Lemon Project

Lidar **E**mitter and **M**ulti-species greenhouse gases **O**bservation i**N**strument

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 821868.

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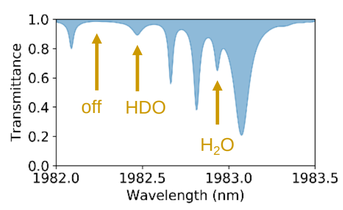
Lemon aims at developing a LIDAR emitter for airborne and future space applications to monitor greenhouse gases and water vapour.

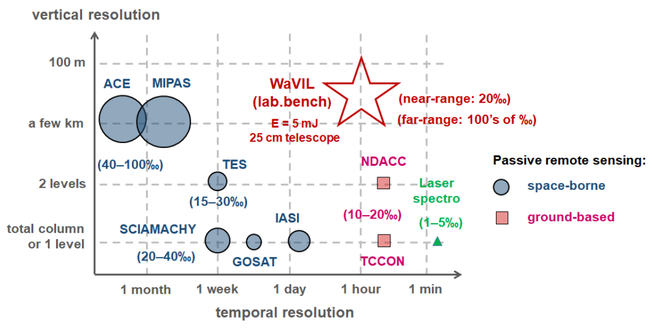
Partners

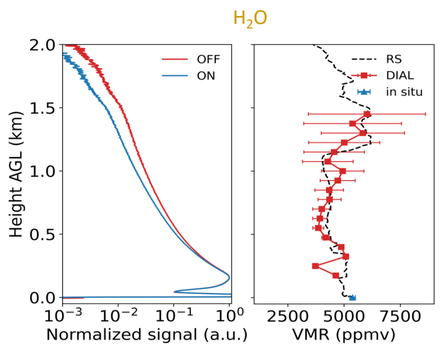
LEMON
KEY EXPLOITABLE RESULTS FOR FUTURE SPACE DIAL APPLICATIONS

INSTRUMENTS FOR GROUND BASED AND AIRBORNE SCIENCE CAMPAIGNS & CAL/VAL OF SPACE MISSIONS

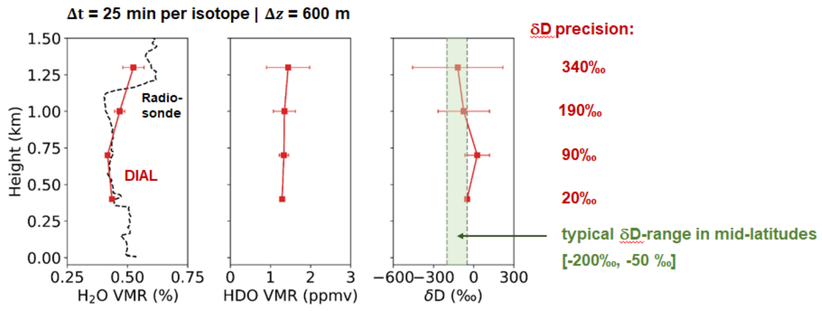
DIAL FOR GROUND BASED WATER VAPOUR & ISOTOPE HDO & CO_2



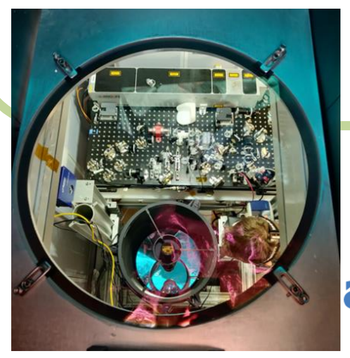




- 150 m range cells
- 75 m sampling



First-ever vertical profile of δD measured by lidar



Laboratory WAVIL equipment financed through https://anr.fr/Project-ANR-16-CE01-0009

anr agence nationale de la recherche AU SERVICE DE LA SCIENCE

CALIBRATED IN-SITU COMMERCIAL CRDS SENSORS AIRBORNE & ULTRALIGHT-BORNE

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PRELIMINARY TESTS OF LEMON IPDA AIRCRAFT INTEGRATION

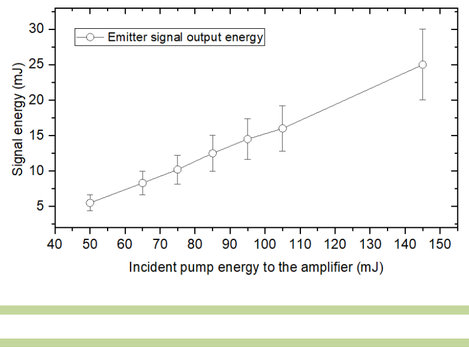
PERIODICALLY-POLED NON LINEAR CRYSTALS FOR HIGH-EFFICIENCY, HIGH BEAM QUALITY, OPO/OPA BASED EMITTERS

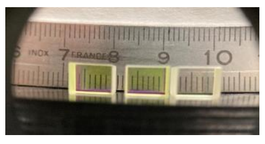
MAIN ADVANTAGES OF QUASI-PHASE MATCHED CRYSTALS:

- Highest non linear coefficient addressed => high efficiency
- No walk-off => high beam quality
- Now available with high aperture (PPKTP)
- No angle tuning => easier temperature tuning

Preliminary radiation testing: OK!

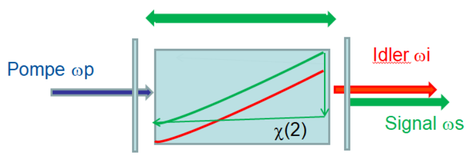
Example: 25 mJ of single frequency around 1982 or 2050nm obtained after OPA





INNOVATIVE OPO FOR FUTURE SPACE DIAL EMITTERS NO INJECTION & NO-CAVITY FREE OPO SYSTEMS

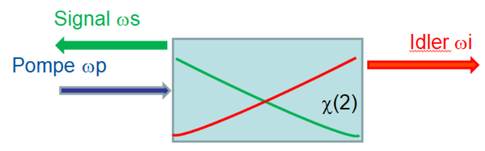
CLASSICAL OPO APPROACH



Chosen solution for :
- Future MERLIN DIAL (CH_4)
- DAQ-1 mission (CO_2)

But complex since needs:
- additional injection seeding sources for narrow linewidth
- robust thermo mechanical OPO cavity design

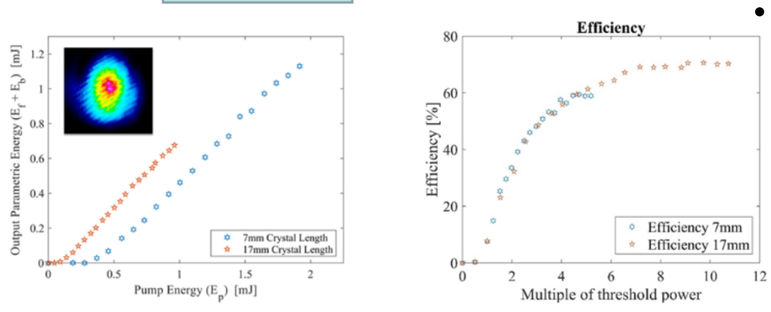
BACKWARD OPO



INTEREST FOR FUTURE SPACE DIAL:
- No cavity needed for oscillation
- Single frequency emission without injection seeding
- Reduced thermal sensitivity

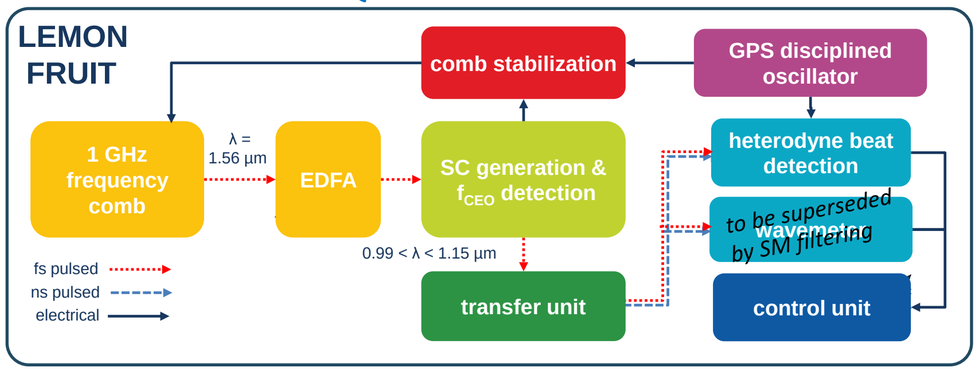
=> Ideal robustness for future spaceborne emitters!

Low TRL => funding needed to pursue the development



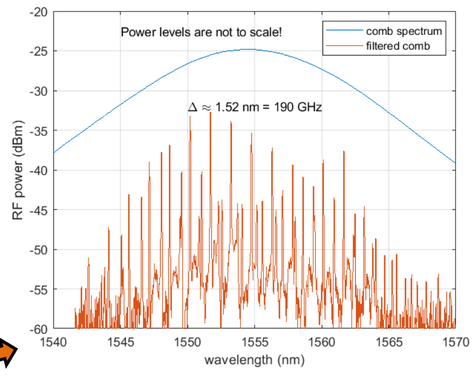
Experimental data for a BWOPO pumped by a 1030 nm, 15 ns, 5 kHz laser source. BWOPO is a PPKTP crystal with a QPM grating of 580 nm : 1981 nm forward wave, 2145 nm backward wave, mJ output and conversion efficiency > 50%

INNOVATIVE FREQUENCY REFERENCE FOR DIAL EMITTERS BASED ON FREQUENCY COMBS



LEMON FRUIT baseline design – EDFA: Erbium doped fiber amplifier – SC: super continuum

- Multi species need a broadband reference
- <100 kHz precise frequency determination (CO_2) can not be done with a simple wavemeter
  - ➢ Beat note detection against **comb line**
- GPS time is a sufficient absolute reference – no gas cell needed onboard
- Wavemeter shall be superseded in future by compact filter elements that resolve the ambiguity of the comb



Silicon-nitride waveguide based filtering

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