

# Super continuum laser for broadband spectroscopy using upconversion

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## Objectives

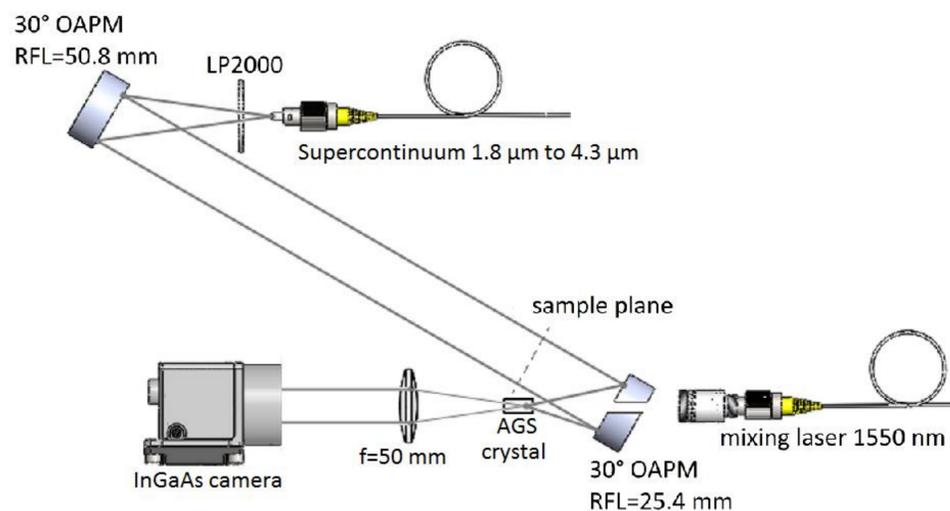
Using mid infrared supercontinuum laser sources in conjunction with parametric upconversion detection systems for broadband spectroscopy and imaging:

- Building, and characterizing MIR supercontinuum sources at NKT Photonics
- Realizing synchronously pumped upconversion systems for both spectroscopy and hyperspectral imaging
- Studying the noise properties of both the supercontinuum generation and the upconversion process
- Studying real life application of such systems for food analysis, gas sensing, non destructive testing etc...

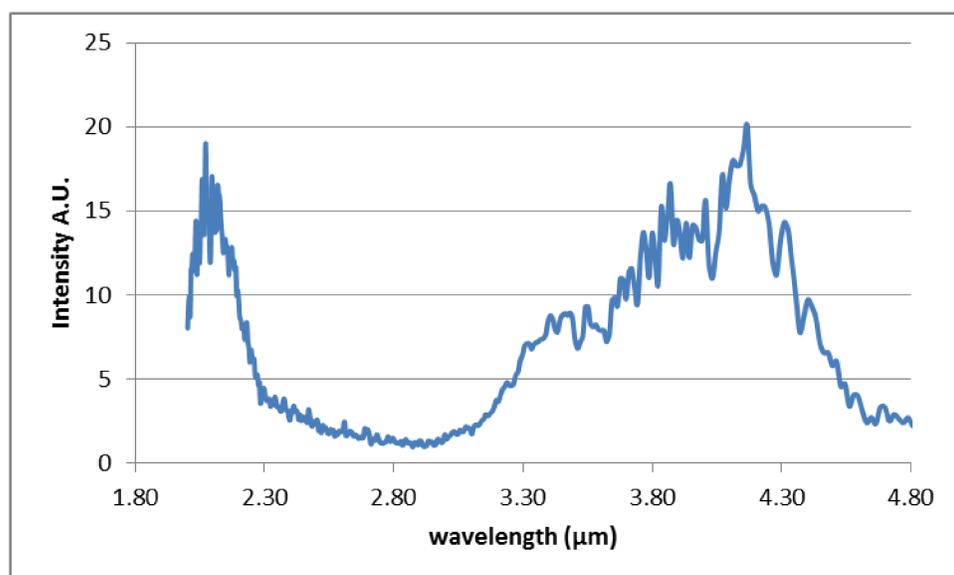
## Achievements

- 2 supercontinuum sources built (1.8 $\mu\text{m}$ ~2.6 $\mu\text{m}$  and 1,8 $\mu\text{m}$ ~4,3 $\mu\text{m}$ )
- First demonstrations of pulsed upconversion imaging using supercontinuum from 1.8 $\mu\text{m}$  to 2.6 $\mu\text{m}$  and 1.8 $\mu\text{m}$  to 4.3 $\mu\text{m}$
- Transmission imaging of human esophagus samples around 4 $\mu\text{m}$

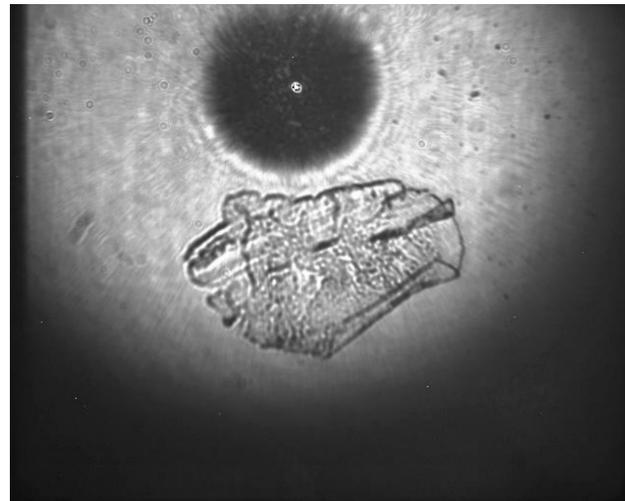
## Current activities



Top view schematic representation of the pulsed upconversion imaging setup. The use of OAPMs make for a mostly achromatic setup. The broadband signal pulse is combined with the 1550 nm pump pulse through a hole drilled through the OAPM.



Spectrum of the supercontinuum



Acquired upconverted transmission image of a human esophagus sample at 4 $\mu\text{m}$ . Images can be acquired in real time at a rate of 22 images per second.

## Secondments and external stays

- Paul Scherrer Institute, Switzerland – M21 – 1 week : investigation on the possibility of using supercontinuum illumination to replace synchrotron light for characterizing strained germanium samples
- DBI (Danish Fire-technical Institute - M27 – 1 month) : Proof of concept experiment on using supercontinuum illumination in conjunction with upconversion in order to detect flammable chemicals on fire scenes
- 1-2 months at NKT Southampton (M26) : Technology transfer and development of a new generation infrared supercontinuum source.

## Dissemination

### Conference contributions:

- All-fiber mid-IR supercontinuum: a powerful new tool for IR-spectroscopy
- Upconversion imaging using an all-fiber supercontinuum source

### Publications:

- All-Fiber Mid-IR Supercontinuum: a Powerful New Tool for IR-Spectroscopy. Proceedings of SPIE
- Towards Supercontinuum-Driven Hyperspectral Microscopy in the Mid-Infrared. Proceedings of SPIE
- Upconversion Imaging Using an All-Fiber Supercontinuum Source. Optics Letters

### Planned publications:

- Broadband upconversion imaging around 4  $\mu\text{m}$  using an all-fiber supercontinuum source
- Upconversion of mid IR supercontinuum light using a synchronous directly modulated diode pump
- Mid IR upconversion spectroscopy using supercontinuum illumination for detection of flammable chemicals
- Hyperspectral infrared imaging of biological tissue using supercontinuum illumination and upconversion detection

## ECTS credits

- Summer school: Mid-IR science and technology 5 ECTS
- Noise in electromagnetic and optical systems 5 ECTS
- Summer school: Entrepreneurship in mid-IR technologies 5 ECTS

### Planned:

- Summer school Biophotonics Ven 2017 5 ECTS
- Summer school: Leadership development for tomorrow's mid-IR technologies and applications 5 ECTS
- DTU Course TBD 5 ECTS