FAST-DOT

COMPACT ULTRAFAST LASER SOURCES BASED ON NOVEL QUANTUM DOT STRUCTURES

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www.fast-dot.eu

FAST-DOT: Compact Ultrafast Laser Sources based on Novel Quantum-Dot Structures

Integrated Project, FP7 European Programme
Coordinator: Dr Edik Rafailov, University of Dundee
Duration: June 2008 – 2012
Funding: 10.1 Million Euros **Partners:** 18

Academic Partners ⟺ Industrial Partners

1. University of Dundee (Coordinator)	1. Philips
2. University of Sheffield	2. Alcatel Thales III-V Lab
3. ETH - Swiss Federal Institute of Technology, Zurich	3. Innolume GmbH (SME)
4. Tampere University of Technology	4. M Squared Lasers Limited (SME)
5. KTH - Royal Institute of Technology, Stockholm	5. TOPTICA Photonics AG (SME)
6. ICFO - Institut de Ciències Fotòniques, FUND. PRIV.	6. TimeBandwidth Zurich (SME)
7. FORTH - The Foundation for Research and Technology - Hellas	7. Molecular Machines and Industries GmbH (SME)
8. Vilnius University	
9. Politecnico di Torino	
10. University of Athens	
11. Technical University of Darmstadt	

FAST-DOT

- **Main targets:**
  - **Enable widespread bio-photonic applications**
    - **Nanosurgery**
    - **Nonlinear microscopy**
    - **Optical Coherent Tomography**
    - **Endoscope**
  - **By development of**
    - **Compact Ultrashort pulsed lasers**
    - **High efficiency and low cost lasers**
  - **Based on unique properties of novel nanostructures: Quantum Dots**

Lasers in Medical applications

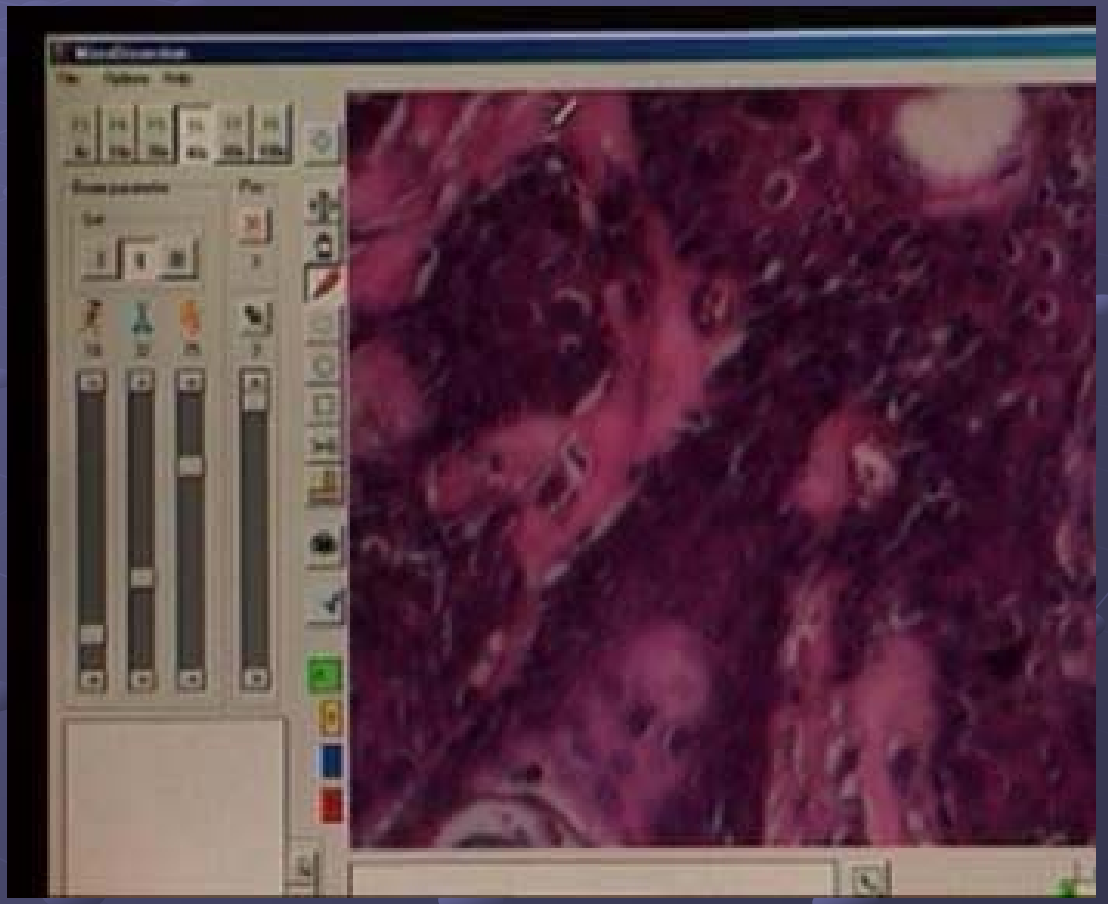
Surgery
- Laser scalpels
- Nanosurgery

Spectroscopic techniques
- Multi-photon microscopy
- Optical Coherent Tomography

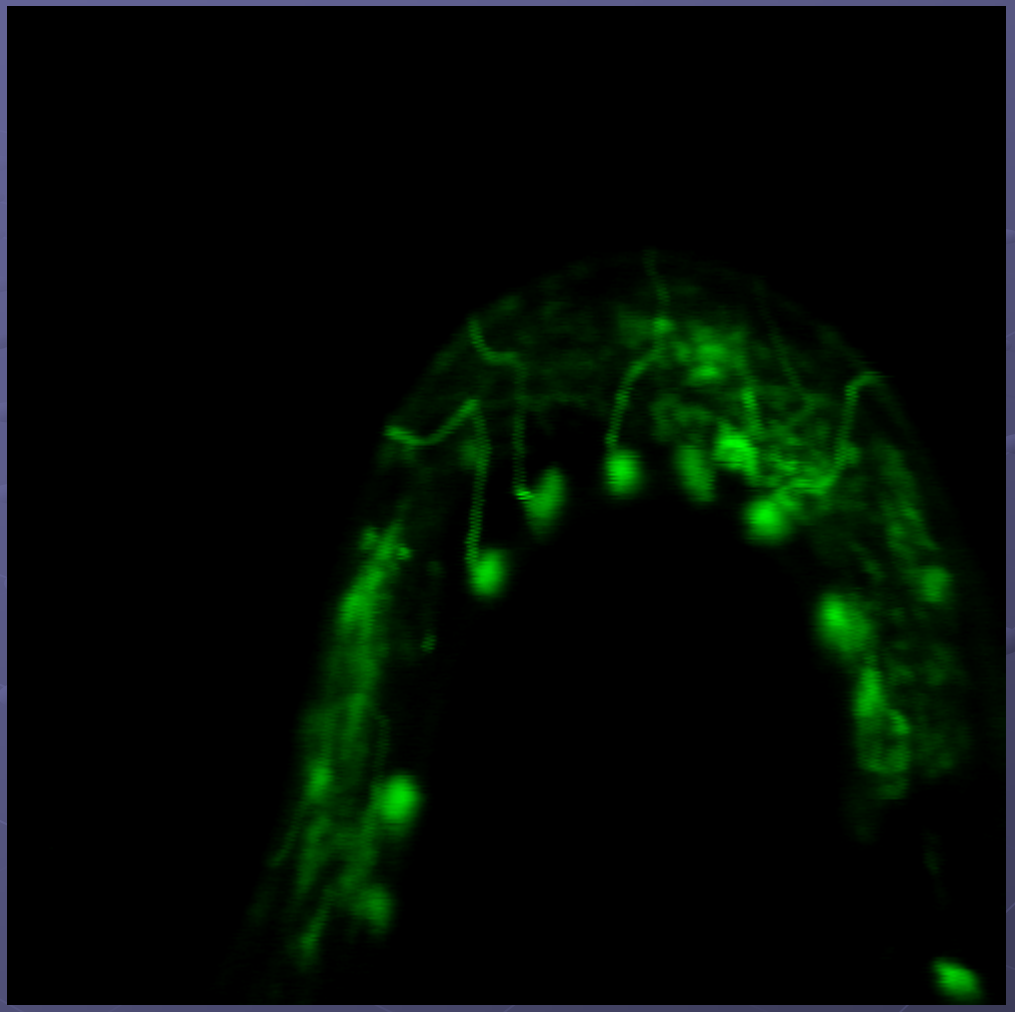
Endoscope & interventional probes and catheter applications

FAST-DOT

Laser microdissection



EXAMPLES I



GFP labeled Neurons in *C elegans* using TPEF microscopy

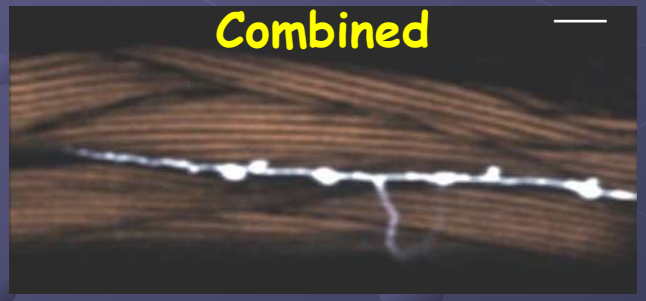
P. Loza-Alvarez ICFO

EXAMPLES II (TPEF+SHG)

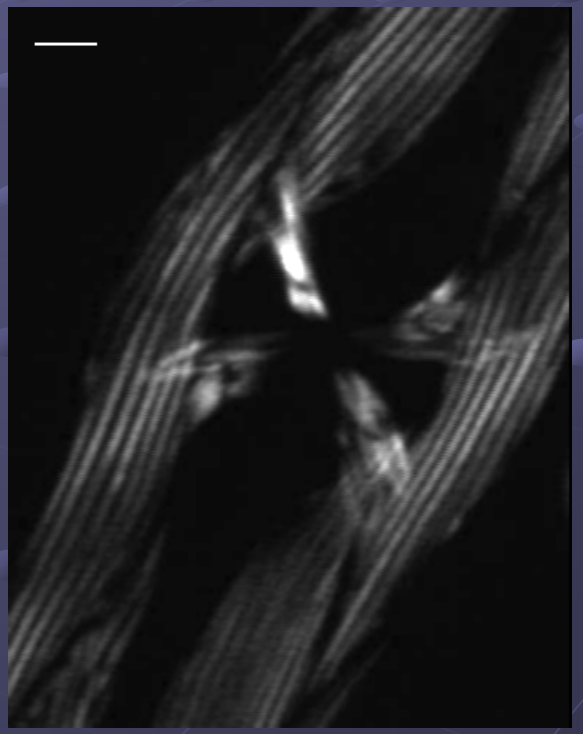
GFP labelled neurons (TPEF)

Body wall muscles (SHG)

C. elegans



SHG Imaging of Vulva Muscles and body walls

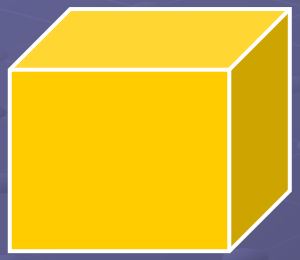


P. Loza-Alvarez ICFO

Quantum-Dot structures

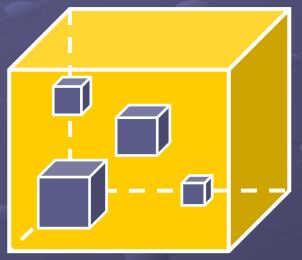
Schematic morphology

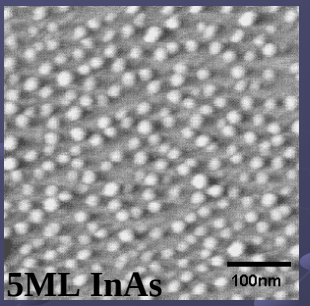
Bulk



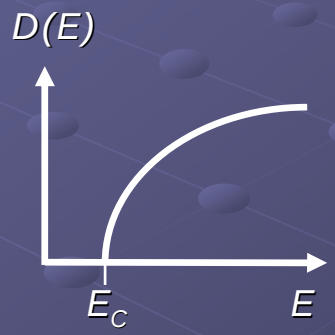
Quantum Well

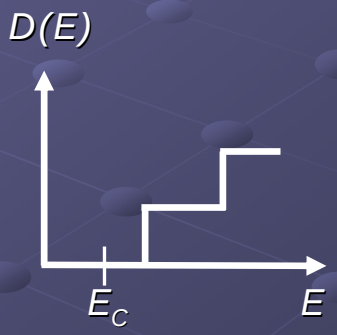
Quantum Dot

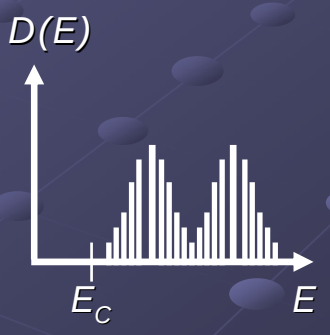


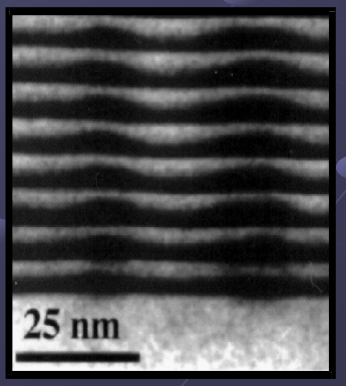


Density of states

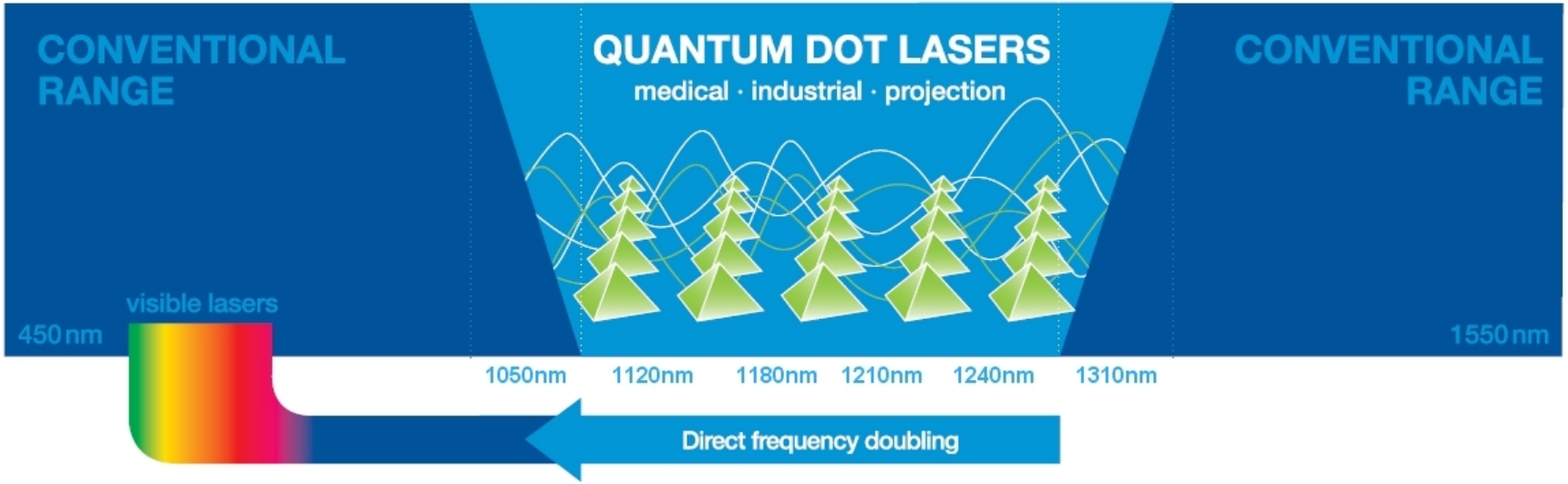


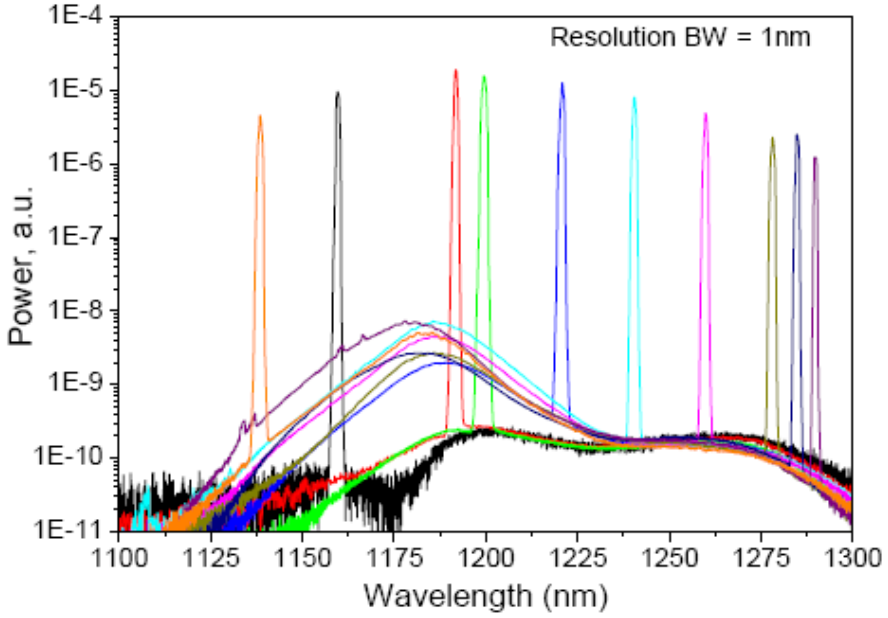


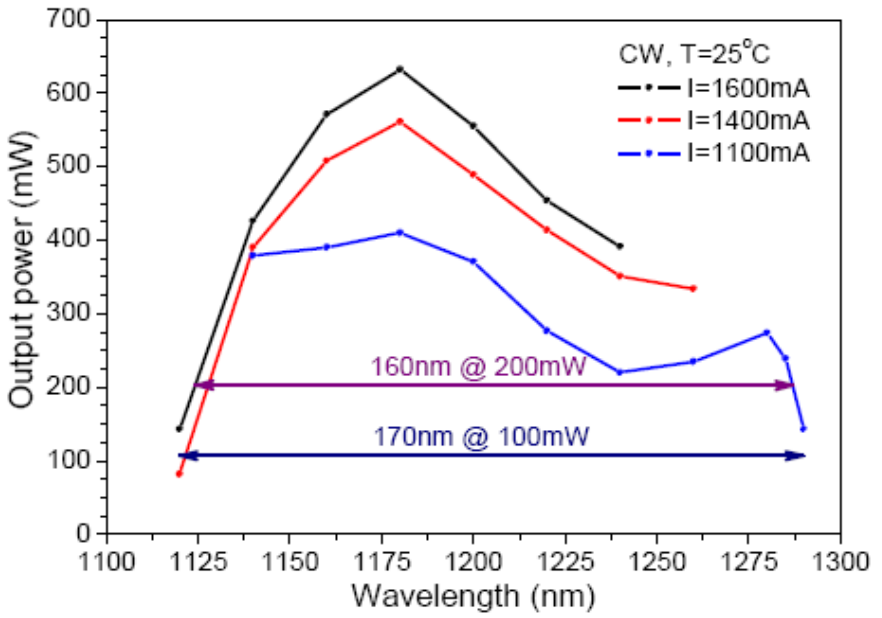




Ultra-broad band QD-structures







Mode-locked QD laser

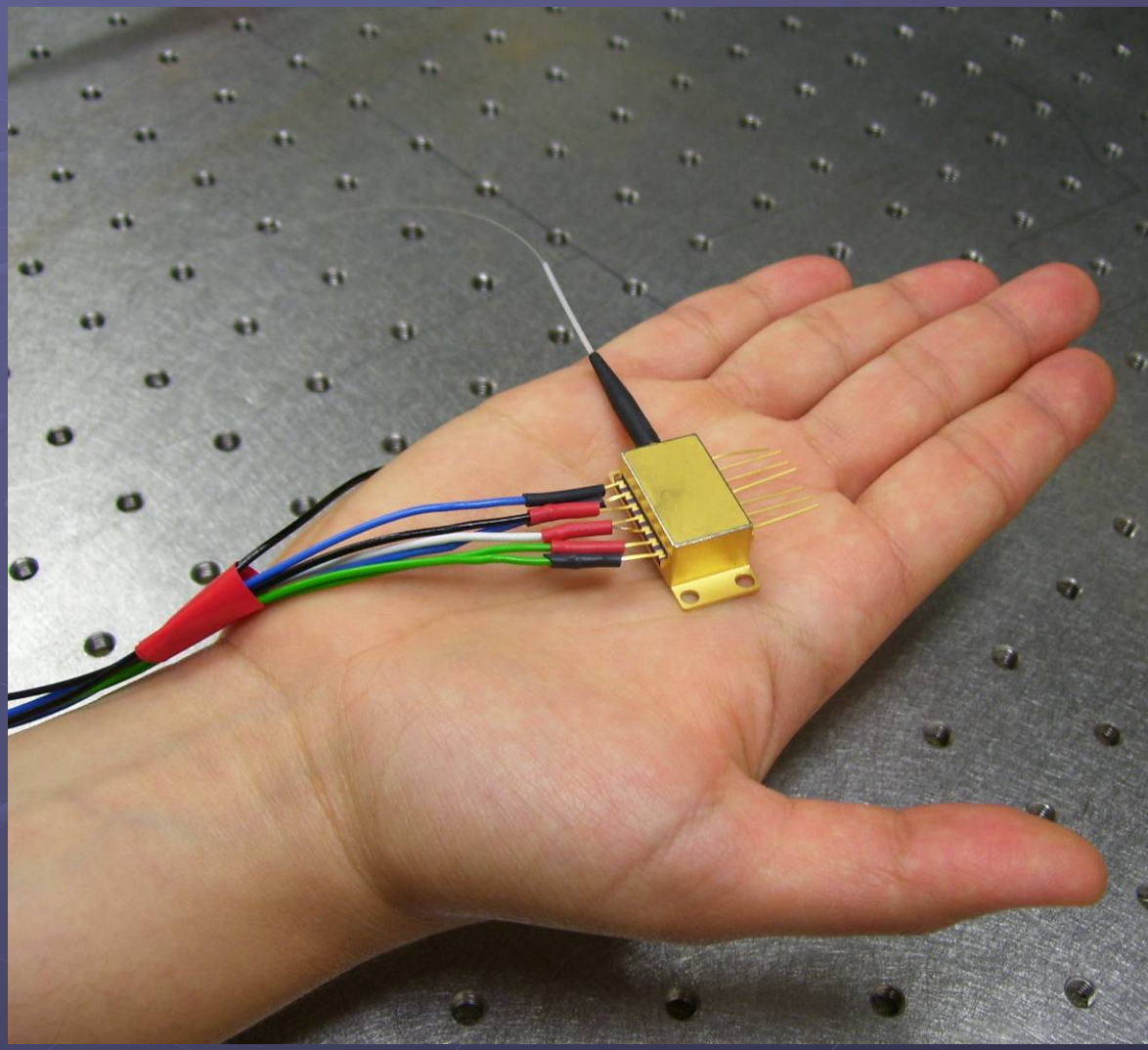
Shortest pulse duration $\Delta\tau$ **<400fs**

High average power P_{av} **> 50mW**

Highest peak power P_{peak} **~3W**

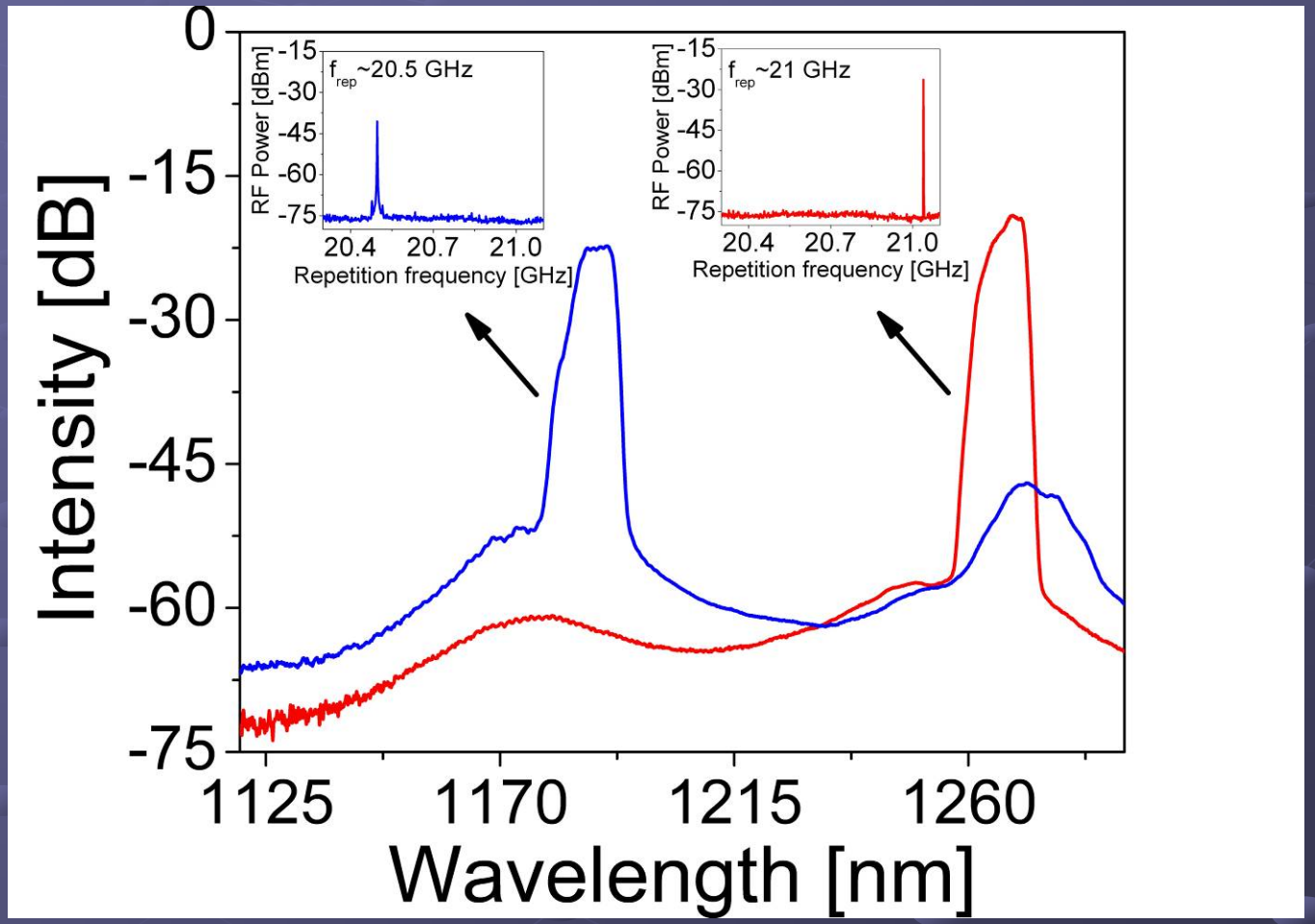
Wavelength bandwidth $\Delta\lambda$ ~ 15nm

Time bandwidth product $\Delta\tau\,\Delta\nu$ ~ 1



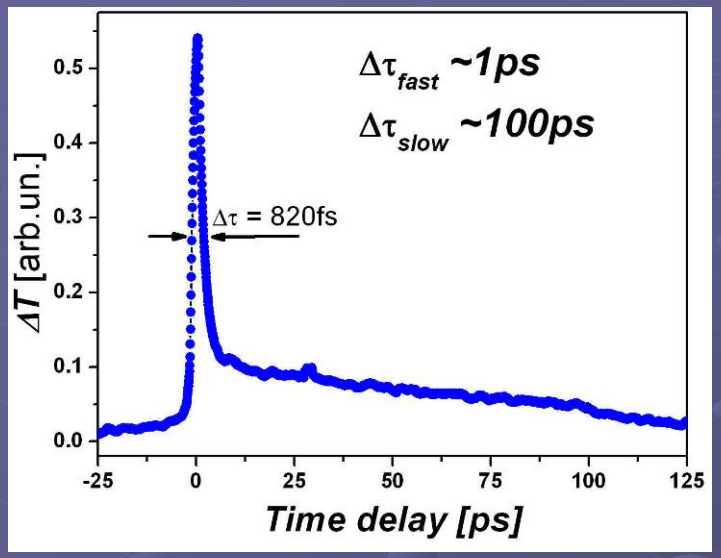
Appl. Phys. Lett. 87, 081107 (2005).
Nature Photonics, v.1, p.395-401, 2007

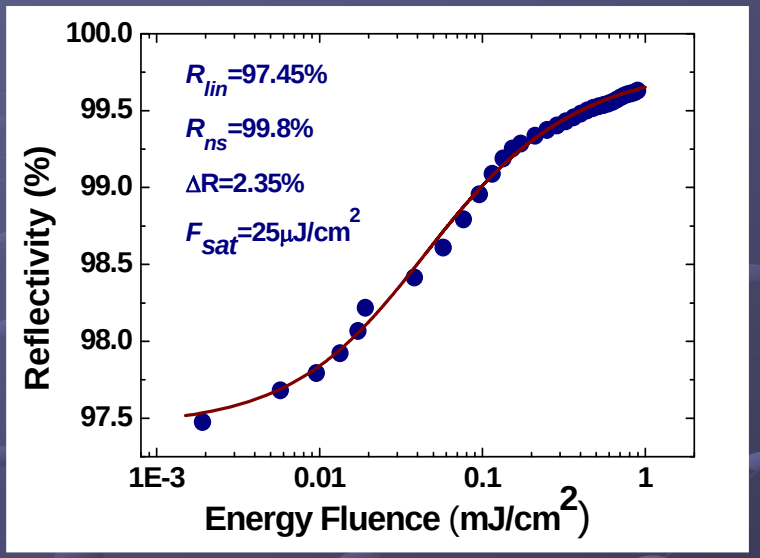
Mode locking via ground or excited states



App.Phys.Lett., 89, 081124, 2006.

Quantum-dot absorbers





Pump-probe measurements of QD device response

- QD structures exhibit fast carrier dynamics.
- No need for post-growth ion-implantation, to reduce recovery time of the absorption

Nonlinear reflectivity measurements of QD-SESAM

R_{lin} - linear reflectivity

R_{ns} - non-saturable reflectivity

F_{sat} - saturation fluence

Phot.Tech.Lett., 16(11), p.2439 (2004)

App. Phys.Lett. 91, 231111-3 (2007)

Solid-state and fibre lasers mode locked by QD SESAMs

Femtosecond Yb:KYW laser at 1040nm

Average output power: 0.5W – 114fs pulses

1.15W – 200fs pulses

Wall plug efficiency: up to 12%

Femtosecond Cr^4:forsterite laser at 1280nm

Average output power: 0.3W – 160fs pulses

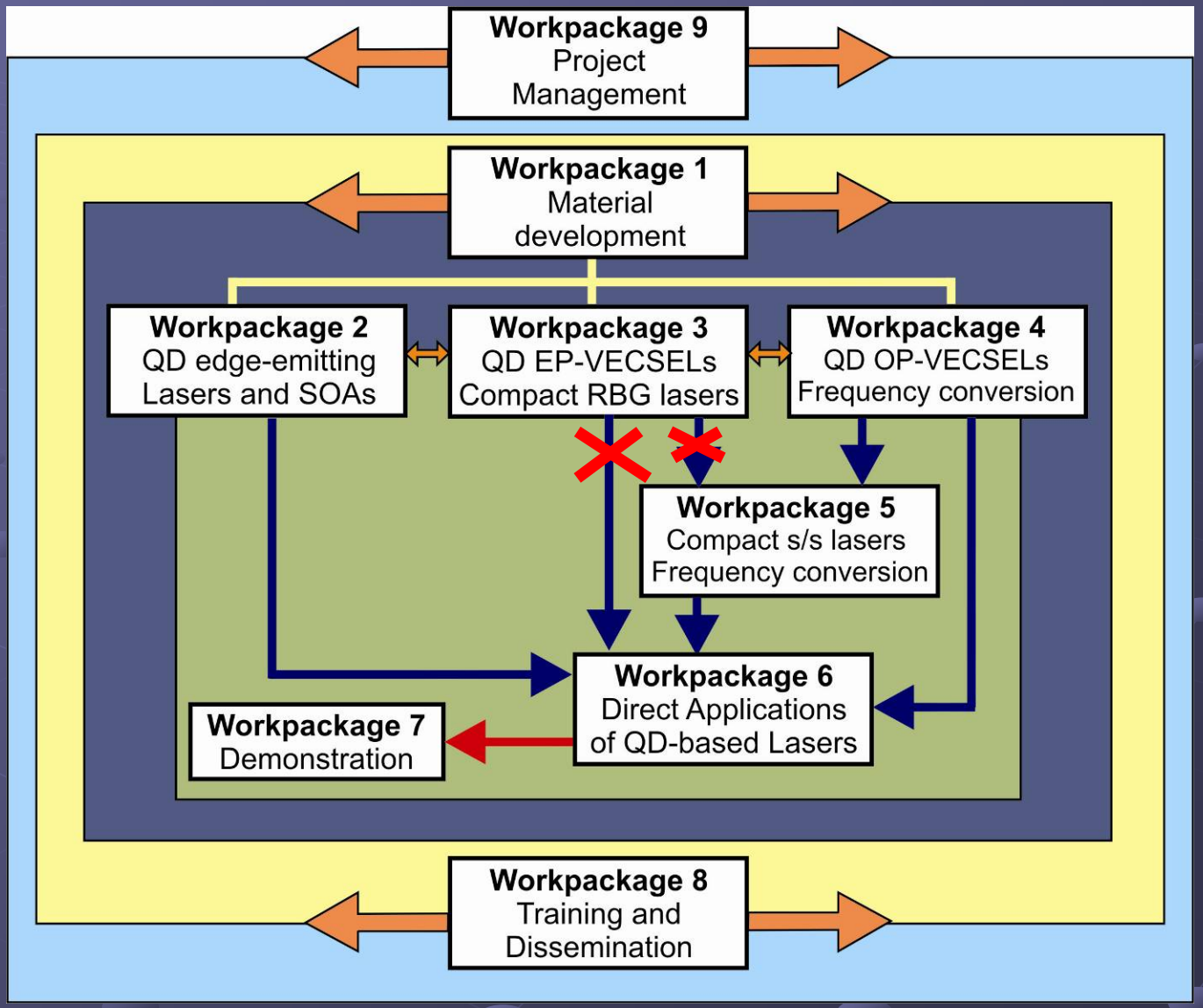
Ultrashort pulse Yb-doped fibre laser at 1040 nm

Low threshold <30mW and 2.8ps pulses

FAST-DOT Project Structure

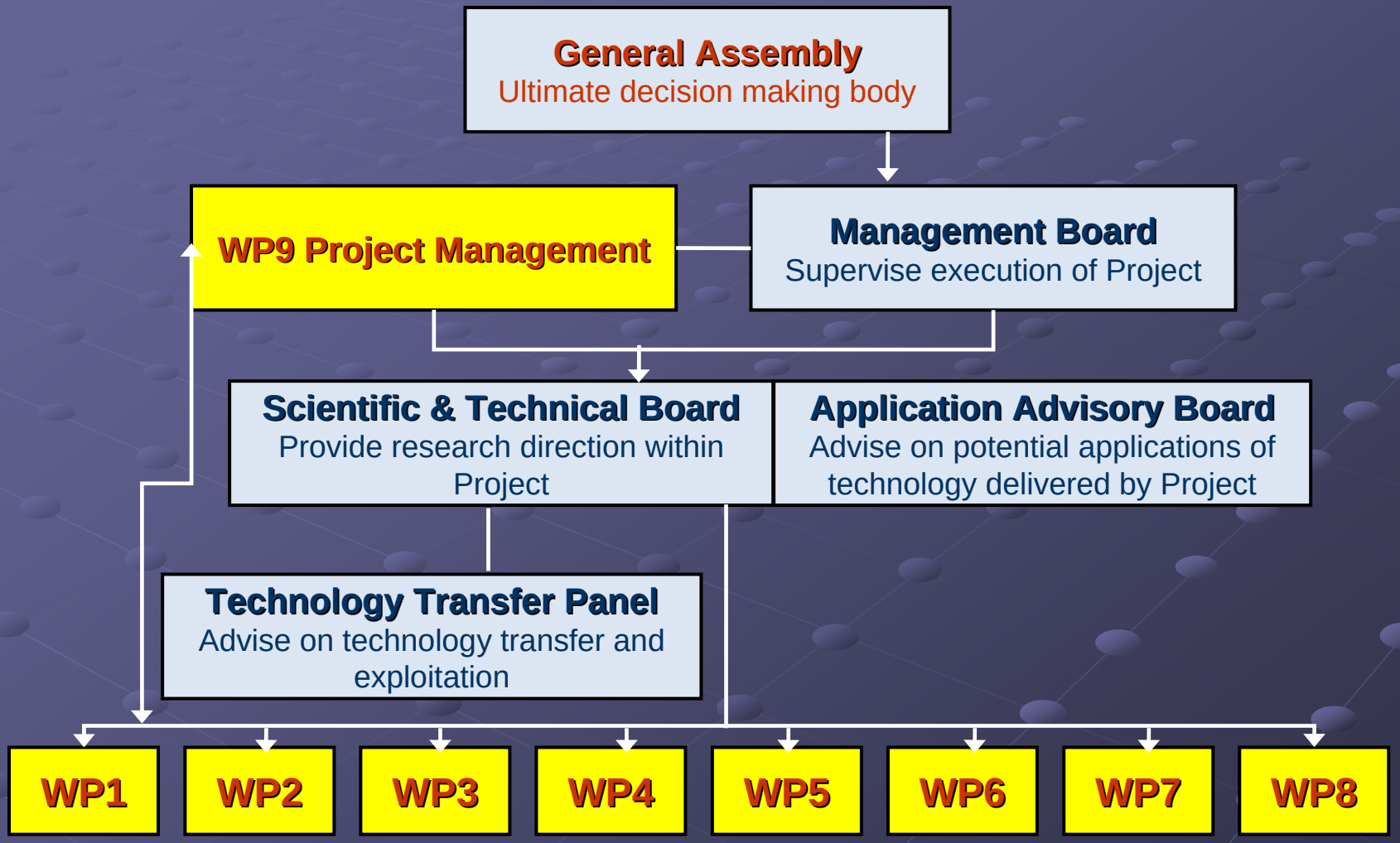
Multi-channel project structure

4 WPs develop potentially interchangeable lasers in parallel

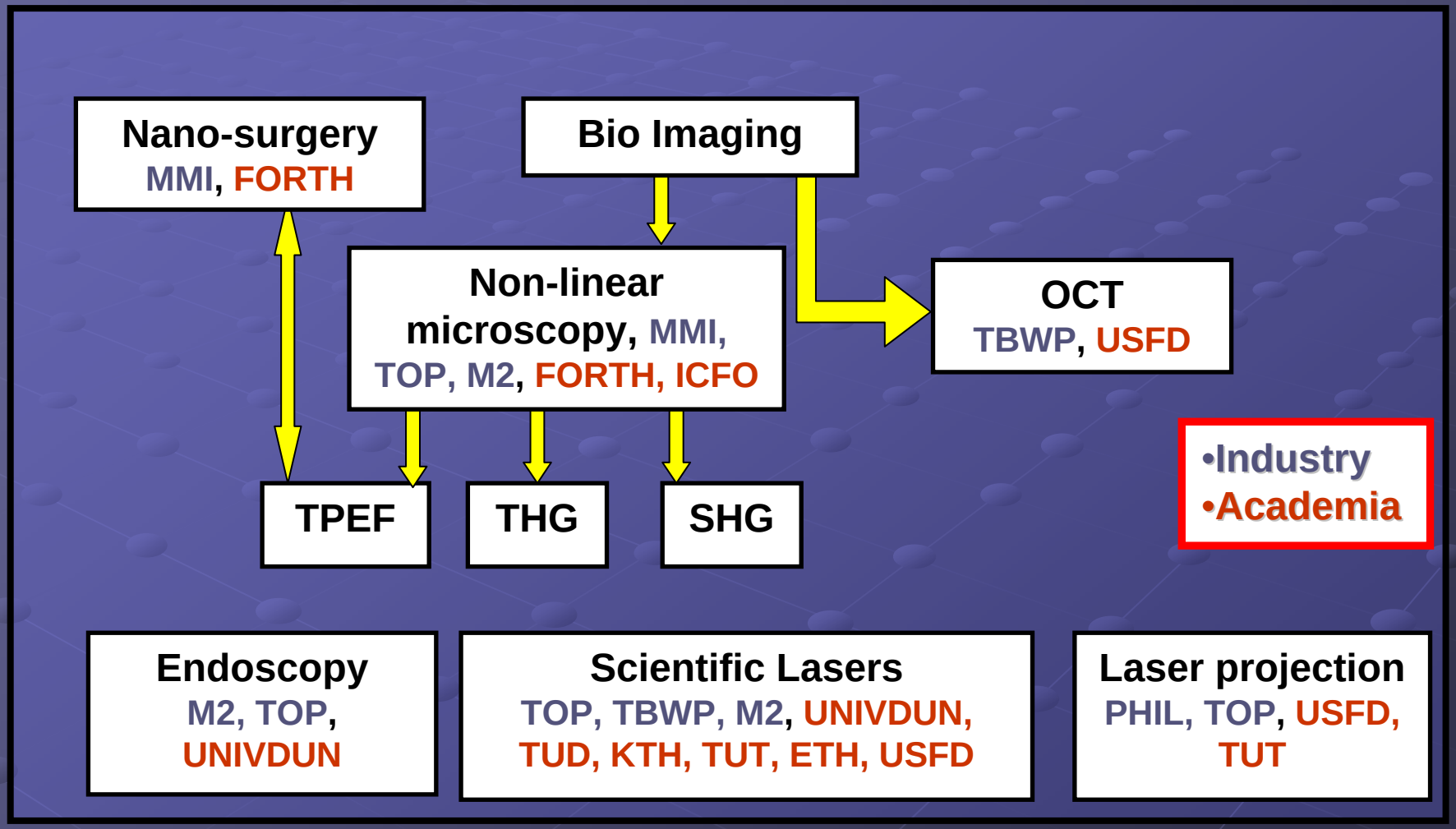


Minimizing of total risk for exploitation

FAST-DOT Management Structure



FAST-DOT target markets



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Kick-off meeting held in Barcelona 2-3 June 2008