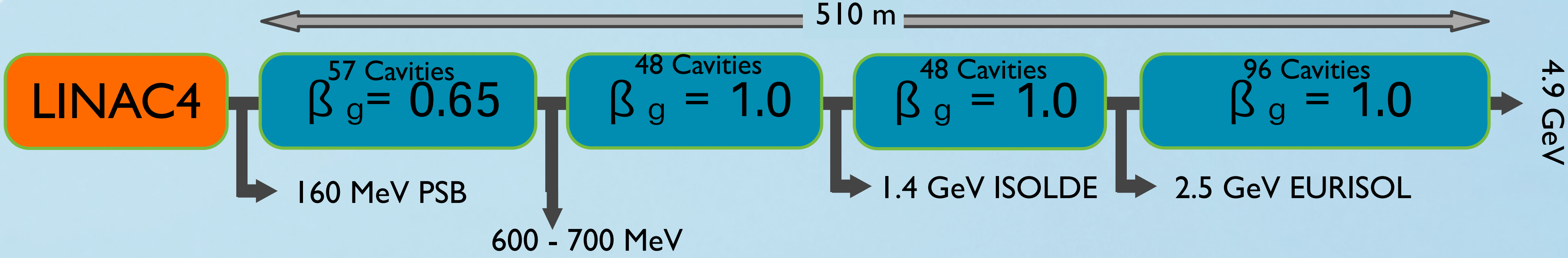
Effect of Errors in the Mixed SPL Architecture

M. Eshraqi
P. A. Posocco

5th SPL Collaboration Meeting
25 and 26 November 2010
Geneva, Switzerland

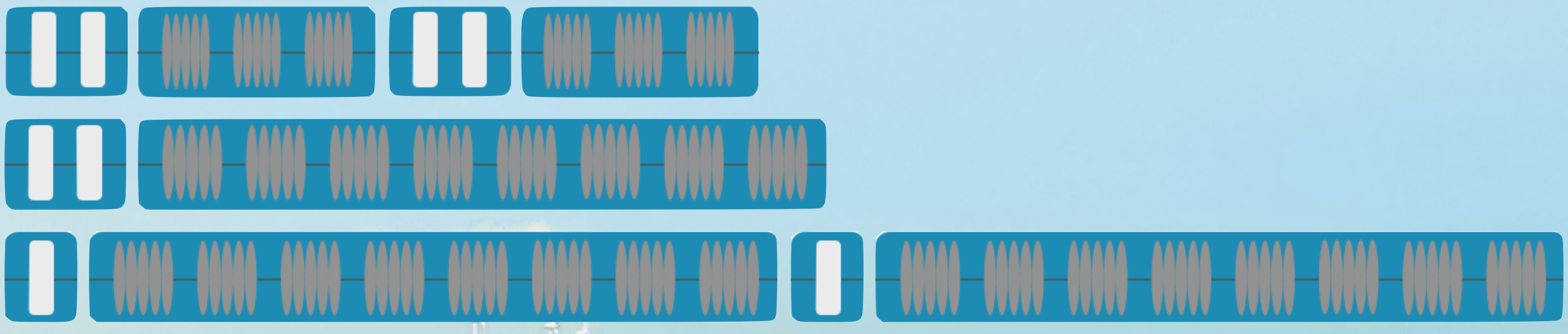
SPL



1 x Lp drift space for lossless extraction at 1.4 GeV

1.5 x Lp drift space for lossless extraction at 2.5 GeV

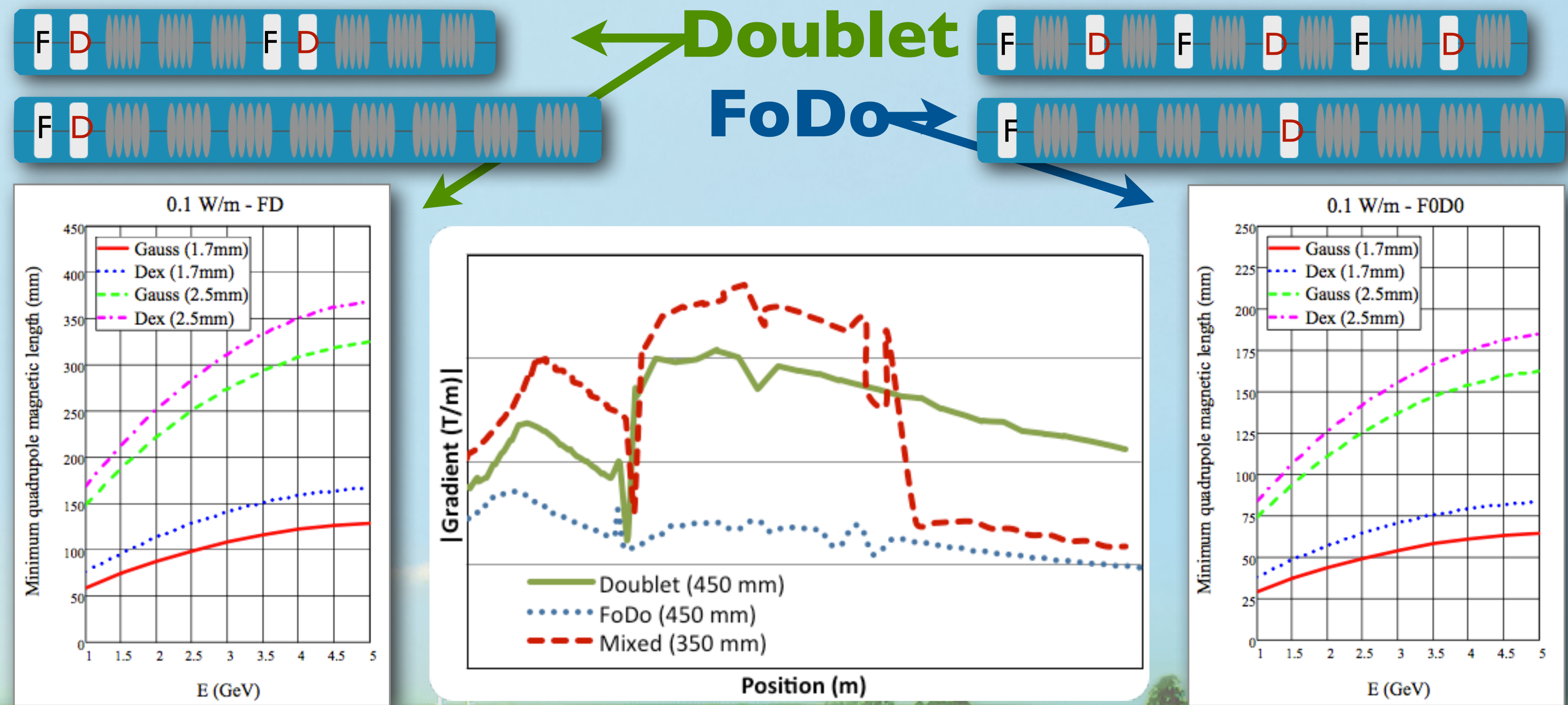
Room temperature quadrupoles



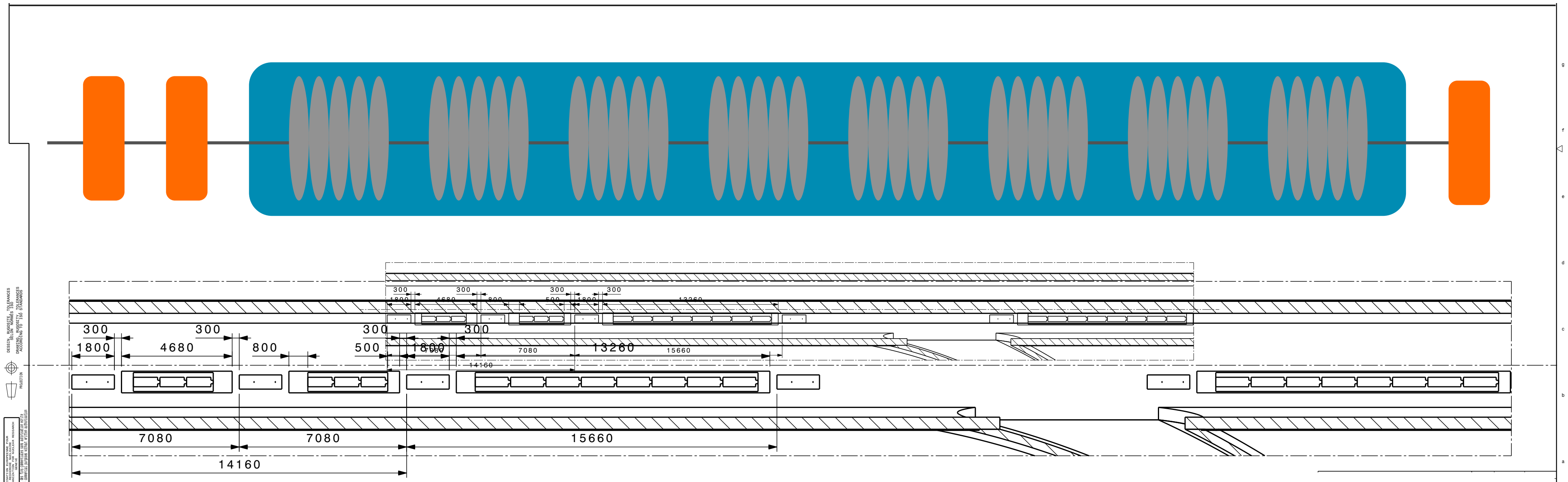
Doublet vs. FoDo

The baseline SPL uses a quadrupole doublet focusing, it has the advantage of being more flexible for cryo-sectioning.

A FoDo interlacing is studied. Its advantage is that it needs weaker quadrupoles to achieve the same focusing.



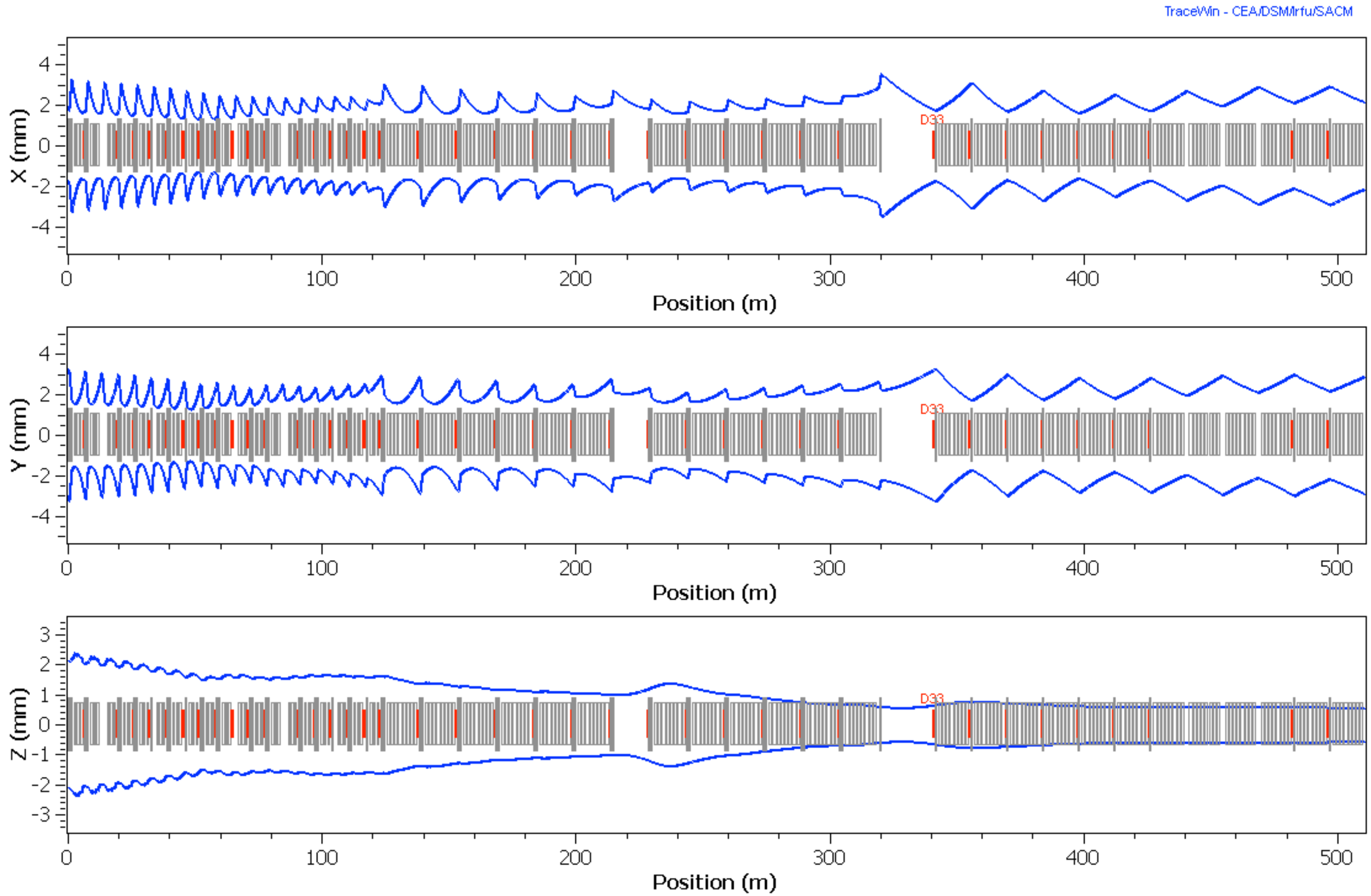
Spacings



From Thierry Renaglia

Cryo to Quad	Quad to Quad	Quad to Cryo	Cryo to Cavity	Cavity to Cavity	Cavity to Cryo
250	600	250	800	580 / 494	645 / 490

Envelopes

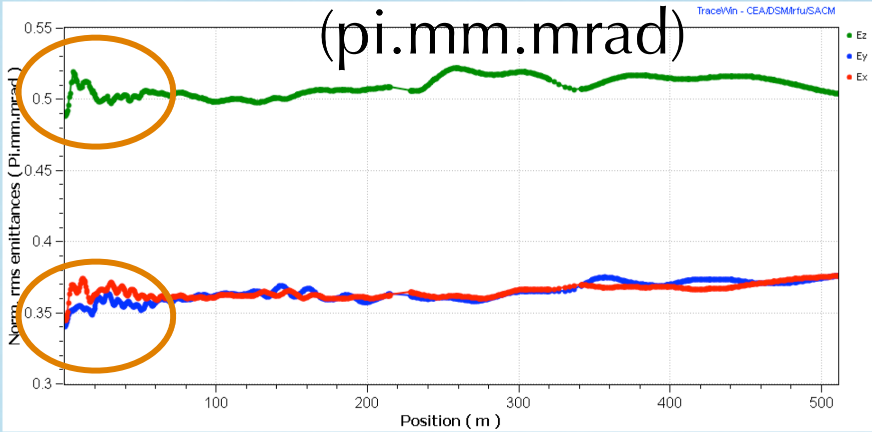


TraceWin - CEA/DSM/Irfu/SACM
X (mm)
Y (mm)
Z (mm)
D33
Position (m)
0
100
200
300
400
500

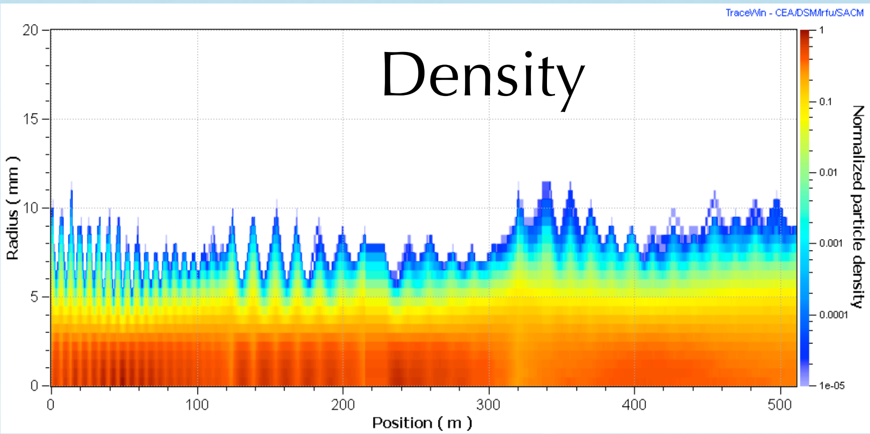
Density, Halo & ϵ

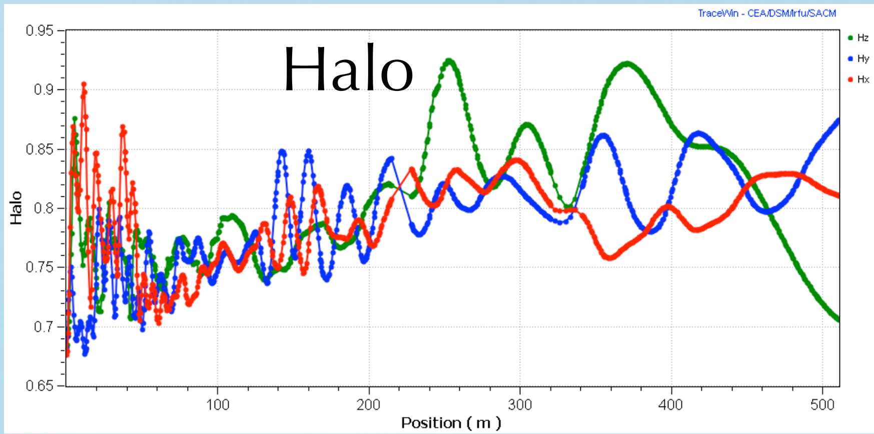
norm. rms. emit. (pi.mm.mrad)

Redistribution



X	9.3%
Y	10.1%
Z	3.2%





Errors and Correctors

Misalignment of magnetic center of quadrupole with respect to beam center:

0.1 mm

Gradient error in quadrupole field:

0.5%

Maximum Steering field (Integrated)

2.5 mT.m

Precision of beam center measurement in BPMs:

0.2 mm

Effect of Quad Errors

$\Delta\epsilon_x$ [%]= 10.98 ± 1.28

$\Delta\epsilon_y$ [%]= 11.47 ± 1.13

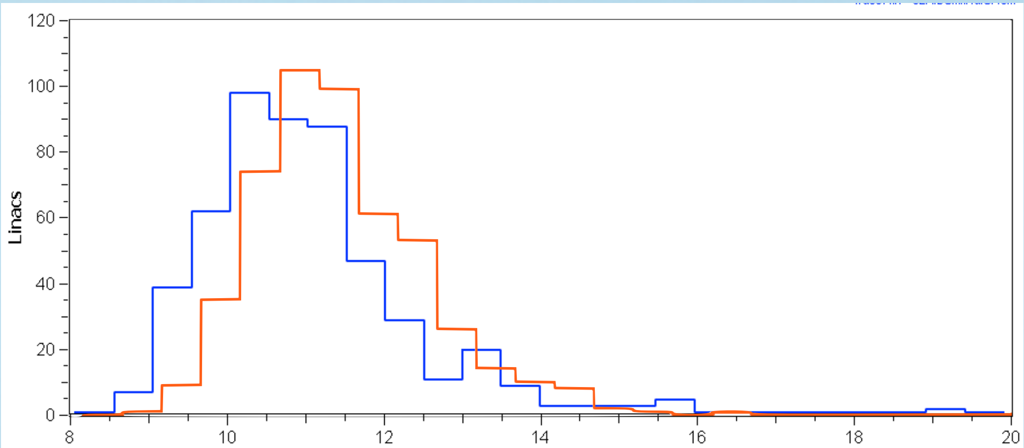
$\Delta\epsilon_x$ [%]= 9.3 Nominal

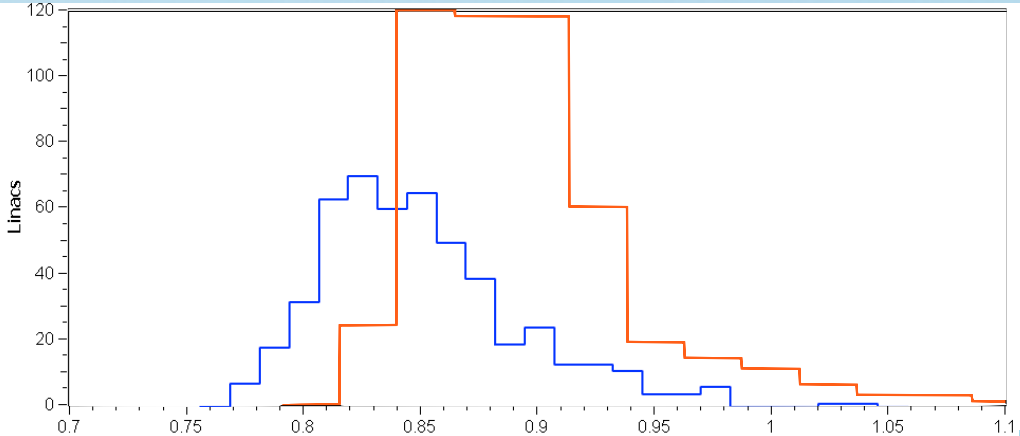
$\Delta\epsilon_y$ [%]= 10.1 Nominal

Hx = 0.85 ± 0.04

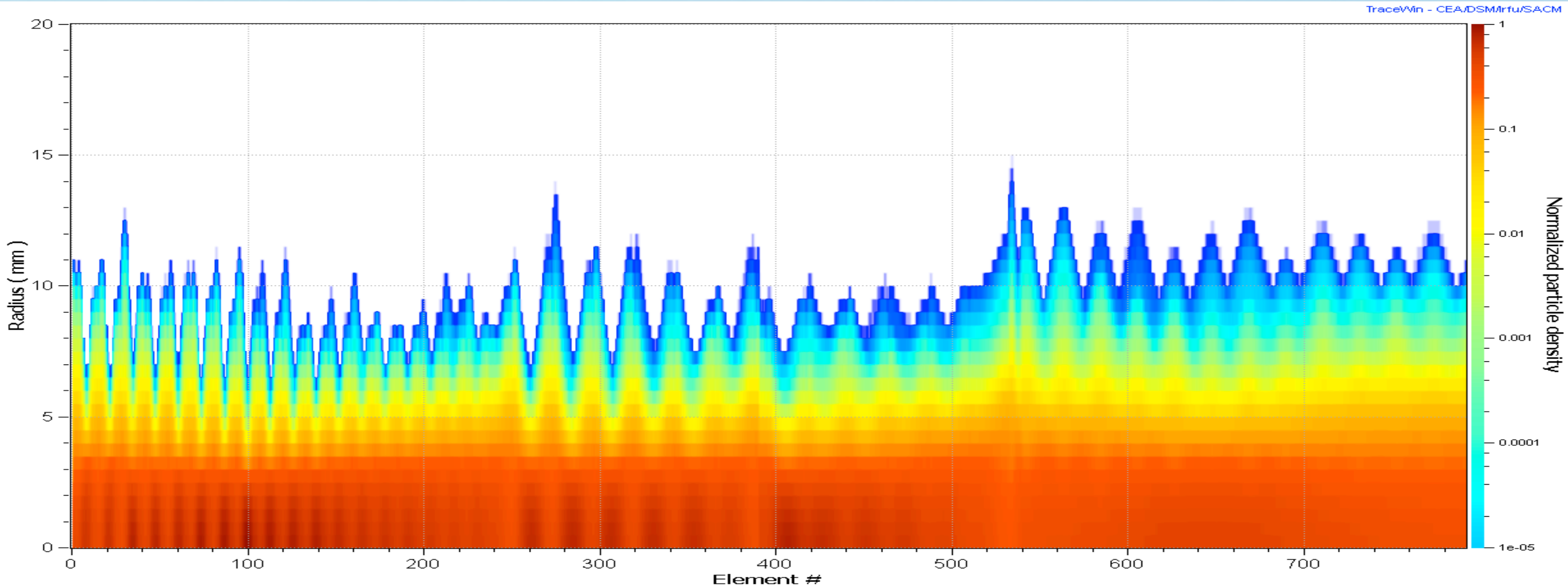
Hy = 0.89 ± 0.05

No Losses





Density with Error



Effect of Sextupole

A sextupole component proportional to 0.1% of the steerers B field is added to the simulations to see the effect on the beam:

Reference radius: 97.5% of Aperture radius = 48.75 mm

$G_6 = 0.1\% \times B_{steerer} / R_{ref}^2 = 0.003$

Effect of the sextupole:

$\Delta\epsilon_x = 360\%$ $\Delta\epsilon_y = 222\%$

$Hx = 18.5$ $Hy = 10.5$

Losses: 1.938%

Very Small Sextupole

For the case where we decrease the component to 0.01% of Steerer field (0.003 T/m^2):

$\Delta\epsilon_x$ [%]= 9.52

$\Delta\epsilon_y$ [%]= 11.1

$\Delta\epsilon_x$ [%]= 9.3 Nominal

$\Delta\epsilon_y$ [%]= 10.1 Nominal

Hx = 0.82

Hy = 0.88

No Losses

Errors + Sextupole

The errors on the quadrupole values are the same, and the sextupole component (0.003) is added during this runs:

$\Delta\epsilon_x$ [%]= 11.13 ± 1.30

$\Delta\epsilon_y$ [%]= 12.08 ± 1.11

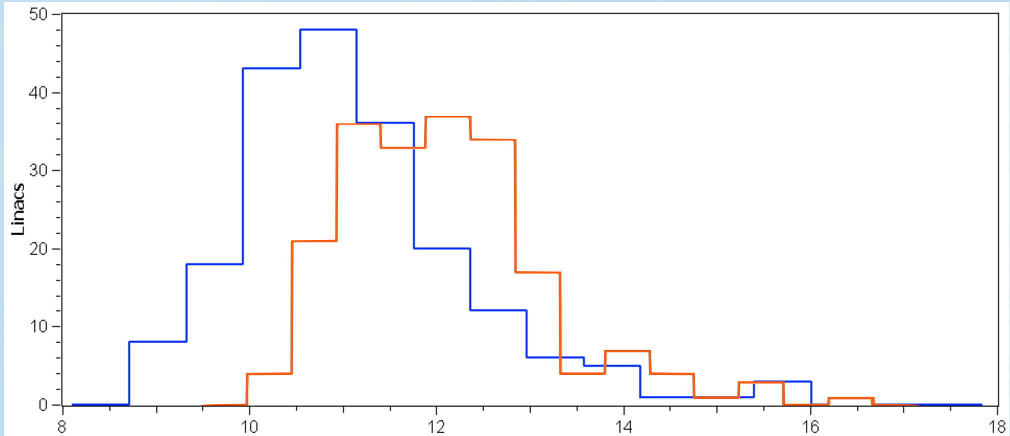
$\Delta\epsilon_x$ [%]= 9.3 Nominal

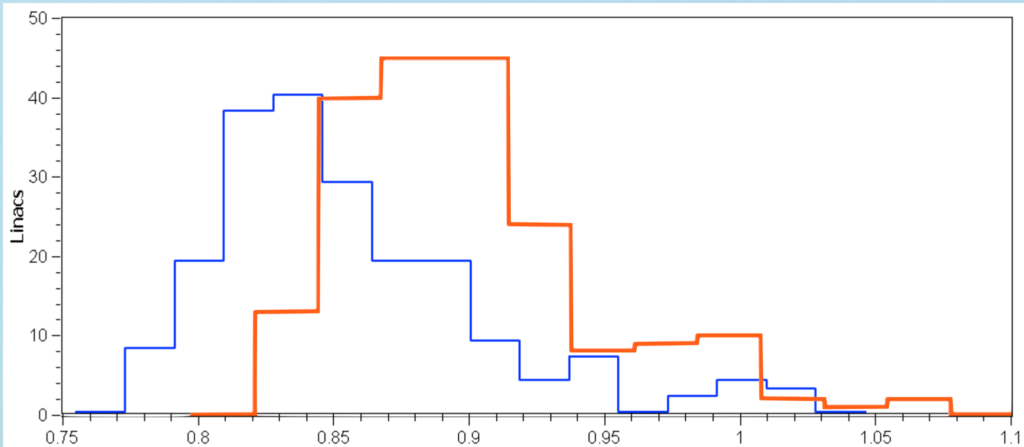
$\Delta\epsilon_y$ [%]= 10.1 Nominal

Hx = 0.86 ± 0.05

Hy = 0.90 ± 0.05

No Losses





Conclusion

The effect of 0.5% error on quadrupole gradient plus 0.1 mm in alignment error is 1% additional emittance increase in transverse planes.

A sextupole component due to steerers in the quadrupoles is acceptable if smaller than 0.003 T/m^2, and the effect is comparable to quadrupole errors.

A sextupole component as big as 0.03 T/m^2 causes unacceptable emittance growth, losses (>100 w/m), and generates halo.

Thank you