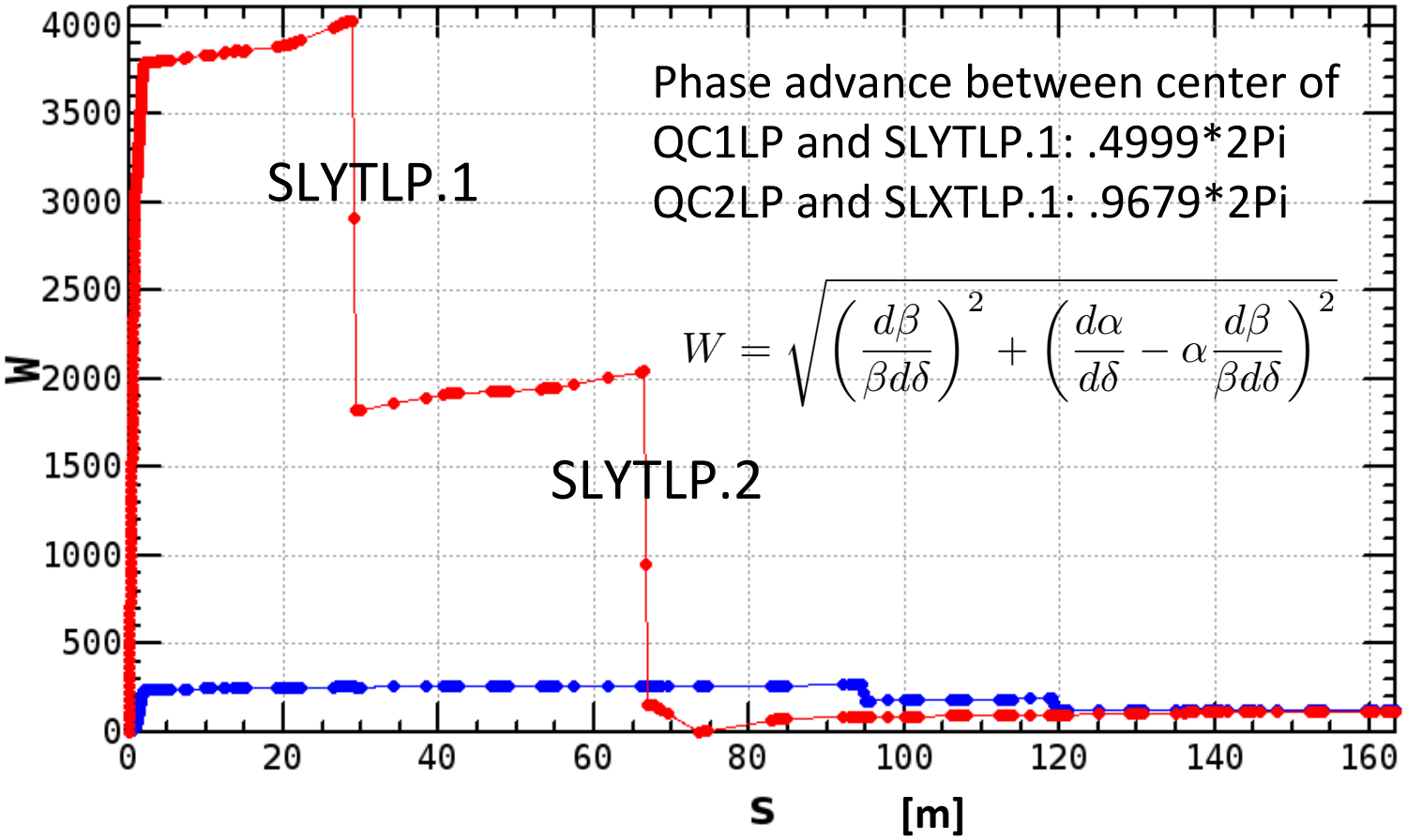
- Amplitude dependent
  - kinematic aberration due to ultra-low beta (not corrected intended)
  - fringe field of final doublet
  - finite length effect of vertical sextupoles in IR (maybe corrected globally by sextupole in ARC)
- Momentum dependent
  - high order chromaticities (corrected globally by sextupole in ARC)
- making effort to correct the high order aberration more locally in the IR.

Lattice of IRL



W function

- W function along the beamline IRL ("INS")
  - blue/red lines for x/y

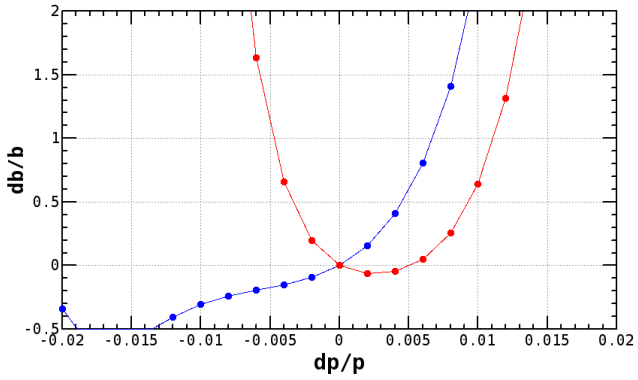


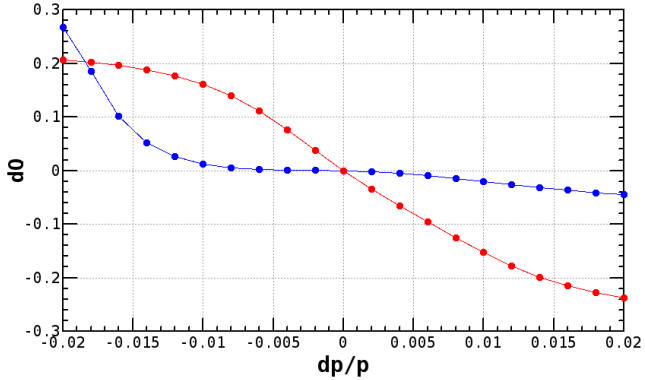
At PTSULM:
Wx=124.9
Wy=114.6

Beta, tune vs. dp/p for only IRL

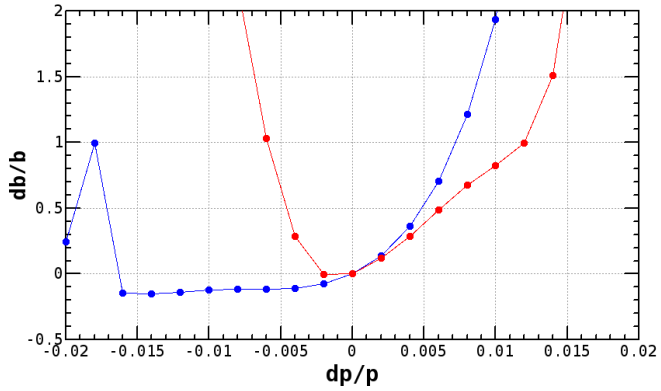
- The high order chromaticity of IR are not corrected locally
  - blue/red lines for x/y

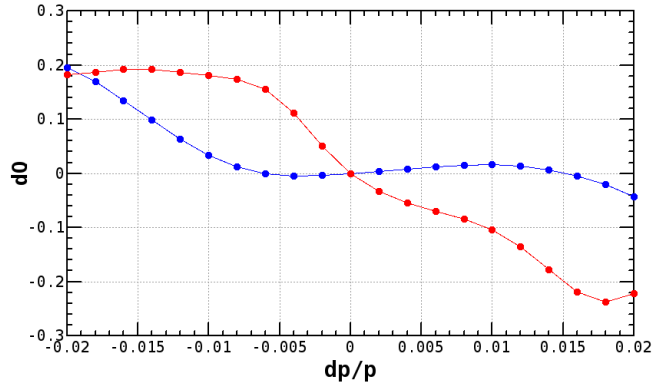
non-periodic solution from "IP.1" to "PTSULM" (with IRL only)





periodic solution at "PTSULM" (with ASC)



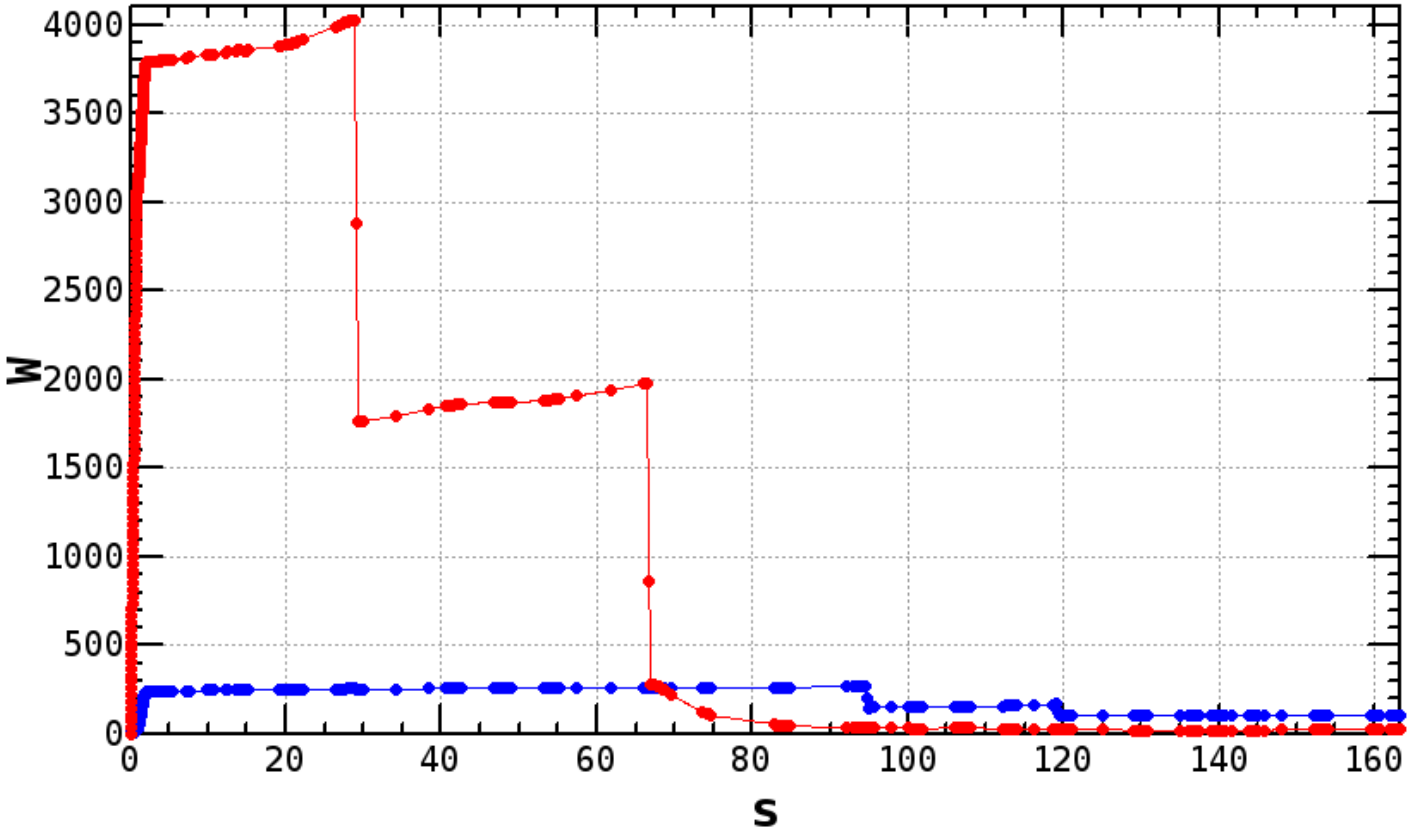


Correction of high order chromaticity

- High order chromaticity due to the small chromaticity from 1st waist of βy, i.e. QLC1LP *K. Oide, SLAC-PUB-4806
- Correct the high order chromaticity with an additional weak sextupole at 1st waist of βy *R. Brinkmann, DESY M-90-14
  - Phase advance (Y direction) of QLC1LP change significantly from 0.338*2Pi to 0.506*2Pi
  - add sextupole after the QLC1LP
  - SLYTLP, SLXTLP reoptimized together
- The 2nd order geometric nonliearity from the additional sextupole is much smaller than other sextupoles
  - QLC1LP: βy*K2=0.28 m^-1
  - SLYTLP: βy*K2=4847 m^-1
  - ARC sextupoles: βy*K2=180 m^-1

Correction result of first try

- The phase advance between FD and sextupole will be tuned as well to further optimization

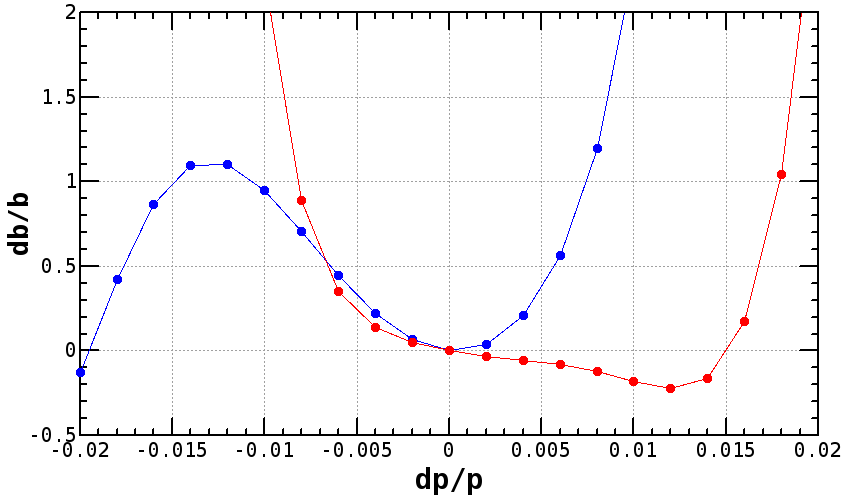


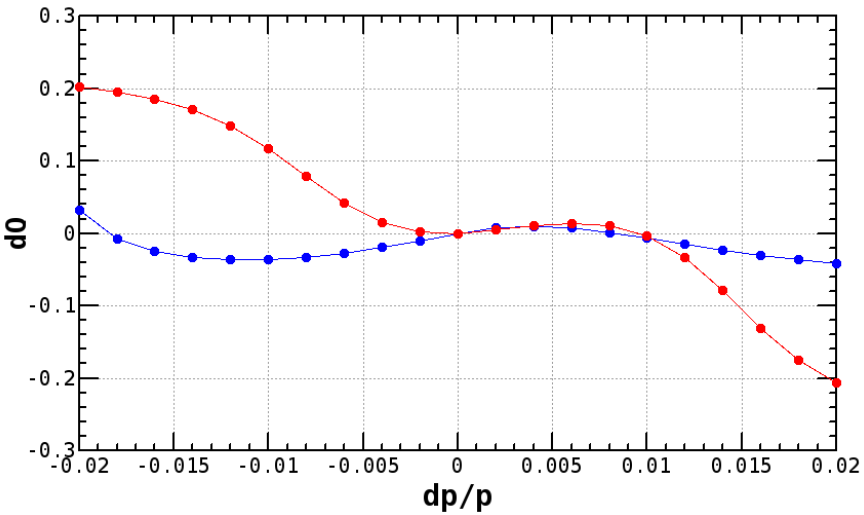
At PTSULM:
Wx=104.5
Wy=27.1

Correction result of first try

- The phase advance between FD and sextupole will be tuned as well to further optimization

non-periodic solution from "IP.1" to "PTSULM" (with IRL only)





Summary

- Try to correct the high order chromaticity of IR more locally
  - Preliminary result got
  - The phase advance between FD and sextupole will be tuned as well to further optimization
  - Further work is under going
- A question on SAD: What's the difference between QUAD and MULT(K2=0)? (For example, changing QLC1LP from "QUAD" to "MULT" will change the W function. Similar experiences in CEPC.)

```
QUAD    QKALP   =(L =.3444     K1 =-.00034232718021650103    ROTATE =-45 DEG     F1 =.211  FRINGE =3
        QKBLP   =(L =.3444     K1 =-.0007170757483515133     ROTATE =-45 DEG     F1 =.211  FRINGE =3
        QLC1LP  =(L =.58372    K1 =-.18042267625564304  F1 =.21401     FRINGE =3 LDEV =.58372 )
```