

Status of X-ray Astronomy Satellite Hitomi (ASTRO-H)

April 8th, 2016

Revised April 11th, 2016

JAXA

Time in this handout is expressed in JST.

1 . Hitomi trajectory and Hitomi Condition

JAXA assumes the object published as ID=41337 by JSpOC (Joint Space Operations Center) is the main body of Hitomi (ASTRO-H) and has been tracking it since the evening of April 4th,2016. The following points are reasons for this assumption.

- Consistent trajectory tracking of the object.
- There is high possibility that the object is a source of radio waves received three times (#) at JAXA ground stations after the communication anomaly was identified.
- The object has been estimated as the largest object in the orbit.
- The object has been estimated a few meters in size by the image of the Subaru Telescope.

(#) After detailed inspection, we have concluded that the signal received on March 29 did not come from Hitomi, although we announced that we received the signal 4 times after the communication anomaly.

【Reference 1】 JSpOC trajectory information

JSpOC released the trajectory of the 11 objects on April 1. The largest piece should be identified as 41337. In this regards, the former 41337 and 80015 were amended to 41442 and 41337, respectively.

【Reference 2】 Total number of observations by JAXA (March 26th – April 7th)

JAXA has observed the four objects below so far.

ID:41442(former41337)=16 times	(KSGC 11times、BSGC 5times)	KSGC :Kamisaibara Space Guard Center
ID:41337=23times	(KSGC 18times、BSGC 5times)	BSGC : Bisei Space Guard Center
ID:41440=3times	(BSGC Two optical telescopes observe three times at the same time)	
ID:41441=1time	(BSGC Three optical telescopes observe once at the same time)	

2. Current status of Hitomi

- According to the optical observation of Hitomi by the University of Tokyo, the estimated rotation period calculated from the light curve is about 5.2 seconds. The rotation style cannot be confirmed at the point because correlation of blink and rotation has to be studied based on structure and surficial material; yet, we consider the rotation speed to be very fast.
- Possible cause for this fast rotations is anomaly in attitude control system. Given that the satellite is rotating at high speed, it is possible that satellites parts that are vulnerable to the rotation such as solar cell paddles or Extension Optical Bench (EOB) to separate off from the satellite main body. The situation is under investigation.

3. Future Activities

(1) Short-term Plans

- Observations by ground-based telescopes

In order to grasp the condition of Hitomi as accurately as possible, additional observational data regarding blinks is to be acquired from JAXA(KSGC, BSGC) and cooperation organizations such as the University of Tokyo and National Astronomical Observatory of Japan. Also observation of other objects in the orbit is continued to be under consideration for the purpose of parts specification.

- Investigation of the causes

Given that anomaly in attitude control system is assumed, the flow of series of events “attitude anomaly”, “separation of multiple objects”, and “communication anomaly” is needed to be focused to specify the mechanism of this incident.

(2) Long-term Plans

At the moment, details of the damage is unclear. It can be considered that the part of the satellite remains functional given the fact that the radio waves were received from Hitomi for a few times after the anomaly was identified. JAXA will continue the operation aiming to re-establish consistent communications with the satellite, meanwhile, rotation coping measures and recovery procedures are subject to be considered.

Appendix 1: Acknowledgement of Cooperation

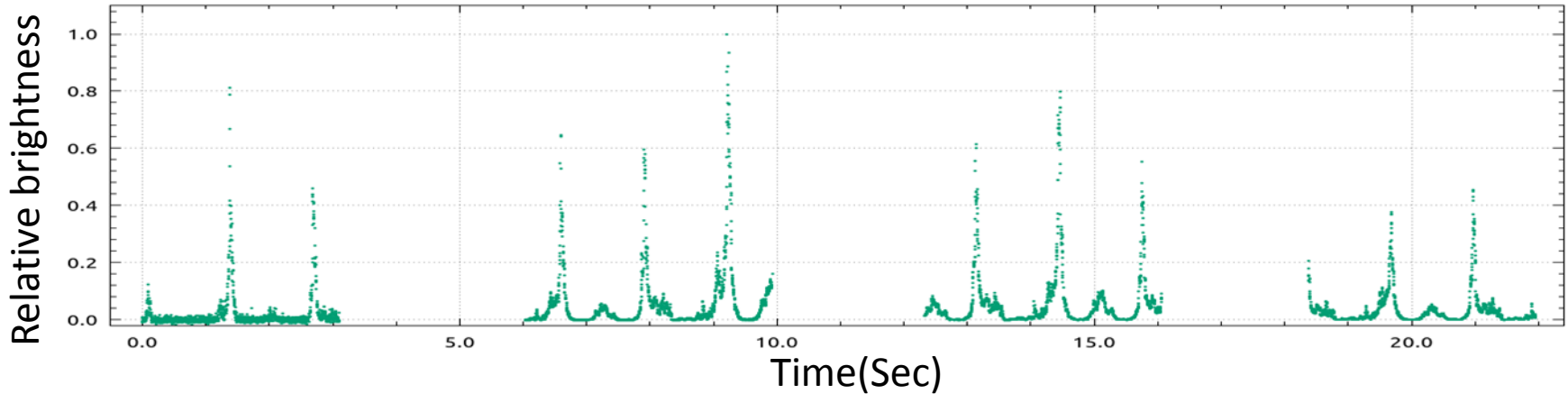
- Kamisaibara Space Guard Center & Bisei Space Guard Center, Japan Space Forum / Japan Space Guard Associations
- Kiso Observatory, University of Tokyo
- Tomo-e Gozen Project
- Ishigaki-shima Observatory, Okayama Astrophysical Observatory & Hawaii Observatory (Subaru Telescope), National Astronomical Observatory of Japan
- Toyama Observatory
- Higashi-Hiroshima Observatory
- Bisei Observatory
- Joint Space Operations Center
- Deutsches Zentrum für Luft- und Raumfahrt
- Centre National d'Etudes Spatiales

Appendix 2: Status of Ground-Based Observations

- JAXA has asked ground-based observations to the observatories below.
 - Ishigaki-shima Observatory (NAOJ): March 28, April 1 & 2
 - Observations by the sky monitor camera and so on, and data providing
 - Kiso Observatory (Univ. of Tokyo) / Tomo-e Gozen: March 31
 - Observations by the proto-type Wide Field Camera Tomo-e Gozen and providing data (Appendix 3)
 - Subaru Telescope (NAOJ): April 2
 - Observations by Hyper Suprime-Cam and data providing (Appendix 4)

The imaging observations above suggest the rapid spin and certain size. JAXA infers 41377 as the main body.

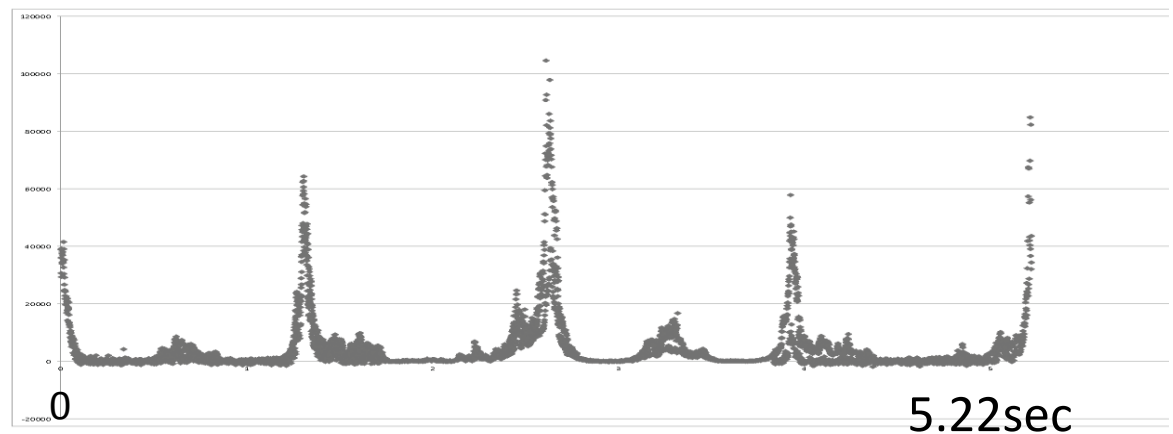
Appendix 3: Light Curves



The number of seconds elapsed from 3/31 11:24:11.3

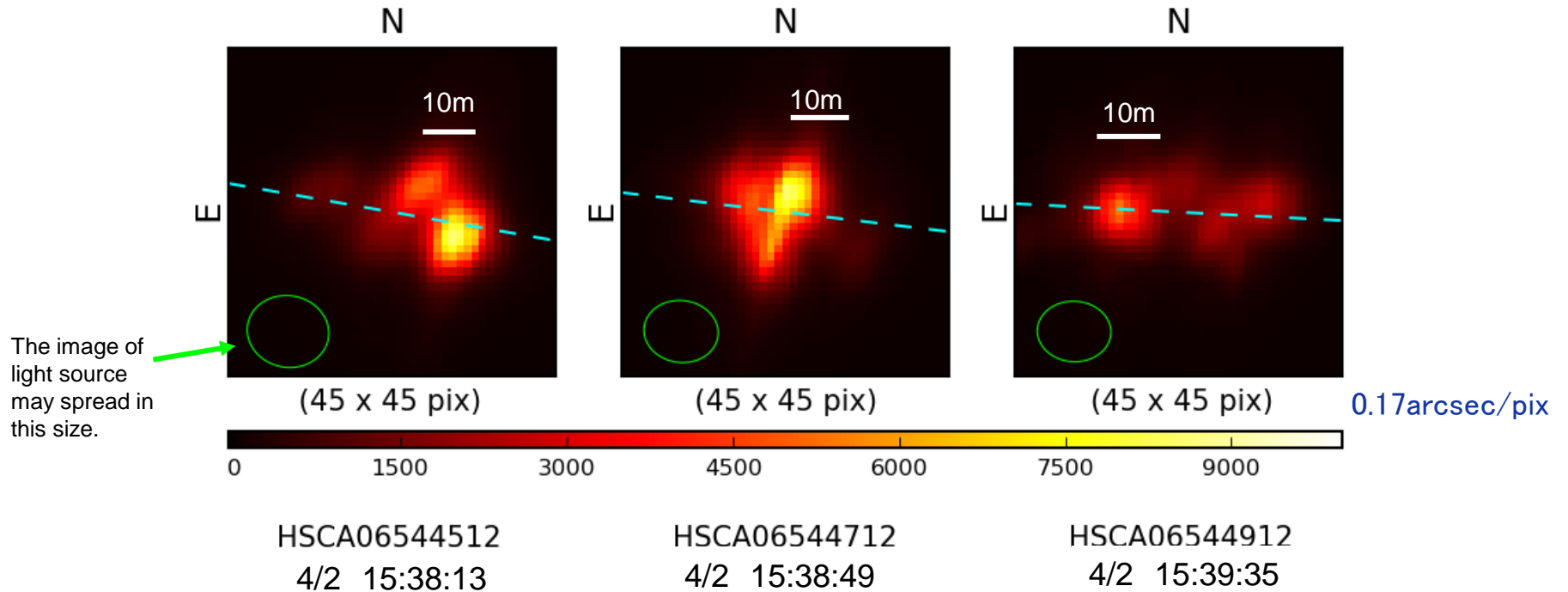
Upper Panel: Light curves observed by the proto-type of the Kiso wide field CMOS camera.

Right Panel: Result of the 5.22 sec period convolution



Original chart is provided by University of Tokyo

Appendix 4: Observation images by Subaru Telescope

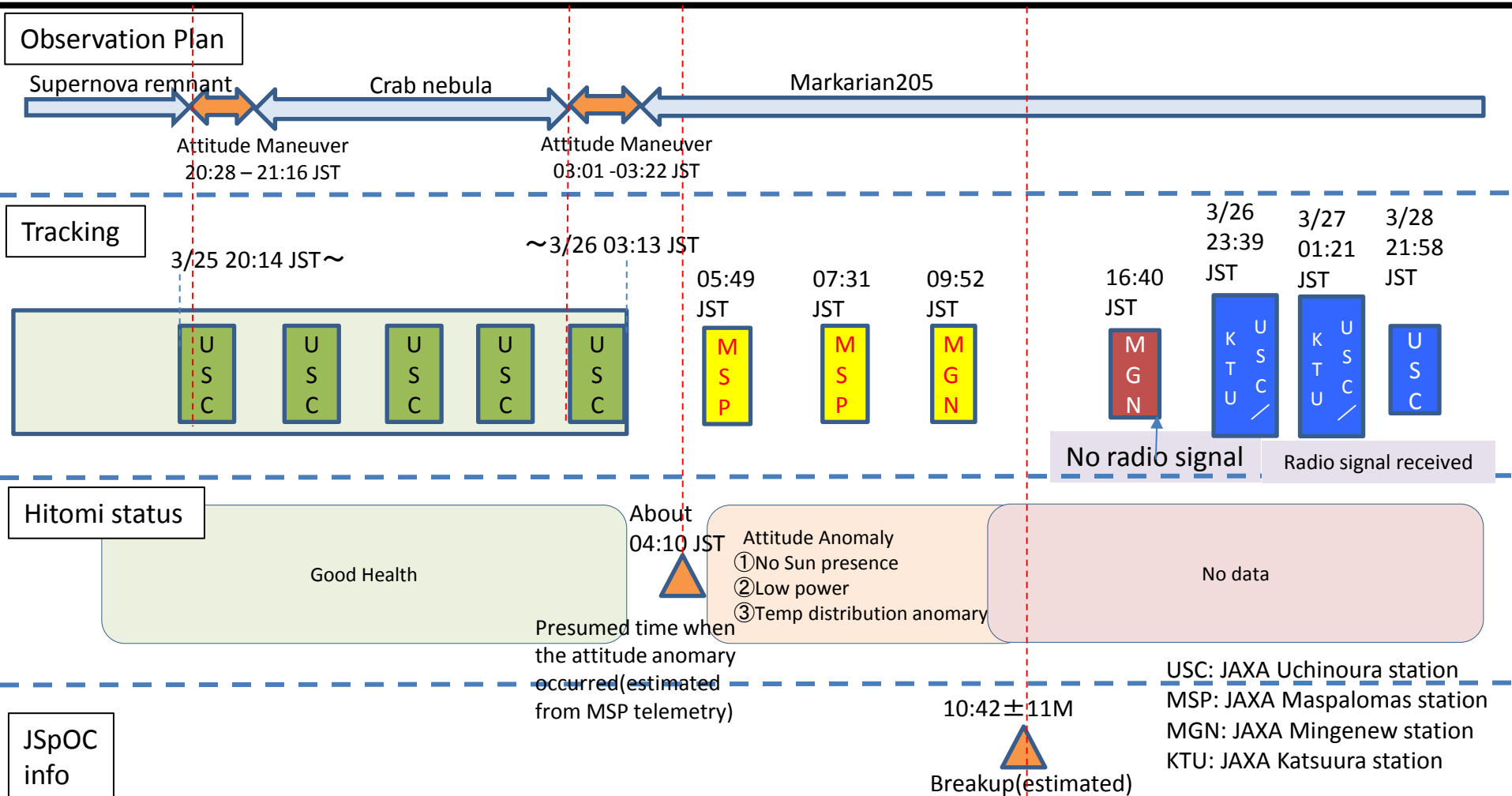


Original images are provided by National Astronomical Observatory of Japan

Although the resolution is not clear enough due to the low elevation of the target and the tracking error, the size of the bright pixels suggests that the object size of several meters. The details are under investigation.

Appendix 5: Hitomi Sequence of Event (Updated from April 1st)

- This shows the observation plan and satellite tracking condition based on events, including the JSpOC information.



The signal as previously thought to be received at SNT on March 29 was not from Hitomi.

Appendix 6: Event List (Updated from April 1st)

JST	Ground Station Operation		Event and Satellite Status	
	Success/failure	Ground Station		
3/26	03:02 - 03:13	○	USC	Good Health
	05:49 - 06:02	○	MSP	Attitude : anomaly Power : anomaly (Low Power by Attitude anomaly) Temperature distribution : Some parts higher (by Attitude anomaly)
	07:31 - 07:44	○	MSP	Attitude : anomaly Power : N/A (No generation power by Shade) Temperature distribution : Some parts higher (by Attitude anomaly)
	09:52 - 10:04	○	MSP	Attitude : anomaly Power : anomaly (Low Power by Attitude anomaly) Temperature distribution : Some parts higher (by Attitude anomaly)
	10:31 - 10:53 (10:42 ± 11min)	-		ASTRO-H Breakups time(JSpOC Twitter)
	16:40 - 16:50	×	MGN	No radio signal. JAXA identified the anomaly of Hitomi.
	23:39 - 23:52	△	USC/KTU	Radio reception record
23:40 - 23:53	USC:From 23:59 to about 3 minutes KTU:From 23:48 to about 3 minutes			
3/27	01:20 - 01:33	△	-	Radio reception record
	01:22 - 01:33			USC:From 01:23 to about 4 minutes KTU:From 01:24 to about 6 minutes
	13:00	-	-	Installation of operational abnormality countermeasure headquarters
3/28	21:58 - 22:11	△	USC	Radio reception record From 22:06 to about 10 sec From 22:07 to about 1 sec
3/29	00:25 - 00:39	△	SNT	Radio reception record From 00:33 to about 7 sec

[Success]

○ : telemetry **reception**

△ : only receive radio waves from a satellite

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[Station name]

MGN: Mingenew Station (Australia)

SNT: Santiago Station (Chile)

MSP: Maspalomas station (Spain)

USC: Uchinoura Space Center

BSGC: Bisei Spaceguard Centre

KSGC: Kamisaibara Spaceguard Centre

※ JAXA has announced that "According to the U.S. Joint Space Operations Center (JSpOC), it is estimated that Hitomi separated to five pieces..." on the web site on March 29. However, JAXA re-confirmed the situation with JSpOC and found that their estimation actually meant, "five objects fell off from the satellite (meaning the satellite is now separated into six parts)."