On-chip **PH**otonics **E**rbium-doped **L**aser for **LI**dar **A**pplications

NEWS – Future applications for OPHELLIA

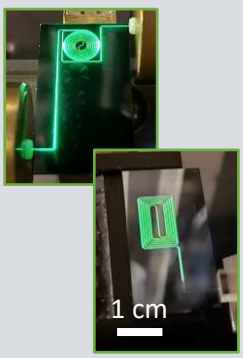
Integrated laser source for Wind mapping (C-Band)

Historically, CO_2 gas lasers were first used to demonstrate coherent wind-sensing lidar systems, but due to their many disadvantages in terms of low aerosol backscatter in 1064nm wavelength CO and dependence on atmospheric conditions, they lost popularity. With the development of diode-laser pump sources, it became possible to make much more frequency-stable, single-frequency, low-power solid-state lasers used for the local oscillator function, and through the development of injection-seeding techniques based on the low-power lasers, it became possible to make high-energy sources for use as the transmitter. Although the first solid-state systems employed Nd: YAG lasers at 1064 nm, concern over eye safety has led to the recent development of sources based on Er-doped solid-state lasers **around 1600 nm.** Integrating Er-doped materials to photonic chip platforms allows for low-cost and compact solutions for these sources.

❑ HIGHLIGHTS

- OPHELLIA's lasers **will not compete with spatial wind and aerosol LiDARs** which will require higher power, but will be good candidates for **cost-effective and shorter-range systems** useful for dense wind mapping. TOTAL Energies and other industrials drive measurement campaigns requiring gas sensors (methane, Nox, CO_2), and wind sensors to simulate the flux of gas at the scale of the urban unit (100km²). These gas sensors can be included on-chip with the lasers via photonic integration technology.
- The ESFRI (European Strategy Forum on Research Infrastructure) and Windscanner Project (DN) invested 20M€ in wind mapping tools and OPHELLIA could propose cost-effective solutions based on 1.5µm or 2µm wavelengths.

Objectives	Technology
Low-cost	Scalable fabrication
Compact	Chip-level
Narrow linewidth	Er-doped Al_2O_3




TotalEnergies, CNRS, University of Rennes' AUSEA drone (courtesy:TotalEnegries)

- Private companies like Total Energies have been working since 2017 with the University of Reims Champagne-Ardenne to develop a CH_4 and CO_2 detector drone, Ausea (Airborne ultralight spectrometer for environmental applications). Combined with a weather station with a lidar to measure the winds and software, it can accurately map methane and CO_2 emissions around a site. More than 1,200 AUSEA flights were carried out in 8 countries to cover 125 sites. A nitrous oxide (NO) sensor could be added. The development of the methane-detecting drone cost 2 million euros, and the measurement campaign will cost another 5.5 million. The campaigns have been implemented with 12 gas sensors and one single meteorological station, completed by atmospheric airflow simulation.

❑ **Perspectives for OPHELLIA** Wind mapping sensors based on OPHELLIA in conjunction with gas sensors to increase measurement accuracy of gas concentration in urban environments based on cost-effective, compact, and narrow linewidth 1.5µm sources.

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