GRAIL

GASEOUS RADIOISOTOPE ANALYSIS IN SITU LABORATORY

INTELLIGENCE VALUE

The GRAIL program seeks to develop technology to enable in situ systems capable of persistent and unattended monitoring of tritium at ultra-trace environmental levels. Effective monitoring of tritium is of high value for the Intelligence Community (IC) because of its use in state-of-the-art nuclear weapon systems to increase a weapon's explosive yield.

Tritium is a radioactive isotope of hydrogen with a half-life of approximately 12 years. While naturally produced through the interaction of cosmic rays in the atmosphere, its anthropogenic sources are nuclear reactors and related material processing activities – something that makes it an ideal indicator of nuclear activity.

Past nuclear weapon tests produced large amounts of atmospheric tritium. Levels peaked in 1963 and have been in decline since the cessation of weapons testing due to the adoption of the Partial Test Ban Treaty in 1963. Today the average concentration of tritium in the atmosphere is exceptionally low. For example, the natural atmospheric concentration of molecular hydrogen, H2, is about 0.5 parts per million, with the relative abundance of tritium at 10-18 of hydrogen. This extremely low atmospheric concentration makes the quantification of environmental tritium levels from specific sources a challenge even in a laboratory setting, and thus far, impossible in the field.

High-sensitivity tritium measurements are typically performed in a two-step process. The first step is the collection of a pure sample. The second step is a quantification measurement, most often performed measuring tritium's radioactive decay. Other methods, such as mass-spectrometry, may also be used for precision measurements. All existing high-sensitivity approaches require large fixed-site laboratory equipment, vast amounts of shielding, and significant sample preparation equipment and processes.

An in situ tritium measurement system capable of laboratory sensitivity has long been desired but technologically out of reach. GRAIL seeks to replace the large laboratory infrastructure with an in situ system by aggressively pursuing a leap in both tritium sampling and measurement technology, when combined, will yield a high-precision measurement system.

PRIME PERFORMERS

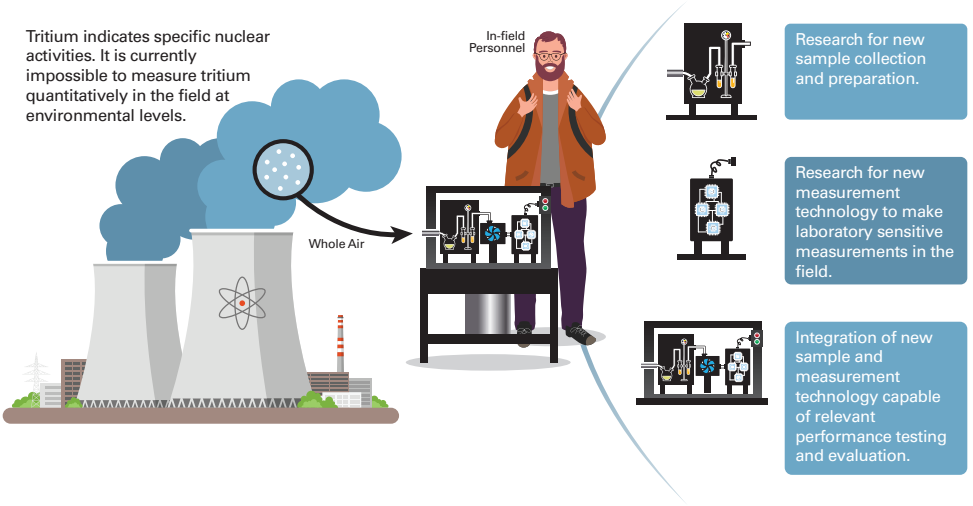
- TBD

TESTING AND EVALUATION PARTNERS

- Savannah River National Laboratory
- Pacific Northwest National Laboratory
- Massachusetts Institute of Technology Lincoln Laboratory
- Lawrence Berkeley National Laboratory
- Fermi National Accelerator Laboratory

KEYWORDS

- Tritium
- Nuclear Monitoring
- Environmental Sampling
- Isotopic measurement



Tritium is a radioactive isotope of hydrogen that is produced by anthropogenic nuclear activities in low environmental concentrations. The GRAIL program seeks to develop technology to enable in situ systems capable of persistent, unattended monitoring of tritium at low environmental levels. Development will occur in three key technical areas: sampling technology, measurement technology, and the integration of these technologies into a system capable of capable of persistent, unattended operation.

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