7-Dimensional Telescope (7DT):
Robotic telescope with rapid ToO capability

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Overview of 7-Dimensional Telescope (7DT)

7DT is a robotic array of **20 0.5-m wide-field telescopes** in Chile.
Each unit features a wide field of view **(1.25 deg²)**, rapid slewing **(50°/s)**, and filter setup supporting both broadband **(SDSS g, r, i)** and 40 medium-band filters **($\lambda = 400 \sim 900 nm$ with $\Delta\lambda = 25 nm$).**
It is optimized for fast, autonomous transient follow-up using diverse observation modes enabled by **TCSpy**.
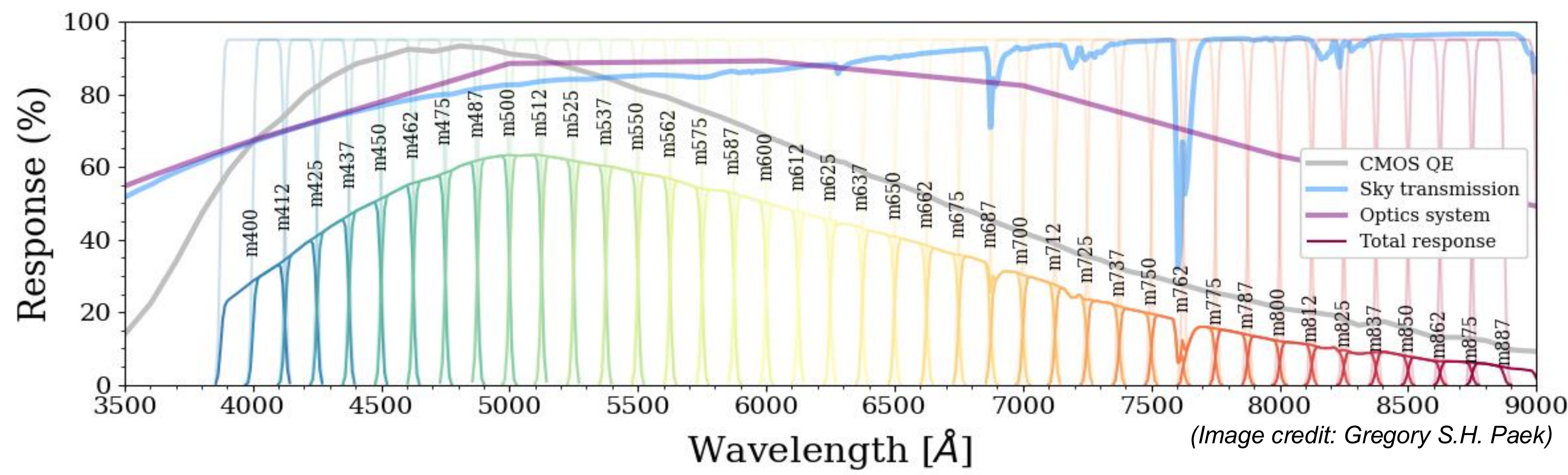

Fig 1. Response curves of the currently installed medium-band filters on 7DT. At present, 20 out of the planned 40 filters (e.g., m400, m425, m450) are operational. The remaining filters are scheduled for installation.
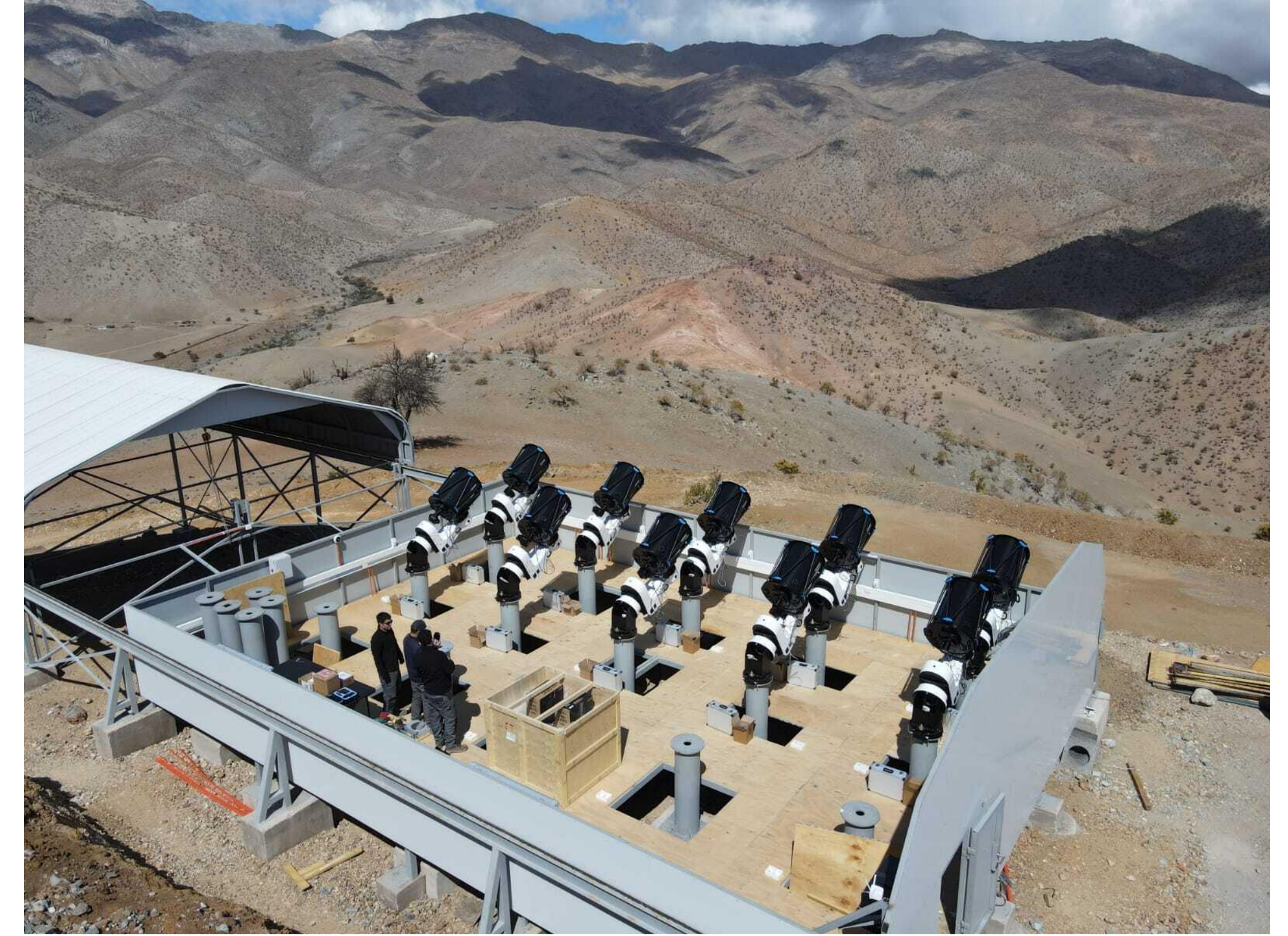

(Image credit: Gregory S.H. Paek)

Fig 2. Overview of 7-Dimensional Telescope (7DT) in Rio Hurtado, in Chile. Currently, 7DT is under construction with 16 of 20 units operational.

Telescope Control System with python (TCSpy)

TCSpy is a dedicated telescope control software for 7DT.
It coordinates communication between the Main Control Computer (MCC) and multiple Telescope Control Computers (TCCs)—each operating an individual telescope unit. This networked architecture enables centralized, fully synchronized control of all telescopes, supporting 7DT's **diverse observation modes** (Fig. 4) and enabling **robotic operation** (Fig. 5) and **rapid Target-of-Opportunity (ToO) response.**
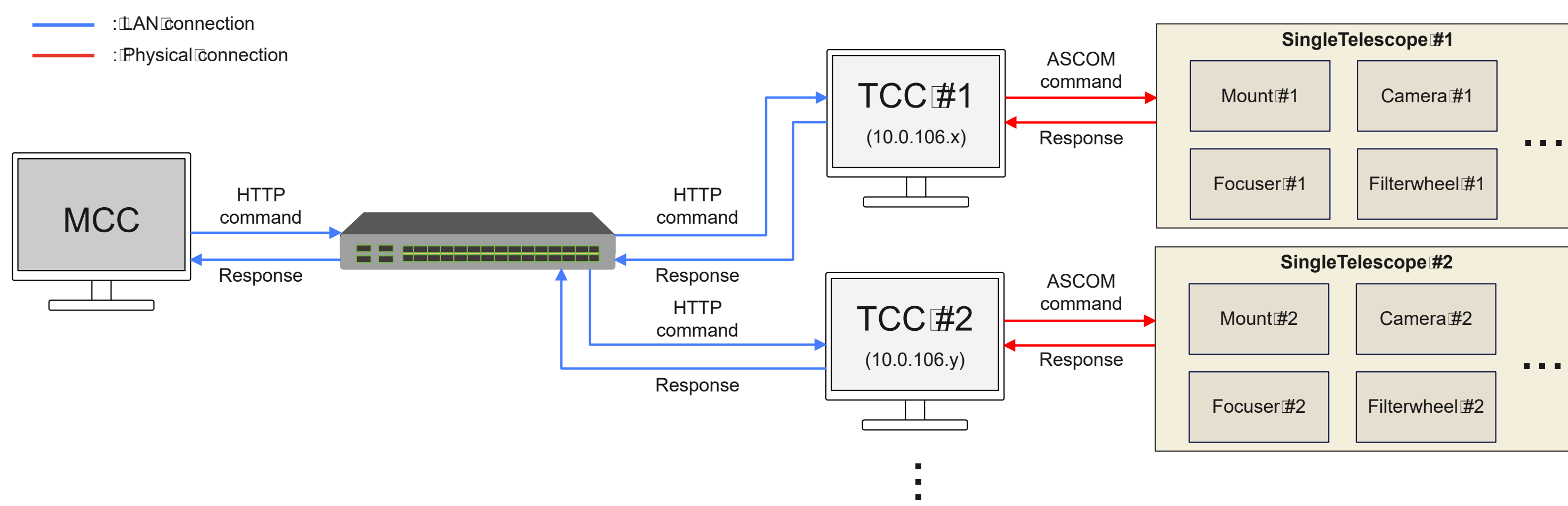

Fig 3. Hardware control schema of TCSpy. In the local network environment, all telescope units communicate with the Main Control Computer (MCC) through Telescope Control Computers (TCCs) with HTTP protocol.
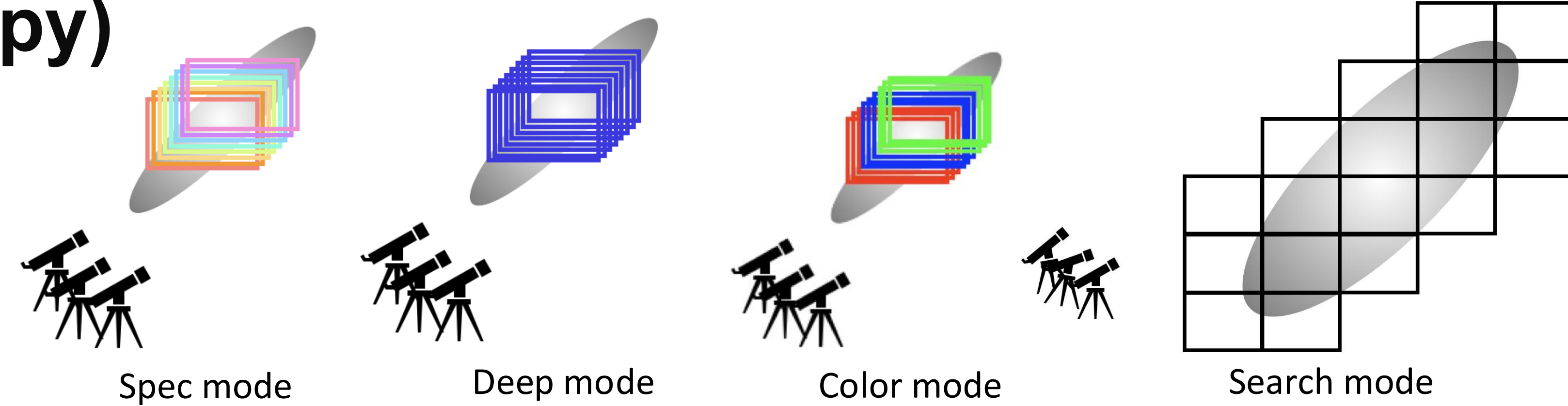

Fig 4. Illustration of the four observation modes supported by TCSpy: Spec, Color, Deep, and Search. Each mode is designed to serve different scientific goals through coordinated operation of the 7DT telescope array.
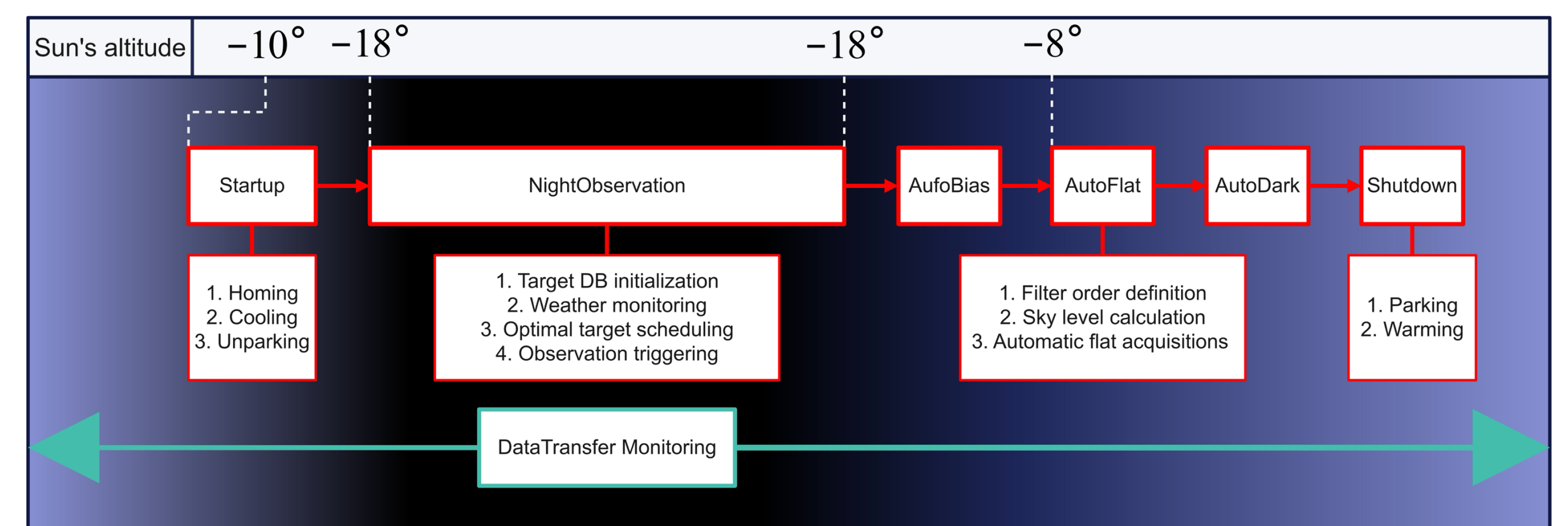

Fig 5. Nightly observation schedule created by TCSpy for 7DT operations

ToO capability of 7DT

7DT can trigger ToO observation **within 1min** after ToO request

◆ **Multiple ToO Request Channels**
Users can submit ToO requests through various platforms — the 7DT ToO website (Fig. 7), email, Slack, or a Google Spreadsheet (for bulk ToOs with large localization areas).

◆ **Automated Alert Monitoring**
The TCSpy system checks for new ToO requests every 30 seconds and automatically uploads them to the observation scheduler.

◆ **Queue-based Dynamic Target Scheduling**
A real-time scoring algorithm autonomously selects optimal targets at a rate of ~30,000 targets s⁻¹, accounting for moon separation, target altitude, and scientific priority.

◆ **Minimal Overhead from Telescope Design**
Unlike typical spectroscopic facilities, 7DT's Spec-mode observations require only a filter change. Combined with the fast-slewing speed, this allows rapid, low-overhead ToO response.
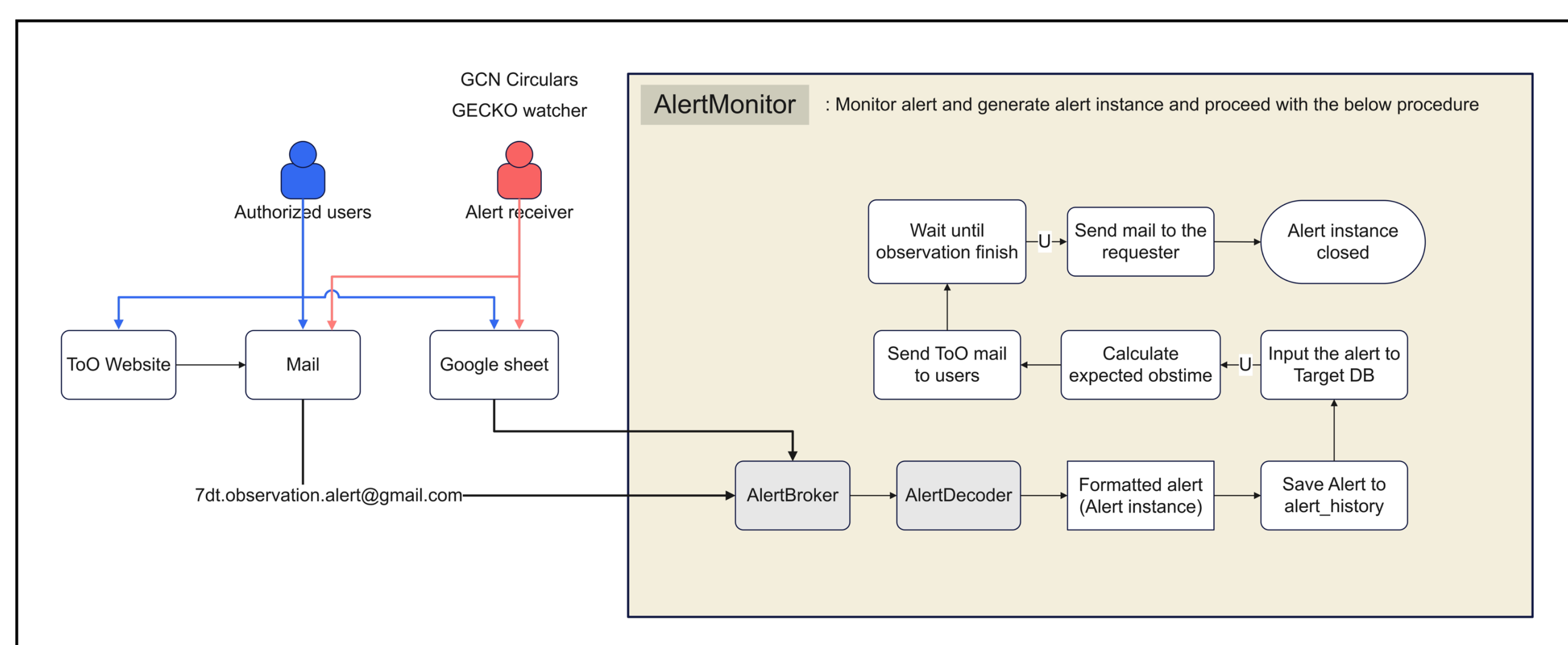

Fig 6. Flow of ToO alerts from user input to telescope observation. The AlertMonitor system continuously monitors user-submitted ToO alerts and automatically triggers observations.

Fig 7. Web-based ToO request system. Users can submit urgent targets directly through a dedicated portal, and the system autonomously initiates observations within one minute. (Webpage is made by Dr. Donggeun Tak)
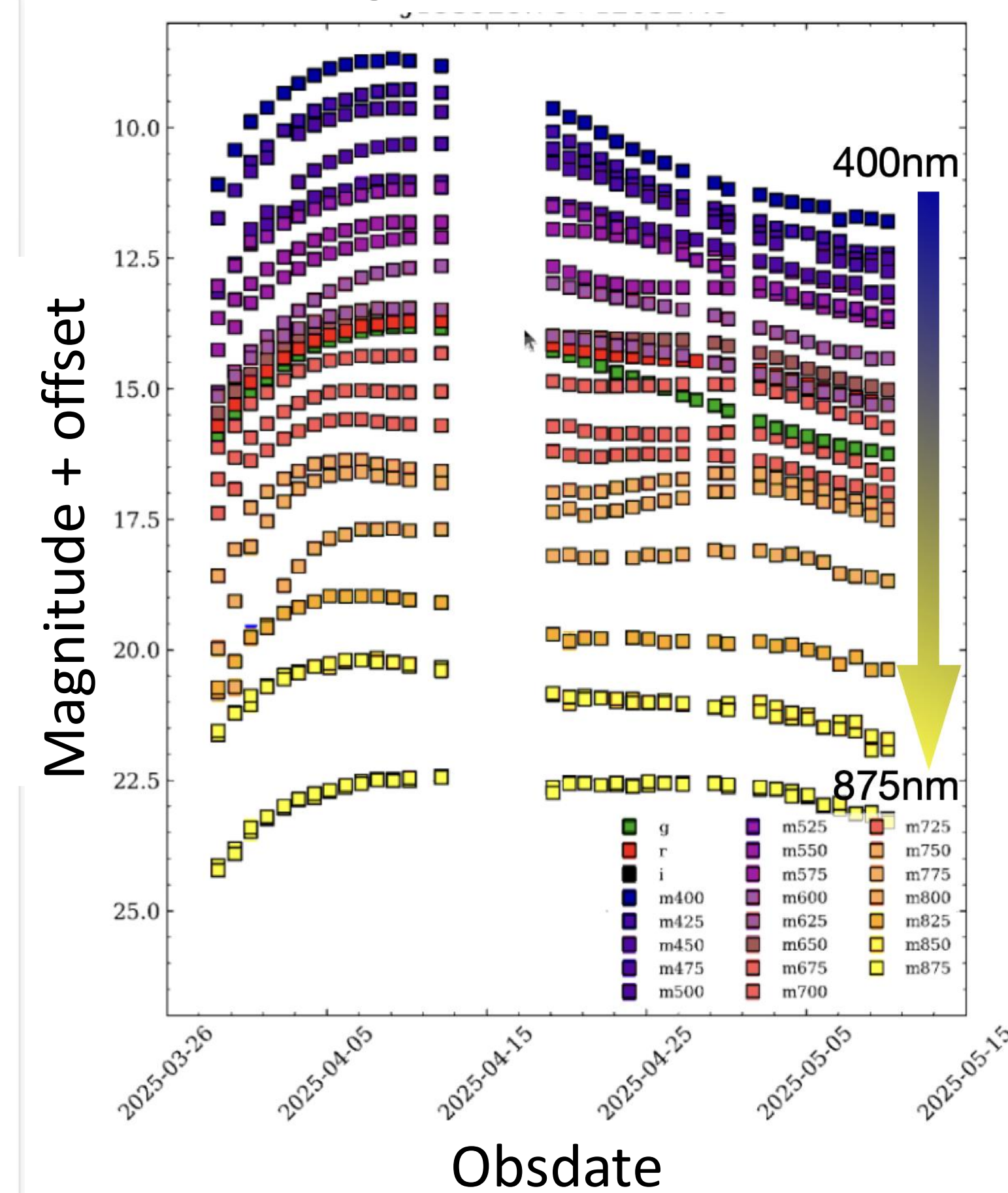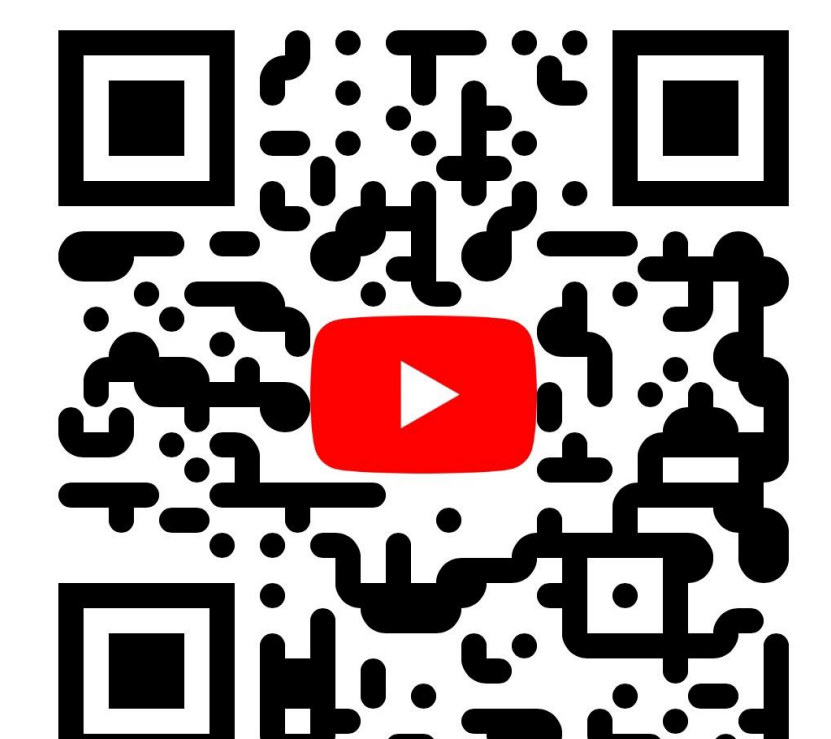

Fig 8. Light curve of a Type Ia supernova observed with the 7DT in Spec-mode. The data points from the purple (m400) to yellow (m875) filters represent observations across different medium bands.

Video of Robotic operation of 7DT