

MIRION
Connect **21**
Annual Users' Conference



The Intelligent Cryo-Cycle™ Hybrid Cryostat: Maximizing your HPGe detector uptime

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Agenda



- What is it?
- Applications
- Operational principle
- Features
- Specifications

Intelligent Cryo-Cycle – The New Hybrid Cryostat

- **Electrically-operated**
- **Liquid-Nitrogen** redundant
- **Ultra-quiet**
- **Hybrid Cryostat**
- For **Maximizing Uptime** of your HPGe detector by combining:
 - **Reliability**
 - With **advanced system-monitoring functions**

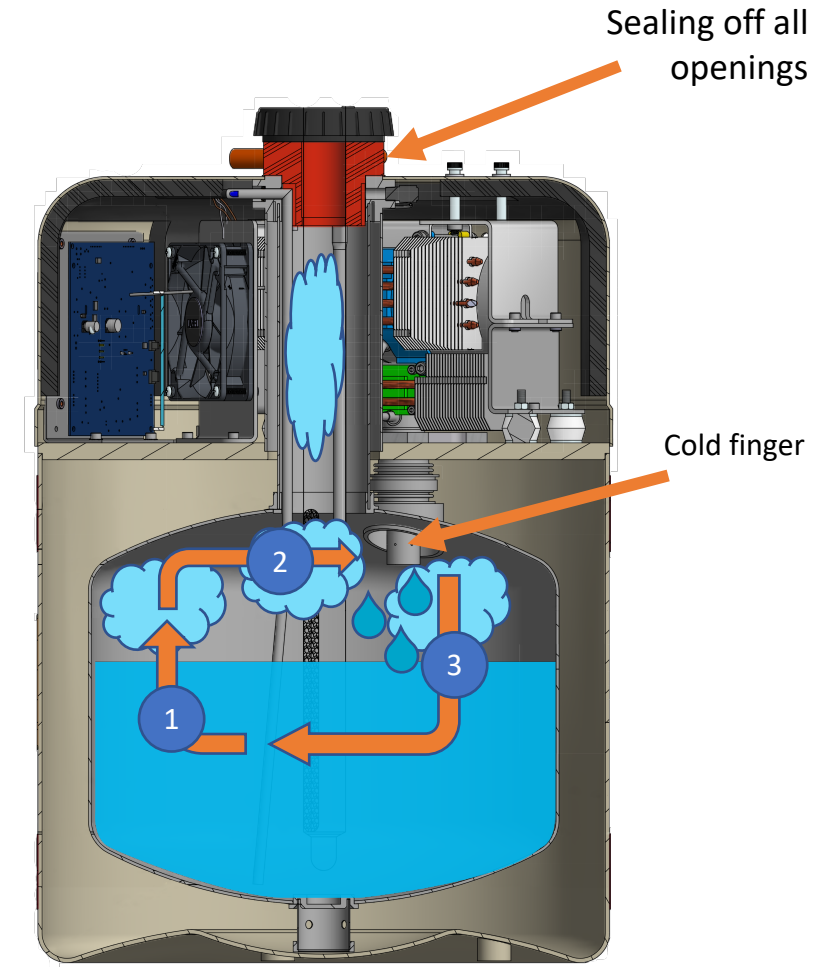


Applications

- Situations where:
 - Frequent LN₂ refills are not desirable due to
 - Limited availability of LN₂
 - A burden on labor resources and operational costs;
 - A risk for LN₂-related injuries and hazards
 - Problem: Conventional LN₂ dewars are not an option
 - **Solution: electric cryocooler (CP5-PLUS)**
 - Frequent or extended power interruptions may occur requiring:
 - A long (LN₂) holding time (up to 7 days) ensuring the HPGe detector
 - Remains cooled down;
 - Does not need additional time for cooling down once power is restored
 - **Solution: Intelligent Cryo-Cycle Hybrid Cryostat**
 - **No thermal cycles required**
 - **Increases detector life span**
- These drivers typically apply to:
 - Laboratories and count rooms
 - Mobile labs
 - Remote measurement stations
 - Waste assay or other industrial systems

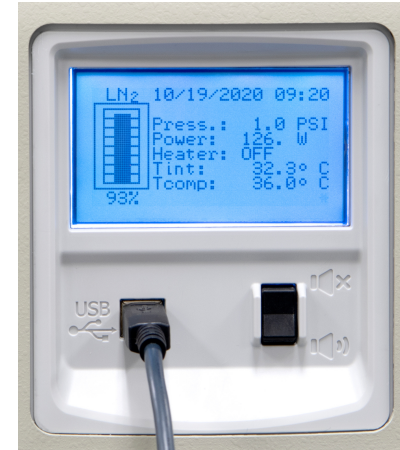
Operational Principle

- Cryo-Cycle principle as successfully launched by Mirion in 2006:
 1. Detector heat load boils off liquid nitrogen
 2. Hermetically seal off Dewar volume: no nitrogen gas can escape, pressure increase
 3. Cold finger recondenses nitrogen gas into liquid nitrogen again:
 - Pressure can be adequately managed
 - Closed N_2 - LN_2 cycle
 - Theoretically no refills required (in practice: up to 2 years between refills)
 4. In case of power interruption:
 - Pressure relief valves open to depressurize.
 - LN_2 holding time of up to 7 days
 - Detector ready for measurements as soon as power is restored
 - LN_2 level can be topped off again when planning allows



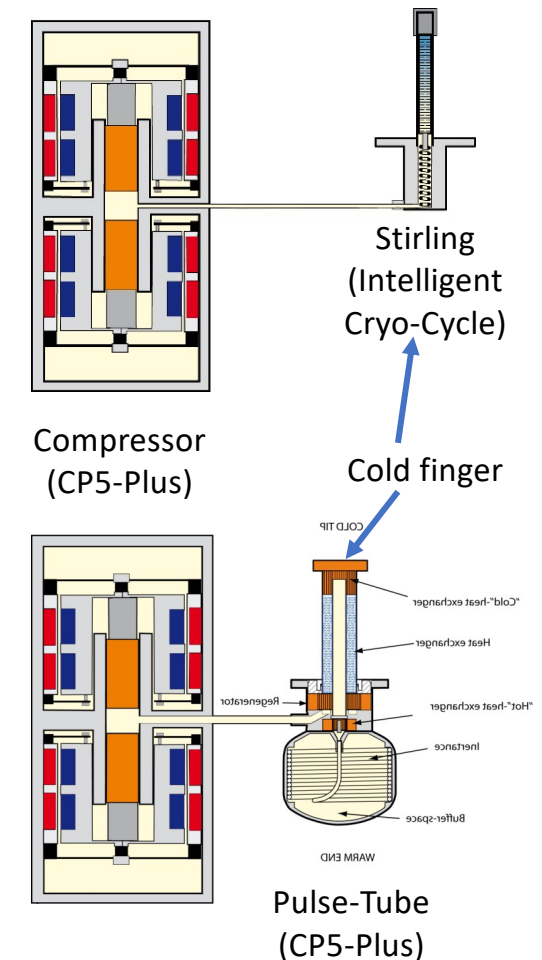
A 360 View

- Air inlet and exhaust above Dewar handles
- Interface panel in the front:
 - LCD screen displaying HW status
 - USB 2.0 connector port
 - Mute switch
- Power connector separated from front interface panel:
 - Facilitating clean installation in the lab



The high-power (Stirling) cryocooler

- Cryocooler lifetime drives the Intelligent Cryo-Cycle lifetime
- Selected cryocooler:
 - Same vendor as the one for the ultra-reliable (Pulse-Tube) CP5-Plus cooler:
 - >2,000 units in the field since 2006
 - Demonstrated >13 years lifetime: <5% cooler failures with >13-year 24/7 operation
 - Compressor technology: same as CP5-Plus
 - Cold finger is Stirling technology:
 - Mechanical displacement (vs passive displacement with Pulse-Tube technology)
 - High efficiency, high power
 - Lifetime NOT at the level of CP5-Plus cold finger
 - Expected lifetime:
 - **7 years:** <5% cooler failures with 7-year 24/7 operation
- **2-year** warranty on complete system (except for collar)
- The Intelligent Cryo-Cycle: an **investment in reliability**



The front panel interface

- Critical parameters monitored on LCD screen
 - LN₂ level
 - Pressure
 - Cryocooler power
 - Heater (On/Off)
 - Internal temperature (measured under the lid)
 - Compressor temperature (measured on compressor heat sink)
- Direct info on status (LCD backlight)
 - Easy to oversee units' status in the lab
 - If all blue screens, no worries!
- Date/Time indication based on internal Real-Time Clock
- In case of warning/alarm, descriptive error message appears on Date/Time-line
 - User guidance for the required corrective action
- USB port: connection to Windows tablet/PC or Lab-Pulse gateway
- Mute switch: muting audio alarm in alarm condition



Blue LCD backlight:

Unit operates normally, no action required

Yellow LCD backlight:

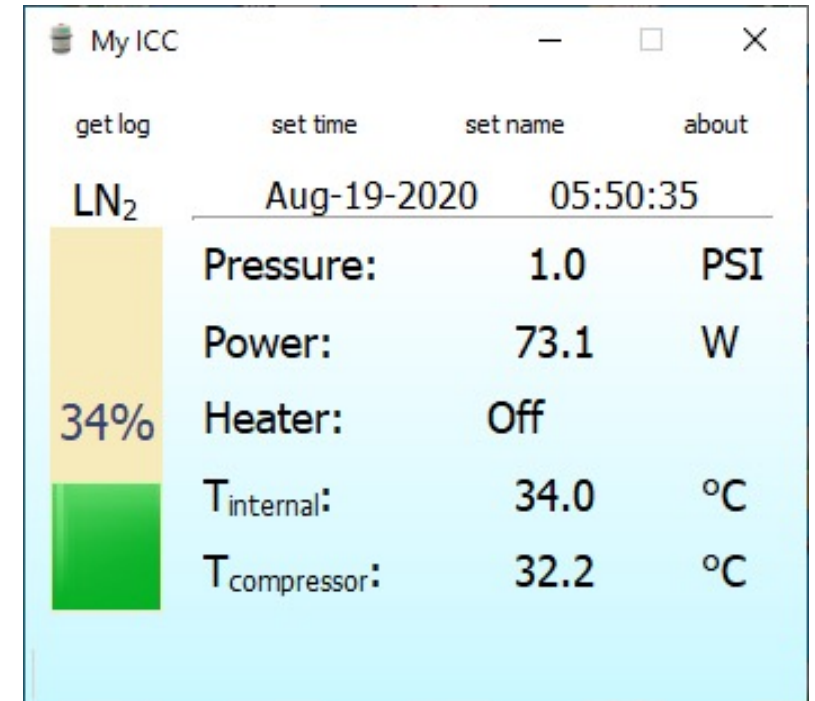
Unit operates but requires attention, see error message for details

Red LCD backlight:

Unit does not operate properly, see error message for details

The Intelligent Cryo-Cycle Display Application

- For external monitoring of LCD info
 - Tablet in front of lead shield
 - Remote PC or Laptop
 - OS requirement: 64-bit Windows 7, 8.1, 10
- Setting date/time and unique name
- Easy access to internally stored log data enabling **remote troubleshooting** for EVERY unit :
 - **Data-driven not observational**
 - **Accurate**
 - **Fast (once/minute)**
- Available at www.mirion.com after Mirion account creation



The log file

- Records stored once per minute
- Battery-backed memory for 4 years of data retention
- Export in CSV format

***** ICC 13003004		S/N 13003004		FW V3.03b																	
																				Fan tachometer warning	
***** Fault bit order:		LN2 level low alarm		Compressor temp high alarm		High pressure alarm		Dewar not pressurizing alarm		Low pressure alarm		LN2 level high alarm		LN2 level low warning		High pressure warning		LN2 level high warning			
***** Status bit order:		Cooler ON		Heater ON		Cooler at max power		Alarm ON		Calibration offset activated											
RecordNum	Date (YY.MM.DD)	Time (hh:mm:ss)	Mute Switch	Fault	Status	Pressure (psig)	Power (W)	Internal Temperature (°C)	Compressor Temperature (°C)	LN2 level (%)	Fan 1 (%)	Fan 2 (%)	Fan 3 (%)	Fan 4 (%)	Fan 1 (rpm)	Fan 2 (rpm)	Fan 3 (rpm)	Fan 4 (rpm)	Heater (%)	Fan Fuse	Message
18355	20.11.11	13:14:34	00000001b	0000000000000000b	10000000b	1	75.83	36.11	34.35	88.64	33	33	33	33	1710	1695	1680	1695	0	1111	NO Error/War
18356	20.11.11	13:15:34	00000001b	0000000000000000b	10000000b	1	76.07	36.12	34.31	88.64	33	33	33	33	1695	1680	1680	1710	0	1111	NO Error/War
18357	20.11.11	13:16:34	00000001b	0000000000000000b	10000000b	1	76.07	36.14	34.35	88.57	33	33	33	33	1710	1695	1710	1695	0	1111	NO Error/War
18358	20.11.11	13:17:34	00000001b	0000000000000000b	10000000b	1	75.67	36.1	34.31	88.64	33	33	33	33	1725	1680	1680	1710	0	1111	NO Error/War
18359	20.11.11	13:18:34	00000001b	0000000000000000b	10000000b	1	75.75	36.13	34.48	88.6	33	33	33	33	1725	1695	1695	1695	0	1111	NO Error/War
18360	20.11.11	13:19:34	00000001b	0000000000000000b	10000000b	1	76.07	36.16	34.34	88.6	33	33	33	33	1695	1695	1680	1710	0	1111	NO Error/War
18361	20.11.11	13:20:35	00000001b	0000000000000000b	10000000b	1	75.59	36.17	34.42	88.67	33	33	33	33	1725	1695	1695	1695	0	1111	NO Error/War
18362	20.11.11	13:21:35	00000001b	0000000000000000b	10000000b	1	75.67	36.17	34.37	88.67	33	33	33	33	1725	1695	1695	1710	0	1111	NO Error/War
18363	20.11.11	13:22:35	00000001b	0000000000000000b	10000000b	1	76.07	36.16	34.29	88.6	33	33	33	33	1725	1710	1680	1680	0	1111	NO Error/War
18364	20.11.11	13:23:35	00000001b	0000000000000000b	10000000b	1	76.07	36.19	34.45	88.67	33	33	33	33	1710	1695	1695	1680	0	1111	NO Error/War
18365	20.11.11	13:24:35	00000001b	0000000000000000b	10000000b	1	76.08	36.17	34.31	88.64	33	33	33	33	1710	1680	1680	1695	0	1111	NO Error/War
18366	20.11.11	13:25:36	00000001b	0000000000000000b	10000000b	1	75.87	36.17	34.49	88.67	33	33	33	33	1710	1695	1710	1695	0	1111	NO Error/War
18367	20.11.11	13:26:36	00000001b	0000000000000000b	10000000b	1	75.27	36.17	34.44	88.64	33	33	33	33	1695	1695	1695	1695	0	1111	NO Error/War
18368	20.11.11	13:27:36	00000001b	0000000000000000b	10000000b	1	75.71	36.2	34.31	88.64	33	33	33	33	1695	1680	1680	1695	0	1111	NO Error/War
18369	20.11.11	13:28:36	00000001b	0000000000000000b	10000000b	1	75.95	36.21	34.47	88.67	33	33	33	33	1710	1695	1680	1695	0	1111	NO Error/War
18370	20.11.11	13:29:36	00000001b	0000000000000000b	10000000b	1	75.6	36.22	34.39	88.57	33	33	33	33	1710	1680	1695	1680	0	1111	NO Error/War
18371	20.11.11	13:30:36	00000001b	0000000000000000b	10000000b	1	76.08	36.22	34.43	88.6	33	33	33	33	1710	1680	1710	1695	0	1111	NO Error/War

Lab-Pulse Ready

- **What does Lab-Pulse Ready mean?**

- The Intelligent Cryo-Cycle is compatible with our Lab-Pulse Service

- **What is Lab-Pulse?**

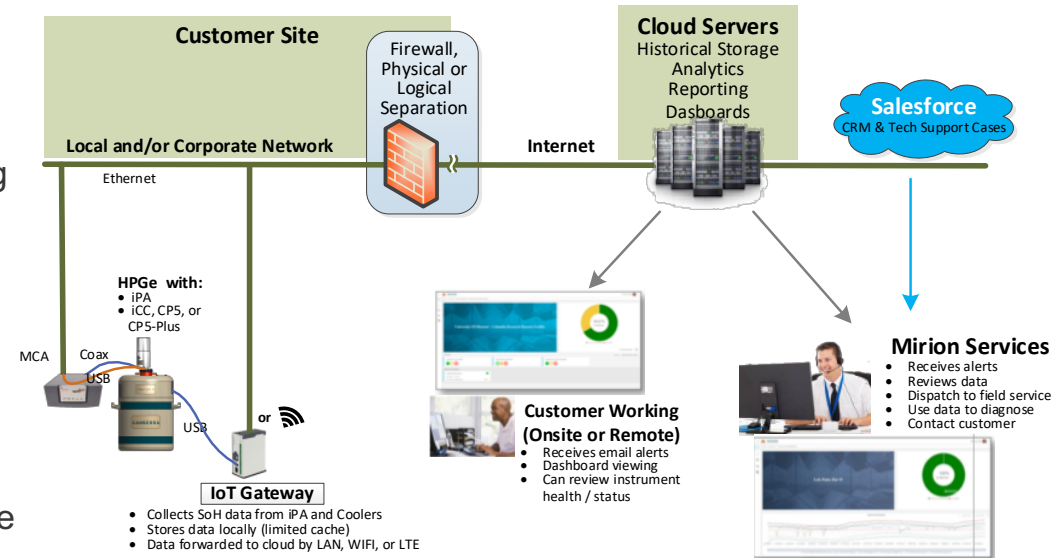
- Service providing real-time state-of-health (SoH) monitoring of Mirion's instruments
- Important and critical step in improving Mirion's awareness and understanding of the SoH of its radiation measurements instrumentation
- Positions Mirion to provide enhanced preventative maintenance offerings and enabling greater instrument uptime for our customers
- We do not look at your data

- **Lab-Pulse System includes:**

- HPGe Detector SoH monitoring via iPA
- HPGe Cryocooler monitoring (iCC, CP5, or CP5-Plus)
- Ambient environment and vibration sensor monitors
- Live time viewing of SoH data on Mirion Lab-Pulse Dashboard
- When SoH alarm threshold is crossed: Automatic creation of Mirion Tech Support Case with email notification and Mirion Services Engagement.

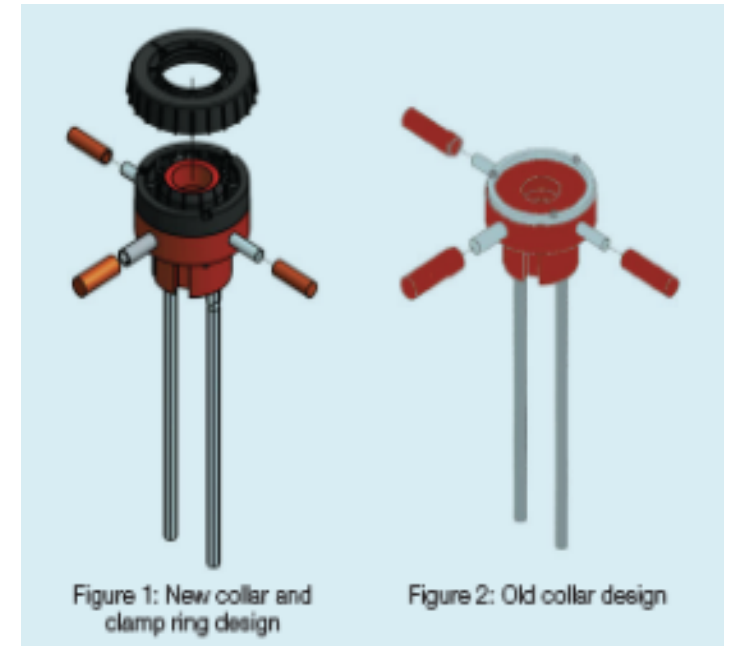
- **How does Lab-Pulse work?**

- A physical gateway device is installed at customer site and connects by USB to the instruments, polling for SoH data.
- The gateway pushes the encrypted data to the cloud via cellular network or ethernet / WiFi.
- Mirion **cloud server** stores data, performs analytics, and **sends alarms in case of instrument alarm or measured parameter goes out of tolerance.**
 - Alarm directly to customer
 - Mirion Tech Support case automatically created and assigned for disposition

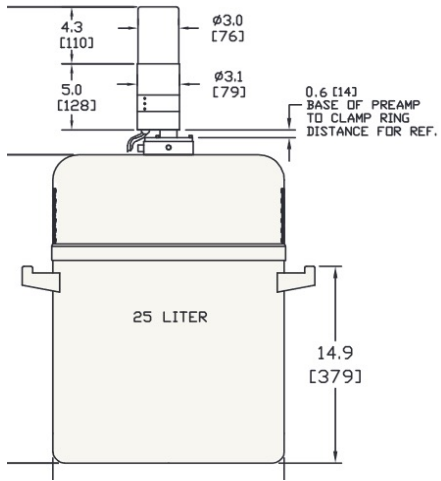


New RTV Collar and Clamp Ring

- Introduced in 2018
- Better collar design
 - Distributes sealing force more evenly
 - Reduces leaks due to tilting of large detectors
 - Reduces leaks due to improper installation (too tight)
 - Supports 1.25" as well as 1.50" tailstocks
- Securing dipstick height is much easier
 - Turn of clamp device screw secures the dipstick
 - No tools required

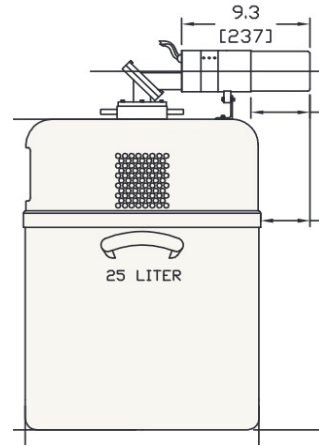


Intelligent Cryo-Cycle Model Numbers



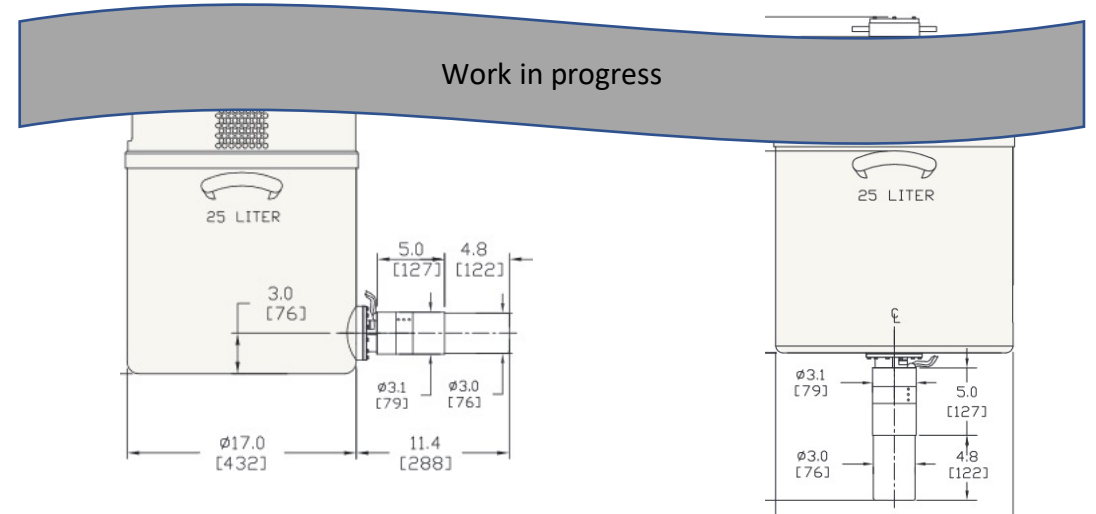
Vertical Dipstick
(7500SL/7500)

iCC-VD



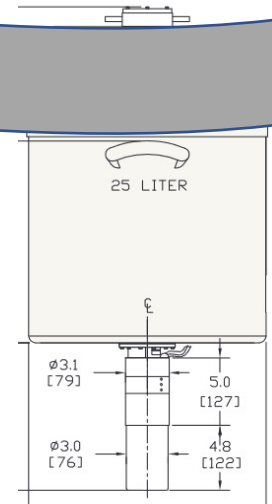
Horizontal Dipstick
(7600SL/7600)

iCC-HD



Horizontal Integral

iCC-HI



Vertical Integral

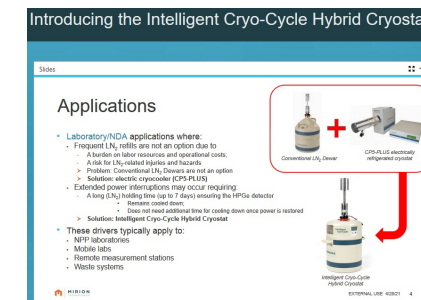
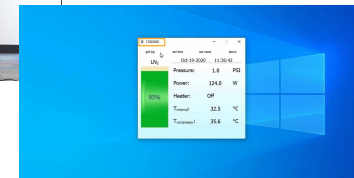
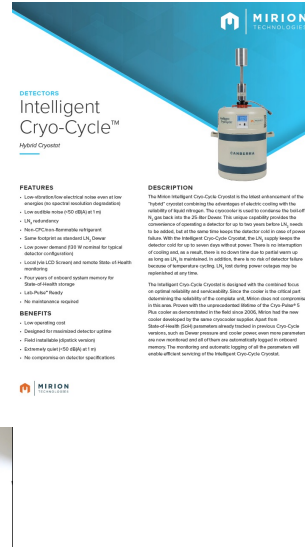
iCC-VI

Specifications

- Specified energy resolution for:
 - Newly purchased Mirion: **no degradation with respect to specification**
 - Older Mirion detector previously installed in CCII: same energy-resolution performance
 - Older Mirion detectors not installed in CCII: maximum 10% degradation between 100 and 500 keV, no guarantee <100 keV
- Audible noise level at 1 m: **50 dB(A)** => Perfectly suited for quiet laboratory environments
- Cooler lifetime: ~7 years
- SoH monitoring
 - Integrated status monitoring and onboard log storage with Real-Time Clock
 - Lab-Pulse Ready: enabling greater detector uptime, enabling enhanced preventive maintenance offerings
- LN₂ holding time:
 - Cooler operating 24/7: up to 2 years
 - Without cooler operation: up to 7 days
- LN₂ Dewar capacity: 25 liters
- Operational temperature range: 5 – 35 °C (41 – 95 °F)
- Power requirements: 130 W typical – 285 W max (in transient operation)

Additional material for your reference

- Spec sheet: <https://www.mirion.com/products/intelligent-cryo-cycle-hybrid-cryostat>
- DIY Videos
 - How to install the collar
 - How to install the iCC under a shield
 - How to install a detector in iCC
 - How to fill an empty and warm iCC
 - How to startup the iCC
 - How to Export Log Data
- Webinar:
 - See <https://www.mirion.com/learning-center/webinars>



Intelligent Cryo-Cycle – The New Hybrid Cryostat

Questions?

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iCC versus other hybrid designs

- Quieter- 50 dB versus 60 dB
- More complete State of Health monitoring
 - iCC monitors more information
 - 4x fan speeds, 4x fan fuses, 2x internal temp., pressure, power, heater, LN2 level
 - Retains a 4-year log and can be exported for further analysis
 - Front panel color-coded indication of status
- 25 liter versus 28 liter capacity
 - Both designs adequately cover the intended purpose
 - Mirion integral detectors consume less LN than other detector designs
- No degradation of resolution with new detector
 - Less than 10% degradation below 500 keV on old detectors