

# Xenon International: A New Capability for Radioxenon Measurements

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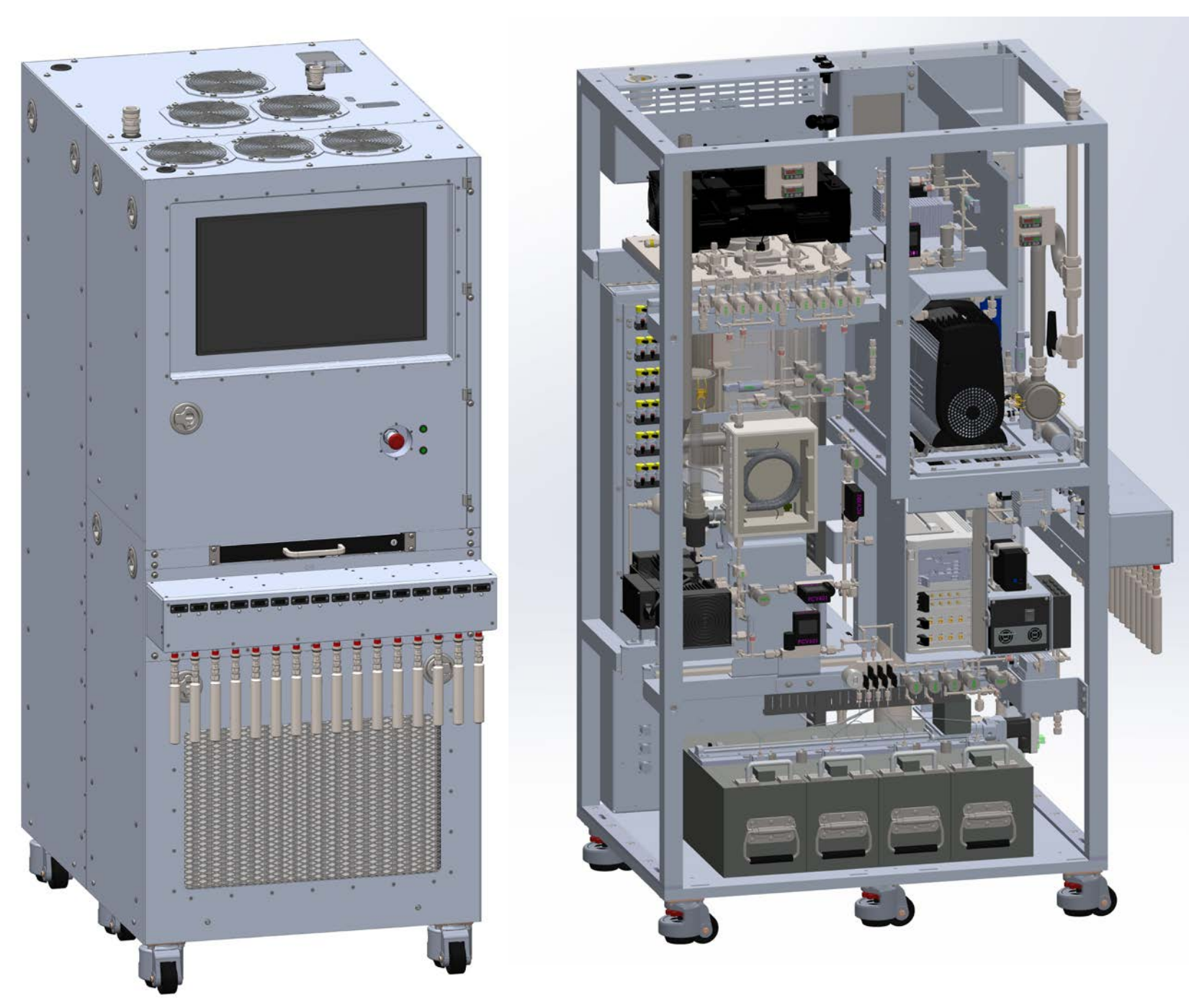
Xenon International is a new ground-based radioxenon measurement system developed by the Pacific Northwest National Laboratory (PNNL) and manufactured by Teledyne Brown Engineering. The system was designed to fold in the lessons learned from the International Noble Gas Experiment over the last two decades and years of experience in radioxenon processing, measurement capability, system engineering, and product development.

## What Does It Do?

Xenon International collects, separates, purifies, quantifies, and performs nuclear counting on radioxenon isotopes (<sup>133</sup>Xe, <sup>135</sup>Xe, <sup>133m</sup>Xe, and <sup>131m</sup>Xe) in the air, continuously monitoring for radioxenon evidence from nuclear explosions. Radioxenon is a product of nuclear explosions that can reach the detector without reacting with chemicals in the air or soil because it is a noble gas making it a proven and important method for distinguishing nuclear explosions from other explosions or earthquakes.

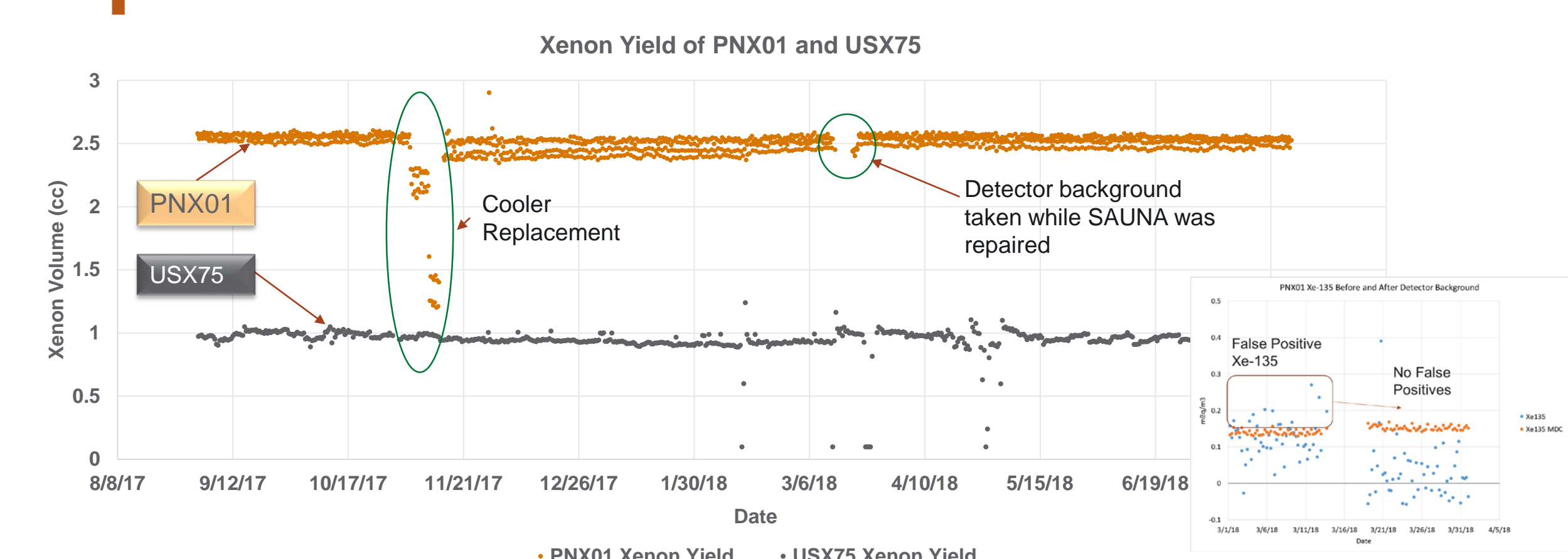
## Performance Testing

- The Xenon International project has produced two operational units, one unit developed at PNNL, one unit developed at Teledyne Brown Engineering
- Operational Performance Testing (OPT) (May 2016 - April 2017)
- Operational Verification Evaluation (OVE) to test data quality objectives (May 2017 - June 2017)
- Operational Field Test (OFT) (July 2017 - July 2018)
- Engineering, Manufacturing and Development phase (EMD) at Teledyne Brown Engineering (Aug 2018 - Sept 2019).

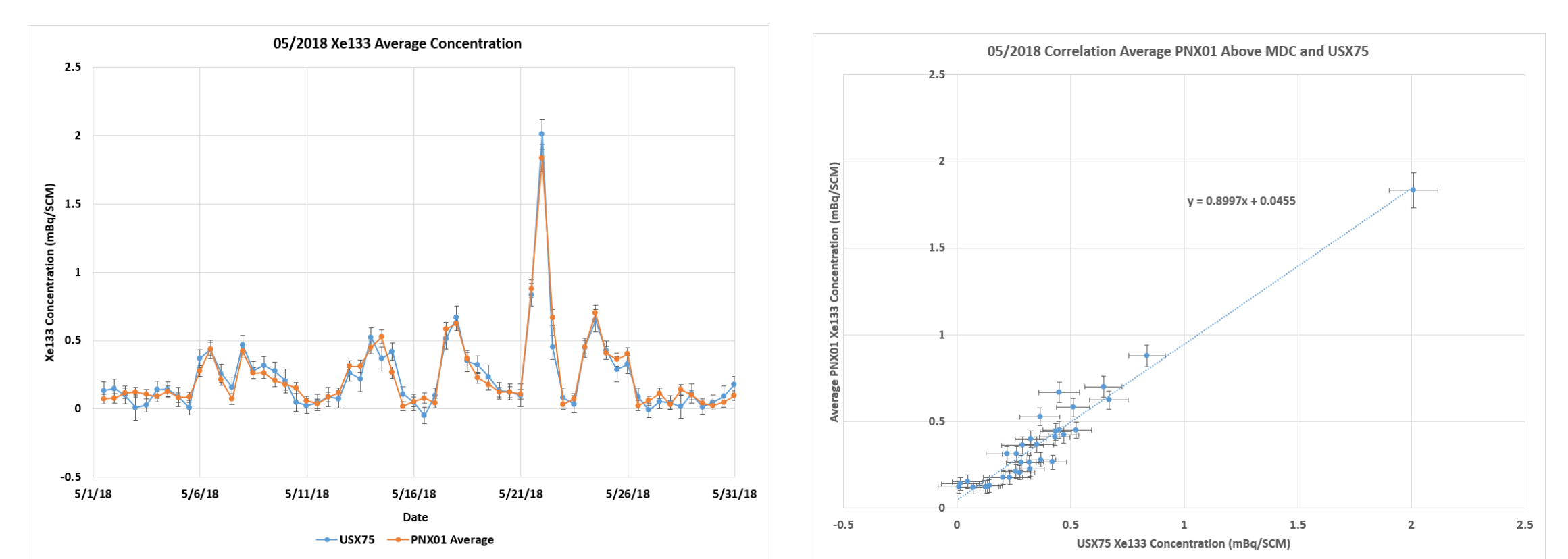


To improve maintainability, robust operation, and to meet IMS 2.0 data formats, hardware and software was updated during EMD.

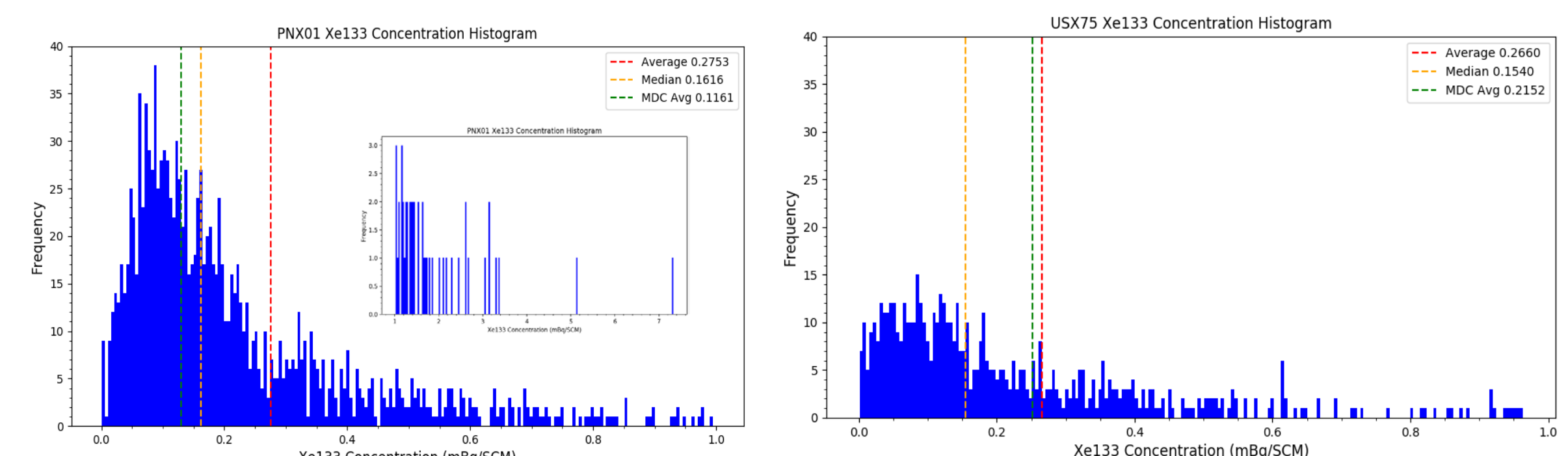
## Operational Field Test Results



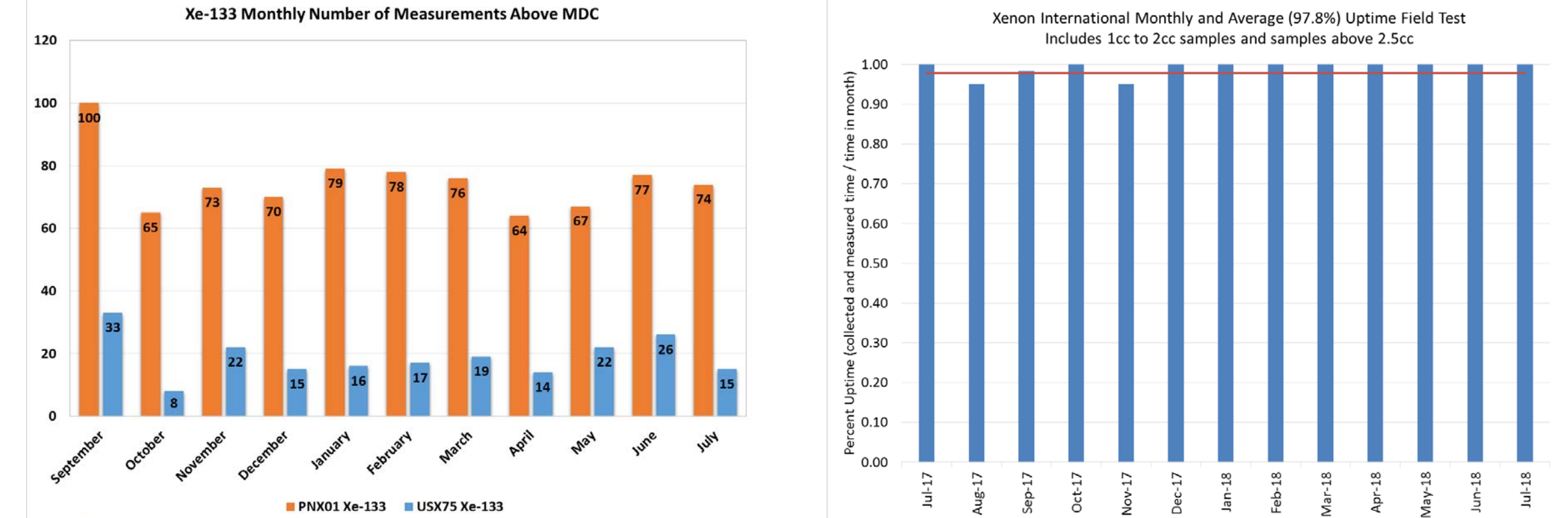
Comparisons of Xenon International (PNX01) and USX75 stable xenon yield for one year side-by-side field test at Charlottesville VA, USA. Detector background acquired during the test to eliminate <sup>135</sup>Xe false positive hits.



USX75 example data vs. PNX01 for <sup>133</sup>Xe hits. Data averaged for PNX01 – two six hour data sets averaged then compared to 12 hour USX75 data, and correlation between the two systems. One month data of Xenon International averaged data on left and correlation on right.



Xenon International <sup>133</sup>Xe distribution from the one year field test in Charlottesville, VA (left). The average <sup>133</sup>Xe detects: 0.27 mBq/m<sup>3</sup> for both systems. The average MDC for Xenon International 0.11 mBq/m<sup>3</sup>, USX75 0.22 mBq/m<sup>3</sup>



Number of positive detects above MDC of <sup>133</sup>Xe for Xenon International and USX75 for each month of the field test. Uptime per month of operation during field test.

## Xenon International Footprint and Operations



Xenon International operates unattended with 6-hour collection cycle time. With four nuclear detectors, <sup>133</sup>Xe detection sensitivity is near 0.1 mBq/m<sup>3</sup>. A nitrogen generator is used in place of gas cylinders and the Xenon International power is regulated through an uninterruptible power supply

## Particulars

- Cycle Time: 6 hour collection, 4 samples per day, continuous sampling 24/7, 100% duty cycle
- Count Time: 12 hour count, 4 nuclear detectors
- Minimum Detectable Concentrations (MDC):
  - <sup>133</sup>Xe: 0.15 mBq/m<sup>3</sup>
  - <sup>135</sup>Xe: 0.5 mBq/m<sup>3</sup>
  - <sup>131m</sup>Xe: 0.15 mBq/m<sup>3</sup>
  - <sup>133m</sup>Xe: 0.15 mBq/m<sup>3</sup>
- Power: 208 VAC (160-275 volt), 50/60 Hz, 30 amp circuit, 4kW (3.5 kW for Xenon International without nitrogen generator)
- Backup Power: Uninterruptible Power Supply
- Weight/Size: 1225 Kg. (2700 lbs.), 79 cm X 112 cm X 192 cm (31.2 inch X 44.2 inch X 75.75 inch)
- Air Flow: 100 L/min (stp; 0°C, 760 torr)
- Carrier gas: Nitrogen generator
- Processing Efficiency: 85%, 2.5 cc Xe collected (stp; 0°C, 760 torr) and counted, per 6 hour collection cycle
- Room size: 2m X 3.3m X 2.1m, (6.7' X 10.8' X 7')
- Communications: IMS global communications infrastructure
- Data Reporting: Every 1 – 24 hours (selectable)

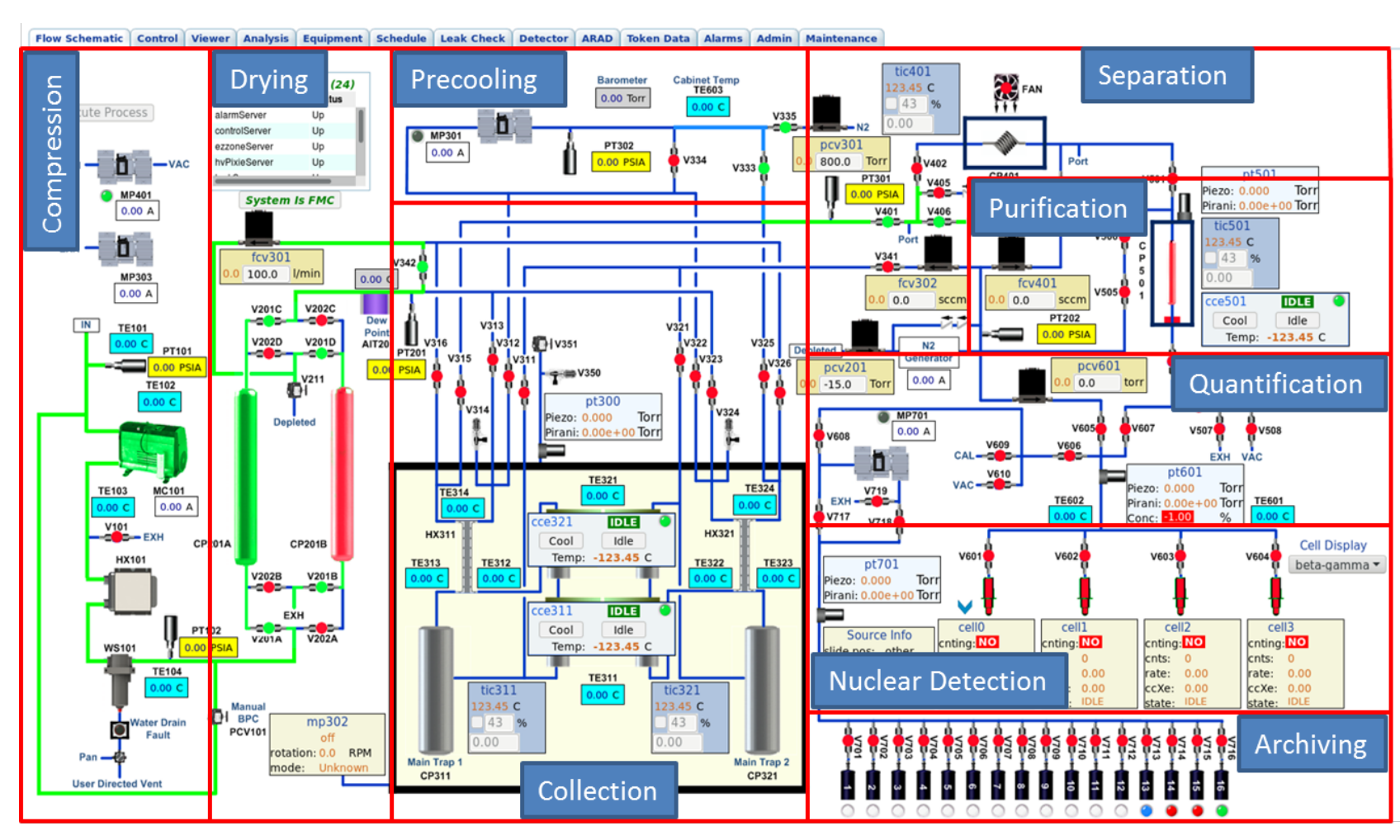
## Summary

Xenon International has completed extensive testing and is undergoing final production upgrades. Data and documentation was shared with the PTS for familiarization with Xenon International operation. The U.S. and the PTS are working on acceptance testing criteria for allowing Xenon International to be used in the (IMS). The PTS will begin acceptance testing at Teledyne Brown Engineering in Oct 2019.

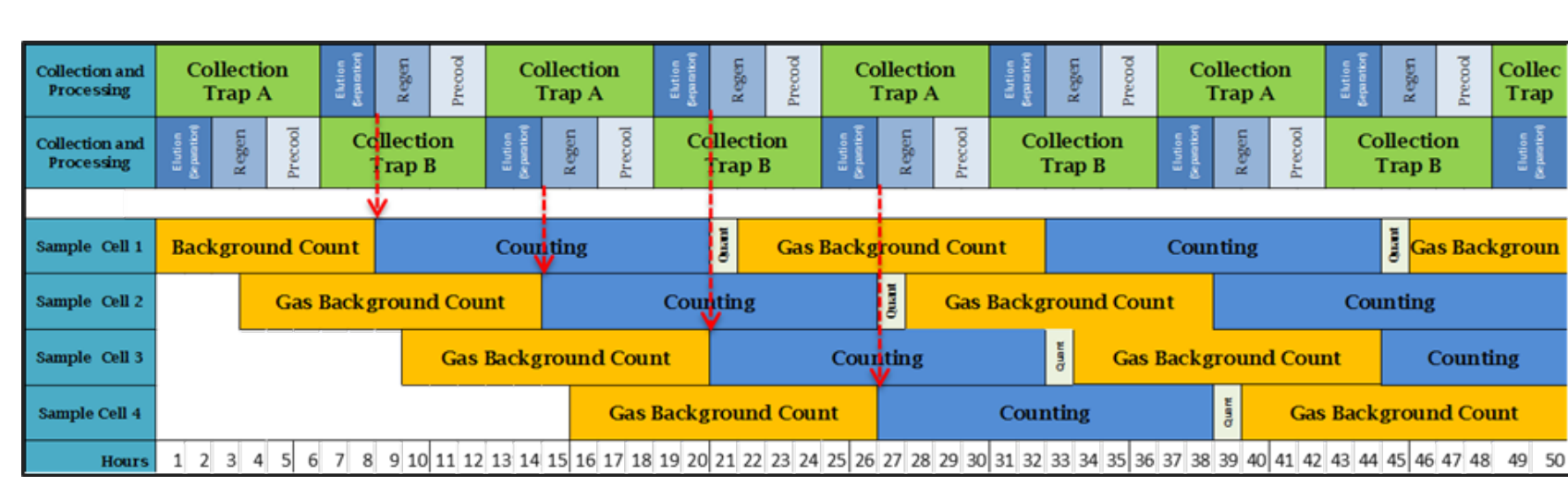
The Xenon International Operational Field Test was successfully completed with outstanding data availability and reliability. There were **1471 six-hour collection periods** possible with **1439 samples collected**, measured and data transmitted.

Data received was 97.8% (1439/1471)  
 Quality data received was 96.7% (1422/1471).

Xenon International commercial web page  
<https://tbe.com/energy/xenon-international>



Xenon International graphical user interface.



Processing diagram for Xenon International. Two collection traps are used for 100% duty cycle, and four detectors allow for 12 hour count time.

The views expressed here do not necessarily reflect the views of the United States Government, the United States Department of Energy, [include other agencies as appropriate; for those posters and presentations that are sponsored by NNSA include "the National Nuclear Security Administration"] or the Pacific Northwest National Laboratory. This work was supported by the U.S. Department of Energy, National Nuclear Security Administration