



Russian Academy of Science
Keldysh Institute of Applied Mathematics

Estimation of current status of geostationary orbit based on results of research in the framework of ISON international project

Presentation for the 46th session of the COPUOS STSC
17 February 2009, Vienna

The UN General Assembly Resolution 62/217

The General Assembly,

.....
Considering, that space debris is an issue of concern to all nations,
.....

28. *Considers* that it is essential that Member States pay more attention to the problem of collisions of space objects, including those with nuclear power sources, with space debris, and other aspects of space debris, **calls** for the continuation of national research on this question, **for the development of improved technology for the monitoring of space debris and for the compilation and dissemination of data on space debris**, also considers that, to the extent possible, information thereon should be provided to the Scientific and Technical Subcommittee, and agrees that international cooperation is needed to expand appropriate and affordable strategies to minimize the impact of space debris on future space missions;

The ISON network

ISON joins:

- 18 scientific institutions in 9 states , including partners from ESOC, AIUB, astronomical organizations of Bolivia, Georgia, Moldova, Russia, Tajikistan, Ukraine, Uzbekistan
- 18 observatories and observation facilities
- 25 optical instruments
- more than 60 observers and researchers

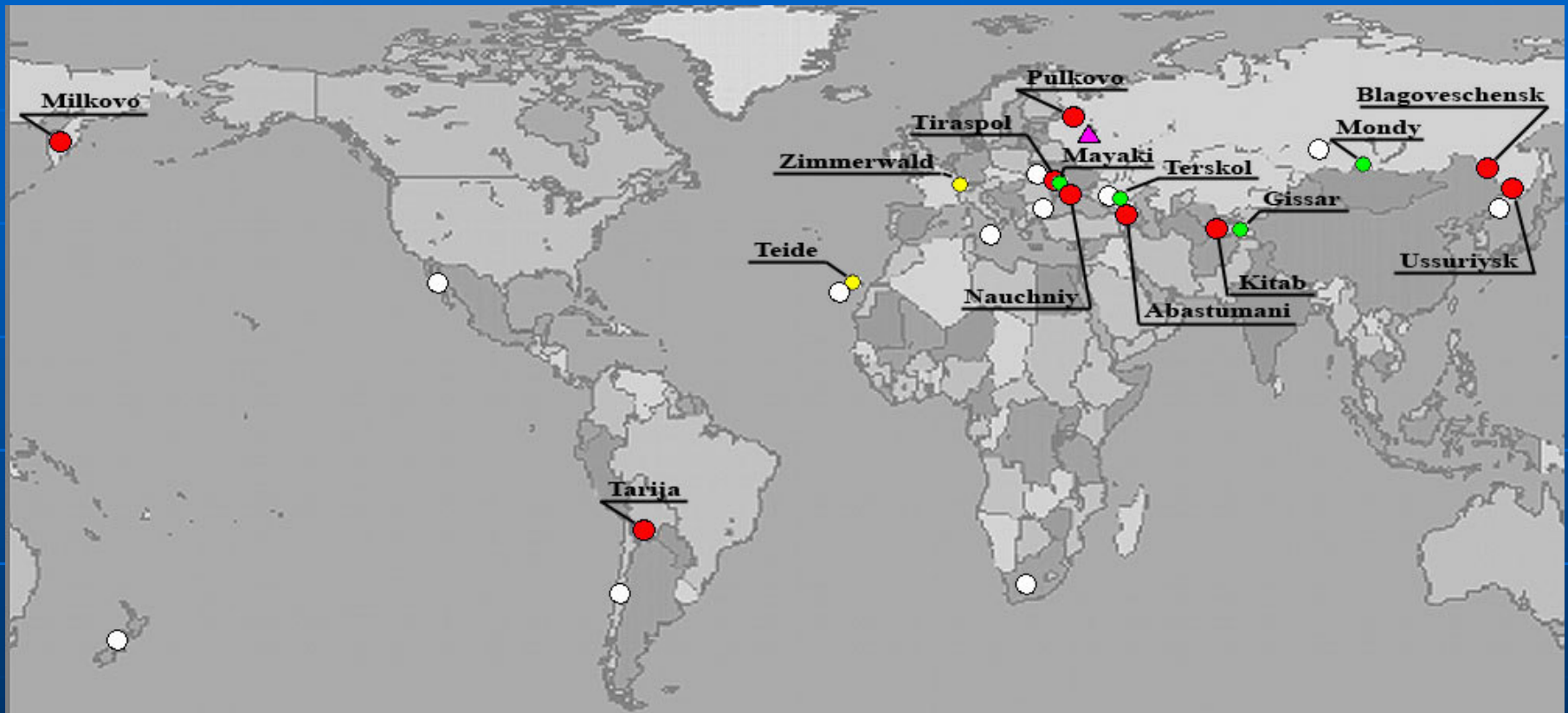
Project principal coordinator is Keldysh Institute of Applied Mathematics of the Russian Academy of Sciences (KIAM RAS).

Current primary tasks:

- regular GEO monitoring, new objects discovering and tracking, maintenance as complete GEO objects database as possible
- new objects on GTO and other HEO regimes discovering and individual tracking, special HEO surveys will start soon

ISON

International scientific optical network



ISON is an open international project for regular monitoring of the near-Earth space, processing and compilation of data on space debris

GEO region study results obtained in 2005-2008

COVERAGE

- Global GEO coverage capability is achieved that is important for continuous studying of space debris situation in that region
- Since Jun 2007 wide GEO survey mode is implemented for longitudes 31.5W to 90E in a zone $\pm 16^\circ$ with respect to the "true" GEO ring. Partial GEO survey mode is implemented for other longitudes

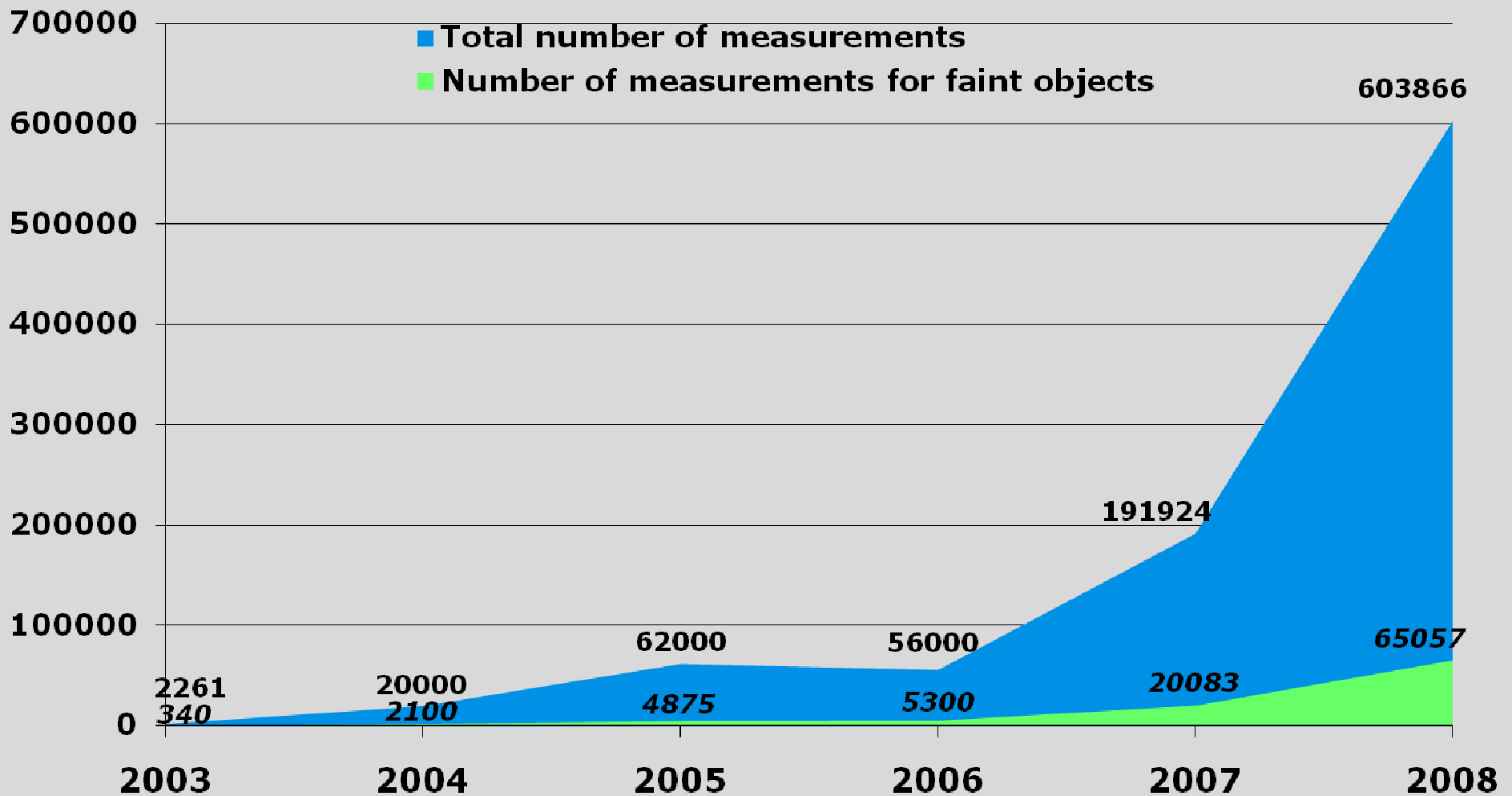
OBSERVATION OUTPUT

- Overall number of obtained measurements exceeded 930000

TRACKED OBJECTS

- Number of continuously tracked objects in GEO is nearly 1420 as of Jan 2009, including 152 unknown bright GEO objects (brighter than 15^m) orbital data for which publishes annually in «ESOC Classification of Geosynchronous Objects» (the last one – Issue 11, Feb 2009)
- Nearly 500 faint (fainter than 15^m) GEO and GTO objects are discovered in GEO region surveys during the last 4 years, including objects with high AMR. Of this number 210 GEO objects are tracked continuously.
- Thus population of known and constantly observing objects in GEO region is increased more than 35 per cent.

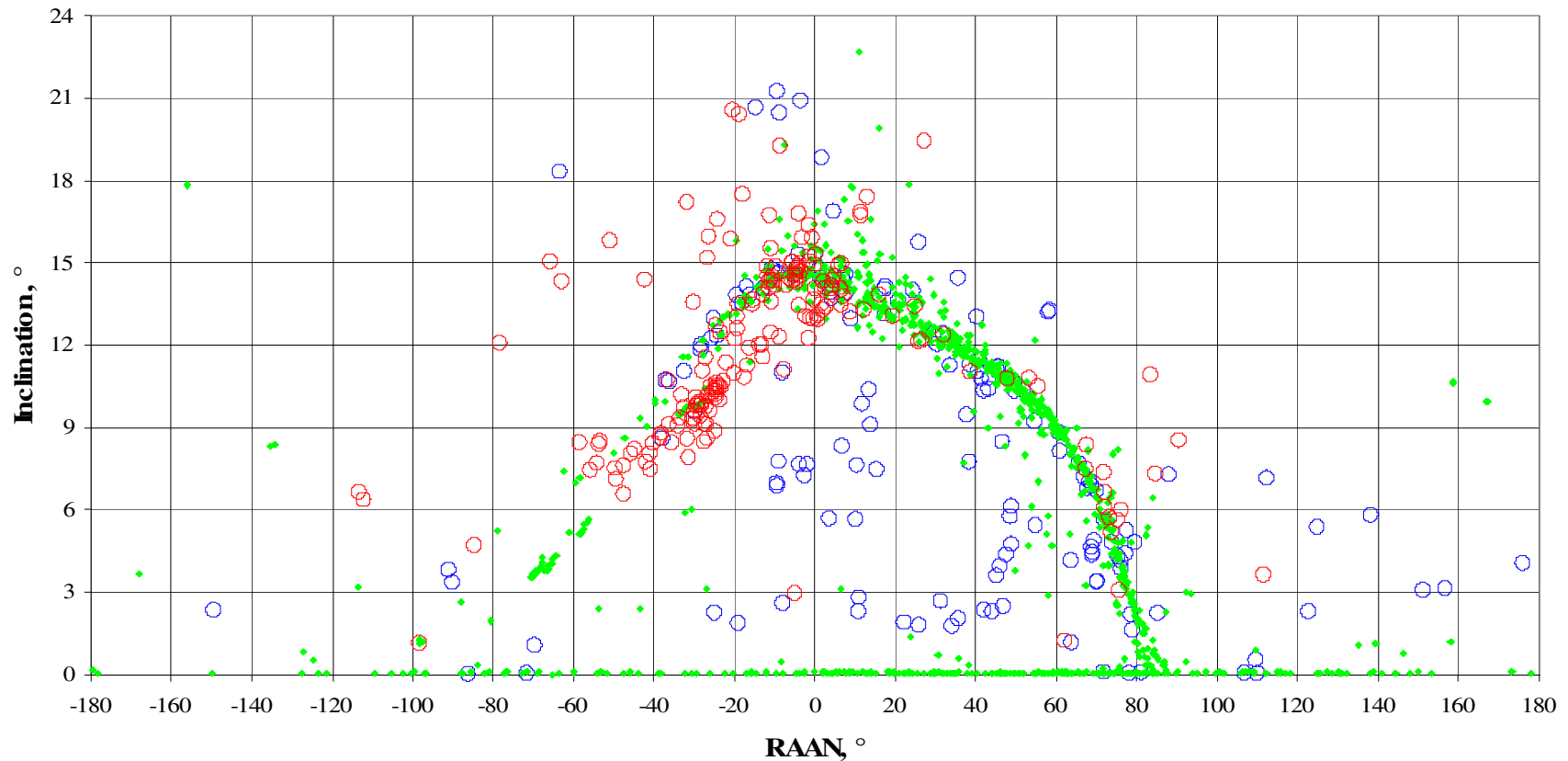
ISON increasing output



All known GEO objects population orbital characteristics

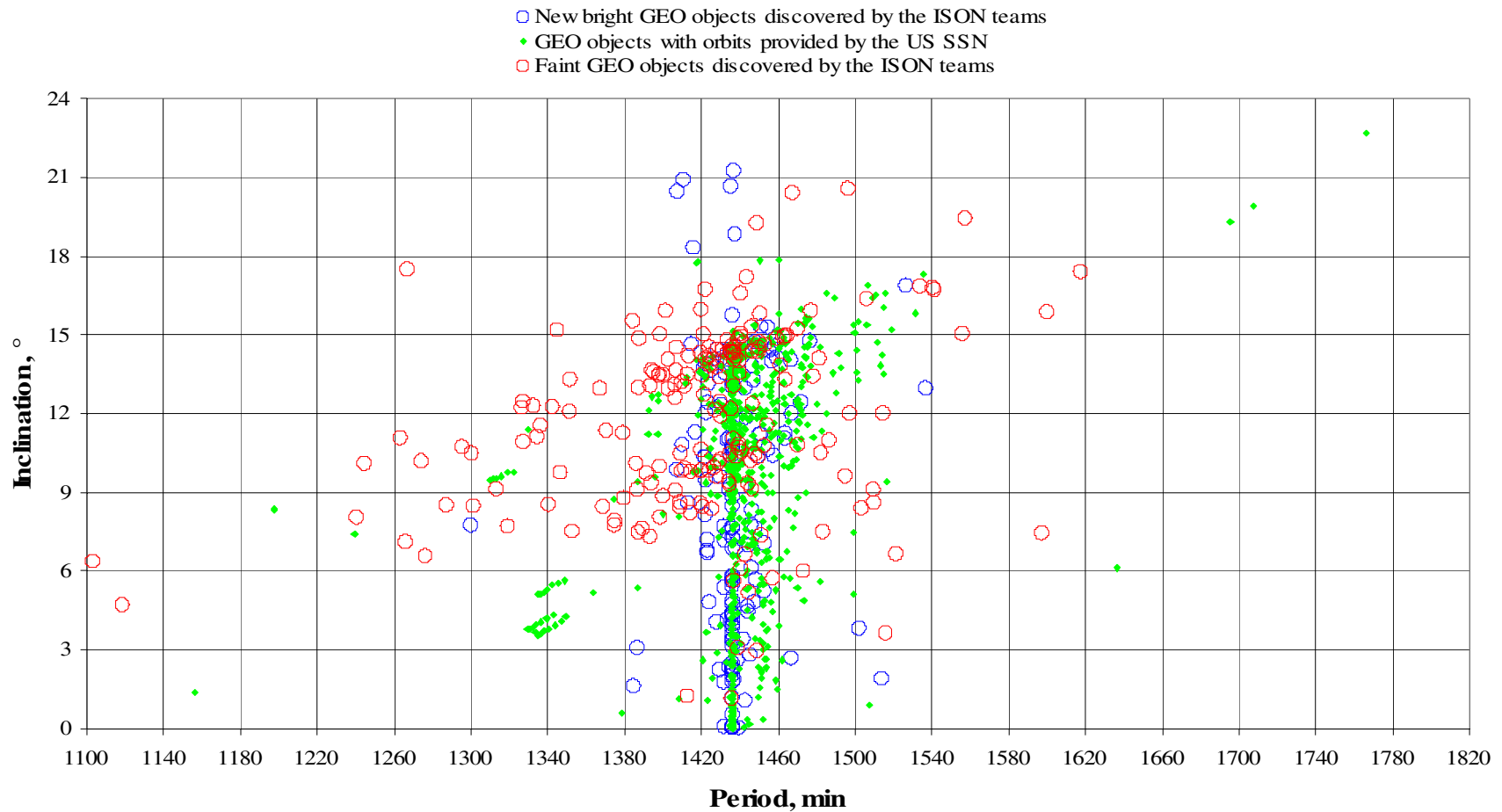
Distribution of 152 bright and 192 faint GEO objects discovered by the ISON and 965 objects with orbits provided by the US SSN by RAAN and inclination

- New bright GEO objects discovered by the ISON teams
- ◆ GEO objects with orbits provided by the US SSN
- Faint GEO objects discovered by the ISON teams



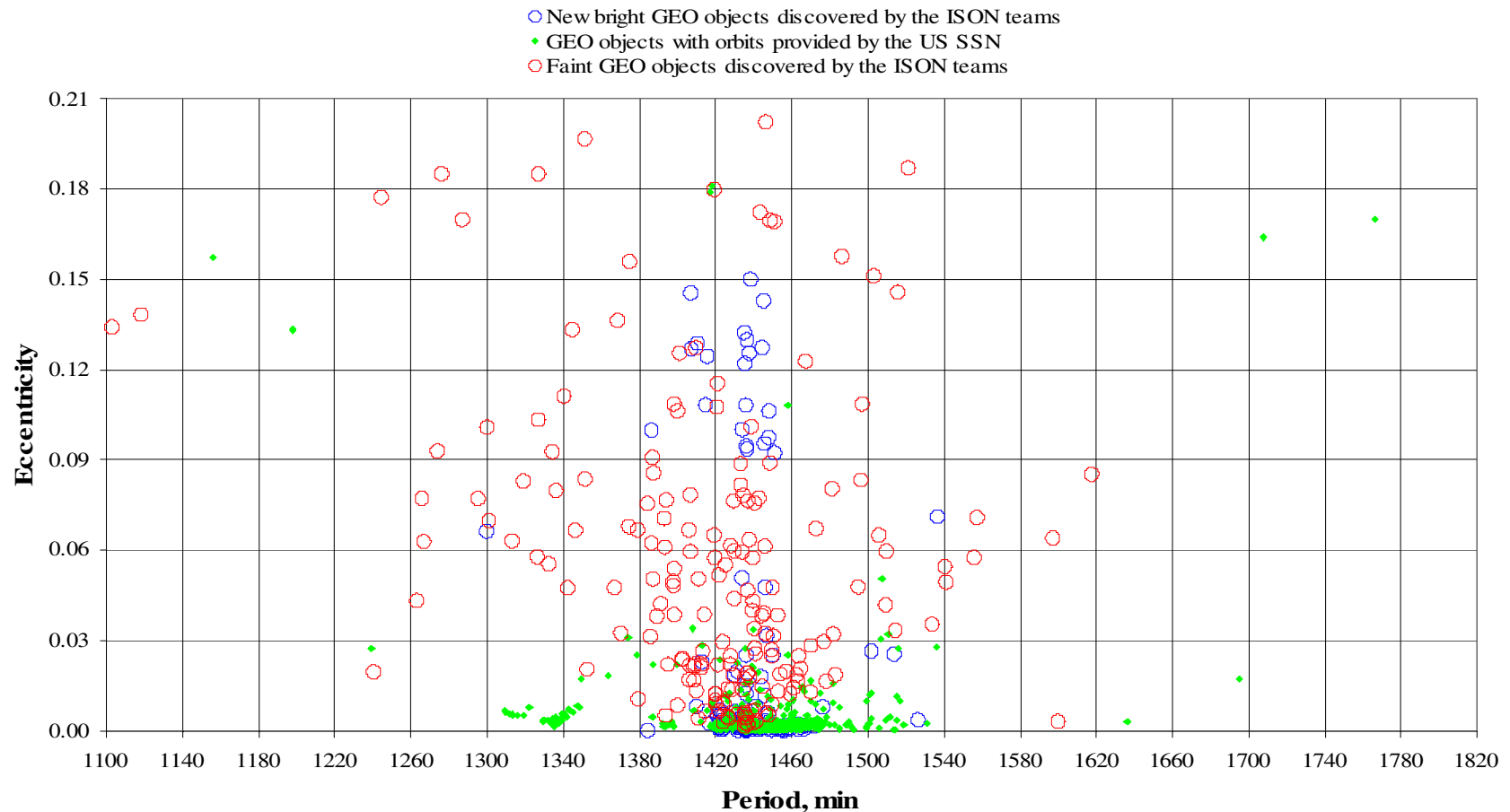
All known GEO objects population orbital characteristics (cont.)

Distribution of 152 bright and 192 faint GEO objects discovered by the ISON and 965 objects with orbits provided by the US SSN by period and inclination

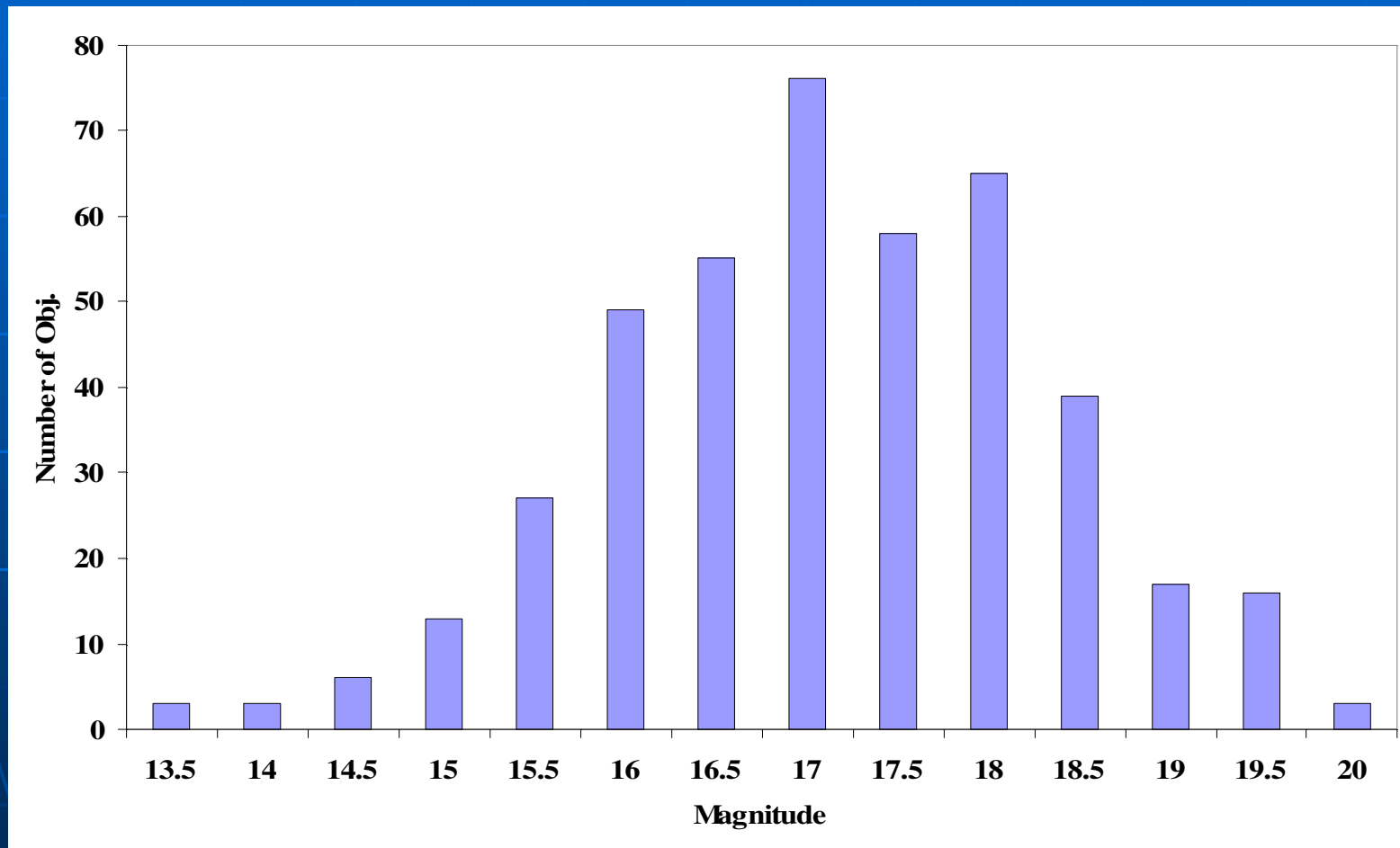


All known GEO objects population orbital characteristics (end)

Distribution of 152 bright and 192 faint GEO objects discovered by the ISON and 965 objects with orbits provided by the US SSN by period and eccentricity

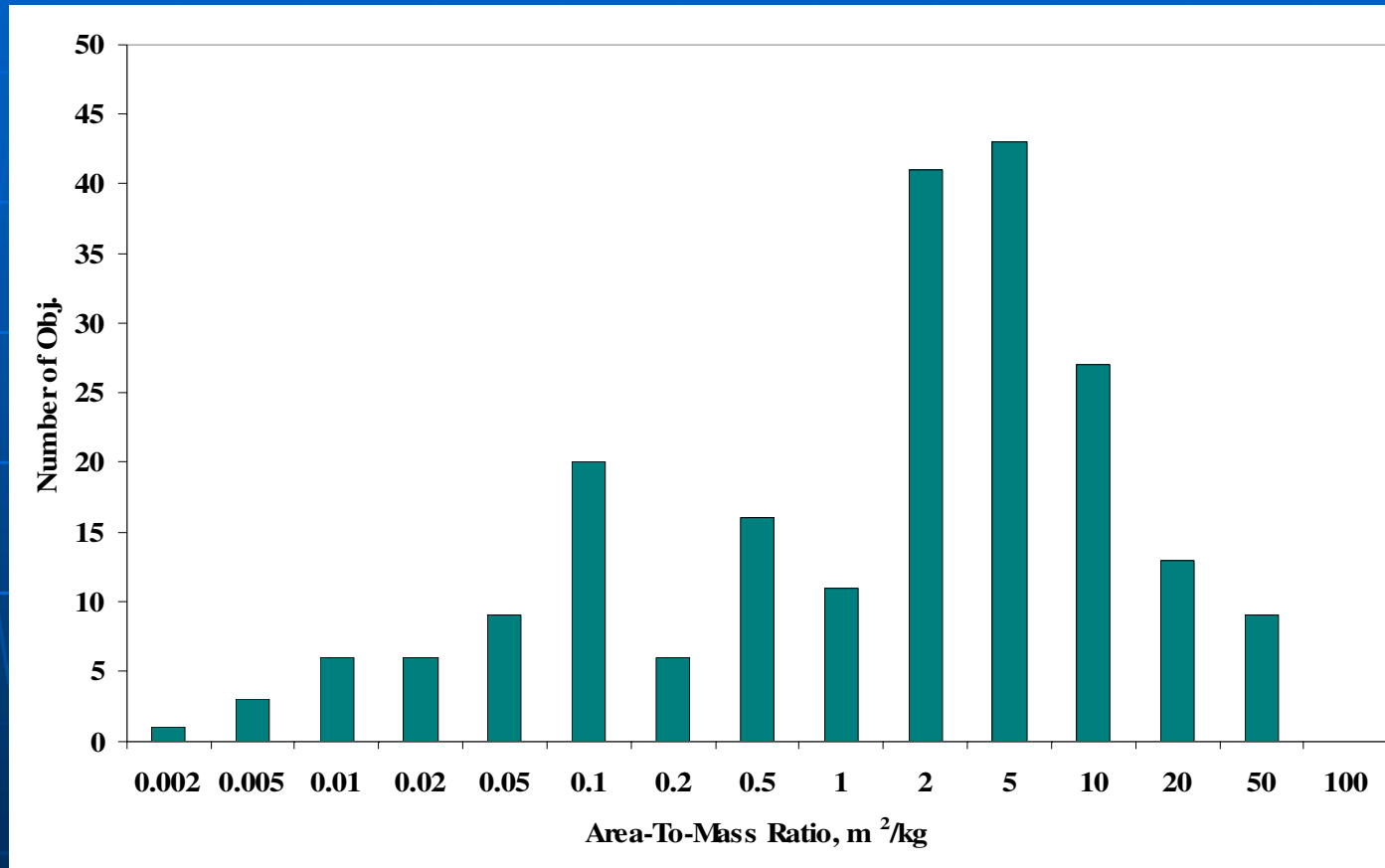


Discovered GEO space debris population characteristics



Distribution of average brightness for 434 fragments

Discovered space debris population characteristics



Distribution of average AMR value for 211 fragments

Operational GEO objects orbital motion characterization

New classification of orbits for GEO operational satellites is proposed based on analysis of obtained data.

Following classes of satellites are observed:

- C1** – maintaining longitude and near-zero inclination
- C2** – maintaining longitude only
- C3** – maintaining longitude and non-zero inclination
- C4** – maintaining non 'true GEO' period and near-zero inclination while remaining in GEO protected region
- C5** – making manoeuvres on non 'true GEO' period orbit (including graveyard one) while remaining in defined GEO region

Each class can be divided into two subclasses:

- orbits with eccentricity less than 0.001
- orbits with eccentricity between 0.001 and 0.15

Operational GEO objects orbital motion characterization (cont.)

As of Jan 2009 operational spacecraft are distributed in accordance with the proposed classification as follows:

C1 – 256
C2 – 122
C3 – 1
C4 – 2
C5 – 1

There are nearly 90 GEO orbital slots where operational satellites are co-locating (i.e. maintaining their average longitude within common 0.5 degree longitude space). In many cases these satellites belongs to different operators and even to different nations.

Observations obtained by ISON shows that sometimes co-located operational GEO spacecraft are moving in dangerous proximity of each other probably due to absence of coordination and data sharing between operators

GEO space debris population

- Surprisingly, number of discoveries of relatively bright GEO debris objects (brighter than 16 magnitude) continues to grow. Every month at about 10 new of such debris objects are discovering
- Many of newly discovered GEO space debris are crossing or permanently staying in GEO protected region increasing threat to operational spacecraft. It is important to discover as many such debris as possible and understand the sources from which they are originating
- It is expected that at least another several hundreds of GEO space debris brighter than 18th magnitude (that corresponds to larger than 30-40 cm in size assuming standard reflectivity characteristics) exist in GEO region. Number of fainter (and thus smaller) objects is not yet estimated correctly

Conclusions

- Deep study of GEO population by ISON network continues. Nearly 1420 objects in GEO region are already continuously tracking. Information obtained by the ISON is more complete and usually more accurate than publicly available data providing by the U.S. Space Surveillance Network
- Quantity and quality of obtaining information permit to perform analysis of potentially dangerous situations in GEO (close encounters of non-cooperating operational spacecraft as well as space debris approaches to functioning satellites)
- Success of the ISON project proved feasibility of creation of international observation network and data center (similar to the Minor Planet Center) on space debris information for high altitude (GEO, MEO, GTO and other HEO) objects in full compliance with the UN General Assembly Resolution 62/217
- Organizations and researcher from all nations are welcome to join ISON project