

Trident Cascade Production in beam-beam interactions

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Thanks to:

Daniel Schulte, Ulrik I. Uggerhøj, Barbara Dalena, André Sailer, Konrad Elsener

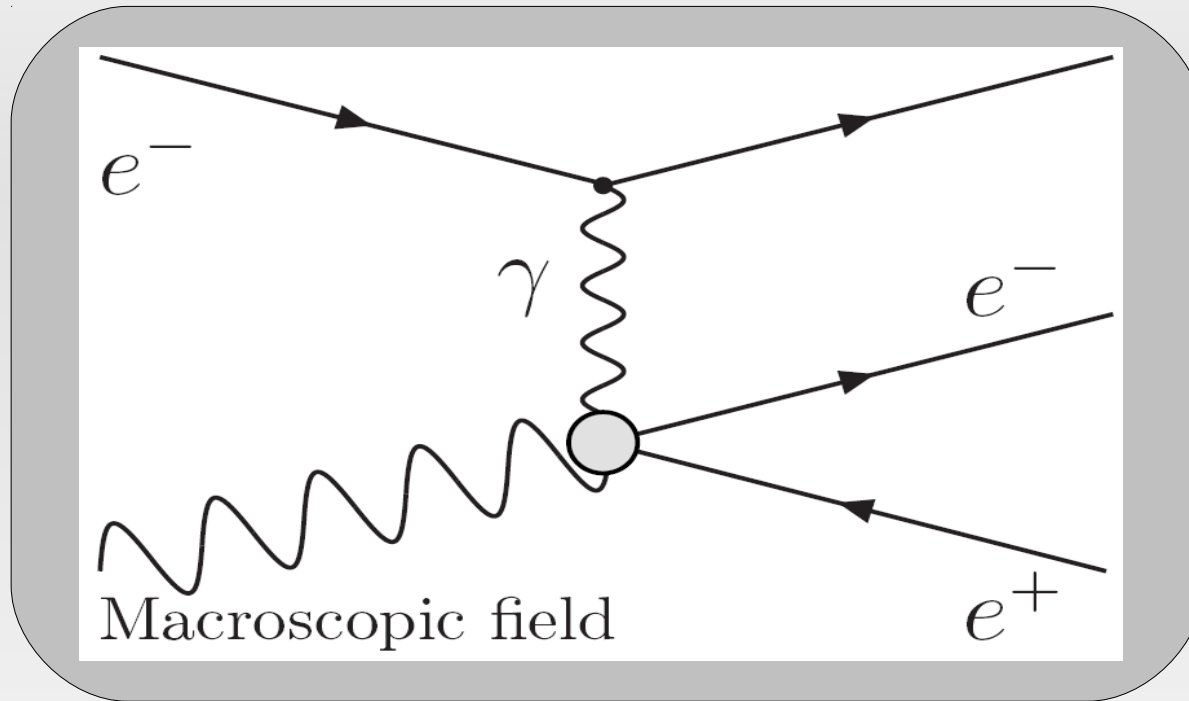


Introductory remarks

- Parameters used are for the 1.5TeV CLIC option.
- Tridents much less important at lower E_{cm}
- A recent very important update in the trident output from GUINEA-PIG++
- I will mainly present *results* of recent simulations.



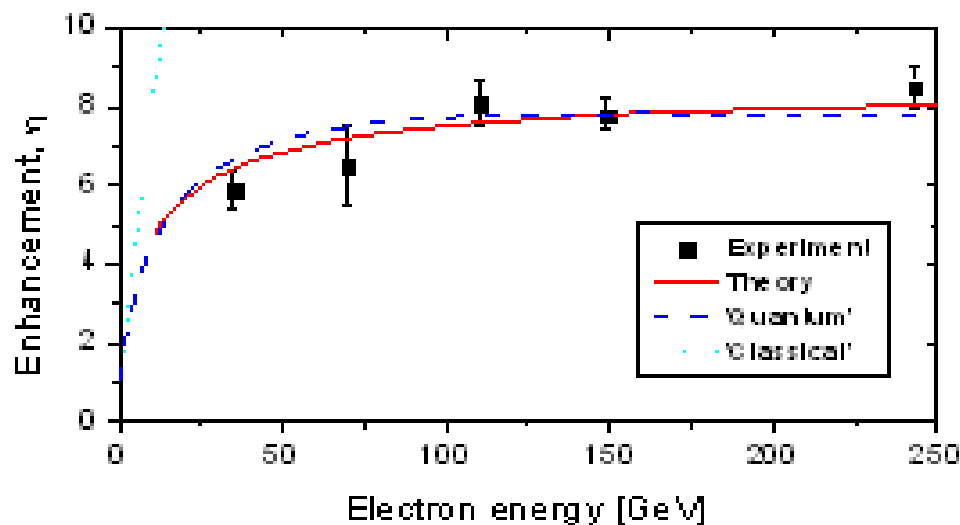
The cascade trident process



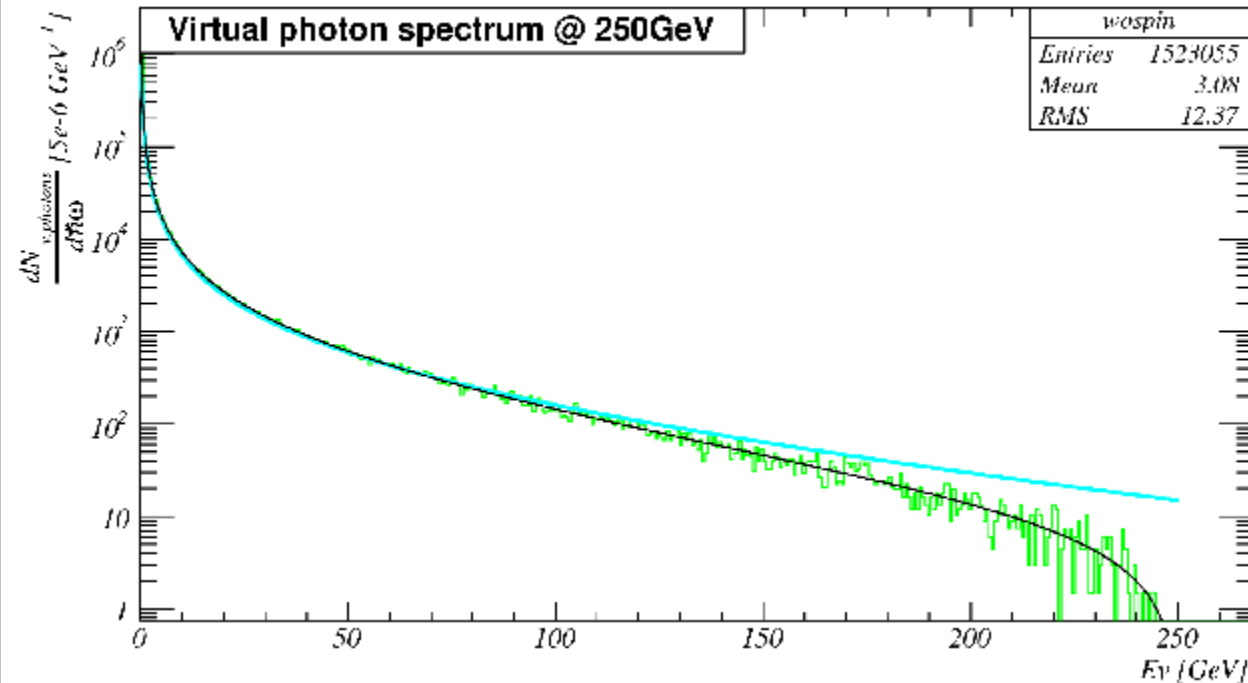
- The trident process is mediated by a *virtual* photon
- No accurate single cross section available in literature
- Depends strongly on $\Upsilon = \gamma E / E_0$
- Calculation using a Weizsäcker-Williams approximation
- We choose $|q|^2 < m^2$ for the virtuality of the photon
- Space-like photon dominance
- Conversion into pair assumes that the photon is unpolarized

Quantum suppression of synchrotron radiation

- The total beamstrahlung yield is suppressed when going into the quantum regime
- An effect of the electron being pushed outside its own cone of radiation by the radiation reaction force during formation.
- This effect affects the coherent pairs but not tridents.



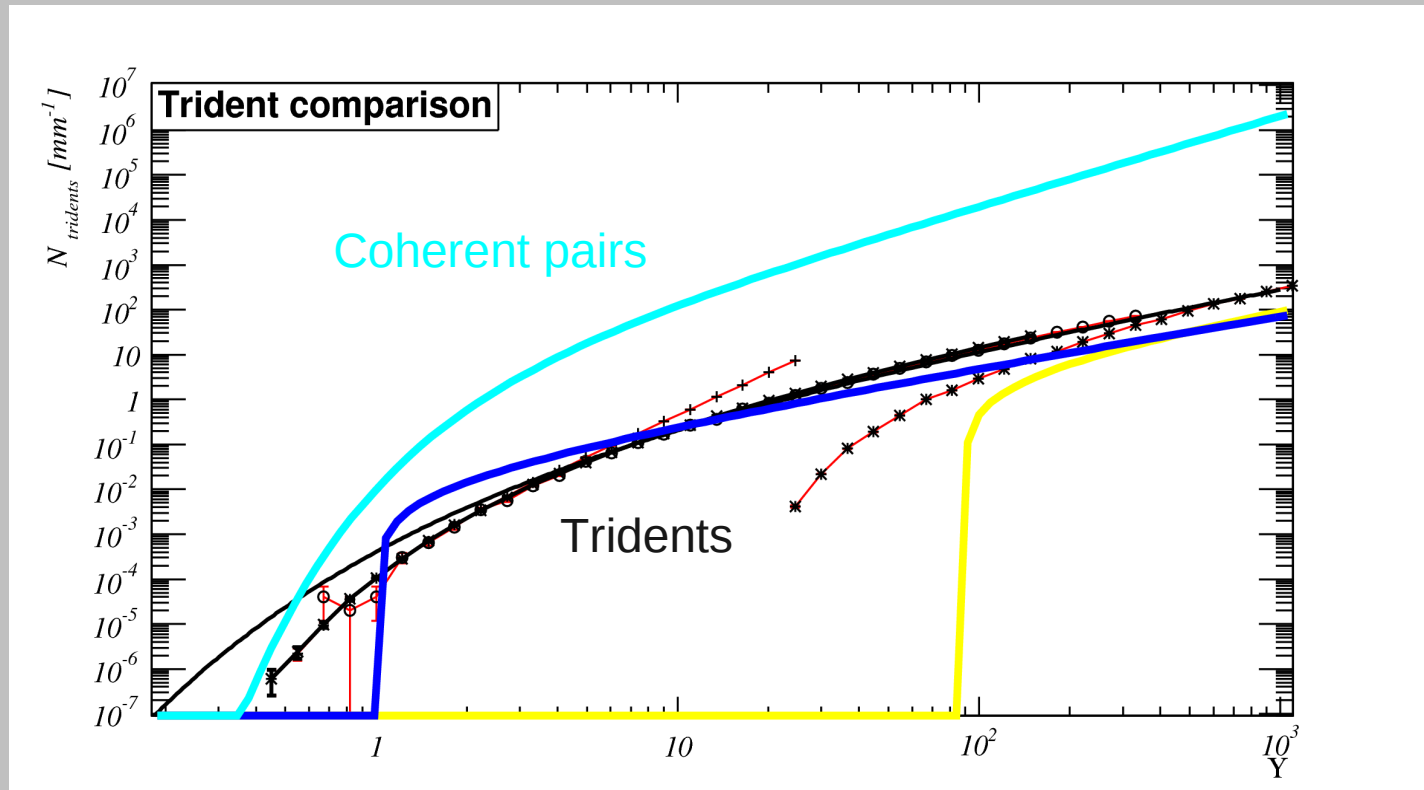
Spectrum of virtual photons



$$\frac{dn(x)}{dx} = \frac{\alpha}{2\pi} \frac{1 + (1-x)^2}{x} \ln\left(\frac{q_{\max}^2}{q_{\min}^2}\right)$$

$$x = \frac{\hbar\omega}{E}$$

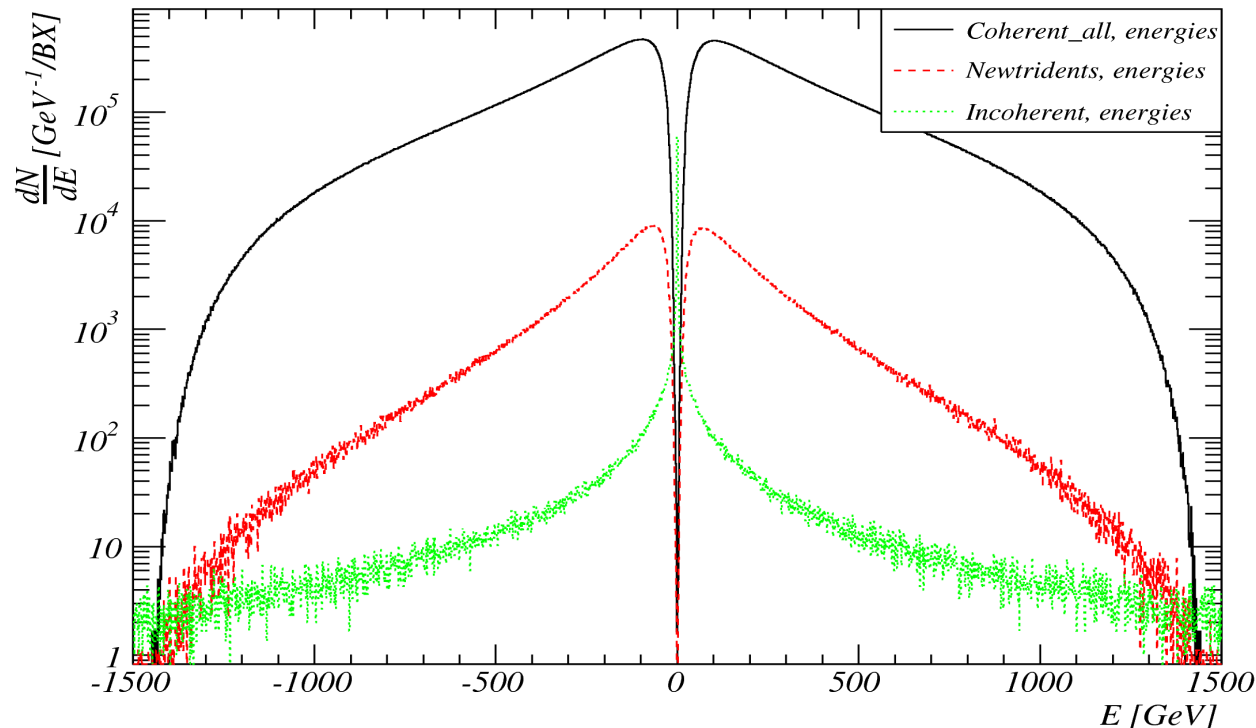
Total coherent yields



- $\langle Y \rangle = \frac{5}{6} \frac{N r_e^2 \gamma}{\alpha (\sigma_x + \sigma_y) \sigma_z} = 4.9$ for present CLIC baseline
- Chen: $N(\text{tridents}) \propto Y \ln(Y)$, $Y \gg 1$
- Cross section calculated here is better at small energies
- Tridents $\propto t$, Coherents $\propto t^2$

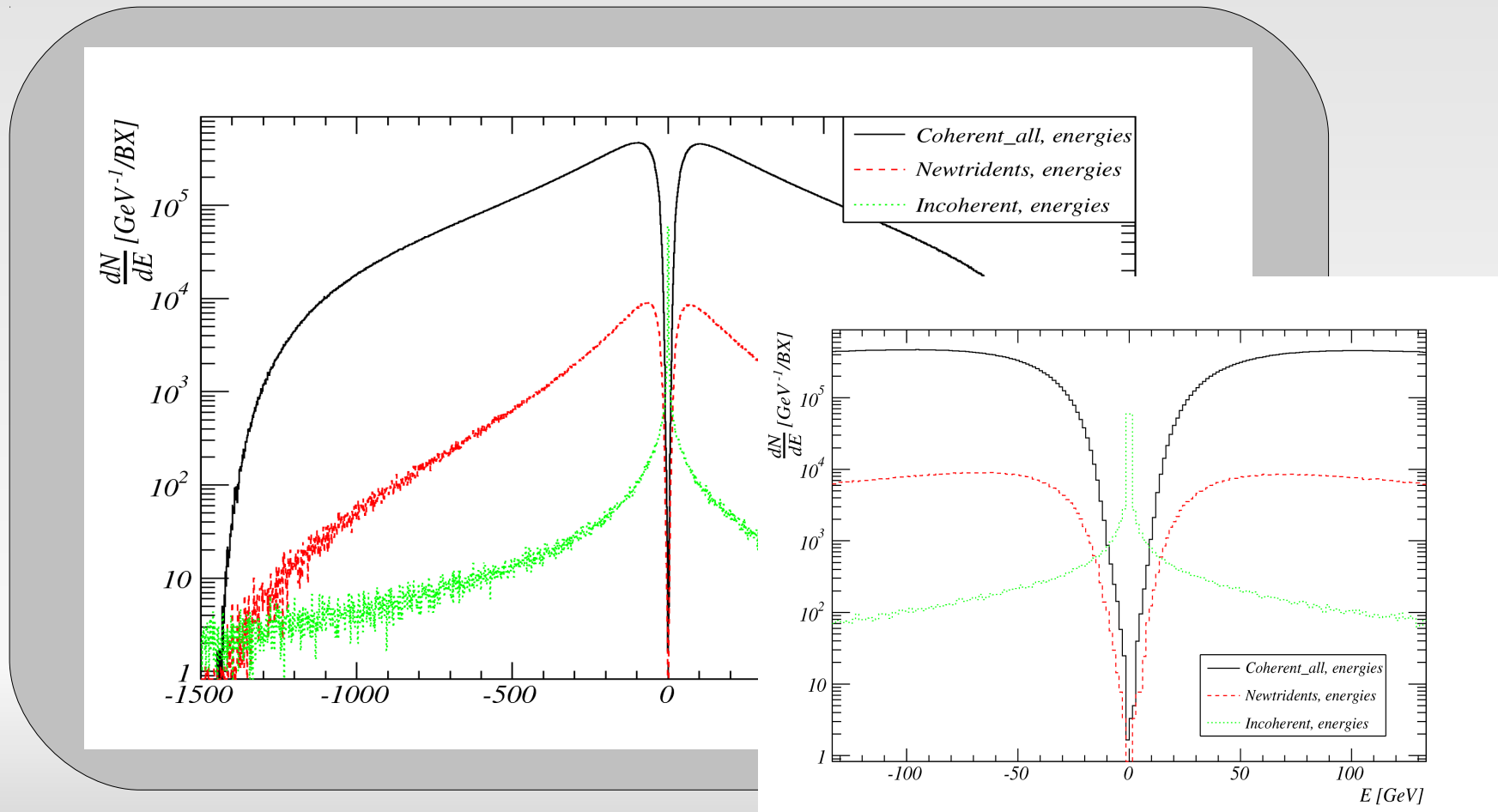
Spectra after full GP simulation

- The relative amount of tridents is as expected.
- Trident spectrum relatively similar to that of the coherent pairs.



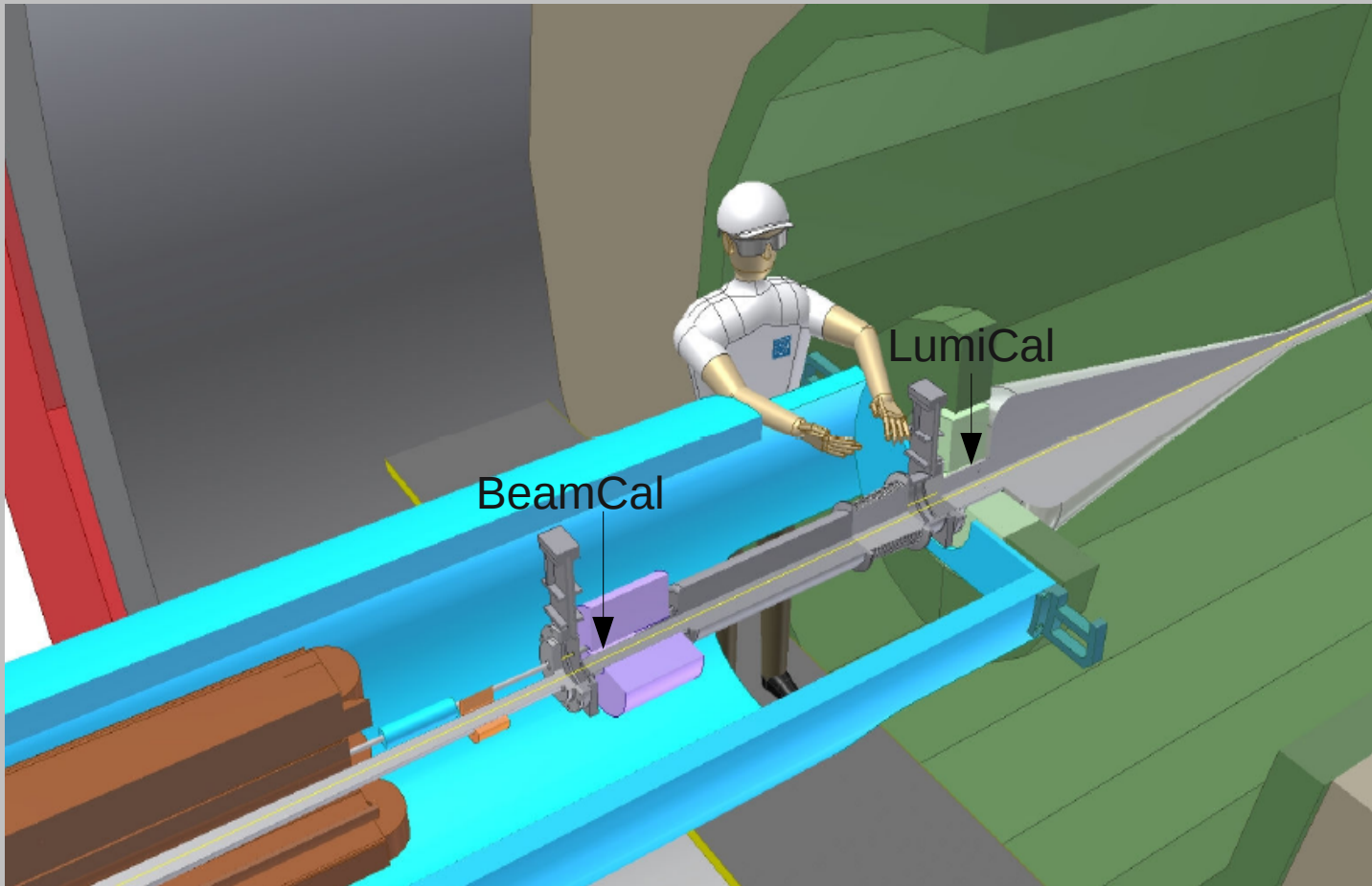
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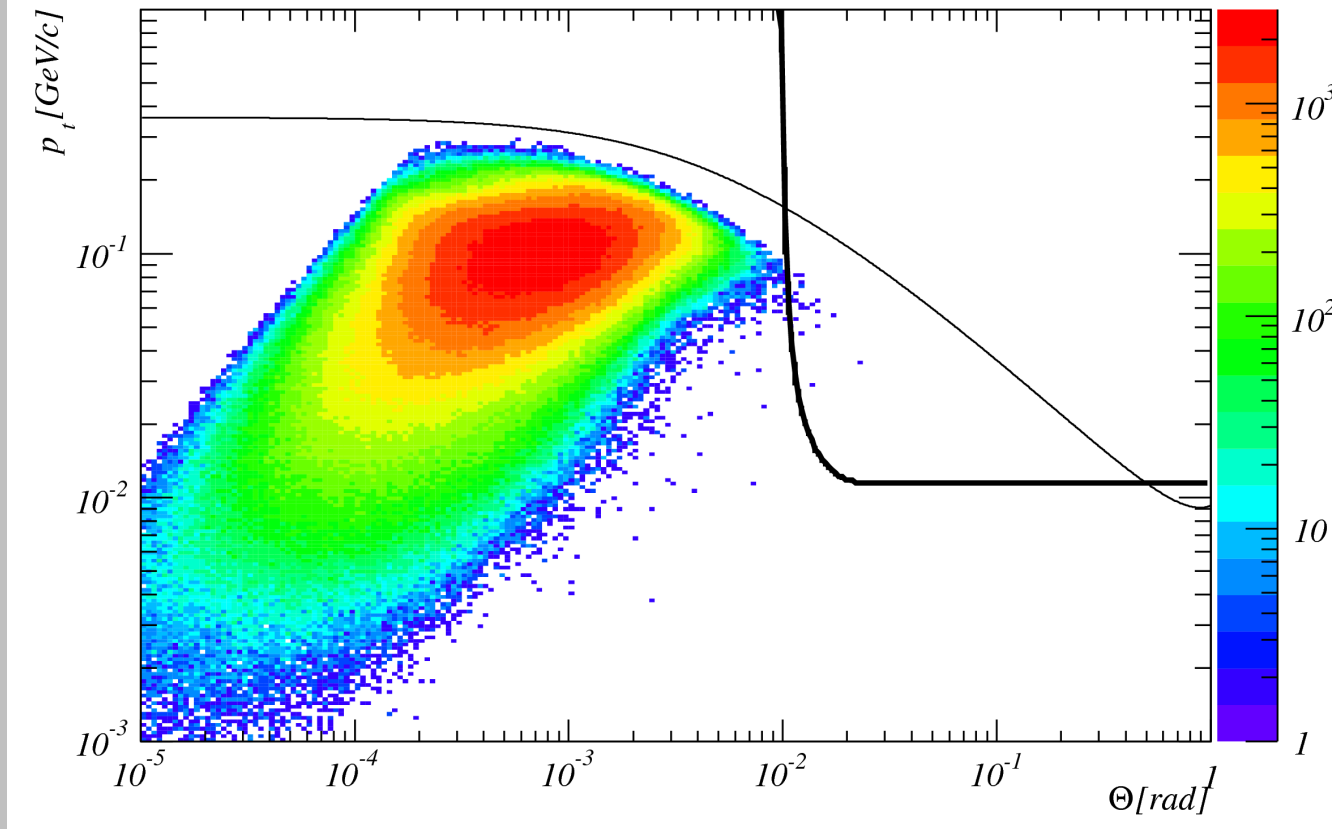


VF detector geometry

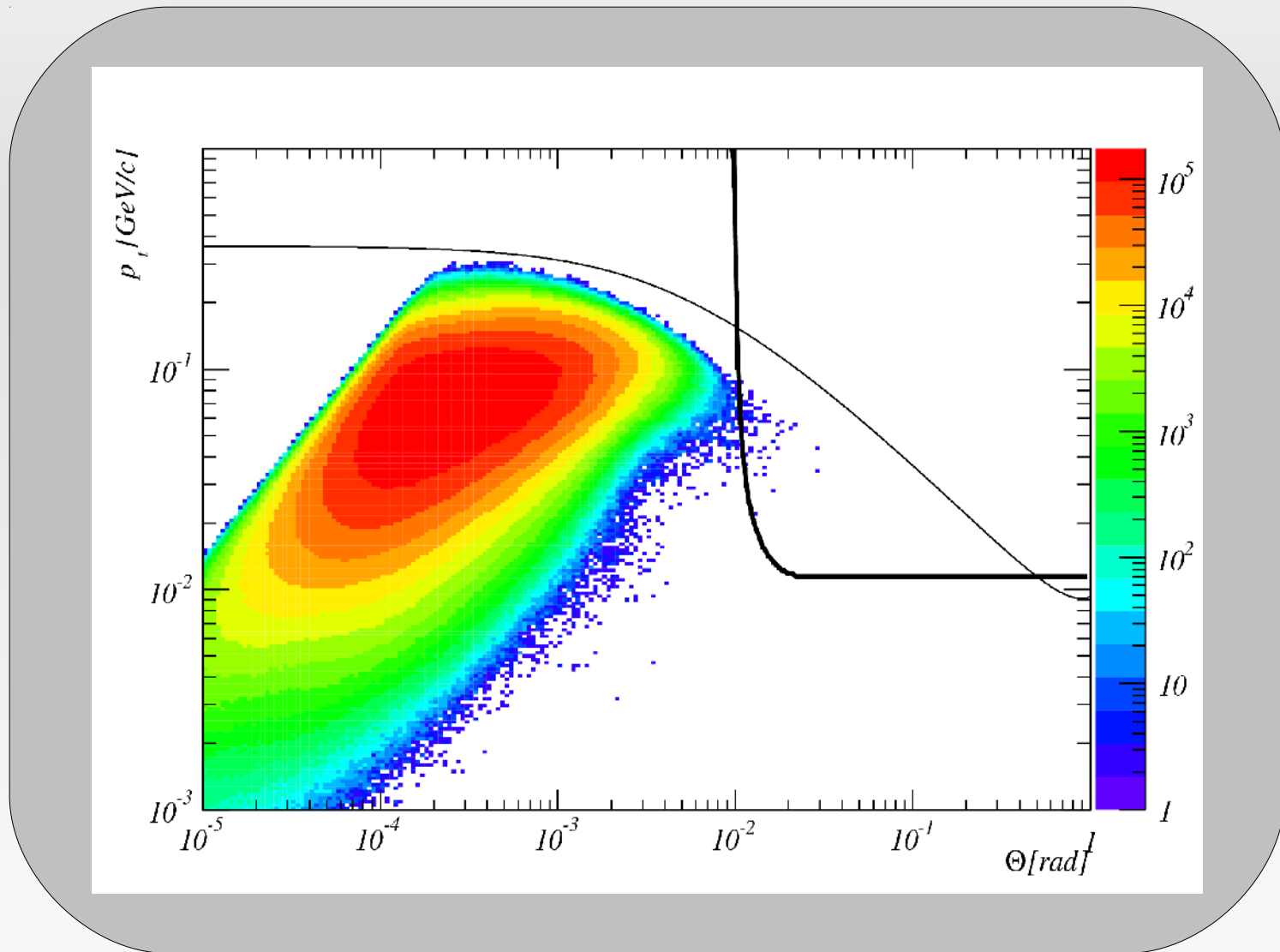
- Are any detectors in danger?



Direct tridents after collision

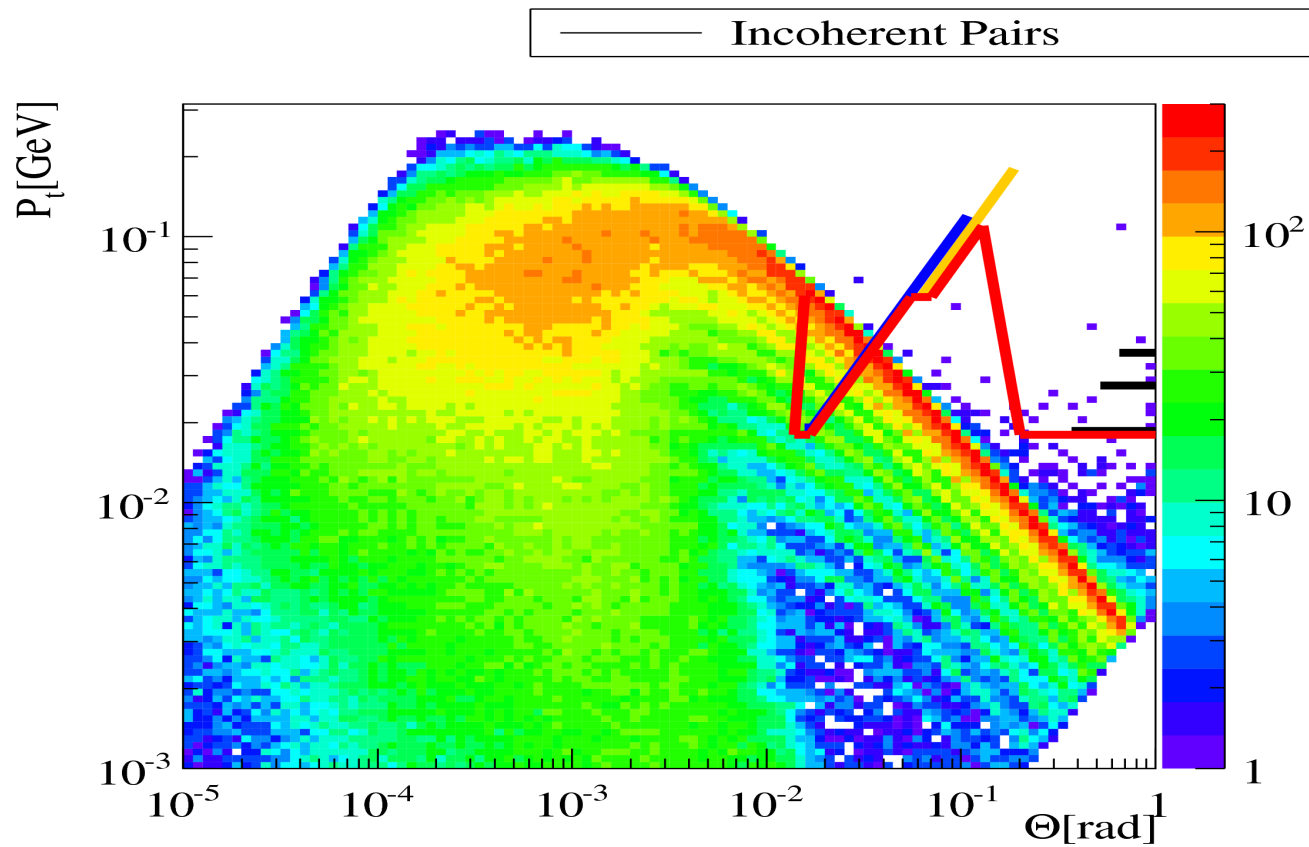


Coherent particles after collision



- Tridents look very much like coherent pairs but are less abundant

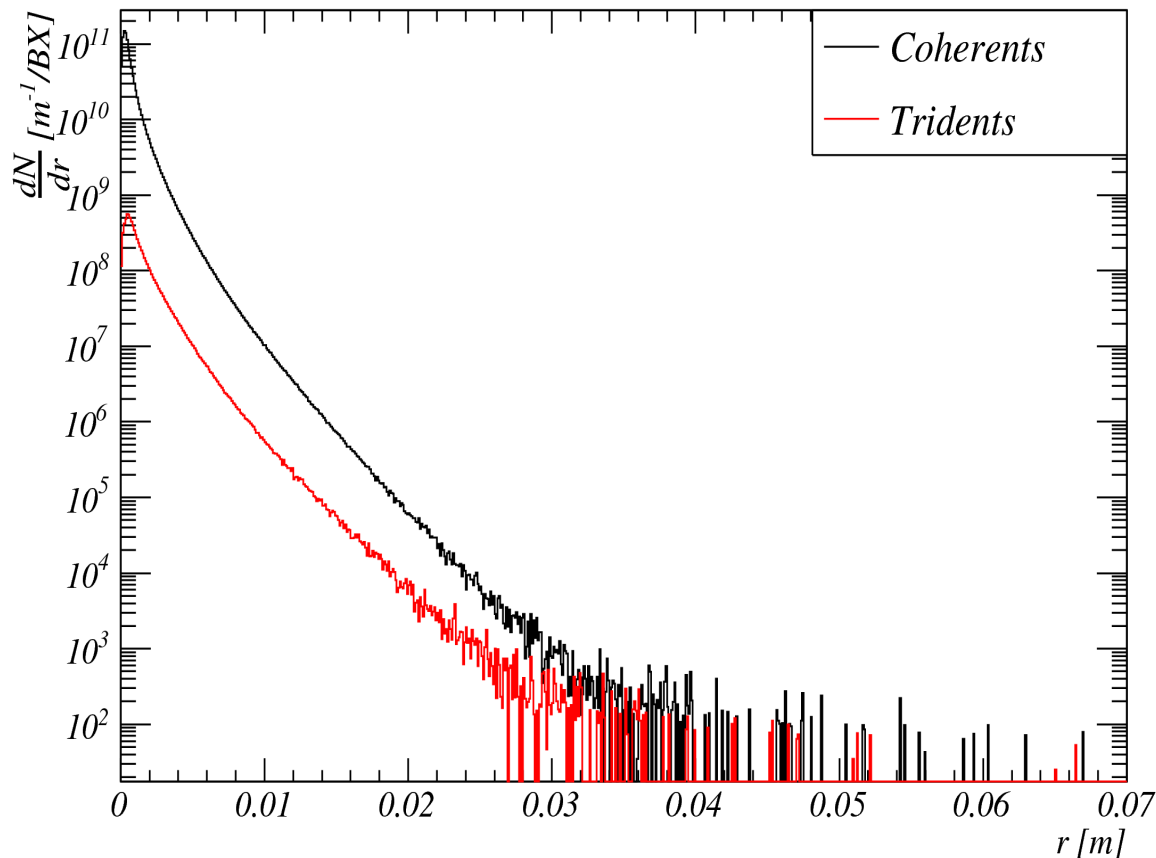
Incoherent pairs after collision



Thanks to André Sailer for this plot

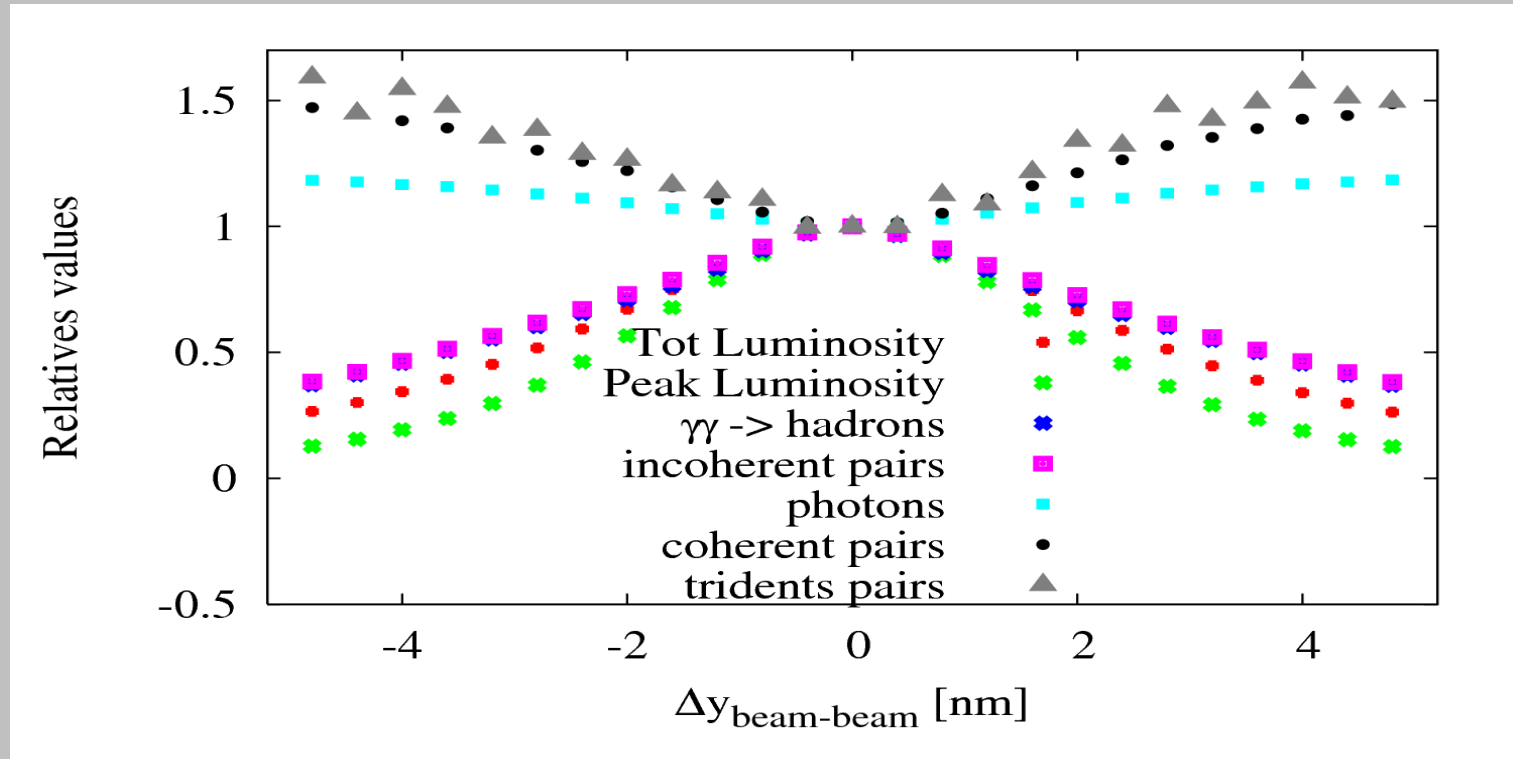
Radial distribution of pairs after post collisional tracking

Radial distribution of particles after 3 meters of tracking in a 5T solenoid field
A crossing angle of 20mrad has been used



Process	Approximate energy deposited in BeamCal
Coherent pairs	2200 GeV
Tridents	880 GeV
Incoherent pairs	27000 GeV

Yields with non-perfect collisions



Thanks to B. Dalena for plot

Plot is limited by statistics and uses an old version of the trident generator
The plot is still more than qualitatively correct
Trident yield is approximately inversely proportional to bunch length

Conclusions

- Tridents behave much like coherent particles in beam-beam collisions.
- Tridents Deposit energy in BeamCal comparable to, but smaller than that of coherent pairs.
- Likely no major impact on post-collisional line or detector design.
- Recent published paper on experimentally produced coherent pairs and tridents, Phys. Rev. D **82** 7 (2010).