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Femtosecond optical parametric oscillators: a practical approach for power scaling and pulse-shape control

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Abstract:

The synchronously pumped optical parametric oscillator (SPOPO) has undergone major developments in the past decade. Quasi-phase-matched nonlinear materials, such as periodically-poled lithium niobate (PPLN) and the availability of higher pump power have led to SPOPO demonstrations with additional functionality including extended tuning ranges throughout the infrared with greater spectral control and frequency tuning agility.

High-power fibre laser systems are an emerging technology for compact, robust and stable generation of femtosecond pulses. Their power levels have now converged with the power levels needed for efficient frequency conversion in quasi-phase-matched nonlinear materials [1]. The combination of these two technologies is seen as an attractive method for producing broadly tunable ultrashort pulses. This paper will present a practical route for power-scaling femtosecond SPOPOs using high-power fibre amplifier systems.

In addition, two demonstrations of extended wavelength performance and spectral control from SPOPO's will also be described, in order to show the future potential for new devices as a result of power-scaling. Firstly, results are presented of a PPLN SPOPO with idler generation (and its direct detection) having both diffraction-limited and bandwidth-limited performance out to 7.25 microns, thus extending well beyond the conventionally accepted IR band edge of ~5 microns [2]. Secondly, the performance of a noncritically phase-matched cadmium selenide SPOPO is described with idler wavelengths tuned, so far, over the range 9.1 – 9.7 microns [3].

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