

Longitudinal Bunch Position Update

Super-B Workshop
Frascati
Dec 2009

Kirk Bertsche

- e⁺ and e⁻ bunches must overlap at crab waist
 - For 5 mm (1σ) bunch, 0.5 degrees of RF phase difference (1.0 mm) between HER and LER will decrease luminosity by 1%
 - Want RMS error < 0.5 deg
- Phase transient
 - Due to ion-clearing gap and heavy beam loading of cavities
 - About 10x the 0.5 degree requirement
 - Generally different for HER and LER

- Perfect matching
 - Occurs with HER and LER at identical beam loading and identical synchronous phase
 - Requires identical beam currents
 - Requires identical ratio of beam/cavity power
 - May require more RF stations than otherwise needed

Parameters--LNF Site



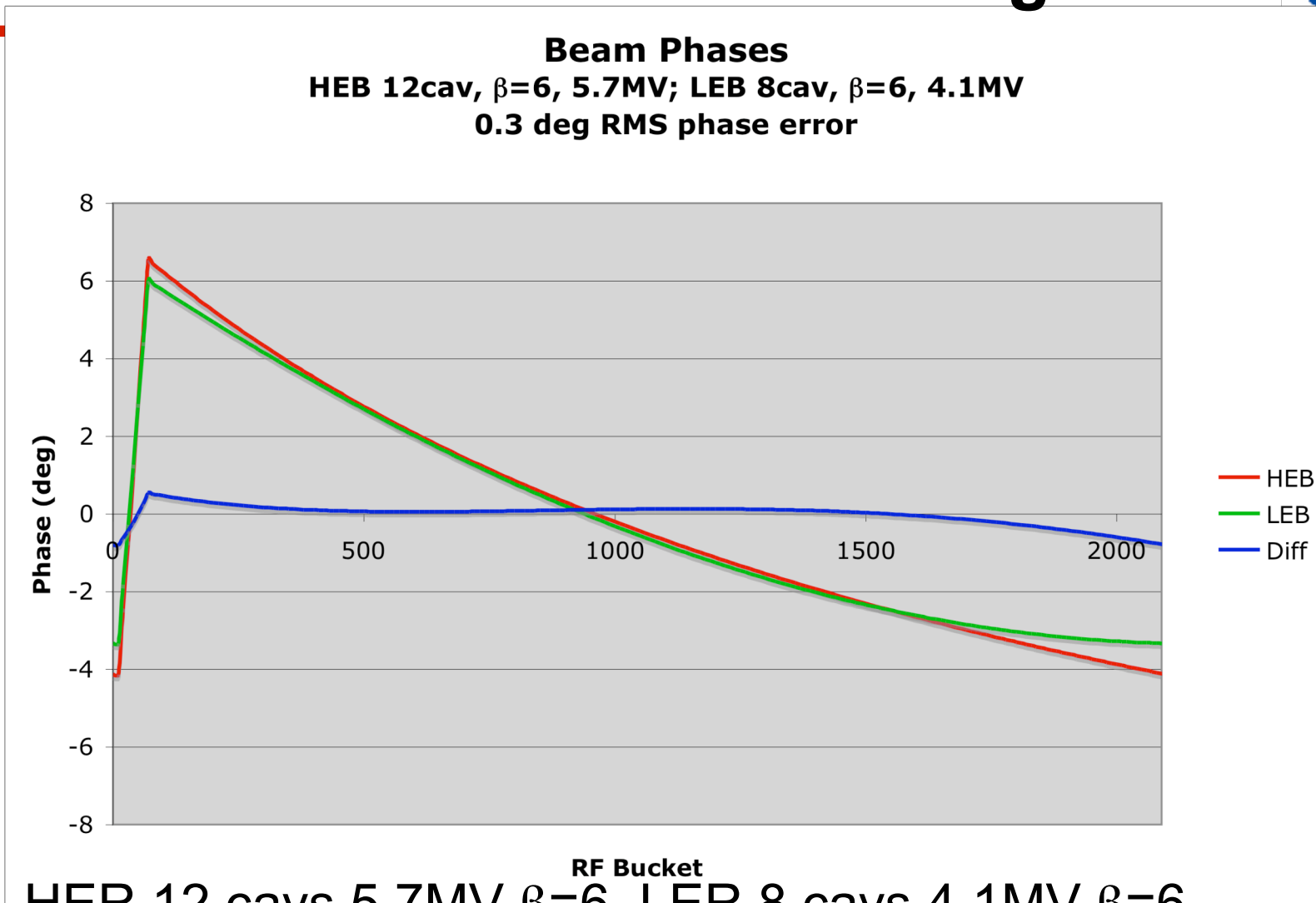
SuperB Parameters July 22 2009

SuperB Parameters		(in bold: computed values)	
Parameter	Units	Super-B TorVergata 1-Mar-09 with SR	Super-B LNF 22-Jul-09 with SR LER
E HER (positrons)	GeV	6.9	6.7
E LER (electrons)	GeV	4.06	4.18
Energy ratio		1.70	1.60
r0	cm	2.83E-13	2.83E-13
X-Angle (full)	mrads	60	60
Beta x HER	cm	2	2
Beta y HER	cm	0.037	0.032
Coupling (high current)		0.0025	0.0025
Emit x HER	nm	1.6	1.6
Emit y HER	nm	0.004	0.004
Bunch length HER	cm	0.5	0.5
Beta x LER	cm	3.5	3.2
Beta y LER	cm	0.021	0.02
Coupling (high current)	%	0.0025	0.0025
Emit x LER	nm	2.8	2.56
Emit y LER	nm	0.007	0.0064
Bunch length LER	cm	0.5	0.5
I HER	mA	2200	2120
I LER	mA	2200	2120
Circumference	m	2105	1315
N. Buckets distance		2	2
Gap		0.97	0.97
Frf	Hz	4.76E+08	4.76E+08
Fturn	Hz	1.43E+05	2.28E+05
Fcoll	Hz	2.31E+08	2.31E+08
Num Bunch		1619	1011
N HER		5.96E+10	5.74E+10
N LER		5.96E+10	5.74E+10
Sig x HER	microns	5.657	5.657
Sig y HER	microns	0.038	0.036

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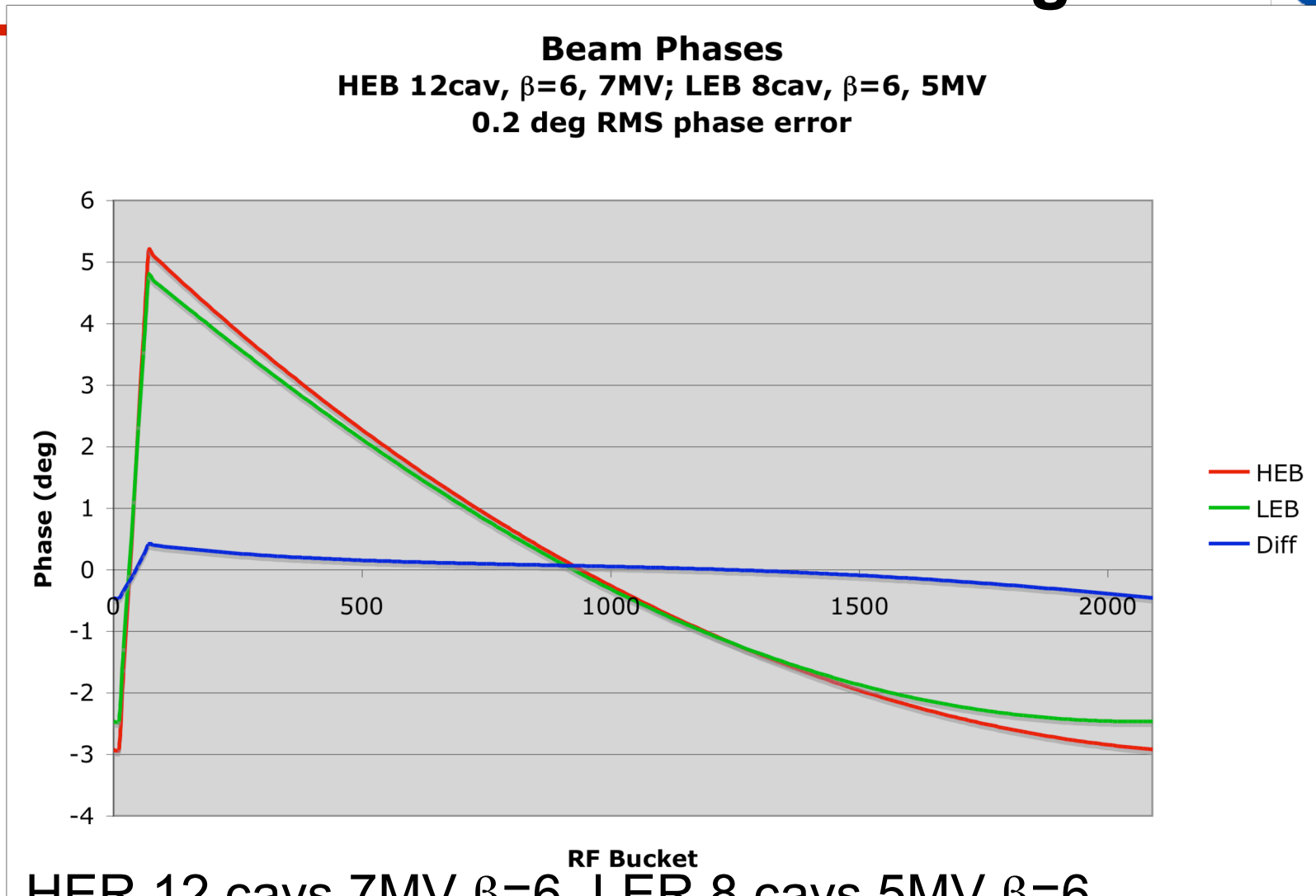
Sig x LER	microns	9.899	9.051
Sig y LER	microns	0.038	0.036
Piwinski angle HER	rad	26.52	26.52
Piwinski angle LER	rad	15.15	16.57
Sig x HER effective	microns	150.15	150.15
Sig x LER effective	microns	150.37	150.32
X-angle factor HER		0.038	0.038
X-angle factor LER		0.066	0.060
Cap Sig X	microns	11.402	10.673
Cap Sig Y	microns	0.054	0.051
R (hourglass factor)		0.900	0.900
Cap Sig X eff	microns	212.13	212.13
Lumi calc	/cm ² /s	1.02E+36	1.02E+36
Tune shift x HER		0.0018	0.0017
Tune shift y HER		0.1271	0.1170
Tune shift x LER		0.0052	0.0045
Tune shift y LER		0.1220	0.1170
Damping_long HER	msec	21	14.5
Damping_long LER	msec	20.0	22.0
Uo HER	MeV	2.3	2.03
Uo LER	MeV	1.40	0.83
alfa_c HER		3.50E-04	4.04E-04
alfa_c LER		3.20E-04	4.24E-04
sigma-EHER		5.80E-04	6.15E-04
sigma-E LER		8.20E-04	6.57E-04
CM sigma_E		1.00E-03	9.00E-04
SR power loss HER	MW	5.06	4.30
SR power loss LER	MW	3.08	1.76
Touschek lifetime HER	min	33	35
Touschek lifetime LER	min	17	16
Luminosity lifetime HER	min	5.20	4.95
Luminosity lifetime LER	min	5.20	4.95
Total lifetime HER	min	4.49	4.34
Total lifetime LER	min	3.98	3.78
RF plug power	MW	16.28	12.13

5mm Natural Bunch Length



- HER 12 cavs 5.7MV $\beta=6$, LER 8 cavs 4.1MV $\beta=6$
- Lose <1% of lumi due to gap transient mismatch

4.5mm Natural Bunch Length



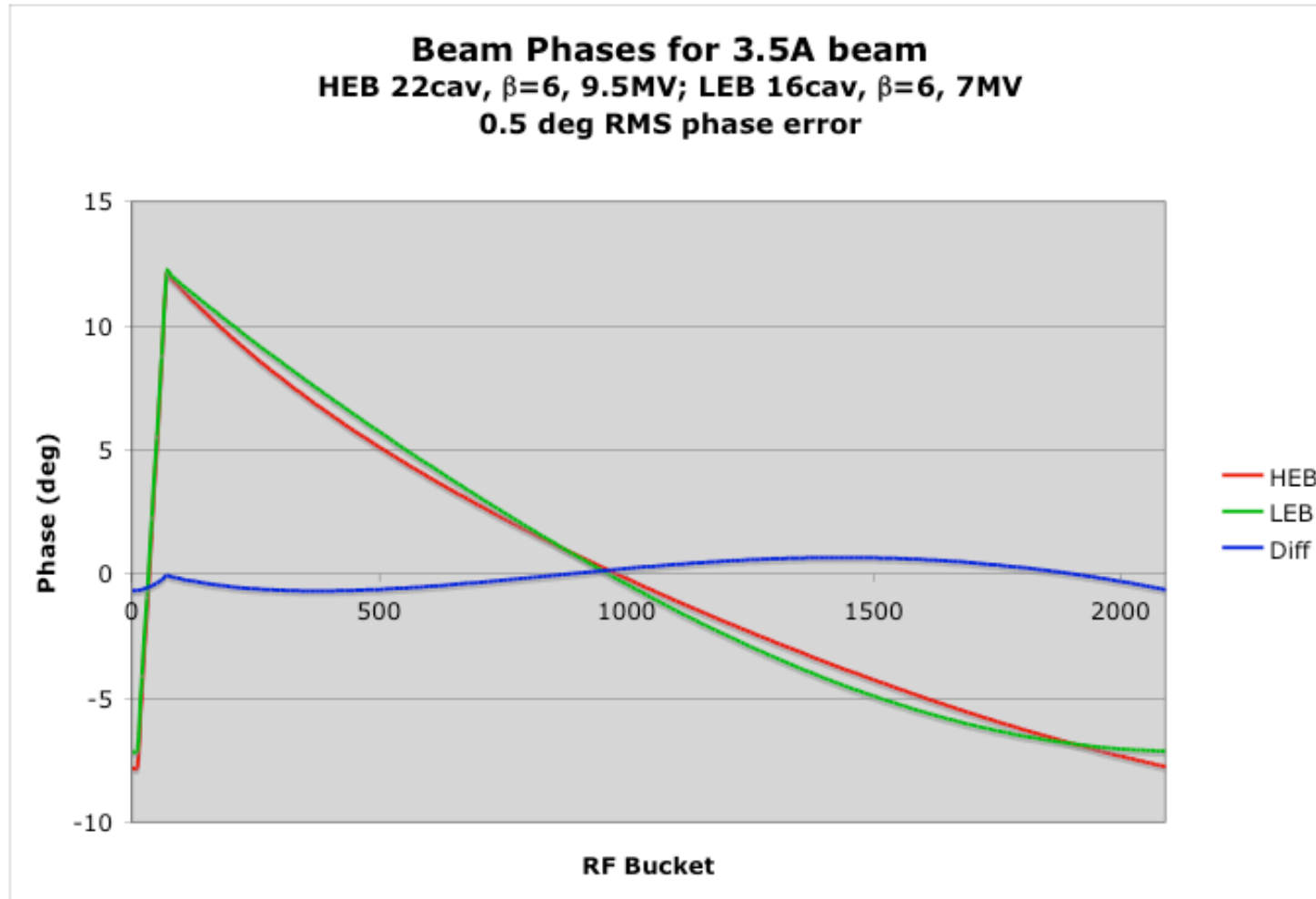
- HER 12 cavs 7MV $\beta=6$, LER 8 cavs 5MV $\beta=6$
- Lose <1% of lumi due to gap transient mismatch

3A Beam Current, $\beta=6$



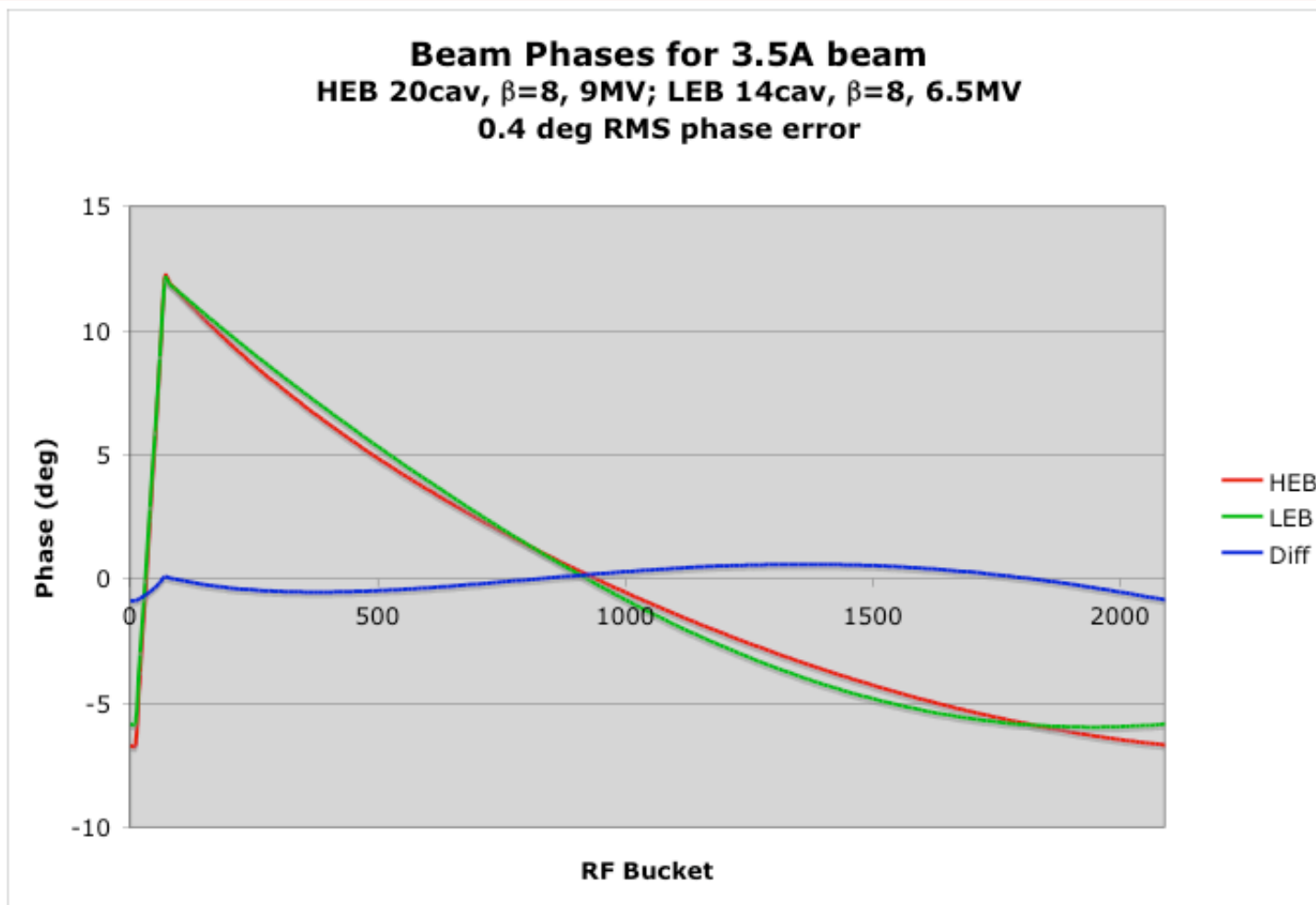
- HER 18 cavs 8MV, LER 12 cavs 5.5MV, 4.2mm bunch
- Lose <1% of lumi due to gap transient mismatch

3.5A Beam Current, $\beta=6$



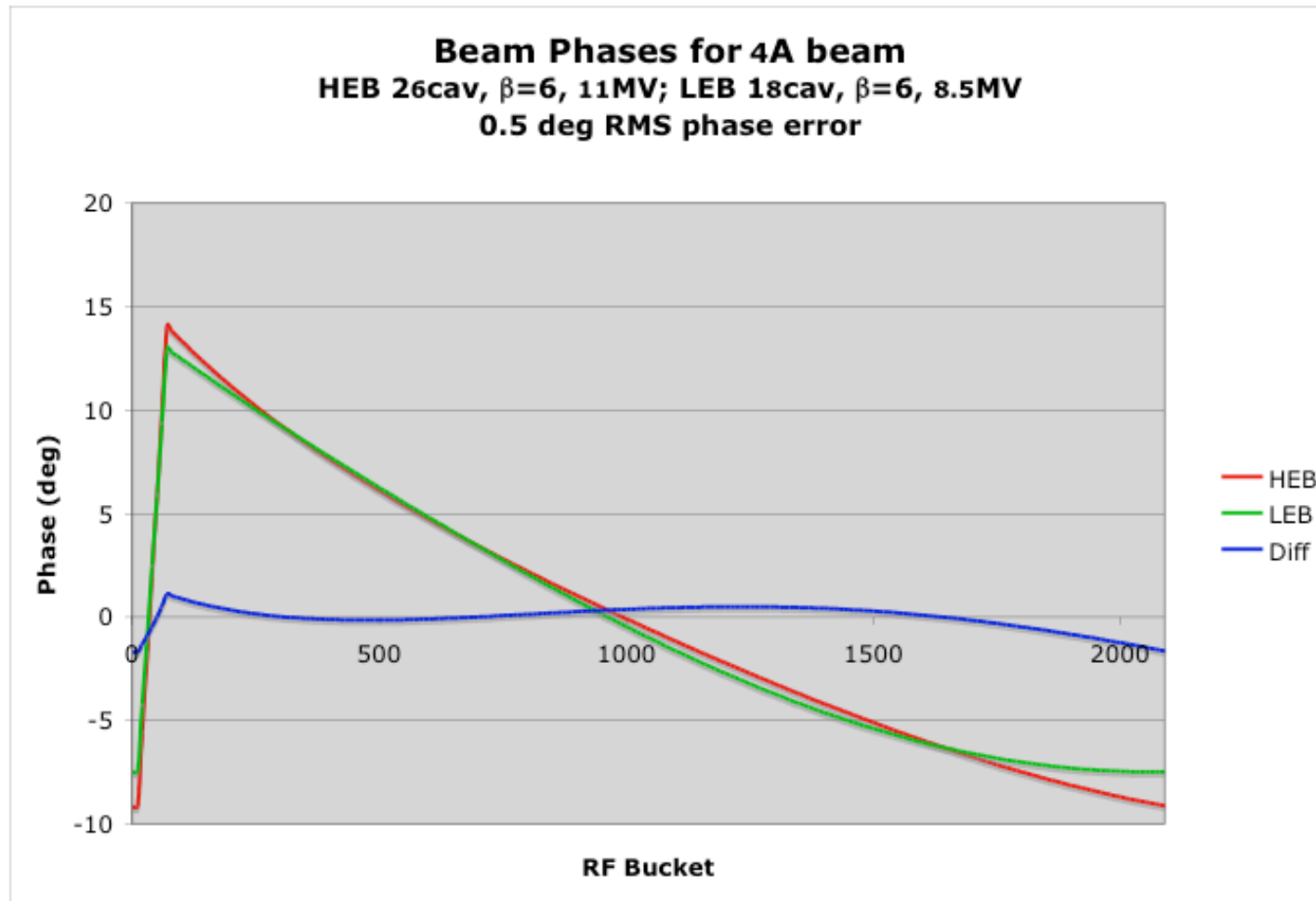
- HER 22 cavs 9.5MV, LER 16 cavs 7MV, 3.8mm bunch
- Lose 1% of lumi due to gap transient mismatch

3.5A Beam Current, $\beta=8$



- HER 20 cavs 9MV, LER 14 cavs 6.5MV, 4mm bunch
- Lose <1% of lumi due to gap transient mismatch

4A Beam Current, $\beta=6$

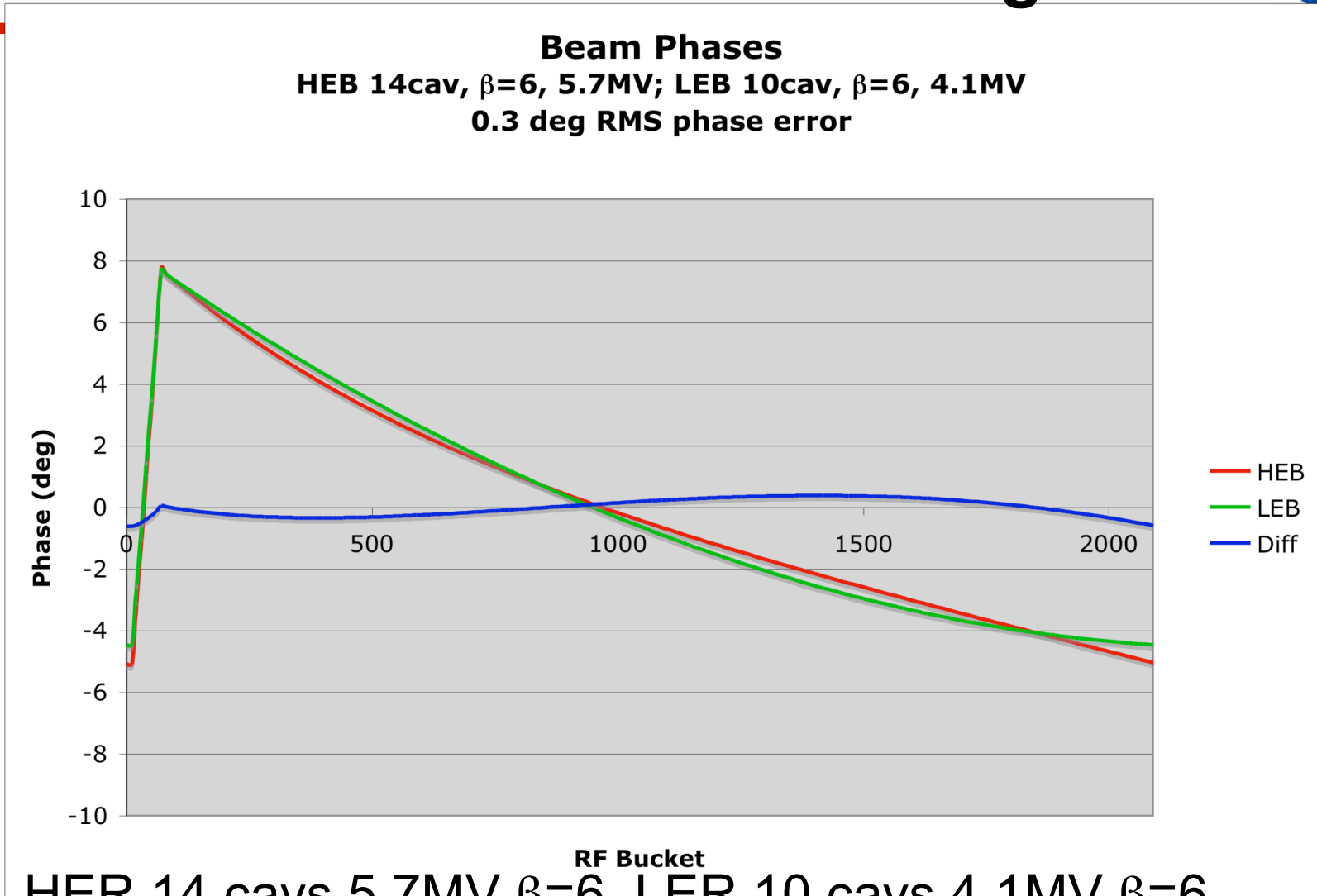


- HER 26 cavs 11MV, LER 18 cavs 8.5MV, 3.5mm bunch
- Lose 1% of lumi due to gap transient mismatch
- Increasing β to 8 allows 3.8mm bunch with 24 HER, 16LER cavities

- Cavity coupling-constant (β)
 - Must increase to ~ 6 for HER to get power into cavities
 - Helpful to also increase for LER
- Minimum number of cavities:
 - 12 HER and 8 LER cavities -- for equal natural bunch lengths in HER and LER (4.5 or 5 mm)
 - Recommend 1 additional RF station (2 cavities) in each ring to allow operation with one dead klystron
- Higher beam currents:
 - Possible with $\beta=6$, but must reduce natural bunch length
 - Increasing β to 7 or 8 provides more flexibility
 - At 4A, cavity detuning is $>2x$ rev freq (unstable)

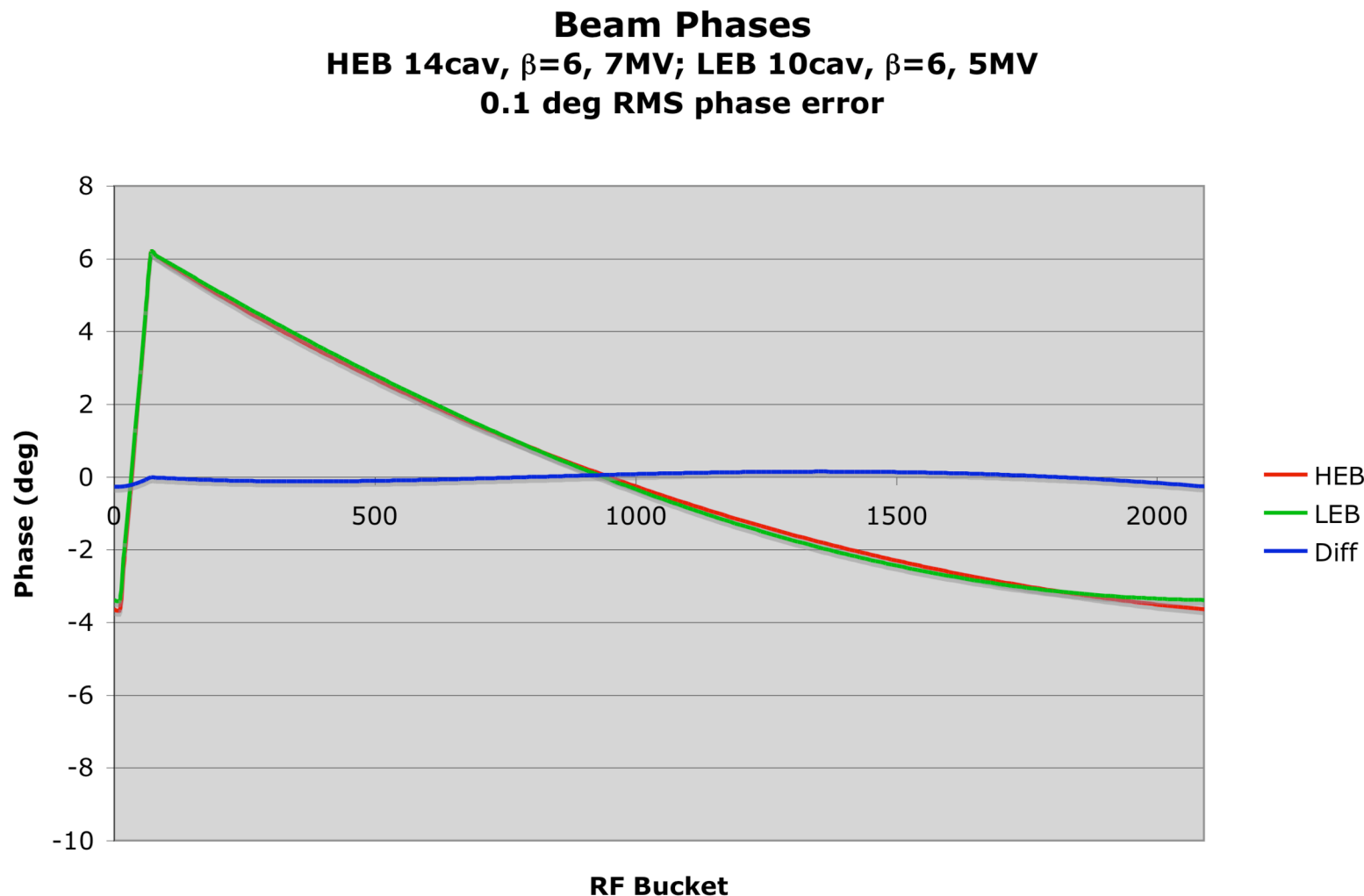


5mm Natural Bunch Length



- HER 14 cavs 5.7MV $\beta=6$, LER 10 cavs 4.1MV $\beta=6$
- Lose <1% of lumi due to gap transient mismatch

4.5mm Natural Bunch Length



- HER 14 cavs 7MV $\beta=6$, LER 10 cavs 5MV $\beta=6$
- Lose <1% of lumi due to gap transient mismatch