High Power Mid-IR Laser Development from 2.65 to 3.5 μm

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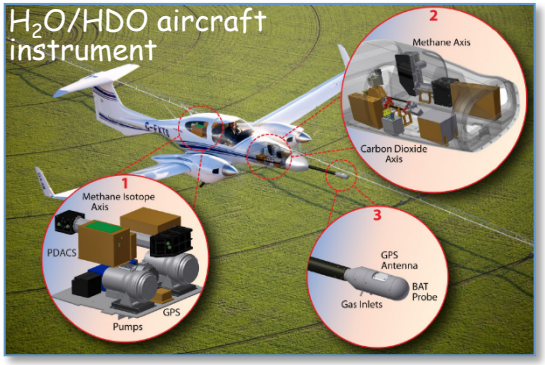
Objective

- Advance the state of the art in continuous wave (CW) and pulsed IR distributed feedback (DFB) and optical parametric generation (OPG) lasers between 2.65 and 3.5 μm to measure key atmospheric chemical species including OH, H_2O, $H_2{}^{18}O$, HDO, CH_4, $^{13}CH_4$, CO_2, $^{13}CO_2$, CH_2O, C_2H_6, HCl
- Combine new lasers with integrated optics and electronics to enable the use of new single mode light sources aboard satellite and UAV platforms to support GACM and ASCENDS mission concepts
- Disseminate laser design and test results as they emerge so that our group and others can field breakthrough laser types in direct absorption, differential absorption lidar (DIAL), and laser induced fluorescence (LIF) systems



Packaged CW DFB laser with TEC

Applicable Platform	Tower, UAV		Satellite, Tower, UAV	
Application	Tunable Diode Laser Absorption		LIDAR, DIAL	LIF
Wavelength	2.65 μm	3.38 μm	3.4 μm	2.8 μm
Chemical Target	H2O/HDO	HCL	CH4	OH

Accomplishments

Harvard: High-Power Pulsed OPG

- Implemented robust MgO:PPLN crystal with low power threshold (150 mW) for OPG conversion
- Demonstrated single-frequency injection-seeded OPG at 3.4 μm and 2.9 μm
  - Achieved greater than 80 mW at 3.4 μm (10% conversion efficiency) with low pump power in order to preserve crystal
  - Achieved greater than 100 mW at 2.9 μm (18% conversion efficiency) with optimized alignment and low pump power
- Verified spectroscopic capabilities of 3.4 μm pulse using CH_4 gas cell and demonstrated line width of <0.02 cm^{-1}

JPL: High-Power Tunable CW Lasers

- Developed GaSb semiconductor lasers at 2.65 μm for HDO detection with 35 mW power at 10°C (exceeded goal of 10 mW)
- Developed GaSb-based interband cascade lasers at 3.38 μm for HCl detection with 40 mW at 0°C (exceeded goal of 5 mW)
- Integrated 2.65 μm laser package into Harvard's existing H_2O/HDO aircraft instrument
- Achieved more than 3,000 hours for 2.65 μm and 10,000 hours for 3.38 μm of reliability testing without changes in performance
- Submitted provisional patents through Caltech

Co-Is/Partners:
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$TRL_{in} = 3$ $TRL_{out} = 4$

ESTO Earth Science Technology Office