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Towards an All-Fiber Femtosecond Laser System as Excitation Source in the Two-Photon Absorption – Transient Current Technique

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Degradation of semiconductor detectors when exposed to high radiation rates leads to the necessity of development of tools and methods for characterization of these devices. One of these methods is the Two-Photon Absorption –Transient Current Technique (TPA-TCT) which provides spatially-resolved inspection of semiconductor detectors. This technique exploits the simultaneous absorption of two photons of same energy. Said energy being lower than the band-gap energy of the semiconductor material and higher than half the band-gap energy. The photons are delivered by a femtosecond laser and the absorption occurs only at the focal point of the laser beam focusing optics, allowing localized generation of transient current. In order to avoid single-photon absorption when performing TPA-TCT on silicon detectors, emission wavelengths longer than 1150 nm are required.

Mode-locked Ti:Sa solid state lasers are the current standard optical source of femtosecond pulses. Their natural emission wavelength is out of the 1550 nm region and complex and expensive conversion techniques are required to extend it. Instead, erbium doped fiber laser emission lies naturally in that region. This is why we recently developed a femtosecond fiber laser system of properties and functionalities particularly designed for the TPA-TCT. Said system was based in an all-fiber chirped pulsed amplification architecture seeded by a solitonic passively mode-locked erbium doped fiber oscillator, where the properties of the output pulses from said architecture were configured arbitrarily by free space optics accessories. These accessories allowed selection of pulse energy from < 10 pJ to > 10 nJ, pulse repetition rate from single shot to 8 MHz and pulse duration from 300 fs to 600 fs.

Our current work aims to achieve all these configurable properties through a fully all-fiber system to offer improved robustness and efficiency, while maintaining the required levels of average power and temporal coherence. We are doing this as follows: firstly, the stretching stage will be based in a chirped fiber Bragg grating of tunable dispersion, which will allow the variation of the pulse duration at the output of the source. Secondly, a fiber-pigtailed acousto-optic modulator will be designed and implemented in the system to perform, all-in-one device, the following functionalities: pulse energy selection, pulse repetition rate tunability and emission-to-detection synchronization.

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