Similariton Based Technique for Determination of Femtosecond Pulse Duration

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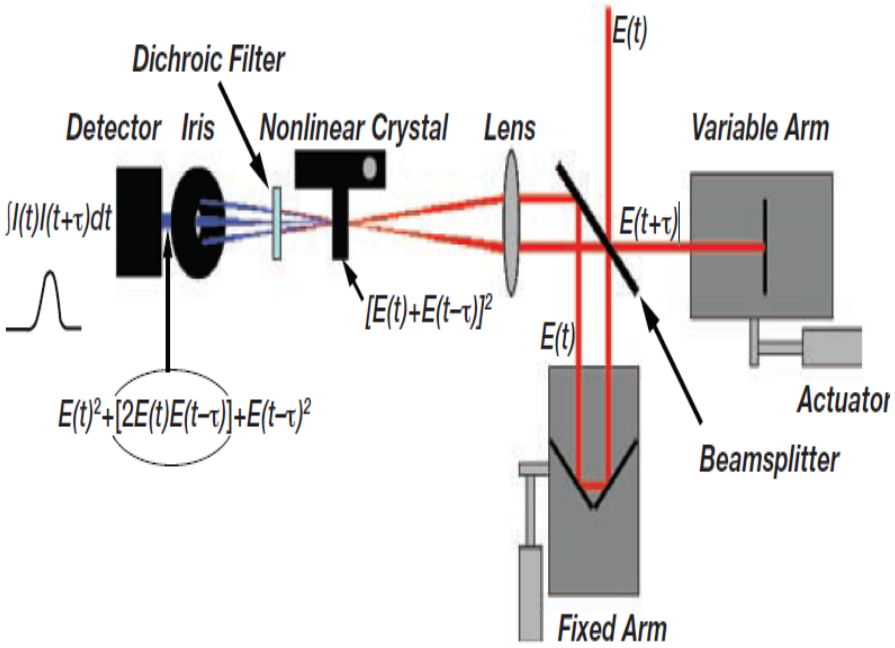
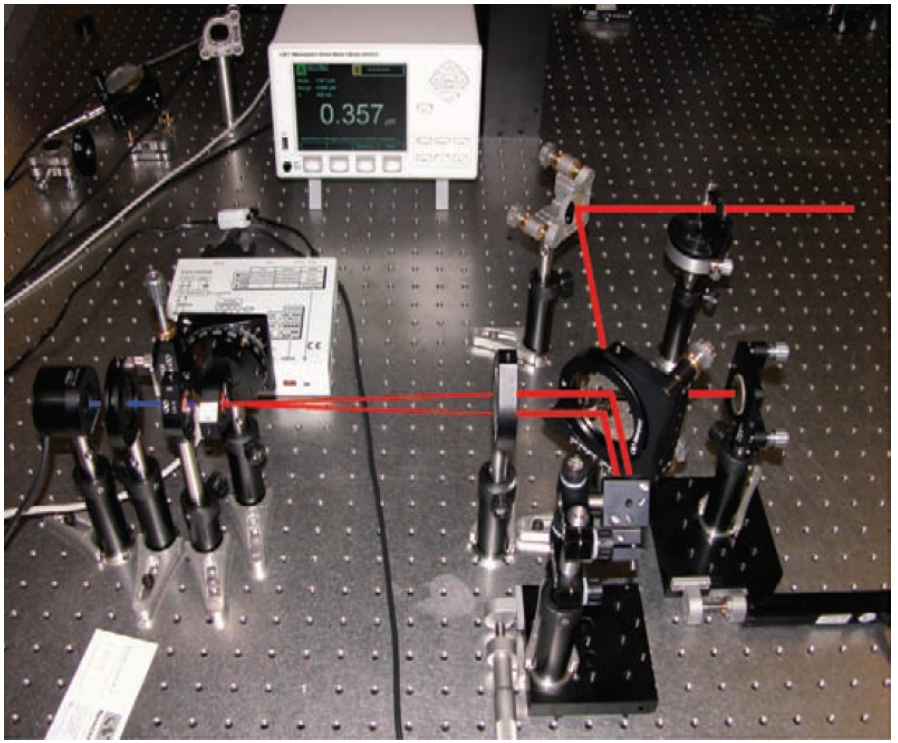
Femtosecond signal characterization

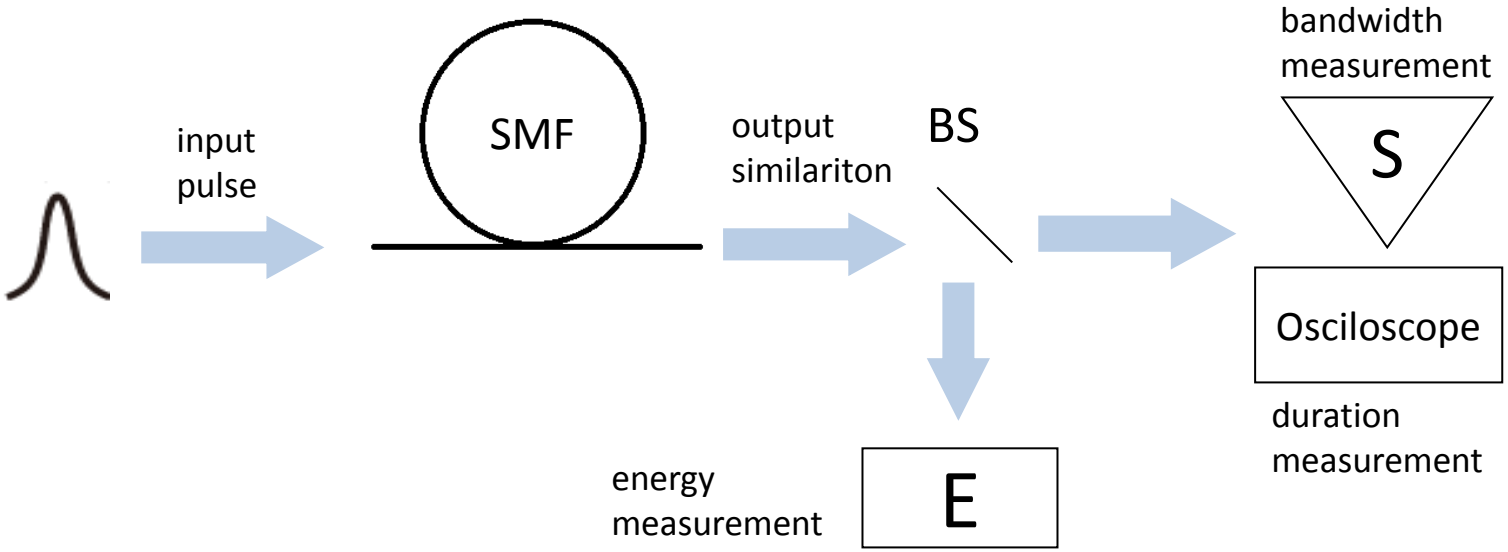
- FROG — $\varphi(\omega)$ *iteration*
- SPIRIT / SPIDER / SORBET — $\varphi(\omega)$
- MIIPS — $\varphi(\omega)$
- Silicon chip-based ultrafast oscilloscope — $I(t)$
- Similariton-based STI — $I(t)$
- Similariton-based SI — $\varphi(\omega)$

Autocorrelation technique

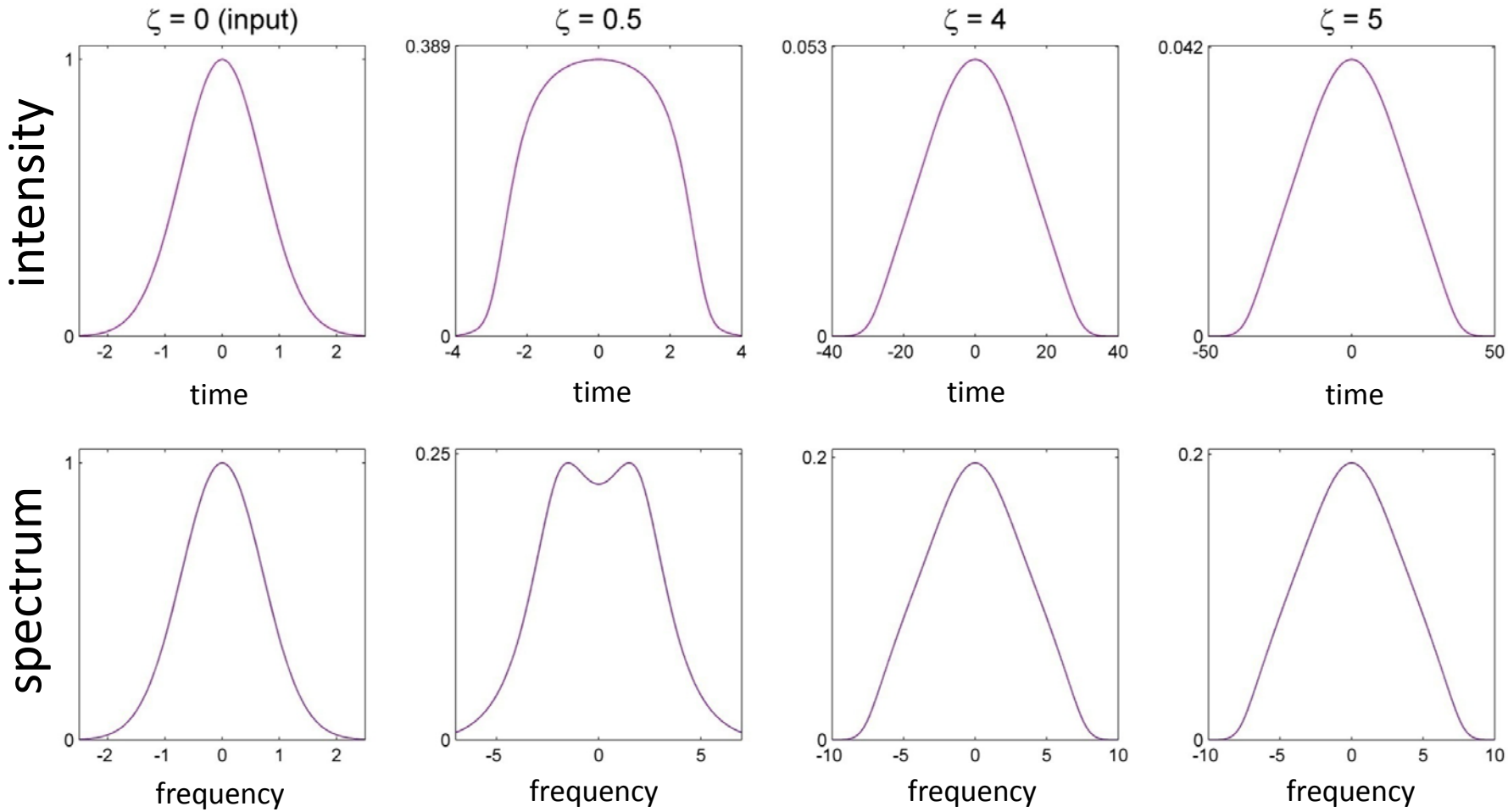




Similaritonic technique of pulse duration measurement

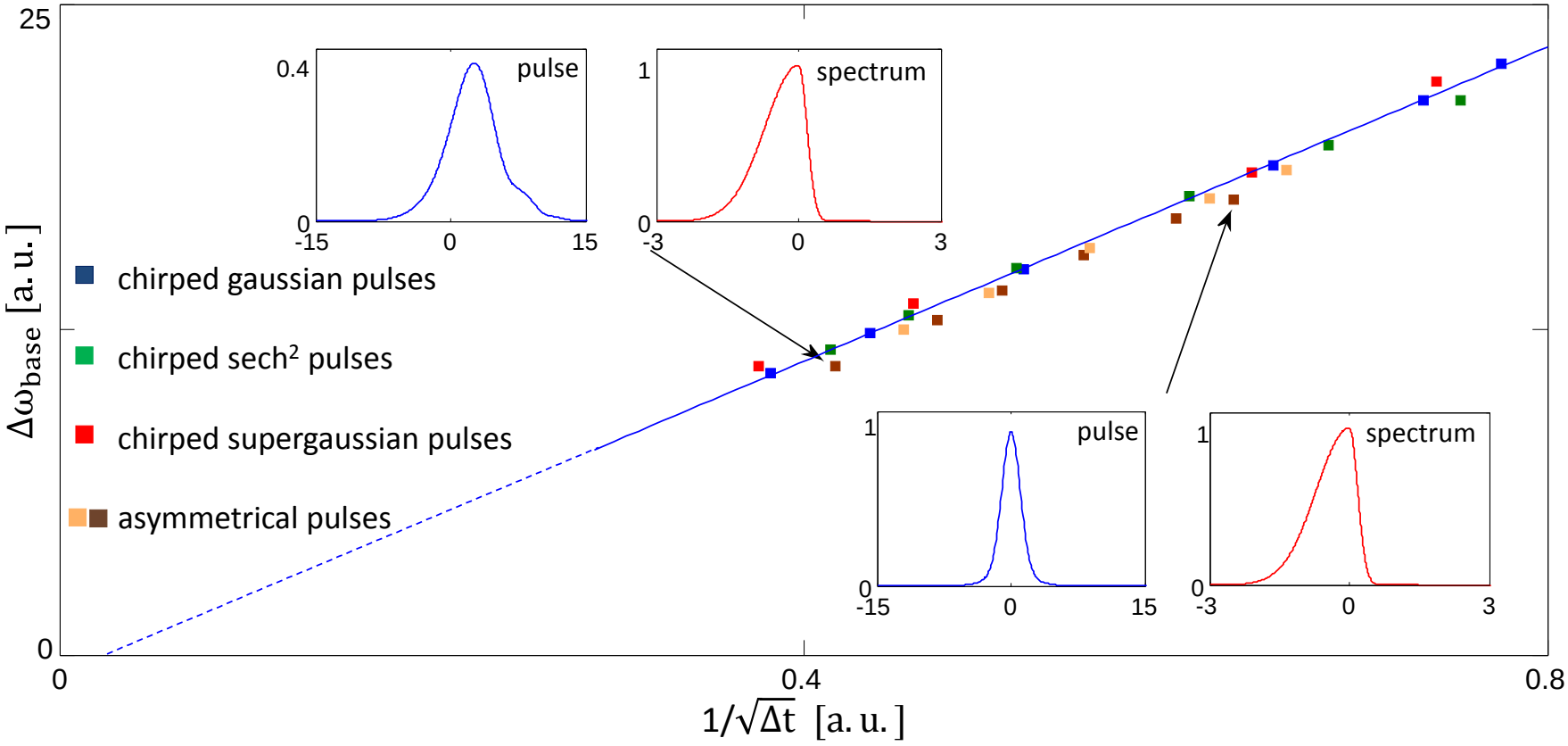


Generation of NL-D similariton in passive fiber



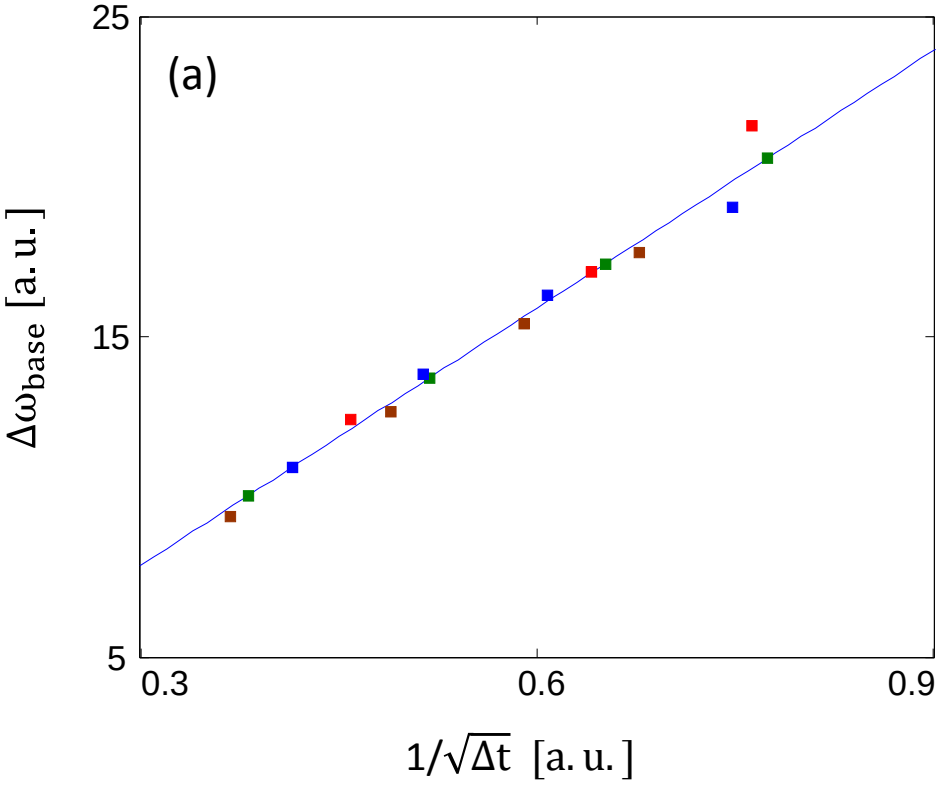
Similariton bandwidth vs the seed pulse duration

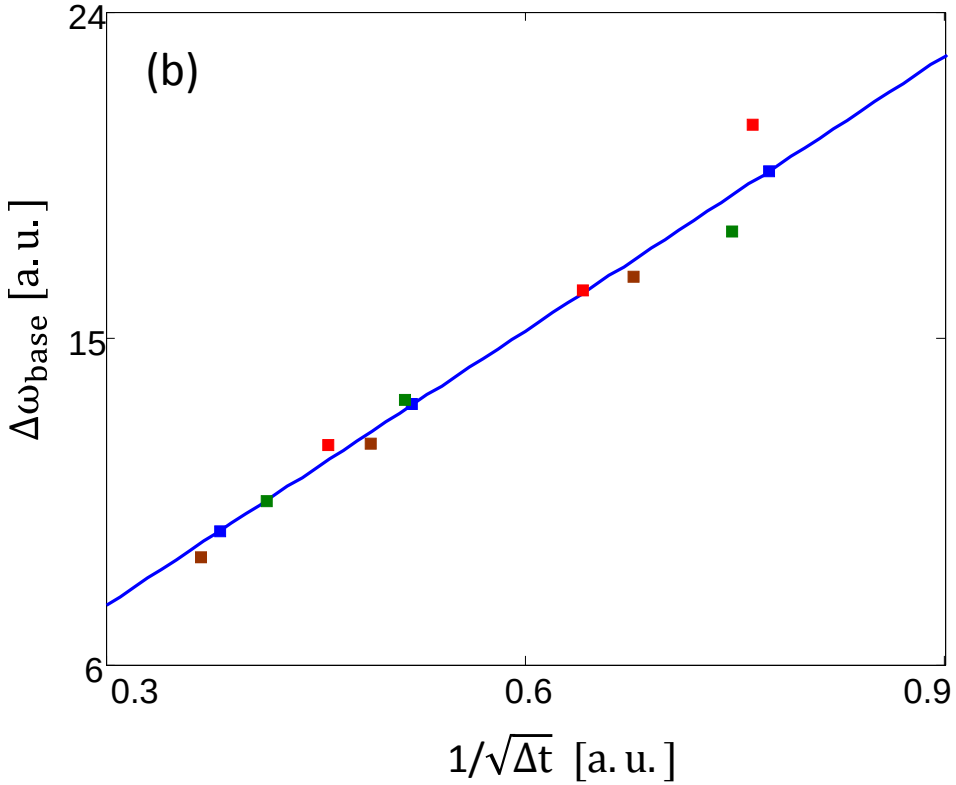
the similariton bandwidth is measured at -20dB level



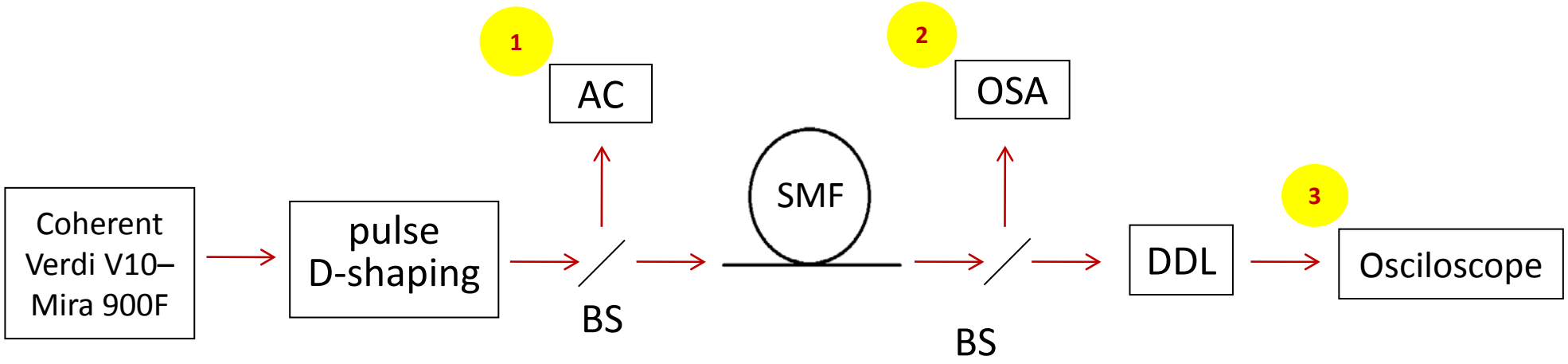
Similariton bandwidth vs the seed pulse duration

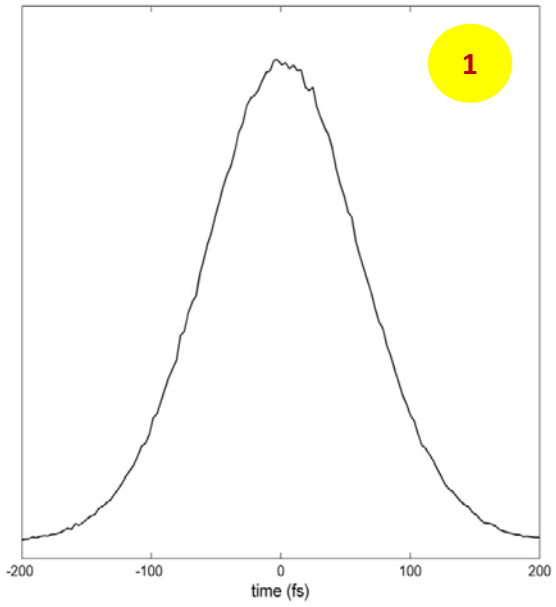
the similariton bandwidth is measured at -13dB (a) and -10dB (b) levels

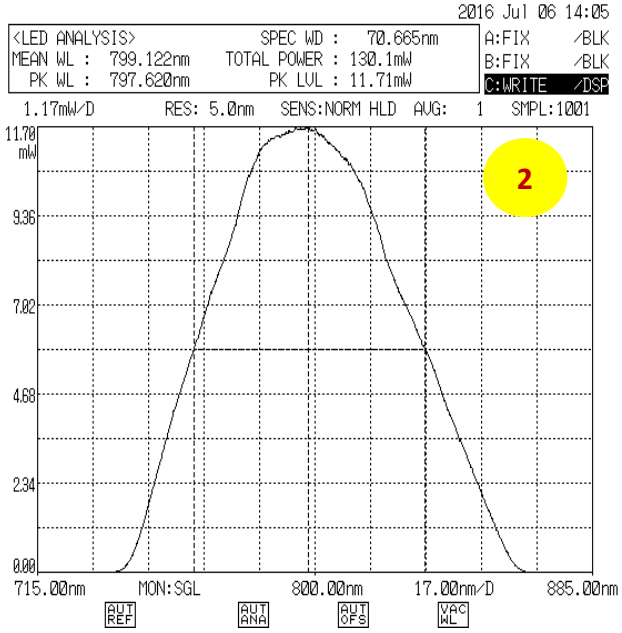


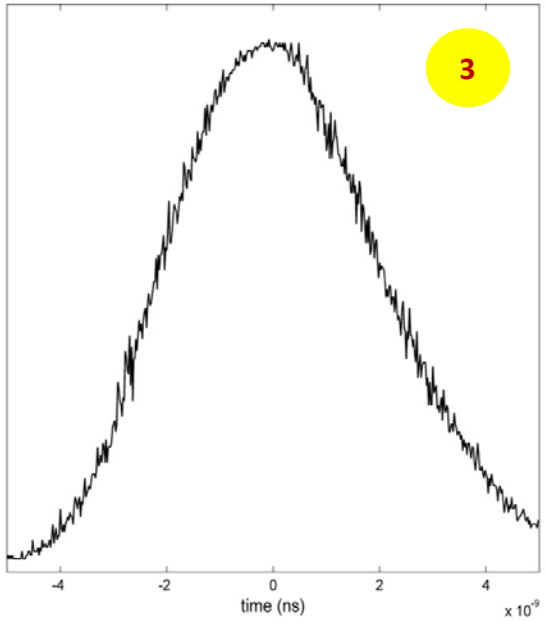


Experimental setup

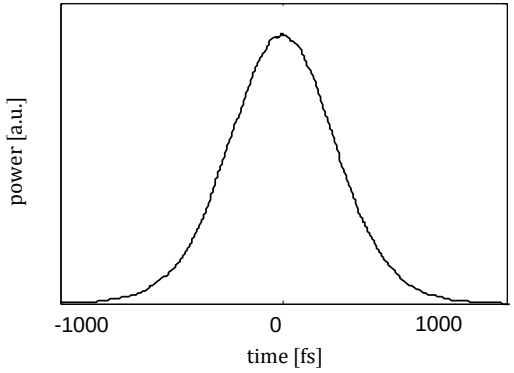


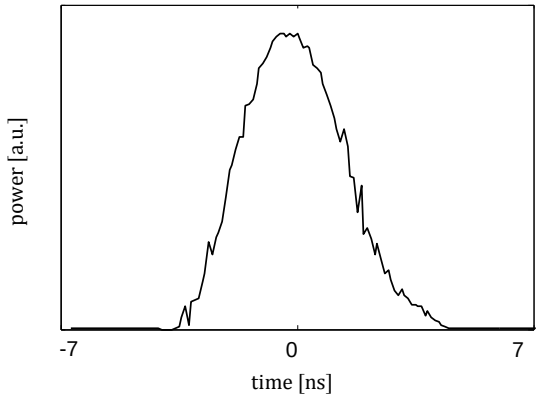


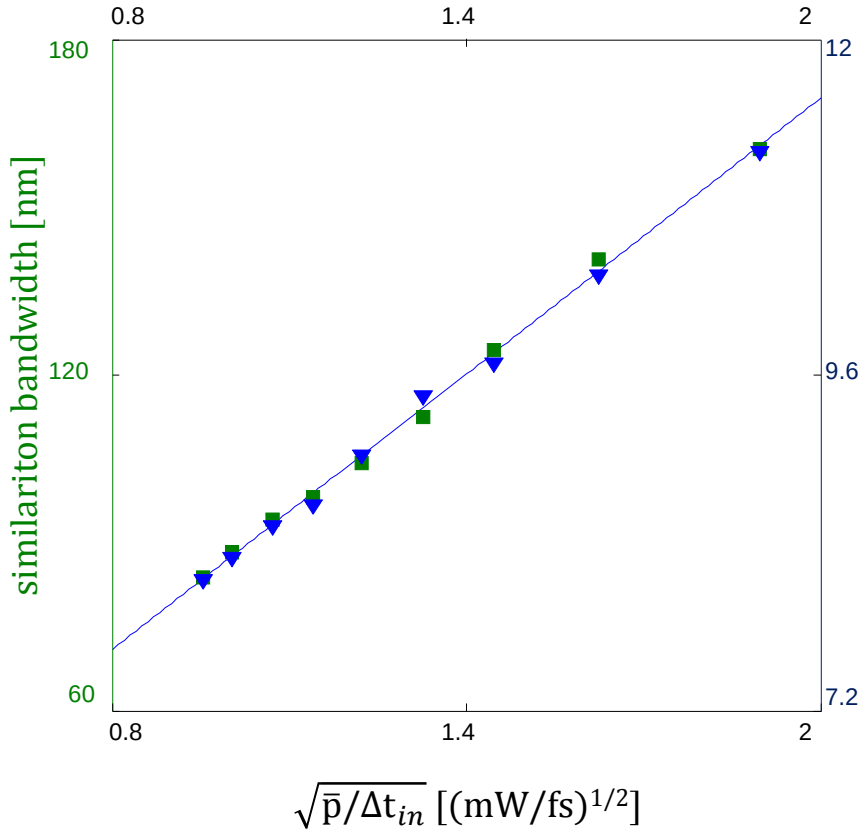


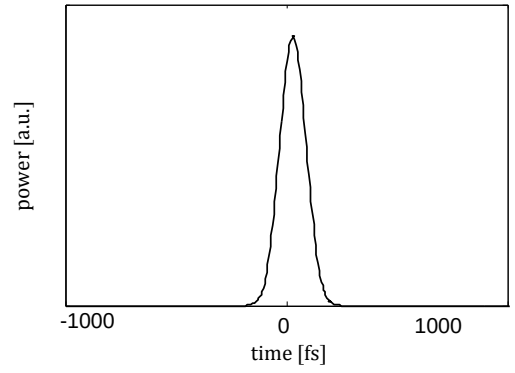


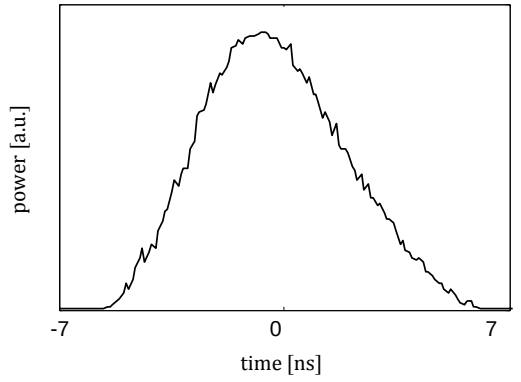
Experimental results



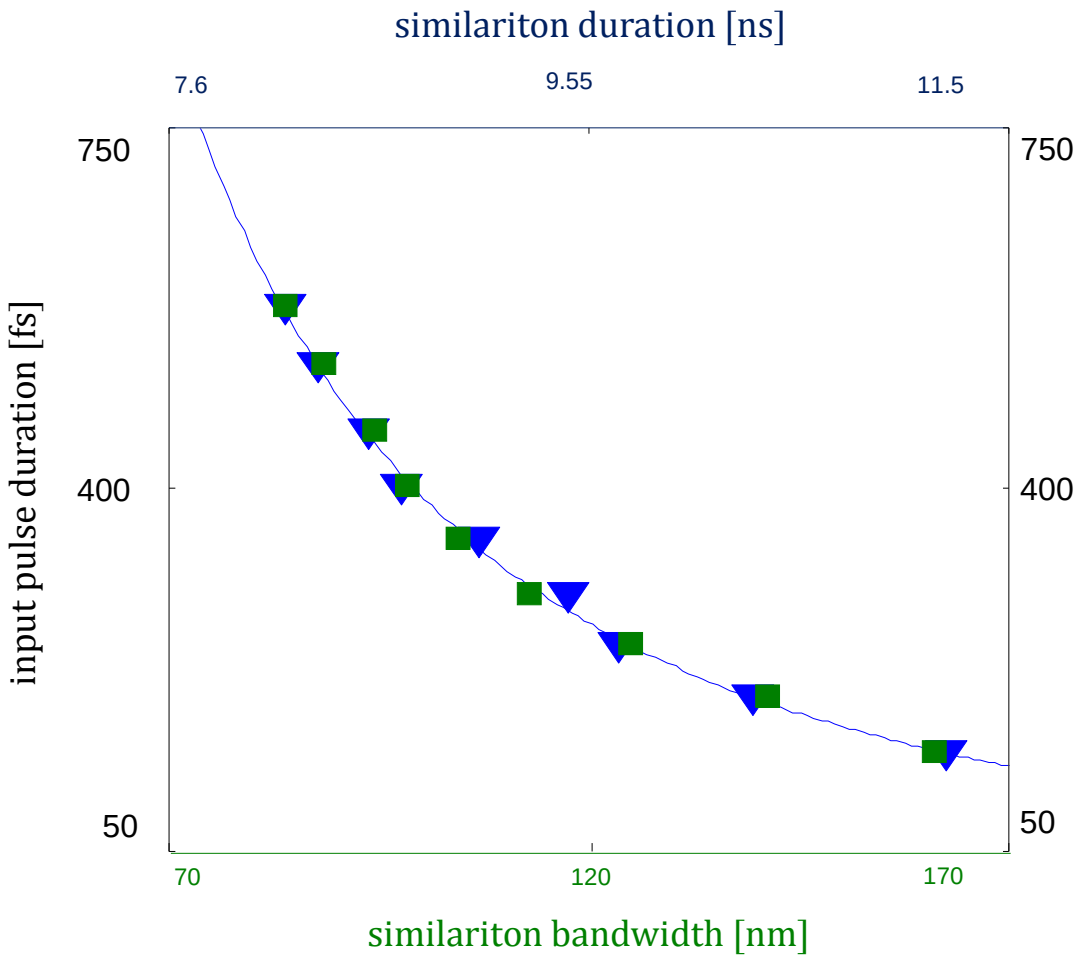




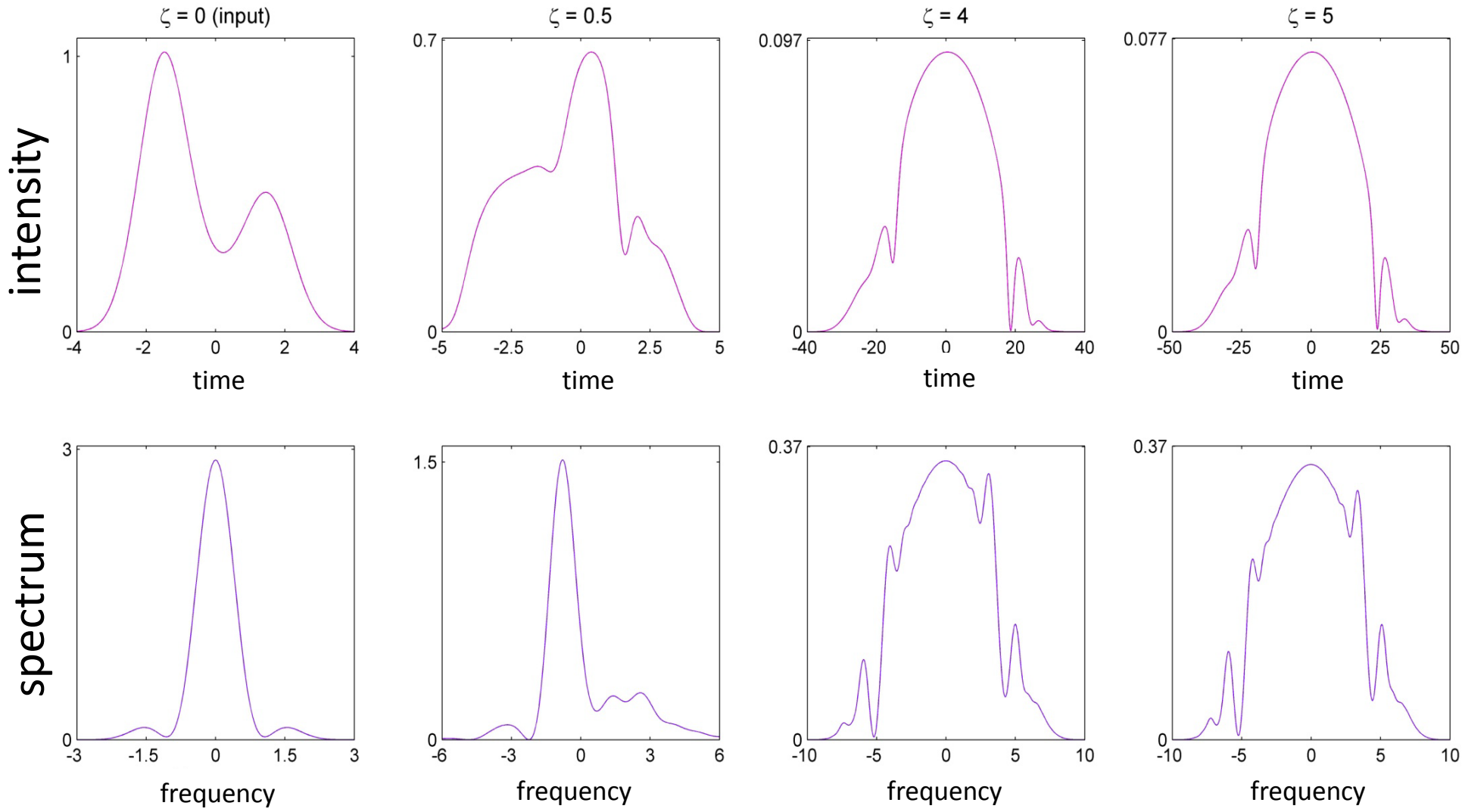




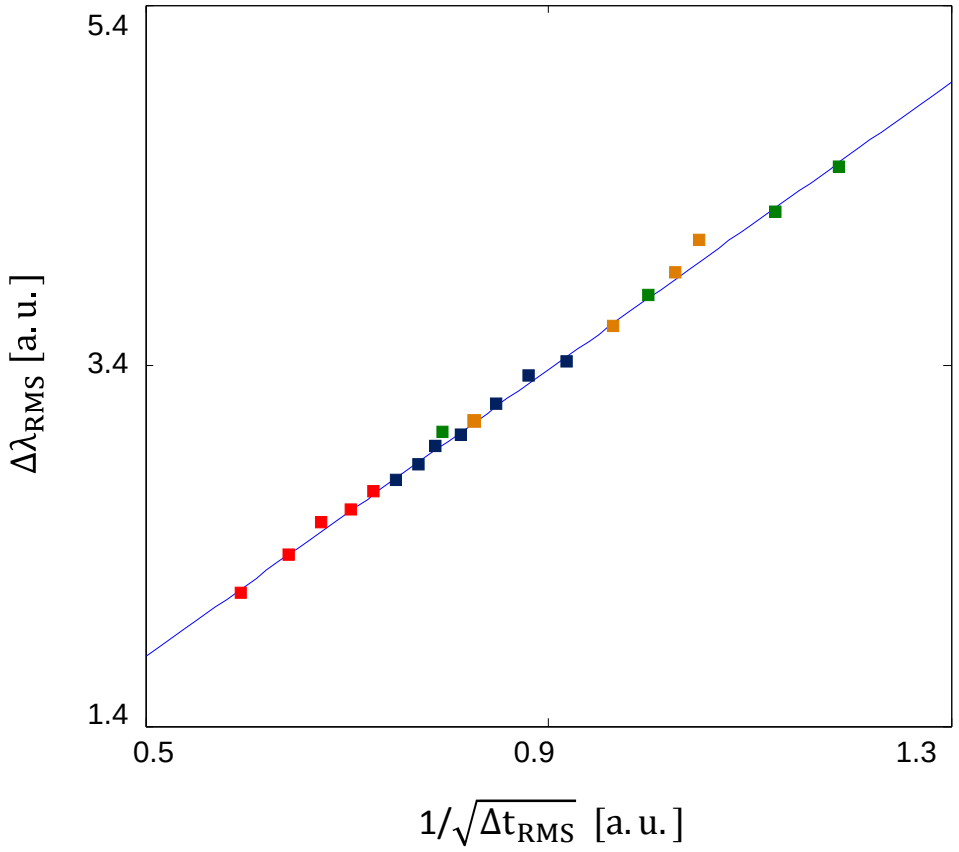
Experimental curve for determination of pulse duration



Similariton generated from two-peak pulse

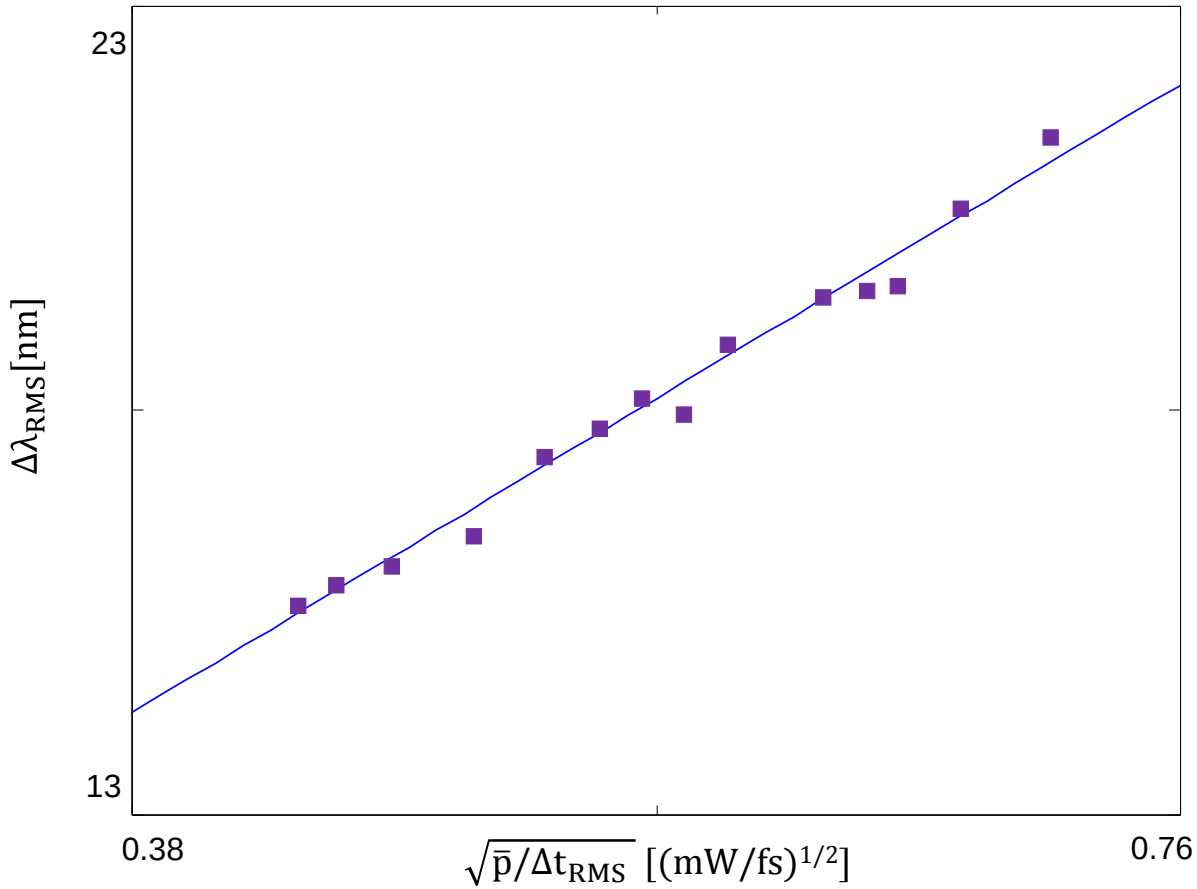


Spectral bandwidth of similariton vs input pule duration (both RMS)

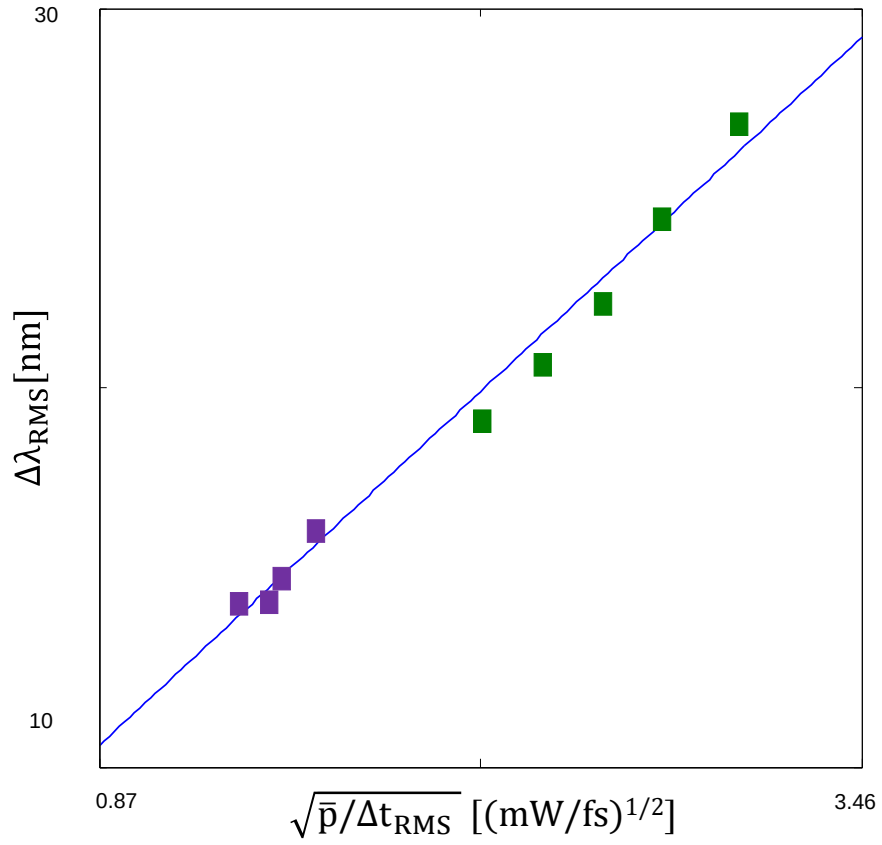


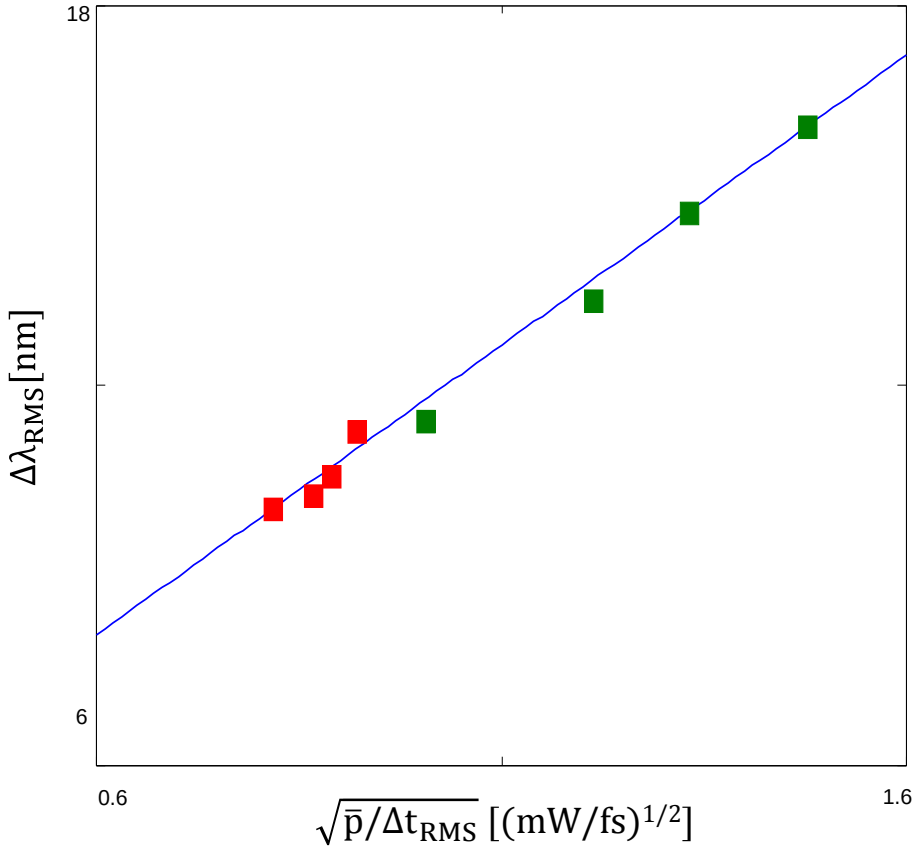
- chirped gaussian pulses
- chirped sech^2 pulses
- two-peak pulses
- three peak pulses

Experimental results for compressed and chirped pulses



Comparison of the technique for pulses with different shapes and spectra





laser pulses compressed pulses two-peak pulses

Results for bell shaped pulses

$$\Delta\omega_{sim}^{FWHM} \sim \sqrt{E/\Delta t_{in}^{FWHM} * R * \Delta\omega_0 \Delta t_0}$$

- chirped Gaussian pulses
- transform-limited pulses

$$\Delta\omega_{sim}^{base} \sim \sqrt{E/\Delta t_{in}^{FWHM} * R}$$

$\Delta\omega_{sim}^{base}$ calculated from:

- 1/10 level – 3% relative error
- 1/20 level – 2.5% relative error

Results for pulses with temporal substructures

$$\Delta\omega_{\mathrm{sim}}^{\mathrm{RMS}} \sim \sqrt{\mathrm{E}/\Delta \mathrm{t}_{\mathrm{in}}^{\mathrm{RMS}} * \mathrm{R}}$$

- bell-shape pulses
- two-peak pulses
- compressed pulses

Conclusion

A simple similaritonic technique for measurement of the duration of femtosecond laser pulses has been developed. The power meter, spectrometer or oscilloscope, and fiber, the standard tools in an optics laboratory, suffice to implement the method that may be used for regular checking of femtosecond laser performance.

Thank you !!!