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# Generation of 7-fs Pulses at 800 nm from a Blue-pumped Optical Parametric Amplifier at Degeneracy

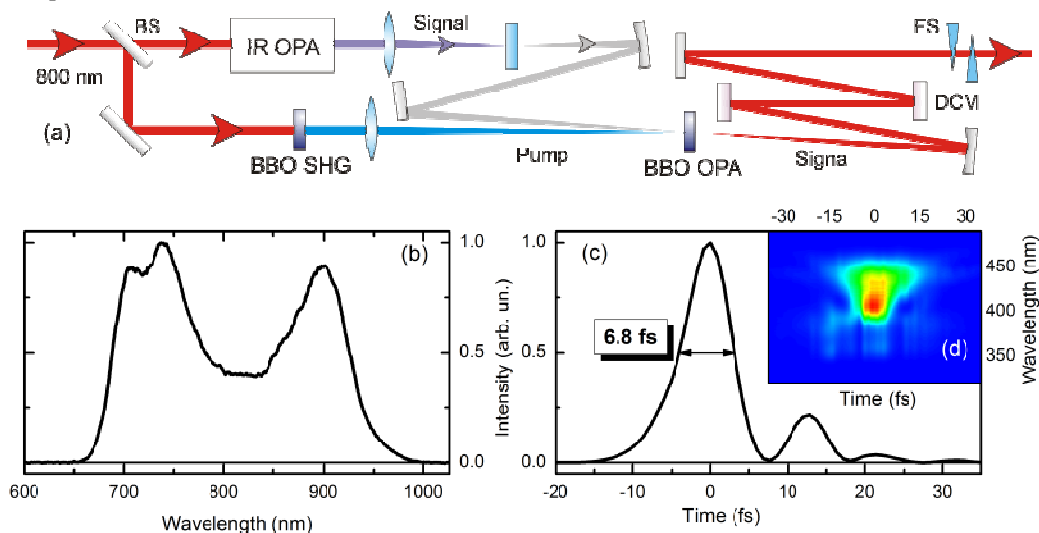
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Optical Parametric Amplifiers (OPAs), thanks to their broad phase matching bandwidths, allow for the dramatic shortening of the duration of the driving pulse. In particular, OPAs pumped by the fundamental frequency (FF) or the second harmonic (SH) of Ti:sapphire and seeded by white-light continuum (WLC) enable the generation of few-optical-cycle pulses in a wide spectral range, from the visible [1] to the near-IR [2]. However the important spectral range around 800 nm has not yet been covered. In fact the WLC produced from an 800-nm driving pulse presents a highly structured amplitude and phase profile around the pump frequency. Previous attempts of amplification at 800 nm of a supercontinuum generated in a photonic crystal fiber resulted in ultra-broadband spectra, which were however not compressed due to the strong chirp on the seed pulses [3]. In this work we report on a two-stage approach for the generation of few-optical-cycle pulses at 800 nm; (i) a FF-pumped near-IR OPA produces pulses at 1.3  $\mu\text{m}$ , which are used to generate a WLC with smooth spectral amplitude and phase characteristics around 800 nm; (ii) this WLC is amplified in a broadband SH-pumped OPA around degeneracy. The pulses are compressed to nearly transform-limited 6.8 fs duration by chirped mirrors.

Figure 1(a) shows a schematic of the experimental setup, which is driven by an amplified Ti:sapphire laser system producing 150-fs pulses at 1 kHz (Quantronix Integra-C). A 150  $\mu\text{J}$  fraction of the pulses is used to drive a two-stage FF-pumped OPA, employing type II  $\beta$ -barium borate (BBO) crystals and generating 15- $\mu\text{J}$  pulses at 1.3  $\mu\text{m}$ ; this OPA presents excellent stability thanks to pump depletion. Next this signal is focused into a 3-mm sapphire plate resulting in a stable broadband WLC extending to 600 nm. In the final stage this WLC is amplified to 2-3  $\mu\text{J}$  in a single pass in a 1-mm BBO crystal (type I, 29°) pumped with 70  $\mu\text{J}$  of the SH. The resulting ultrabroadband spectrum is displayed in Fig. 1(b). The output is compressed with 2 bounces on broadband double chirped mirrors with cancelling dispersion ripples and through 1.25 mm of bulk fused silica; the reconstructed 6.8 fs pulsewidth and the corresponding FROG trace are shown in Fig. 1(c)-(d). The compressed amplified output is stable and has excellent beam quality. We note that we achieve a shortening of the pulsewidth by a factor of  $\sim 20$  starting from a conventional long-pulse femtosecond system. In future work, we will generate the WLC with the Carrier Envelope Phase stable idler of the NIR OPA to generate a phase stable output at 800nm [4].



**Fig. 1** (a) Setup of the broadband SH-pumped OPA at degeneracy BS, beam splitter; DCM, double-chirped mirror; FS, fused silica wedge; (b) OPA spectrum; (c) corresponding pulse profile and (d) measured FROG trace after compression.

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