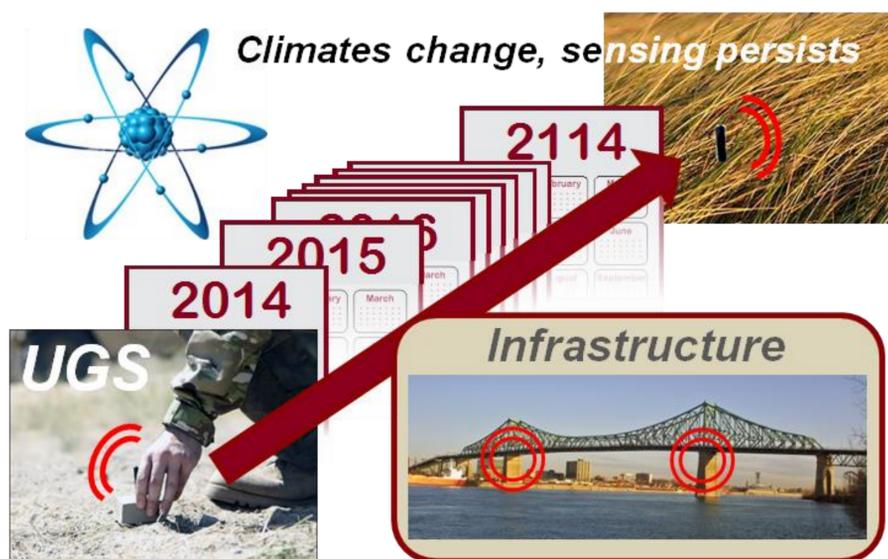


## S&T Campaign: Materials Research Energy & Power Power Generation & Energy Harvesting

James Carroll  
(301) 394-0243  
james.j.carroll99.civ@mail.mil

### Research Objective

- Develop radionuclide-based, long-lived (> 10 years) power sources for unattended sensors
- Near-term: Tritium battery demonstrator
- Mid-term: New energy-conversion materials
- Far-term: Switchable-output radionuclides
- Advancing the state-of-the-art in WBG materials and structures, and nuclear isomer physics



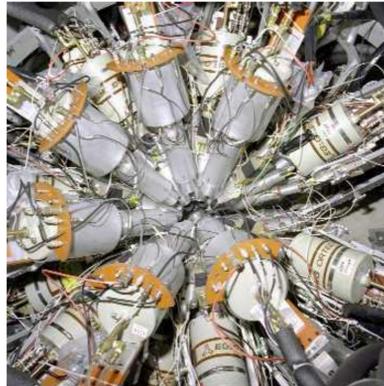
Persistent sensing, enabled by radionuclide power sources

### Challenges

- Energy-conversion materials
- Wide-band-gap material development needed to ensure radiation tolerance and high efficiency for betavoltaics – present focus on GaN
- Phosphor and photovoltaic development needed for betaphotovoltaics – spectral matching
- Radionuclide output switching
- Characterization of mechanisms for switching isotopes requires accelerator-based spectroscopy



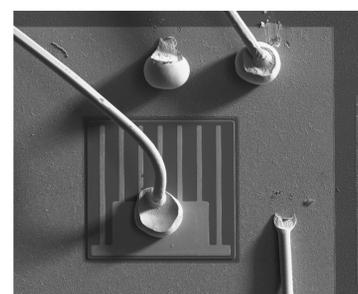
Tritium battery demonstrator in BA5590 form factor



GEANIE spectroscopic array at LANL for accelerator-based spectroscopy

### ARL Facilities and Capabilities Available to Support Collaborative Research

- Materials growth and cleanroom facilities
- State of the art analytical characterization facilities, incl.:
  - Electron beam induced current (EBIC) imaging
  - Ultrahigh vacuum variable temperature STM
- Thermoelectron emission and energy conversion device modeling
- Electron linear accelerators in X-Ray Effects Laboratory



SEM secondary electron image



Preparation for tests with ARL electron linac

- Extensive suite of radiation detectors and instruments
- Monte Carlo simulation of radiation transport
- Unique expertise
  - Wide-band-gap materials design and characterization
  - Integration of radionuclides and energy conversion
  - Radiation detection and nuclear physics
- Recent publications include:
  - Matters et al., Phys. Rev. C 93, 054319 (2016)
  - Matters et al., Phys. Rev. C 92, 054304 (2015)

### Complementary Expertise / Facilities / Capabilities Sought in Collaboration

- Expand growth and fabrication of low-defect GaN-based materials and devices
- Development and characterization of high-efficiency phosphors, including absolute cathodoluminescence
- Neutron and charged-particle irradiation capabilities for nuclear spectroscopy and radionuclide switching tests
- Novel approaches to energy conversion from radiation