Dynamics aperture study for HL-LHC

Flat optics for HL-LHC at collapse

Colas Droin, for the beam-beam team

Supervisor: Guido Sterbini

Configuration

- Collapse:
  - no CC, Q'=15, octupole scan at "tune scan diag+0.5e-3" at round beta* = 1.1 m (or 1.0 m) [Cola, Guido]

Configuration selected following actions from summer DA Simulation meeting (at collapse):

Collapse process

Collapse process is defined by the target lumi in the range of 1-2.5e34

L-Nb [10^34]	Energy	beta sep	beta cross	MO	Emit [um]	ppb	Crab	sep	crossing	Q'	LHCb - 1.5m / Alice 10m [10^34]	Optics
2.5 - 2200	7	0.7	0.7	450	2.3	2.3	0	0	250	15	0.2/0.014	Opt_collapse_700_1500, opt_collapse_700_1500_thin
2.5 - 2200	7	0.6	1.2	450	2.3	2.3	0	0	250	15	0.2/0.014	
2.5 - 2200	7	0.45	1.8	450	2.3	2.3	0	0	250	15	0.2/0.014	Opt_flathv_450_1800_1500, opt_flathv_450_1800_1500_thin
2.3 - 2200 or 2.0 - 1960	7	0.5	2	450	2.3	2.3	0	0	250	15	0.2/0.014	opt_flathv_500_2000_thin.madx
2.5 - 2748 or 1.8 - 1960	7	1.1	1.1	450	2.3	2.3	0	0	250	15	0.2/0.014	Opt_collapse_1100_1500.madx
2.5 - 2748 or 1.8 - 1960	7	0.9	1.8	450	2.3	2.3	0	0	250	15	0.2/0.014	opt_collapse_flathv_900_1800_1500.madx
2.5 - 2748 or 1.8 - 1960	7	0.7	2.8	450	2.3	2.3	0	0	250	15	0.2/0.014	opt_collapse_flathv_700_2800.madx
	7	1.0	1.0	450	2.3	2.3	0	0	250	15	0.2/0.014	opt_collapse_1000_1500.madx

Selected filling scheme is 8b4e, L = 2.04 e34 in IP1/5, L = 2e33 in IP8, and 5σ separation in IP2

Filling scheme and bunch schedule

8b4e

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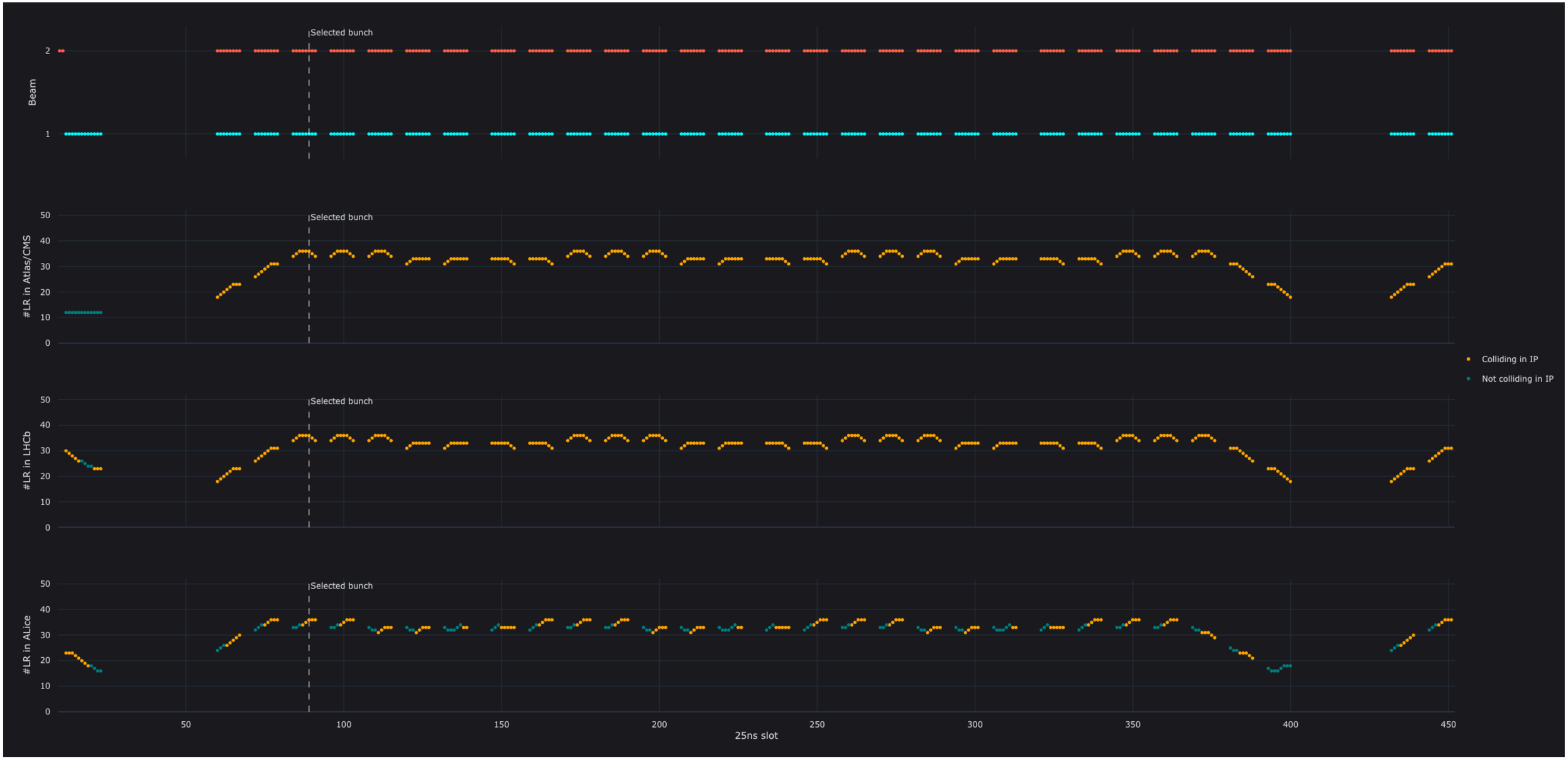
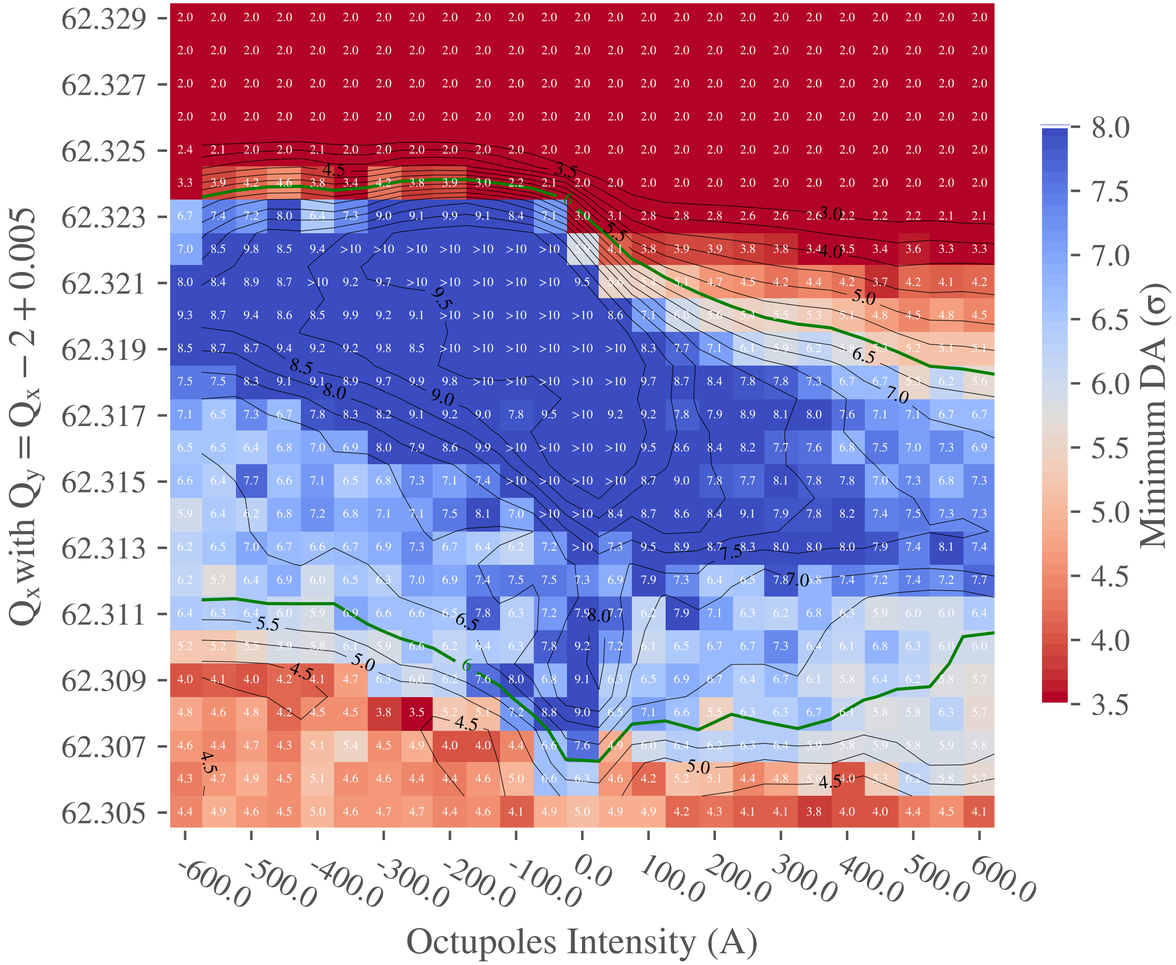
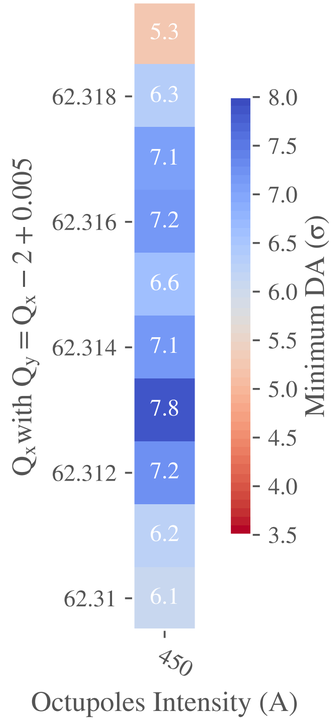


Simulations result

HL-LHC v1.6. E = 7.0 TeV. $N_b \simeq 2.3 \times 10^{11}$ ppb,
$L_{1/5} = 2.04 \times 10^{34} cm^{-2} s^{-1}$, $L_2 = 3.46 \times 10^{30} cm^{-2} s^{-1}$, $L_8 = 2 \times 10^{33} cm^{-2} s^{-1}$
$\beta^*_{x,1} = 1$ m, $\beta^*_{y,1} = 1$ m, polarity $IP_{2/8} = 1/1$
$\Phi/2_{1(H)} = 250$ µrad, $\Phi/2_{5(V)} = 250$ µrad, $\Phi/2_{2,V} = -170$ µrad, $\Phi/2_{8,V} = 170$ µrad
$\sigma_z = 7.61$ cm, $\varepsilon_n = 2.3$ µm, $Q' = 15$, $C^- = 0.001$
8b4e_1972b_1960_1178_1886_224bpi_12inj. Bunch 89.



Beam 2 validation:



- DA target easily reached for almost all octupoles values scanned!
- Negative values yield better results.

No time to run other simulations…

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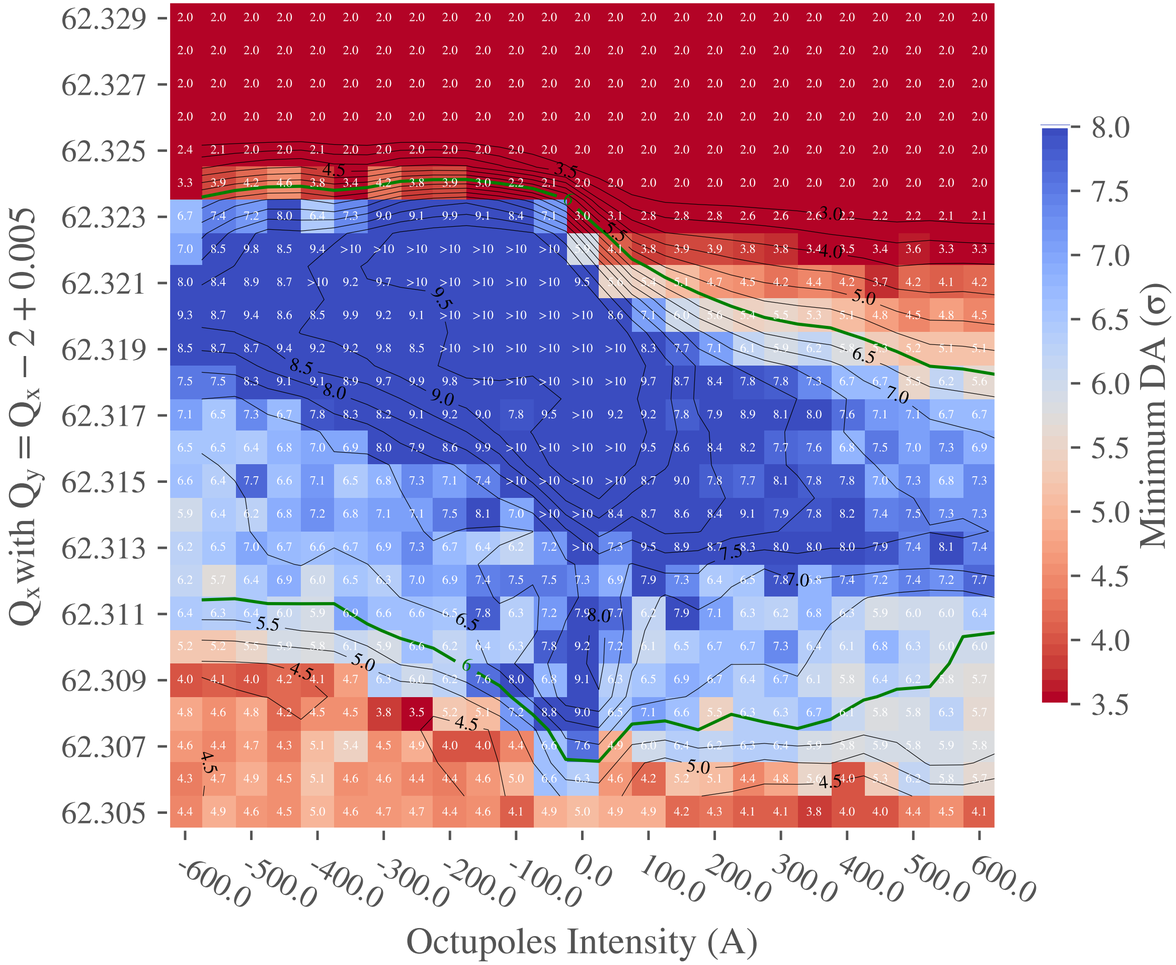
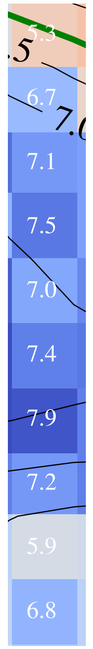
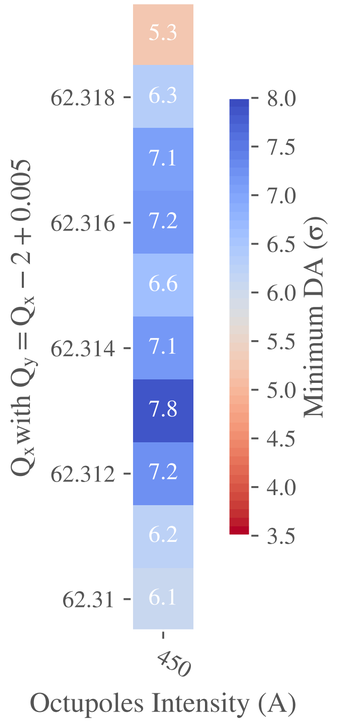


Beam 1



Beam 2



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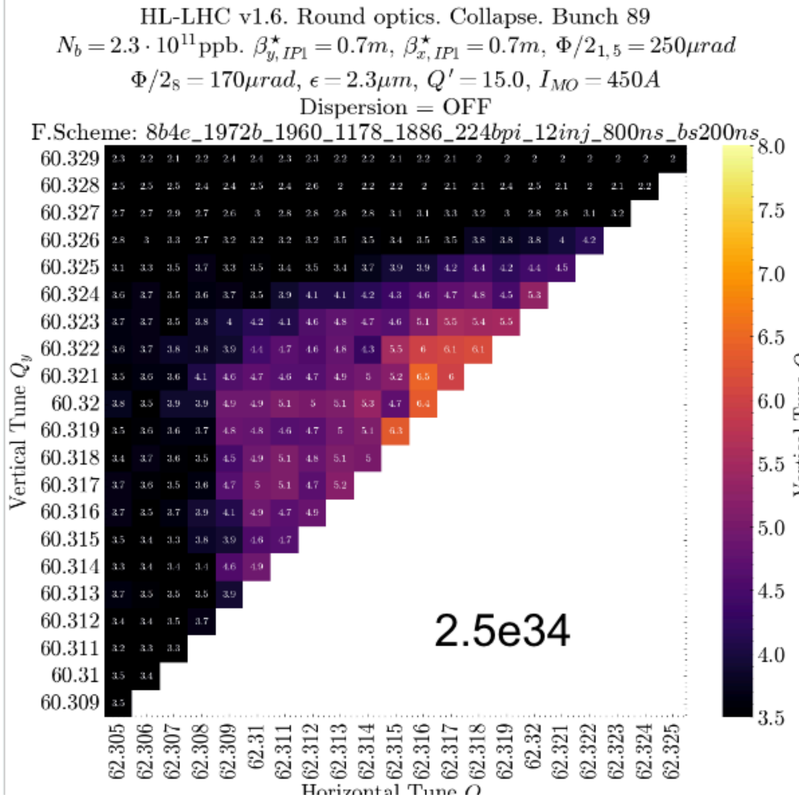
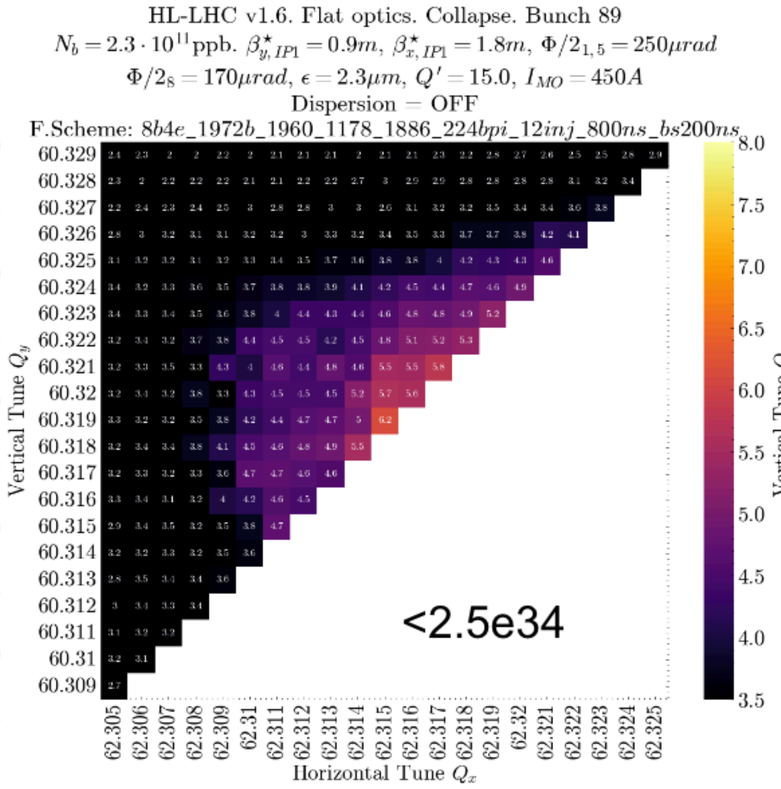
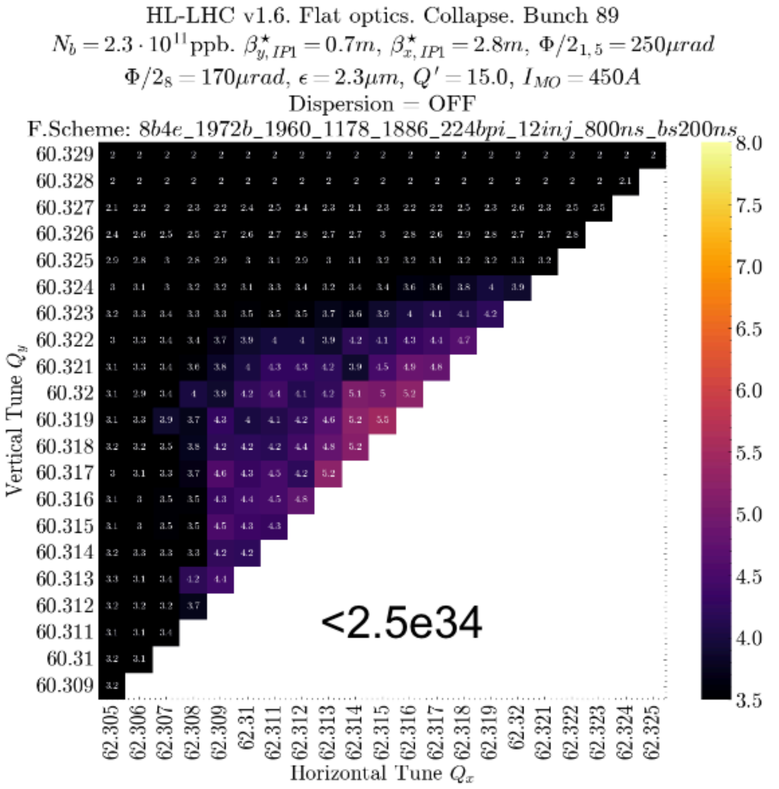
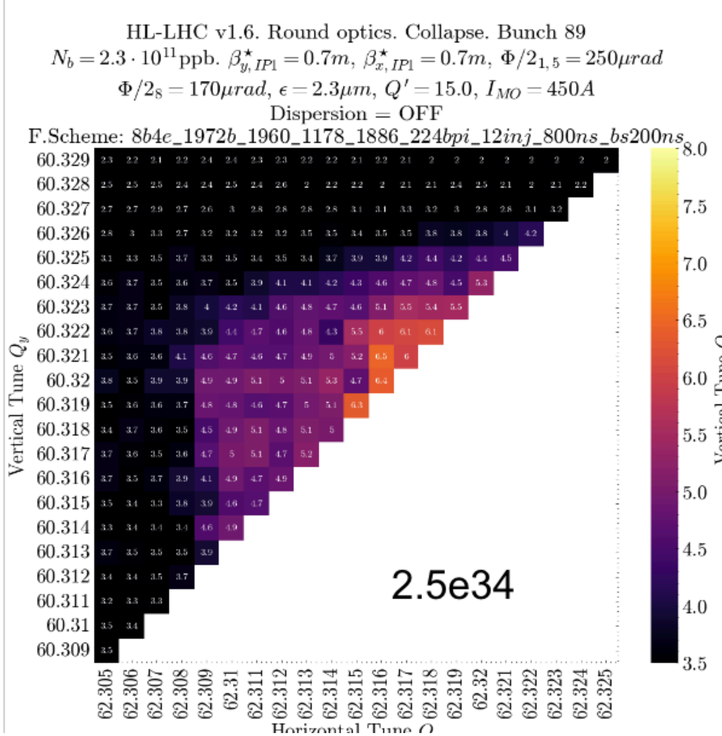
A note on last presentation simulations

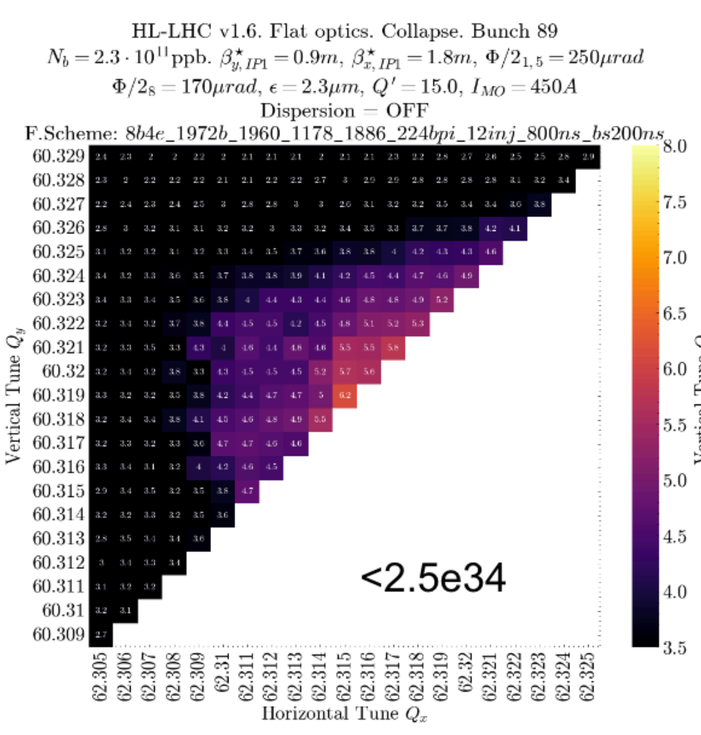
Collapse (without CC and 8b4e)

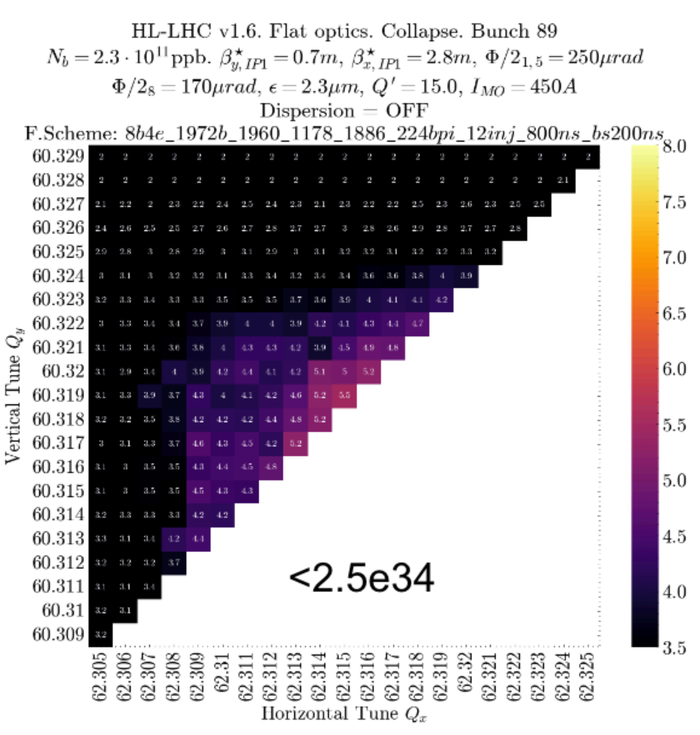




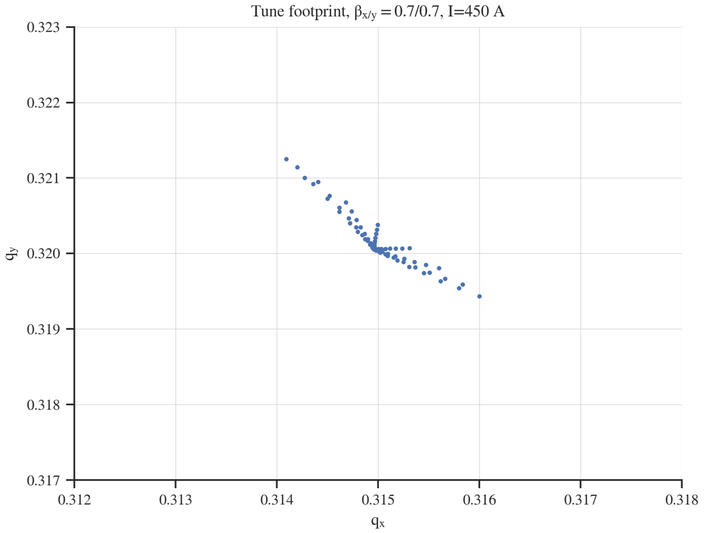


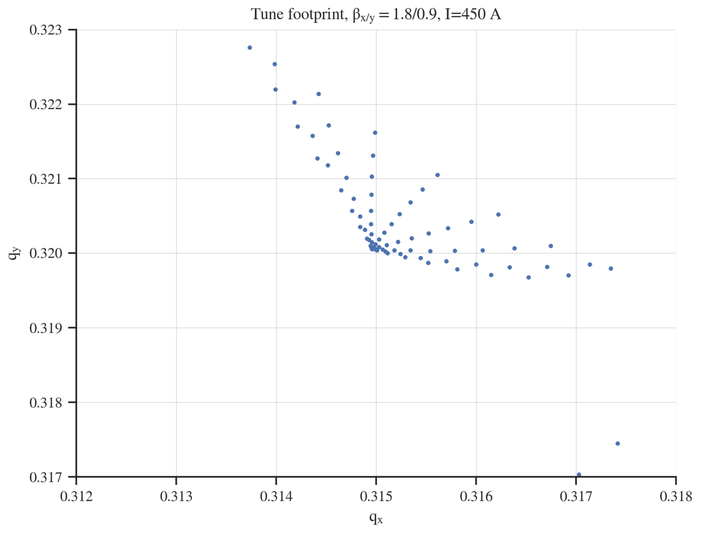


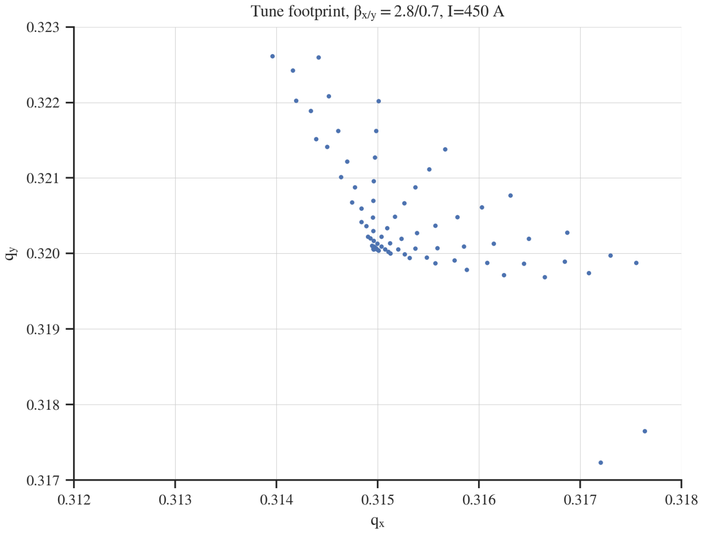




Tune footprints without beam-beam



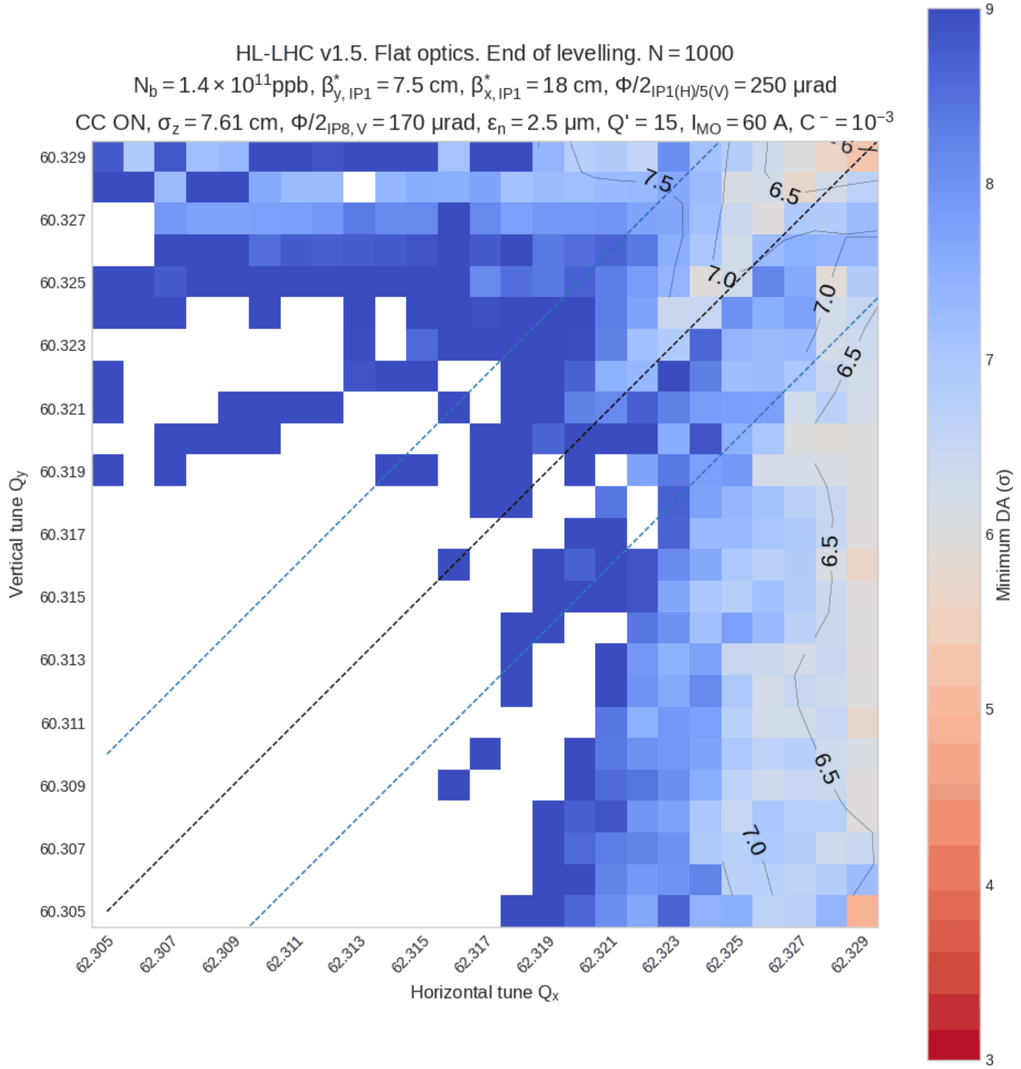


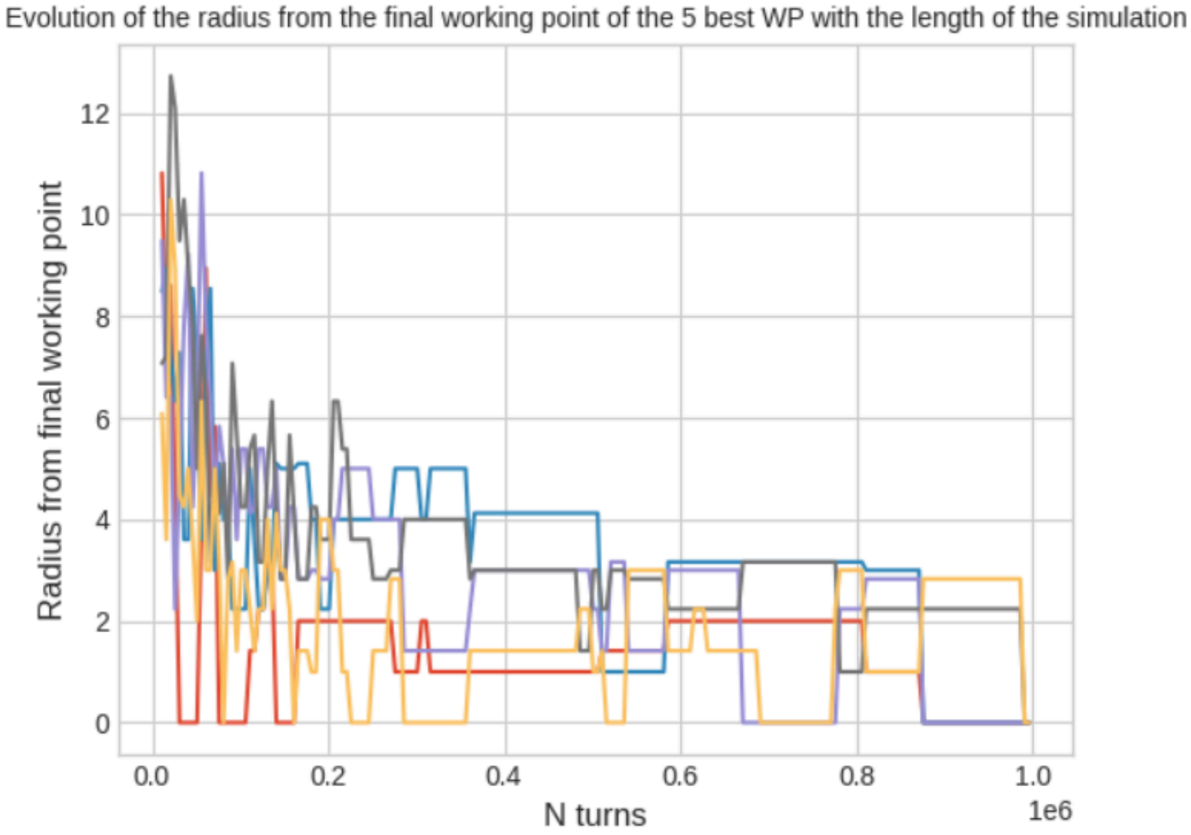


The octupoles act more on the flat beams… The tune-scans are not comparable

A note on simulation process improvement

An area enclosing the final working point can be defined way before 1M turns:





Thank you!