Ptarmigan status update

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LUXE Simulation, Analysis and Software

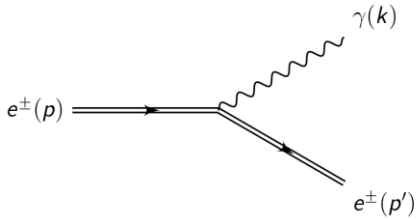
UNIVERSITY OF GOTHENBURG

Ptarmigan status update

Interactions with linearly polarized (LP) lasers

Electron + laser

Nonlinear Compton scattering



Signals:

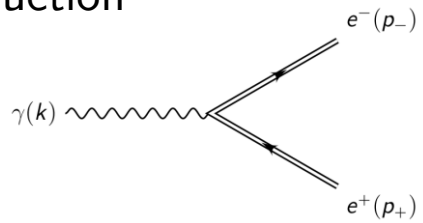
- Intensity dependence of Compton edges
- γ-photon angular profile

Needed:

- Photon emission rate (LMA, LP)

Bremsstrahlung γ + laser

Nonlinear Breit-Wheeler pair production



Signals:

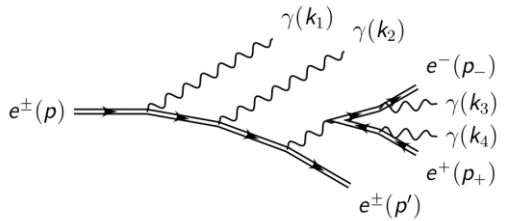
- Intensity dependence of positron yield

Needed:

- Pair creation rate (LMA, LP), unpolarized γ photons

Electron + laser

Nonlinear trident pair creation



Signals:

- Intensity dependence of positron yield

Needed:

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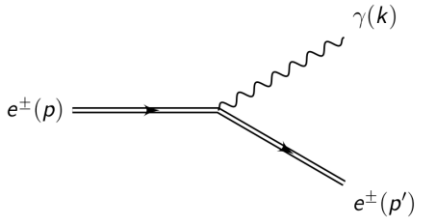

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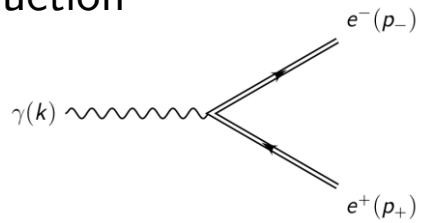

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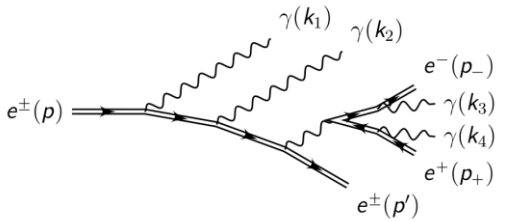

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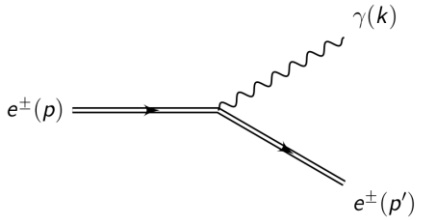

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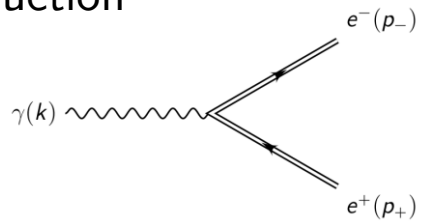

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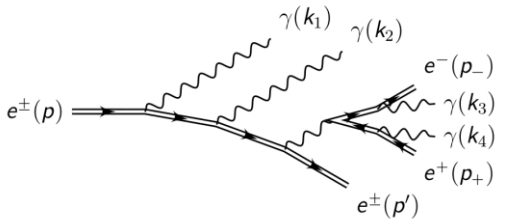

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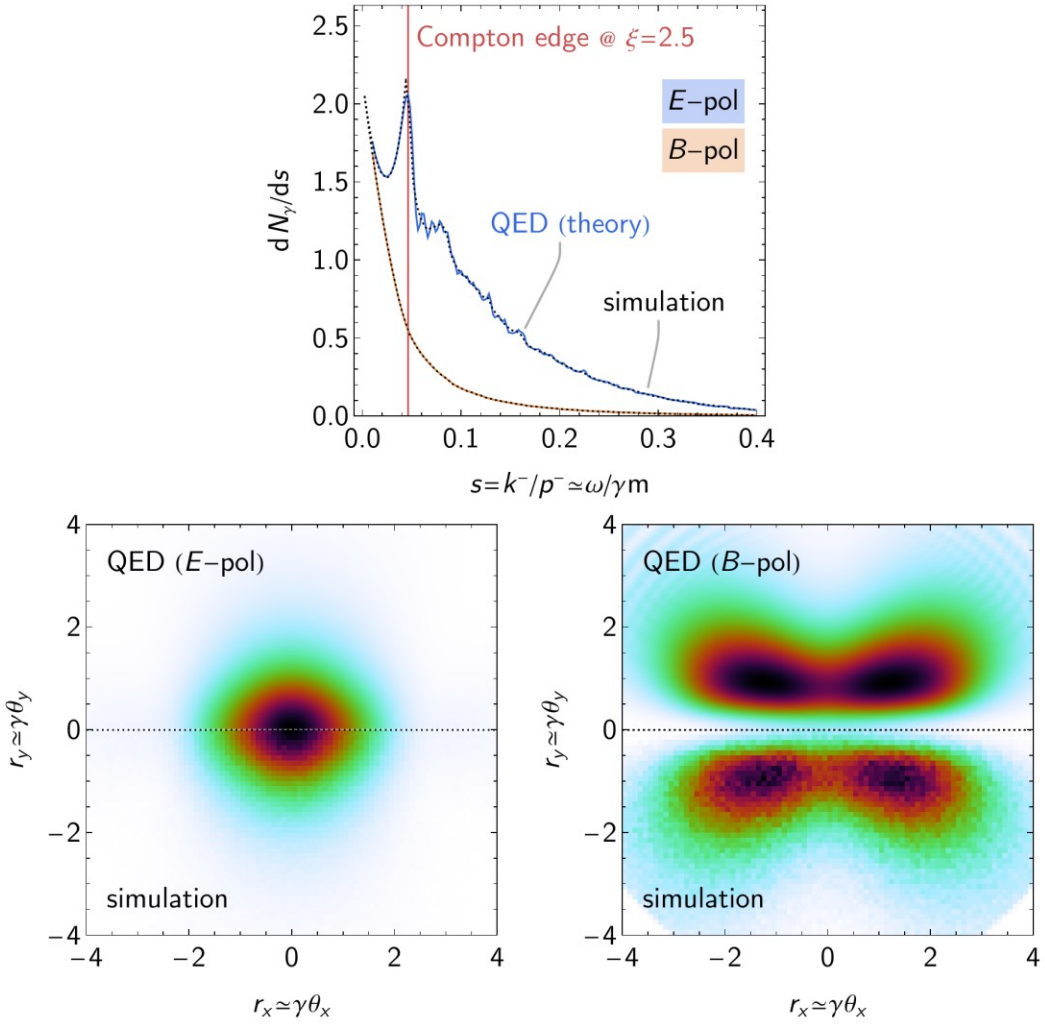
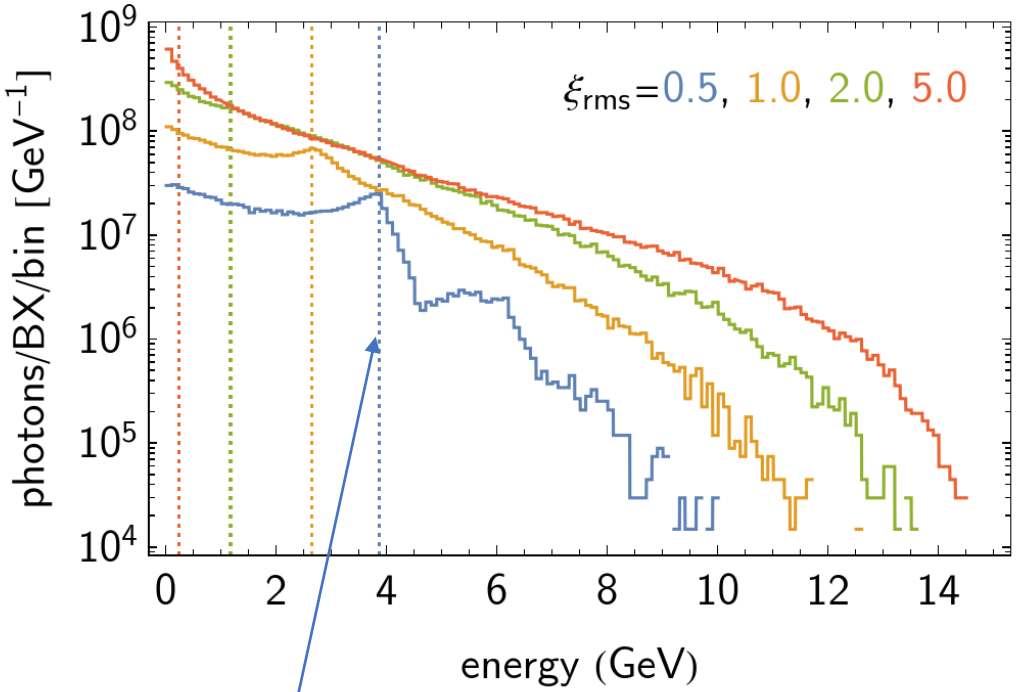
Nonlinear Compton scattering in LP backgrounds



- Implemented photon emission in LP lasers
  - Under LMA, accurate over full range of ξ
  - And LCFA, accurate for ξ > 5..10
  - Resolved in polarization of emitted γ's and averaged over electron spins.
- Benchmarked against QED for monochromatic electrons + plane-wave laser pulses (data from Ben King and Suo Tang)

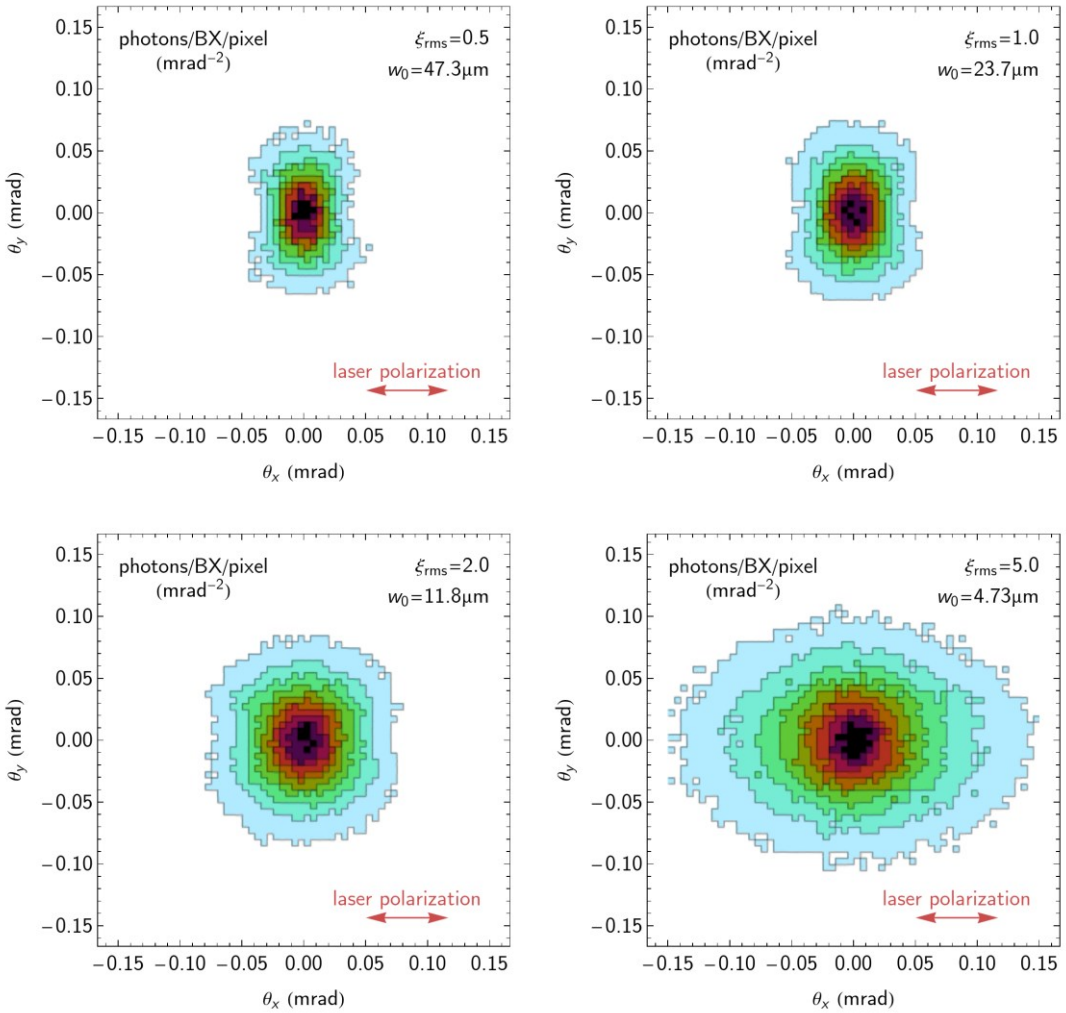
Nonlinear Compton scattering in LP backgrounds



$$\frac{E_{\text{edge}}}{E_{\text{initial}}} = \frac{2\eta}{1+2\eta+\xi_{\text{rms}}^2} = \frac{2\eta}{1+2\eta+\xi^2/2}$$

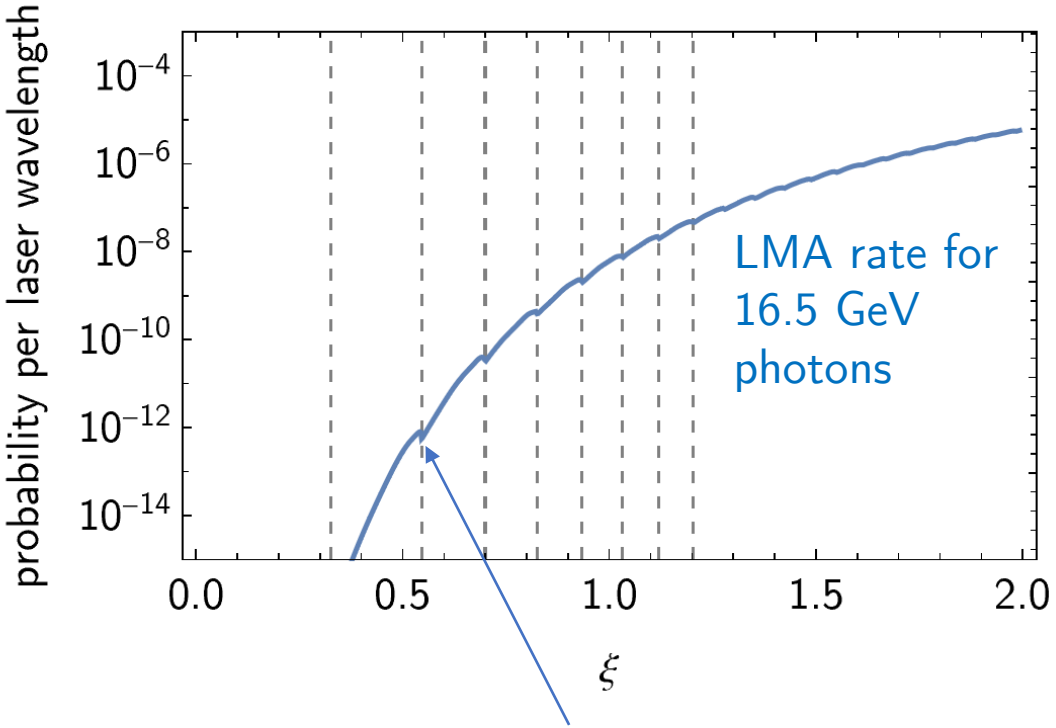
- Data available for photon emission for phase-0 laser parameters, under `/nfs/dust/luxe/MCProduction/Signal/ptarmigan-v0.9/e-laser/phase0/gbp`
- NB: Files labelled by root-mean-square ξ, which differs from the peak ξ by a factor of sqrt(2).
- Results for LP and CP lasers at the same ξ are comparable, because laser spot size is the same.

Nonlinear Compton scattering in LP backgrounds



- Transition from perturbative to nonperturbative visible in γ-ray angular profiles
- Dipolar for small ξ (elongated perpendicular to laser polarization)
- Increasingly elliptical + elongated along the polarization direction as ξ increases
- Comparison to earlier LCFA results needed

Nonlinear Breit-Wheeler in LP backgrounds



kinks/steps in rate originate from additional harmonics crossing the centre of mass threshold ("channel opening")

- Implementation of pair creation rates (under LMA, LP lasers) underway.
- LCFA rates already available, likely to be accurate in high ξ regime.
- Polarization-resolved rates unnecessary for CP backgrounds.
- Needed for LP backgrounds, where the correction is 10-20% in size.

Summary

- Simulations of interactions with linearly polarized lasers require implementations of:
  - Photon emission, γ-polarization resolved (e-laser): complete
  - Pair creation, γ-polarization averaged (brem γ-laser): WIP
  - Pair creation, γ-polarization resolved (e-laser)

- Benchmarking with QED indicates good accuracy across the necessary range of ξ.

- For gamma profiler, now possible to compare more accurate LMA-based simulations with earlier LCFA-based results.