SITELLE CCD CAMERAS

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SITELLE Science Meeting, Wendake May, 2013

Overview

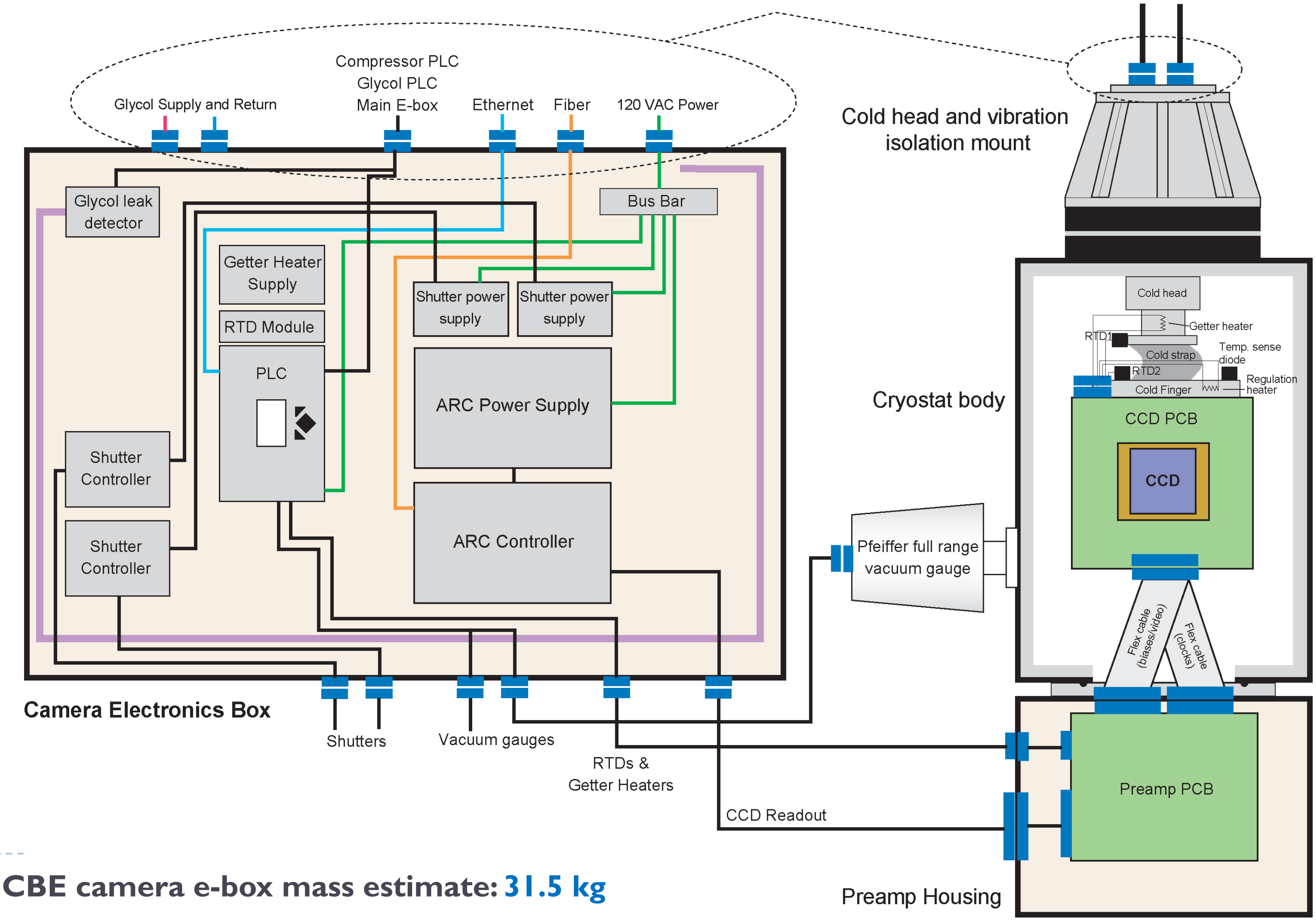
- Camera cooling
- System architecture
- Cryostat mechanical
- Nominal CCD performance (E2V tests)
- ARC controller performance
- Vibrations

Camera cooling

- Uses a PolyCold PCC cooler (“Cryotiger”) for refrigeration
- Getter temperature is typically less than 85 K, allows for efficient cryo-pumping of N_2 and O_2
- Have seen a vacuum hold steady at $3x10^{-7}$ Torr for 3 weeks, but typically a hold vacuum 1 magnitude higher is seen. Both are acceptable.
- System is plumbed with two sets of cryo gas lines; one for instrument storage off the telescope and the second for operation on the telescope.
- Two sets of gas lines are teed at the compressor so that both sets of lines are isobaric. This prevents problems when swapping lines and avoids disconnecting lines at the compressor during an exchange.
- Efficiency difference beetween the two sets of cryo lines is negligible resulting in a 2 K difference in the cold-head temperature.

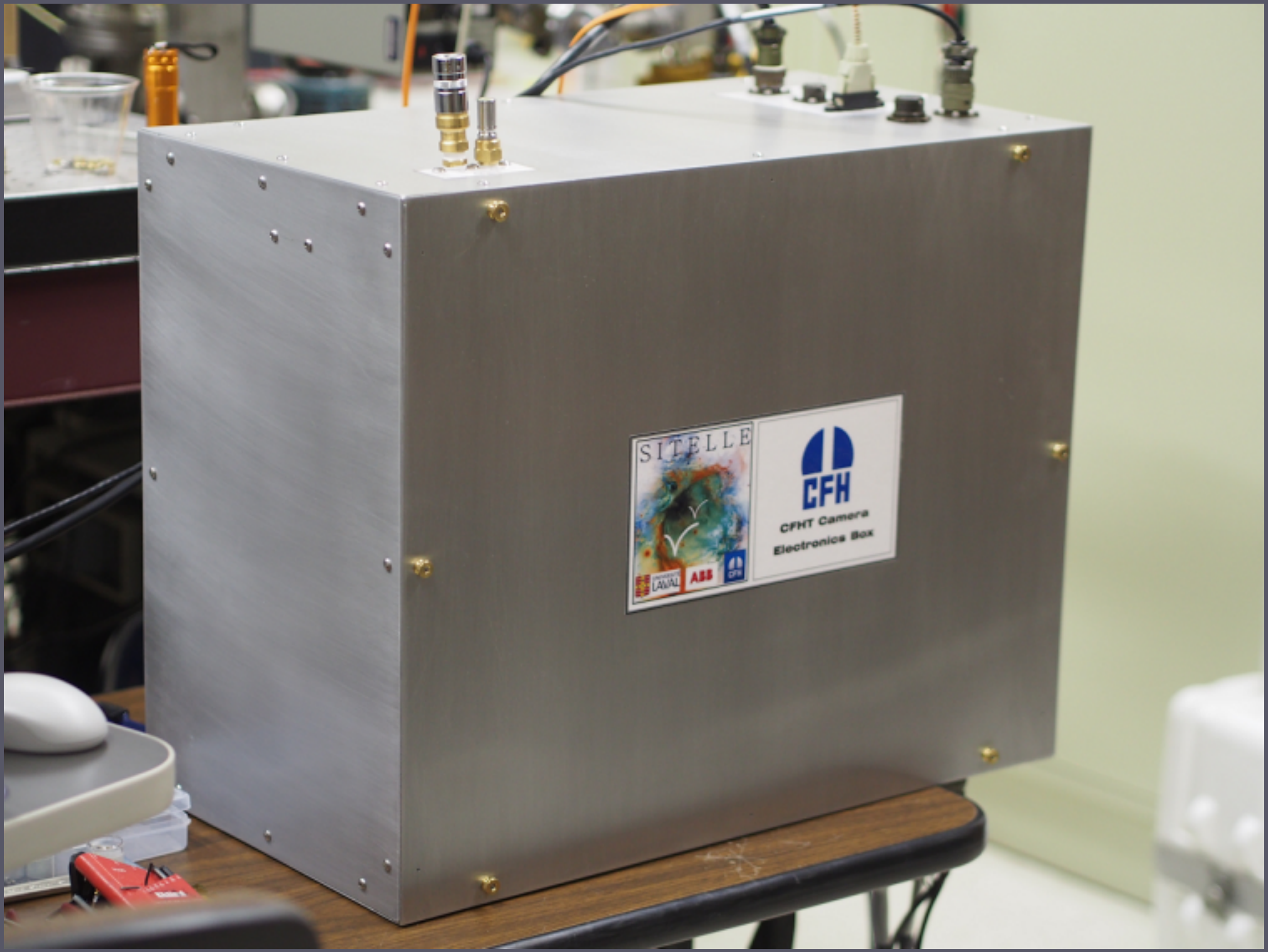
Camera Support Electronics

Connections un-made/made during an instrument exchange

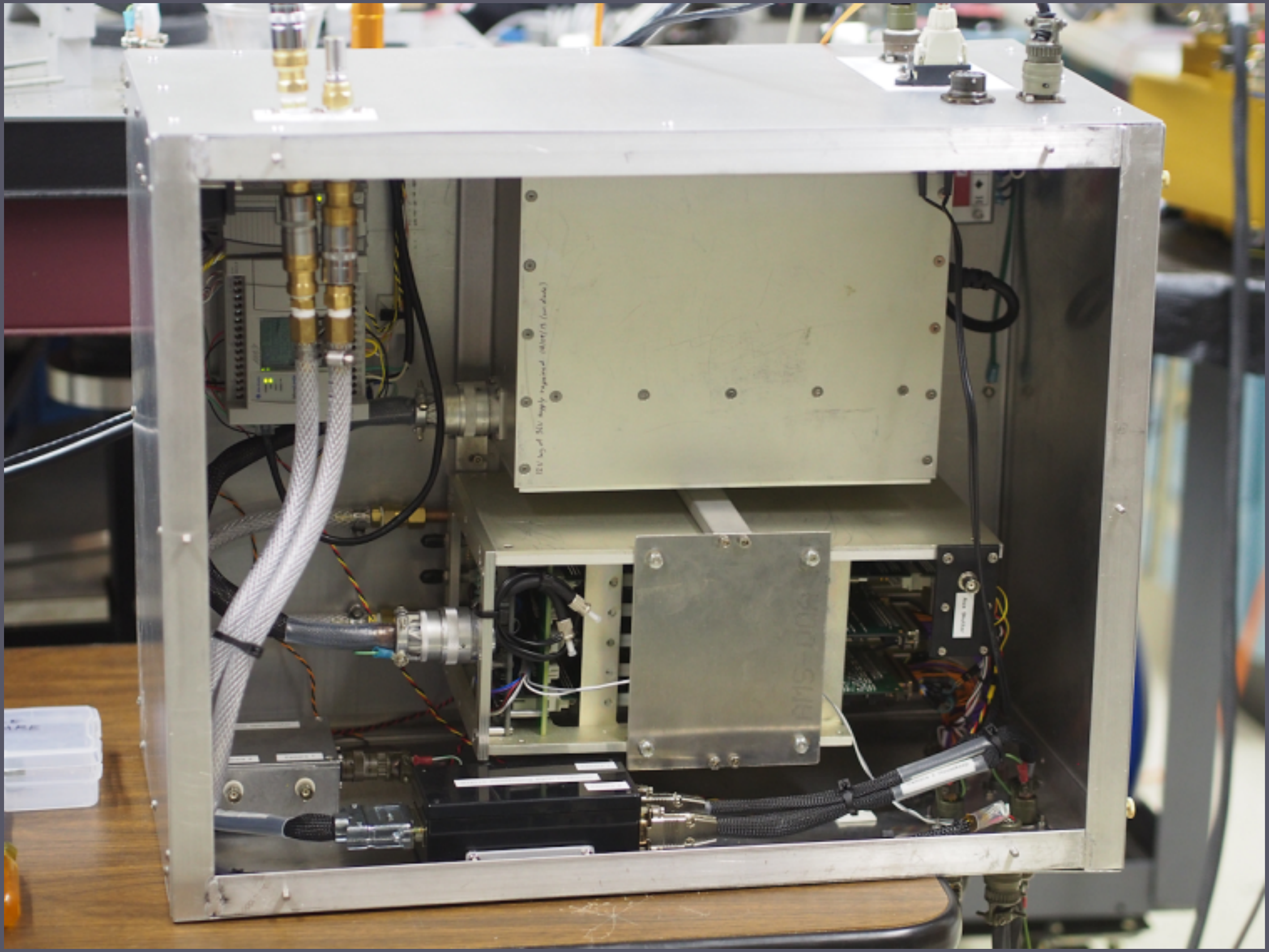


- **CBE camera e-box mass estimate: 31.5 kg**

Camera electronics box

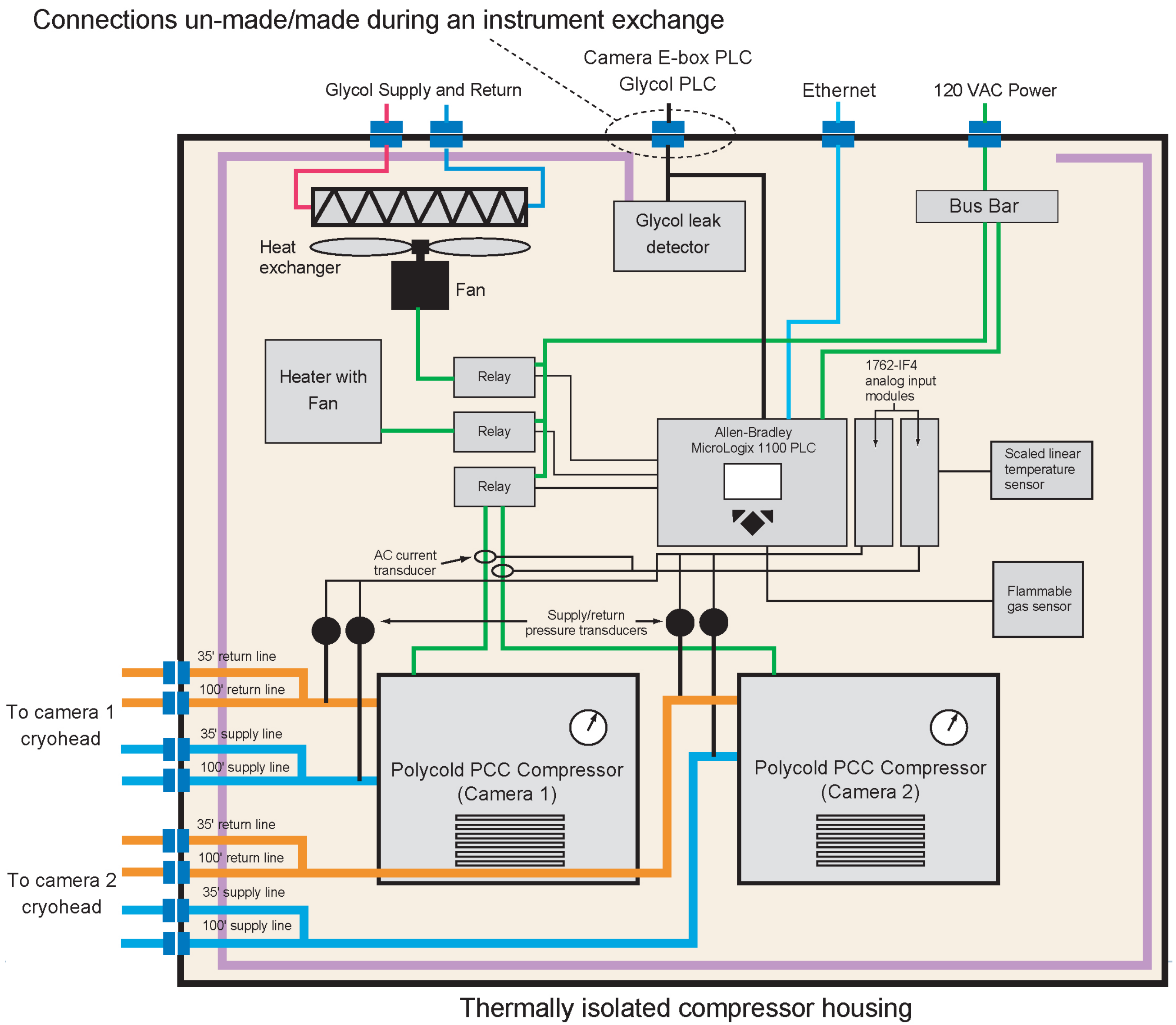


Camera electronics box internals



- Current weight (no shutter control hardware): 25.6 kg

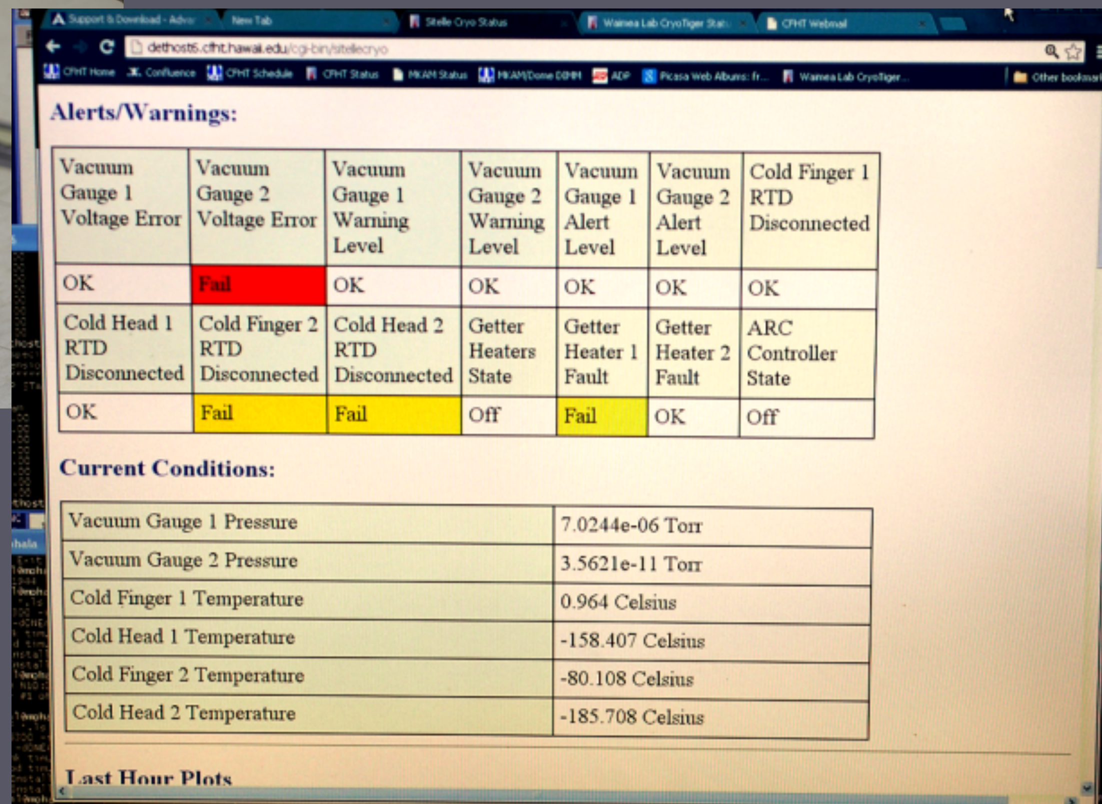
Cryo Compressor Support Hardware



Cryo Compressor

Polycold compressor

Cryogenics and vacuum status web page



Alerts/Warnings:

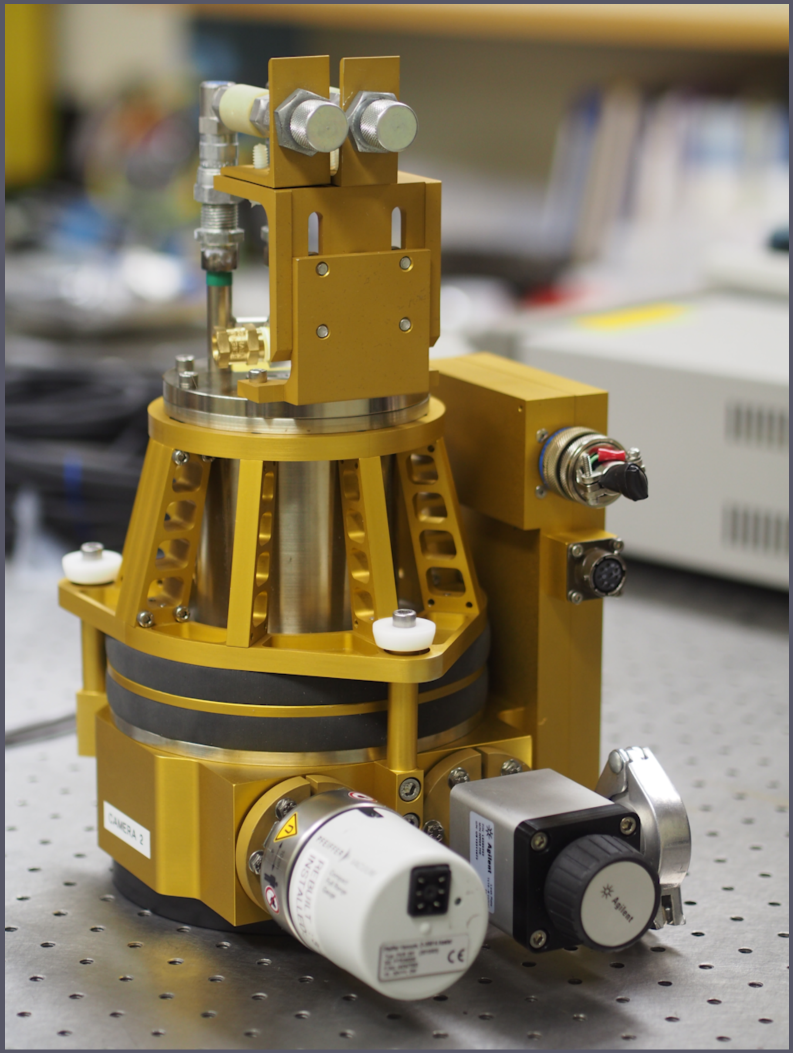
Vacuum Gauge 1 Voltage Error	Vacuum Gauge 2 Voltage Error	Vacuum Gauge 1 Warning Level	Vacuum Gauge 2 Warning Level	Vacuum Gauge 1 Alert Level	Vacuum Gauge 2 Alert Level	Cold Finger 1 RTD Disconnected
OK	Fail	OK	OK	OK	OK	OK
Cold Head 1 RTD Disconnected	Cold Finger 2 RTD Disconnected	Cold Head 2 RTD Disconnected	Getter Heaters State	Getter Heater 1 Fault	Getter Heater 2 Fault	ARC Controller State
OK	Fail	Fail	Off	Fail	OK	Off

Current Conditions:

Vacuum Gauge 1 Pressure	7.0244e-06 Torr
Vacuum Gauge 2 Pressure	3.5621e-11 Torr
Cold Finger 1 Temperature	0.964 Celsius
Cold Head 1 Temperature	-158.407 Celsius
Cold Finger 2 Temperature	-80.108 Celsius
Cold Head 2 Temperature	-185.708 Celsius

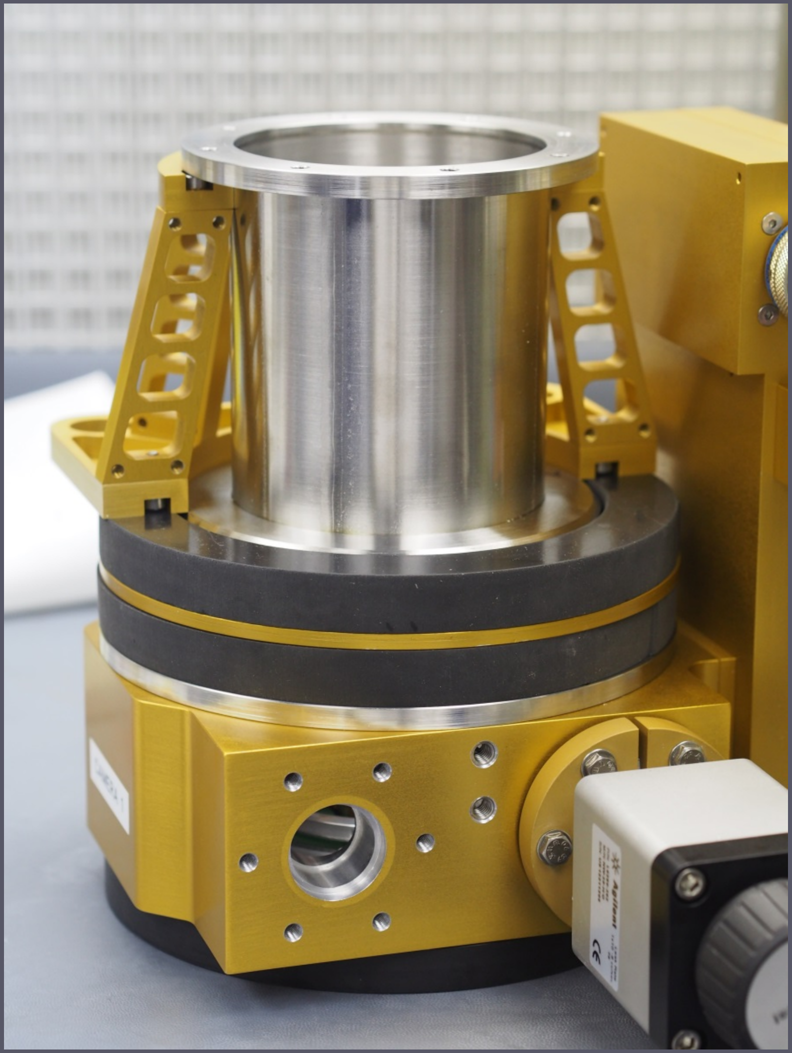
Last Hour Plots

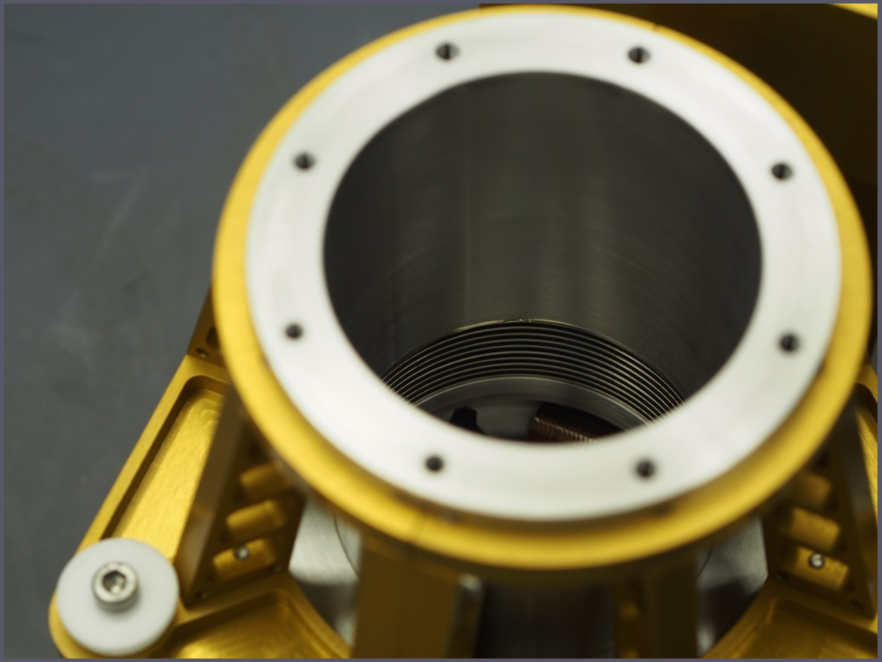
Cryostat mechanical



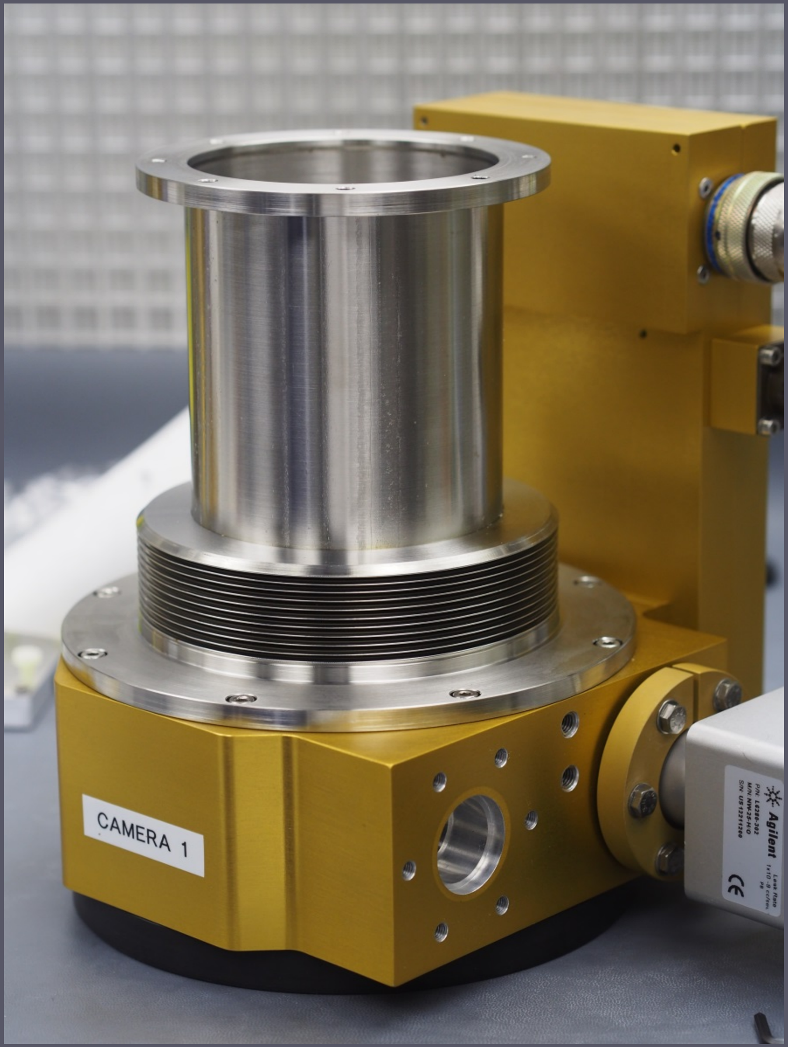
- Compact design with component placement optimized for installation on the SITELLE instrument.
- Cryo-head is mounted on a passive vibration isolator and vacuum bellows to minimize transmission of vibrations to the instrument.
- Preamplifier board connects directly into flex-circuit vacuum feedthrough to minimize signal lengths from CCD outputs to pre-amplifier circuits.
- Camera weight without cables attached is 9.9 ± 0.2 kg

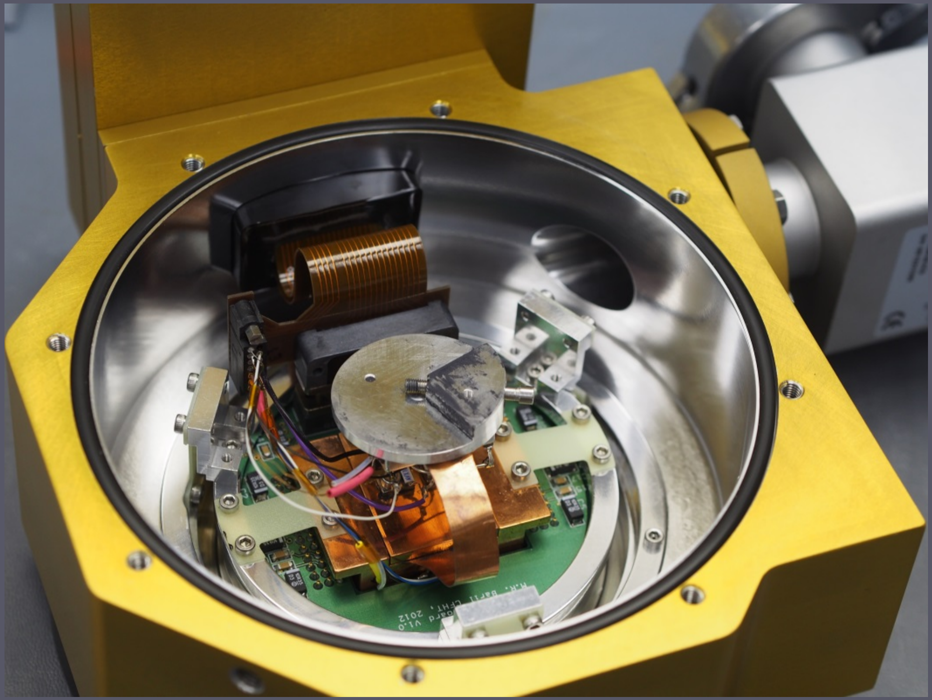
Disassembling the cryostat





…and more disassembly





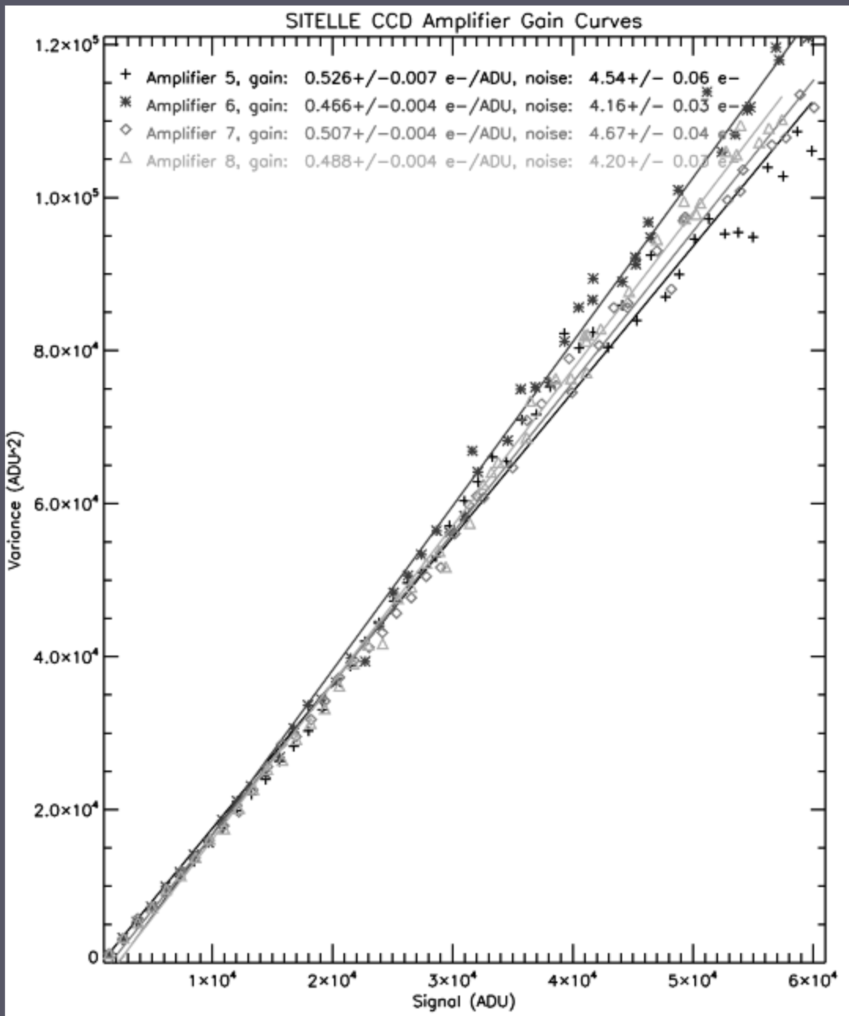
CCD performance – E2V measurements on Science Grade Arrays

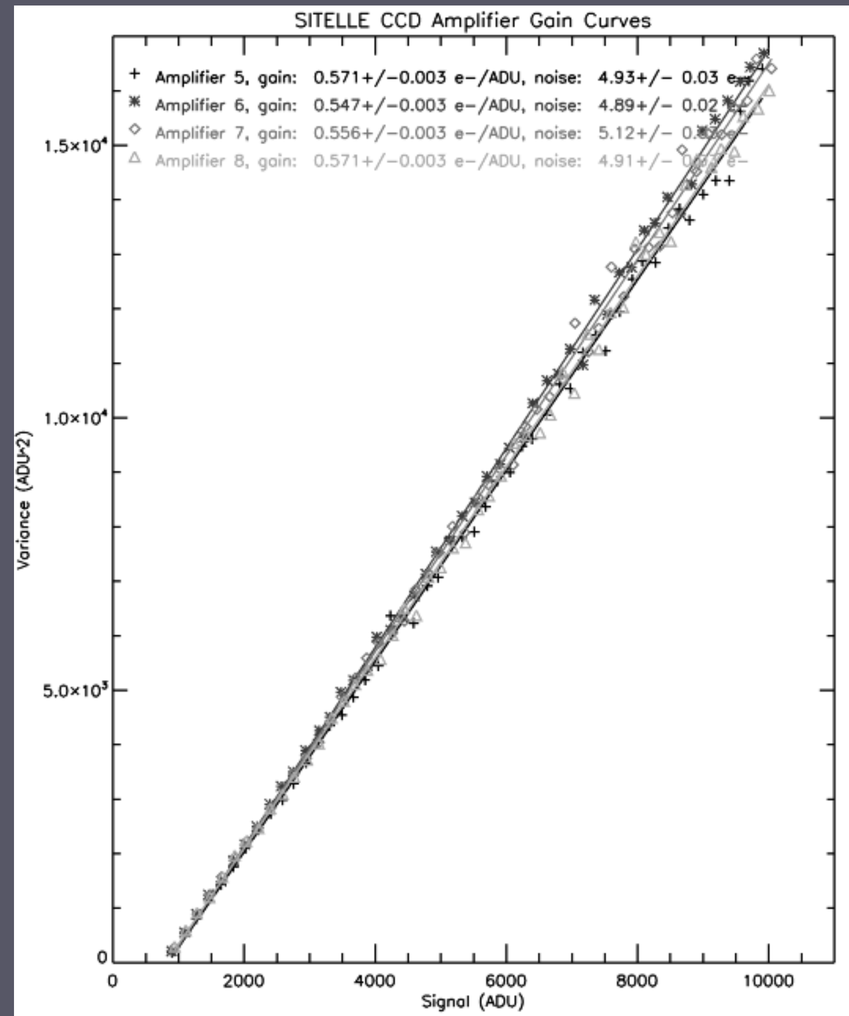
		Serial # 12234-10-04	Serial # 12234-10-02
Quantum efficiency	350 nm	53.2	49.9
	400 nm	98.8	99.7
	500 nm	99.1	97.0
	650 nm	99.3	97.3
	900 nm	65.6	63.4
Readout noise @ 50 kHz	OS-E	3.1	3.3
	OS-F	3.3	3.2
	OS-G	3.3	3.3
	OS-H	3.3	3.2
Charge capacity		330-347 ke^-	345-362 ke^-
Array flatness (peak to valley)		5 µm	6 µm
Dark count @ -100 C (calc.)		0.012 e^-/pix/s	0.0054 e^-/pix/s

ARC controller performance

- Readout noise with array CCD230-42-1-150 (SN 6413-06-01) is 5e^- with a horizontal register rate of 400 kHz (2480 ns period).
- At this clock rate the CCD is read in 2.98 s, however other overheads (clearing the CCD and waiting for the shutter to settle) adds another 0.5 s to the readout.
- No obvious sign of cross-talk, estimated at less than 0.1%, but exact level needs to be characterized.
- A recent grounded input test at the CCD PCB showed inconsistent behavior between the amps and noise that is incommensurate with the readout noise obtained with the CCD. This will be a starting point of investigations when I return.

Transfer curves





- Read noise is just below 5 e^- with a gain of 1.8 ADU/e^-

Remaining work before shipment

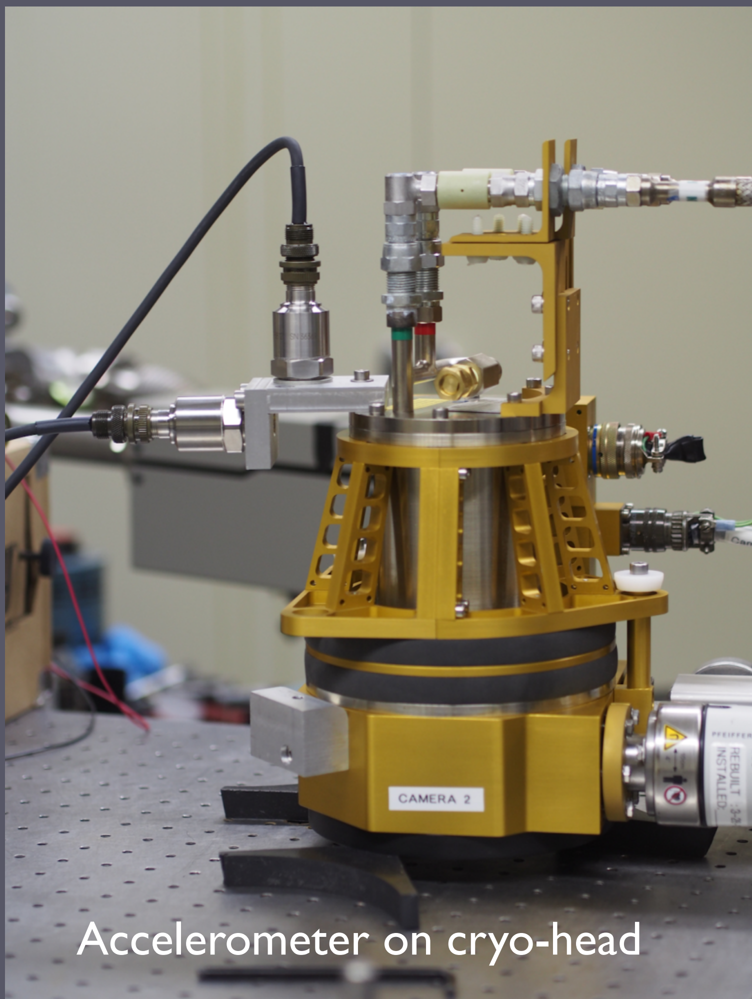
- Finish spare feedthrough (1 feedthrough to be replaced before final testing), 1 day (Tom/Marc)
- Investigate grounded input strangeness (Marc).
- Install and flatten science grade CCD mounting to spec, 2 days (Tom/Marc)
- Complete e-box (1-2 days, Marc/Tom/Grant).
- Tune clocking and voltages for best noise and readout speed (1 weeks).
- Tune binned clocking (2x2, 4x4) for best noise (1 week or less).
- Check that crosstalk is at a workable level.
- Check that persistence is acceptable.
- Check that RTDs no longer feed noise into the camera, tune RTD filters if necessary (1-2 days).
- Pack and ship everything (1 week).

Vibration tests

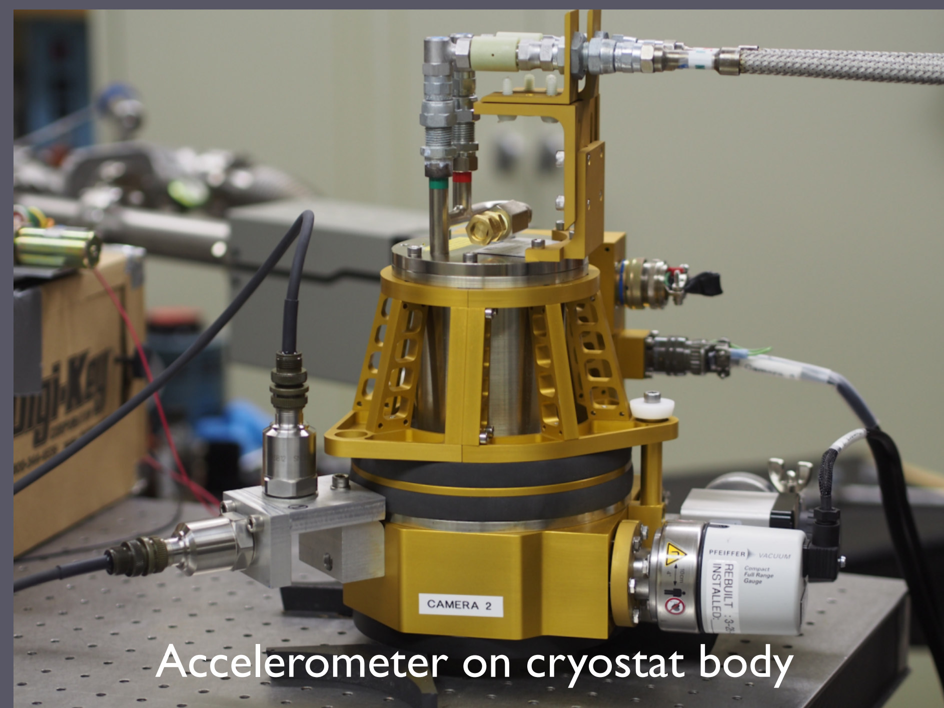
- PolyCold PCC head generates vibrations that can couple into SITELLE, degrading the modulation efficiency (or worse).
- Initial tests of a PCC head rigidly installed on a cryostat at CFHT indicated ~2 mg RMS accelerations on this cryostat.
- For reference, SpIOMM began to show degraded performance when vibrations measured on the OMM telescope reached 1 mg.
- Tested the SITELLE cameras by clamping these to a large optical bench and measuring the vibrations on the isolated (bench) side and cryo-head (non-isolated) side of the cryostat.

Accelerometer locations

Accelerometer on optics bench



Accelerometer on cryo-head



Accelerometer on cryostat body

- Cryostat shown resting on Sorbothane pads.

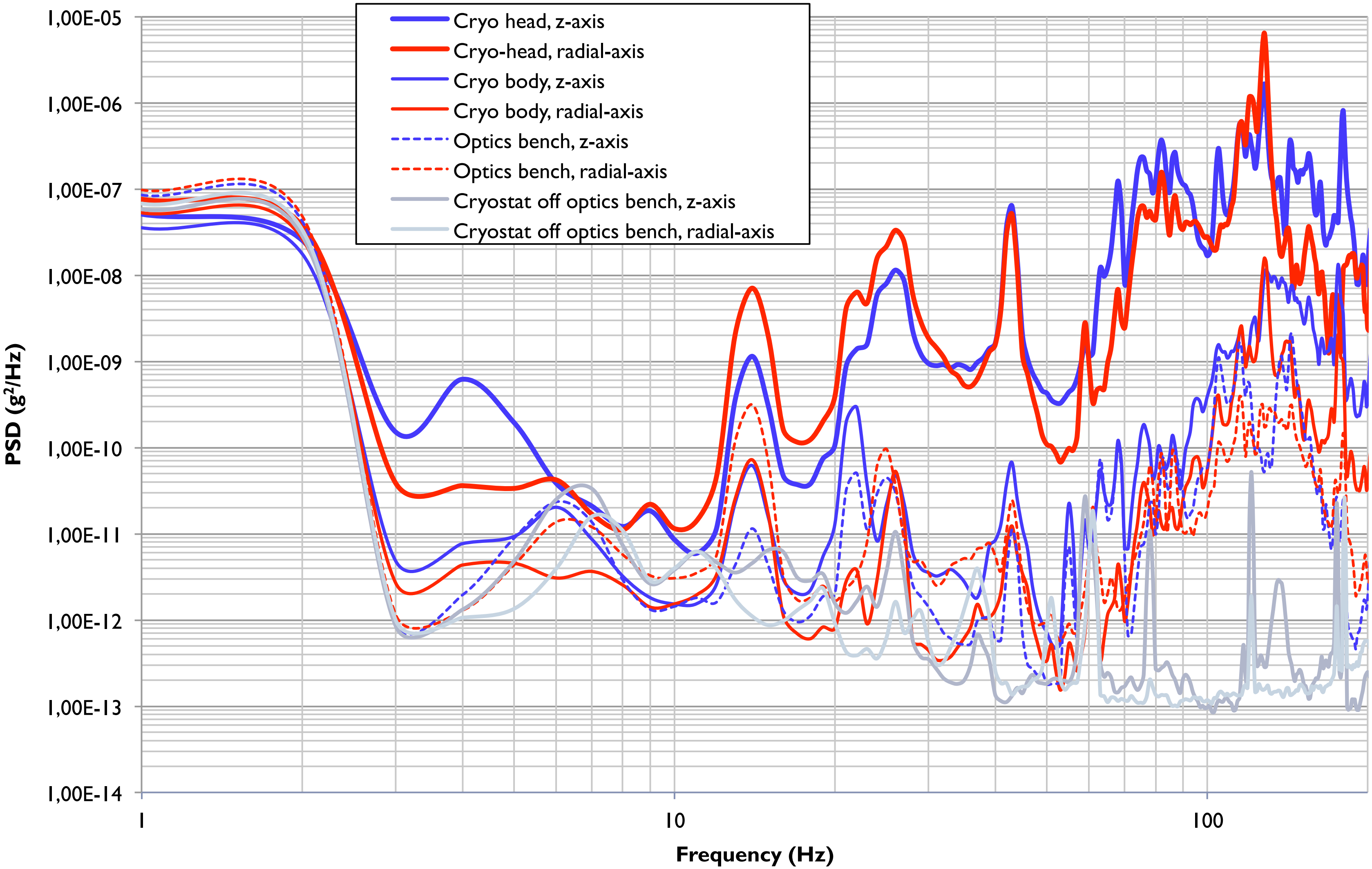
RMS acceleration levels vs. accelerometer and cryostat configuration

Three cryostat configurations:

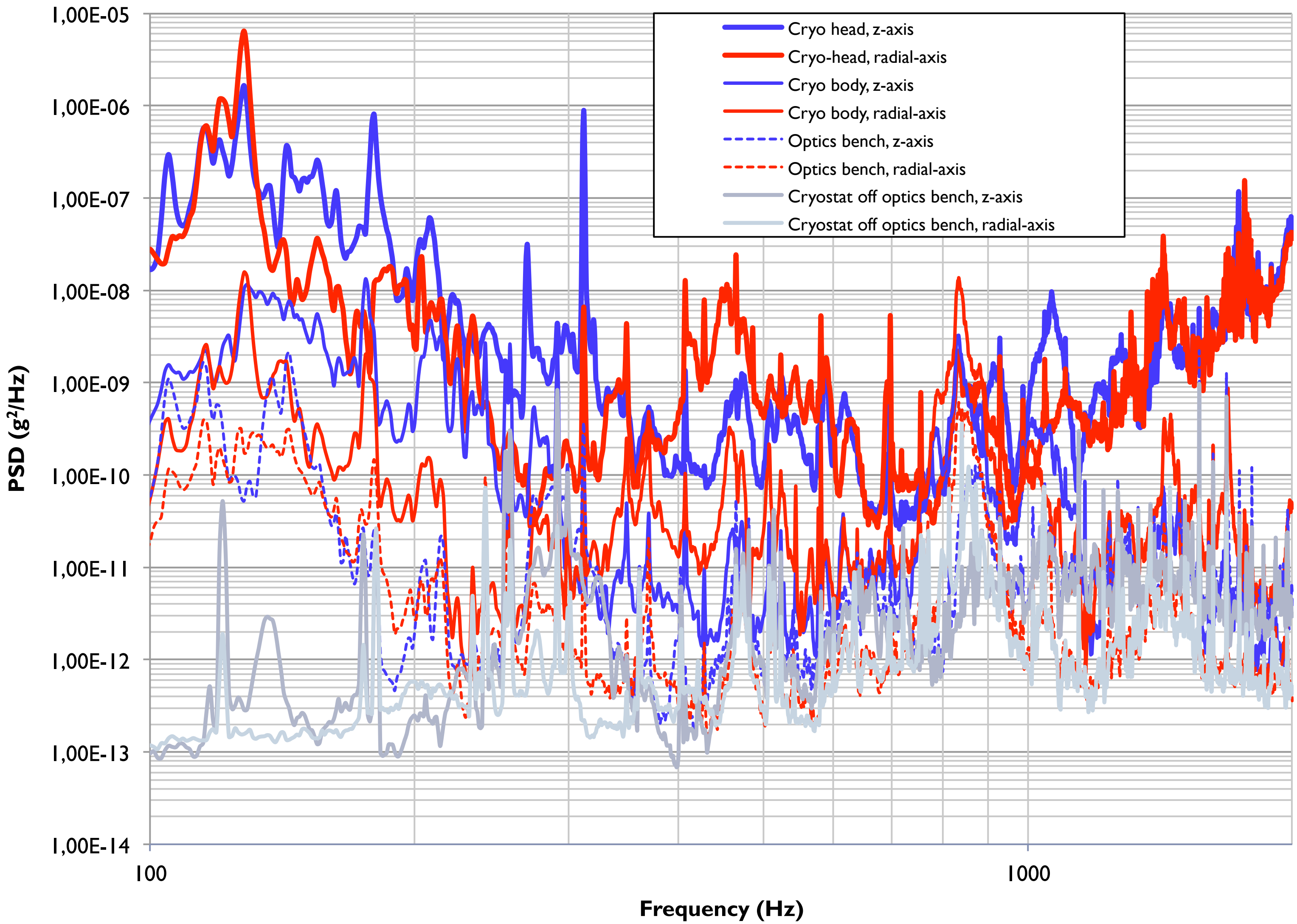
- Cryostat bolted to bench with no modifications made
- Cryostat bolted to bench with isolator clamped down on bench, compressing the isolator (“soft clamping”)
- Cryostat bolted to bench with isolator clamped down on some hard stops (“hard clamping”).

	Channel	Cryostat with unmodified isolator	Cryostat with “soft-clamped” isolator	Cryostat with “hard-clamped” isolator	Cryostat off the optics bench
Accelerometer on cryo-head	z-axis radial axis	4.7 ± 0.1 5.1 ± 0.3	4.1 ± 0.1 4.4 ± 0.25	3.5 ± 0.1 3.5 ± 0.1	n.a. n.a.
Accelerometer on cryostat body	z-axis radial axis	0.60 ± 0.02 0.59 ± 0.02	1.64 ± 0.07 0.82 ± 0.02	1.18 ± 0.03 0.99 ± 0.03	n.a. n.a.
Accelerometer on optics bench	z-axis radial axis	0.203 ± 0.008 0.159 ± 0.004	0.300 ± 0.009 0.194 ± 0.004	0.42 ± 0.02 0.243 ± 0.004	0.109 ± 0.001 0.069 ± 0.001

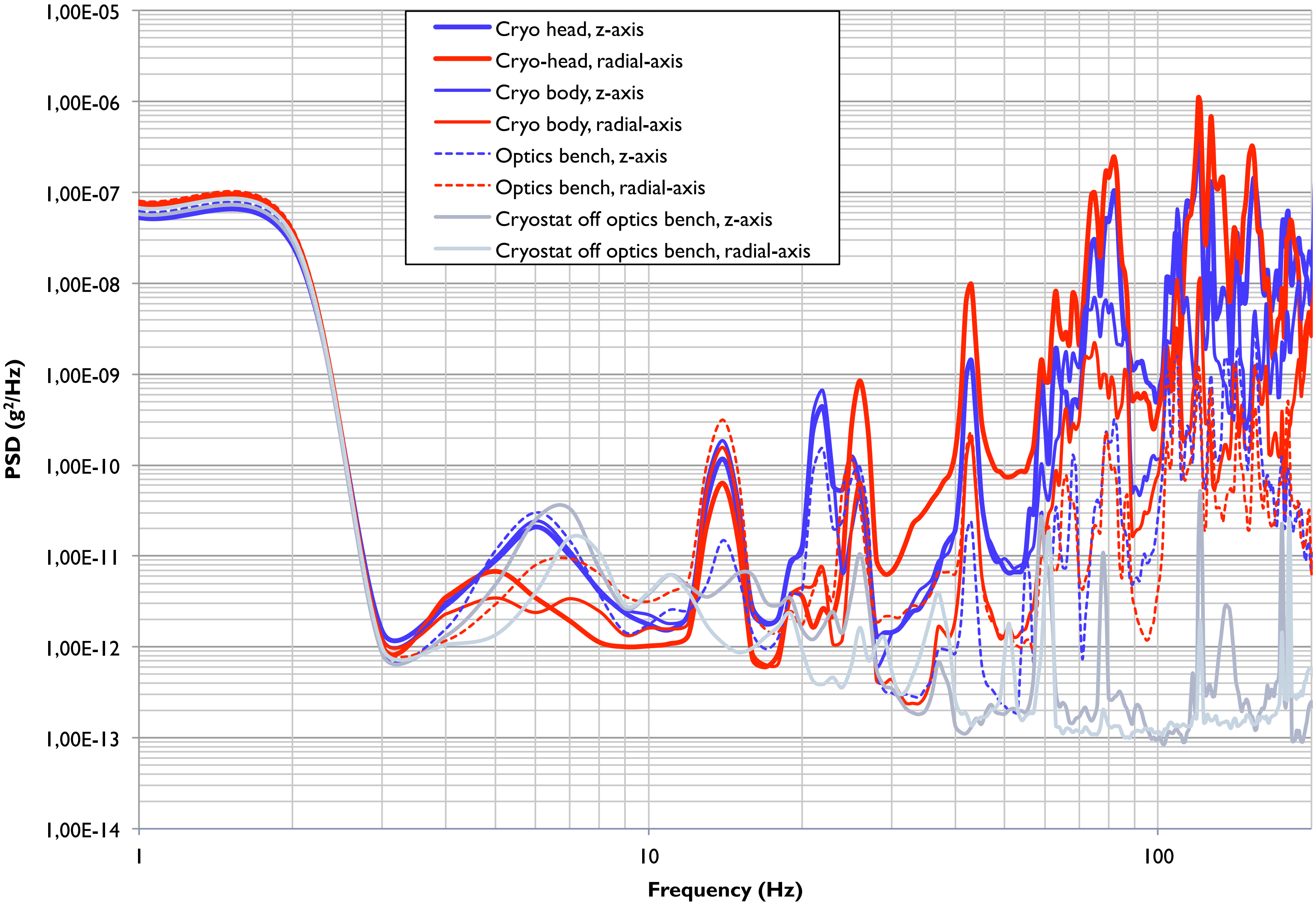
Unmodified isolator, 1-200 Hz



Unmodified isolator, 0.1-2 kHz



Hard clamped isolator, 1-200 Hz



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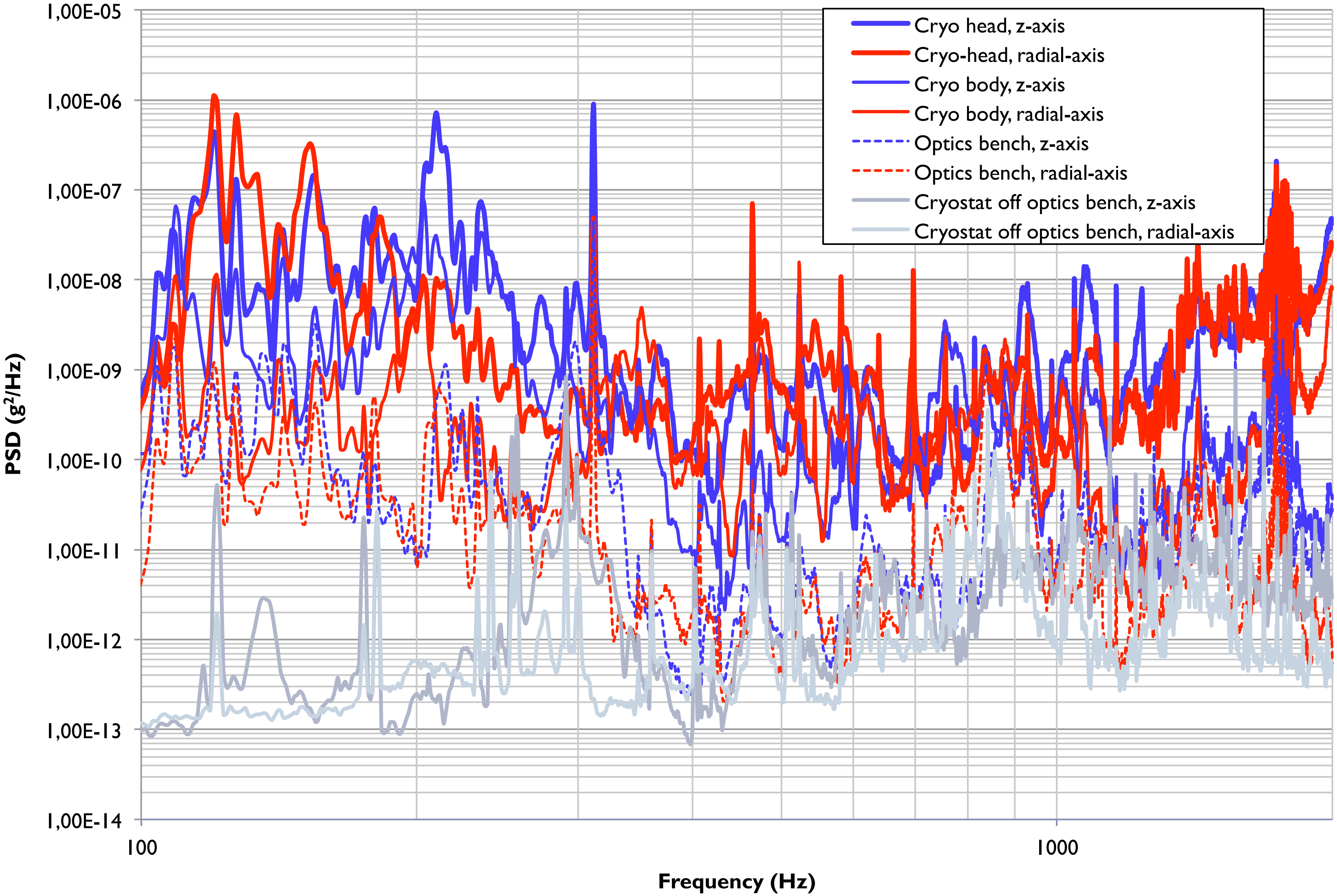
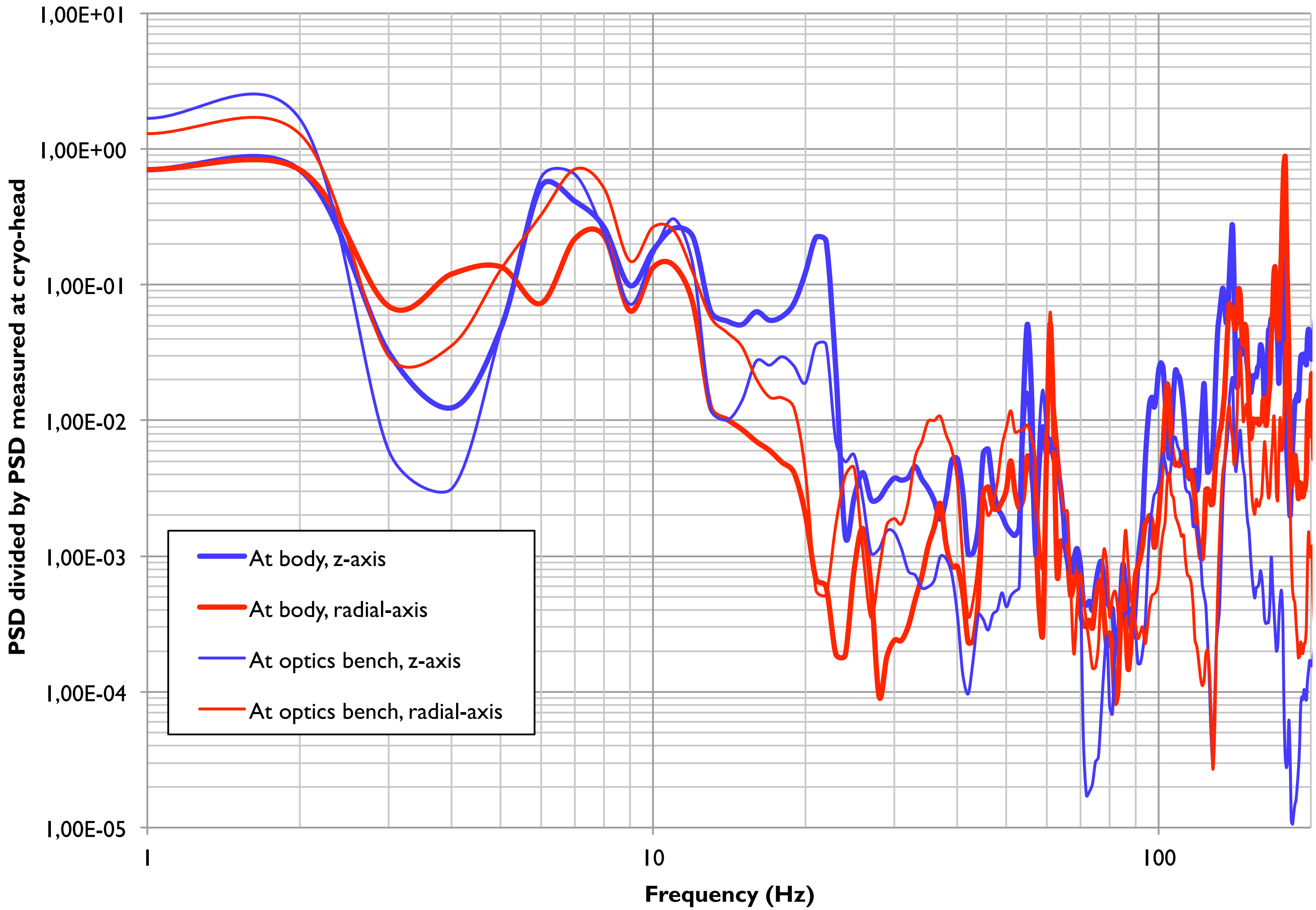


Ratio of cryostat body to cryo-head PSD (unmodified cryostat)



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