

# THE PHOTSAT MISSION

Ultraviolet and visible all-sky monitoring with a CubeSat

**Ignasi Ribas**

PI

**Guillem Anglada-Escudé**

co-PI

**Josep Manel Carrasco**

Project Scientist

**Ignasi Esteva**

Project Manager

**Carles Sierra-Roig**

Systems Engineer

**IEEC<sup>®</sup>**

Institut d'Estudis  
Espacials de Catalunya

**PhotSat** 

# INTRODUCTION

PhotSat is the first astrophysical satellite developed from design to operations by IEEC and the local industrial ecosystem

## Objectives

- **All-sky monitoring** of the 40 million brighter stars and other astrophysical objects. Its main science case is in the support of high precision programmes of all kind (exoplanets, solar system, cosmology, transients).
- **Develop the capability** of executing science experiments from scratch, including preliminary design, construction, launch, and operations; using off-the-shelf #newspace technologies.

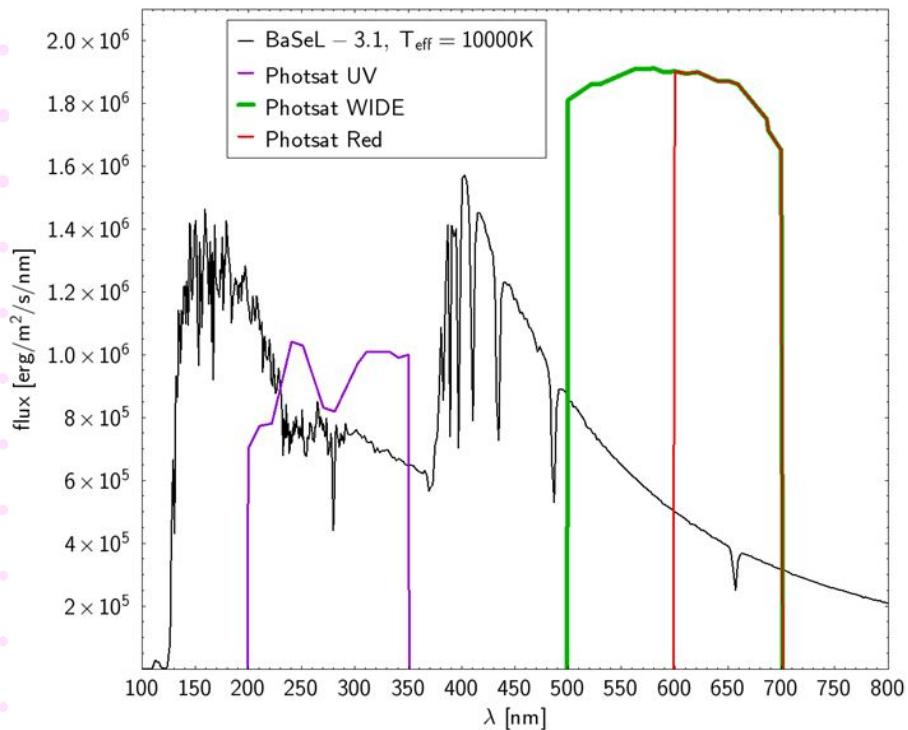
# CONCEPT OF THE MISSION

- FoV - 8 deg
- CMOS detector 2048x2048 pixels, 6.5  $\mu\text{m}$  pixel, constant image rate
- Sampling 14 arcsec/pix, pointing stability <5 arcsec
- Two channels (200-365 nm UV, 380-840 nm VIS, TBD)
- Full sky covered in 2-3 days
- Sun avoidance angle 45 deg

# SCIENCE CASES

- **UV domain** not accessible from ground telescopes.
- Homogeneous **full sky coverage** not accessible from a single ground-based telescope with a single instrument.
- **Complete catalog** of celestial objects in UV and VIS.
- **High cadence time-domain** coverage for bright sources not accessible from larger telescopes.
- **Full colour** coverage of the stellar types (white dwarfs, red giants, emission line stars, ...)
- **Balmer jump** good quality measurement, not accessible from ground.
- **Transient events:** Supernovae, stellar flares, gamma-ray bursts, AGN, ... (earlier in the UV)
- **Periodic events:** variable stars, exoplanet transits, ...
- **Solar system objects:** asteroids and near-Earth objects.
- **Space weather:** Solar particles.

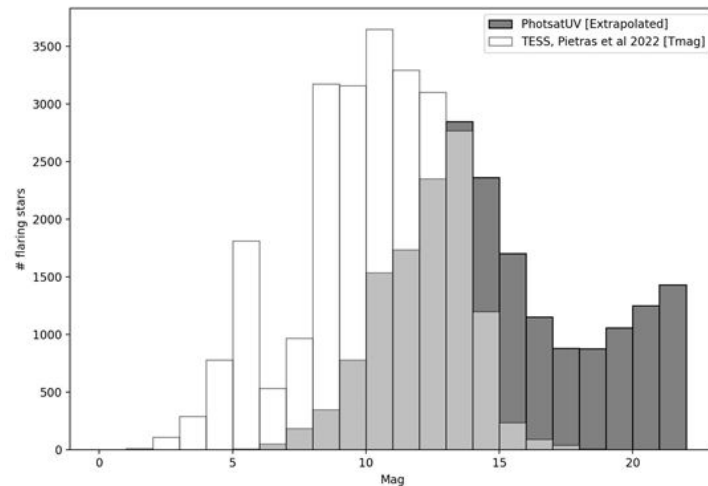
# SCIENCE CASES



Balmer jump for an A star

# Expected number of transient events

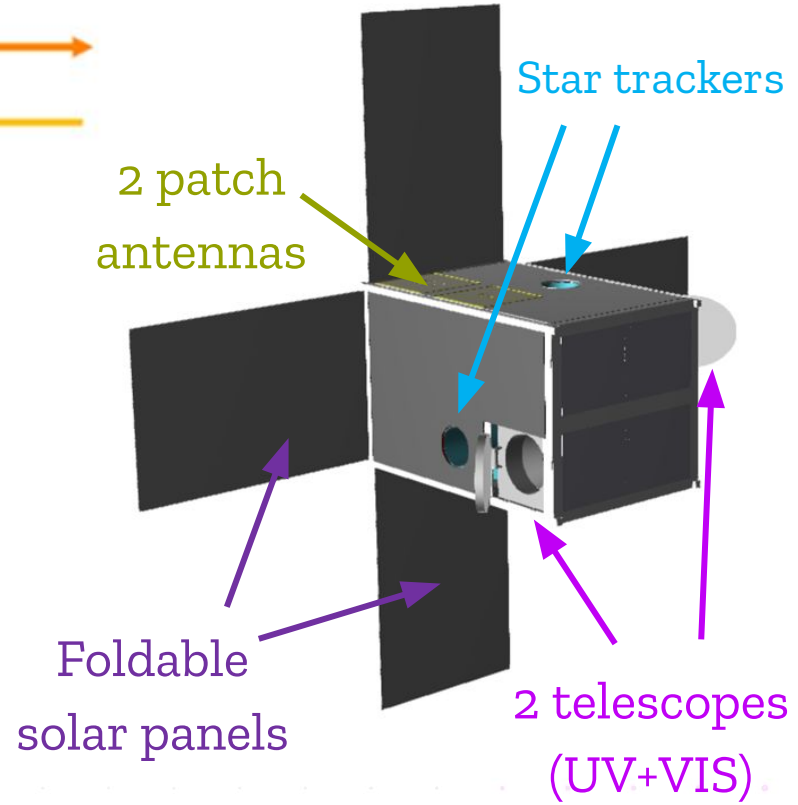
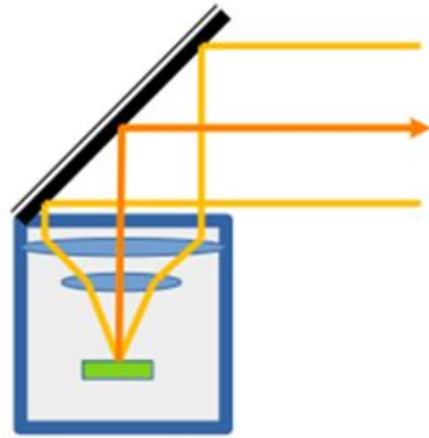
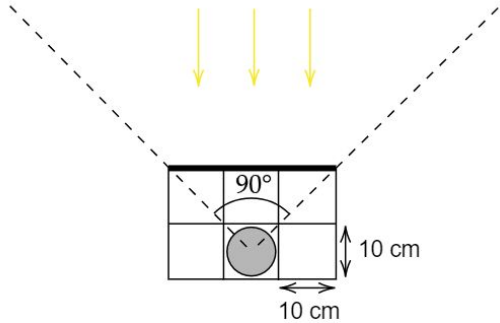
mag	Total candidates (2019-2023)	Average/year	Standard deviation
< 10	6	1.2	0.9
< 11	64	12.8	4.2
< 12	178	35.6	5.1
< 13	376	75.2	7.0
< 14	767	153.4	18.9
< 15	1542	308.4	53.3
< 16	3081	616.2	110.7
< 17	5930	1186.0	193.3
< 18	11652	2330.4	328.7
< 18.5	16284	3256.8	313.4



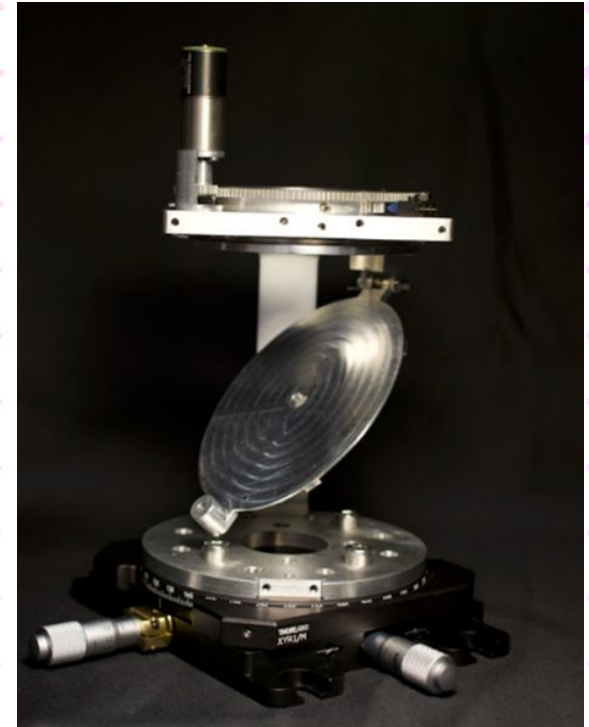
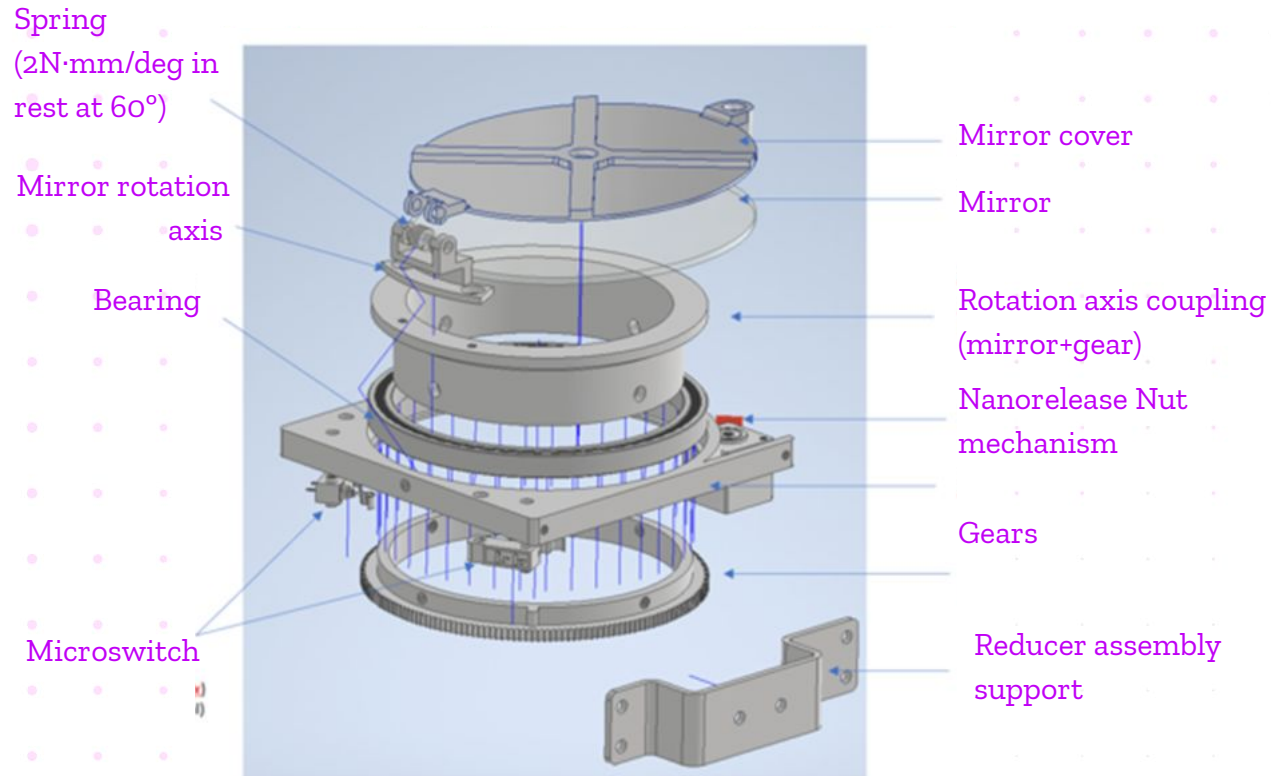
Stellar flares

# THE INSTRUMENT CONCEPT

# SIDEROSTAT

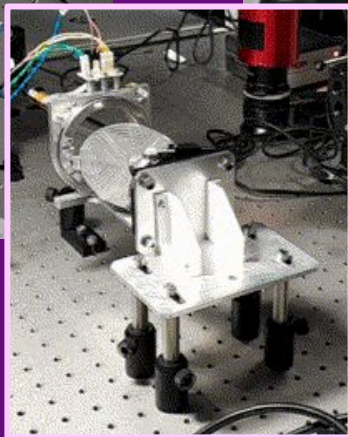
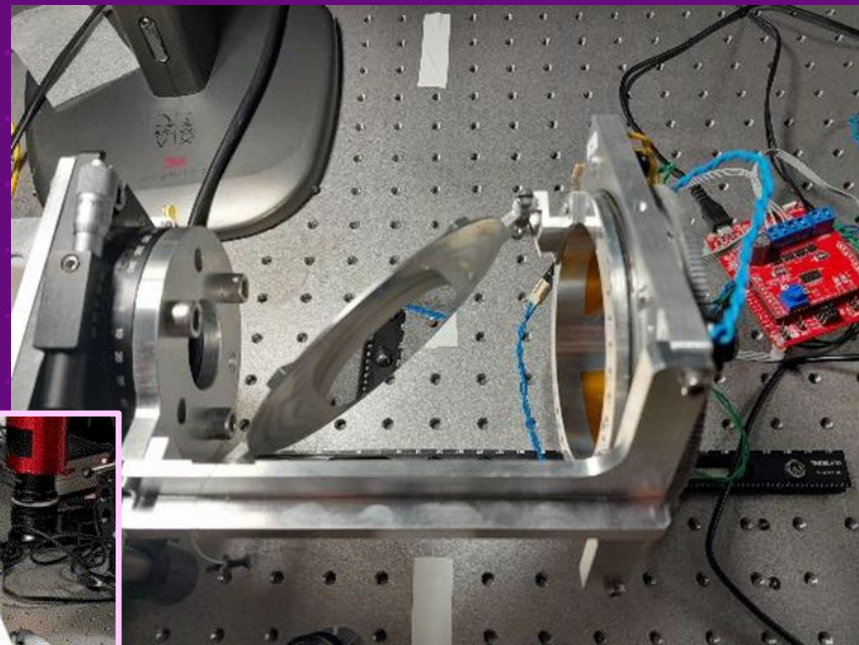
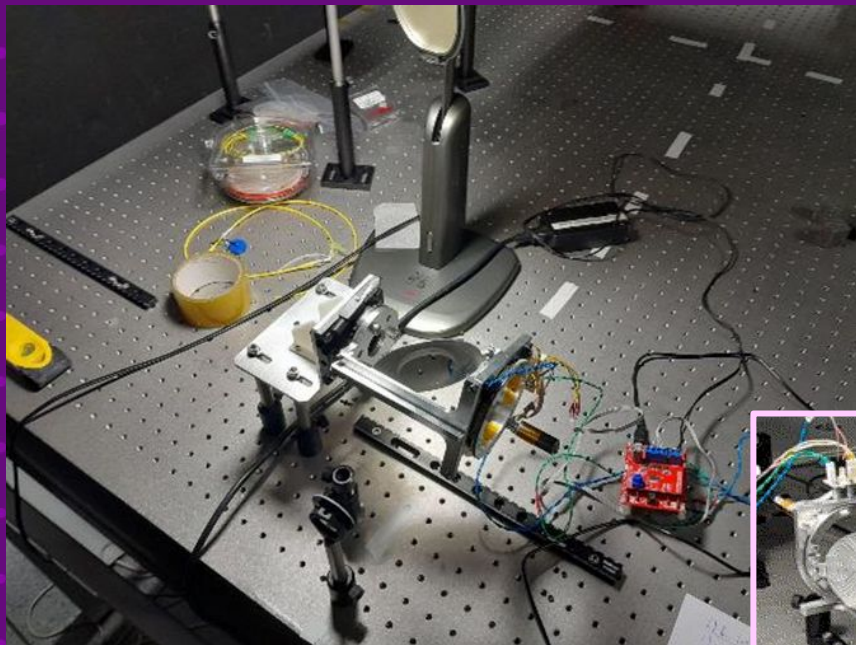


# SIDEROSTAT



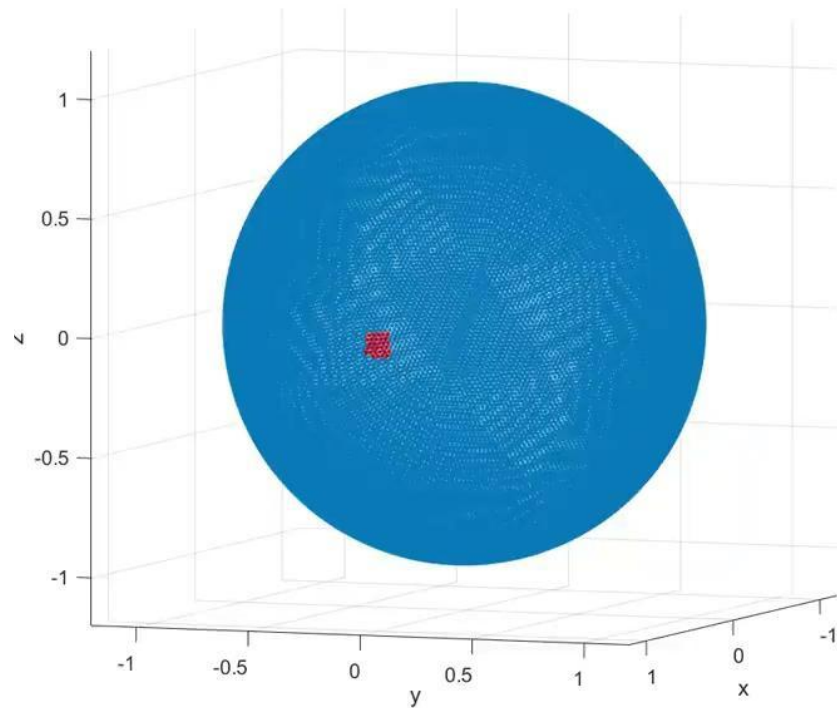
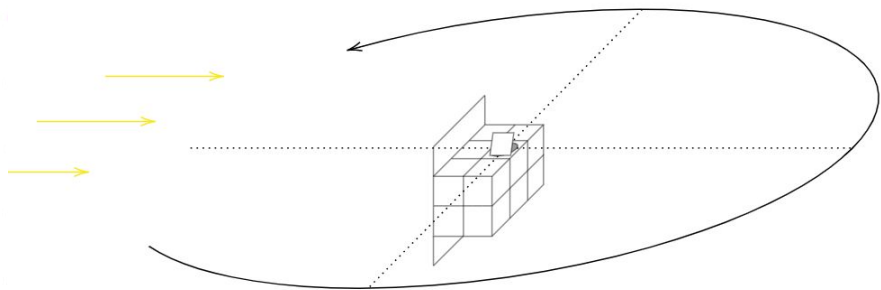


# SIDEROSTAT: prototype



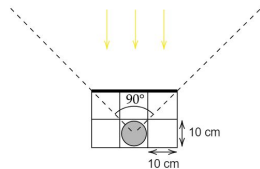
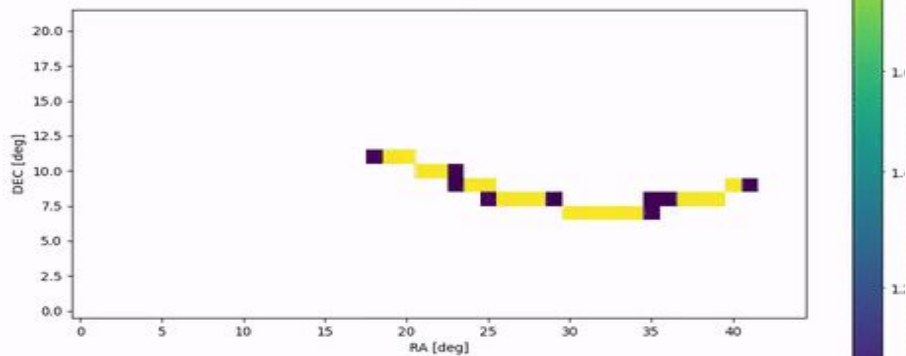
10 deg rotation test

# SCANNING LAW

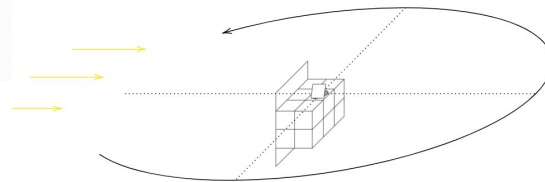


# SCANNING LAW

## First days of mission

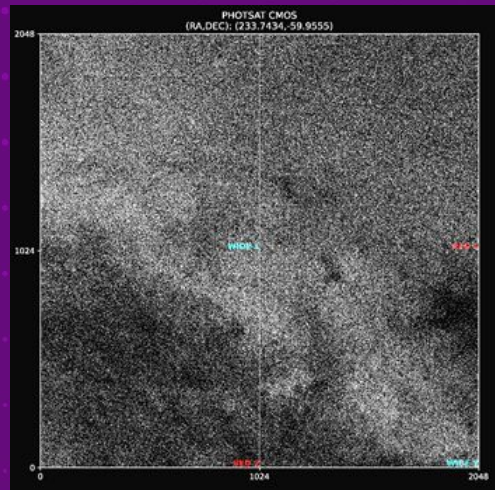


## One year of mission

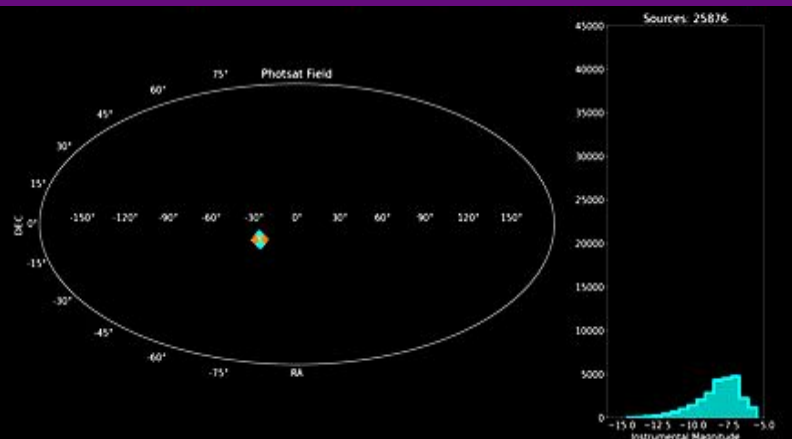
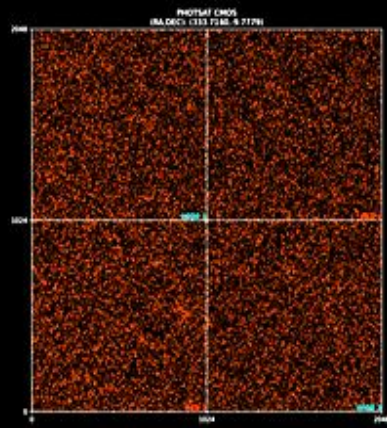
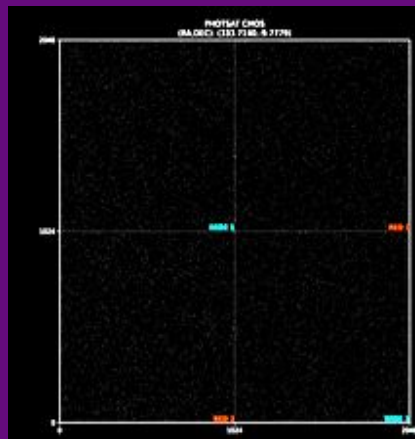


# OBSERVABLE SOURCES

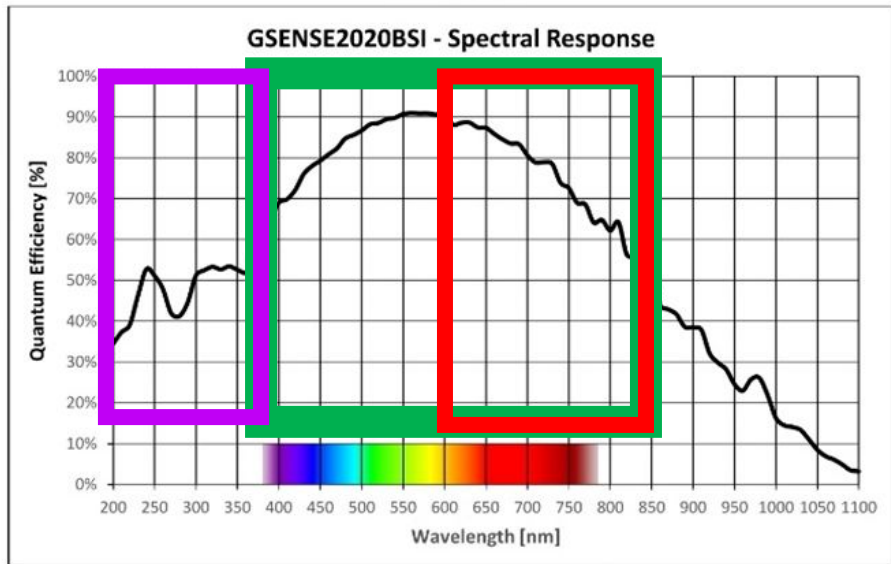
Passband	< 15 mag	< 12 mag
<i>Gaia</i>		
<i>G</i>	36 909 335	3 087 821
PhotSat UV	1 978 173	177 972
PhotSat WIDE	31 876 370	2 672 181
PhotSat RED	36 406 062	3 042 216
GALEX		
NUV	181 323	3 726
PhotSat UV	347 449	16 603



Crowded field  
example



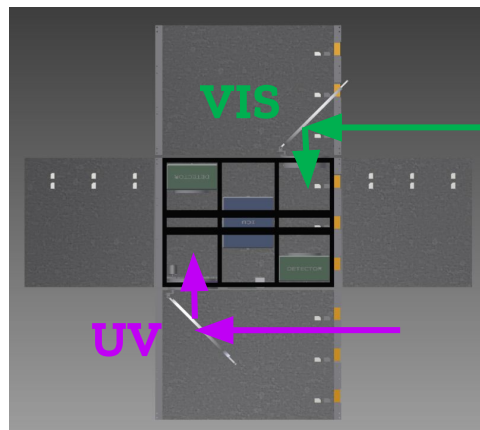
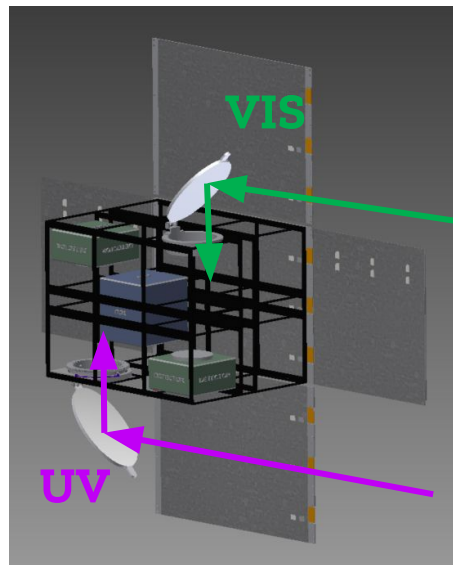
# INSTRUMENT CONCEPT



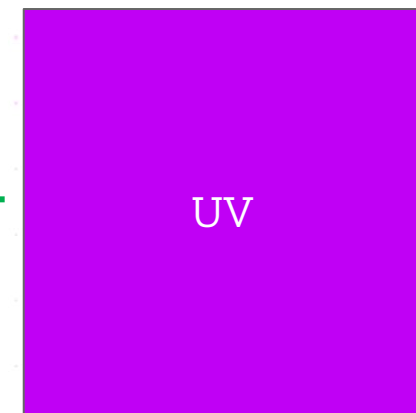
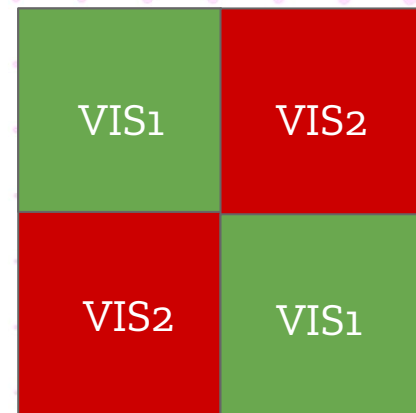
UV  
200-365 nm

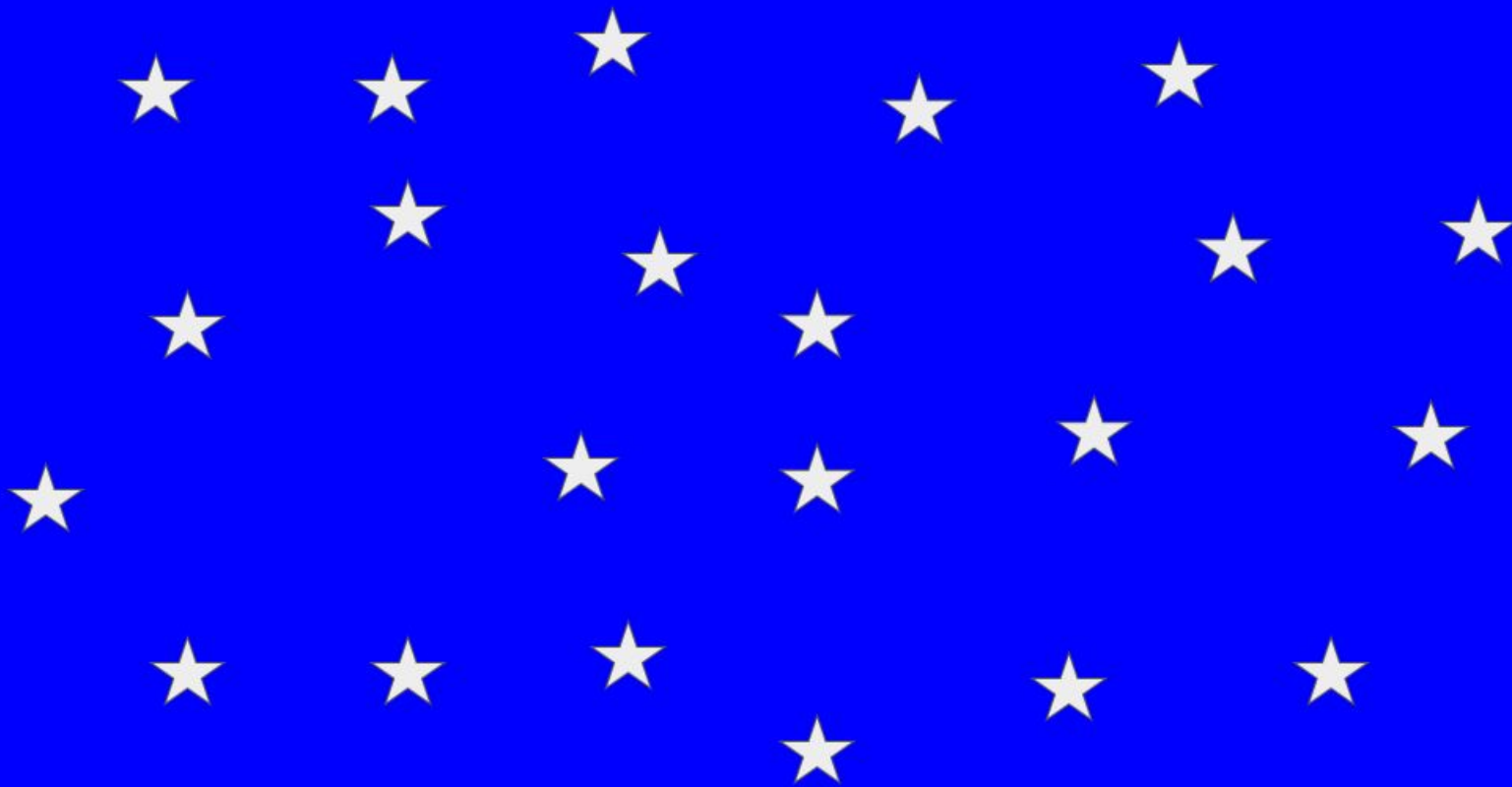
VIS1  
380-840 nm

VIS2  
600-840 nm

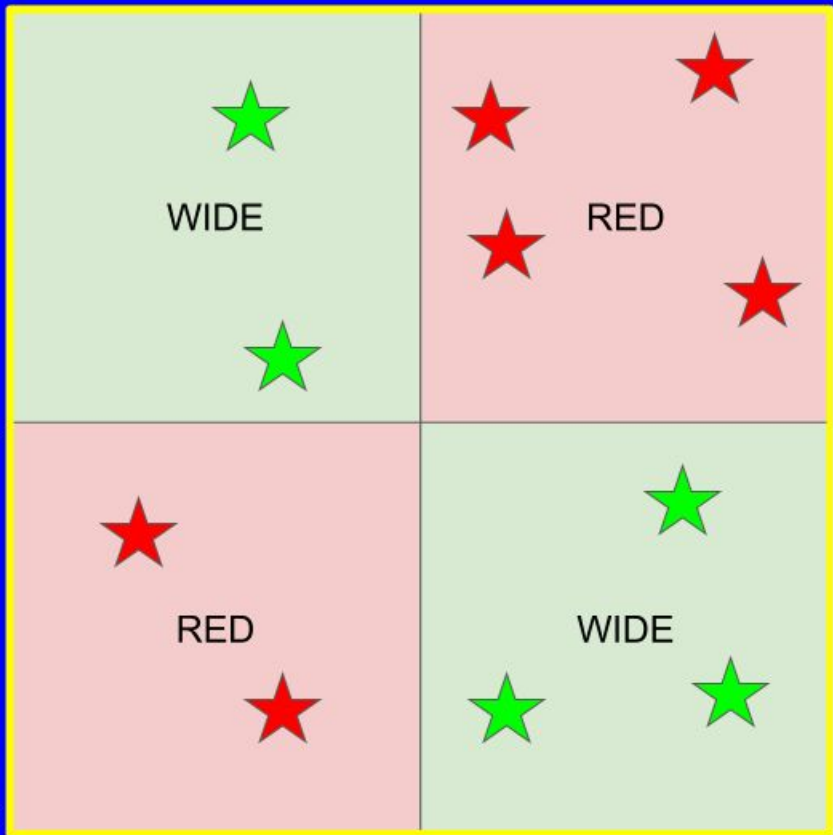


CMOS detectors





2048 pixels



WIDE

RED

RED

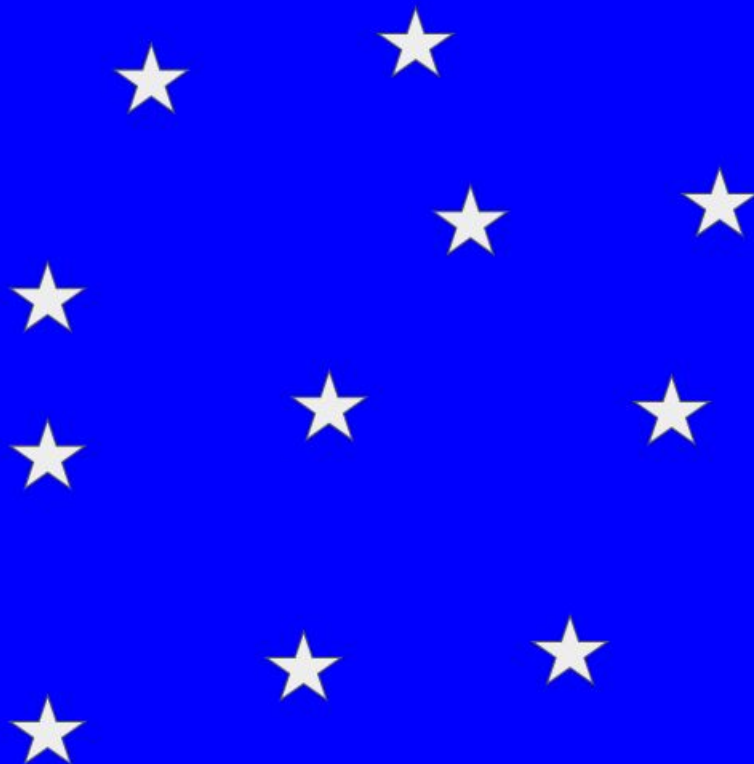
WIDE

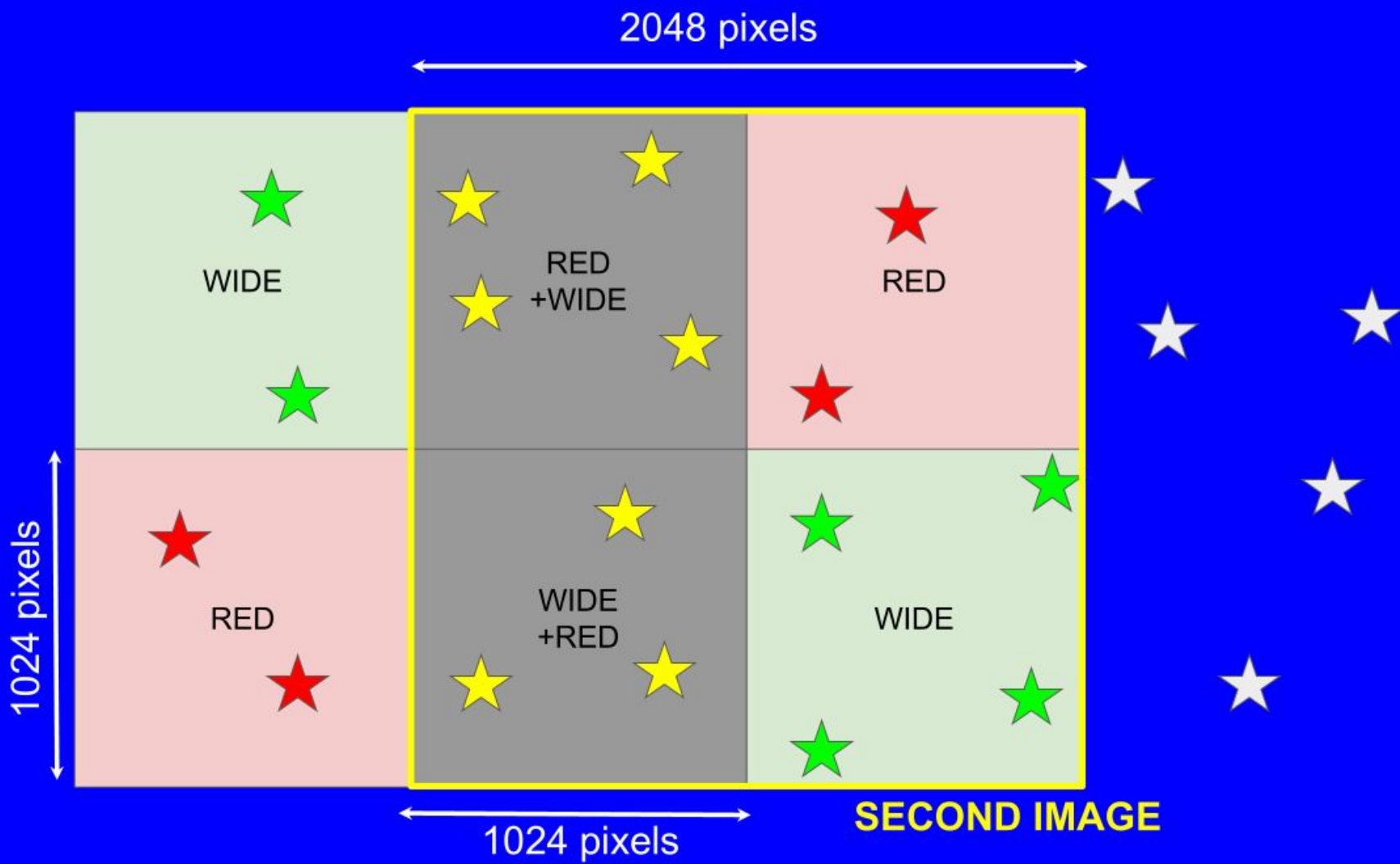
1024 pixels



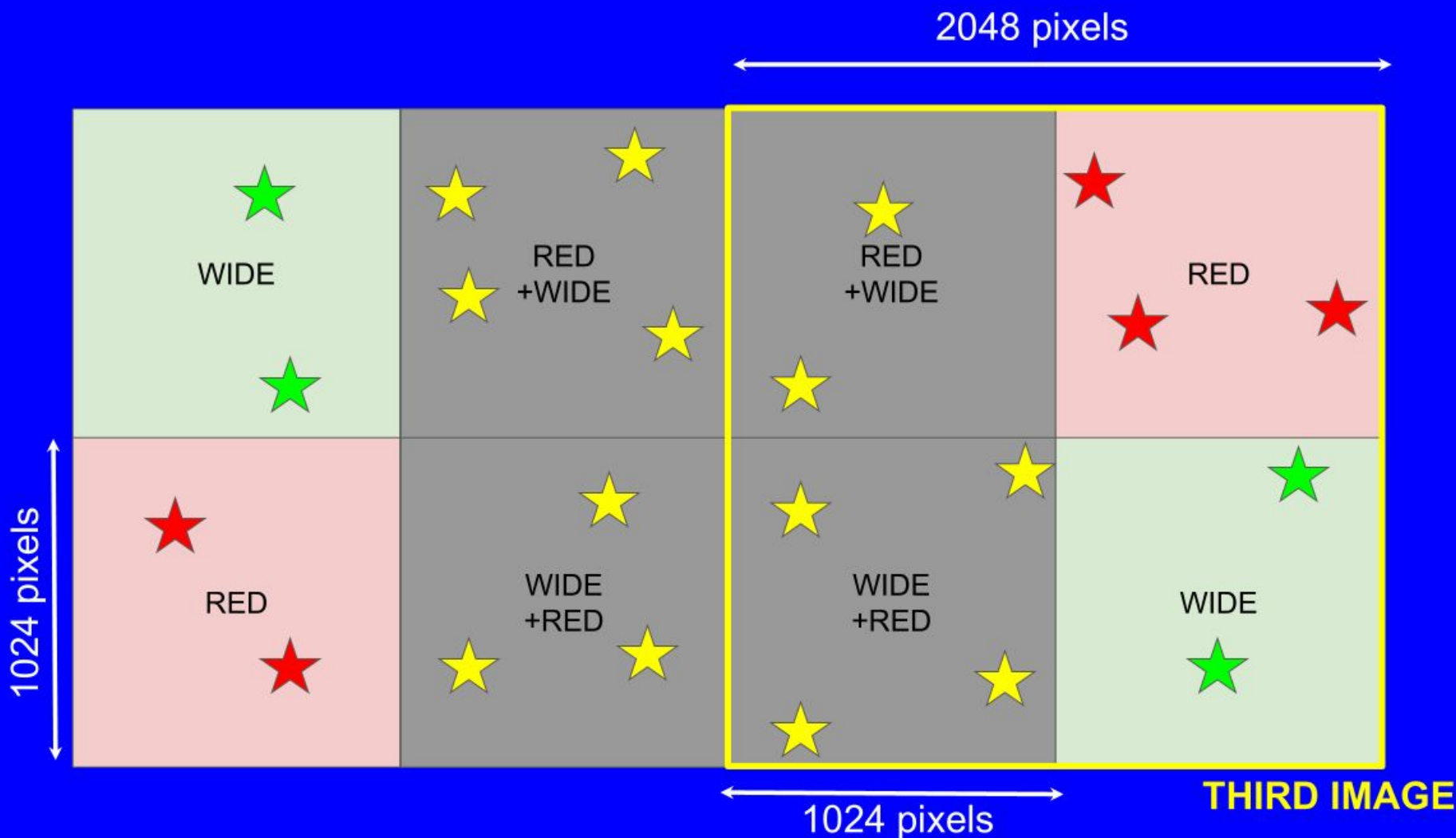
1024 pixels

**FIRST IMAGE**

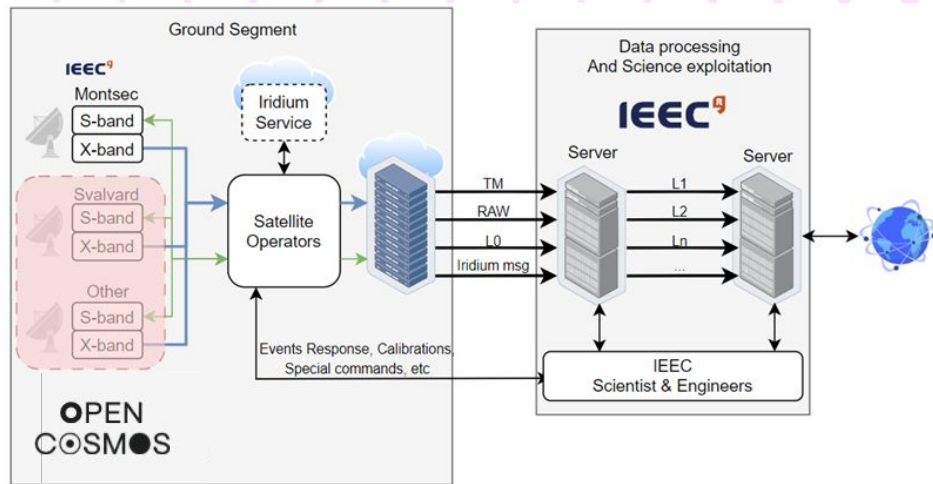
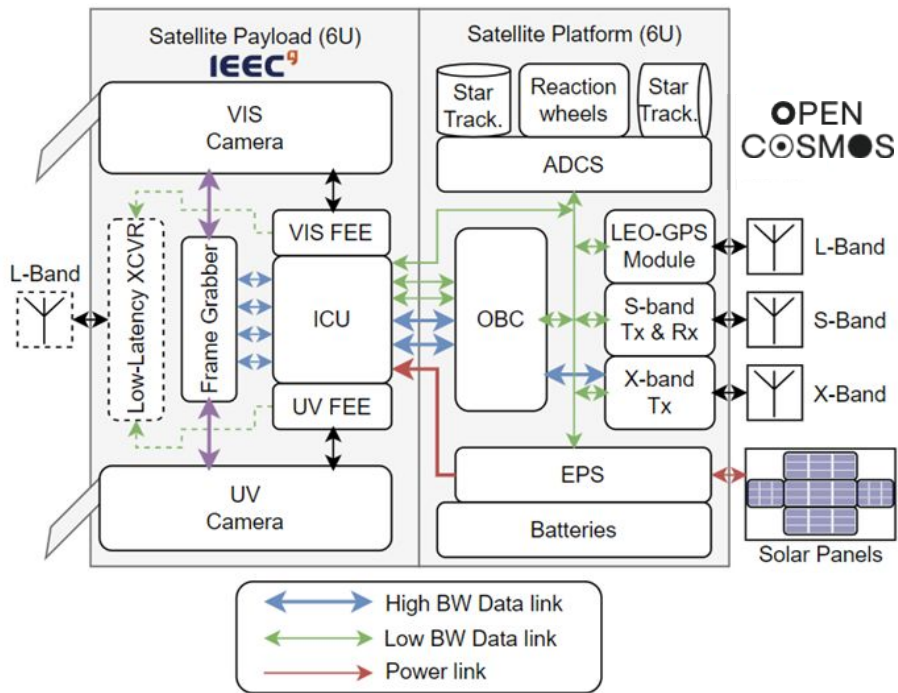




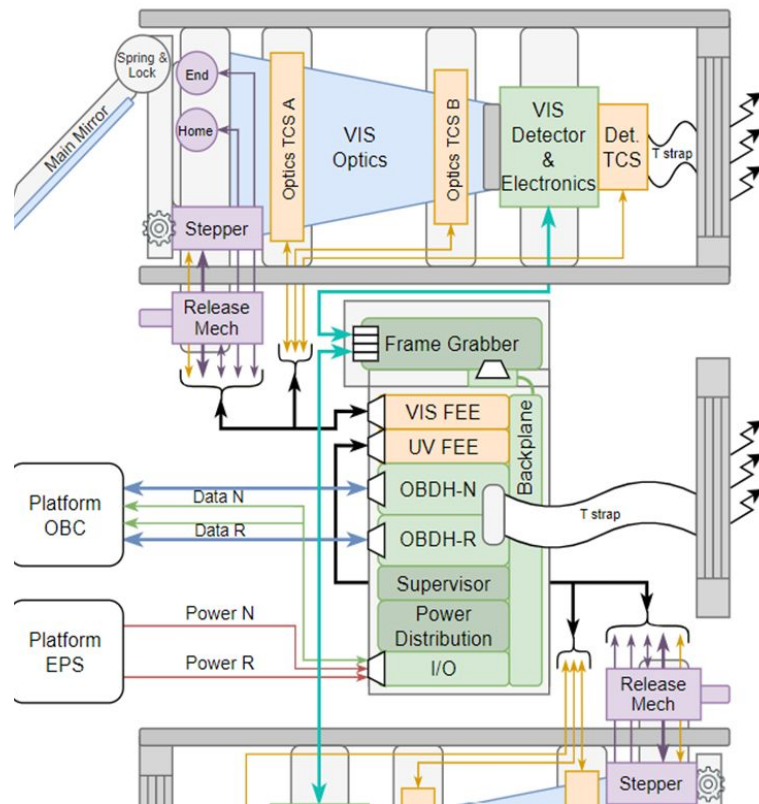
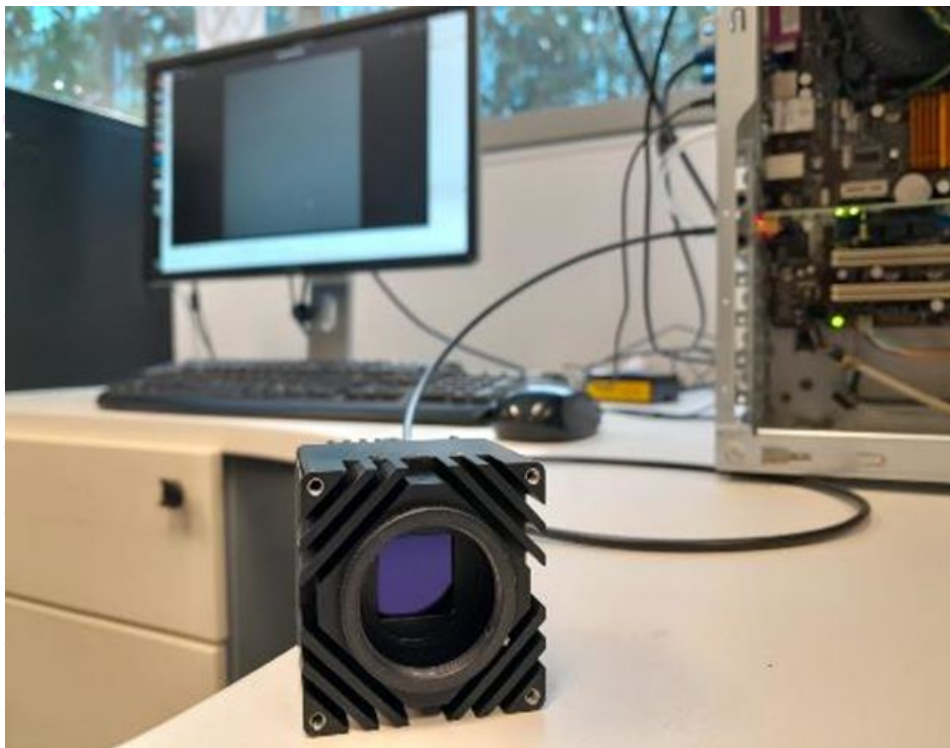




# SYSTEM DEVELOPMENT

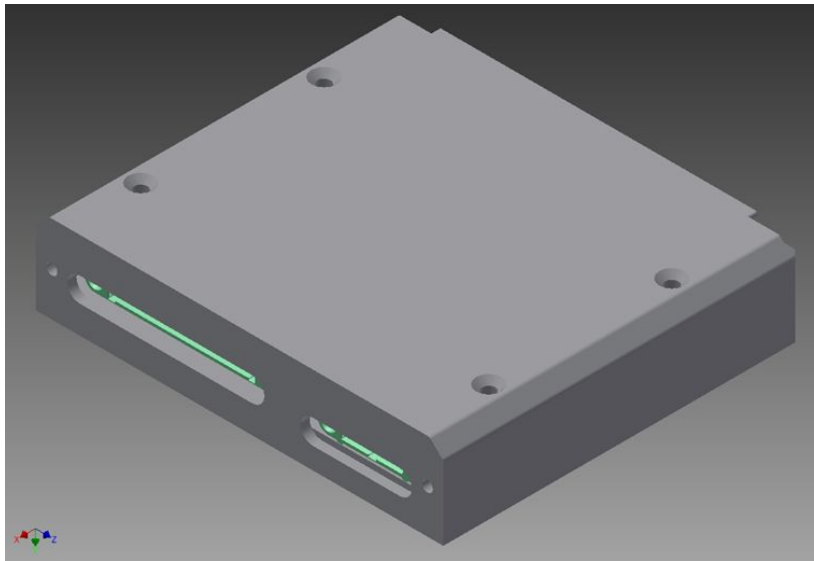


# OPTICAL SYSTEM



# PAYLOAD INSTRUMENT CONTROL UNIT (ICU)

Prototype is being built to test space environment resilience

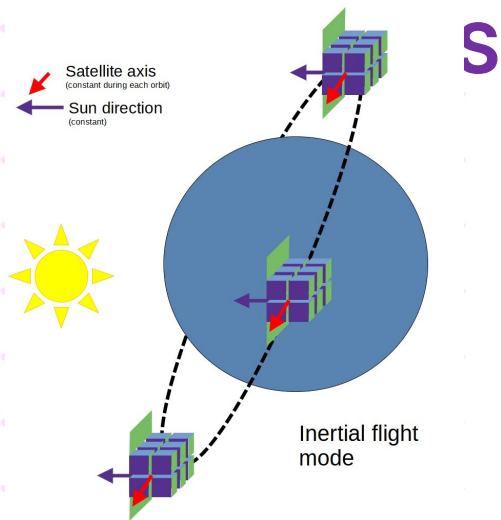


ICU based on a backplane with cards that follow the VNX+ standard



Cold-Redundant main processor based on a SoM with a Xilinx MPSoC

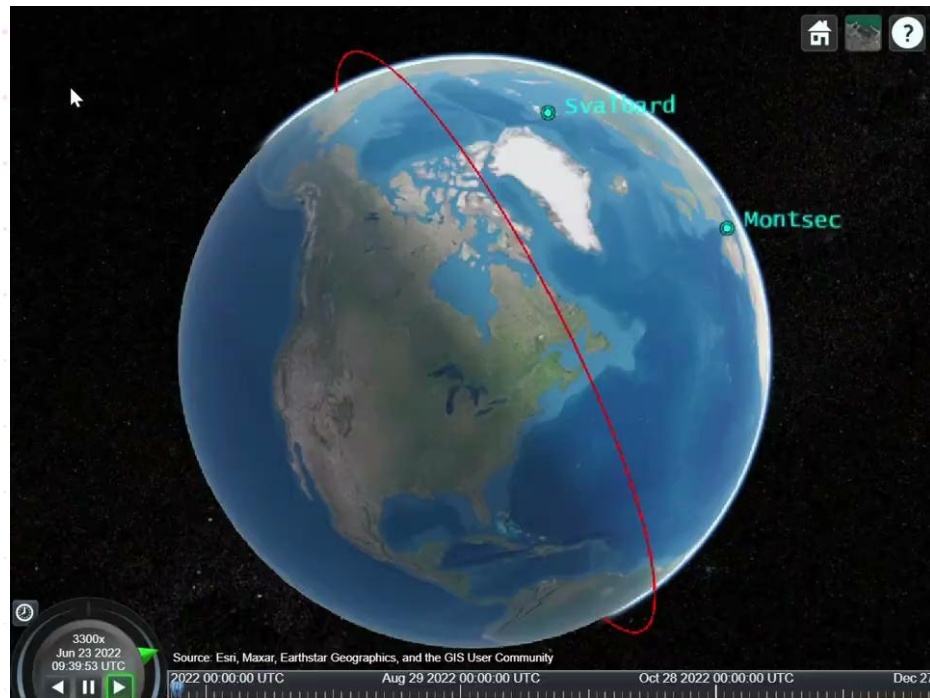
# ORBIT & COM



## Storage & telemetry budget

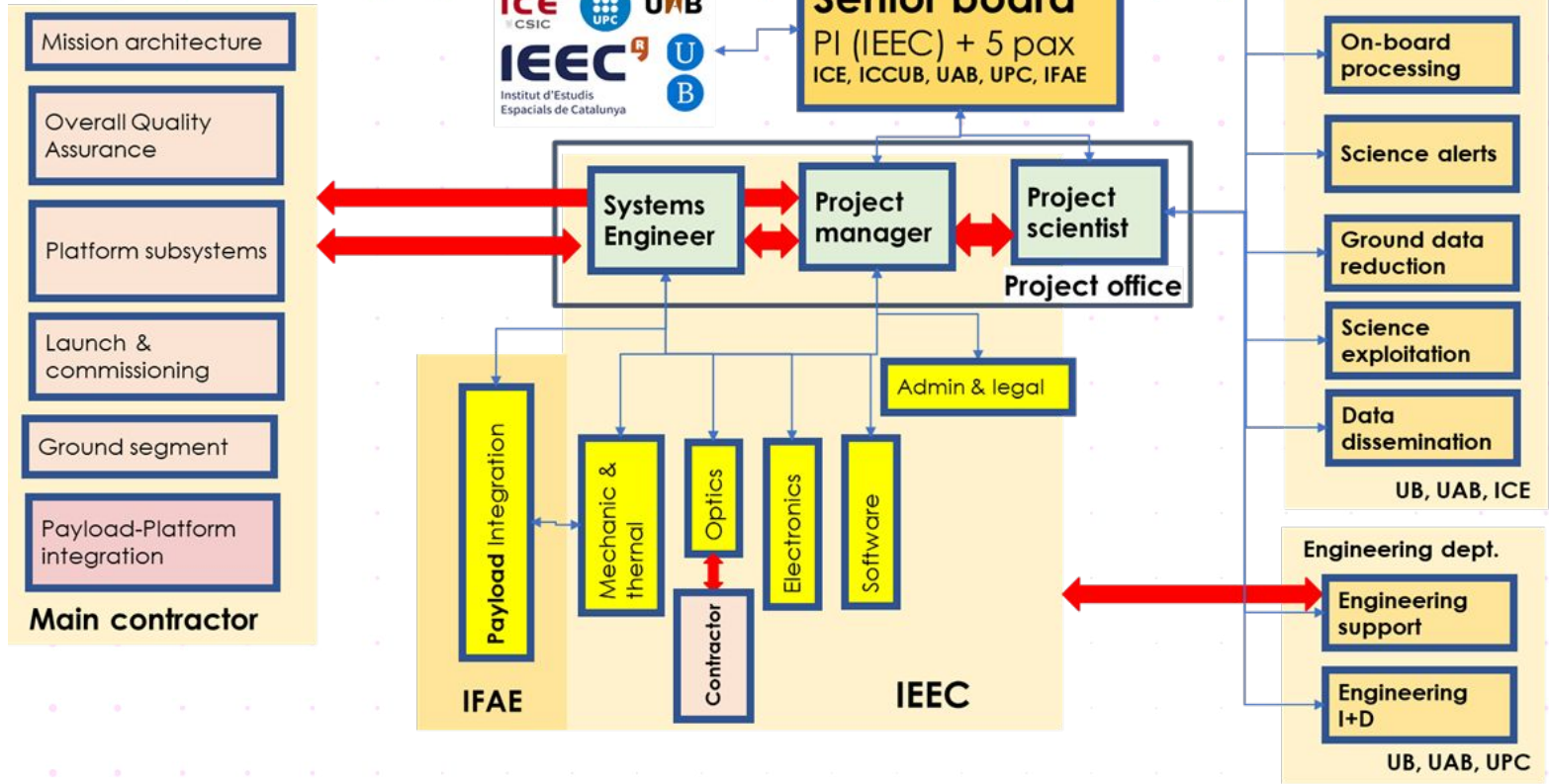
	Orbit (GB)	Day (GB)	All sky (GB)
Full image	0.55	8.8	24.5
7x7 pix windows	0.21	3.4	9.4

Download (X band) ~9 GB/pass

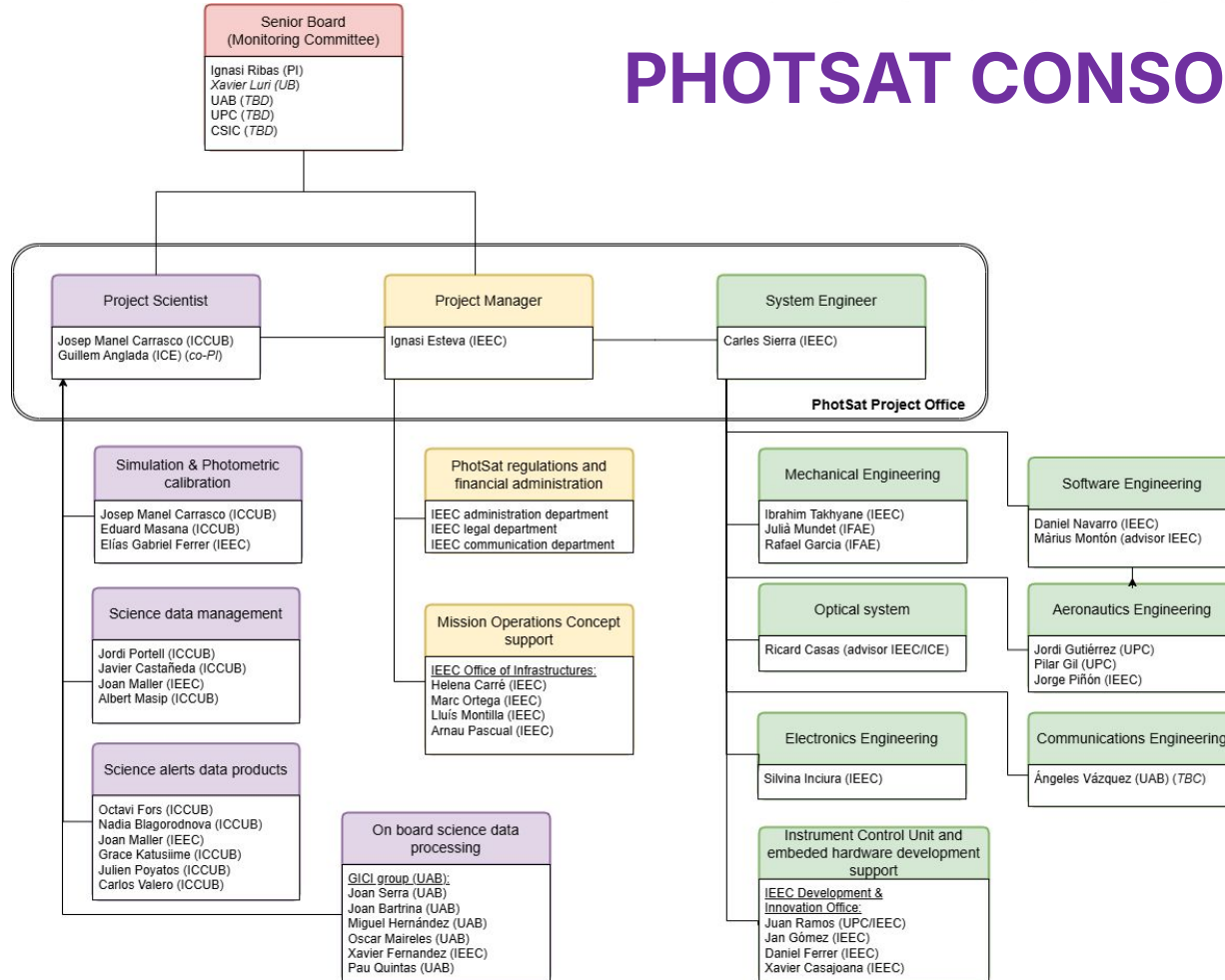


# THE PHOTSAT CONSORTIUM

# PHOTSAT CONSORTIUM

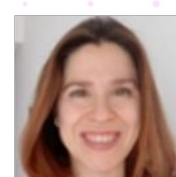
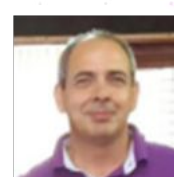
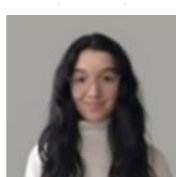
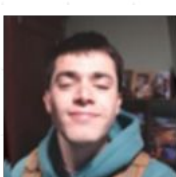
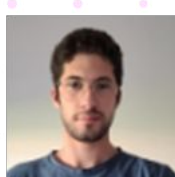
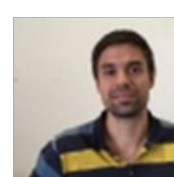
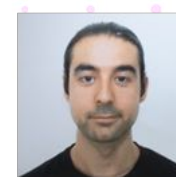
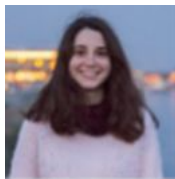


# PHOTSAT CONSORTIUM





# PHOTSAT CONSORTIUM



# PHOTSAT CONSORTIUM

**Senior Board - IEEC (PI), +5 members** ICE/CSIC, UAB, ICCUB, UPC

**Project Office** - IEEC, Project manager (full time), Systems Engineers (full time), Project Scientist (part time), communication, admin & legal

**Science exploitation team** - ICE, UB, UPC, UAB (+ partners, funding for operations)

**Engineering development & advisory** - IEEC, UPC, UAB, ICCUB

**Payload assembly and QA** - IEEC, IFAE, terms & contract to be negotiated

## Contractor

**Main contractor** - Mission architecture, platform, launch, commissioning, operations, ground segment, with advise from consortium

**Minor contracts for payload subsystems** - Optics

## PhotSat Exploitation Consortium

**Science exploitation** - pipelines, alerts, archival and dissemination- Institutes, not fully funded : national/international partners

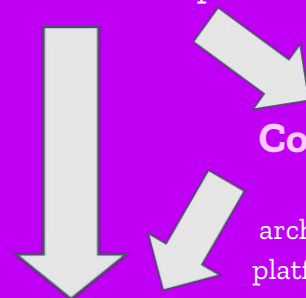
**Operations** - IEEC (not fully funded). Requests to infrastructure support funding Gen.Cat & intl partner contributions.

### PhotSat consortium

Mission definition, payload

**2023**

Science modes and products



**2024**

### Contractor

Mission architecture and platform & minor

### PhotSat Exploitation Consortium

**2025**

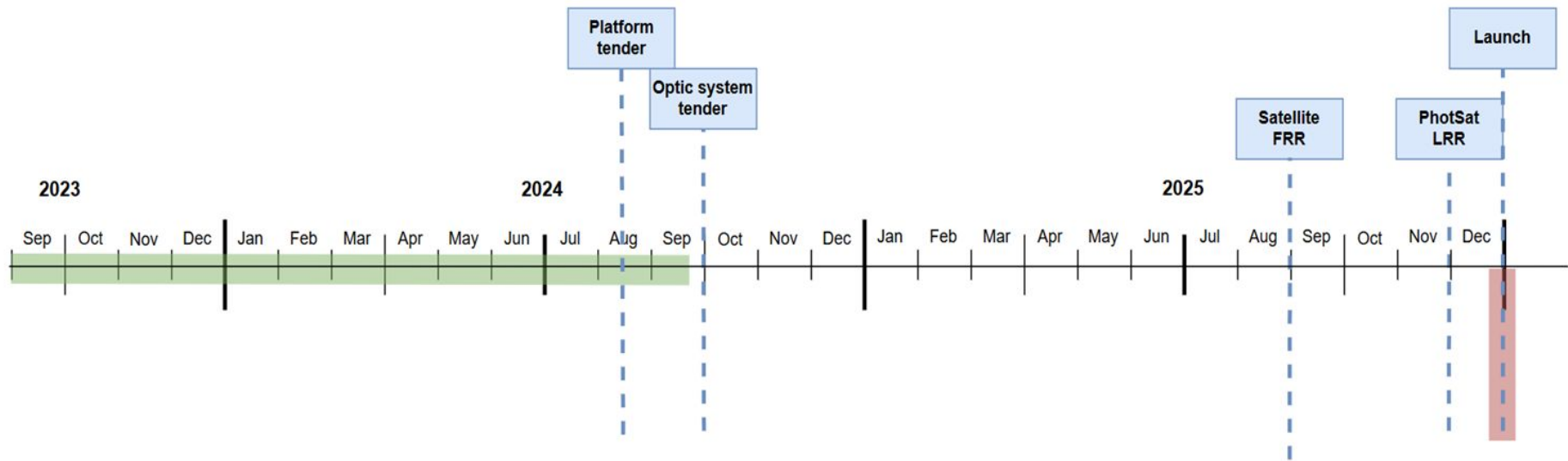
### Consortium

Operations and science

exploitation (open to international partners)

**2026+**

# PROJECT STATUS



**IEEC**<sup>R</sup>

**PhotSat** 

**THANK YOU**

Contact: [carrasco@fqa.ub.edu](mailto:carrasco@fqa.ub.edu)

**CERCA**  
Centres de Recerca  
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 **UNIVERSITAT POLITÈCNICA  
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 **CSIC**