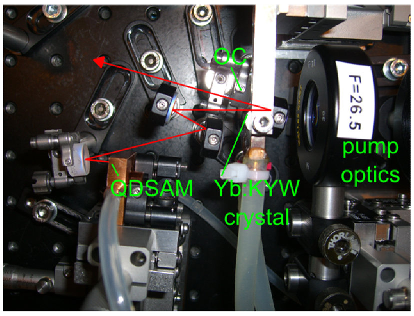
WP5 - Highlights

QD-SESAM ML solid state and fibre lasers

Partners at WP5 developed saturable absorber technology based on GaAs/InAs quantum dots for mode-locking high-repetition rate and low gain solid state lasers operating at wavelengths spanning from 1 µm to 1.53 µm. This work highlights the unique flexibility afforded by the quantum dot technology.

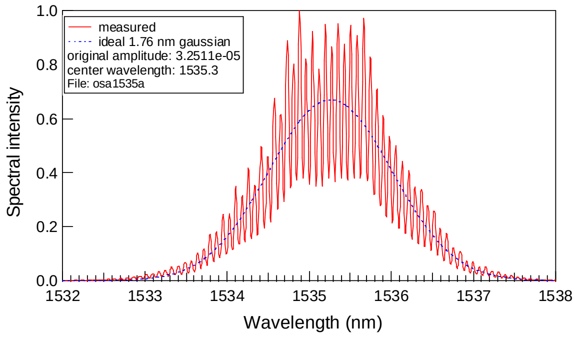
Yb:KYW picosecond pulsed laser for 1.0 µm



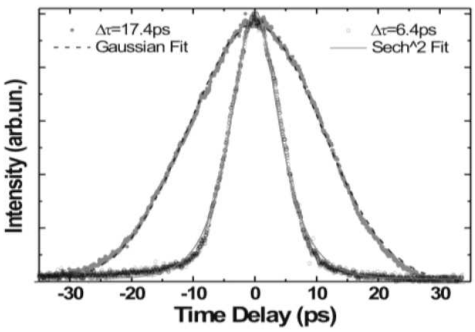
The figure on the left shows the Yb:KYW laser operating at 1.04 µm and generating picosecond pulse train with the repetition rate of 1.5 GHz. The laser has been built by KTH group using saturable absorbers designed in the WP5 and grown by Innolume GmbH.

QD-SESAM modelocked 10 GHz Er:Yb:glass laser at 1.55 microns

An extreme example of high-repetition rate and low gain laser is the Er:Yb:glass laser operating at 1.55 µm and generating mode-locked picosecond pulses at 10 GHz repetition rate. A similar laser has been previously developed by Time Bandwidth products using a QW-SESAM, but within FAST-DOT the QD-SESAM version has been realized. QD-SESAMs in high rep rate lasers demonstrate some attractive benefits that will be exploited in the future.

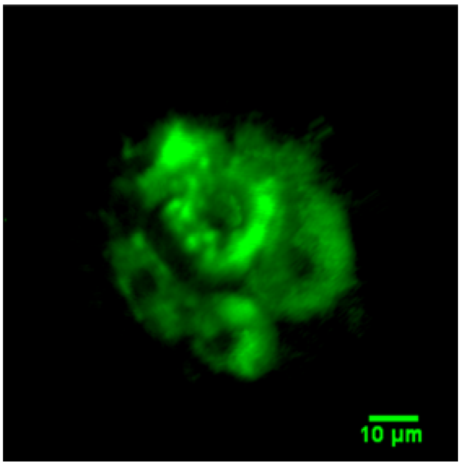


Cr:Fosterite mode-locked laser with a quantum dot saturable absorber



The group at University of Dundee employed quantum-dot saturable absorbers containing reverse-biased p-n-junction to control the pulse length produced by Cr:Fosterite laser. Patent application has been filed. The figure blow show the pulse narrowing from 17.4 ps down to 6.4 ps as the reverse bias of 4.5V is applied across the quantum-dot saturable absorber.

Third-harmonic generation imaging with an Er:fiber laser operating in 1.55 µm

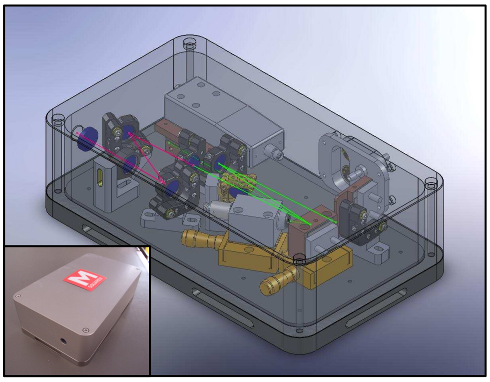


A femtosecond Er:fiber laser investigated in the project by Toptica AG was instrumental in demonstrating third-harmonic generation imaging in biological objects without employing any fluorescence markers as shown in the picture below. The fact that the third-harmonic of the Er:fiber laser operating in 1.55 µm spectral region appears in the visible green range is highly beneficial due to lower absorption and lower autofluorescence background. Those are the typical problems encountered in using third-harmonic imaging with standard near-infrared lasers, such as ubiquitous Ti:Sapphire.

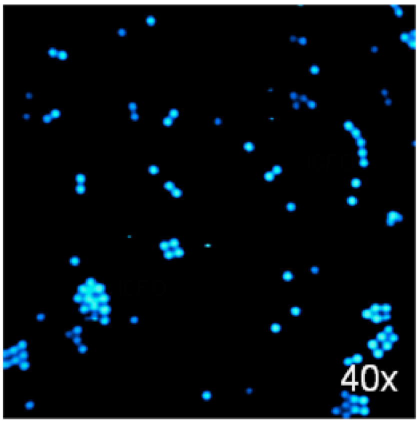
Development of a prototype fs laser for non-linear imaging and cell-surgery application

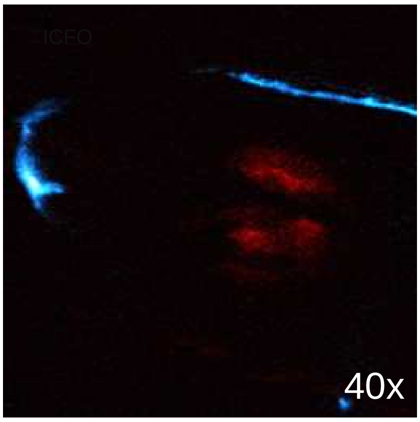
During the project Time-Bandwidth Products AG developed a prototype laser based on Yb-dope double tungstate laser crystal and generating femtosecond pulses with 167 kW peak power. The laser was specifically developed for nonlinear imaging and cell-surgery application. The laser prototype has been delivered to our partners at Molecular Machines International GmbH and successfully integrated into their unique laser microscopy, cellular surgery and dissection machine.

Development of a prototype W-level mode-locked solid sate laser for bio-medical imaging



Compact packaging of Watt-level average power mode-locked lasers is an important issue affecting stability of the laser and eventually the usability in nonlinear imaging systems. Efficient solutions for heat-load management, are crucial for reliable hands-off laser operation. FAST-DOT partner M-Squared Ltd has developed a unified compact packaging technology platform for high-repetition rate watt-level mode-locked solid state lasers and optically-pumped VECSELs. The new prototype laser is mode-locked by employing QD-SESAM designed and fabricated by FAST-DOT partners. The laser, envisioned for nonlinear imaging applications, generates pulses shorter than 1.5 ps at a repetition rate of 500 MHz and average powers exceeding 1 W. The laser center wavelength is 965 nm, which lies at the maximum of the two-photon action cross section of the widely used GFP marker. Some biomedical imaging samples taken at ICFO with the M-Squared prototype are shown below.





Left: TPEF images of green fluorescent beads. Right: C. elegans nematode head. In red is the Second-Harmonic Generation (SHG) image of pharyngeal muscles and in blue the TPEF image of neurons expressing Green Fluorescent Protein.