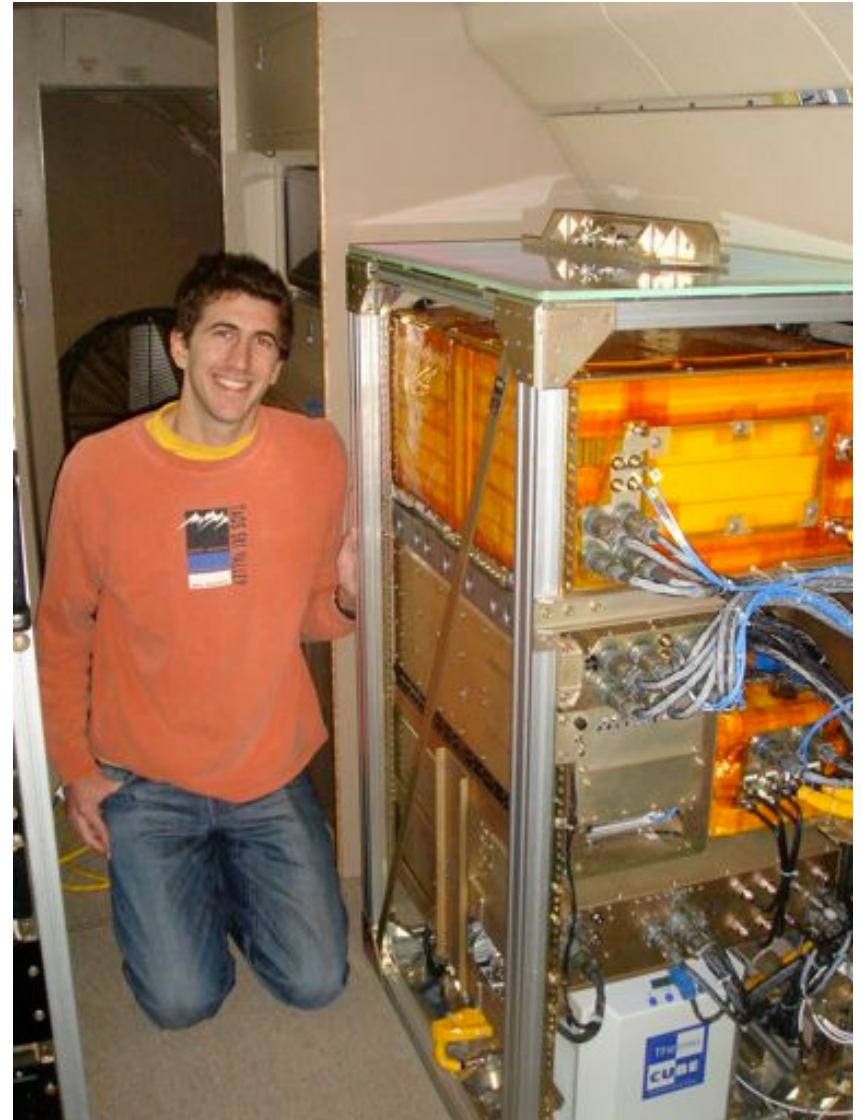
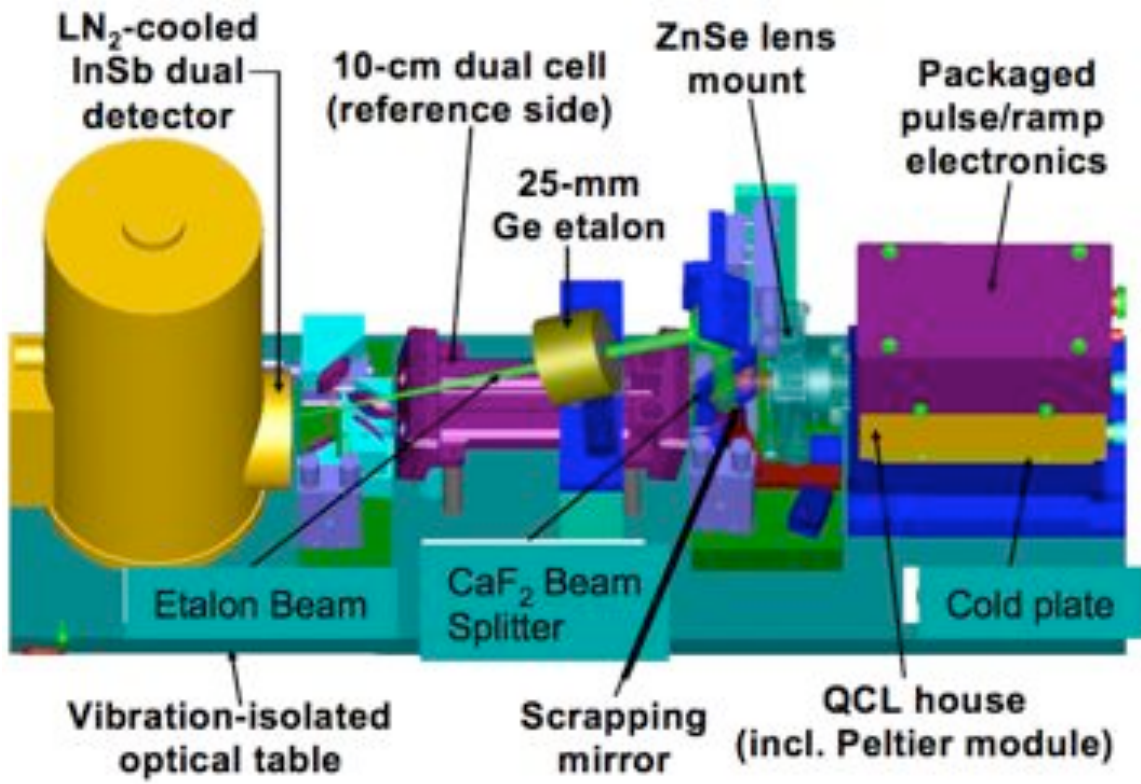


# Harvard QCLS: Quantum Cascade Laser Spectrometer

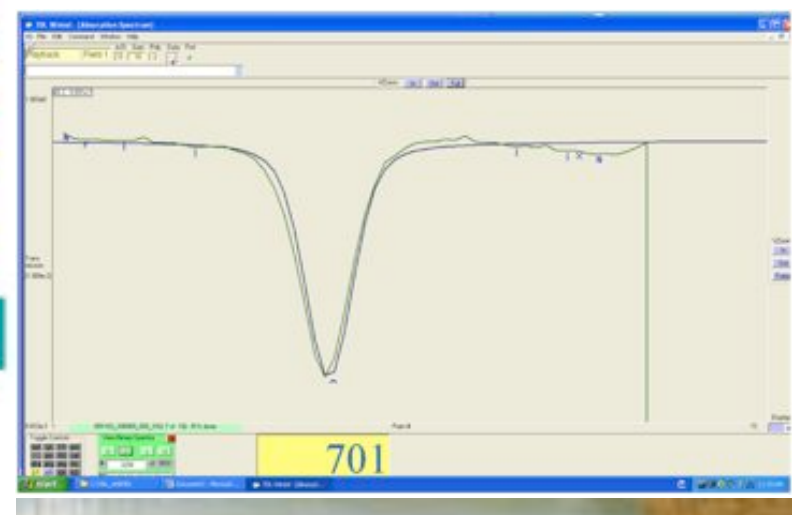
Eric Kort, Bruce Daube, Rodrigo Jimenez, Greg Santoni, Jasna Pittman, Steve Wofsy

- 2 Spectrometers, 3 pulsed QC lasers
  - CO<sub>2</sub>: 4.3 micron
  - DUAL: CH<sub>4</sub> & N<sub>2</sub>O (7.8 micron), CO (4.6 micron)
- Direct Absorption Spectroscopy
- Fast response (1-Hz), high accuracy & precision

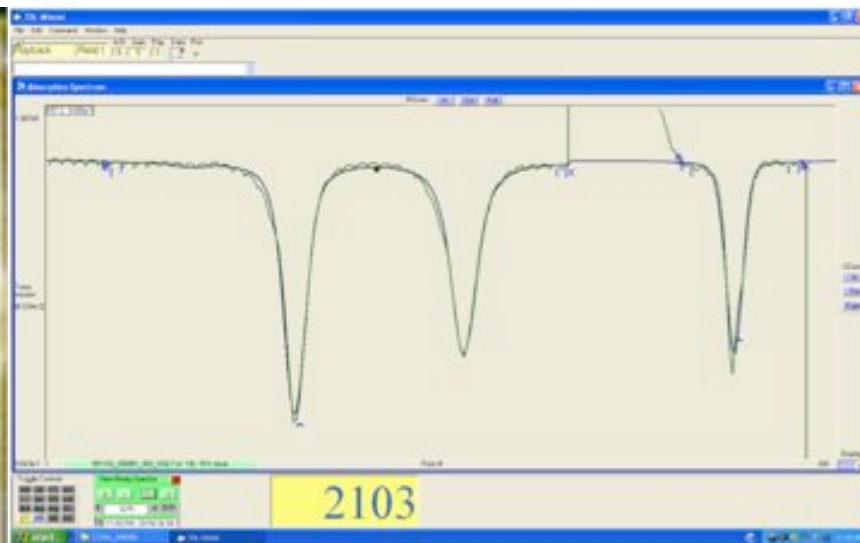
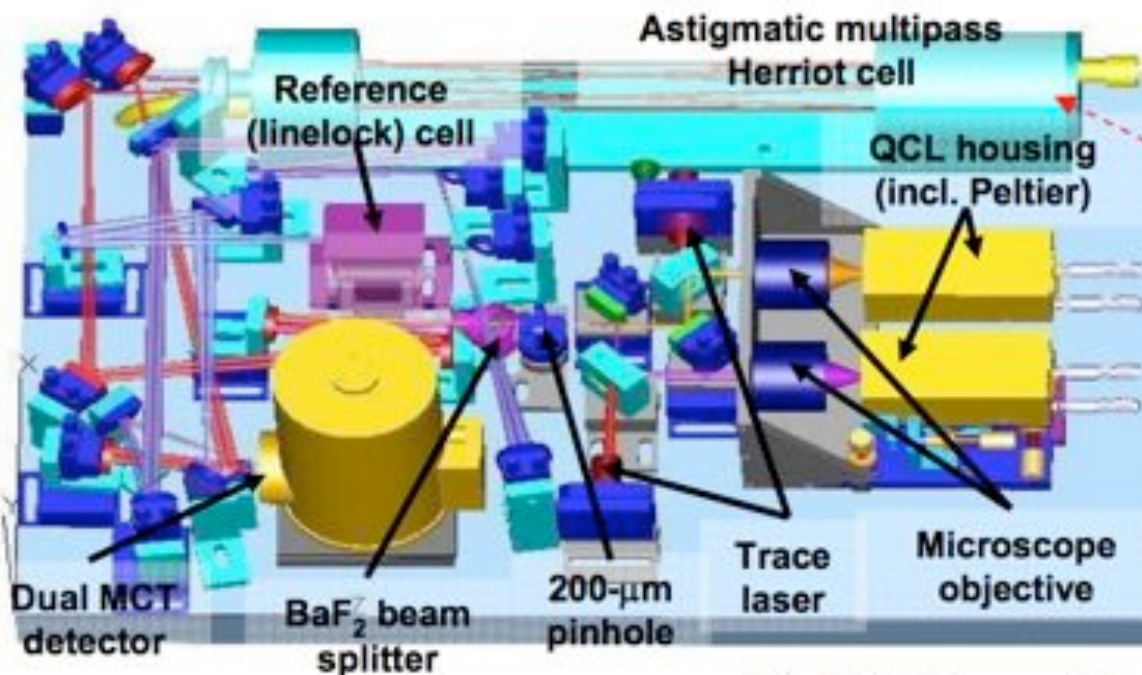




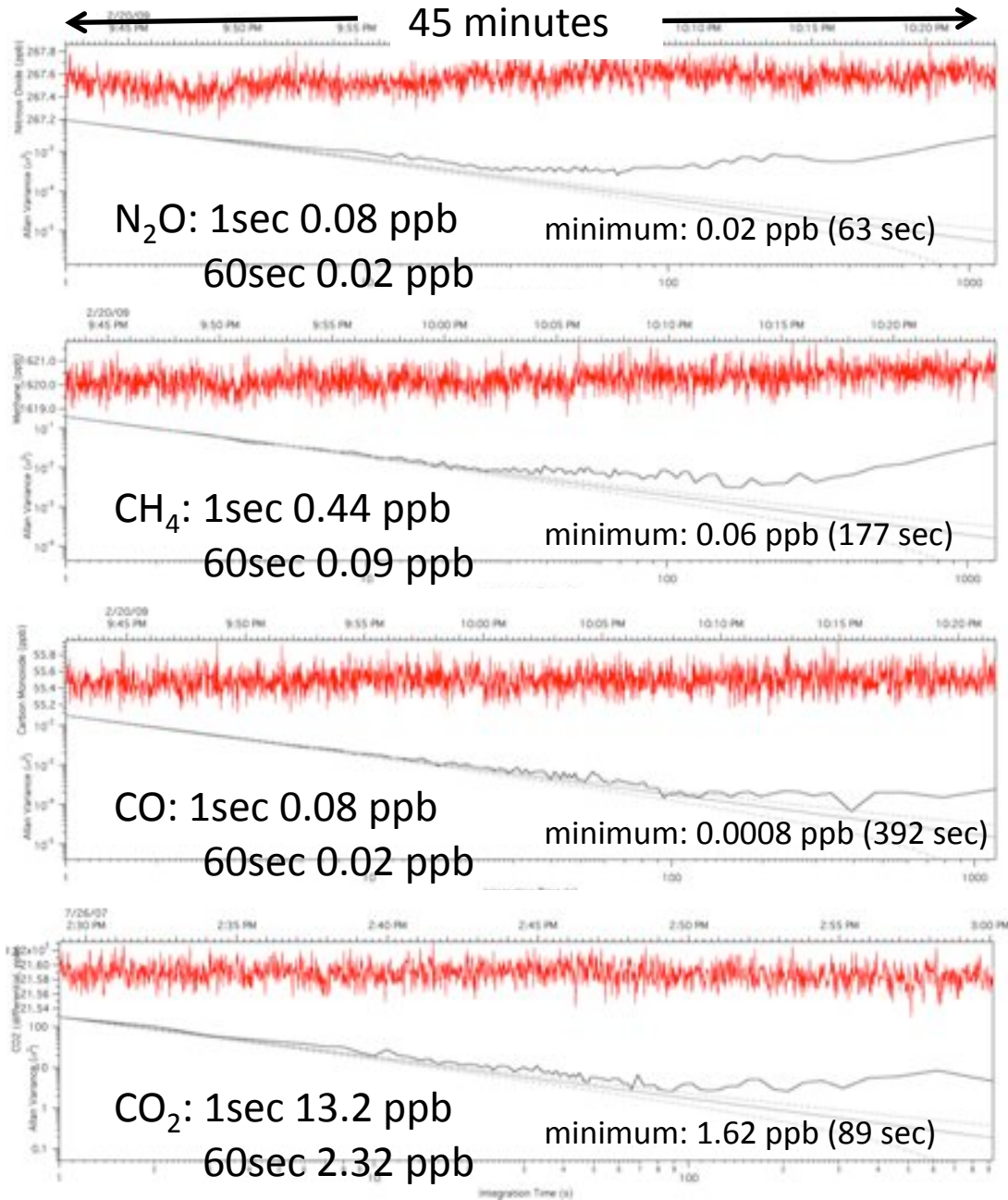
CO<sub>2</sub>



# DUAL (CH<sub>4</sub>, N<sub>2</sub>O, & CO)



# Allan-variance, lab tests on tank air



(ppb)	Precision	Accuracy
N <sub>2</sub> O	0.09	0.2
CH <sub>4</sub>	0.5	1
CO	0.15	3.5
CO <sub>2</sub>	20	100

- Frequent in-flight calibrations
  - 15 minutes partial cal ('zero')
  - 30 minutes total cal ('zero', low span, high span)
- Quick look to final data
  - Adjust to calibration gas
  - Refit spectra w/ observed P & T (negligible)
  - Remove anomalies from pressure, detector LN2 burps (~10 over 3 campaigns)

# Ground Calibration

- CO<sub>2</sub>:
  - Secondary tanks and gas decks tied to NOAA/WMO primaries via ground calibration Li-Cor system
    - GD equilibration issue
    - Isotopic correction
- CH<sub>4</sub>, N<sub>2</sub>O, CO:
  - Secondary tanks and gas decks tied to NOAA/WMO primaries directly with flight system before and after each mission

# Calibration Performance: 4 campaigns versus NOAA CCG flasks/ Calnex Picarro (Ryerson & Peischl) & VUV

QCLS- other	CO2 (ppm)	CH4 (ppb)	N2O (ppb)	CO (ppb)
HIPPO-1	-0.16	3.5	0.5	-3
HIPPO-2	-0.18	3.9	1.15	-0.04
HIPPO-3	-0.1	5.5	1.4	-2.8
CALNEX	-0.07	6.2		0.02

# Data Status

- HIPPO-1: Final Data now on server
- HIPPO-2:
  - Currently uploaded (in SUBMIT folder):
    - CH<sub>4</sub>, N<sub>2</sub>O, CO Final pending check of primary tanks.
    - Updated CO<sub>2</sub> Final pending investigation of gas deck calibrations
- HIPPO-3: currently uploaded quicklook
  - Finalized soon pending check of primary tanks/gas deck calibrations



# Changes for HIPPO-4 and 5

- Addition of in-flight 'Primaries'
- Long term standard for all gases with continuity through HIPPO-4 and 5