2° Forum della Ricerca Sperimentale e Tecnologica

FlyEye Ground-Based Telescope: Unveiling New Frontiers in Astronomical Science

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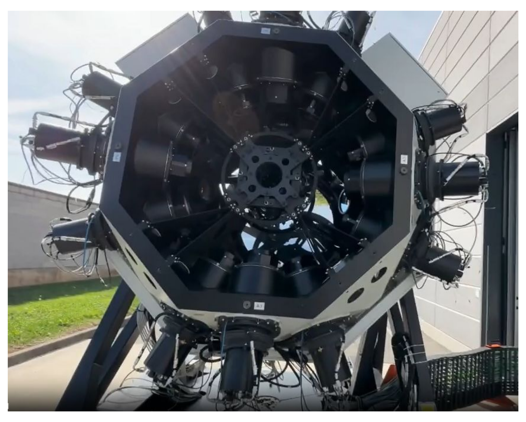
The FlyeEye design:



The FlyEye distinctive design **splits the field of view** (FoV) **into 16 channels**, creating a unique multi-telescope system. The **wide (44 square degree), panoramic** FoV and the **seeing-size pixel-scale** enable e.g. near-earth objects detection down to apparent magnitudes insisting on a 1m diameter spherical mirror.

The FlyEye allows the survey of **two-thirds of the visible sky three times per night** revolutionizing **time-domain astronomy**, enabling comprehensive studies of **transient phenomena** and placing FlyEye in a new era of exploration of the dynamic universe. Efforts to develop automated calibration and testing procedures are keys to realizing this transformative potential.

Other implementations and opportunities:

The unique capabilities of the FlyEye design are appealing to a plethora of applications. While the NEOSTEL operations will be focussed in the detection and characterization of near-earth objects, **ASI** will adopt **four FlyeEye telescopes** to build a net of observatories for **space surveillance and tracking (SST)**.

Other applications that could benefit from dedicated FlyEye telescopes include time-domain astronomy. For example assisting the characterization of fast radio bursts and other high-energy phenomena: its ability to quickly pivot and focus on different regions of the sky allows the follow up on alerts from other observatories. A dedicated FlyEye telescope can strategically work in synergy with other major astronomical projects like the Vera Rubin Telescope (9.5 square degree FoV) and the Zwicky Transient Facility (47 square degree FoV).

ESA NEOSTEL: the FlyeEye debut

FoV	6.7x6.7 deg = **44 square deg**
Cameras	**16**
N pix tot	16 x 4096 x 4096 = 0.26 bilion
FoV gaps	**NO (100% fill factor)**
(E)ntendue*	0.00674
Pix. scale	**1.5 arcsec/px**
Sensors	Astronomical grade CCD (e2v Teledyne, model CCD231-84-BI)
Cooling	CCDs operated at -45°C using a Thermoelectric Cooler (TEC)
Quantum Efficiency	>95% peak, >75% mean over a 470-780nm spectral window
Readout noise	2e RMS maximum @ 50kHz readout frequency
Lim. mag.	**V=21.5 mag with 40s DIT**
Mount type	Equatorial

*E= effective collecting area[m^2] × FoV [sr]

The prime contractor for the NEOSTEL is OHB-Italia, receiving extended support from the Italian National Institute for Astrophysics (INAF).
The NEOSTEL has been accepted in-factory. Telescope and mounting are being moved to an temporary site in Matera (ASI Space Geodesy Center) where the two components will be coupled for the first time. The planned final site of the first NEOSTEL will be at the top of Mount Mufara (Sicily).

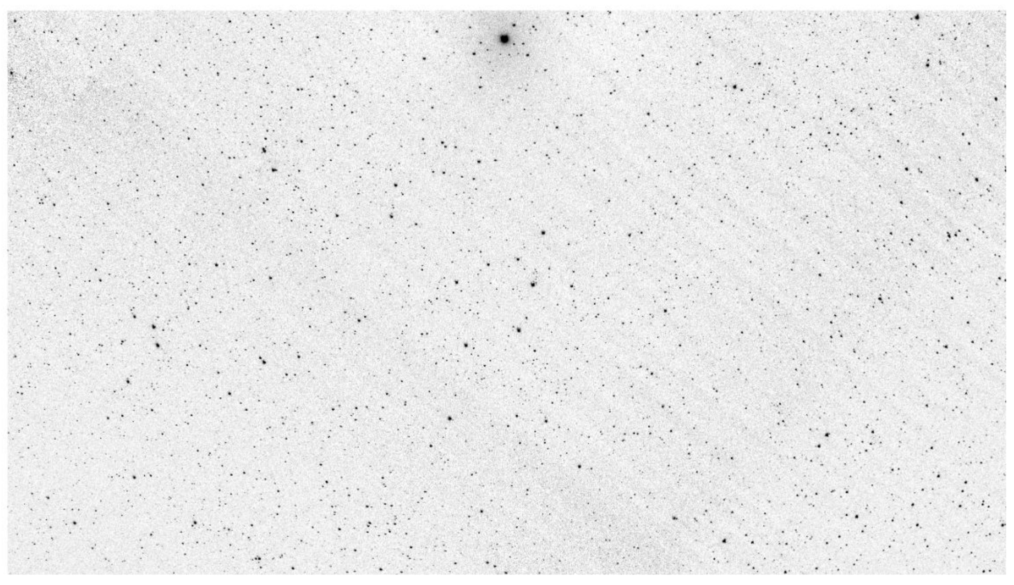
INAF current involvement:

INAF, and our team in particular, is deeply involved in the implementation of the FlyEye design and correlated activities.

NEOSTEL:
Since the beginning of the NEOSTEL project, our team is providing extensive support to OHB-Italia, specifically on the alignment procedure of the optical components of the telescope. We are developing procedures and softwares to commission the instrument when it will be integrated in the ASI site in Matera (planned for the end of 2024).

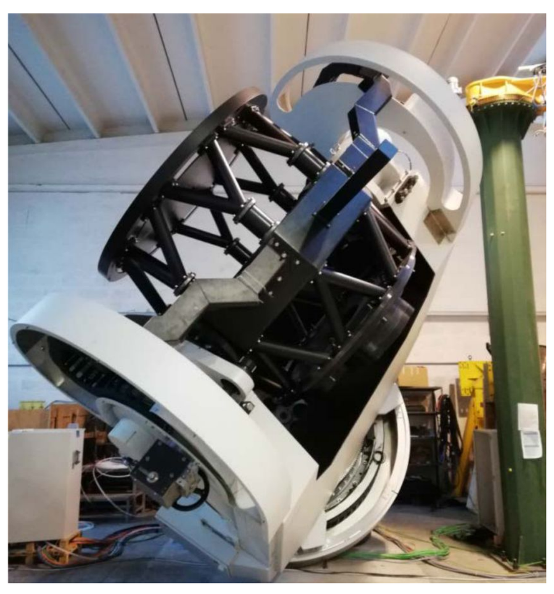
ASI:
Our team is also involved in the deployment of the four Flyeye telescopes for ASI.
In the context of the ASI+INAF – Agreement "Detriti spaziali e sostenibilità delle attività spaziali a lungo-termine" 2024-2026 we perform two kind of activities:

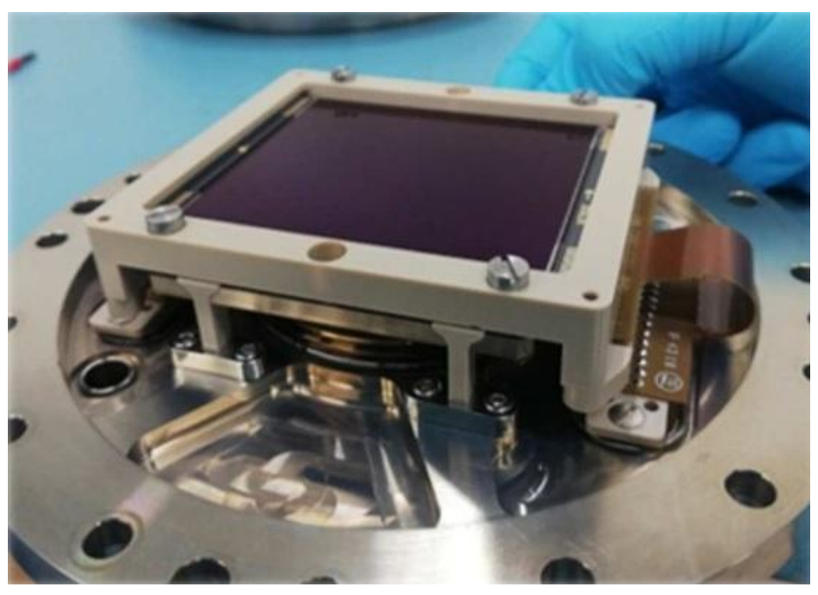
1. we serve as reviewers (for ASI) during the design phase of the FlyEye telescopes;
   after this initial phase ends, we aim to assist OHB-Italia in the commissioning of the telescopes;
2. we provide observations with the INAF facilities at Asiago in the context of SST activities;
   Both the Copernico and the Schmidt telescopes in asiago are used. The wide field of view of the Schmidt telescope makes it particularly suited for the monitoring of orbital properties of satellites like the GPS ones, or to perform follow-up observations when collisions between satellites are detected.
   The Copernico telescope, equipped with AFOSC, have a smaller field of view but it can perform also spectroscopic (slit) observations. This makes it particularly suited to characterize geostationary satellites.



*← Zoom-in (**2.3deg x 1.3deg**) of a NEOSTEL image taken at Turate site. The channels (3 visible here) of the FlyEye provide a uniform FoV.*

↓ ESA NEOSTEL: the first FlyEye. Left. Telescope on elev. only mount in Turate. Center. The equatorial mount in Verona. Right. One of the 16 ASTROCAD cameras. https://www.ohb-italia.it/multimedia/flyeye_22.mp4





Conclusions:

The FlyEye design is currently been implemented in different applications. The first telescope that adopts this design is the NEOSTEL of ESA is in an advanced stage of construction and is currently being displaced to an ASI site in Matera for integration with the equatorial mounting. Other four FlyEye telescopes are being constructed for ASI in the context of SST. **INAF is deeply involved in the FlyEye development providing extensive support in the design, integration and commissioning.**
From a scientific perspective, **the on-sky performance** of the current FlyEye telescopes **will bring detailed info for the development of a dedicated FlyEye for astronomical applications**. Monitoring two-thirds of the visible sky about three times per night, a FlyEye telescope will help building a continuous and detailed record of the astronomical landscape, especially working in synergy with other astronomical facilities. This capability is a strong asset not only for capturing rare astronomical events but also for tracking slower changes in the universe that are no less scientifically important. **Efforts to develop automated calibration and testing procedures are keys to realizing this transformative potential.**

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