



HAL
open science

All-fibered high-quality 28-GHz to 112 GHz pulse sources based on nonlinear compression of optical temporal besselons

Anastasiia Sheveleva, Christophe Finot

► **To cite this version:**

Anastasiia Sheveleva, Christophe Finot. All-fibered high-quality 28-GHz to 112 GHz pulse sources based on nonlinear compression of optical temporal besselons. Conference on Lasers & Electro-Optics Europe, Jun 2021, Munich, Germany. pp.CD-P18. hal-03183255

HAL Id: hal-03183255

<https://hal.science/hal-03183255v1>

Submitted on 31 May 2021

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

All-fibered high-quality 28 GHz to 112 GHz pulse sources based on nonlinear compression of optical temporal besseles

A. Sheveleva, C. Finot

Laboratoire Interdisciplinaire Carnot de Bourgogne, UMR 6303 CNRS-Université Bourgogne Franche-Comté, 21000 Dijon, France

Introduction

GOAL : generation of high-quality pulse trains at high repetition rates

Besselon waveform [1] :

1. CW + temporal sinusoidal phase

$$\psi(t) = \exp(iA_m \cos(\omega_m t))$$

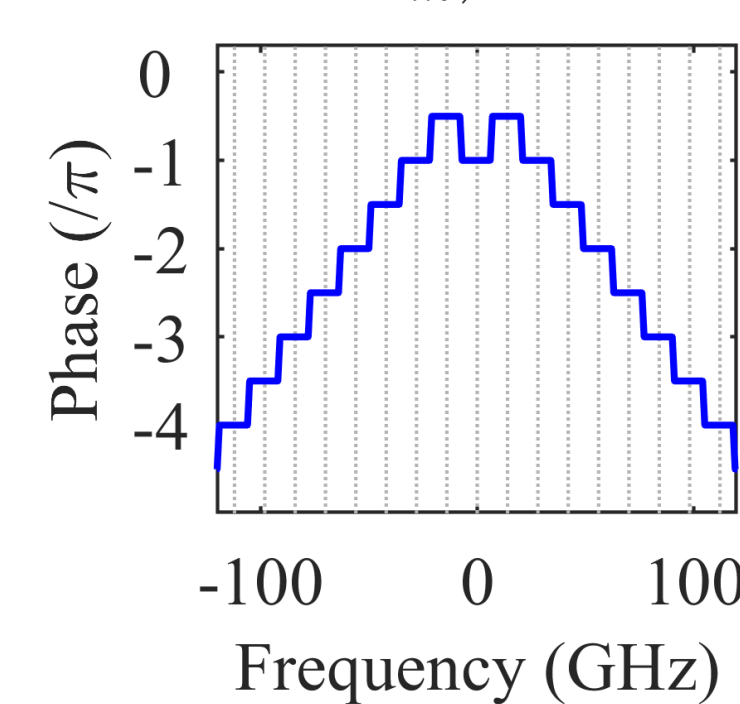
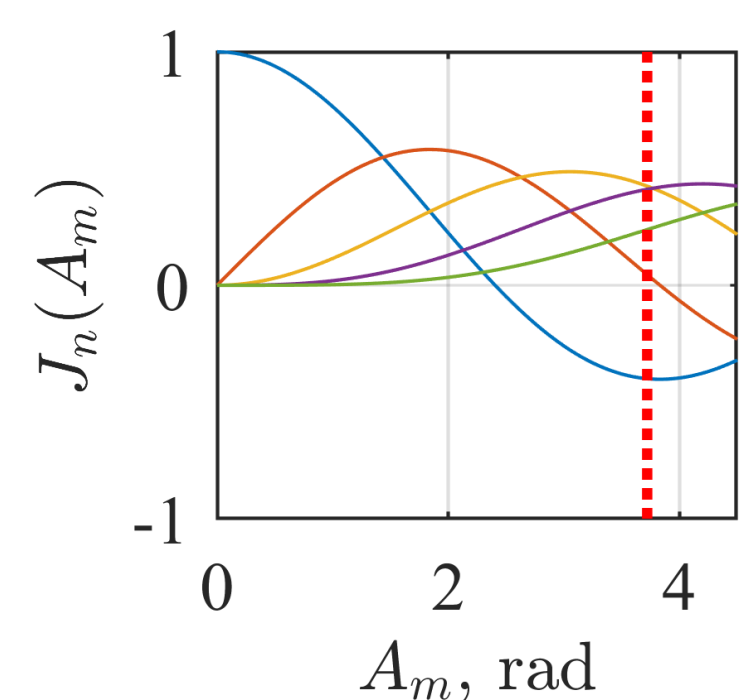
⇒ Jacobi-Anger expansion :

$$\psi(t) = \sum_{-\infty}^{\infty} J_n(A_m) \exp(in\omega_m t)$$

$\omega_m = 2\pi f_m$ - repetition rate

A_m - modulation amplitude (rad)

J_n - Bessel function of the first kind of order n



⇒ subsequent spectral lines have a $\pi/2$ phase shift

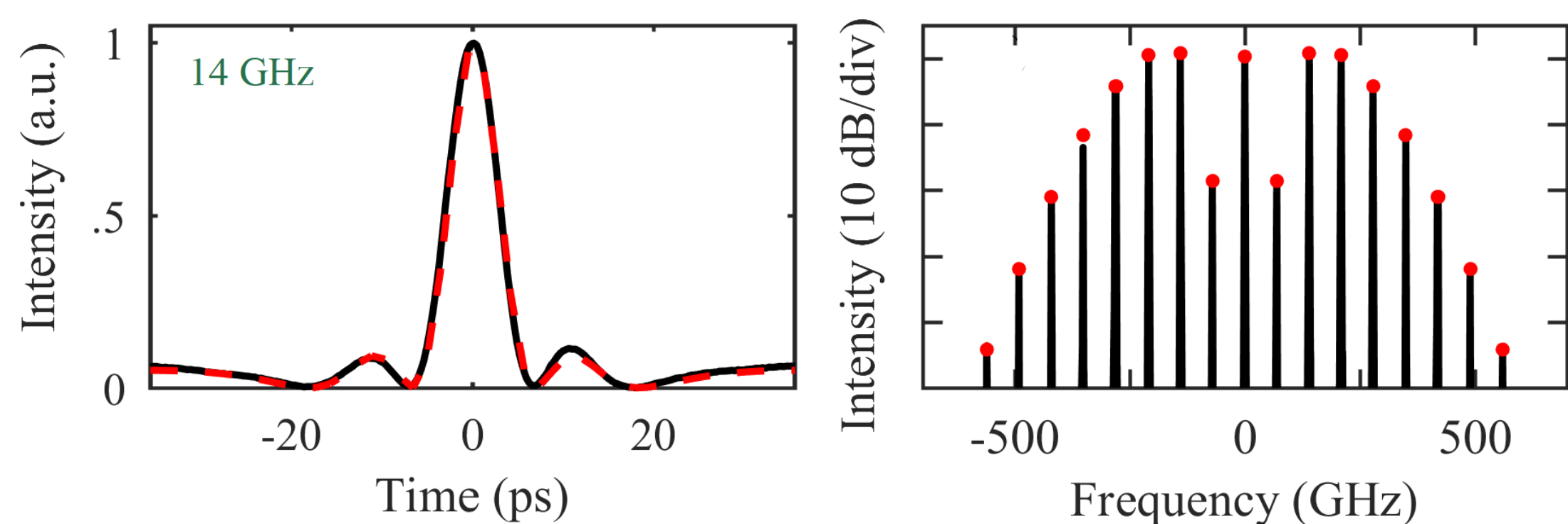
2. Triangular spectral phase to cancel out the phase offset [2]

⇒ Fourier transform limited waveform

⇒ high extinction ratio

⇒ full theoretical description available

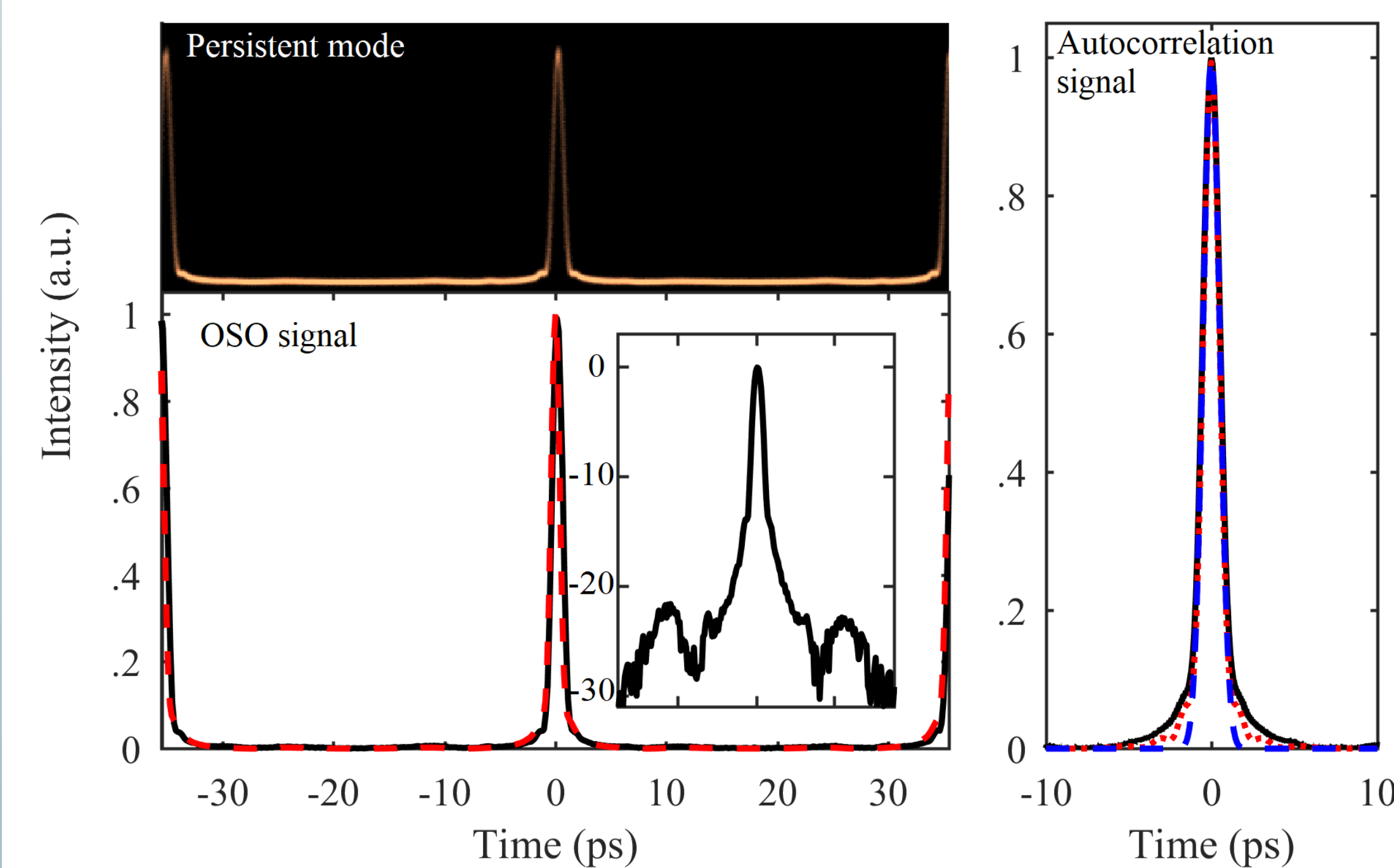
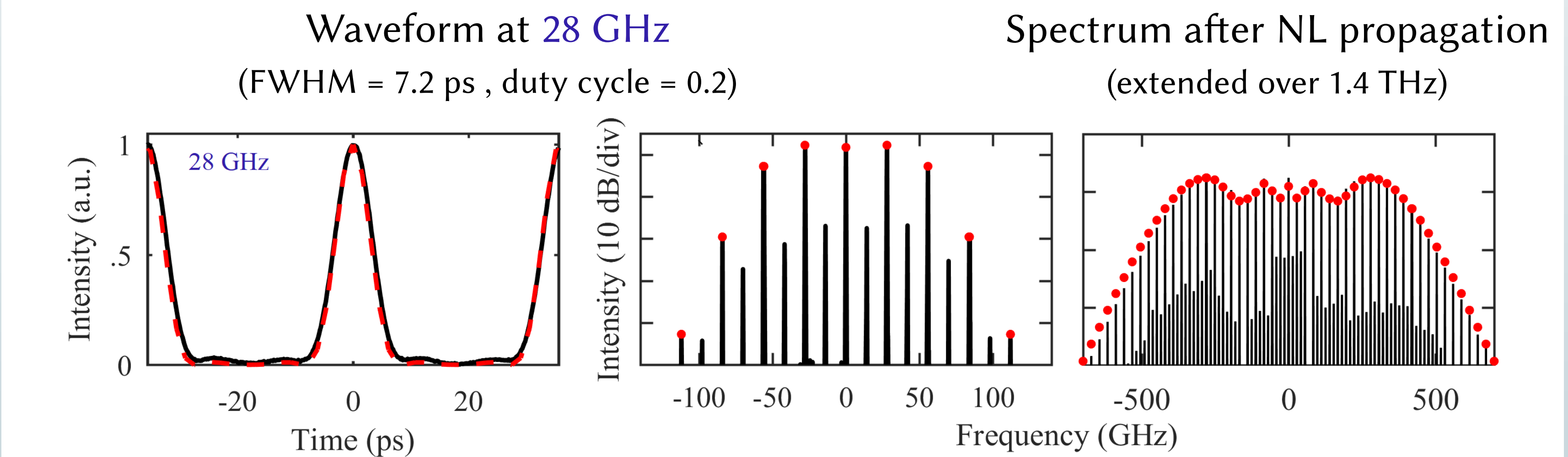
Besselon waveform generated at 14 GHz and $A_m = 3.72$ rad
(FWHM = 7.2 ps, duty cycle = 0.2)



red - theory, black - experiment

Results at 28 GHz, 56 GHz and 112 GHz

1. Phase-notch filter to multiplex the repetition rate before the nonlinear stage [3]

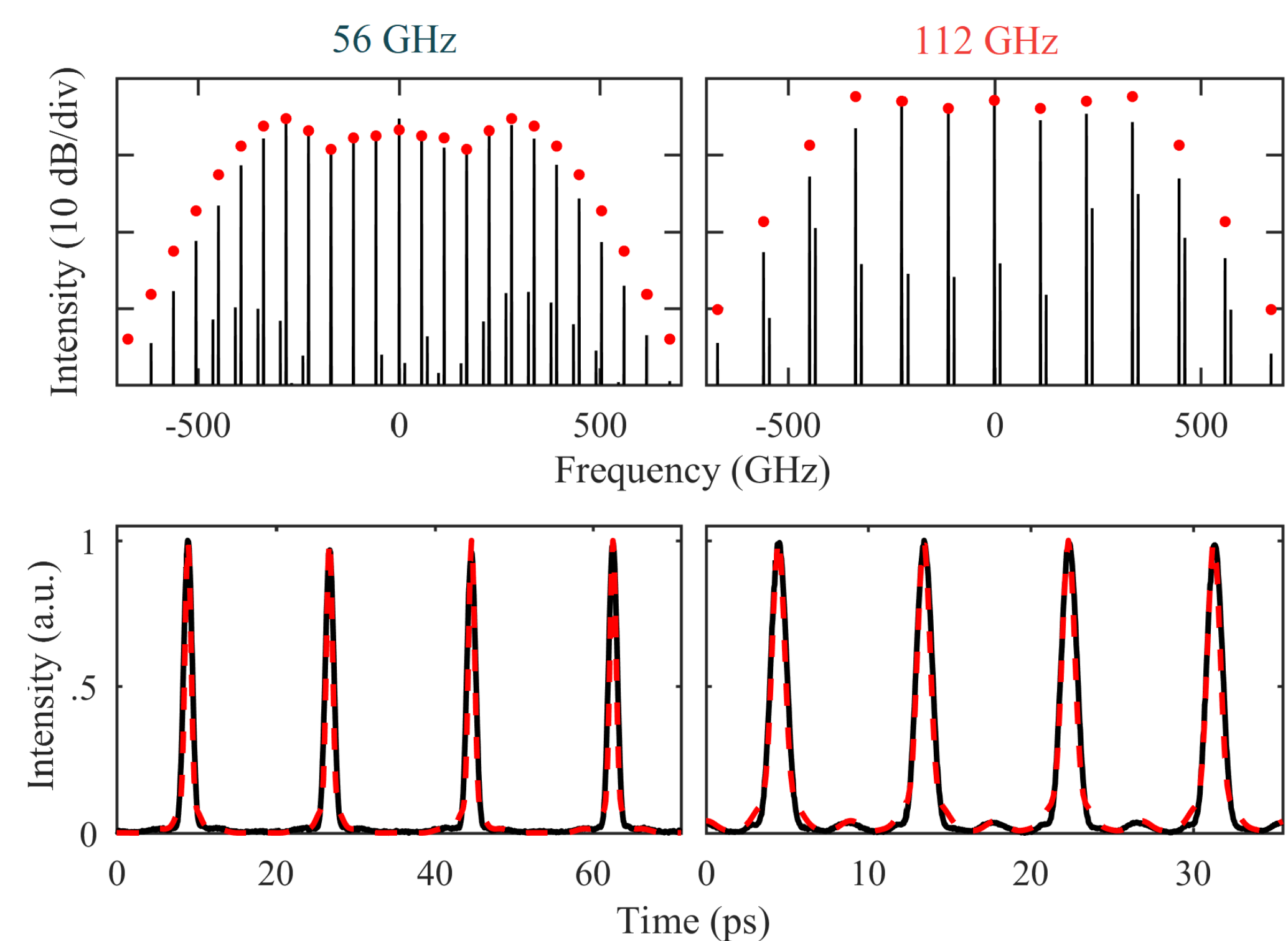


red - NLSE simulation, black - experiment, blue - autocorrelation of a Gaussian pulse

After the chirp compensation :

- high ER (more than 20 dB)
- high stability
- low duration (OSO and autocorrelation signal)

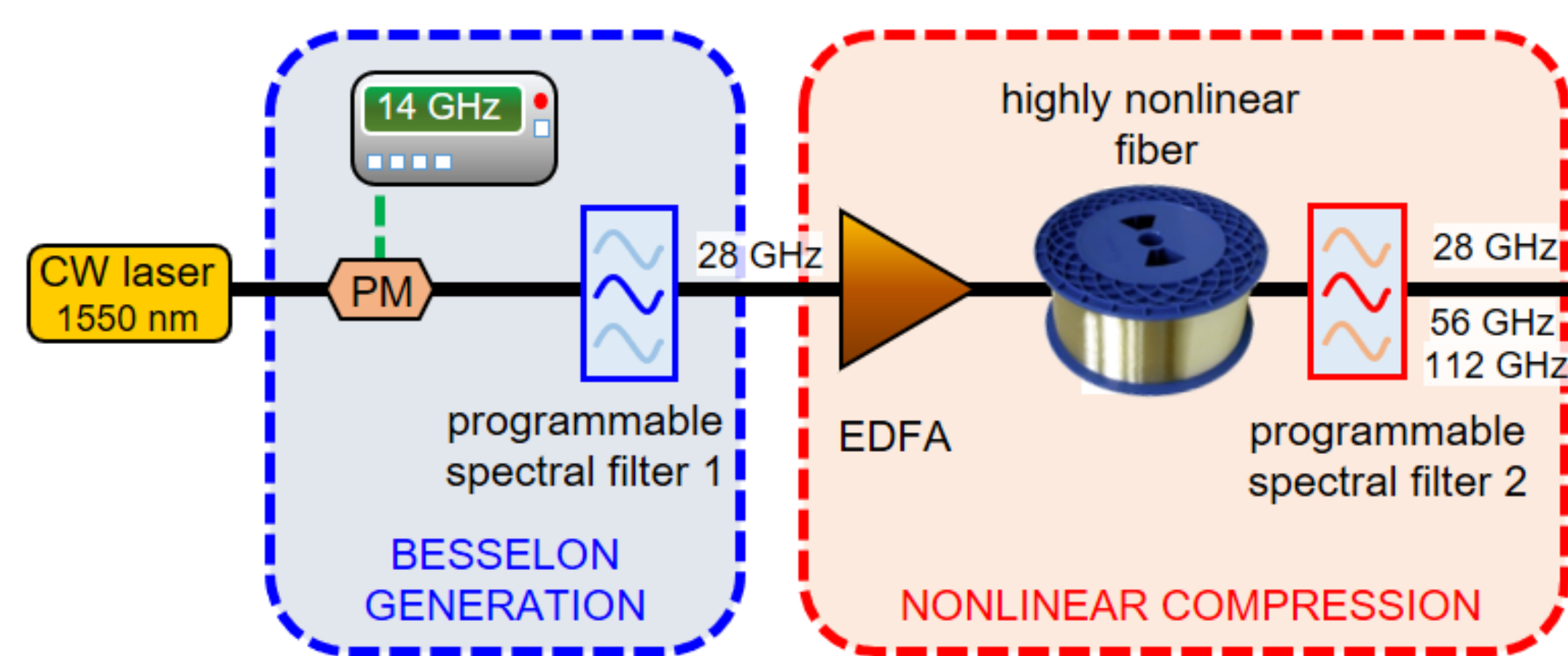
2. Attenuation of spectral lines of the NL-broadened spectrum to further multiplex



red - NLSE simulation, black - experiment

	28 GHz	56 GHz	112 GHz
FWHM, ps	0.78	0.83	0.94
Duty cycle	0.022	0.074	0.105

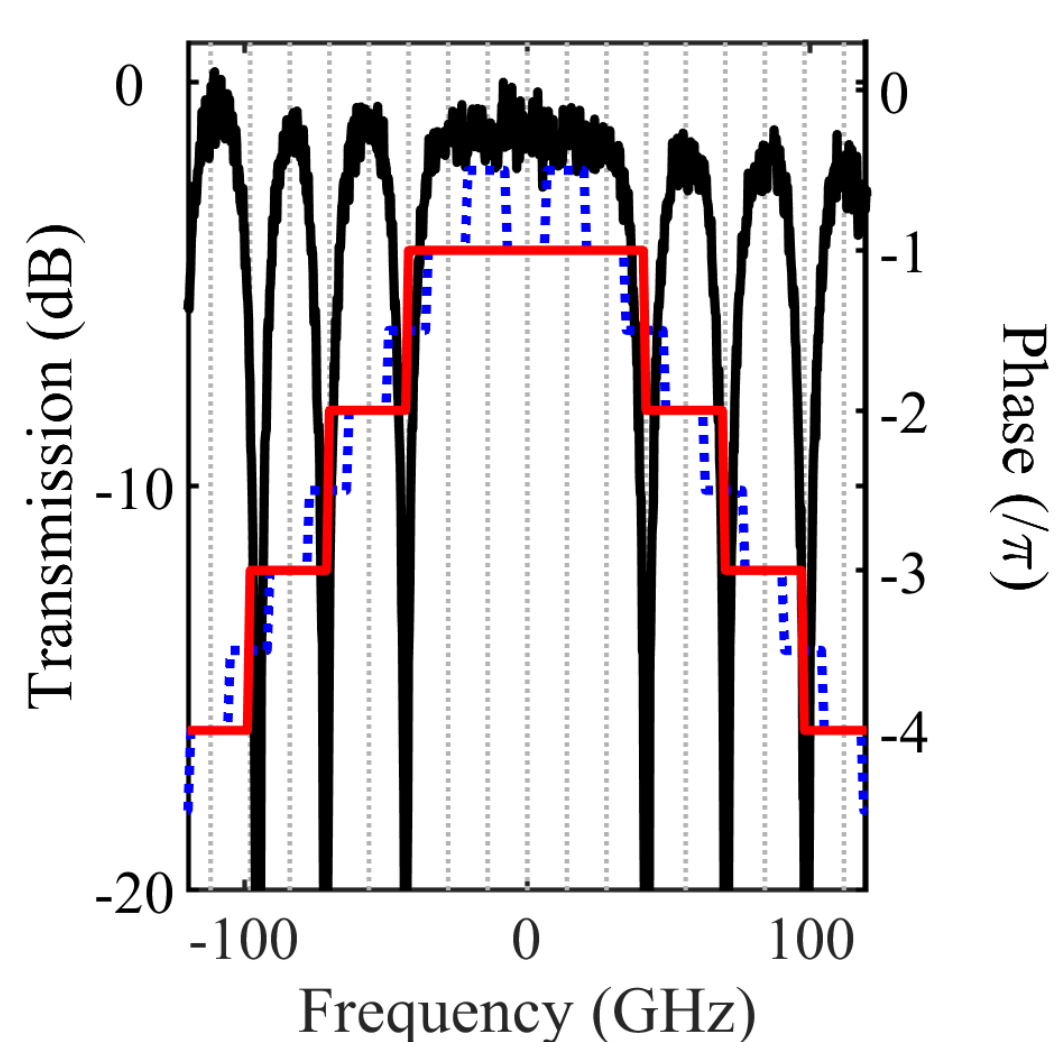
Experimental setup



WaveShaper 1

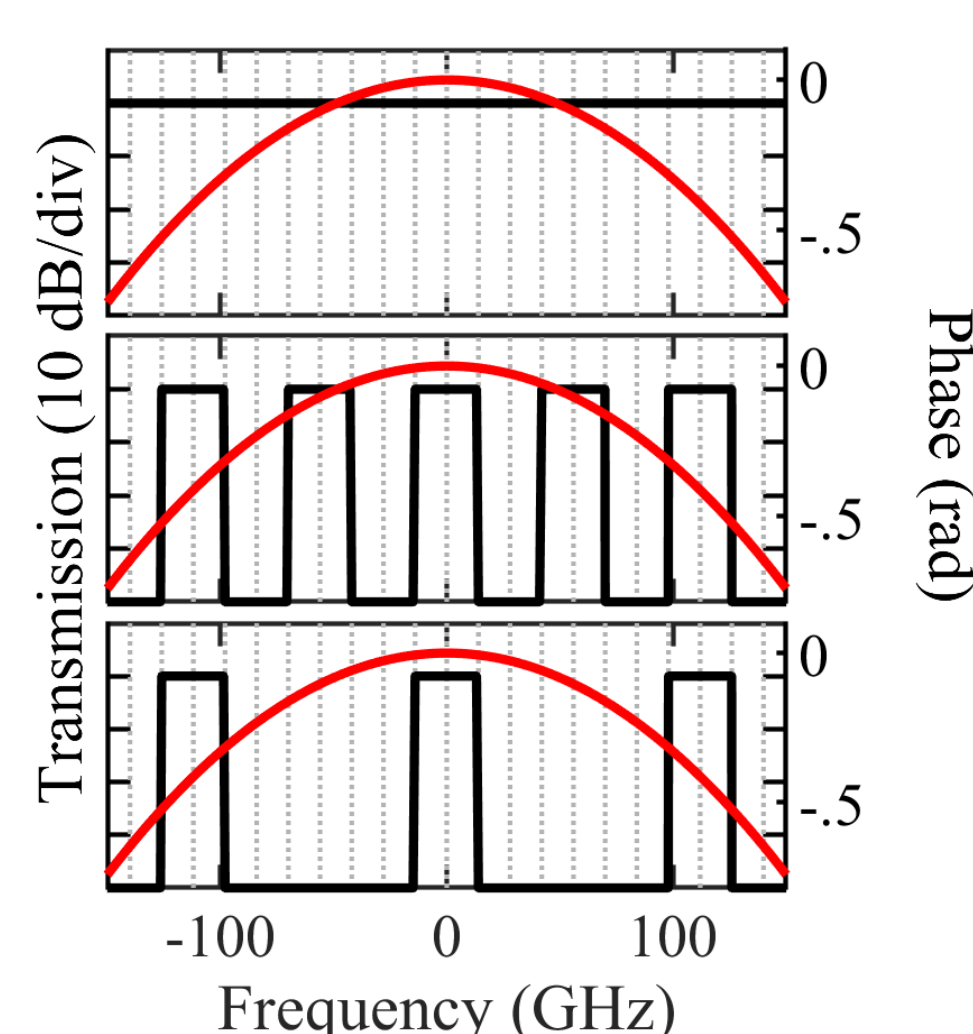
- Only phase profiles for 14 GHz (blue) or for 28 GHz (red)

black - ASE signal



WaveShaper 2

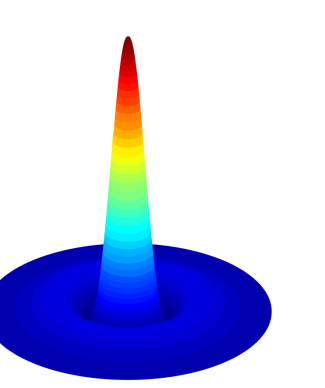
- Quadratic spectral phase for chirp compensation (red)
- Filters used for multiplexing (black)



HNLFF : $L = 1$ km, $\gamma = 10$ /W/km, $\beta_2 = 0.89$ ps²/km, $\alpha = 0.5$ dB/km

Conclusion

- high repetition-rate source
- simple setup (single phase modulator)
- high-quality pulse trains at 14 GHz, 28 GHz, 56 GHz and 112 GHz



References

1. A. Sheveleva, U. Andral, B. Kibler, S. Boscolo, and C. Finot, "Temporal Optical Besselon Waves for High-Repetition Rate Picosecond Sources," *JPhys Photonics*, <https://doi.org/10.1088/2515-7647/abdd1080> (2021).
2. U. Andral, J. Fatome, B. Kibler, and C. Finot, "Triangular spectral phase tailoring for the generation of high-quality picosecond pulse trains," *Opt. Lett.* 44, 4913 (2019).
3. A. Sheveleva and C. Finot, "Nonlinear Compression of Besselon Waves for High Repetition-Rate Subpicosecond Pulse Trains," *IEEE Photon. Technol. Lett.* 32, 1493 (2020).
4. T. Kobayashi, H. Yao, K. Amano, Y. Fukushima, A. Morimoto, and T. Sueta, "Optical pulse compression using high-frequency electrooptic phase modulation," *IEEE J. Quantum Electron.* 24, 382-387 (1988).
5. D. Marion and J. Lhermite, "Electro-optically modulated lasers: pulse energy and contrast enhancement derived from theoretical spectrum," *Opt. Lett.* 45, 2664-7 (2020)

