ESA Optical Surveys to Characterize the Small-Size Space Debris Environment in GEO and HEO

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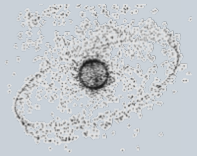
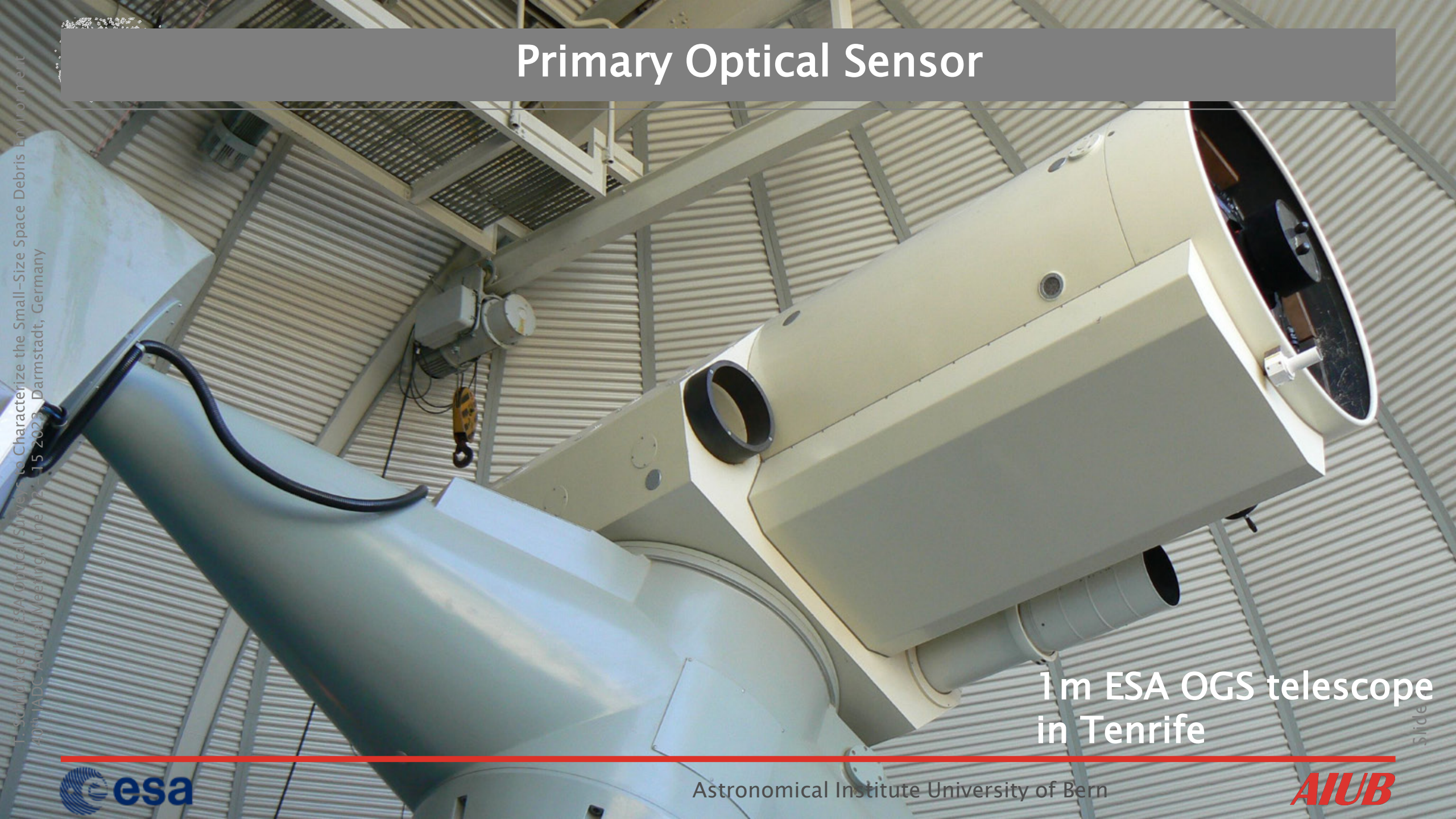


Objectives

- **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**

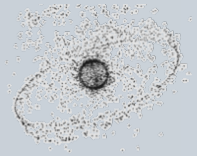
Primary Optical Sensor



1m ESA OGS telescope in Tenrife

Sensors for Follow-up Observations

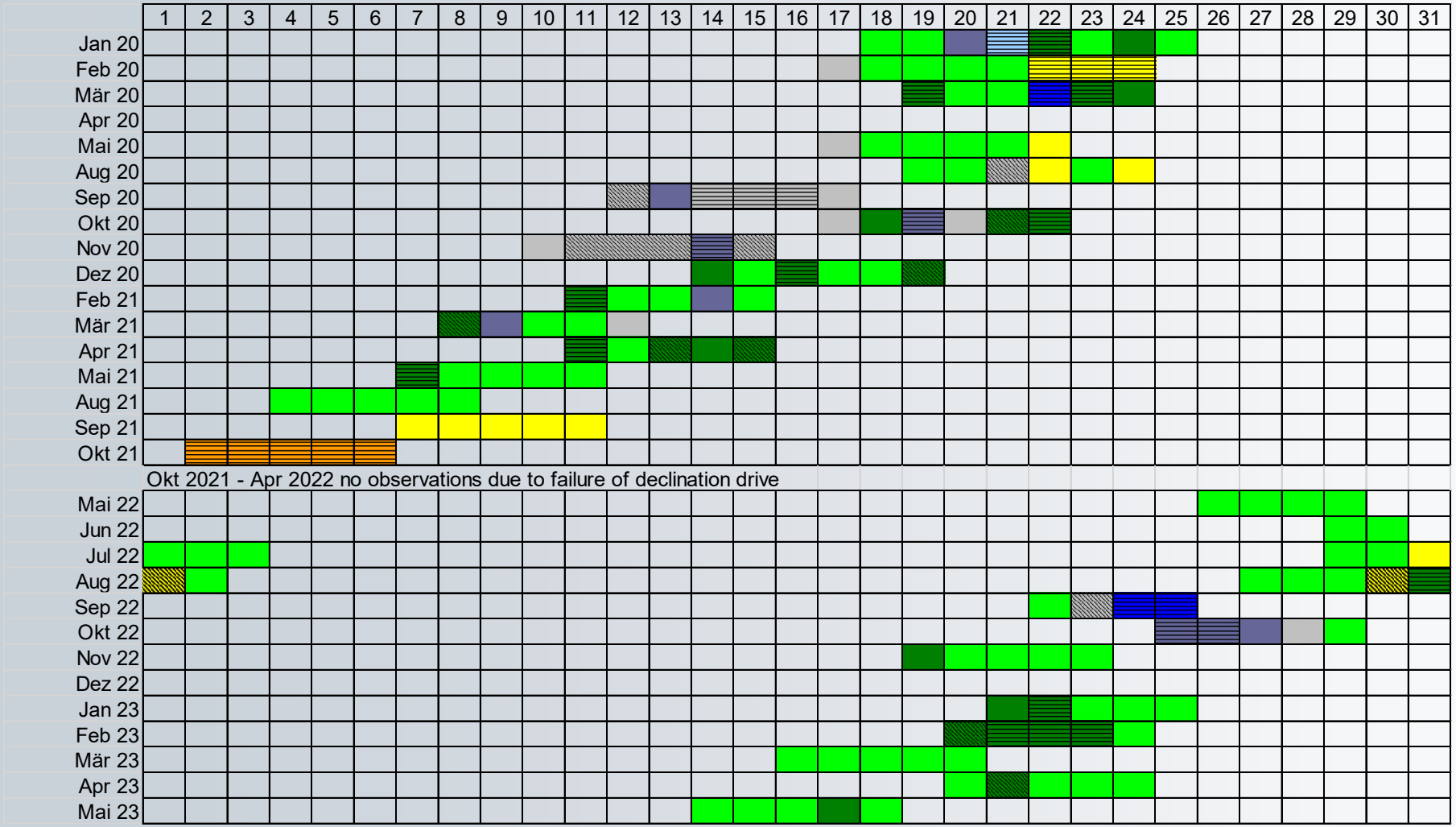
Swiss Optical Ground Station and Geodynamics Observatory Zimmerwald

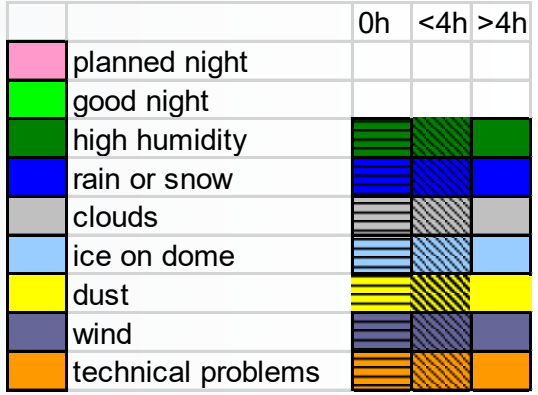


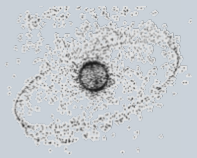
Observations

- 1m ESA Telescope Tenerife
  - 19–36 good nights per year (~25–45 scheduled)
    - GEO surveys (3–4 night campaigns at New Moon)
- 1m 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



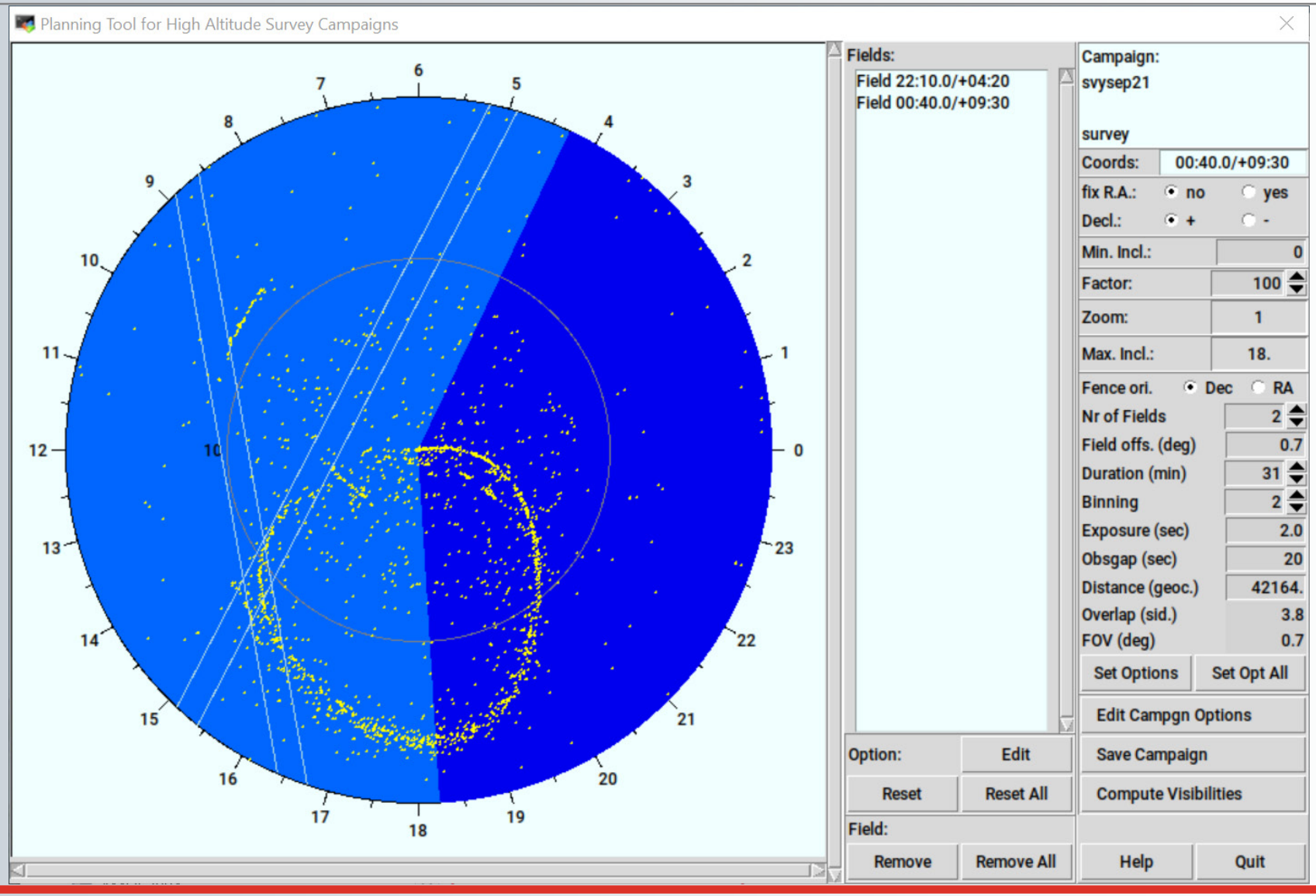




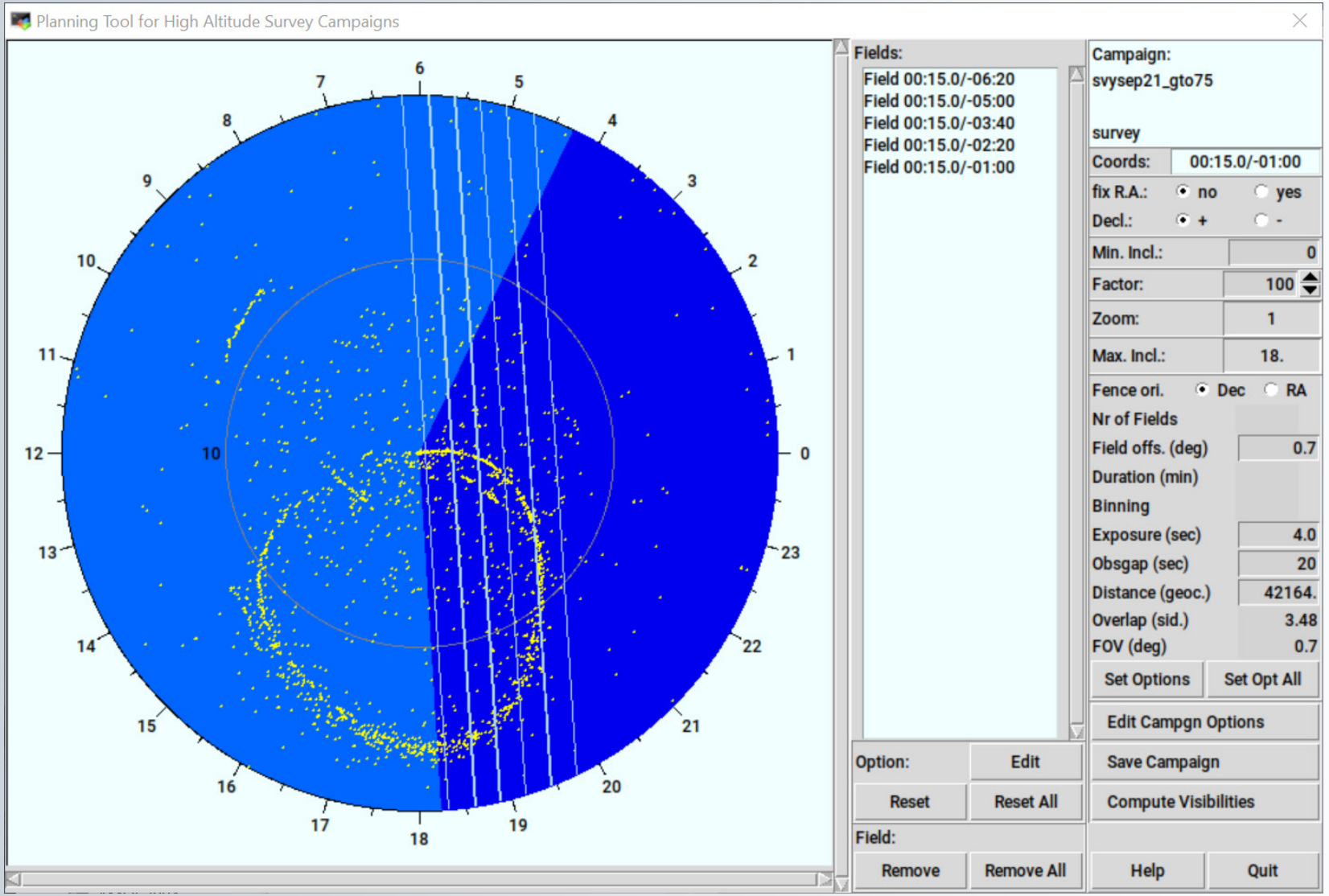
Planning, Data Acquisition, Processing

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

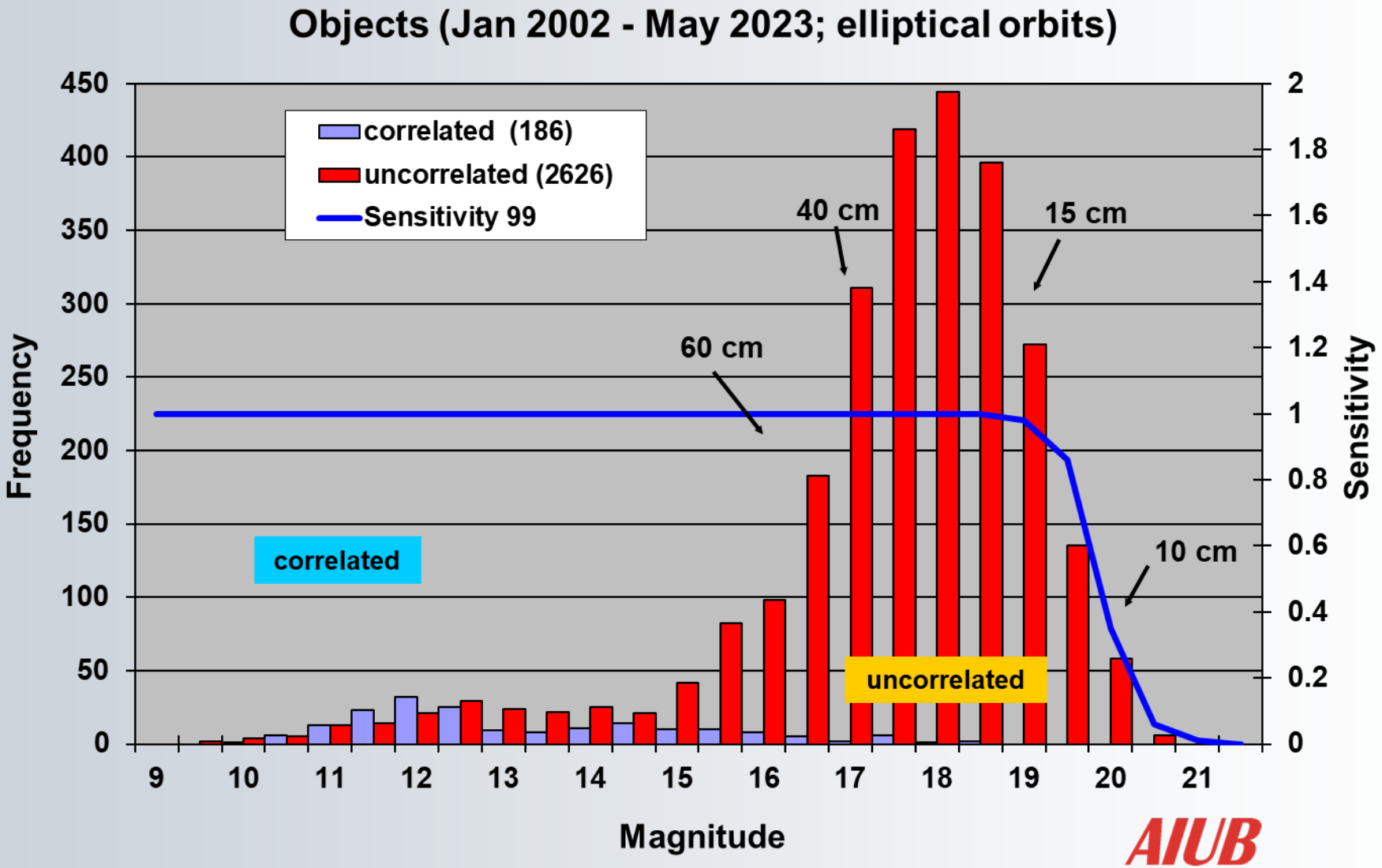
Planning of Survey Fields



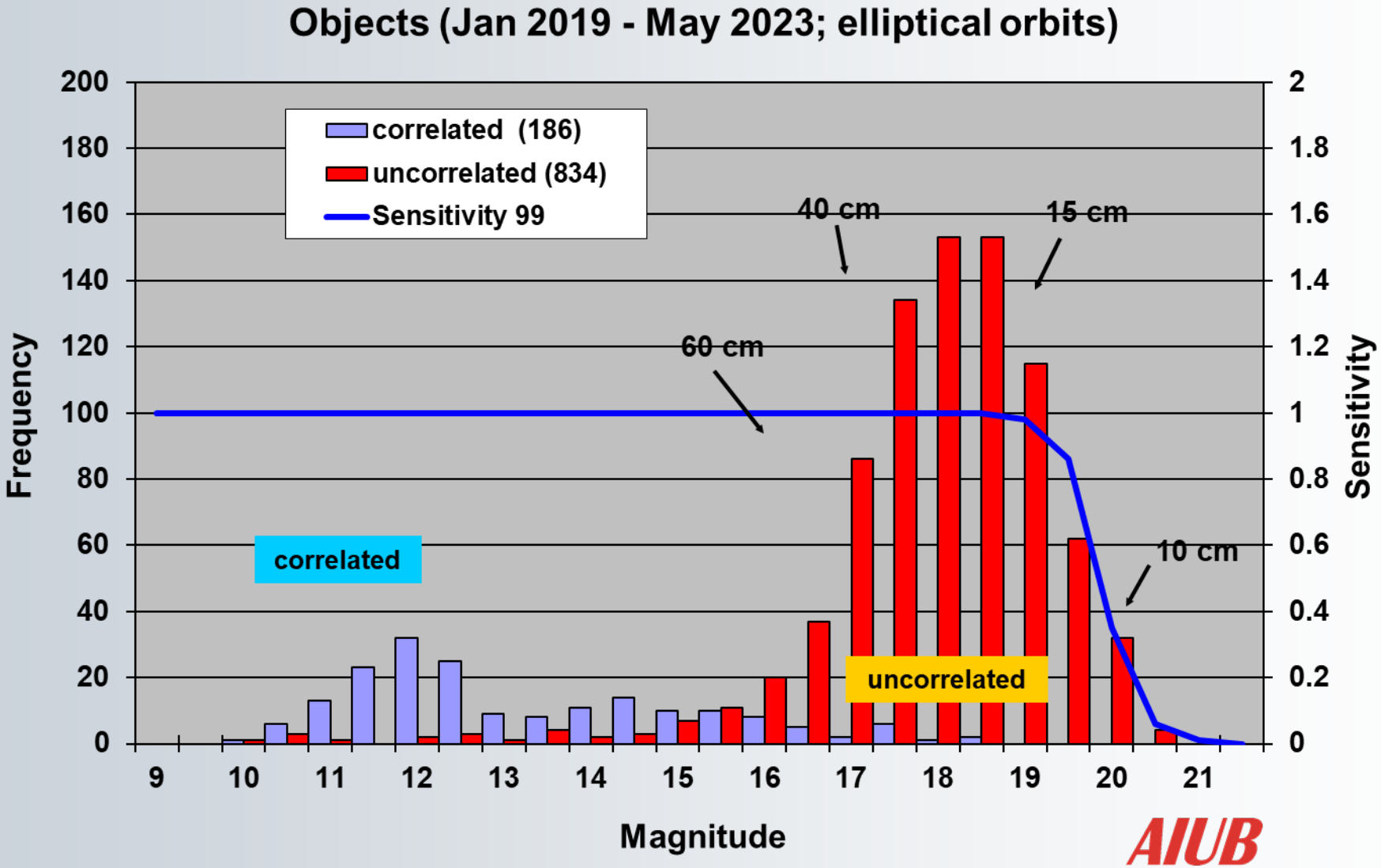
Planning of Survey Fields



High-Altitude Surveys GEO/GTO



High-Altitude Surveys 2019-2023



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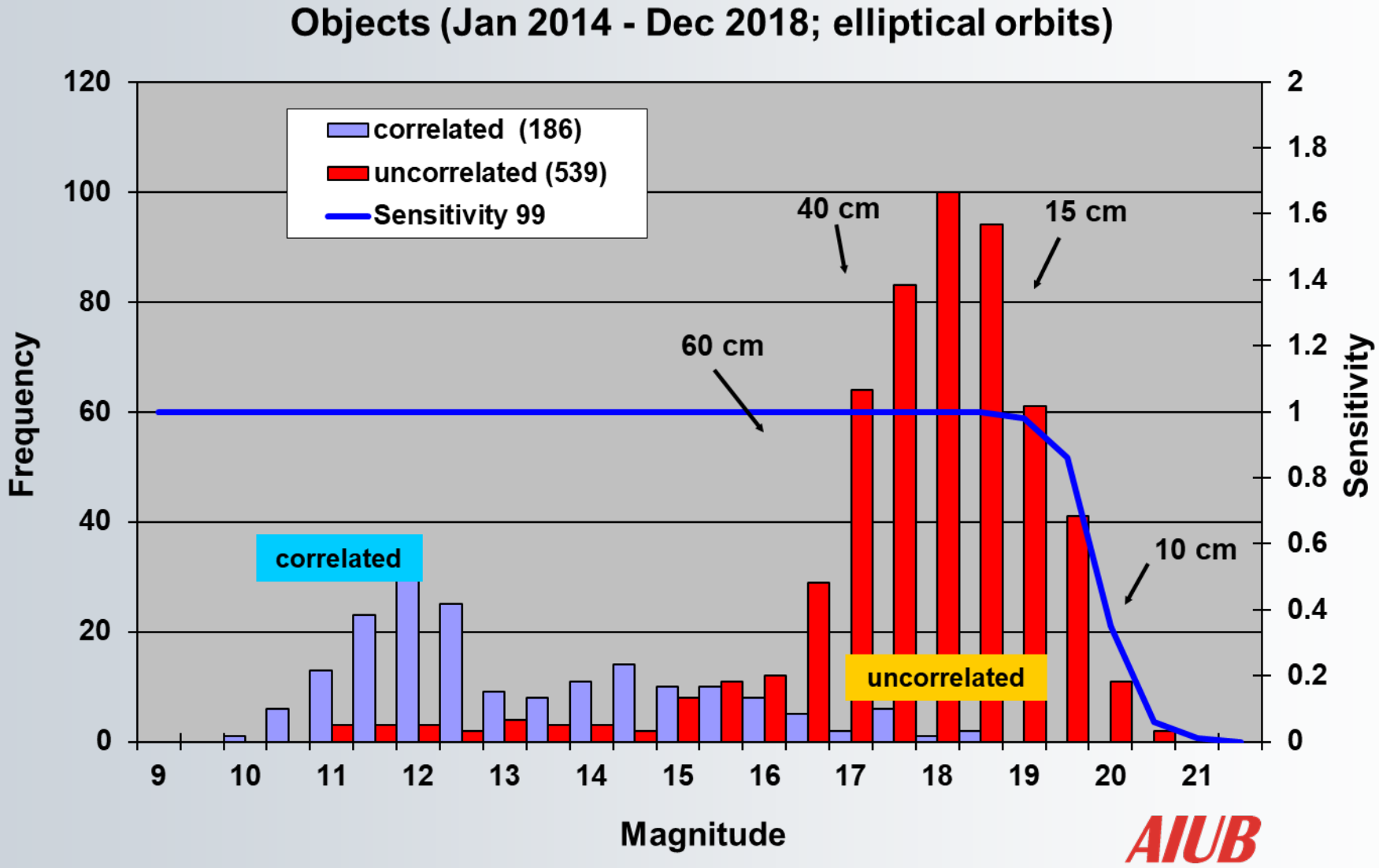
High-Altitude Surveys 2014-2018



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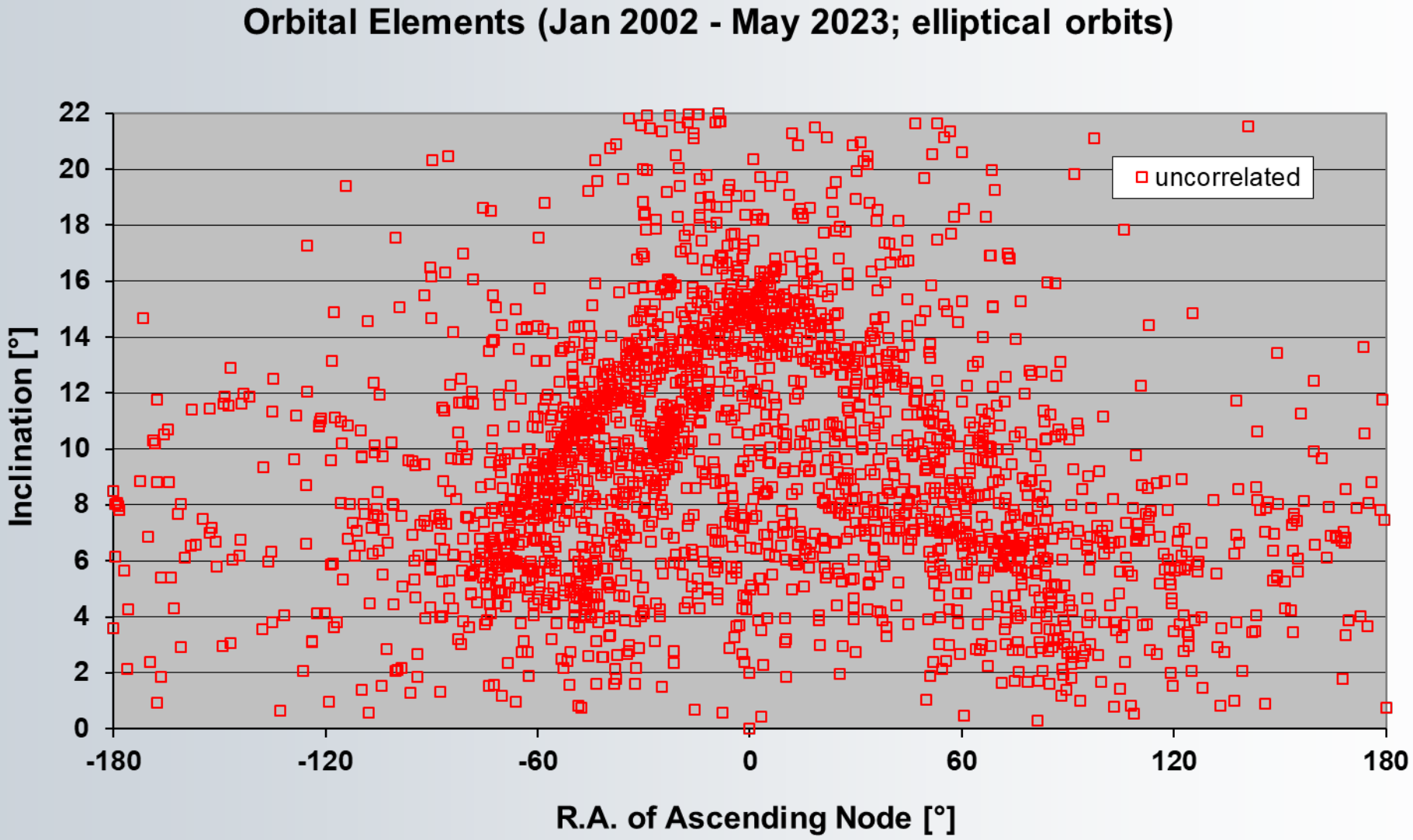
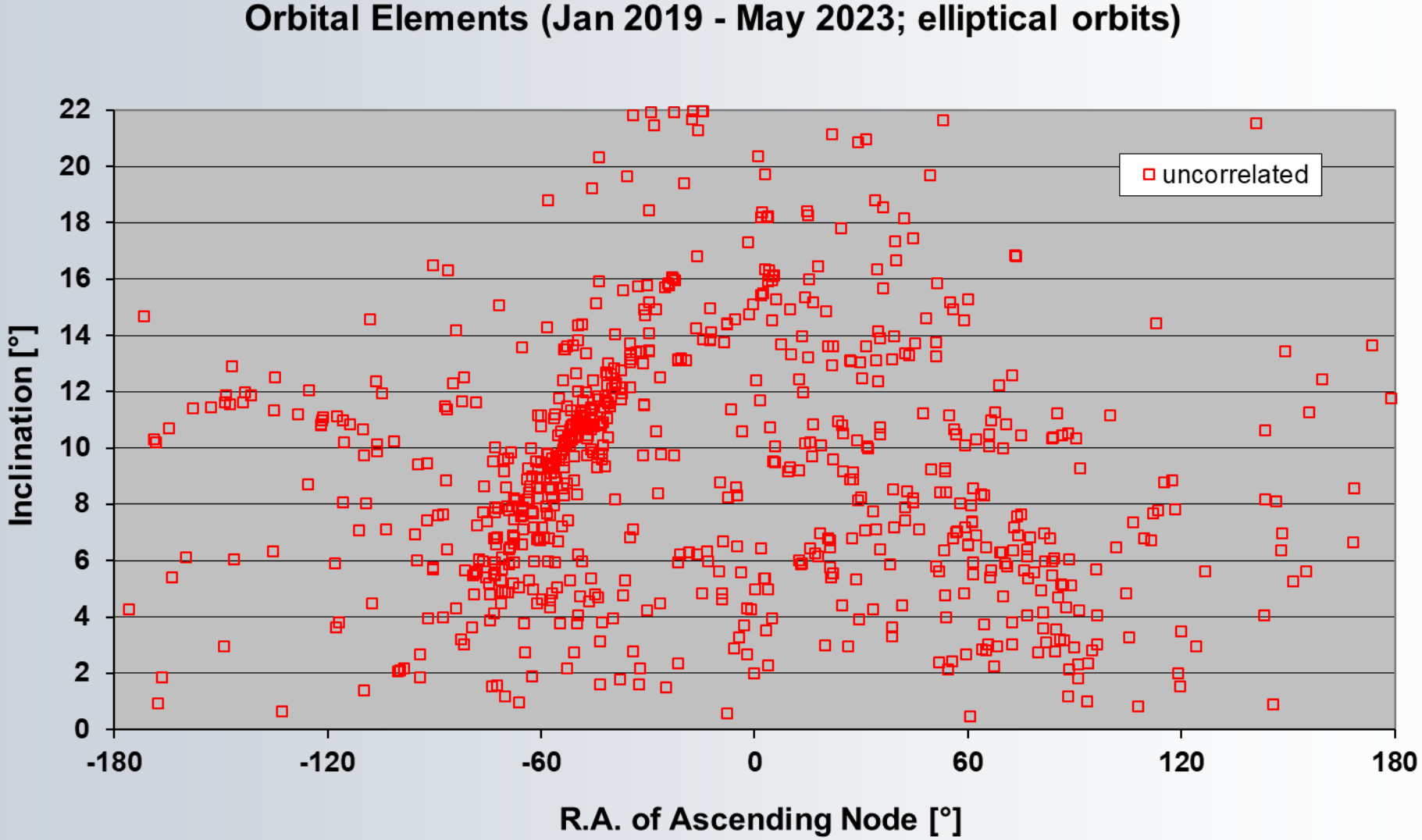
High-Altitude Surveys GEO/GTO



High-Altitude Surveys 2019-2023



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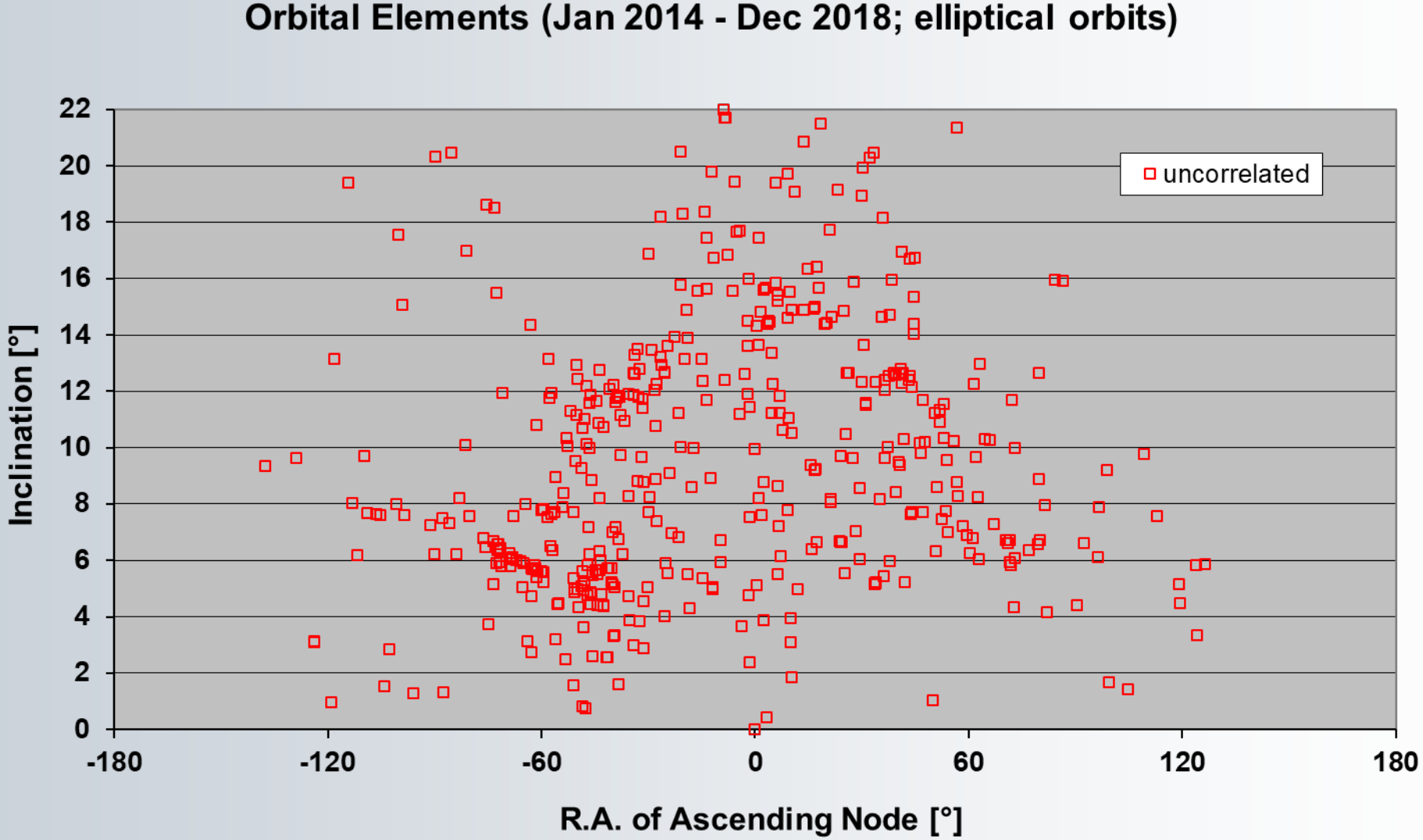

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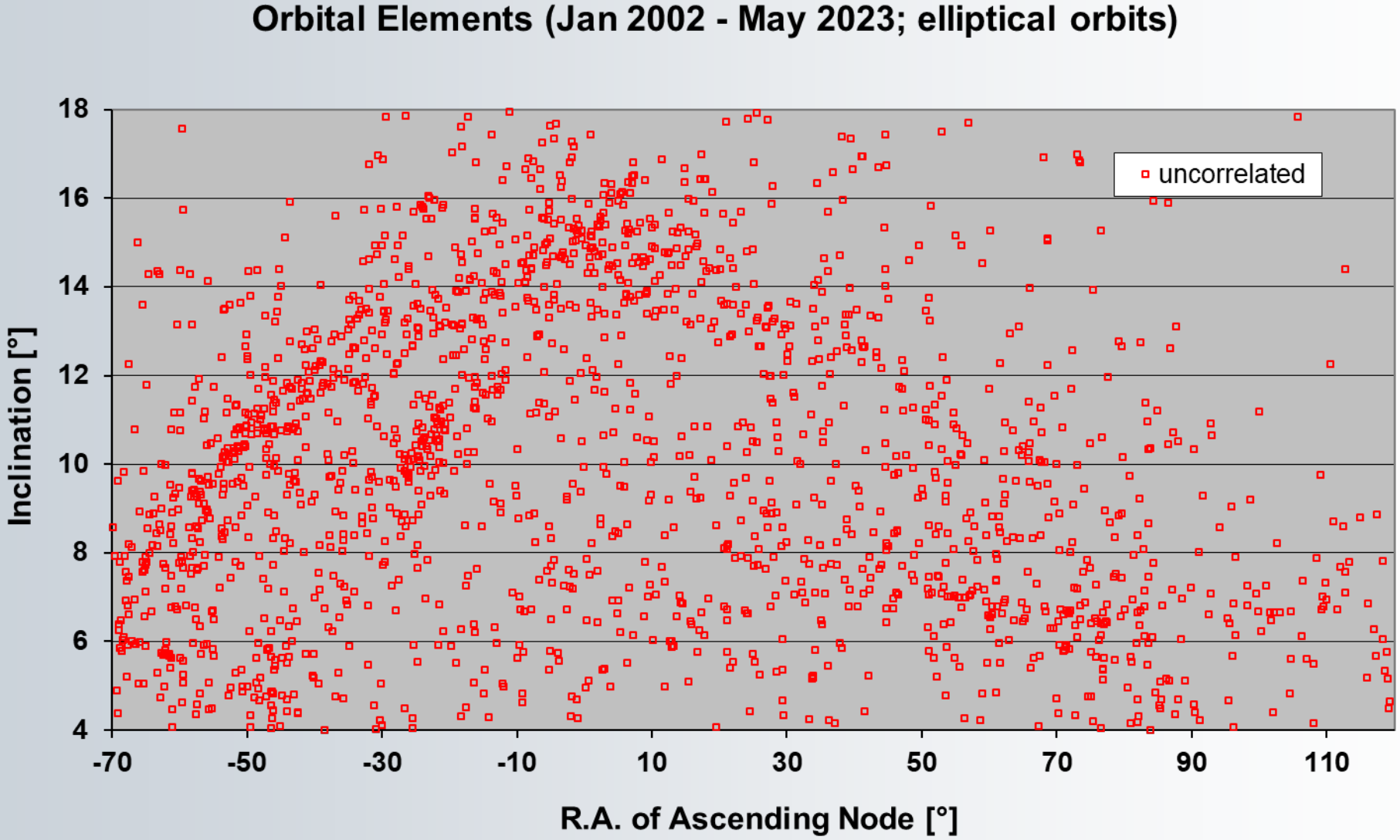
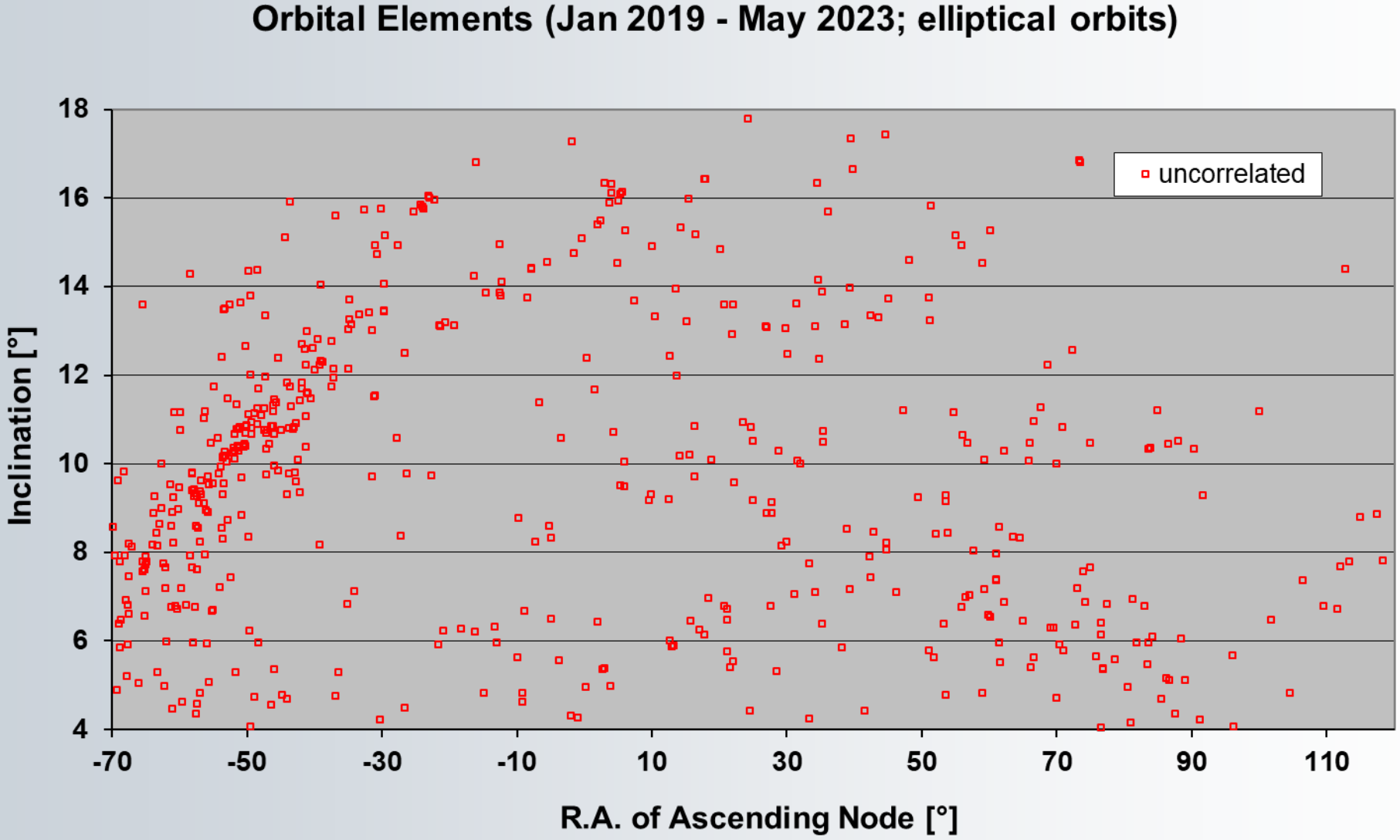
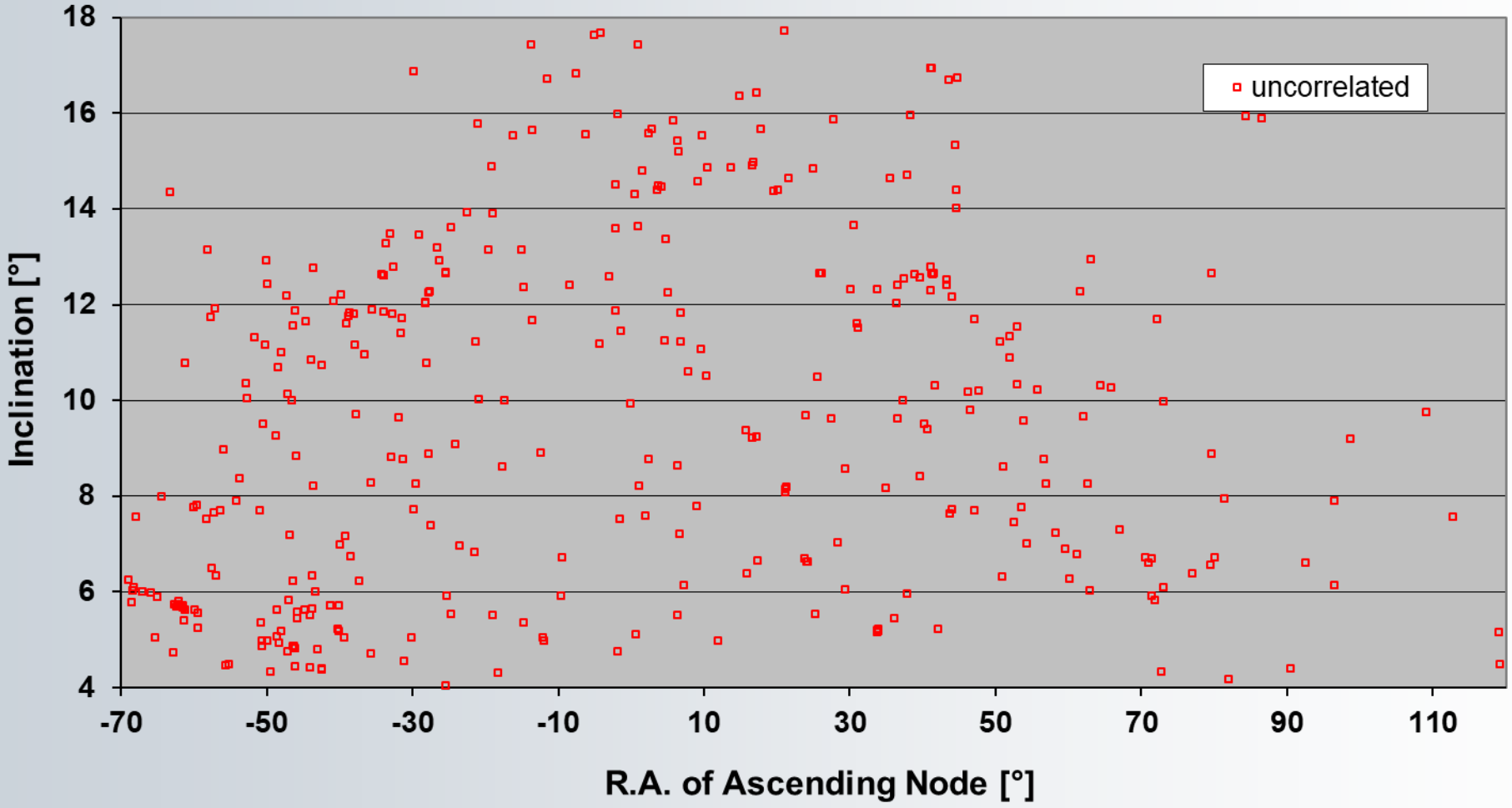


High-Altitude Surveys 2019-2023



High-Altitude Surveys 2014-2018



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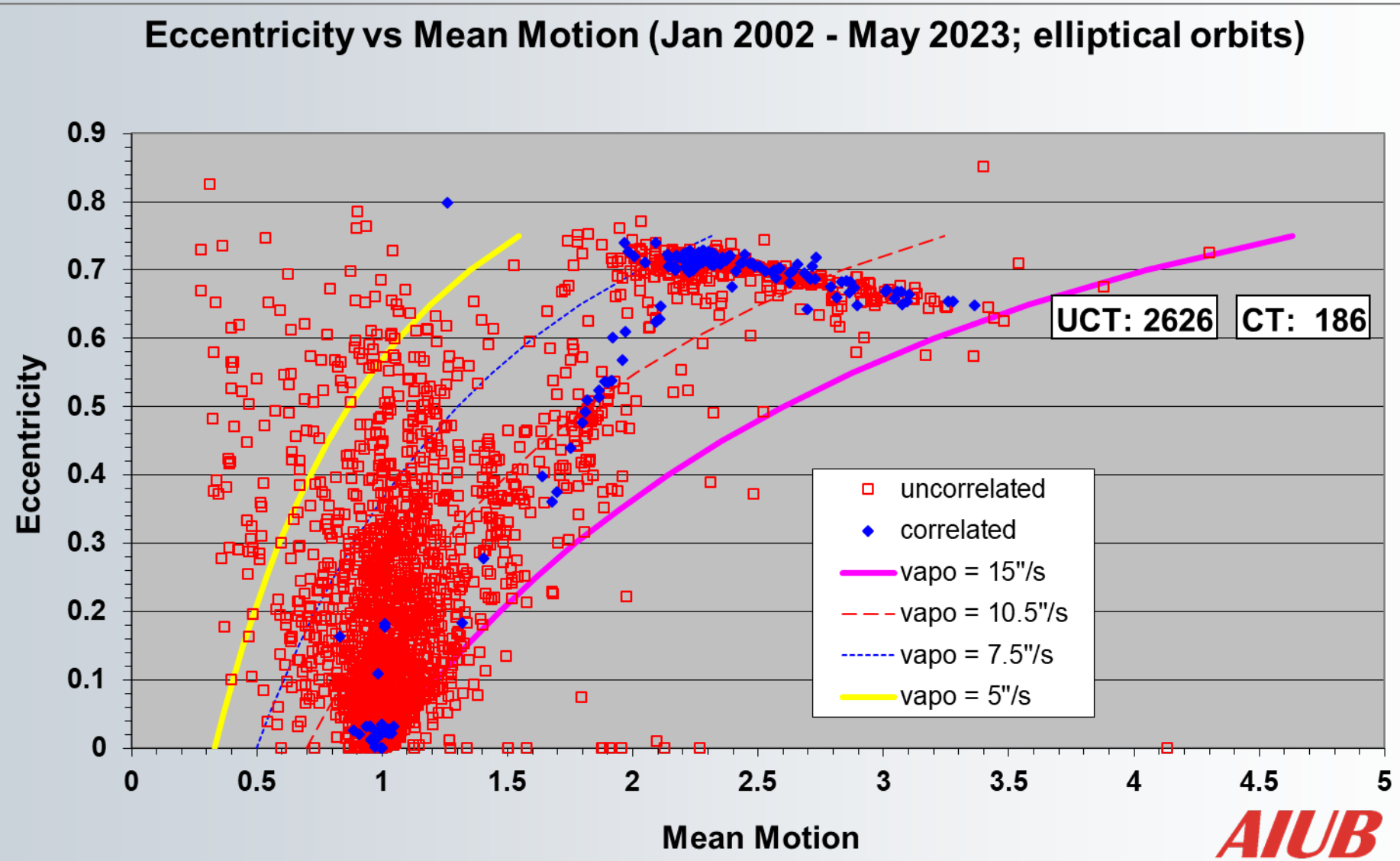

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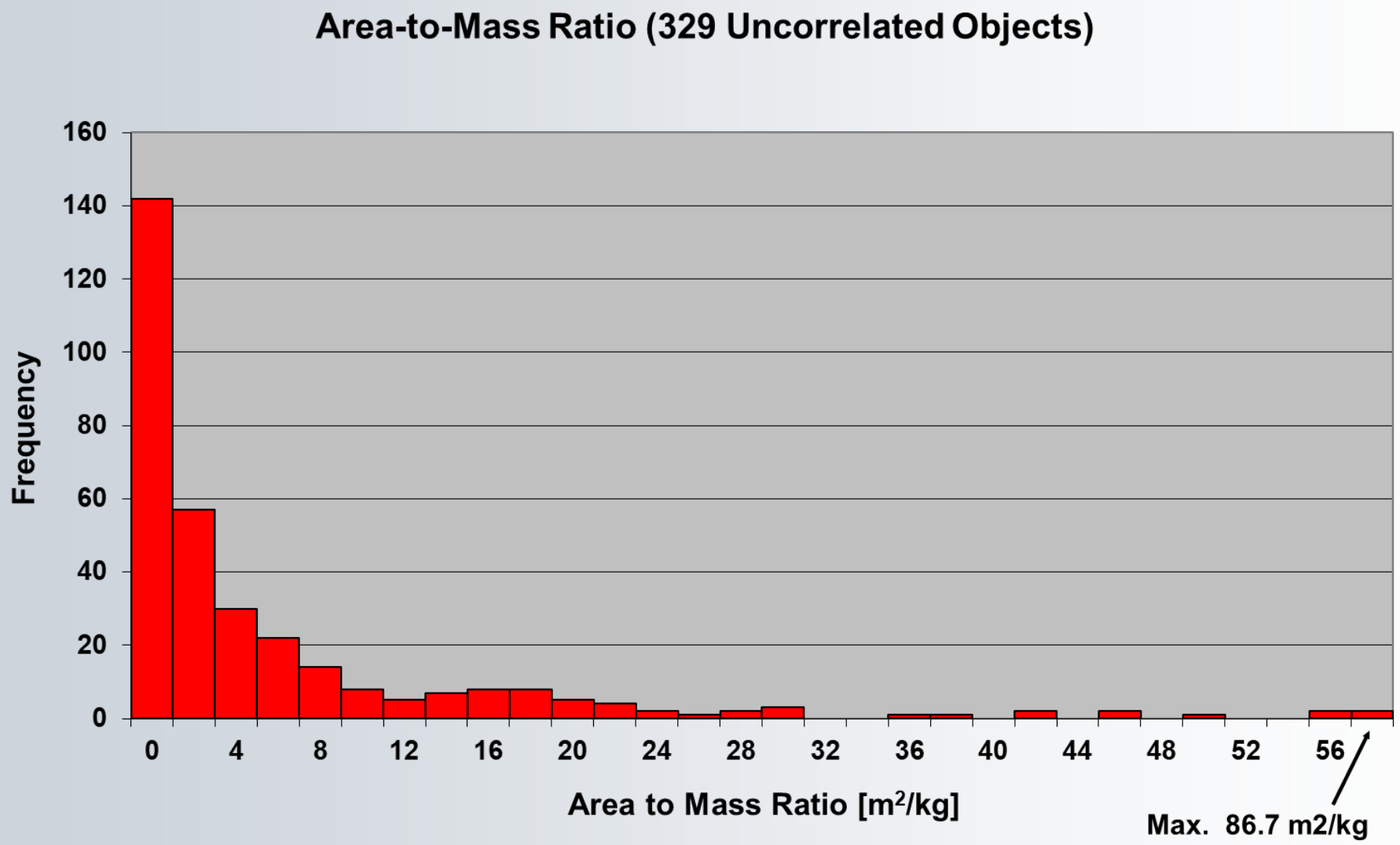

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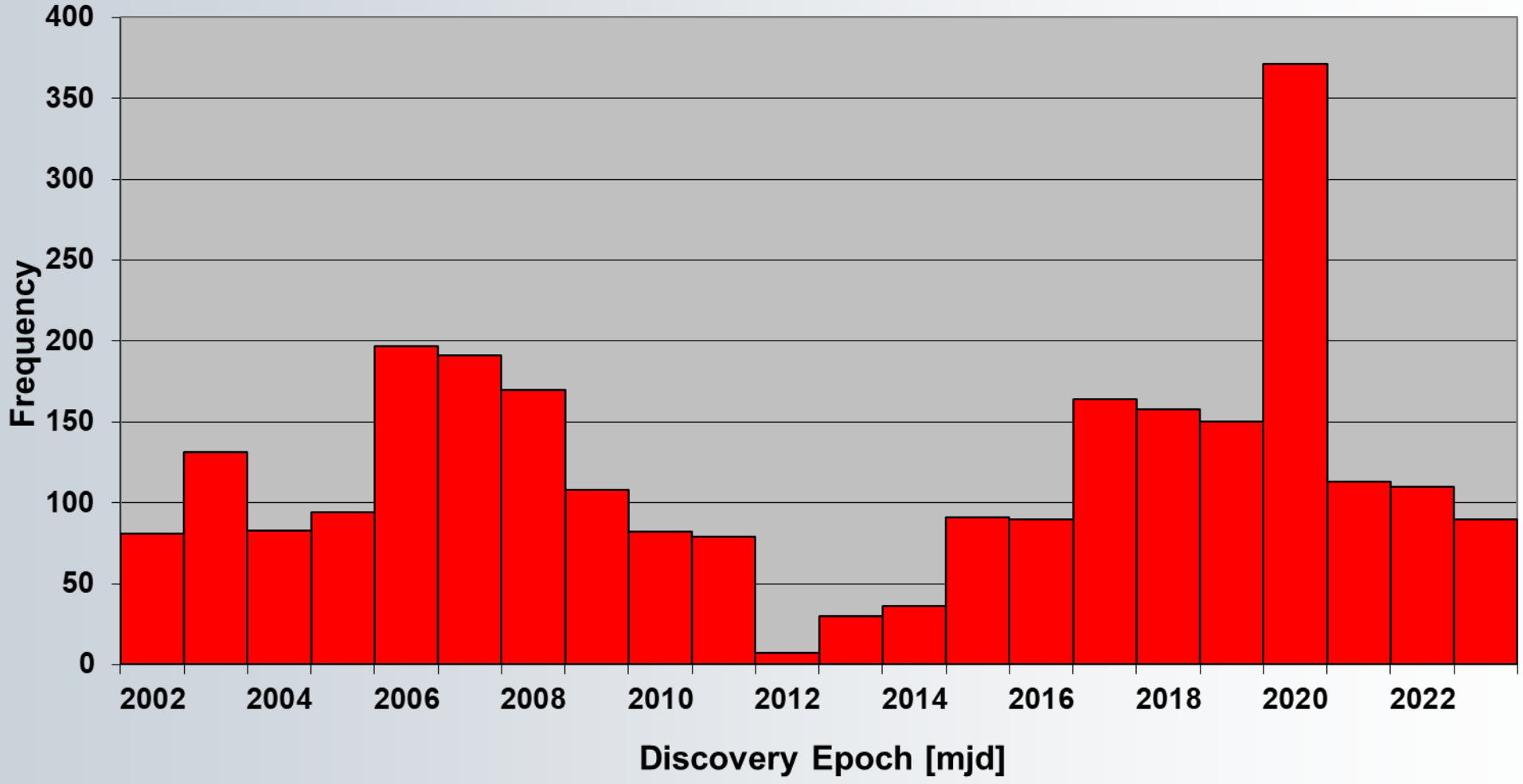

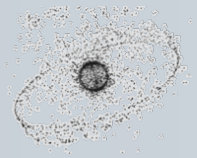

Summary – Lessons Learned

- 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!