WHY DO WE NEED TO SHIELD ICE IN WIGGLERS?

1. Harmful Effects of Beam Impedance in the e- Ring
2. Calculations of the ICE Impedance
3. Evaluations of Possible Luminosity Improvements

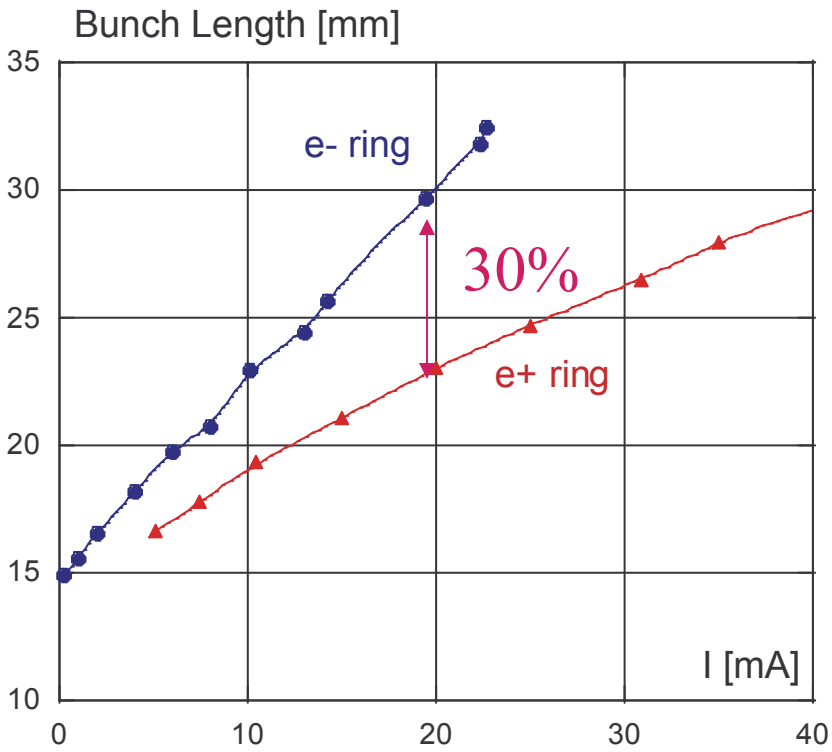
BASIC IDEAS (1)

Reduction of the e- ring beam impedance may give 6-fold luminosity improvement:

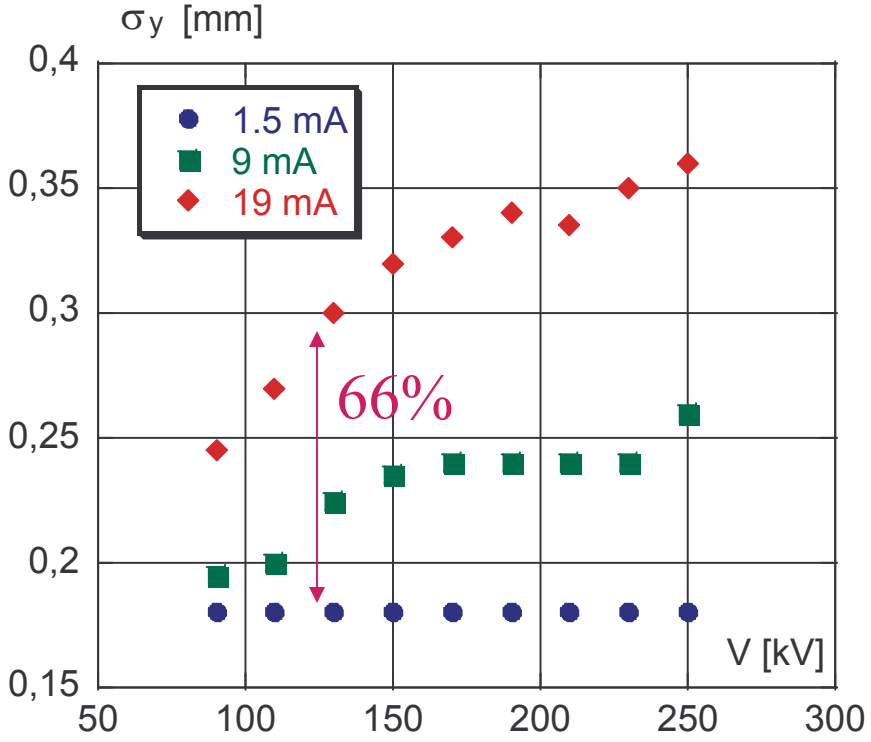
1) Geometric luminosity increase
2) Beam dynamics luminosity increase
3) No beam size blow up above the microwave instability threshold
4) No quadrupole instability in the e- ring
5) Possibility to go closer to integer tunes
6) Possibility to use optics with negative momentum compaction

Impedance Effects in the e- Ring

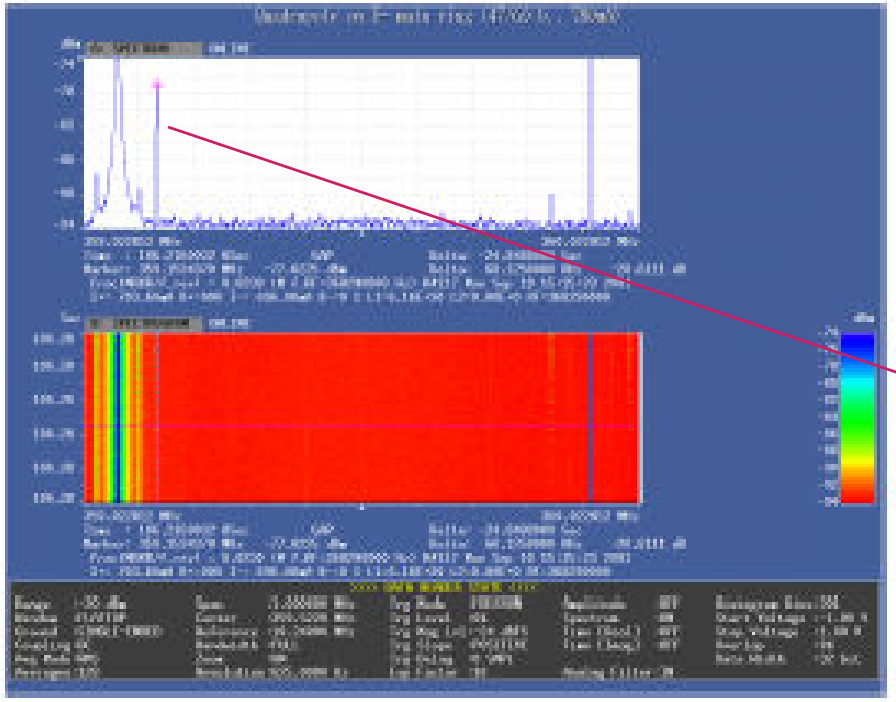
Stronger Bunch Lengthening



Vertical Size Blow $f(V_{RF}, I_b)$

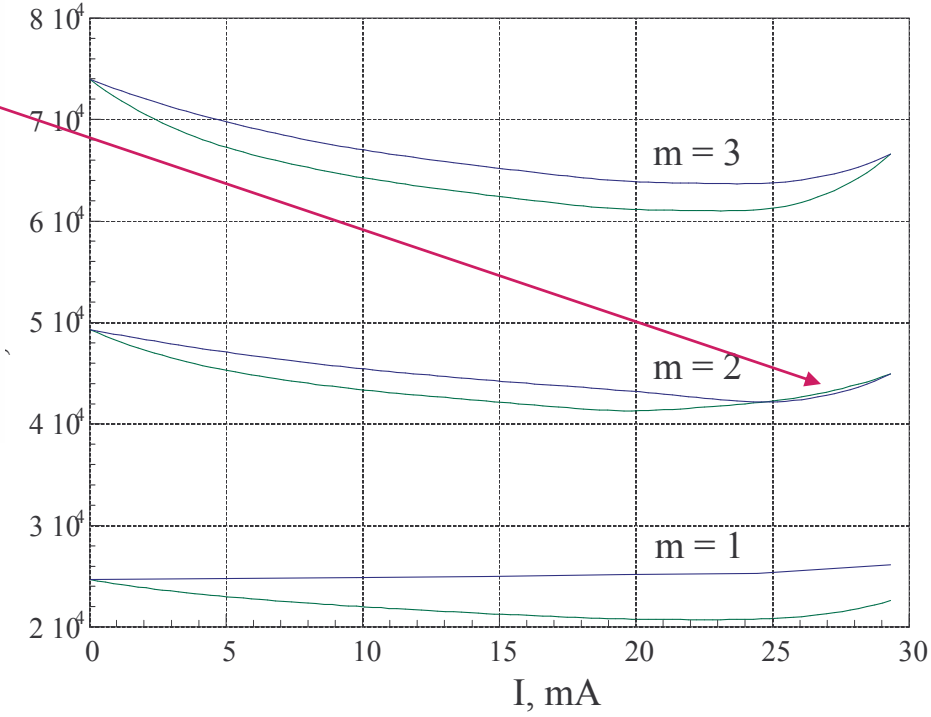


DAΦNE e- Ring Quadrupole Instability

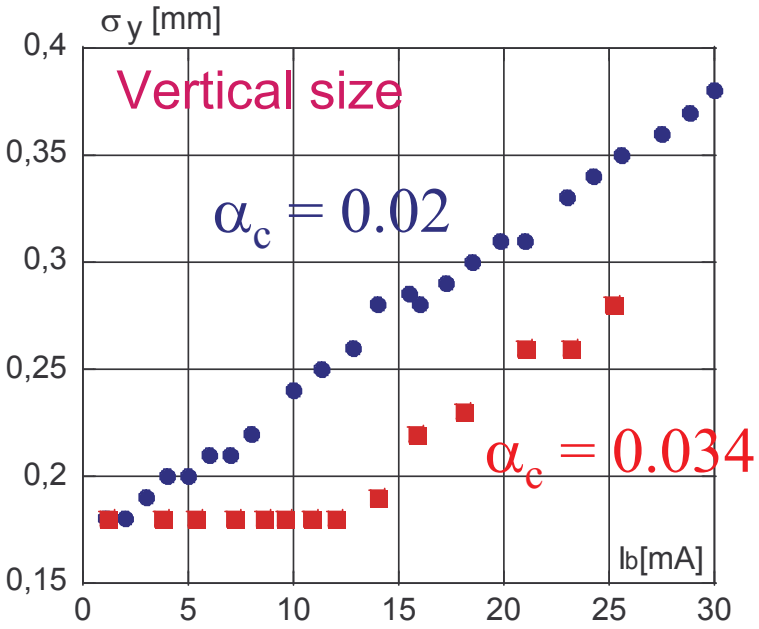


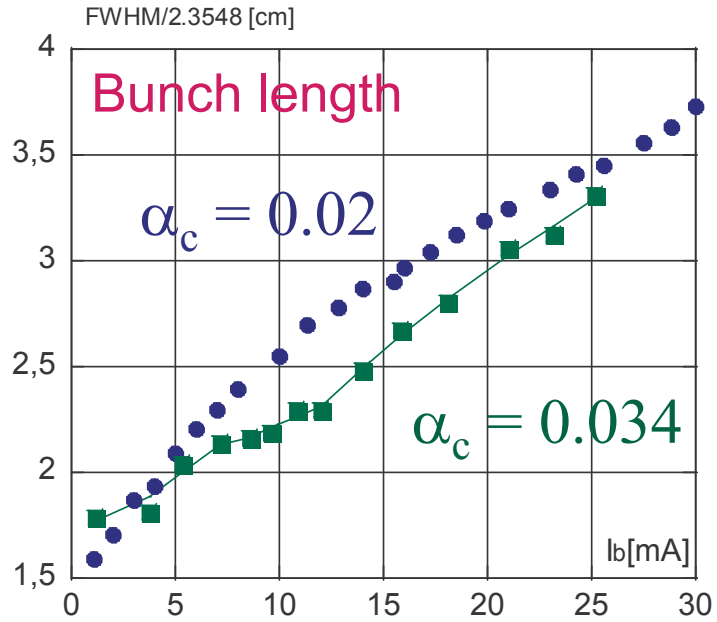
A.Drago et al., Phys.Rev.Special Topics 6:052801,2003

M.Zobov et al., DAΦNE Technical Note BM-3, June 7 1998



Vertical Size Blow Up





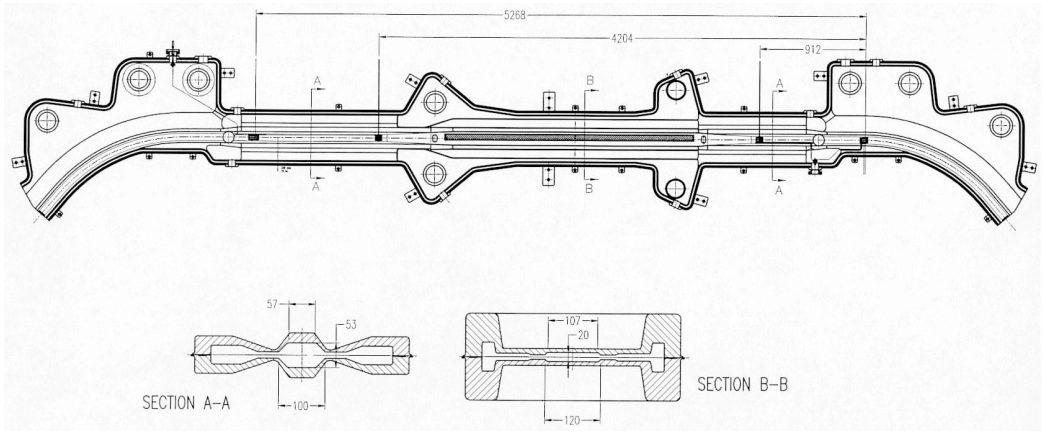
- Single bunch (beam) effect
- It is correlated with the longitudinal microwave instability:

a) The same threshold

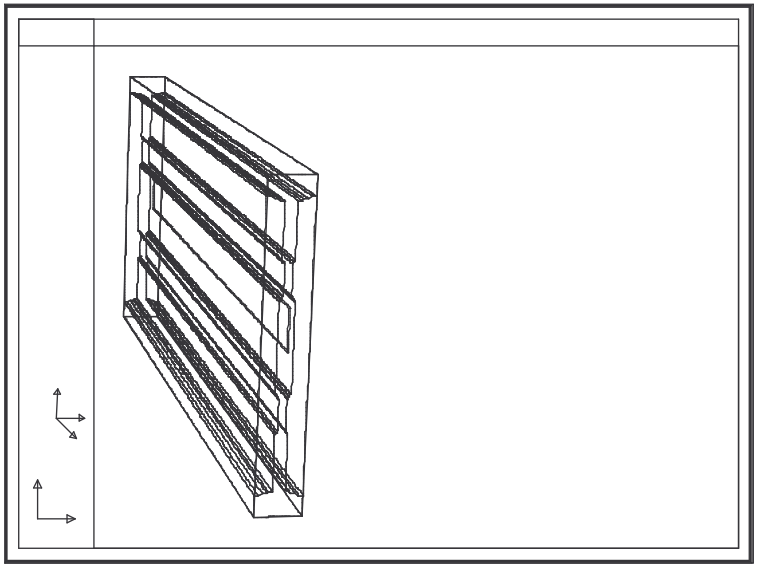
b) The same dependence on RF voltage

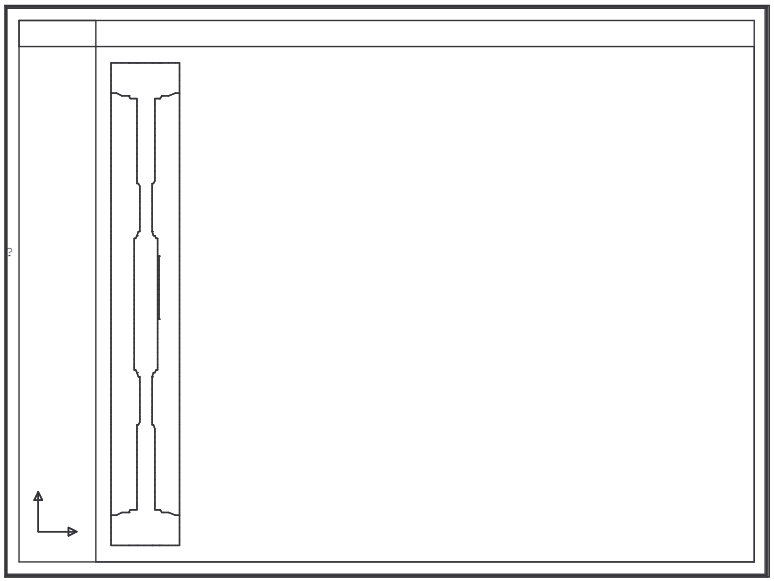
c) The threshold is higher for higher momentum compaction

d) More pronounced for e- ring having higher coupling impedance



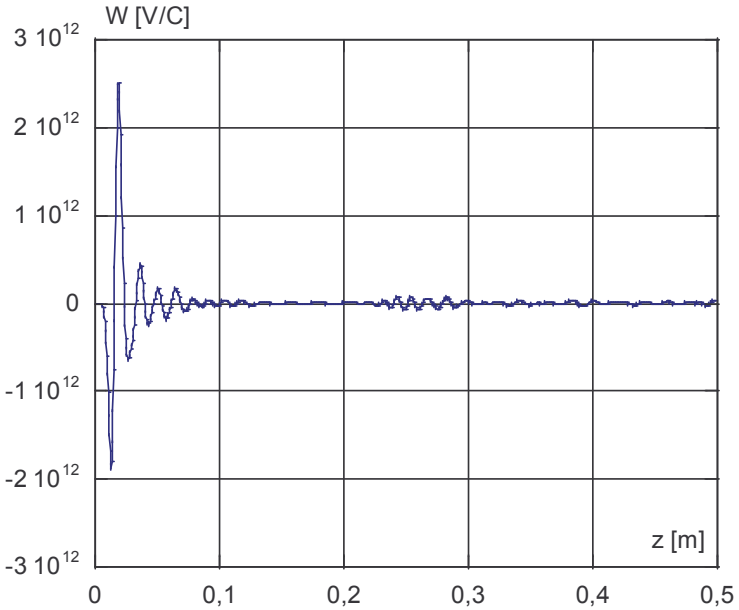
Modeling with MAFIA

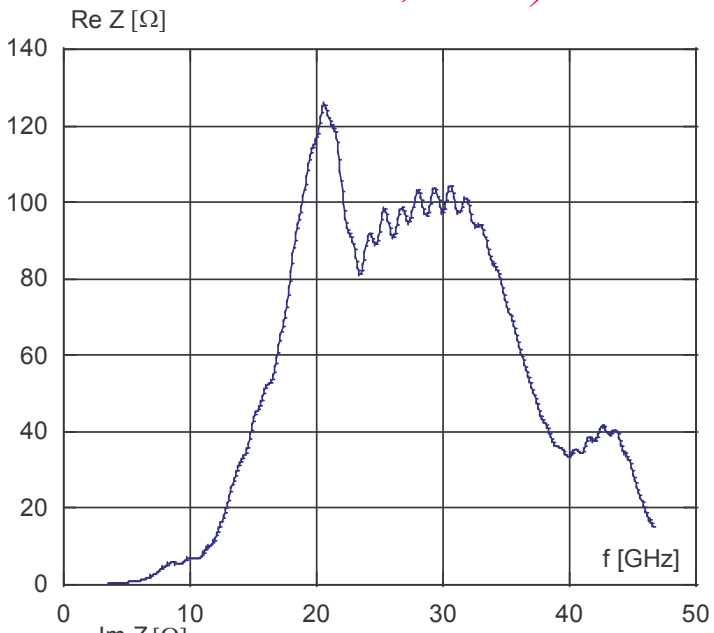


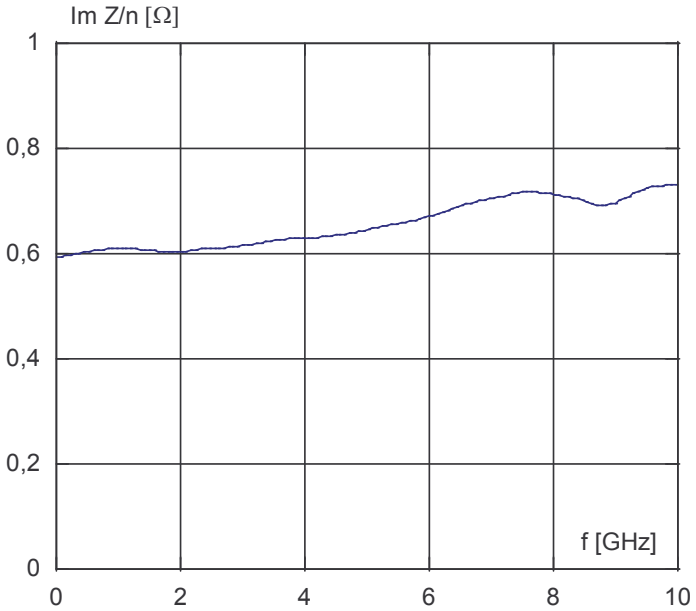


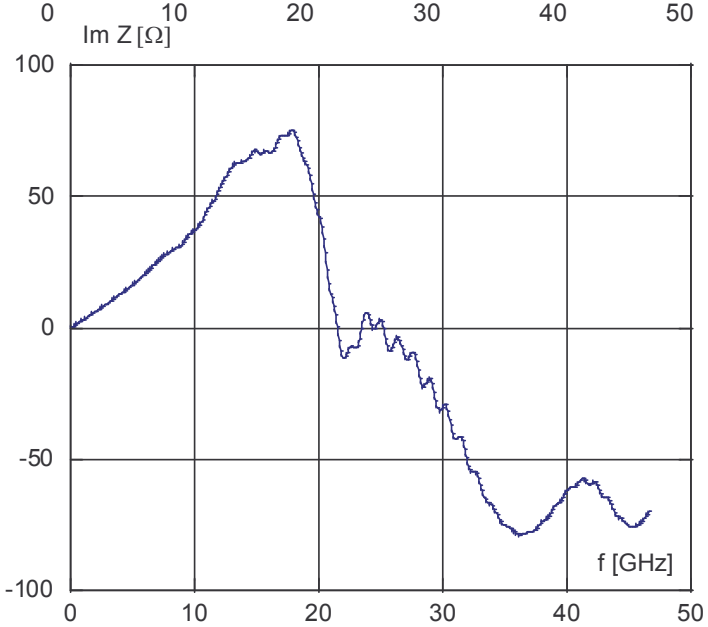
ICE Wake Field and Impedance

(Spataro and Zobov, DAΦNE Technical Note G-64, 2005)









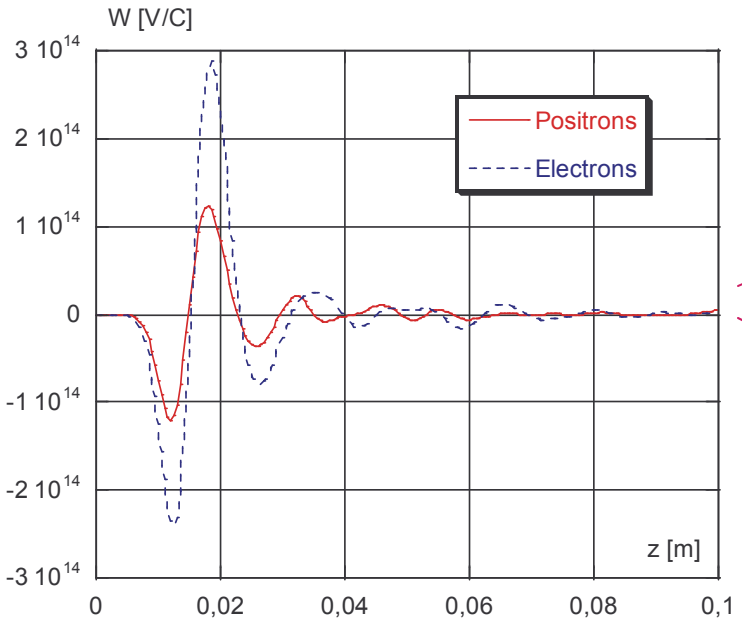
Conclusions on ICE Impedance

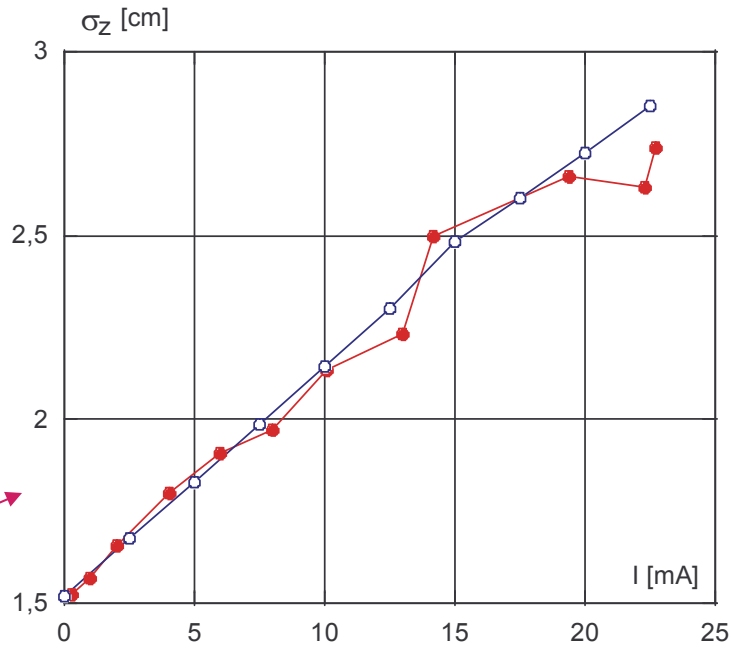
(Spataro and Zobov, Internal Report on July 12, 2004)
www.lnf.infn.it/acceleratori/dafne/report/Spataro_Zobov.pdf

- The present ICE design helps to eliminate the resonant impedance and excessive power losses. On the other hand, the ICE coupling impedance is highly inductive that makes bunches longer in the e- ring than in the e+ one.
- As it is shown by numerical simulations the low frequency impedance scales as:
  - The square root of the ICE material dielectric ε
  - Proportional to the electrode length L
  - Proportional to the electrode thickness d
- The dominant contribution to the coupling impedance comes from the 4 wiggler ICE, since they are very long ($L > 2$ m) and are very close to the beam (the width of the wiggler vacuum chamber is 2 cm).

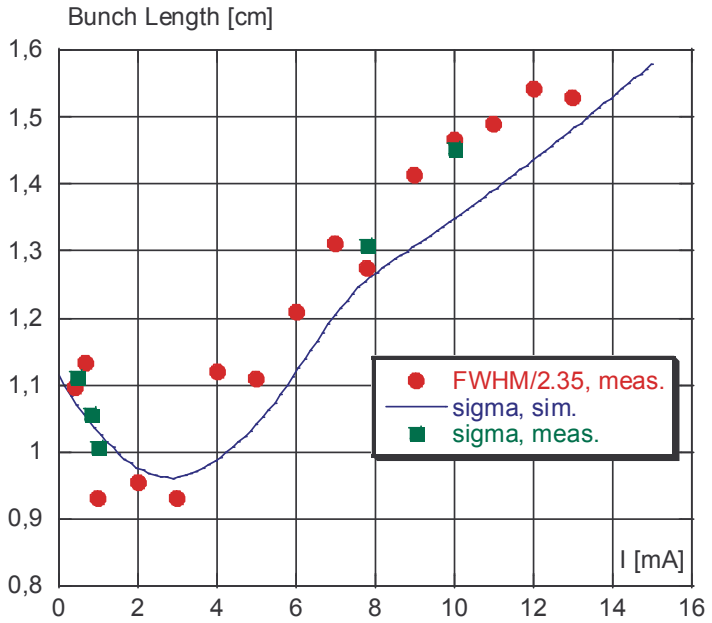
Bunch Lengthening in e- Ring

$\alpha_c > 0$





$\alpha_c < 0$



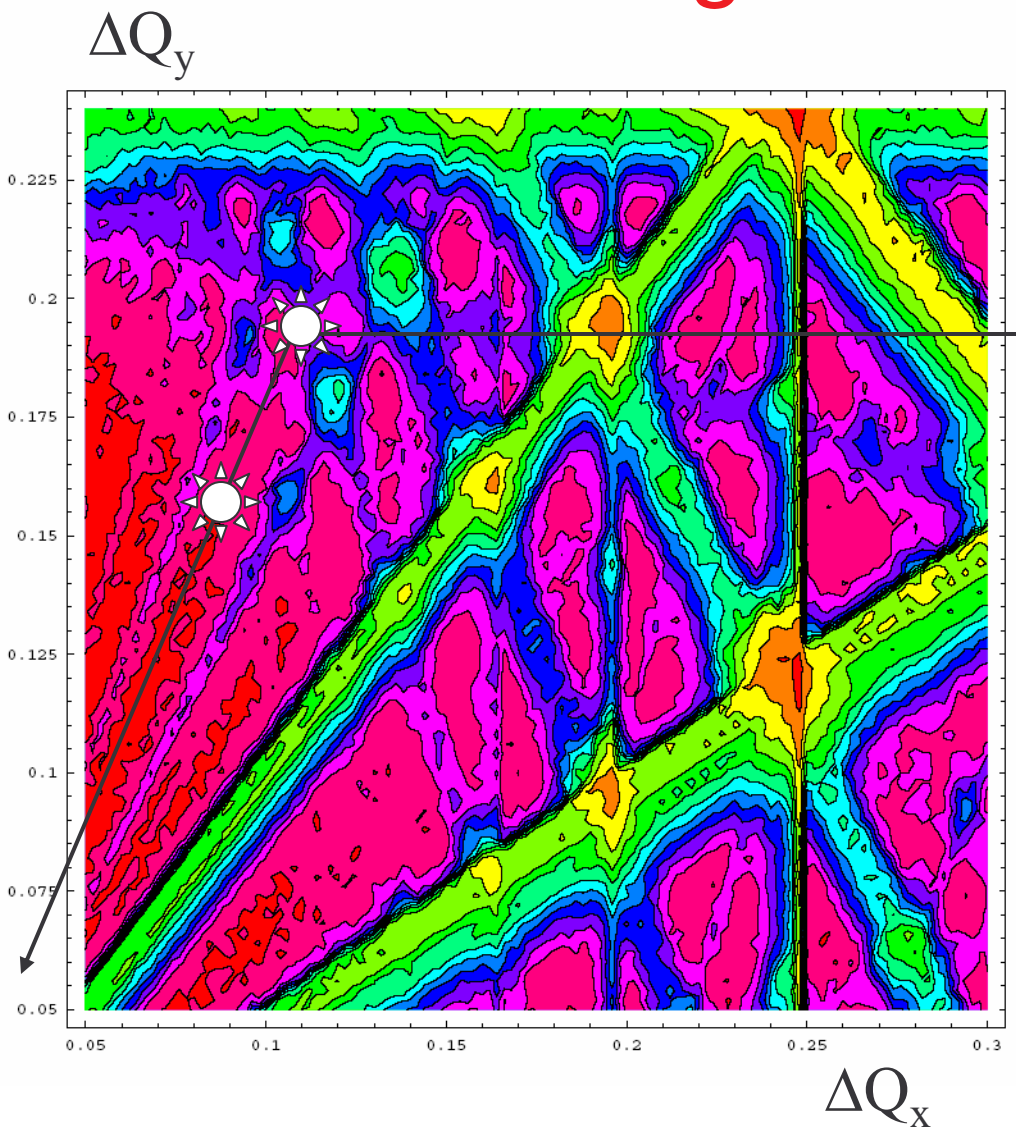
GEOMETRIC LUMINOSITY GAIN

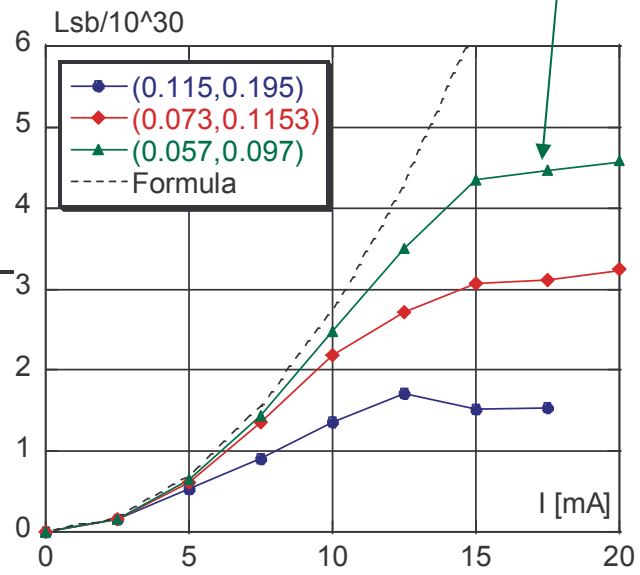
If $\beta_{x,y}$ scales as $\sqrt{\left(\sigma_z^+\right)^2+\left(\sigma_z^-\right)^2}$

Conditions	σ_z (e-), cm	σ_z (e-), cm	Gain, %
Normal operations	3.0 (meas.)	2.1 (meas.)	0
Low Impedance	2.3	2.1	18
Low Impedance Negative αc	1.4 (sim.)	1.3 (sim.)	92

Working Point Choice

> 4x10^{32}





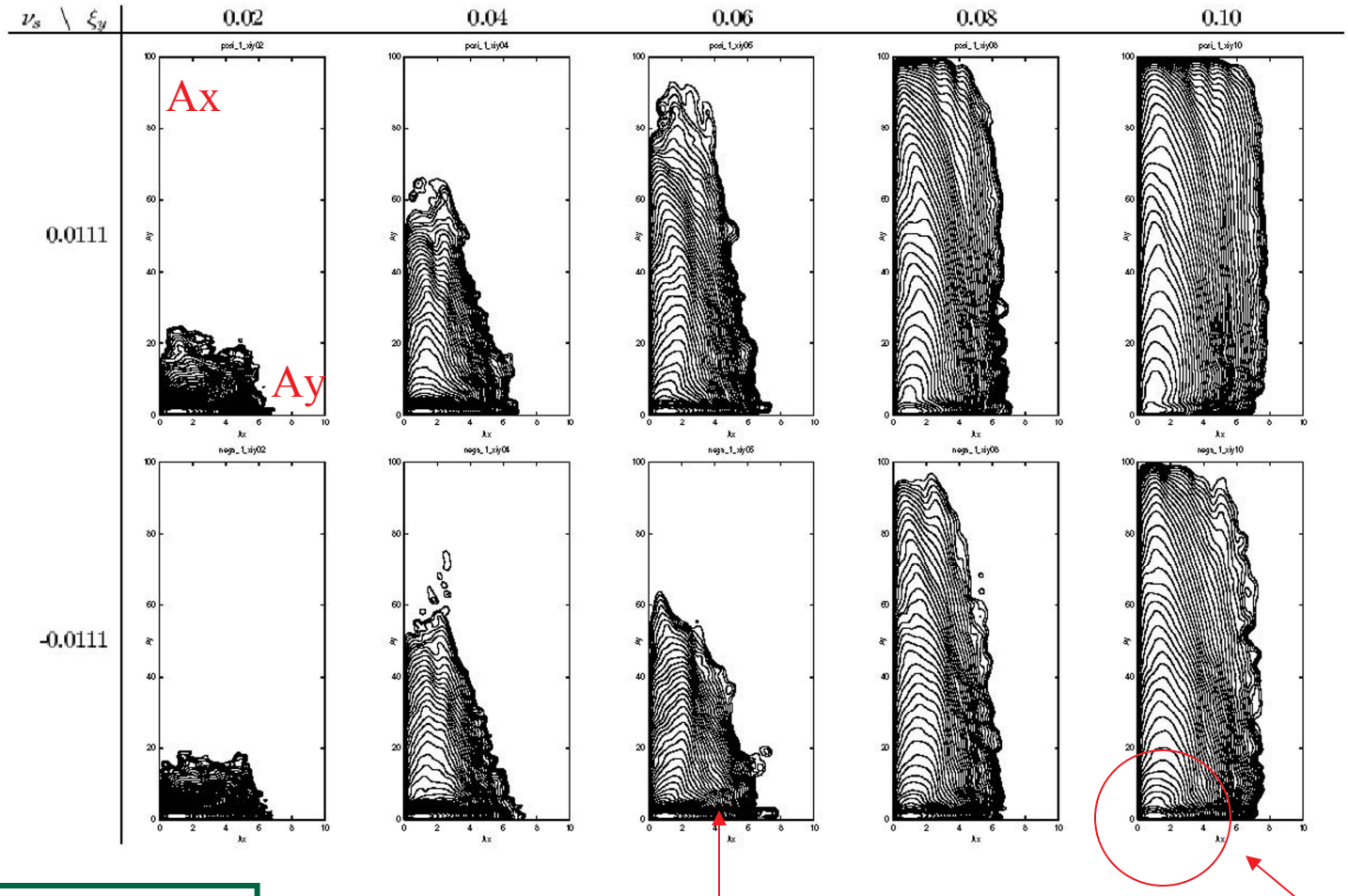
Going closer to the integers we hope to improve both the peak luminosity and lifetime

This is possible with the new wigglers since DA is satisfactory at low tunes!

M.Zobov

Equilibrium Density Contour Plots

(Working Point (0.057;0.097)



$\alpha_c > 0$

$\alpha_c < 0$

D.N.Shatilov, M. Zobov

Acceptable tails

No blow up yet!

Simulations with $\alpha_c < 0$

$\beta_x = 1.5$ m; $\beta_y = 1.5$ cm; $k = 0.2\%$; $\varepsilon_x = 0.5 \times 10^{-6}$; $\varepsilon_y = 10^{-9}$

I, mA (bunch)	ξ_x	ξ_y	σ_z, cm	L, 10^{30} (expected)
5	0.009	0.020	**1.359,1.545**	0.728
10	0.018	0.040	**1.314,1.651**	2.889
15	0.027	0.060	**1.337,1.773**	6.550
20	***0.036***	***0.080***	**1.376,1.939**	***11.64***
25	0.045	0.100	**1.436,2.056**	1.819
30	0.054	0.120	**1.489,2.171**	2.620

$>7 \times 10^{32}$ in 110 bunches

…and possibility to go higher

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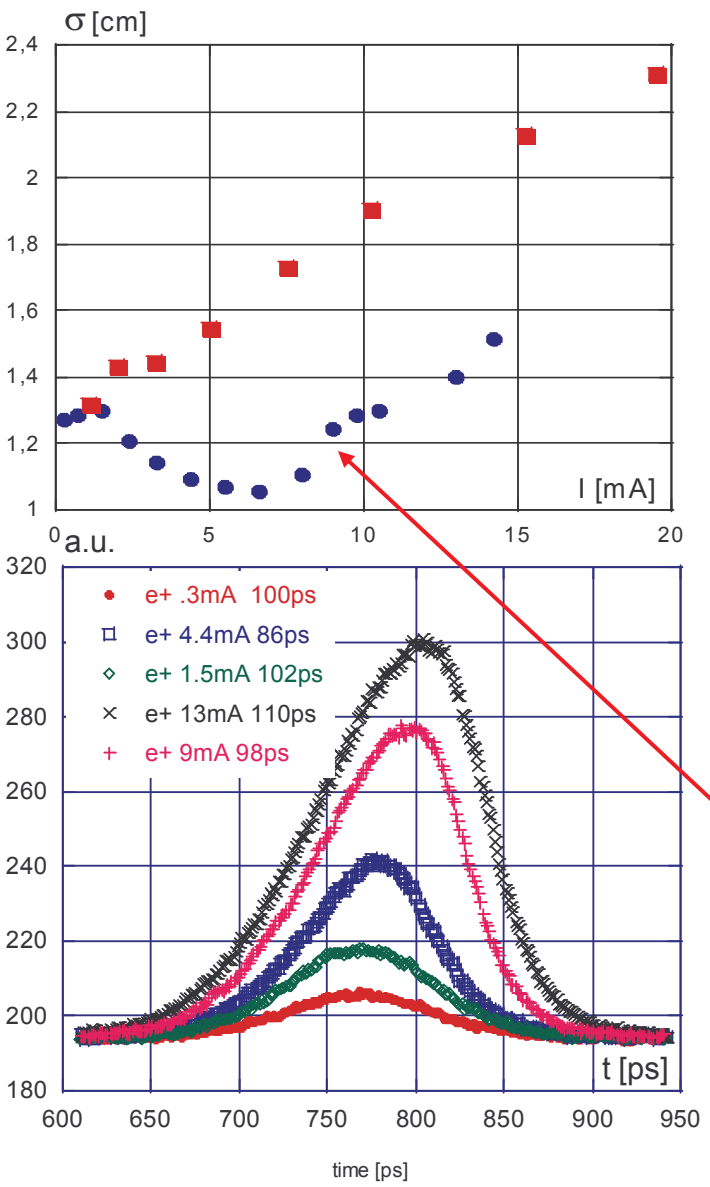
Experiment with $\alpha_c < 0$



- Bunch shortens as predicted by numerical simulations
- Good agreement with DAΦNE optics model
- $I_{bunch} > 40$ mA is stored with negative chromaticity
- No problems with RF and feedbacks: about 1 A of stable current in both beams
- Coupling and geometric luminosity as in usual operation conditions
- First collisions at low currents (200 mAmps) with $L_{peak} = 2.5 \times 10^{31}$
- **Bunch length of 1-1.3 cm with currents of about 10 mA has already been achieved!**