

Catalogue of High AMR GEO-like Debris

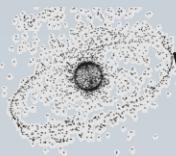
T. Schildknecht, A. Vananti, A. Hinze

Astronomical Institute, University of Bern, Switzerland

H. Krag, T Flohrer

ESA / ESOC, Darmstadt, Germany

30th IADC Meeting, May 22 – 25, 2012,
CSA, Montreal, Canada



Why do we Maintain Catalogue of Debris?

■ Open Questions

• Population

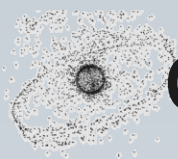
- how many?
- size distribution?
- orbit regions?
- nature of objects?
- sources, sinks?

• Physics/Mechanisms

- creation
- evolution of orbits

• Long-term monitoring of environment

- identification of new sources
- verification of evolution models



Characteristics of Observation Campaigns

■ Four types of observations

1. GEO surveys:

- search area optimized for GEO orbits with 0–20° inclination
- blind tracking optimized for object in GEO

2. GTO surveys:

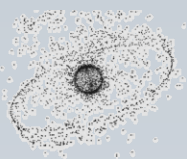
- search area and blind tracking optimized for GTO orbits with 0–20° inclination (Ariane GTO launches)

3. MEO surveys:

- survey of current MEO constellations completed (2011)
- surveys for eccentric MEO orbits to be started in 2012

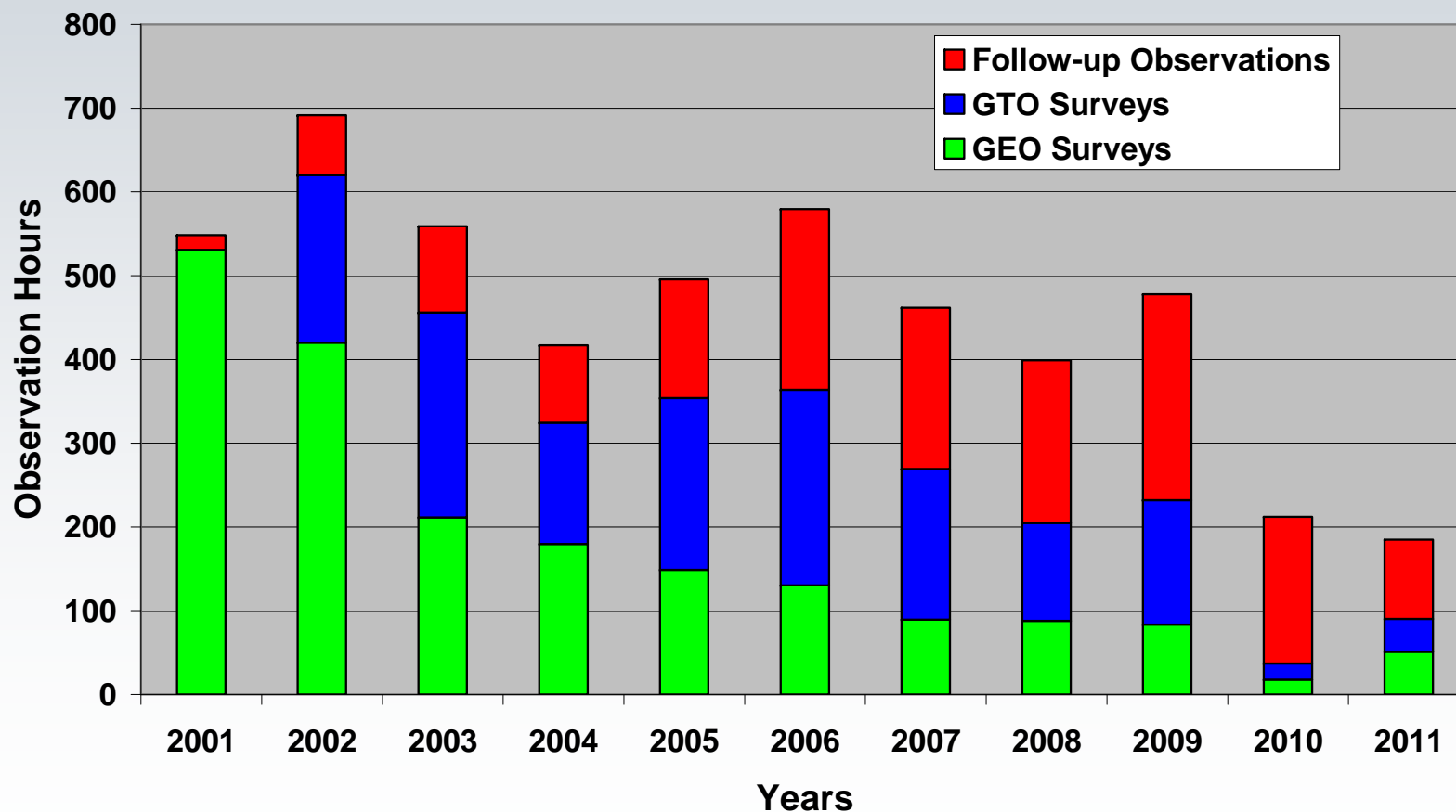
4. Follow-up observation to maintain HAMR catalogue:

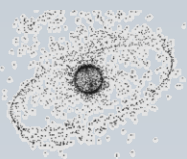
- follow-up of subset of objects discovered in surveys (maintenance of a catalogue of debris objects)
- arcs between a few hours up to many months



OGS Observation Statistics

Repartition of Observation Time

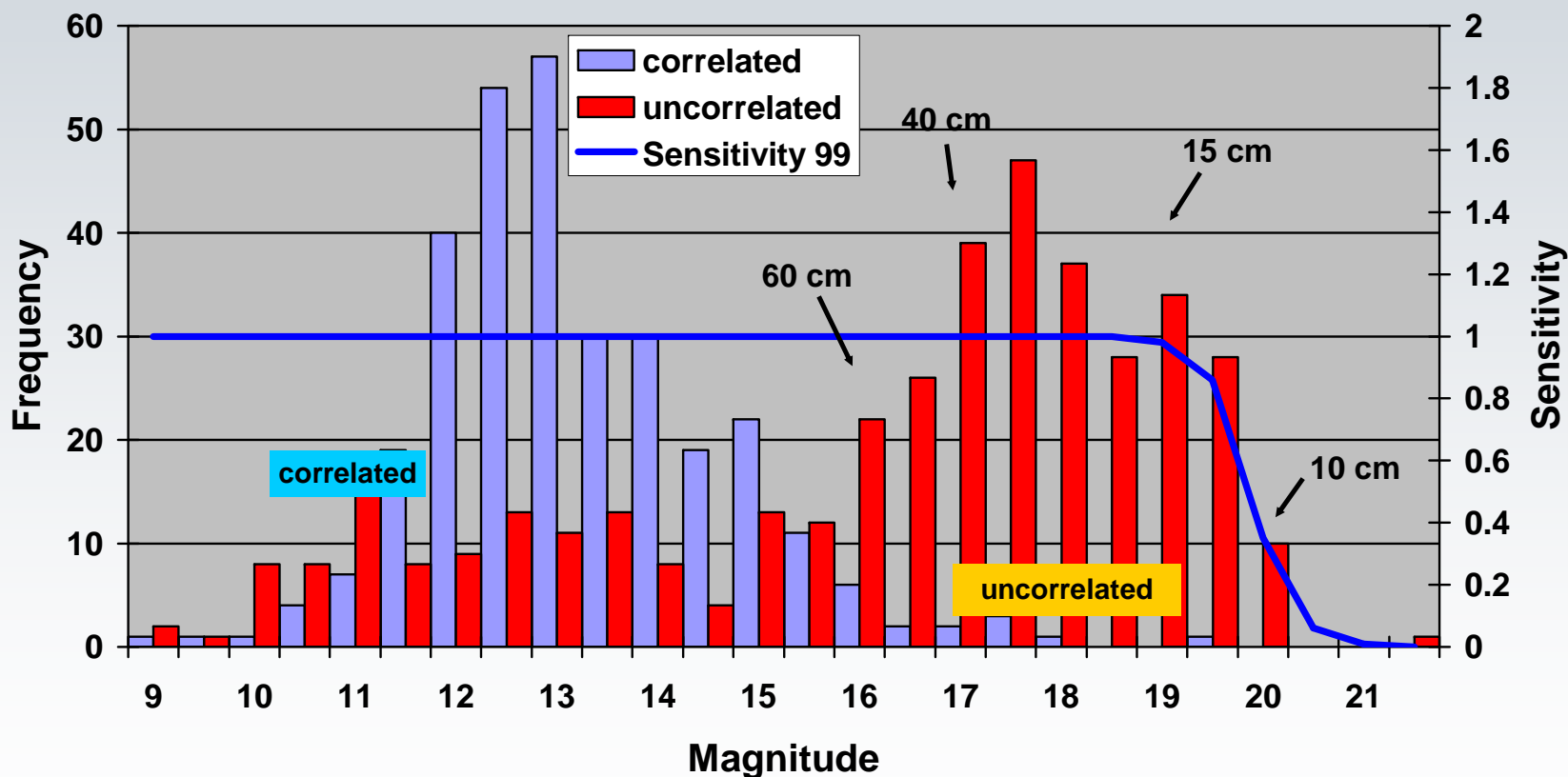


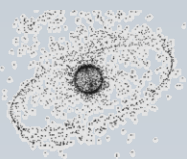


ESA 2008 GEO/GTO Surveys

Continuous program, ~80 nights per year

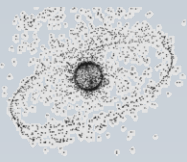
Detections (Jan 2008 - Dec 2008)





High AMR GEO/GTO Catalogue

- **Discover new objects:** Obs. From Tenerife (OGS, AIUB)
 - **Secure orbits:** obs. from OGS, Zimmerwald (AIUB)
 - **Maintain orbits:** obs. from OGS, Zimmerwald, international partners, International Scientific Optical observation Network (ISON), ...
 - **Daily orbit maintenance** at AIUB and Keldysh Institute of Applied Mathematics of the Russian Academy of Sciences (KIAM)
- Orbit catalogue of high-altitude space debris
- **Provide predictions:**
 - To other partners (CNES, JAXA, NASA, Roscosmos...)
 - → to investigate physical properties of objects



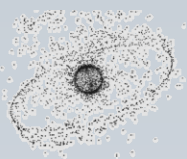
Sensors



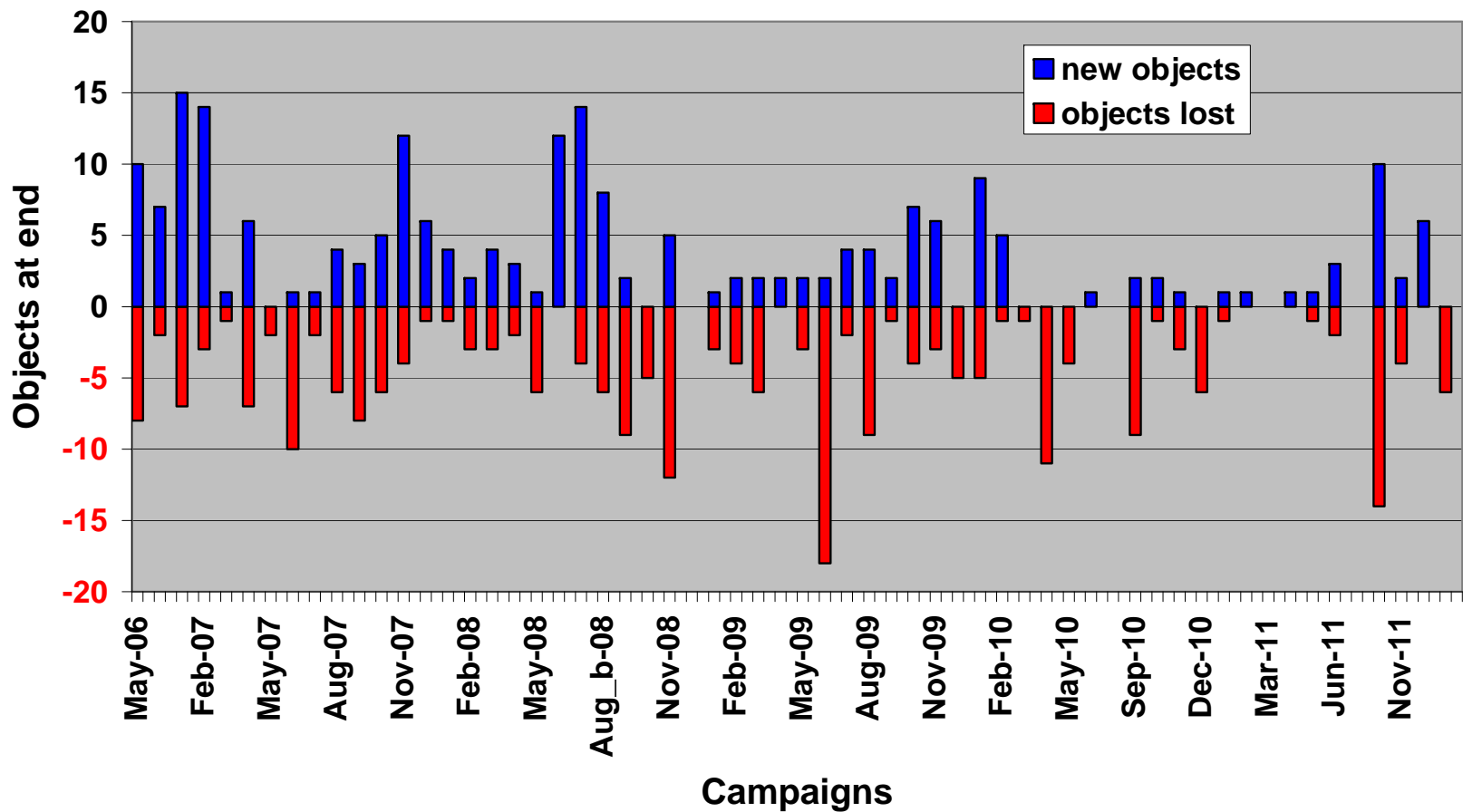
1-m ESA Telescope
Tenerife

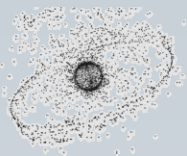


1-m ZIMLAT
Switzerland

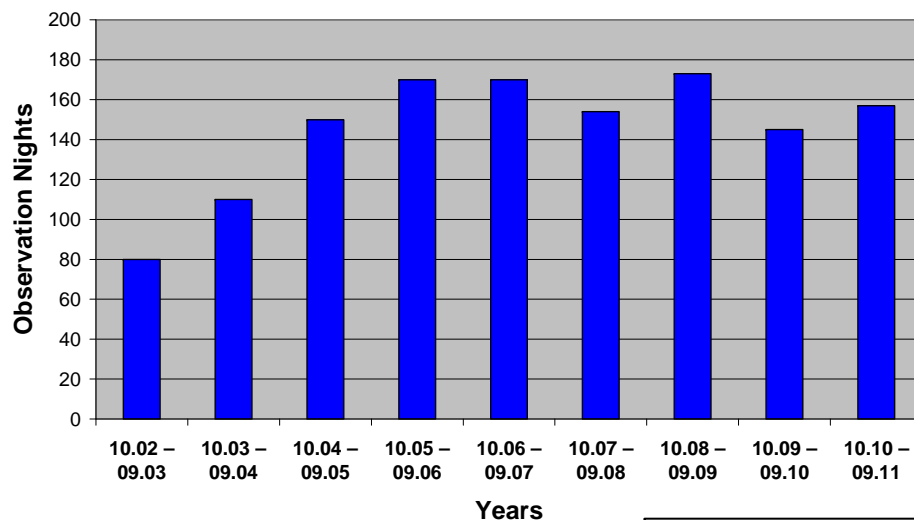


“Hard to Find, Easy to Loose”

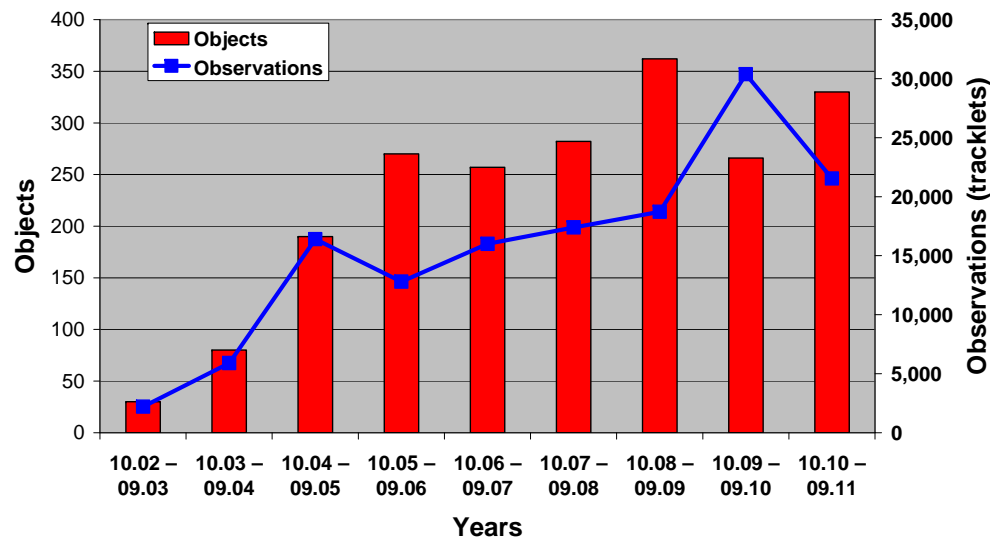




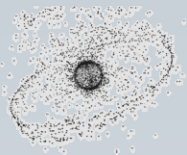
“Routine” ZIMLAT Support



ZIMLAT
Observation Nights

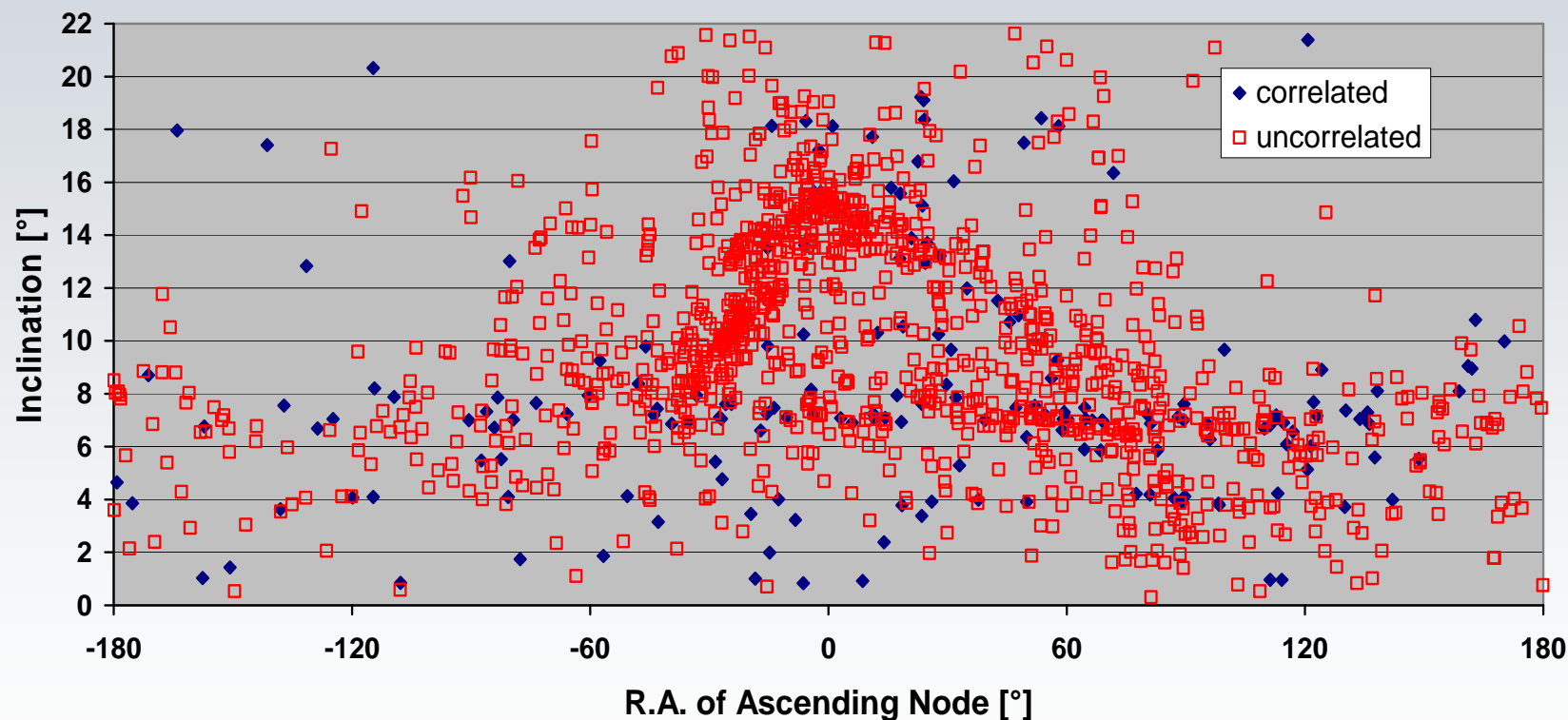


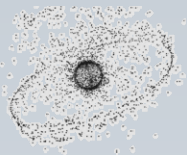
ZIMLAT
Observations / Objects



6-param. Orbits – i vs Ω

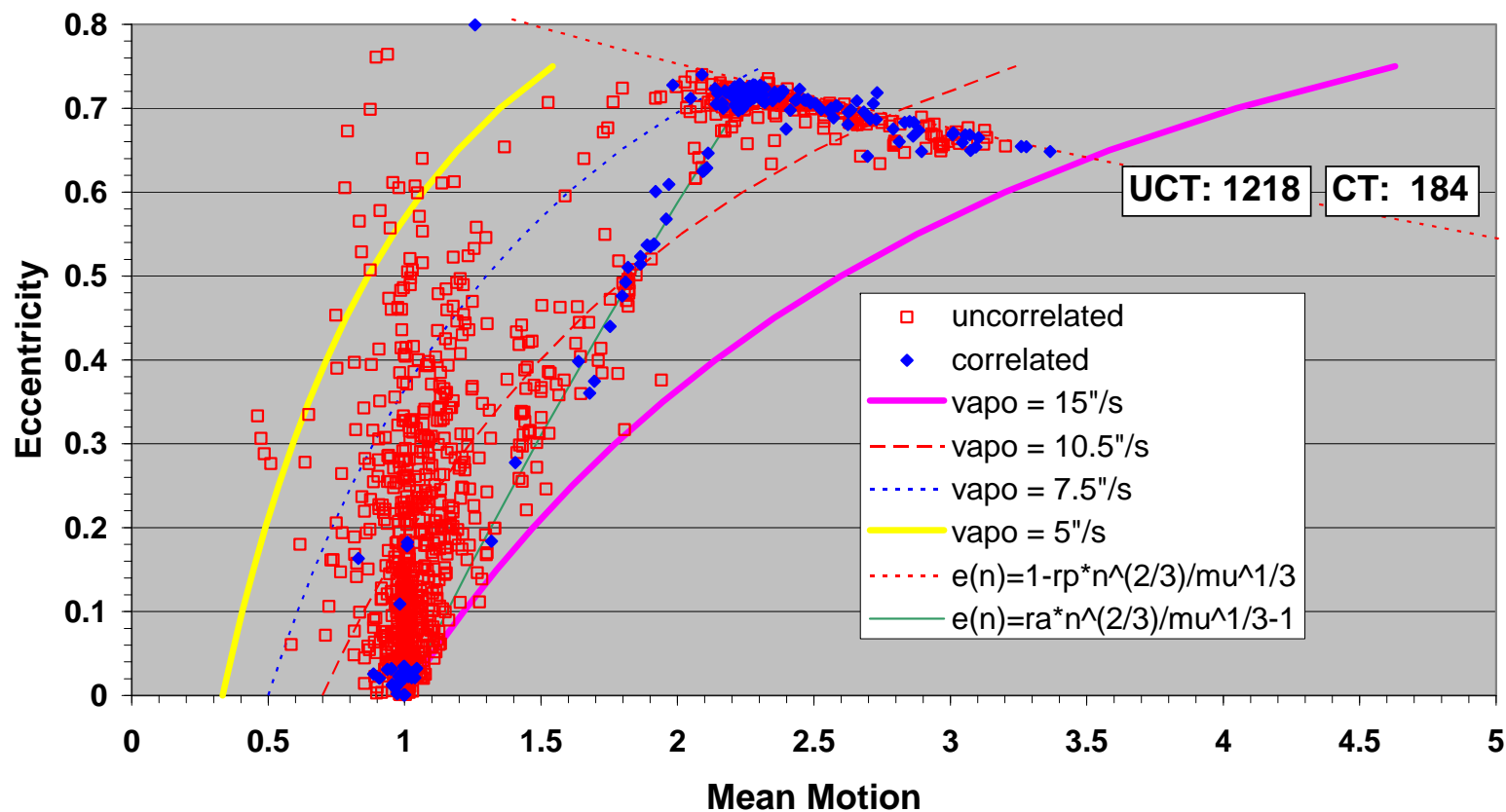
Orbital Elements (Jan 2002 - Jan 2012; elliptical orbits)

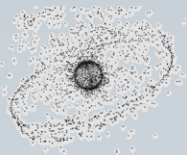




High AMR GEO/GTO Catalogue

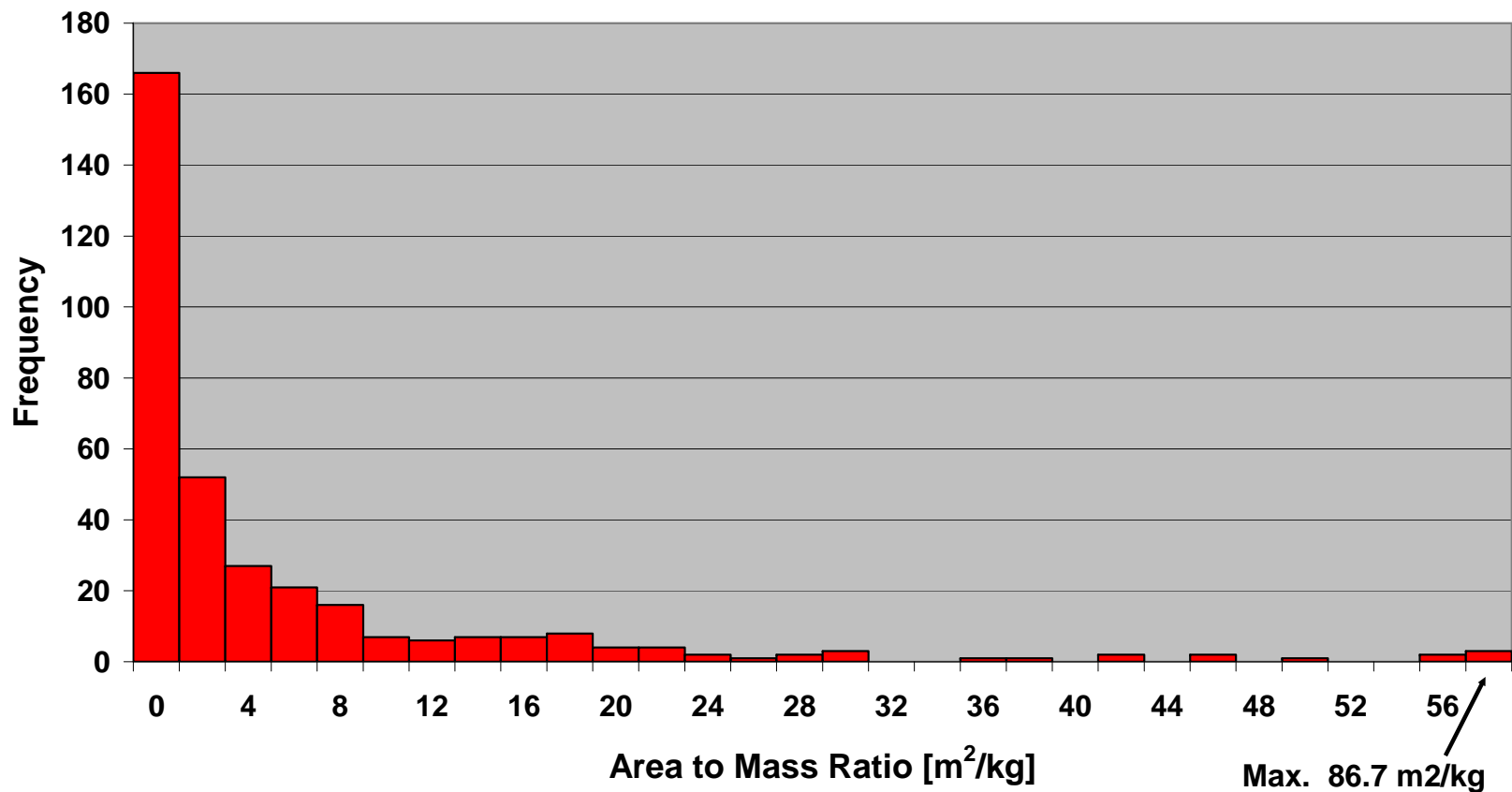
Eccentricity vs Mean Motion (Jan 2002 - Jan 2012; elliptical orbits)

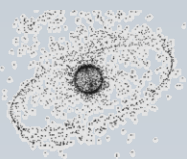




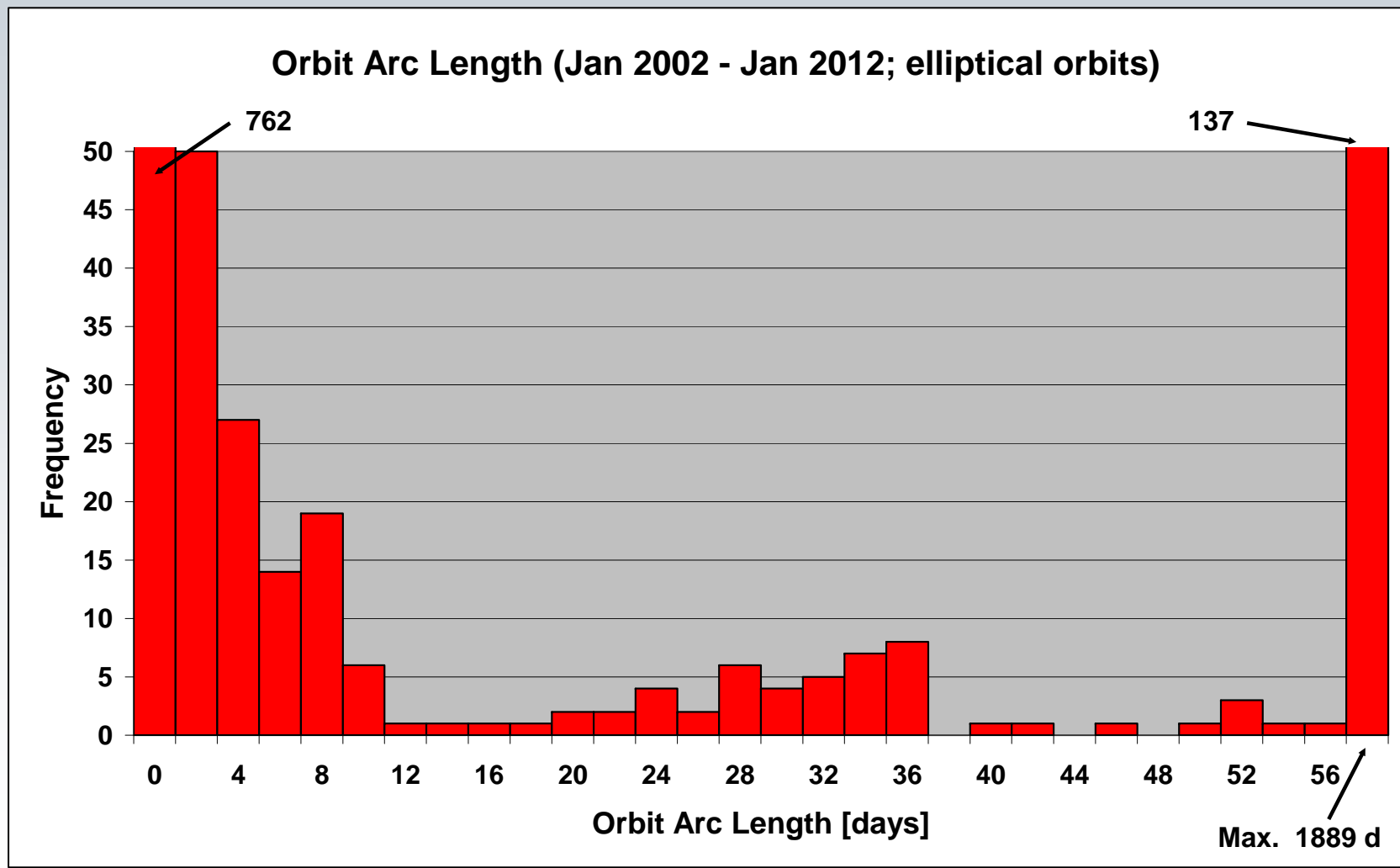
High AMR GEO/GTO Catalogue

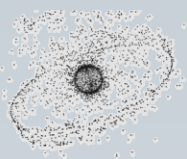
Area-to-Mass Ratio (345 Uncorrelated Objects)



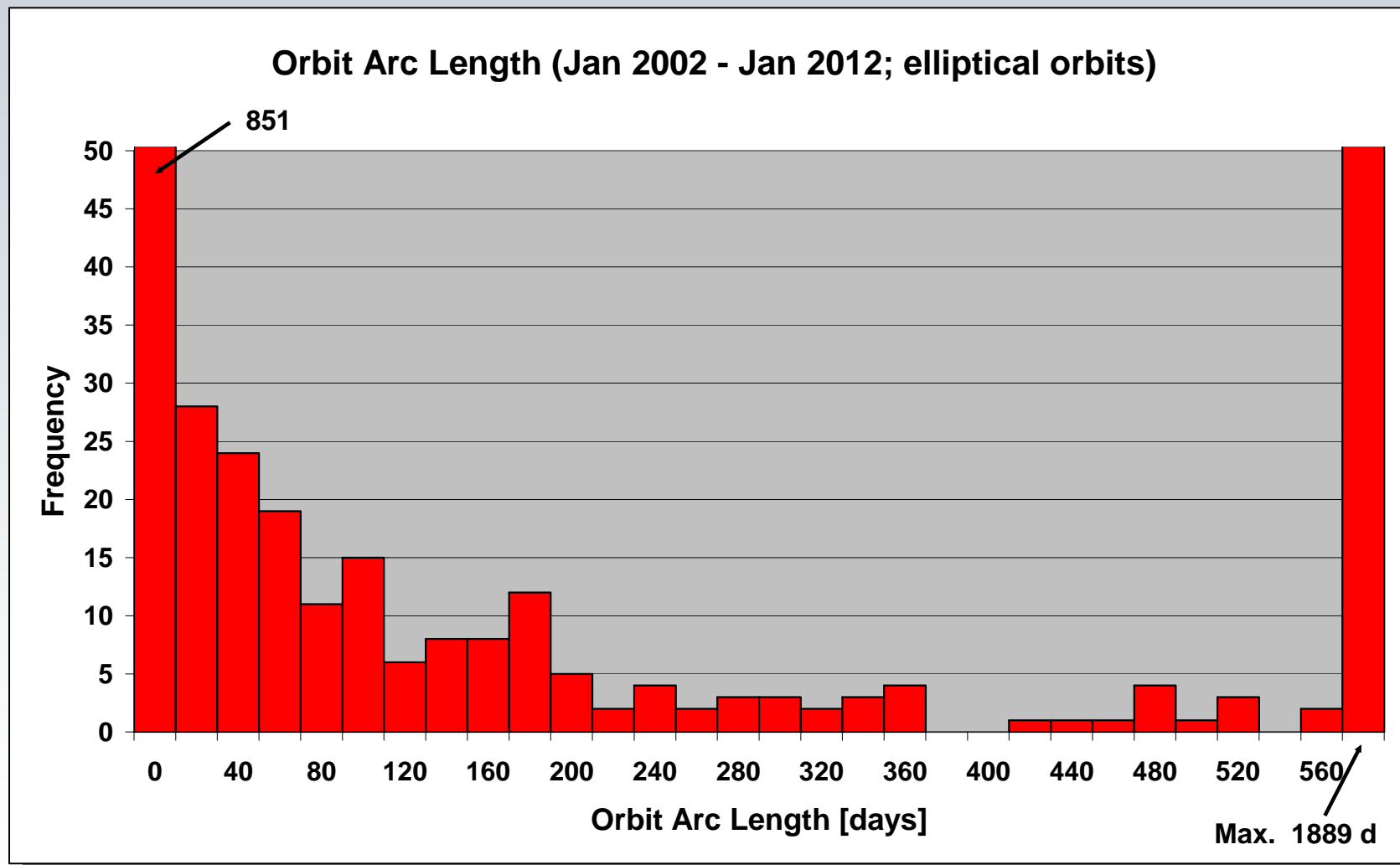


High AMR GEO/GTO Catalogue





High AMR GEO/GTO Catalogue





Conclusions

- Continuous GEO/GTO/(MEO) surveys
 - long-term monitoring
 - continuous search for high AMR objects
- Catalogue of high AMR GEO objects
 - major objective is to enable physical characterization
 - orbits secured by involving near real-time hand-over to Zimmerwald (25% of Zimmerwald observation time)
 - orbits maintenance by sharing the data in a network of observatories (KIAM, ISON)
 - Provision of precise predictions to other groups (CNES, JAXA, NASA, ...)
- Input for MASTER model
 - data used to validate MASTER 2009 model (MLI population)



Acknowledgments

- Great thanks to our observers at the OGS and Zimmerwald!
- Support in the form observations to maintain the orbits is provided by the Keldysh Institute of Applied Mathematics (KIAM) in the framework of the ISON collaboration (AIUB–KIAM collaboration).