

Comparing Pre and Post-retrofit backend temperatures

Focus on all available data in monitor and scan_stat databases.

Components analyzed include mostly those within 50K or colder shells. Outlying points removed.

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3/5/2021

Tables (1): 250mK far and it's stability

slowdaq_250mK_far_mean

20100000 - 21200000

mean	median	std	min	max
8.047	0.323	15.633	0.306	40.000

21200000 - 22300000

mean	median	std	min	max
0.337	0.332	0.019	0.318	0.402

22300000 - 30000000

mean	median	std	min	max
0.530	0.363	0.250	0.354	0.993

slowdaq_250mK_far_std

20100000 - 21200000

mean	median	std	min	max
1.065	0.001	3.686	0.000	18.252

21200000 - 22300000

mean	median	std	min	max
0.004	0.001	0.007	0.000	0.035

22300000 - 30000000

mean	median	std	min	max
0.008	0.003	0.024	0.000	0.144

- Post-retrofit, the focal plane as a median temperature comparable to the pre-retrofit median of ~350mK, but on average is ~200mK warmer.
- Given the ~1K max and larger std, the high average is most likely the result of a small number readings which were taken when the fridge wasn't a base temperature. Similar to the readings for runs 20100000 - 21200000. Inspecting the data, there was indeed a two anomalous runs which were already discussed [here](#).
- Stability of individual focal plane temperature readings (given as the std) agrees with the above. Focal plane std has median comparable to pre-retrofit, but very high max @ 144mK.

Tables (2): 4K backend cryogenics

- SC mainplate mean temperature decreased slightly over the retrofit.
- SC ultrahead mean increased ~100mK (however, variance of these averages is quite high)
- SC interhead mean readings increased dramatically by ~800mK. Variance is very low. So high it seems unphysical. (see slide 5)

slowdaq_SC_Fridge_Mainplate_mean					
20100000 - 21200000					
	mean	median	std	min	max
	3.966	3.999	0.121	3.800	4.182
21200000 - 22300000					
	mean	median	std	min	max
	3.976	3.986	0.079	3.811	4.148
22300000 - 30000000					
	mean	median	std	min	max
	3.782	3.778	0.082	3.669	4.071

slowdaq_SC_Fridge_Ultrahead_mean					
20100000 - 21200000					
	mean	median	std	min	max
	0.347	0.296	0.167	0.283	1.808
21200000 - 22300000					
	mean	median	std	min	max
	0.350	0.296	0.162	0.290	0.850
22300000 - 30000000					
	mean	median	std	min	max
	0.457	0.333	0.255	0.312	1.057

slowdaq_SC_Fridge_Interhead_mean					
20100000 - 21200000					
	mean	median	std	min	max
	0.481	0.375	0.385	0.365	2.315
21200000 - 22300000					
	mean	median	std	min	max
	0.375	0.374	0.002	0.369	0.379
22300000 - 30000000					
	mean	median	std	min	max
	1.140	1.131	0.069	1.118	1.621

Tables (3): 4K backend cyrogenics stability

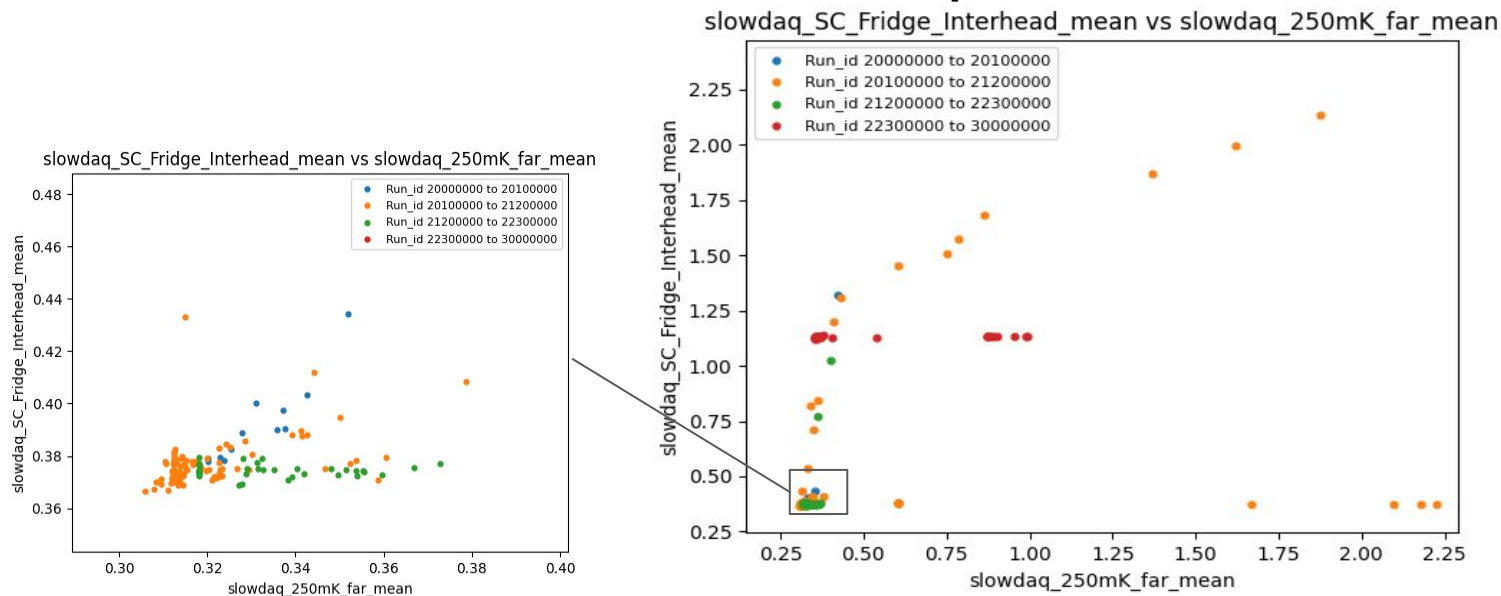
- Mainplate, ultrahead, and interhead individual reading stabilities all comparable to pre-retrofit values.
- All three sensors have high stability, so conclusion on last page are probably reasonable.
- Some values appear as zero; they are not. This was from formatting .

slowdaq_SC_Fridge_Mainplate_std					
20100000 - 21200000					
	mean	median	std	min	max
	0.010	0.010	0.003	0.008	0.027
21200000 - 22300000					
	mean	median	std	min	max
	0.010	0.008	0.005	0.006	0.026
22300000 - 30000000					
	mean	median	std	min	max
	0.016	0.007	0.019	0.002	0.075

slowdaq_SC_Fridge_Ultrahead_std					
20100000 - 21200000					
	mean	median	std	min	max
	0.016	0.002	0.037	0.000	0.274
21200000 - 22300000					
	mean	median	std	min	max
	0.004	0.000	0.019	0.000	0.125
22300000 - 30000000					
	mean	median	std	min	max
	0.008	0.003	0.026	0.001	0.187

slowdaq_SC_Fridge_Interhead_std					
20100000 - 21200000					
mean	median	std	min	max	
0.015	0.001	0.046	0.000	0.341	
21200000 - 22300000					
mean	median	std	min	max	
0.019	0.000	0.082	0.000	0.392	
22300000 - 30000000					
mean	median	std	min	max	
0.003	0.000	0.012	0.000	0.063	

SC interhead and 250mK far temperatures



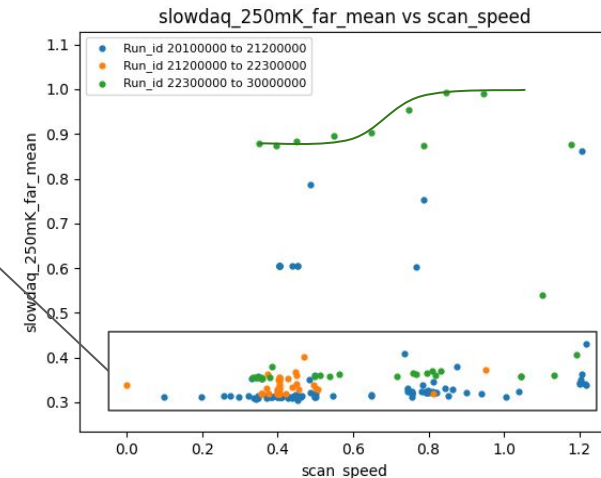
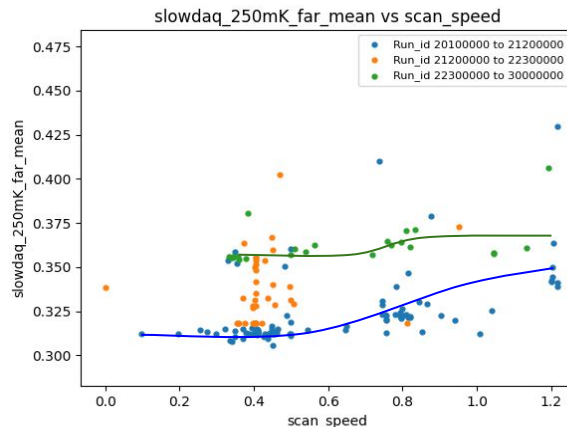
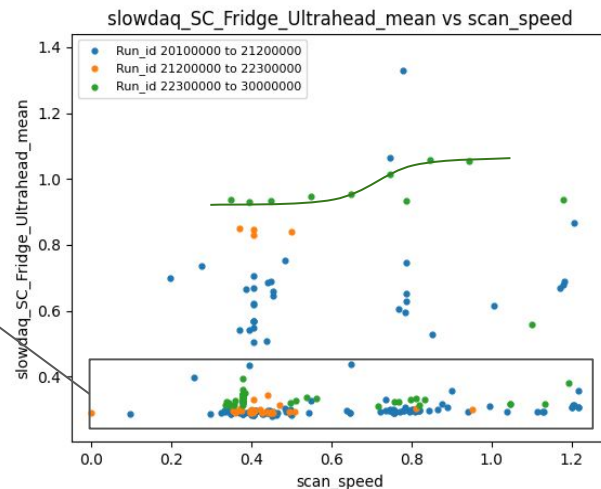
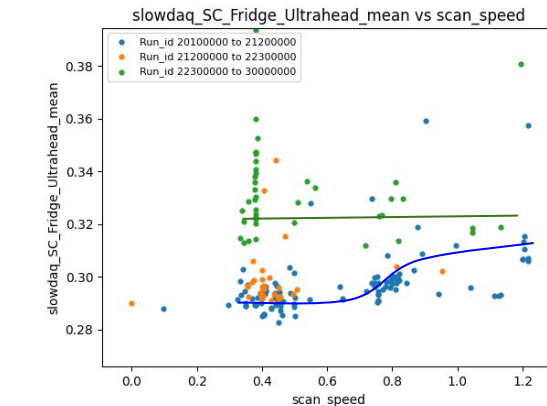
Post-retrofit (red) data not correlated with focal plane temperature while pre-retrofit is at least somewhat correlated. This is another convincing reason why the interhead temperatures may be faulty.

Note the “logarithmic” looking readings for run 20100000 - 21200000. These I also attribute to faulty readings and were first found [here](#).

Ultrahead and focal plane wrt scan speed

(speculative)

- Seems like a focal plane heating pattern may exist pre and post retrofit (roughly sketched)
- While the data >0.5K in the rightmost plots is either unphysical or recorded when the fridge is not in base temperature, the erroneous pattern of runs 22300408-9 looks (very roughly) similar to patterns in the base temperature range.
- In general, temperature seems to increase steadily for scan_speeds >0.6.



Tables (4): 50K bottom and head

- 50K bottom decreased significantly by ~9.5K and 50K head decreased moderately by ~7K.

slowdaq_50K_Bottom_mean						slowdaq_50K_Bottom_std					
20100000 - 21200000						20100000 - 21200000					
mean	median	std	min	max		mean	median	std	min	max	
80.262	80.243	2.801	73.922	87.096		0.073	0.049	0.070	0.002	0.406	
21200000 - 22300000						21200000 - 22300000					
mean	median	std	min	max		mean	median	std	min	max	
85.929	86.094	2.938	81.282	92.547		0.129	0.098	0.088	0.018	0.332	
22300000 - 30000000						22300000 - 30000000					
mean	median	std	min	max		mean	median	std	min	max	
76.591	76.658	0.778	74.703	77.773		0.047	0.039	0.032	0.012	0.133	

- Stability of both temperature readings increased dramatically.
- Stability of individual temperature readings (see std data) remained comparable to pre-retrofit.

slowdaq_50K_Head_mean						slowdaq_50K_Head_std					
20100000 - 21200000						20100000 - 21200000					
mean	median	std	min	max		mean	median	std	min	max	
73.321	73.870	2.595	68.129	79.136		0.065	0.036	0.086	0.006	0.608	
21200000 - 22300000						21200000 - 22300000					
mean	median	std	min	max		mean	median	std	min	max	
73.864	73.567	1.473	70.876	76.961		0.102	0.090	0.080	0.019	0.395	
22300000 - 30000000						22300000 - 30000000					
mean	median	std	min	max		mean	median	std	min	max	
56.807	56.692	0.217	56.554	57.347		0.133	0.129	0.009	0.123	0.163	

Tables (5): 4K OT and blackbody

- OT 4K Head and Heat Link, and 4K Blackbody all decreased markedly from the retrofit.
- OT 4K head decreased by ~0.15K, OT 4K heat link by ~0.42K, and 4K blackbody by about ~0.63K.
- Above supported by the still very high level of stability. For all three components, stability actually increased.

slowdaq_OT_4K_Head_mean						slowdaq_OT_4K_Head_std					
20100000 - 21200000						20100000 - 21200000					
	mean	median	std	min	max		mean	median	std	min	max
	3.891	3.882	0.063	3.776	4.074		0.105	0.105	0.004	0.094	0.115
21200000 - 22300000						21200000 - 22300000					
	mean	median	std	min	max		mean	median	std	min	max
	3.816	3.815	0.037	3.748	3.902		0.102	0.101	0.004	0.094	0.110
22300000 - 30000000						22300000 - 30000000					
	mean	median	std	min	max		mean	median	std	min	max
	3.648	3.648	0.014	3.626	3.678		0.088	0.088	0.002	0.085	0.092
slowdaq_OT_4K_Heat_Link_mean						slowdaq_OT_4K_Heat_Link_std					
20100000 - 21200000						20100000 - 21200000					
	mean	median	std	min	max		mean	median	std	min	max
	3.974	3.977	0.102	3.759	4.214		0.015	0.015	0.001	0.014	0.021
21200000 - 22300000						21200000 - 22300000					
	mean	median	std	min	max		mean	median	std	min	max
	3.965	3.973	0.088	3.785	4.159		0.016	0.016	0.002	0.014	0.023
22300000 - 30000000						22300000 - 30000000					
	mean	median	std	min	max		mean	median	std	min	max
	3.449	3.452	0.031	3.398	3.514		0.017	0.017	0.000	0.016	0.018
slowdaq_4K_blackbody_mean						slowdaq_4K_blackbody_std					
20100000 - 21200000						20100000 - 21200000					
	mean	median	std	min	max		mean	median	std	min	max
	5.015	5.015	0.138	4.718	5.349		0.004	0.003	0.004	0.001	0.018
21200000 - 22300000						21200000 - 22300000					
	mean	median	std	min	max		mean	median	std	min	max
	4.972	4.969	0.133	4.755	5.281		0.006	0.005	0.005	0.001	0.022
22300000 - 30000000						22300000 - 30000000					
	mean	median	std	min	max		mean	median	std	min	max
	4.341	4.349	0.041	4.265	4.433		0.002	0.002	0.002	0.001	0.008

Faulty sensors

Post-retrofit, there are many more sensors which return faulty readings (i.e. always reading a single value or unphysically large/small values) or no reading at all.

Here is a partial list of the faulty sensors:

Backend

- Backend 4K head
- Backend 4K heat link
- SQUID card

OT

- Aperture lens
- Collimator lens
- Field lens
- Lyot stop blackbody
- 50K filter left
- 50K filter right

Mirrors

- All primary mirror sensors

Runid reference table

Modifications were made on the receiver between the 200*****, 201*****, 212*****, 223***** runs

Many differences and nonlinearities between temperature data sets can be explained by considering the data separately in these periods:

	First runid	First date	Last runid	Last date
Original receiver	20000021	2018-12-26	20000327	2019-03-06
After first round of modifications	20100001	2019-03-08	20102003	2019-11-30
After second round of modifications	21200001	2020-01-30	21200399	2020-03-19
Post-retrofit	22300000	2021-01-07	22300523*	2021-01-29*

*most recent data in database

<https://bolowiki.berkeley.edu/bin/view/Main/PB2aDeploymentObservations>