

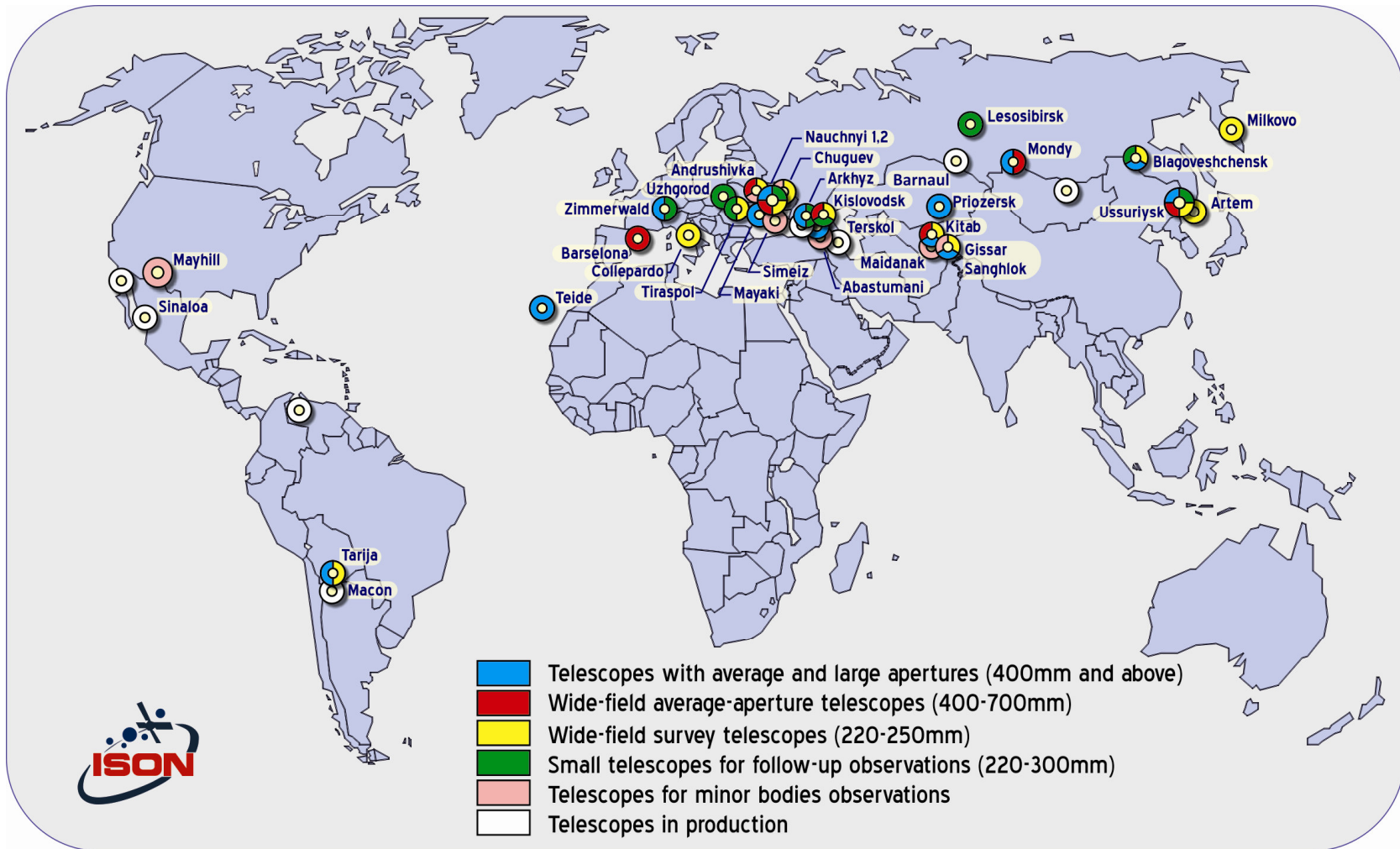


Russian Academy of Sciences
Keldysh Institute of Applied Mathematics

Results of GEO and HEO space debris population research and asteroids study within the framework of ISON international project in 2011

49th session of STSC of COPUOS
Vienna
6-17 Feb 2012

ISON Current Status



ISON – International Scientific Optical Network

As of Dec 2011 joins:

- Observation scheduling, coordination and data processing center (KIAM RAS)
- 27 facilities in 12 countries
with 42 telescopes of different class (aperture from 19 cm to 2.6 m)
- Company for the network maintenance and instruments development (ASC Project-Technics)

ISON Research Goals in Space Debris Area

- Estimation of real population of space debris at higher geocentric orbits
- Determination of physical properties of discovered space debris objects
- Determination of probable sources of newly discovering space debris fragments
- Verification of existing models of space debris distribution and evolution at higher orbits
- Higher orbit space debris risk assessment
- Improvement of technologies of studying of space debris population using optical instruments
- Improvement of motion models for space debris objects with complex physical properties

Development of ISON in 2011

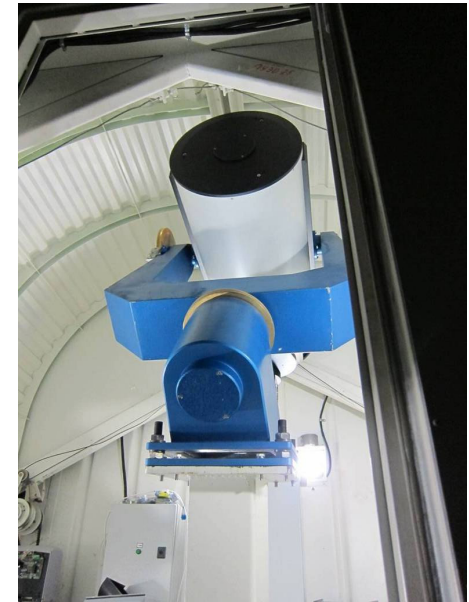
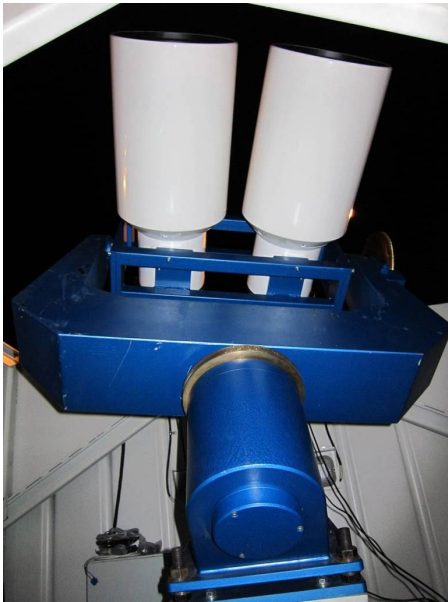
5 new telescopes put into operation and 1 more joined ISON project. Unified GEO survey scheduling is implemented.

Construction of 14 new observation instruments of different class (twin 19 cm, 25 cm, 40 cm, 50 cm and 65 cm apertures) initiated and supported by special grant of Roscosmos is finished. The first group of instruments is deployed at North Caucasus facility near Kislovodsk (Russia).

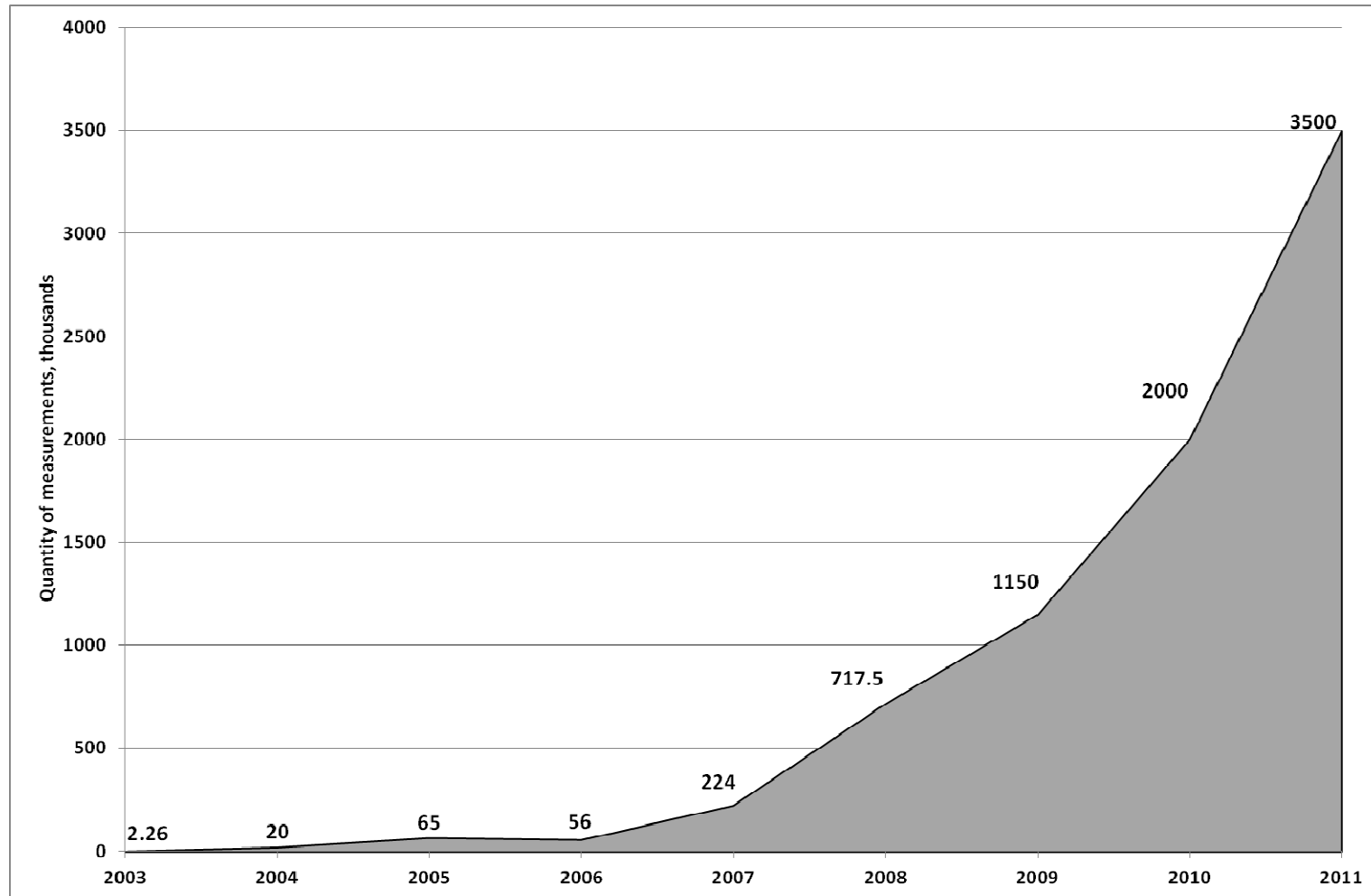
Construction of 6 new observation instruments and special equipment for two large telescopes of Byurakan observatory is started.

Negotiations took place with colleagues from Argentina, Indonesia, Mexico and Spain about initiation of joint projects with ISON. Collaboration with Spain partners (Telescope Fabra ROA Montsec project) already started.

Newly developed ISON instruments

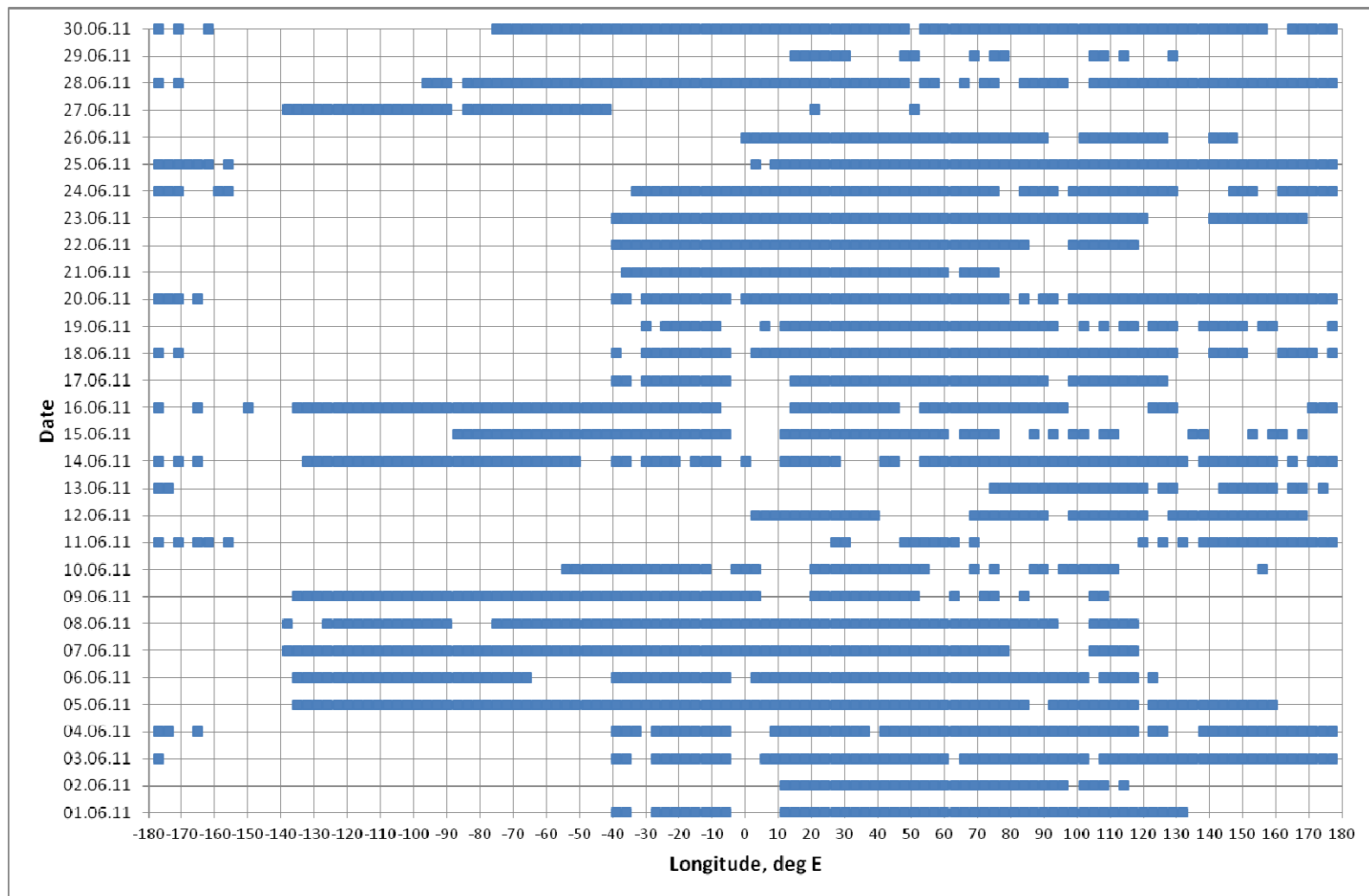


Quantity of measurements accumulated by ISON instruments (by year)



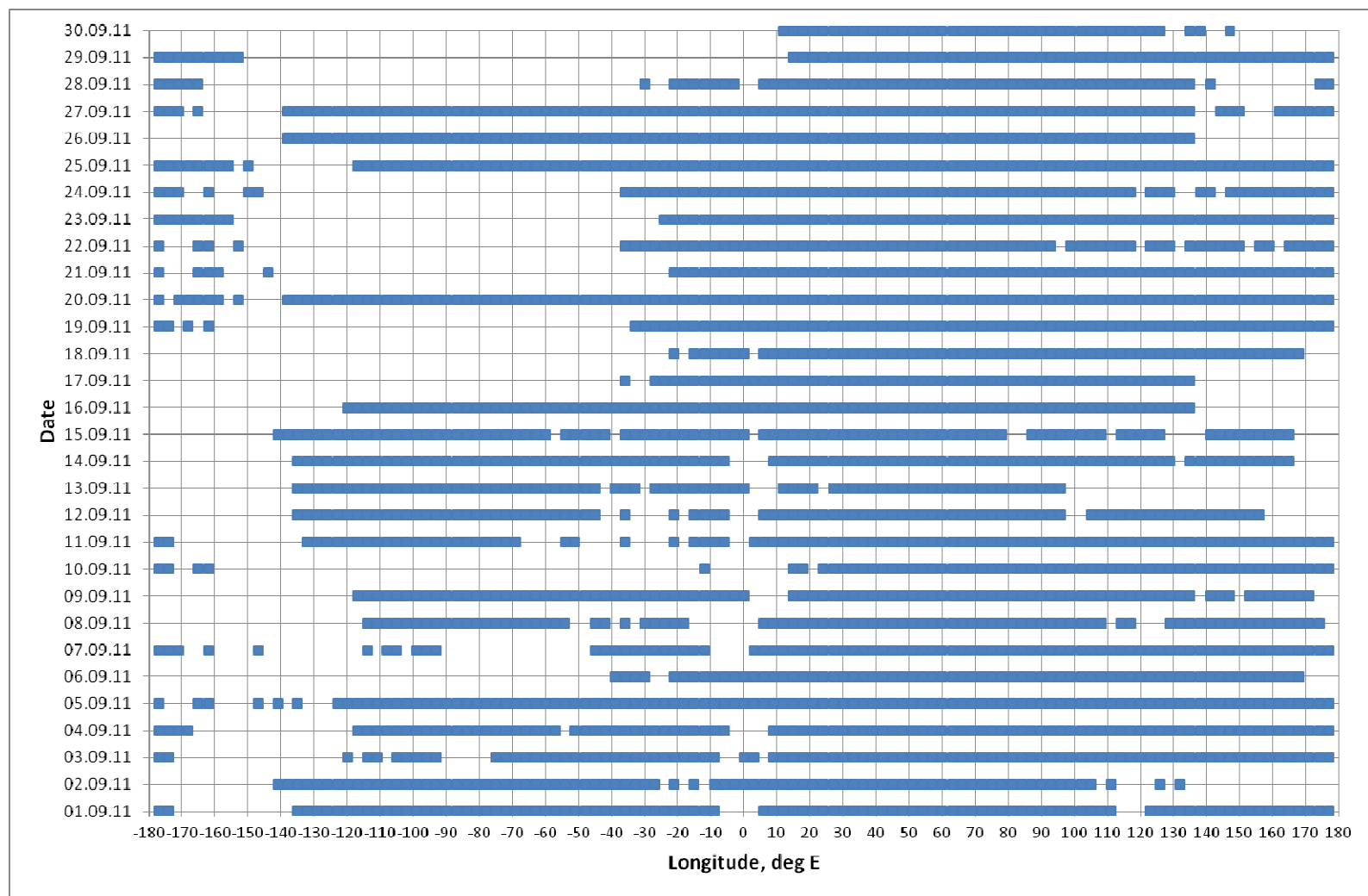
GEO Longitudes Coverage by ISON.

June 2011

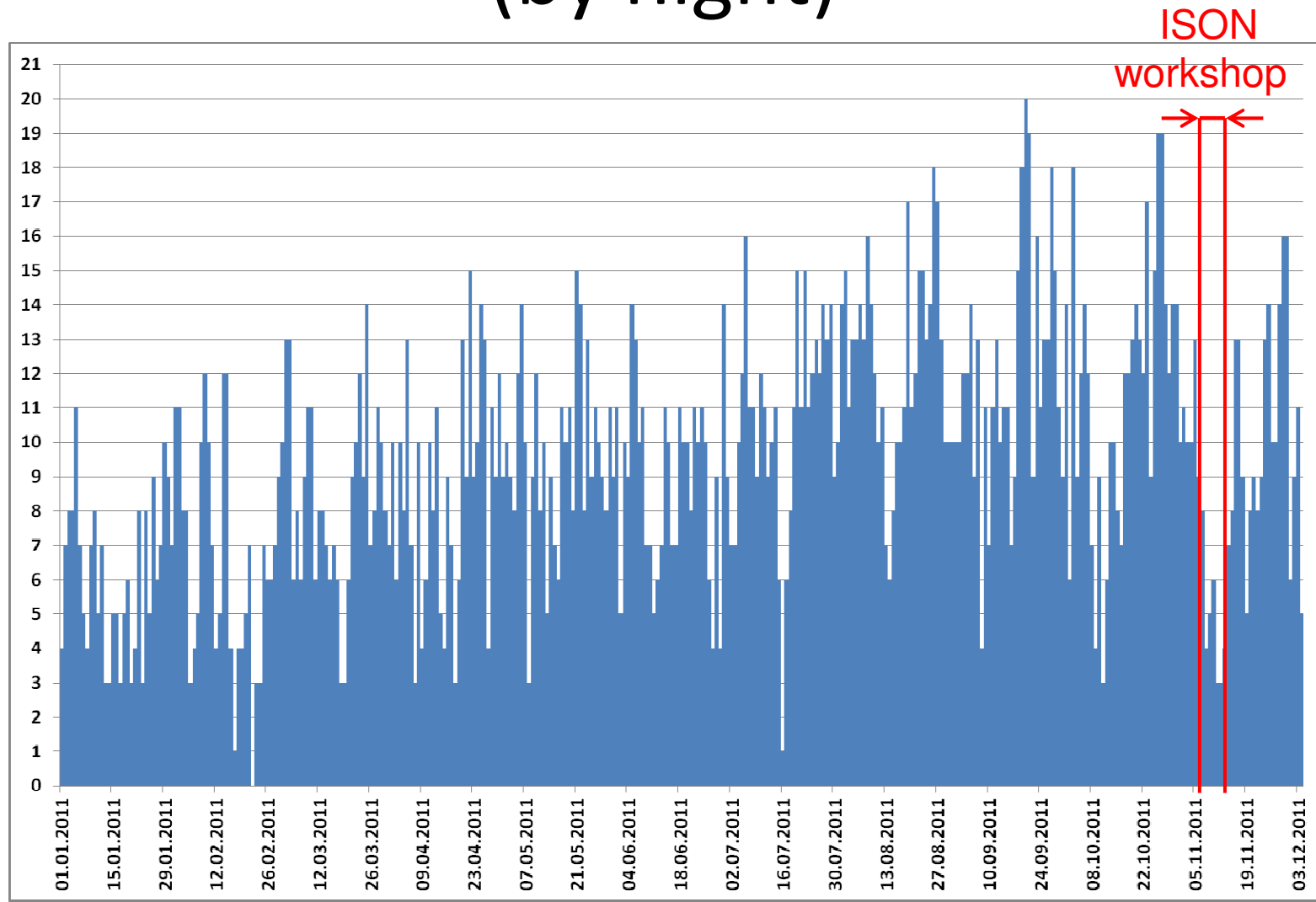


GEO Longitudes Coverage by ISON.

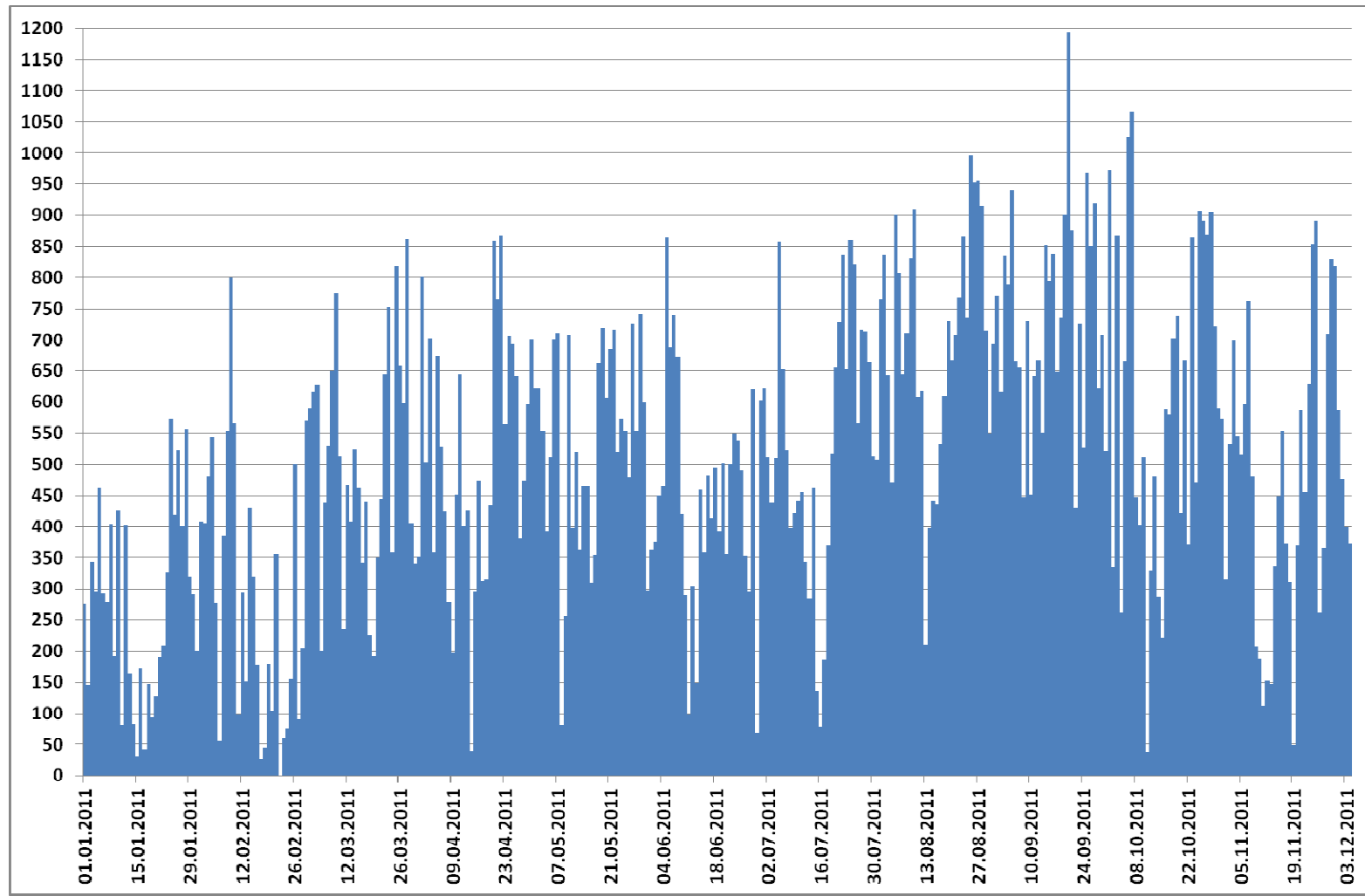
September 2011



Number of telescopes worked in 2011 (by night)



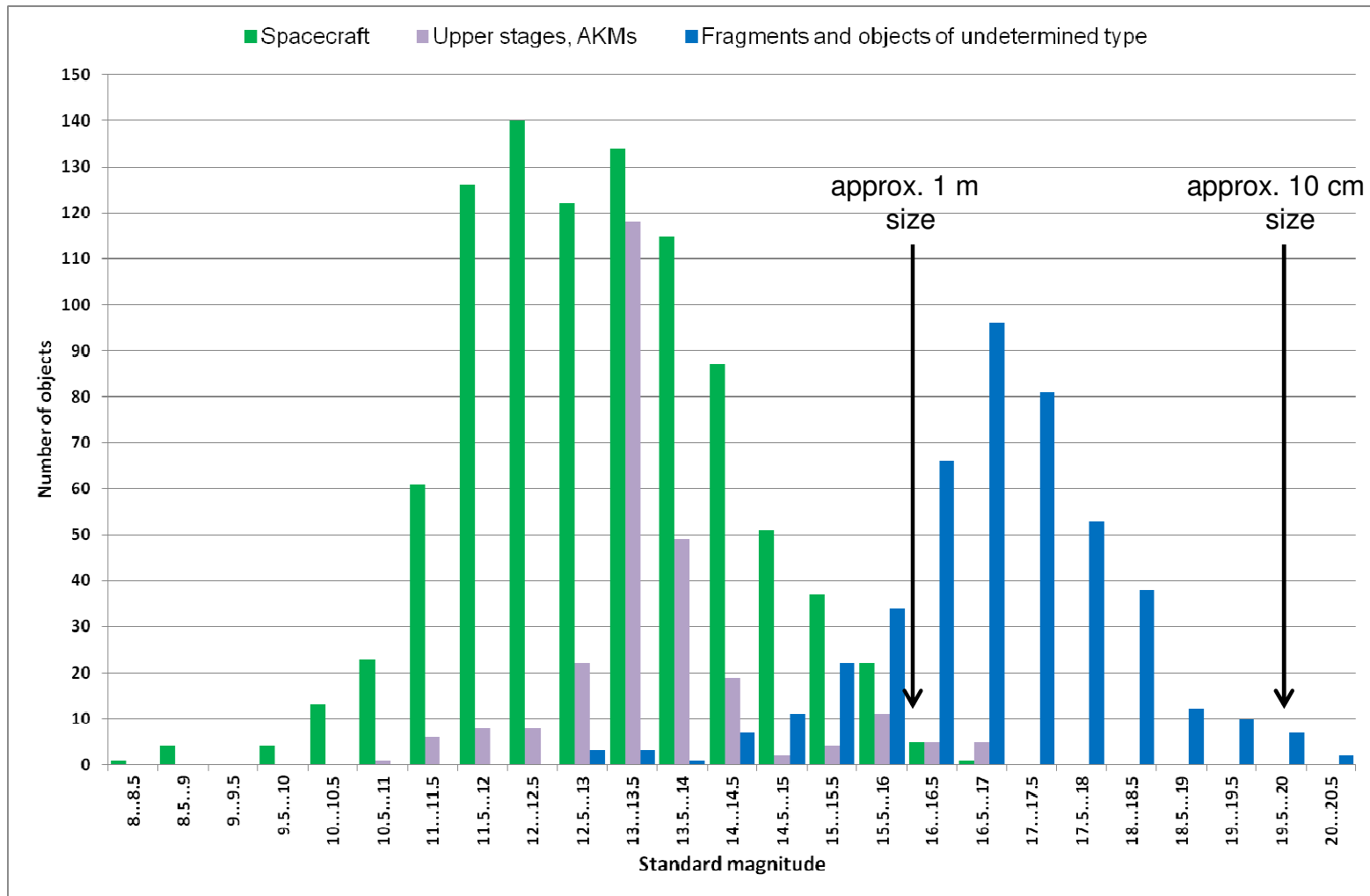
Number of individual objects observed in 2011 (by night)



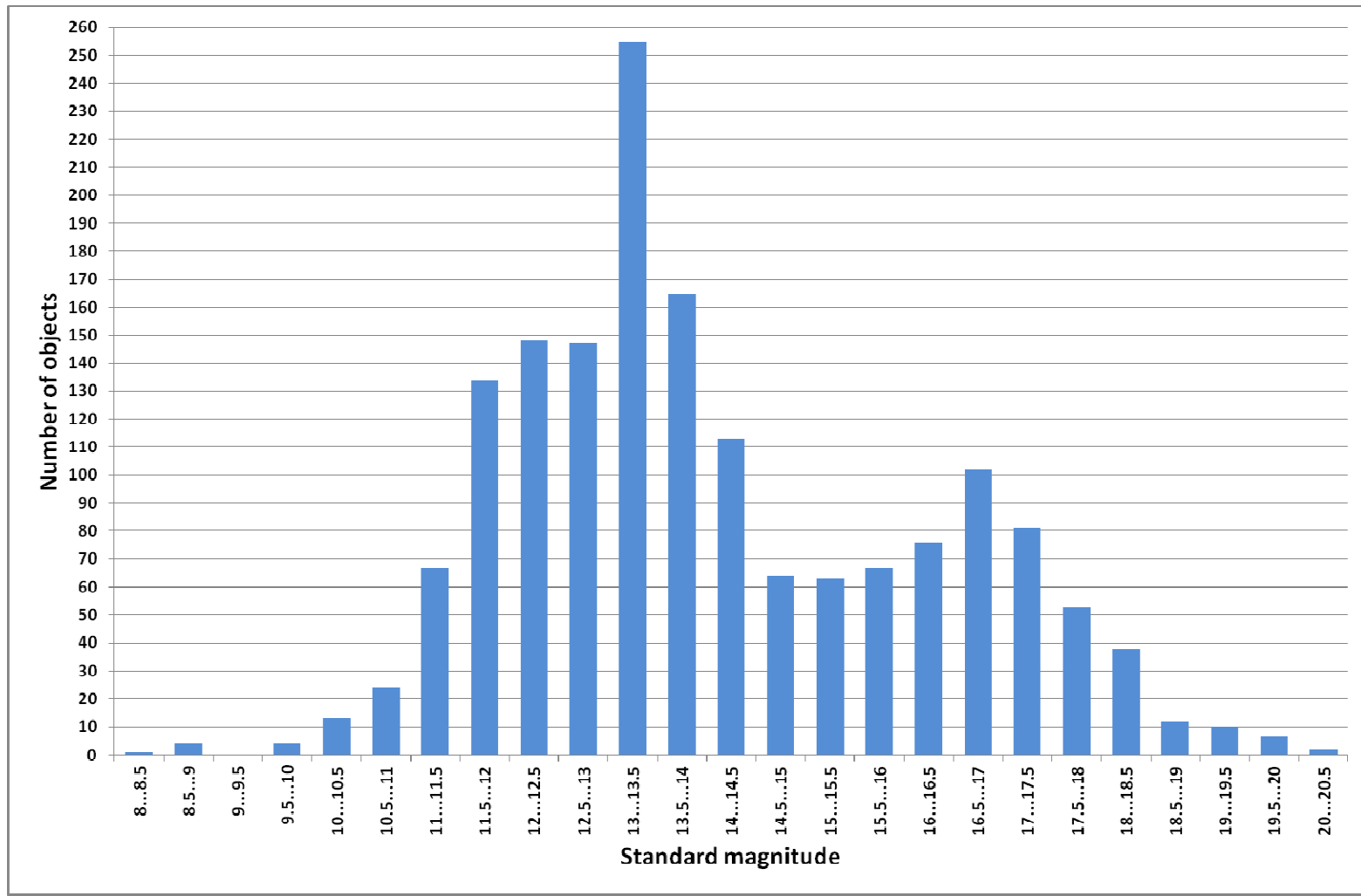
ISON Monitored GEO Region Objects

- 1557 GEO region objects were tracked by ISON early 2011 (compare 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 by ISON in 2011
- 1704 GEO region objects are in the ISON database as of 31.12.2011

ISON Tracked GEO Objects Distribution by Standard Magnitude – 1704 objects

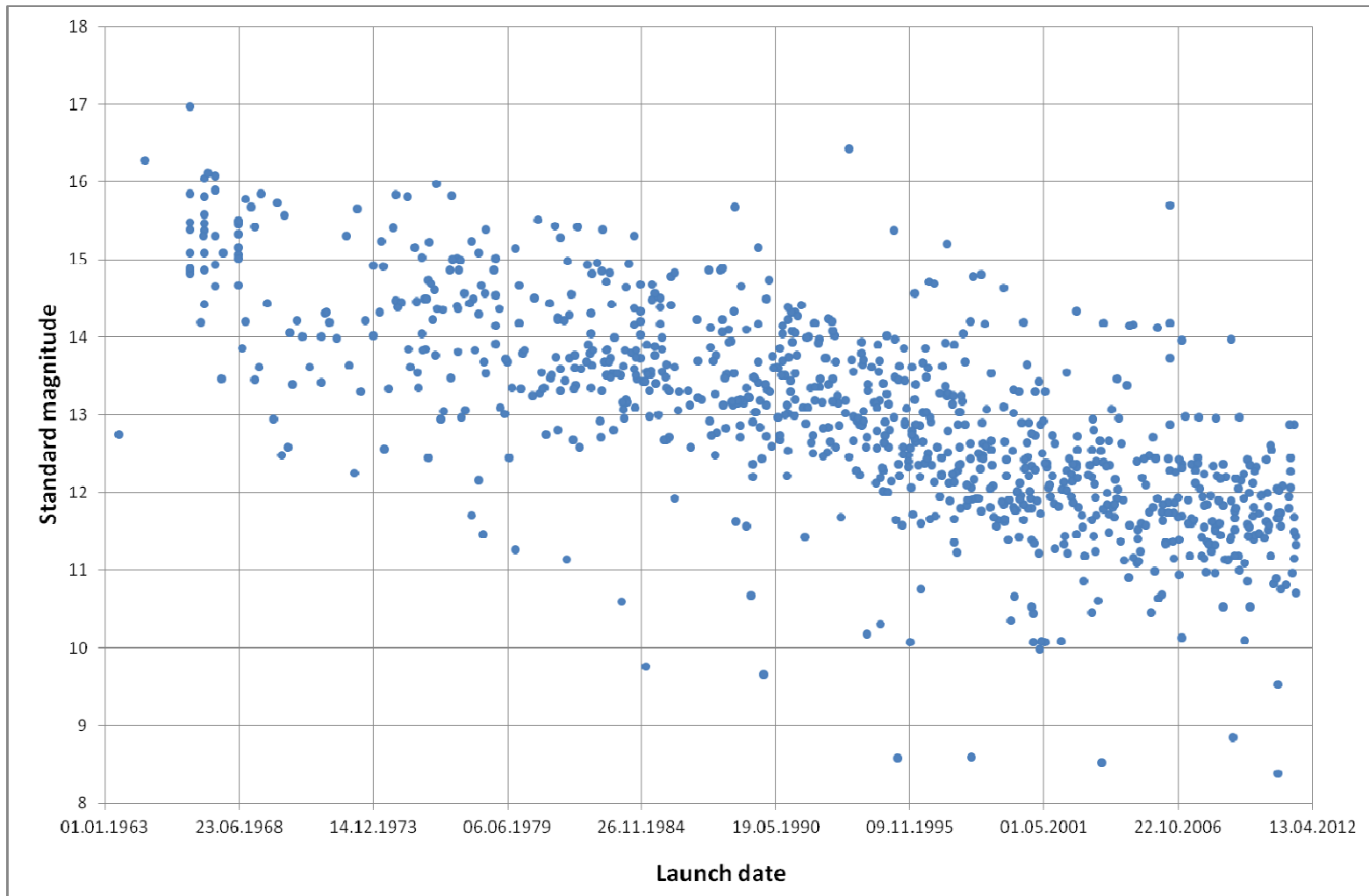


ISON Tracked GEO Objects Distribution by Standard Magnitude – 1704 objects

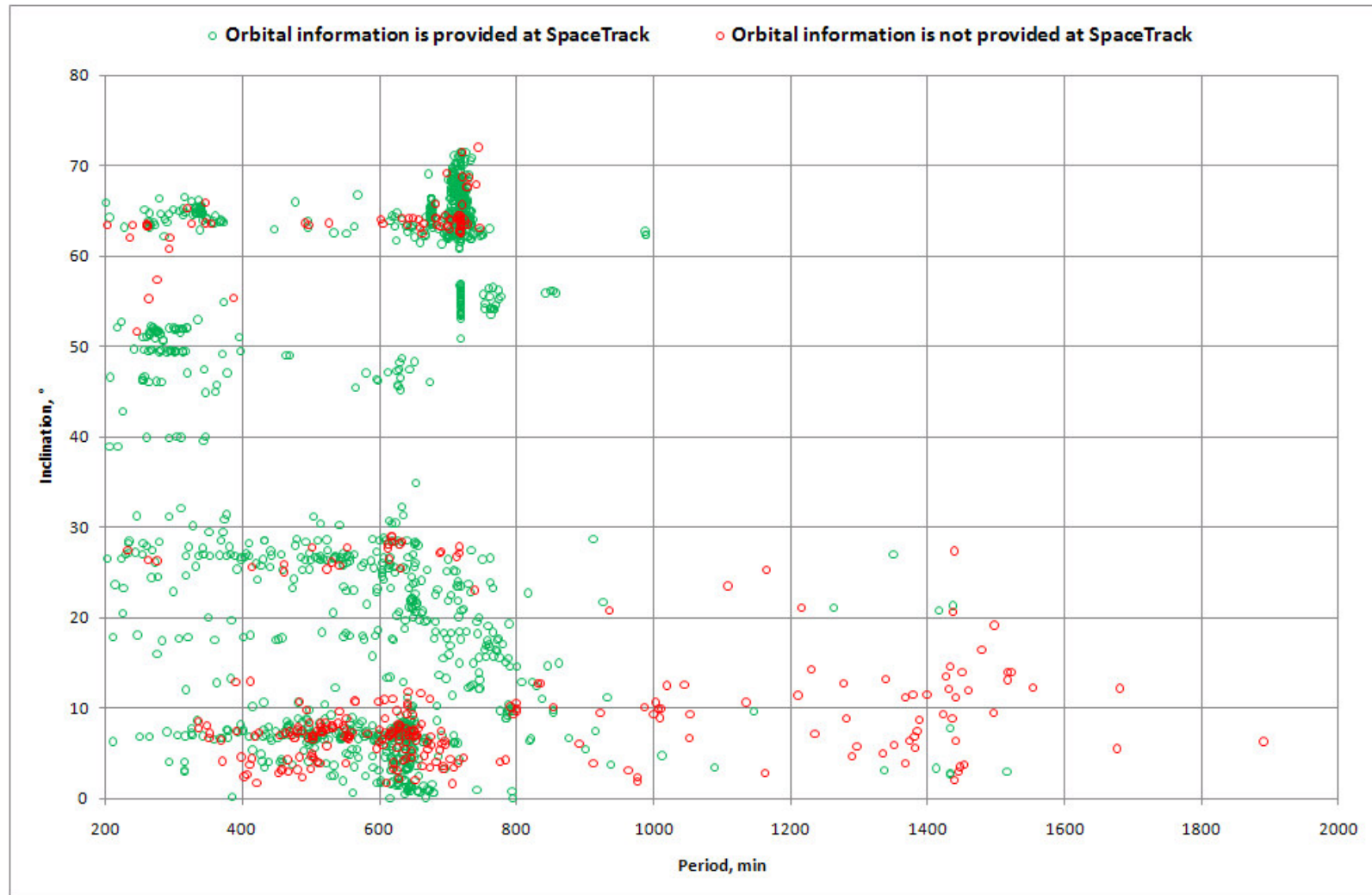


ISON Tracked GEO Spacecraft

Standard Magnitude vs. Launch Date



HEO and MEO Objects



GEO Spacecraft Conjunction Assessment. Ekspress 4A Example

Ekspress 4A and Cosmos-2319 :

09.09.2011 16:20:41.2 UTC, min distance - 1.91 км

Relative position vector components:

$dR = 1.68 \text{ км}, dI = 0.89 \text{ км}, dC = 0.08 \text{ км}$

Estimated position errors at the moment of predicted conjunction (1 sigma):

Ekspress 4A:

$sR = 0.07 \text{ км}, sI = 0.13 \text{ км}, sC = 0.05 \text{ км}$

Cosmos-2319:

$sR = 0.11 \text{ км}, sI = 0.20 \text{ км}, sC = 0.08 \text{ км}$

ISON Asteroid Observation Subsets

Two subsets of telescopes are formed during the last three years as part of ISON with the goal of asteroids study. Formation of the third subset takes place at present.

- (I) Several telescopes (with apertures more than 40 cm) are involved to carry out the photometry of asteroids
- (II) Two wide-field telescopes (45.5 cm and 60 cm) are used for asteroids search. The main objects of our interest are NEAs. We have plans to install few more telescopes (50 cm and 65 cm) for asteroid surveys.
- (III) New subset of several dedicated telescopes (35 cm, 40 cm and 50 cm) is forming to react to the Gaia-produced alerts and to perform follow-up observations of NEAs discovered by ISON observatories.

NEAs Search by ISON

Two remotely controlled telescopes are involved into asteroid search:

- 45.5 cm telescope Centurion-18 at H15 ISON-NM Observatory, Mayhill, USA;
- 60 cm telescope at A50 Andrushivka Astronomical Observatory, Ukraine.

Both telescopes have relatively wide field of view: 100x100 and 51x51 arcmin.

45.5 cm telescope (f/2.8)
Mayhill, New Mexico



60-cm telescope (f/4)
Andrushivka, Ukraine



ISON Results of Asteroid Surveys in 2011

H15 ISON-NM Observatory started asteroid searching in July 2010.

During 2011 the 45.5 cm telescope:

- produced 135302 measurements (8th place among all the world observatories) for 30818 asteroids and 43 comets,
- discovered 768 new asteroids.

Since the beginning of operation more than 900 asteroids are discovered including 2 NEAs (2010 RN80, 2011 QY37), 5 Trojans (2011 QJ9, 2011 QQ47, 2011 YA3, 2012 AF1, 2012 BB27).

2 new comets (C/2010 X1 (Elenin), P/2011 NO1 (Elenin) are discovered as well.

A50 Andrushivka Astronomical Observatory began asteroid surveys in 2003. In 2011 there it produced 33034 measurements (13th place among all the world observatories) for 9339 asteroids and 3 comets with 60-cm telescope. 72 discoveries of new asteroids were made. One interesting object is discovered - 2011 HY52.

The world results of asteroid surveys in 2011 (based on data provided by MPC)

№	MPC Code	Name	Total observations	Total objects	Numbered MPs	Unnumbered MPs	Comets	% Num. MPs	% Unnum. MPs	% Comets
1	G96	Mt. Lemmon Survey	1751716	238345	172227	66118	60	72.26%	27.74%	15.67%
2	704	LINEAR	1712623	124659	119064	5595	74	95.51%	4.49%	19.32%
3	703	Catalina Sky Survey	1349735	136545	122517	14028	66	89.73%	10.27%	17.23%
4	F51	Pan-STARRS 1	1270637	214701	160693	54008	53	74.85%	25.15%	13.84%
5	691	Spacewatch	686175	112611	86115	26496	19	76.47%	23.53%	4.96%
6	E12	Siding Spring Survey	213861	31052	29028	2024	20	93.48%	6.52%	5.22%
7	D29	Purple Mountain Obs.	185854	40523	37627	2896	11	92.85%	7.15%	2.87%
8	H15	ISON-NM Observatory*	135302	30818	27188	3630	43	88.22%	11.78%	11.23%
9	106	Črni Vrh Observatory	85133	18770	17989	781	9	95.84%	4.16%	2.35%
10	291	Spacewatch II	52006	12982	8606	4376	28	66.29%	33.71%	7.31%
...										
13	A50	Andrushivka Obs.*	33034	9339	8634	705	3	92.45%	7.55%	0%

* - ISON observatories

Conclusions

- ISON network collects on a routine basis astrometric and brightness measurements for more than 1700 objects in GEO region and more than 600 objects at HEO orbits
- Obtained measurement data are processing to improve orbits and to find various events (appearance of a new object due to launches, fragments separation etc., possible close encounter, manoeuvres of different purpose)
- Accumulated information is using to support spaceflight safety tasks, including those ones solving within the framework of ASPOS OKP system by Roscosmos jointly with RAS
- ISON produced first results within asteroid research program
- Development of ISON – the first international network for monitoring near-Earth space – continues and all nations are welcome to join us

Thank you for your attention!