Online tuning of storage ring non-linear dynamics at SIRIUS and fast ORM measurement

Matheus Melo Santos Velloso
MSc. student

Gleb Wataghin Institute of Physics - University of Campinas
Accelerator Physics Group (FAC) - Brazilian Syncrhotron Laboratory (LNLS)

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Contents

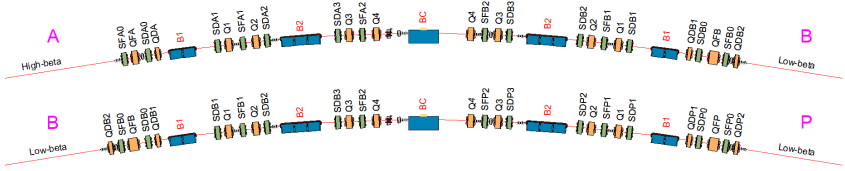
SIRIUS storage ring

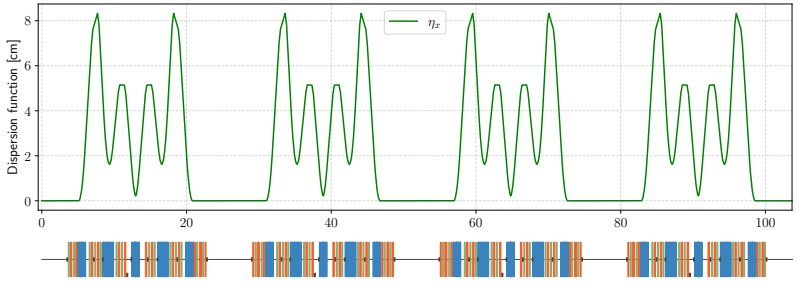
Designed, built and operated by the Brazilian Synchrotron Laboratory (LNLS), at the Brazilian Center for Research in Energy and Materials (CNPEM) campus, at Campinas, Brazil.

Parameter		Currently	Phase I
Energy	E_0	3 GeV	
Current	I_0	100 mA	350 mA
Operation mode		Top-up	
RF Cavities		1 NC	2 SC + HC
RF Voltage	$\hat{V}_{\mathrm{rf}}$	1.5 MV	3.0 MV
RF Frequency	f_{rf}	499.667 MHz	
Harmonic Number	h	864	
Momentum compaction factor	α	1.6×10^{-4}	
Energy Spread	σ_δ	8.5×10^{-4}	
Bunch length	σ_z	2.5 mm	12 mm
Energy loss p/ turn	U_0	470 keV	870 keV
Lifetime	τ	15 h	> 10 h

SIRIUS Lattice and Optics

20-cell 5BA lattice with 5-fold symmetric high (A) and low (B, P) betatron functions sections





Introduction

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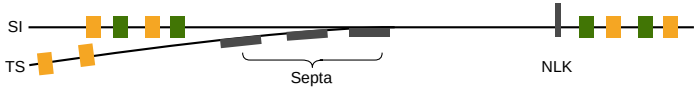
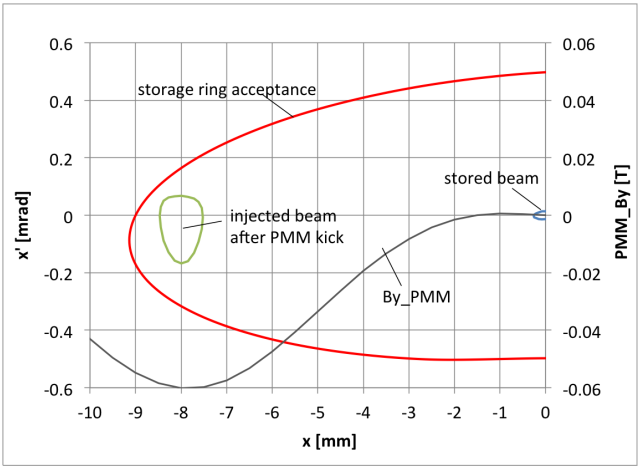
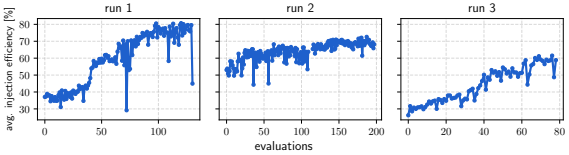
Fast ORM Measruement

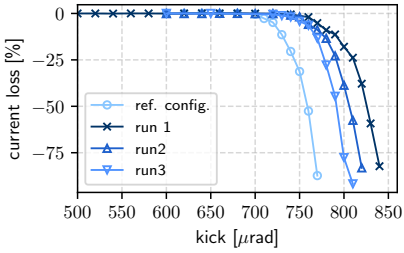
Off-axis injection scheme



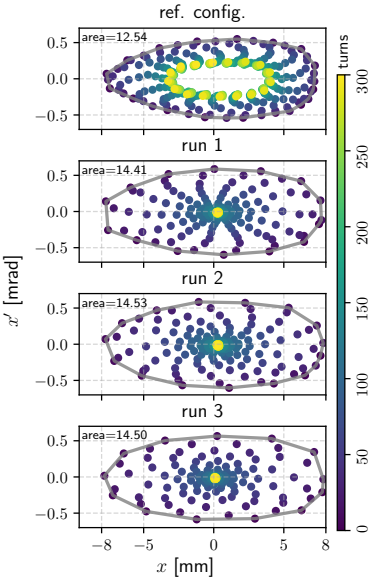


Tuning at $\nu_x = 49.08, \nu_y = 14.14$ (Working Point 1)

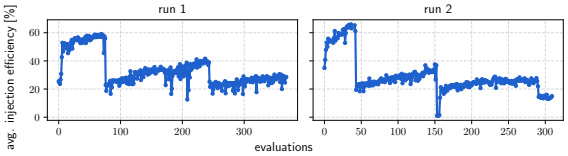


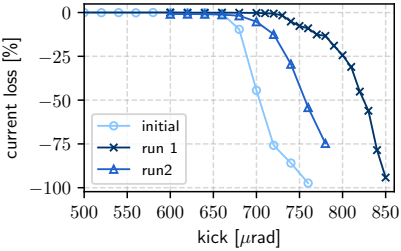


configuration	injection efficiency [%]
ref-config	88 ± 8
run 1	91 ± 1
run 2	98 ± 1
run 3	87 ± 3

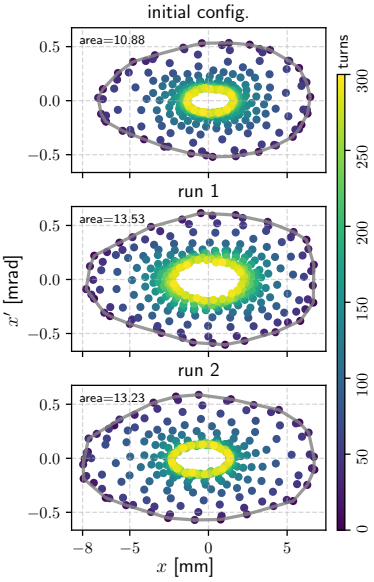


Tuning at $\nu_x = 49.20, \nu_y = 14.25$ (Working Point 2)

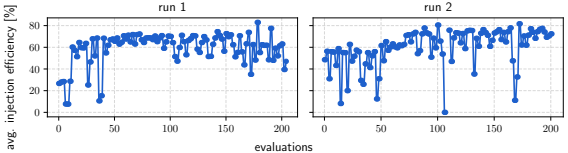


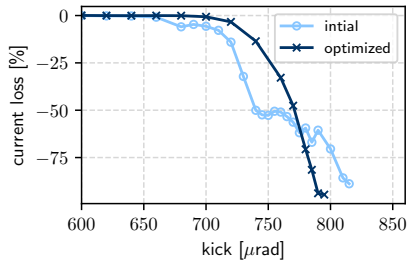


configuration	injection efficiency [%]
non-optimized	51 ± 1
run 1	79 ± 3
run 2	65 ± 1

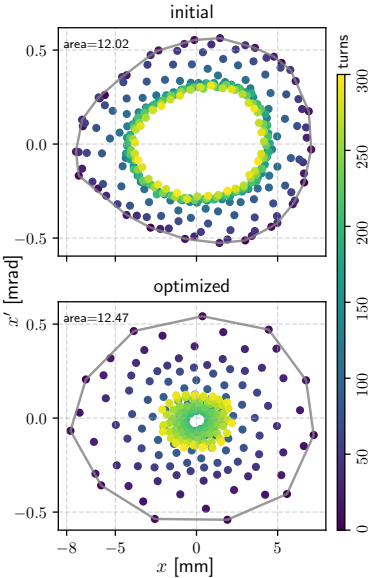


Tuning at $\nu_x = 49.16, \nu_y = 14.22$ (Working Point 3)





configuration	injection efficiency [%]
non-optimized	$-\pm 1$
optimied	93 ± 3



Summary

- Tuning was effective at optimizing injection efficiency
- Some mysteries
  - Larger kick resiliency $\not\Rightarrow$ larger phase portrait areas $\not\Rightarrow$ injection efficiency
- A good sextupole setting was found in WP 3, which contributed for SIRIUS recent milestone of reaching $< 1\%\sigma_x$ and $< 4\%\sigma_y$ orbit stability in the horizontal and vertical, respectively

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