Current Status and Plan of the First Korean Satellite Laser Ranging System(ARGO-M)

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Abstract

The first Korean satellite laser ranging (SLR) system, SEJONG SLR station(SEJL station) was developed by Korea Astronomy and Space Science Institute (KASI) in 2012, whose main objectives is focused on space geodesy researches. So Korea became the 25th country that operates SLR system in support of the international laser tracking network. The SEJL station is designed to be capable of 2 kHz laser ranging with a few mm precision in daytime and nighttime observation for satellites with laser retro-reflector array (LRA) up to the altitude of 25,000 km. In this study, the technical aspects including characteristics and specifications are addressed for the SEJL station. The ranging precision is also analyzed based on the single-shot root mean square (RMS) of ground calibration, Starlette and LAGEOS satellite in order to investigate its system performance compared to ILRS SLR systems. And the SEJL station was upgraded into 10 kHz laser ranging in 2015 with more compact operation system and new optoelectronic controller, which leads more returned signals and then increase ranging precision, With the high technology incorporated into SEJL station, it is expected that SEJL station plays an important role in the development of laser ranging data products.

Overview of ARGO Project

- Name of Korean SLR program : ARGO
  - 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
- Development Period : 2008 – 2017 (10 years)
- Applications
  - Precise orbit determination of satellite
  - Space geodesy
  - Space Situation Awareness

Fig. 1. SEJONG SLR station(ARGO-M)

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

Fig. 2. Configuration of ARGO-M

Fig. 3. External View of ARGO-M

Current Status of SEJONG SLR station(SEJL)

- History
  - 2012.11 : ARGO-M became a 25th member of ILRS
    : DAEK(Daedeok) station in KASI's Headquarter
  - 2015.07 : For GGOS Fundamental Station, ARGO-M was moved out Sejong City
  - 2015.08 : Re-registration to ILRS → SEJL(Sejong) station
  - 2016.03 : Test Operation and System Upgrade(2kHz → 5kHz repetition rate)
  - 2016.05 : Data Upload to ILRS as a SEJONG station
  - 2016.07 : Registered as a Validation Station
- Receiving Optics of ARGO-M

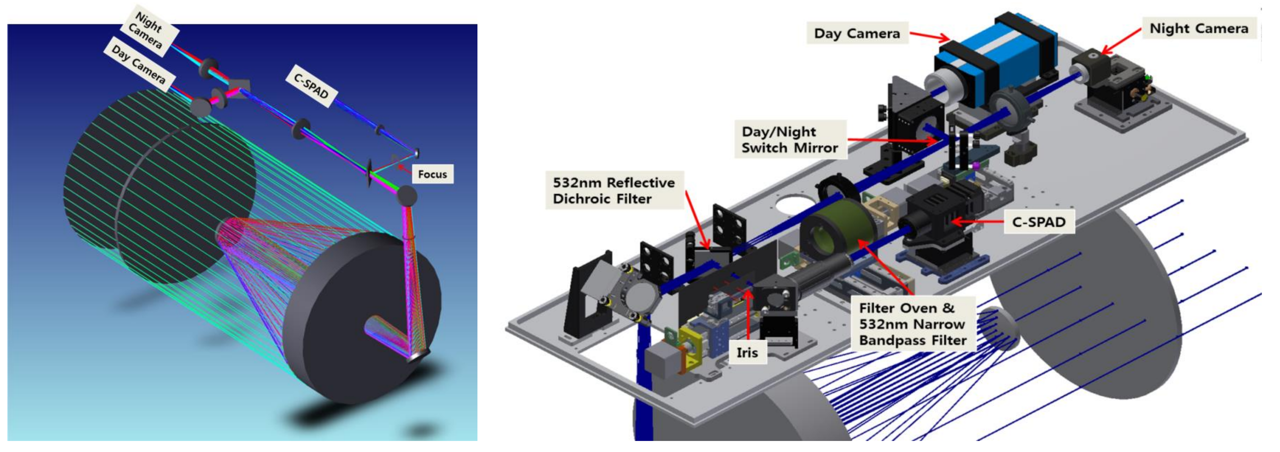


Fig. 4. Design of Receiving optics of SEJL

- Separate path(Tx/Rx telescope) to reduce back scattering
  → FoV of C-SPAD detector : 100 arcsecond
  → Dichroic mirror : C-SPAD(532nm reflected) and day/night camera(others penetrated)
- Iris
  → 3 holes and one blocked hole
  → the spatial filters(day, night and twilight) and the sun shutter
- Narrow bandpass filter : 0.3nm for daytime tracking
- Two cameras : 5 arcmin FoV
  → day camera to see laser beam even in day and night
  → night camera for star calibration of mount model
- New Range Gate Generator(up to 10 kHz)
  - KASI developed the new RGG(Range Gate Generator) and a processing software
  - But, KASI is observing using the 5kHz RGG because of the Laser Specification
- ATRAS(Auto-Transmitter & Receiver Alignment System)
  - Obtain Laser propagation direction from the Back scatter image of the camera
  - Estimation of differential direction between laser propagation direction and receiving axis of the telescope
    → Based on very rigorous theoretic and engineering approach
  - It performs well with atmospheric turbulence and even under very adverse atmospheric conditions

Fig. 5. 10 kHz Range Gate Generator

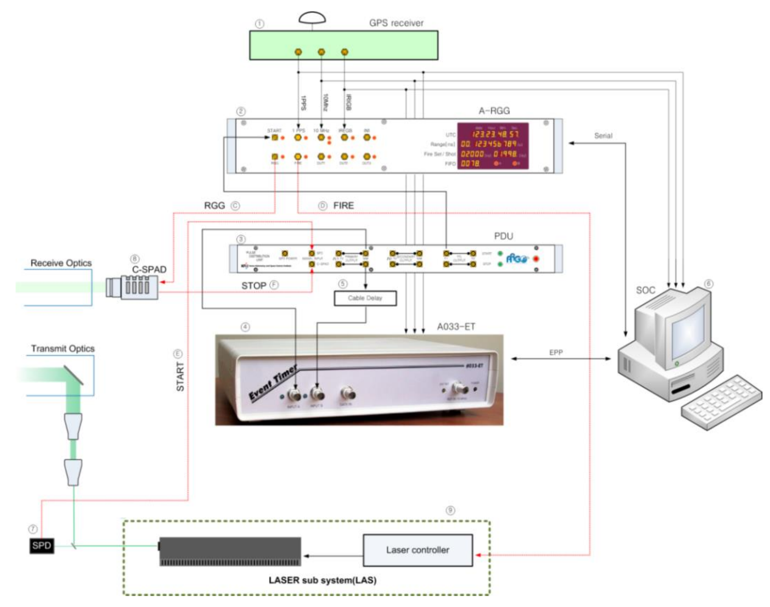


Fig. 6. Block Diagram for 10 kHz Laser Ranging

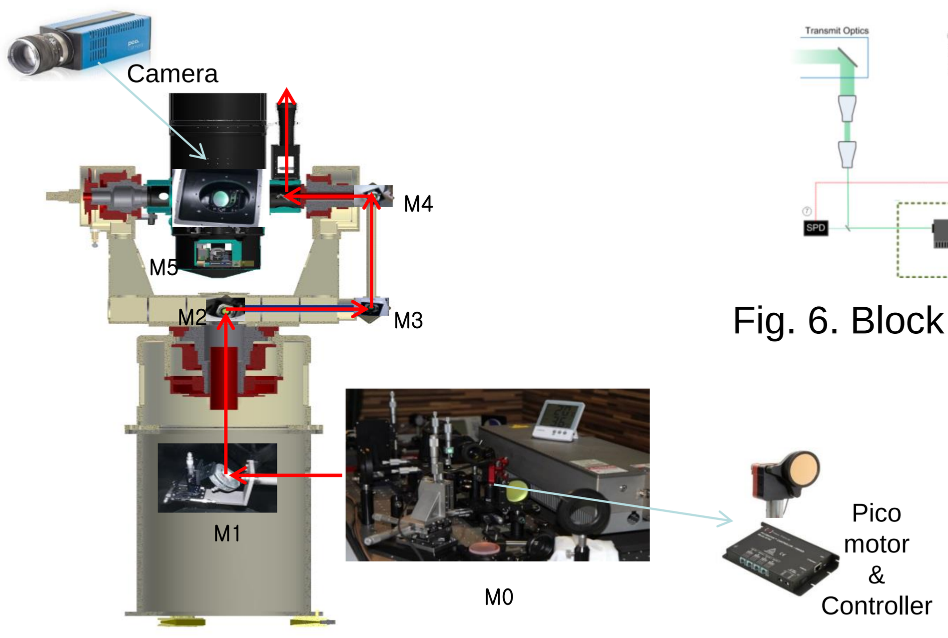
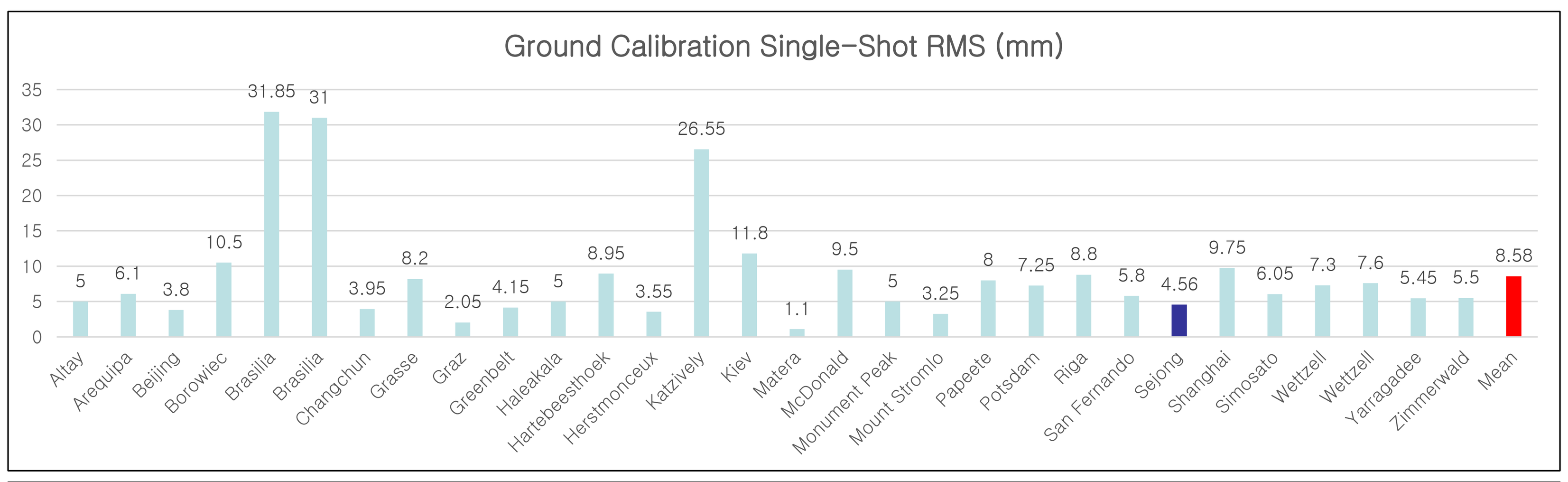


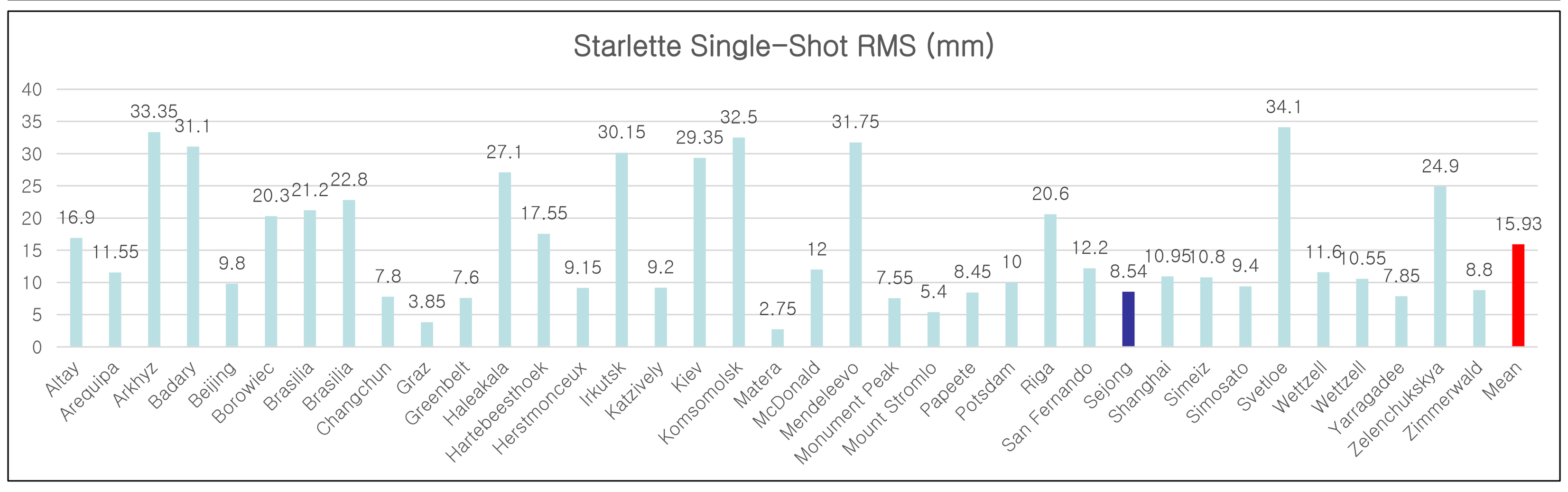
Fig. 7. ATRAS Hardware Configuration

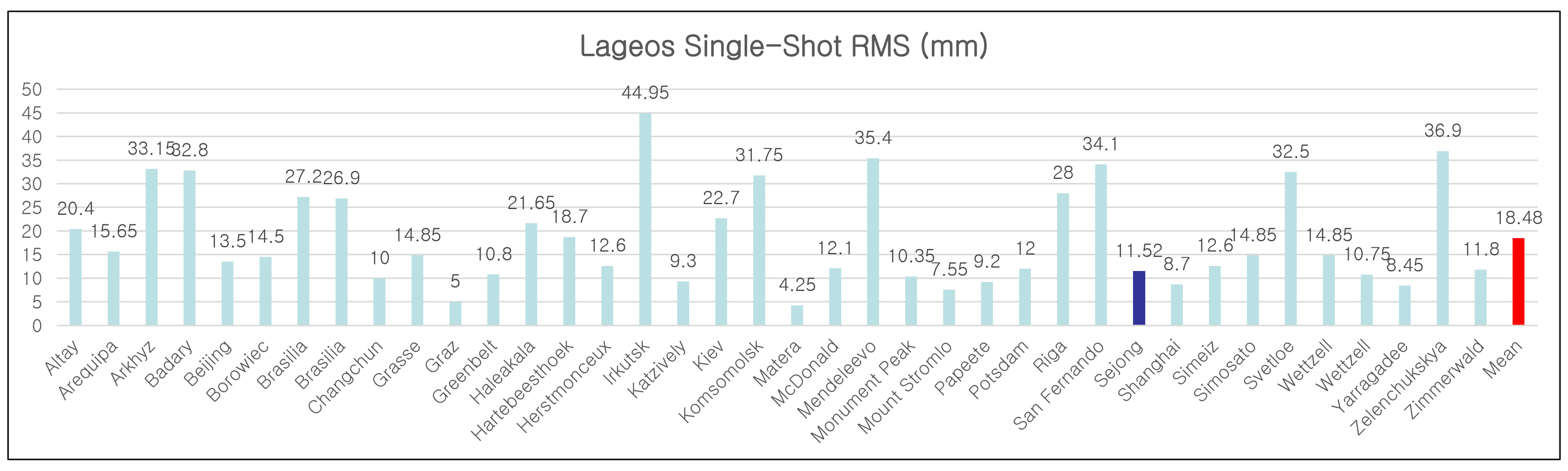
Fig. 8. Operation S/W for 10 kHz Laser Ranging

Laser Ranging Results for SEJONG SLR station

- Data Acquisition
  - Data of ILRS stations : 1 & 2 Quarter 2016 on ILRS
  - Data of SEJONG station : 1& 2 Quarter 2016 on KASI
  - Ground Calibration / Starlette / Lageos Single-shot RMS(mm)







Summary and Future works

- Summary
  - Sejong SLR station is operating to high repetition rate system(2 → 5 kHz)
  - Sejong SLR station(SEJL) has been working as a member of ILRS from July 2016
- Future works
  - KASI is going to upgrade more high repetition rate system(5 → 10kHz)
  - For Space Geodesy, Sejong SLR station is going to play a role as a GGOS Fundamental station with GNSS, VLBI, DORIS etc.

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