EPIC Online Technology Meeting on Photonics Hybrid Integrated Circuits

Monday 16 September 2024

Ultra-narrow linewidth tunable and swept source lasers enabled by hybrid photonic integrated circuits

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CTO at Chilas B.V.

Characteristics of Hybrid integrated external cavity laser

www.chilasbv.com

3 main characteristics of hybrid integrated external cavity lasers:

High output powers

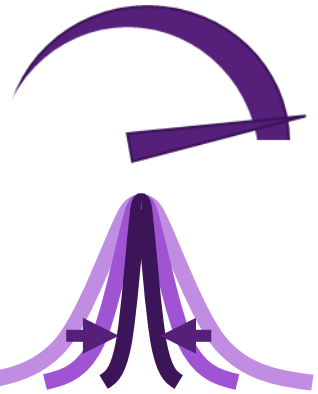
Provided by the InP semiconductor optical amplifier (SOA) gain medium.

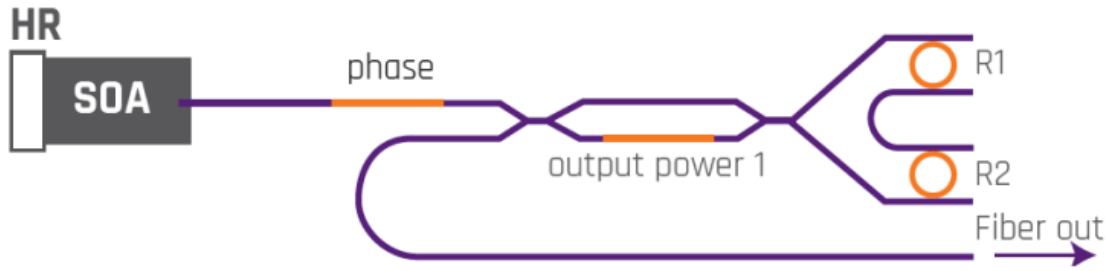
Ultra narrow linewidth

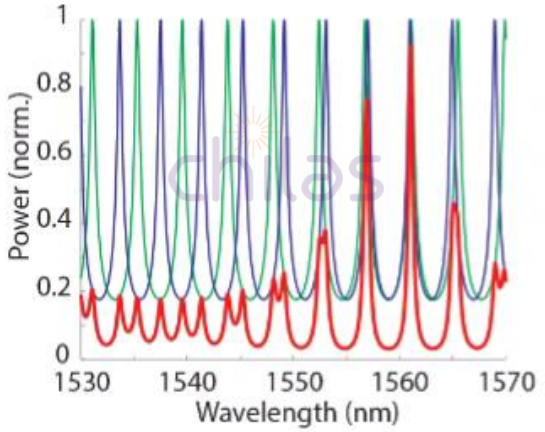
Thanks to low loss Si_3N_4 waveguide circuit as external cavity.

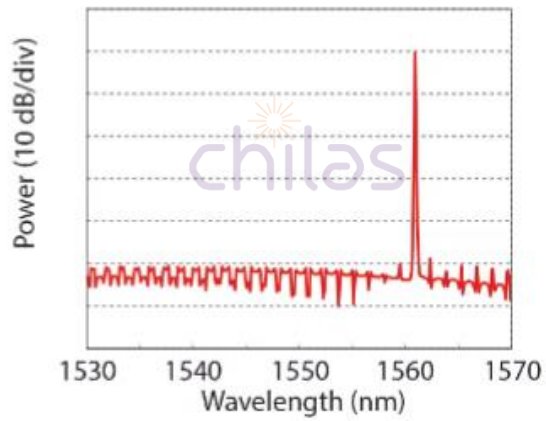
Broad tuning of the wavelength

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









Chilas Featured Products

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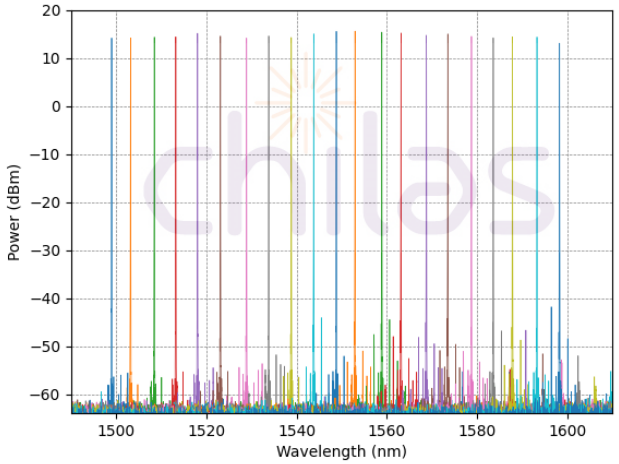
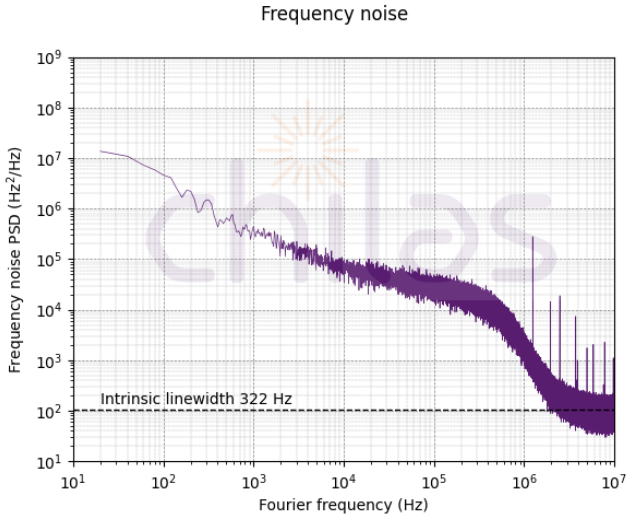
	Chilas Fixed 1550nm	Chilas COMET Swept source	CT3 100nm
Wavelength	Anywhere in C-band +/- 10pm	Full C-band (40nm/s)	1490nm – 1590nm
Power	> 13 dBm	> 13 dBm	> 13 dBm
Linewidth	< 5 kHz	< 5 kHz	< 5 kHz

CT3 100nm spectrum



Narrow linewidth



Characteristics - Applications

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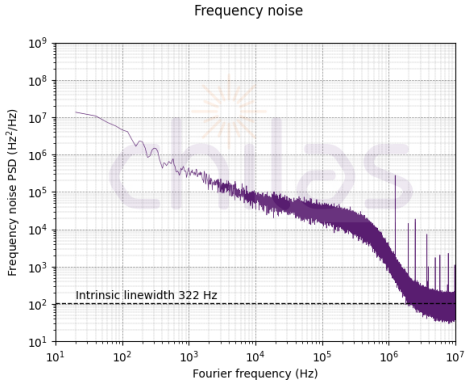
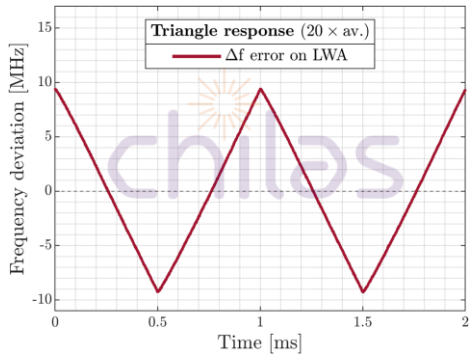
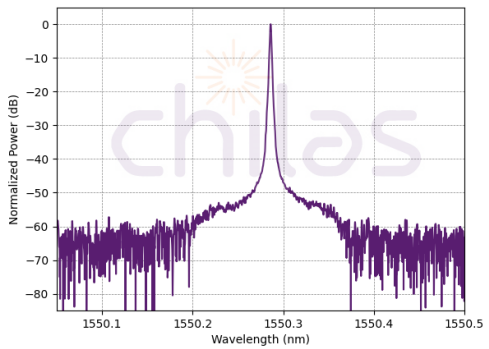
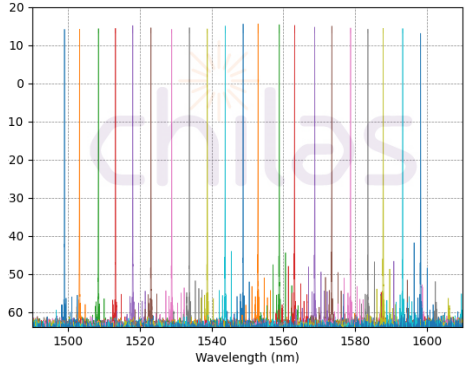
1. Ultra stable (locked) for **Quantum** applications.
2. Frequency modulated Continuous Wave (FMCW) operation for **LiDAR.**
3. Mode hop free (MHF) tuning, for **spectroscopy**.
4. Swept source applications such as **OCT & FBGS.**









Wavelength locking/stabilization of lasers

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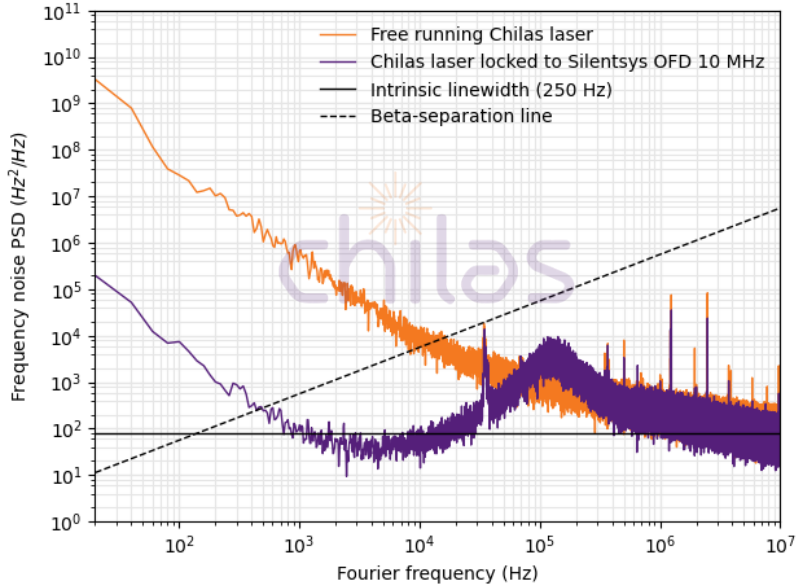
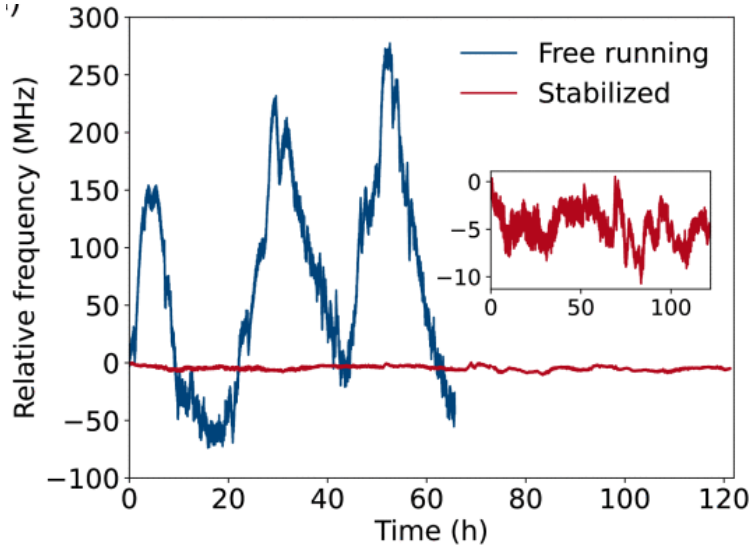
- **Stabilization of the wavelength is important for atomic clocks or noise sensitive applications, such as sensors.**
- Free-running: 1.2 MHz
- Locked: 8.3 kHz over 20 ms



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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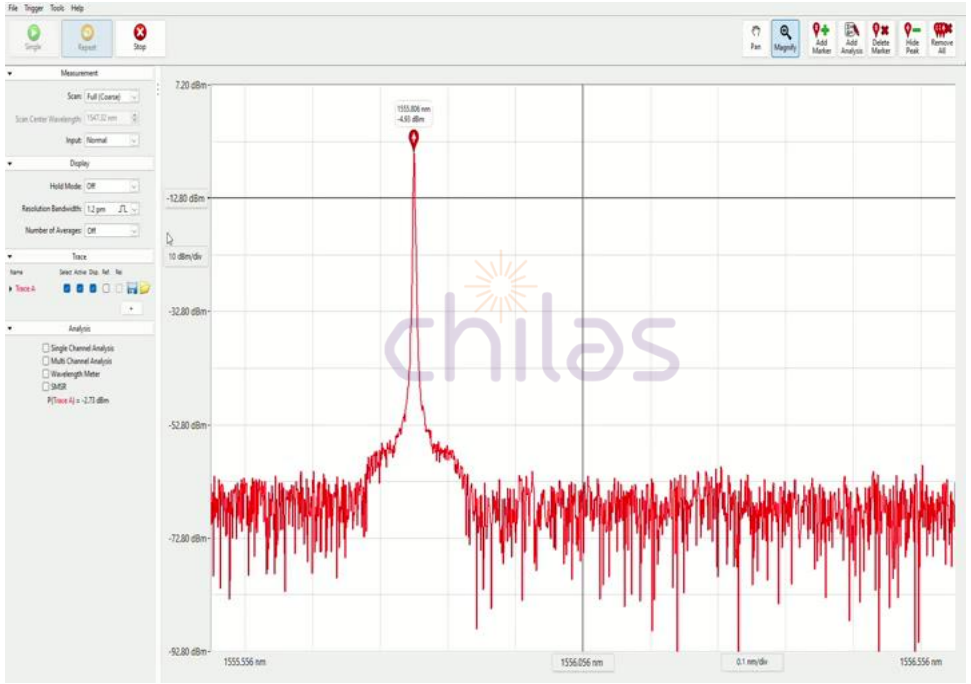
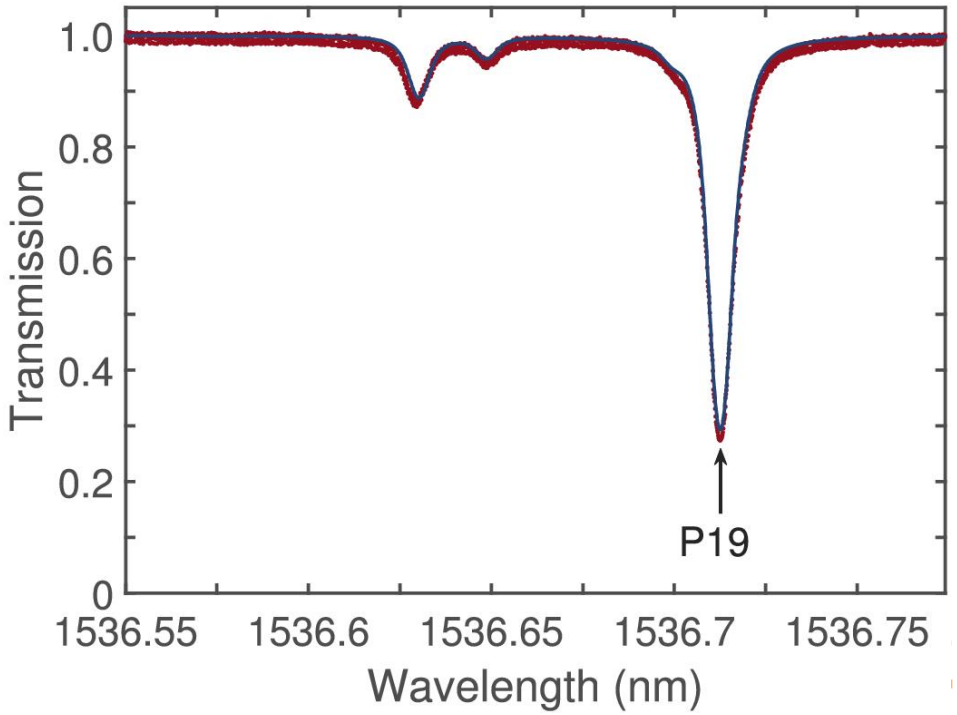
- Modehop free tuning, for precise wavelength scanning.



- 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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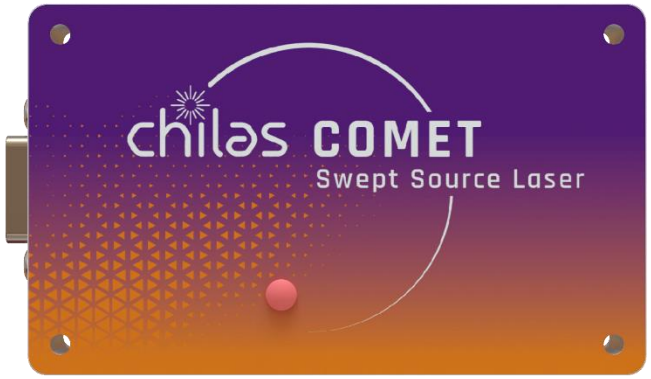
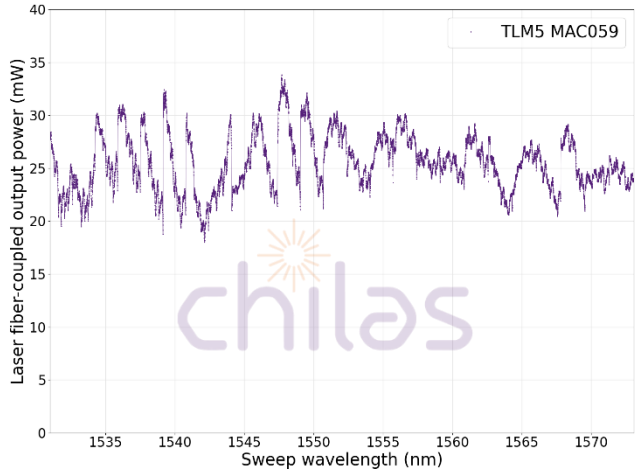


Parameter	Specified values
Wavelength range	C-Band
Wavelength grid	4 pm
Intrinsic Linewidth	< 5 kHz
Fiber output power	≥ 13 dBm
Fiber type	PM FC/APC
Swept source characteristics	40 nm/s
Package	100*60*20 mm



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

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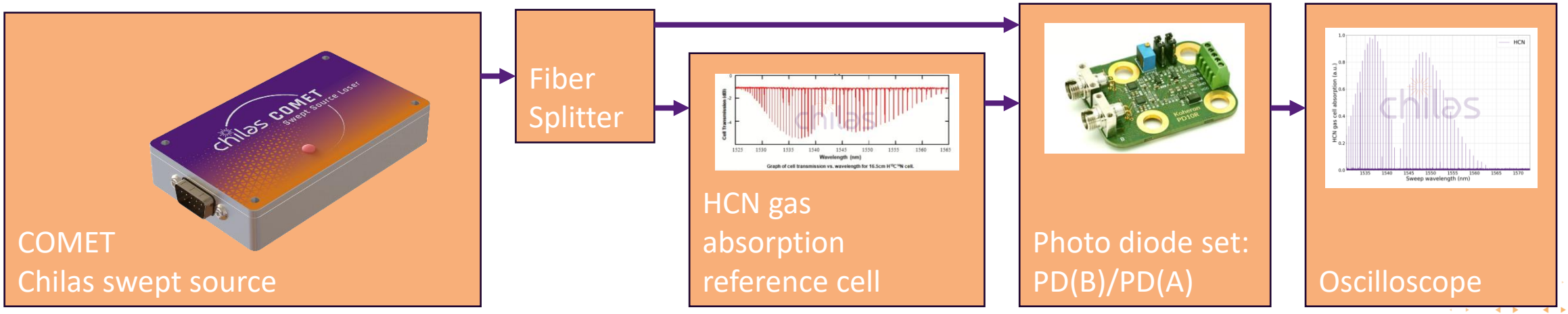
- Demonstration Setup: detecting the absorption peaks
- Laser scans continuous over the C-band
- Measurement done using a set of diodes and an oscilloscope: all analog electronics



Demo HCN absorption cel (C-band)

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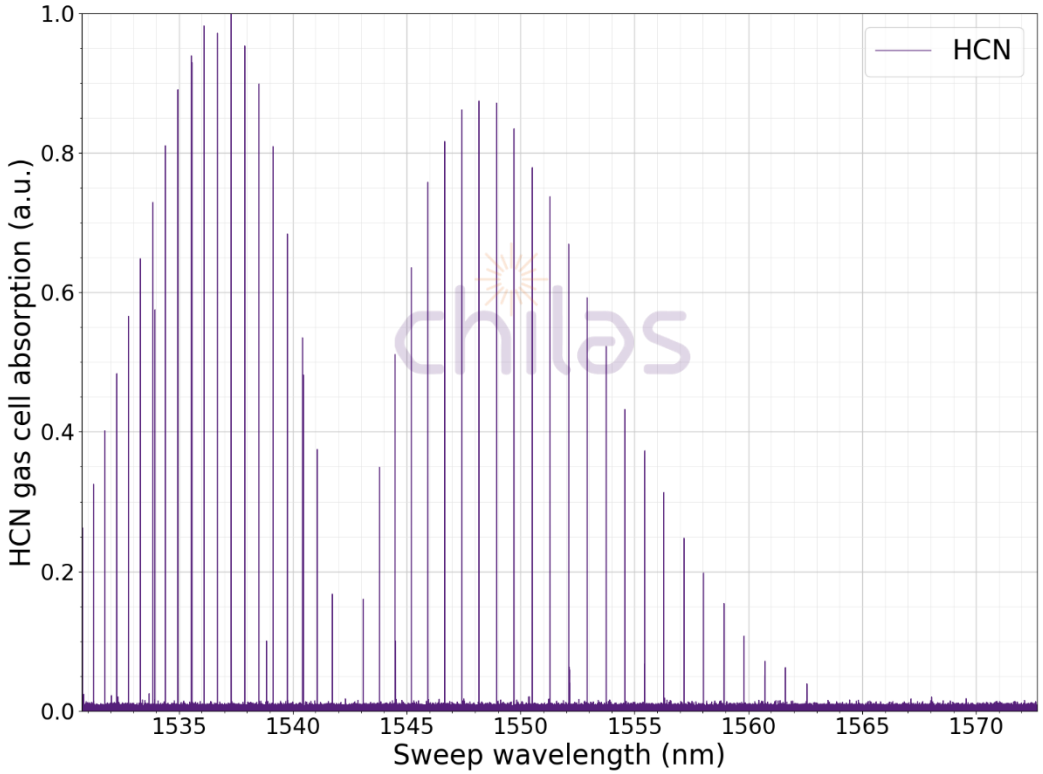
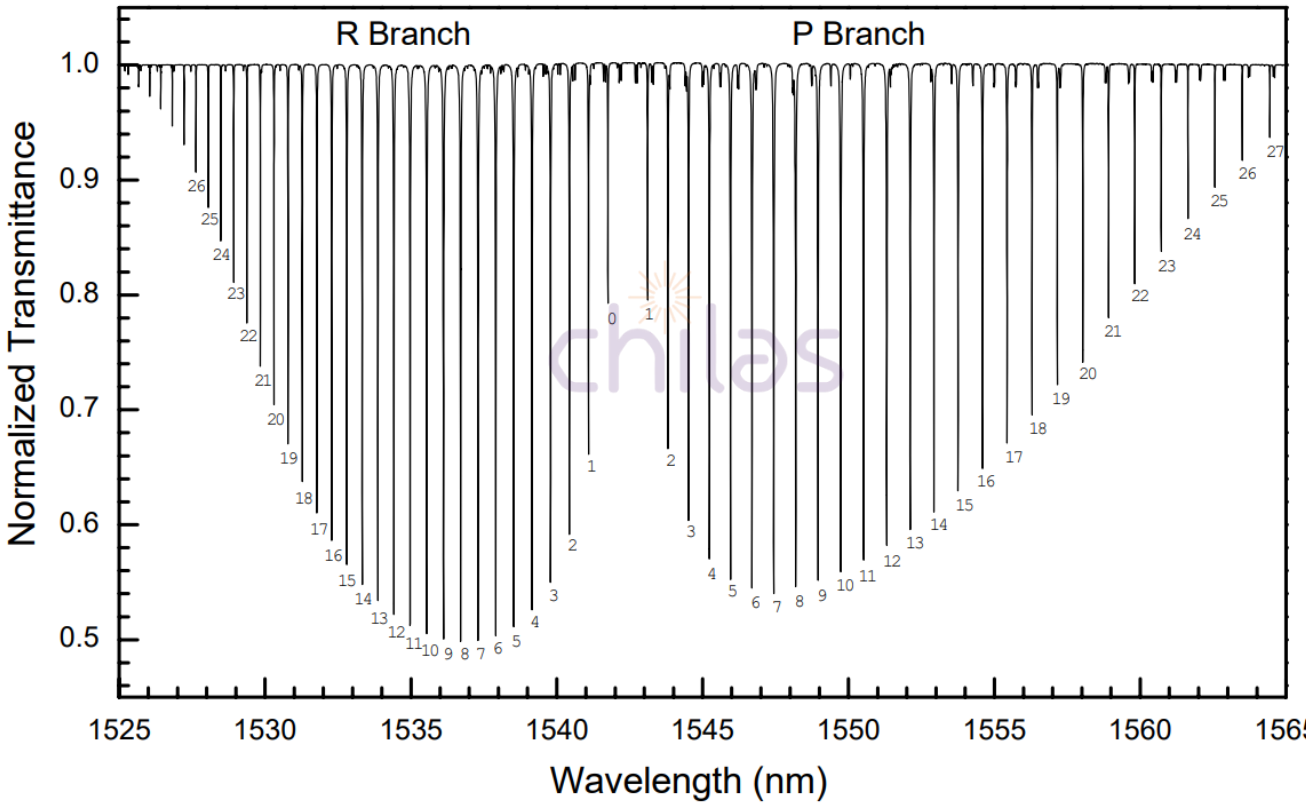
- All absorption lines resolved in a single second.

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



Demo HCN absorption cel (C-band)

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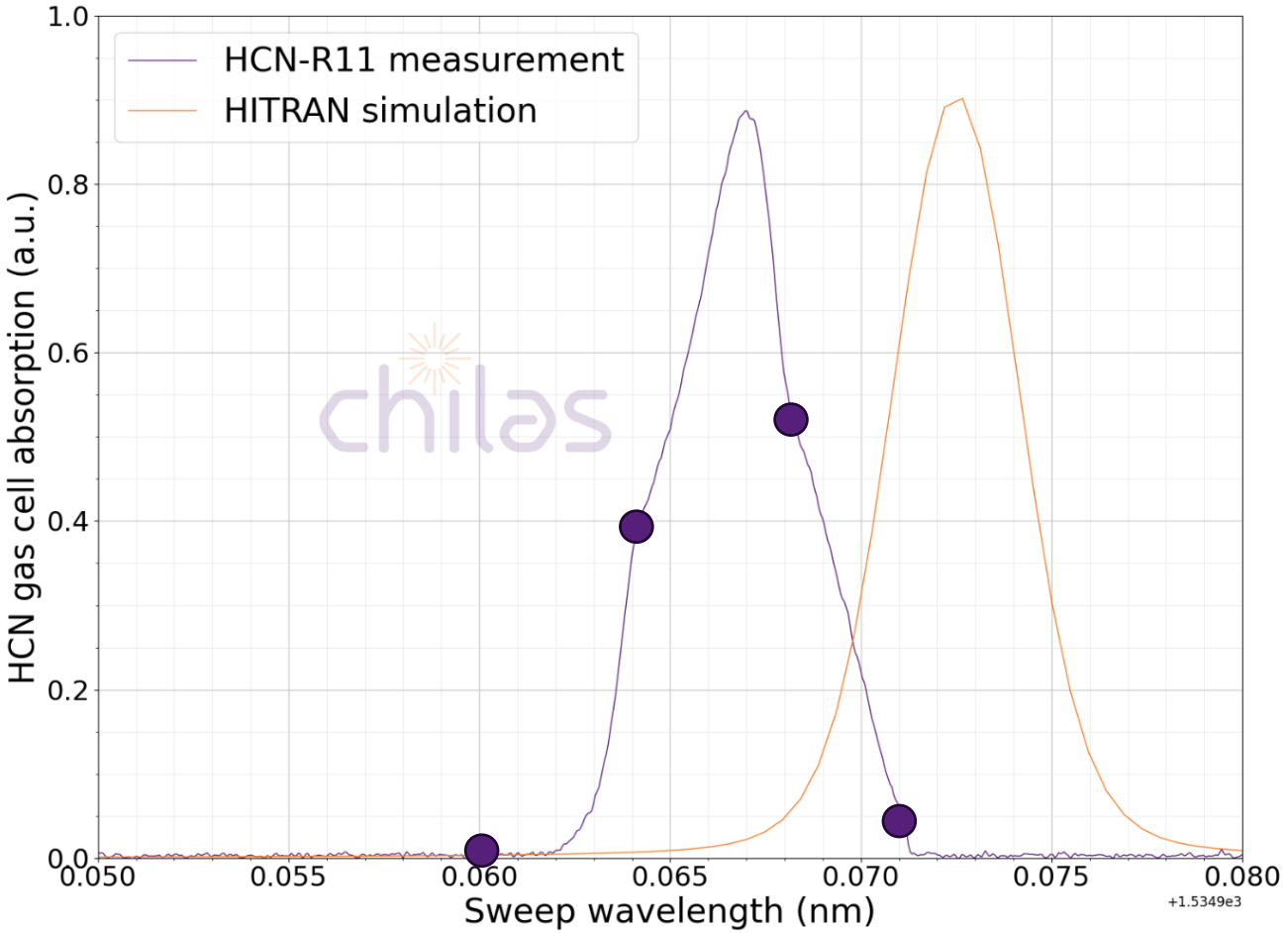
- Comparison between
  - COMET measurement
  - /Theoretical model (HITRAN)
- Resolution not limited by Laser
  - < 5 kHz linewidth
- 4 pm scan step size visible
  - Continuous sweep between sample points
- Offset 6 pm
  - Probably caused by a time delay in synchronization.



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

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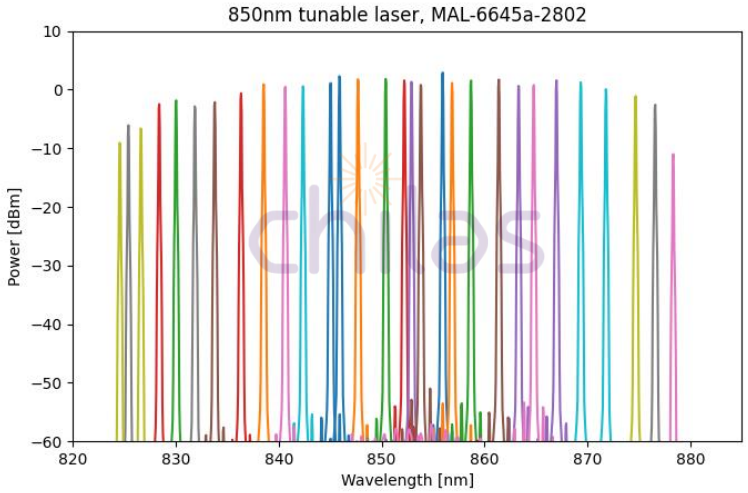
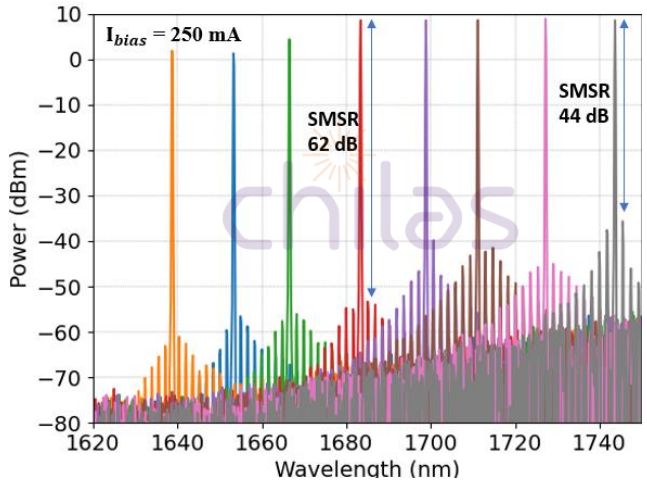
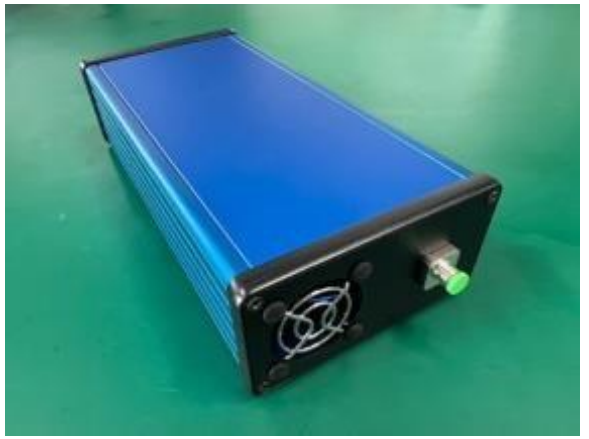
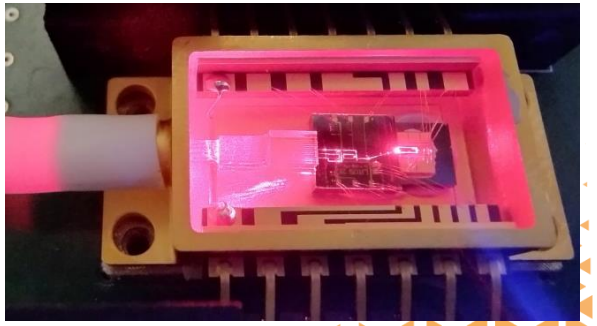
Prototypes	Chilas VT3	Chilas BT3	Chilas UT3
Wavelength	680 nm / 690 nm / 707 nm / 780 nm	850 nm	1700 nm
Power	> 1 mW	> 3 mW	> 7 mW
Tuning range	+/- 10 nm	+/- 25 nm	+/- 50 nm









Chilas lasers: compact, robust, wavelength agile and volume ready

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