

30<sup>th</sup> IADC Meeting, May 22-25, 2012  
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# Updated results of 8 years of GEO region surveys

**Presentation of the Roscosmos delegation  
to the IADC WG1**

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# Instruments for GEO Surveys

- Typical 22 cm and 25 cm aperture telescopes  
FOV – from  $2.8^{\circ} \times 2.8^{\circ}$  to  $5.5^{\circ} \times 5.5^{\circ}$
- Facilities having survey instruments

Blagoveshchensk, Colleparado, Milkovo, Nauchny, Pulkovo, Tarija, Ussuriysk

- New instruments with 40 and 50 cm aperture

# ISON Monitored GEO Region Objects

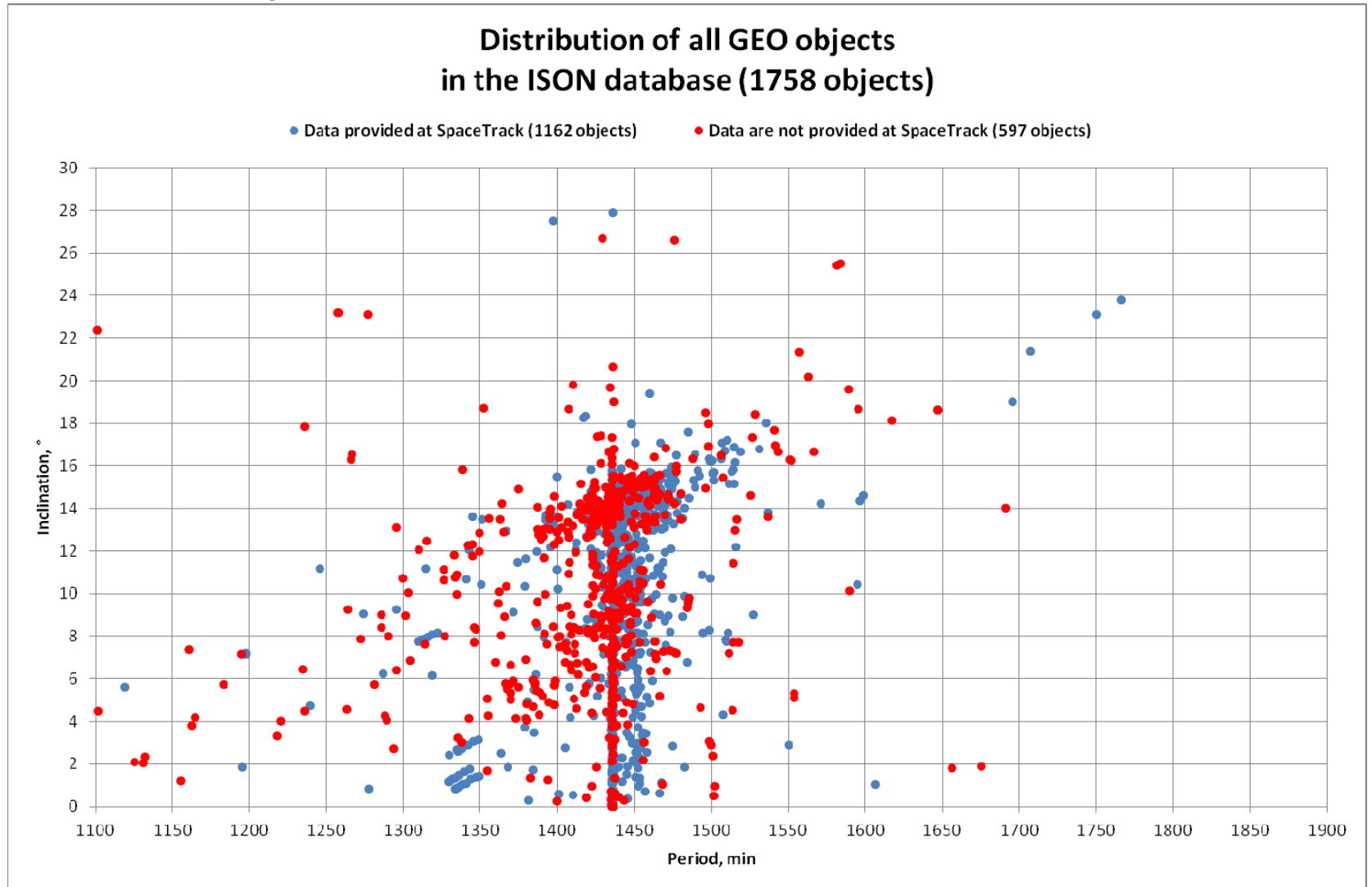
■ 1557 GEO region objects were tracked by ISON early 2011 (compared to 1016 objects of the same region for which orbital data were providing at SpaceTrack), including

- spacecraft – 922
  - 404 – active
  - 518 – non-active
- upper stages and AKMs – 257
  - of more than 15 different types (modifications)
- fragments and objects of undetermined type – 378
  - (only 20 GEO fragments are officially catalogued at SpaceTrack)

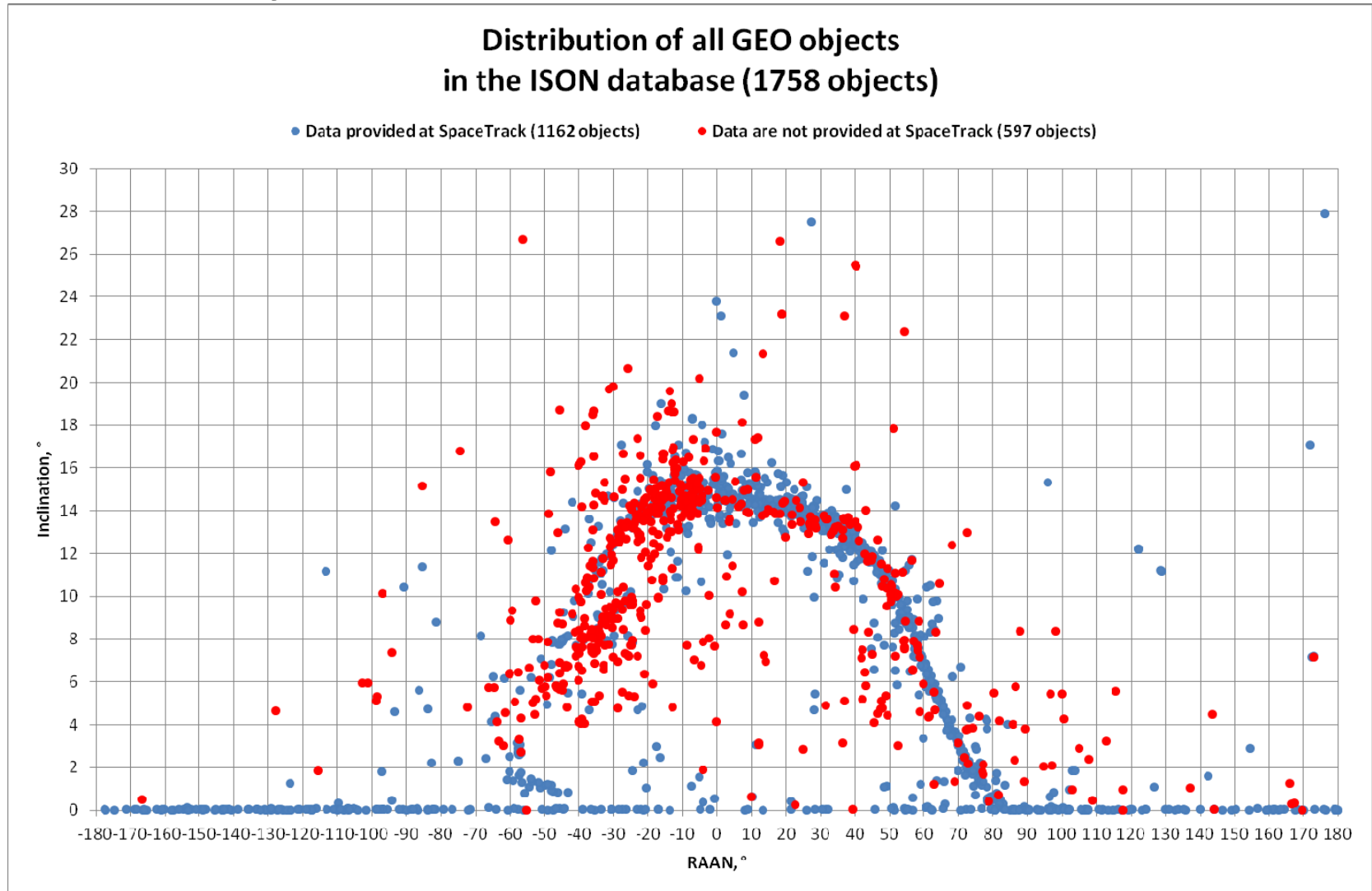
■ 147 new GEO objects are discovered and added to the ISON database in 2011

■ 1704 GEO region objects are in the ISON database as of 31.12.2011  
54 new GEO region fragments are discovered in 2012

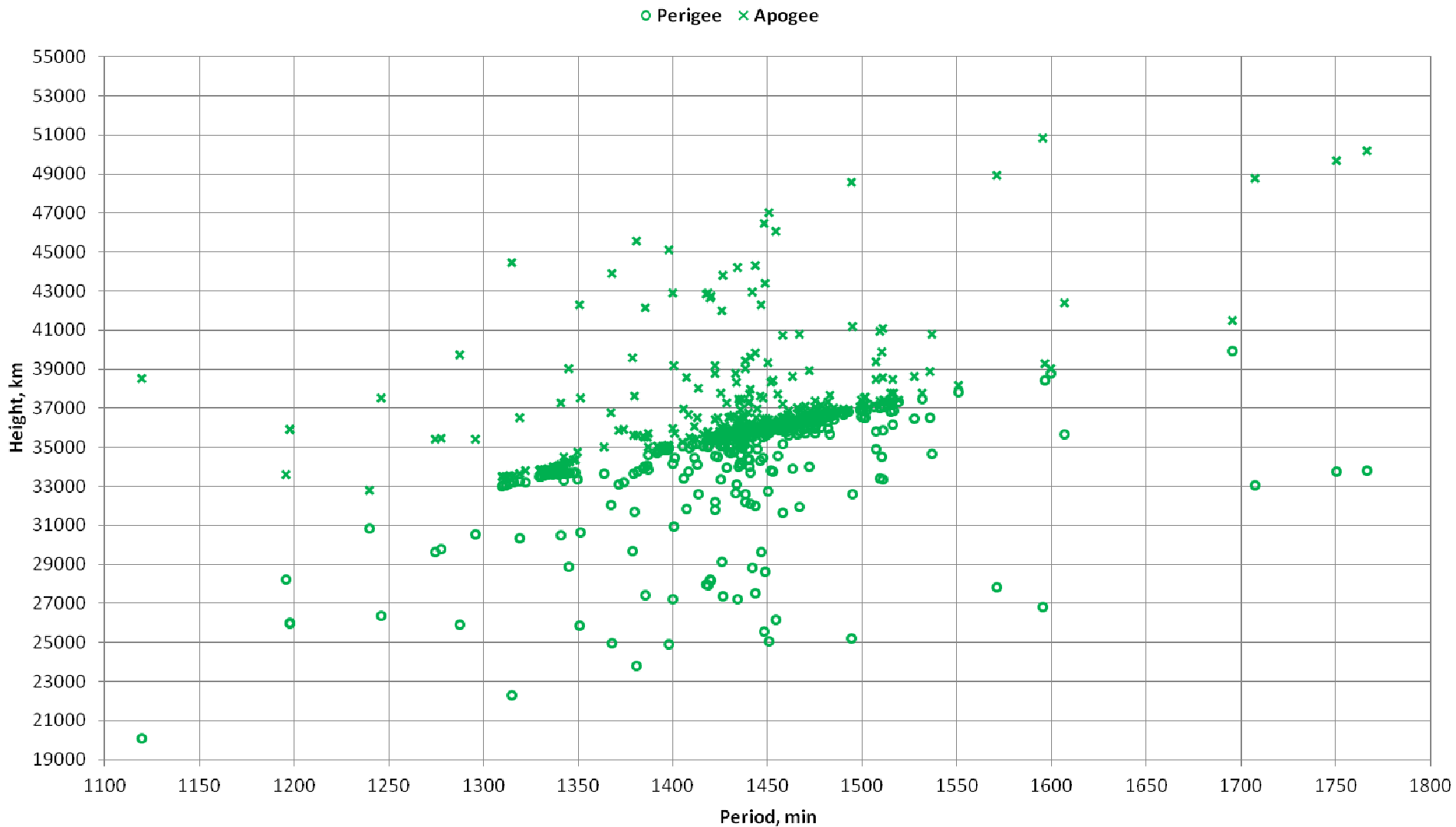
# Distribution of observing GEO objects by period and inclination



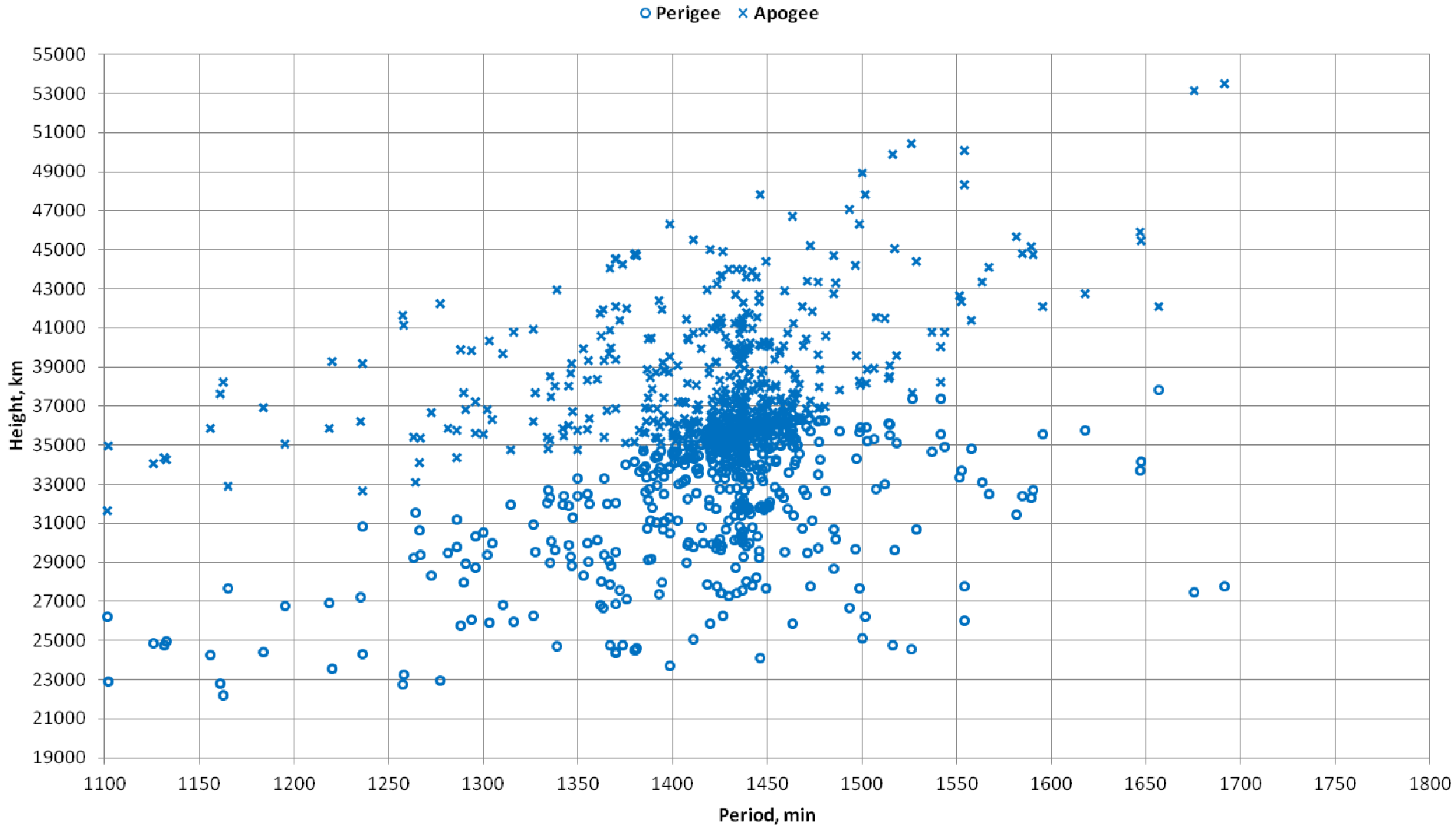
# Distribution of observing GEO objects by RAAN and inclination



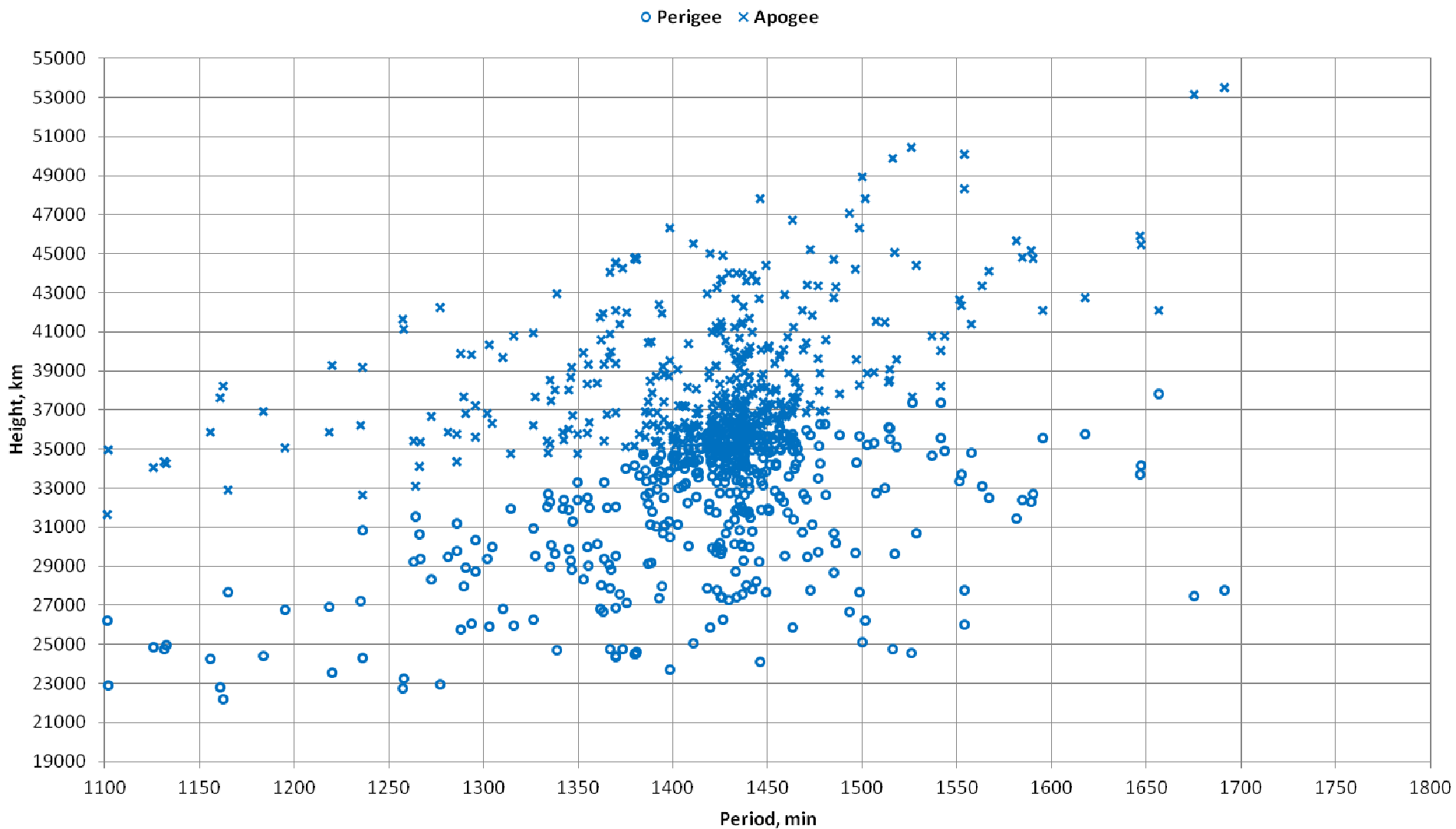
# Gabbard diagram for all GEO objects with orbital data providing at SpaceTrack (1161 objects)



# Gabbard diagram for all GEO objects in ISON database without orbital data at SpaceTrack (597 objects)

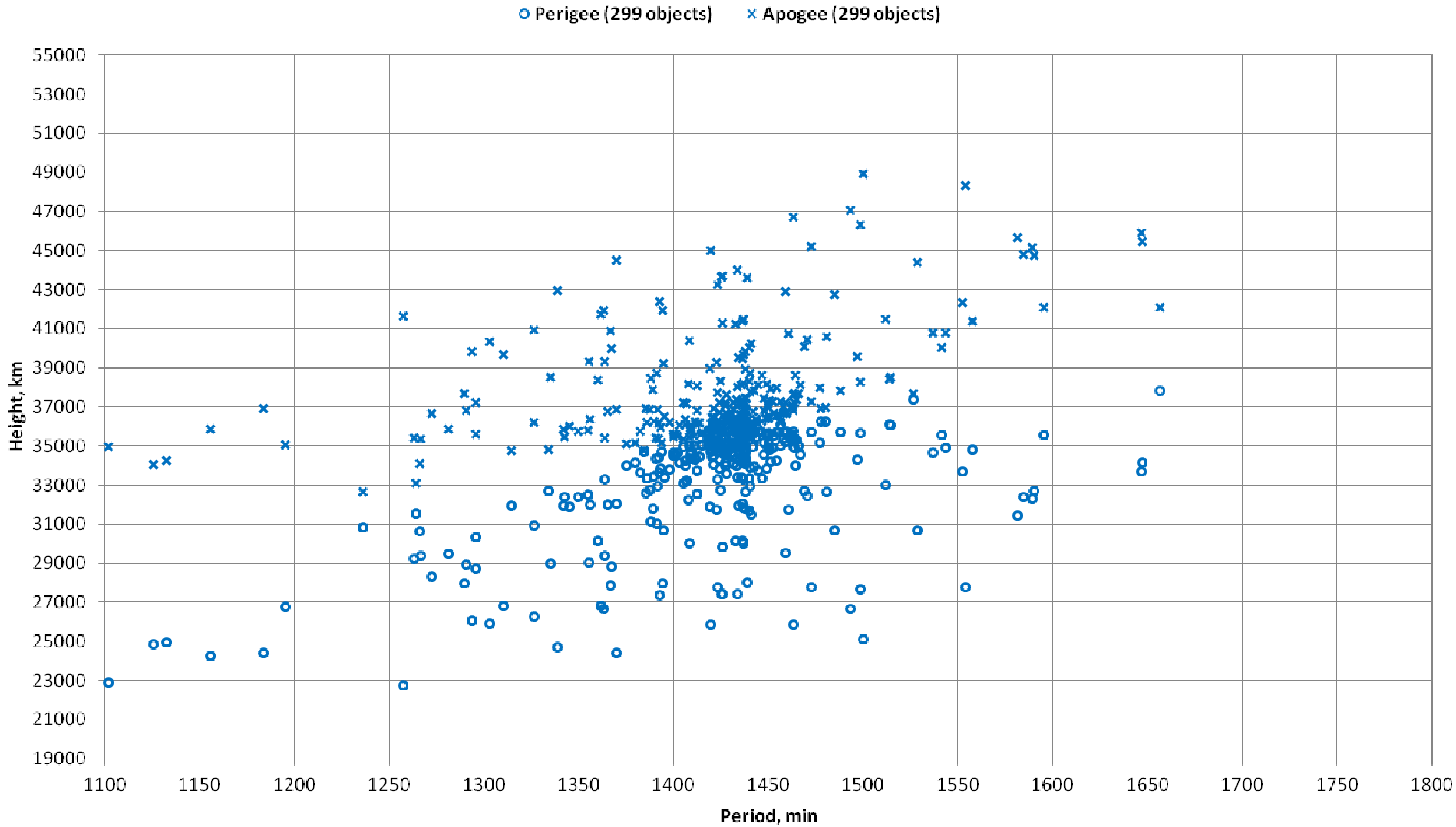


# Gabbard diagram for GEO fragments in ISON database without orbital data at SpaceTrack (450 objects)





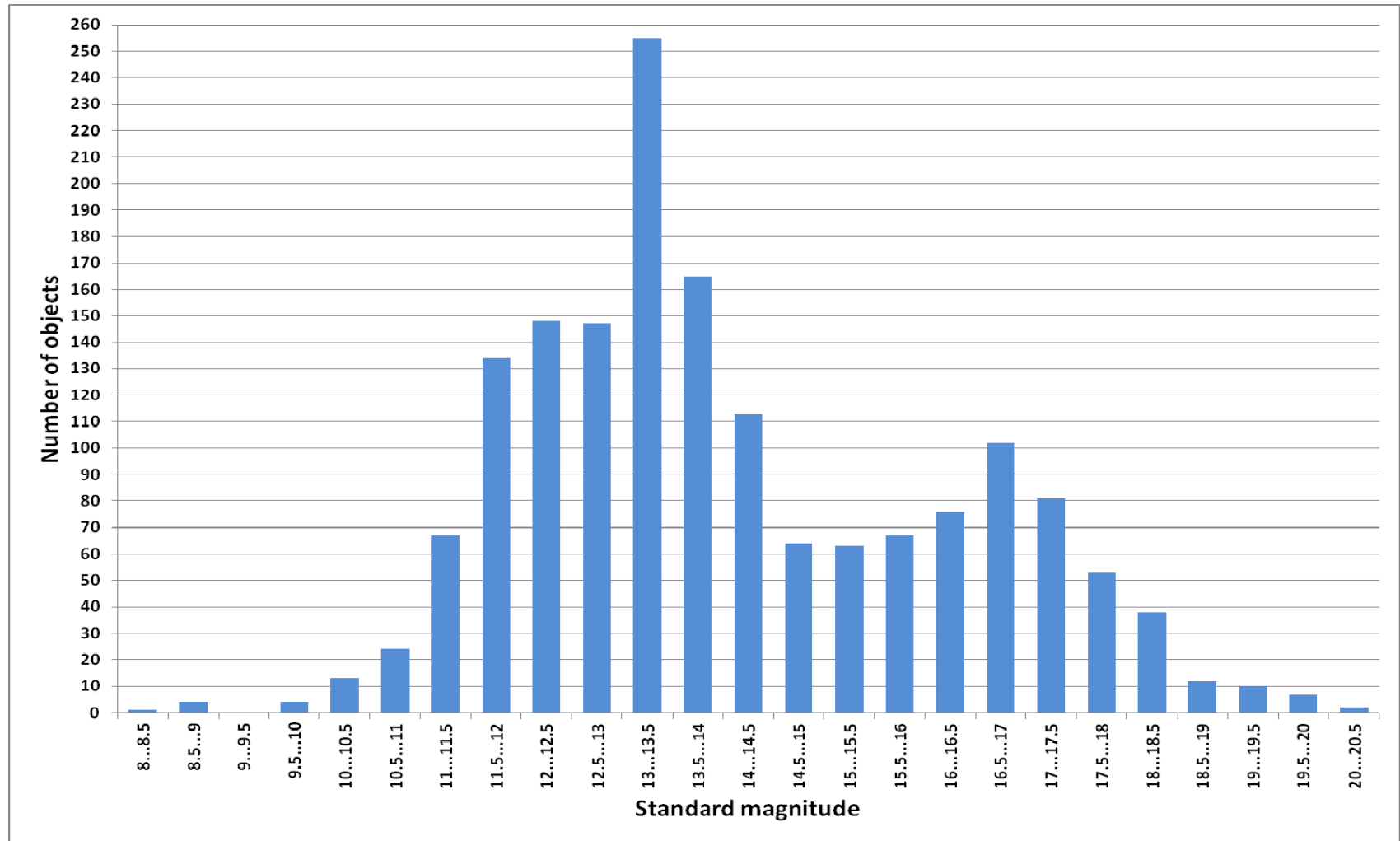
# Gabbard diagram for GEO fragments in ISON database without orbital data at SpaceTrack (HAMR objects removed)



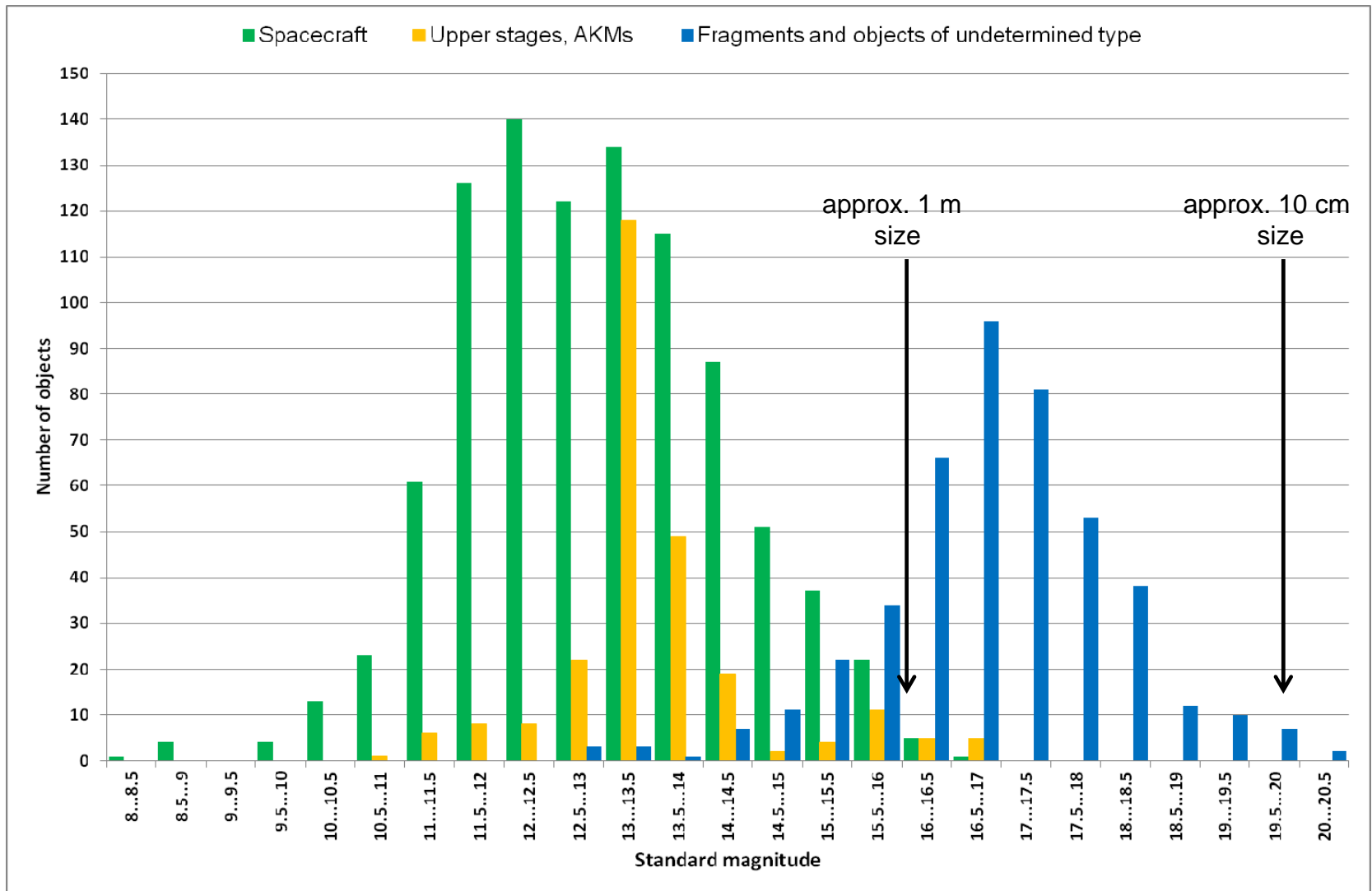
# Brightness distribution of observing GEO objects

- Each object is assumed as a diffuse sphere with albedo of 0.15
- Differences between diffuse sphere phase function and real phase function for particular object are ignored
- Standard brightness (referring to a zero phase angle and 40000 km distance) is calculated for each object based on all collected measurements to the date
- Objects are split into 3 groups:
  - spacecraft,
  - rocket bodies (upper stages, AKMs),
  - fragments and objects of undetermined type

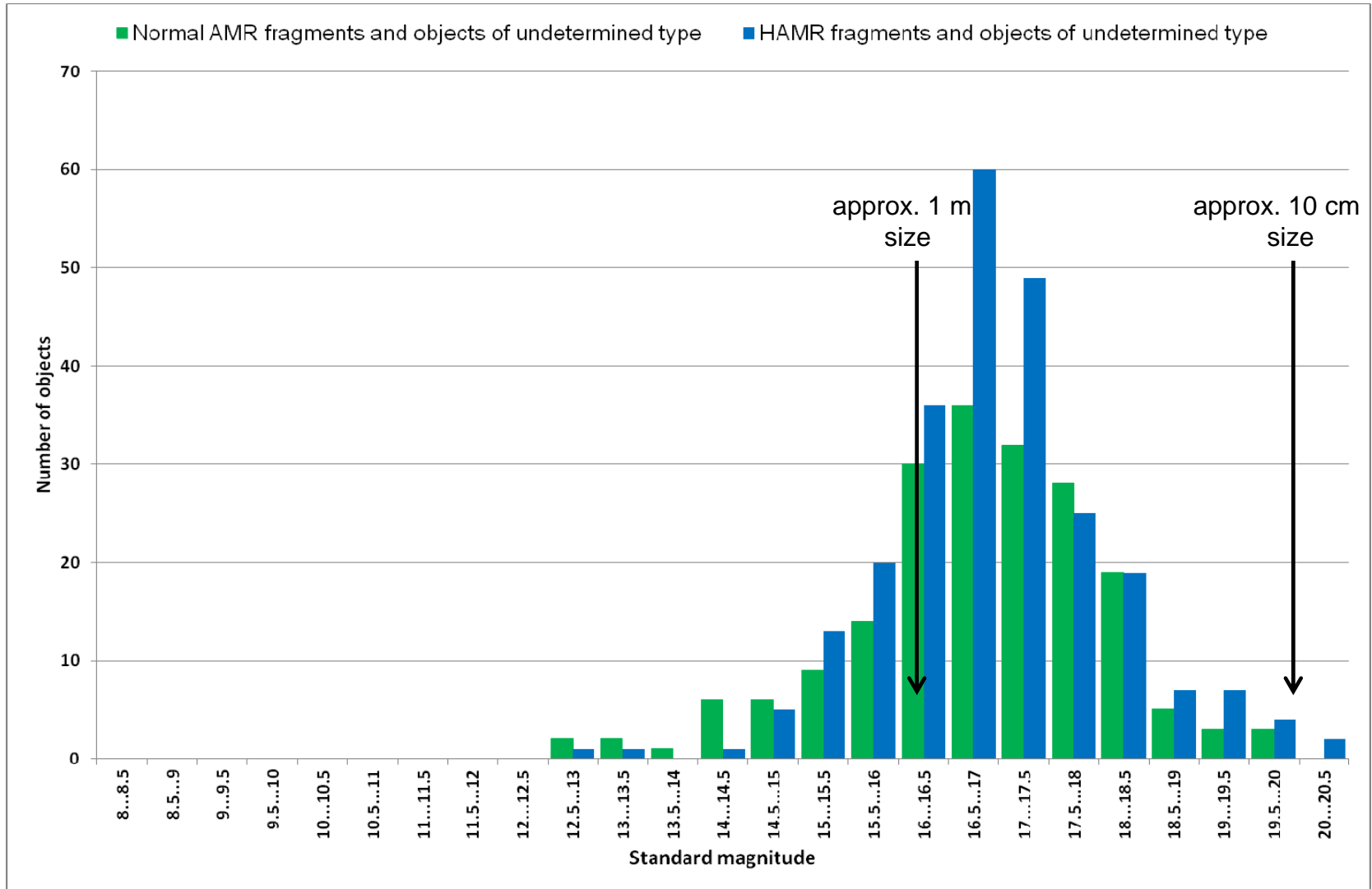
# ISON Tracked GEO Objects Distribution by Standard Magnitude – 1704 objects



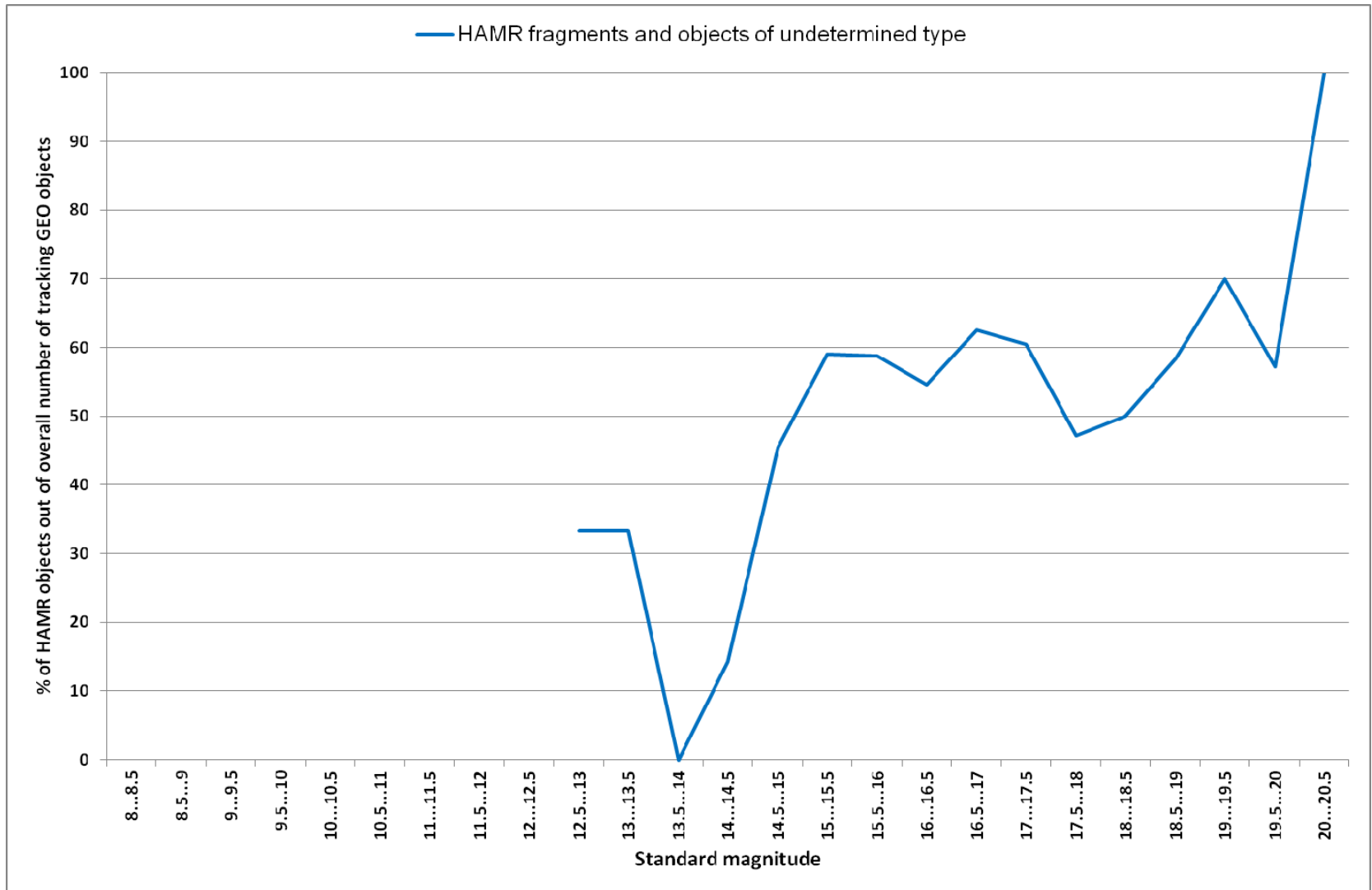
# ISON Tracked GEO Objects Distribution by Standard Magnitude – 1704 objects



# ISON Tracked GEO Fragments and Objects of Undetermined Type

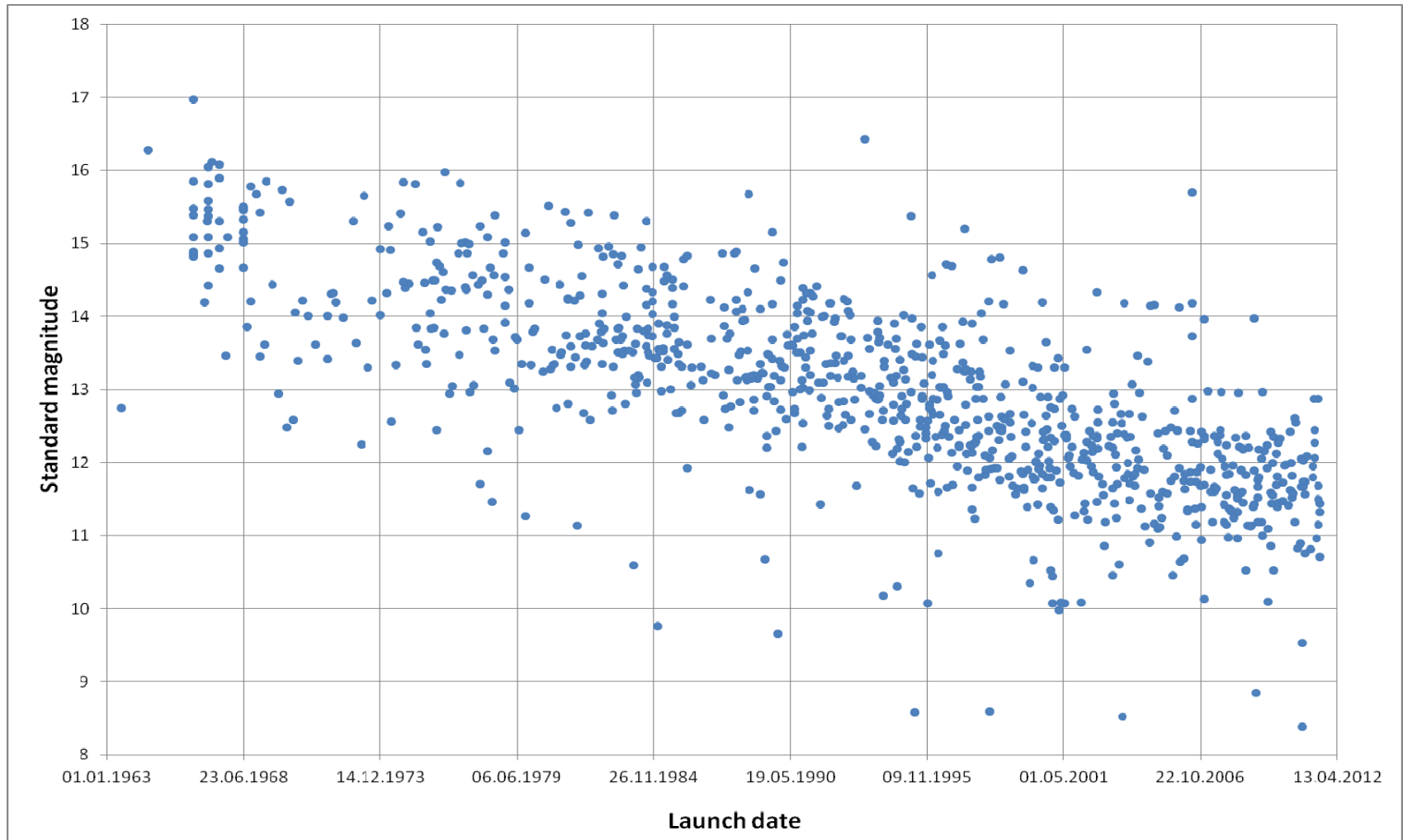


# GEO HAMR Objects. How many?

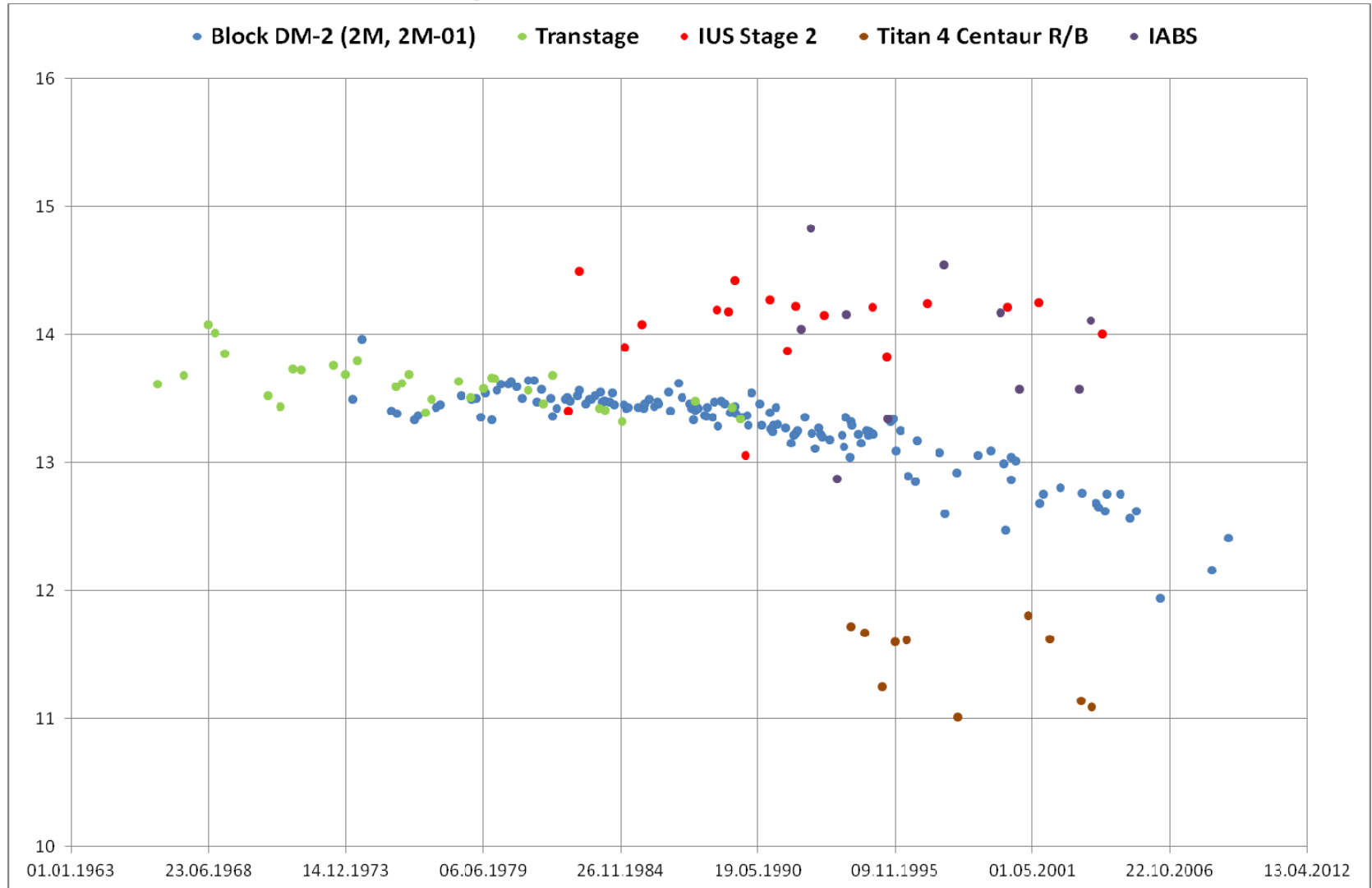


# ISON Tracked GEO Spacecraft

## Standard Magnitude vs. Launch Date



# ISON Tracked GEO Upper Stages Standard Magnitude vs. Launch Date





# Conclusions

More than 9 millions of measurements (RA, DECL) are collected within the ISON project since 2003

1758 GEO objects are tracked by ISON as of May 2012, including 597 ones without orbital data at SpaceTrack

Large population of HAMR objects is discovered and studied

Brightness properties of tracking objects are studied in a different way

# Acknowledgements

Great thanks to all ISON observers and engineers

Special thanks to the AIUB team for support of continuing multiyear cooperative GEO and HEO debris research especially HAMR ones