

## Long Strip Stave Testing Setup



## Setup

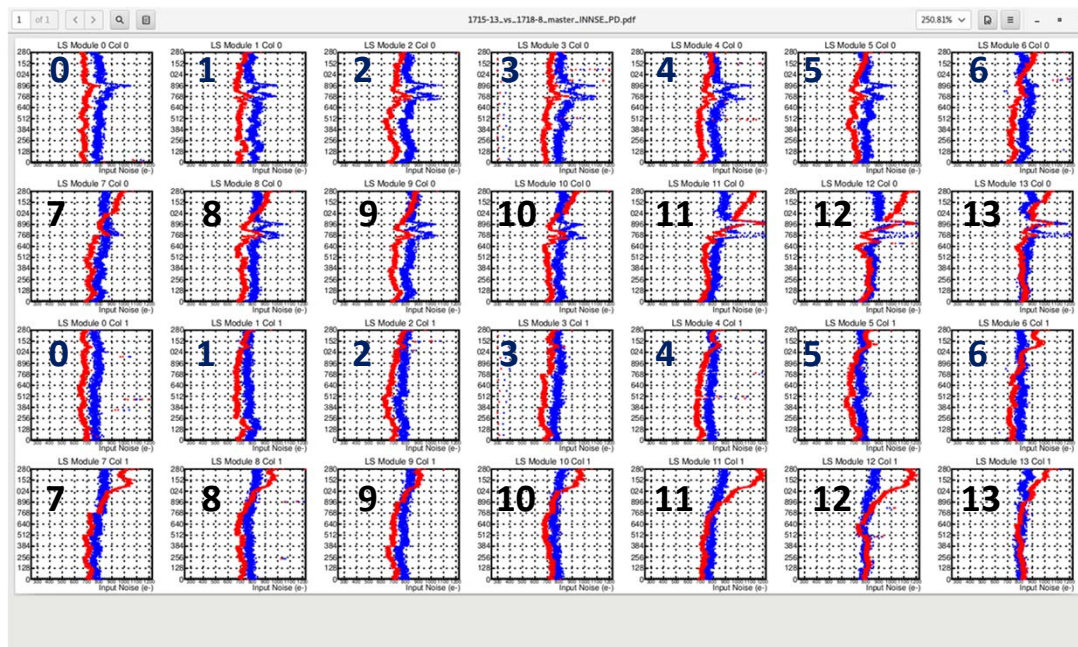
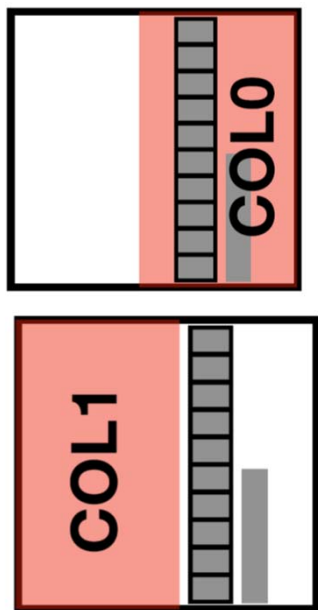


## Readout

- Stefania got each side running independently by using Peter’s suggestion of reading out the ABCStar on-chip counter to make s-curves rather than reading out the data stream. This is assumed to have been necessary due to bandwidth limitations at some point in the event transfer chain, but requires further study.
- Peter arrived Saturday 8<sup>th</sup> February and got both sides running simultaneously. Cold running first took place on Thursday 13<sup>th</sup>. The severity of the noise issue we discuss today was realized on Friday 14<sup>th</sup> during analysis of the previous day’s data.
- Note when we say “running at -60°C”, inlet temperature to the stave is about -45°C, or 15 degrees higher

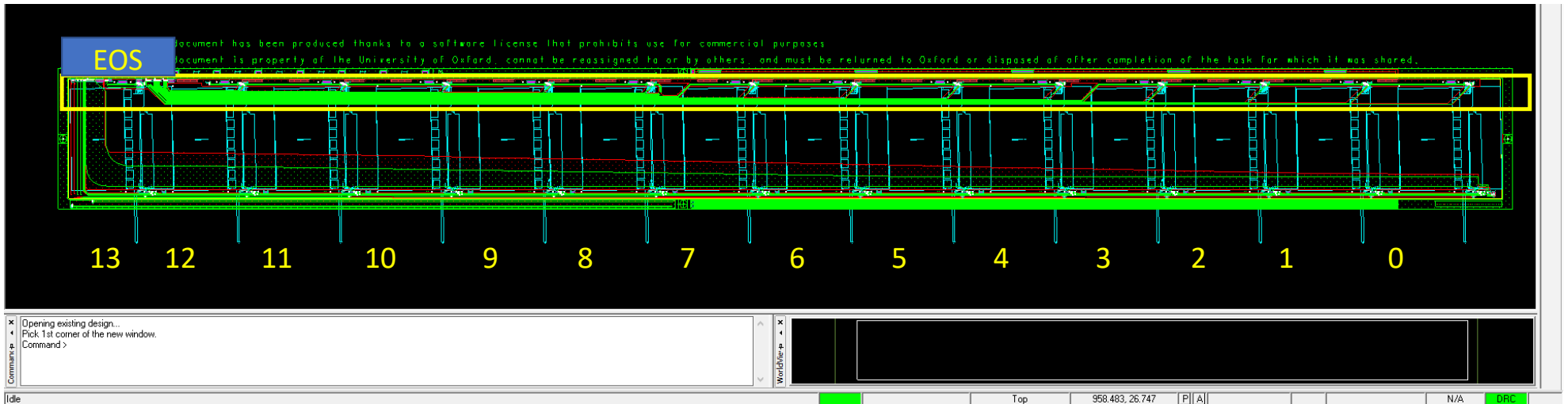
T setpoint	T chiller	T in	T out	P in [psi]	Vout	Flow [cc/s]	Inlet Hose $\Delta T$ [K]	Stave $\Delta T$ [K]	Power [W]
40	42.8	49.1	46.8	180	2.65	26.27	6.3	-2.3	-103.9
30	29.6	36.9	36.2	165	2.5	24.78	7.3	-0.7	-29.8
20	22.9	29.9	29	150	2.41	23.89	7	-0.9	-37.0
10	18.5	23.9	22.8	150	2.32	23.00	5.4	-1.1	-43.5
0	8.3	13.9	13.2	130	2.12	21.01	5.6	-0.7	-25.3
-10	-1.3	5.4	5.3	120	2.02	20.02	6.7	-0.1	-3.4
-20	-19.3	-6.6	-4.8	110	1.94	19.23	12.7	1.8	59.5
-30	-24.3	-14.6	-13	110	1.9	18.83	9.7	1.6	51.8
-40	-40.3	-26	-22.3	110	1.84	18.24	14.3	3.7	116.1
-50	-50.5	-35.5	-30.9	110	1.79	17.74	15	4.6	140.4
-60	-60.9	-45.8	-40	120	1.76	17.44	15.1	5.8	174.0
-60	-60	-45.6	-40.8	140	1.84	18.24	14.4	4.8	150.6
-60	-58.8	-45.6	-40.9	150	1.94	19.23	13.2	4.7	155.4
-60	-58.6	-44.4	-40.4	180	2.03	20.12	14.2	4	138.4

# Mapping to noise plots

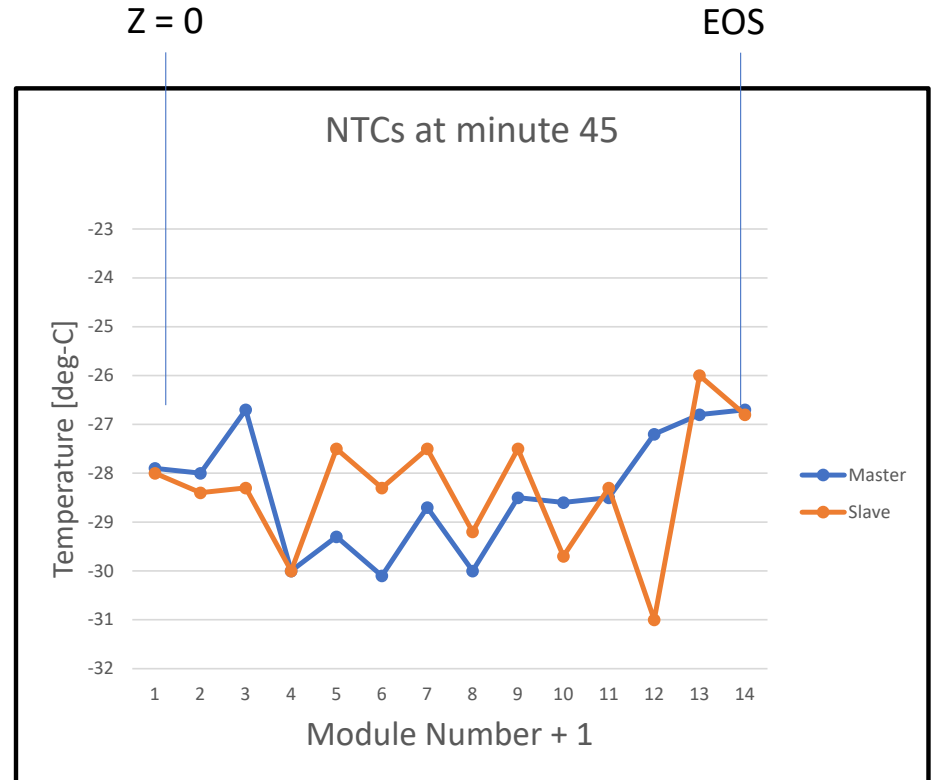
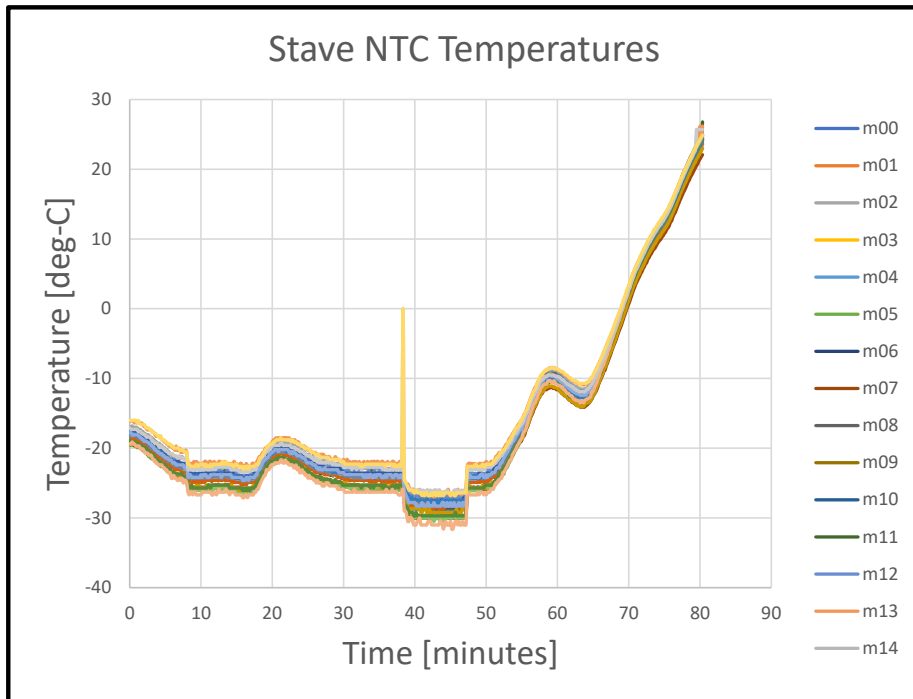


## Bus tape and region of noise

Noise in region shows increase in this direction



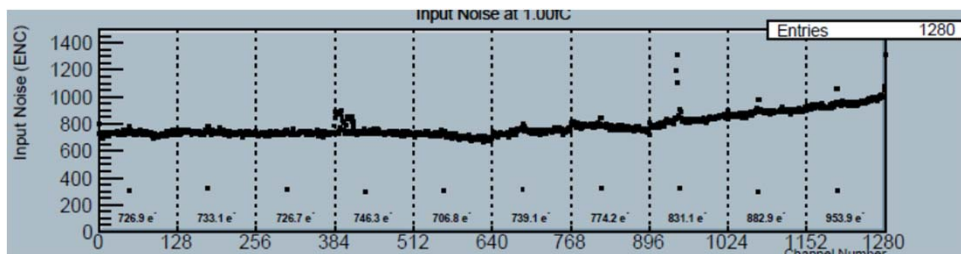
# NTC Temperatures (Setpoint = ??)



Plan as of Tuesday 18<sup>th</sup> February.  
 Crossed out items have been done

Initial investigations on Friday 14<sup>th</sup> Feb  
 had already shown:

- unbonded channels not affected
- no dependence upon drive current for CCR
- no dependence upon drive current for data
- no significant change running 4 modules/side



Plan

- ~~Faraday shielding~~
- ~~Add aluminum foil to exposed panel~~
- ~~Sealed seams with conductive tape and fabric mesh gasket~~
- ~~Ground box. This is to be done to single point ground on HV supply.~~
- ~~Ground table~~
- ~~Switch fluid inlet/outlet.~~
- ~~Run 11V to get baseline.~~
- ~~Run 40C to see if above changes made a difference.~~

Run from 10V (for ABC130 stave we showed noise independent of Vin for Vin = 10V, 10.5V, and 11V). We've done no tests on ABC\* stave. Run cold.

Run with 500V

Run just master side, then just slave side (unplug HV!!!)

Susceptibility to Lenze Inverter pickup (controls booster pump)

Change setting from 20 to 10 (and thus flow rate) with no change. But best test is to bypass it. But am not sure stave will not heat up as chiller itself can only deliver 20 psi. So first do temperature test with NTCs. If works, then do data run.

Susceptibility to chiller's refrigerator.

I think we did this, but let's repeat. Chiller allows you to press button that turns off refrigerator. But first do test with NTCs to see if stave heats up too much during time it takes to do 3pt gain.

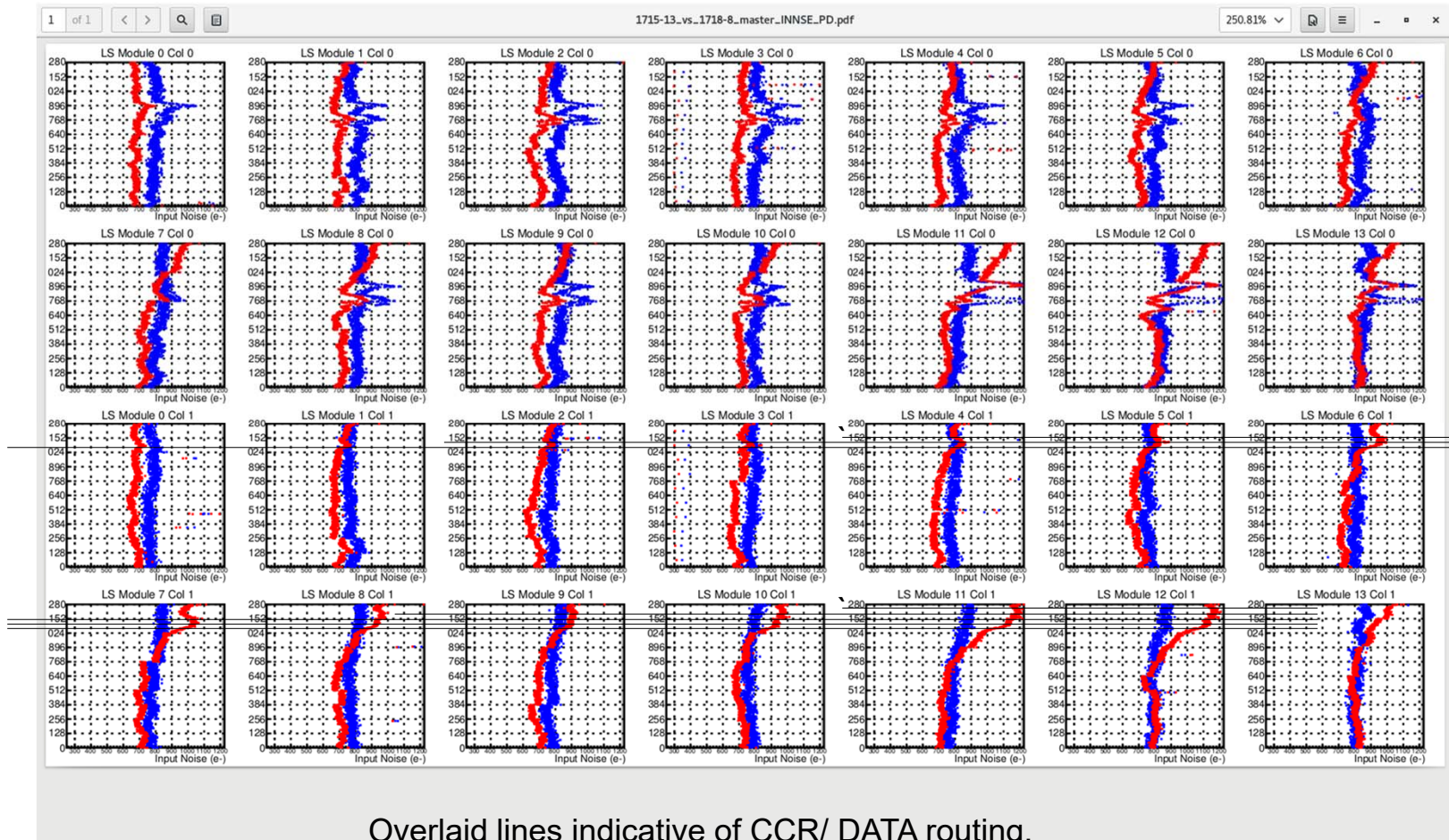
Ntrigger investigation. Why did Stefania see better results with Ntrig = 255 then ntrig = 1020?

~~Remove AC grounds~~

~~Was done in situ: this did not require disconnection of the stave.~~

LS STAVE MASTER SIDE, RED = COOLANT -60C, BLUE = COOLANT +20C

Noise Issue

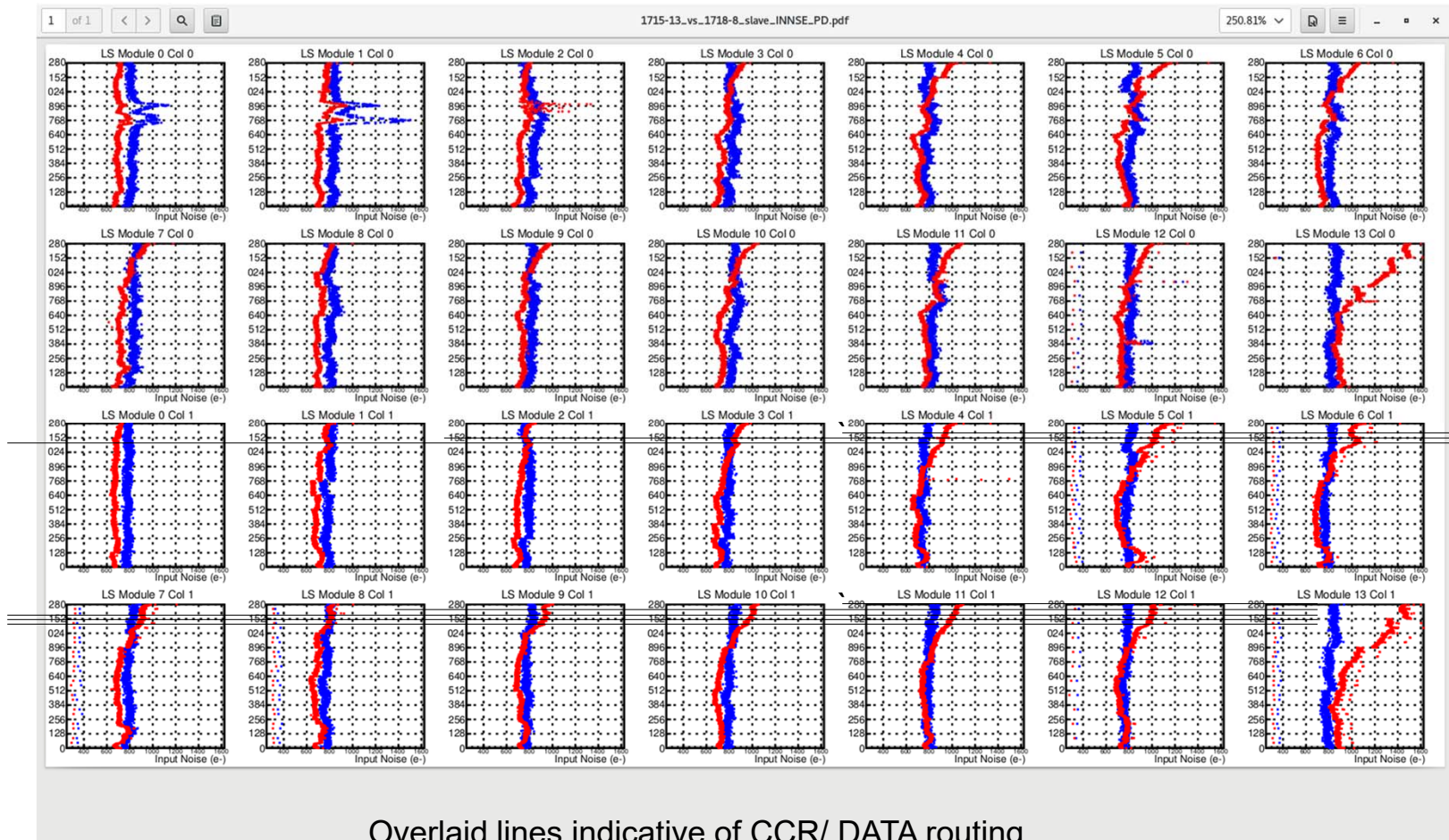


Overlaid lines indicative of CCR/ DATA routing.  
As Occupancy counters were used, only CCR was driven during the tests



LS STAVE SLAVE SIDE, RED = COOLANT -60C, BLUE = COOLANT +20C

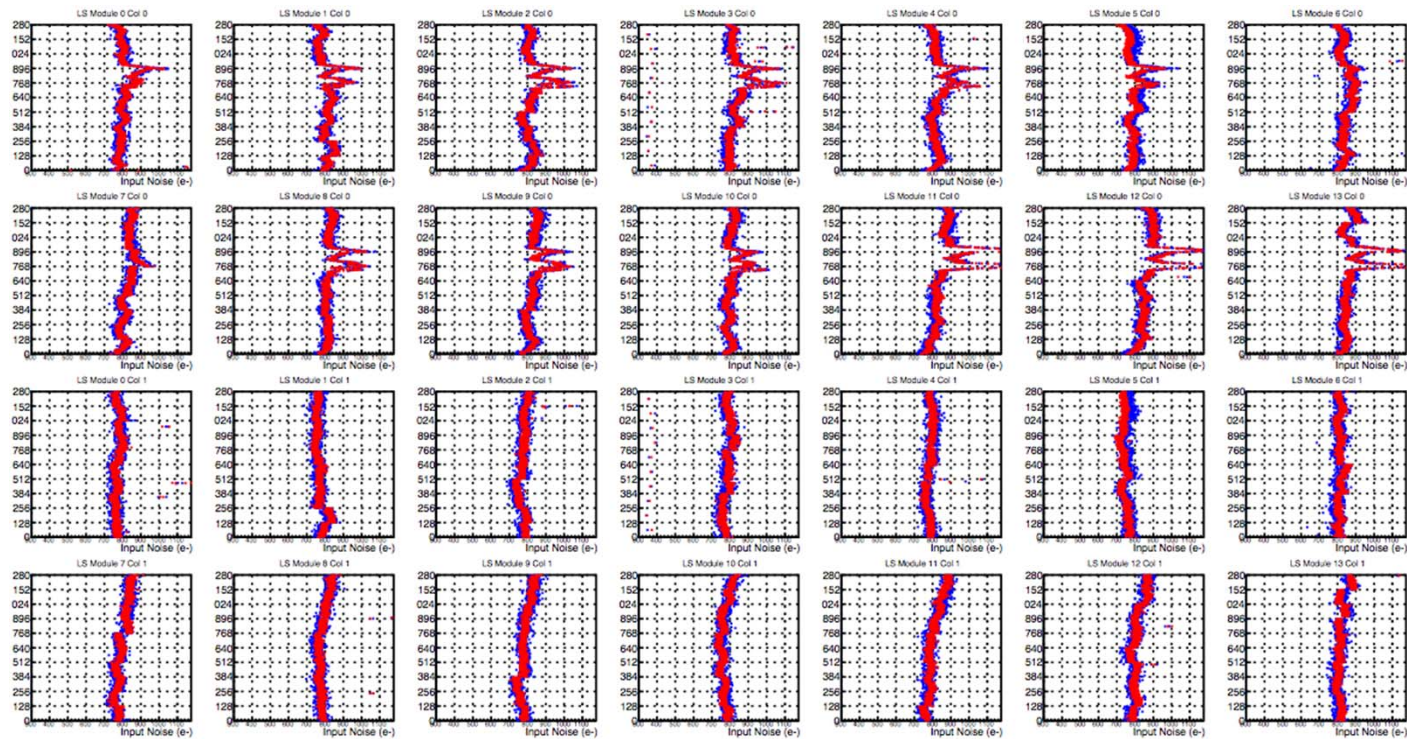
Noise Issue



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As Occupancy counters were used, only CCR was driven during the tests

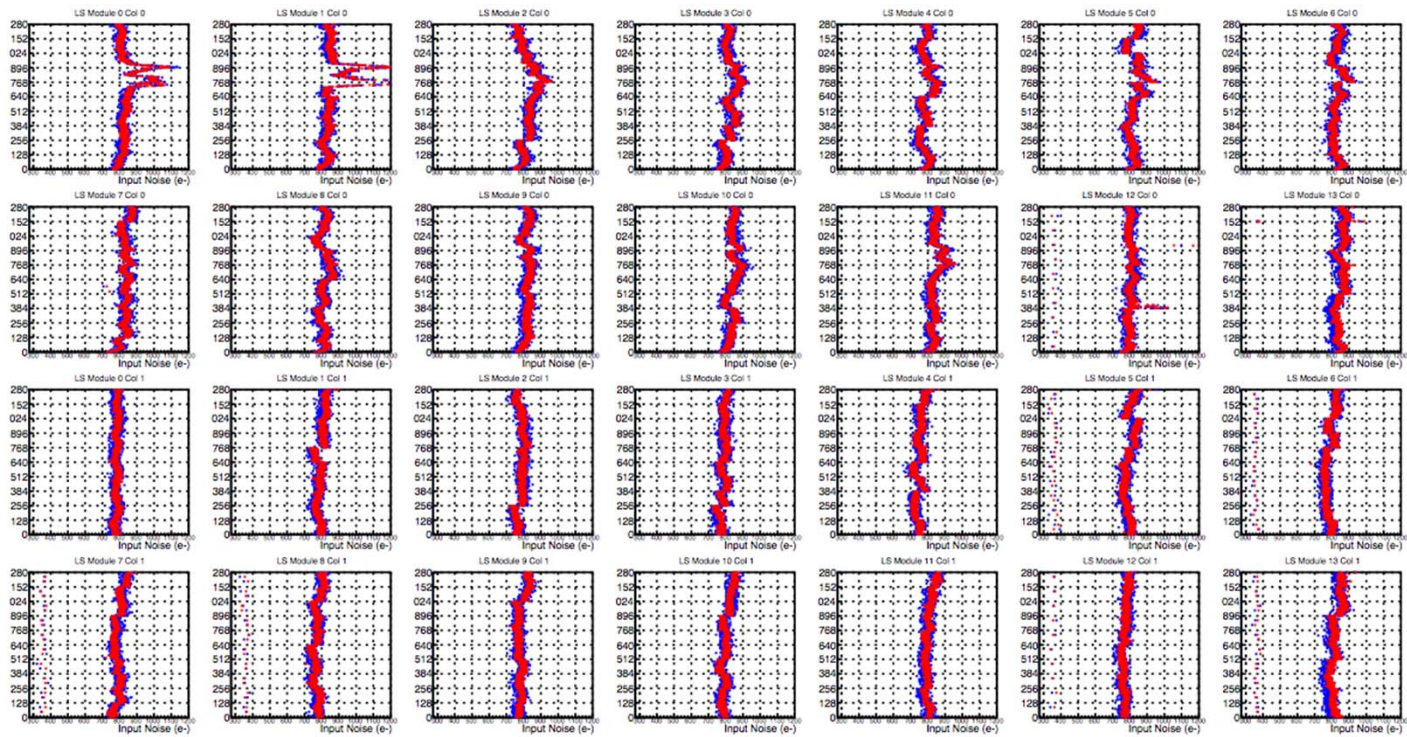
Faraday shielding. Added aluminum foil to exposed panel. Sealed seams with conductive tape and fabric mesh gasket. Grounded box. Ground table. Switch fluid inlet/outlet

Coolant +20C, Coolant +20C new shielding, MASTER



Faraday shielding. Added aluminum foil to exposed panel. Sealed seams with conductive tape and fabric mesh gasket. Grounded box. Ground table. Switch fluid inlet/outlet

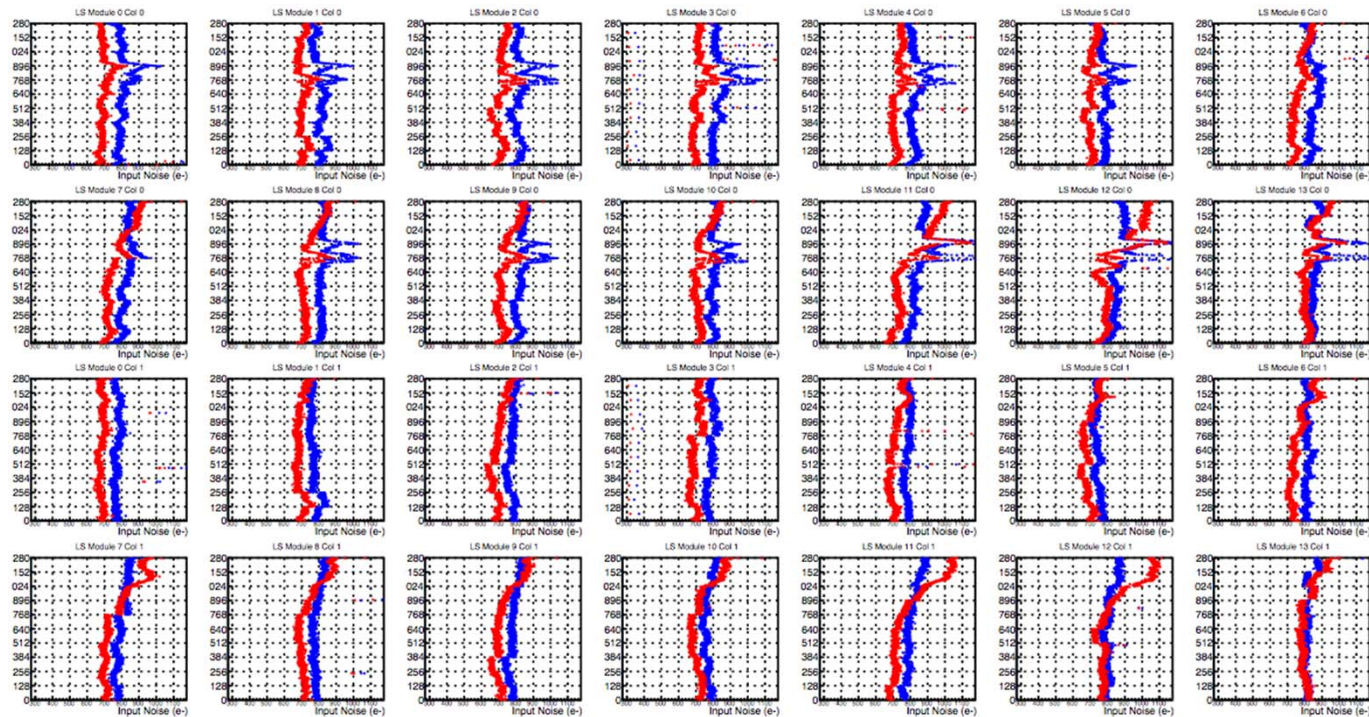
Coolant +20C, Coolant +20C new shielding, SLAVE



No improvement @20C

Last week comparison has been done between 20C and -60C coolant temperature. In order to compare with that setup, I'd need to go to -60C as well. Dave pointed out we shouldn't risk it, so we decided to go to -50C (shield@-50 slightly better than unshielded at -60--inconclusive)

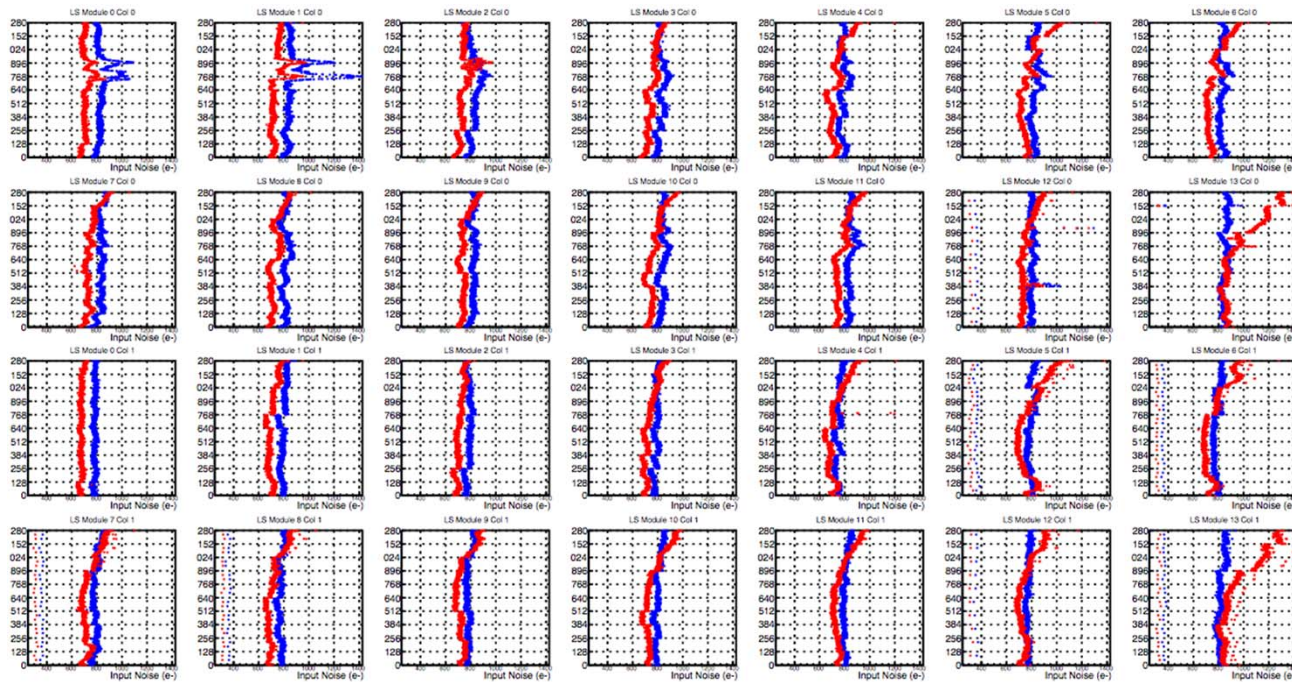
Coolant +20C, Coolant -50C, MASTER



to be compared with the one in slide 8

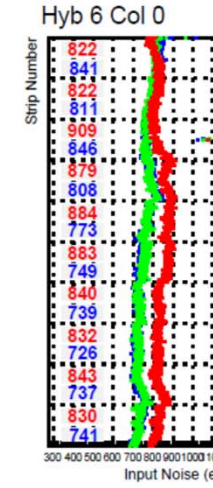
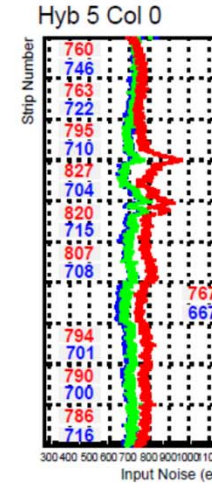
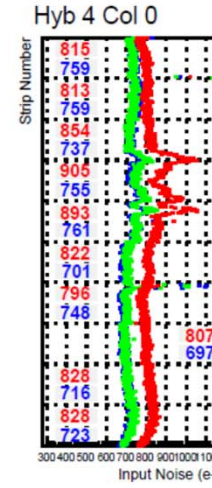
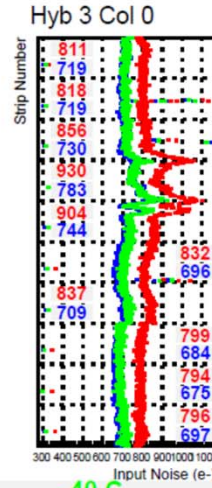
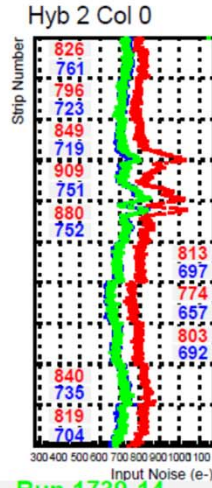
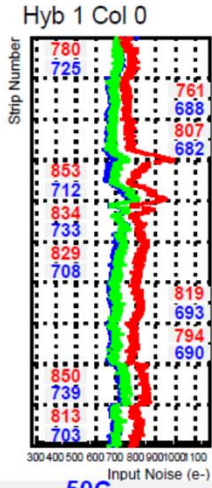
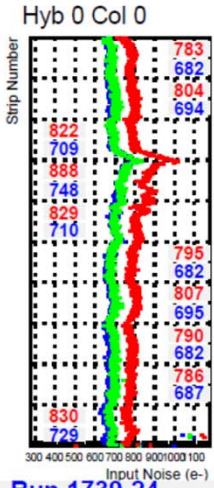
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Coolant +20C, Coolant -50C, SLAVE

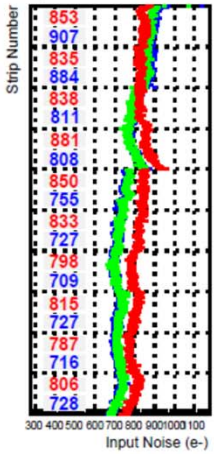


to be compared with the one in slide 9

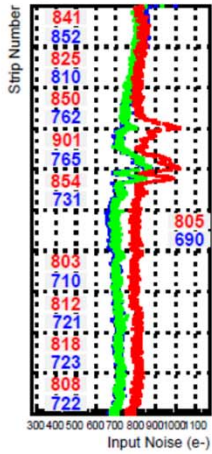
Noise plot for master column zero (strips with hybrid on top) at -50C, -40C, 20C



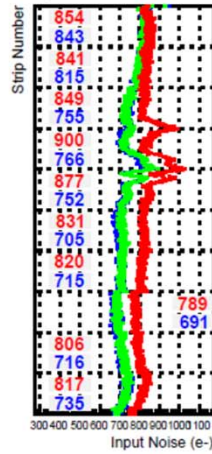
Run 1739-24  
Run 1739-6  
Hyb 7 Col 0



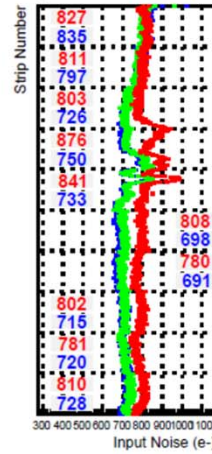
-50C  
RT  
Hyb 8 Col 0



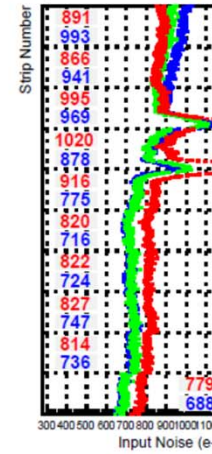
Run 1739-14  
-40 C  
Hyb 9 Col 0



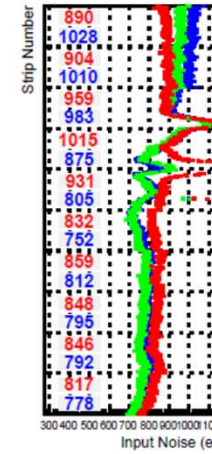
-40 C  
Hyb 10 Col 0



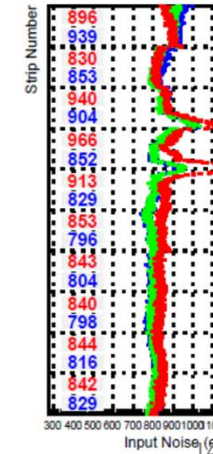
-40 C  
Hyb 11 Col 0



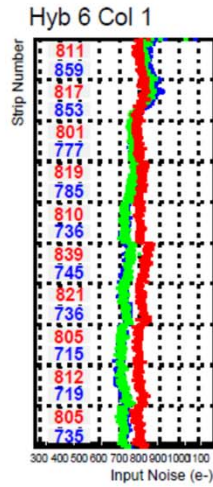
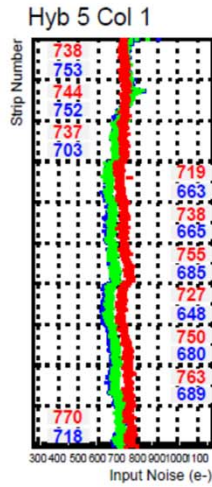
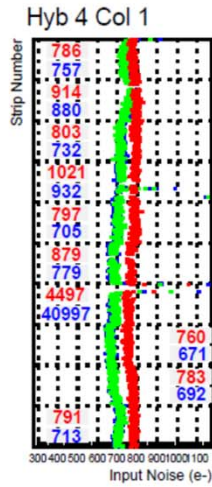
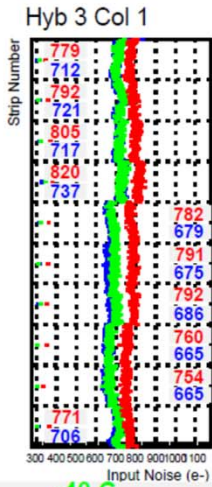
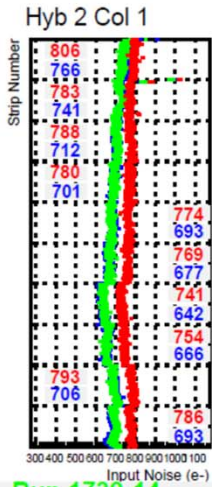
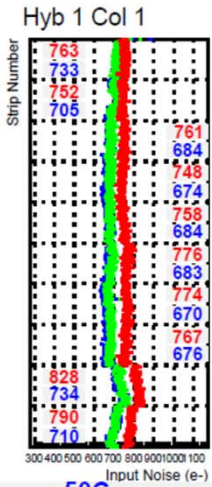
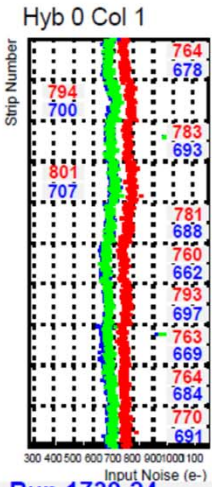
-40 C  
Hyb 12 Col 0



-40 C  
Hyb 13 Col 0



Noise plot for master column one (strips with no hybrid on top) at -50C, -40C, 20C

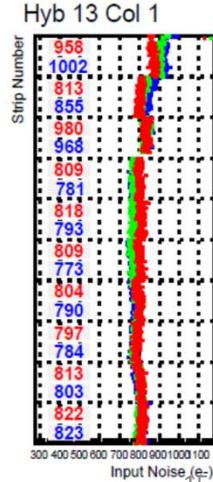
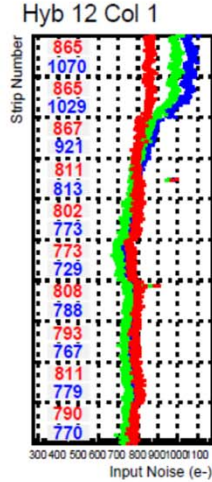
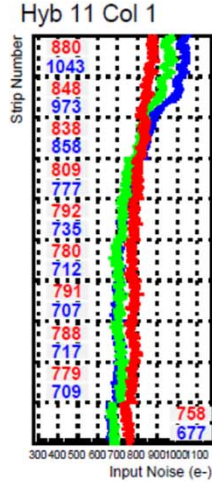
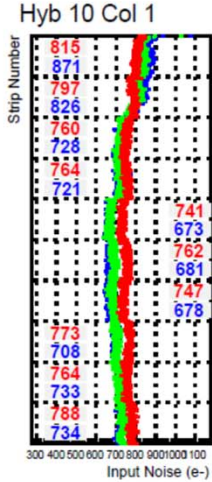
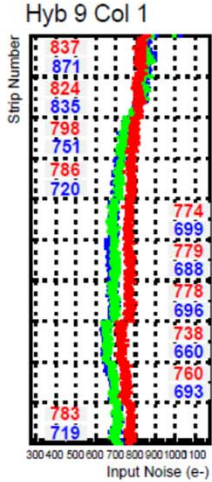
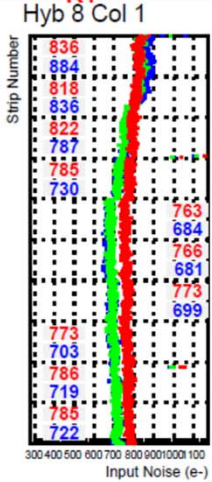
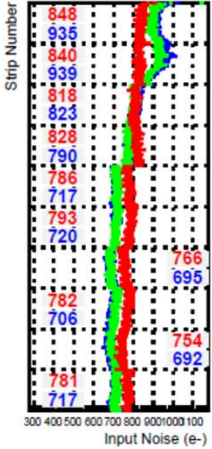


Run 1739-24  
Run 1739-6

-50C  
RT

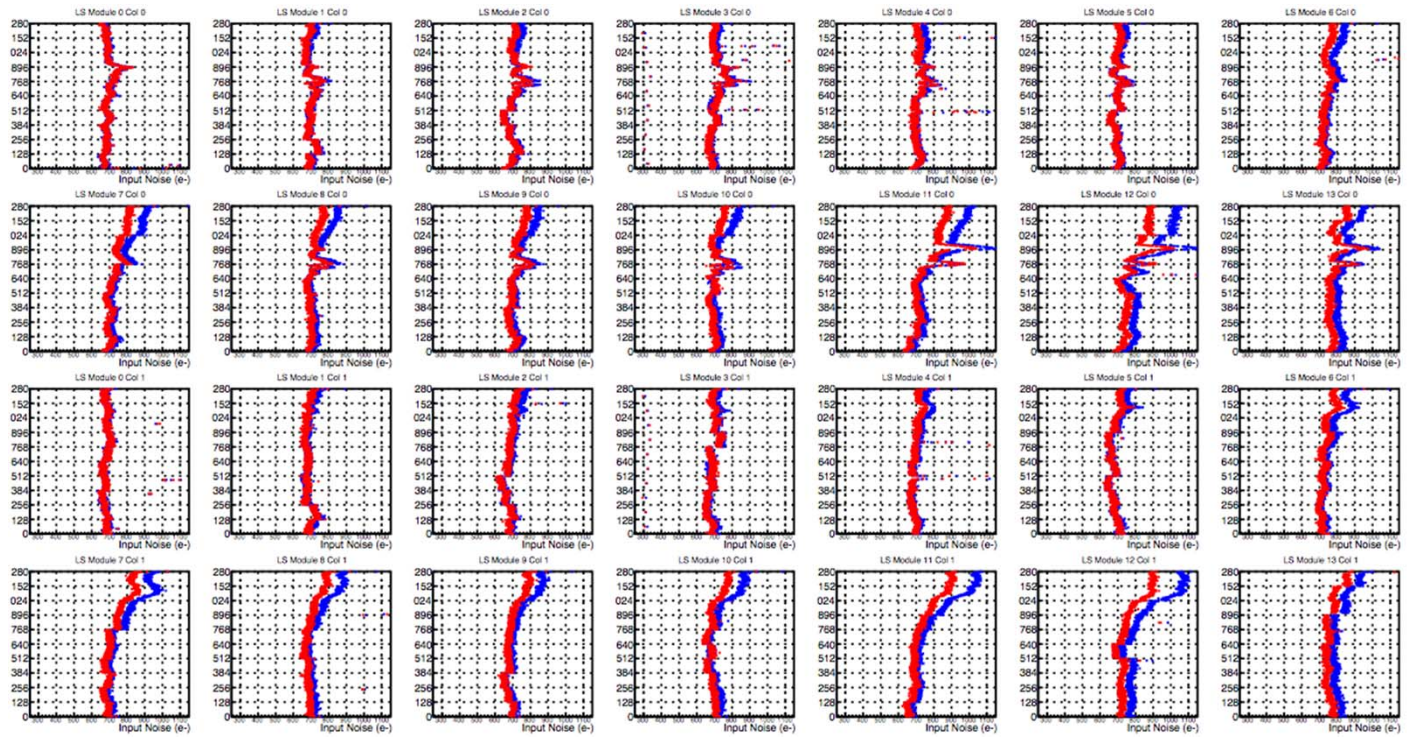
Run 1739-14

-40C



Running at 10V

11V, 10V MASTER

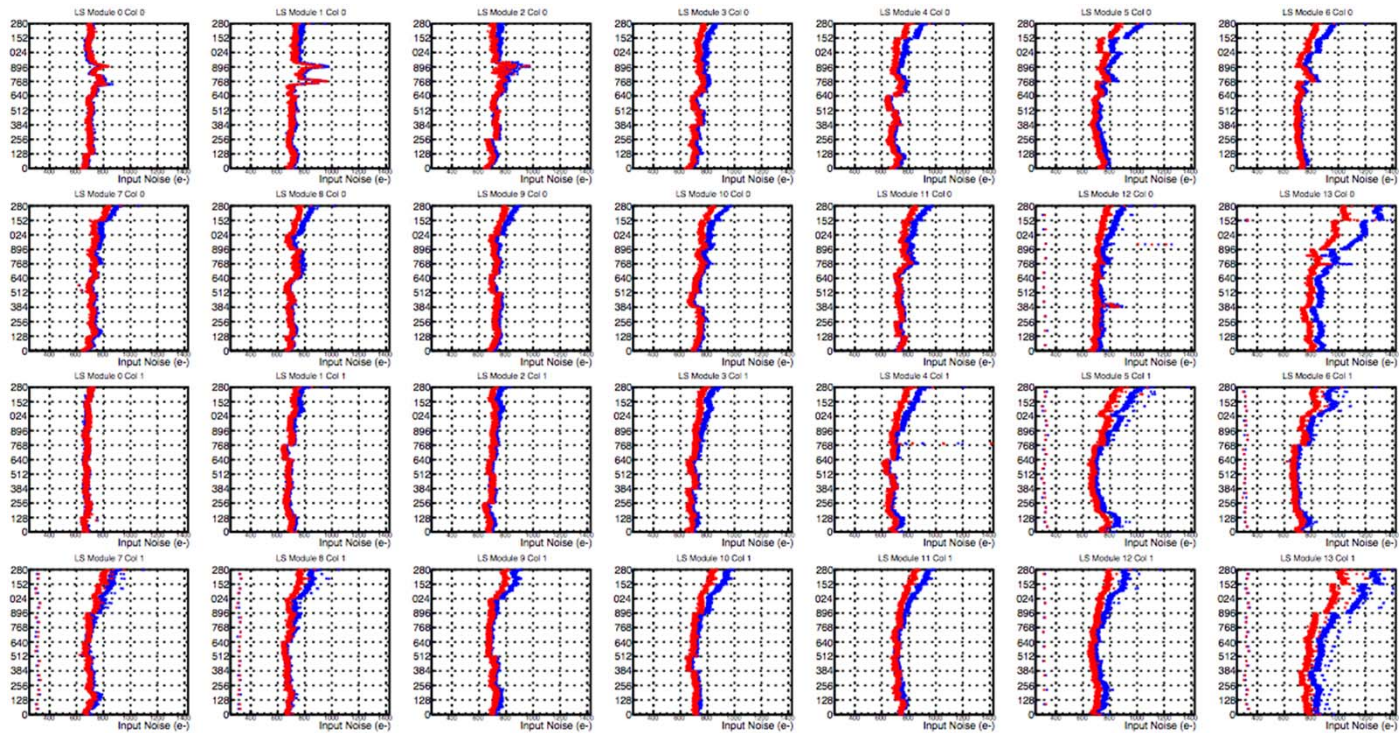


Noise decreases! Is it related to the DC-DC then?



Running at 10V

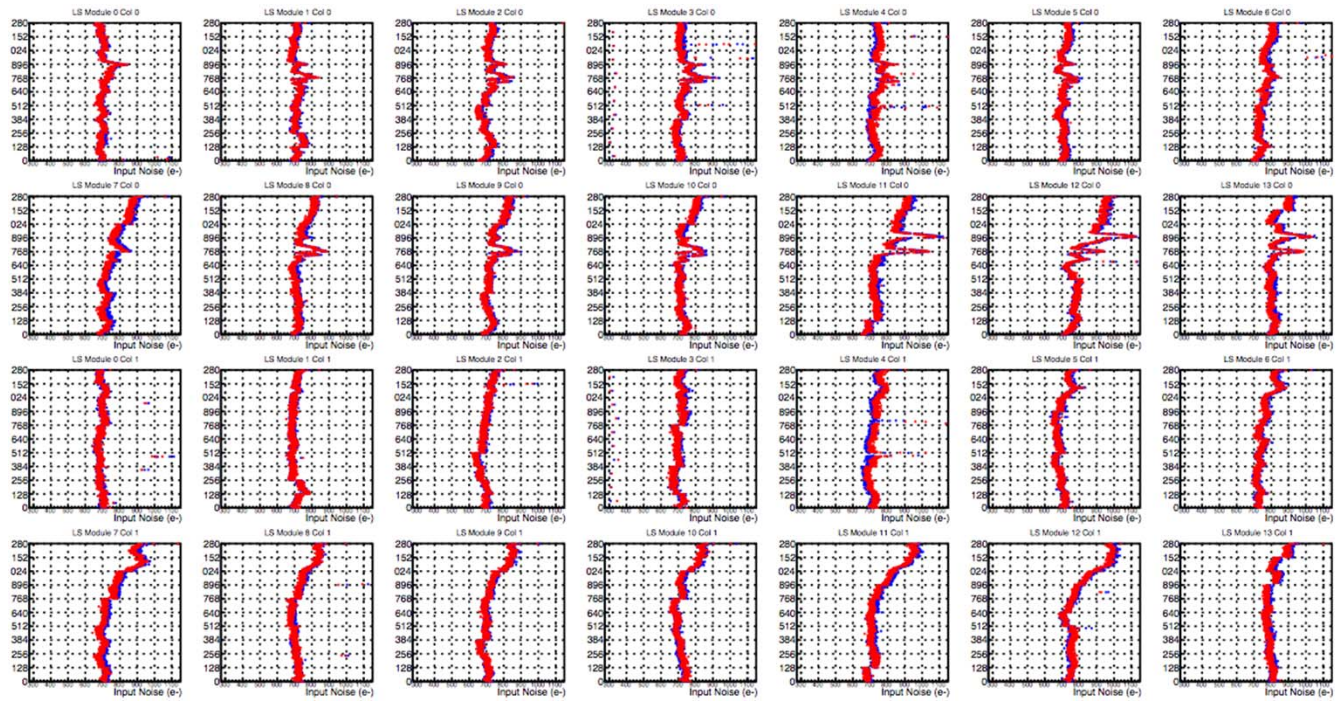
11V, 10V SLAVE



Noise decreases! Is it related to the DC-DC then?

Running at -500V, @-40C

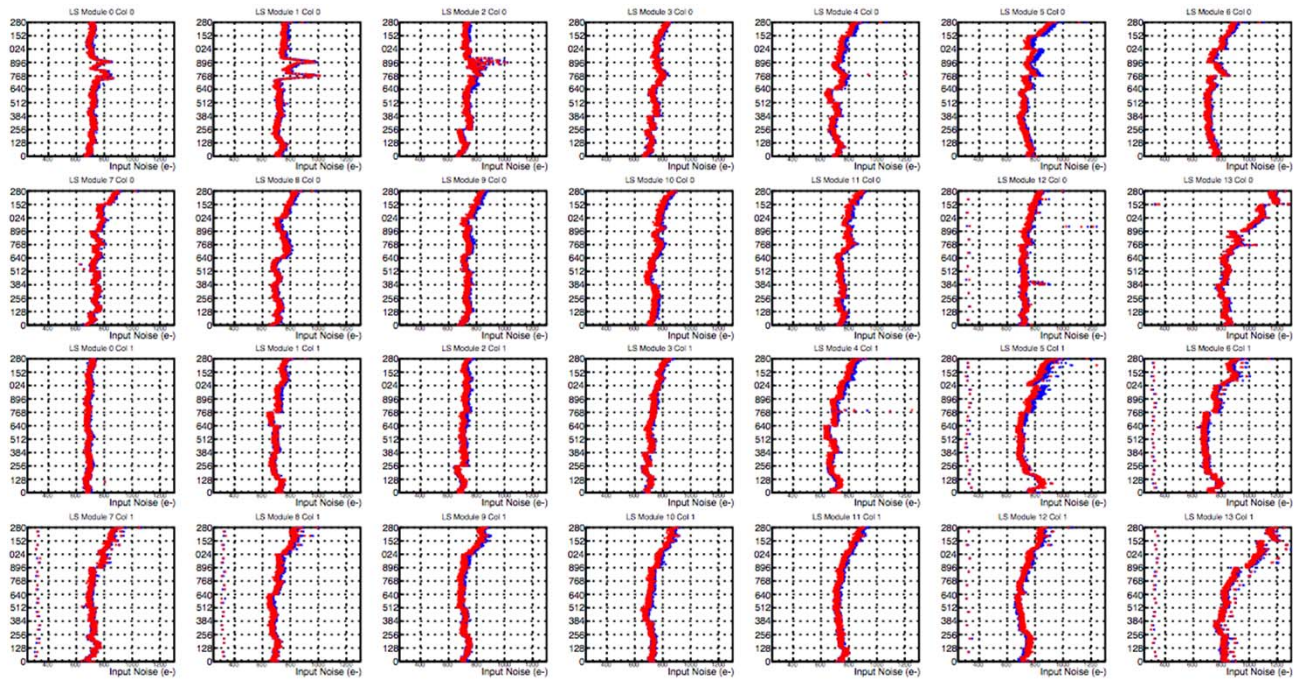
-400V, -500V MASTER



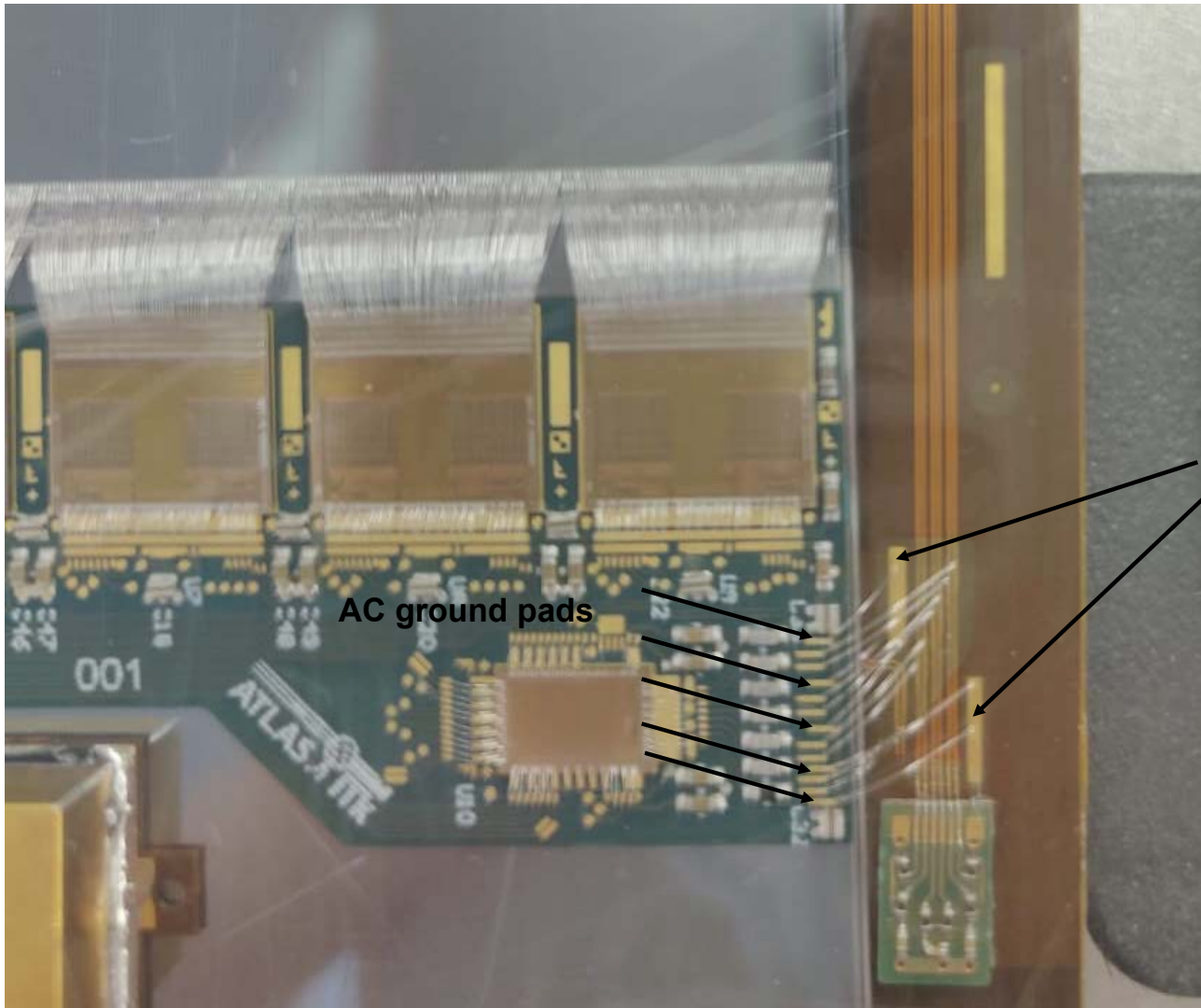
No difference

Running at -500V, @-40C

-400V, -500V SLAVE



No difference

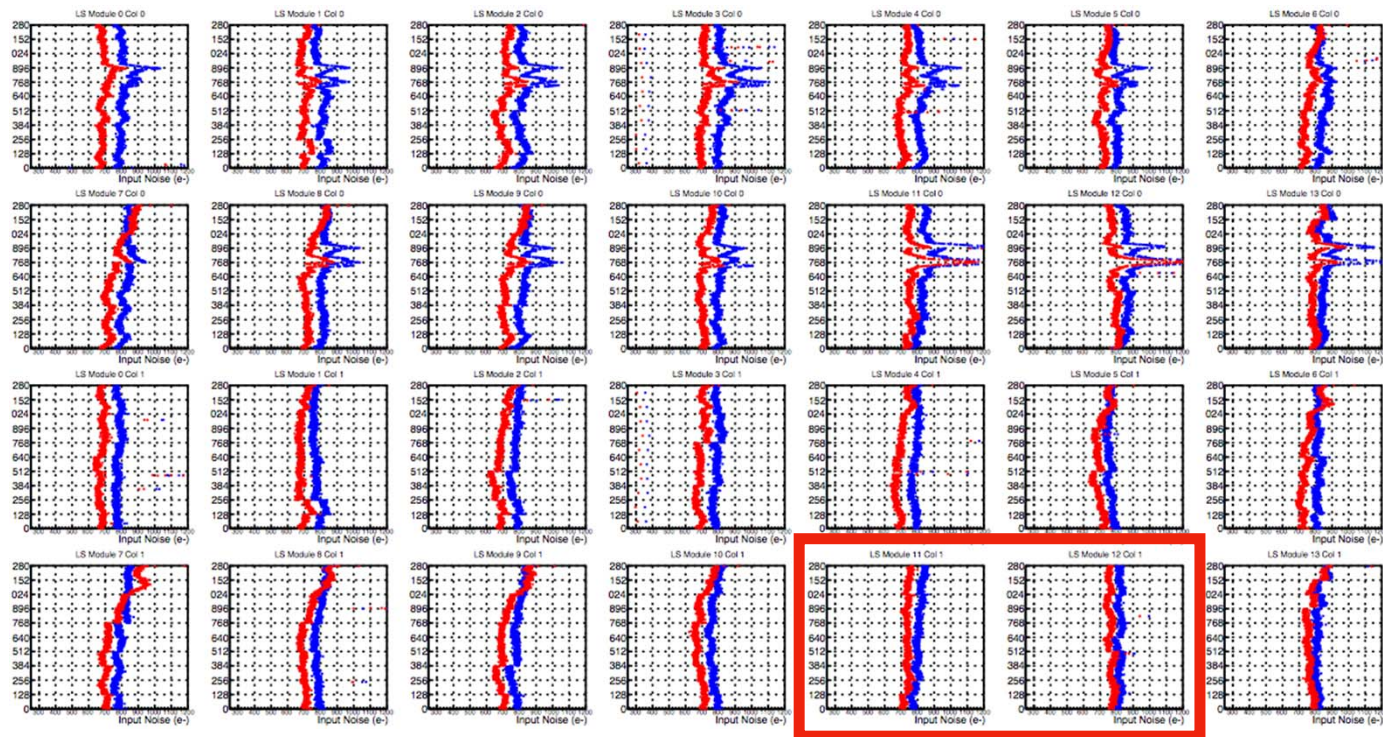


AC ground pads

AC ground  
(Fast Signal Ground)

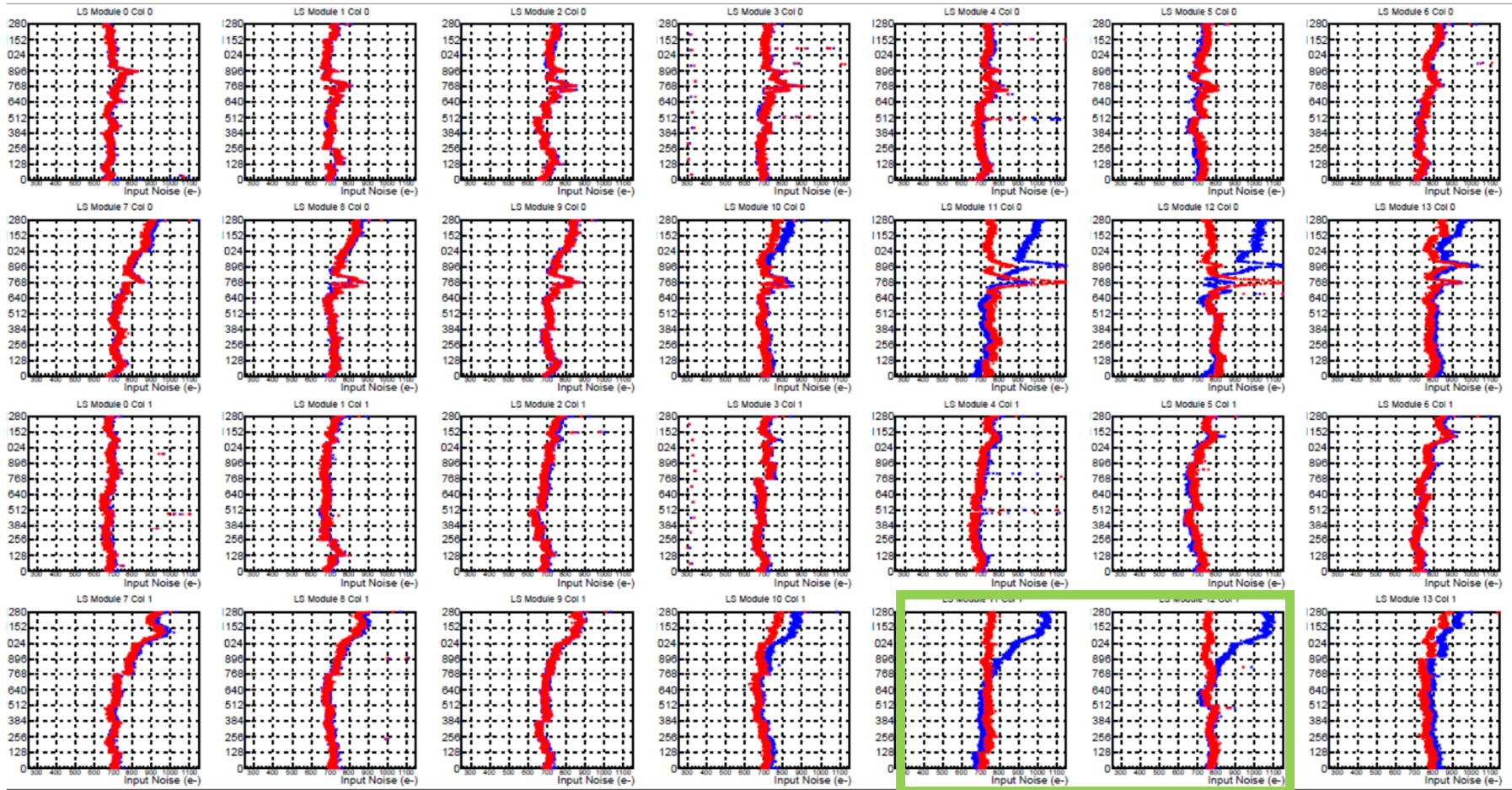
## Pulling AC ground off on modules 11 & 12 (master)

20C, -50C MASTER



to be compared with the one in slide 12

# Pulling AC ground off on modules 11 & 12 (master), -50C, Before and After



## Summary

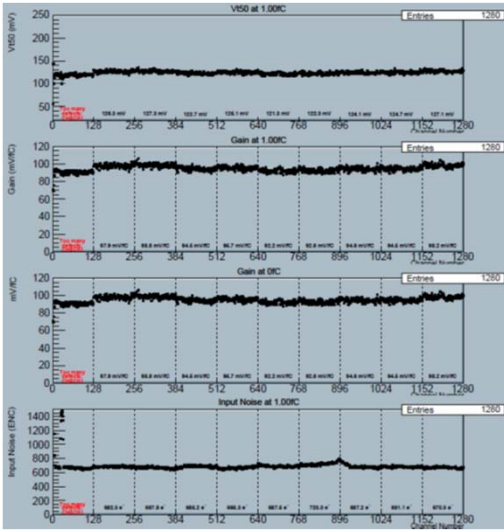
- |   |                                   |
|---|-----------------------------------|
| • Changes to grounding, shielding, and fluid flow direction | Inconclusive unless we go to -60C |
| • Going to 500V   | No effect                         |
| • Vsupply from 11V to 10V                                   | Improvement                       |
| • Removing hybrid AC bond wires                             | Improvement                       |

Ideas. Let's go to Peter's presentation

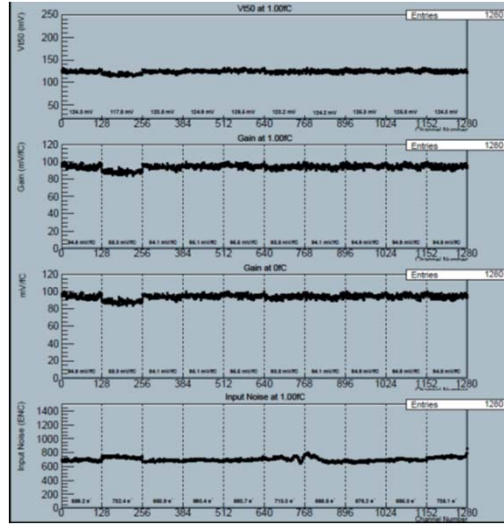
## Backup Slides



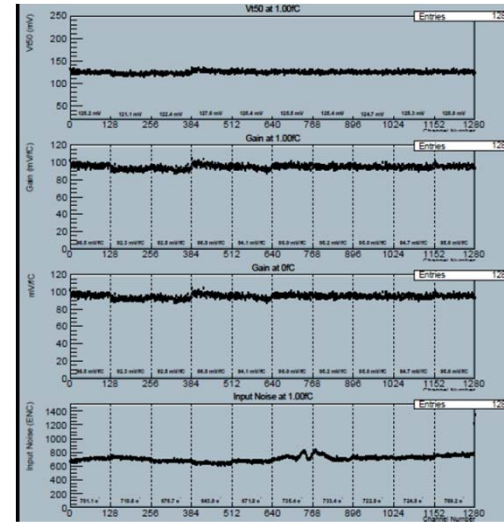
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1

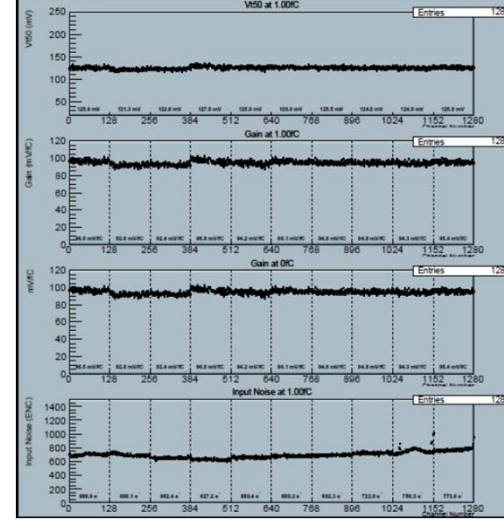
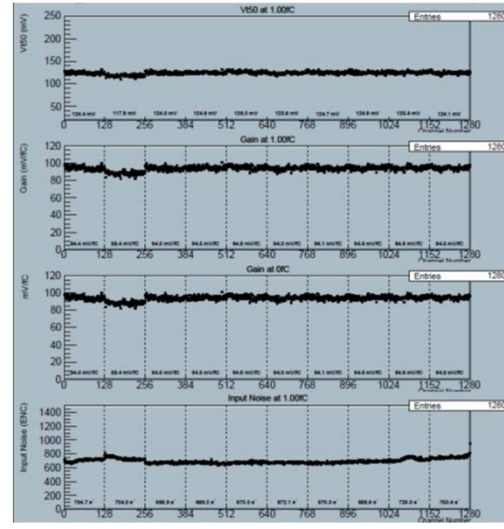
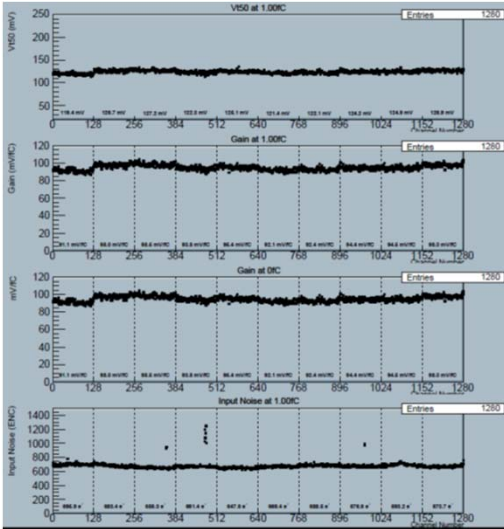


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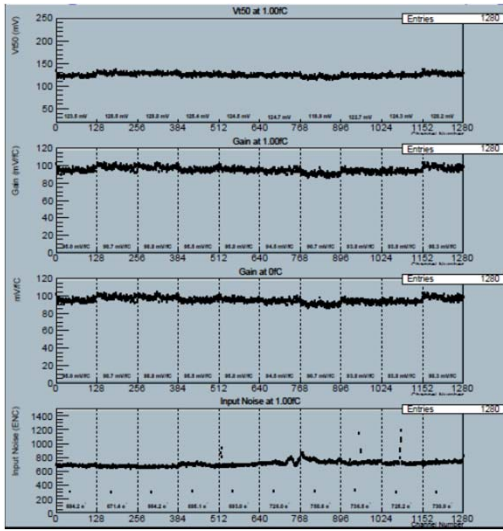
Master Side  
-40, Feb 14 2020

Strips with hybrid and powerboard

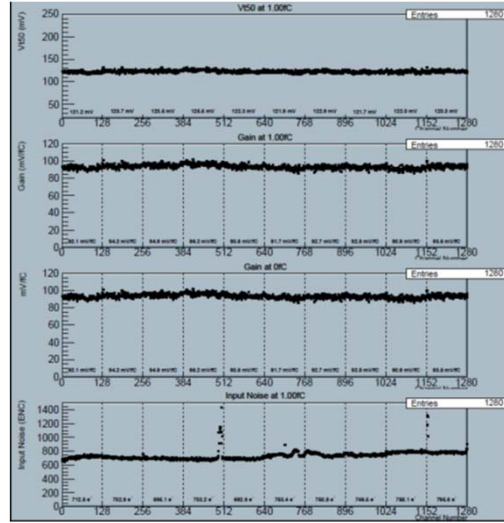


Bare strips

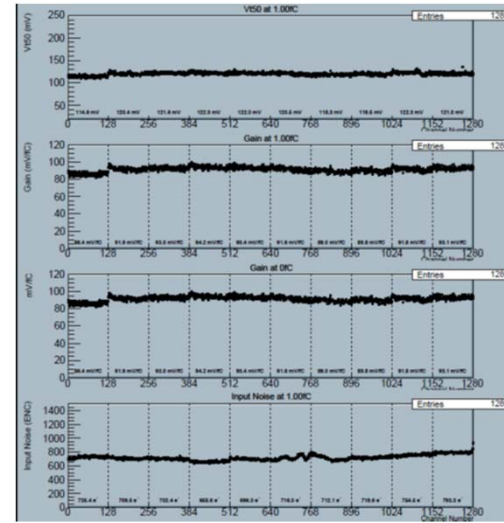
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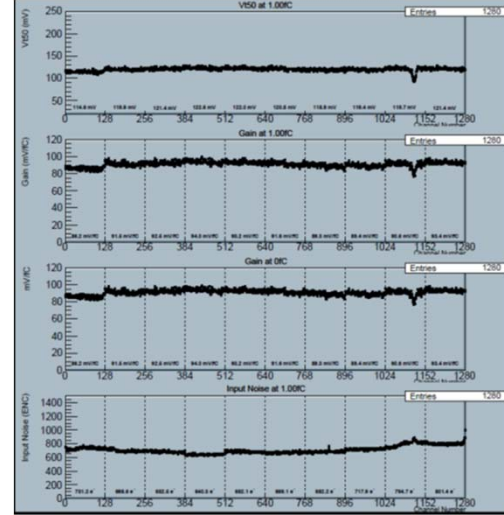
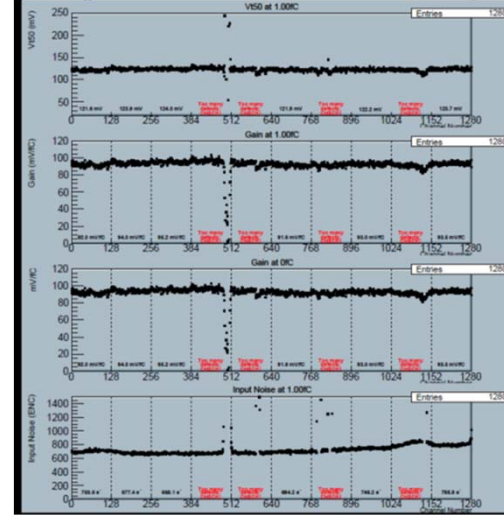
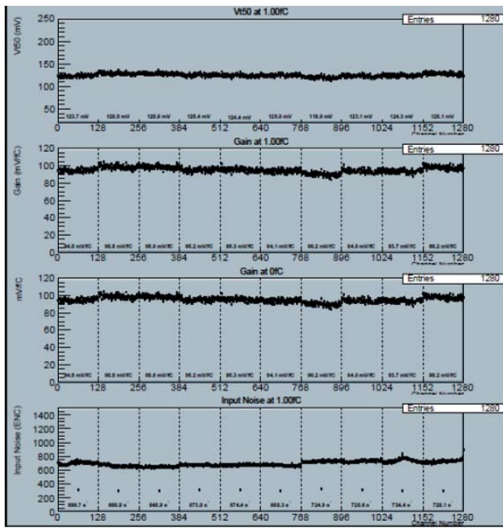
4



5

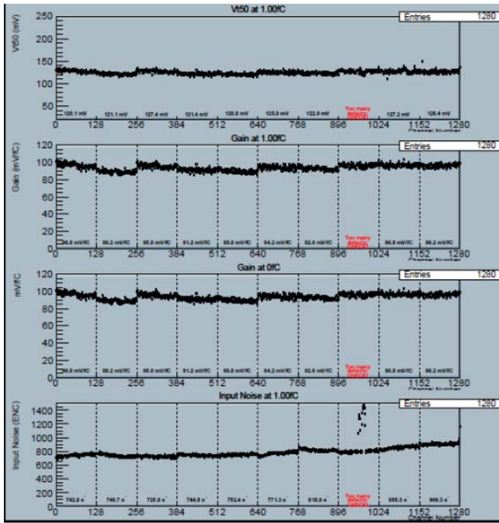


Strips with hybrid and powerboard

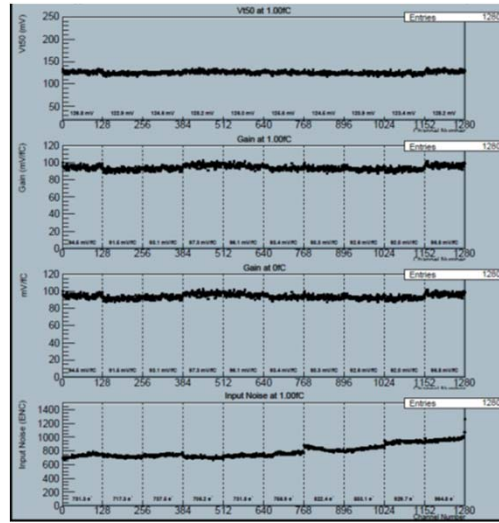


Bare strips

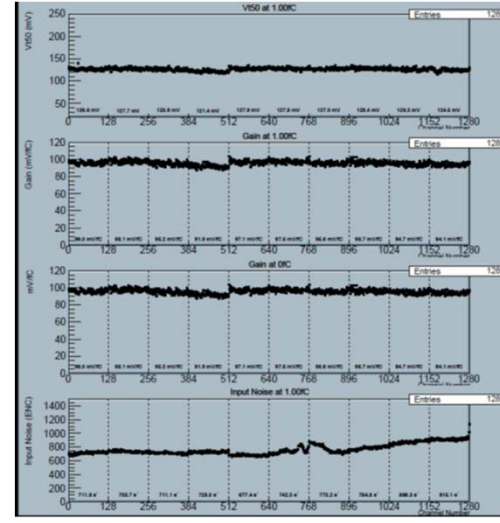
6



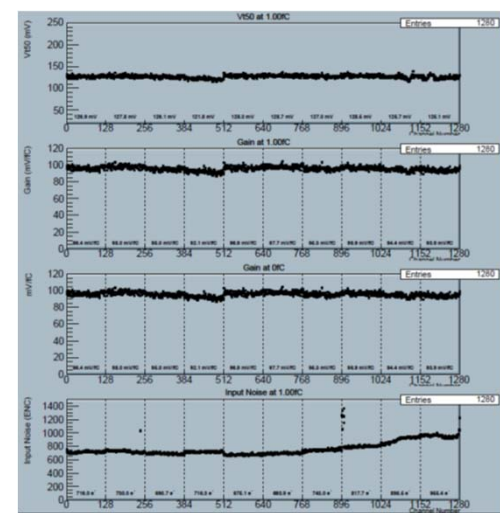
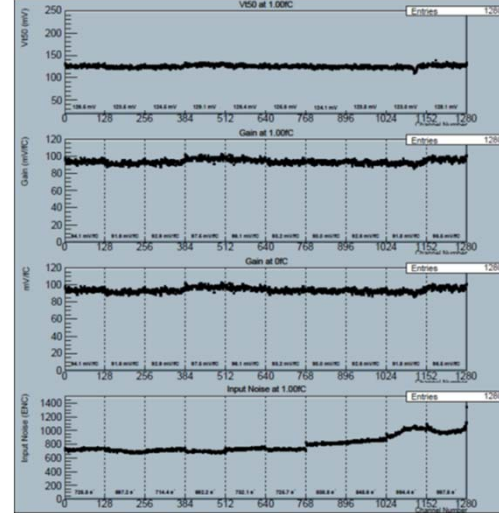
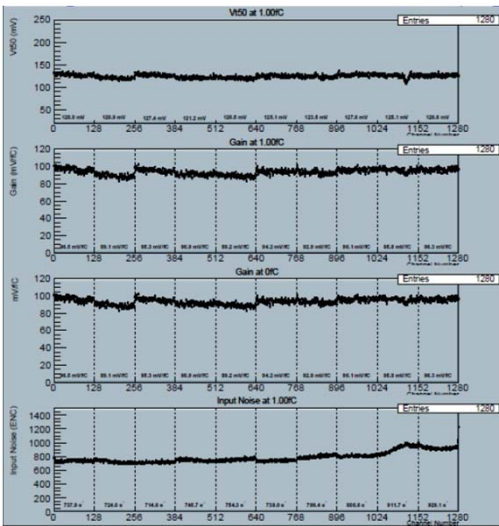
7



8

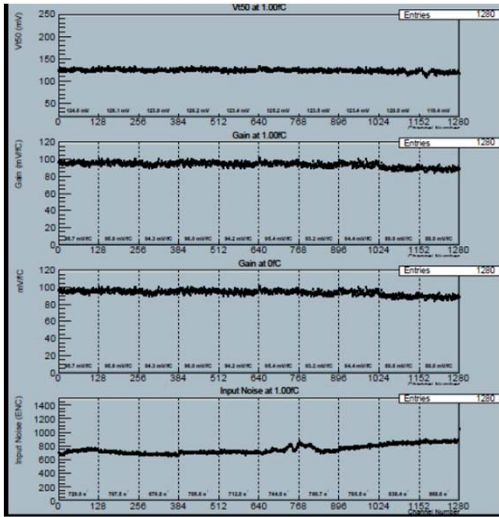


Strips with hybrid and powerboard

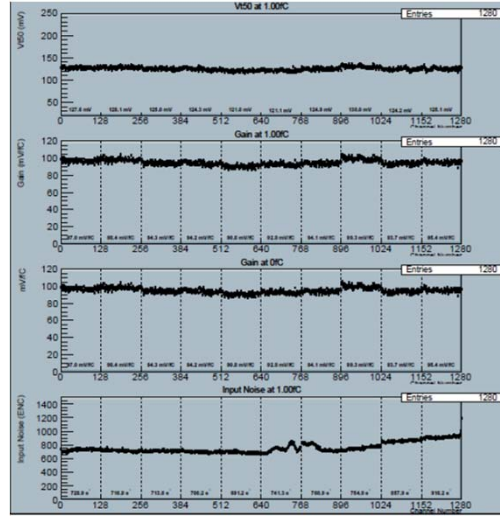


Bare strips

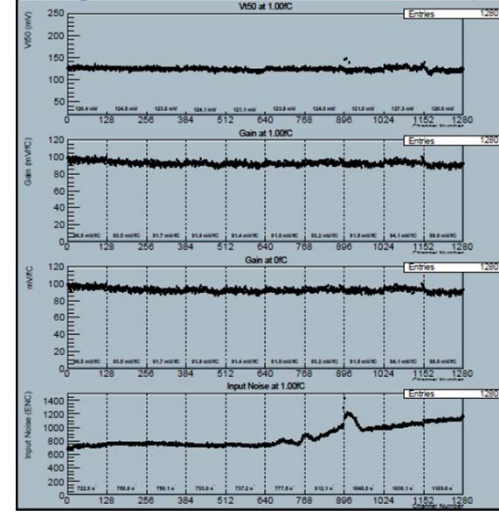
9



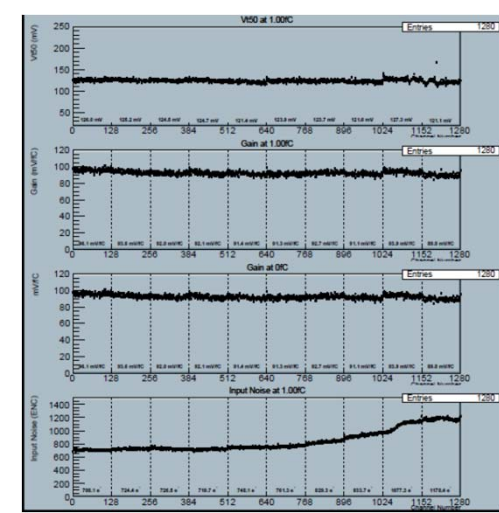
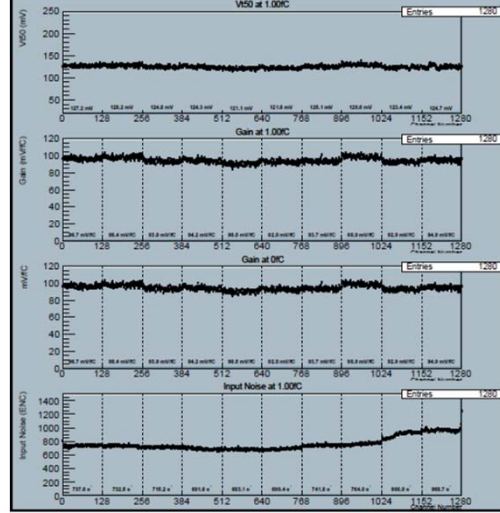
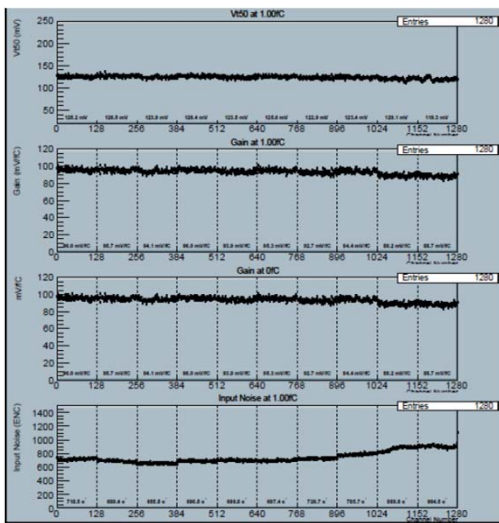
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11



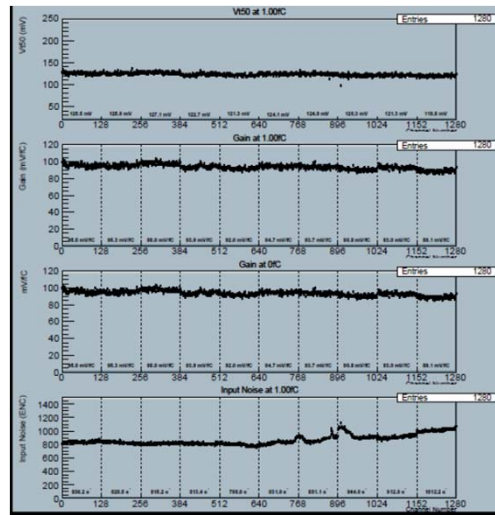
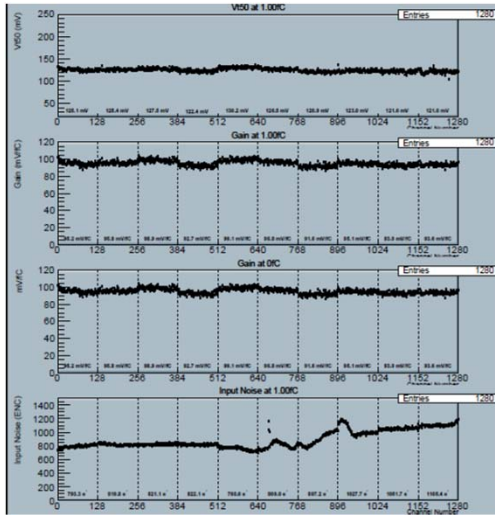
Strips with hybrid and powerboard



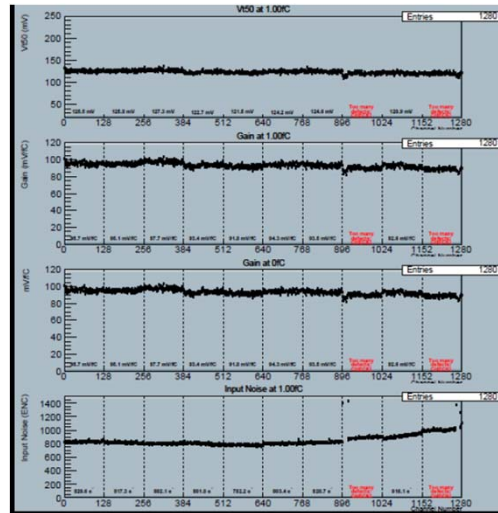
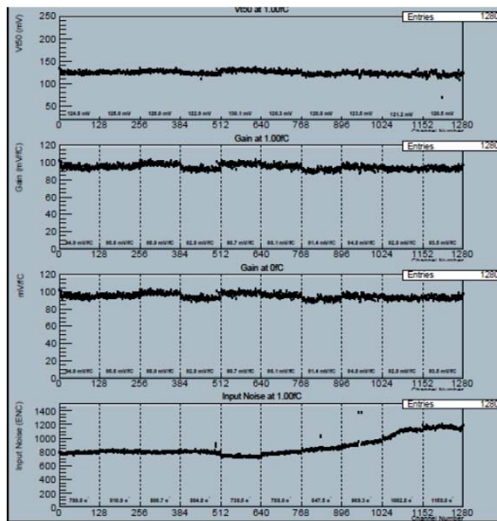
Bare strips

12

13



Strips with hybrid and powerboard



Bare strips

What changes when you go cold??

Components?

ASICs

ABCStar Gain

Lpgbtx ?

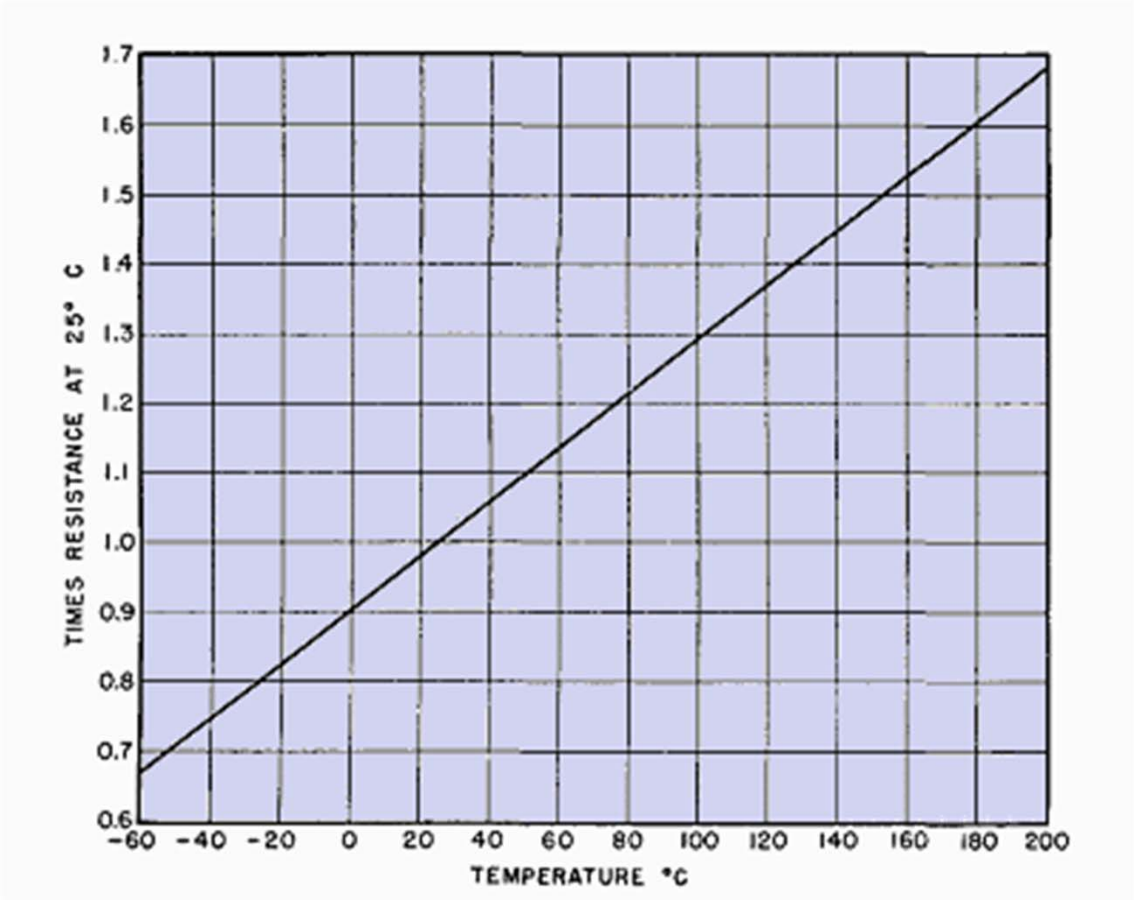
HCCStar ?

Decrease in copper resistance by 75% at -40C compared to 25C

Temperature asymmetry due to inlet/outlet temperature at module 13.

Chiller refrigerator is working harder

Increase in DC-DC efficiency



## Temperature Chart

Chiller Pres	air flow [Sl	Lenze								Inlet Hose	Stave	
10	10	20	<i>T setpoint</i>	<i>T chiller</i>	<i>T in</i>	<i>T out</i>	P in [psi]	Vout	Flow [cc/s]	$\Delta T$ [K]	$\Delta T$ [K]	Power [W]
		20	40	42.8	49.1	46.8	180	2.65	26.27	6.3	-2.3	-103.9
		20	30	29.6	36.9	36.2	165	2.5	24.78	7.3	-0.7	-29.8
		20	20	22.9	29.9	29	150	2.41	23.89	7	-0.9	-37.0
		20	10	18.5	23.9	22.8	150	2.32	23.00	5.4	-1.1	-43.5
		20	0	8.3	13.9	13.2	130	2.12	21.01	5.6	-0.7	-25.3
		20	-10	-1.3	5.4	5.3	120	2.02	20.02	6.7	-0.1	-3.4
		20	-20	-19.3	-6.6	-4.8	110	1.94	19.23	12.7	1.8	59.5
14		20	-30	-24.3	-14.6	-13	110	1.9	18.83	9.7	1.6	51.8
		20	-40	-40.3	-26	-22.3	110	1.84	18.24	14.3	3.7	116.1
		20	-50	-50.5	-35.5	-30.9	110	1.79	17.74	15	4.6	140.4
		20	-60	-60.9	-45.8	-40	120	1.76	17.44	15.1	5.8	174.0
14-16		22	-60	-60	-45.6	-40.8	140	1.84	18.24	14.4	4.8	150.6
		24	-60	-58.8	-45.6	-40.9	150	1.94	19.23	13.2	4.7	155.4
		26	-60	-58.6	-44.4	-40.4	180	2.03	20.12	14.2	4	138.4