VCSEL Data Status

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HIPPO Data Status

HIPPO 1: Final data submitted for RF01-RF07

- lost all laser intensity after RF07 landing in CHC due to opaque residue on mirrors; tried to fix remotely but unsuccessful
- calibrations identical to START08/PreHIPPO

HIPPO 2: only quicklook data

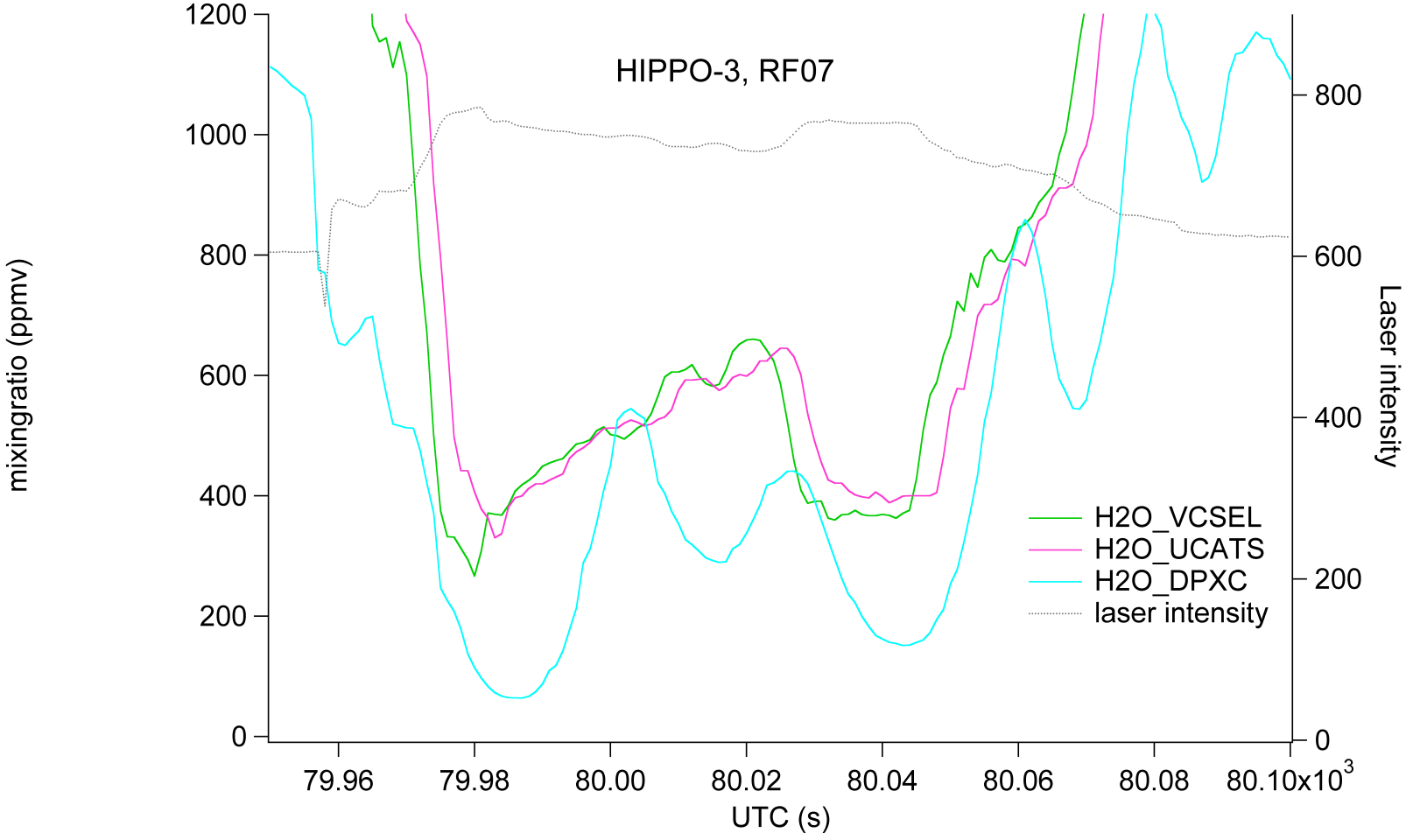
- gradual decrease of signal throughout transect; detector, bandpass filter, and focusing optics needed cleaning in CHC
- nylon cover not effective at protecting mirror surfaces on tarmac

HIPPO 3: only quicklook data

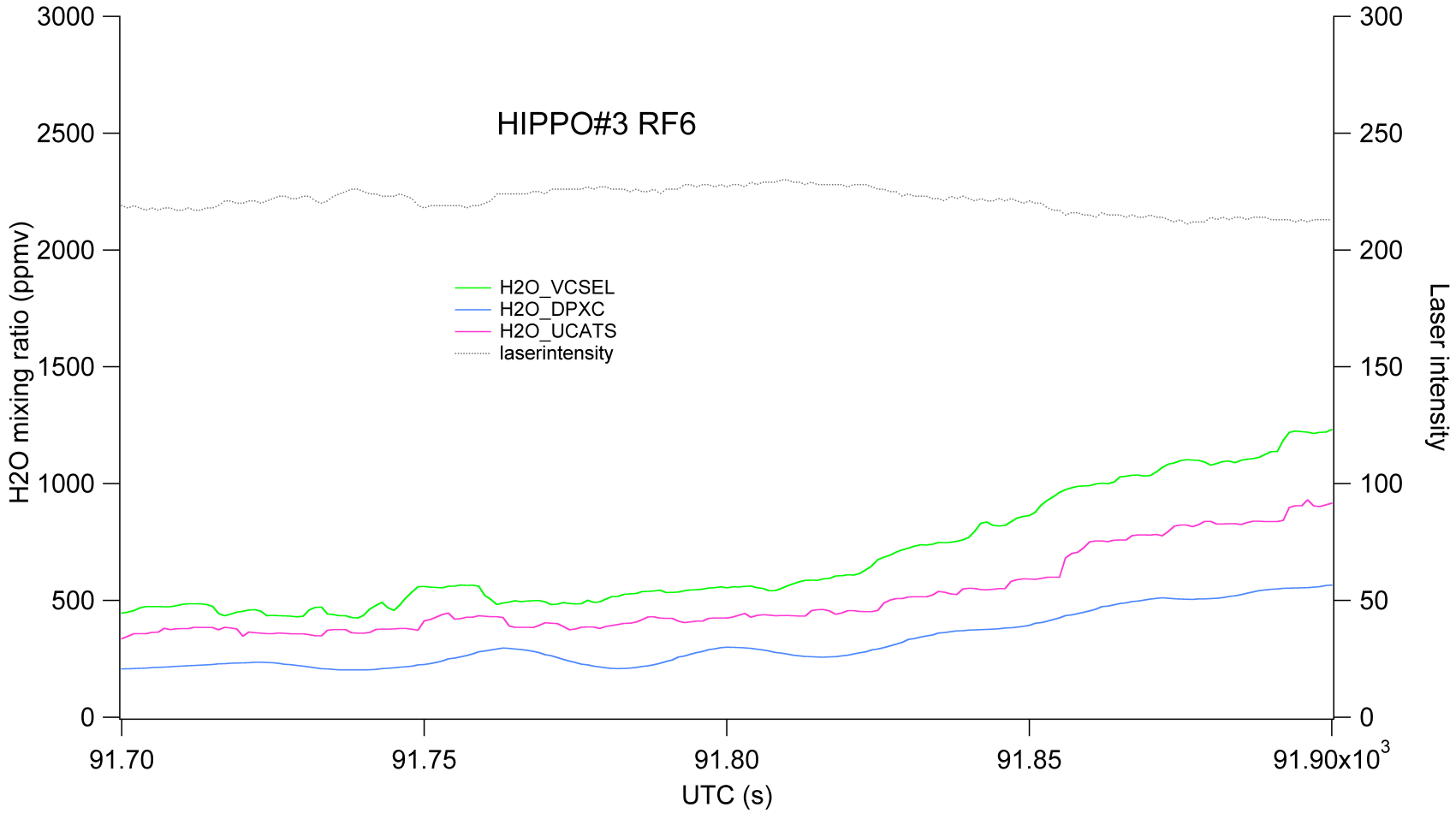
- improved mirror quality but still needed to clean interior optics at CHC and return to ANC

In HIPPO-2 and HIPPO-3, often observed very low laser intensities on detector which appeared to cause a high bias in data -> need add'l laboratory studies (also caused linelocking problems at low altitudes)

Example of low light biases



Example of low light biases



Timing / Synchronization

VCSEL data acquisition triggered by pulse-per-second signal from GPS

- absorption feature scanned at 1500 Hz
- internal clock integrates 60 scans into Δt=0.04 s measurements (25 Hz)

hh:mm:ss timestamped by G-V data acquisition immediately after GPS signal

x.00 data in archive is averaged $-x.50 \leq t < +x.50$

(i.e. 1 s average centered on x.00)

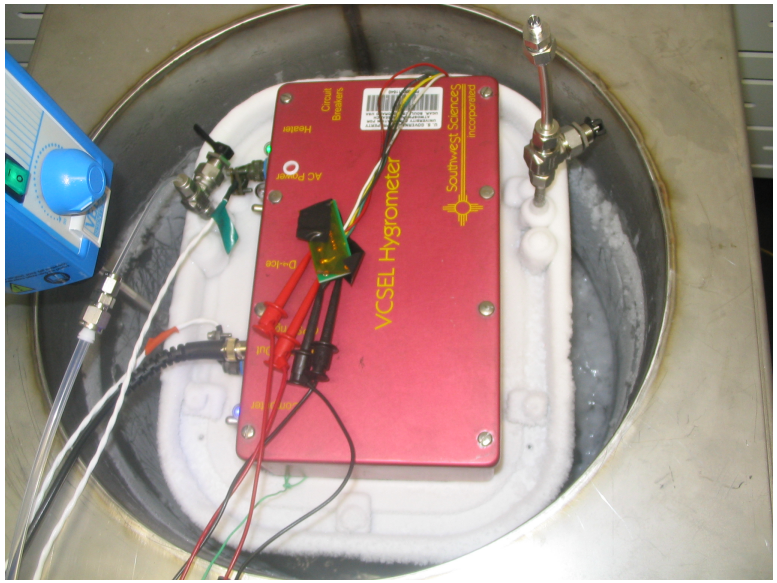
Other issues:

Any data when switching absorption lines (1853.03, 1853.37 nm) or mode (direct, 2f) are automatically removed ± 3 s in archived data

Calibrations: flowing and static

Flowing: critical orifice system (1-2500 sccm) (saturated or unsaturated)

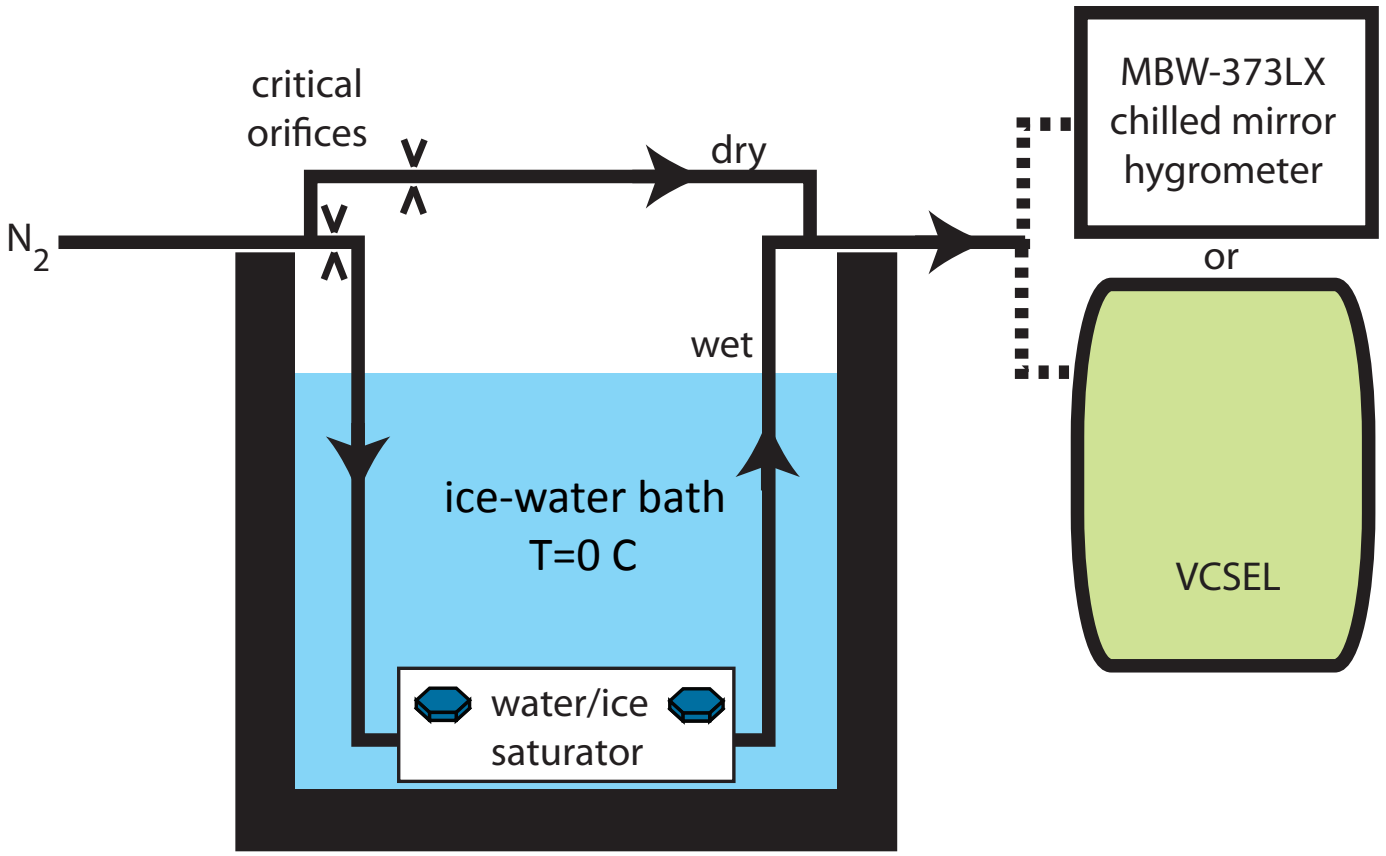
- flows extremely stable and reproducible (±2% over 2.5 years)
- avoids drifts in flow controllers, warm up times, PID controls
- flow only dependent upstream (not downstream) pressure
- use ice-water baths for saturator for reproducibility



Static:

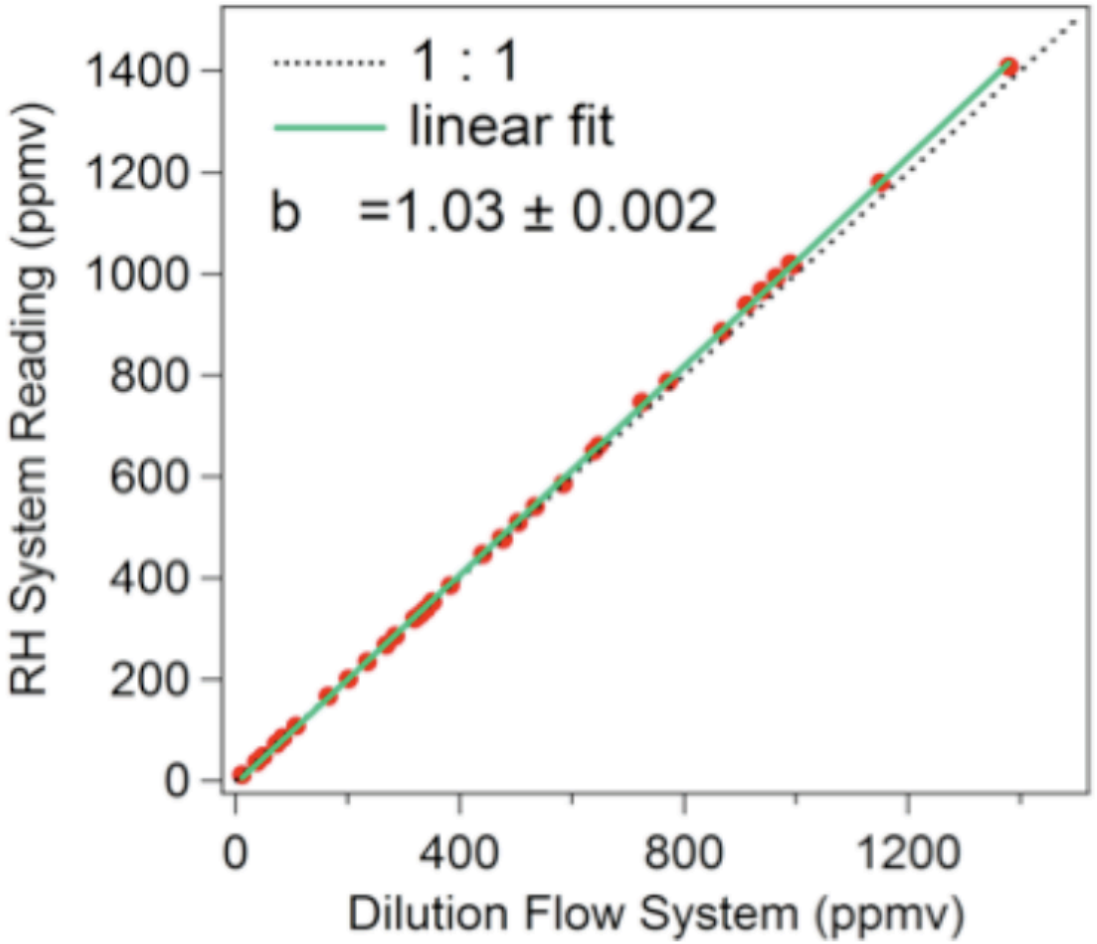
1. isolate VCSEL inside sealed housing
2. add 10-100 mL liquid water
3. immerse VCSEL/housing and reach steady-state temperature
4. Use liq. N_2/organic solid-liquid baths or regulated temperature bath (±0.02 K stability at -80°C)
5. Clausius-Clapeyron eqn. (Murphy and Koop, 2005) to determine ice vapor pressure

Calibrations: 1) standard dilution of flows (1013 hPa, 298 K)



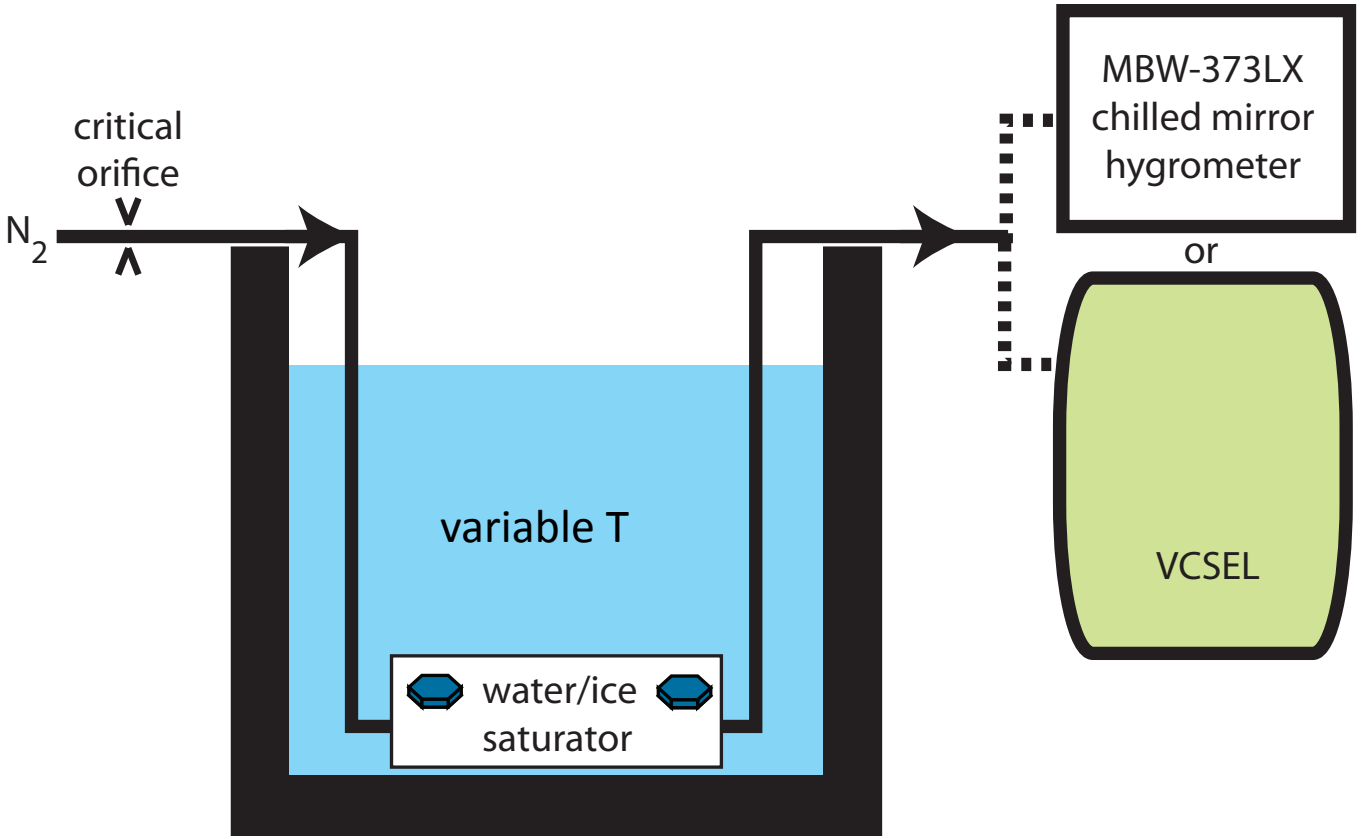
caveat: unknown H_2O in "dry" nitrogen (typically 1-5 ppmv)

Calibrations: 2) flowing, sub-saturated conditions at RT



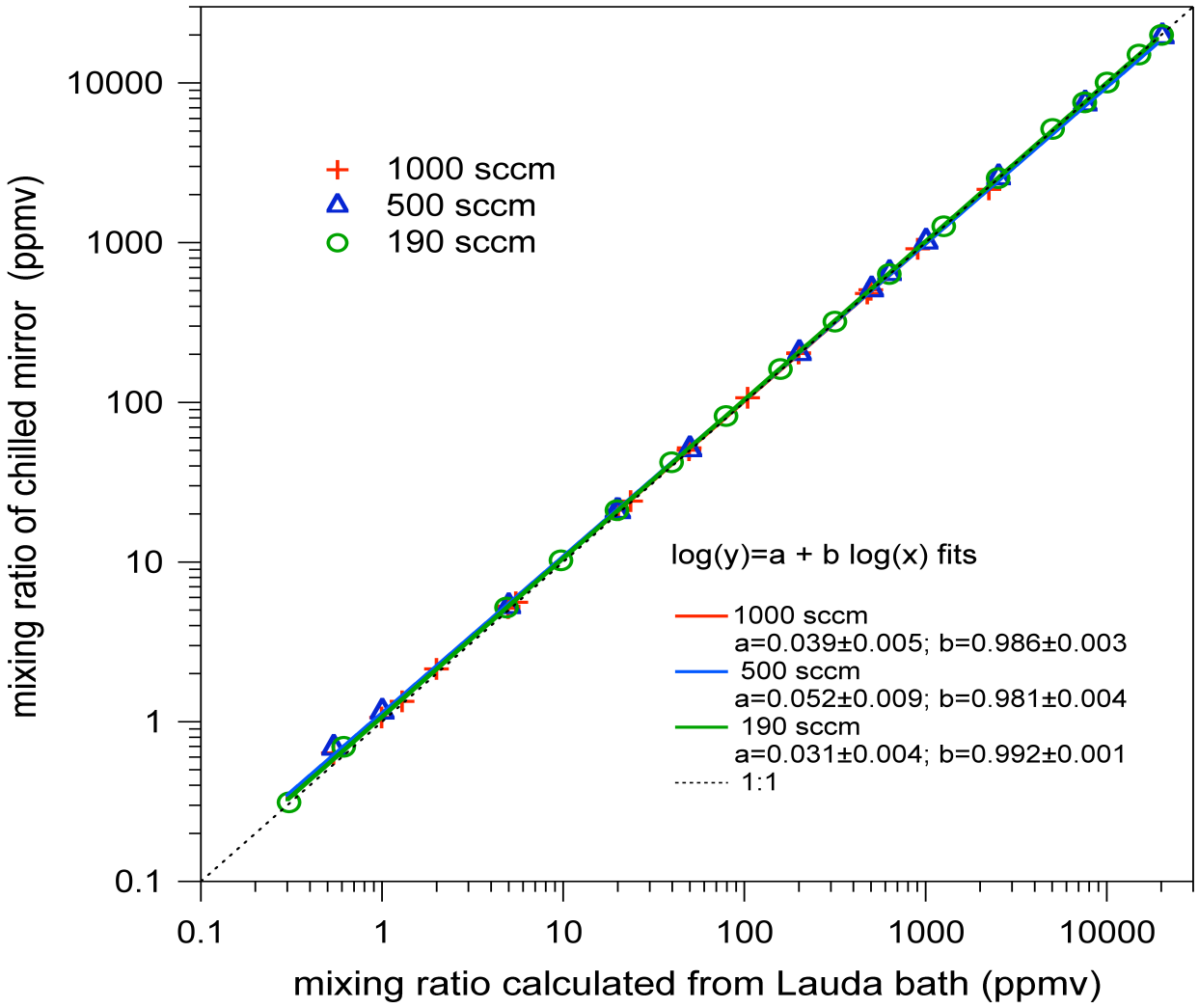
excellent agreement with chilled mirror system

Calibrations: 2) flowing, saturated conditions at RT



saturate "dry" nitrogen in 1 L volume, 200-1000 sccm flows (bath -85 to +20°C)
amount of water determined by Clausius-Clapeyron Eqn. (bath temp.)

Calibrations: 1) flowing, saturated conditions at RT

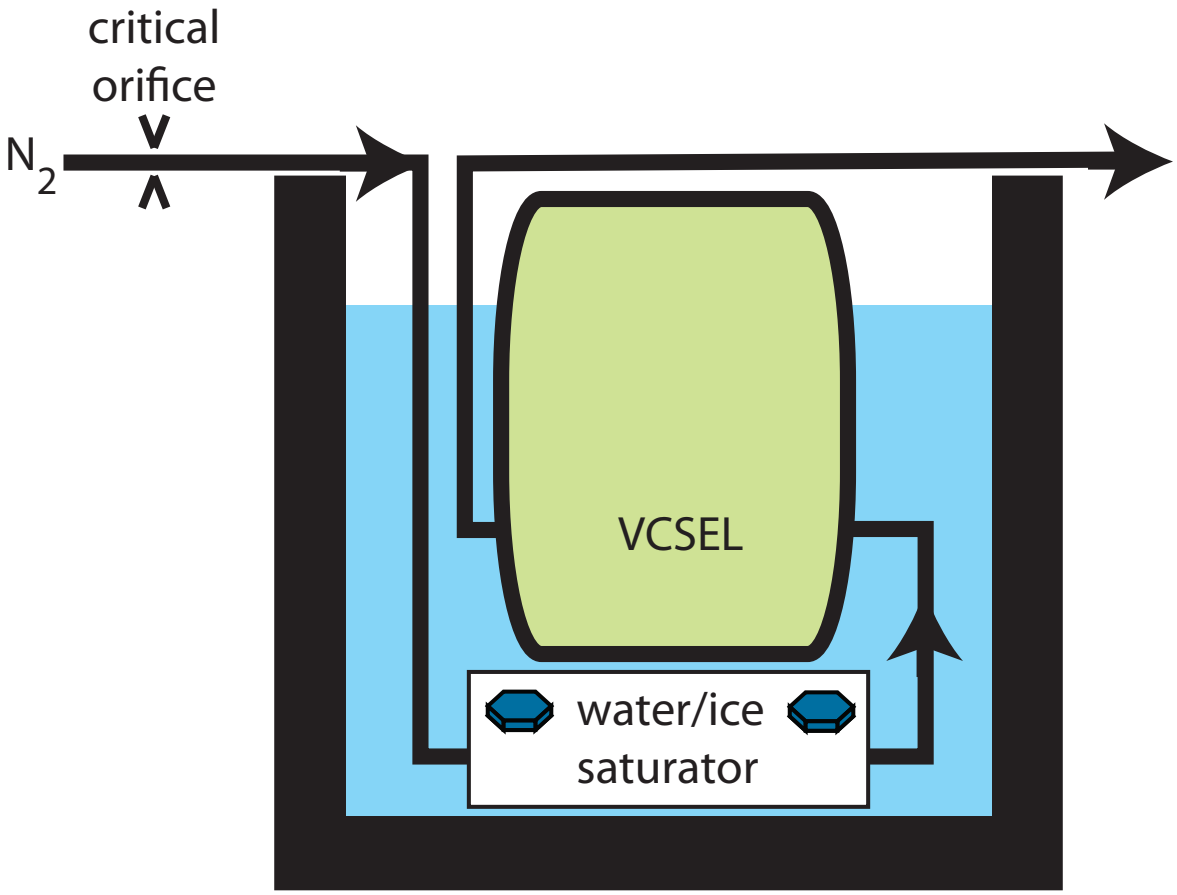


two independent methods of saturation agree extremely well to 0.3 ppmv

➔ bath, chilled mirror temperatures well-calibrated

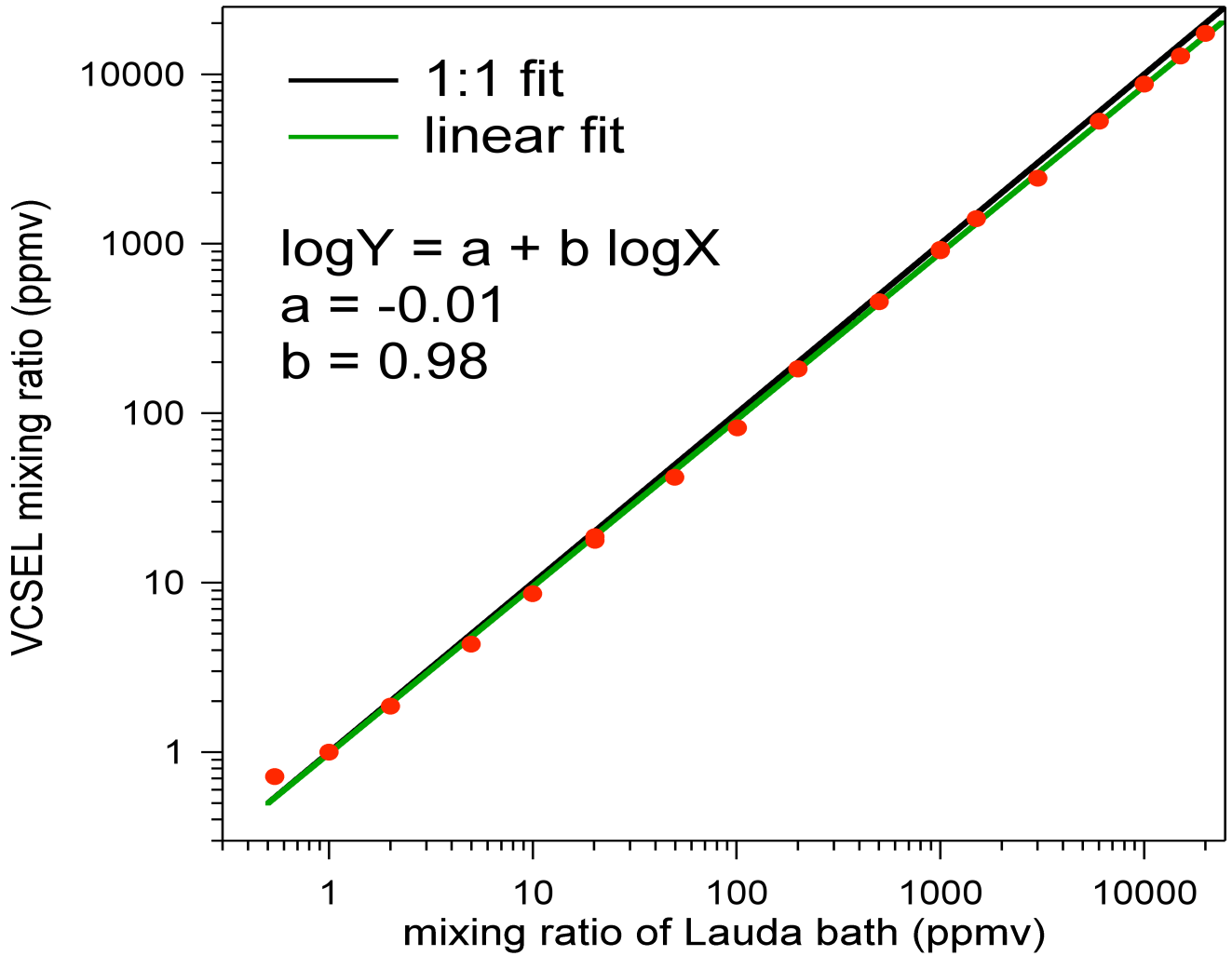
no dependence upon flow rates 190-1000 sccm ➔ fully saturated flows

Calibrations: 3) flowing, saturated near bath temp.



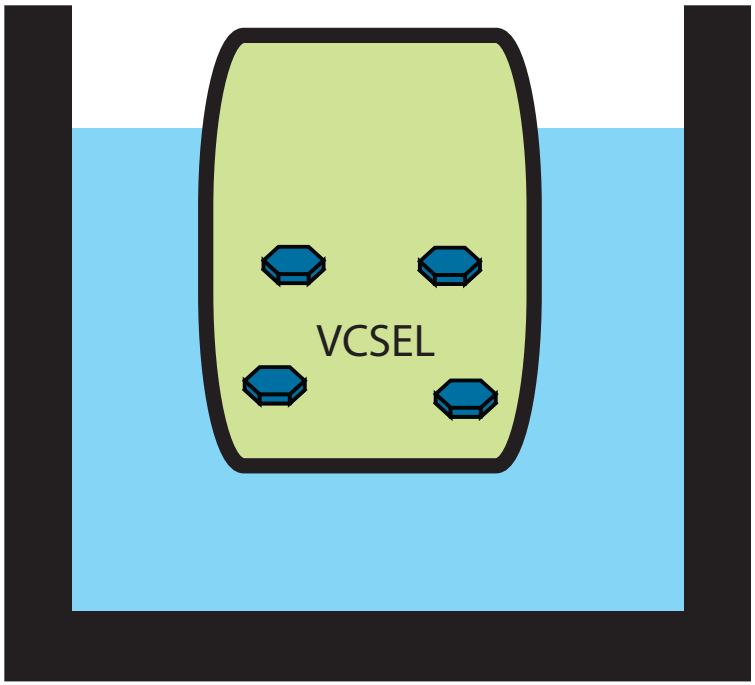
simultaneous concentration, pressure, and temperature conditions

Calibrations: 3) flowing, saturated near bath temp.



simultaneous concentration, pressure, and temperature conditions

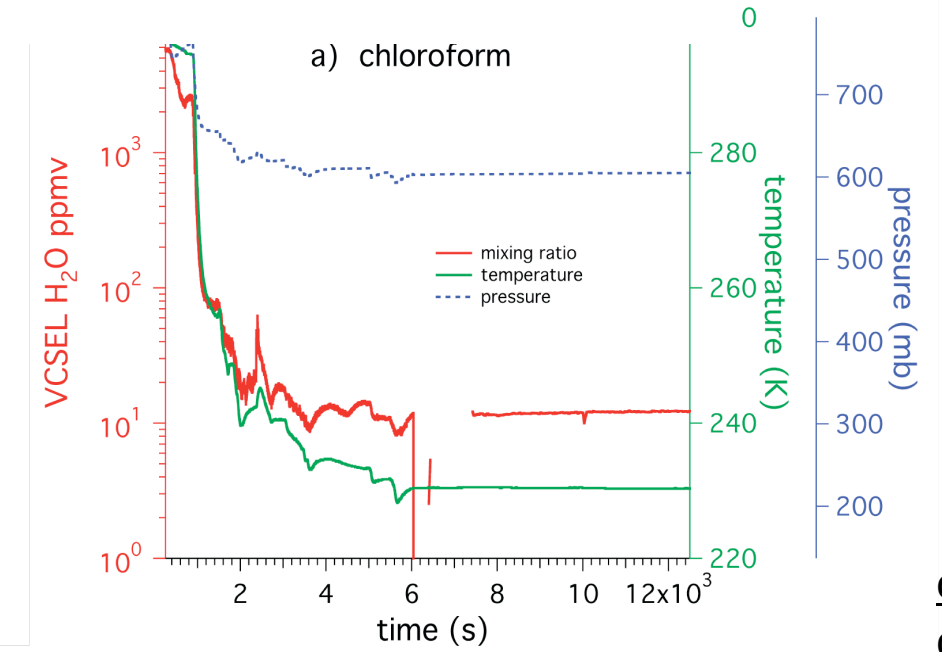
Calibrations: 4) organic, liq. N_2 bath

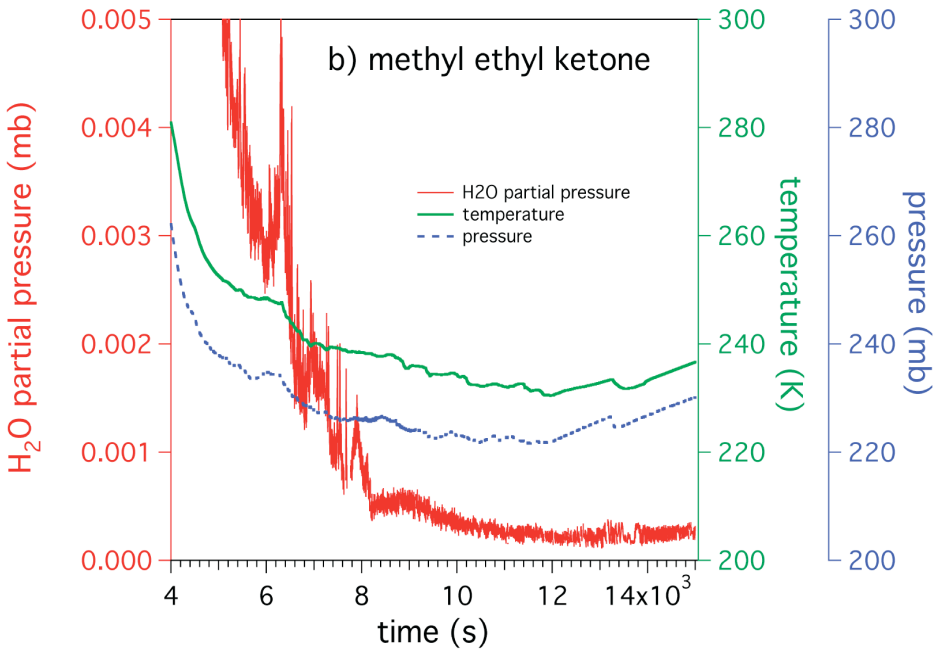


temperature-controlled bath

organic (melt. temp.)
chloroform (-63.41°C)
2-butanone (-86.64°C)
acetone (-94.7°C)

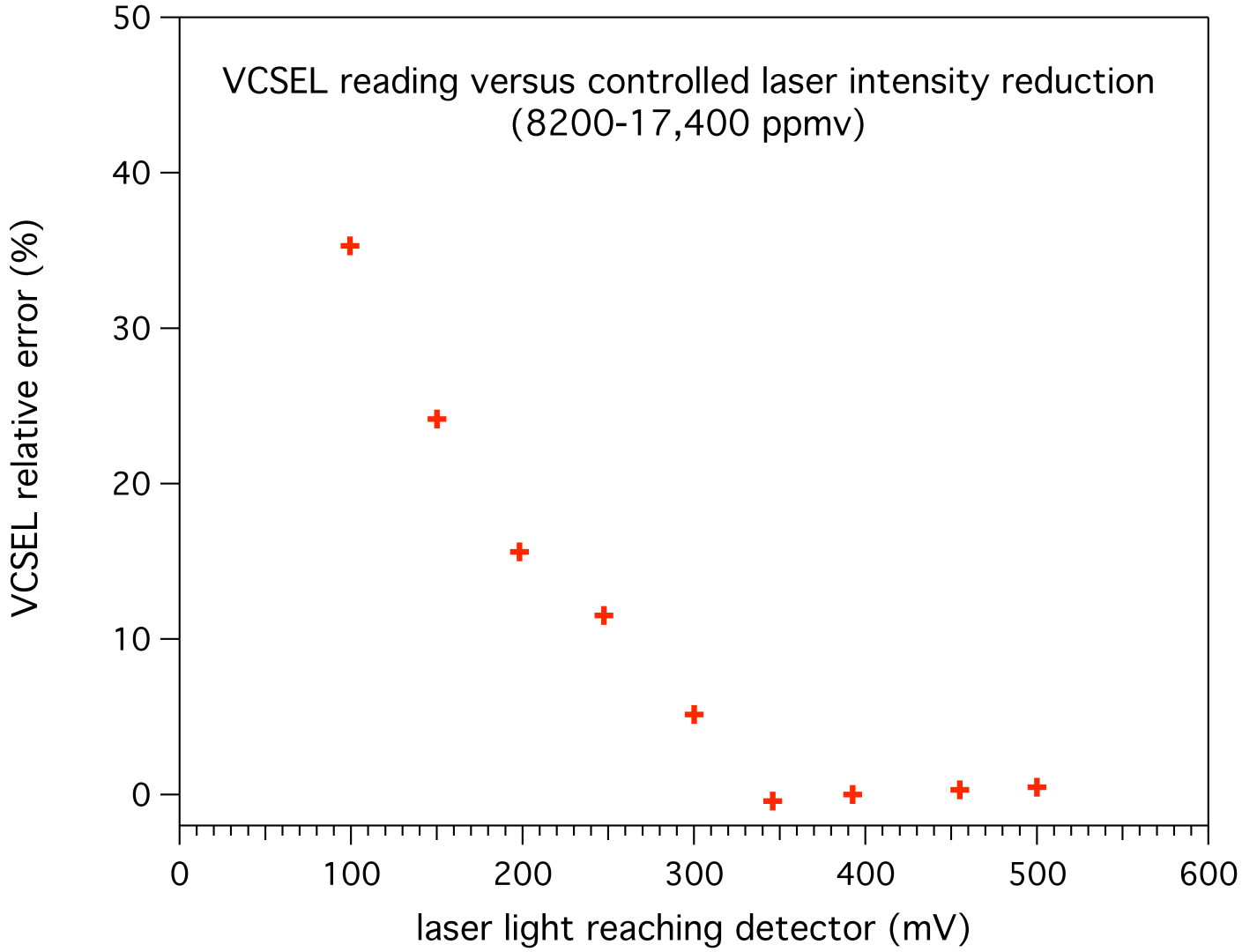
Calibrations: 4) organic, liq. N_2 slush bath





organic (melt. temp.)	nominal	VCSEL (ppmv)
chloroform (-63.41°C):	11.23	11.7 ± 0.2
2-butanone (-86.64°C):	0.77	1.07 ± 0.21
acetone (-94.7°C):	0.18	0.50 ± 0.30

Experimental results at low light intensity



VCSEL shows a high bias below 350 mV; more studies needed

Changes for HIPPO 4/5

To help avoid low laser intensities on detector:

- harder dielectric coatings with Ni-mirrors (tested late in PREDICT)
- higher reflectivity of 1854 nm light than old mirrors
- replace fiber optic feedthrough with new one

...but ultimately the problem lies with interior, recessed surfaces on detector side (i.e. one can clean the mirrors endlessly with little improvement)

Priorities now until mid-April:

1. Replace broken cartridge heater in mirror (broke in PREDICT)
2. Replace fiber optic feedthrough
3. Sensitivity experiments to very low laser light intensities
4. Calibrations at simultaneous temps., pressures, and mole fractions of UT/LS

Submit HIPPO-2/HIPPO-3 data by end of April.