Short Pulse Upconversion and Imaging

Morgan Mathez (ESR:7)
Supervisors: Christian Pedersen, Peter Tidemand-Lichtenberg and Majid Ebrahim-Zadeh

DTU Fotonik
Department of Photonics Engineering

Objectives

- Upconversion of a MID infrared pulsed beam into the visible spectrum.
- Imaging using MID infrared illumination.
- 3 to 6 μm wavelength probing generated by a tunable MID infrared pulsed source
- Application in cancer diagnostics.

Achievements

- First demonstration of a synchronized upconversion using a 2 μm wavelength very short pulsed beam, in a single pass process inside a lithium niobate bulk crystal

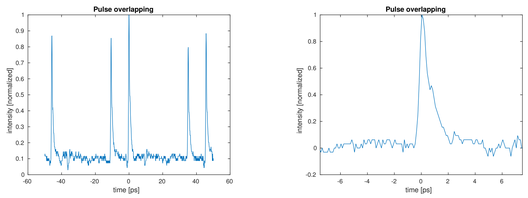

Fig. 1 Synchronization of two pulses. Time interval, without (left) and with (right) path delay

- Upconversion imaging using a 2 to 4 μm MID infrared signal, from a tunable optical parametric oscillator.
- Investigations about the field of view by rotating the crystal and tuning the wavelength of the MID infrared beam.
- Study of the different sources of blurring
- Definition of the actual smallest resolvable element.

Experimental Setup

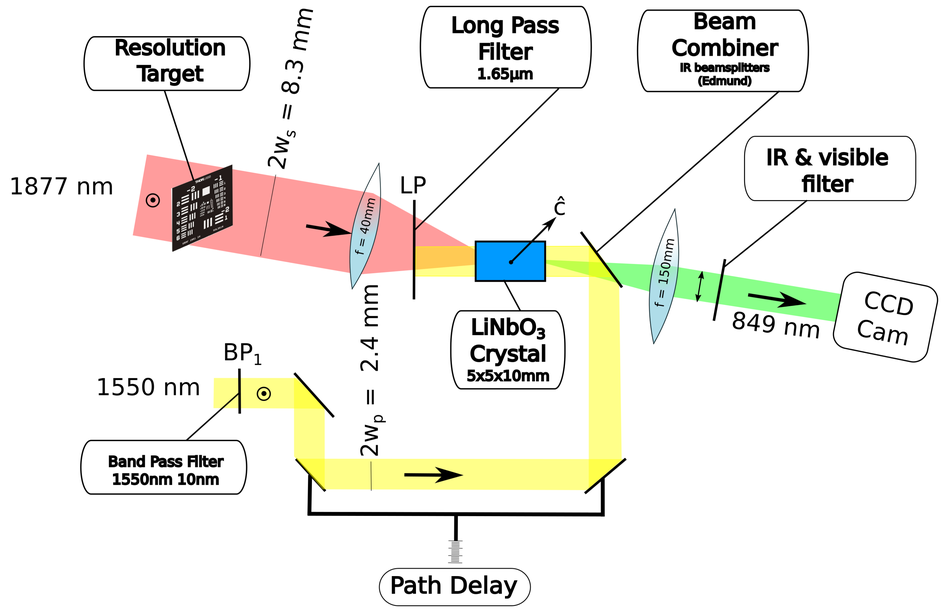

Fig. 2 Experimental setup. The resolution target is imaged with the MID infrared signal (red beam).

Results

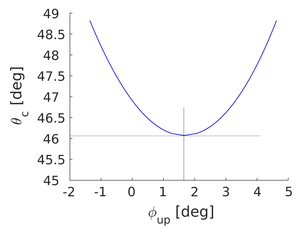

Fig.3 The field of view can be increased by imaging at different angle rotations. This plot represents the direction of the upconverted beam depending on the crystal angle.

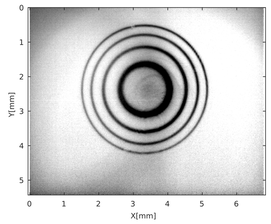

Fig. 4 Four different crystal angles (0.1° step), producing four different propagation directions

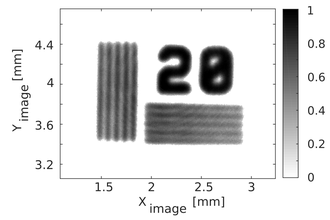

Fig. 4 The smallest resolvable element can be defined by imaging a resolution target. Here 20 lines/mm represents the highest resolution

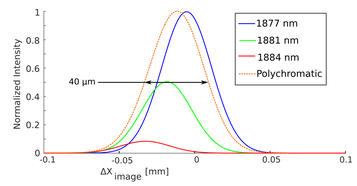

Fig.5 The different blurring effects can be gathered in one function. This plot highlight the effect of a polychromatic source.

External Stays

- ICFO, Barcelonna, Spain - M23 & M27 - 2 months: Upconversion imaging using a narrow bandwidth MID infrared source, produced by a tunable OPO.
- University of Exeter, Exeter, England: Cancer diagnostic using short pulsed MID infrared illumination

Dissemination

Publication

- Upconversion imaging using short-wave infrared picosecond pulses, status: peer review process

Planned publications

- Large wavelength tunability for upconversion imaging.
- Femtosecond pulses upconversion.

Conference paper

- Investigation of mid-IR picosecond image upconversion, status: writing process

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: Leadership development for tomorrow's mid-IR technologies and applications 5 ECTS
- Self study course: Electronic properties of materials
- Self study course: Nonlinear optics