

## **Workshop UBA17**

“Ultrafast Beams and Applications”  
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# ***Numerical Study of Femtosecond Signal Spectral Self-Compression***

*M.Sukiasyan*<sup>1,2</sup>, *V. Avetisyan*<sup>1</sup>, *H. Toneyan*<sup>1,2</sup>, *A. Kutuzyan*<sup>1</sup>,  
*V. Tsakanov*<sup>2</sup>, and *L. Mouradian*<sup>1,2</sup>

<sup>1</sup>*Ultrafast Optics Laboratory, Yerevan State University*



<sup>2</sup>*CANDLE Synchrotron Research Institute*

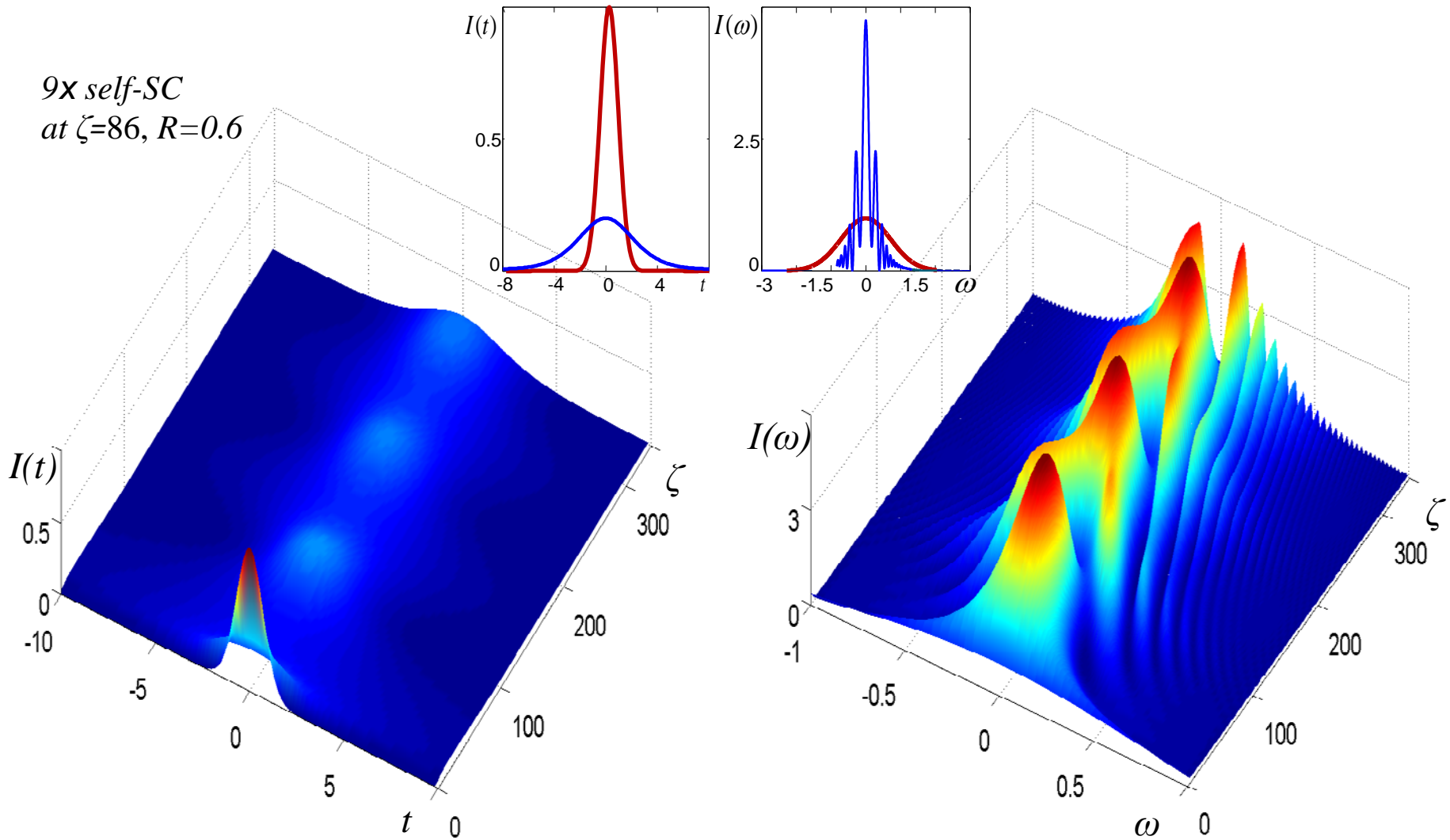


# *Outline*

- Self-SC of coherent pulses
- Self-SC of partially coherent pulses
- Experiment
- Conclusion

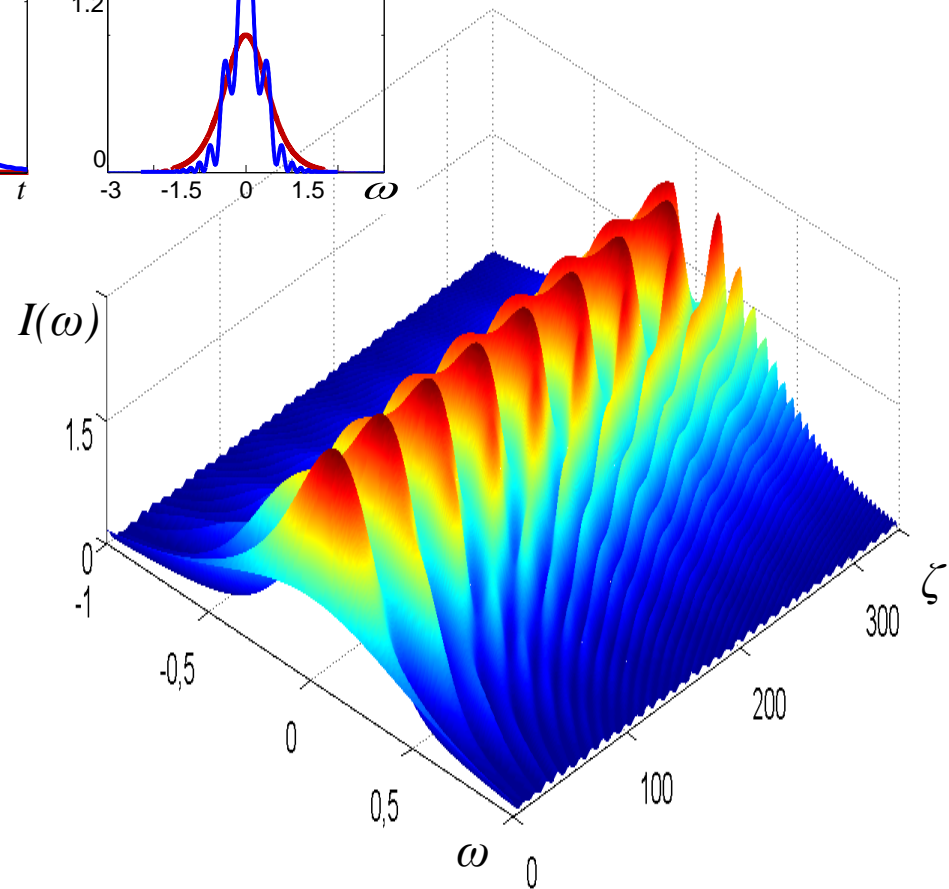
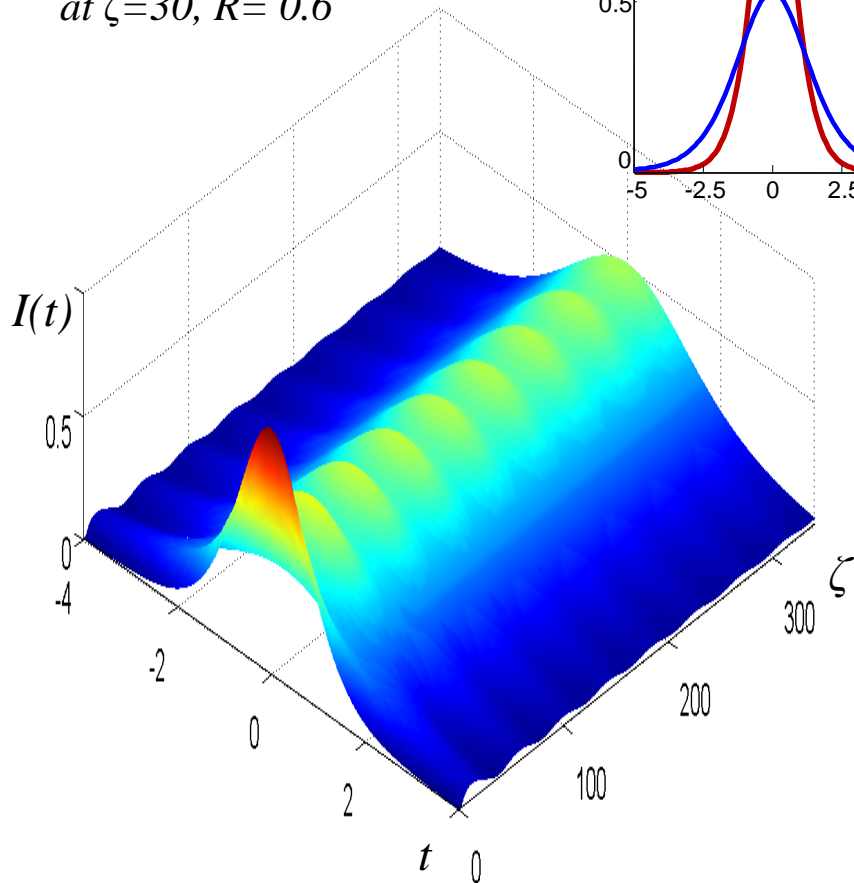
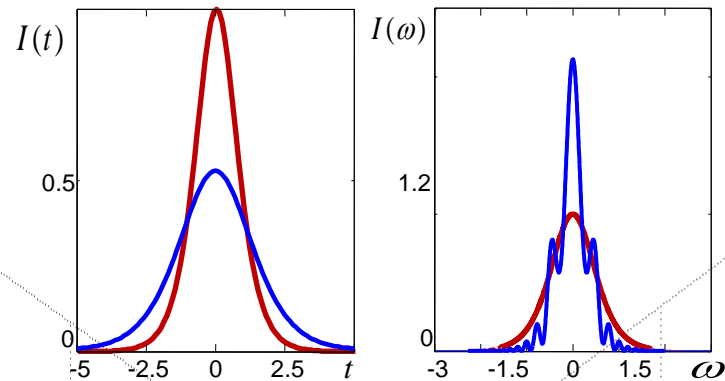
# Evolution of a Gaussian pulse

9x self-SC  
at  $\zeta=86$ ,  $R=0.6$



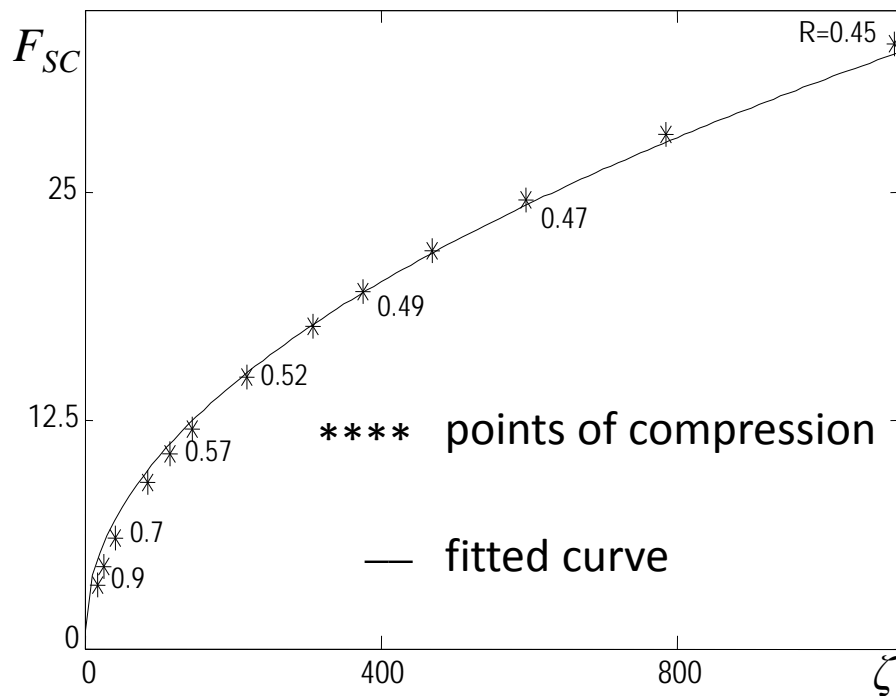
# Evolution of a sech pulse

3x self-SC  
at  $\zeta=30$ ,  $R=0.6$

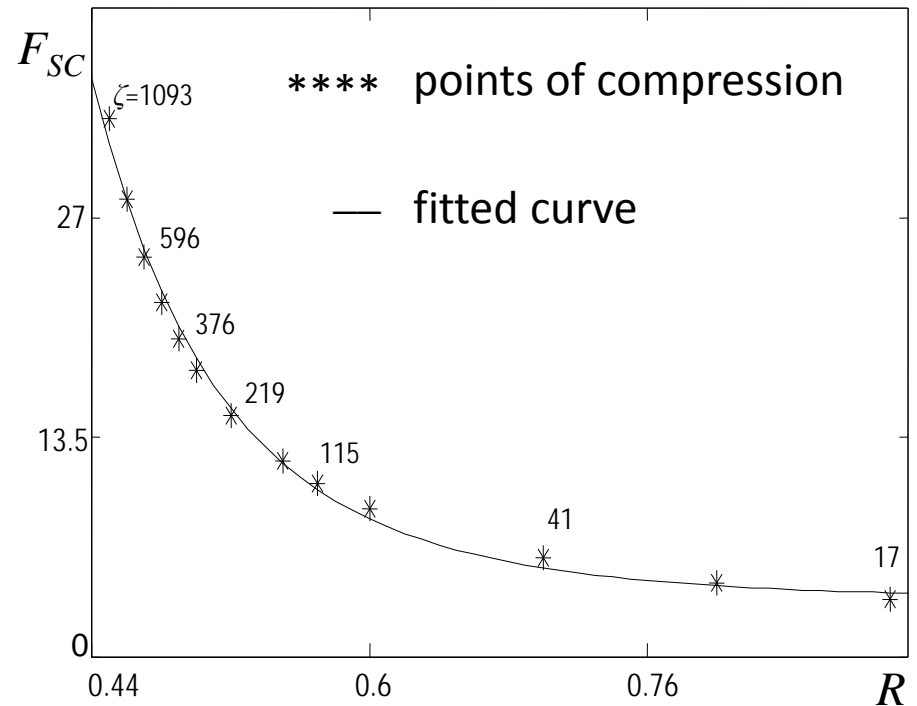


# Optimization curves of self-SC

(for Gaussian pulse)



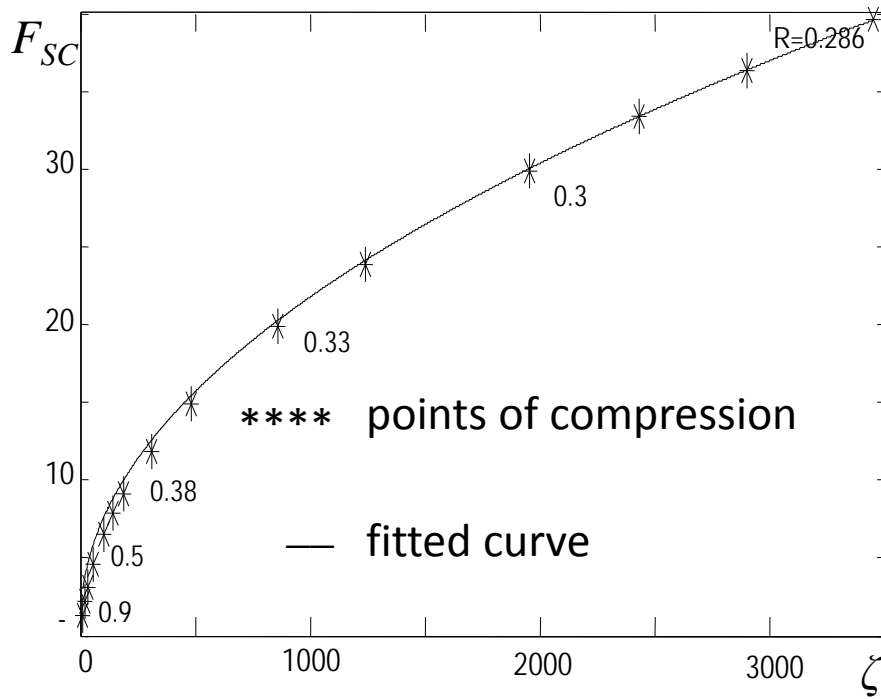
$$F_{SC} = 0.9546 \times \sqrt{\zeta} + 1$$



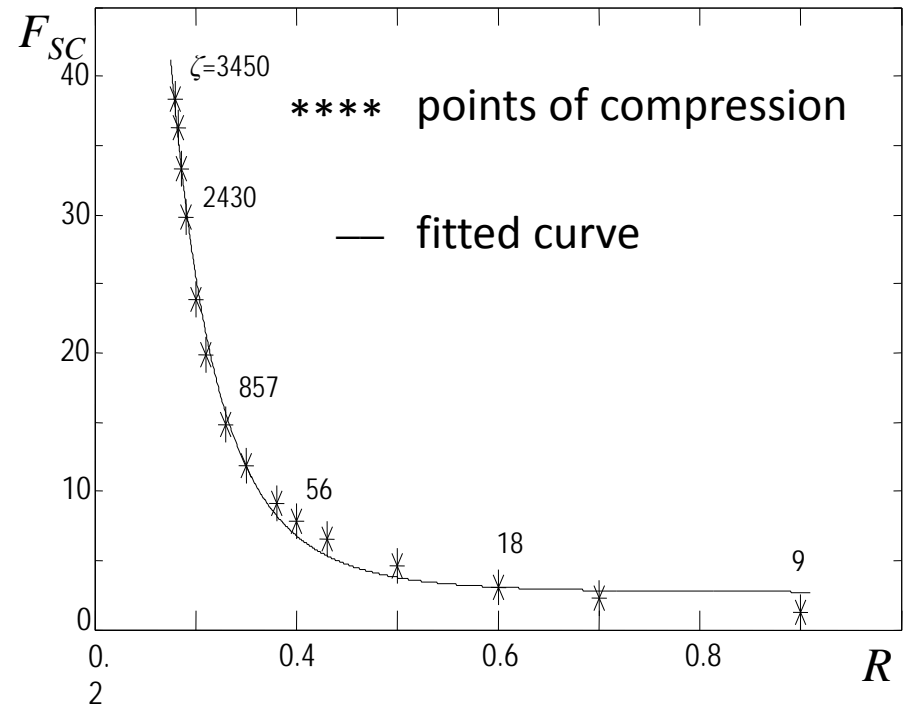
$$F_{SC} = 0.2331 \times R^6 + 2.951$$

# Optimization curves of self-SC

(for sech pulse)



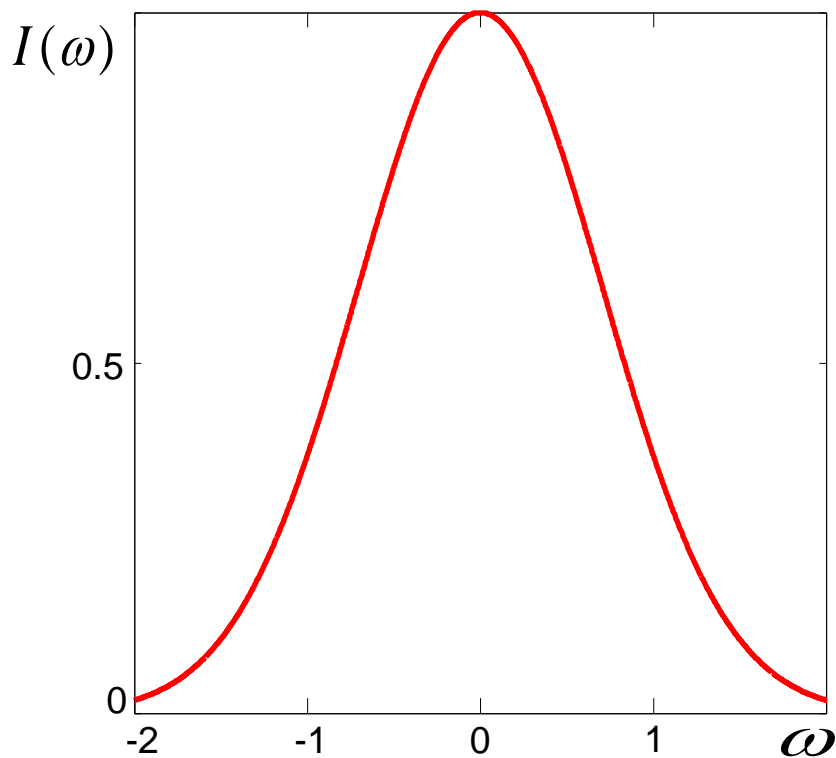
$$F_{SC} = 0.6565 \times \sqrt{\zeta} + 1$$



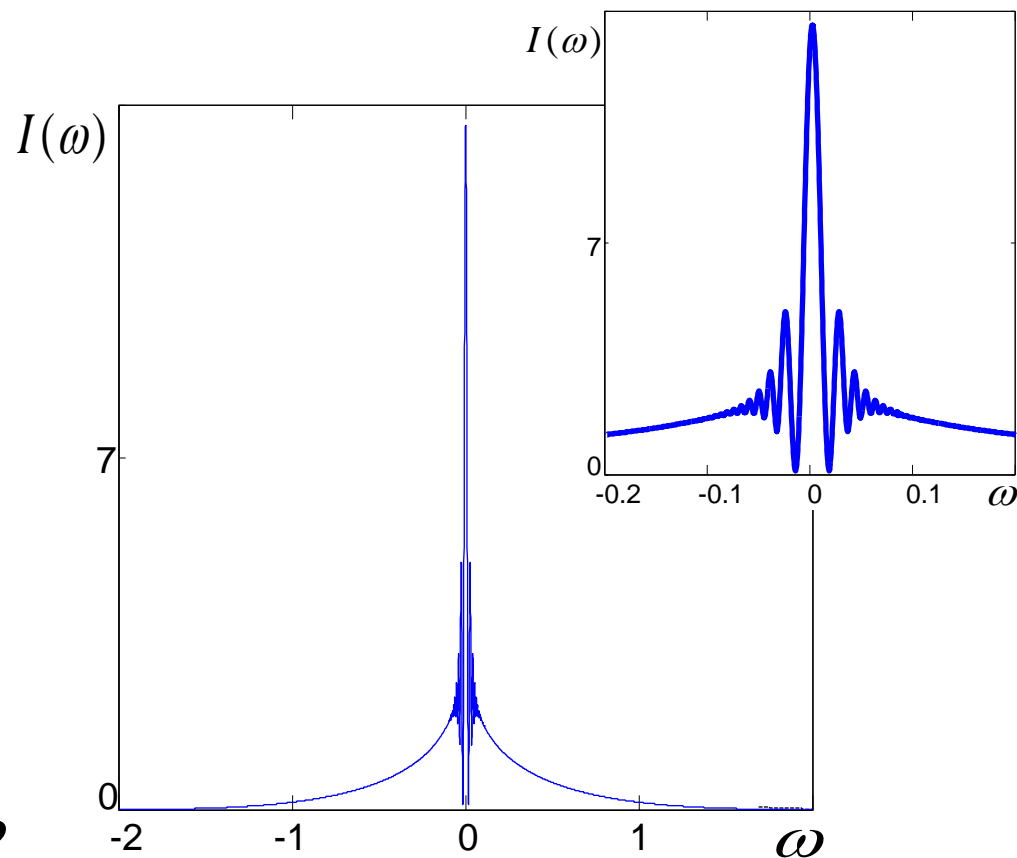
$$F_{SC} = 0.01664 \times R^6 + 2.682$$

# A high-ratio SSC ( $\approx 100X$ ) for Gaussian pulse

100x Self-SC  
at  $\zeta=13000$ ,  $R=0.41$

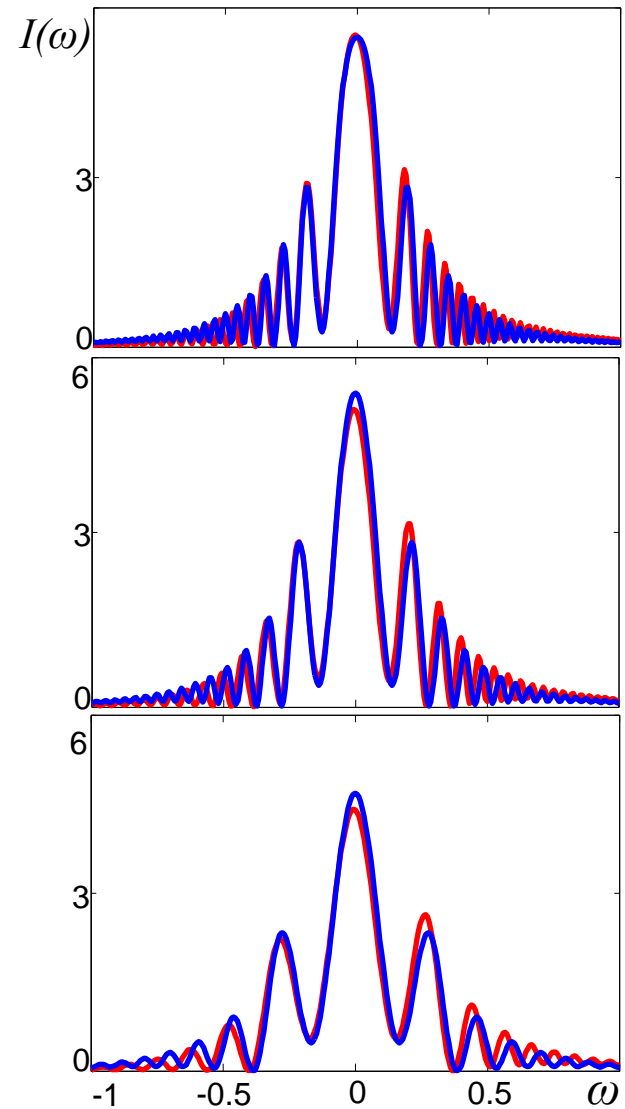
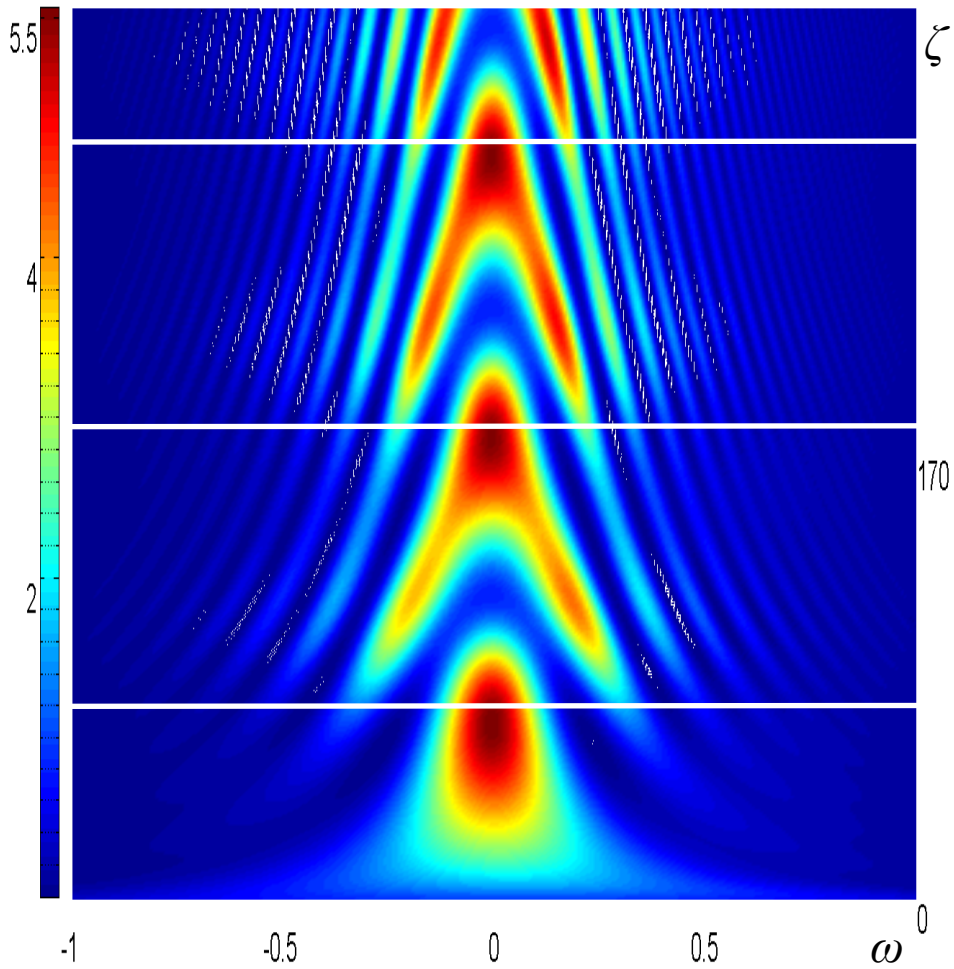


initial spectrum



self-compressed spectrum

# Impact of 3rd order dispersion





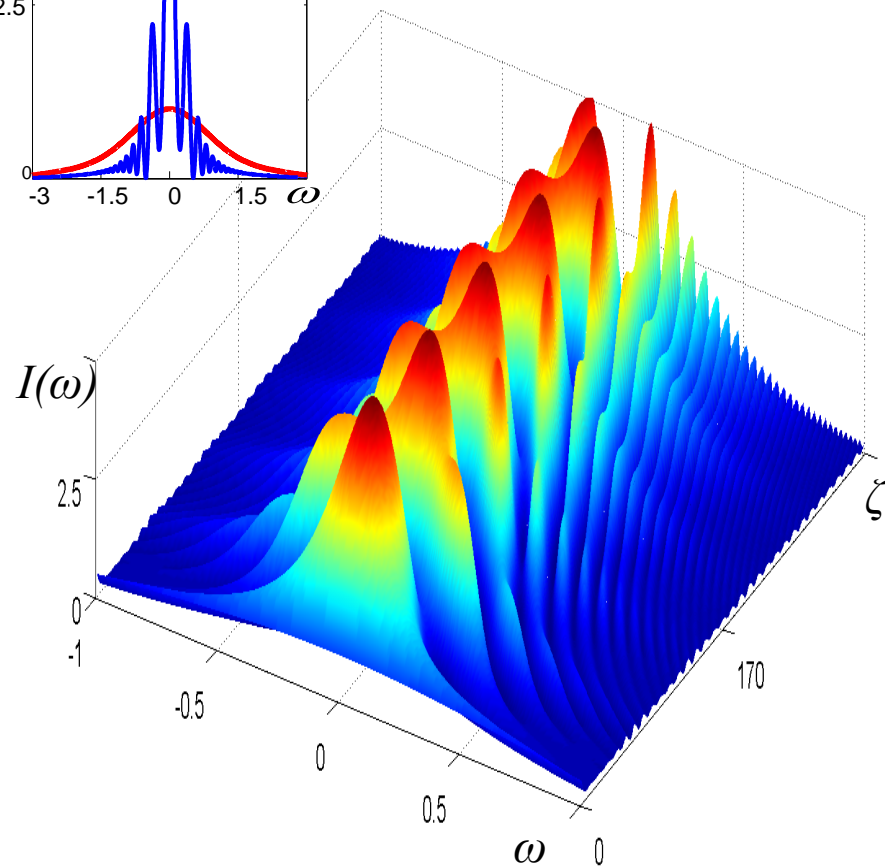
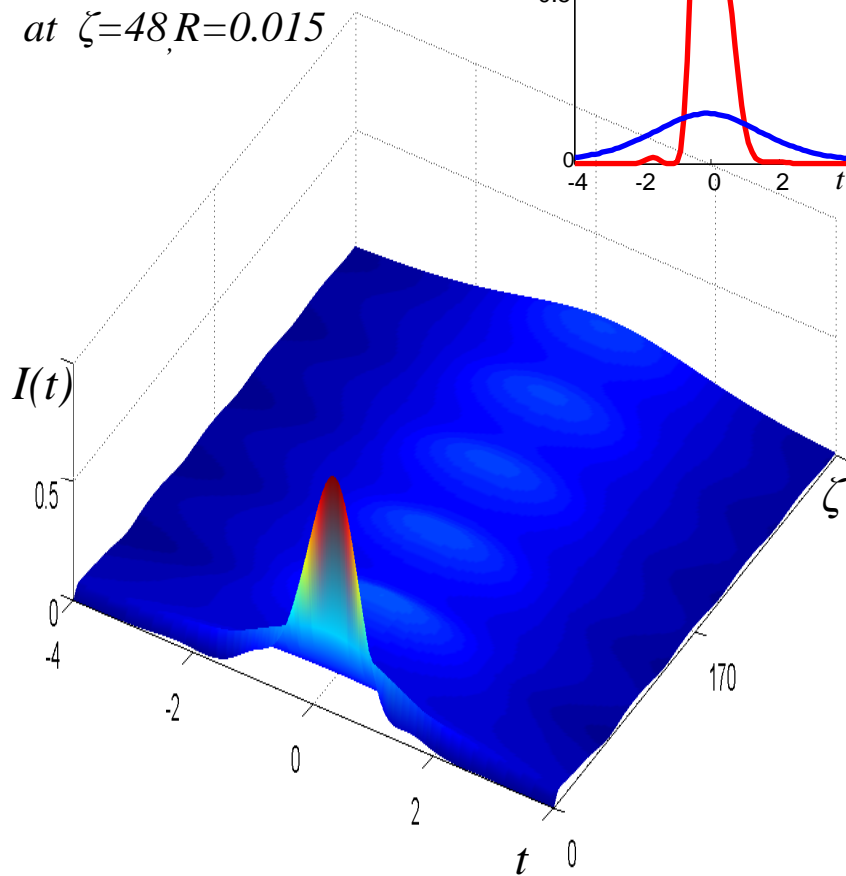
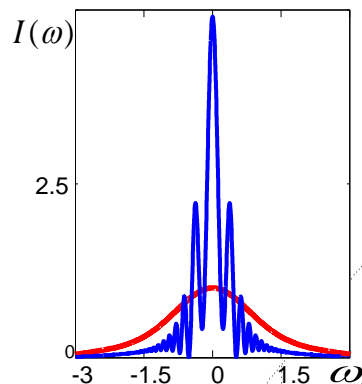
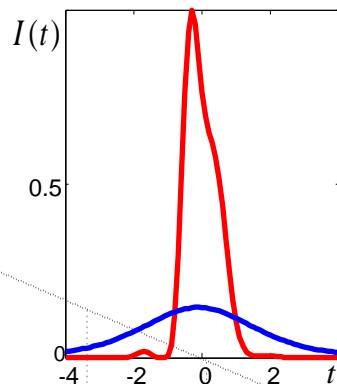
# Evolution of a pulse with random AM

$$A(t) = A_0(t)[1 + \sigma\zeta(t)]$$

$$A_0(t) = \exp(-t^2/2)$$

9x self-SC

at  $\zeta = 48, R = 0.015$



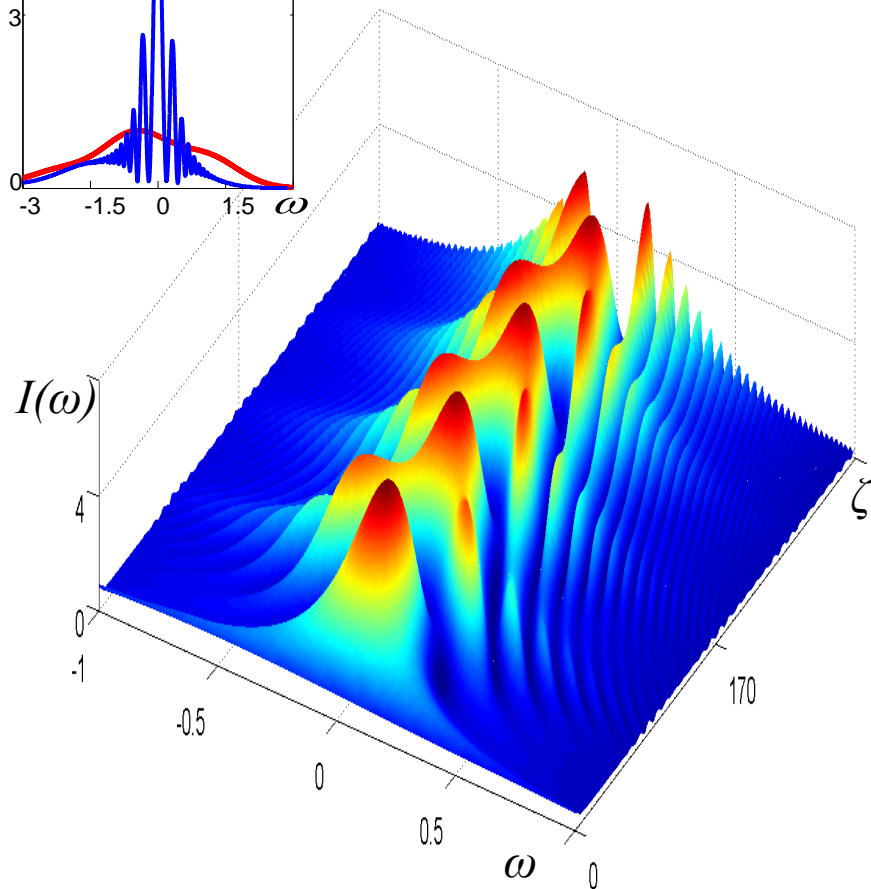
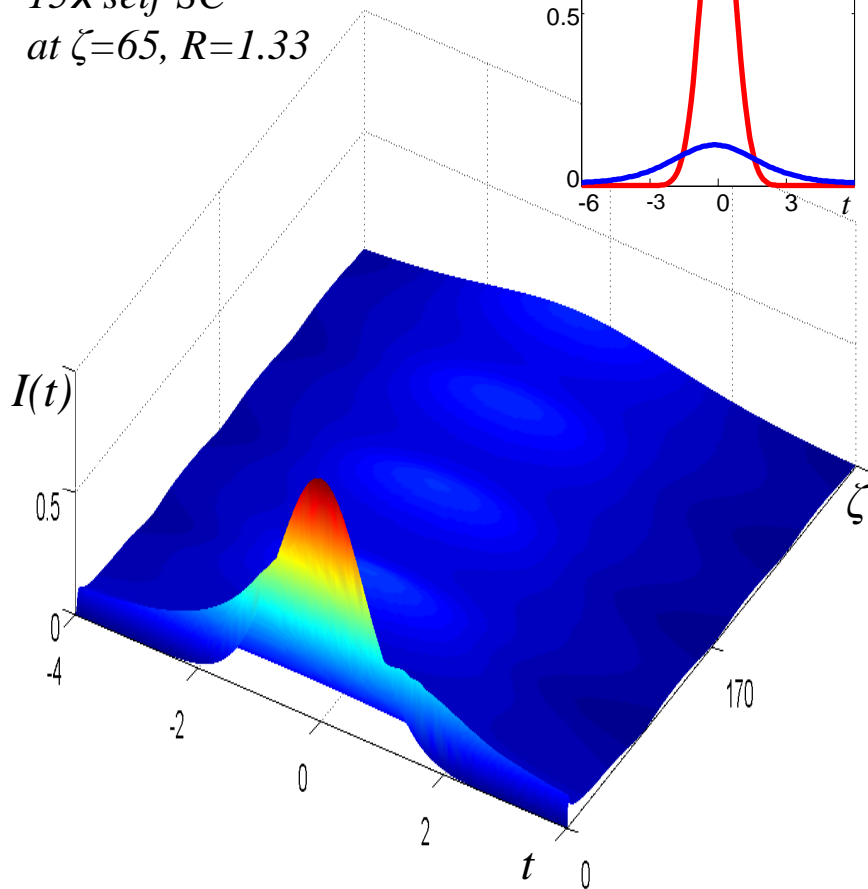
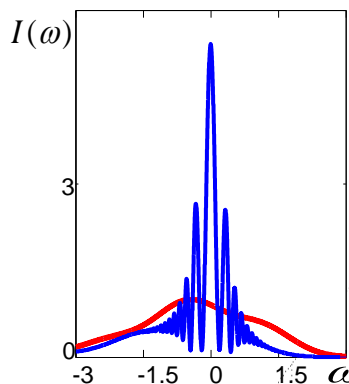
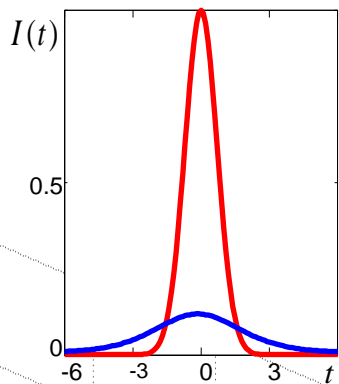
# Evolution of a pulse with random PM

$$A(t) = A_0(t) \exp[i\sigma\zeta(t)]$$

$$A_0(t) = \exp(-t^2/2)$$

15x self-SC

at  $\zeta=65$ ,  $R=1.33$



# Evolution of a pulse with random APM

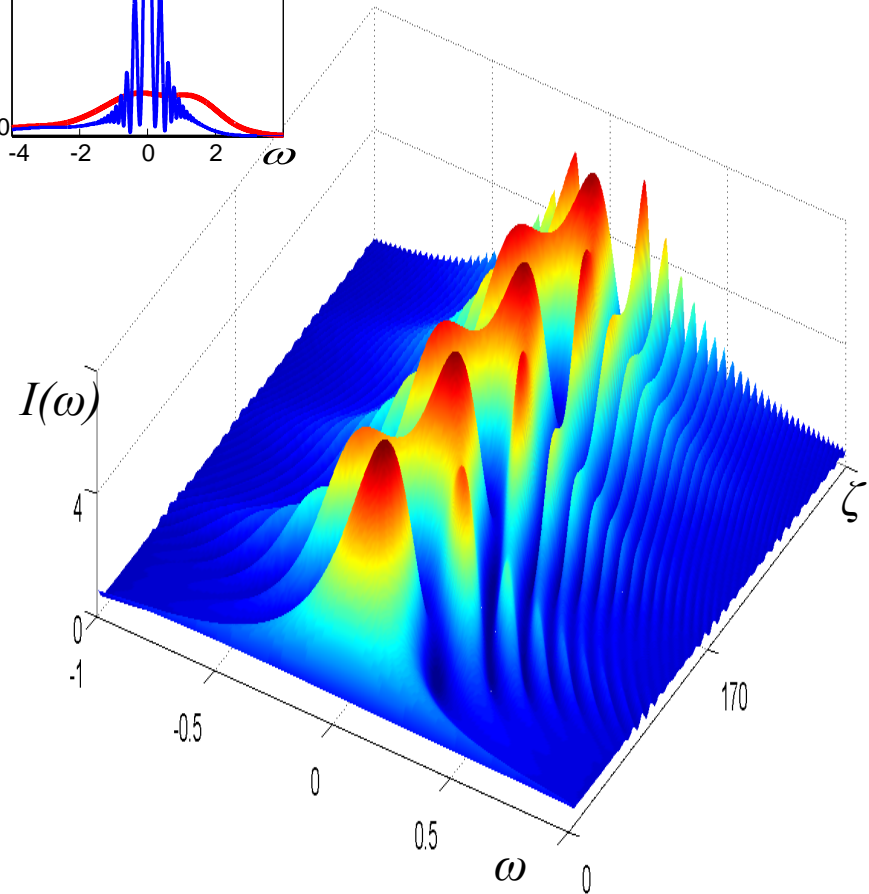
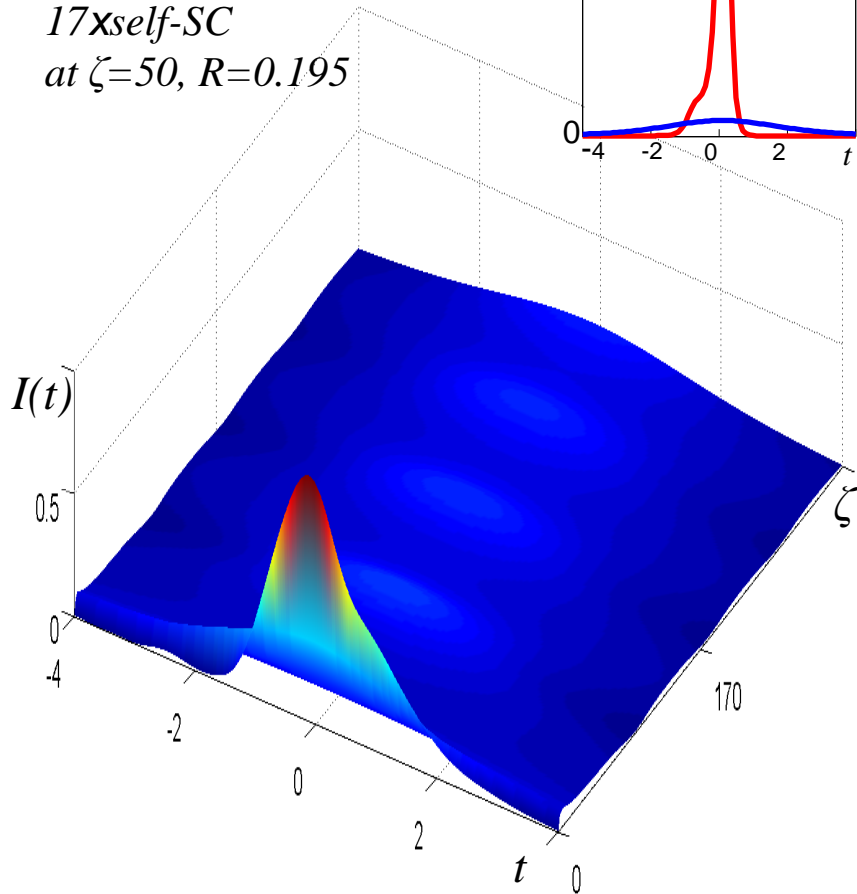
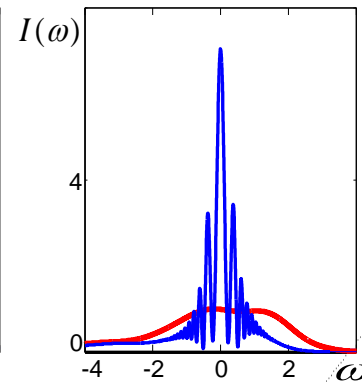
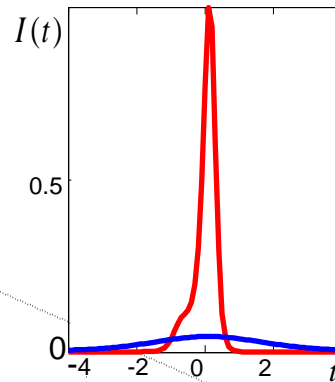
$$A(t) = A_0(t)[1 + \sigma \zeta(t)]$$

$$\zeta(t) = \zeta_1(t) + i\zeta_2(t)$$

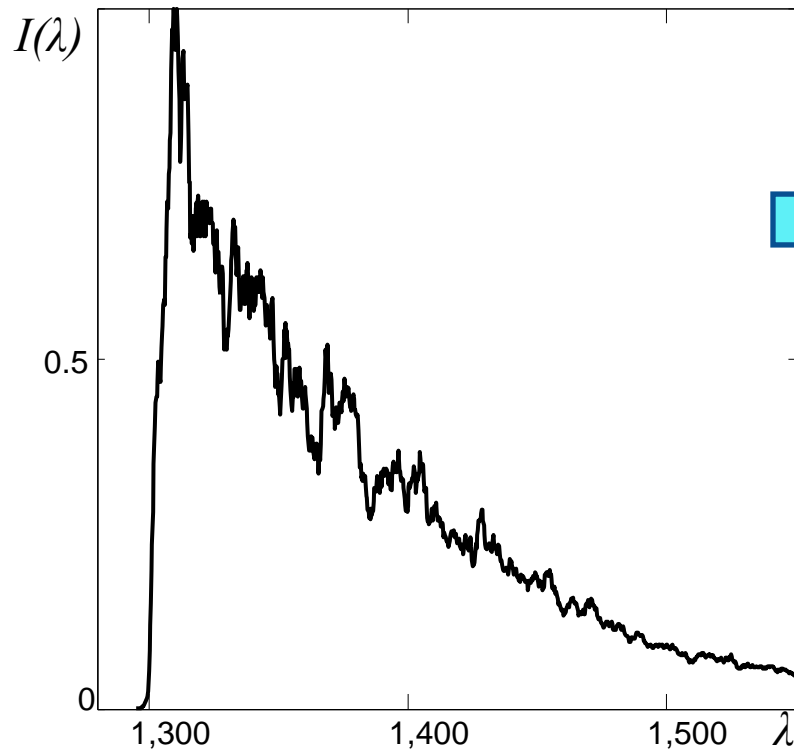
$$A_0(t) = \exp(-t^2/2)$$

17xself-SC

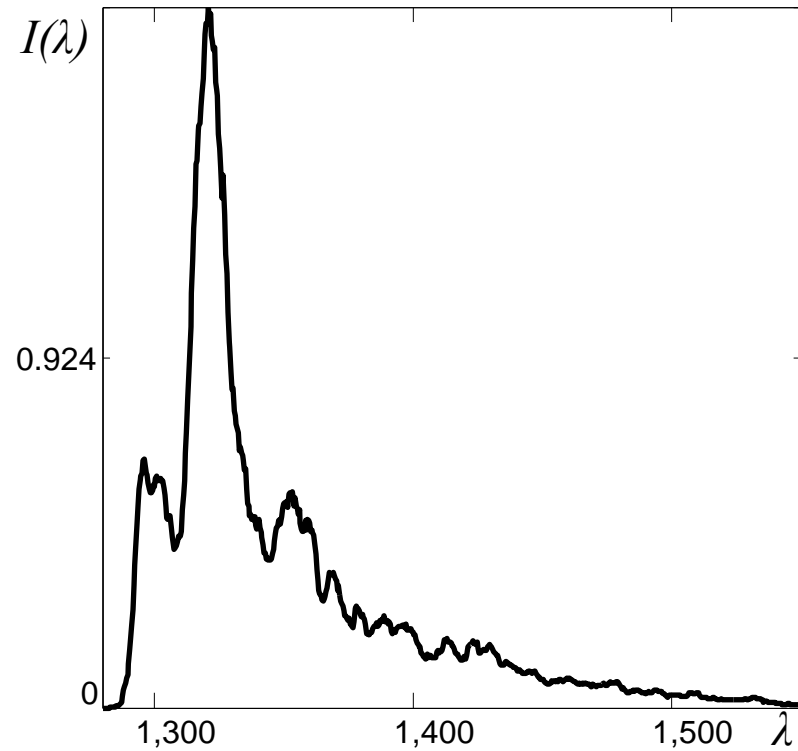
at  $\zeta = 50$ ,  $R = 0.195$



# Experimental result



*supercontinuum spectrum*



*self-compressed spectrum ( $\approx 4X$ )*

# *Conclusion*

- We show self-SC of coherent and partially coherent pulses through numerical simulations
- We have received optimization curves and corresponding formulas on the bases of numerical analysis
- We demonstrate 100x self-SC for Gaussian pulse
- Self-SC suppresses the noise



*Thanks*