# DFS Studies on the Main Linac with Rnd-walk-like motion

LET Beam Dynamics Workshop

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# Dynamic Impact of Global Correction

- Pac07 paper (Eurotev-report-2007-020):
  - On tolerances

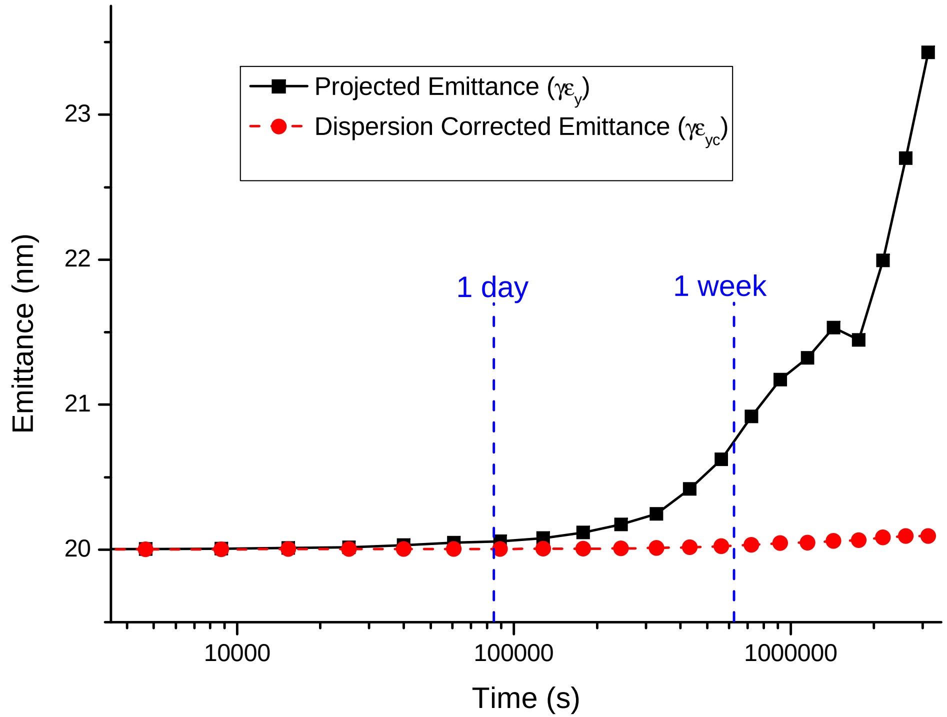
Shown:

results of ATL ground motion after time T

Within this model, the girders (support of cryomod.) are vertically moved.

*A* was chosen to be 4×10-18 m.s-1. At every point a perfect one-to-one steering correction was applied to the model and the BPM resolution was set to a perfect resolution (0 mm).

The linac is straight and wakefields are included.



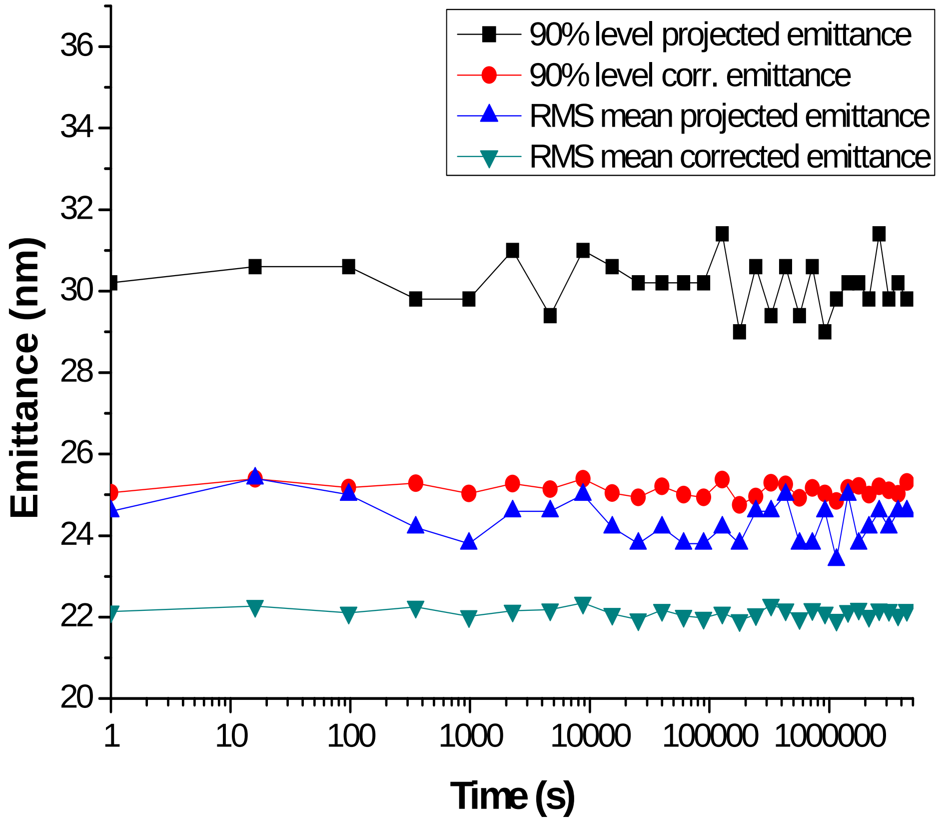

Global correction → increase the long-term stability of the emittance with diffusive ground motion



Correction throughout this study: Energy correlation numerically removed

# DFS after ATL

- **Start with a misaligned linac**
  - Std errors on elements
  - 100 Rnd Seeds
- **Apply DFS (DMS**)**
  - Weight fixed
  - Energy modification strategy:
    - -20% gradient
    - -20% initial beam
  - Segmentation (40 quad, 20 overlap)
  - Final ( energy corrected*) mean Emittance = ~22 nm
- **Apply random walk** (ATL) A=4 10^-18 m/s
- Then **apply DMS algorythm**
  - Found that the time scale over which the DMS was applied do give good results: DMS works. (energy correlation removed).
- *This is probably because the additional errors are small compared to the initial uncorrelated random errors:*
  - *Betatron wavelength sets the scale* $\lambda_\beta$ ~ 200m:
  - $\sigma^2 \sim (4\times10^{-18})\times10^6\times200 \Rightarrow \sigma \sim 28\ \mu m$




Emittance value stable over studied time scale.

*Correction throughout this study: Energy correlation numerically removed

**DMS: Dispersion Matched Steering (as dealing with a curved beamline)

# Rnd-walk-like correlation

- Apply random misalignment with a random-walk-like correlation, where the variance of the differential offset between two adjacent points is proportional to the distance between them:

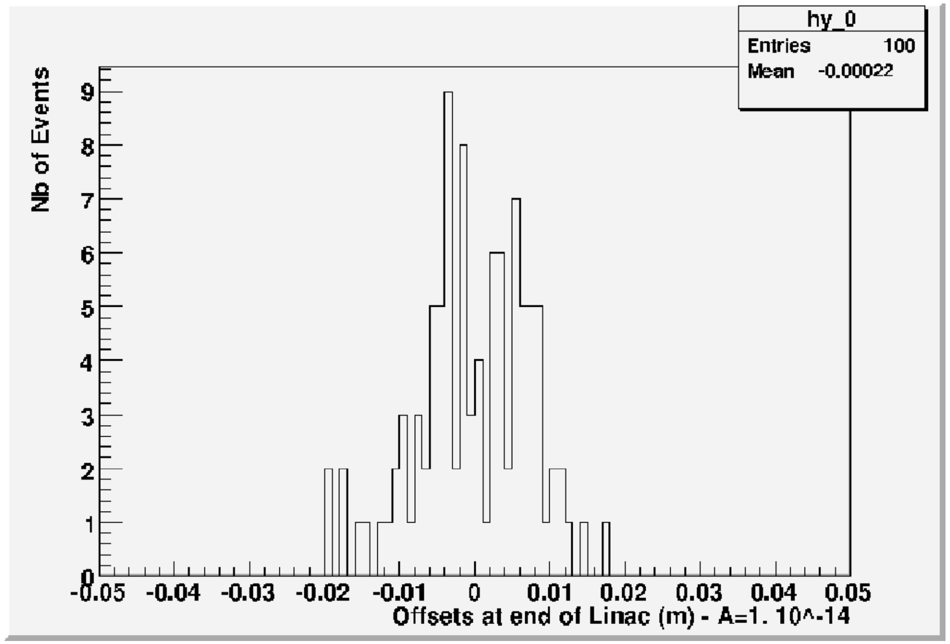
$$\sigma^2 = C\,L$$

  - In order to achieve a total of a ~1cm RMS offset at the end of the linac, we have
    $C$ = 1 cm$^2$ / 10 km ~ 10$^{-8}$ m

- Strategy is as follow:
  - Misaligned elements (std errors)
  - Apply rnd walk
  - Apply DMS

- Check out the final emittance at the end of linac.

Offset at the end of linac (100 seeds):




RMS= 7.6 mm at end of linac

C= 6 10^-9 m.

# Rnd-walk-like Result

Mean Vertical Emittance (100 seeds)

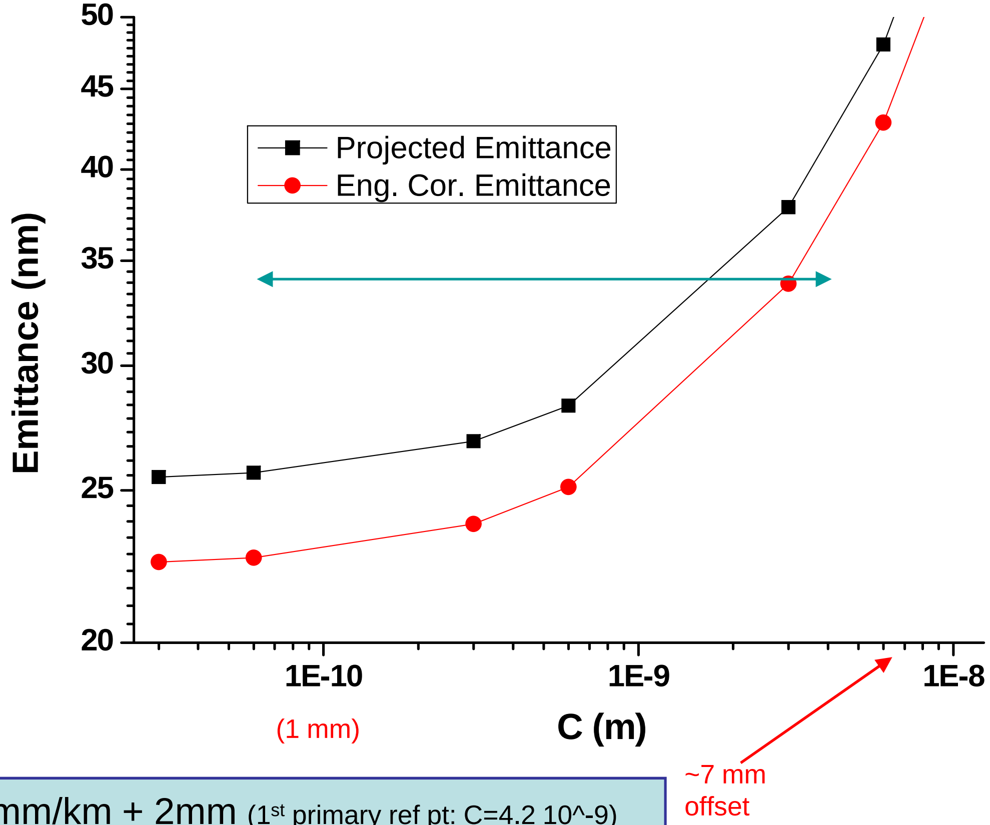
Curved machine, with wakefields.

Misalignment errors has been applied prior to this study

Apply CL model

Apply DMS

Fixed weight Wdiff=40




*From M.Schloesser (DESY) → 0.5mm/km + 2mm (1st primary ref pt: C=4.2 10^-9)

*From C.Adolphsen (wiki) → 2mm/km global (but old value), C= 4 10^-9m

*From RDR (ML p.234, 1sigma tolerance) → 200 um/200m, C= 2 10^-10m

***From ILC/GDE meeting at DESY → 200 um / 600m, C= 6.7 10^-11 m**

Present discussion between the metrology people and the physics accelerator group.

# Impact of Wakes

- Tesla wakefield in use here.
- C=3.10^-8 m (High value)
- Mean corrected Emittance w/wo wakes:

$$\langle \varepsilon_{yc} \rangle_{with\ wake} = \sim 99 \quad nm$$

$$\langle \varepsilon_{yc} \rangle_{no\ wake} = \sim 22 \quad nm$$

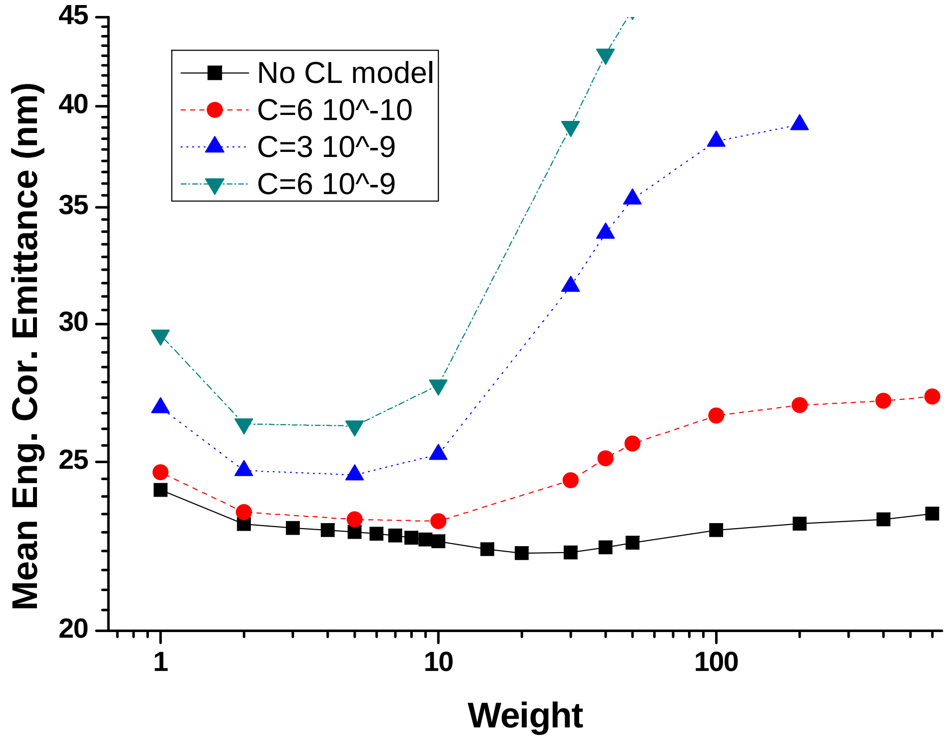
The main reason of the emittance increase is coming from the wakefield (note: cavities are moved away of the curved beamline)

# Weight Effect

DMS optimisation depends on constrains:

$$\chi^2 = \frac{\Delta y(\delta).\Delta y(\delta)}{W^2_{\mathrm{diff}}} + \frac{y(0).y(0)}{W^2_{abs}}$$

- Weight Effect
  - In previous studies W_diff=40
  - Used in benchmarking,
  - Found to be in a stable region to minimize the final emittance.

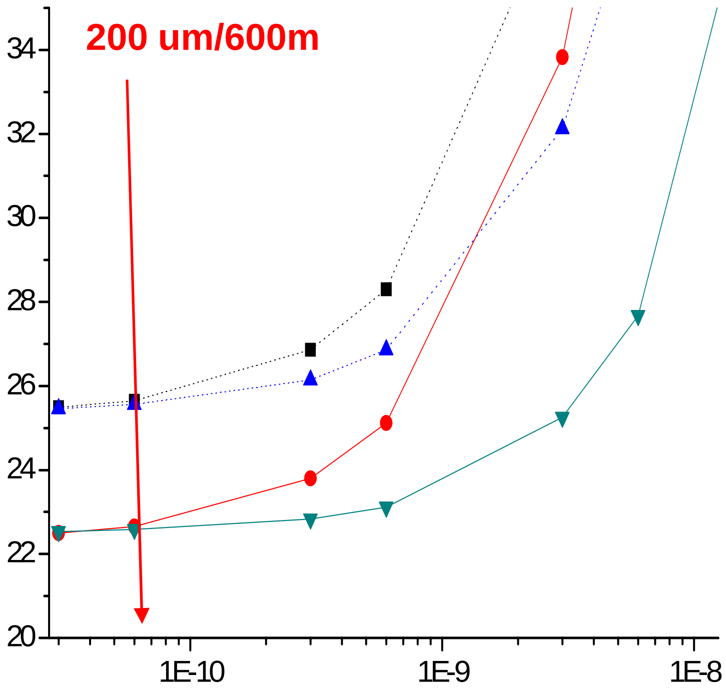


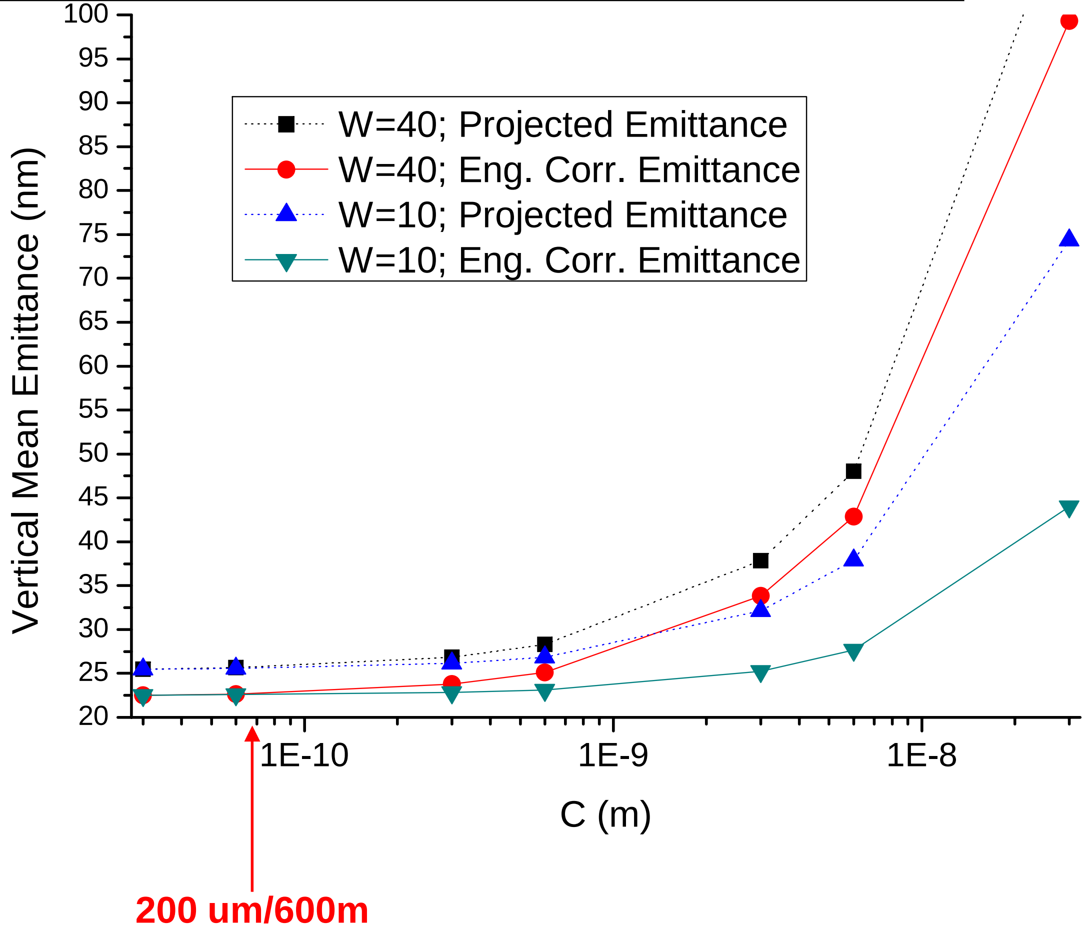

Region of stability of W_diff is reduced

BPM resolution=5um (no scale error)

# Weight Effect (2)

- Choice of 2 different weight:
  - Wdiff = 40
  - Wdiff = 10



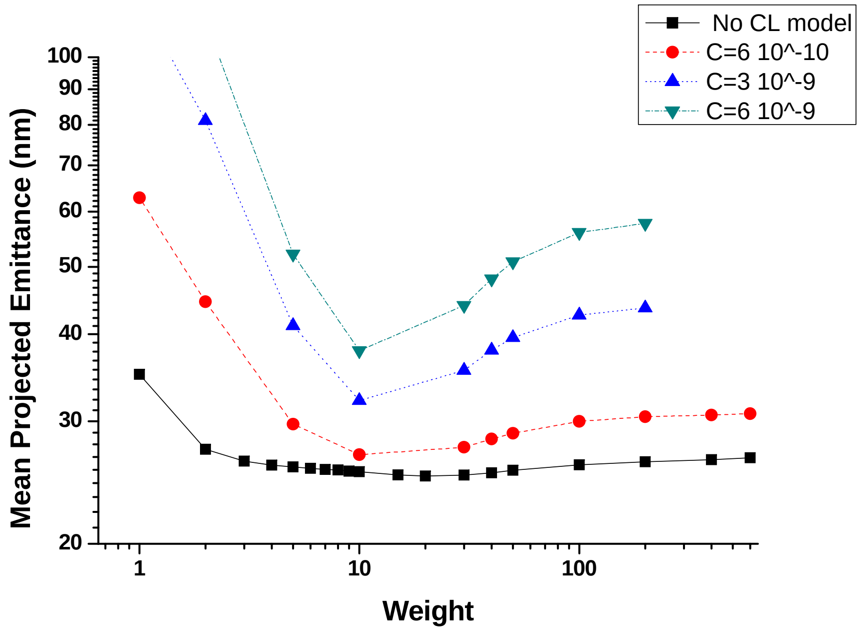

**•A smaller weight here helps to keep the emittance growth lower wrt to C.**

# Conclusion

- Conclusion
  - With the simple CL model, 200um/600m no significant impact on the corrected emittance.
  - Though the impact of a random-walk-like correlation could be non negligible if alignment was worse. The results are highly dependent on the values of the alignments (need to be precise on what we mean)
  - Here the choice of a wrong weight for the DMS could make things worse (scanning the weight would resolve the problem).
- More work (refinement):
  - Rnd-walk-like CL model too simple?
  - Binning effect? Iterations?

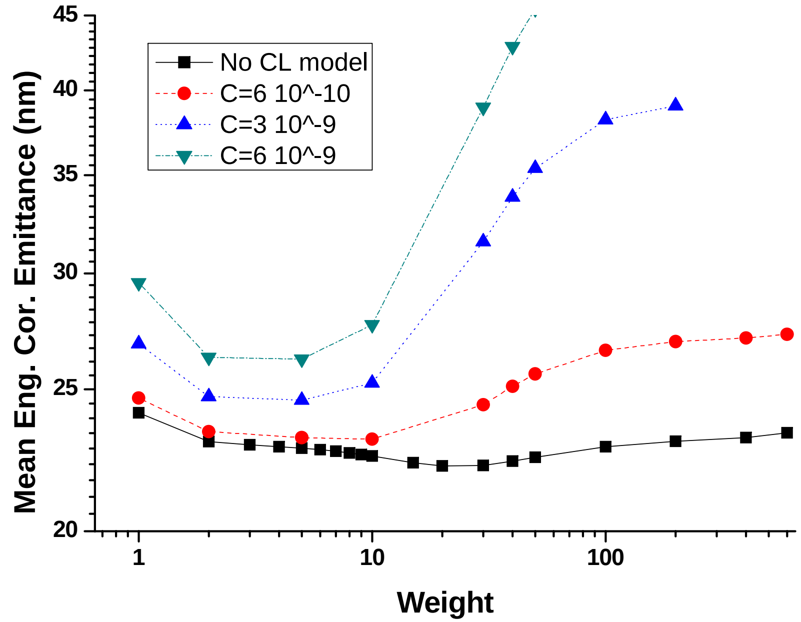
- Additional slides

## Projected Emittance




- Ey_mini (no CL model) =25.0 nm at W=20
- Ey_mini (C=610^-9m) = 37.9 nm at W=10

## Emittance with energy correlation numerically removed




- Eyc_mini (no CL model) =22.2 nm at W=20
- Eyc_mini (C=610^-9m) = 26.2 nm at W=5

# Offset along the linac