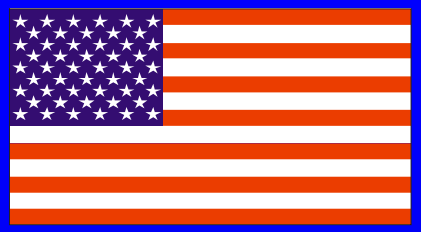
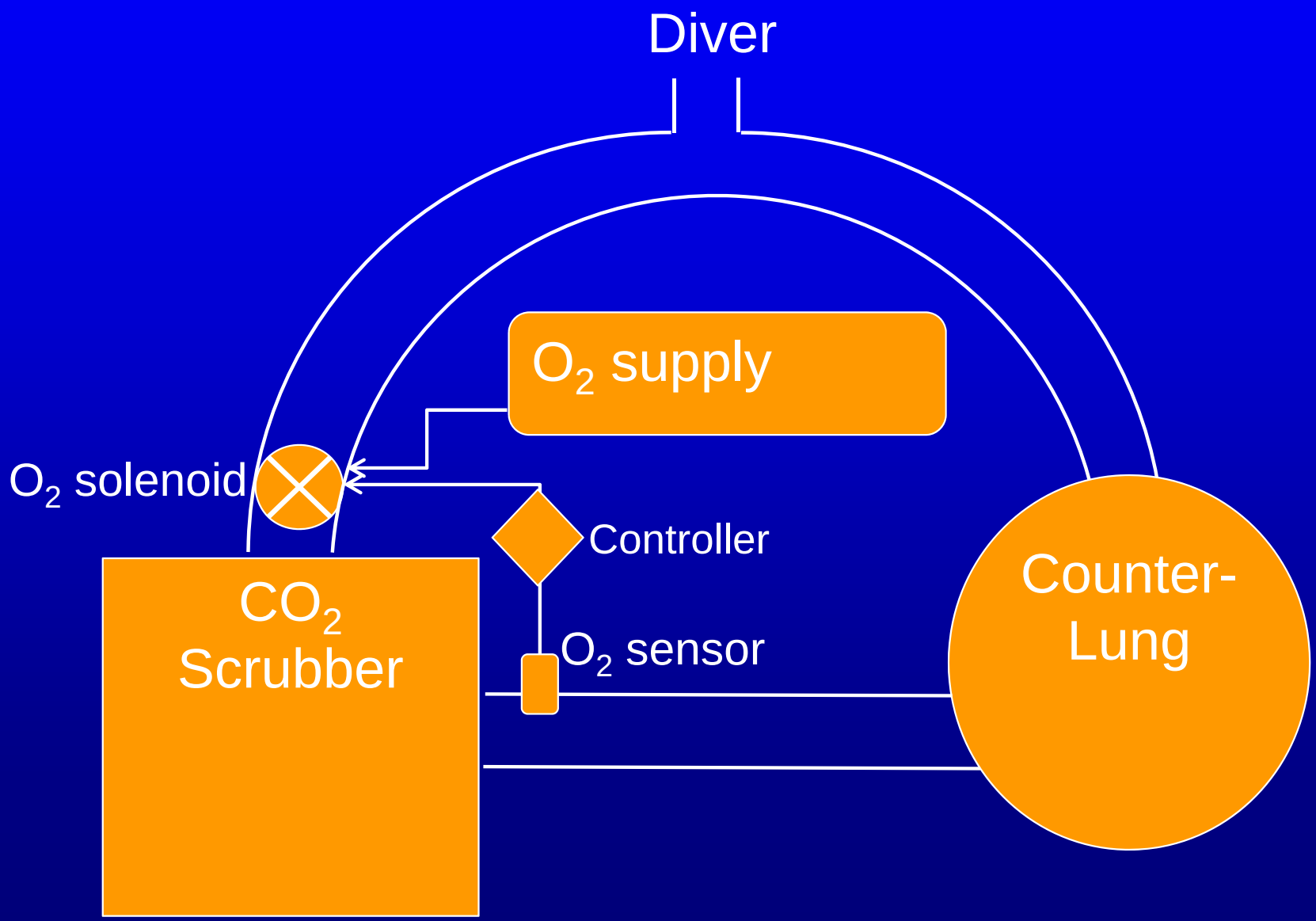


Opposing effects of temperature and humidity in two UBA oxygen control sensors

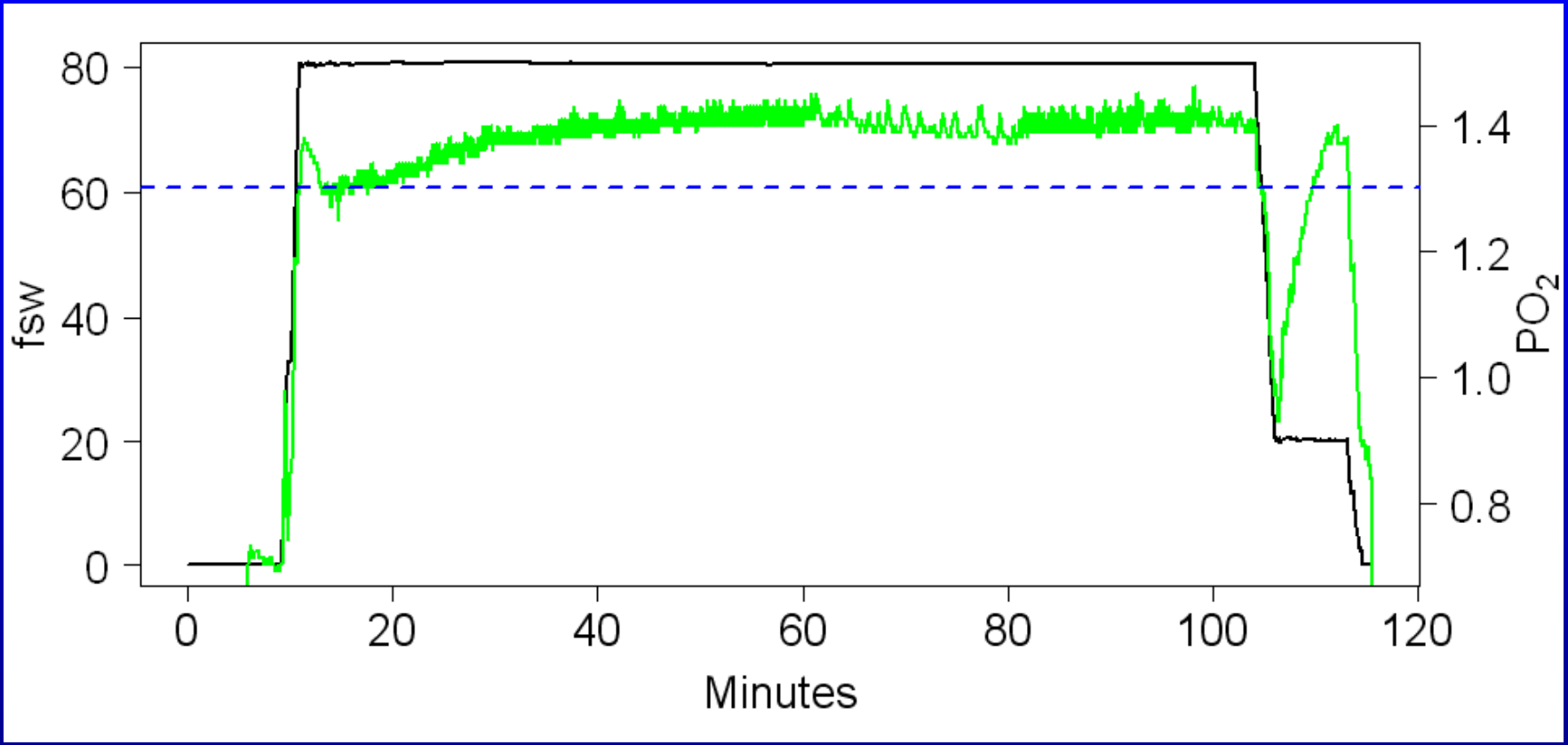
BM Keuski, DJ Doolette, RJ Steckel

Navy Experimental Diving Unit, Panama City (FL)

Oxygen Control in a Mixed-Gas Closed-Circuit Underwater Breathing Apparatus (UBA)

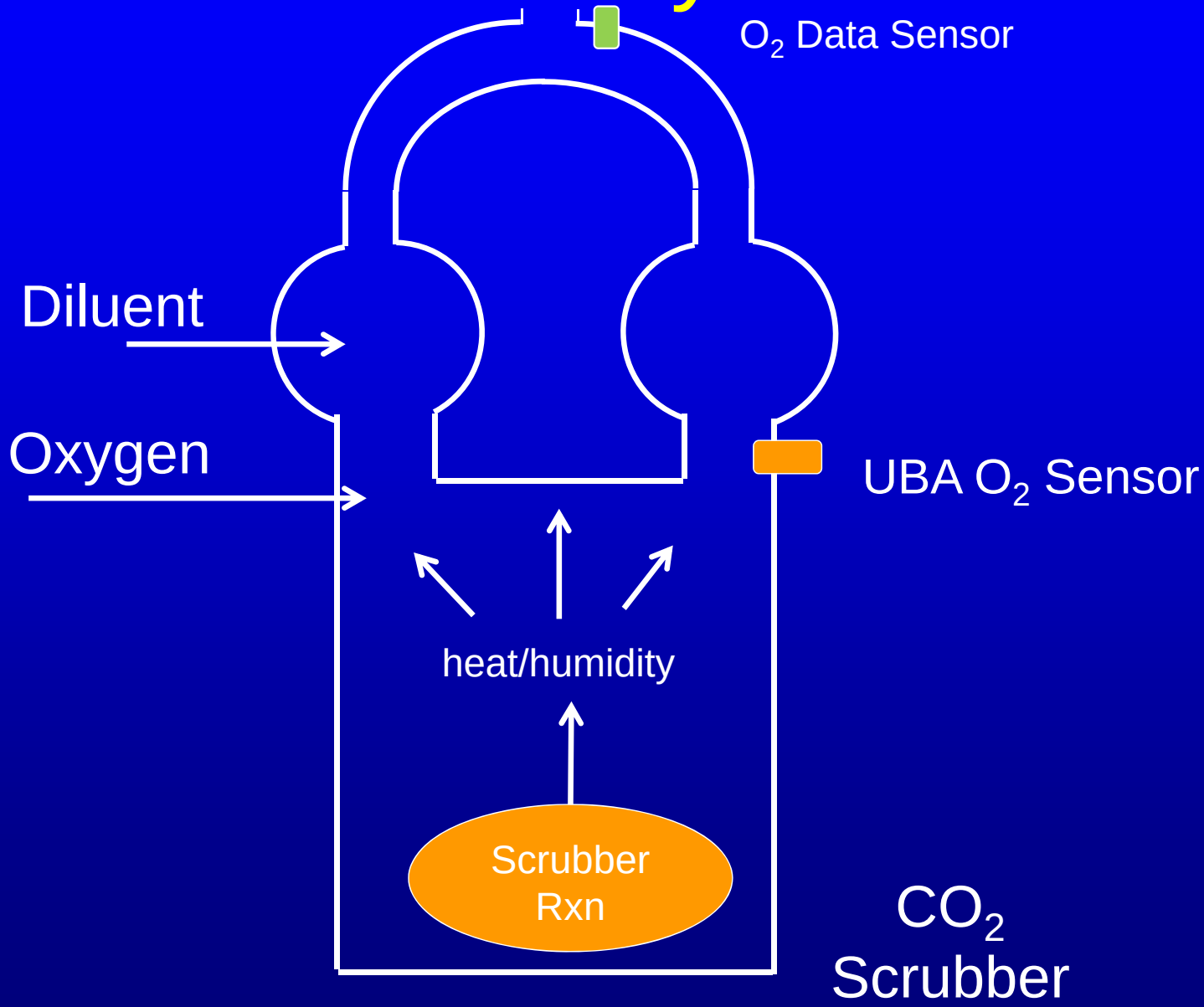


Representative Dive Profile



Upward PO_2 drift: R22 vs. K1-D?

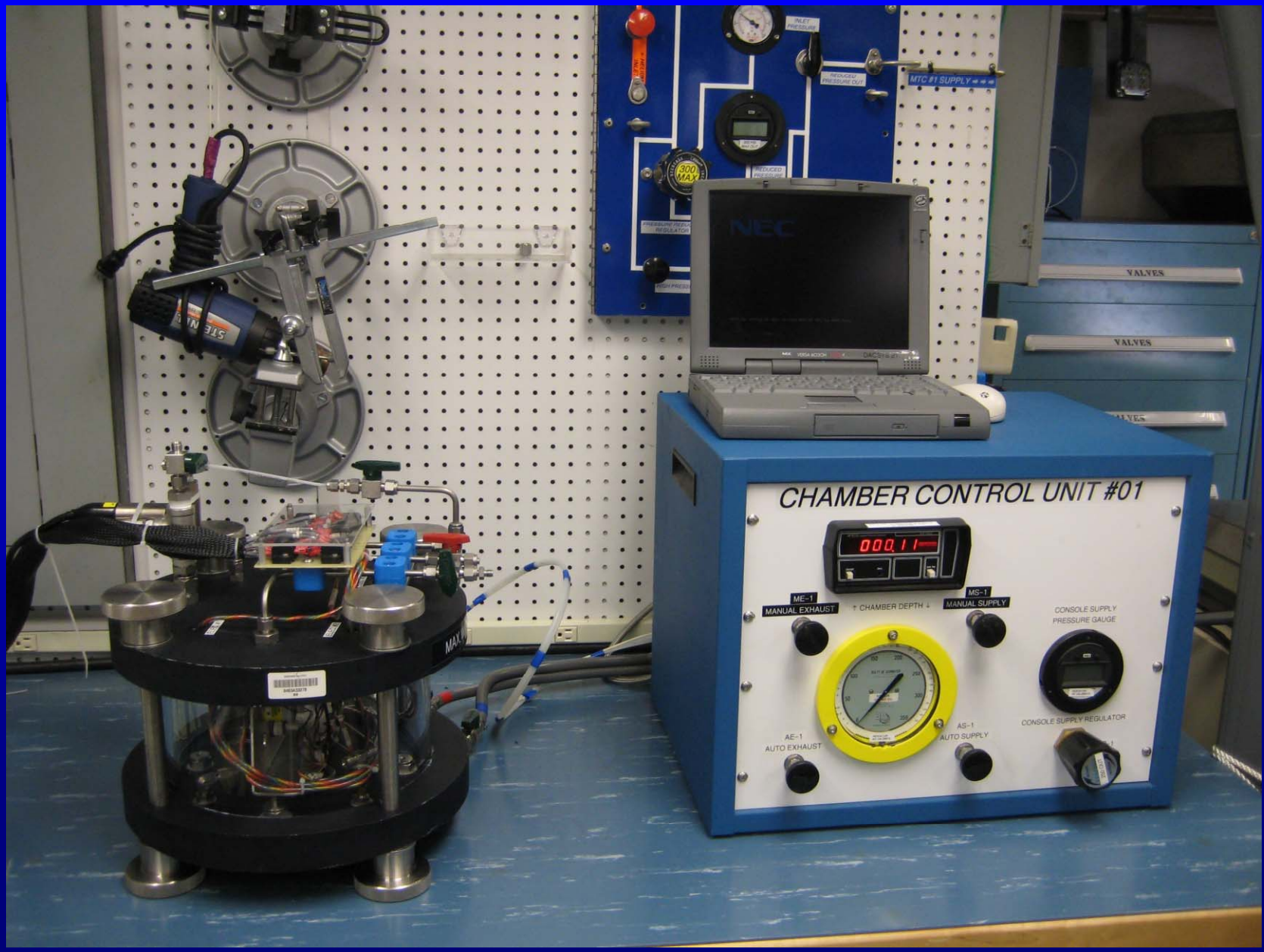
Heat and Humidity Production



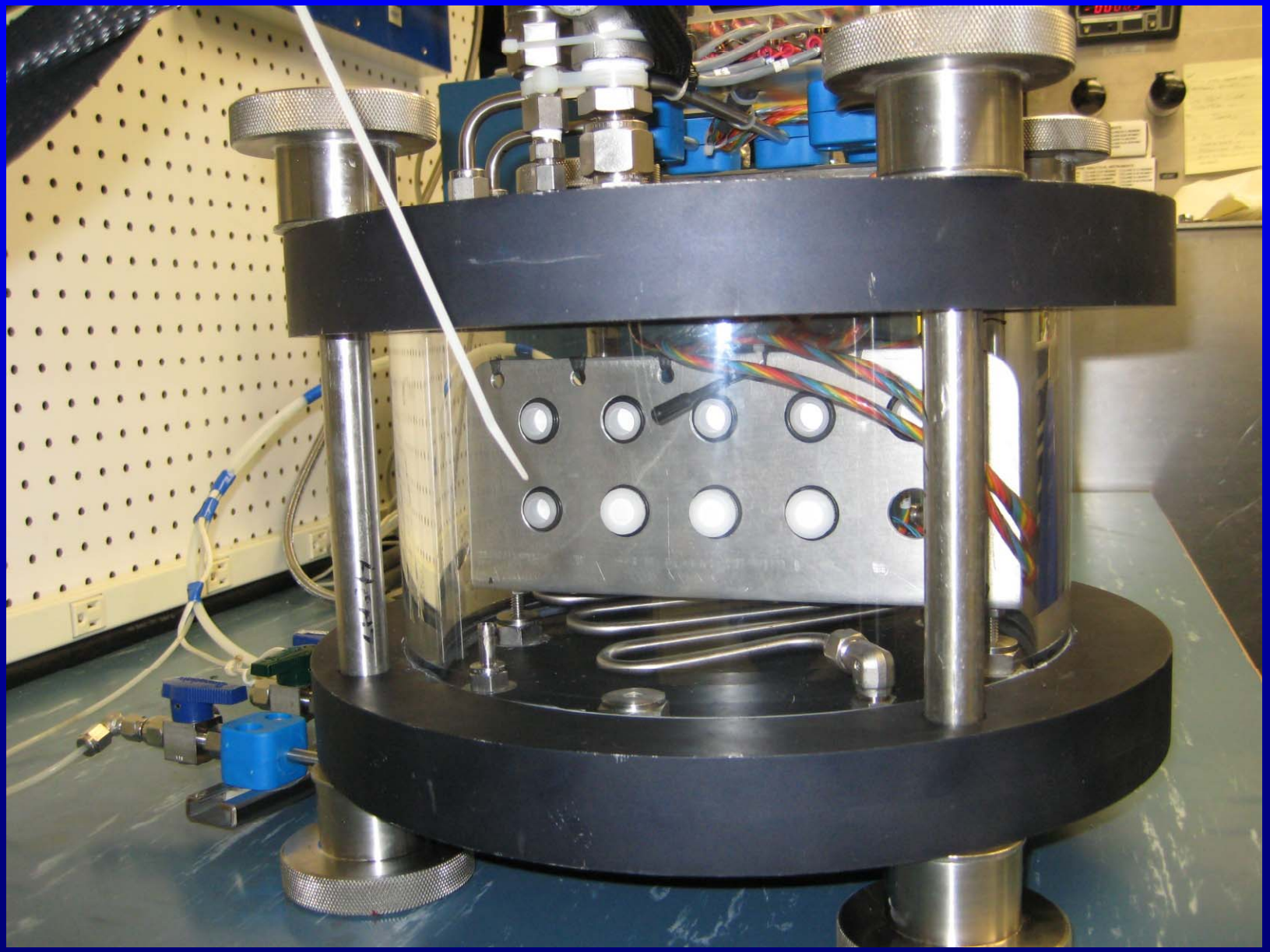
Methods

- Comparison of new and used (36 atm·h) K1-D (data) and R-22 sensors (UBA)
- 49.99% O_2 (balance N_2) at pressure
- 1 to 6.99 atm·abs increments of 0.5 atm
- voltage and temperature acquired at 10 Hz
- At room temperature (~23 °C) with dry gas
- Again at ~30 °C with visible condensation.

Acrylic Chamber

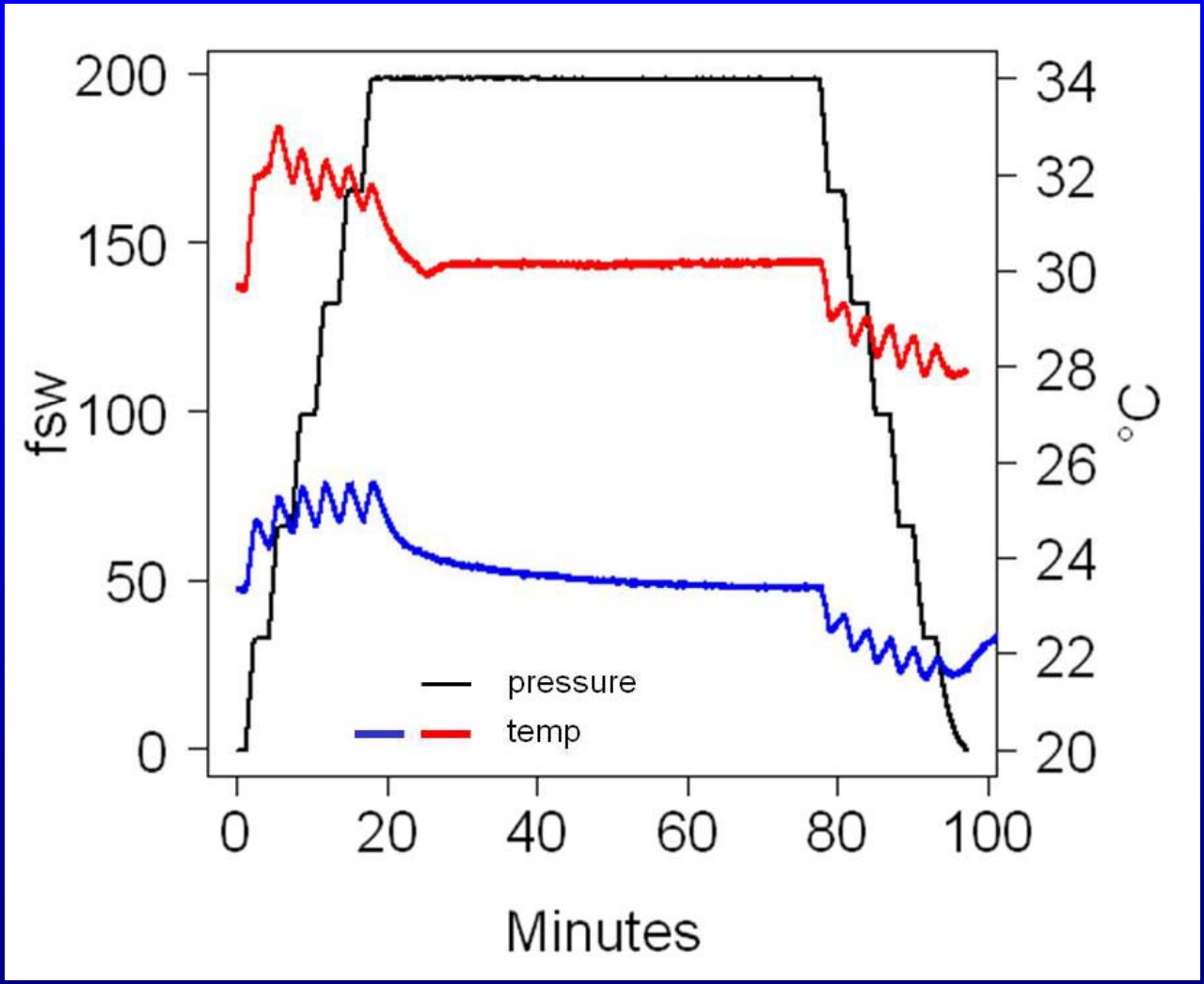


Acrylic Chamber



Acrylic Chamber - Humid

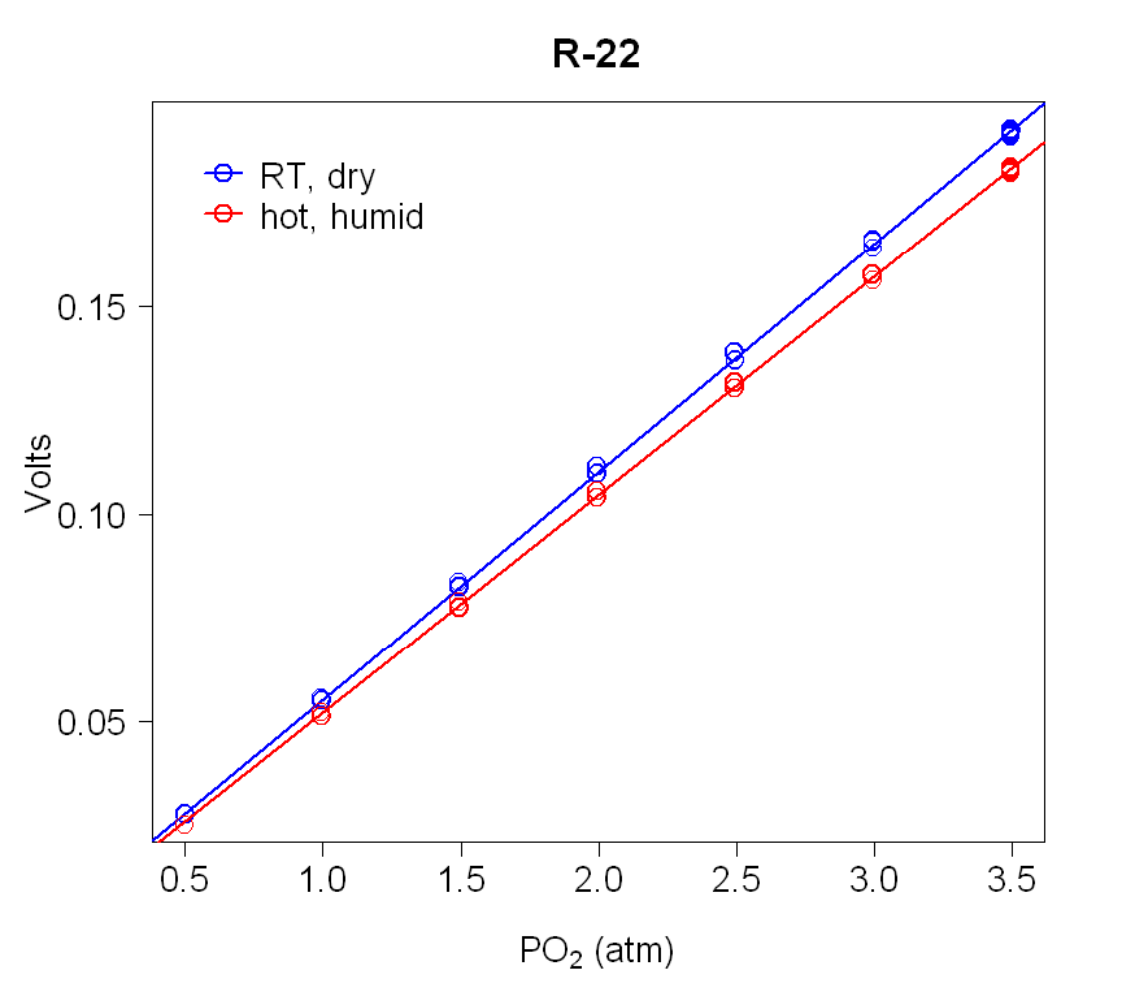
Temperature/Depth Profiles



Results

- All sensor voltages were linear vs. PO_2 over tested range (0.5 to 3.5 atm);
- $V=ß_0 + ß_1 X PO_2$
  - $R^2>0.9998$
- No significant differences between new and used sensors.
- Significant differences between RT/dry vs Hot/humid

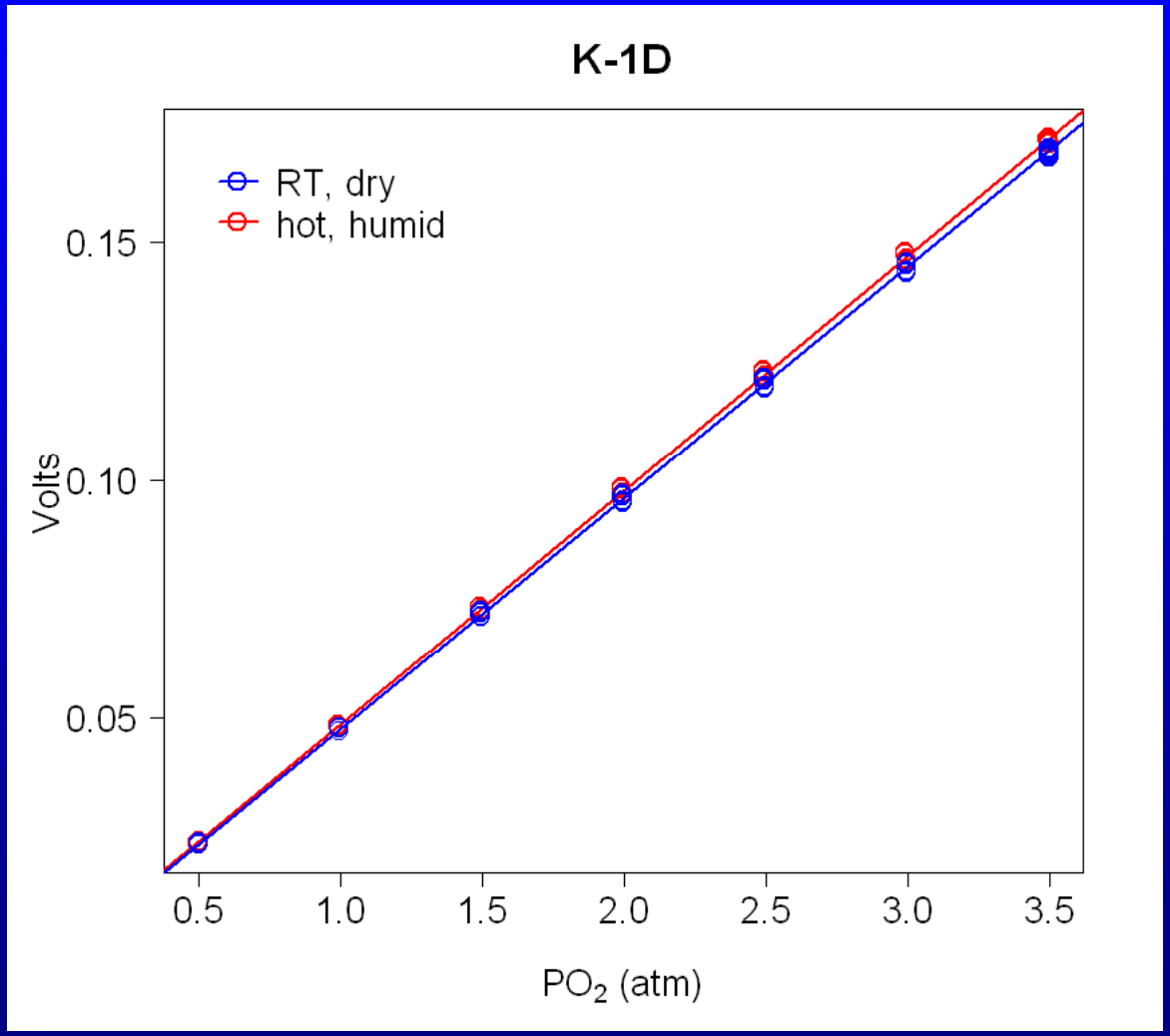
Results: R-22



R-22 signal was decreased under hot, humid conditions

~5% decrease in $ß_1$ compared to RT, dry.

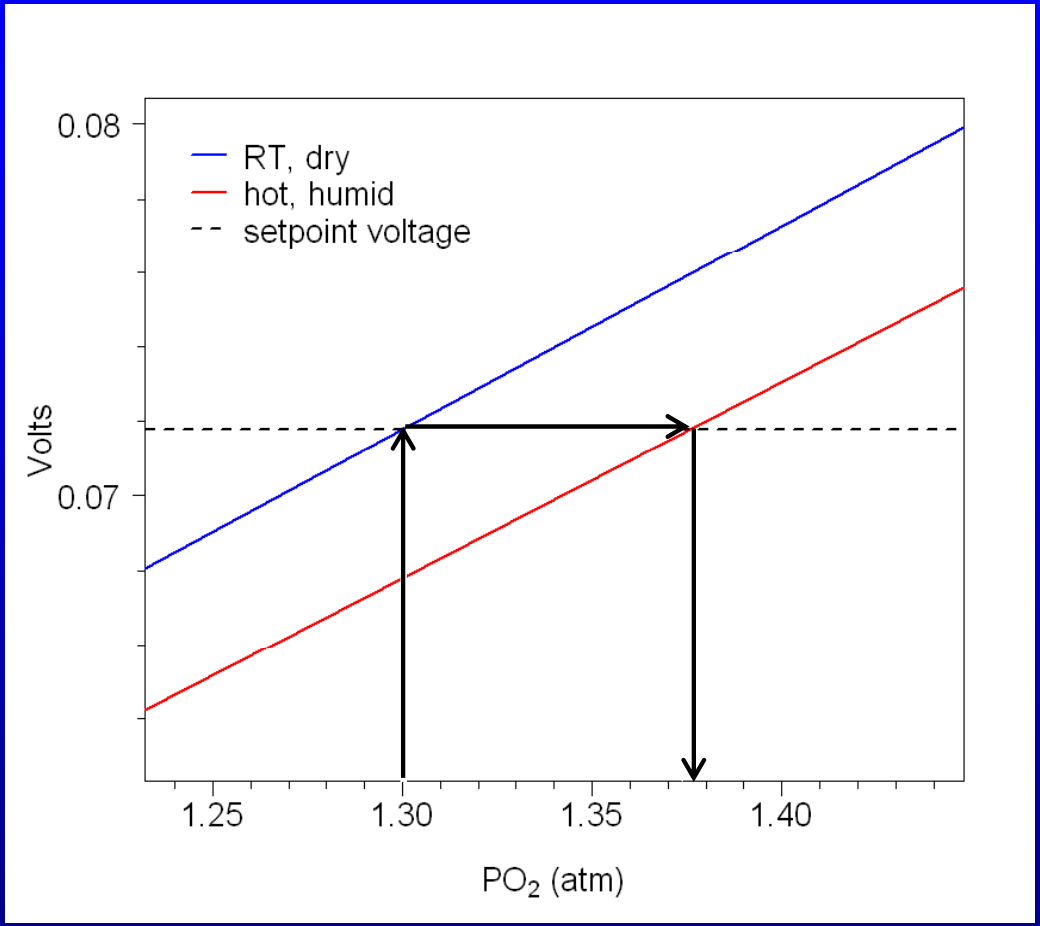
Results: K1-D



K1-D signal increase under hot, humid conditions

~1% increase in $ß_1$ compared to RT, dry.

Calibrated Room Temp/Dry Used Hot/Humid



$$V_{set}=PO_{2set} \times ß_{1RT} + ß_{0RT}$$

$$PO_{2.real}=(V_{set}-ß_{0hot})/ß_{1hot}$$

Discussion

- Smaller, opposite effect seen in K1-D
- Combined effects accounted for discrepancy seen in UBA testing
- Possible mechanisms
  - Heat: increased diffusion of O_2 leads to increased voltage
    - Temperature Compensation (neg coefficient resistor)
    - Temp. Compensation may differ between R-22 and K1-D
  - Humidity/Condensation: decreased diffusion of oxygen
    - R-22 may be more sensitive to this (hence the lower voltages)

Conclusions

- Many UBAs use the R-22 sensor
- UBAs calibrated at room temp and dry may maintain PO_2 at a higher than intended set point
- In this study, this was a small effect; however, this may be significant in other circumstances

Questions?