The MACRO Consortium

Robotic Telescope Software Development with the MACRO Consortium's *Robert L. Mutel Telescope*: **Pyscope**

AAS 244
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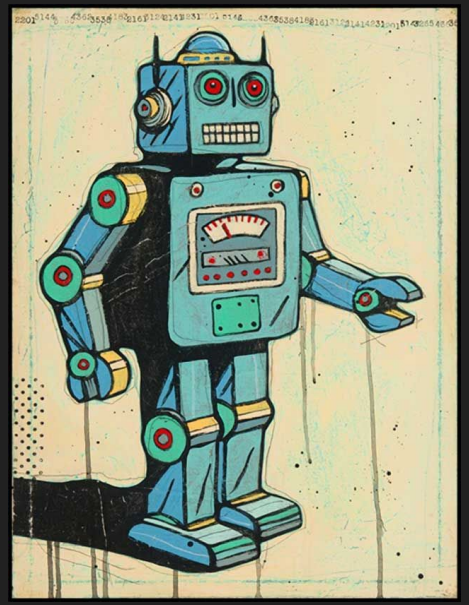
IOWA

Why should I roboticize my university telescope?

- Who doesn't love sleep?
- (Half-)meter telescopes provide flexibility that is otherwise unavailable
- Some research programs are impossible on competitively allocated facilities
- Efficient time use via dynamic queues
- More student engagement and project ownership
- Unique instrumentation development opportunities



Robots Have Anxiety Too – Joel Ganucheau

The Precursors: Talon & IOTA

- Talon was written in C by Elwood Downey
- Systematics drove Robert Mutel to move telescope to Winer Observatory, necessitating remote operations
- After several telescope iterations, the IOTA code was developed by Kevin Ivarsen (now head of software at PlaneWave)
- Iowa Observatory Telescope Automation (IOTA) was Python-based but not generalized
- The transition from the Gemini system operated by the University of Iowa to RLMT operated by MACRO provoked a complete rewrite of telescope software

Credit: Robert Mutel

Introducing pyscope

Three goals:

1. Unify robotic telescope operation under a common and consistent Python-based API that is familiar to astronomers already
2. Does not require special setup and can operate in parallel with remote/manual operations
3. Provides rapid setup and operation of autonomous data collection to support a wide variety of experimental designs

pyscope

Complete Observatory Control

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Package Architecture

Three Main Modules:

1. Observatory
   a. Creates and enforces a consistent API for driver communication
   b. `observatory` class
2. Telrun
   a. Uses the Observatory module to provide automated data collection
   b. `schedtel` and `TelrunOperator`
3. Reduction
   a. Basic functions and wrappers for near-immediate science-ready data products for student lab use
   b. `ccd-calib`, `calc-zmag`, `astrometry-net-wcs`

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An Example: The *Robert L. Mutel Telescope* Setup

```
[site]
site_name = Winer Observatory
instrument_name = Robert L. Mutel Telescope
instrument_description = The MACRO Consortium
latitude = 31d39m56.00000s
longitude = -110d36m06.40000s
elevation = 1515.7
diameter = 0.508
focal_length = 3.454

[camera]
camera_driver = _MaximCamera
camera_kwargs =
cooler_setpoint = -80.0
cooler_tolerance = 1.0
max_dimension = 2048

[cover_calibrator]
cover_calibrator_driver = IPCoverCalibrator
cover_calibrator_kwargs = tcp_ip='192.168.1.22',tcp_port='2101',buffer_size='1024'
cover_calibrator_alt = 27.95316
cover_calibrator_az = 87.20497

[dome]
dome_driver =
dome_kwargs =

[filter_wheel]
filter_wheel_driver = _MaximFilterWheel
filter_wheel_kwargs =
filters = lrg, u, g, r, hrg, i, z, o, y, s, ha, lum, red, green, blue, empty
filter_focus_offsets = 0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0

[focuser]
focuser_driver = PWI4Focuser
focuser_kwargs =

[observing_conditions]
observing_conditions_driver = HTMLObservingConditions
observing_conditions_kwargs = url='https://winer.org/Site/Weather.php'
```

```
[safety_monitor]
driver_0 =
driver_1 =
driver_2 =

[switch]
driver_0 =
driver_1 =
driver_2 =

[telescope]
telescope_driver = ASCOMTelescope
telescope_kwargs = identifier='SiTech.Telescope'
min_altitude = 30.0
settle_time = 3.0

[autofocus]
autofocus_driver = PWI4Autofocus
autofocus_kwargs =

[scheduling]
slew_rate = 0.5
instrument_reconfig_times = {}
```

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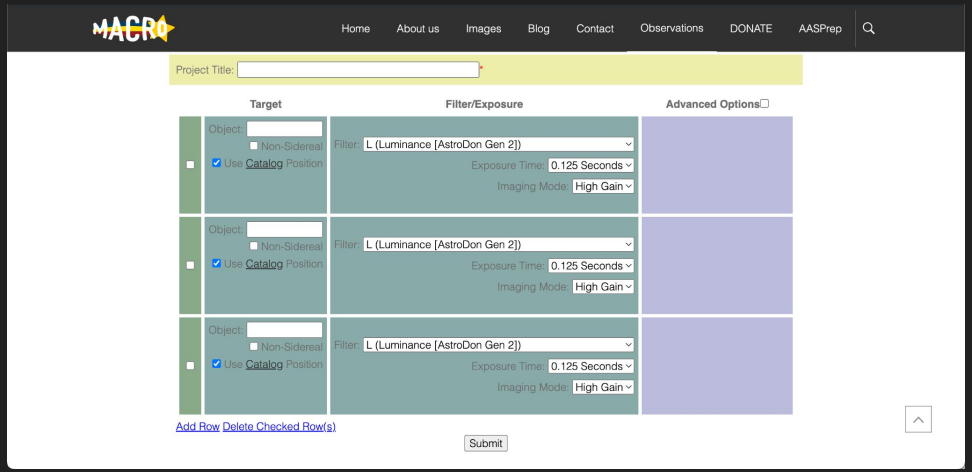
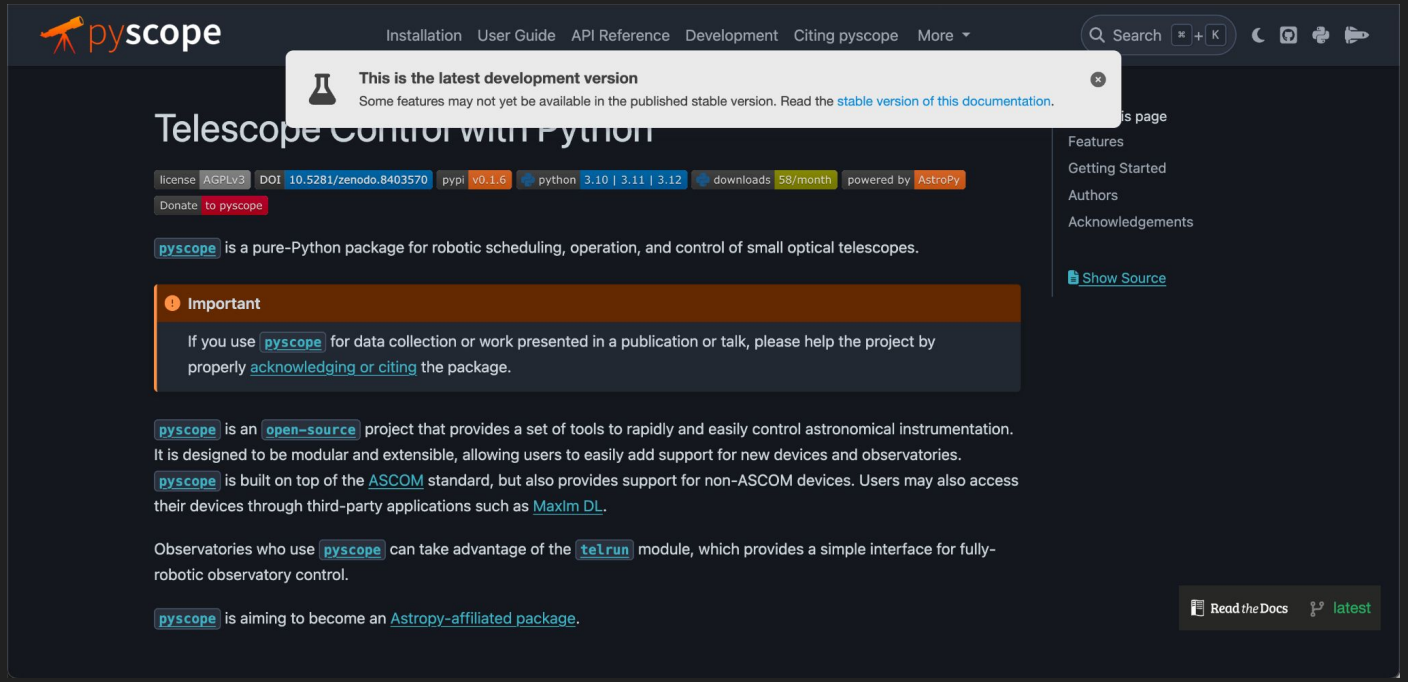
Adding on to pyscope: What will YOU do?

The common API allows users to develop tools to interface with pyscope methods.

Example: the scheduling submission form on the MACRO webpage

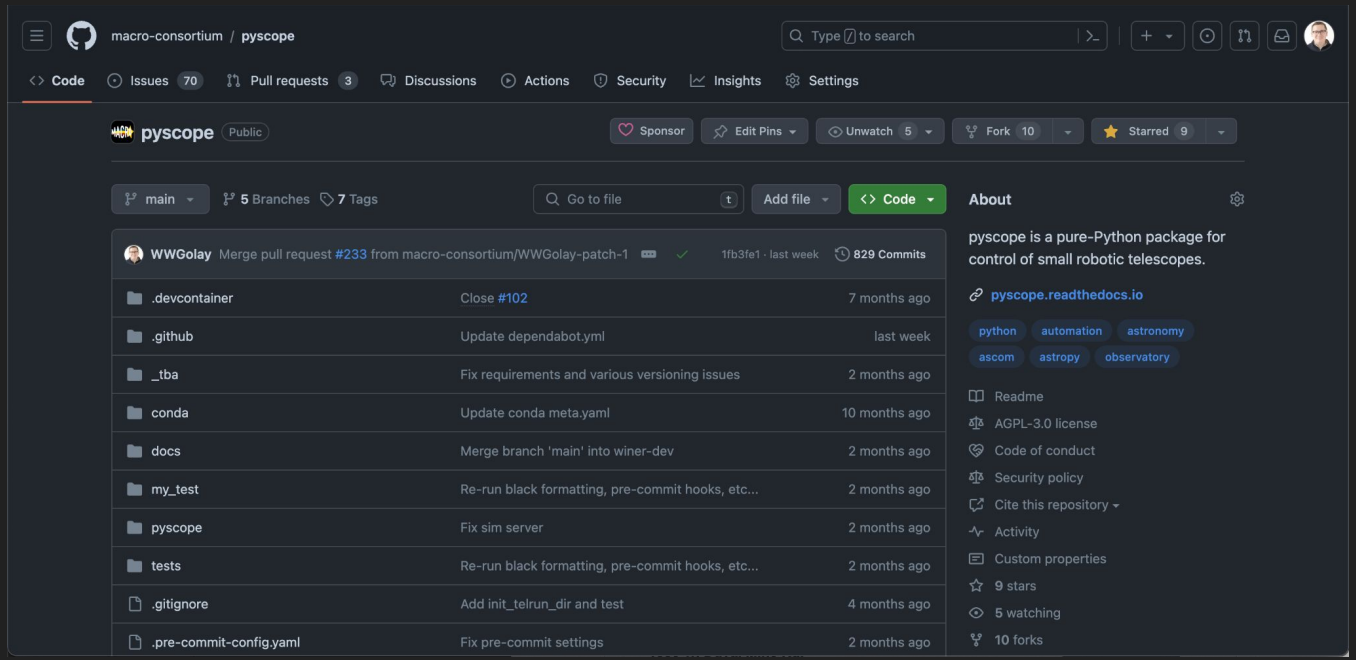


Documentation is on the way!



https://pyscope.readthedocs.io/en/latest/

Our GitHub page: Get updates



https://github.com/macro-consortium/pyscope

Our GitHub page: Contribute

https://github.com/macro-consortium/pyscope

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Complete Observatory Control

Thank You!

Questions?

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