

# A common interface for small and giant telescopes



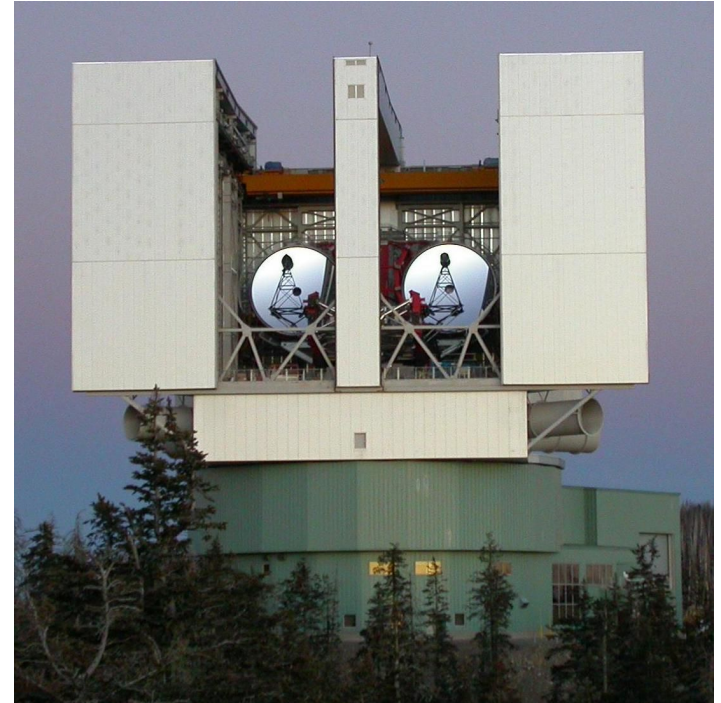
Davide Ricci, Lorenzo Cabona, Andrea Damonte  
6° ChiantiTopics, 2024-02-28

# “Small telescopes in the giant era”

- Astelco Alt-Az **80cm**, two Nasmyth foci: SBIG STX-16081 **CCD**, and ocular
- “Commissioning and improvements of the instrumentation and launch of the scientific exploitation of OARPAF”, **2021JATIS...7b5003R**
  - <https://doi.org/10.1117/1.JATIS.7.2.025003>



- **2x 8.2m**, several focal station. **SHARK-NIR** on gregorian left
- *Improvements to SHINS, the SHARK-NIR instrument software, during the AIT phase, **2022SPIE12189E..20R***
  - <https://doi.org/10.1117/12.2629469>



# “Small telescopes in the giant era”

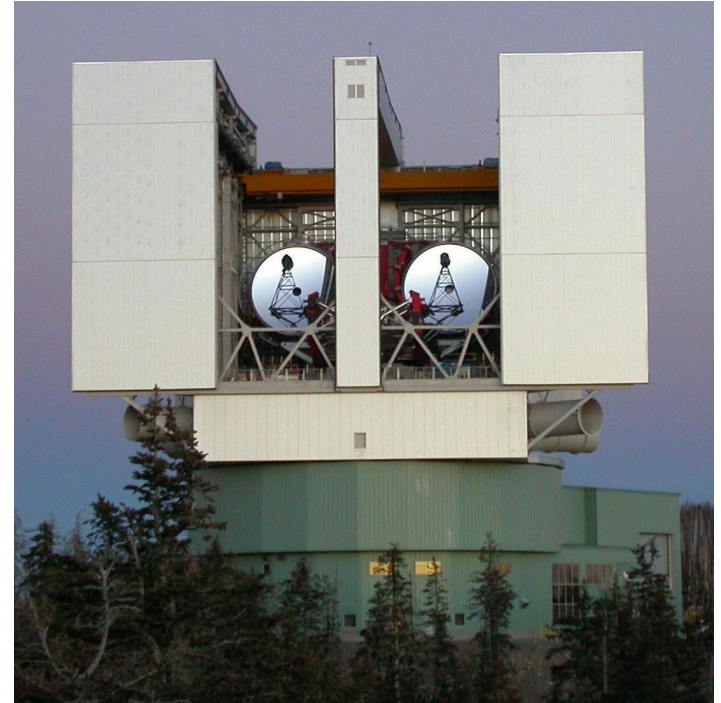
- Astelco Alt-Az **80cm**, two Nasmyth foci: SBIG STX-16081 CCD, and ocular



YESTERDAY



- **2x 8.2m**, several focal station. **SHARK-NIR** on gregorian left
- *Improvements to SHINS, the SHARK-NIR instrument software, during the AIT phase, **2022SPIE12189E..20R***
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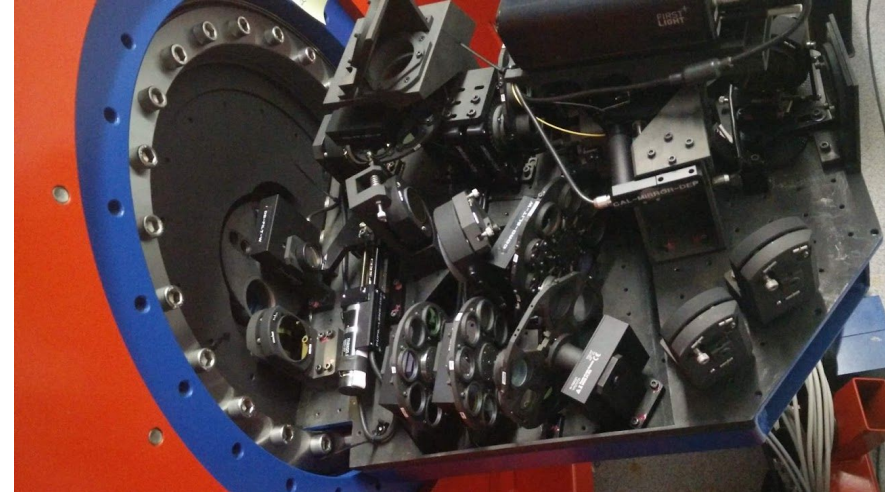


# “Small instruments in the giant era”

- **OARPAF observatory (Imaging and photometry)**
  - Astelco Telescope
  - Gambato + OmegaLab Dome and Lights
  - SBIG STX-16081 CCD camera with filters
  - (ip camera...)

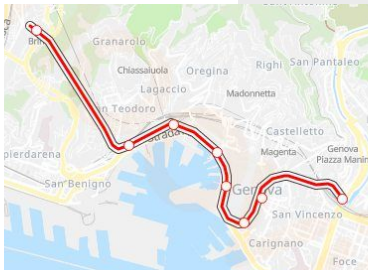
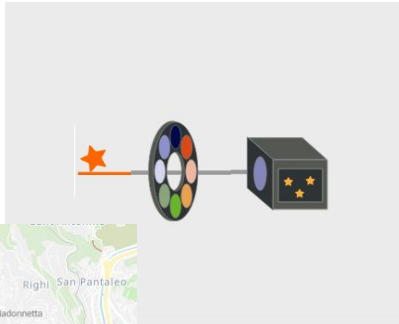


- **SHARK-NIR (coronagraphy, direct imaging, LSS spectroscopy)**
  - (interface with LBT telescope)
  - **5** Deployers + shutter
  - **7** Wheels
  - Atmospheric Dispersion Correctors
  - Derotator
  - **3** Calibration Lamps
  - NIR scientific camera
  - Real Time Computer:
    - Technical camera
    - Deformable Mirror

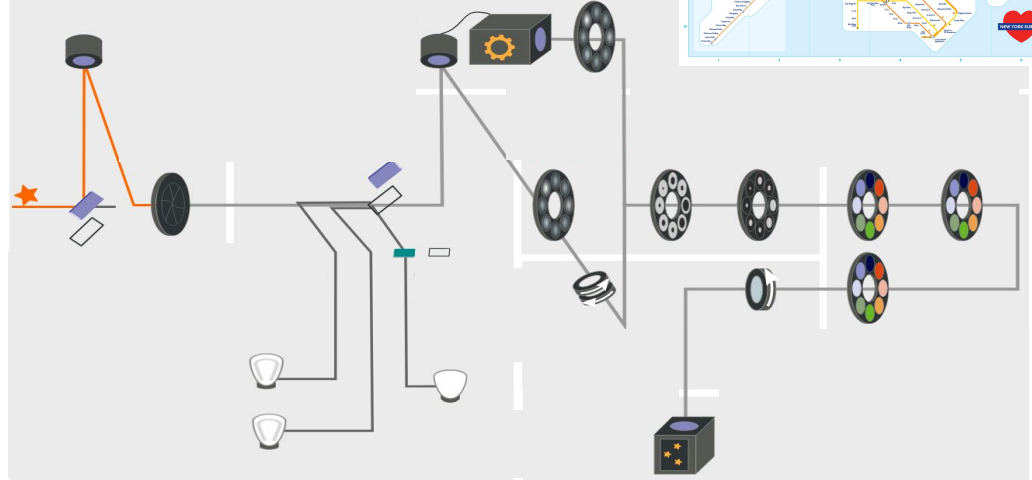


# “Small synoptic views in the giant era”

- **OARPAF observatory (Imaging and photometry)**
  - Astelco Telescope
  - Gambato + OmegaLab Dome and Lights
  - SBIG STX-16081 CCD camera with filters
  - (ip camera...)

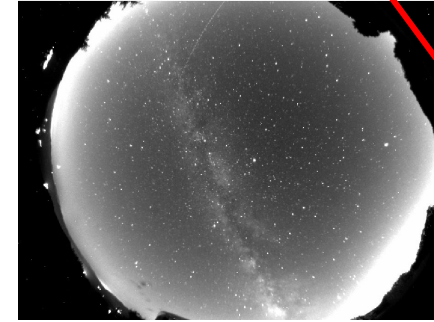
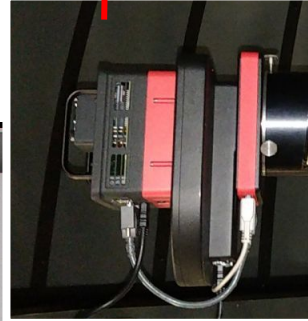


- **SHARK-NIR (coronagraphy, direct imaging, LSS spectroscopy)**
  - (interface with LBT telescope)
  - **5** Deployers + shutter
  - **7** Wheels
  - Atmospheric Dispersion Correctors
  - Derotator
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  - NIR scientific camera
  - Real Time Computer:
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    - Deformable Mirror

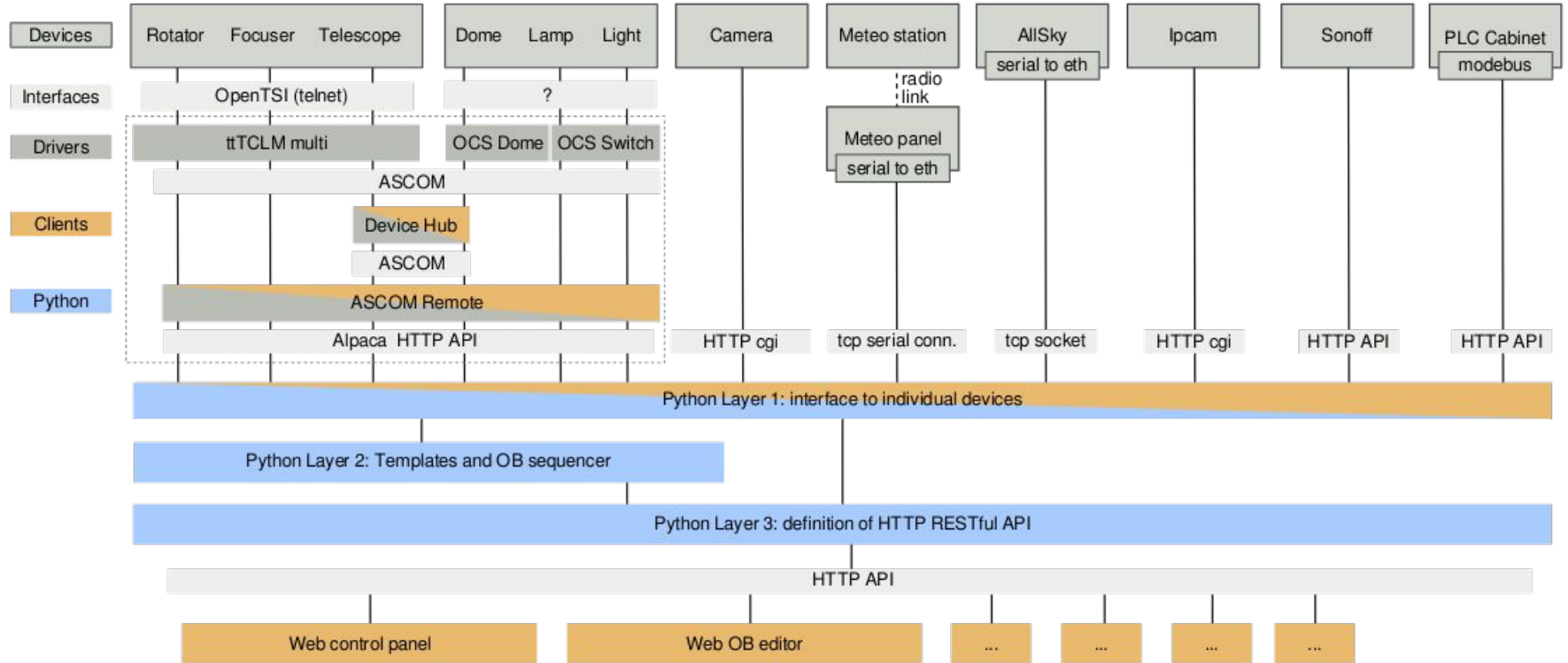


# OARPAF control software stack

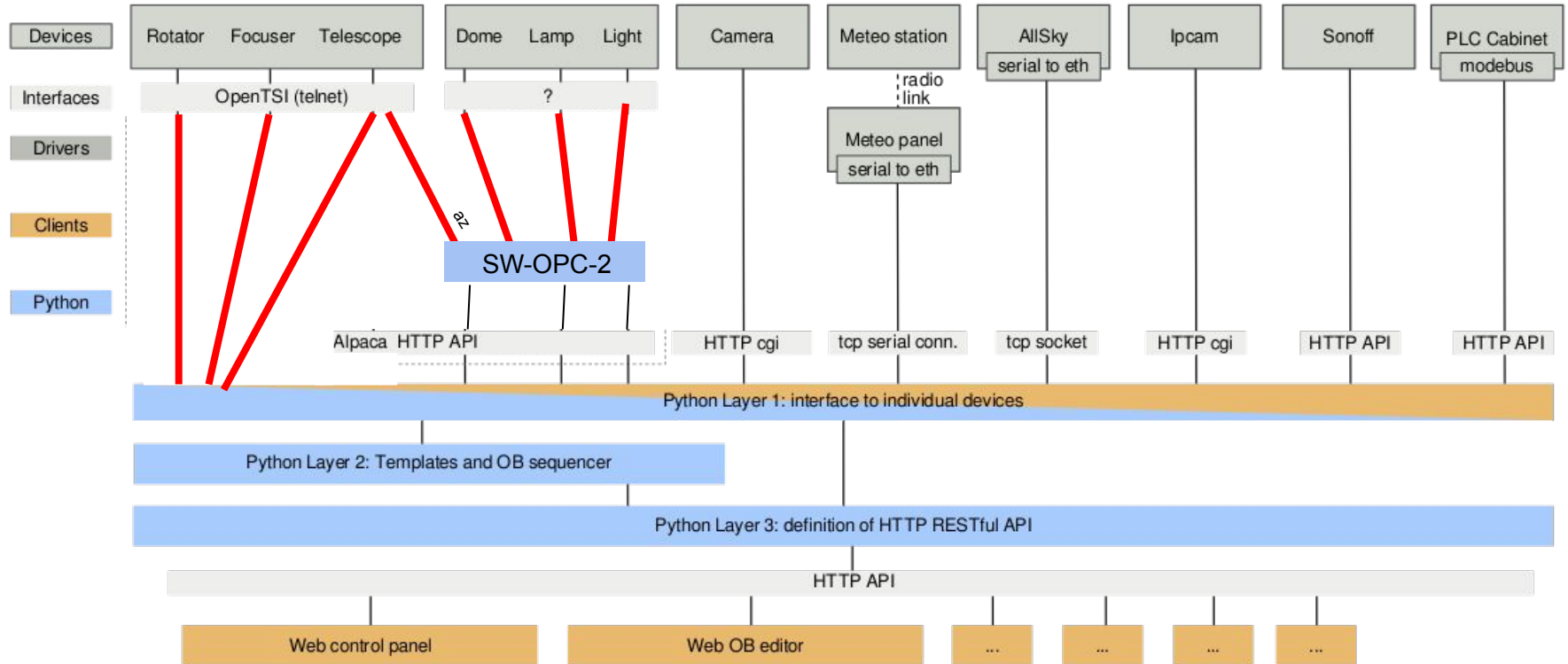
- “Toward the remotization and robotization of the OARPAF Telescope”,
  - [Proc. SPIE 12186](#)



# 2022: stack involving a windows pc (ascom remote = web server Alpaca)

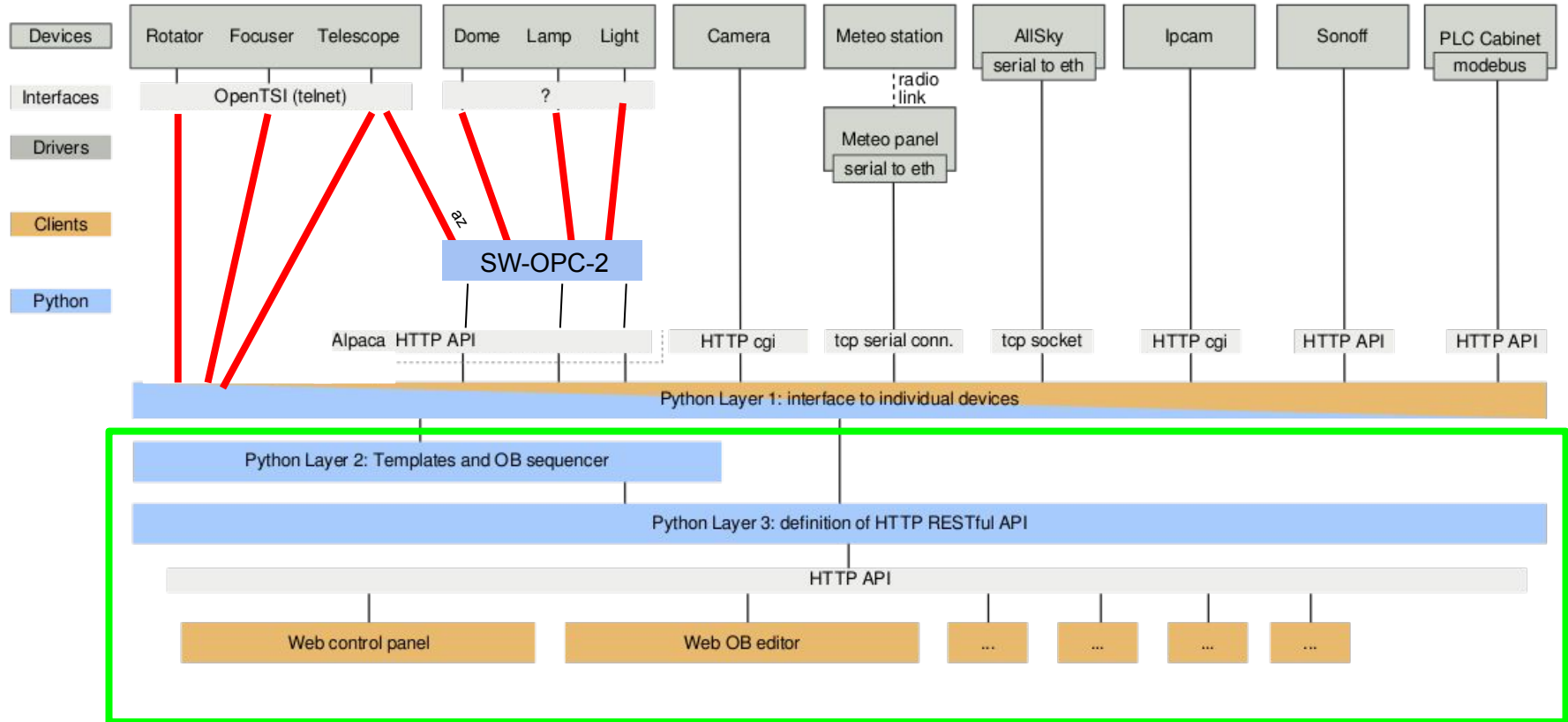


# 2024: improvements thanks to the @Luca Fini “Alpaca” driver 4 Chianti

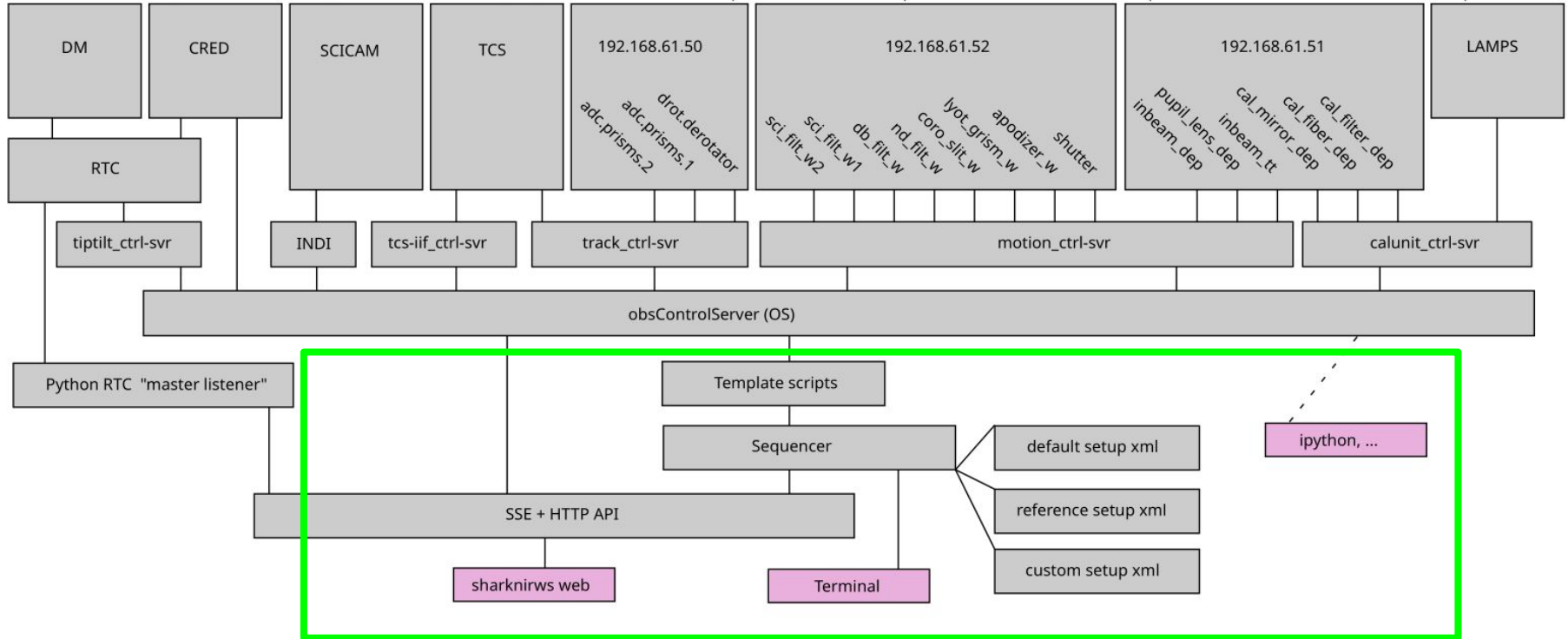




# 2024: improvements thanks to the @Luca Fini “Alpaca” driver 4 Chianti



# SHARK-NIR: low level OS over C++ TwiceAsNice libraries from MPIA



# Small REST APIs in the modern web era

- A “standard” of this decade
  - **GET** a **resource** or the state of an action
  - **PUT** (update) it
  - **POST** (create) a new one or start an action
  - **DELETE** it or stop an action
- Valid for both:
  - Atomic operations on devices
  - Build and launch OBs
- flask-restx → Swagger auto-documented
- Anyone can build its own client
  - ...such as its own **web interface**
- Next big step: easy to implement automatic **TESTS**
  - `curl -X GET blabla > blabla.json`
  - `diff blabla.json blabla.ref.json`

The screenshot displays a REST API interface with a list of endpoints grouped by resource. Each endpoint is represented by a colored button indicating the HTTP method, followed by the URL and a brief description. The endpoints are:

- dome** (Dome related operations):
  - GET /blocks/ Show all observation OB files
  - POST /blocks/ Create a new OB file based on name
  - DELETE /blocks/ Delete an OB file based on name
- telescope** (Telescope related operations):
- camera** (Camera related operations):
- logger** (Logger):
- blocks** (Observation blocks):
  - GET /blocks/{name} Show a specific OB
  - POST /blocks/{name} Add a template to the selected OB
  - PUT /blocks/{name} Update the OB
  - DELETE /blocks/{name} Delete a template instance in the selected OB
- sequencer** (Sequencer):
- other** (Other tests):
- Models**



Stable

- Init panel
- Control panel
- OB editor
- Sequencer

Devel

External Resources

- Meteo
- Buttons
- Display
- API docs
- AllSky zap
- Webcam

### Telescope status

Is Cab Switch On?  true Power on/off  
(Warm camera before switching off)

Is Tel Parked?  true Unpark Park

Is Tel Tracking?  false Point webcam Track Polaris

Petals  0 Open Close  
(1 is open, 0 is closed)

Global Status  0 Clear error # 2 ⌵  
(0 is operational, 1 is error, 2 is warning, 3 is info)

### Telescope offsets

Zd Az  ⌵  ⌵ ° Set

Rot  ⌵ ° Set  
zd: 0.0 az: 0.0 rot: 0.0

### Dome

ASCOM   true

Az  0 ⌵ ° Move Sync  false  
slaved: false az: 56.84

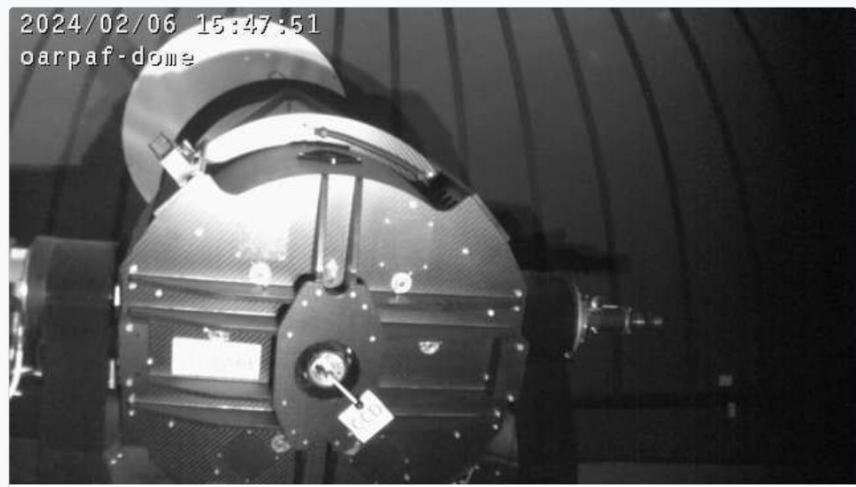
Position Park Stop  false

Shutter Open Close  1

### Camera

Is Cam Switch On?  false Power

Cool  0 ⌵ ° Set  
cool: fan: % amb: ° T: ° set: °



### Dome Webcam

Light  true Lamp  false Reset Look top

Move  ⌵ ° ↑ ↓ ← →

- Server-side bulk GET to send a **“global status”** over **Server-Sent Events (SSE)** every 1.0s
- Client-side PUT/POST/DELETE to trigger APIs using buttons
- Better method?
  - websocket?
  - **TARANTA-SKA-style?**
    - → Mini-grant
  - Let's discuss!

*@Matteo Canzari  
suggested GraphQL?*



Stable

Init panel **Control panel** OB editor Sequencer

Dev

External R

Meteo Buttons Display **API docs** A

## Telescope

Alt Az Radec / ID

$\alpha, \delta$  / ID Polaris hms ±dms / id

Slew Stop

$\alpha$ : 20 58 50.7  $\delta$ : -01 16 49.4 ha: -20 27 48.8  
alt: 24.611 az: 241.076 lst: 00 31 01.9

Focus 0  $\mu\text{m}$  Set

fov: 0

## Telescope offsets

Zd Az -800 -25 " Set

zd: 0.0 az: 0.0

## Dome

Az 0 ° Move Stop false

slaved: false az: 56.84

Shutter Open Close 1

humidity: 96% T: 2.8° dew: 2°

## Camera

Frame Full Half 2' Binning 1x1

binning: 1, 1

$X_0$   $Y_0$  123 234 px

$Y_f$   $Y_f$  678 789 px

Type Light Filter

Exptime 10.0 s Repeat 1 #

Object Test

Recenter  300 px Bump

Expose Stop

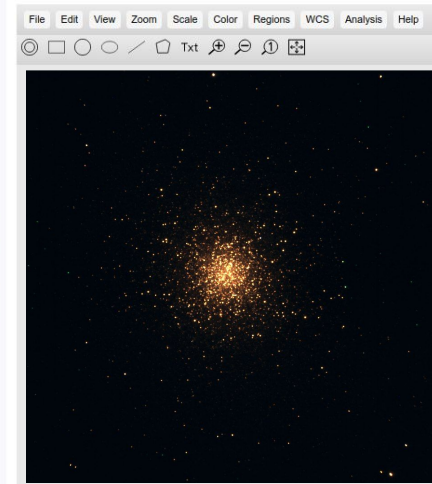
cool: false fit: 1 moving: 0 state: 0  
fan: 0% set: 25° T: 6.9° amb: 7°

Display

## Monitors

FITS Webcam **Output**

## Display



latest

- Displaying FITS files in a web page: always a pain. js9 is the "less painful"...
- **output** → focus or offset correction plot
- NO database for simplicity, but maybe in the future?



Stable

Init panel

Control panel

OB editor

Sequencer

# Small OB editor and sequencer in the ESO P2 and BOB era

## Ob list

Load OB  or Create new

m92

### 1 acquisition

radec

### 2 observation

objname

binning

filter

exptime

repeat

frametype

xystart

xyend

### Ob controls

Add template

- bias
- fillheader
- flat
- acquisition
- box
- observation
- testlamp
- focus
- lampsoff

*@Lina Tomasella  
no DB/scheduler  
up to now*

*Same for SHARK-NIR!*

## Ob sequencer

Load OB

### Sequencer log

```

2022-06-20 11:00:08 DEBUG | Total elapsed time: 0.21s (sequencer execute:66)
2022-06-20 11:10:51 INFO | Loading the ob from file ob/make_bias.json (sequencer load_file:20)
2022-06-20 11:10:51 INFO | There are 1 templates in the ob (sequencer execute:37)
2022-06-20 11:10:51 INFO | ----- (sequencer execute:42)
2022-06-20 11:10:51 INFO | Running template bias (basetemplate run:28)
2022-06-20 11:10:51 DEBUG | Params: (basetemplate run:33)
2022-06-20 11:10:51 DEBUG | binning 1 (basetemplate run:35)
2022-06-20 11:10:51 DEBUG | repeat 3 (basetemplate run:35)
2022-06-20 11:10:51 INFO | Running content bias (basetemplate run:37)
2022-06-20 11:10:51 INFO | Running template observation (basetemplate run:28)
2022-06-20 11:10:51 DEBUG | Params: (basetemplate run:33)
2022-06-20 11:10:51 DEBUG | binning 1 (basetemplate run:35)
2022-06-20 11:10:51 DEBUG | repeat 3 (basetemplate run:35)
2022-06-20 11:10:51 DEBUG | objname Bias frame (basetemplate run:35)
2022-06-20 11:10:51 DEBUG | exptime 0 (basetemplate run:35)
2022-06-20 11:10:51 DEBUG | filter U (basetemplate run:35)
2022-06-20 11:10:51 DEBUG | frametype Bias (basetemplate run:35)
2022-06-20 11:10:51 INFO | Running content observation (basetemplate run:37)
2022-06-20 11:10:51 INFO | Running template templates.lampsoff (basetemplate run:28)
2022-06-20 11:10:51 WARNING | Params are empty: {} (basetemplate run:31)
2022-06-20 11:10:51 INFO | Running content templates.lampsoff (basetemplate run:37)
2022-06-20 11:10:51 INFO | Luce Flat found to be Off (lampsoff content:24)
2022-06-20 11:10:51 INFO | Luce Flat is now Off (lampsoff content:28)
2022-06-20 11:10:51 INFO | Luce Cupola found to be Off (lampsoff content:24)
2022-06-20 11:10:51 INFO | Luce Cupola is now Off (lampsoff content:28)
2022-06-20 11:10:51 INFO | Template templates.lampsoff ended (basetemplate run:40)

```

# SHARK-NIR motors engineering panel with synoptic view

Services: OB editor, Sequencer, **Devices**, ITC

Sensors

LBT0 network Resources: PDU1, PDU2, SCICAM, TECCAM, DM, Monit, Webcam

### ICS panel

Parameter	Value	Status	Encoder
ADC1_PosAng	min_disp	?	enc: 6382765
ADC2_PosAng	min_disp	?	enc: 48032
ADC_Mode	OFF	?	enc: 0
APODIZER_W	SP1_APO	?	enc: 0
CAL_FF_LAMP	OFF	?	enc: 0
CAL_FIBER_DEFOCUS_LAMP	OFF	?	enc: 0
CAL_FIBER_DEP	FOCUS_IN	?	enc: 0
CAL_FIBER_FOCUS_LAMP	OFF	?	enc: 0
CAL_FILTER_DEP	IN	?	enc: 0
CAL_MIRROR_DEP	OUT	?	enc: 0
CORO_SLIT_W	FQPM	?	enc: 0
DB_FILT_W	WINDOW	?	enc: 0
DROT_Mode	PUPIL	?	enc: 0
DROT_PosAng	no named pos	?	enc: 139.996
INBEAM_DEP	OUT	?	enc: 0
INBEAM_TT	IN	?	enc: 821487,878994
LYOT_GRISM_W	PRISM	?	enc: 0
ND_FILT_W	OD4	?	enc: 0
PUPIL_LENS_DEP	OUT	?	enc: 0
SCI_FILT_W1	HOLE	?	enc: 0
SCI_FILT_W2	HOLE	?	enc: 0
SHUTTER	IN	?	enc: 0

### Synoptic panel

INBEAM\_TT: 821487,878994 IN

DM LOOP: OPEN

CRED TEMP °C: -15

CRED FREQ: 1000

SHUTTER: 0 in home!

CAL\_MIRROR\_DEP: OUT

INBEAM\_DEP: 0 in home!

CAL\_FIB\_DEP: 0 in home!

CAL\_FILT\_DEP: IN

APO: 0 in home!

CORO: 0 in home!

LYOT: 0 in home!

SCI1: 0 in home!

SCI2: 0 in home!

ADC1: 6382765 min\_disp

ADC2: 48032 min\_disp

DROT: 139.996 not defined

DB: 0 in home!

PUPIL\_LENS\_DEP: 0 in home!

CAMERA TEMP K: 76.0421

NREADS: 1

NDIT: 1

NCOADDS: 1

NDROPS: 0

NGROUPS: 1

LEFT Instrument Authorized: MODS

RIGHT Instrument Authorized: MODS

- Same technology
- svg changing **fill** or **display** attributes



Services

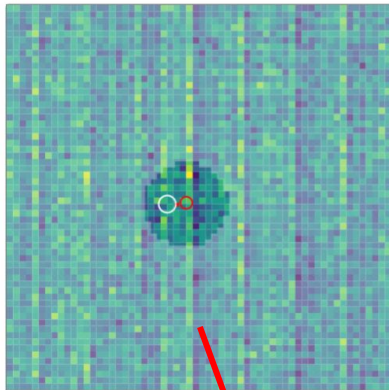
Sensors

LBTO network Resources

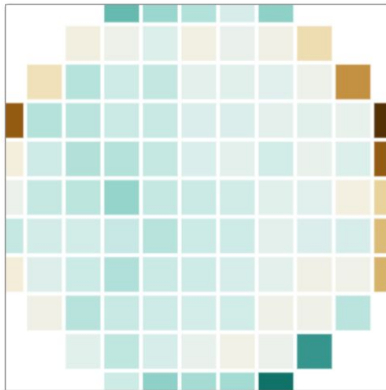
RTC control panel  
 plot

# SHARK-NIR RTC control panel

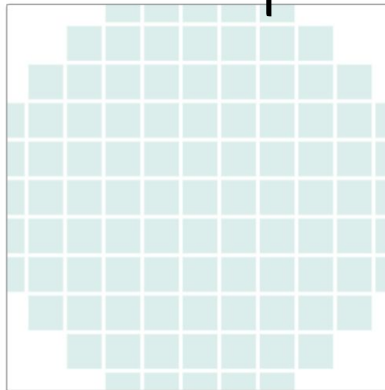
@David Darson:  
 Present: CRED,  
 Future: SWIR?



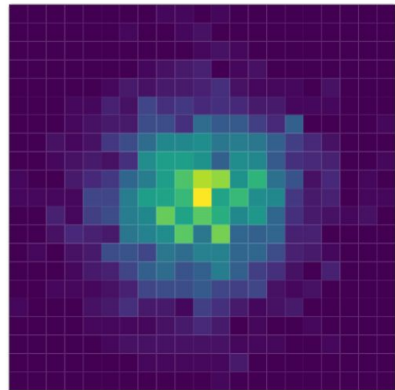
CRED2 image  
 Color min , max    
 image min (counts) 3639  
 image max (counts) 4367  
 8x8 around rtc centr (counts/ frame) 255170



Mirror shape  
 Color min , max    
 actuator min -0.26  
 actuator max 0.21



Mirror shape without flat  
 Color min , max    
 actuator min -0.26  
 actuator max 0.21



Centroid cloud  
 Color min , max    
 histo min (counts) 0  
 histo max (counts) 43  
 PV x (mas) 88.05088  
 PV y (mas) 97.82816  
 RMS x (mas) 12.88384  
 RMS y (mas) 14.20416

● **64x64 JSON array is not a big deal, but ASCII is the worst choice for this job**

Control

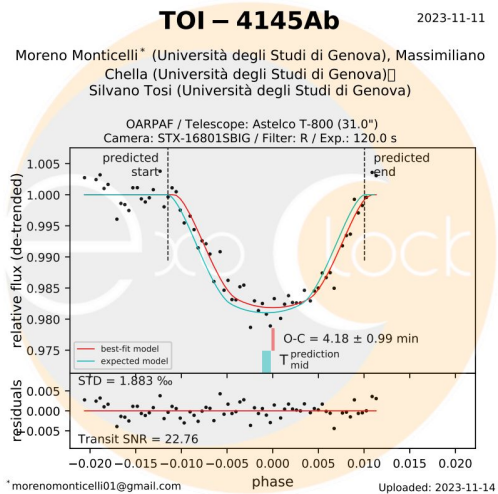
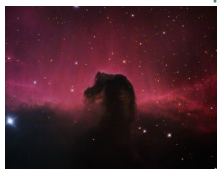
Ref. pixel X , Y    Loop    Mode   Samples    
 Gain type , size Point gain   Freq   Tint   Temp    
 Dark  or Type to search...   Subtract dark to CRED2 image display  
 Flat  or Type to search...   
 NCPA  or Type to search...  Rotate NCPA    
 DM Mode:    
 Select Actuator , intensity     
 Reference Camera :TECCAM  Reference Camera :SCICAM Relative Tip tilt       
 Star current pos on SCICAM: X , Y         PUPIL     
 stages deltas [mm , mm]: undefined

ref px [-1,1]: 0.12, 0.04 rtc centr [-1,1]: 0.06, 0.03 loop: OPEN  
 freq [Hz]: 1000 tint (s): 0.00094919 temp (°C): -15  
 dark: 2024-02-06T01-42-36\_PixelBias\_-15C\_1000Hz-06x064.dat  
 flat: dm\_shape\_2024-02-06-01-35-04\_int\_140b\_90el\_TJC\_-1as.txt  
 ncpa file: zeri.txt ncpa: undefined  
 DM mode: MODAL  
 out: undefined



# OARPAF local observations by students of University of Genoa

- Observational Astronomy **PhD** class XXXVII and XXXVIII cycle:
  - <https://www.difi.unige.it/en/phd/cycles/37>
  - <https://www.difi.unige.it/en/phd/cycles/38>
- **Master degree in Physics**
  - Observations in the framework of the **Introduction to Astrophysics and Cosmology** class
  - <https://corsi.unige.it/off.f/2023/ins/67344>



HOlonom Photometric Software

**HOlonom Photometric Software v3.1.2**

Copyright (c) 2017-2024 Angelos Tsiaras, atsiaras@star.ucl.ac.uk

UPDATES & USER MANUAL - v3.2.0 now available

MY PROFILE

Analyse your data step by step

1. **\*\* SELECT DATA & TARGET \*\***
2. **\*\* RUN REDUCTION \*\***
3. **INSPECT FRAMES**
4. **\*\* RUN ALIGNMENT \*\***
5. **\*\* PHOTOMETRY \*\***
6. **EXOPLANET FITTING**

Data: TOI-4603b  
Target: HD 245134 / Host of: TOI-4603b  
Location: +44:35:28.32 09:12:12.24

Completed under v3.1.2

Files discarded: 0

You need to complete this step to proceed

**\*\* mandatory step \*\***

EXIT

HOlonom Photometric Software

INSPECT

Sky (count/spx)

PSF (FWHM)

On the time-sky or PSF-sky graph above double-click on a point to see the frame on the left panel. To mark this point as family, use the right double-click. To undo, use the right double-click again.

Sky Threshold 0.0 PSF Threshold 3.4

RETURN TO MAIN MENU

SAVE OPTIONS & RETURN TO MAIN MENU

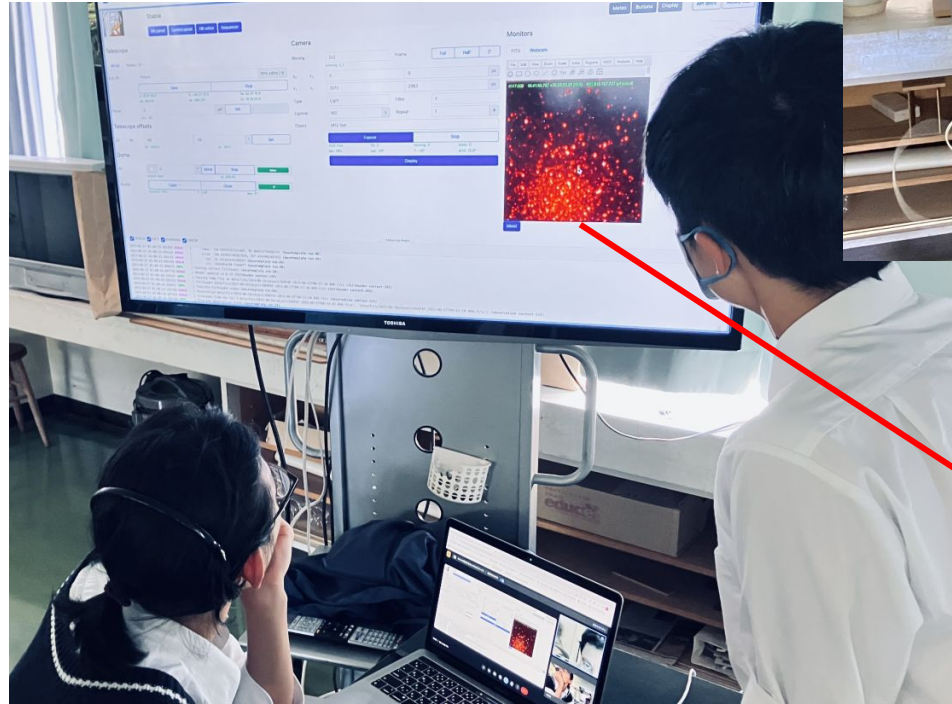
SAVE OPTIONS & PROCEED

Exoclock

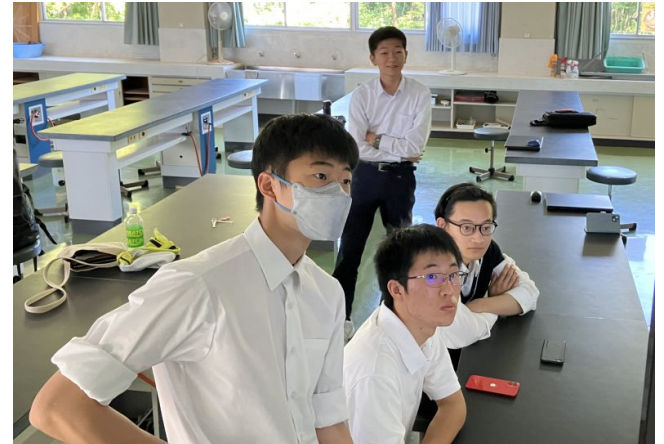
*@Anastasia Kokori's  
HOPS*

# OARPAF remote observation from Kōryō High School, Japan!

2023-06-20:  
08:00 Hokuto = 23:00 UTC = 01:00 Genova  
12:00 Hokuto = 03:00 UTC = 05:00 Genova → Sunrise



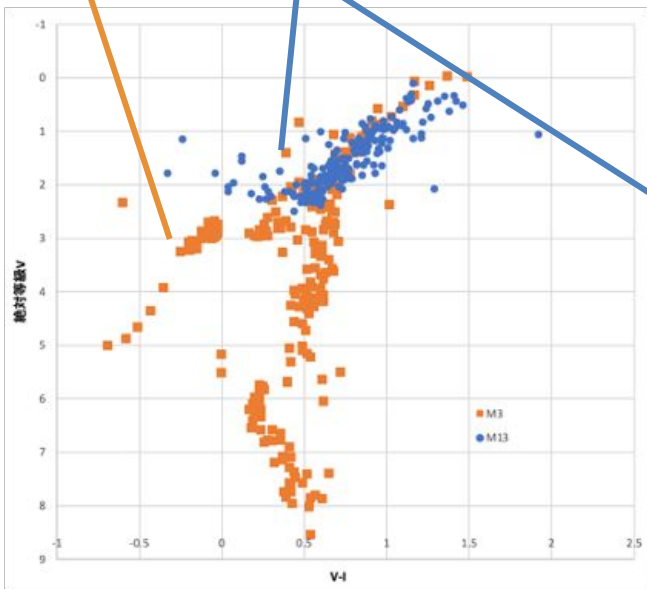
**M13**  
3x180 V  
3x180 I  
flat  
bias



# Small proposals in the giant era

M3 data : from literature

M13: OARPAF  
(ds9 “ring” on ~200 stars!)



## OARPAF Proposal

Observation of M11,M13

Yusei Kato<sup>1</sup> and Kanji Ito<sup>1</sup>

<sup>1</sup> Koryu High School, 2003 Nagasakamijicho Nagasakicho, Hokuto-city, Yamanashi 408-0021, Japan,

June 16, 2023

Open clusters are relatively young clusters of stars, while globular clusters are older clusters of stars. Due to this difference, the distribution of Color-Magnitude Diagram (CMD) is different. The purpose of this observation is to compare the distribution of CMD and to improve our understanding of the stars that make up the open clusters and globular clusters.

### Contents

1	Scientific Facts	1
1.1	M11	1
1.2	M13	1
2	Objective	1
3	Proposed Runs	1
4	Justification of Runs	2
4.1	Instrument	2
4.2	Months of Observation	2
4.3	Observation Time	2
4.4	Seeing	2
5	Targets	2
6	Telescope Justification	2

### 1 Scientific Facts

#### 1.1 M11

M11 is an open cluster in the constellation Scutum. It looks more like a globular cluster than an open cluster. It is classified as the densest of the open clusters, and the distance between stars at the center of the cluster is less than one light year. The cluster is composed of Type I stars, and since it is a group of newly born stars, pale, hot O-type stars and B-type stars are prominent. Therefore, it is expected that there are many main-sequence stars and few red-giant stars are seen.

#### 1.2 M13

M13 is a globular cluster in the constellation Hercules, containing 500,000 stars. It contains many Type II stars and is estimated to be more than 10 billion years old, making it a very old object. Because of its extremely high density, close interactions and collisions between stars are thought to occur from time to time. Blue

straggler, which are located near the main-sequence, are sometimes seen, and their temperature is high enough to be equivalent to F- or A-type stars. Therefore, there are many red-giant stars that are far from the main-sequence, but sometimes we can see stars that are distributed at the position of blue main-sequence stars when we draw the CMD.

### 2 Objective

The purpose of this observation is to determine the magnitudes of the stars in the globular cluster M13 and the open cluster M11, to make CMD of each cluster, and to compare the globular and open clusters.

### 3 Proposed Runs

Observation dates may be postponed due to weather, humidity, or equipment conditions. We use V and I filters to observe star clusters.

1

We intend to make at least three observations with exposure times of 180 seconds each per filter.

Run	Instrument	Time	Month	Seeing
A	SBIG STX-16801	3h	June	2"

### 4 Justification of Runs

#### 4.1 Instrument

The SBIG STX-16801 camera is a dedicated tool for high performance photometry at OARPAF observatories. Its excellent cooling performance allows the CCD to be cooled sufficiently to reduce noise. Therefore, it is possible to accurately determine the magnitude of stars with this tool.

#### 4.2 Months of Observation

M11 is located in the constellation of Scutum and M13 is in the constellation of Hercules. Both can be seen in the summer night sky.

#### 4.3 Observation Time

At least, 20 minutes would be needed to prepare for the observation and 40 minutes each to observe the object. Three hours is also reasonable, taking into account the time needed to make a re-observation. Therefore we want three hours per observation.

#### 4.4 Seeing

The seeing at the OARPAF site is 2.0", with an average seeing of 2.5" on summer nights. The humidity is high during the summer months, so the average seeing may be lower during the observation.

### 5 Targets

M11 is a dense cluster, so its visual diameter is relatively small. Therefore, we believe that many stars can be observed even at high magnitude.

M13 is one of the largest globular clusters in the northern sky and has very good visibility. The relatively high magnitude allows us to observe even the stars of cluster's center.

For these reasons, we considered these two clusters to be easy to observe and suitable for observing.

Under the facts about these objects and at this observation site, the motion on the sky is as shown below.

Name	M11	M13
Type	open cluster	Globular Cluster
$\alpha$ /J2000	18 51.1	16 41 41.6
$\delta$ /J2000	-06 16	+36 27 40.7
Magnitude	6.3	6.4

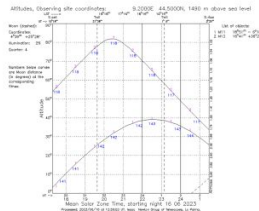


Figure 1: M11 and M13 observability

### 6 Telescope Justification

The OARPAF telescope has sufficient performance to study the magnitudes of M11 and M13. The success of previous observations of TXS 0506+056, which is at about 15th magnitude, suggests that our observations will have a high probability of success.

### References

- [1] Sadanori Okamura Astronomy Dictionary, NIPPON HYORON SHA CO., LTD.(2012).
- [2] German Lanzavecchia and Albert Rescia, OARPAF Proposal-Observation of TXS 0506+056,
- [3] Le Catalogue de Messier, AstroArts, <https://www.astroarts.co.jp/alcarte/messier/index.js.html>,2023/06/14 2023/06/14

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- **2nd place at 44th Yamanashi Prefecture High School Arts and Culture Festival Natural Science Division "Student Natural Science Research Presentation Competition"**
- ~50 groups, for a total of 200 high school students.

# Small summary in the giant era

- REST APIs can be a valuable resource to build comprehensive control tools for both **small** telescopes and instruments for **giant** telescopes;
- Small telescopes:
  - **test bench** for hardware and software solutions in the giant world;
- Web technologies are standard
  - and maybe it's simpler to find developers/collaborators
  - +... fundraising?

# Priceless for training and engagement:

- Understand the control software stack.
  - They can be involved in further implementations; this lead to:
- Understand how to control single devices while manually operating the telescope for **their projects**; this leads to:
- Understand the automated template operations,
  - that is also **the way giant telescopes work**.
- Modern astrophysics is its technology too → **INAF**
  - Get involved in instrument control software development



