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PTC-PyORBIT SIS18 Benchmark

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Summary

Giuliano Franchetti's SIS18 benchmark has been performed with the PTC-PyORBIT code, the results are detailed in this report.

1 Introduction

Details of the SIS18 benchmark can be found at: https://web-docs.gsi.de/ giuliano/research_activity/trapping_benchmarking/main.html

These instructions are repeated and expanded upon here.

2 Simulation Setup

The parameters in table 1 are used in steps 1 - 6, and the changes in table 2 are used in steps 7 - 9.

Parameter	Symbol	Value	Unit
Sextupole Strength	K_2	0.2	m^{-2}
Maximum Tuneshift	ΔQ_x	0.1	–
Horizontal Transverse Size (rms)	X_{rms}	5	mm
Vertical Transverse Size (rms)	Y_{rms}	5	mm
Longitudinal Size (rms)	Z_{rms}	40.35	m
Horizontal Geometric Emittance (2 σ)	ϵ_x	12.57	$mm\ mrad$
Vertical Geometric Emittance (2 σ)	ϵ_y	9.30	$mm\ mrad$
One Synchrotron Oscillation	N_{synch}	15000	$turns$
Bunch Length (4 σ_z)	τ	3472.7	ns
Kinetic Energy	E_k	11.4	MeV/u
Transition Gamma	γ_t	5	–
Momentum Spread (3 σ)	$\frac{\Delta p}{p}$	$2.5{\cdot}10^{-4}$	–
Sextupole Strength	K_2	0.2	m^{-2}

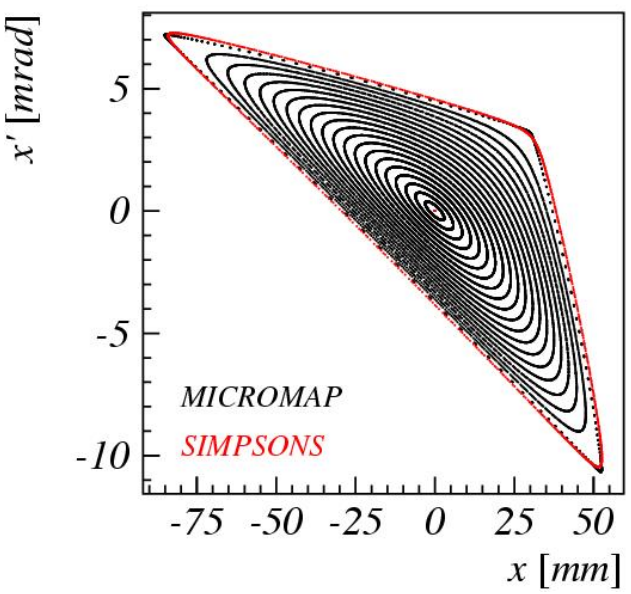
Table 1: Parameters used for the SIS18 benchmark steps 1 - 6.

Parameter	Symbol	Value	Unit
Longitudinal Size (rms)	Z_{rms}	2.69	m
One Synchrotron Oscillation	N_{synch}	1000	$turns$
Bunch Length (4 σ_z)	τ	231.51	ns

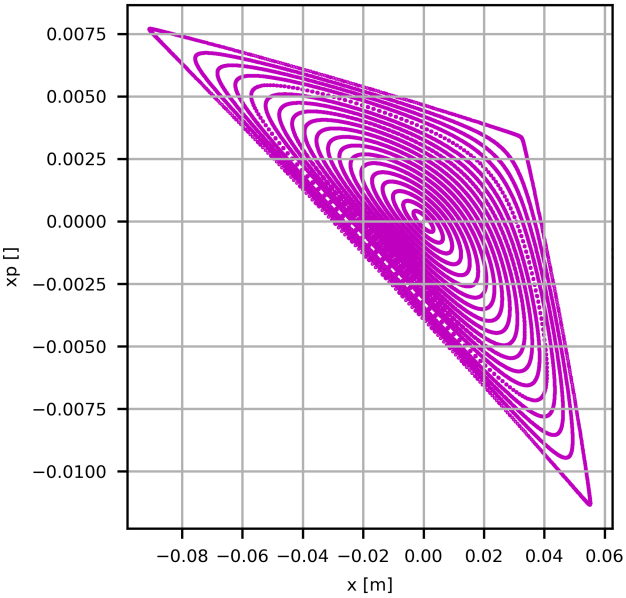
Table 2: Parameter changes used for the SIS18 benchmark steps 7 - 9.

3 Step 1: Benchmarking of the phase space

The first step is to confirm that the phase space near the 3rd order resonance has the same topology for all codes. We check the orbits up to the border of stability (dynamic aperture). For this test the tunes are $Q_x = 4.338$, $Q_y = 3.2$, the Poincaré section is plot at the beginning of the SIS18 lattice.

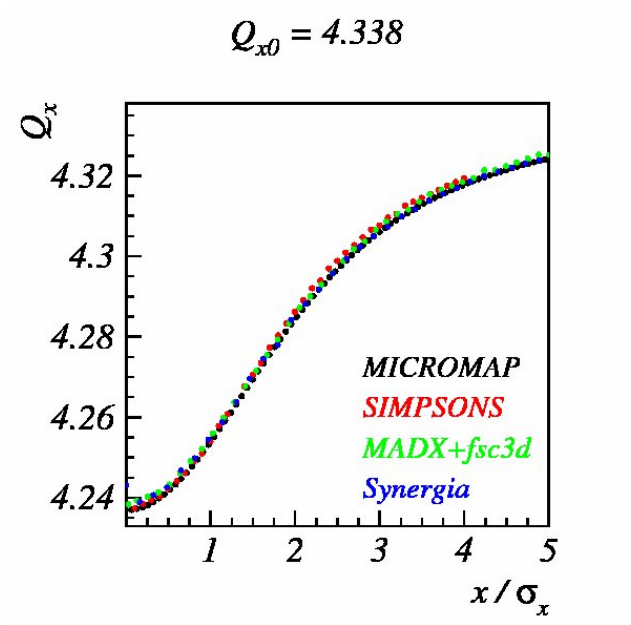


(a) MICROMAP and SIMPSONS.

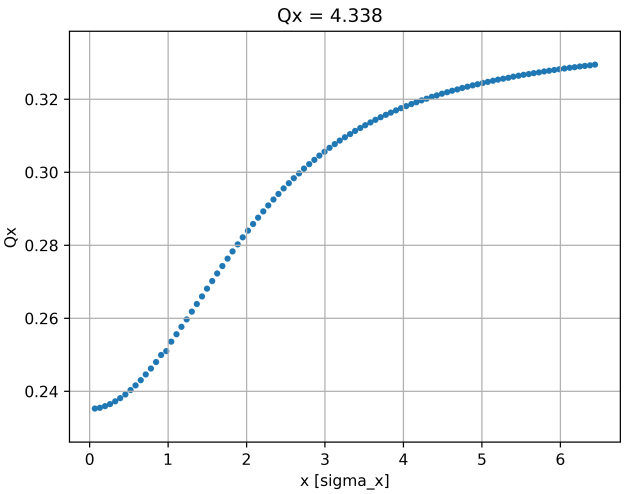


(b) PTC-PyORBIT.

Figure 1: Step1: Phase space with sextupole on and no space charge.



(a) MICROMAP and SIMPSONS.



(b) PTC-PyORBIT.

Figure 2: Step2: Tune with space charge.

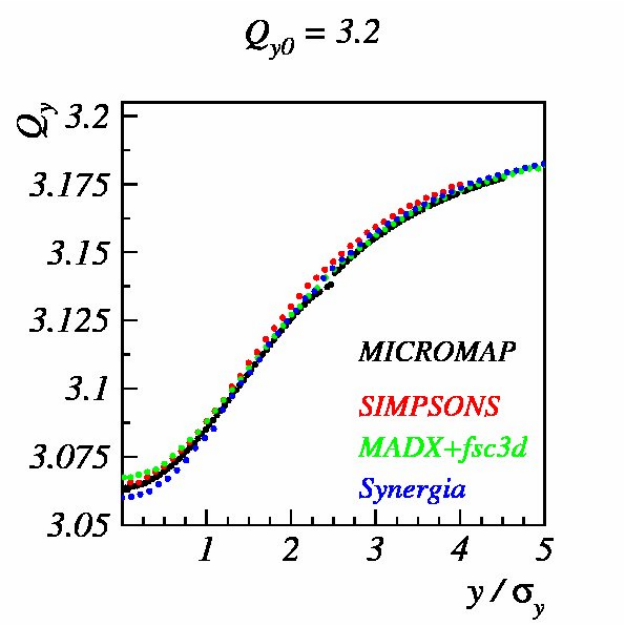


Figure 3: Step2.

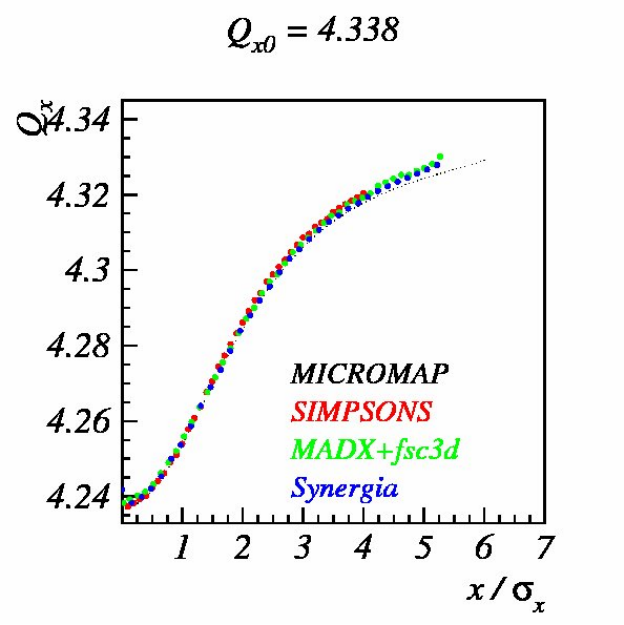


Figure 4: Step3.

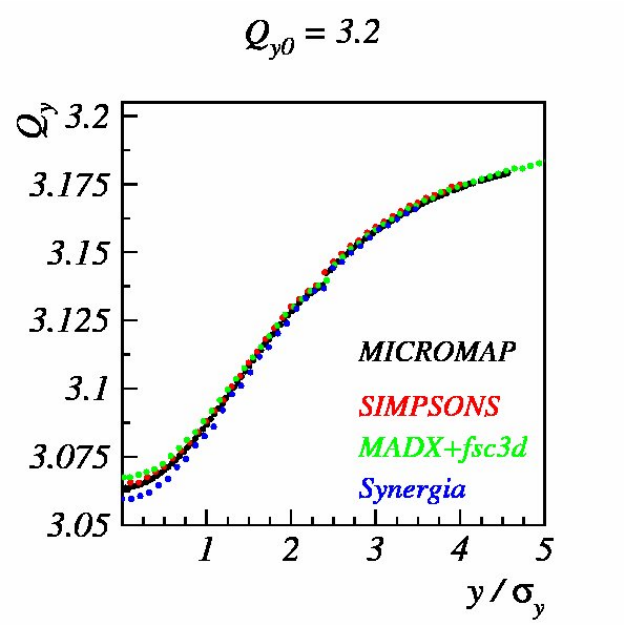


Figure 5: Step3.

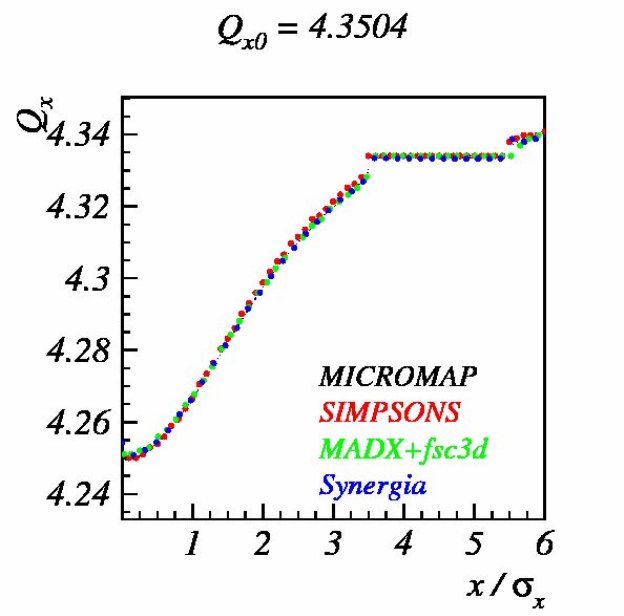


Figure 6: Step4.

4 Step 2: Tunes with sextupole off

5 Step 3: Tunes with sextupole on at $Q_x = 4.338$

6 Step 4: Tunes with sextupole on at $Q_x = 4.3504$

7 Step 5: Phase space with space charge and sextupole on at $Q_x = 4.3504$

8 Step 6: Benchmarking of trapping in 1 synchrotron oscillation for $Q_s = 1/15000$

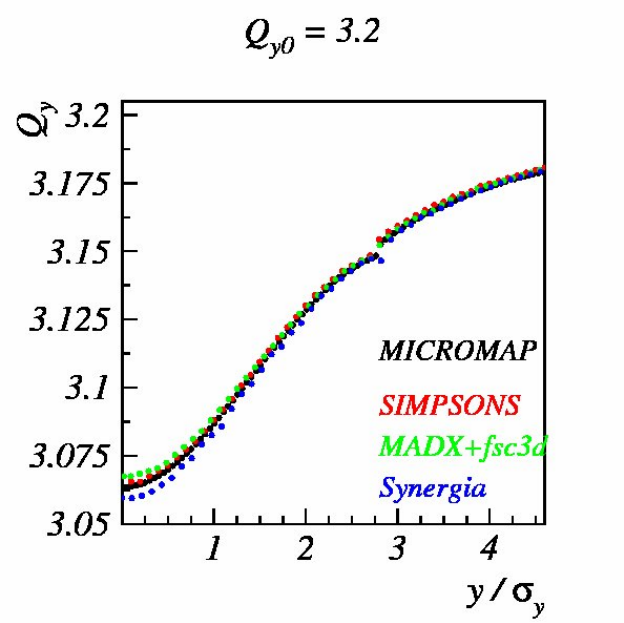


Figure 7: Step4.

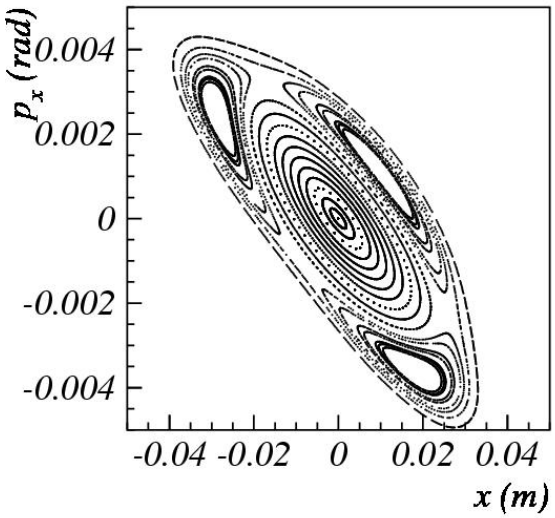


Figure 8: Step5.

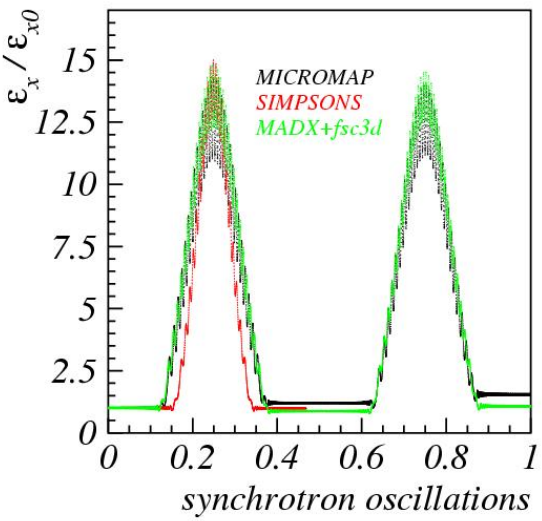


Figure 9: Step6.

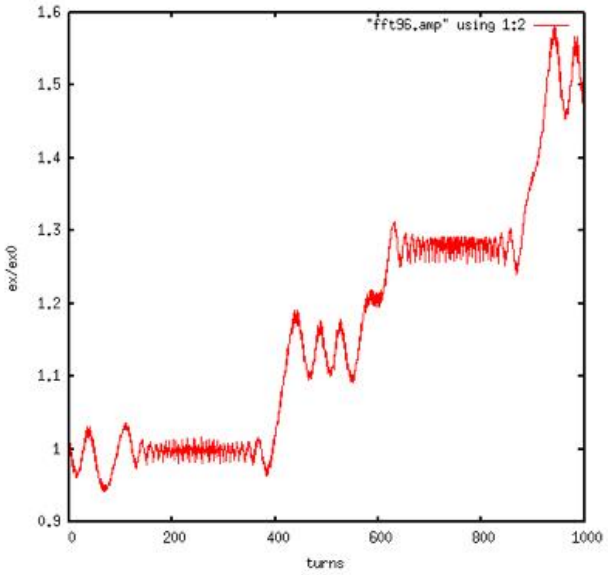


Figure 10: Step7.

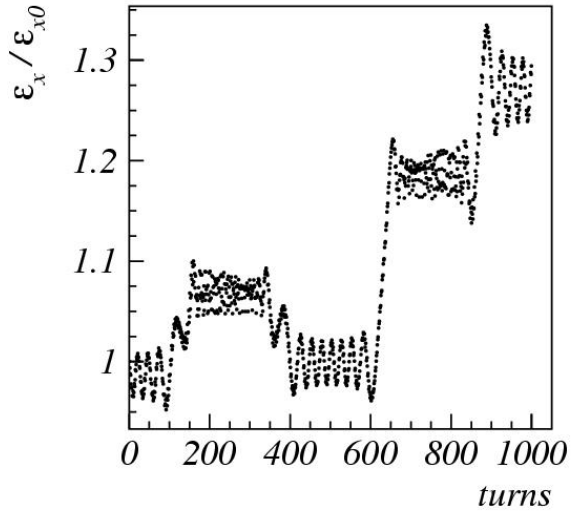


Figure 11: Step7.

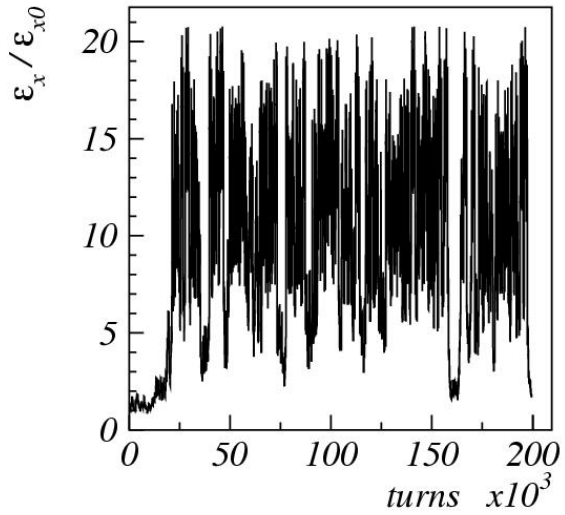


Figure 12: Step8.

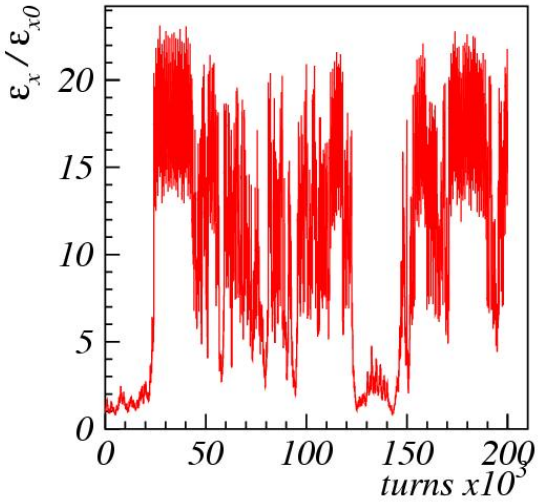


Figure 13: Step8.

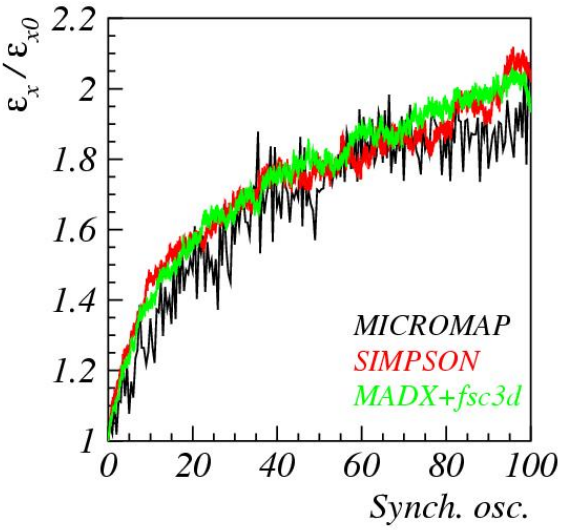


Figure 14: Step9.