JAXA Agency Report

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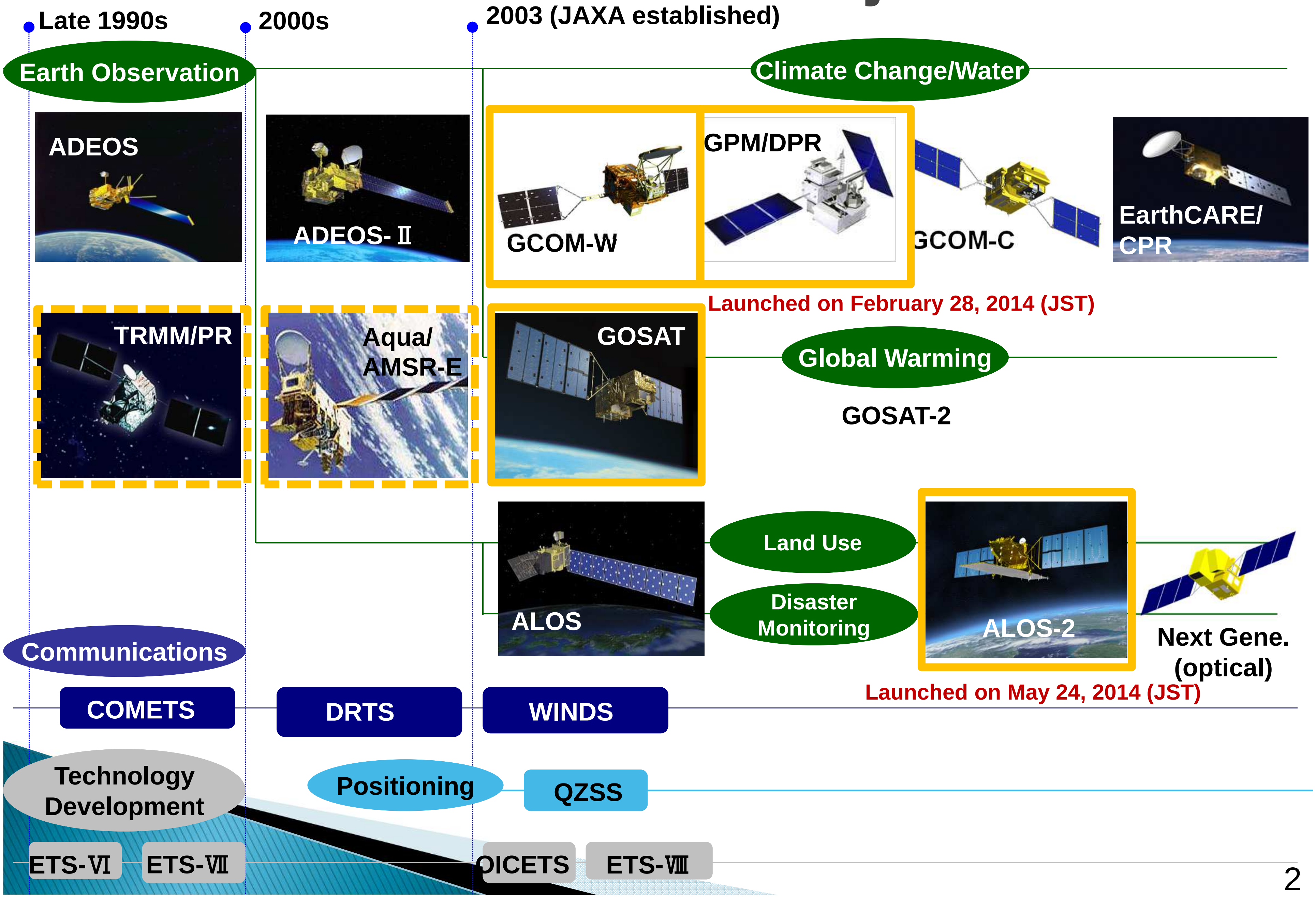
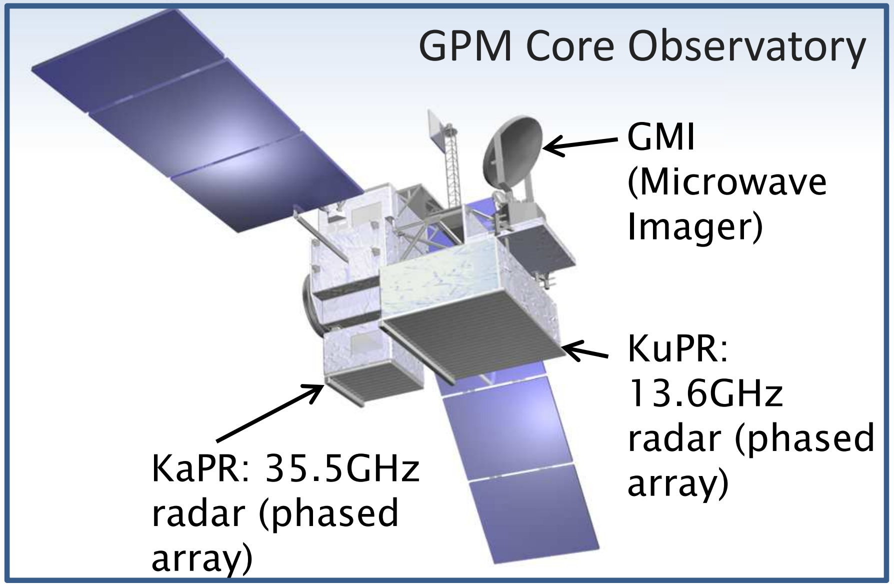
Japan Aerospace Exploration Agency (JAXA)

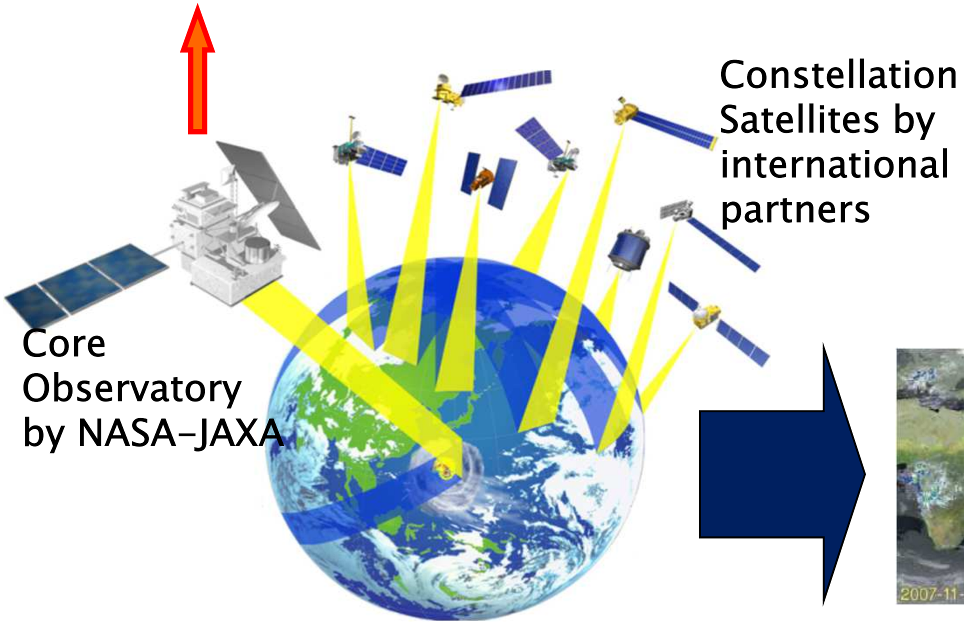
GSICS/GRWG Meeting
Delhi, India (remote participation)
March 17, 2015

JAXA Satellite Projects

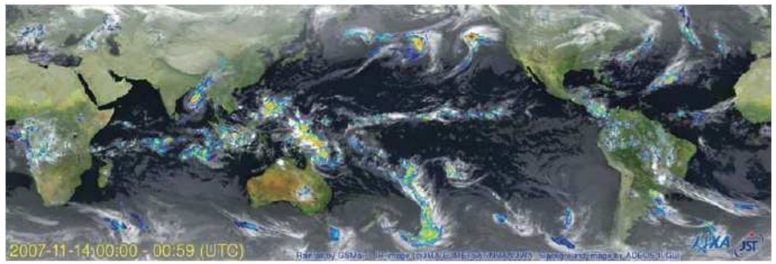


GPM





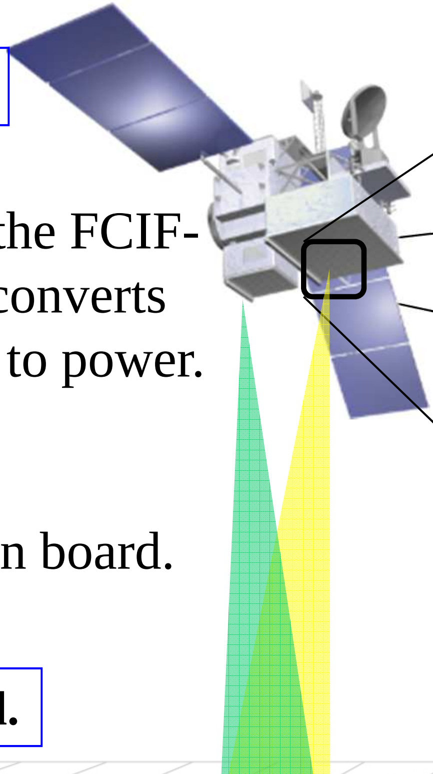
- GPM is an international mission consisting of the GPM Core Observatory and Constellation Satellites for high accurate and frequent global precipitation observation.
  - Core Observatory: developed under NASA and JAXA equal partnership.
  - Constellation satellites: provided by international partners (includes GCOM-W1).
- Dual-frequency Precipitation Radar (DPR)
  - developed by JAXA and NICT
  - DPR is composed of two radars: KuPR & KaPR
- GPM Core Observatory was successfully launched **on 28 Feb. 2014 (JST).**



Concept of DPR Calibration

The calibration of DPR is divided by 'Internal calibration' and 'External calibration'

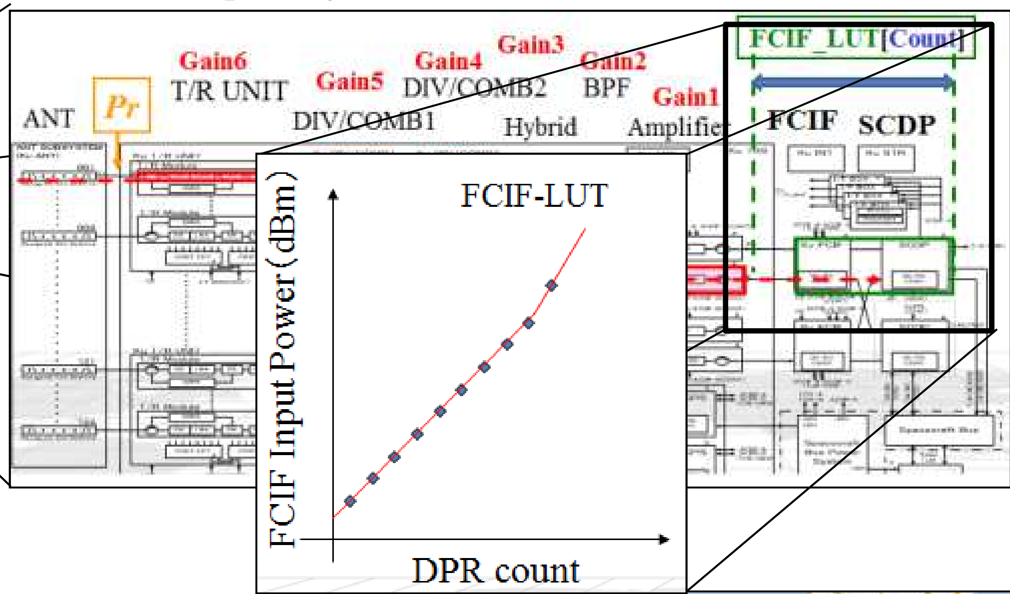
Internal Cal.



【Purpose】
To calibrate the FCIF-LUT which converts digital count to power.

【Frequency】
Per a week on board.

Radio Frequency is not tramsmited to out of DPR



External Cal.

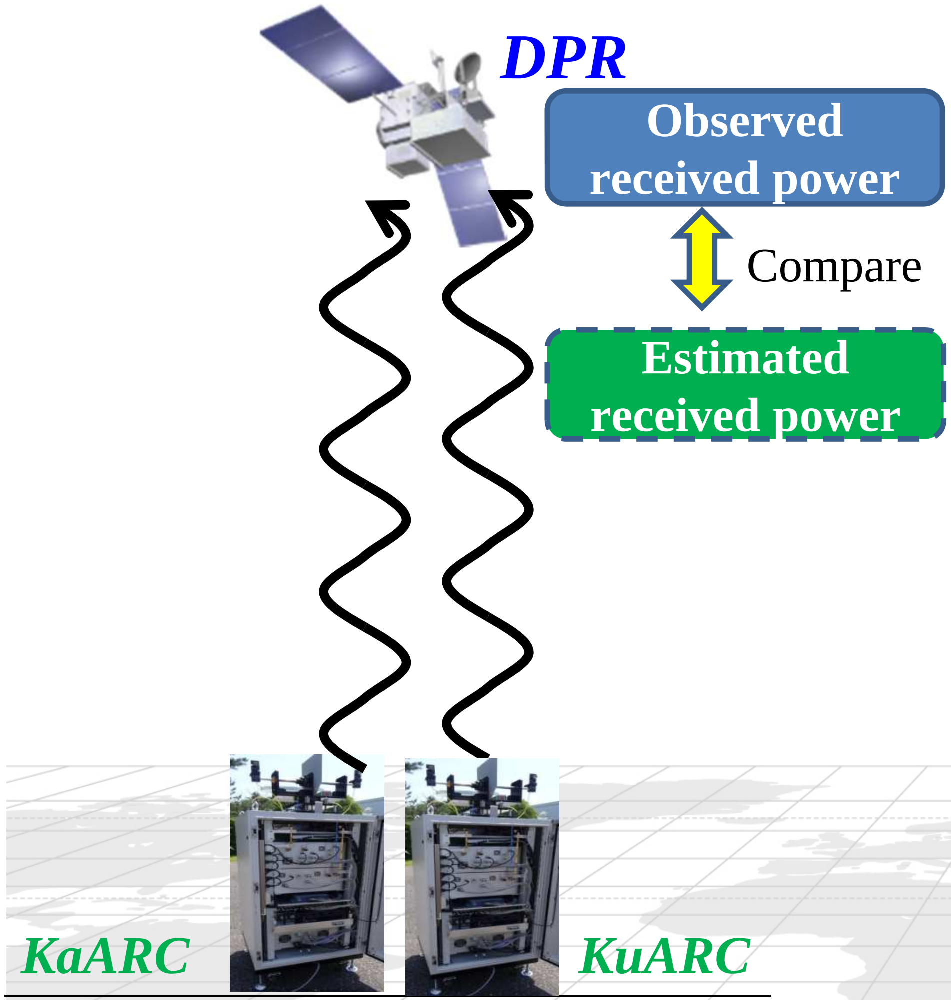
【Purpose】
To calibrate the absolute value of the DPR transmitted / received powers.

【Frequency】
External calibration will be planed 10 times in a year.
During check out phase, the calibration have been conducted 10 times a month at JAXA tsukuba space center in Japan.

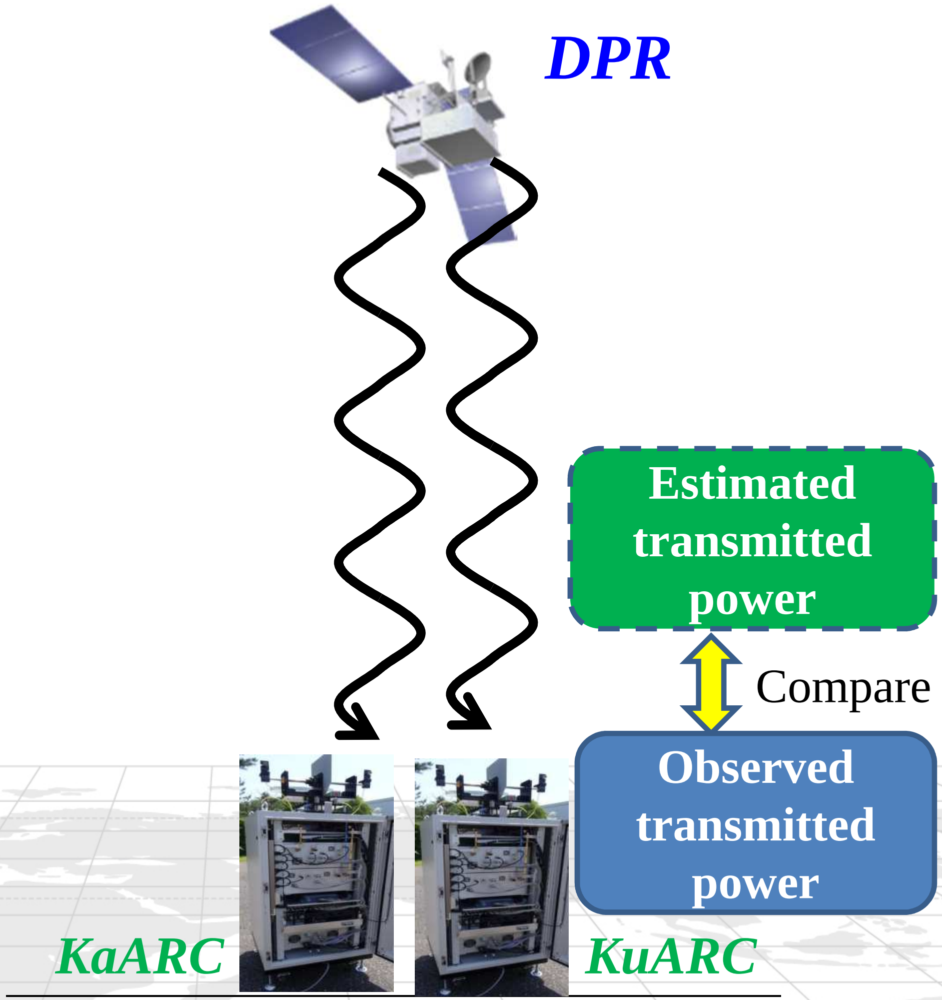
FCIF: Frequency Converter & IF

Concept of DPR External Calibration

DPR receiver system



DPR transmitter system



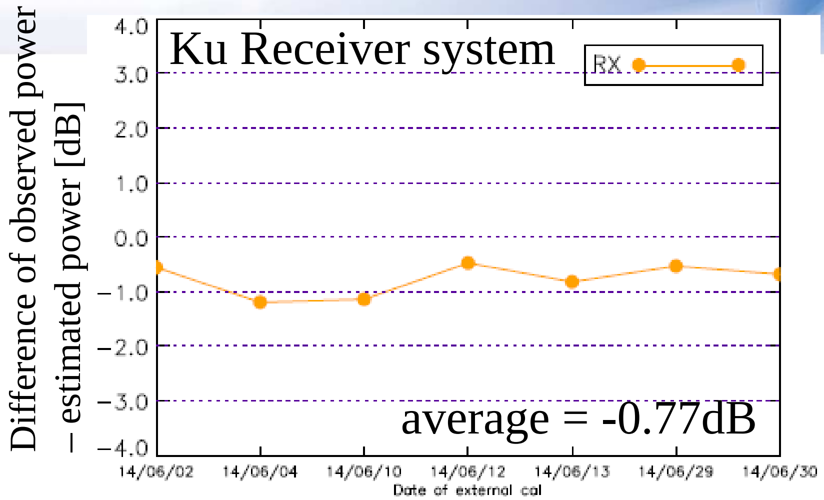
To calibrate the received power and the transmitted power of DPR,
the difference between observed power and estimated power is evaluated.

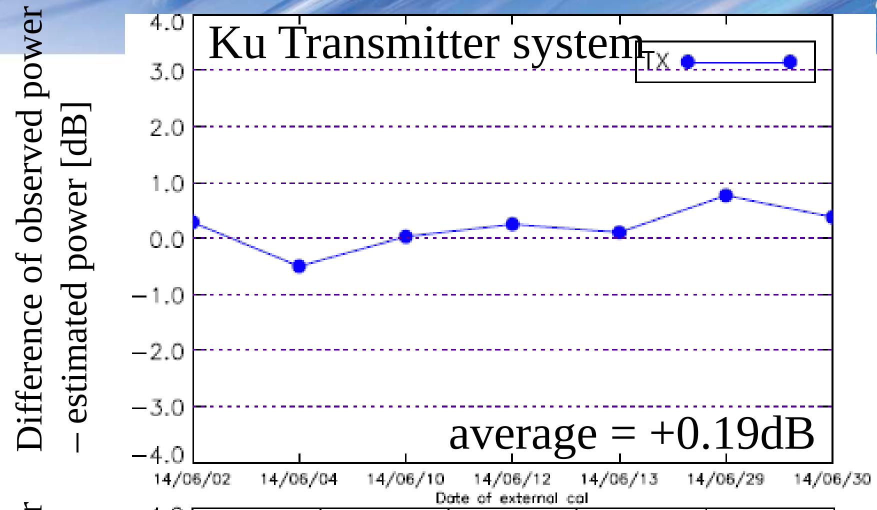
Active Radar Calibrator

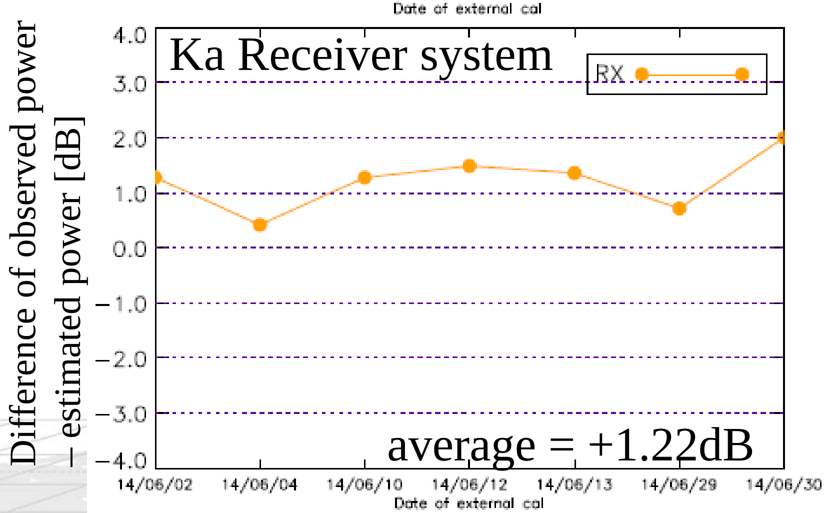
Active Radar Calibrator (ARC)

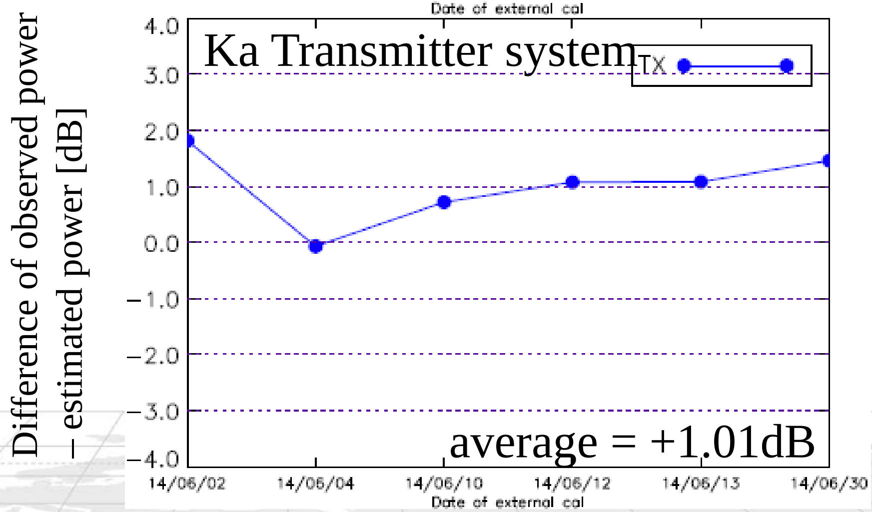
The situation of external calibration

Results of External Calibration







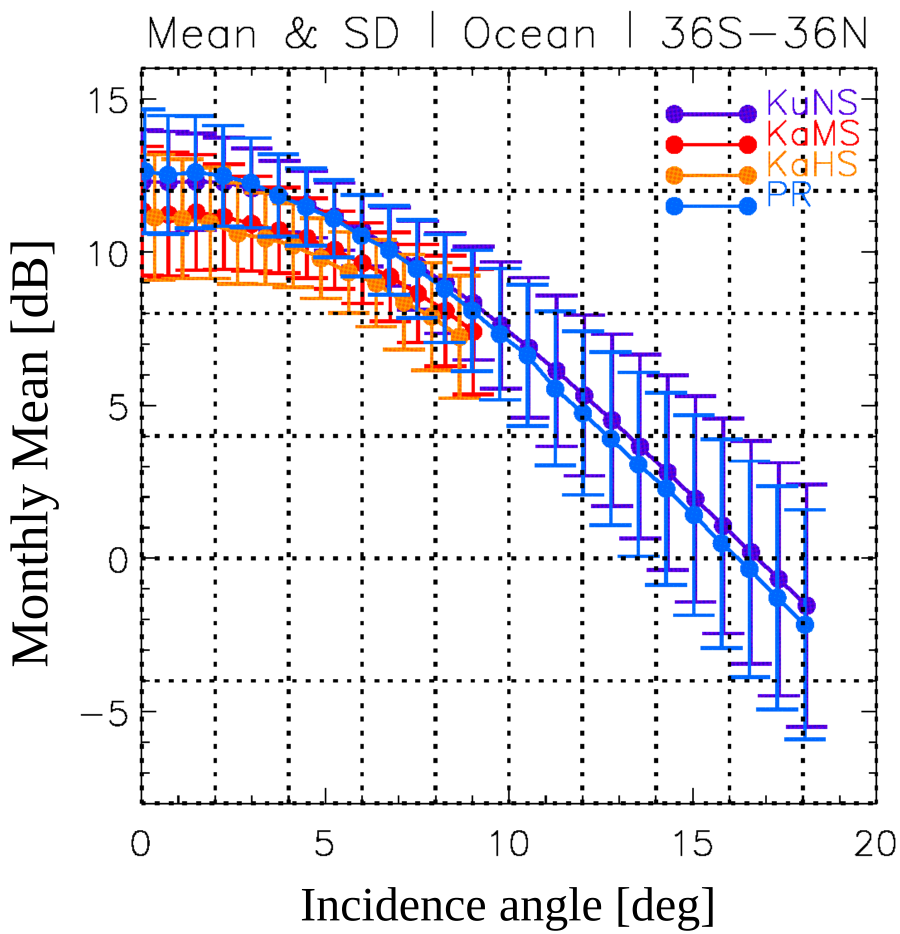


- Although the trends have some offsets, these are stable. JAXA will research for these offsets.
- Since the current calibration coefficient satisfies continuity of sigma^0 in DPR L2 from TRMM/PR (not shown), gain offsets found in external calibration has not been adapted now.

Intercomparison Oceanic σ^0

- Comparison with reference to the TRMM/PR

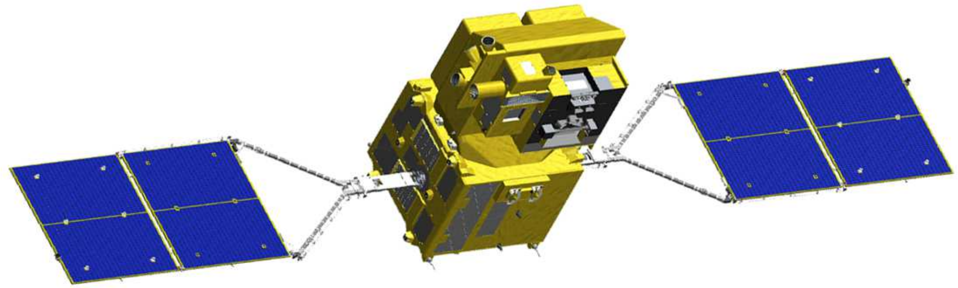
Monthly mean & SD



GCOM 1st Generation Satellites

- 2 types of medium-sized satellites and 3 generations: 10-15 years observation

“SHIZUKU”



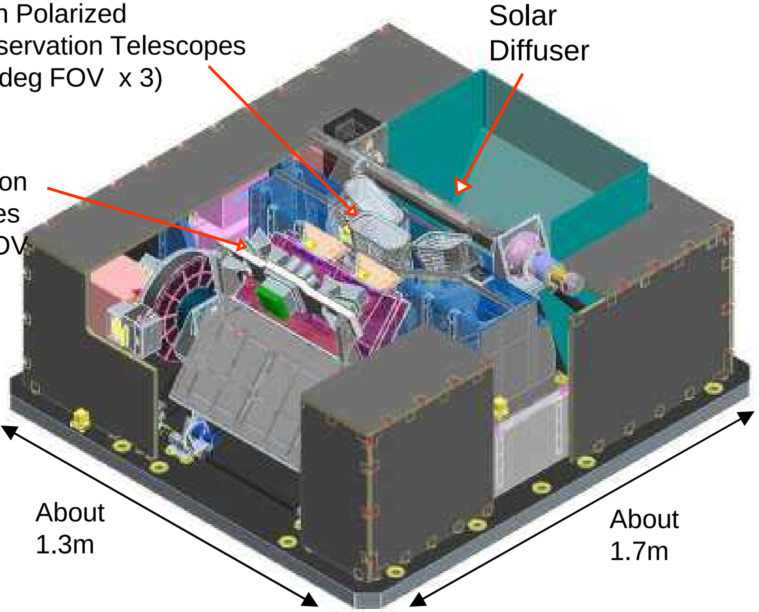
GCOM-W1 (Water)

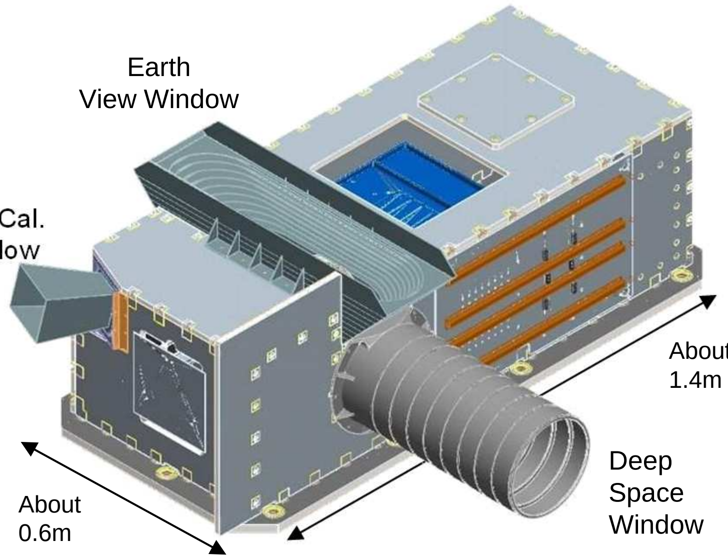
Instrument	**Advanced Microwave Scanning Radiometer-2**
Orbit	Sun Synchronous orbit Altitude : 699.6km (on Equator) Inclination: 98.2 degrees Local sun time: 13:30+/-15 min
Size	5.1m (X) * 17.5m (Y) * 3.4m (Z) (on-orbit)
Mass	1991kg
Power gen.	More than 3880W (EOL)
Launch	May 18, 2012
Design Life	5-years

GCOM-C1 (Climate)

Instrument	**Second-generation Global Imager**
Orbit	Sun Synchronous orbit Altitude : 798km (on Equator) Inclination: 98.6 deg. Local sun time: 10:30+/- 15min
Size	4.6m (X) * 16.3m (Y) * 2.8m (Z) (on orbit)
Mass	2093kg
Power gen.	More than 4000W (EOL)
Launch	JFY 2016
Design Life	5-years

SGLI on GCOM-C



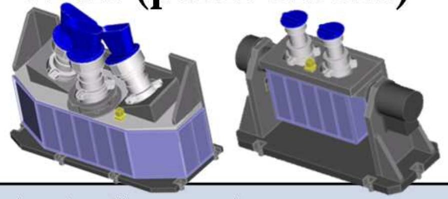
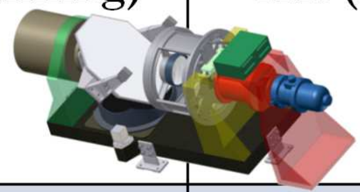


Visible and Near Infrared Radiometer (SGLI-VNR)

Infrared Scanning Radiometer (SGLI-IRS)

Sensor Unit	features
SGLI VNR	Non Polarized Observation (11ch), IFOV 250m, Swath 1150km Polarized Observation (2ch), IFOV 1km, Swath 1150km
SGLI IRS	Shortwave Infrared (SWI 4ch), IFOV 250m/1km, Swath 1400km Thermal Infrared (TIR:2ch), IFOV 500m, Swath 1400km

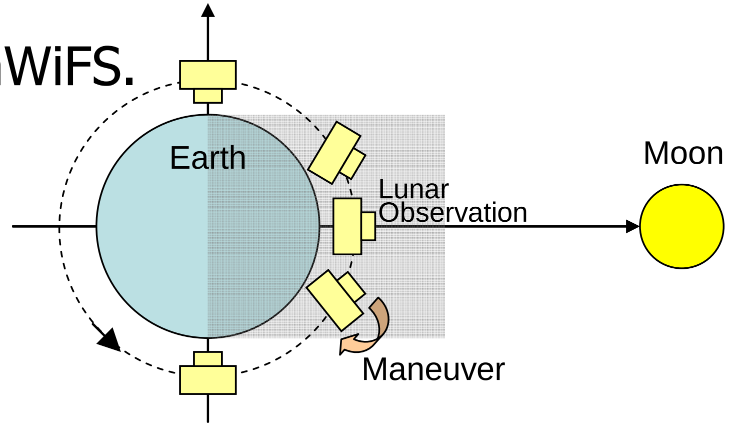
SGLI calibration (radiometric)

Sensor component / Calibration target	VNR (push-bloom) 	SWIR (scanning) 	TIR (scanning)
Pre-launch characterization	Gain (radiometric sensor model), diffuser, RSR, linearity, polarization, MTF (PSF), ..		Gain, blackbody, RSR, linearity..
Functional check	Electric calibration, sensor telemetry monitoring..		
Offset	**Optical black** (every line), and nighttime observations	**Deep-space** or nighttime observations	**Deep-space** and pitch maneuver observations
Launch shift	**LED** to check change of **diffuser**	halogen lamp (+LED) to check diffuser change	**Black body** calibration
Short term gain change	solar light → **diffuser** (~once/week)	solar light → light guide → **diffuser** (every path)	
Long term change	Monthly **Moon** (7°) observations by pitch maneuver for evaluation of the diffuser degradation (with GSICS)		***Primary source***
Vicarious adjustment	Vicarious calibration over the CEOS instrumented sites and ocean cruises	Vicarious calibration at the CEOS instrumented sites (land)	Vicarious/cross calibration by SST
Cross check and image quality	Vicarious & cross calibration over the CEOS invariant sites (Libya, Dome-C, TuzGolu..), stray light by moon, pol sensitivity by simultaneous VNR-PL..		

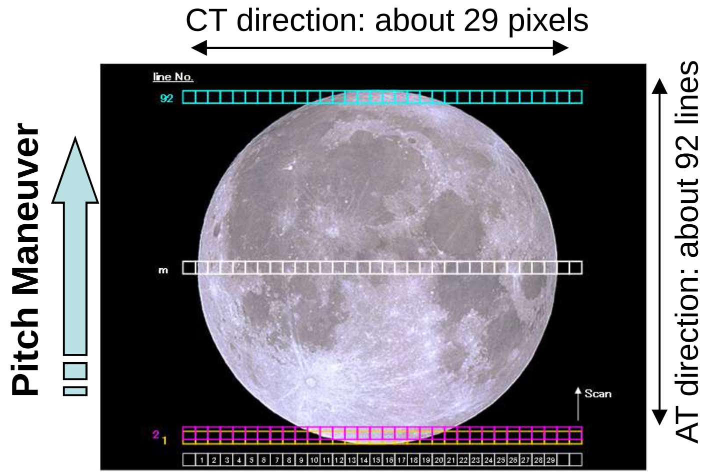
These tasks will be led by the joint team of the JAXA GCOM-C hardware development and data-analysis & application groups

SGLI Lunar Calibration

- Moon reflecting solar light is a stable light source as a long term calibration reference of the optical sensors.
- GCOM-C lunar calibration maneuvers are planned to be conducted every 29.5 days during 5 years mission.
- Lunar calibration concept is similar to SeaWiFS.



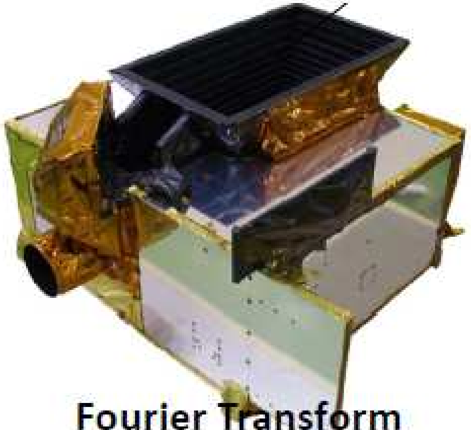
Calibration interval	Every 29.5 days (= synodic period of the moon and the sun)
Lunar phase angle	7deg +/-3deg
SGLI lunar observation	All bands (VNR & IRS) 250m resolution
Satellite Maneuver Requirement	- Pitch rate of 0.15 deg/s with high stability - Selectable roll angle (lunar image in SGLI swath)



TANSO-FTS and CAI specifications

2009 ~ present in operation

Thermal And Near infrared Sensor for carbon Observation (TANSO)



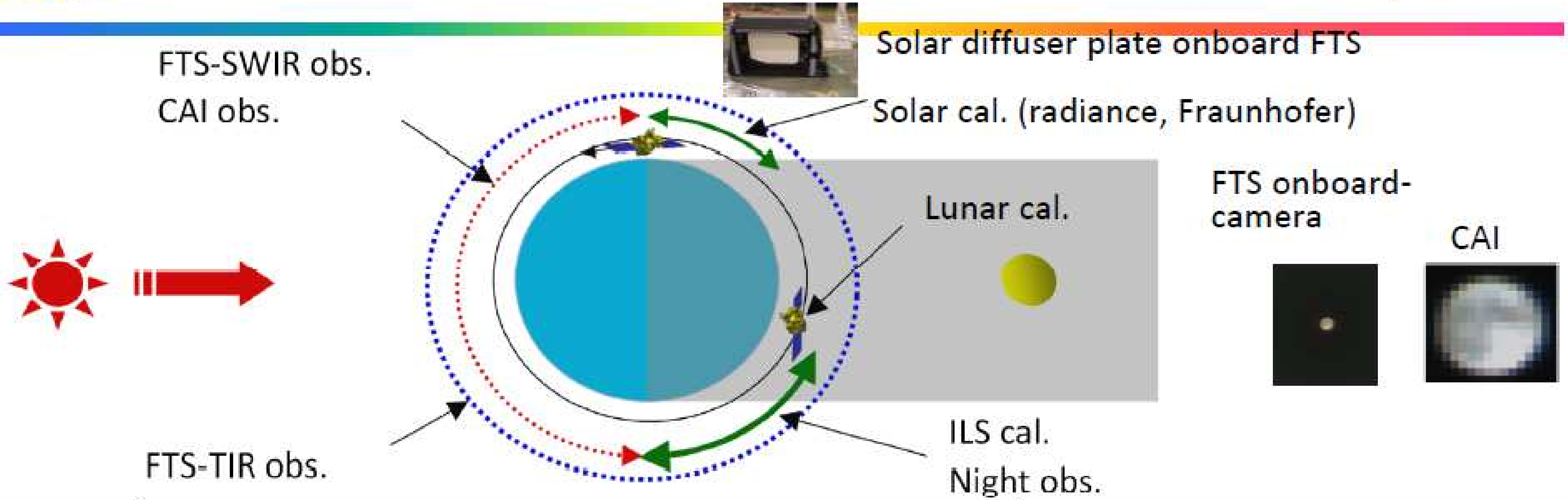
Fourier Transform Spectrometer (FTS)

Cloud and Aerosol Imager (CAI)

Fourier Transform Spectrometer (FTS)	
Mission	GHGs measurements
Band	SWIR-0.76μm, 1.6μm, 2.0μm bands with P/S polarization (O_2-A, CO_2, CH_4, H_2O band)
	TIR-5.5~14.3μm (CO_2, CH_4, O_3 band)
Spec. Res.	$0.2cm^{-1}$
Swath	750km ex: 5 points / every 180km
Footprint	10.5km

Cloud and Aerosol Imager (CAI)	
Mission	Cloud detection and aerosol correction within FTS IFOV
Band	0.38, 0.67, 0.87, 1.60μm band
Swath	750-1000km
Footprint	0.5 and 1.5km

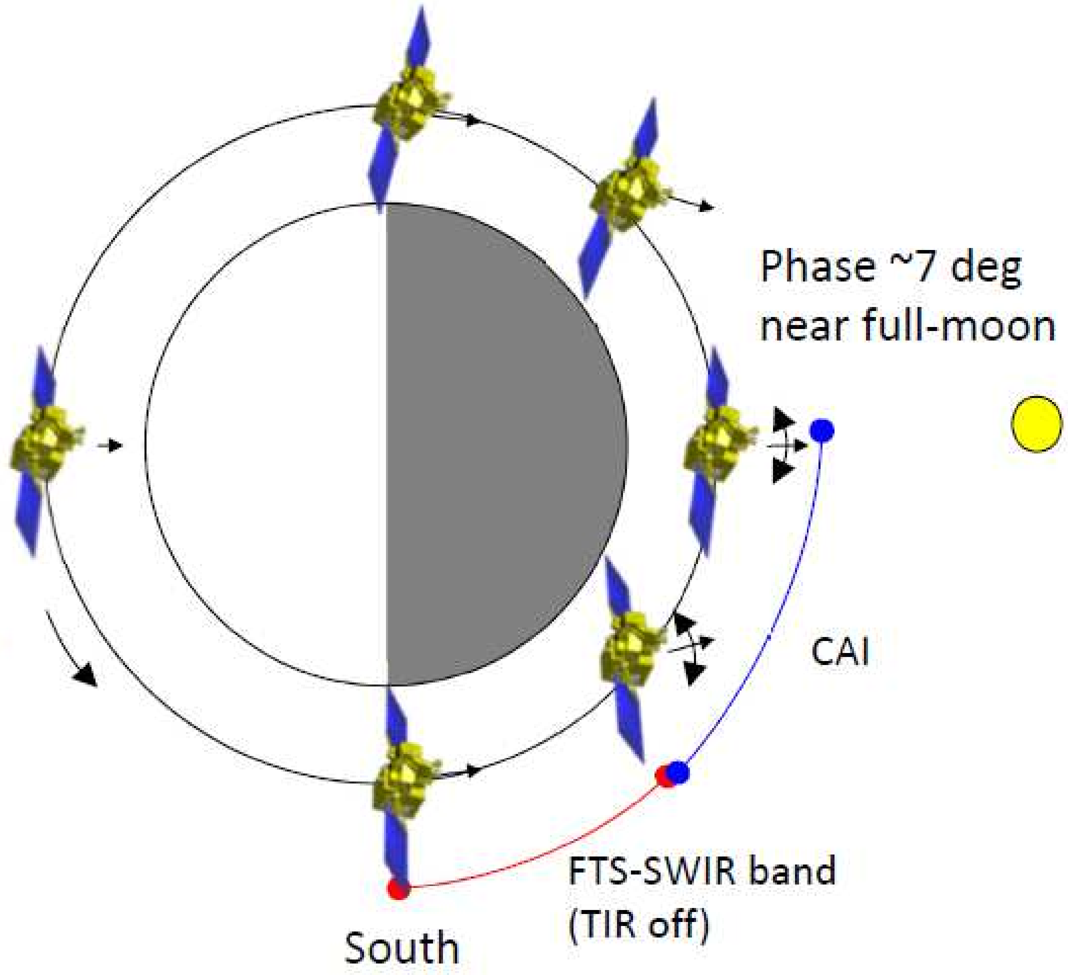
GOSAT calibrations



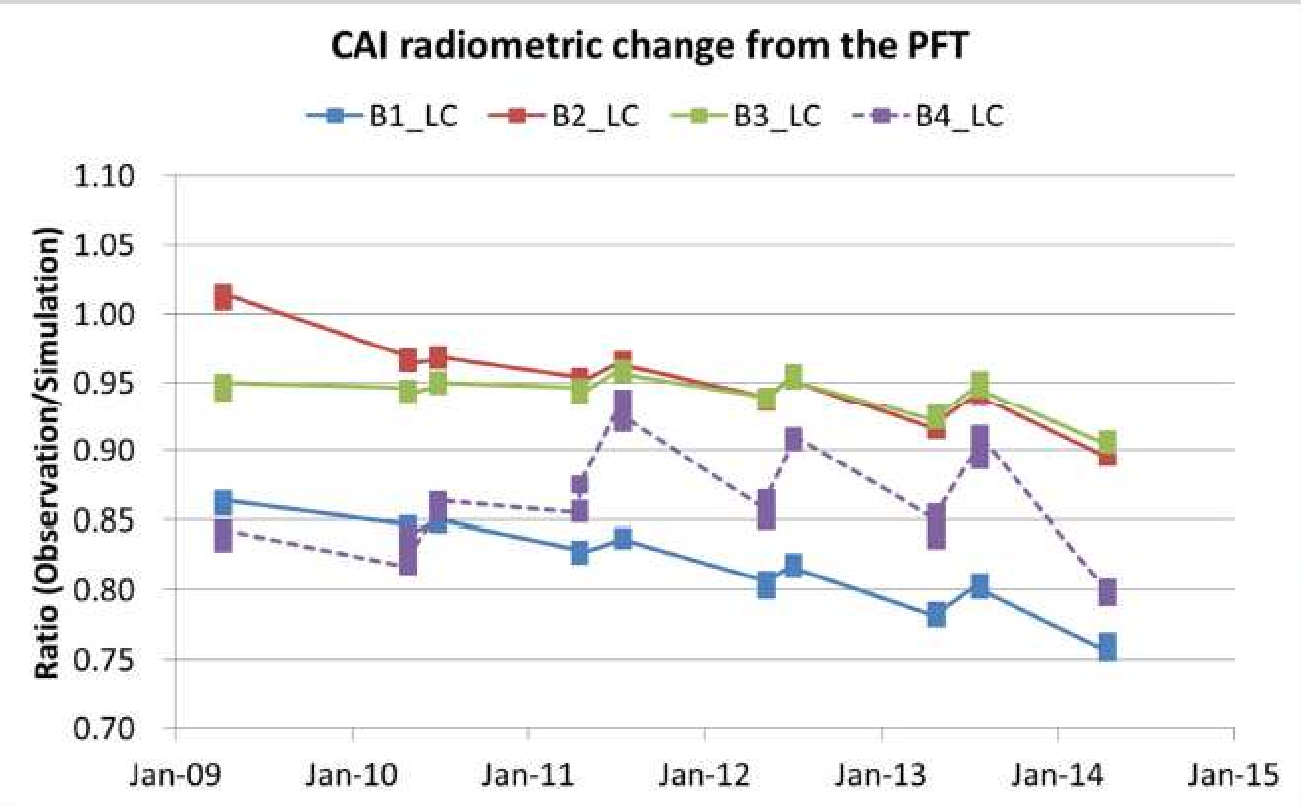
	FTS				CAI			
	B1P/S 0.76um	B2P/S 1.6um	B3P/S 2um	B4 5.5-14.3um	B1 0.38um	B2 0.67um	B3 0.87um	B4 1.6um
Radiance	Vicarious calibration (1/year) Solar calibration (backside: 1/month) Lunar calibration (2/year)			Vicarious calibration (1/year) Cross comparison (AIRS)	Vicarious calibration (1/year) Lunar calibration (2/year) Dark (Night observation: 1/month)			
Spectral features	Fraunhofer line (spectral shift) ILS calibration (B2P/S: 1/month)			-	-			
Geometry	FTS onboard-camera image is validated by using AVNIR-2.				Validated by using GSHHS			

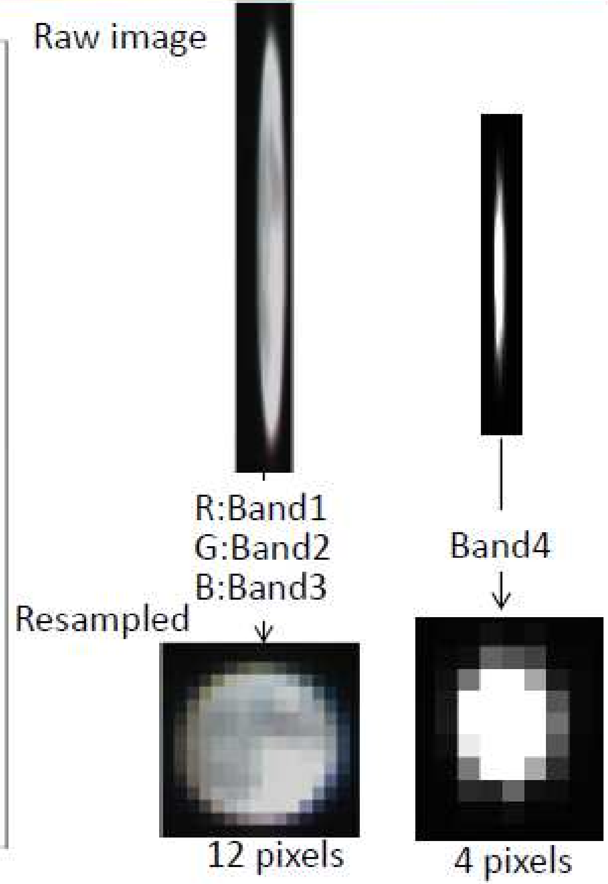
Lunar calibration for GOSAT

- Radiometric onboard calibration for FTS SWIR and CAI
- For FTS, gazing the moon by the satellite pointing with half IFOV
- For CAI, scanning the moon by the satellite pitch motion
- Once a year (also with backup, i.e. total twice)
- Bright and stable target with observation phase angle of 7 degrees near full-moon



CAI lunar calibration result





- Band4 IFOV is broader than the identical. It might not be well-evaluated.
- Band1-3 radiometric trends are evaluated well.

CAI lunar observation on 28 April 2010. Images are oversampled in along-track direction.

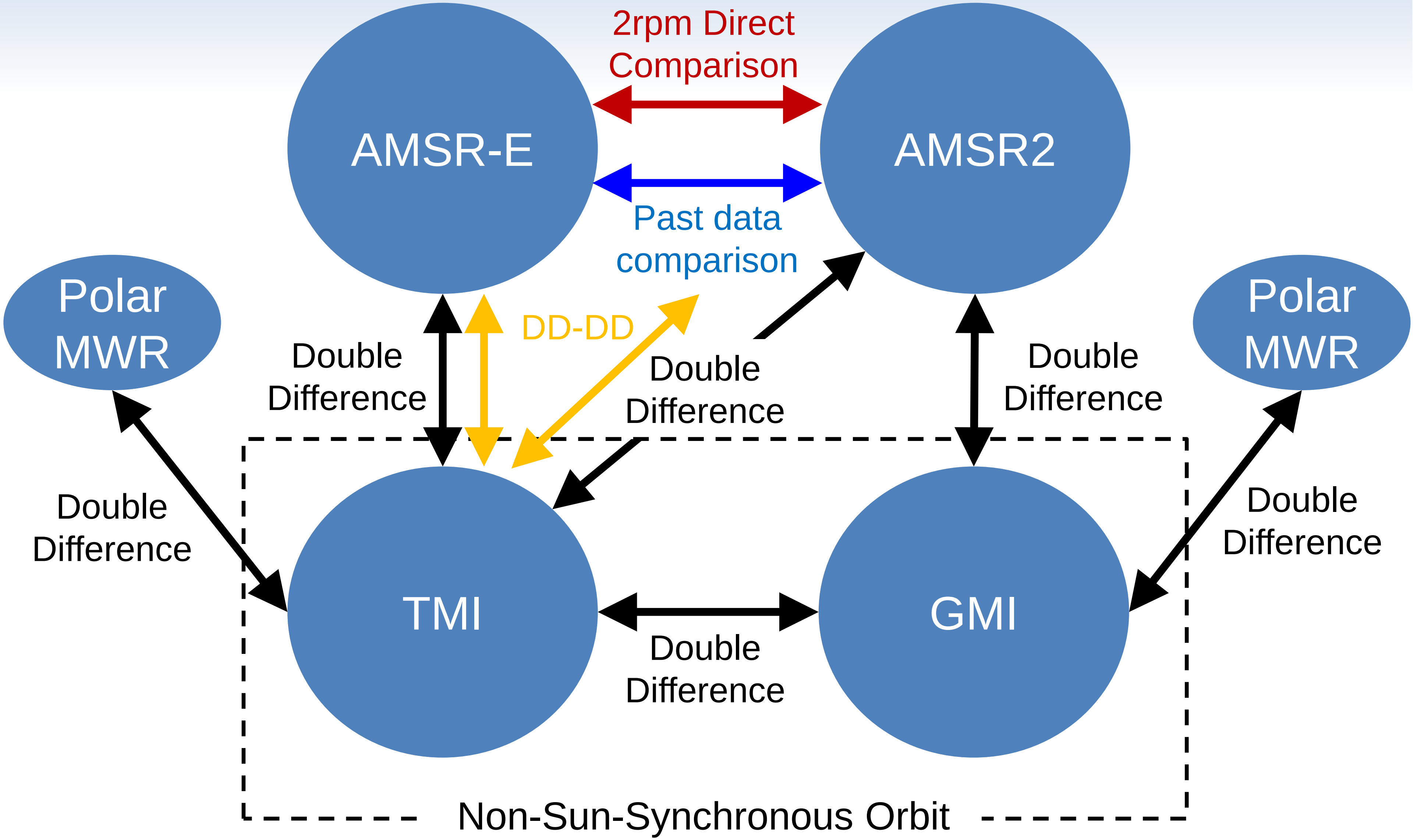
MWR for Intercomparison

	TMI (TRMM)	AMSR-E (Aqua)	AMSR2 (GCOM-W)	GMI (GPM)
Launch Year	**1997**	**2002**	**2012**	**2014**
Sensor appearance				
Channels for Intercalibration	10.65 V/H 19.35 V/H 21.3 V 36.5 V/H 85.5 V/H	10.65 V/H 18.7 V/H 23.8 V 36.5 V/H 89.0 V/H	10.65 V/H 18.7 V/H 23.8 V 36.5 V/H 89.0 V/H	10.65 V/H 18.7 V/H 23.8 V 36.64 V/H 89.0 V/H
Approximate incidence angle [degree]	53.4 * (after boost)	55.0 54.5 for 89B	55.0 54.5 for 89B	52.8
IFOV at 36GHz [km]	16*9	14*8	12*7	16*9

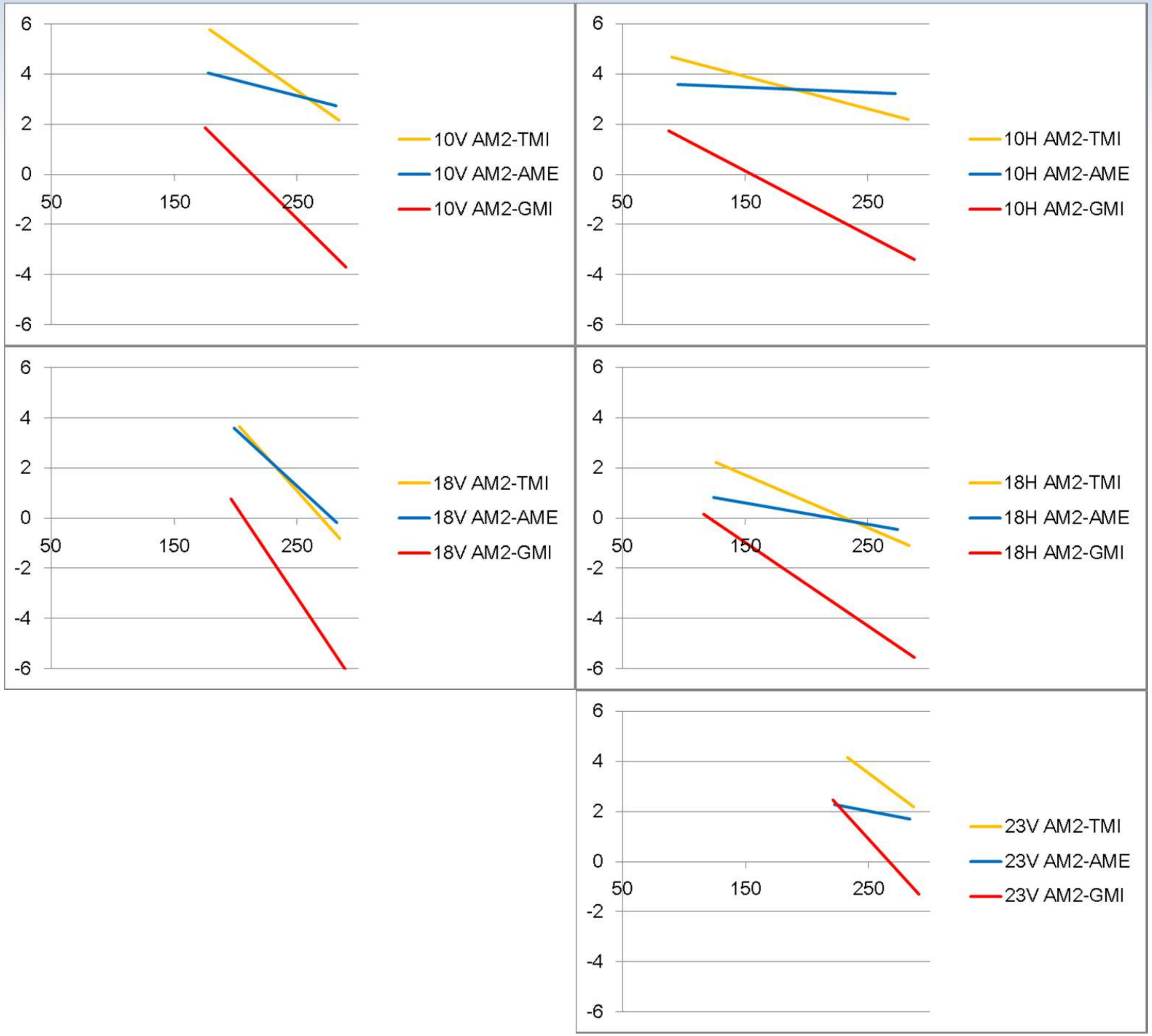
* Recent information on TMI incidence angle through GPM X-CAL team: Incidence angles at 10V, 10H, and 37V are differ from the base value about 0.65, 0.22, and 0.12 degrees, respectively.

Photo of TMI and GMI by NASA

Overview of Intercomparison



Intercomparison Summary



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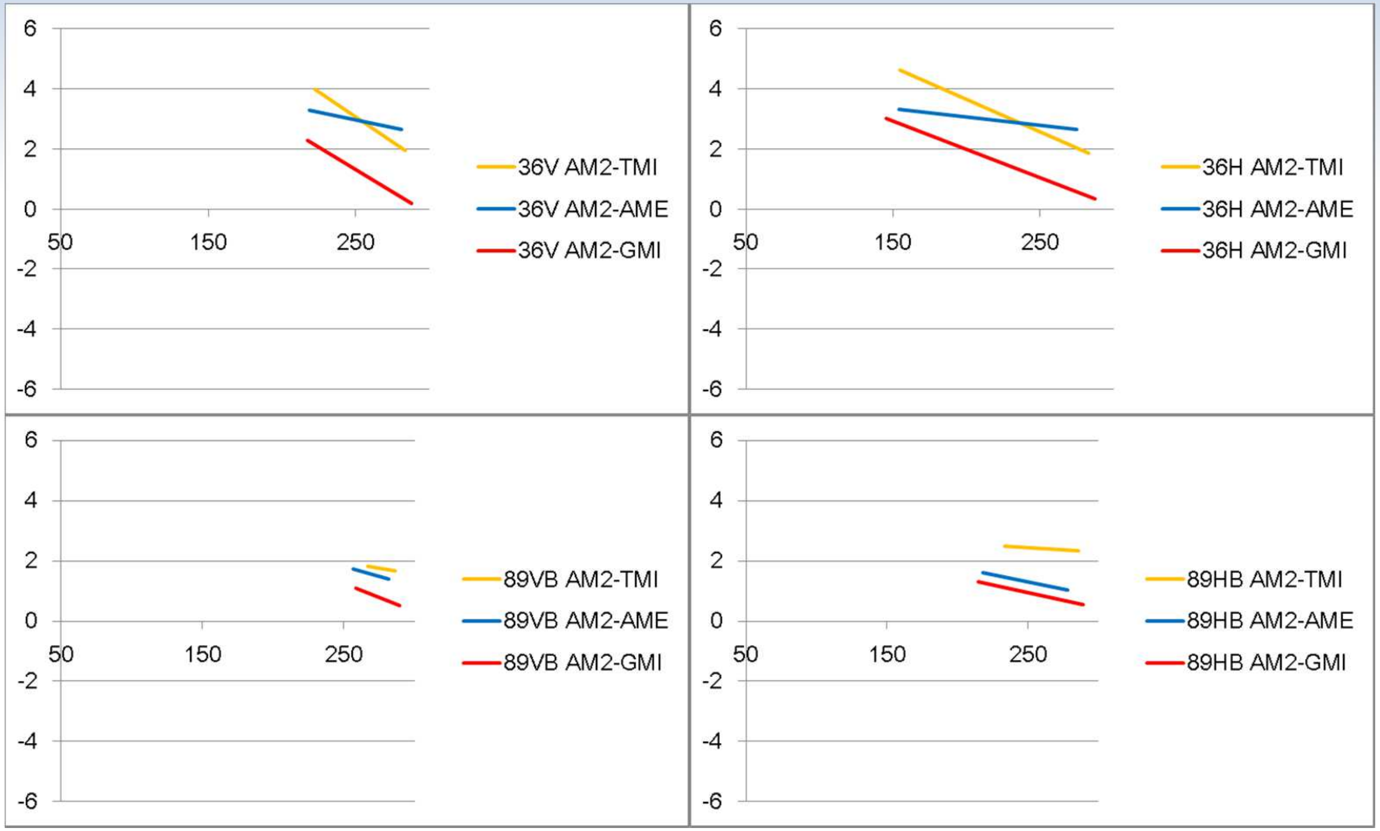

Thank you