# MIRION Connect 26

## AMERICAS

## Annual Users' Conference

## ADVANCING RADIATION SAFETY. EMPOWERING PROGRESS.

M Resort, Henderson, NV | June 15 – June 18

MIRION TECHNOLOGIES

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# Real World Applications for Continuous Spectroscopic Monitoring

**Steven Mell**

Business Development, New Nuclear

Mirion Connect | Annual Users' Conference 2026

Henderson, Nevada

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# Scan QR code to log your attendance for today's (Thursday, June 18th ) breakout session

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# Agenda

- Introduction and a story
- Overview of Continuous Spectroscopic Monitoring
- What’s New
- Applications
- Questions – How can we help?
- A story



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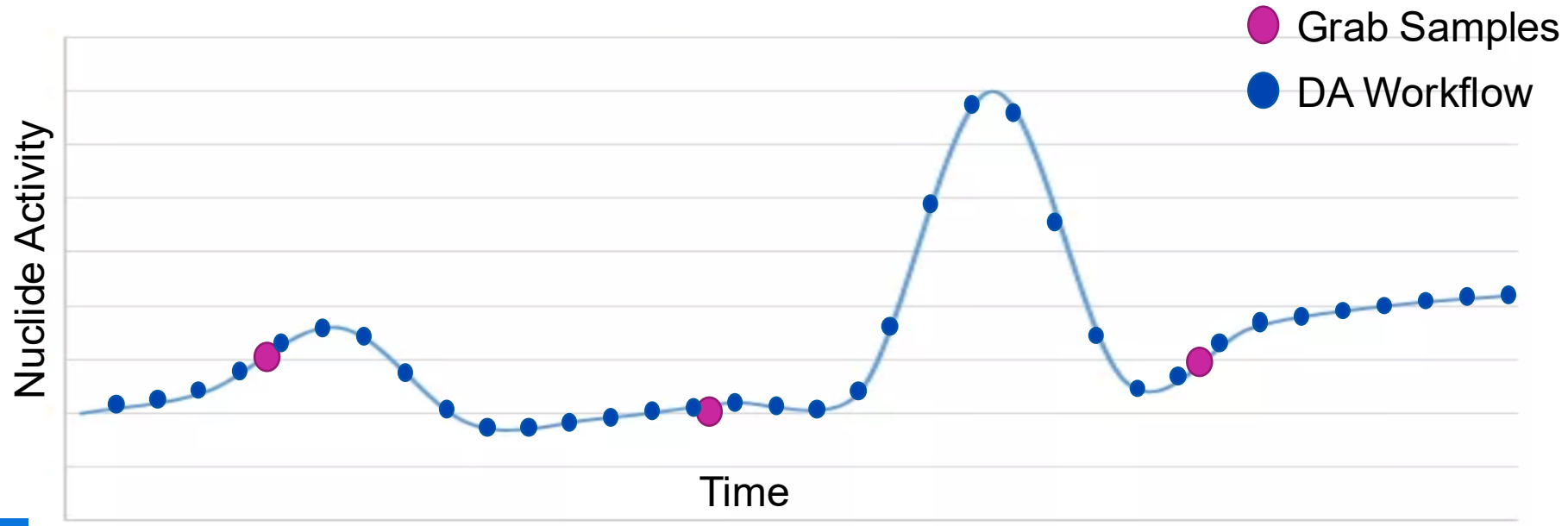
# Continuous Spectroscopic Monitoring (CSM)

# The Advantage of Continuous Monitoring

- Manual Sampling is much less frequent & can miss events



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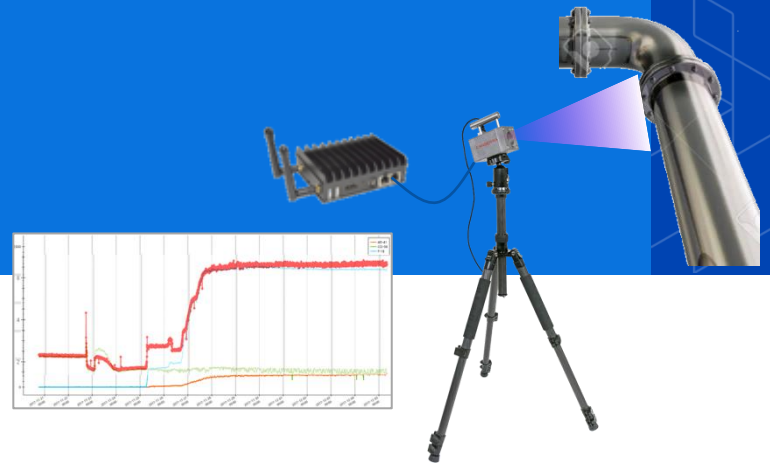
# Sample Counting vs. Continuous Spectroscopy



- **Traditional Sample Counting**
  - Calibrate detector for specific container geometries
  - Collect several samples per day from sampling points
  - Put sample in shield & count, results analyzed
  - Review results on report
  - Publish/use reports, decide if there's an issue

- **Continuous [or triggered] Spectroscopy**
  - Measurement is done In-situ
  - Calibrate via ISOCS
  - Point detector at object to be measured
  - Automated counting & analysis, 24/7
  - View results live & view trend plots & utilize
  - See alarms immediately



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# Building Blocks

## Detector and MCA

**Scintillators**

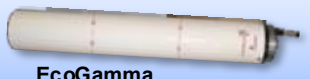
NaI, LaBr, CeBr — Osprey

**HPGe** (ISOCS)

**CZT**

GR1

**GM doserate**



EcoGamma

## Data Analyst

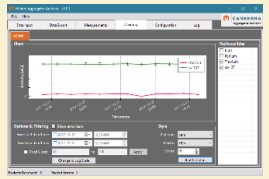
(Embedded Software)

**Autonomous Operation**

## Results / Visualization

**DA Dashboard**

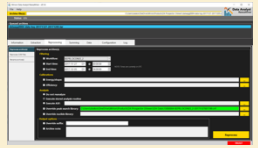
**DA Prospector**



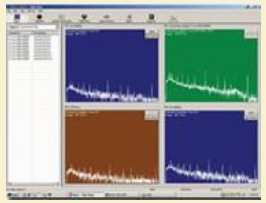
**DA Touch Screen Console**

**Horizon**

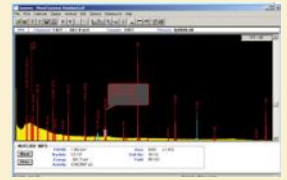
**ReexaMiner**



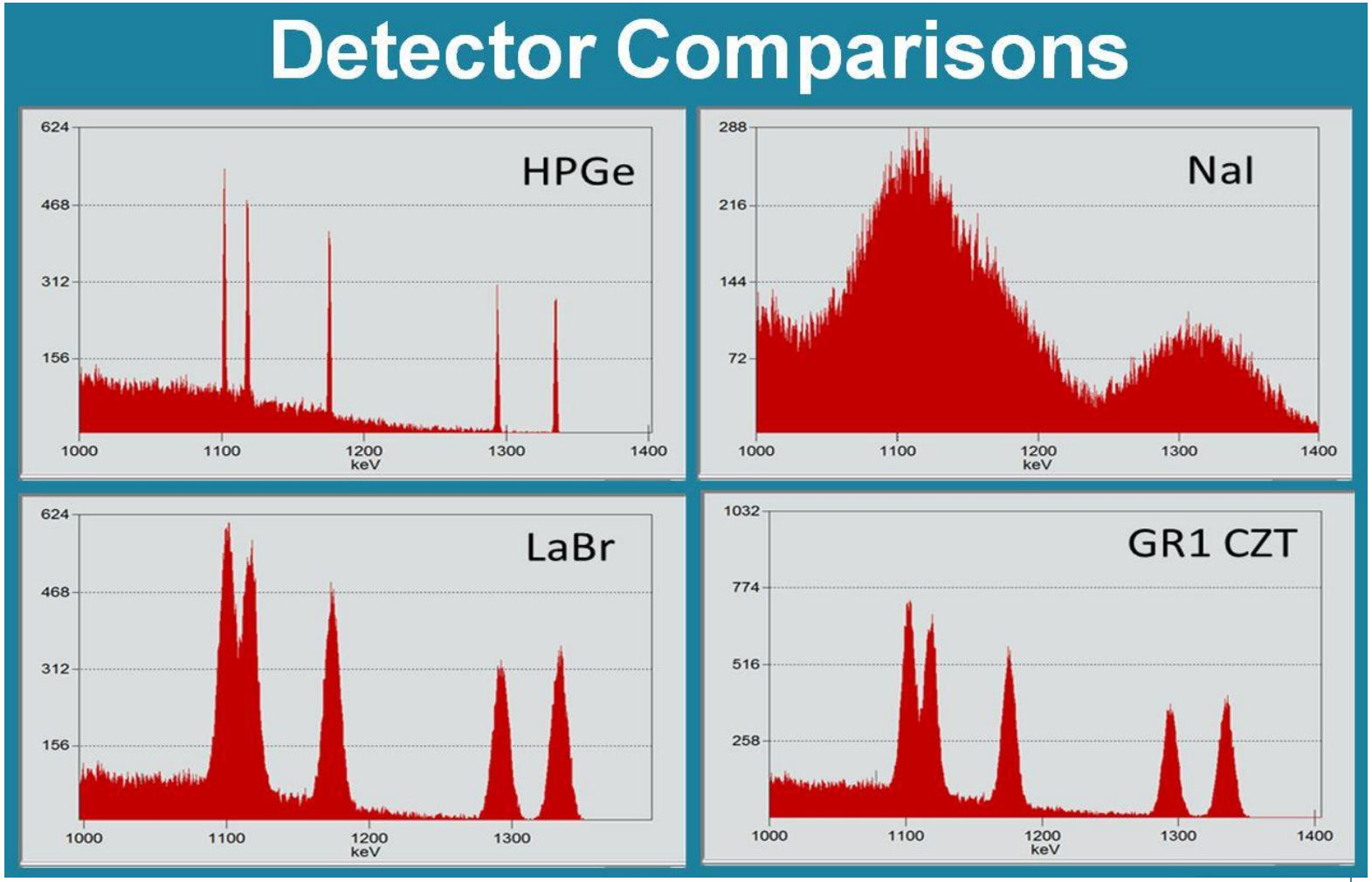
**Apex-Gamma**



**Genie**



# Detector types and performance



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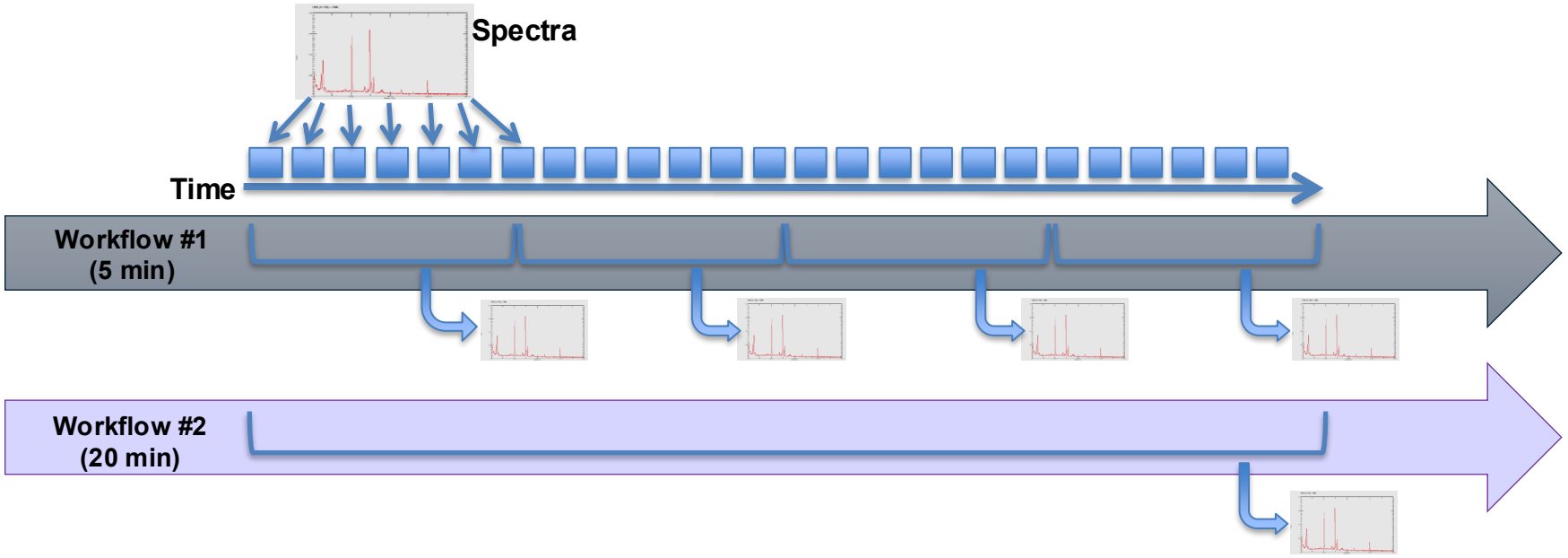
# Workflows

- Aggregate & analyze measurement data at preset interval(s)
- Multiple Workflows can be used simultaneously



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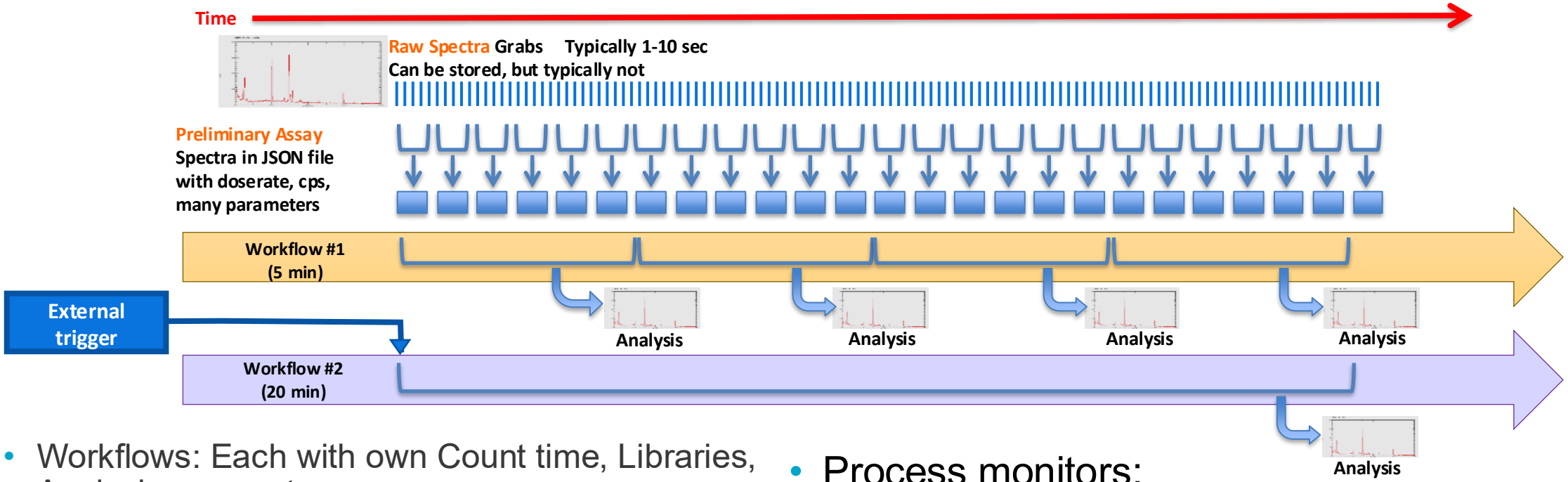
# Data Analyst Operation




- Workflows: Each with own Count time, Libraries, Analysis parameters
- Multiple workflows can operate at the same time:
  - e.g. short sample, long sample, very long QC
- Continuous Spectroscopy Mode; Triggered Mode; or Both
- Alarm outputs: based upon nuclide-specific assay results

- Process monitors:
  - Generally Continuous Mode
  - Short count workflow for quick response
  - Long count workflow to detect low activity nuclides
  - Longer count time for continuous QC assay

- Sample assay systems
  - Triggered for sample type 1
  - Triggered for sample type 2
  - Triggered for sample type n
  - Continuous mode long count time for QC assay



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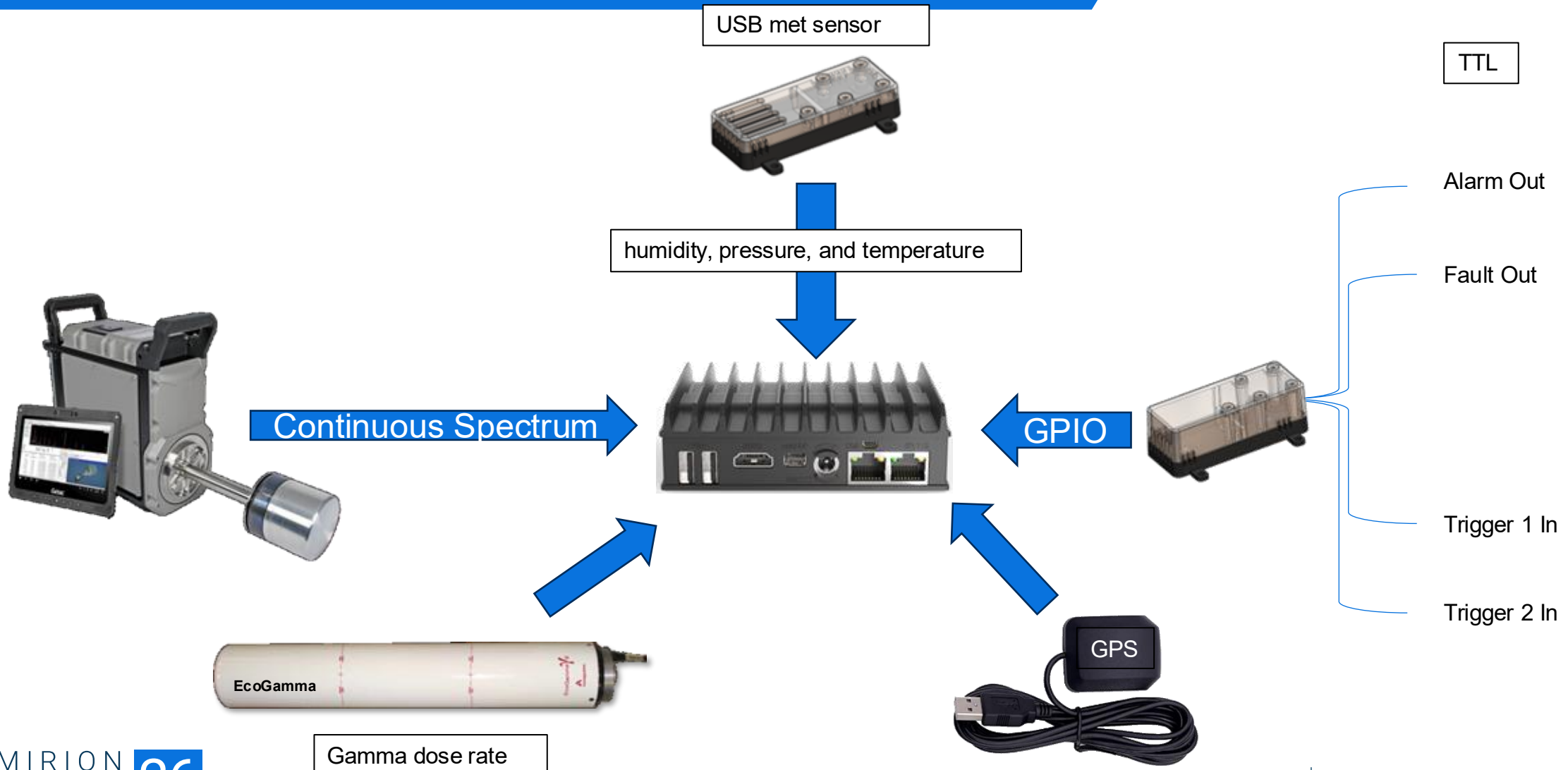
# Data Analyst Inputs



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# Data Analyst Interface

Setup, Config, Operations

Alarm, Fault indicators

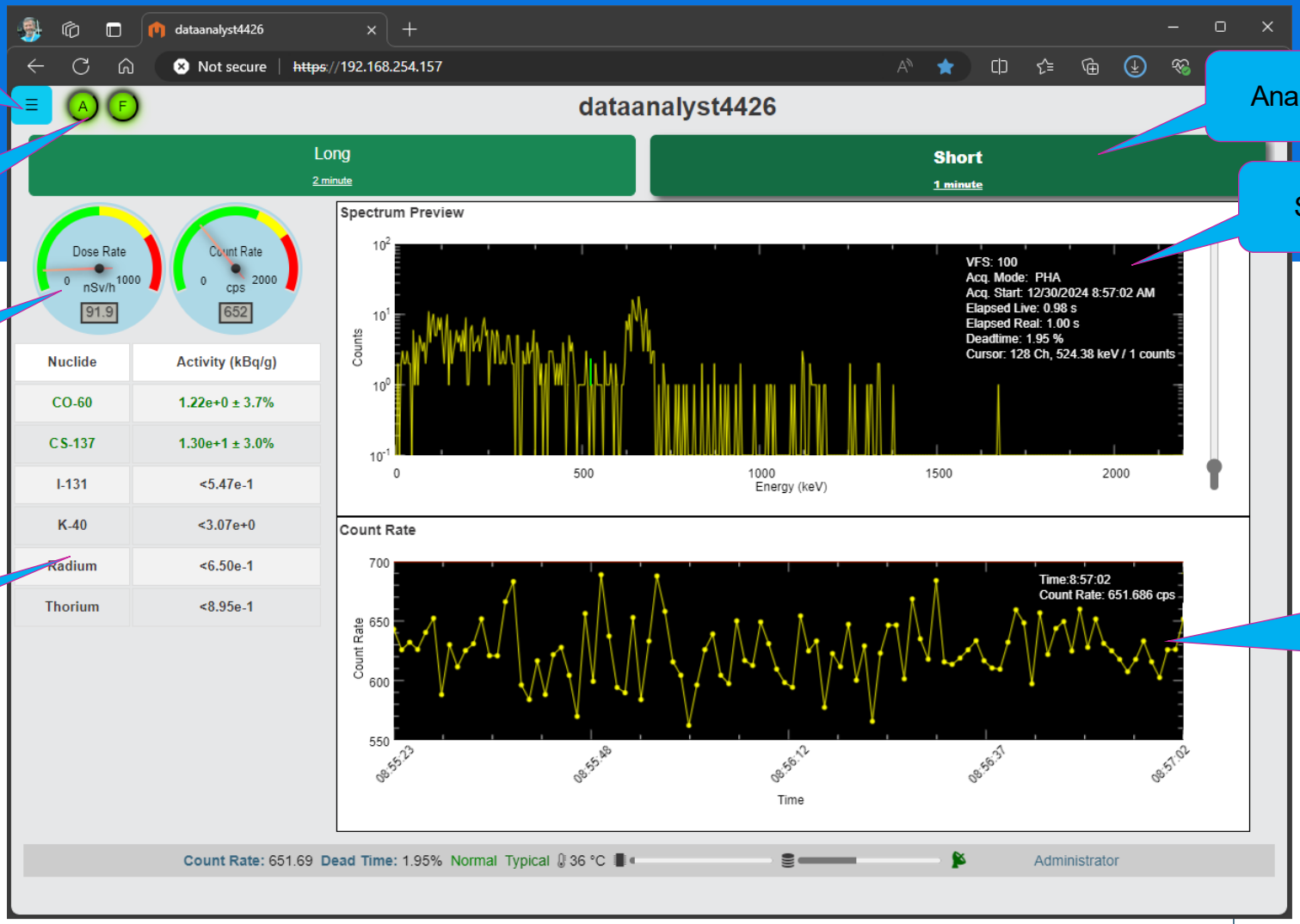
Dose & Count Rate Meters

NID Results

Analysis Workflows

Spectrum Display

Data Time Plot for Dose, and Nuclide Activity

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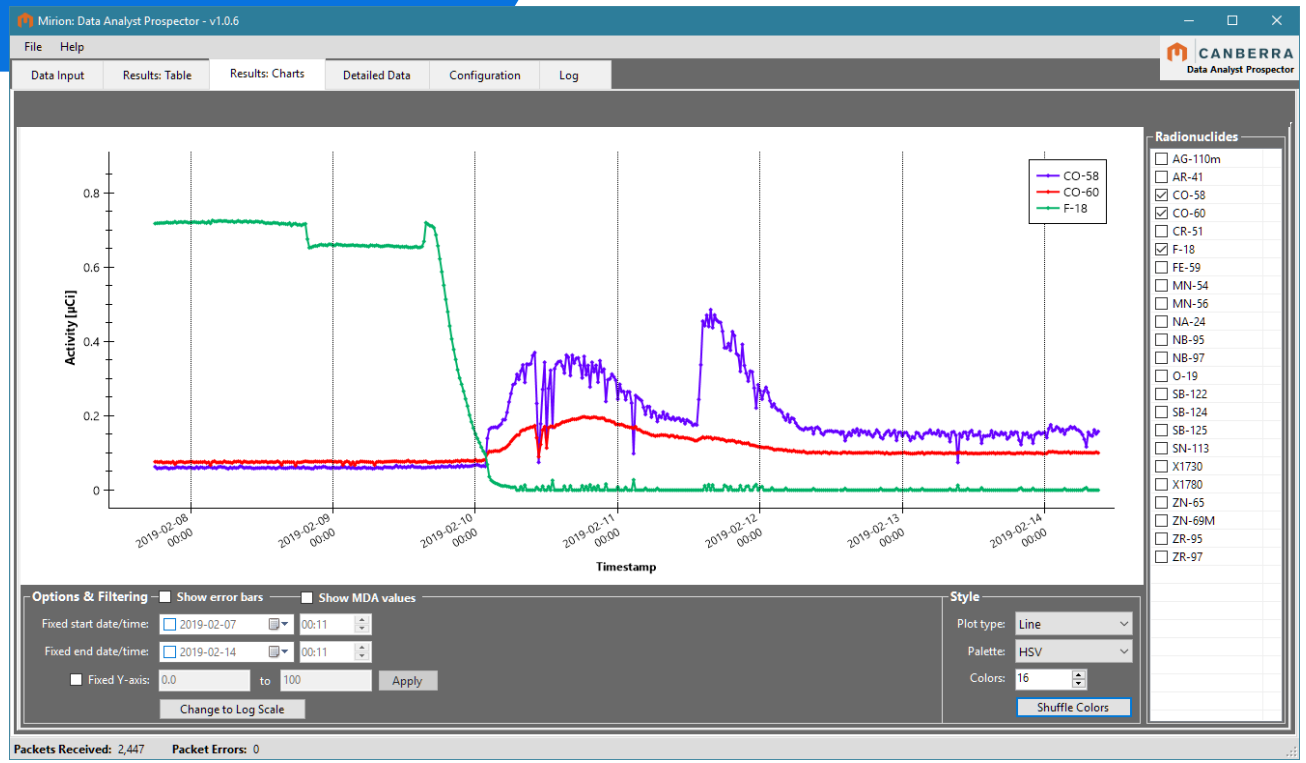
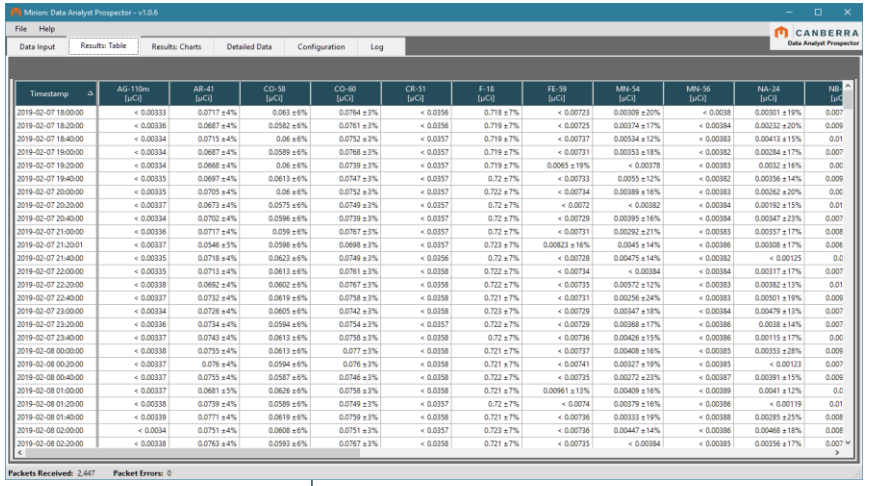
# DA Prospector

- **For In-Depth Analysis** of live and historical data
- **Powerful Visualization**
  - individual nuclide activity – simultaneous multiple nuclides
  - CPS and doserate
- Tabular data can be extracted to Excel for further analysis
- Graphs can be exported for input into reports
- Reads Archive files from DA for historical data
- Creates FTP server and reads live data



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# Review of CSM

- **Continuous Spectroscopy Monitoring**
  - Automated counting at defined intervals
  - Enabled by the Data Analyst
  - Also remotely triggered analyses
- **Data Analyst** is the core building block, providing real-time nuclide activity results.
- **Runs continuously,** recording the data locally as well as transmitting live data to real-time monitoring systems.
- Can be **embedded within larger systems** such as stack monitors and scanning systems, or be used on mobile platforms like drones and robots
- **Automated counting & analysis** of a gamma spec system, 24/7
- Ability to view results & trend plots **live**
- See alarms **immediately**
- **ISOCS calibration for in-situ geometries**



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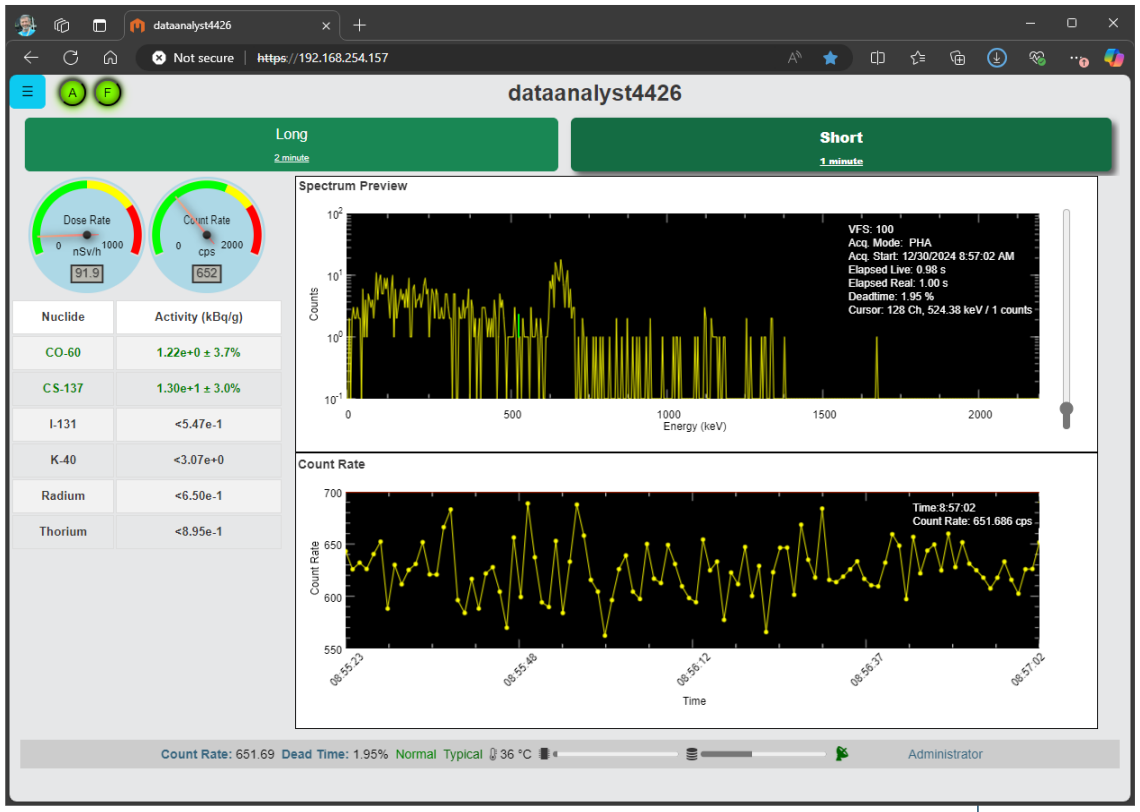
# What’s New?

# Data Analyst Software Version 2.0

# Released Summer 2025

- Main update is the all new HTML5 based user interface
  - Compatible with all major web browsers (Chrome, Edge, Safari, etc)
  - No need for standalone desktop applications
  - Provides for remote access from any device



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# New hardware support

- DSA-LX - MCA
- Aegis Portable HPGe w/ MCA
- MicroGe
- Spir-Explorer - MCA with dose rate
- RDS-32 – Gamma Survey Meter







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# New features

- Quick Quality Control
  - Previously feature only available with Horizon
  - Monitors Activity, Energy, FWHM
  - Up to 2 energies
  - Alerts and Alarms can be generated
  - Workflow can be Triggered [for conventional check source operation] or Continuous using built-in low activity source [see later slides]
- Dynamic Workflow enhancements
  - User enters Minimum, Incremental, and Maximum count time values
  - Assays are done after Minimum time, and after each incremental time.
  - Count terminated based upon "MDA to meet" value for selected nuclides
- Software Triggering implemented
- Linux Mint 22 now supported and installed for new systems
- Adobe Air replaces Flash



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# Applications

# CSM-GR1 Kit

- Quick and Easy deployment of CSM platform using a GR1 or GR1+ CZT detector with collimator





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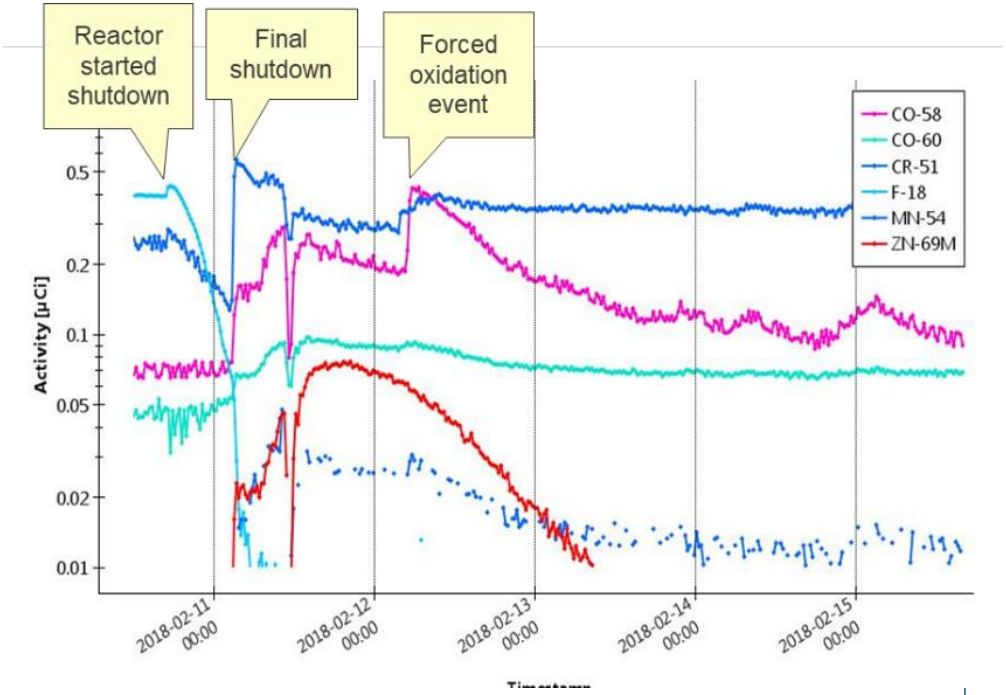
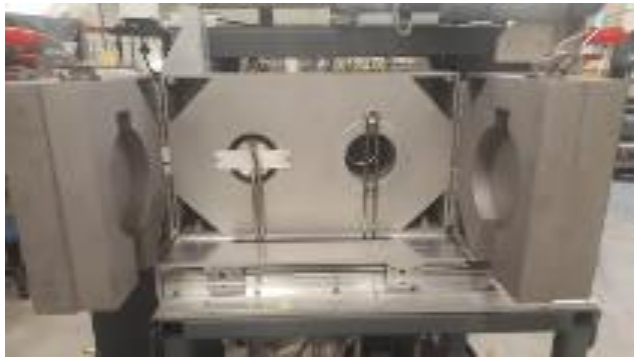
# EPRI projects for Source Term Determinations

- DCPP 1: 2-week trial then 5 units for outage
- Oconee 2: 1 unit for outage, then 2.5 years
- Assay Results consistent with expectations
  - CZT does good job for major gamma emitters
  - Requires careful setup of Libraries and analysis parameters
  - Weak gammas and low energy gammas would do better with HPGe system; much easier to set up
  - Reliable power for temporary applications difficult to come by




# EPRI – Primary Coolant

- Part of EPRI “Smart Chemistry” project to demonstrate automated chemistry operations at NPPs
- Primary Coolant flows thru unit, past HPGe detector
- Dual sample chambers
  - Large volume, 30m count after 23hr decay
  - Small volume, continuously counting 23hr/day
- Tanks holding cleaning solution and clean water
- PLC system to control operations
- System worked flawlessly for 7mo
  - Installed and operated remotely under COVID rules
- Methodology not viable unless find better piping material





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# Gamma-Isotopic Effluent Stack Monitor (STAX)

- Earliest large system use of Data Analyst
- Pump pulls sample from stack
- Pre-filter to remove particulates and Iodine
  - Could be monitored separately for P-I-NG
- Assay container 17 Liter Marinelli Beaker
  - Inside modified 747 shield
- HPGe [GR30xx]
  - Electrically cooled with CP5-Plus
- Lynx-II MCA with Data Analyst
- 8-decade dynamic range
- Temperature and Pressure corrections to concentration
- Stack flow input to convert results to effluent rate
- Horizon for remote display and data archive
- DA set for 3 simultaneous counts




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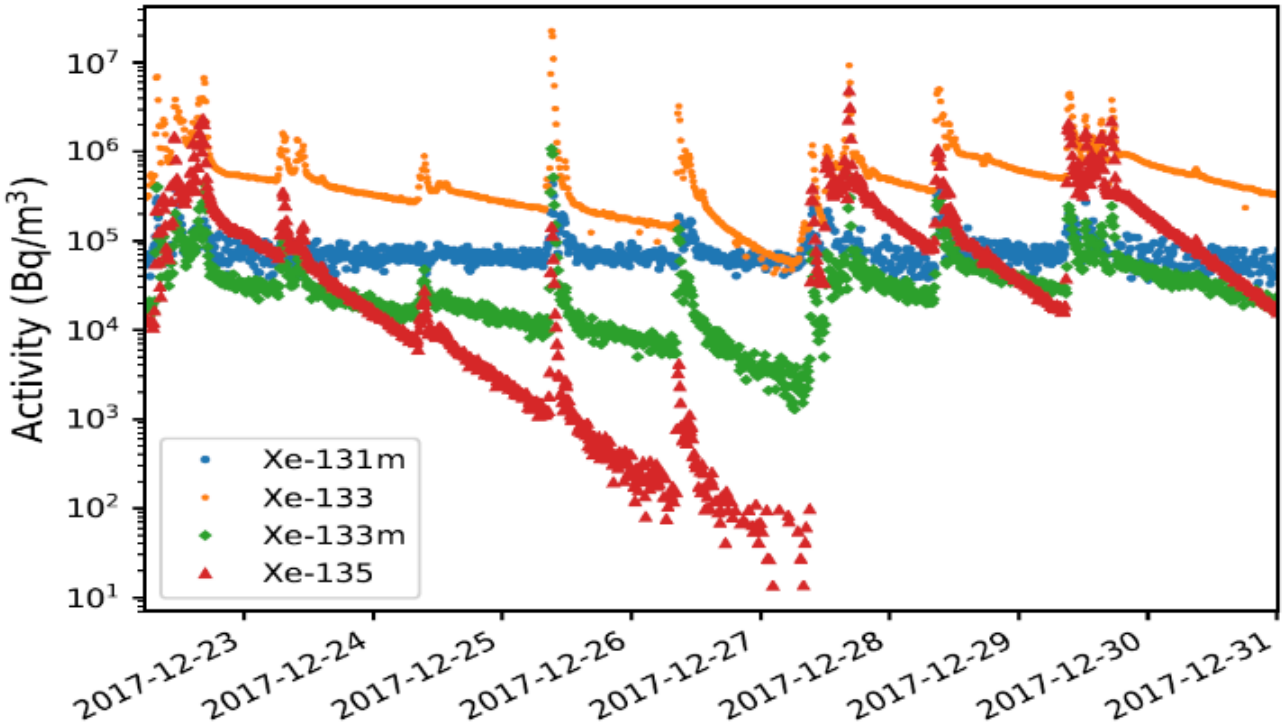
# Noble Gas MDC's




| MDC (Bq/m³) | | | |
|---|---|---|---|
| Nuclide | 600 sec acquisition | 3600 sec acquisition | 14400 sec acquisition |
| Kr-85 | 6.91E+04 | 2.50E+04 | 1.19E+04 |
| Kr-85m | 1.85E+02 | 6.77E+01 | 3.25E+01 |
| I-131 | 2.20E+02 | 7.67E+01 | 3.61E+01 |
| Xe-131m | 7.41E+03 | 2.72E+03 | 1.31E+03 |
| Xe-133 | 5.74E+02 | 2.10E+02 | 1.01E+02 |
| Xe-133m | 1.56E+03 | 5.66E+02 | 2.70E+02 |
| Xe-135 | 1.87E+02 | 6.77E+01 | 3.24E+01 |
| Xe-135m | 2.46E+02 | 8.25E+01 | 3.82E+01 |



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# New Nuclear & Qualified Fuels

## Authorization pathway for Nuclear Facilities (DOE-STD-1271-2025)

- **The baseline:** Qualified fuels with proven operating history (TRISO, TRIGA, EBR-II) are the preferred choice — established manufacturing processes provide the strongest safety assurance

- **The reality:** Design constraints may require fuel or operating conditions that deviate from qualified bounds — creating uncertainty in fuel integrity that qualification alone can't cover

- **The safeguard:** Real-time fission break monitoring continuously tracks primary coolant activity; if it exceeds the acceptance threshold, the reactor automatically shuts down pending root cause determination

- **Universal coverage:** Active monitoring applies to all out-of-bounds scenarios — both unqualified fuel forms and qualified fuels pushed beyond their operating envelope



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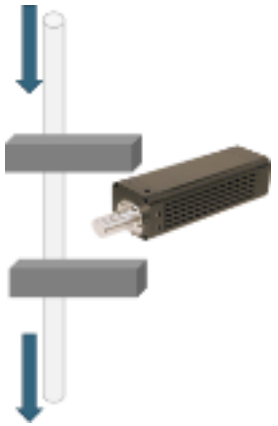
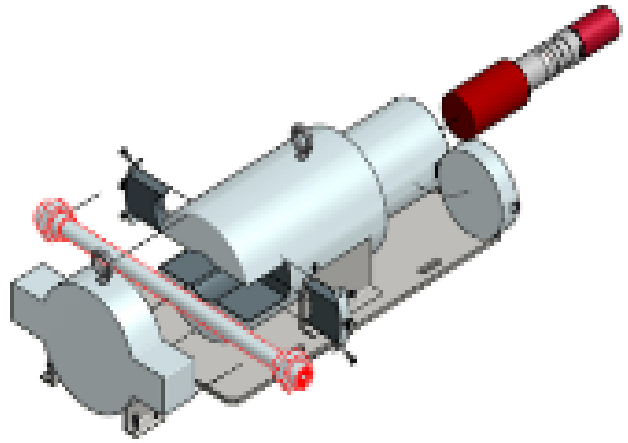
# Pipe Assay CSM

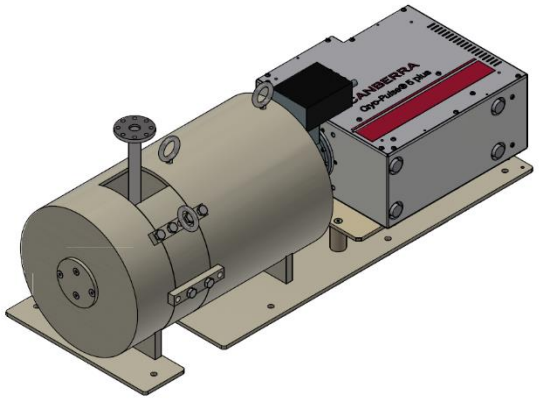
- This is the most frequently discussed system – fission-product monitoring for New Nuclear
- They are quite easy to implement, either by us or by a knowledgeable user
- Easiest and least expensive:
  - CZT system using standard shield
  - OK for moderately complex nuclide mix
- Most Sensitive:
  - NaI system;  3x3 LED-stabilized detector
- Best for Complex Situations
  - HPGe system with CP5 cooler
  - Wide dynamic range, Low energy, ..



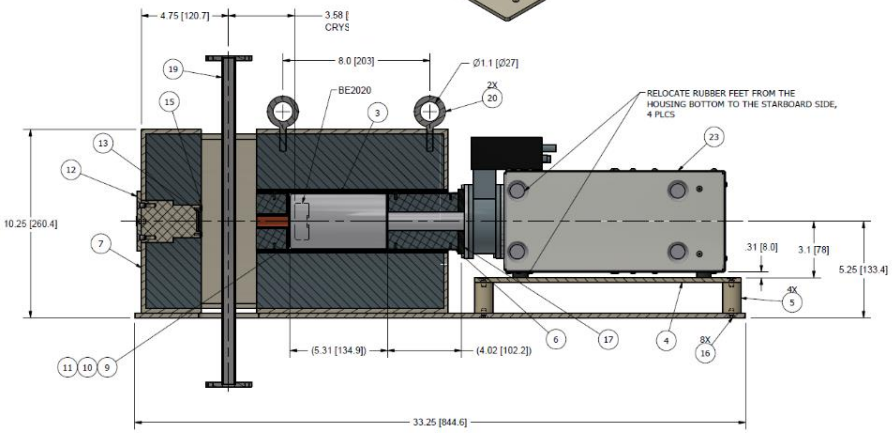


Pipe process monitor NaI

Plutonium chromatography system, uGe



NPP in-situ CZT system



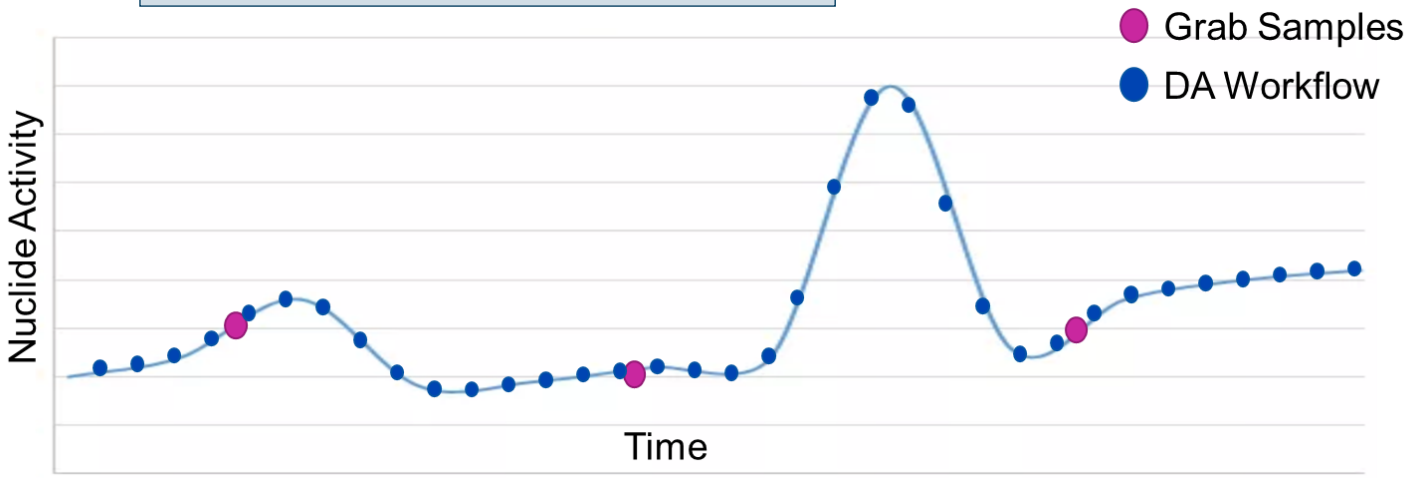

HPGe shielded pipe assay system

# Applications for Fuel-Cycle

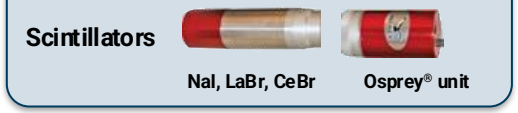
- Inline enrichment monitoring
- Survey trending for process equipment
- Continuous holdup
- Burnup monitoring

NPP in-situ CZT system

- Automated and triggered counting and analysis at defined intervals
- Enabled by the Data Analyst platform








**Data Analyst™ CSM Platform**
**(Embedded Software)**

Autonomous Operation

Data Analyst Web UI



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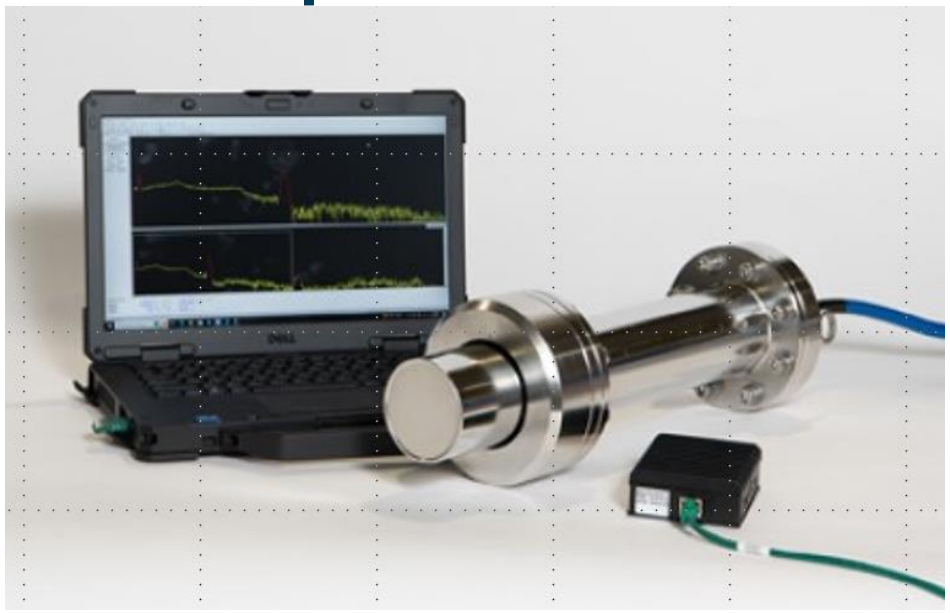
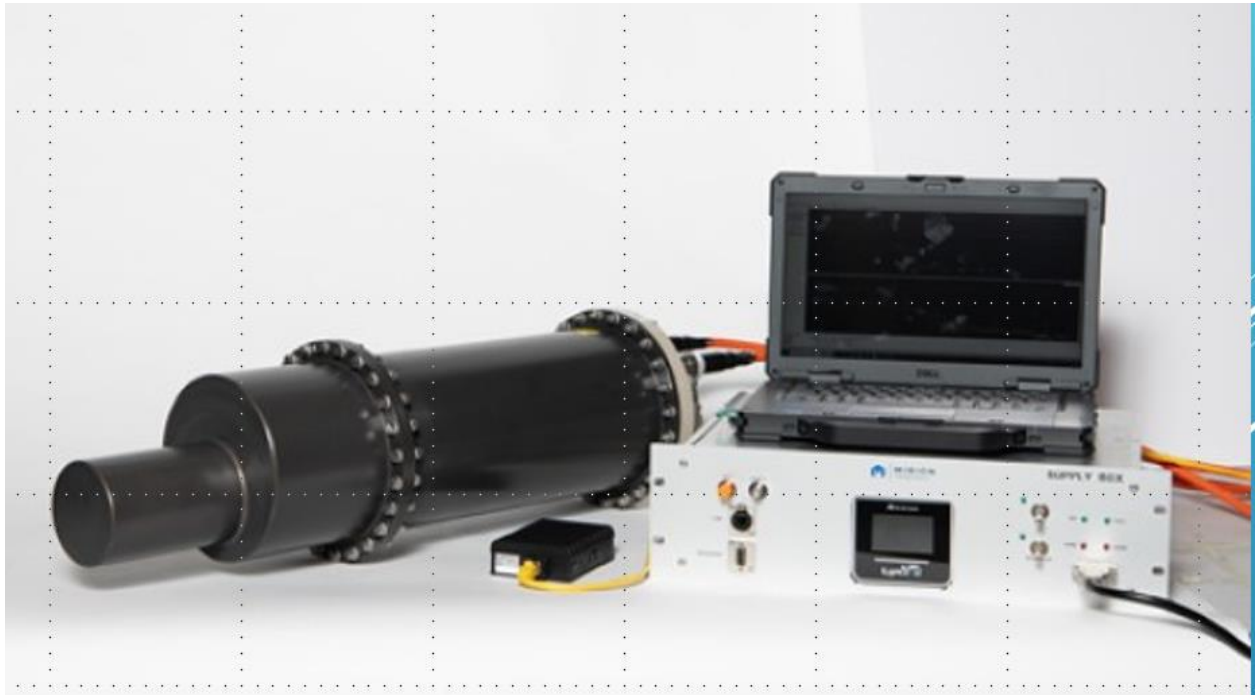
# Underwater Monitoring – LaBr and HPGe in Spent Fuel Pool

- LaBr3 detector and Osprey MCA in housing
  - 75’ Ethernet cable
  - Data Analyst and PC remote
- HPGe – 25% Relative Efficiency SEGE
  - CP5 electrical cooler
  - 98’ composite cable
  - Lynx MCA, Controller, Data Analyst, and PC all remote
- ISOCS Characterization both detectors
- ISOCS infinite thickness calibration for Fuel Pool water
  - Customer can do underwater object calibrations using standard ISOCS

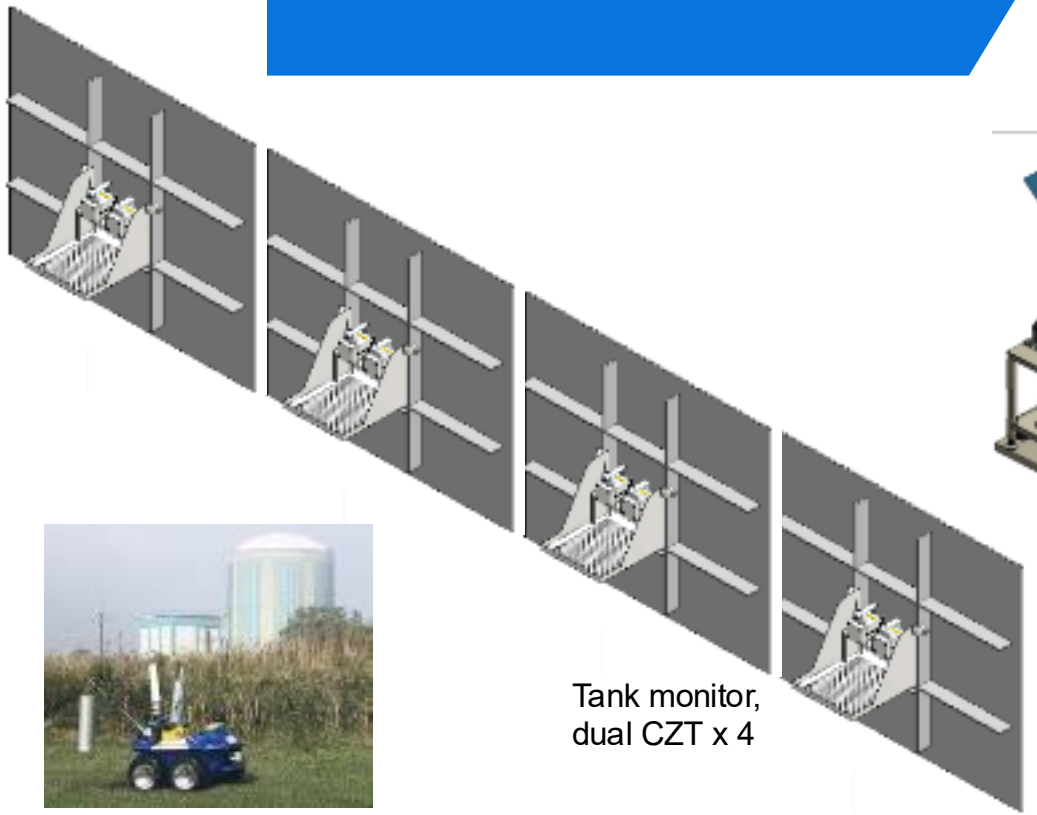




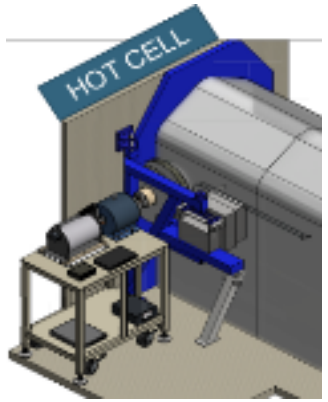
# Applications

Stack Gas Monitor HPGe

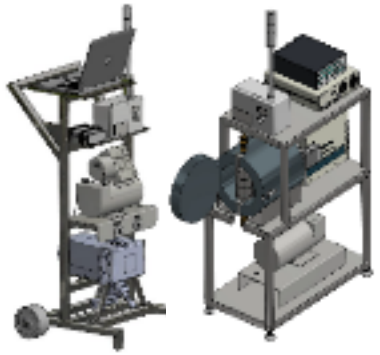
HPGe Primary Coolant Monitor



Tank monitor, dual CZT x 4

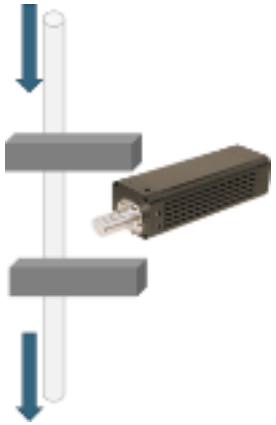



Fuel Rod Scanner HPGe



Particulate, Iodine, Gas monitor CZT [left] HPGe [right]

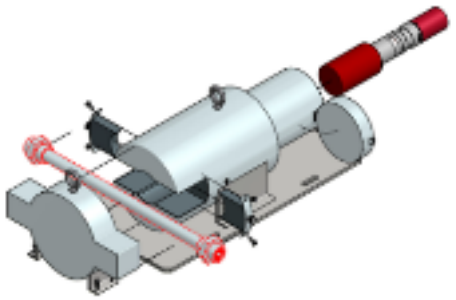
NPP in-situ CZT system



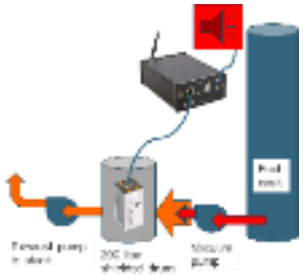
Plutonium chromatography system, uGe



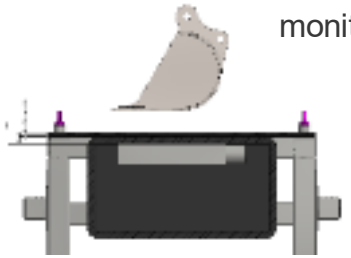
Robot ground and floor, dual NaI



Pipe process monitor NaI

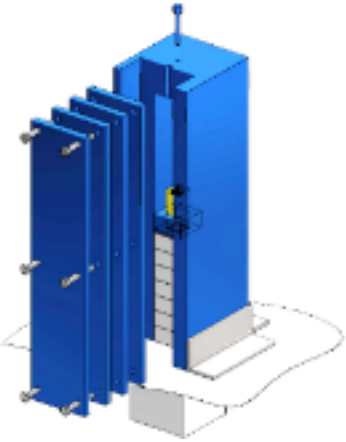


Fuel cask monitor CZT detector



Excavation bucket monitor

BWR primary coolant monitor, CZT



Lu177 assay, CZT

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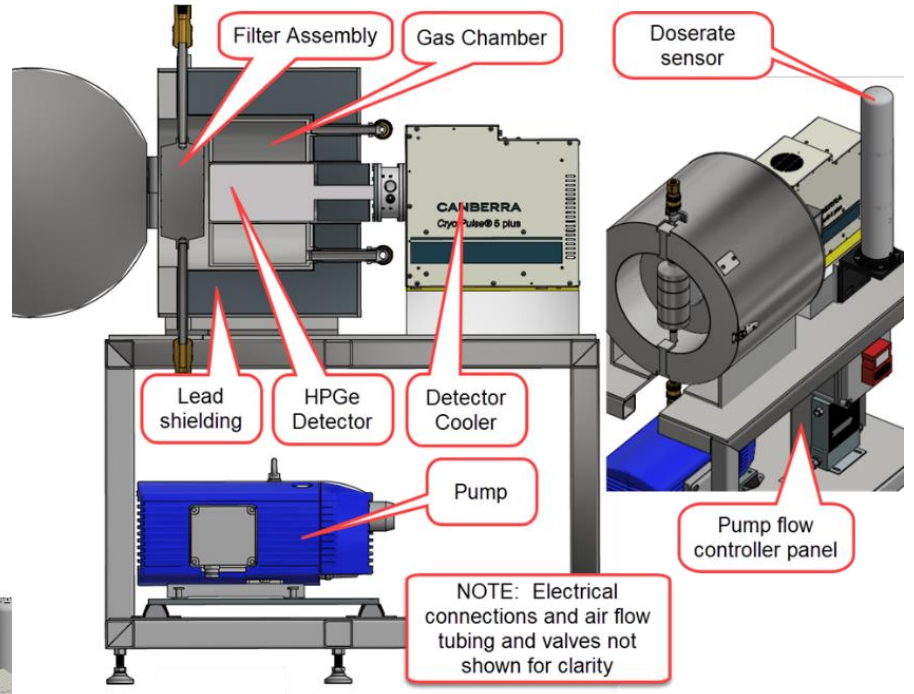
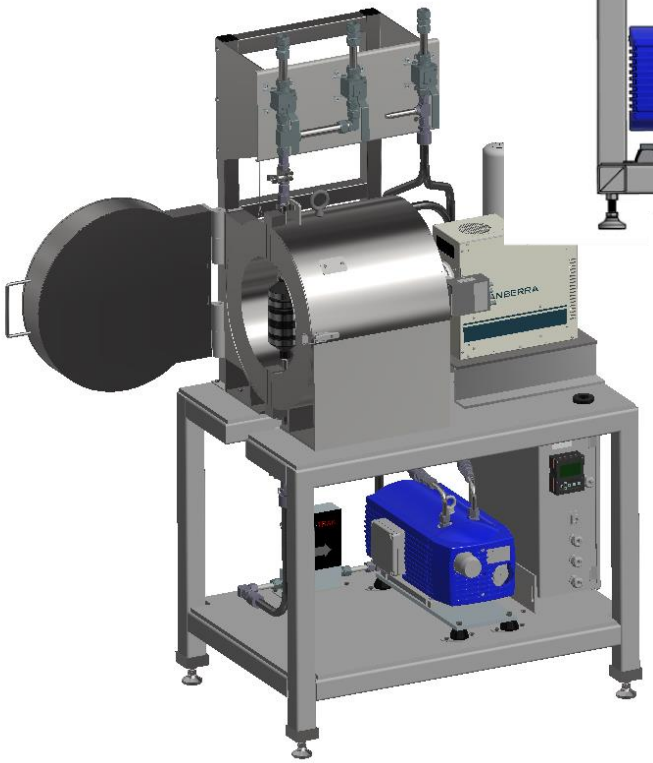
# SPING Spectroscopy Particulate Iodine and Noble Gas Monitor

- Started out in 2019 as NaI-based Spectroscopic Iodine room air monitor
- Contract 2021 for HPGe SPING for Stack Effluent – $600K
- HPGe detector viewing 3 separate sample volumes
- 3 separate outputs: P I NG
- Differential assays convert integrated activity on filters into concentration in air





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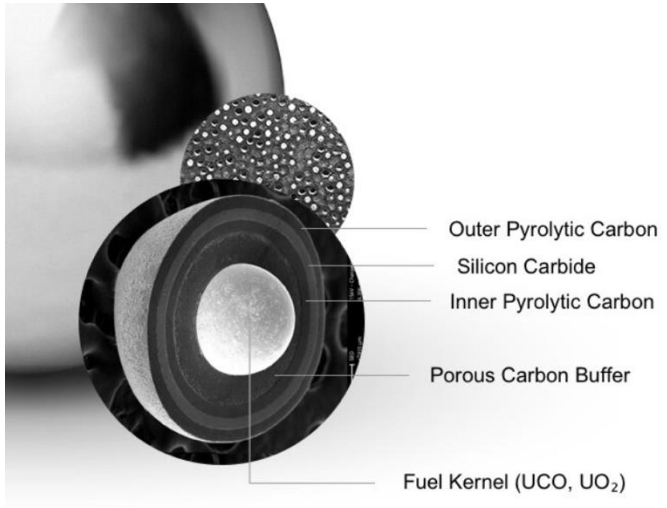
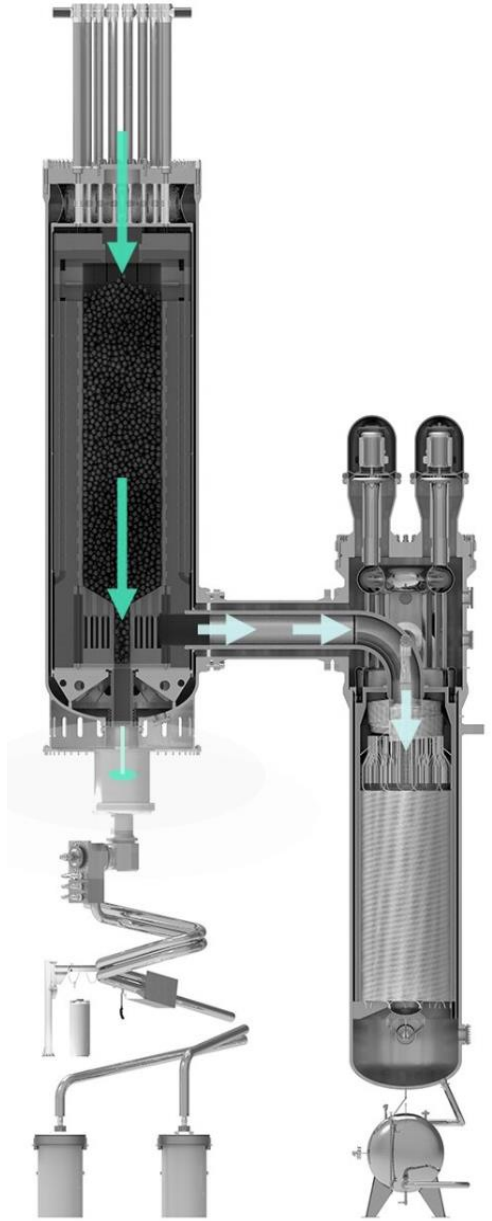
# X-Energy BUMS

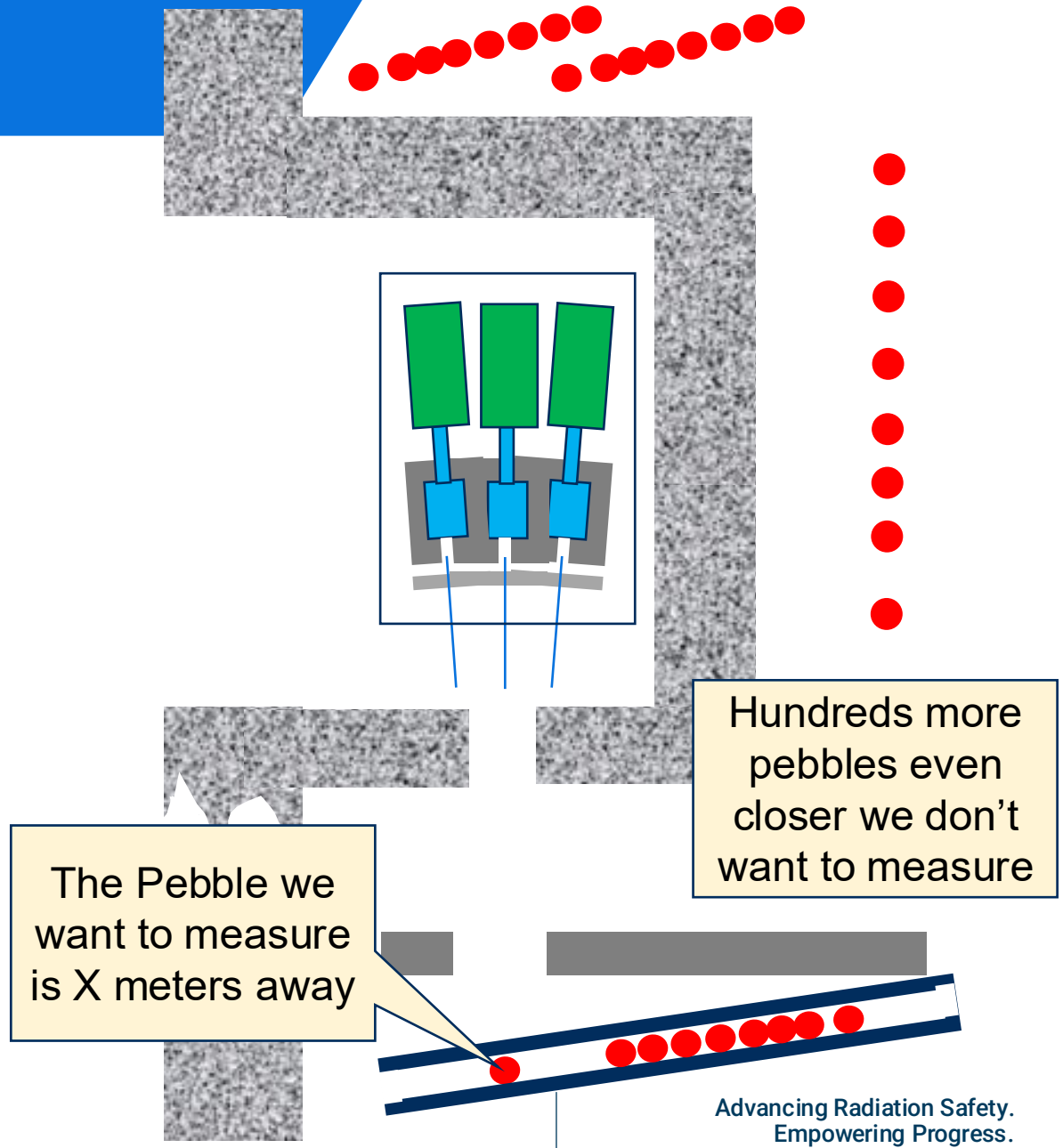
- 200 MW thermal, 80 MW electrical
- 6cm diameter pebbles contain the fuel
  - TRISO – TRI-structural ISOtropic
  - 18,000 TRISO particles in each pebble
- 220,000 pebbles in reactor at same time
- Helium flows around the pebbles to extract heat
- Continuous refueling for 60 year operation
- Pebbles come out of Reactor to be assayed in BUMS
  - Most go back into Rx until max BU reached [160 GWd/t]
  - Max utilization of fuel; minimum fuel cost



# BUMS continued

- 3+ years into 5y project to Design BUMS & Build Prototype
  - HPGe Detector & Collimator design done
  - Prototype Algorithm developed
  - Detailed design now underway
  - Developed in partnership with X-Energy
- Shielding design complicated.
  - Many pebbles close causing high background
  - Gamma and neutron background considerations
  - Equipment high-dose lifetime considerations
- Data Analyst key to success
  - Triggered mode for pebbles
  - Continuous QA & detector parameter monitoring





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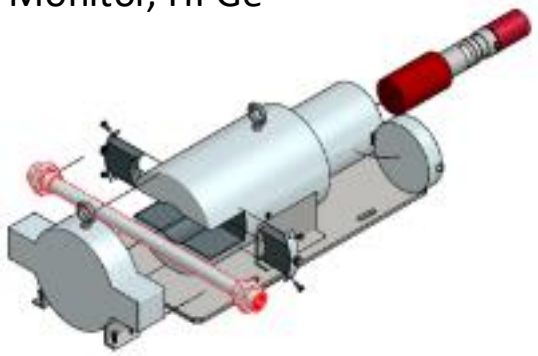
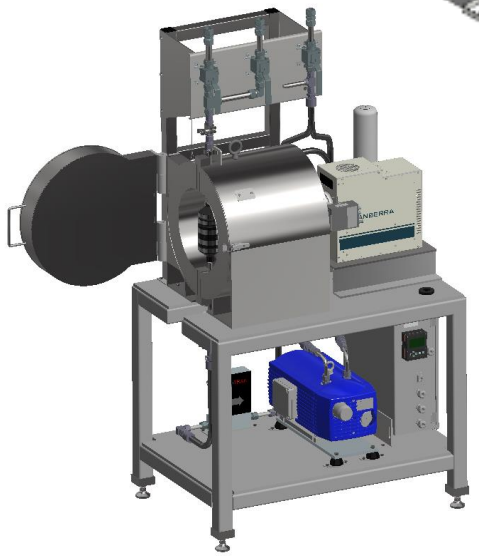
# Continuous QC

Primary Coolant Monitor, HPGe



Pipe process monitor NaI



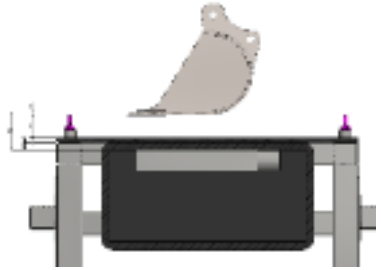
Particulate, Iodine, Noble Gas Monitor, HPGe



Tank monitor, dual CZT x 4

Continuous Monitors

Sample Assay system can also use it



Excavation bucket monitor, NaI

High E source [Thorium]
Behind 2-3cm W, removes low E
Continuous Workflow – always On
Monitoring Activity, FWHM, Centroid
Low activity to not interfere with sample assays
Long count Workflow – e.g. 24hr



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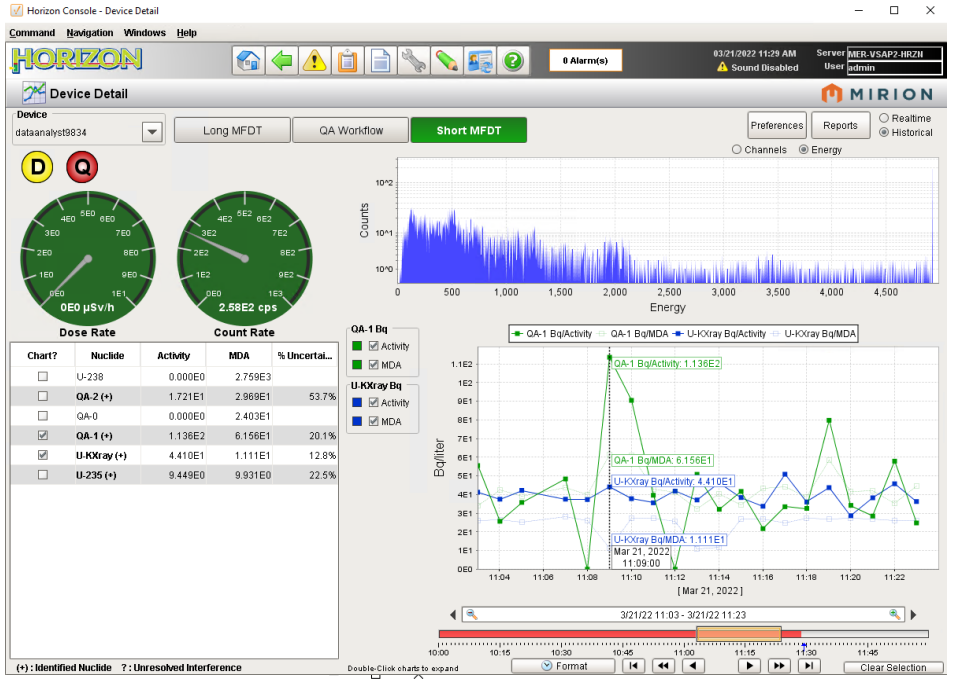
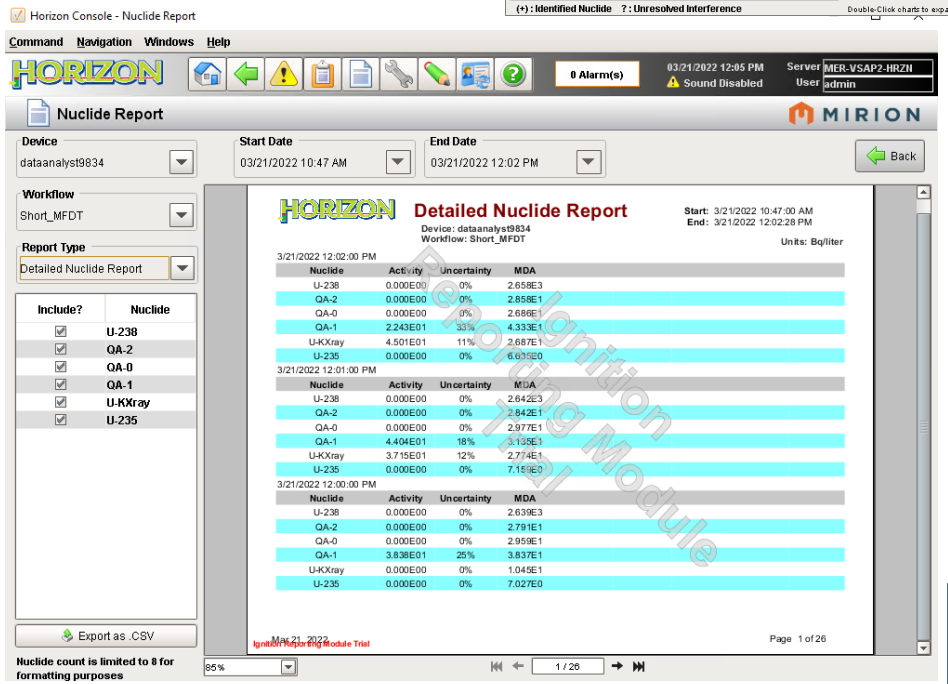
# Horizon Supervisory Software

- Supervisory system to remotely monitor live data
- Single or Multiple Data Analyst inputs
- Records / displays Historical data for Review
- Displays faults/warnings/alarms from DA
- Detailed nuclide reports
- View analyzed spectra
- QA workflow monitor
  - Activity, FWHM, centroid
  - Alarms, text messages
- Custom calculations and screens




Reporting Module Trial

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# Supervision Platform

The first step in our Vital platform strategy

## HP / RP

Telemetry/Dosimetry, access control, handheld, C&C, area monitors, RTLS

## RMS & Environmental

CAMs, tritium, Iodine, area, outdoor, perimeter monitors

## Spectroscopic Systems

Stack monitors, in-Situ, CSM, Aegis

## Defense/Security

Emergency response, event screening/monitoring, HLS

Vital

Communications Hub

Data Hub & Historian

Platform Services

Web App Framework

Client Web Visualization

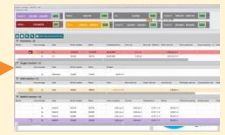
Plant Data
(flow, releases, etc.)

Radiological Data & Alarm Info

Plant Computer

## Supervisory App

Site Maps



Dashboards

Instrument detail & historical data display

Alarm/Event display & management

Data viewing with exports



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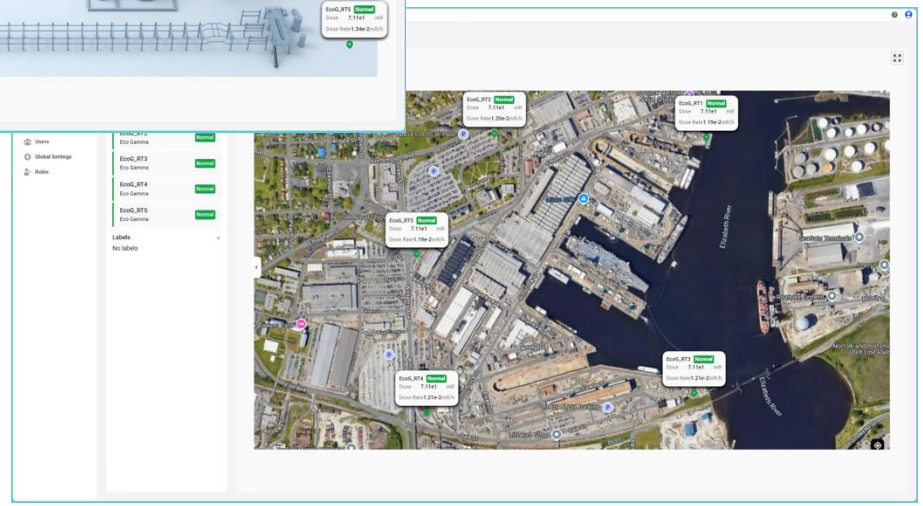
# Vital – Maps

- **Site Areal View** (drawing or satellite)
  - Perimeter monitors
  - Specific Area (e.g. tank farms)
- **Building Views**
  - Buildings (full building)
  - Floors
  - Rooms





Demo



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# Questions?
# Discussion

# How can we help?

Survey for:

# Continuous Spectroscopy Monitoring for Nuclear Power Applications

Please take a moment to fill out a short survey on this session.

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# Thank you