

Hinode
mission status and
Observations

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T. Shimizu (ISAS/JAXA)

Overview

- Hinode has been operated for two years after the launch on 23 September 2006 (JST).
- All the three telescopes are continuing to observe the Sun with the expected excellent performance.
- The Sun has been quiet for most of the last one year and Hinode's observations were mainly focused on the quiet Sun studies.
- Spacecraft functions are OK except for a problem in X-band downlink.
- X-band downlink problem gives a restriction to the volume of science data but we have almost established scientific operations baseline since the transition to S-band backup high-speed downlink.

Main Aims: Systems approach to understand generation, energy transfer and release of solar magnetic energy with 3 well-coordinated advanced telescopes onboard Hinode

Solar Optical Telescope

(**SOT**)

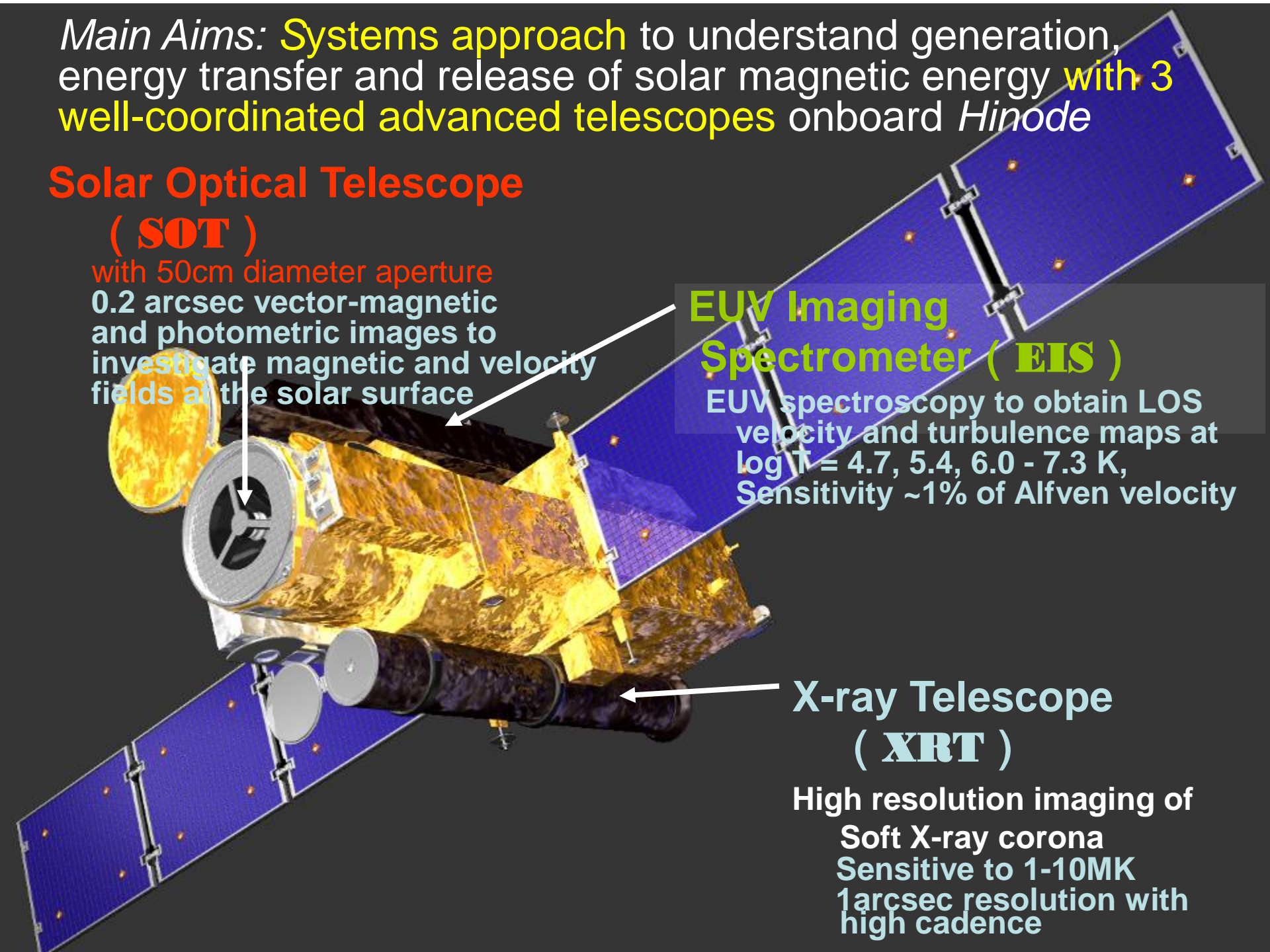
with 50cm diameter aperture
0.2 arcsec vector-magnetic and photometric images to investigate magnetic and velocity fields at the solar surface

EUV Imaging Spectrometer (EIS)

EUV spectroscopy to obtain LOS velocity and turbulence maps at $\log T = 4.7, 5.4, 6.0 - 7.3$ K, Sensitivity $\sim 1\%$ of Alfvén velocity

X-ray Telescope (XRT)

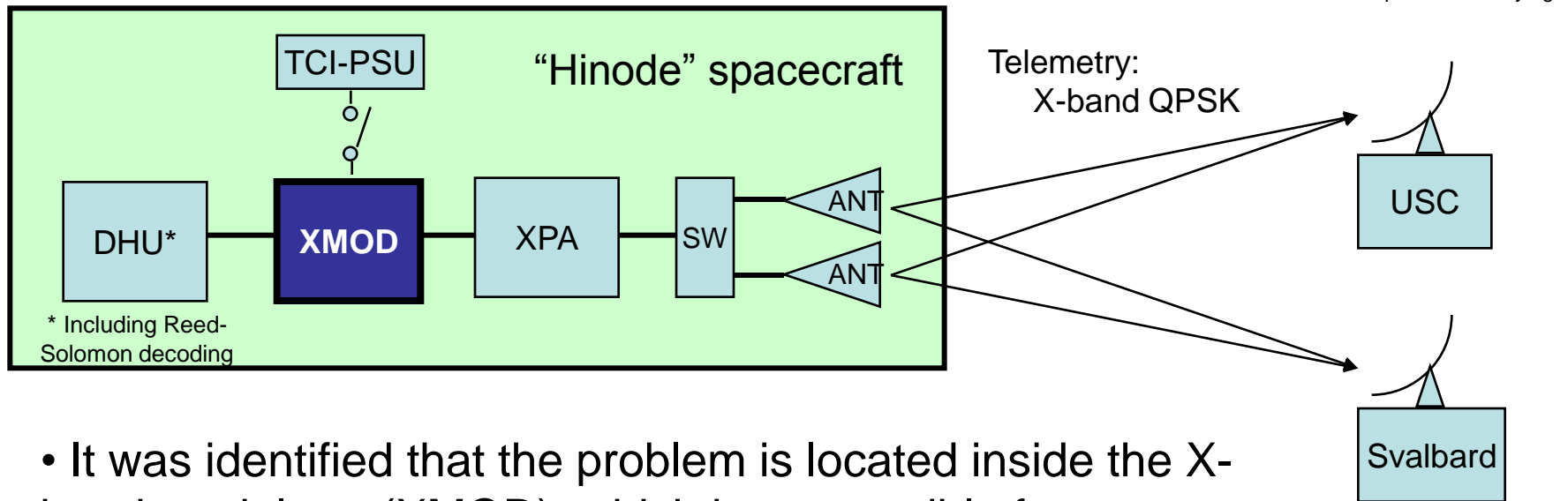
High resolution imaging of Soft X-ray corona
Sensitive to 1-10MK
1arcsec resolution with high cadence



X-band downlink problem

- Starting at the end of last year, X-band transmitter signal began to experience irregularities in the latter half of each contact with the ground stations.
- Irregular signal has caused partial and complete loss of science telemetry data.

◇ X-band data transmission system

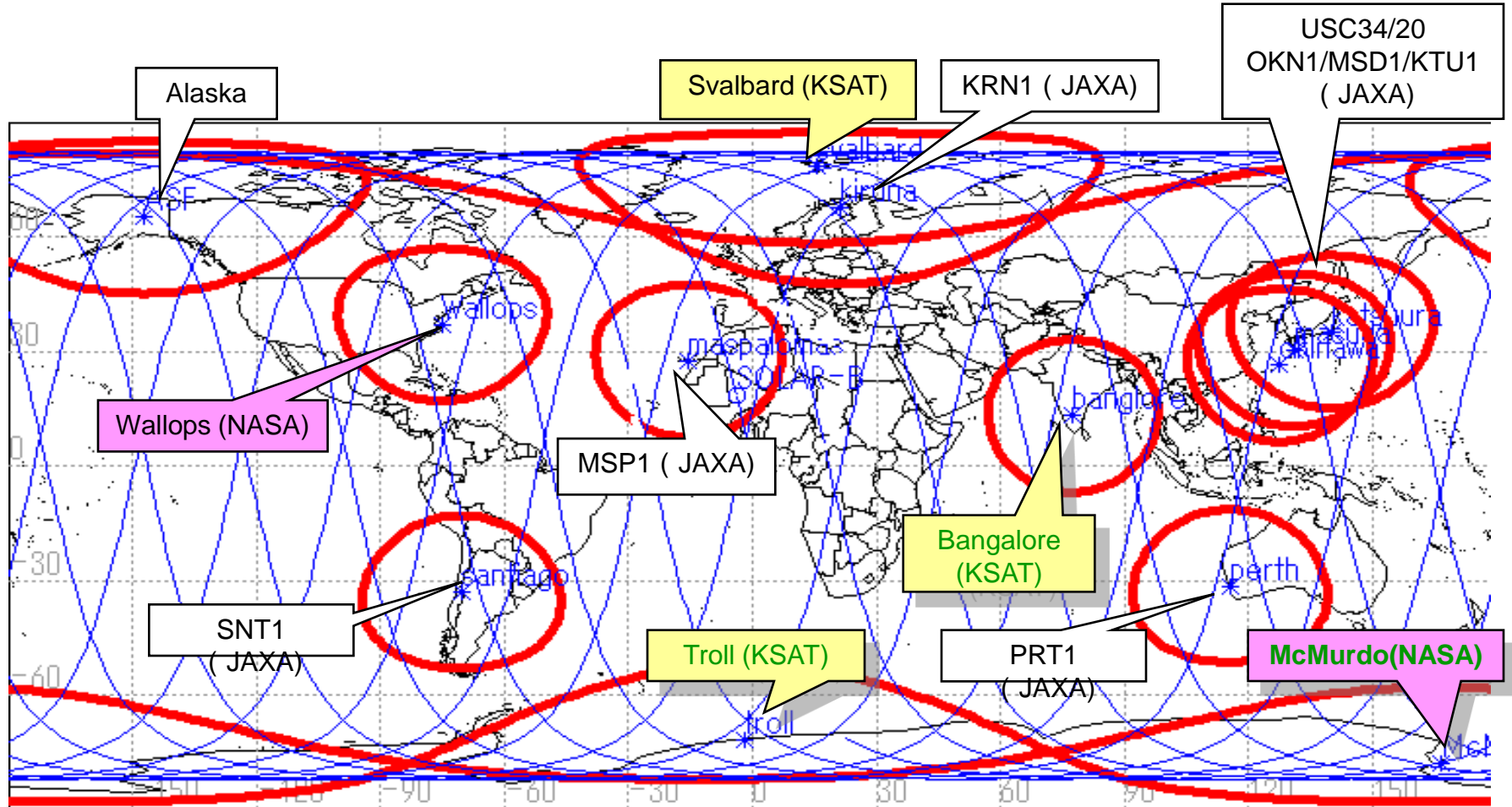


- It was identified that the problem is located inside the X-band modulator (XMOD), which is responsible for generating transmitter analog signal from digital data.

Recovery from X-band problem

- The probability that X-band full function will be back is extremely low.
- We switched the primary downlink path to S-band high-speed backup line this March.
- Downlink with S-band results in decreased downlink speed.
 - 256Kbps instead of 4Mbps in X-band
- Two major actions have been taken to mitigate the situation.
 - More efficient data compression and trade-off of less useful complimentary data (including FOV, pixel size, lines, cadence etc) have been implemented to observing sequences. (1/2 ~1/4.5 data volume reduction)
 - Working on adding downlink stations and performing science data downlinks more frequently.

Hinode S-band downlink network



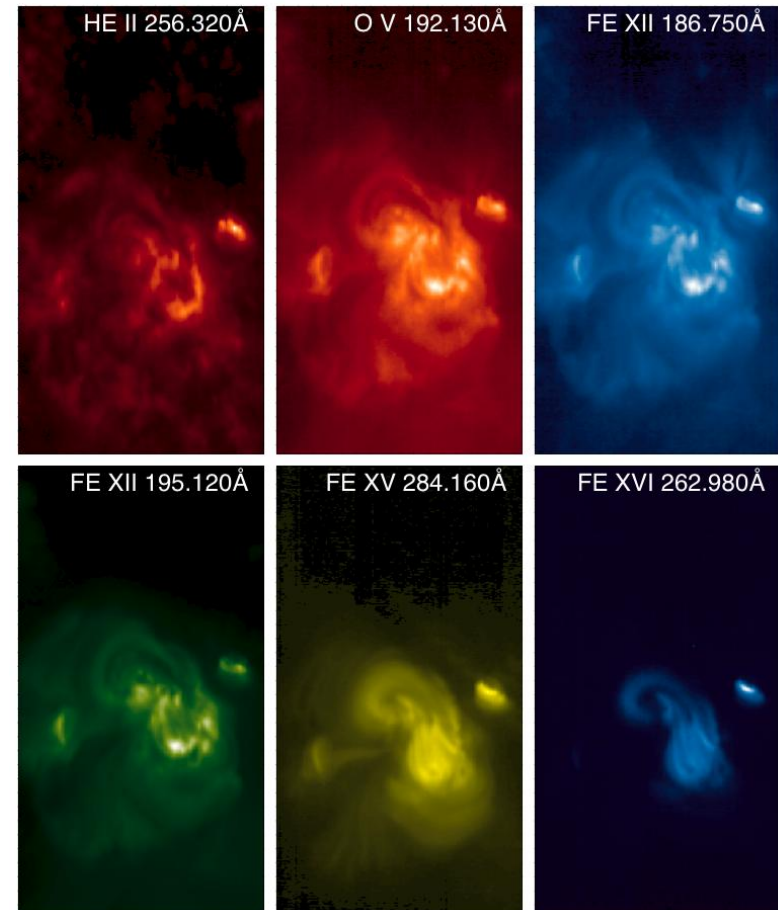
Currently more than 4 hours as the total duration of downlink in one day. Thanks to ESA, NASA, and JAXA supports, the downlink duration per day will be increasing more (→ 6 hours or longer).

Science Data volume

- The total duration of S-band downlink passes per day is currently 4.6 ~ 5.8 hr.
- Science data volume is roughly 3400~4300Mbits per day.
- SOT:XRT:EIS= 70:15:15
= (2380~3000) : (500~650) : (500~650) Mbits in a day
- Note that the allowable data volume may change depending on the remaining data volume in data recorder.
- After starting supports at NASA McMurdo (expected after middle January), the science data volume may be increased.

EIS Observations since transition to S-band

- Raster scan during eclipse season, June 2008
 - covering active region 10998
 - and a neighbouring coronal hole (to the north).
- Data are a slit raster with:
 - Information on:
 - Intensity
 - Velocity
 - Line widths
 - over a broad range of T
 - $\sim 5 \times 10^4$ to 3×10^6 K
 - with density diagnostic information



(courtesy of D. Books & Williams)

Long-duration data

- EIS narrow-slot raster movie
 - Taken 18th September 2008

- Data show the evolution of a filament over long duration.

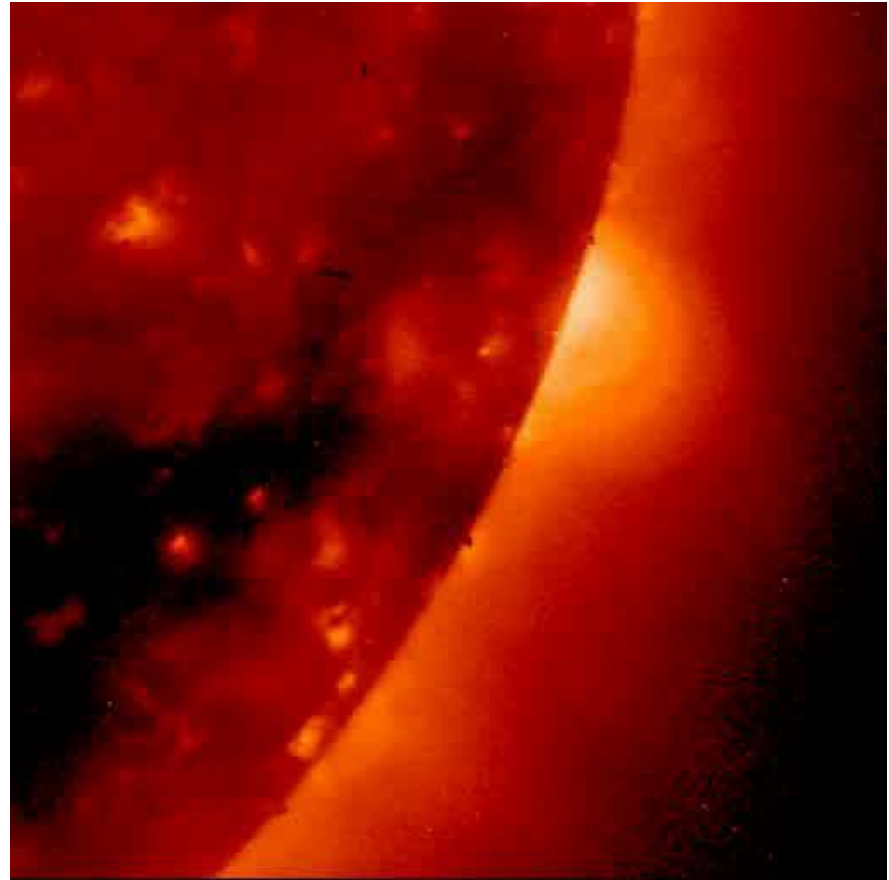
- Cadence 30 seconds
- Multiple temperatures covered
 - 5×10^4 to 2.2×10^6 K
- Over 7 hours' continuous data
 - Duration limited by other observations, not by volume!

QuickTime™ and a Cinepak decompressor are needed to see this picture.

(courtesy of D. Books & Williams)

XRT Observations since transition to S-band

- XRT made a rare and exciting observation on 9 April, 2008.
- The long-duration movie clearly shows **dynamical evolution of coronal magnetic fields during a CME**
 - The main X-ray flare source is hidden behind the limb, allowing XRT to capture dynamical evolution of faint coronal structures in details.

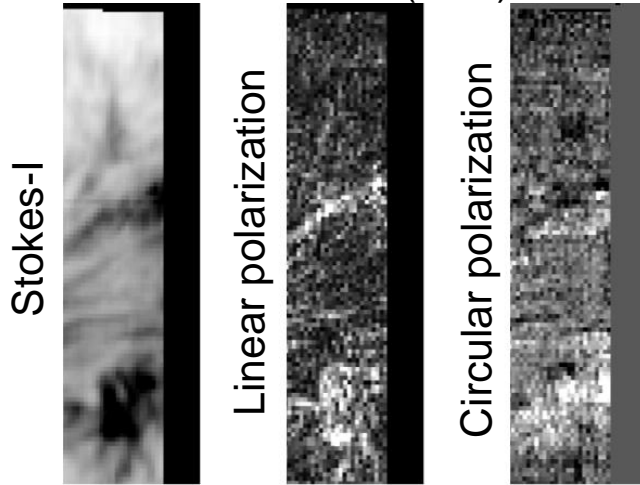


XRT movie on 9 April 2008
long-duration coverage from 4:24 to 17:32 UT)

SOT Observations since transition to S-band

Hinode-VTT coordination on May 2008

He I 10830 (VTT)

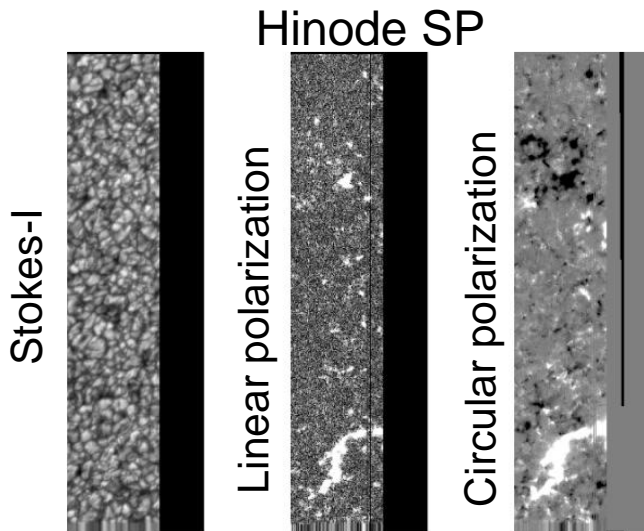
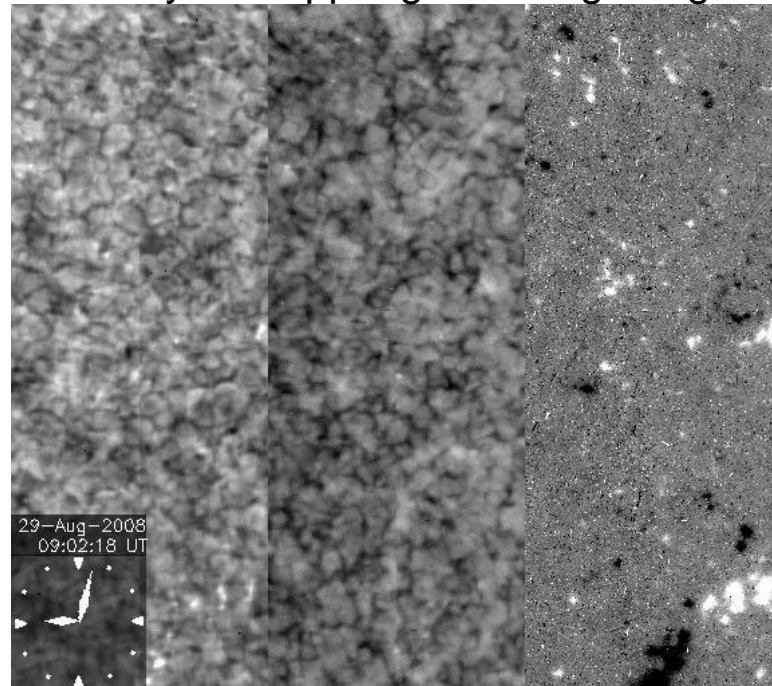


- Magnetic-field observations well coordinated with ground-based observatories have been performed for quiet Sun studies, providing valuable data for analysis.

Hinode-STT coordination on Aug 2008

NFI Mglb observation

intensity dopplergram magnetogram



Solar Activity in Solar Cycle 24

(courtesy of R. Ishikawa & Y.Katsukawa)

Scientific Operations

- Some updates have been made to Hinode scientific operations.
 - Currently science planning every 2 or 3 days.
 - Give more flexibility to the usage of limited telemetry resource.
 - Can be back to daily planning, by request in advance. For example, daily planning may give us target-selection flexibility, when the solar activity becomes up in the near future.
- Resumed to receive HOP proposals
 - Any scientists are encouraged to submit proposals.
 - See http://www.isas.jaxa.jp/home/solar/hinode_op/ for guidance
 - Hinode team would like to have **better observations for everyone**. Some modifications may be made to perform proposed observations under restriction of telemetry resource and coordination.
- Need further considerations
 - Hinode has been operated with “observatory” style.
 - Hinode’s observations when the solar activity is up.
 - What is the best observations for solar flares and AR long-term evolution?

Flare and AR long-term observations

- Currently “observatory” style operations with HOP programs
 - General rule of resource (duration, telemetry) allocation
50%: 50% = HOP proposed observations: instrument-team driven observations
- Hinode should acquire good data for flares and AR long-term evolution studies.
 - Hinode has acquired 3 X-class, ~5 M-class, and ~39 C-class flares until now (according to the flare catalog by Dr. K. Watanabe).
 - They were acquired with observing sequences developed for various science objects (HOP proposals).
 - The data may not be suitable for flare and AR long-term evolution studies.
 - Hinode should be well-prepared to make high quality inter-instrument observations for these important objectives.

Flare and AR long-term observations

- Hinode operations may go into another mode, when energetic active regions appear.
 - 100% resource is used for the “baseline” core programs, by canceling or postponing the pre-scheduled HOP observations.
 - “Baseline” core programs will be prepared either for flare observations or AR long-term evolution observations.
 - “Baseline” core programs can acquire the Hinode data useful for many scientists.
 - Final decision authority for going into the mode by ISAS/JAXA Hinode managers.

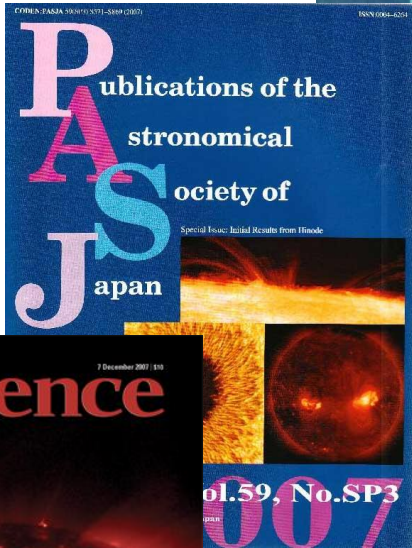
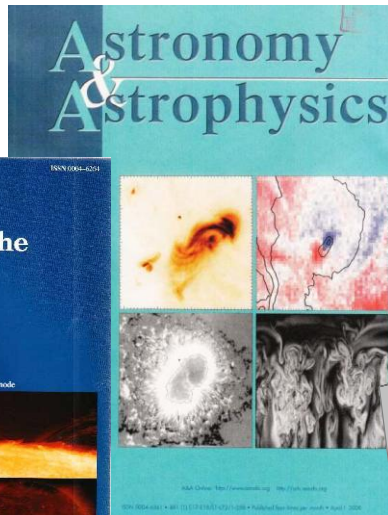
Dr. Cirtain will discuss a draft plan of the baseline core programs. The Hinode team expects scientific feedbacks from scientists to improve the programs.

Final remarks

- Many thanks to all the people involved in Hinode daily operations and data analysis.
- To keep Hinode observations valuable, we continuously need huge number of ground stations supports from ESA, NASA, and JAXA.
- Keeping our Hinode research activities active encourages the agencies to continue their long-period supports.
- Hinode is one of key observatories for solar activity studies in solar cycle 24. Scientists here are encouraged to give any scientific feedbacks to the Hinode team for having valuable data near the future.

Result Publications

- 124 papers have been published in refereed journals, including Hinode special issues of PASJ, Science, and A&A.
 - 63 papers in 2007, 61 papers in 2008(~Aug), not including “in press” papers.
- Data analysis over the world



Country based on the nationality of the institute of the first author (searched by Dr. Shimojo)

