MSN Marker Catalogue

For more information contact us
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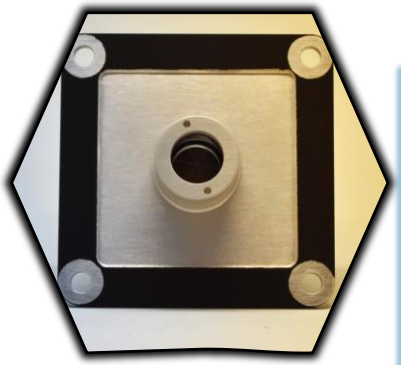
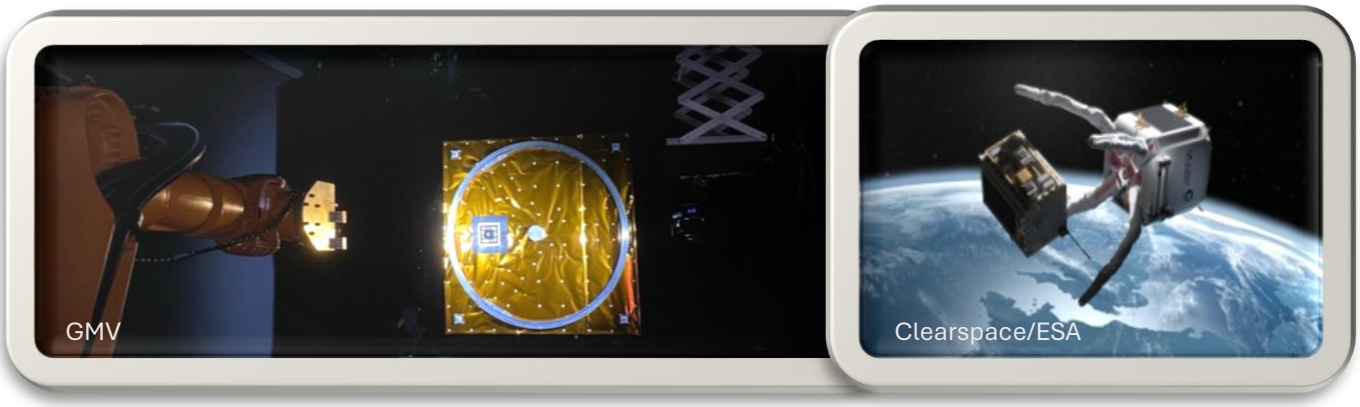
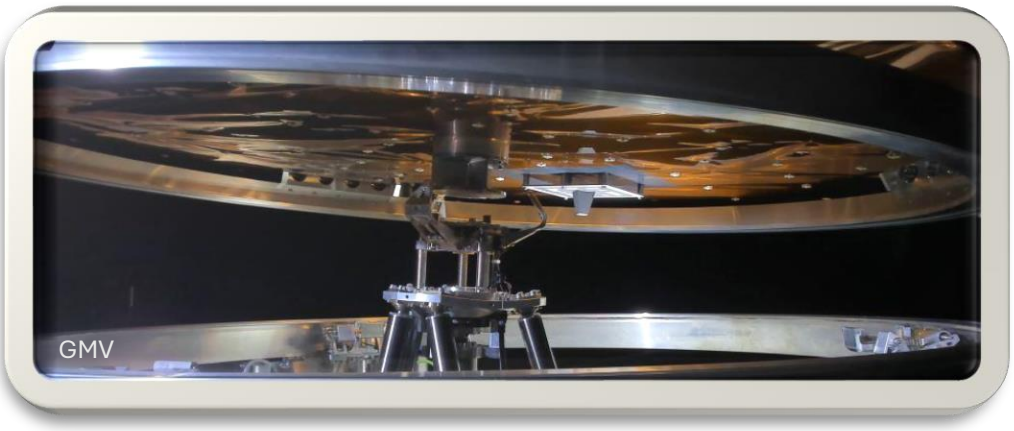


Removal of non-functional satellites from orbit at end-of-life is receiving more and more attention to ensure a clean and secure space environment. These operations can be supported using reflective solutions, such as rendezvous markers, installed on the target spacecraft, as a passive and cheap solution to improve the target recognition and pose estimation.

From far to close rendezvous (50-5 m), planar distributed 2D markers can be used, while for the last moments of the rendezvous, up to capture (5-0 m), a single 3D marker is required to perform pose estimation.





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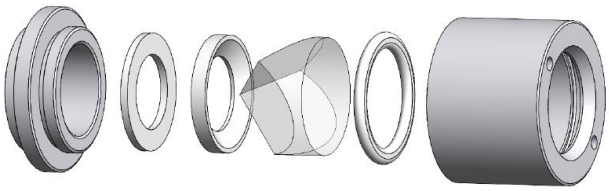
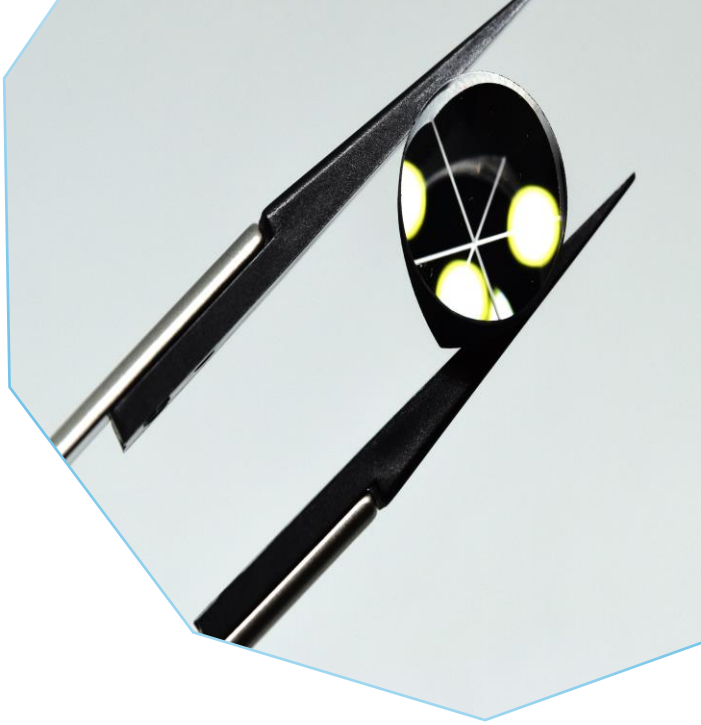
The 2D Marker is equipped with a central LRR (Laser Retroreflector) unit to allow orbit determination by laser ranging from ground, due to having unique LRR patterns on each face of the spacecraft.

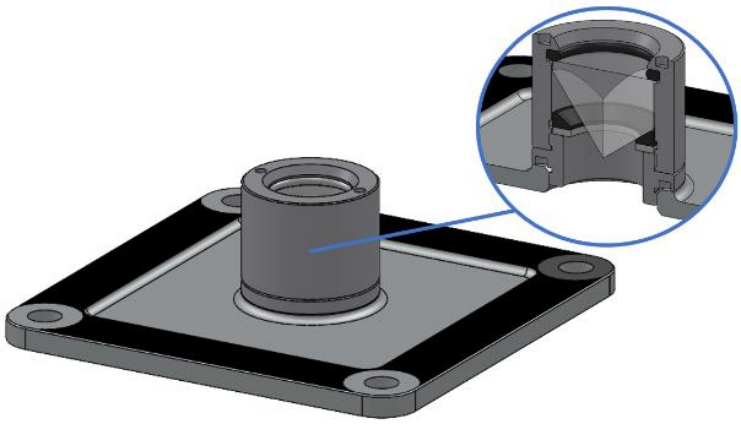


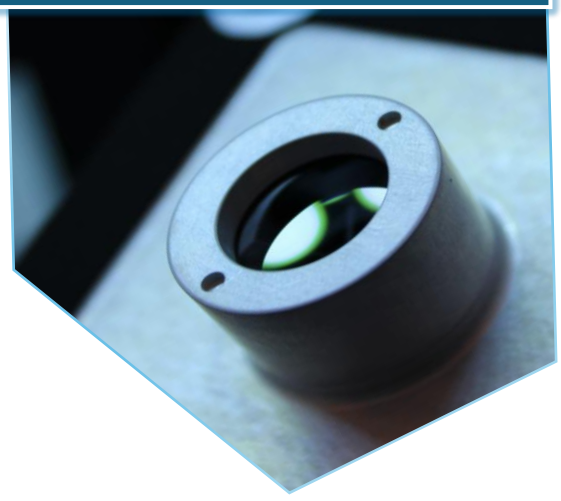


The Markers were developed and qualified by Admatis Ltd specifically for ESA Copernicus HPCM missions.

Their robustness allows them to surpass the expected operational life of the spacecraft, withstand the extreme space environment in LEO ensuring that they remain functional even after the mission ends. The dark and light coating pair provides excellent contrast in both the visible and infrared spectrum, ensuring detectability under various conditions.

Although TRL 9 has been reached, the development of the Markers continues to advance. The Markers are currently undergoing In-Orbit Demonstration (IOD) on the LUR-1, which was equipped with six 2D Markers. This IOD is a crucial step in validating their performance in a real-space environment, setting the stage for their use in future space missions.





For the Copernicus mission satellites, each set consists of 20 2D Markers (4 per side on 5 sides) and 1 3D Marker mounted on the LAR face.

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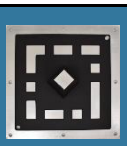
Technical parameters

Properties	2D Marker 	3D Marker 
Dimensions (L, W, H) [mm]	60x60x16,5	150x150x43
Weight [g]	~29.6	~211.2
Baseplate material	Aluminum	Aluminum
Surface passivation	Conversion Coating	Conversion Coating
Coating	Space qualified paint	Space qualified paint
Central element	Laser retroreflector	Pyramidal element
Fixation	4 pcs MJ4x10 Cheese head screw	5 pcs MJ4x10 Cheese head screw
Navigation support	from 50 m to 5 m	from 5 m to 0 m
Grounding	implemented by the interface screws	implemented by the interface screws

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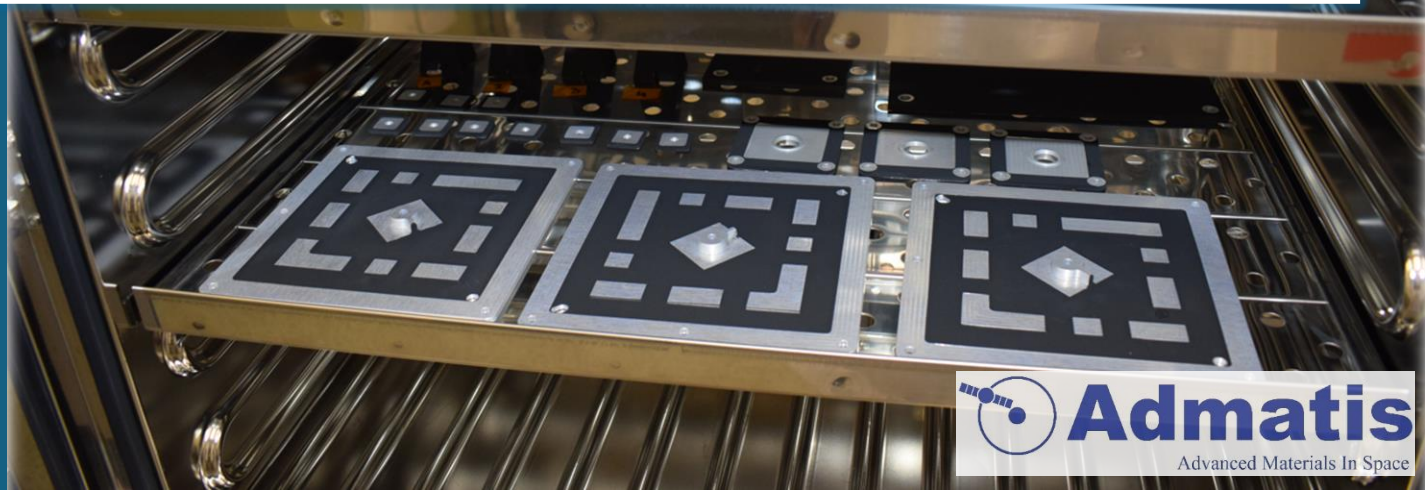
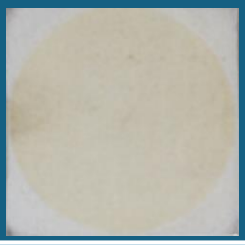
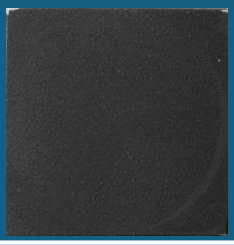
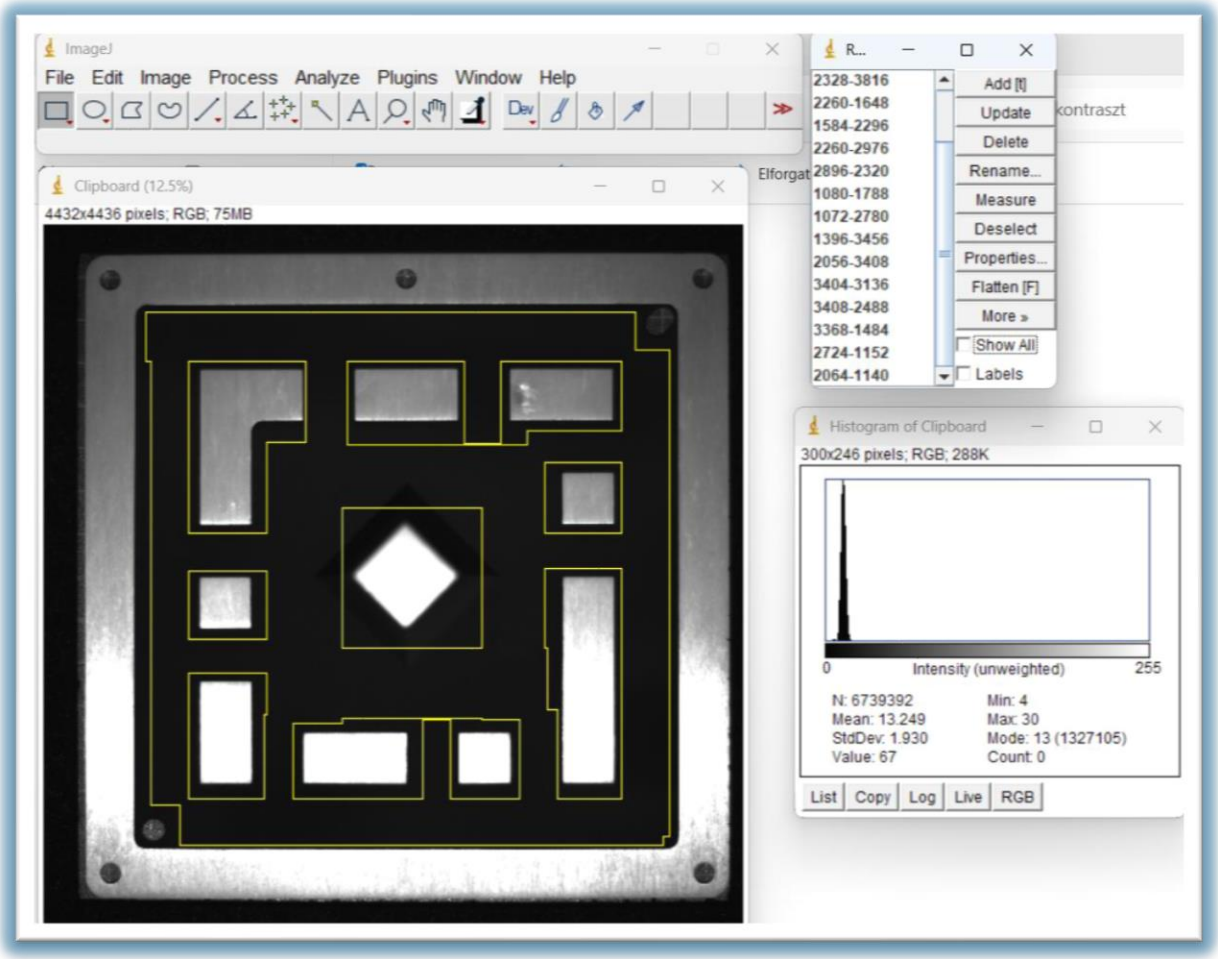
Qualification

- Humidity testing, representing 10 years of on ground storage
- Environmental testing representing 12 years of in orbit operation:
  - Thermal cycling
    - TVAC: Temperature: -175 /+160°C
      No. of cycles: 20 cycles
      Pressure: < 1.3 x 10-5mbar
    - APTC: Temperature: -175 /+160°C
      No. of cycles: 80 cycles
      Pressure: ambient pressure in N_2 atmosphere
  - Particle irradiation
    Particles: 3 MeV electrons
    Surface dose: 180 Mrad
  - ATOX Fluence: $2.7x10^{21}$ particles/cm^2
  - UV Irradiation level: 7067 ESH
- Launch mechanical loads:
  - Shock test
  - Vibration test
- Performance parameters determination:
  - Visual
  - Cleaning
  - Mass
  - Adhesion
  - Reflectance
  - Contrast
  - Optical measurements (WFE, FFDP, Reflectivity)
  - Integrity thermo-optical properties (emissivity and solar absorbance)



Detectability is largely governed by the contrast between the two coatings, which has been thoroughly assessed from different angles and distances across both the infrared and visible spectra, utilizing the Michelson contrast formula. Based on the results of the aging tests, it can be concluded that neither the performance nor the contrast of the coatings undergoes any significant change from the Beginning of Life (BOL) to the End of Life (EOL) state.

Conversion coating in **BOL** condition	Conversion coating in **EOL** condition	Thermo-optical paint in **BOL** condition	Thermo-optical paint in **EOL** condition
			



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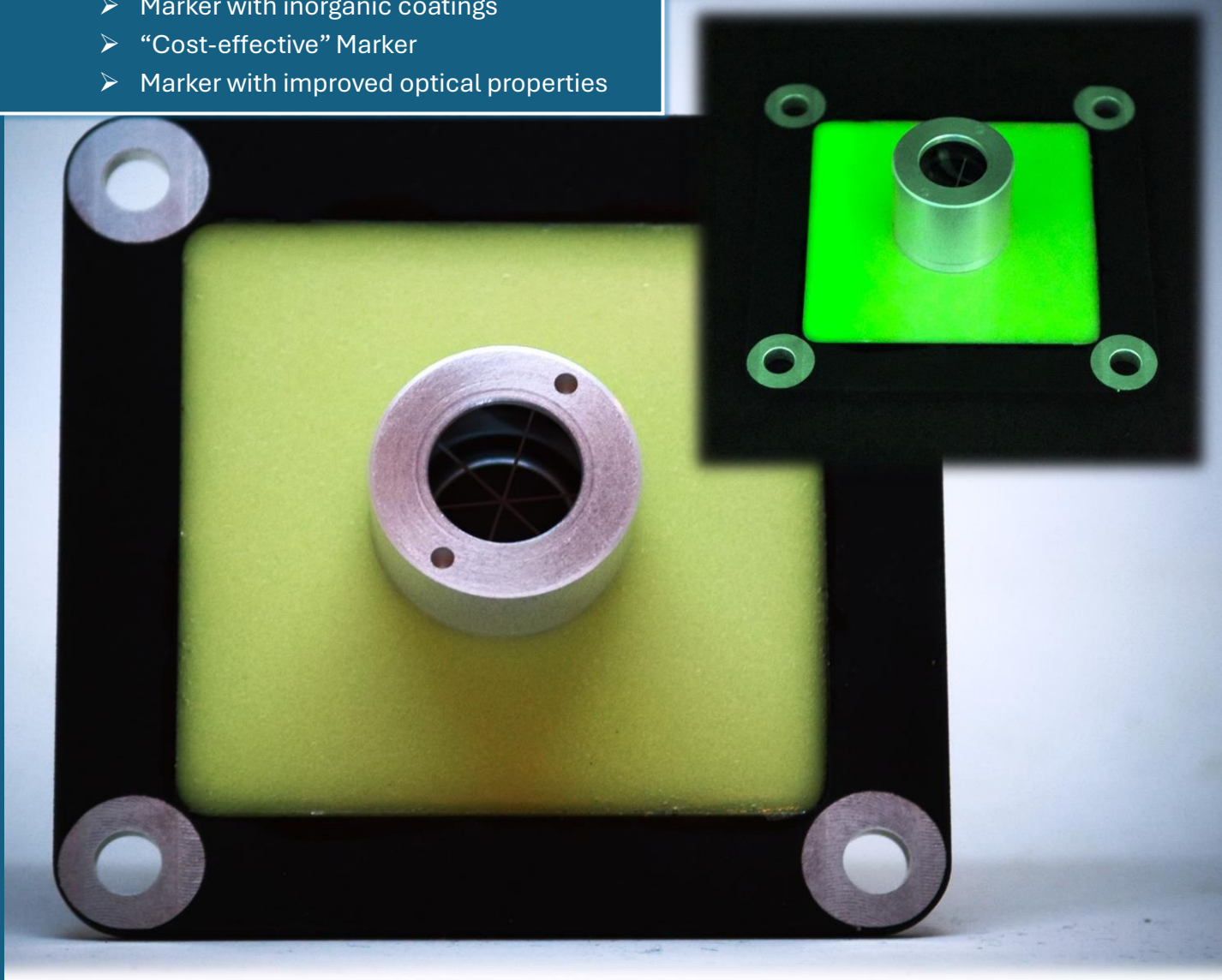
Next generation Markers

„Glow in the dark" Marker

The development of phosphorescent coatings for the Markers aims to ensure their visibility under all illumination conditions (including eclipse) as the distance is too far to use artificial illumination. However, no phosphorescent paints have been qualified currently for space use, making this a unique challenge. The coating must not only withstand the harsh conditions of space but also maintain long-term stability and reliability.

- Marker with inorganic coatings
- "Cost-effective" Marker
- Marker with improved optical properties



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