Merlin DFS studies following discussion (Very preliminary)

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DESY

- Simulation parameters
  - Bins of 40 quads (20 overlap)
  - BPM resolution = 5 um
  - No other errors than the one given here (i.e BPM Offset or RF pitch)
  - Wakefield included
  - DFS energy strategy (check slide later)
    - Initial Beam Energy (-20% or 0)
    - Gradient along Linac (-20%)

Note: The strategy including an Initial Beam Energy adjustment has the best effect on the emittance growth limitation ("**Energy adjustment strategy for dispersion free steering at the ILC using the MERLIN package ILCDFS** " - EUROTEV-REPORT-2006-106)

DFS Algorithm based on the following equation ($w=w_{diff}$ in later slides is the constrain on the difference orbit)

Preliminary

Dispersion Free Steering

Minimisation of the absolute trajectory of the beam (wrt to a design orbit) and the difference orbit when the energy is changed

$$\chi^2 = \frac{\Delta y(\delta).\Delta y(\delta)}{W_{\text{diff}}^2} + \frac{y(0).y(0)}{W_{abs}^2}$$

W_{diff}: Constrain on difference orbit (or W= free parameter)

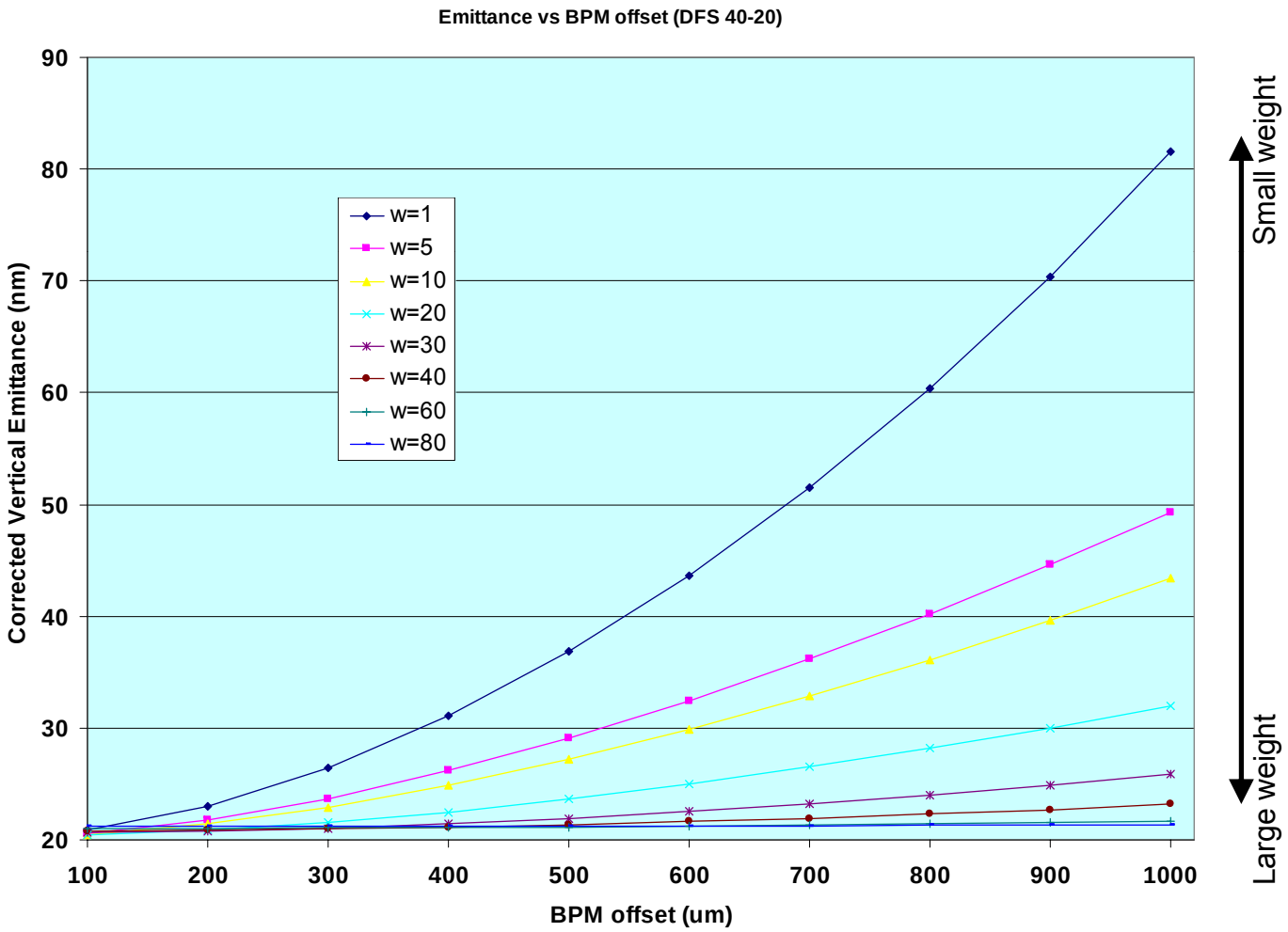
W_{abs}: Constrain on absolute orbit (fixed = 1)

- DFS technique is applied on segment of the linac:
  - 40 quads with
  - 20 quads overlapping
- Energy Difference at beginning of each segment = 20%
  - At beginning of linac:
    - On-energy beam = 15 GeV
    - Off-Energy beam = 12 GeV
- Energy Gradient = -20%

→ See later studies

Emittance vs BPM Offset Error

- Vertical emittance versus the BPM offset is here checked.
- Energy Strategy:
  - Grad= -20%
  - Init. Beam= -20%



The slope of the emittance versus the BPM Offset is highly dependent on the weight chosen

I.e. difficult to make a direct comparison between codes without the knowledge of the weight used in the various code (and understanding of the DFS algorithm)

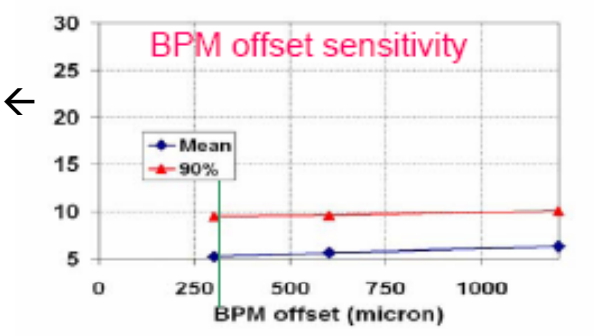
Corrected Emittance= Energy Correlation numerically removed.

Preliminary

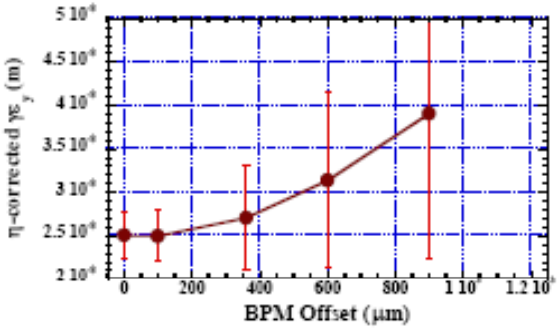
Comparison

K. Ranjan results

Large weight?←

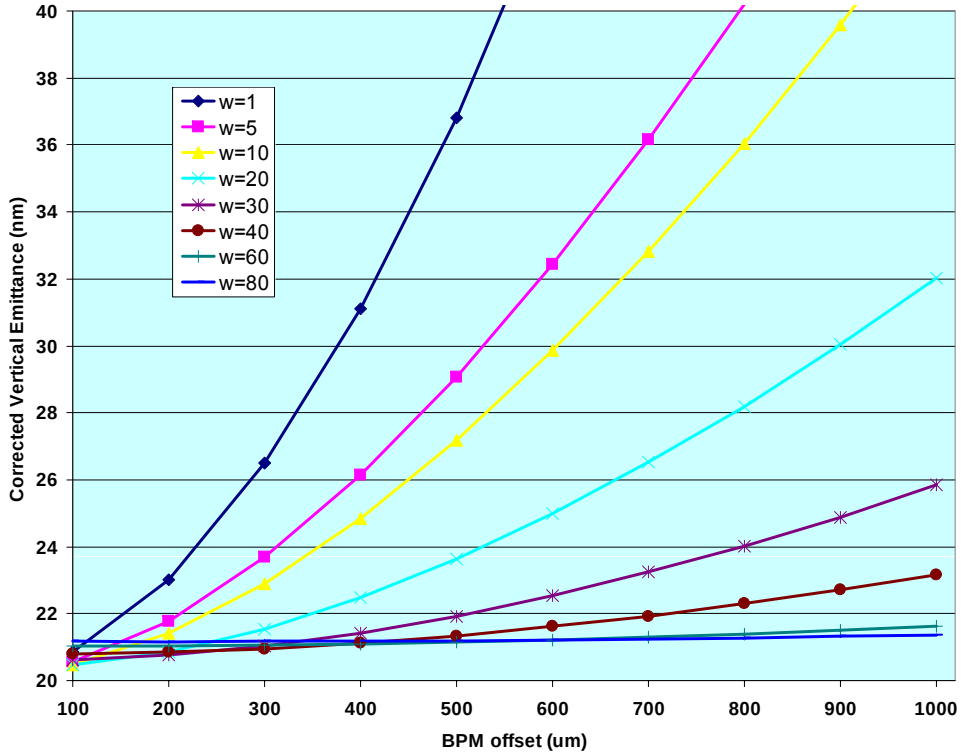


KK results



→ Small weight?

Difference between the two plots seems to be the weight (constrain)

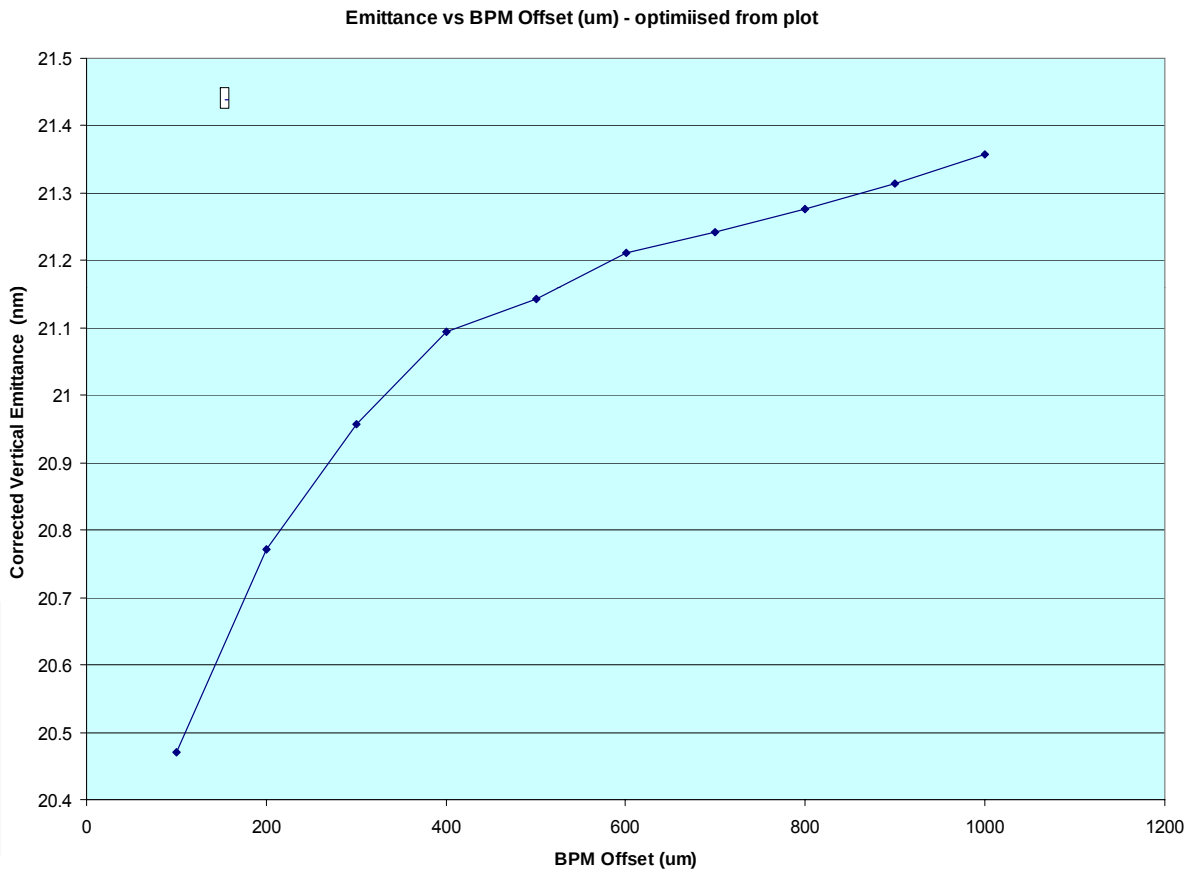


Large weight= less dependent to BPM Offset

Preliminary

Optimisation (*)

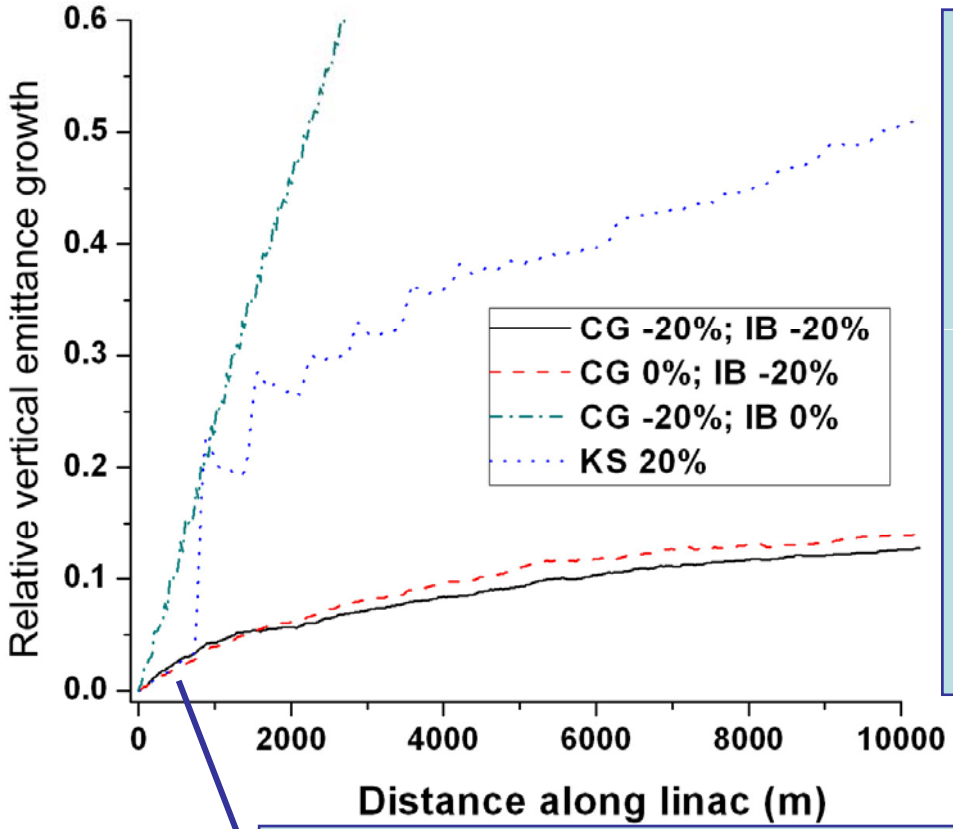
- Optimisation from previous plot: Here the idea is to find the weight which minimize the emittance at the end of the linac



Emittance versus BPM Offset shows a different behaviour than in previous study i.e. more logarithmic than exponential

(*) The optimisation is relatively crude here

Energy Adjustment Result



1) IB: **Initial energy is the most effective single adjustment**. ($\gamma\varepsilon_{yc}$=22.8 nm)

2) CG: Constant gradient only least effective (59.3 nm)(*)

3) Combination of IB and CG helps to obtain better results (22.5 nm)

4) KS: Klystron Shunting (30.2 nm). Steps probably an artefact of simu. due to steering effect. Decrease with energy

Very big difference wrt to strategy at the beginning of linac

BPM = 1 μm

W_{diff} = 1/(√2*40) μm

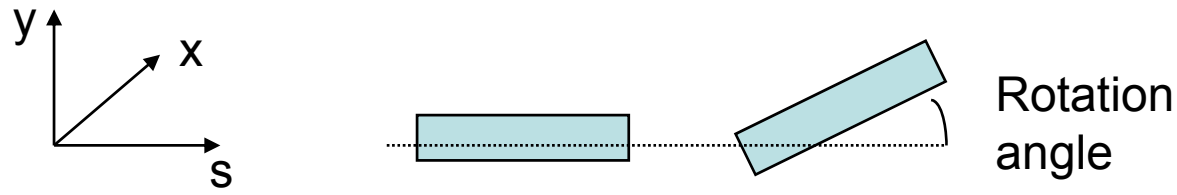
W_{abs} = 1 μm

*CG do not effectively correct dispersion **at the beginning as relative uncorrelated energy spread is highest**.

See: *Energy Adjustment Strategy for DFS at the ILC using the MERLIN Package ILCDFS* – EUROTeV report 2006-106

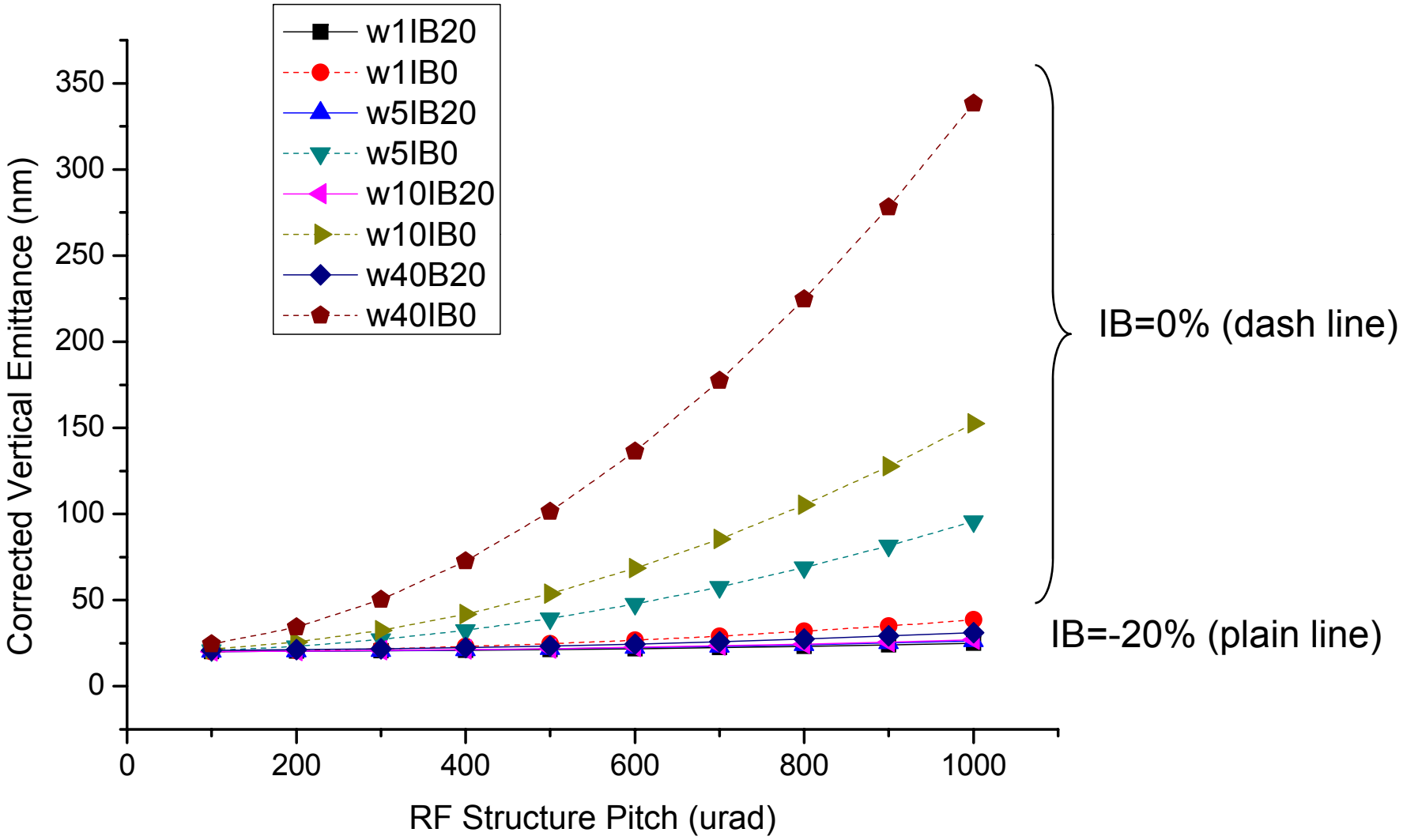
Emittance vs RF Pitch Error

- Cavity pitch = the RF structure is rotating around the x-axis:



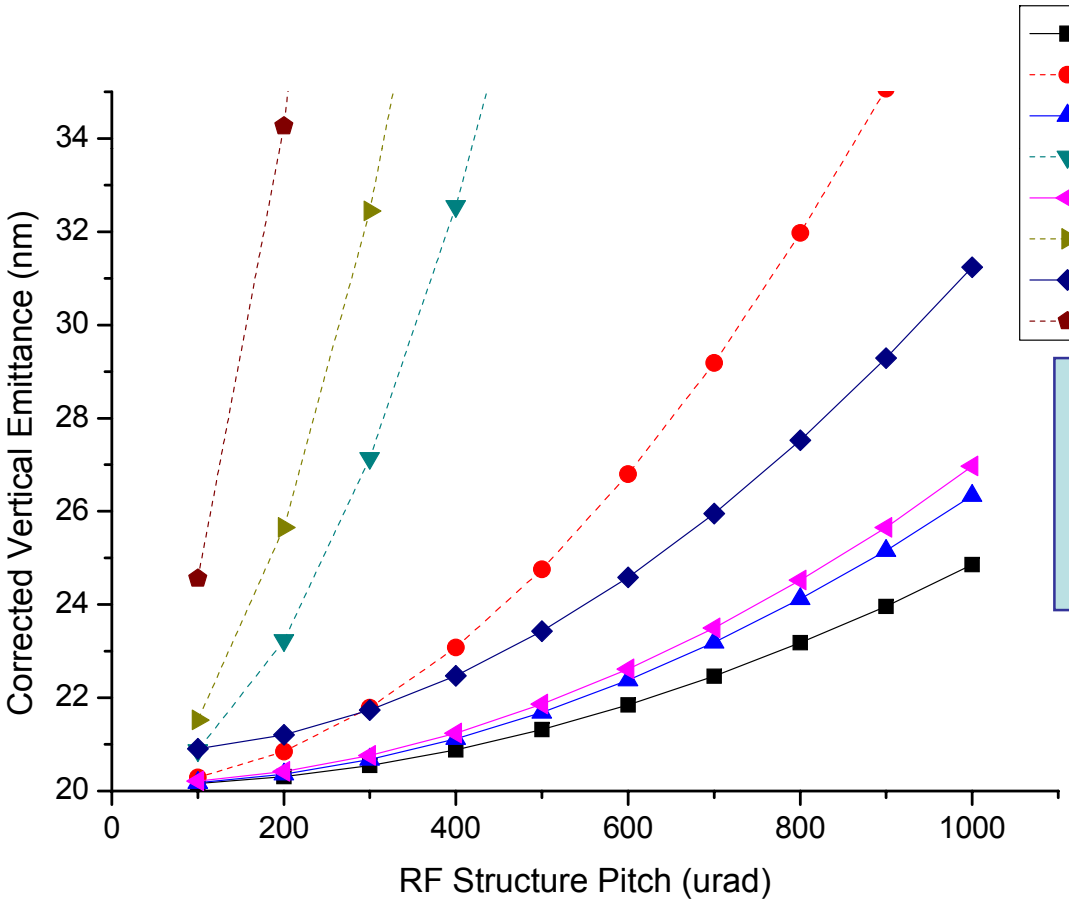
- In the following the gradient is all the time -20%, and the initial beam energy is 0% or -20%; Various weight have been looked at.

Results from Merlin



Pitch Error

- Close-up from previous slide:



IB (Initial Beam Energy):

Dash → IB=0%

Plain → IB=-20%

The use of a 2nd test beam with an initial decreased energy allows here to be less sensitive to RF structure pitch errors

→ This can explain the difference between KK results and K. Rajan results (*)

(*) Though a clear understanding of the various algorithm used for DFS would further help to know where might be other differences