

Comments on 10Hz Option

- 1, 50% duty: Beam loading in e⁺ ring
- 2, Bypass DR: e⁻ beam for e⁺ production

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Beam Loading in 50% duty in e⁺ ring

- Beam is injected and extracted in ~1 msec
 - Beam loading change from zero to full and full to zero.
 - Need RF control (change amplitude and phase of input RF) to keep acc. voltage constant.
 - Accurate control is necessary especially in extraction, for keeping beam quality down stream.
 - More power may be required for the fast control
 - depend on parameters
 - Reflection from cavities
 - zero current → almost 100% reflection

Relevant parameters

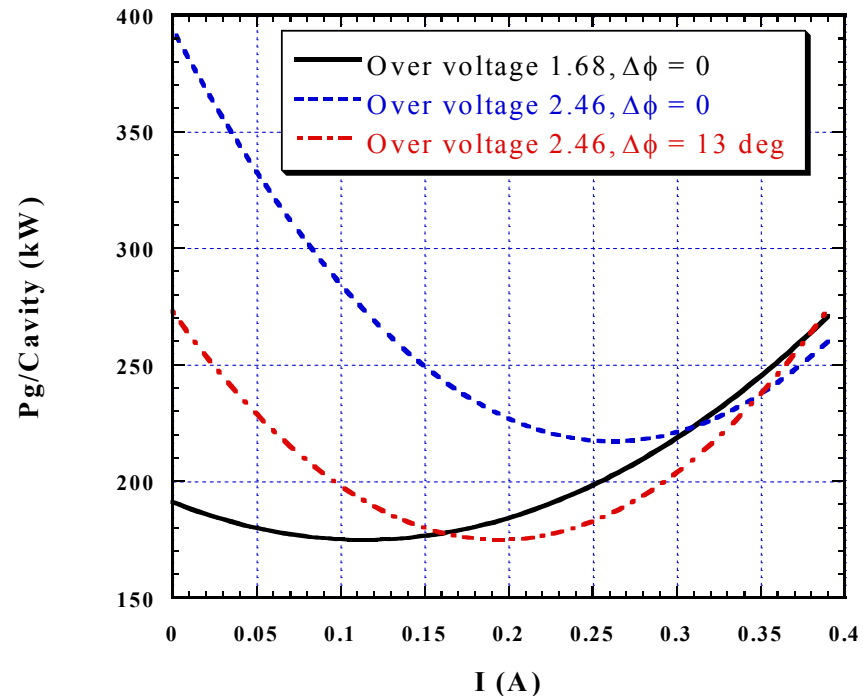
	low α	high α
Circunference (m)	3238	
Full beam current (A)	0.39	
Total RF voltage (MV)	1.17 x 12	19.7
Total R/Q of cavities (Ω)	8.9 x 12	8.9 x 16
Over Voltage	1.7	2.5
Momentum compaction	1.8E-4	3.3E-4
Number of bunches/train	45	
Number of trains/ring	29	

Required power for RF control

- Keep voltage (amplitude and phase) constant
- Assume Cavity resonance frequency is unchanged during extraction (injection)
 - Optimum tuning for full current: $\Delta\phi=0$, and fixed.

If Over Voltage < 2,
No extra power needed.

If Over Voltage > 2
Need extra power
May be acceptable by
choosing cavity detuning

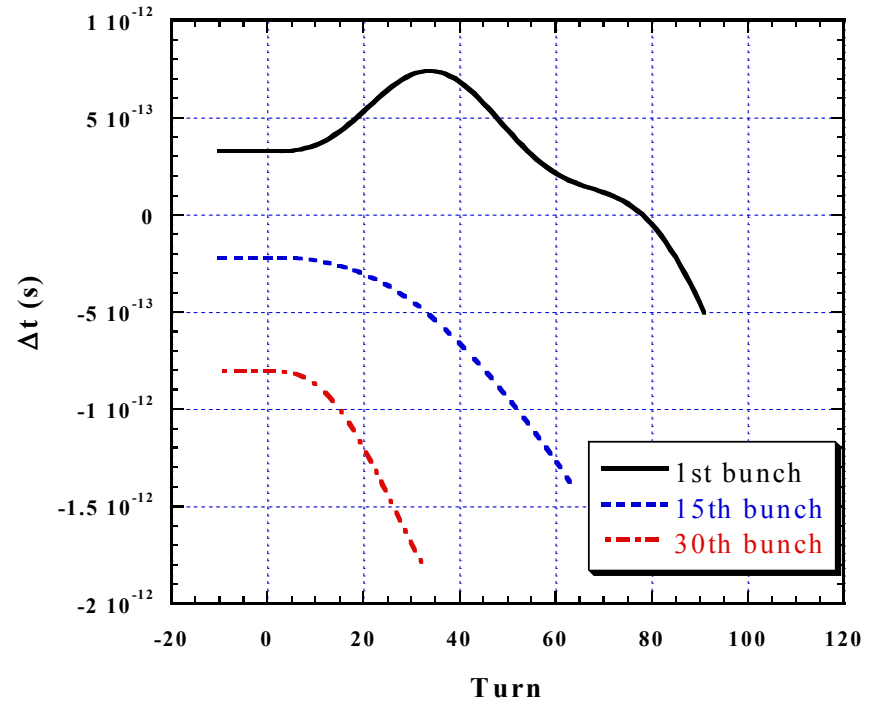
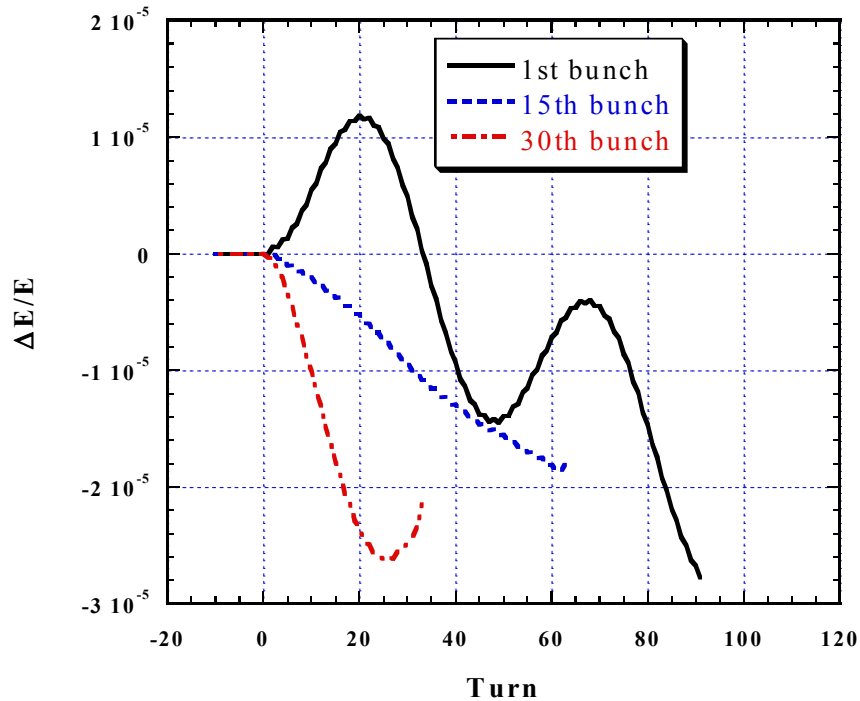


Induced longitudinal oscillation during extraction

- Even if average voltage is kept constant, configuration of beam trains and train gaps is changed and change of the transient loading may affect beam

Longitudinal motion during extraction

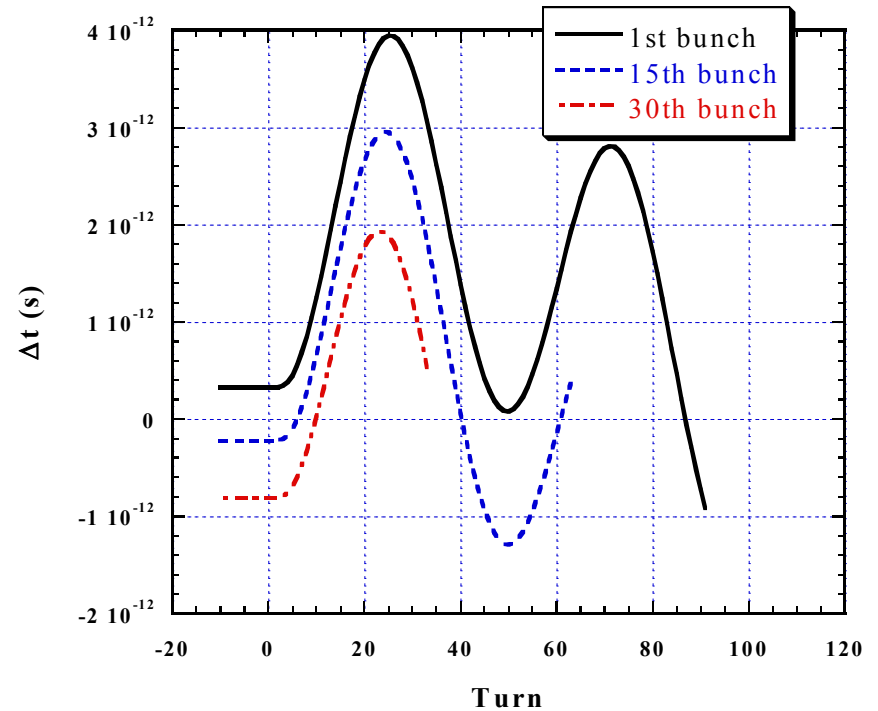
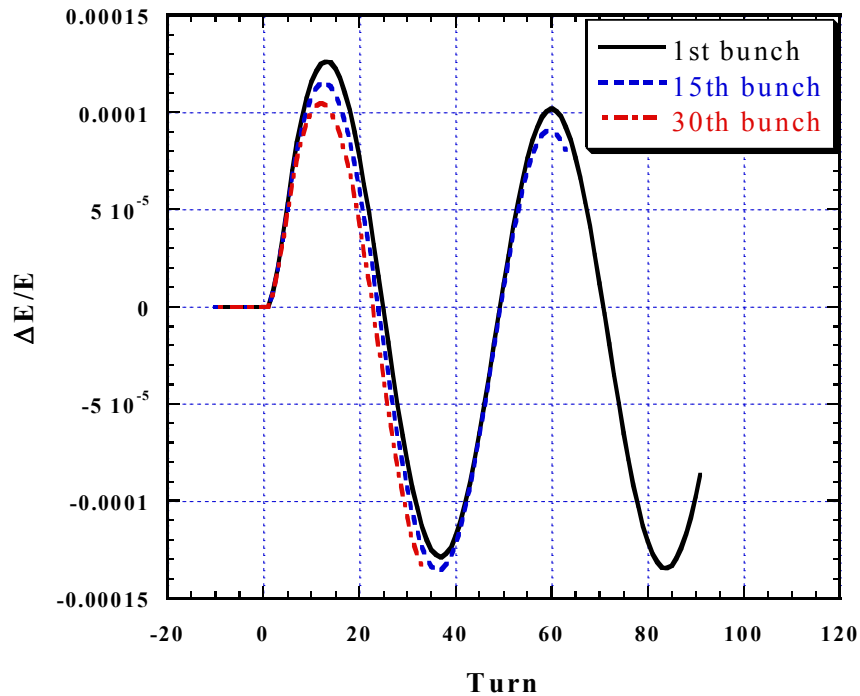
RF Control is as calculated



Induced motion will be very small. \ll energy spread and bunch length

Longitudinal motion during extraction

RF Control has error: amplitude 0.5% larger than calculated



With 0.5% cavity voltage error, induced motion will be about $0.1 \sim 0.2\sigma$.
Tolerable?

e+ production e- beam Bypass DR ?

	from DR	Bypassed
$\gamma\epsilon_x / \gamma\epsilon_y$ (m)	8E-6 / 2E-8	4.5E-5
$\sigma E/E$	0.1 ~ 0.15%	0.1%*
σz	6 mm	7.5 mm*

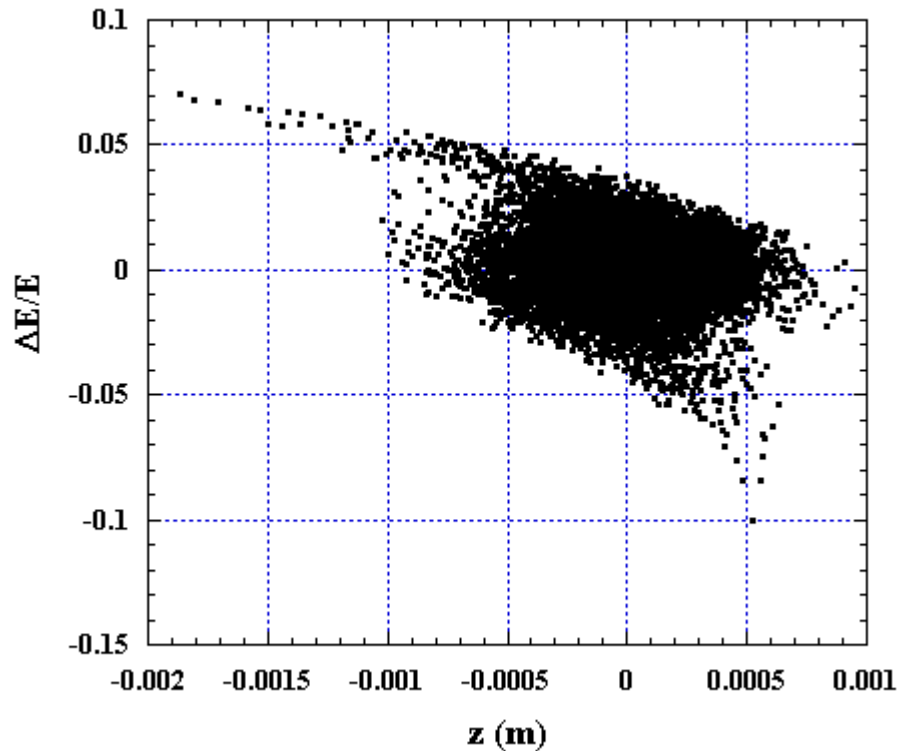
*calculated as: (From injector: $\sigma E/E \sim 0.3\%$, $\sigma z \sim 2.5$ mm,
Then, energy compressed before DR)

Larger transverse emittance will not be a problem in RTML And ML.
(In undulators for e+ production?)

Longitudinal parameter difference will not be significant..

z-E distribution after BC

Assume $\sigma_z = 8$ mm, $\sigma_{E/E} = 0.15\%$ at entrance of RTML
→ $\sigma_z = 0.29$ mm, $\sigma_{E/E} = 1.6\%$
(BC designed for $\sigma_z = 6$ mm, $\sigma_{E/E} = 0.15\%$)



Summary

- **Beam loading in 50% duty operation**
 - Need RF control (keep cavity voltage constant).
 - During extraction, voltage error $< 0.5\%$.
 - No extra power needed if Over Voltage < 2
 - Not much extra power needed even if Over Voltage ~ 2.5
 - Large reflection from cavities.
- **DR Bypassed beam (compare with beam from DR)**
 - Larger transverse emittance. Will not be a problem.
 - No significant difference of longitudinal parameters.