Update on beam-beam tuning

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Introduction

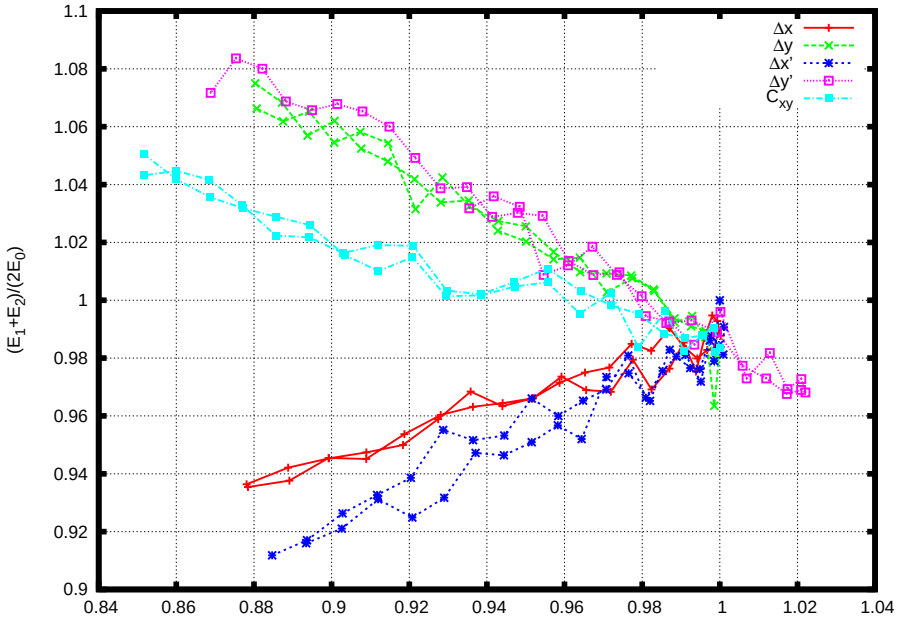
- Beam parameters at the IP (offset, angle, waist, etc) can be tuned to optimise luminosity.
- Fast tuning signal needed. Best would be luminosity. Here the use of beamstrahlung has been studied.
- For CLIC the sensitivity to noise in the tuning signal has been investigated.

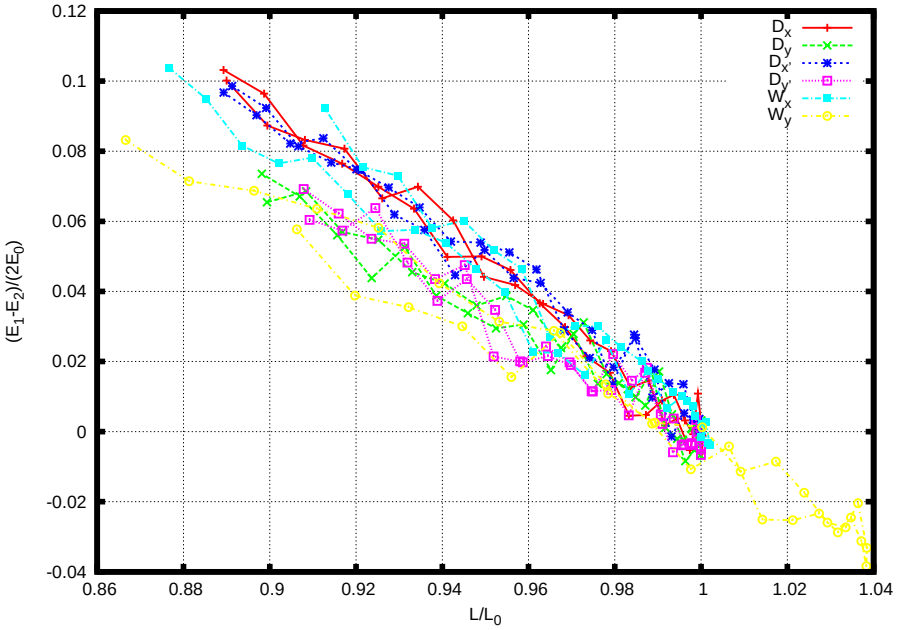
ILC simulations

- Electron and positron beams consisting of 50000 were used. No correlated energy spread.
- Guineapig used to simulate collisions.
- Luminosity and beamstrahlung energy losses calculated.
- For these initial studies (without realistic knobs) a program was used to manipulate coordinates of the beam before collision, thereby emulating knob tuning.

Luminosity vs beamstrahlung energy

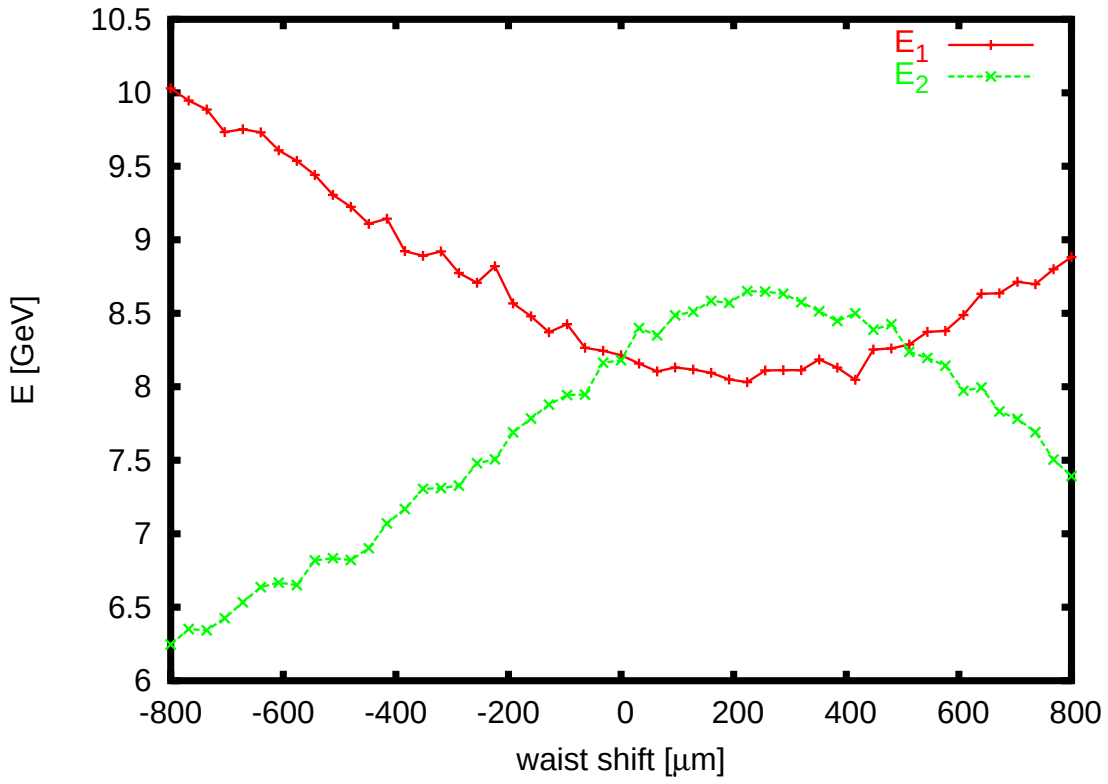
- Parameter scans performed to study correlation between luminosity and beamstrahlung energy losses.
- Beamstrahlung gives a signal with quite good resolution.





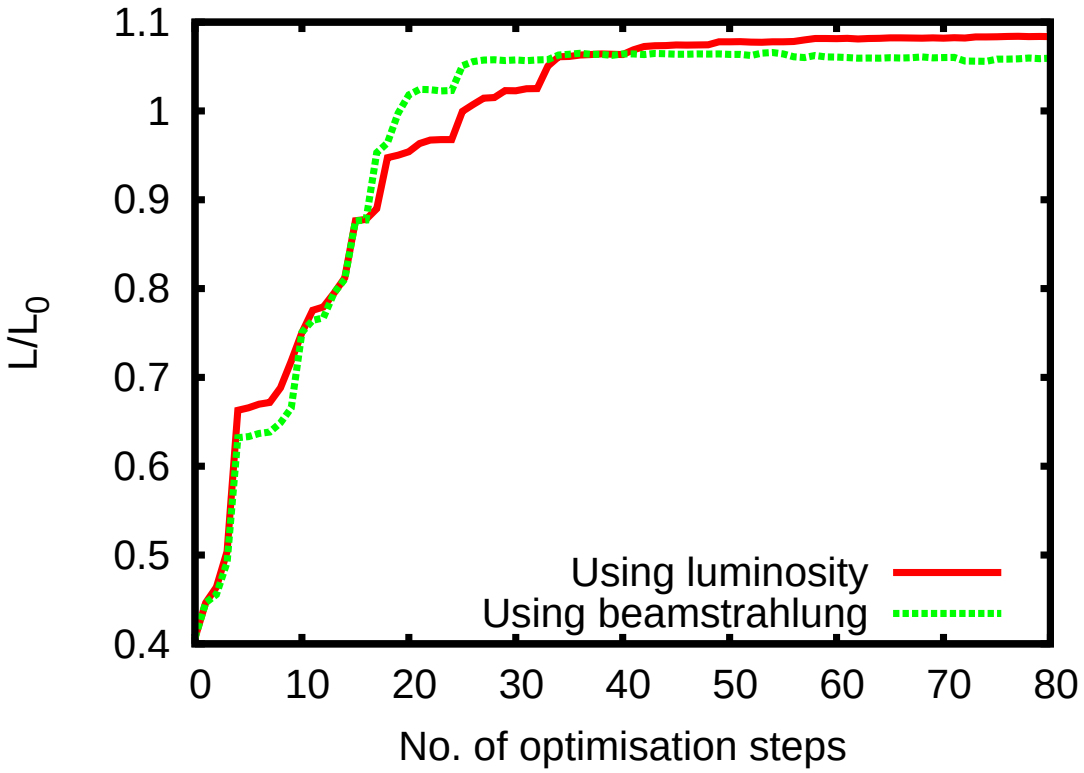
Waist scan

- Difference of beamstrahlung energy loss should be maximised/minmised



Parameter optimisation (luminosity vs beamstrahlung signal)

- Initially all parameters (but coupling) were randomly changed to each give a luminosity decrease of the order of 10%. Parameters were then tuned one by one.
- Parameter optimisation gives almost the same results for each of the two signals.
- In both cases final luminosity is even higher than the nominal one.

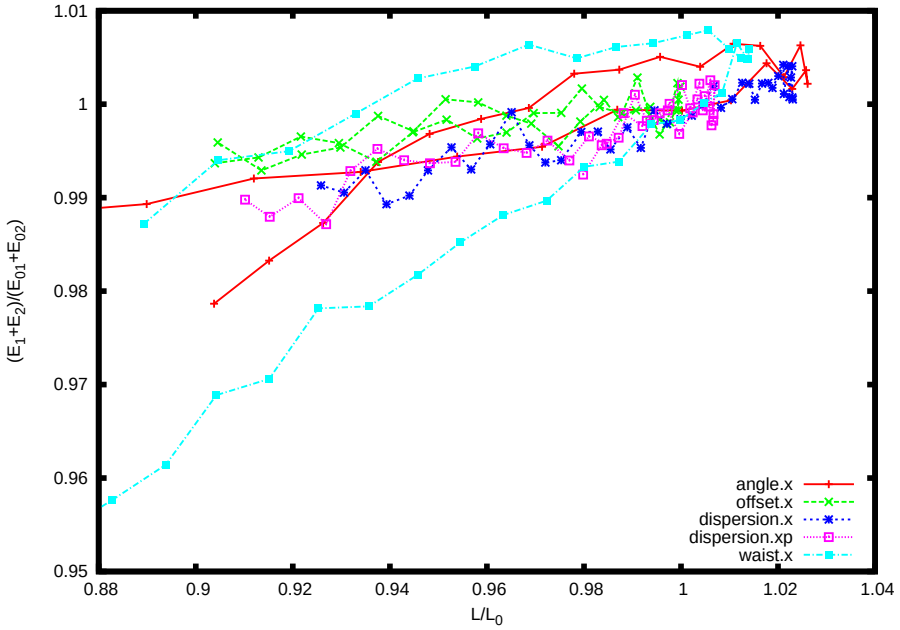


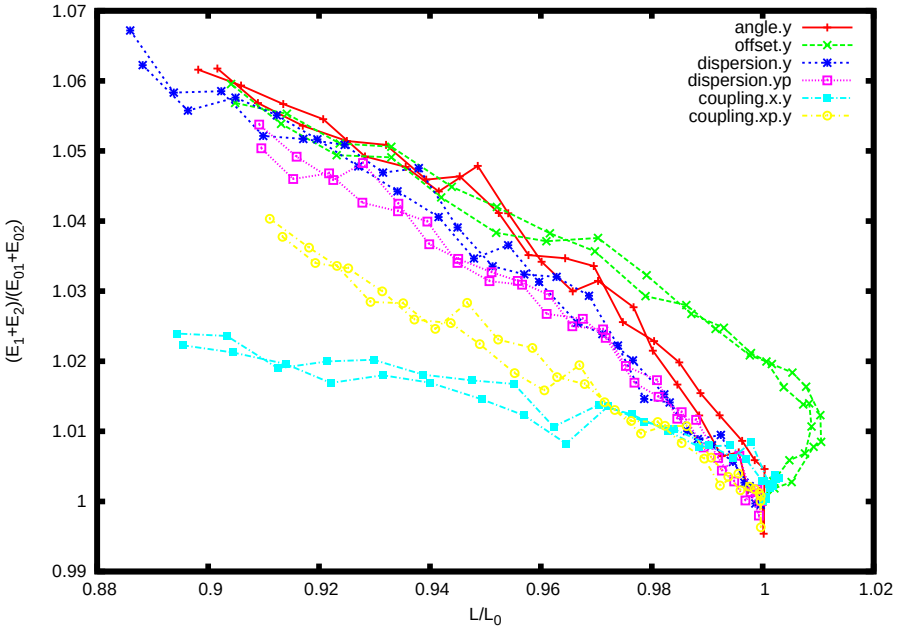
CLIC simulations

- 50000 particles tracked (using Placet) through main linac and BDS system to create an electron and a positron beam. More realistic beams. In this case also correlated energy spread.
- Guineapig used to simulate collisions. Every collision simulated 5 times for statistics.
- Luminosity and beamstrahlung energy losses computed. computed.
- As for ILC the knobs were emulated by manipulation of the particles coordinates directly.

Luminosity vs beamstrahlung energy losses

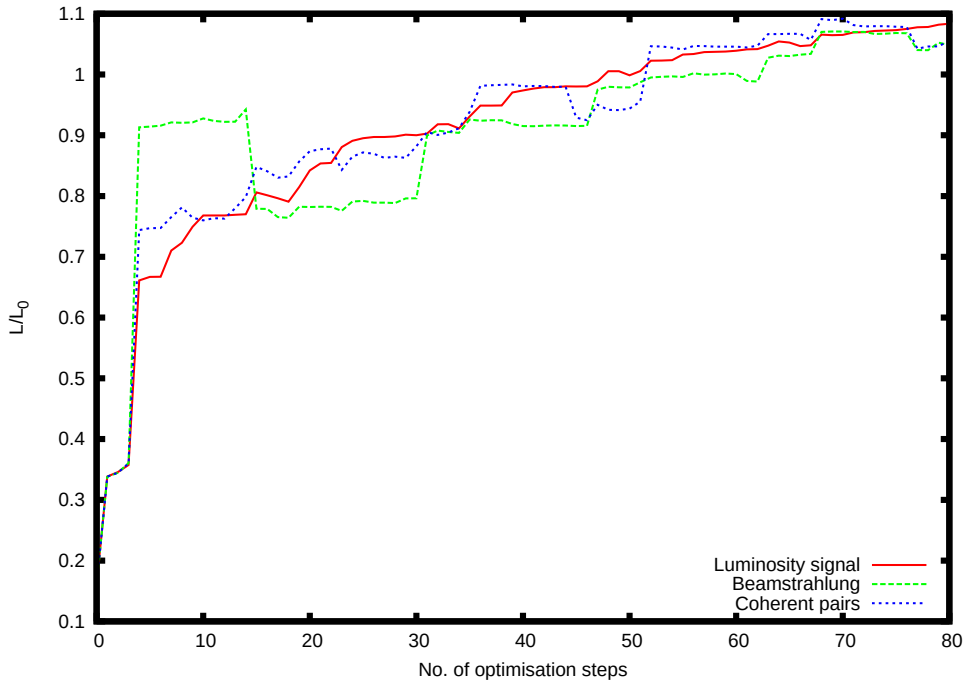
- Scans performed to study correlation between luminosity and beamstrahlung energy losses.
- Horizontal parameters might be difficult to tune (bad resolution).
- Better resolution for vertical parameters (except for coupling).





Parameter optimisation using the three different signals

- During first studies no noise was taken into account apart from what is caused by the limited number of macroparticles.
- All the signals give more or less the same result. The optimisation using luminosity is the most stable though.
- In all cases the tuning leads to a final luminosity higher than the nominal one.



Noise levels in the signals

- Since all collisions are performed five times the noise in the different signals could be approximately determined.
- Almost no noise in luminosity signal. Coherent pairs signal very noisy.

- Luminosity: $< 0.1\%$

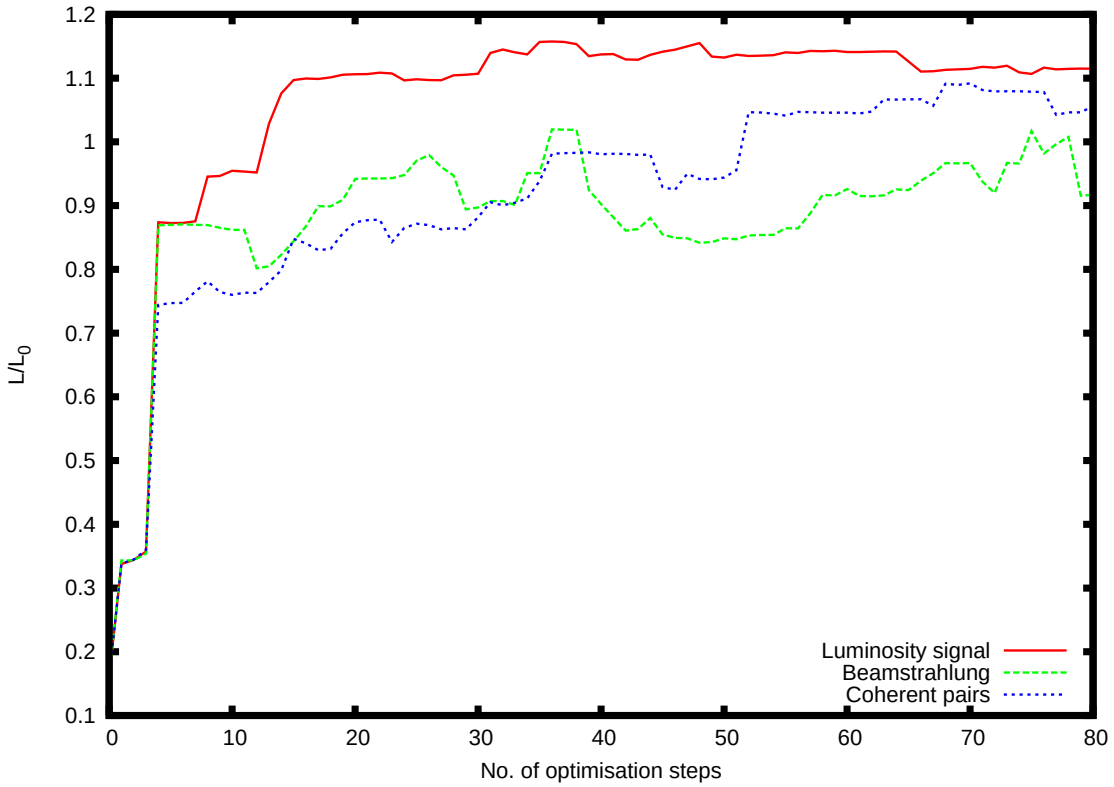
- Beamstrahlung: $< 1\%$

- Coherent pairs: $< 5\%$

- In reality there would also be an error in the measurement of the luminosity and the beamstrahlung. For the next simulation a noise with gaussian distribution of $\sigma = 3\%$ was added to these signals.

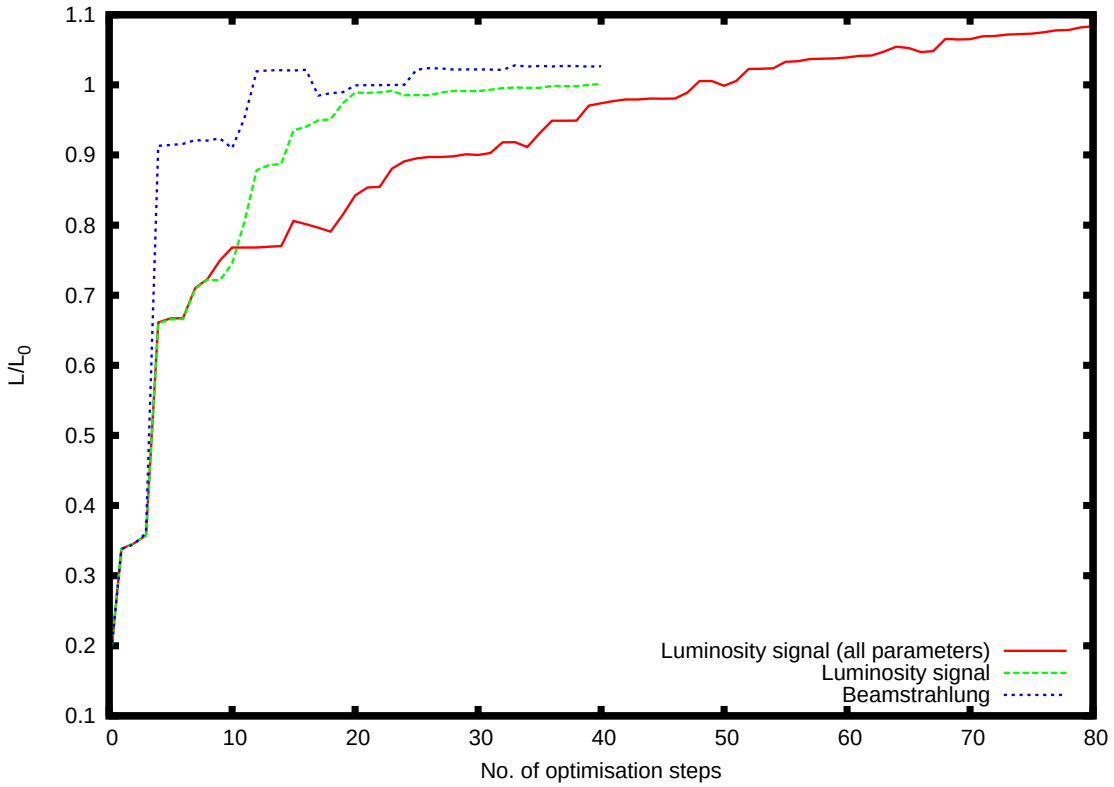
Parameter optimisation with noise

- Luminosity and beamstrahlung with 3% noise, coherent pairs as before.



Optimisation of offset, angle and waist

- In some situations the dispersion tuning seemed to cause problems and simulations were therefore also performed by tuning only offset, waist and angle.
- The result is once again very good. These results should be compared to simulations using realistic knobs.



Conclusions

- Scans show on a clear correlation between luminosity and beamstrahlung (both for CLIC and ILC). For a few knobs the resolution of the beamstrahlung signal is not very good.
- Beamstrahlung seems to be useful as a tuning signal for IP parameter tuning.
- An optimisation of only offset, angle and waist is also enough to recover nominal luminosity.
- Realistic knobs should be designed and tested.