INFN Frascati contributions to BPH-DRV:

Drive Beam Recombination Complex

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Drive Beam Recombination Complex

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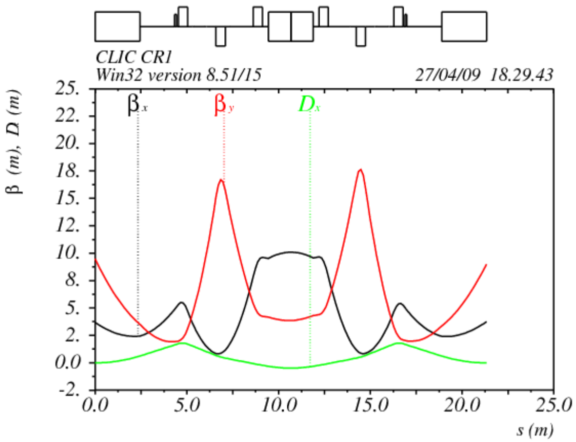
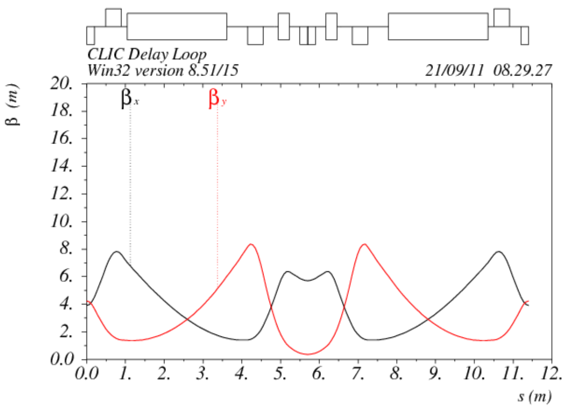
- The recombination scheme and the pulse length define ring circumferences
- Preservation of bunch length: isochronicity
- Output emittance < 150μm·rad
- Large energy spread

DBRC Design

- Lattice ring design
- Optimisation of ring non linear behaviour
- Non achromatic injection bumps
- Transfer lines design
- Start to end simulations
- Include CSR effects
- Iterate optimisation, if necessary

Example of optimisation: Comparison between different isochronous cells





- CTF3 type
- Good flexibility
- Limited energy acceptance

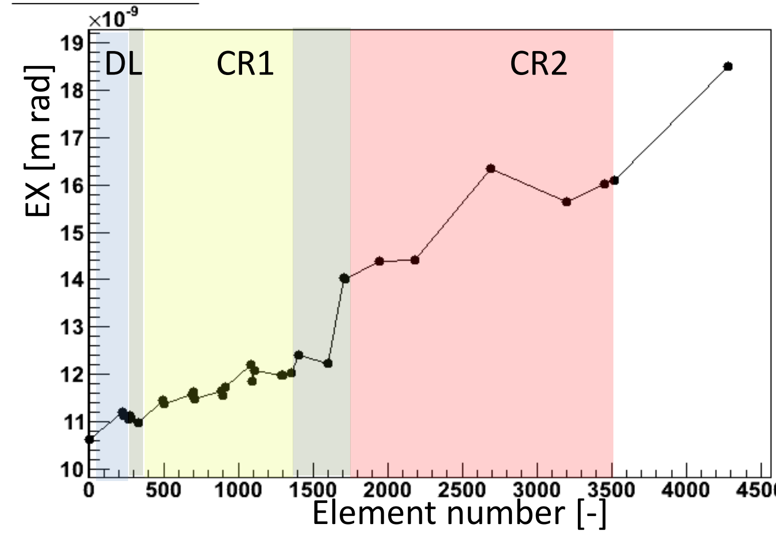
- new DL cell: better energy acceptance
- more space for dipoles: longer ρ, better for csr effect minimisation

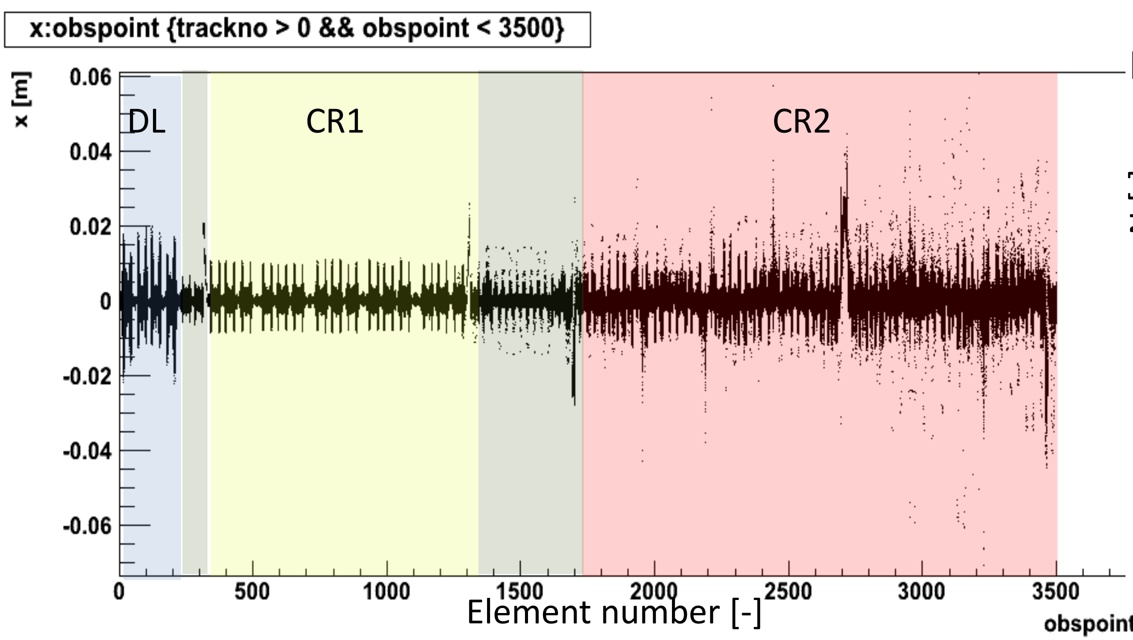
Start to End simulations

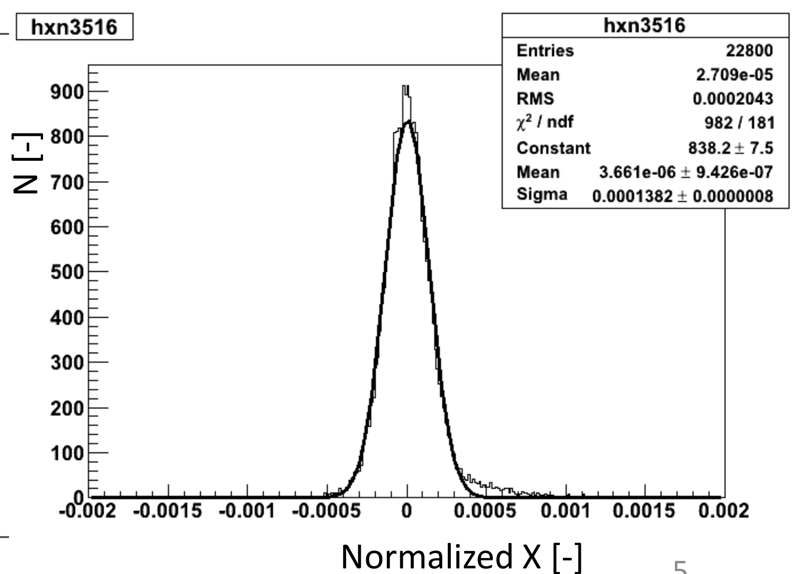
Horizontal Emittance Growth

- Distribution from linac simulations
- Very well conserved till the end of Combiner Ring 1
- 1 particle lost over 22801

Geometrical emittance (sigma)

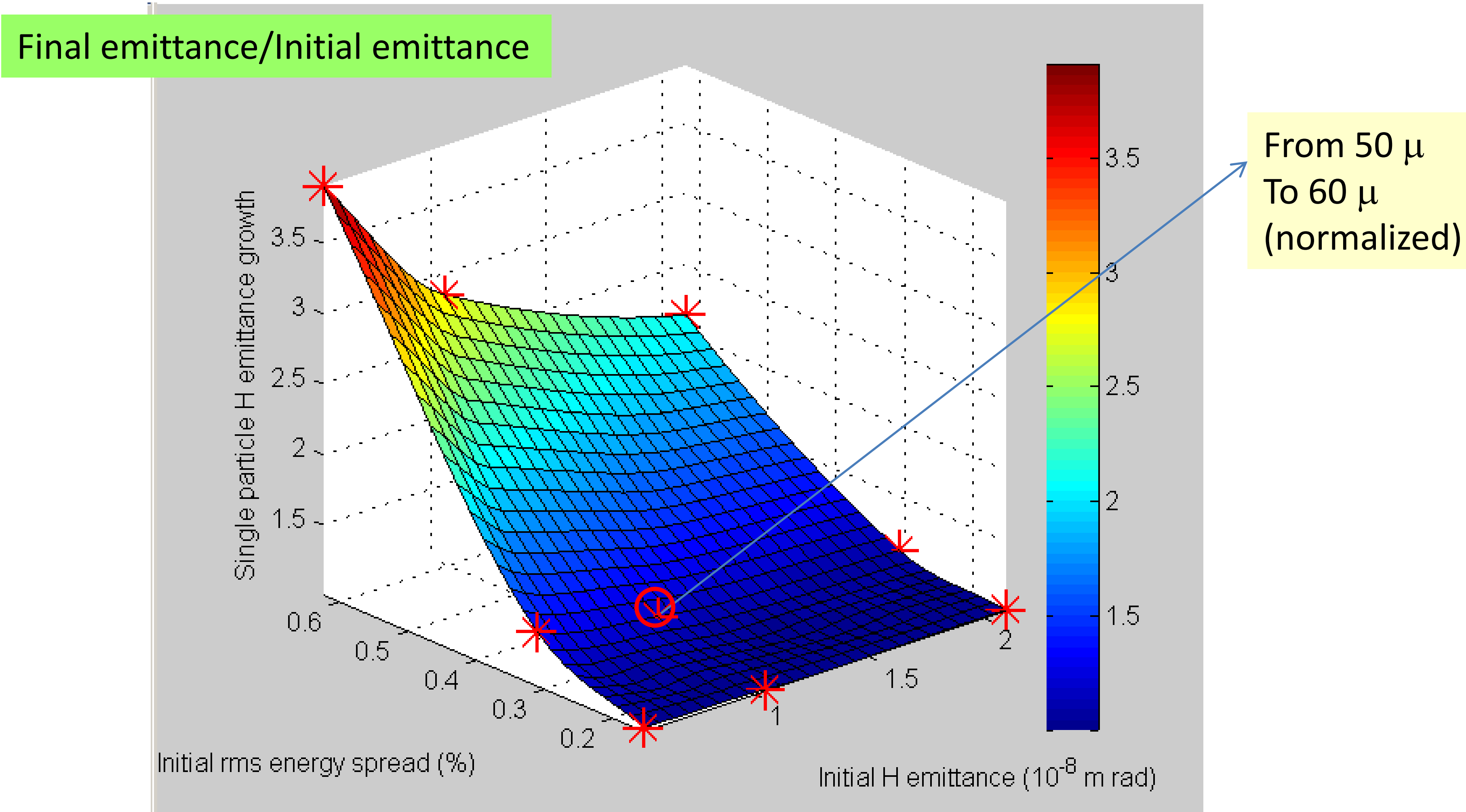






Example of CSR effects simulations:

Emittance growth due to non linear single particle dynamics (DL)
(sextupole configuration to be optimised)



Issue : Preserving low emittance beams with high energy spread

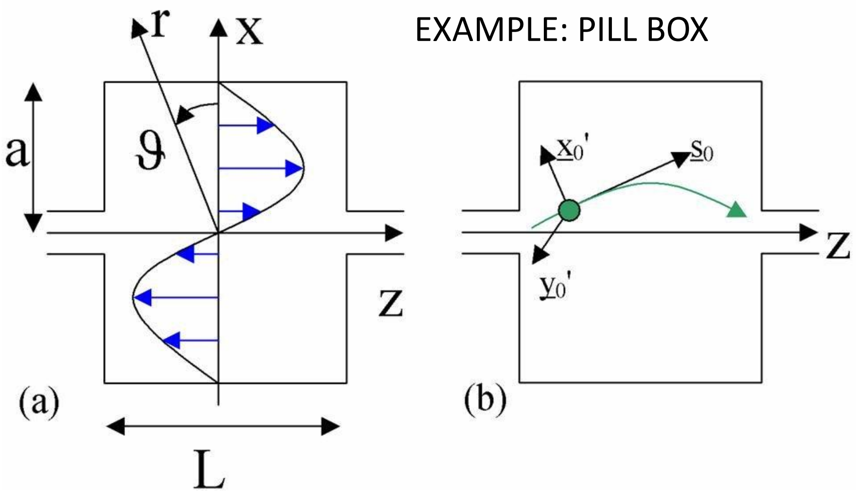
General considerations on Beam loading in RFD:

Deflecting field excited by the beam in RF deflectors

The **deflecting field has a longitudinal electric field** off-axis.

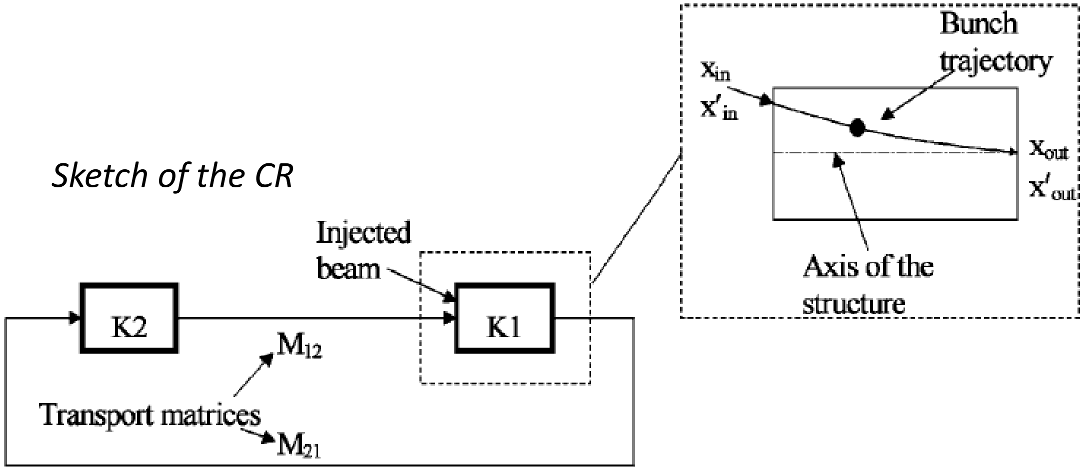
Unwanted deflecting field can be **excited by the beam if it passes off-axis** into the deflectors both in the horizontal than in the vertical plane.

The transverse deflecting voltage and the longitudinal one are **90 deg out-of-phase** as states by the Panofsky-Wenzel theorem.



$$\tilde{V}_{x\_RFD} = j\frac{c}{\omega_{RF}}\nabla_x \tilde{V}_{z\_RFD}$$

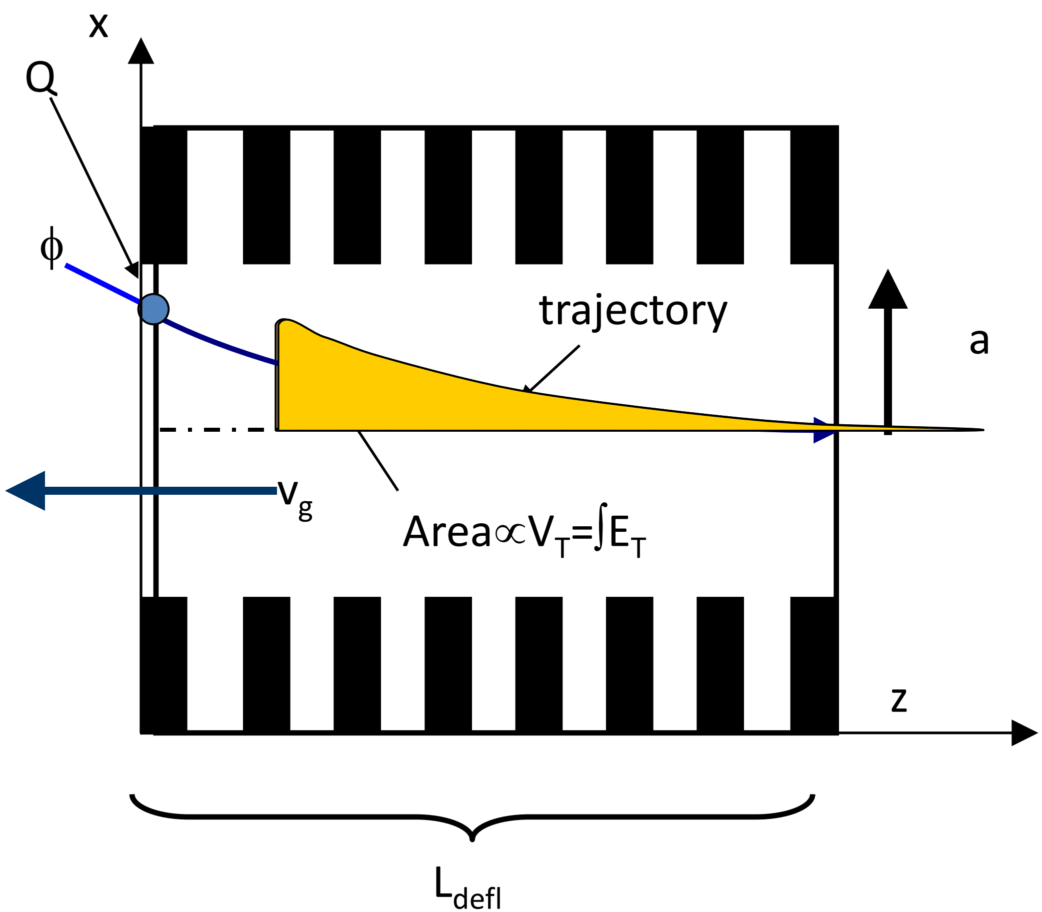
Sketch of the CR



In the CR we can have **beam loading effects** in the horizontal (deflecting) plane, **even in the case of perfect injection** since the bunch passes off axes into the deflectors.

General considerations on Beam loading in RFD:

HOW the Beam loading works (TW case)



Leading bunch charge

Trajectory of the leading bunch translated according to the group velocity

$$E_T = \frac{1}{2} q \frac{\omega_{RF}^2}{c} \frac{R}{Q} x \left(z - \frac{T_{RF}}{4} v_g \right)$$

Transverse field seen by a trailing bunch

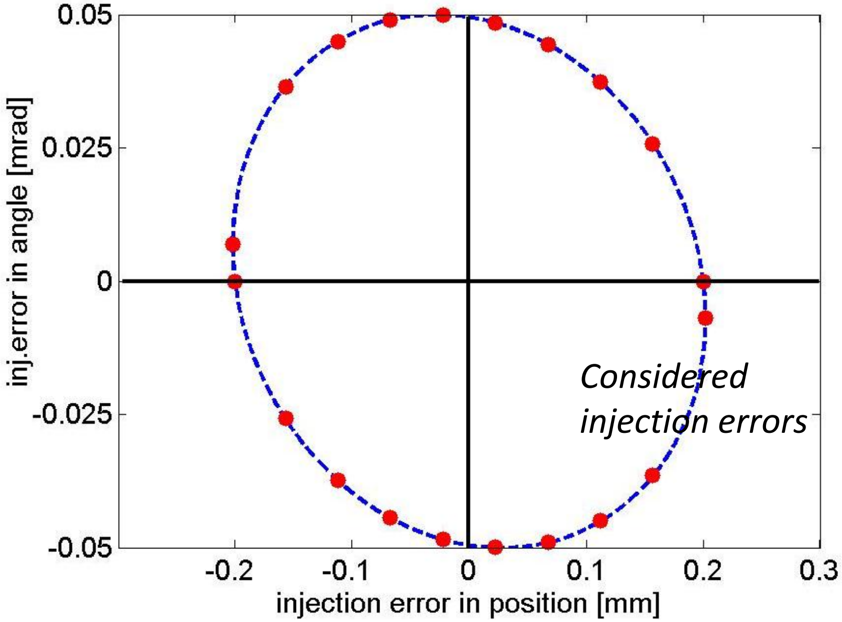
RFD parameters

Beam Loading in CR1: Injection errors

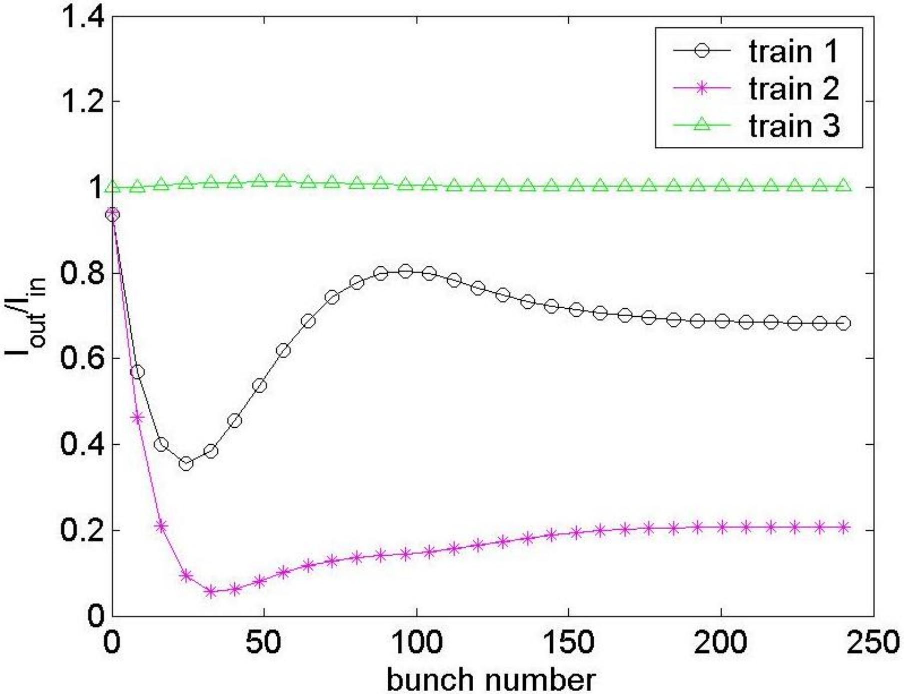
The case of **injection errors** has also been explored.

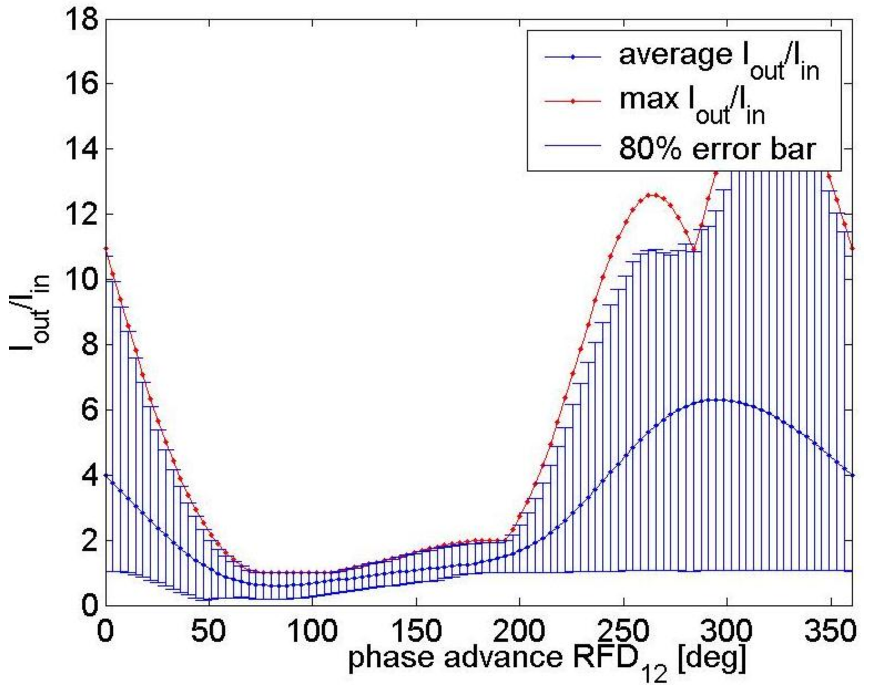
The **ratio between the output CS invariant of each bunch and the initial invariant** has been calculated for different **phase advances** between the two deflectors and for different injection errors.

The results shows that the amplification factor can be taken under control in a wide range of CR1 tunes.



Plots referred to the case of an injection error in position



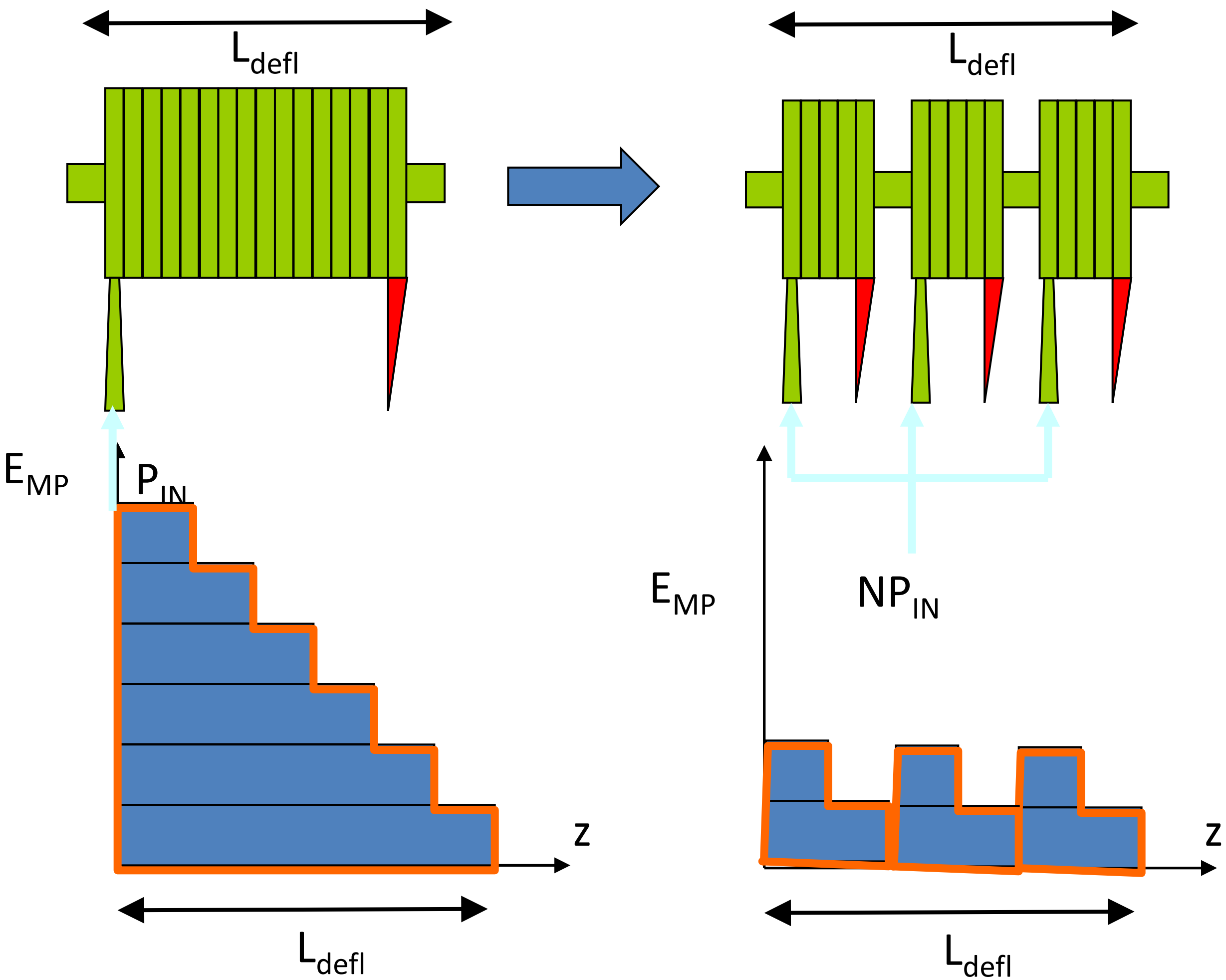


Multiple deflectors

The only practical solution is to use more RFDs. This is equivalent to have a **strongly damped structure**.

In this case **the effect of the wake is reduced by a factor N².**

The main disadvantage is that one has to feed each structure with the nominal input power and therefore one has to have **N times the available input power**.



$$\langle x_{osc} \rangle \propto \phi \frac{q}{E_0} f_{RF}^2 \frac{R}{Q} \frac{L_{defl}^3}{N^2 v_g}$$

$$P_{IN\_CLIC} \approx \frac{100}{N^2} P_{IN\_CTF3}$$

N=4

$$P_{IN\_CLIC} \approx 6 P_{IN\_CTF3}$$

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