# *Development of a Portable Unit for Metabolic Analysis*

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# *Objective*

Develop, test and calibrate a prototype portable device that will measure human metabolic activity; namely time resolved measurements of gas temperature, pressure and flow-rate, and oxygen and carbon dioxide partial pressure during inhalation and exhalation.

# *Motivation*

- Rate of metabolic activity is a better measure of fitness than heart rate and workload.
- Need for a unit to measure metabolic rate during varied activities (including EVA).
  - Cardiovascular Alteration.
  - Muscular Alteration.
  - Nutrition Fitness and Rehabilitation.
- Evaluation of fitness and training programs.

# *ISS **G**as **A**nalyzer **S**ystem for **M**etabolic **A**nalysis **P**hysiology*

# *Design Goals*

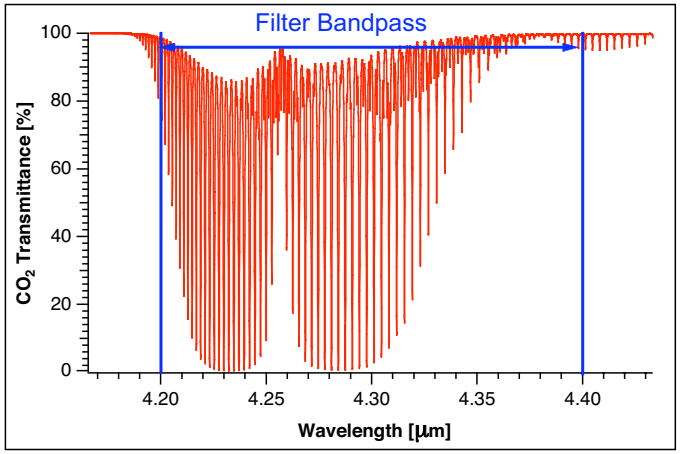
- Breath by breath analysis *and* within breath analysis
  - Design goal is 10 Hz (minimum)
- Eliminate timing issues with existing fixed and portable units (sampling at mask instead of remotely)
- Utilize better oxygen sensor technology than exists with existing portable units (electrochemical cell)
- Integrate PUMA with other Glenn BEC projects

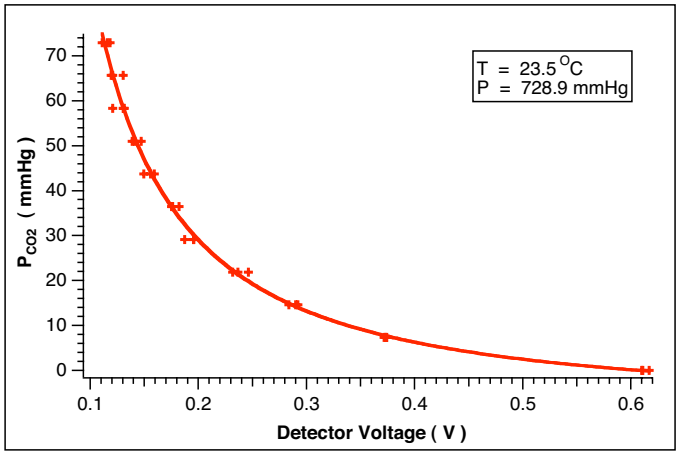
# *Specific Technologies*

- Pressure (used indirectly)
  - Use COTS technology
- Temperature (used indirectly)
  - PUMA-1 uses COTS technology
  - Next generation may use different technique
- Flow
  - PUMA-1 uses COTS technology (ultrasonic sensor)
  - Also looking at GRC-developed thin film sensors
- Carbon Dioxide
  - Infrared absorbance (custom developed system)
- Oxygen
  - Fluorescence quenching (custom developed system)

# *Carbon Dioxide Subsystem*

- Technology similar to commercial $CO_2$ sensors

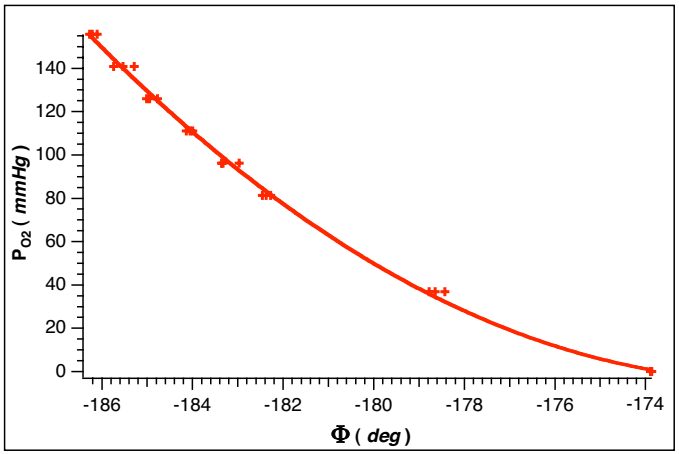


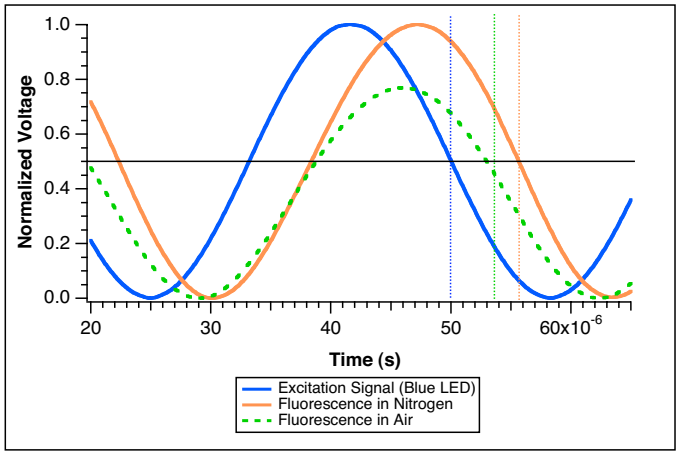




- Modulated IR source (currently incandescent-chopped)
- PbSe photoconductive detector (cooled)

# *Oxygen Subsystem*

- Commercial sensor uses absolute intensity
- Modulated blue light source
- Custom detection electronics/algorithm



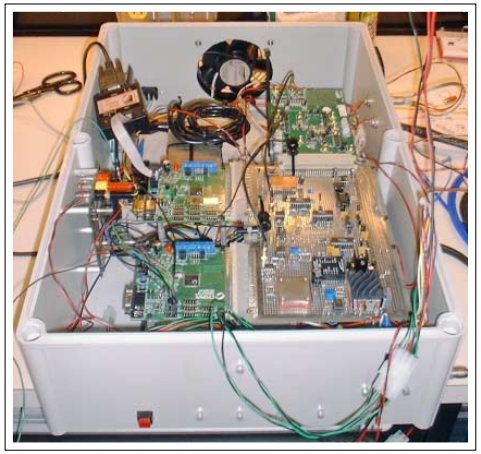




Measuring phase shift is:

- More stable/repeatable
- Less temperature dependent
- Not as sensitive to ambient light

# *PUMA-1 Overview*

- First generation $CO_2$ and second generation $O_2$ sensor
- First unit to incorporate simultaneous measurement of all quantities
- $CO_2$ unit working, but needs modification



- Current sample rate is 2.5 *Hz*
- Unit is 22" x 15" x 7" and approximately 22 lbs

# *Future Work*

- Complete characterization of PUMA-1 (Summer '04)
- Get IRB approval for Human Subject Testing (Summer '04)
- Human Subject Testing on PUMA-1 (Fall/Winter '04)
- Begin design work on PUMA-2
  - Battery powered
  - 10 Hz minimum sample rate
  - Suitable for use on a belt pack
- Software to allow use as a digital spirometer