

WIEC Thermal Test

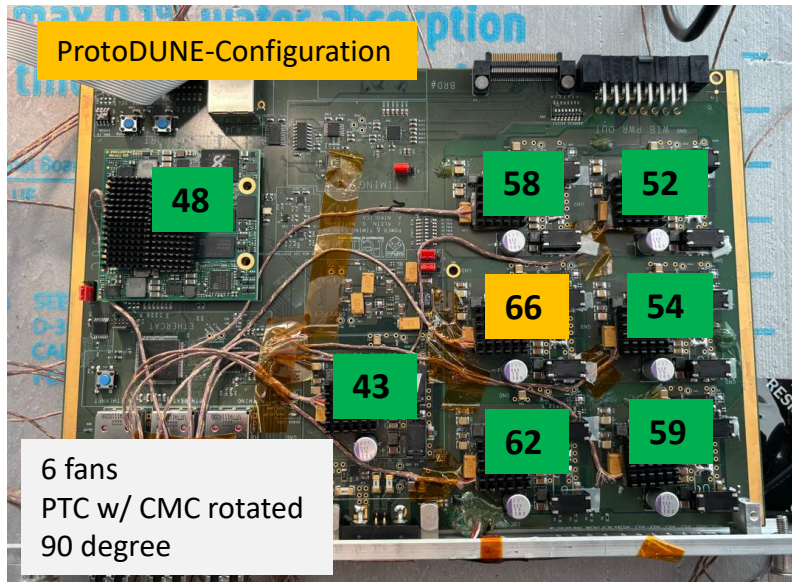
in controlled ambient

Shanshan Gao and Manhong Zhao on behalf of the BNL CE team

Conclusion from previous study

- Manhong's talk in February
 - <https://indico.fnal.gov/event/63336/>

Ambient Temperature 30.6C, 22.5V for 6 fans



Temperatures on WIB: ZYNQ 55C, DC-DC 53C
WIEC power: 47.6V, 8.572A

Recommended WIEC changes for thermal performance

- 6 Fans
- Open up slot for PTC
- Baffle plate in air mixing box



Recommended PTC changes

- Heat sinks on DC-DCs and FPGA
- CMCs with 90-degree rotation
- Air guide is not needed

PTC and thermocouple mapping

Thermal couples are attached to a new DUNE PTC, on the most heat dissipating components.



Thermocouple no.	Device under measurement
1	DC/DC for WIB3
2	DC/DC for WIB2
3	DC/DC for WIB1
4	DC/DC for WIB4
5	DC/DC for WIB5
6	DC/DC for WIB6
7	DC/DC for PTC itself
8	PTC FPGA

WIEC configuration:

worst case of power consumption

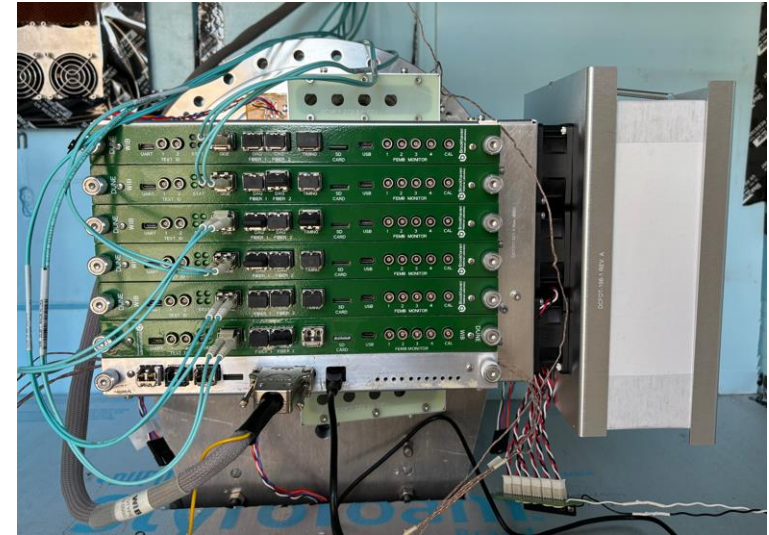
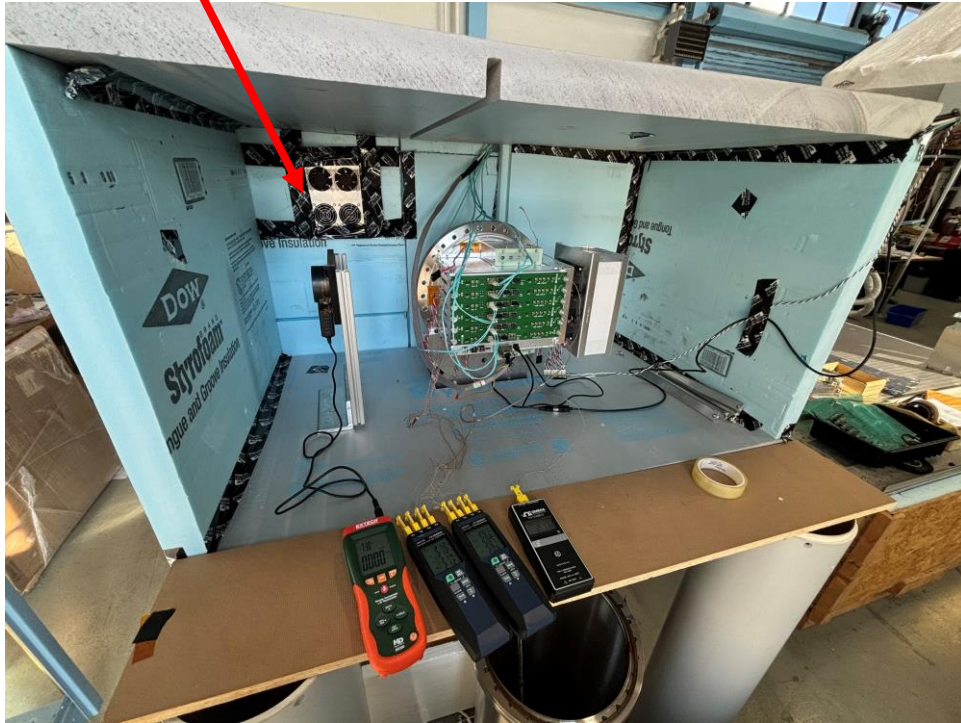
(24 FEMBs, 4.0V for FEMBs, LArASIC SEDC enabled), PL506 current readout: **9.xxxA**

typical (ProtoDUNE) configuration of power consumption

(24 FEMBs, 4.0V for FEMBs, LArASIC SEDC disabled), PL506 current readout: **8.xxxA**

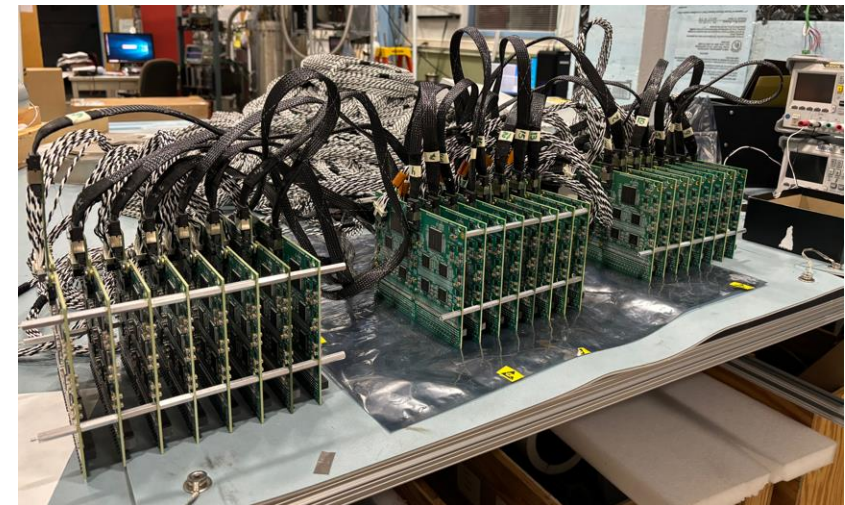
Setup of WIEC thermal test

Exhaust



Latest version of WIEC crate

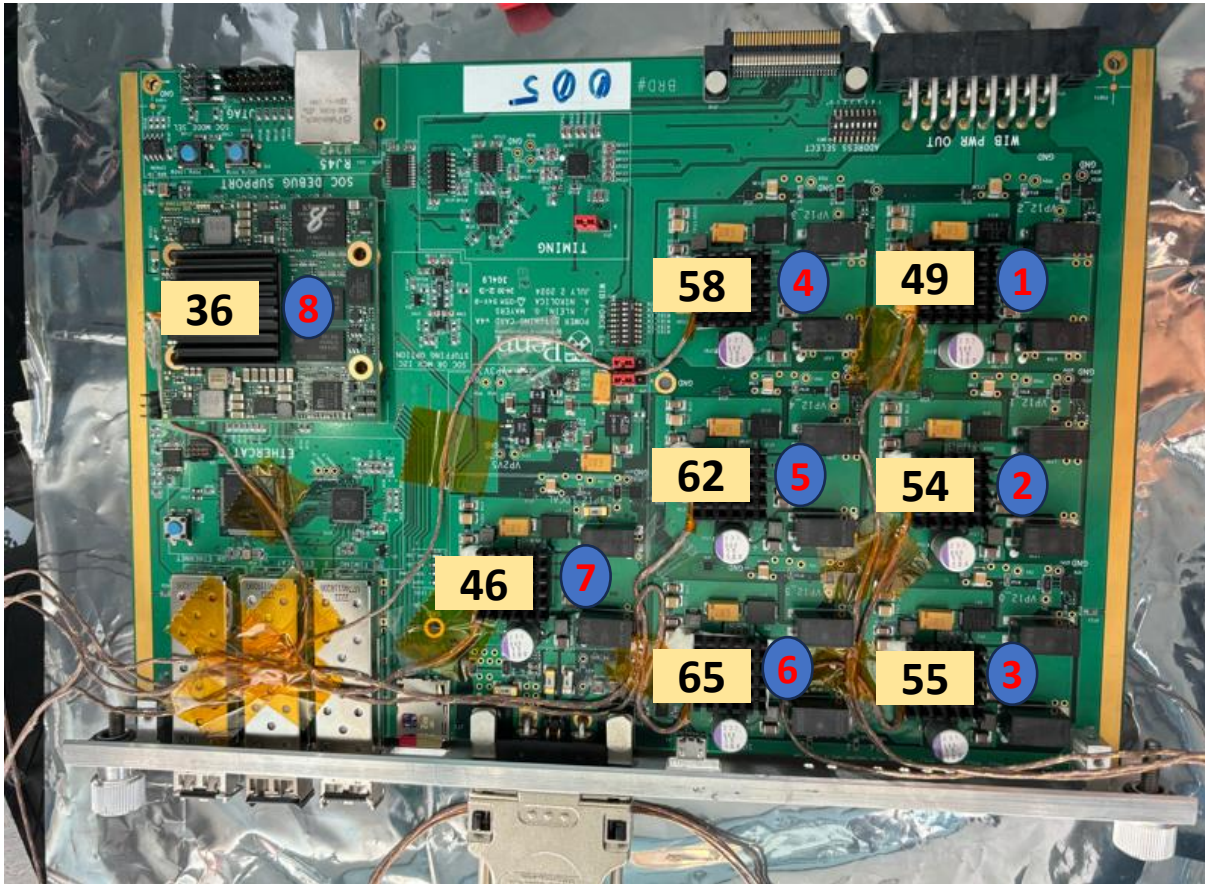
- The WIEC is enclosed in a foam chamber
 - Carry out a test in an environment like what we will have at SURF, where the temperature underground will be up to 85 deg F or 30 deg C.



24 DUNE FEMBs as load

Worst case of power consumption

WIEC: 6 fans powered with 18V



Ambient temperature: 30 °C

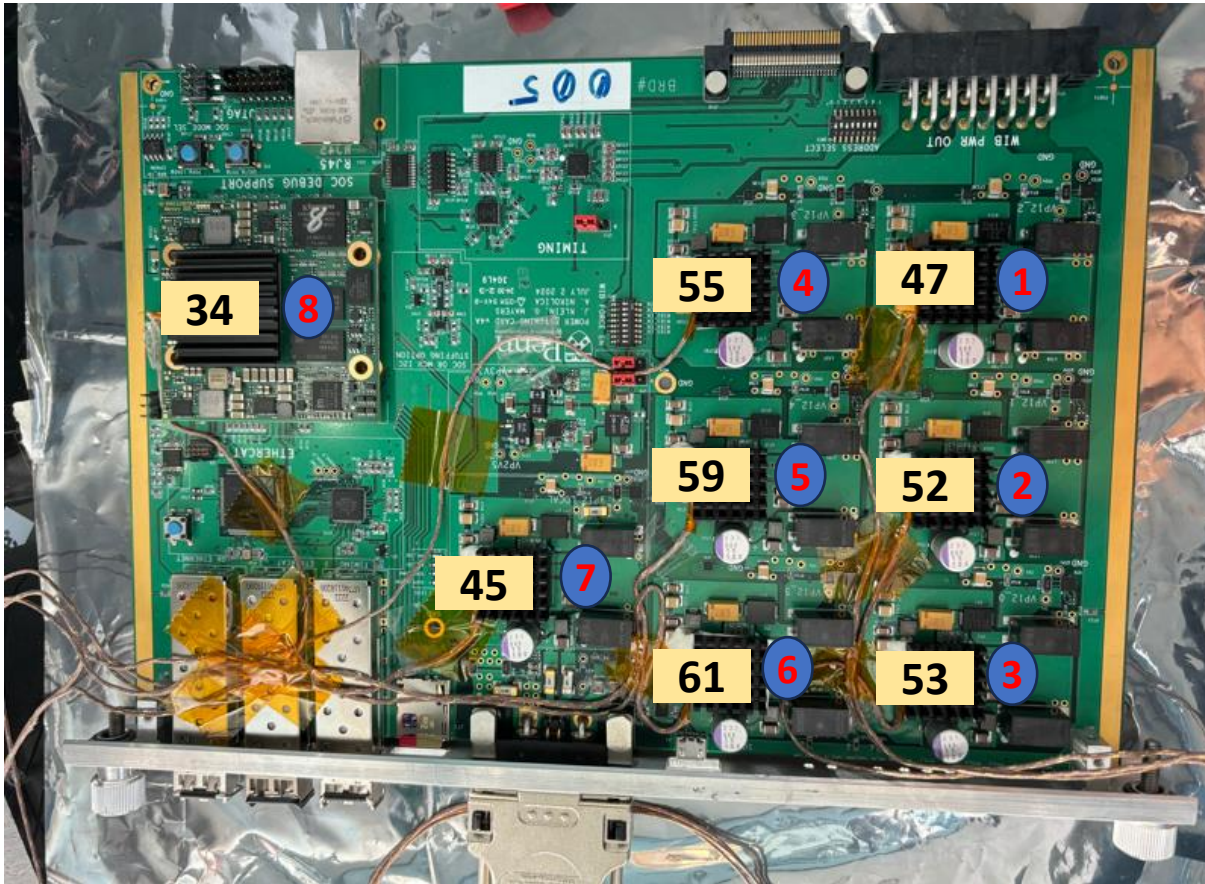
Total power consumption: 47.63V, 8.98A



WIB#	ZYNQ FPGA (°C)	Hottest DC-DC (°C)
1	51	48
2	55	56
3	54	51
4	53	55
5	53	55
6	52	54

Typical (ProtoDUNE) configuration of power consumption

WIEC: 6 fans powered with 18V



WIB#	ZYNQ FPGA (°C)	Hottest DC-DC (°C)
1	51	48
2	55	56
3	54	50
4	53	55
5	55	55
6	52	54

Ambient temperature: 30 °C

Total power consumption: 47.63V, 8.31A

Worst case of power consumption

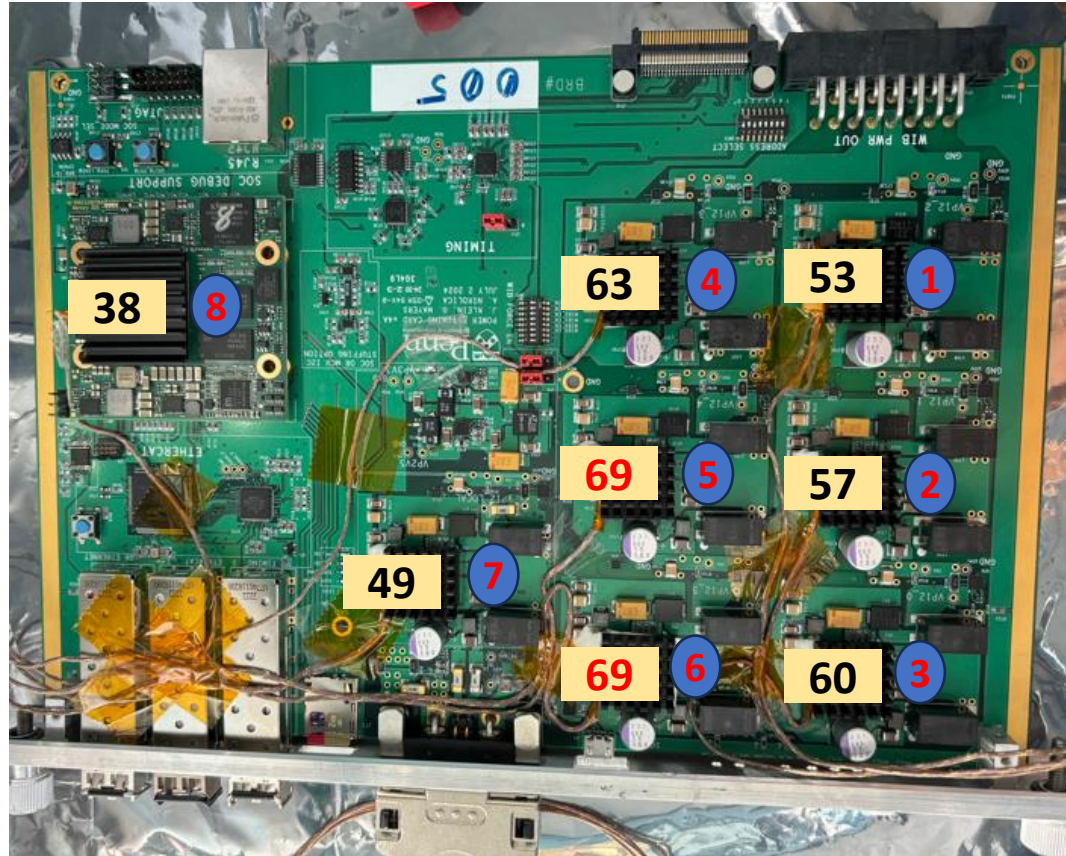
Front (Panel) ← → Back (Flange)

WIEC: 3 fans close to flange side powered with 18V



OFF

ON



Ambient temperature: 30 °C

Total power consumption: 47.63V, 9.04A



WIB#	ZYNQ FPGA (°C)	Hottest DC-DC (°C)
1	55	50
2	-	-
3	59	52
4	54	58
5	54	57
6	51	52

Worst case of power consumption

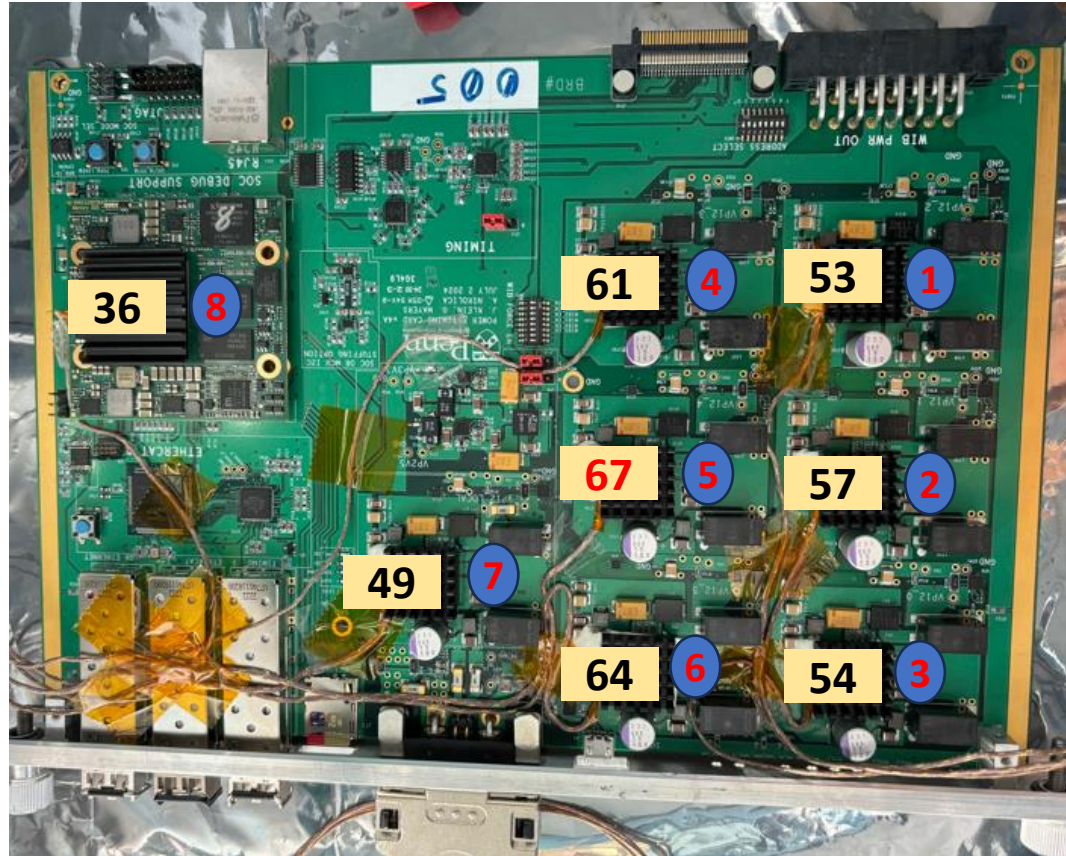
Front (Panel) ← Back (Flange) →

WIEC: 3 fans close to panel side powered with 18V



ON

OFF



Ambient temperature: 30 °C

Total power consumption: 47.63V, 9.04A



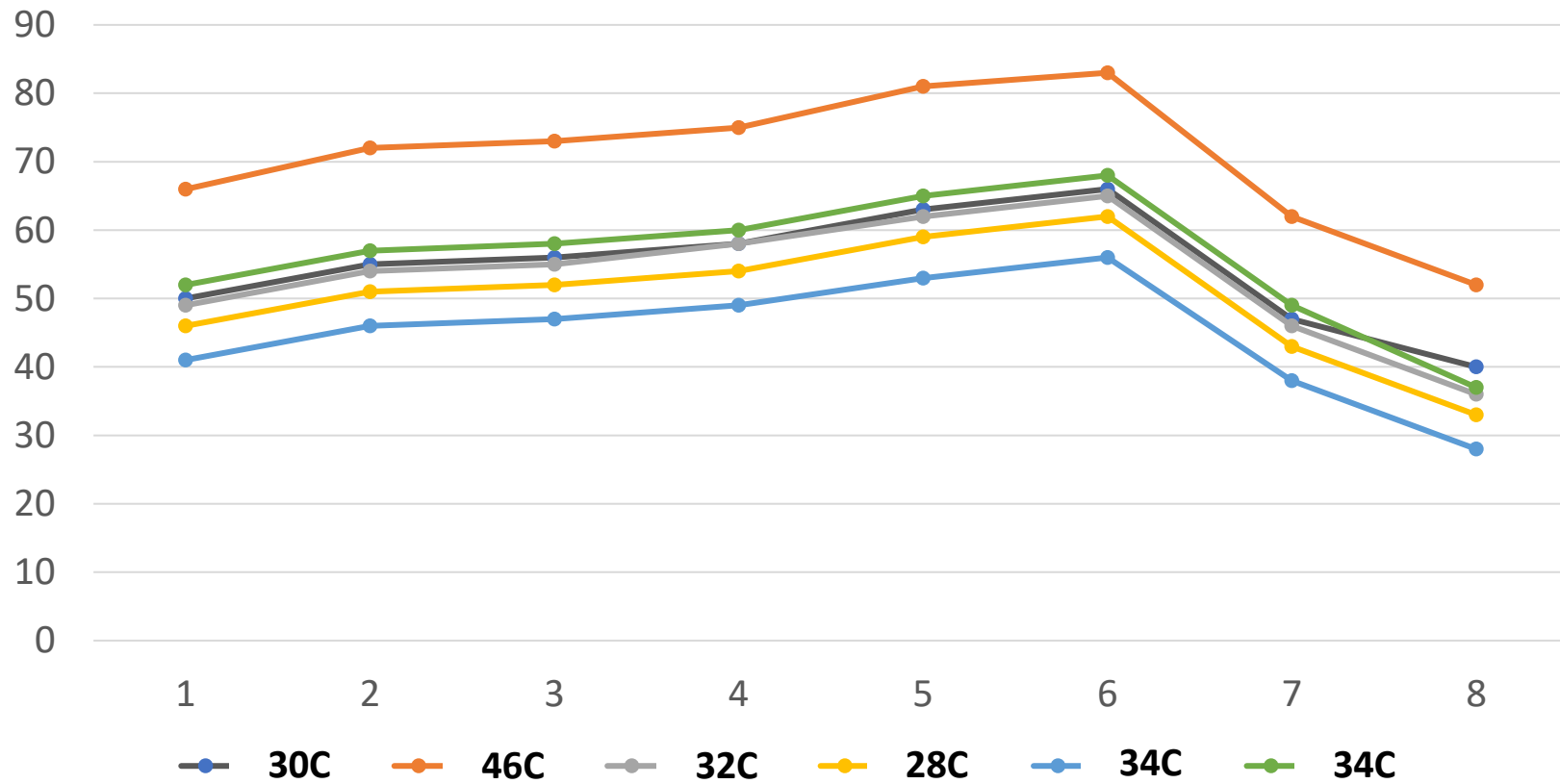
WIB#	ZYNQ FPGA (°C)	Hottest DC-DC (°C)
1	60	49
2	62	58
3	62	54
4	58	57
5	61	58
6	62	55

Test record

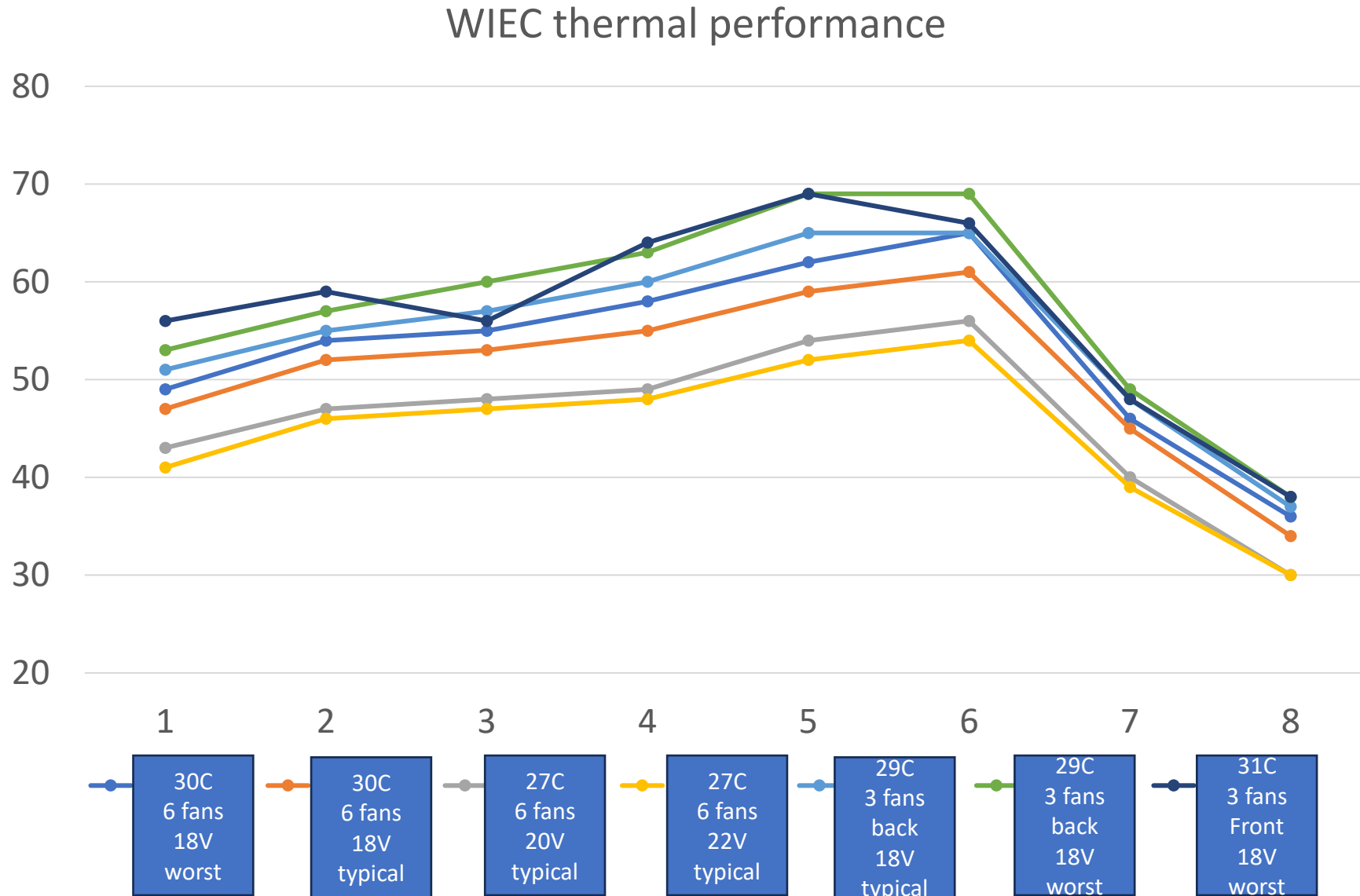
date	time	FAN	FE SEDC	Ambient T	1	2	3	4	5	6	7	8			
Nov.7	11:37	6, 18V	ON	32	50	55	56	58	63	66	47	40			
	12:53	6, 18V	ON	46	66	72	73	75	81	83	62	52	PS for exhaust was tripped		
	13:19	6, 18V	ON	30	49	54	55	58	62	65	46	36			
	14:24	6, 18V	ON	28	46	51	52	54	59	62	43	33			
	14:58	6, 18V	ON	24	41	46	47	49	53	56	38	28			
	15:30	6, 18V	ON	34	52	57	58	60	65	68	49	37			
	16:36	6, 18V	OFF	34	51	55	56	58	63	65	49	38			
	16:52	6, 18V	OFF	30	47	52	53	55	59	61	45	34			
	17:03	6, 18V	OFF	28	45	49	50	53	56	59	43	33			
	17:10	6, 20V	OFF	27	43	47	48	49	54	56	40	30			
	17:18	6, 22V	OFF	27	41	46	47	48	52	54	39	30			
Nov.8	8:49	3 (back), 18V	OFF	29	51	55	57	60	65	65	48	37			
	9:17	3 (back), 18V	OFF	34	55	59	61	64	70	69	52	41			
	9:42	3 (back), 18V	ON	35	59	64	67	70	76	76	55	44			
	10:05	3 (back), 18V	ON	29	53	57	60	63	69	69	49	38			
	10:26	3 (back), 18V	ON	43	67	73	76	78	86	85	63	51			
	10:48	3 (back), 18V	ON	25	48	53	55	59	64	64	45	34			
	11:05	3 (front), 18V	ON	25	47	50	48	55	60	59	41	30			
	13:25	3 (front), 18V	ON	53	87	93	88	98	106	101	78	64	PS for exhaust was tripped		
	14:08	3 (front), 18V	ON	22	47	50	47	55	60	57	40	30			
	14:36	3 (front), 18V	ON	31	56	59	56	64	69	66	48	38			
	14:58	3 (front), 18V	ON	29	53	57	54	61	67	64	46	36			
	15:58	3 (front), 18V	ON	45	70	74	71	79	85	82	62	50	PS for exhaust was tripped		
	16:38	3 (front), 18V	ON	27	52	55	53	60	65	63	45	34			

Test Record

6 fans with 18V, worst case power consumption



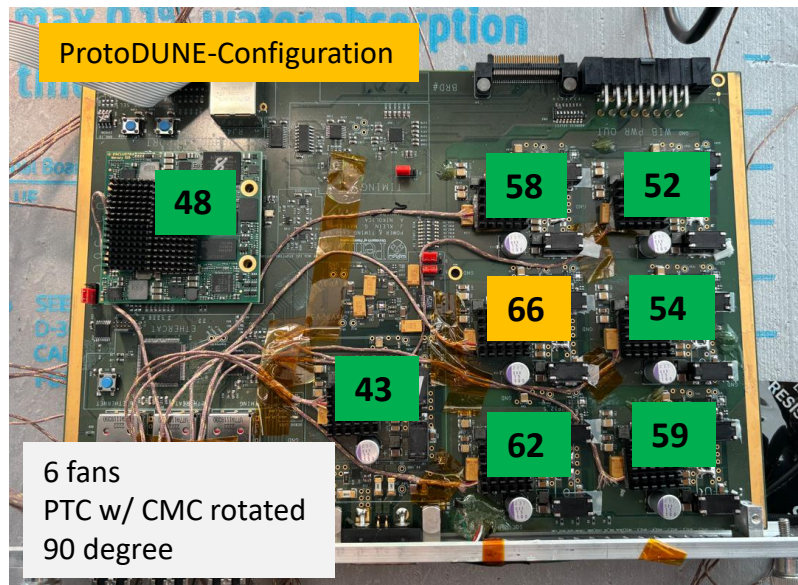
Test Record



Conclusion

Optimal thermal performance is confirmed with changes applied to WIEC crate and PTC.

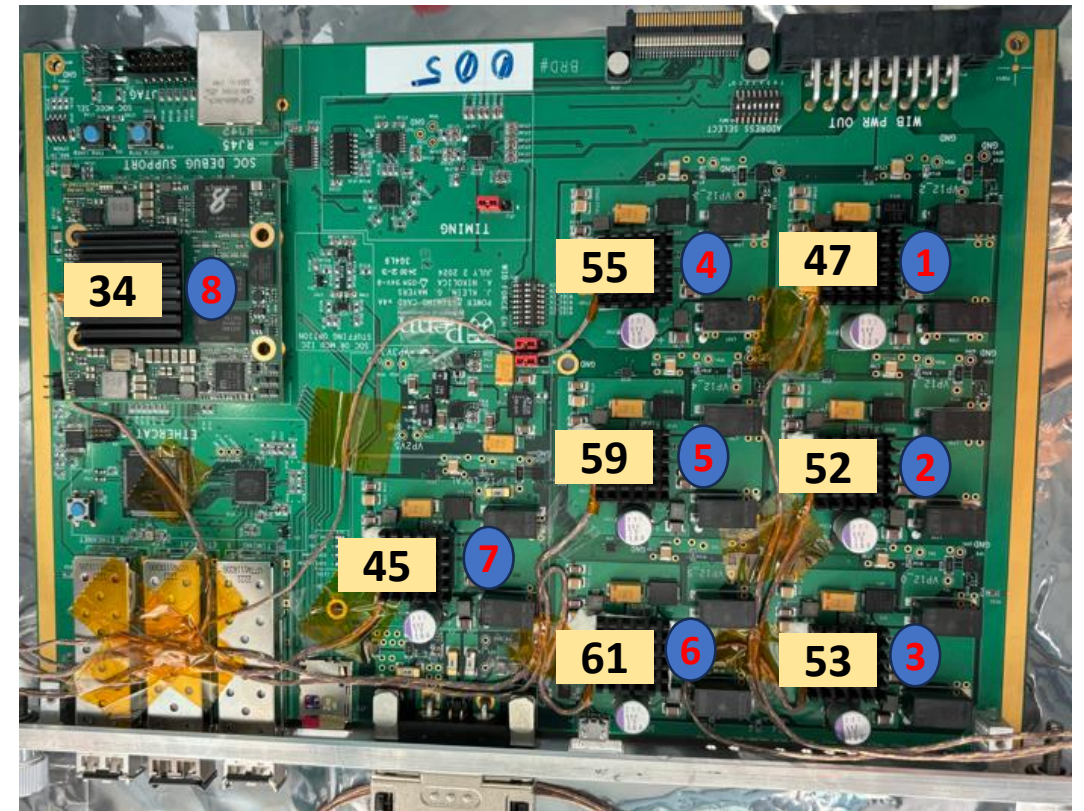
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Jan 2024

WIEC: 6 fans powered with 18V



Ambient temperature: 30 °C

Total power consumption: 47.63V, 8.31A

Nov. 2024