AP issues for harmonic cavities for ALS-II

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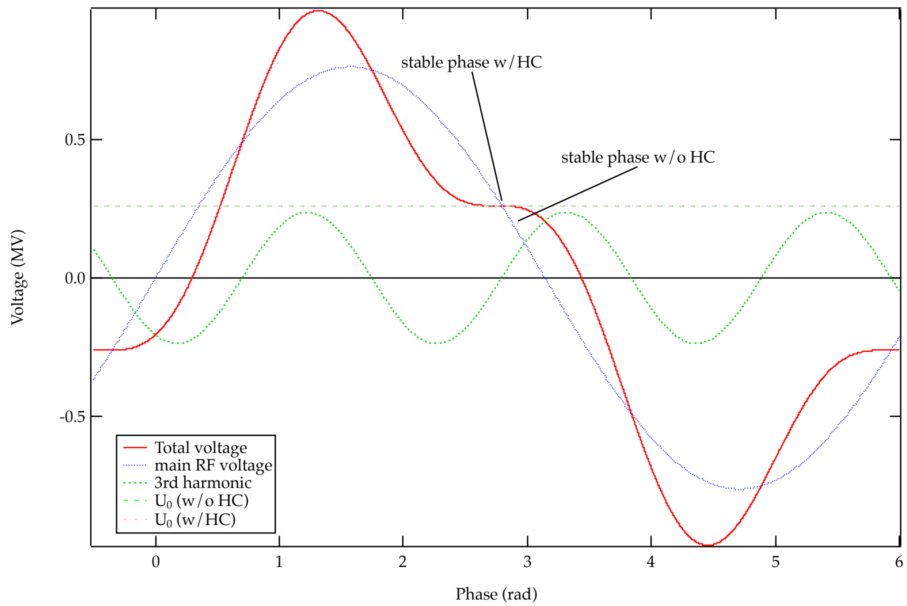
Bunch lengthening

- Use harmonic voltage to reduce focusing at bunch center, causing bunch to lengthen. Lots of Landau damping added.



For ALS2 parameters, bunch length increase is factor 4.3 for zeroed focusing.

ALS2 RF parameters

E=2 GeV

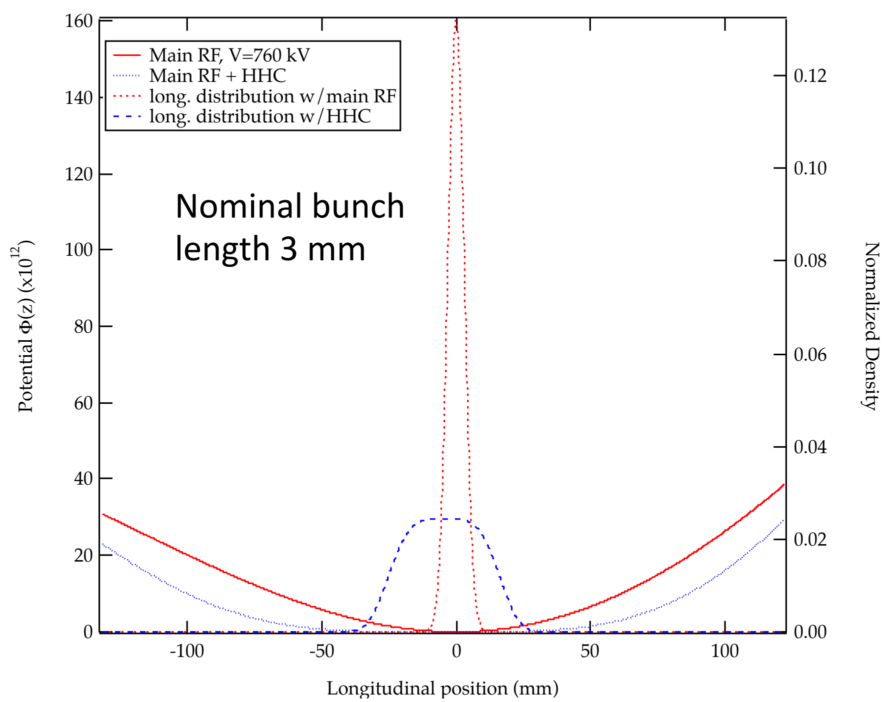
Frf=500 MHz

Vrf=670 kV

U0=260 kV

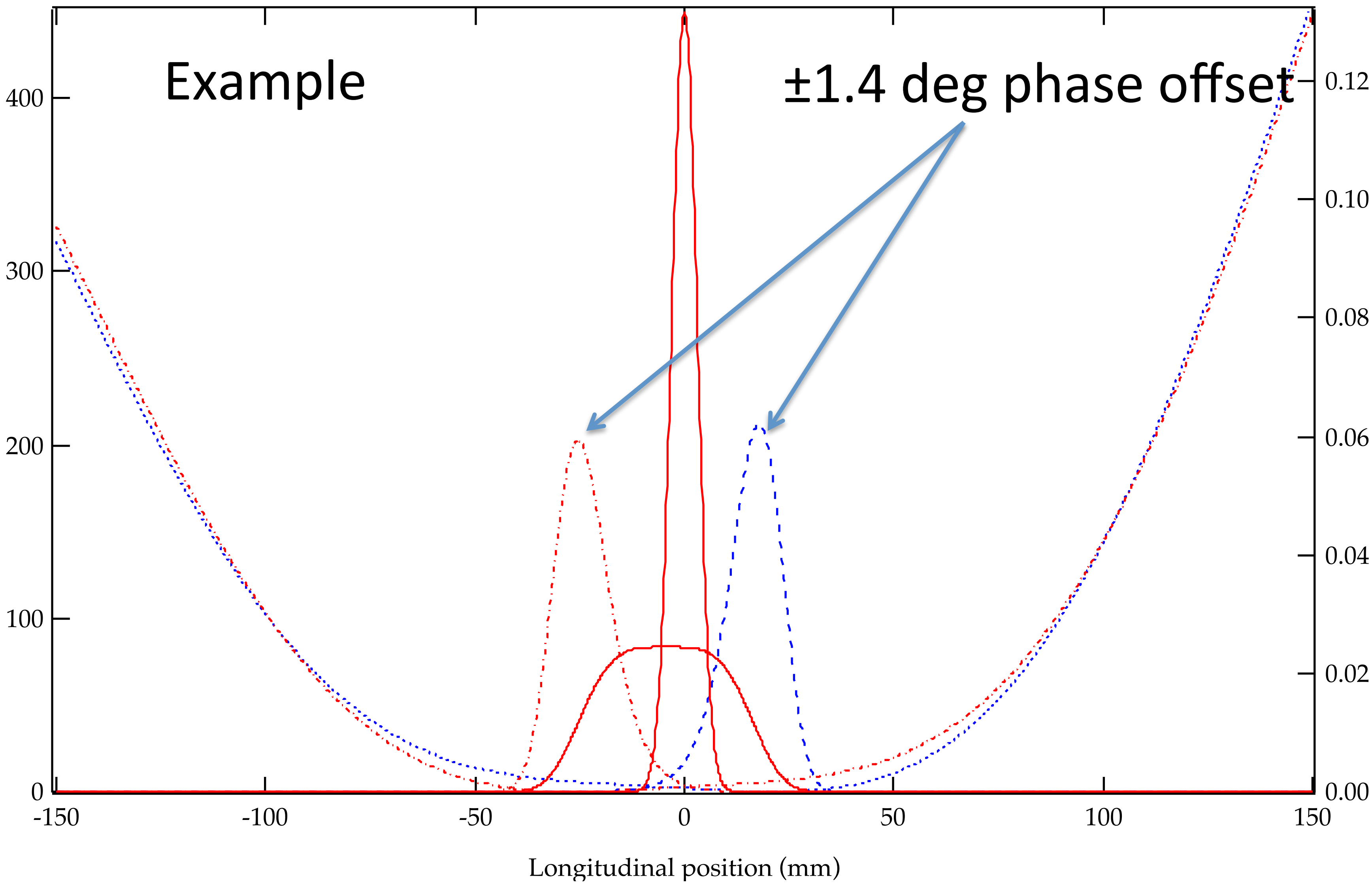
Alpha=2.69e-4

Third harmonic RF



Effects of variable HC phase

- Bunch lengthening effects very sensitive to phase of HC when focusing is gone.



Past observations

- All 3GLS with harmonic cavities see the same effect
  - With gap in beam fill pattern, transient beam loading causes variation of harmonic cavity phase along bunch train, resulting in less than optimal bunch lengthening except closer to middle of train. Effect is proportional to total R/Q of the harmonic RF system, beam current, and size of gap.
- Results:
  - SRF HC is better because voltage reached with smaller number cavities (smaller total R/Q)

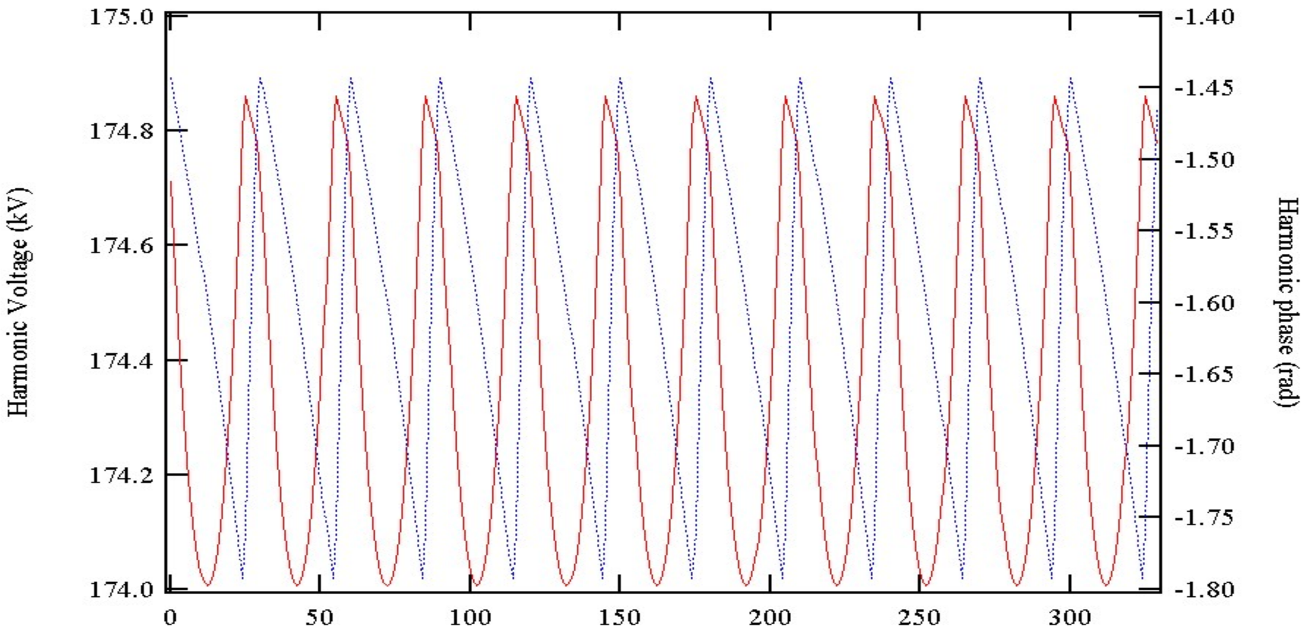
Phys. Rev. ST Accel. Beams 5, 092001

Beam and RF Tracking Code

- To model “steady-state asymmetric” beam loading for various beam fill patterns and RF configurations, we use a simple macro-particle tracking code.
- Output is RF and HC phase along bunch train which is then used to calculate bunch shape along bunch train. This can be used to calculate overall lifetime increase.
- Because each bunch is a macro-particle, code is limited to running with single fixed points. This can be fixed.
- Warning! Not all RF configurations are stable (AC and DC Robinson effects). RF and beam must be initialized as close as possible to steady-state conditions.

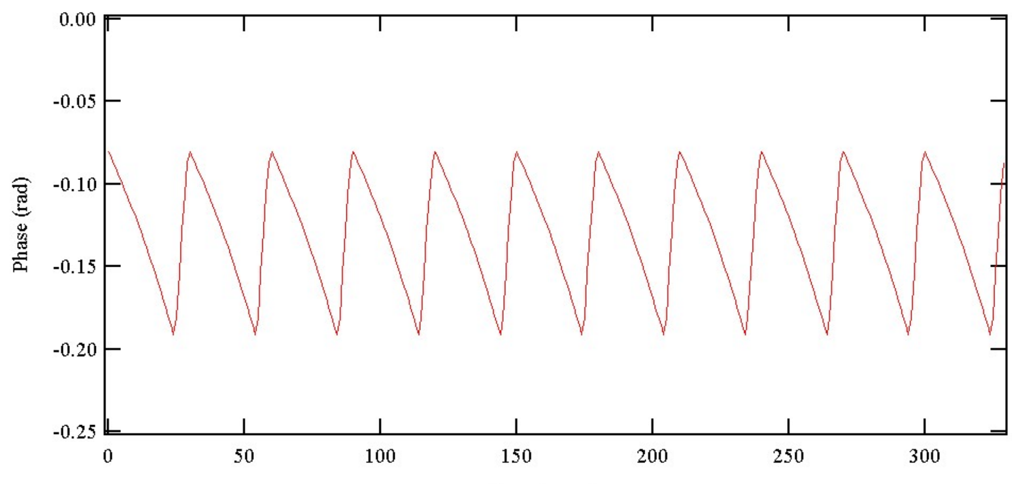
Example: Tracking code

- ALS-II parameters. 11 bunch trains of 25 bunches (10 nsec gaps.)



Harmonic cavity voltage and phase along bunch train

Synchronous phase along bunch train.



HC Options

- NC cavity
  - R/Q=80-100 Ohm
- SC cavity
  - R/Q=40 Ohm
- ARES NC cavity
  - R/Q=15 Ohm

For ALS-II SC HC is the baseline. It would be "uncool" to find an ARES option.

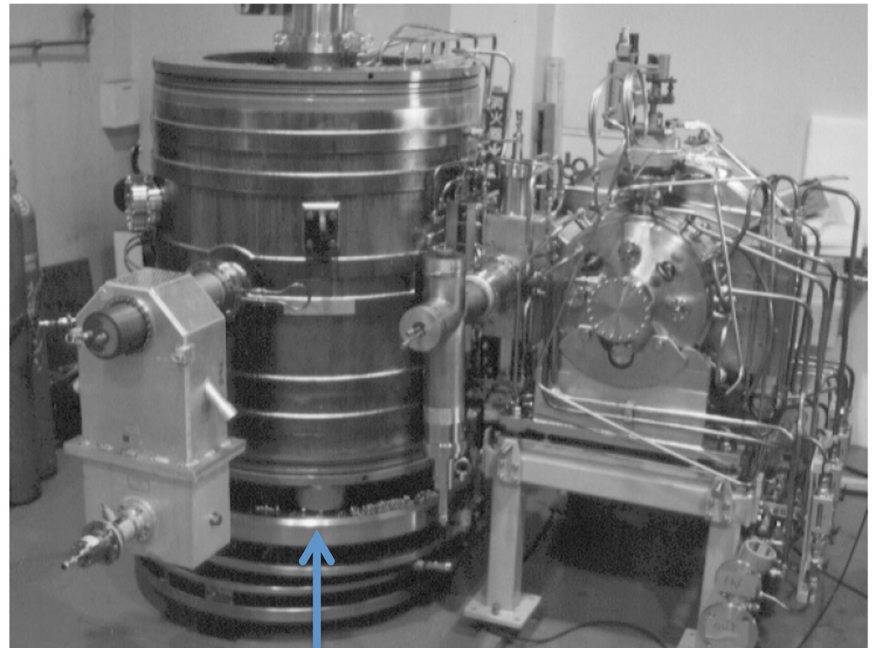


Figure 2: A photograph of the first high-power ARES cavity.

d=1070 mm, l=1190 mm

"The ARES Cavity for the KEK B-Factory", T Kageyama et al, EPAC 1996, WEP054

Main Issues for DLSR

- Emittance is small enough that bunch lengthening is required to avoid IBS and further lifetime degradation. True for SXR rings. HXR?
- Small gaps are needed for on-axis injection of bunch trains. Do the transients from these gaps have an acceptable reduction of bunch lengthening? If not, how do we fix it?
- ALS-II plan:
  - Model predicted effects using previously developed approach using NC, SC and ARES-style cavities (R/Q is high, medium, and low).

Other Interesting HC Issues

- Effect on multibunch stability from Landau damping.
- Effect on single bunch stability limits from both Landau damping and reduction of peak current.
- Go from passive HC to "mildly" active SC HC for use in reaching harmonic voltages in single bunch operation for beam studies.