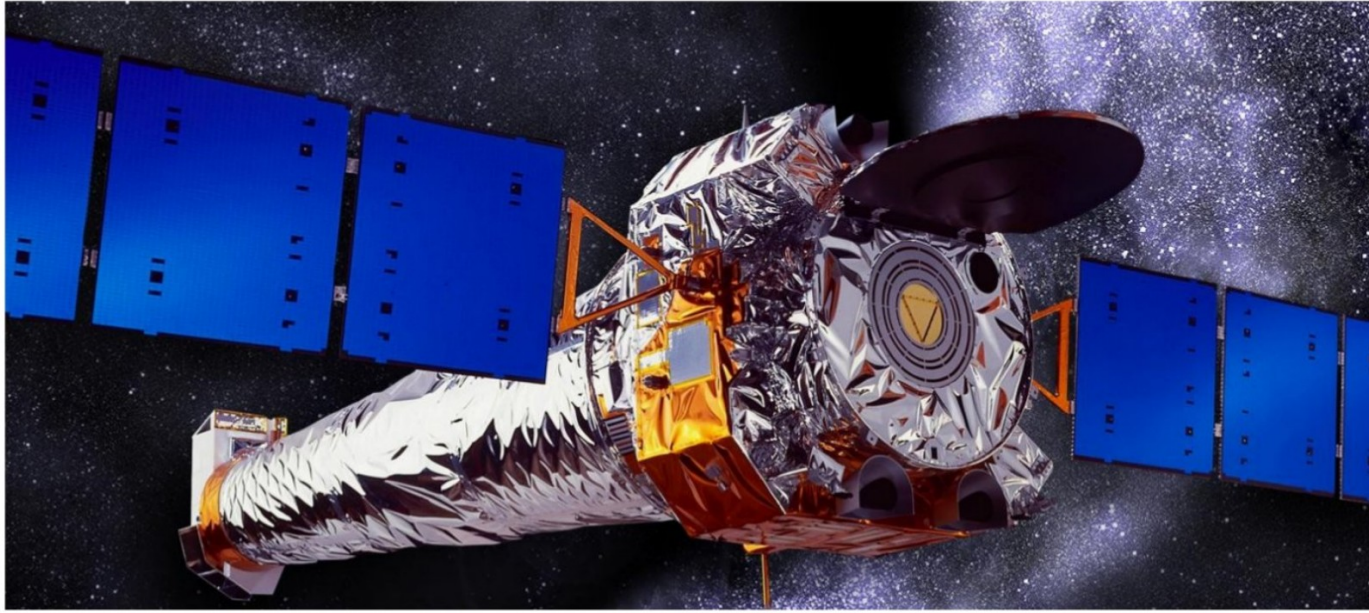


Proposal to Increase the 1DPAMZT Planning, Caution and Warning High Limits – May 2022



Proposed Limit Increase

Raise the 1DPAMZT Planning, Caution, and Warning High Limits by 1° C.

Present:

Warning High: +41.5° C
Caution High: +39.5° C
Planning Limit: + 37.5° C

Proposed:

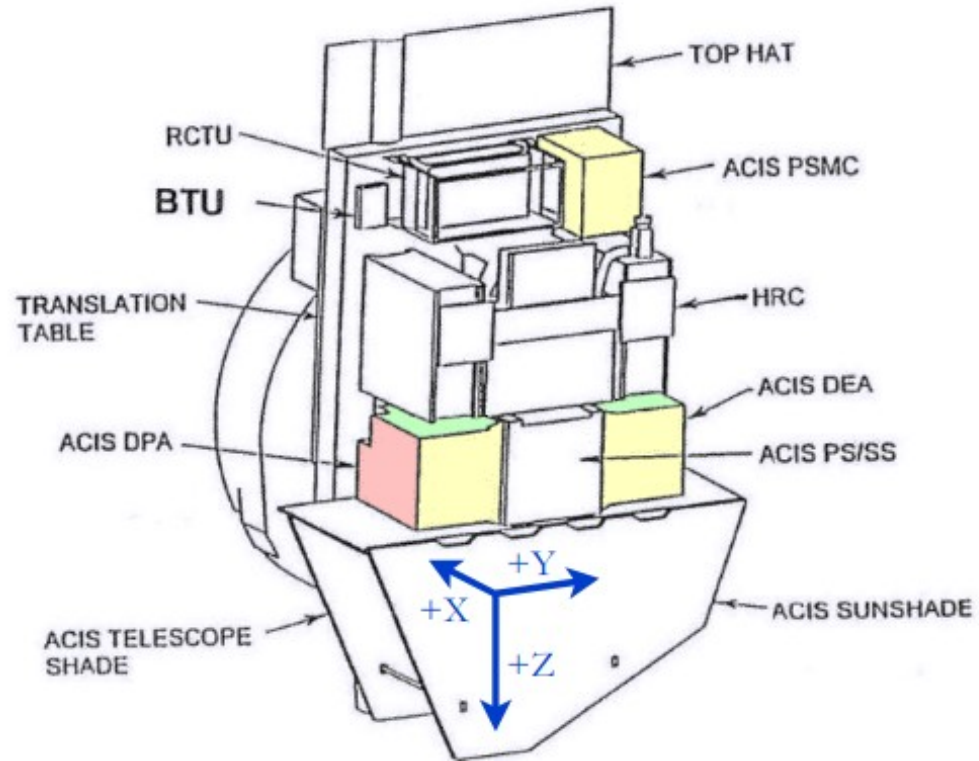
Warning High: +42.5° C
Caution High: +40.5° C
Planning Limit: + 38.5° C

MIT ACIS Instrument Team has approved these limit increases.

NOTE: The +12 degree C. lower limit to reduce the range of thermal cycling must now be set to +13 degrees C.

Description of 1DPAMZT

- 1DPAMZT DPA Minus Z Panel Temperature
- External Thermistor located on the ACIS Digital Processor Assembly (DPA) which contains the Back End Processors (BEPs), and the Front End Processors (FEPs).



What Does 1DPAMZT Tell Us?

- Thermistor measures temperature of the Minus Z Panel – the box.
- Used as a proxy for the BEP and FEP Board temperatures because BEP/FEP temps appear in ACIS Housekeeping (science) data
 - OCC has no insight into BEP/FEP Thermistor values
- BEP/FEP Board temps are the KEY values.
 - Temp of aluminum box not of direct value.

1DPAMZT as a BEP/FEP Proxy

1DPAMZT: R/W: +41.5

Y/C: +39.5

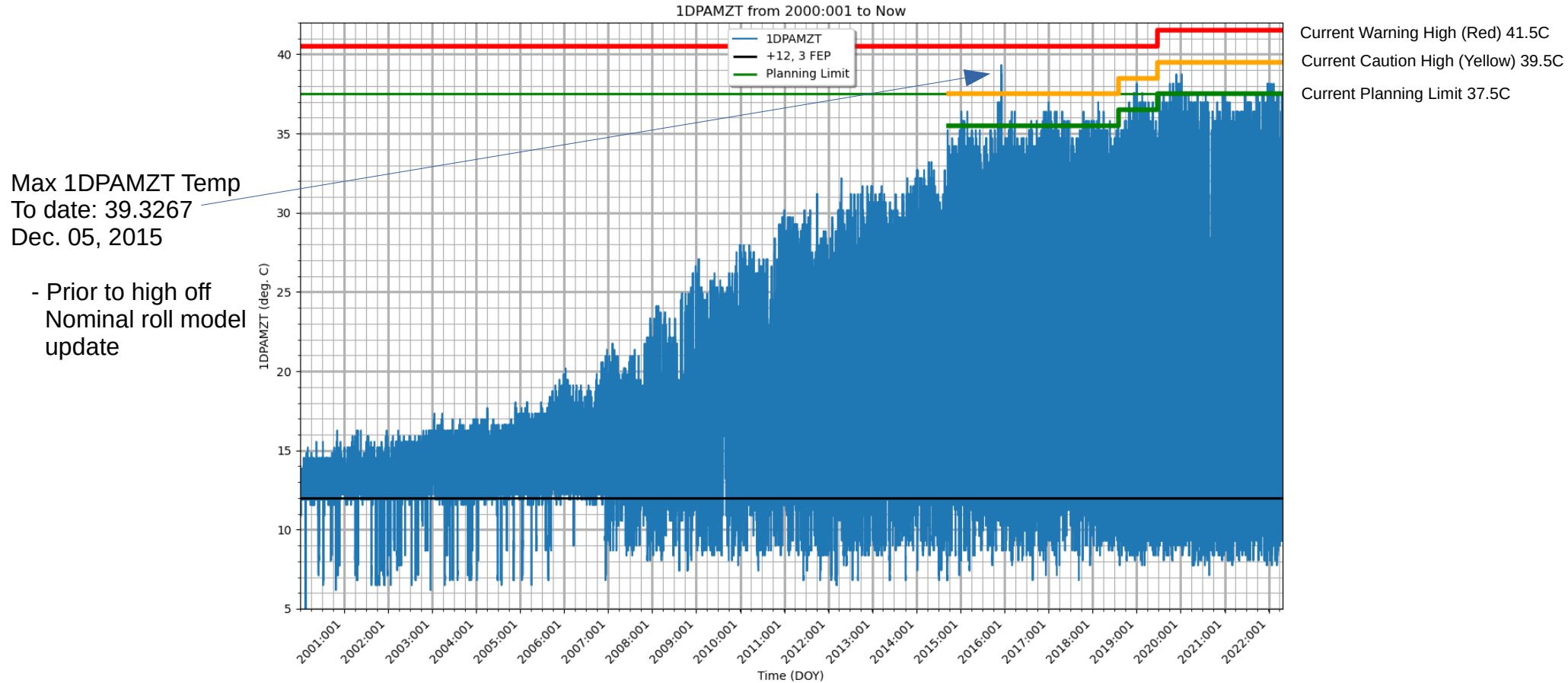
P/L: + 37.5

# Channel	ccd	size	red_lo	yel_lo	yel_hi	red_hi	# Description
#-----							
ADC_TMP_BEP_PCB	10	3	-10.0	6.5	44.0	49.0	# DPA Thermistor 1 - BEP PC Board
ADC_TMP_BEP_OSC	10	3	-10.0	6.5	42.0	47.0	# DPA Thermistor 2 - BEP Oscillator
ADC_TMP_FEP0_MONG	10	3	-10.0	0.0	48.0	53.0	# DPA Thermistor 3 - FEP 0 Mongoose
ADC_TMP_FEP0_PCB	10	3	-10.0	0.0	45.0	50.0	# DPA Thermistor 4 - FEP 0 PC Board
ADC_TMP_FEP0_ACTEL	10	3	-10.0	0.0	47.0	52.0	# DPA Thermistor 5 - FEP 0 ACTEL
ADC_TMP_FEP0_RAM	10	3	-10.0	0.0	46.0	51.0	# DPA Thermistor 6 - FEP 0 RAM
ADC_TMP_FEP0_FB	10	3	-10.0	0.0	43.0	48.0	# DPA Thermistor 7 - FEP 0 Frame Buf
ADC_TMP_FEP1_MONG	10	3	-10.0	0.0	49.0	54.0	# DPA Thermistor 8 - FEP 1 Mongoose
ADC_TMP_FEP1_PCB	10	3	-10.0	0.0	46.0	51.0	# DPA Thermistor 9 - FEP 1 PC Board
ADC_TMP_FEP1_ACTEL	10	3	-10.0	0.0	48.0	53.0	# DPA Thermistor 10 - FEP 1 ACTEL
ADC_TMP_FEP1_RAM	10	3	-10.0	0.0	48.0	53.0	# DPA Thermistor 11 - FEP 1 RAM
ADC_TMP_FEP1_FB	10	3	-10.0	0.0	43.0	48.0	# DPA Thermistor 12 - FEP 1 Frame Buf

These limits approved by MIT ACIS Instrument Team September 19, 2017

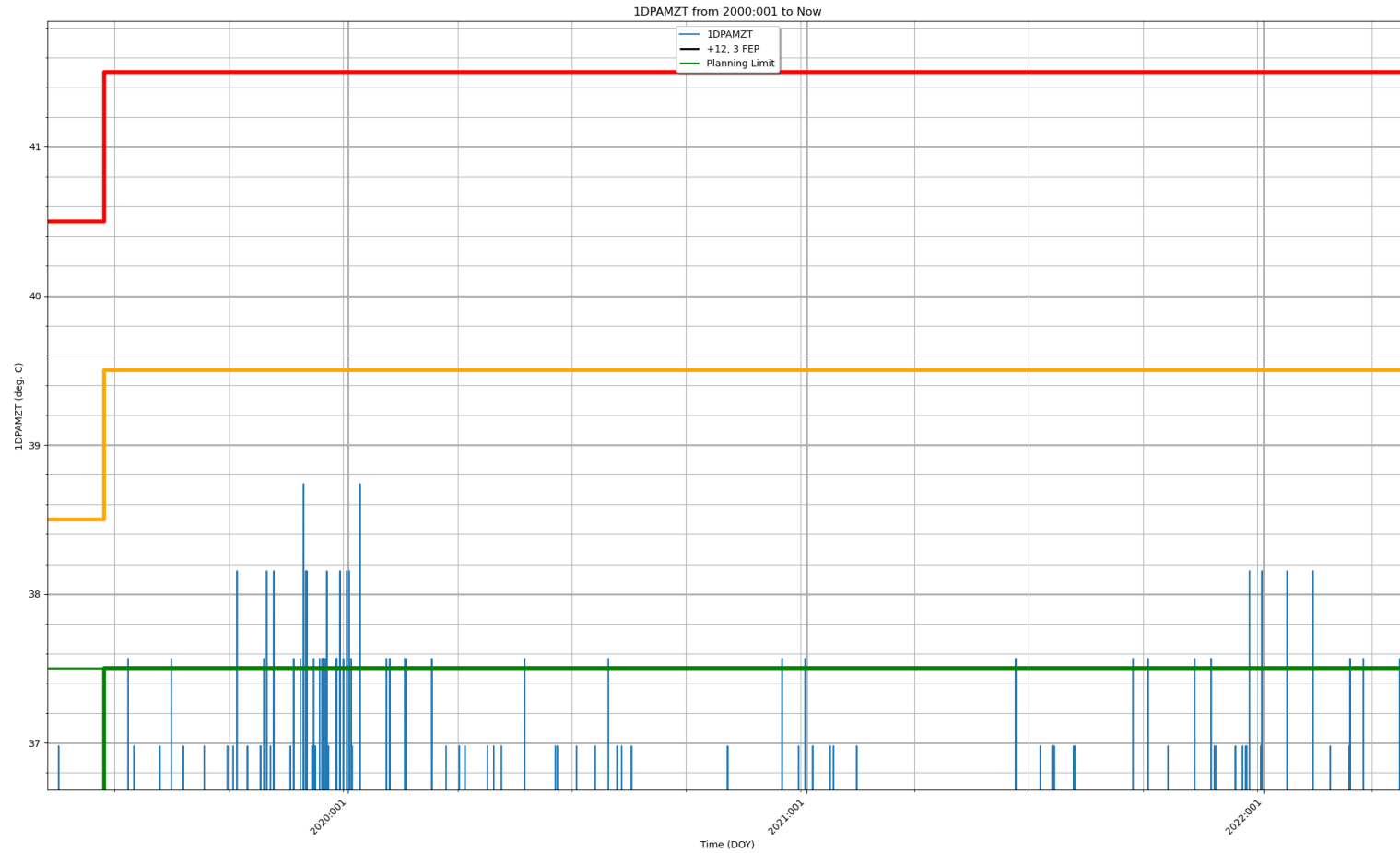
We model BEP PCB, FEP1 Mong and FEP1 ACTEL because they run the hottest. We track violations for FEP0/FEP1 Mong, ACTEL, FB, and BEP OSC and PCB.

1DPAMZT Mission Thermal History



Prepared by: Gregg Germain

46 P.L. violations since the last limit increase. No Yellow Caution Limit Violations



No Yellow Caution Limit violation since Dec. 2015

So long as the Thermal Model maintains its 2°C accuracy, FOT MP can build plans which avoid Yellow Caution Violations.

1DPAMZT measures the temperature of a metal box. It's actual value is not a Health & Safety issue. No credible failure mechanism for 1DPAMZT if it hits 41.5°C.

The critical temperatures are the FEP/BEP boards.

So can we safely move the 1DPAMZT Red High Warning limit one degree and still keep the FEPs/BEPs safe?

ACIS Ops studied the thermal risks to the DPA P.C. boards by raising the 1DPAMZT Red High Warning Limit.

The ACIS Instrument team believes the risk is minimal because:

- Margin available with the BEP/FEP temperatures.
- Experience with models and Mission planning.

TMP_BEP_PCB Caution High: 44.0 Warning High: 49.0

4 chips: Max 1DPAMZT: 35.80667 Max TMP_BEP_PCB : 36.85 Y_Caution - max board: 7.15
5 chips: Max 1DPAMZT: 36.39334 Max TMP_BEP_PCB : 37.50 Y_Caution - max board: 6.496
6 chips: Max 1DPAMZT: 38.15335 Max TMP_BEP_PCB : 38.37 Y_Caution - max board: 5.626

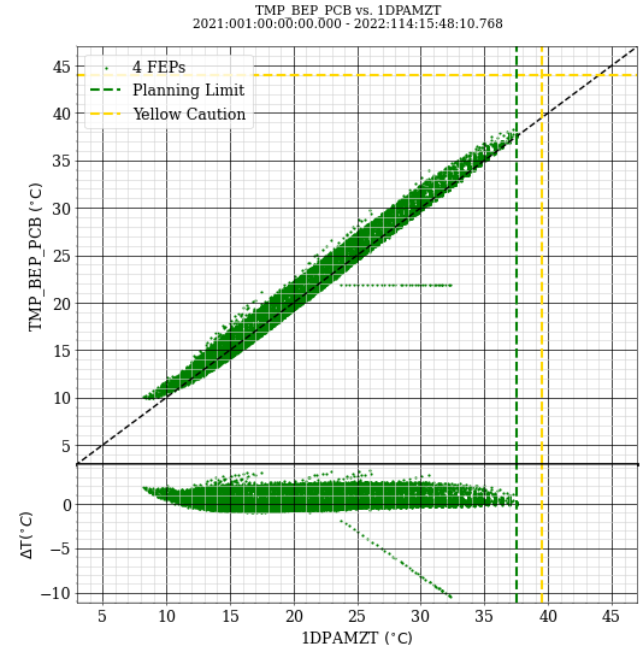
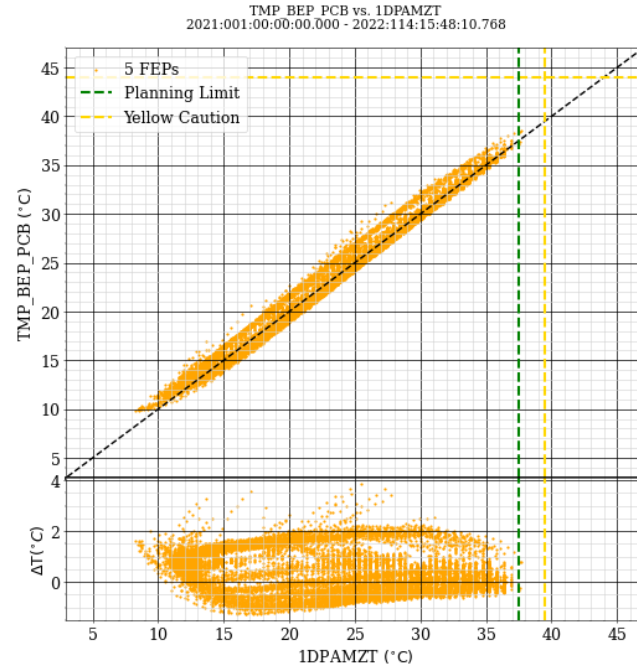
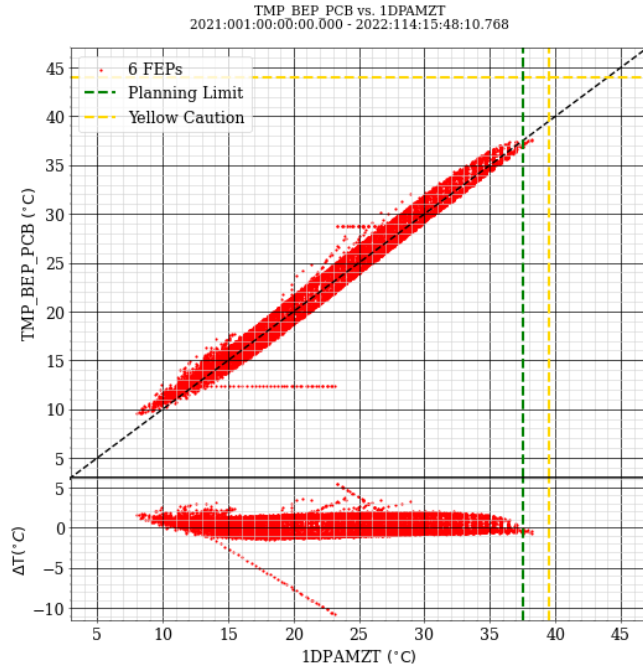
TMP_FEP1_MONG Caution High: 49.0 Warning High: 54.0

4 chips: Max 1DPAMZT: 35.80667 Max TMP_FEP1_MONG : 39.98 Y_Caution - max board: 9.022
5 chips: Max 1DPAMZT: 36.39334 Max TMP_FEP1_MONG : 40.42 Y_Caution - max board: 8.576
6 chips: Max 1DPAMZT: 38.15335 Max TMP_FEP1_MONG : 42.99 Y_Caution - max board: 6.008

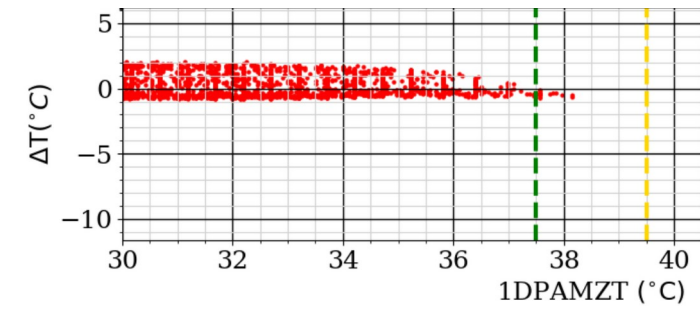
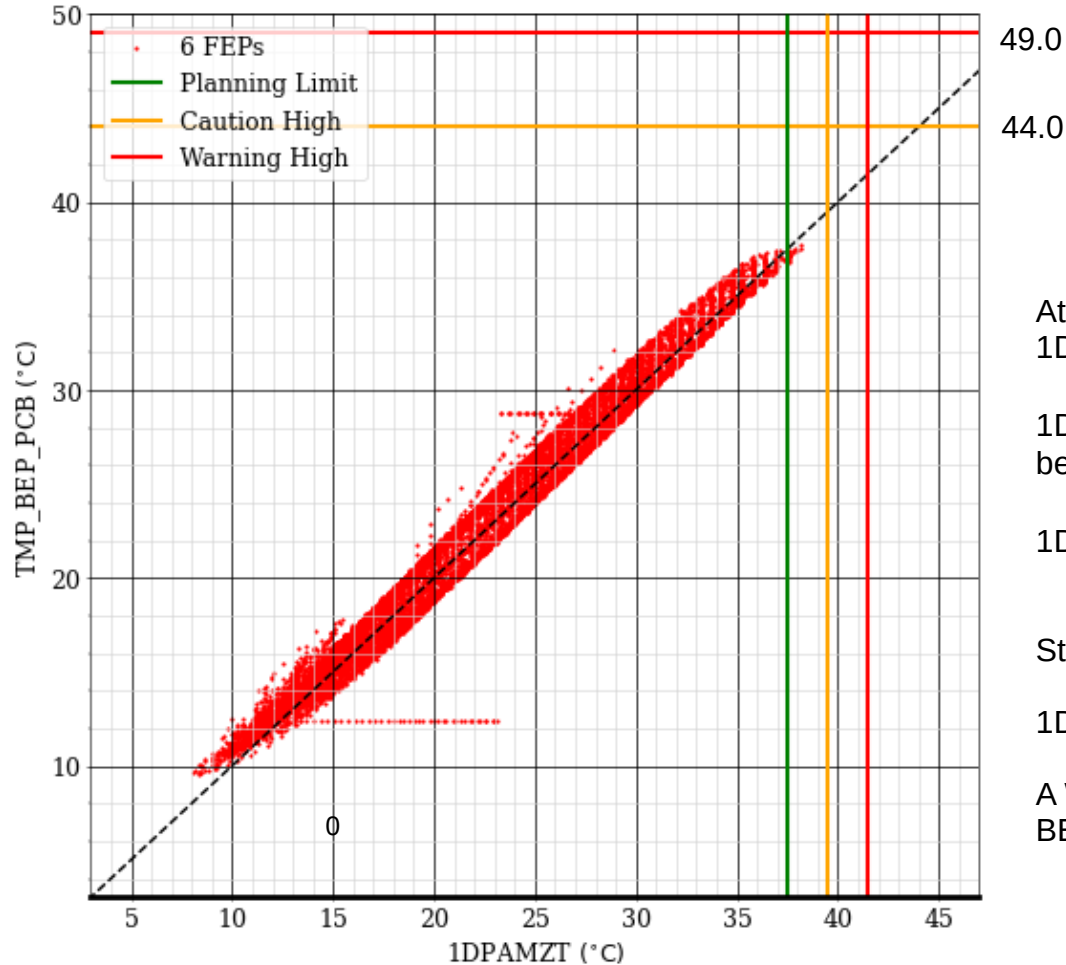
TMP_FEP1_ACTEL Caution High: 48.0 Warning High: 53.0

4 chips: Max 1DPAMZT: 35.80667 Max TMP_FEP1_ACTEL : 39.44708 Y_Caution - max board: 8.553
5 chips: Max 1DPAMZT: 36.39334 Max TMP_FEP1_ACTEL : 39.72464 Y_Caution - max board: 8.275
6 chips: Max 1DPAMZT: 38.15335 Max TMP_FEP1_ACTEL : 43.10983 Y_Caution - max board: 4.89

BEP PCB v 1DPAMZT



TMP BEP PCB vs. 1DPAMZT
2021:001:00:00:00.000 - 2022:115:18:56:07.732



At the hot end, the worst case difference between the BEP PCB and 1DPAMZT is ~ 2 degrees.

1DPAMZT Caution High at 40.5 \rightarrow BEP PCB = 42.5: safely below BEP PCB Caution High

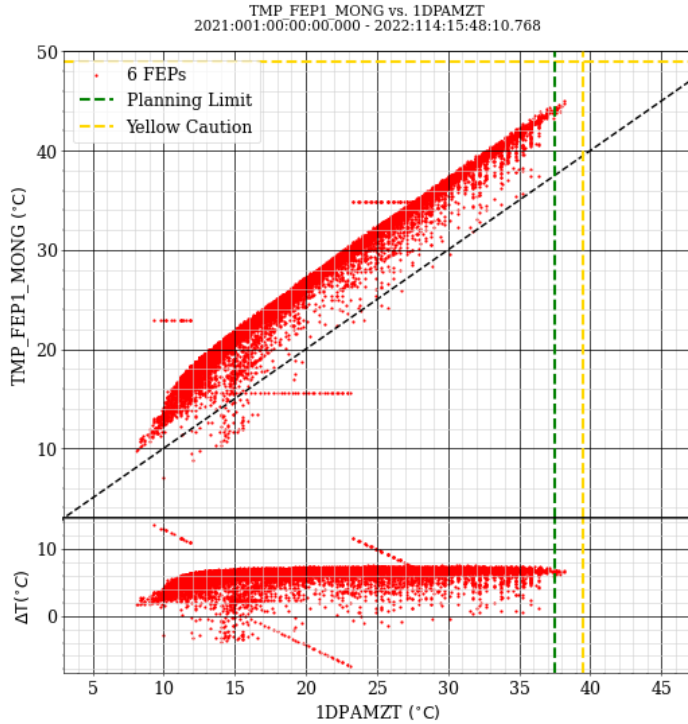
1DPAMZT Warning High of 42.5 \rightarrow BEP PCB = 42.5 + 2.0 = 44.5
- This is a BEP PCB Caution High violation of 0.5C

Still 4.5 degrees away from BEP PCB Warning High.

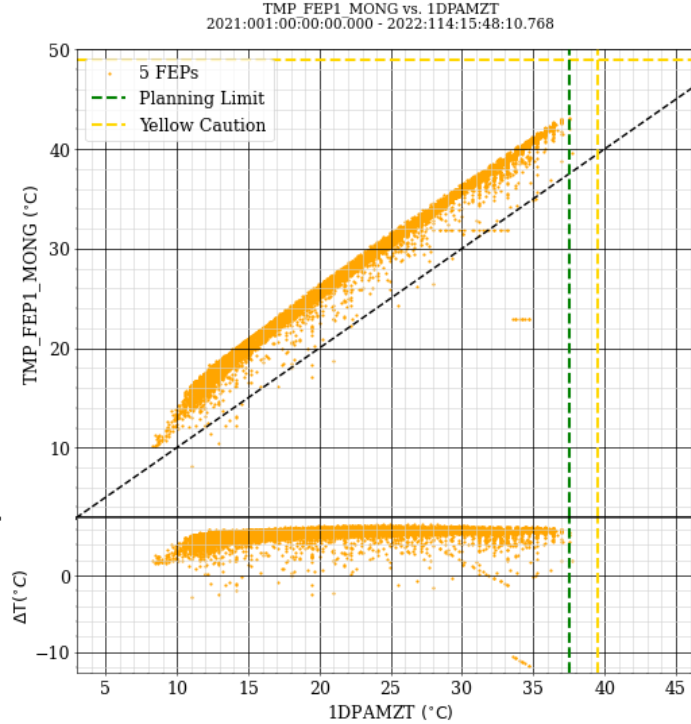
1DPAMZT model demonstrates accuracy well within 2 degrees.

A Warning High violation of 1DPAMZT is 8 bit flips away from the BEP PCB Warning high violation

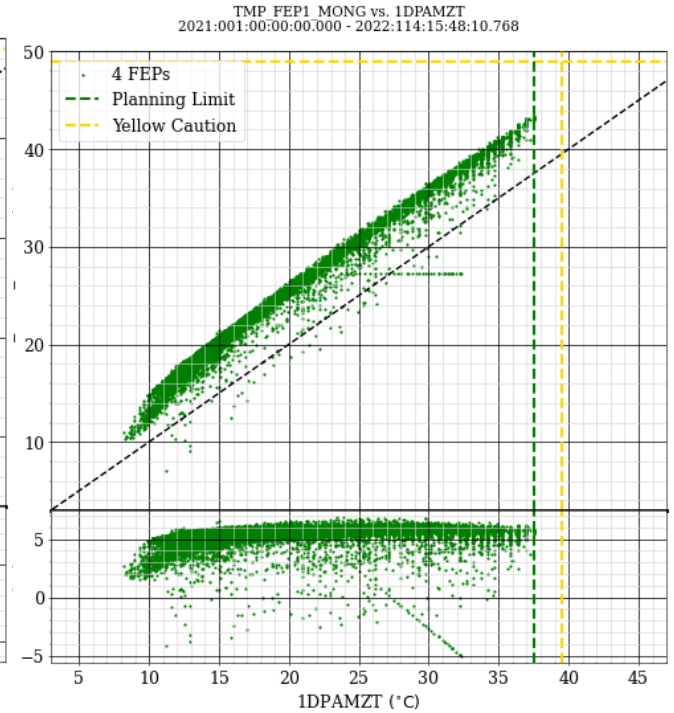
FEP1 Mongoose v 1DPAMZT



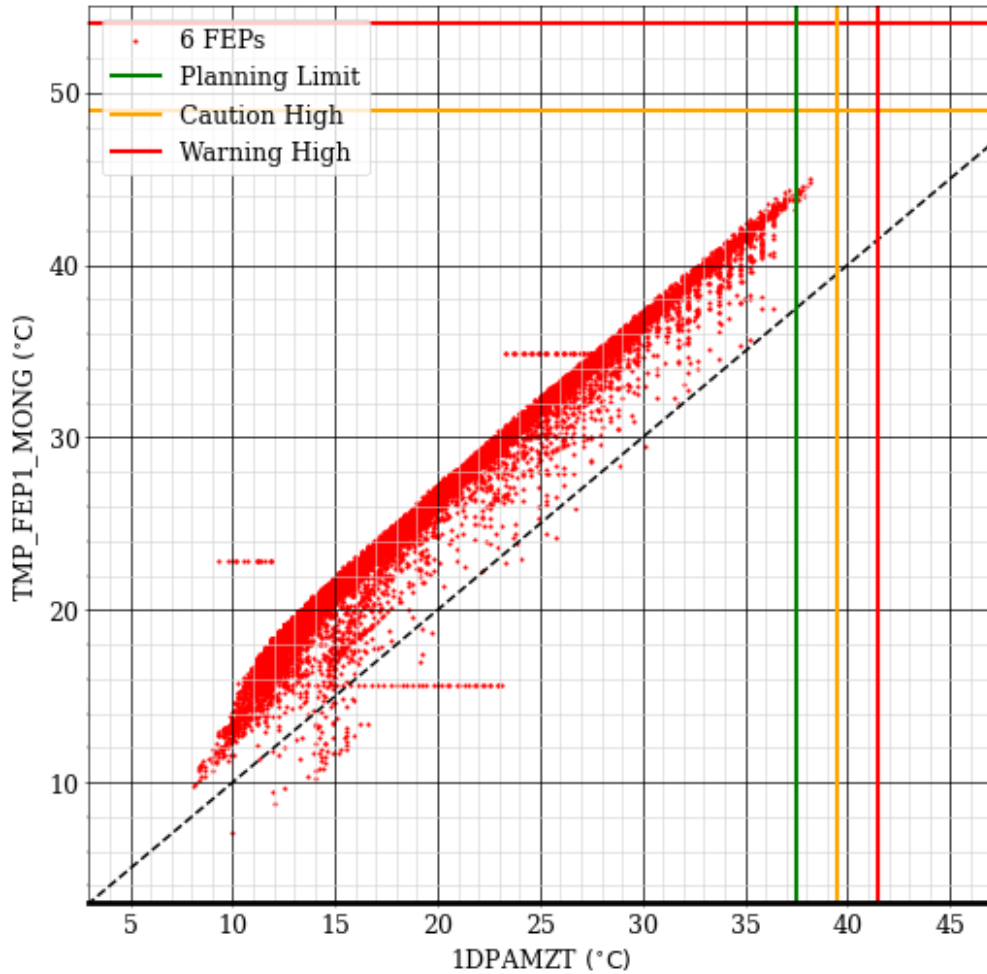
~ 8 deg. C delta at the hot end



~6.25 deg. C delta

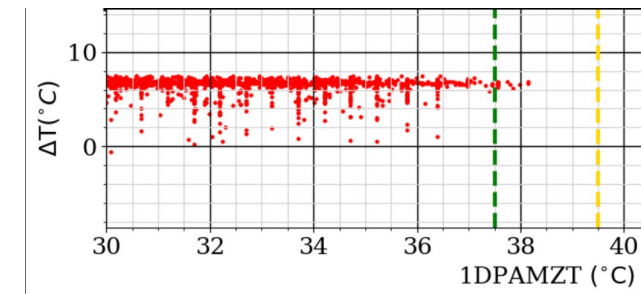


~5.5 deg. C delta



54.0

49.0



Worst case difference between FEP1 Mong and 1DPAMZT is ~8 deg. C

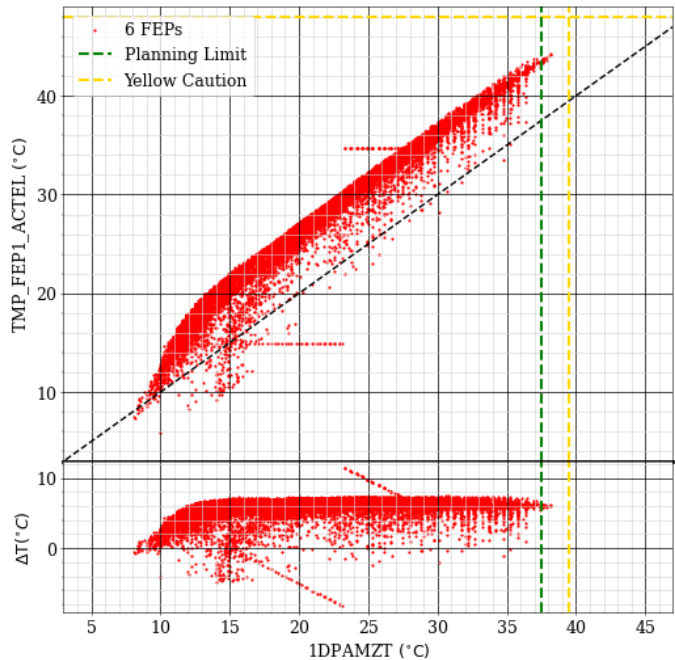
1DPAMZT Caution High at 40.5 -> FEP1 Mong of 48.5 – just under FEP1 Mong Caution High.

1DPAMZT Warning High at 42.5C = 50.5C FEP1 Mong which is a 1.5 deg Caution High violation.

Still 3.5 deg. C away from a FEP1 Mong Warning High.

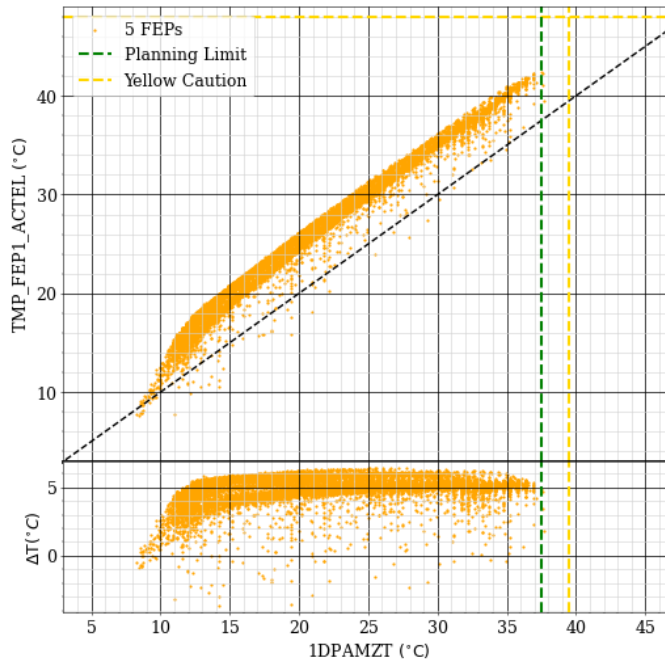
6 1DPAMZT bit flips away from FEP1 Mong Warning High.

TMP FEP1 ACTEL vs. 1DPAMZT
2021:001:00:00:00.000 - 2022:114:15:48:10.768



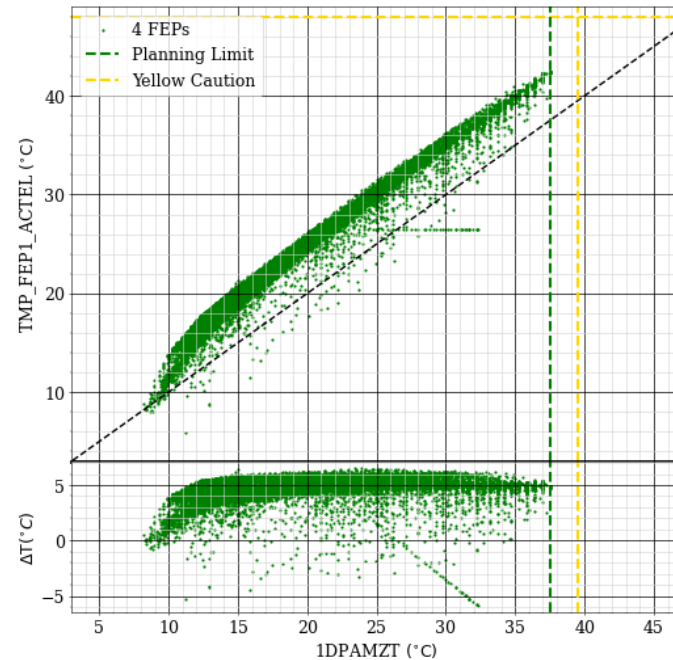
~6.5 deg. C delta

TMP FEP1 ACTEL vs. 1DPAMZT
2021:001:00:00:00.000 - 2022:114:15:48:10.768

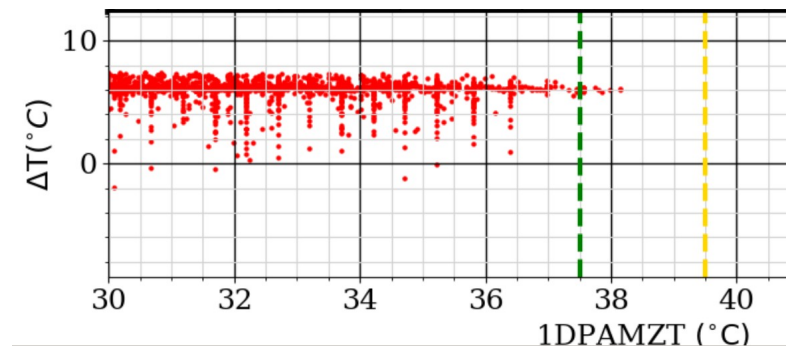
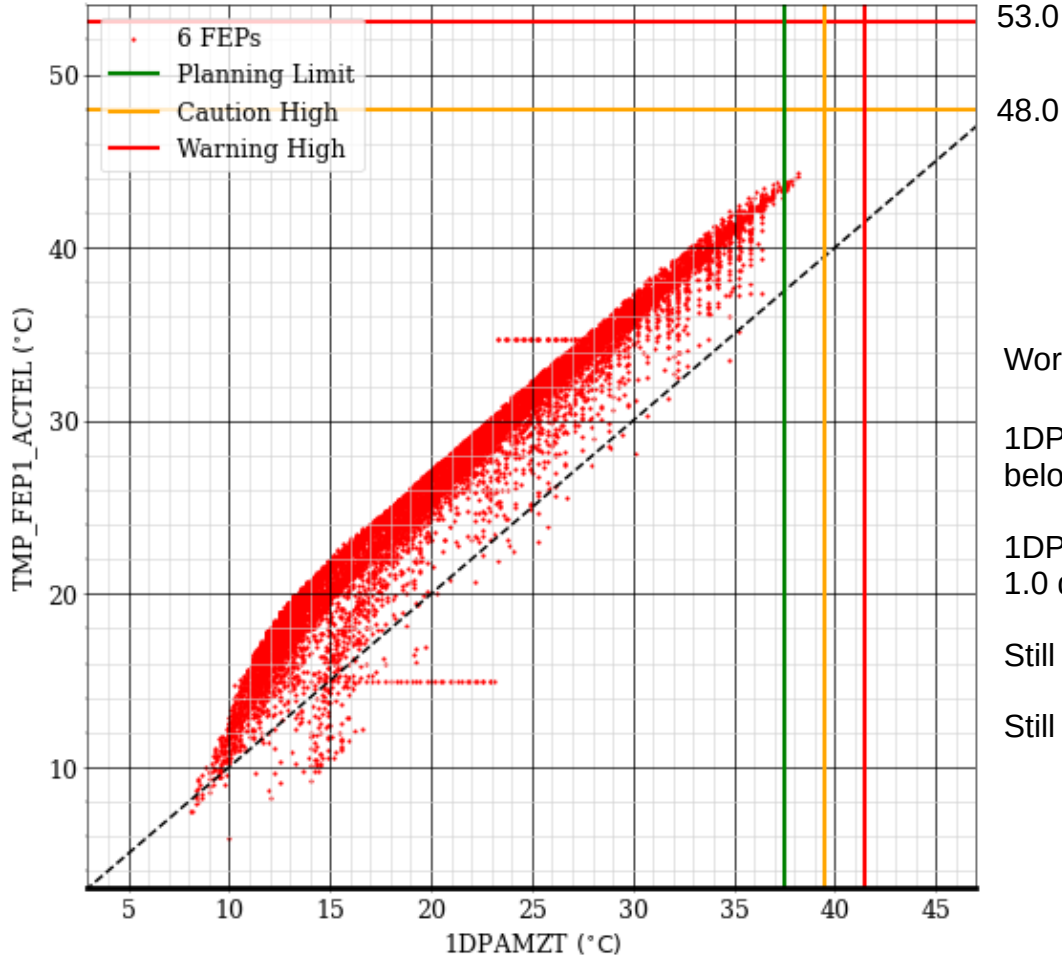


~6.0 deg. C Delta

TMP FEP1 ACTEL vs. 1DPAMZT
2021:001:00:00:00.000 - 2022:114:15:48:10.768



~6.5 deg. C delta



Worst case difference between 1DPAMZT and FEP1 ACTEL is ~6.5 deg C

1DPAMZT Caution High at 40.5 → FEP1 ACTEL = 46.5: safely below BEP PCB Caution High

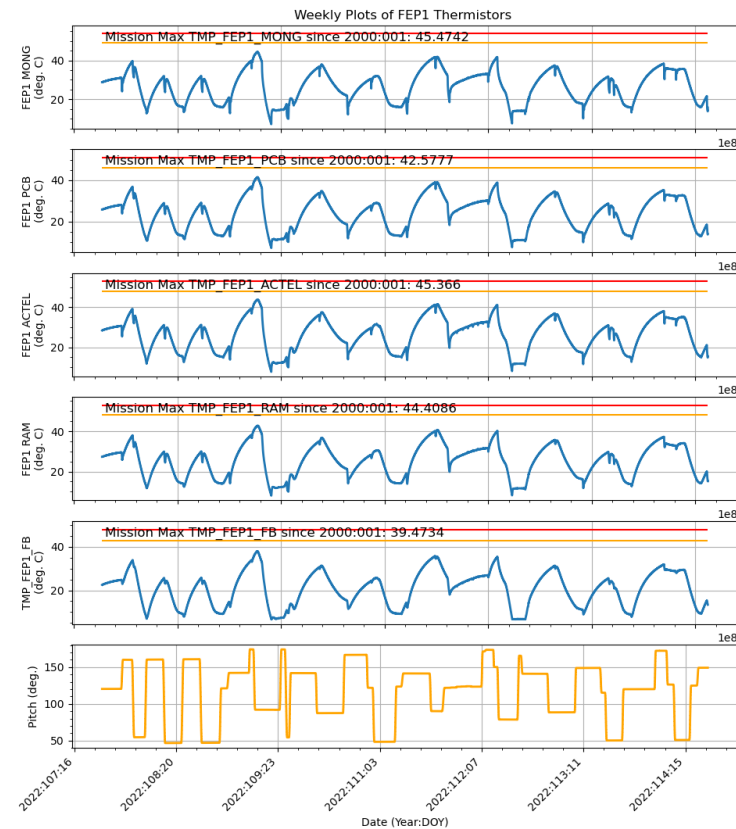
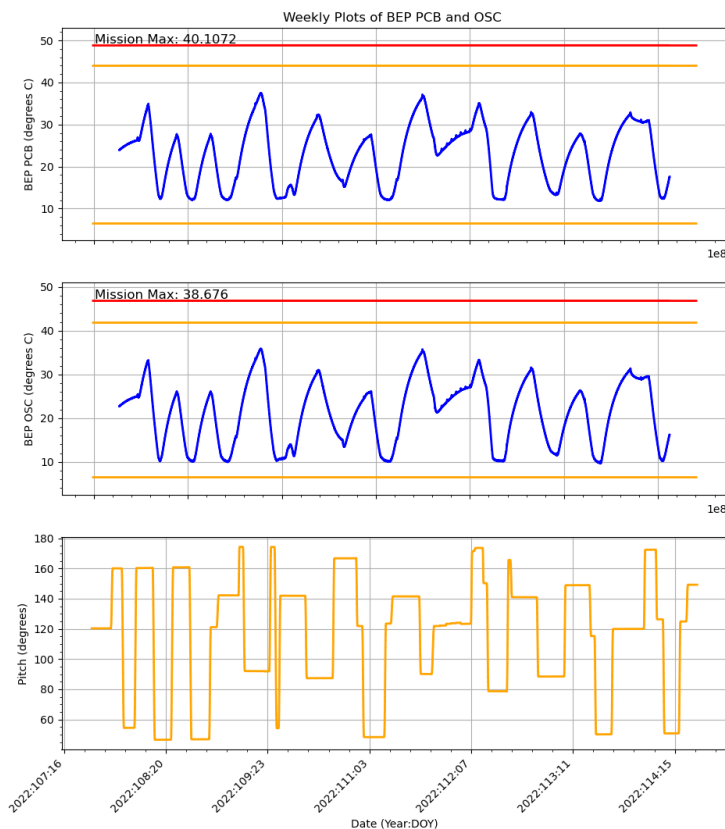
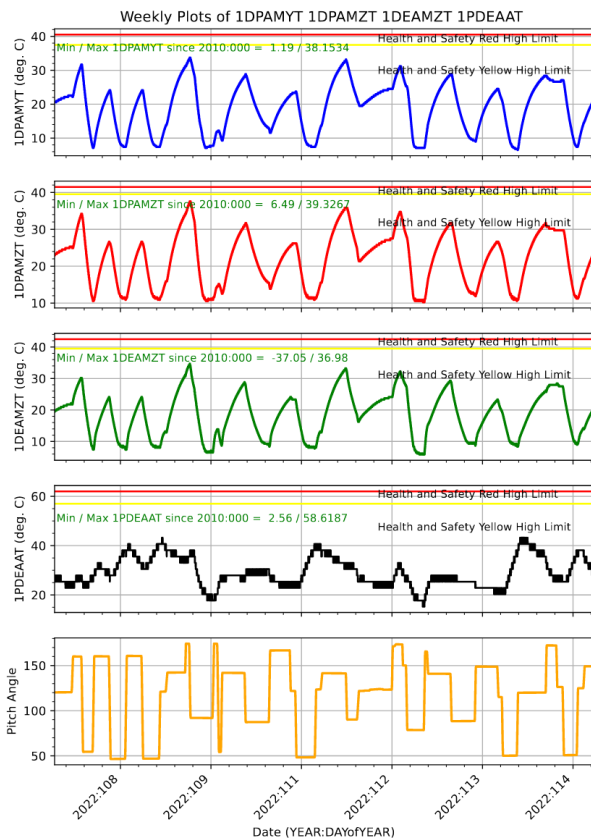
1DPAMZT Warning High at 42.5C = 49.0 C FEP1 ACTEL which is a 1.0 deg Caution High violation.

Still 4 degrees away from a FEP1 ACTEL Warning High violation.

Still 7 1DPAMZT bit flips away from a FEP1 ACTEL Warning High violation.

Monitoring of Temperature Trends and Thermal Model Performance

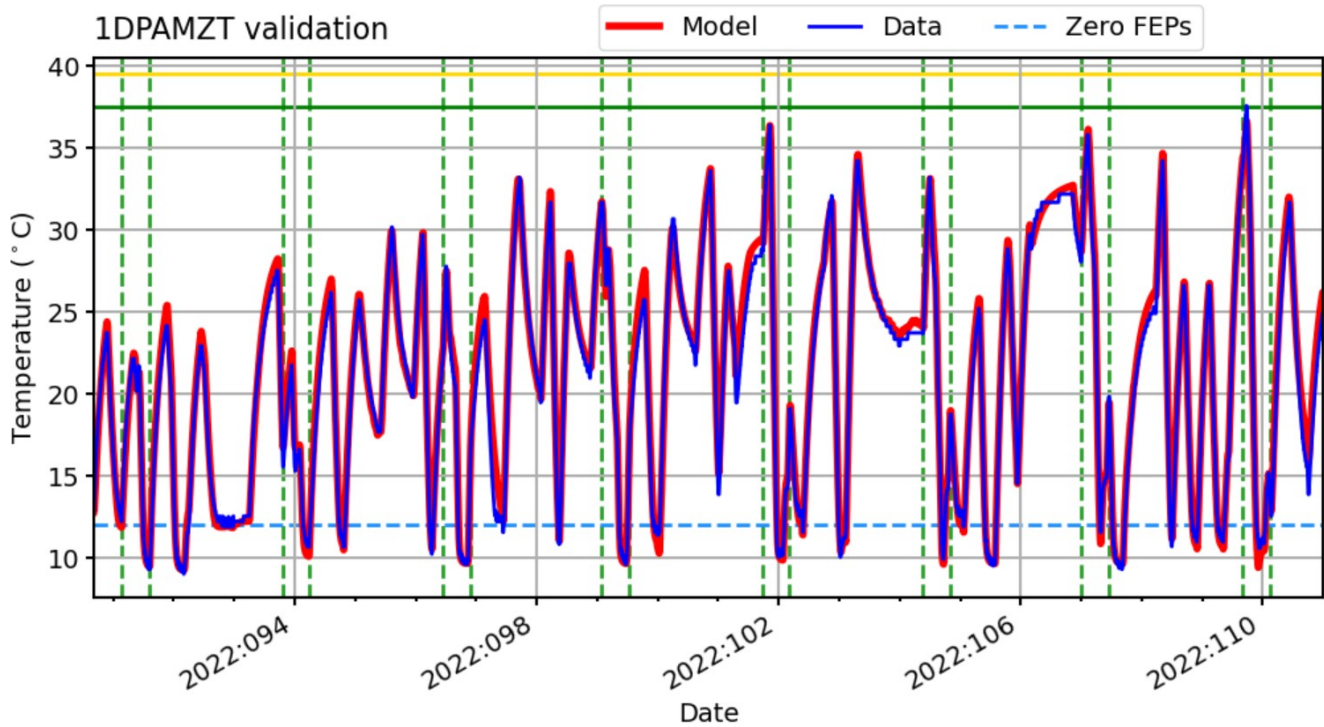
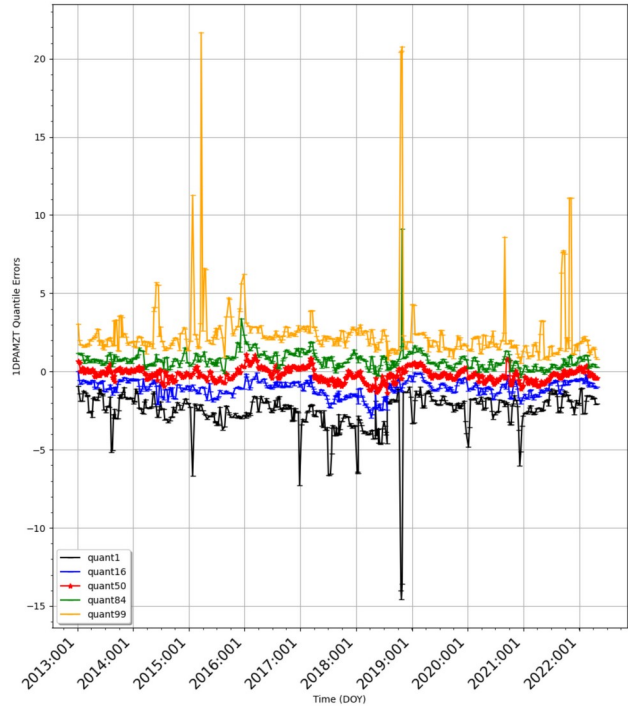
ACIS Ops monitors the temperature trends of many msid's on a weekly basis:



Prepared by: Gregg Germain

...as well as monitoring the performance of the Thermal Models on each weekly load:

MSID	1%	5%	16%	50%	84%	95%	99%
1dpamzt	-2.08	-1.51	-1.00	-0.41	0.27	0.54	0.80
pitch	-5.449	-0.160	-0.001	0.000	0.001	0.193	5.602
tscpos	-1	-1	-1	0	0	0	0
roll	-1.095	-0.063	-0.003	0.000	0.003	0.093	1.049



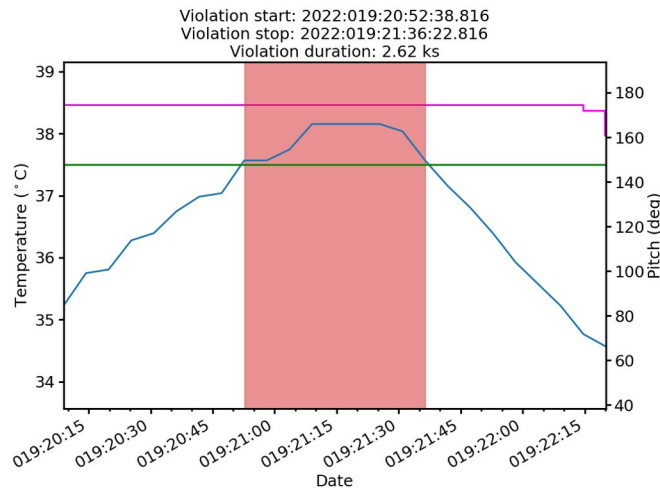
1DPAMZT, BEP and FEP Violations Tracking

Emails sent to ACIS Ops whenever a Violation is detected.

2022 1DPAMZT Violations

1DPAMZT Planning High Limit Violations

Date start	Date stop	Max temperature	Duration (ks)	Plot
2022:019:20:52:38.816	2022:019:21:36:22.816	38.15	2.62	link



TMP_BEP_PCB Violations Tracking

High Violations

No high violations are currently reported for TMP_BEP_PCB.

Low Violations

- [2022 TMP_BEP_PCB Low Violations](#)

TMP_FEP1_ACTEL Violations Tracking

High Violations

No high violations are currently reported for TMP_FEP1_ACTEL.

Low Violations

- [2022 TMP_FEP1_ACTEL Low Violations](#)

TMP_FEP1_MONG Violations Tracking

High Violations

No high violations are currently reported for TMP_FEP1_MONG.

Low Violations

- [2022 TMP_FEP1_MONG Low Violations](#)

Are the limit increases safe?

1DPAMZT is sufficient to monitor the BEP/FEP board temps because we are not close to the 1DPAMZT Red High limit and the BEP/FEP Temperature margin is large.

- Only 1DPAMZT is available to controllers.

Retaining the 2°C spacing between the three limits, the 1DPAMZT Red High limit must be increased.

The risks are low because of the available margin on the BEP/FEP boards. Worst case scenarios of the hottest boards show that Red High Warning Limit violations on BEP/FEP boards not likely to occur. But this requires maintaining the 2°C limits spacing.

Experience shows we can adequately predict and manage the temperatures.

- ACIS Ops assesses model performance and thermal trends every week.

2°C 1DPAMZT Model accuracy must be maintained.

This must be done in conjunction with a 1DEAMZT limits increase as well

The ACIS Team approves the 1DPAMZT Limits increase.

The limits increase makes MP load scheduling easier and increases observing efficiency.

ACIS Team believes the thermal risk to the DPA PC boards is negligible and therefore acceptable.

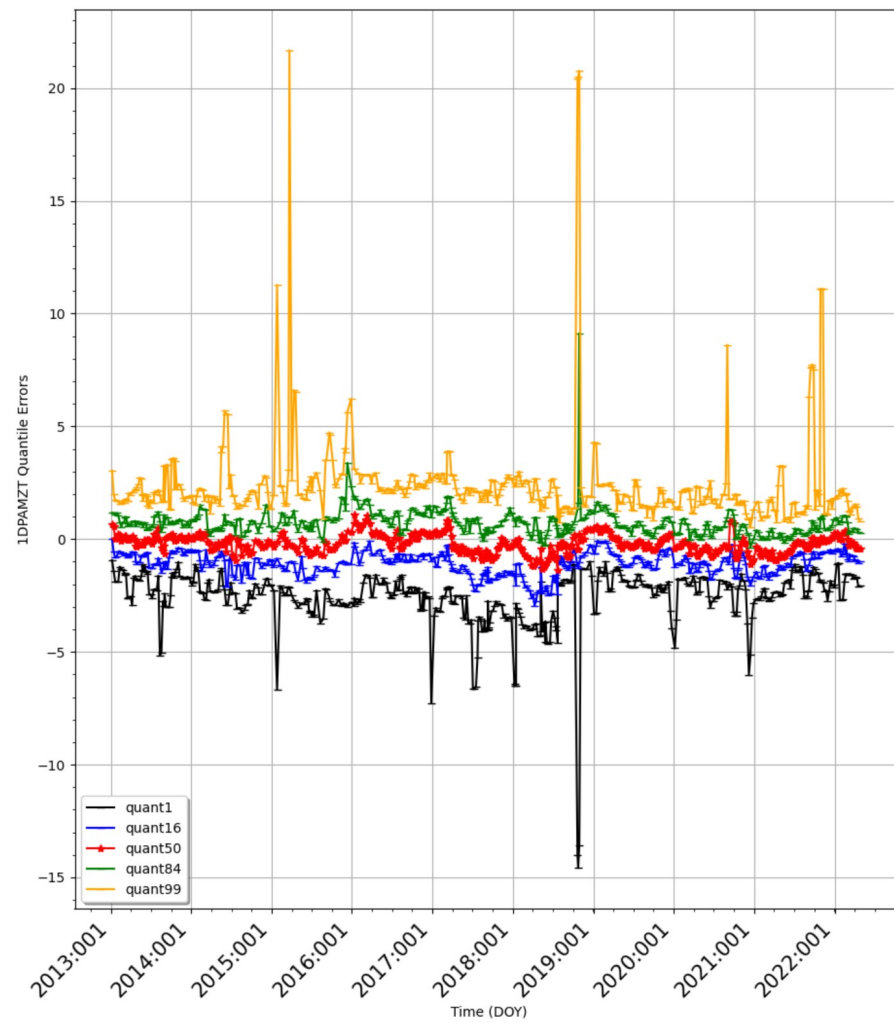
- Accurate Modeling
- BEP/FEP margins
- ACIS Ops weekly reviews of model performance and thermal trends

NOTE: The 12 Degree C. lower limit to reduce thermal cycling must now be set to 13 degrees C.

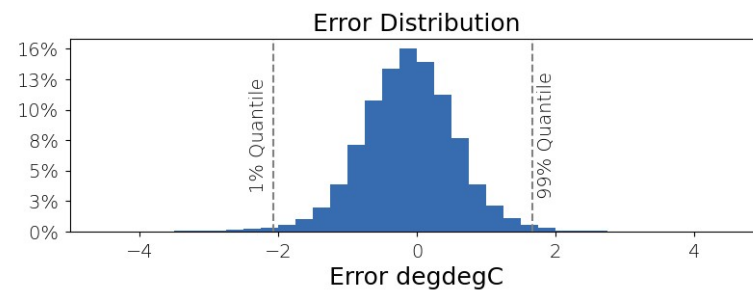
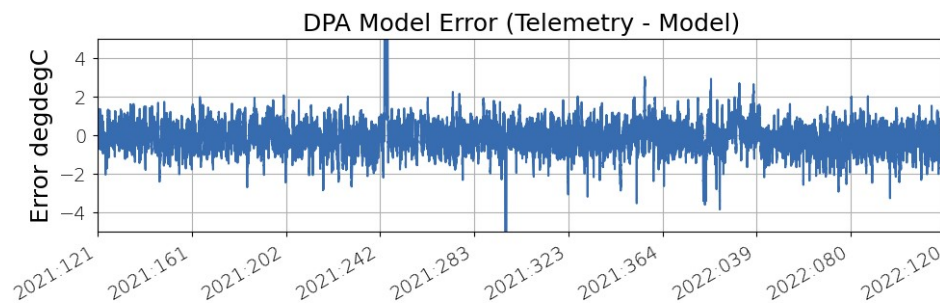
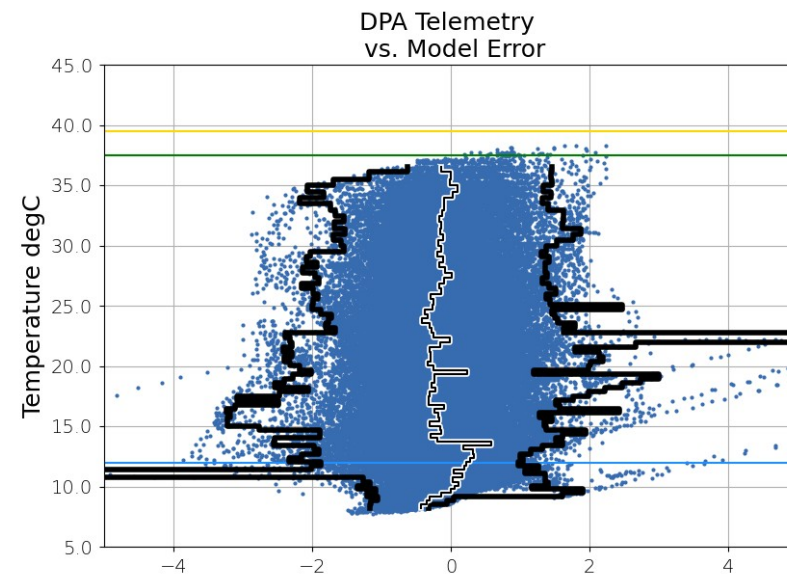
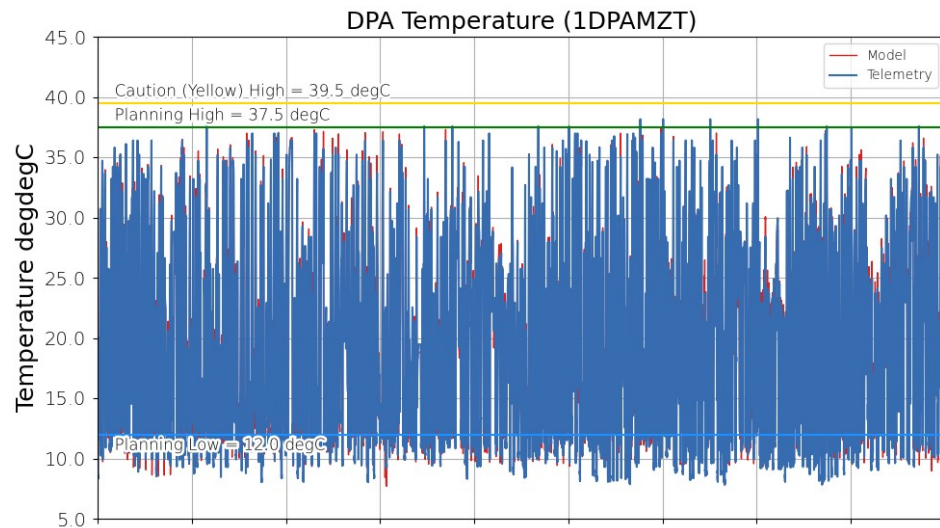
1DPAMZT Limit Rationale and Budget

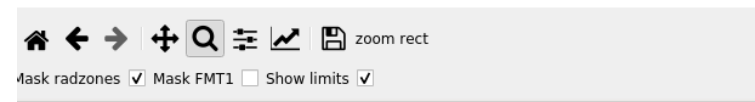
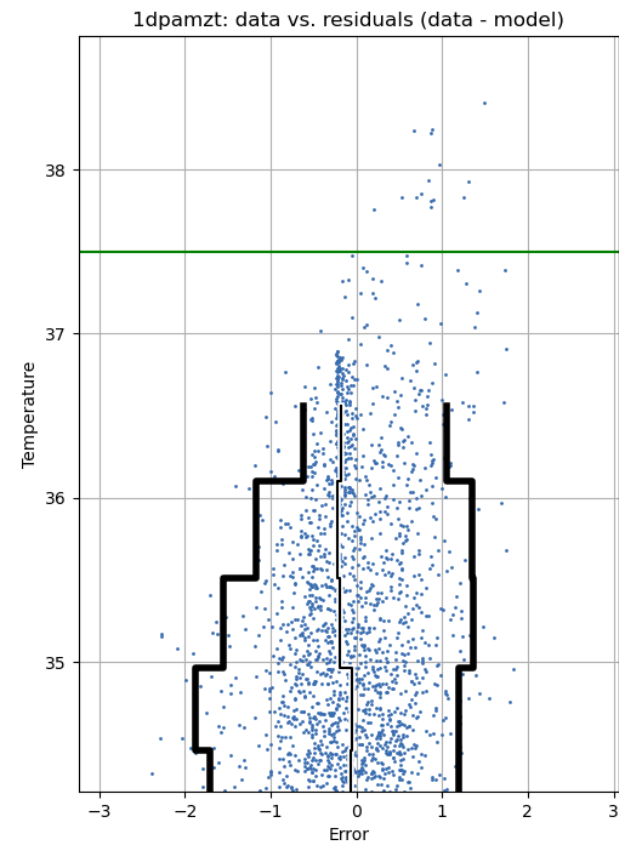
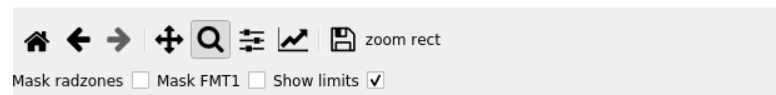
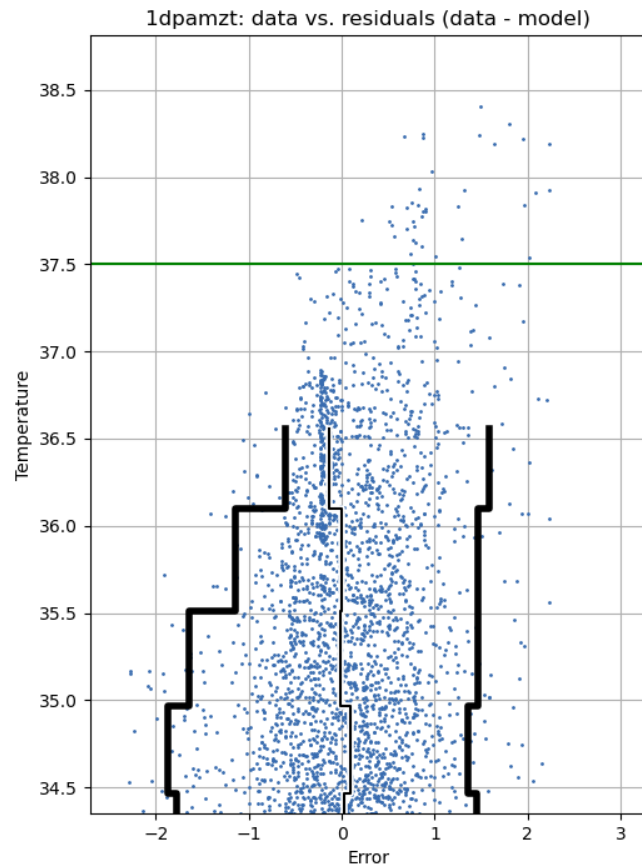
Limit	Value	Budget	Rationale
Warning High	42.5° C		Sufficient margin between the BEP/FEP temps we are seeing and the C/W limits. Worst case 1DPAMZT scenario is still safe. Maintain 2° C Spacing on all limits
Caution High	40.5° C	2.0° C	Limit provides warning before the Warning High limit is reached; ensures that BEP/FEP board temps are below their limits if this limit were to be reached. ACIS Instrument team confirms 2° C pad is sufficient.
Planning Limit	38.5° C	2.0° C	Model error of less than 2 degrees indicates a 2° C pad between the P.L and Caution High is sufficient with a well-calibrated thermal model

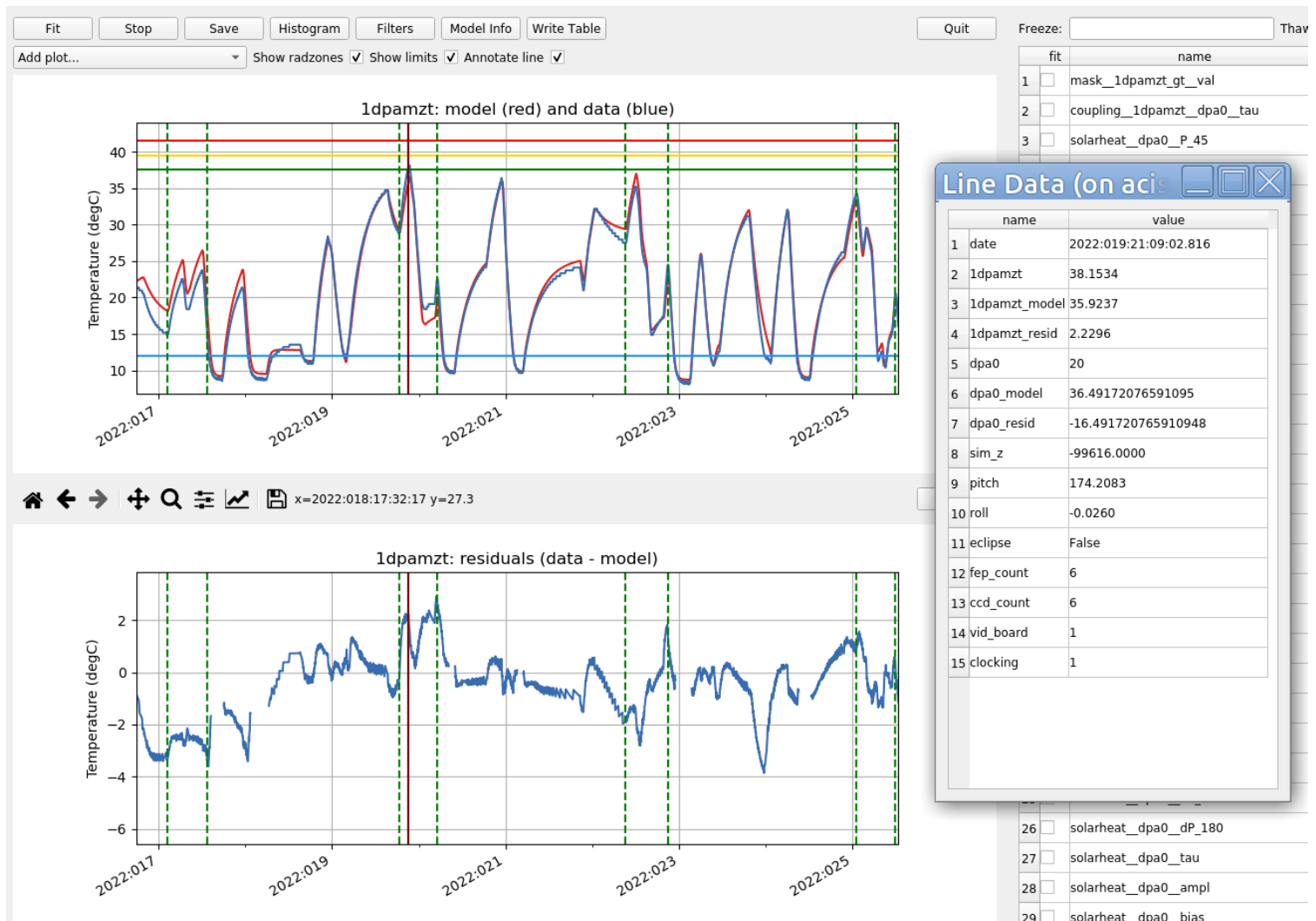
Appendix



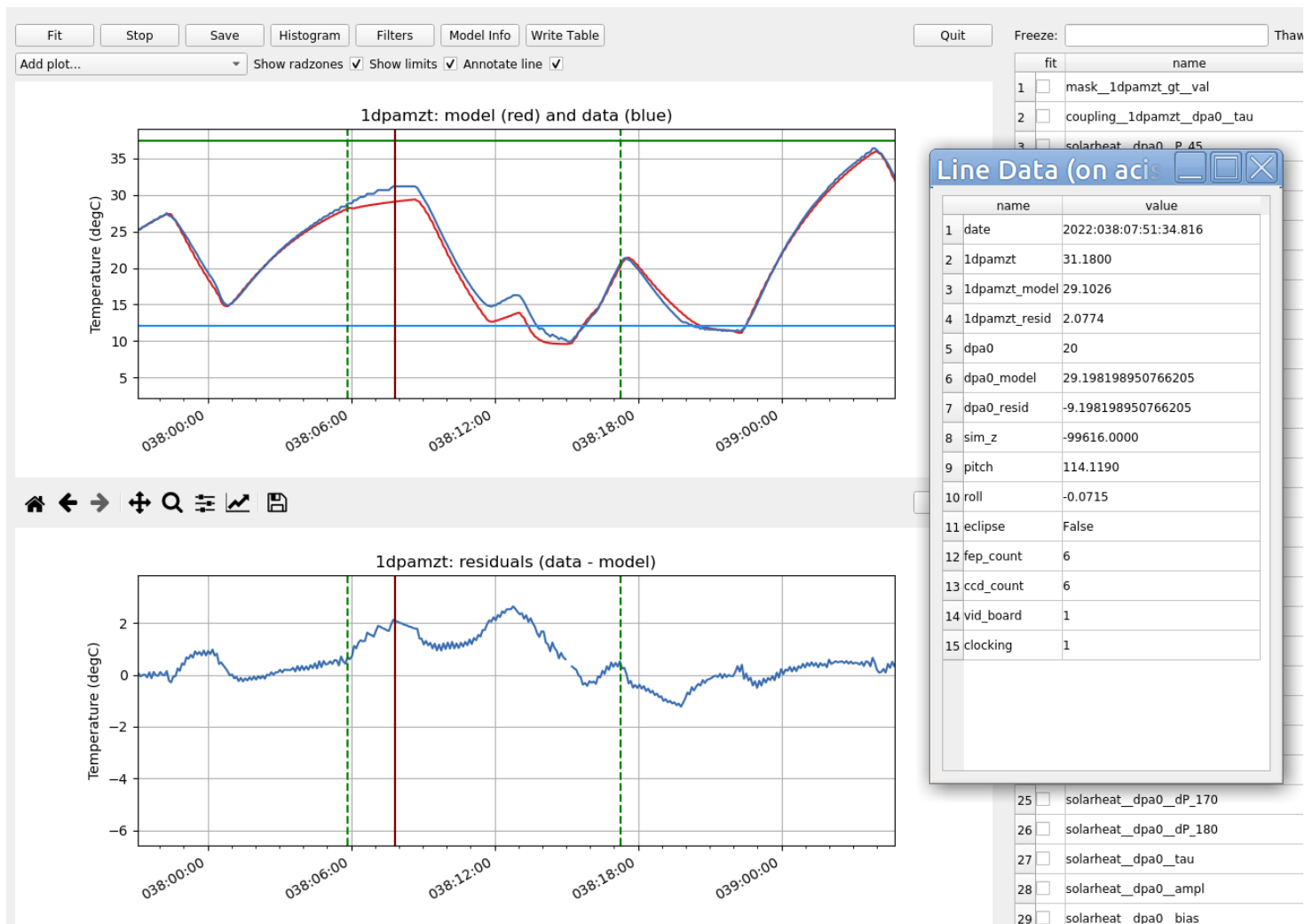
Prepared by: Gregg Germain



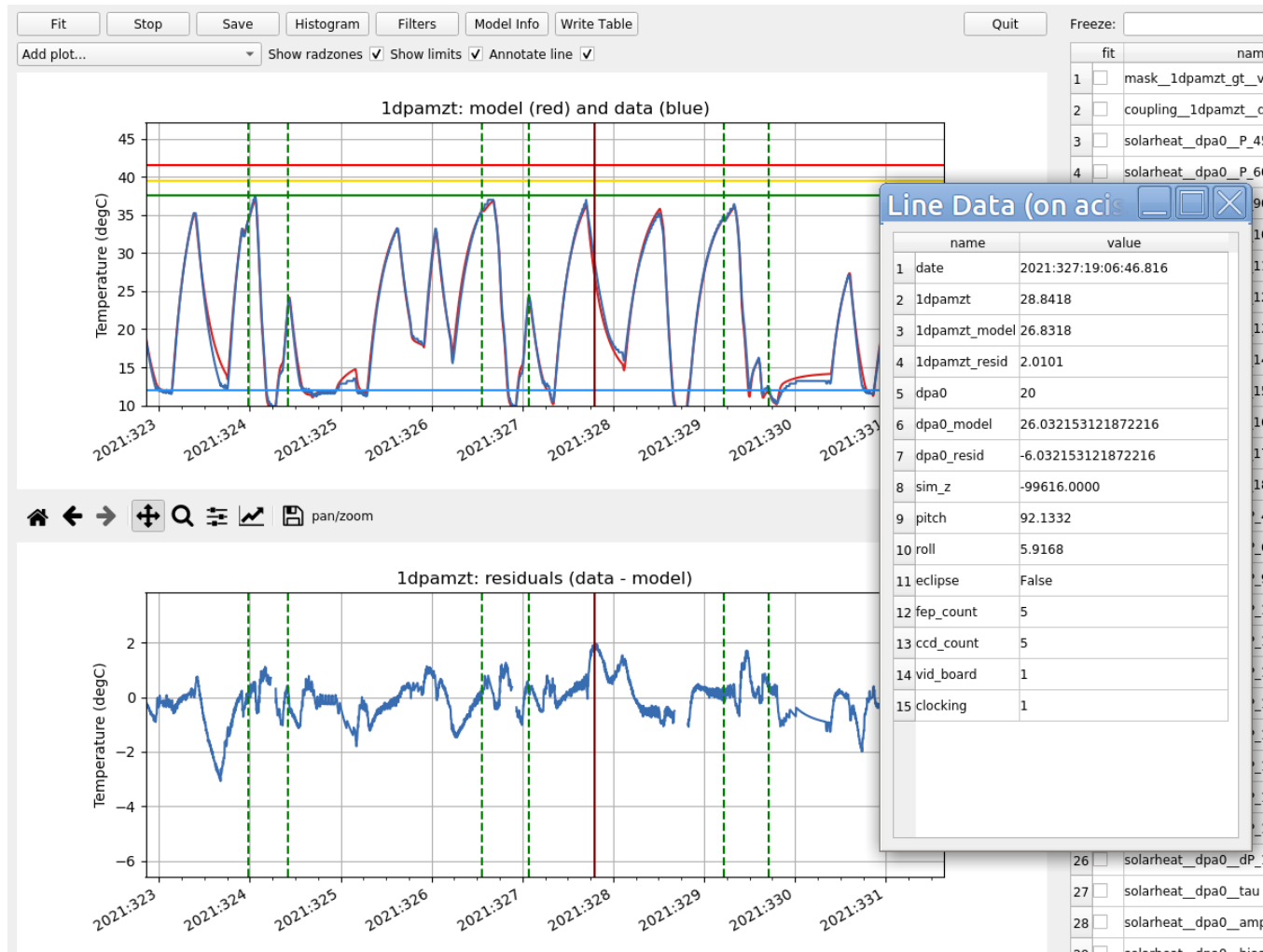


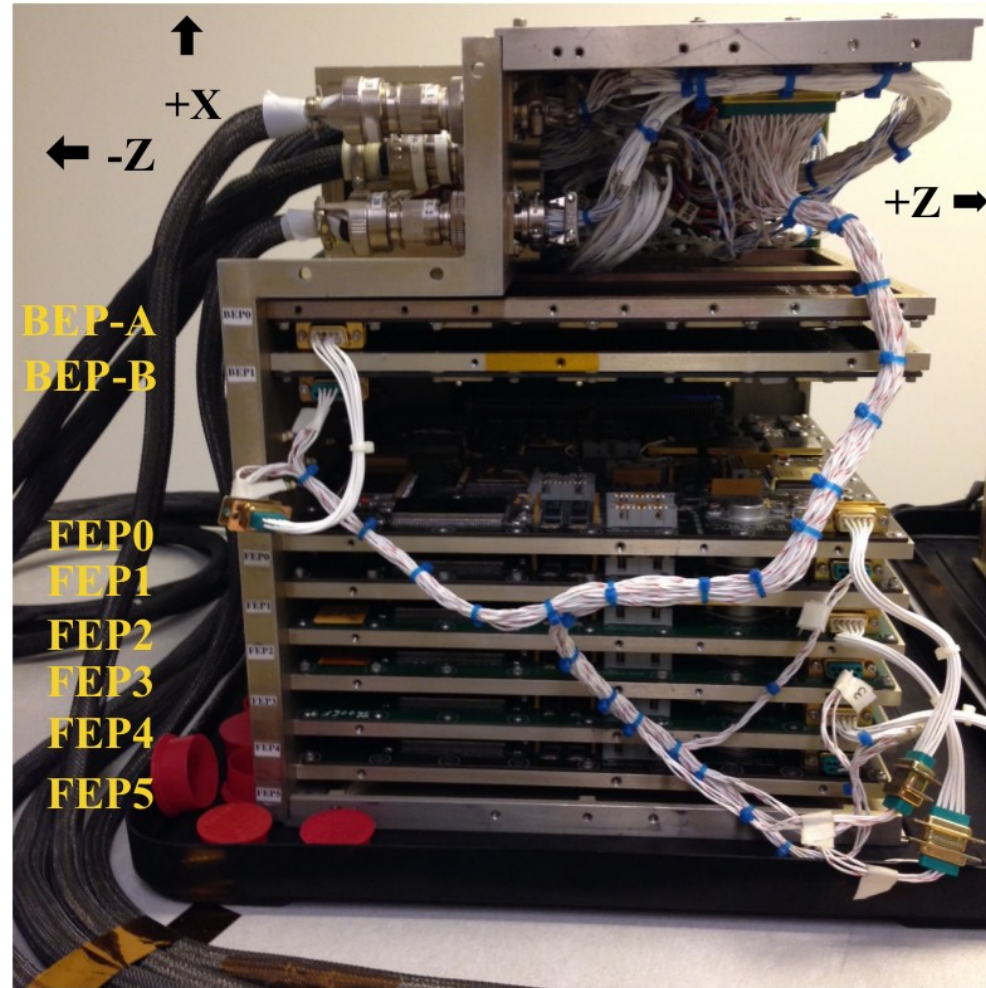


Prepared by: Gregg Germain



Prepared by: Gregg Germain



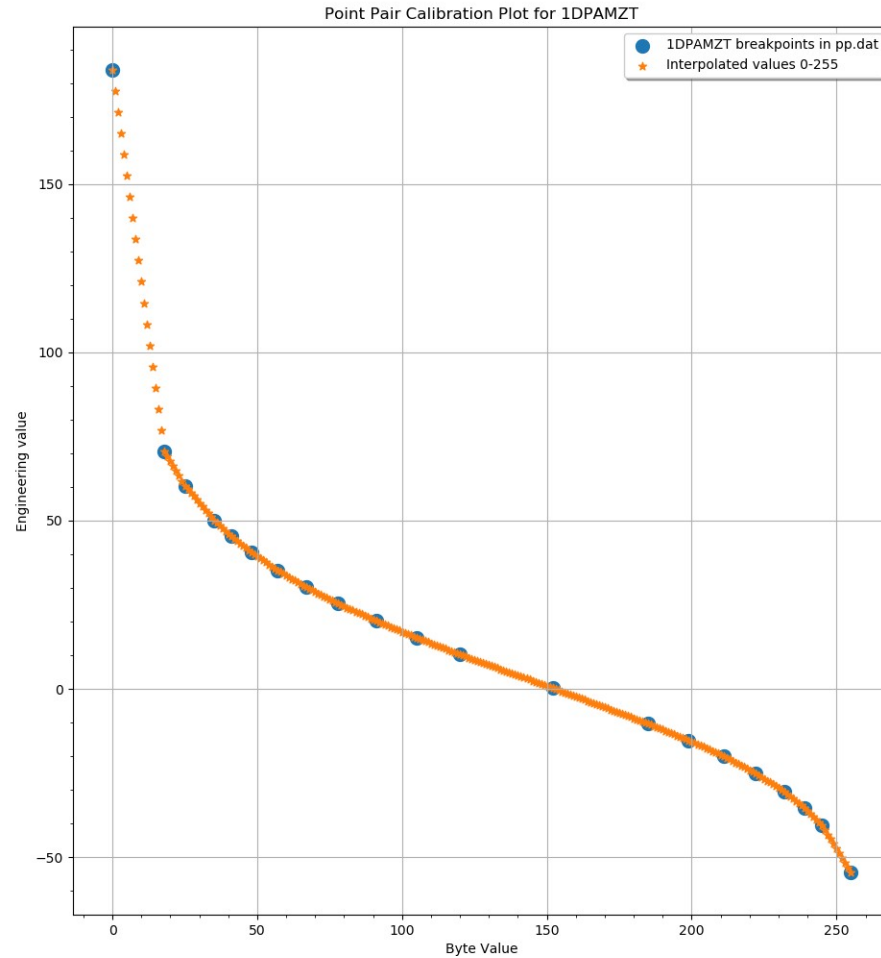


Prepared by: Gregg Germain

1DPAMZT P016 Point Pair Calibration Breakpoints

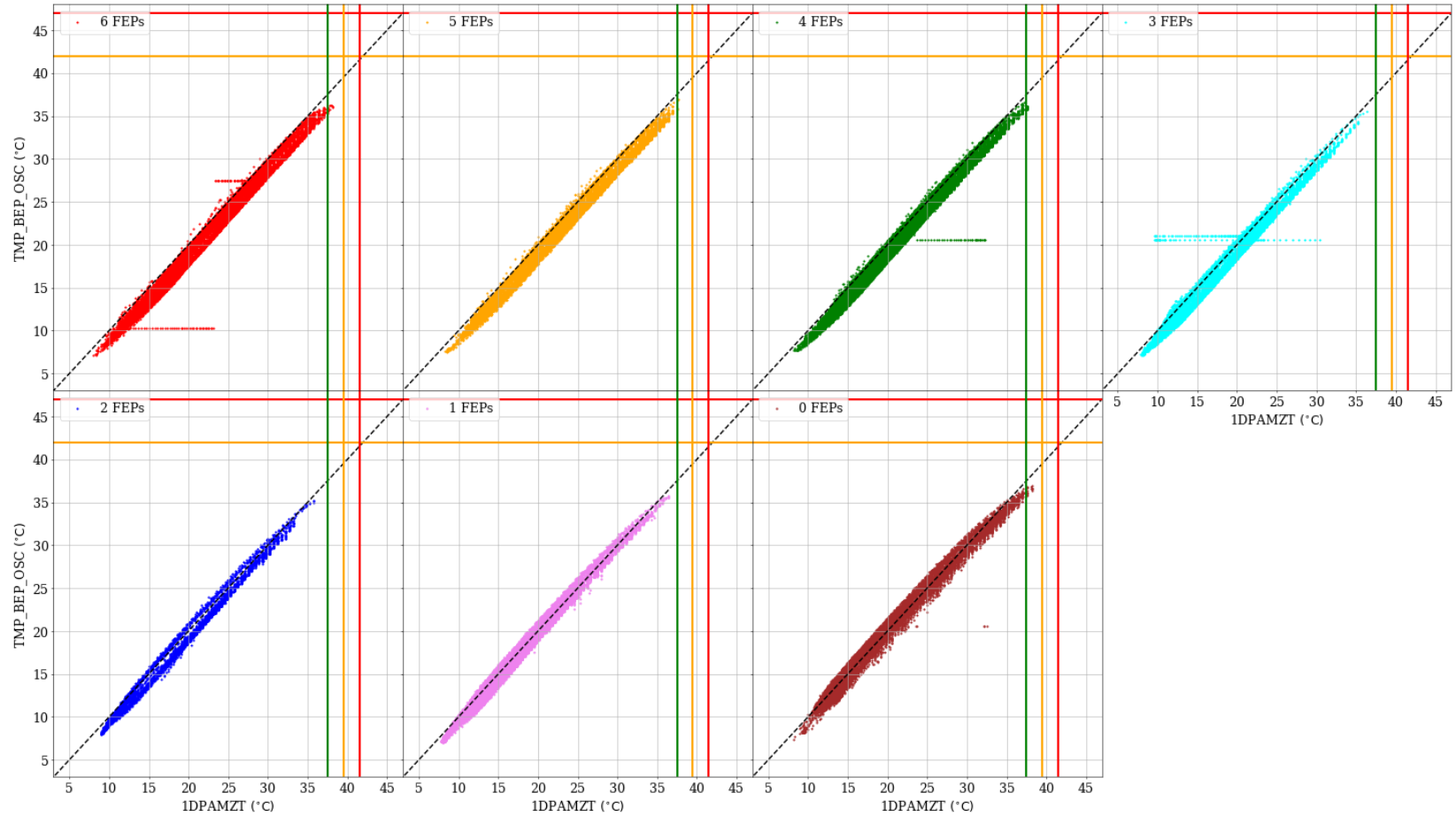
1DPAMZT	,	1,	21,	255, -54.4	;
1DPAMZT	,	1,	10,	91, 20.18	;
1DPAMZT	,	1,	19,	239, -35.34	;
1DPAMZT	,	1,	18,	232, -30.57	;
1DPAMZT	,	1,	17,	222, -25.06	;
1DPAMZT	,	1,	16,	211, -20.03	;
1DPAMZT	,	1,	15,	199, -15.27	;
1DPAMZT	,	1,	14,	185, -10.29	;
1DPAMZT	,	1,	13,	152, 0.2509	;
1DPAMZT	,	1,	20,	245, -40.47	;
1DPAMZT	,	1,	1,	0, 183.9	;
1DPAMZT	,	1,	9,	78, 25.3	;
1DPAMZT	,	1,	8,	67, 30.17	;
1DPAMZT	,	1,	7,	57, 35.22	;
1DPAMZT	,	1,	6,	48, 40.5	;
1DPAMZT	,	1,	5,	41, 45.29	;
1DPAMZT	,	1,	4,	35, 50.1	;
1DPAMZT	,	1,	3,	25, 60.36	;
1DPAMZT	,	1,	2,	18, 70.59	;
1DPAMZT	,	1,	11,	105, 15.19	;
1DPAMZT	,	1,	12,	120, 10.23	;

1DPAMZT P016 Point Pair Cal Plot with Interpolated Bit Values

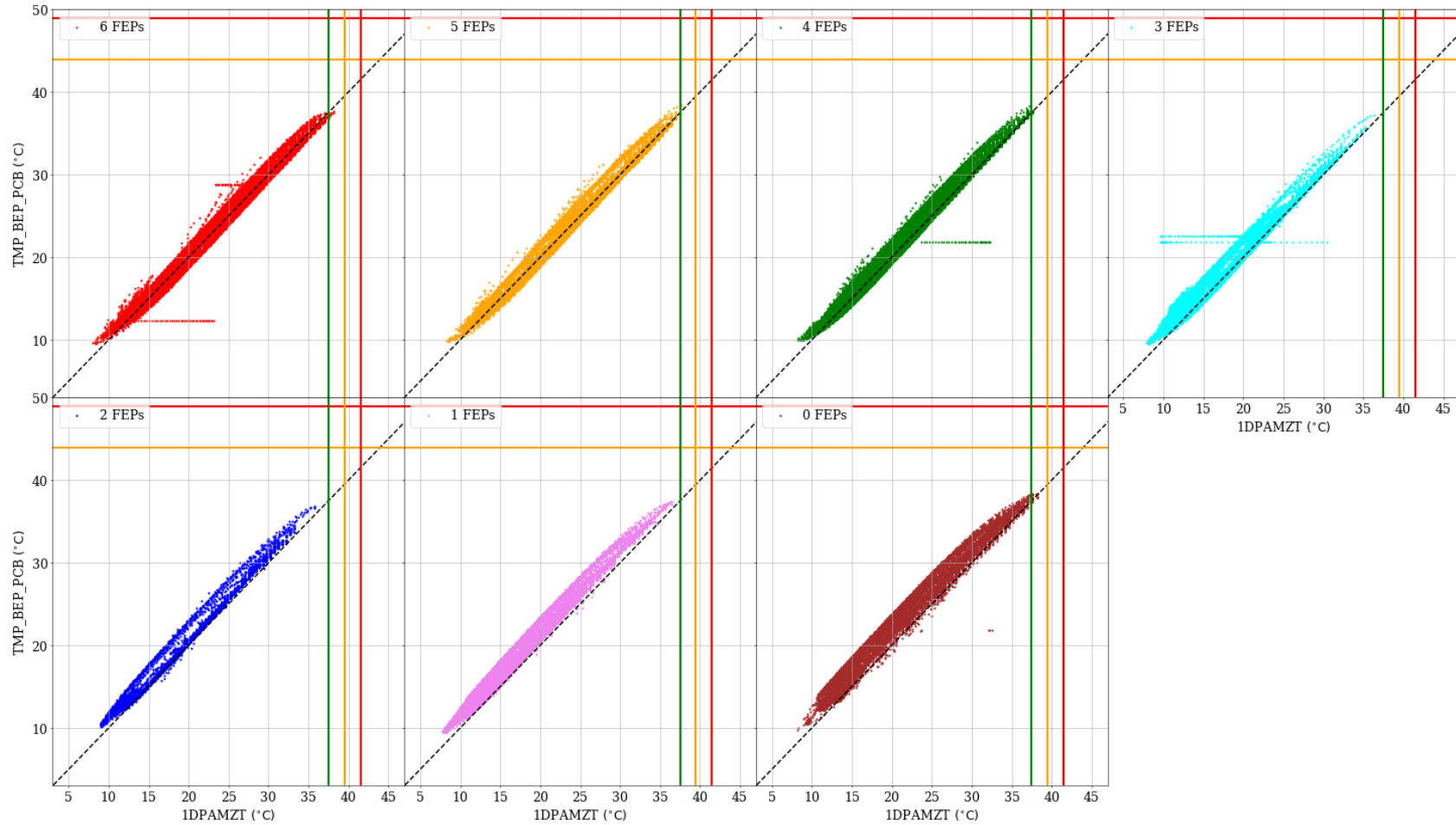


Prepared by: Gregg Germain

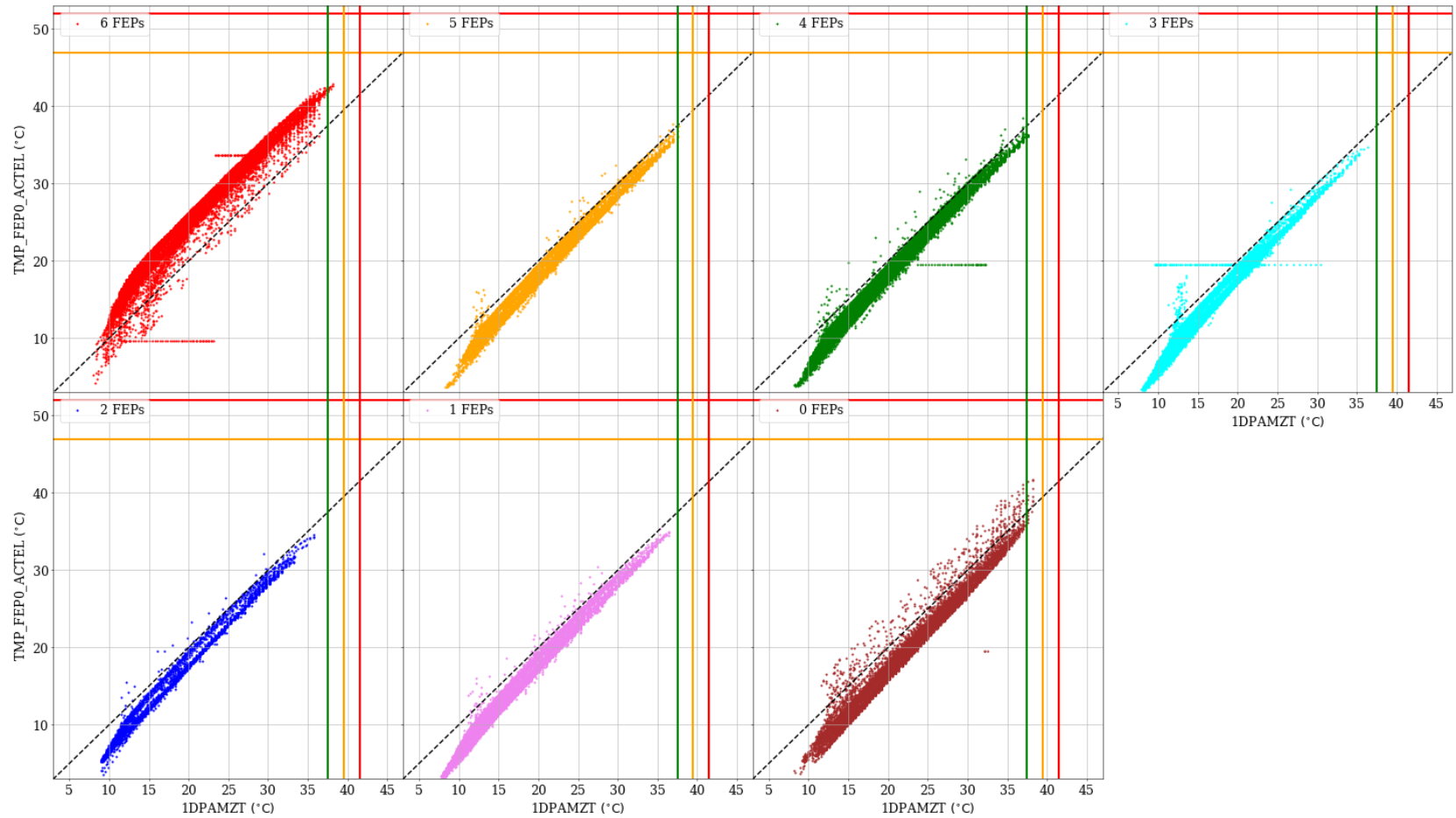
TMP BEP OSC vs. 1DPAMZT 2021:001:00:00.000 - 2022:115:17:53:52.078



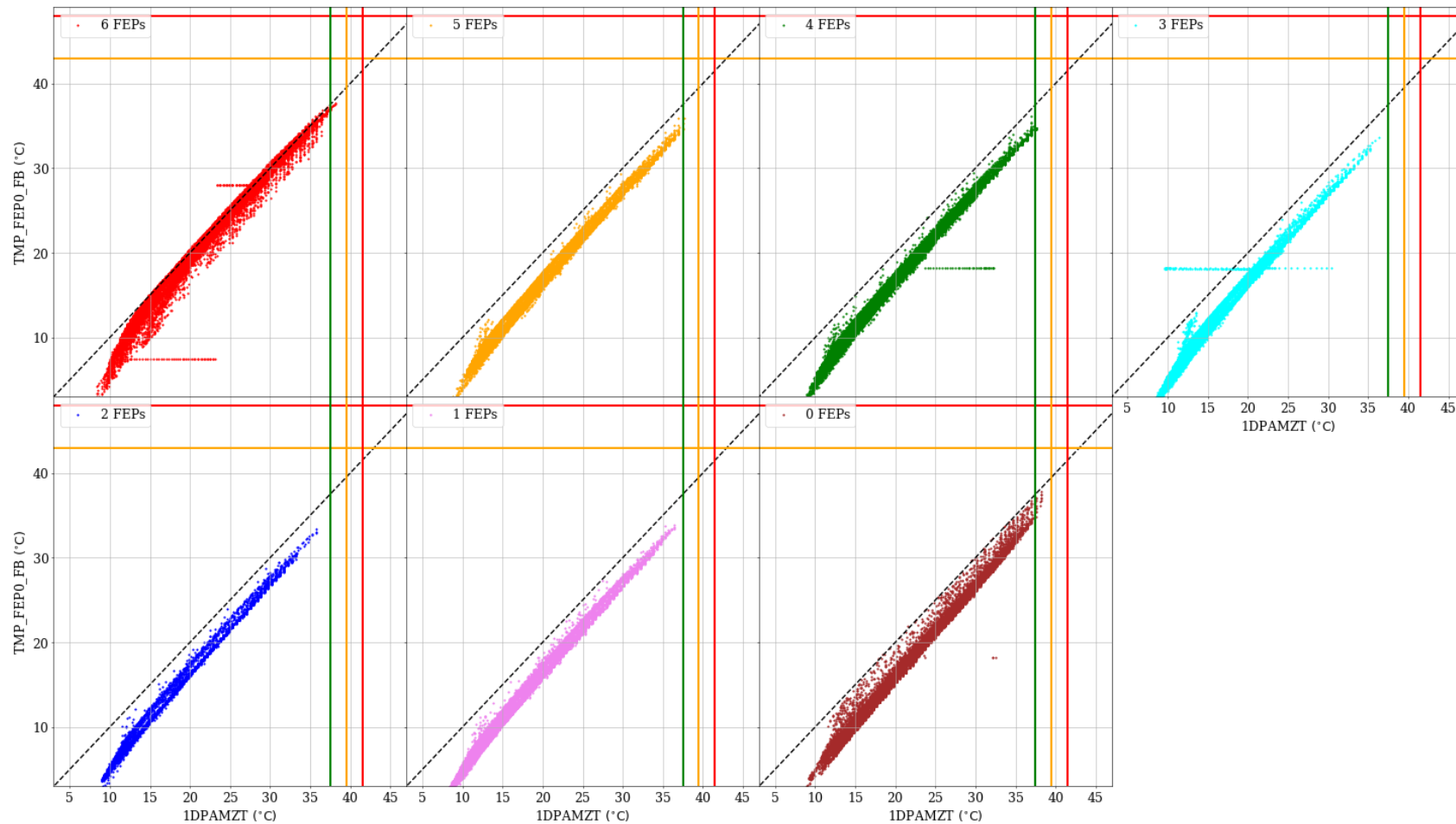
TMP_BEP_PCB vs. 1DPAMZT
2021:001:00:00:00.000 - 2022:115:17:53:52.078



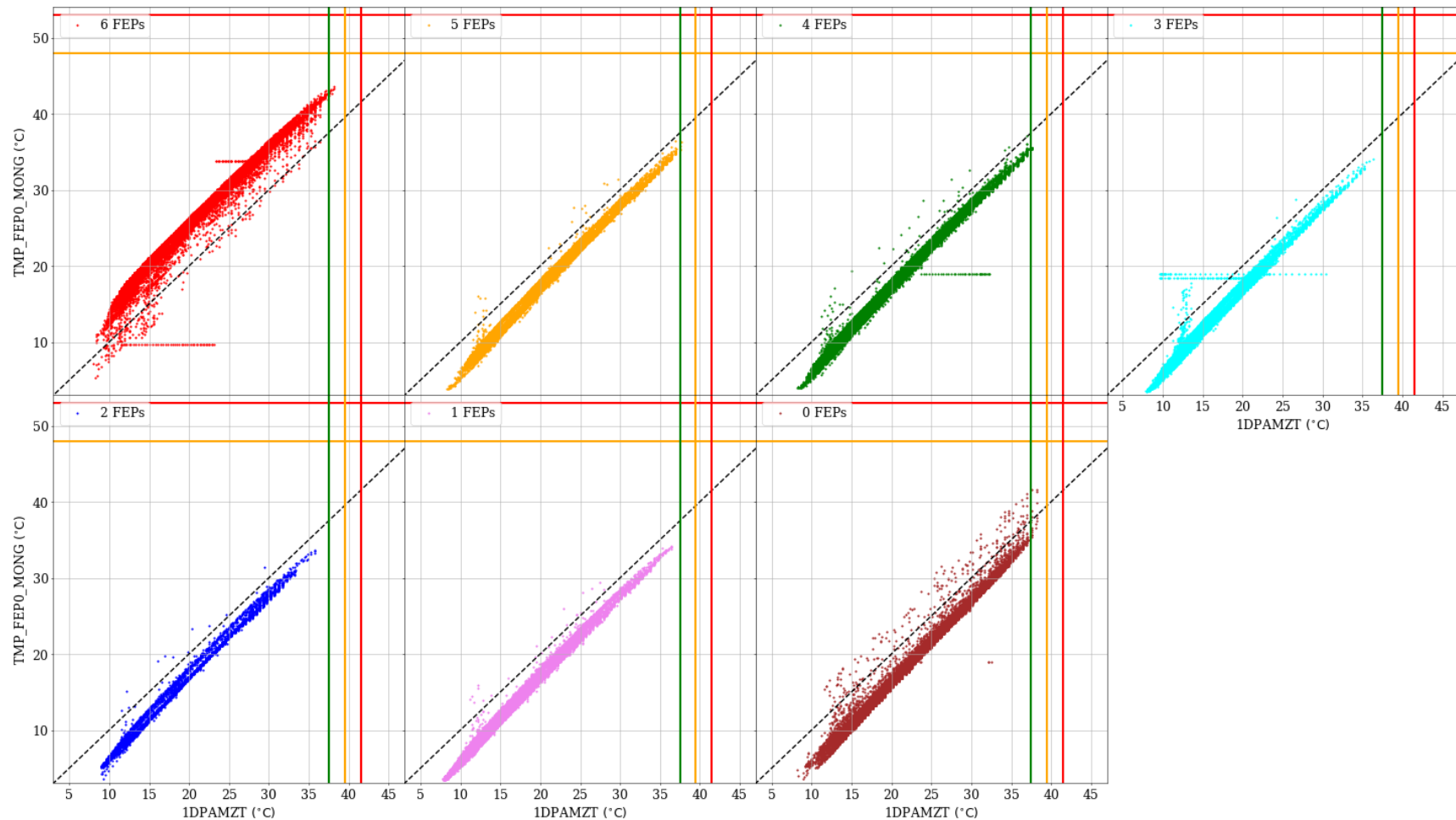
TMP_FEP0_ACTEL vs. 1DPAMZT
2021:001:00:00:00.000 - 2022:115:17:53:52.078



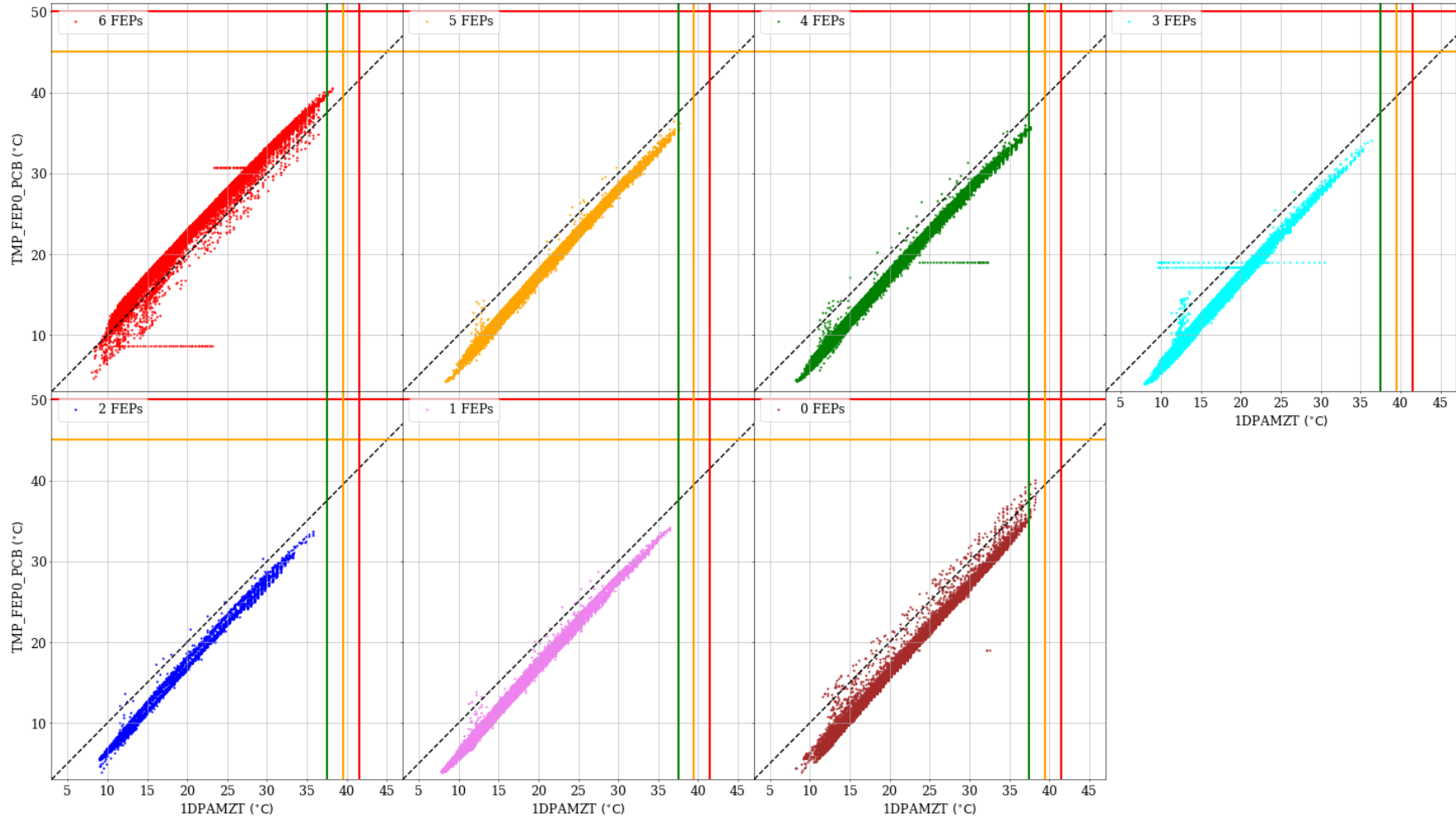
TMP_FEP0_FB vs. 1DPAMZT
2021:001:00:00:00.000 - 2022:115:17:53:52.078



TMP_FEP0_MONG vs. 1DPAMZT
2021:001:00:00:00.000 - 2022:115:17:53:52.078

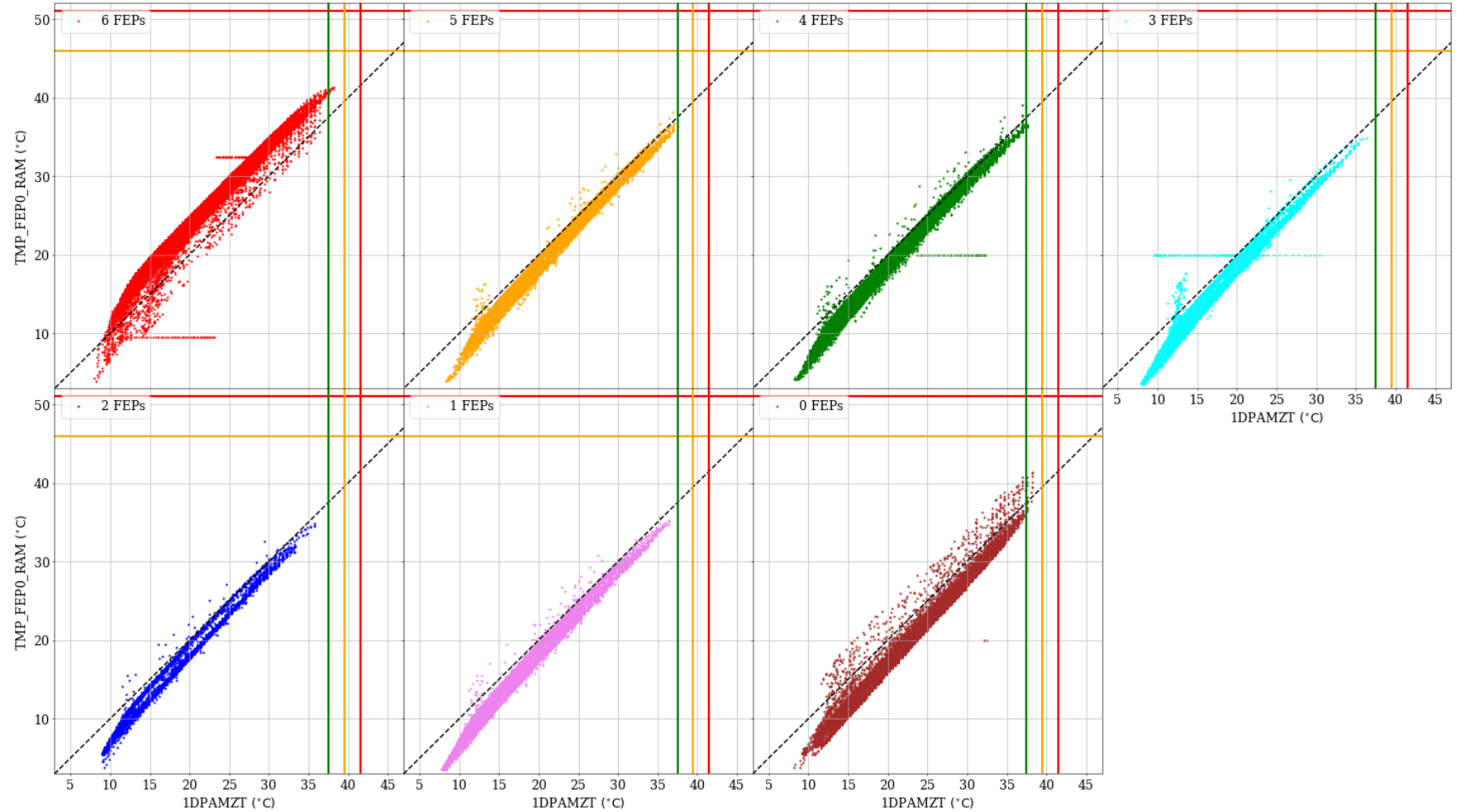


TMP_FEP0_PCB vs. 1DPAMZT 2021:001:00:00:00.000 - 2022:115:17:53:52.078



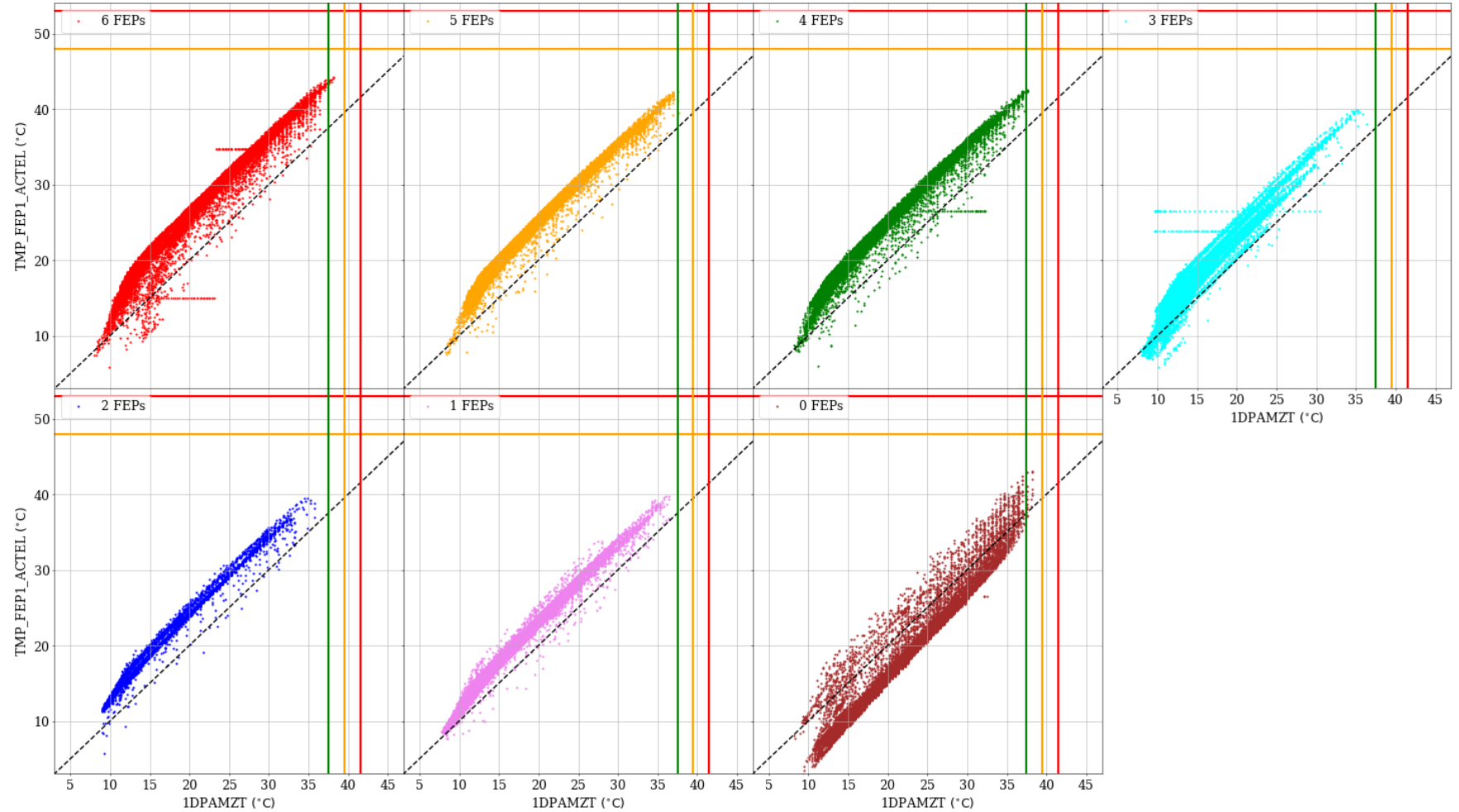
Prepared by: Gregg Germain

TMP_FEP0_RAM vs. 1DPAMZT
2021:001:00:00:00.000 - 2022:115:17:53:52.078



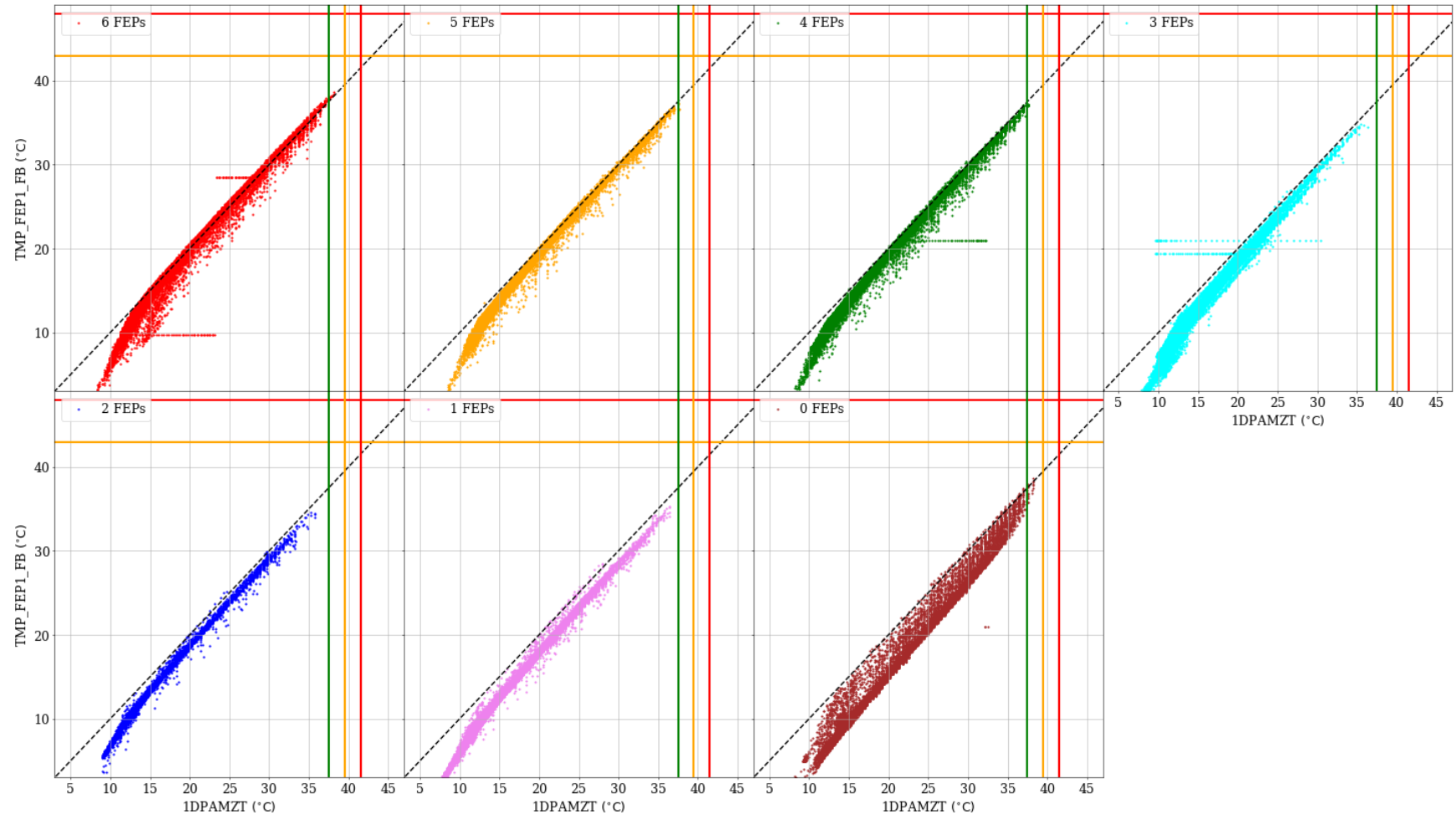
Prepared by: Gregg Germain

TMP_FEP1_ACTEL vs. 1DPAMZT 2021:001:00:00:00.000 - 2022:115:17:53:52.078



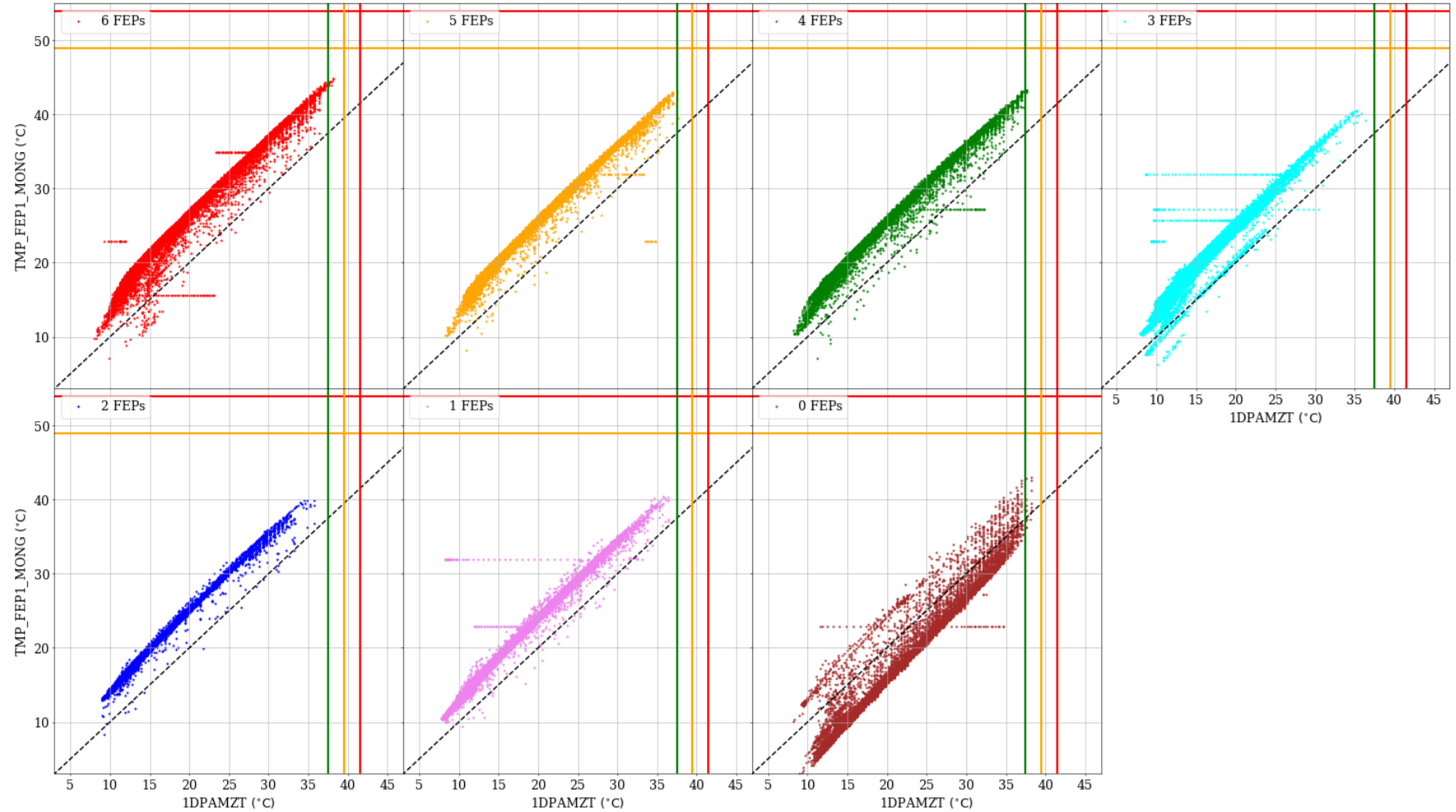
Prepared by: Gregg Germain

TMP_FEP1_FB vs. 1DPAMZT
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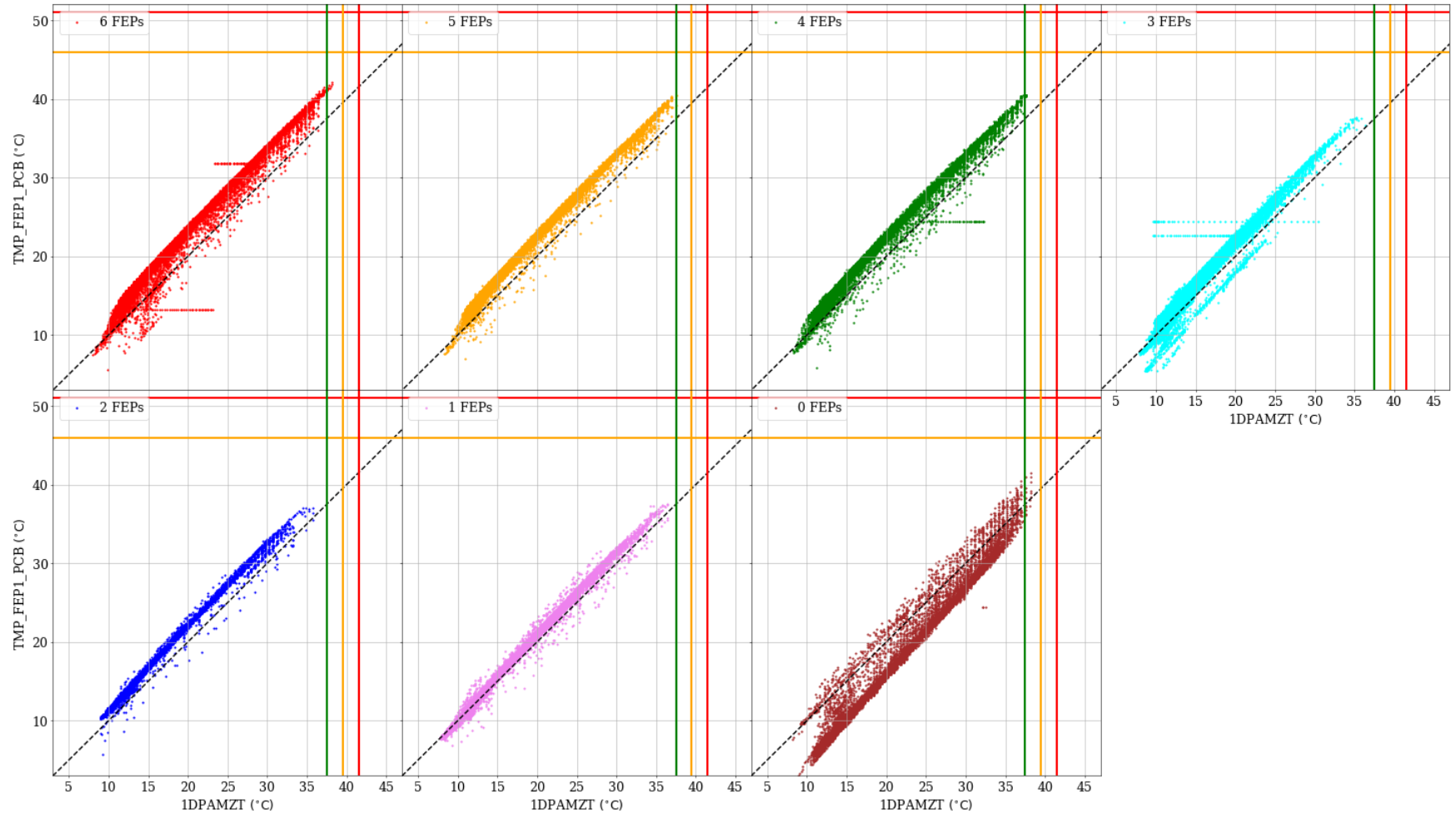
Prepared by: Gregg Germain

TMP_FEP1_MONG vs. 1DPAMZT
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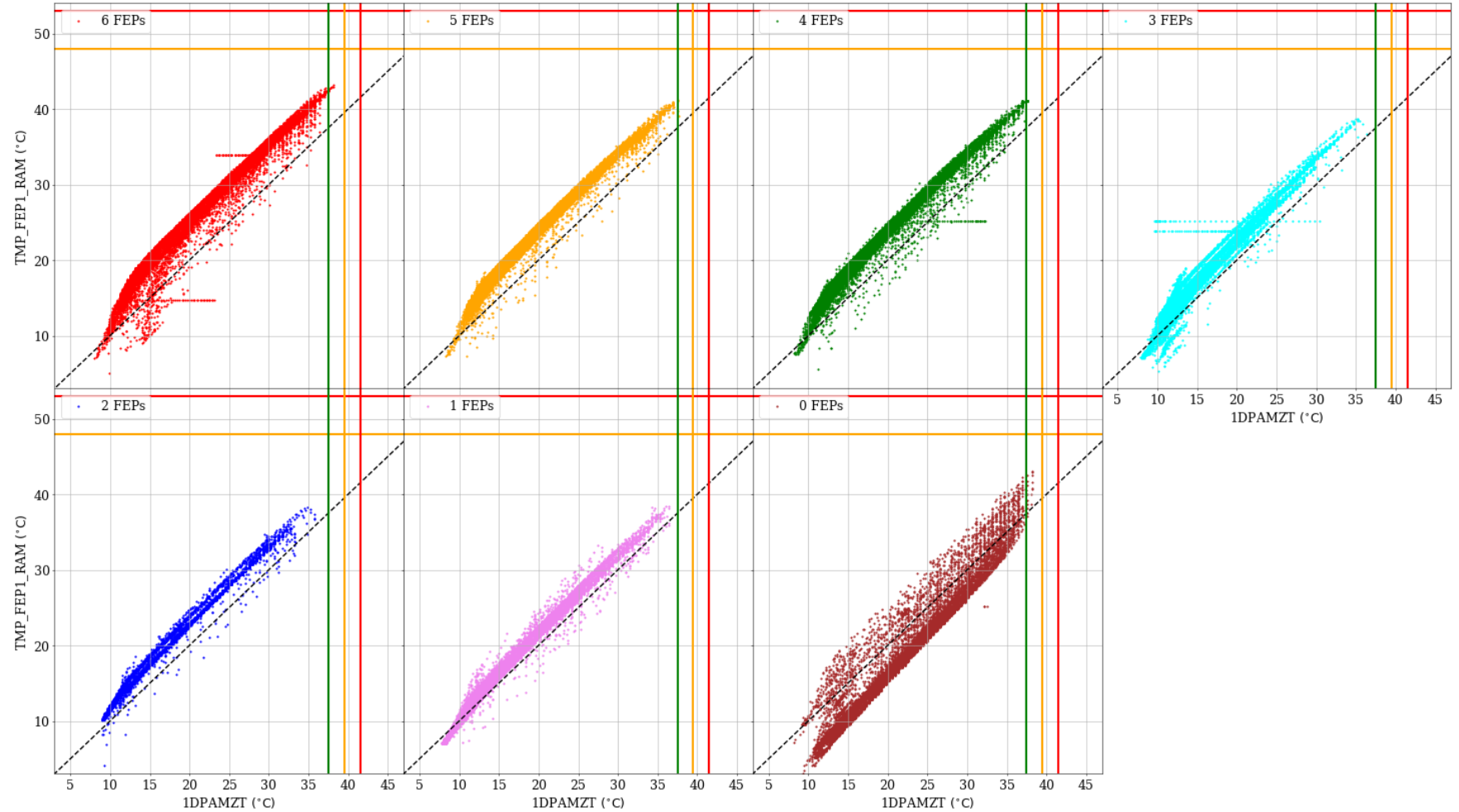
Prepared by: Gregg Germain

TMP_FEP1_PCB vs. 1DPAMZT
2021:001:00:00:00.000 - 2022:115:17:53:52.078



Prepared by: Gregg Germain

TMP_FEP1_RAM vs. 1DPAMZT 2021:001:00:00:00.000 - 2022:115:17:53:52.078



Prepared by: Gregg Germain