QStat By RAJANT HEALTH

Modular Wearable Hub Platform

Overcoming the Limitations of Today's Wearables

Why Consumer-Grade Devices Fall Short for Medical and Industrial Applications

From our extensive experience sponsoring clinical trials, we've identified several critical shortcomings in today's mainstream wearables:

- **No Access to Raw Data:** Most consumer wearables do not expose raw sensor data, restricting the depth of analytics and the ability to develop customized or advanced health insights.
- **Limited Medical Utility**: These devices suffer from motion artifacts, poor calibration across skin tones, and sensitivity to improper fit—making them unreliable for clinical-grade applications. They prioritize situational awareness and battery life over data quality and precision.
- **Vendor Lock-In**: Proprietary ecosystems prevent integration with third-party tools and systems, limit platform flexibility, and put long-term data ownership and innovation at risk.
- **Data Ownership Concerns**: Data is typically stored in vendor-controlled cloud platforms, with minimal transparency on usage or access—leaving users without control over their personal health information.
- **Lack of Customization**: Off-the-shelf wearables are not designed for hardware flexibility, reducing adaptability across specialized use cases or unique environmental needs.
- **Unreliable Connectivity**: Consumer-grade devices often fail in challenging RF environments (e.g., hospitals, construction sites, mines), making them unsuitable for continuous and mission-critical data transmission.

Introducing QStat by Rajant Health

A Modular Wearable Hub Platform Designed to Meet Real-World Needs

The QStat wearable hub constitutes well over 30 sensors to systematically address each of these challenges with a feature-rich, medically relevant, and highly customizable platform:

How QStat Solves the Problem

- **Continuous Raw Data Streaming**: Enables full access to raw waveforms and metrics—ideal for AI-driven diagnostics and advanced analytics.
- **Advanced Sensor Fusion and Signal Processing**: Reduces motion-induced errors and noise, and enhances signal reliability, delivering clinical-grade accuracy.
- **Commercial Off-The-shelf (COTS) Sensor Integration**: Seamlessly connects with over 10 commercial off-the-shelf (COTS) sensors for multi-modal health and environmental monitoring.
- **Open APIs for Data and Control**: Eliminates vendor lock-in. Customers maintain full control of data pipelines and integration architectures.

- **Modular Hardware Architecture**: Designed for adaptability—rapidly incorporate new sensors, comms, or power modules as mission needs evolve.
- **Onboard Storage and Reliable Data Pipelines**: Built-in storage with customizable ingestion paths ensures lossless transmission in offline or constrained environments.
- **Flexible Communication Options**: Standard Wi-Fi and Bluetooth LE support out-of-the-box, with modular options for LTE, Satellite, or LoRa—ideal for environments requiring long-range, high-availability connectivity.
- **Smart Power Optimization:** Intelligent switching between communication modes extends operational life without sacrificing performance.

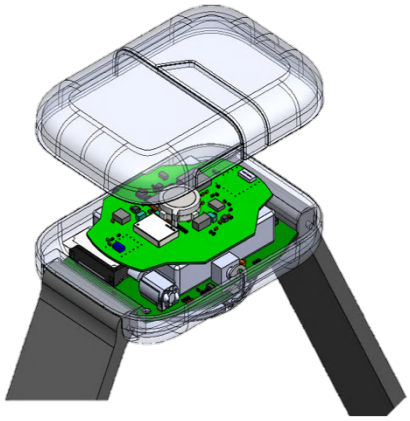

Figure 1 Modular Design based on multiple PCBs each for different functions: communications, processing, and sensors

Key Technical Specifications

- **Communications:** BLE, Wi-Fi, (options: LTE, Satellite, LoRa, NFC)
- **Storage:** 4 to 7 days of full data collection
- **Battery:** >1 day (with fast charging support)
- **Sensors:**
    - **Photoplethysmography (PPG):** Raw waveforms and vitals: HR, RR, HRV, SpO2.
    - **9-axis Inertial Measurement Unit (IMU)**: Accel., Gyro., & Mag.: activity, falls, etc.
    - **GNSS:** GPS, GLONASS, Galileo, BeiDou used for location tracking
    - **Proximity Sensor**: used in skin contact detection and compliance tracking
    - **Color sensor**: used for skin tone measurement
    - **Barometer**: measure sudden change in relative altitude used in fall detection
    - **Galvanic Skin Response Sensor**: measure skin conductance for stress & hydration
    - **EKG/ECG**: 1-lead (spot measurement)
    - **Temperature Sensor:** used for measuring skin temperature

    And several other optical and biometric sensors… **(contact RHI for more information!)**
- **Sensor Fusion Algorithms** implemented on-board the QStat enhanced with our **PATENTED** motion-artifact removal for improved accuracy
- **Audio:** Microphone, Speaker
- **User Interfaces:** High res. touch display, haptic feedback, multi-function programmable buttons
- **Haptic**: For alerts and notifications
- **Bluetooth Hub** functionality: Can simultaneously connect to over 10 BLE devices simultaneously
- **Modular PCB Design:** Separates processing, communication, and sensor functions for rapid customization and upgradability
- **Physical:** Compact (50 x 35 x 13 mm), Water-resistant IP67 5 ATM, (Pending) FCC, IC, Safety
- **Durability**: Complies with MIL-STD-810G
- **Updates:** Firmware-Over-The-Air (FOTA) updates using Wi-Fi and Bluetooth
- **Warranty:** Standard 1-year warranty

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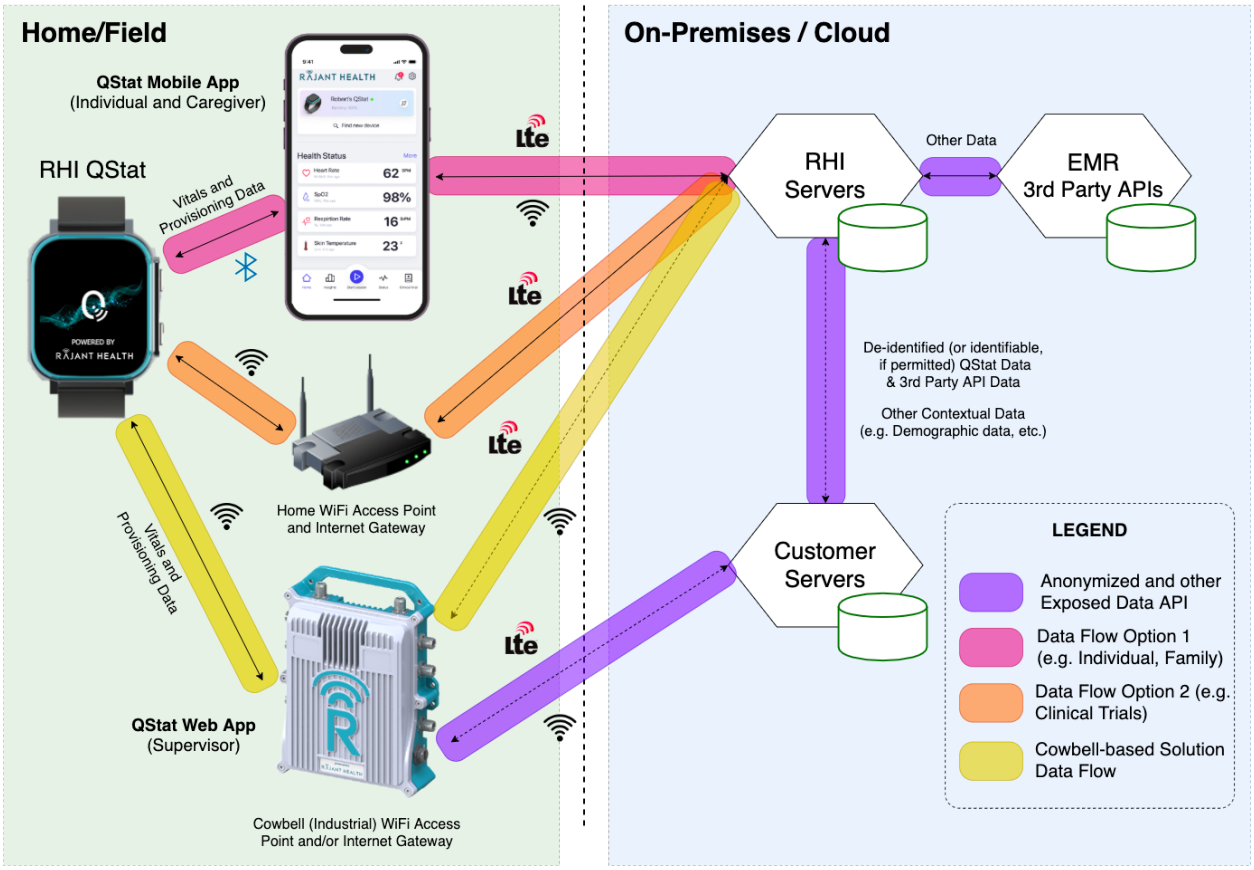
Improved Operational Agility via Flexible Deployment Pipelines

The QStat system is architected for **maximum flexibility**, enabling seamless deployment across home, clinical, and industrial settings. Its multi-modal data pipelines and infrastructure options allow for rapid adaptation to varying operational needs:



Individual / Family Use (Pink Path)

- Agility Strengths:
  - No additional infrastructure needed—data flows directly from wearable to mobile to cloud via LTE.
  - Rapid setup for home use and remote monitoring.
  - Ideal for chronic care, elder monitoring, or home-based rehabilitation.
- Deployment Time: Minutes
- Connectivity: BLE to mobile app, LTE/ethernet backhaul
- User Control: High (individual-level ownership via app)

Clinical Trials & Supervised Use (Pink/Orange/Yellow Path)

- Agility Strengths:
  - Supports structured, high-fidelity data capture through Wi-Fi gateways.
  - Passive monitoring without requiring subject interaction.
  - Ideal for decentralized clinical trials, hospital-at-home, or supervised cohort studies.
- Deployment Time: 1–2 days (gateway setup or via mobile app)
- Connectivity: Home Wi-Fi or BLE to mobile app, LTE/ethernet backhaul
- Data Ownership: Research sponsor or healthcare provider

Industrial / Field Use (Yellow Path)

- Agility Strengths:
  - Operates in connectivity-constrained environments via the Cowbell industrial Wi-Fi gateway.
  - Ruggedized for harsh conditions (e.g., mining, defense, oil & gas).
  - Real-time data relay to supervisors or safety monitors.
- Deployment Time: Hours to days depending on site
- Connectivity: Local Wi-Fi + mesh, LTE/ethernet backhaul
- Use Cases: Workforce safety, mission health, compliance

Data Ecosystem Integration (Purple Path)

- Agility Strengths:
  - Provides interoperability with external systems, such as EMRs, customer servers, or research databases.
  - Supports both anonymized and identifiable data depending on permissions.
  - Enables rapid onboarding of third-party services and cross-organizational analytics.
- Deployment Time: Days to weeks (API integration)
- Use Cases: Longitudinal studies, population health, enterprise insights

Summary of Agility Features

Use Case	Infra Needs	Setup Speed	Connectivity Flexibility	Best For
Individual	Low	Fast	BLE via mobile	Home care, personal wellness
Clinical	Moderate	Medium	Wi-Fi + LTE or BLE via mobile	Trials, monitored care
Industrial	Medium	Medium	Wi-Fi + mesh, rugged LTE	Safety, remote ops
Ecosystem	High	Variable	Cloud APIs	Research, enterprise data ops

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Appendix B: Pricing Model

The QStat pricing model is structured to provide flexibility across different deployment scales and customer needs. It includes a one-time hardware cost for the QStat wearable hub, which comes equipped with sensors and firmware for monitoring health and activity data. Optional accessories such as charging docks or ruggedized cases are available to suit different environments, including clinical, industrial, or field deployments.

In addition to the hardware, QStat operates on a monthly subscription model for software and cloud services. This subscription is offered in multiple tiers:

- **Basic Tier** includes essential features like data syncing, standard dashboards, and device health monitoring, over-the-air updates, and basic vitals (e.g., HR, RR, HRV) and analytics such as motion classification, sleep/wake classification.
- **Pro Tier** includes access to raw data and adds more advanced analytics utilizing the advanced sensors to derive biometric insights.
- **Enterprise Tier** is designed for large-scale or mission-critical applications, offering custom algorithm support, integration with third-party systems, enhanced security, and priority support.

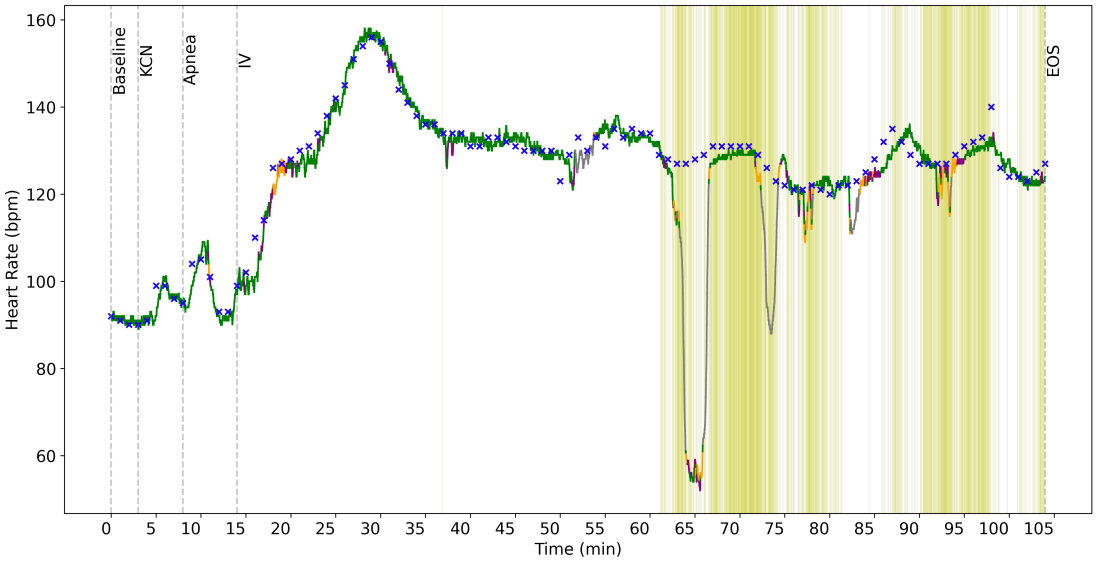
Optional services can be added to further tailor the deployment, such as onboarding and training, custom algorithm development, and dedicated support and maintenance. Volume discounts and long-term contract options are also available to align with budgetary and operational planning needs.

This pricing model enables organizations to scale as needed—starting with a small pilot or deploying across hundreds or thousands of users—while ensuring long-term support, data ownership, and operational flexibility.

Appendix C: Data Validation Studies

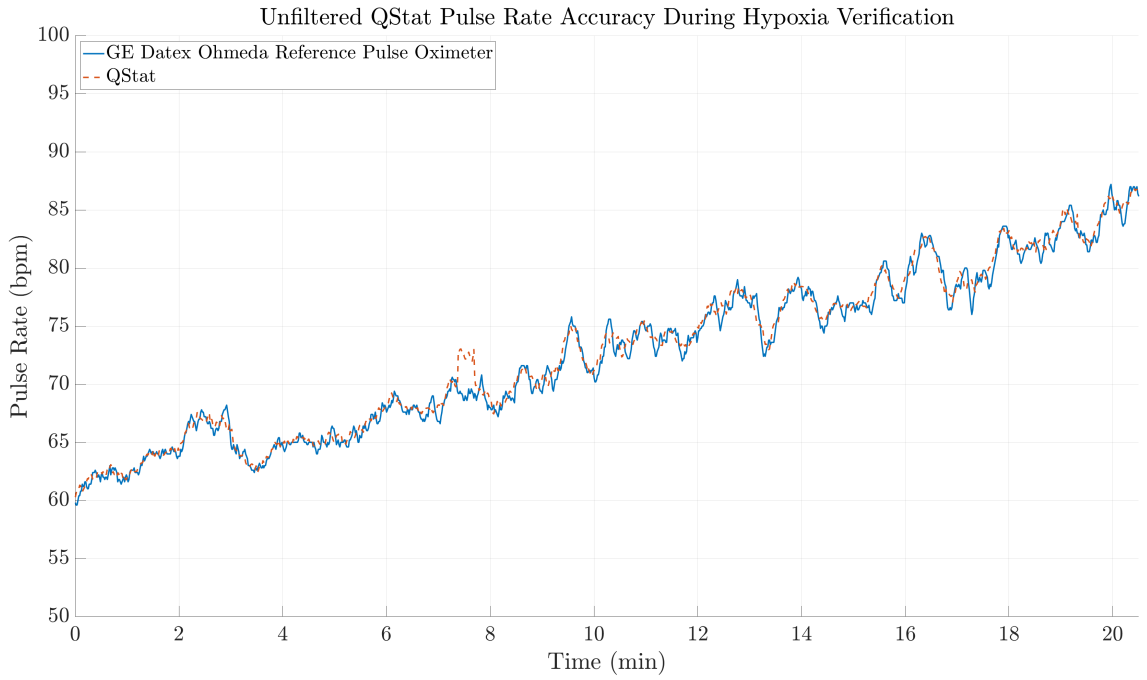
Validation Result 1 – Pulse Rate (Heart Rate) during Preclinical Study at CU Anschutz

Plot below shows the comparison between an FDA cleared patient monitor, Drager's heart rate from ECG and QStat's pulse rate from PPG during a pre-clinical study at CU. Heart rate (HR) from the Drager/Patient Watch ECG sensor is plotted against pulse rate (PR) from the QStat PPG sensor (25 Hz) for a pig. Drager/Patient Watch data is represented by the blue x. Q-Stat data is represented by various colors based on the 'hr_confidence' score which is a quality metric associated with each HR datapoint. A gray line represents a 'hr_confidence' of 0, an orange line represents a 'hr_confidence' of 25, a purple line represents a 'hr_confidence' of 50, and a green line represents a 'hr_confidence' value greater than 50. This color coding provides a visual cue to understand the confidence level of the heart rate reading at each data point. Datapoints corresponding to improper skin contact, as measured by the QStat, was omitted. Periods of significant motion (greater than the defined threshold) from QStat PPG dataset is highlighted with a yellow background. Annotations noted during the observational period are marked by vertical dashed gray lines with one of the following labels: "Baseline" for baseline parameters and start of the study; "KCN" for the start of cyanide infusion; "Apnea" for observed apnea; "IV" for the start of phosphate/saline infusion; "EOS"/"EOS – Tox" for euthanasia at the end of the observational period or when the animal has died from KCN toxicity, respectively.



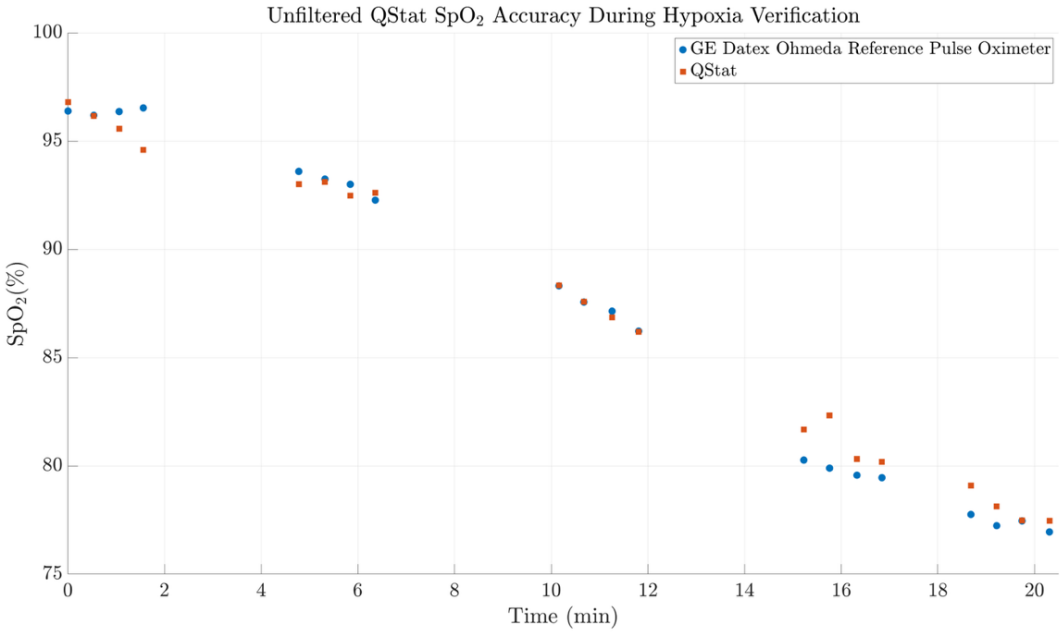
Validation Result 2 – Pulse Rate (Heart Rate) during Hypoxia Study

The plot below demonstrates the unfiltered pulse rate measurements from the QStat wearable device compared against a clinical-grade GE Datex Ohmeda reference pulse oximeter over a 20-minute hypoxia verification session. The QStat closely tracks the reference device throughout the session, showing excellent alignment in both trend and value. The QStat wearable shows reliable, near-clinical-grade pulse rate accuracy even in physiologically challenging conditions, supporting its use in remote monitoring, clinical research, and health-at-home settings.



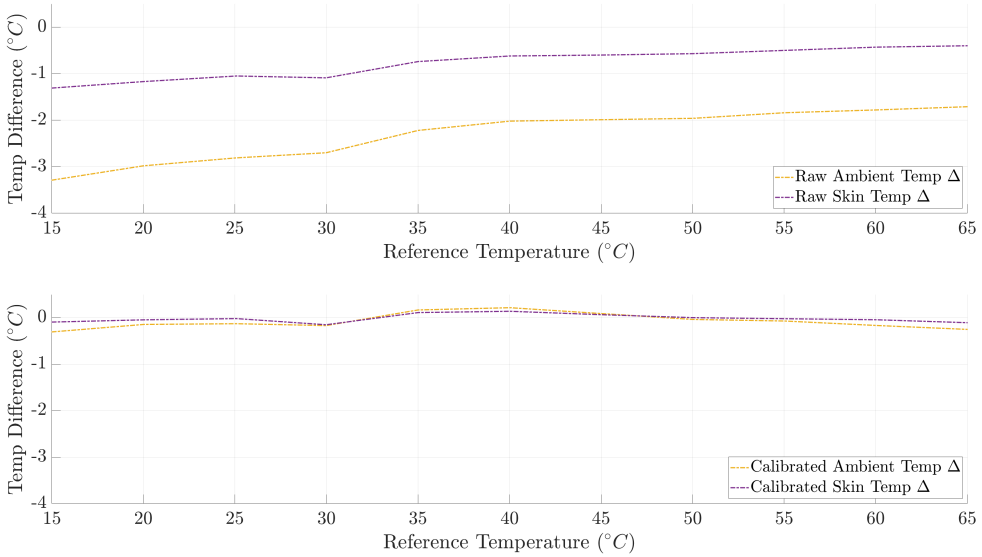
Validation Result 3 – SpO2 during Hypoxia Study

The plot below demonstrates the unfiltered SpO2 measurements from the QStat wearable device compared against a clinical-grade GE Datex Ohmeda reference pulse oximeter over a 20-minute hypoxia verification session. The QStat closely tracks the reference device throughout the session, showing excellent alignment in both trend and value. The QStat wearable shows reliable, near-clinical-grade SpO2 % accuracy even in physiologically challenging conditions, supporting its use in remote monitoring, clinical research, and health-at-home settings.



Validation Result 4 – Skin and Ambient Temperature during Environmental Study

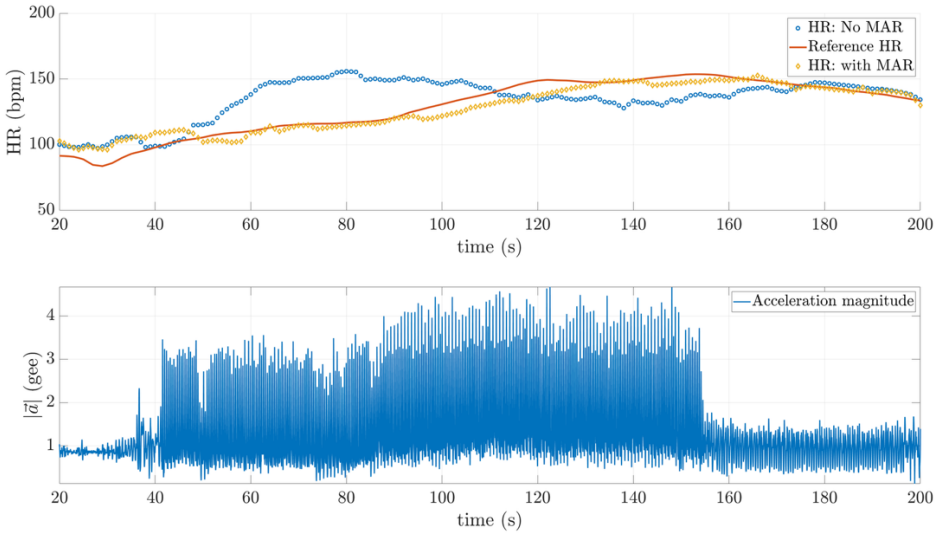
The plot below demonstrates the raw skin and ambient temperature measurements from the QStat wearable device compared against an industrial-grade temperature chamber reference temperature readings over a 65-minute environmental study. The QStat's calibrated temperature values closely tracks the reference temperature values throughout the session, showing excellent alignment in both trend and value.



Validation Result 5 – Impact of Motion on the Accuracy of Heart Rate

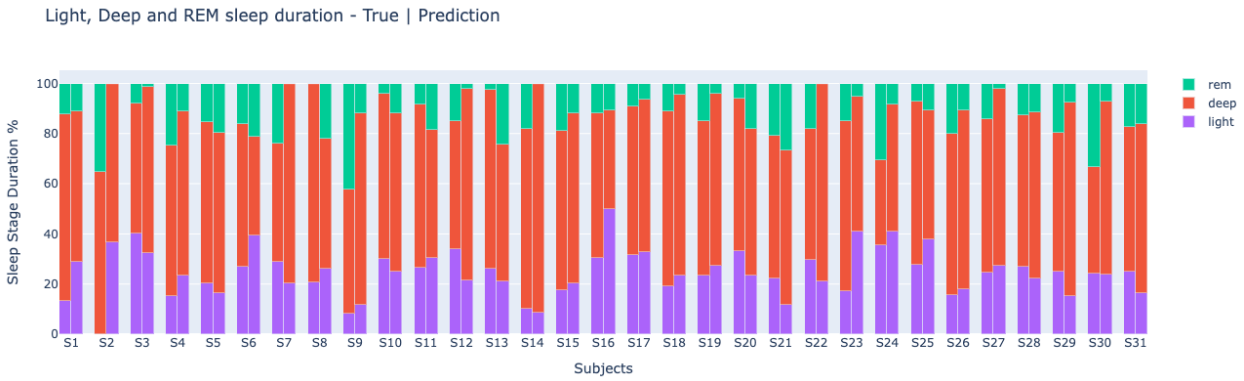
The plot below highlights the benefits of using PPG and IMU fusion to improve heart rate (HR) accuracy during motion. Our **patented** Motion Artifact Removal (MAR) algorithm significantly enhances HR tracking when the subject is in motion. The top plot compares HR estimates with and without MAR,

showing clear improvements during active periods. The bottom plot shows accelerometer magnitude, indicating motion intensity. Without MAR, HR estimation becomes unreliable during high motion. In this publicly available dataset, MAR improved HR accuracy by nearly 300%, demonstrating the effectiveness of our sensor fusion algorithm.



Validation Result 6 – Sleep Stage Classification from Public Datasets

Our sleep stage classification system is a multi-sensor, modular framework that processes gyroscope, accelerometer, and heart rate data to detect in-bed status and classify sleep stages. The pipeline begins with an in-bed detection module that incorporates user-logged or estimated sleep onset time and sensor activity to determine whether the subject is in bed. If the subject is in bed, the system applies the Cole-Kripke algorithm to distinguish sleep from wake states and extracts features from heart rate and movement data in 1-minute windows. These features are used to classify sleep into Light (N1/N2), Deep (N3), and REM stages based on characteristic heart rate trends. The system outputs both sleep metrics (e.g., total sleep duration) and stage-level labels, enabling continuous, real-world sleep monitoring without reliance on lab-based polysomnography.



The sleep stage distribution chart illustrates our predicted proportions of Light Sleep (N1/N2), Deep Sleep (N3), and REM Sleep across 31 subjects using a publicly available dataset. Each subject's sleep is represented as a stacked bar showing the percentage of time spent in each stage. Deep sleep consistently constitutes the largest portion, with an average of 64.18% ± 11.49, followed by REM sleep at 25.6% ± 9.53, and light sleep at 10.22% ± 7.52.