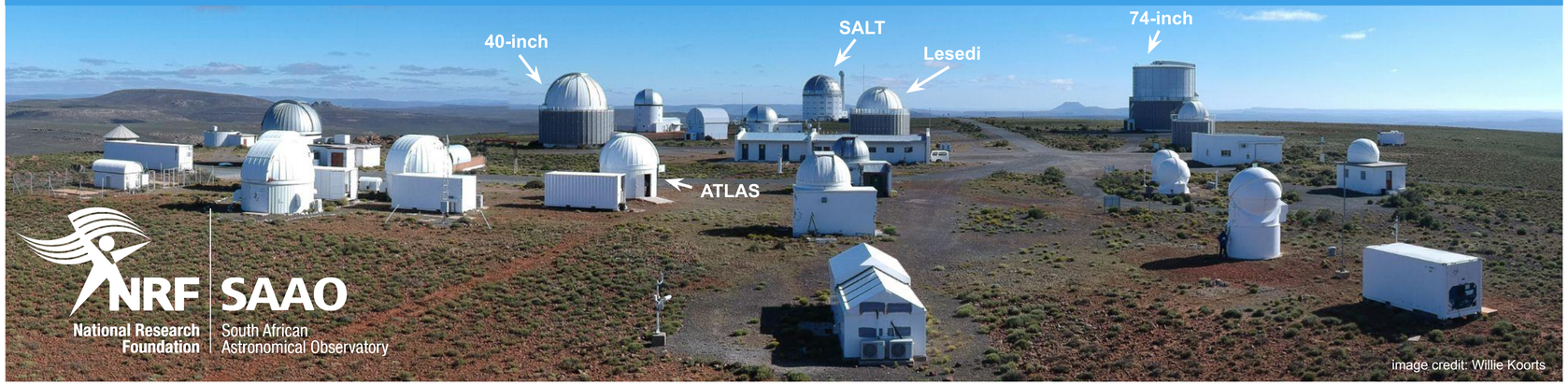
Progress on NRF-SAAO's IO project and Autonomous Follow-up Programs

N. Erasmus[a,b], S. Potter[a,c], H. Worters[a], C. van Gend[a], P. Rabe[a] and D. Cunnama[a]

[a]South African Astronomical Observatory, Cape Town, 7925, South Africa
[b]Department of Physics, Stellenbosch University, Stellenbosch, 7602, South Africa
[c]Department of Physics, University of Johannesburg, Johannesburg, 2006, South Africa



INTRODUCTION & BACKGROUND:

The South African Astronomical Observatory (NRF-SAAO) Intelligent Observatory (IO) initiative is a strategic modernisation programme designed to meet the scientific demands of the data-driven, Fourth Industrial Revolution era of astronomy. The IO project encompasses hardware, software, and infrastructure upgrades enabling remote and fully robotic telescope operations, alongside emerging technologies such as LLM-based tools and AI-driven telemetry monitoring to improve operational efficiency and scientific responsiveness. Several science programmes have already benefited directly from the IO framework, leveraging modernised systems for rapid transient follow-up, flexible scheduling, and more efficient observing modes, positioning the SAAO for a future of agile, globally interconnected automated telescope networks.

OUR ROBOTIC TELESCOPE

Lesedi is a 1-meter f/8 alt-azimuth telescope that can accommodate instruments on both Nasmyth ports, utilising a rotating tertiary mirror to direct the science beam to the relevant port. On one of the ports is mounted with Mookodi, a multipurpose instrument with a low-resolution spectrograph mode and a multi-filter imaging mode available (see Figure 1 for specifications). Lesedi with the Mookodi instrument is now completely queue scheduled and robotically operated.

science, technology & innovation
Department:
Science, Technology and Innovation
REPUBLIC OF SOUTH AFRICA

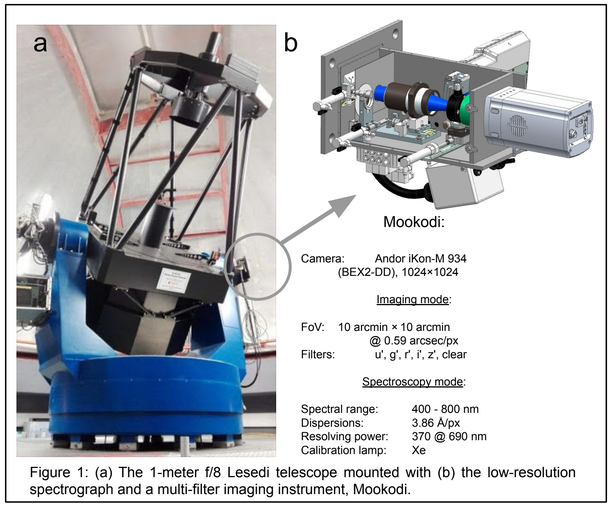


Figure 1: (a) The 1-meter f/8 Lesedi telescope mounted with (b) the low-resolution spectrograph and a multi-filter imaging instrument, Mookodi.

SUBMITTING & SCHEDULING OBSERVATIONS

Mookodi has been fully integrated into the NRF-SAAO's IO programme via the recently open-sourced Observatory Control System (OCS) software developed by Las Cumbres Observatory (LCO), and is now completely queue-scheduled and robotically operated. Observations are submitted through the OCS web portal (see Figure 2a+b), but can also be submitted programmatically via an API. The OCS employs a dynamical scheduler that recalculates the observing queue every minute (see Figure 2c), enabling it to accommodate rapid-response requests.

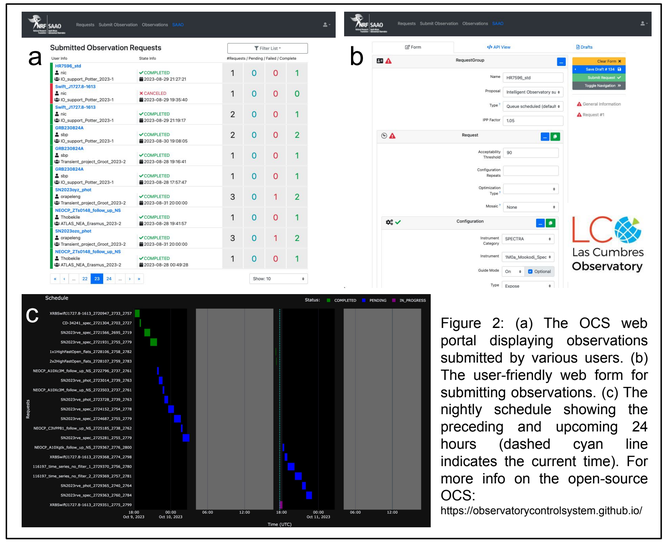


Figure 2: (a) The OCS web portal displaying observations submitted by various users. (b) The user-friendly web form for submitting observations. (c) The nightly schedule showing the preceding and upcoming 24 hours (dashed cyan line indicates the current time). For more info on the open-source OCS: https://observatorycontrolsystem.github.io/

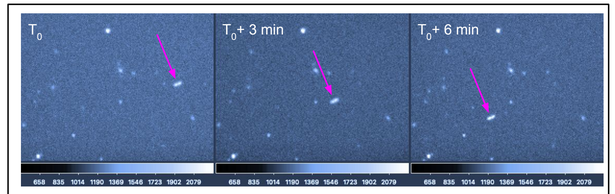


Figure 3: Automated follow-up observations of asteroid 2023 QB. See Ngwane et al. (2025) & Ngwane et al. (2026) for further details on this programme.

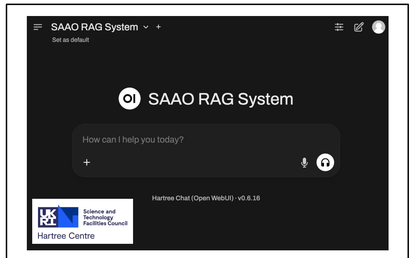


Figure 4: The LLM-powered chat interface available to observers and technical staff (still under development).

AUTONOMOUS FOLLOW-UP PROGRAMS

Lesedi + Mookodi is well suited for fully automated rapid-response (e.g., photometric/astrometric follow-up of newly discovered NEAs, see Figure 3, and long term spectroscopic/photometric monitoring of transient/variable targets, see Figure 4.

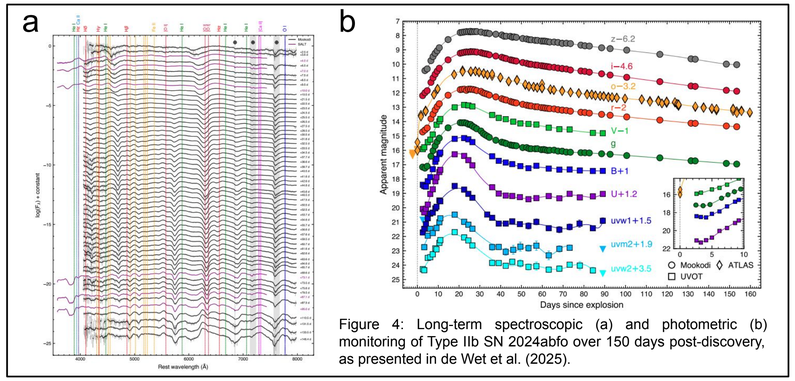


Figure 4: Long-term spectroscopic (a) and photometric (b) monitoring of Type IIb SN 2024abfo over 150 days post-discovery, as presented in de Wet et al. (2025).

FUTURE WORK

Our plan is to incorporate more of our telescopes into the IO network (e.g. the 74-inch and SALT) to better respond to a variety of science triggers, and to eventually have an AI-assisted system helping with decisions on which telescope to use and what type of observation to perform (see Figure 5). We are also actively working in collaboration with the Hartree Centre on AI technologies to improve our operations — including a RAG system to assist observers and technical staff with observing and maintenance procedures (see Figure 4), and active monitoring of system telemetry for preventative maintenance.

Figure 5: Ultimate vision of IO program. An integrated smart telescope network able to intelligently and efficiently respond the astronomical discoveries.