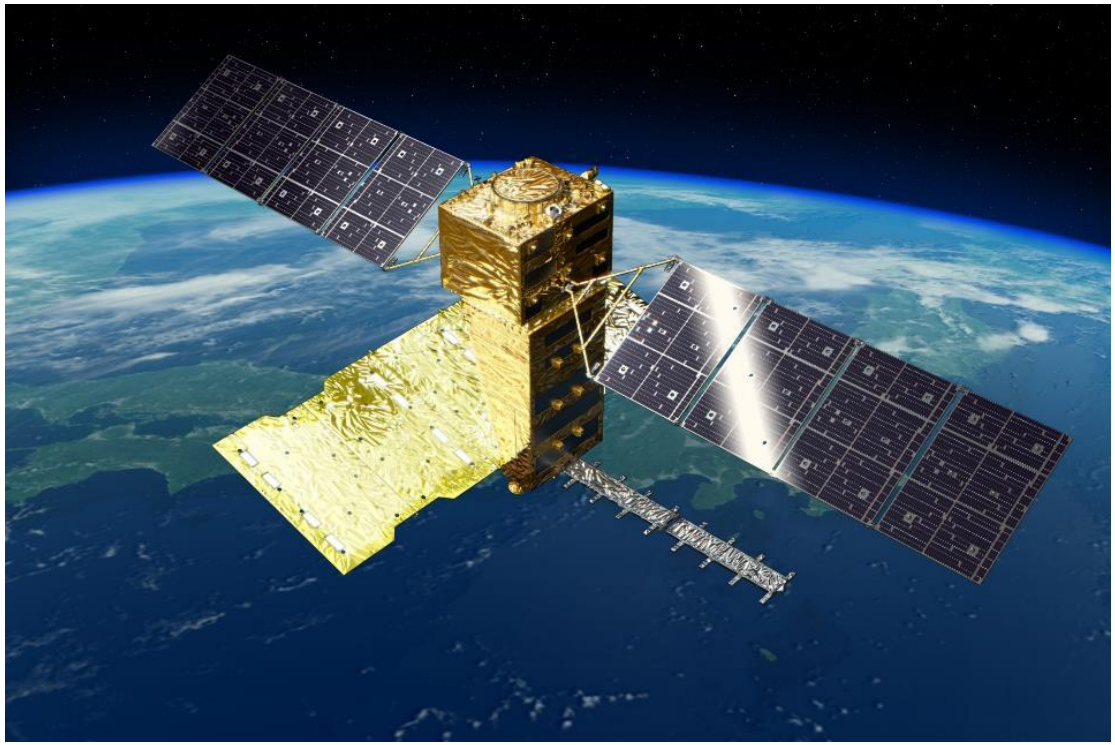
ALOS-4 status update



○Takeshi Motohka

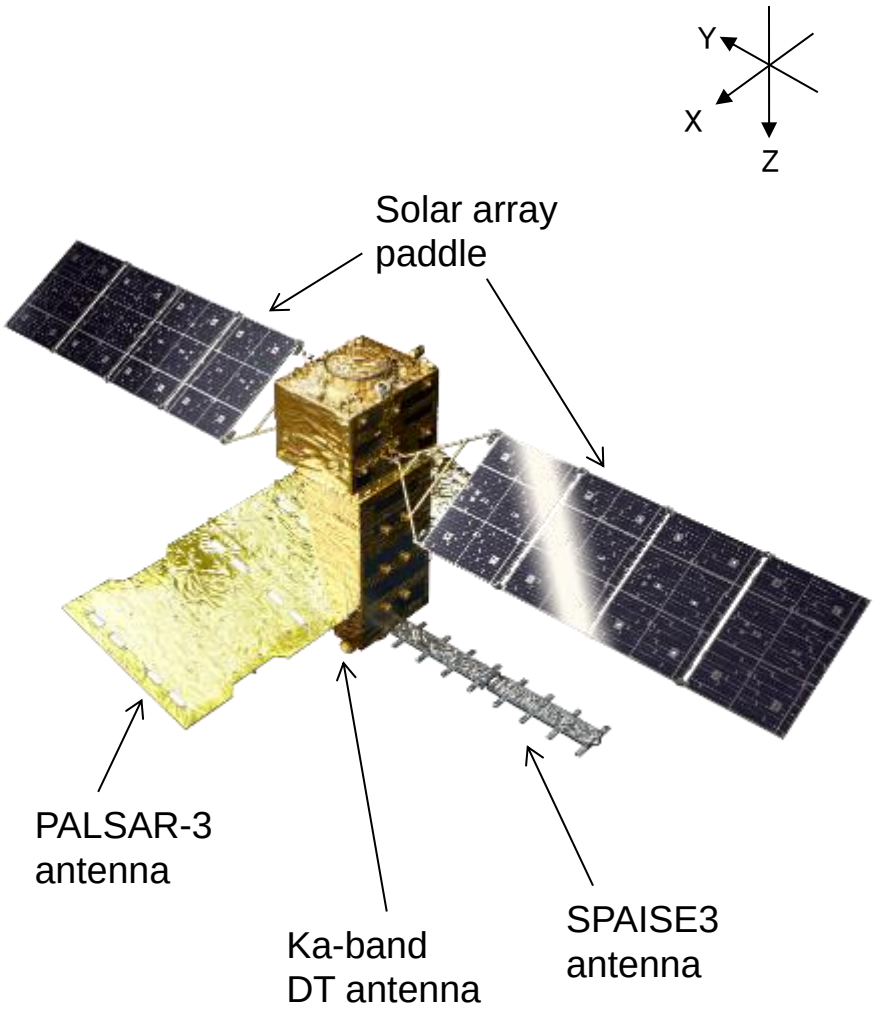
Japan Aerospace Exploration Agency (JAXA)

ALOS-4 project team / EORC

ALOS Kyoto & Carbon Initiative meeting

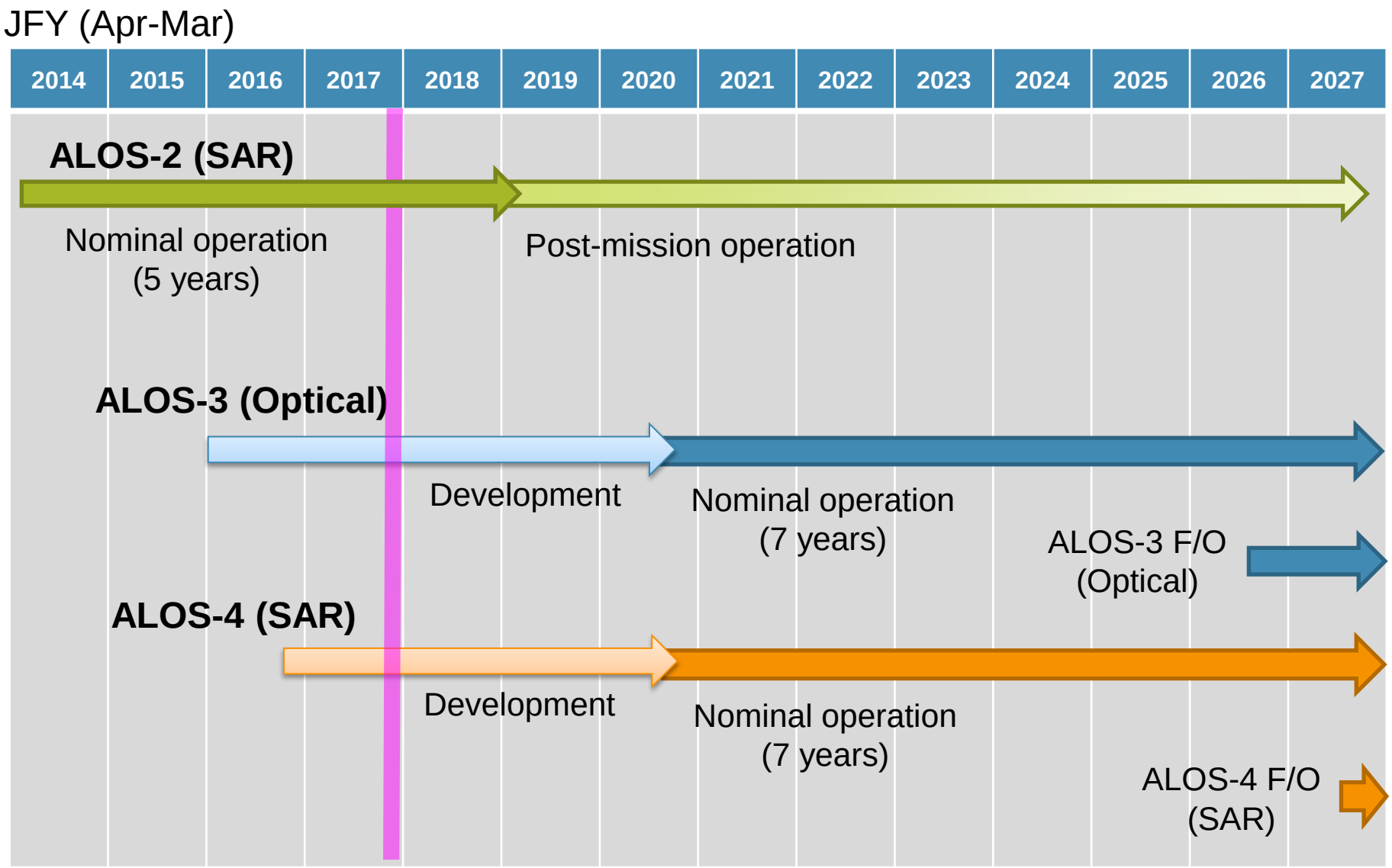
Jan. 30, 2018

ALOS-4 System characteristics



Launch	**JFY 2020** **H3 launch vehicle**
Orbit	**Same orbit as ALOS-2** Sun-synchronous sub-recurrent orbit Altitude: 628 km Inclination angle: 97.9 degree Local sun time at descending: 12:00 ± 15 min. Revisit time: 14 day (15-3/14 rev/day)
Lifetime	**7 years**
Satellite Mass	approx. 3 tons
Downlink	3.6 Gbps/1.8 Gbps (**Ka-band**)
Mission Instruments	- **PALSAR-3** (Phased Array type L-band Synthetic Aperture Radar-3) - **SPAISE3** (SPace based AIS Experiment 3)
Prime contractor	Mitsubishi Electric Corporation

ALOS series development/operation



Mission objectives of ALOS-4

1. Land deformation and subsidence monitoring

- Volcano, earthquake, landslide, land subsidence, …

2. Disaster monitoring

3. Other continuous missions and new applications

- Environment, ocean, agriculture, natural resources, …
- Inspection of increasing aging infrastructures (dams, airports, etc.) using time-series interferometry

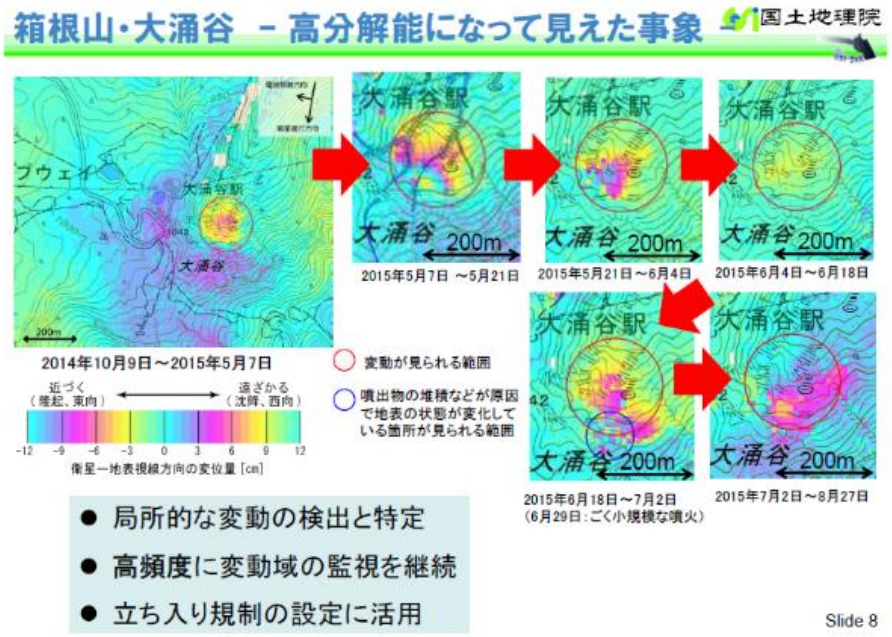
Mission objectives of ALOS-4

Land deformation and subsidence monitoring

- ✓ Increasing observation swath and frequency is necessary to detect anomalies at an earlier stage

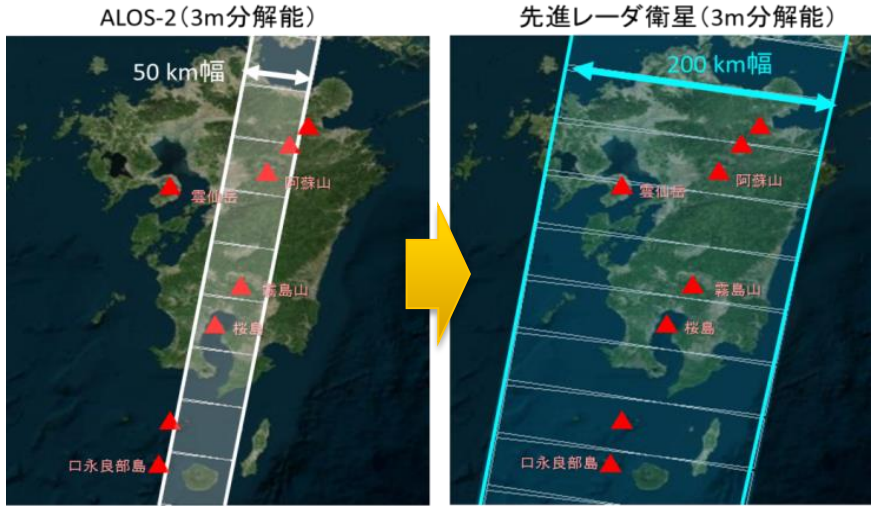
14 days interval InSAR monitoring of Mt. Hakone eruption in 2014-2015

By Geospatial Information Authority of Japan (GSI)



Coverage of volcanoes in Kyushu island, Japan

ALOS-2 ALOS-4



42~56 days interval

14 days interval

User needs to system requirements

Main user needs

Land deformation and subsidence

- High observation frequency and spatial resolution
- Basemap observation over Japan

Disaster monitoring

- Observation at night time and bad weather condition
- Quick initial response

Continuation from ALOS-2 and new applications

- Infrastructure (dams, etc.)
- Forest and wetland
- Ship detection
- Agriculture
- Sea ice and ice sheet
- Natural resources

System requirements

- High spatial resolution
- **High observation frequency**
- **Wide area coverage**
- **Repeat-pass orbit and the same orbit as ALOS-2**
- Wide observable range and high-speed data transmission
- Polarimetric observation
- **Long time continuous operation**

Characteristics of ALOS-4 SAR

- ✓ Expanding swath width without decreasing the resolution by using the digital beam forming (DBF).
- ✓ Keeping the observation geometry, major observation modes, and performance (NESZ, ambiguity level, etc.) of PALSAR-2

Swath width of ALOS-2/4

Modes	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

Coverage of 1 repeat cycle (14 days)

ALOS-2 (50 km)

ALOS-4 (200 km)

Stripmap 10 m mode

ALOS-4

Modes	Stripmap 10 m		
Bandwidth	28 MHz **(split-band option: 28+10 MHz)**		
Resolution	10 m x 10 m		
Swath	**200 km**	**100 km**	
Polarization (H/V linear)	1, 2	1, 2	4
Incidence angle range	**28-56 deg.**	**8-70 deg.**	**8-70 deg.**
NESZ	< -28 dB *		
Range S/A	> 20 dB *		
Azimuth S/A	> 20 dB *		

ALOS-2

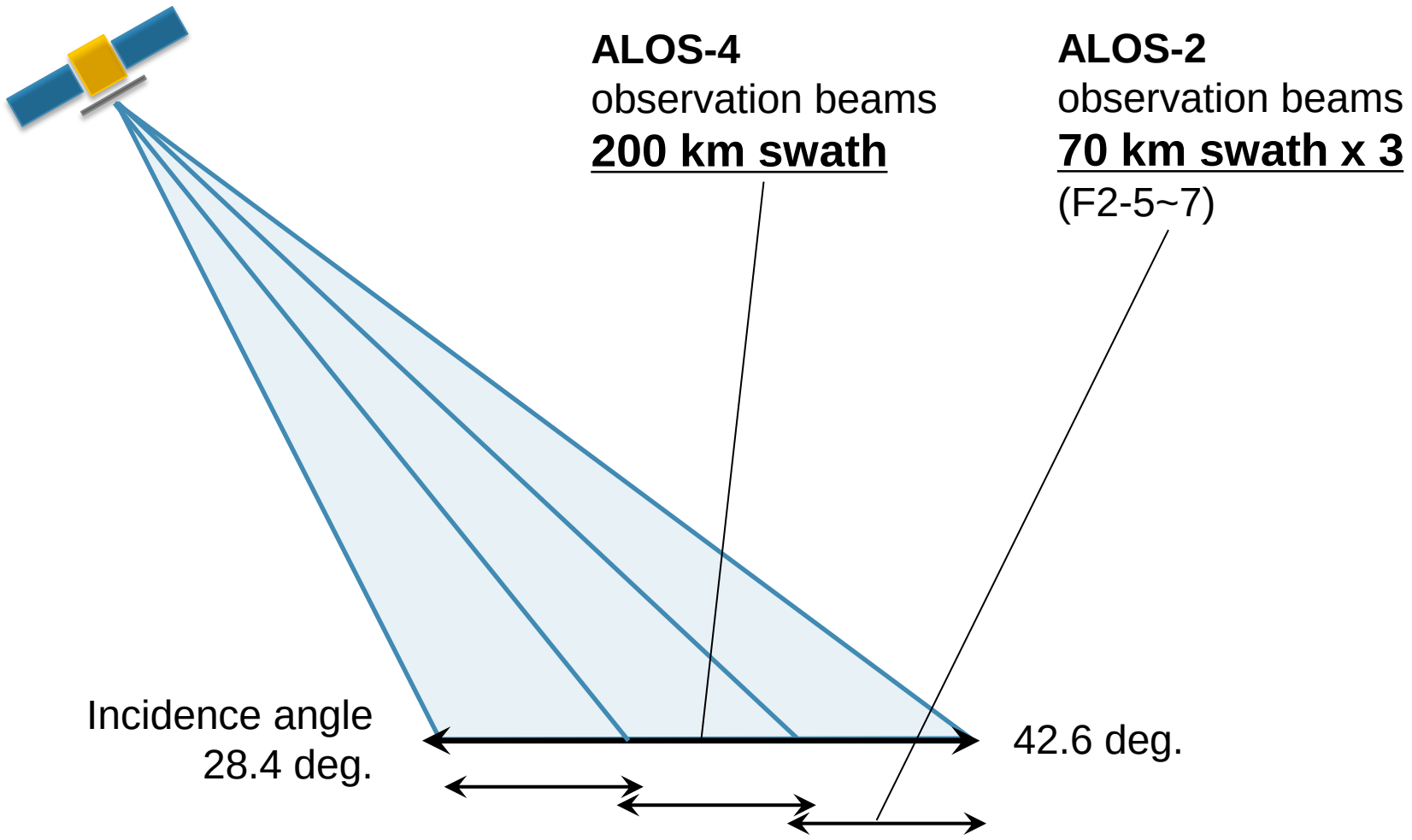
Modes	Stripmap 10 m
Bandwidth	28 MHz
Resolution	10 m x 10 m
Swath	**70 km**
Polarization (H/V linear)	1, 2, 4
Incidence angle range	8-70 deg.
NESZ	< -26 dB *
Range S/A	> 20 dB *
Azimuth S/A	> 20 dB *

* specifications for incidence angle 28.5-42.5 deg.

Compatibility with ALOS-2

same orbit,
same geometry

e.g., Stripmap 10-m mode



InSAR capability between ALOS-2 and ALOS-4

Master/slave of InSAR pair		ALOS-4		ALOS-2	
		Stripmap	**ScanSAR**	**Stripmap**	**ScanSAR**
ALOS-4	**Stripmap**	○	○	○	○
	ScanSAR	○	○	○	×

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

System improvement from ALOS/ALOS-2

	ALOS 2006-2011	ALOS-2 2014-	**ALOS-4** **2020-**
Antenna size	3 m × 9 m	3 m × 10 m	**3.6 m** × 10 m
Number of T/R module	80 (Si)	180 (GaN)	**232 (GaN)**
Transmit power	2,000 W	6,120 W	**7,888 W**
Receive beam	Single beam	Dual beam (azimuth)	**DBF (range)** + Dual beam (azimuth)
Ionospheric correction	N/A	N/A	**Split-band mode (28 + 10 MHz)**
Pointing	Right	Right and Left	Right and Left
Orbit control	< +/- 2.5 km (at equator)	< +/- 500 m (all latitude)	< +/- 500 m (all latitude) **Laser reflector for absolute calibration**
Data recorder	90 GB	128 GB	**1 TB**
Data transmission	120 / 240 Mbps	800 Mbps	**3.6 / 1.8 Gbps**

Products and user interface system

✓ **Product format**

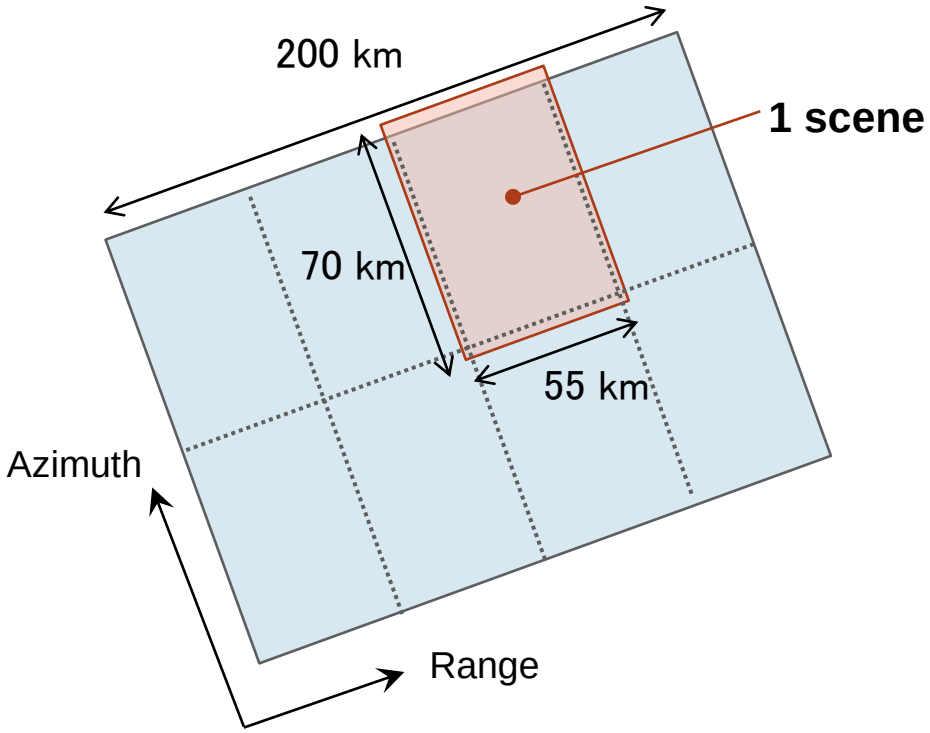
- Standard products: L1.1, L1.5, L2.1
- CEOS format (same as ALOS-2)

✓ **User requests for products and new user interface system**

- Available for many OS (Windows, Mac, Linux) and web browsers
- API for searching and downloading products
- Downloading orbit data separately from image files
- Ordering only images of selected small area (> 10 km x 10 km) for making the handling of data easy
- Download files can be split and concatenate
- Local incidence angle information for the L2.1 ortho product

etc…

Definition of “scene”



- ✓ Original full-size image is divided into the same size as ALOS-2 scenes.
- ✓ ALOS-2 path/frame ID can be also used for ALOS-4

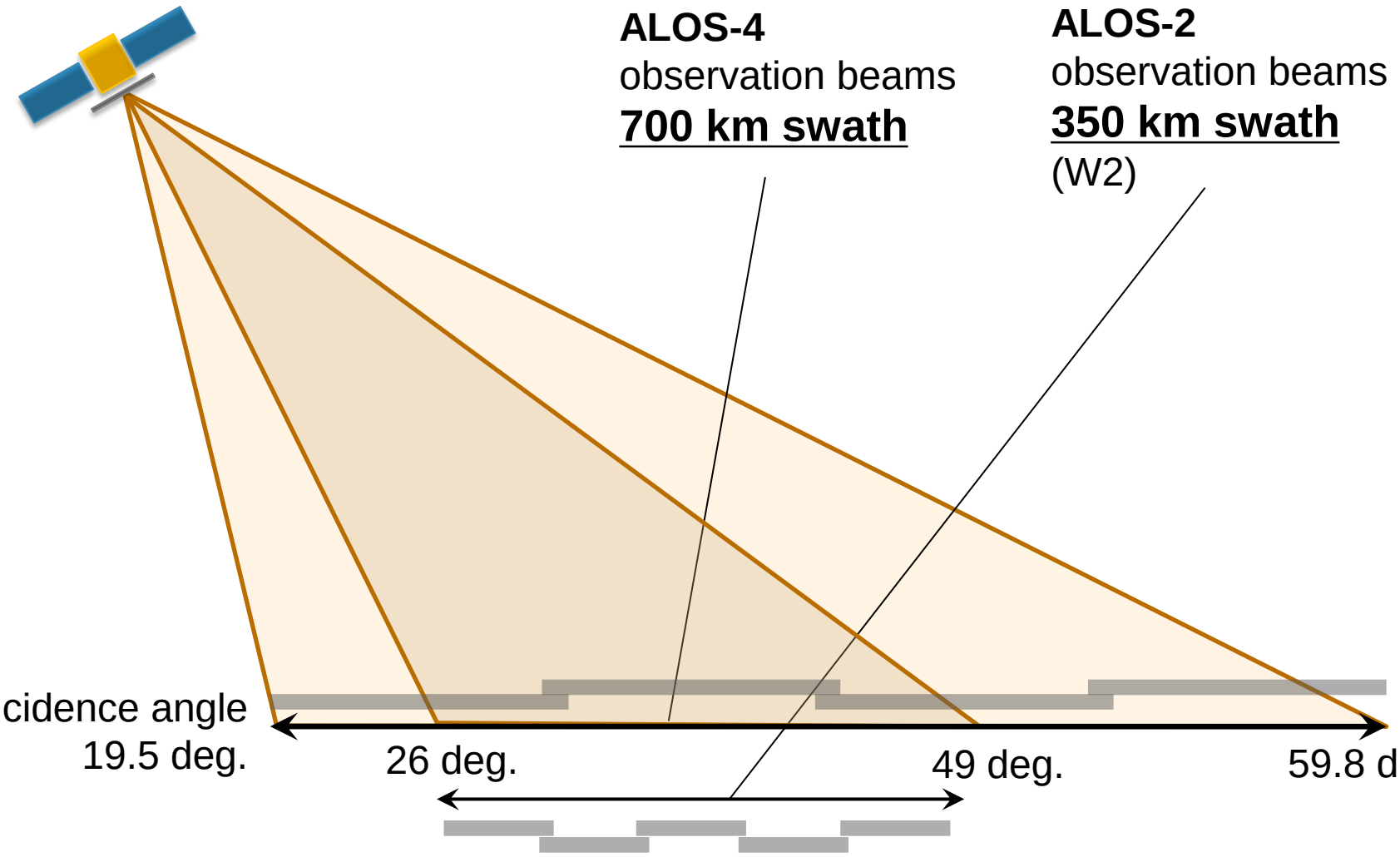
	Spotlight	Stripmap 3m/6m	Stripmap 10m	ScanSAR
Swath	35 km	100 or 200 km	100 or 200 km	700 km
Scene width	35 km	55 km	70 km	350 km
Scene length	35 km	70 km	70 km	355 km

Project status

- ✓ ALOS-4 project passed PDR (preliminary design review) in December 2017.
- ✓ Engineering model is now developed and tested.
- ✓ CDR (critical design review) will be held in this year.

ScanSAR mode

same orbit,
same geometry



ScanSAR mode

ALOS-4

Modes	ScanSAR
Bandwidth	28 MHz
Resolution	25 m x 25 m
Swath	**700 km (4 scans)**
Polarization (H/V linear)	1, 2
Incidence angle range	8-70 deg.
NESZ	< -20 dB *
Range S/A	> 15 dB *
Azimuth S/A	> 15 dB *

ALOS-2

Modes	ScanSAR
Bandwidth	14 or 28 MHz
Resolution	100 m x 100 m (multi-looked)
Swath	**350 or 490 km (5 or 7 scans)**
Polarization (H/V linear)	1, 2
Incidence angle range	8-70 deg.
NESZ	---
Range S/A	---
Azimuth S/A	---

* Specifications for 19-60 deg.