Preliminary Simulation of Coupler RF Kick in Bunch Compressors

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Kiyoshi Kubo

Coupler RF Kick

Asymmetries of couplers (input coupler and HOM couplers) make transverse RF field in accelerating cavity.

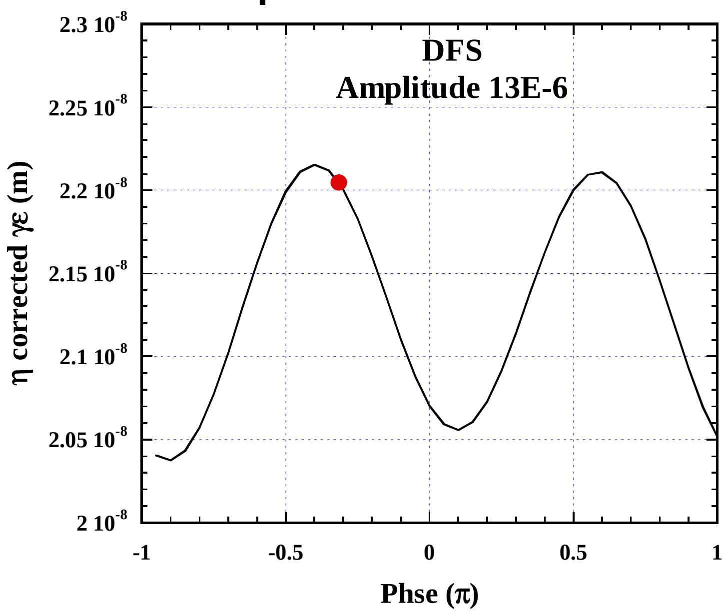
Data from V. Yakovlev

- Private communication. Also from presentation in Wakefield Workshop, Dec. 2007, at SLAC
- Phase: -0.99 rad from peak of accelerating field
- Amplitude: 13E-6 times accelerating field

$$V_y = ae^{i\theta}V_z \quad (a = 1.3\times10^{-5},\ \ \theta = -0.99)$$

From report in the last meeting on ML simulation with Coupler RF Kick

- Main Linac simulation was performed including Coupler RF kick. Using simulation code SLEPT
- Emittance growth due to the coupler RF kick is about 2 nm (10% of nominal) after DFS.
- The calculated phase is close to the worst. (in ML)
- Effect in Bunch Compressors should be studied.



Simulation in Bunch Compressors including Coupler RF Kick

- Simulation code SAD was used
  - Because SLEPT does not change relative longitudinal positions in a bunch
- Simulations here does not include
  - Wake field (might be included but very slow ?)
  - Cavity edge focus (Cavity tilt error should be reduced by factor two)
  - Radiation
- Coupler RF kick is included as a crab-cavity inserted at each accelerating cavity. (“TCAV” in SAD)
- Lattice “2007b” was used.
  - Off crest angles are: -104 deg. in BC1 and -27 deg. in BC2

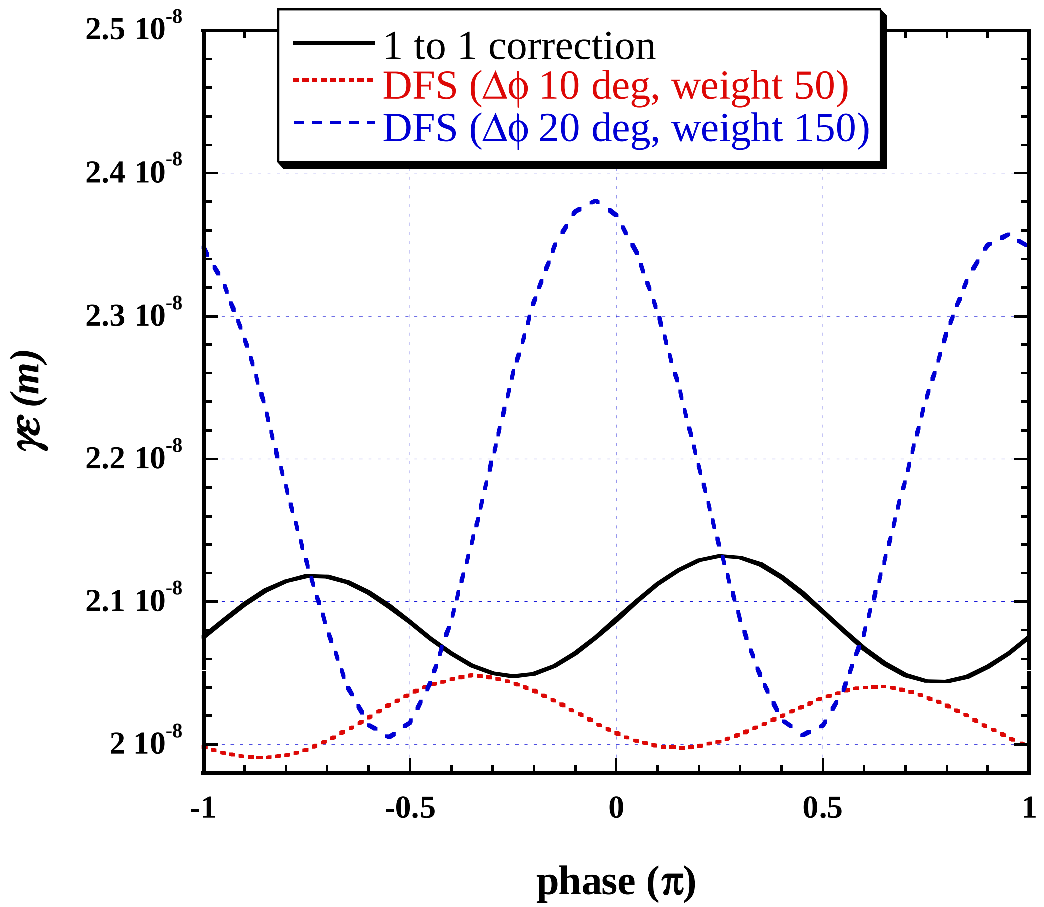
Steering corrections in Bunch Compressors

- one-to-one
  - Steer bunch center to every BPM center
- DFS (Dispersion Free Steering)
  - Measure orbits (readings of BPM) with three different settings
    - nominal : A
    - RF phase change by $+\Delta\phi$: B
    - RF phase change by $-\Delta\phi$:C
    - Minimize A^2+weight^2*(B-C)^2
    - Results depend on $\Delta\phi$ and weight. Optimum parameters depend on errors.

Emittance vs. phase of Coupler RF Kick

No errors, no misalignment

1. one-to-one correction with perfect BPM
2. DFS, two cases with different parameters



Results of DFS is complicated.
No simple explanation.
Hard to tell which phase is good or bad from these results.

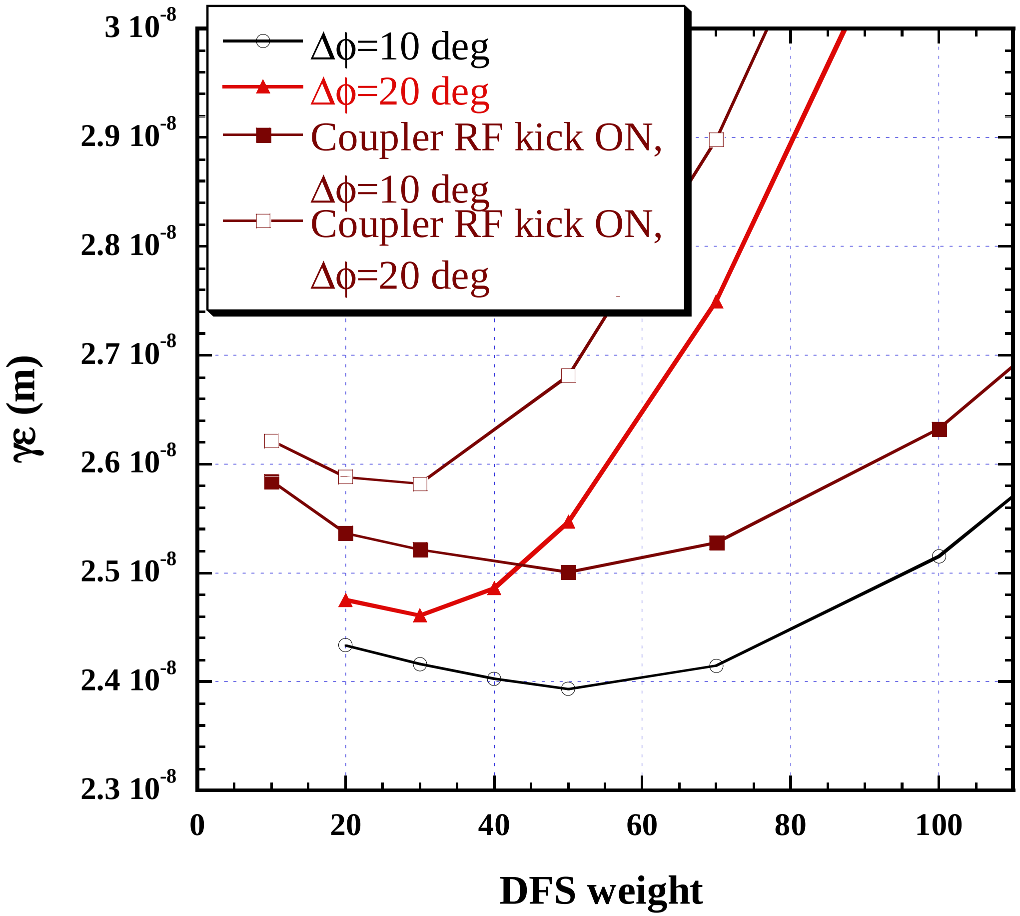
“Standard” errors

- Quad, cavity, BPM misalignment
  - 150 um in warm section
  - 30 um in cold section
- Cavity tilt
  - 300 urad (set 150 um in SAD)
- BPM resolution
  - 1 um

Rotations were not set here. Not very important and not relevant for Coupler Kick study.

DFS weight parameter vs. emittance, “standard” errors with/wo Coupler RF Kick

Coupler RF Kick: Amplitude = Vz x 13E-6, Phase = Vz phase -0.99 rad



Optimum weight depends on phase change.
Coupler RF kick increase emittance about 1 nm

Summary

- Effects of Coupler RF Kick in Bunch Compressors were simulated
  - Results are preliminary. Parameters should be checked
- Emittance growth due to Coupler RF Kick is about 1 nm (5% of nominal) after DFS. (But depend on DFS parameters which should be chosen depending on other conditions.)
- RF filed calculations should be confirmed.
- Transverse kick by coupler wakefield is another issue.
  - Design may have to be changed for mitigating this effecs.
- Results are still preliminary.
  - Need more studies by other people and simulation codes.