



Imaging Capabilities of the MACRO Consortium's Robert L. Mutel Telescope

James Wetzel

Adjunct Assistant Professor of Physics, Coe College, jwetzel@coe.edu

On behalf of the
The MACRO Consortium



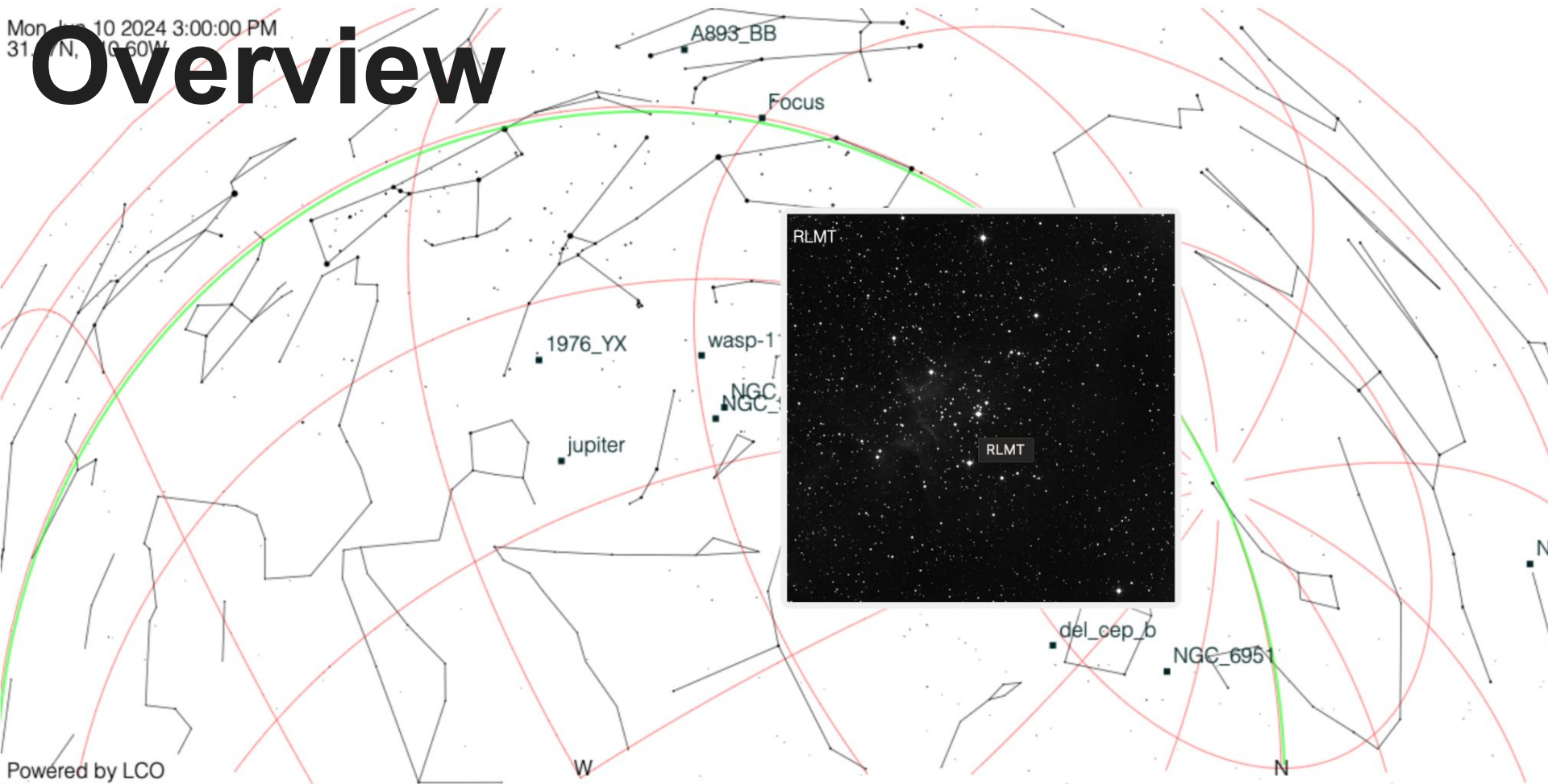
AAS 244
Madison, WI

IOWA



Mon Jun 10 2024 3:00:00 PM
31° N, 106° 60' W

Overview



Powered by LCO

Rewind One Hour

Advance One Hour

Reset to Midnight

Cycle Projection

Overview

- The RLMT system allows users to schedule optical observations via the web.
(www.macroconsortium.org)
- Observations are scheduled by user priority.
- Images are automatically taken, calibrated, and published to the web.
- Users can specify cadences, non-sidereal objects, exposure times, filters...

The MACRO Telescope Consortium
Macalester, Augustana, Coe Remote Observatory
Home of the Robert L. Mutel Telescope

[Make an Observation Request...](#)

Project Information:
Project Title:

Target	Filter/Exposure	Advanced Options
Object: <input type="text"/> <input type="checkbox"/> Non-Sidereal <input type="checkbox"/> Use Catalog Position RA: <input type="text"/> :00:00:00 Dec: <input type="text"/> :00:00:00	Filter: L (Luminance [AstroDon Gen 2]) Exposure Time: 0.125 Seconds Imaging Mode: High Gain	Repeats: 0 Delay: <input type="text"/> Start Time: <input type="text"/> LST Observe Date: <input type="text"/>

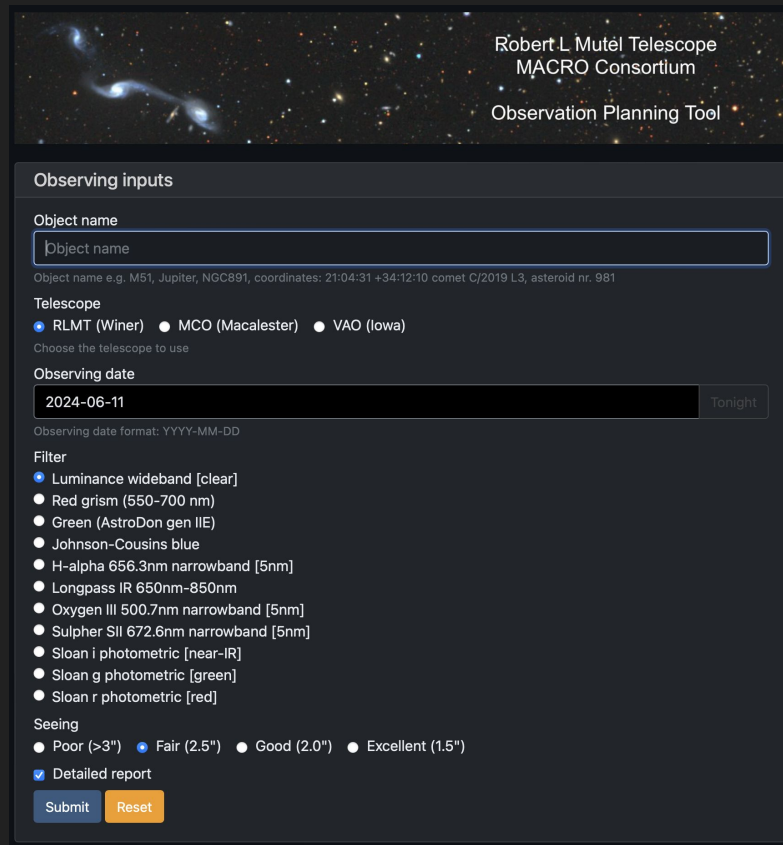
<https://macroconsortium.org/images/reduced/2024-06-10/>

Index of /images/reduced/2024-06-10

Name	Last modified	Size	Description
Parent Directory	-	-	-
cjh_Lagoon_blue_30s_..>	2024-06-10 10:49	8.0M	
cjh_Lagoon_blue_30s_..>	2024-06-10 10:49	8.0M	
cjh_Lagoon_blue_30s_..>	2024-06-10 10:49	8.0M	
cjh_Lagoon_blue_30s_..>	2024-06-10 10:49	8.0M	

Overview

- Obsplanner tool
- Allows students to predict exposure times for a given object for a given filter.



Robert L. Mutel Telescope
MACRO Consortium
Observation Planning Tool

Observing inputs

Object name

Object name e.g. M51, Jupiter, NGC891, coordinates: 21:04:31 +34:12:10 comet C/2019 L3, asteroid nr. 981

Telescope
 RLMT (Winer) MCO (Macalester) VAO (Iowa)

Choose the telescope to use

Observing date
 Tonight

Observing date format: YYYY-MM-DD

Filter
 Luminance wideband [clear]
 Red grism (550-700 nm)
 Green (AstroDon gen IIe)
 Johnson-Cousins blue
 H-alpha 656.3nm narrowband [5nm]
 Longpass IR 650nm-850nm
 Oxygen III 500.7nm narrowband [5nm]
 Sulphur SII 672.6nm narrowband [5nm]
 Sloan i photometric [near-IR]
 Sloan g photometric [green]
 Sloan r photometric [red]

Seeing
 Poor (>3") Fair (2.5") Good (2.0") Excellent (1.5")

Detailed report

Instrument Description



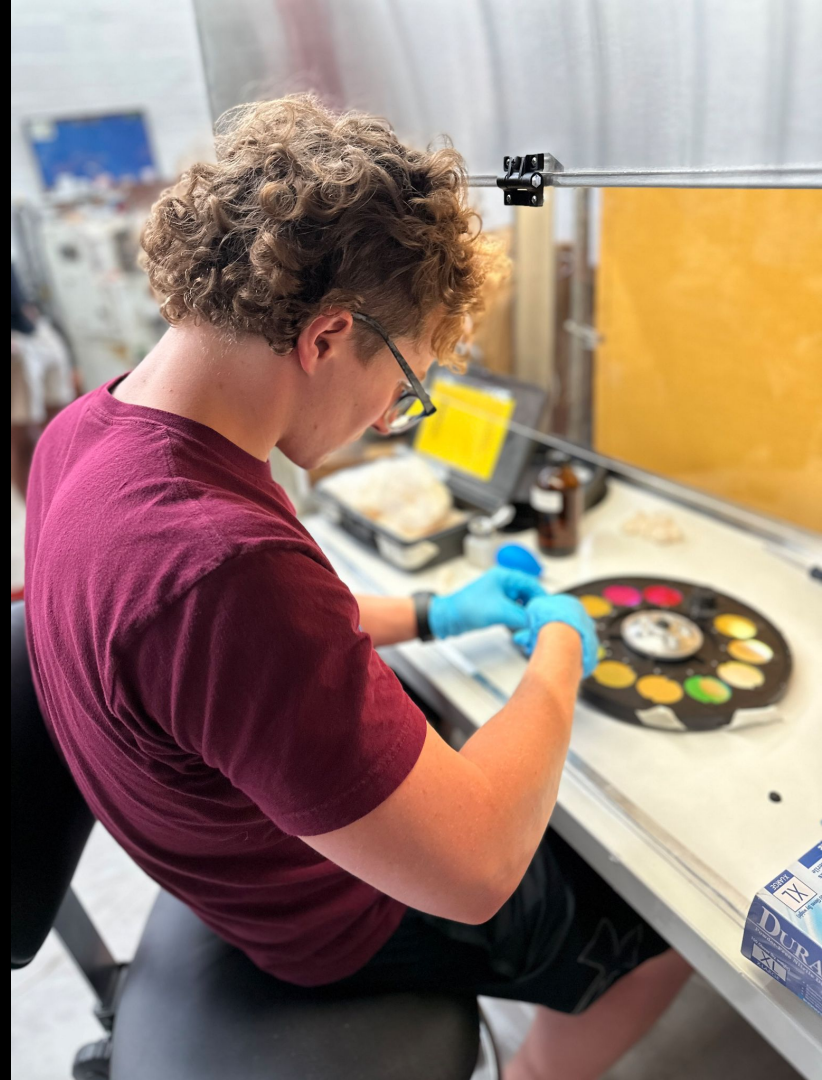
Instrument Description

- 0.51 m PlaneWave CDK 20
- $f/6.8$ Dall-Kirkham optics
- Mathis MI750 equatorial mount
- Andor iKon L936 CCD camera
- Two filter wheels
- Water chiller

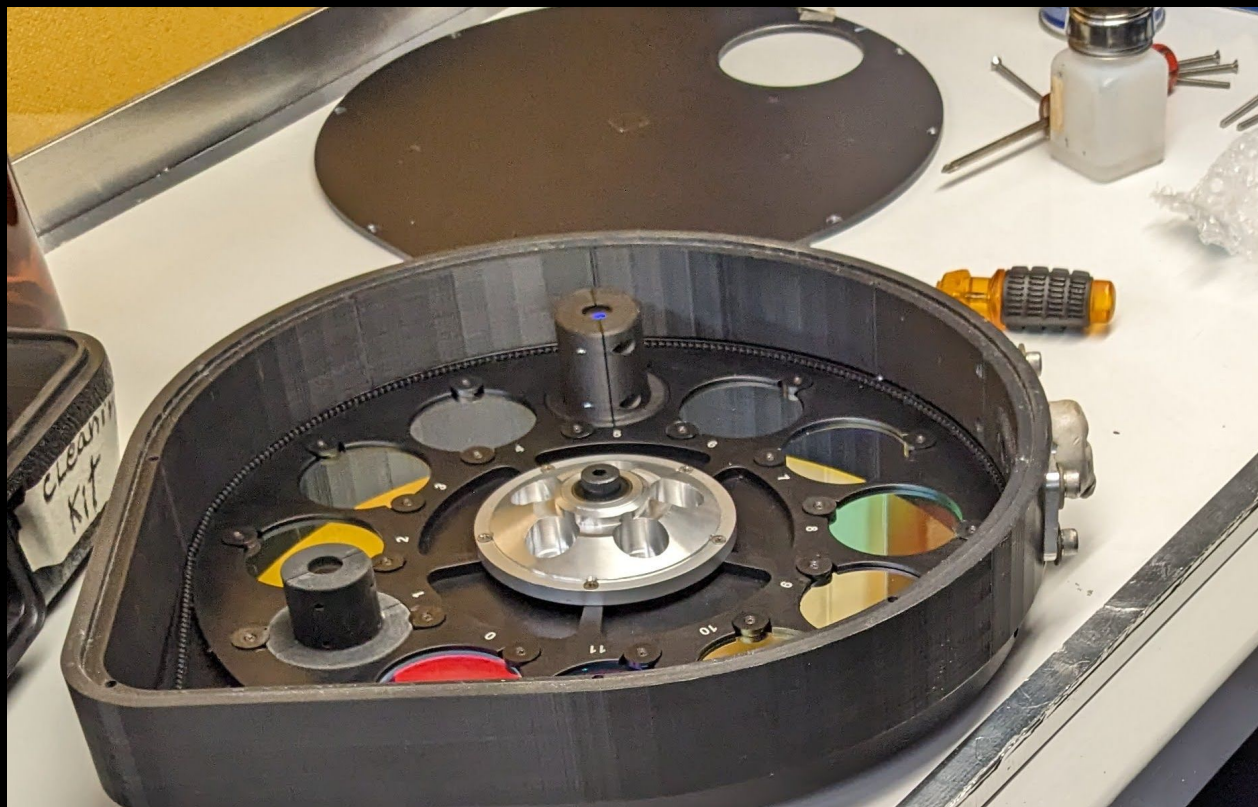


Filter Wheels

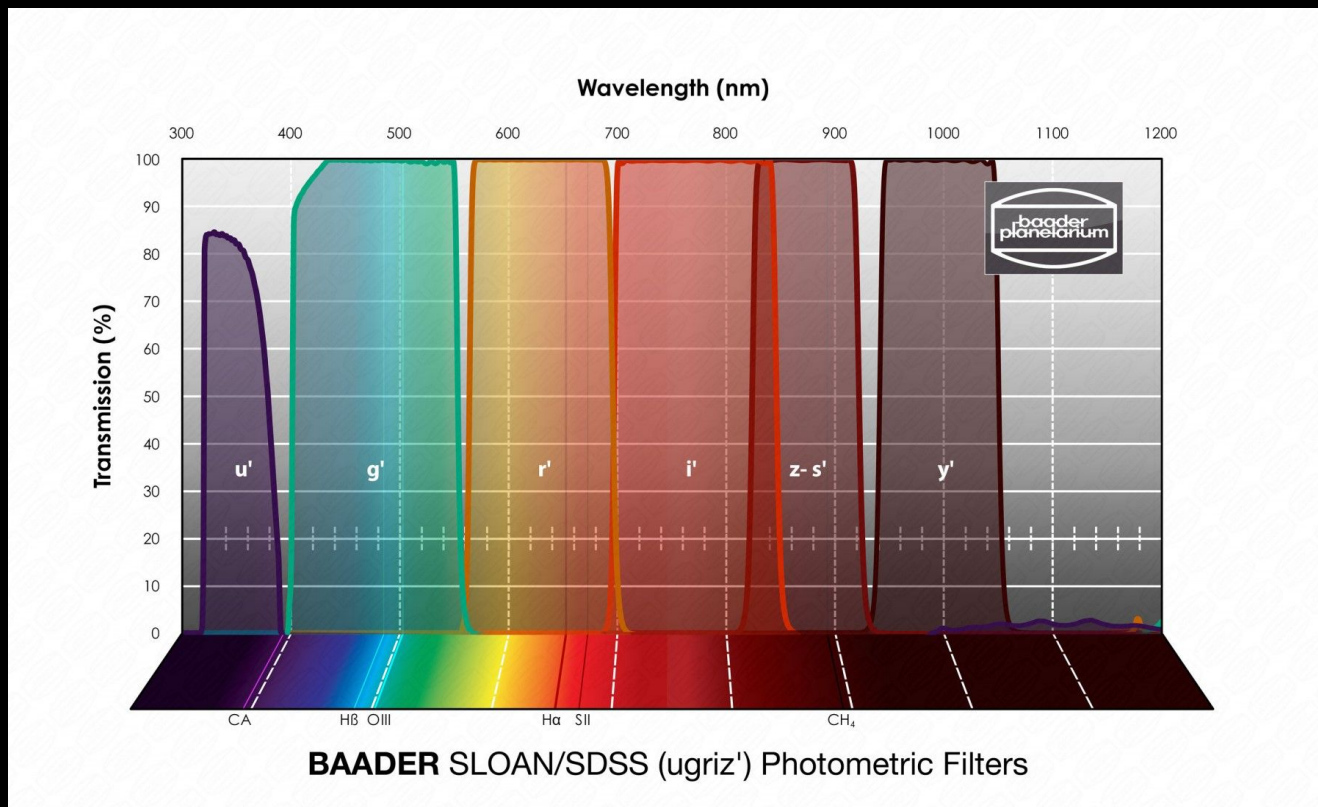
- Finger Lakes Instruments CFW3-12
 - Sloan (u', g', r', i', z', y')
 - Low Resolution Grism
 - High Resolution Grism
 - OIII, SII, Ha
- Finger Lakes Instruments CFW9-5
 - Red, Green, Blue, Lum



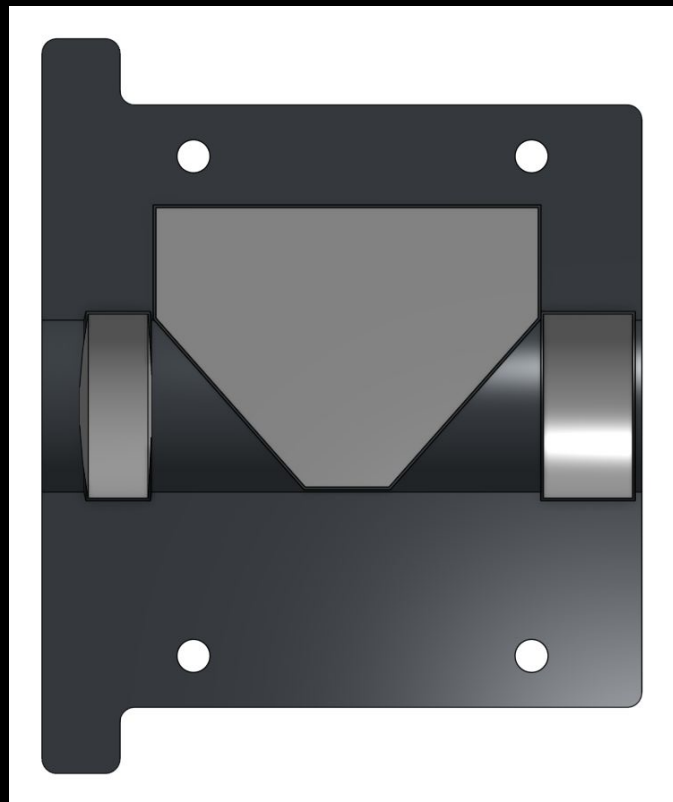
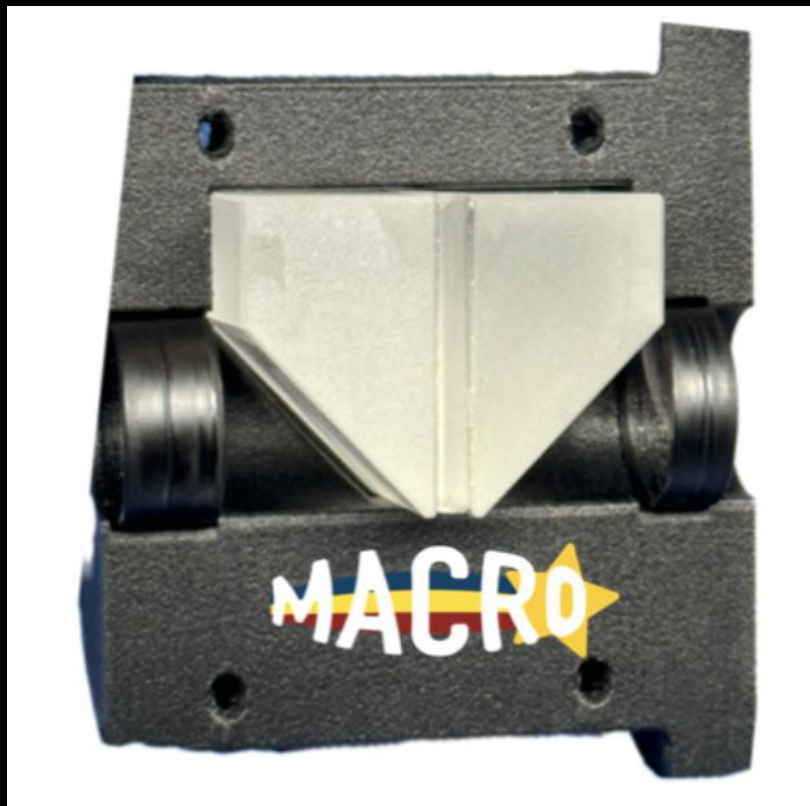
Filter Wheels



Filter Wheel - Photometric Filters

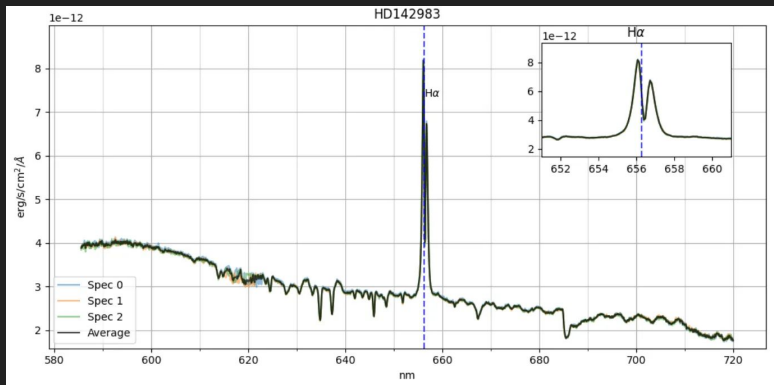


Grisms:

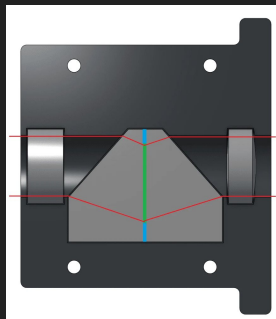
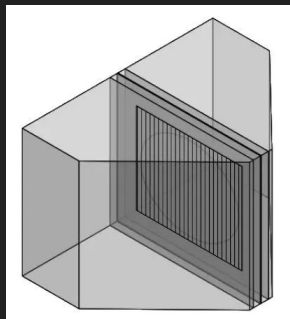
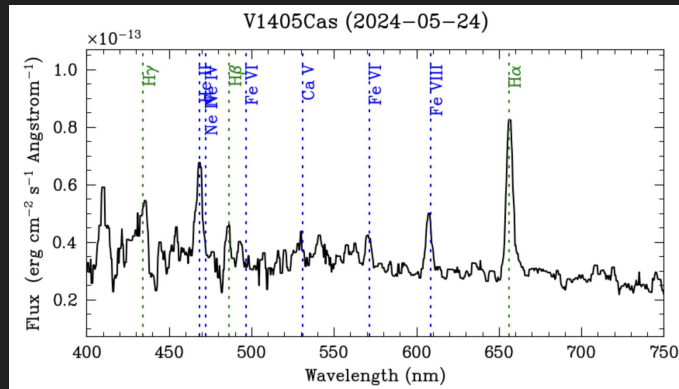


Grisms

- High Resolution Grism

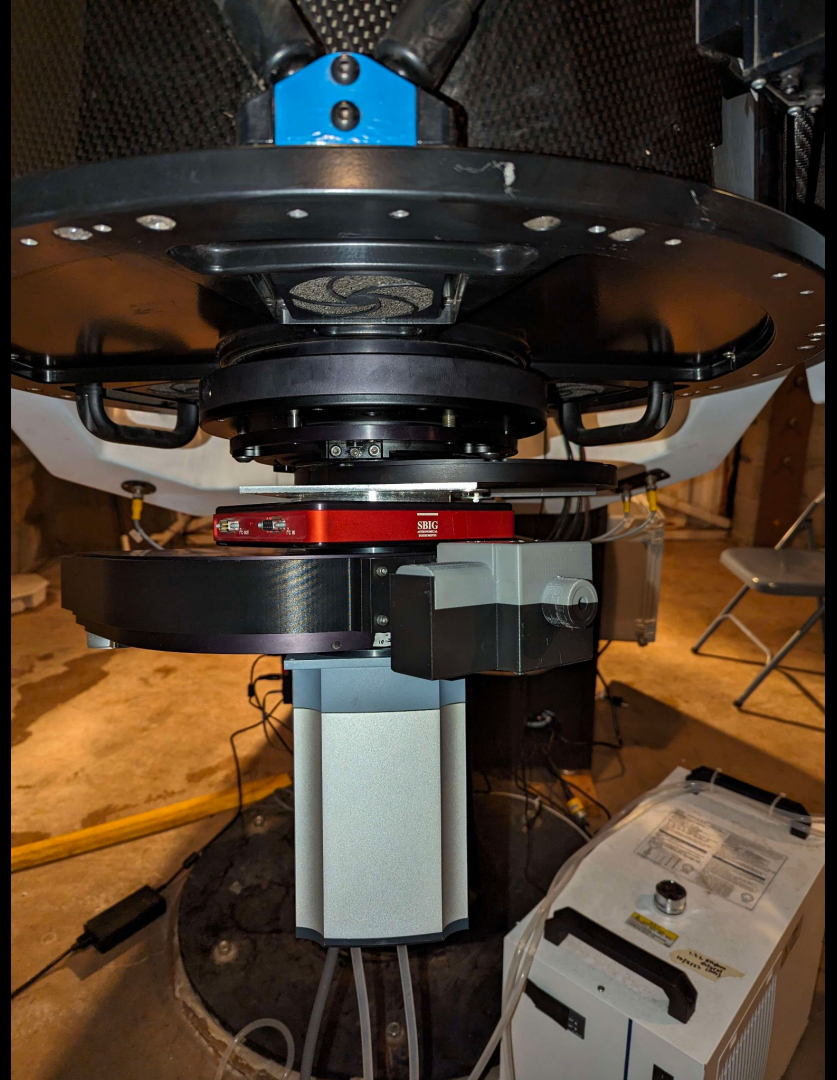


- Low Resolution Grism

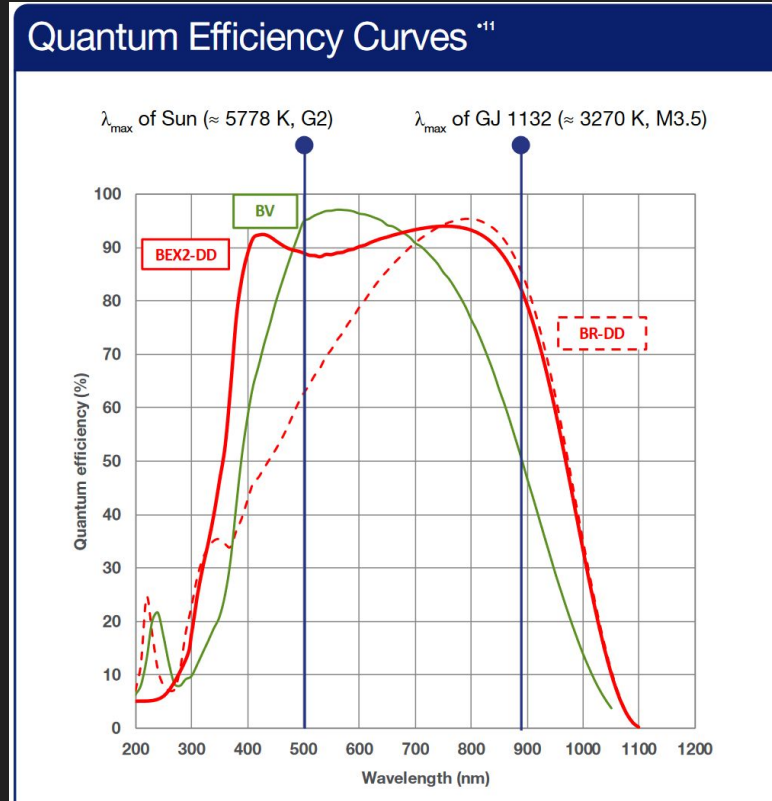


Camera

- Andor iKon 936-L
 - 100°C ΔT from ambient
 - Operates at -80°C
 - Water/Glycol-Chilled



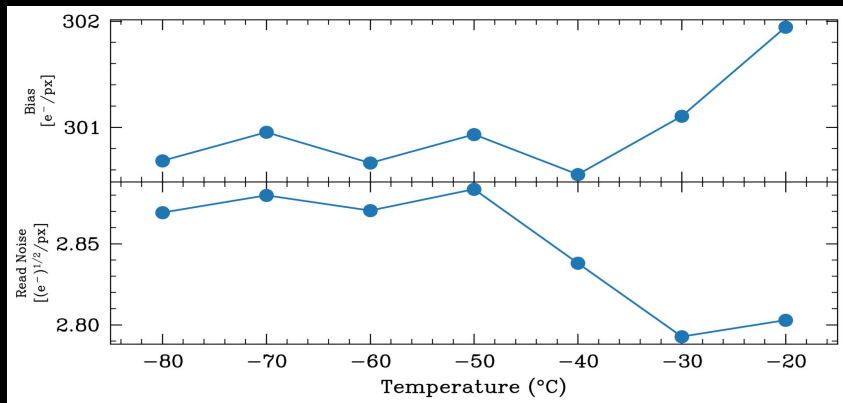
Camera



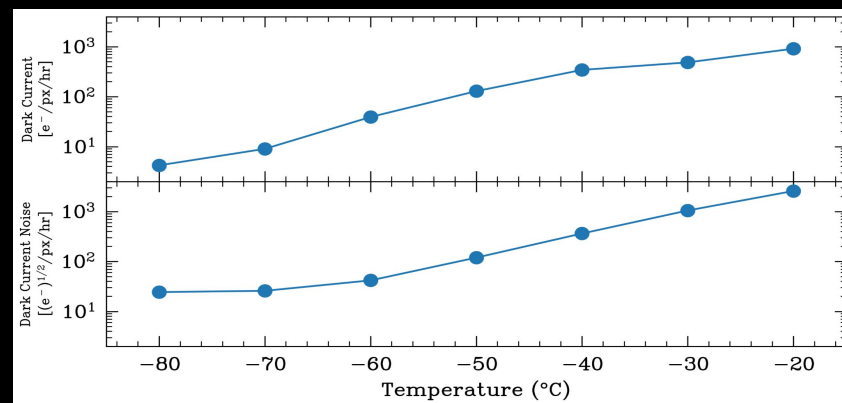
Detector Performance

Detector Performance

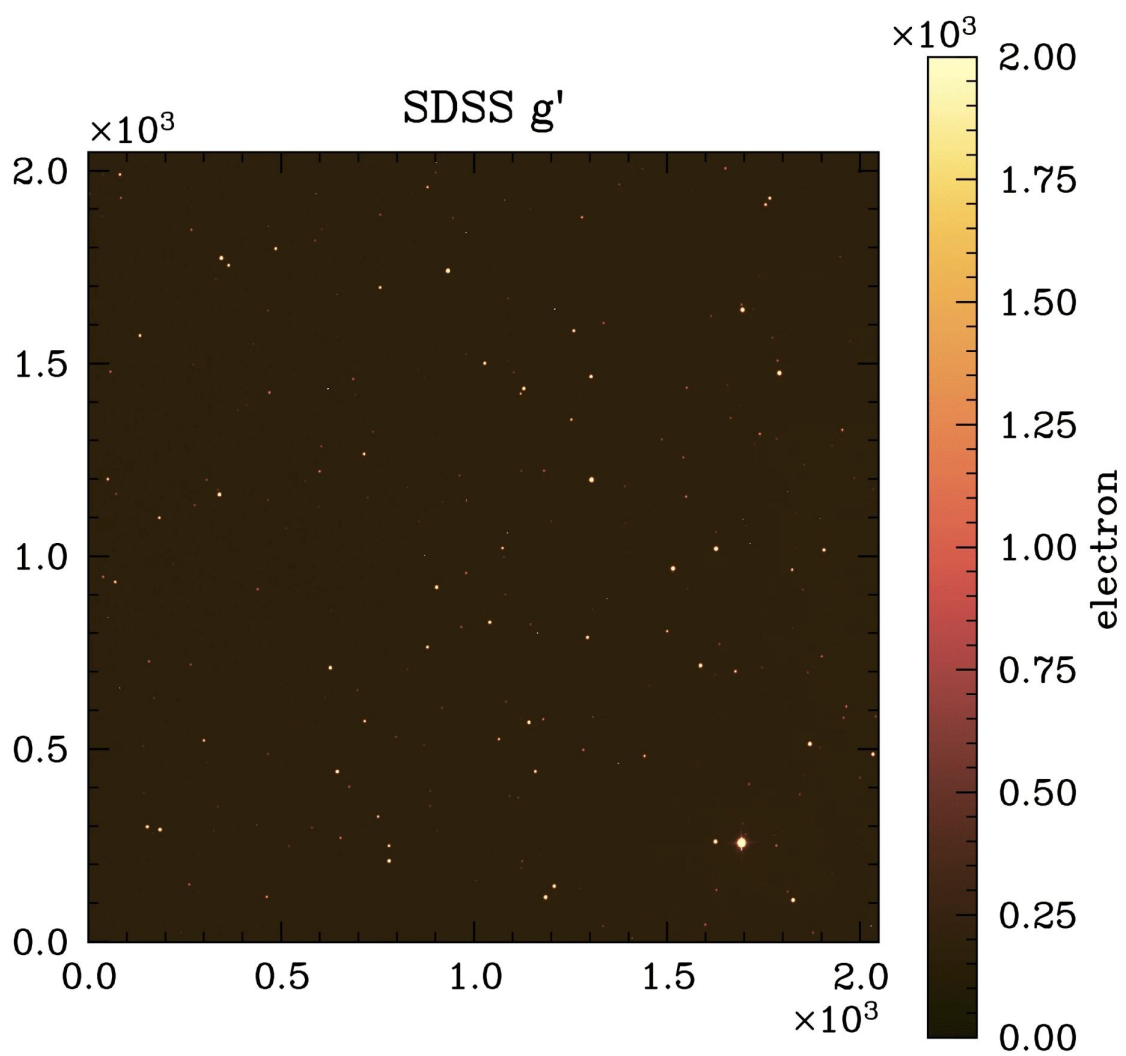
Temperature-dependent bias and read noise properties of the Andor iKon 936-L: 2.9 root-electrons per pixel read noise @ -80°C



Temperature-dependent dark current and estimated noise properties: Dark current of 4.2 electrons per pixel per hour at -80°C .



System Performance

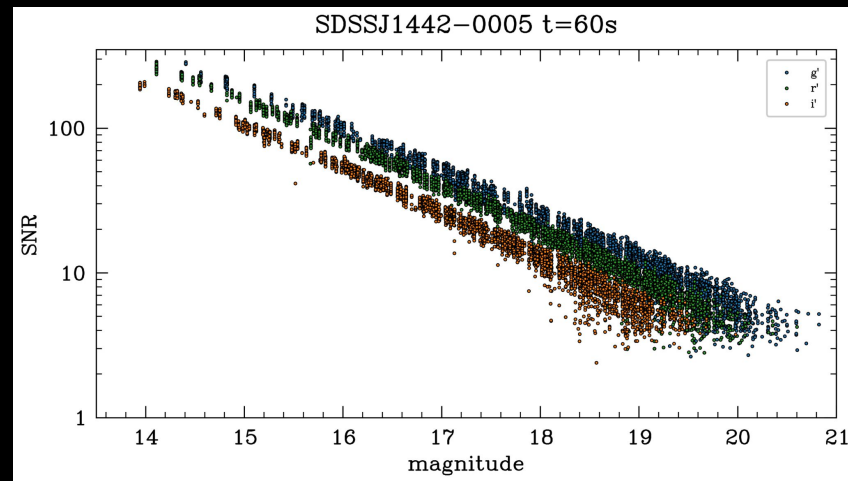
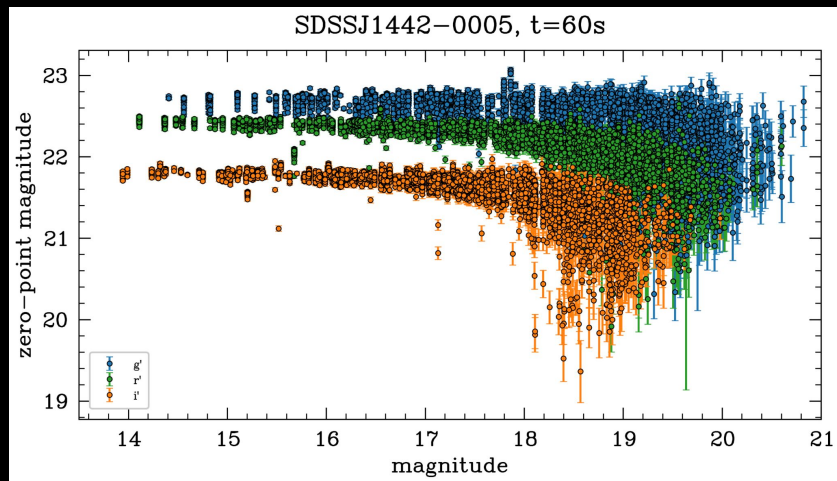


System Performance

The zero point magnitude in Sloan g' , r' , and i' filters estimated from 10 images of the SDSSJ1442-0005 field. Results:

$$g' = 22.43 \pm 0.81,$$
$$r' = 22.17 \pm 0.86,$$
$$i' = 21.53 \pm 0.79$$

Signal-to-noise ratio in the same field, dominated by the source's Poisson noise or the sky's Poisson noise at very dim magnitudes. For photometric modes, the detector-generated noise makes only a negligible contribution.



Imaging Calibration

Imaging Calibration

Images taken by the system are automatically calibrated and published on the web for download by users.

Calibration Steps:

- 1 - Master bias subtraction
- 2 - Master dark frame subtraction
- 3 - Divide out a normalized flat frame
- 4 - Cosmic Ray removal
- 5 - Seeing/ZP Mag calculations

Imaging Calibration

Calibration images can be acquired with skyflats, or using a screen + lamps in the observatory.



Imaging Calibration

Raw and Reduced copies of the images and the calibration images used are published to the web.

Calibration files used are added to the Reduced image's FITS header.

Each morning a summary email is sent to users.

Observing statistics

Total number of observing projects: 9

Total number of images: 224

Moon phase range: 23% - 28%

Median zenith seeing: 3.0 +/- 0.5 arcsec

Total observing time: 7.7 hrs

Code	Observer	N image	Time (min)	UT range
irm	alexandra-moreno	36	9	1222 - 123759
ige	anna-fox	2	8	75043 - 75524
ice	connor-stomp	1	17	71049 - 71049
xwg	wgolay	6	4	74706 - 114858
ibb	ryan-paris	1	17	35722 - 35722
ide	olivia-kasych	1	1	35421 - 35421
ica	caroline-roberts	3	25	104604 - 110602
iab	isabella-burgos	3	12	120736 - 121655
ibc	hannah-hehn	3	8	34405 - 35405
ida	leila-assadi	1	4	115150 - 115150
iac	hayden-ersbo	3	6	115832 - 120335
icd	carson-simon	3	51	80924 - 85011
idd	mackenzie-kanach	3	10	80006 - 104810
ibf	paige-e-pearson	1	8	111459 - 111459
icf	ashley-rankin	1	17	73647 - 73647
itq	salvatore-quaid	2	25	101356 - 102750
icc	natalie-santiago	3	51	91533 - 95042
ibe	ella-crawford	3	25	112358 - 114140

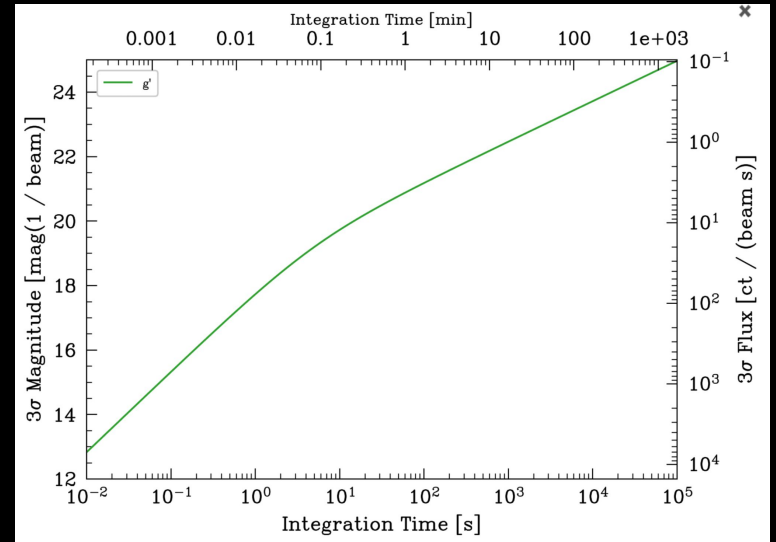
Next Steps

Next Steps

Signal-to-noise Model:

Dependent on seeing, relative Rayleigh scattering and Mie scattering, moon phase, etc.

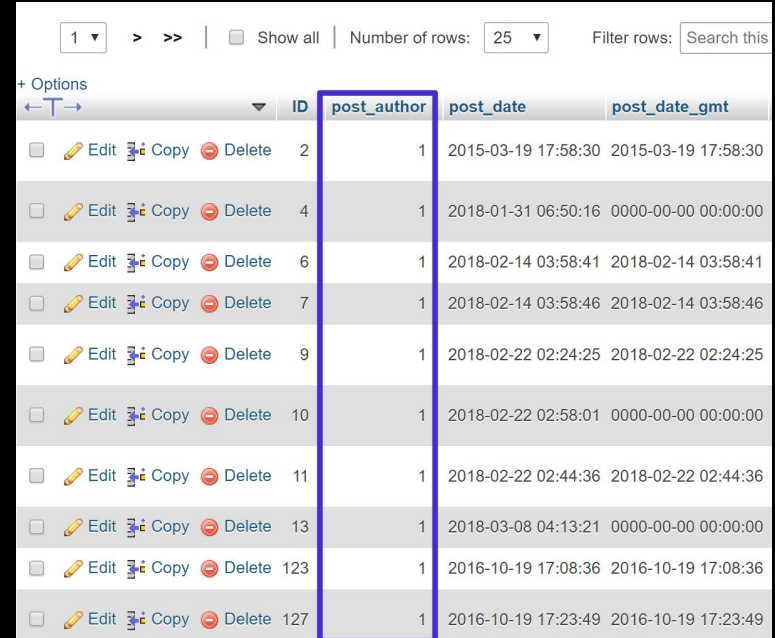
We plan to characterize the time-dependent properties of the Winer Observatory site using this model. A sample plot generated by our model is shown right for the predicted properties of the site.



Next Steps

Move to Database Schema-

- Target scheduling, tracking, and results all stored in a database.
- Allows unscheduled targets to be rescheduled.
- Allows sorting and searching for specific targets and filters and exposure times.



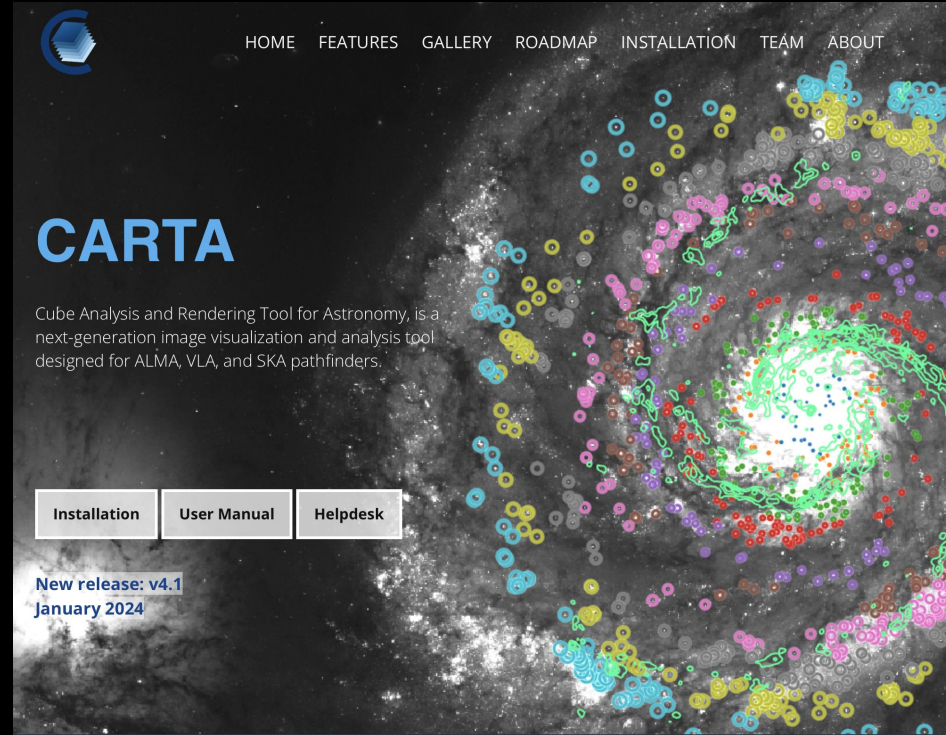
The screenshot shows a database table with the following columns: ID, post_author, post_date, and post_date_gmt. The table contains 10 rows of data. The 'post_author' column is highlighted with a blue box. The interface includes a search bar at the top right and a table header with options for editing, copying, and deleting rows.

ID	post_author	post_date	post_date_gmt
2	1	2015-03-19 17:58:30	2015-03-19 17:58:30
4	1	2018-01-31 06:50:16	0000-00-00 00:00:00
6	1	2018-02-14 03:58:41	2018-02-14 03:58:41
7	1	2018-02-14 03:58:46	2018-02-14 03:58:46
9	1	2018-02-22 02:24:25	2018-02-22 02:24:25
10	1	2018-02-22 02:58:01	0000-00-00 00:00:00
11	1	2018-02-22 02:44:36	2018-02-22 02:44:36
13	1	2018-03-08 04:13:21	0000-00-00 00:00:00
123	1	2016-10-19 17:08:36	2016-10-19 17:08:36
127	1	2016-10-19 17:23:49	2016-10-19 17:23:49

Next Steps

Server-side analysis tools:

- CARTA
- Jupyter notebooks
- Allows easy access to images for students
- Easier for computer labs to not need specific analysis tools installed across all campuses



Thank you!

MACRO

The word "MACRO" is written in a large, white, rounded, sans-serif font. It is set against a background of three horizontal stripes: blue on top, yellow in the middle, and red on the bottom. To the right of the word, a large yellow five-pointed star is positioned, partially overlapping the letters 'R' and 'O'. The entire graphic is centered on a black background.