9mA meeting on gradient tilts

J. Carwardine

15 June 2010

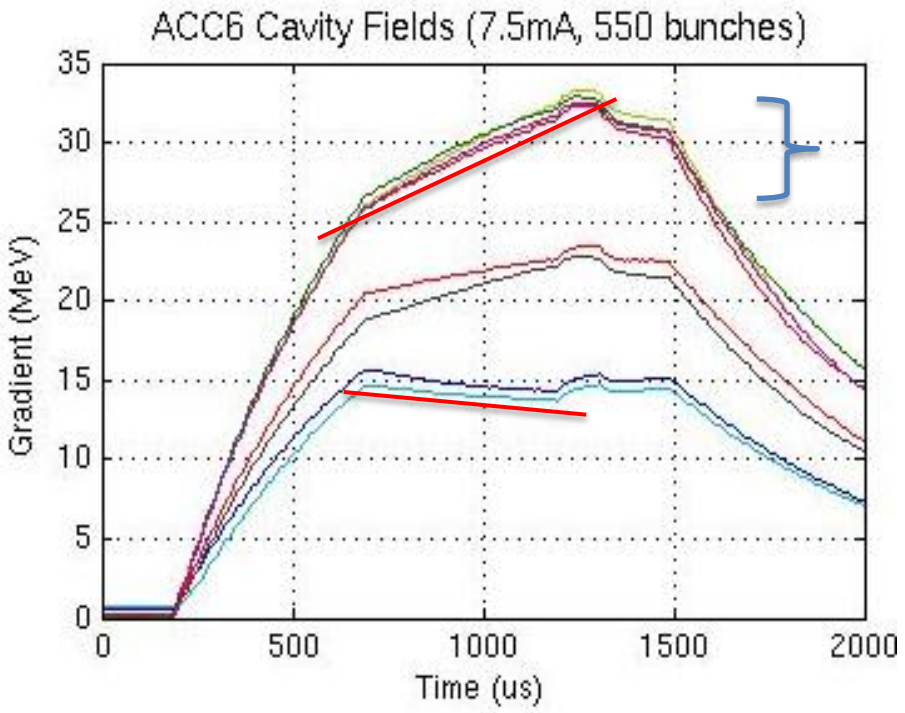
Agenda

- Quick recap
- Modeling & simulation (Julien Branlard)
- Revisiting error budgets
- Studies…

- FEL long bunch-train studies schedule

Issue

- Gradient deviations on individual cavities cause emittance growth
- Minimize gradient deviations for individual cavities over the bunch-train
  - 'Working spec' from Beam Dynamics Group: 1% max deviation
- Deviations from vector sum are a consequence of running different gradients on different cavities in the same vector sum



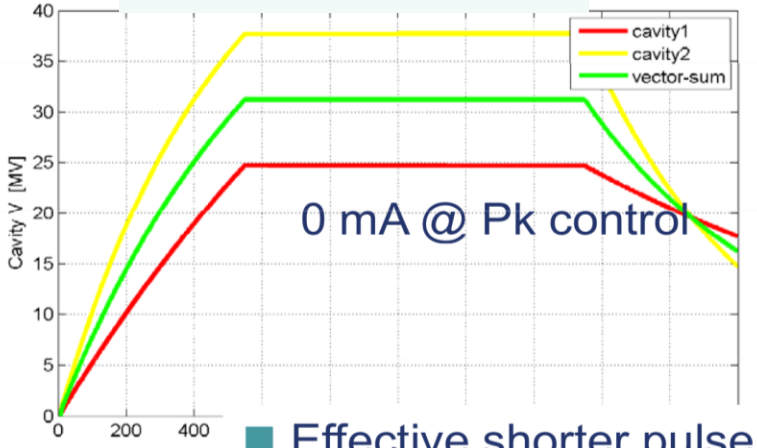
Linear slope due to beam-current mis-match with gradient, Pk, Qext

$$I_{matched} = \frac{V_k}{\left(\frac{r}{Q}\right) Q_{ext}}$$

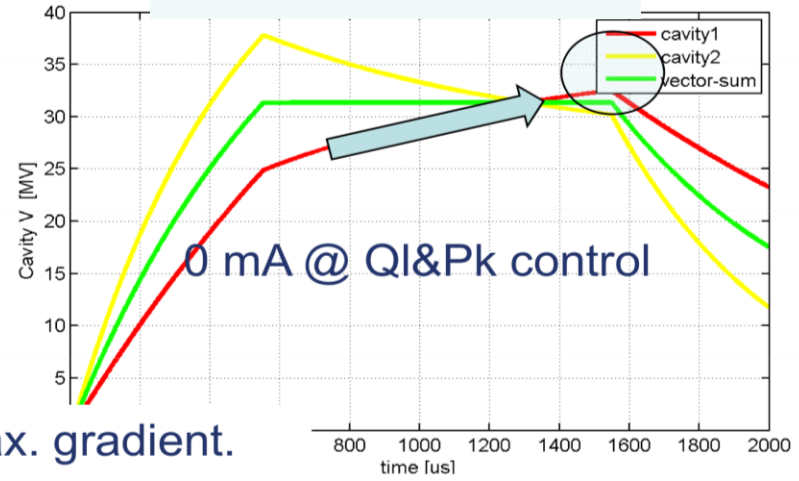
Curvature due to LFD (gradient dependent)

Cavity gradient tilts: RF distribution schemes

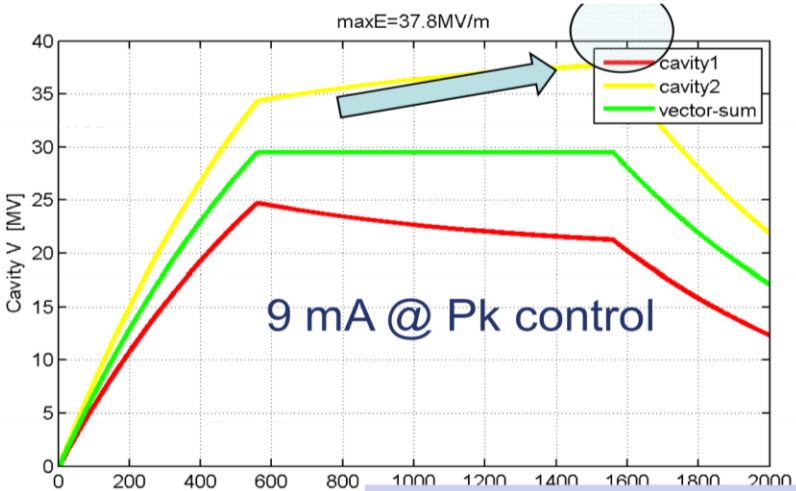
FLASH standard setup

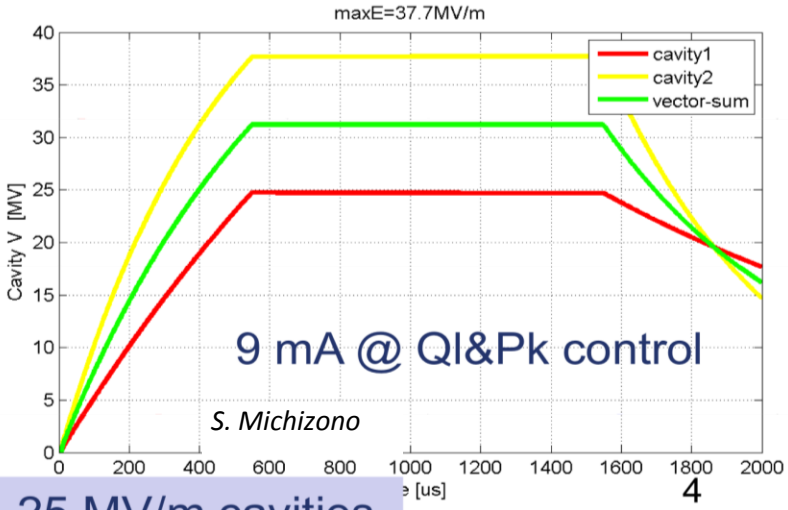


ILC Reference Design



- Effective shorter pulse at max. gradient.
- Same quench limit?





Simulation for 38 MV/m & 25 MV/m cavities

Sources of Errors

No feedback

- Lorentz Force Detuning (20%, 20deg)
  - A function of gradient and various cavity parameters
- Cavity P_k, Q_l and beam loading (2%, 2deg)
  - Test with simulator
- Microphonics (2%, 5 deg)
- Static detuning (1%, 2deg)
- Beam loading variation
- Vector sum calibration errors and drifts (1%, 1deg)
- Receiver linearity
- Noise
- Residual loop error (.2%, .2deg)
- Reference line drifts (0%, .3deg)

Initial estimates!

B. Chase (18 May)

Error Budget

Discussion on 1 June

- Lorentz Force Detuning (.2%, .2deg)
  - A function of gradient and various cavity parameters
- Cavity P_k, Q_l and beam loading (.2%, .2deg)
  - Test with simulator
- Microphonics (.2%, .2 deg)
- Static detuning (.1%, .1deg)
- Beam loading variation (.1%, .1deg)
- Vector sum calibration errors and drifts (.1%, .1deg)
- Receiver linearity (.1%, .1deg)
- Noise (.02%, .02deg)
- Residual loop error (.1%, .1deg)
- Reference line drifts (.1%, .1deg)

B. Chase (18 May)

Extras

Categorize into ‘static’ and ‘dynamic’

- Repeatable pulse to pulse
  - Common effects across cavities
    - Fully or partially detectable on vector sum
    - LLRF system with feed-forward compensation
  - Individual cavity effects
    - Not detectable on vector sum
    - Fast orbit kickers with feed-forward compensation
- Random pulse-to-pulse
  - Common-mode – detectable on vector sum
    - LLRF system with feedback regulation
  - All cavities different – not detectable on vector sum
    - Fast orbit kickers with feedback regulation

Issues for study

- Optimum tuning / setup for ‘zero’ tilt at nominal beam current
  - Cavity Pk / Qext
  - Cavity tuning

How well can we set up Pk / Qext?

- LFD feed-forward compensation using piezo tuners

- Dynamic effects
  - Beam current variations from nominal
  - Microphonics (unique by cavity, common to all cavities in a cryomodule)

- How well can we measure…?
  - Measurement errors (calibration, noise)

Sensitivites to various effects & errors… ***Model first, then study***

LFD compensation with piezo tuners

- ‘Residual errors are at the same level as the microphonics’
  - Can we always correct to this point, or is it that the microphonics are higher than expected?

Quantify microphonics on test stands (FLASH, HTS)

Studies

- Piezo tuner studies
  - FLASH (16 cavities)
  - Fermilab HTS (single cavity)
  - KEK – ‘S1-global’
  - *What issues to address?*
- HLRF Pk/Qext setup at FLASH
  - Study scenario
  - Min beam current for meaningful studies/
  - What can we do without beam…?
- Microphonics characterization
  - FLASH