Opportunity Title: Material Characterization Techniques for Quantum Computing
Opportunity Reference Code: ICPD-2023-16

Organization Office of the Director of National Intelligence (ODNI)

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How to Apply **Create and release your Profile on Zintellect** – Postdoctoral applicants must create an account and complete a profile in the on-line application system. **Please note: your resume/CV may not exceed 2 pages.**

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 2/28/2023 6:00:00 PM Eastern Time Zone

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

As qubit technology advances towards high fidelity gates for quantum computing applications, materials often become limiters to performance levels. Historically physicists have often taken an empirical approach to optimizing material properties and/or have designed qubits to be as insensitive as possible to material sources of loss and noise. However, as performance levels continue to improve, material driven considerations continue to be a major fundamental limitation. This topic aims to close the loop and optimize correlations between material characterization techniques and qubit performance metrics.

Example Approaches:

Both well-known and to-be-developed novel material characterization techniques will be considered. The ideal project would aim to uncover a strong correlation between material properties and qubit performance metrics, where the material is characterizable without resorting to full-blown qubit gate implementation. Also in scope is the identification of optimized or novel material approaches to overcome uncovered limitations. Such optimization should be done using the correlated material characterization technique, thus demonstrating the utility of such a correlation.

Example technologies of interest:

- Superconducting qubits with materials such as Al, Nb, Ta, TiN etc.
- Silicon-based gate defined quantum dots with materials such as: Si, SiGe, SiO2 (MOS) etc.
- Trapped ion qubits, using surface traps with materials such as Si, Au, Nb etc.
- Novel qubit approaches such as the use of hybrid superconducting-semiconducting materials for superconducting qubits e.g. nanowire

approaches

Example material characterization areas of interest:

- Bulk materials e.g. loss, noise
- Interfaces between materials e.g. substrate-metal; substrate-vacuum etc.
- Spurious defect characterization such as color centers, line defects, etc.
- Materials in qubit environment e.g. packaging, wiring, shielding etc.

Example qubit metrics of interest:

- Qubit energy lifetime and decoherence rates
- Qubit 1 and 2 qubit gate fidelities
- Spread in qubit parameters such as the above metrics or qubit frequency, coupling strengths etc.
- Fluctuations in time of the above parameters

Relevance to the Intelligence Community (IC):

High fidelity qubit control is required for fault-tolerant quantum computing. Often the accuracy of gate operations is limited by the materials, interfaces and defects that make-up the qubit and its surrounding environment. This topic aims to overcome and deepen the understanding of this limitation by uncovering strong correlations between quantum gates and state-of-the-art material characterization techniques. This directly aligns with the “computing” category of the identified IC wide S&T needs.

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

Key Words: #Quantum Computing, #Qubits, #Materials, #Noise, #Superconducting Qubits, #Spin Qubits, #Trapped Ions, #Characterization

Eligibility Requirements

- **Citizenship:** U.S. Citizen Only
- **Degree:** Doctoral Degree.
- **Discipline(s):**
  - **Chemistry and Materials Sciences** (12 👁)
  - **Communications and Graphics Design** (6 👁)
  - **Computer, Information, and Data Sciences** (17 👁)

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- **Earth and Geosciences** (21 👁)
- **Engineering** (27 👁)
- **Environmental and Marine Sciences** (14 👁)
- **Life Health and Medical Sciences** (48 👁)
- **Mathematics and Statistics** (11 👁)
- **Other Non-Science & Engineering** (2 👁)
- **Physics** (16 👁)
- **Science & Engineering-related** (1 👁)
- **Social and Behavioral Sciences** (29 👁)