Neutrino Factory front-end: 44-88 MHz (rotation) progress

44-88 MHz Front-end (1/2)

Pion production: 2 GeV proton beam on a 26 cm long Hg target in 20 T field (SPL+accumulator & compressor ring).

Decay: 30 m long in 1.8 T.

Rotation: particles with 100-300 MeV in kinetic energy rotated by 44 MHz (2 MV/m) RF cavities (energy spread divided by 2).

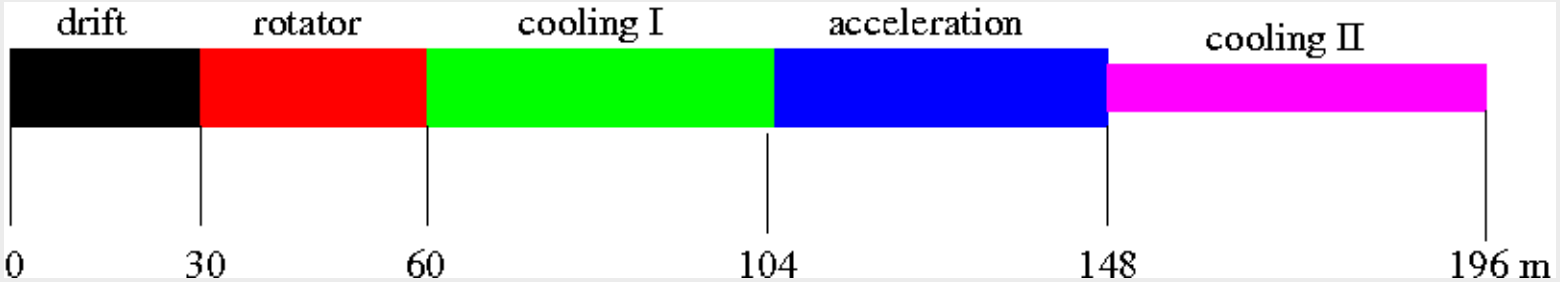
Cooling I: 44 MHz RF + H_2 absorbers reducing the transverse emittance in each plane by a factor 0.6.

Acceleration I: particles accelerated to an average energy of 300 MeV with 44 MHz cavities.

44-88 MHz Front-end (2/2)

Cooling II: 88 MHz (4 MV/m) RF + H_2 absorbers.

Acceleration II: 88 MHz cavities.



Lattice transverse optics (1/3)

Initial beam of 4 particles with (x,px,y,py) coordinates:

x1 = (a,0,0,b)

x2 = (acos(30),b/2,a/2,bcos(30))

x3 = (a/2,bsin(60),asin(60),b/2)

x4 = (0,a,b,0)

a = 0.01 m b = 0.01075 GeV/c.

(x-y) plane circle of radius a.

(x,px) plane ellipse of semi-axes a,b.

(y,py) plane ellipse of semi-axes a,b.

Need xi belonging to the same 4D ellipsoid.

Lattice transverse optics (2/3)

ICOOL gives for each z position & momentum but not the optics parameters (twiss, emittance...).

Transfer map R between plane i & i+1 is Xi+1 = R.Xi:

-retrieve from ICOOL XI = (x1,x2,x3,x4) plane i

-retrieve from ICOOL XF = (x1,x2,x3,x4) plane i+1

$$XF = R.XI \Leftrightarrow R = XF.(XI)^{-1}$$

XI needs to be invertible

Beam ellipsoid σ such as $X^T.\sigma^{-1}.X = 1$ for each plane:

$$\sigma_{i+1} = R.\sigma_i.R^T$$

must stay an ellipsoid after each transformation

Lattice transverse optics (3/3)

Determination of σ_0 coefficients.

Assume $\sigma_{ij} = \langle x_i . x_j \rangle$ (correct ?)

Use the relations:

$\langle cosx.cosx \rangle = \langle sinx.sinx \rangle = ½$

$\langle cosx.sinx \rangle = 0$ (can we ?)

Problems:

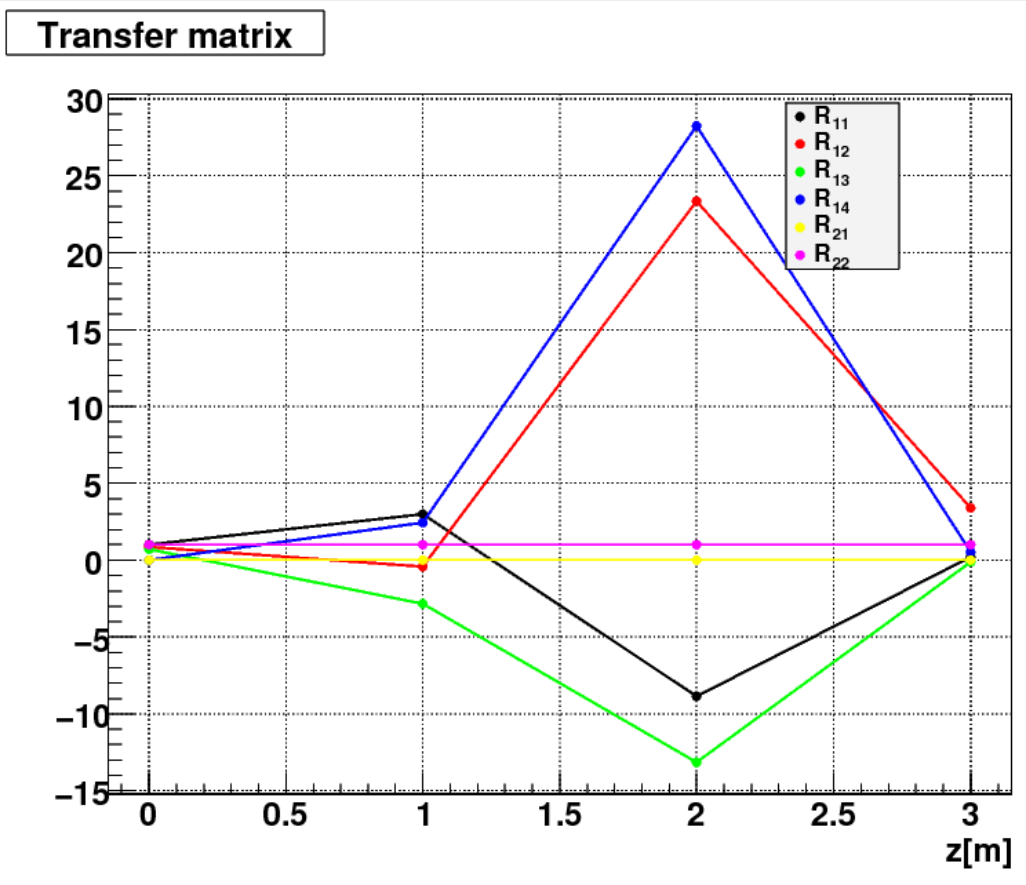
$\det(\sigma_0) = 0$

2x2 sub-matrices in (x,px) and (y,py) factor ½

Checking the algorithm (1/1)

No RF & no magnetic field: drift, no x-y coupling.

In 2D R is indeed the map of a drift $R_{11} = 0$, $R_{12} = L$, $R_{21} = 0$, $R_{22} = 1$ in (x,px) or (y,py) planes.

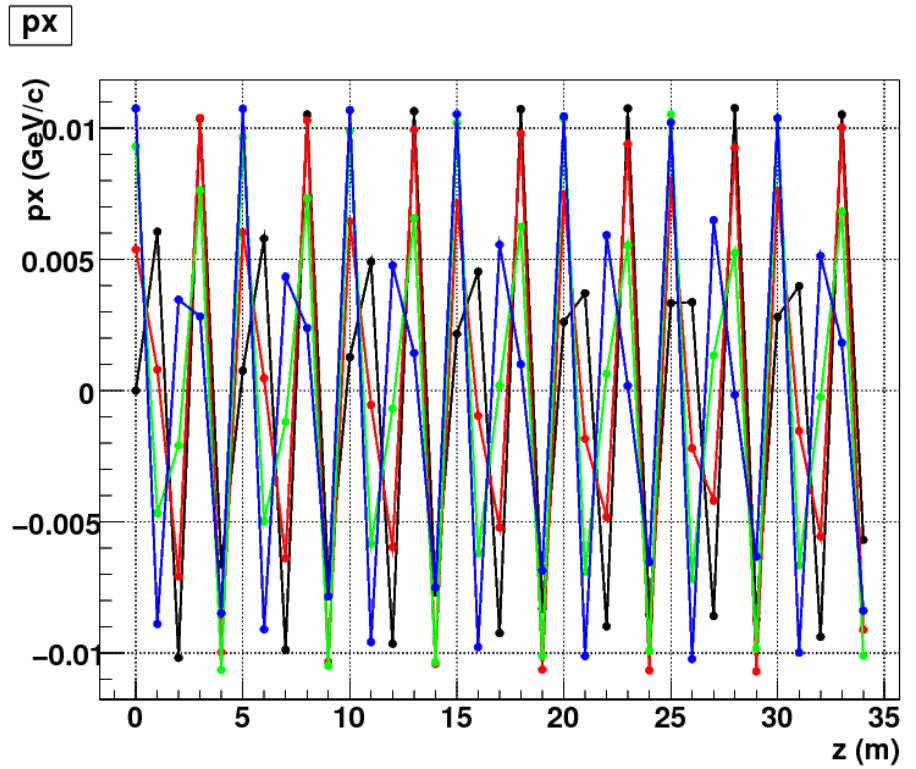


Does not work for 4D ?

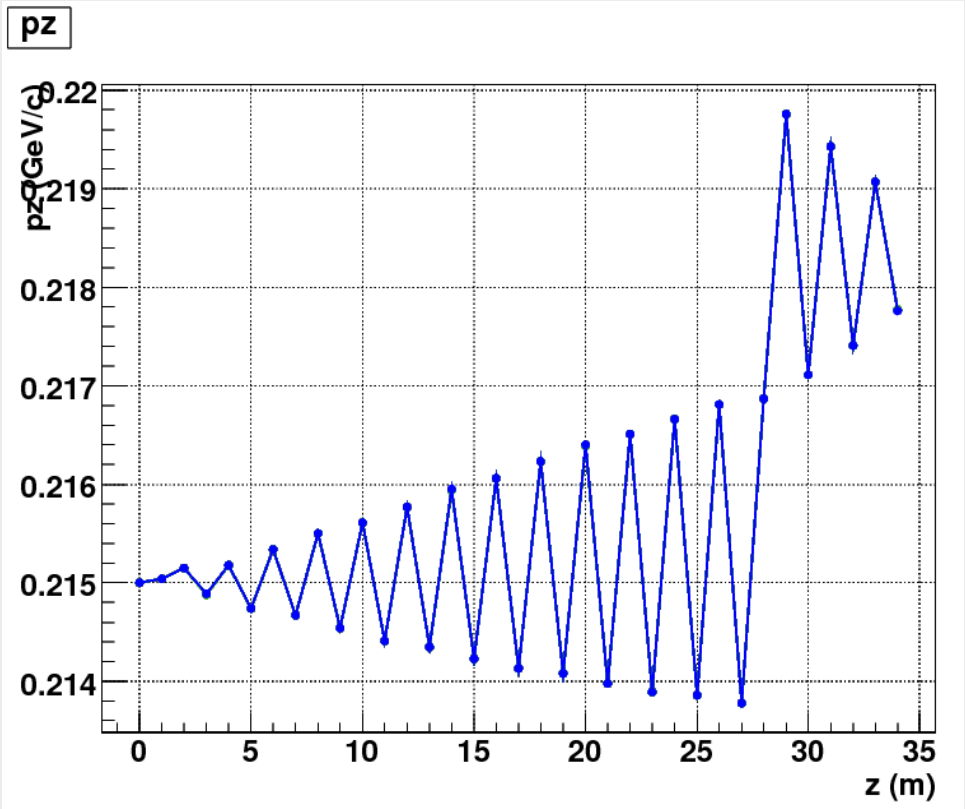
R11 is not 1

R12 is not L

Momentum transformation (1/1)

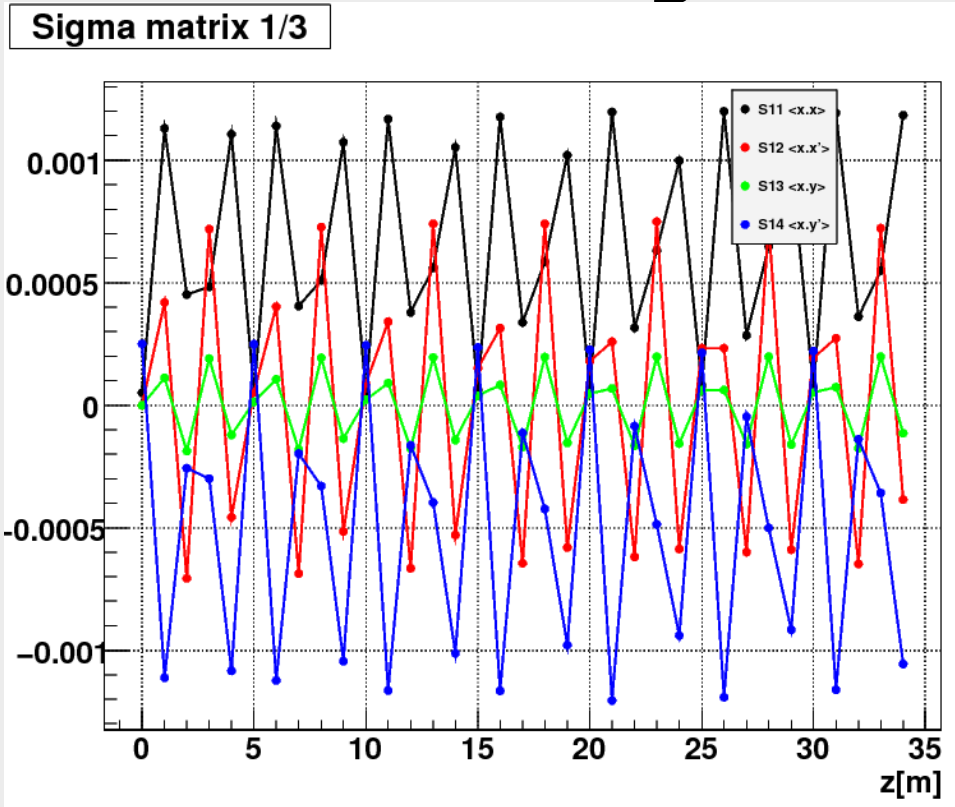


Need to check if energy spread /2

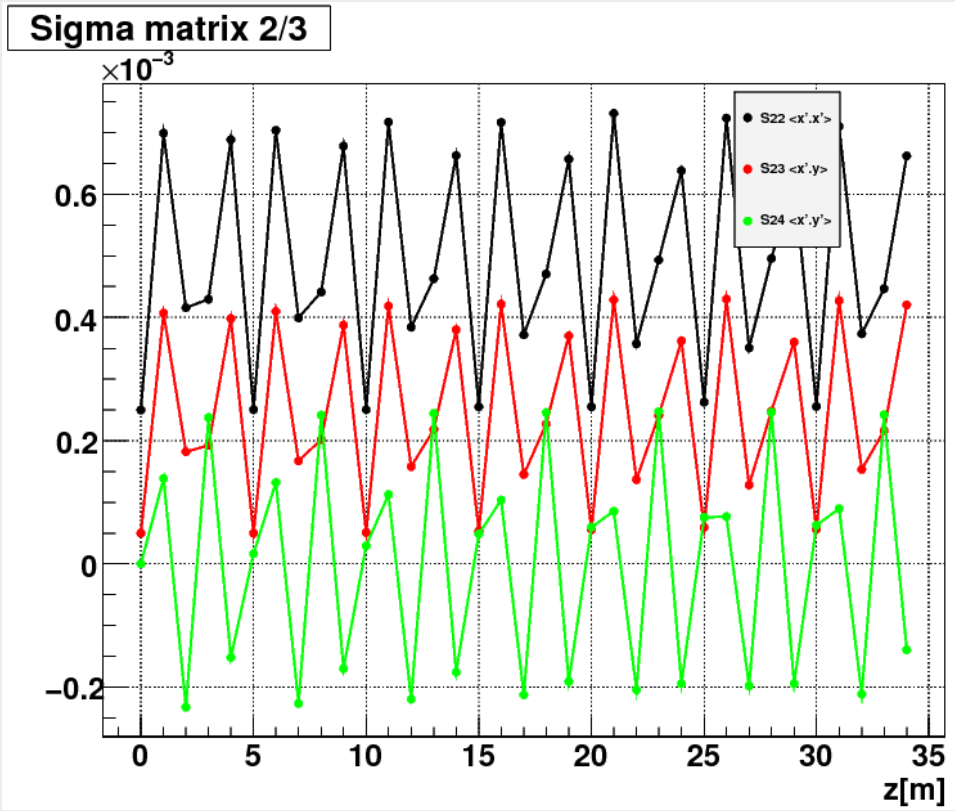


November 10th 2009

Sigma matrix (1/2)



5 m periodicity



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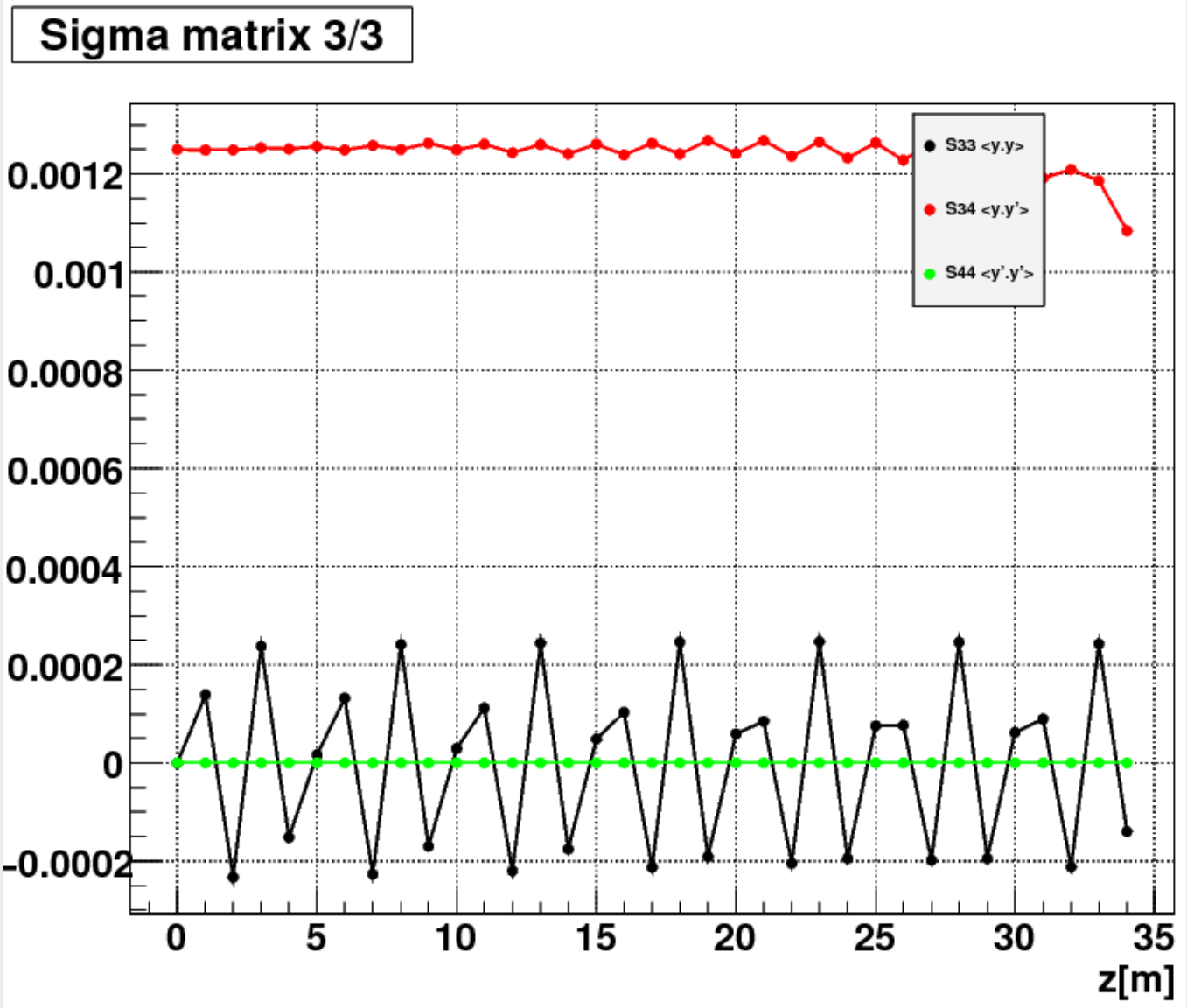
Sigma matrix (2/2)



To do

Try to understand the problems or change to a “real” optics code (MAD-X, OPTIM, PATH).

- pros: ICOOL not designed for transverse optics

- cons: more code learning/implementation time lost

Implement cooling & acceleration in the lattice.

Look at the longitudinal phase space.

Implement the 20T to 1.8 T drift part.

Test a 5-15 GeV beam on this lattice.