Technical Aspects and Progress of Korean SLR System

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Outline

Overview of Korean SLR Project

- **ARGO**
  - Name of Korean SLR project
  - **A**ccurate **R**anging system for **G**eodetic **O**bservation
- **Development Period**
  - 2008 - 2016 (9 years)
- **Final Goal**
  - One mobile system(40cm/10cm) : ARGO-M (2008 ~ 2013)
  - One fixed system(1m) : ARGO-F (2013 ~ 2016)

- **Objectives**
  - Space geodesy research and GEOSS/GGOS contribution by laser ranging for satellites with LRA
  - Precise obit determination(POD) through laser ranging measurement with mm level accuracy
  - Contribution to international SLR societies and ILRS network participation

Milestone of ARGO Project

- **Mobile SLR System (ARGO-M)**
  - Development History
    - Development was completed : Oct. 2012
    - Participation in ILRS network : Nov. 2012
      - ✓ Station name : Daedeok
    - Test operation in KASI HQ : Nov. 2012 – Sep. 2013
    - Date uploading to ILRS DC : 29th Oct. 2013
  - Status and Plan
    - Temporal normal operation in KASI HQ : Oct. 2013 – Oc. 2014
    - Moving to Sejong site : December 2014
    - Permanent normal operation in Sejong site : Jan. 2015

- **Fixed SLR System (ARGO-F)**
  - Status and Plan
    - System requirements and specification : July 2013
    - PDR(July 2014), CDR(Jan. 2015), FAT(Nov. 2015), SAT(March 2016)
    - Permanent normal operation in Gamak Mt. : April 2016
  - Development Strategy : Joint development with foreign institute

Major Characteristics of ARGO-M

- **Tracking Capability**
  - Capable of tracking satellites between 300km and 25,000km altitude
    - STSAT-2(300x1,500km), KOMPSAT-5, GPS, Galileo
  - Daytime and nighttime tracking
  - 2KHz laser ranging

- **Target Ranging Accuracy**
  - Lageos : <10mm(SS), <5mm(NP)
  - Ground Target : <5mm(SS)
- **Operational Functions**
  - Controlled from the remote site
  - Automated scheduling, planning and orbit prediction capability
  - Automatic ranging based on schedule and aircraft detection(using radar)
- **Future Plan**
  - Upgrading to 10KHz laser ranging (Oct. 2014)
  - Developed RG generator by KASI

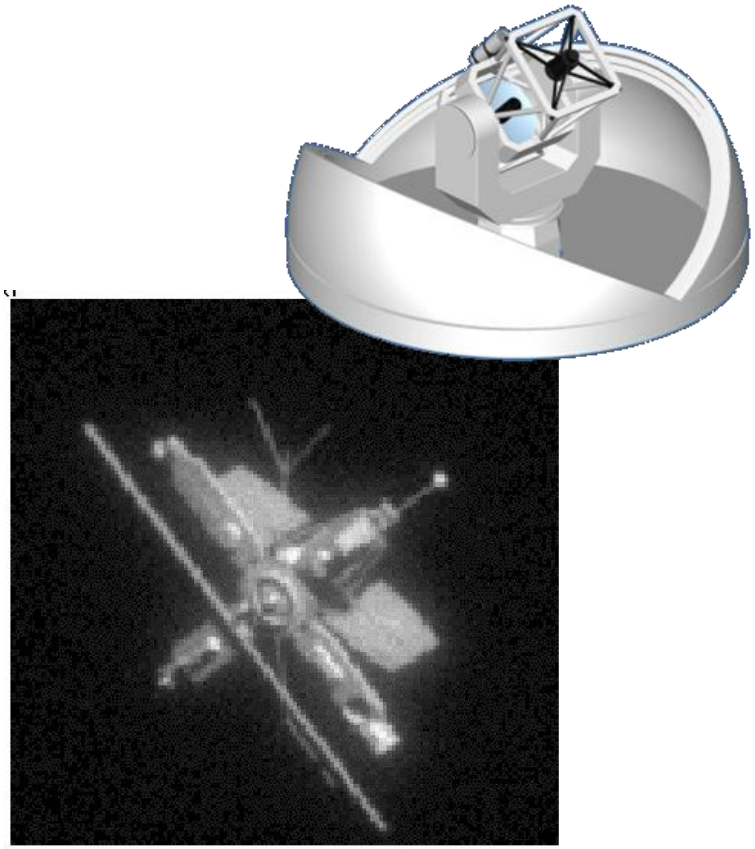
Major Characteristics of ARGO-F

- **Tracking Capability**
  - Capable of tracking satellites between 300km and 36,000km altitude
    - STSAT-2(300x1,500km), KOMPSAT-5, GPS, GEO satellites
  - Daytime and nighttime tracking
  - **Satellite imaging using adaptive optics**

- **Target Ranging Accuracy**
  - Lageos : <10mm(SS), <3mm(NP)
  - Ground Target : <5mm(SS)

- **Operational Functions**
  - Fully automatic remote operation

- **Future Plan**
  - Space debris laser ranging (Dec. 2017)
  - High power laser + Adaptive optics



Comparisons between ARGO-M and ARGO-F

Item	Parameter	ARGO-M	ARGO-F
Telescope	Optical path	Bistatic	Common Coude
	Rx and Tx telescope	40/10 cm	> 100 cm
	Primary mirror F-ratio	1.5	-
	Transmit beam divergence	5 ~ 200 arcsec	-
	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	MCP-PMT or C-SPAD
	Quantum efficiency	20%	-
Laser	Wavelength	532 nm	532 nm
	Pulse energy or Power	2.5mJ @2 kHz	> 1W
	Pulse width	50 ps	< 20 ps
	Repetition rate of Operation	2 kHz	-
	Beam diameter @ Tx telescope	7.5 cm	> 50 cm
Etc	Timing system	Event timer	Event Timer
	Aircraft detection type	Radar	Radar

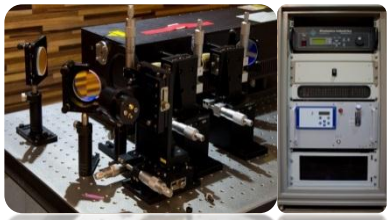
Configuration of ARGO-M

Telescope/Mount

Operation System

Radar

Ground Target



Laser

Electronics

External Image of ARGO-M

Test site at KASI HQ

Internal Structure of ARGO-M

Laser room

- Tracking mount
- Laser
- Optical table
- Ground target pillar

Operation room

- Electronics : Event timer, GPS and etc
- Tracking mount servo system
- Operation system
- Radar controller(LCU)
- Firewall and network system

Accessory room

- UPS
- Power distribution unit
- Surge protection device

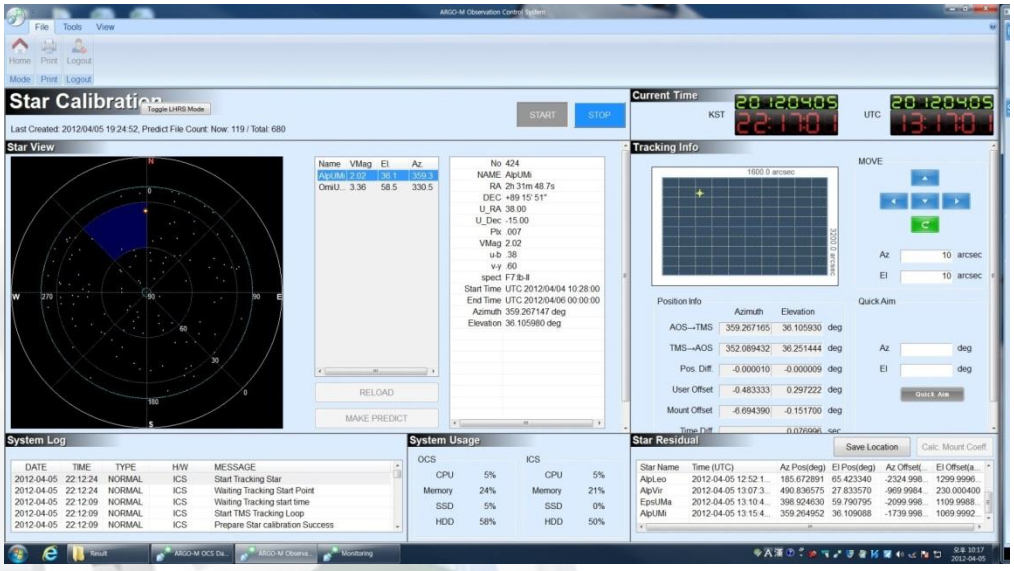
Star Calibration Results of ARGO-M

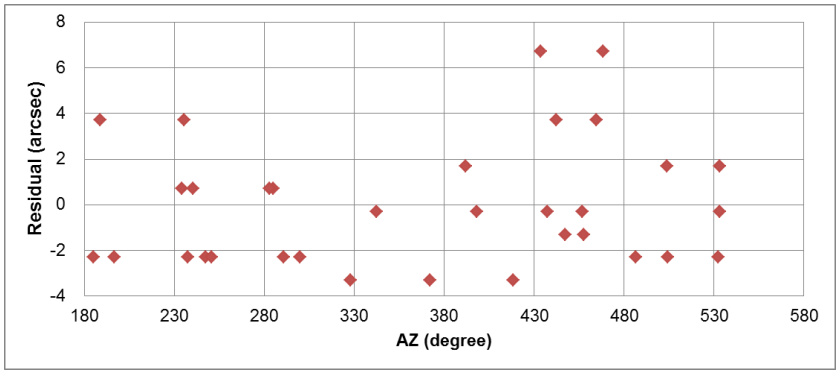
- Mount model : 7-parameter model

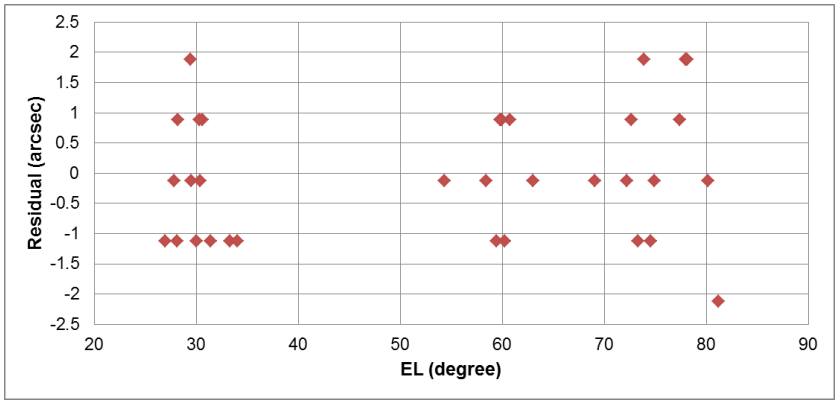
  Delta A = C0 +C3*tanE + C4*secE + C5*coaA*tanE + C6*sinA*tanE

  Delta E = C1 + C2*cosE − C5*sinA + C6*cosA

- Pointing accuracy (RMS)
  - 2.8 arcsec (Az), 1.1 arcsec(El)
  - Requirement accuracy : < 5 arcsec

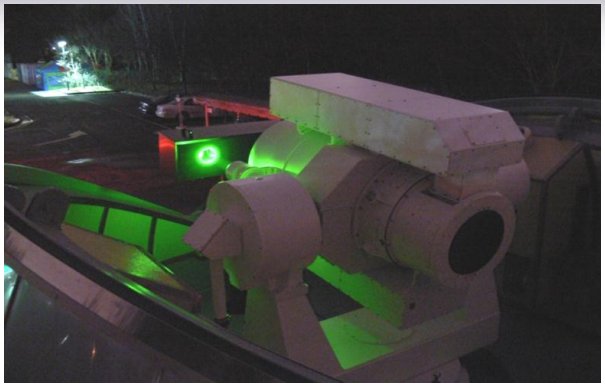


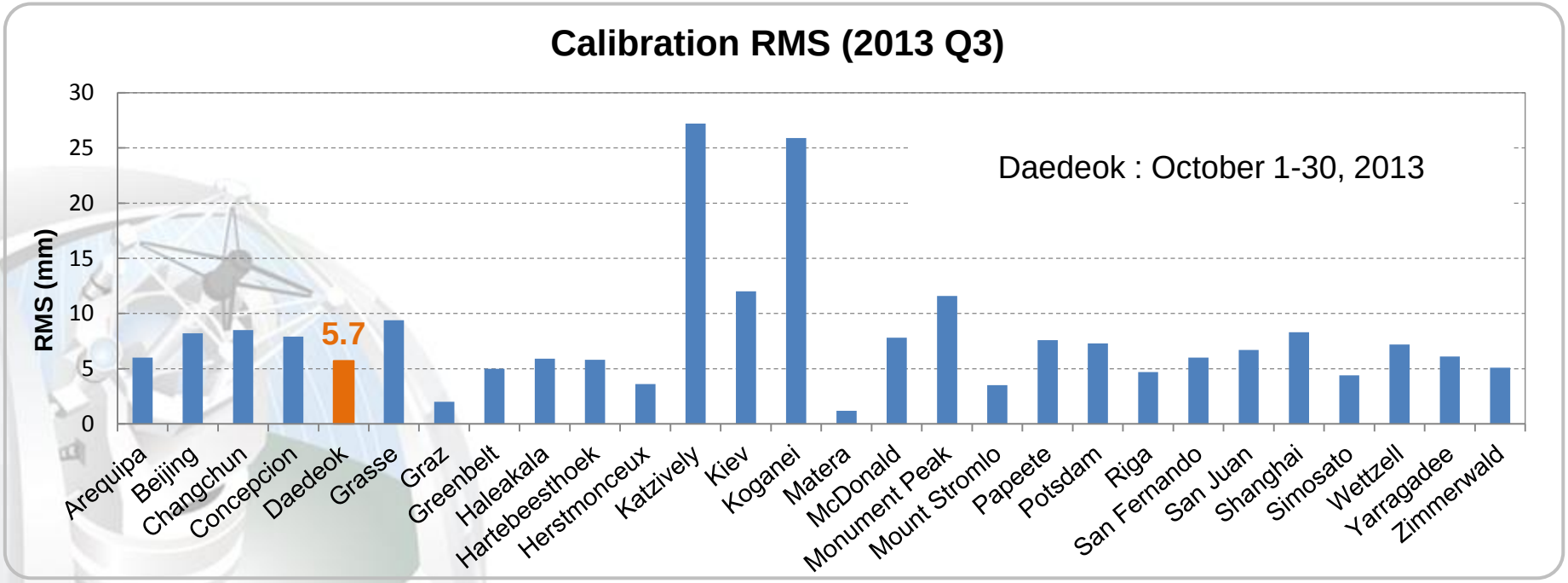




Laser Ranging Results of ARGO-M (1/3)

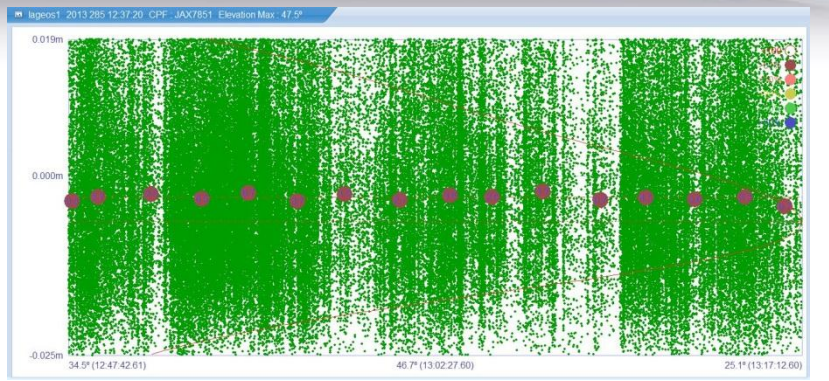
- **Ground Calibration**
  - Consisting of prism, diffuser and ND filter
  - Ground target in the dome
  - Average single-shot RMS
    - ARGO-M : 5.7mm (Oct 1-30, 2013)
    - ILRS stations(mean) : 7.9mm (2013 Q3)

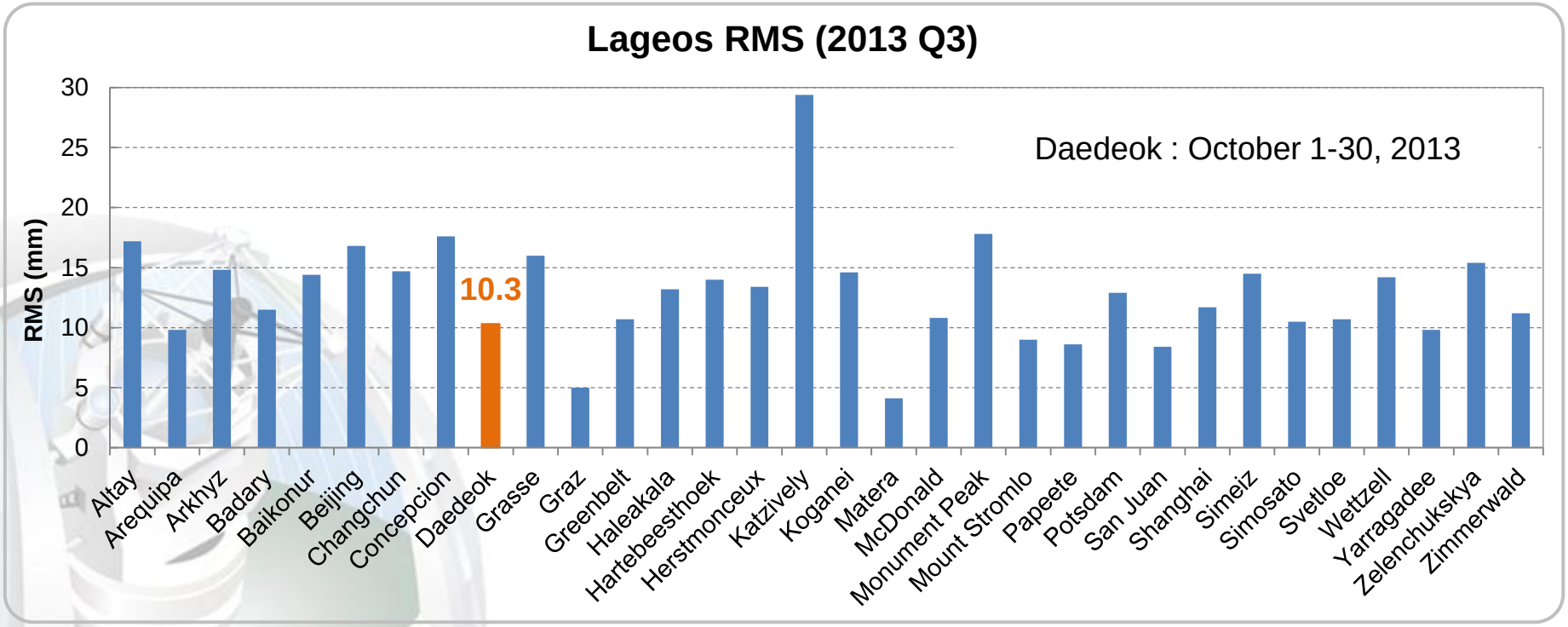




Laser Ranging Results of ARGO-M (2/3)

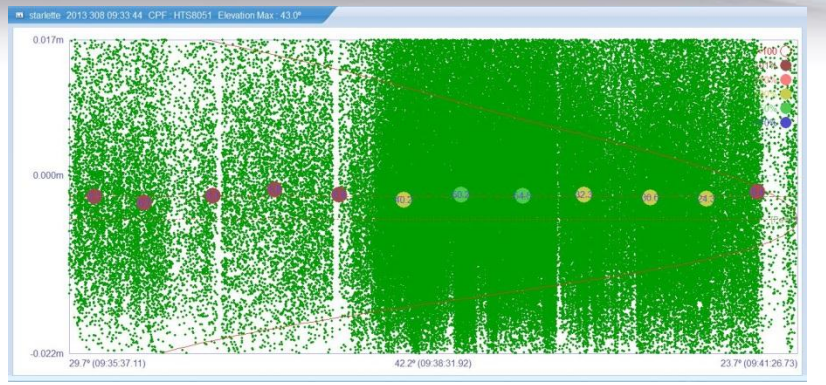
- **LAGEOS**
  - Launch Date : May 4, 1976
  - Altitude : 5850 km
  - Average single-shot RMS
    - ARGO-M : 10.3mm (Oct 1-30, 2013)
    - ILRS stations(mean) : 12.9mm (2013 Q3)

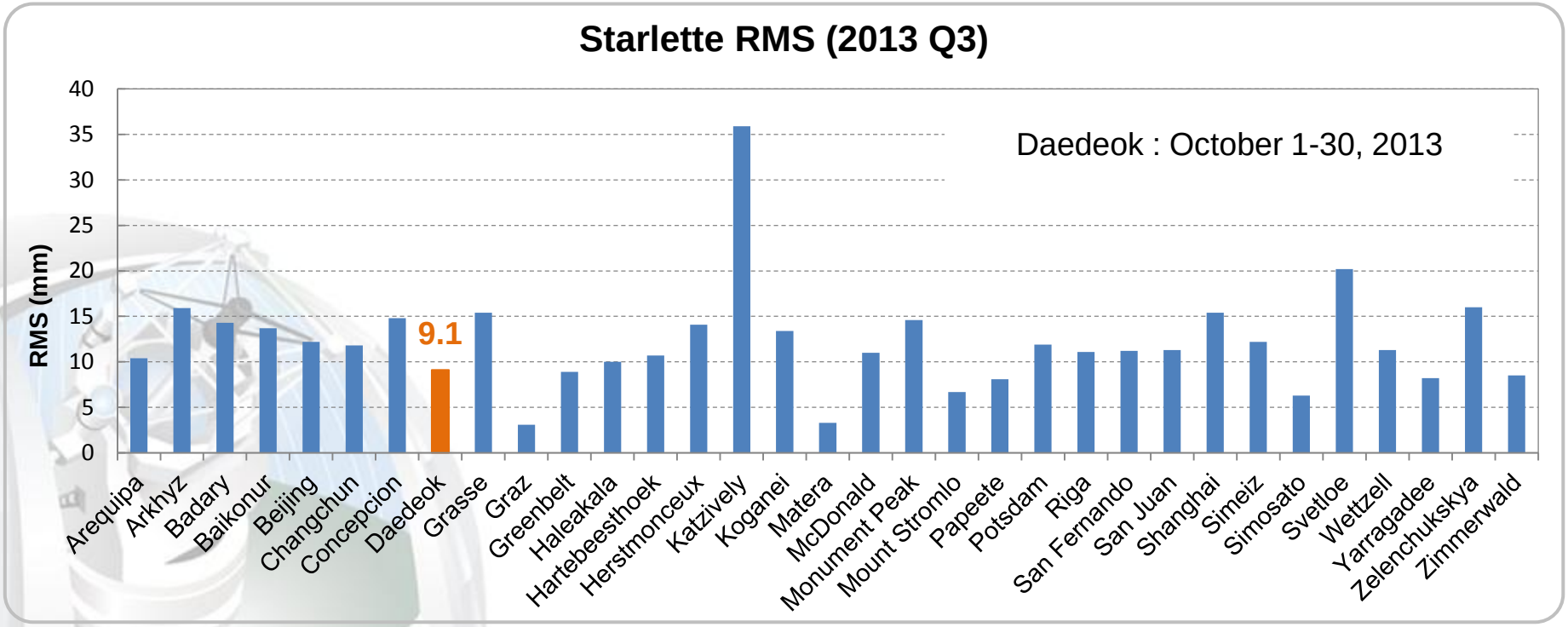




Laser Ranging Results of ARGO-M (3/3)

- **Starlette**
  - Launch Date : February 06, 1975
  - Altitude : 812 km
  - Average single-shot RMS
    - ARGO-M : 9.1mm (Oct 1-30, 2013)
    - ILRS stations(mean) : 12.2mm (2013 Q3)





Future Plan – Fundamental Station

- **Composition**
  - VLBI, GNSS, Gravity meter : NGII (National Geographic Information Institute)
  - SLR, DORISS : KASI (Korea Astronomy & Space Science Institute)
- **Site**
  - Sejong city (altitude : 250m)
  - ARGO-M will be moved to Sejong site in December 2014
    - Can be delayed due to Korean government approval for the use of land

Thanks for your attention !!!