Lattice studies for SOLEIL ring upgrade

2016

Alexandre Loulergue

On behalf of the accelerator physics group

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

Low emittance $\leq 300$ pm

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

Very low emittance $\leq 100$ 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. 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

Actual:
12 m  7 m  3.8 m
4 nm
45 % of straights

Test:
8 m  5 m  3 m
200-250 pm
32 % of straights

1/8 of the ring here
2.75 GeV
7BA case

Over 1 turn

Tracking by AT

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

\[ G_{\text{max}} = 70 \, \text{T/m} \text{ and } 30 \, \text{T/m in bend (0.6 T)} \quad S=800 \, \text{T/m}^2 \text{ over 200 mm} \]
6BA case

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 ...

Tracking by AT
Merging 7 and 6BA

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!)

\[ \beta_x = 8.6 \text{m} \]
\[ \beta_z = 1.5 \text{m} \]
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

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

![Before MOGA optimization graph](image1)

After MOGA optimization

![After MOGA optimization graph](image2)

MOGA-BMAD

~ 800 generations
300 populations
within 2 days
over 64 CPUs

MA improvement

Over 1 cell

![Over 1 cell graph](image3)
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

...