

The background of the slide is a photograph taken from space, showing the curved horizon of the Earth. A bright, glowing blue and white arc of light represents the atmosphere and the sun's position. In the dark void of space, a small, thin crescent moon is visible to the right of the center.

Statistical Analysis of Small-Size Space Debris Environment in GEO and HEO

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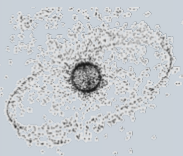
*42nd IADC Annual Meeting,
April 16th – 19th 2024, Bengaluru, India*

Objectives

- **Survey Objectives**
 - **GEO/HEO surveys for sub-catalogue objects**
 - statistical data for MASTER model upgrades
 - **breakup fragment surveys**
 - OGS for new fragmentation events only (small FoV)
- **HAMR/breakup fragment follow-up**
 - **follow-up of HAMR**
 - OGS for faint fragments only
 - follow-up at SwissOGS
 - **follow-up of breakup fragments**
 - OGS for faint fragments only
 - follow-up at SwissOGS

Primary Optical Sensor

1m ESA OGS telescope
in Tenerife



Sensors for Follow-up Observations

Swiss Optical Ground Station and Geodynamics Observatory Zimmerwald



0.8m ZimMAIN
Switzerland



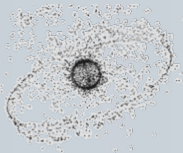
1-m ZIMLAT
Switzerland



AIUB ZimSMART

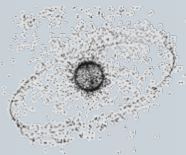


2x0.4-m ZimTWIN
Switzerland

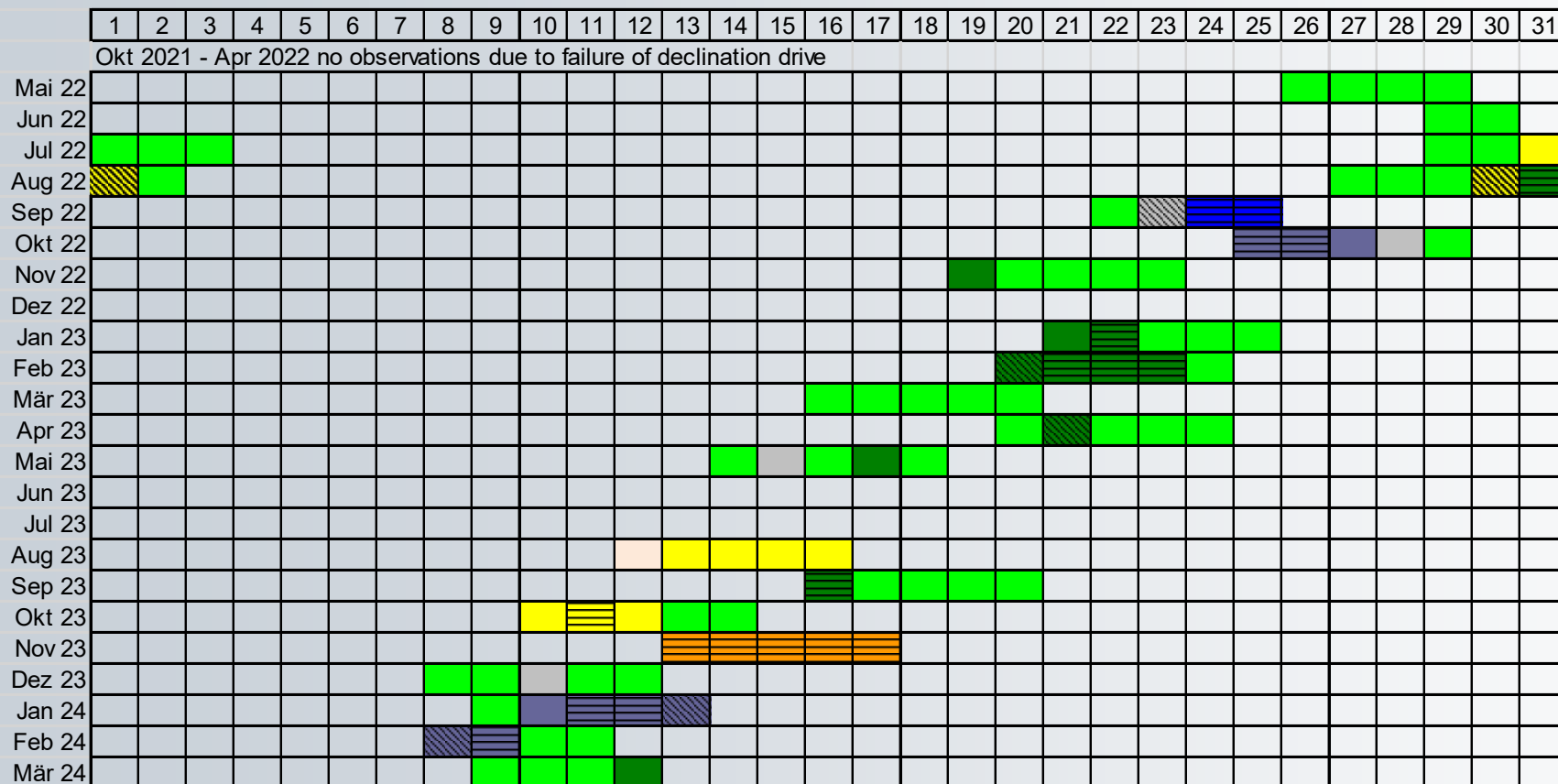


Observations

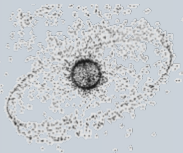
- **1 m ESA Telescope Tenerife (OGS)**
 - 19–36 good nights per year (~25–45 scheduled)
 - GEO surveys (3–4 night campaigns at New Moon)
- **1 m ZIMLAT / 0.8m ZimMAIN (SwissOGS)**
 - follow-up of objects discovered by ESA telescope
 - continuous follow-up of HAMR objects
- **0.2m ZimSMART / 0.4m ZimTWIN (SwissOGS)**
 - continuous catalogue maintenance (bright objects)



OGS Observations



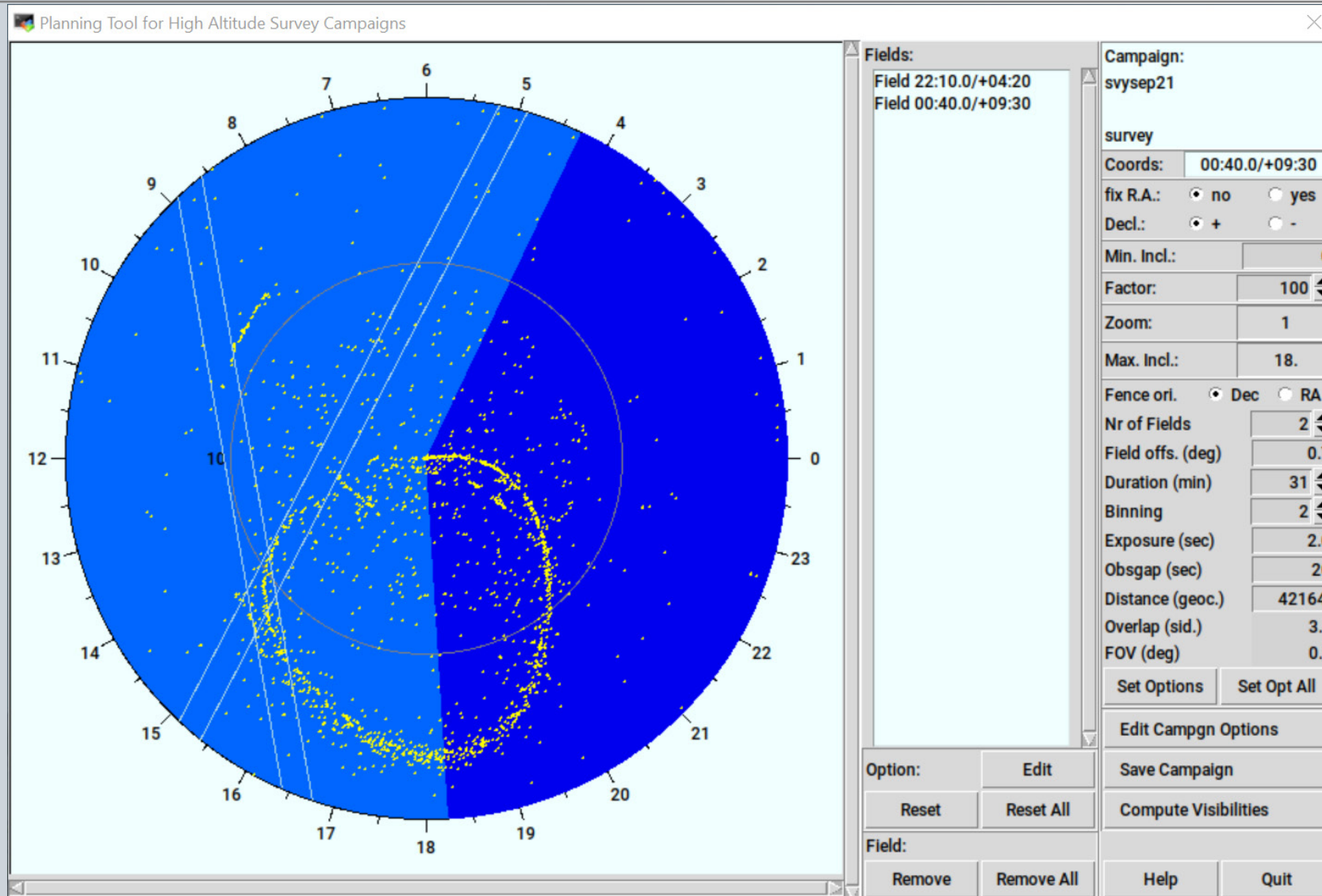
		0h	<4h	>4h
planned night				
good night				
high humidity				
rain or snow				
clouds				
ice on dome				
dust				
wind				
technical problems				



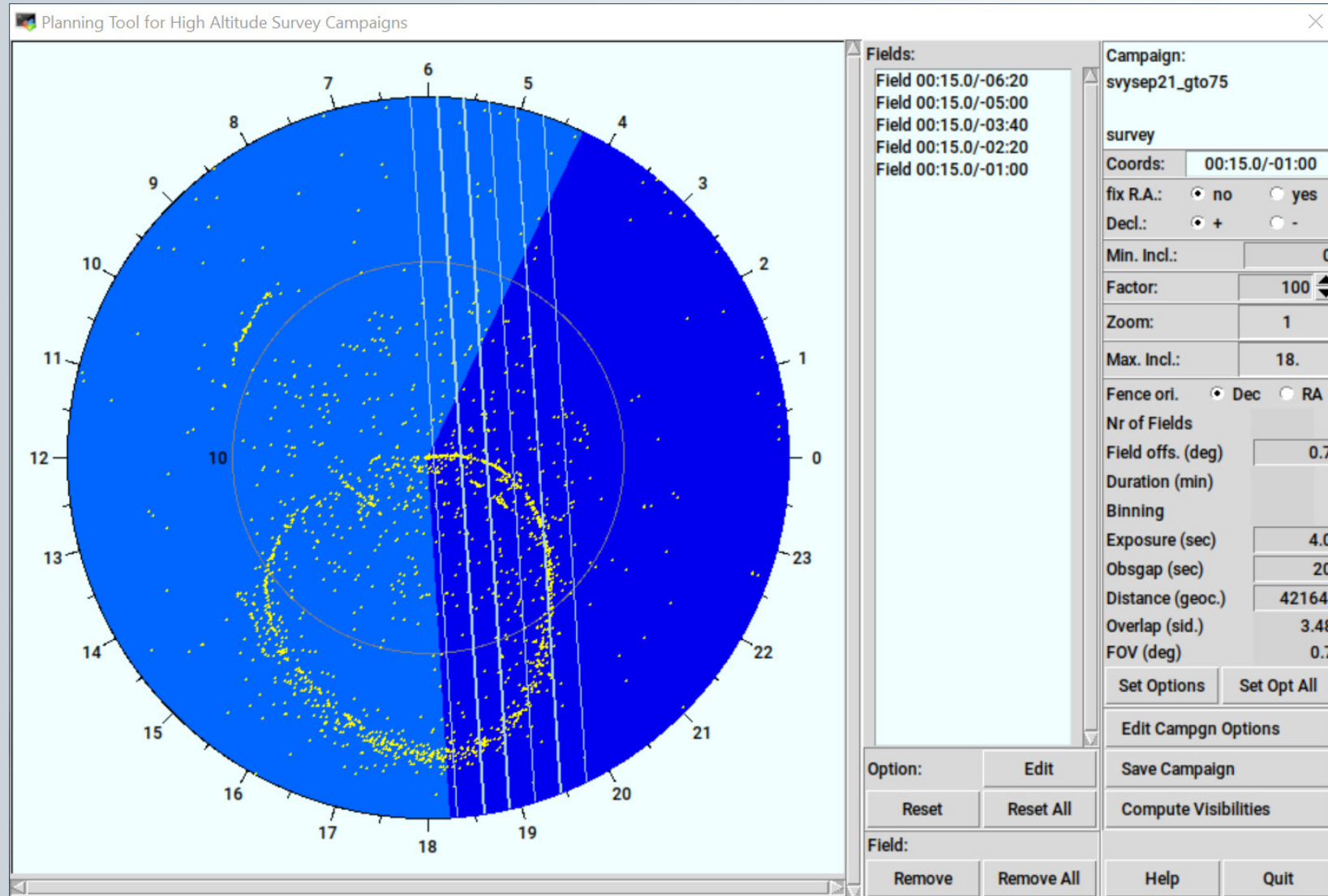
Planning, Data Acquisition, Processing

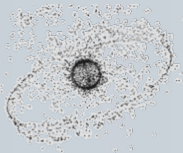
- Monthly planning cycles for OGS
- Daily planning for SwissOGS (follow-up)

Planning of Survey Fields



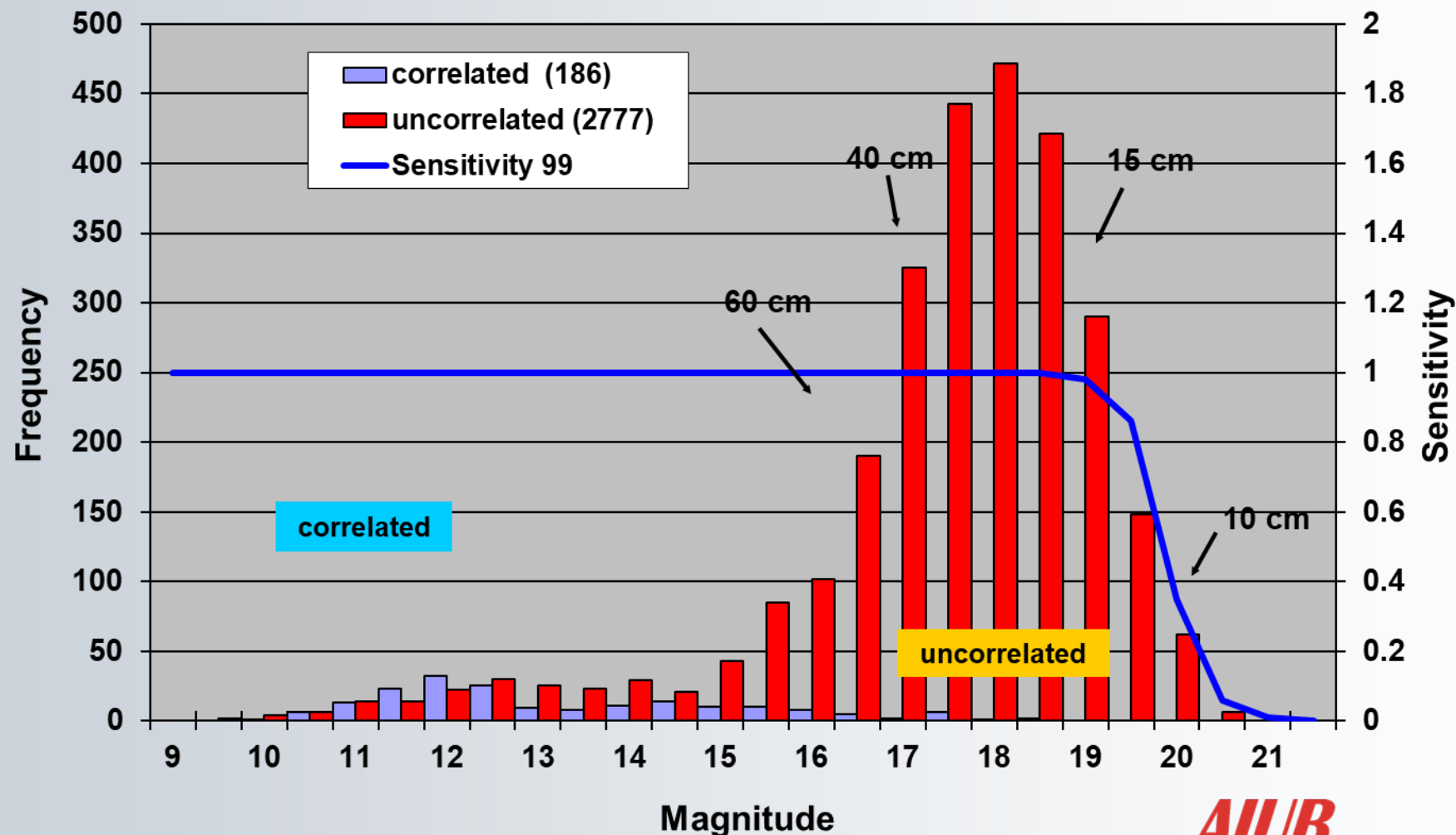
Planning of Survey Fields



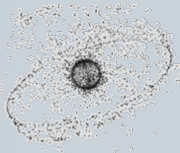


High-Altitude Surveys GEO/HEO 2002–2024

Objects (Jan 2002- Feb 2024; elliptical orbits)

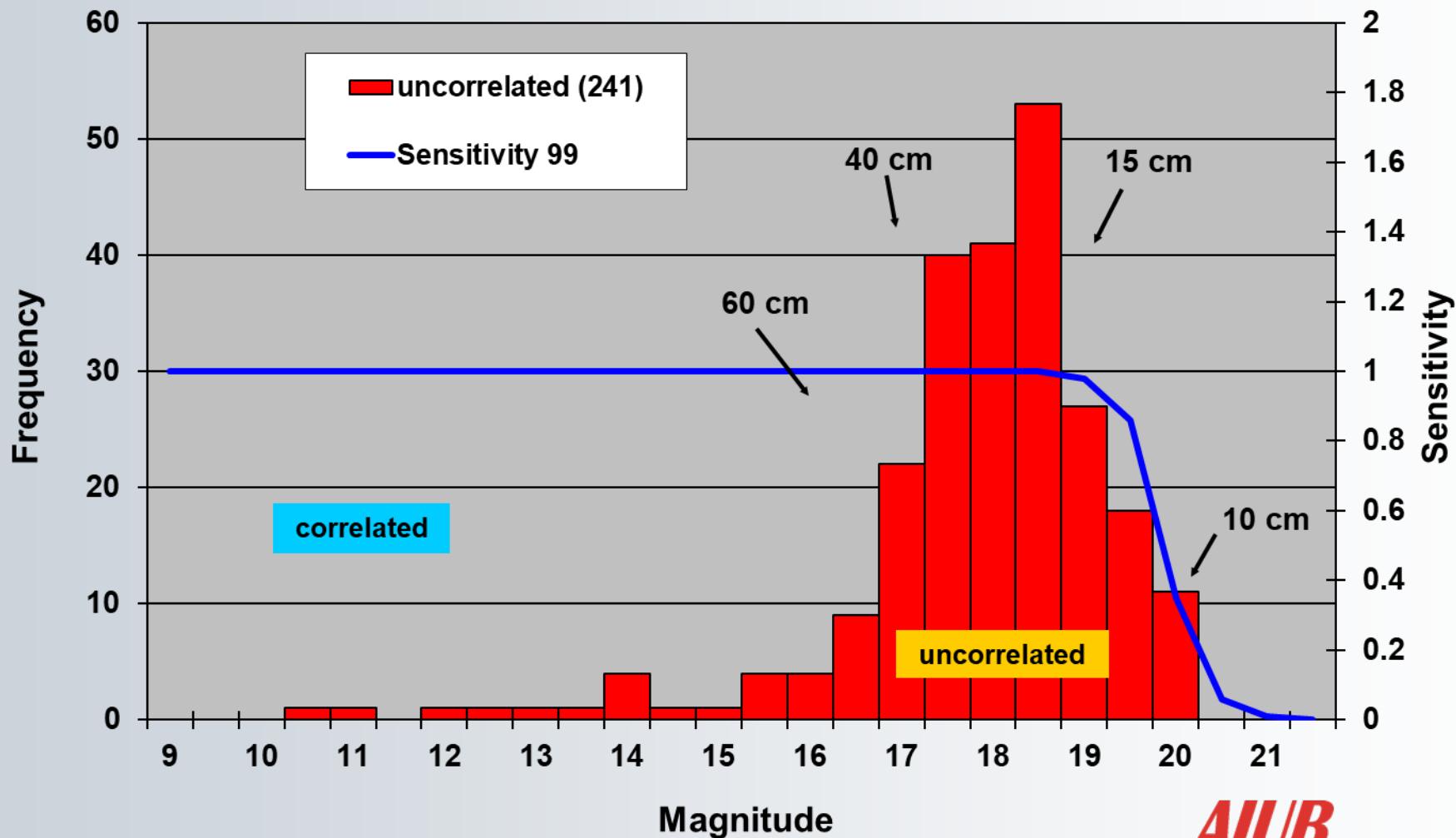


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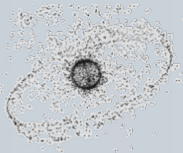


High-Altitude Surveys GEO/HEO 2023

Objects (Jan 2023- Feb 2024; elliptical orbits)

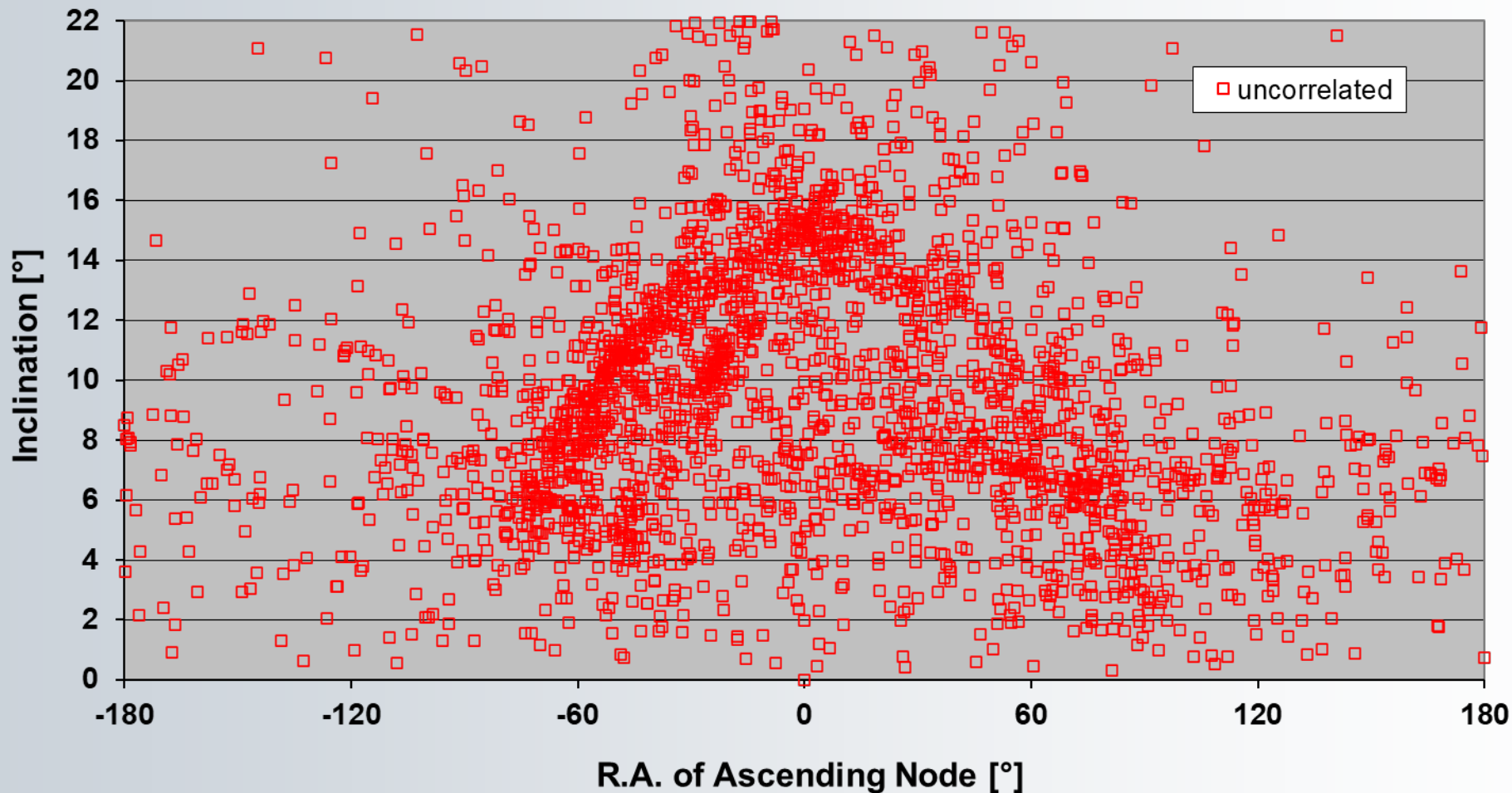


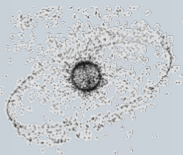
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High-Altitude Surveys GEO/HEO 2002–2024

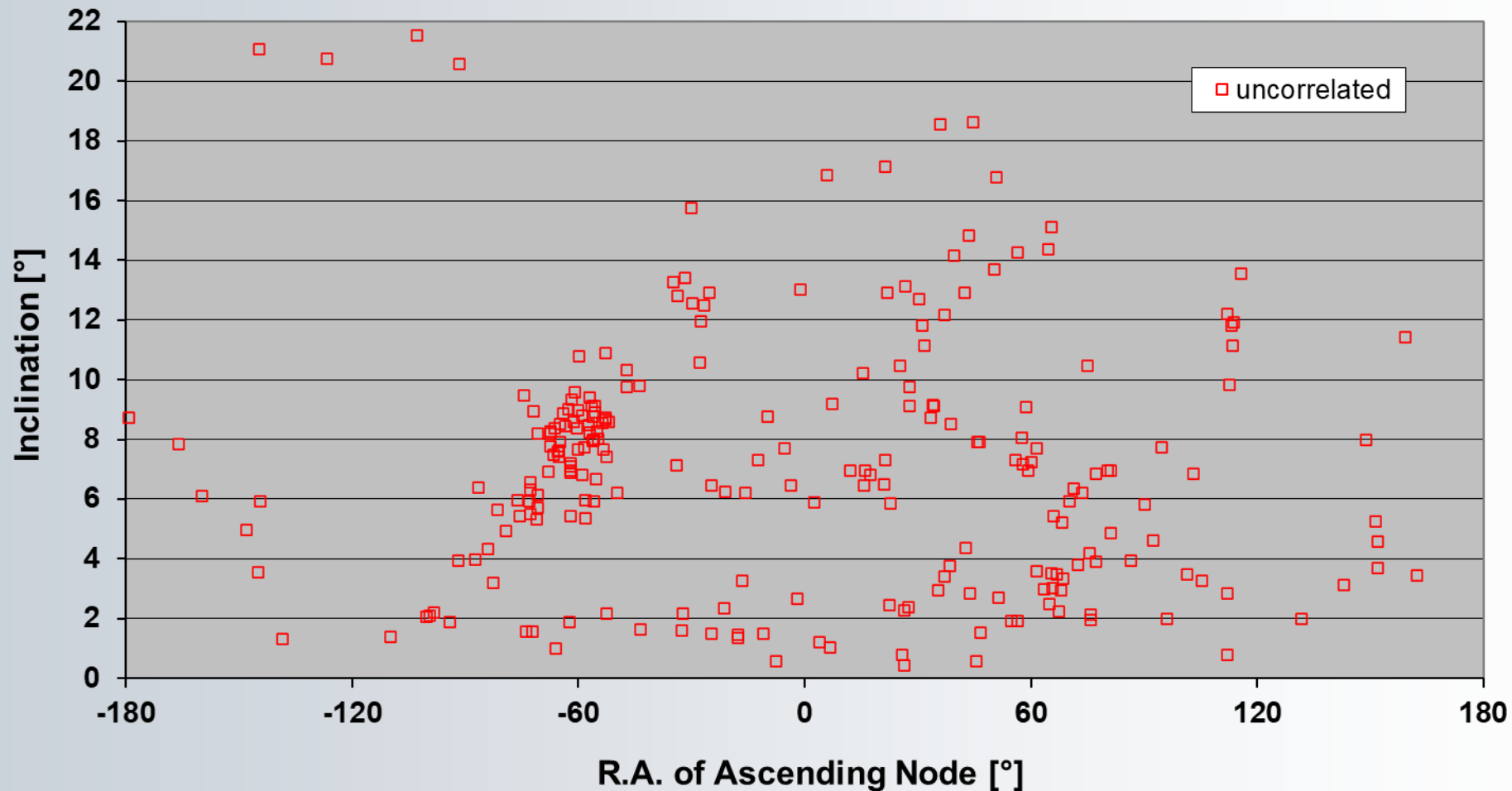
Orbital Elements (Jan 2002- Feb 2024; elliptical orbits)

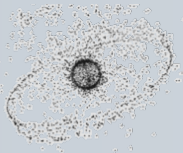




High-Altitude Surveys GEO/HEO 2023

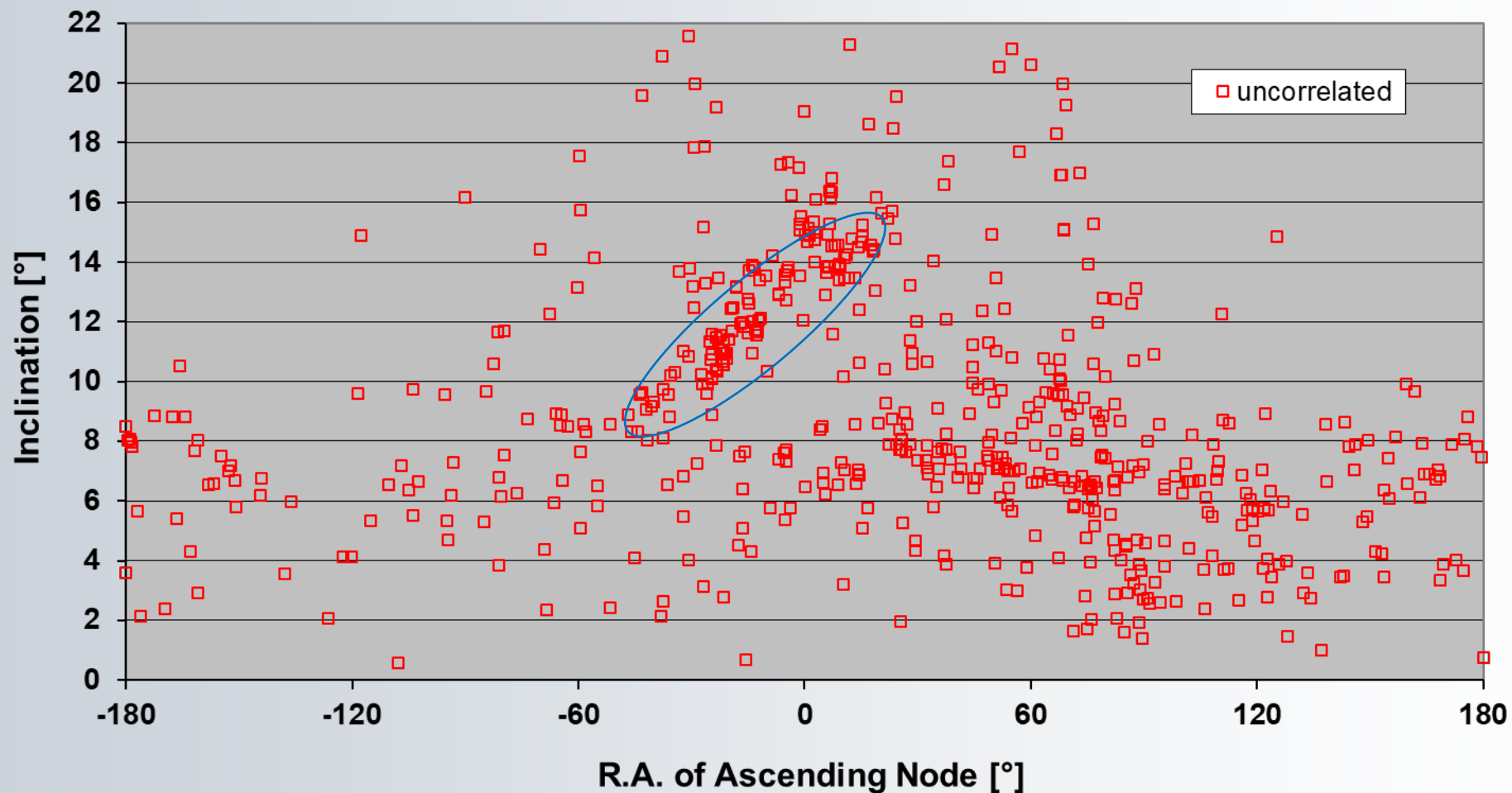
Orbital Elements (Jan 2023- Feb 2024; elliptical orbits)

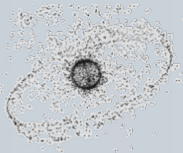




High-Altitude Surveys GEO/HEO 2006–2012

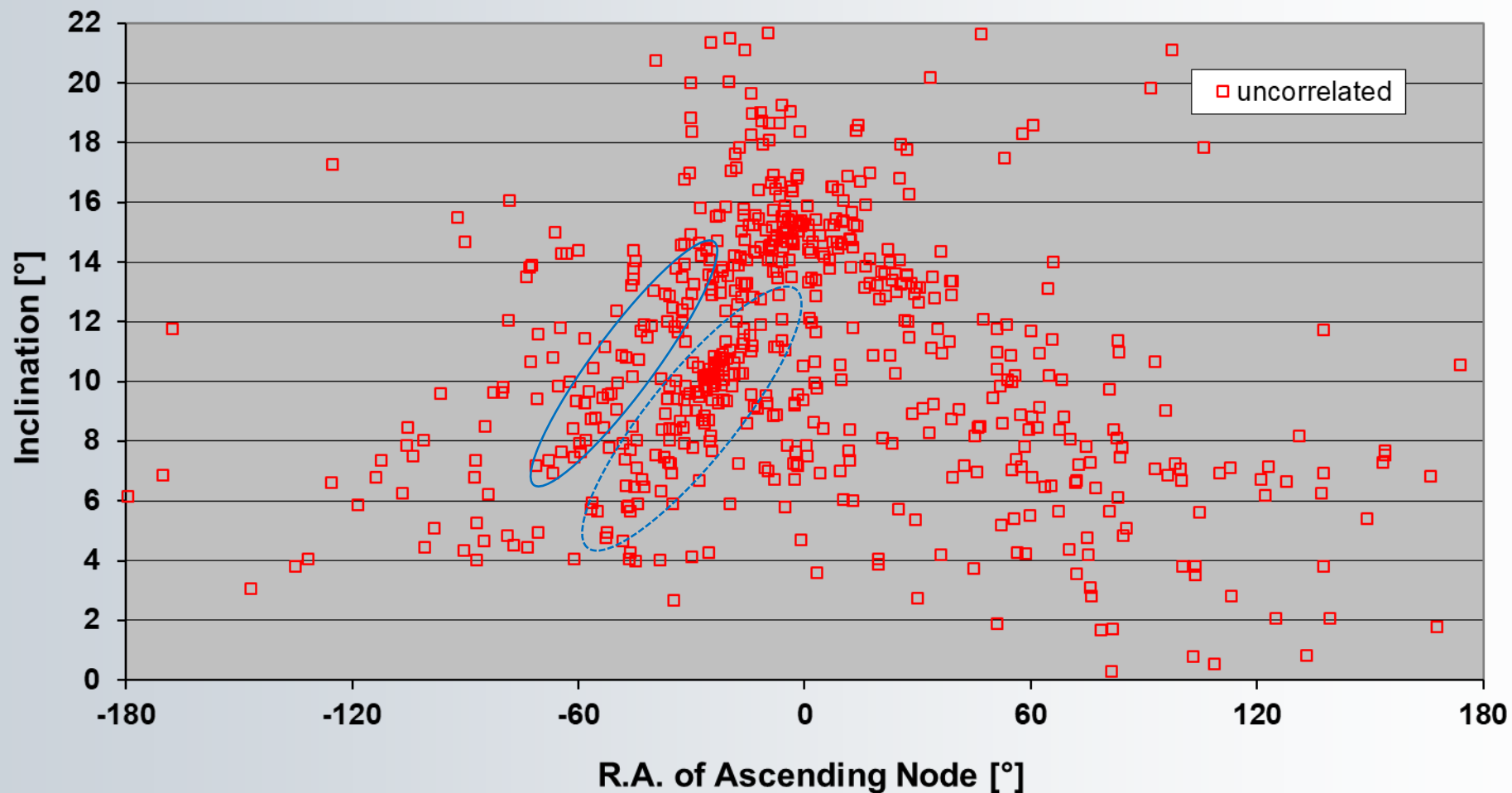
Orbital Elements (Jun 2002 - Dec 2006; elliptical orbits)

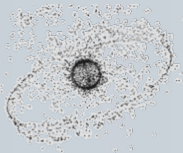




High-Altitude Surveys GEO/HEO 2007–2011

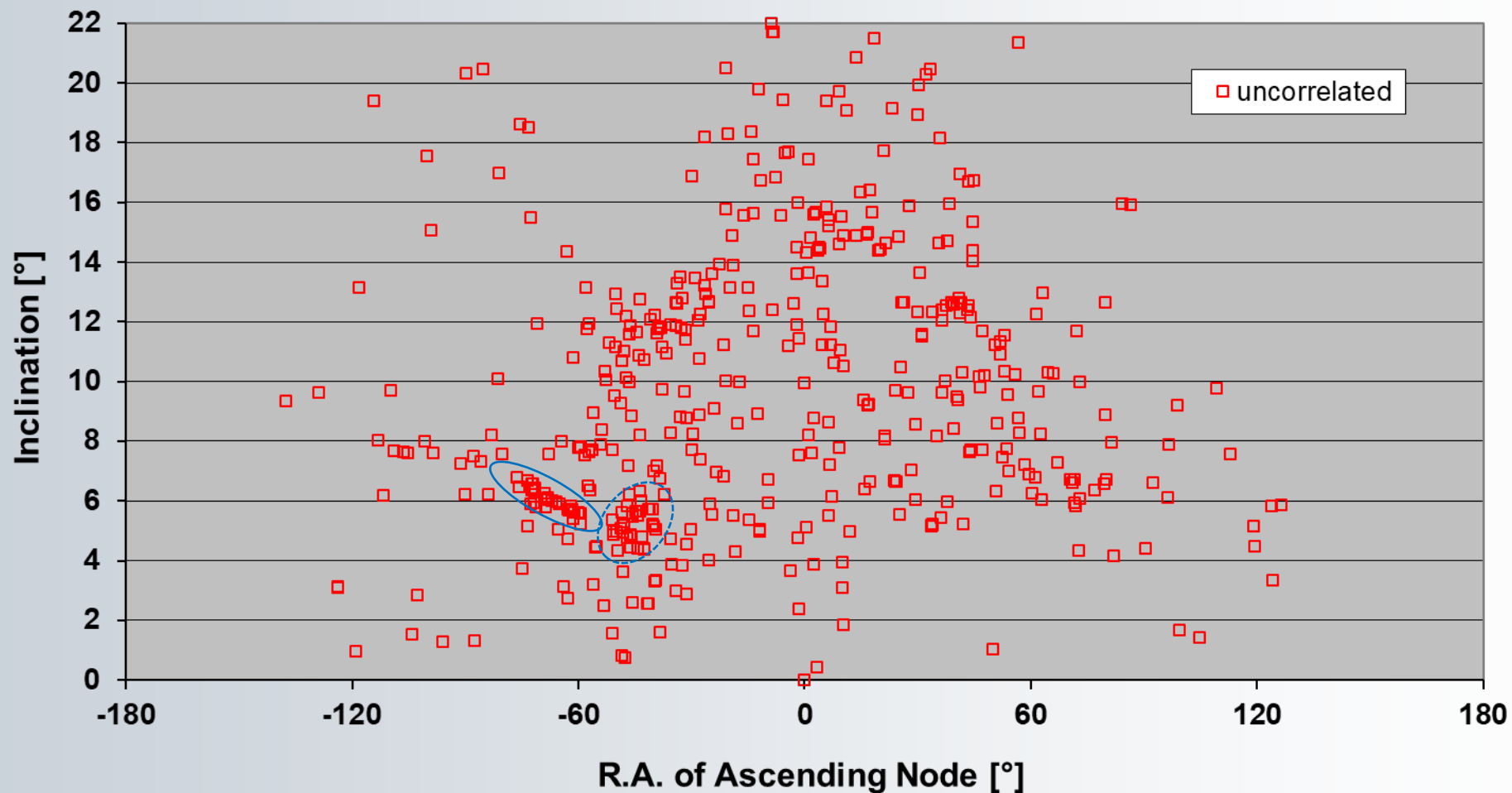
Orbital Elements (Jan 2007 - Dec 2011; elliptical orbits)

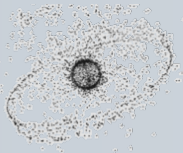




High-Altitude Surveys GEO/HEO 2014–2018

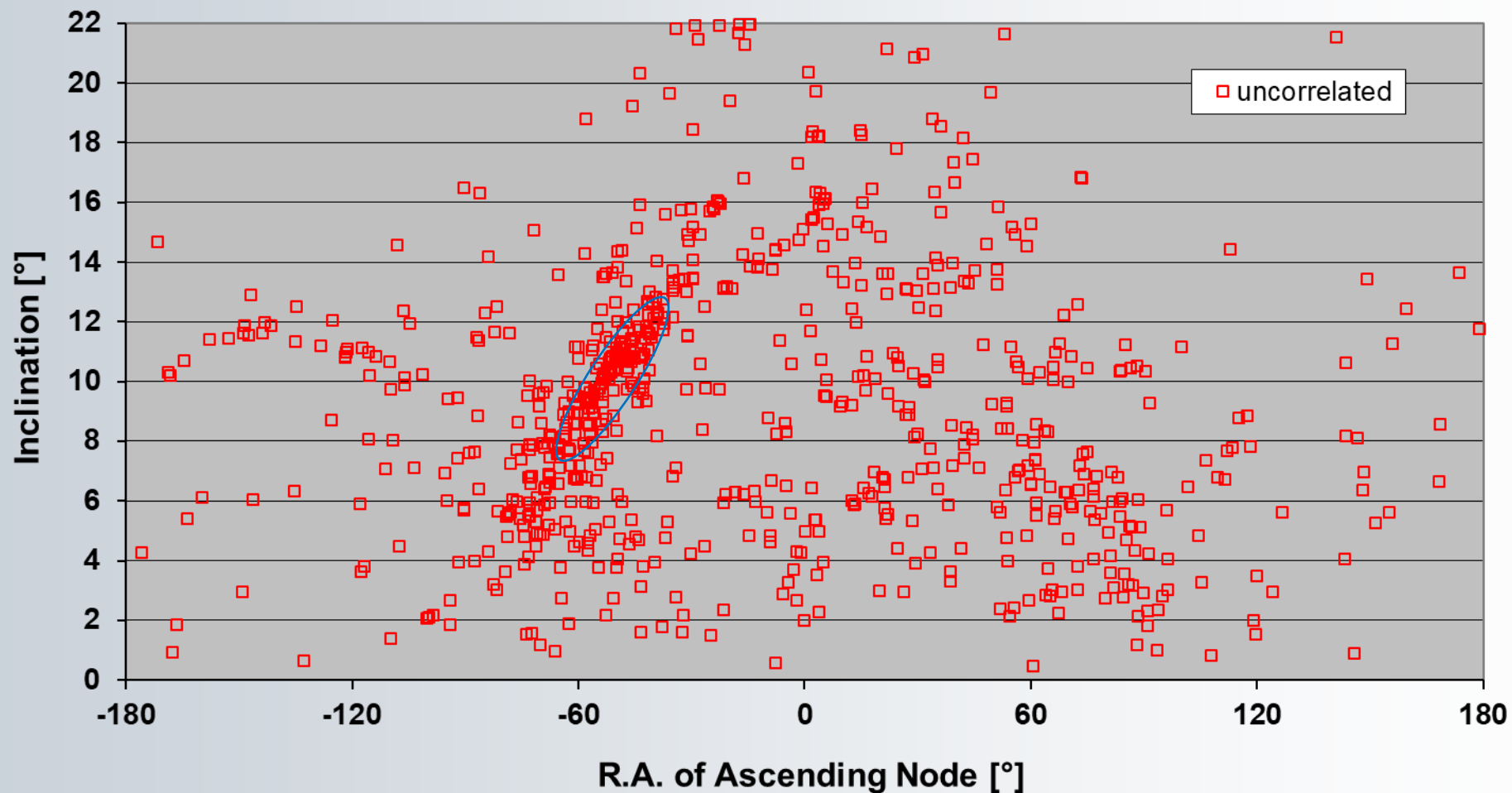
Orbital Elements (Jan 2014 - Dec 2018; elliptical orbits)

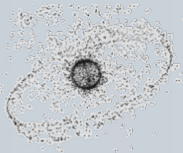




High-Altitude Surveys GEO/HEO 2019–2023

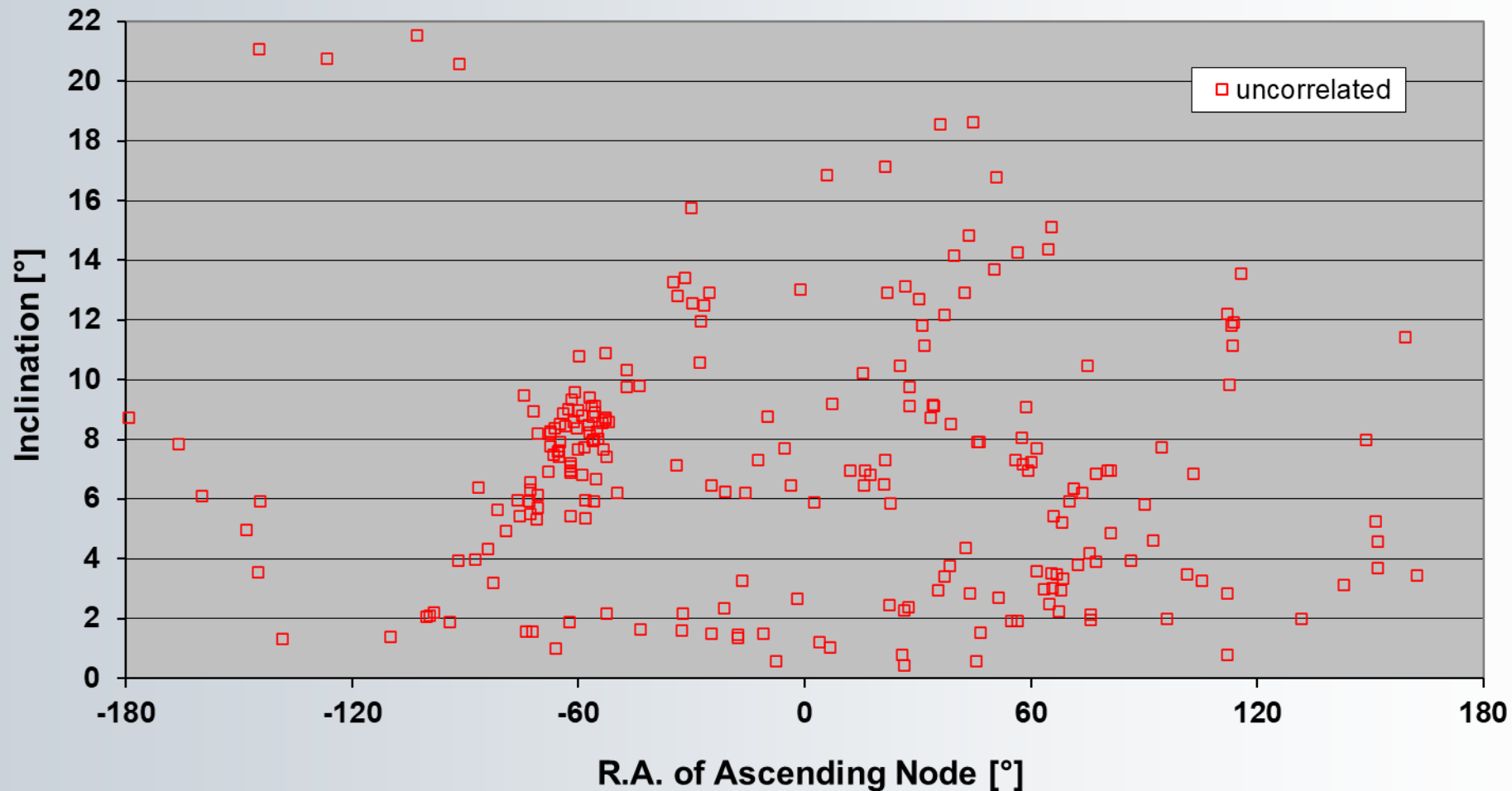
Orbital Elements (Jan 2019 - May 2023; elliptical orbits)

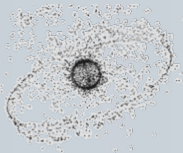




High-Altitude Surveys GEO/HEO 2023

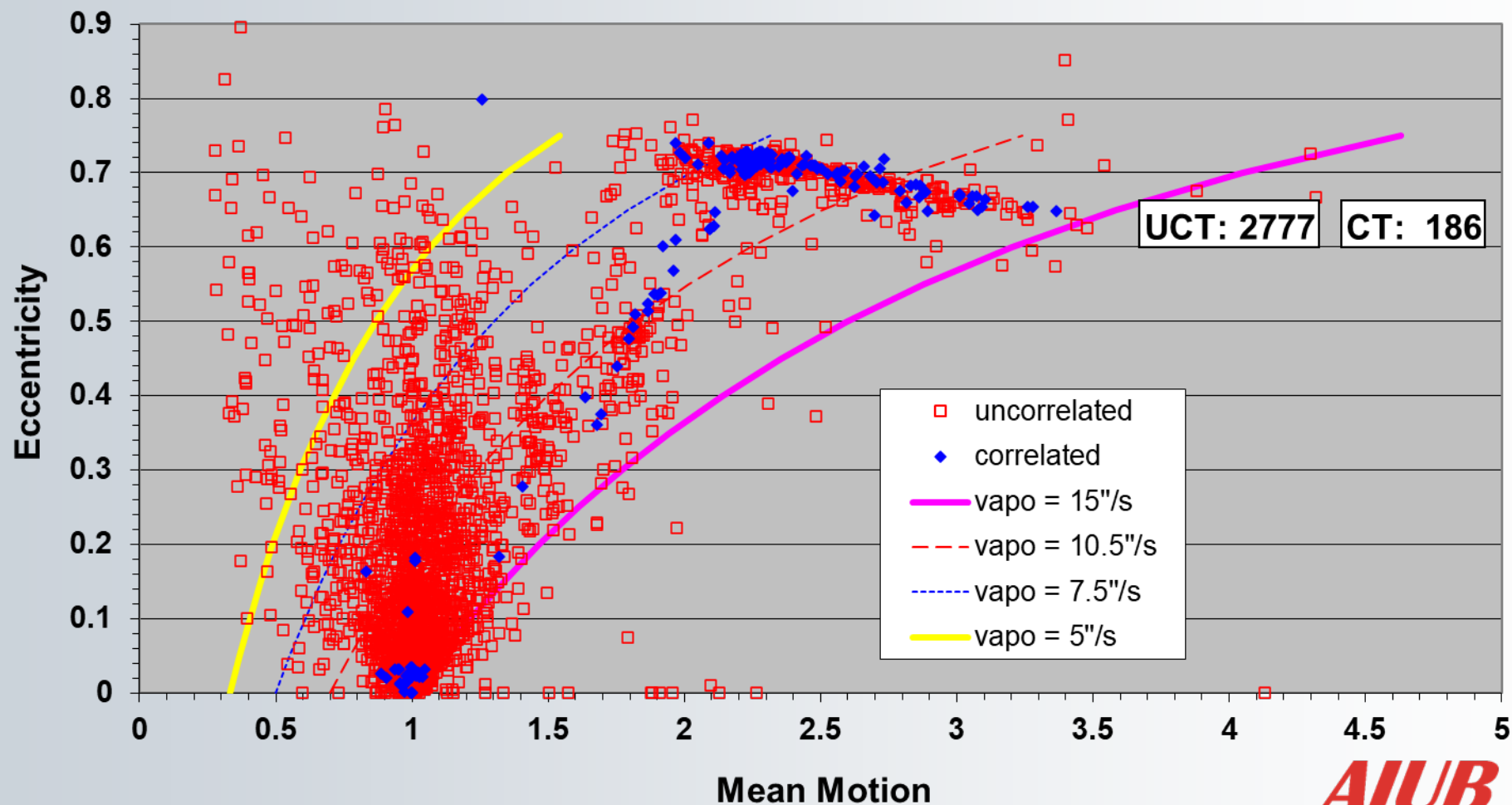
Orbital Elements (Jan 2023- Feb 2024; elliptical orbits)



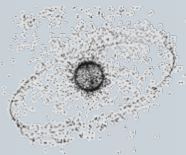


High-Altitude Surveys GEO/HEO

Eccentricity vs Mean Motion (Jan 2002- Feb 2024; elliptical orbits)

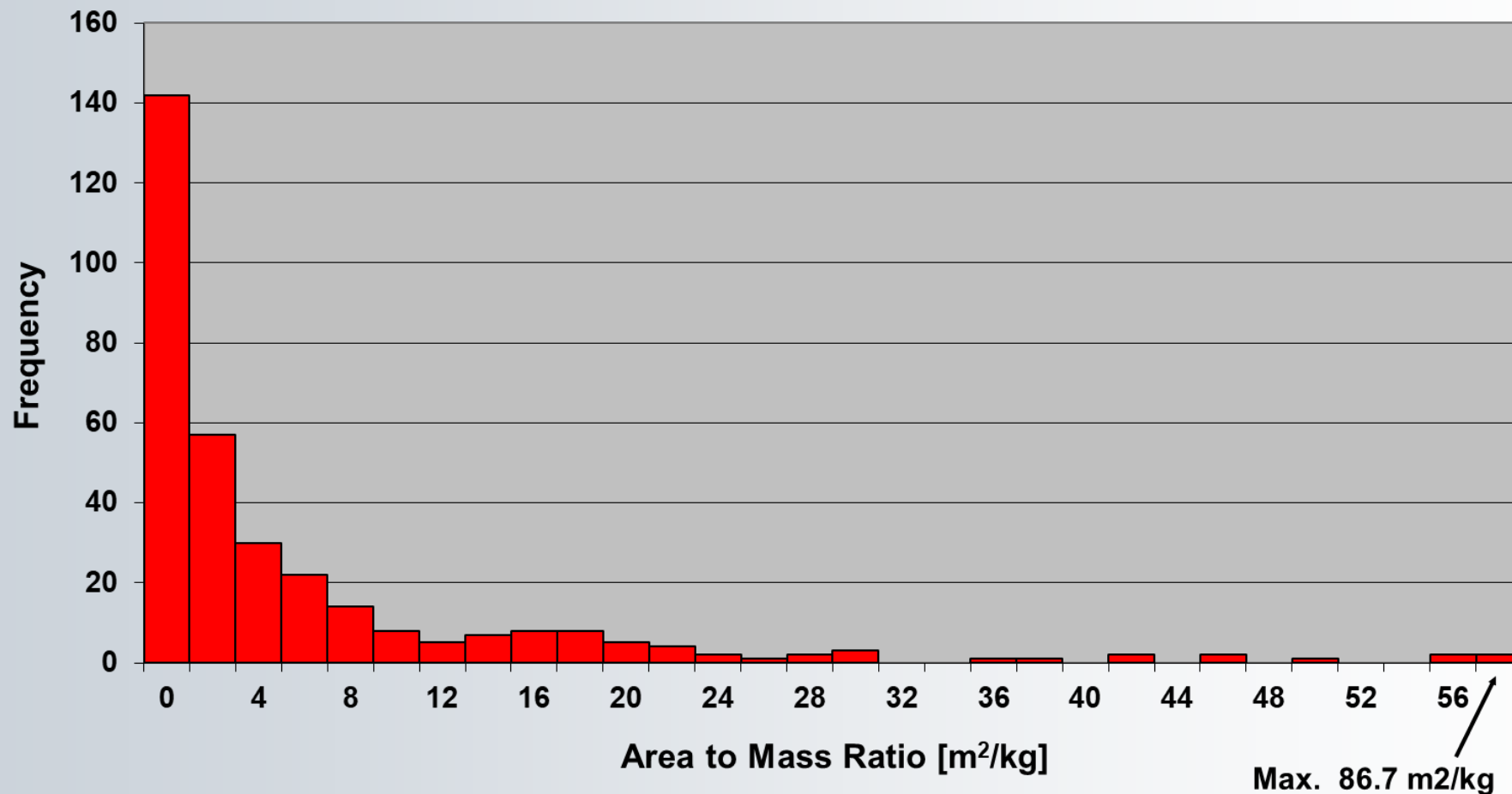


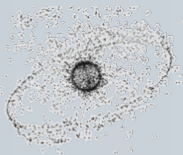
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High-Altitude Surveys GEO/HEO

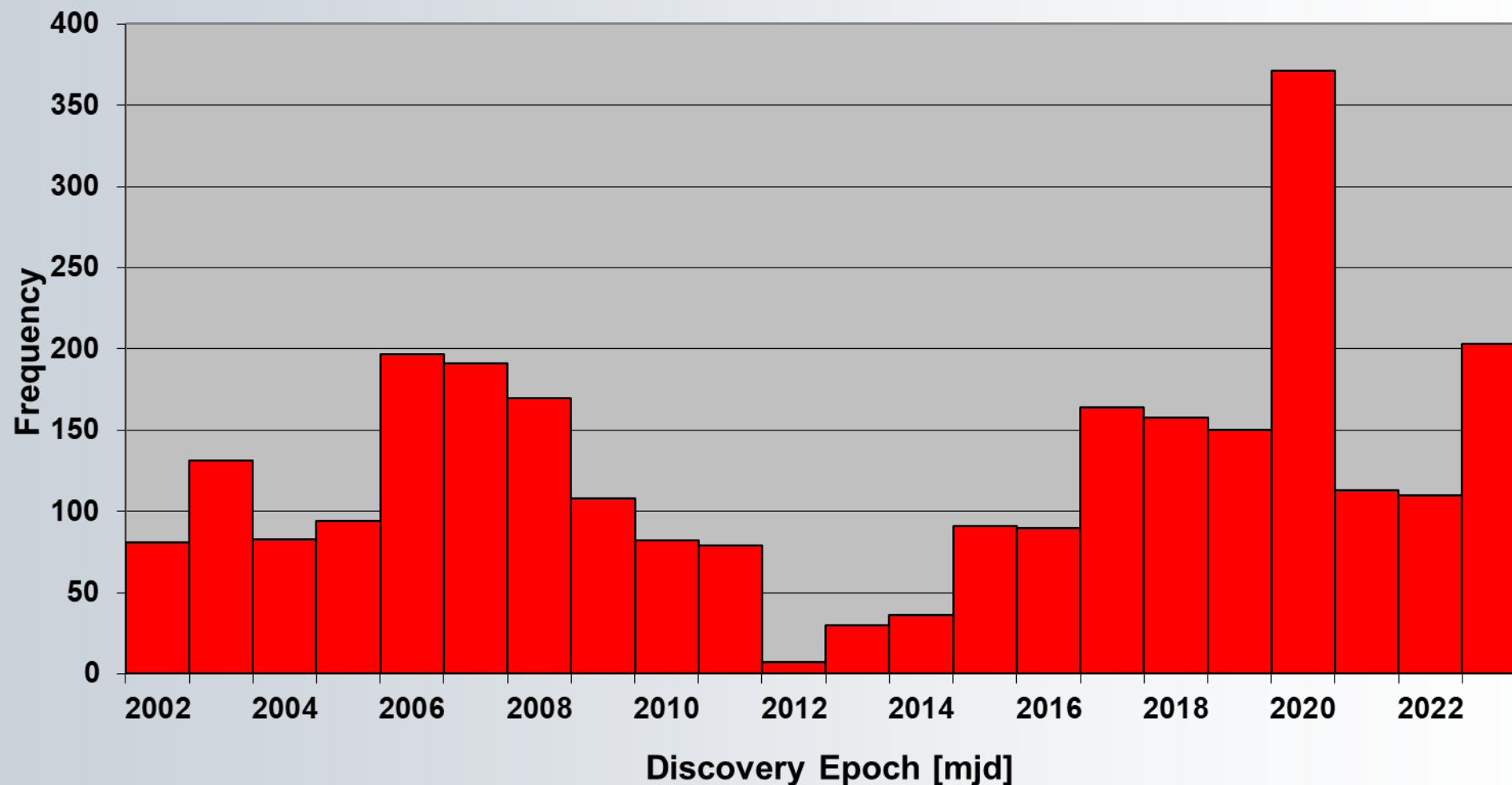
Area-to-Mass Ratio (329 Uncorrelated Objects)





High-Altitude Surveys GEO/HEO

Discovery Rate (Jan 2002- Feb 2024; elliptical orbits)





Summary – Lessons Learned

- **Regular optical survey at the ESA–OGS essential to**
 - monitor changes in the environment (breakup events, ...)
 - provide statistical data to validate models (MASTER)
 - maintain a catalogue of high A/m–ratio objects to allow physical characterization
- **ESA continues optical surveys in GEO and HEO**
- **Recent results show that the debris environment in GEO and HEO is still very dynamic!**

A space-themed background featuring a bright, glowing arc of Earth's horizon against a black sky. A small crescent moon is visible in the distance, positioned just above the horizon line.

Thank you for your time!