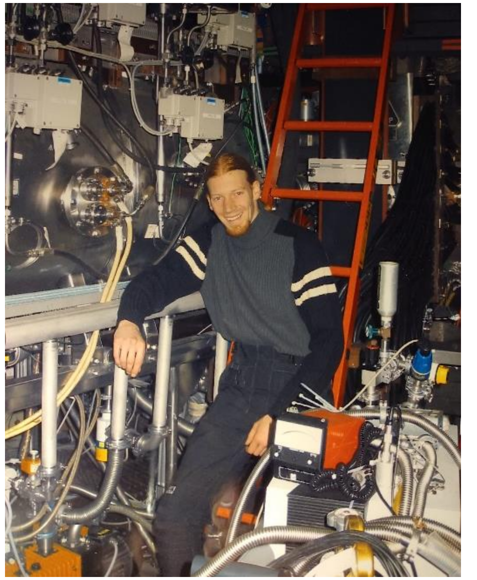
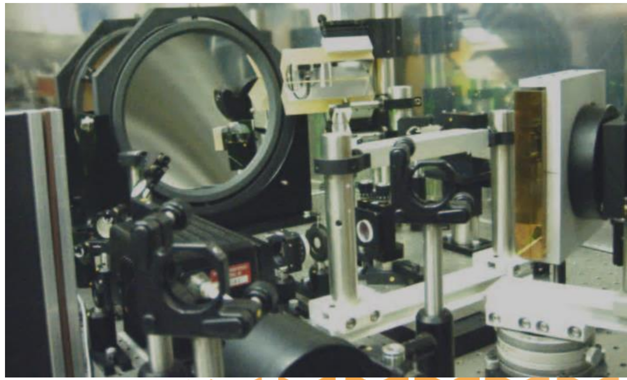
# Carla camp 2024: Why working in photonics is fun and versatile.

Dimitri Geskus

# Personal history from Pigs to PICS

- Dimitri Geskus born 1979
- Education trajectory, from Pigs to PICS:
  - **Mavo 1996**
    - **Conclusion: working in the slaughterhouse was not my thing**
  - Havo 1998
  - **HTS Saxion** Applied physics Traineeships at **ASTRON** (NL), **CERN** (Swizerland) and **Forshungszentrum Juelich** (Germany) (2003)
    - **Conclusion, academic environment could be fun!**
  - MSC UT (2006) Lasers.
  - PhD UT: (2011) chip-lasers.
- Professional trajectory
  - Engineer: Glueing chips together at XioPhotonics 2012
  - Post-Doc: Making lasers in **São-Paulo** Brazil 2014
  - Researcher KTH **Stockholm**: Microchip lasers 2016
  - Lionix international: Glueing chips together (Assembly) and Making lasers 2020
  - Now CTO at Chilas, putting the lasers on the market.





# Why Photonics is fun: New technology lots of tasks to do

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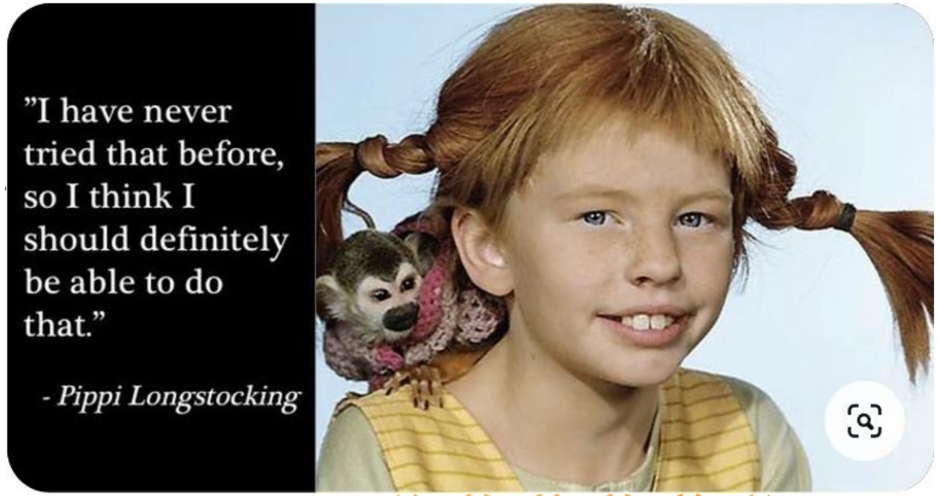
- Photonics is still in its child-phase (**Hand Craft**)
- This gives a lot of opportunities in **Cutting-edge tech**:
  - New technology development
    - new materials, new fabrication, new combinations
  - New applications
    - Quantum, Terahertz, computing, sensing, remote communication..
  - Downscaling of existing devices:
    - OCT, Lidar, Raman spectroscopy, microscopy, sensing..
  - New devices
    - Retina projectors, white light sources, RF sources, beamformers, lasers

The current **status of Photonics**
Compares to
The **status of Electronics in the late 60s**:
having the lithographic transistor on the shelf.
And we all know the ripple that development made in the 70 years after


...And some ~~headaches~~ Challenges..

- Unknown behavior of chips for (new/any) applications.
- Failing Fabrication/Design/Assembly/electronics/understanding.
- Lack of customer knowledge: some prophecy still being spread.
- **You have to be opportunistic!**



# Why Photonics is fun: Daily activities PC-Handwork-PC

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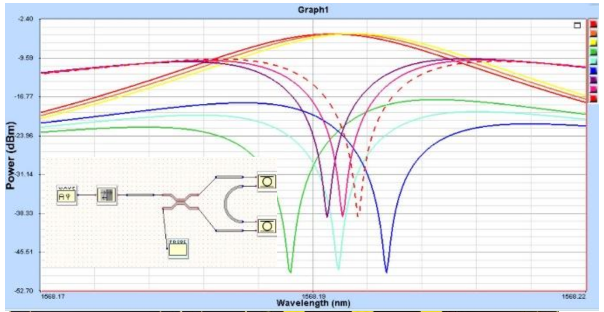


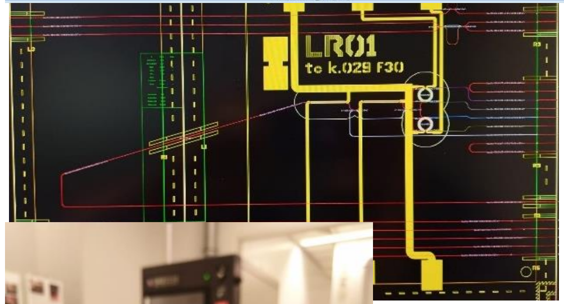


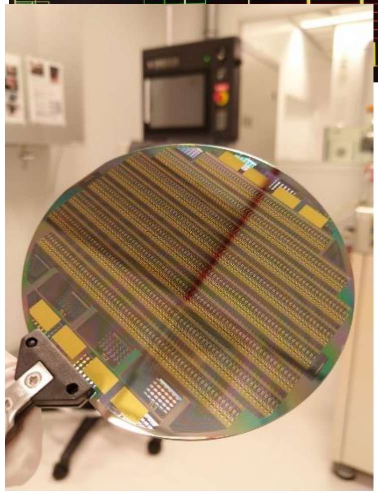

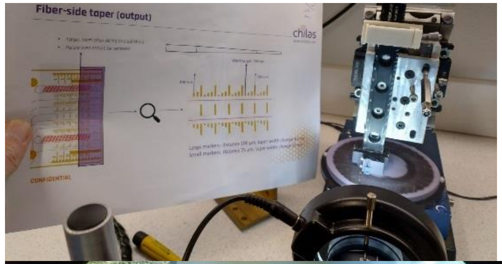


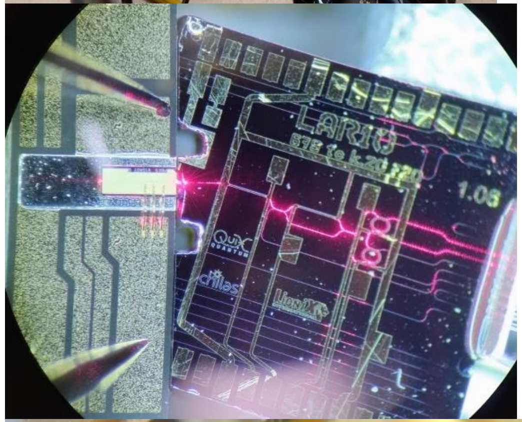

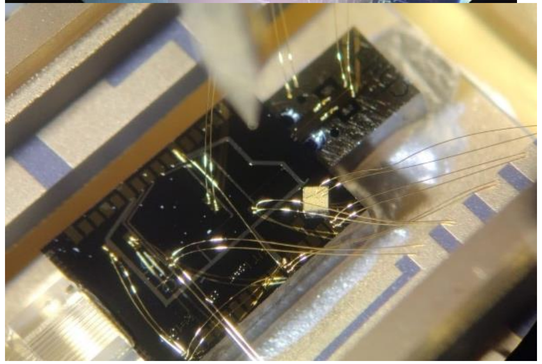

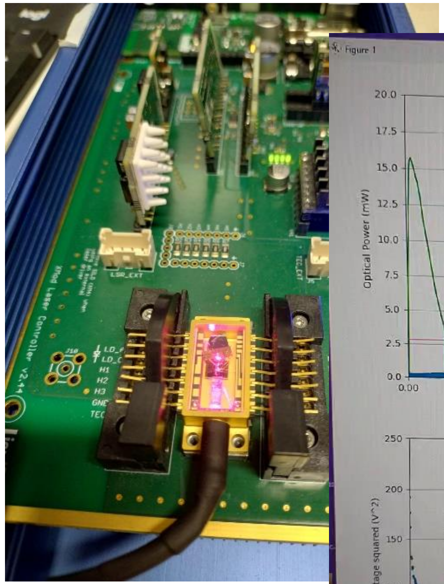

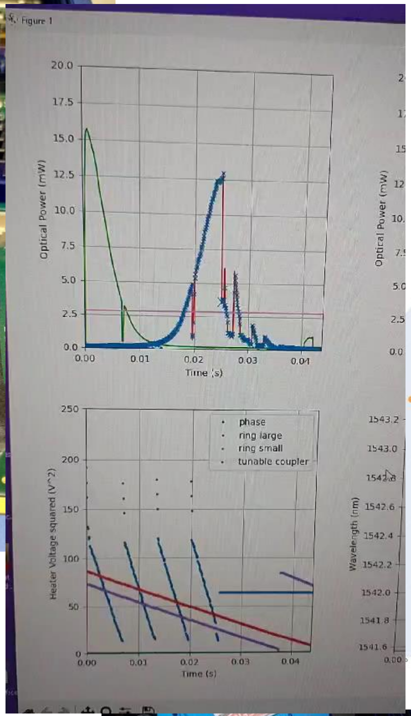


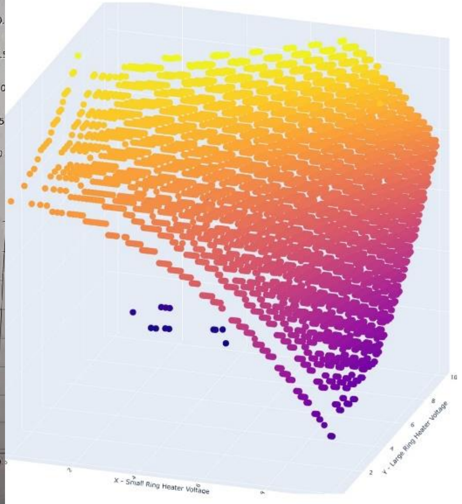


Design, layout, fabrication (Behind PC) - Cut, Polish, Glue, stitch (In da Lab) - Test evaluate calibrate map (PC) –Scale up (outsource).

# Why Photonics is fun: Daily activities, Customized laser

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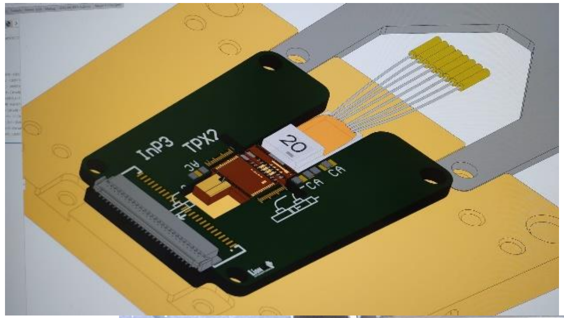
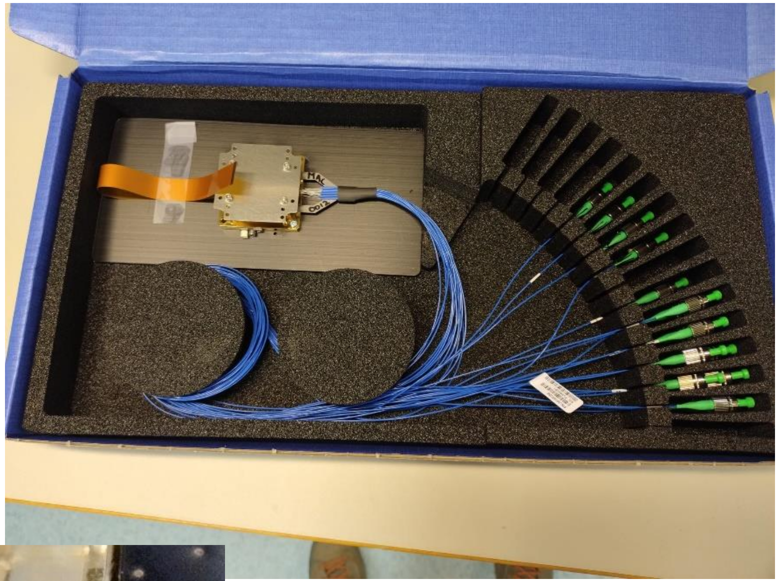


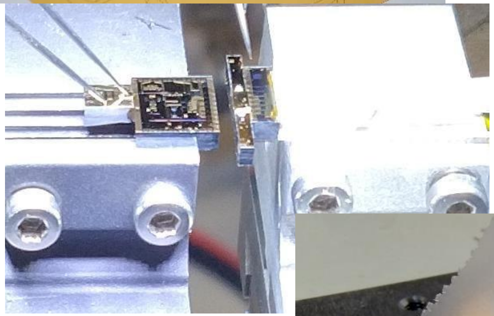

1 year project

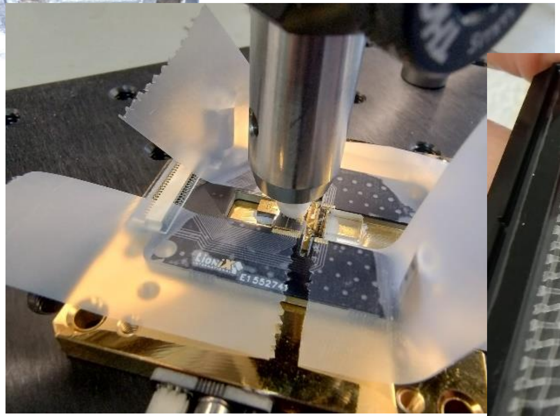
1 responsible

2 people strongly involved

Team around for support







# Why Photonics is fun? About Chilas, and its product: Laser source

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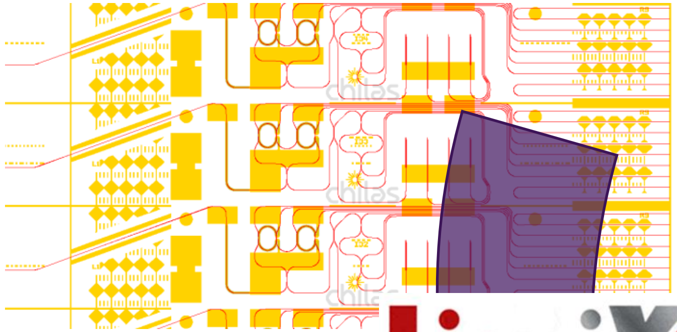
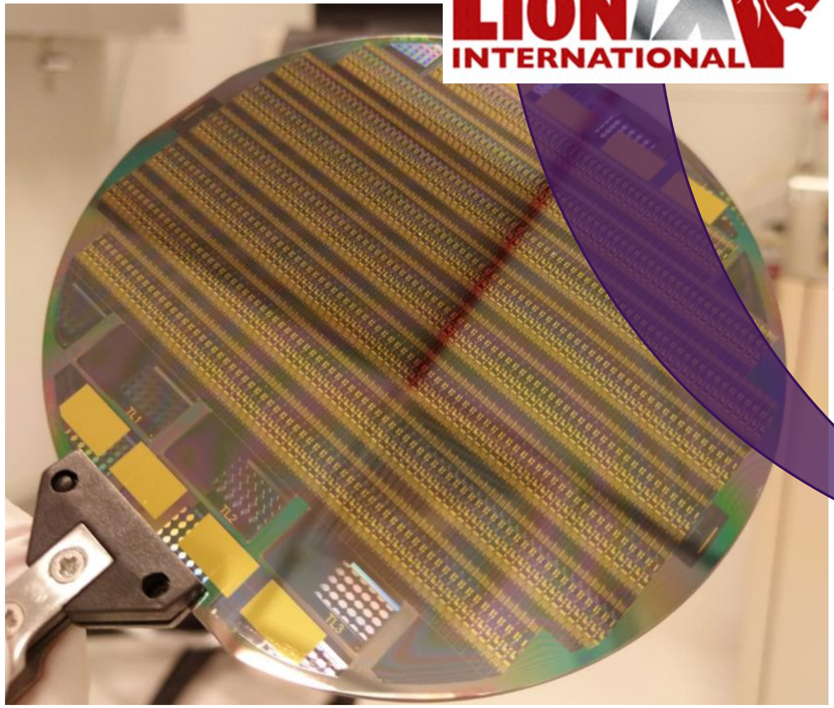
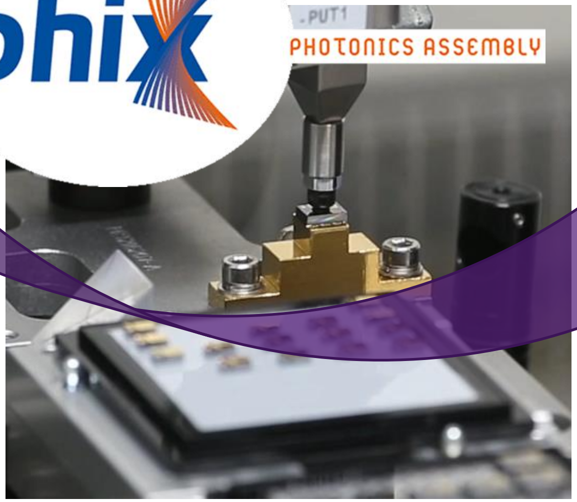




LioniX INTERNATIONAL

- Chilas is one of the few companies making a product
- You have to know all steps

phix




chilas

# Characteristics of Hybrid integrated external cavity laser

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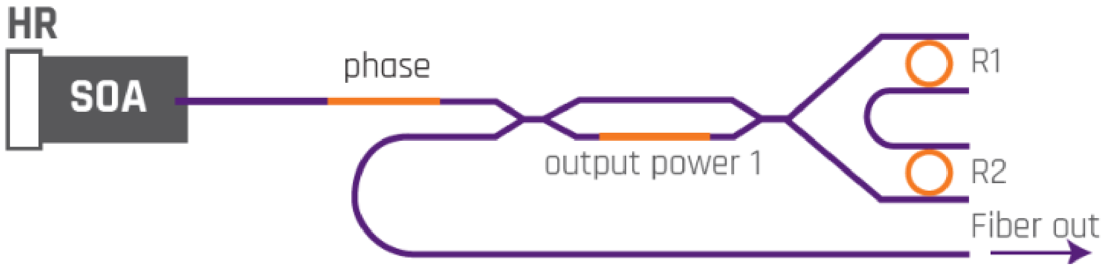
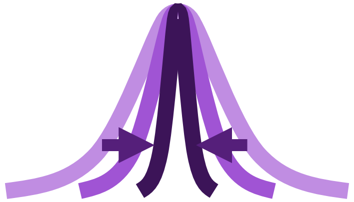
## 3 main characteristics of hybrid integrated external cavity lasers:




### High output powers

Provided by the InP semiconductor optical amplifier (SOA) gain medium.

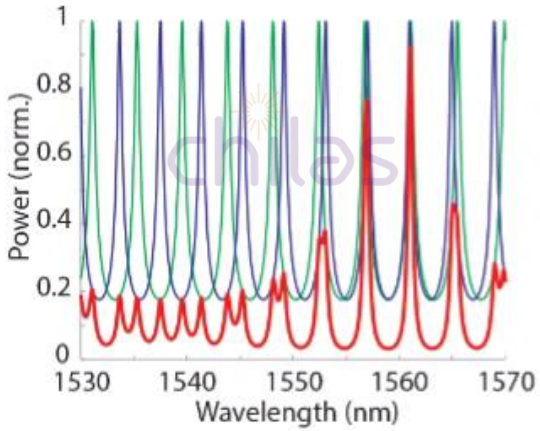
### Ultra narrow linewidth

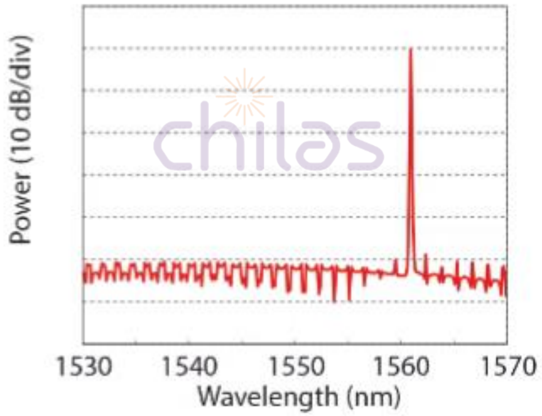


Thanks to low loss $Si_3N_4$ waveguide circuit as external cavity.

### Broad tuning of the wavelength

Due to two coupled micro-ring resonators (MRRs) with slightly different FSR in the cavity exploiting the Vernier effect.



# Characteristics - Applications

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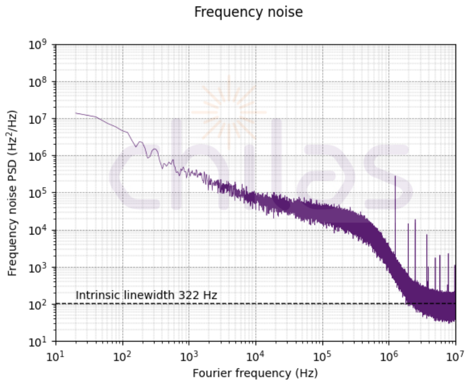
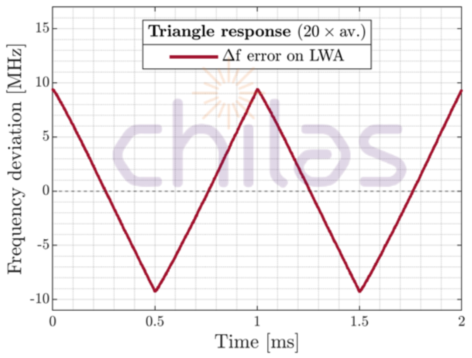
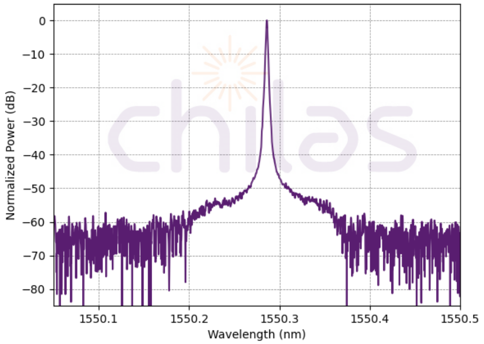
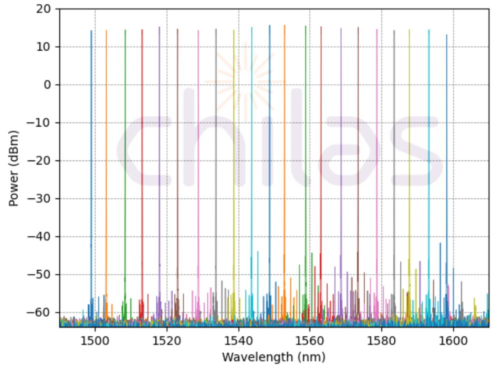
1. Ultra stable (locked) for **Quantum** applications.
2. Frequency modulated Continuous Wave (FMCW) operation for **LiDAR.**
3. Modehop-free (MHF) tuning, for **spectroscopy**.
4. Swept source applications such as **OCT & FBGS.**



# Wavelength locking/stabilization of lasers

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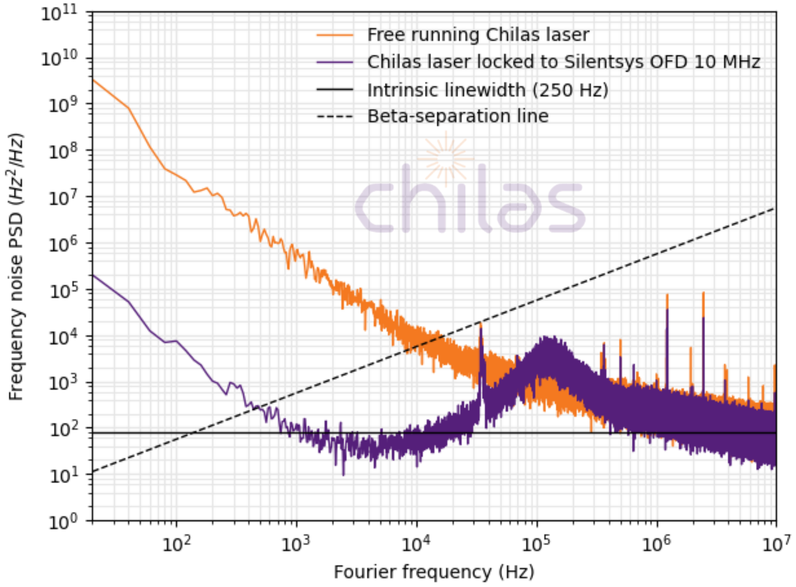
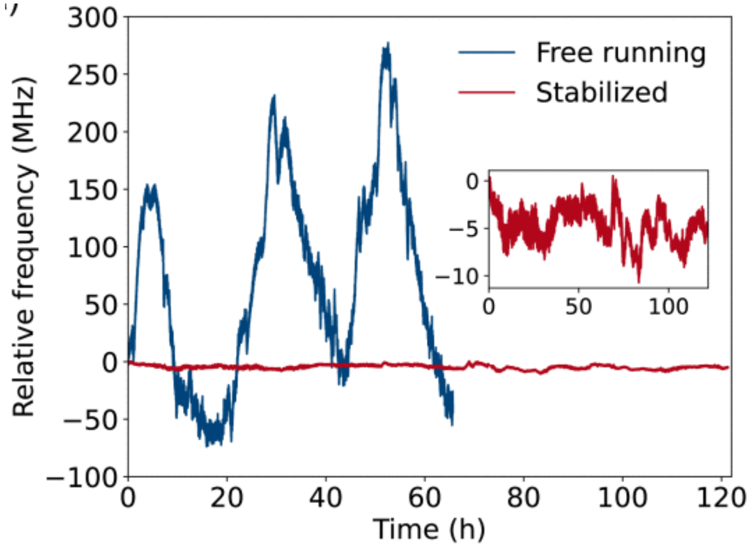
- **Stabilization of the wavelength is important for atomic clocks or noise sensitive applications, such as sensors.**
- Free-running: 1.2 MHz
- Locked: 8.3 kHz over 20 ms




Long-term locking to an acetylene absorption line




A. van Rees, L. V. Winkler, et al, IEEE Photonics Journal 15, 5 (2023)

# Precise wavelength scanning: for spectroscopy

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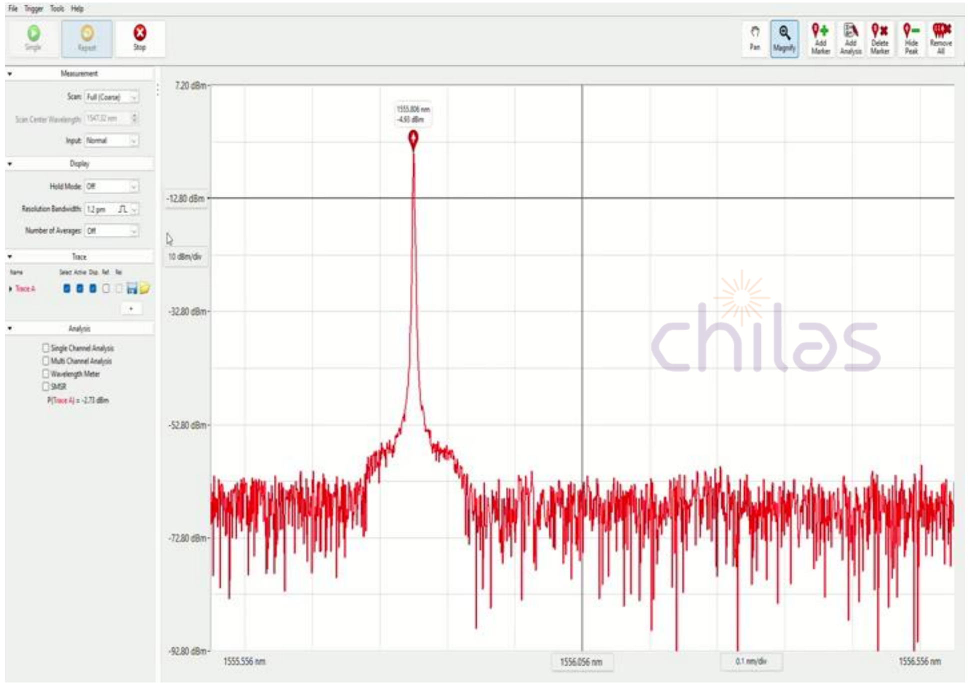
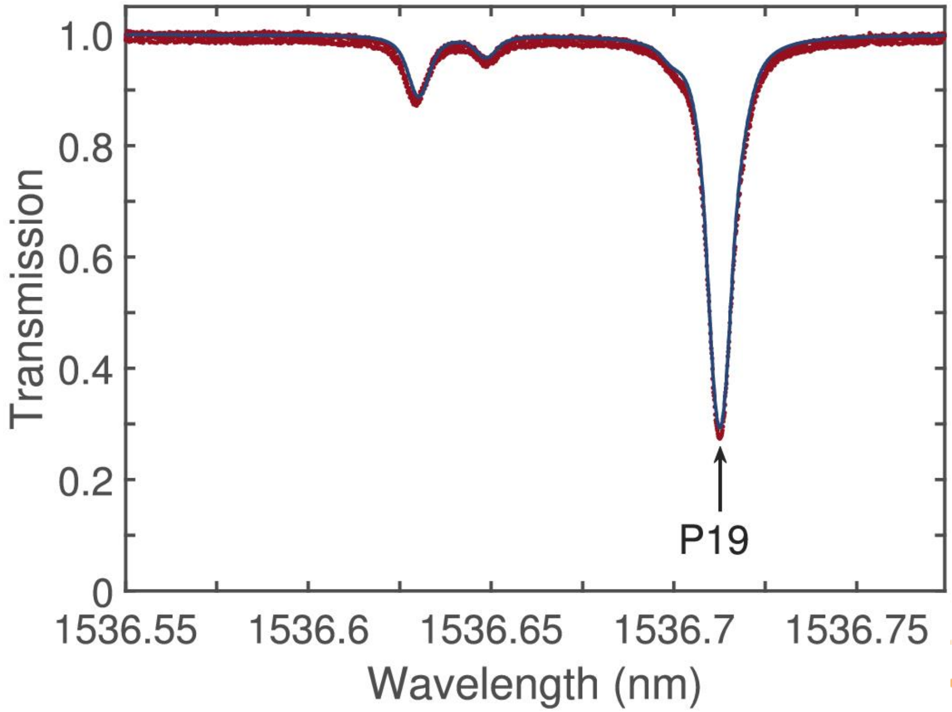
- Modehop free tuning, for precise wavelength scanning.



- Application: monitor the position of a gas absorption cell




Albert van Rees et al. Opt. Express 28, 5669-5683 (2020)

# Chilas COMET: Compact Swept Source Laser

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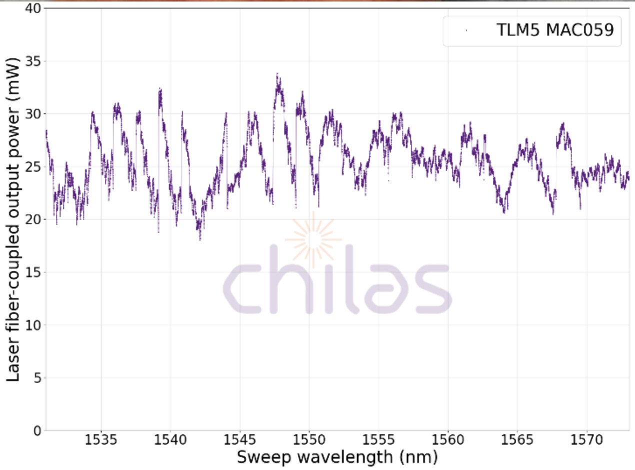



| Parameter | Specified values |
|---|---|
| Wavelength range | C-Band |
| Wavelength grid | 4 pm |
| Intrinsic Linewidth | < 5 kHz |
| Fiber output power | ≥ 13 dBm |
| Fiber type | PM FC/APC |
| Swept source characteristics | 40 nm/s |
| Package | 100*60*20 mm |

**No mechanical tuning elements:**

1. Giving **instantaneous range reset** and no delay between end and start of scan: resulting in a nearly **100% duty cycle**
2. **High reproducibility** from scan to scan
3. Compact and robust chip based form factor: **ready for high volume applications**
4. Easily tailored to **drive nearly any application**

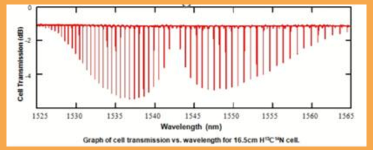
# Performance demonstration: scan of HCN gas absorption reference cel



- Demonstration Setup: detecting the absorption peaks
- Laser scans continuous over the C-band
- Measurement done using a set of diodes and an oscilloscope: all analog electronics


COMET
Chilas swept source

Fiber
Splitter




HCN gas
absorption
reference cell

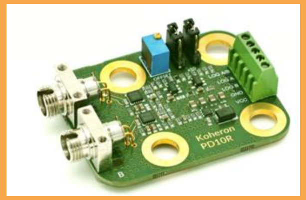
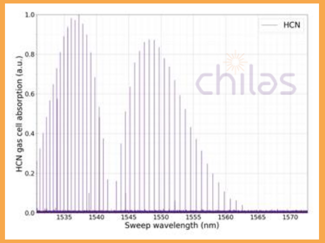



Photo diode set:
PD(B)/PD(A)




Oscilloscope

# Demo HCN absorption cel (C-band)

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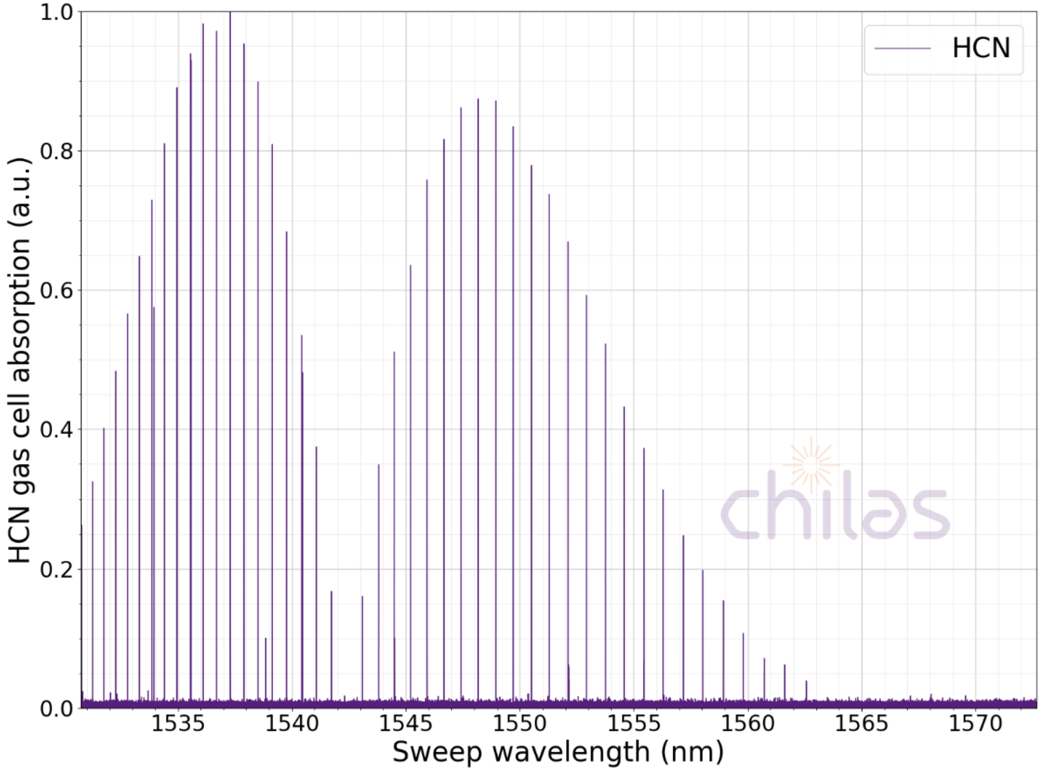
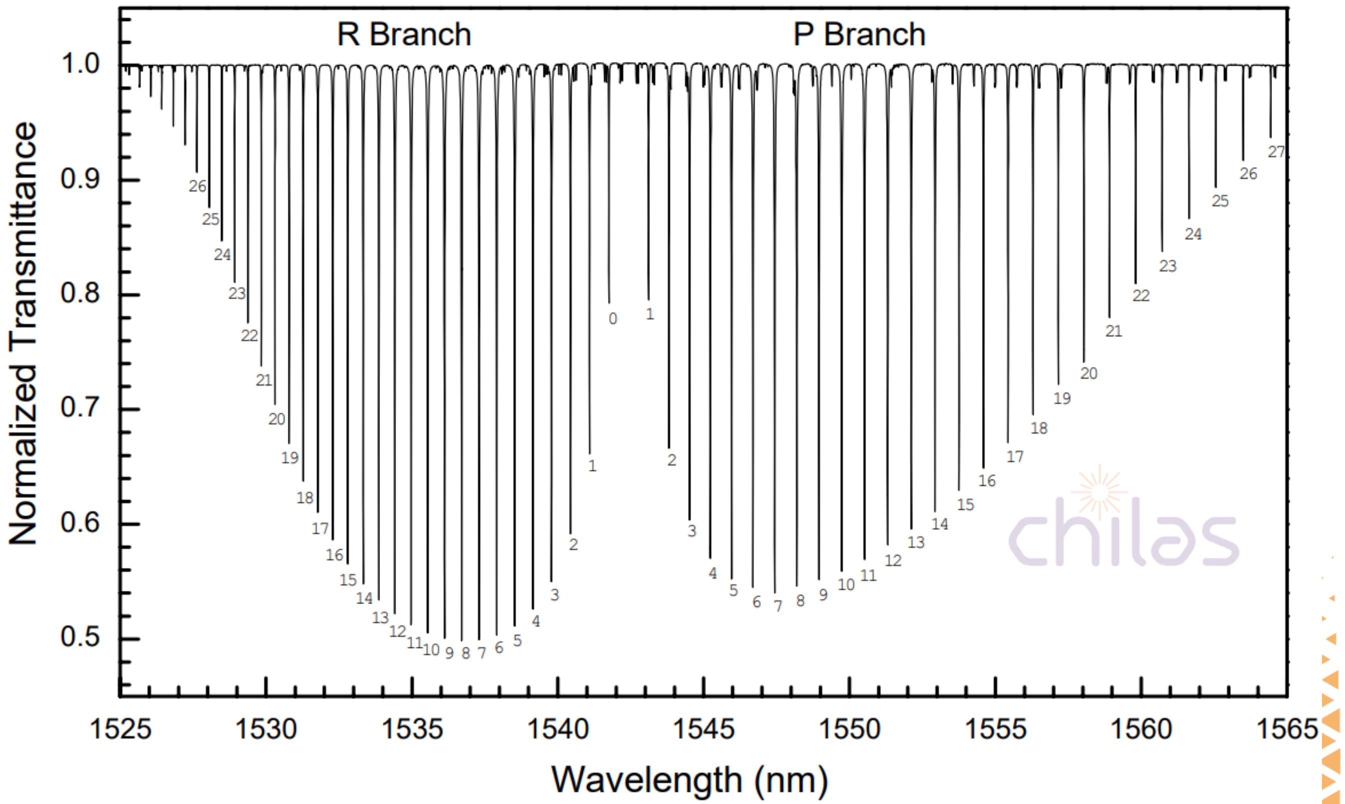
- All absorption lines resolved in a single second.

**Measured absorption spectrum of an HCN gas cell using the Chilas COMET laser**




**Expected absorption spectrum of HCN gas cell.**
Source: www.nist.gov/system/files/documents/srm/SP260-137.pdf



# Other wavelengths on request! Anywhere between 400 nm - 2200 nm

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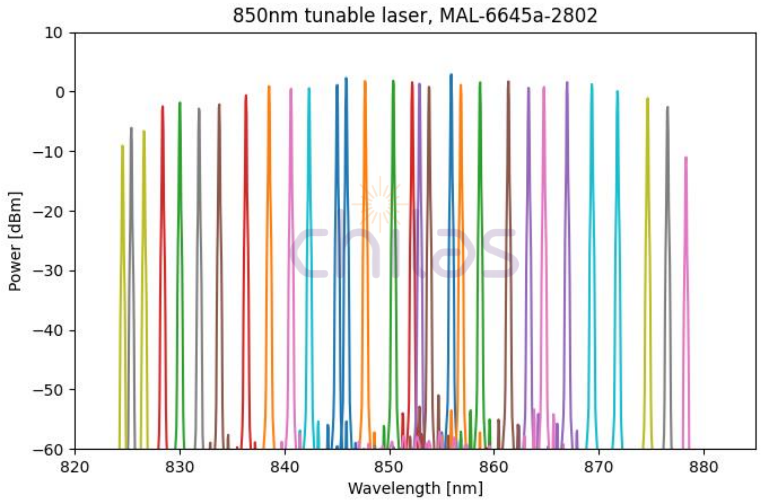
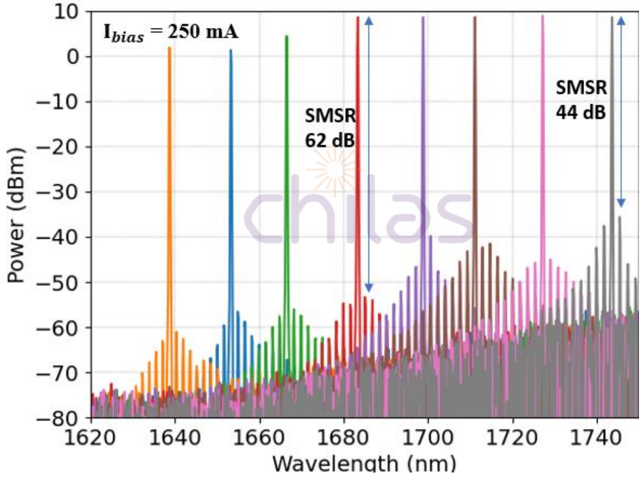
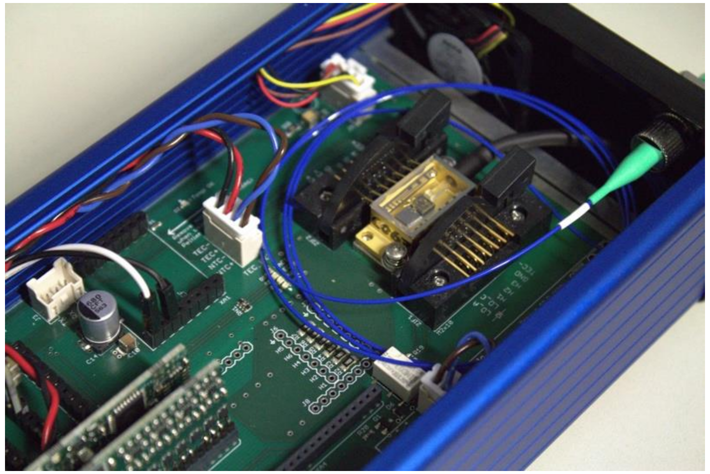
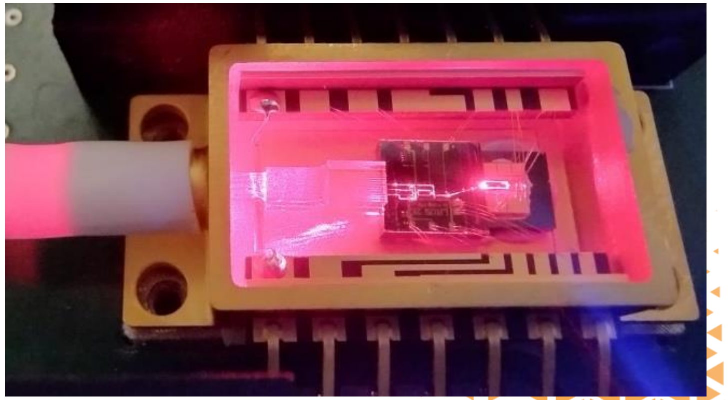
| Prototypes | Chilas VT3 | Chilas BT3 | Chilas UT3 |
|---|---|---|---|
| Wavelength | 680 nm / 690 nm / 707 nm / 780 nm | 850 nm | 1700 nm |
| Power | > 1 mW | > 3 mW | > 7 mW |
| Tuning range | +/- 10 nm | +/- 25 nm | +/- 50 nm |





# Everything grows