Technical Aspects and Progress of Korean 1m Satellite Laser Ranging System(ARGO-F)

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Abstract

The Korea Astronomy and Space Science Institute(KASI) plans to built a Fixed Satellite Laser Ranging system(Accurate Ranging system for Geodetic Observation-Fixed, ARGO-F) with the functions of satellite laser ranging and satellite imaging for space geodesy research and space situational awareness and so on. This system is being developed jointly by Electro Optic Systems(EOS) in Australia from 2013. ARGO-F is capable of tracking satellites in the range of 300km and 36,000km altitude and 24 hours tracking coverage including daylight tracking. And ARGO-F consists of optical tube assembly including the 100cm diameter of primary mirror, Transmitting & Receiving optical system, tracking mount, laser system, opto-electronic system, adaptive optics, operation system, weather system and aircraft surveillance radar. This system shall be installed in an observatory, which is located in Mt. Gamak, and a remote control center, which is located in KASI headquarter. KASI performed Preliminary Design Review(July 2014), Critical Design Review(Dec. 2014), and Factory Acceptance Test(Dec. 2015). The current status of ARGO-F is almost completed on the sub-systems and KASI is going to implement the system integration and Site Acceptance Test from May 2017. In this paper, the technical aspects and future plans including the characteristics and specifications are discussed for Korean 1m Satellite Laser Ranging system.

Overview of ARGO Project

❑ ARGO : **A**ccurate **R**anging system for **G**eodetic **O**bservation

❑ Final Goal
- One mobile system(40cm / 10cm) : ARGO-M
- One fixed system(1m) : ARGO-F

Fig.1. ARGO-M in Sejong City

❑ Objectives
- Space geodesy research / Precise Orbit Determination
- GEOSS/GGOS contribution by laser ranging for satellites with LRA
- Contribution to international SLR societies and ILRS network participation

Tab. 1. Comparisons between ARGO-M & ARGO-F

Item	Parameter	ARGO-M	ARGO-F
Telescope	Optical path	Bi-static	Common Coude
	Rx and Tx telescope	40/10 cm	100 cm
	Max slew rate	20 deg/sec (Az) 10 deg/sec (El)	30 deg/sec (Az) 15 deg/sec (El)
	Tracking & Pointing accuracy	< 5 arcsec	< 1 arcsec
Detector	Type	C-SPAD	C-SPAD
	Quantum efficiency	20 %	20 %
Laser	Wavelength	532 nm	532 nm
	Pulse energy or Power	5 W	1W (SLR) 25 W → 200W (DLT)
	Pulse width	50 ps	20 ps (SLR) 5 ns (DLT)
	Repetition rate of Operation	5 kHz	60 Hz (SLR) 10 Hz (DLT)
	Beam diameter @ Tx telescope	10 cm	90 cm
Etc	Timing system	Event timer	Event Timer
	Aircraft detection type	Radar	Radar

Major Characteristics of ARGO-F

❑ Status and Plan
- Status : PDR(Jul. 2014), CDR(Dec.2014), Factory Acceptance Test(Dec. 2015)
- Plan : Site Acceptance Test(May 2017), Test Operation(~ Aug. 2017)

❑ Tracking Capability
- Capable of tracking satellites between 300km and 36,000km altitude
- Daytime and nighttime tracking
- 60Hz laser ranging for satellites and 10Hz laser ranging for space debris
- Satellite imaging using Adaptive Optics

❑ Ranging Accuracy
- LAGEOS : <10mm(SS) / <3mm(NP)
- Ground Calibration : <5mm(SS)

❑ Operational Functions
- Fully automatic operation
- Automatic ranging based on schedule and aircraft detection using RADAR

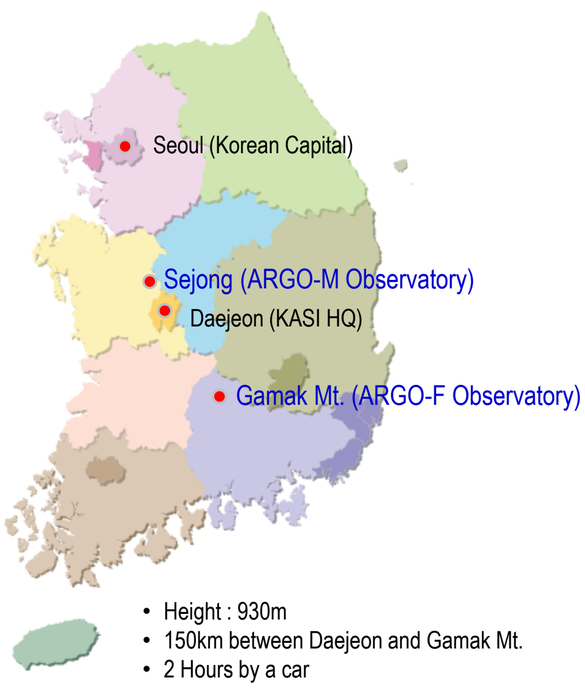


Fig. 2. Location of SLR Observatories in KOREA

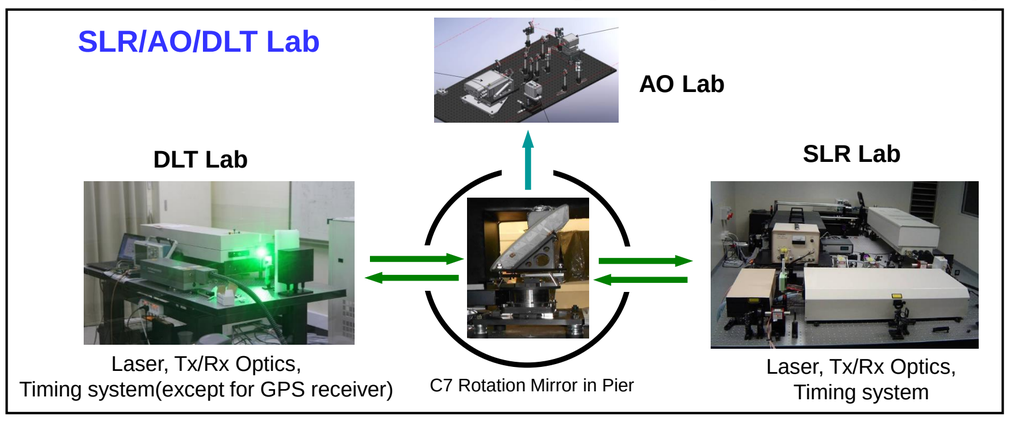
Fig. 3. ARGO-M Observatory

Fig. 4. ARGO-F Observatory(Under Construction)

System Configurations of ARGO-F

❑ System Configurations of ARGO-F
- Consist of three parts : SLR / DLT(Debris Laser Tracking) / AO(Adaptive Optics)
- EOS : SLR system(Optical Tube Assembly, Laser, Operation System, Timing System, Tx/Rx Optics) and AO
- KASI : Tracking Mount, Dome, Facilities, Radar, Operation System and DLT

Using one OTA, gimbal and operation system



Electric Room

Operation Room

Fig. 5. ARGO-F System Configuration for SLR and DLT

❑ Tracking Mount.

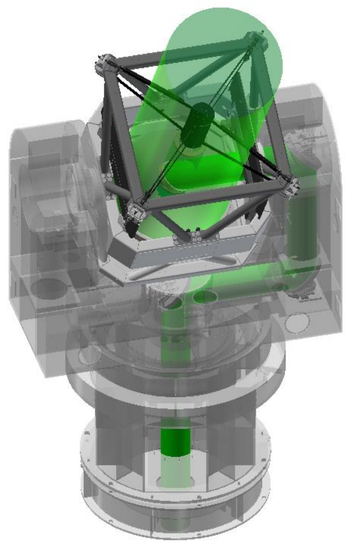


Fig. 6. Tracking Mount for ARGO-F

Tab. 2. Specification of Tracing Mount for ARGO-F

Item		Spec.
Azimuth	Working range	± 335。
	Slew rate	≥ 30。/ s
	Acceleration	≥ 10。/s²
	Motor torque(Avg/Max)	980/3900 Nm
Elevation	Working range	-5 ~ 185。
	Slew rate	≥ 15。/s
	Acceleration	≥ 5。/s²
	Motor torque(Avg/Max)	180/720 Nm
Pointing/Tracking accuracy		≤1 arcsec

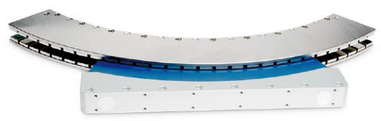


Fig. 7. ARC motor in Tracking Mount for ARGO-F

❑ Laser System.

Tab. 3. Laser Specification for SLR & DLT

SLR	Item	DLT
60 Hz	Repetition rate	10 Hz
≤20 ps	Pulse width	≤5 ns
15 mJ (nominal) 20 mJ (maximum)	Pulse energy	2.5 J
≤±2.5 %	Energy stability	≤±3.0 %
10 mm	Beam diameter (1/e²)	12 mm
≤0.75 mR	Beam divergence	≤0.45 mR
≤0.25 mR	Beam pointing stability	≤0.03 mR
EOS	Manufacturer	Continuum

Summary and Future works

- Summary
  - ARGO-F is being developed jointly by EOS in Australia from 2013
  - ARGO-F is consist of three parts ; Satellite Laser Ranging, Debris Laser Tracking, Adaptive Optics
  - KASI has been working to develop Tracking Mount, Dome, Observatory Facility, Radar etc.
- Future Works
  - KASI is going to implement the system integration and Site Acceptance Test from May 2017
  - KASI will conduct more test for performance and function of ARGO-F
  - ARGO-F is going to play a role as a SLR, DLT and Space Situation Awareness