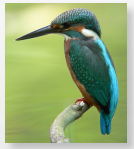
HyspIRI and SBG Community Science and Applications Workshop 2018
August 15 – 17, 2018, Washington DC, US




HISUI Status Toward FY2019 Launch and Collaboration with Other Missions


Jadeite

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"HISUI" has two meanings in Japanese, names of a mineral and a bird.


Kingfisher

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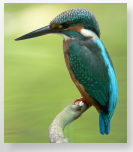
[1] National Institute for Environmental Studies (NIES), [2] University of Tokyo,
[3] National Institute of Advanced Industrial Science and Technology (AIST), [4] Japan Space Systems,



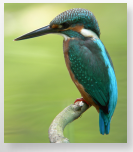
What is **HISUI**?
A Successor of Terra **ASTER**

- **HISUI (Hyperspectral Imager SUIte)** is a spaceborne hyperspectral imager being developed by Japanese Ministry of Economy, Trade, and Industry (METI) as its 4th spaceborne optical imager mission.
  1) OPS onboard JERS-1 satellite (1992 – 1998)
  2) ASTER onboard NASA's Terra satellite (1999 -)
  3) ASNARO (2014-)
  4) HISUI (2020 -)

- HISUI covers 0.4 – 2.5 μm region with 185 bands, 20 x 30 m spatial resolution, and 20 km swath. It consists of a reflective telescope and two grating spectrometers.

- HISUI launch is currently scheduled in **January 2020 by SpaceX's Falcon-9 (SpX-20)**.

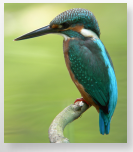
- **HISUI will be deployed on Japan Experiment Module (JEM) of International Space Station (ISS) for three year operation**.



HISUI Specifications

HISUI was originally designed for a dedicated satellite with 600 km altitude.
ISS orbit ≈ 400 km altitude

Parameter		HISUI Specifications
Imaging Type / Spectral Dispersion		Pushbroom / Grating
Spatial Resolution / Swath		20 m (CT) x 30 m (AT) / 20 km
Spectral	Range / Bands	0.4 - 2.5 μm / 185 bands
	Resolution	10 – 12.5 nm
SNR (30% albedo)		≥ 450 @620 nm ≥ 300 @2100 nm
MTF		≥ 0.2
Dynamic Range		Saturated at 70% alebdo
Spectral Calibration		VNIR : 0.2 nm SWIR :0.625 nm
Radiometric Calibration		Absolute : ±5%, among bands :±2%
Onboard Calibration Sources		Halogen lamp and filter wheel
Quantization / Data Compression		12 bits / Lossless (70%)
Telescope Diameter		≈ 30 cm
HISUI Exposed Payload (ExP) Dimensions / Mass		≈ 2.3 x 1.5 x 1.6 m ≈ Nominal / Max 550 / 570 kg including Hyperspecral Imager (≈ 240 kg)

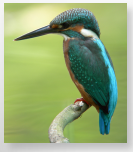


HISUI Chronology

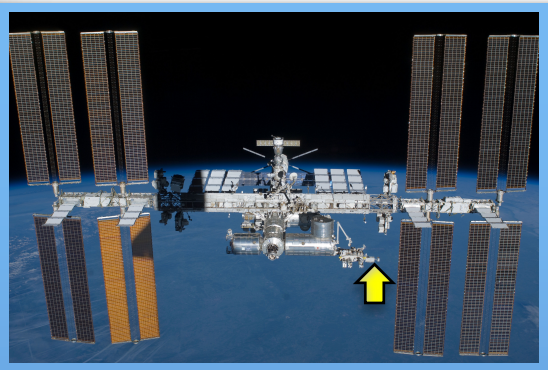
- 2018 “HISUI will be launched in January 2020 by SpX-20 flight.”
- 2017 “HISUI, without a cross track pointing system, will be launched in 2019 by Space-X’s Falcon 9 rocket.”
- 2015 “HISUI hyperspectral imager will be launched in 2018 and attached to ISS JEM EF.”

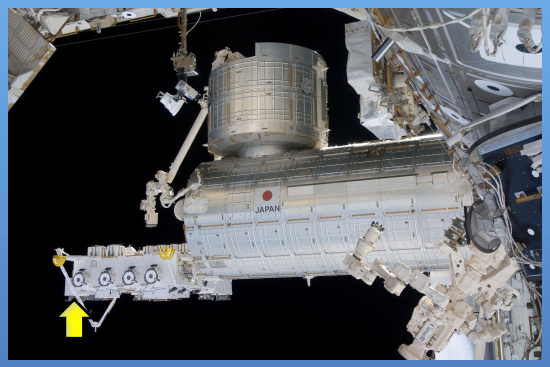
- 2014 “HISUI will be launched in 2018 or later. ”
- 2013 “HISUI development will be completed in 2016. ” “Discussions with satellites/ground data system providers are ongoing. ”
- 2012 “HISUI will be launched in 2015 or later. ”
- 2010 “HISUI will be launched in FY 2014.”

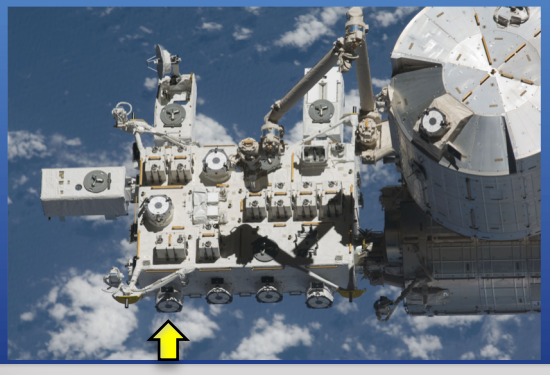
- 2009 “METI’s hyperspectral and multispecyral sensor systemn JAXA’s ALOS-3 satellite will be launched by H-IIA rocket in 2013 – 2014.”
- 2007 “METI’s hyperspectral and multispecyral sensor system onboard JAXA’s disaster monitoring satellite will be launched by H-IIA rocket in FY2012.”



HISUI Deployment on ISS JEM



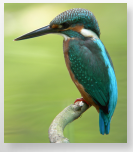




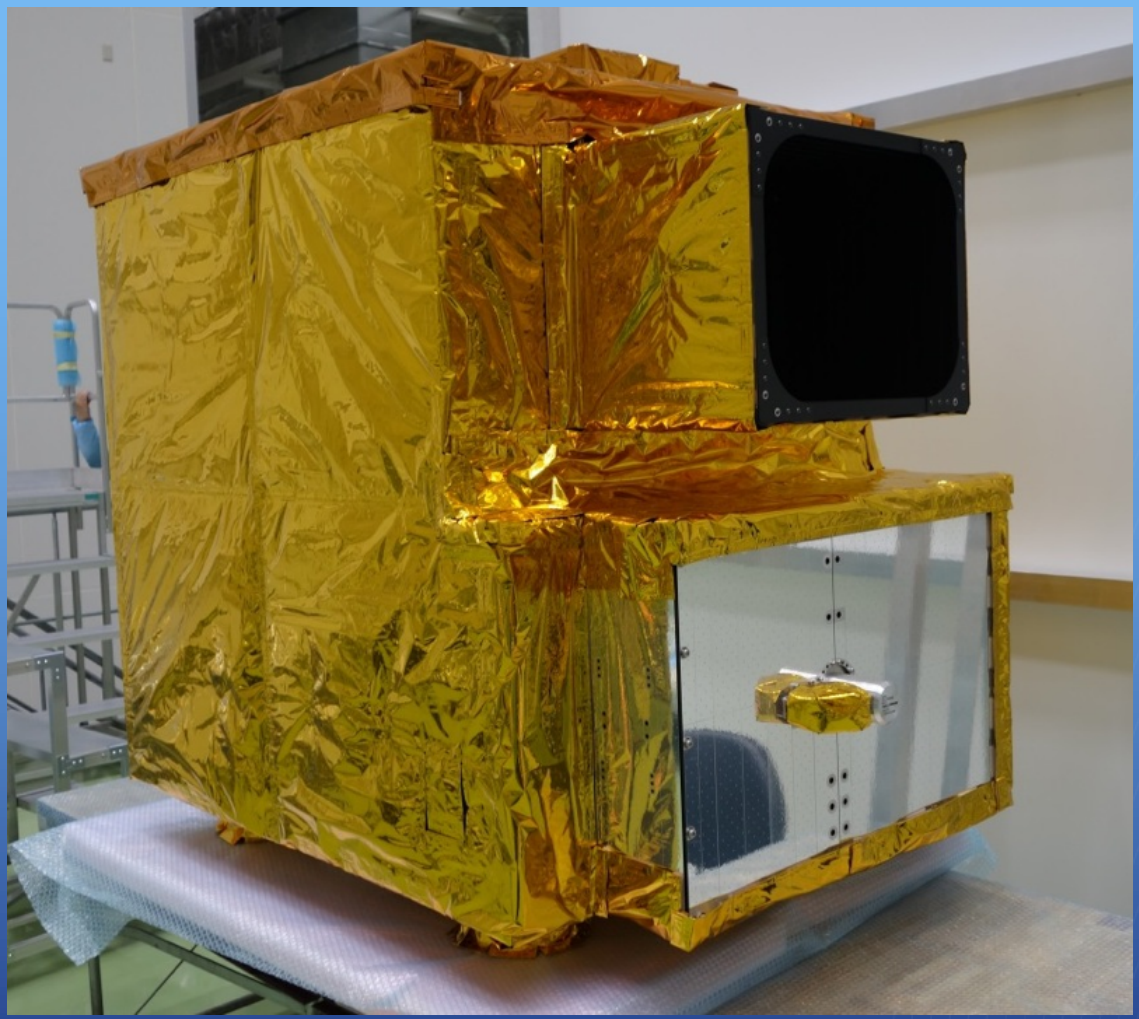
- HISUI consists of two components:
  - Exposed Payload (HISUI-ExP)
  - HISUI-Mission Data Recorder - Pressurized Module (MDR-PM)

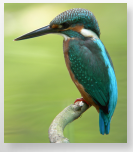
  They will be delivered to ISS by Dragon / Falcon 9 cargo rocket(SpX-20) in January, 2020.
- HISUI-ExP will be attached to Port #8 of JEM Exposed Facility (EF) as a nadir-viewing instrument. It also has support sensors such as a gyro, two star trackers, GPS receivers, and a mission data processor.
- MDR-PM will be installed in JEM-PM.
- HISUI data will be partially transmitted to ground stations (≈ 10 GB/day ≈ 30,000 km^2/day). The rest (≈ max. 300 GB/day ≈ 900,000 km^2/day) will be recorded in removal media and shipped back to Earth by cargo ships three or four times a year.

Priority downlink

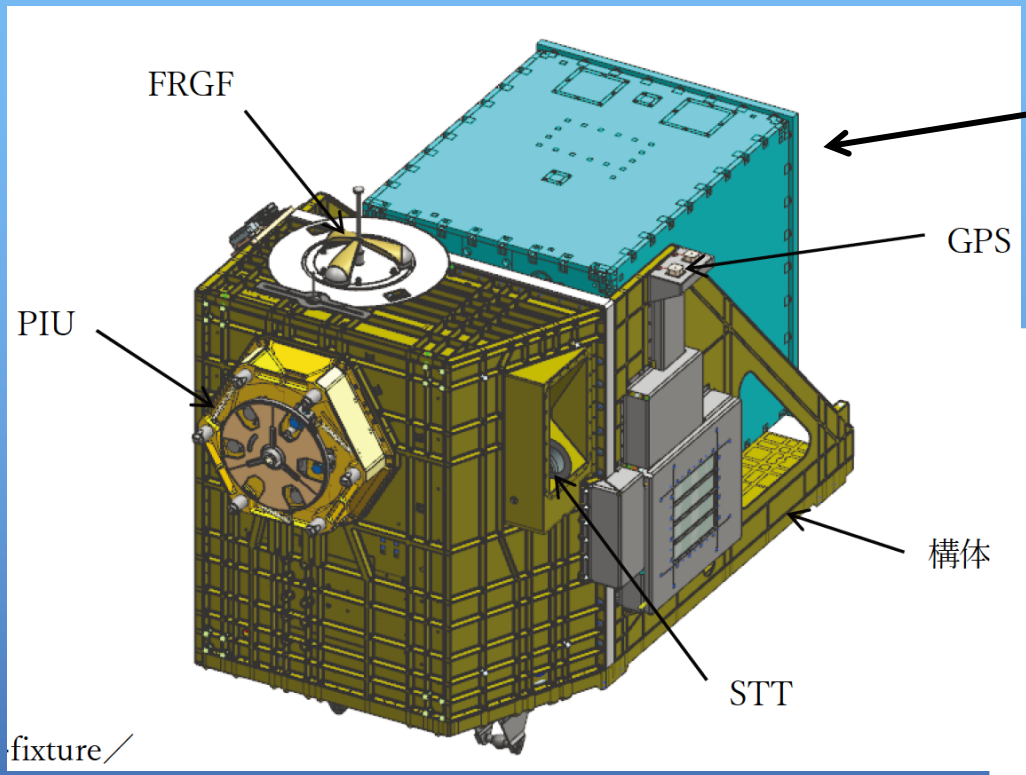


HISUI Flight Model

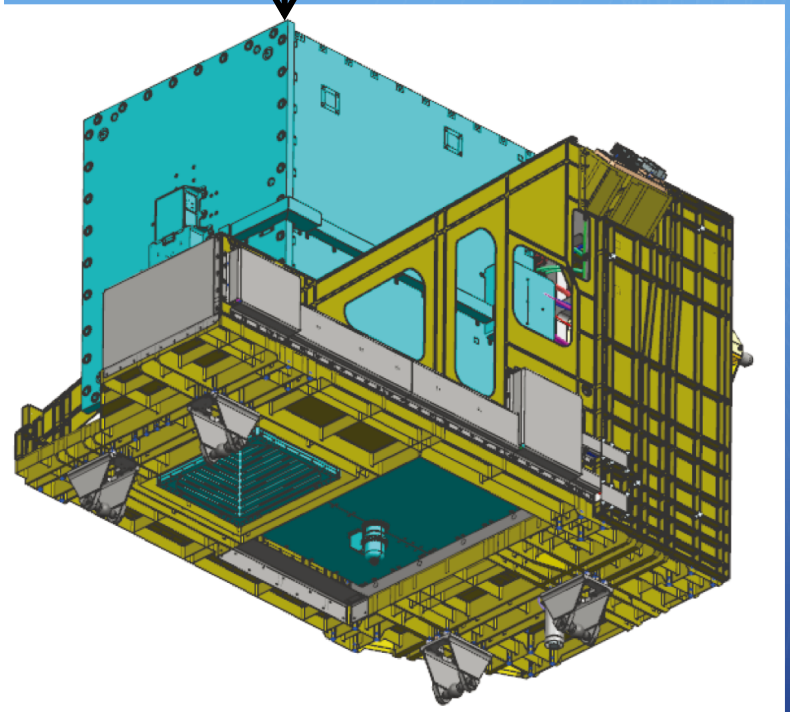




HISUI Exposed Payload (HISUI-ExP)



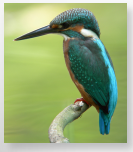
HISUI Spectrometer



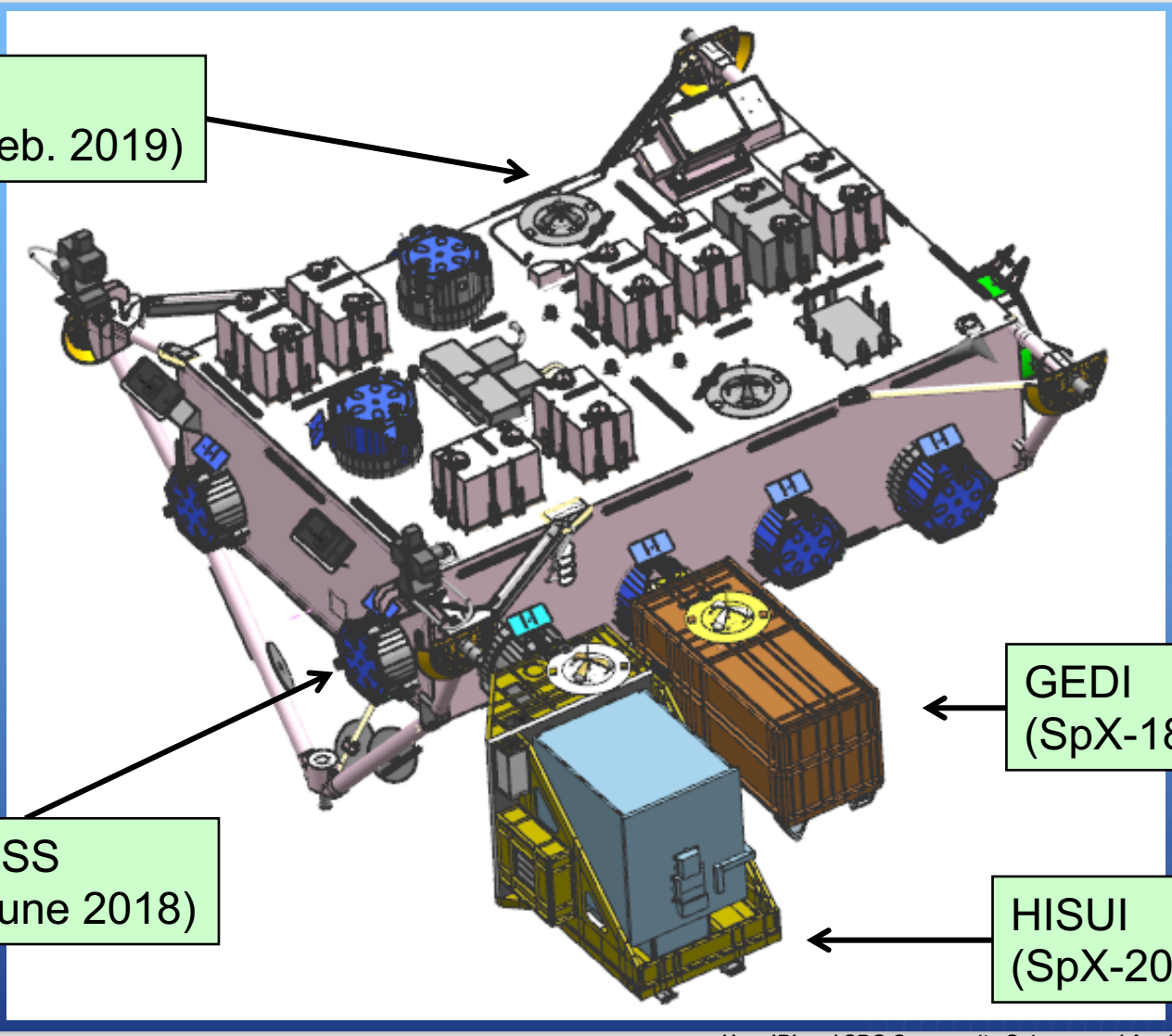
FRGF : Flight Releasable Grapple Fixture

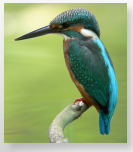
PIU : Payload Interface Unit

STT: Star Tracker



HISUI ExP Attached to Port 8 of JEM EF

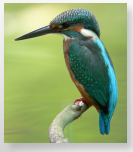




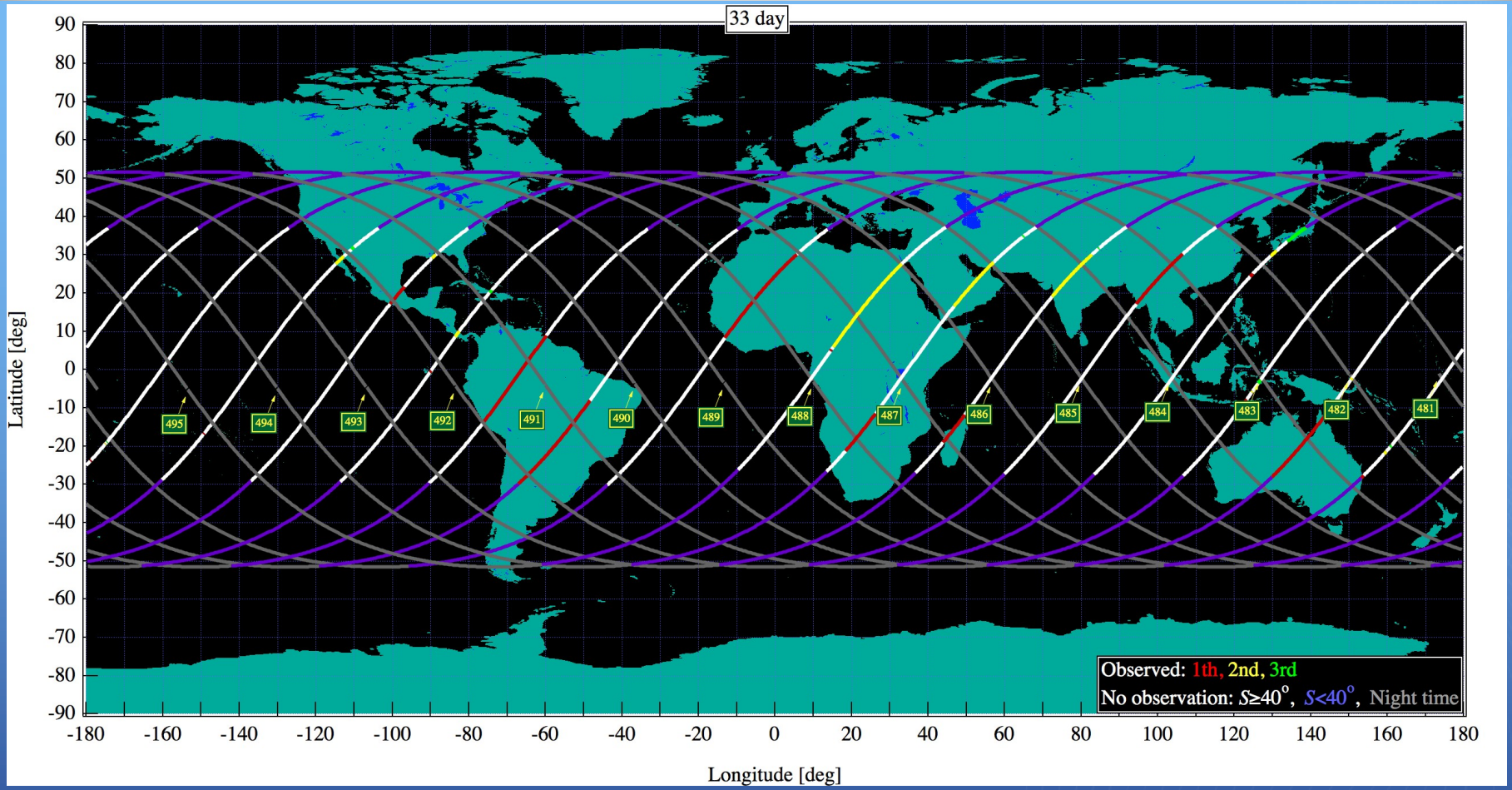
HISUI Product List as of July, 2018

Name (Format)	Description
Level 0	Raw data
Level 1A (TIFF)	Raw DN product with all radiometric calibration coefficients. Spatial resampling is not applied.
Level 1R (TIFF)	Top-of-atmosphere spectral radiance product. Spatial resampling is not applied.
Level 1G (GeoTIFF)	Geometrically corrected / orthorectified top-of-atmosphere spectral radiance product. Parallax correction, keystone property, and spectral continuity between VNIR and SWIR spectrometers are considered.
Level 2 (TBD)	Atmospherically corrected surface spectral reflectance product generated from L1G with QA information. This is Science Product for research purpose and not validated.

* Cloud statistical data are attached to L1 and L2 products.

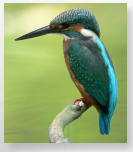


Example of One-day Observation of HISUI



15 orbit/day, 8 minute/orbit (≈ 3600 km/orbit), and
3 segment/orbit (1st segment, 2nd segment, and 3rd segment)

(Source : 2017/10/13)



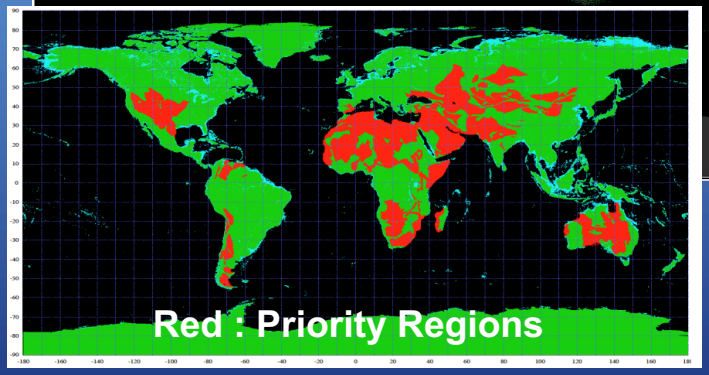
HISUI 3-year Operation Simulation with 200 targets, Priority region, and Global mapping, Using MODIS Cloud Statistics

Number of Cloud-free Observation

3 years

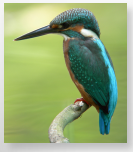
Cloud-free observation
- 1 time
- 2 times .....
- No cloud-free observation
- No planned observation

1 — 12

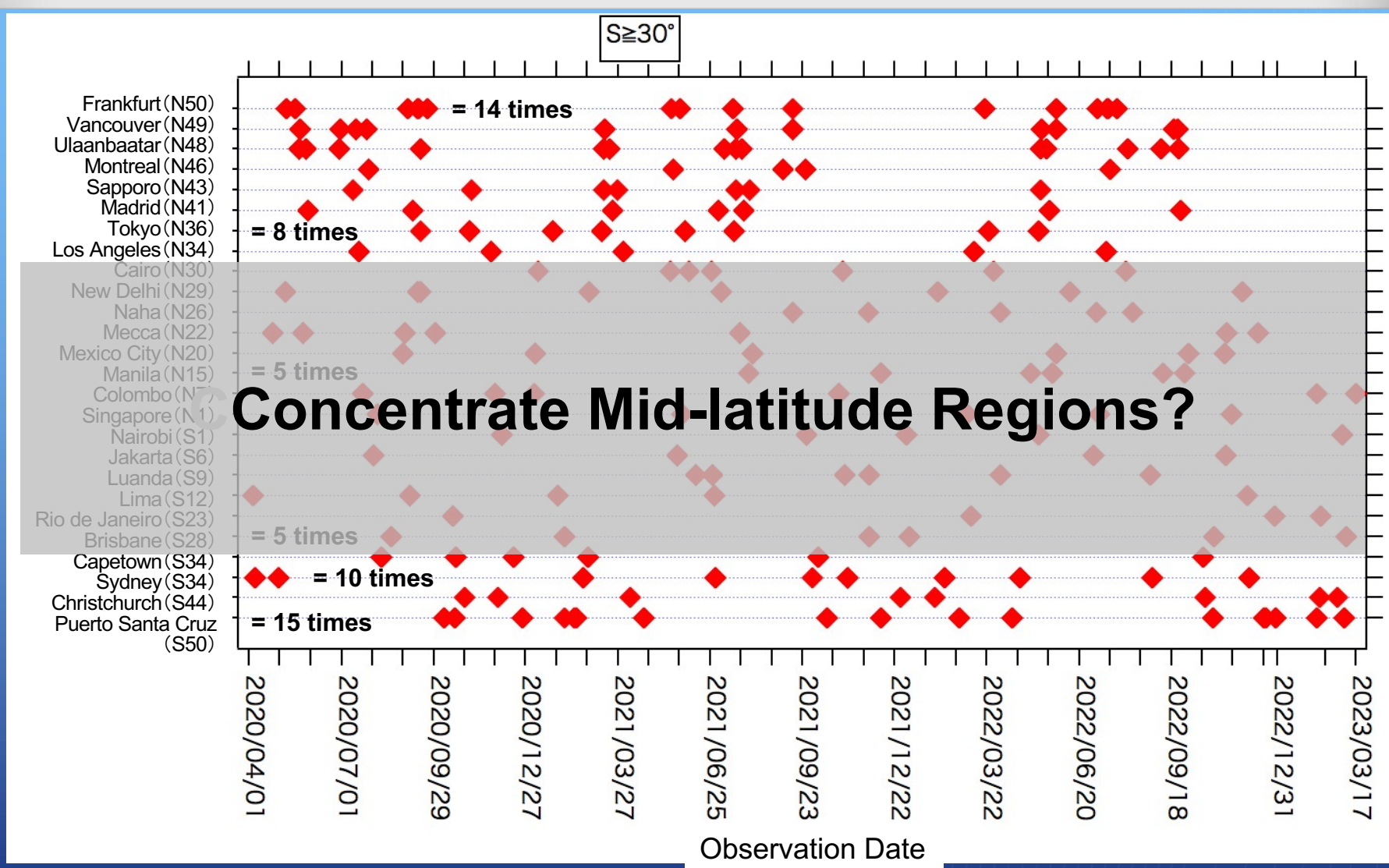


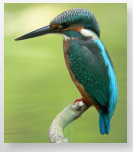
Cloud-free coverage in three years :
Priority Regions ≈ 65 => 85 => 92 %
Global Mapping ≈ 48 => 67 => 76 %

(Source : 180724)

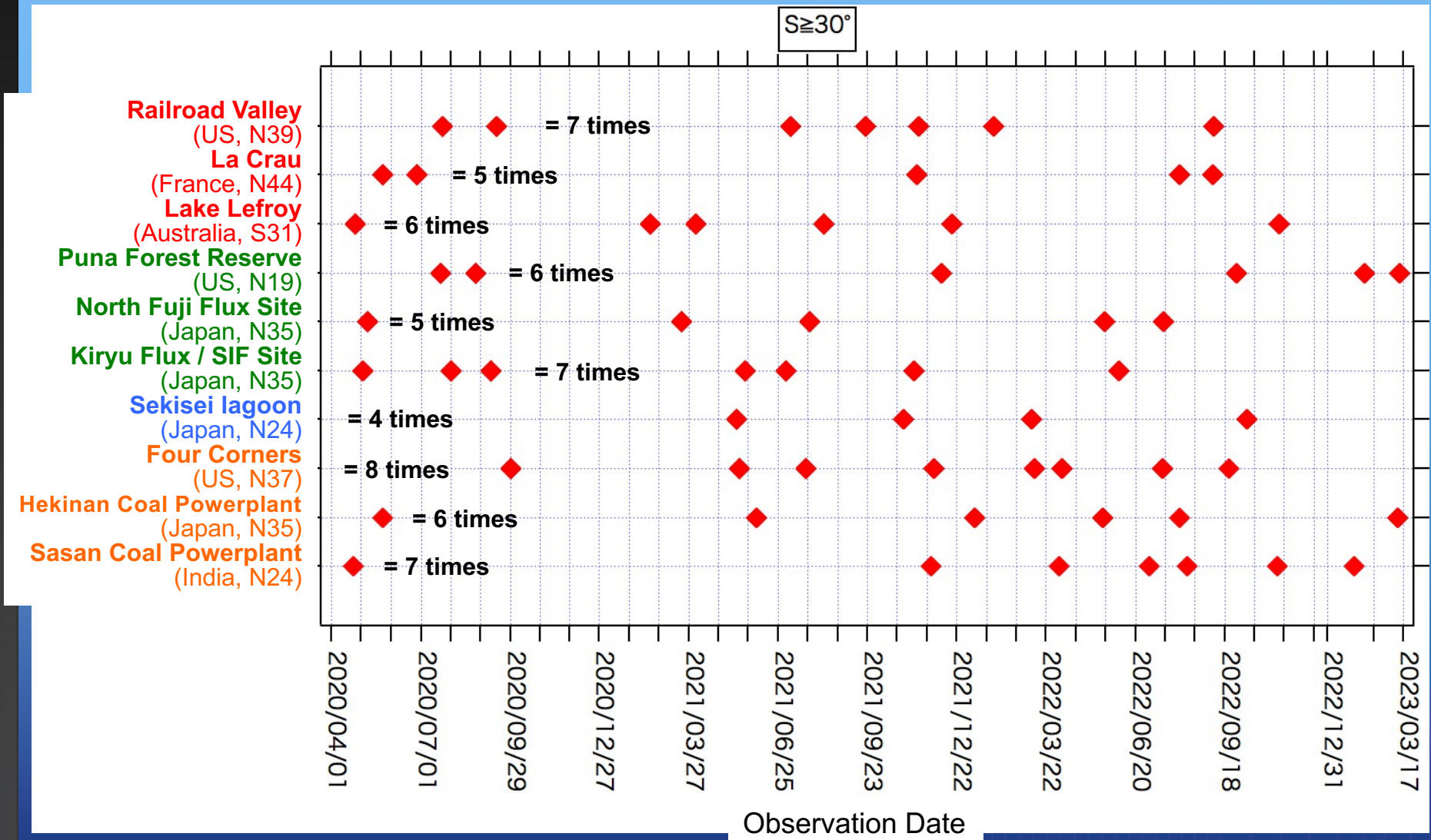


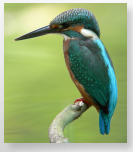
HISUI Observation Oppotunities of Large Cities in Three Years (Solar Elevation ≥ 30 °)





HISUI Observation Oppotunities of Important Sites in Three Years (Solar Elevation ≥ 30 °)

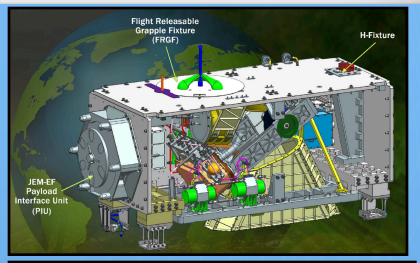




Other Earth Observing Instruments onboard ISS around 2020

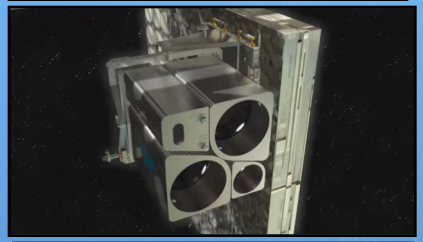
ECOSTRESS :

Measure **the temperature of plants** and use that information to better understand how much water plants need and how they respond to stress. Launched in June 2018



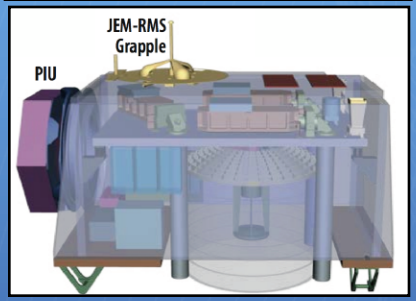
DESIS :

Provide **VNIR hyperspspectral data with high spectral resolution (2.3 nm)**. One of instruments attached to MUSES. Launched in June 2018



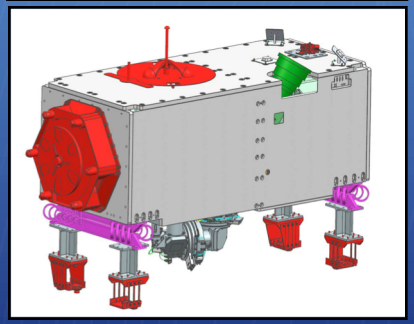
GEDI :

Provide the first global, high-resolution observations of **forest vertical structure** using a lidar. To be launched in Dec. 2018



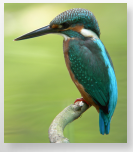
OCO-3 :

Investigate the distribution of **atmospheric carbon dioxide** and **Fluororescence from terrestrial vegetation**.
To be launched in February 2019.



Other missions:

NASA's EMIT (2024) and JAXA's lidar, MOLI (FY2021-)

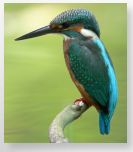


Operation Periods of ECOSTRESS, DESIS, GEDI, OCO-3, and HISUI

Year	2018				2019				2020				2021			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
ECOSTRESS																
DESIS																
GEDI																
OCO-3																
HISUI																

	Launch		Design Lifetime		Nominal Operation
	Extended Operation				

Design lifetime of DESIS and OCO-3 are 5 and 3 years, respectively.



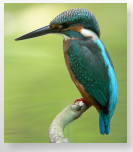
Ideas for Collaborations with Other Missions

- **HISUI and DESIS**
  - Radiometric and spectral calibration in VNIR (DLR - JSS discussion startred)
  - Joint observation for high temporal resolution of VNIR hyperspectral data.

- **HISUI and ECOSTRESS**
  - ECOSTRESS ET and HISUI vegetation parameters (e.g. PRI)
    May give answers to some of CQs?
  - High temperature targets at night
    (Spectral region : HISUI = SWIR, ECOSTRESS = TIR)

- **HISUI and GEDI**
  - GEDI biomass and HISUI vegetation parameters (e.g. LAI)
    Simultaneous observation required?

- **HISUI and OCO-3**
  - Radiometric calibration at 0.765 μm, 1.61 μm, and 2.06 μm.
  - OCO-3 SIF and HISUI vegetation parameters (e.g. PRI)
  - CO2 point sources
    (Pixel size: HISUI = 20 x 30 m, OCO-3 = 1.8 x 2.2 km)



HISUI Research Announcement and Data Policy

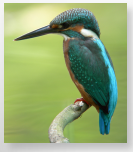
- HISUI Research Announcement (Ver 2.0) was issued in November 2017. Proposals from overseas users will be accepted from April 2019 (TBR). Contact : hisui_application@jspacesystems.or.jp

- For collaborating organizations / missions and research announcement investigators, priority observation*, priority downlink, and data distribution for their requested areas will be given for free.

  *One AOI is about 10 x 10 km. Requests for multiple AOIs and for multiple observation of AOIs are acceptable.

- The archived HISUI data will be provided for free to other science users with some conditions (e.g. submission of reports to HISUI Project).

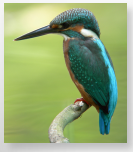
- The data policy for commercial users is not finalized yet.



Thank you

Contact : matsunag@nies.go.jp

Contact for Research Annoucement :
hisui_application@jspacesystems.or.jp



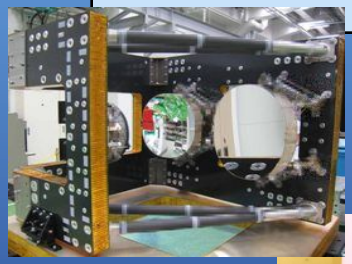
Optical Diagram of HISUI Hyperspectral Imager

Filter Wheel Assembly
- Bandpass filters
- NIST SRM2065 + Myler film

Lamp
(Halogen lamp)

On-board Calibration Mechanism

Telescope (Three Mirror Anastigmat Type)

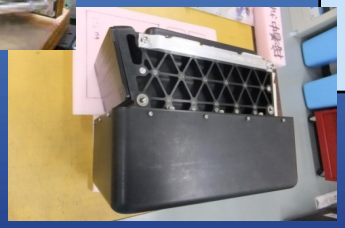


Slit Assembly

VNIR Spectrometer (Offner Type)

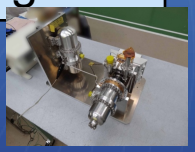
CMOS 2D Detector

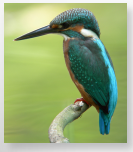
SWIR Spectrometer (Offner Type)



MCT 2D Detector
(≈145 K)

Stirling Type Cooling Unit





HISUI Long-term (3 years) Operation Simulation Setup

Cloud assessment and HISUI observation rescheduling

8 minute / orbit
excluding warming up / shut-down time,
3 segments

HSRU

410 km altitude

1 deg attitute fluctuation

20 km swath

Terra MODIS global daily 1km cloud mask for three years

JEM EF MDP

0.4 Gbps
26 Gbyte/orbit

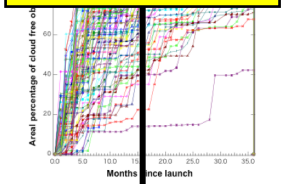
40 Mbps

JEM PM MDR-PM

10 GByte/day daily transmission

300 GByte/day media transport several times per year

A) Emergency / Calibration Obs.
B) Verification Observation



C) Priority Region Mapping
D) Global Mapping