

*Chandra X-ray Observatory*  
**The 2020 HRC Anomaly**

*Plan of action for the Side B Swap*  
Chandra Community Briefing  
31 August 2020

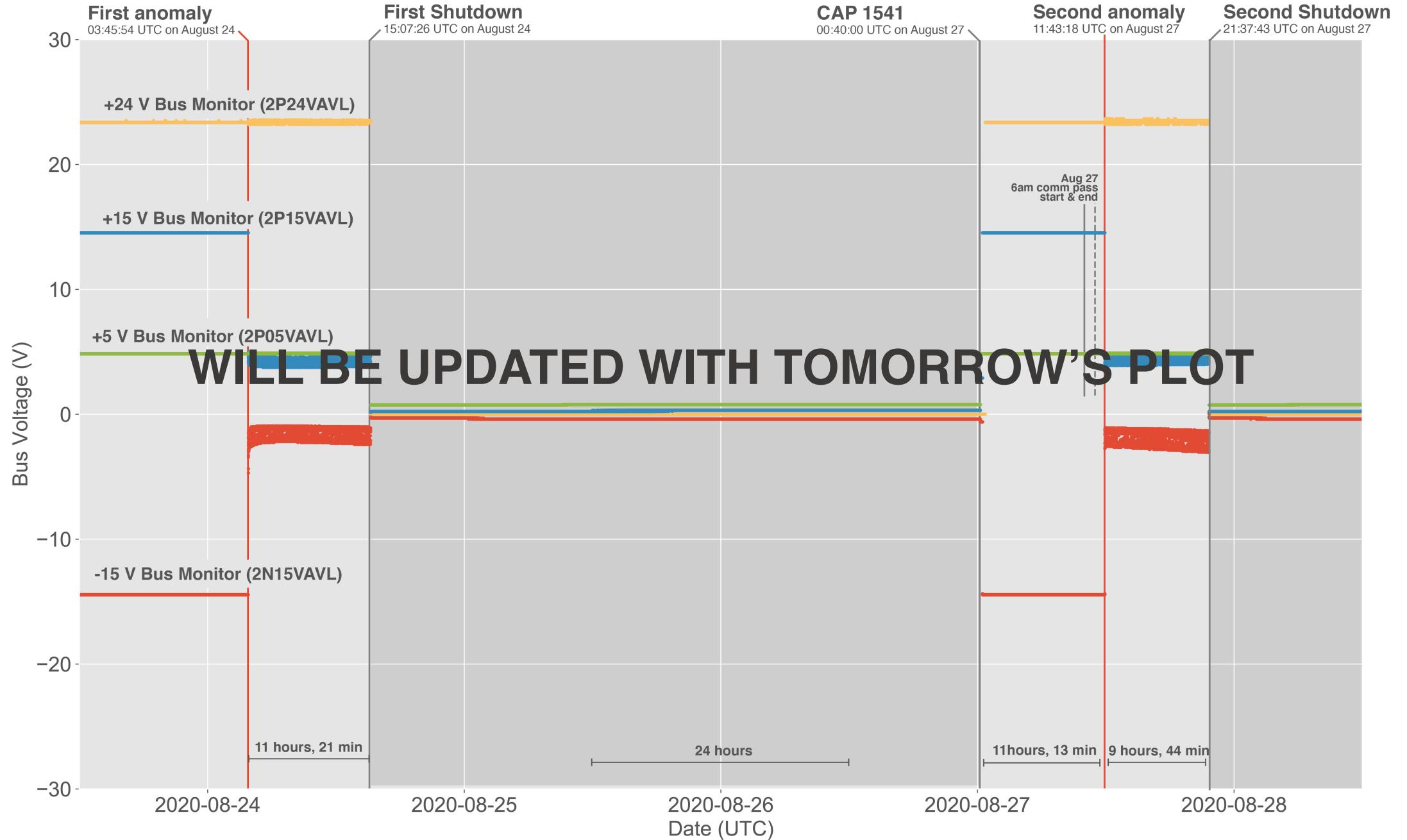
HRC Operations Team

D. Patnaude, R. Kraft, P. Nulsen, G. Tremblay, T. Gauron, A. Kenter, K. Gage, B. Bissell, G. Austin, J. Chappell

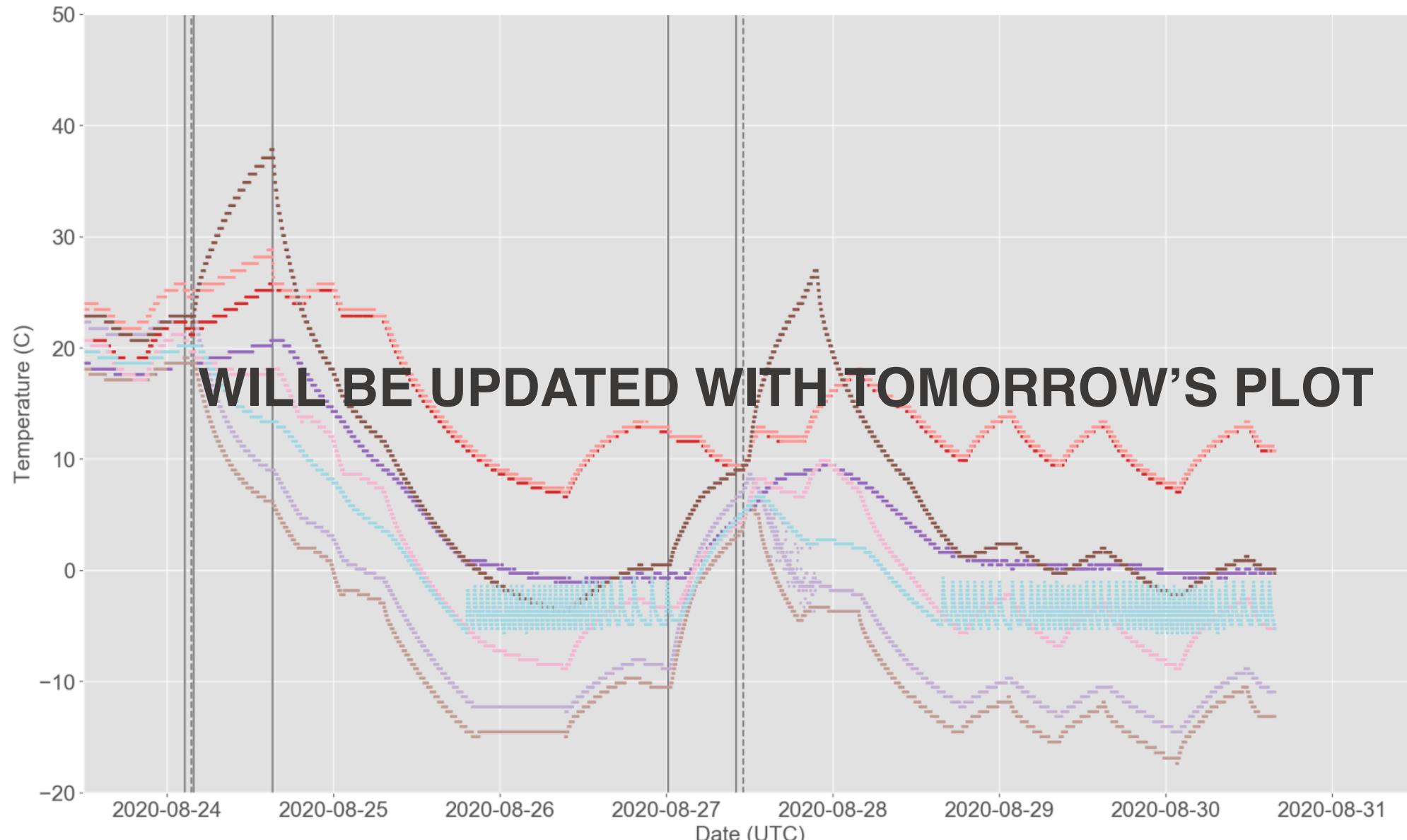
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# The Anomaly

- Last Monday, the HRC suffered from an anomaly of unknown cause, leading to off-nominal voltages on its +/- 15 V bus. The HRC cannot be used for science in this state.
  - A detailed discussion of the anomaly and our subsequent actions can be found in our prior community briefings from last week, [linked here](#).
- Our first plan of action was to **attempt a reset of the Side A power supply bus**, which we successfully completed last Wednesday evening via CAP 1541.
- While the Side A reset did initially return the voltages to nominal values, **the anomaly occurred for a second time** ~11 hours later.
- Our remaining option is to **swap the HRC's power configuration to CEA B on the redundant bus**.



# Current thermal status of the HRC

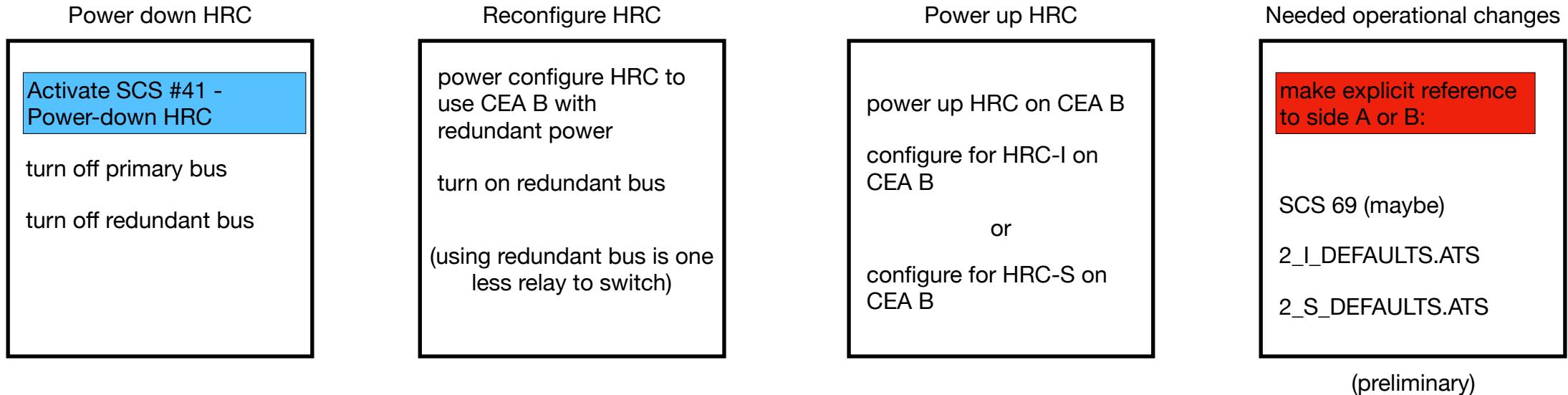


# Plan for the Side B Swap

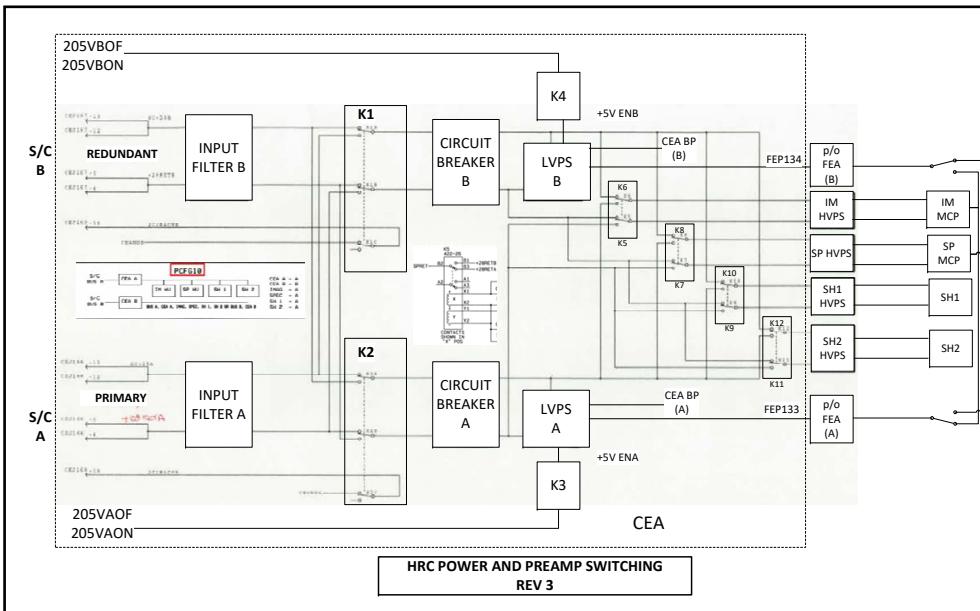
- For the past three days, the HRC Team has been reviewing, analyzing, and discussing the commanding and procedures necessary to make this change.
  - This includes an informative search through shift reports, early logs and notes, etc.
- We have now prepared **CAP 1543**, which will switch the +5 V, +/- 15 V, and +24 V power supplies to Side B electronics using the redundant +28 V power bus from the spacecraft.
  - The CAP also performs a configuration of the instrument to its default state. It does *not* power up the voltages on the micro-channel plates, nor does it bring up the anti coincidence shield. This will be done after the HRC Team is satisfied with the health and stability of the instrument following the CAP.
- Pending a successful review immediately following this meeting, the HRC Team and the FOT **are prepared to execute this CAP today**.
  - We will use this afternoon's 1:40pm EST (BOT) extended (2h 35m) comm pass for this activity.

# EXTRA SLIDES

## Top level diagram to switch from Side A on the Prime Bus to Side B on the Redundant Bus



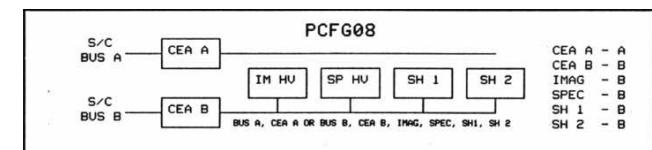
### HRC Power Switching



### Post-power up HRC

turn on PMT#2  
turn on HRC-I/S HV  
ramp up HRC-I/S HV - point at blank sky

Swap to side B on redundant bus is represented by power configuration PCFG08



## Hypotheses from 8/28 tag

- The rapid reoccurrence of the anomaly **now disfavors a single event upset (SEU) scenario.**
- Timescales argue that **the thermal environment is one potential driver of whatever is causing the anomaly.**

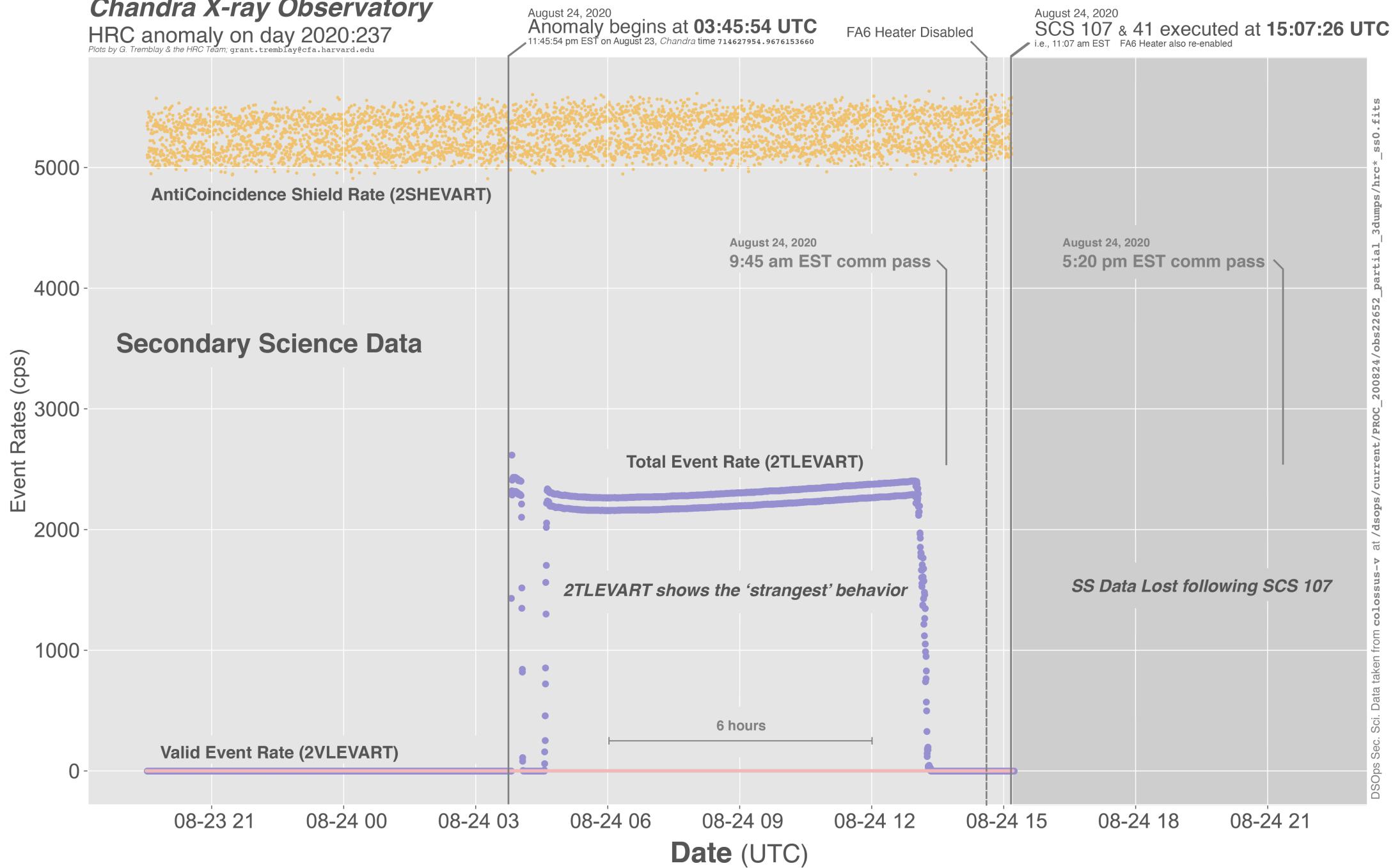
# Hypotheses from 8/26 tagup

- The anomaly is due to a problem **with the +/- 15 V power supply bus on Side A**
    - **A problem in the +15 V bus would also take out the -15 V power supply due to DC-to-DC design**
      - A problem in the -15 V bus would not cause issues with the +15 V bus
    - **There could be a fault in the electronics on this bus**
      - A load fault that is transient in nature (e.g. an SEL). This should clear with a power cycle.
- ... or ...
- A failed component that is dragging down the +15V bus. This would not clear with a power cycle and would require an A/B swap.
- ... or ...
- A latched-up component downstream of DC-DC converter may clear with power cycle. Otherwise an A / B swap is indicated.

# Chandra X-ray Observatory

HRC anomaly on day 2020:237

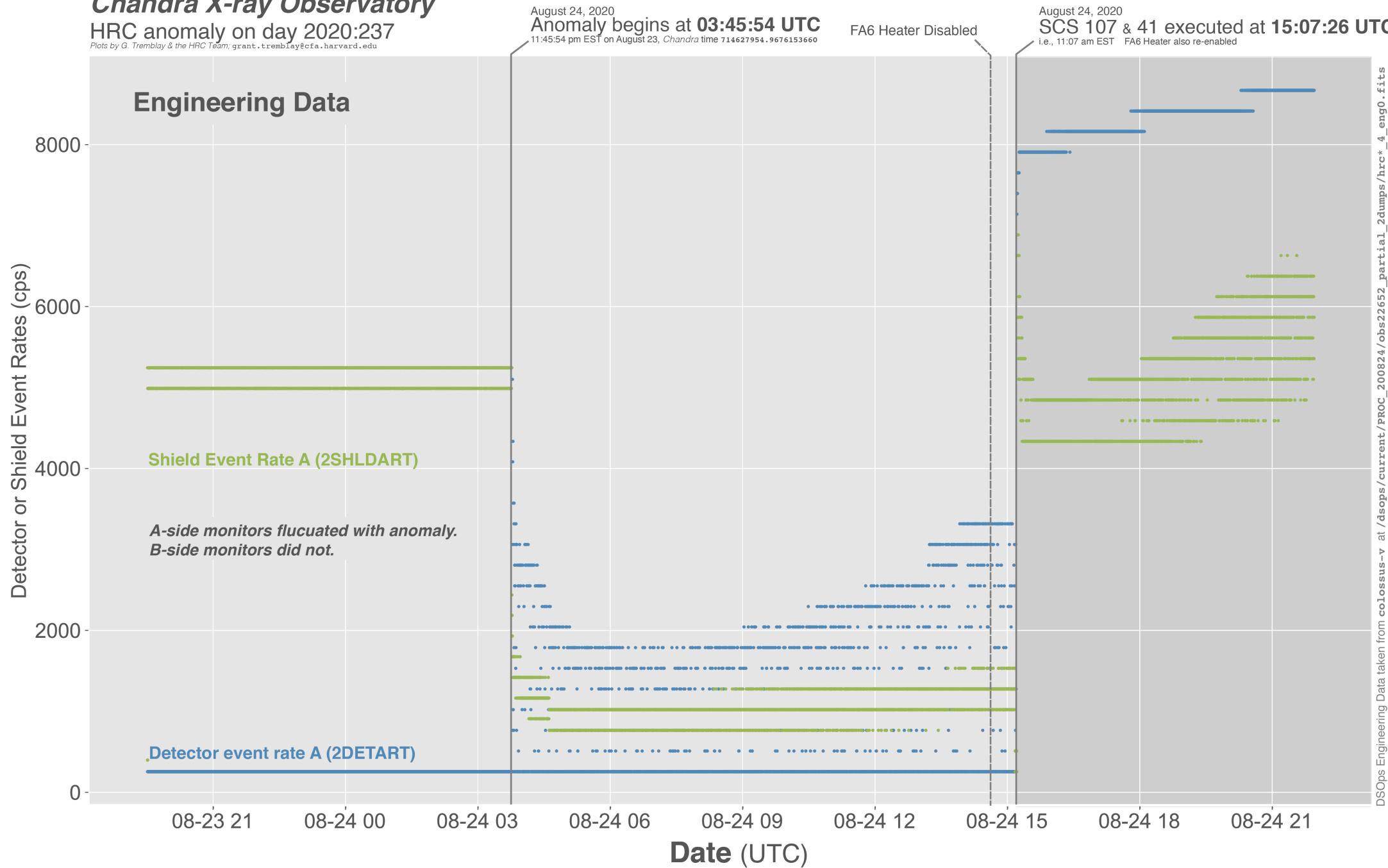
Plots by G. Tremblay & the HRC Team: grant.tremblay@cfa.harvard.edu



## ***Chandra X-ray Observatory***

HRC anomaly on day 2020:237

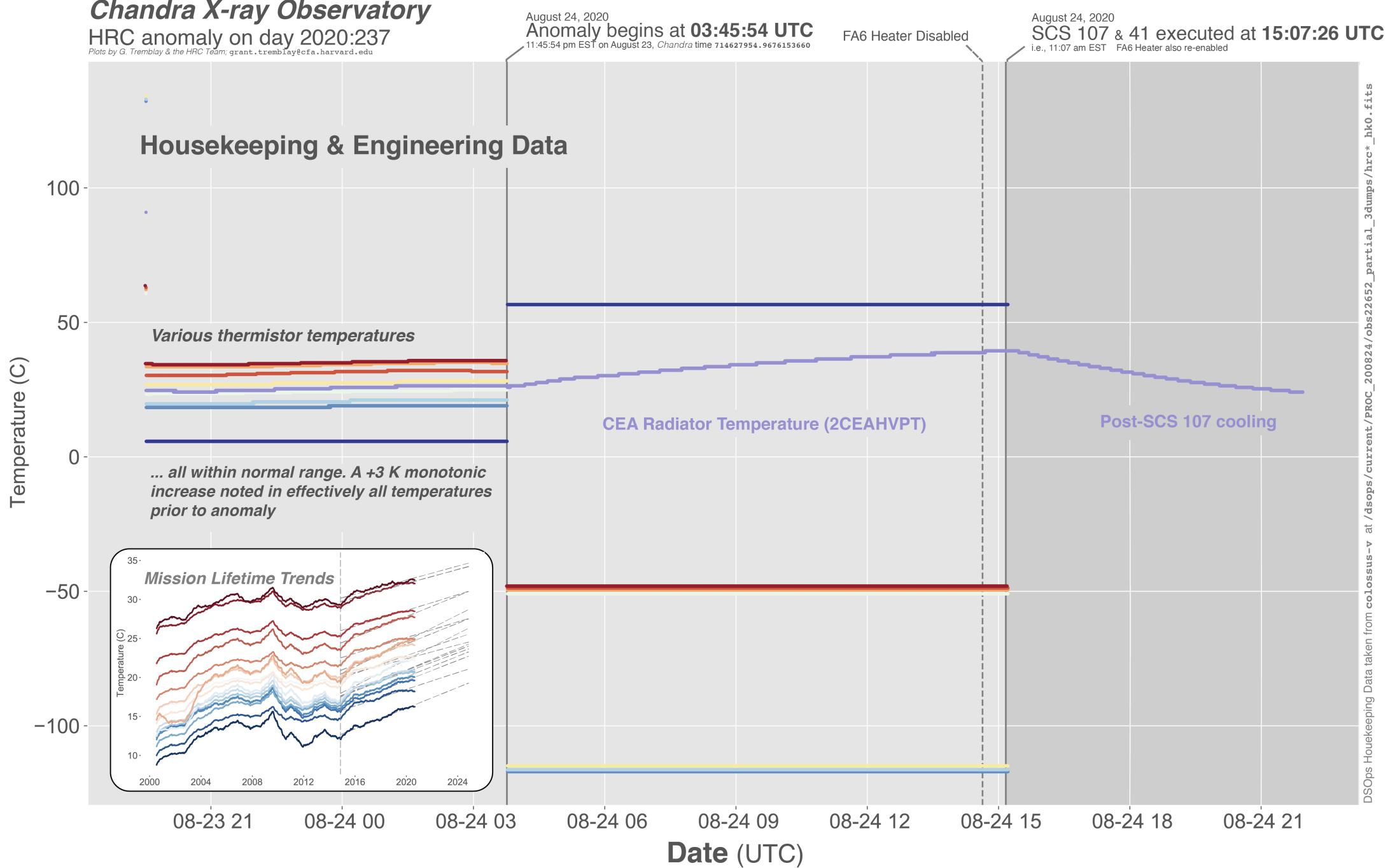
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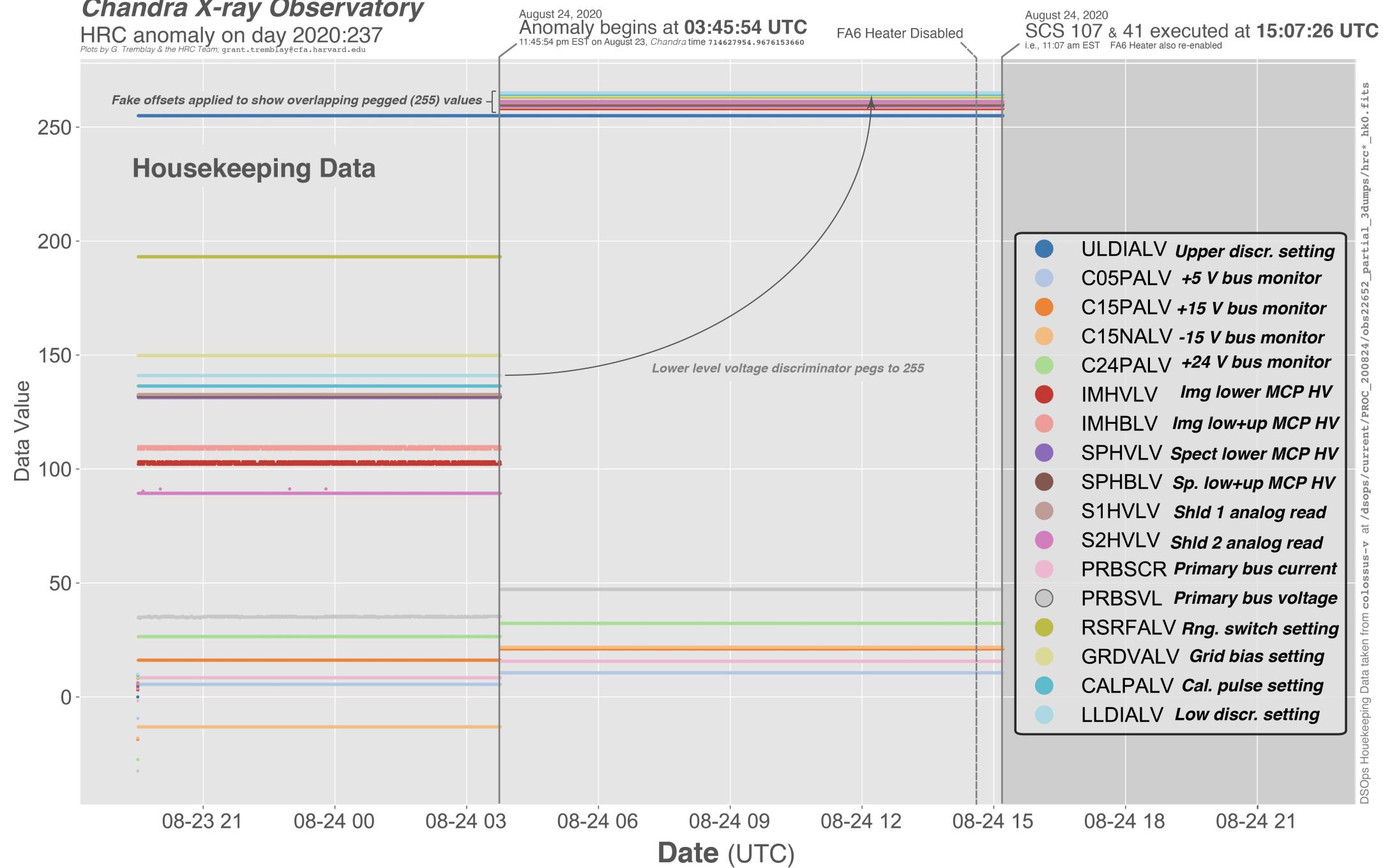
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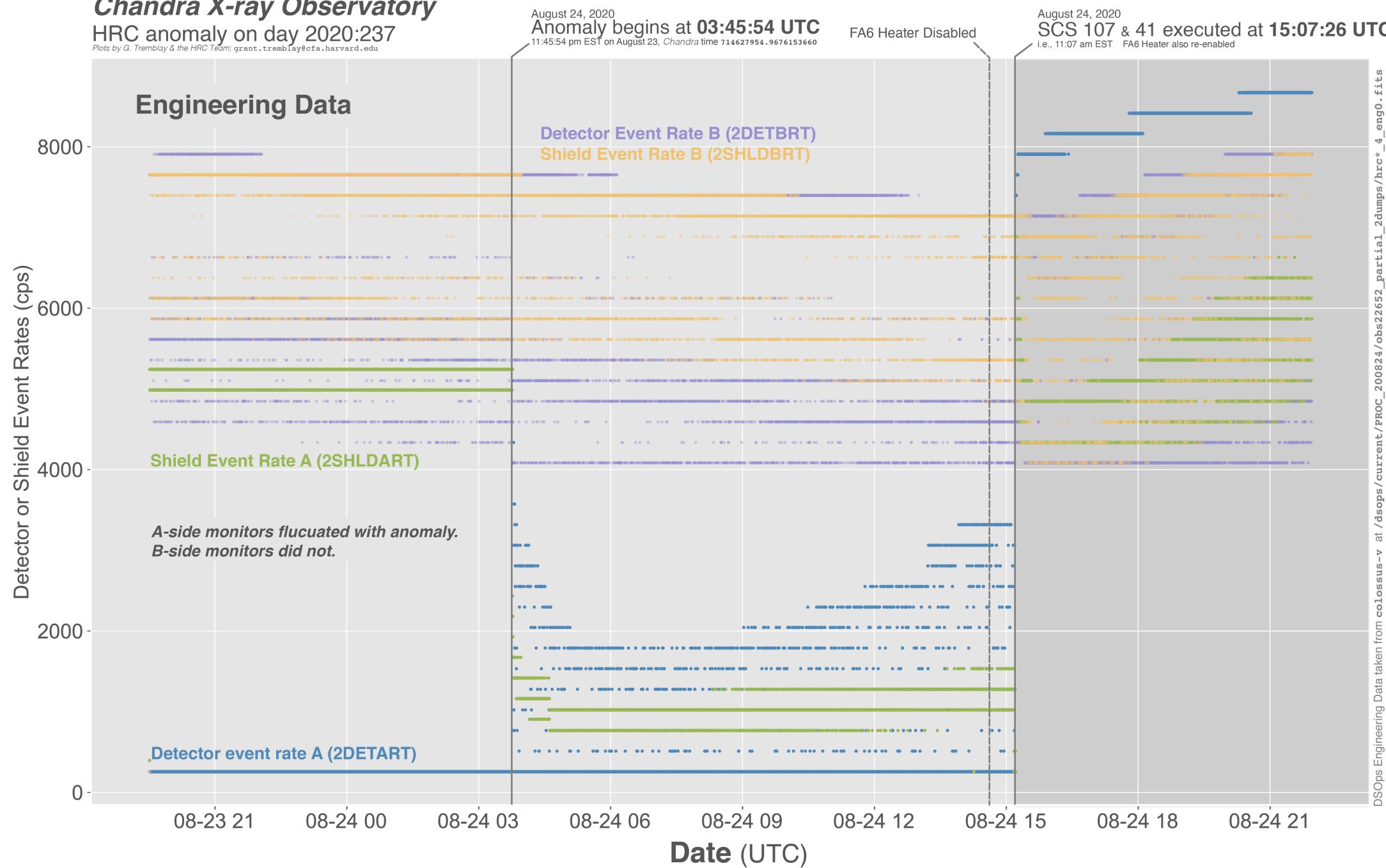
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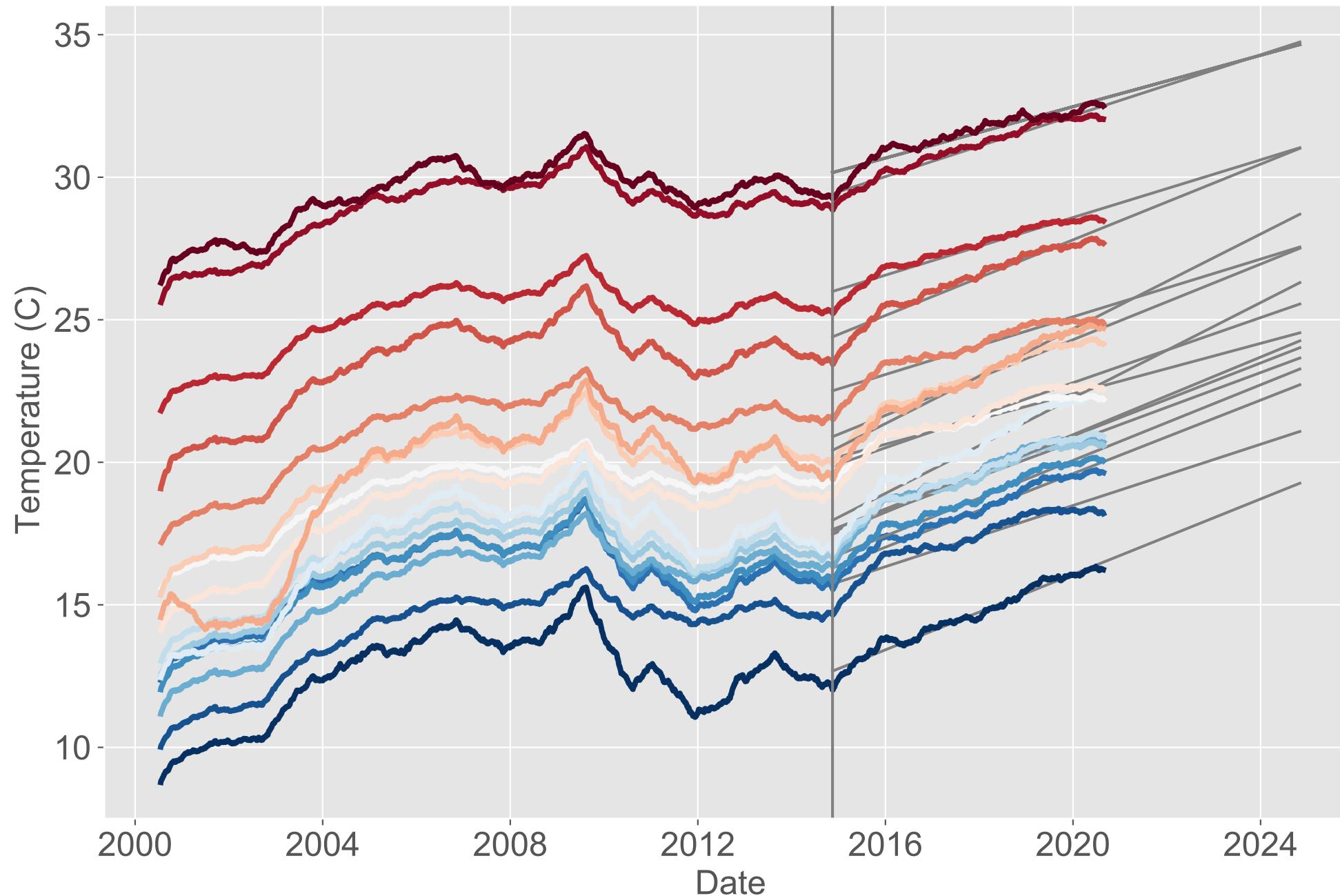
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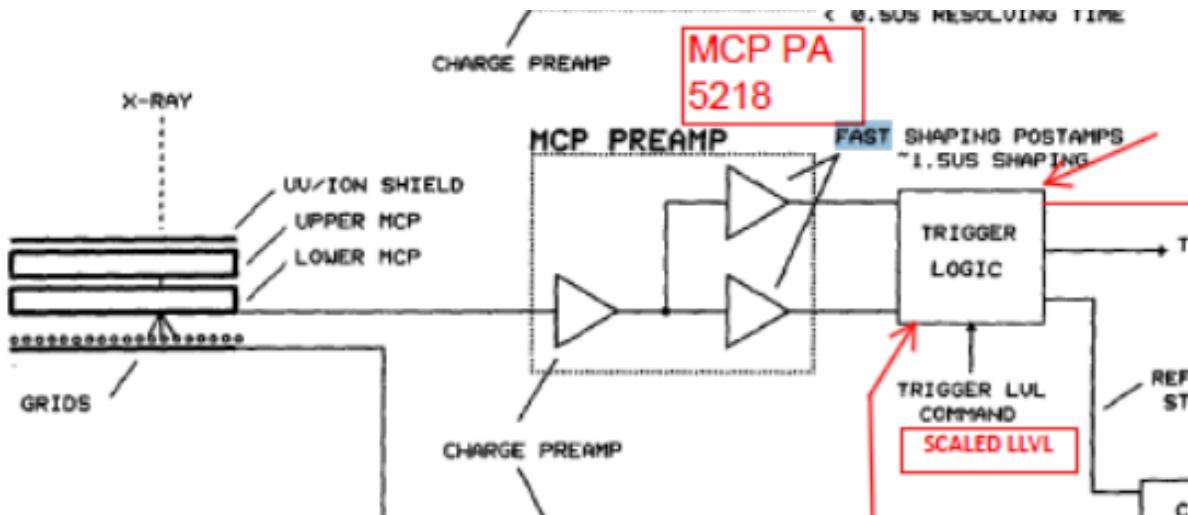
## Forecasted HRC Thermistor Temperatures if Current Slopes Hold



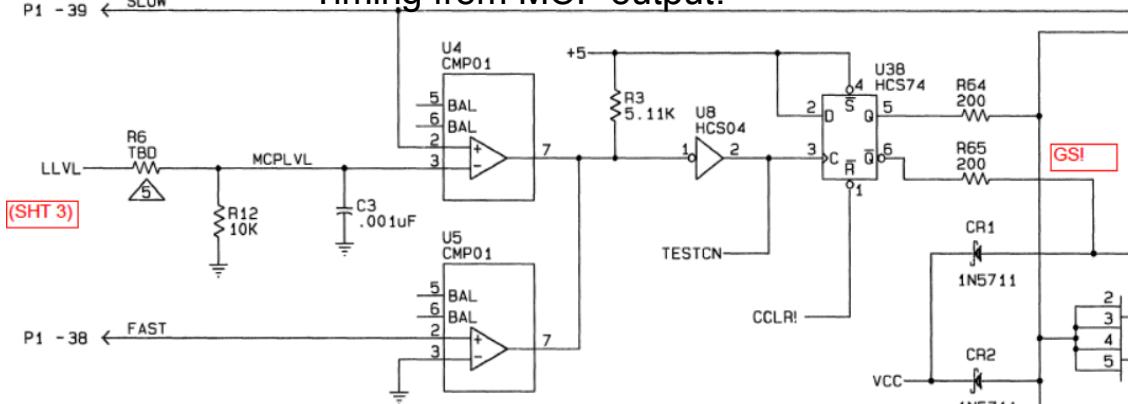
# Explanation of trigger noise

(T. Gauron)

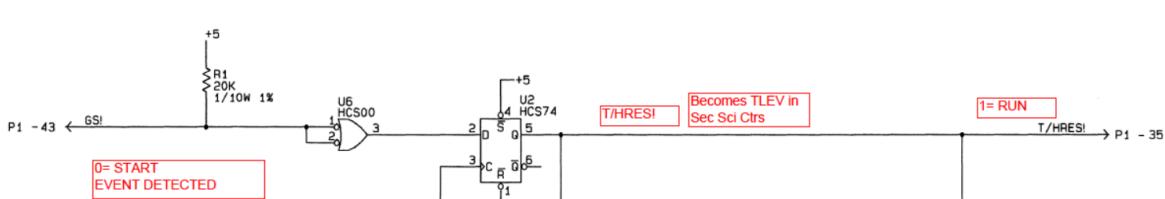
Top Level Trigger from MCP output:



Timing from MCP output:



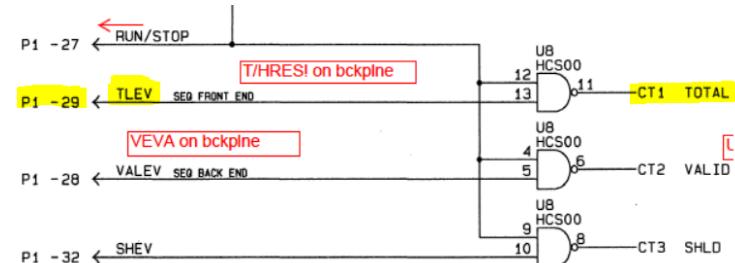
GSI! is synced with S/C clock and becomes T/HRES! in SEQUENCER



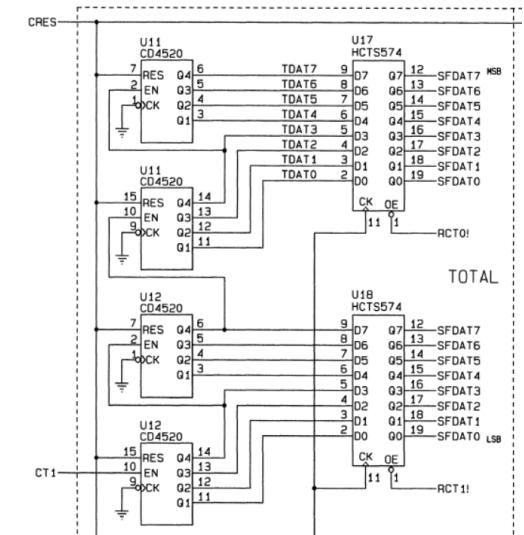
T/HRES! Routes to SEC\_SCI\_CTR pin 29 on backplane

CE	SLOT 11	SEC SCI CTR A
5209		
CEJ11	0 1	CE+15A
46	0 2	CEGND
47	0 3	CE-15A
48	0 4	CEGND
49	0 5	CE+5A
50	0 6	CE-5A
51	0 7	
52	0 8	
53	0 9	
54	0 10	
55	0 11	
56	0 12	
57	0 13	
58	0 14	
59	0 15	
60	0 16	
61	0 17	
62	0 18	
63	0 19	
64	0 20	
65	0 21	
66	0 22	
67	0 23	
68	0 24	
69	0 25	
70	0 26	
71	0 27	
72	0 28	
73	0 29	T/HRES! A
74	0 30	SECTIC! A
75	0 31	1.024MHZ2A
76	0 32	

It's called TLEV on the SEC\_SCI PWA



...and gets counted for TOTAL EVENTS



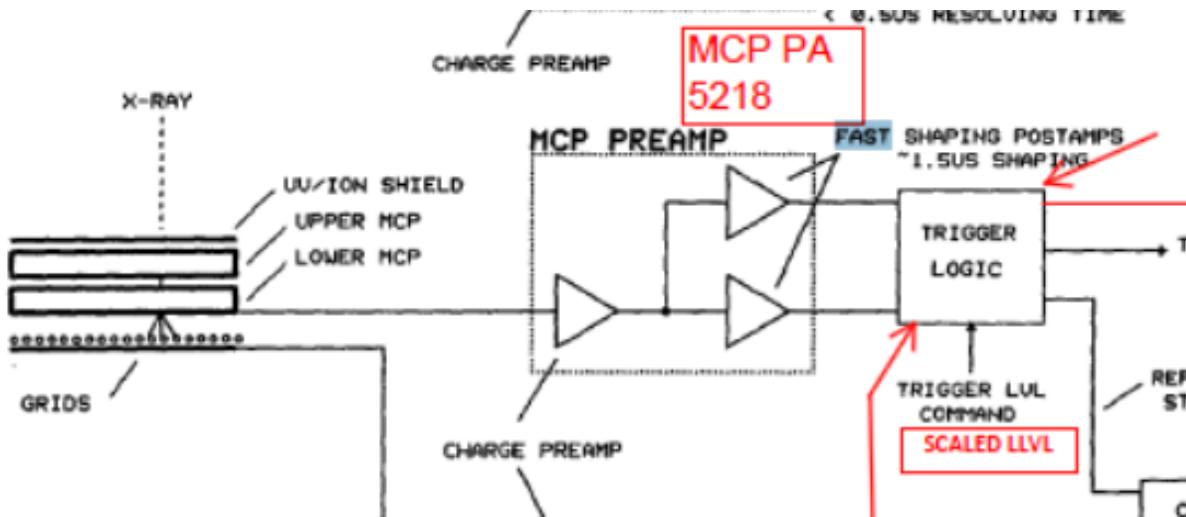
# Why is a Side A reset preferred?

- Resetting Side A offers *lower risk* than swapping to Side B.
  - The HRC team ***cannot find any plausible scenario*** in which turning on the 5 and 15 V would cause any damage to the single stream components (e.g., MCPs, crossed grid array, etc.)
  - This is a **straightforward procedure** derived from an SCS
  - This addresses the possible “single event latchup” hypothesis
- **Swapping to Side B is more complicated and risky.**
  - It requires switching of latching relays which we haven’t activated in 20 years.
  - It requires shutting the 28 V bus power to the HRC off.
  - B-side electronics have not been used in 20 years
  - It entails significant alteration of all HRC commanding, including protected SCSs, ATSs, and support software
  - It would require a complete calibration of the detectors

# Explanation of trigger noise

(T. Gauron)

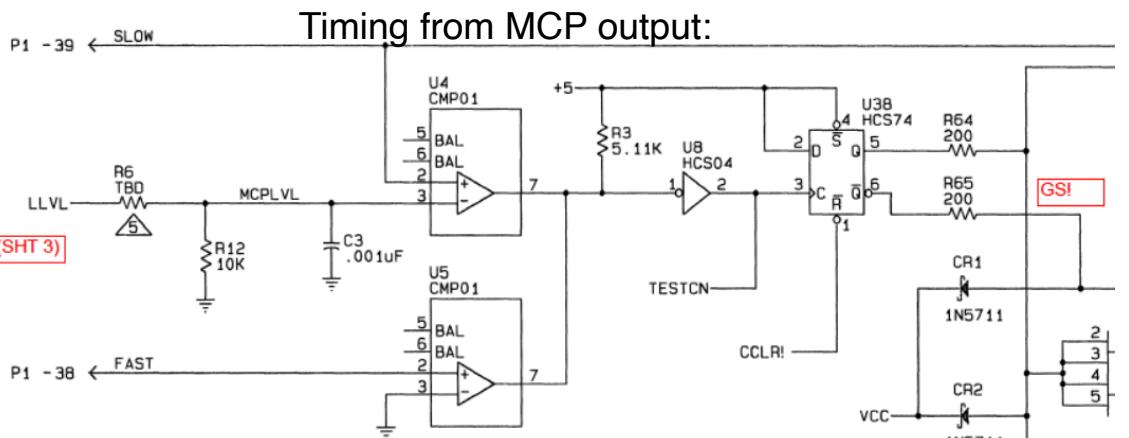
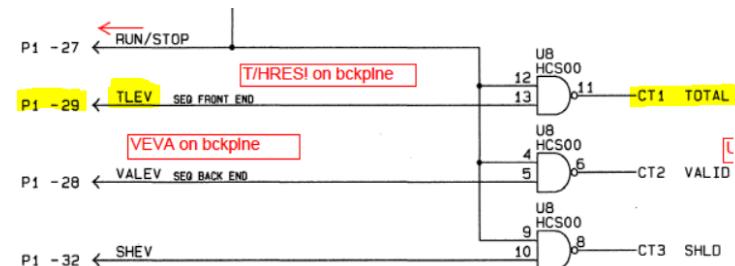
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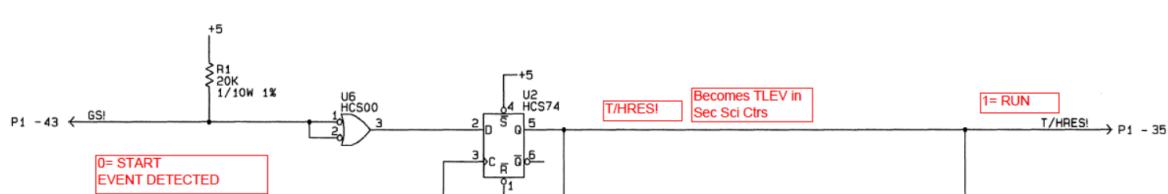
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54	0 9	
55	0 10	
56	0 11	
57	0 12	
58	0 13	
59	0 14	
60	0 15	
61	0 16	
62	0 17	
63	0 18	
64	0 19	SFDAT7A
65	0 20	SFDAT6A
66	0 21	SFDAT5A
67	0 22	SFDAT4A
68	0 23	SFDAT3A
69	0 24	SFDAT2A
70	0 25	SFDAT1A
71	0 26	SFDAT0A
72	0 27	
73	0 28	VEVA
74	0 29	T/HRES! A
75	0 30	SECTIC! A
76	0 31	1.024MHZ2A
	0 32	

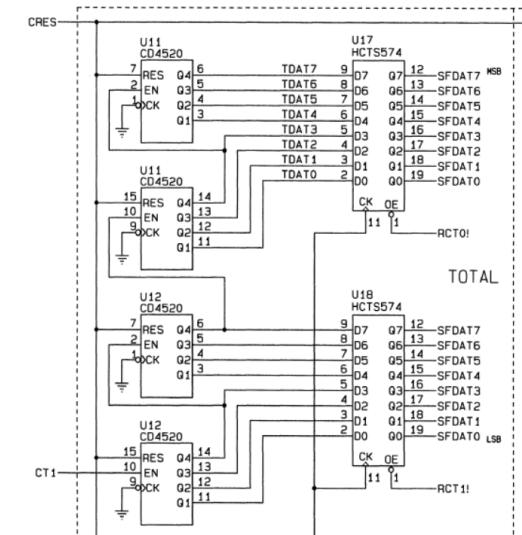
It's called TLEV on the SEC\_SCI PWA



GSI is synced with S/C clock and becomes T/HRES! in SEQUENCER



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# Prime and redundant side wiring

## (T. Gauron)

