Real World Application for Continuous Spectroscopic Monitoring

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Agenda

- Overview of CSM and the Data Analyst™

- What's new in the Data Analyst™ since MC24

- Discussion of multiple user Applications

- Questions and Discussion

  - How can we help you with your CSM needs?

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CSM with Data Analyst™

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What is CSM?

- **Continuous Spectroscopy Monitoring**
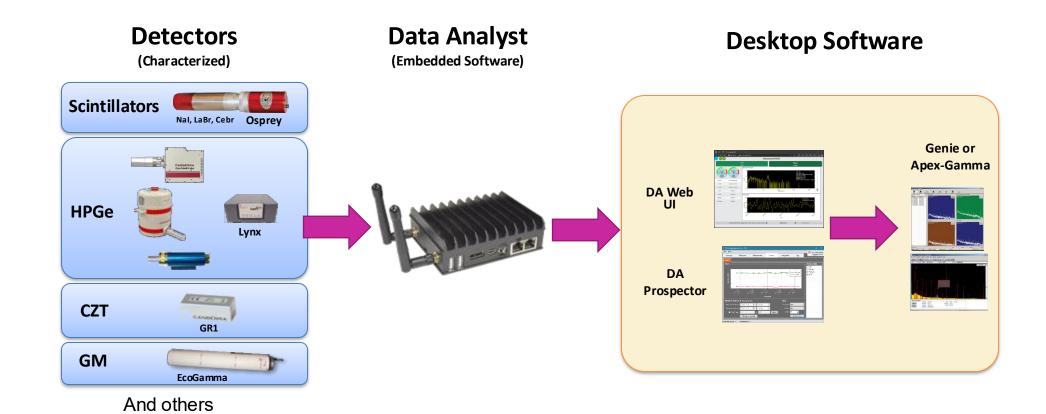
  - Automated counting at defined intervals

  - Enabled by the Data Analyst

  - Also remotely triggered analyses

- **Data Analyst is a core building** block for advanced online monitoring systems, 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**

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Basic Components of CSM

Detectors
(Characterized)

- **Scintillators** — NaI, LaBr, Cebr / Osprey
- **HPGe** — Lynx
- **CZT** — GR1
- **GM** — EcoGamma

And others

Data Analyst
(Embedded Software)

Desktop Software
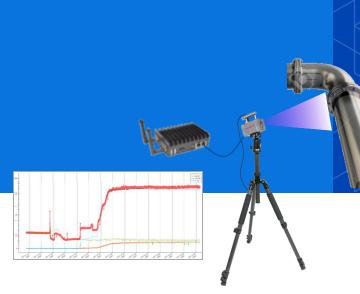
DA Web UI

DA Prospector

Genie or Apex-Gamma

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
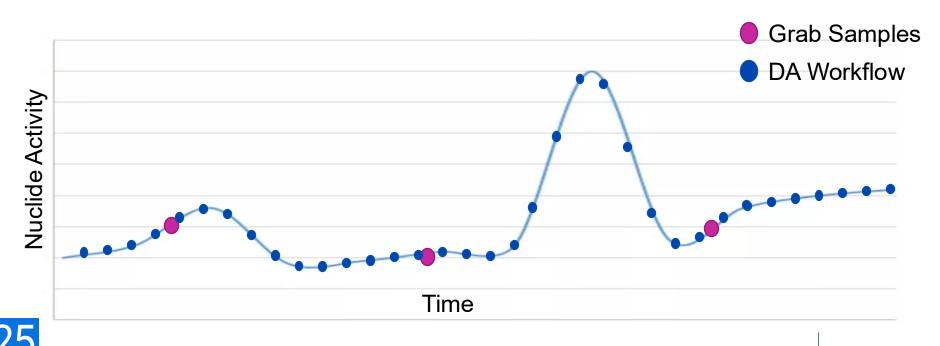
  - Publish/use reports, decide if there's an issue

- **Continuous [or triggered] Spectroscopy**

  - Measurement is done In-situ

  - Calibrate via ISOCS

  - Point detector at object to be measured

  - Automated counting & analysis, 24/7

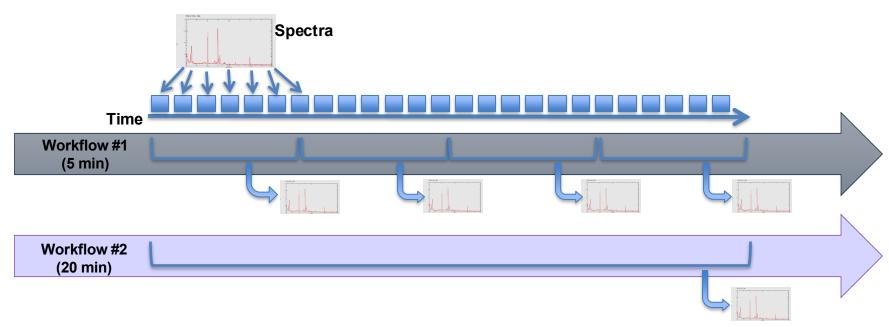 - View results live & view trend plots & utilize

  - See alarms immediately

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The Advantage of Continuous Monitoring

- Manual Sampling is much less frequent & can miss events

Workflows

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

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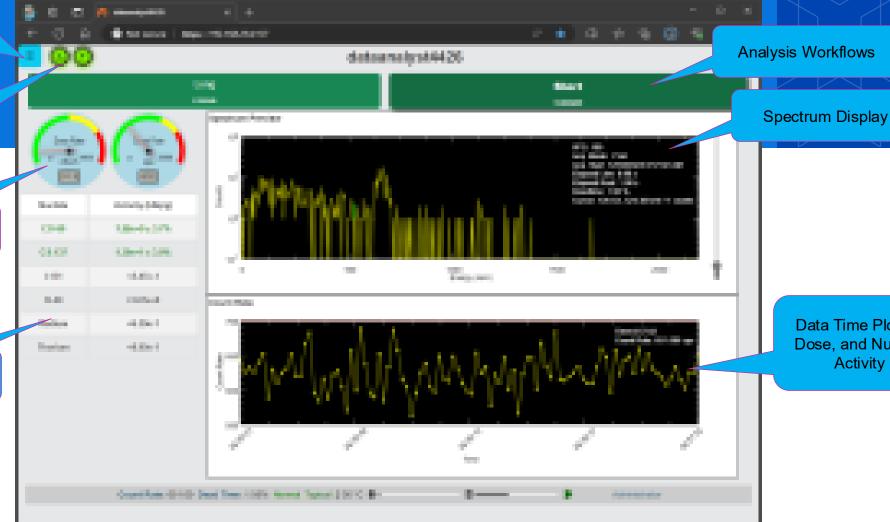# ALL NEW Data Analyst Interface

Setup, Config, Operations

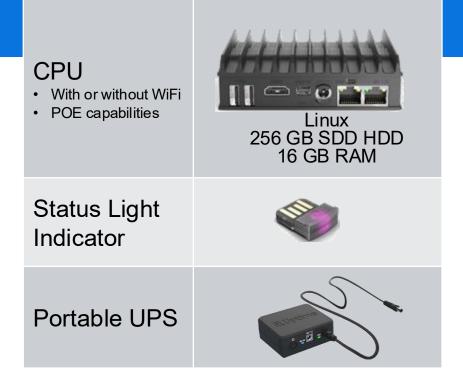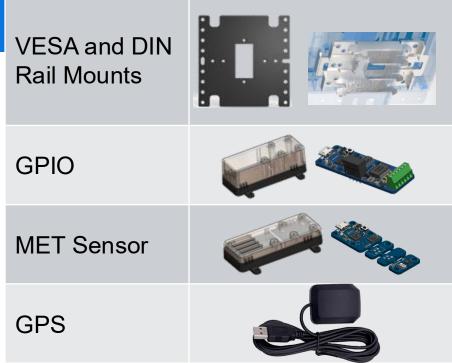Alarm, Fault indicators

Dose & Count Rate Meters

NID Results

Analysis Workflows

Spectrum Display

Data Time Plot for Dose, and Nuclide Activity

What is included in DA-PRO

CPU • With or without WiFi • POE capabilities	Linux 256 GB SDD HDD 16 GB RAM	**VESA and DIN Rail Mounts**	
Status Light Indicator		**GPIO**	
Portable UPS		**MET Sensor**	
		GPS	

Includes DA-PRO software preinstalled

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What's New since MC24?

—

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 - MCA and HPGe Portable

- MicroGe

- Spir-Explorer - MCA and can also double as a Dose device

- RDS-32 - Dose device

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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

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Legacy interface

Adobe Flash & Adobe-AIR

- The legacy Data Analyst UI is built using Adobe Flash technology
- **Still available in the DA 2.0 software distribution for existing systems that already have documentation/training based on the Flash based UI**
- Flash Player no longer supported by Adobe as-of Dec 31, 2020
- Flash Players have been removed or disabled in most major browsers
- An alternative is to use Adobe-AIR to run the DA User Interface
- We include the installable DA Adobe-AIR application on our software CD
- This application is the same software that runs in the browser but needs to be installed on the client computer
- Adobe-AIR runtime is now maintained by HARMAN (Samsung) and can be downloaded from their website airsdk.harman.com/runtime

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ADOBE AIR™

HARMAN
A SAMSUNG COMPANY

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Applications

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Continuous or Triggered Spectroscopy using the Data Analyst

Stack Gas Monitor HPGe

HPGe Primary Coolant Monitor
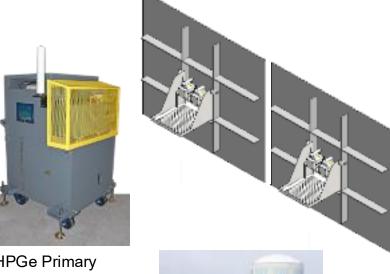
NPP in-situ CZT system

Plutonium chromatography system, uGe
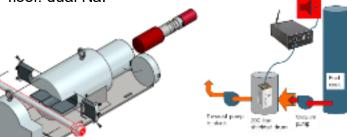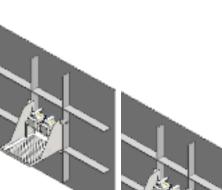
Robot ground and floor. dual NaI

Pipe process monitor NaI
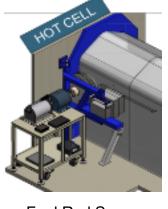
Tank monitor, dual CZT x 4

Fuel cask monitor CZT detector

HOT CELL

Fuel Rod Scanner HPGe

BWR primary coolant monitor, CZT
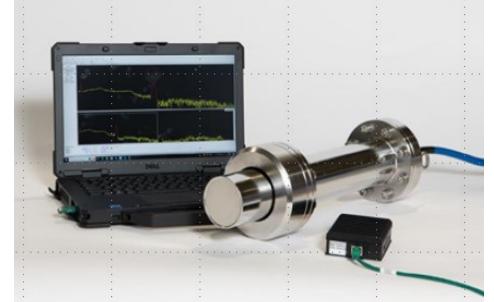
Excavation bucket monitor

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

Lu177 assay, CZT

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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
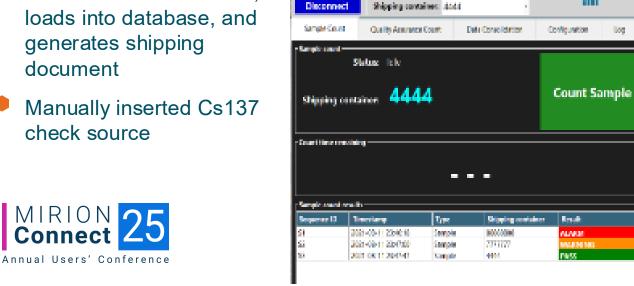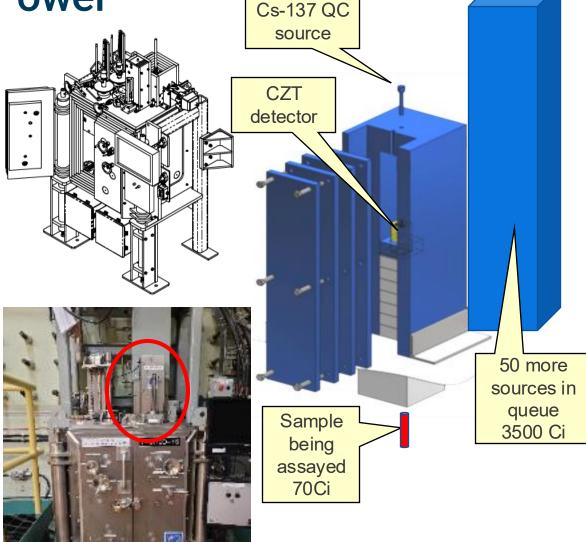 - Customer can do underwater object calibrations using standard ISOCS

Lu-177 assay system at Bruce Power

- Targets are enriched Yb-176, 1-2 week activation, 1d decay
  - Yb-177 [T½ = 1.9hr] produced; decays to Lu-177 [T½ = 6.7d]
- Sample assayed at 40cm away inside 15cm thick tungsten box
  - Estimated activity at time of measurement is ~70 Ci [3E12 Bq]
  - About 50 more samples of similar activity are waiting in the queue only 20 cm and away behind 15cm of Tungsten
- Heavily attenuated CZT detector
- Custom Touch screen PC for operator
  - 2 Touch screen triggered Workflows
  - One for QC source and Background, One for Targets
- Custom software consolidates all the data, loads into database, and generates shipping document
- Manually inserted Cs137 check source

Cs-137 QC source

CZT detector

50 more sources in queue 3500 Ci

Sample being assayed 70Ci

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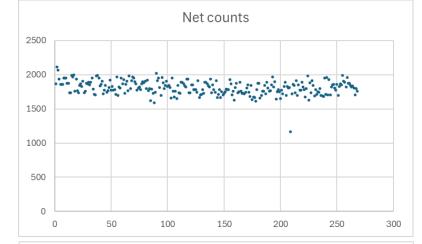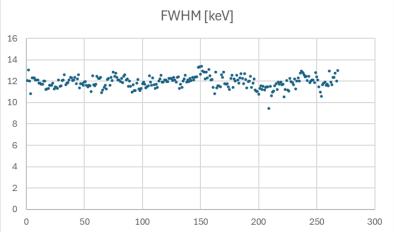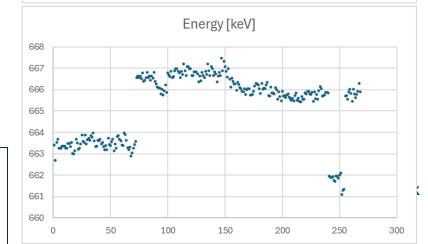
2.5 years of QC data on Lu177 system

- CZT detector and Cs-137 check source

- Detector ~50' away on USB-Ethernet-USB cable

- In hot [thermal] area; ~40C

- 275 measurements of check source
  - Before and after each shipment batch

- Net counts – warning/alarm to operator
  - very stable; 1 outlier, repeat count was good

- FWHM – very stable
  - 1 outlier – same as above

- Energy – changes, but not enough to change activity
  - Human error; after battery change the incorrect energy calibration was entered

Issue uncovered in DA Area Engine: minor change in energy coefficient caused incorrect ROI settings in Area engine; not new issue, fix available if needed

Net counts

FWHM [keV]

Energy [keV]
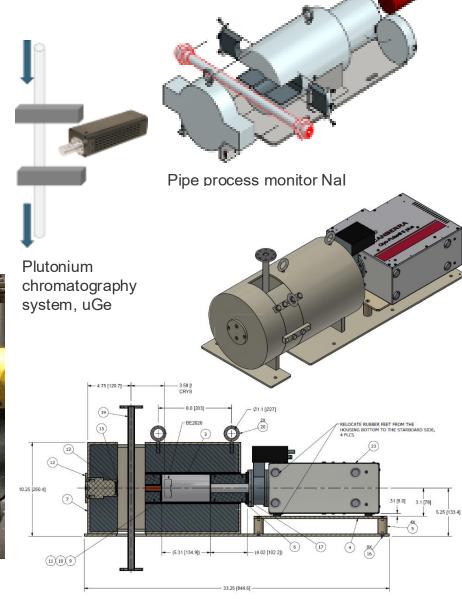
Pipe Assay Continuous Monitoring Systems

- This is the most frequently discussed system

- They are quite easy to implement, either by us or by a knowledgeable user

- Easiest and least expensive:
  - CZT system using standard shield
  - Easy to set up and deploy
  - OK for moderately complex nuclide mix

- Most Sensitive:
  - NaI system; 3x3 LED-stabilized detector

- Best for Complex Situations
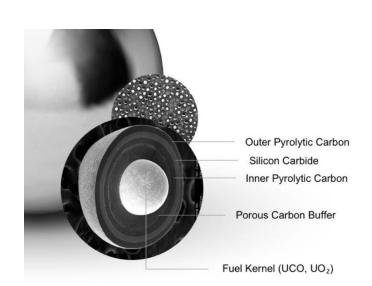 - HPGe system with CP5 cooler
  - Wide dynamic range, Low energy, ..

Pipe process monitor NaI

Plutonium chromatography system, uGe

NPP in-situ CZT system

HPGe shielded pipe assay system

X-energy Pebble Bed Reactor BurnUp Monitoring System - BUMS
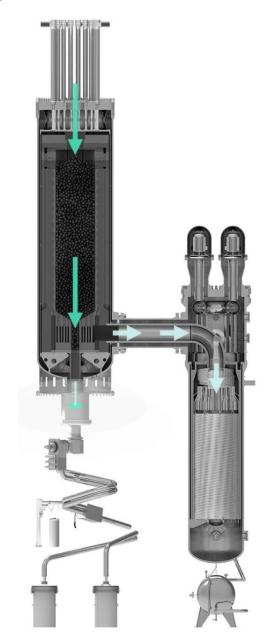
- 200 MW thermal, 80 MW electrical

- 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

Outer Pyrolytic Carbon
Silicon Carbide
Inner Pyrolytic Carbon
Porous Carbon Buffer
Fuel Kernel (UCO, UO$_2$)

XE-100

https://youtu.be/Aause IxFQRE
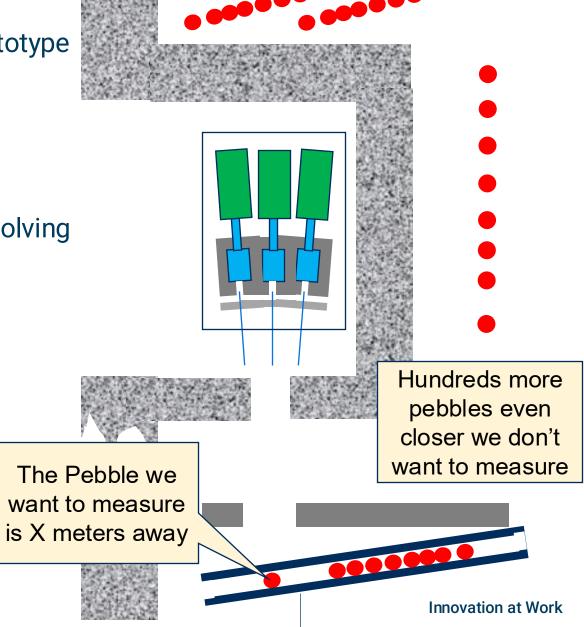
Mirion Project

- 2+ years in a 5y project to Design BUMS & Build Prototype

  - HPGe Detector & Collimator design done

  - Prototype Algorithm developed

  - Detailed design now underway

  - Much interface with customer as the Rx design evolving

- 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

Hundreds more pebbles even closer we don't want to measure

The Pebble we want to measure is X meters away

Key Features used and Items added to Data Analyst for BUMS
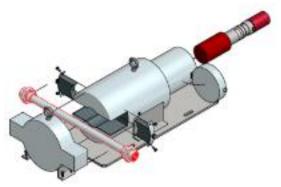
- **Standard capabilities used:**
  - Post-NID script to determine pebble type and burnup
    - Standard capability in the DA and now in Genie 4.1
  - Triggered mode for Pebble, and simultaneous Continuous mode for Continuous-QC
  - Dynamic Workflows – counts just long enough for accurate decision
    - Count to MDA standard, adding count to precision
- **New features:** – can be used on other projects when needed
  - OPC-UA data/result outputs compatible with PLCs
  - Vital Supervisory software to replace Horizon
  - Remote triggering of differing analysis operations modes
  - Watchdog and Heartbeat outputs
  - Time synchronization of 1 or more DAs with external clock

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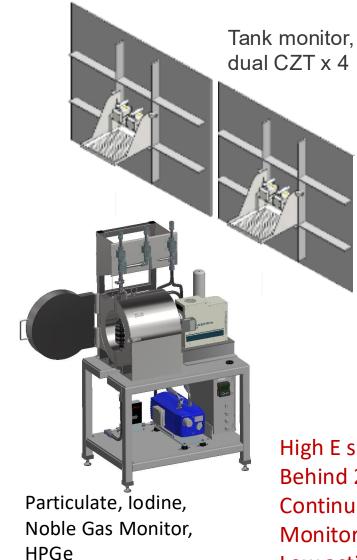
Projects using Data Analyst with Continuous QC

Primary Coolant Monitor, HPGe

Pipe process monitor NaI

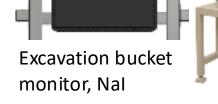Particulate, Iodine, Noble Gas Monitor, HPGe

Tank monitor, dual CZT x 4
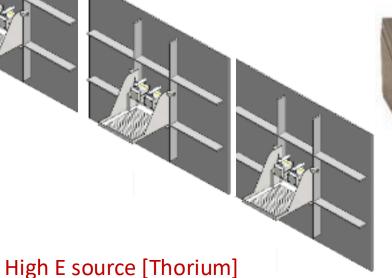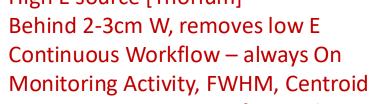
Continuous Monitors

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
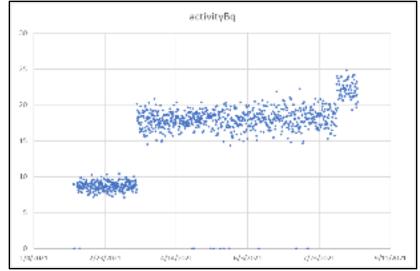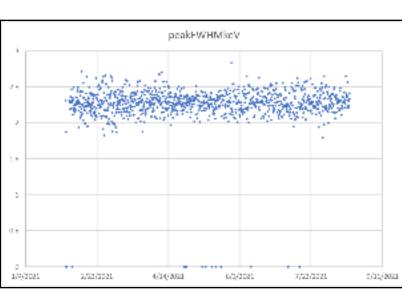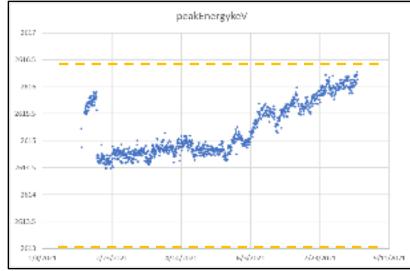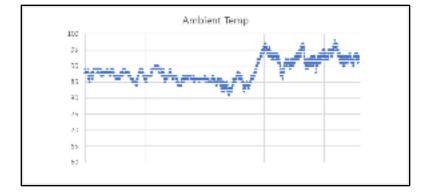
Example - QA data from Primary Coolant Monitoring system

- HPGe system in operating NPP for 6mo
- Thorium 2614 keV line used
  - Activity [efficiency]
  - Energy [gain]
  - FWHM [detector quality
- Activity stable
  - Changes are from equipment reconfiguration
  - Most important QC parameter
- FWHM stable; ~2.3 keV
  - Detector quality indicator
- Gain showed changes, but
  - Always within QC limit of 0.5 FWHM
    - Nuclide ID good until about 1.0 FWHM
  - Much of Gain changes due to temperature changes
- During COVID, otherwise would have adjusted the gain

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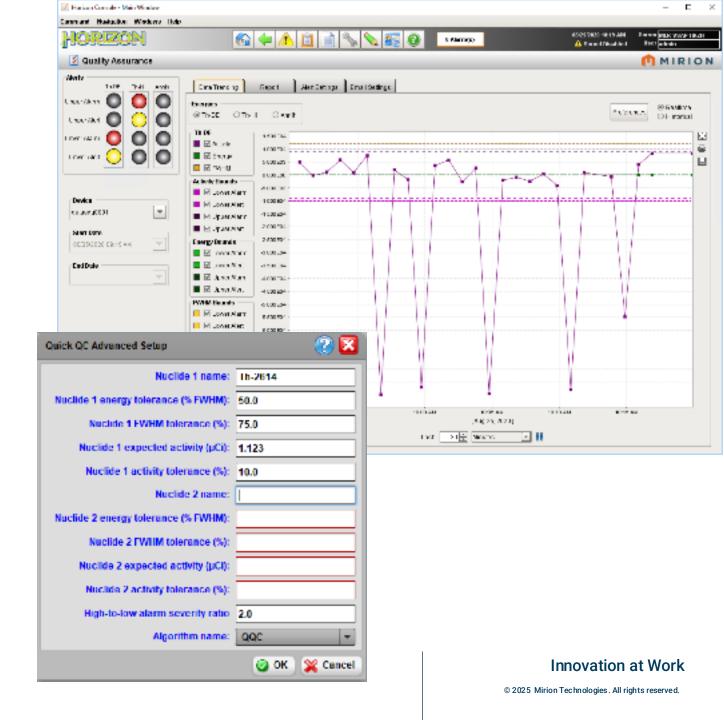
Notification to Data Analyst User for Alerts and Alarms

- **Horizon Users**
  - Displays live DA output
  - Tests for Hi & Lo QC Limits
  - Activity, Energy, FWHM
  - 1-3 single-line Nuclides
  - On-screen Alert & Alarms
  - Sends text messages upon Alarm

- **Data Analyst users [new feature]**
  - QQC – Quick Quality Control
  - Tests for Hi & Lo Limits
  - Activity, Energy, FWHM
  - 1-2 single-line Nuclides
  - Activates Alert and Alarm flags
  - LED on-screen indicators [if viewing]
  - GPIO signals for Alert and Alarm

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Waste Management 2026 Call for Papers

- Abstracts are due August 22
  - Papers around end of November for 1st draft
  - Meeting March 8-12, Phoenix AZ
- Sasha Philips and Frazier Bronson are the coordinators of Track 3 Waste Characterization
- We are responsible to solicit papers – this it !
- It is a Great meeting for those of us involved, now or in the future, with D&D and ER projects

Questions?
Discussion

How can we help?

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Thank you

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