

Wearable Metabolic Sensor to Inform Real-Time Warfighter Readiness, Energy Management, and Performance Optimization

Adam B. Lanik, MS, MBA; Russell W. Elliot, MS; Jerome P. Fanucci, PhD

ZKxKZ
LLC

PANEL 1

THE OPERATIONAL CHALLENGE

Military readiness requires direct metabolic insight.

Warfighter readiness depends on sustaining energy, managing fatigue, and adapting to environmental stressors. Current approaches rely on indirect physiological proxies such as heart rate and generalized nutrition guidance. These proxies do not directly reflect metabolic state, limiting actionable decision-making that optimizes performance, energy management, and readiness.

WHY IT MATTERS



OPTIMIZE WARFIGHTER READINESS

Sustain performance across training and operations.



MANAGE ENERGY

Personalize fueling and workload based on measured metabolism.



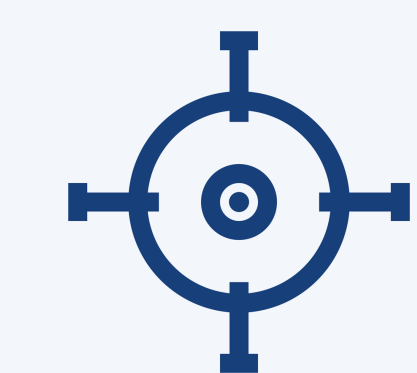
REDUCE FATIGUE

Identify physiological strain before performance degrades.



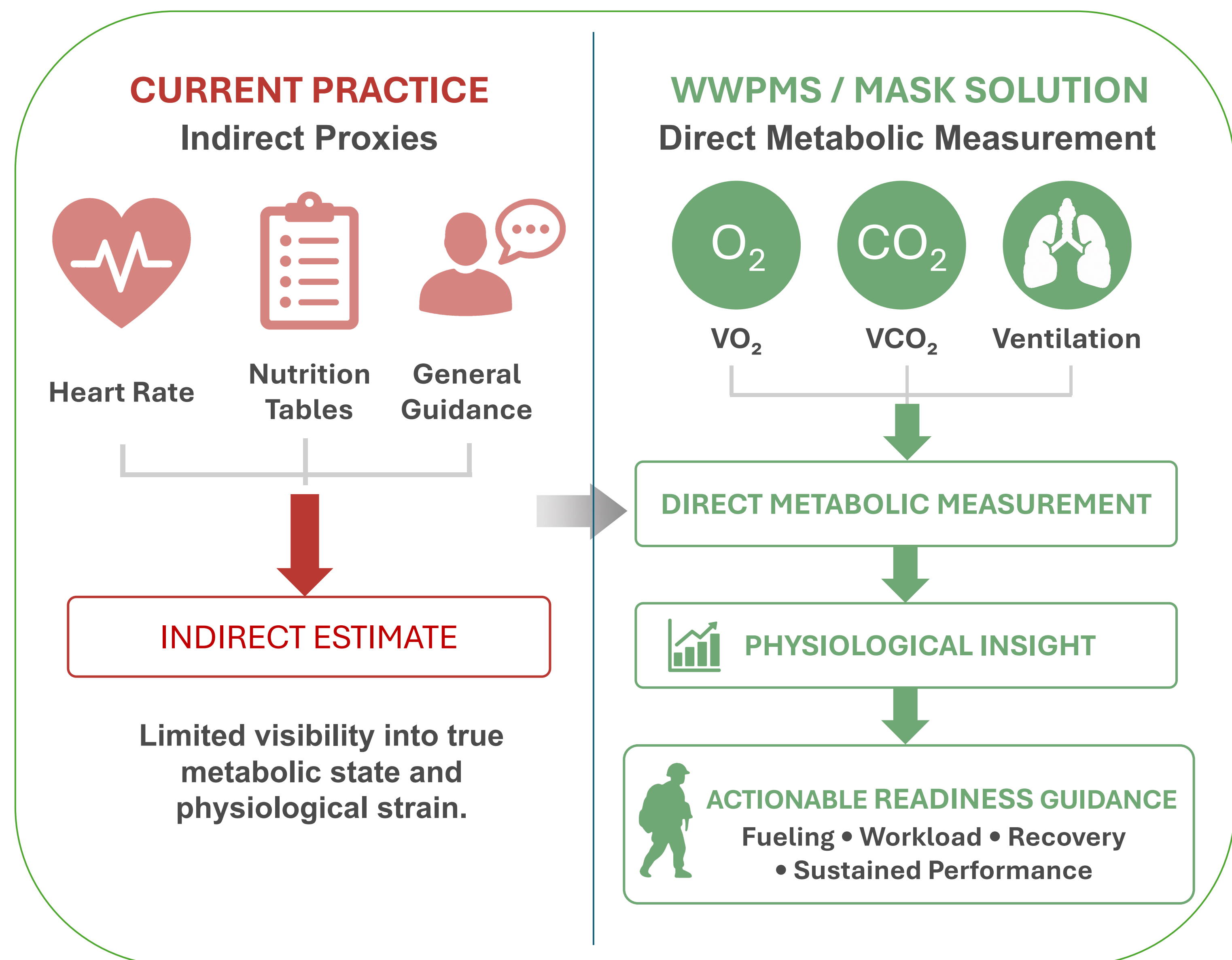
IMPROVE DECISION MAKING

Replace indirect estimates with direct metabolic measurement.



DHA SBIR OBJECTIVE

Develop a compact, wireless wearable metabolic sensor capable of laboratory-quality metabolic measurements outside traditional laboratory environments, enabling real-time physiological decision support for Warfighters.

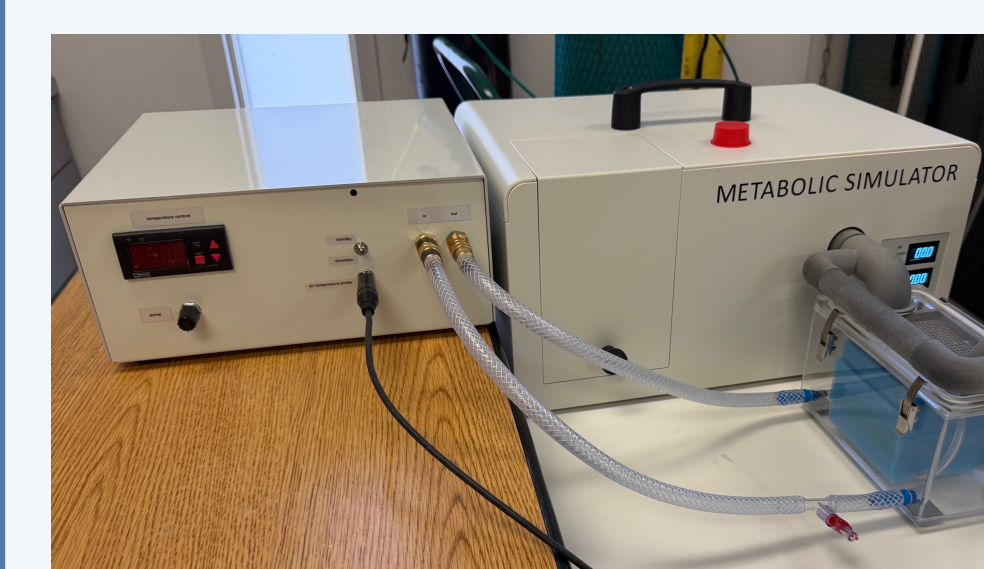
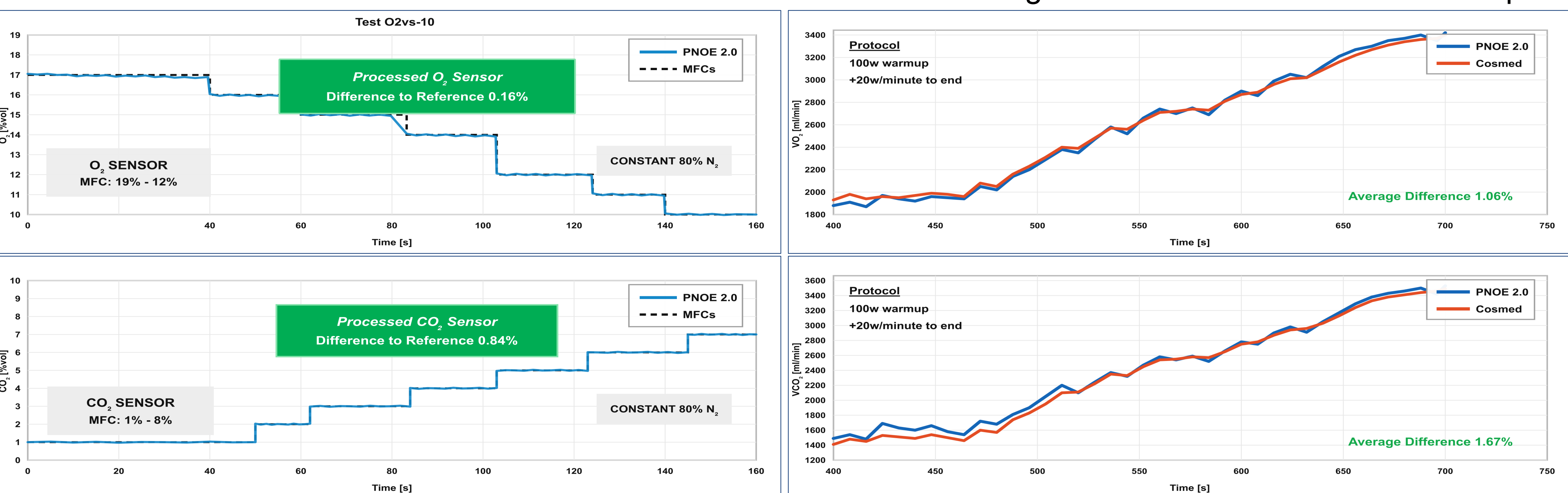


PANEL 3

VALIDATION & QUALIFICATION

Laboratory-quality metabolic measurements with a path to operational qualification.

Prototype testing demonstrates close agreement with laboratory reference systems across controlled gas mixtures and human exercise protocols.



METABOLIC SIMULATOR

Foundation for Accuracy
• Certified gas mixtures (O₂, CO₂, N₂)
• Repeatable and stable respiratory profiles
• Used throughout development for sensor verification and system calibration
• Enables precise, controlled validation of measurement accuracy

RESULT

WWPMS delivers accurate, reliable metabolic measurements in a compact, wireless wearable system.



ENVIRONMENTAL QUALIFICATION

Engineered for the Operational Environment
• Controlled environmental chamber is used to validate performance in a wide range of military environments.
• Temperature: 33°F to 110°F
• Humidity: up to 99% RH (non-immersive)
• Operational stressors: dust, mud, vibration, repeated movement
• Human environmental testing planned in late-stage program

Ensures reliable performance across representative military operating conditions and mission demands.



RIGOROUS VALIDATION AND ENVIRONMENTAL QUALIFICATION BUILD CONFIDENCE IN ACCURACY AND OPERATIONAL RELIABILITY.

Laboratory-quality measurements. Engineered for the field.

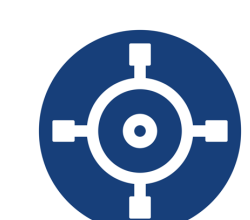
PANEL 2

THE WWPMS SOLUTION

Engineering direct metabolic measurement into actionable readiness guidance.

WWPMS transforms laboratory-quality metabolic measurements into individualized insights that inform fueling, training, workload management, and recovery—enabling optimized performance and readiness.

KEY ENGINEERING OBJECTIVES



MEASUREMENT ACCURACY

Laboratory-quality data in field environments.



WEARABLE & COMFORTABLE

Lightweight, unobtrusive, designed for extended wear.



EASE OF USE

Simple operation and rapid setup for any user.



EXTENDED BATTERY LIFE

Designed for long-duration operations and training.



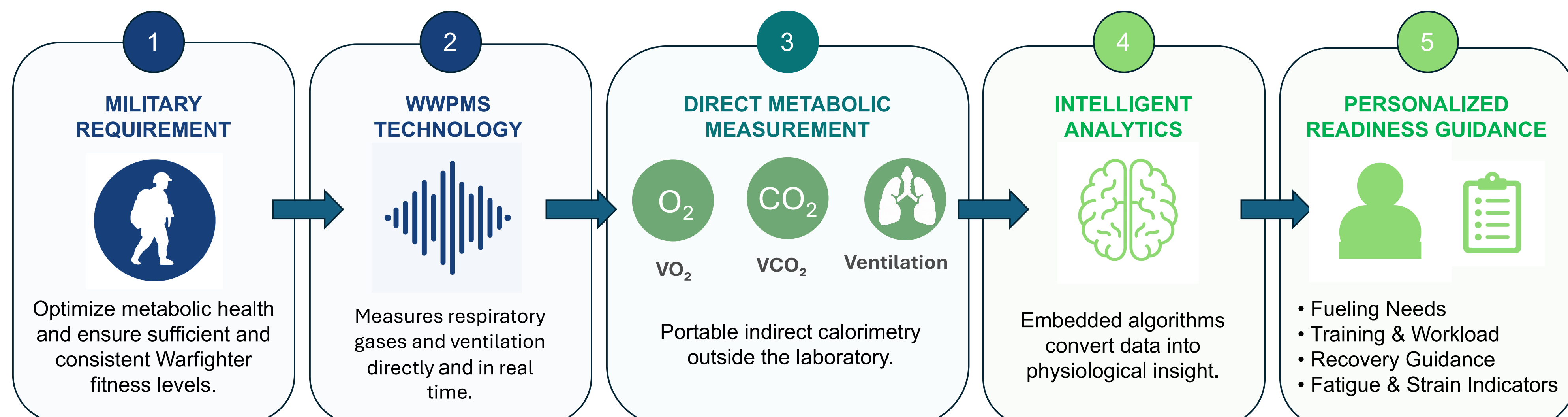
OPERATIONAL COST

Low cost per use through reusable design.



FIELD DEPLOYABILITY

Built for the rigors of military training and operations.



PERSONALIZATION AT THE CORE

Rapid assessments (<30 minutes) establish individualized metabolic profiles and zones. Extended monitoring quantifies energy demand and fatigue to inform real-time decisions.

ENABLES TWO POWERFUL OPERATIONAL USE CASES



RESEARCH IN EXTREME & UNIQUE CONDITIONS

Place operational personnel in tough or unusual environments (heat, cold, altitude, stress, restricted sleep, etc.) to observe metabolic responses—impractical with a metabolic cart.



GRAND EXPERIMENTS AT SCALE

Outfit 100–200+ Warfighters with WWPMS devices during training or operational missions. Collect and analyze diverse physiological data to drive evidence-based decisions.

DESIGNED FOR DHA OPERATIONAL REQUIREMENTS



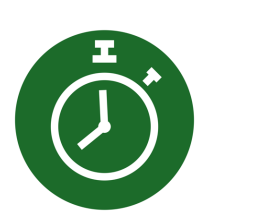
Direct respiratory gas measurement (VO₂, VCO₂, VE)



Ambient air calibration



Portable indirect calorimetry in the field



Rapid assessments (<30 minutes)



Extended monitoring during training and operations



Personalized metabolic profiles and zones

PANEL 4

INTRODUCING MASK

Prototype Metabolic Analysis System Kit



WEARABLE DURING EXERCISE



COMFORTABLE & SECURE

Ergonomic design maintains a stable seal throughout movement.

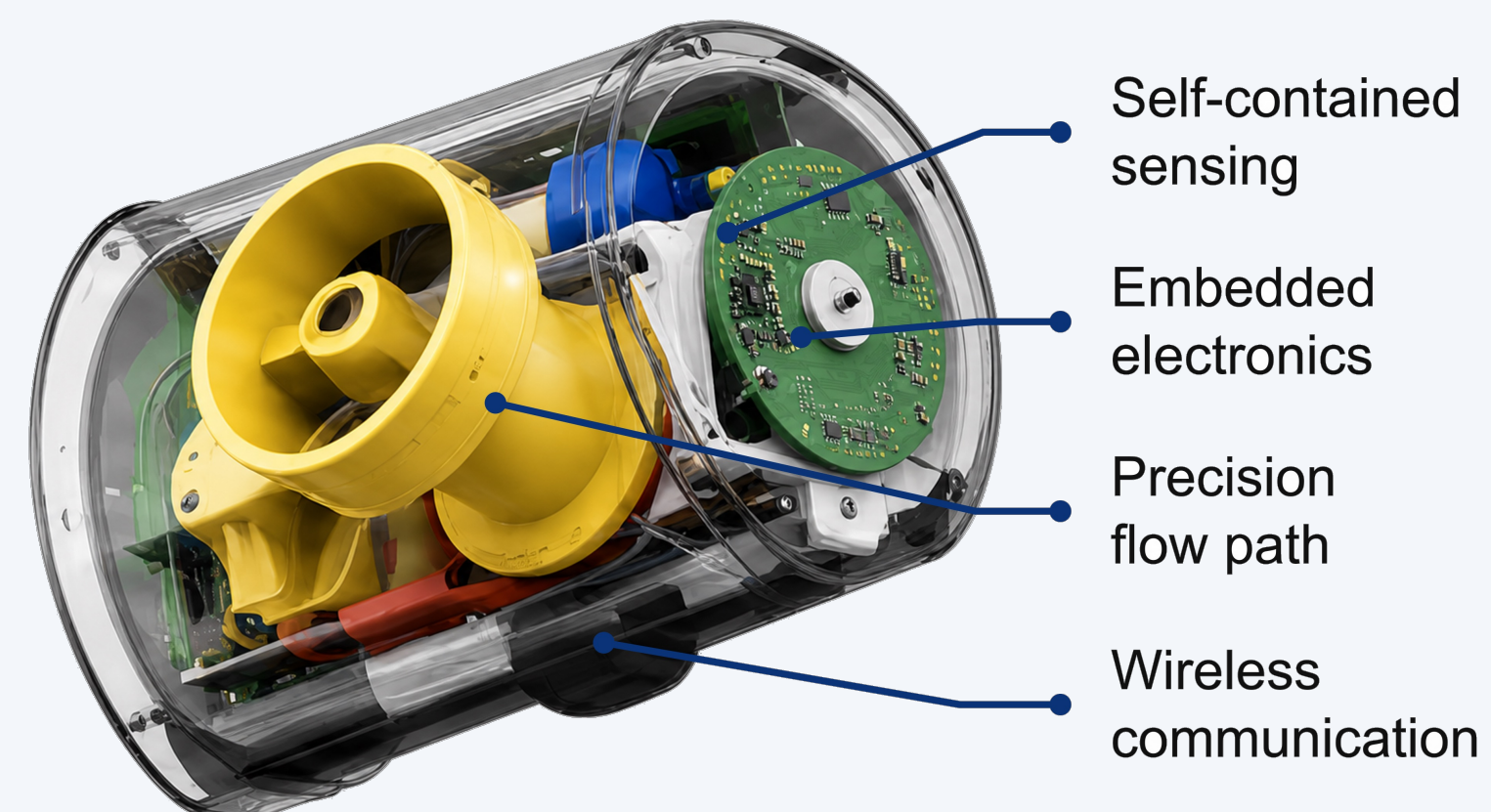
DESIGNED FOR REAL-WORLD USE

Optimized for treadmill, field exercise, and operational environments.

DATA YOU CAN TRUST

Minimal motion artifact for high-quality metabolic measurements.

INSIDE THE MEASUREMENT UNIT



All sensing, processing, and communications are integrated into a compact, self-contained unit.

COMPACT & INTEGRATED

Lightweight, low profile, and engineered for comfort and stability during movement.

BUILT FOR PERFORMANCE

Secure fit and balanced design minimize motion artifact and maximize data quality.

PROTOTYPE SYSTEM

Developed under the DHA SBIR program and currently in test, validation, and qualification.

GROW PLUS MOBILE APPLICATION



GUIDED PROTOCOLS

Structured tests for rest, exercise, and submaximal assessment.

REAL-TIME VISUALIZATION

Live metabolic data with key indicators and trends for immediate insight.

ACTIONABLE INSIGHTS

VO₂, VCO₂, RER, and substrate utilization to inform training, readiness, and recovery.

Engineered. Validated. Built for the Warfighter.

A portable metabolic analysis system delivering laboratory-quality measurements in operational environments.

