

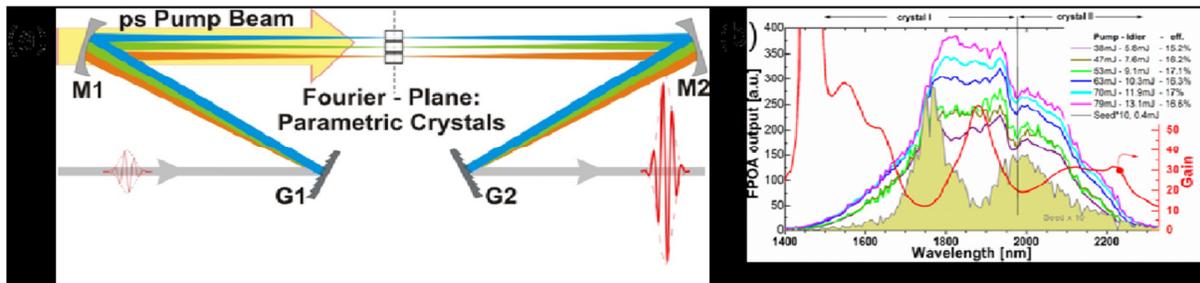
Seminar

Frequency domain Optical Parametric Amplification

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The universal dilemma of gain narrowing occurring in fs amplifiers prevents ultra-high power lasers from delivering few-cycle pulses. This problem is overcome by a new amplification concept: Frequency domain Optical Parametric Amplification – FOPA [1,2]. It enables simultaneous up-scaling of peak power and amplified spectral bandwidth and can be performed at any wavelength range of conventional amplification schemes, however, with the capability to amplify single-cycle pulses. The key idea for amplification of octave-spanning spectra without loss of spectral bandwidth is to amplify the broad spectrum "slice by slice" in the frequency domain, i.e. in the Fourier plane of a 4f-setup (figure 1).



Opposed to traditional schemes where amplification takes place in time domain, we propose to amplify different spectral parts independently of each other in the spectral domain. Therefore, the pulse's input spectrum is spectrally dispersed and then several individual narrowband optical parametric crystals are used whereby each is tuned for optimal amplification of its corresponding spectral slice. Fig. 1. (a) Schematic of a Frequency domain Optical Parametric Amplifier. (b) Amplified spectra as a function of pump energy (from Titanium-Sapphire laser). With 79 mJ of pump, 13.1 mJ FOPA output has been measured denoting 16.6% conversion efficiency. The striking advantages of this scheme, are its capability to amplify (more than) one octave of bandwidth without shorting the corresponding pulse duration. This is because ultrabroadband phase matching is not defined by the properties of the nonlinear crystal employed but the number of crystals employed. In the same manner, to increase the output energy one simply has to increase the spectral extension in the Fourier plane and to add one more crystal. Thus, increasing pulse energy and shortening its duration accompany each other.

A proof of principle experiment was carried out at the Advanced Laser Light Source (ALLS) on the sub-two cycle IR beam line [3] and yielded record breaking performance in the field of few-cycle IR lasers. 100µJ two-cycle pulses from a hollow core fibre compression setup were amplified to 1.43mJ without distorting spatial or temporal properties. Pulse duration at the input and after FOPA remains the same. Recently, we have started upgrading this system to be pumped by 250 mJ to reach 40 mJ two-cycle IR few-cycle pulses and latest results will be presented at the conference.

[1] B. E. Schmidt et al. "Frequency domain optical parametric amplification.," Nature Commun. 5, 3643 (2014).

[2] P. Lassonde et al. "High gain Frequency domain Optical Parametric Amplification", IEEE J. Sel. Top. Quant. Electr. 21, 8700410 (2015).

[3] B. E. Schmidt et al. "CEP stable 1.6 cycle laser pulses at 1.8 µm," Opt. Express 19, 6858-6864 (2011).

Wednesday, Apr 27th 2016

11:30 AM (Tea/Coffee at 11:15 AM)

Seminar Hall, TCIS