CHANDRA
X-ray Center 60 Garden St., Cambridge Massachusetts 02138 USA

Date: September 26, 2025
From: Gregg Germain
To: Chandra Operations Team
Subject: Chandra Radiation Event and Shutdown June 1, 2025
Cc: MSFC Project Science, CXC Director's Office

1 Abstract

On June 1, 2025 (2025:152:05:51:32) the MAY2625B science load was interrupted, by an ACIS *txings* commanded SCS-107, and ACIS was safed. No long term ECS measurement was taken. The already-approved JUN0225A load was not run. The Return to Science commenced with the activation of the JUN0225B pickup load. In total, ACIS accumulated an attenuated ACE P3 fluence of 7.25e+08 p/(cm^2-sr-MeV) from the start of the orbit to the shutdown. The fluence saved because of the shutdown was 3.75e+09 p/(cm^2-sr-MeV) . This memo describes the shutdown and return to science decisions during the solar storm event.

2 Introduction

ACIS *txings* is the sole radiation monitor for Chandra and its autonomous activation has been a key means of reducing soft-proton dosing from numerous storms in recent years. The trigger on June 1, 2025 was the second *txings* initiated shutdown in 2025.

3. Detailed Timeline May 26-June 2, 2025

- MAY2625B load activated. Time of first command 2025:146:01:40:21.753; load scheduled to end at 2025:152:23:54:14.558. ACE P3 rates quiescent.

- 2025:151:08:32 SpaceWeather issued an alert:
  SOLAR FLARE ALERT: Earth-orbiting satellites have just detected a M4.5 class solar flare at 31-May-2025 at 08:18:00 UTC.

- 2025:151:13:10 ACIS Ops status email for the 8:40am Comm reports all is well; that ACE P3 is at ~111, and that it occasionally will quickly rise to a few thousand and then rapidly drop back down.

- 2025:151:15:10 SpaceWeatherAlerts.com predicts a storm:
  GEOMAGNETIC STORM PREDICTED: A geomagnetic storm is in the offing. Here are predicted storm levels for the next three days:
  Jun 01: G3 (Strong) Jun 02: G4 (Severe) Jun 03: G2 (Moderate).

- 2025:151:16:59 SpaceWeather News reports:
  SEVERE GEOMAGNETIC STORM WATCH: A major solar flare on May 31st hurled a CME straight toward Earth. Severe geomagnetic storms and widespread auroras are possible when the CME arrives on June 1st or 2nd.

- 2025:151:17:17 ACIS Ops notes that the GOES Proxy for HRC shield rates is on the rise and that ACE P3 rates are elevated.

- 2025:151:20:02 SpaceWeather sends an alert:
  GEOMAGNETIC STORM PREDICTED: A geomagnetic storm is in the offing. Here are predicted storm levels for the next three days:
  Jun 01: G4 (Severe) Jun 02: G4 (Severe) Jun 03: G2 (Moderate)

- 2025:152:01:47 ACIS Ops observes an increase, in the GOES Proxy for HRC Shield Rates plot, to approximately 100. Concludes the situation does not warrant a shutdown at the next Comm. ENLIL pinwheel plot suggests a spike late the next day.

- 2025:152:04:40 ACIS Ops notes the ACE P3 rates are up to ~30k with no clear turnover.

- 2025:152:05:44 SpaceWeather Alerts announce a CME approaching Earth and arriving in 20 to 30 minutes.

- 2025:152:06:26 ACIS Automated P3 monitor reports ACIS P3 fluence = 1.01e+09. Latest ACE P3 protonflux = 1.79e+05.

- 2025:152:10:41 ACIS Automated P3 monitor reports ACIS P3 fluence = 3.02e+09, Latest ACE P3 protonflux = 1.16e+05.

- 2025:152:11:10 ACIS Ops observes that ACE P3 is at 114,000, 21 hours to RADMON DISABLE, collected fluence already at 3.38×10^9, and that the GOES Proxy exceeded the red limit of 256, but then moved below the limit. Next Comm at 2025:152:12:30. ACIS Ops concludes that unless a *txings* commanded SCS-107 is seen to have occurred at the

2025:152:12:30 (8:30 local) Comm, that a manual SCS-107 is required. Email to sot_red_alert calling for a telecon at 08:15am

- 2025:152:12:30 Comm - SCS-107 was observed to have run at 2025:152:05:51:32 in response to an ACIS/*txings* high radiation flag.

- 2025:152:16:09 JUN0225B Return to Science Load out for review.

- 2025:153:19:30 Comm; JUN0225B Return to Science load uplinked and activated.

4. Discussion

Solar activity has decreased somewhat this year, having just passed the solar maximum (Figure 1). SpaceWeather issued an M4.5 solar flare alert on May 31, 4:32am local (2025:151:08:32).
On May 31 at the 8:40am (2025:151:13:10) Comm, ACE P3 rates were slightly elevated at ~111. For several previous days, P3 rates were unsettled as they would occasionally rise quickly to a few thousand and then immediately drop back to normal levels. At 11:10am, (2025:151:15:10) we received a SpaceWeather Geomagnetic Storm Prediction stating that "A geomagnetic storm is in the offing". At 12:59pm (2025:151:16:59) SpaceWeather News published a Severe Geomagnetic Storm Watch, stating that a "...major solar flare on May 31st hurled a CME straight toward Earth…" and predicted the storm would reach Earth on June 1st or 2nd.

May 31, 1:17pm (2025:151:17:17:00) ACIS Ops notes that the GOES proxy for HRC shield rates were on the rise (Figure 2). Another SpaceWeather alert predicted that the storm levels for June 1 and 2 were G4 (Severe).

At 9:40pm on the evening of May 31st, (2025:152:01:40) ACIS Ops discussed the radiation situation via email. Fluence collected so far was $3.5x10^{7}$, the HETG was presently in, but would retract in ~3.5 hours, and ACE P3 rates were ~5000. At that point the GOES Proxy for HRC shield rates had not exceeded the limit (Figure 3). Though a trigger was not expected, ACIS Ops observed the next Comm to see if one had occurred. Indeed by the end of the Comm, no SCS-107 had occurred.

June 1, 12:40am (2025:152:04:40) ACIS Ops observed that the ACE P3 rates had risen to ~30,000 with no clearly indicated turnover. The next Comm was 8:30am (2025:152:12:30). At 1:44am (2025:152:05:44:00) SpaceWeather announced: "CME ALERT: A coronal mass ejection (CME) is approaching Earth. CMEs generally arrive 20 to 30 minutes after you receive this email."

June 1 at 2:26am (2025:152:06:26:00) The ACIS Ops automated fluence monitor reported that the $1x10^{9}$ fluence limit was exceeded. At 6:41am the ACIS Ops automated fluence monitor reported that the collected fluence was now at $3.03x10^{9}$, and that the latest P3 flux was $1.16x10^{5}$.

A check of the situation at 7:00am (2025:152:11:00) showed an ACE P3 of 114,000 (Figure 4 and Figure 5). If an automatic shutdown did not previously occur, the collected fluence would be

3.384×10^9, and there were ~21 hours to go before RADMON DISABLE at 2025:153:08:12 (Figure 6). The ACIS Ops team concluded that if an automatic shutdown had not occurred, then a manual shutdown should be executed at the upcoming 8:30am (2025: 152:12:30) Comm. Consequently, ACIS Ops called for a telecon on sot_red_alert for 8:15am (2025:152:12:15). By the time of the telecon, the ACE P3 rates had dropped to ~20,000, and the GOES Proxy for HRC Shield Rates had dropped below the trigger level (Figure 7). During the telecon, ACIS Ops reported the status and the conclusion that if there was no automatic shut down indicated at the upcoming 8:30am Comm that ACIS would call for a manual shutdown. The subsequent Comm revealed that a *txings* commanded SCS-107 ran at 2025:152:05:51:32. The *txings* plot for the shutdown is shown in Figure 8. The transition was nominal, with science loads halted and the spacecraft and instruments in a safe configuration.

Given that the ACE P3 rates had dropped and the GOES Proxy was below the limit, the decision was made to build a Return To Science Pick Up load - JUN0225B – which was built, reviewed, uploaded and activated at the 2025:153:19:30:00 Comm.

The history of the ACE Flux throughout the June 1, 2025 storm can be seen in Figure 9.

5 Lessons Learned

This was a relatively straightforward storm and storm response. *Txings* performed it's function well. There were no new lessons to be learned from this storm.

6 Plots and Images

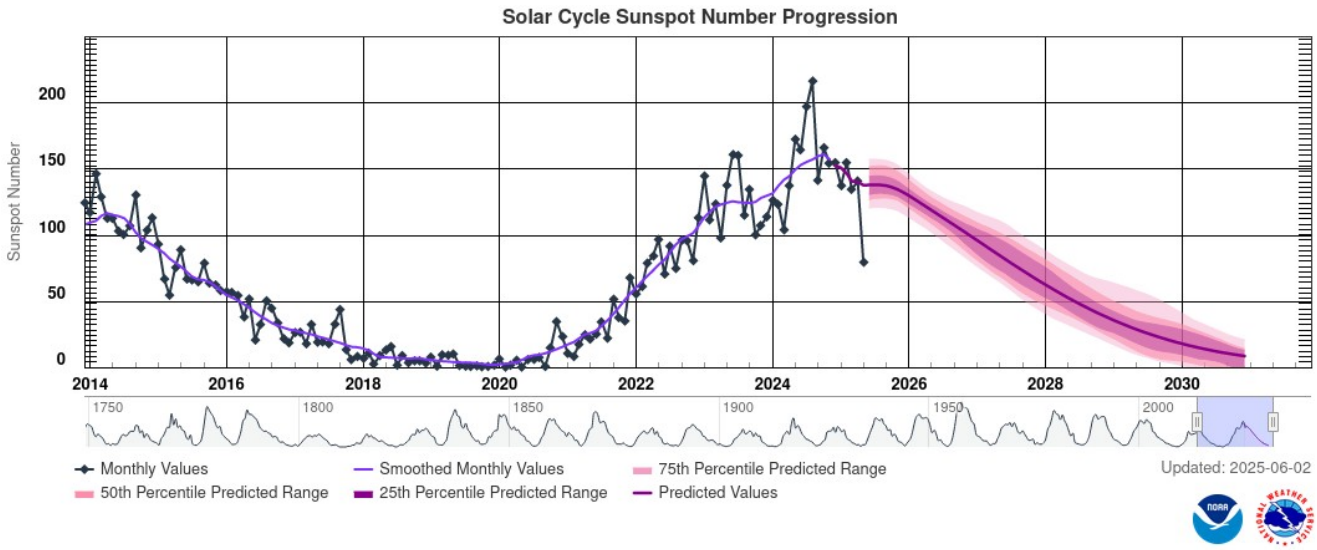

Figure 1: Solar Cycle Progression - Past the Peak

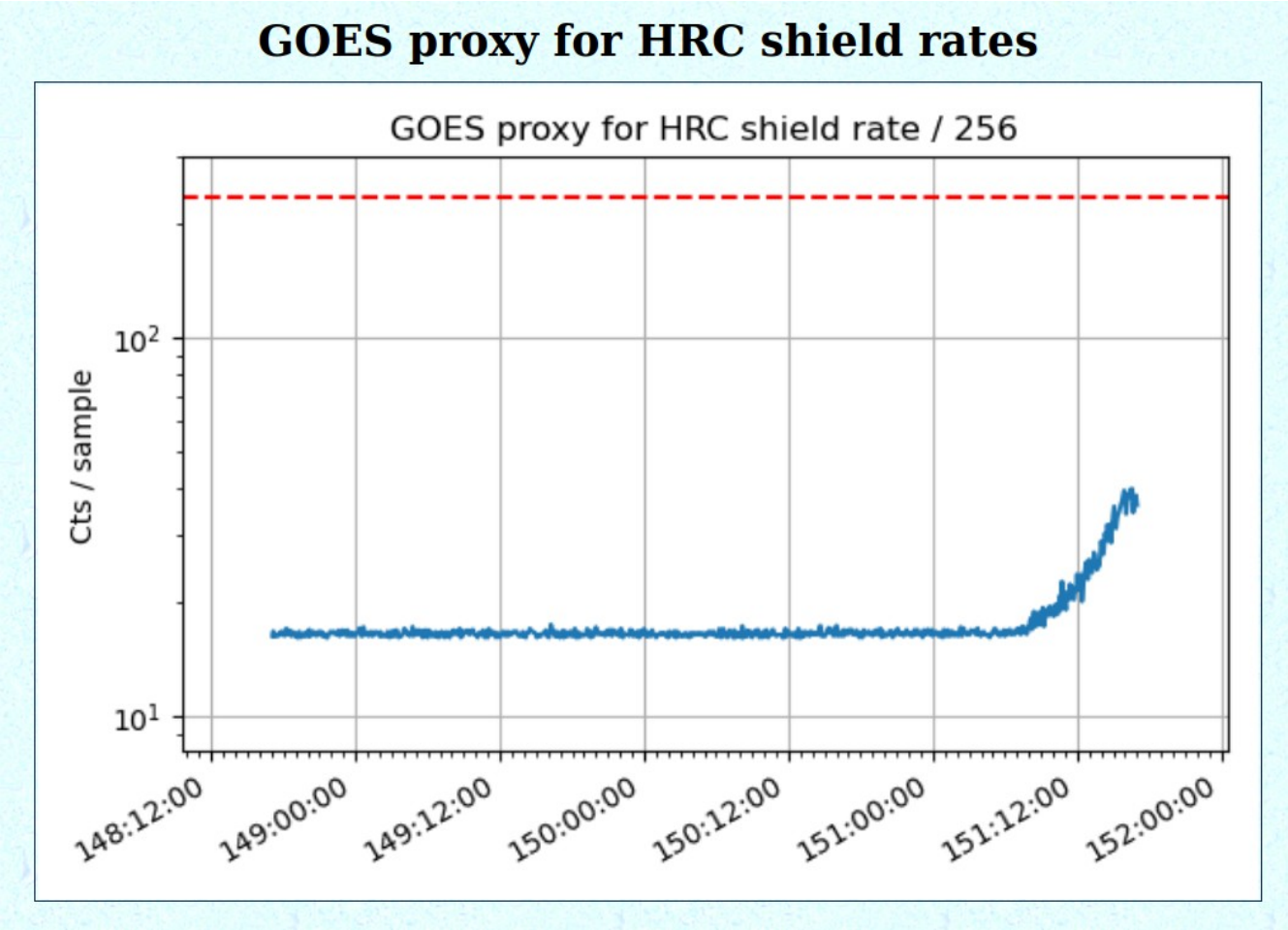

Figure 2: GOES Proxy for HRC Shield Rates May 31, ~9:40pm

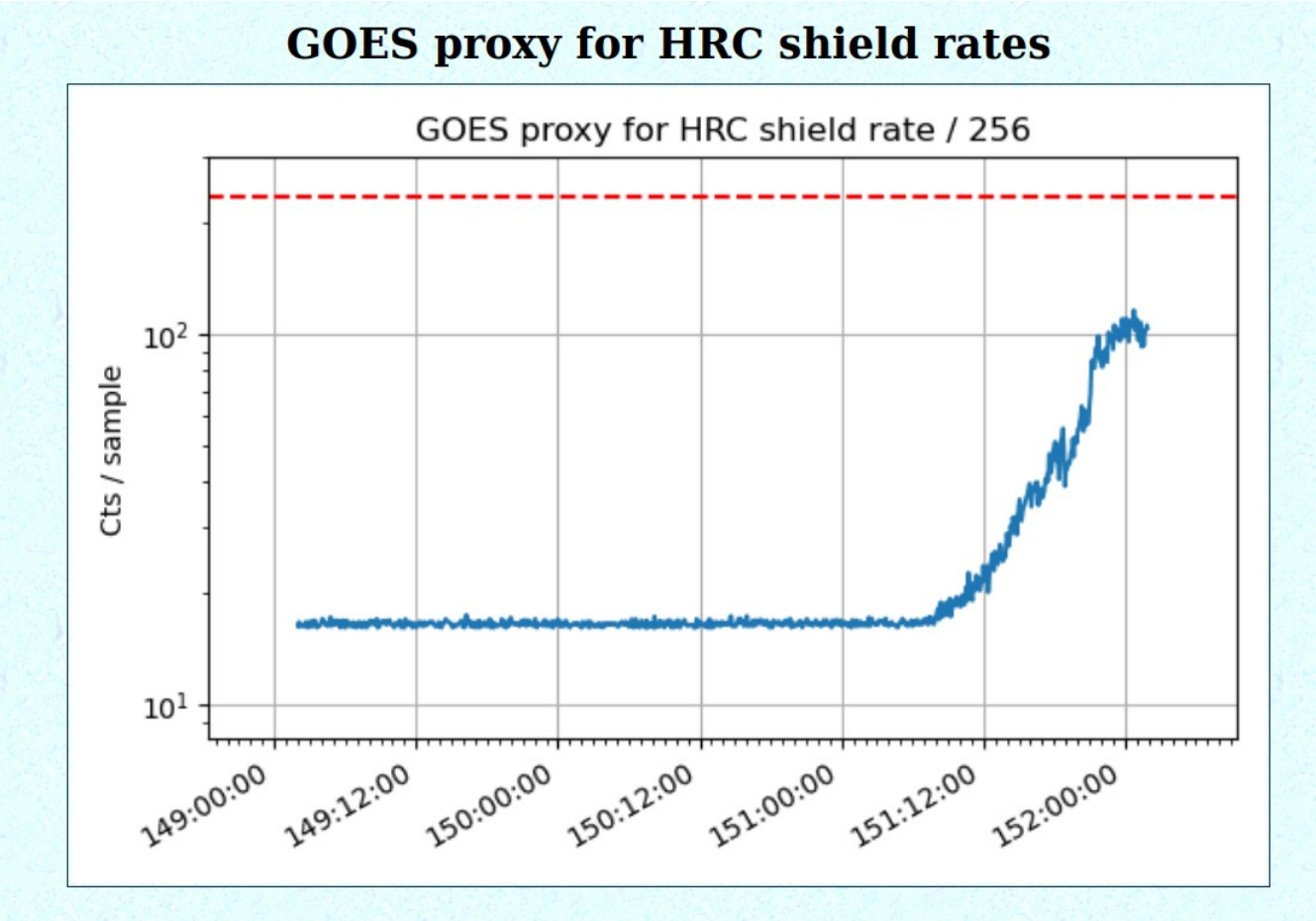

Figure 3: Goes proxy during the ACIS Ops storm status discussion May 31 9:47pm

Most recent ACE observations
Differential Flux particles/cm2-s-ster-MeV

UT Date			Time	--- Electron keV ---		---------- Protons keV ----------					
				DE1	DE4	P2	P3	P3ScaledP5	P3scaledP6	P5	FP6p	P7
YR	MO	DA	HHMM	38-53	175-315	47-68	115-195	112-187*	112-187**	310-580	761-1220	1060-1910
2025	6	1	920	2100000.000	19200.000	399000.000	117000.000	249200.000	997200.000	35600.000	27700.000	9740.000
2025	6	1	925	1890000.000	17000.000	350000.000	100000.000	212100.000	871200.000	30300.000	24200.000	8620.000
2025	6	1	930	1700000.000	15800.000	353000.000	104000.000	224000.000	932400.000	32000.000	25900.000	9030.000
2025	6	1	935	1710000.000	15700.000	355000.000	104000.000	231000.000	975600.000	33000.000	27100.000	9550.000
2025	6	1	940	1610000.000	15300.000	364000.000	105000.000	226800.000	907200.000	32400.000	25200.000	8710.000
2025	6	1	945	1570000.000	14100.000	360000.000	107000.000	235900.000	900000.000	33700.000	25000.000	8880.000
2025	6	1	950	1660000.000	13700.000	401000.000	132000.000	315700.000	1360800.000	45100.000	37800.000	12600.000
2025	6	1	955	1700000.000	14200.000	391000.000	126000.000	303100.000	1407600.000	43300.000	39100.000	13700.000
2025	6	1	1000	1680000.000	14000.000	393000.000	129000.000	303800.000	1296000.000	43400.000	36000.000	12200.000
2025	6	1	1005	1640000.000	13100.000	347000.000	113000.000	265300.000	1098000.000	37900.000	30500.000	10600.000
2025	6	1	1010	1630000.000	13000.000	349000.000	113000.000	263900.000	1137600.000	37700.000	31600.000	10800.000
2025	6	1	1015	1510000.000	12300.000	307000.000	98500.000	225400.000	961200.000	32200.000	26700.000	9280.000
2025	6	1	1020	1360000.000	11300.000	312000.000	101000.000	230300.000	943200.000	32900.000	26200.000	9390.000
2025	6	1	1025	1310000.000	12100.000	322000.000	109000.000	247100.000	1044000.000	35300.000	29000.000	9740.000
2025	6	1	1030	1340000.000	10100.000	339000.000	116000.000	264600.000	1123200.000	37800.000	31200.000	10200.000
2025	6	1	1035	1290000.000	9650.000	326000.000	113000.000	256200.000	1040400.000	36600.000	28900.000	10200.000
2025	6	1	1040	1190000.000	9160.000	325000.000	114000.000	258300.000	1080000.000	36900.000	30000.000	9830.000
2025	6	1	1045	935000.000	7620.000	297000.000	109000.000	249900.000	1072800.000	35700.000	29800.000	9510.000
2025	6	1	1050	697000.000	6080.000	247000.000	88500.000	206500.000	889200.000	29500.000	24700.000	8240.000
2025	6	1	1055	663000.000	5720.000	258000.000	94700.000	220500.000	921600.000	31500.000	25600.000	8650.000
2025	6	1	1100	653000.000	5740.000	306000.000	114000.000	263900.000	1083600.000	37700.000	30100.000	10200.000
2025	6	1	1105	663000.000	6040.000	285000.000	105000.000	246400.000	1033200.000	35200.000	28700.000	9610.000
2025	6	1	1110	814000.000	7070.000	230000.000	82300.000	207200.000	914400.000	29600.000	25400.000	8750.000
2025	6	1	1115	801000.000	7120.000	214000.000	76800.000	194600.000	874800.000	27800.000	24300.000	8210.000

Figure 4: ACE P3 June 1, 7:00am

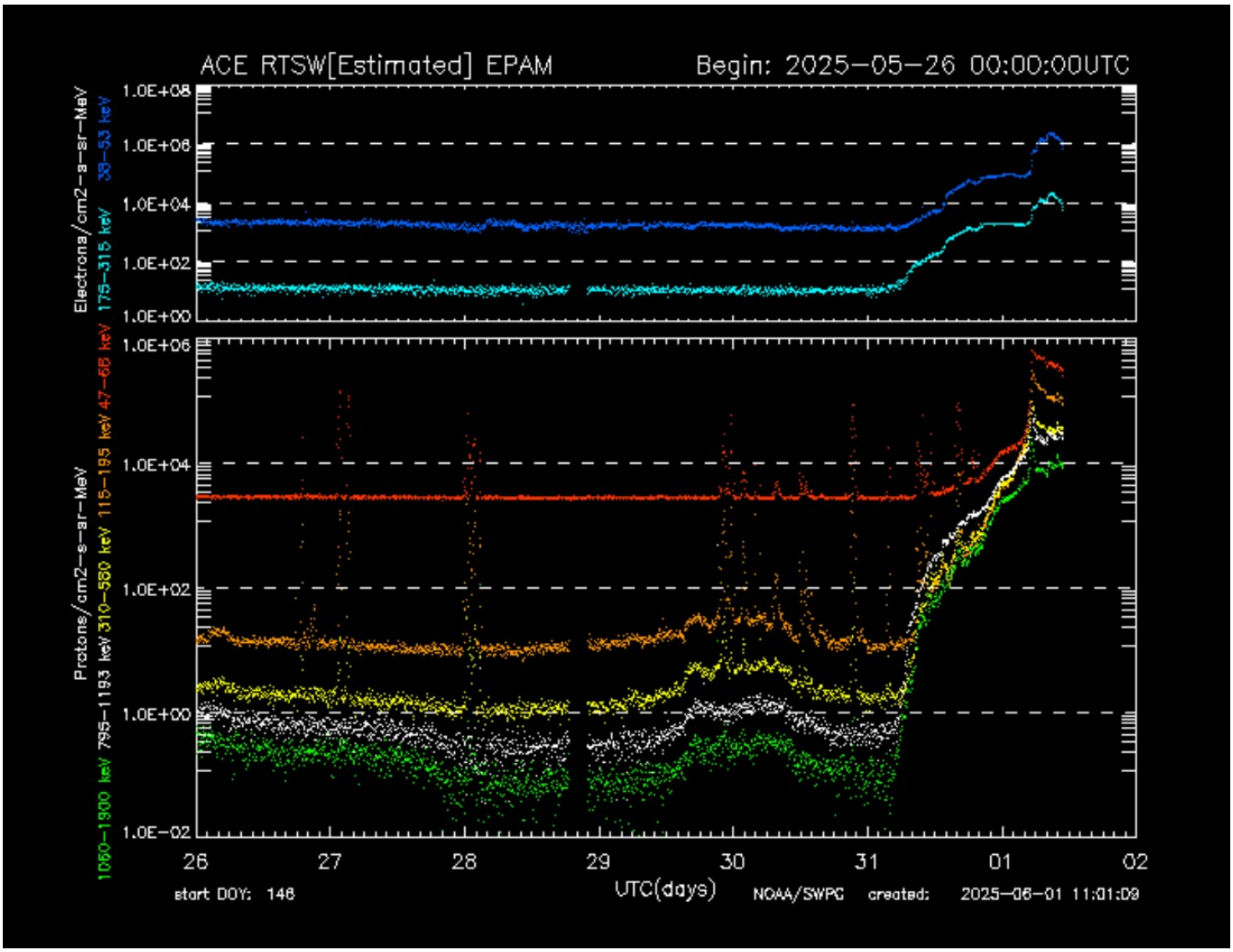

Figure 5: ACE Rates June 1, 8:01am

Time (UT)	Event	Delta time	Time (Eastern)
2025:152:12:30:00	Comm pass on DSS-24 (duration 1:00)	- 6:14	8:30 AM Sun 01-Jun
2025:152:12:33:41	SCS107 detected during realtime comm	- 6:10	8:33 AM Sun 01-Jun
2025:152:13:57:56	Maneuver to 14.48543 -71.99991 129.338 [2025:152:14:30:25]	- 4:46	9:57 AM Sun 01-Jun
2025:152:14:34:55	Obsid: 28037 SI: ACIS-S (21 ksec) Target: SMC 2857	- 4:09	10:34 AM Sun 01-Jun
2025:152:17:55:00	Comm pass on DSS-34 (duration 1:00)	- 0:49	1:55 PM Sun 01-Jun
2025:152:18:44:01	---------- NOW ----------	0:00	2:44 PM Sun 01-Jun
2025:152:20:24:55	Maneuver to 161.25123 -59.66785 264.988 [2025:152:20:46:23]	1:40	4:24 PM Sun 01-Jun
2025:152:21:07:20	Obsid: 30949 SI: HRC-I (10 ksec) Target: Eta Car	2:23	5:07 PM Sun 01-Jun
2025:152:23:51:14	Load JUN0225A:CL152:2301 [2025:154:11:35:01]	5:07	7:51 PM Sun 01-Jun
2025:152:23:51:14	Load JUN0225A:CL152:2301 [2025:154:11:35:01]	5:07	7:51 PM Sun 01-Jun
2025:152:23:54:14	Maneuver to 255.45208 -42.24572 358.003 [2025:153:00:18:03]	5:10	7:54 PM Sun 01-Jun
2025:153:00:22:33	Obsid: 28074 SI: ACIS-I (23 ksec) Target: XMMU J170147.3-	5:38	8:22 PM Sun 01-Jun
2025:153:00:45:00	Comm pass on DSS-65 (duration 1:00)	6:00	8:45 PM Sun 01-Jun
2025:153:06:48:16	Maneuver to 182.03978 29.30663 224.995 [2025:153:07:30:57]	12:04	2:48 AM Mon 02-Jun
2025:153:07:35:27	Obsid: 29760 SI: ACIS-S (1 ksec) Target: 1eRASS J120806.	12:51	3:35 AM Mon 02-Jun
2025:153:08:07:08	Maneuver to 67.99900 -62.19900 177.926 [2025:153:08:46:27]	13:23	4:07 AM Mon 02-Jun
2025:153:08:10:42	Grating: HETG	13:26	4:10 AM Mon 02-Jun
2025:153:08:12:45	RADMON Disable	13:28	4:12 AM Mon 02-Jun
2025:153:08:50:57	ER Obsid: 42372 (0 ksec) Purpose: Perigee Attitude	14:06	4:50 AM Mon 02-Jun
2025:153:09:06:38	Maneuver to 254.00000 -25.00000 49.000 [2025:153:09:39:51]	14:22	5:06 AM Mon 02-Jun
2025:153:09:44:21	ER Obsid: 42371 (7 ksec) Purpose: Perigee Attitude	15:00	5:44 AM Mon 02-Jun
2025:153:11:20:00	Comm pass on DSS-26 (duration 1:00)	16:35	7:20 AM Mon 02-Jun
2025:153:11:41:01	Maneuver to 57.13790 -54.32550 167.461 [2025:153:12:15:09]	16:57	7:41 AM Mon 02-Jun
2025:153:12:19:39	ER Obsid: 42370 (3 ksec) Purpose: Perigee Attitude	17:35	8:19 AM Mon 02-Jun
2025:153:14:21:18	Maneuver to 254.00000 -25.00000 50.078 [2025:153:14:55:30]	19:37	10:21 AM Mon 02-Jun
2025:153:15:00:00	ER Obsid: 42369 (3 ksec) Purpose: Perigee Attitude	20:15	11:00 AM Mon 02-Jun
2025:153:17:37:17	Maneuver to 352.79948 -36.56170 106.012 [2025:153:18:06:32]	22:53	1:37 PM Mon 02-Jun
2025:153:17:37:52	Grating: NONE	22:53	1:37 PM Mon 02-Jun
2025:153:17:46:44	RADMON Enable	23:02	1:46 PM Mon 02-Jun
2025:153:18:11:02	Obsid: 28327 SI: ACIS-I (6 ksec) Target: PSZ2G358.94-70.	23:27	2:11 PM Mon 02-Jun
2025:153:19:30:00	Comm pass on DSS-54 (duration 1:00)	1d 00:45	3:30 PM Mon 02-Jun
2025:153:20:00:05	Maneuver to 278.28734 34.05703 150.987 [2025:153:20:34:51]	1d 01:16	4:00 PM Mon 02-Jun
2025:153:20:39:21	Obsid: 28192 SI: ACIS-S (10 ksec) Target: NGC 6657	1d 01:55	4:39 PM Mon 02-Jun
2025:153:23:26:01	Maneuver to 165.41665 -61.01585 262.644 [2025:154:00:15:46]	1d 04:42	7:26 PM Mon 02-Jun
2025:154:00:20:16	Obsid: 28517 SI: ACIS-I (15 ksec) Target: PSR J1101-6101	1d 05:36	8:20 PM Mon 02-Jun
2025:154:02:30:00	Comm pass on DSS-65 (duration 1:00)	1d 07:45	10:30 PM Mon 02-Jun

Figure 6: Replan Central Comm Schedule

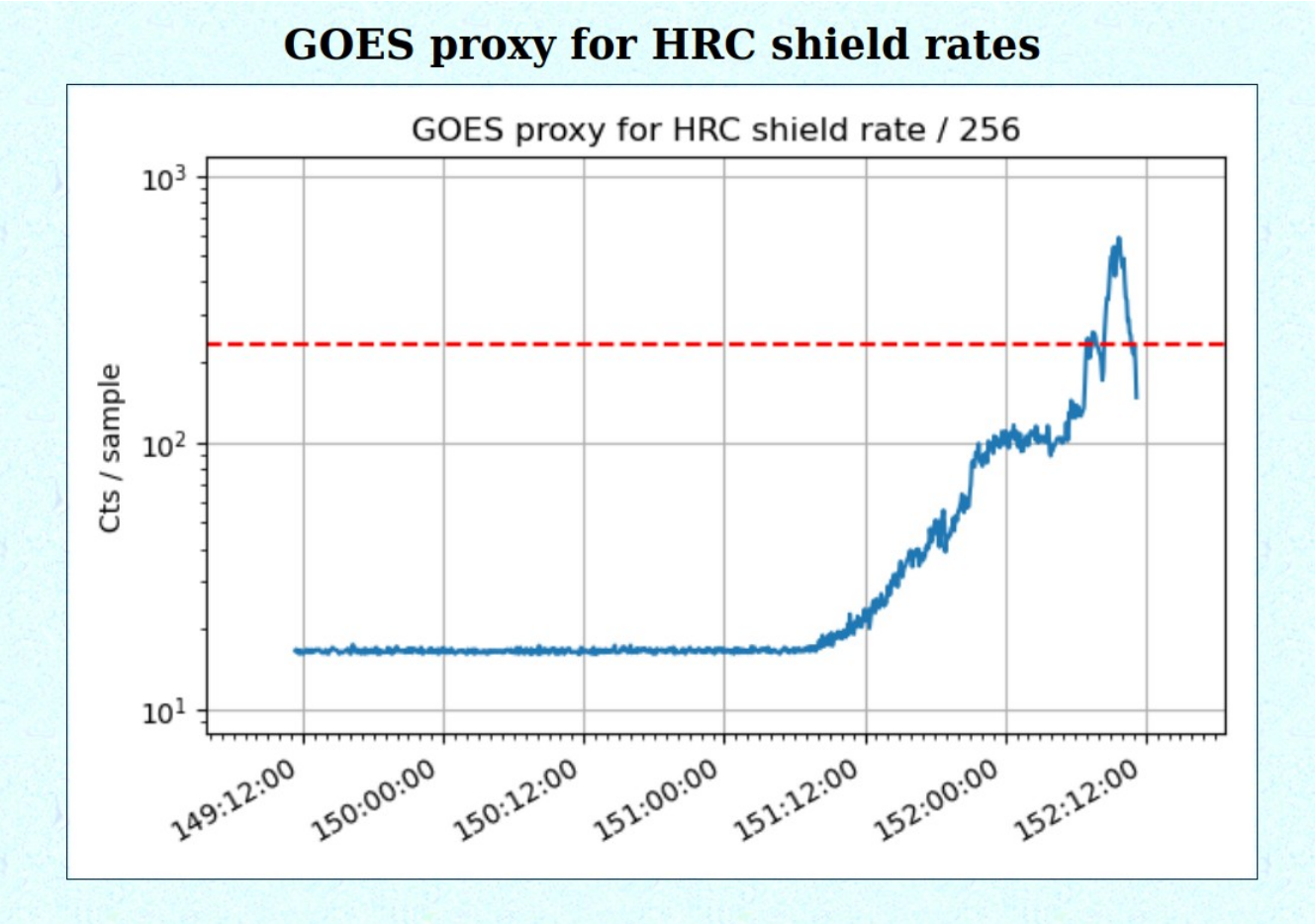

Figure 7: GOES Proxy for HRC Shield Rates around the time of the June 1, 8:15am Telecon

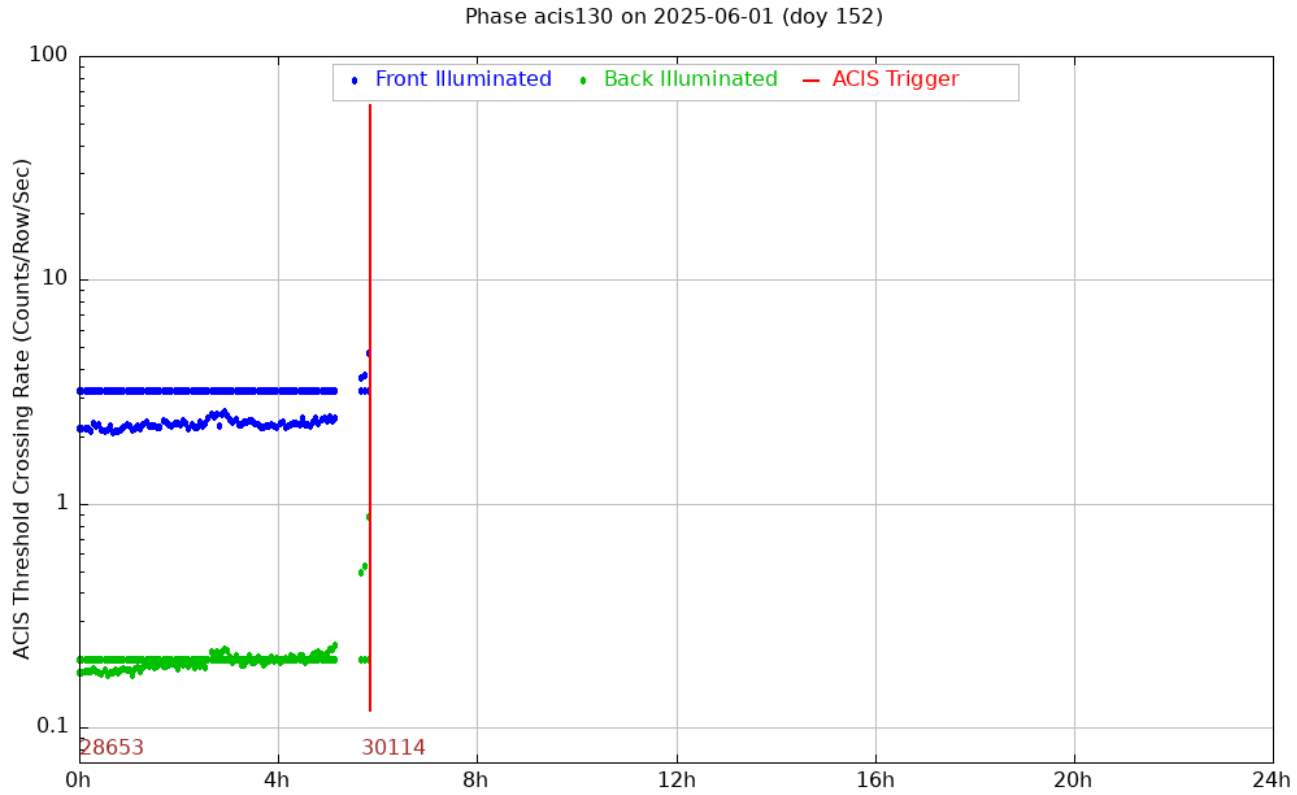

Figure 8: ACIS FI and BI txings rates leading up to the Jun 1, 2025 SCS-107

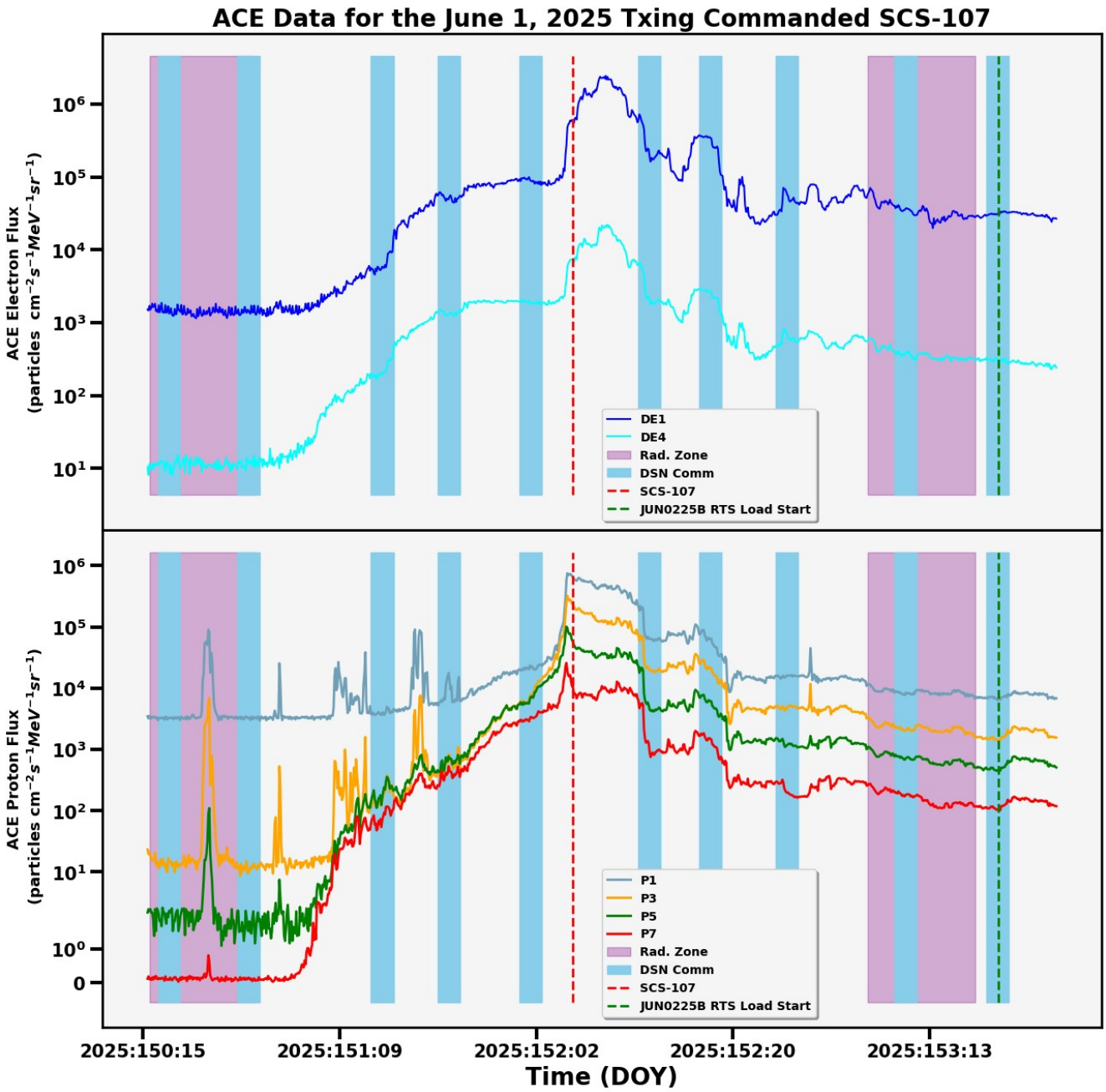

Figure 9: ACE Electron and Proton Flux During the June 1, 2025 Storm

7 Resources and Notes

Peter Ford of MIT provided the data for the *txings* plots

ACE data was obtained from ftp://mussel.srl.caltech.edu/pub/ace/browse/

ACE fluxes are given in units of particles/(cm^2-s-sr-MeV) , and ACE fluences are in units of particles/(cm^2-sr-MeV).