ALOS-2 and PALSAR-2 Development Status

Cal-Val Science Team (CVST) meeting
13,11,25 @ Tsukuba Space Center
JAXA ALOS-2 project team
Kankaku Yukihiro

Agenda

- *Mission and overview of ALOS-2*
- *Specification of PALSAR-2*
- *Features of PALSAR-2*
- *Development status of ALOS-2 and PALSAR-2*

Mission of ALOS-2

- ***Disaster Monitoring*** for Secure the public safety
  - **Fast access to damaged areas and continuous monitoring**
  - **In-SAR data necessary for deformation forecast/monitoring**

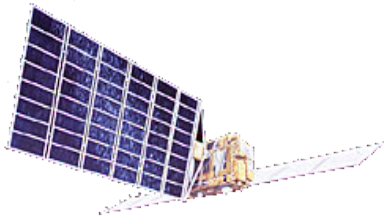
- ***Land Monitoring*** for Preserve and manage national land
  - **based upon archived data**

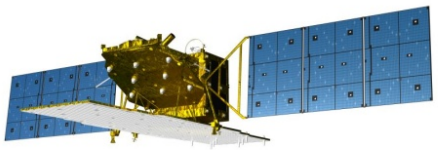
- ***Agricultural Monitoring*** for Facilitate food supply
  - **necessary for evaluation of irrigated rice**

- ***Natural Resource Exploration*** for Facilitate natural resources and energy supply
  - **necessary for detecting oil and mineral resources in the ground and seabed**

- ***Global Forest Monitoring*** for Resolve global-level environmental issues
  - **global monitoring of tropical rain forests to identify carbon sinks**

L-band SAR History in JAXA



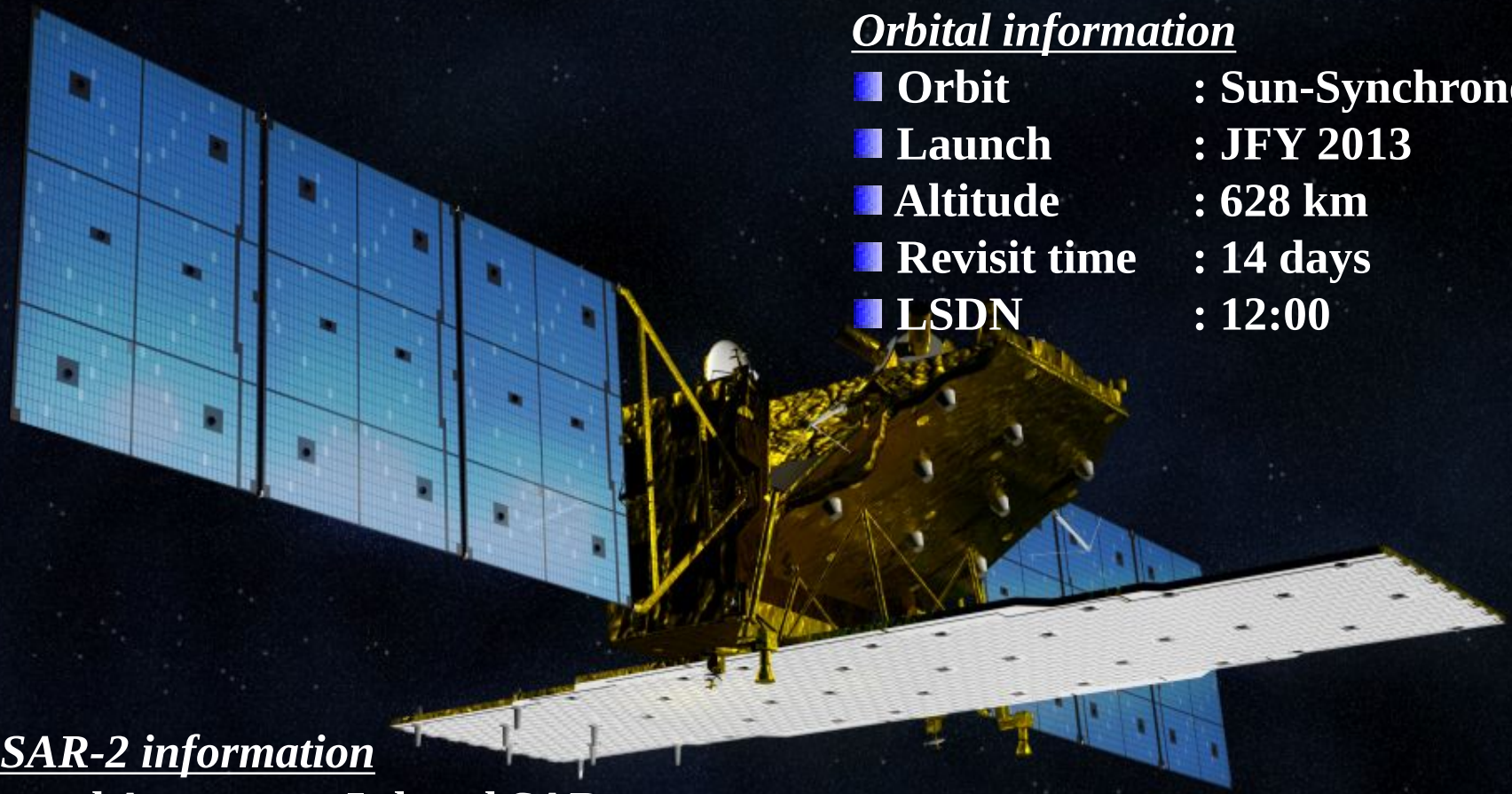


Satellite	JERS-1	ALOS	ALOS-2
SAR sensor	SAR	PALASR	PALSAR-2
Operation period	1992 – 1998	2006 - 2011	JFY 2013 -
Resolution	18 m	10 m	3m / 10 m
Swath	75 km	70 km	50 km / 70 km
LSDN	10:30	10:30	12:00
Incidence angle	38 degrees fixed	8 - 60 degrees	8 – 70 degrees
Look direction	Right	Right	Right or Left
Mission sensor	SAR＋OPT	SAR＋OPT	SAR
Revisit time	44 days	46 days	14 days

Upgrade!

features!

Overview of ALOS-2



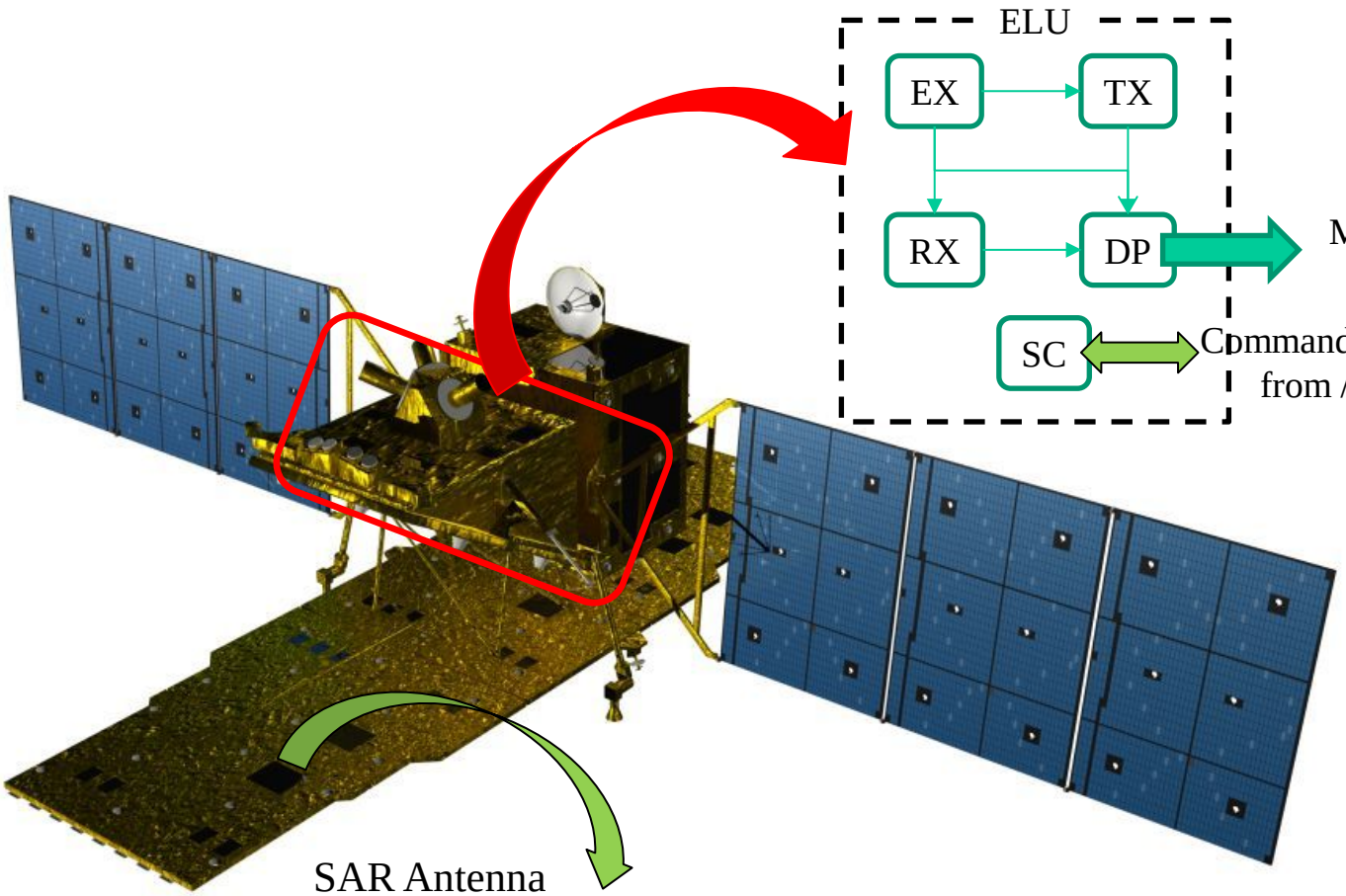
Orbital information

- Orbit : Sun-Synchronous
- Launch : JFY 2013
- Altitude : 628 km
- Revisit time : 14 days
- LSDN : 12:00

PALSAR-2 information

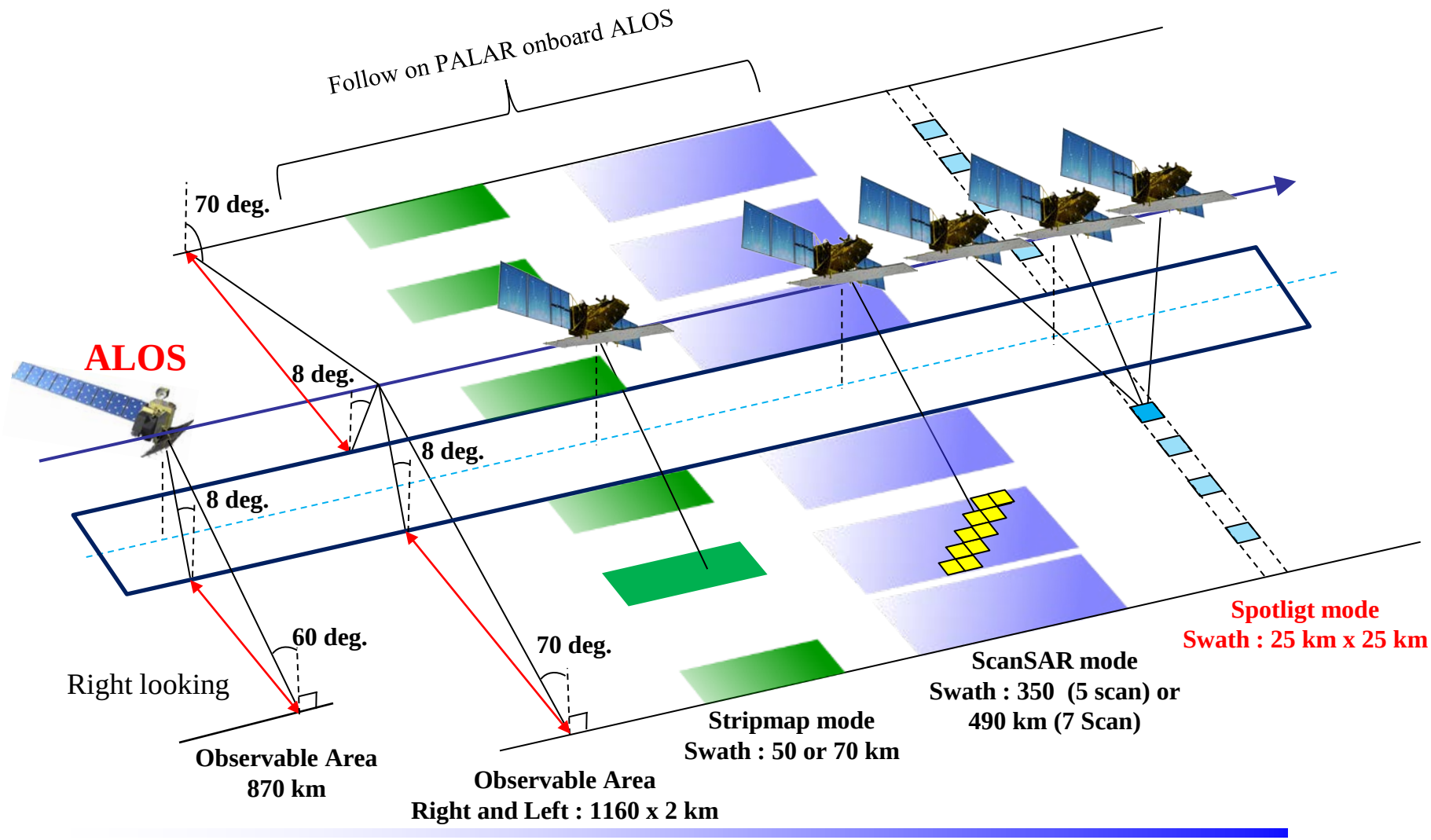
- Phased Array type L-band SAR
- Imaging modes : Spotlight / Stripmap / ScanSAR
- Antenna size : 3 m for El, 10 m for Az
- Bandwidth [MHz] : 14 / 28 / 42 / 84
- Resolution [m] : 1 (Az) (Spotlight) / 3 or 6 or 10 (Stripmap) / 100 (ScanSAR)
- Swath [km] : 25 (Spotlight) / 50 or 70 (Stripmap) / 350 or 490 (ScanSAR)

PALSAR-2 Sub-System



- ✓ 5 electric panels
  (3/5 panels and whole panels would use to transmit)
- ✓ 1080 radiation elements / 180 TRMs
- ✓ Electric beam steering
  +/- 30 degrees for EL and +/- 3.5 degrees for Az

PALSAR-2 Imaging Modes



Specification of PALSAR-2

Modes		Unit	*Spotlight*	Stripmap					ScanSAR		
				Ultra-Fine	*High-sensitive*		*Fine*		*ScanSAR*		*ScanSAR*
Center Frequency		**MHz**	**1257.5**		**1236.5 / 1257.5 / 1278.5 selectable**						
Bandwidth		**MHz**	**84**	**84**	**42**		**28**		**14**	**28**	**14**
Resolution		**m**	**Rg x Az 3 x 1**	**3**	**6**		**10**		**100 (3look)**	**100 (3look)**	**60 (1.5look)**
Incidence angle		**deg.**	**8～70**	**8～70**	**8～70**	**20～40**	**8～70**	**23.7**	**8～70**	**8～70**	**8～70**
Swath		**km**	**Rg x Az 25 x 25**	**50**	**50**	**40**	**70**	**30**	**350 (5Scan)**	**350 (5Scan)**	**490 (7Scan)**
Polarization*		**N/A**	**SP**	**SP/DP**	**SP/DP CP**	**FP**	**SP/DP CP**	**FP**	**SP/DP**	**SP/DP**	**SP/DP**
NESZ		**dB**	**-24**	**-24**	**-28**	**-25**	**-26**	**-23**	**-26**	**-23**	**-26**
S/A	**Rg**	**dB**	**25**	**25**	**23**	**23**	**25**	**20**	**25**	**25**	**20**
	Az		**20**	**25**	**20**	**20**	**23**	**23**	**20**	**20**	**20**

@ Incidence angle is 37 degrees

Follow on PALSAR

ScanSAR-ScanSAR InSAR

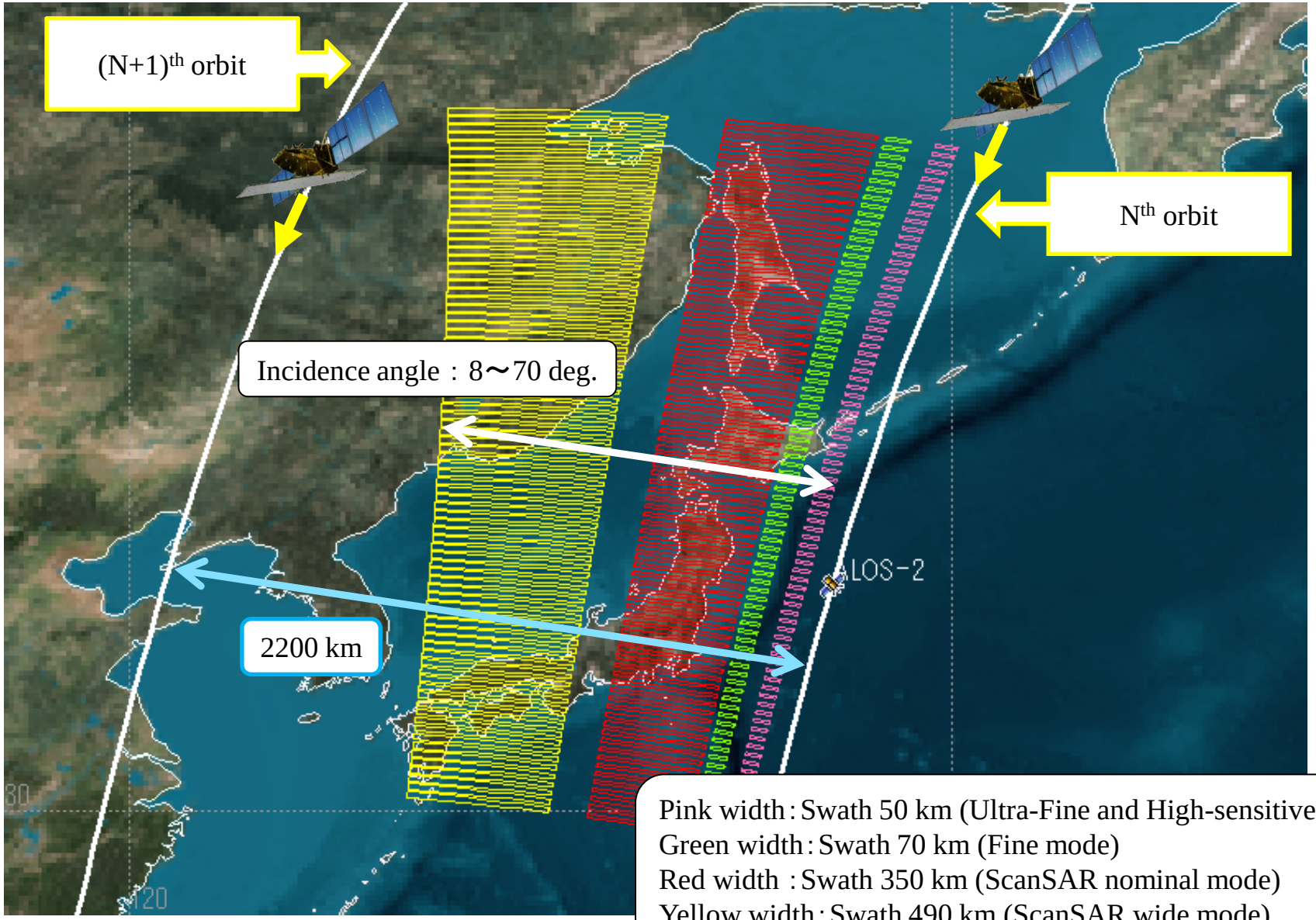
*** : Single Polarization HH or HV or VV or VH**

: Dual Polarization HH+HV or VV+VH

: Full Polarization HH+HV+VV+VH

: Compact Polarization Circular or 45 degrees oriented for EXPERIMENTAL MODE

Swath image of PALASR-2



Pink width : Swath 50 km (Ultra-Fine and High-sensitive)
Green width : Swath 70 km (Fine mode)
Red width : Swath 350 km (ScanSAR nominal mode)
Yellow width : Swath 490 km (ScanSAR wide mode)

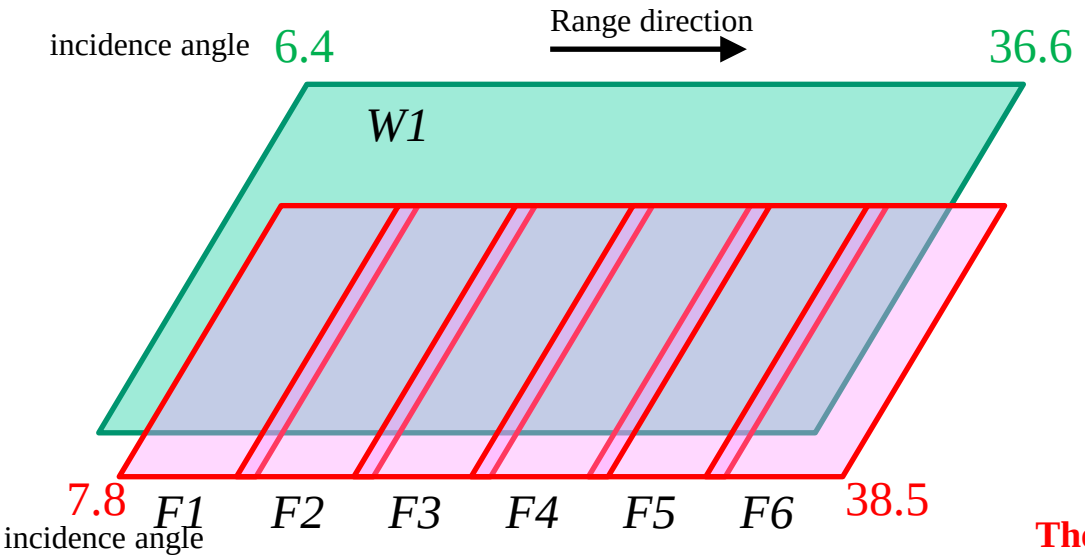
The relationship of beam numbers between ScanSAR, Ultra-Fine and Fine

Beam umber		1	2	3	4	5	6	7	8	9	10	11	12
Off nadir [deg]	ScanSAR	9.1	15.1	20.7	26.2	30.8	34.9	38.6	41.8	44.7	47.3	49.5	51.5
	350 km	W1							W3				
					W2								
	490 km						V2						
		V1										V3	
	Ultra-Fine	9.6	13.9	18	21.9	25.6	29.1	32.4	35.4	38.2	40.6	42.7	44.7
	Fine	9.8	14.7	19.4	23.8	28.2	32.5	36.2	39.3	41.9	44.3	46.4	48.2

Beam umber		13	14	15	16	17	18	19	20	21	22	23	24
Off nadir [deg]	ScanSAR	53.2	54.7	56.1	57.3	58.3	-	-	-	-	-	-	-
	350 km	W4											
	490 km	V3											
	Ultra-Fine	46.4	48	49.5	50.9	52.1	53.3	54.3	55.3	56.2	57	57.7	58.4
	Fine	49.8	51.2	52.4	53.5	54.6	55.5	56.3	57.1	57.8	58.5	-	-

There is slightly difference at the off nadir of each beam between Fine and ScanSAR mode because of the antenna management for the swath.

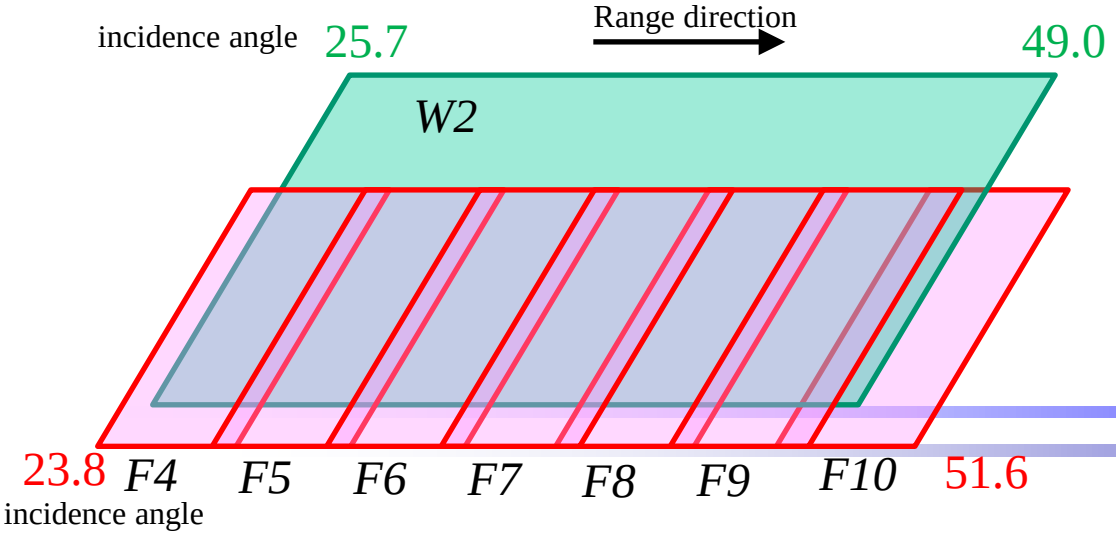
The overlap swath estimation for interferometry between ScanSAR and Fine



overlap swath [km]

	W1-1	W1-2	W1-3	W1-4	W1-5
F1	58	0	0	0	0
F2	0	**60**	0	0	0
F3	0	13	48	0	0
F4	0	0	26	36	0
F5	0	0	0	46	26
F6	0	0	0	0	40

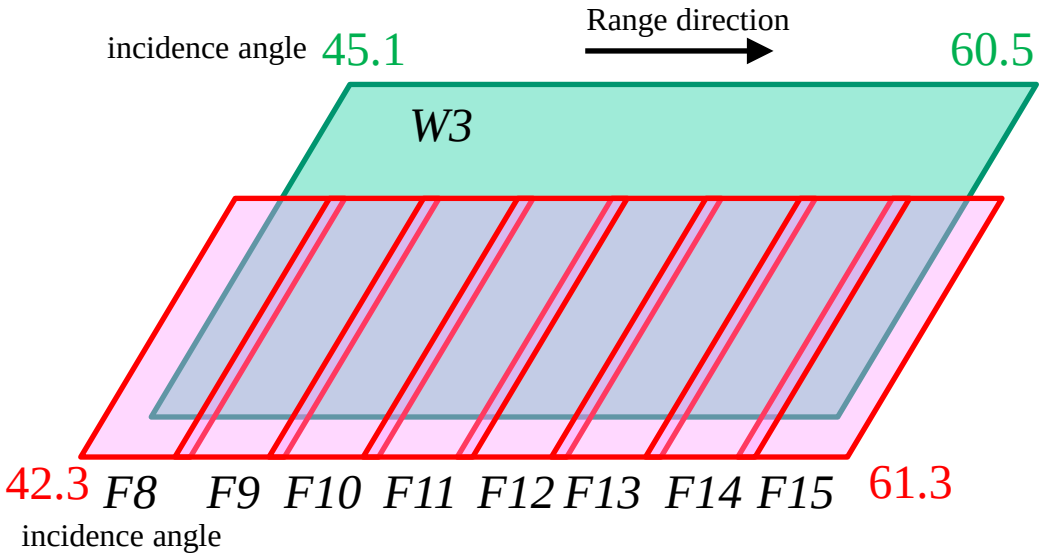
The values in Red Bold are showed the fully overlap between ScanSAR sub-swath and Stripmap.



overlap swath [km]

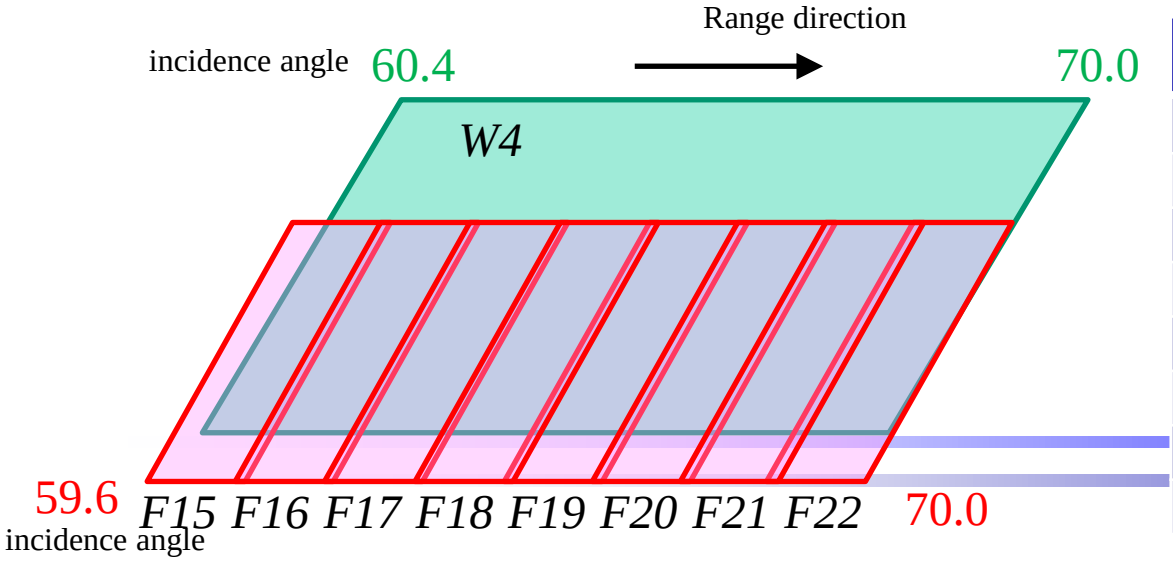
	W2-1	W2-2	W2-3	W2-4	W2-5
F4	36	0	0	0	0
F5	46	26	0	0	0
F6	0	40	0	0	0
F7	0	0	46	22	0
F8	0	0	0	51	12
F9	0	0	0	0	**60**
F10	0	0	0	0	7

The overlap swath estimation for interferometry between ScanSAR and Fine



overlap swath [km]

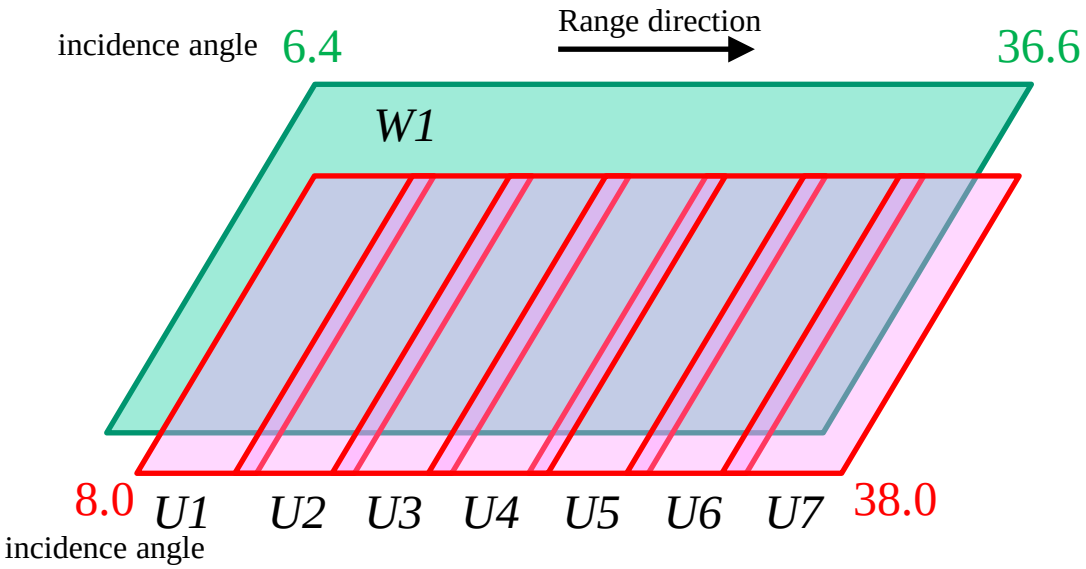
	W3-1	W3-2	W3-3	W3-4	W3-5
F8	12	0	0	0	0
F9	**60**	0	0	0	0
F10	7	57	0	0	0
F11	0	19	38	0	0
F12	0	0	30	22	0
F13	0	0	0	54	2
F14	0	0	0	0	**50**
F15	0	0	0	0	23



overlap swath [km]

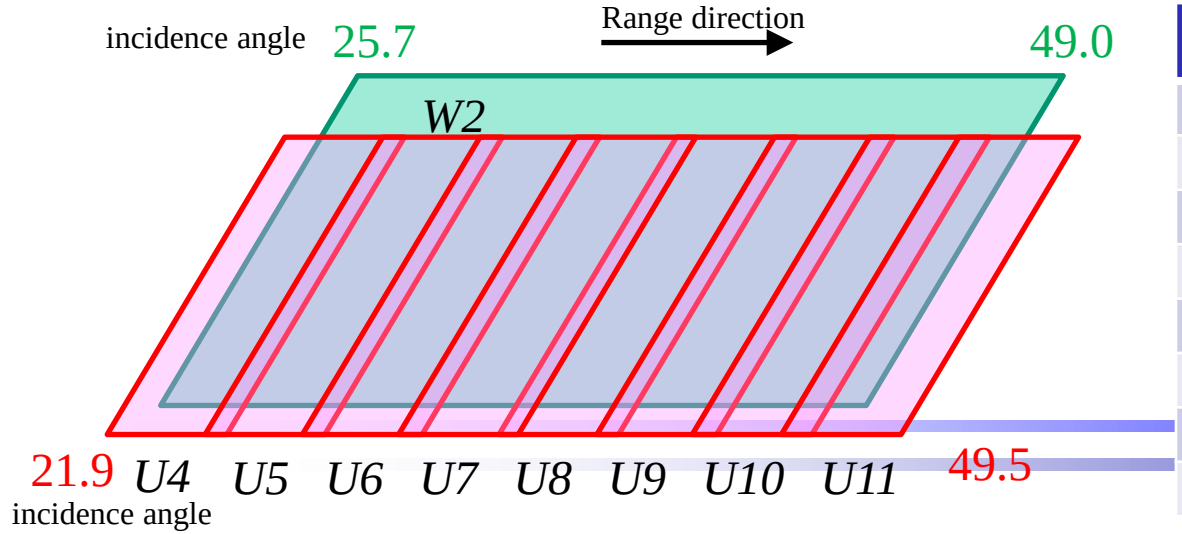
	W4-1	W4-2	W4-3	W4-4	W4-5
F15	26	0	0	0	0
F16	46	3	0	0	0
F17	0	**50**	0	0	0
F18	0	20	28	0	0
F19	0	0	48	7	0
F20	0	0	0	**42.5**	0
F21	0	0	0	28	20
F22	0	0	0	0	**50**

The overlap swath estimation for interferometry between ScanSAR and Ultra-Fine (High sensitive)



overlap swath [km]

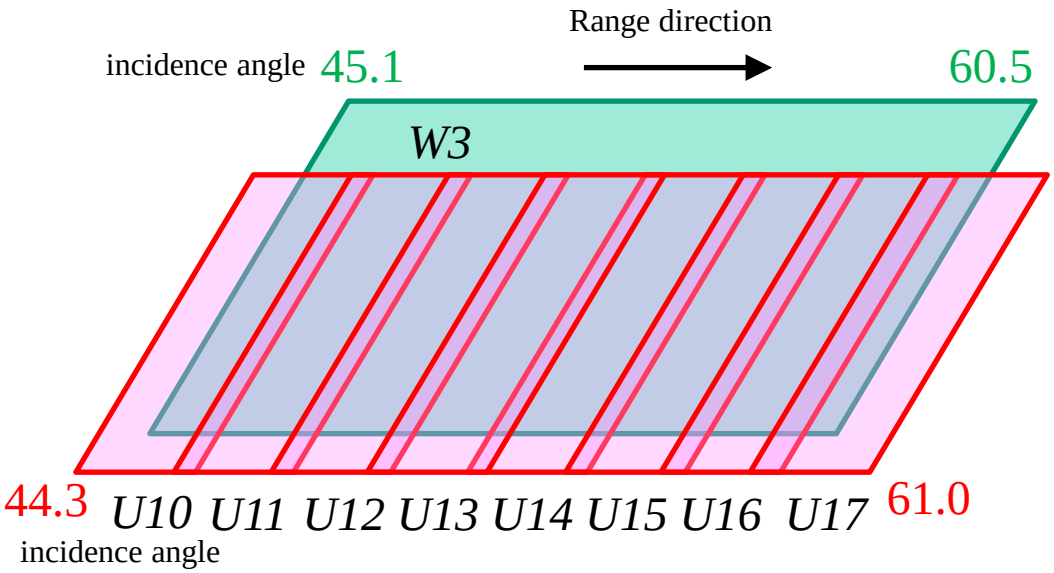
	W1-1	W1-2	W1-3	W1-4	W1-5
U1	**50**	0	0	0	0
U2	7	48	0	0	0
U3	0	23	28	0	0
U4	0	0	0	8	0
U5	0	0	0	**50**	0
U6	0	0	0	24	32
U7	0	0	0	0	35



overlap swath [km]

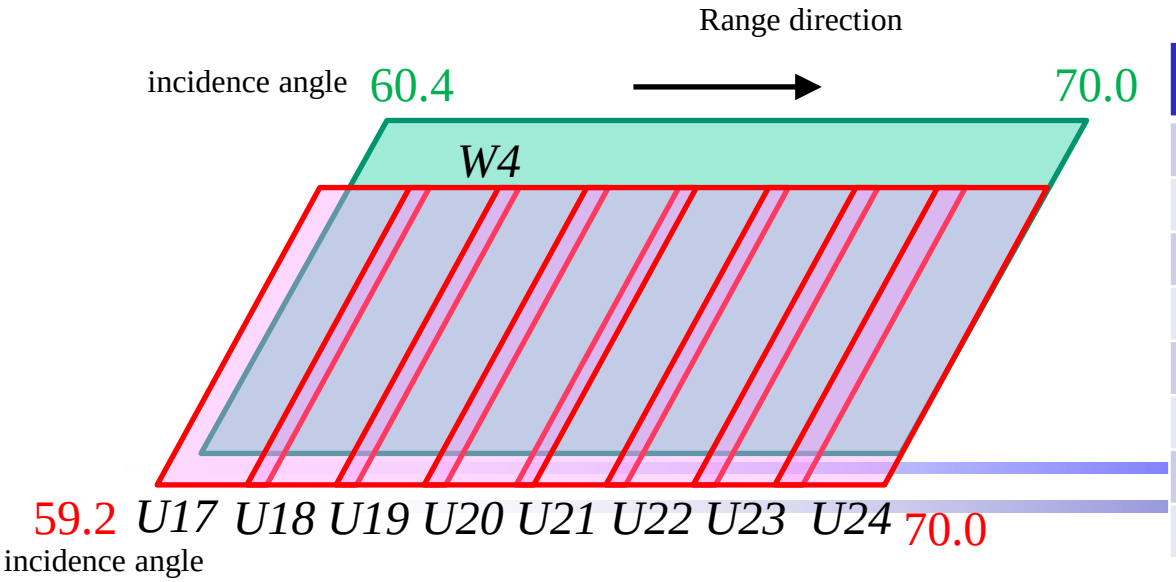
	W2-1	W2-2	W2-3	W2-4	W2-5
U4	8	0	0	0	0
U5	**50**	0	0	0	0
U6	24	32	0	0	0
U7	0	35	23	0	0
U8	0	0	**50**	3	0
U9	0	0	3	**50**	0
U10	0	0	0	21	34
U11	0	0	0	0	40

The overlap swath estimation for interferometry between ScanSAR and Ultra-Fine (High sensitive)



overlap swath [km]

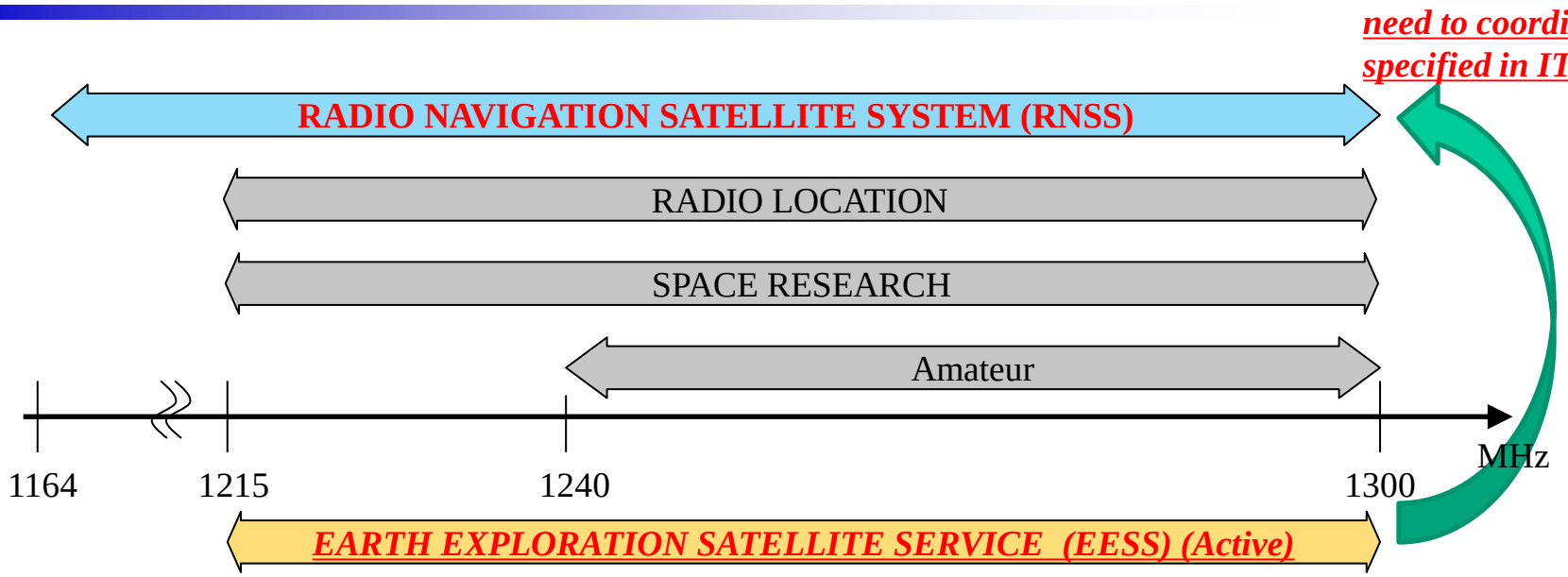
	W3-1	W3-2	W3-3	W3-4	W3-5
U10	34	0	0	0	0
U11	40	13	0	0	0
U12	0	**50**	0	0	0
U13	0	15	35	0	0
U14	0	0	37	14	0
U15	0	0	0	**50**	0
U16	0	0	0	13	38
U17	0	0	0	0	37



overlap swath [km]

	W4-1	W4-2	W4-3	W4-4	W4-5
U17	17	0	0	0	0
U18	**50**	0	0	0	0
U19	9	39	0	0	0
U20	0	34	17	0	0
U21	0	0	**50**	0	0
U22	0	0	11	42	0
U23	0	0	0	28	20
U24	0	0	0	0	**50**

Allocated frequency range in L-band



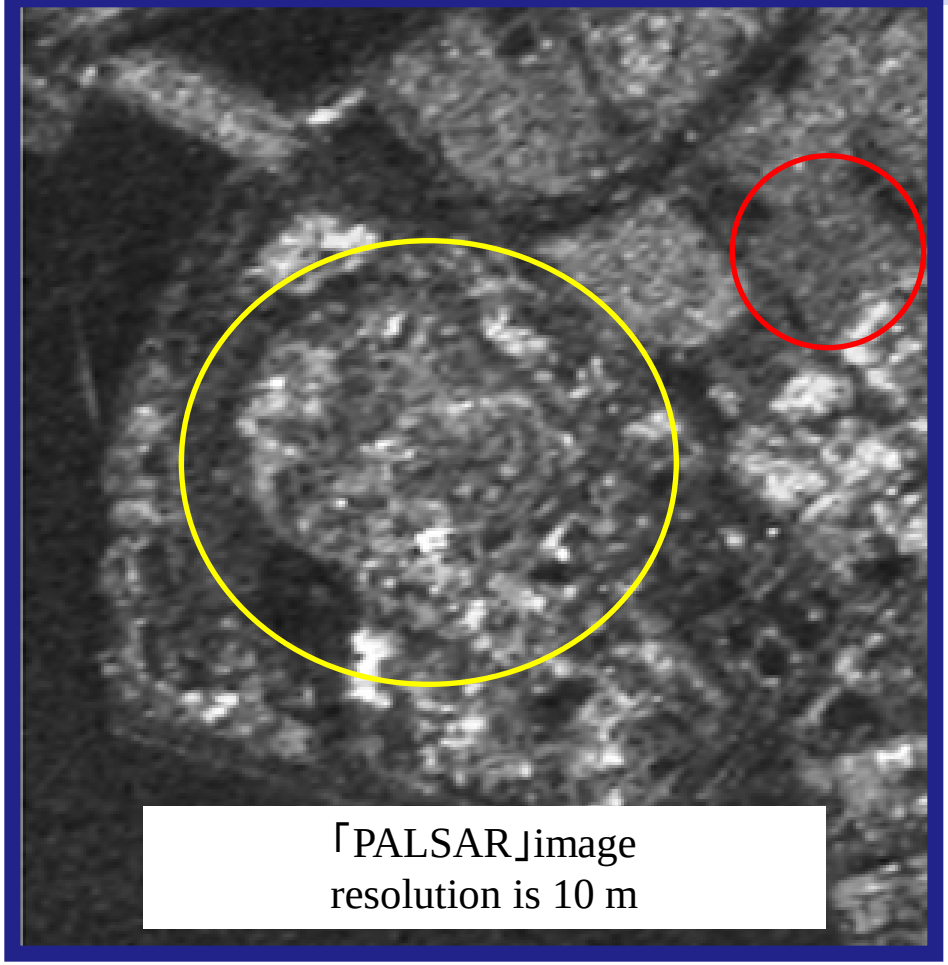
Allocated L-band for EESS (active) is from 1 215 to 1 300 MHz (**max. bandwidth is 85 MHz**).

The max. bandwidth of PALSAR-2 is 84 MHz.

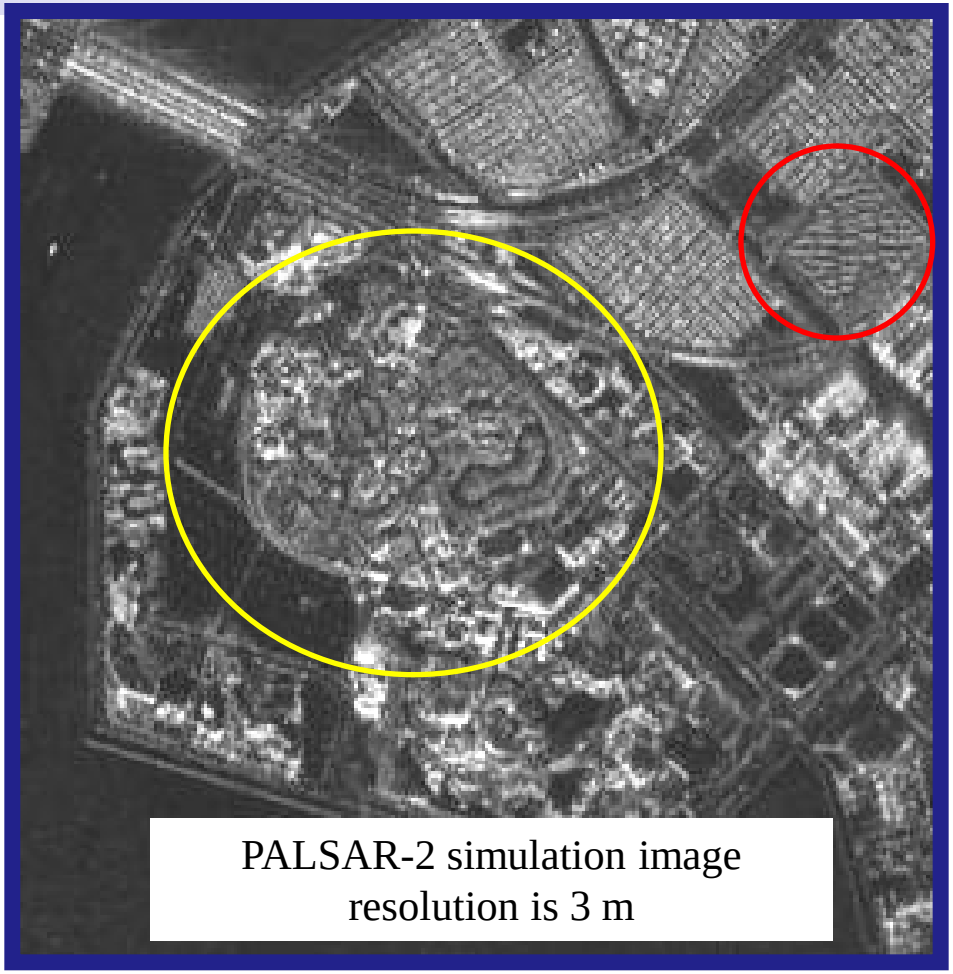
The resolution of PALASR-2 is the highest in L-band SAR!!

The coordination with RNSS is difficult.....

FEATURE OF PALSAR-2
Spatial Resolution



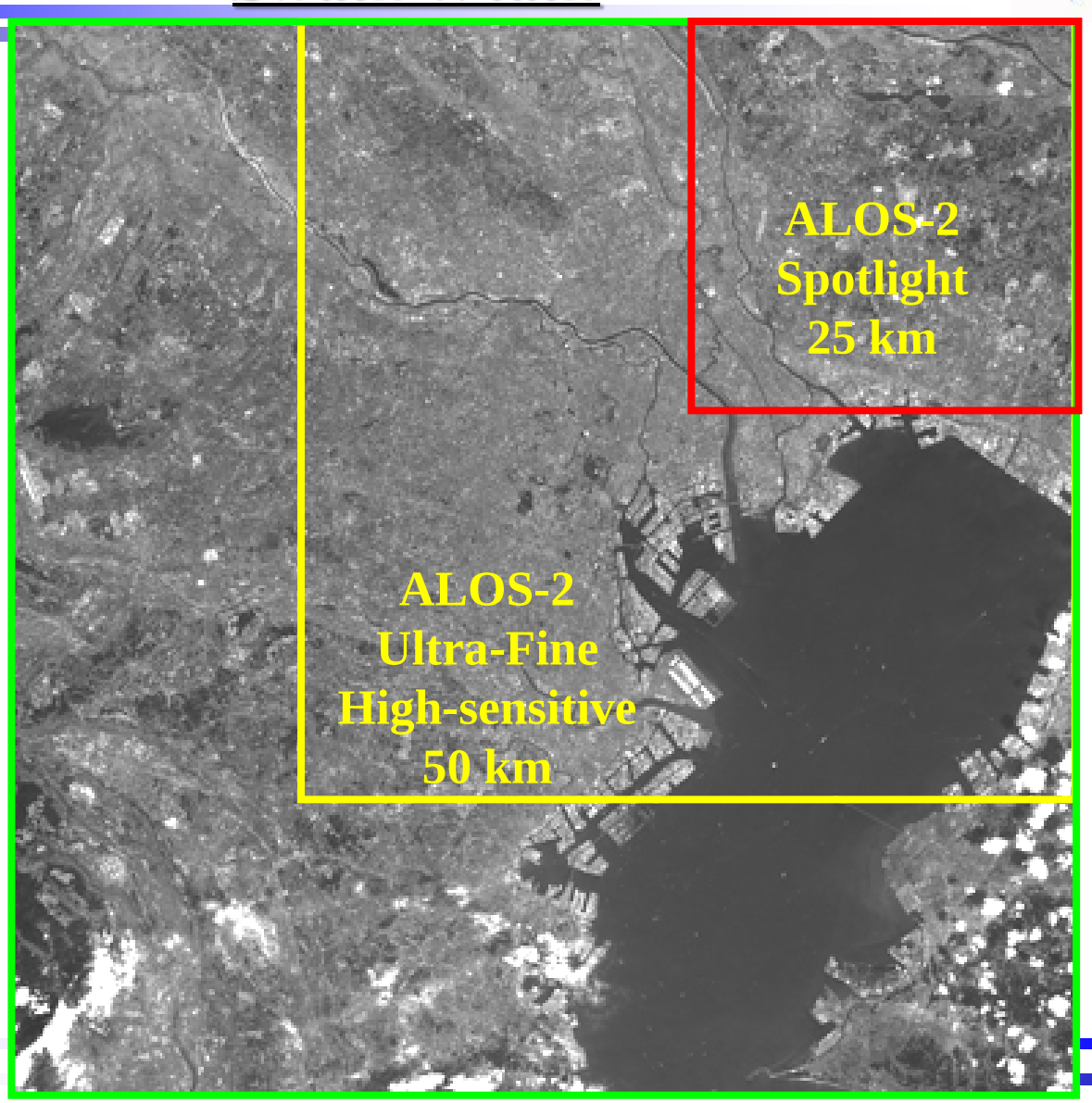
「PALSAR」image
resolution is 10 m



PALSAR-2 simulation image
resolution is 3 m

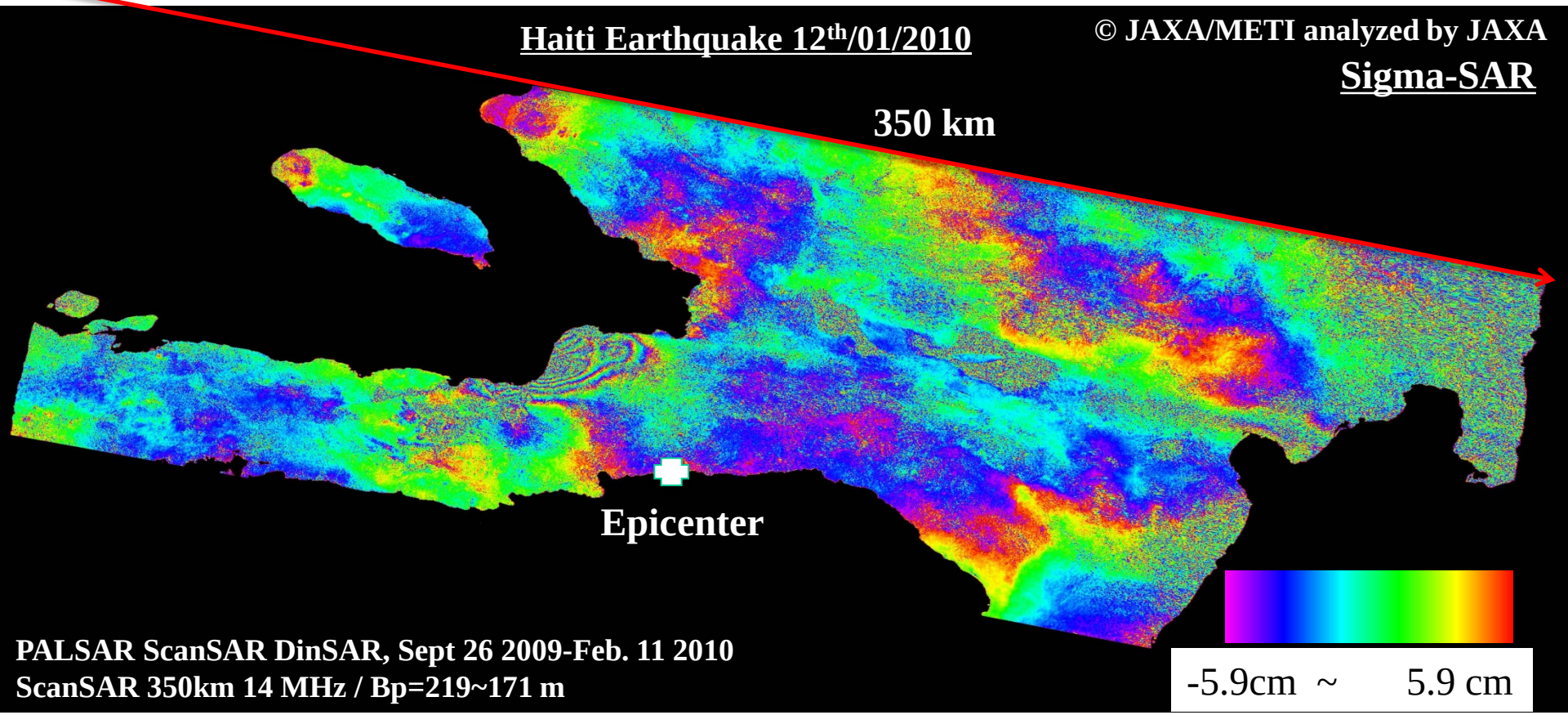
FEATURE OF PALSAR-2

Swath Width



PALSAR Fine
ALOS-2 Fine
70 km

FEATURE OF PALSAR-2
ScanSAR-ScanSAR InSAR



The advantage of PALSAR-2 for high coherence ScanSAR-ScanSAR InSAR :

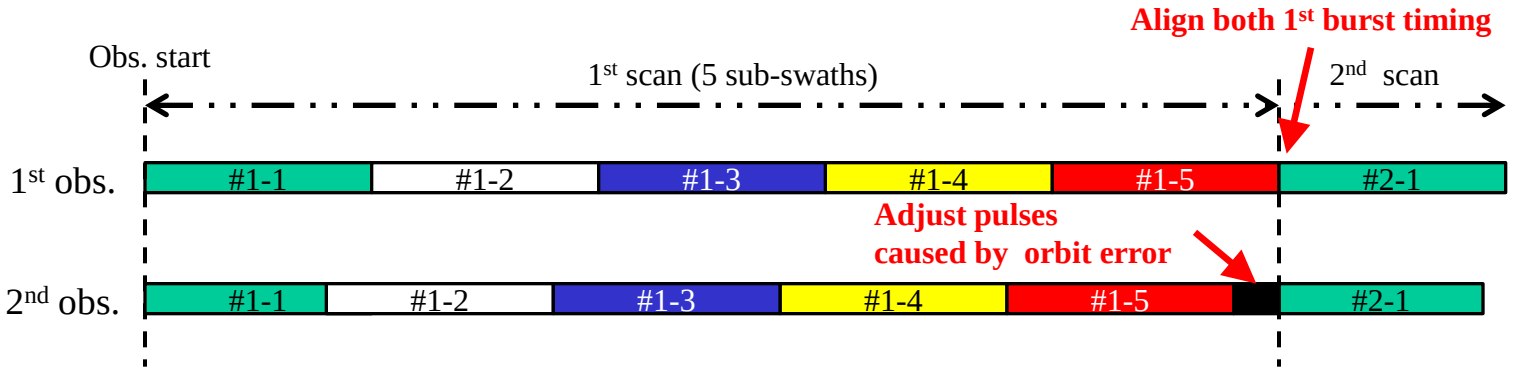
- ✓ **The wide bandwidth (28 MHz) observation for ScanSAR mode**
- ✓ **The controllable burst timing for ScanSAR mode**
- ✓ **The high accuracy (500 m tube) orbit control**

FEATURE OF PALSAR-2
ScanSAR-ScanSAR InSAR

- ***Bandwidth***
  - PALSAR-2 can operate ScanSAR mode with **28MHz** bandwidth.

- ***Image pairs for ScanSAR InSAR***
  - PALSAR-2 controls **argument of latitude** for each observation.
  - For ScanSAR mode, **each 1st burst timing will be aligned**.

  ⇒ **The beam overlap** ratio for sub-swath pairs is **more than 90 %**



ALOS-2 will contribute to ScanSAR InSAR analysis!

FEATURE OF PALSAR-2
New Technologies

- **High power amplifier for TRM** (Transmitting and Receiving Module)
  - **GaN** device is used for HPA.

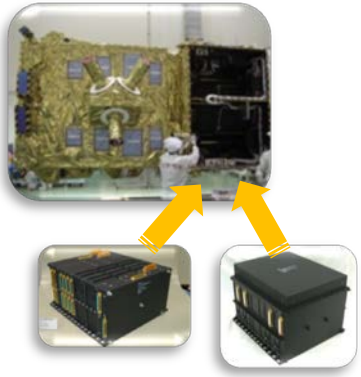
- **DRC (Dual Receive Channel)** technique
  - Pulse Repetition Frequency (PRF) could be reduced with DRC.

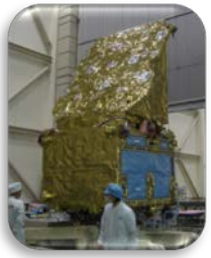
- **Compact Polarimetry (CP)**
  - PRF could be reduced with CP observation.
  - ALOS-2 is the first satellite using CP in the world!
  - CP is **experimental** mode because imaging processing of CP mode should be verified.

- **DS(Down Sampling)-BAQ** data compression
  - Selectable DS-BAQ or conventional BAQ
  - As the result of our simulation, **the amplitude and phase errors are lower** than conventional BAQ.

ALOS-2 SYSTEM VERIFICATION

Integration → Initial Electrical → Thermal Vacuum → SAR Antenna Integration





Parallel verification of PALSAR-2 antenna,

Vibration & Shock → EMC → Final Electrical → Launch Pad

Acoustic
Sinusoidal
PAF Separation
Pyro Shock

Now

Including Compatibility
with Ground Station

RESULTS OF VERIFICATION

Initial electrical and functional test

Purpose

- Electrical connection; System -Components
- Electrical function of all sub-system
- Total function and performance as system

Thermal vacuum test

Purpose

- Verify the thermal design of satellite system
- Function and performance of thermal control device
- Electrical function and performance under vacuum

EMC test is on going

Purpose

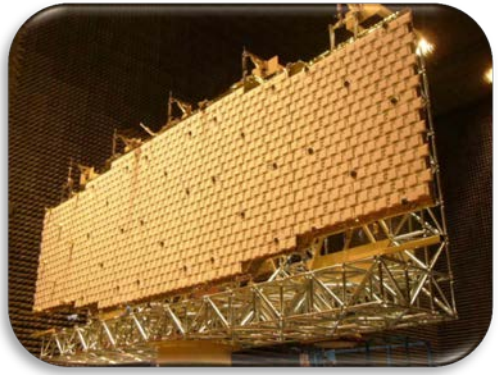
- Function and performance of EMC condition
- Now on going

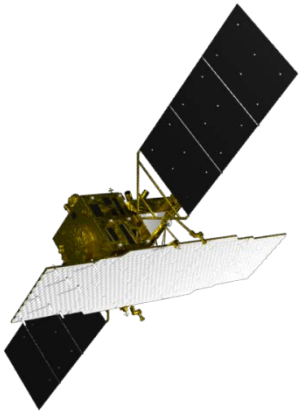
The requirements of total function and performance of system was confirmed to be satisfied.

PALSAR-2 SUB-SYSTEM VERIFICATION

Panel unit test → RF impulse response test → Thermal Vacuum test #1& #2

ANT integration → Sub system final test → **To ALOS-2 system**



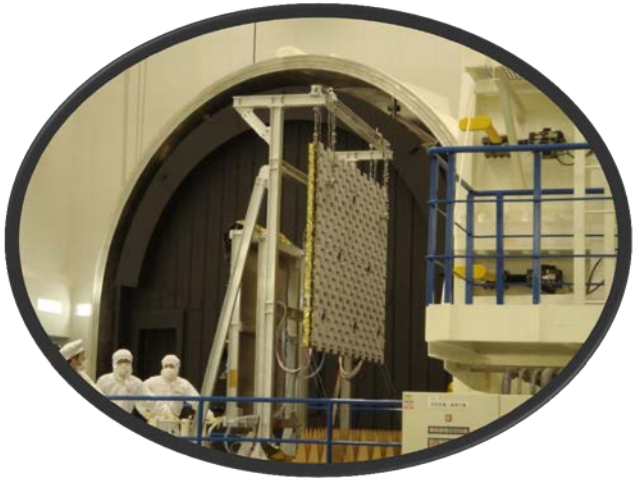


RESULTS OF VERIFICATION

RF Impulse response in Vacuum condition

Purpose

- confirmation total system function without discharge
- confirmation of resolution



Mode	chirp	resolution [m]
Ultra-Fine	UP	**2.79**
	DOWN	**2.81**
High-sensitive	UP	**5.69**
	DOWN	**5.75**

SAR-ANT thermal Vacuum test

Purpose

- confirmation antenna of the function in space environment
- verification of the thermal modes
- As limit of chamber size, the test was carried out twice.

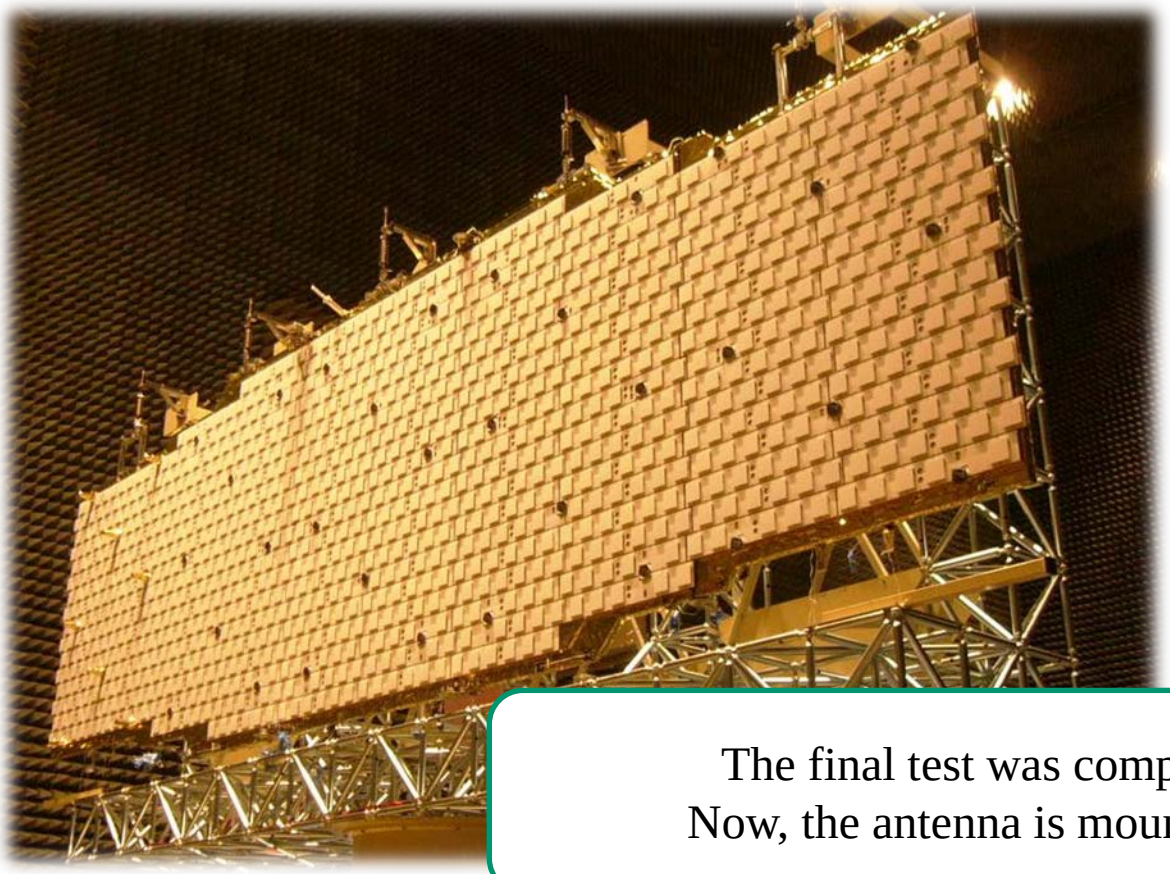
RESULTS OF VERIFICATION

Final test of

PALSAR-2 antenna

Purpose

- confirmation of total function for observation
- confirmation of antenna pattern with full apterutre



The final test was complete with good results.
Now, the antenna is mounted on ALOS-2 system.

Conclusion

- **ALOS-2 will succeed to ALOS mission with enhanced capabilities.**
  - **High resolution, Wide swath, Good NESZ and Various Polarization**
- **Quick response to disasters and flexible observation**
  - **Agile right- or left-looking function by satellite body rolling.**
- **PALSAR-2 sub-system test was completed and ALOS-2 System final test including environmental test have been on-going.**
- **ALOS-2 will be launched by the H-IIA Launch Vehicle.**

THANK YOU FOR YOUR ATTENTION!