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Tunable high-power MOPA systems for hyperspectral imaging, spectroscopy and non-linear conversion

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Objectives

Development of compact, high power, widely tunable Master Oscillator Power Amplifier (MOPA) lasers emitting at a wavelength of 976 nm.

- Used by **ESR 8** for high-sensitive Infra Red (IR) spectroscopy
- Used by **ESR 9** for IR hyperspectral imaging
- ➢ 1st deliverable: 4 nm tunable MOPA with P > 3W ☑
- ➢ Final objective: 16 nm tunable MOPA ☐

Realization & Design

- **MO:** Y-branch Distributed Bragg reflector laser or Sampled Grating (SG) Laser
- **PA:** High power tapered diode amplifier

Fig. 1 Images of the developed 4 nm tunable hybrid MOPA laser, including the micro-lenses used for the optical coupling. Left image ©**FBH/schurian.com**

1st Approach: Y-branch Laser

- Wavelength tuning by micro-heaters
  - 4 nm tuning range for a single branch
  - Combination of 4 branches could reach 16 nm
- Single-mode operation
- Spectral emission width < 20 pm
- Few hundreds of milliwatts of output power

Optical design

- Investigation of different s-bend shapes: sin, cos, …
- Simulation of waveguides

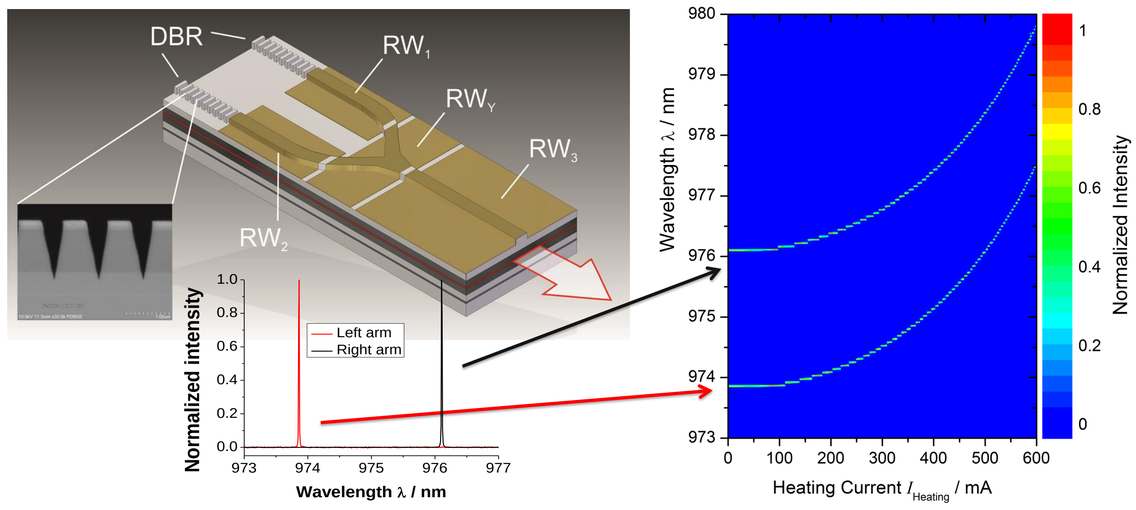

Fig. 2 Two DBR lasers combined via a Y-branch. Each branch emits at a different wavelength defined by the corresponding grating.

Fig. 3 Wavelength tunability as function of the heating current of the Y-laser. Each branch can be tuned up to 4 nm.

2nd Approach: Sampled Grating Laser

- Diode laser with two intrinsic periodic Sampled Gratings (SG)
- Wavelength tuning by micro-heaters at the front and back mirror
- Feasible of achieving >16 nm wavelength tunability

Challenging approach

- SG lasers at 1.5 µm (InP based) are commercially available, but at 976 nm (GaAs based) are yet to be developed
- New technology development
- Opto-electrical simulation

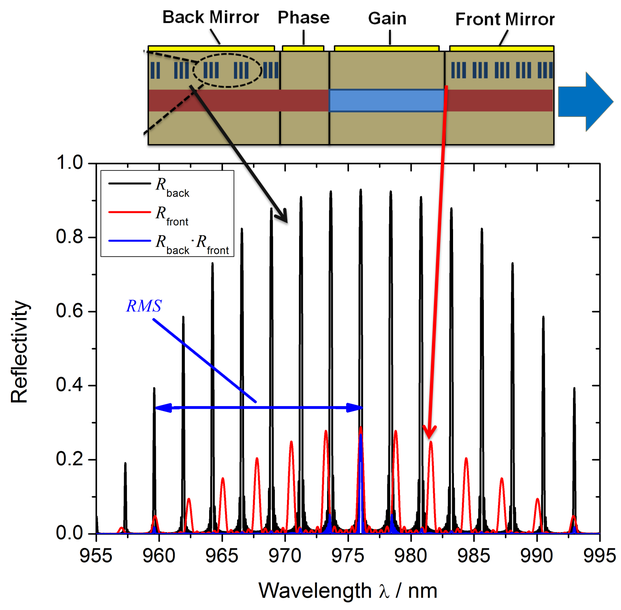

Fig. 4: SG based DBR lasers consist of a front/back mirror sections each with different Reflectivity curves R_{back} and R_{front}. The product $R_{back} \cdot R_{front}$ shows the Repeat Mode Spacing (RMS).

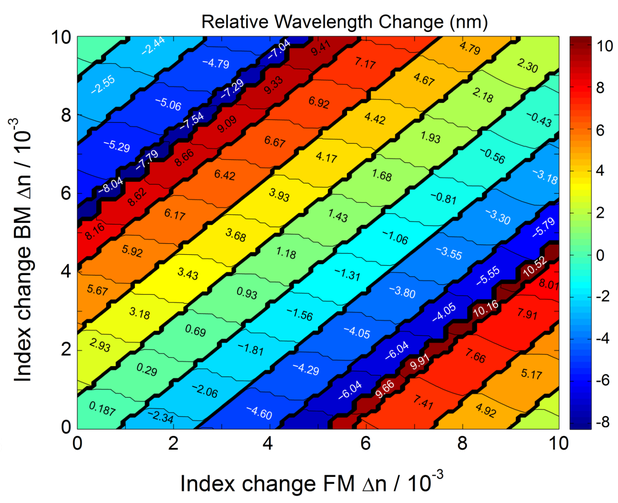

Fig. 5: Relative wavelength tuning as function of index change Δn of the Front/Back Mirror (FM/BM).

Secondments & Purpose

1. **DTU:** Learn about upconversion based hyperspectral imaging. Cooperation with **ESR 8** & **ESR 9**.
2. **Eagleyard Photonics:** Concepts for product development.
3. **University of Exeter:** Apply upconversion hyperspectral imaging for medical applications. Cooperation with **ESR 1**.

Planned Publications

- ✓ Concept and numerical simulations of widely tunable GaAs-based sampled-grating diode laser emitting at 976 nm (Submitted)
- Design and characterization of tunable Y-branch lasers
- Widely tunable Sampled Grating laser at 976 nm
- Widely tunable MOPA system for nonlinear conversion
  - ➢ Joint publications with **ESR 1, 8 & 9**.

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