Status and Progress of ARGO

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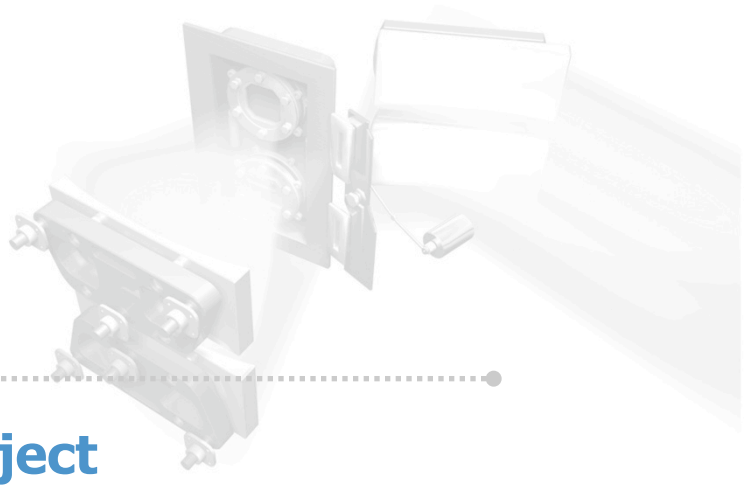
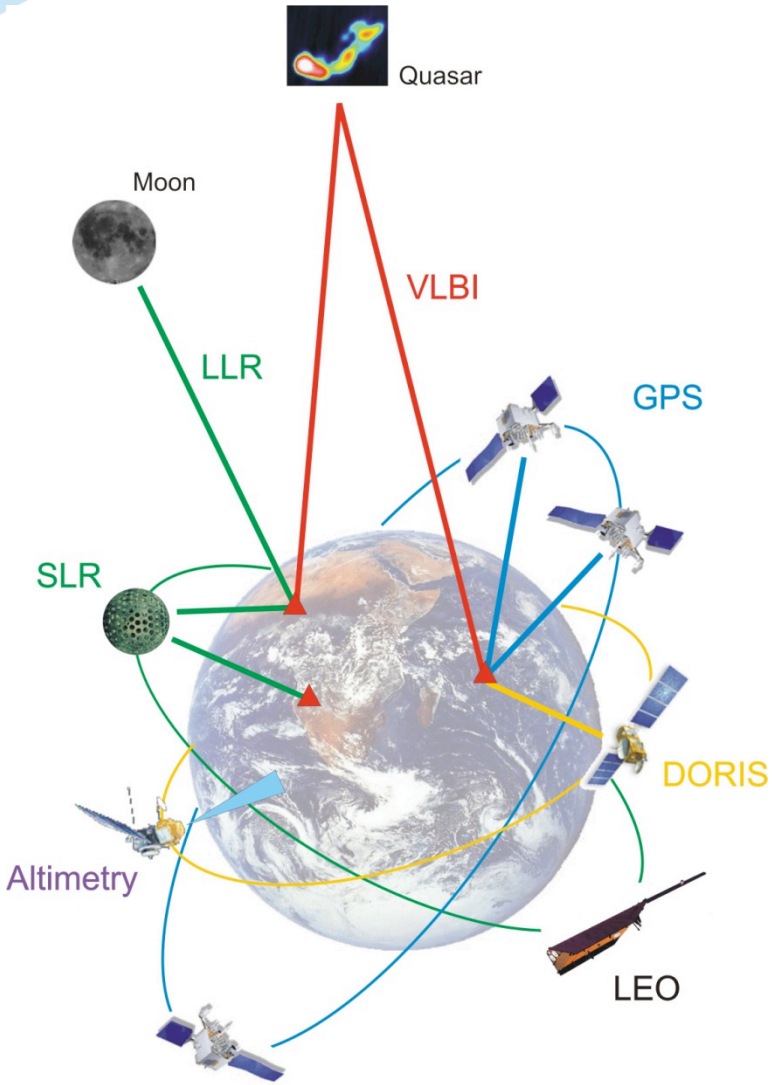
Outline



1. Backgrounds
2. Overview of ARGO Project
3. Requirements of ARGO System
4. Milestone of ARGO Project
5. Summary

Backgrounds

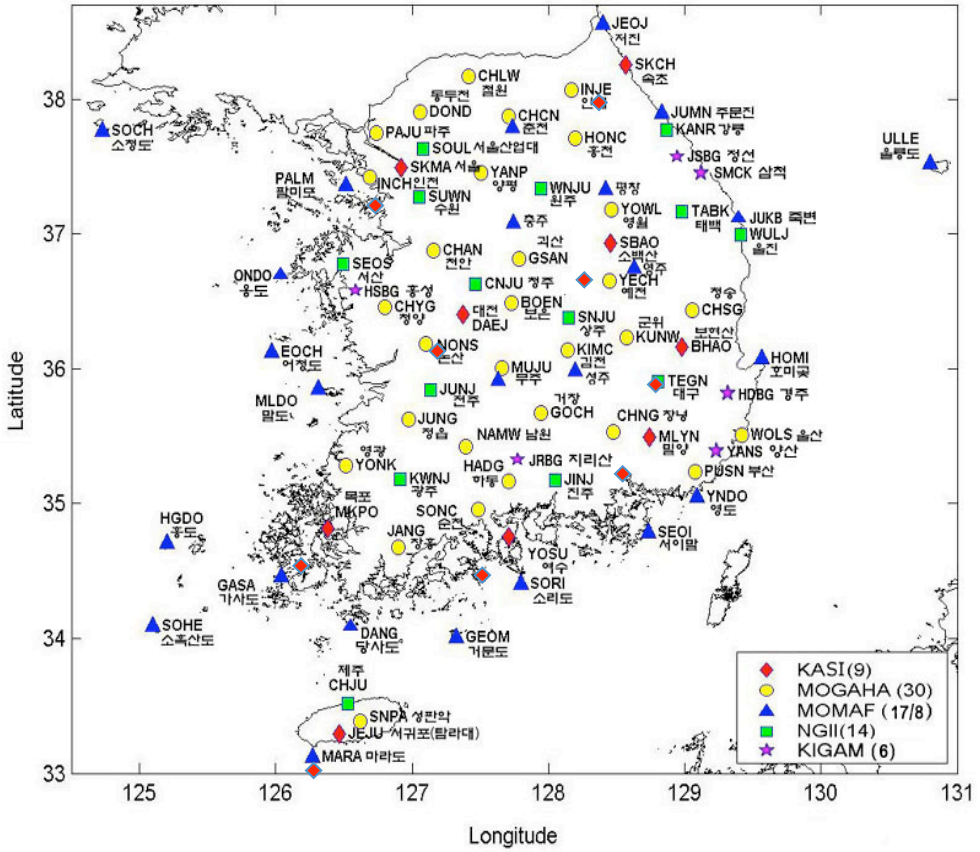


The objective of this presentation is to show the current status and forth coming steps of ARGO project; Kore an new SLR systems.

Space Geodesy in KASI was started from early 90's and now...

- ✓ 9 permanent GPS sites
- ✓ IGS site (DAEJ)
- ✓ IGS Global Data Center
- ✓ 3 VLBIs & Correlation Center
- ✓ Space Mission (KOMPSAT-5)
- ✓ Geodynamics, GNSS meteorology, Gravity, and other applications with very passionate staffs.

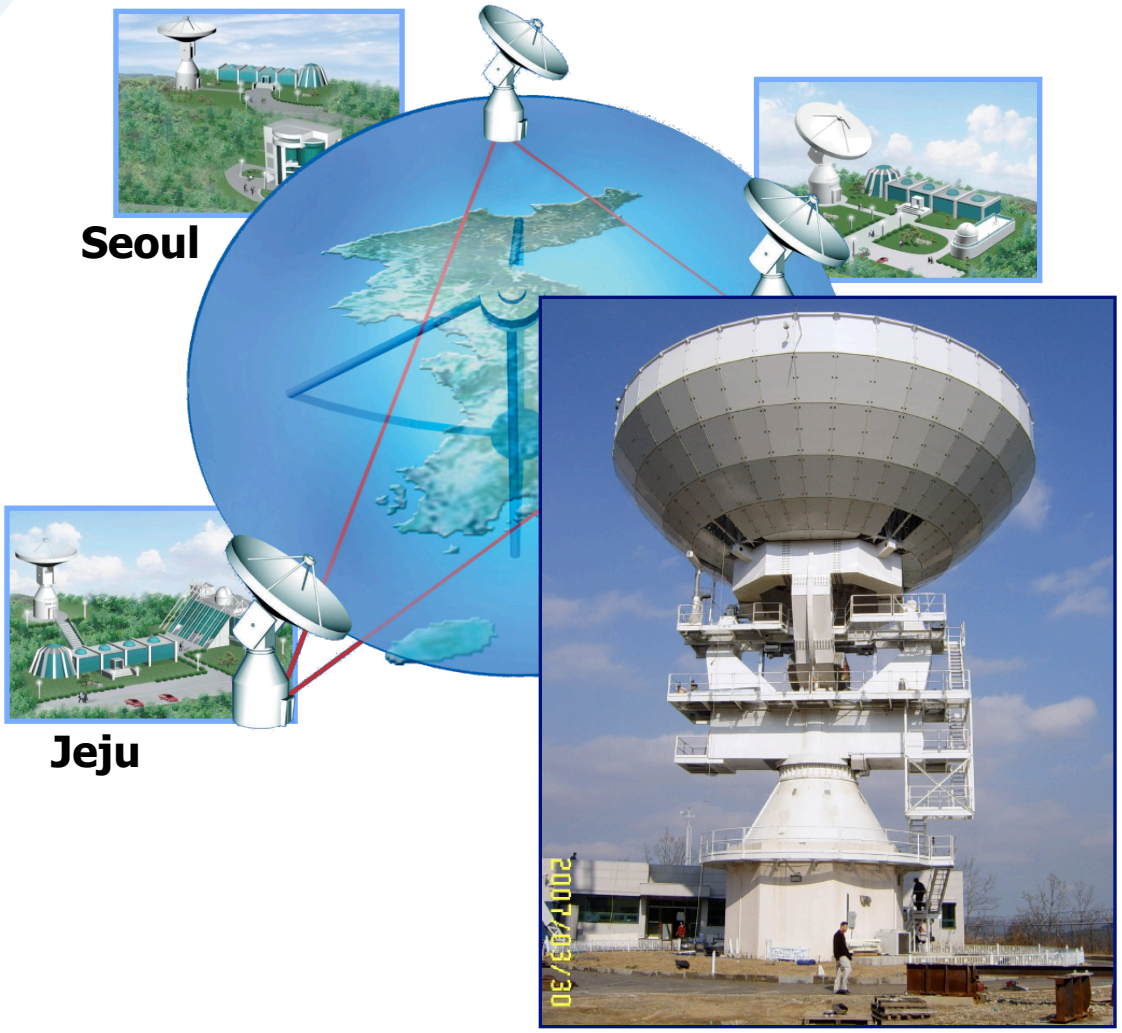
Korean GPS Networks



한국천문연구원 Korea Astronomy and Space Science Institute (KASI)
행정자치부 Ministry of Government Administration and Home Affairs (MOGAHA)
해양수산부 Ministry of Maritime Affairs and Fisheries (MOMAF)
국토지리정보원 National Geographic Information Institute (NGII)
한국지질자원연구원 Korea Institute of Geoscience and Mineral Resources (KIGAM)

- 85 GPS Reference Stations including 2 IGS sites operated by 5 Agencies or Institutes
- Well-distributed, nationwide GPS network with 20~50 Km inter-spacing
- National Reference of Geodetic Coordinate, Mapping, Survey, Cartography, Navigation, ITS, LBS and Space Geodesy
- Modernization plan for next generation GNSS services in near future

Korean VLBI Networks



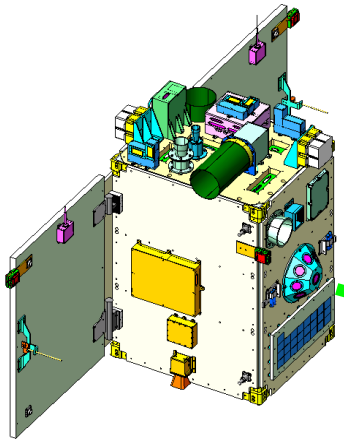
- Three 21m Antennas
- 2001-2008 by KASI
- Astronomy/Geodesy

Main Spec.	
Diameter	21m
Mounting	AZ/EL type
Aperture Efficiency	60%(@100GHz)
Operating Range	AZ :± 270°, EL: 0~90°
Operating Speed	1"/sec ~ 3°/sec
Max. Acceleration	3°/sec²
Pointing Accuracy	4" @ wind 10m/sec
Surface Accuracy	65 ㎛(Manufacturing)
Total Accuracy	150 ㎛ (@wind 10m/s)
Frequency	2/8GHz, 22GHz, 43GHz 86GHz, 129GHz

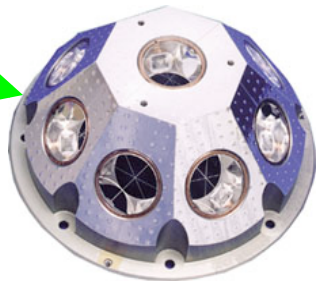
Backgrounds - SLR

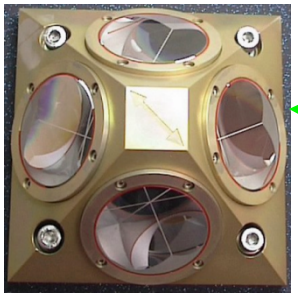
Korean SLR System

- Feasibility Study on Korean SLR system in 2004/2005
- Planning Study on the R&D Project for SLR in 2005/2006
- **Development of Korean SLR Systems from 2008**
  - **40 Cm Mobile (ARGO-M) in 2011 and 1 M Fixed (ARGO-F) in 2013**
- STSAT-2 in 2009 and KOMPSAT-5 in 2010

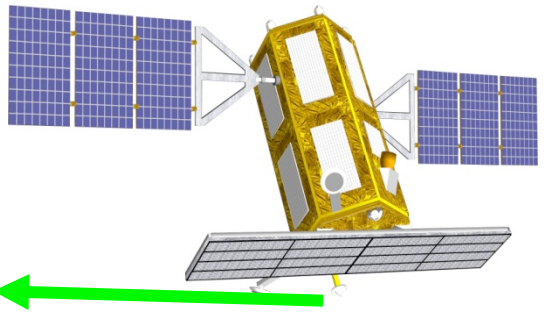


(STSAT-2)



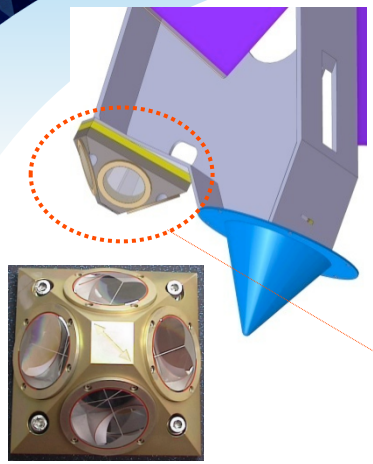


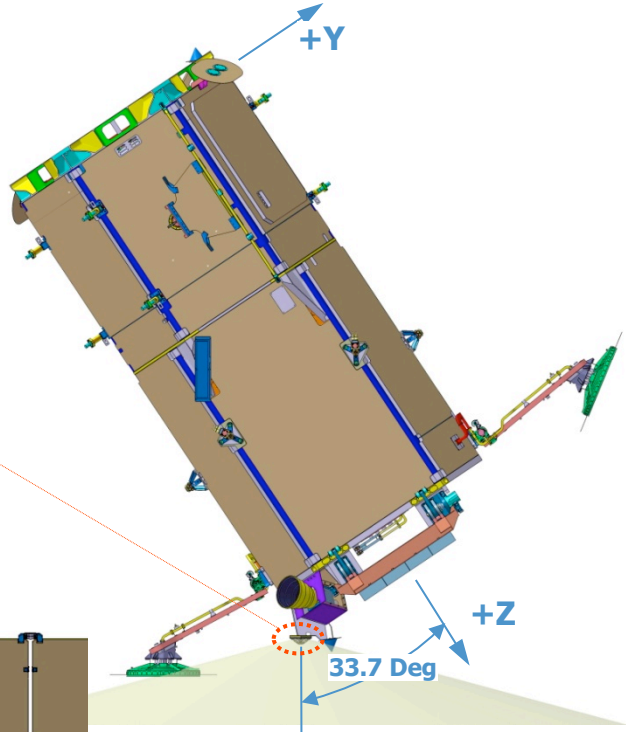
Laser Retro-Reflector Array

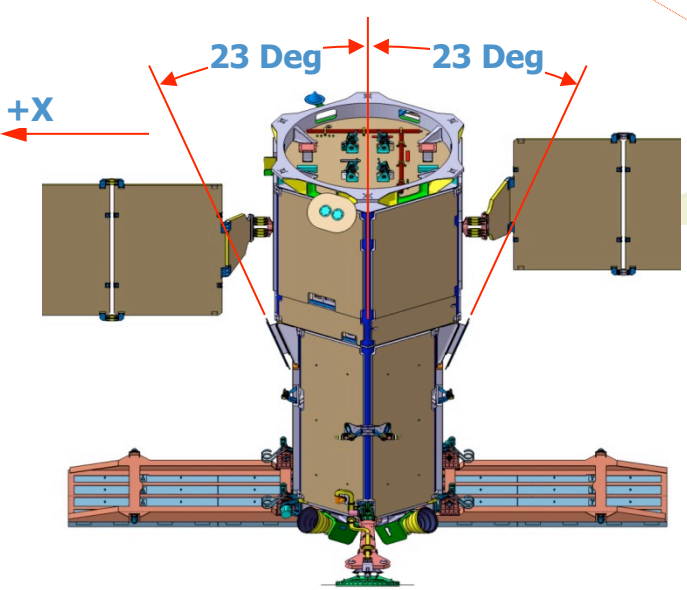


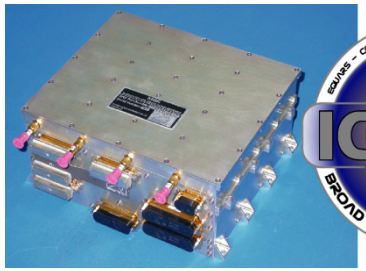
(KOMPSAT-5)

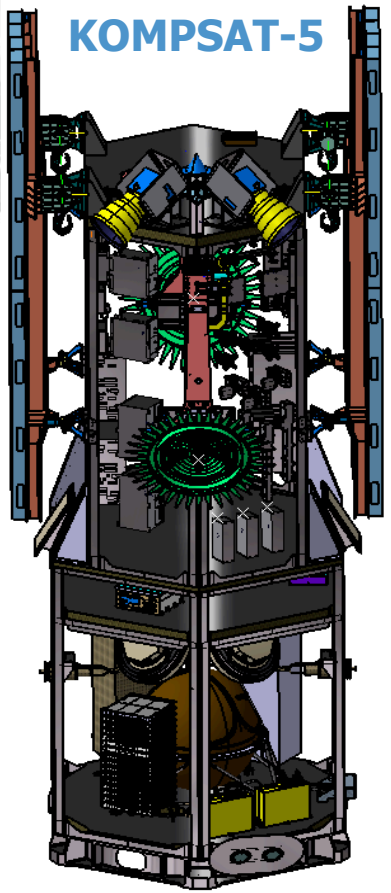
Backgrounds – KOMPSAT 5







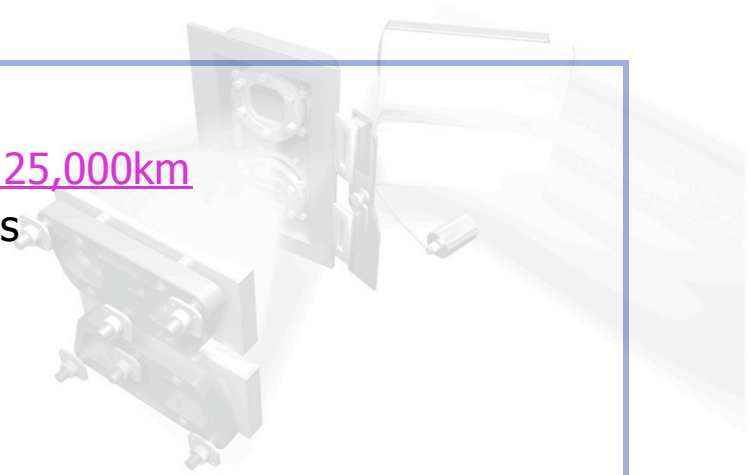




Overview of ARGO Project

- **ARGO**: Accurate Ranging system for Geodetic Observation
  - The Name of Korean SLR program
  - It comes from the ship on which a great group of heroes boarded to find the Golden Fleece in the ancient Greek mythology
  - means also a group of specialists to carry out a great mission
- **Development Phase: 2008 – 2013 (6 years)**
- **Final Goal**
  - One fixed system(1m) and one mobile system(40cm)
- **Team members & Supporters**
  - KASI, KIMM, KAERI, SatRec & Kongju Univ.
  - Advisory Committees, ILRS, … **All of You!!**

Requirements - General

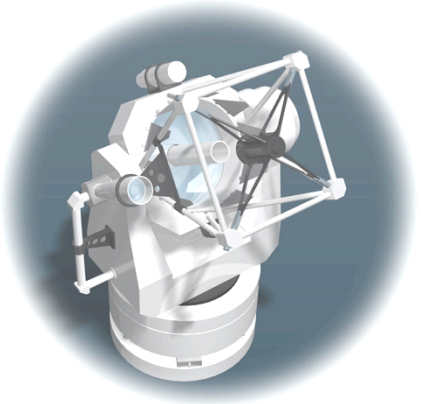


- **Tracking Coverage**
  - Possible to track satellites in the altitude of 25,000km
  - STSAT-2, KOMPSAT-5, GPS, Galileo Satellites
- **Ranging Accuracy**
  - Lageos : 10mm(SS), 2-3mm(NP)
  - GPS and Galileo : 20mm(SS), 3-5mm(NP)
  - Ground Target : 3mm(SS), 1mm(NP)
  - Epoch for NP data within 0.12μs of GPS time
- **Automatic Operation**
  - All system can be controlled from the remote site for the SLR systems
  - Automatic observation according to the schedule and aircraft detection using radar
  - Automated calibration by star camera and ground target
  - Automated scheduling, planning and orbit prediction capability
  - Automated diagnostic warning to network monitor
- **Etc**
  - Daylight tracking
  - Optical tracking for the spacecraft and space launch vehicle (ARGO-F)

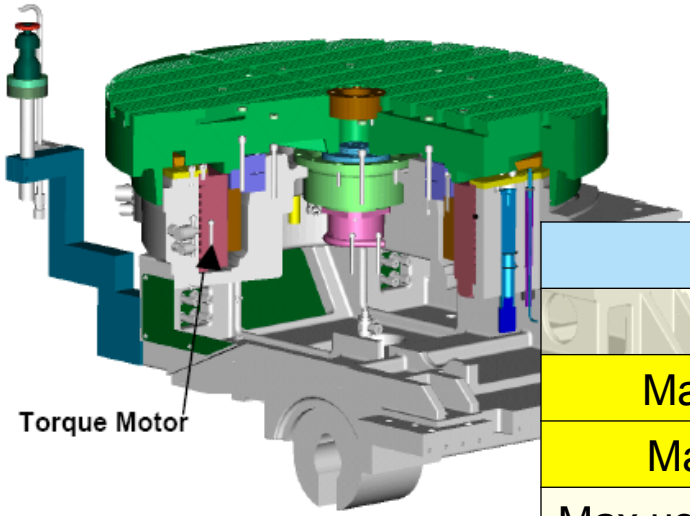
Requirements - Optics

Optics system

Classification		ARGO-M	ARGO-F
Rx Telescope	Type	Cassegrain	Richey-Cretien
	Aperture(cm)	40	100
Tx Telescope	Type	Refractor	Richey-Cretien
	Aperture(cm)	10	100
Generals	M1 F Ratio	1.5	
	FOV	10 arc minutes	50 arc seconds
	Tube Length	975 mm	1425 mm
Materials		Zerodur/CFRP	
Tx.Rx path		Separate	Perforate mirror
Daylight filter		Oven controlled spe ctral filter	Fabry-Perot
Daylight Filter Bandwidth(nm)		0.3	1

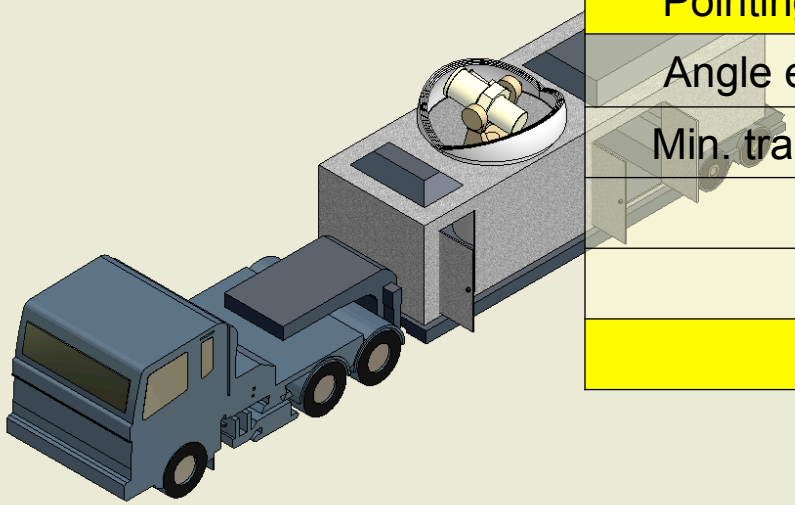


Requirements - Mount



Tracking Mount

Classification	ARGO-M	ARGO-F
Mount Type	EL over AZ	
Max slew rate Az (deg/s)	20	
Max slew rate El (deg/s)	10	
Max used tracking rate Az (deg/s)	>= 5	TBD
Max used tracking rate El (deg/s)	>= 2	TBD
Pointing accuracy (arc sec)	TBD	<= 5
Angle encoder accuracy (“)	<0.1	
Min. tracking elevation (deg)	15	15
Motors	PMSM Torque Motors	
Motor control	Servo control	
Drive type	Direct drive	



Requirements - Laser

Laser system

Classification	ARGO-M	ARGO-F
Laser type	Nd:YAG	Nd:YAG
Primary wavelength (nm)	1064	1064
Primary max. energy (mJ)	Not used for ran ging	Not used for ran ging
Secondary wavelength (nm)	532	532
Secondary max. energy (mJ)	1	20
Xmit energy adjustable	No	Yes
Pulse width(FWHM) (ps)	10	<100
Max. repetition rate (Hz)	1000	20
Fullw. Beam divergence (“)	5-200	7-60
Eye-safe	No	No

by Y.K.Seo 2008-09-04

Requirements - Electronics

Optoelectronics system

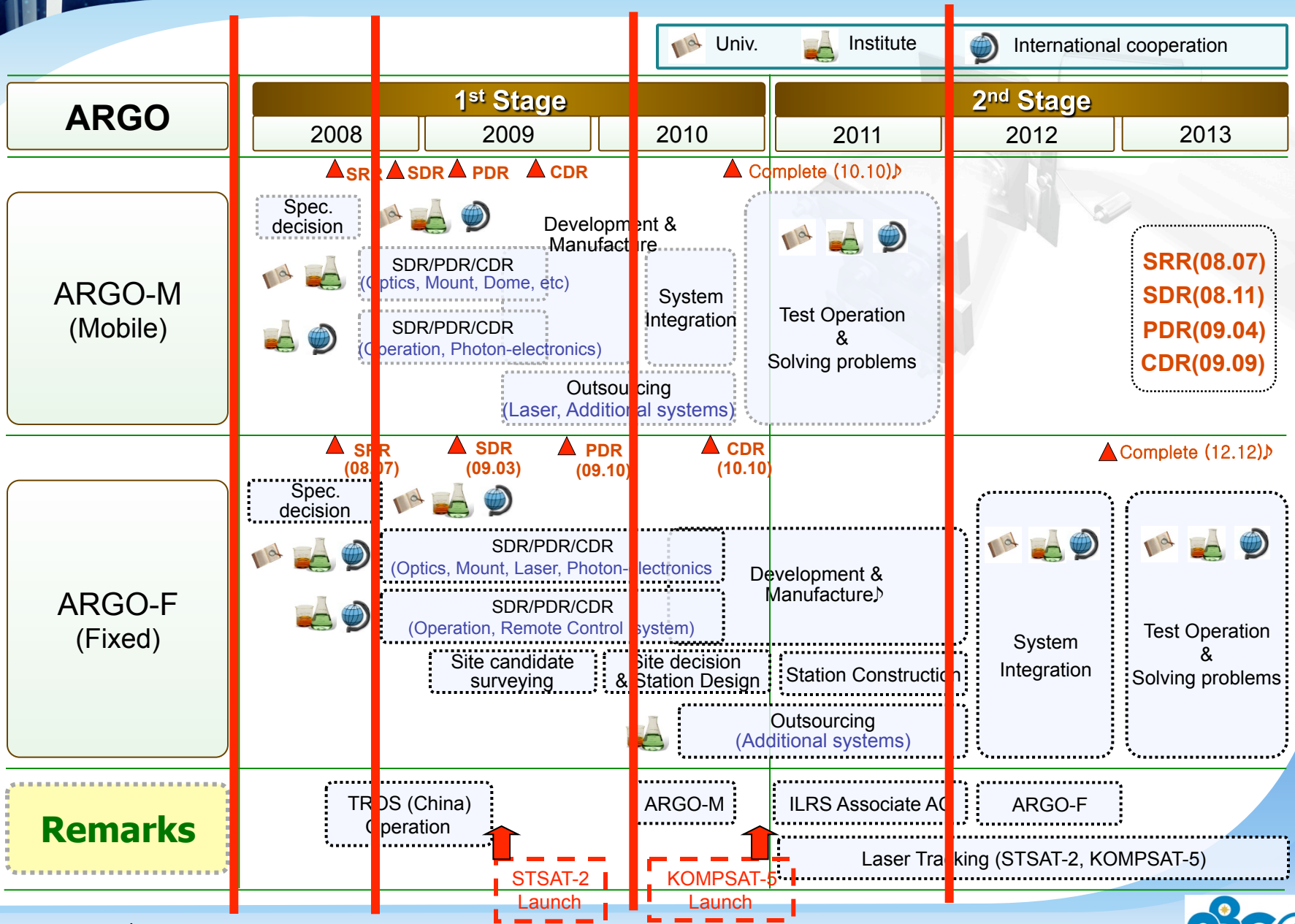
Classification		ARGO-M	ARGO-F
Chain wavelength		532	532
Detector	Type	CSPAD	CSPAD
	FoV (“)	40-60	12
Signal Processing	Type	Time walk com pensated	Time walk internally
	Amplitude measurem ent	N/A	Yes
	Return-rate controlled	Yes	Yes
	Mode of operation	Muti photons	Single to Multi photons
Time of Fligh t Observatio n	Type	Event timer	Event timer
	Resolution (ps)	<1.5	<1.5
	Precision (ps)	<10	<10

Requirements - Operation

Operation and Control system

Classification			ARGO-M	ARGO-F
Tracking Capabilities	Satellites	GPS (21,000km)	Yes	Yes
	Average values for Lageos	Single shot RMS (mm)	8	<10
		# of obs. per NP	~ 12,000	~ 100
	Range gate width (ns)		200	200-5,200
	Beam pointing accuracy(“)		5	2
	Operation	Secondary Mission	Nothing	Optical tracking
		Remotely controllable	Yes	Yes
Calibration	Calibration type/location		Pre+Post / External	Pre+Post / External
	Mode of operation		Few photons	Single to multi
	Single shot RMS (mm)		<3	<3
Frequency Standard	Type		Crystal oscillator	Crystal oscillator
	Epoch accuracy (ns)		<100	<100
Preprocessing information	On-site NP generation		Yes	Yes
	Upload interval		Daily	Daily
Aircraft detection			Radar + ATC data	Radar + ATC data

Milestone of ARGO Development



Summary

1 ARGO System

- ARGO, the name of forthcoming Korean SLR Systems, officially started from Jan. 1st, 2008 to build a 40 cm mobile SLR system and 1 meter fixed SLR system.
- The lightweight telescopes, a KHz laser, remote control and fully automation concept are introduced for ARGO-M & ARGO-F.
- ARGO will be the member of ILRS sites in 2012 and 2014, respectively

2 Related Missions

- Space Programs equipped with LRRA
  - ✓ STSAT-2 in 2009 & KOMPSAT-5 in 2010
- Planned fundamental Station in Korea
- Korean 2th science complex in Antarctic
- ILN Program & Lunar Exploration 2020 Project

Thank you !!!

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