# Triple-Pulsed 2-µm Direct Detection Airborne Lidar for Simultaneous and Independent $CO_2$ and $H_2O$ Column Measurement

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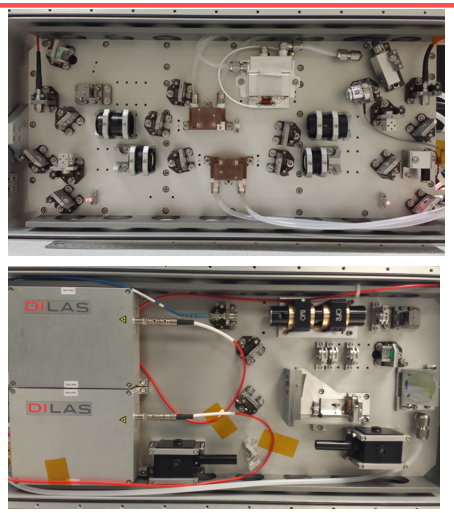
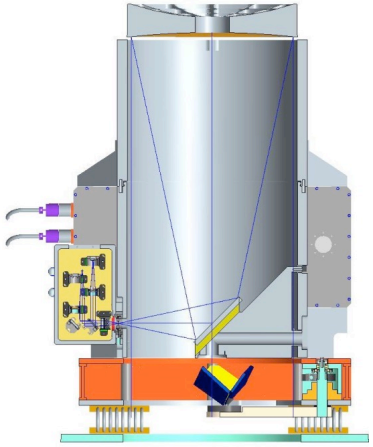
## Objective

- Demonstrate simultaneous and independent measurement of the weighted-average column dry-air mixing ratios of carbon dioxide ($XCO_2$) and water vapor ($XH_2O$) from an airborne platform
- Design and fabricate a space-qualifiable, fully conductively-cooled, triple-pulsed, 2-µm laser transmitter
- Design and develop wavelength control system for rapid and fine tuning of the three sensing lines of the $CO_2$ and $H_2O$ Integrated Path Differential Absorption (IPDA) lidar
- Integrate laser transmitter with receiver to develop the triple-pulsed 2-µm direct detection IPDA lidar
- Conduct extensive ground and airborne column $CO_2$ and $H_2O$ measurement and validate with in situ sensors




Space-qualifiable, triple pulsed laser transmitter for airborne application



Integrated 2-µm $CO_2$ and $H_2O$ airborne packaged IPDA lidar

## Accomplishments

- Designed and fabricated a space-qualifiable, conductively-cooled, triple-pulsed, 2-µm laser transmitter for airborne platforms. This transmitter produces 3 injection seeded pulses at a repetition rate of 50 Hz. Total energy as high as 75mJ was demonstrated (34mJ, 26mJ, and 15mJ for the first, second, and third pulse respectively).
- Developed wavelength control system for rapid and fine tuning of the three sensing wavelengths of the $CO_2$ and $H_2O$ IPDA lidar. The three seeding wavelengths are produced from a single semiconductor seed laser with respect to the $CO_2$ R30 absorption line center using RF modulation technique and fiber grating discriminator to select 2050.509 nm for $H_2O$ on-line, 2051.0509 nm for $CO_2$ on-line and 2051.1915 nm for off-line.
- Integrated the laser transmitter with the receiver to conduct ground measurement for $CO_2$ and $H_2O$.
- Demonstrated simultaneous and independent measurement of the weighted-average column dry-air mixing ratios of $CO_2$ and $H_2O$ from an airborne platform with 0.2 ppm and 4.8 ppm biases and 7.9 and 61.1 ppm sensitivity, respectively.

**Co-Is/Partners:** Ken Davis, Penn State Univ.; Jirong Yu, Mulugeta Petros, NASA LaRC

**$TRL_{in}$= 3** **$TRL_{out}$= 6**