Burst Driven Parametric Frequency Down Conversion

A Pugzlys[1,2], R Jutas[2], J Roman[2], A Imani[2], P Carpeggiani[2], P Polynkin[3], E Kaksis[2], V Stummer[2], M Schneller[2], R Sharma[2], H Hu[2], J Kolenda[4], T Bartulevicius[4], K Michailovas[4], A Michailovas[1,4], and A Baltuska[1,2]

[1] *Center for Physical Sciences & Technology, Vilnius, Lithuania*
[2] *Photonics Institute, TU Wien, Vienna, Austria*
[3] *College of Optical Sciences, University of Arizona, Tucson AZ, USA*
[4] *Ekspla, Vilnius, Lithuania*
Contact Email: pugzlys@tuwien.ac.at

Bursts of high-intensity ultrafast laser pulses enable many exciting applications, which cannot be driven by traditional types of ultrafast lasers. On the one hand, isolated femtosecond pulses, boosted to high energies from conventional chirped-pulse amplifiers, are ideal for nonlinear-optical frequency conversion, but lack spectral selectivity unless a complex technique of spectral focusing is employed during the up- or down-conversion of the fundamental optical frequency. On the other hand, cw mode-locked sources at MHz-GHz repetition frequencies, which offer high spectral selectivity and enable frequency comb spectroscopies, cannot be amplified to mJ pulse energy levels due to excessive average power of the laser source as well as due to optical load on the spectroscopic targets. Fortunately, operation in the burst mode [1] solves these problems by limiting the average power but allowing one to reach high single-pulse intensity levels that are suitable for many nonlinear applications, including time- and frequency-resolved nonlinear spectroscopy on gas and condensed phase. In addition, high spectral selectivity, essential for resonant nonlinear spectroscopies, becomes available in carefully engineered bursts, where wavelength tunability is obtained by a direct electronic phase control with no moving parts in the laser system [2].

When generating high-energy Terahertz (THz) pulses via optical rectification (OR) by driving with a burst of closely spaced NIR pulses [1] a control over central THz frequency of equidistant narrowband spectral peaks can be achieved by adjusting the pulse number and spacing in the burst. The spectral tunability in combination with a conventional bolometric detection allows selective detection of narrowband resonances of particular organic samples.

The talk will present the technology of generating phase- and amplitude-controlled amplified pulse bursts, discuss the limits of energy scaling and solutions, demonstrate applications of burst-driving for parametric frequency conversion. At the end we address the energy scaling in a burst-mode Nd:YAG amplifier with an opportunity to de-multiplex a near-IR pulse bursts into individual multicolour pump channels in KTA based OPCPA, such that they can be spatially and temporally combined as a pump in a zinc germanium phosphide (ZGP) nonlinear optical crystal.

References

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