Daedeok Station Receive Optical System Upgrade

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Abstract

Korea Astronomy and Space Science Institute (KASI) has been developing two SLR systems, one mobile system (0.4m, ARGO-M) and one fixed system (1m, ARGO-F). The development of ARGO-M was completed in 2011 and the system was registered as an active validated station (Daedeok, 7359) in 2014 to the ILRS. KASI is upgrading the Daedeok station by implementing : 1) the Automatic Transmitter Receiver Alignment System (ATRAS) 2) an operating software and ARGO Range Gate Generator (A-RGG) for 10kHz laser ranging 3) the new optical receiving system for more efficient daytime tracking. At the presentation we discuss on the receiving optical system. The new design improves three points : 1) The new design divides the optical path for the observation and the laser direction monitoring. In the case of the old optical design, the monitoring has the same FOV as the C-SPAD because the iris is located at the common optical path. This case makes it difficult to operate ATRAS only in the daytime tracking because the C-SPAD FOV is small, about 10 arcseconds. But the new design keeps the monitoring FOV constant even though the C-SPAD FOV changes. 2) The new design uses the reflective dichroic filter instead of the transmissive dichroic filter The implemented transmissive dichroic filter in the old design can be influenced by the surrounding temperature because the enter wavelength of the transmissive filter is shifted depending on temperature. 3) The new design adds a temperature controller to the bandpass filter for constant temperature. Like the transmissive dichroic filter, the center wavelength of the bandpass filter also changes depending on surrounding temperature. So the new optical design will increase the return rate and ranging precision for both daytime and nighttime tracking.

1. Korean Daedeok Station (7359)

1. **Daedeok station**
   - Agency : Korea Astronomy and Space Institute
   - Address : 776 Daedeok-Daero Yuseong-gu Daejeon Republic of Korea
   - Position : X -3120073.0671 m
     Y 4084624.9392 m
     Z 3763990.7446 m
   - Telescope :
     Receiving Type: Cassegrain
     Aperture: 0.4m
     Mount: AZ-EL
     Xmitting Type: Refractor
     Aperture: 0.1m
   - Laser : Nd:YAG, 532nm, 2kHz
   - Detector : C-SPAD

Fig. 1 Daedeok Station (7359)

2. Current Receiving Optical System

1. **Receiving Telescope (Fig. 2)**
   - Ritchy-Chretien type
   - Primary mirror = 400 mm
   - Secondary mirror = 80 mm
   - F/ratio = 16
   - FOV = ~ 80 arcseconds (Night)
     ~10 arcseconds (Day)
2. **Detector Box (Fig. 2)**
   - Detect the reflected laser light from satellite and Monitor laser tracking
   - Configure (Fig. 3)
     - C-SPAD, 532nm Bandpass Filter, Day Camera, Night Camera, 532 nm Transmissive Dichroic Filter, Day/Night Switch Mirror

Fig. 2 Receiving Telescope

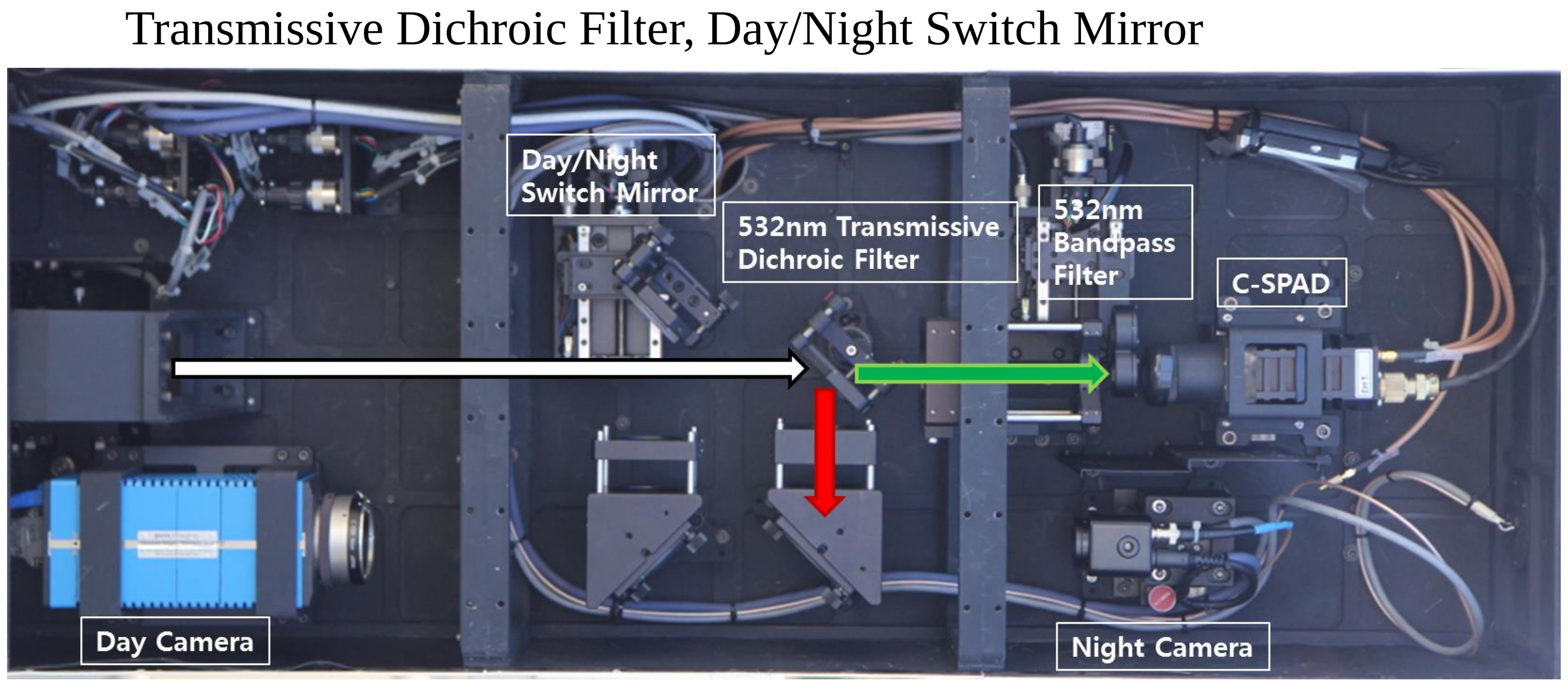
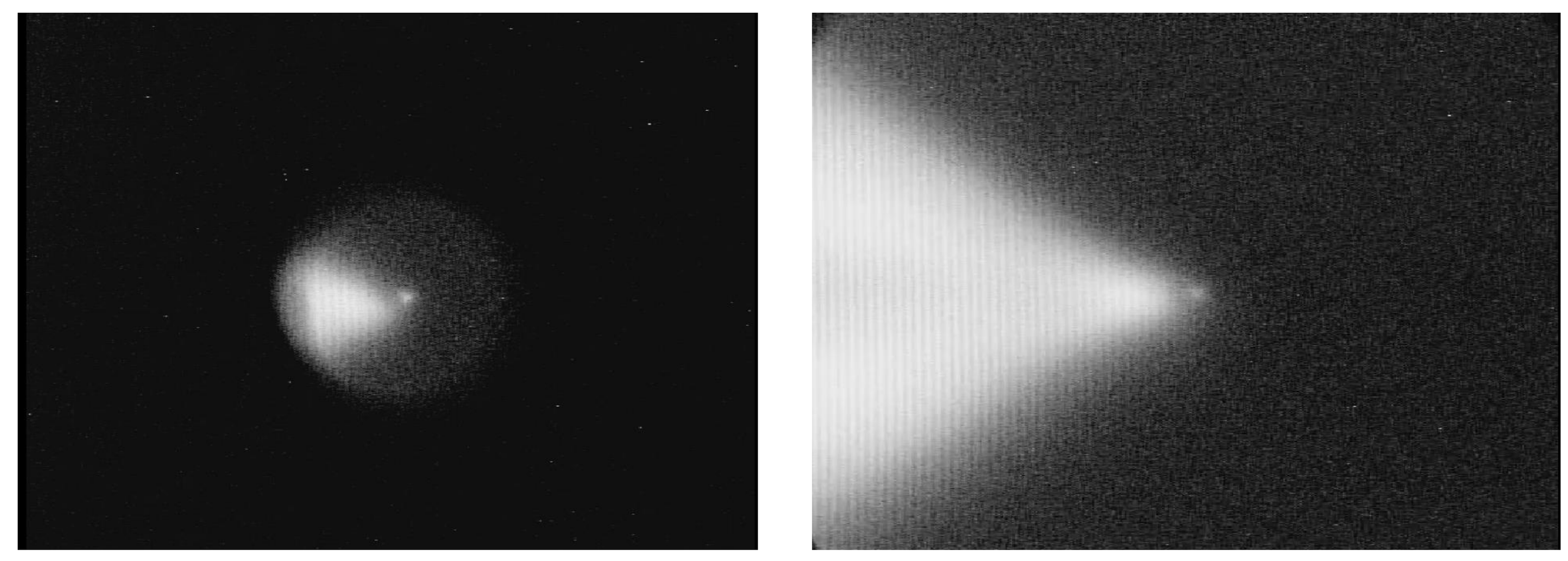


Fig. 3 Detector Box

3. Receiving Optical System Upgrade

1. **Receiving Optical System Upgrade**
   1) Motivation
   - In the case of the old optical design (Fig. 5 (a)), the monitoring has the same field of view (FOV) as the C-SPAD because the iris is located at the common optical path. In the daytime tracking, it is difficult to operate ATRAS (in detail poster #3063).



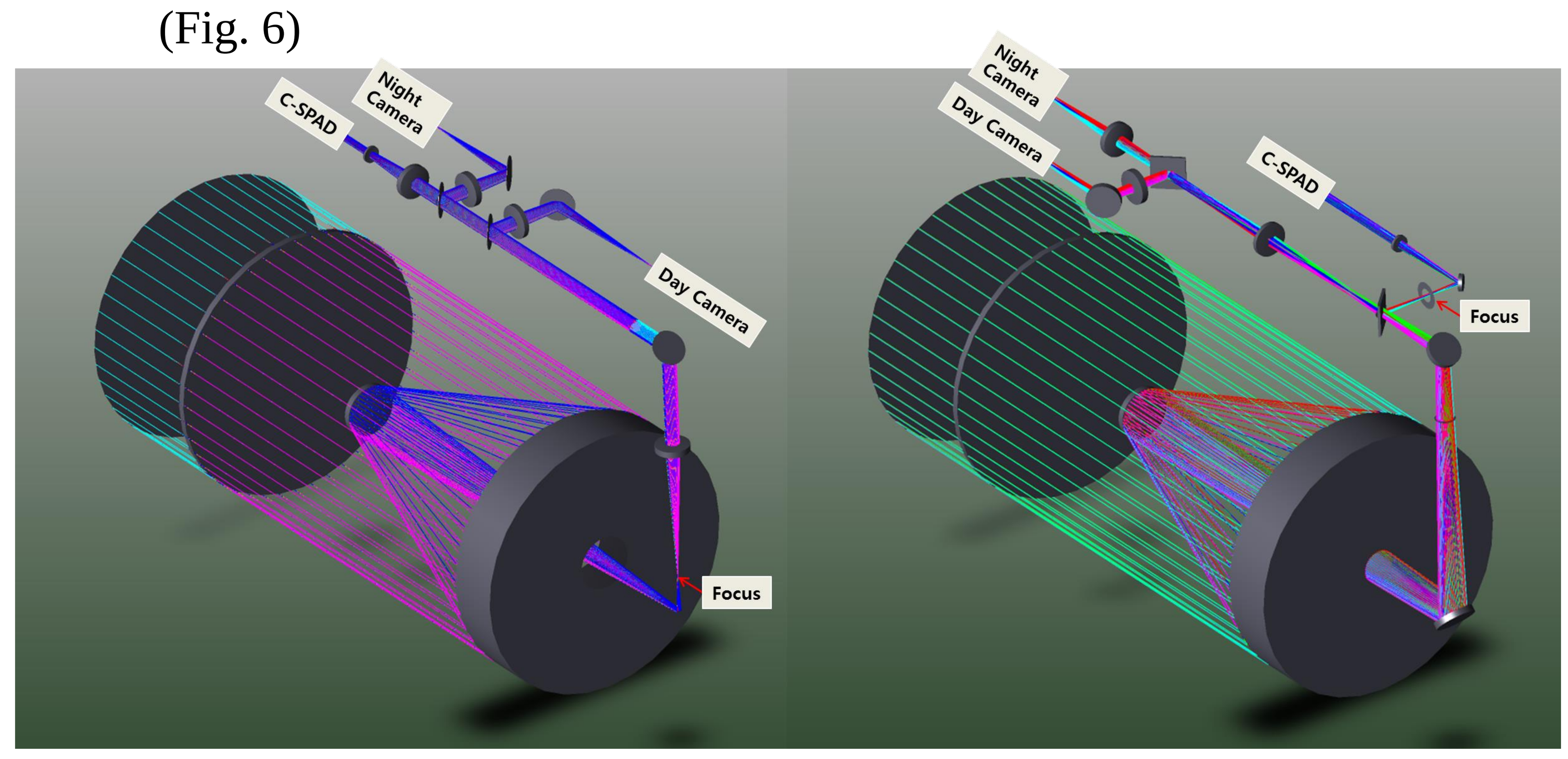
(a) 60 arcseconds (b) 300 arcseconds

Fig. 4 Night Camera FOV change for C-SPAD FOV change

   - We use the transmissive dichroic filter for dividing optical path between observation and monitoring in the old design. The transmissive dichroic filter is influenced by the surrounding temperature. (Fig. 3)
   - Narrow bandpass filter is influenced by the surrounding temperature. Transmission change by temperature decreases the returned signal rate.

   2) New Design Conditions
   - C-SPAD FOV : 95 (Night), 47.5, 10 (Day) arcseconds
   - Day Camera FOV : 300 arcseconds
   - Night Camera FOV : 300 arcseconds
   - Constant Day/Nigh camera FOV for C-SPAD FOV change
   - Make Space for installing the thermostatic device of narrow bandpass filter to keep a constant temperature.
   - Use as possible of the existing optical parts

2. **New Design**
   1) Optical Design
   - Move focus position for using the reflective dichroic filter instead of the transmissive filter. (Fig. 5 (b), Fig. 6)
   - Move focus position for securing the constant day/night monitoring FOV for C-SPAD FOV change. (Fig. 5 (b))
   - Install Filter Oven to keep a constant narrow bandpass filter temperature. (Fig. 6)



(a) Old optical design (b) New optical design

Fig. 5 Optical Design

   2) Mechanical Design (Fig. 6)
   - Using commercial lens economically
   - Using existing optical parts

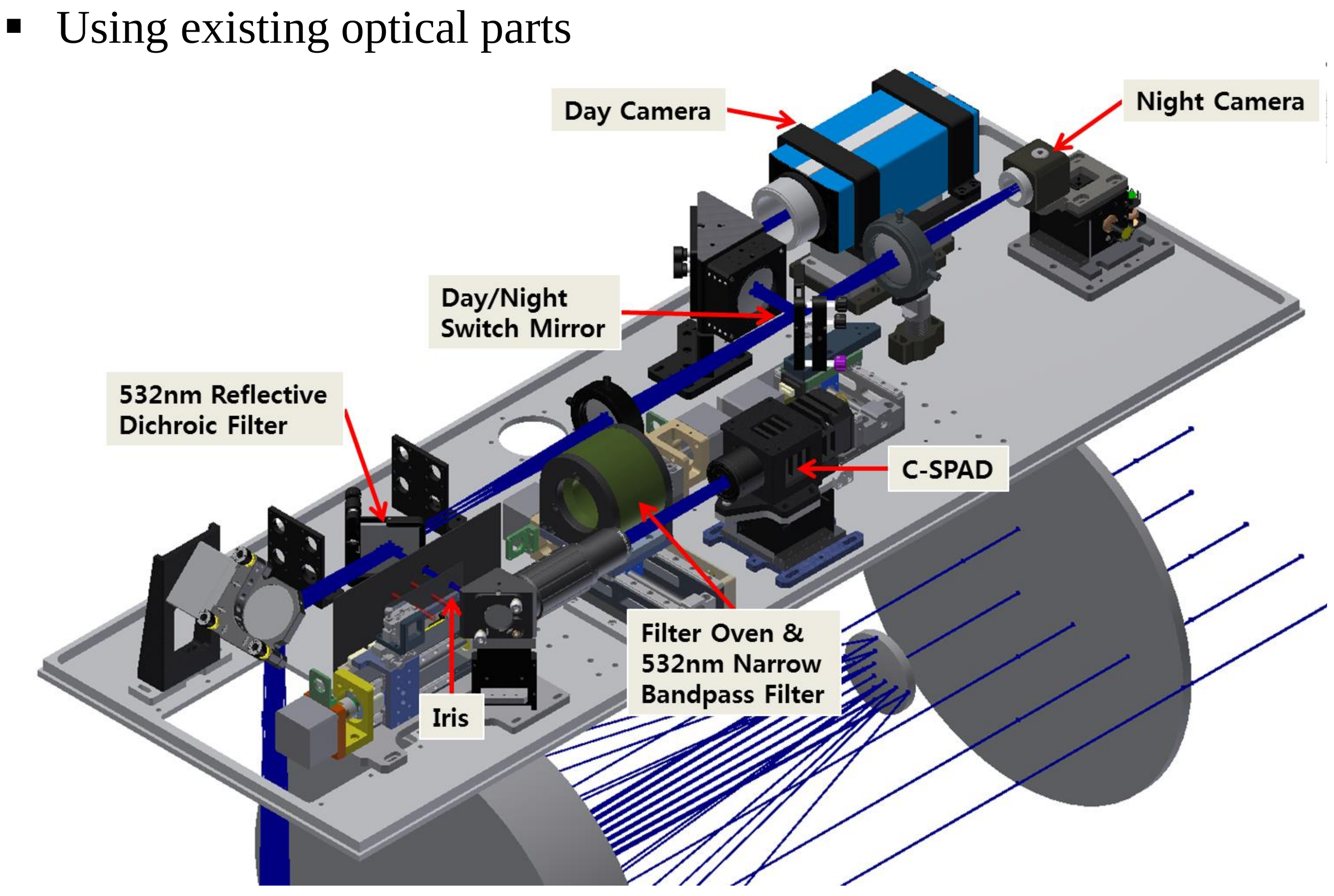


Fig. 6 New mechanical Design