Status of transmission simulations in an isochronous FFAG lattice e-model and muon-ring

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ENG meeting, CERN 31/08/2005

Design of the isochronous cell [Ref.G.Rees]

Original design

BF is a multipole

- gradient is dB/dx.

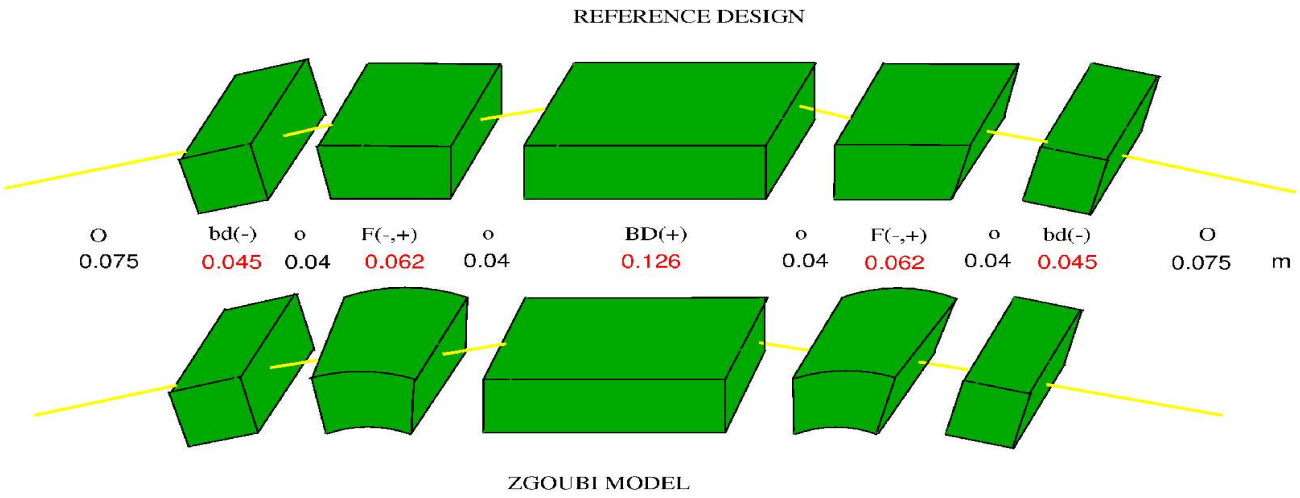


Figure 1: The isochronous cell.

Zgoubi model:

BF magnet is a sector magnet

- gradient is dB/dr
- sector angle value of half the cell deviation

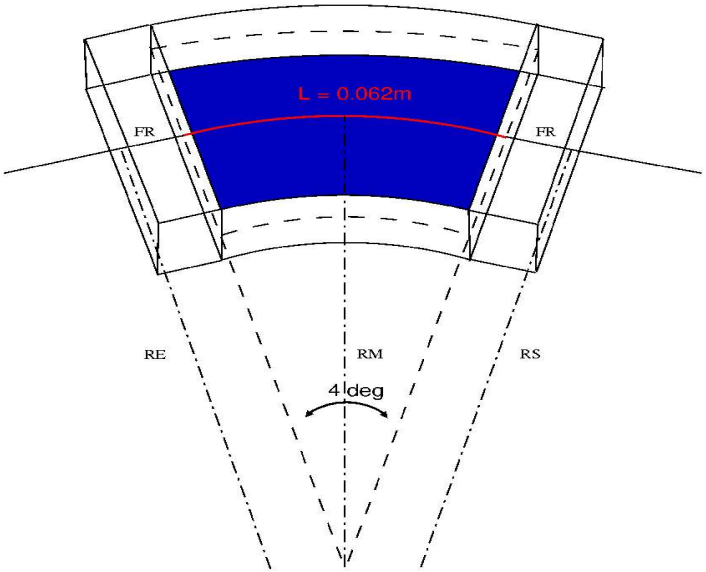


Figure 2: The sector magnet in the zgoubi model

New fitting procedures

- The magnetic field has multipole components up to the dodecapole
- We have enhanced fitting capabilities in Zgoubi in relation to FFAG design, for instance allow automatic adjustement of bi's coefficients

$$B(x) = b_0 + b_1 x + b_2 x^2 + b_3 x^3 + b_4 x^4 + b_5 x^5$$

so as to match tunes, or isochronism, etc …

- Automatic search of closed orbits and Twiss parameters, for given set of energies

Acceleration cycle

- A 5000 particle beam is launch for a full acceleration cycle.
- Constant ΔE - no phase effect.
- E-model :

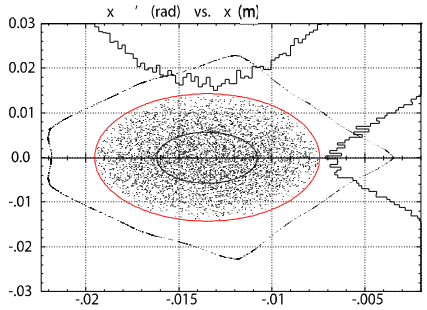
  15 turns (45 cells/turn), from 11 to 20 MeV, 40 kV per cavity.
  Cavities are put every three cells at the center of the long drift.

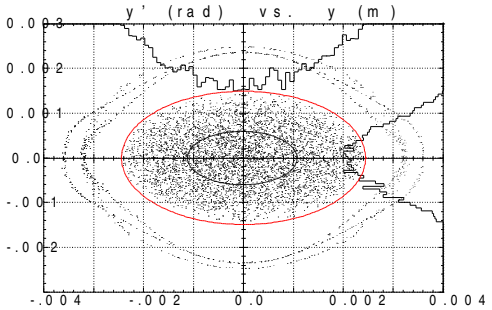
- Muon-ring :

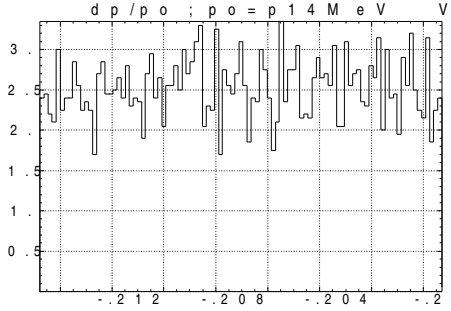
  16 turns (123 cells/turn), from 8 to 20 GeV, 18,3 MV per cavity.
  Cavities are put every three cells at the center of the long drift.

e-model : Beam transmission iterations

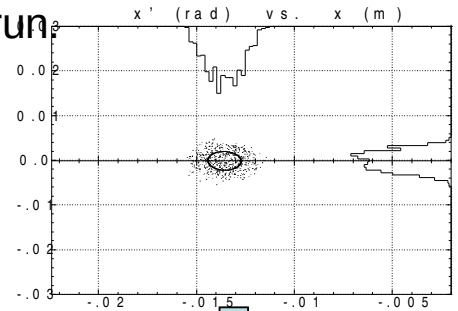
Initial phase spaces are inserted into the stability limits found by previous multiturn tracking.

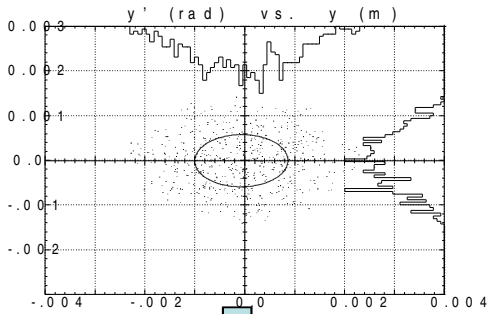


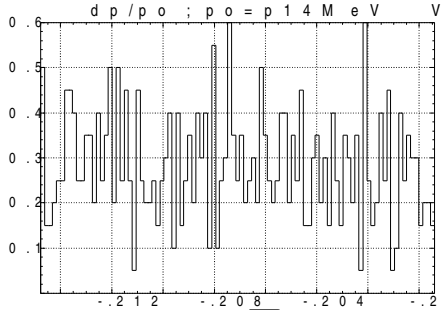


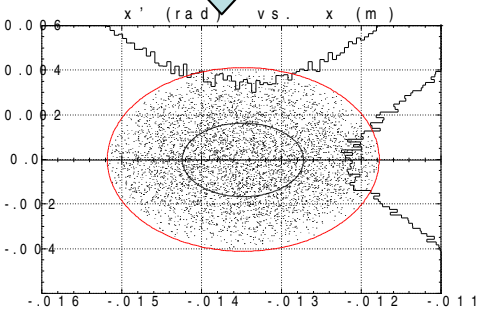


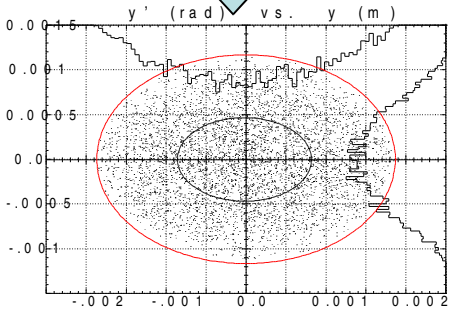
The phase spaces of transmitted particles are used as new initial phase spaces for the next run.

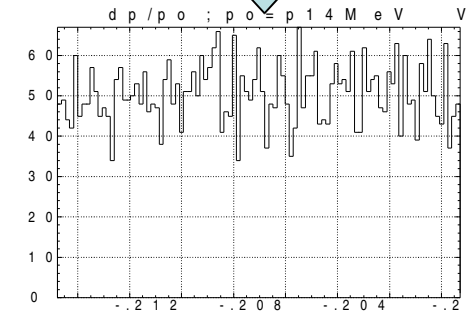












e-model : transmission results

3 iterations have been done.

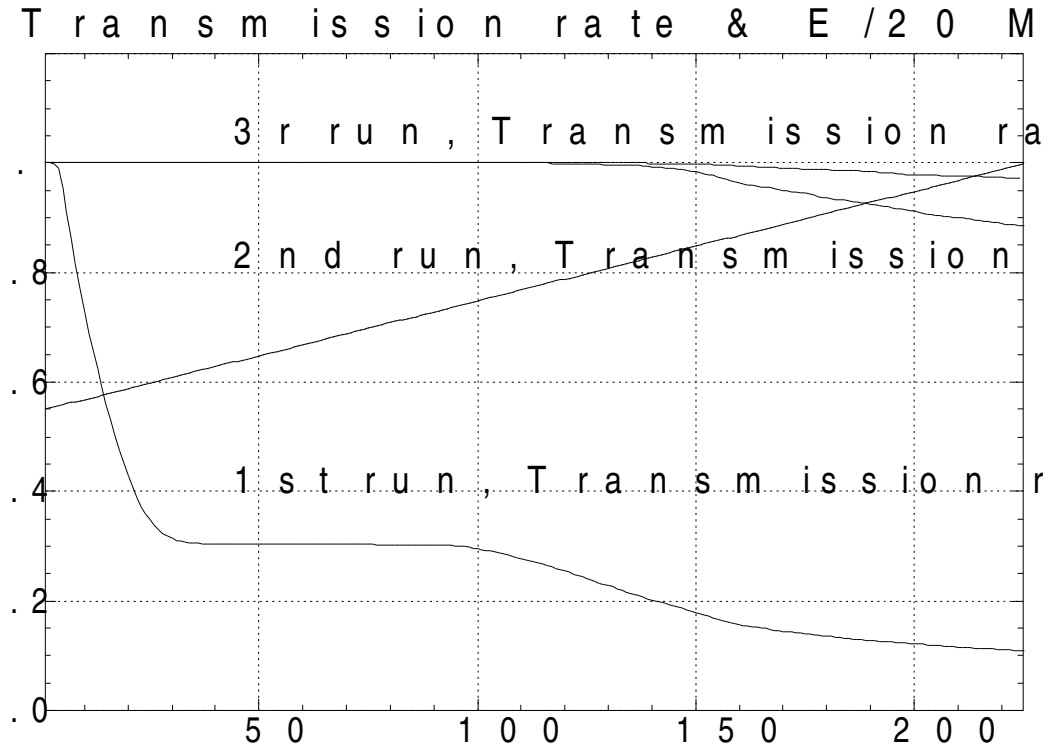
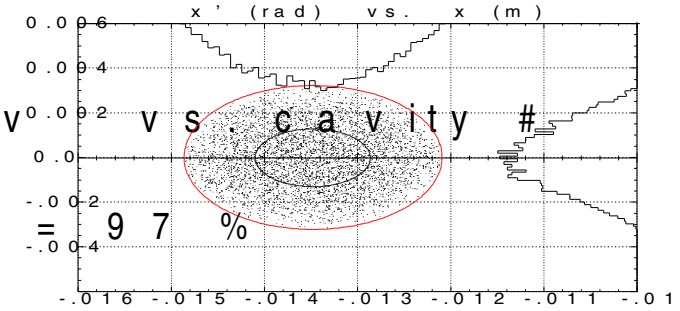


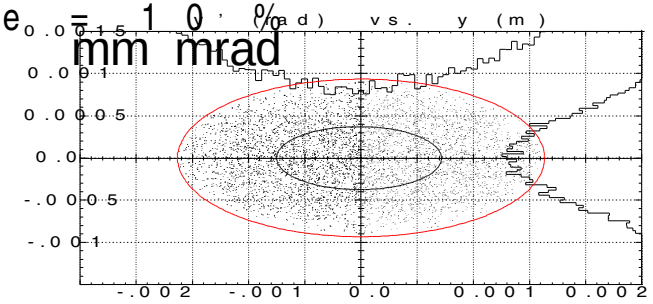
Figure 3 : transmission rate for the three iterations

Acceptance for a transmission rate of 97



$\varepsilon_x = 17\ \pi$ mm mrad

$\varepsilon_{x,\text{normalised}} = 387\ \pi$ mm mrad



$\varepsilon_y = 5.8\ \pi$ mm mrad

$\varepsilon_{y,\text{normalised}} = 131\ \pi$ mm mrad

Muon ring : transmission results

The same procedure as for the e-model has been done but the transmission rate is not better than 14 % .

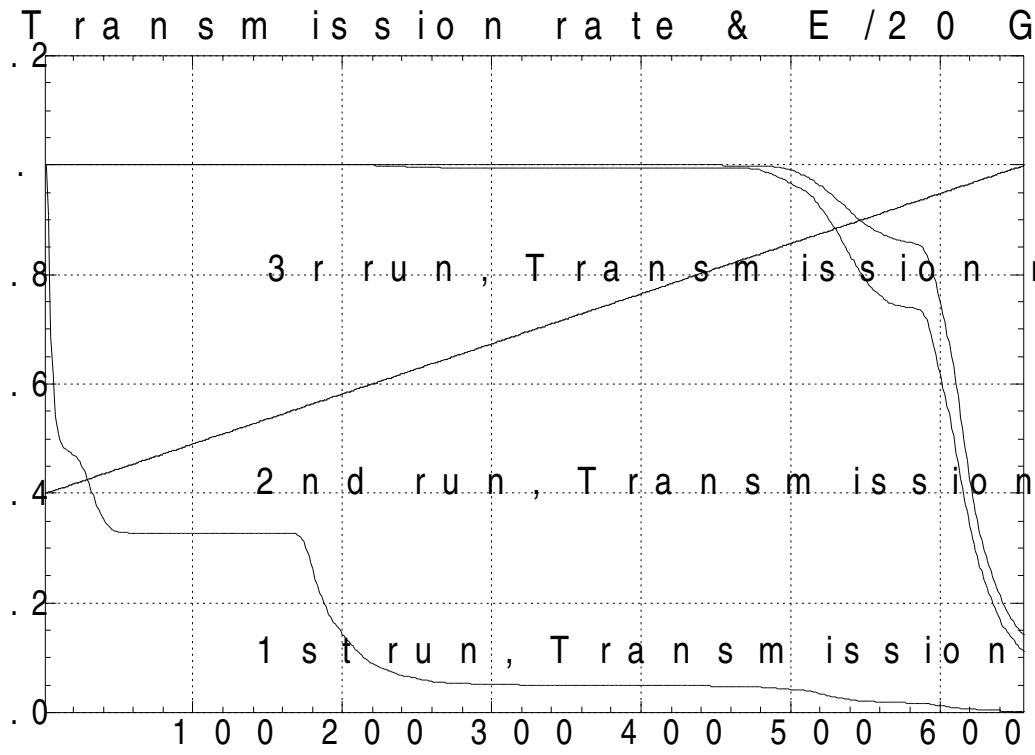
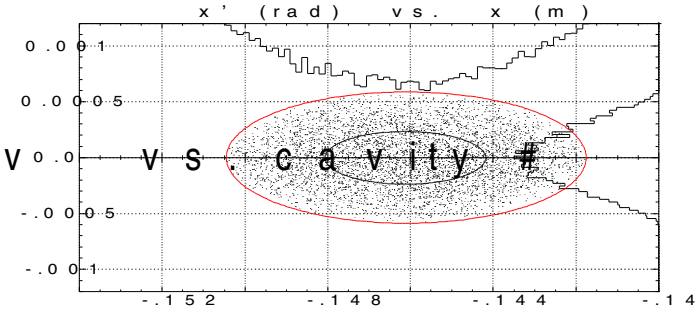


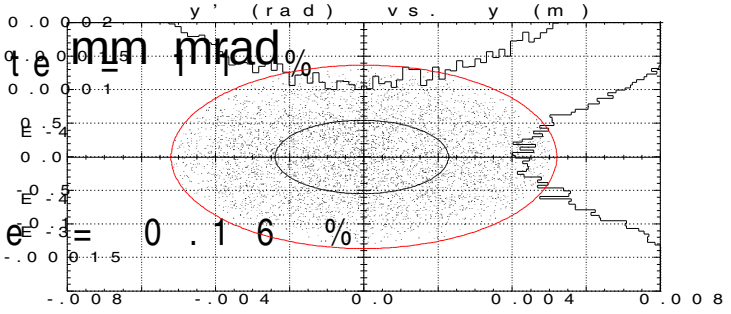
Figure 4 : transmission rate for the three iterations

Acceptance for a transmission rate of 14 %



$\varepsilon_x = 9.8\ \pi$ mm mrad

$\varepsilon_{x,\text{normalised}} = 752\ \pi$ mm mrad



$\varepsilon_y = 2.7\ \pi$ mm mrad

$\varepsilon_{y,\text{normalised}} = 207\ \pi$ mm mrad

Systematic beam losses at the end of the cycle !

Muon ring : beam losses

The beam losses are correlated with blow-up of the beam envelopes

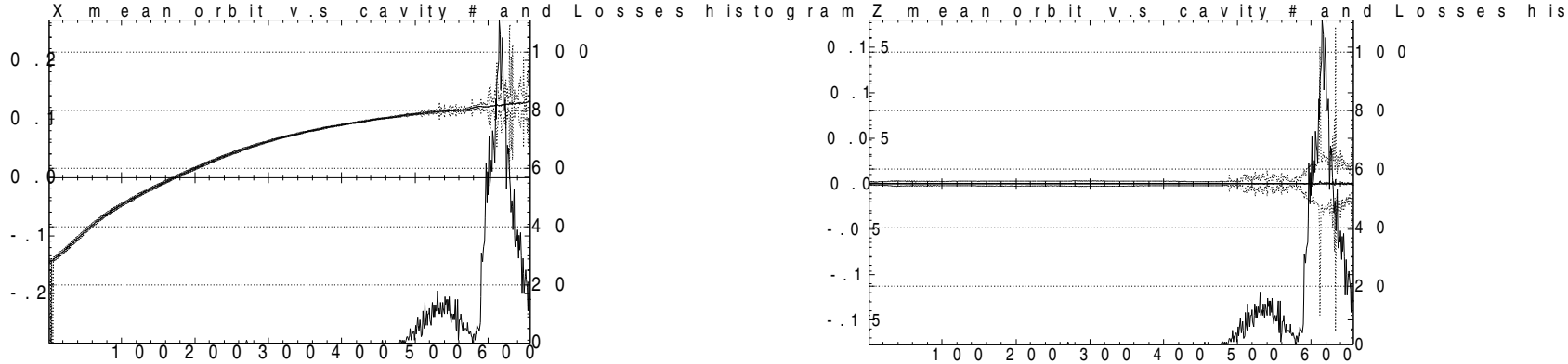
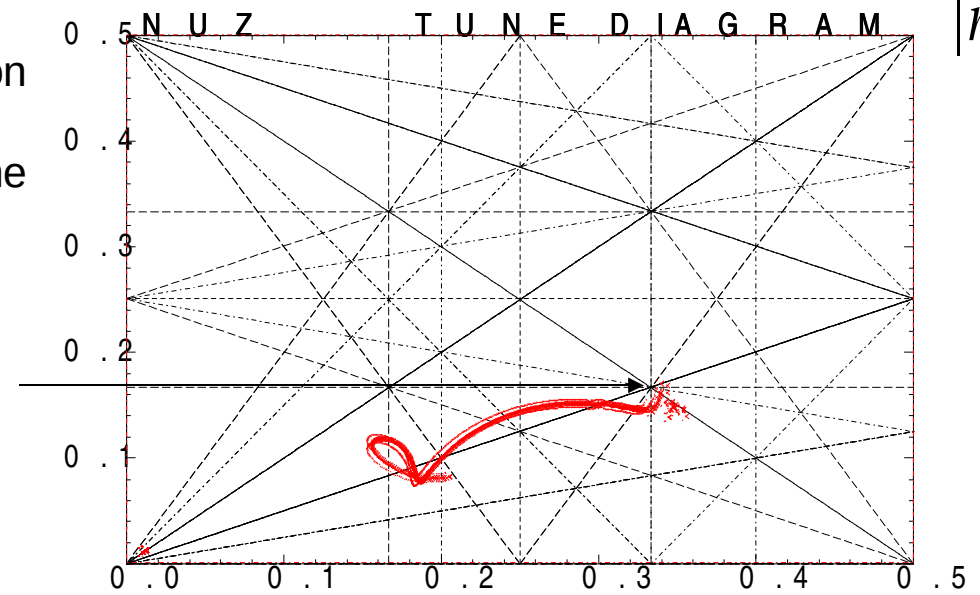


Figure 5 : Beam envelopes for the full cycle and histogram of particles losses

A particle is launched at the injection energy (8 GeV) on its closed orbits, tunes are computed during the acceleration cycle.

Fatal crossing of a resonnances node



$|m|+|n|$

Summary

Status of transmission simulations :

	transmission rate %	ε_x π mm mrad	$\varepsilon_{x,normalised}$, π mm mrad	ε_y π mm mrad	$\varepsilon_{y,normalised}$, π mm mrad
E-model	97	17	387	5.8	131
Muon-ring	14	9.8	752	2.7	207