Some Remarks on Luminosity Signals

D. Schulte

- Luminosity measurement is critical to be able to optimise machine
- Conventional signals may be too slow for efficient luminosity optimisation
- New signals need to be found for tuning

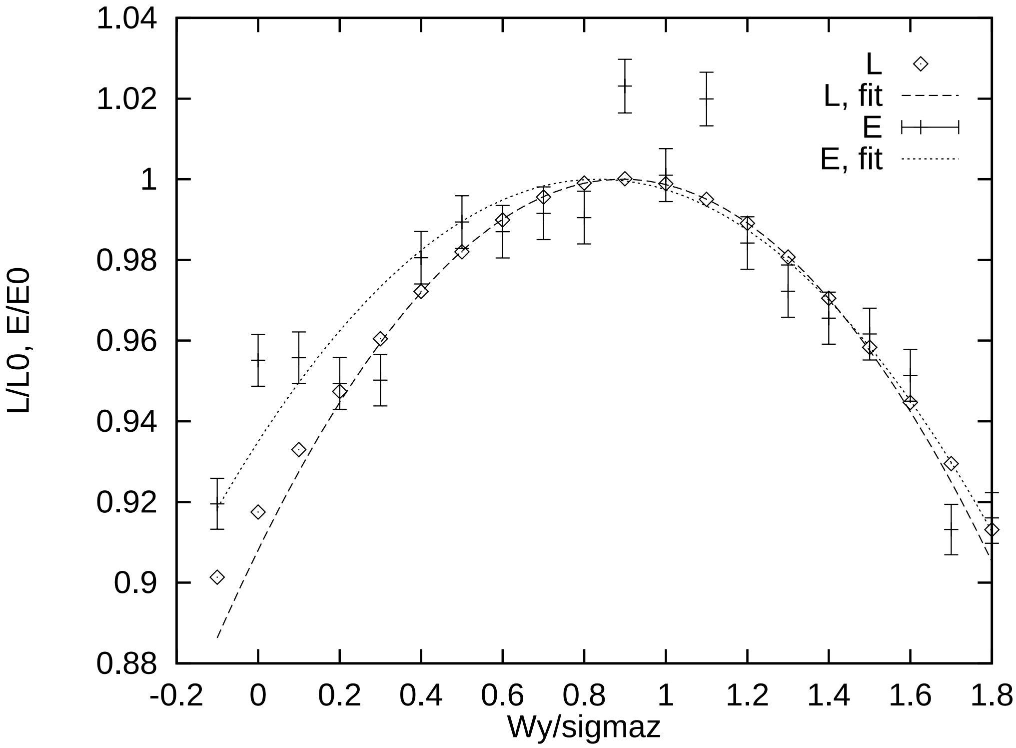
Direct Luminosity Measurements

- Two main methods
  - Large angle Bhabhas
  - Radiative Bhabhas (bremsstrahlung)
- Large angle Bhabha can been seen because of their angle
- They are safe due to coincidence test
- But signal may be too slow
- Radiative Bhabhas are normally seen due to their energy loss
- In CLIC they are not visible in the spent beam

$\Rightarrow$ Identify other signals that can be used, e.g.

  - Incoherent pairs
  - Beamstrahlung
  - Coherent pairs

Incoherent Pair Production



- Energy of incoherent pairs is proportional to luminosity, but also depends on some other parameters

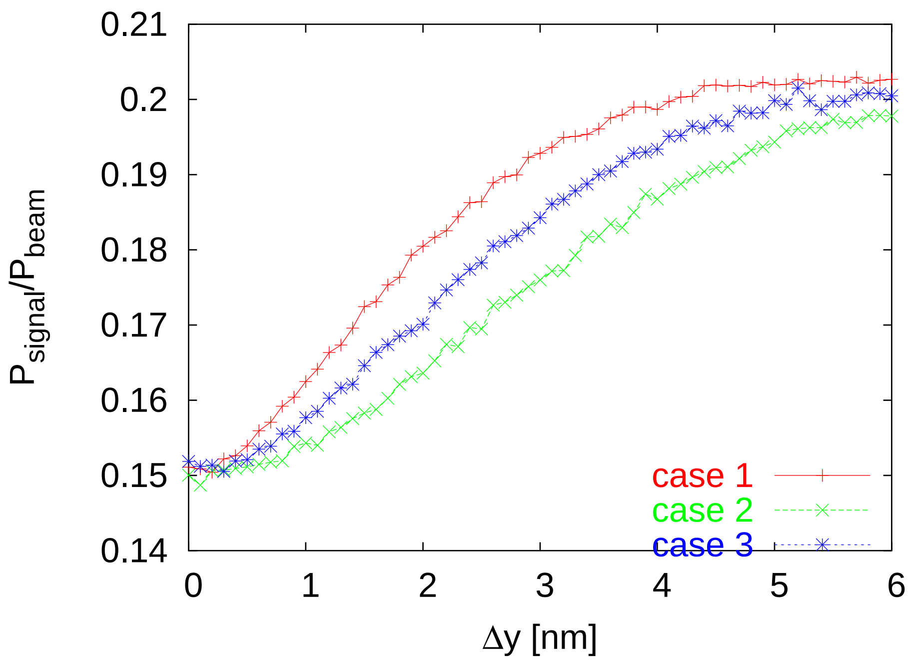
  $\Rightarrow$ use to optimise a knob

- Typical RMS fluctuation 2%
- Tuned luminosity was $\Delta L/L \approx 4 \cdot 10^{-4}$ lower than optimum
- In CLIC likely overwhelmed by coherent pairs

Beamstrahlung

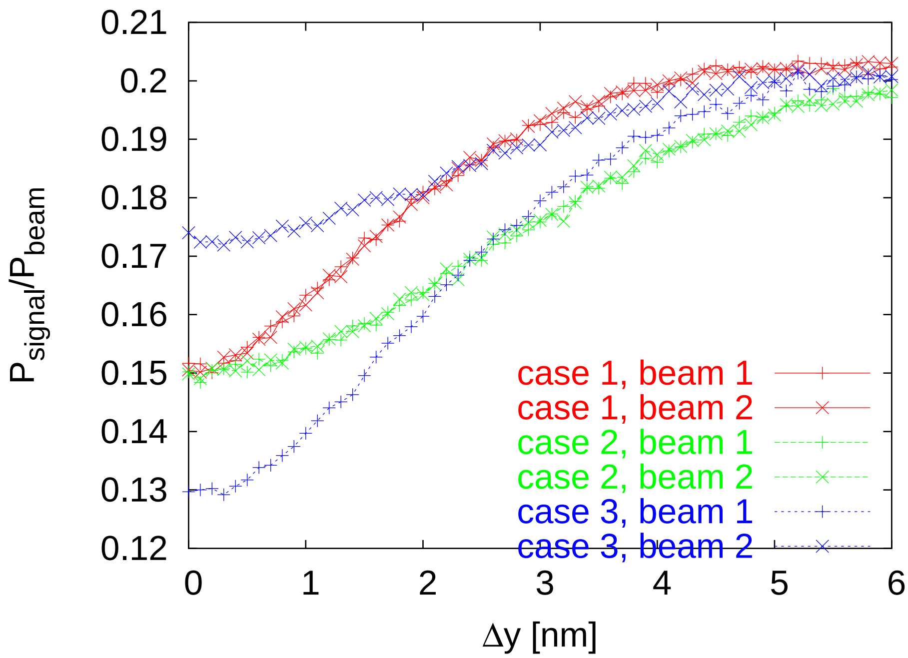
- Beamstrahlung is not proportional to luminosity
- It depends mainly on N, σ_x, σ_y, σ_z
- But it can be used for tuning knobs, where only one beam parameters is modified at a time
- E.g. two beams with different σ_y but otherwise same parameters will emit different amounts of beamstrahlung
- Coherent pairs give a similar signal
- Need to study the detection of the very strong signal (MW)

Offset Optimisation



- The total emitted beamstrahlung power is smallest for head-on collision without offset
- Three cases:
  - case 1: nominal beams
  - case 2: both beams have $\sigma_y = 2\sigma_{y,0}$
  - case 3: one beam has $\sigma_y = 2\sigma_{y,0}$
- Full simulation of 50 realistic machines (CLIC) with PLACET+GUINEA-PIG
- Offset varied to minimise beamstrahlung
- Vertical collision angle varied to minimise beamstrahlung
- 99.7% of optimum luminosity achieved

Vertical Beam Size Optimisation

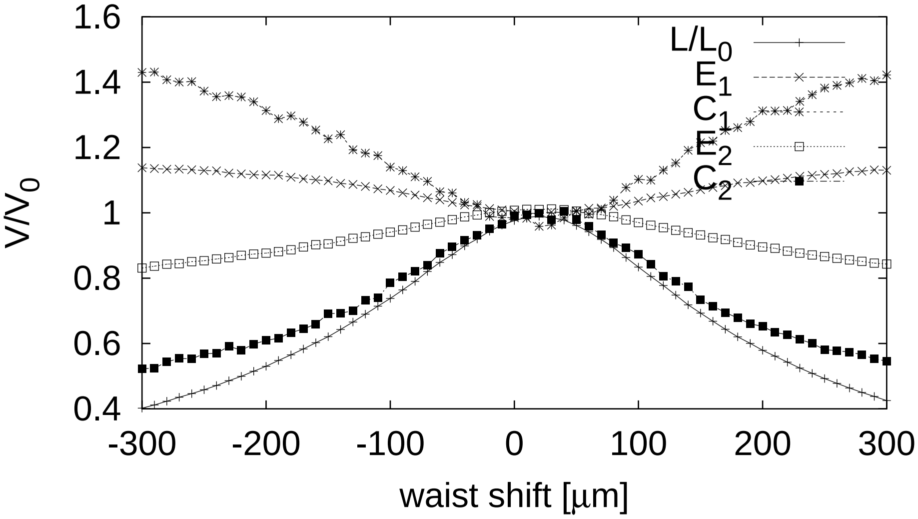


- In offset scan can identify vertical beam size of both beams
- Can minimise beam size by minimising beam-strahlung that it emits and maximising that of the other beam
- Two examples worked through"

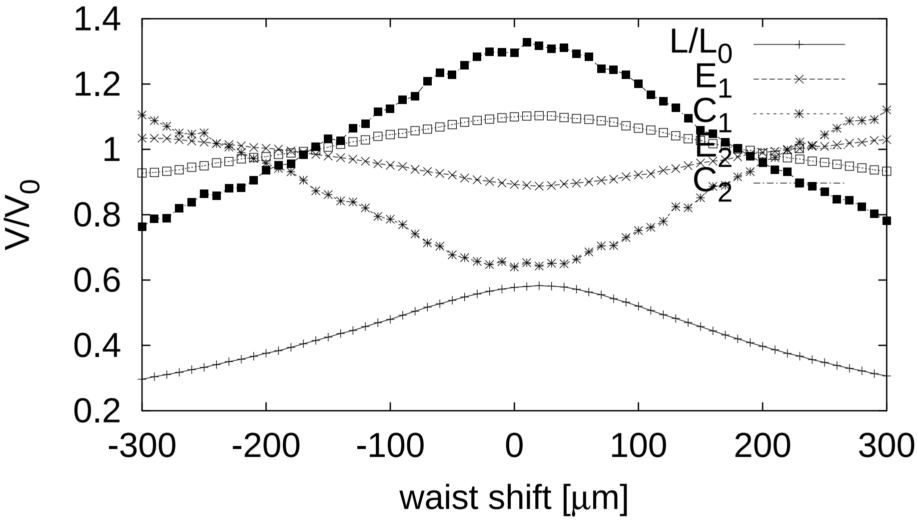
  - waist shift

  - emittance due to wakefield kick

Waist Optimisation

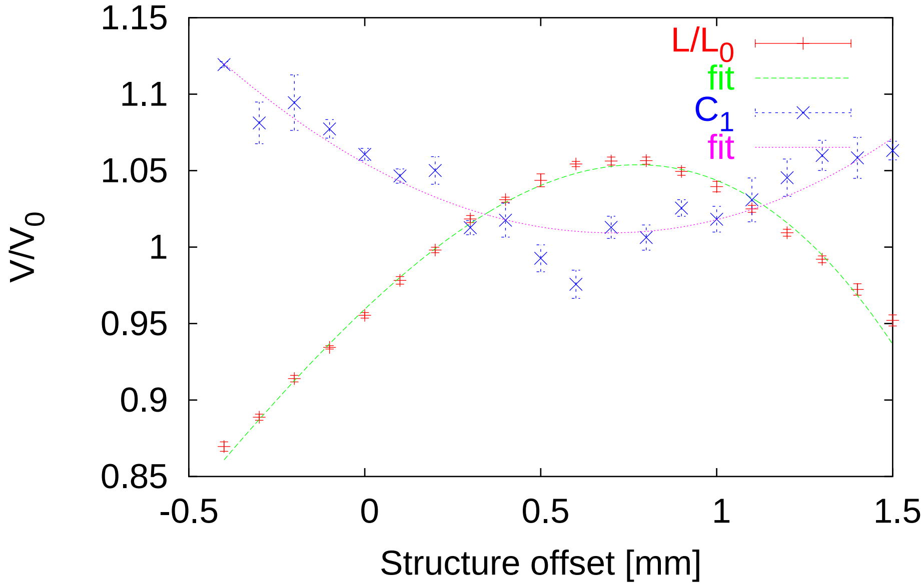


- Optimise waist of beam 1 in CLIC
- Waist of beam 2 is at collision point



- Waist of beam 2 is $200\mu m$ before collision point
- realistic bunches yield 99% of optimum luminosity

Luminosity Tuning Bump Optimisation



- Bump consists of structre that can be moved transversely
- Use one bump only
- 50 machines yield an average of 99.2% of optimum
- Need to study use of more than one bump

Conclusion

- Coneventional fast luminosity measurement will be difficult at CLIC
- Some fast signals exist that could be used for luminosity optimisation
- Sensitivity of tuning procedures to small fluctuations in beam parameters needs to be understood
- Quite a way to go