Workshop UBA17
"Ultrafast Beams and Applications"
04-07 July 2017, CANDLE, Armenia

Phase peculiarities of Spectron: Numerical analysis

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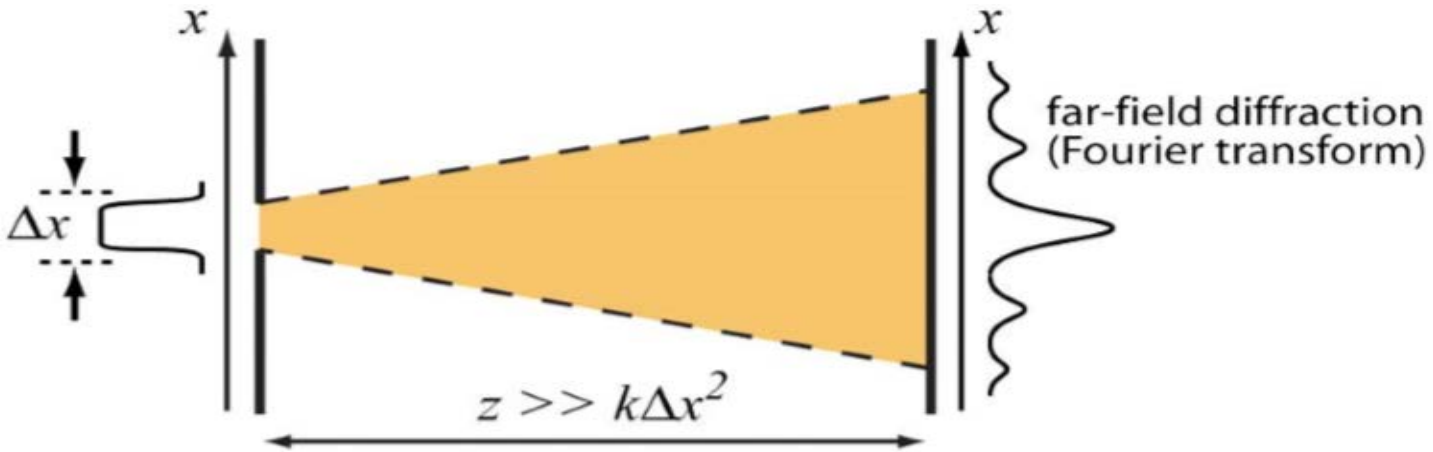
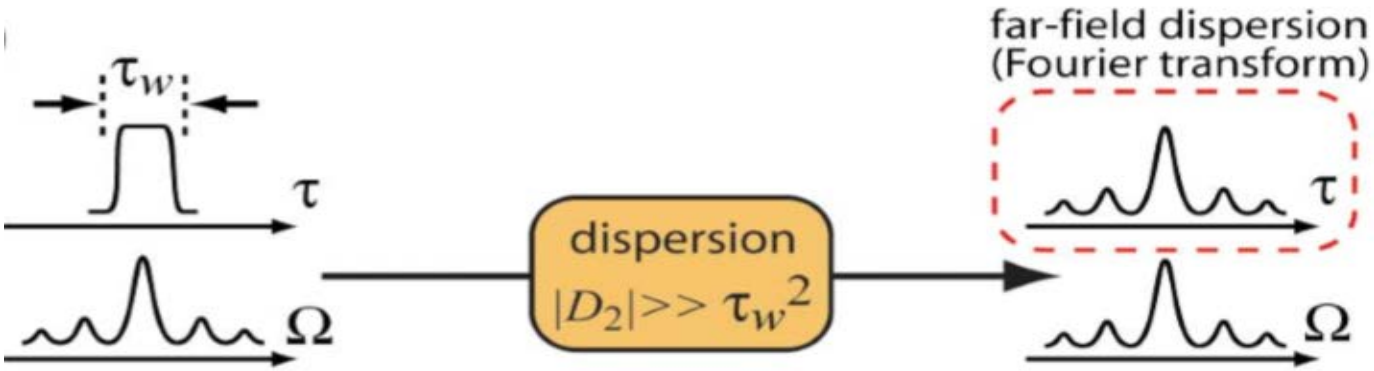
Concept of the spectron pulses: space-time duality





Research objectives

- Study the phase of the spectronic pulses
- Find the amount of dispersion necessary for the mimicking between spectron phase and initial spectral phase

Analytical discussion of spectron generation

Dispersion equation:

$$\frac{\partial A}{\partial z} = -\frac{i}{2} k_2 \frac{\partial^2 A}{\partial \eta^2}$$

$$A(z,\eta) \approx \frac{1}{(i2\pi k_2 z)^{1/2}} exp\left(-\frac{i\eta^2}{2k_2 z}\right) \widetilde{A}(0,\Omega) \quad \text{when } z \gg L_D = {\tau_0}^2/k_2$$

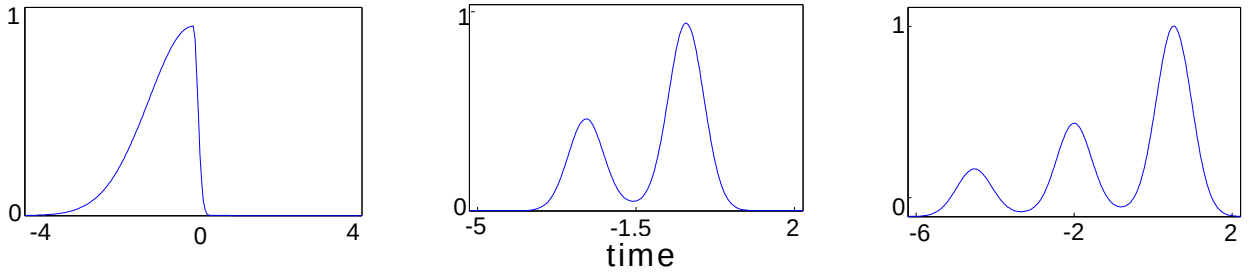
$$|A(\eta,z)| \propto \left|\widetilde{A}(\Omega,0)\right| \qquad \Omega = \eta/k_2 z$$

$$\varphi(\eta,z) \approx -\frac{\Omega^2 z k_2}{2} + \widetilde{\varphi}(\Omega,0)$$

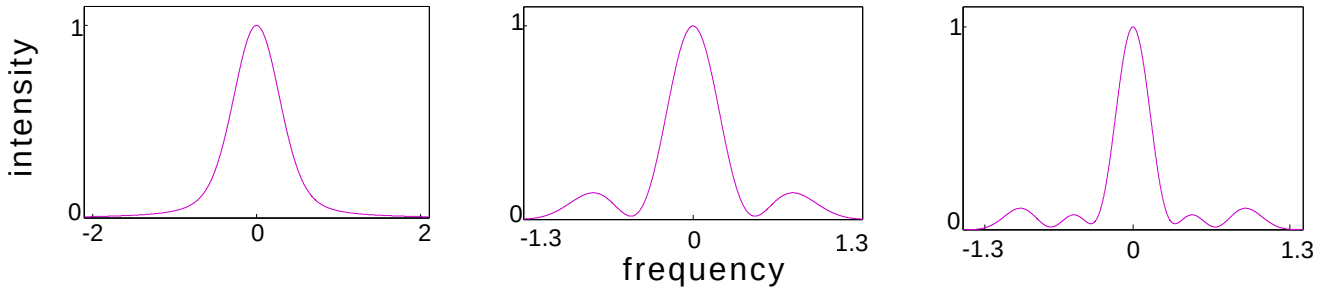
A – complex amplitude
z – spatial coordinate
η – retarded time
k_2 – second order dispersion coefficient
τ_0 - transform-limited pulse width

Spectron shaping from various seed pulses

initial pulse

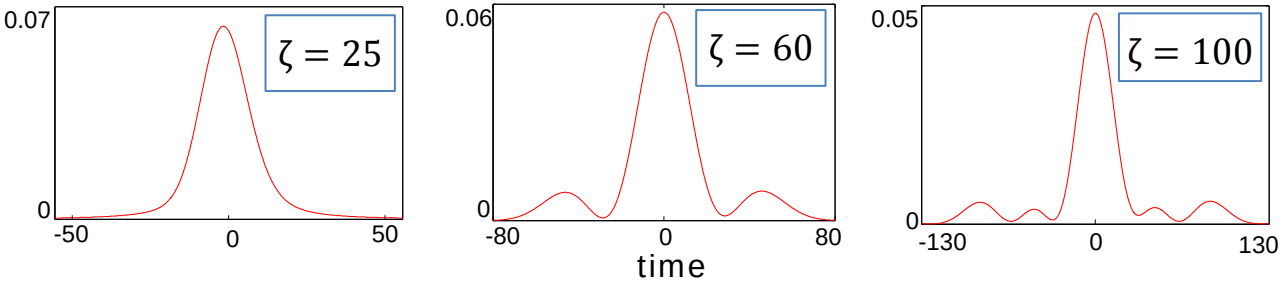


spectrum



spectron pulse

$(\zeta = z/L_D)$

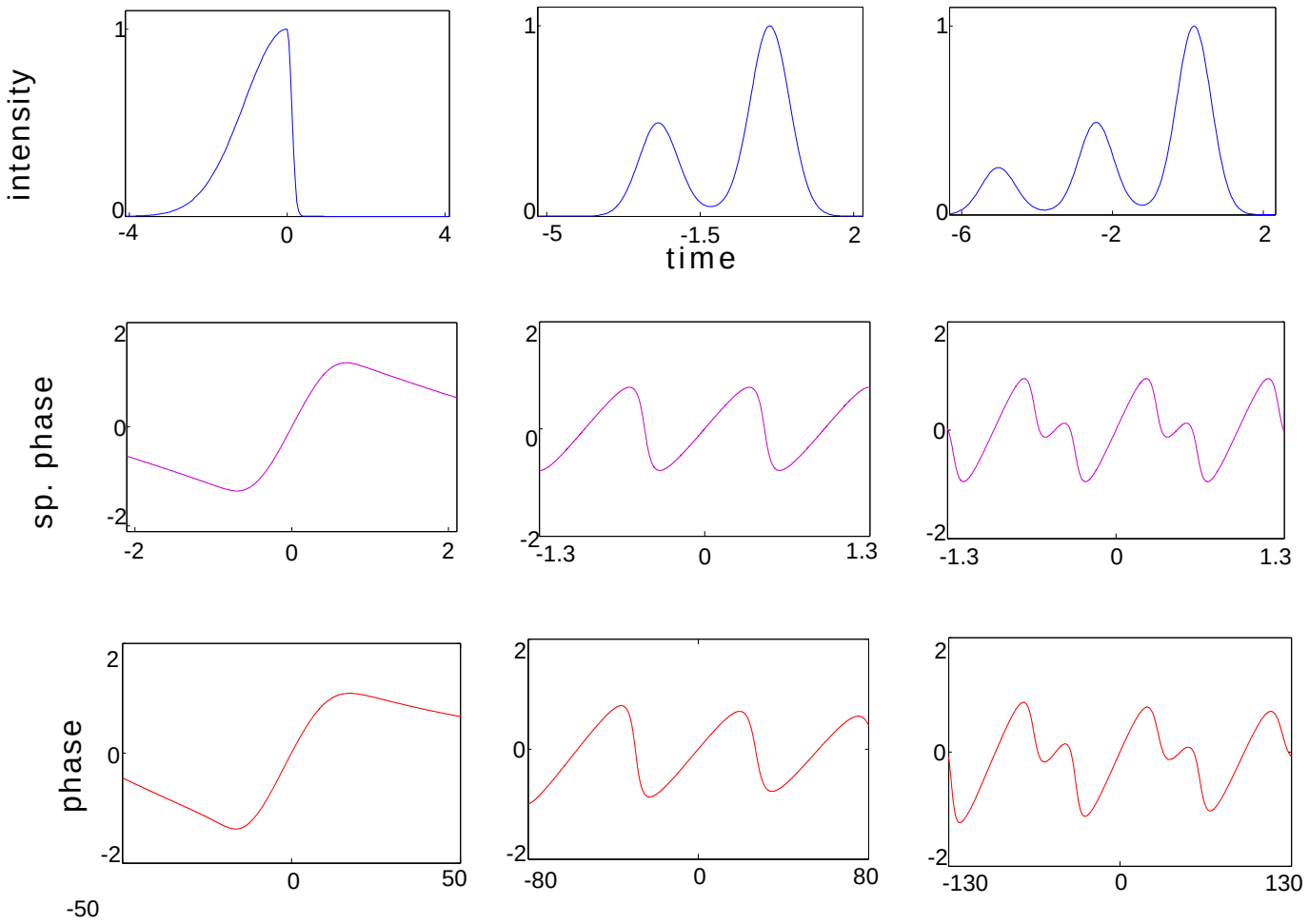


Phase of spectron

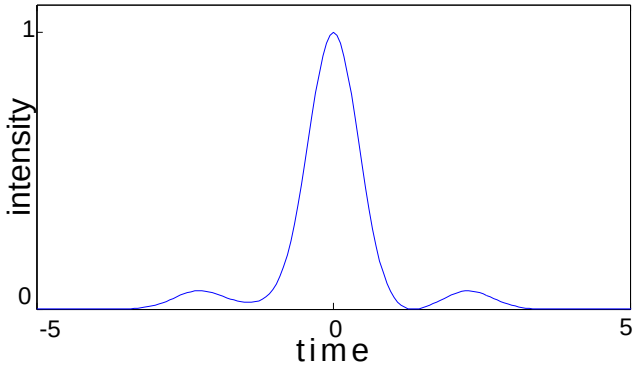
initial pulse

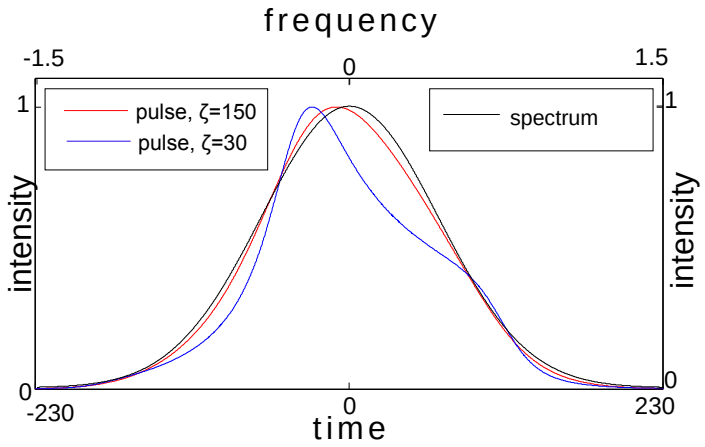
initial spectral phase

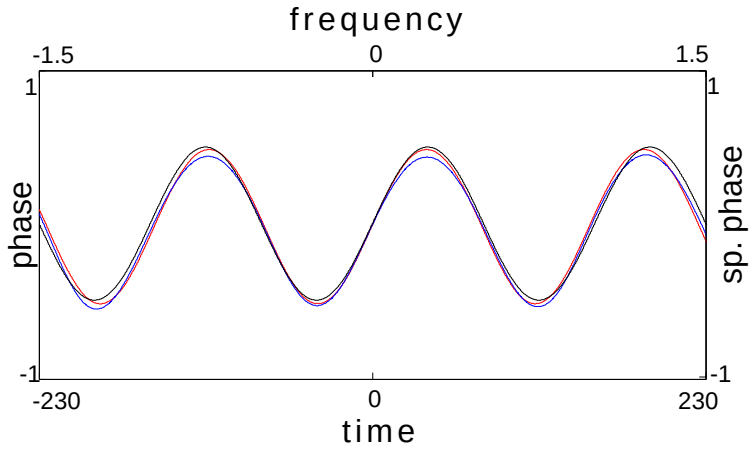
spectron's temporal phase



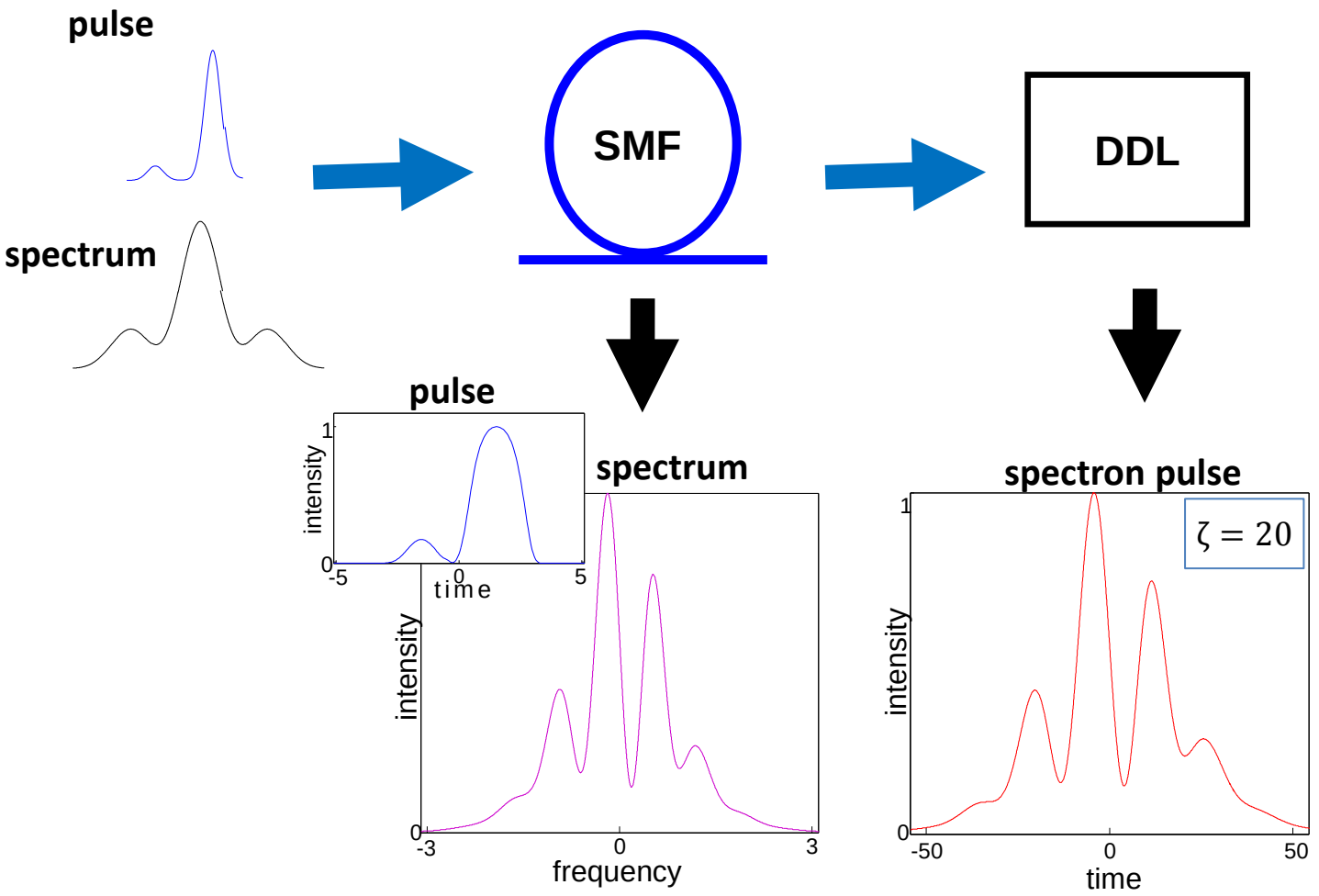
Spectron shaped from seed pulse with sinusoidal spectral phase



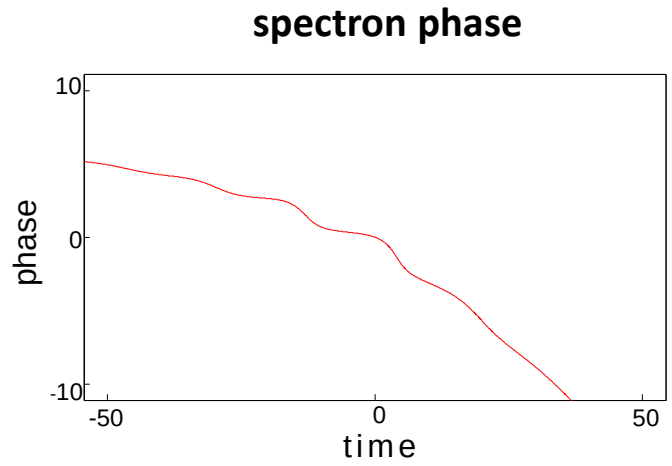


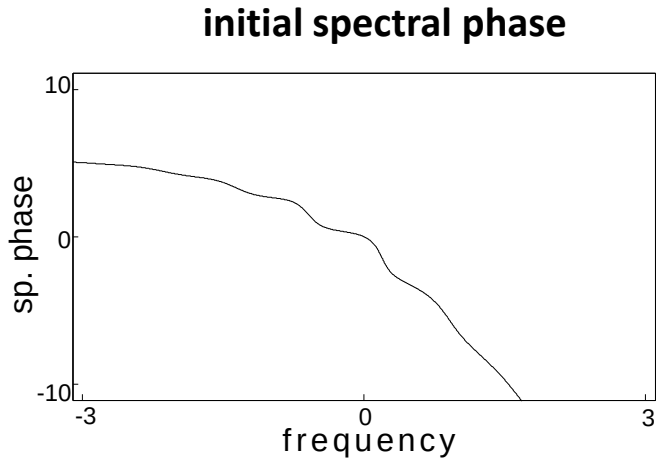


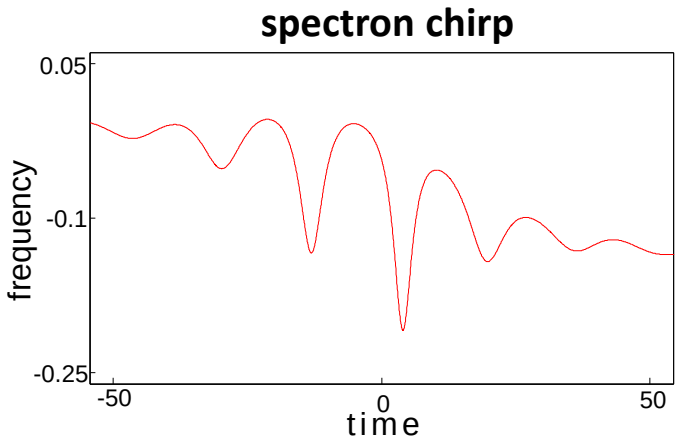
Spectron shaped from self-phase modulated two-peak seed pulse

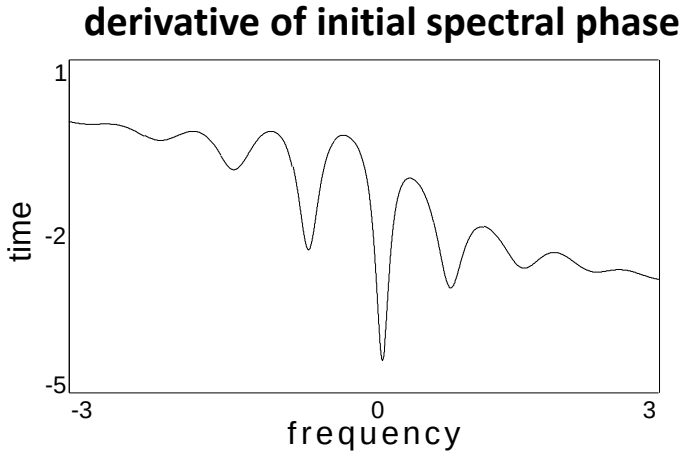


Phase and chirp of the spectron shaped from the self-phase modulated two-peak seed pulse









Application

Characterization of optical pulses in fs domain:

- FROG/GRENOUILLE → Methods for fs pulse retrieving
- STI → Methods for time-to-frequency conversion and spectral imaging of the temporal pulse
- Classic SI
- SPIDER/SPIRIT/SORBETS
- Similariton based SI

→ Methods for measurement of the spectral phase and retrieve the pulse shape

Conclusion

The study of the peculiarities of spectronic pulses has shown that the spectron's phase repeats the spectral phase:

- for the multiple-peak and asymmetric pulses the request of dispersion for the spectron generation is the same as for the phase mimicking, i.e. $\zeta_{ph} \approx \zeta_{amp}$
- for the pulses with sinusoidal spectral phase $\zeta_{ph} < \zeta_{amp}$
- for the pulses with initial SPM $\zeta_{ph} \approx \zeta_{amp}$

Thanks

Proposed experimental setup