Compton Edge and Frequency doubling considerations

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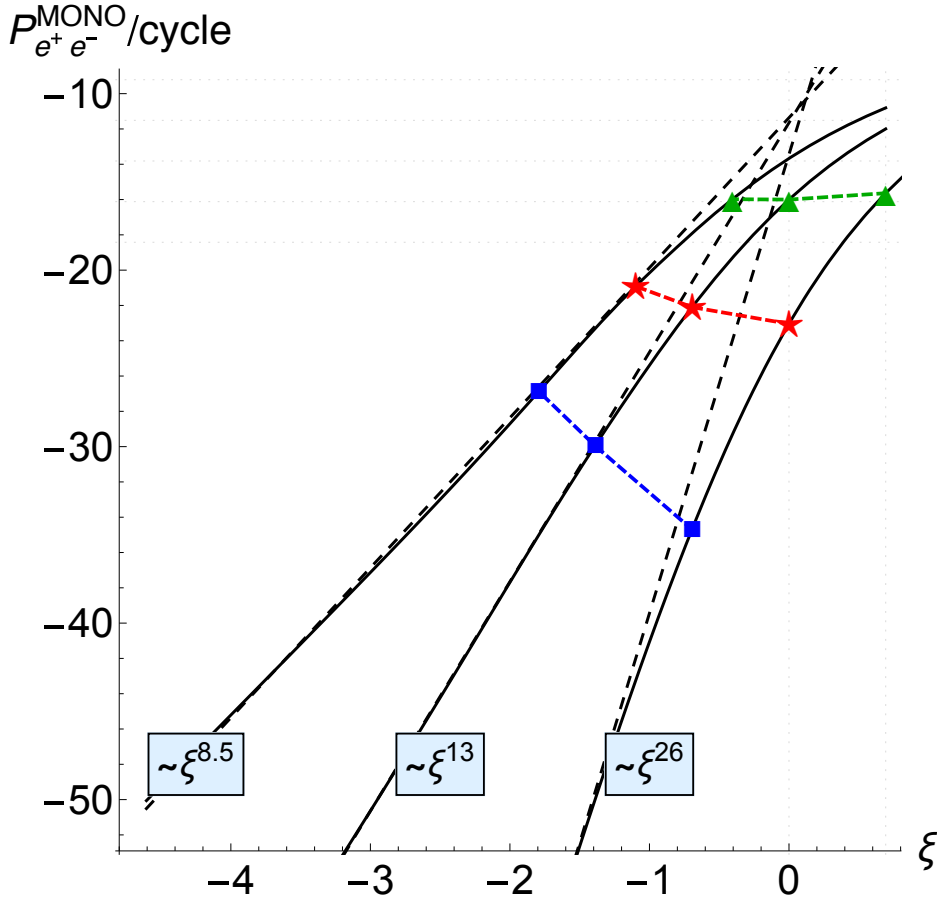
- Update on increasing laser frequency
- Compton edge in short pulses

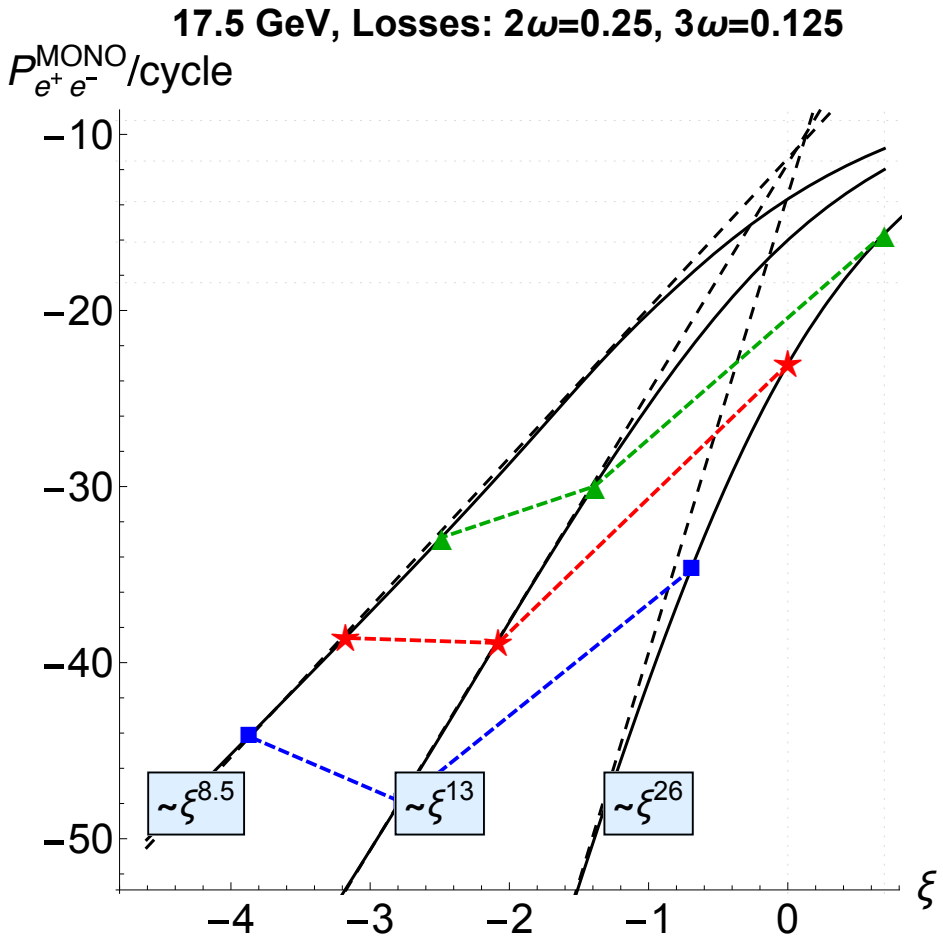
Increasing laser frequency: Pair creation

Assuming no losses in frequency conversion process ($17.5\,\mathrm{GeV}$ γs):



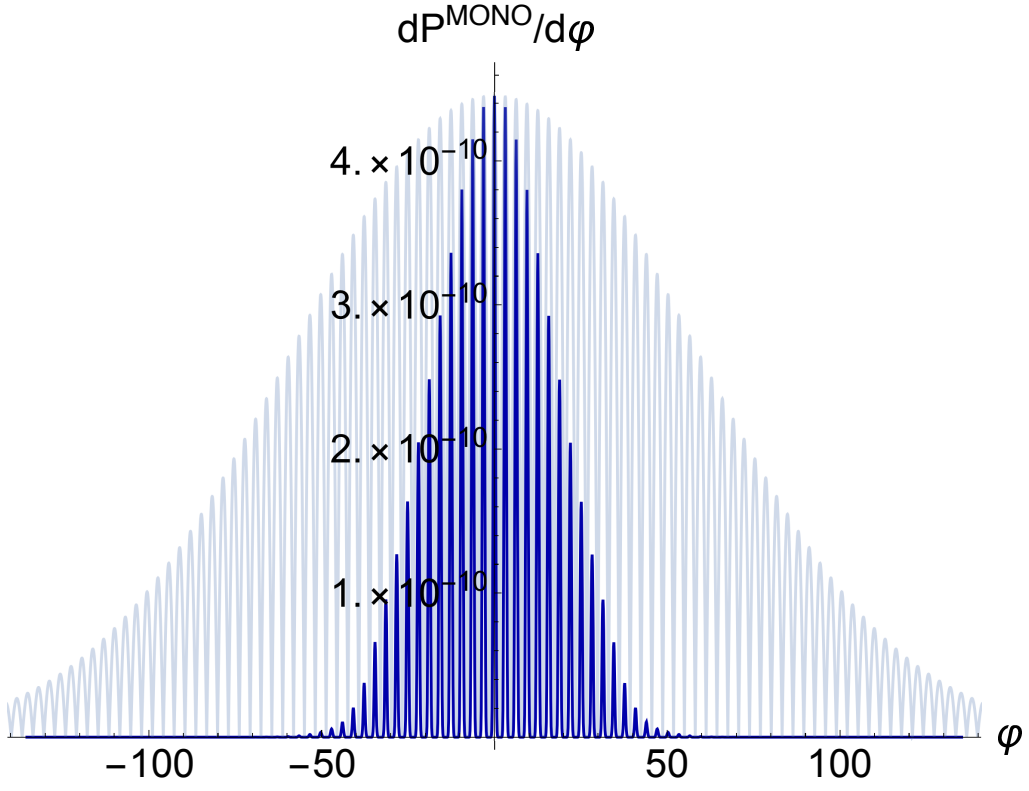
- Clear advantage to increasing the frequency of the laser for intensities $\xi \lesssim 2$

Assuming realistic losses in frequency conversion process:

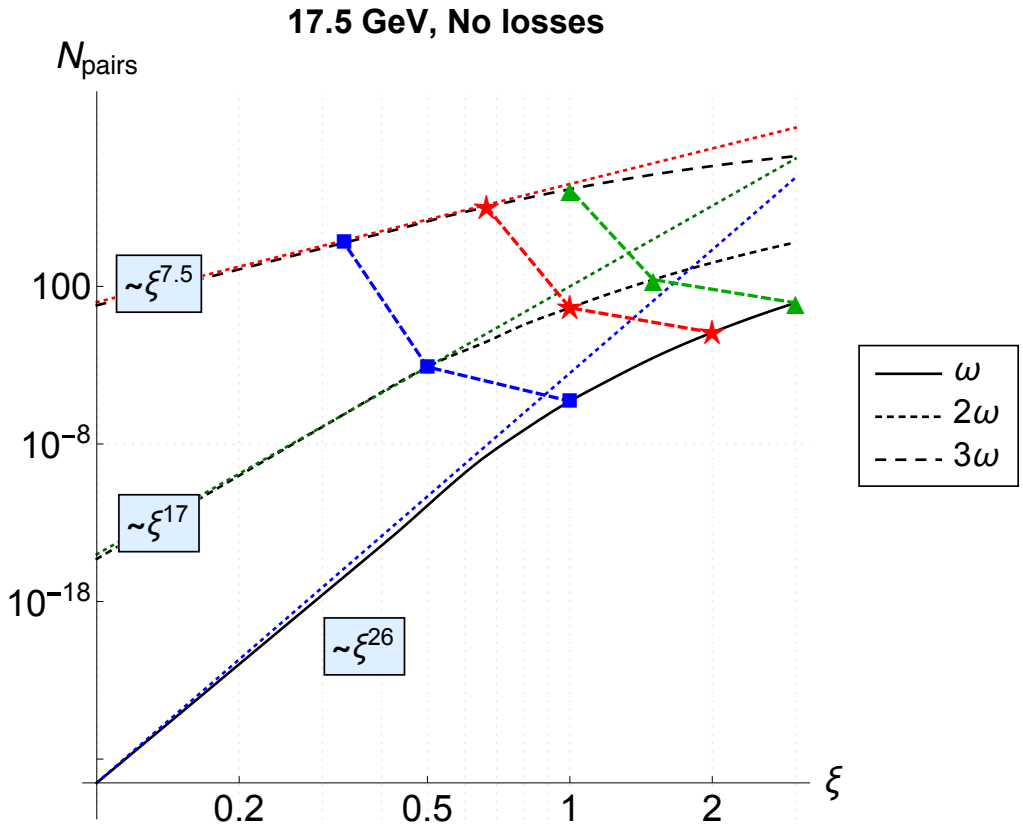


- Advantage of frequency-increasing, is neutralised by losses.

Integrating each case over 35 fs pulse (shown here e.g. second harmonic):

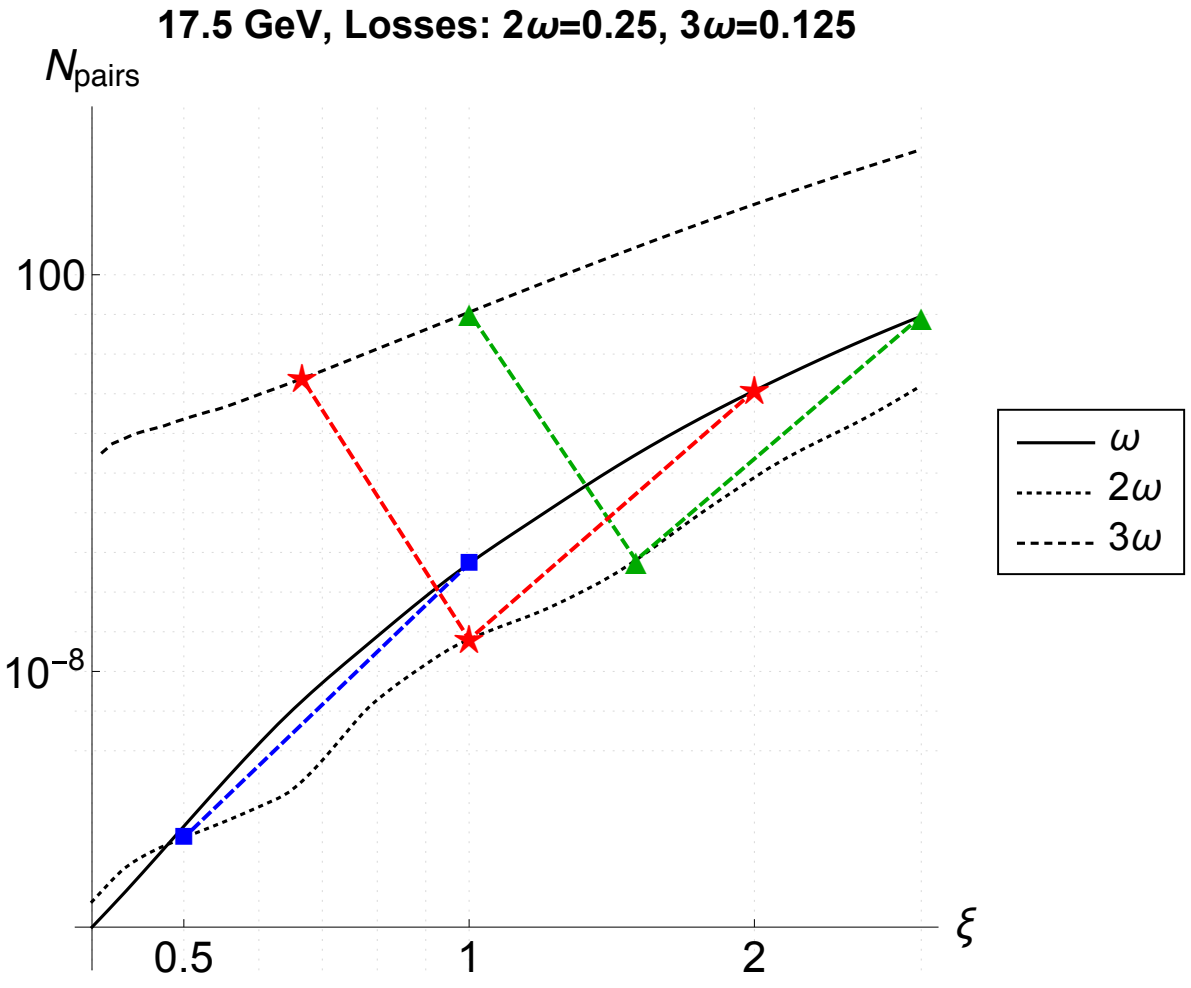


Integrating over 35 fs pulse assuming no losses:



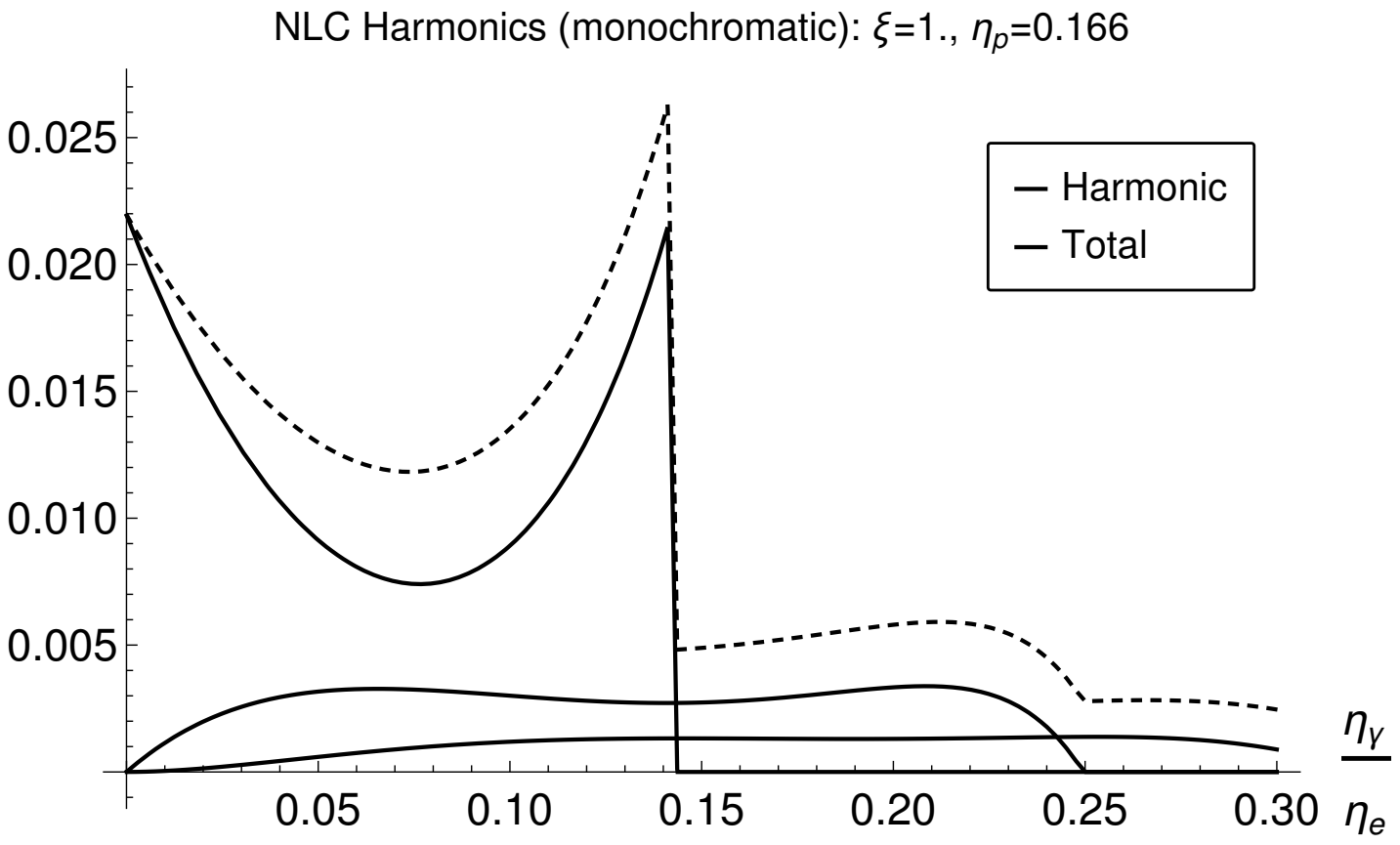
- Even more of an advantage of frequency-increasing

Integrating over 35 fs pulse assuming realistic losses:

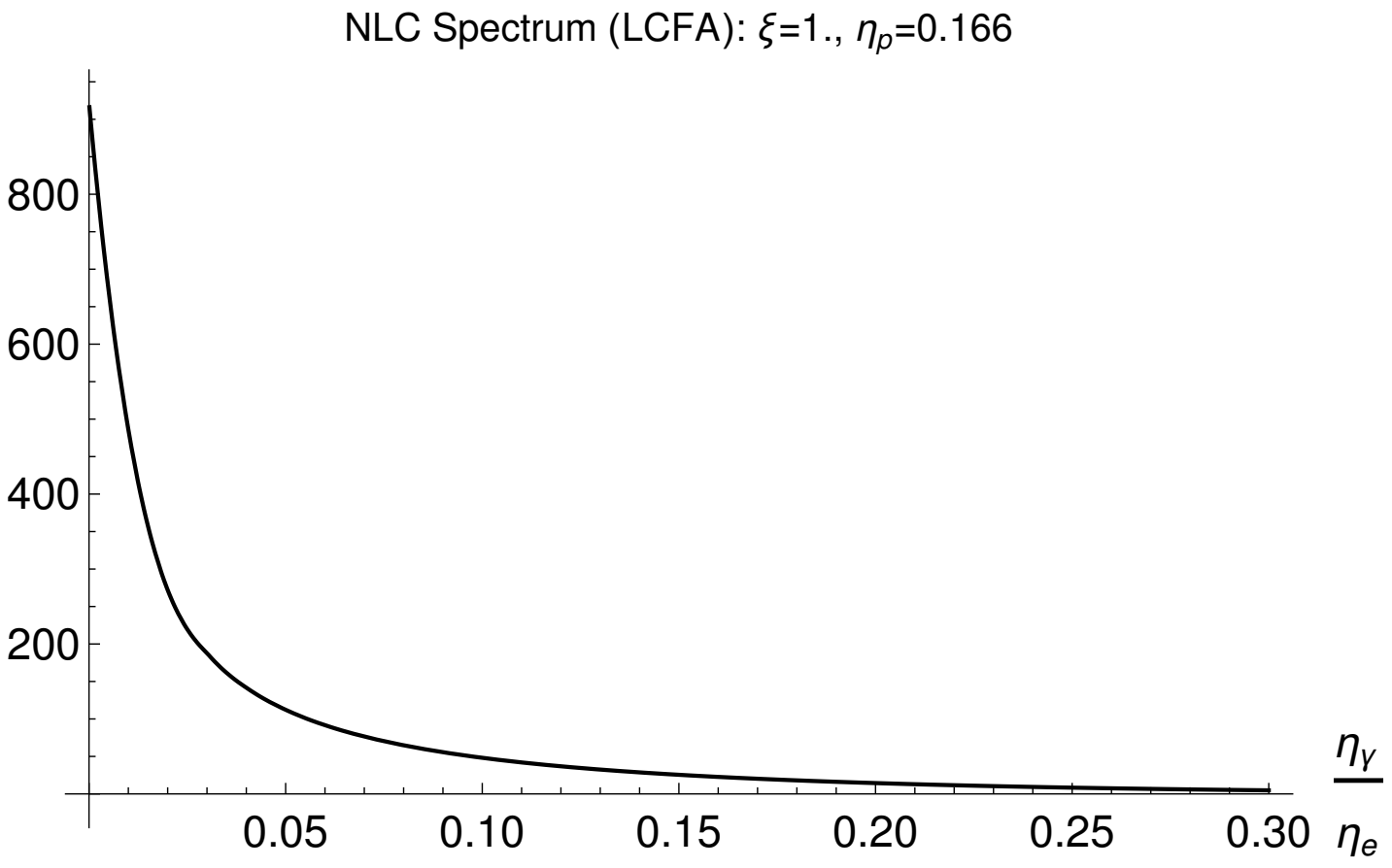


- Advantage of frequency-increasing to 2ω is neutralised by losses, but not to 3ω.

- For a given electron lightfront momentum (energy and angle), the pulse form determines the Compton spectrum

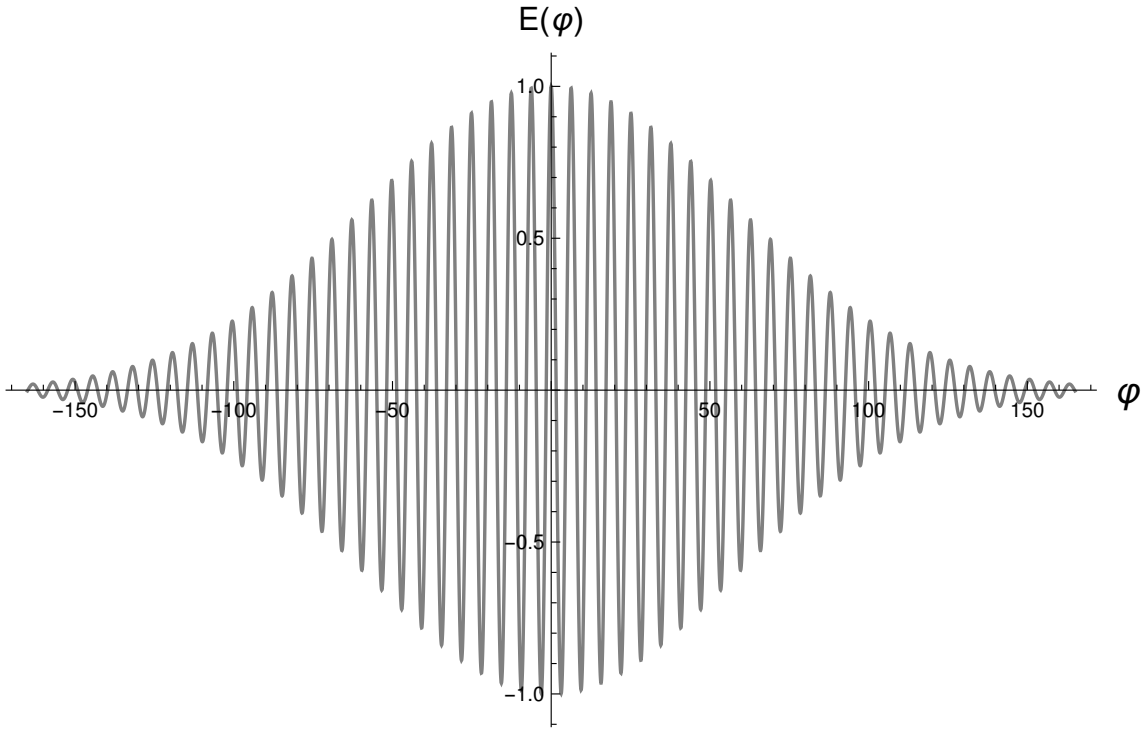


- For a given electron lightfront momentum (energy and angle), the pulse form determines the Compton spectrum



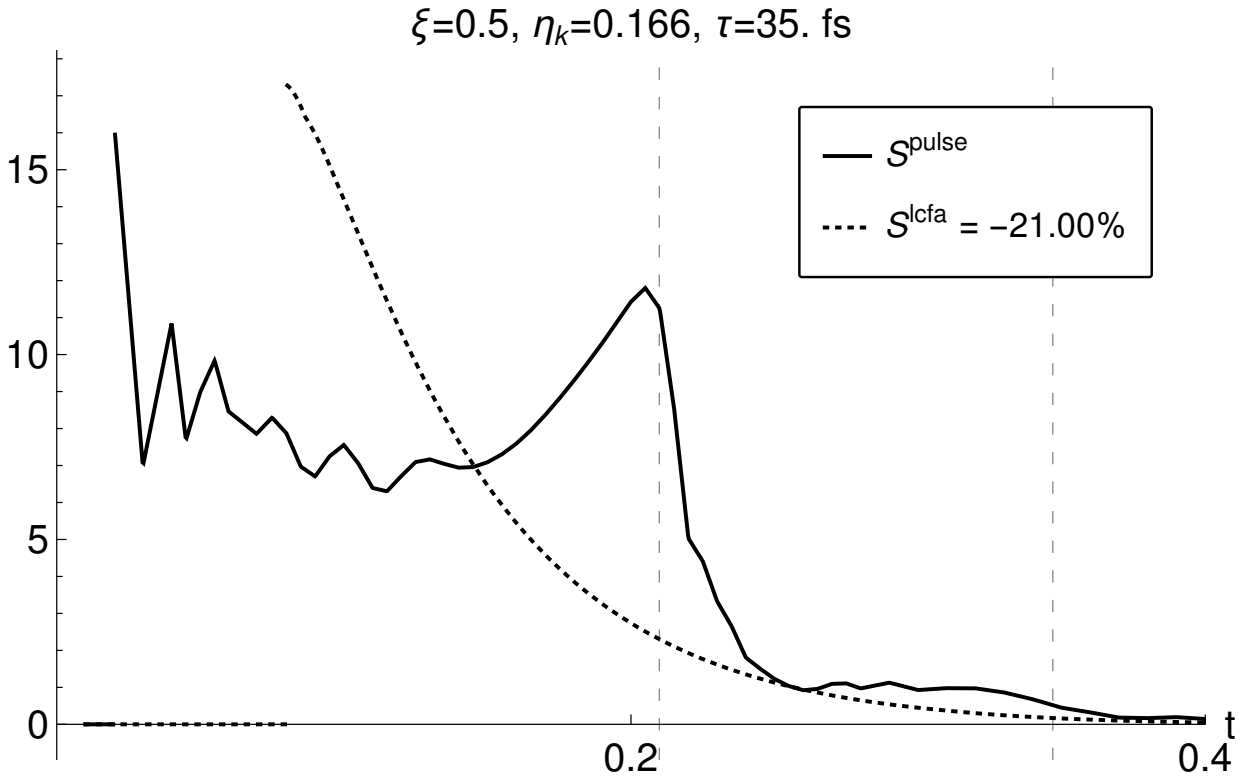
$$\mathsf{P} \quad = \quad -\frac{\alpha}{\eta_e}\frac{i}{2\pi}\int_0^1 ds \int \frac{d\varphi d\varphi'}{\varphi-\varphi'}\, \mathrm{e}^{\frac{i\,s}{2\,\eta_e(1-s)}\,\theta\mu(\theta)} \left\{1-\frac{[a(\varphi)-a(\varphi')]^2}{2}\left(1+\frac{s^2}{2(1-s)}\right)\right\},$$

$$s=\frac{\eta_\gamma}{\eta_e}; \qquad \theta=\varphi-\varphi'; \qquad \mu(\theta)=1-\langle\xi^2\rangle-\langle\xi\rangle^2$$



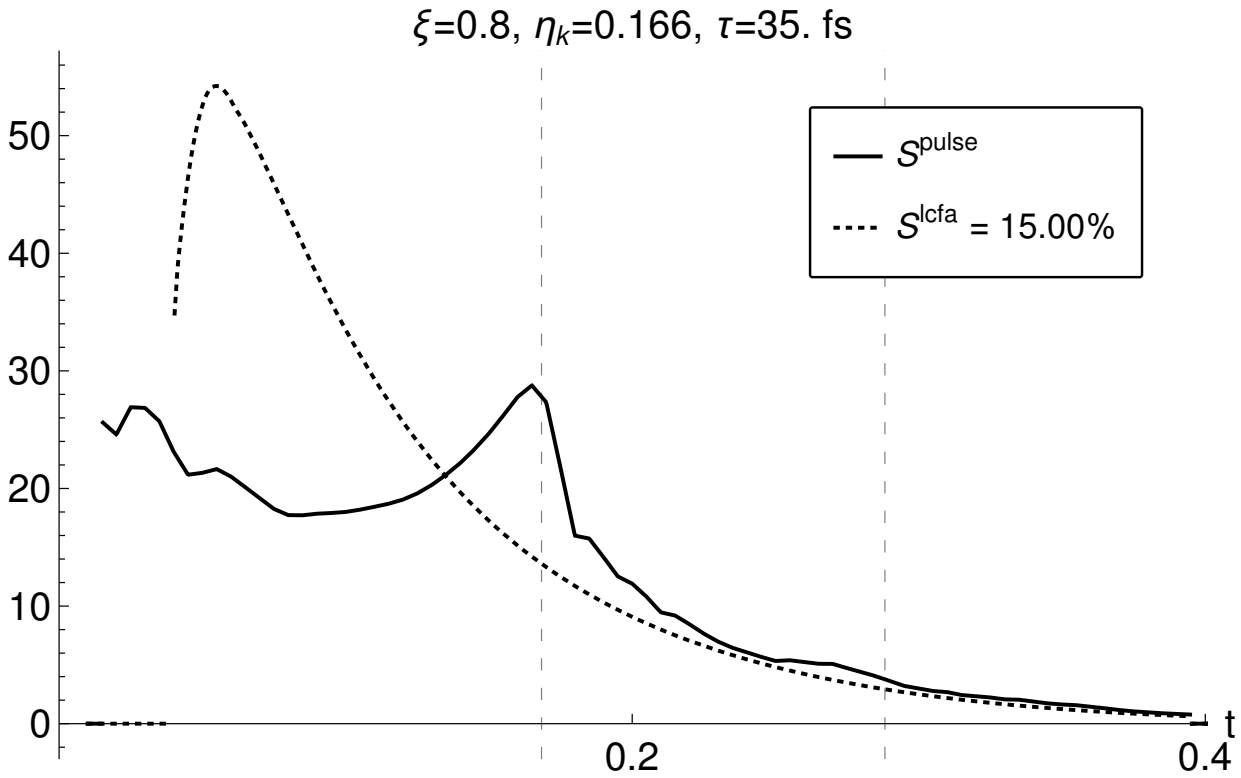
Changing ξ:

$\xi = 0.5$



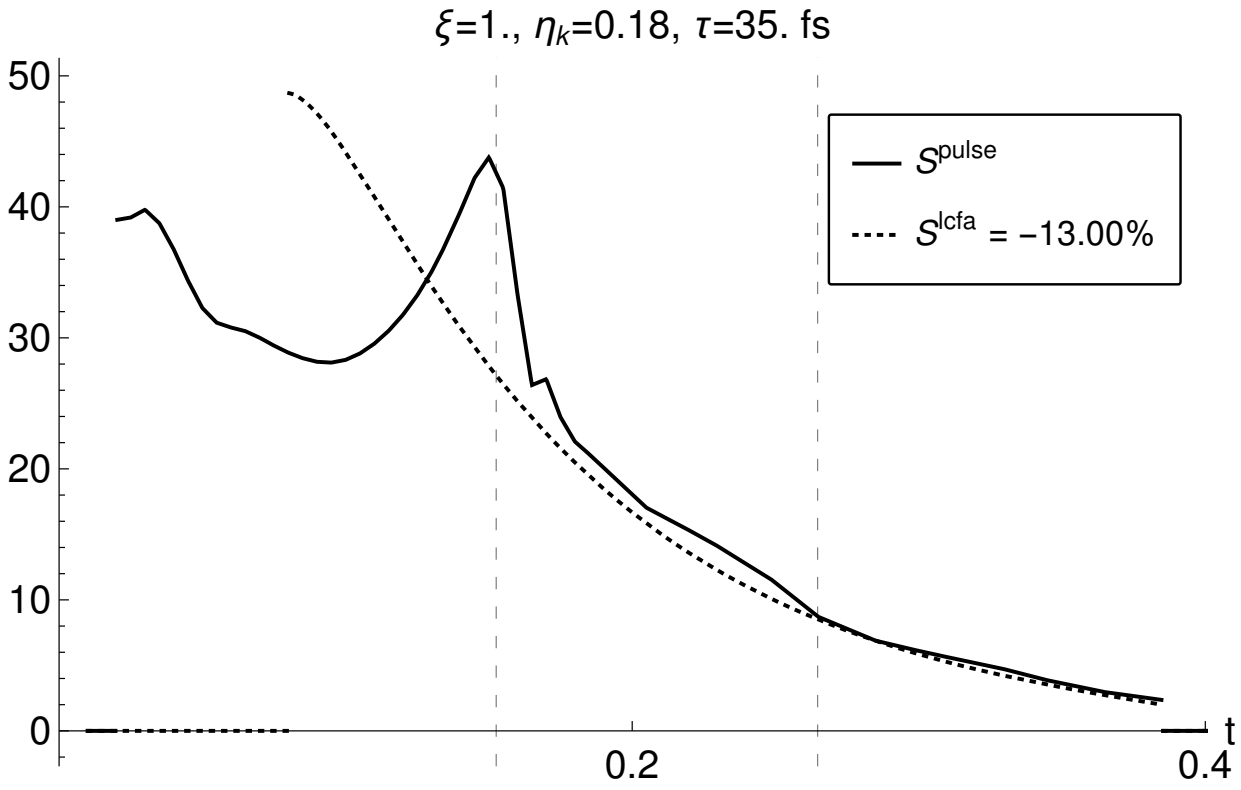
Changing ξ:

$\xi = 0.8$



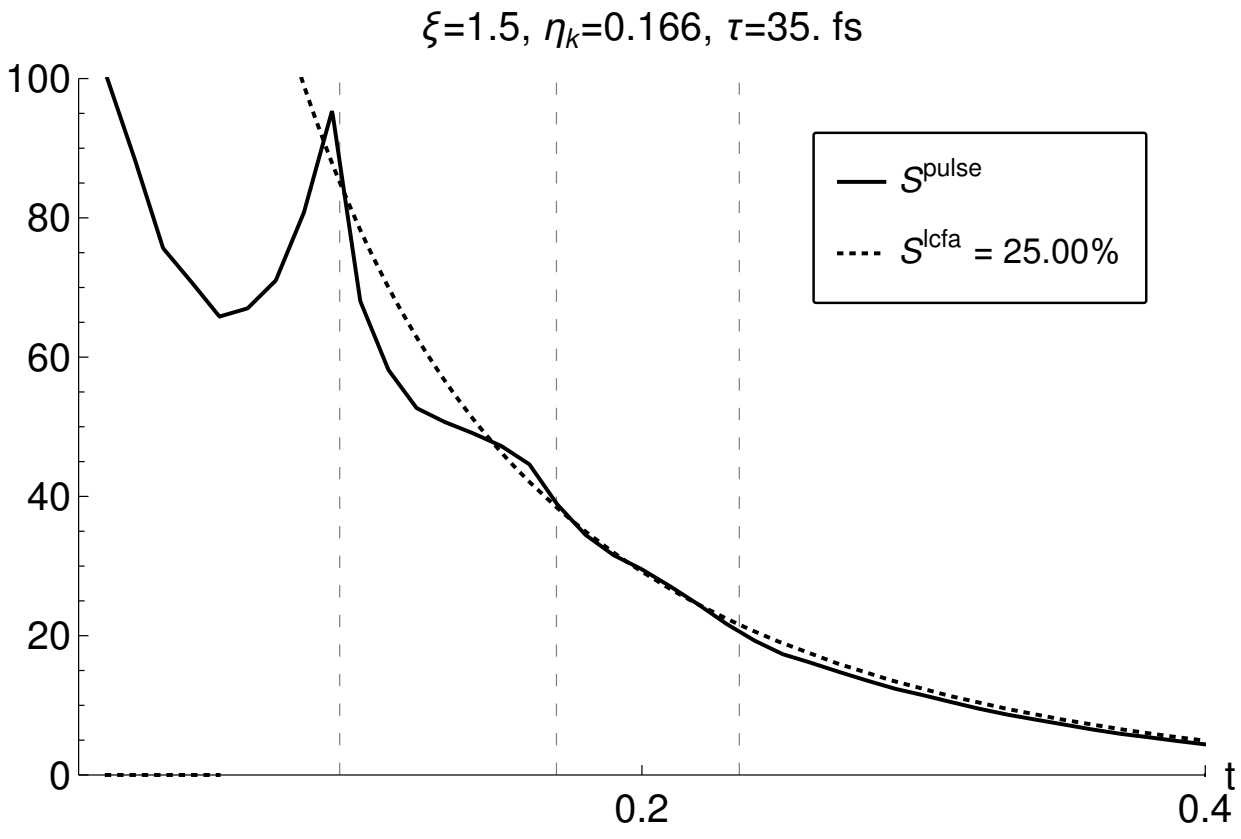
Changing ξ:

$\xi = 1$



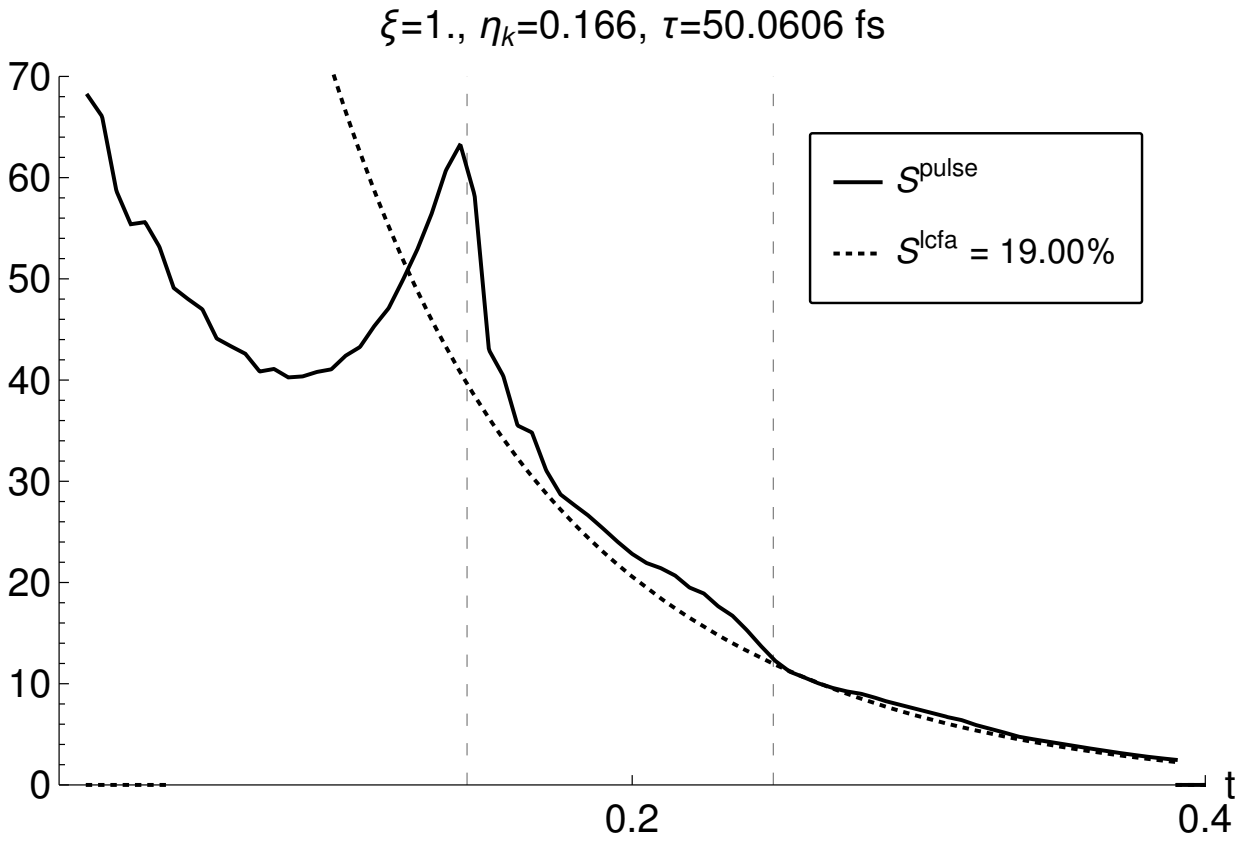
Changing ξ:

$\xi = 1.5$



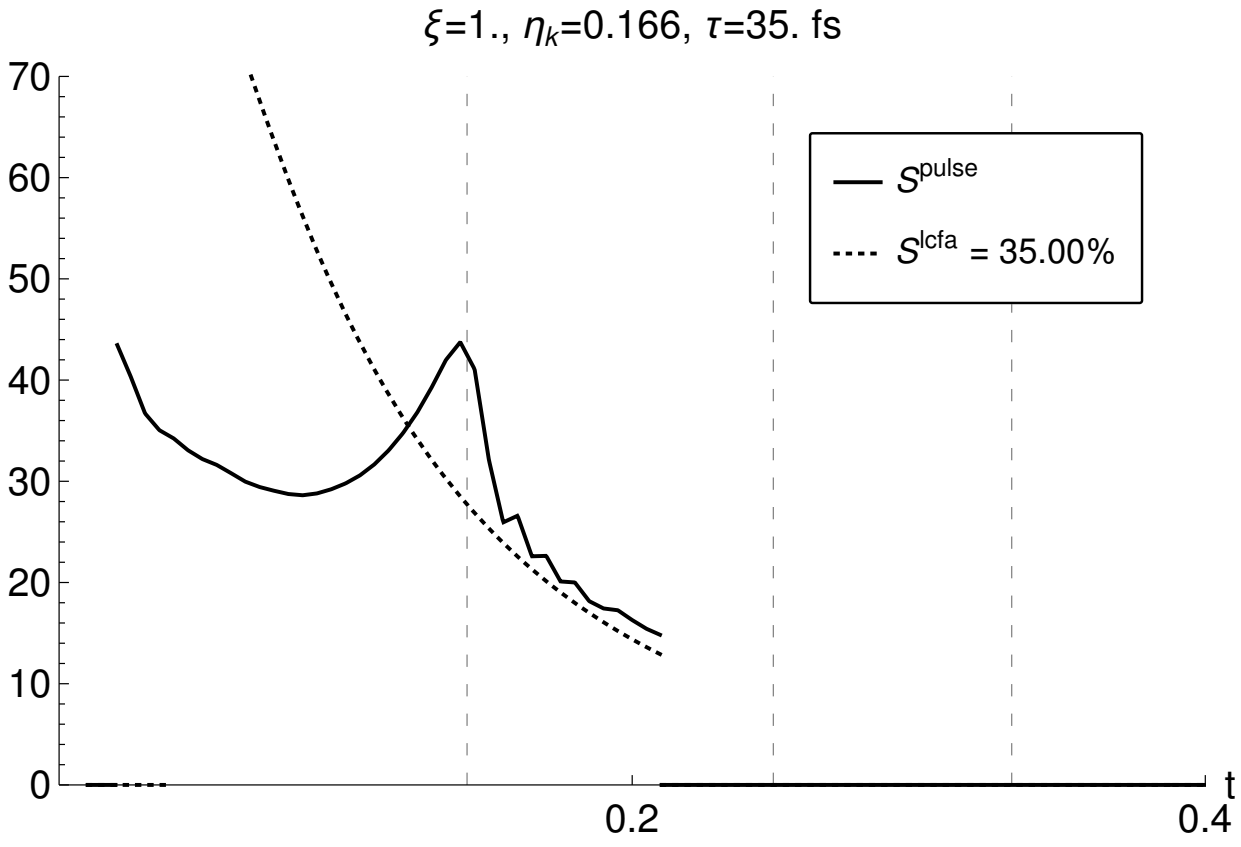
Changing τ:

$\tau = 50\,\mathrm{fs}$



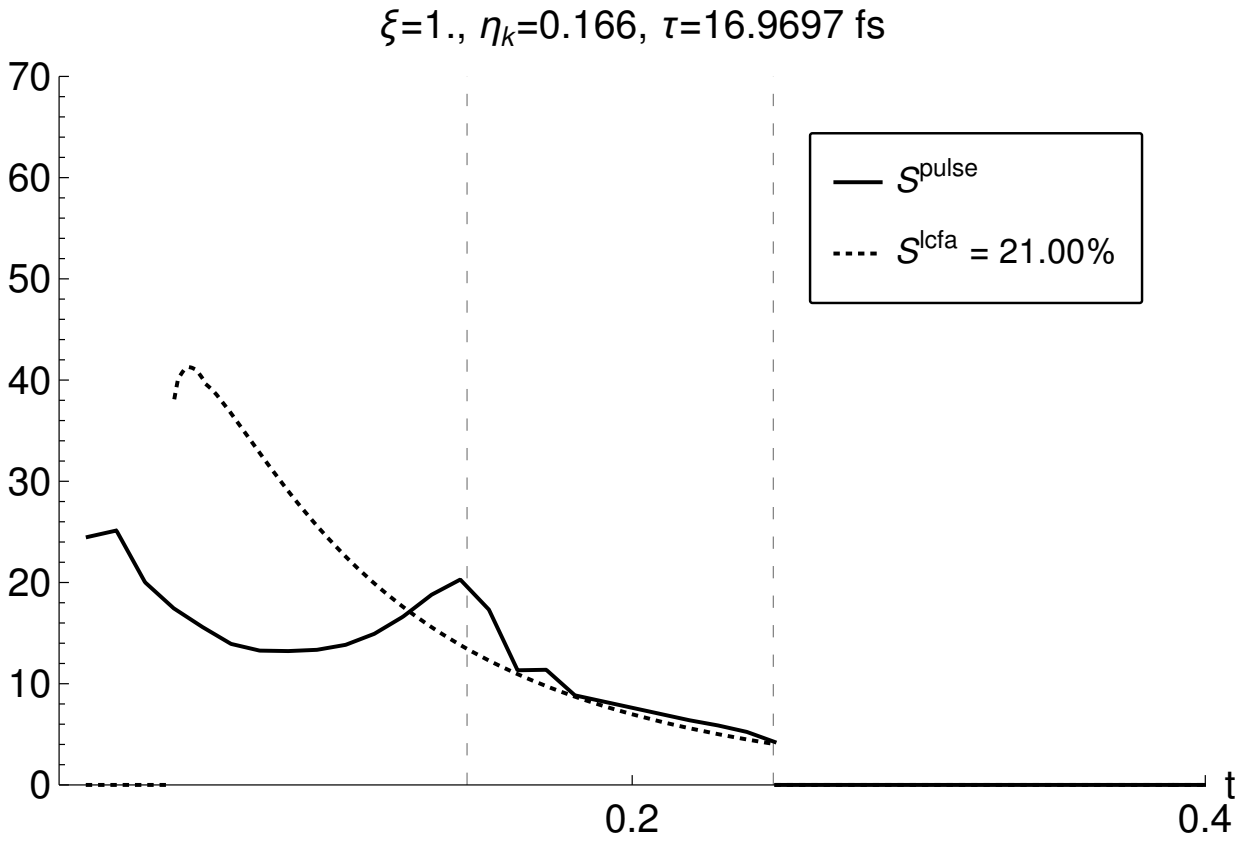
Changing τ:

$\tau = 35\,\mathrm{fs}$



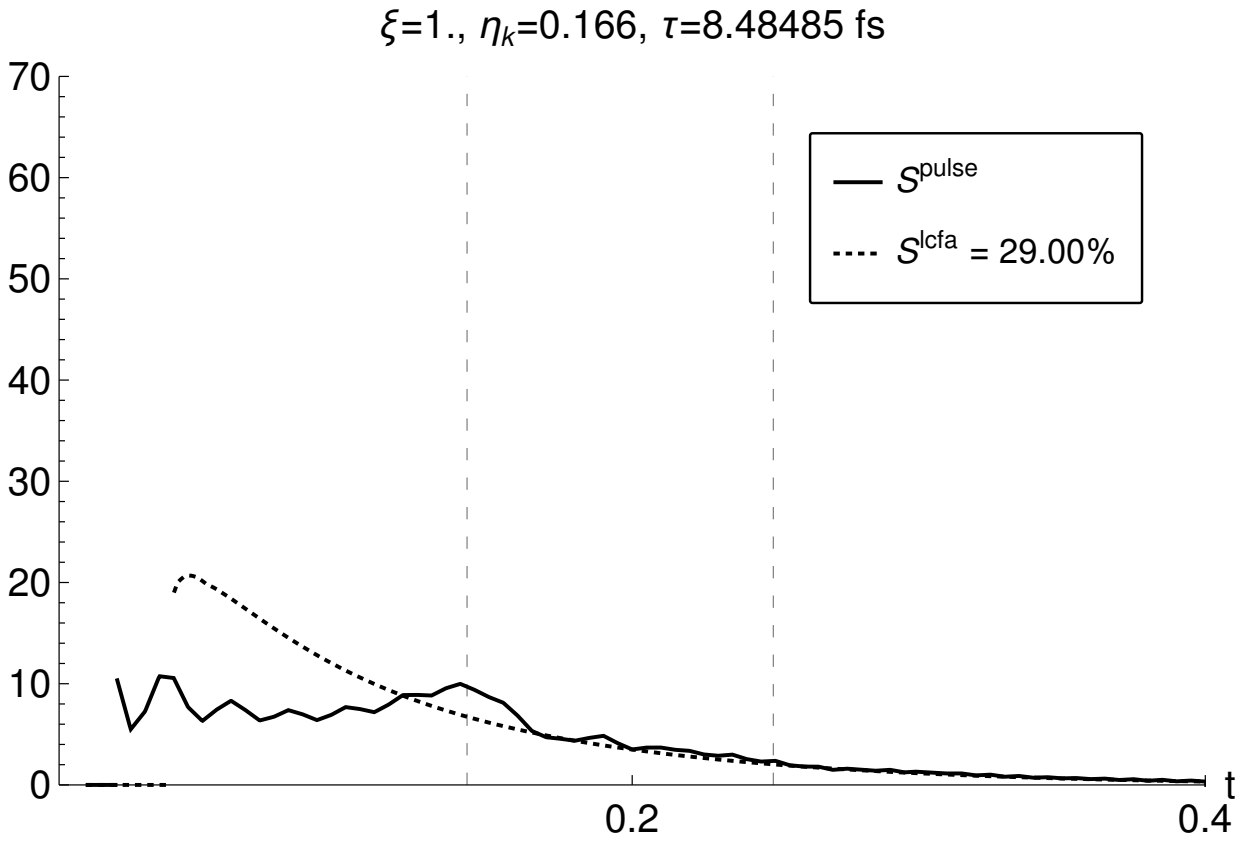
Changing τ:

$\tau = 17\,\mathrm{fs}$



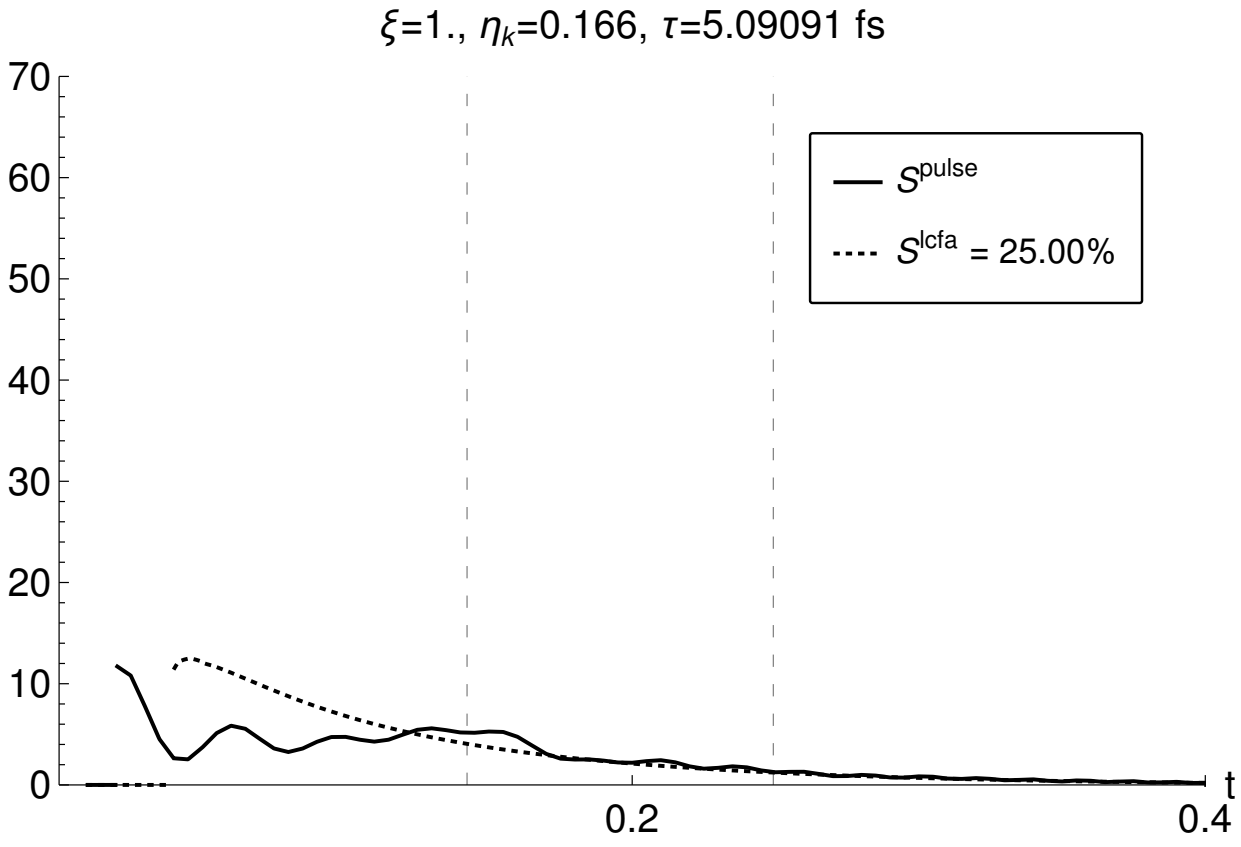
Changing τ:

$\tau = 8.5\,\mathrm{fs}$



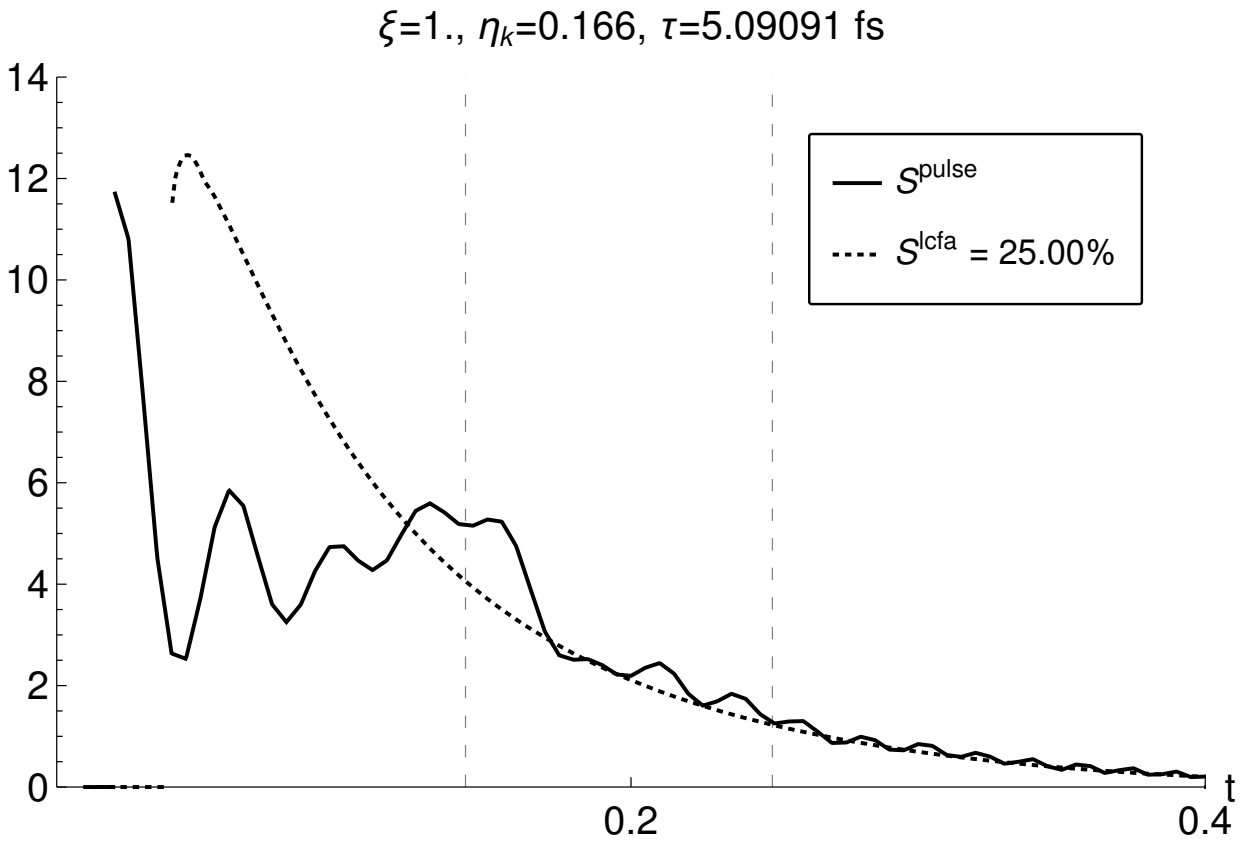
Changing τ:

$\tau = 5\,\mathrm{fs}$



Changing τ:

$\tau = 5\,\mathrm{fs}$



- Compton-edge washed out in ultra-short pulses.
- To do: finite focus effects.