Longitudinal Bunch Position Update

Super-B Workshop
SLAC
7 October 2009

Kirk Bertsche

Problem

- e+ and e- bunches must overlap at crab waist
  - For 6 mm (1σ) bunch, 0.6 degrees of RF phase difference (1.2 mm) between HER and LER will decrease luminosity by 1%
  - Want RMS error < 0.6 deg
- Phase transient
  - Due to ion-clearing gap and heavy beam loading of cavities
  - About 10x the 0.6 degree requirement
  - Generally different for HER and LER

Matching Phase Transients

- 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

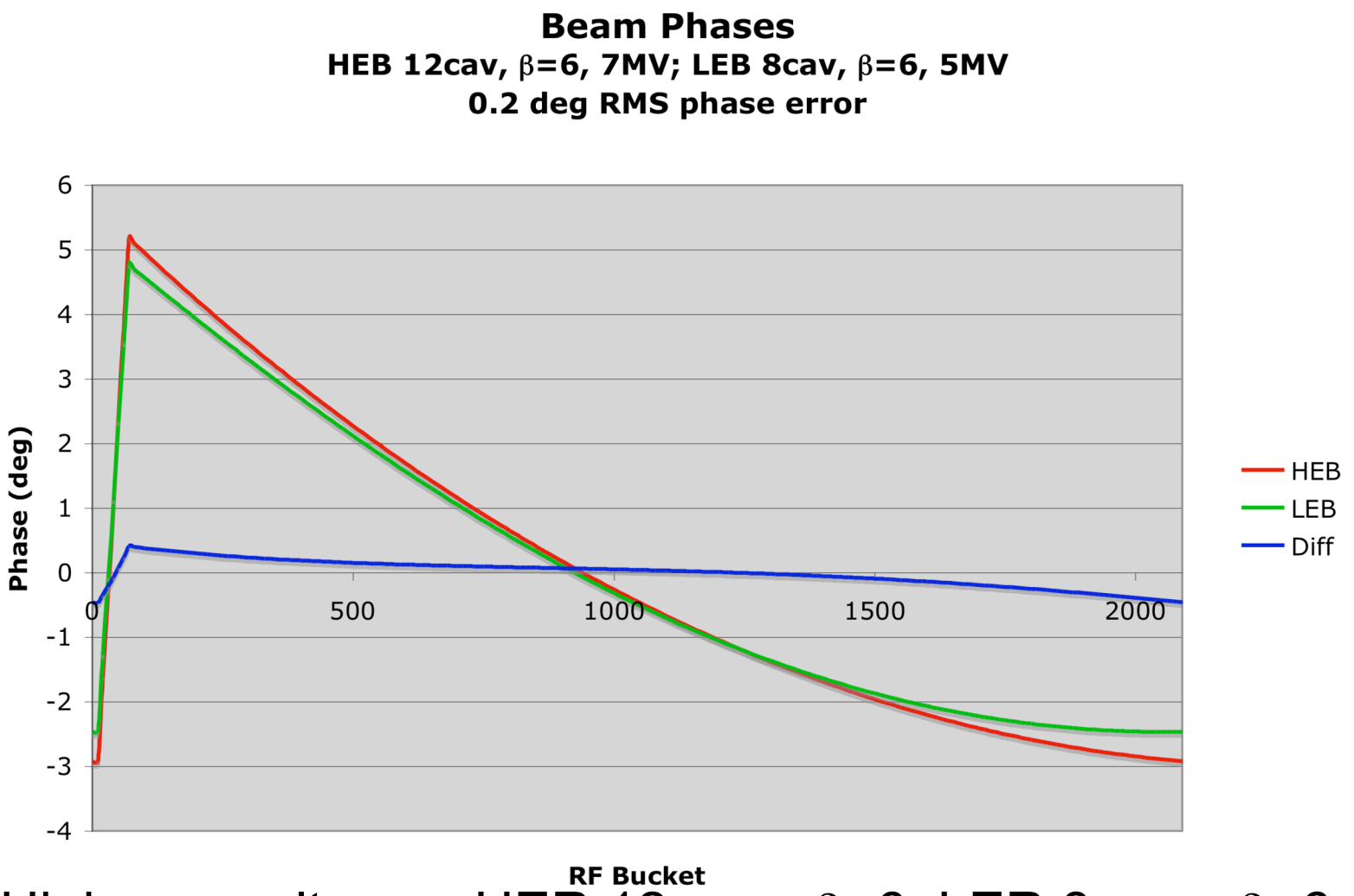
SuperB Parameters July 22 2009

SuperB Parameters		(in bold: computed values)		
Parameter	Units	Super-B		Super-B
		TorVergata		LNF
		1-Mar-09		22-Jul-09
		with SR		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)	mrad	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**

SuperB Parameters July 22 2009

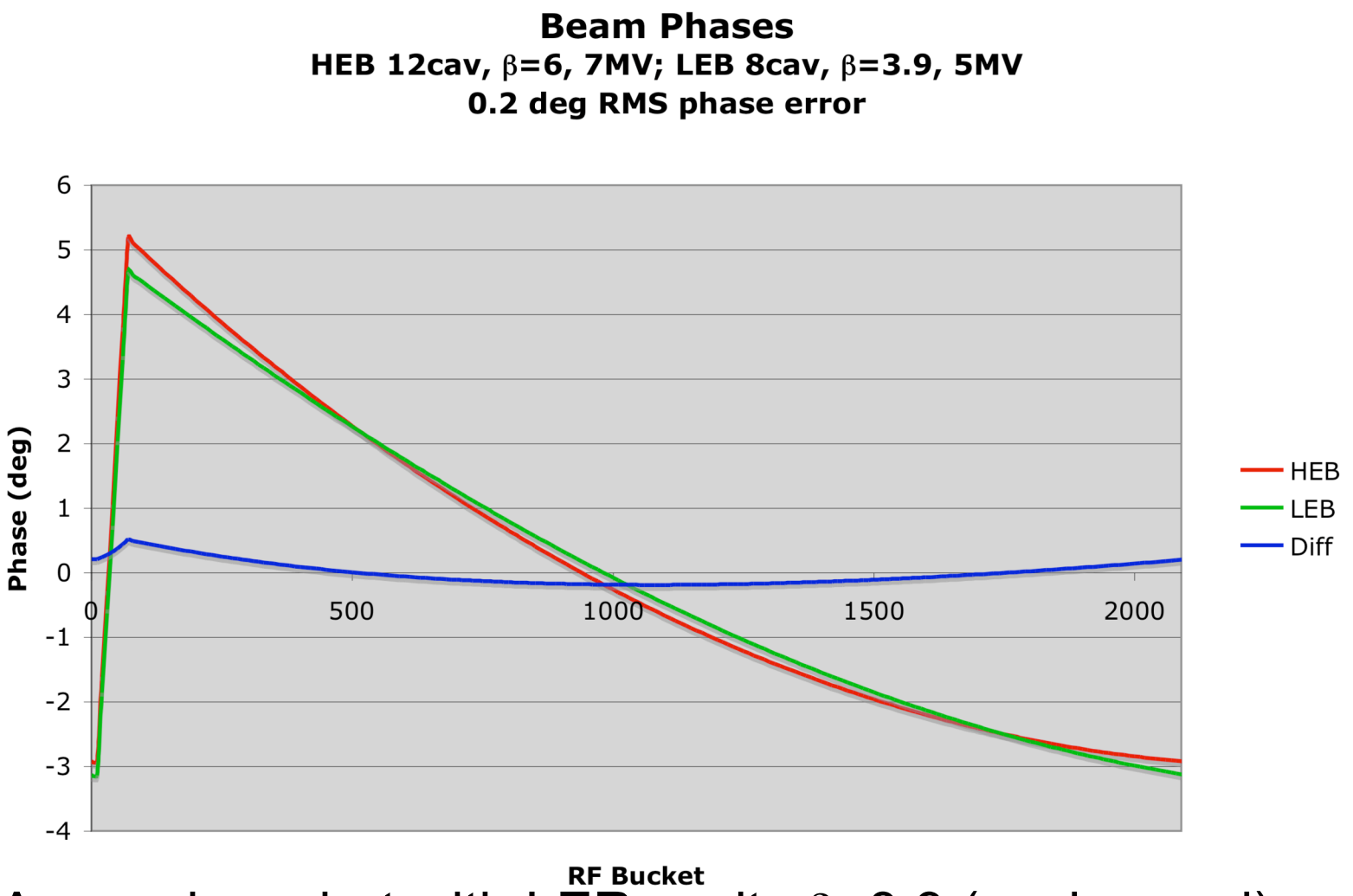
Sig x LER	microns		**9.899**		**9.051**
Sig y LER	microns		**0.038**		**0.036**
Piwinski angle HER	rad		**26.52**		**26.52**
Piwinski angle LER	rad		**15.15**		**16.57**
Sig x HER effective	microns		**150.15**		**150.15**
Sig x LER effective	microns		**150.37**		**150.32**
X-angle factor HER			**0.038**		**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	/cm2/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**

High Gap V



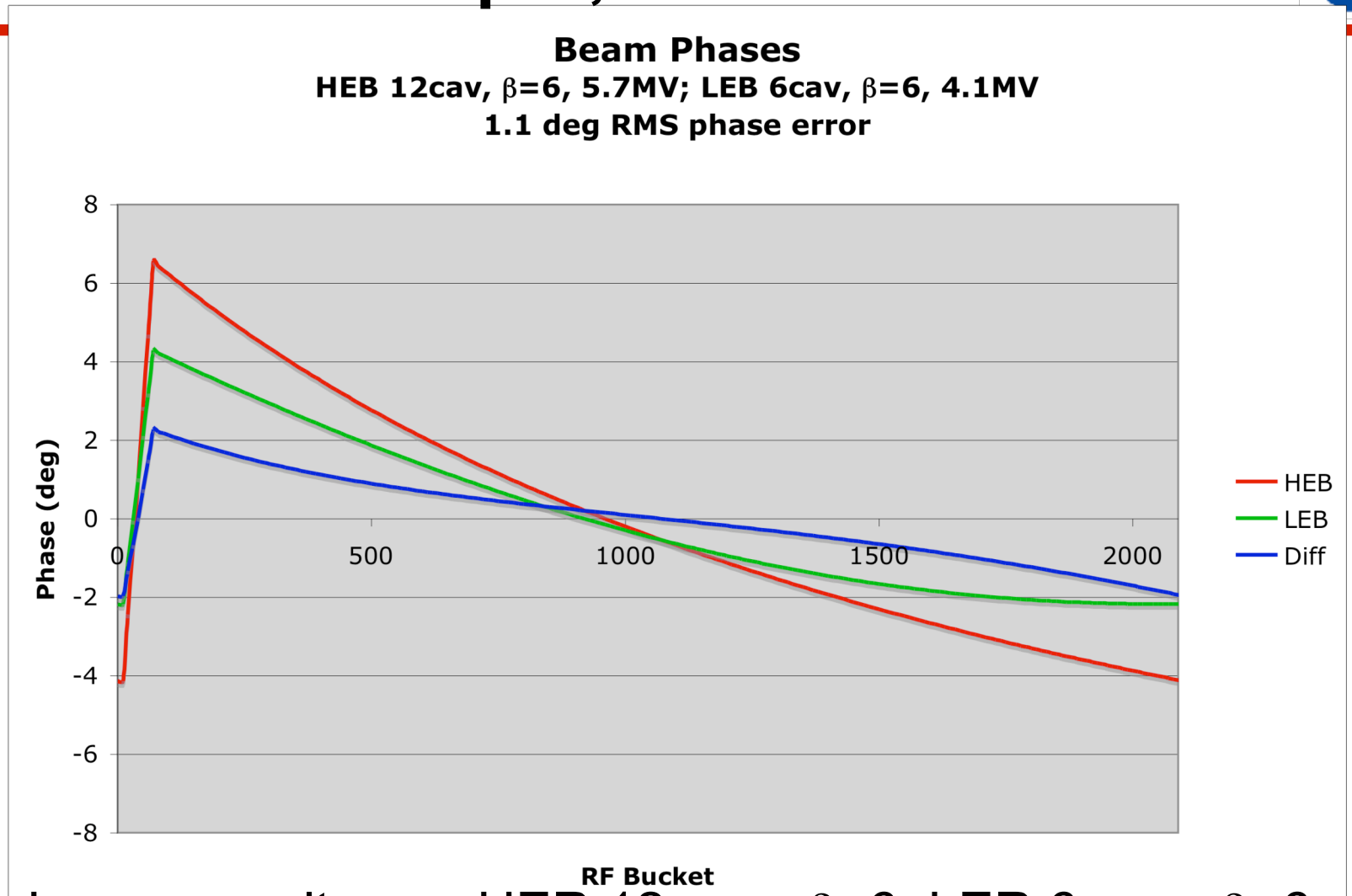
- High gap voltages, HER 12 cavs β=6, LER 8 cavs β=6
- Lose <1% of lumi due to gap transient mismatch

High Gap V



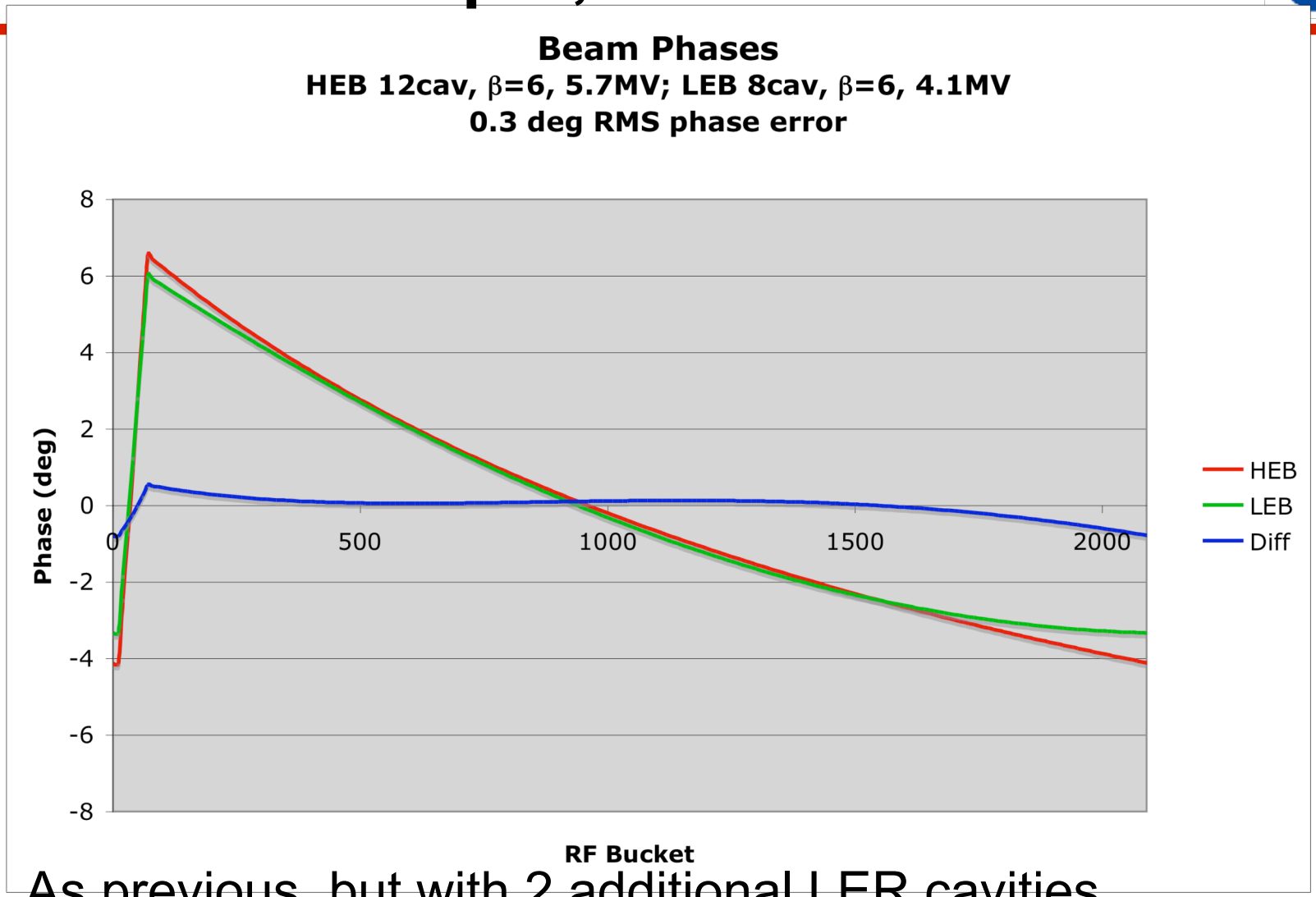
- As previous, but with LER cavity β=3.9 (unchanged)
- Lose <1% of lumi due to gap transient mismatch

Low Gap V, 6 LER cavities



- Low gap voltages, HER 12 cavs β=6, LER 6 cavs β=6
- Lose ~3.5% of lumi due to gap transient mismatch

Low Gap V, 8 LER cavities



- As previous, but with 2 additional LER cavities
- Lose <1% of lumi due to gap transient mismatch

Comments

- Must increase cavity coupling for HER
  - Otherwise cannot get power into cavities
- Helpful to also increase cavity coupling for LER
  - Reduces reflected power
- Recommend 12 HER and 8 LER cavities
  - Adequate for both low and high gap voltage options
  - 6 LER cavities not enough for good match