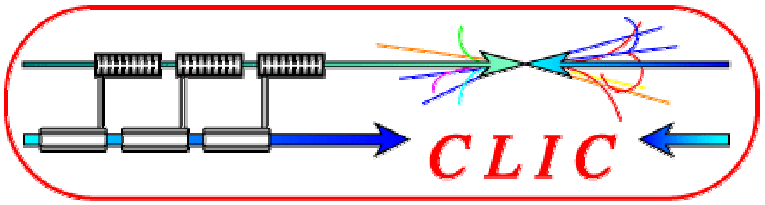

IP parameter tuning

P. Eliasson, D. Schulte

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Introduction

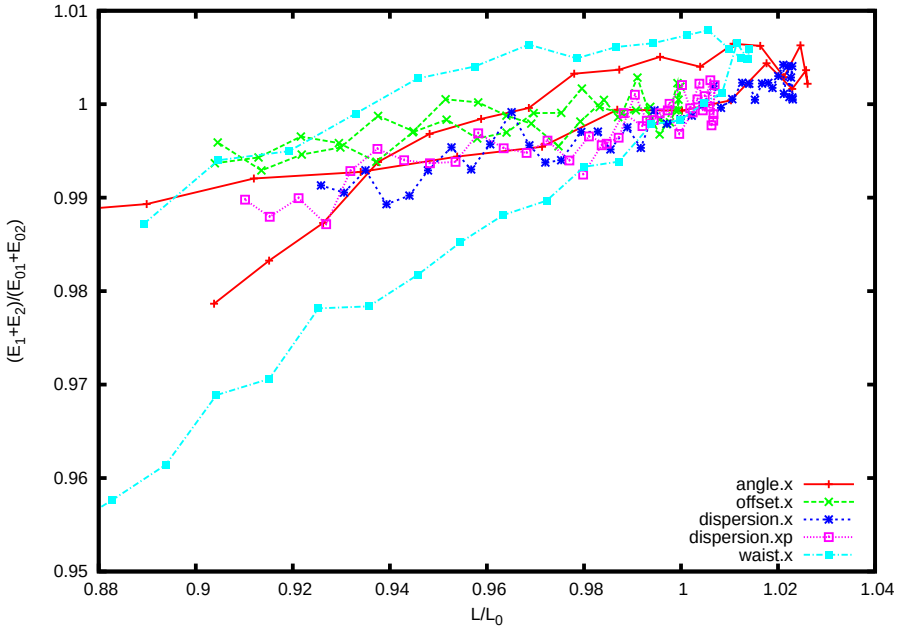
- Beam parameters at the IP (offset, angle, waist, etc) can be tuned to optimise luminosity.
- Fast tuning signal needed. Best would be luminosity. Beamstrahlung and coh. pairs also studied here.
- Sensitivity to noise in tuning signal investigated.
- Realistic knobs

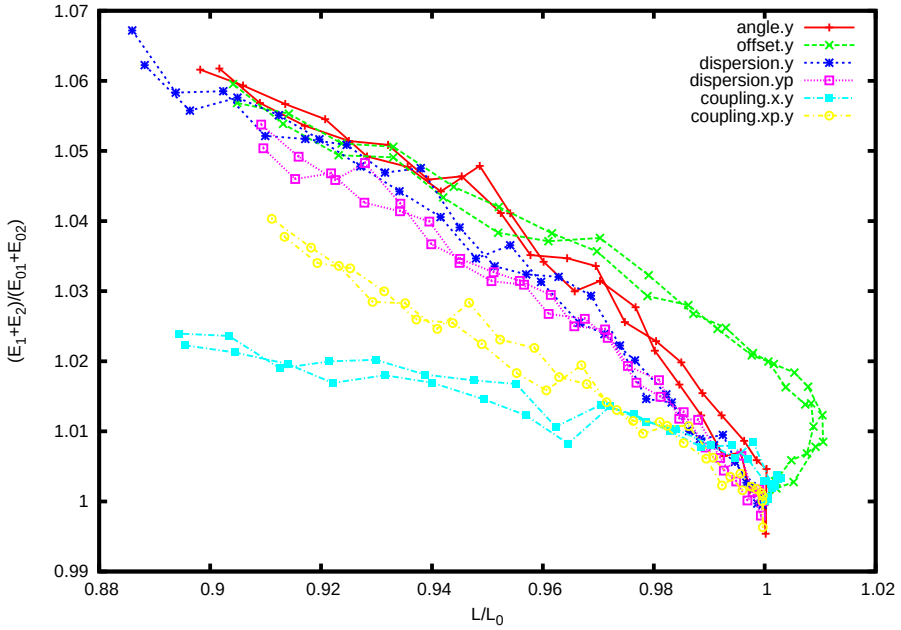
Simulations

- 50000 particles tracked (using Placet) through main linac and BDS system to create an electron and a positron beam.
- Guineapig used to simulate collisions. Every collision simulated 5 times for statistics.
- Luminosity, beamstrahlung energy losses and coh. pairs energy losses computed.
- 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 losses

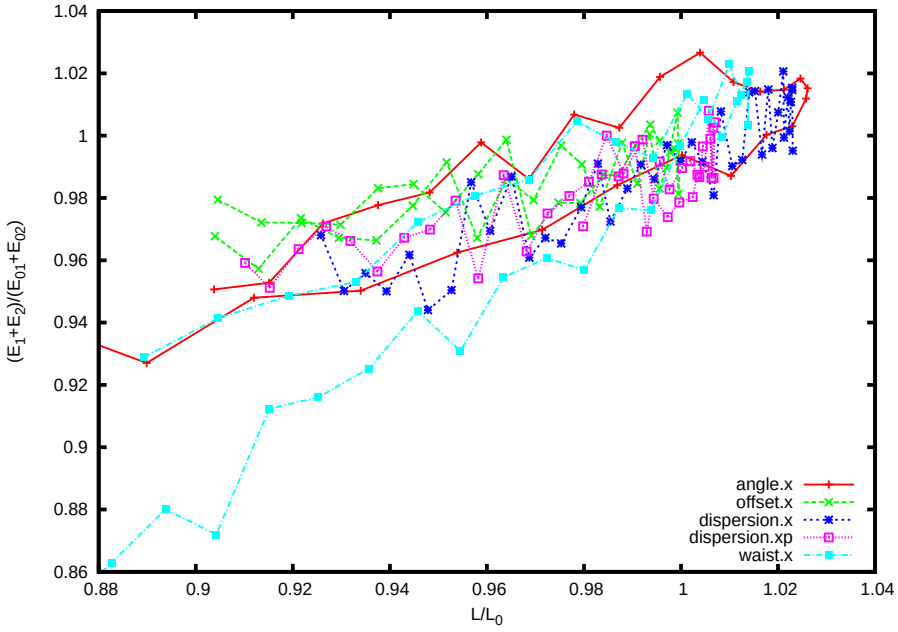
- Scans performed to study correlation between luminosity and beamstrahlung energy losses.
- Horizontal parameters might be difficult to tune (bad resolution).
- Better resolution for vertical parameters (except for coupling).

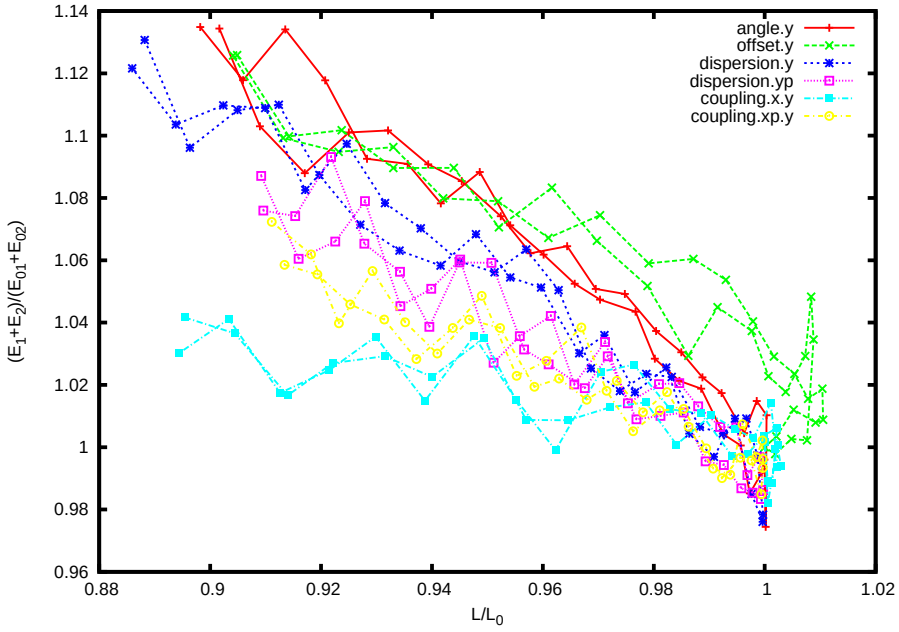




Luminosity vs coherent pairs

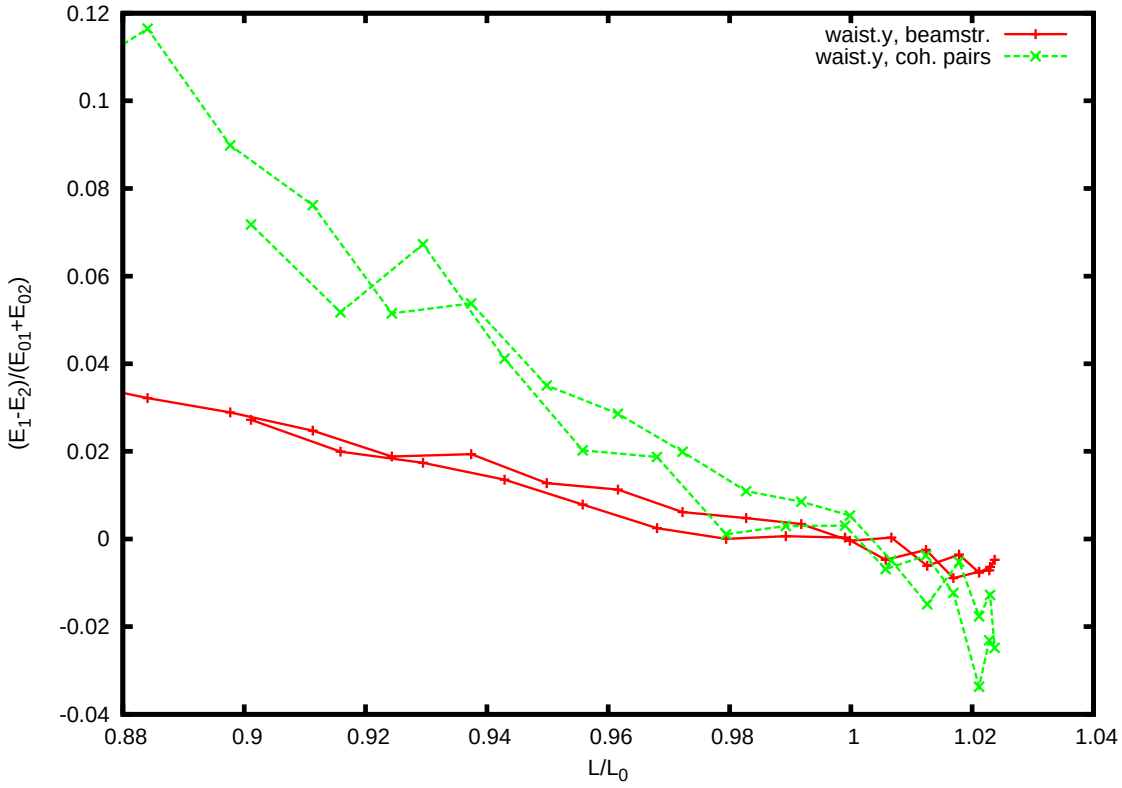
- Correlation between luminosity and coherent pairs energy losses.
- Better resolution than for beamstrahlung, but more noisy signal.





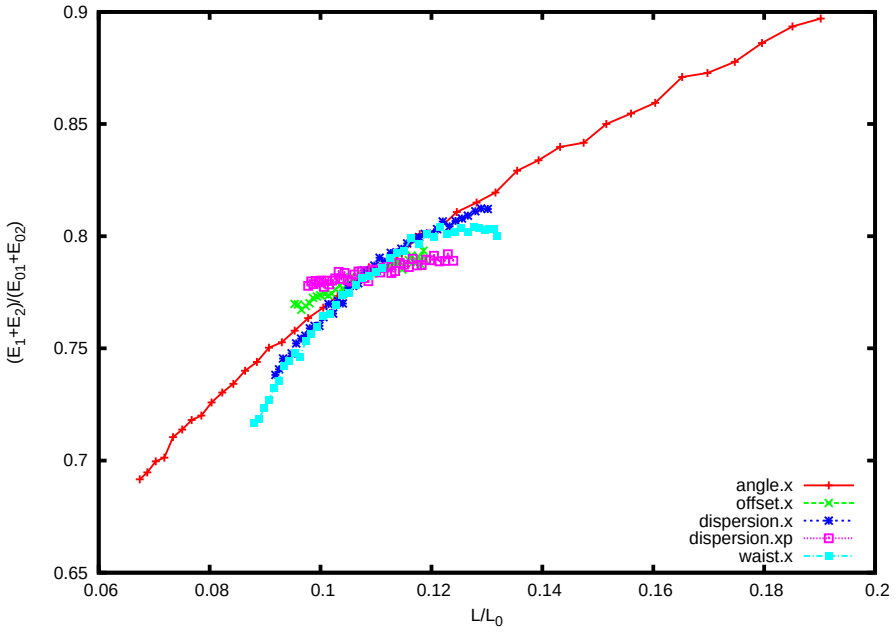
Vertical waist scan

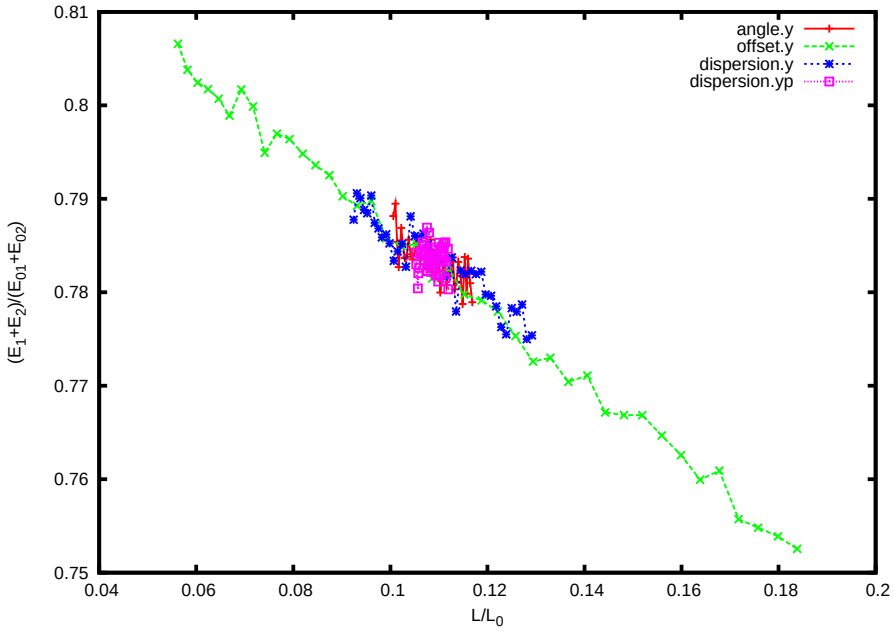
- For vertical waist the difference (not the sum) between the energy losses of the electron and positron beams should be maximised/minimised.



Luminosity vs beamstrahlung energy losses (imperfect collision)

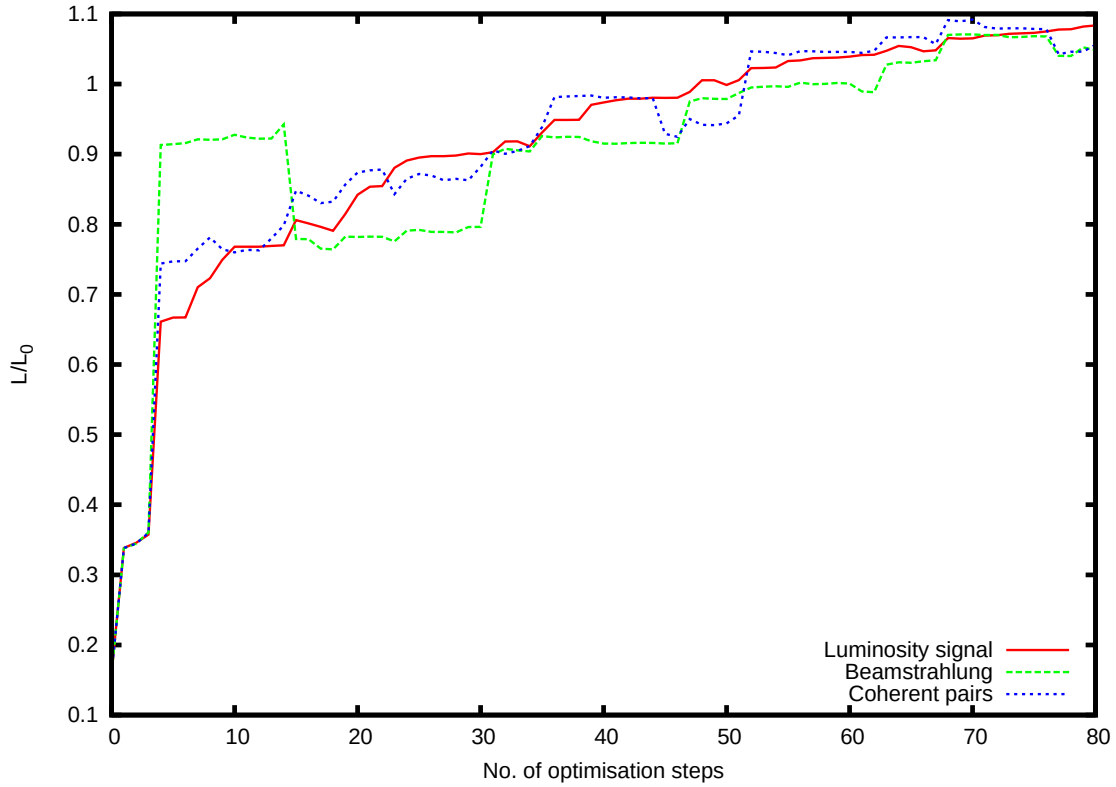
- Parameters are randomly changed to each reduce luminosity by roughly 10%.
- Scans performed as before. Beamstrahlung signal.





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

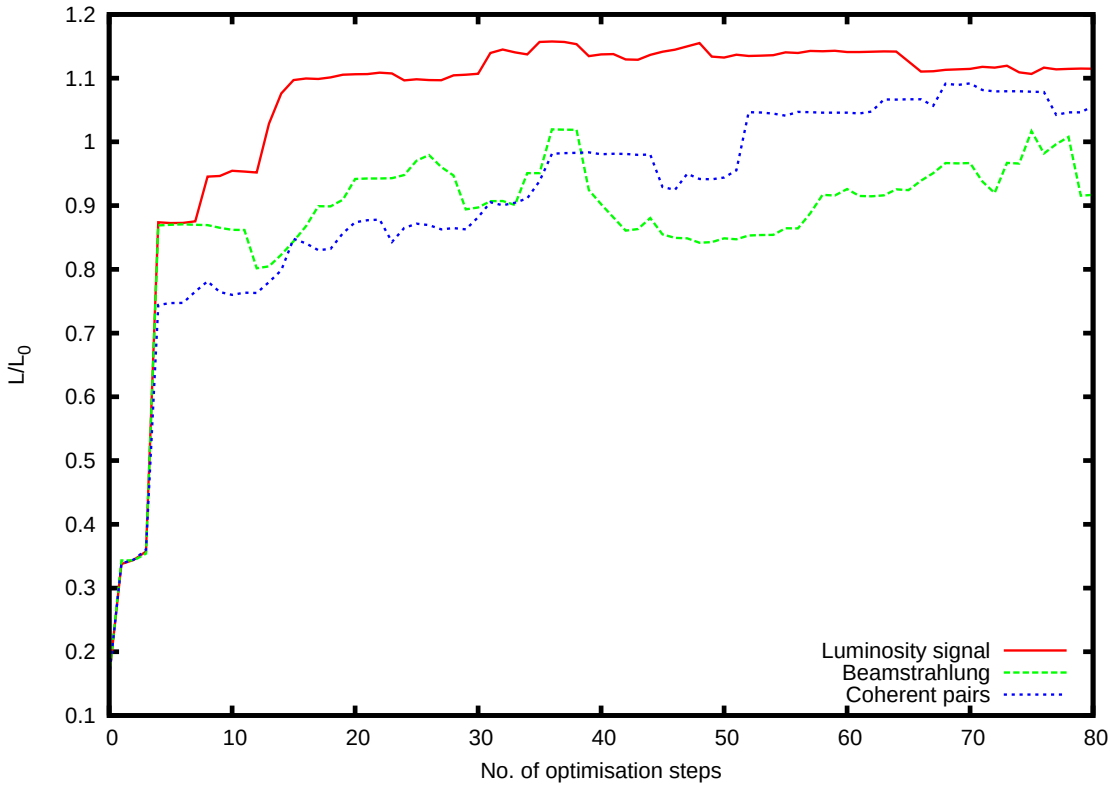
- Since all collisions are performed five times the noise in the different signals could be approximately determined.
- Almost no noise in luminosity signal. Coherent pairs signal very noisy.

- 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.

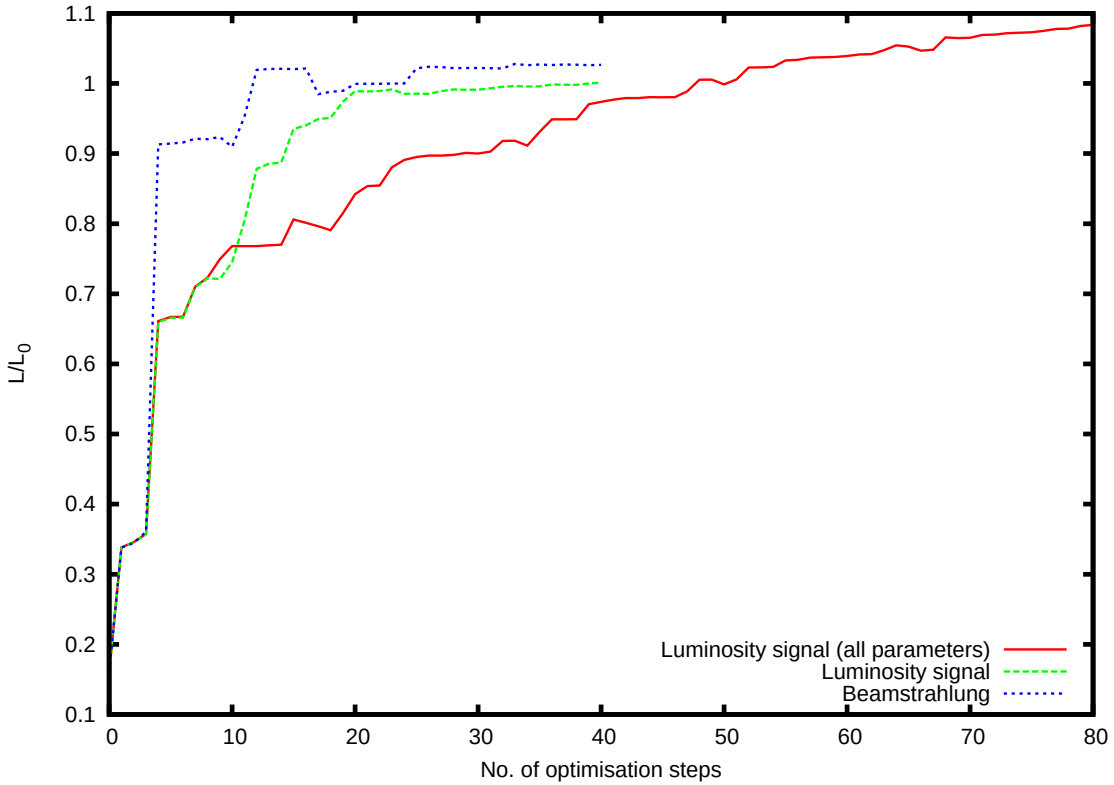
Parameter optimisation with noise

- 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. This results should within shortly be compared to simulations using realistic knobs.



Conclusions

- Scans show on a clear correlation between luminosity and beamstrahlung, and also between luminosity and coherent pairs. For a few knobs the resolution of the beamstrahlung and coherent pairs signal is not very good.
- Both beamstrahlung and coherent pairs seem to be useful as tuning signals for IP parameter tuning.
- Coherent pairs signal has better resolution than beamstrahlung signal, but it is quite noisy.
- An optimisation of only offset, angle and waist is also enough to recover nominal luminosity.
- Rogelio has started designing some realistic knobs. New simulations will be performed to study how well they work.