FCCee Optics Design Meeting
17 July 2015, CERN

Nonlinear Dynamic Study of FCCee collider

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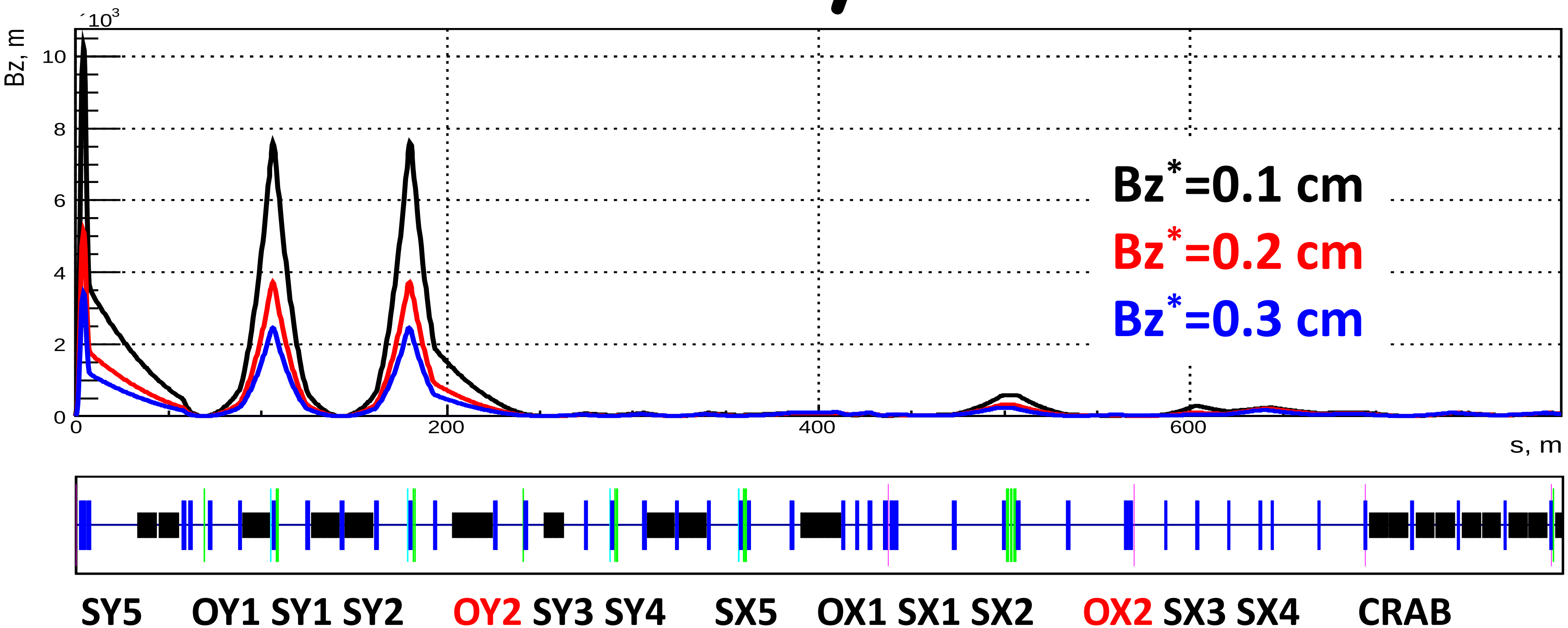
Model

- Sextupoles (IR's & Arc's)
- Octupoles (only in IR)
- Quadrupole fringe fields
- Kinematic term
- RF cavities
- Crab sextupole
- With and without damping (no fluctuation)

Main Version 16-14.3

Betas @ IP	0.1/50	0.2/50	0.3/50	cm
Sigmas @ IP	29/0.058	29/0.081	29/0.1	um
Nat. chroms	-138.8/-828.4	-140.6/-440.7	-139.3/-347.9	
Betas @ SY	22/7042	22/3449	22/2282	m
Betas @ SX	184/31	189/15	190/10	m
K2 @ SY	-8.72	-8.84	-8.84	m^{-3}
K2 @ SX	-7.46	-7.0	-6.46	m^{-3}

IR Layout



SY1 & SY3 – main ver sext pair SY2 & SY4 – weak ver sext comps

SX1 & SX3 – main hor sext pair SX2 & SX4 – weak hor sext comps

SY5 & SX5 – ver and hor sexts for off-energy optimization

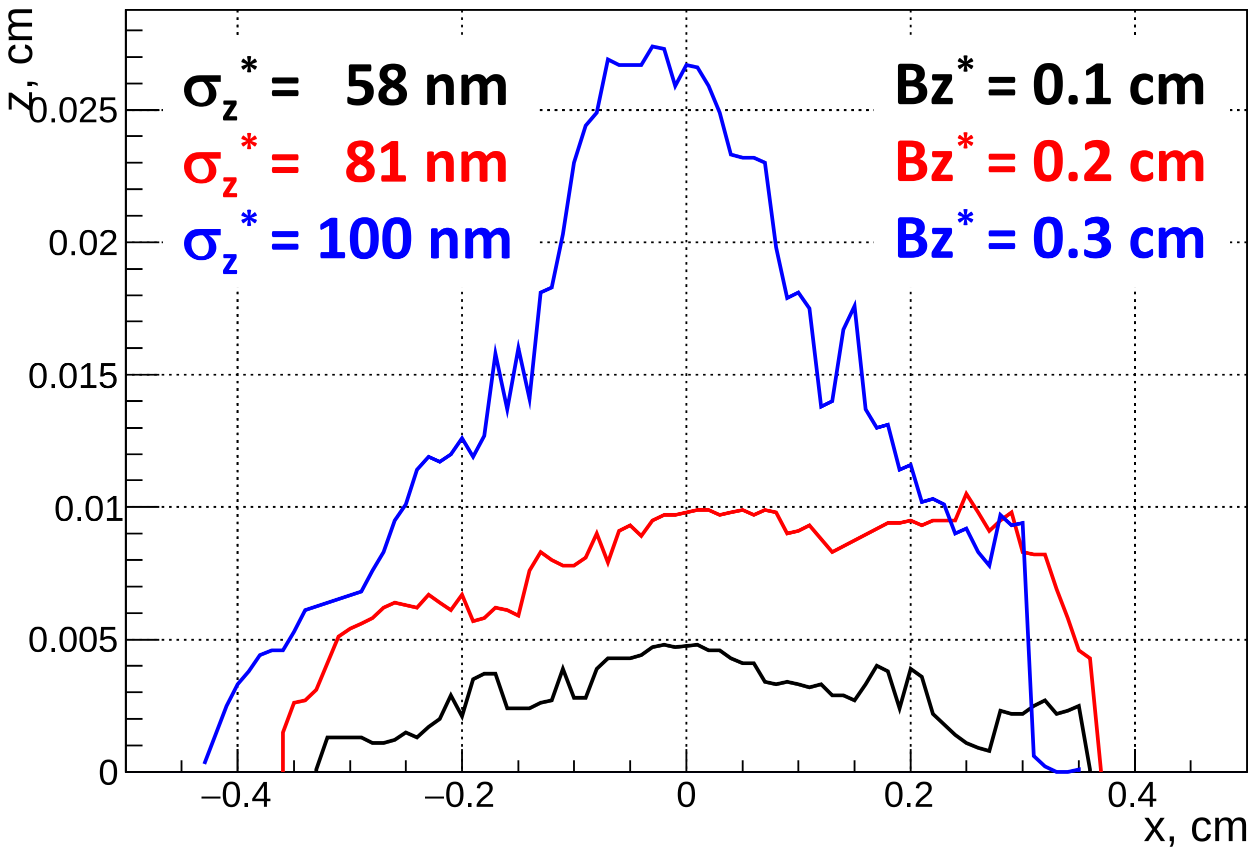
OY1 & OX1 – ver and hor octupoles

OY2 & OX2 – don’t work

MSF & MSD – arc sexts

IR's Dynamic Aperture

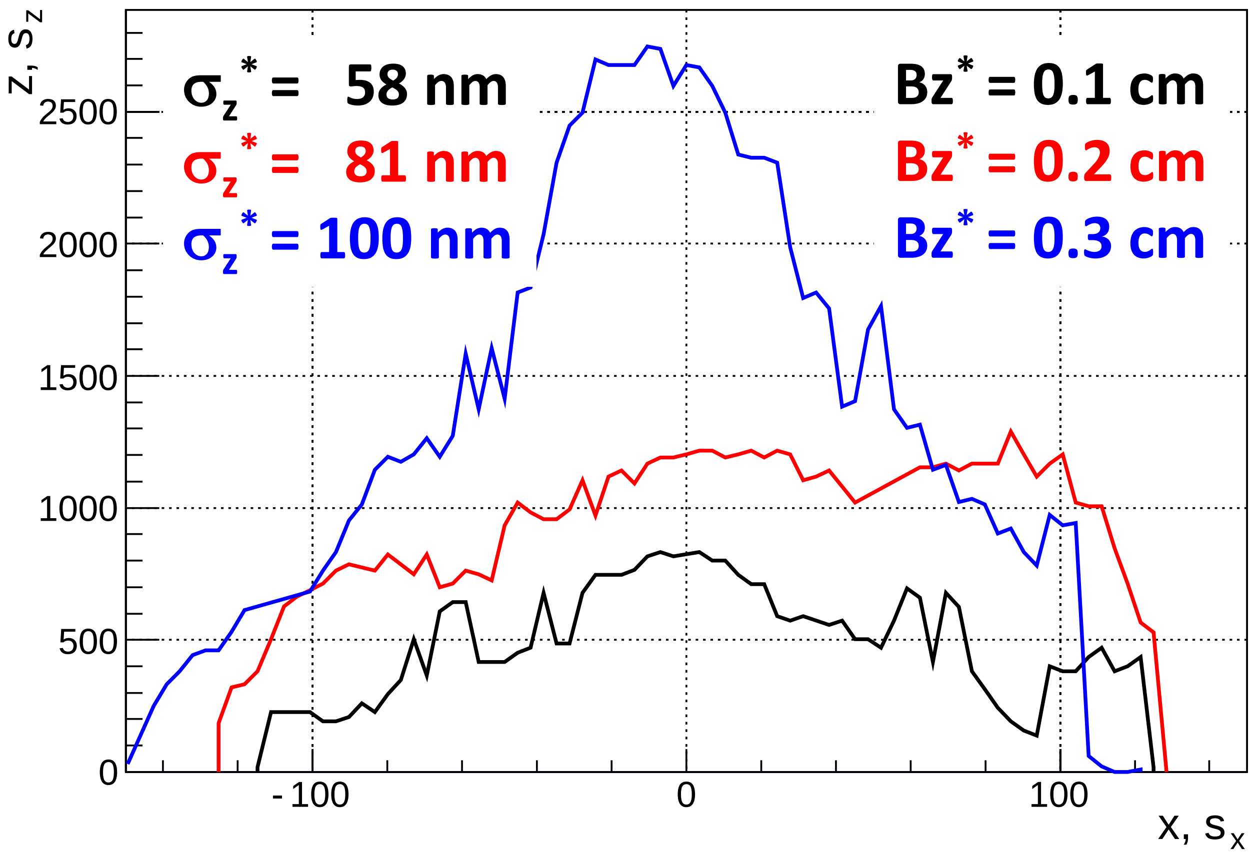
1000 turns without damping, no rf, no arc's sexts, no crab



ε_x=1.7 nm·rad, 0.2% coupling, σ_x=1.6·10^{-3}

IR's Dynamic Aperture

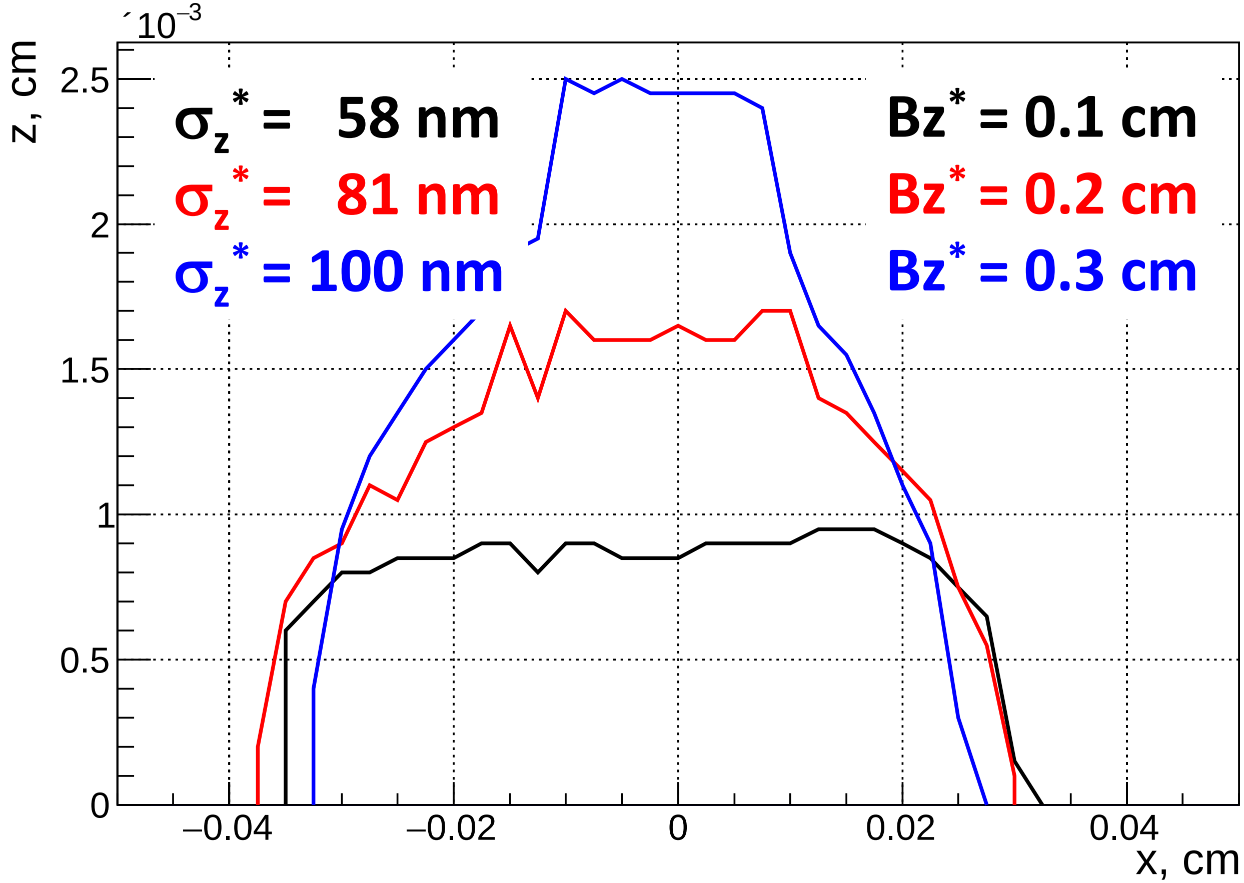
1000 turns without damping, no rf, no arc's sexts, no crab



ε_x=1.7 nm · rad, 0.2% coupling, σ_x=1.6 · 10^{-3}

Total Dynamic Aperture

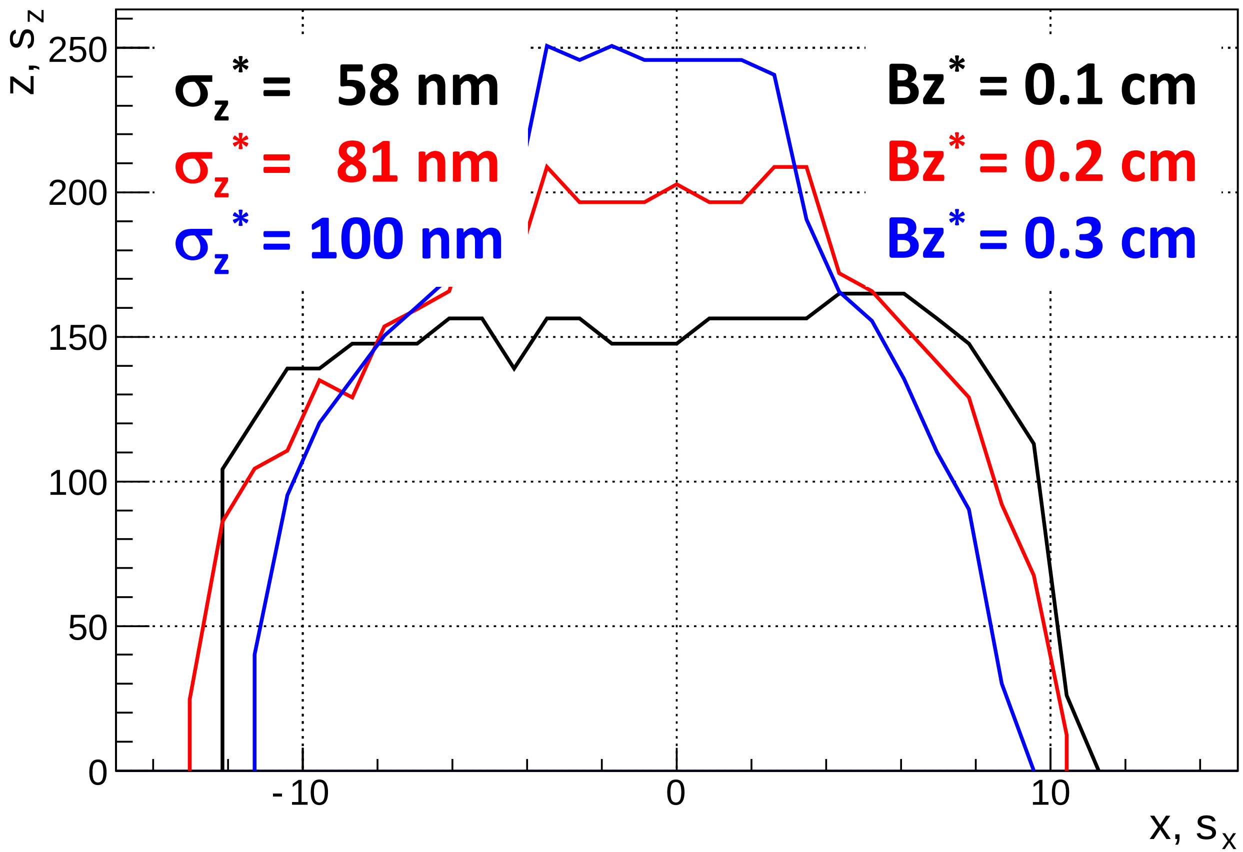
1000 turns without damping, rf, no crab



ε_x=1.7 nm·rad, 0.2% coupling, σ_x=1.6·10^{-3}, Urf=2.5 GV

Total Dynamic Aperture

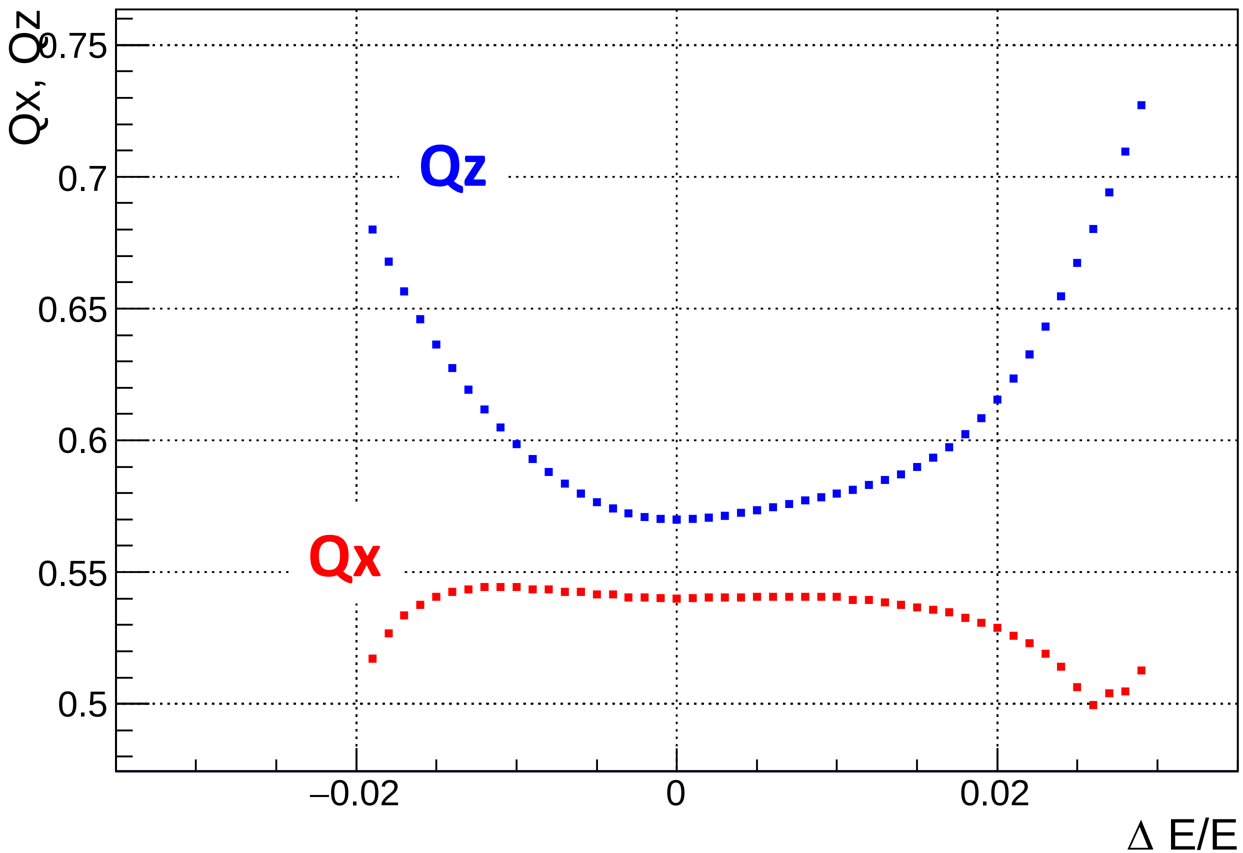
1000 turns without damping, rf, no crab



ε_x=1.7 nm·rad, 0.2% coupling, σ_x=1.6·10^{-3}, Urf=2.5 GV

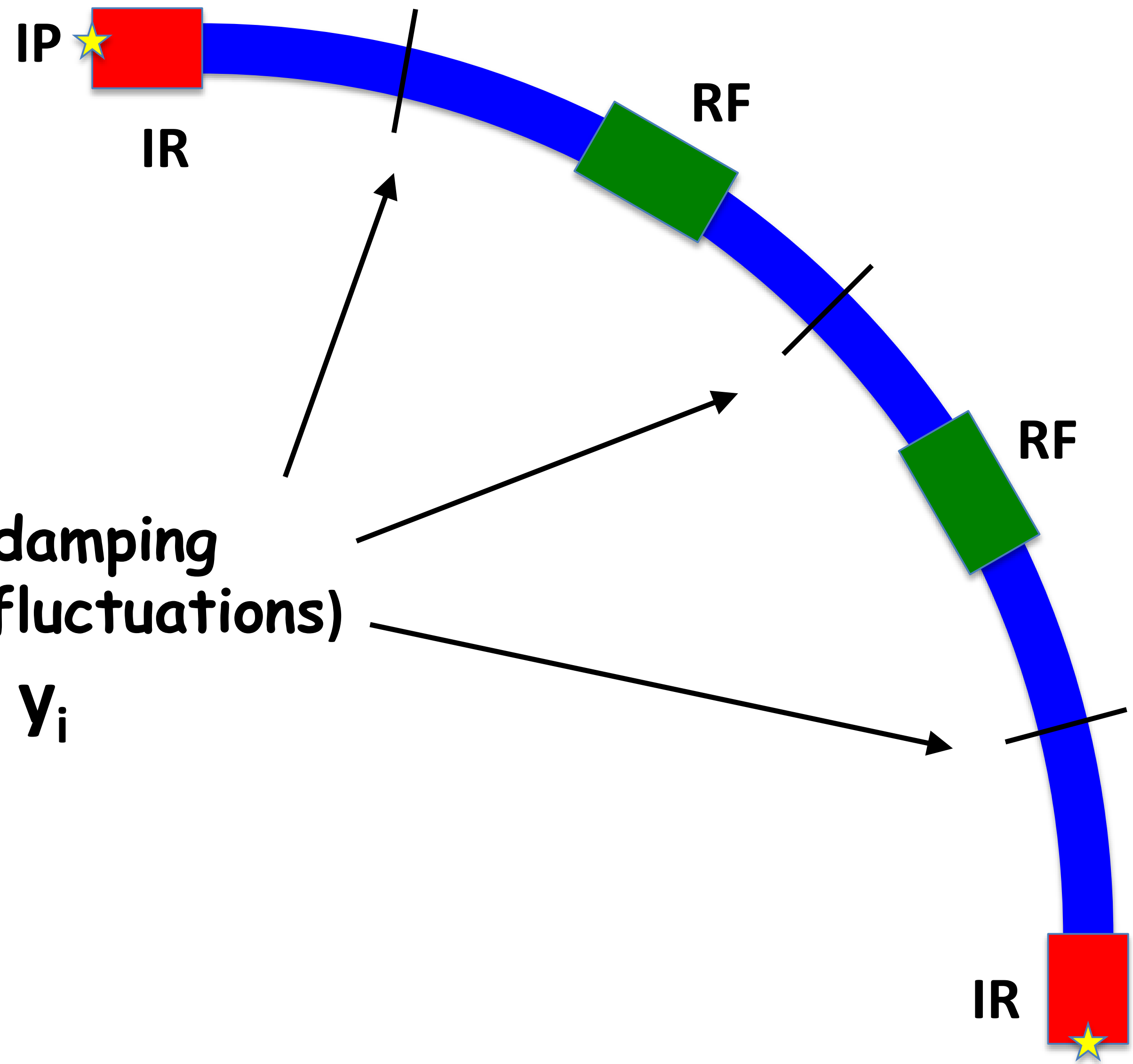
Energy Acceptance

1000 turns without damping, no rf, no crab



ε_x=1.7 nm·rad, 0.2% coupling, $\sigma_x=1.6\cdot10^{-3}$

Simulation with Damping

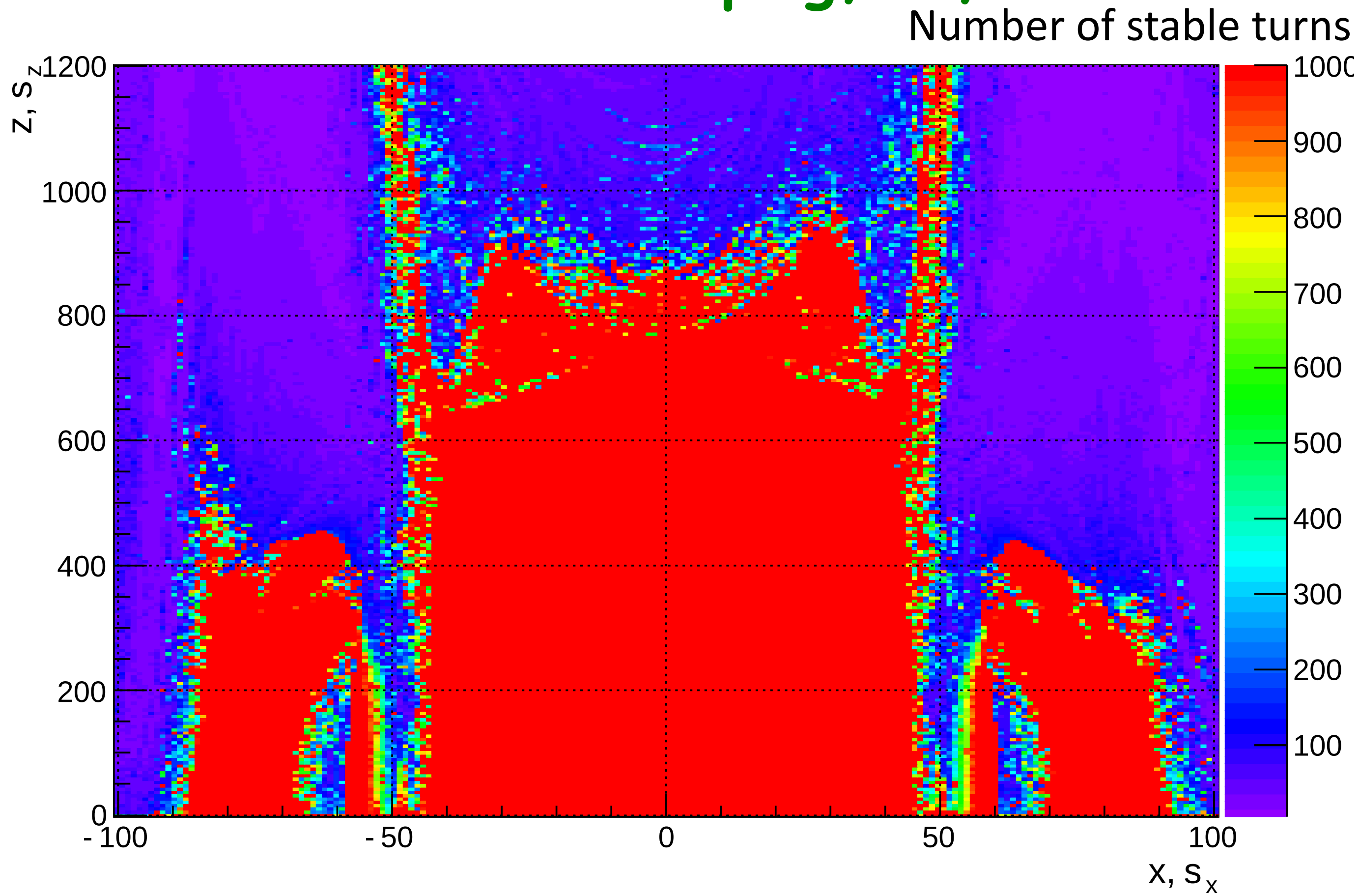


3 points for damping
(no quantum fluctuations)

$$Y_i = e^{-\lambda} y_i$$

Dynamic Aperture @ 45 GeV

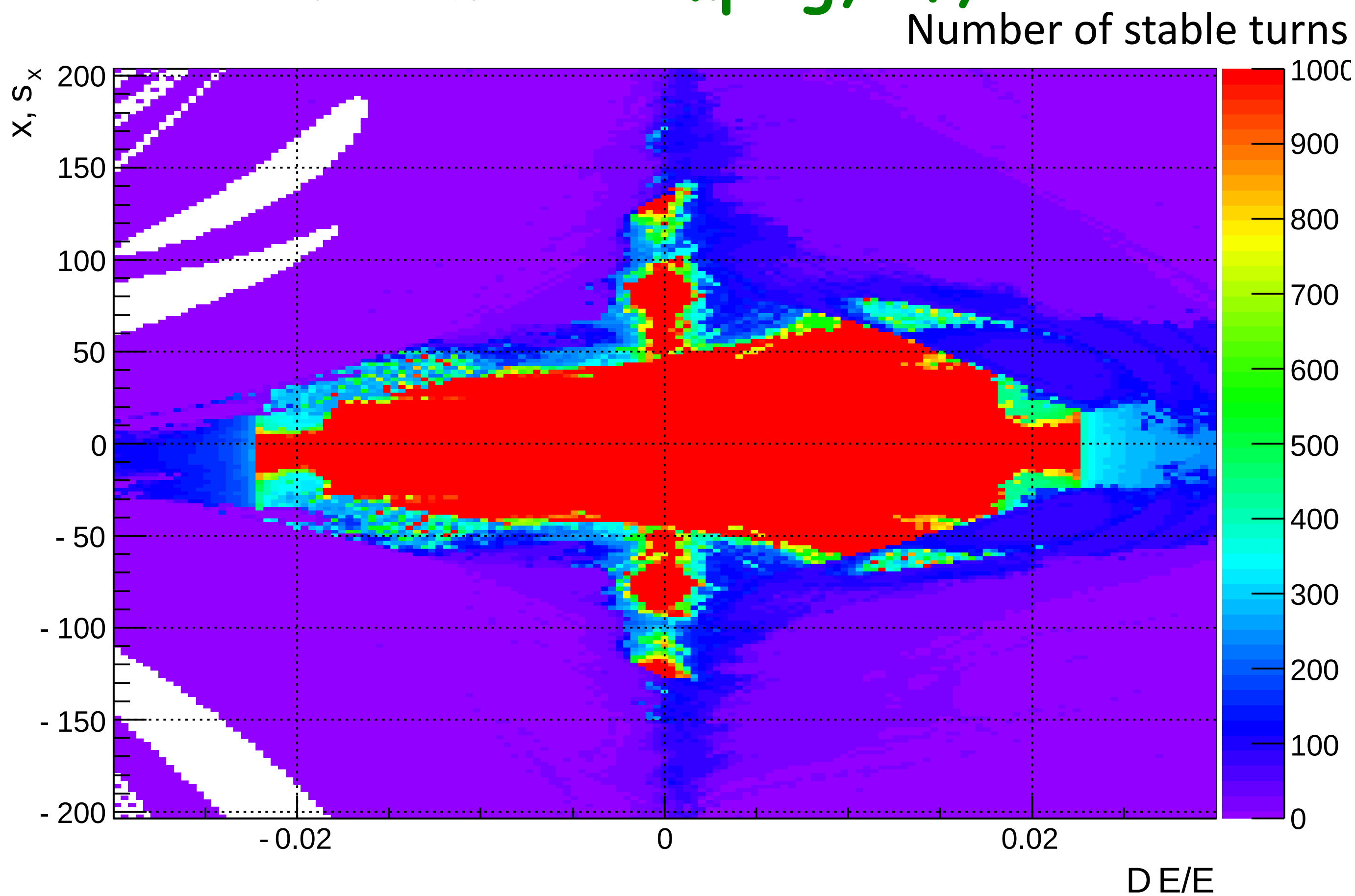
1000 turns with damping, rf, no crab



ε_x=0.11 nm·rad, 0.2% coupling, $\sigma_x=4\cdot10^{-4}$, τ_x~10^4 turns, Urf=21 MV

Energy Acceptance @ 45 GeV

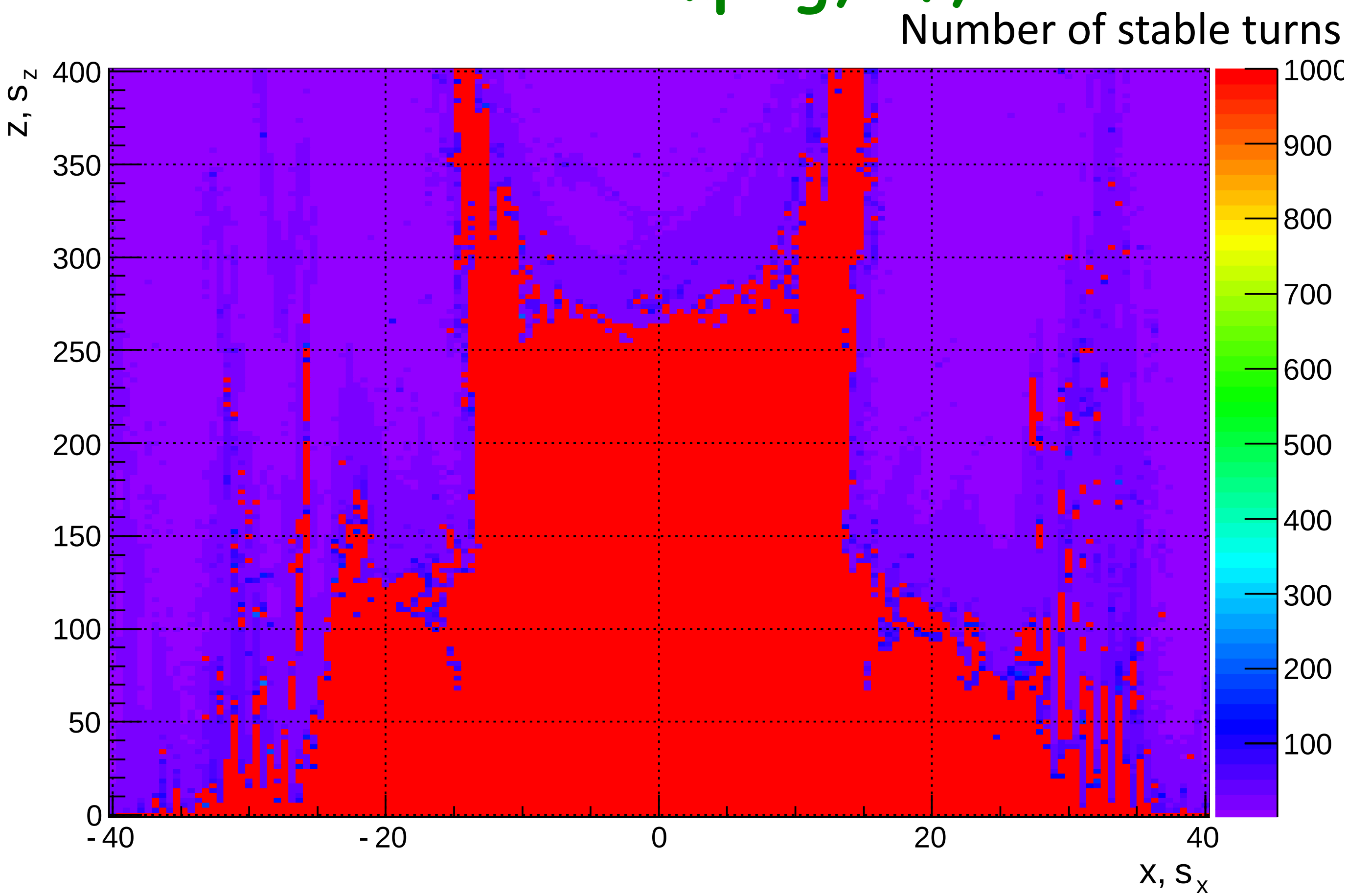
1000 turns with damping, rf, no crab



ε_x=0.11 nm·rad, 0.2% coupling, $\sigma_x=4\cdot10^{-4}$, $|_x\sim10^4$ turns, Urf=21 MV

Dynamic Aperture @ 175 GeV

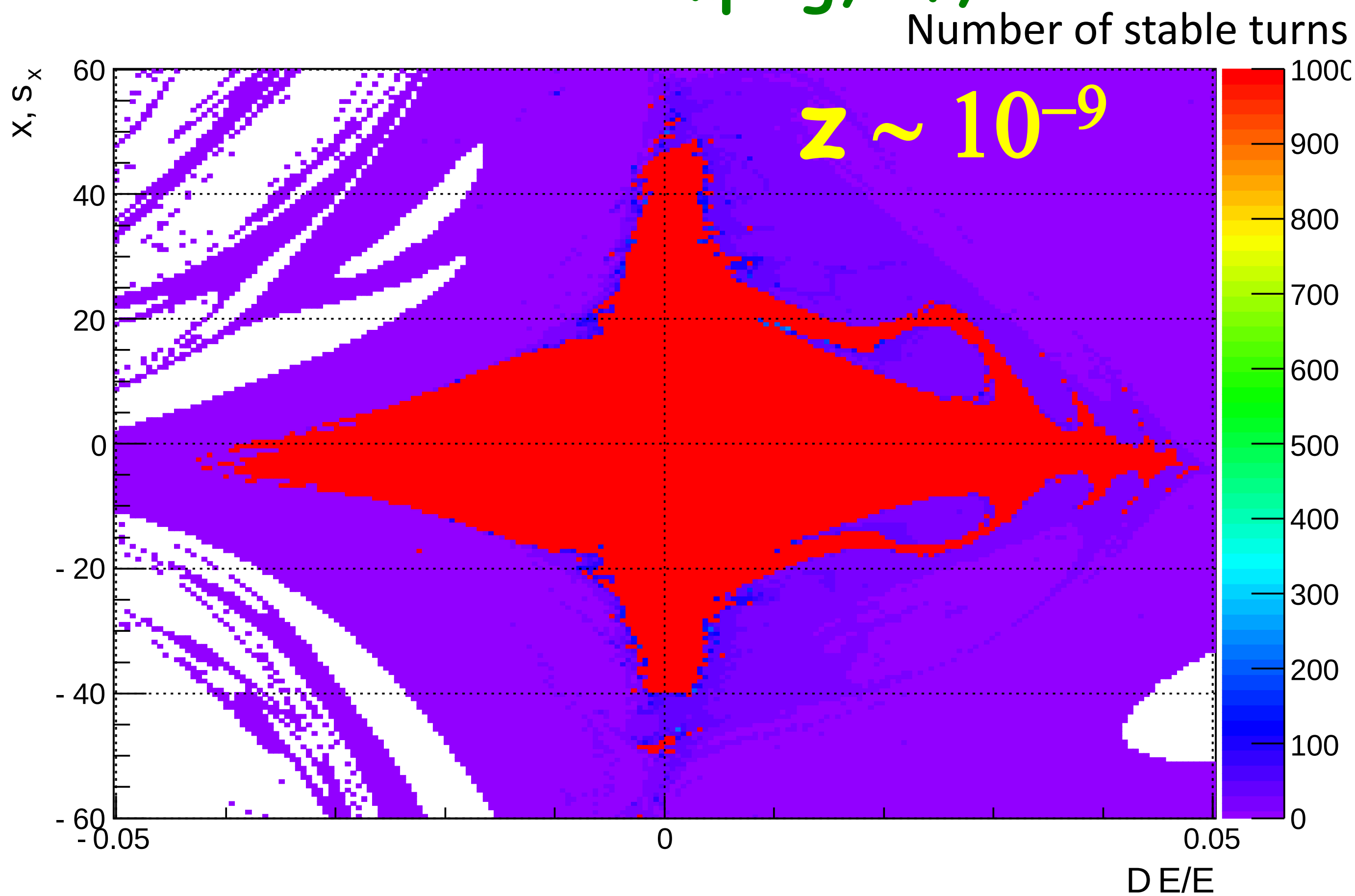
1000 turns with damping, rf, no crab



ε_x=1.7 nm·rad, 0.2% coupling, σ_x=1.6·10^{-3}, $|_x$~150 turns, Urf=2.5 GV

Energy Acceptance @ 175 GeV

1000 turns with damping, rf, no crab



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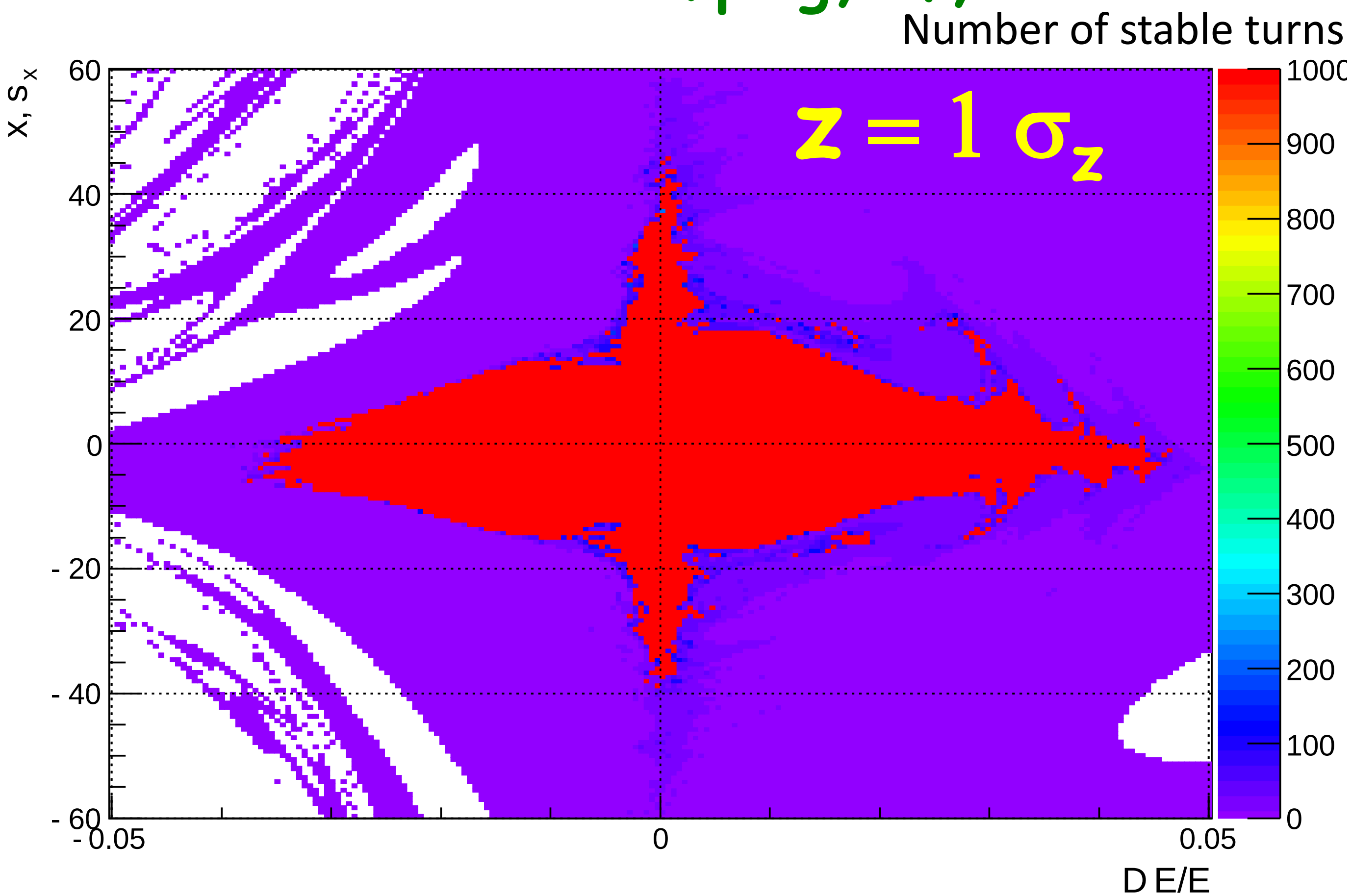

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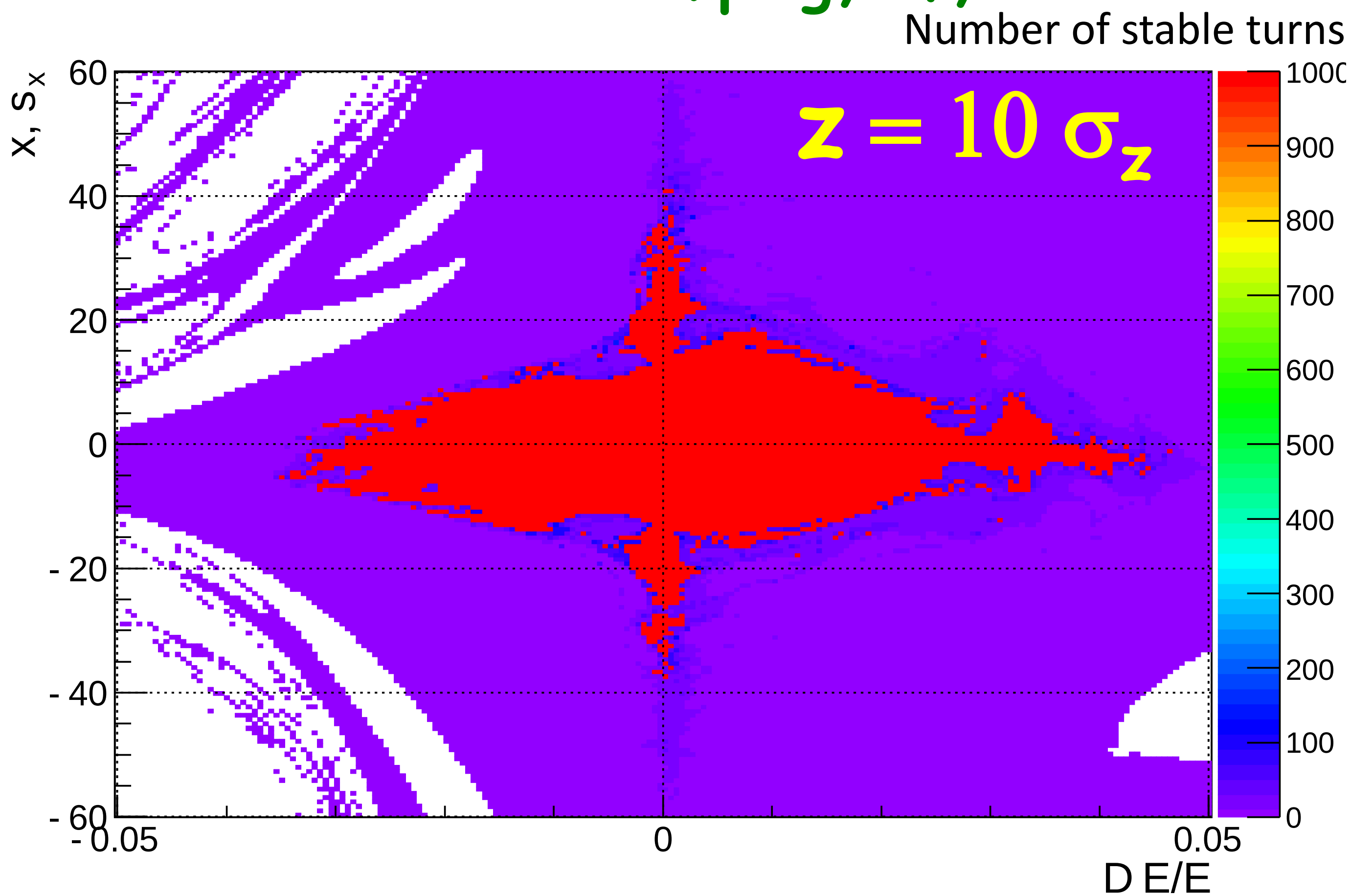

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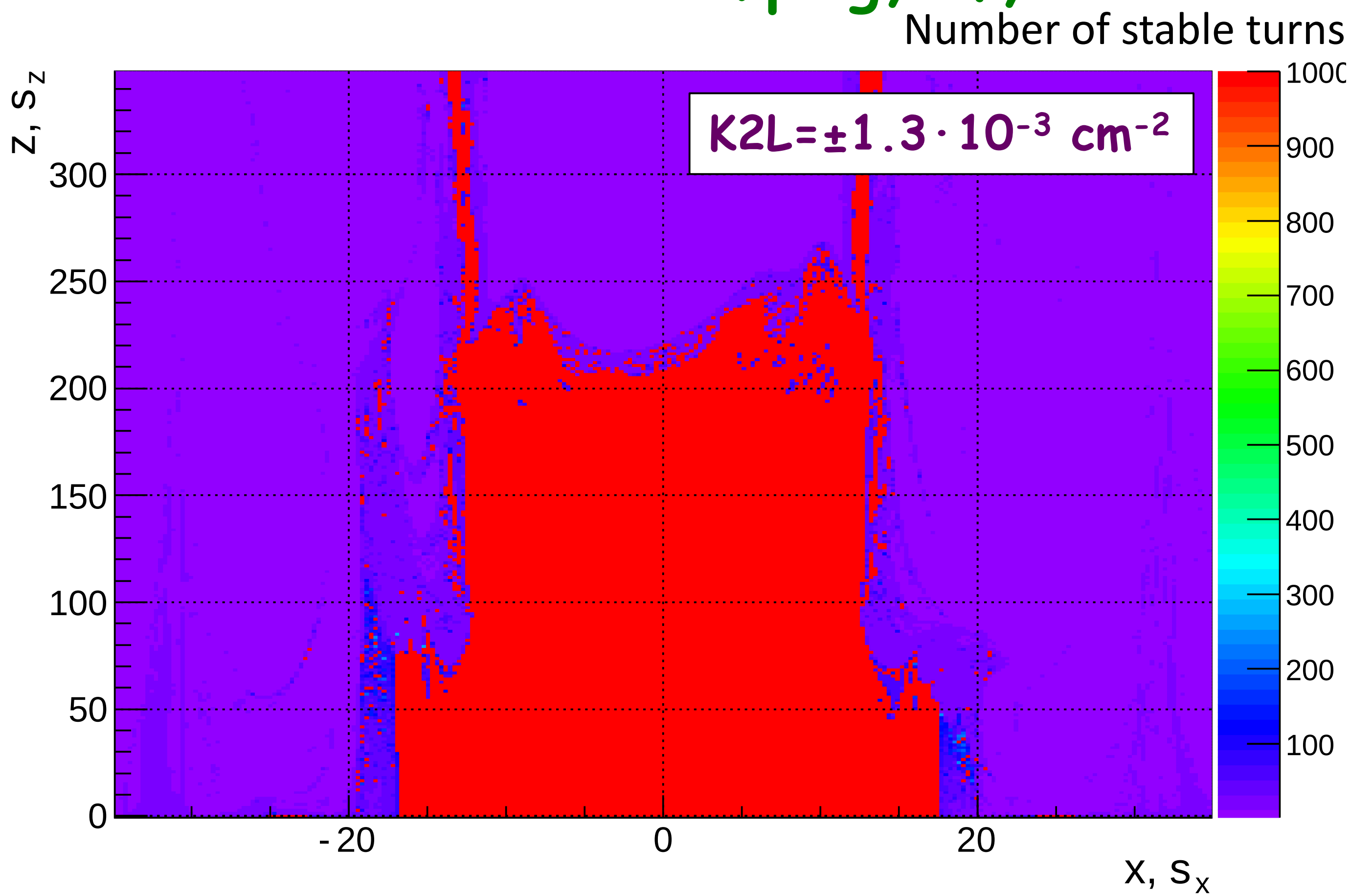

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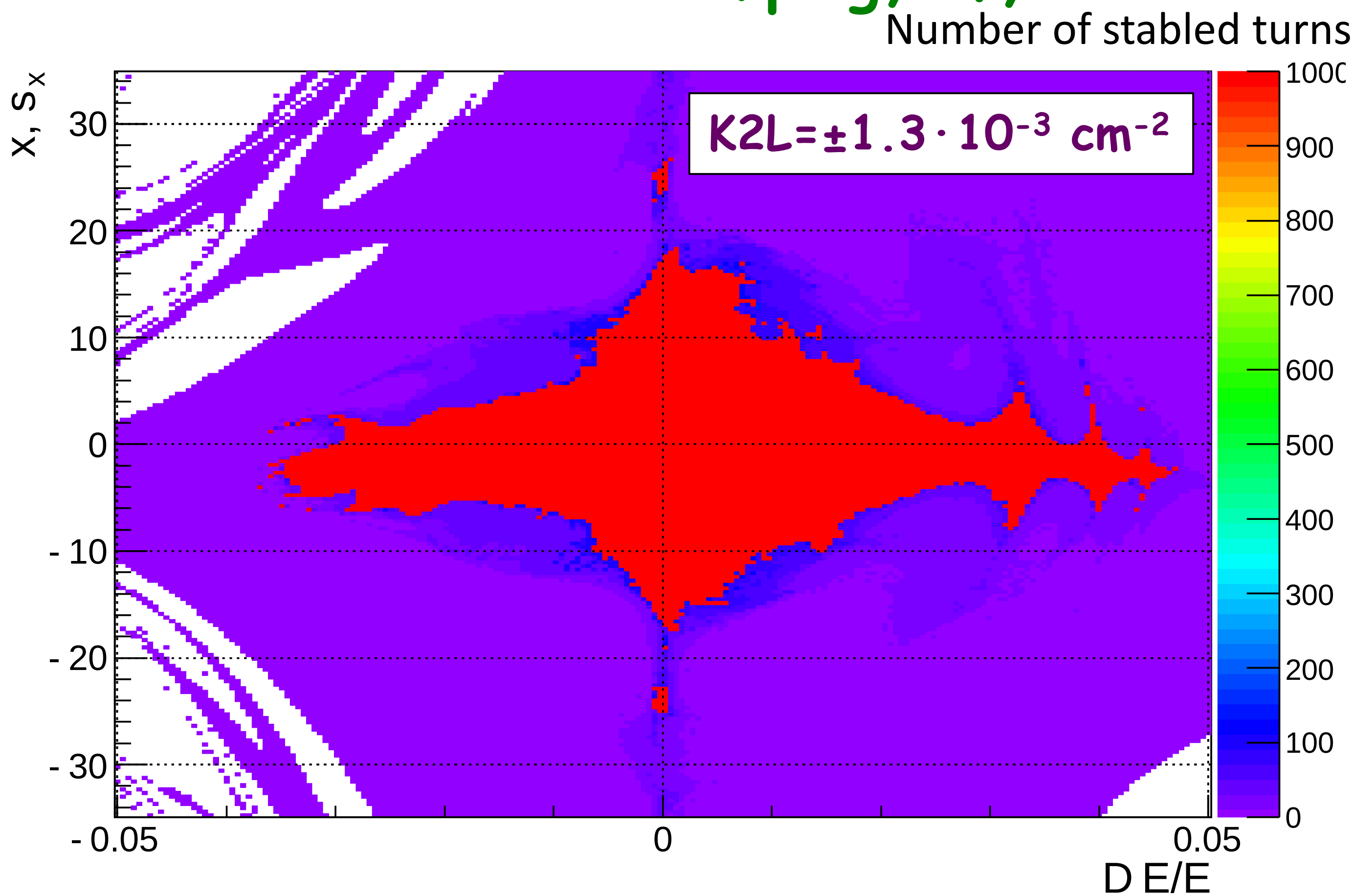

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Summary

- DA & DE without Crab Sexts is good
- Quadr Fringe Fields and Kinematic term are not strong and can be compensated by 2 IR's octupoles
- Only IR's DA and only Arc's DA are large
- DA limitation due to interaction between IR's Sexts and Quadr Fringe Fields with Arc's Sexts
- Damping plays important role

Plans

- Further global optimization of DA & DE
- Check new version of IR by Bogomyagkov
- Crab sextupole investigation
- Introduce realistic damping with energy losses along beam arc
- Simulations with Beam-Beam