



Annual Users' Conference

**ADVANCING RADIATION SAFETY.
EMPOWERING PROGRESS.**

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



MIRION
TECHNOLOGIES

*Advancing Radiation Safety.
Empowering Progress.*

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The Latest in HPGe Detector Advancements The Intelligent CP5 Cryostat

Dieter Pauwels

PLM Standard HPGe Detectors

Mirion Connect | Annual Users' Conference 2026

Henderson, NV

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



Agenda

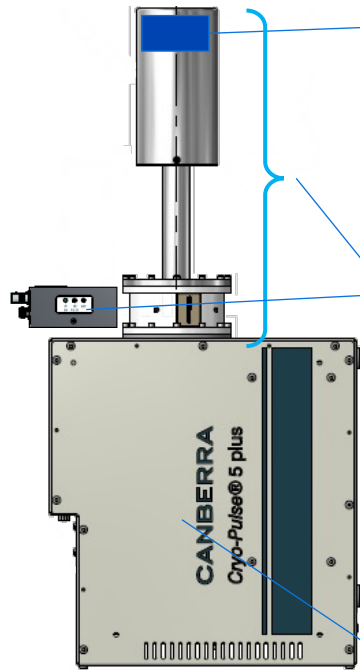


- *Introduction:*
 - *HPGe detector basics*
 - *Why LN₂-free cooling?*
 - *LN₂-free HPGe cooling with CP5-Plus*
- *Coming soon: the Intelligent CP5 cryostat*
 - *What is it?*
 - *How iCP5 will make your HPGe life easier*

Introduction

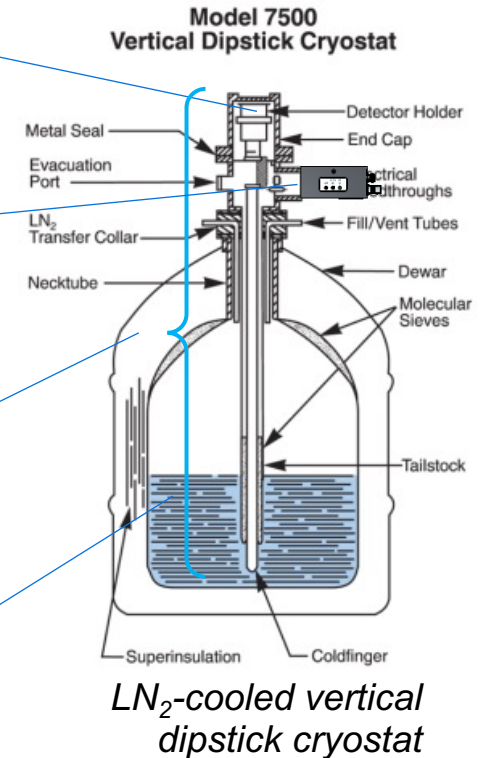


The four HPGe detector building blocks



Electrically-cooled
CP5-Plus cryostat

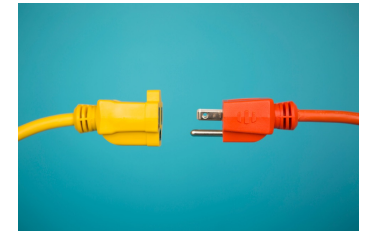
- Germanium detector
 - Absorb and convert gamma-ray energy into proportional amount of electron-hole pairs
 - Collect electrons and holes at detector contacts
- Detector preamplifier
 - Convert number of holes and electrons to a proportional voltage pulse
 - Access to detector/cryostat/preamp State-of-Health (SoH) information
- Detector cryostat
 - Vacuum chamber for thermal and electrical isolation
- Cooler
 - Cooling source for the germanium detector



LN₂-cooled vertical
dipstick cryostat

Why LN₂-free cooling?

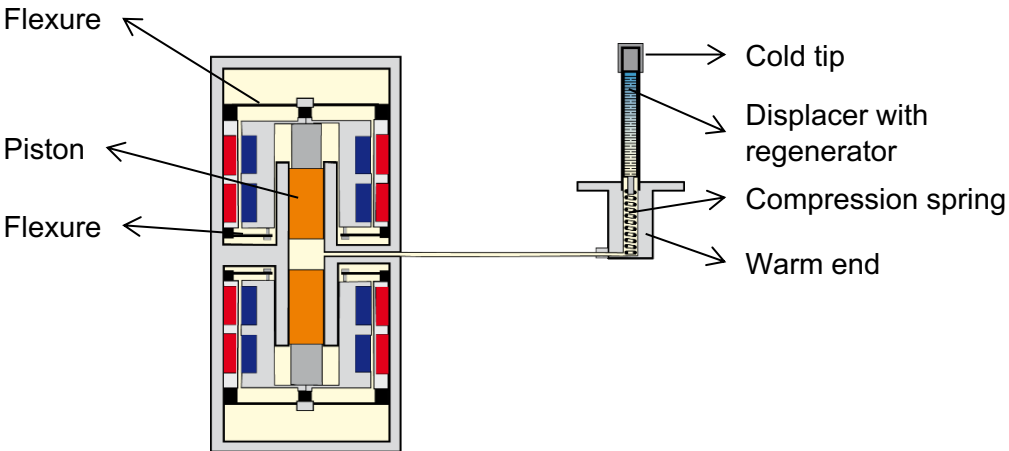
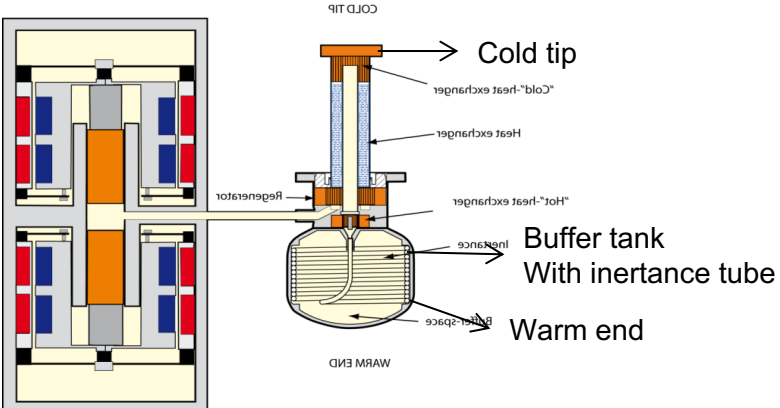
- No safety hazards
 - Eliminate LN₂ handling and associated hazards:
 - Asphyxiation
 - Frostbite
 - Pressure risks
 - Enable remote operation reducing dose exposure in controlled or high-dose environments
- Lower operational cost and infrastructure requirements
 - Removes the need for LN₂ supply, storage, and associated infrastructure/maintenance
 - Eliminate regular LN₂ refilling, reducing labor, and downtime
- Easier to monitor status
- But what about...
 - Reliability/Lifetime?
 - Impact on energy resolution performance?



One outstanding cooler technology:
Cryo-Pulse®

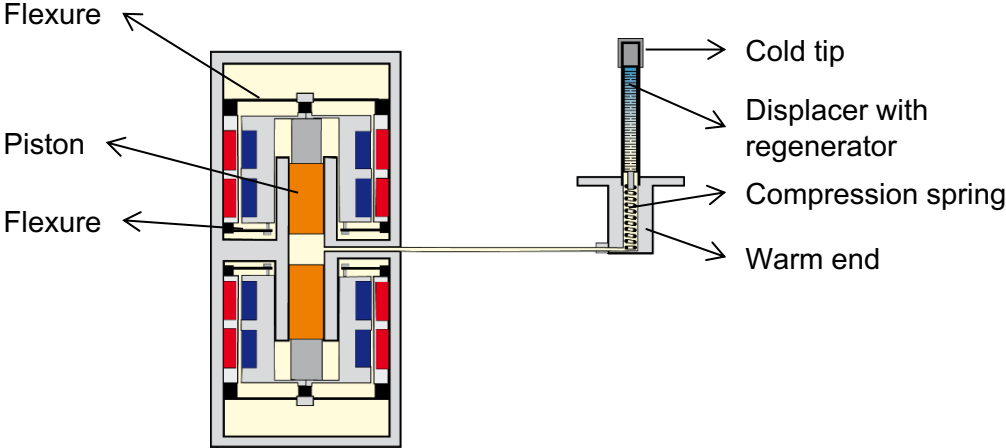
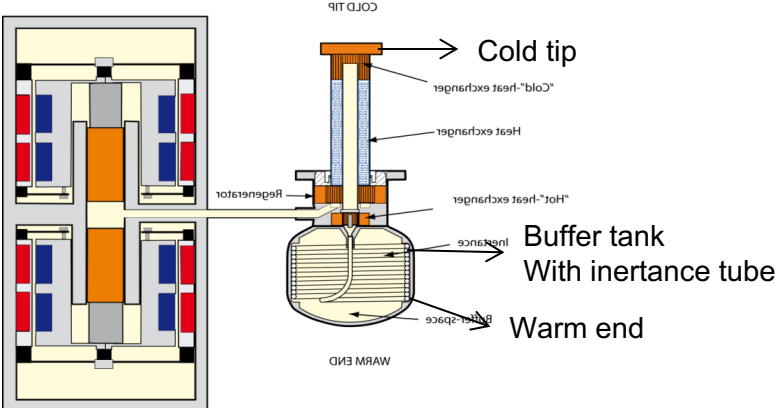
Cryo-Pulse® Technology: Pulse Tube vs Stirling

Compressor: cycles of compression (gas warming up) and decompression (gas cooling down)

	Stirling cold finger	Pulse tube cold finger
What?	Mechanical gas displacement with mass-spring system  Flexure Piston Flexure Cold tip Displacer with regenerator Compression spring Warm end	Gas displacement results from flow resistance in inertance tube and buffer tank  Cold tip Cold heat exchanger Heat exchanger Hot heat exchanger Regenerator Inertance Buffer tank With inertance tube Warm end

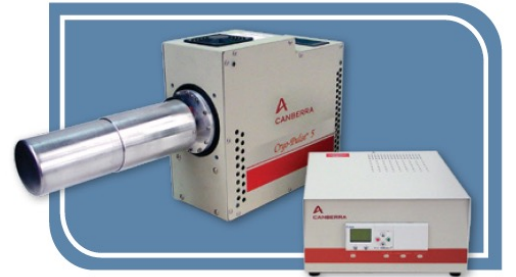
Cryo-Pulse® Technology: Pulse Tube vs Stirling

Compressor: cycles of compression (gas warming up) and decompression (gas cooling down)

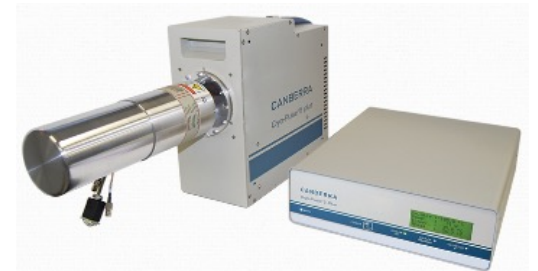
	Stirling cold finger	Pulse tube cold finger
What?	Mechanical gas displacement with mass-spring system 	Gas displacement results from flow resistance in inertance tube and buffer tank 
Advantages	Efficient (direct gas displacement)	No vibrations (no moving parts in cold tip) No mechanical wear
Disadvantages	Vibrations => microphonics noise Mechanical wear	Less efficient => larger/heavier system

Cryo-Pulse Technology: some key dates and key figures

- 2006: Cryo-Pulse 5 (CP5) released in the market as HPGe detector cooler
 - 2012: Cryo-Pulse 5 Plus (CP5-Plus) update – but still **identical cooler**
-
- 20 years of field-proven Cryo-Pulse reliability and performance:
 - ~6 Million hours cooler MTTF
 - **>15 years cooler lifetime** (more than HPGe detector)
 - Uncompromised HPGe detector resolution performance



CP5: 2006 - 2012

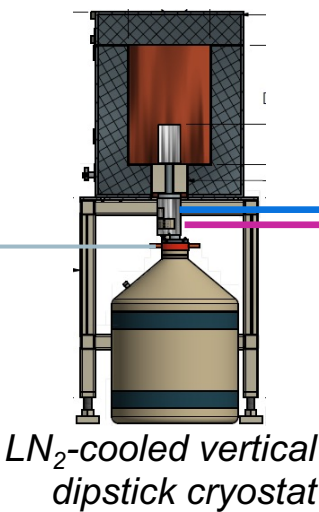


CP5-PLUS: 2012 - present

What else is needed to get to the spectrum? (1/2)



*LN₂ infrastructure
Regular refills
LN₂ hazards*



*LN₂-cooled vertical
dipstick cryostat*

Signals:

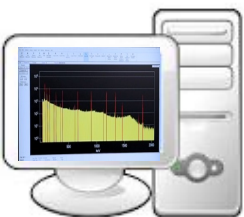
- Preamp Power
- Energy
- HV

Protection:

- HV INH

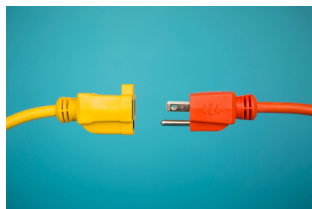


Ethernet or
USB

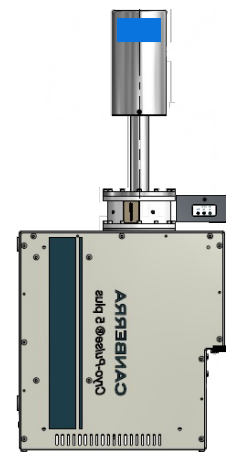


Lynx II MCA

Genie
User Interface



*Cabling
AC power supply*



*Electrically-cooled
CP5-Plus detector*

Protection:

- HV INH

Signals:

- Preamp Power
- Energy
- HV

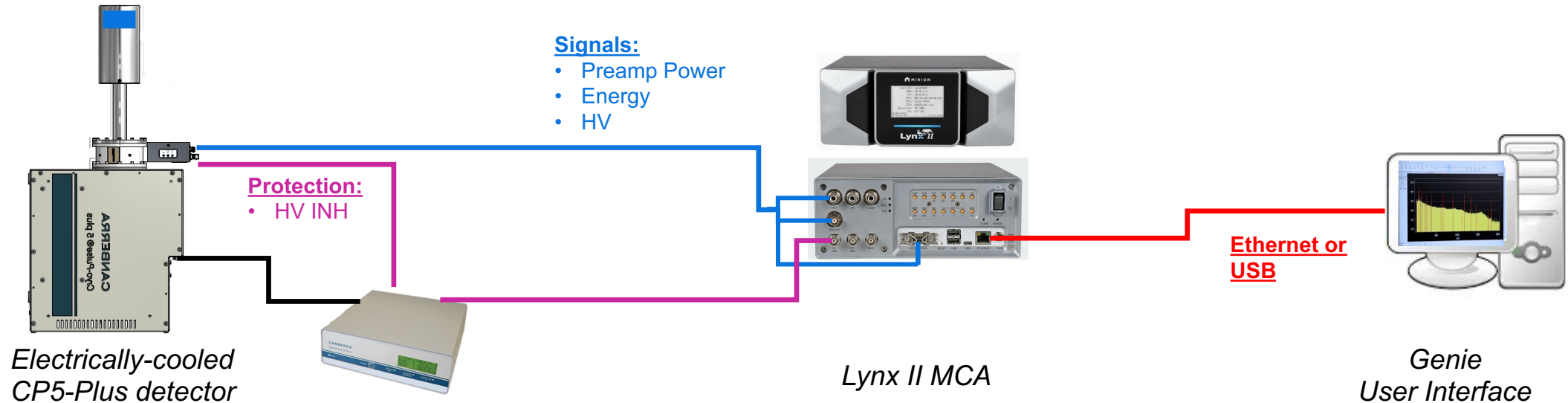
Cooler Control



Ethernet or
USB

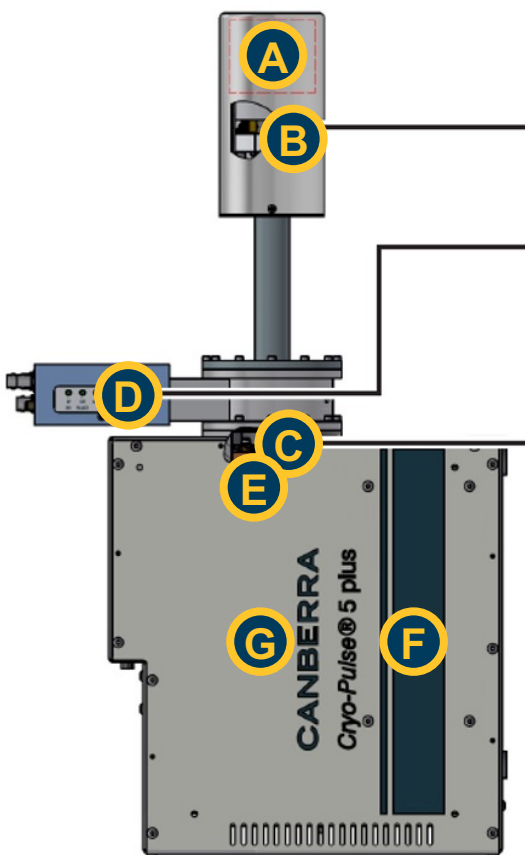


What else is needed to get to the spectrum? (2/2)

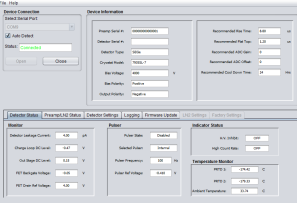
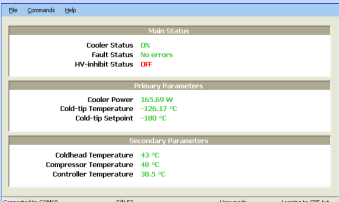


1. Cabling
2. Cool down
3. System Setup: HW parameters – Calibrations – QA/QC program
4. Measure and Maintain: (LN₂ refilling) – QA/QC – Samples – Data review & interpretation
5. (Whenever failing QA/QC or getting unexpected outcomes: Analyze/Troubleshoot) => **Reactive!**
6. How to become more pro-active? **State of Health Monitoring!**

Introduction: State of Health Monitoring (CP5-Plus)

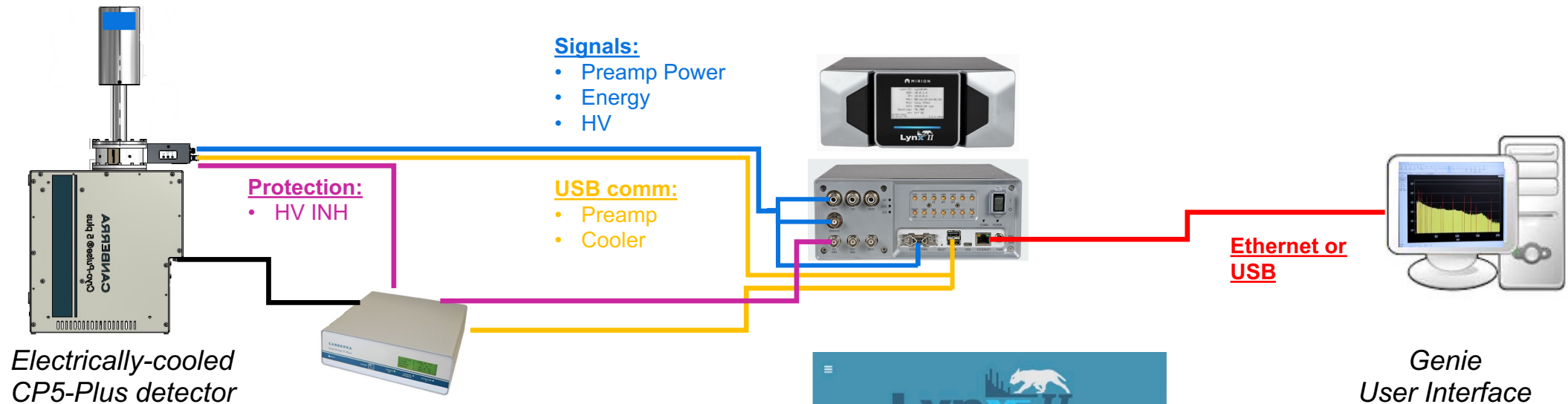


Electrically-cooled
CP5-Plus detector

Building block	SoH parameter	Short description
iPA II 	A Detector leakage current	Leakage current
	B PRTD1	HPGe temperature
	C PRTD2	Cold-tip temperature
	D Ambient Temp	iPA II electronics temperature
CP5-Plus 	E Cold-tip Temp	Cold-tip temperature
	F Compressor Temp	Compressor temperature
	G Coldhead Temp	Cold-tip (warm end) temperature
	Cooler Power	Cooler input power

- Key indicators (before seen in QA/QC!) for common HPGe failure modes:
 - Vacuum loss
 - Inadequate cooling power
 - Ambient temperature

Introduction: Centralized monitoring of CP5-Plus SoH data?



With the Lynx II MCA:

- Have Lynx II FW V1.1 (or later) installed
- Make USB connections to iPA II and CP5-Plus
- Access Lynx II web client UI

Lynx II

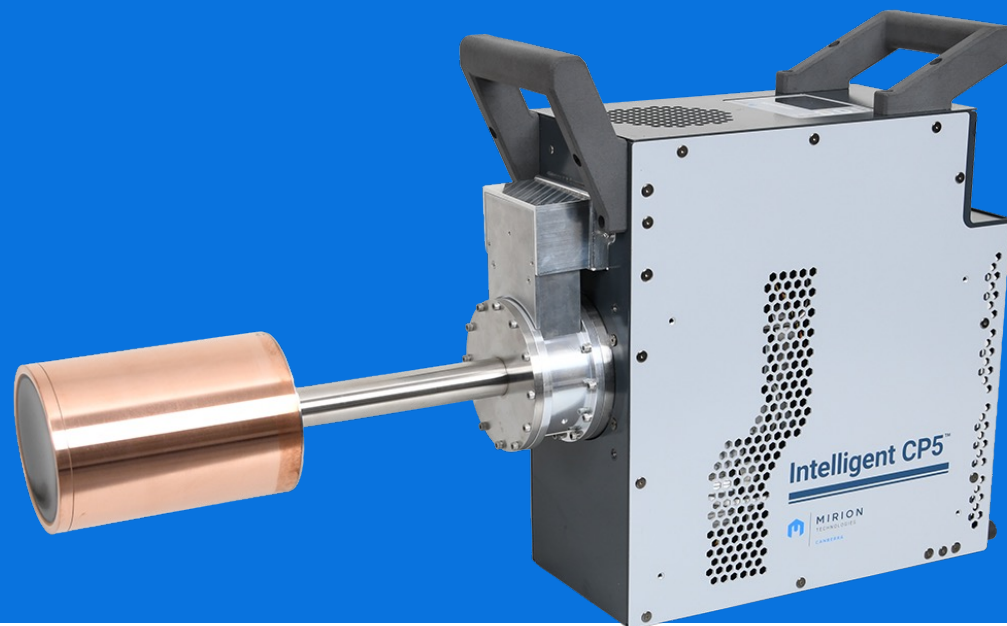
Preamp

Data Settings

Name	Value
Model	ipa
Charge Loop Avg DC Level	0.76
Detector Leakage Current	215
FET Backgate Voltage (ADC)	1.42
FET Drain Voltage (ADC)	0.048

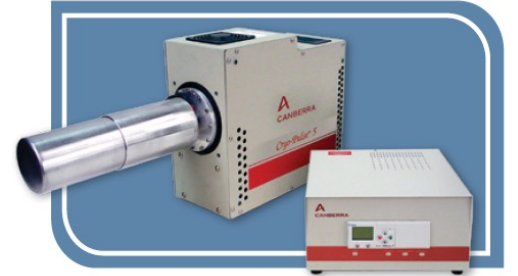
Name	Value
Model	cp5
Cold Head Temperature (°C)	19.9
Cold Tip Set Point (°C)	-185
Cold Tip Temperature (°C)	19.48
Compressor Temperature (°C)	18.9

The Intelligent CP5

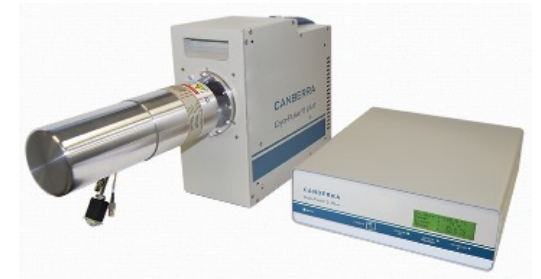


Cryo-Pulse Technology: some key dates and key figures

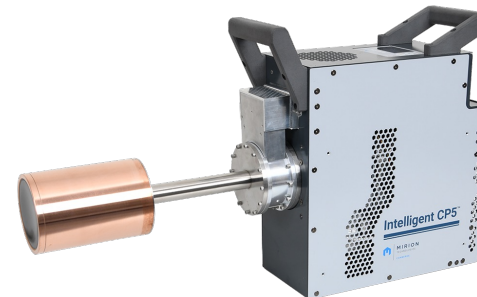
- 2006: Cryo-Pulse 5 (CP5) released in the market as HPGe detector cooler
- 2012: Cryo-Pulse 5 Plus (CP5-Plus) update – and identical cooler
- 20 years of field-proven Cryo-Pulse reliability and performance:
 - ~6 Million hours MTTF
 - **>15 years lifetime** (more than HPGe detector)
 - Uncompromised HPGe detector resolution performance
- 2026: Intelligent CP5 update – and identical cooler



CP5: 2006 - 2012



CP5-PLUS: 2012 - present



Intelligent CP5: Coming soon!

Intelligent CP5 (iCP5): Hardware Integration

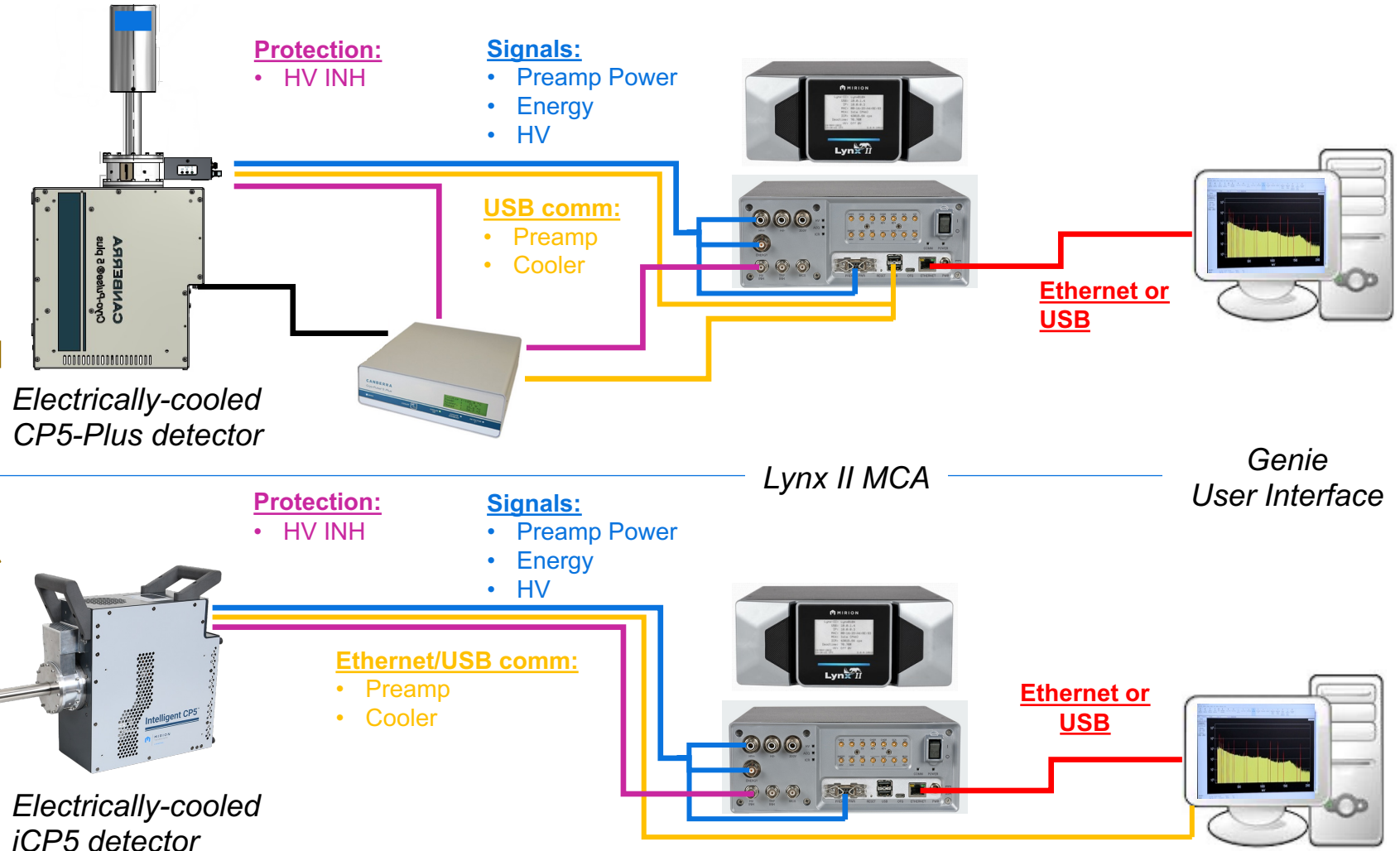
- Cables: 9
- Footprint:
 - Overall: 20.7 liter
 - Coldhead: 13.0 liter

Integration of iPA II and cooler controller

-33%

- Cables: 6
- Centralized connections
- Footprint:
 - Overall: 14.7 liter

-29%



iCP5: Centralized connections

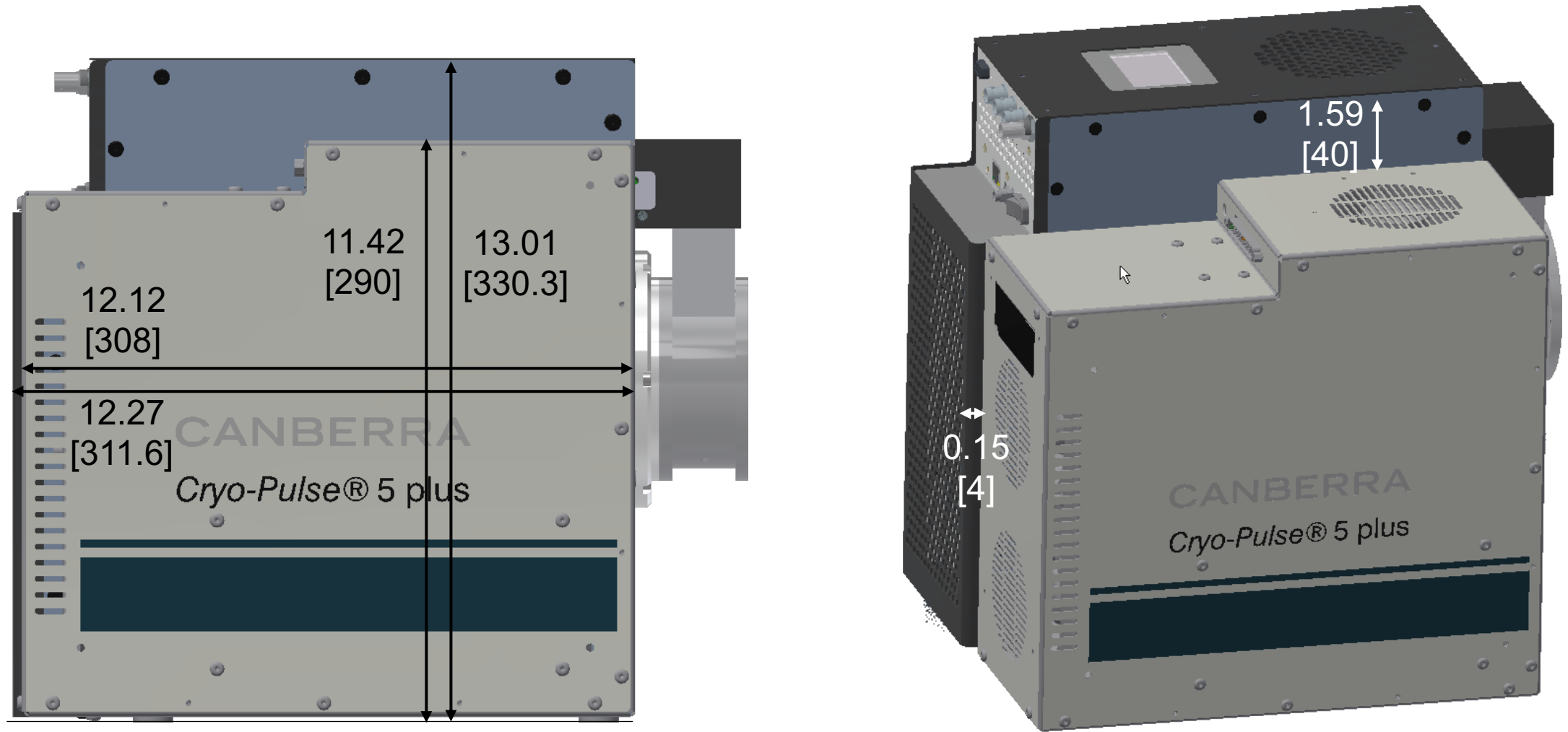


Preamplifier

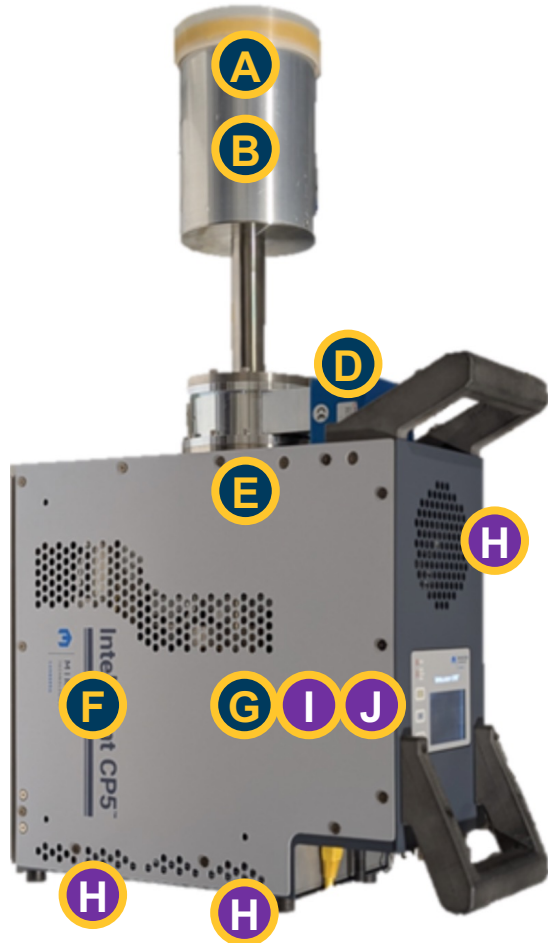
iCP5 System



iCP5: Footprint comparison to CP5-Plus coldhead



iCP5: Expanded set of sensor data

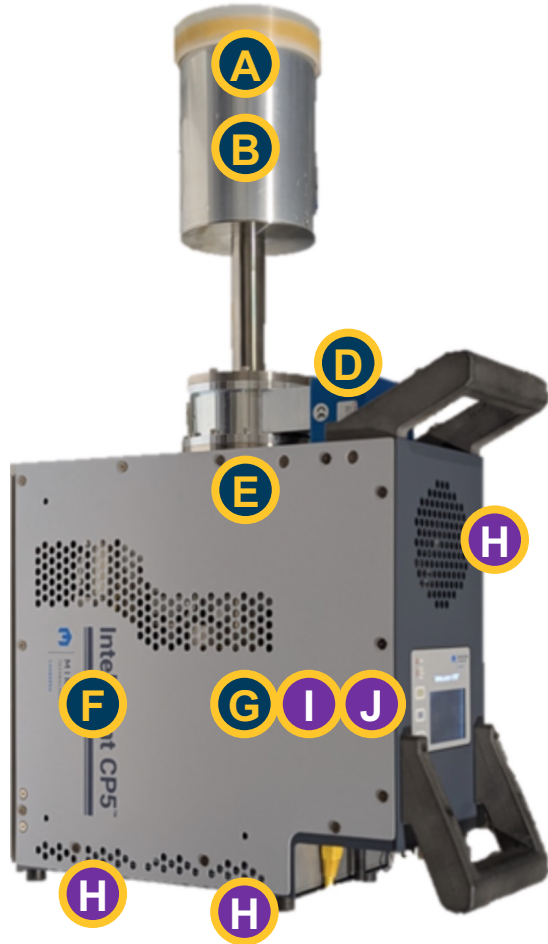


Electrically-cooled
iCP5 cryostat

Building block	SoH parameter	Short description
iCP5 (CP5-Plus legacy)	A Detector leakage current	Leakage current
	B PRTD1	HPGe temperature
	C Ambient Temp	iPA II electronics temperature
	D Cold-tip Temp	Cold-tip temperature
	E Compressor Temp	Compressor temperature
	F Coldhead Temp	Cold-tip (warm end) temperature
	G Cooler Power	Cooler input power
iCP5 (New)	Fan Temps	Inlet (true ambient), Exhausts (coldhead/compressor)
	H Fan speeds	Inlet and exhausts
	I Accelerometer	Detector orientation
	J Cooler board Temp	iCP5 electronics temperature

- *More complete data set available to evaluate:*
 - Cooler performance
 - Ambient conditions

iCP5: Benefits of new sensor data



*Electrically-cooled
iCP5 cryostat*

Accelerometer

*Verify detector orientation
during setup.*

*Provides historical data to
support cooler performance
analysis.*

Fan Temps Fan Speeds Accelerometer

*Additional insight into cooler
performance.*

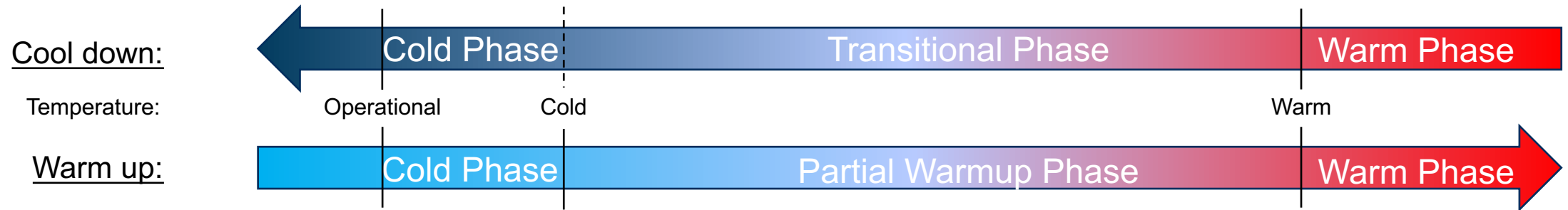
*Help identify when heat sink
cleaning or maintenance is
required.*

Cooler Board Temp

*Along with the other system
parameters, insurance of
operation within safe limits.*

iCP5: Automated cooler control

- Cryostat based on molecular sieves
 - Large pumping capacity, but only in “Cold Phase”
 - Enables flexibility: compatible with all standard (and special) detector configurations
 - Partial warmups exceeding 10-15 minutes: thermal cycle required (12-24 hours depending on configuration)



- Upon powering up iCP5:
 - If in “Cold Phase” or in “Warm Phase”: cooler promptly switches on after system has started up.
 - If in “Partial Warmup Phase”: cooler cannot be switched on ; cooler automatically switches ON when warm.

Built-in intelligence ensures detector is cooled down **properly** and as **fast** as possible

iCP5: Intuitive Control and Monitoring, Local and Remote

Local:
On Top Panel



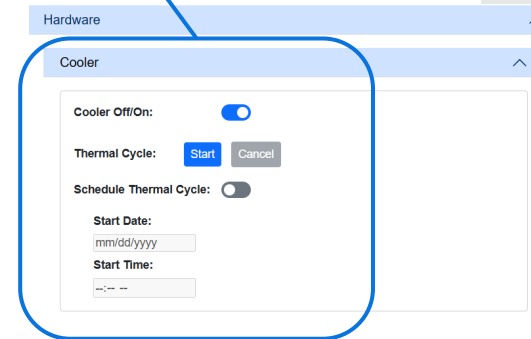
Overall status
Preamp leakage current status
Cooler status
SoH parameter monitoring



Remote:
In Web UI

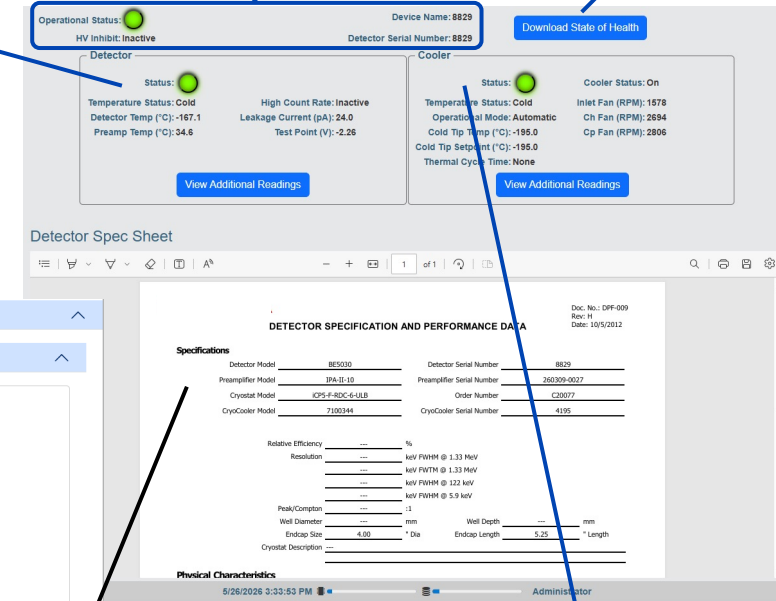
Detector status (iPA II)
(green – orange – red)

Cooler control



System and HV Inhibit status
(green – orange – red)

Download SoH log



Detector spec sheet

Cooler status
(green – orange – red)

- Fully automated cooler control, but also intuitive and easy manual control
- Digital Dashboard: easy and fast monitoring of **COMPLETE** detector status

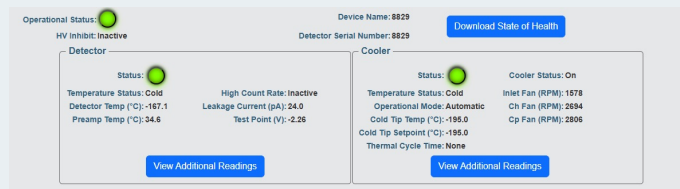
Enhanced Serviceability, Minimizing downtime

01

EARLY ISSUE DETECTION

Enable early detection of (potential) issues, providing sufficient lead time for service review and planning

- Centralized State of Health Monitoring

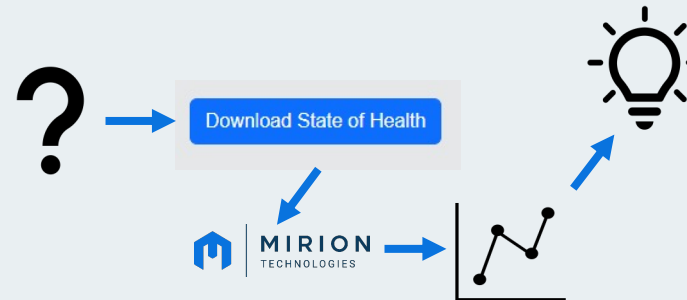


02

STREAMLINED ASSESSMENT

Streamlined assessment phase delivering greater speed and accuracy

- Transition from anecdotal observations to data-driven troubleshooting (on-board data logging)



03

FIELD SERVICEABILITY

Improved maintenance workflows and enhanced field serviceability for:

- Fans
- Heat sinks
- RTC battery
- Preamplifier



Compatibility with modern IT environments



- *Based on Mirion's proven Lynx II cybersecurity architecture:*
 - All software technologies within the firmware are scanned using a suite of vulnerability tools.
 - Firewalls are in place.
 - Transport Layer Security (TLS) - authenticates and encrypts communication interfaces.
 - Secure Boot - ensures the integrity and authenticity of all firmware components during startup.
 - Browser communications are secured via authentication and encryption.
 - Each update of firmware is reviewed for potential security vulnerabilities and enhancements.

iCP5: Concluding remarks and summary

- *iCP5 is soon to be released!*
- *What does this mean for CP5-Plus?*
 - *Will for sure remain available for quoting through 2026;*
 - *Will be rationalized in early 2027, potentially as early as January 2027;*
 - *Guaranteed service support until (at least) 2032*
- *Most important iCP5 benefits:*
 - *Maintained exceptional Cryo-Pulse® reliability and performance*
 - *HW integration led to footprint optimization and reduced cable management*
 - *Simplified cooler control and SoH monitoring (local and remote)*
 - *Cyber secure platform*
 - *Optimized serviceability and maintenance*
 - *Future-ready HPGe platform*



Survey for:

The Latest in HPGe Detector Advancements



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

Thank you



Basic Text Slide

SUBHEAD ALL CAPS

Lorem ipsum dolor sit amet, consectetur adipiscing elit.

- *Bullet style*
 - *Sub-bullet style*
 - *Third Level*

Two Column Layout (Blue Accent)

Two Column Layout (Magenta Accent)

Two Column Layout (Bright Blue Accent)

Slide Title

Slide Title

Two Column Layout

- *Lorem ipsum dolor sit amet, consectetur adipiscing elit*
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