

MIRION
Connect **21**
Annual Users' Conference



Developments in Portable HPGe for Gamma Spectroscopy

Greg Landry
PLM In Vivo Products

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Agenda

- The Aegis Portable HPGe Spectrometer
 - What is it and what does it look like?
 - Ingress Protection
 - Interface
 - Optional back shielding
 - Models, configurations, FWHM performance
 - Batteries
 - UHV technology
 - Ergonomics
 - The electric cryocooler
 - Applications

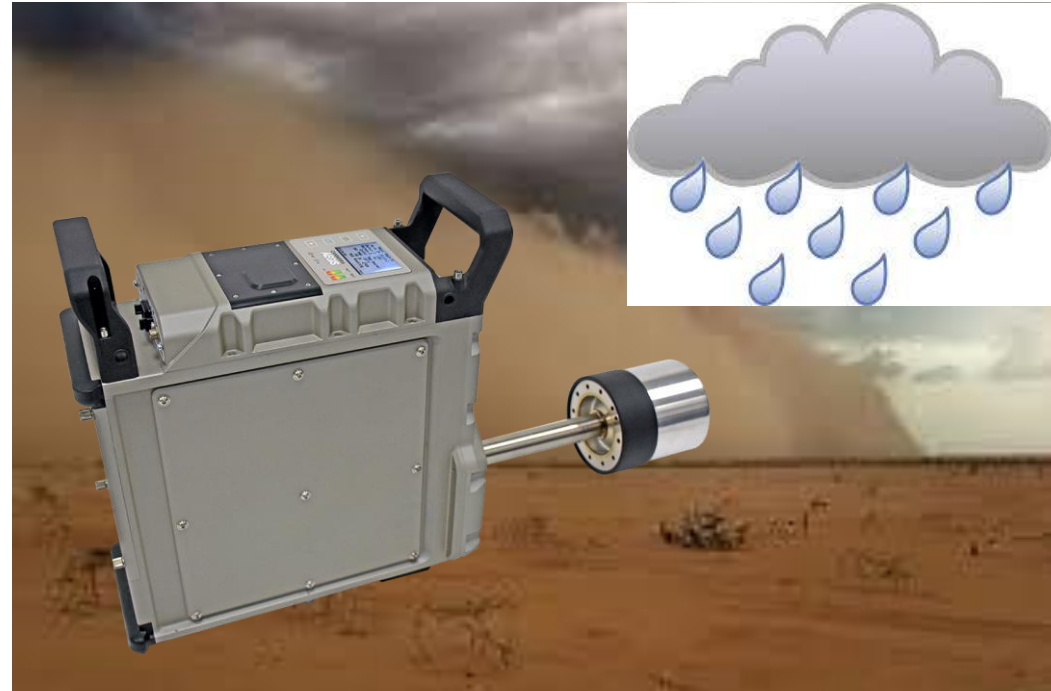
Aegis – The New Portable HPGe Spectrometer



**All-In-One,
portable,
Electrically-operated
HPGe gamma spectroscopy
instrument
with key functions to serve
in-situ and laboratory
applications**

IP65 Ingress Protection Rating

- **No cooling fans** for a **water & dust proof** enclosure seal. The fully passive heat-dissipation design allows **laboratory-grade energy resolution** thanks to an advanced cooling system.
 - No need to worry about sudden **rainstorms or dusty conditions**. No need to wrap in plastic or bring & set up large tents to use outdoors.
 - Ideal for use in **(potentially) contaminated areas**. No air is drawn into the chassis for cooling which eliminates the potential for internal contamination. Enclosure surface is smooth (no radiator fans) enabling easy decontamination of the surface.



Aegis top panel

- GPS module
- Wi-Fi module

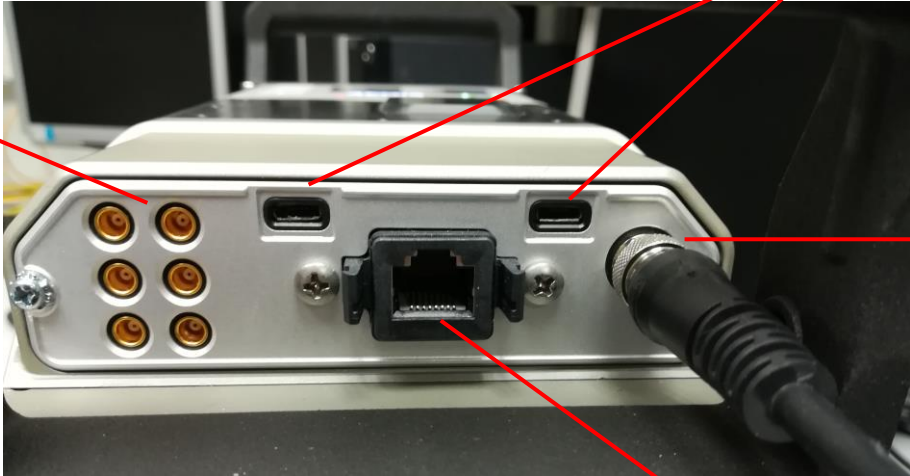
Note: Can be physically removed in the factory



- LEDs for status of:
 - Device power
 - Detector HV bias
 - Cooler
 - Fault/Error
 - Ion pump
 - ICR
 - Battery level in 25% increments
- User Controls:
 - Device power ON/OFF
 - HV bias ON/OFF
 - Cooler START/STOP
 - LCD page navigation
- LCD Display
 - Special display is visible in bright sunshine
 - Hardware status: General, Batteries, MCA, Cooler, Ion pump, Preamplifier, Computer Unit, GPS, network



Aegis back panel

- 6 GPIO MMCX connectors
 - 3 MCA GPIOs in left column
 - Drive sample changer
 - PHA acquisition output level
 - PHA external Start/Stop pulse and level
 - ICR output pulses
 - (Anti-)coincidences
 - 2 CPU and 1 Mon OUT GPIOs in right column
 - 1 Future Use
 - 1 GPIO: Fault-Error status TTL output level
 - 1 Mon OUT
 - Two USB connectors (future use)
 - 24-V dc power supply
 - RJ-45 ethernet connector
- 

Aegis Operational Software

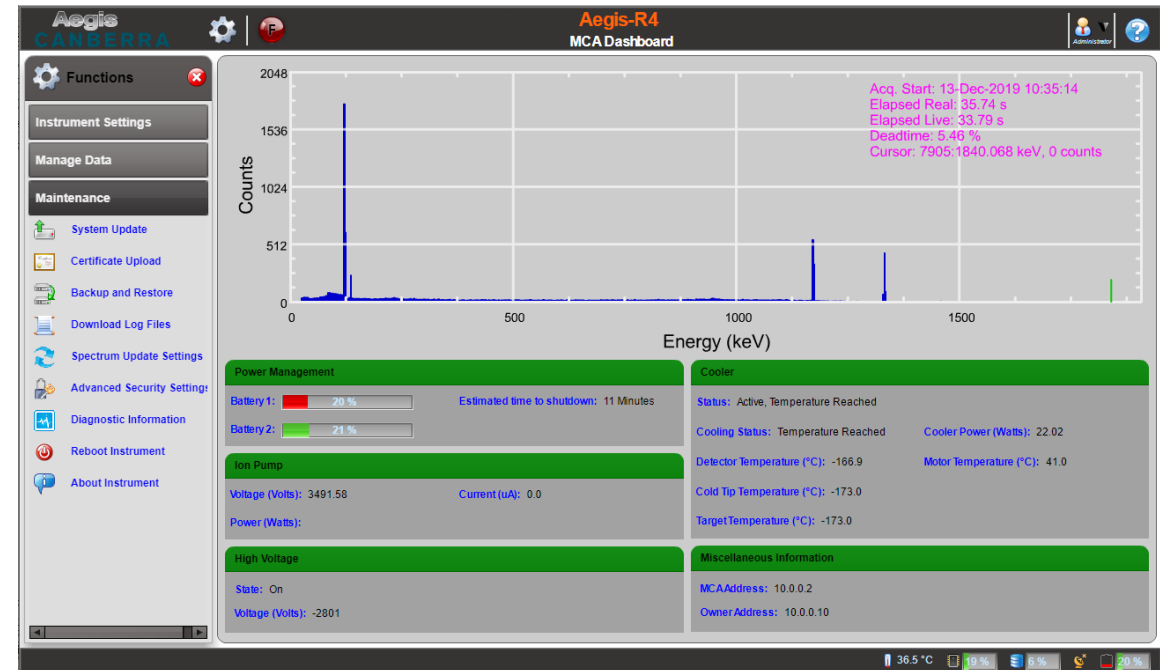
- Genie 2000 Acquisition and Analysis

- Genie 2000 on a laptop/tablet is used for performing measurements
- Version S504 V3.4.2 required (Aegis Genie-2000 driver)
- Connection is by a wired or Wi-Fi Ethernet connection (via physical access point)
- Wi-Fi and GPS (can be optionally physically removed for sites where this is not allowed)

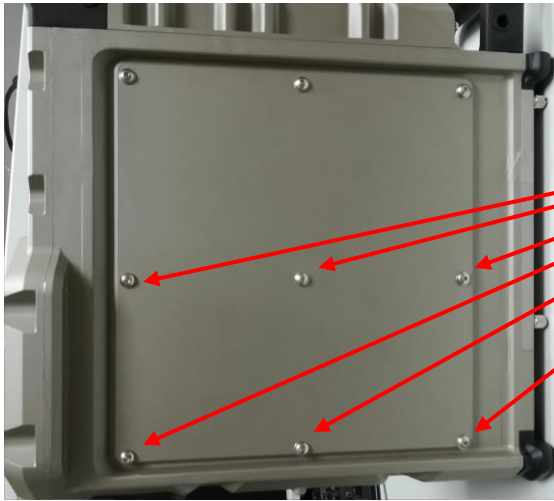


- Aegis Dashboard

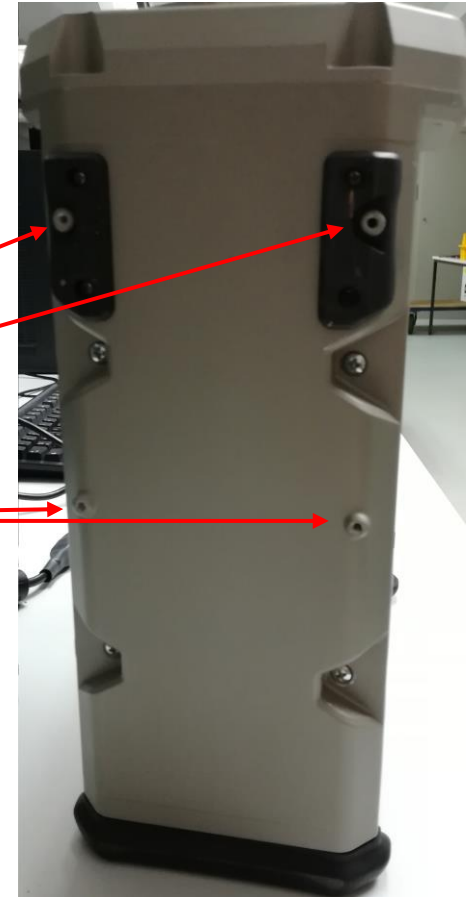
- No installation required
- Dashboard can be viewed while connected with Genie
- Current spectrum shown from MCA memory
- SoH monitoring
- Required for basic functions like:
 - Firmware Update
 - User Account management
 - Network and Wi-Fi manager



Aegis side and bottom panels



- 100 x 100 mm² VESA mounts at:
 - The two side panels
 - 2 x 6 mounts
 - The bottom panel
 - 4 mounts
- Enabling custom mounting solutions with standard mounting arms



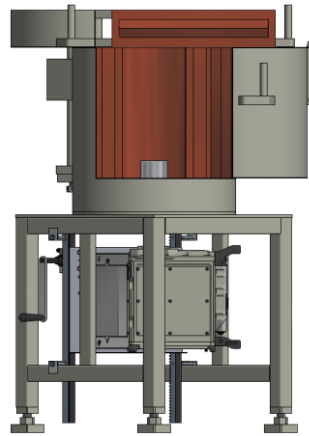
The RDC option



(Optional)



- Turning Aegis into a lead-shield mountable device
 - Designed to fit 4" shields for optimal back shielding
 - Excellent background conditions for each application



Models and configurations

Model	Lead-shield mountable?	HPGe crystal	Description
AEGIS-GC40	No	40% SEGe	Standard Electrode Germanium with diffused outer contact
AEGIS-GX40	No	40% XtRa	Extended Range Germanium with stable thin front window: - Extra low-energy sensitivity
AEGIS-BE5030	No	BE5030: 50 cm ² , 30 mm	Broad Energy Germanium with stable thin front window and point contact: - Extra low-energy sensitivity - Premium energy-resolution performance
AEGIS-GC40-RDC	Yes	40% SEGe	Standard Electrode Germanium with diffused outer contact
AEGIS-GX40-RDC	Yes	40% XtRa	Extended Range Germanium with stable thin front window: - Extra low-energy sensitivity
AEGIS-BE5030-RDC	Yes	BE5030: 50 cm ² , 30 mm	Broad Energy Germanium with stable thin front window and point contact: - Extra low-energy sensitivity - Premium energy-resolution performance



STRUCTURE CODE:

Active Volume	Implanted or Barrier Contact (P+)
Diffused Contact (N+)	Passive Surface

Energy Resolution Specifications

	AEGIS-GC40(-RDC)	AEGIS-GX40(-RDC)	AEGIS-BE5030(-RDC)
FWHM* (122 keV) [keV]	1.4	1.4	1.0
FWHM* (1332 keV) [keV]	2.1	2.1	2.0
Low-energy sensitivity [keV]	40	15	15
Endcap diameter [inch]	3.25	3.25	4.0

*Guaranteed FWHM specifications at 23°C (73°F) ambient temperature.

- Laboratory-grade energy resolution
- XtRa and BEGe low-energy sensitivity driven by rugged 0.5-mm Al end cap
- End-cap diameters fit Mirion lead shields, 7413-425 tripod and standard ISOCS shield

Hot-swappable LiFePO₄ batteries

- Built-in UPS

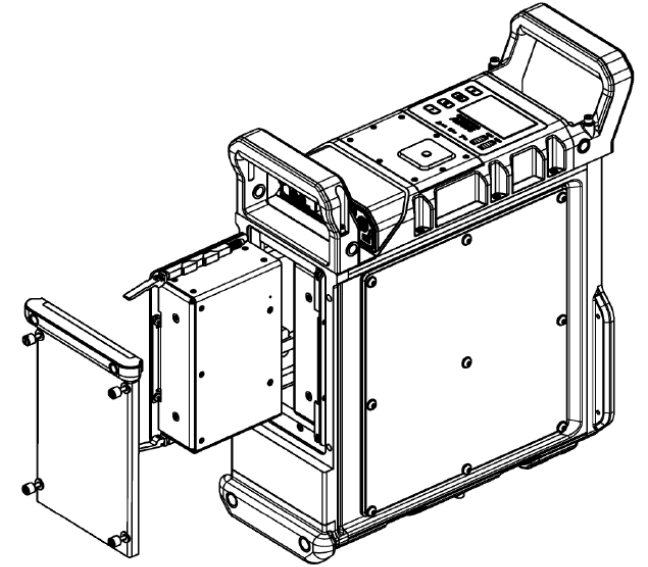
- Covering power flickers/outages
- Autonomous out-door operation once cooled down: ~2.5 hours per battery set
- Charging time with batteries installed in Aegis: <2 hours
- No transportation issues
 - Batteries <100 Wh and combined weight <5 kg: Aegis can be air shipped per IATA regs
 - UN3481 certified for shipping LiFePO₄ batteries in or with equipment via passenger flights
- LiFePO₄ Lithium Iron Phosphate batteries: safer, longer service life, longer storage time, larger temperature range

- Included in standard Aegis package:

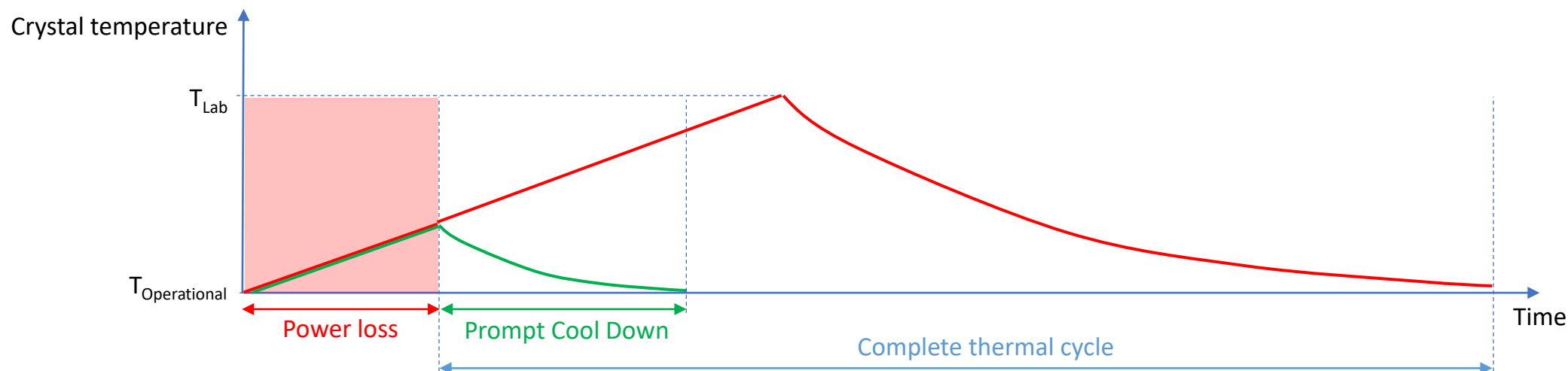
- Two sets of two batteries
- Two external battery chargers: 1 hour to full charge

- Hot swappable

- Safe battery replacement
- Without interrupting ongoing data acquisition



UHV Technology



- **Conventional cryostats based on molecular sieves**

- Large pumping capacity but only at cryogenic temperatures
- If partial warm up occurs, complete warm up to lab temperature required before cooling down again:
Complete thermal cycle

- **Aegis cryostat based on UHV (Ultra-High Vacuum) technology**

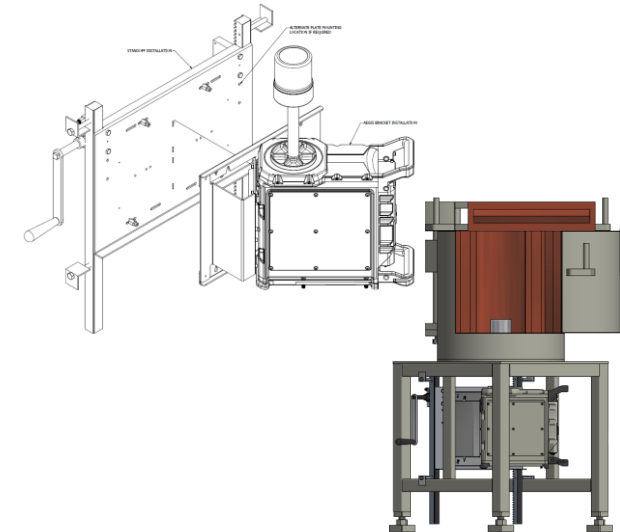
- Intrinsic UHV, also at non-cryogenic temperatures
- If partial warm up occurs, detector can be promptly cooled down again
- Note: ion pump is integrated for maintaining UHV



Thermal-cycle free: maximizing up time

Ergonomics

- Modest weight
 - 16.6 kg [36.5 lbs] (BE5030 with RDC, 2 batteries installed)
- All-In-One package
 - Detector
 - Cooler with controller
 - MCA
 - Wi-Fi
 - UPS
- Two handles to carry
- VESA mounts
 - Custom mounting solutions with standard mounting arms
- ISOCS adaptor plate
 - Easy to mount Aegis on ISOCS cart
- 7413-425 adapter plate
 - Easy to mount Aegis on 7413-425 tripod
- 7415 adapter plate
 - Easy to mount Aegis on 7415 detector lift



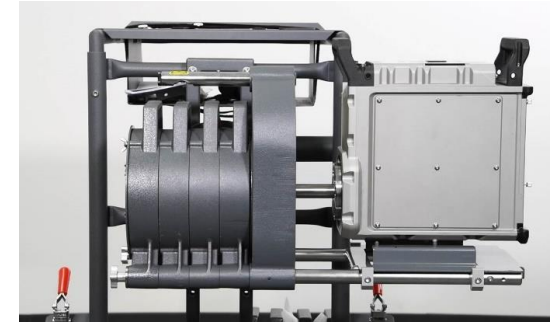
Deployable as Multi-Use Device

- IP65 rated, All-In-One package
- Laboratory-grade E resolution
- Lead shield mountable
- Mechanical adapter solutions



Fixed Lead
Shield Setup

ISOCS Lead
Shield Mount



Tripod
Mount



Mobile labs, survey vehicles



The cryocooler

- Stirling cooler
- Cooler technology with best efficiency allowing:
 - Maximum battery autonomy
 - Passive cooling over wide temperature range:
 - No cooling fans: IP65
 - -20 to 50 °C (-4 to 122 °F)
 - Time to cool down: <12 hours
- No microphonics issues
- Excellent quality and lifetime expectancy
 - Same cryocooler supplier as for CP5-Plus
 - Cooler lifetime expectancy: >7 years



Intended Applications

- **ISOCS** or other in-situ counting applications requiring transportable ruggedized HPGe detector:
 - Clearing objects, outdoor Box Counters, Field remediation, Plant Holdup measurements, Mapping radiological fields, Security & Safety applications, etc ...
 - All in-situ hand-carry field applications (cf. Falcon), now with:
 - IP65 Ingress Protection Rating;
 - Optional lead backshielding (thanks to RDC option)
- **Lab Applications** requiring ‘multi-use’ detectors, i.e. in lab or ‘emergency response’ in-situ measurements
 - Now possible thanks to RDC option
- Also **low ‘down time’** systems – due to thermal-cycle free design
 - Reduces cycle time after power loss



ISOCS Applications (I)

- IP65 Ingress Protection rating
 - No issue with counting in rain while operator controls from a more comfortable location
 - No risk on internal contamination
- ISOXSHLD adapter kit available for:
 - All standard ISOCS carts
 - ISOCS lift
- 7413ADAPT adapter kit available for:
 - 7413-425 tripod
- Aegis with RDC option:
 - Replacing (Big)MAC or CP5-Plus with MCA (IN2K)
- All-in-one Aegis package:
 - UPS, Wi-Fi, MCA, cooler with controller
 - Laboratory-grade energy resolution



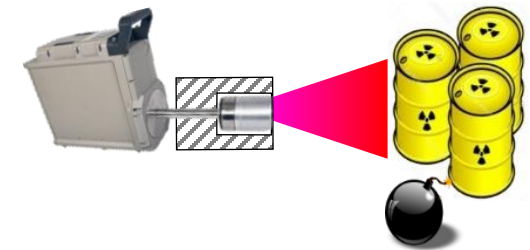
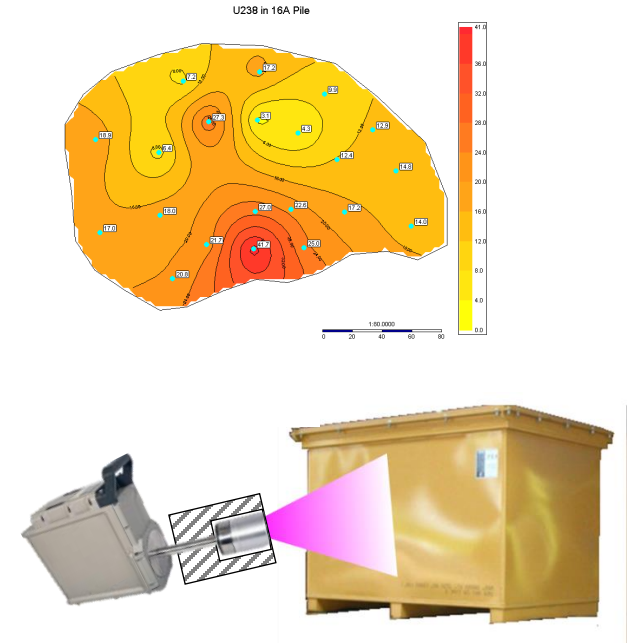
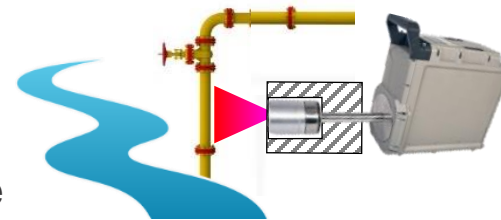
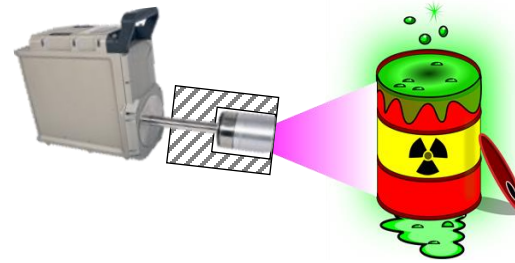
Only external PC needed w/wo ethernet cable

Most compact solution 😊



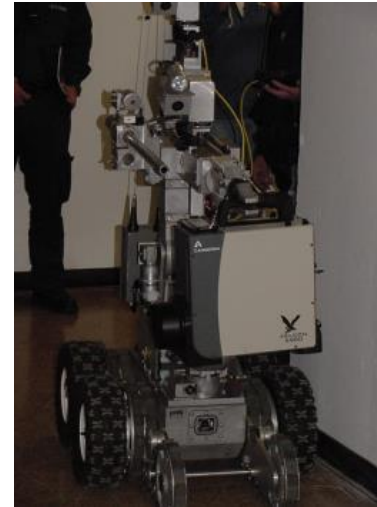
ISOCS Applications (II)

- Ground surveys/field mapping
- In-field waste assays/hazard assessments:
 - Pipes, transfer lines
 - Tanks
 - Ventilation systems
 - Equipment in circuits
- Emergency response applications
 - Municipal water intakes
 - Unstable situations with potential for liquid or airborne releases



Non-RDC Use Cases

- Secondary inspections for portals
 - Aegis mounted to an adjustable platform
 - Remote Control from a nearby building (Wi-Fi)
 - Deployable in rain and dust
- Bomb squad – Unknown Package Evaluation
 - Identification of Complex Scenarios possible (Laboratory-grade energy resolutions)
 - Deployable in all in-door and out-door conditions (rain/dust)
- In-Situ decontamination measurements
 - Running ISOCS
 - Remote Control (Wi-Fi)
 - Real-time results drive cleanup actions
 - Deployable in rain and dust



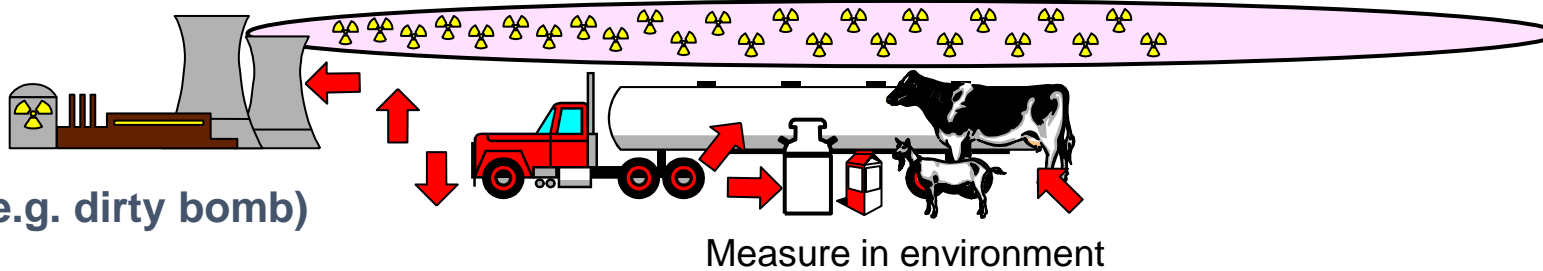
Lab Applications

- RDC version compatible with:
 - 4 inch lead shields in general
 - Mirion 747, 767 lead shields in particular
- Minimal down time:
 - Built-in UPS to cover power interruptions
 - Thermal-cycle free thanks to UHV technology
- Ideal for mobile labs, Movers vans, survey vehicles:
 - Rugged, low-down time
- 'Multi-Use' Detector:
 - Routine lab use but can be taken out for Emergency Response

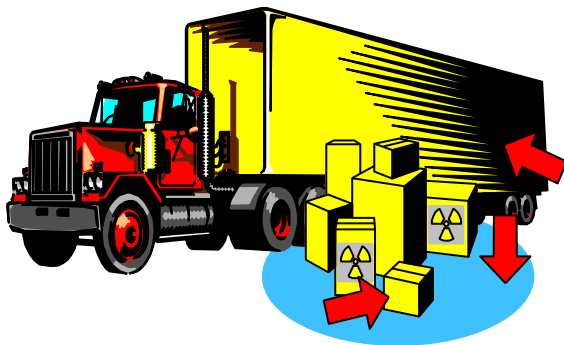


Emergency Response Use of a Lab Detector

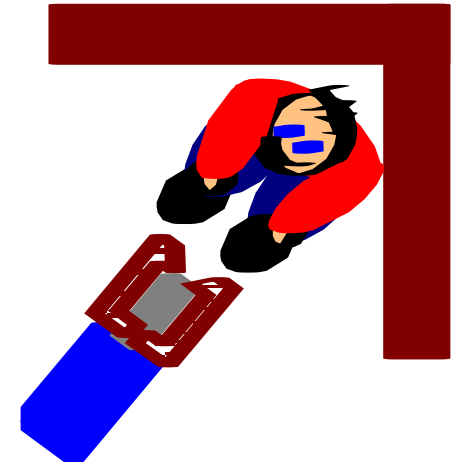
NPP or RDD (e.g. dirty bomb)
releases
real or imagined



Transportation accidents
with radioactive material



- Immediate response
- Reliable Nuclide ID [Ge]
- **Quantification [ISOCS]**
- Easily transportable
- Ready quickly



In-field **in-vivo** measurements
(thyroid, lung, intestines, ...):

- Injured people in hospital
- General public

Aegis Summarized

- IP65 design
 - For use in rain & dusty environments (no cooling fans)
 - Easy to decontaminate
- Laboratory-grade energy resolution
 - 1.0 keV FWHM at 122 keV (BE5030)
 - 2.0 keV FWHM at 1332 keV (BE5030)
- All-In-One with optional RDC:
 - Lead-shield mountable
 - Multi-use
- More elaborate analysis features
 - Genie 2000
 - ISOCS/LabSOCS (option)

