Xenon International: A New Capability for Radioxenon Measurements

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Pacific Northwest NATIONAL LABORATORY

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Xenon International is new ground-based radioxenon measurement system being developed by the Pacific Northwest National Laboratory (PNNL) and will be manufactured by Teledyne Brown Engineering. This system folds in the lessons learned from the International Noble Gas Experiment over the last decade and years of experience in radioxenon processing, measurement capability, system engineering, and product development residing at PNNL and Teledyne Brown Engineering.

Goals and Objectives

The Xenon International system has improved sensitivity and higher frequency sampling period than currently fielded systems, which will provide higher confidence in both radioxenon concentrations and estimates from where the radioxenon originated. In addition, the Xenon International system is designed to have high reliability and uptime, low maintenance costs, and minimal consumables. A full gas processing and measurement prototype has been built at PNNL and a second at Teledyne Brown Engineering.

Performance Testing

- The Xenon International project has produced two operational units; one unit developed at PNNL, one unit developed at Teledyne Brown Engineering
- Both systems are undergoing testing to demonstrate they meet requirements and to enter into the engineering, manufacturing, and development phases

Operational Performance Testing
November 2016 – March 2017

- Burn-in testing
- Key performance parameters tested on both prototypes
- Operational modes: startup, shutdown, full mission capable, and partial mission capable
- Equivalency testing
- Requirements tests – DOI: 10.2172/1122330
- Prototype 1: functional requirements – processing and measurement requirements
- Prototype 2: non-functional requirements – environmental requirements

Operational Verification Evaluation
May 2017 - June 2017

- Both prototypes tested using standardized methods

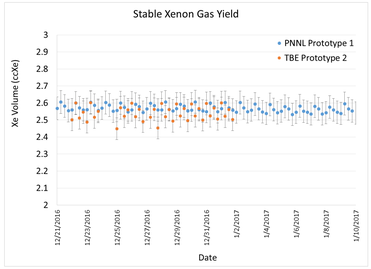
Operational Field Test
June 2017- June 2018

- Test prototype 1 unattended for a period of time at Charlottesville
- Test prototype 2 for field maintenance and operational modes

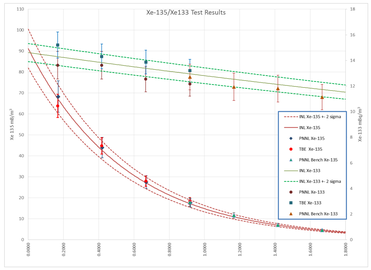
Systems Performance

Equivalency Testing

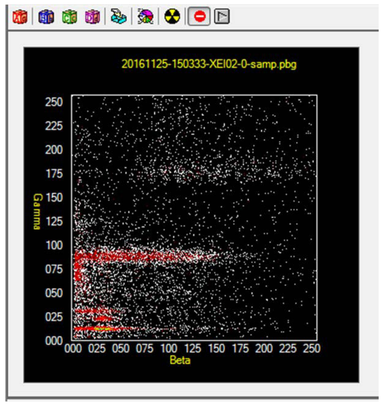
Both independently built prototype systems were tested for measurement and operational equivalency. Both systems measure radioxenon backgrounds on a daily basis.



- Upon startup and minimal tuning, both systems produce stable xenon measurements of ~2.6 cc for every six hour collection cycle



- Plot of a mixture of X-135 and Xe-133 produced by Idaho National Laboratory and measured by both prototypes
- Samples were made in a single batch and split for each system
- Measurements started at same time in different time zones
- Results of both systems are compared to the Idaho National Laboratory standard



- First ever observed suspected Xe-125 from a ground based system
- Xe-125 (16.9 hr) is an activation product from Xe-124 by way of thermal neutron irradiation (n, γ), or from Cs-125 (45 min) decay
- Xe-124 occurs 0.01% naturally

Prototype Development

TBE Xenon International Unit

Commercial Nitrogen Generator

Uninterruptible Power Supply

Summary

The Xenon International project has completed system development and a robust set of operational and validation testing. The systems are in preparation for operational field testing. Both systems have measured complex background signatures, and have operated in laboratory conditions for over a year. The next steps are:

- Complete Operational Verification Testing – June 2017
- Ship Prototype 1 to Charlottesville for Operational Field Test – June 2017
- Perform field operator training during field tests in a relevant environment – June 2017
- Complete systems documentation (interface control document, operations and training manuals)
- Perform formal reviews to document that the system has passed through the Technology Ready Level gates
- Update production package

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U.S. DEPARTMENT OF ENERGY

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Xenon International commercial web page
http://tbe.com/energyenvironment/xenon-international

www.pnnl.gov