# HEADTAIL upgrade

## new features & options

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thanks to R. Tomás, E. Métral

18 July 2008

# Outline

# Linear Transport

## The model

Linear transport through the direct MAD-X output by means of matrices

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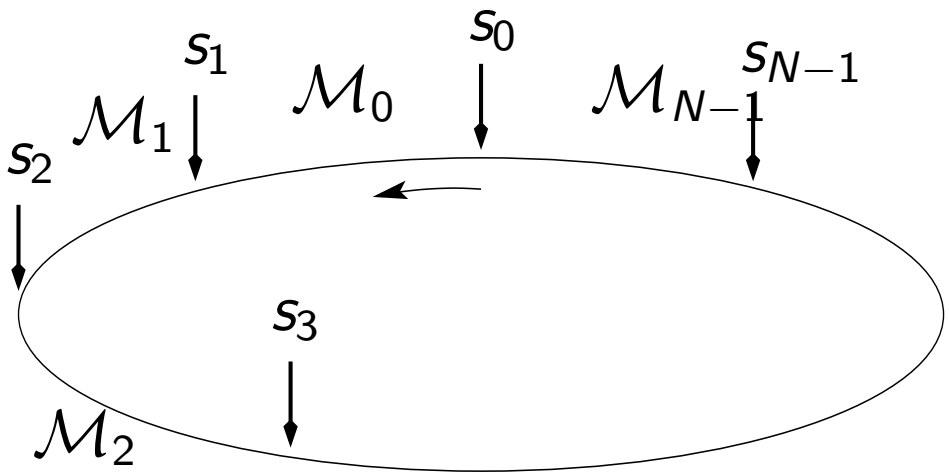

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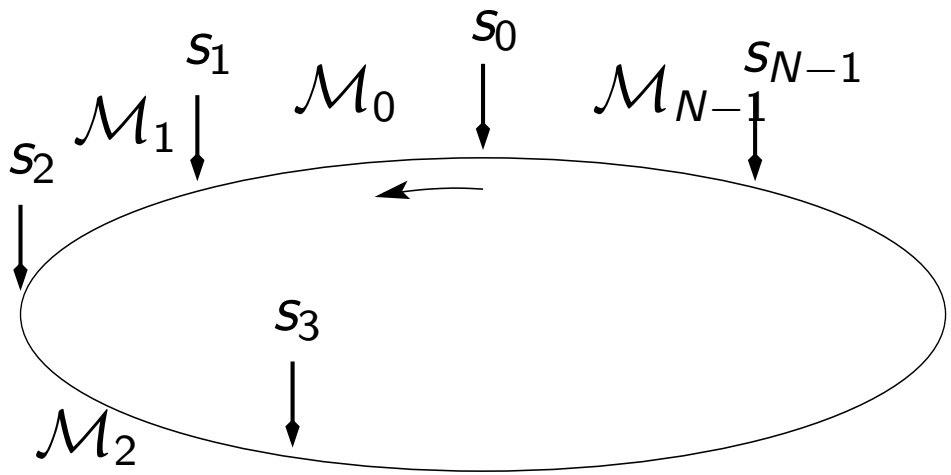


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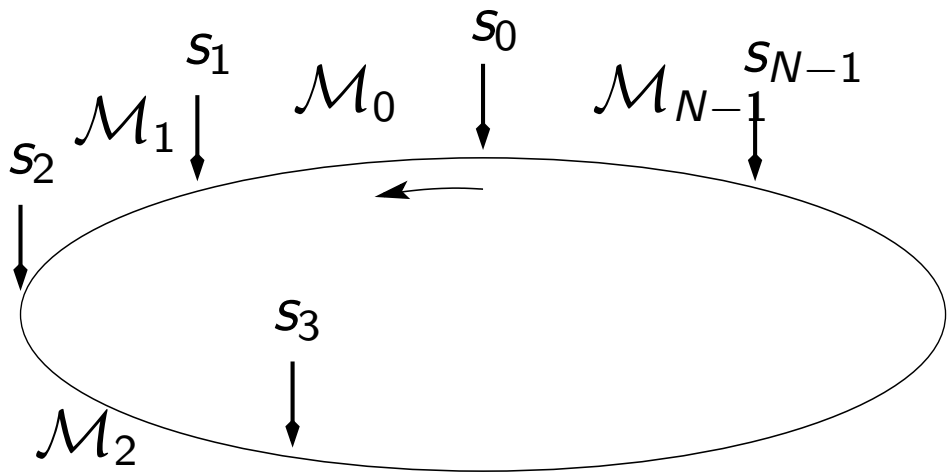


Reading the TWISS parameters $\psi, \beta, \alpha$ and the positions $s$ of the elements and building up the matrices for the different points

$$\mathcal{M}_j = \mathcal{M}\left(s_{j+1}|s_j\right)$$

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$$\Delta\psi_{j+1,j} = \delta\,\xi_{j+1,j} \qquad \xi_{j+1,j} = \frac{1}{4\pi}\int_{s_j}^{s_{j+1}} ds\,\left[k(s) - mD(s)\right]\beta(s)$$

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From MAD-X we get $d/d\delta\ \psi_{j+1,j} = \xi_{j+1,j}$
For the transport

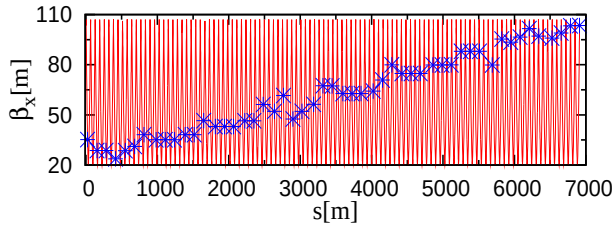
$$\mathcal{M}_j^{Chr} = \mathbf{T}_{j+1}\mathbf{R}\left(\psi_j\right)\mathbf{R}\left(\Delta\psi_{j+1,j}\right)\mathbf{T}_j^{-1} = \mathcal{M}\left(s_{j+1}|s_j\right)\mathcal{M}^{\Delta\psi_{j+1,j}}\left(s_j|s_j\right)$$

# Outline

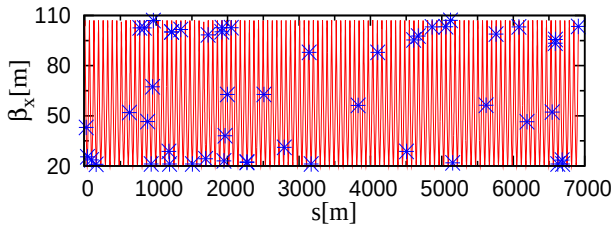
# Choice of the observation and interaction points 1/2

3 options to choose the $\beta$ function at kick points

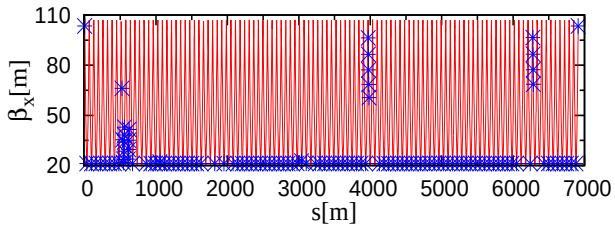
$\beta_{x,y}$ sampled through $[\beta_{Inf.}, \beta_{Sup.}]$




$\beta$ randomly distributed over the ring




$\beta$ chosen by means of the interaction point



# Choice of the observation and interaction points 2/2

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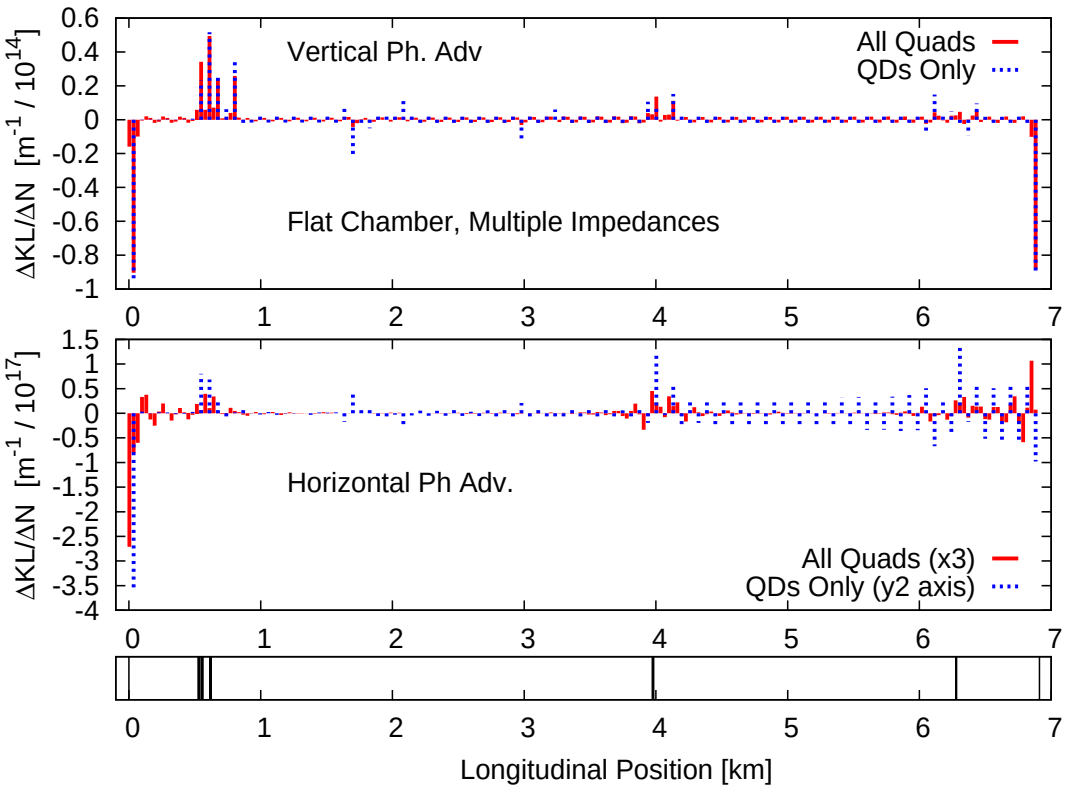


pictures from Rama's talk on May 30th, 2008

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**The model**

hdtl takes the fields from ZBASE $\rightarrow$ wake field kick

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$$p_j(\Delta t) = p_j(0) + f_j(q_j) \cdot \Delta t \qquad j = x, y$$

with

$$\int_{s_j}^{s_j+\Delta s} ds\, f_j(q_j) = \kappa \left( W_j^{Dip.} \hat{q}_j + W_j^{Quad.} q_j \right)$$

being $\hat{q}_j$ the coherent motion spatial coordinate

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**...getting the fields**

$W_j^{Dip.}$ and $W_j^{Quad.}$ fields for *every* device (source of impedance) directly taken from ZBASE

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**EXAMPLE**

```
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|---|---|
| BPM | observation at the BPMs |
| 3 | option to choose the $\beta$ |
| START | place where to start the lattice from |
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`hdtl` can directly access ZBASE
at each element, its own wake field !

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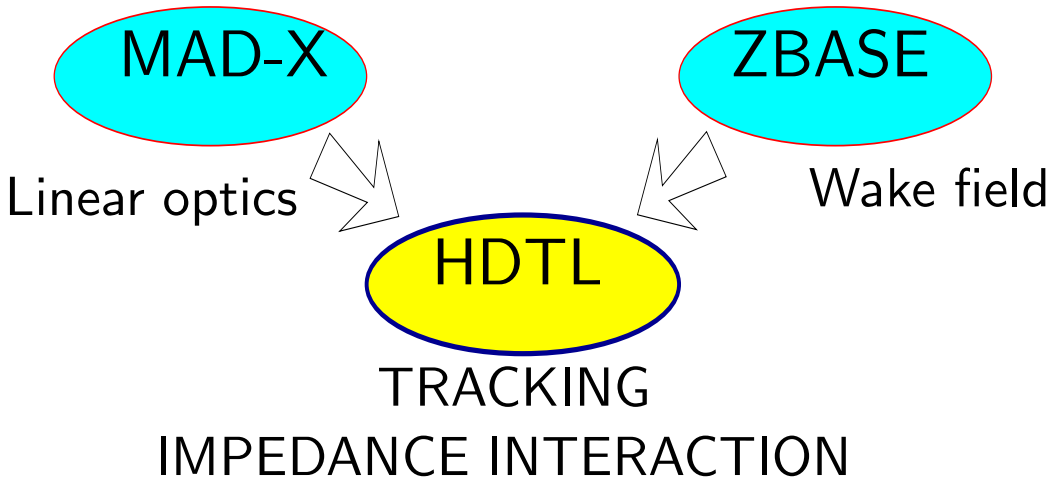
| ARG | TYPE | MEANING | DESCRIPTION |
|---|---|---|---|
| 1 | `*char` | MAD-X file | lattice structure |
| 2 | `*char / int` | elements name/number | beam observation points |
| 3 | `int` | observation points choice | selecting lattice points |
| 4 | `*char` | first lattice element | detailed bunch |
| 5 | `*char` | wake field interaction points | sources of impedance |

# Link between MAD-X and ZBASE



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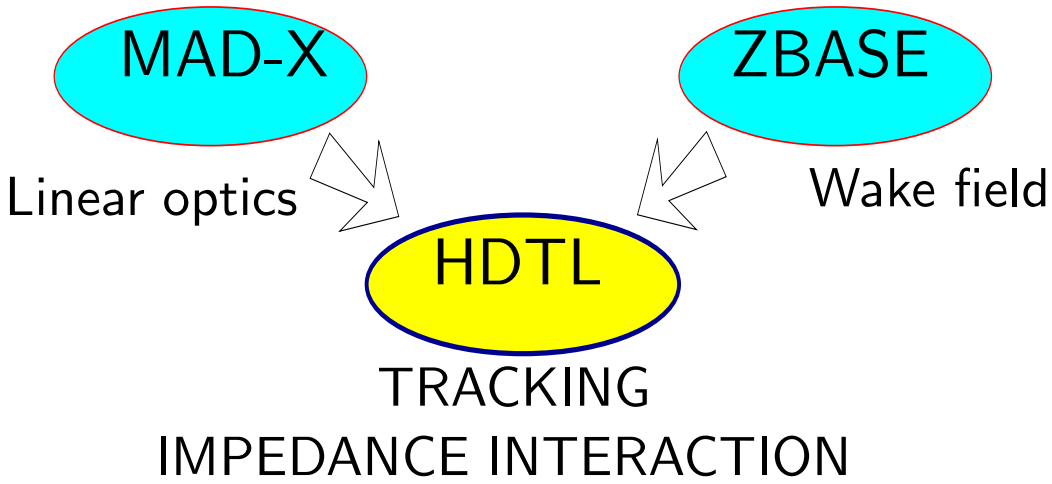


Linear model of the machine from MAD-X
&
wake fields from ZBASE

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We have simulated the interaction of the bunch with the kickers' impedances

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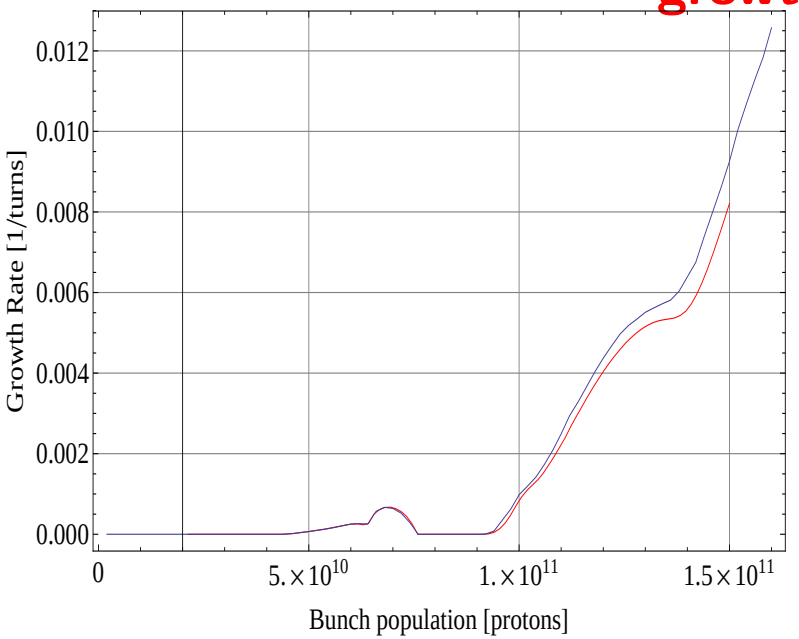


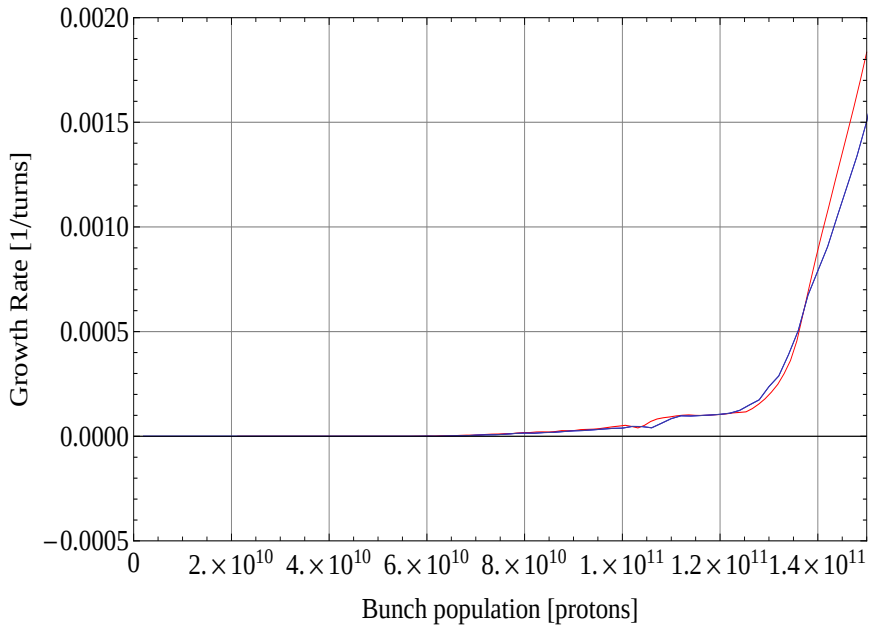


- one-kick approximation
- many kicks each turn

left(vertical plane) & right(horizontal plane)

# Mode coupling 1/2

Analysis of the tune vs. bunch intensity

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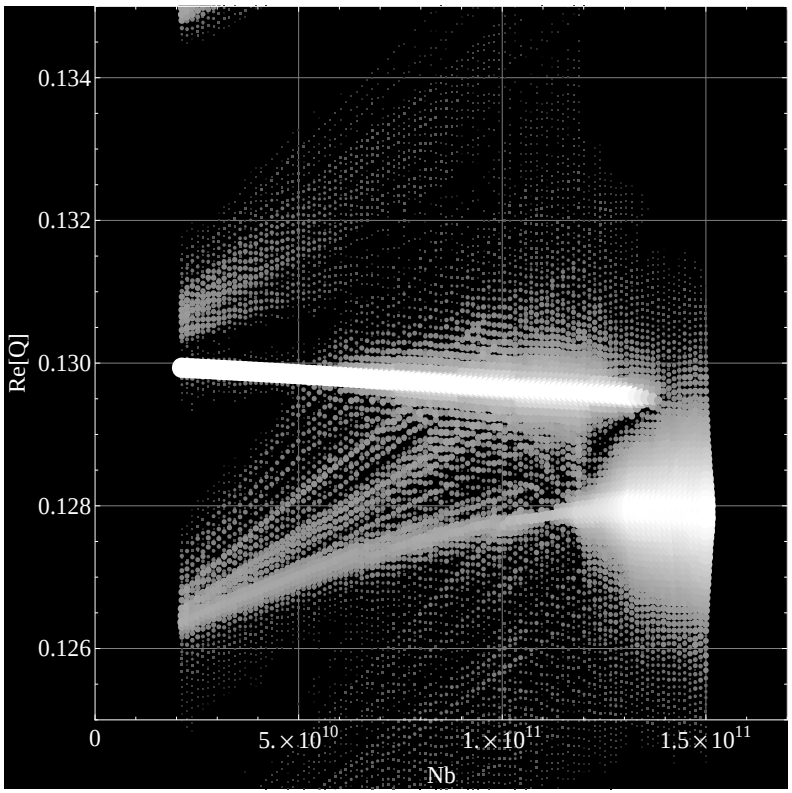
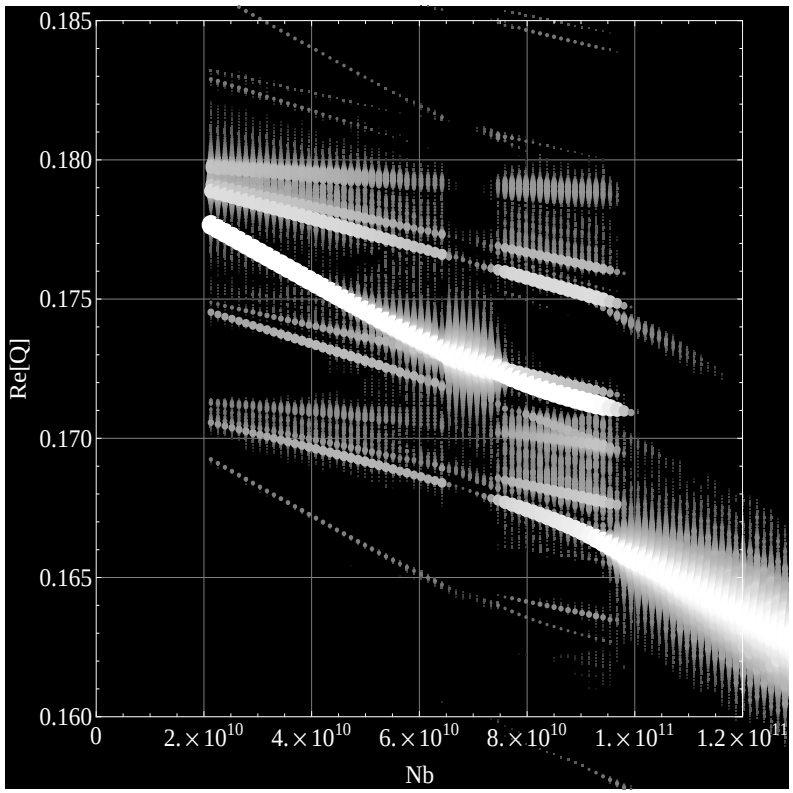
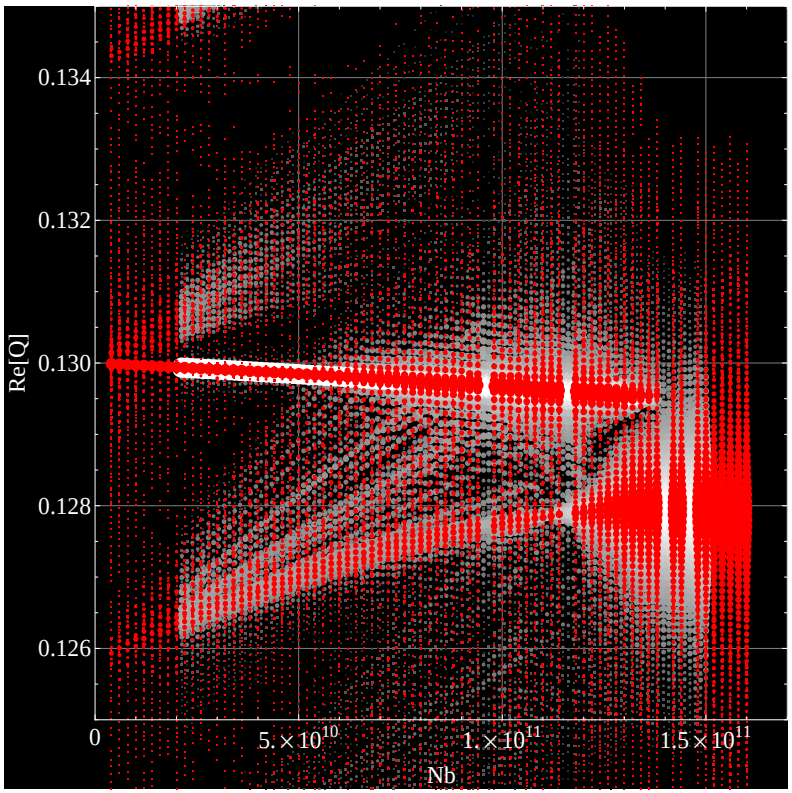


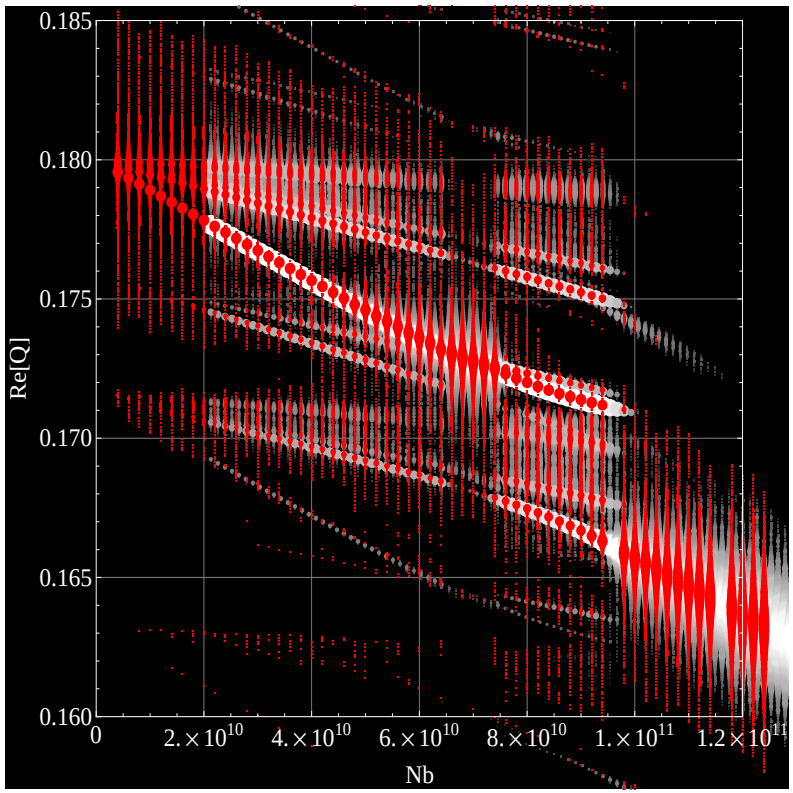




left(horizontal plane) & right(vertical plane)

# Mode coupling 2/2

Comparison between the one kick and the new model

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# Outline

- `hdtl` has been successfully interfaced with MAD-X for the linear transport
- `hdtl` has been successfully interfaced with ZBASE to get the dipolar and quadrupolar components of the wake fields for each element
- SPS kickers impedances: benchmark between the one-kick approximation (using $\beta$-weighed fields) and the new code with multiple kicks at their actual locations shows an excellent agreement
- `hdtl` can do realistic simulations for a single bunch through an arbitrary sequence of known impedances