# An update on main linac tuning bumps

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# Introduction

- As previously shown, both for ILC (Tesla lattice) and CLIC, tuning bumps work very well as a complement to beam-based alignment.
- A study of the robustness of the bumps has now been carried out.
- The bump performance has also been studied for the new ILC lattice (32-cavity quadrupole spacing, 75° and 60° FODO-cell phase advance).

  \- In this case the bump tuning has been simulated both in combination with DFS and with 1to1-correction respectively.
- Initial studies for CLIC indicate that the bumps will work well in a dynamic environment.

# Emittance/luminosity tuning bumps

- For ILC two different kinds of bumps have been used.
- The effect of the tuning is evaluated with two laserwires at the end of the linac (see next slide).

## Dispersion bump (ILC)

- Two knobs adjust offset and angle dispersion independently.
- No realistic implementation, particle coordinates are simply adjusted to emulate a dispersion change.

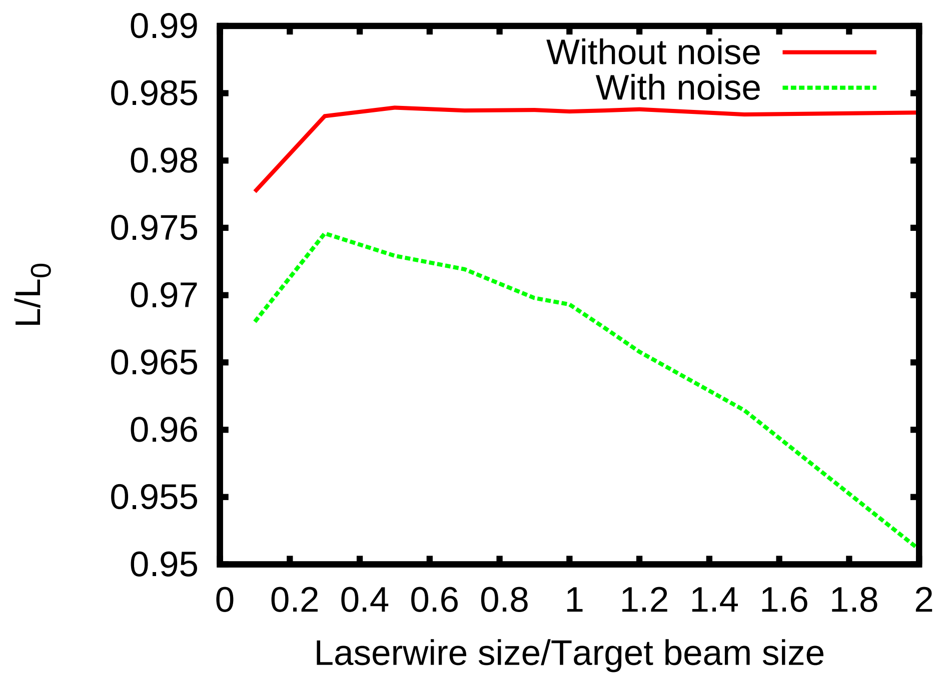
## Dispersive wakefield bump (ILC)

- Two pairs of quadrupoles used. Separated by a phase advance of $60^\circ$.
- Quadrupoles of a pair separated by $360^\circ$. First quad kicks beam out of its ideal orbit and second kicks it back.

# Wide laserwires for emittance/luminosity measurement

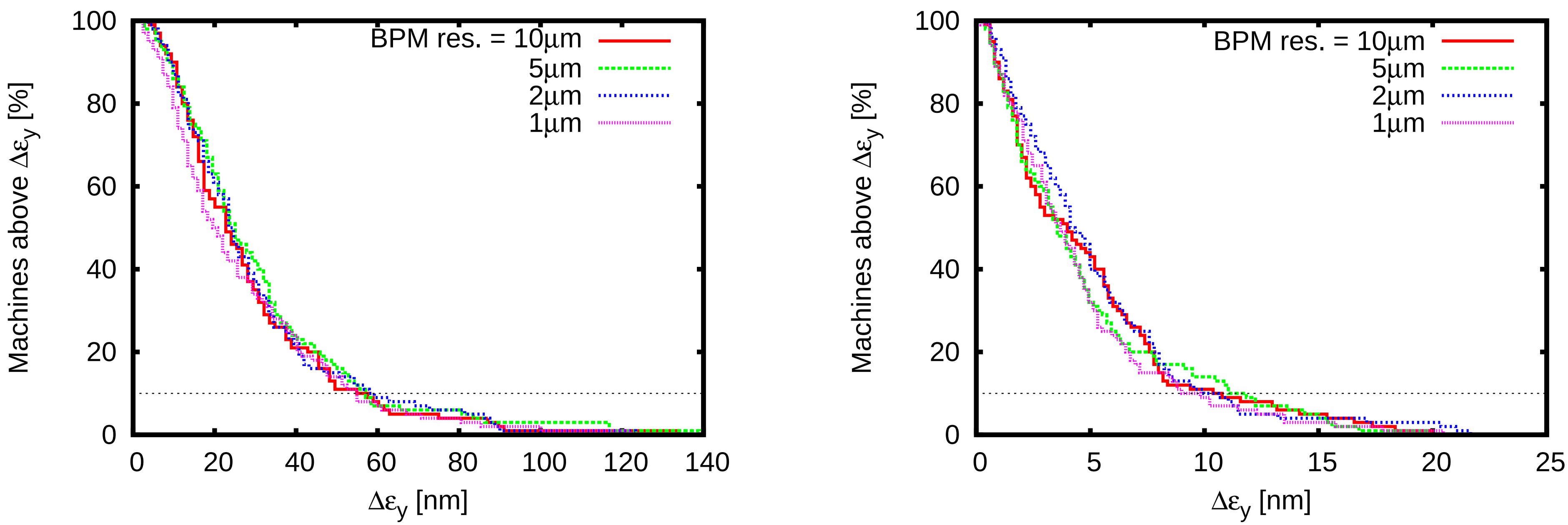
- Two laserwires used to emulate collision with a perfect beam.

- Laserwires have a gaussian transverse profile with a size representing the target beam.
- Laserwires are separated by a betatron phase advance of 90° to measure on both phases.
- Exact laserwire size is not important.



# A remark on DFS bpm resolution

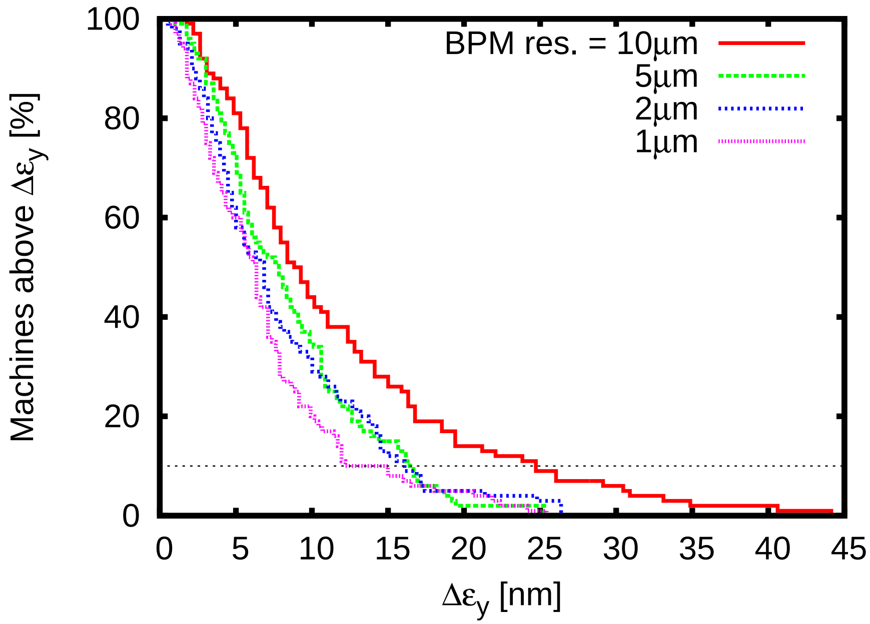
- Initial misalignments according to TRC model.
- Left: After DFS, Right: After DFS and tuning of two dispersion bumps.
- Energy differences of the DFS test beams created by gradient changes. 4 different BPM resolutions. Resolution seems to be unimportant for the emittance.

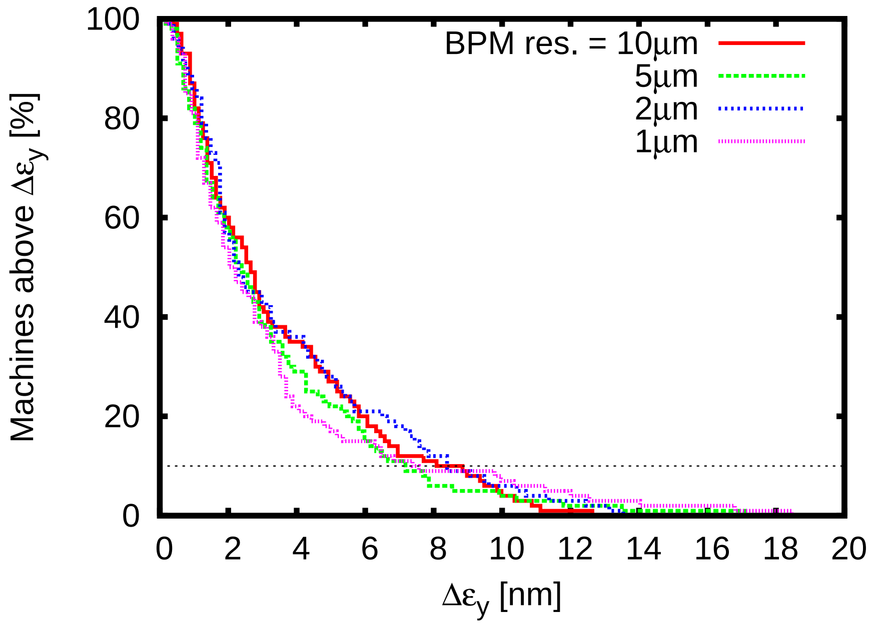



P. Eliasson, D. Schulte, *Dispersion Free Steering and Emittance Tuning Bumps in the ILC Linac*, EUROTeV-Report-2005-021-1

# A remark on DFS bpm resolution (cont.)

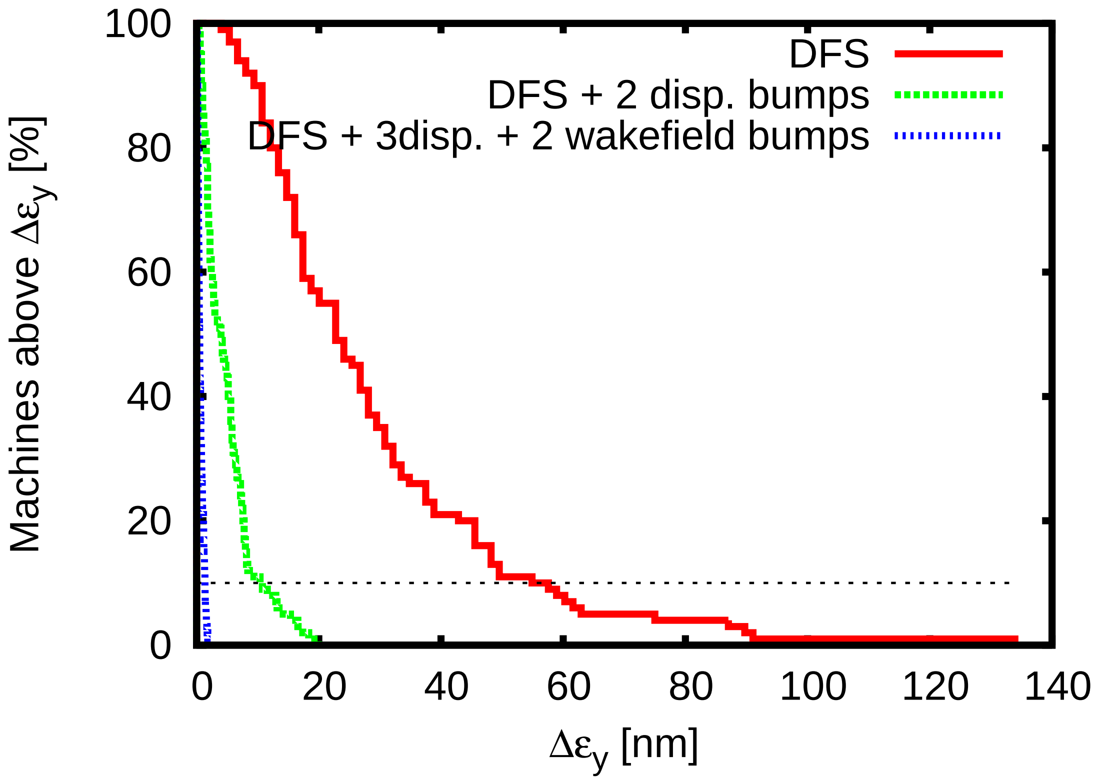
- Left: After DFS, Right: After DFS and tuning of two dispersion bumps.
- Assuming that DFS test beams have different energies already at entrance of main linac. Before bump tuning their is a certain difference for different resolutions. The difference is negligible when bumps have been tuned.



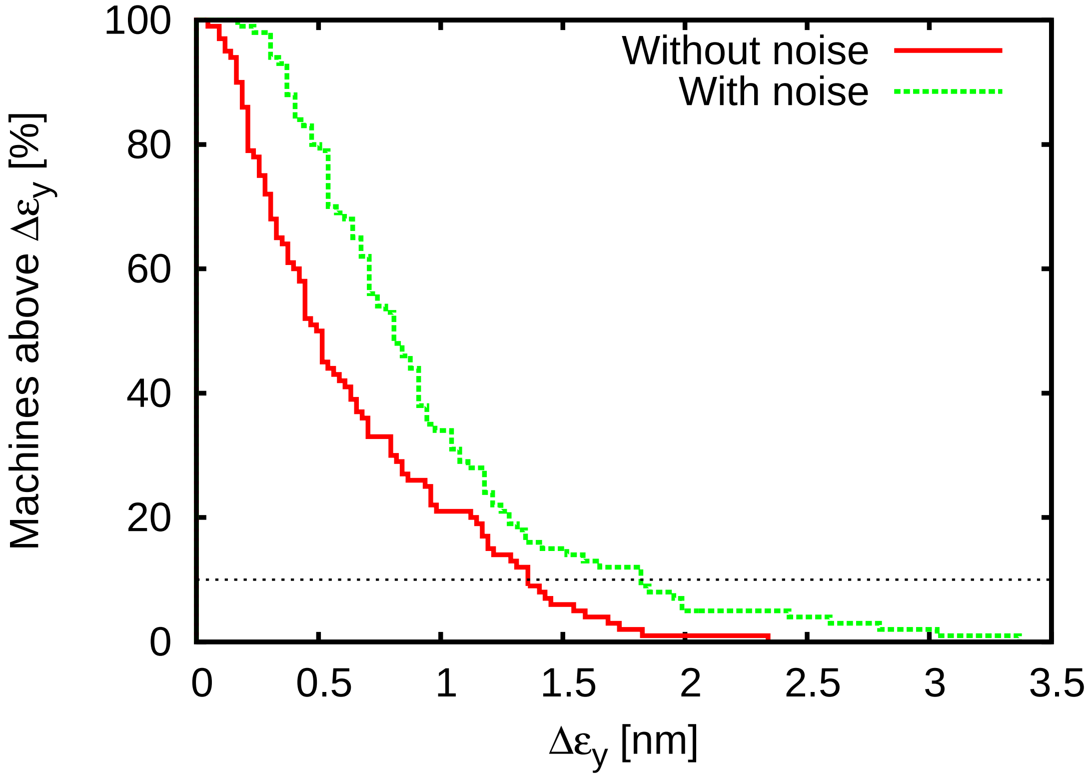
# Performance of the tuning bumps

- Comparison of the performance of DFS only to the performance of DFS complemented by 2 dispersion or 3 dispersion and 2 wakefield bumps.
- BPM resolution: $10\mu m$. Test beam energy differences by gradient changes.



# Robustness of tuning bumps

- Emittance histogram for simulations with and without noise (3%) in laserwire measurements.

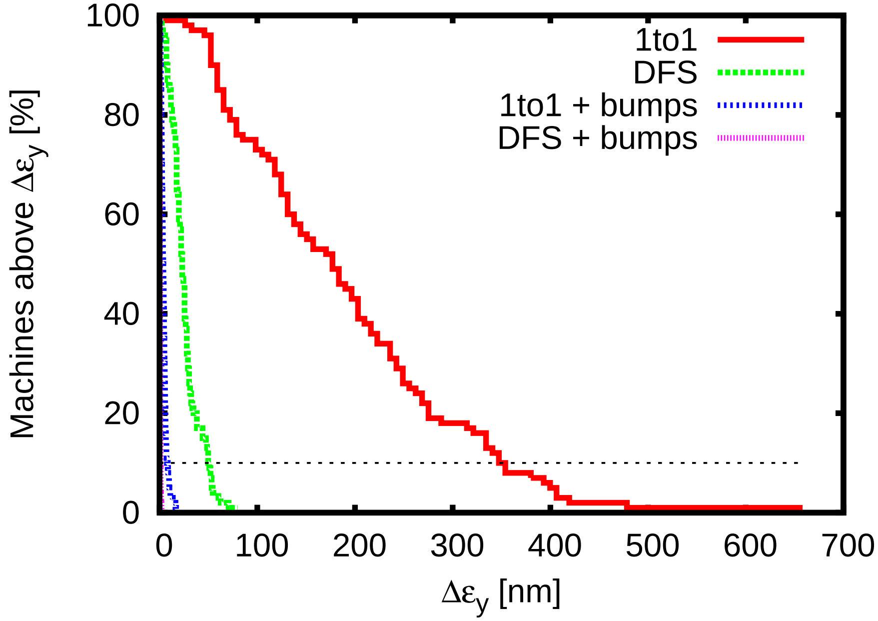


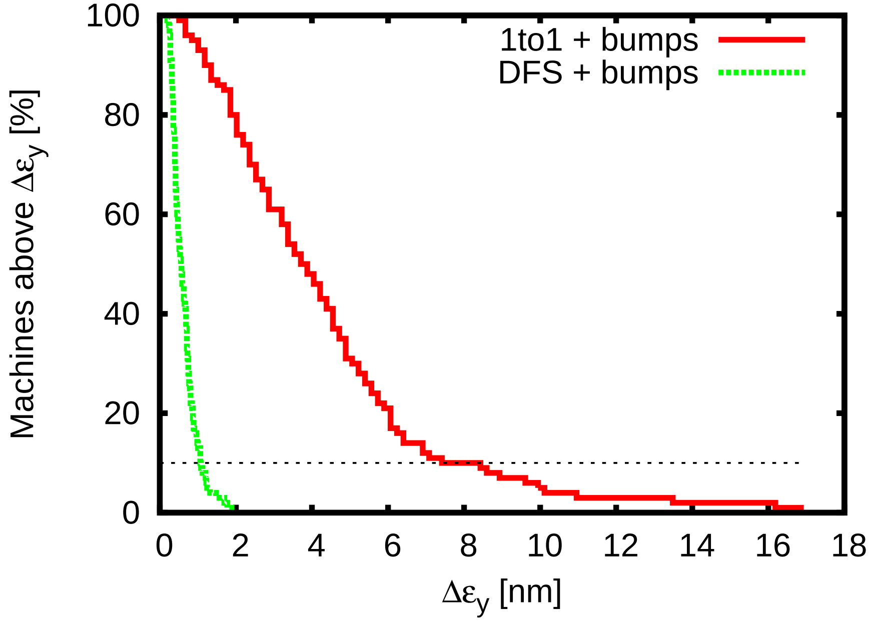

- Tolerance of final machine state to different noise sources. Initially $\epsilon = 20.63$ nm.

| Noise source | RMS noise | $\langle\epsilon\rangle$ | $\langle$Proj. $\epsilon\rangle$ |
|---|---|---|---|
| beam jitter | $0.222\sigma_y$ | 20.87 | 21.63 |
| bunch charge | 10% | 20.67 | 20.73 |
| gradient | 0.0734% | 20.70 | 21.63 |
| bunch length | 10% | 20.66 | 20.67 |
| phase | $0.378°$ | 20.68 | 21.63 |

# Simulations of new ILC lattice

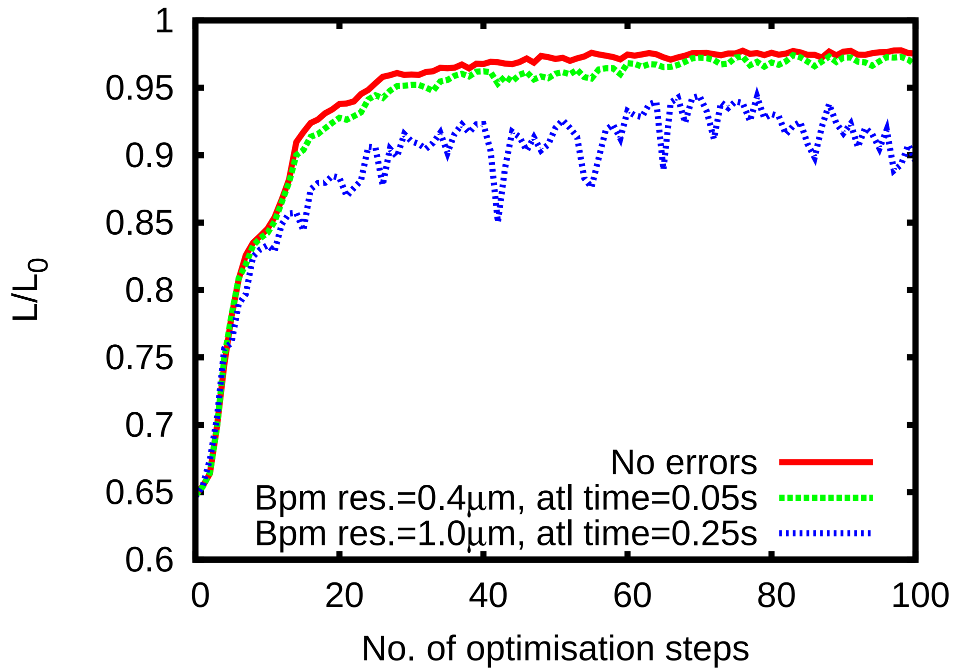
- Simulations performed using new ILC lattice with 32-cavity quadrupole spacing and 75°, 60° phase advance.
- BPM resolution: $10\mu m$. Test beam energy differences by gradient changes. 3% noise in laserwire measurements.
- Even when only 1to1-correction and bump tuning is used the final emittance growth is less than 8nm in 90% of all cases.



# CLIC bump studies in dynamical environment

- Ground motion according to ATL-law. 40 feedbacks, each consisting of two quadrupoles and three bpms. Feedback gain=0.02.
- 5 wakefield bumps each implemented as offsets of two acc. structures.
- Response matrix between acc. structures and bpms calculated. Information used to steer beam back to ref. trajectory after each bump adjustment.
- Bpm resolution enters both for feedback corrections and for the reponse matrix calculation.



# Conclusions

- Using dispersion and wakefield bumps as a complement to DFS reduced the emittance from unacceptable to acceptable levels.
- The bpm resolution does not seem to be of importance when both DFS and bumps are used.
- Studies show that noise in the "luminosity" measurement increases the final emittance slightly, but final emittance is still very low.
- For the final states of the machines, tolerance levels to different noise sources were calculated with good results.
- For the new ILC lattice the results are very good and simulations also show that good results can be obtained using only 1to1-correction followed by bump tuning.
- Initial studies of wakefield bumps for CLIC in a dynamic environment (incl. ground motion) indicate that bump tuning will also work under these circumstances. Similar studies will be carried out for ILC.