CHANDRA
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MEMORANDUM

Date:	September 23, 2024
From:	Jack Steiner
To:	Chandra Operations Team
Subject:	Chandra Radiation Shutdown in July 2024
Cc:	MSFC Project Science, CXC Director's Office
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1 Abstract

During the evening of July 22, 2024 (local), July 23, 2024 UTC, owing to a far-side solar particle flare, *txings* tripped during the outbound ECS measurement while RADMON was disabled. This was noticed in real time during comm and is the first time a *txings* trip in the belts has occurred. Because RADMON was disabled, *as expected*, this trip did not cause the OBC to initiate SCS-107. After RADMON was enabled, particle rates remained high and variable as the science orbit commenced, although no further trip occurred during the remainder of the comm. However, shortly after losing comm, *txings* again tripped, this time resulting in an SCS-107 autonomous shutdown.

The attenuated fluence saved from the shutdown was 8.9×10^8. This memo discusses the event timeline and relevance for future *txings* trips.

2 Introduction

This solar cycle has been associated with heightened activity compared to previous cycles. ACIS *txings* is the sole radiation monitor for *Chandra*, and its autonomous activation has been a key means of reducing soft proton dosing from several storms this year alone. Presently, *txings* operates benignly during ECS measurements at belt passages, i.e., although *txings* is running, RADMON is disabled, preventing an SCS-107 trigger in response to a *txings* trip.

On July 23, 2024 UTC during the ascending ECS measurement, a *txings* trip was observed during a real-time comm in which unexpected high and variable hard particle rates were observed. This was the first time a belt-passage trip has occurred. A short time later, but out of comm, *txings* tripped again after RADMON had been enabled in the

science orbit, this time producing an autonomous SCS-107 shutdown. The particle activity was attributed to a large X14 flare on the far-side of the sun, and was detected by Solar Orbiter. This was the largest flare of the cycle thus far.

3 July 22-25 2024 Detailed Timeline

- 2024:204:23:55 Approximate time of far-side X14 solar flare.
- 2024:205:01:40 Approximate time of *txings* trip during the ascending leg ECS.
- 2024:205:01:57 ACIS-only real-time red-alert messages were sent out warning of the *txings* trip in the belts.
- 2024:205:02:00 ACIS Ops discussed trip on Slack and on gmeet/1165; the trip was recognized as having occurred during ECS in the belts and so no immediate action was required.
- 2024:205:02:10 OC was contacted by ACIS to arrange for a comm extension.
- 2024:205:03:11:48 *txings* trip initiated autonomous SCS-107 while out of comm.
- 2024:205:17:36:24 OC came up early on comm, SCS-107 was detected, and alert-messages sent. During the following team-wide radiation shutdown discussion, ACIS requested to perform a LT-ECS while the replan was underway.
- 2024:206:02:23 ACIS executed a 24-hr LT-ECS CAP.
- 2024:208:03:00:00.000 Radiation replan load JUL2624A began execution.

4 July 23 2024 Shutdown-Event Discussion

The autonomous SCS-107 initiated by the *txings* trip was not a suprise owing to the shortly-preceding trip caught in the previous hour in the ascending-leg ECS measurement. The initial assessment of the first trip quickly revealed that the trip was in the belts and so RADMON was disabled. However, the elevated (and rising) particle rates which caused the ECS trip remained elevated and noisy entering the science orbit and the team determined significant probability of a trip near the start of the science orbit. Because a *txings* trip requires several-minutes worth of data after the bias completion, and the end of comm was set to occur close to the earliest possible trip, ACIS wanted to extend the comm to monitoring more deeply into the science orbit. The OC was contacted to request this extension to monitor for a potential *txings* trip and SCS-107 in the science orbit, and to inform them of the benign trip during the ECS. Approximately 10 minutes extra comm-time was arranged. Unfortunately, the particle rates were sufficiently variable

that the *txings* trip wasn't immediate and in the end occurred less than 10-minutes after (the extended) comm ended. If the trip had been detected during this comm, an expedited recovery response would have been possible for MP and ACIS teams.

Figure 1 shows the ACE P3 rate over the period in question, and a corresponding plot of the other ACE proton rates is shown in Figure 2. The abrupt rise in particle rates is evident.

Science resumption loads were initially planned for JUL2524 (which would have begun 2024:207:03:15:00, after the LT-ECS completion). Those loads were reviewed and approved, but an issue with the DSN station prevented load uplink and instead an alternative JUL2624 set of science-resumption loads was built, uplinked, and activated (only the implemented recovery load is depicted in the timeline).

The total science-available time which was lost due to the radiation shutdown was $\sim$ 220 ks, and the corresponding attenuated ACE P3 fluence avoided by shutting down during that time was 8.9×10^8. This is not an instance in which we would have opted to trigger manually, as the Earth-directed soft proton flux from this event was rather low. However, in light of this sequence it may still be worth ACIS discussing the possible merits of having RADMON enabled during belt passage, particularly on the ascending leg.

4.1 Lessons Learned

Although the extra comm time allocated here was insufficient to detect the second *txings* trip and the SCS-107 run, this steps followed appears to have been the correct course of action. Given the long gap between planned comms (16 hours from start-to-start) which delayed recognizing that SCS-107 had run, it would have been useful to obtain an additional short comm in-between (if possible) which would revealed the SCS-107 activation.

Although the confluence of events here was unusual, in case of another *txings* trip in the belts, the following course of action is suggested: consult with the ACIS team immediately, as this suggests a heightened likelihood of a SCS-107 in the science orbit ahead, particularly if the trip occurred during the ascending leg. Request a comm extension/additional comm time depending on the schedule, and consider alerting MP to the possibility of an impending RADMON trip.

5 Notes

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

ACE fluxes are given in units of particles s^{-1} cm^{-2} MeV^{-1} sr^{-1}, and ACE fluences are in units of particles cm^{-2} MeV^{-1} sr^{-1}.

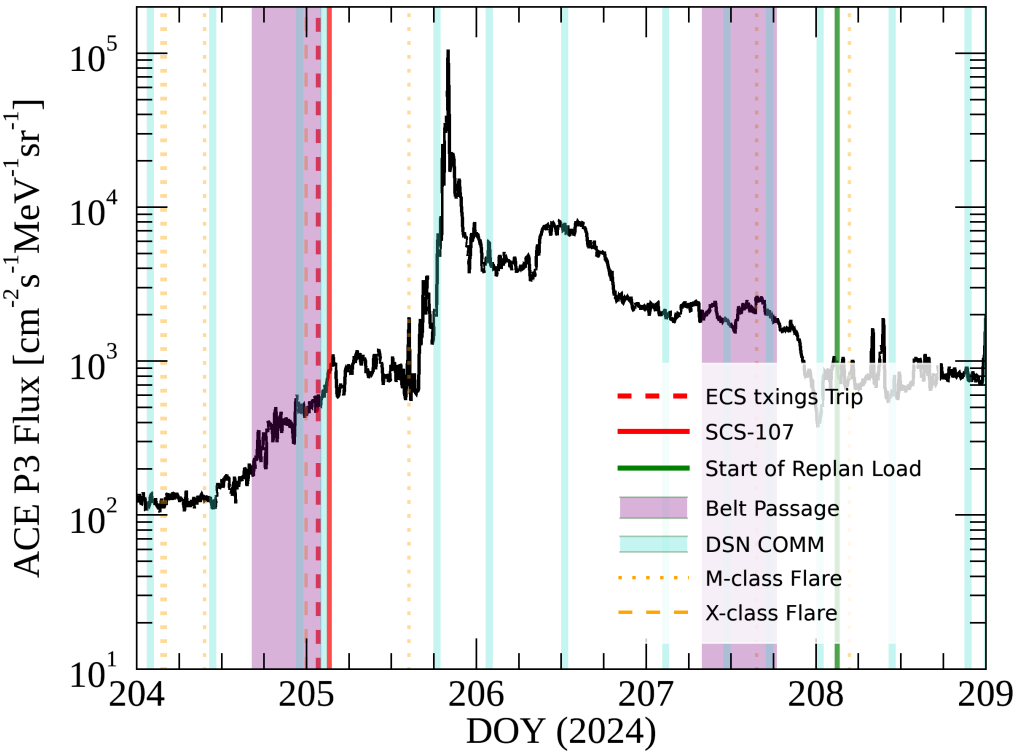

Figure 1: The ACE P3 flux associated with the far-side X14 flare, with time markers indicating the start of the science-resumption load (dark green), the autonomous SCS-107 (solid red), and the times of flares (orange). Shaded regions indicate belt passages (purple) and DSN comms (blue).

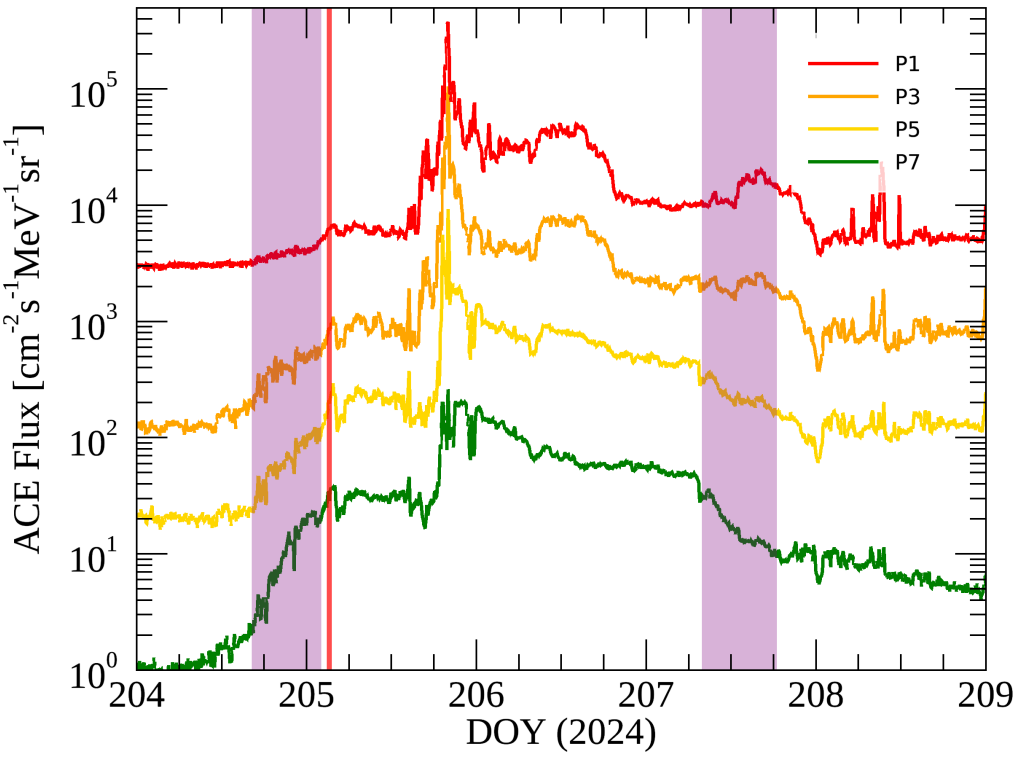

Figure 2: ACE proton bands associated with the far-side X14 flare. The red vertical line marks the time of shutdown and purple shaded regions depict the belt passages.

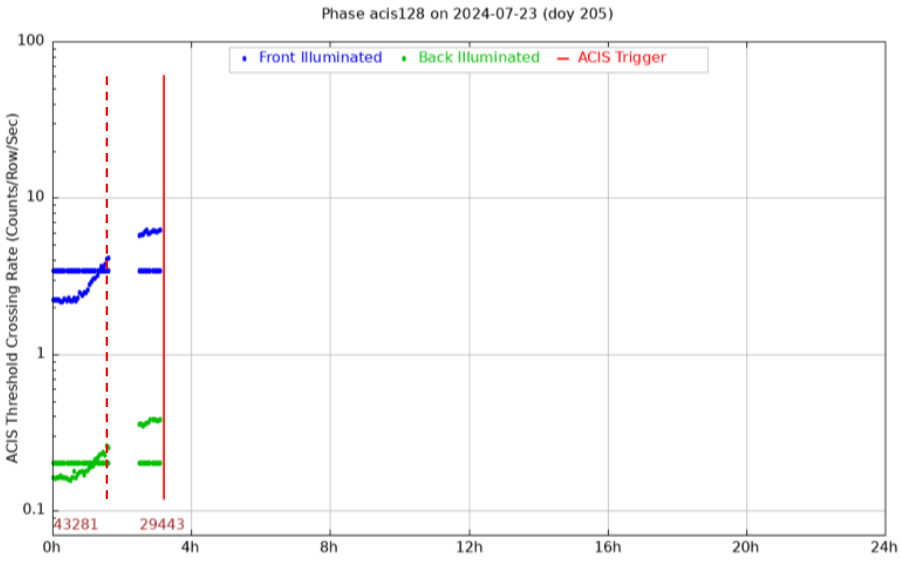

Figure 3: *txings* data for July 23, 2024 showing the rate-crossing which produced the trip during the ECS measurement (dashed red line, timing approximate), and the following trip during the first science-orbit observation (solid red line).