Lattice studies for SOLEIL ring upgrade

2016

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On behalf of the
accelerator physics group

Low Emittance Ring Lattice Design Workshop Lund, 1-2 December 2016

Ring lattice options

Low emittance ≤ 300 pm

7 (6) BA based + dispersion bump + ~ -I transform
Off axis injection

Very low emittance ≤ 100 pm

MBA based
On axis injection

100 % inspired from :

L. Farvacque et al. , A Low-Emittance Lattice for the ESRF, Proceedings of IPAC (2013)

A. Alekou, et al., Study of Double Triple Achromat Lattice for a 3 GeV Light source Proceedings of IPAC (2016)

A. Streun, The anti-bend cell for ultralow emittance storage ring lattices NIMA, 737 (2014)

Ring lattice footprint

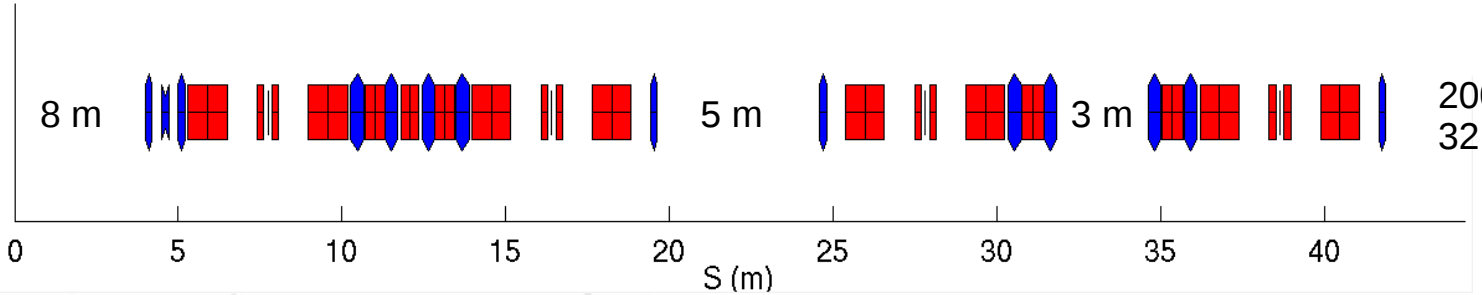
C=354 m 16 cells of 2 kinds

1/8 of the ring here
2.75 GeV

Actual :

4 nm
45 % of straights

Test :

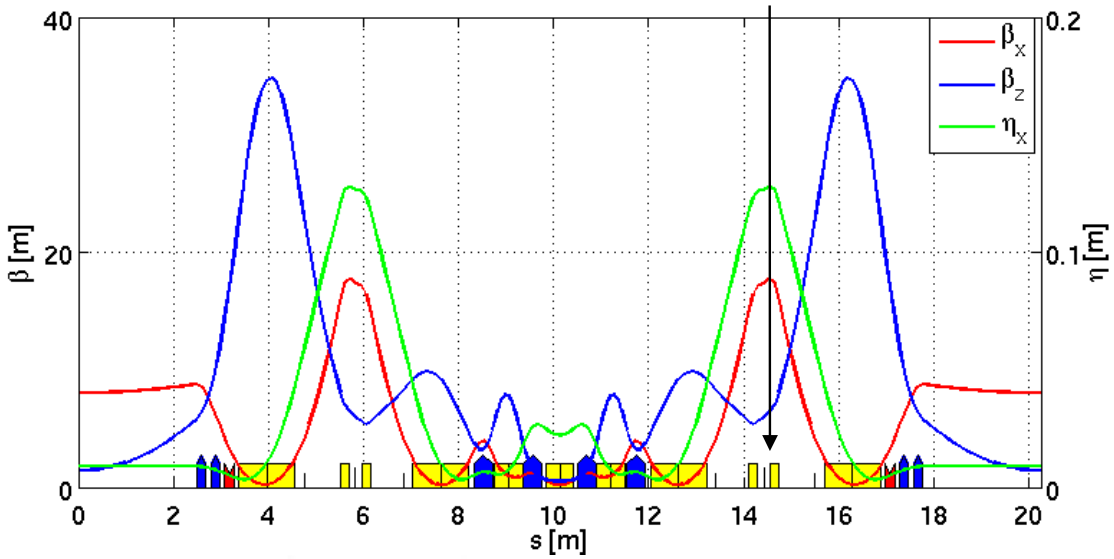


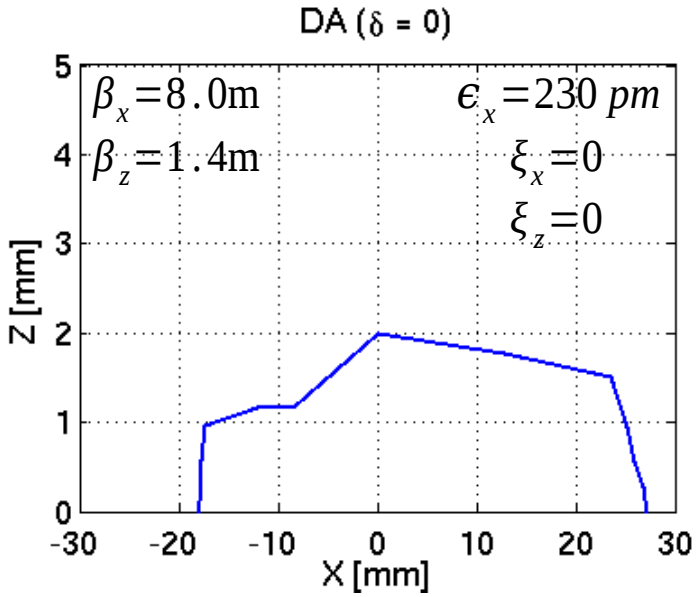
200 -250 pm
32 % of straights

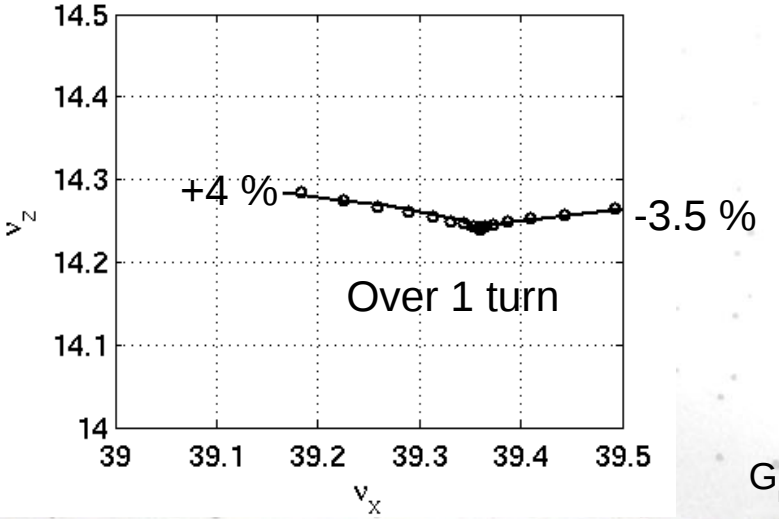
7BA case

Tracking by AT

22.5° / cell including -0.75° from anti-bend







No long. gradient in bend

3 sextupoles families in dispersion bump

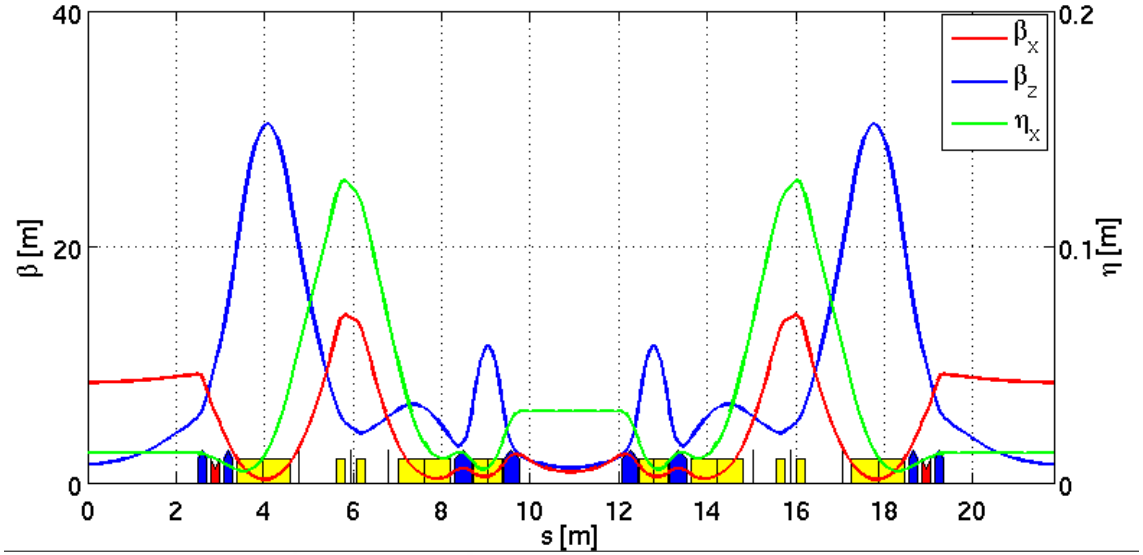
Optics and sextupoles tuned to reduce tune vs energy
The use of anti-bend helps here

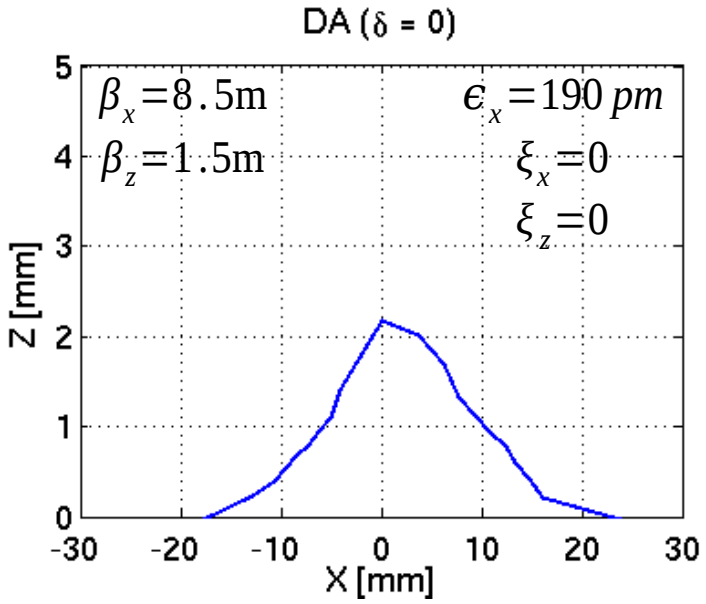
Tune vs amplitude still large / No octupoles

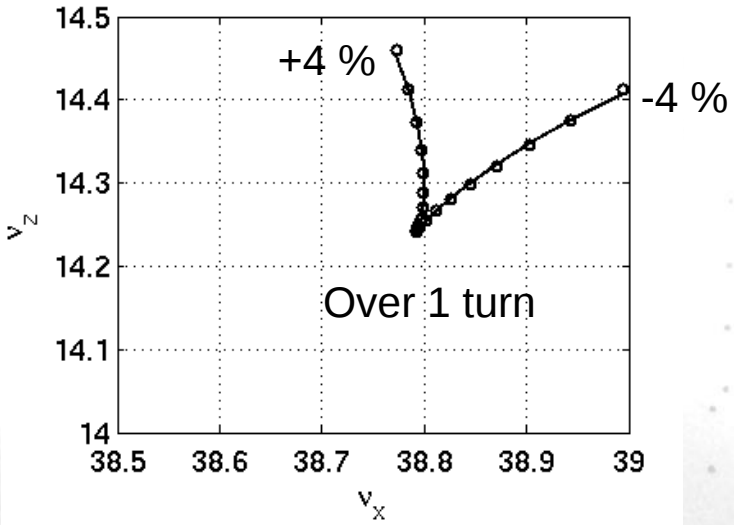
G_{max} = 70 T/m and 30 T/m in bend (0.6 T) S=800 T/m^2 over 200 mm

6BA case

Tracking by AT







From 7 to 6BA :
Removing the central dipole = OK
Enlarging the central section = more difficult vs NL

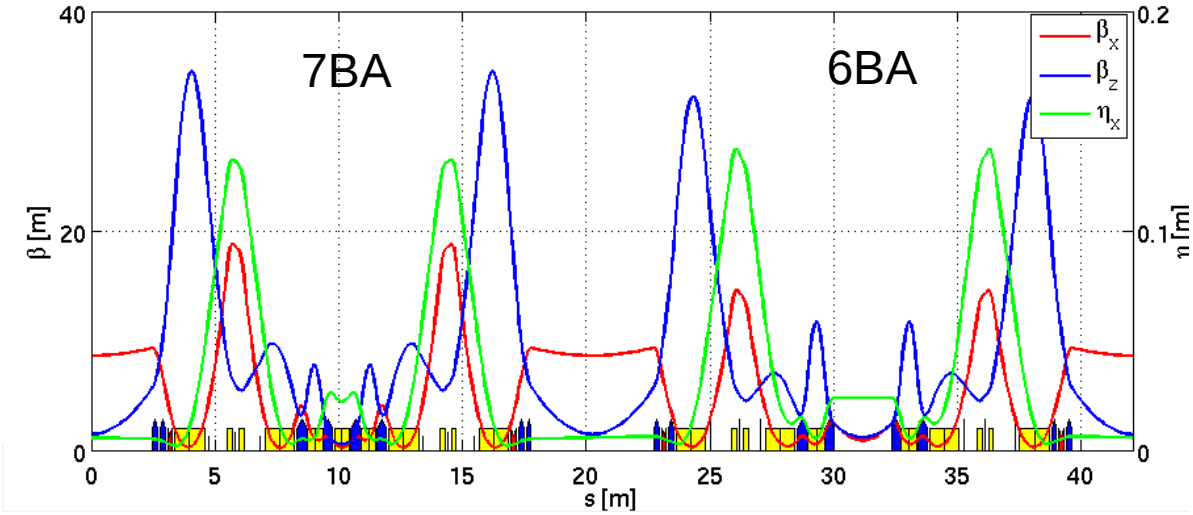
Optics and sextupoles tuned to reduce tune vs energy
The use of anti-bend helps here

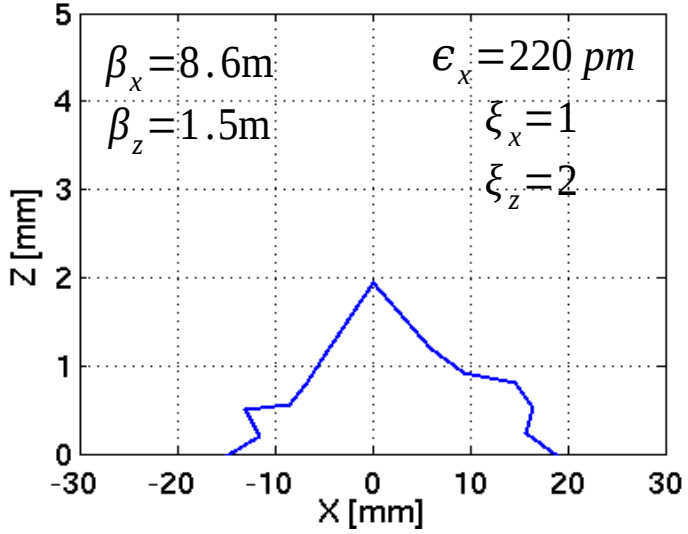
Tune vs amplitude still large / No octupoles

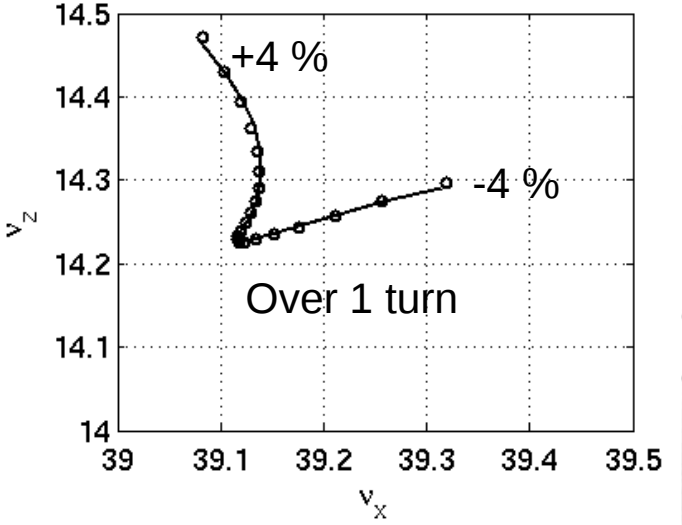
Central straight : Dispersion a bit large (~ 20 mm)
Length a bit short : 2.3 m here ...

Merging 7 and 6BA

Tracking by AT



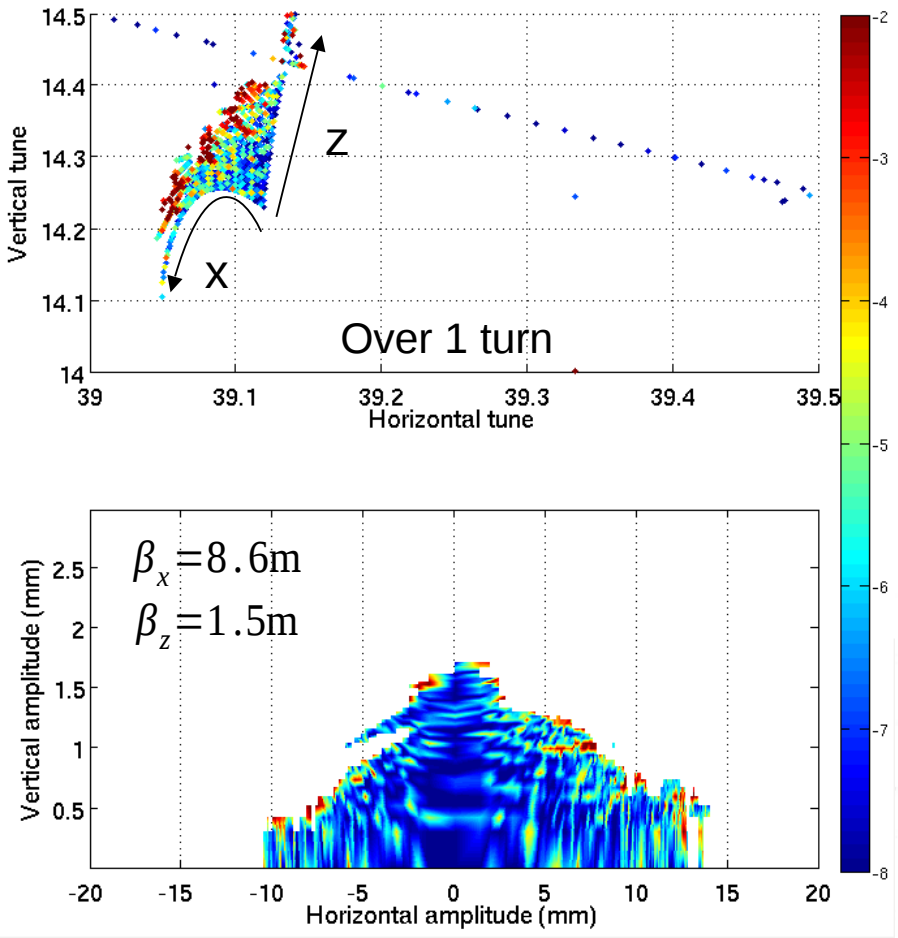




Simple merging + small retuning
Off momentum acceptance OK
DA a bit reduced
Tune vs amplitude still large / No octupoles

Recall : tracking with thin sextupoles only
No fringe fields, no multipole errors ...

FMA by TRACY



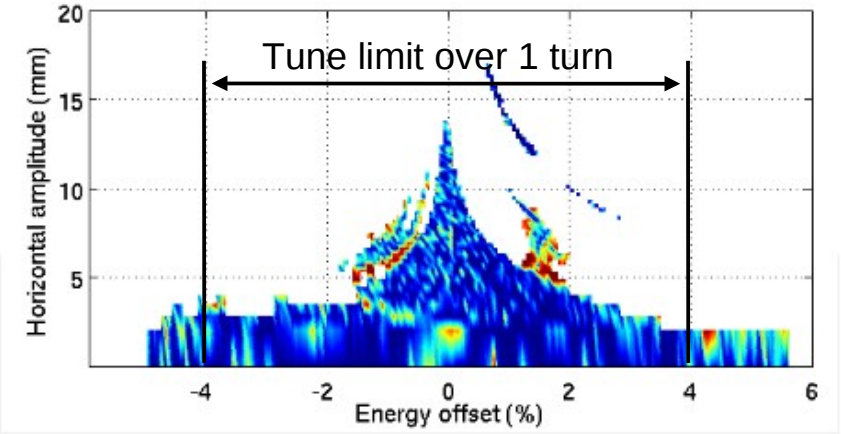
Tune vs amplitude too large :

==> Will be very sensitive to errors

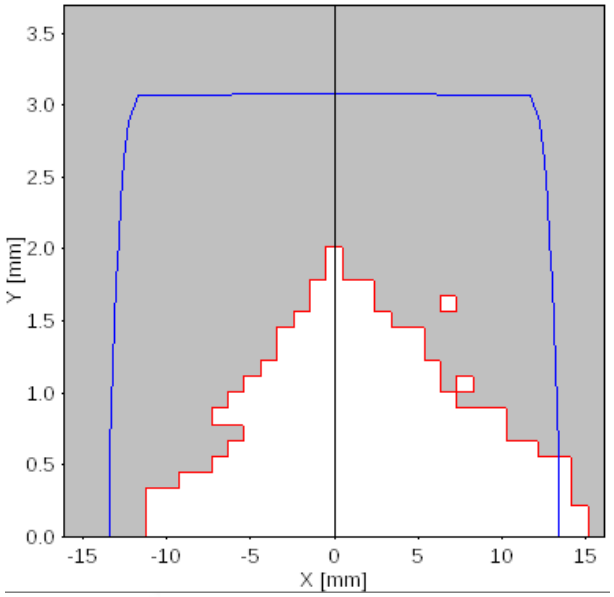
==> DA fast drop with energy

Next :

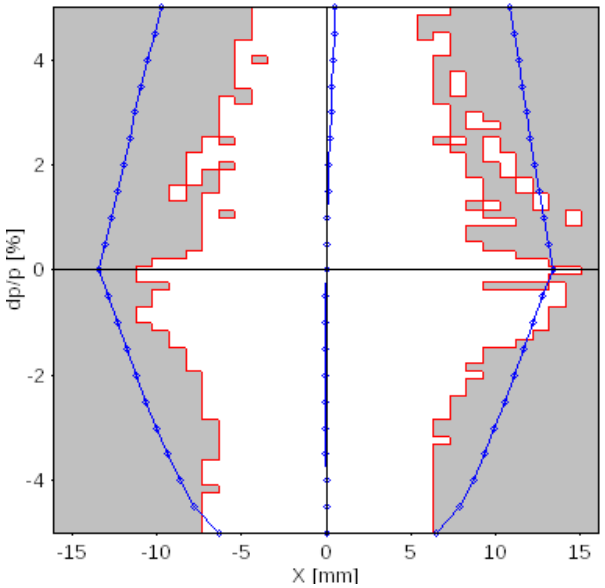
Add octupoles
MOGA optimization
Test with sextupole only didn't show Improvement … (too few families!)

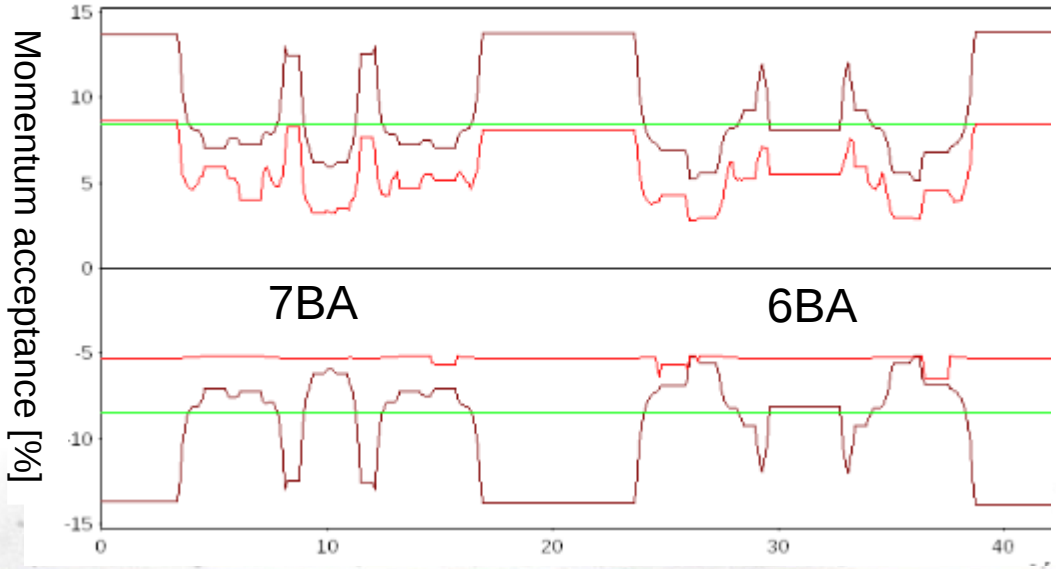


Lifetime by OPA



Very similar than
AT – TRACY - BETA





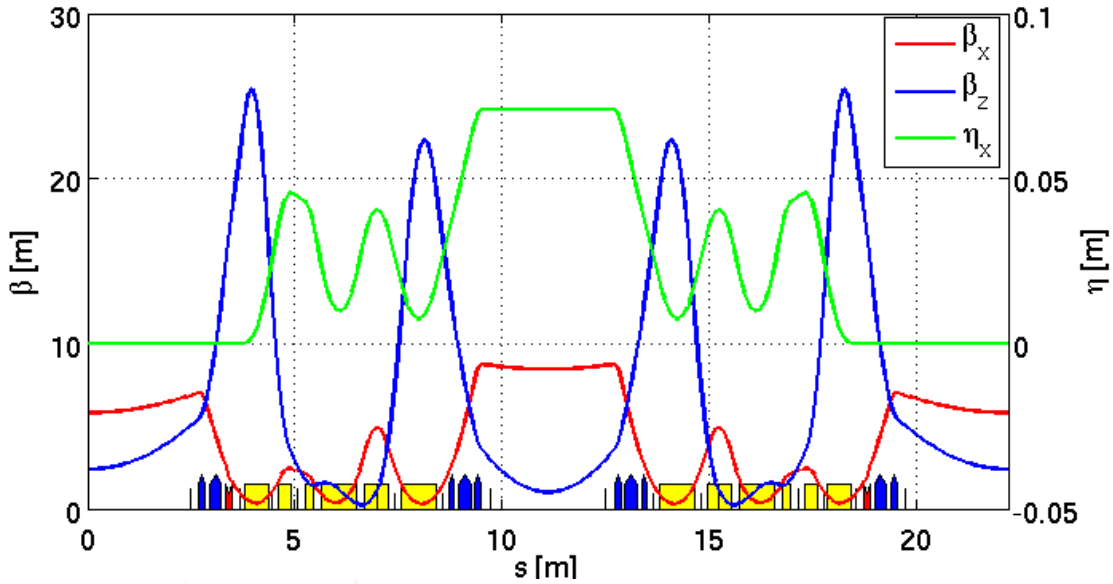
500 mA over 416 bunches
1.2 mA per bunch
8 pm in vertical (~ 4 % coupling)
10 ps rms (0 A bunch length)
3 MV at 352 MHz

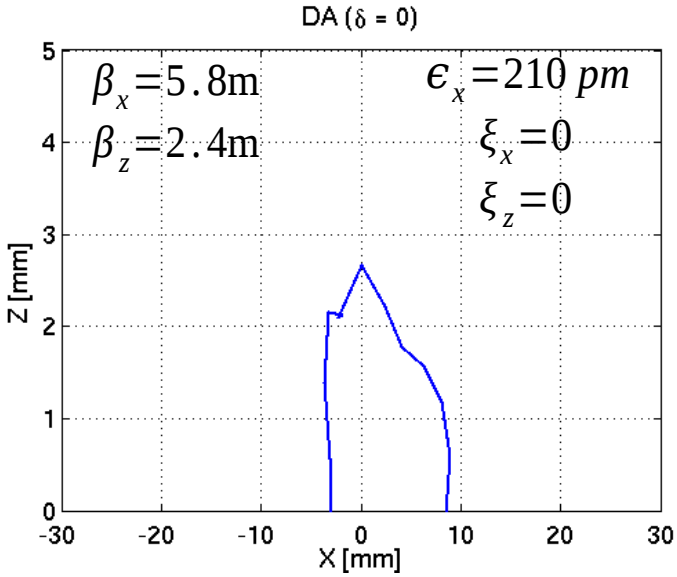
Touschek-lifetime :

Pipe H diameter 40 mm ~ 10 h
32 mm ~ 6.6 h

6BA case – w/o dispersion bump

22.5° / cell including -1.5° from anti-bend





6BA with short straight section of 3 m
No -I transform
8 sextupole families (1 harmonic)

Under investigation with rather large emittance of 210 pm
Small DA < 5 mm with simple optimization

Test with MOGA approach

G_{max} = 50 T/m and 60 T/m in bend (0.6 T) S=4500 T/m^2 over 200 mm

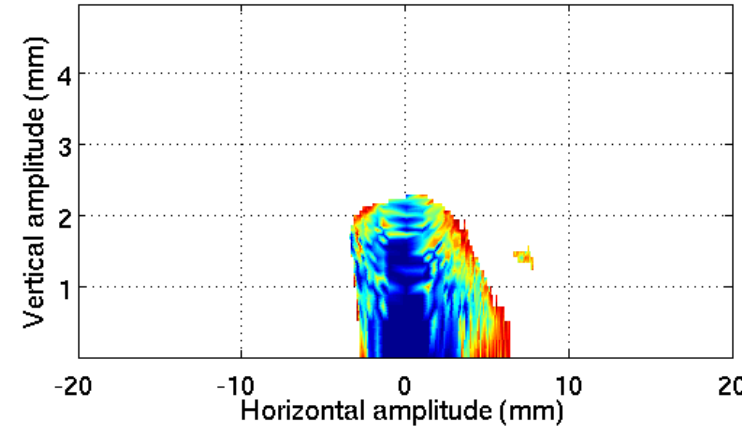
6BA case – Test MOGA pass

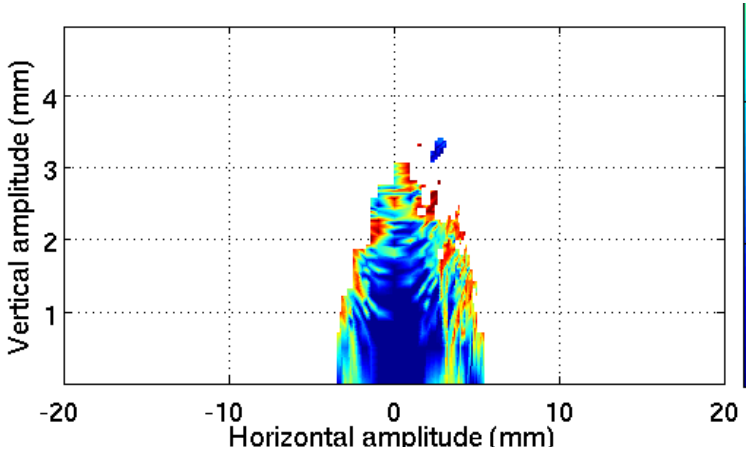
Works performed by Hung-Chun Chao
in post doc position at SOLEIL

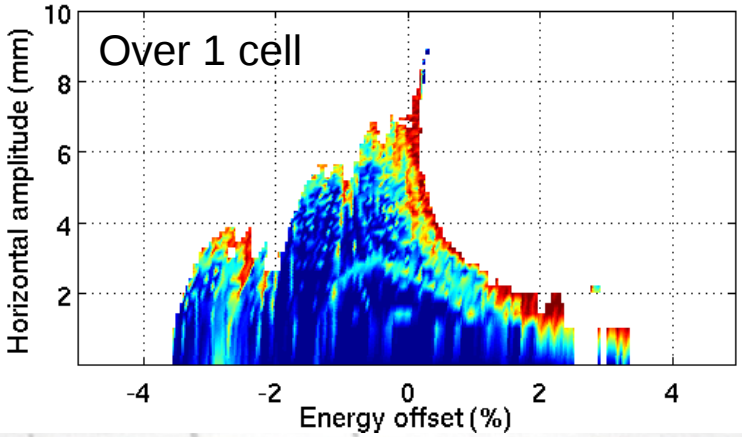
M. P. Ehrlichman, Genetic algorithm for chromaticity correction in diffraction limited storage rings, PRSTAB,19, 044001 (2016)

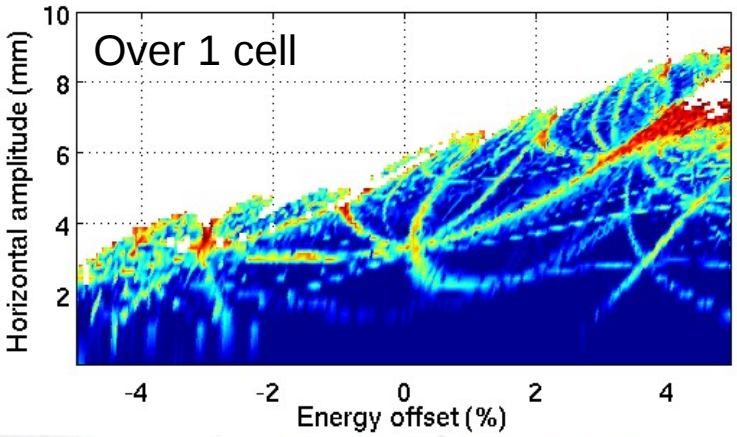
Before MOGA optimization

After MOGA optimization









MOGA-BMAD

~ 800 generations
300 populations
within 2 days
over 64 CPUs

MA improvement

Conclusion

Need to enlarge the short straight section

Add larger beta function at injection point

Include thick sextupoles & fringe field

Control the tune versus amplitude
==> Includes octupoles
==> MOGA tools

Include the double low beta preserving the two canted long beam line geometry

Lattice error sensitivity

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