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# All-fibered high-quality low duty-cycle 40-GHz picosecond pulse source based on nonlinear compression of besselons

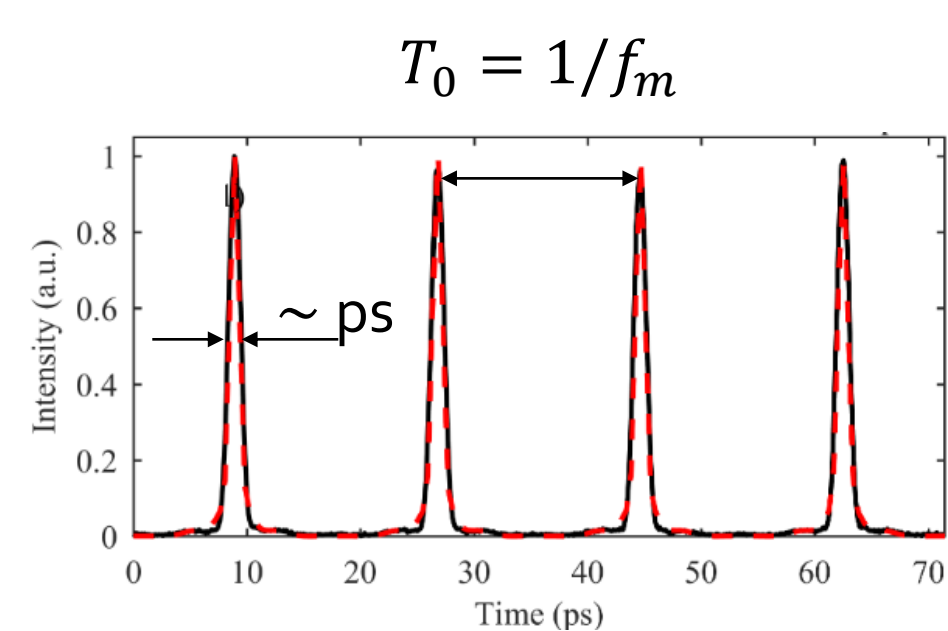


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## INTRODUCTION

**GOAL** : Ultrashort pulse train generation at high repetition rates using a simple all optical setup

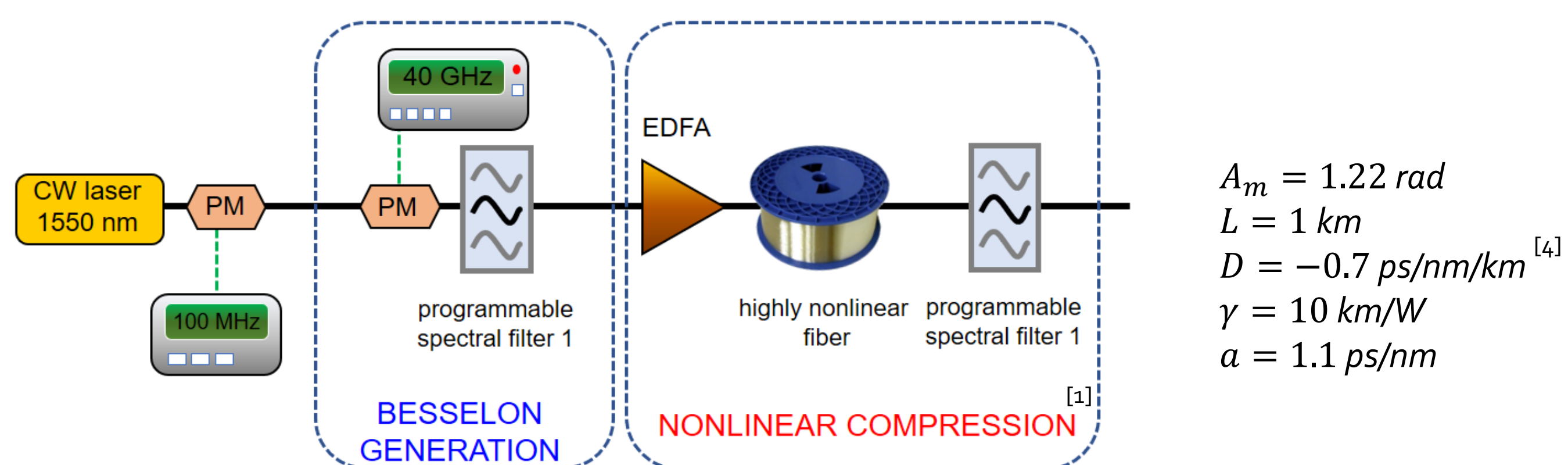


$$f_m \sim 5-100 \text{ GHz}$$

$$\text{Duty Cycle, } D = \frac{\text{FWHM}}{T_0} \ll 1$$

$$\text{Extinction Ratio, ER} = \frac{I(T_0)}{I(T_0/2)} \rightarrow \infty$$

## I. EXPERIMENTAL SETUP



$$A_m = 1.22 \text{ rad}$$

$$L = 1 \text{ km}$$

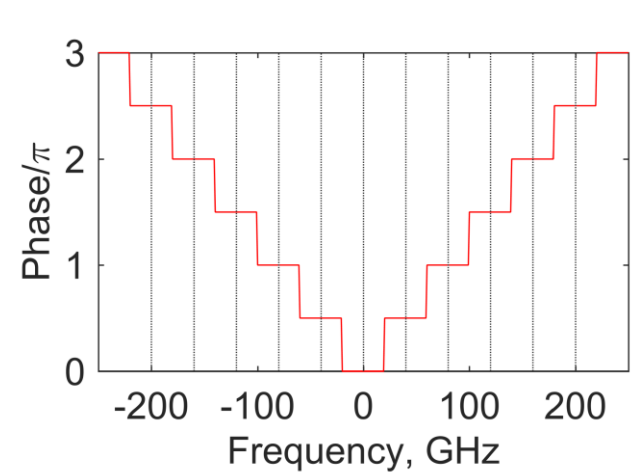
$$D = -0.7 \text{ ps/nm/km} \quad [4]$$

$$\gamma = 10 \text{ km/W}$$

$$\alpha = 1.1 \text{ ps/nm}$$

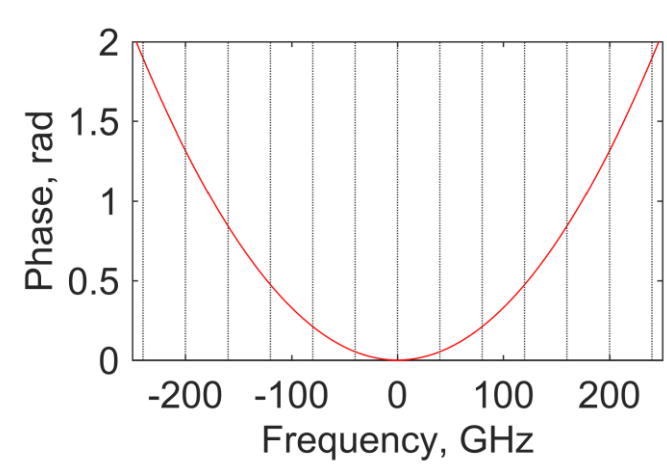
WaveShaper #1

Triangular step phase generates the Besselon waveform

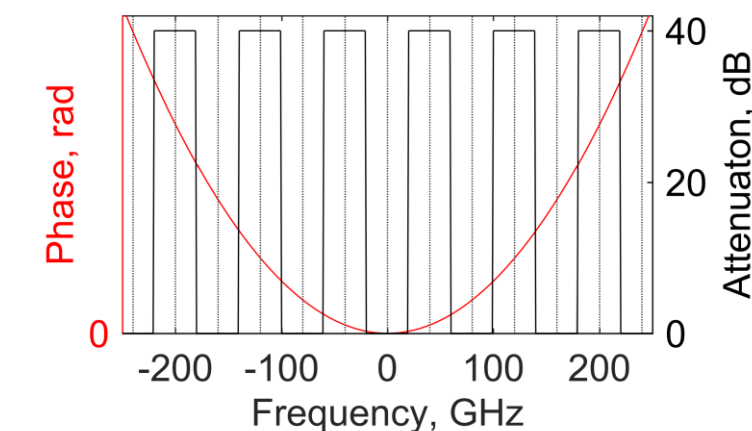


WaveShaper #2

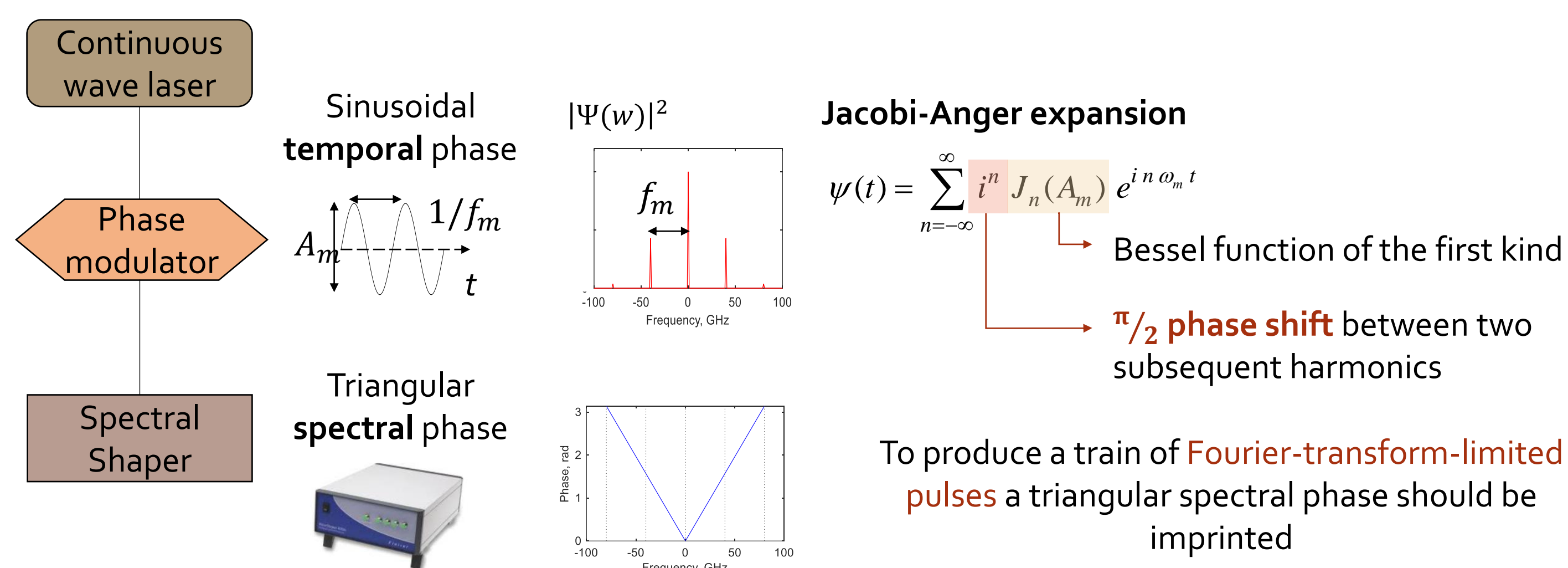
Quadratic phase compensates induced chirp [2, 5]



Suppression of spectral lines allows to multiplex the repetition rate

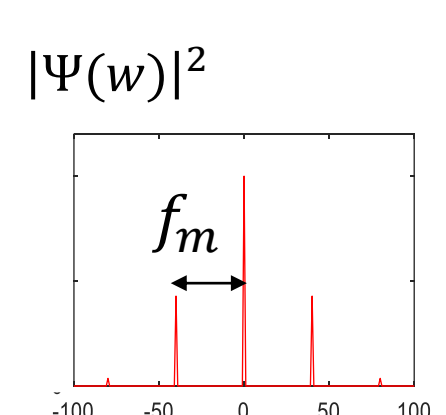


## II. BESSELON PULSE GENERATION



Sinusoidal temporal phase

$$A_m \sin(2\pi f_m t)$$



Triangular spectral phase



Jacobi-Anger expansion

$$\psi(t) = \sum_{n=-\infty}^{\infty} J_n(A_m) e^{i n \omega_m t}$$

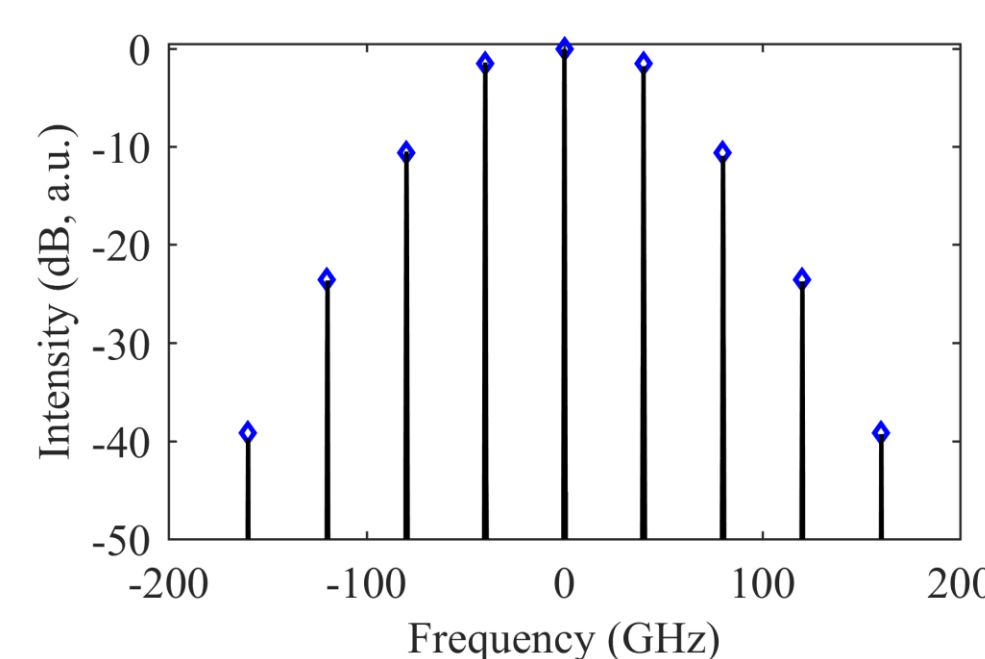
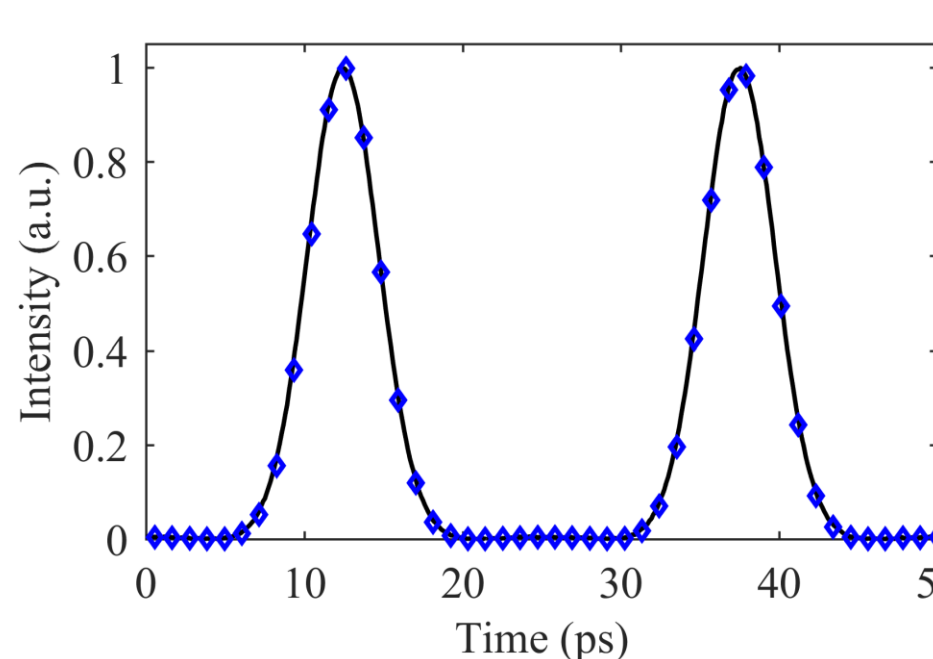
Bessel function of the first kind

$\pi/2$  phase shift between two subsequent harmonics

To produce a train of Fourier-transform-limited pulses a triangular spectral phase should be imprinted

— Theory  
 — Experiment

$$f_m = 40 \text{ GHz}, A_m = 1.22 \text{ rad}$$



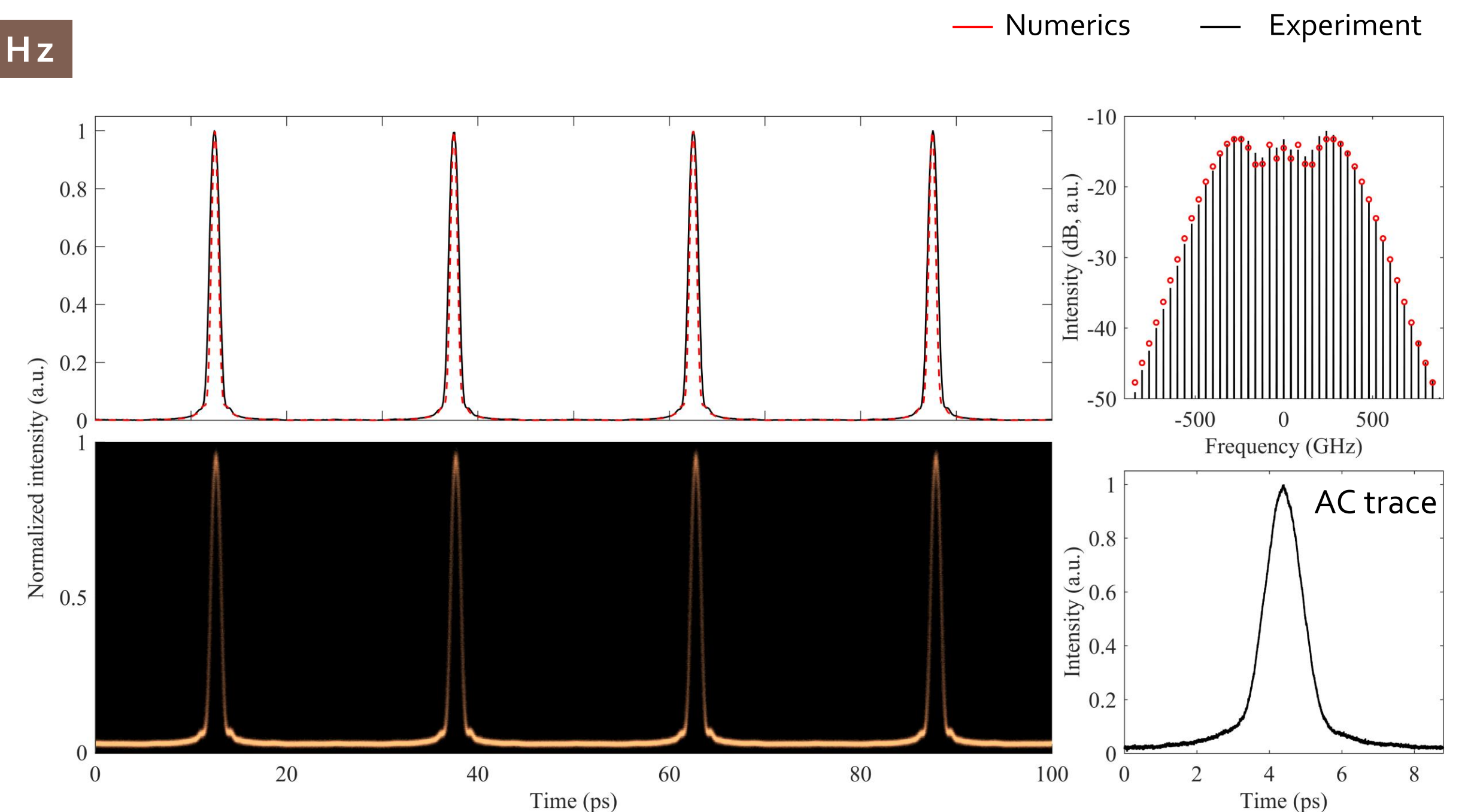
### BESSELON

- Background-free
- FWHM = 5.4 ps
- Duty cycle = 0.22

For more details refer to : [3], [6]

## III. NONLINEAR COMPRESSION

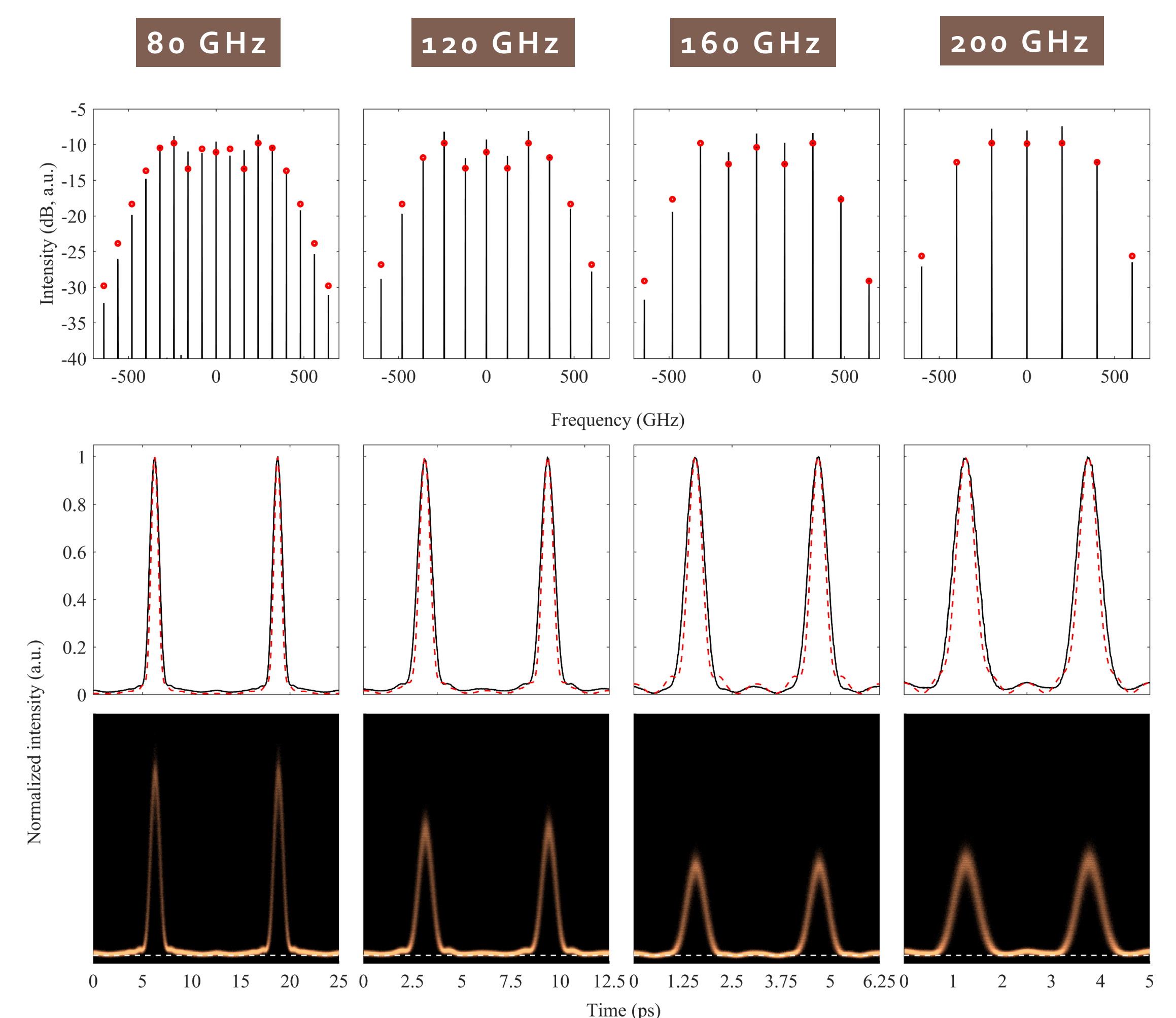
40 GHz



	Besselon	NL compressed pulse
FWHM, ps	5.4	0.9
Duty cycle	0.22	0.04

× 9 times improvement

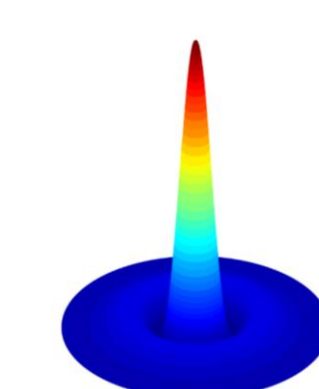
## IV. REPETITION RATE MULTIPLEXING



	80 GHz	120 GHz	160 GHz	200 GHz
FWHM, ps	0.85	0.77	0.73	0.95
Duty cycle	0.07	0.09	0.12	0.19

## CONCLUSION

- High extinction ratio ✓
- Low sidelobes ✓
- High repetition rate ✓
- Low duty cycle ✓



- Background-free pulse train
- Sub-ps pulses at (1 : 5) × 40 GHz
- All-optical setup of low complexity
- Significant improvement of the results

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