Reviving ROTSE-IIIc: A Cost Effective Restoration of a Legacy Telescope in Namibia

ROTSE NAMIBIA

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Introduction

The Robotic Optical Transient Search Experiment (**ROTSE**) was developed to study the optical afterglows of Gamma-Ray Bursts (**GRBs**) using fast-response, autonomous telescopes capable of slewing to targets within seconds. Early systems, such as ROTSE-I, demonstrated the power of robotic optical facilities, capturing the first contemporaneous optical flash from GRB 990123 in 1999 [1]. Building on this success, the ROTSE-III network was established in 2003 with four 0.45 m f/1.9 wide-field telescopes in Texas, Turkey, Australia, and Namibia. The Namibian unit, ROTSE-IIIc, was shut down in 2013 due to funding and operational challenges, ownership was transferred to the landowner where it remained inoperable for nearly a decade.

In 2022, the African Astronomical Society (**AfAS**) initiated the revival of ROTSE-IIIc, aiming to re-establish the facility as a modern resource for the African astronomical community. The refurbished telescope is envisioned as a potential first instrument of the African Integrated Observation System, supporting transient astronomy and multi-messenger follow-up of GRBs, gravitational-wave events, near-Earth objects, and other fast transients.

Restoration required overcoming significant hardware and software obsolescence, including upgrading and replacing outdated and missing hardware, modernizing the Observatory Control System (**OCS**), and installing a new environmental monitoring system. The project emphasizes maintainability and a cost-effective implementation by reusing legacy hardware where possible, adopting the open-source PyObs OCS [2], and applying 3D printing for rapid prototyping and component manufacturing. By July 2025, successful remote observations were achieved, marking a major milestone in bringing ROTSE-IIIc back online.

Figure 1: The ROTSE-IIIc telescope enclosure at the H.E.S.S. site in the Khomas Highlands, Namibia, with the hatch cover fully closed.

System Design & Restoration

Roof Enclosure & Controller: The original ROTSE-III motorized hatch had previously been controlled via a proprietary daemon and hardware watchdog. The controller has now been replaced with a modern Arduino-based roof controller.

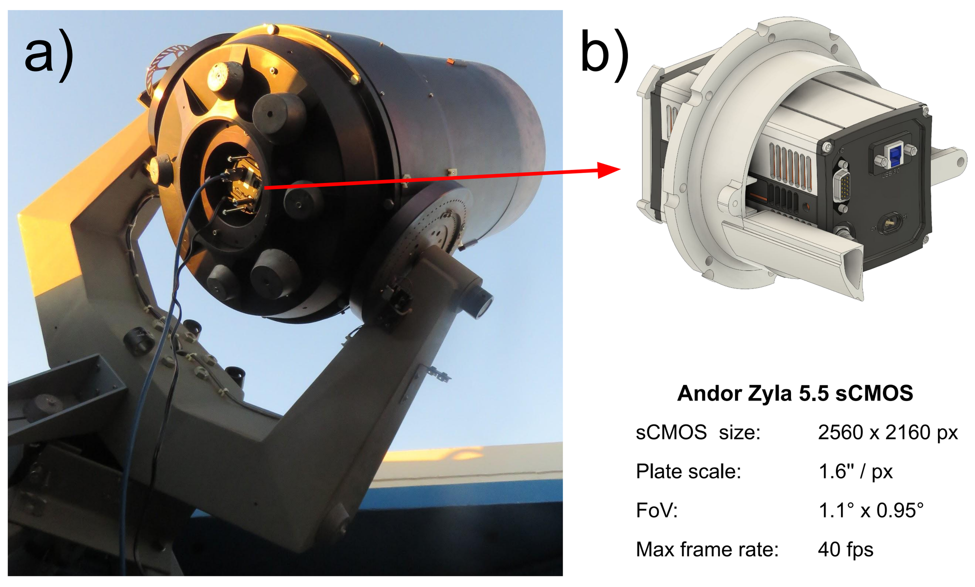

Figure 2: (a) ROTSE-IIIc 0.45-m f/1.9 OTA with (b) Andor Zyla 5.5 sCMOS, mounted via a custom 3D-printed interface.

Science Camera & Focusing Mechanism: The missing CCD and obsolete focuser were replaced with modern hardware and custom Python drivers. The new Andor Zyla 5.5 sCMOS camera reaches Gaia G ≈ 18 in 15 min in dark Moon conditions, slightly less sensitive than the original Marconi CCD [1] due to its lower QE (~60%).

Mount Driver: A new AsyncIO-based driver was developed to replace the legacy control system and allow Python control of the modified AstroWorks Centurion-II EQ [1]. Communicating via RS-232 with encoder position commands, the driver implements all coordinate conversion, motion sequencing, and safety logic. Integrated with PyObs, the driver achieves rms ~0.25° pointing without a model, enabling safe automated tracking and reliable remote operation despite the quirks of legacy hardware.

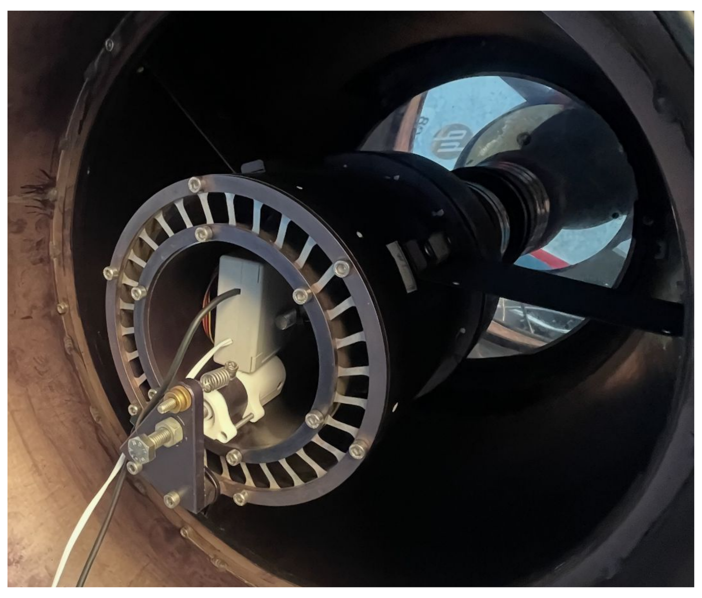

Figure 3: Interim focusing mechanism for ROTSE-IIIc, replacing the original micrometer with a linear actuator housed in a custom 3D-printed mount.

Environment Monitoring: As part of the refurbishment, we developed an extremely low-cost (< €200.00) environmental monitoring system integrating wind, temperature, humidity, and pressure sensors with a custom-built all-sky camera (see Fig. 4).

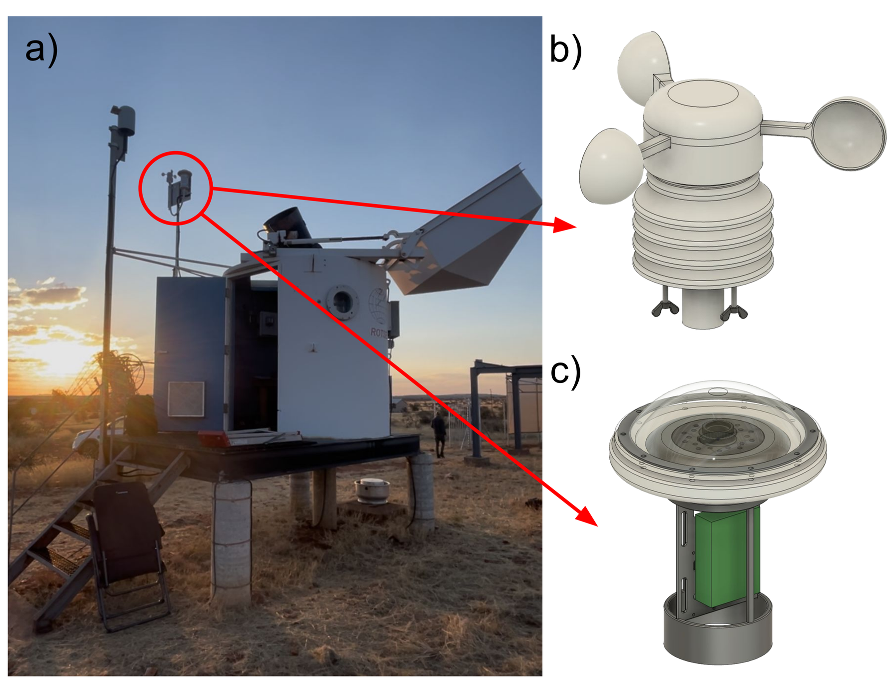

Figure 4: a) ROTSE-IIIc telescope with newly added environment monitoring instruments. b) Custom 3D-printed weather station. c) Custom 3D-printed all-sky camera.

Figure 5: Nighttime all-sky image from the newly installed camera, using a 120° FOV lens with a Sony IMX477R back-illuminated stacked sensor (12.3 MP).

OCS Implementation

The original "rotsed" OCS [1] daemon running on a Windows NT system was replaced with a Linux server running a PyObs daemon managing all core observatory functions.

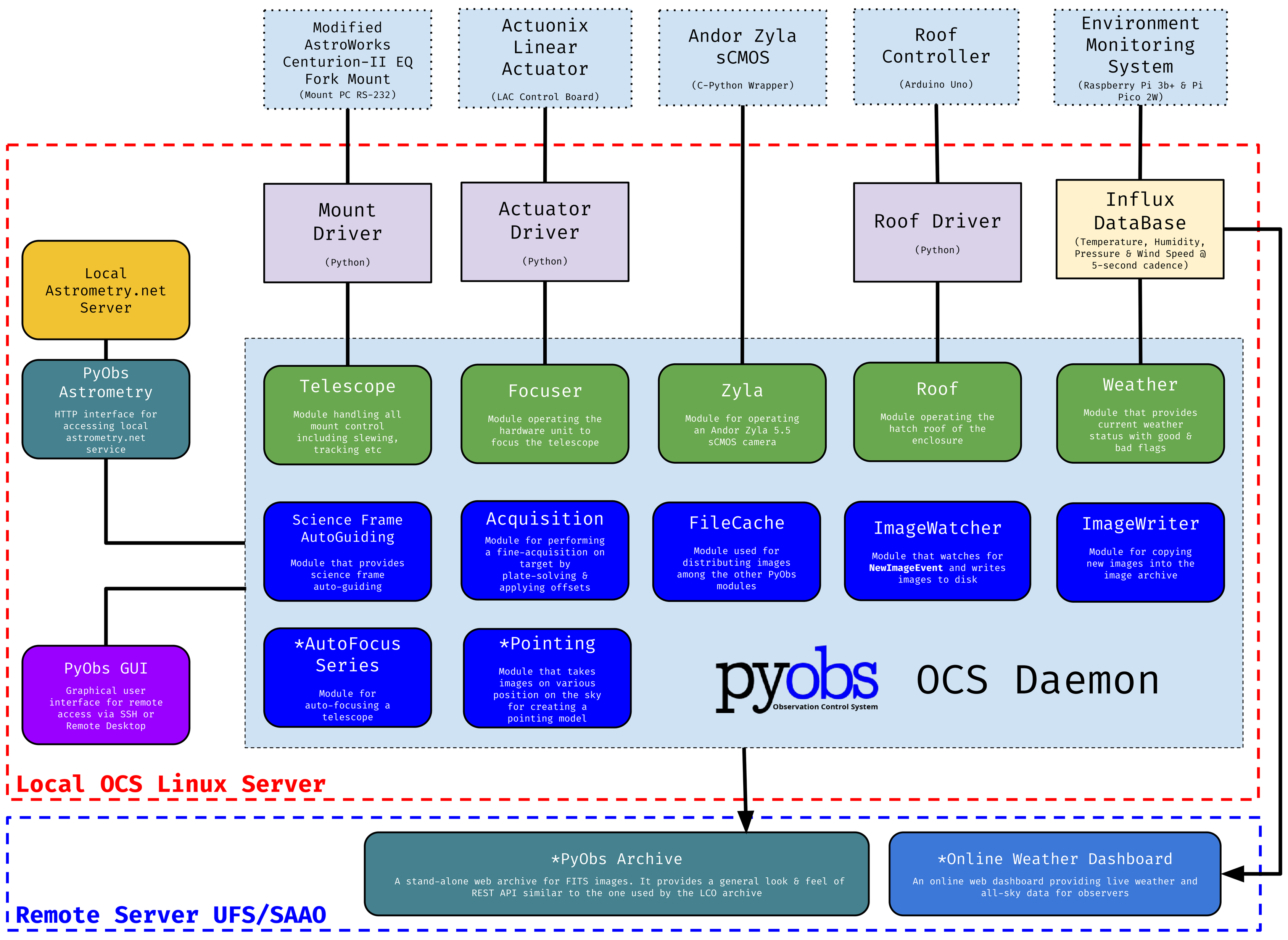

Figure 6. System architecture of the local OCS for ROTSE-IIIc. The modular design shows hardware interfaces (top), custom asynchronous device drivers (purple), and PyObs modules run by the daemon (green and blue). Green modules indicate custom PyObs modules developed for ROTSE-IIIc hardware, while blue modules represent standard PyObs-core components.

Initial On Sky Testing

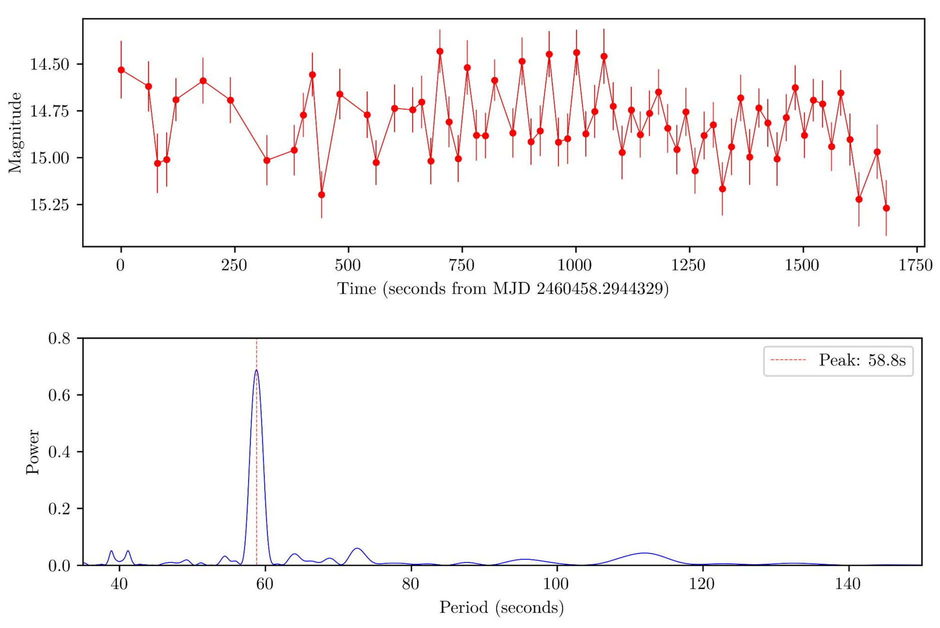

Figure 7: (Top) Light curve of the white dwarf-pulsar AR Sco obtained from 85 × 20 s repeat exposures (~30 min). (Bottom) Lomb–Scargle periodogram revealing the 59 s harmonic of the beat period.

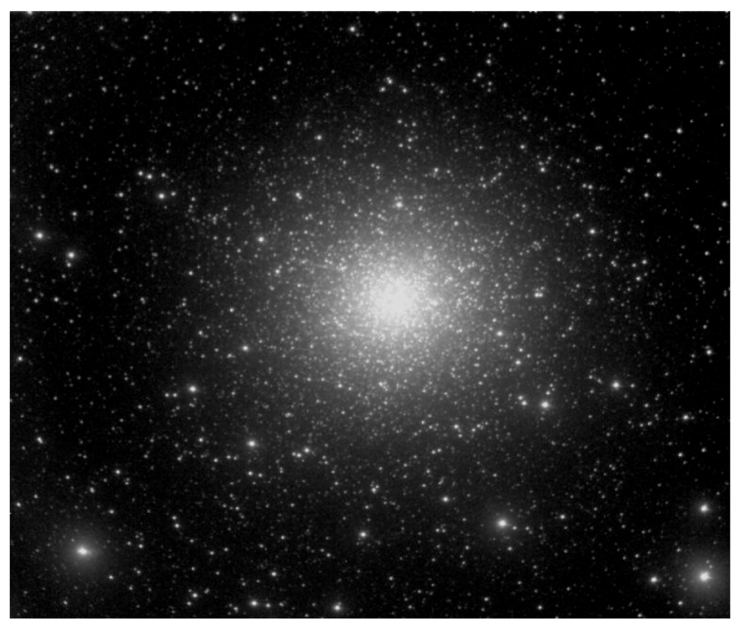

Figure 8: A 30 s exposure of Omega Centauri using 2 × 2 pixel binning.

References

[1] Akerlof et al., "The ROTSE-III Robotic Telescope System."
[2] Husser et al., "Pyobs - An Observatory Control System for Robotic Telescopes."

NRF SAAO National Research Foundation South African Astronomical Observatory
AfAS African Astronomical Society
pyobs Observation Control System
UFS
DARA Development in Africa with Radio Astronomy
AstroRob 2025