TELESCOPE & NIR SURVEILLANCE SYSTEM

Consulting-Grade Technical Report

Low-Earth-Orbit Fast-Moving Objects | Lunar Surveillance | Mars Surveillance | Visible and Near-Infrared Imaging

Illustrative DeltaRho 350 deep-sky reference image supplied by the client. Image demonstrates wide-field sensitivity, not the live visual appearance or planetary scale.

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Status: Preliminary consulting specification

Commercial-use notice: prices are indicative budgeting allowances, not binding quotations. Final procurement requires current written offers, Belgian VAT treatment, freight, crating, installation, site engineering and warranty confirmation.

Executive Summary

This report defines a modular optical surveillance facility for three distinct missions: (1) acquisition and tracking of fast-moving low-Earth-orbit objects, (2) high-resolution lunar monitoring, and (3) repeatable Mars imaging in visible and near-infrared wavelengths. No single optical configuration is optimal for all three missions. The recommended architecture therefore uses a high-speed direct-drive mount with two complementary optical channels.

The primary recommendation is a PlaneWave L-500 direct-drive mount carrying a DeltaRho 350 f/3 wide-field channel and a CDK14 f/7.2 long-focus channel. The DeltaRho is assigned to rapid acquisition, wide-field survey, faint-object detection and contextual NIR imaging. The CDK14 is assigned to lunar and Mars detail, photometry and high-frame-rate lucky imaging. A monochrome full-frame QHY600-class camera serves the wide-field channel, while an IMX585-class monochrome camera serves the planetary/NIR channel.

Recommended capital allowance: approximately EUR 145,000-185,000 incl. VAT, before building works, professional installation, recurring software, insurance and site-specific civil engineering.

Mission	Primary channel	Expected capability	Principal limitation
LEO fast-moving objects	DeltaRho 350 + direct-drive mount	TLE/ephemeris acquisition, wide-field tracking, streak and point-source recording	Small, faint or poorly predicted objects remain difficult; daylight operation is specialized
Moon surveillance	CDK14 + high-speed mono camera	Kilometre-scale regional monitoring; sub-kilometre detail during excellent seeing	Atmospheric seeing usually dominates practical resolution
Mars surveillance	CDK14 + red/NIR filters	Global disk, major albedo regions, polar caps, clouds, dust and regional change monitoring	No Earth-based 350 mm telescope can resolve buildings, caves or local installations
NIR surveillance	Both channels	685-850 nm imaging, improved seeing stability and haze penetration	Longer wavelength reduces diffraction-limited angular resolution

Key Recommendation

- Use the L-500 rather than the L-350 when two OTAs are intended to remain mounted simultaneously.
- Use the DeltaRho 350 as the wide-field survey and LEO acquisition instrument, not as the sole Mars instrument.
- Use a CDK14 or comparable 350-400 mm long-focus OTA for lunar and planetary imaging.
- Integrate the equipment into the Signals Platform as separate acquisition, tracking, evidence and processing nodes.
- Treat any Mars-site investigation as remote-sensing research; do not present telescope imagery as evidence of a specific installation.

1. Scope and Consulting Basis

The system is intended for professional observation, technical demonstrations, evidence-oriented recording, research consulting and future integration with the Systems Studio Signals Platform. It is not specified as a certified military space-surveillance sensor, air-traffic sensor, or astronomical research observatory compliant with a named institutional standard.

1.1 Design assumptions

- Installation in Belgium or a comparable north-west European climate.
- Operation from a permanent pier and automated enclosure is preferred over a portable field arrangement.
- Visible and silicon-detector near-infrared range, approximately 400-1,000 nm.
- Remote operation, timestamped evidence, automated target scheduling and image processing are required.
- Indicative prices include European retail VAT where known; estimates use conservative rounded allowances.
- Site horizon, light pollution, vibration, roof loading, lightning protection and planning permission require separate assessment.

2. Mission Requirements

2.1 Low-Earth-orbit fast-moving objects

LEO targets can cross the observable sky at angular rates of several degrees per second. The mount must therefore slew rapidly, reverse smoothly, track non-sidereal rates, accept TLE or externally generated ephemerides, and maintain low latency between prediction, acquisition and camera capture. Wide field of view is more important during initial acquisition than maximum focal length.

- Direct-drive axes with no gear backlash and high-resolution encoders.
- Maximum slew capability substantially above normal astronomical GoTo rates.
- Low-latency camera readout with region-of-interest modes.
- GPS-disciplined or network-disciplined time with sub-second event timestamps.
- Wide-field finder or all-sky cueing camera to recover prediction errors.
- Software support for TLE, SGP4, custom ephemerides and rate commands.

2.2 Lunar surveillance

Lunar surveillance is a high-resolution, high-signal mission. Short exposures and lucky imaging are used to freeze atmospheric turbulence. Repeat observations should be performed at comparable illumination and libration angles. The useful product is not merely a visually attractive image, but a calibrated, timestamped series that allows change detection and feature registration.

2.3 Mars surveillance

Mars is observed as a small rotating disk. A 350 mm aperture can record major surface albedo regions, polar features, clouds, limb haze and dust activity. It cannot resolve structures, cave entrances, vehicles or local facilities. The appropriate research objective is repeatable regional monitoring coordinated with public orbital datasets.

Scientific boundary: the proposed system can monitor broad Martian phenomena. It cannot confirm or directly image the alleged 'Aries Prime' site. Any candidate coordinates remain a hypothesis and must be labelled accordingly.

3. Recommended System Architecture

3.1 Preferred dual-channel observatory

Subsystem	Recommended equipment	Role
Mount	PlaneWave L-500 direct-drive mount	Carries dual OTAs; rapid LEO tracking; high payload reserve
Wide-field OTA	PlaneWave DeltaRho 350, 350 mm, 1,050 mm, f/3	LEO acquisition, survey, contextual NIR and faint-object imaging
Long-focus OTA	PlaneWave CDK14, 356 mm, approx. 2,563 mm, f/7.2	Moon, Mars, high-resolution visible/NIR imaging
Wide-field camera	QHY600M-PH or equivalent IMX455 mono camera	Full-frame 60 MP survey imaging and calibrated science frames
Planetary/NIR camera	ZWO ASI585MM Pro or equivalent IMX585 mono camera	High-frame-rate lunar/Mars capture; strong NIR response
Acquisition camera	Small global-shutter mono camera + 50-100 mm lens	Wide-field cueing and object recovery
Filters	L/R/G/B + 610/685/742/807/850 nm pass filters	Surface, atmosphere, seeing stabilization and spectral comparison
Enclosure	Automated 2.3-3.2 m dome or roll-off roof	Weather protection and unattended operation
Control	RTX workstation + observatory controller + UPS	Capture, tracking, stacking, AI-assisted detection and evidence storage

3.2 Why the L-500 is preferred

The L-350 has a nominal 45 kg payload and is well matched to one DeltaRho 350 or one CDK14. A permanently installed dual-OTA configuration, including cameras, focusers, rotator, filters, plates and cabling, can approach or exceed a prudent L-350 payload margin. The L-500 provides substantially more reserve and reduces the risk of operating near the mount's structural and dynamic limits.

Where the project budget must be reduced, an L-350 can be used with one OTA at a time, or with the DeltaRho 350 as the primary instrument and a much smaller planetary/finder telescope mounted externally.

4. Optical and Imaging Performance

4.1 DeltaRho 350

Parameter	Value	Implication
Aperture	350 mm	Professional-class light collection and approx. 0.39 arcsec theoretical visible-light diffraction limit
Focal length	1,050 mm	Wide field; Mars remains small at native focus
Focal ratio	f/3	Rapid survey imaging and short exposures for faint moving targets
Corrected image circle	60 mm	Supports large sensors such as IMX455
OTA mass	Approx. 21 kg	Requires observatory-class mount and careful instrument balance

With 3.76 micrometre pixels, the DeltaRho 350 samples at approximately 0.74 arcsec/pixel. With 2.9 micrometre pixels, sampling is approximately 0.57 arcsec/pixel. This is excellent for wide-field survey work but insufficient planetary image scale at native focus.

4.2 CDK14 long-focus channel

At approximately 2,563 mm focal length, a 2.9 micrometre pixel camera samples near 0.23 arcsec/pixel. This is a practical starting point for lunar and Mars imaging. A moderate 1.5x-2x telecentric amplifier may be used during excellent seeing, subject to back-focus and optical compatibility testing.

4.3 Practical resolution

Target	Theoretical/typical result	Consulting interpretation
Moon	Approx. 0.5-1.5 km practical ground scale in normal-to-good seeing; better under exceptional conditions	Suitable for repeat regional surveillance and feature comparison
Mars	Broad regions spanning hundreds of kilometres	Suitable for albedo, cloud, polar and dust monitoring only
LEO at 500 km range	Angular resolution does not directly guarantee object identification; exposure, tracking and target brightness dominate	Shape/detail may be recorded for large bright objects, but performance is target-dependent

5. Near-Infrared Equipment and Filter Strategy

Silicon CMOS cameras remain sensitive into the near-infrared, generally to around 1,000 nm. The project should use monochrome sensors because a colour filter array discards spatial and spectral efficiency. NIR pass filters can stabilize poor seeing and improve contrast through haze, but the diffraction limit becomes coarser as wavelength increases.

Filter band	Primary use	Operational note
Red 610-650 nm	Lunar and Mars surface contrast	Best balance of resolution and seeing in many conditions
IR-pass 685 nm	General planetary and LEO imaging	Recommended default NIR filter
IR-pass 742 nm	Poorer seeing and atmospheric stabilization	Slightly lower angular resolution
IR-pass 807/850 nm	Experimental deep-NIR and haze suppression	Requires more exposure; noticeably softer diffraction limit
Blue 400-500 nm	Mars clouds, haze and atmospheric phenomena	Most vulnerable to poor seeing
UV/IR-cut	Natural visible colour and focusing control	Used for RGB or colour-camera work

6. Camera and Detector Selection

6.1 QHY600M-PH wide-field camera

The QHY600 family uses the Sony IMX455 full-frame back-illuminated monochrome sensor with 3.76 micrometre pixels, approximately 60 megapixels, native 16-bit conversion and onboard buffering. It matches the DeltaRho's large corrected field and provides high-quality calibrated survey data.

6.2 ASI585MM Pro planetary/NIR camera

The ASI585MM Pro uses a 3840 x 2160 monochrome Sony sensor with 2.9 micrometre pixels and a full-resolution rate up to approximately 47 frames per second. Region-of-interest readout allows much higher effective rates for Mars, lunar details and moving targets. Its NIR sensitivity makes it suitable for 685-850 nm work.

6.3 Optional specialized LEO camera

For demanding satellite work, a high-frame-rate global-shutter scientific CMOS camera with external trigger input should be evaluated. A global shutter avoids rolling-shutter geometric distortion during rapid tracking. Final selection depends on required field, limiting magnitude, exposure time and synchronization accuracy.

7. Tracking, Software and Signals Platform Integration

Node / software layer	Function
Mount Control Node	PWI4/ASCOM connection, pointing model, rate commands, safety limits and mount health
Orbital Prediction Node	TLE ingestion, SGP4 propagation, visibility windows, angular-rate prediction and pass scheduling
Acquisition Node	Wide-field cueing camera, plate solving, predicted-path overlay and automatic reacquisition
High-Speed Capture Node	ROI video, exposure/gain control, hardware timestamp ingestion and lossless frame recording
Lunar Surveillance Node	Libration/illumination matching, mosaic planning, feature registration and change detection
Mars Surveillance Node	Central-meridian prediction, filter sequence, WinJUPOS-compatible capture metadata and map comparison
Evidence Node	Immutable session metadata, hashes, operator markers, source files, processed products and audit trail
AI Analysis Node	Object detection, streak classification, frame quality ranking and anomaly triage - with human validation

Recommended software stack: PlaneWave PWI4, ASCOM Alpaca/Platform, SGP4-capable orbital software, SharpCap or FireCapture for high-speed imaging, N.I.N.A. or equivalent automation, PIPP/AutoStakkert!/AstroSurface for planetary processing, WinJUPOS for Mars derotation and astrometric tools such as Astrometry.net or ASTAP. Licensing and unattended-use terms must be confirmed before commercial deployment.

8. Indicative Equipment List and Prices

The following budget is a consulting allowance in euros. PlaneWave prices are based on published European pricing where available. Other prices are rounded market allowances and should be replaced by written supplier quotations. Belgian VAT is 21%; some cited PlaneWave European list prices include German 19% VAT, so invoiced Belgian totals may differ.

Item	Qty.	Budget EUR incl. VAT	Basis / comment
A. Core optics and motion			
PlaneWave DeltaRho 350 OTA	1	27,900	Published EU price incl. 19% VAT; crating/shipping extra
PlaneWave CDK14 OTA	1	24,100	Long-focus lunar/Mars channel; published EU price incl. 19% VAT
PlaneWave L-500 direct-drive mount	1	33,800	Published EU price incl. 19% VAT

Equatorial wedge for L-500 at Belgian latitude	1	5,550	Published EU price incl. 19% VAT
Pier, adapter, mounting plates and counterbalance hardware	1 lot	6,500	Allowance; civil base excluded
Series-5 focuser/rotator/controllers and adapters	1 lot	10,500	Allowance based on published accessory prices
Subtotal A		108,350	
B. Cameras and filters			
QHY600M-PH full-frame monochrome camera	1	5,000	Indicative EU allowance
Large filter wheel and off-axis guider	1 set	1,600	Indicative
ZWO ASI585MM Pro monochrome camera	1	900	Indicative EU allowance
High-frame-rate global-shutter LEO camera	1	3,500	Budget allowance; final model by test
Acquisition/finder camera and lens	1	1,200	Wide-field cueing
LRGB and photometric filter set	1 set	1,500	Large-format filters for QHY600
Planetary red/blue + IR 685/742/807/850 nm filters	1 set	900	1.25 or 2 inch format
Filter wheel for planetary camera	1	450	Motorized
Telecentric amplifiers / optical adapters	1 lot	900	Compatibility to be verified
Subtotal B		15,950	
C. Observatory and environmental systems			
Automated dome or roll-off enclosure	1	25,000	Wide allowance; site and size dependent
Dome controller, shutters and safety interlocks	1	4,500	Allowance
All-sky camera and cloud/weather station	1 set	2,500	Rain, cloud, wind, humidity
Dew control, heaters and environmental sensors	1 lot	1,500	Allowance
UPS, surge protection and controlled power distribution	1 lot	3,500	Excludes building lightning-protection design
Subtotal C		37,000	
D. Computing, networking and data			
RTX workstation, 128 GB RAM, 4 TB NVMe	1	6,500	Processing and AI analysis allowance
Observatory control PC	1	1,800	Industrial or small-form-factor
GPS-disciplined time server / GNSS receiver	1	1,500	For consistent event timing
10 GbE switch, fibre/copper links and cabling	1 lot	1,800	Allowance
Primary data storage, 40-80 TB usable	1	5,500	RAID/NAS allowance
Off-site backup capacity and setup	1	2,000	Initial allowance; recurring fees excluded
Subtotal D		19,100	
E. Integration and contingency			
Mechanical/electrical installation and commissioning	1 lot	12,000	Preliminary allowance
Signals Platform integration and test campaign	1 lot	15,000	Software engineering allowance
Freight, crating, import handling and specialist travel	1 lot	8,000	Preliminary allowance
Contingency	Approx. 10%	21,500	Applied to equipment and integration uncertainty
Subtotal E		56,500	

8.1 Budget summary

Cost group	Indicative total
Core optics and motion	EUR 108,350
Cameras and filters	EUR 15,950
Observatory and environmental systems	EUR 37,000
Computing, networking and data	EUR 19,100

Integration, freight and contingency	EUR 56,500
Preliminary project total	EUR 236,900 incl. VAT

The EUR 236,900 total represents a complete dual-OTA observatory allowance. A reduced first phase using one DeltaRho 350, an L-350 mount, one planetary camera and a manual/compact enclosure can be targeted at approximately EUR 75,000-110,000, depending on enclosure and integration scope.

9. Procurement Options

Option	Configuration	Indicative project range	Assessment
Phase 1 - Survey first	DeltaRho 350 + L-350 + QHY600 + ASI585 + basic enclosure	EUR 75k-110k	Strong LEO/wide-field system; planetary capability is limited but usable
Balanced professional	DeltaRho 350 + CDK14 + L-500 + dual cameras + automated dome	EUR 170k-240k	Recommended architecture; covers all three missions without repeated OTA changes
Planetary first	CDK14 + L-350 + ASI585 + NIR filters	EUR 55k-85k	Best Moon/Mars value; reduced LEO acquisition field and faint-object survey performance
Advanced SSA upgrade	Add scientific global-shutter camera, precision timing and specialist software	+EUR 20k-60k	For higher-quality satellite measurement and externally triggered observations

10. Implementation Plan

Phase	Main activities	Acceptance outcome
0. Site survey	Horizon, vibration, roof/ground loading, power, network, weather, permissions, lightning and security	Approved site and civil/electrical design basis
1. Core mount and one OTA	Install pier, mount, DeltaRho, camera and control workstation	Remote sidereal and non-sidereal tracking demonstration
2. LEO test campaign	TLE ingestion, pass scheduling, acquisition, tracking and timestamp validation	Repeat capture of selected known satellites with evidence logs
3. Lunar/Mars channel	Install CDK14, planetary camera, filters and high-frame-rate workflow	Validated lunar mosaic and Mars filter sequence
4. Automation and safety	Weather interlocks, dome control, UPS, remote shutdown and fault recovery	Unattended safe-state tests
5. Signals Platform integration	Session records, media evidence, hashes, object registry, processing and dashboards	End-to-end auditable observation session

11. Engineering Risks and Controls

Risk	Impact	Control
Atmospheric seeing	Limits lunar/Mars resolution regardless of aperture	High-frame-rate lucky imaging, red/NIR filters, site selection and seeing monitor
Cloud and humidity	Low observing availability in Belgium	Automated weather station, flexible scheduling and remote-site option
Dual-OTA payload and inertia	Reduced mount dynamics or unsafe imbalance	Use L-500, detailed mass/moment schedule and factory review
Fast f/3 back-focus/tilt	Field degradation on large sensor	Factory-compatible focuser/rotator, tilt adjustment and commissioning tests
Satellite ephemeris error	Target outside camera field	Wide-field cueing, updated TLEs and automatic search pattern
Timestamp uncertainty	Weakens consulting/evidence value	GNSS/NTP/PTP time architecture and logged

		clock health
Data volume	Storage saturation	ROI capture, retention policy, tiered storage and off-site backup
Overinterpretation	False claims from ambiguous imagery	Calibration, blind comparison, independent review and explicit confidence labels
Laser/aviation safety	Potential legal and safety issue	No laser pointing system unless separately authorized and engineered

12. Consulting Deliverables Enabled by the System

- Timestamped observation dossiers for known LEO passes.
- Target acquisition and tracking performance reports.
- Calibrated lunar mosaics and repeat-surveillance comparisons.
- Mars visible/NIR maps showing central meridian, filter, seeing and processing metadata.
- Technical feasibility studies for client observatories and surveillance nodes.
- Equipment schedules, procurement specifications and commissioning protocols.
- Signals Platform evidence packages containing original files, hashes, processing lineage and operator notes.
- Public-facing demonstrations that clearly distinguish measured observations from hypotheses.

13. Conclusion

The DeltaRho 350 is highly appropriate for wide-field survey, fast target acquisition and LEO tracking when paired with a PlaneWave direct-drive mount. It is not, at native f/3 focus, the optimal instrument for detailed Mars imaging. A complementary CDK14-class long-focus OTA is therefore recommended for lunar and planetary work.

For a consulting-grade facility with simultaneous mission readiness, the preferred configuration is the DeltaRho 350 and CDK14 on an L-500 mount with monochrome full-frame and high-frame-rate NIR-sensitive cameras. The complete project should be treated as an observatory integration programme rather than a telescope purchase.

Recommended decision: commission a supplier-supported mass, moment, back-focus and dual-instrument integration study before ordering the mount, enclosure or custom adapters.

14. Sources and Pricing References

1. PlaneWave Europe, DeltaRho 350 product page: aperture 350 mm, focal length 1,050 mm, f/3, 60 mm field, OTA mass and published EU price. https://www.planewave.eu/en/products/telescopes/delta-rho-350-f/3-telescope-with-cassegrain-focus
2. PlaneWave Europe, L-350 product page: direct drive, 45 kg payload, up to 50 degrees/s slewing, encoder and tracking specifications. https://www.planewave.eu/en/products/mount/l-350-direct-drive-mount
3. PlaneWave Europe Price List 06/2025: DeltaRho, CDK14, L-350, L-500, L-600, wedges, focusers, rotators and related accessories. https://www.planewave.eu/fileadmin/Daten/downloads/PlaneWave-e-2025-06_01.pdf
4. PlaneWave Instruments, DeltaRho 350 official product information. https://planewave.com/products/deltarho-350-ota/
5. PlaneWave Instruments, L-Series tracking information and satellite-tracking application. https://planewave.com/l-series-out-of-this-world-tracking-performance/

6. QHYCCD, QHY600 series official specifications: Sony IMX455, full-frame, 3.76 micrometre pixels, native 16-bit ADC and onboard memory. https://www.qhyccd.com/astronomical-camera-qhy600/

7. ZWO, ASI585MM/MC Pro official specifications: Sony 4K sensor, 2.9 micrometre pixels, 3840 x 2160, up to approximately 47 fps and NIR sensitivity. https://www.zwoastro.com/product/asi585mc-mm-pro/

15. Disclaimer

This document is a preliminary engineering and procurement study. It does not constitute a binding quotation, manufacturer warranty, astronomical performance guarantee, structural calculation, electrical design, planning application, aviation authorization or legal opinion. Actual performance depends on site conditions, seeing, target brightness, orbital prediction quality, integration quality and operator procedure. Prices and availability can change without notice.