Conventional Systems: Cooling, Power Supplies, Cables, and all some of that stuff

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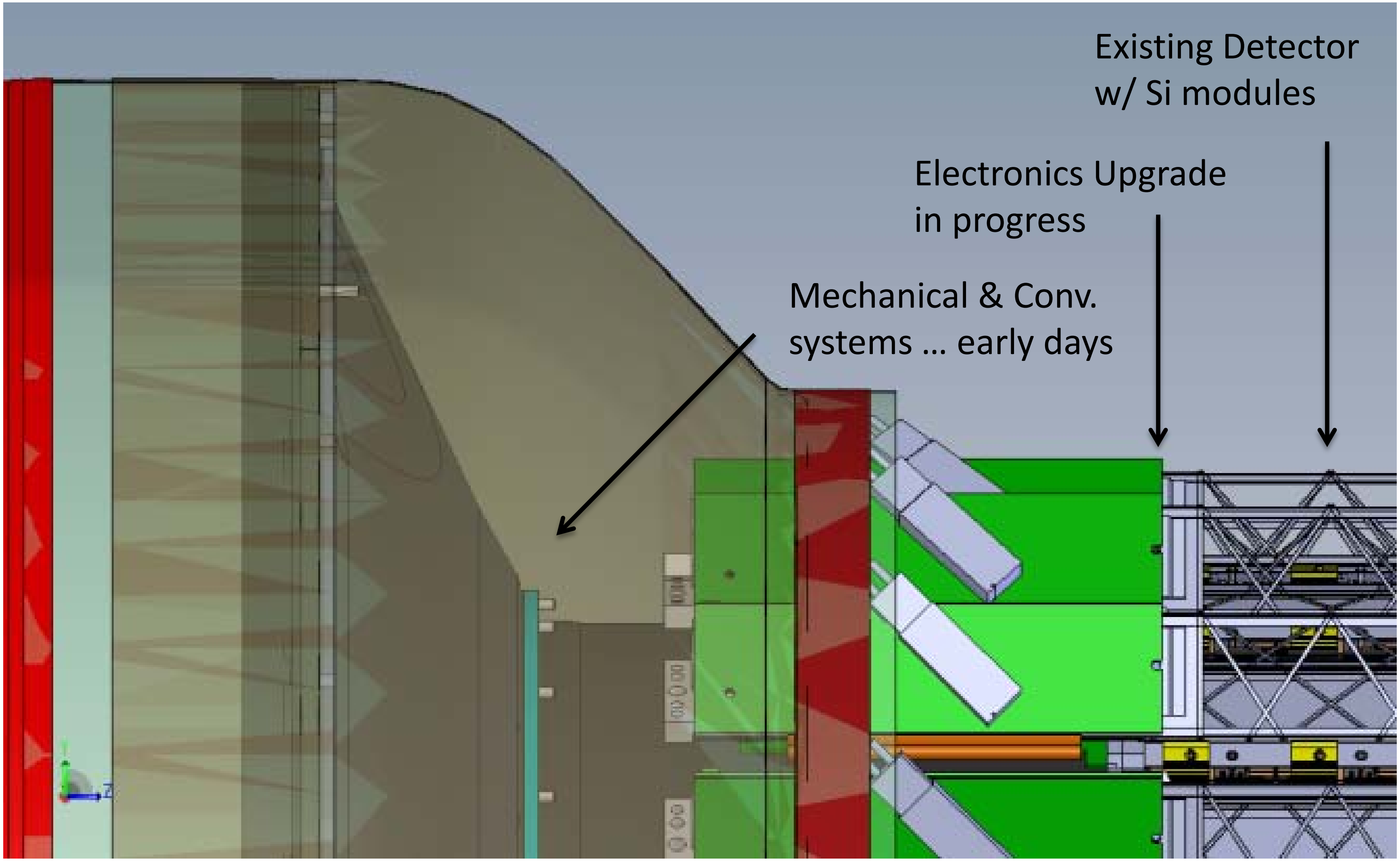
To Do: Final routing of cooling & cables



The SSD is air cooled – (2002 test results)

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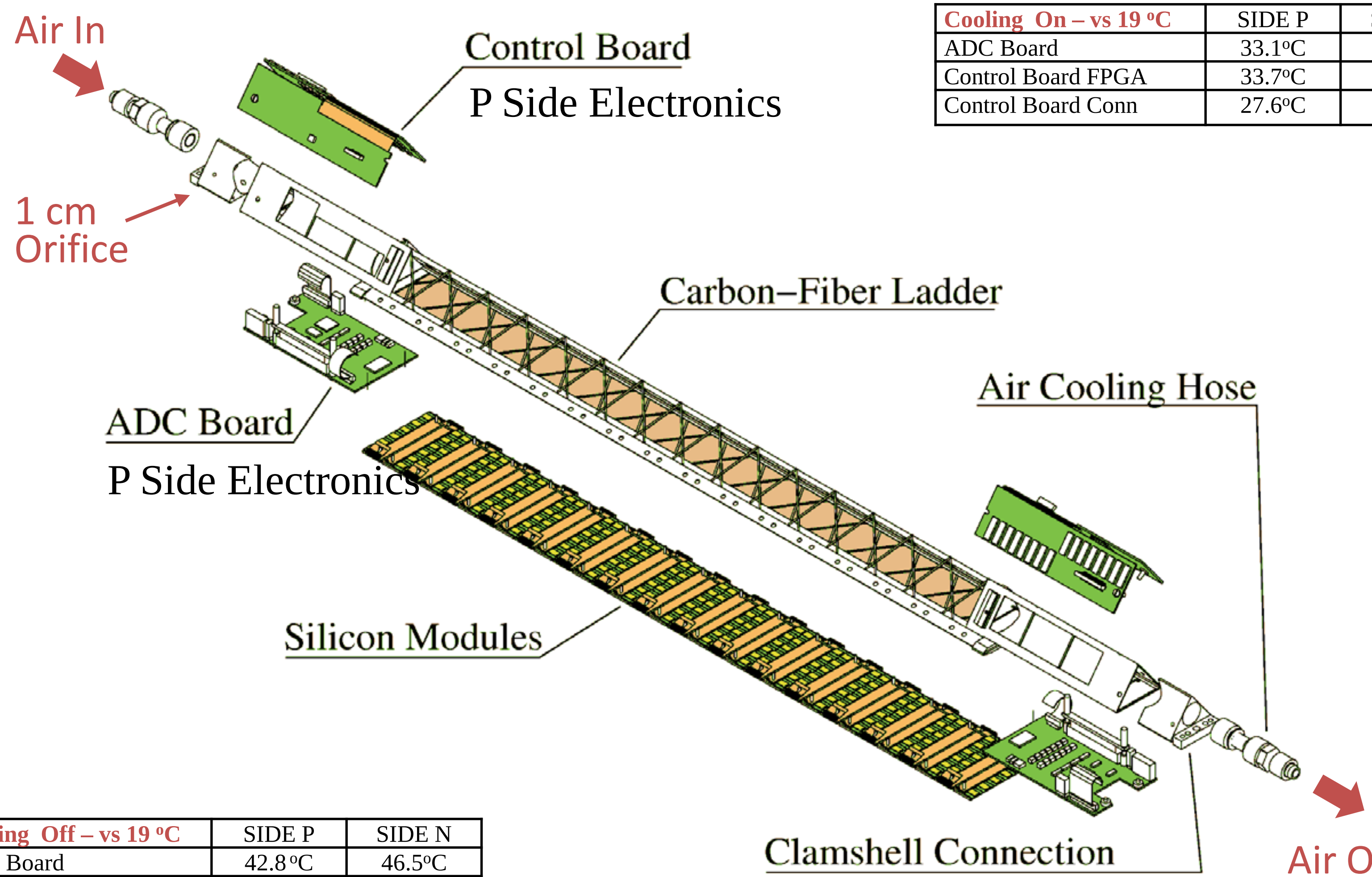
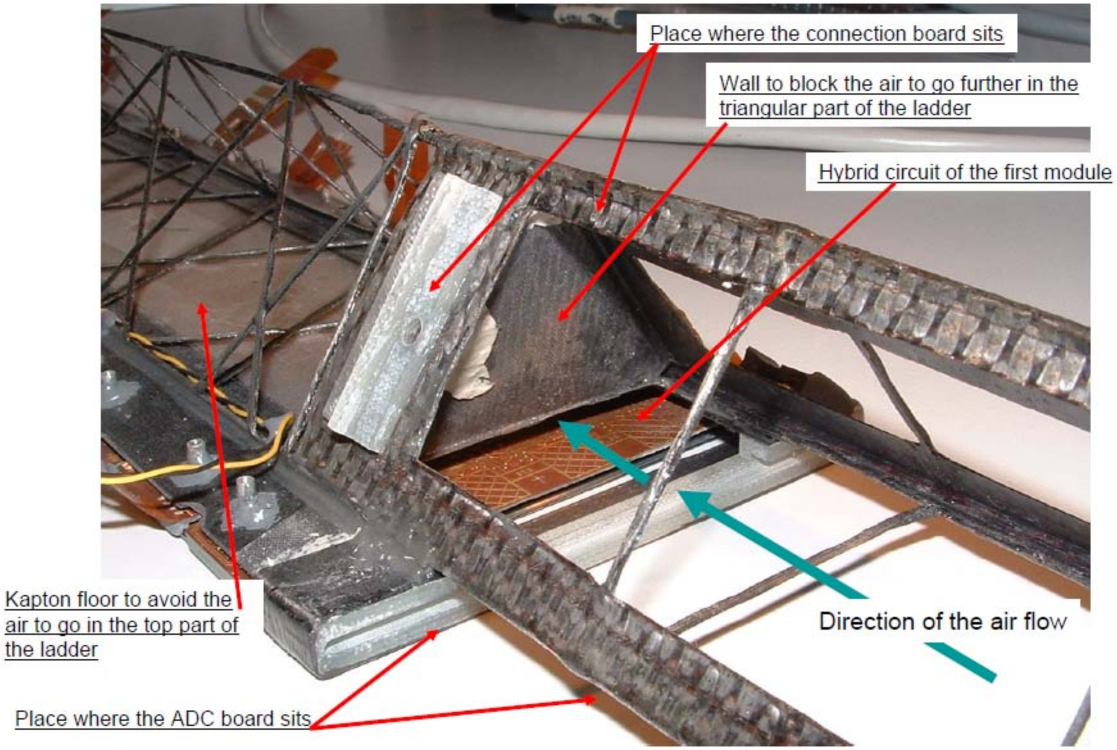
Cooling On – vs 19 ºC	SIDE P	SIDE N
ADC Board	33.1ºC	33.2ºC
Control Board FPGA	33.7ºC	30.7ºC
Control Board Conn	27.6ºC	24.5ºC



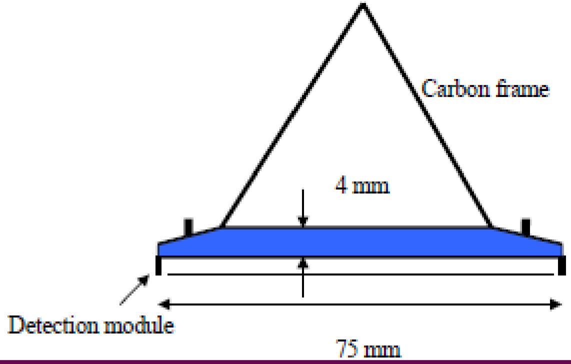
Cooling Off – vs 19 ºC	SIDE P	SIDE N
ADC Board	42.8 ºC	46.5ºC
Control Board FPGA	34.8ºC	36.5ºC
Control Board Conn	45.2ºC	45.4ºC

Air Path in an SSD Ladder

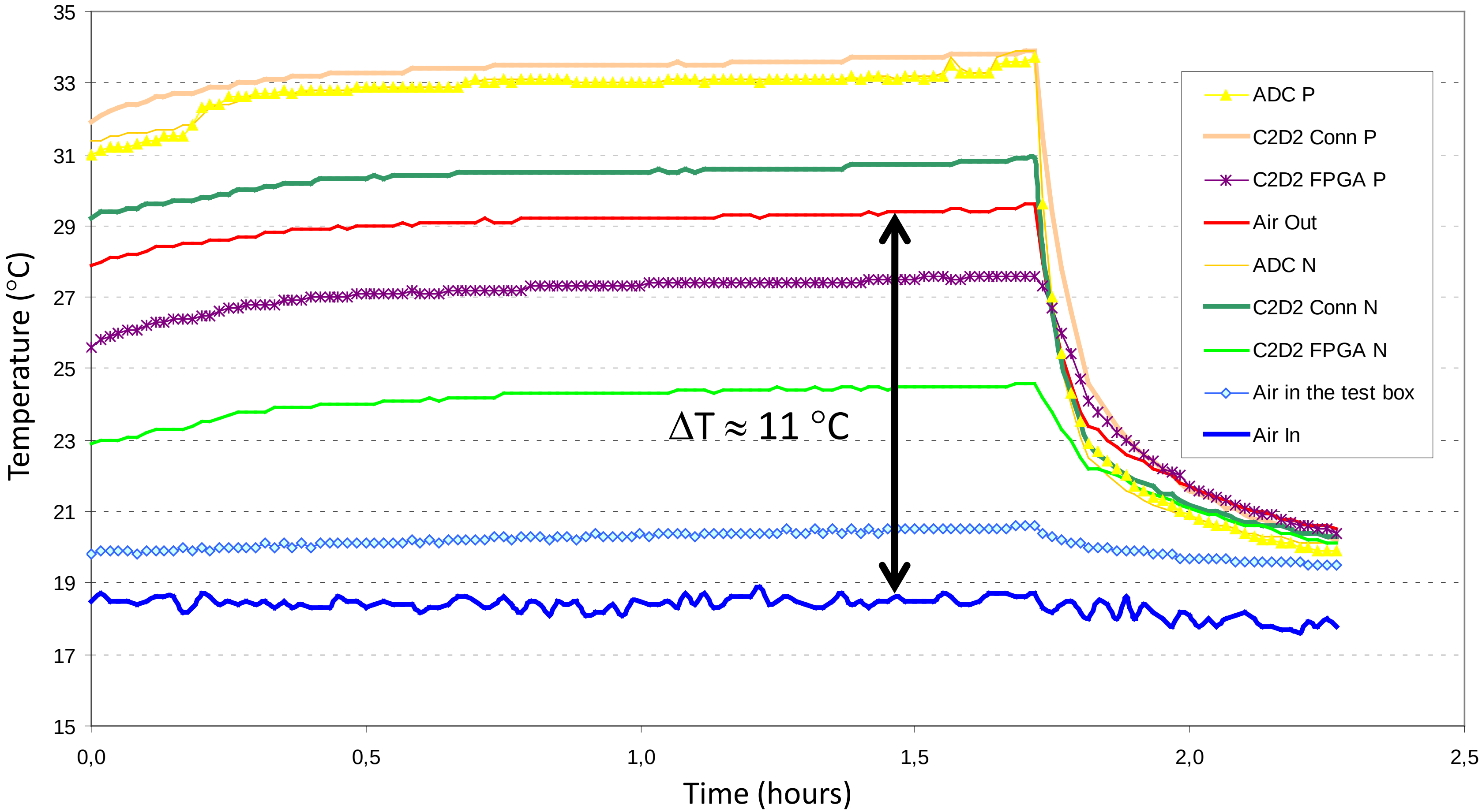


- Air enters the ladder board region through an ~ 1 cm orifice
- The entire ladder is wrapped in mylar to trap the air flow inside the triangular structure of the ladder
- The air flow is blocked by a 'wall' to force the air over the Si detectors

- Air at the midline of the detector travels through a tunnel, 75 mm x 4 mm (or ~ 3 cm^2)
- Length of this air tunnel is ~ 68 cm (not including ladder board sections on ends)
- An air flow of 1 liter/sec through the tunnel corresponds to an air speed of 3.3 m/sec



Performance of Cooling System on Ladder #0



Measurements confirm that the majority of heat from the ladder is transferred to the cooling air stream. The system is efficient.

New Electronics – New Expectations

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FEE POWER	Number of elements	Predicted Power	**Measured Power**
Detection Module w/ parallel readout	16 per 1adder	720 mW per module	
TOTAL FEE		**11.5 W**	

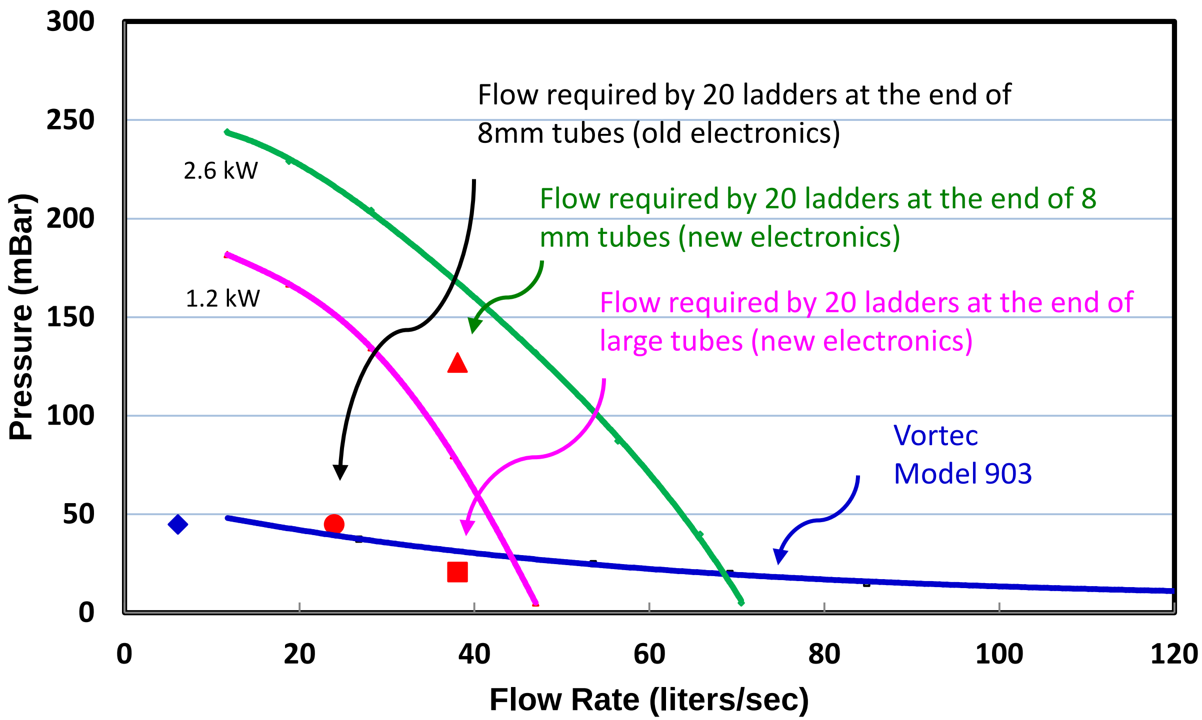
New Electronics Boards	Number of elements	Predicted Power	**Measured Power**
Ladder Boards	2 per Ladder	6.7 W per card	
Total Electronic Boards/Ladder		**13.4 W**	

Total Consumption: 25 Watts per Ladder
24 watts typical / 26 watts max

- 25 Joules into 1 liter of air suggests a ΔT of ~ 21 degrees °K at the old flow rate of 1 liter/sec (ambient air is 24° so total is 45°, which is in the danger zone).
  - Heat capacity of lab air is 0.0012 J / cm^3 / °K
- So to achieve the same ΔT as before, we need 1.6 liters/second of air flow with a velocity of 0.8 m/sec near the ladder boards and 5.4 m/sec over the Si detectors

We need more air than before, also careful about vibrations

Dust Collector Vacuum Sources



'Large tubes' means 4 long tubes with 2.5 cm (ID) each, then distributed locally to 20 ladders without additional pressure drop

- A wide variety of options are available. Shown above are the vacuum curves for a 1.2 kW and a 2.6 kW vacuum system from a company in California. (Old system was 76 kW)

The airflow can be increased ~2x by using a bigger pump and larger tubes

More Air … is available

- The wood products industry uses high volume vacuum sources to clear wood chips from around saws and lathes.
- Thus, there is a commercial line of vacuum sources that provide vacuum with more flow and pressure than we need.
- These vacuum sources can be purchased, off the shelf, and are designed for continuous operation. They run on 3 phase 240 VAC.
- We have tested the 1.2 kW model. Depending on losses, may need 2.6 kW model

http://www.dustcollectorsource.com

Power Requirements for the SSD

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	-2 V	+2 V	+5 V
typical	870 mA	2172 mA	909 mA
max	883 mA	2186 mA	1357 mA

Current for one ladder end (each Nicomat Connector) from “star_ssdU_v14” (C. Renard)

	Bias
typical	16*5 μA
max	16*10 μA

Bias current for one ladder (both ends, due to HV jumper)

SSD Cable Design Calculator (G. Visser)

INSUL_T= 0.014 inch — INSUL_T= 0.011 inch

LENGTH= 10 feet — LENGTH= 85 feet

Inner cable — Outer cable

Service	Vload	Iload	strand	nStrands	cond, in2	total, in2	R	IR	I2R	strand	nStrands	cond, in2	insul, in2	R	IR	I2R	Vsource
+2	2.5	2.2	28CCAW	7	0.000873	0.002955	0.144286	0.317429	0.698343	26CU	7	0.00139	0.003224	0.497857	1.095286	2.409629	5.325429
-2	2.2	0.9	28CCAW	7	0.000873	0.002955	0.144286	0.129857	0.116871	26CU	7	0.00139	0.003224	0.497857	0.448071	0.403264	3.355857
+5	5	1.4	28CCAW	7	0.000873	0.002955	0.144286	0.202	0.2828	26CU	7	0.00139	0.003224	0.497857	0.697	0.9758	6.798
BIAS	200	0	28CCAW	1	0.000125	0.001295	1.01	0	0	32CU	7	0.000352	0.001463	1.967143	0	0	200
+2 sense	2	0	28CCAW	1	0.000125	0.001295	1.01	0	0	32CU	7	0.000352	0.001463	1.967143	0	0	2
-2 sense	2	0	28CCAW	1	0.000125	0.001295	1.01	0	0	32CU	7	0.000352	0.001463	1.967143	0	0	2
+5 sense	5	0	28CCAW	1	0.000125	0.001295	1.01	0	0	32CU	7	0.000352	0.001463	1.967143	0	0	5
					DIA=	0.167588		POWER=	2.196029			DIA=	0.17621		POWER=	7.577386	

Bias Voltage settings for the SSD

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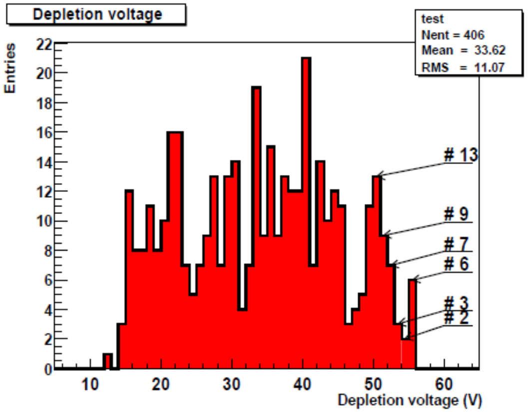
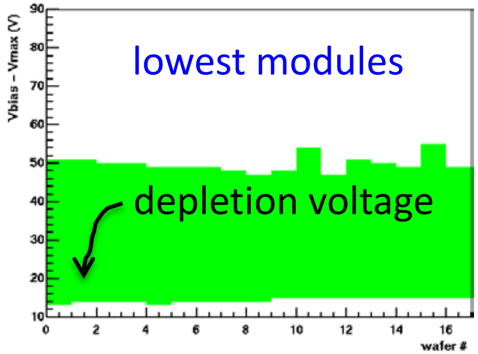
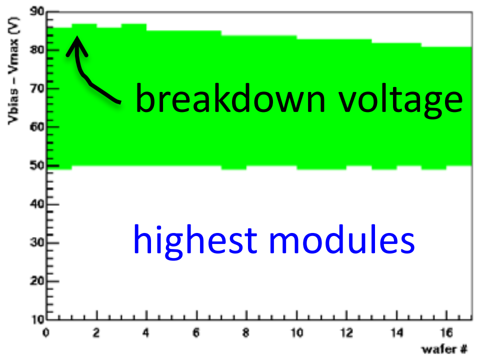


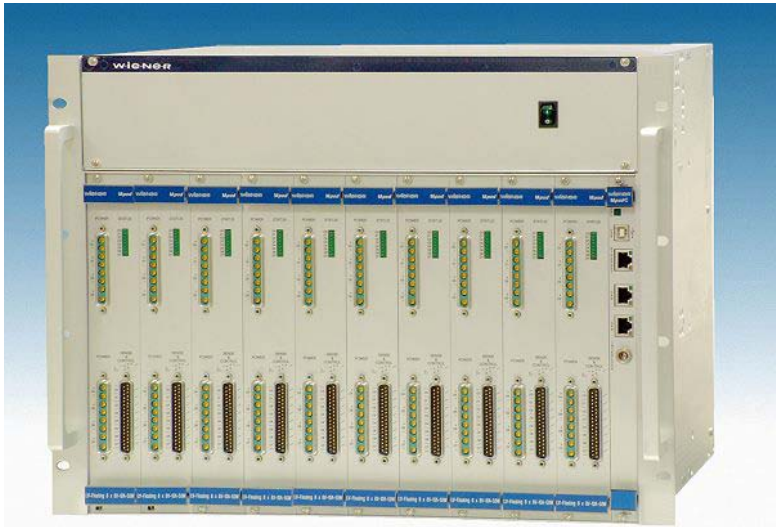




name	depletion voltage (V)	breakdown voltage (V)
star_015	19	49
star_026	26	61
star_093	20	57
star_050	22	60
star_096	22	56
star_097	21	**39**
star_103	14	48
star_106	14	46
star_111	18	52
star_115	**32**	61
star_132	26	58
star_237	25	56
star_280	15	47
star_107		
star_108		
star_046	22	60

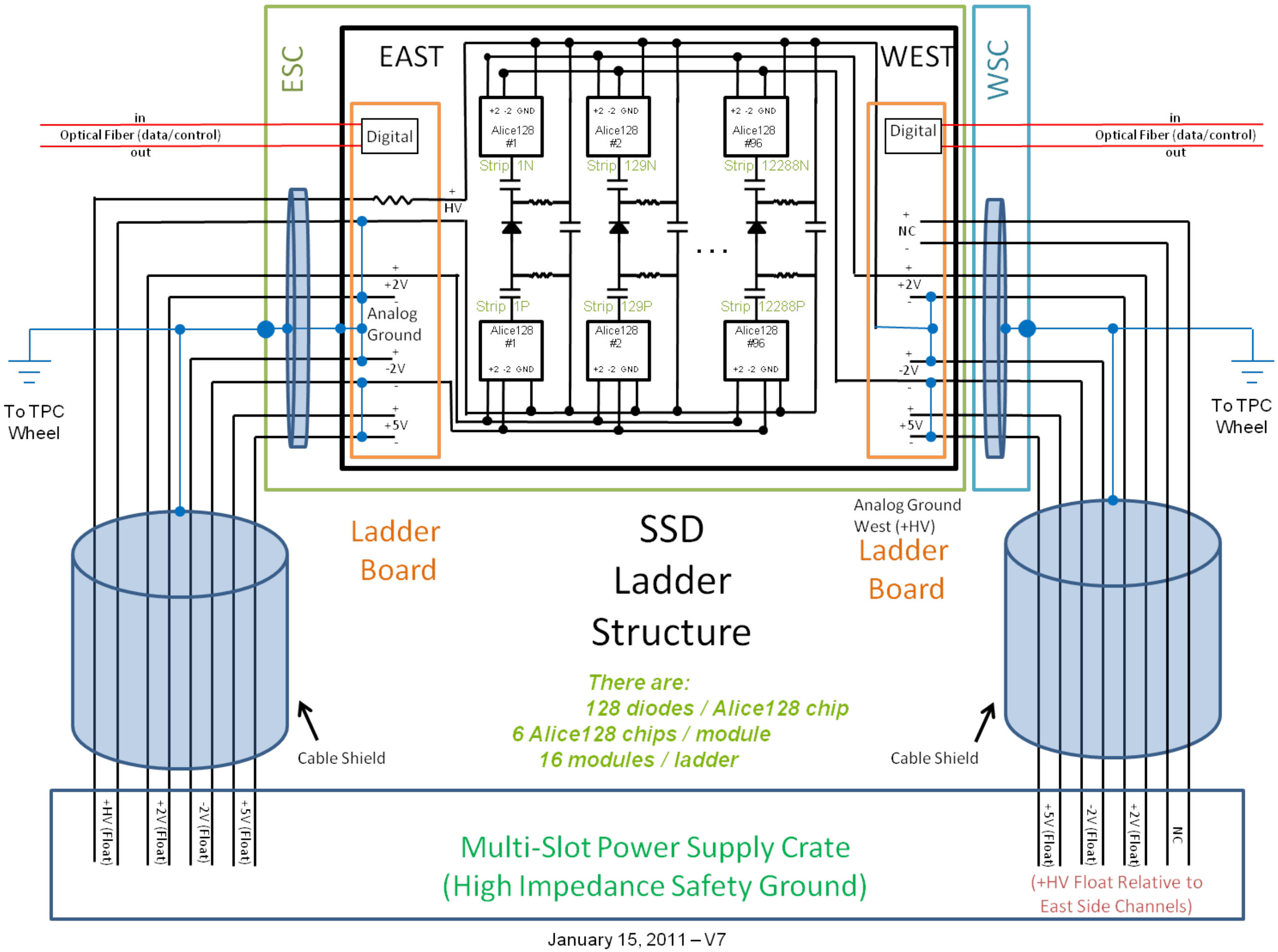
- The modules were sorted and grouped by operating point to form full ladders (16)
- The lowest depletion voltage (out of 406 modules) is 13 V
- The highest breakdown voltage is 86 V
- Thus need a Bias supply with a range from 0-100 V
- Low current, high stability

Power Supplies



- Upgrade from previous Caen supplies to achieve greater reliability and better interfaces
- Wiener selected for compatibility with FGT, IST, and MTD
- We will use rear facing MPOD crates with facilities for vertical cooling and fans (8U+1U)
- Choices for LV supplies are
  - MPV8008LI 0-8V 5 amp *
  - MPV8016 0-16V 5 amp
- Choice for Bias supply is
  - Wiener/ISEG EHS F2 01-F High Precision HV Module 16 channel, w/floating ground

Grounding Plan



- Digital signals over optic fiber
- Si Modules biased to ~50 V
- Single point ground on East
- Analog data read from both sides of pn junction.

  p ⇒ E, n ⇒ W
- Analog on one end held at HV bias potential
- Power supplies for +2, -2 and +5 are floating PS

Connectors

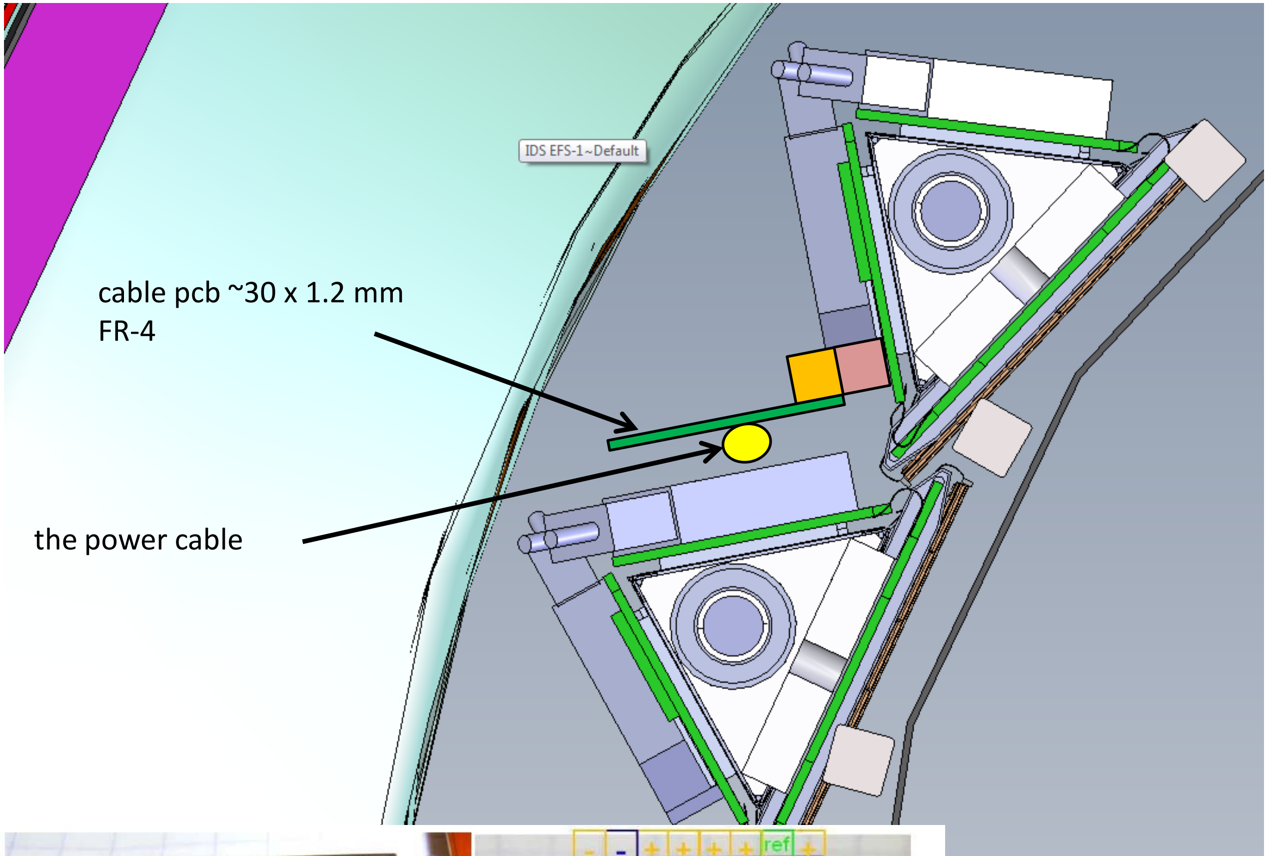
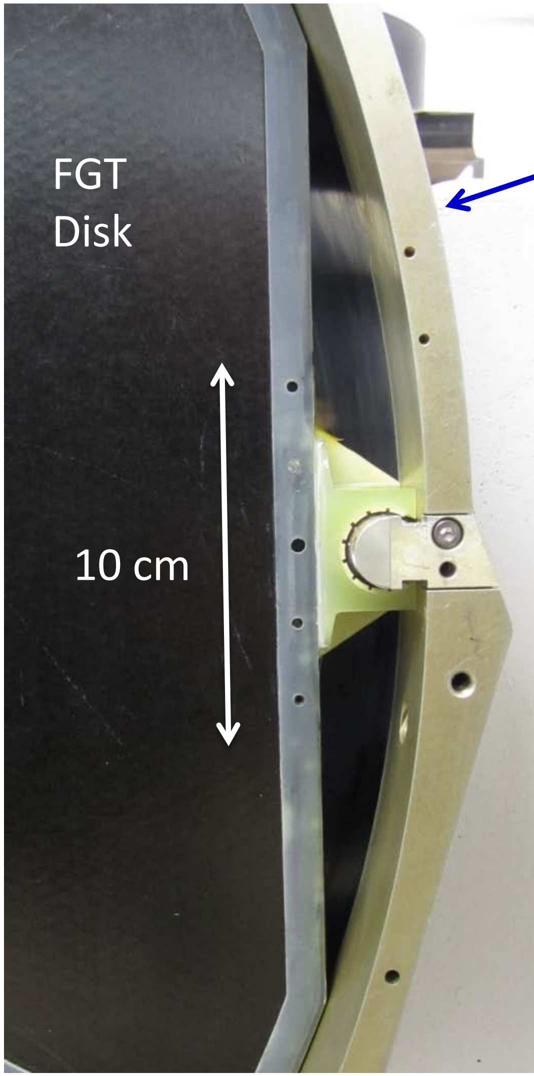


Figure 17: *Nicomatic power connector cabling*

Nicomat Connectors and auxiliary card
Note that Bias supplied to one ladder end, only, due to jumper across ladder

Cable Trays



- Cable tray needed above and below the FGT rail to hold 5 cables and 5 fiber pairs (5 ladders per tray, 10 ladders left, 10 ladders right, 20 total)
- Cable tray mounted to WSC
- Can only be installed after the FGT has been removed from STAR … part of summer 13 installation activities
- Not designed yet

SSD Cable pathways on the platform

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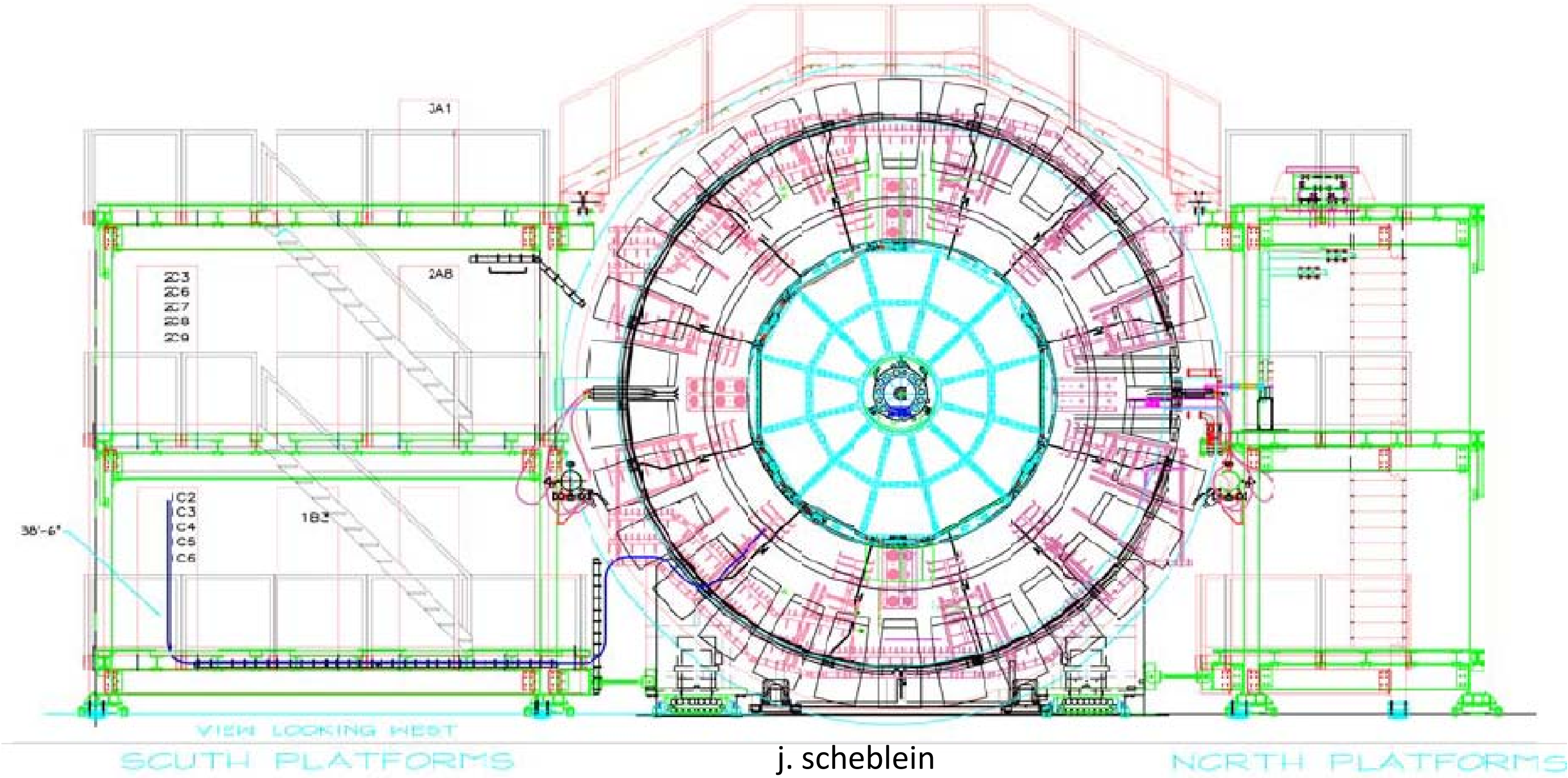

j. scheblein

- Cable path from Rack 1C6 to PXL patch panel is 70 feet via shortest route
- This summer, we must verify that there is space in these racks (and reserve!)
- Next most desirable path is longer … on the order of 100 feet

The Shroud

To Do:

Split the shroud so it is easier to install the SSD ladders

Air in and out for SSD vacuum

Ladder mounts

Cable and air hose routing under the shroud

SSD Upcoming Reviews

WBS	New Task Name	New Date	Old Date
1.4.2.1.1.2	L2 CP - SSD Prototype Ladder Board Design Finished	10/15/2010	10/15/2010
1.4.2.2.1.3	L2 CP - SSD QRDO Board design finished	7/19/2011	7/25/2011
1.4.2.2.1.7	L3 CP - QRDO Complete	8/23/2011	5/9/2011
1.4.2.1.1.9	L3 CP - Ladder Board Prototype Phase I Complete	10/31/2011	7/6/2011
1.4.4.1.1.2	L3 CP - PCB for Ladder Board Cable Ready for Fabrication	11/2/2011	9/2/2011
1.4.2.3.2.2	L3 CP - Production DAQ Design Review Completed	11/28/2011	11/28/2011
1.4.2.2.1.15	L3 CP - SSD RDO Design Finished	1/27/2012	
1.4.1.2	L3 CP - Mechanical Design of SSD components on OSC complete - HFT design Review to sign off	6/1/2012	6/1/2012
1.4.4.2.9	L3 CP - Power Supply Design Review Complete	6/29/2012	2/8/2012
1.4.2.2.2.4	L2 CP - SSD Preproduction Design Review of RDO	7/13/2012	5/30/2012
1.4.2.1.2.10	L3 CP - Preproduction Ladder Board PCB Received	8/10/2012	8/31/2012
1.4.2.1.3.2	L3 CP - Production Ladder Board Internal Review Completed	10/8/2012	10/29/2012
1.4.2.1.3.4	L2 CP - SSD Production of Ladder Boards Ready to Begin	11/6/2012	11/29/2012
1.4.2.1.3.7	L3 CP - Production Ladder Board PCB Received	1/22/2013	2/12/2013
1.4.4.4.2.12	L3 CP - Slow controls ready for testing	1/30/2013	4/18/2012
1.4.2.2.3.7	L3 CP - Production RDO Board Received	3/22/2013	2/6/2013
1.4.1.7	L3 CP - Mechanical Components on OSC Installed	4/1/2013	4/1/2013
1.4.2.5	L3 CP - Electronics Complete	6/14/2013	7/22/2013
1.4.3.1.5	L3 CP - Survey Complete	7/9/2013	5/30/2013
1.4.4.3.15	L3 CP - Installation of cooling on STAR platform and Magnet Endcap complete	8/16/2013	7/31/2013
1.4.3.2.7	L2 CP - SSD Assembled on OSC Ready for Installation	8/28/2013	7/1/2013

Complete
Future
Late

Also a safety review, soon, with Yousef Makdisi et al.

Summary

- Excellent progress on many conventional systems
- Nothing particularly unusual or complex
- Much work remains to be done