HEADTAIL upgrade

new features & options

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thanks to R. Tomás, E. Métral

25 August 2008

Outline

Linear Transport

The model

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

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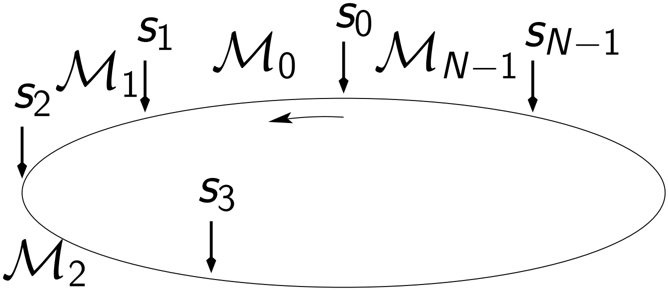

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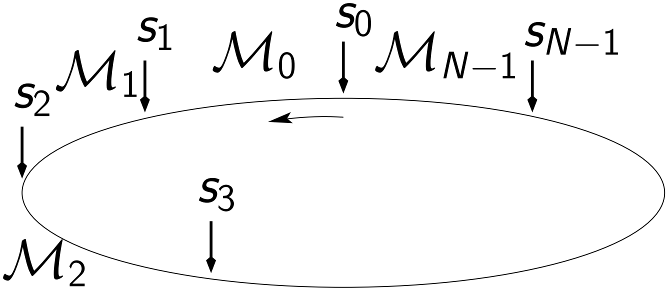

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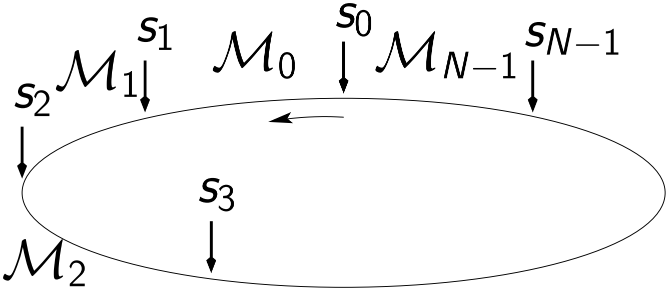

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$$\Delta\psi_{j+1,j} = \delta\, \xi_{j+1,j} \qquad \xi_{j+1,j} = \frac{1}{4\pi} \int_{s_j}^{s_{j+1}} ds\, \left[k(s) - m(s) D(s)\right] \beta(s)$$

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For the transport

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

Outline

Choice of the interaction and observation points 1/3

Three kind of interactions are taken in account

i) Space charge: present everywhere in the machine

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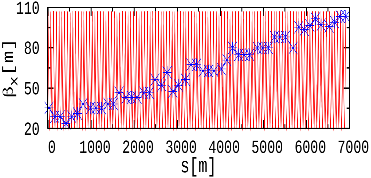
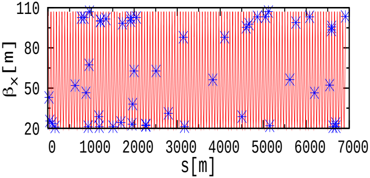
Choice of the interaction and observation points: space charge 2/3

Space charge forces depend on the transversal size of the beam
$\sigma_{x,\,y} \simeq \sqrt{\epsilon_{x,\,y}\beta_{x,\,y}}$
E. g. SPS' lattice example





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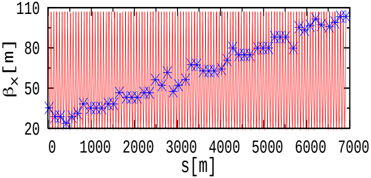

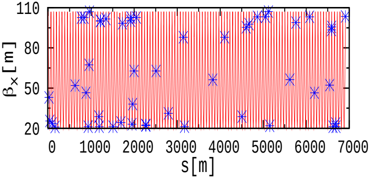

$\beta_{x,y}$ sampled through $[\beta_{Inf.}, \beta_{Sup.}]$ (left) $\longrightarrow$ we can take in account any size of the beam

β randomly distributed over the ring (right) $\longrightarrow$ using different seeds we can do some statistical studies

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Example for the SPS

$$\texttt{\$ hdtl } \underbrace{\texttt{sps.dax}}_{\text{MAD-X file}}\ \overbrace{\texttt{2 200}}^{\text{s.c options}}\ \underbrace{\texttt{ec BMM}}_{\text{e.c interaction at}}\ \overbrace{\texttt{wf MKQ MKV MKH}}^{\text{w.f interaction at}}\ \underbrace{\texttt{ob BPV BPH}}_{\text{observation points at}}$$

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The string `BMM` means each element of that family.

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argv	option	type	description	comment
1	-	*char	MAD-X input file with lattice structure	contains all the MAD-X instructions
2	0	int	sampling through all β_x range of variation	-
	1	int	sampling through all β_y range of variation	-
	2	int	random choice of both β_x and β_y	-
	3	int	no space charge force	-
3	-	int	numbers of elements for the space charge force	compulsory if argv2$= 0, 1, 2$
>4	-	*char	elements' name for ec wf and ob points	you can even use one of the three

Outline

Needed files and how does hdtl work...1/2

- .cfg*: contains all the information concerning the bunch as well as some of the physical parameters
- .dax*: contains the MAD-X instructions to get all the information about the machine
- match_htdl.cmdx*: contains the MAD-X instructions to match both the tunes and the chromaticities whose values are in the .cfg file
- selectedlattice.txt: contains the used lattice with the twiss parameters
- ELEMENT_NAMES.txt: contains all the elements used in the simulation and a flag to distinguish between them

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in red are those files whose name must not change
* are those files hdtl needs to work

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`hdtl` takes the fields from ZBASE $\longrightarrow$ wake field kick

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

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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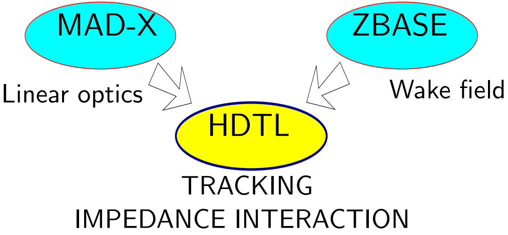
...getting the fields

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

Link between MAD-X and ZBASE



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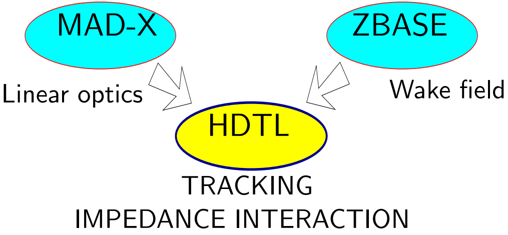

Linear model of the machine from MAD-X
&
wake fields from ZBASE

Outline

Impedance sources localization

Centroid motion at BP(M/V/H) selected by means of the names

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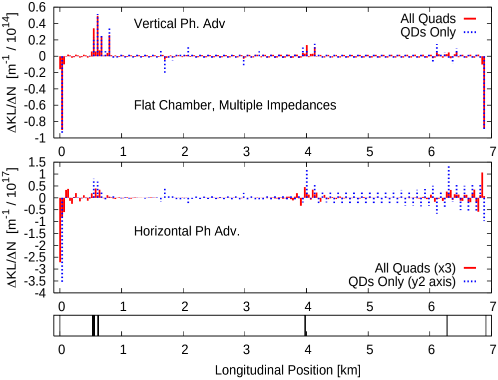

pictures from Rama's talk: SPS Impedance Meeting, May 30th, 2008

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Growth rates

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

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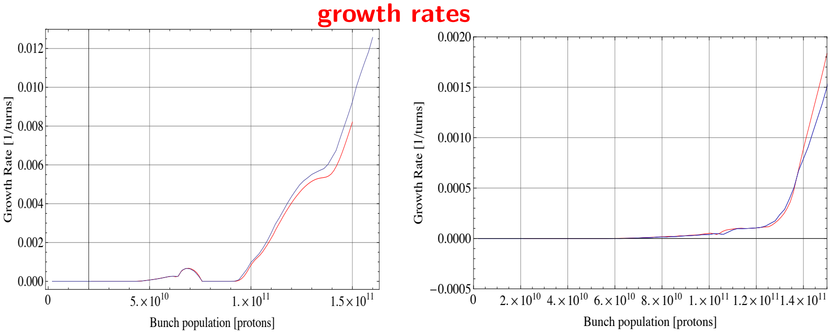

- one-kick approximation
- many kicks each turn

left(vertical plane) & right(horizontal plane)

Mode coupling 1/2

Analysis of the tune vs. bunch intensity

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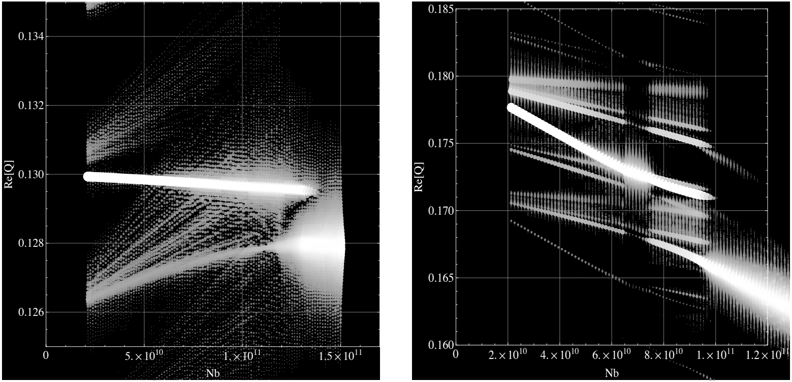
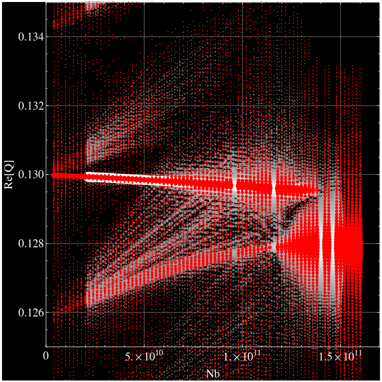
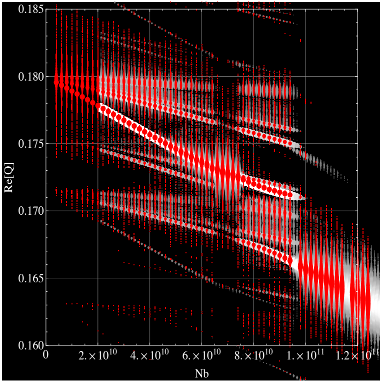


left(horizontal plane) & right(vertical plane)

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 β-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
- any suggestion, idea, help...would be most welcome...debugging is still ongoing