



wavelet

THE WEARABLE PLATFORM
FOR HEALTH RESEARCH



PLATFORM OVERVIEW

A new healthcare platform, for a new era of health

Medical Grade

- For patient diagnosis
- Condition specific biometric data
- Accessible data
- Limited & fixed mobile phone apps
- Fixed sample rate from sensors
- High cost/unit
- Proprietary and closed platform

wavelet Clinical Trial Grade

- For research & product development
Rich longitudinal data
Accessible data
Customizable apps
Adjustable sample rate
3rd party device integration
Platform licensing

Consumer Grade

- For motivating consumers, patients
- Limited, sometimes inaccurate data
- Limited access
- Fixed mobile phone apps
- Fixed sample rate from sensors
- Low price/unit
- Some license others do not

Capable of aggregating a wide range of physiological signals for enhancing insights and knowledge in clinical research

PLATFORM WORKFLOW

Transform wearable device information to clinically-relevant health insight



Easy-to-use wearable
device to capture data

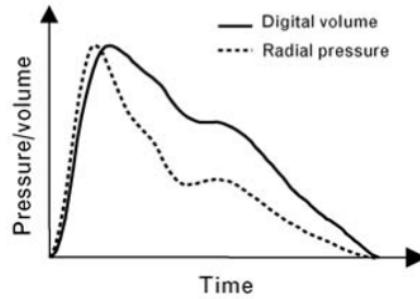
iPad/mobile apps to
collect and transmit data

Cloud servers and web interface to receive,
analyze, store and download data

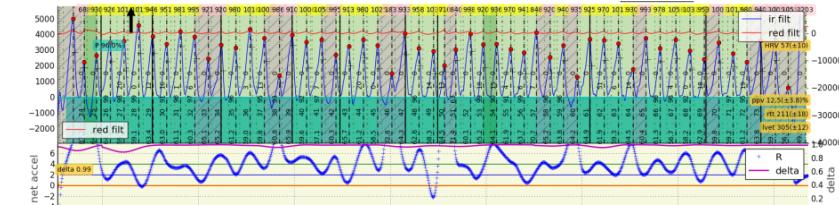
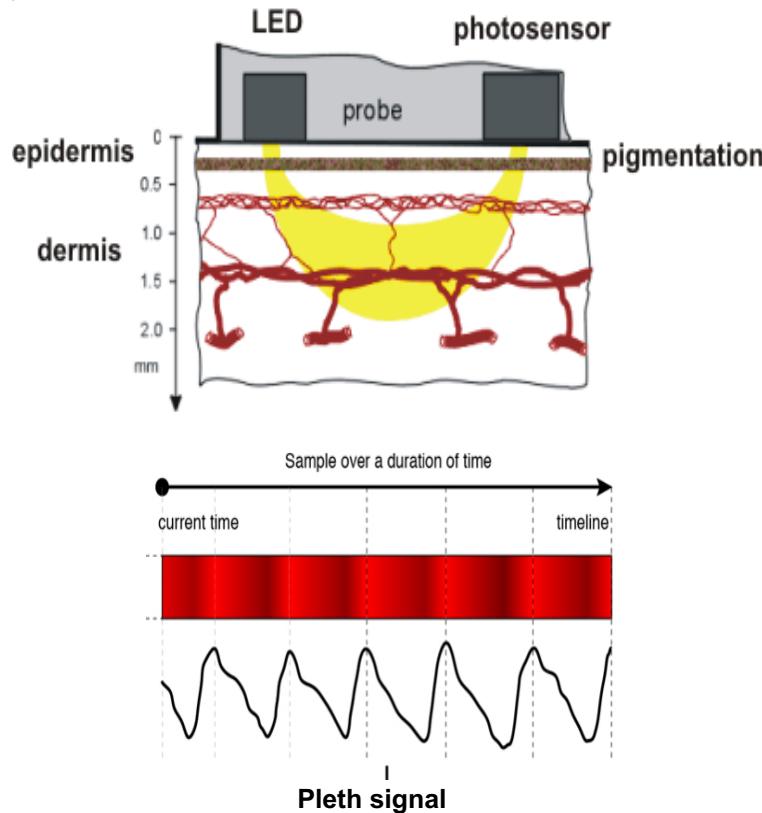
Collect, transfer, analyze, download patient wearables data through the fully integrated platform.

HIGH QUALITY PHOTOPLETHYSMOGRAPHY (PPG)

Non-invasively collect physiological signals at the skin surface to derive clinical insights



Millasseau et al. 2006 Hypertension



Beat-to-beat signal qualification with sensor fusion

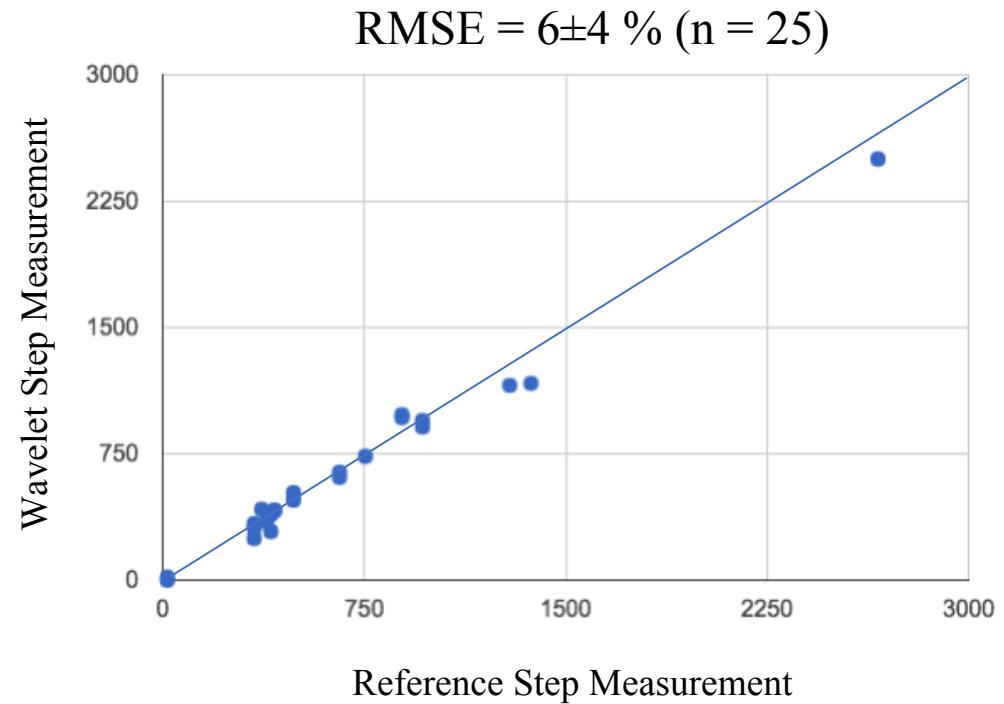
ACTIVITY TRACKING WITH WAVELET

Accelerometer and gyroscope data fusion for accurate motion information



Sensors PPG light sensor
 3-axis accelerometer,
 3-axis gyroscope

- ✓ Raw acceleration/gyro
- ✓ Steps
- ✓ Physical Activity
- ✓ Sleep Latency
- ✓ Total Sleep Time
- ✓ Sleep Efficiency
- ✓ Nocturnal biometrics



ADVANCED ACTIGRAPHY FOR ACTIVITY CLASSIFICATION

Multiple devices to capture whole body movement and allow activity classification

Typical Activities Classified

Walking

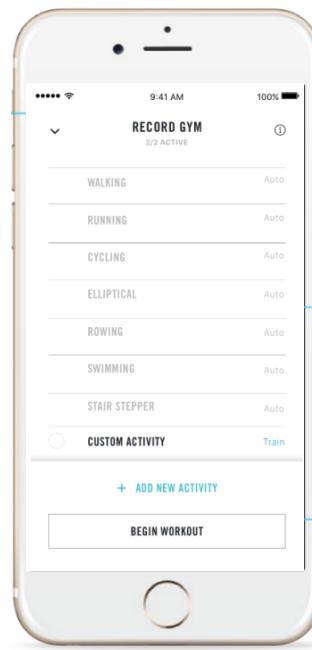
Running

Cycling

Elliptical

Stair Stepper

Swimming



Classify over 100 self-trained activities leveraging 12 dof full body motion.

BIOACUSTIC SIGNAL RECORDING

Wideband physiological audio signal analysis along with activity and temperature tracking



Sounds Recorded & Processed

Natural language processing

Breathing

Wheezing

Snoring

Sneezing

Coughing

Heart sounds (when placed on the chest wall)

Clips on the shirt to track and analyze cardiorespiratory sounds physical activity for 36 hours.

3rd PARTY DEVICE INTEGRATION

Flexible platform architecture to integrate various sensing technologies and connected devices



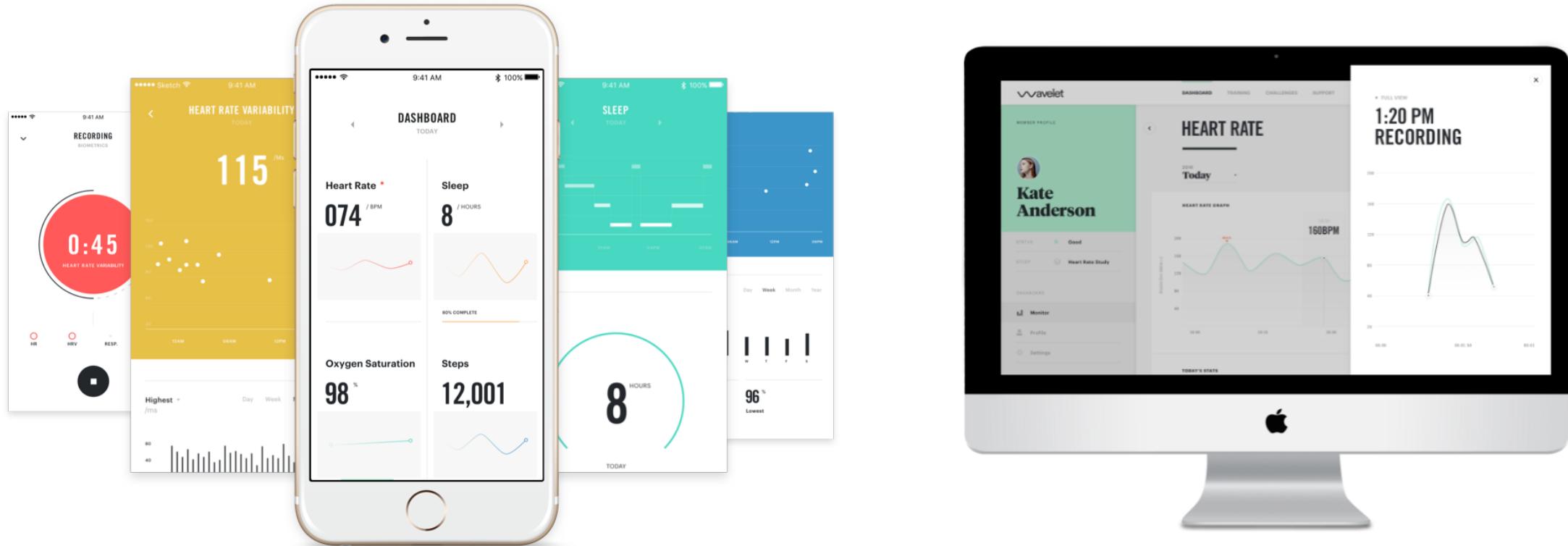
**Connected smart-pill container
with humidity and
temperature sensors**



**Continuous core-body
temperature monitoring**

ACROSS THE BOARD CUSTOMIZATION

Devices, mobile and web Apps customizable to address your research and companion digital health product needs



VALIDATION STUDY OVERVIEW

Cardiovascular

- (1) Assessment of digital pulse waveform changes in Hypertrophic Cardiomyopathy (HOCM) Patients receiving investigational drugs
- (2) Assessment of digital pulse waveform changes in Dilated Cardiomyopathy (DCM) patients receiving investigational drugs
- (3) Prediction of major risk factors in congestive heart failure using remote monitoring with biosensors
- (4) Clinical Validation of Wavelet Biometrics (HR, HRV, ET, BR, VSI)
- (5) Assessment AF burden during sleep with a wrist-worn biosensor (HRS and Europace Conferences)
- (6) Comparison of functional capacity (VO₂max) and physical activity changes in HOCM/HF patients
- (7) Outpatient monitoring of pulse wave morphology to assess comorbidity in HOCM patients
- (8) Predictive analytics to prevent adverse events in interstage infants with congenital diseases

Sleep & Respiration

- (9) Validation of SpO₂ during rest compared to blood gas measurements
- (10) Utility of wristband device as a portable screening tool for obstructive sleep apnea (ESC Conference)

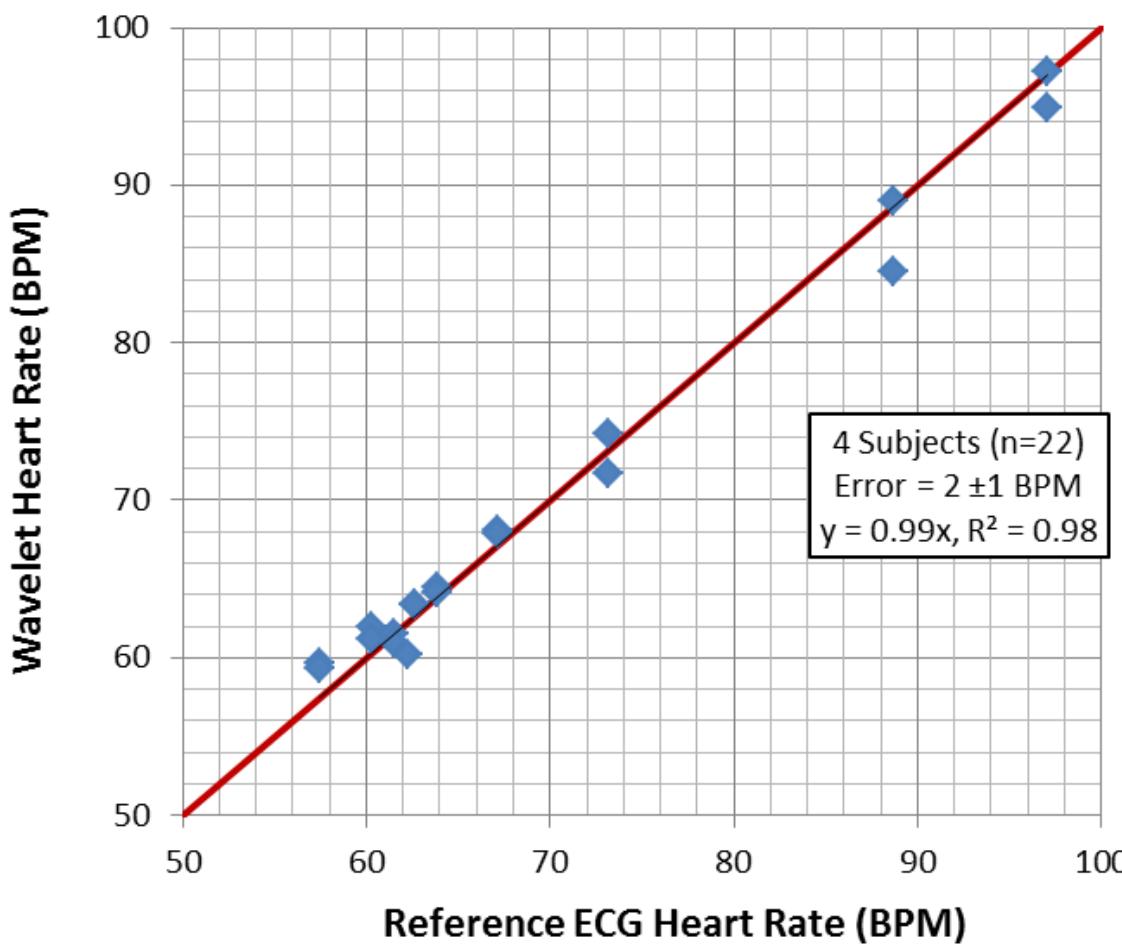
Others, Physical Activity & Functional Performance

- (11) Evaluation of qualify of life in radiation oncology patients using wearable devices
- (12) Post-discharge physiologic tracking of transsphenoidal pituitary patients using a wrist-mounted device
- (13) Validation of step counts, cadence, activity recognition
- (14) Rehabilitation of foot drop through motion/gait analysis using wearable devices

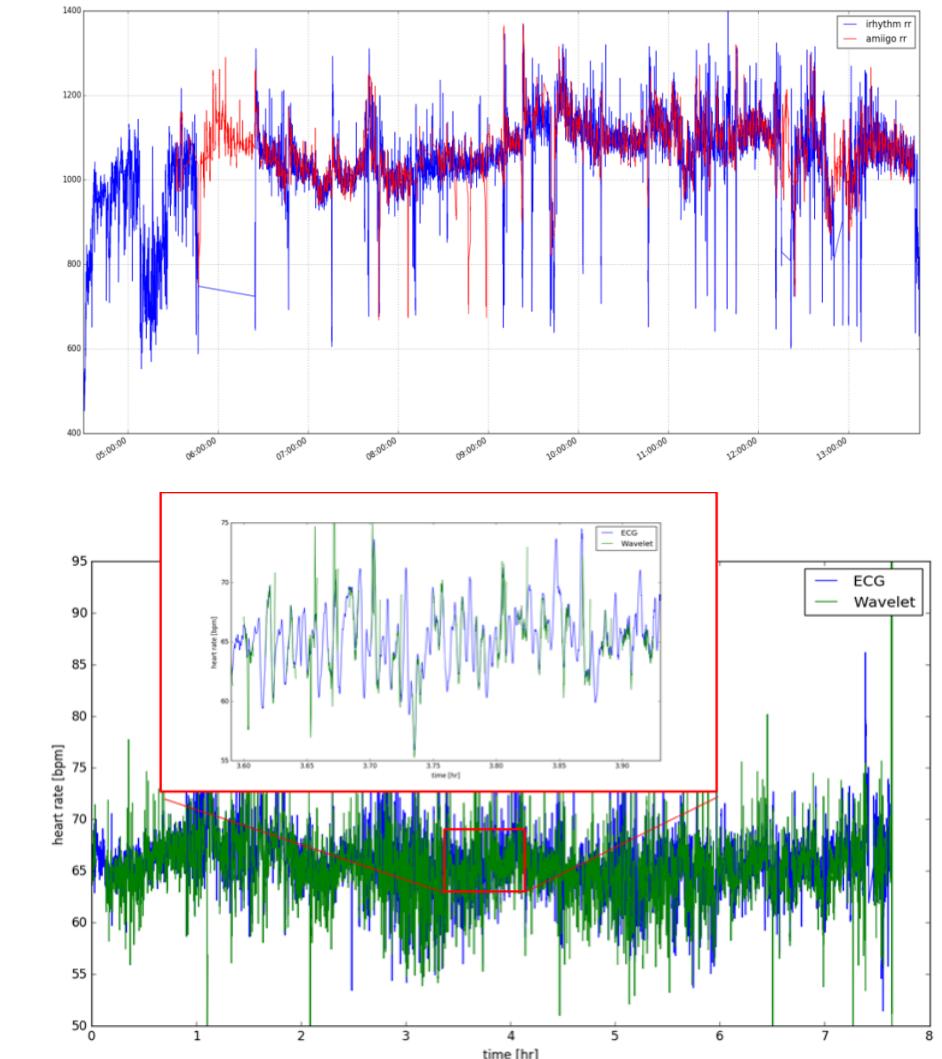
Heart Rate Accuracy: 3 ± 2 BPM (RMSE)

heart rate measurements confirmed compared to 12-lead ECG and patch devices

PPG HR measurements matched within 2 ± 1 BPM to the reference research grade ECG (BME/SJSU)

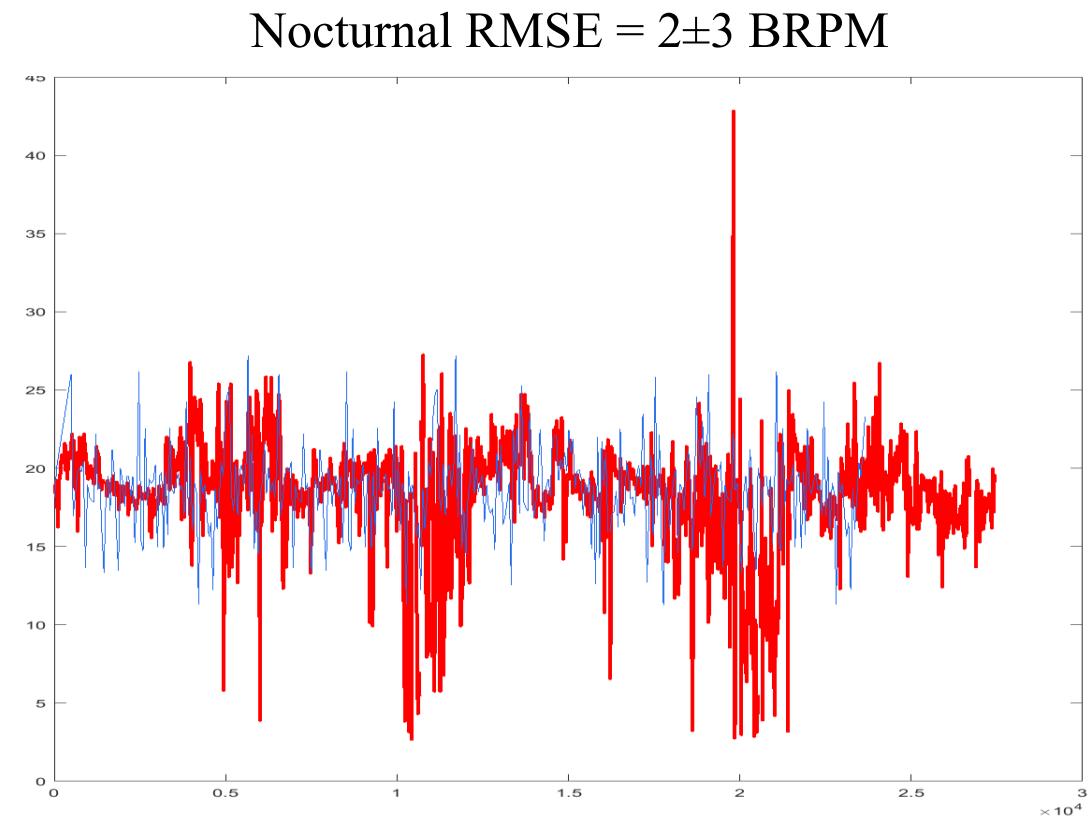
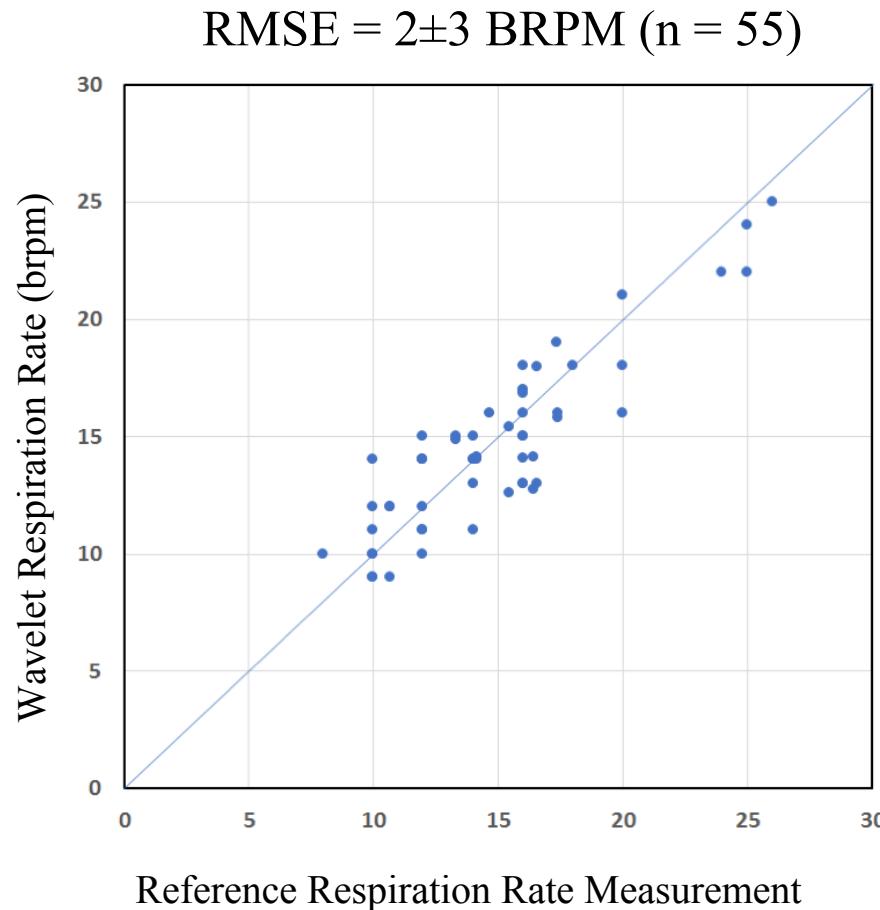


PPG RR interval estimations match closely with measurements from Zio Patch (iRhythm) over several nights. – Scripps/UCSD



Respiration Rate Accuracy 2 ± 3 % (RMSE)

Wavelet respiration rate compared to reference respiration analyzer measurements



CURRENT VALIDATION FOCUS AREAS

Sleep & Respiration

- Sleep Duration
- Sleep Efficiency
- Respiration Rate
- Blood Oxygen Saturation (SpO₂)
- LF / HF
- Sleep Stages

Cardiovascular

- Heart Rate
- Heart Rate Variability
- Vascular Resistance
- LV Ejection Time
- Perfusion Index
- Pulse Volume Variation
 - Pulse Pressure Variation
- Ankle Brachial Index

Functional Performance

- Steps
- Exercise/Activity Classification
- Energy Expenditure
- Gait/Cadence
- Balance