

TacDIVE: Underwater Physiological Monitoring for Real-Time Diver Safety and Risk Detection

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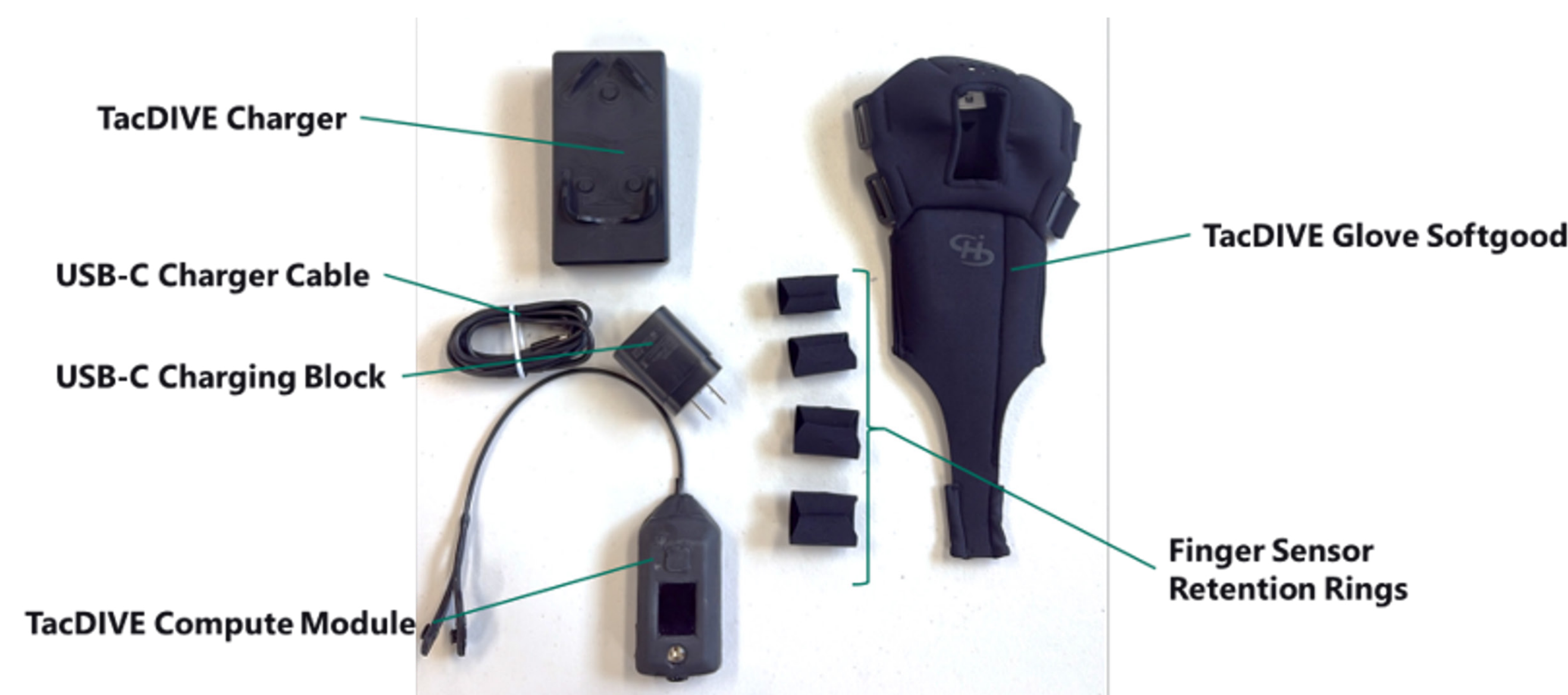
Background

Military diver training and operational diving expose personnel to extreme physiological stress in environments where visibility is limited and early signs of distress are often difficult or impossible to detect. Current safety practices rely primarily on visual observation, which may not identify hypoxia, cardiovascular strain, or thermal stress before serious injury occurs. TacDIVE was developed to provide continuous, real-time physiological monitoring in submerged environments using a rugged, wearable platform that enables early detection of physiological degradation, enhances diver safety, and supports data-driven training and operational decision-making.

Description

TacDIVE is a rugged, glove-based physiological monitoring platform designed to improve the safety of military divers through continuous, real-time assessment of physiological status in submerged environments. Developed to operate where conventional monitoring is impractical, the system combines wearable physiological sensing with onboard processing and edge analytics to detect early indicators of physiological degradation, support post-mission review, and provide a scalable foundation for future military diving technologies. The platform was designed to meet the following operational and engineering requirements:

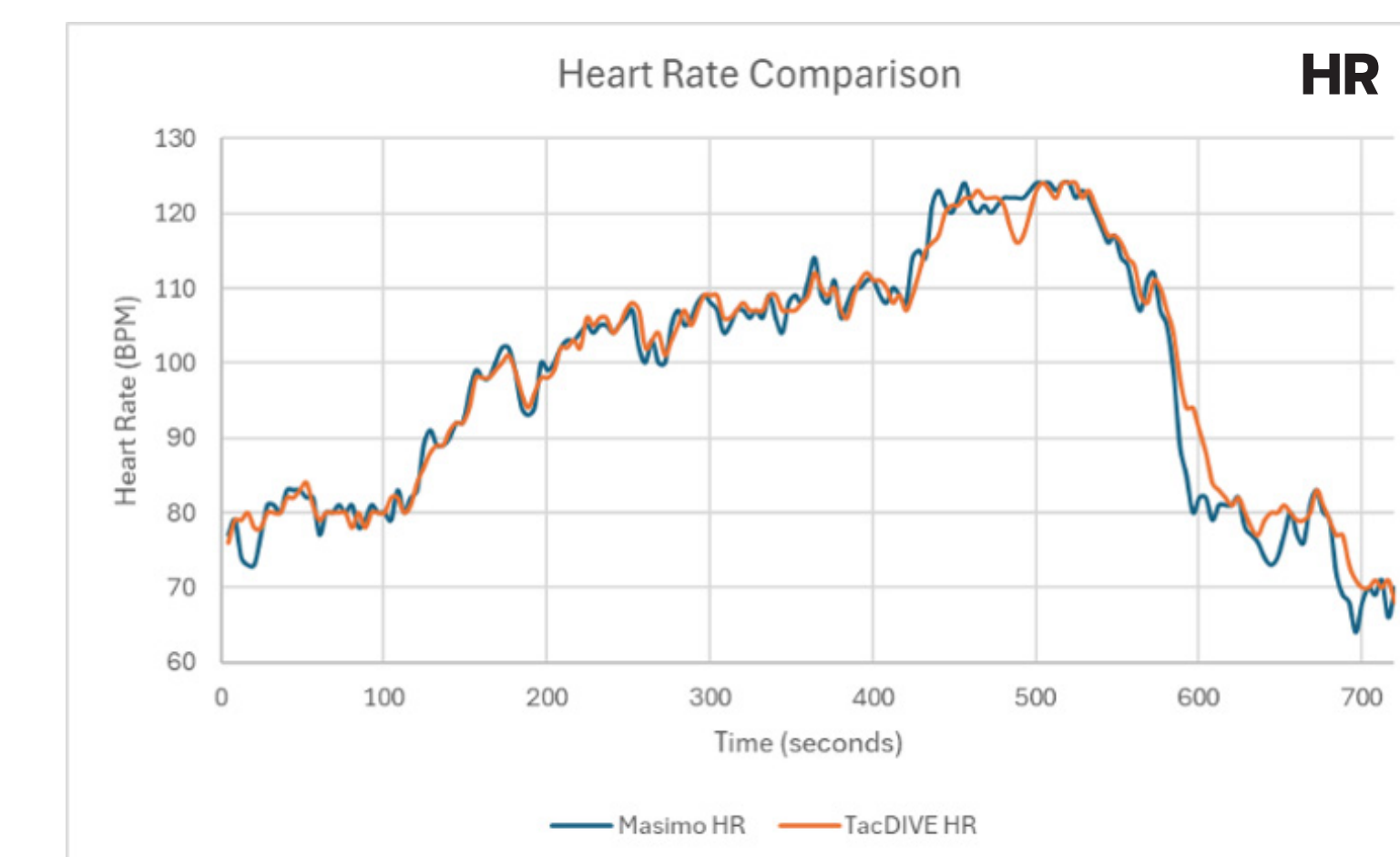
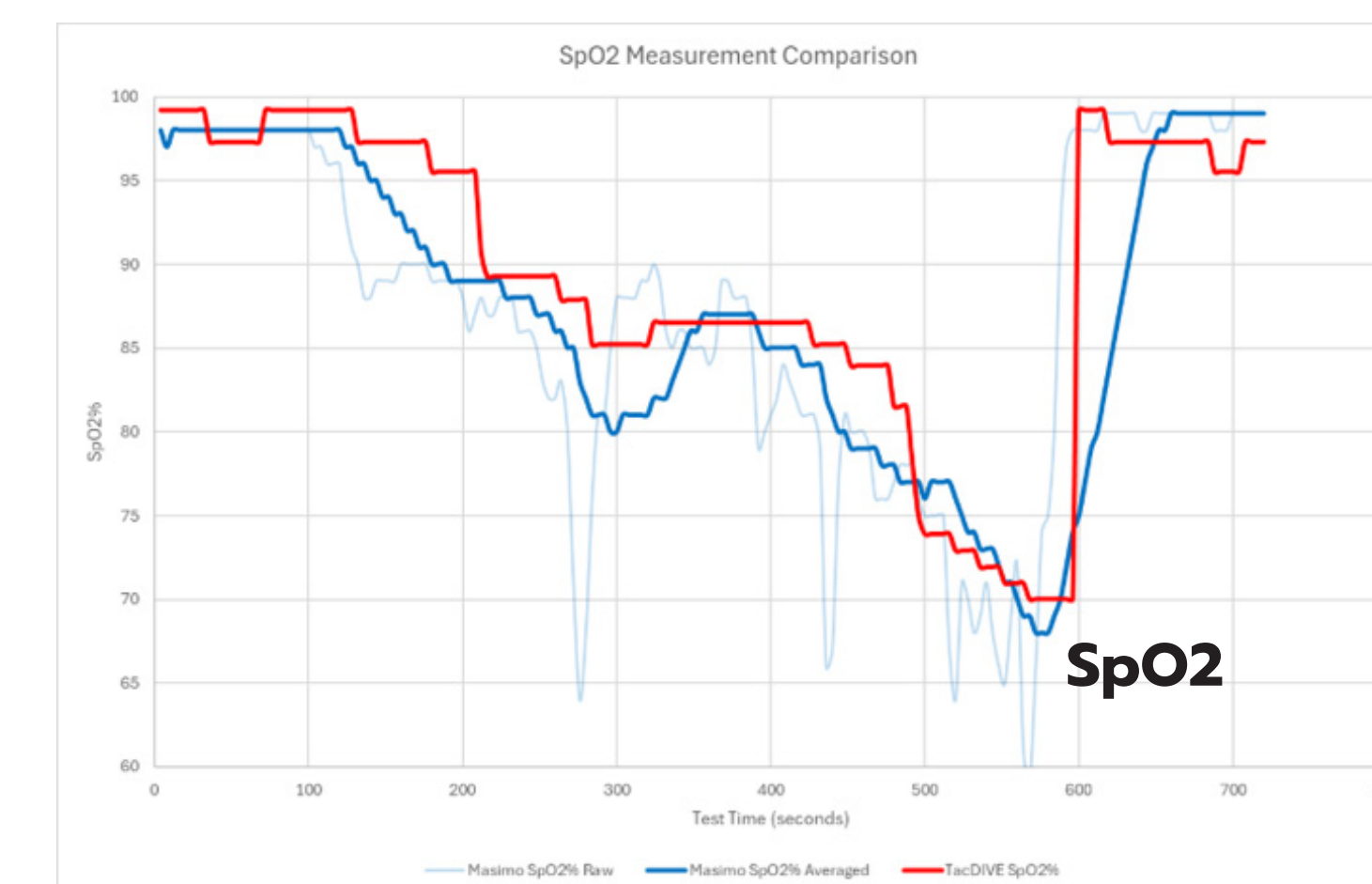
- Continuous monitoring of heart rate, blood oxygen saturation (SpO₂), and diver motion
- Early detection of hypoxia, cardiovascular strain, and physiological degradation
- Rugged, waterproof design for operation in demanding underwater environments
- Low size, weight, and power (SWaP) to minimize impact on diver mobility and dexterity
- Onboard processing and data logging for operation in disconnected environments
- Modular architecture supporting future integration of physiological sensors, underwater communications, and advanced decision-support algorithms



Results

Human subject testing was conducted in laboratory and submerged pool environments to evaluate physiological monitoring performance and system robustness. TacDIVE demonstrated:

- **Accurate Heart Rate Monitoring**, with measurements typically within 1–2 bpm of reference ECG and Garmin devices across rest, activity, and submerged conditions.
- **Reliable SpO₂ Trend Monitoring**, with measurements tracking reference systems while exhibiting an average 4–5% offset, consistent with expected calibration limitations and targeted for future refinement.
- **Stable Underwater Performance**, maintaining physiological monitoring during submerged activity without functional degradation.
- **Robust Environmental Durability**, successfully completing pressure testing to **150 ft depth** (device only) with **no water ingress or loss of functionality**.
- **Robust performance and positive usability**, with the system maintaining functionality under mechanical stress while demonstrating favorable user feedback for comfort, ease of use, cable management, and SafeGuard integration for physiological monitoring and post-mission analysis.



TacDIVE Architecture

Glove/Sleeve Sensor

- Forearm glove form factor
- HR & SpO₂ sensor
- Added IMU for motion sensing
- Added environmental sensors
- Enhanced sensor algorithms
- Extended battery (24h)
- Extended memory (24h)
- BAN support
- Alarm LED indicator

Body Area Network

- Integrates sonar modem
- Integrates remote sensors
- Integrates other 3rd party peripherals

Ancillary Sensors

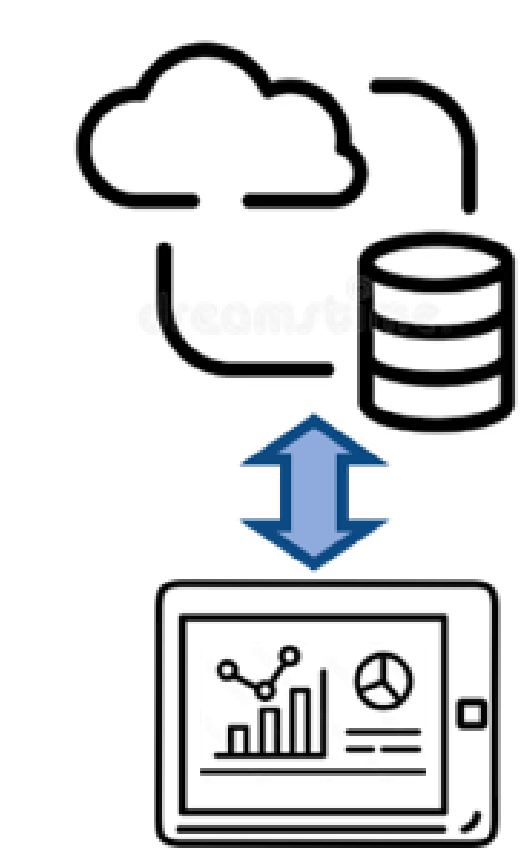
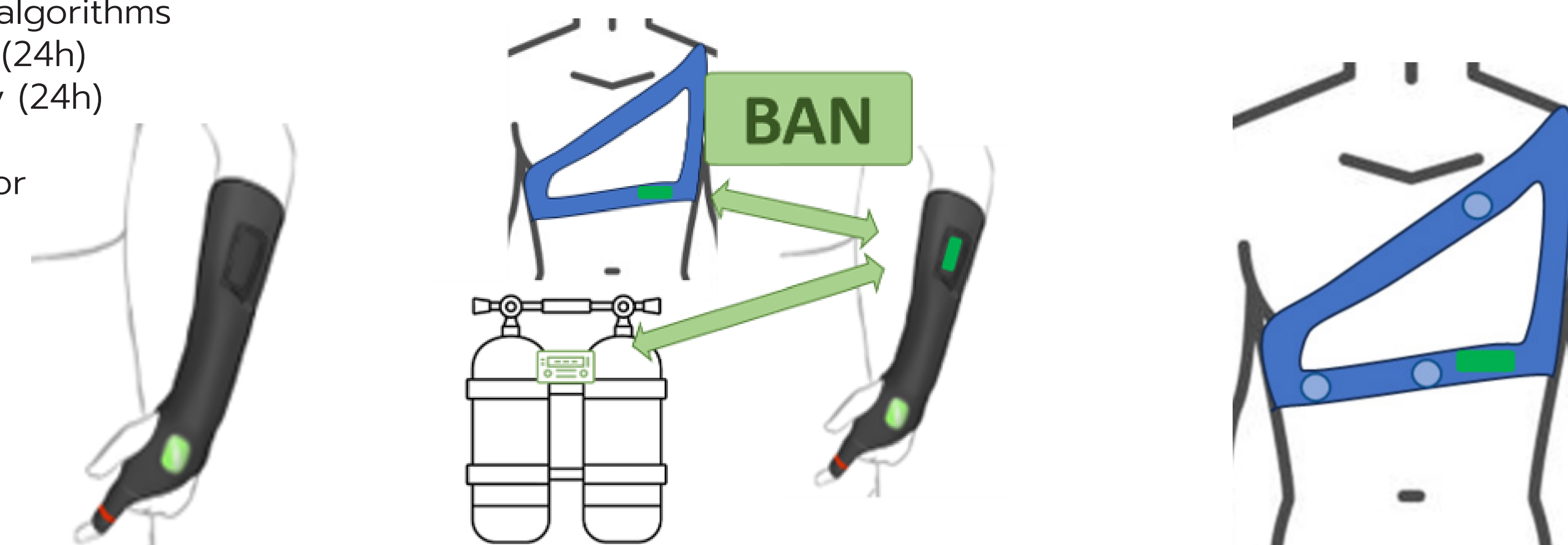
- Adds respiration band
- Adds ECG electrodes
- Improves skin and core temp.
- Provides real-state for underwater modem

Communications

- Underwater modem
- Over water: WiFi/BLE/RF (Buoy)
- BAN interface to system
- TAK communications support

Software

- Signal processing and algorithm capabilities
- Metrics dashboard
- Multi-user data management
- Data security
- Integration with DoW DB



Conclusion

TacDIVE demonstrated the feasibility of continuous physiological monitoring in underwater environments using a rugged, low-SWaP, glove-based wearable platform. The system successfully integrated heart rate, SpO₂, and motion sensing with onboard processing and data logging while maintaining reliable operation during laboratory and submerged testing. These results support the use of wearable physiological monitoring to enhance diver safety, improve training oversight, and provide objective physiological data for operational decision-making. TacDIVE establishes a scalable foundation for next-generation underwater physiological monitoring technologies.

Future Work

Future development will focus on improving physiological sensing accuracy, expanding human subject testing, and integrating advanced physiological algorithms, including core temperature estimation and other parameters. The modular architecture will also support underwater communications and AI-enabled decision support to advance TacDIVE toward operational military diving applications.

Acknowledgement

This work was supported by the U.S. Army through the Small Business Innovation Research (SBIR) Program under Contract W51701-24-C-0068. The authors gratefully acknowledge the support of U.S. Army Applied Lab.