Resolved Photon Backgrounds

Work performed by
David Asner, U Pittsburgh

(all brilliance his, all mistakes mine)

Jeff Gronberg / LLNL
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Photons structure complicates the calculations

\[ \gamma \quad \rho \quad \text{“} \gamma \text{”} = 0.99 \gamma + 0.01 \rho \]

- Three types of $\gamma\gamma$ collisions
  - Direct
  - Once resolved
  - Twice resolved

Electroweak

Electroweak (DIS)

Strong ($\rho\rho$ collider)
Photon-photon total cross-section measured out to 200 GeV

- At 200 GeV resolved processes are dominant
- A Factor of 3 model uncertainty in predicting the cross-section at 1 TeV
- Not important for $e^+e^-$ LC, beamstrahlung spectrum small above 100 GeV
Groups have been tuning Pythia to match the available data

1) Default Pythia parameters: Most similar to the study by de Roeck, Schulte, Telnov (circa Snowmass 2001)

2) Preliminary Butterworth parameters: Used in our earlier work. 6x larger background.

3) Updated Butterworth parameters:
   http://jetweb.hep.ucl.ac.uk/Fits/322/index.html
   http://jetweb.hep.ucl.ac.uk/Fits/757/index.html
   - PARP(67)=4.0 vs 1.0  PARP(91)=1.0 vs 0.0
   - PARP(81)=1.8 vs 1.5  PARP(99)=1.0 vs 0.0
   - MSTP(82)= 1 vs 4  \( \chi^2/\text{dof} = 4.96 \) vs 4.97
   - Newer fit use ~ ¼ LEP, HERA, Tevatron luminosity

4) Agreement with the data and consensus between US and Europe on levels. Good data to cover the LC, uncertainties for the \( \gamma \gamma \) collider
Photon collider luminosities push into the unmeasured region of $\gamma\gamma$ total cross-section

Higgs factory

LC 500
Occupancy: Charged Tracks

Plots correspond to 17000 bunch crossings

Cos $\Theta$ vs Energy (GeV)

3.7 tracks/crossing ($|\cos \Theta| < 0.9$)

$E_{\text{avg}} = 0.7$ GeV ($p > 0.2$ GeV)
Occupancy: Neutral Showers

Plots correspond to 17000 bunch crossings

Cos $\Theta$ vs Energy (GeV)

5.5 showers/crossing ($|\cos \Theta| < 0.9$)

$E_{\text{avg}} = 0.4$ GeV
# of additional hadronic events that overlay the physics

- Recall $\gamma\gamma$-NLC – rep. rate is 11.4kHz
  - $1.5\times10^{10}$ e$^{-}$/bunch
  - 95 bunches/train
  - 120 trains/second

- Higgs factory
  - 6700 overlay events/second
  - 56 events/train
  - 0.6 events/crossing

- 500 GeV Machine ~3x larger
Conclusion

- Hadronic background for LC from beamstrahlung should be well described by pythia with these parameters
  - As long as you trust the beamstrahlung calculation
  - Small in any event

- Dominant background for Photon Collider
  - Many additional events per train
  - Effect on jet reconstruction must be studied
  - Pushes for better timing in the detector to reduce the number of bunches that must be integrated