RX15-14

1. **Research Title:** Using Electron Beams for Direct Excitation of Metastable States in a Lasing Gas
2. **Individual Sponsor:** List the AFRL research topic sponsor's contact information

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3. **Academic Area/Field and Education Level**

Field and Education Level: Graduate student in materials science/materials engineering/physics-optics (MS or PhD level)

4. **Objectives:** Carbon nanotube (CNT) fiber field emission cathodes present the opportunity to develop an efficient pumping source for excited metastable states in a gas. Field emission cathodes can be used to pump Argon atoms into an excited state with minimal ionization of the background gas. This approach offers the potential for a much more efficient method of generating the excited lasing states in a gas, rather than by using an electrical discharge or optical pumping. However, for this approach to be feasible, the electron energy distribution function of the field emitted electrons must be precisely determined.
5. **Description:** Microplasma generation has advantages in practical applications due to its relatively high electron density and high electron temperature. Carbon Nanotube (CNT) fibers are proposed to be efficient electron sources for generating microplasmas due to their ability to field emit significant current at low voltage [1]. This is advantageous for directly exciting the lasing states in a gas since it allows for a large anode-cathode gap distance, thereby permitting larger volumes of gas to be excited [2]. In addition, larger electron currents can be achieved with the lower electric field requirements of the CNT fiber cathodes, thus increasing the electron density in the gas. This increases the production rate of the metastable excited states Ar to that of Ar ions. However, for this approach to be useful, an exact determination of the Electron Energy Distribution Function (EEDF) of the field emitted electrons is needed so that operating conditions are known. This will determine the applied field required to generate the exact beam energy to excite the metastable states. The EEDF characterization experiment will by modifying an existing field emission characterization to include the capability to measure the kinetic energy and spatial distribution of the field emitted electrons.

[1] D. Shiffler, et. al., IEEE TRANSACTIONS ON PLASMA SCIENCE, VOL. 40, NO. 7, JULY 2012
[2] Q. Zou Q, et. al., JOURNAL OF APPLIED PHYSICS 106, **013305** (2009)

6. **Research Classification/Restrictions:** Unclassified
7. **Eligible Research Institutions:** Indicate to what organizations this topic should be provided

■ **DAGSI** (Wright State University, AFIT, Ohio State University, University of Dayton, Miami University, Ohio University, University of Cincinnati) NOTE: Topics submitted to DAGSI must be approved for public release. Need PA Approval # 88ABW-2014-3171