APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED

Soldier and Small System Energy

S&T Campaign: Sciences for Maneuver
Intelligent Power

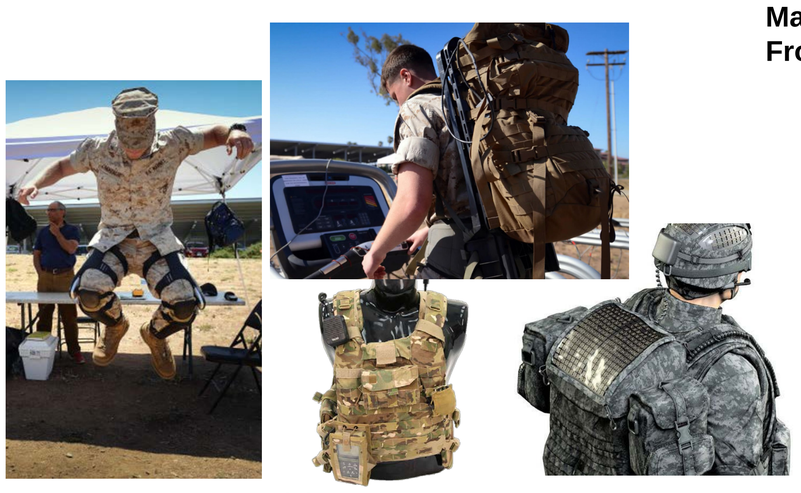
Dr. Christopher Meyer, 301-394-4286
christopher.d.meyer1.civ@mail.mil

Dr. Patrick Taylor, 301-394-1475
c patrick.j.taylor36.civ@mail.mil

Dr. Brendan Hanrahan, 301-394-1960
brendan.m.hanrahan.ctr@mail.mil

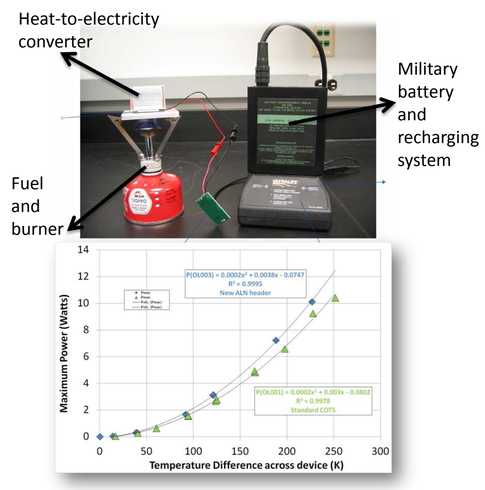
Research Objective

- Enable intelligent power systems to enable extended duration, expeditionary-type missions with minimal physical burden and without the need for resupply



Wearable Energy Harvesters

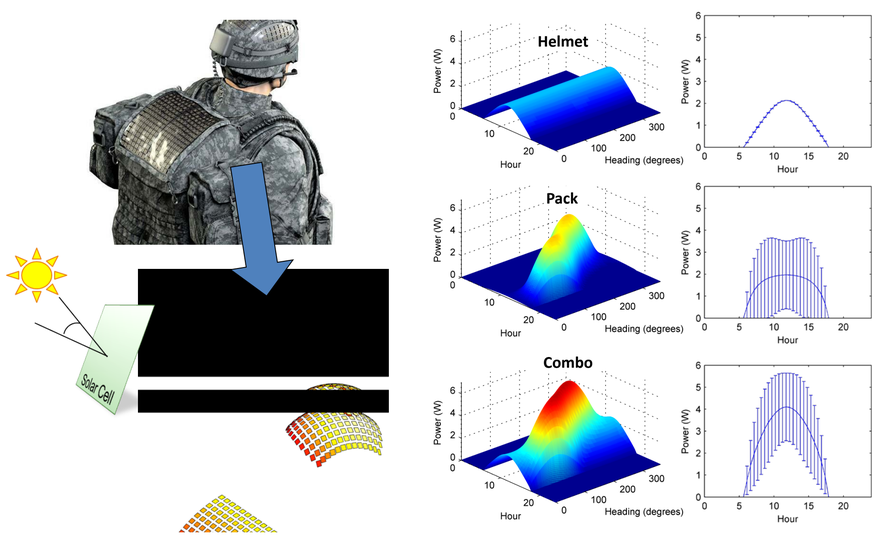
Man-portable Battery Recharging From Scavenged Waste Heat



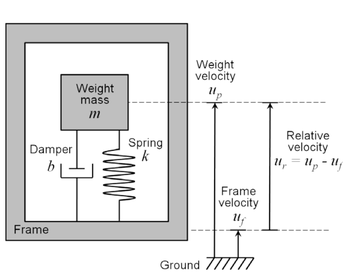
- Very High Power Density Values: = 10 Watts/0.0016m² ~ >5000 Watts/m²

Challenges

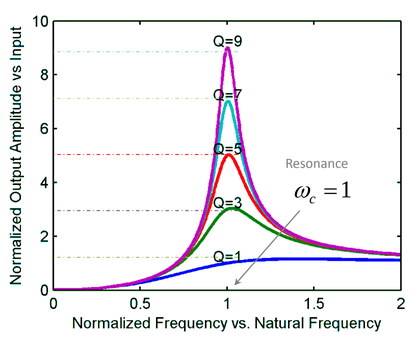
- Energy harvester output is highly dependent on environmental variables and usage-case scenarios, while operational benefit is strongly tied to predictability of output
- Models must account for realistic usage profiles and cover multiple scales from system level to device physics level for adaptability
- Materials with high transduction efficiency for thermal to electrical energy conversion



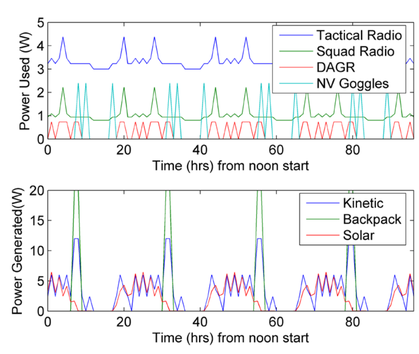
Conformal photovoltaic panels in motion



Electromechanical energy harvesting



Quality factor: Frequency selectivity vs. power output

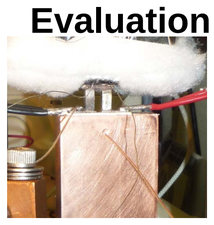


Predicted energy usage and generation for mock scenario

ARL Facilities and Capabilities Available to Support Collaborative Research

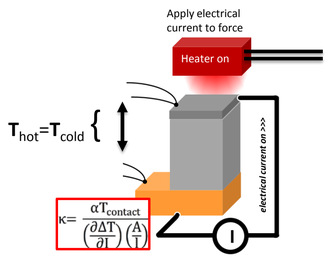
- Custom thermoelectric materials development and MBE tools, TE conductivity & device characterization
- Vacuum probe station with wide temperature range (20-600K) for characterization of pyroelectric generators.
- Time domain thermoreflectance pump-probe thermal characterization system

Custom TE Device Evaluation

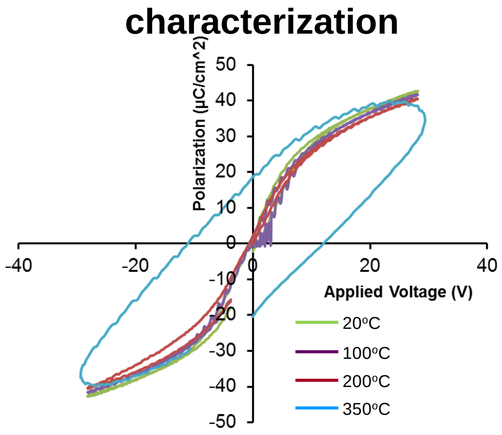


Thermoelectric MBE Materials Research

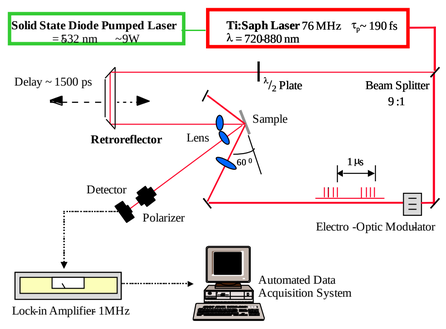
Thermal Conductivity Measurement

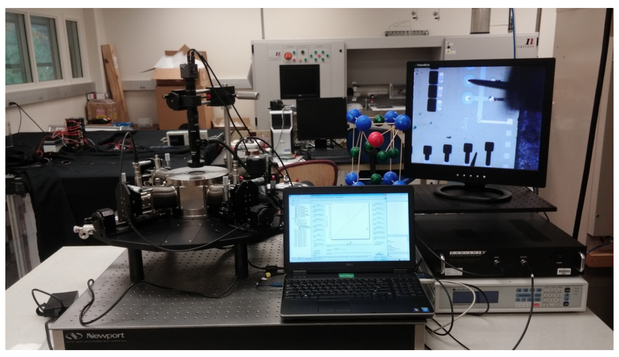


Ferroelectric material characterization



Time-domain thermoreflectance





Pyroelectric material and device characterization with expanded temperature range

Complementary Expertise/ Facilities/ Capabilities Sought in Collaboration

- Novel transduction materials, batteries, or fuel cells to be integrated on-chip with MEMS devices
- Energy harvesting devices for characterization and modeling in Army-relevant scenarios
- Devices and topologies that exploit multi-modal energy transduction for more power dense and predictable generation
- Thermal-to-electric materials development partners
- Solid-state thermodynamic systems modeling

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED