Low-Emittance Issues for ILC Damping Rings

Andy Wolski

Lawrence Berkeley National Laboratory

2nd ILC Workshop, Snowmass

August 16, 2005

Lattices for baseline ILC design are still evolving

Most of the "reference lattices" being studied for the ILC DR configuration recommendation have a normalized horizontal emittance of around 5 μm.

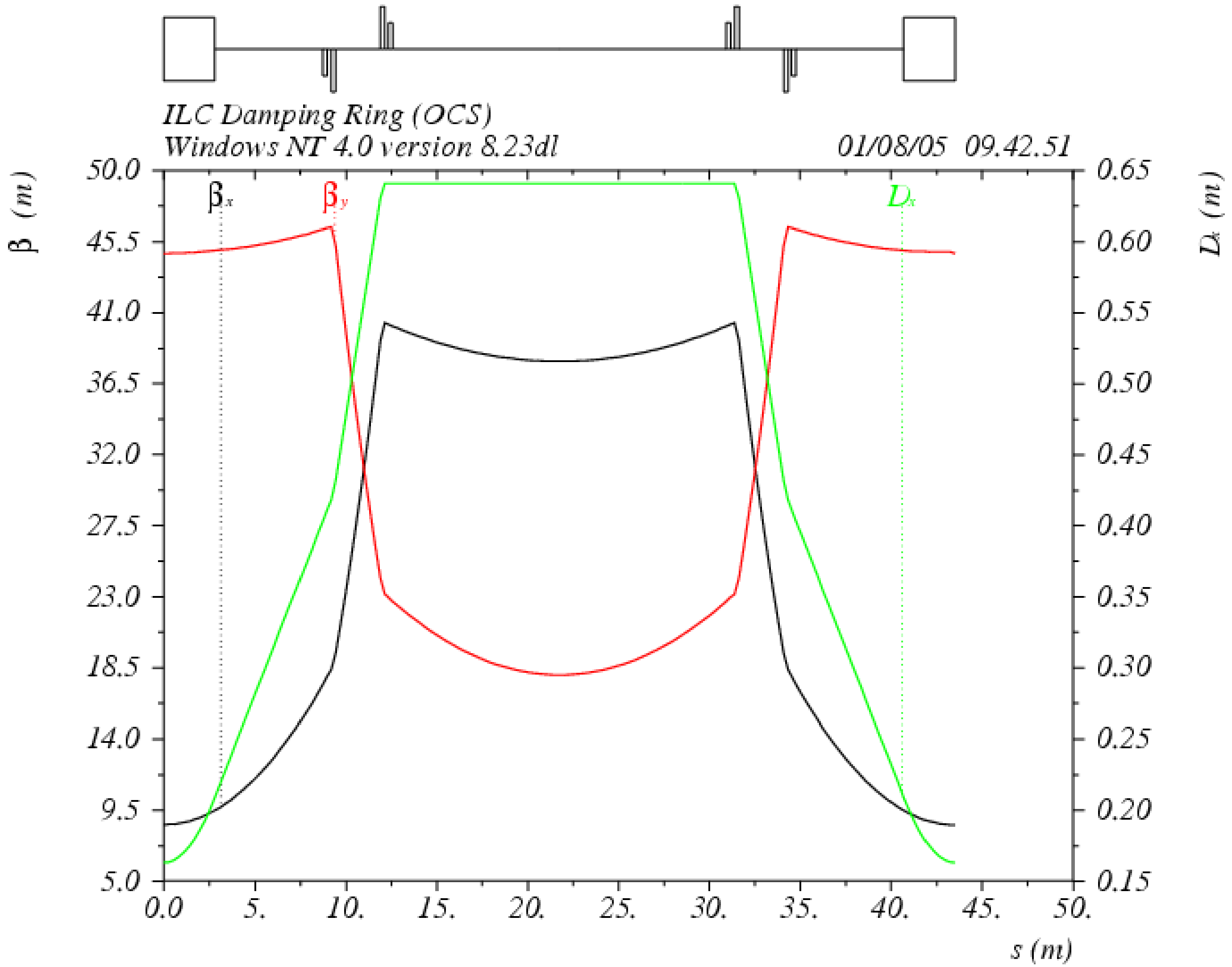
Several different lattice styles are being considered:

- TME
  - capable of very low emittance with a small number of cells.
- PI
- FODO
  - has some nice features, but needs many cells for very low emittance.

Circumference is still not decided

- 17 km
  - Dogbone lattice, looks difficult for acceptance.
- 6 km
  - Could be a good compromize.
- 3 km
  - Looks difficult for kickers, collective effects…

TME cell provides best prospects for very low emittance



Theoretical Minimum Emittance does what it says

$$\gamma\varepsilon_0 = K \frac{1}{12\sqrt{15}J_x} C_q \gamma^3 \theta^3$$

For example, 5 GeV, TME (*K*=1) lattice with 100 cells

$$\gamma\varepsilon_0 \approx 2\mu\text{m}$$

Wiggler will provide radiation damping with relatively little quantum excitation, leading to a further reduction in the emittance.

However…

Dynamics in very low emittance lattices can be difficult

Several features tend to lead to strong sextupoles, and it can be difficult to achieve a good dynamic aperture:

- Strong focusing for low beta function in dipole results in large chromaticity.
- Low dispersion means chromatic sextupoles must be strong to have an effect.

Tunability of emittance is not a feature of the “reference” lattices for the ILC DR configuration studies.

Low-emittance lattices generally have low dispersion, and hence a low momentum compaction factor.

- This can be a problem for some collective instabilities.
- Momentum compaction factor can be raised e.g. by using long dipoles.

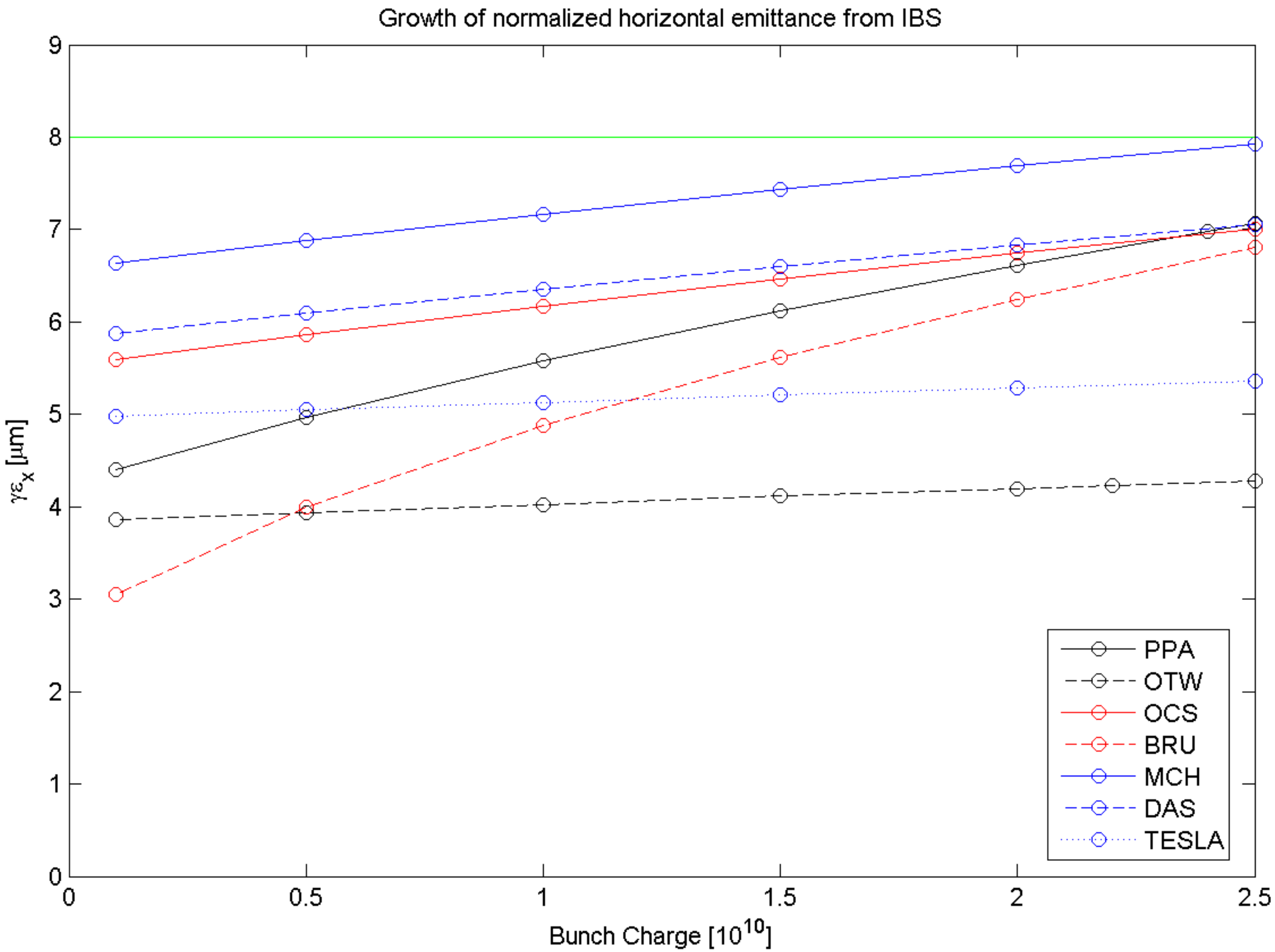
Collective effects can get worse at low emittance.

Reducing the energy reduces the emittance…

- …but then collective effects also get worse.

Intrabeam scattering can increase the equilibrium emittances

http://www.desy.de/~awolski/ILCDR/USTeleconference_files/2005-07-13/05-07-13-IBS-ILCDR.pdf



Comments

Present "reference" lattice designs have normalized natural emittances of around 3 - 7 μm.

It may be possible to reduce the *natural* emittance to ~ 1 μm in some lattice design, but a tunable solution will be very difficult to find.

Collective effects (especially IBS) will tend to increase the emittance to several μm, even if a very small natural emittance is achieved.

One possible solution is to use "too much" wiggler.

- Simple to study - estimates can be performed relatively easily.
- Tunable - extra wiggler can be turned off when not needed.
- Extra wiggler reduces the damping times, and helps with the collective effects, including IBS.

What emittance is needed? How much wiggler would be required?