ATLAS: A Global, All-Sky Robotic NEO Detection System

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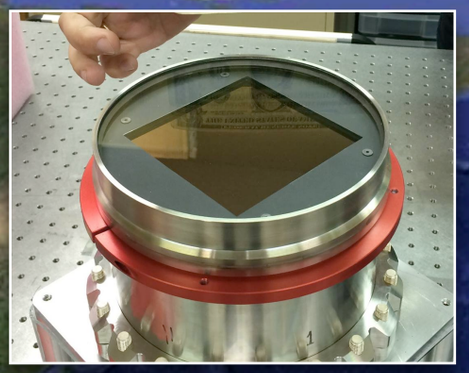
EU-ESA Workshop on NEO Imminent Impactors Warning Coordination, London
December 2022

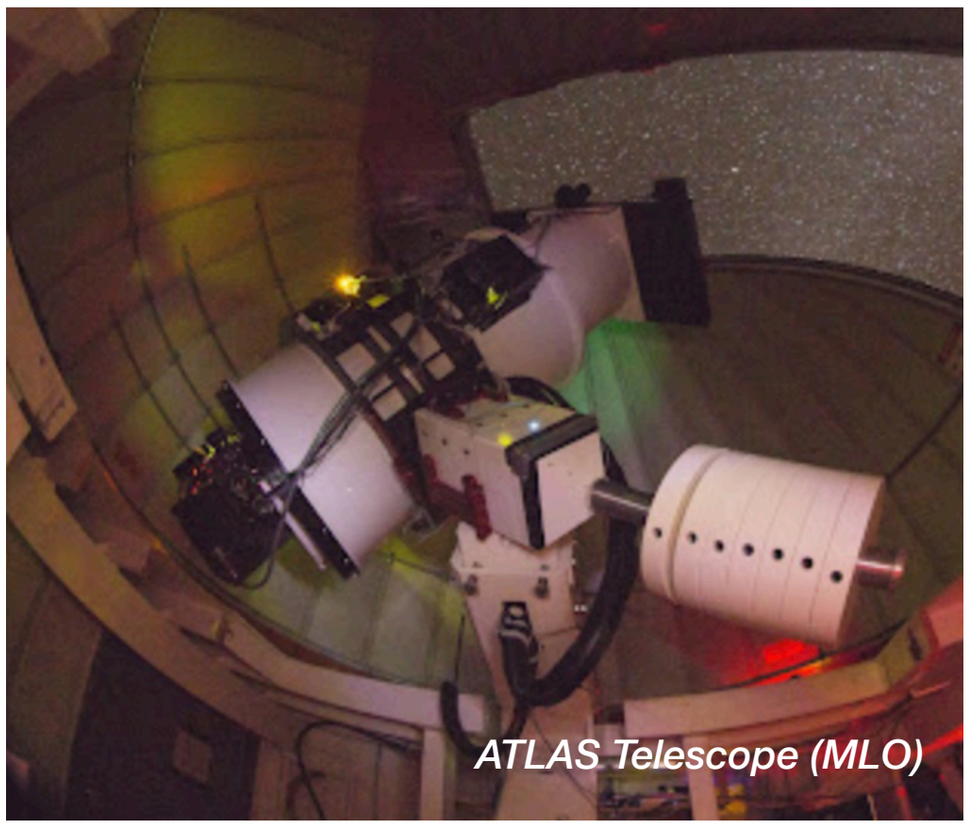
ATLAS System

ATLAS Dome (STH)



ATLAS 10K x 10K camera

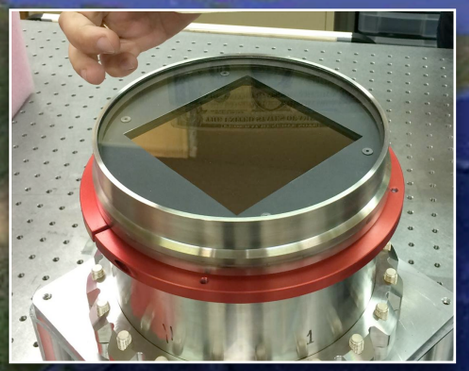
- Currently funded by NASA PDCO through 2025, 5 FTEs
- 0.5 m primary, *f*/2 Schmidt, 30 deg² (7.5° FOV illuminating 5.4° × 5.4°), ~2.5″ PSF
- 110 Mpixel STA1600 detector, 1.9″ pixels
- **Two broadband filters: “cyan” (*g*+*r*) and “orange” (*r*+*i*)**
- **Four 30-second observations over a ~20-minute “quad”**
- Entire dark sky (“pole-to-pole”) down to *m*=19.7 ~nightly
- 100% robotic operation & automatic real-time processing
- Tonry+ 2018 PASP (arXiv:1802.00879)



ATLAS Telescope (MLO)

ATLAS System

ATLAS Dome (STH)



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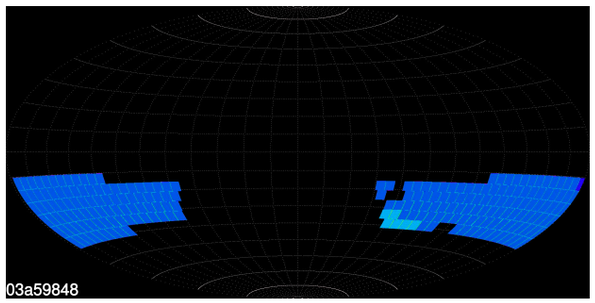
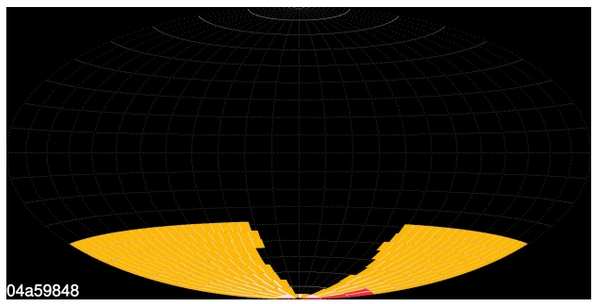
ATLAS Telescope (MLO)

ATLAS Sky Coverage

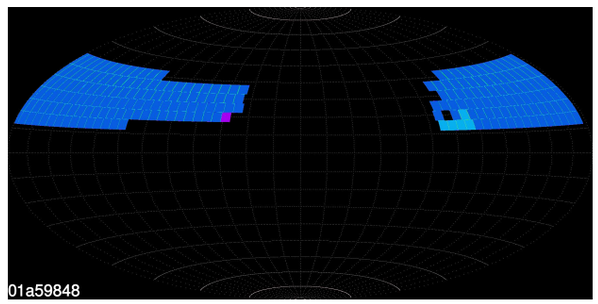
Typical Night



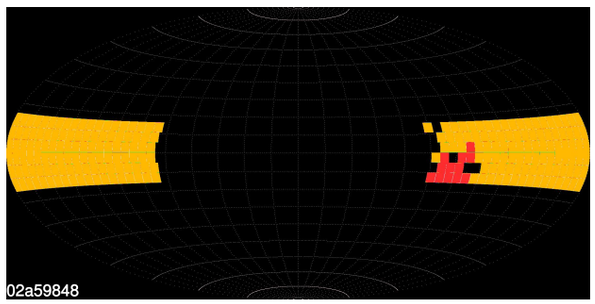
South Africa



Chile

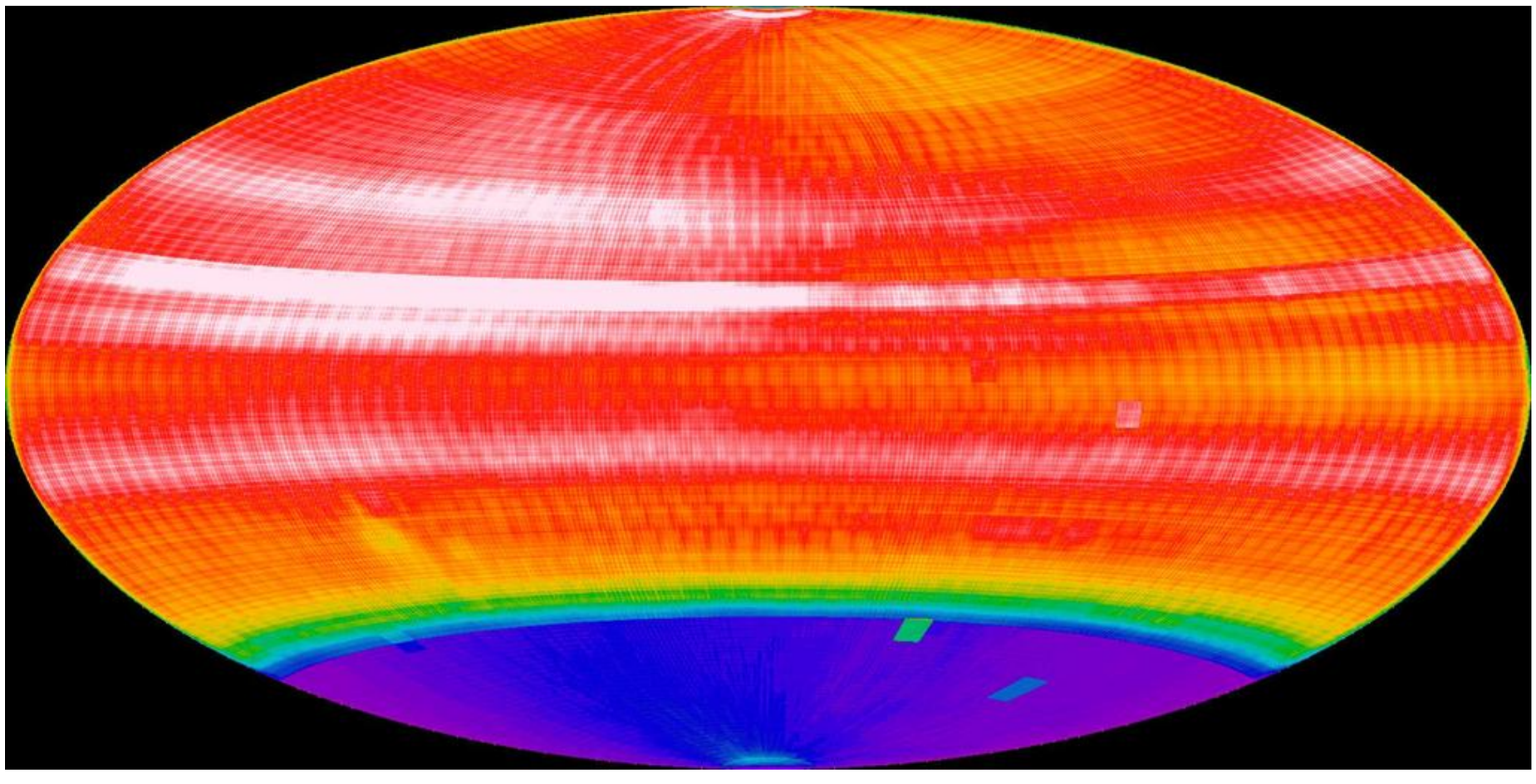


Mauna Loa



Haleakalā

4 30-second observations at each footprint over 30 minutes
c (“*g*+*r*”) when moon is down, *o* (“*r*+*i*”) when moon is up



Sky coverage 2015-2022

900 obs

1800 obs

2700 obs

3600 obs

ATLAS Telescope Scheduling

- Nominal schedule is computed from a pre-assigned declination band (just “fill the band”), avoiding only the Sun and bright moon
- Scheduler has a hardware model that knows about dome and mount performance and precise physical layout of telescope
- **Schedule is recomputed every exposure to correct for weather and observational glitches**
- **The nominal schedule is interruptible; system can inject high-priority observations into the existing schedule**

ATLAS as a Real-Time System

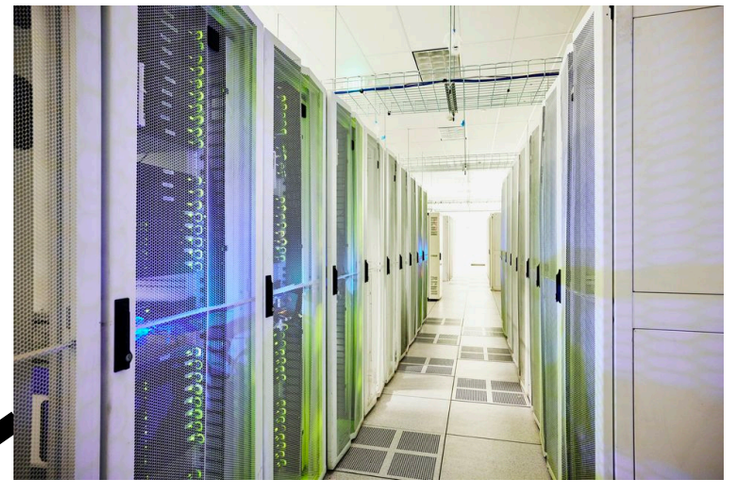
ATLAS Staff
and Collaborators

Tracklet
Review

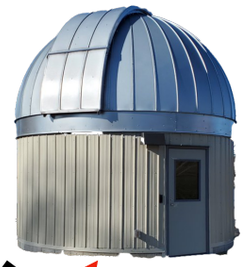
Submit
NEOs

Followup
Requests

IfA Manoa Datacenter (UH)



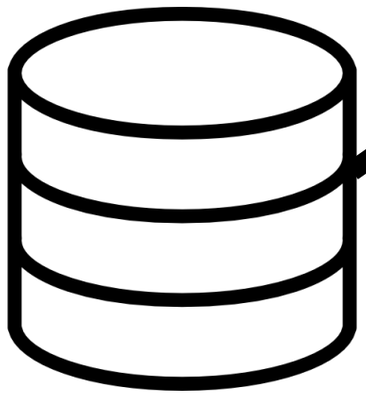
Mauna Loa (T08)



Reduced
Images

Special
Observation
Requests

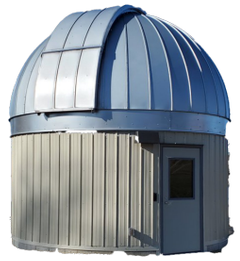
Haleakalā (T05)



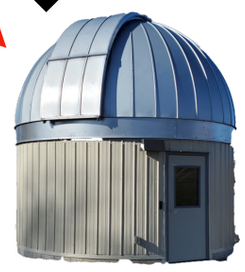
ATLAS Data
Repository

ATLAS NEO
Observations

MPC



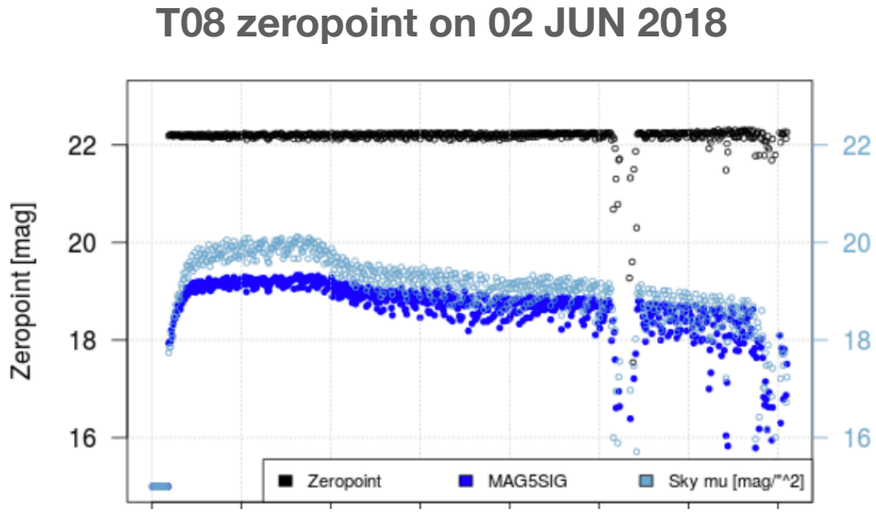
Chile (W68)

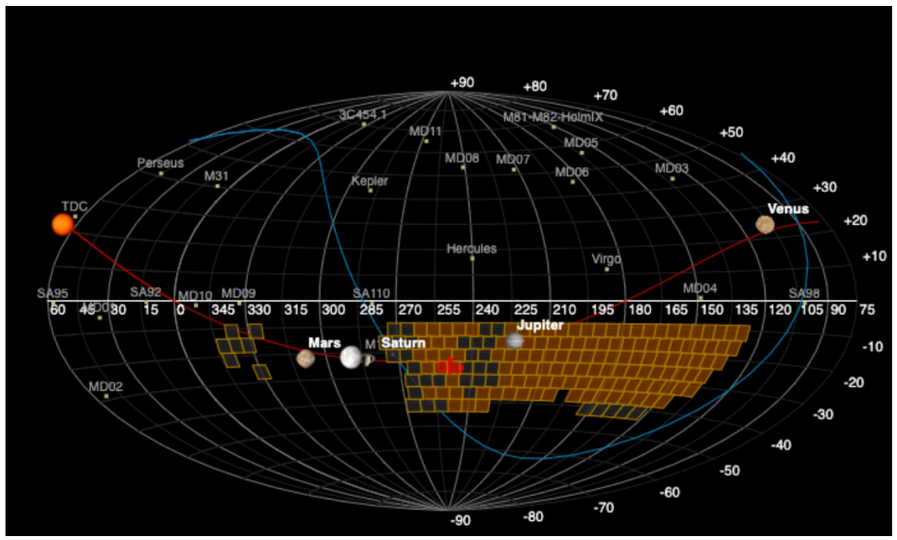


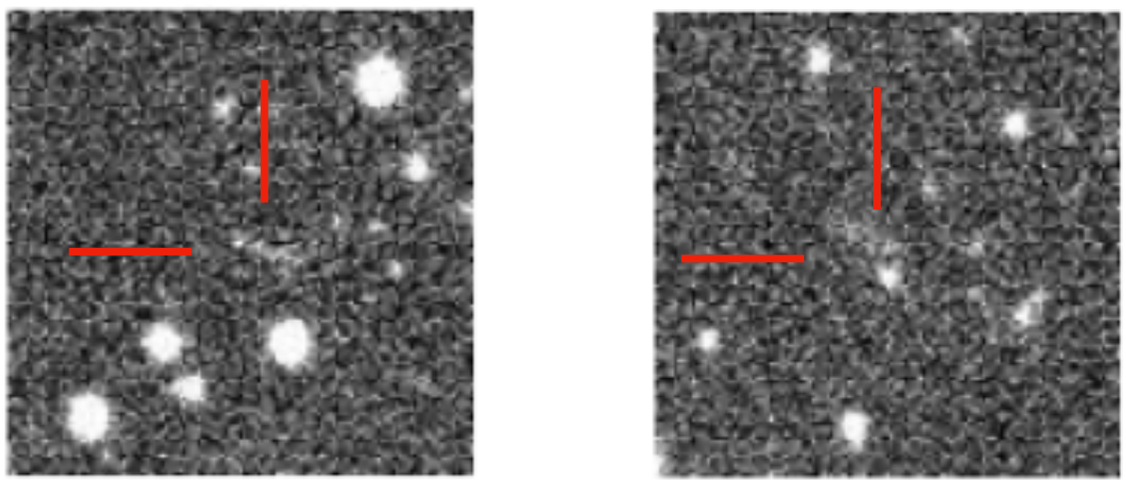
Sutherland (M22)

2018 LA

- Detected 08:22 UT by G96 (22:22 HST)
- 04:31 HST Scout alert; A. Gibbs at CSS attempts to contact ATLAS by SMS
- T08 was already scheduled to cover the area in poor conditions
- Two detections retrieved by A. Heinze; arc extended from 85 to 230 min. Three detections are required for automatic processing.

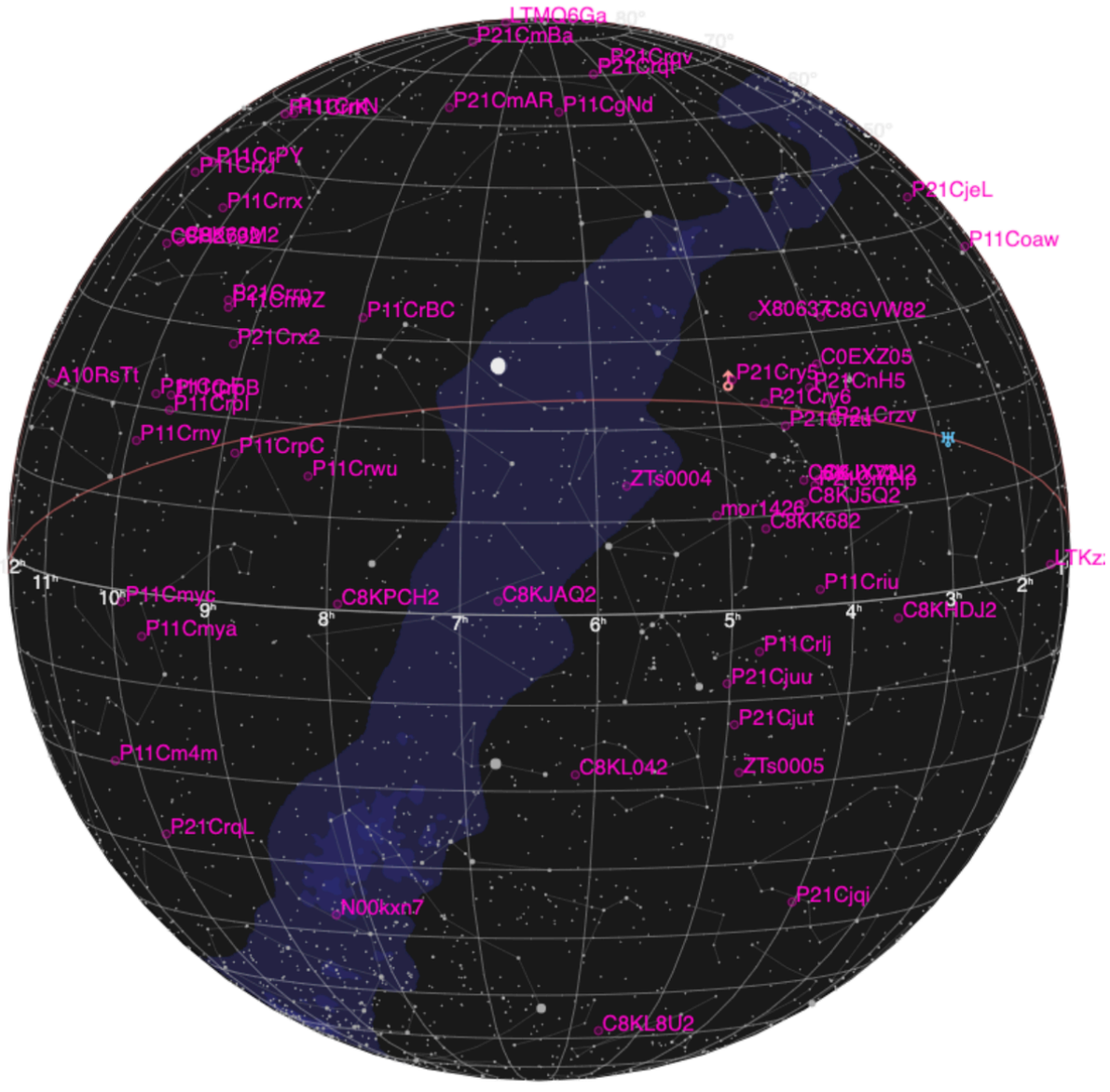






2018 LA in ATLAS T08 exposures

ATLAS NEOCP Handoff



Select NEOCP object to follow up: C0EXZ05

Your email address:

An optional comment about this request:

Request followup

ATLAS telescopes are commanded within 30 seconds of receiving a request!

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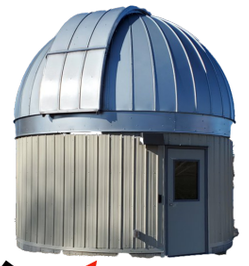
Mauna Loa (T08)



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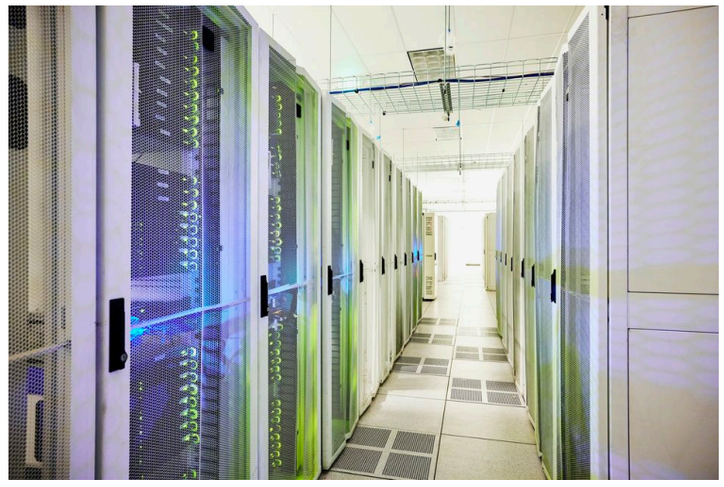
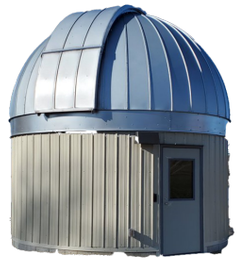




Haleakalā (T05)

Marco Micheli

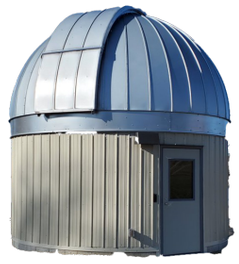
NEOCP
Handoff

NEOCP
Handoff

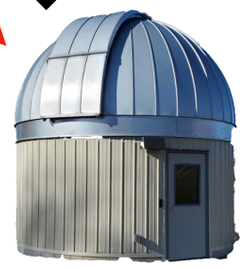
Catalina Sky Survey

ATLAS NEO
Observations

MPC



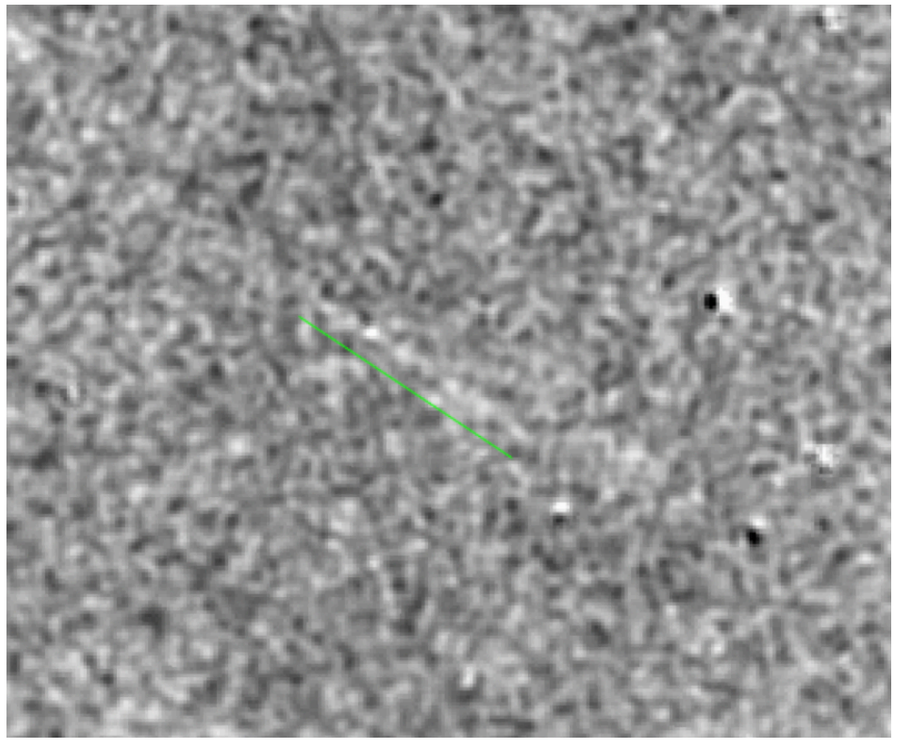
Chile (W68)



Sutherland (M22)

2022 WJ1

- Detected 04:53 UT by G96
- 06:38 UT Handoff request for C8FF042 by D. Rankin of CSS
- T08 and T05 started observations at 06:39 UT. W68 at 06:40. (M22 was closed).
- Pointing was based on nominal NEOCP RA/Dec for obscode=500. *Normally this is good enough!*
- Due to parallax and object faintness, it was recovered visually via Horizons ephemeris in only one ATLAS exposure
- 84 deg/day (211 arcsec/minute)



C8FF042 / 2022 WJ1 in ATLAS exposure 02a59902o0215o

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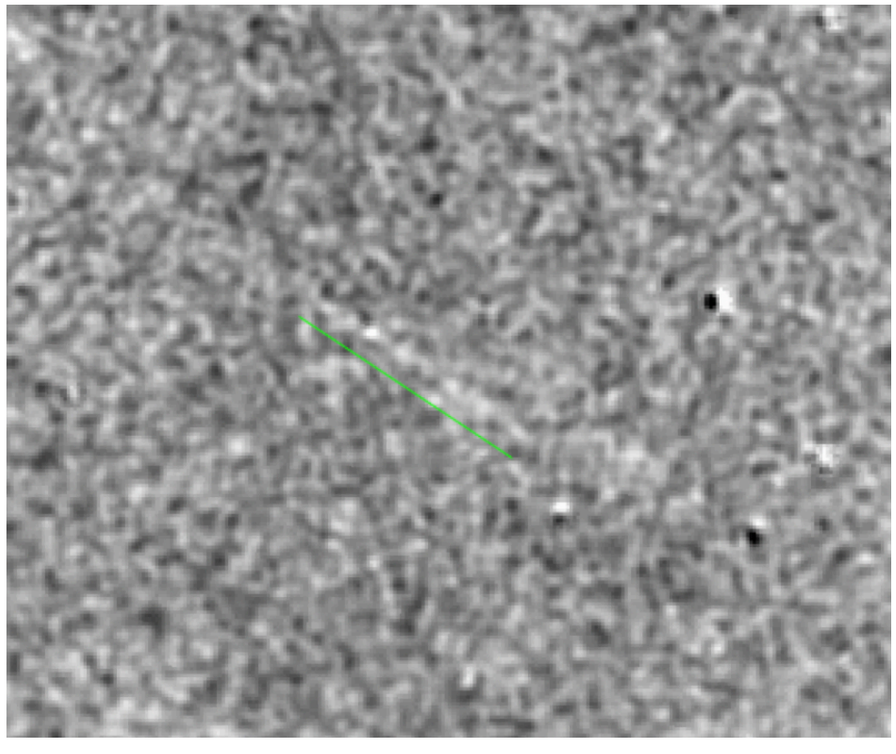
Handoff request worked flawlessly

Ephemeris was poor

Object was very challenging (and fortunately completely harmless)



C8FF042 / 2022 WJ1 in ATLAS exposure 02a59902o0215o

Next steps

- Improve ephemeris computation and scheduling for difficult cases, in particular for very high rates of motion.

- Devise special real-time processing and reporting for external urgent requests using motion as a prior. This may bypass the regular ATLAS pipeline.

- Develop software to report real-time precoveries for all NEOCP and hand-off objects.

- **Develop community standards for machine-to-machine communication where needed. (Remember VOEvents?)**

- **Community access and/or automatic Scout/ NEODys triggers?**