Linear sweep of telecoms lasers for OCT applications

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1. Introduction

Optical Coherence Tomography (OCT) is proven to be a non-invasive, high resolution (µm), medical optical imaging capable of providing cross-sectional and 3D images to visualize the structure of biological samples and internal organs.[1]

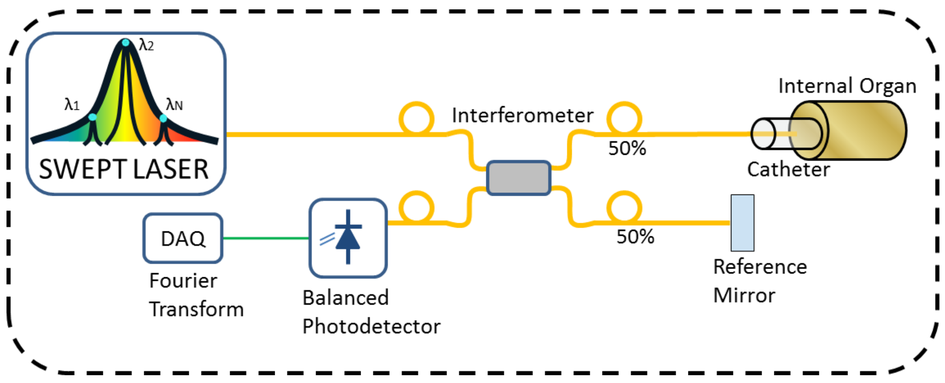

Figure 1. Basic structure of a SS-OCT system. DAQ : Data Acquisition

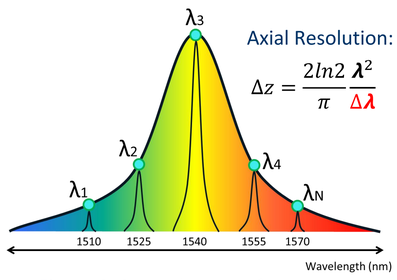

Figure 2. Swept laser performance

Swept-source OCT (SS-OCT) requires a laser that is able to sweep over a wide wavelength range as a linear function of time. The axial resolution is defined by wavelength coverage.[2]

Objective

To develop a tunable swept laser using telecoms laser technology that is able to create a linearly increasing sweep as a function of time, suitable for OCT.

OCT

2. Methods

A telecoms laser, with a wavelength coverage of ≈ 60 nm centered at 1540 nm, was optical characterized (lasing wavelength/SMSR) power using the setup shown in Fig. 3.

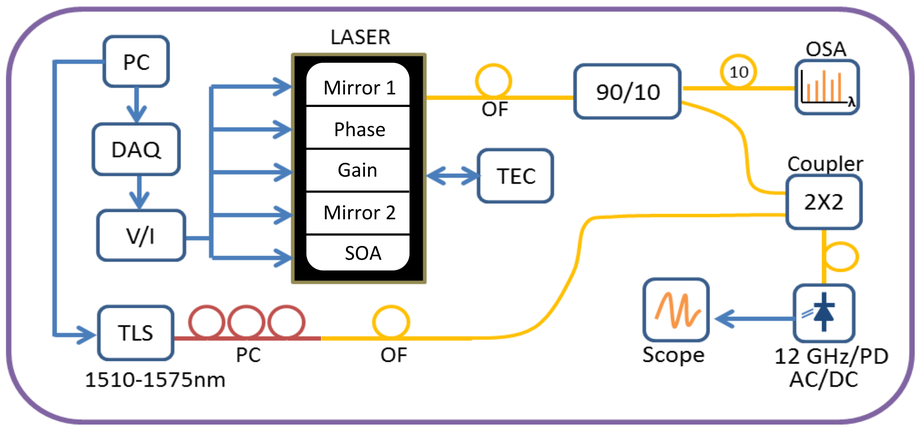

Figure 3. Experimental setup to characterize the optical performance of a tunable laser in terms of its lasing wavelength and SMSR. DAQ : Data Acquisition; V/I – Voltage to Current converter; PD: Photodiode TLS: Tunable Laser Source; TEC: Thermoelectric Controller; OSA: Optical Spectrum Analyzer [3]

- 5 section tunable laser allows 'akinetic' tunable mechanism
- All-electronically tunable laser without mechanical parts (Vernier tuning)
- Good wavelength coverage

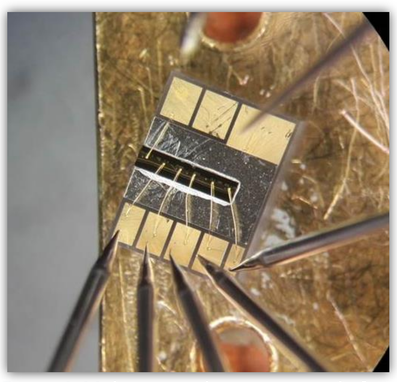

Figure 4. Multi-section laser composed of five sections: 2 mirrors, phase, gain and semiconductor optical amplifier (SOA)

3. Results

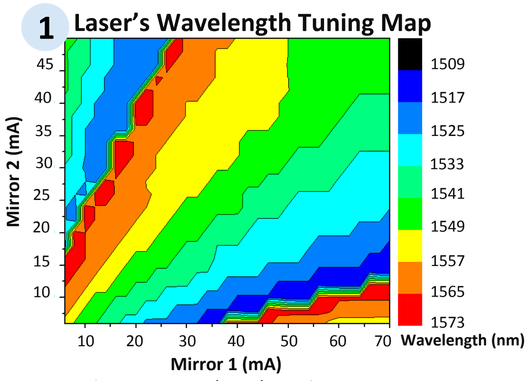

Figure 5. Wavelength Tuning Map

- Tuning paths clearly identified
- Mode hopes in the borders
- Wavelength linearly increases

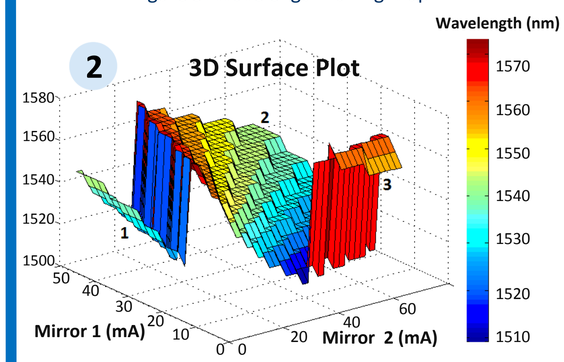

Figure 6. Surface Plot of the Tuning Map

- Wavelength levels are clear
- There are three main regions
- Perform tuning in Region 2

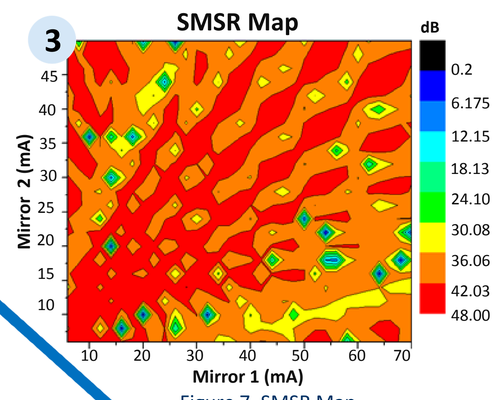

Figure 7. SMSR Map

- Outstanding single mode operation
- Useful to increase OCT image quality

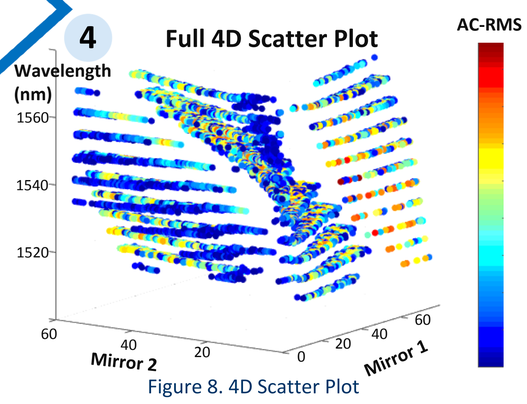

Figure 8. 4D Scatter Plot

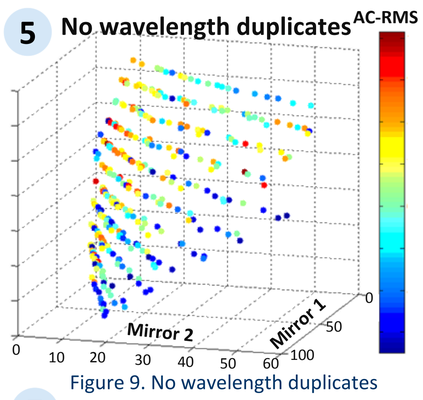

Figure 9. No wavelength duplicates

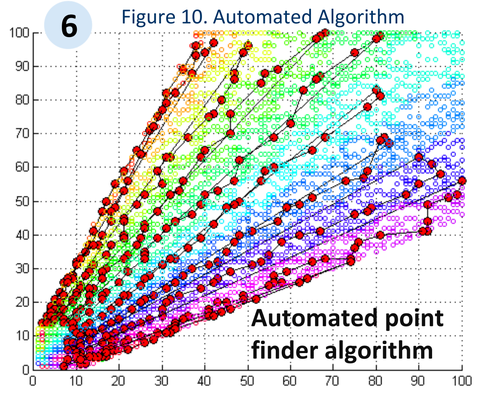

Figure 10. Automated Algorithm

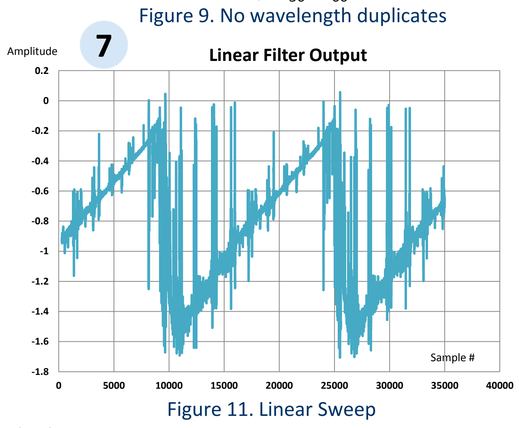

Figure 11. Linear Sweep

(4) 3000 points are found

(5) 300 points are selected to build a linear sweep

(6) Automated algorithm to perform a linear sweep

(7) 3 KHz sweep measurement

4. Conclusion

A linear wavelength sweep can be obtained using a telecoms laser but its performance can be further improved by reducing the noise of the driver electronics and avoiding high noise transitions.

References

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