

SEEING Family: Low-SWaP, High-Performance Imagers for Multi-Domain Applications

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ABSTRACT

The SEEING family is a new generation of compact, high-performance imagers developed by Safran Reosc for the New Space market. The program was initiated with the in-orbit deployment of the SEEING 130 WIDE, formerly known as NIORD Low-Light Imager, embarked on the NorSat-4 satellite. Since its launch in early 2024, the instrument has delivered a large volume of imagery with outstanding quality, fully demonstrating its capabilities as a low-light imaging system.

Since then, several additional imagers at different stages of maturity have been developed. The SEEING 230 has entered into serial production, with the first unit delivered in March 2026 and a first flight scheduled for October 2026. In parallel, a dedicated imager for Space Situational Awareness (SSA) applications has been developed for debris detection in low Earth orbit. The SEEING DETECT system has so far been produced as a single unit, with launch planned for early 2027. The SEEING 500, targeting very high-resolution applications (with a ground sample distance on the order of 0.5 m), is currently in its detailed design phase.

This paper provides an overview of the SEEING family, including the main system specifications and the current development status of each imager.

Keywords: New Space, Low-SWaP Imaging, High-Performance Imagers, Low-Light Imaging, Multispectral Imaging, Earth Observation, Space Situational Awareness

1. INTRODUCTION

Historically, Safran Reosc has been primarily involved in major institutional space programs, working in close cooperation with leading satellite prime contractors and manufacturing large-scale optical components, particularly large mirrors. In recent years, the company has become an integral part of Safran's Space Global Business Unit, which was established to strengthen synergies among the Group's various entities operating in the space sector.

At the same time, the rapid growth of the New Space market is driving increasing demand for compact, cost-effective, and high-performance payloads [1][2]. Optical imagers must provide advanced imaging capabilities while meeting stringent constraints on size, weight, and power consumption. Low-SWaP architectures are therefore a key enabler for small-satellite missions, allowing high-performance optical payloads to be integrated into resource-constrained platforms without compromising overall mission performance.

Against this background, and as a complement to its involvement in major institutional programs [3], Safran Reosc has developed a family of compact imagers known as SEEING™, standing for Small instrumEnt for Earth imagING. The family originated with the SEEING 130 WIDE, formerly known as the NIORD Low-Light Imager [4][5], which was embarked on the NorSat-4 satellite and placed into orbit in early 2024. Although SEEING DETECT is not intended for Earth observation, the SEEING name was retained when the product family was subsequently extended to Space Situational Awareness applications.

The SEEING product family is intended to provide a range of imagers with distinct yet complementary capabilities, covering applications from Earth observation and low-light imaging to space situational awareness. Developing a common

family of instruments also enables design heritage, operational feedback, and lessons learned from each imager to be transferred across the entire product range, thereby reducing development risk and supporting continuous performance improvement.

The following sections present the main characteristics of each SEEING imager, together with their current development status and maturity level. This paper demonstrates how a common product-line approach, combining shared design principles, manufacturing heritage and verification methods, can be applied to four optical payloads covering substantially different spatial resolution, radiometric and observation requirements.

2. SEEING 130: A FLIGHT-PROVEN WIDE-FIELD LOW-LIGHT IMAGER

SEEING 130 WIDE is a compact catadioptric imager optimized for wide-area Earth observation under both daylight and low-light conditions. From an orbital altitude of 600 km, the instrument provides a ground sampling distance (GSD) of 10 m over a ground footprint of approximately $65 \times 43 \text{ km}^2$. This combination of moderate spatial resolution and wide coverage is particularly well suited to applications requiring the observation of extended areas, including maritime surveillance, coastal monitoring and the detection of vessels over large ocean regions. The instrument operates in time-delay-integration mode, allowing the signal collected along the satellite ground track to be accumulated while maintaining a compact focal-plane architecture. Its total mass is below 9 kg, with a power allocation of 25 W, making it compatible with the limited resources available on small-satellite platforms.

The optical design combines an entrance doublet, a Mangin mirror and a five-lens field corrector. Several aspherical surfaces are used to achieve high optical performance over the entire rectangular field of view within a particularly compact volume. The optical components are mounted in individual cells and integrated into a titanium structure connected to the spacecraft through three bipod flexures. The design was athermalized over the specified operating range of $22 \pm 4^\circ\text{C}$, accounting for both the variation in refractive index of the optical materials and the differential expansion of the lenses and mechanical structure. The optical surfaces use a combination of high-performance anti-reflection and protected-silver coatings, resulting in an average transmission above 73% over the 400–900 nm spectral range.

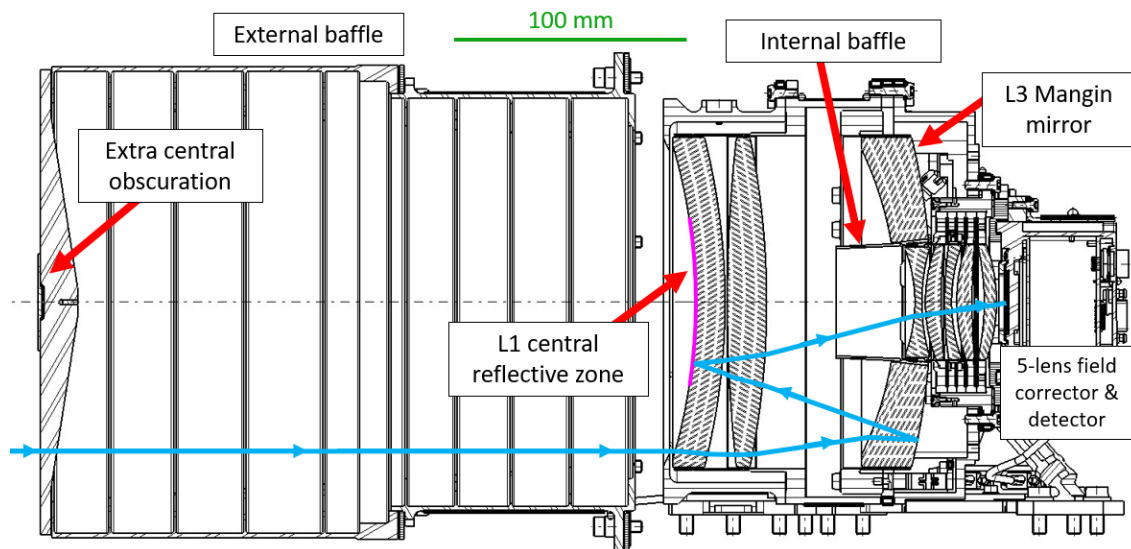


Figure 1. SEEING 130 WIDE opto-mechanical design cross-section

Particular attention was paid to stray-light rejection, which is essential for low-light imaging. The baffling system combines a conventional external baffle with internal vanes, a conical internal baffle and an additional frontal obscuration. The latter prevents large-angle rays from reaching the detector through multiple reflections within the catadioptric optical train. Ghost levels were calculated to remain below -40 dB relative to the useful signal over the complete field of view. Additional analyses considered direct solar illumination, solar glint, clouds and lunar illumination during nighttime observations.

Stray-light rejection was also assessed using point-source transmittance (PST), a standard system-level metric for quantifying the response of an optical instrument to off-axis point sources [6].

At large incidence angles, the point-source transmittance decreases sharply as a result of the exclusion angle provided by the external baffle.

The performance of the fully integrated instrument, including the detector, was characterized using dedicated wavefront-error and modulation-transfer-function test benches. The measured wavefront error ranges from 24 to 67 nm RMS across the complete field of view. At the detector Nyquist frequency of 91 cycles/mm, the measured MTF ranges from 0.22 to 0.32, significantly exceeding the initial in-orbit requirement of 0.10. The close correlation between the measured results and the as-built optical model also provided confidence in the prediction of performance under orbital conditions. Measurements conducted under vacuum and over the specified operational temperature range confirmed the effectiveness of the passive athermalization approach. Finally, the instrument successfully completed thermal-vacuum cycling between $-30\text{ }^{\circ}\text{C}$ and $+70\text{ }^{\circ}\text{C}$, as well as random-vibration testing at levels ranging from approximately 10 to 26 g RMS depending on the excitation axis.



Figure 2. NorSat-4 satellite fully assembled

Following integration onto the complete NorSat-4 satellite platform (Figure 2) and its launch from Vandenberg Space Force Base aboard the Transporter-12 Falcon 9 mission, SEEING 130 WIDE has remained fully operational in orbit and continues to acquire high-quality imagery. The data collected since commissioning provide direct in-orbit validation of the instrument's end-to-end performance, including optical alignment stability, detector functionality, thermal control, and stray-light rejection.

Daytime observations have demonstrated the instrument's capability to resolve detailed coastal and harbor features over wide areas, whereas nighttime acquisitions have confirmed its performance under low-light conditions. Images acquired over the Port of Rotterdam (Figure 3a-c) clearly resolve harbor infrastructure and individual vessels within a scene covering approximately $66 \times 44\text{ km}^2$. In addition, nighttime imagery of the Strait of Gibraltar (Figure 3d) has demonstrated the detection of maritime traffic, together with coastal and terrestrial features whose visibility was not necessarily anticipated under such low-illumination conditions. These observations further confirm the imaging performance and operational robustness of SEEING 130 WIDE under representative in-orbit conditions.

The continued acquisition of sharp and well-contrasted images is an important achievement for the SEEING product line. It demonstrates not only the initial performance of the payload after launch, but also its ability to maintain this performance throughout its operational life. Recent in-orbit images should therefore occupy a prominent place in this section, as they provide the most representative evidence of the maturity and sustained performance of SEEING 130 WIDE.

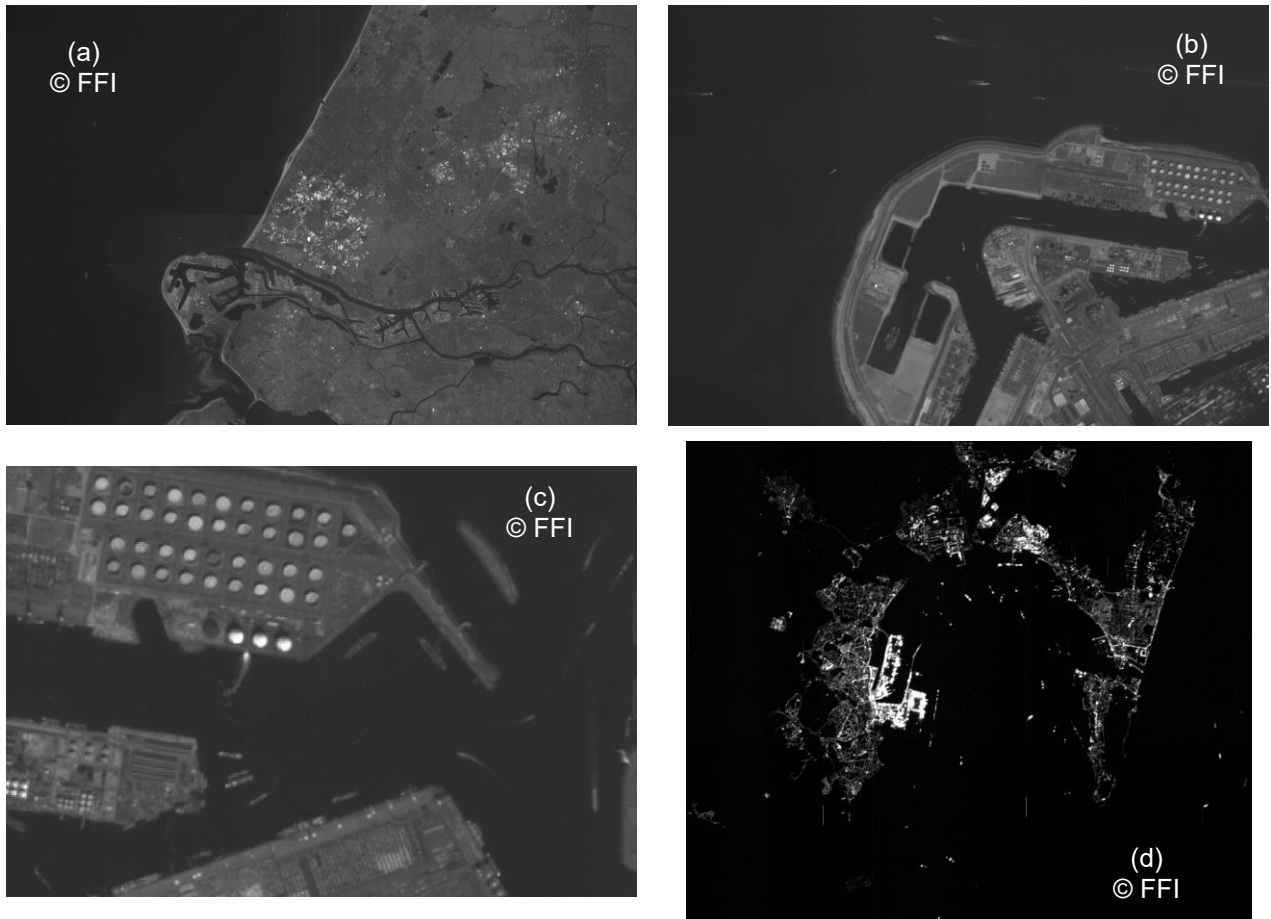


Figure 3. Rotterdam port area (a), with enlarged details of the image (b and c), and nighttime image of the Strait of Gibraltar (d), acquired by SEEING 130 WIDE aboard NorSat-4

3. SEEING 230: A COMPACT METER-CLASS MULTISPECTRAL IMAGER

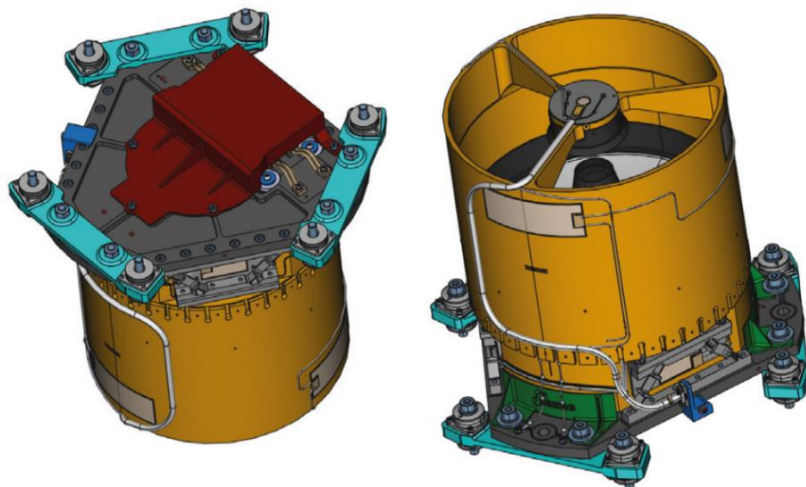


Figure 4. Isometric views of SEEING 230 IDENT

SEEING 230 is a compact high-resolution imager developed for meter-class Earth observation from small-satellite platforms [7]. It is designed to provide a ground sampling distance of 1 m from an orbital altitude of 500 km. The instrument has a focal length of 1550 mm and an entrance pupil diameter of 230 mm, corresponding to an F/6.7 aperture. Its field of view of $1.11^\circ \times 0.83^\circ$ produces a ground footprint of approximately $9.7 \times 7.2 \text{ km}^2$ at the reference altitude. In its nominal push-broom operating mode, the 9.7 km across-track dimension defines the effective imaging swath. Despite this level of spatial resolution, the complete instrument has a mass below 14 kg and fits within an envelope approximately 305 mm long and 330 mm in diameter, including its spacecraft interface.

The optical system is based on a compact Korsch architecture. In contrast to conventional metallic telescope structures, the primary mirror, the main supporting structure and the tube connecting the primary and secondary mirrors are all manufactured from ZERODUR®. The other optical elements are directly bonded to the main ZERODUR® structure using a space-qualified adhesive process. This architecture minimizes differential thermoelastic deformation between the optical components and their supporting structure, thereby providing a high degree of passive thermal stability. The telescope is connected to a stainless-steel baseplate through three bipod flexures, which mechanically decouple the optical assembly from platform-induced deformation. The fully reflective optical design also avoids chromatic aberrations over the complete operating spectral range.

The focal plane operates from 450 to 900 nm and includes one panchromatic band and seven multispectral bands distributed over the visible and near-infrared spectrum. The panchromatic band, covering approximately 500–750 nm, is acquired at the full detector sampling of $3.2 \text{ }\mu\text{m}$ per pixel. The multispectral bands use pixel binning to improve their signal-to-noise ratio. Digital time-delay integration can be implemented with up to 32 stages in each band, enabling the radiometric performance to be adjusted to the mission conditions and available ground velocity. The optical distortion variation over these TDI stages remains negligible relative to the detector pixel size, which limits image degradation during signal accumulation.

The measured optical performance confirms the effectiveness of the design and alignment approach. Following integration of the telescope, the wavefront error was measured to be 48 nm RMS on axis and below 55 nm RMS over the complete field of view. Full-instrument MTF measurements, including the detector contribution, were performed using a slanted-edge target in accordance with ISO 12233 [8]. In the panchromatic band, the measured MTF reaches approximately 0.11 at the Nyquist frequency of 156 cycles/mm. In the binned multispectral bands, values between 0.20 and 0.23 were obtained at 78 cycles/mm (see Figure 5). These measurements provide margin relative to the expected on-orbit panchromatic performance requirement.

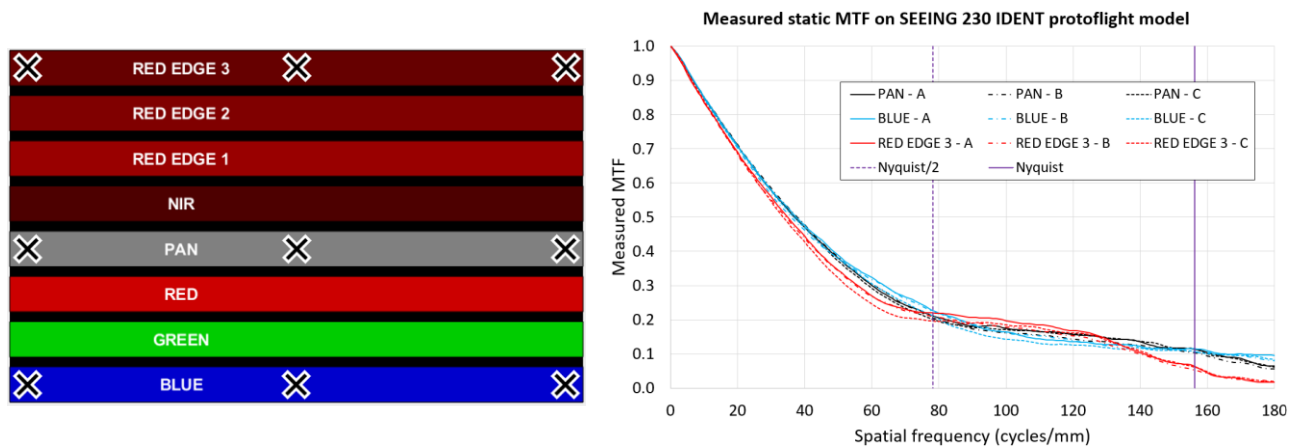


Figure 5. SEEING 230 IDENT measured static MTF on first protoflight model

The Korsch configuration and its intermediate focal plane also contribute to effective stray-light rejection. The main ZERODUR® tube acts directly as the primary external baffle, while additional baffles are located around the secondary mirror and close to the intermediate focal plane. The point-source transmittance decreases to approximately -37 dB immediately outside the useful field and falls below -50 dB beyond approximately 2° off axis. For representative operational conditions, the direct solar contribution remains below 1% of the useful signal, while stray light associated

with the illuminated Earth background contributes approximately 2%. The combined contribution therefore remains below 3% of the useful signal. The predicted signal-to-noise ratio exceeds 20 for a spectral radiance of $15 \text{ W} \cdot \text{sr}^{-1} \cdot \text{m}^{-2} \cdot \mu\text{m}^{-1}$ and 70 for a radiance of $100 \text{ W} \cdot \text{sr}^{-1} \cdot \text{m}^{-2} \cdot \mu\text{m}^{-1}$, for both the panchromatic and multispectral channels. The average orbital power consumption, including the thermal-control hardware, is approximately 8 W, with a peak value of approximately 15 W during simultaneous imaging and maximum heater operation.



Figure 6. SEEING 230 IDENT first flight model after integration (left) and the project team with the instrument packed in its transport crate (right)

Since the previous publication [7], the complete SEEING 230 instrument has successfully completed its environmental qualification campaign, including both thermal cycling and vibration testing. This milestone validates the complete payload rather than only the telescope or individual subsystems and confirms its ability to withstand the mechanical launch environment and the expected orbital thermal conditions.

SEEING 230 has now entered low-rate series production. More than ten flight units are currently being manufactured, marking the transition from a development program to an industrial product. This production phase also benefits from the assembly, alignment and testing procedures established during the qualification campaign, allowing the measured performance of the reference instrument to be reproduced across multiple units. The first orbital launch of a SEEING 230 instrument is scheduled for October 2026. The combination of completed qualification, meter-class ground resolution and ongoing series production positions SEEING 230 as the most industrially mature high-resolution instrument within the SEEING range.

4. SEEING DETECT: A WIDE-FIELD IMAGER FOR SPACE SITUATIONAL AWARENESS

SEEING DETECT was developed in response to the need for space-based passive optical systems capable of improving the detection and characterization of small orbital-debris populations that are difficult to observe with ground-based sensors [9]. For Space Situational Awareness (SSA) applications, the instrument must detect and characterize faint moving objects against a complex stellar background. In contrast to Earth-observation instruments, whose performance is typically described in terms of ground sampling distance and swath width, SEEING DETECT is primarily characterized by its angular field of view, angular sampling, limiting magnitude, and ability to suppress unwanted light from bright sources. To meet these requirements, the instrument combines a wide field of view with a fast optical system, thereby maximizing the photon flux collected from faint targets while maintaining sufficient angular resolution for accurate object localization.

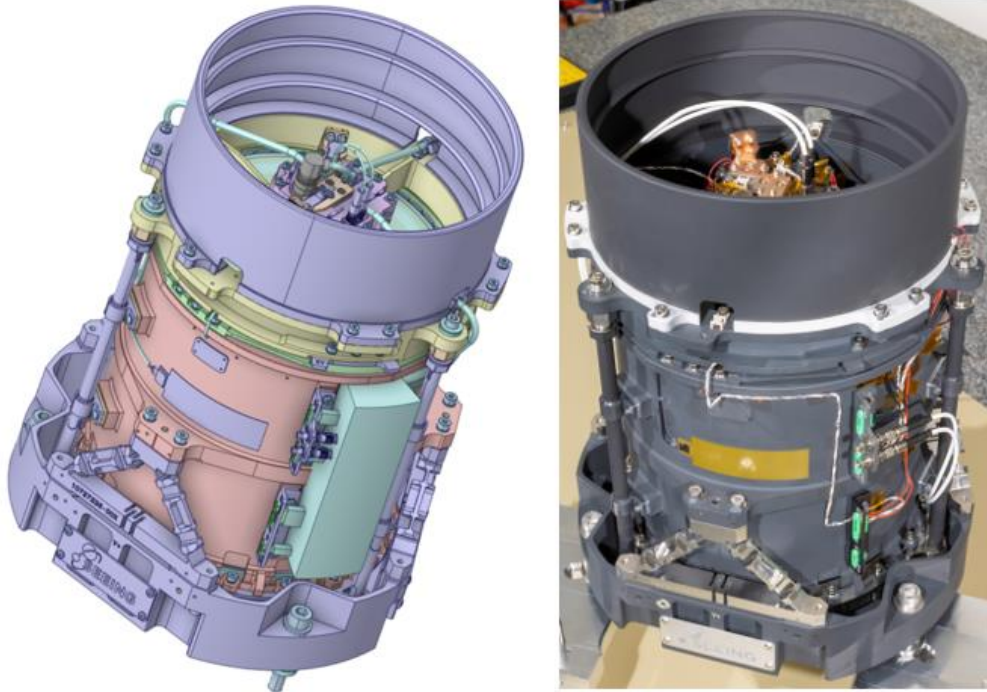


Figure 7. SEEING DETECT CAD model and protoflight model

The optical design is based on a compact Schmidt telescope with a focal length of 241 mm and an entrance aperture of 184 mm, corresponding to a focal ratio of approximately F/1.3. The system combines this fast optical design with a wide field of view of $6.0^\circ \times 5.3^\circ$, providing a favorable balance between light-gathering capability and angular coverage for surveillance applications. The image is formed on a global-shutter CMOS detector with a $3.2 \mu\text{m}$ pixel pitch, operating over a spectral range from 420 to 800 nm. This optical and detector configuration results in a native angular sampling of approximately 2.7 arcsec per pixel. In nominal operation, 2×2 pixel binning increases the angular sampling to approximately 5.5 arcsec per binned pixel, thereby improving the signal collected from faint objects while preserving an angular resolution well suited to the intended surveillance application.

The choice of a global-shutter detector is particularly well suited to the observation of moving objects, since all pixels are exposed simultaneously, thereby avoiding the geometric distortions that may arise from rolling-shutter readout. Beyond its imaging performance, SEEING DETECT was also designed to remain compatible with the resource constraints of a compact spaceborne payload. The camera and readout electronics consume approximately 9 W during imaging operations, while the inclusion of the active thermal-control system brings the expected average payload consumption to approximately 17 W. In terms of mass, the measured protoflight model remains below 14 kg.

In addition to platform-level constraints, stray-light rejection is a major design driver for SEEING DETECT. In the representative SSA scenario considered during development, objects as faint as magnitude 13.5 may need to be detected near stars as bright as magnitude 2.5, corresponding to an optical-flux ratio on the order of 2.5×10^4 . Under such conditions, even weak ghost reflections or scattered light may mask the target or increase the local background. Stray-light mitigation was therefore addressed through high-performance anti-reflection coatings and a dedicated optical baffle with internal vanes, designed to prevent scattered rays from reaching the focal plane.

The calculated point-source transmittance confirms the effectiveness of this architecture (Figure 8). Within the useful field, extending to a semi-field angle of approximately 3° , the response is normalized to 0 dB. Immediately outside the field, the PST decreases to approximately -37 dB, or about 0.02% of the useful signal, and remains below -50 dB over most of the remaining angular range. This rapid attenuation limits contamination from bright stars close to the observation direction and helps preserve the detectability of faint objects.

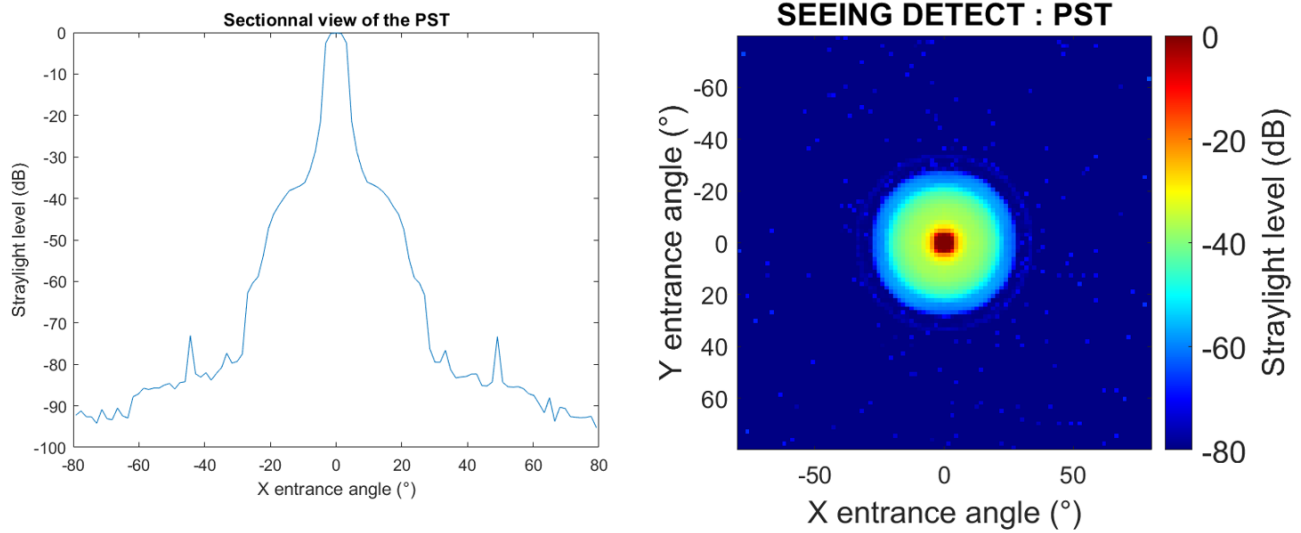


Figure 8. SEEING DETECT Point Source Transmittance

Beyond stray-light rejection, image quality was assessed through the ensquared energy contained within an area corresponding to 2×2 binned pixels. At the detector center, at least 50% of the energy is required to fall within this area. Tolerance analyses performed for several mechanical and thermal configurations yielded values ranging from 57% to 91%, demonstrating compliance in all cases. Image geometry was also evaluated, with a nominal maximum distortion of approximately 0.3% across the field, remaining compatible with the intended angular observation and calibration strategy. Finally, radiometric performance was assessed at both beginning and end of life for moving objects of magnitude 13.5, accounting for detector temperature, exposure time, angular velocity, and focal-plane binning. The resulting signal-to-noise ratio remains above 1, allowing the object position to be estimated through barycentric centroiding and the debris to be tracked over successive acquisitions.

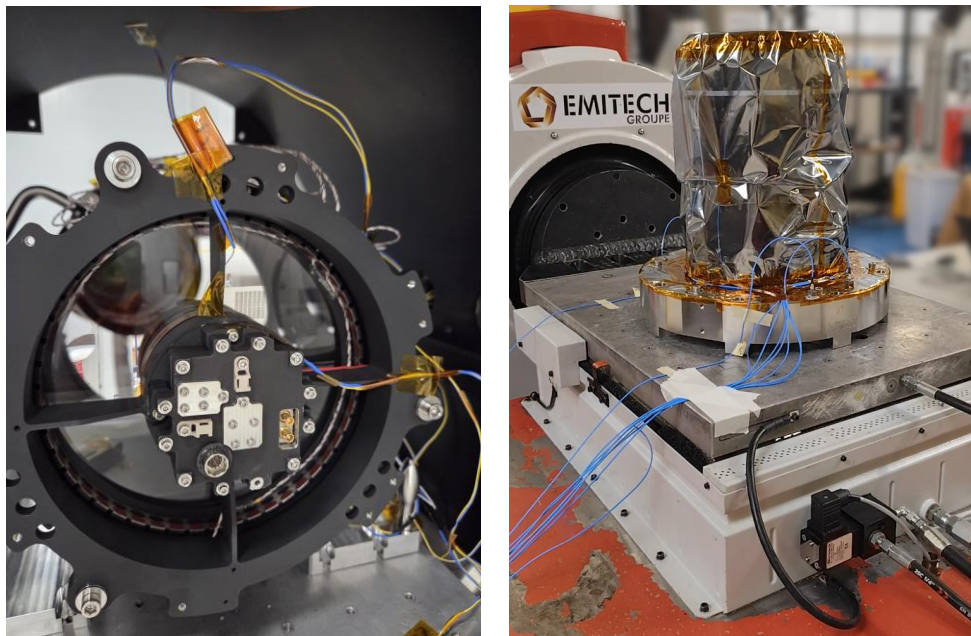


Figure 9. SEEING DETECT inside thermal vacuum chamber (left picture) and on the vibration shaker (right picture)

The first SEEING DETECT unit has been developed as a protoflight model, serving both as qualification hardware and as the flight unit. While this instrument is currently the only unit produced, the SEEING DETECT design is intended to support the manufacture of additional flight models in the near future. The protoflight model has successfully completed its instrument-level qualification campaign (see Figure 9). Its integration onto the satellite platform is planned for summer 2026, followed by spacecraft-level integration and verification activities, with launch currently scheduled for February 2027.

SEEING DETECT marks the first application of the SEEING product range to space-object surveillance rather than Earth observation. The successful qualification of this first unit demonstrates the ability to combine a fast, wide-field optical system, stringent stray-light rejection, and compact packaging compatible with small-satellite platforms within a single payload. Its future operation in orbit will provide the first opportunity to assess these capabilities in the operational space environment and will support the development of subsequent SEEING DETECT units.

5. SEEING 500: A MODULAR HALF-METER-CLASS IMAGER

SEEING 500 is the largest and highest-resolution instrument currently considered within the SEEING product family. It is designed to achieve a ground sampling distance of 0.5 m from an orbital altitude of 500 km while remaining compatible with the mass, volume, and power constraints of a small-satellite platform. The telescope features a 500 mm entrance pupil and, in its current baseline configuration, a focal length of 3760 mm, resulting in an optical field of view of approximately $0.81^\circ \times 1.37^\circ$. Depending on the arrangement of the two focal-plane detectors, the instrument can provide a swath of approximately 7 km when the detectors are offset in the along-track direction, or up to approximately 12 km when arranged across-track. This flexibility allows the focal-plane configuration to be tailored to the coverage requirements of the mission. The payload is intended to support imaging sequences lasting up to ten minutes per orbit, with successive acquisitions initiated less than 30 seconds apart. Despite the larger aperture and increased resolution compared with the other instruments in the SEEING range, the target mass remains approximately 50 kg and the maximum electrical power consumption below 51 W. The complete payload fits within a cylindrical envelope approximately 640 mm in diameter and 720 mm in length, including the required mechanical margins.

A key feature of SEEING 500 is the modularity of its optical architecture. Rather than being tied to a single focal-plane technology, the telescope can accommodate detectors with pixel pitches ranging from 3.76 to 7 μm while preserving the target 0.5 m GSD. The corresponding focal length can be adjusted over a range of approximately 3760 to 7000 mm through controlled modifications of the mirror curvatures during manufacturing, without changing the nominal positions of the main optical components. As a result, the telescope front section, the M1 and M2 mirror blanks, and the primary-mirror computer-generated hologram can remain common to several configurations. This approach limits the redesign required when adapting the instrument to a different detector and preserves as much as possible the manufacturing and qualification heritage of the main telescope assembly.

This flexibility extends to the focal plane, which can accommodate two independent detectors. In the current baseline, two CMOS sensors are offset in the along-track direction. Depending on the mission, this arrangement can be used either to exploit the larger dimension of the optical field in the across-track direction and increase effective imaging coverage, or to combine detectors operating over different spectral ranges. The architecture is also compatible with alternative focal-plane technologies, including CMOS arrays, conventional Time Delay Integration (TDI) CCDs, and CCD-on-CMOS detectors with TDI capability. Similarly, the instrument can support different acquisition strategies, including push-frame, push-broom, and step-and-stare imaging, depending on the mission objectives and spacecraft agility. The focal-plane and acquisition architecture can therefore be adapted to different mission concepts without requiring fundamental changes to the telescope structure.

The baseline spectral configuration covers the 400–900 nm range and combines a broad panchromatic channel with at least three additional spectral bands, all operating at the same 0.5 m spatial sampling. The current concept divides the visible and near-infrared response into four bands, while retaining the possibility of extending the spectral coverage further into the near infrared. The mechanical and electronic architecture also allows for the later integration of additional functions, such as an internal shutter or dedicated electronics housed within the baseplate.

The optical and radiometric performance requirements have been defined accordingly. The targeted modulation transfer function is 0.10 at the Nyquist spatial frequency associated with a 0.5 m GSD, including the contributions of the telescope, focal plane, and thermal environment. The panchromatic signal-to-noise ratio is specified to remain above 80 for a scene radiance of $L = 50 \text{ W.sr}^{-1}.\text{m}^{-2}.\mu\text{m}^{-1}$, considering a maximum forward-motion-compensation factor of six. In parallel, the contribution of stray light at the focal planes is required to remain below 1% of the useful signal.

Scaling the telescope to a 500 mm entrance pupil introduces additional opto-mechanical constraints. In particular, the monolithic ZERODUR® structural tube adopted for SEEING 230 was not retained, as scaling such a component to the required diameter would significantly increase manufacturing and handling complexity. Instead, the SEEING 500 secondary mirror is supported by an internal conical spider (see Figure 10). This architecture reduces the size and complexity of large monolithic ceramic components while providing the stiffness required to preserve M2 alignment under launch and orbital loads. The instrument is designed to withstand quasi-static loads of 30 g along each axis, together with random-vibration levels derived from the Falcon 9 rideshare environment. The specified environmental range extends from -30 to +65 °C for survival, with a nominal operating temperature of $21 \pm 5 \text{ °C}$.

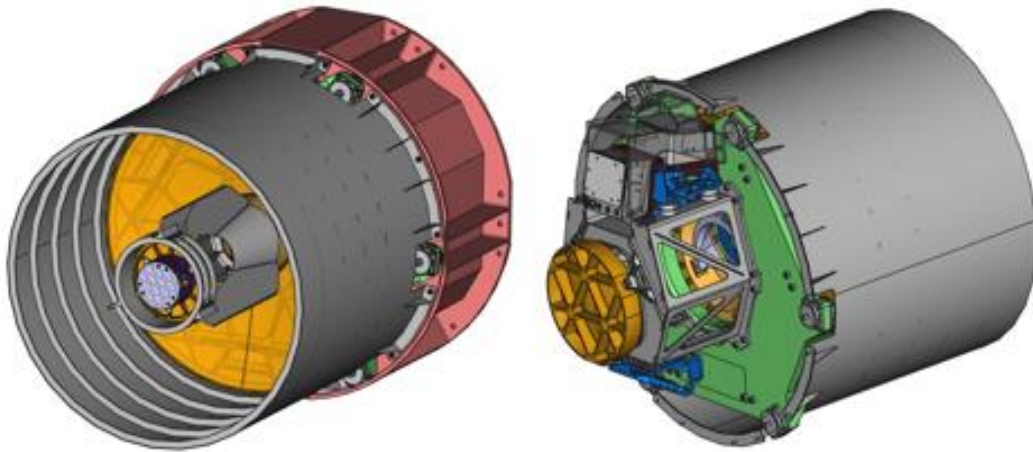


Figure 10. SEEING 500 isometric views

To maintain optical performance under mechanical and thermal variations, SEEING 500 incorporates an active refocusing mechanism behind the secondary mirror. It provides accurate and repeatable axial adjustment to compensate for thermoelastic effects and residual alignment errors, while maintaining sufficient stiffness during launch.

SEEING 500 is therefore conceived as a configurable high-resolution imaging platform rather than as a single fixed telescope configuration. By defining compatible detector ranges, controlled optical adaptations, and common mechanical interfaces from the outset, the architecture can be tailored to different focal planes, spacecraft platforms, spectral configurations, and acquisition modes while preserving a stable telescope design. At the current stage, the instrument is defined by a detailed design baseline together with its optical, mechanical, thermal, and radiometric requirements. Ongoing development activities are focused on consolidating this baseline, validating the refocusing mechanism, and demonstrating that the required 0.5 m imaging performance can be maintained throughout the specified mechanical and thermal environments.

The development is currently progressing toward the Critical Design Review, scheduled for the end of 2026. This milestone will consolidate the optical architecture, structural concept, focal-plane configuration, thermal design, and refocusing mechanism before proceeding to the detailed manufacturing and verification phases.

6. DISCUSSION AND CONCLUSION

The SEEING family demonstrates Safran Reosc's ability to translate its heritage in high-performance space optics into a scalable range of compact instruments addressing complementary New Space applications. As summarized in Table 1, the four imagers cover a broad range of applications and performance levels, from wide-field low-light Earth observation to meter and half-meter-class imaging, as well as wide-field detection for Space Situational Awareness.

Table 1. Comparison of the Main Characteristics and Development Status of the SEEING Imager Family

Imager	Main capability	Key performance	Status as of July 2026
SEEING 130 WIDE	Wide-field, low-light Earth imaging	10 m GSD at 600 km $65 \times 43 \text{ km}^2$ coverage	Operational aboard NorSat-4 since January 2024
SEEING 230 IDENT	High-resolution multispectral Earth imaging	1 m GSD at 500 km PAN + 7 multispectral bands	Fully qualified and in low-rate series production First launch in October 2026
SEEING DETECT	Wide-field space-object detection (SSA)	Detection down to magnitude 13.5 $6.0^\circ \times 5.3^\circ$ FoV	Protoflight model qualified Launch planned for February 2027
SEEING 500	Modular very-high-resolution Earth imaging	0.5 m GSD at 500 km Compatible with multiple focal-plane configurations	Under development CDR scheduled for late 2026

SEEING 130 WIDE has provided the first in-orbit validation of this approach and continues to deliver high-quality daytime and nighttime imagery, confirming the stability and operational performance of the complete payload. Building on this heritage, SEEING 230 combines meter-class multispectral imaging with a compact and thermally stable architecture. It has now progressed from qualification to low-rate series production, with its first launch scheduled for October 2026. SEEING DETECT extends the family beyond Earth observation, demonstrating that the same overall design philosophy can be adapted to the detection of faint space objects under stringent image-quality and stray-light constraints. Its qualified protoflight model is scheduled for launch in February 2027. Finally, SEEING 500 represents the next step in both performance and modularity, targeting a ground sampling distance of 0.5 m while remaining compatible with multiple focal-plane configurations and mission concepts.

The development status and key capabilities reported in Table 1 also illustrate the progressive maturation of the product family, ranging from an operational flight-proven instrument to qualified flight hardware, serial production, and an advanced instrument currently approaching its Critical Design Review. Shared design principles, manufacturing processes, qualification methods, and operational feedback allow experience to be transferred between instruments, thereby reducing development risk and supporting the industrialization of future payloads. The forthcoming launches of SEEING 230 and SEEING DETECT, together with the SEEING 500 Critical Design Review planned for late 2026, will constitute the next major milestones in the continued expansion of the SEEING product family.

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