Opportunity Title: Nuclear Forensics Challenges: High-Efficiency Measurement of Beta-Emitting Fission Products
Opportunity Reference Code: ICPD-2019-14

Organization Office of the Director of National Intelligence (ODNI)

Reference Code ICPD-2019-14

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Complete your application – Enter the rest of the information required for the IC Postdoc Program Research Opportunity. The application itself contains detailed instructions for each one of these components: availability, citizenship, transcripts, dissertation abstract, publication and presentation plan, and information about your Research Advisor co-applicant.

Additional information about the IC Postdoctoral Research Fellowship Program is available on the program website located at: https://orise.orau.gov/icpostdoc/index.html.

If you have questions, send an email to ICPostdoc@orau.org. Please include the reference code for this opportunity in your email.

Application Deadline 3/1/2019 6:00:00 PM Eastern Time Zone

Description **Research Topic Description, including Problem Statement:**

- The Intelligence Community requires a high-efficiency method for measuring radioactive decays with near 100% efficiency. The desired research will seek to advance the 'state of the practice' as well as drive research to develop a complete analysis chain that can determine beta-emitting fission products at levels 10-100 times lower than readily available through commercially available techniques, is applicable to the kinds of environmental samples likely to be used in treaty monitoring, and incorporates data analytics or other methodologies to increase confidence in the results as well as utility for a wide range of national security applications.

- Currently, the 'state of practice' is to employ rather sophisticated chemical separation techniques to efficiently isolate groups or single elements, thereby avoiding interfering, cross-contaminating activity that can confound high-confidence analysis of trace beta-activity. For example, if a sample solution were to contain 1000 Bq of NORM isotopes (where NORM is naturally occurring radioactive materials)and 0.01 Bq ofmolybdenum-99 (^{99}Mo), the separation chemistry must segregate ^{99}Mo from NORM isotopes at a level of 1 part in 1,000,000 to ensure that NORM contribution to the measurement is not greater than 10% of the measurement of ^{99}Mo. Exacerbating this problem for trace-level measurements is the fact that naturally occurring materials readily contain levels of radioactivity from NORM that will interfere and overwhelm the measurement instrument relative to the measurement of the target isotope. The challenge becomes developing a separations process that is highly specific to the target isotope (providing required analyte selectivity) and is of high purity relative to introduction of unwanted background radioactivity from naturally occurring materials (requiring process blank purity).

- Improved measurement of anthropogenic radionuclides in complex environments will advance treaty monitoring capabilities and enable other national security applications. To obtain required measurements at trace levels, a complete analysis chain must include a means to isolate the isotopes of interest, a method to measure them at levels typically below the levels present in naturally occurring materials, and a data analysis scheme to increase confidence in the measurement and indicate other observables of interest. In the case of fission products

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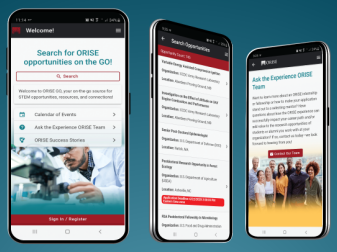
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that have weak or non-existent gamma-ray emission, the measurement of beta-decay particles could potentially satisfy these requirements.

Example Approaches:

- Experimental approaches, technical demonstrations on surrogate samples of interest, improvements in data exploitation and data analytics, accompanied by a trade study are the preferred outcomes for the supported research. As such, a successful proposal should address the following at a minimum:
  - What is the ultimate minimum detectable activity for a given process as characterized by the process blank background rate?
  - What are the trades between the various end-to-end approaches and are there figures of merit that can be used to predict performance on real-world samples vice ideal laboratory samples?

Relevance to the Intelligence Community:

- Advancing trace-level radionuclide-analysis capabilities to identify constituents in environmental samples supports focused monitoring of nuclear testing and arms control treaties and advances application of environmental modeling technologies to pressing and increasingly challenging national security problems. This research will also help strengthen the technical base and expertise at academic centers of excellence and at national laboratories as well as in the federal government. Developing a robust analysis chain, enhanced subordinate capabilities, new process approaches, and innovative data exploitation/analytics methods will also materially support attribution methodologies for post-detonation national technical nuclear forensics (NTNF) and an expanded nuclear counterproliferation and nuclear counterterrorism mission.

Key Words: Fission products, Radiation measurement, Chemical separations, Background reduction methods, Environmental monitoring, Nuclear forensics, Nuclear attribution

Qualifications

Postdoc Eligibility

- U.S. citizens only
- Ph.D. in a relevant field must be completed before beginning the appointment and within five years of the application deadline
- Proposal must be associated with an accredited U.S. university, college, or U.S. government laboratory
- Eligible candidates may only receive one award from the IC Postdoctoral Research Fellowship Program.

Research Advisor Eligibility

- Must be an employee of an accredited U.S. university, college or U.S. government laboratory
- Are not required to be U.S. citizens

Eligibility Requirements

- **Citizenship:** U.S. Citizen Only
- **Degree:** Doctoral Degree.

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- **Discipline(s):**
  - **Chemistry and Materials Sciences** (12 👁)
  - **Communications and Graphics Design** (6 👁)
  - **Computer, Information, and Data Sciences** (16 👁)
  - **Earth and Geosciences** (21 👁)
  - **Engineering** (27 👁)
  - **Environmental and Marine Sciences** (14 👁)
  - **Life Health and Medical Sciences** (45 👁)
  - **Mathematics and Statistics** (10 👁)
  - **Other Non-Science & Engineering** (5 👁)
  - **Physics** (16 👁)
  - **Science & Engineering-related** (1 👁)
  - **Social and Behavioral Sciences** (28 👁)