Experimental Demonstration of Spectral Self-Compression of Supercontinuum Radiation Fraction

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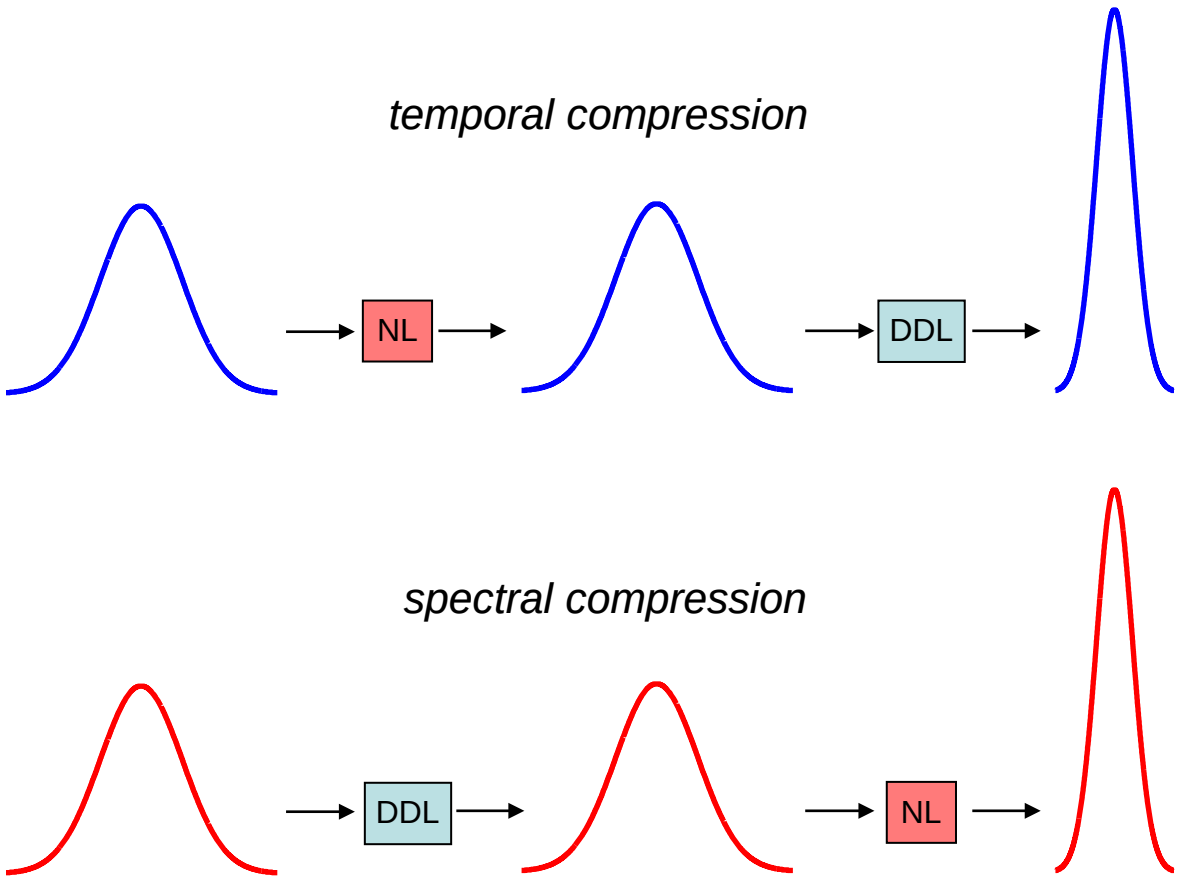
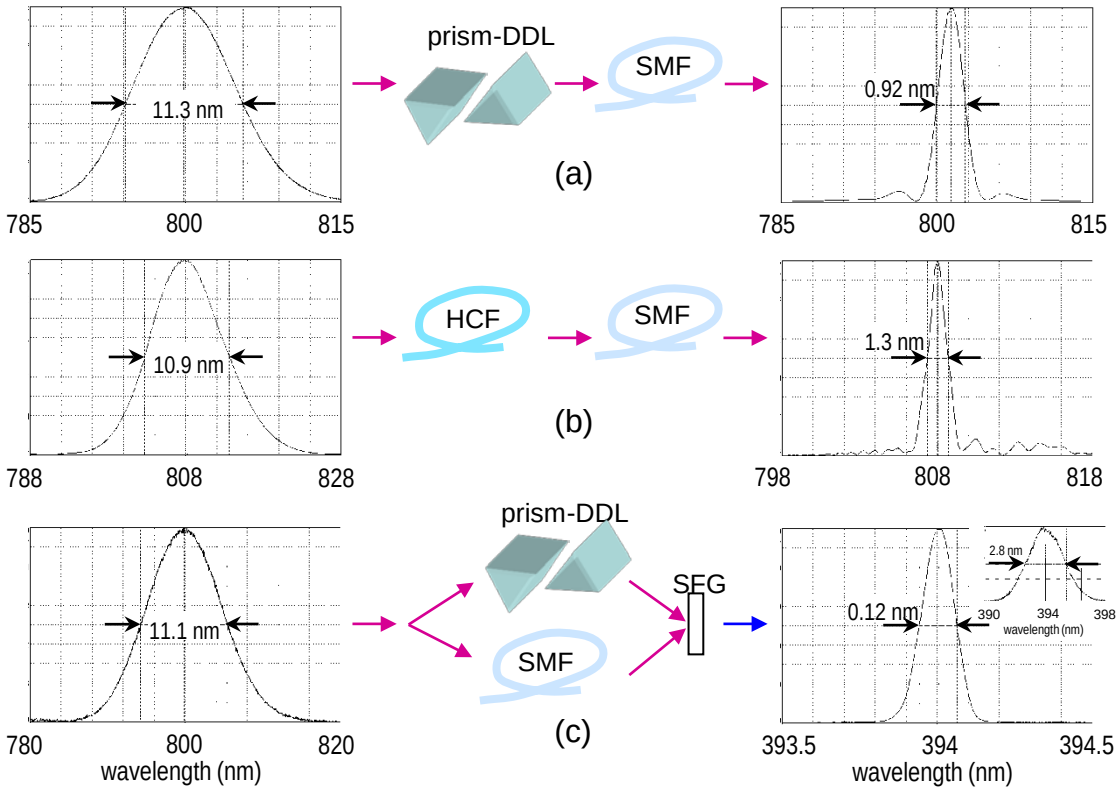
Spectral and temporal compression



Spectral compression

H.Toneyan, et al “8x, 12x, and 23x Spectral Compression by All-Fiber, Classic, and Similaritonic Techniques” FiO 2014, paper FW4D.5.

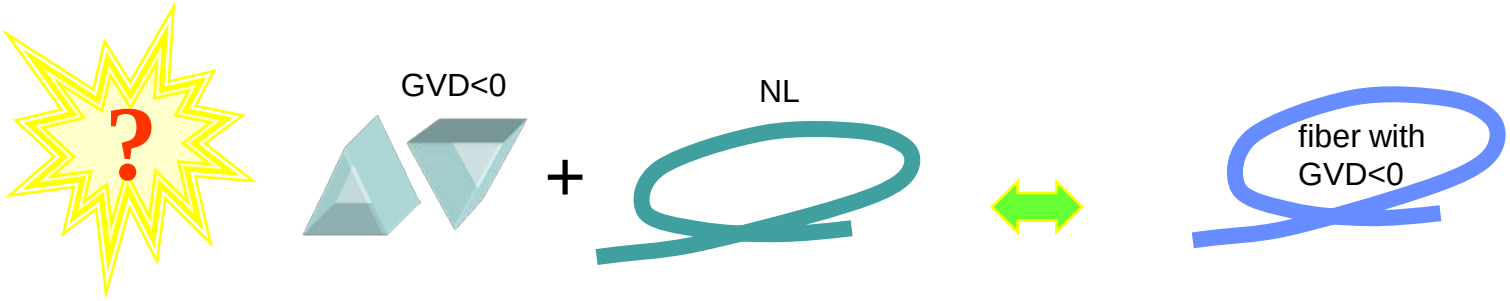
comparative experimental studies of various schemes:



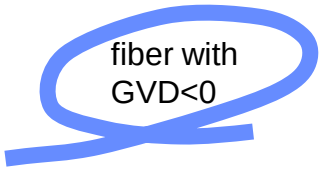
12x
SC by classic technique

8x
all-fiber SC

23x
aberration-free SC by the SFG-similaritonic technique



Soliton pulse compression



L.F.Mollenauer, et al "Extreme picosecond pulse narrowing by means of soliton effect in single mode fibers" Opt. Lett. **8**, 289 (1983).

L.F.Mollenauer et al "Experimental-observation of picosecond pulse narrowing and solitons in optical fibers" Phys. Rev.Lett. **45**, 1095 (1980).

Recent progress in the technology of photonic crystal fibers and nanowires

Generation of few-cycle pulses:

T.Balciunas, et al "A strong-field driver in the single-cycle regime based on self-compression in a Kagome fibre" Nat. Commun. 6:6117 doi: 10.1038 / ncomms 7117 (2015).

A.A.Amorim, et al. "Sub-two-cycle pulses by soliton self-compression in highly nonlinear photonic crystal fibers" Opt. Lett. **34**, 3851 (2009).

M.A.Foster, et al "Soliton-effect compression of supercontinuum to few-cycle durations in photonic nanowires" Opt. Express. **13**, 6848 (2005).

A.B.Salem, et al "Soliton-self compression in highly nonlinear chalcogenide photonic nanowires with ultralow pulse energy" Opt. Express **19**, 1995510 (2011).

Analytical discussion of self-SC process

GVD: $\tilde{A}(\omega, z) = \tilde{A}(\omega, 0)\ \exp[-i\omega^2 (z / L_D) / 2]$

SPM: $A(t, z) = A(t, 0) \exp[i n_2 \beta_0 \mid A(t, 0)|^2\ z] \approx$

$$\approx A_0(t) \exp(iz / L_{NL}) \exp[-it^2 (z / L_{NL})]$$

t	*running time*
ω	*centered frequency*
$\beta_{0,2}$	*coefficent of dispersion*
n_2	*kerr index of silicia*
$\Delta\omega_0$	*spectral bandwidth*
τ_0	*initial time duration*
$R = L_D / L_{NL}$	*NL parameter*
$\zeta = z / L_D$	*dimensionless propagation distance*

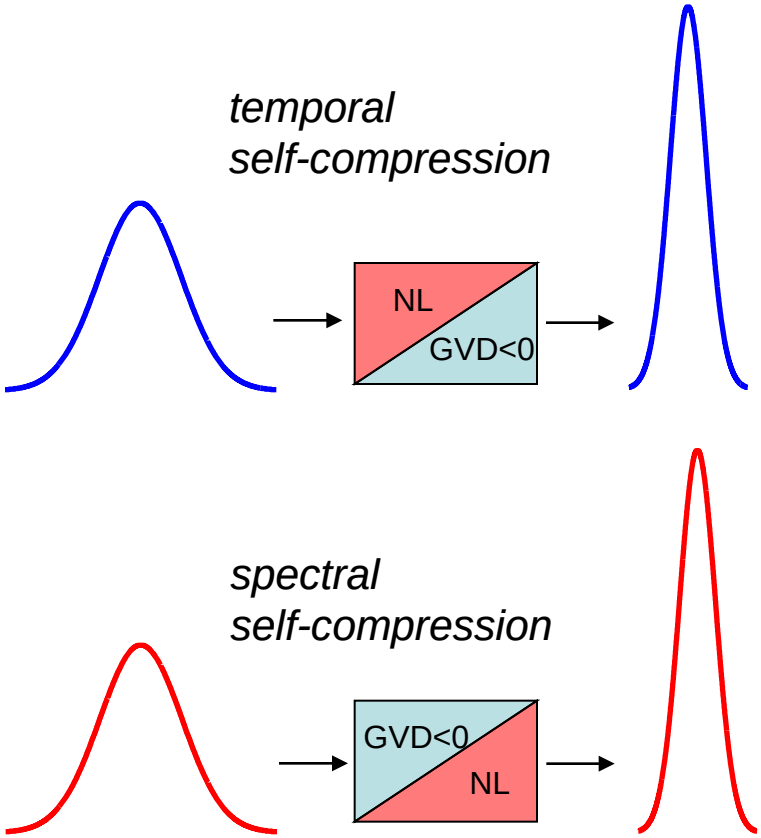
$L_{NL} < L_D$ *Soliton effect compression*

$L_{NL} > L_D$ *Self spectral compression*

$$L_{NL} \equiv [\beta_0 n_2 \mid A(0,0) \mid^2]^{-1}$$

$$L_D \equiv (\beta_2 \Delta\omega_0^2)^{-1}$$

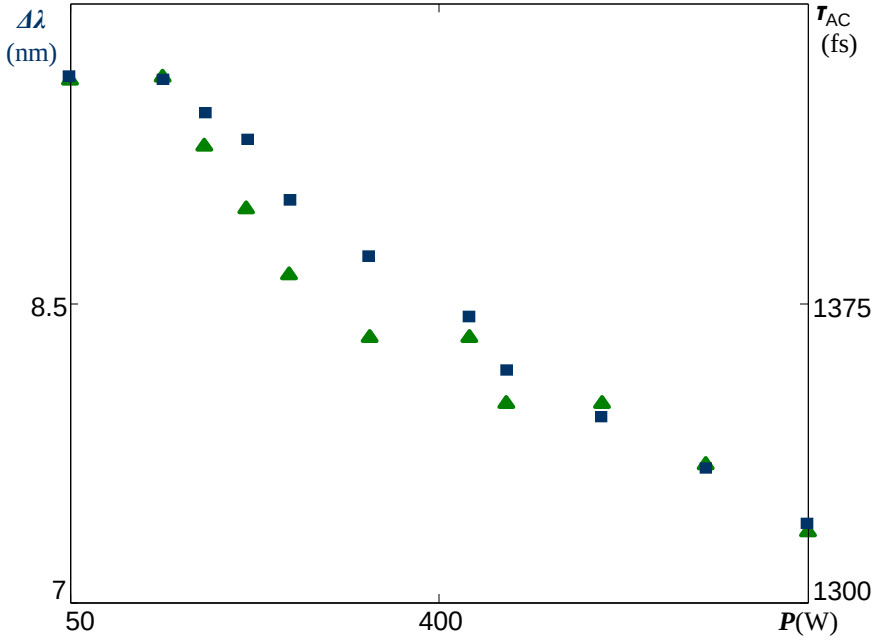
Soliton-effect compression



Initial experiment with HCF

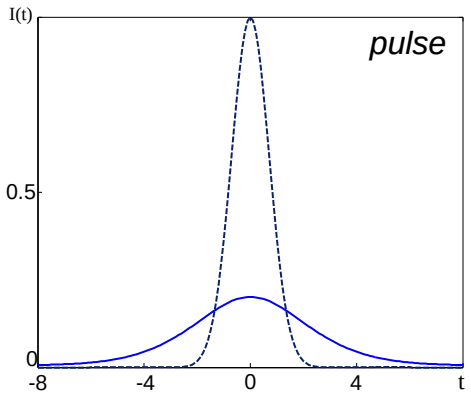
experimental setup

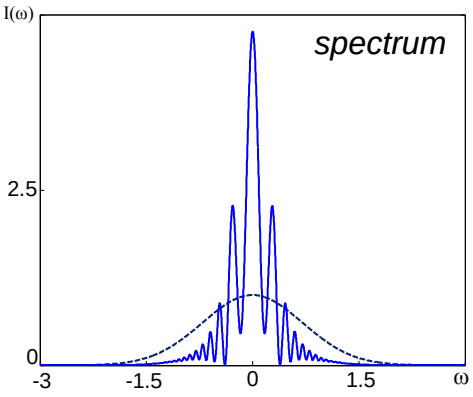
demonstration of self-SC
with 30% spectral narrowing

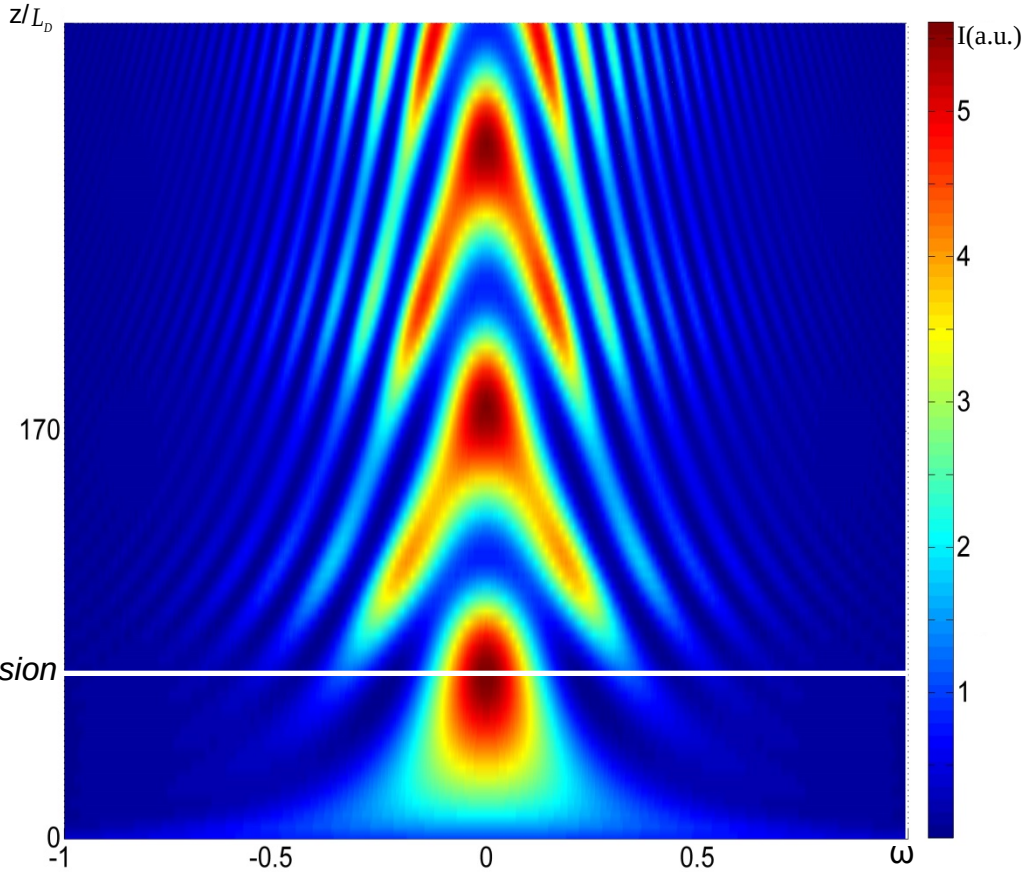


Numerical study of self-SC process

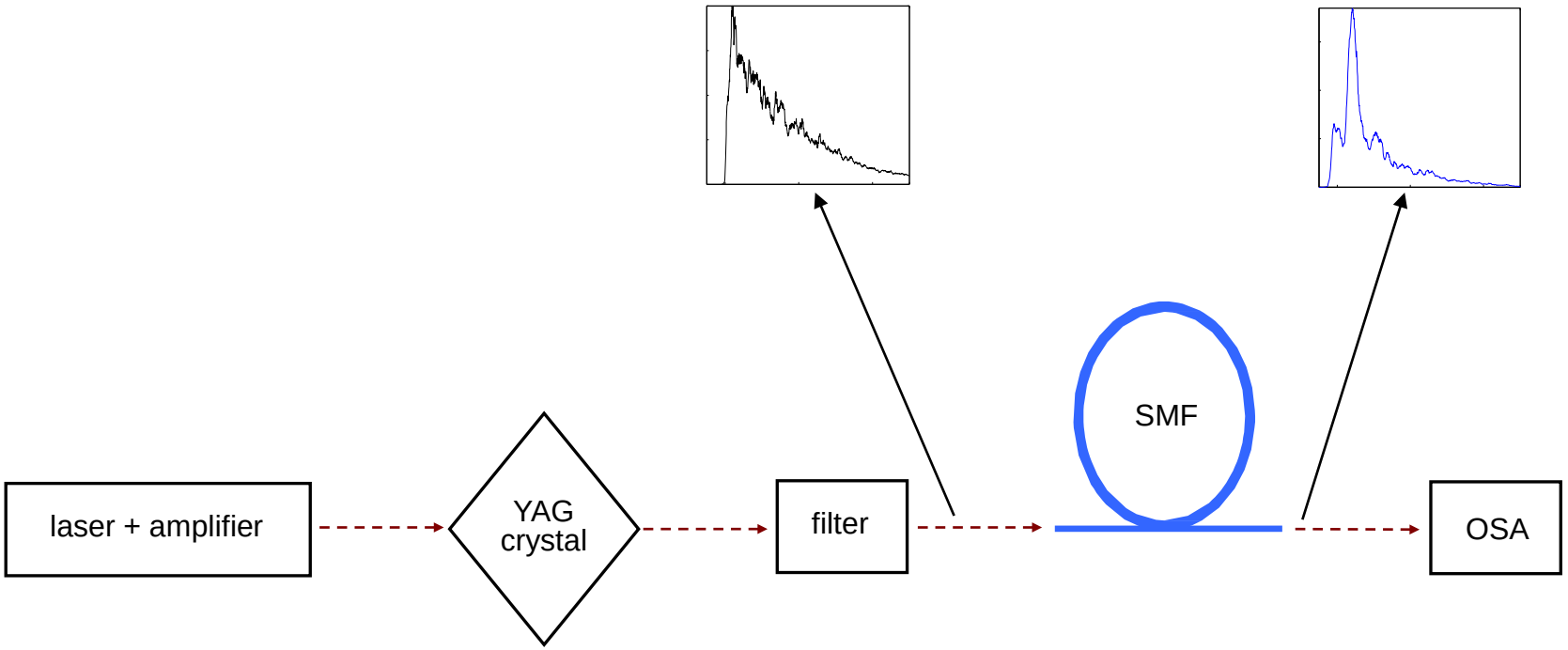
M.Sukiasyan, et al
"Numerical Study of Femtosecond Signal Spectral Self Compression"
UBA17 Workshop, 2017



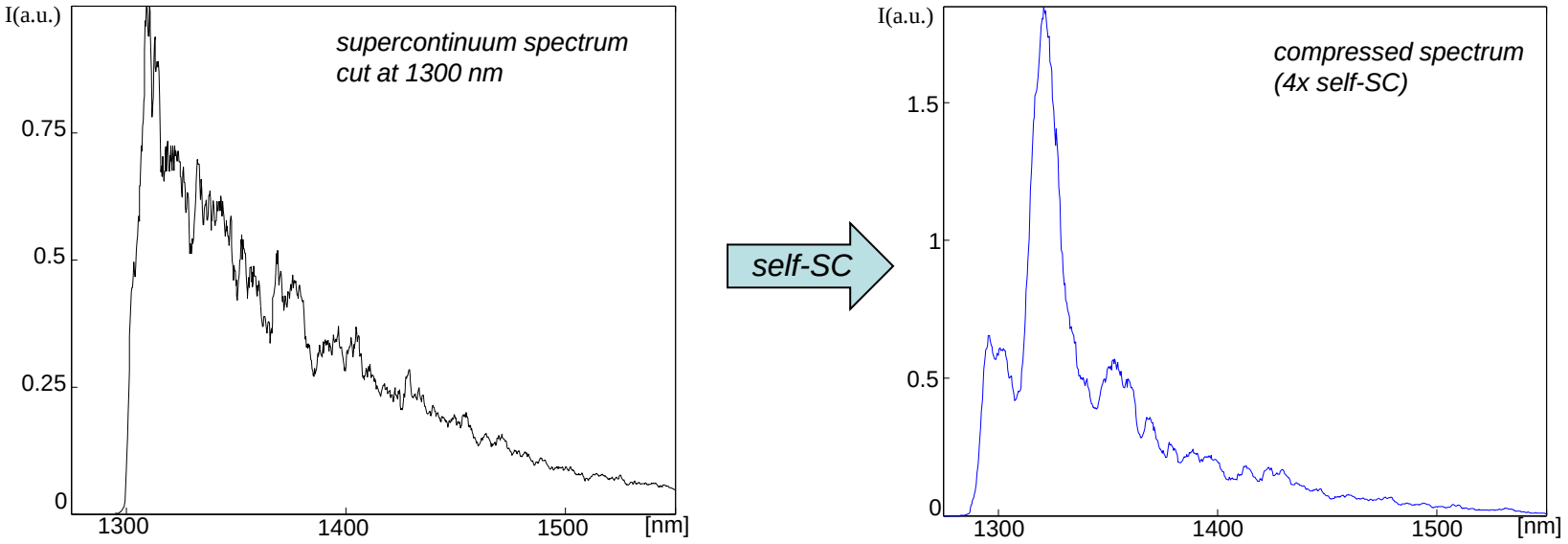




Setup of self-SC for supercontinuum radiation



Experimental results of self-SC of supercontinuum fraction



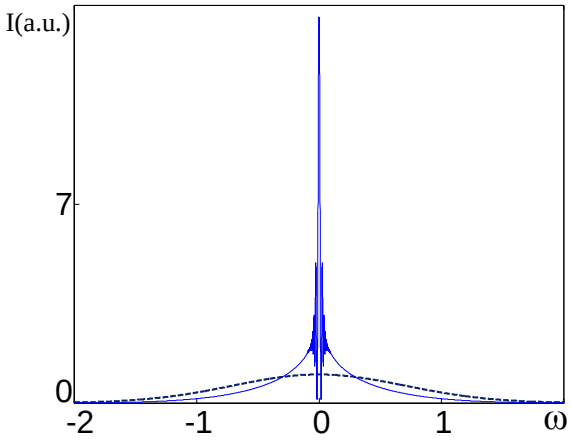
Conclusion

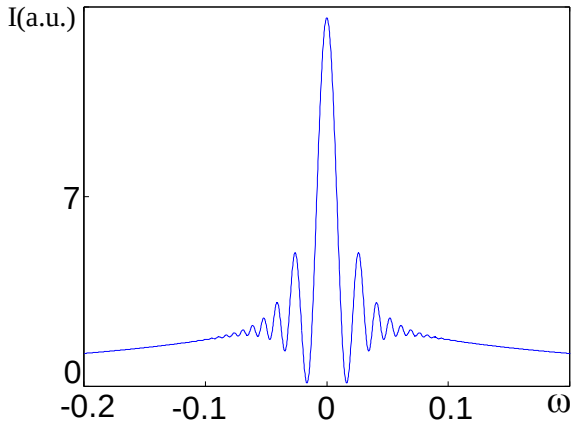
We experimentally demonstrated:

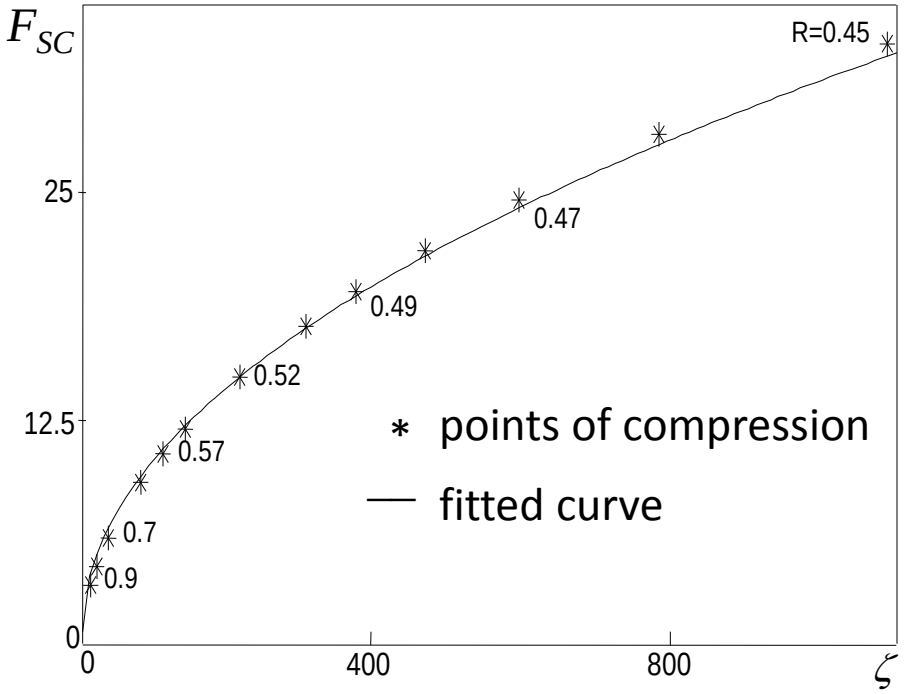
- 30% self-SC in a hollow-core fiber @800nm central wavelength
- 4x self-SC of fraction of noisy supercontinuum spectrum

THANKS

Numerical demonstration of Gaussian pulse self-SC







Experimental results of self-SC of supercontinuum fraction