



# Diver Health Monitoring System

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## Project Goal

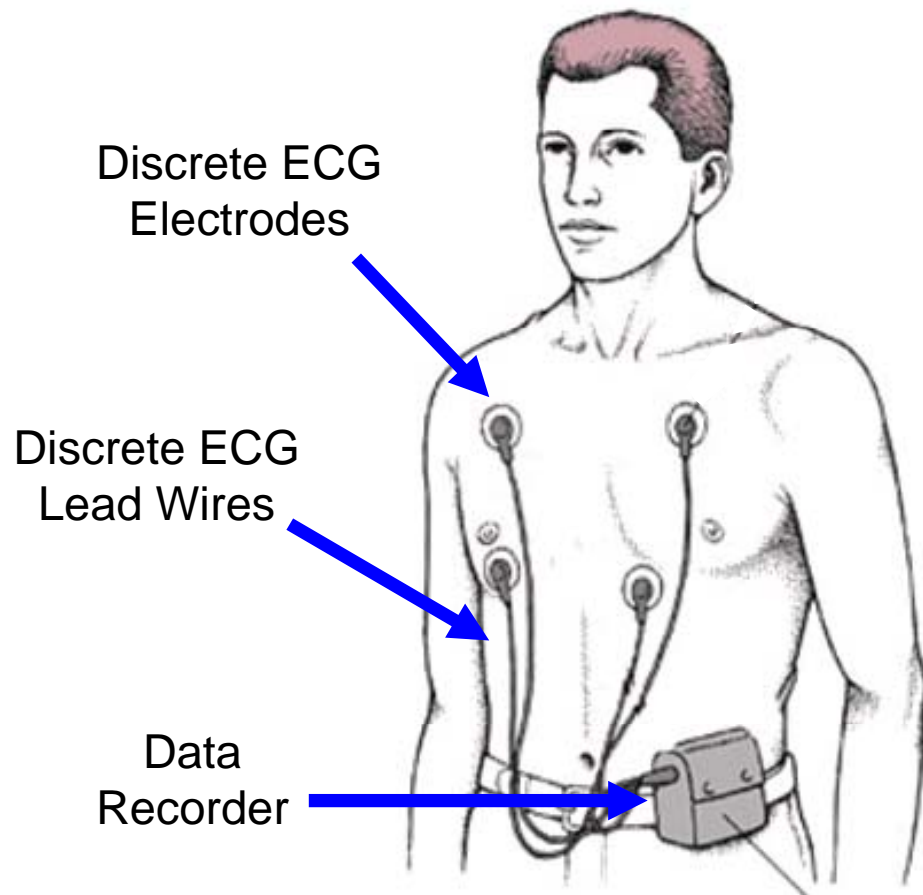
- **Real-time monitoring of heart rate during diving and in hyperbaric chamber research**

## Desired Features

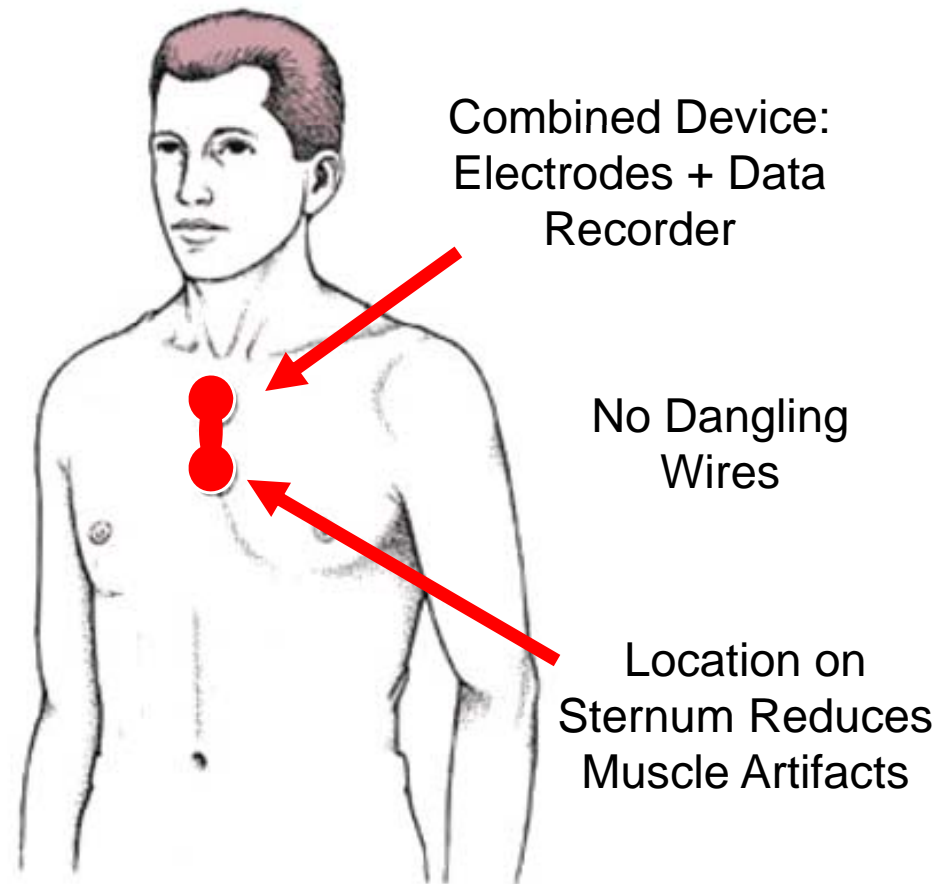
- **Unobtrusive package**
- **300 feet of sea water (fsw) working depth**
- **Wireless data telemetry in air to eliminate wire harnesses when used in NEDU OSF or other research settings**
- **Storage of raw ECG data on device in non-volatile memory**
- **Readily expanded to include additional sensors**
- **Simple export of physiologic data into common formats (MATLAB, Excel) for research**

# ECG Recording Methodology

## Existing Systems



## Creare Approach



# Dog Bone Construction

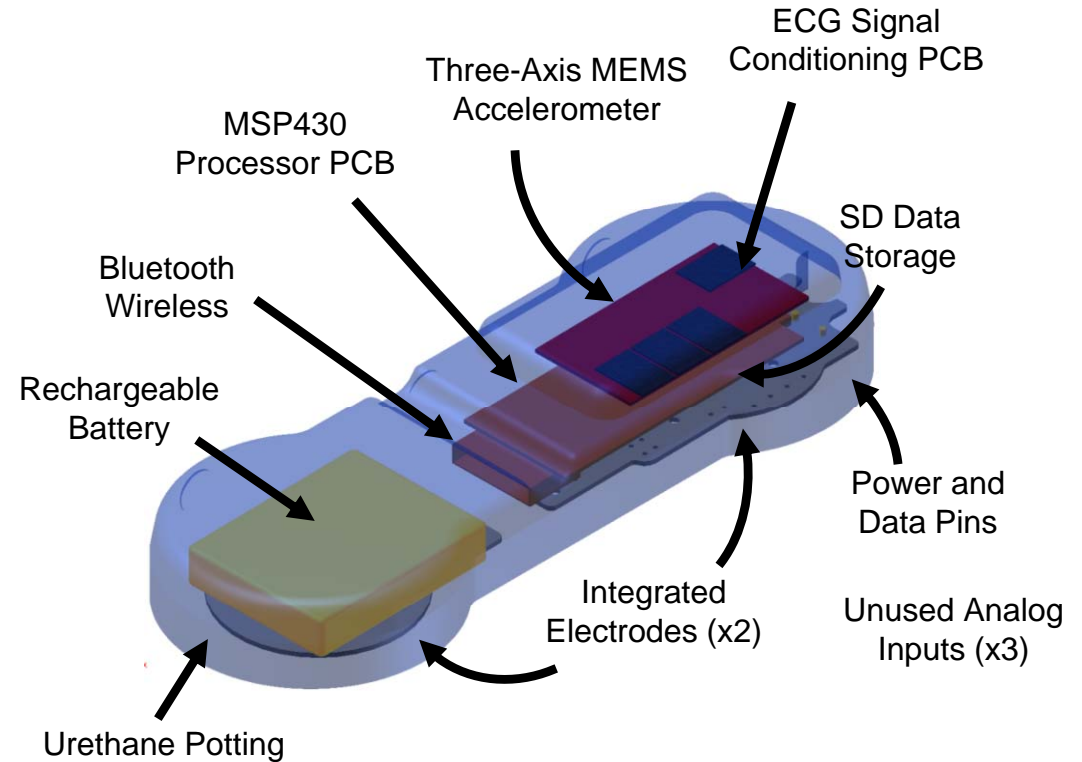
**Top View**



**Bottom View**



Disposable  
Hydrocolloid  
Adhesive

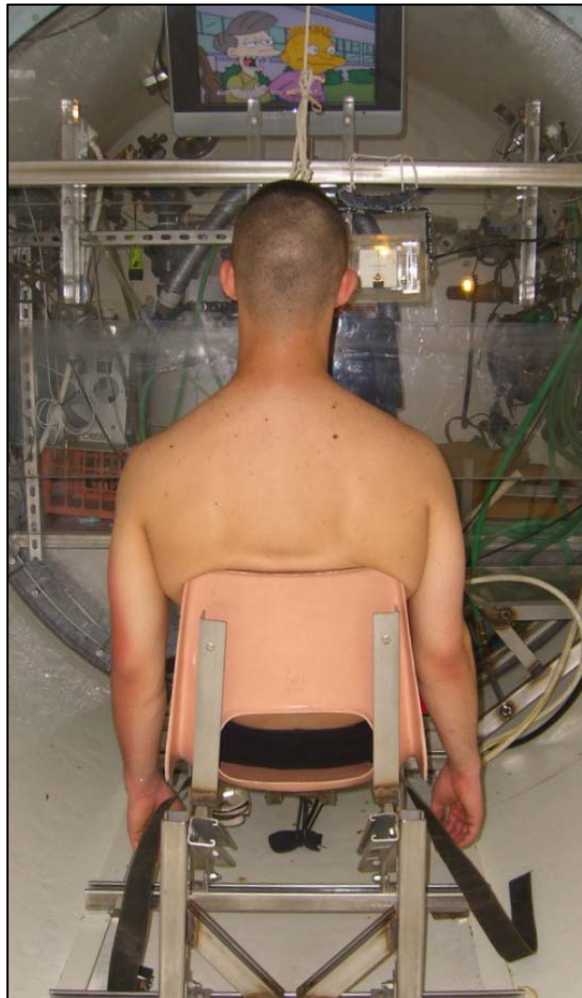
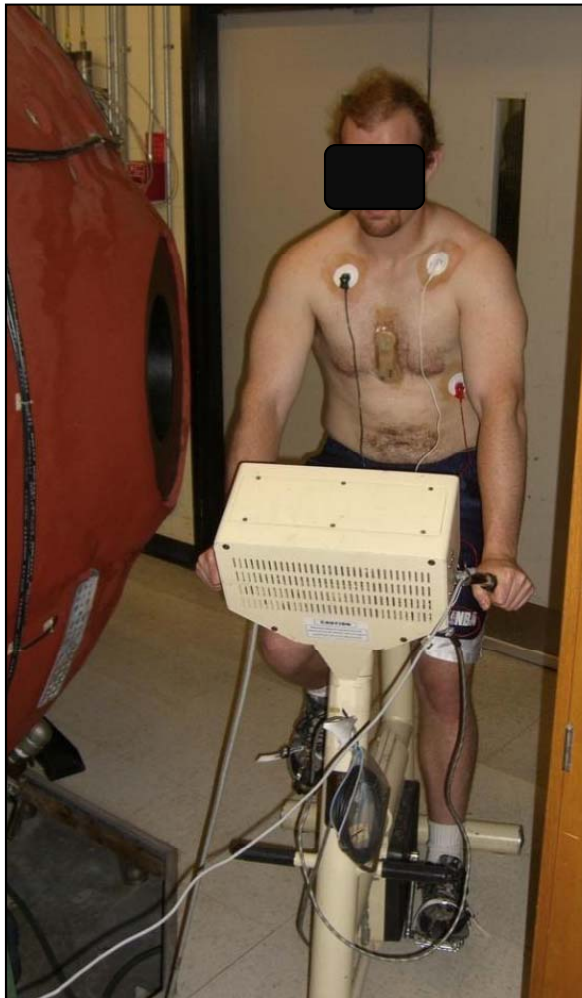


## Device Specifications

<b>ECG Data</b>	Single Differential Channel 500 Hz, 12 Bit Sampling No Lead Wires
<b>Data Logged</b>	Raw ECG and Instantaneous Heart Rate 2 GB Non-Volatile Storage (> 100 hrs)
<b>Wireless Telemetry</b>	Standard Bluetooth Connection Real-Time Raw ECG and Heart Rate Post-Test Download Raw ECG and HR
<b>Battery Life</b>	~8 hours While Transmitting Raw ECG Data
<b>Activity Monitoring</b>	Motion and Body Orientation Measurement ( <i>under development</i> )
<b>Pressure Tolerance</b>	300 Feet of Sea Water (~9 atm)



# System Testing

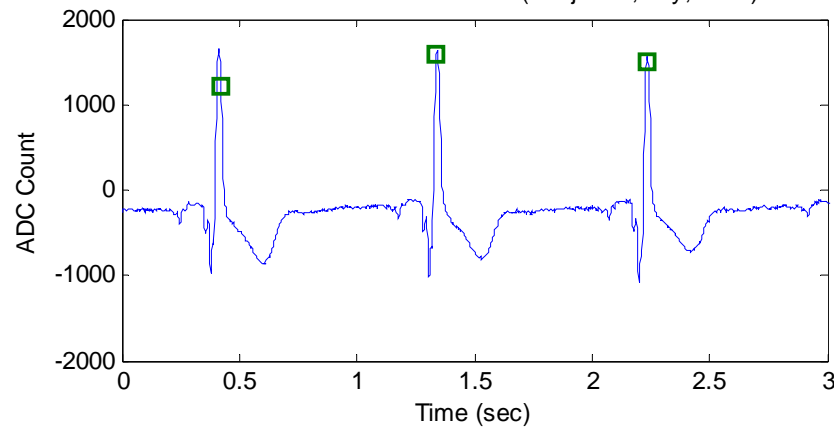


**Testing Ongoing at CRESE**  
**Dry/Wet, Surface/20 fsw, Rest/Exercise**

# Example ECG Traces

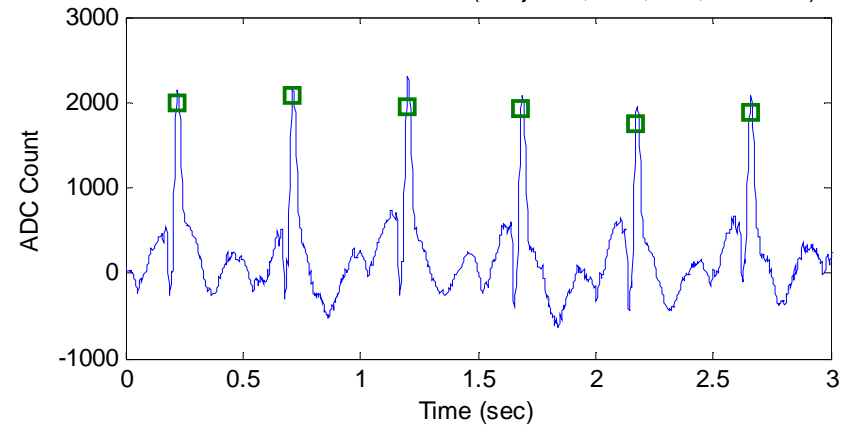
## Dry, At Rest

Raw ECG from Creare Sensor (Subject 2, Dry, Rest)

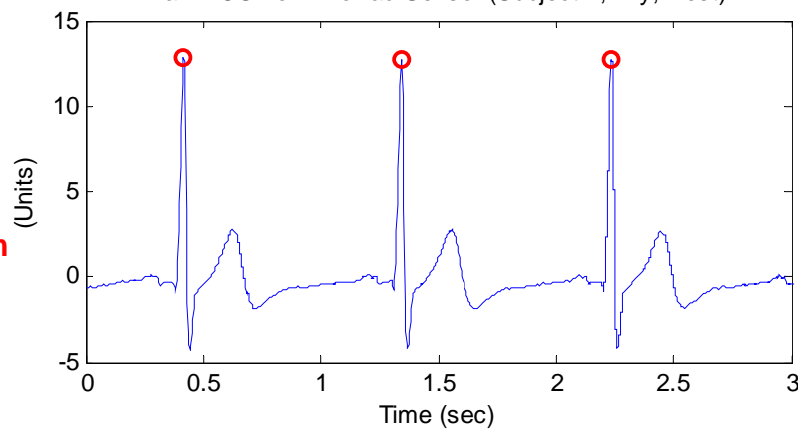


## Wet at 20fsw, Exercise

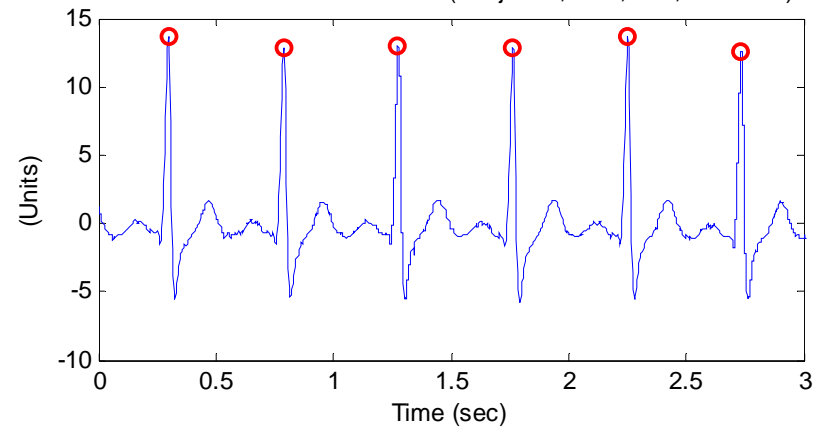
Raw ECG from Creare Sensor (Subject 2, Wet, 20ft, Exercise)



Raw ECG from BioPac Sensor (Subject 2, Dry, Rest)



Raw ECG from BioPac Sensor (Subject 2, Wet, 20ft, Exercise)



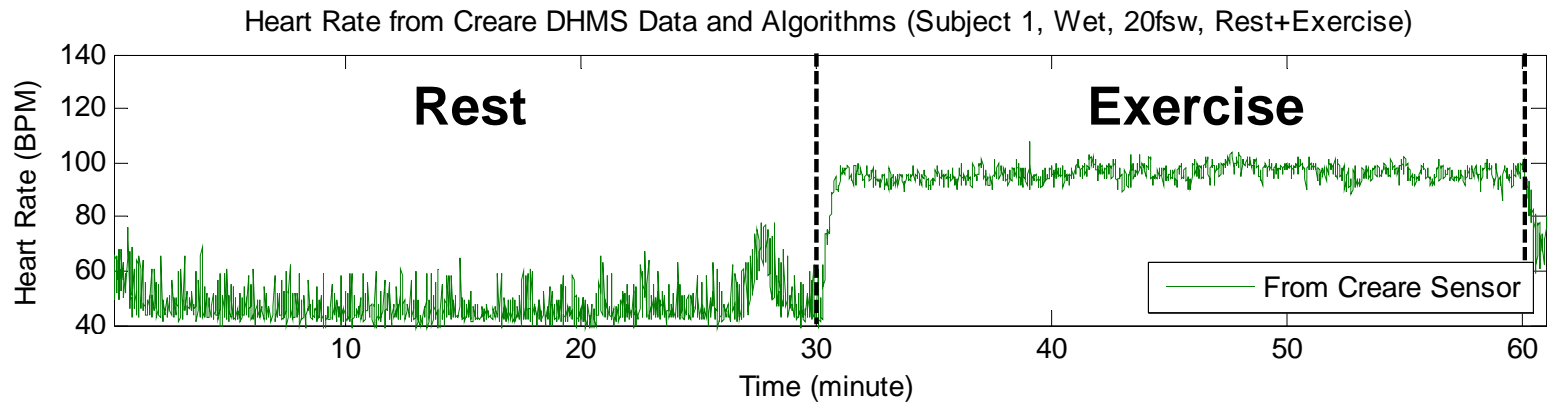
**Creare**

**BioPac**

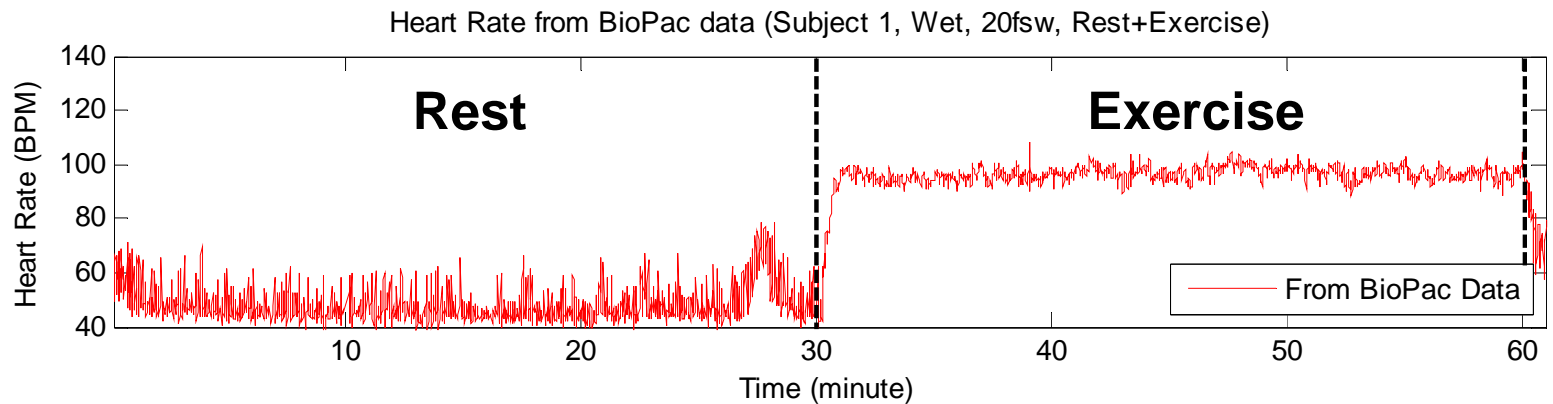
Tethered ECG System

# Example Heart Rate Traces (Wet, 20 fsw)

Creare



BioPac  
Tethered ECG Reference





## Limitations / Next Steps

- **Novel electrode configuration affects ECG morphology**
  - No impact on heart rate
- **Eight-hour battery life while continuously streaming raw ECG data**
  - Larger battery available
- **No *wireless* data telemetry while submerged**
- **No *wired* high-speed data download when docked**
  - Can be supported in future revision
- **Additional validation testing needed**
  - Ongoing at CRESE

## Conclusions

- Developed wireless ECG monitoring system for use by divers
- Wireless transmission of ECG/HR data with onboard storage
- Demonstrated successful operation: wet/dry, surface/20 fsw, rest/exercise

