

THE ASTRA PROJECT

THE FIRST ITALIAN NETWORK FOR SPACE SURVEILLANCE AND TRACKING

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Aula Magna del Dipartimento di Fisica, UniTO
Via Pietro Giuria 1, Torino
25-26 novembre 2022

PRISMA Day

La scienza delle meteore e delle meteoriti in Italia

Quarta giornata di studio e confronto, per professionisti, amatori ed educatori attivi nello studio di meteore e meteoriti sul territorio nazionale

Informazioni: prisma_po@inaf.it
<https://indico.ict.inaf.it/event/1864/>

UNIVERSITÀ DI TORINO

INAF
ISTITUTO NAZIONALE DI ASTROFISICA

Un progetto sostenuto da Fondazione CRT

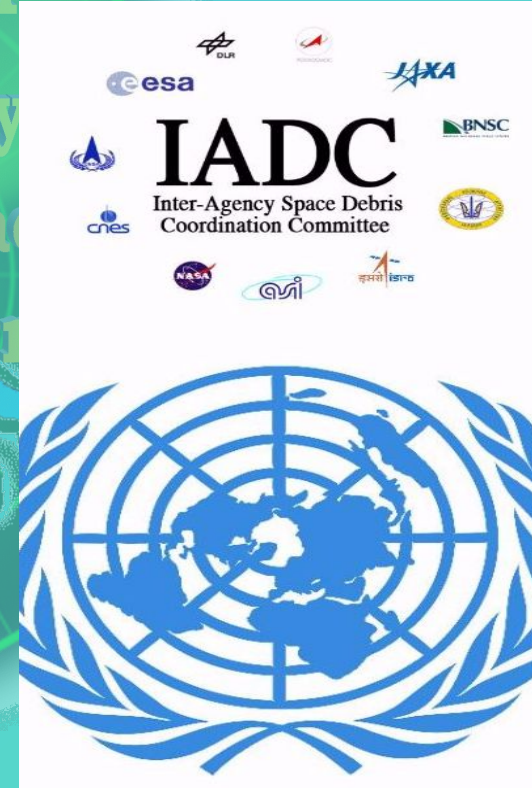
PI: Alberto Buzzoni

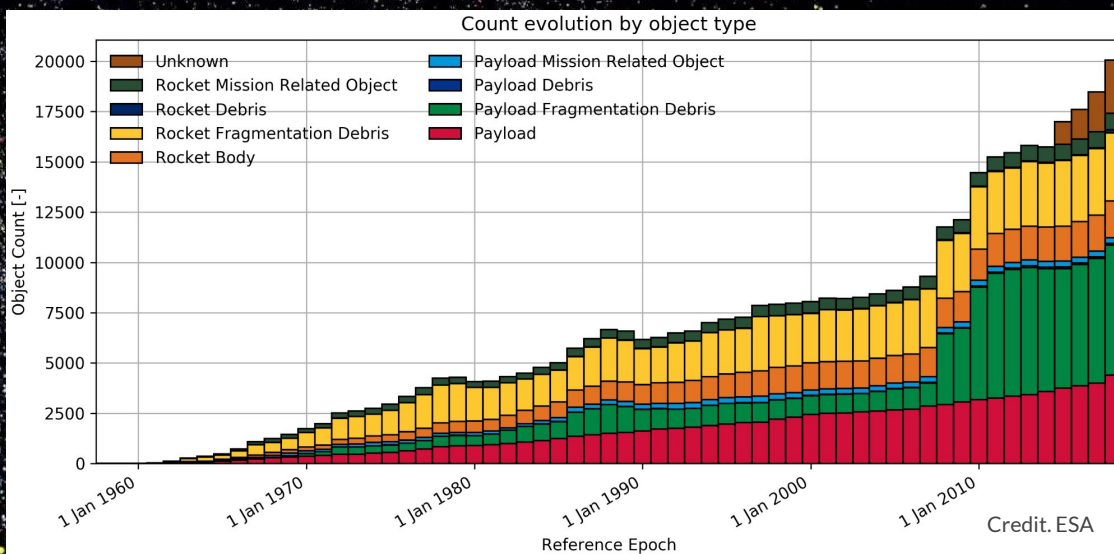
CONTRIBUTORS: Elena Barbantini, Albino Carbognani, Roberto Di Luca, Silvia Galletti, Roberto Gualandi, Luca Rosignoli & the whole SSA Group @OAS.

IADC SUPPORT:

WG1

Debris measurements





TRACKED OBJECTS (SSN + EUSST) ~ 36500

UNTRACKED OBJECTS (MASTER-8 model):

~ 1M size 1-10 cm

~ 130M size 0.1 - 1 cm

Credit. ESA

ASTRA (All Sky TRacking Array)

CONCEPT:

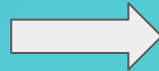
Network of 5 ultra wide angle ($60^\circ \times 80^\circ$ effective FOV) cameras, suitably located on the Italian territory.

TARGET:

Performing a SST service of the LEO objects (≤ 1000 km) of metric size through optical surveying, for both follow up the known objects and recognize the new ones.

REQUIREMENTS

- STAND ALONE AND ALMOST MAINTENANCE-FREE
- REMOTELY CONTROLLABLE
- PRECISE TIMESTAMP



GET THE BEST QUALITY IMAGE
AND TIMING ACCORDING TO
ORBITAL TRAFFIC CONSTRAINTS

Control Room ASTRA/EUSST @LOIANO

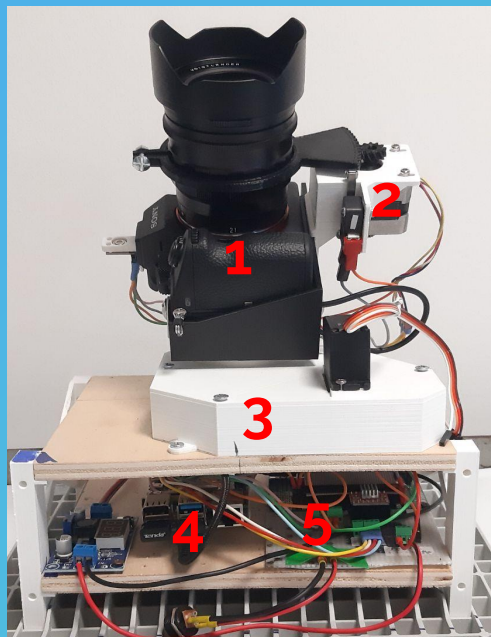




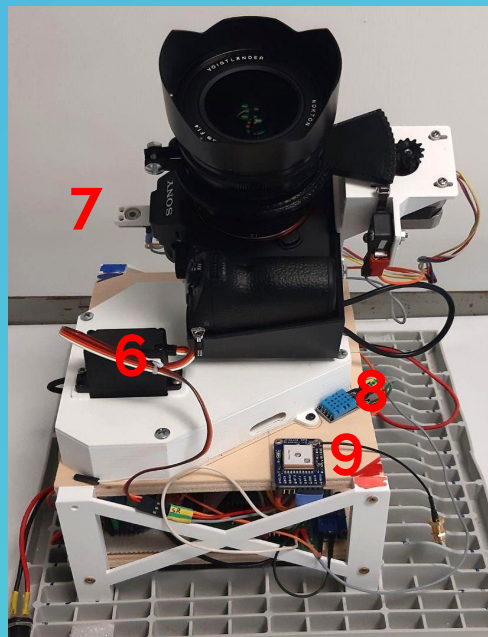
Crossing time



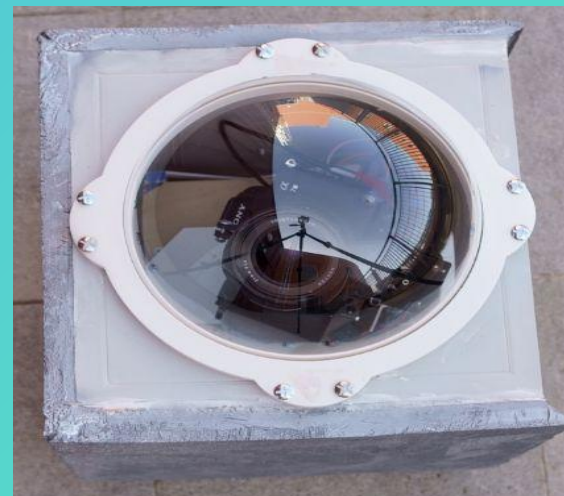
THE HARDWARE



1. **CAMERA (Sony Alpha 7 iii) and OPTICS (Voigtlander Nokton 21mm f1.4)**
2. **STEPPER MOTOR**
3. **BASEMENT (Az. steerable)**
4. **CONTROL UNIT**

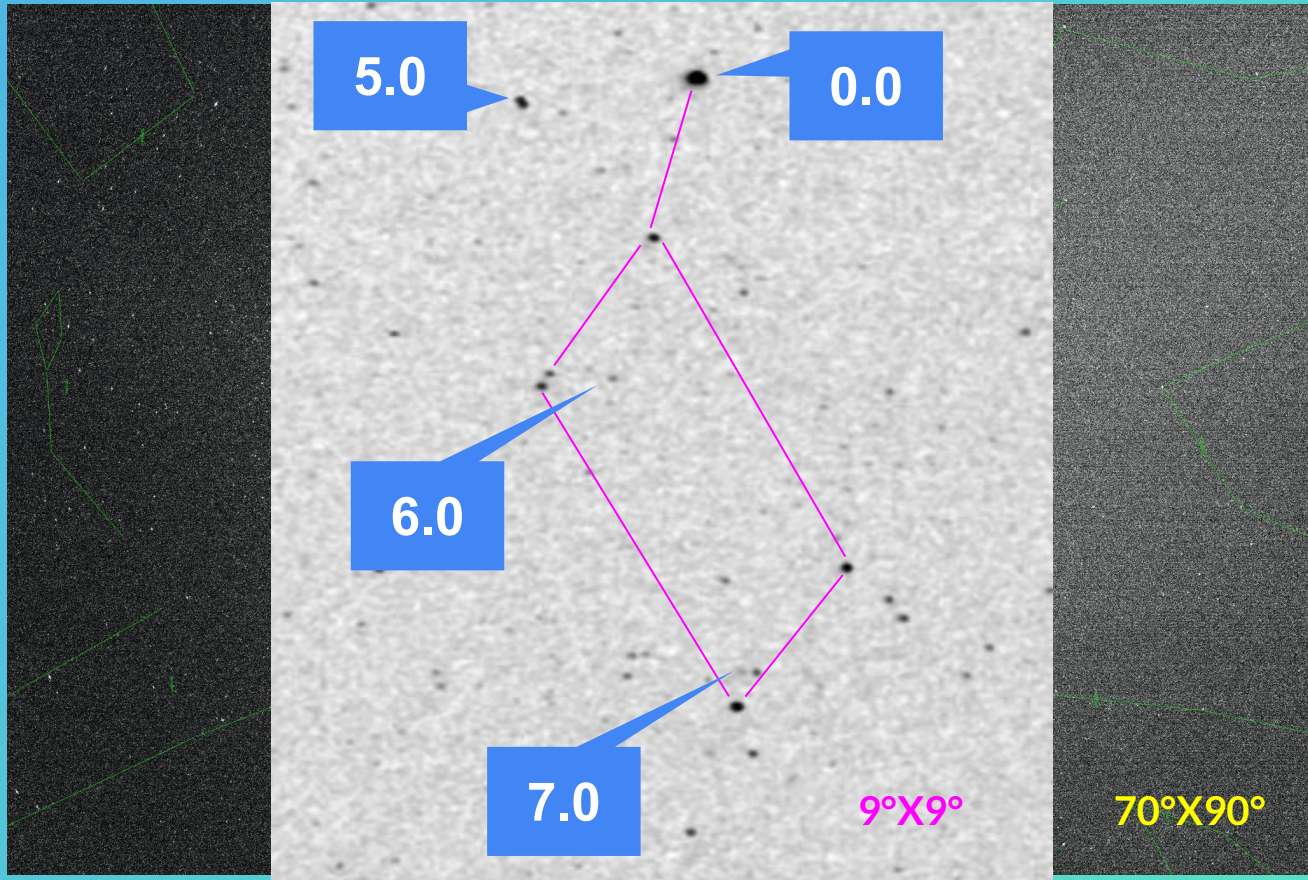


5. **ELECTRIC CIRCUIT**
6. **SERVO MOTOR**
7. **CLOUD SENSOR**
8. **TEMPERATURE and HUMIDITY SENSOR**
9. **GPS + PPS MODULE**

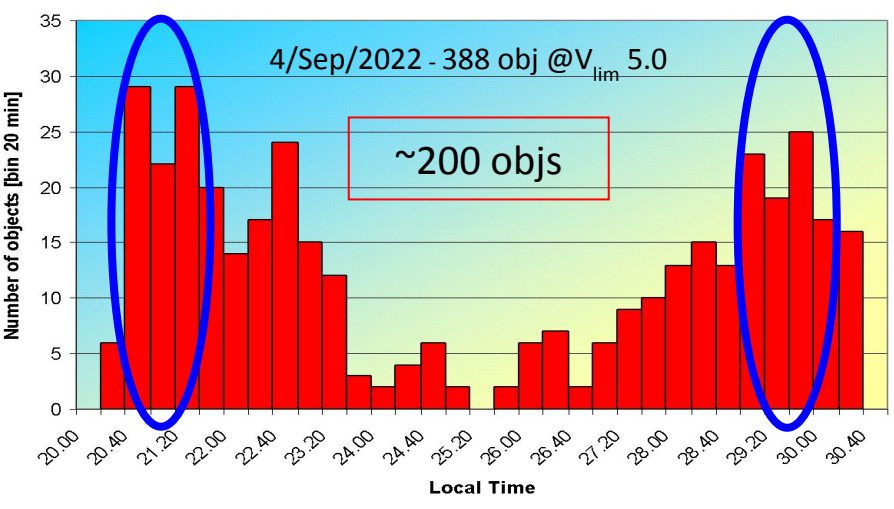
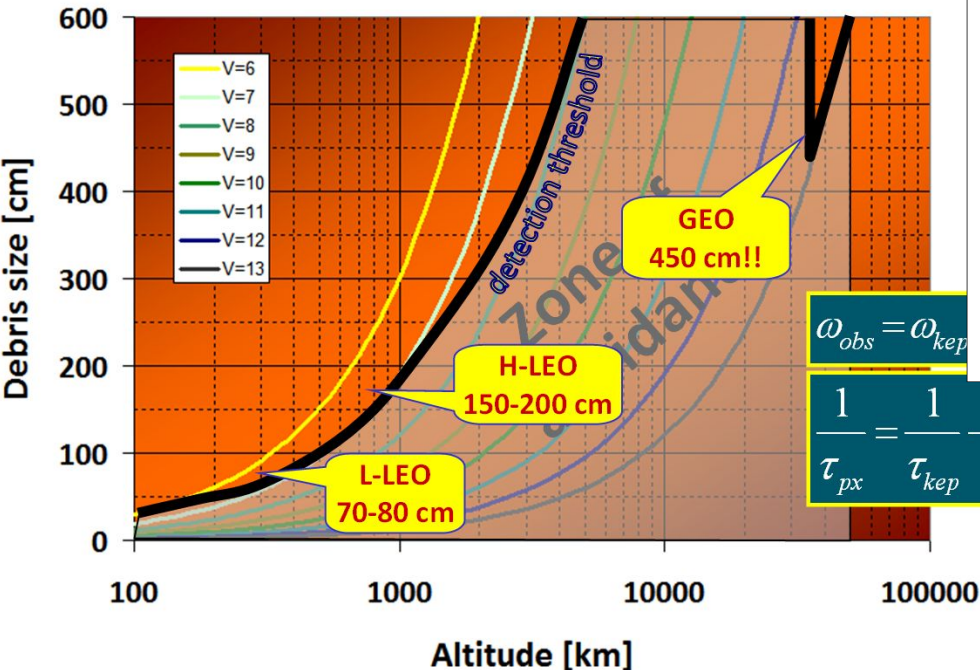


THE IMAGE

EXP. TIME = 0.1 s
ISO = 6400
FL = 21 mm
f = 1.4



SPECS



$V_{lim} \sim 6.5$ namely a factor of 4 more targets



Orbit determination (TLE) for
(nominally) ~ 800 obj/night

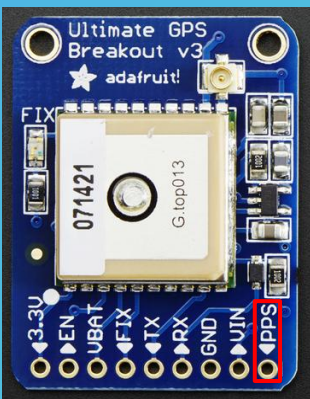
THE SOFTWARE

OS: Raspbian (Linux) 5.10.103 (Astroberry distro's)

HTML Remote Desktop

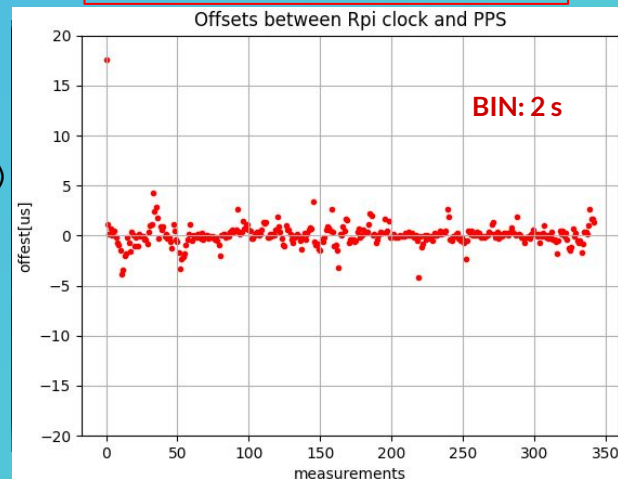
TIME MANAGEMENT

On-BOARD NTP SERVER: **CHRONY** (v. 3.4)



TIME REFERENCE:
GPS

CLOCK REFERENCE:
PPS



PPS: -0.000009664

**OFFSET IN SECOND
BETWEEN Rpi AND PPS**

DEVICES CONTROL

PYTHON LIBRARIES

- Servo motor
- Stepper motor
- Weather sensors

GPHOTO2 (v. 2.5.20)

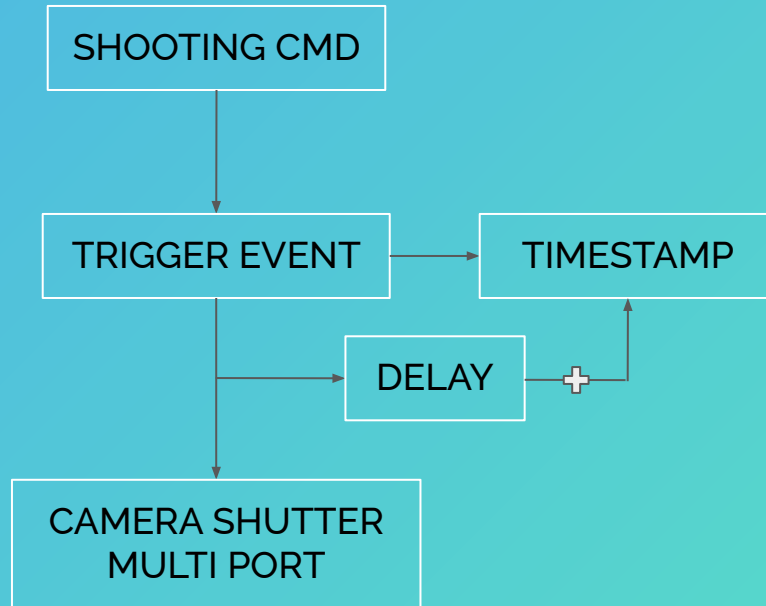
Camera settings and
download of the files

TIMING

LEO OBJECTS VELOCITY $\sim 7\text{-}8 \text{ km/s}$



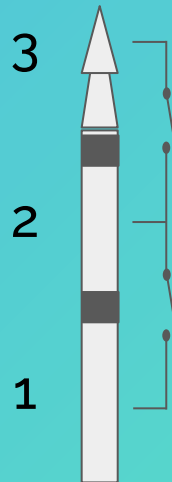
WE NEED TO OPERATE IN THE ORDER OF
A MILLISECOND ACCURACY ON
SHOOTING TIME



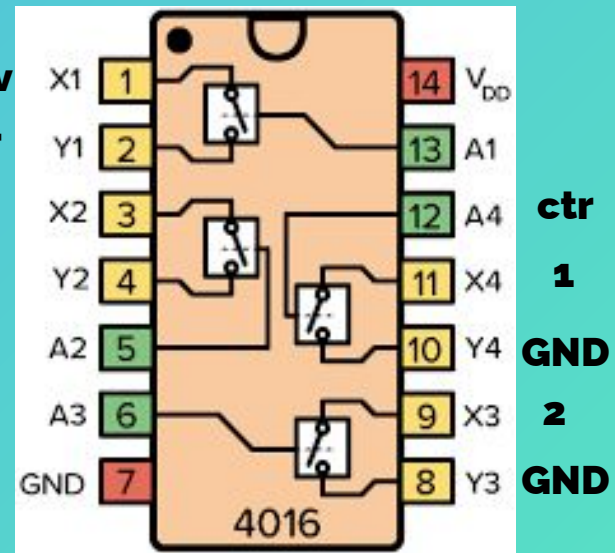
ANALOGIC SHOT TRIGGER



MULTI PORT

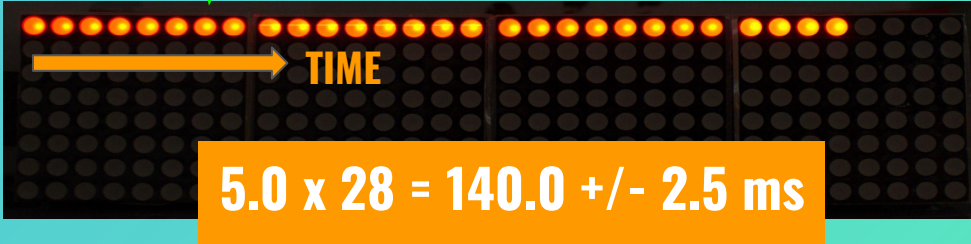
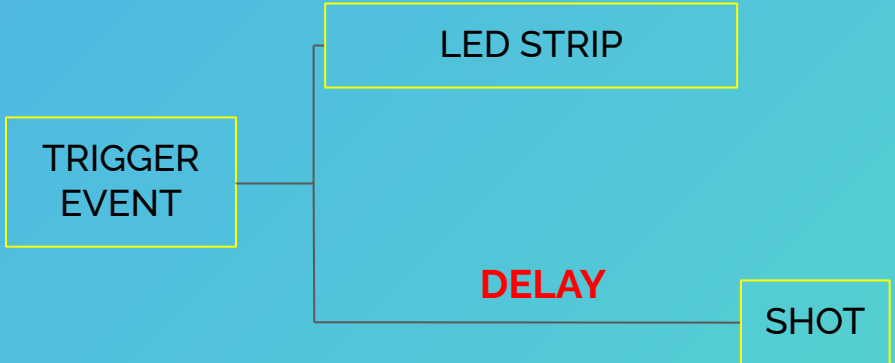
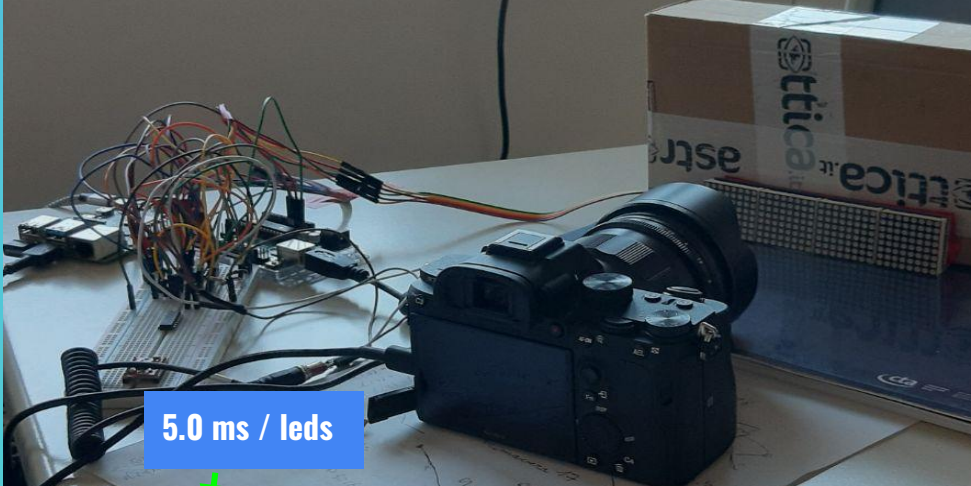
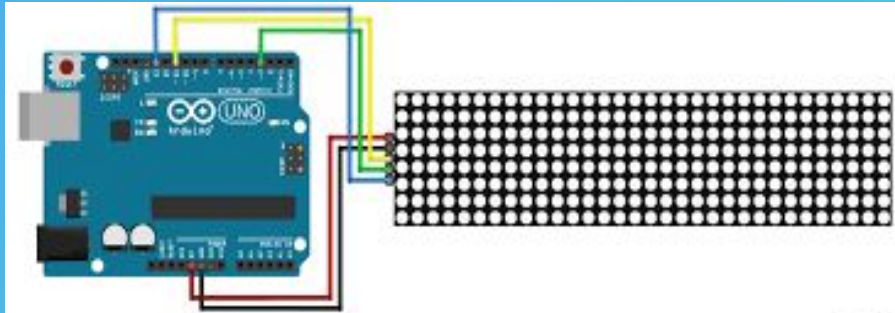


**3.3v
ctr**



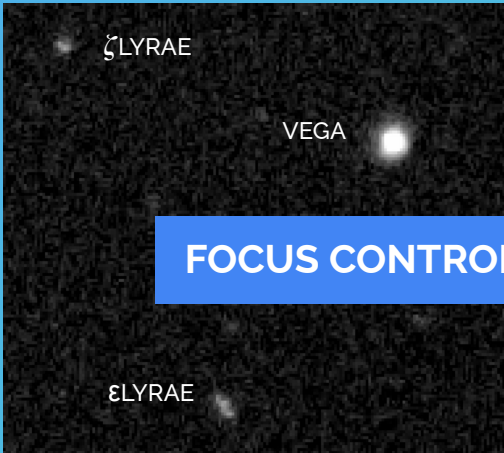
3 -> GND

DELAY MODELLING

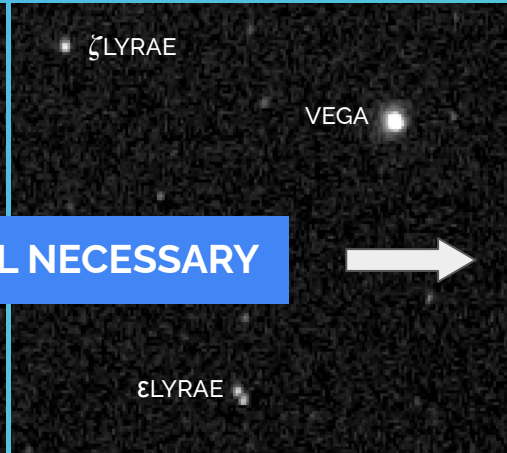


FOCUSSING

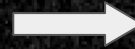
INFINITE POSITION



BEST POSITION*



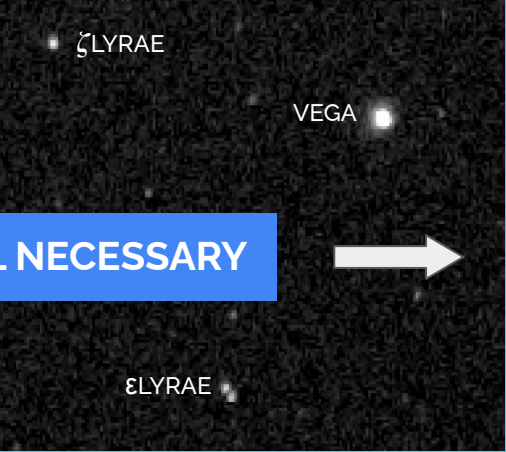
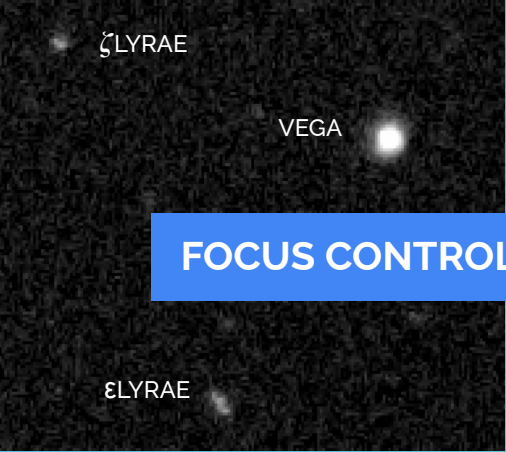
FOCUS CONTROL NECESSARY



FOCUSSING

INFINITE POSITION

BEST POSITION*



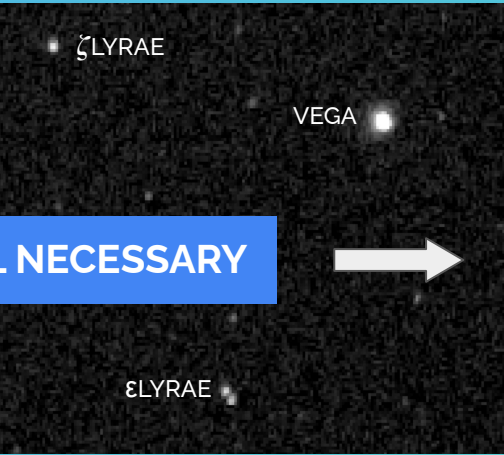
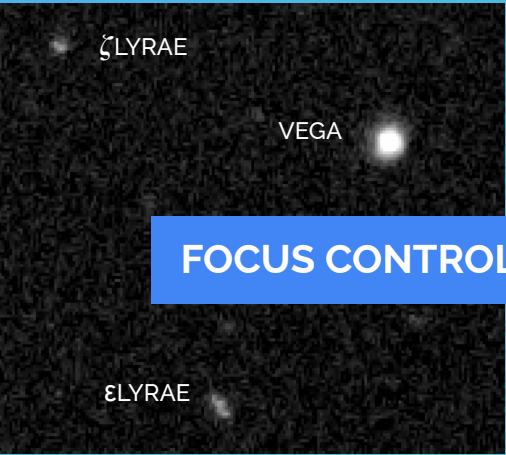
FOCUS CONTROL NECESSARY



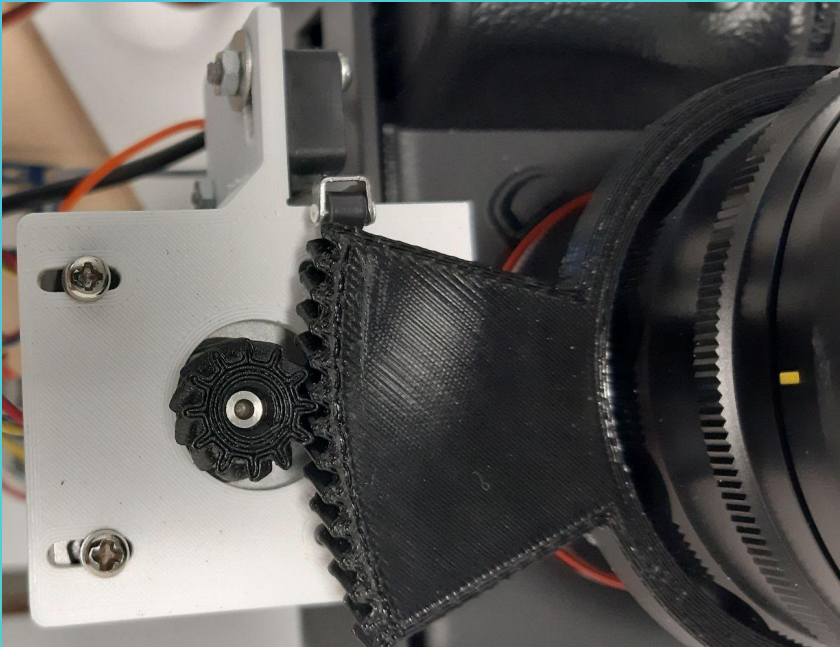
FOCUSSING

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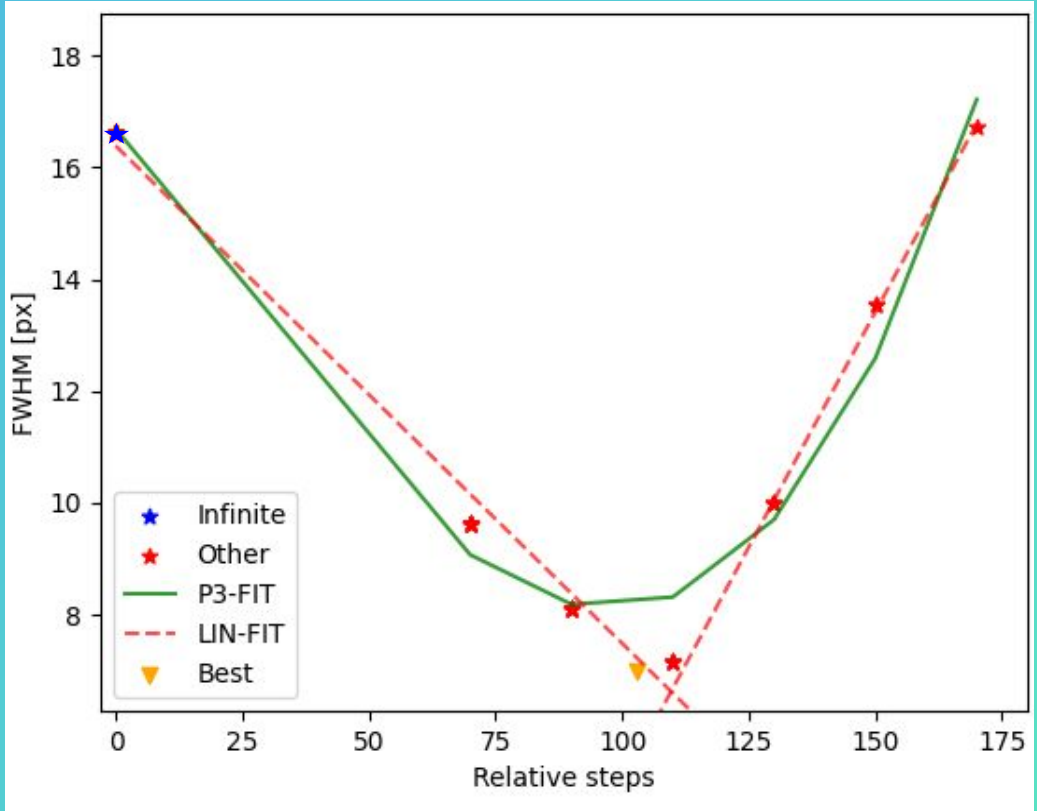
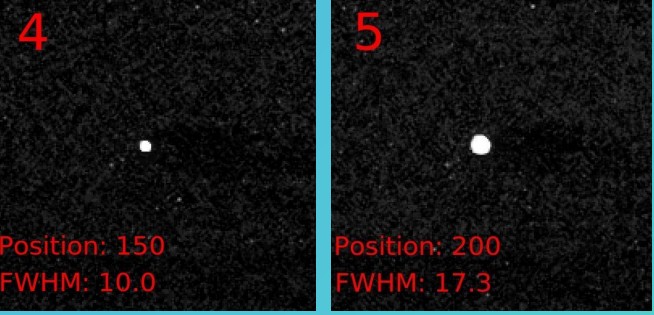
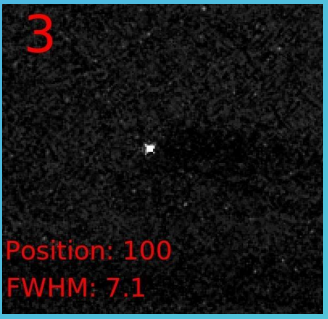
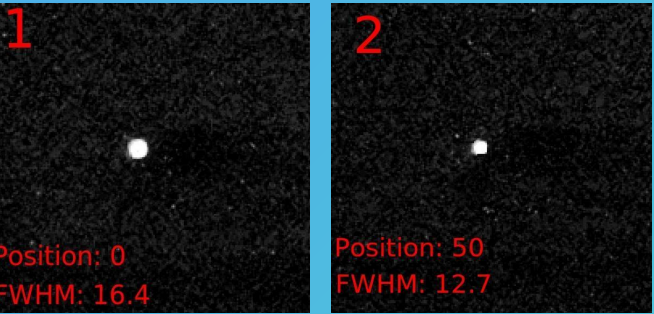
BEST POSITION*



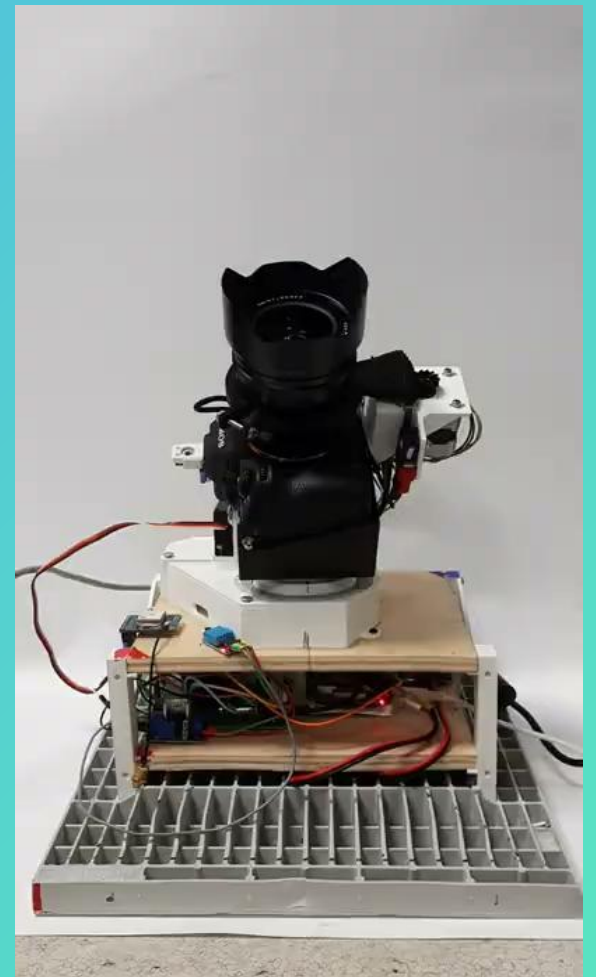
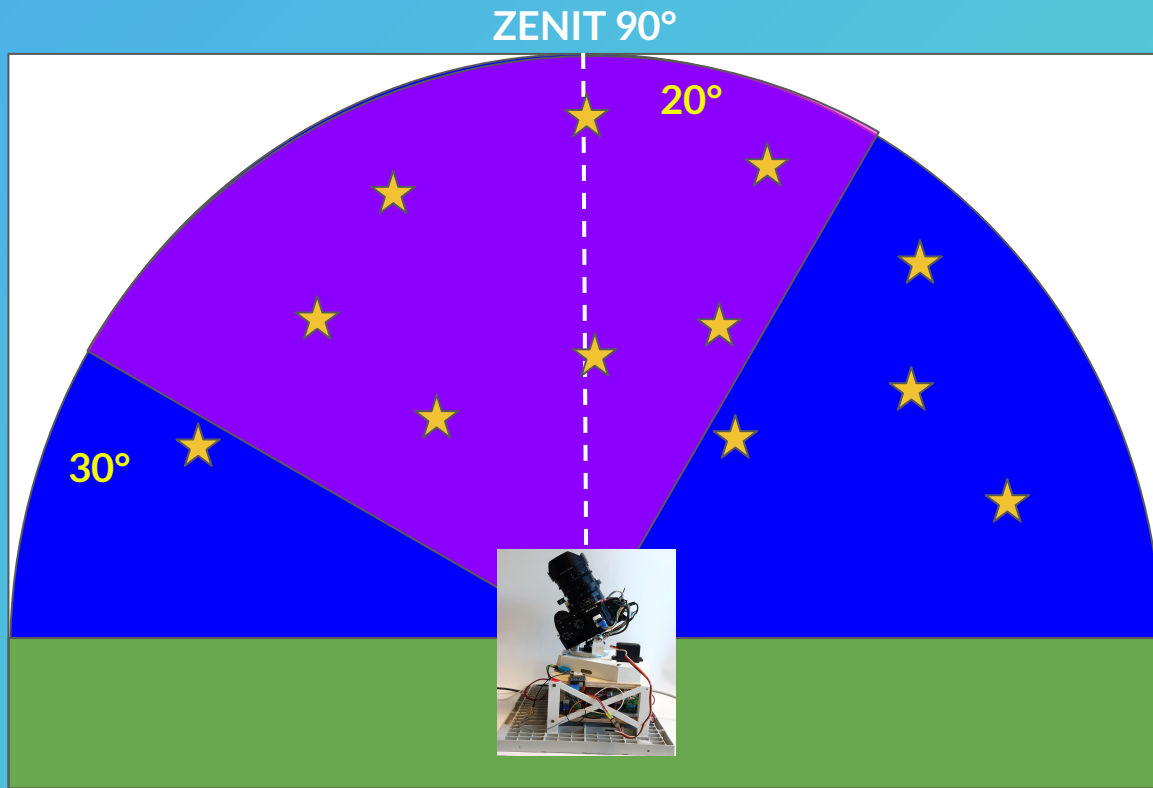
FOCUS CONTROL NECESSARY



FOCUS ROUTINE

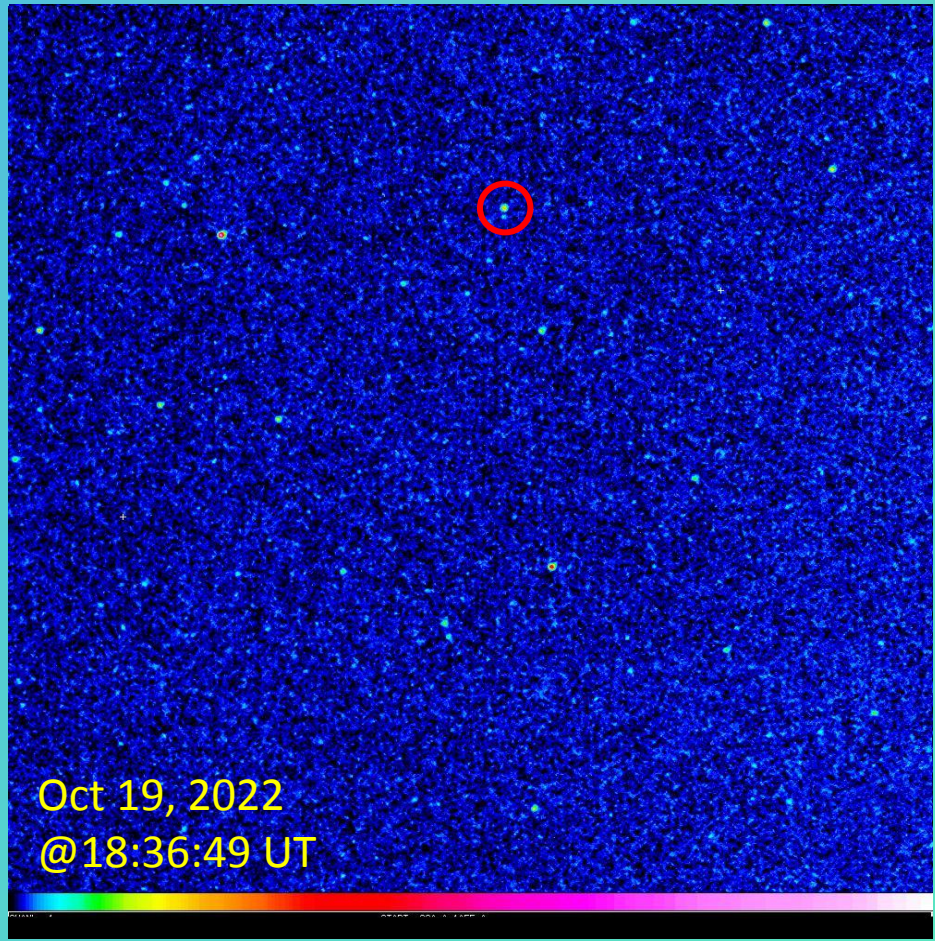
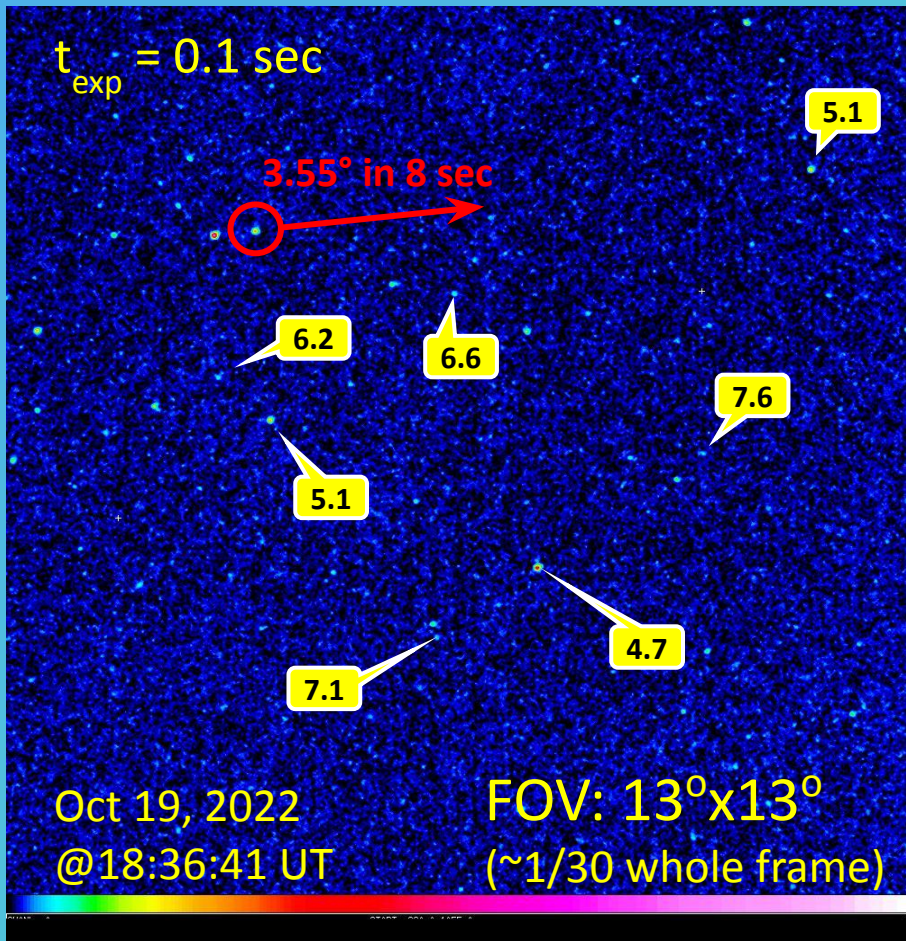


Az. MOVEMENT



PRELIMINARY RESULTS: Intercepting the LEO debris the FengYun 1C, ASAT event (Jan 2007)

FY 1C Deb; Norad: 30300; Cospar: 1999-025ZM; RCS: 0.01 m² (~0.5 m size) Altitude @obs: 840 km; Slant @obs: 1100 km



TO DO LIST

HARDWARE

REFINING THE FIRST STATION ASTRA-1@LOI:

- STRESS TEST ON REAL NIGHT SKY (ASAP).
- COMPLETE SENSOR CHARACTERIZATION.

IMPLEMENTATION OF THE SECOND CAMERA (JUN 2023)

IMPLEMENTATION OF THE FULL NETWORK (END 2023)

SOFTWARE

BUILD THE PIPELINE PROCESSING:

- LUMINANCE EXTRACTION AND OPTIMIZATION OF THE S/N RATIO.
- OBJECT EXTRACTION (single frame)
- TRACKLET RECONSTRUCTION (set of frames)
- ORBIT DETERMINATION

OPTIMIZATION OF THE SCHEDULING

45 Mb for each image, at least 1000 images for each station, 5 station network -> $5000 \times 45 = 223$ Gb of data

WE EXPECT TO MANAGE HUNDREDS OF GB PER NIGHT!!

THANKS FOR THE ATTENTION and CLEAR SKIES!

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Timeliness!

(astronomers never sleep)

