CLIC bump performance in dynamic environment

P. Eliasson and D. Schulte

CLIC meeting
February 7, 2006

Introduction

- Previous simulations have shown that tuning bumps as a complement to beam-based alignment efficiently reduces emittance growth by static imperfections.
- Dynamic effects, such as ground motion, that can only be corrected by feedbacks make things more complicated.

- Interaction between bumps and feedbacks has to be studied.

- The influence of dynamic imperfections on the static correction using bumps should also be investigated.

- First simulations seem promising.

Prealignment

- 100 machines created using Placet. All results are averages over these 100 machines.
  - Elements are initially scattered according to a normal distribution.
  - Ballistic alignment is applied and accelerating structures aligned.
- Average beam-laser luminosity after ballistic alignment is $0.648 \cdot L_0$.

Element	σ
Quads	50 μm
Acc. struct.	10 μm
Acc. struct. realign.	10 μm
Acc. struct. vert. angle	10 μ
Bpms	10 μm

Emittance/luminosity tuning bumps

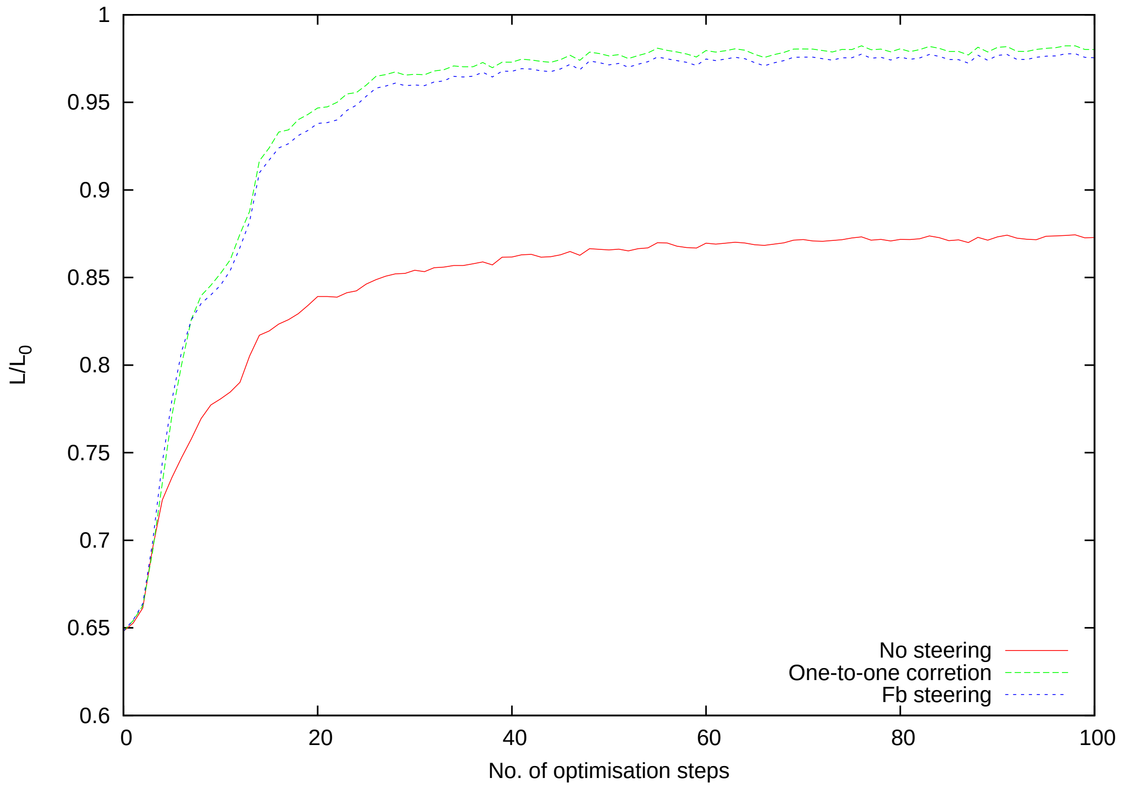
- During the following simulations 5 tuning bumps were used.
- Consist of two accelerating structures that can be moved transversally. Separated by 72° phase advance.
- Positioned close to focusing quadrupoles (where β_y is high and the effective wakefield kick is strong).
- After each bump the beam is steered back to the reference trajectory.
- Wide laserwire to evaluate the effect of the structure offsets.

Trajectory feedbacks

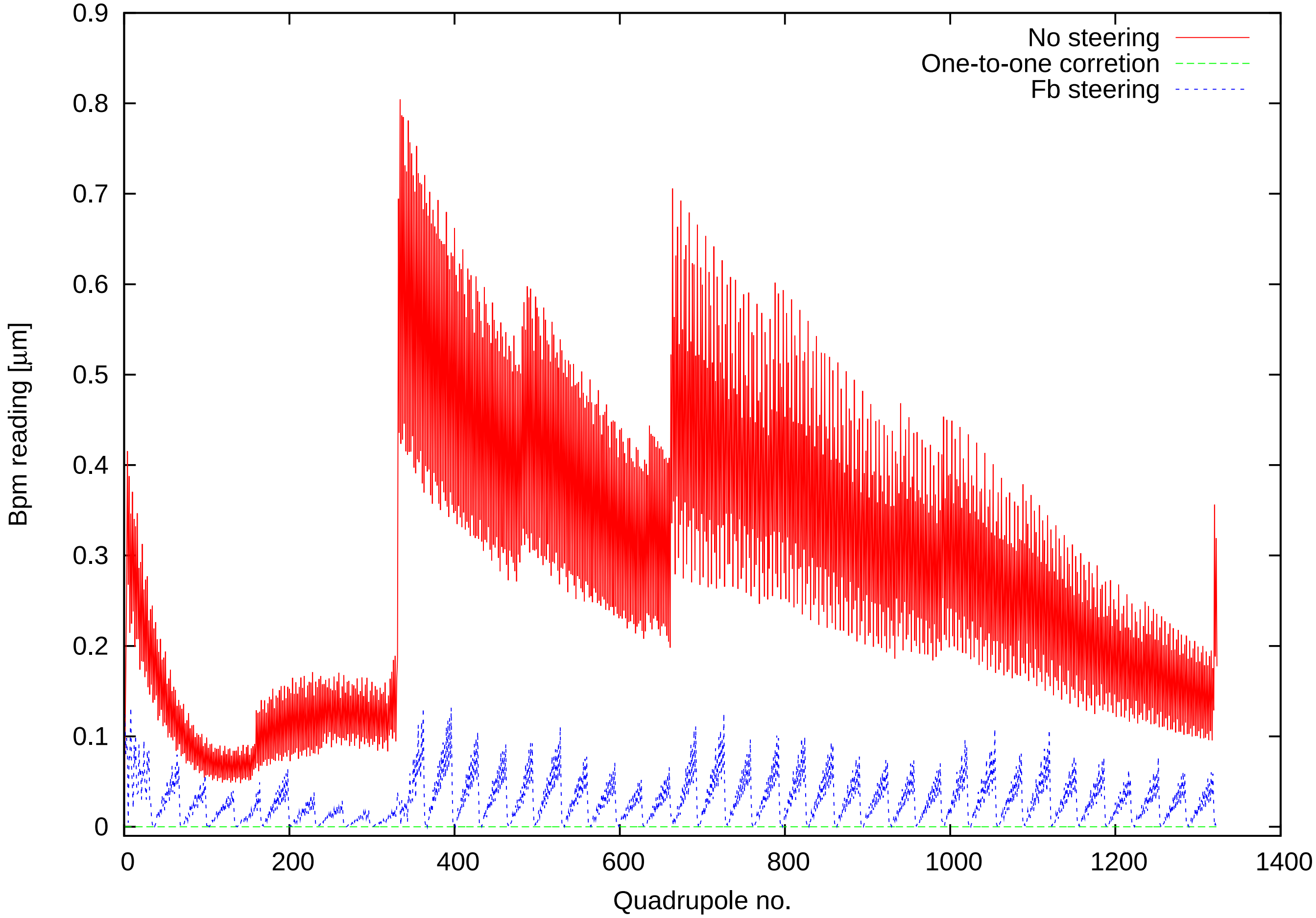
- During the following simulations 40 feedbacks along the linacs were used.
- Each feedback consists of two focusing quadrupoles and three bpms (in front of the second quad and the two next foc. quads).
- Response of quad offsets on the bpm readings calculated.
- The feedbacks locally (in the bpms) resteer the beam back to the reference orbit. A certain gain (here 0.02) is used to only partly correct the trajectory.
- In the following simulations the feedbacks are also used to automatically steer the beam back after the quadrupole movements. For this purpose a response matrix is set up to reflect the response of bump tuning on the bpms.

Bump tuning without dynamic imperfections

- Comparison of no steering back after knob turn to steering back using one-to-one correction and steering back with the feedbacks and the cavity-to-bpm response matrix.
- The use of the feedbacks works just as well as the one-to-one correction and is much faster. Perfect knowledge of the matrix values assumed though.

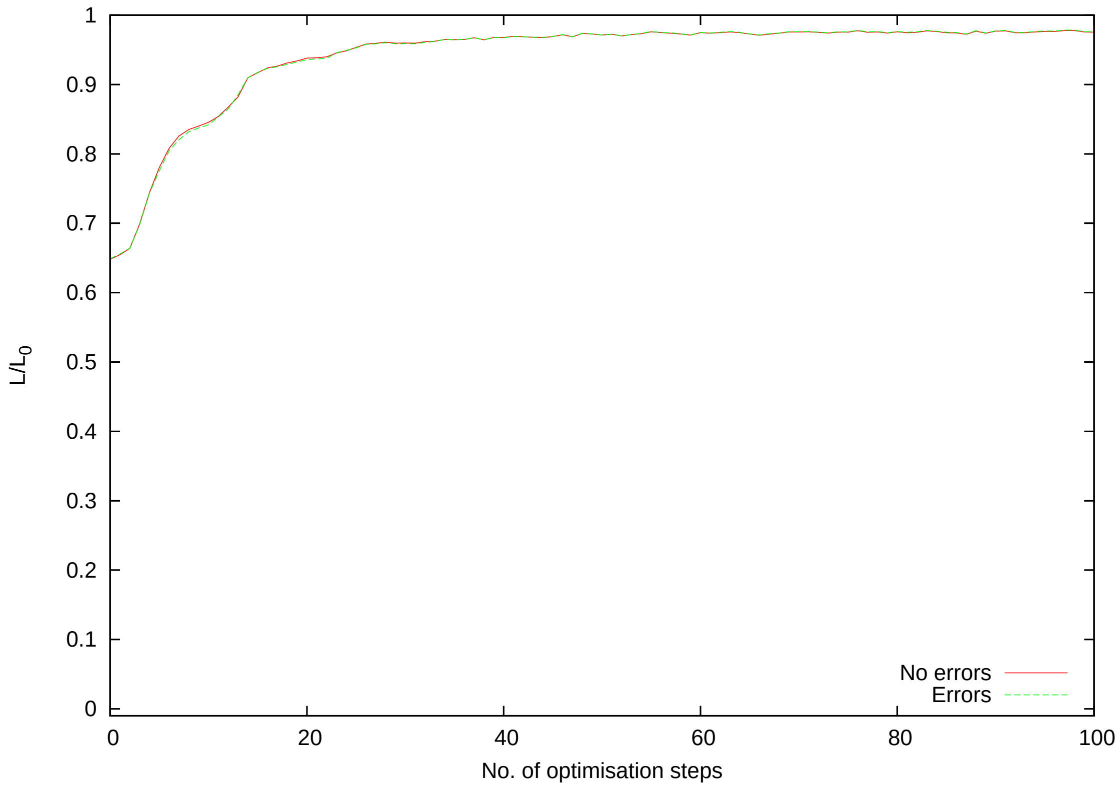


Bpm readings along the linac



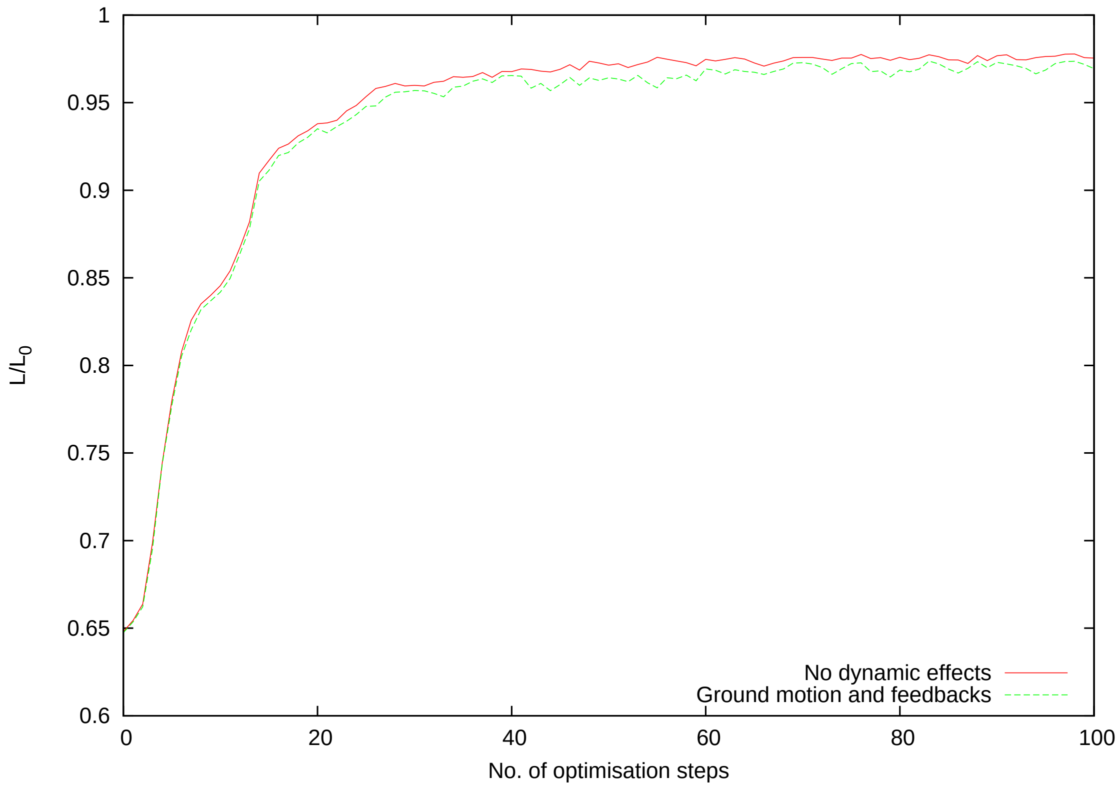
Effect of errors in the cavity-to bpm response

- Noise in the response matrix simply added assuming that the response matrix elements were determined with bpms with a resolution of $0.1\mu m$.



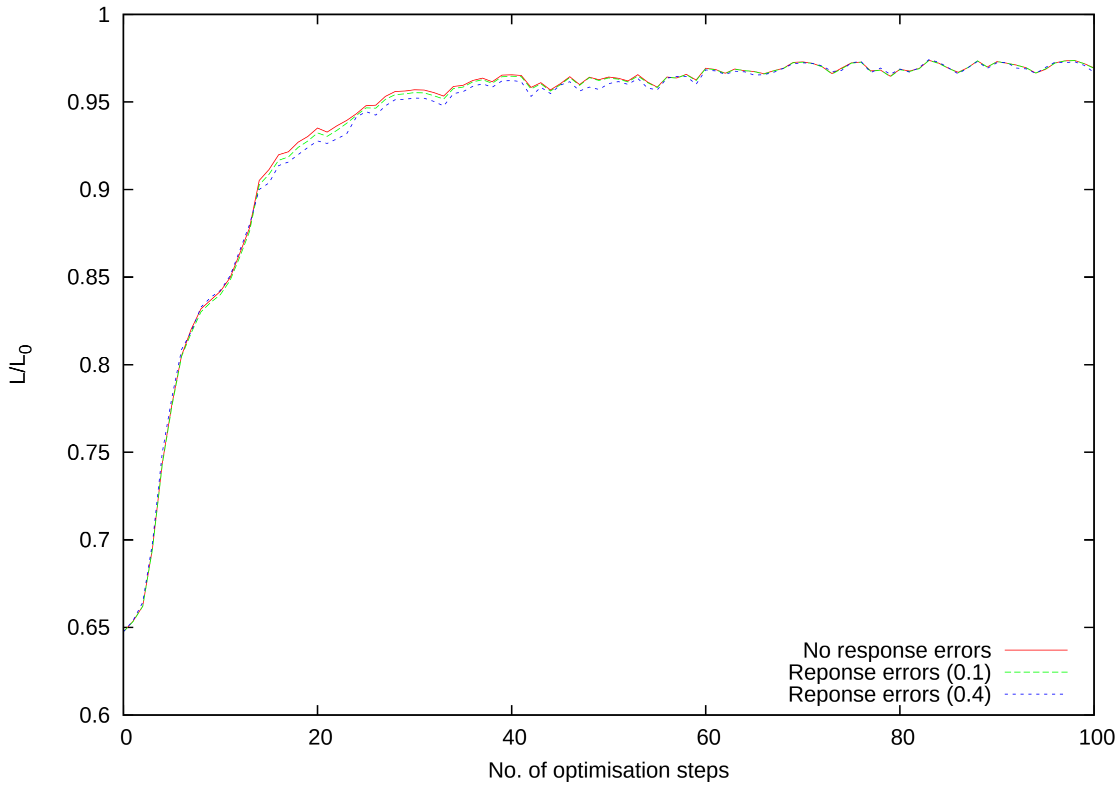
Tuning bumps and feedback corrected ground motion

- Ground motion according to the ATL law simulated. Assuming 0.05s between feedback corrections. Feedback gain 0.02. Bpm resolution 0.1μm.



Bpm resolution and errors in the cavity-to-bpm response

- Perfect measurement of response matrix elements compared to errors due to $0.1\mu m$ and $0.4\mu m$ bpms.



Conclusions

- Just a start, but seems to work well. Bpm resolutions and groundmotion effects are too optimistic though.
- Tolerances should be determined.
- Response matrix errors has to be studied in more detail.