

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

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Germany*

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

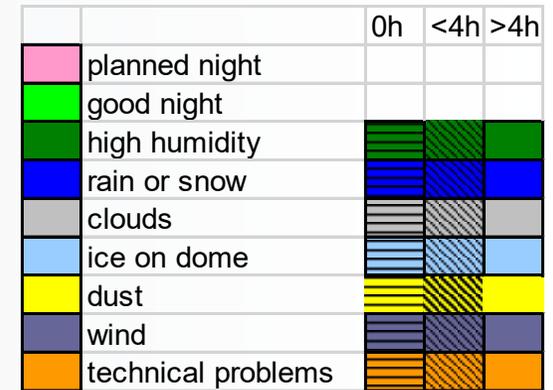
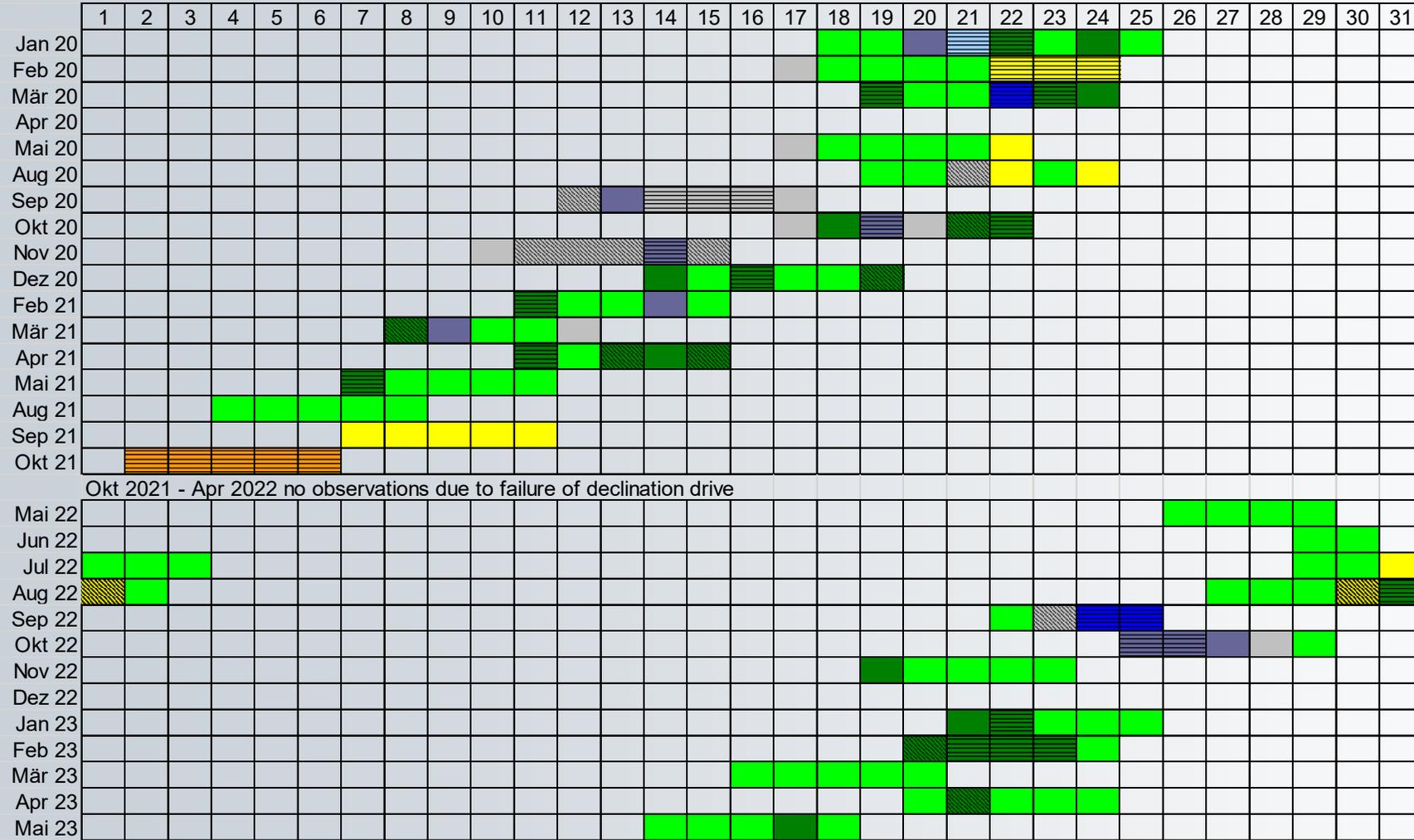


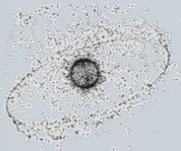
Observations

- **1 m ESA Telescope Tenerife**
 - 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)



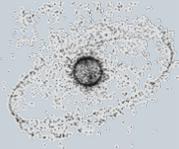
OGS Observations





Planning, Data Acquisition, Processing

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



Planning of Survey Fields

Planning Tool for High Altitude Survey Campaigns

Fields:
Field 22:10.0/+04:20
Field 00:40.0/+09:30

Campaign:
svysep21

survey

Coords: 00:40.0/+09:30

fix R.A.: no yes

Decl.: + -

Min. Incl.: 0

Factor: 100

Zoom: 1

Max. Incl.: 18.

Fence ori. Dec RA

Nr of Fields: 2

Field offs. (deg): 0.7

Duration (min): 31

Binning: 2

Exposure (sec): 2.0

Obsgap (sec): 20

Distance (geoc.): 42164.

Overlap (sid.): 3.8

FOV (deg): 0.7

Set Options Set Opt All

Edit Campgn Options

Save Campaign

Compute Visibilities

Option: Edit

Reset Reset All

Field: Remove Remove All

Help Quit



Planning of Survey Fields

Planning Tool for High Altitude Survey Campaigns

Fields:

- Field 00:15.0/-06:20
- Field 00:15.0/-05:00
- Field 00:15.0/-03:40
- Field 00:15.0/-02:20
- Field 00:15.0/-01:00

Campaign: svysep21_gto75

survey

Coords: 00:15.0/-01:00

fix R.A.: no yes

Decl.: + -

Min. Incl.: 0

Factor: 100

Zoom: 1

Max. Incl.: 18.

Fence ori. Dec RA

Nr of Fields

Field offs. (deg) 0.7

Duration (min)

Binning

Exposure (sec) 4.0

Obsgap (sec) 20

Distance (geoc.) 42164.

Overlap (sid.) 3.48

FOV (deg) 0.7

Set Options Set Opt All

Edit Campgn Options

Save Campaign

Compute Visibilities

Option: Edit

Reset Reset All

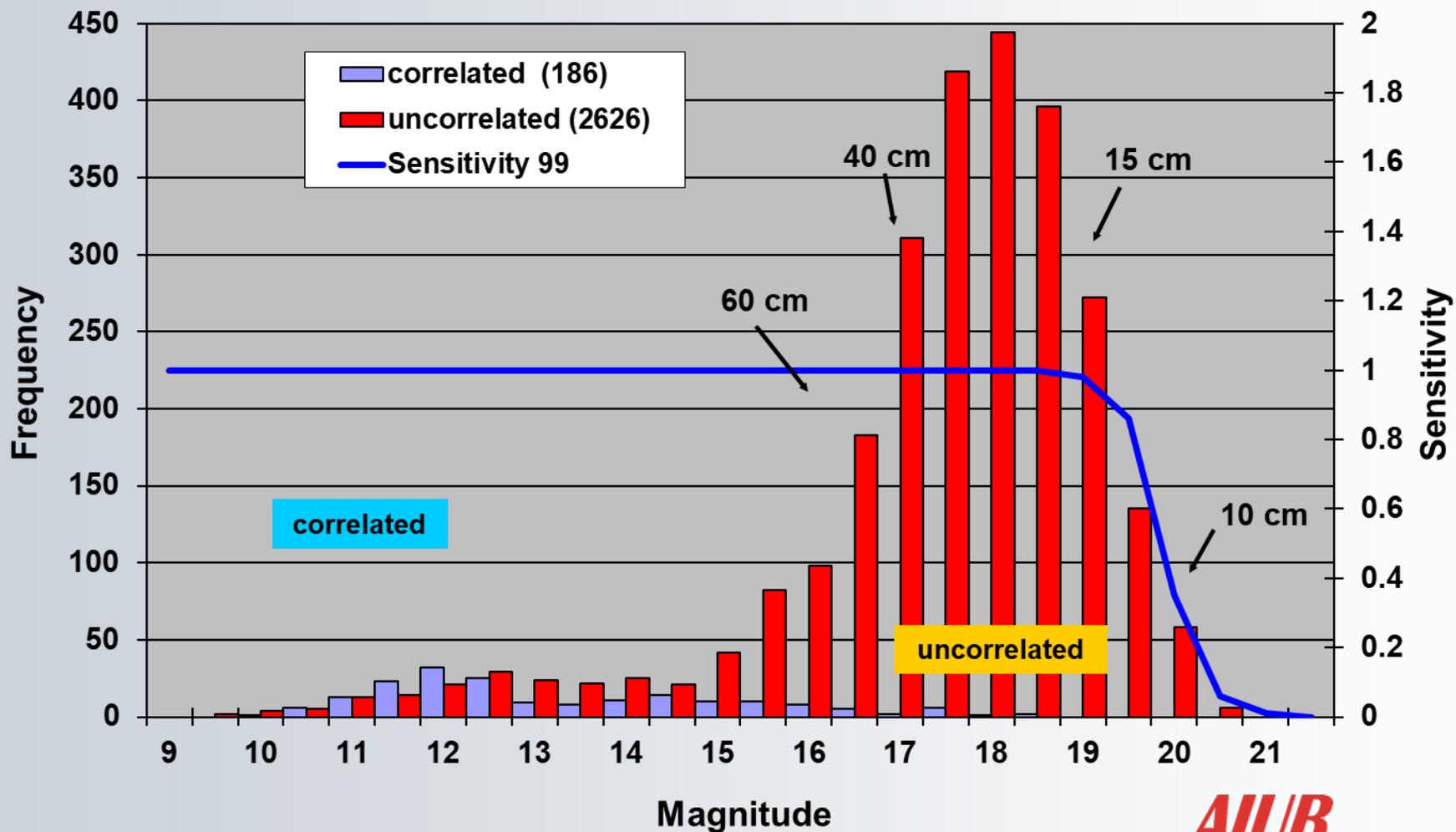
Field: Remove Remove All

Help Quit



High-Altitude Surveys GEO/GTO

Objects (Jan 2002 - May 2023; elliptical orbits)

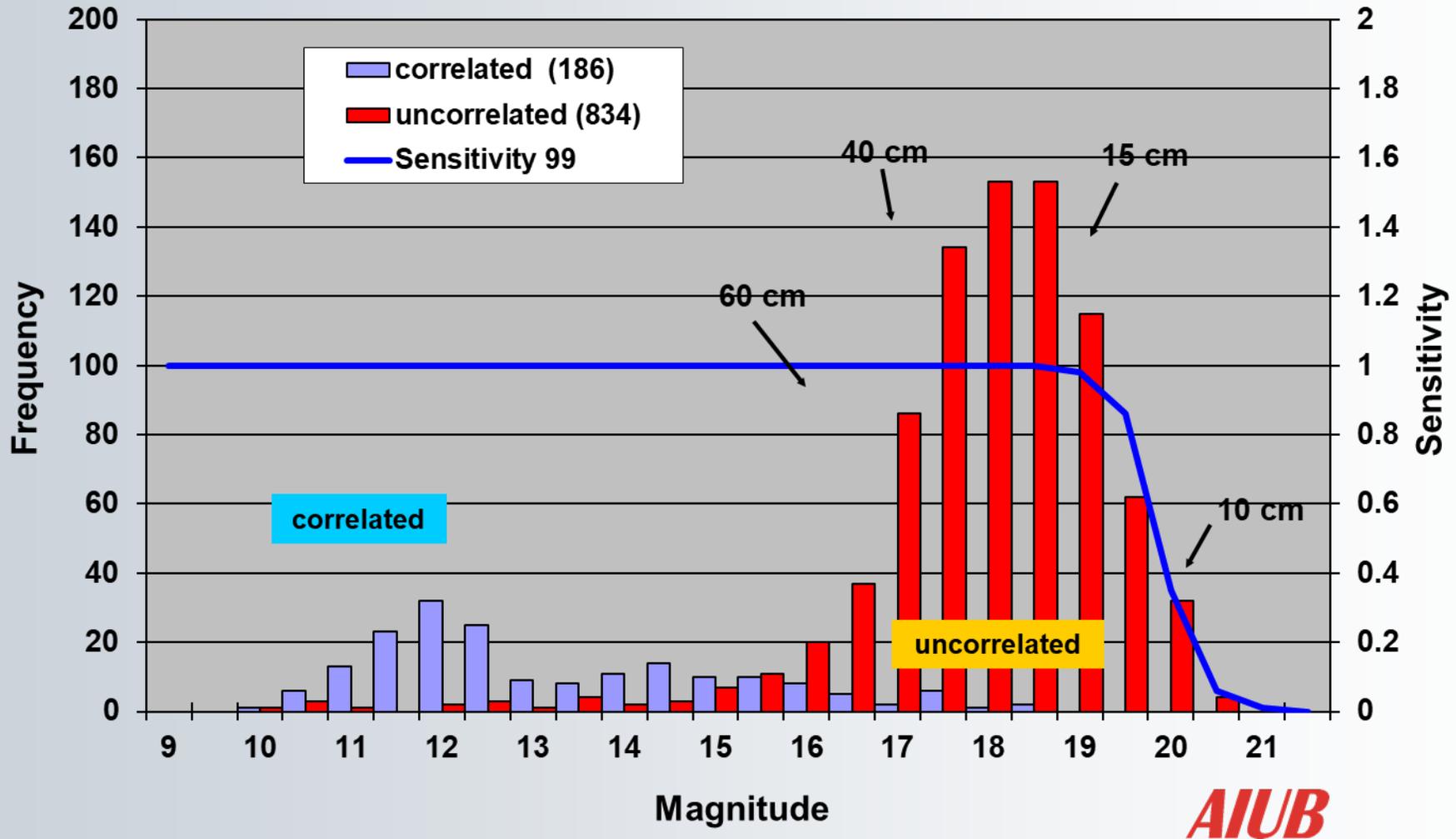


AIUB



High-Altitude Surveys 2019-2023

Objects (Jan 2019 - May 2023; elliptical orbits)

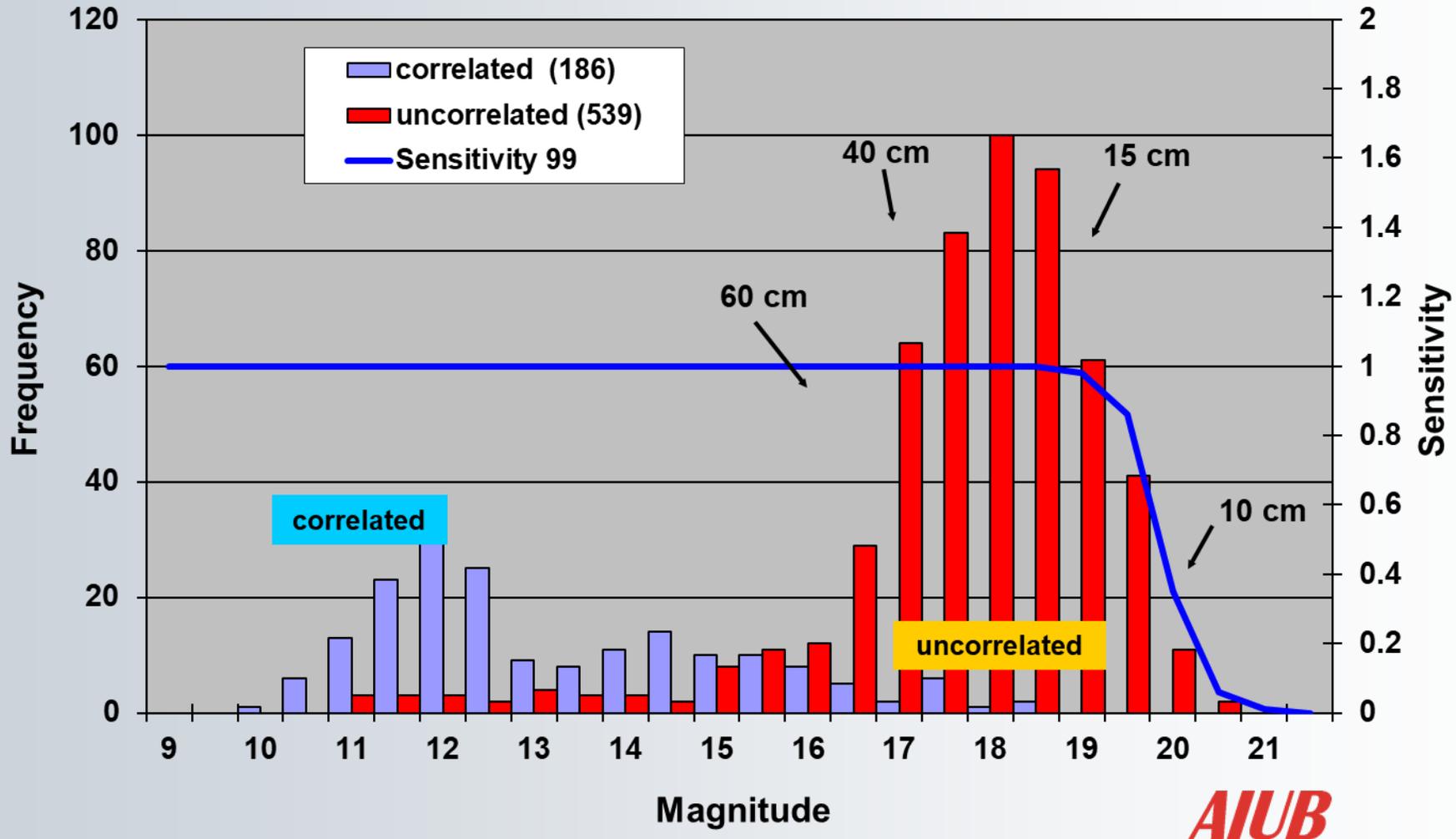


AIUB



High-Altitude Surveys 2014-2018

Objects (Jan 2014 - Dec 2018; elliptical orbits)

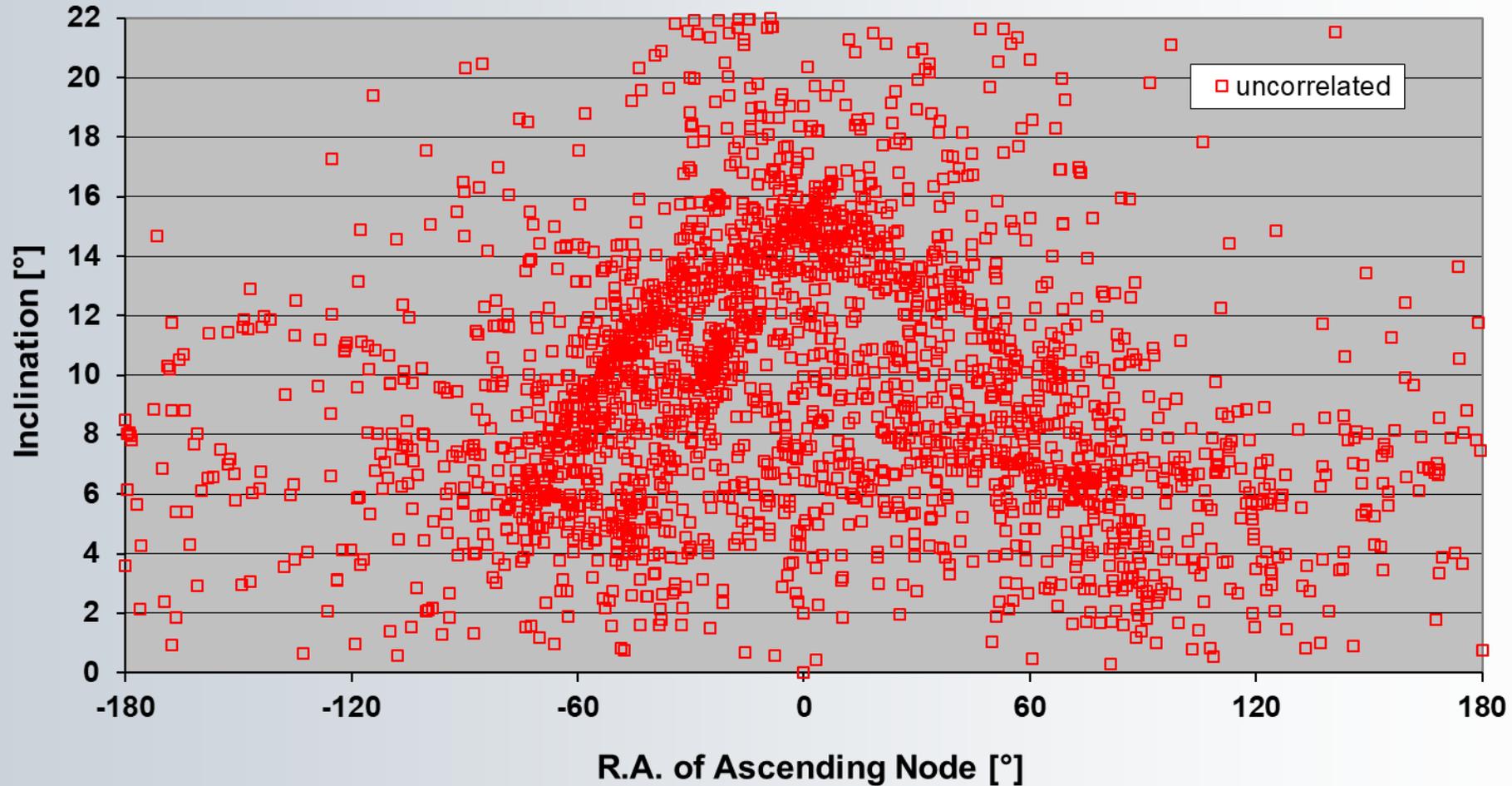


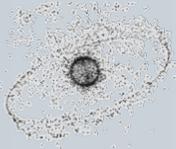
AIUB



High-Altitude Surveys GEO/GTO

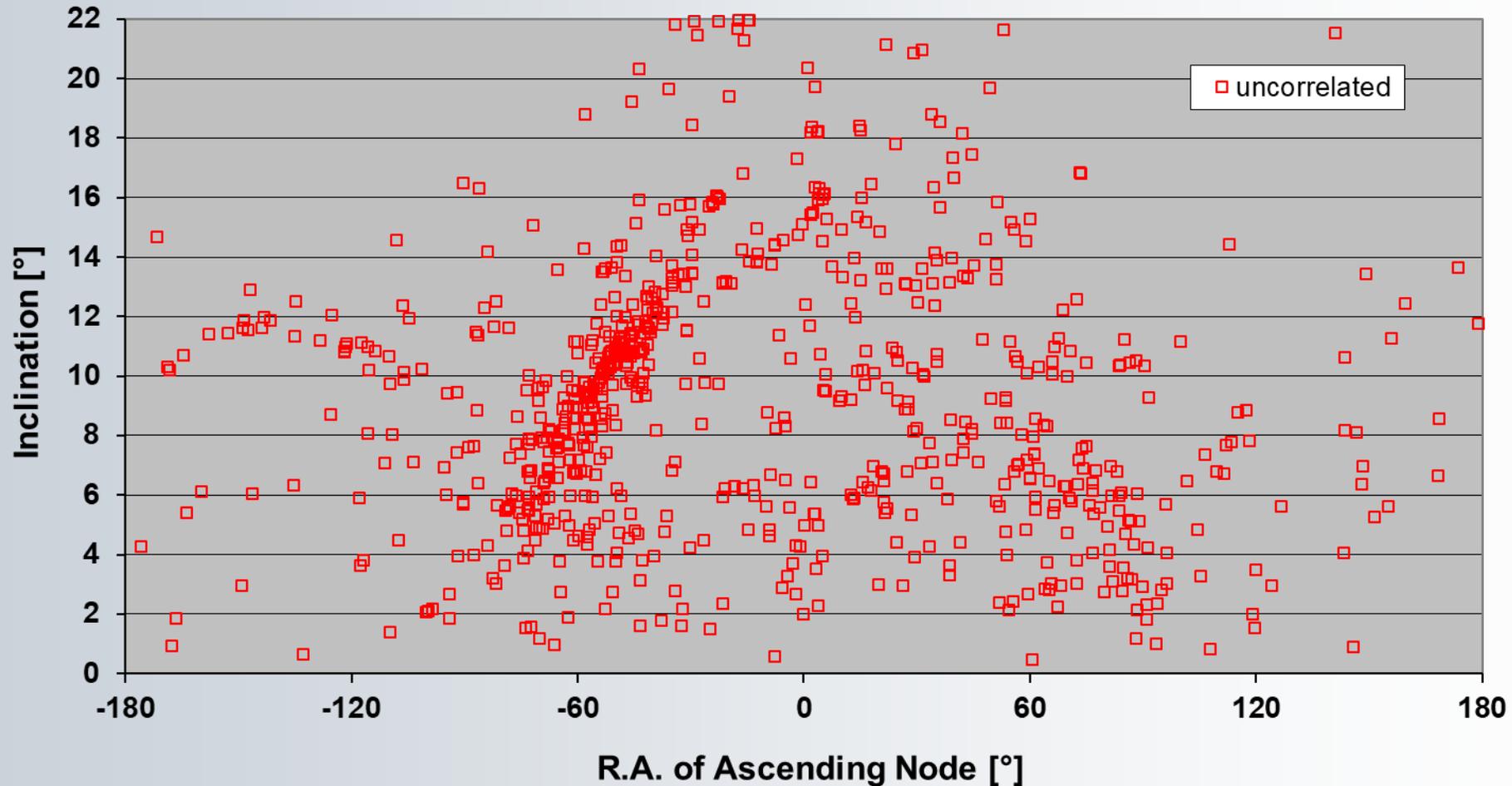
Orbital Elements (Jan 2002 - May 2023; elliptical orbits)





High-Altitude Surveys 2019-2023

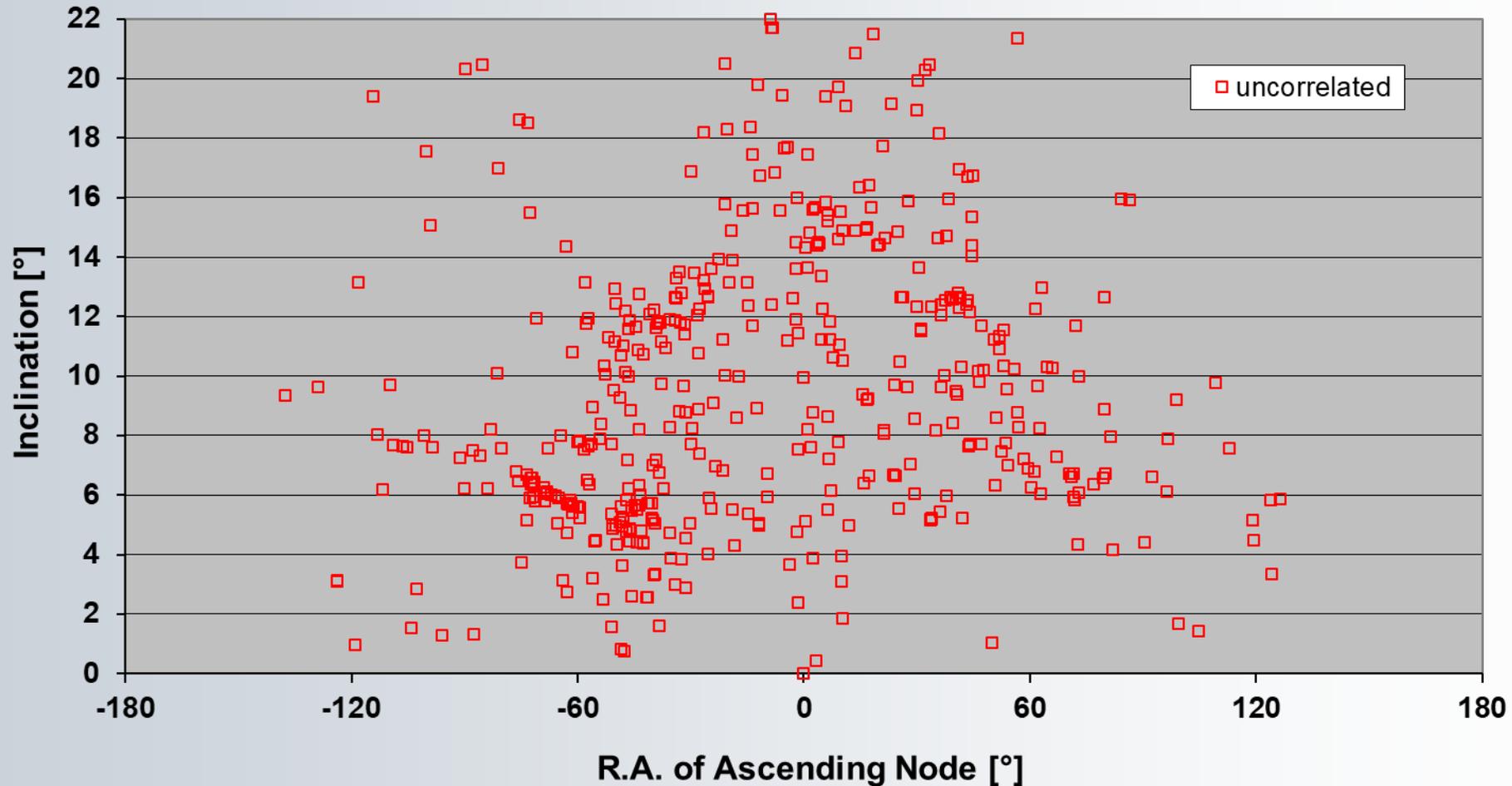
Orbital Elements (Jan 2019 - May 2023; elliptical orbits)





High-Altitude Surveys 2014–2018

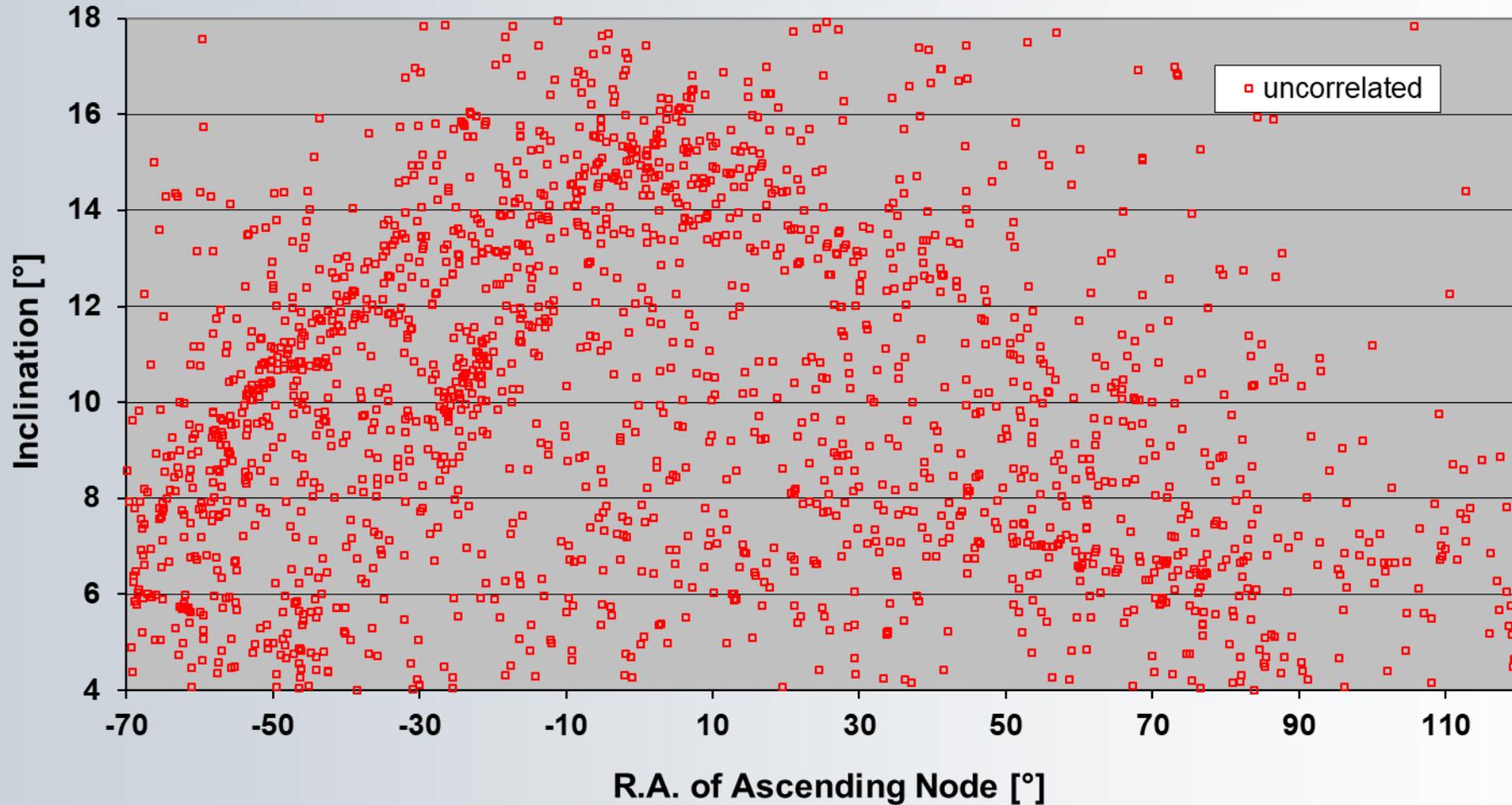
Orbital Elements (Jan 2014 - Dec 2018; elliptical orbits)





High-Altitude Surveys GEO/GTO

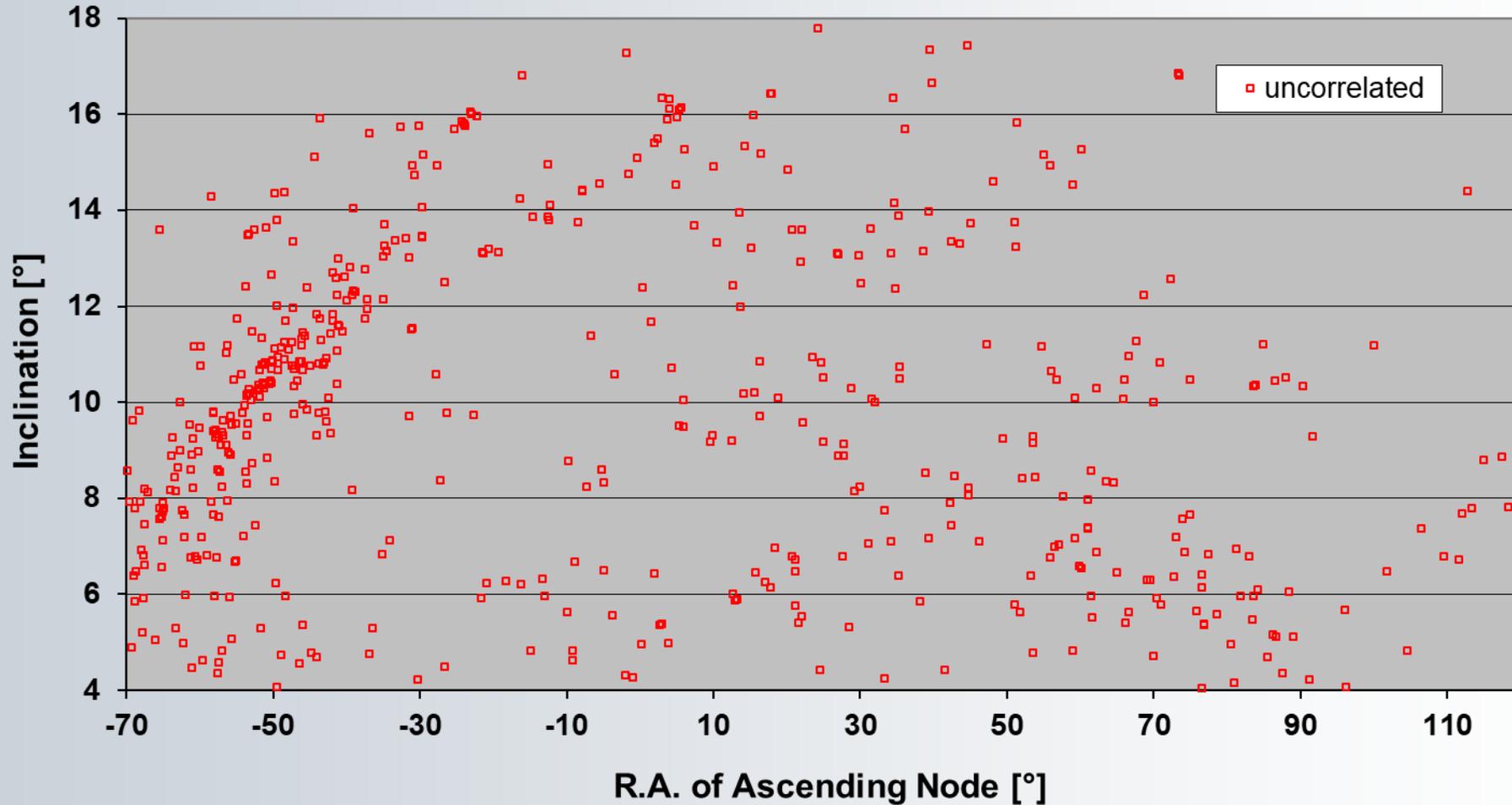
Orbital Elements (Jan 2002 - May 2023; elliptical orbits)





High-Altitude Surveys 2019–2023

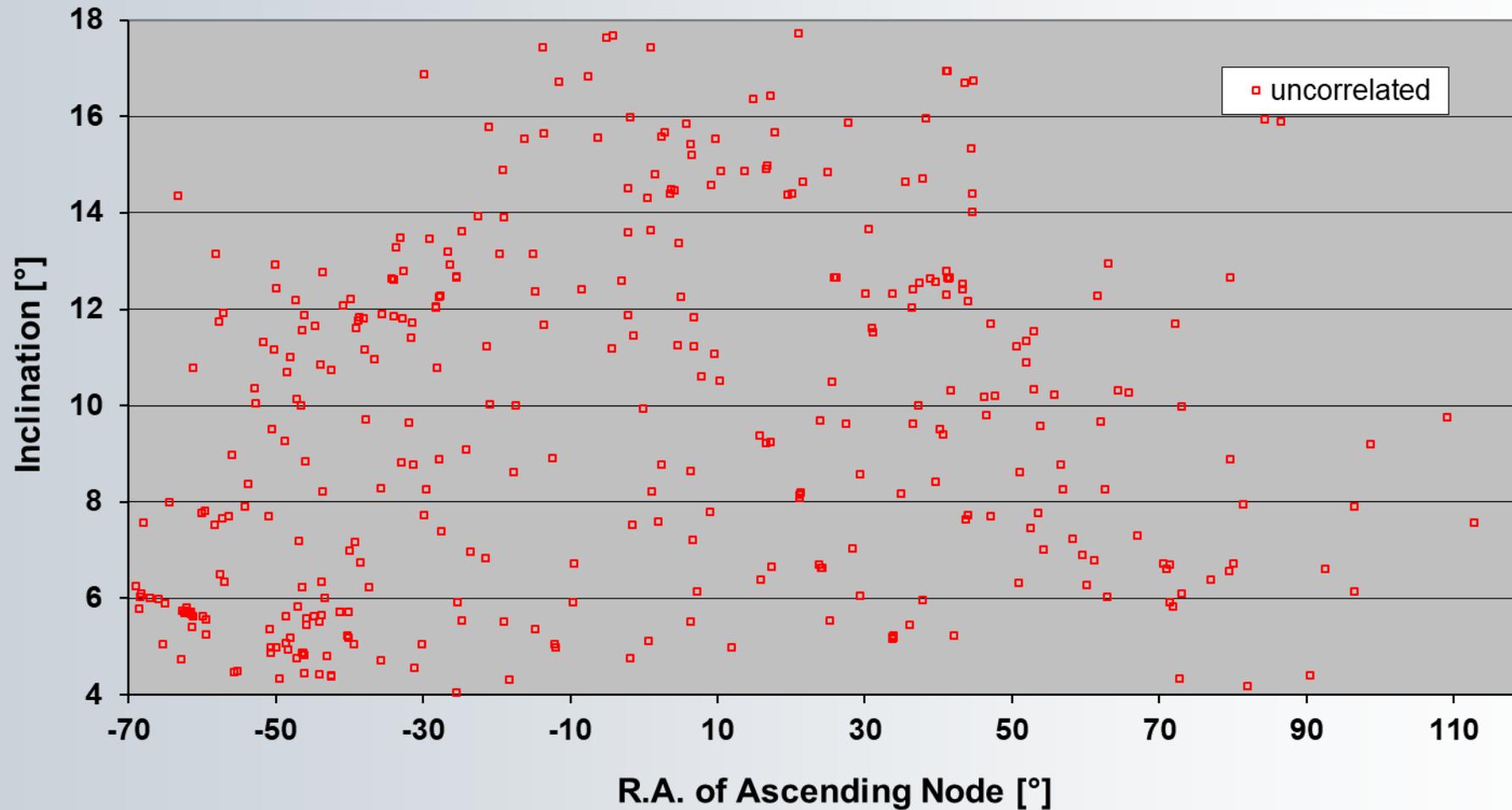
Orbital Elements (Jan 2019 - May 2023; elliptical orbits)

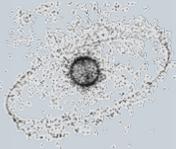




High-Altitude Surveys 2014–2018

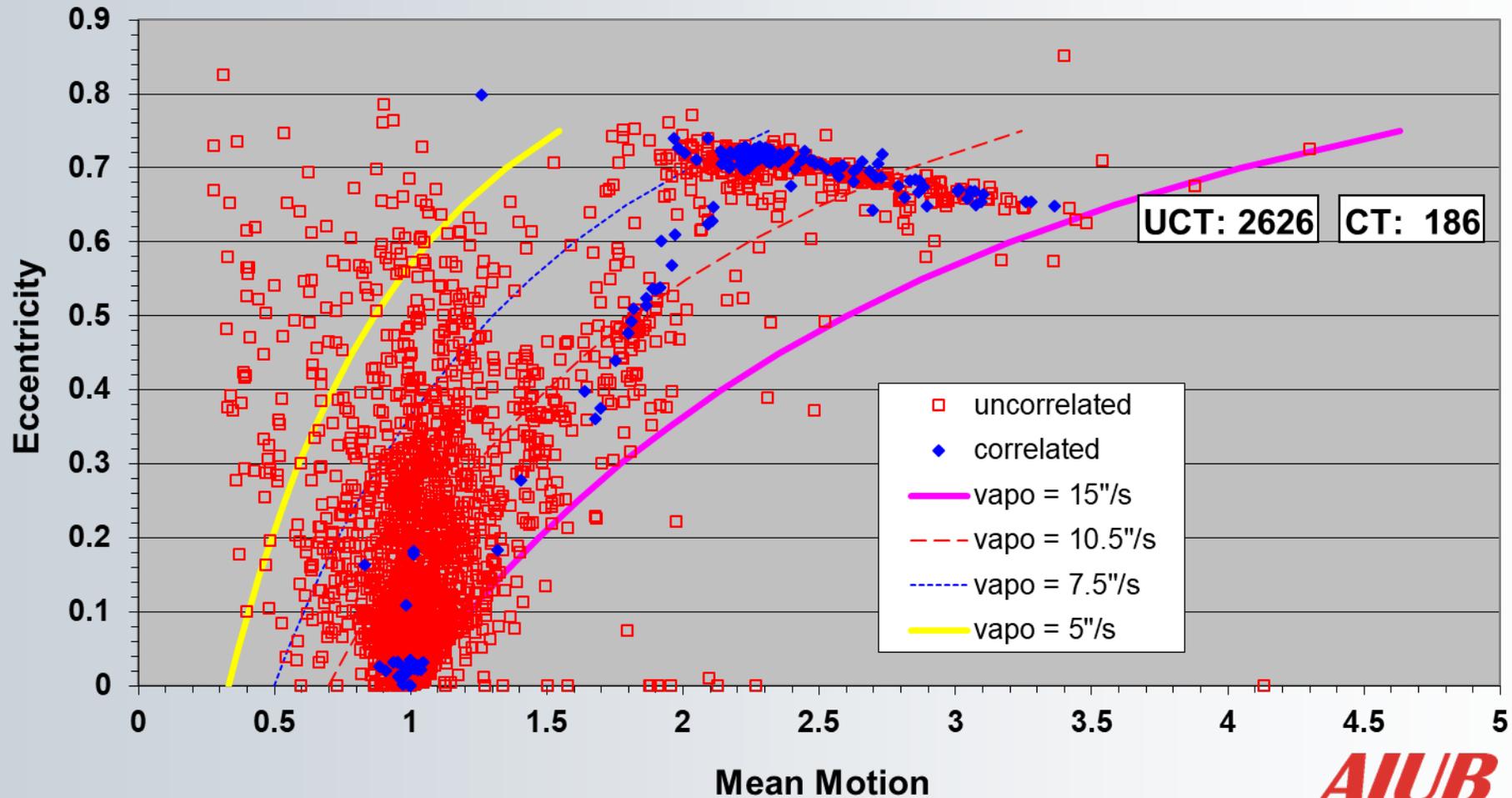
Orbital Elements (Jan 2014 - Dec 2018; elliptical orbits)





High-Altitude Surveys GEO/GTO

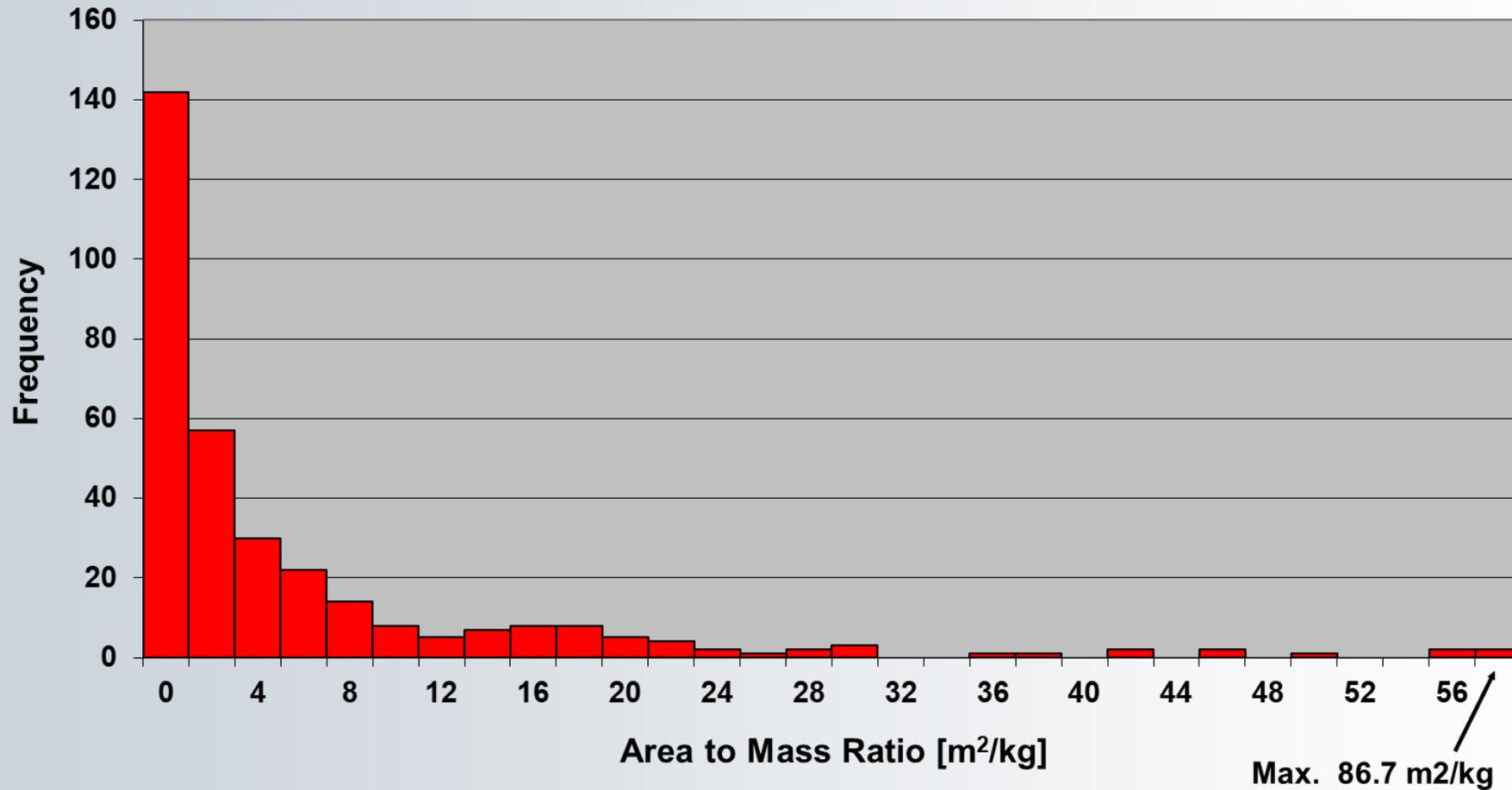
Eccentricity vs Mean Motion (Jan 2002 - May 2023; elliptical orbits)





High-Altitude Surveys GEO/GTO

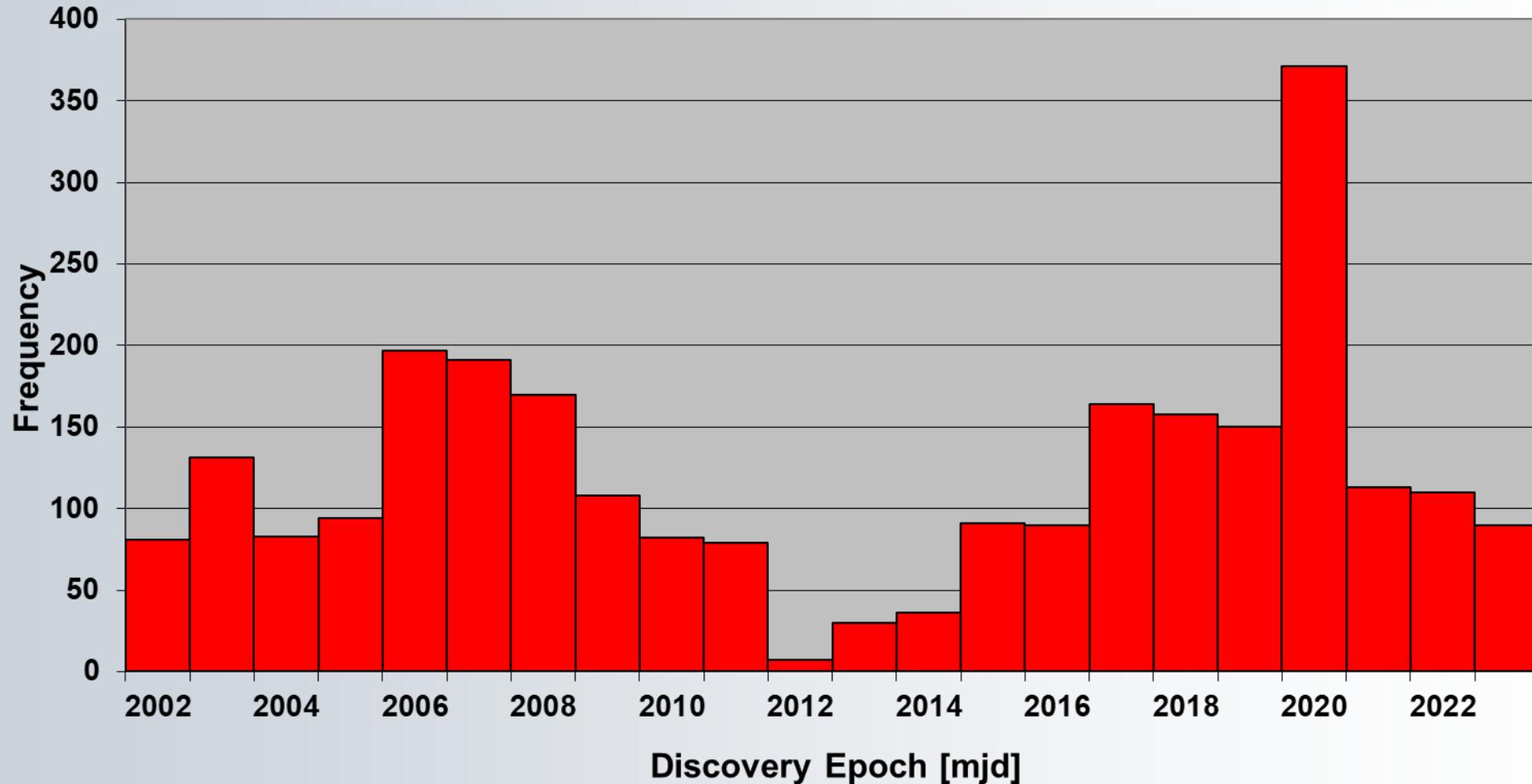
Area-to-Mass Ratio (329 Uncorrelated Objects)





High-Altitude Surveys GEO/GTO

Discovery Rate (Jan 2002 - May 2023; 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!**

