

## Status and Progress of ARGO

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### Abstract

*Over the last few years, Korea Astronomy and Space Science Institute had prepared for introducing the SLR system in Korea. Even though we spent a lot of time to overcome the many barriers just same as other projects, we could finally start the ARGO project to make the series of SLR from this year. ARGO, new SLR systems of Korea, stands for the Accurate Ranging system for Geodetic Observation and this was the name of ship on which Jason and Argonauts voyaged to retrieve the Golden Fleece in Greek mythology. The goal of ARGO project is to make two SLR systems, one is a 40 centimeter mobile SLR system and another one is an 1 meter fixed SLR system, and to start the operation from the year 2011 and 2013 respectively. The participants of ARGO project are involved in five working groups related with the components of SLR system, for example Electro-Optics, to work more specifically. Due to their efforts including the visiting to several SLR sites in abroad, we could determined the more detailed requirements and scheduling for ARGO system. In this paper, we will give the current status and future plan of ARGO project with the context of requirements and scheduling of ARGO.*

### Introduction

ARGO means Korean SLR system and stands for 'Accurate Ranging system for Geodetic Observation', which comes from the ship on which a great group of heroes boarded to find the Golden Fleece in the ancient Greek mythology. The final goal of ARGO program is to develop two SLR systems for 7 years from 2008 to 2014, one 40cm mobile system(ARGO-M) and one 1m fixed system(ARGO-F). The objectives of ARGO program can be categorized into three items; i) space geodesy research and GEOSS/GGOS contribution by laser ranging for satellites with LRA, ii) precise orbit determination(POD) through laser ranging measurement with mm level accuracy, iii) contribution to international SLR societies and ILRS network participation. ARGO will be developed with the cooperation of foreign institutes and under supports of international advisory committee and domestic advisory committee which consist of ten experts, respectively. As shown in Figure 1, ARGO-M will be completed by 2011 and then ARGO-F by 2014. Two Korean satellites with LRA, STSAT-2 and KOMPSAT-5 will be launched in 2009 and 2010, respectively. So, ARGO-M and ARGO-F will be used for laser tracking of these two Korean satellites.

System requirements of ARGO-M was generated by five working groups in September 2008, optics subsystem, opto-electronics subsystem, laser subsystem, tracking mount subsystem and ARGO operation system. Until now, system configuration and conceptual design of ARGO-M were made and its detailed specifications were also generated. Major characteristics of ARGO-M are following:

- **Tracking Capability**
  - Possible to track satellites between 300km and 25,000km altitude
    - STSAT-2(300x1,500km), KOMPSAT-5, GPS, Galileo
  - KHz laser ranging
  - Daylight and night tracking
- **Ranging Accuracy**
  - Lageos : 10mm(SS), 5mm(NP)
  - Ground Target : 3mm(SS), 1mm(NP)
- **Operational Functions**
  - All subsystems can be controlled from the remote site
  - Automated scheduling, planning and orbit prediction capability
  - Automatic ranging according to the schedule and aircraft detection
  - Automated diagnostic warning to monitoring system

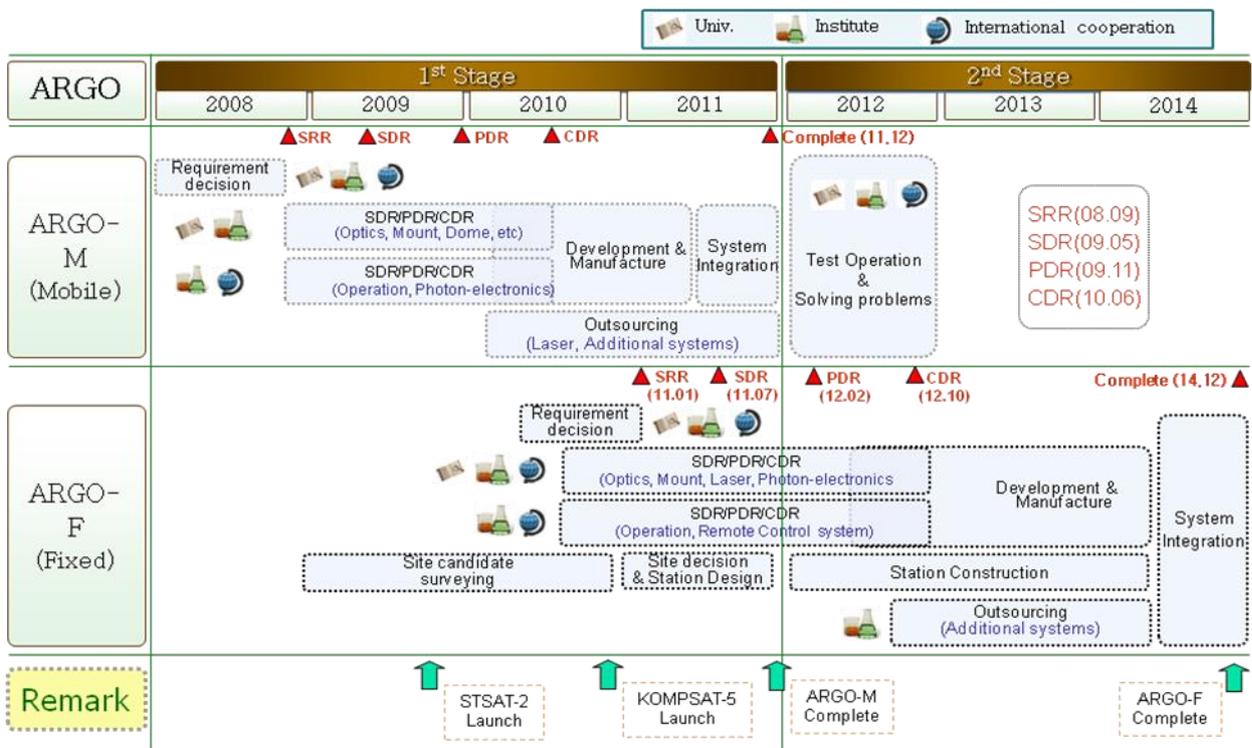


Figure 1. Milestone of ARGO program

**Overview of ARGO system**

The optical path of ARGO-M is separate type but ARGO-F is common type for both optical tracking and laser tracking of space debris. In addition ARGO-F has larger laser energy than ARGO-M because it is not capable of KHz laser ranging. Some important characteristics of ARGO system is summarized in Table 1.

As for ARGO-M, many requirements and specifications are determined. It has satellite tracking camera to get an image of laser scattering from satellites and aircraft detection camera to detect aircrafts besides radar system. It has also the beam divergence optics and the

tilt mirror for both satellite acquisition and tracking. For low earth orbiting satellites, fast event timer will be installed within FPGA board and digital RGG will be also used instead of programmable delay chip. FPGA board will perform the function of laser pulse shift to prevent the overlap of transmitting and receiving beam. Laser system will be introduced from foreign company because it is required to be very stable for KHz laser ranging, whose status will be monitored from a remote site. The tracking mount is designed such that it can support the maximum payload of 300kg, whose maximum slew rates are 20deg/sec for azimuth and 10 deg/sec for elevation. Pointing and tracking accuracy are required to be under 5arcsec. The requirements and specification of operation system are following:

- Ground calibration for the computation of system delay
  - Calibration type : external within dome
- Available for both local and remote operation
- Control subsystems through the monitoring of subsystems
- Generation of tracking schedule considering sunlight direction, satellite priority and satellite elevation angle(>20deg)
- Generation of FR(full rate) data and NP(normal point) data
- System safety from monitoring of the sun, aircraft and weather
  - Surveillance range of radar < 40km for airplanes, hang gliders and paragliders
  - Weather sensor : temperature, pressure, humidity, rain, wind speed and direction
  - All sky monitoring system with Infrared camera(TBD)
- Station surveillance system to monitor SLR station and its surroundings

**Table 1.** Configuration of ARGO-M and ARGO-F

Item	ARGO-M	ARGO-F
Tx/Rx Path	Separate	Common
Aperture of Receiving Telescope	40cm	100cm
Aperture of Transmitter	10cm(TBD)	100cm
Mount and Pointing Accuracy	Al/Az, 5arcsec	Al/Az, <5arcsec
Pulse Energy (532 nm)	0.4mJ	20mJ
Pulse Width	10ps	<100ps
Repetition Rate	2KHz	20Hz
Receiver Type	C-SPAD	C-SPAD
Time Interval Unit	Event Timer	Event Timer
Ranging Accuracy	5mm (NP), 10mm (SS)	3mm (NP), 10mm(SS)

## Summary

ARGO is 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, remote control and fully automation concept are introduced for the development

of ARGO-M and ARGO-F. ARGO will be the member of ILRS sites in 2012 and 2014, respectively. Additionally, Korea has a plan to build the fundamental station because Korea has operated about 80 GPS stations and 3 VLBI systems.