Beam-Beam Simulations for SuperB

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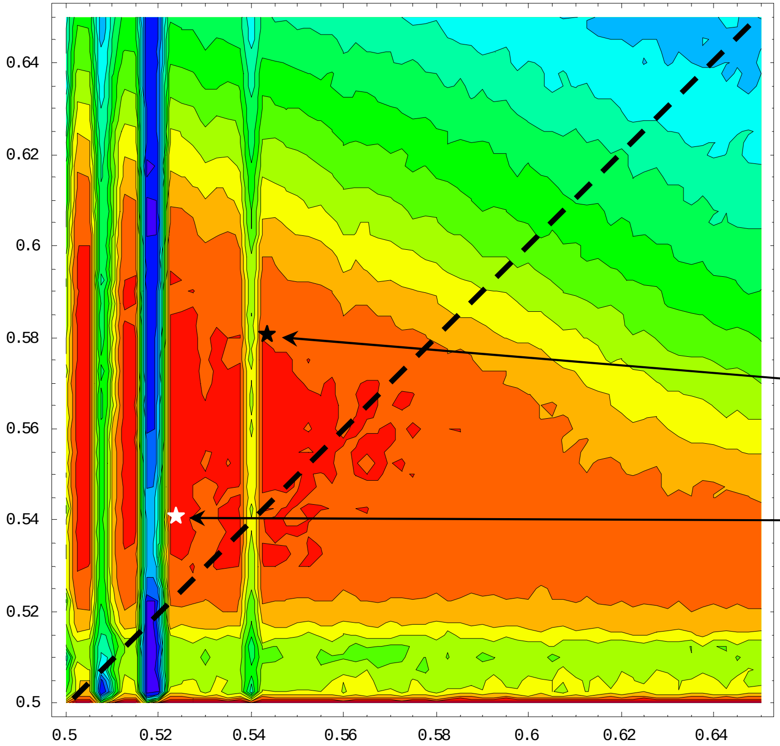
Basic equations: $L \propto \frac{I_{tot} \cdot \xi_y}{\beta_y^*}$; $\xi_y \propto \frac{N_p \cdot \beta_y^*}{\sigma_z \sigma_y \theta}$

What is the limit for ξ_y ?



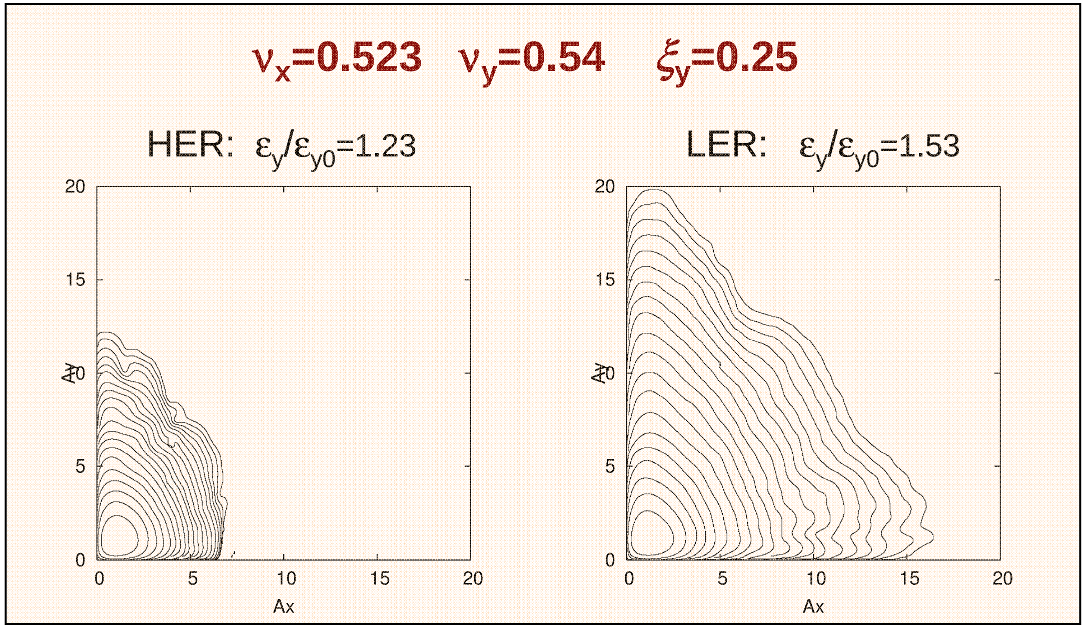
Luminosity contour plot vs. the betatron tunes. Parameters as of December 2006, ξ_y**=0.17**. In the red areas the luminosity exceeds 10^{36} $cm^{-2}c^{-1}$.

Relatively large "good" areas mean that the value of ξ_y did not reach the limit yet.

For larger ξ_y the "good" areas shrink towards smaller betatron tunes. In other words, when shifting the working point closer to half-integer, the maximum achievable tune shift increases.

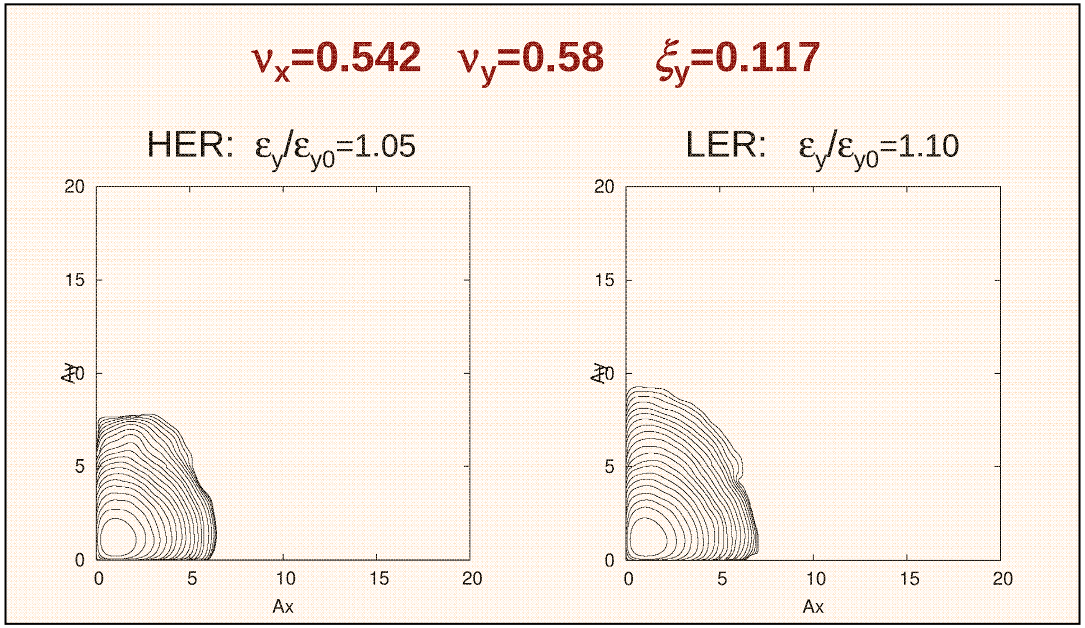
Now the preliminary working point is (0.542, 0.580). The Dynamic Aperture is expected to be larger here.

However, at the point (0.523, 0.540) ξ_y can reach the value of 0.25!



Asymmetry between LER and HER results in the different beam-beam tune shift limits.

The difference becomes visible when ξ_y is large enough (close to the limit).



List of Parameters LER / HER

ε_x (cm)	$(2.56 / 1.6) \cdot 10^{-7}$
ε_y (cm)	$(6.4 / 4.0) \cdot 10^{-10}$
β_x (cm)	3.2 / 2.0
β_y (cm)	0.02 / 0.032
σ_z (cm)	0.5
$N_{e,p}$	$5.74 \cdot 10^{10}$
θ (mrad)	60
ξ_y	0.117
L ($cm^{-2}c^{-1}$)	10^{36}

As of September 2009.

Why the design value of ξ_y is so small ?

Advantages of having larger ξ_y: the same luminosity can be achieved with smaller total beam currents, or higher luminosity with the same current. But…

- Dynamic Aperture considerations may require shifting the working point to up-right direction.
- Technically it can be difficult to achieve larger values of ξ_y with the same bunch current.
- IBS and Touschek lifetime considerations.
- Luminosity lifetime considerations.

If the designed luminosity of 10^{36} cm^{-2}c^{-1} can be achieved with relatively small ξ_y, why not?

Advantages of having small ξ_y:

- Widening the area of possible working points.
- Both the beam core and tails remain unperturbed.
- We always have a possibility to increase ξ_y without incurring into beam-beam problems – if the other conditions allow.

More reliable simulations must take into account the real nonlinear lattice of the ring.

What prevent us from doing this:

- The lattice is changing too often. Need to wait until it converges…
- The 6D Dynamic Aperture still needs some optimizations…

As soon as we have a stable lattice (nonlinear) we proceed with beam-beam simulations.

Summary

- The designed value of ξ_y is far below the limit, so we do not expect any serious problems with beam-beam effects.
- Beam-beam simulations with account of nonlinear lattice are required. They will be performed as soon as the lattice is available and DA optimized.
- The next step will be checking the tolerances on various imperfections. But preliminary estimates are rather optimistic: we do not expect serious problems here.