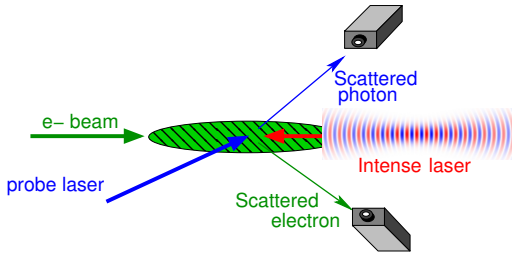
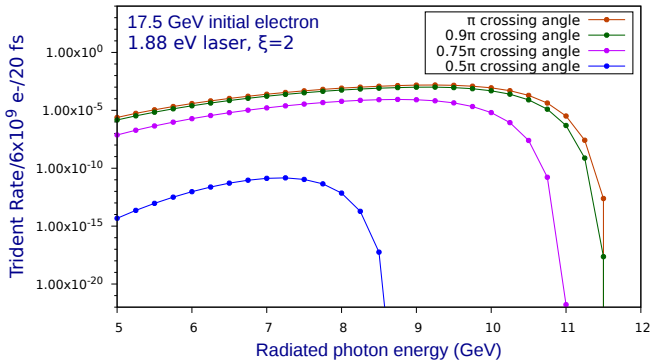
# OPPP crossing angle study

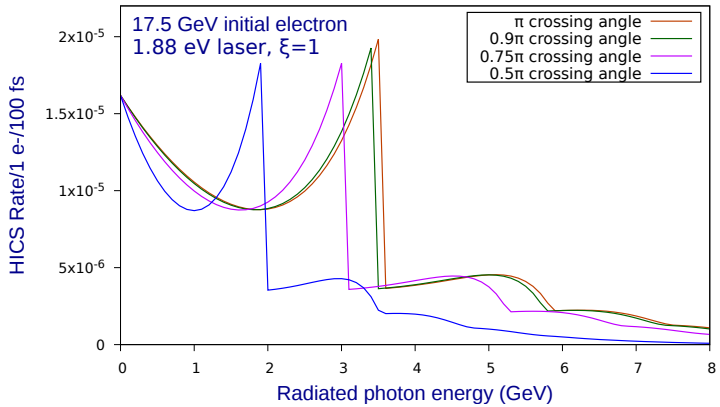
- Crossing angle between strong laser and oncoming electron beam (head on corresponds to $\pi$)
- Analytic study assumes perfect beam overlap and constant laser intensity
- HICS rate produces half energy radiated photons at $\pi/2$
- Pair production rate is best for head on collision, $0.5\pi$ sees rate fall off by several orders of magnitude (unworkable at LUXE)



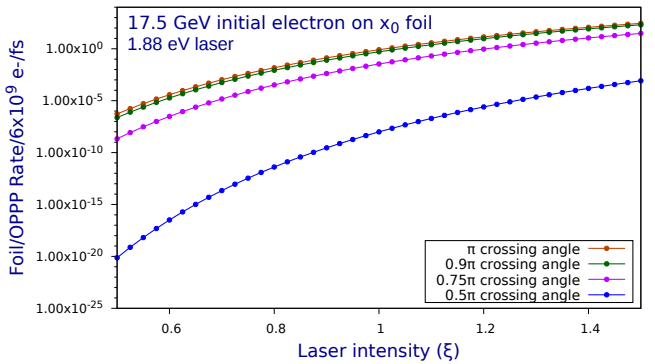

2 step Trident rate vs intermediate photon energy




HICS rate vs radiated photon energy



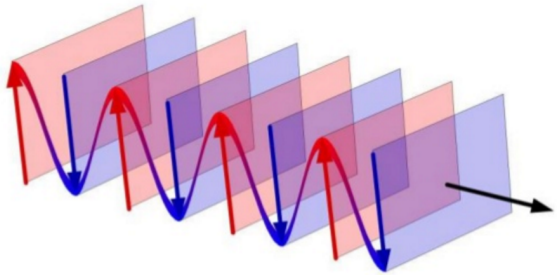

Foil bremsstrahlung/OPPP rate vs xi



# Exact solutions for realistic laser pulses

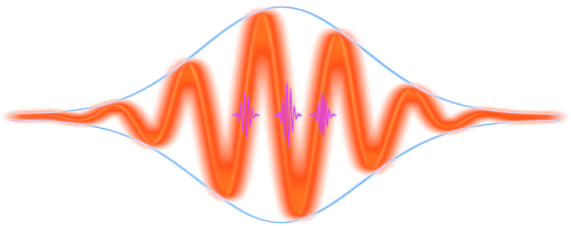
circularly polarised plane wave

$$A_\mu^{\text{PW}} = a_{1\mu} \cos k\cdot x + a_{2\mu} \sin k\cdot x$$



Gaussian pulse, $\tau$

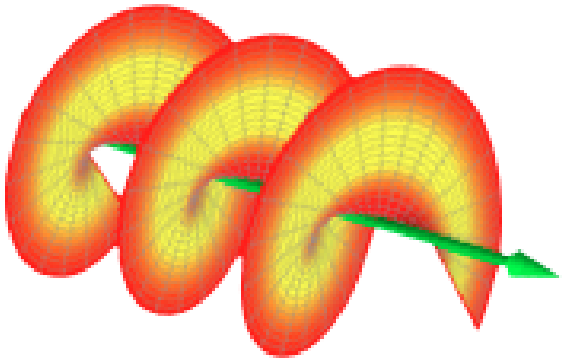
$$A_\mu^{\tau} = e^{-k\cdot x/\tau^2} A_\mu^{\text{PW}}, \quad \tau \text{ is pulse length}$$



Twisted photons

$$A_\mu^{\text{TW}} = \int \frac{\mathrm{d}k_\perp}{(2\pi)^2} \epsilon_{k\Lambda\mu}\, a_{\kappa m}\, e^{-ik\cdot x}, \quad a_{\kappa m} = \frac{\sqrt{2\pi}(-i)^m}{\sqrt{\kappa}} e^{im\phi_{\mathrm{k}}}\, \delta[\kappa - |k_\perp|]$$

$m$ = helicity mode, $\kappa$ = conical momentum spread



Electromagnetic fields at a strongly focussed laser pulse are highly non trivial

**New dirac equation solutions required!**

# Bound Dirac equation solutions in any intense electromagnetic field

- **Bound Dirac Lagrangian** for electrons in external fields
- **Volkov solution** (one plane wave external field) ensures local gauge invariance
- There is a whole family of **locally gauge invariant** solutions
- **Rotational symmetry** allows solutions in two external fields propagating in any direction
- **New solutions now available**, Calculate new transition probabilities and study!