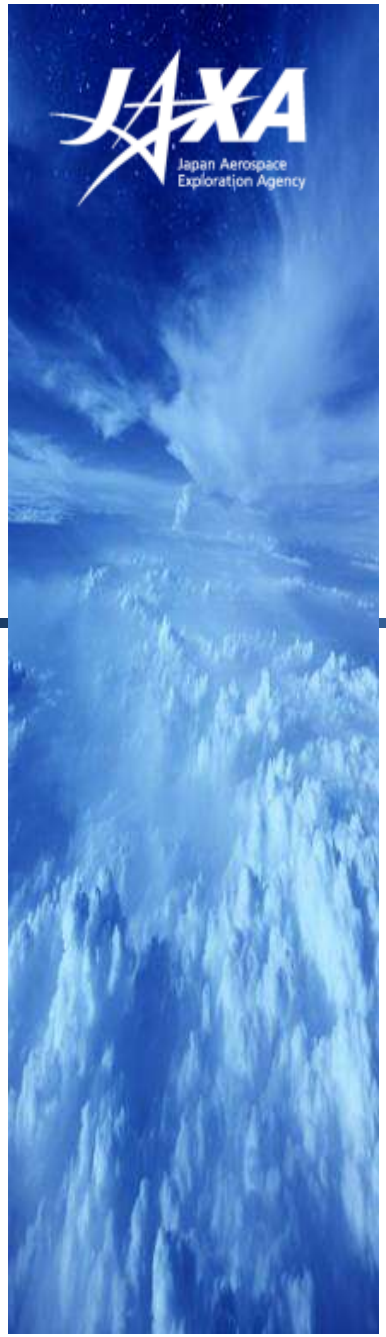


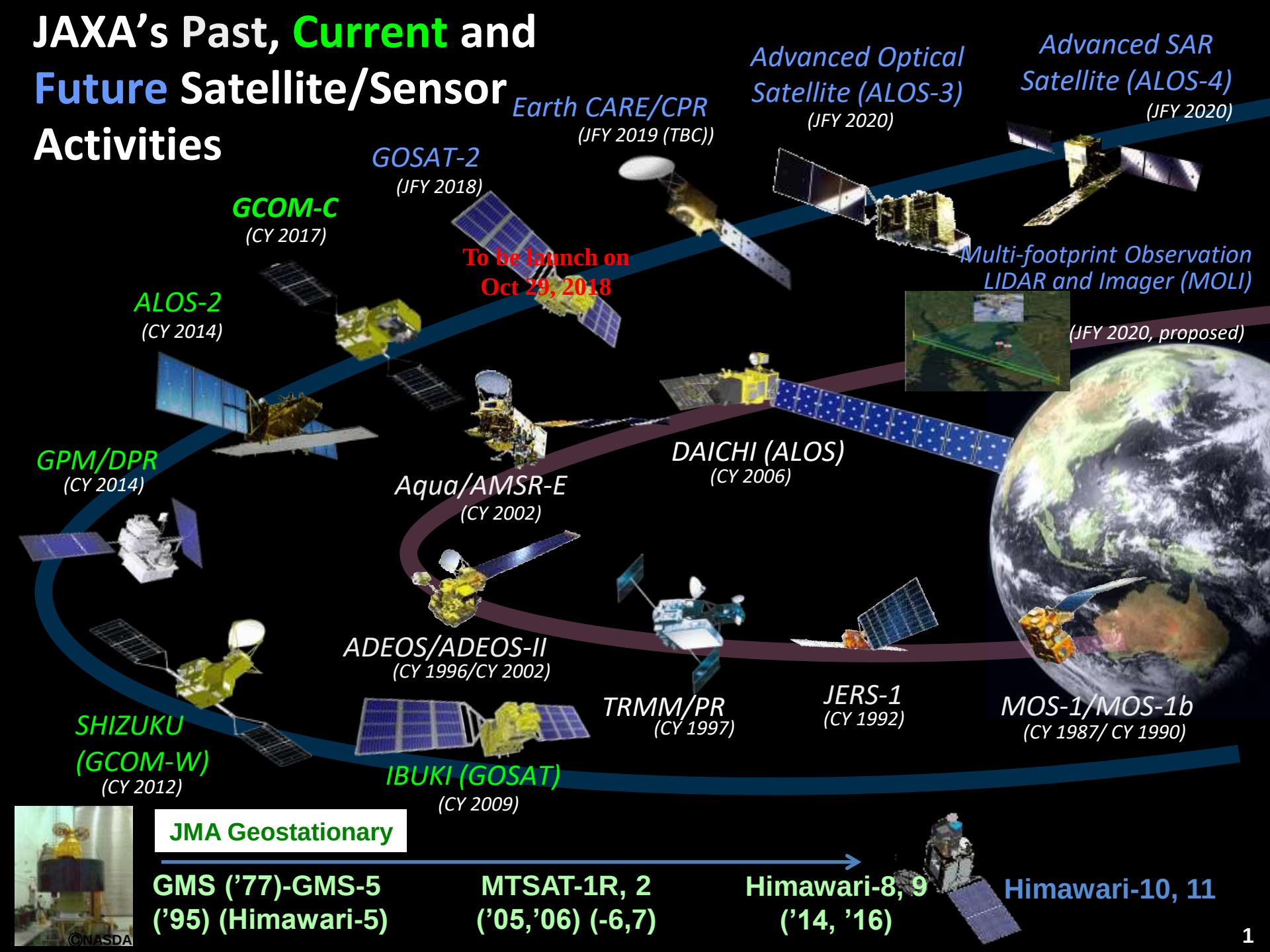
JAXA EO Program Updates

CEOS LSI-VC / SDCG / GEOGLAM Joint Meeting
European Commission Joint Research Centre

6 September 2018

Takeo Tadono[1] and Ake Rosenqvist[1,2]
[1] **Earth Observation Research Center (EORC)**
Japan Aerospace Exploration Agency (JAXA)
[2] **soloEO, Japan**

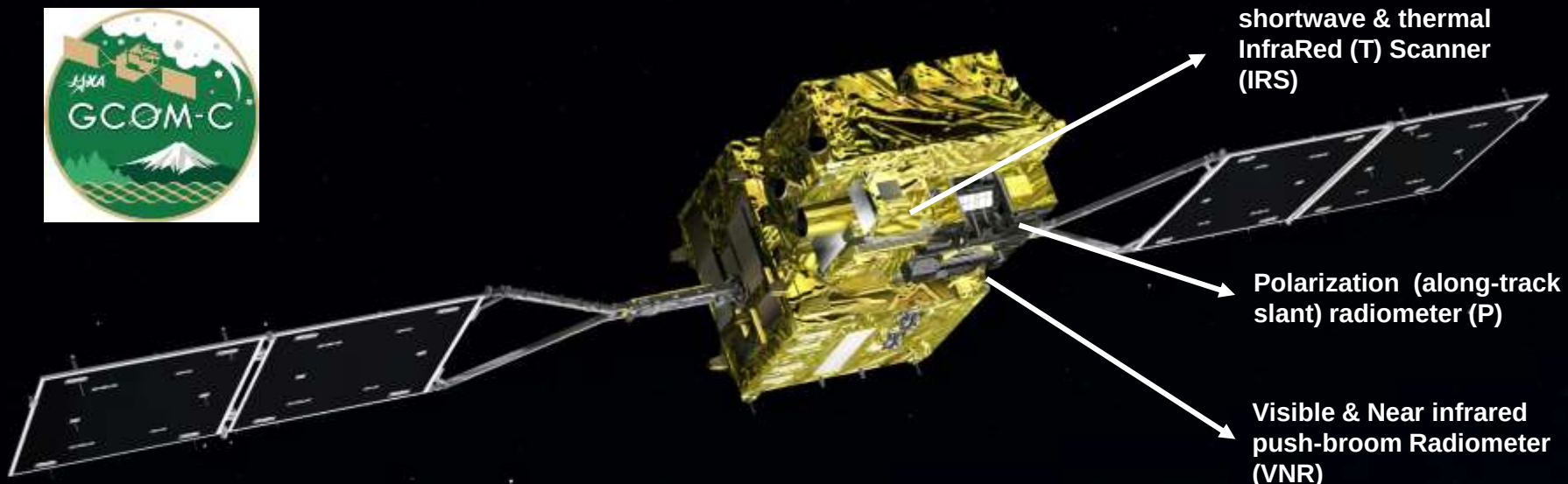
JAXA's Past, Current and Future Satellite/Sensor Activities



JMA Geostationary

GMS ('77)-GMS-5 ('95) (Himawari-5) → MTSAT-1R, 2 ('05,'06) (-6,7) → Himawari-8, 9 ('14, '16) → Himawari-10, 11

Global Change Observation Mission-Climate (GCOM-C)

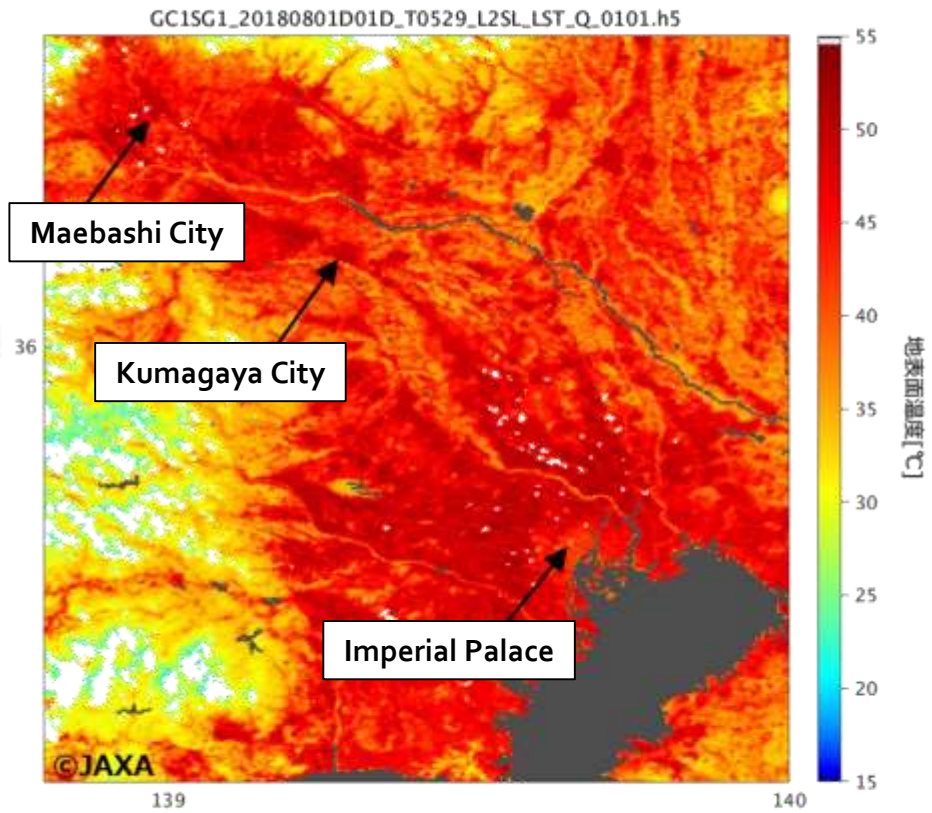


Data release will be planed from December 2018

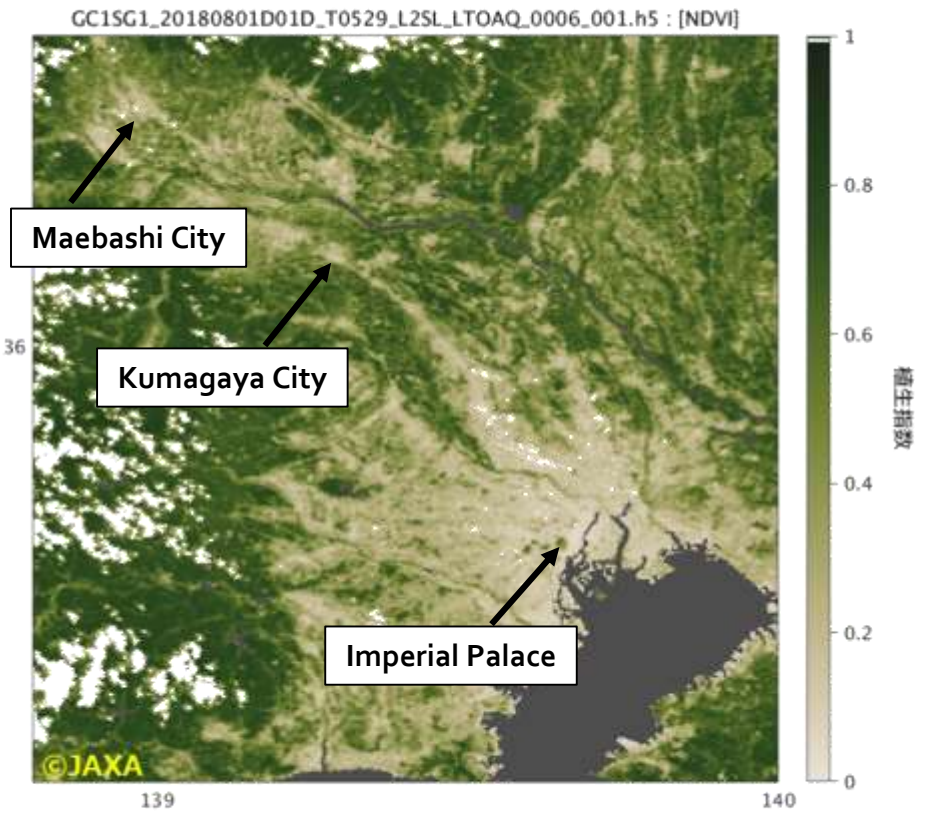
GCOM-C SGLI characteristics	
Orbit	Sun-synchronous (descending local time: 10:30), Altitude: 798 km, Inclination: 98.6 deg
Launch Date	**December 23, 2017**
Mission Life	5 years
Scan	Push-broom electric scan (VNR: VN (11ch) & P (2ch)) Wisk-broom mechanical scan (IRS: SW (4ch) & T (2ch))
Scan width	**1150 km** cross track (VNR: VN & P) **1400 km** cross track (IRS: SW & T)
Spatial resolution	**250 m** (land and coastal areas), 500 m, 1 km
Polarization	**3 polarization angles for POL**
Along track tilt	Nadir for VN, SW and TIR, & +/-45 deg for P

GCOM-C Satellite PFM @ JAXA Tsukuba Space Center

LST in Summer 2018 by GCOM-C



Land Surface Temperature (LST)



True color composite image

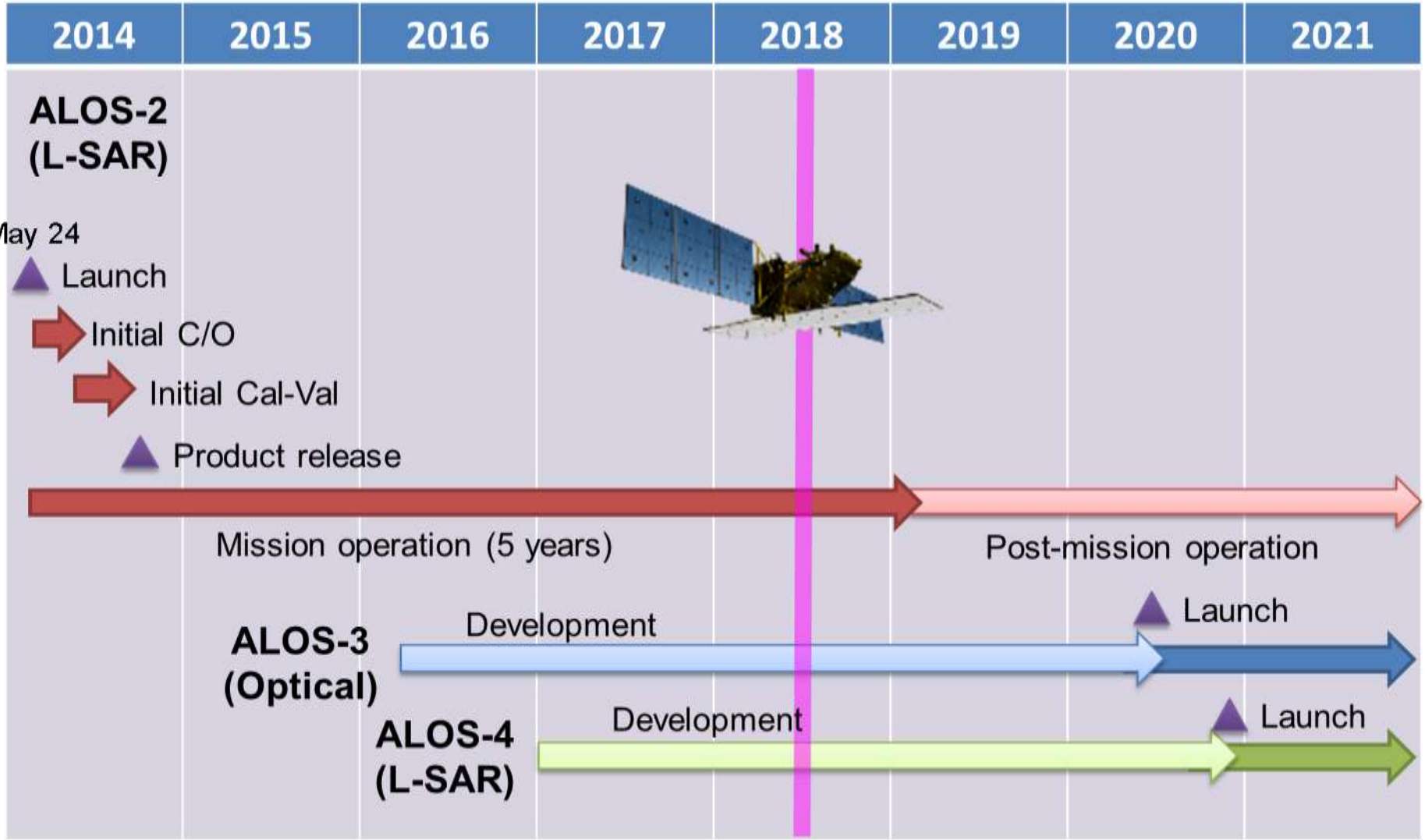
GCOM-C SGLI image around Tokyo, Japan acquired on Aug. 1, 2018.

Updated Schedule of ALOS/ALOS-2 Data Processing and Open Free Access

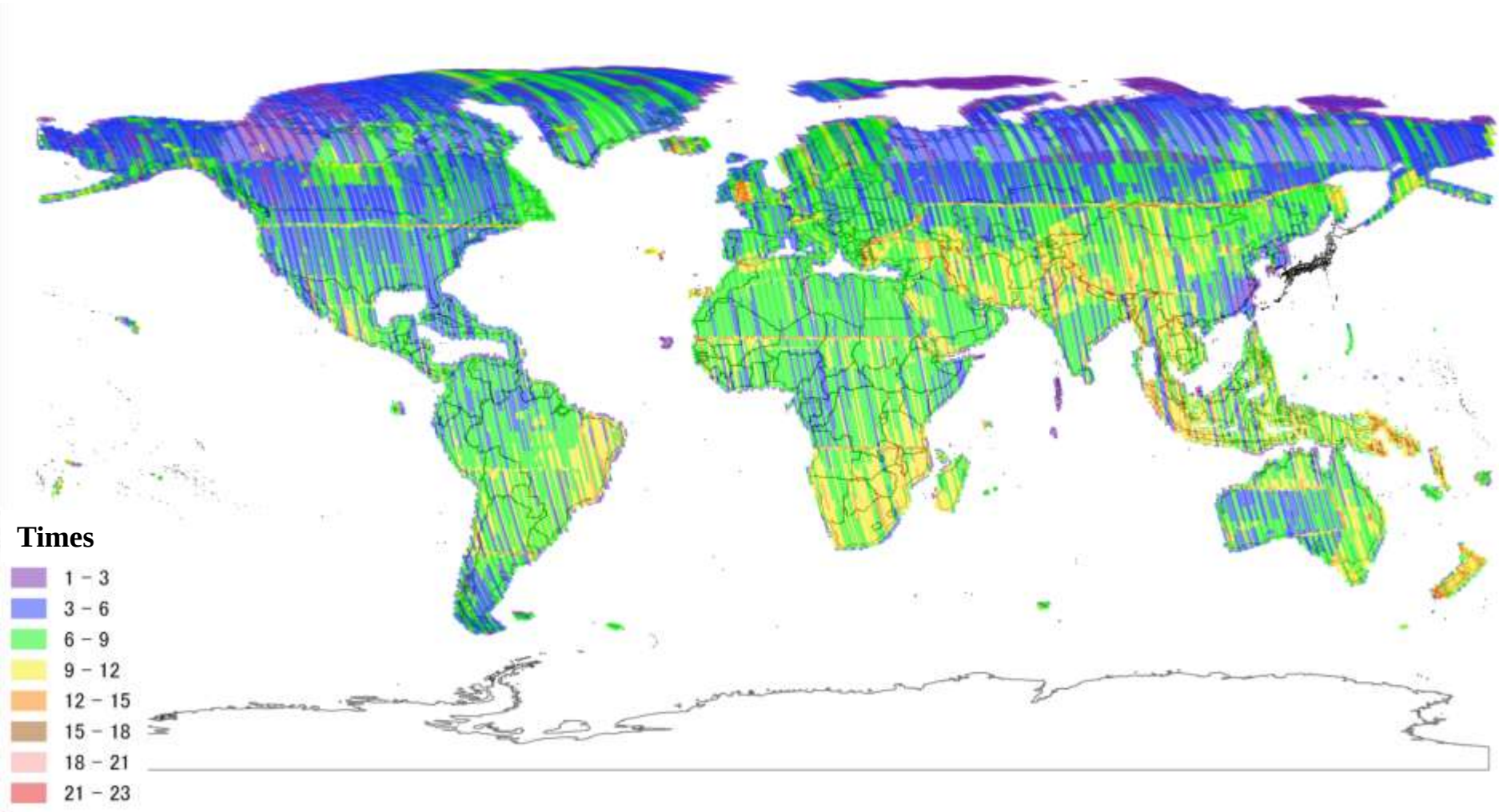
As of August 2018

		2018				2019			
		1Q Jan Mar	2Q Apr Jun	3Q Jul Sept	4Q Oct Dec	1Q Jan Mar	2Q Apr Jun	3Q Jul Sept	4Q Oct Dec
ALOS	AVNIR-2 (10 m)	Japan Area			±60 Degree Area		Global		
		Data Processing							
	PALSAR (10 m)	Under negotiation with METI							
					Japan Area		±60 Degree Area		Global
		Data Processing							
ALOS-2	ScanSAR (100 m)	Under negotiation with PD							
	Fine Mode (10 m)	Under negotiation with PD							

ALOS Series Development and Operation



Acquisition Status of ALOS-2



Data acquisition status by ALOS-2 FBD 10 m (Aug. 2, 2014 – Jul. 1, 2018)

ALOS-3

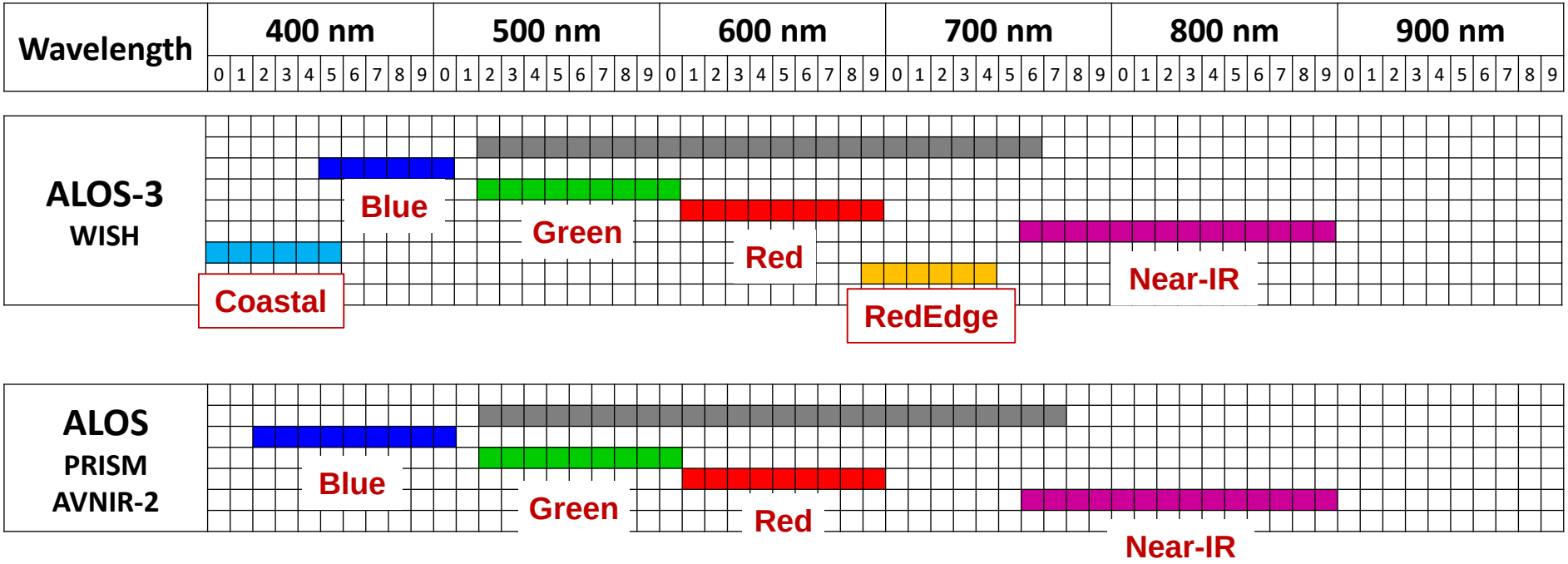
Items		Specifications
Orbit	Type	Sun-synchronous sub-recurrent
	Altitude	669 km at the equator
	Local Sun Time	10:30 am +/- 15 minutes at the descending node
	Revisit	35 days (Sub-cycle 3 days)
Instruments		- Wide-swath and high-resolution optical imager (WISH, as a tentative) - Dual-frequencies Infrared sensor (hosted payload)
Ground Sampling Distance (GSD)		- Panchromatic band of WISH (Pa): 0.8 m - Multispectral band of WISH (Mu): 3.2 m (6 bands)
Quantization		11 bit / pixel
Swath width		70 km at nadir
Mission data rate		Approx. 4 Gbps (after onboard data compression: 1/4 (Pa) and 1/3 (Mu))
Mission data downlink		- Direct Transmission: Ka and X-band - *via.* the Optical Data Relay Satellite
Mass		Approx. 3 tons at launch
Size		5 m × 16 m × 3.5 m on orbit
Duty		10 mins / recurrent
Design life time		Over 7 years

Wide-swath and high-resolution optical imager (WISH)

In-orbit configuration

ALOS-3

Observation channel band allocations among optical satellites (visible to near-infrared).



ALOS-3

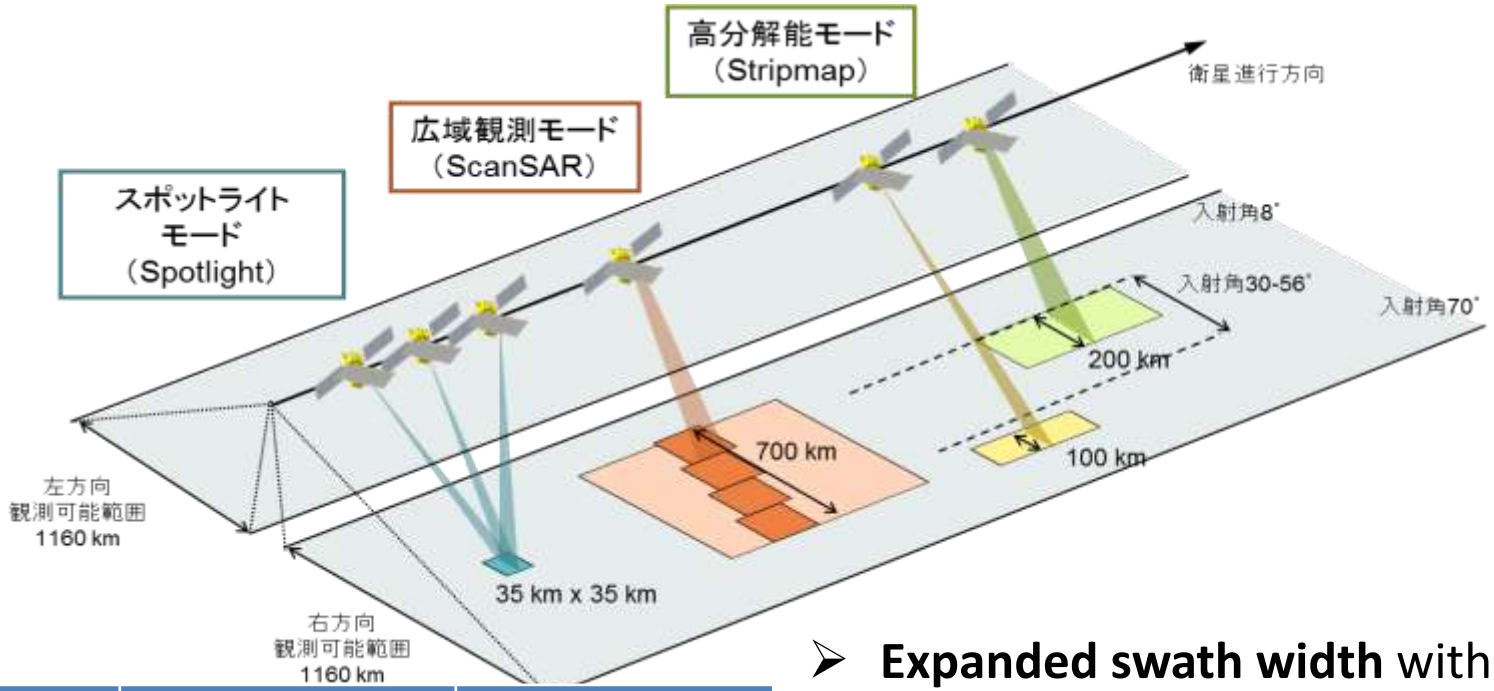
1	**Strip-map observation**	The satellite can normally perform observation covering 70 km in width and 4,000 km in along-track direction as the strip-map observation mode. To increase the acquisition frequency, the images will be taken by less than 25 deg. pointing angle in cross-track direction (GSD < 1m) when the satellite track is in oceans.
2	**Point observation**	If the user has a certain ground point or an area of interest (AOI), the satellite can observe there using pointing capability within 60 deg. This mode will be used for natural disaster monitoring, for example.
3	**Observation direction changing**	The satellite can observe any given point by the pointing capability up to 60 deg. in all direction against the satellite nadir. In the case of Japan, it can be activated within 24 hours after receiving the request. This will be used when the large natural disaster happens e.g. the expecting Nankai Trough large earthquake.
4	**Wide-area observation**	This mode can cover in wide-ranging area of 200 km (in along-track direction) x 100 km (in cross-track direction) by satellite's single orbital passage. This will be also used when the large natural disaster happens.
5	**Stereoscopic observation**	Two ways proposes to acquire stereo-pair image: 1) in single orbit path, and 2) combining two strip-map observations by nadir view and backward view in neighboring path after three days (sub-cycle revisit orbit). The way 1) will be however not sufficient base-to-height ratio (B/H) to derive terrain information. As the advantages of the way 2), that is possible to set suitable B/H, and can acquire images over large area. However, this will depend on weather conditions i.e. cloud covers, to success stereo image acquisition within short period as a disadvantage.

1 and 5 will be used in the basic observations.

Mission Objectives

1. Precise monitoring of land deformation and subsidence for detecting anomalies at an early stage
2. Continuation and enhancement of the ALOS-2 mission and also exploring new applications
   - All-weather disaster monitoring
   - Forest monitoring
   - Sea ice monitoring
   - Large infrastructure monitoring, etc.
3. Marine monitoring with AIS (Automatic Identification System)

ALOS-4/PALSAR-3



	ALOS-4	ALOS-2
Stripmap (res. 3/6/10 m)	**100-200 km**	30-70 km
ScanSAR (res. 25m*)	**700 km**	350-490 km
Spotlight (res. 1 x 3 m)	**35km × 35km**	25km × 25km

*Single look

- **Expanded swath width** with maintained spatial resolution and image quality of PALSAR-2 by digital beam forming (DBF).
- To guarantee the continuity of ALOS-2 applications, PALSAR-3 will inherit **the major function and performance (NESZ, S/A, etc.) of PALSAR-2.**

InSAR capability between ALOS-2 and ALOS-4

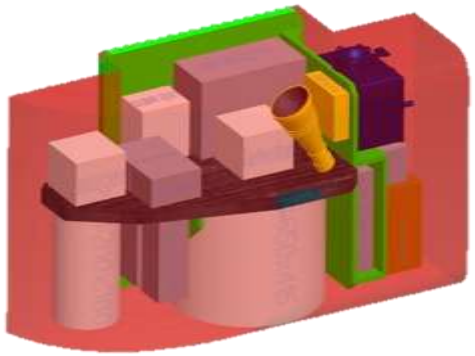
Master/slave of InSAR pair		ALOS-4		ALOS-2	
		Stripmap 100/200 km	ScanSAR 700 km	Stripmap 50/70 km	ScanSAR 350/490 km
ALOS-4	Stripmap 100/200 km	○	○	○	○
	ScanSAR 700 km	○	○	○	×

- ✓ ALOS-4 reference orbit is the same as ALOS-2
- ✓ Controlling accuracy is within +/- 500 m (= small baseline)

Multi-footprint Observation LIDAR and Imager (MOLI)

- JAXA LIDAR mission to fly on the International Space Station, Japan Experimental Module (ISS-JEM)
- Mission Design Review completed May 2017
- Operations foreseen from around 2020

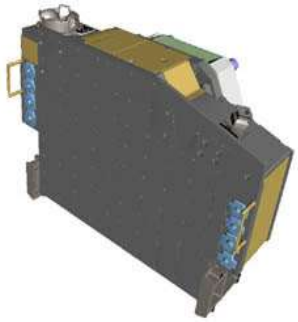
Multi-footprint Observation LIDAR and Imager (MOLI)



Envelope 1600x640x830

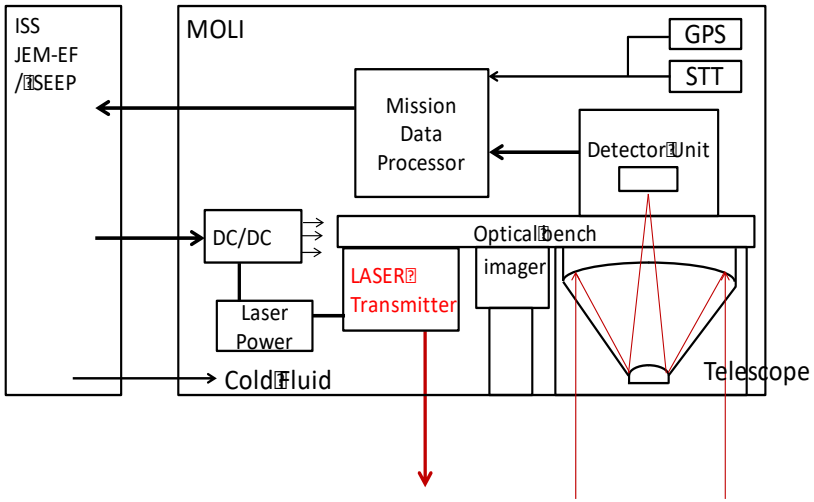
MOLI

+



i-SEEP

(IVA-replaceable Small Exposed Experiment Platform)



Schematic diagram of MOLI

MOLI characteristics

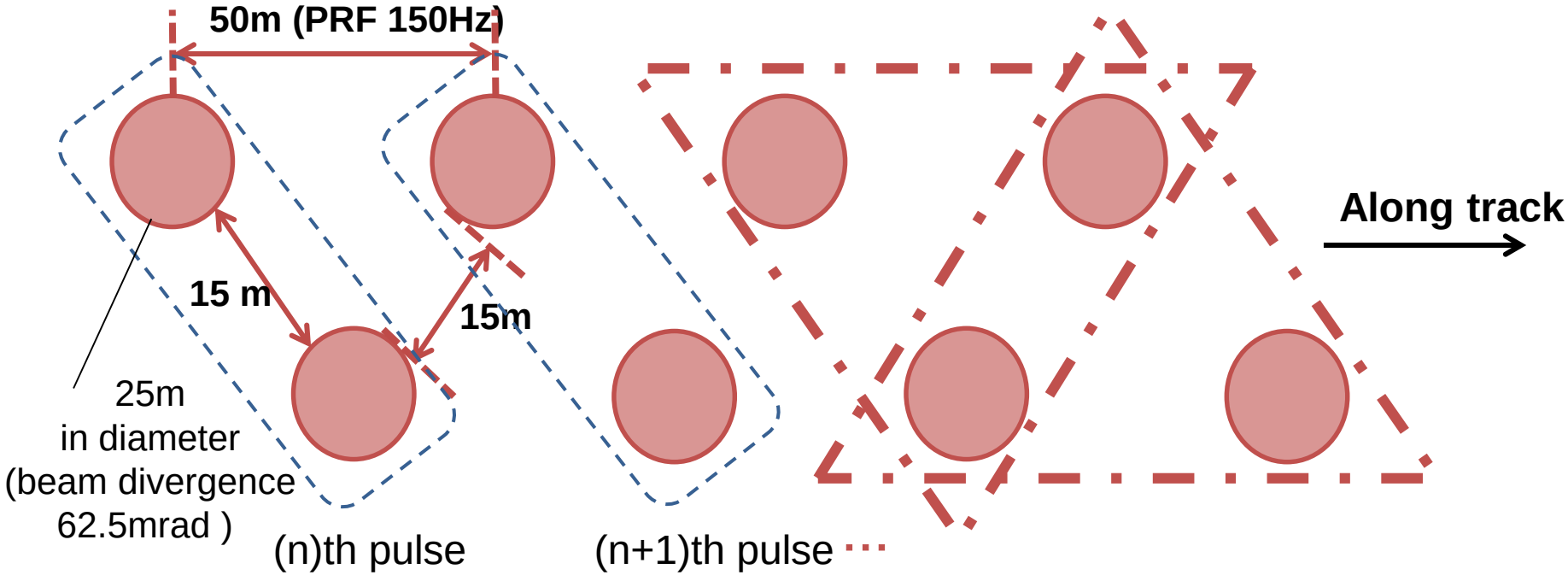
- Demonstration mission on ISS-JEM
- ISS Orbit
  Altitude 400 km, Inclination 51.6 deg
- Instruments
  - **Double beam LIDAR**
    - **Wavelength: 1064 nm**
    - **Pulse width: less than 7 ns**
    - **PRF: 150 Hz**
    - **Double beam (2 foot prints)**
  - **Multiband Imager**
    - **Resolution: 5 m**
    - **Swath: 1 km**
    - **Band: NIR, R, G**
- Canopy measurements
  - Foot print 25m diameter
  - Height accuracy =< 3m
- Mission duration; > 1 year
- Planned Launch year 2020

Using i-SEEP platform, more flexible environment and services by astronauts are expected. Laser Transmitter to be returned (post mission) for degradation evaluation on ground.

Multi-footprint Observation LIDAR and Imager (MOLI)

Foot print design for terrain relief calibration:

- For calibration of terrain relief:
  - Staggered double footprints with the same transmitting timing
- For estimation of ground surface slope angle:
  - Slope estimation using 3 footprints
  - Target slope: ≦30 deg. No snow cover.



Multi-footprint Observation LIDAR and Imager (MOLI)

Standard Products (quality assured)

level	Product category	Products	Remark
L1	Lidar footprint products	Full waveforms	including geolocation data
	Imager product (1km swath)	Image	geometrically corrected
L2	Lidar footprint products	Canopy heights	including geolocation data
		AGB*	including geolocation data

***: Above Ground Biomass**

Research Products (quality evaluated)

level	Product category	Products	Remark
L3	Synergy products with MOLI Lidar and imager (1km swath)	Tree canopy heights	Line to 2D expansion
		Forest biomass	
L4	Synergy products with MOLI and other satellites Wall-to-Wall map products	Tree canopy height Map	“Wall2Wall” expansion
		Forest biomass map	

Summary

- JAXA's EO program and status introduced:
  - ✓ GCOM-C is in orbit, and GOSAT-2 will be soon,
  - ✓ ALOS-2 is working well; Global mosaic production is ongoing as ARD,
    - ✓ Reprocessing ALOS AVNIR-2 and PALSAR are ongoing,
  - ✓ ALOS-3/4 and MOLI are under development.
- IGARSS 2019 will be held in Yokohama, Japan https://igarss2019.org/
  - ✓ Plan to propose the invited session on the related CARD4L