LIONIX INTERNATIONAL

Ultra-Narrow Linewidth Tunable Laser at 780 nm

Just Out of View

The near-infrared spectrum has never been nearer. Our tunable laser technology has been applied towards a new 780 nm laser. It is ideal for many medical diagnostic, quantum, and gravimetric applications.

On-Chip Light Production & Tuning

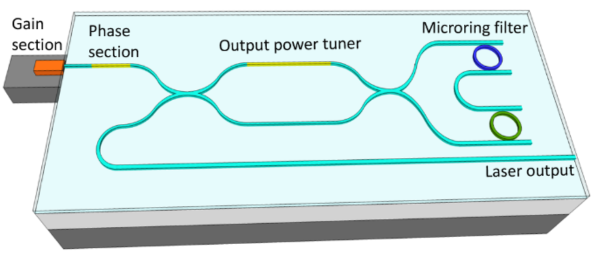
Our tunable lasers are made of photonic integrated circuits (PICs) on carefully selected materials with proven reliability. These integrated modules offer more robust and compact devices than conventional systems, with a target tunable range from 770 to 820 nm and a Lorentz linewidth <10 kHz.

Less than a centimeter long, the chip assembly can withstand temperature variation down to 3 K and mechanical shocks up to 40 g. The chip materials can be passivized for human body insertion while handling high operation power.

External Micro-ring Resonator Cavity

Our laser design follows a hybrid integration scheme: a semiconductor optical amplifier chip acts as the gain section, and a TriPleX® silicon nitride external cavity selects the light output wavelength.

The gain section includes a high-reflection coating on one facet and a port on the opposite facet for passing the light into the TriPleX® cavity. The cavity includes phase and power controls, as well as two micro-ring resonators enabling precise wavelength selection and a wide free spectral range.



Schematic of the laser showing the amplifier and tuning PICs

More Than A Laser With TriPleX®

Tiny and efficient tunable lasers are made possible only through high-performing and versatile materials. Our multilayer waveguide platform, TriPleX®, takes the best features of silicon nitride and fortifies them. It provides ultra-low propagation losses under variable environmental and mechanical conditions. With a very wise transparency range, from 405 to 2350 nm, it is suitable for many applications.

By using multiple waveguide profiles and converting between them, chips with high feature density, high light confinement, and varied mode field sizes can all be realized on the same platform. The same laser external cavity chip can include your own custom circuit designs for seamless function integration. Furthermore, with spot size conversion, coupling light into, between, and out of our chips inflicts minimal light losses.

Applications

Tunable lasers centered at 780 nm have been deployed in technologies across various application fields. Medical diagnostics provided the initial spark for this laser's development, with its first application as an interrogation laser for an ultrasonic detector in photoacoustic microscopy (see overleaf). It found parallel use in optical coherent tomography (OCT) within ophthalmology, dermatology, and other biomedical industries. The tunability and phase control of the laser make it an excellent swept-source and spectral-domain light source with no moving parts.

In biosensors, the laser is used in conjunction with other TriPleX® building blocks to detect biomolecules through multiple light properties. With a Mach-Zehnder interferometer, the conjugation of target molecules to antibodies can be detected via changes in the phase of a biofunctionalized waveguide. With spiral waveguides, conjugation can be detected via spectral losses. With micro-ring waveguides, changes in the resonance frequency of the ring indicate biomolecule conjugation. The versatility of our platform allows for broad creativity in device design and precise results in the final application.

Ultra-narrow linewidths of <1 kHz are essential for quantum instruments where laser precisions and stability are paramount. Photonic integration of light sources eliminates the spatial uncertainties of free-space optics, which is an essential upgrade for quantum applications. Such equipment streamlining also lets manufacturers scale-up equipment manufacturing volumes. Furthermore, control of wave properties via PICs allows for finer tuning, down to 0.1 pm resolutions with our current driver electronics. Linear and circular polarization can be achieved with high purity, improving the efficiency of atomic systems control schemes.

As a vertically integrated custom microsystems provider, we supply optimized photonic circuits designs and fabrication processes, TriPleX® chips and assemblies, driving electronics, and packaging for each application.

REAP fact sheet

Grant Agreement: 101016964

Topic: ICT-36-2020 - Disruptive photonics technologies

Duration: January 2021 - December 2024 (48 Months)

Coordinator: Medical University of Vienna

Contact:
Dr. Mengyang Liu, MUW
(*mengyang.liu@meduniwien.ac.at*)

Project website: www.projectreap.eu

Total Budget: € 6,185,978.75

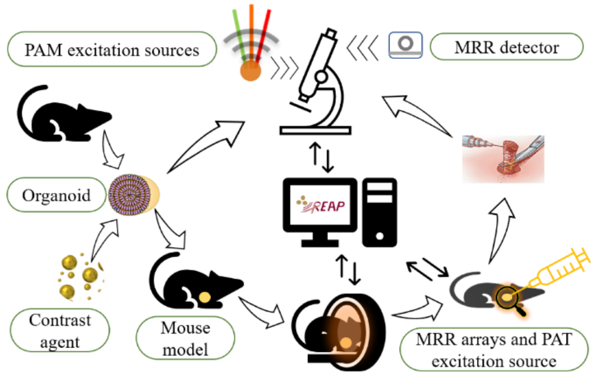
Consortium:
- Medical University of Vienna (AT)
- AIT Austrian Institute of Technology (AT)
- University of Santiago de Compostela (ES)
- Picophotonics Ltd. (FI)
- Tampere Universities (FI)
- Polytechnic University of Turin (IT)
- InnoLas Laser GmbH (DE)
- LaVision BioTec GmbH (DE)
- LioniX International B.V. (NL)

www.projectreap.eu

This project has received funding from the European Union's Horizon 2020 programme under grant agreement number 101016964

Main Objectives

Available cancer therapies often fail due to the development and metastasis of drug-tolerant presistor cells. Once treatment is stopped after the successful removal of targeted cancer tumors, drug-tolerant persistor cells linger in the body in unobservable clusters. These cells can act as sources for new tumors long after the treatment is stopped. There are no effective methods for the detection of these cells, especially as they can be very few and varied. To address this challenge, REAP is developing multimodal imaging systems: an optical coherence photoacoustic microscopy (OC-PAM) system to make images of cancer samples at cellular and sub-cellular levels, an optical coherence photoacoustic tomography (OC-PAT) system to make images of very small tumor clusters and their environments, and a second PAT system to make images of the whole body to track tumor growth and metastasis. Conventional piezoelectric ultrasound transducers will be replaced with integrated photonic micro-ring resonators. Additionally, a novel contrast agent using biofunctionalized nanoparticles will be used to label the target persistor cells.



Overview of REAP's project goals

Our 780 nm Interrogation Laser

The proposed imaging systems require increased sensitivity and precision, achievable through photonic integration, to outperform conventional detection methods. Photoacoustic imaging shines light on the sample tissue and produces an acoustic wave. In this project, the wave is absorbed by an integrated micro-ring resonator, which changes its optical resonance wavelength. Our 780 nm tunable laser will scan through its tuning range to identify the change in the resonance wavelength of the ring. As our laser can tune to any wavelength within its range in 1 μs, it will considerably increase image acquisition speed, and is thus able to better exploit the sensitivity of photoacoustic detection.

LioniX International
PO Box 456
7500 AL Enschede
The Netherlands
Email: info@lionix-int.com
Phone: +31 53 20 30 053
www.lionix-international.com