

A fs-pulsed synchronously pumped optical parametric oscillator developed for three-photon and third harmonic generation microscopy.

G. Norris and G. McConnell

Centre for Biophotonics, SIBPS, University of Strathclyde, 27 Taylor Street, Glasgow G4 0NR, United Kingdom

Email: greg.norris@strath.ac.uk

Three photon and third harmonic generation (THG) microscopy techniques both offer excellent potential for deep fluorescence imaging of biological samples. As both methods require a longer wavelength excitation source than one or two photon processes, less scatter will occur and hence deeper penetration into the sample becomes possible. It has also been shown that longer wavelengths may cause less damage to cells than standard shorter wavelength methods [1]. However, clearly this places implications on the laser source. Ultra-short pulsed output at longer wavelengths are required and although the wavelength tuning range of the commonly used Ti:Sapphire laser extends to around 1040nm, this corresponds to a single photon absorption in the ultraviolet range of the spectrum yet many natural and synthesised fluorophores have absorption maxima in the visible spectral region. Chromium and Erbium doped fibres and dielectric materials can support ultra-short pulses at wavelengths longer than the Ti:Sapphire, but the wavelength tuning range is restrictive. By providing a tunable excitation source at these wavelengths, many common dyes become available as labels for samples when using three photon and THG microscopy.

This project aims to develop an ultra-short pulsed, wavelength tunable optical parametric oscillator (OPO) as an excitation source for three photon and THG microscopy. A periodically poled lithium niobate (PPLN) crystal was designed to provide wavelength tunable output from 1400 nm to 1600 nm when synchronously pumped with a 330 fs-pulsed 1064nm laser with a repetition rate of 80 MHz and an output power of 1W.

We will present an overview of the OPO design and crystal considerations, and wavelength tuning mechanisms and results will be discussed. A discussion of opportunities for dispersion management for this novel source will also be reported, with a view to maximising the probability of three photon excitation events.

[1] D. Debarre et al., Nature Methods, **3**, 47 (2006).