DFS Simulations on ILC bunch compressor

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- SLEPT DFS has been newly improved in order to change the RF phase of accelerating cavities besides of changing the initial energy of test beam.

- Two algorithms are introduced.

  Old DFS: $\sum_i \{w\left(y_i(\varphi) - y_i(0)\right)^2 + y_i(0)^2\}$

  New DFS: $\sum_i \{w\left(y_i(+\varphi) - y_i(-\varphi)\right)^2 + y_i(0)^2\}$

- These two new DFS were tested on BC2 of ILC

Comparison between including coupler's kicks and without coupler's kicks (Ⅰ)

- Errors

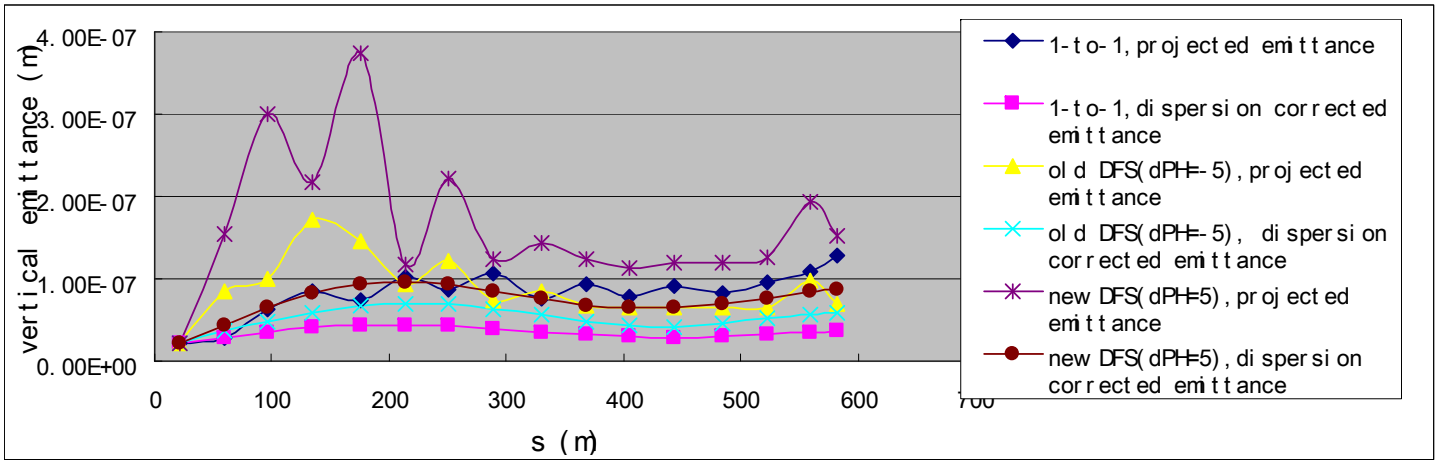
  Quadrupole vertical offset: 300 μm
  BPM vertical offset: 300 μm (aligned independently)
  BPM resolution: 1 μm

- Random seeds: 40

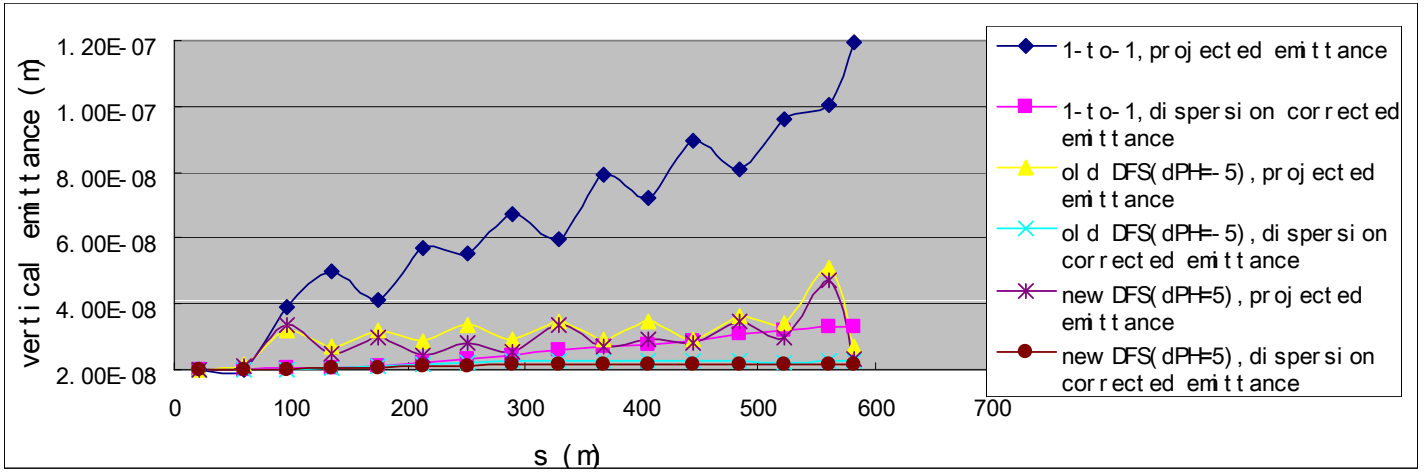
- Weight=5000

Comparison between including coupler's kicks and without coupler's kicks (Ⅱ)

Vertical emittance vs. distance from the entrance including coupler's kicks



Vertical emittance vs. distance from the entrance without coupler's kicks



Comparison between including coupler's kicks and without coupler's kicks (Ⅲ)

- DFS through changing RF phase is affected by coupler RF kicks.

  changing RF phase will also change coupler RF kicks on test beams and then change the trajectories of test beams.

- At present, we just close coupler's kicks to study the elements' errors separately.

  We will modify the code later in order to include coupler's kicks.

- New DFS is better than old DFS.

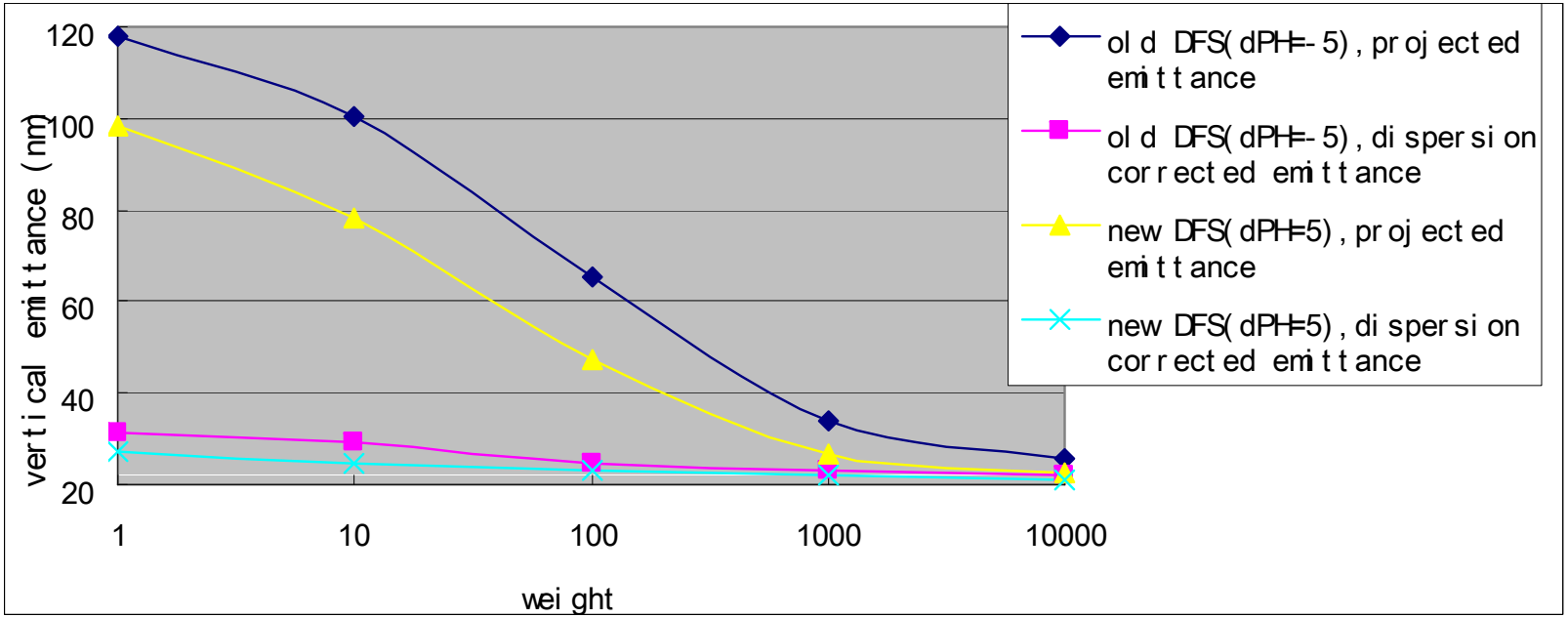
Comparison between old DFS and new DFS without coupler's kicks (Ⅰ)

- Errors

  Quadrupole vertical offset: 300 μm
  BPM vertical offset: 300 μm (aligned independently)
  BPM resolution: 1 μm

- Random seeds: 40

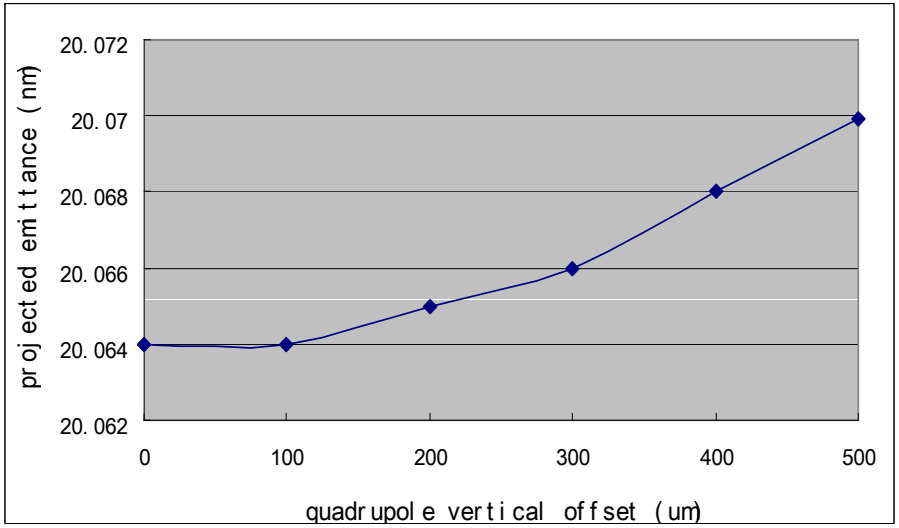
Comparison between old DFS and new DFS without coupler's kicks (Ⅱ)

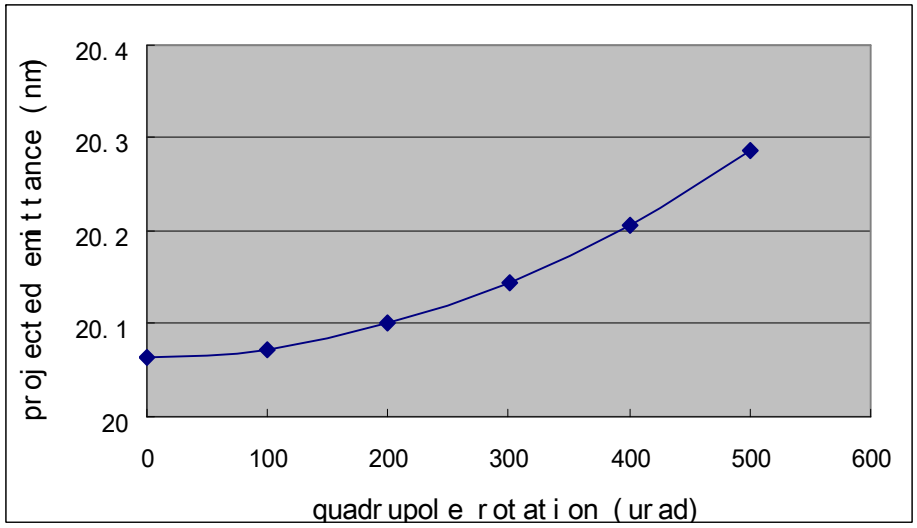


Again, new DFS is better than old DFS.

Sensitivity of new DFS to each error (without coupler's kicks) (Ⅰ)

△φ=5°, weight=5000, random seeds=20





Sensitivity of new DFS to each error (without coupler's kicks) (Ⅱ)

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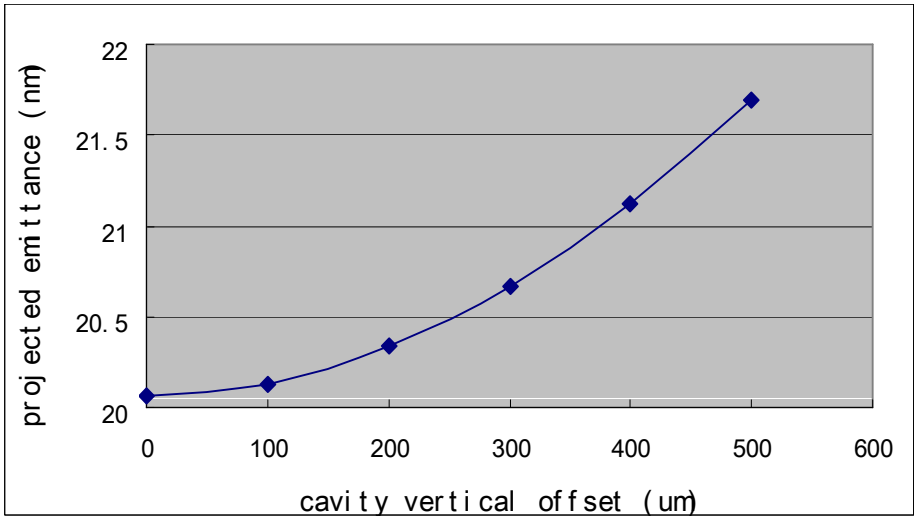
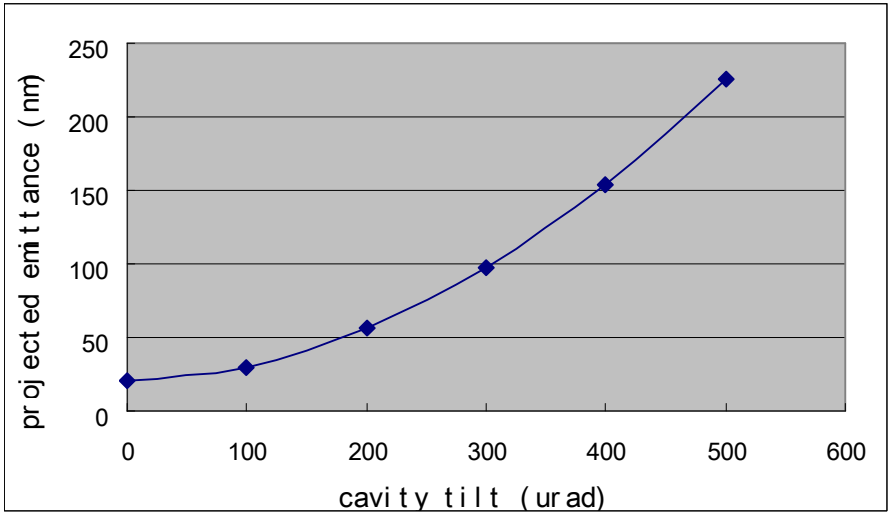
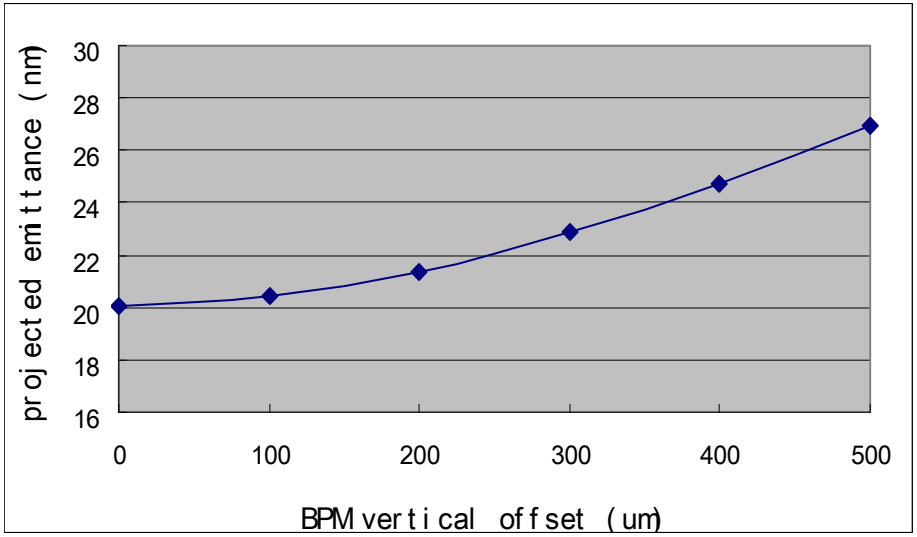
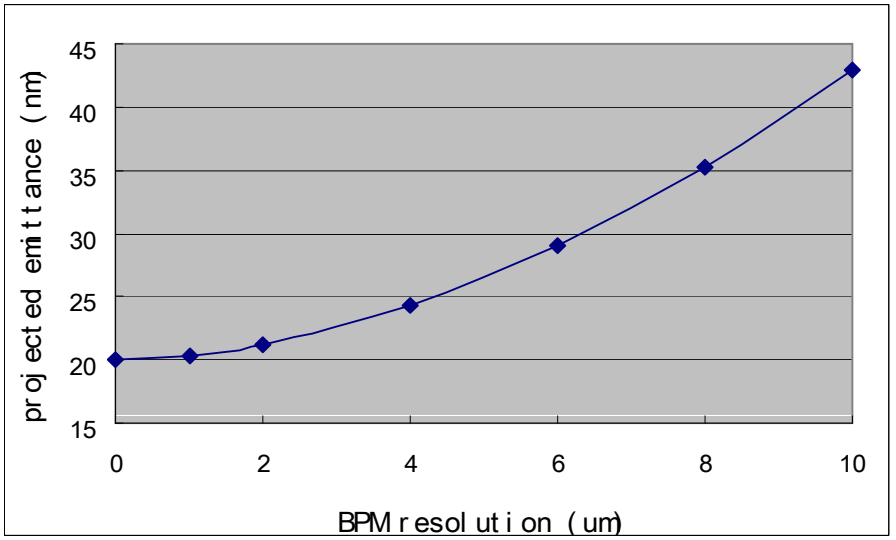




Sensitivity of new DFS to each error (without coupler's kicks) (Ⅲ)

△φ=5°, weight=5000, random seeds=20





Sensitivity of new DFS to each error (without coupler's kicks) (Ⅳ)

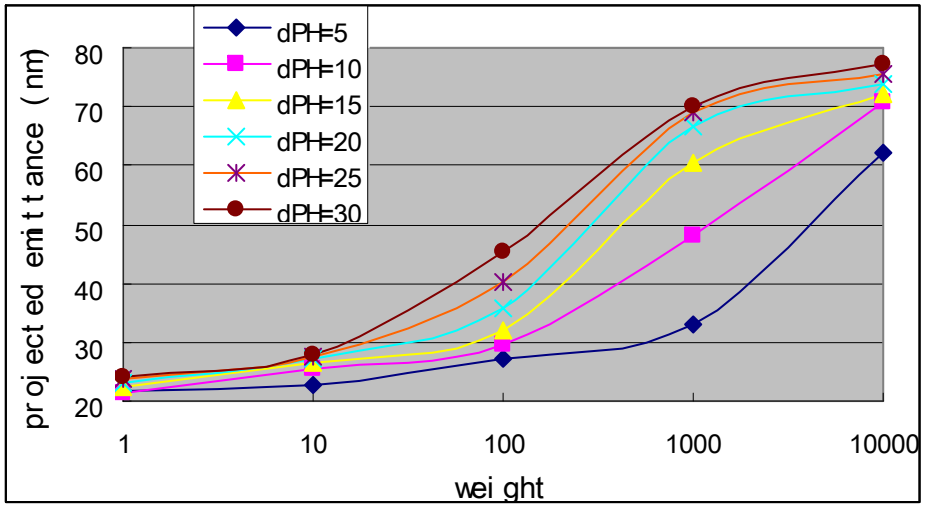
- Almost no dependence on Quad offset and Quad rotation
- Some dependence on cavity offset, BPM offset and BPM resolution
- Strong dependence on cavity tilt

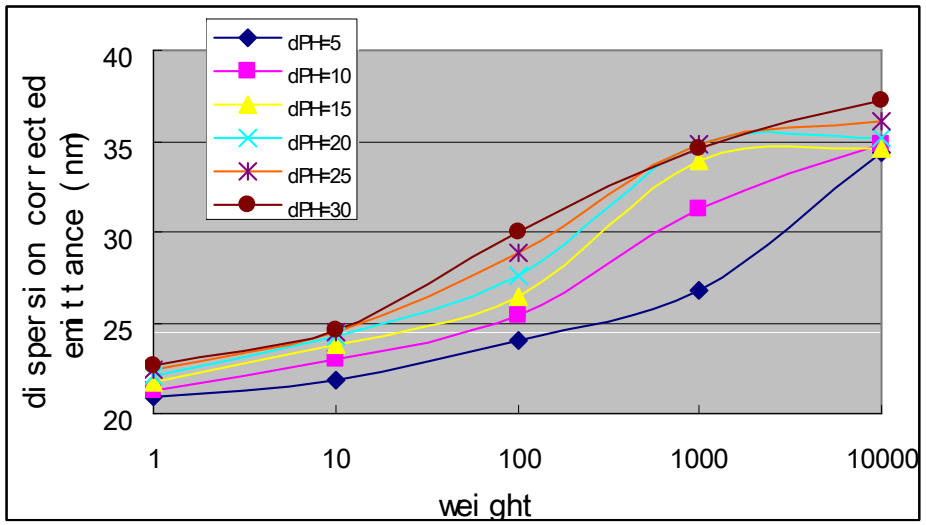
The effect of new DFS to cavity tilt (I)

- Cavity tilt only

  cavity tilt: 200 μrad

  random seeds=40

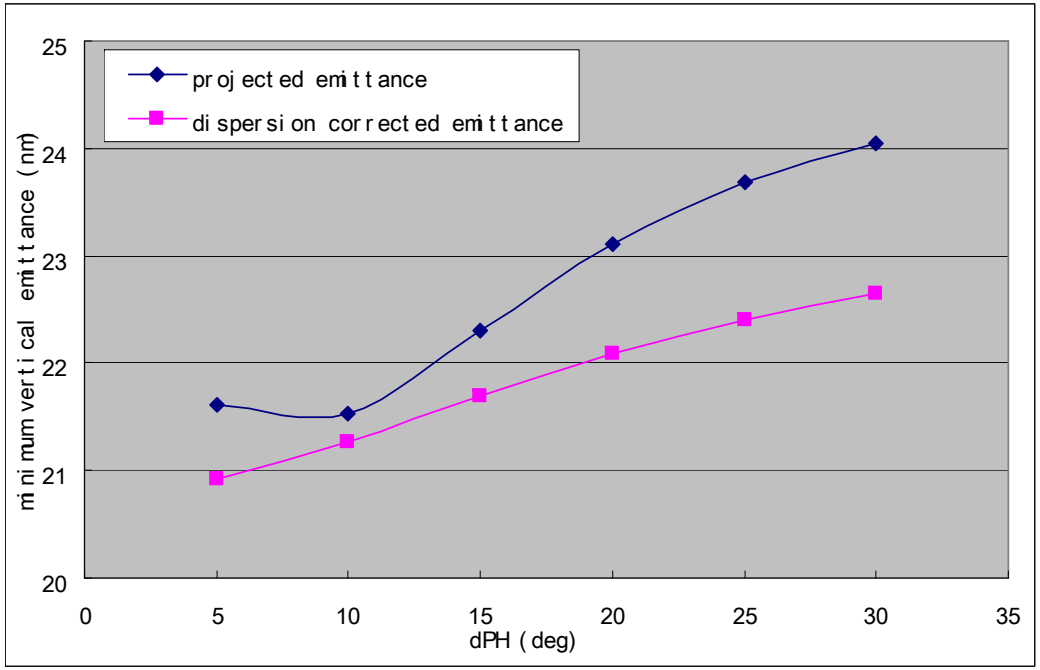




Larger weight, larger vertical emittance.

The effect of new DFS to cavity tilt (Ⅱ)

- Cavity tilt only (continued)



Larger phase change, larger minimum vertical emittance.

The effect of new DFS to cavity tilt (Ⅲ)

- All errors except for cavity tilt

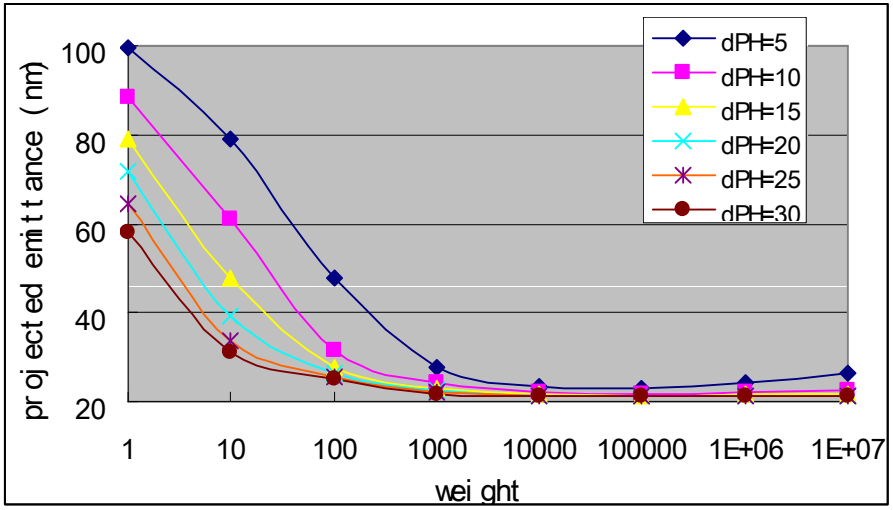
  Quadrupole vertical offset: 300 um, Quadrupole rotation: 300 urad

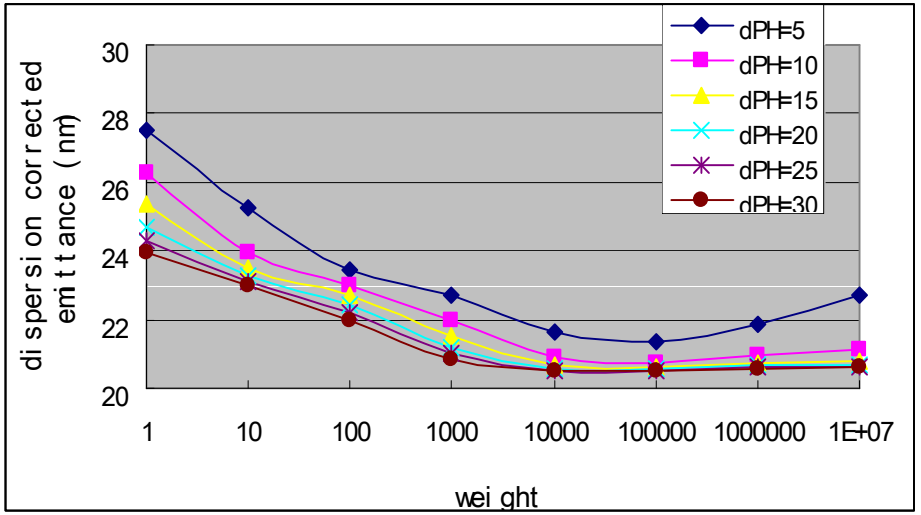
  Cavity vertical offset: 300 um

  BPM vertical offset: 300 um (aligned independently)

  BPM resolution: 1 um

  random seeds=40

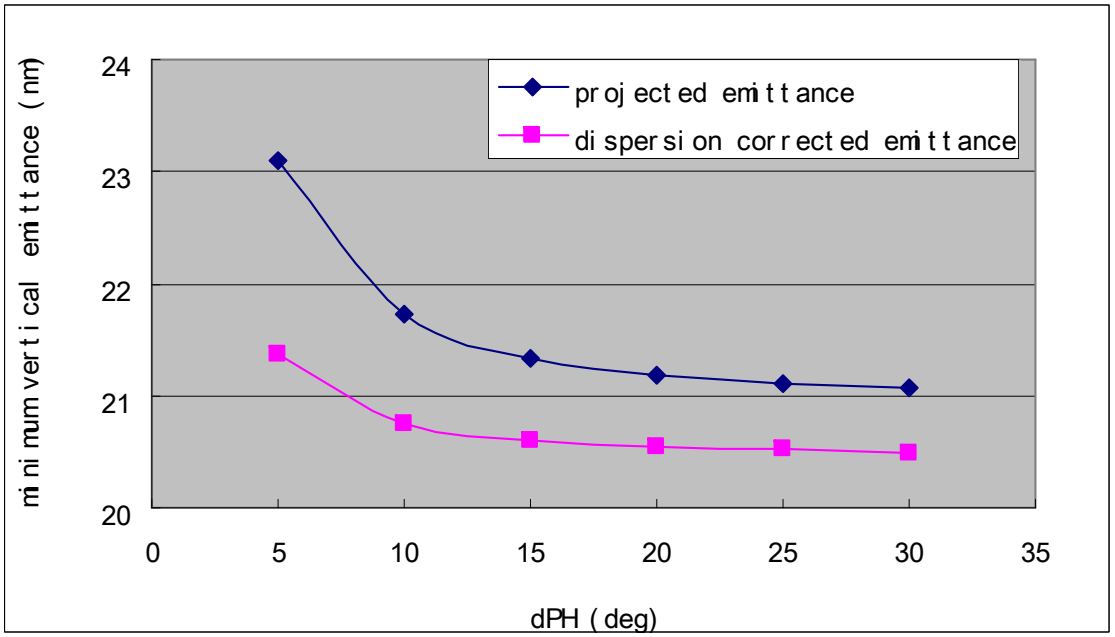




Larger weight, smaller vertical emittance (reasonable).

The effect of new DFS to cavity tilt (Ⅳ)

- All errors except for cavity tilt (continued)



Larger phase change, smaller minimum vertical emittance.

Conclusion: Our DFS is not effective to cavity tilt.

Maybe cavity tilt can change the trajectory of test beam.

New DFS on BC2 including all the errors (without coupler's kicks) (Ⅰ)

- Errors:

  Quadrupole vertical offset: 300um

  Quadrupole rotation: 300urad

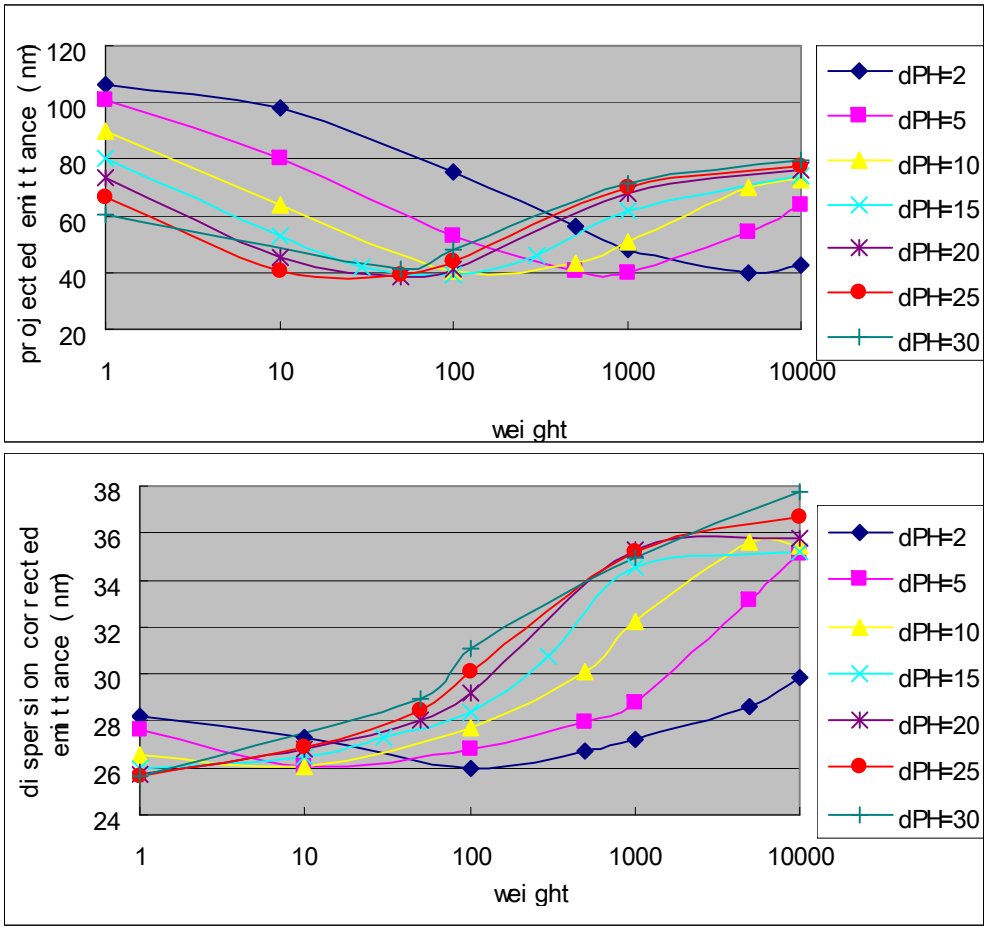
  Cavity vertical offset: 300um

  Cavity tilt: 200urad

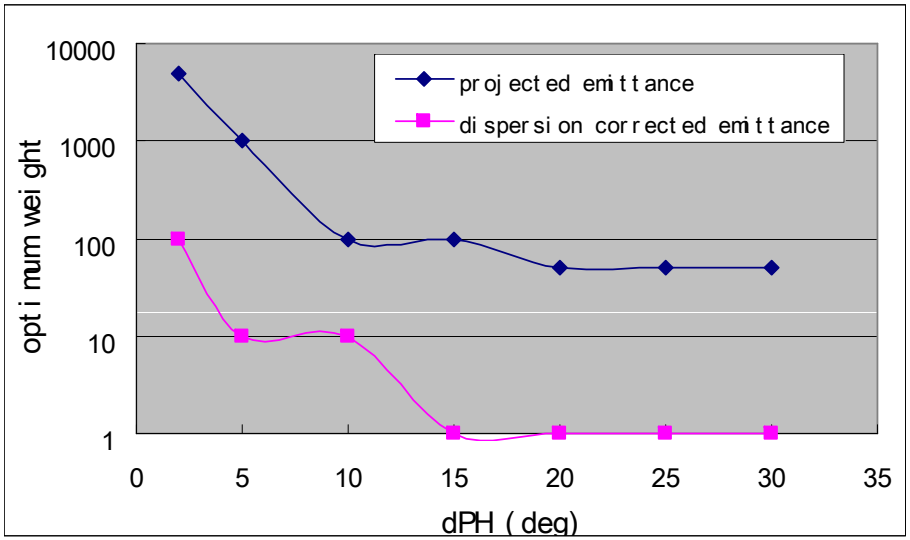
  BPM vertical offset: 300 um (aligned independently)

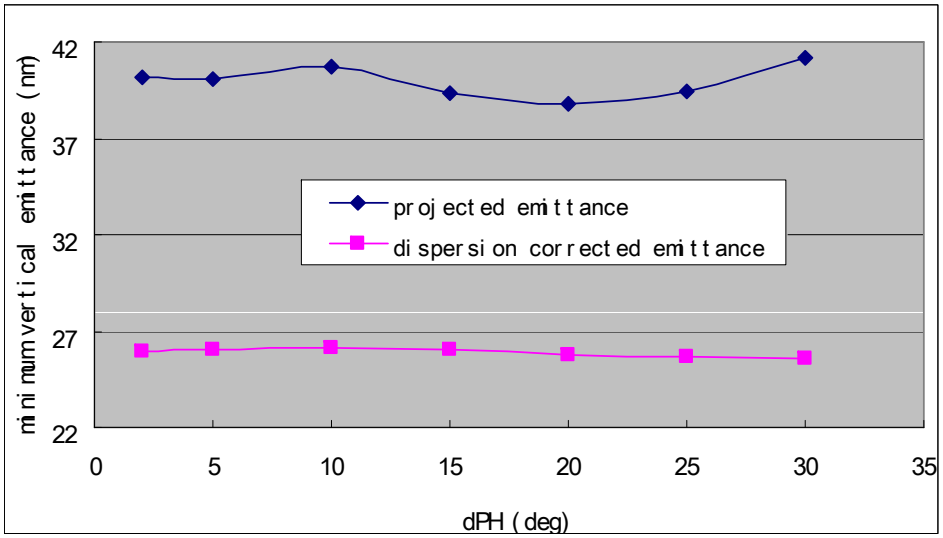
  BPM resolution: 1 um

- random seeds=40



New DFS on BC2 including all the errors (without coupler's kicks) (Ⅱ)





- DFS is not very effective because of cavity tilt.
- The minimum final emittance growth can be controlled to 6 nm including all the errors.

Summary

- After modification, SLEPT DFS can change RF phase of cavities for BC. Two DFS algorithms are introduced.
- DFS through changing RF phase is affected by coupler RF kicks. We will change the code later to include coupler's kicks.
- New DFS is effective to all the errors except for cavity tilt.
- The final dispersion corrected emittance growth can be controlled to 6 nm including all the errors (not acceptable) for BC2. With all other errors except for cavity tilt, the final dispersion corrected emittance growth can be controlled to 0.5 nm.