Main Linac Beam Optics and Tolerances

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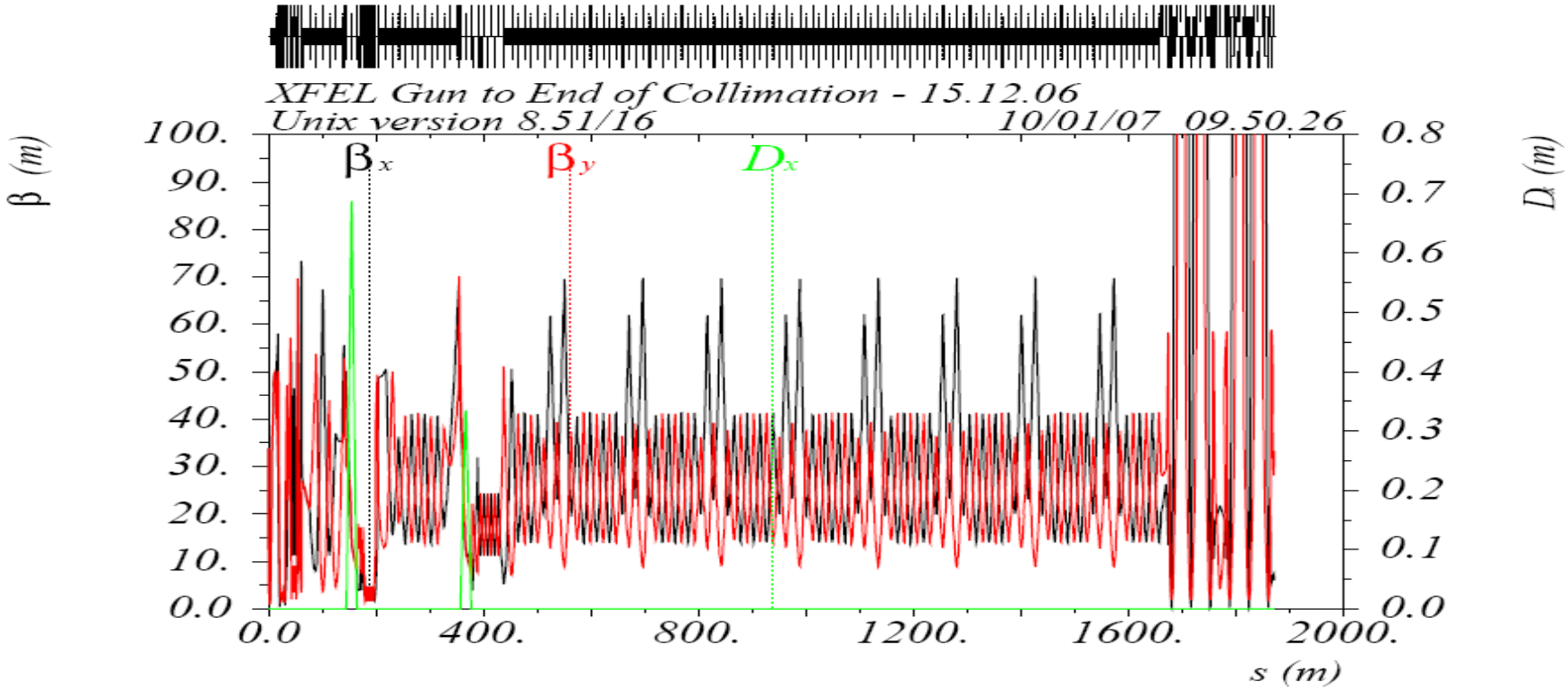
DESY

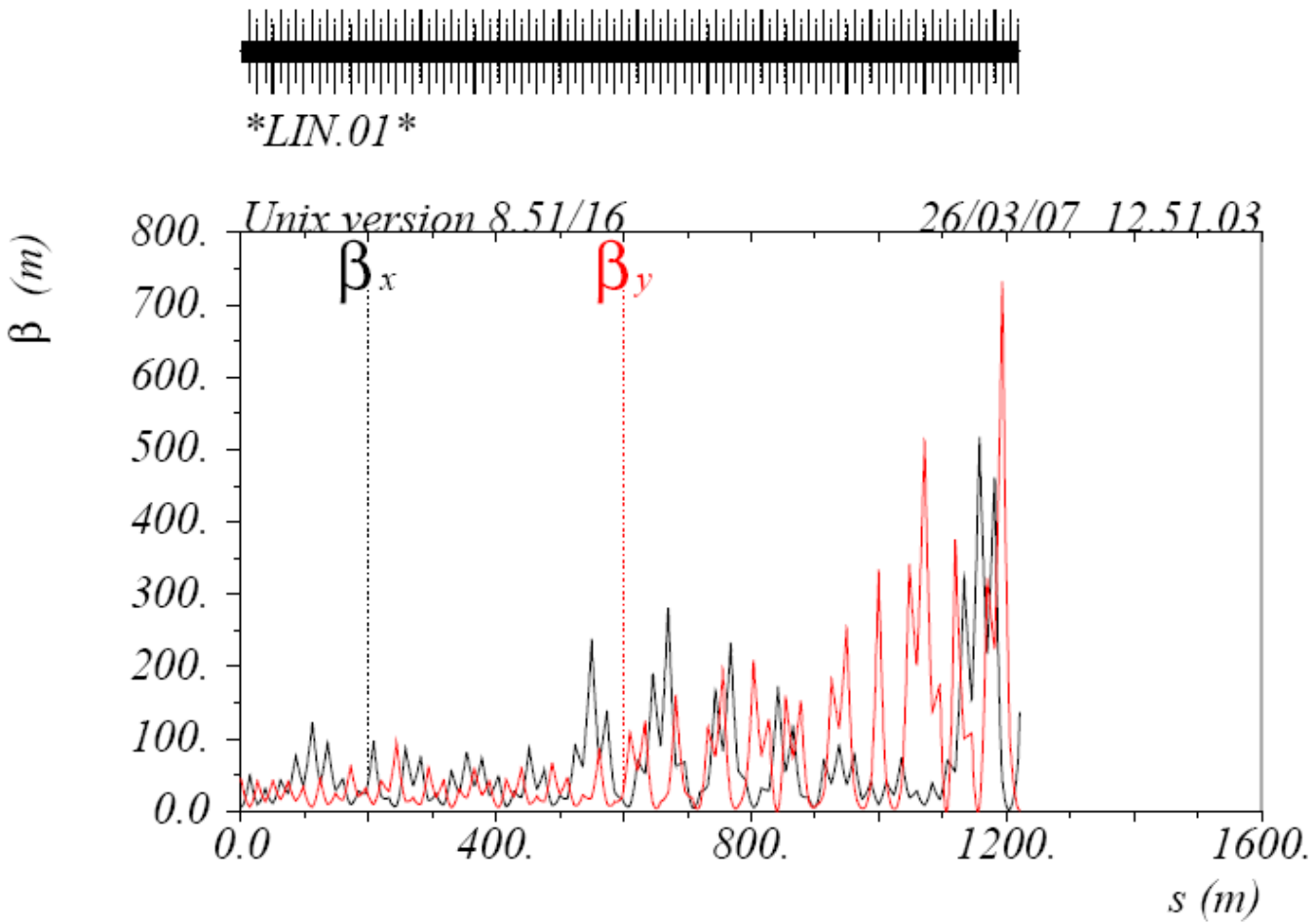
Linac beam optics

- 60 deg , 24 m long FODO
- Individually powered quadrupoles
- One steerer per quadrupole
- String connection boxes ‘perturb’ periodicity

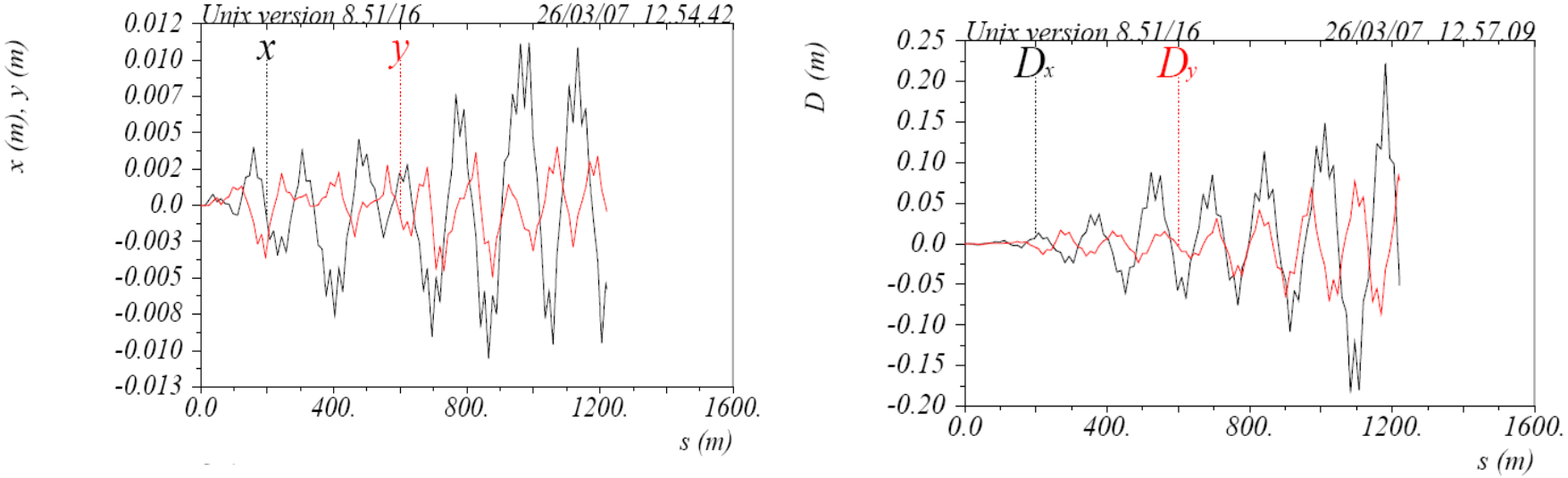


Tolerances – Energy Profile

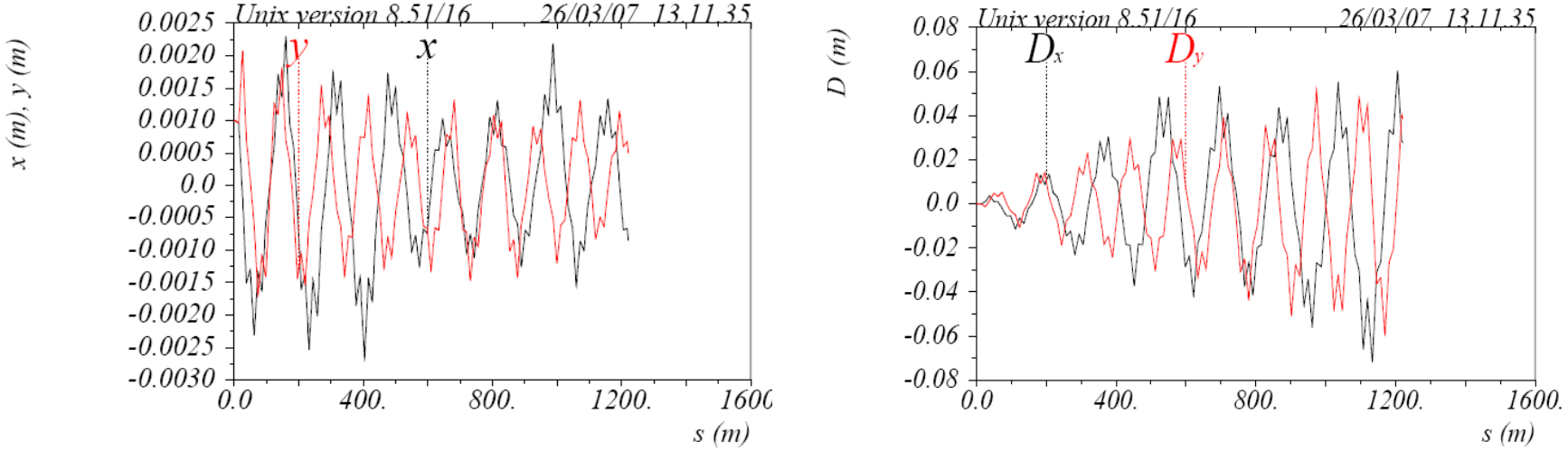
- Assume 1 % RMS error in energy gain knowledge (or 1 % error in quadrupole gradient)



Tolerance – Orbit Error



R56 : +10 µm for +2% initial energy deviation



R56 : +1.5 µm for +2% initial energy deviation

Summary

- Tolerances in LINAC rather relaxed
- Energy management needed
- BPM resolution of 50 μm (single bunch) sufficient
- Alignment of quads, cavities, modules: 500 μm
- Cavity tilts 0.25 mrad
- No number for quad tilts yet

XFEL
X-Ray Free-Electron Laser

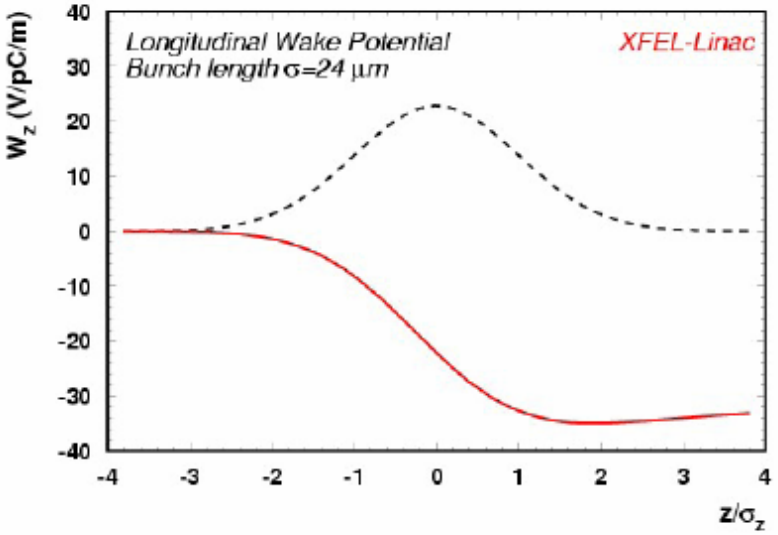
DESY

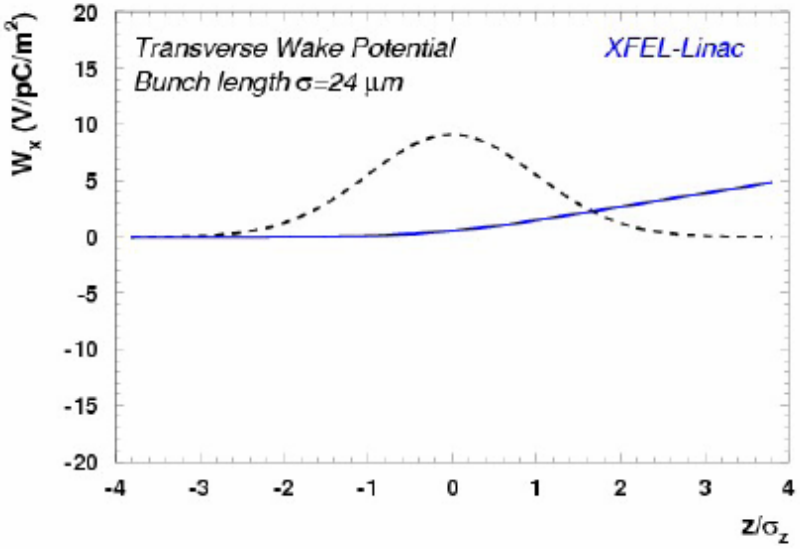
Single Bunch Emittance Growth due to Short Range TESLA Cavity Wakes

V. Tsakanov, G. Amatuni, W. Decking, R. Brinkmann
CANDLE
DESY

Talk based on FLS2006 presentation by V. Tsakanov

Wake Potentials





Wake functions

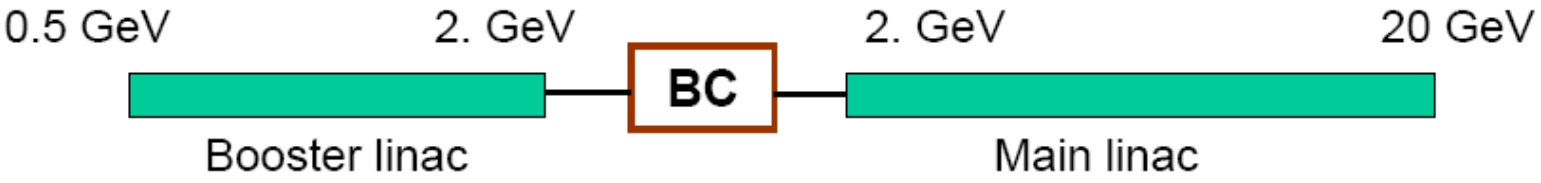
$$w_z(s) = 41.5\exp\left(-\sqrt{\frac{s}{1.74mm}}\right), \quad \left[\frac{V}{pC\cdot m}\right]$$

$$p(s) = \sqrt{s/0.92mm}$$

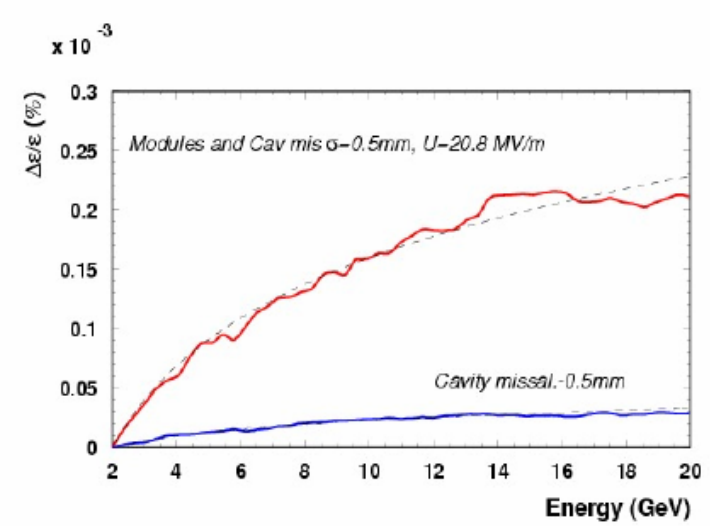
$$w_x(s) = 121\left[1-\left(1+p(s)\right)e^{-p(s)}\right], \quad \left[\frac{V}{pC\cdot m^2}\right]$$

T. Weiland, I. Zagorodnov, TESLA Rep. 2003-19, 2003.

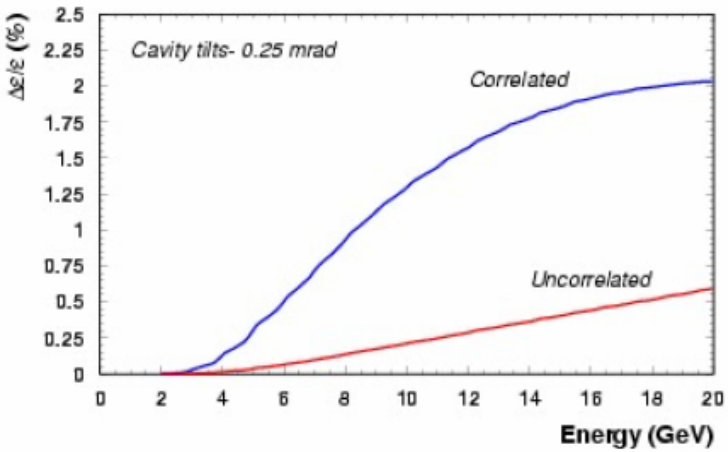
Parameter list



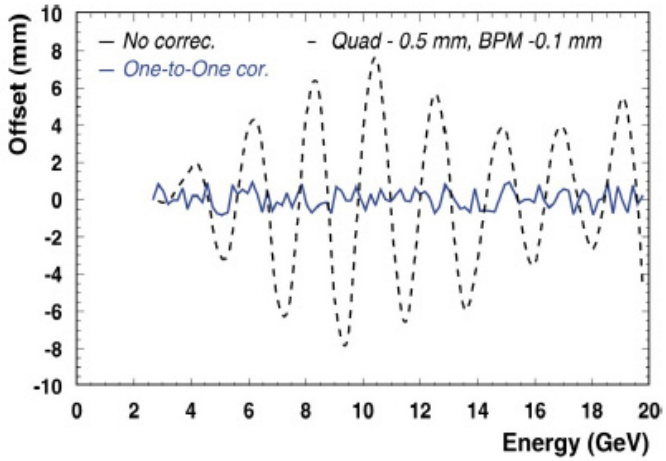
	Booster	Linac
• Energy (GeV)	0.5-2.0	2.0-20
• Accel. Grad (MV/m)	16	20.8
• FODO cells	6	50
• Emittance (mm-mrad)	1.4	1.4
• Bunch charge (nC)	1	1
• Bunch rms length (μm)	112	24
• Initial cor. energy spread	1.75%	0.4%
• Inital uncor. Energy spread (includes laser heater)	500 keV	2500 keV
• Misal. Quads, Cav. (mm)	0.5	0.5
• BPM – 0.1mm, res – 0.02mm		



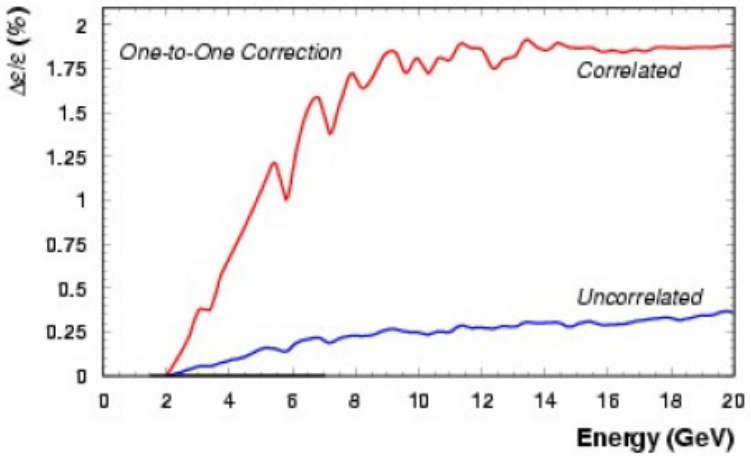
cavity & module misalignments



cavity tilts



quadrupole offset - trajectory



emittance growth after trajectory correction

Summary of Emittance Dilution (Standard Cell)

	Booster	Linac
• Coherent oscillations		
uncorrelated	$6 \cdot 10^{-6}$	$2 \cdot 10^{-4}$
correlated	$2 \cdot 10^{-3}$	$1.2 \cdot 10^{-3}$
• Cavity Misalignments	$5 \cdot 10^{-6}$	$3 \cdot 10^{-7}$
• Modules Misalignments	$4 \cdot 10^{-5}$	$2.5 \cdot 10^{-6}$
• Correlated Misal. (130°)	-	$7 \cdot 10^{-6}$
• Cavity tilts		
uncorrelated	$5.8 \cdot 10^{-5}$	0.6%
correlated	0.6%	1.9%
• One-to-One correction		
uncorrelated	$6.3 \cdot 10^{-5}$	0.4%
correlated	1.7%	2%

Total Emittance dilution <5% with 2 Modules/Cell

Summary

- Chromatic effects dominate
- Initial offset, cavity misalignment etc. lead to increase off energy spread and emittance dilution in the order of one percent
- Cavity tilts and quadrupole misalignment lead to off-axis beam trajectory in the order of a few mm and emittance dilution of a few percent (if not corrected)
- Only cavity wakes considered