



# Introducing New Diver Health Monitoring Technology

Bergen International Diving Seminar 2021

*Keeping Diving Relevant for the Future*

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confidence under pressure

# AGENDA

Health Monitoring in Diving

Existing Diver Health Monitoring Systems and their Limitations

Wearable Diver Health Monitoring Systems

Wearable Health Monitoring System Integration

Questions

# The Importance of Health Monitoring in Diving

# Requirement

- Saturation divers operate in remote, often harsh environments → maximising safety is **paramount**
- Divers are susceptible to numerous medical conditions, including (but not limited to):
  - Barotraumas (Pulmonary, Sinus), Hypo and Hyperthermia, Infections, Gas Embolisms, Decompression Illness, etc.
- There is an increasing average age of Divers → Increases likelihood of conditions arising
- Being able to react and help the Diver is vital
- Intervention before an emergency occurs is ideal



# So how do we address this currently?

There are several health/medical monitoring and treatment systems commercially available for saturation divers

# D-MAS HyperSat - DanMedical

Remote health monitoring system designed for Saturation Diving and Hyperbaric Treatment Chambers

→ Health data relayed to onshore medical staff

- Blood pressure
- Saturated Oxygen (SpO<sub>2</sub>)
- ECG
- Core Body Temperature
- + Additional Functions

Rated to 450msw

Satisfies DMAC 28 and OGP 411 recommendations

Typically only used once an incident has occurred





# O'Dive Pro – Azoth Systems

Assessment of diver decompression and likelihood of suffering from decompression illness

Uses Doppler ultrasound to count vascular bubbles and grades based on likelihood of DCI

Requires diver to have returned to surface  
→ More suited to air or defence diving than saturation



[3] Azoth Systems, *O'Dive Pro and Vision*, 2020, accessed 14<sup>th</sup> October 2021, <https://www.azoth-systems.com/en/home/#pro>



# Medical Emergency Systems

Other medical emergency equipment exists that is not directly related to health/medical monitoring  
(not an exhaustive list)

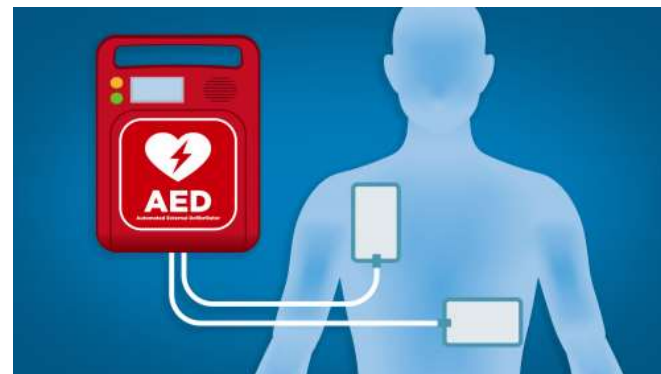
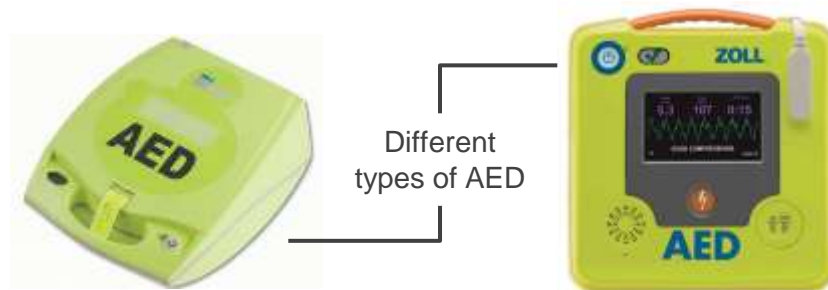
# Automated External Defibrillator (AED) Zoll Med

AEDs automatically diagnose life-threatening cardiac arrhythmias and attempt to return normal cardiac rhythm by delivering an electric shock

Standard (unmodified) AEDs can be unreliable when stored and used inside hyperbaric chambers

AEDs can be adapted for use in hyperbaric environments

- AED unit can be stored outside chamber
- AED electrodes remain inside the chamber, connected to the unit through electrical penetrators



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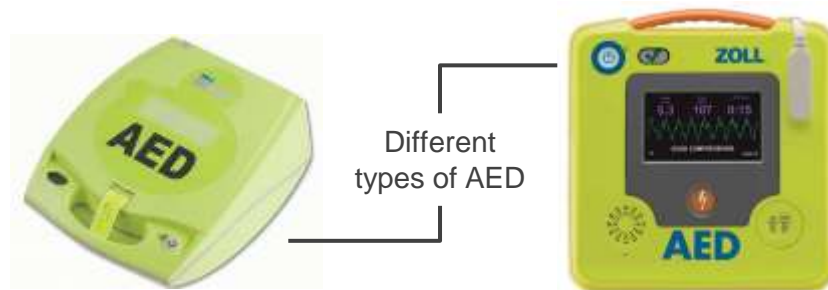
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- AED electrodes remain inside the chamber, connected to the unit through electrical penetrators

AEDs can also be contained in a 1atm housing and stored inside the chamber

Other equipment includes: HERK, DMAC 015 kits, Hyperlite hyperbaric stretchers, confined space stretchers, bell survival kits, etc...



# All current options are REACTIVE

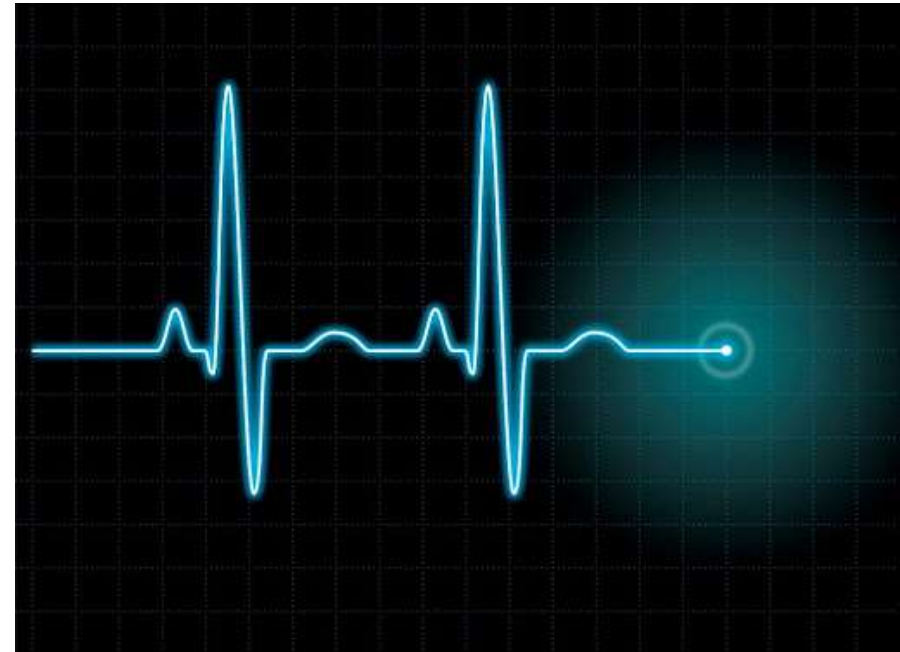
An incident has to have already occurred or the diver presents it

# Solution

Being able to monitor diver health **continuously** would facilitate earlier detection of incidents or medical emergencies

- Throughout an entire diving campaign: underwater, in chamber, and during hyperbaric evacuation
- Earlier detection would improve prognosis for the diver, and minimise job downtime
- Data logs would also help reduce chances of repeat incident

→ **WEARABLE HEALTH TECHNOLOGY**



# Wearable Health Technology

Wearable technology or “wearables” would facilitate continuous diver health monitoring

→ Common wearables include: Apple Watch, Polar, GreenTEG CORE, **AstroSkin**



Apple Watch



Polar H10



GreenTEG CORE



AstroSkin

... unfortunately none are suitable for saturation diving

So, we decided to create our own  
Saturation Diver Health Monitoring System



# Proof Of Concept System

Collaboration between JFD Fathom and the University of Strathclyde

Standalone prototype for assessing system feasibility

- ECG, PPG, Skin Temp, Blood Pressure, Heart Rate, Breath Rate
- Wireless (Bluetooth) and battery powered
- Watch based spot checks – initially for dry diving applications
- Completed successful hyperbaric testing and diver trials



**Fathom**



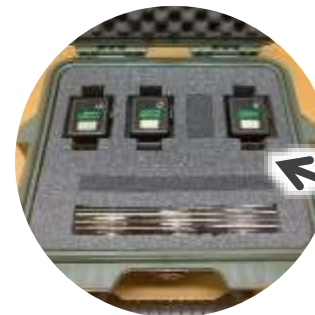
Knowledge  
Transfer  
Partnerships



System Software with  
Waveforms and Data



Diver Health  
Monitoring Watch



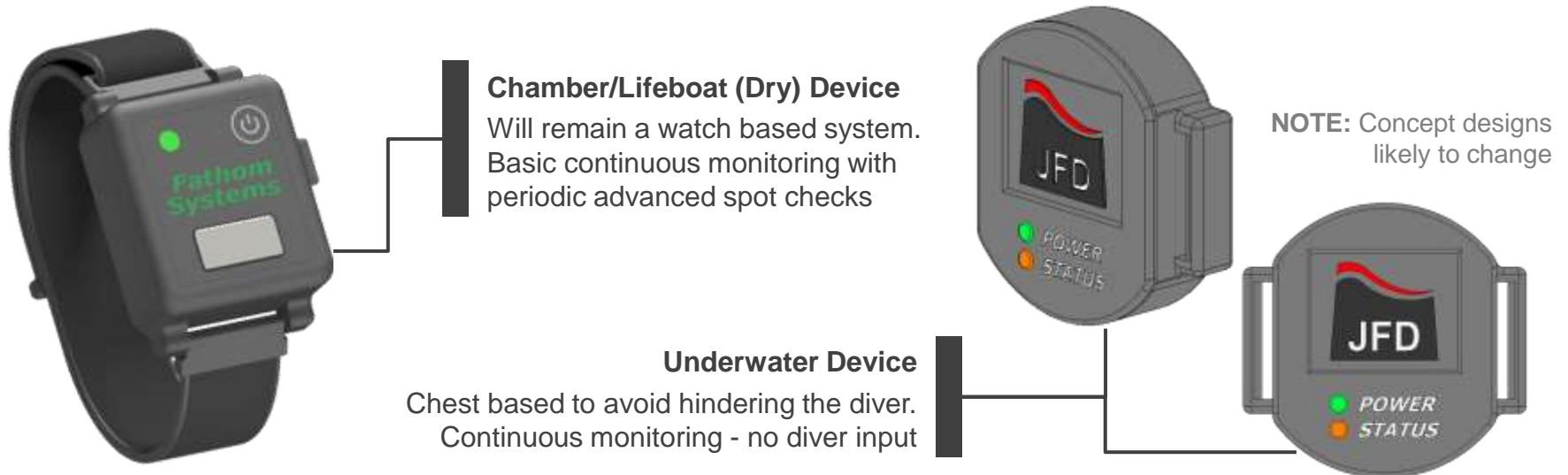
Health Monitoring System

# Next Steps

In development is the creation of a **Health Monitoring Platform** with additional and advanced functionality:  
→ **Core Body Temperature, SpO<sub>2</sub>**, Hydration Level, Depth

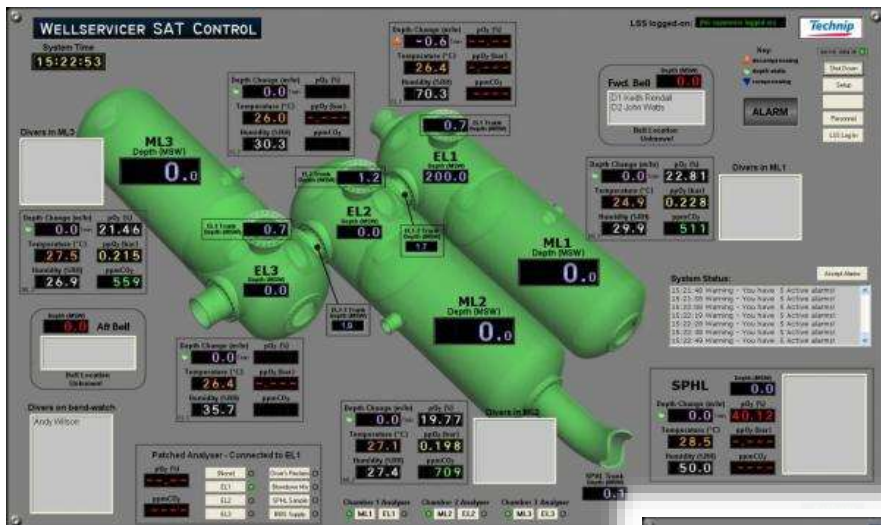
Platform will be common across several commercial and defence diving applications:

- Different solutions will then be created for both in-chamber/lifeboat (dry) and in water monitoring



# System Integration

# Saturation Dive Monitoring System (DMS)



SAT Client

→ Watch based 'spot checks'



Concept implementation  
not indicative of end design



DIVE Client

→ Continuous in-water monitoring



# Air Dive Monitoring System (AirDMS)



Concept implementation not indicative of end design

Combining biometrics with Fathom HD Camera and DMS technology will provide state-of-the-art dive and diver monitoring

## AirDMS Client

- Continuous in-water monitoring
- Chest based system – no input required from divers



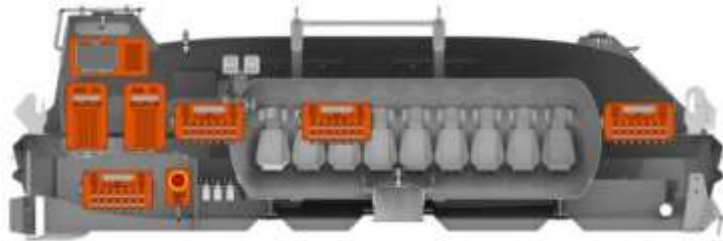


# Critical Systems Monitoring And Tracking System (CSMSTS)

CSMSTS is a standalone system consisting of a distributed array of sensors fitted to an SPHL that provides the information to ensure the SPHL is always operationally ready

→ Relays data to onshore personnel via the Iridium satellite network

→ IOGP 478 and IMCA D052 recommendation



→ Authorised onshore personnel can log in via online via dedicated CSMSTS website and mobile applications

→ Current and historical data

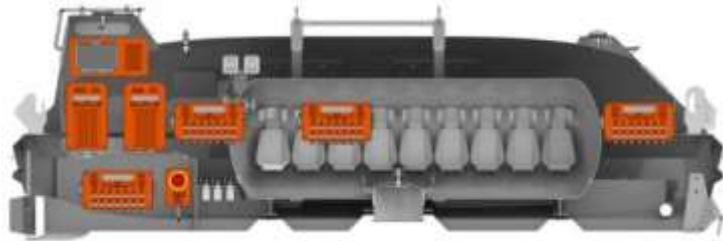


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→ Authorised onshore personnel can log in via online via dedicated CSMTS website and mobile applications

- Current and historical data
- Operating mode
- Diver information (name, SPHL)





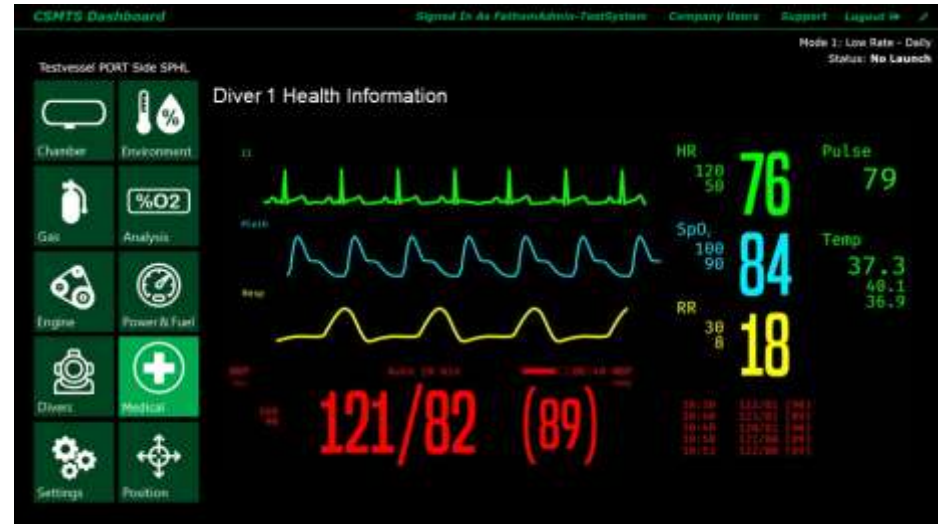
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Extending CSMSTS to also monitor diver health is the logical next step

Watch-based health monitoring solution

- Diver spot checks
- Alarms on suspect data
- Enables onshore personnel (inc. HRF) and medics to prepare for diver arrival

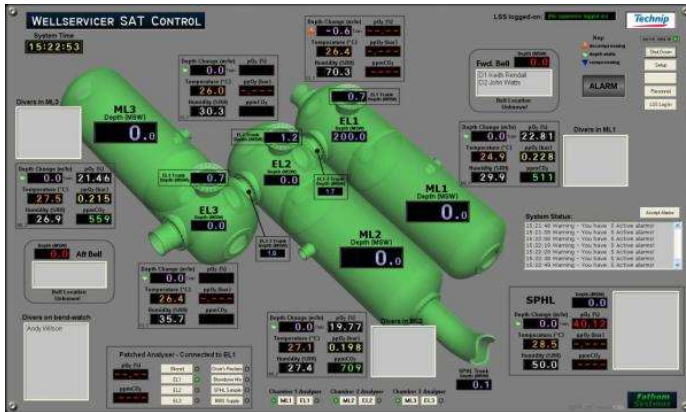


# Reporting and Health Monitoring System for Divers

Diver's recommended changes for a better future **Table 10 – Step 3:**

*“A trusted third-party **reporting and health-monitoring system for divers** should be created to eliminate the under-reporting problem and to obtain valuable health data that at present is being missed.”*

DMS and CSMTS with health-monitoring technology is the answer



Post dive campaign monitoring could also be achieved by sending divers away with a health monitoring device and mobile logging app.

Thanks for your attention.

Questions?



***Fathom***



Knowledge  
Transfer  
Partnerships

