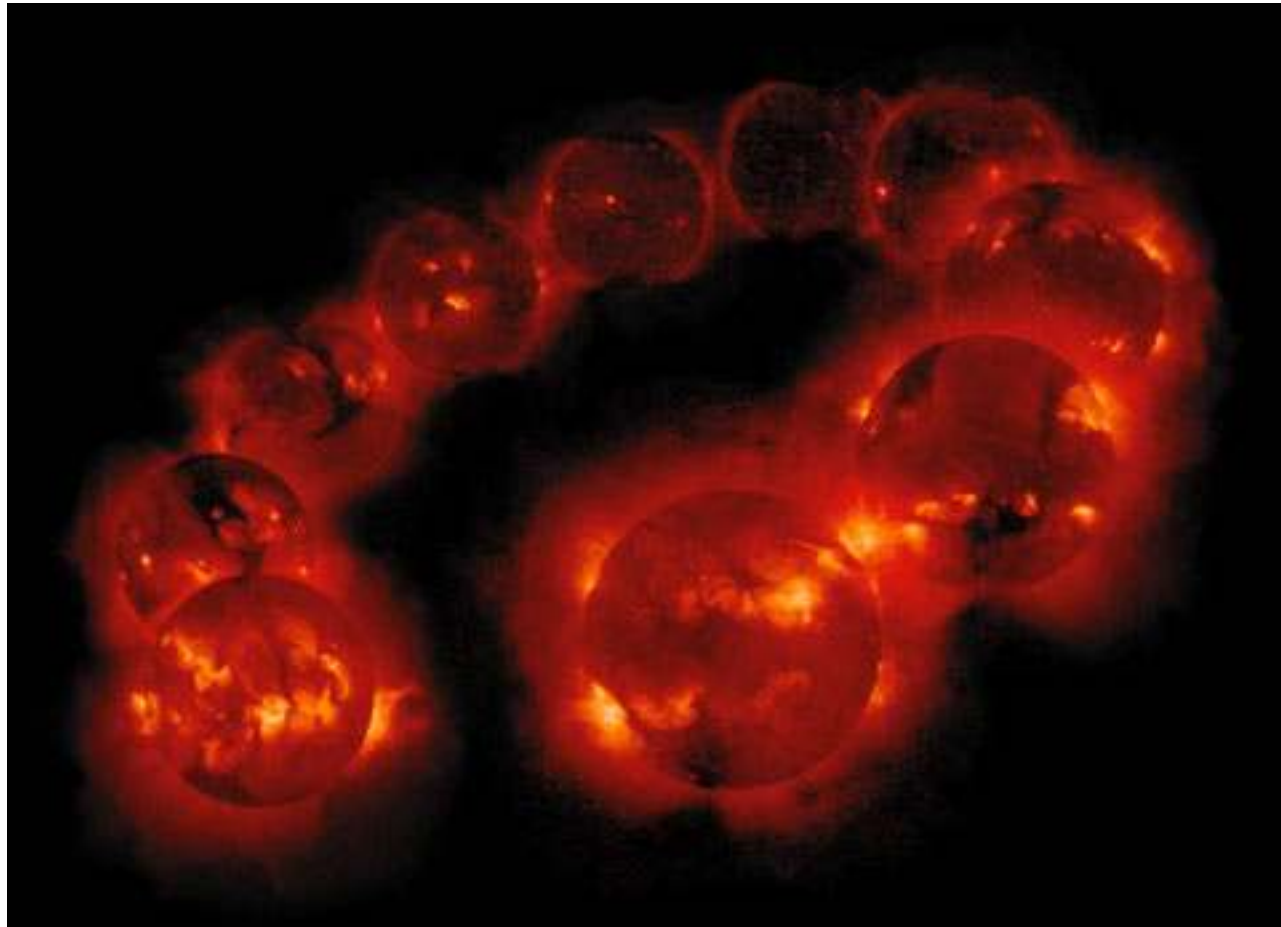# Yohkoh Experience

Nariaki Nitta (LMSAL)

Yohkoh Partial Chronology

- 30 August 1991 Launched, normal science operations started two weeks later

- 13 November 1992 SXT: First entrance filter anomaly

- June 1992   Post pass e-mail transmission of SXT coordinates information

- 1 October 1993 First year data put in public domain at SDAC

- January 1994 Yohkoh Analysis Guide published

- February 1997 First SOHO Yohkoh CDAW

- October 1997 SXT weekly science nuggets started

- March 2001 All Yohkoh data became available without time delay

- 14 December 2001 End of science operations

- 12 September 2005 Re-entry

Historical Perspectives

- Scientific discoveries, especially establishing the importance of magnetic reconnection

- Long term, uninterrupted full-disk movie in soft X-rays

- Contribution to future resources (>50 PhDs)

- First mission to make extensive use of Internet for public outreach and data distribution

- The longest operating CCD camera in space

- Genesis for SolarSoft, which has drastically changed the way solar data are analyzed

Operations

- ## Four science experiments
  - Soft X-ray Telescope (SXT)
  - Hard X-ray Telescope (HXT)
  - Bragg Crystal Spectrometer (BCS)
  - Wide Band Spectrometer (WBS)
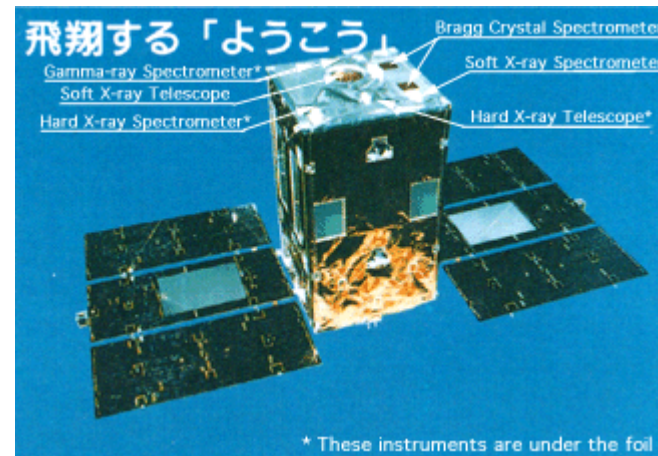
- ## Three levels of operators

  - KSC Tohbans – interact with people who send commands to the satellite at up to 5 contacts a day, not a job for non Japanese speakers (at Kagoshima Flight Center)

  - SSOC Tohbans – edit daily operations commands on mainframe computer, communicate with KSC and NASA/DSN (at ISAS main campus), and plan/finalize DSN passes 1-2 weeks ahead

  - SXT Chief Observer – edit SXT tables, also on mainframe, as often as needed (at ISAS main campus), and serve as contact for campaign observations
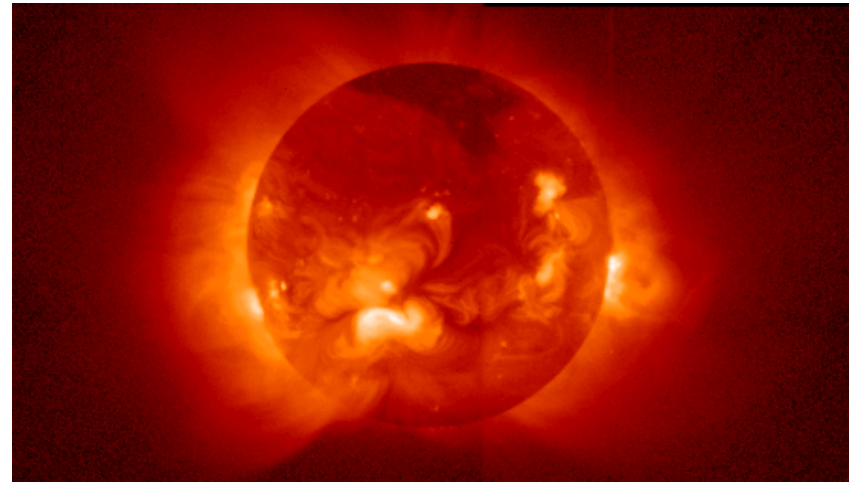
- ## Weekly operations meeting at ISAS main campus (Mon. 10 am)

Operations

- Operations of non-SXT instruments were straightforward.

- SXT-related operations
  - CCD bakeout
  - Offpoint
    - Get terminator images for straylight correction
    - Observe an extended corona

- The SXT image sequence was prescribed in the SXT table, as prepared by the SXT Chief Observer, and the table was uplinked at the specified contact.

- In case of anomaly, the SXT Super-Tohban was always on call, telling the KSC tohbans how to fix the problem.

Data

- All the downlinked data were stored on the SIRIUS system, which was connected to mainframe at ISAS main campus. Data were reformatted on US-provided workstation, after they were transferred from SIRIUS.

- SIRIUS was updated only during local business hours, so data from passes after Friday evening were not reformatted until Monday morning.

- Around 1995, the "temporary" SIRIUS was routinely reformatted following each KSC pass, and SXT data became of more use for planning.

- Official reformatting was done on a weekly basis, after confirming the arrival of all the DSN data.

- Over the Yohkoh life time, data distribution media changed from Exabyte tape, CD, to Internet.

Data Use

- Data were not open in the beginning, with "team members" having one year privileged use.

- But a small number daily images were sent to NOAA from the beginning (and the Yohkoh team got GOES 3-sec X-ray flux data).

- In reality, data were always available through collaborations with team members.

- Data use was to be administered by the Yohkoh Science Council, and the Data Use Coordinators, and a research proposal was required to analyze data, but this system was practically defunct.

- Apart from data access, the Yohkoh team always welcomed coordinated observations.

Data Reformatting

- Data from all the instruments and the satellite system were reformatted at the same time with a consistent format and file name (i.e., XXXyymmdd.hhmm, where XXX stands for one of "ada", "bda", "cba", "hda", "sfr", "spr" and "wda".)

- Auxiliary data (satellite pointing, observing log, etc.) were also generated during reformatting and saved as weekly files.

- The amount of data (100-150 MB/day) was quite modest in today's standard.

Real-time Data

- Message from the KSC tohbans after each contact, reporting the coordinates of SXT partial frame images. It also included what they saw in SXT quick-look data.

- "FirstLight" was automatically generated after each KSC pass since 1996. This is a basis of the "Latest Events" page.
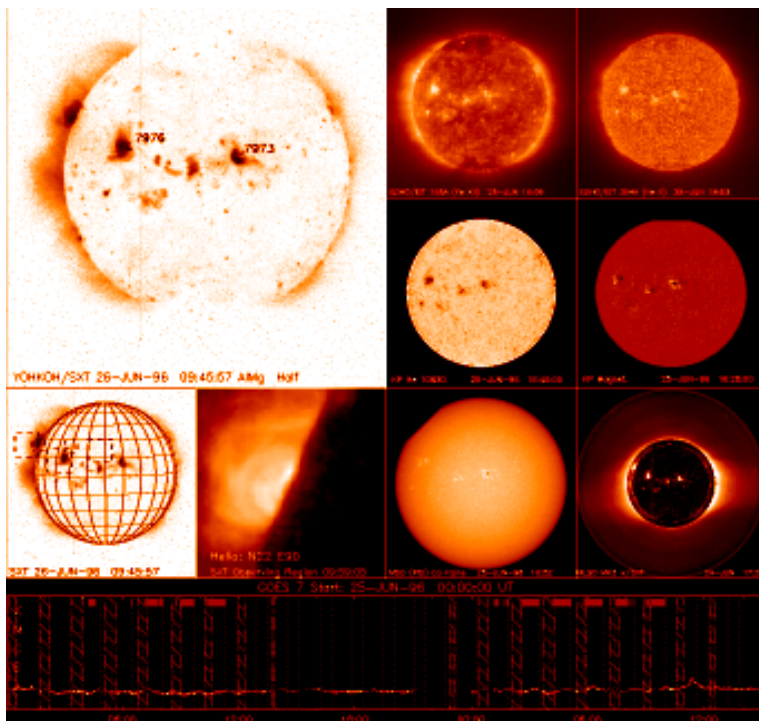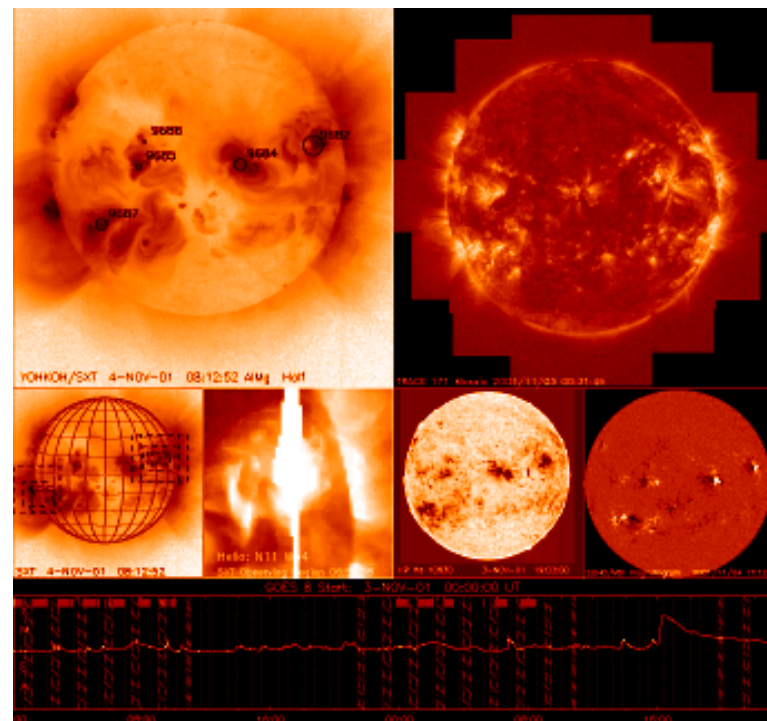
Outreach

- Yohkoh had a significant EPO program called YPOP that was targeted primarily for grade schools.

- In October 1997, Hugh Hudson started SXT weekly science nuggets on the Web, reporting on what the SXT Chie Observer found interesting in the Yohkoh data. This is inherited to RHESSI, and the ACE team has similar (but more refined) reports.

- SOHO-Yohkoh Coordinated Data Analysis Workshops (starting in February 1997) stimulated scientific collaborations.

- Yohkoh was a rather minor presence as far as the NASA press releases were concerned. Perhaps having PR personnel stationed at GSFC would have helped.

Uniqueness of SXT (until XRT)
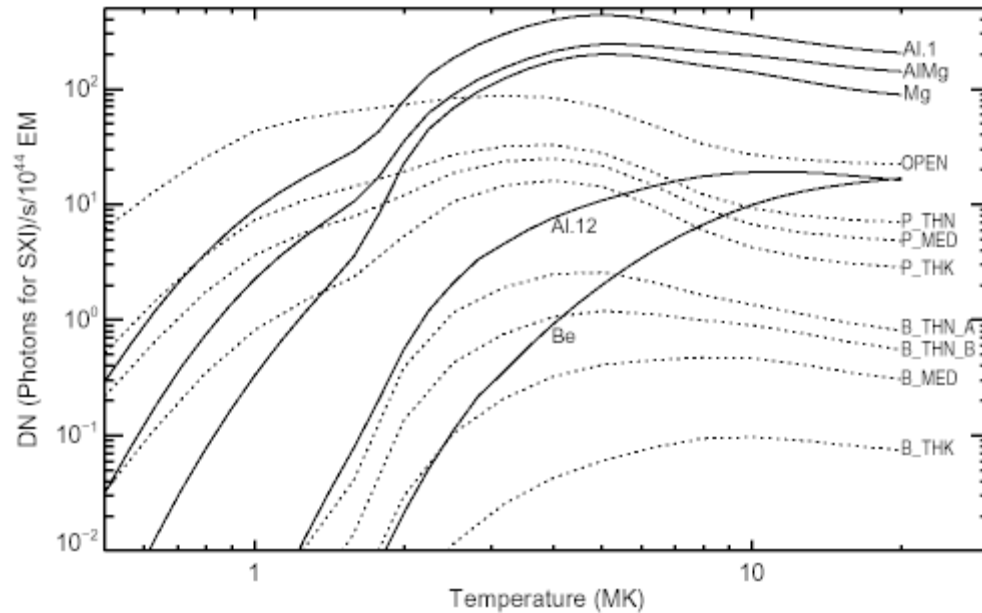
SXI is more (less) sensitive to high (low) temperatures
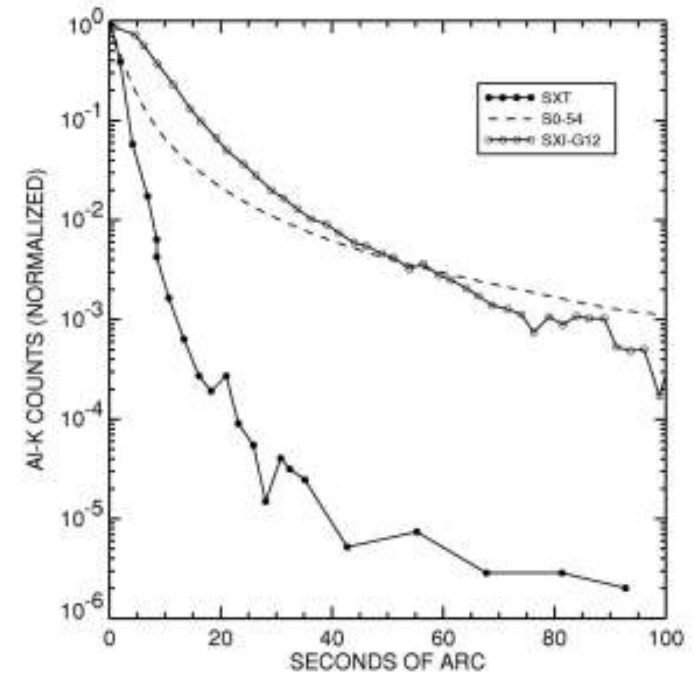
Comparison of Point Spread Function. This explains the appearance of the images

With these properties, SXT observed coronal structures and dynamic phenomena better than other instruments, whenever >3 MK plasma was created

SXT Images, FFI vs PFI

- The standard sequence included the following images

  - In Quiet mode

    - 512x512 (half resolution, 5") full-disk images (FFIs), 128 s

    - 128x128 (full resolution, 2.5") partially readout images (PFIs), 32 s

  - In Flare mode (triggered by the Soft X-ray Spectrometer)

    - 64x64 (all resolutions) PFIs, 2s

- In Quiet mode telemetry, FFI:PFI could have been 4:1 (FFI dominant) or 1:4 (PFI dominant), but we stayed on FFI dominant most of the time.

- Full disk images were interrupted for other reasons, i.e., satellite night (LEO), data overwriting (limited onboard storage + limited downlinks) and flare mode. These were unavoidable.

Importance of Full-Disk Images

4-APR-00   15:11:53

4-APR-00   16:36:54
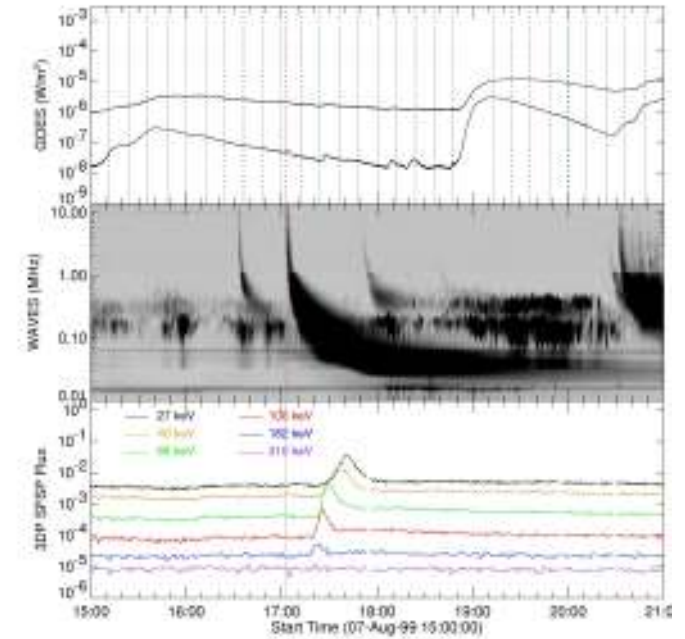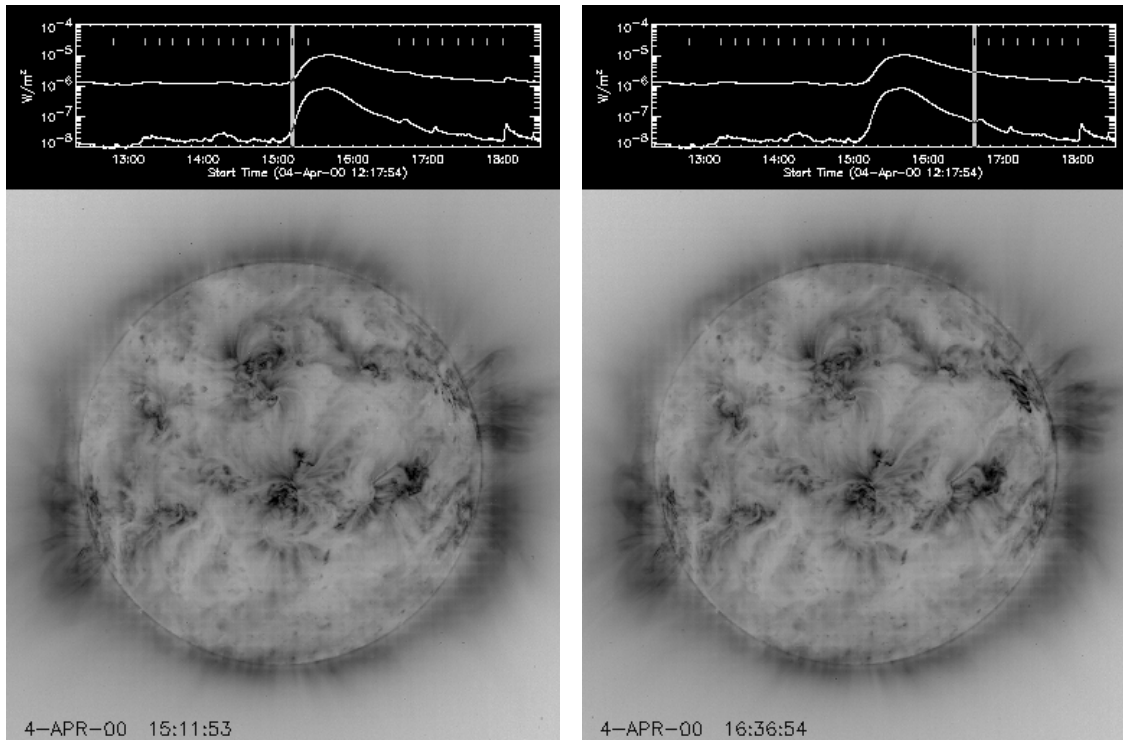
Tiny brightening not identified

Details of the eruption not captured

Why was Yohkoh successful?

- Best possible open data policy at the time

- Mission wide consistency of data distribution

- Adherence to the SXT standard sequence, with PFIs not interrupting the full-disk sequence while producing nice results in coordinated observations

- Contribution to the development of SolarSoft

- Emphasis on EPO activity

- CDAWs and science nuggets to communicate with outside communities

Conclusions

- Yohkoh set a model for solar physics missions, not only in terms of scientific impacts, but also in terms of the way data were archived and distributed, and because of the harmonious way international teams worked together.

- Operations were relatively simple, and even scientists had little difficulty with them (apart from interaction with mainframe).

- The LEO and limited on-board data storage reduced data coverage. In addition, flares and non-synoptic science operations interrupted full-disk soft X-ray images. But the impact was made minimal.