

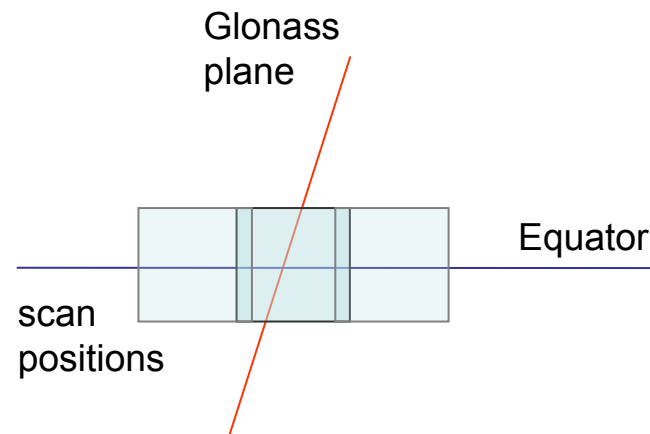
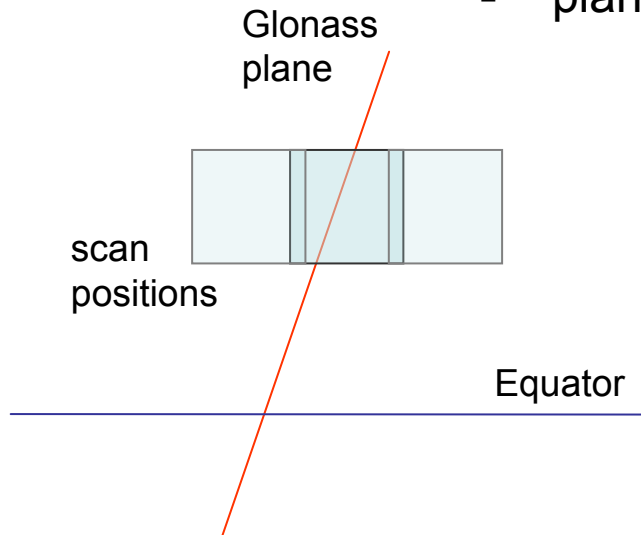
# Sampling MEO orbits

P. Herridge and J. Dick  
Space Insight Ltd.

# Survey scheme

2 surveys of Glonass plane at  $\Omega \sim 334^\circ$

- 10 nights at equator crossing point
- 4 nights at  $15^\circ$  above equator crossing
- 3 position scan across Glonass plane
- plane selected closest to Earth shadow point



# Sensor information

UK MoD PIMS-FX wide field of view technology demonstrator

Small aperture – 10 cm

Large field of view –  $4^\circ \times 4^\circ$

Piggy backed on PIMS sensor at Herstmonceux, UK



# Resultant observations

## – correlated objects

### Equatorial scans

- 41 MEOs
- 19 MEO rocket bodies (near circular at MEO)
- 4 MTO bodies (apogee < 26,000 km)  
including 2 launch failures
- 47 GEOs
- 15 GEO rocket bodies (near circular at GEO)
- 23 GTOs
- 1 polar orbit

# Resultant observations

## – correlated objects

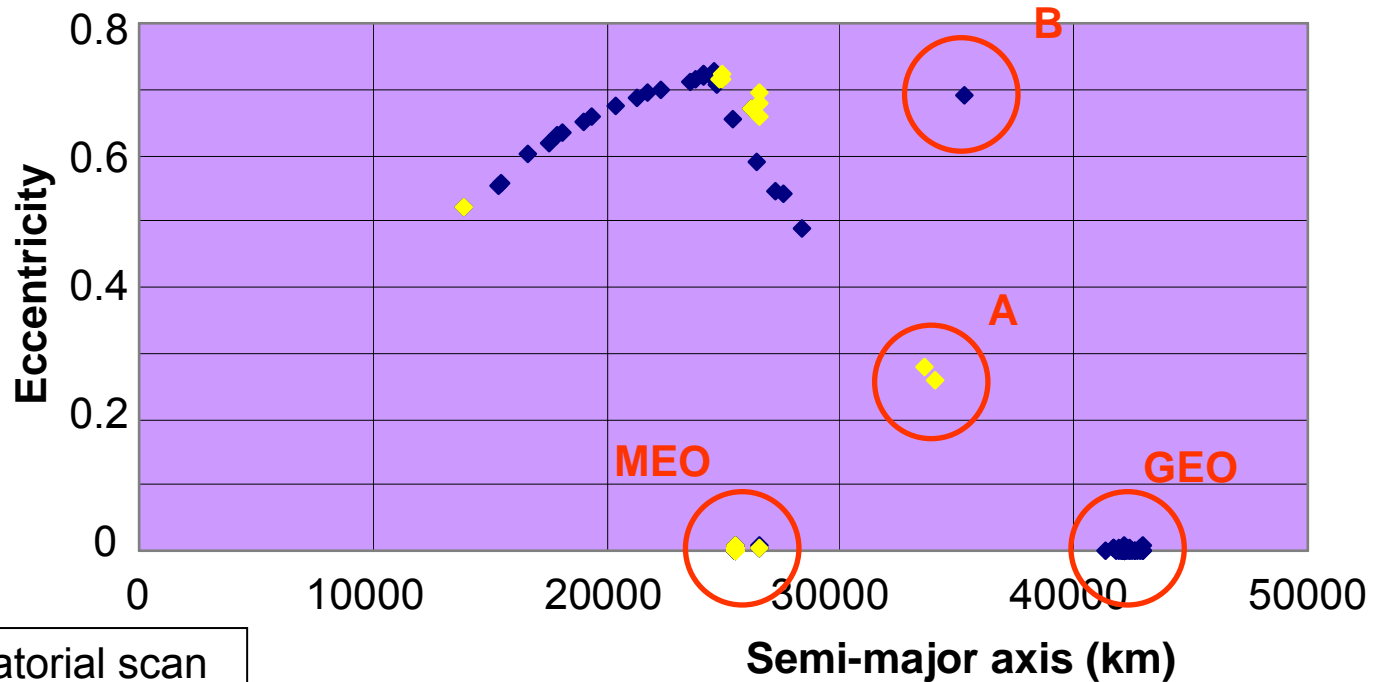
### +15° scans

- 14 MEOs
- 8 MEO rocket bodies (near circular at MEO)
- 1 MTO bodies (apogee < 26,000 km)
- 7 GTOs
- 2 stranded GTOs
  
- no GEOs or GEO rocket bodies

Nearly half of these objects were common with the equatorial scans

# Eccentricity – Semi-major axis

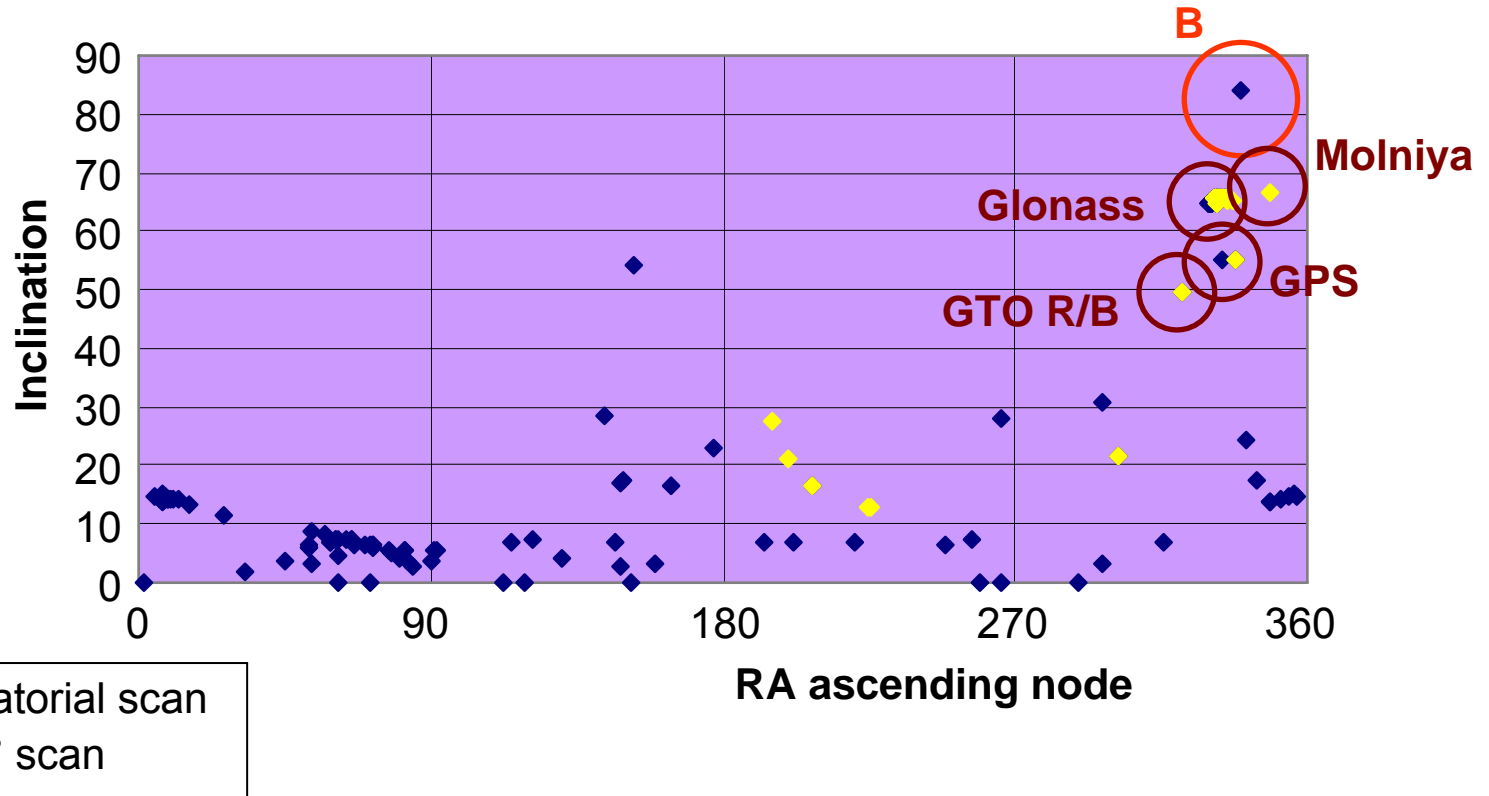
## – correlated objects



**A 2004-050A/B US Demo satellite and Delta 4 R/B**  
**~13° inclination, ~1.4 revs/day, apogee ~42940km, perigee ~25000km**

# Inclination – Node

## – correlated objects



**B 1996-013A NASA “POLAR”**  
**84° inclination, 1.3 revs/day, apogee 59600km, perigee 11120km**

# Summary of correlated objects

- wide variety of objects from both scan schemes
- MEOs in both scan schemes
  - 40% of objects in equatorial scans
  - 70% of objects in +15° scans
- many GEOs in equatorial scans
  - no GEOs in +15° scans
- many GTO objects
- some “unusual” orbits



# Uncorrelated objects

101 uncorrelated objects

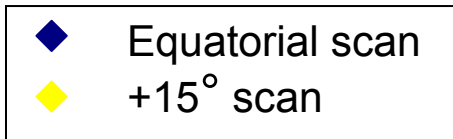
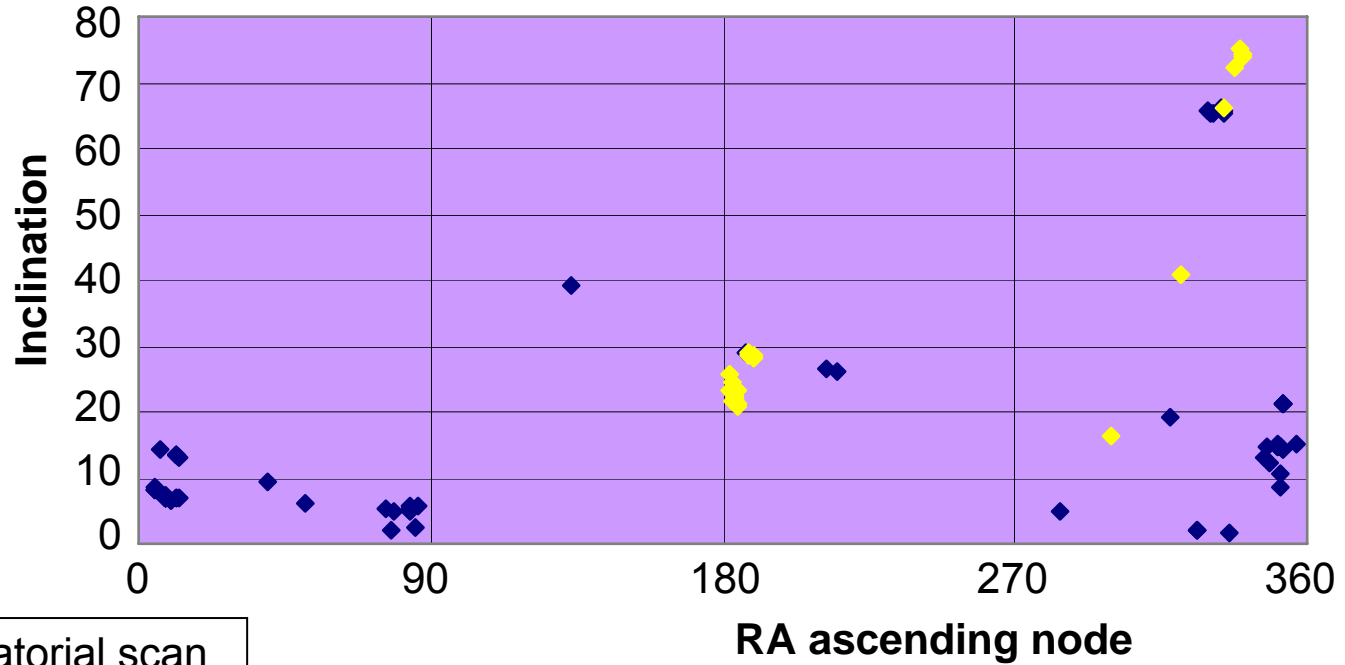
- 72 from equatorial scan
- 29 from +15° scan

No attempt made to cross correlate objects

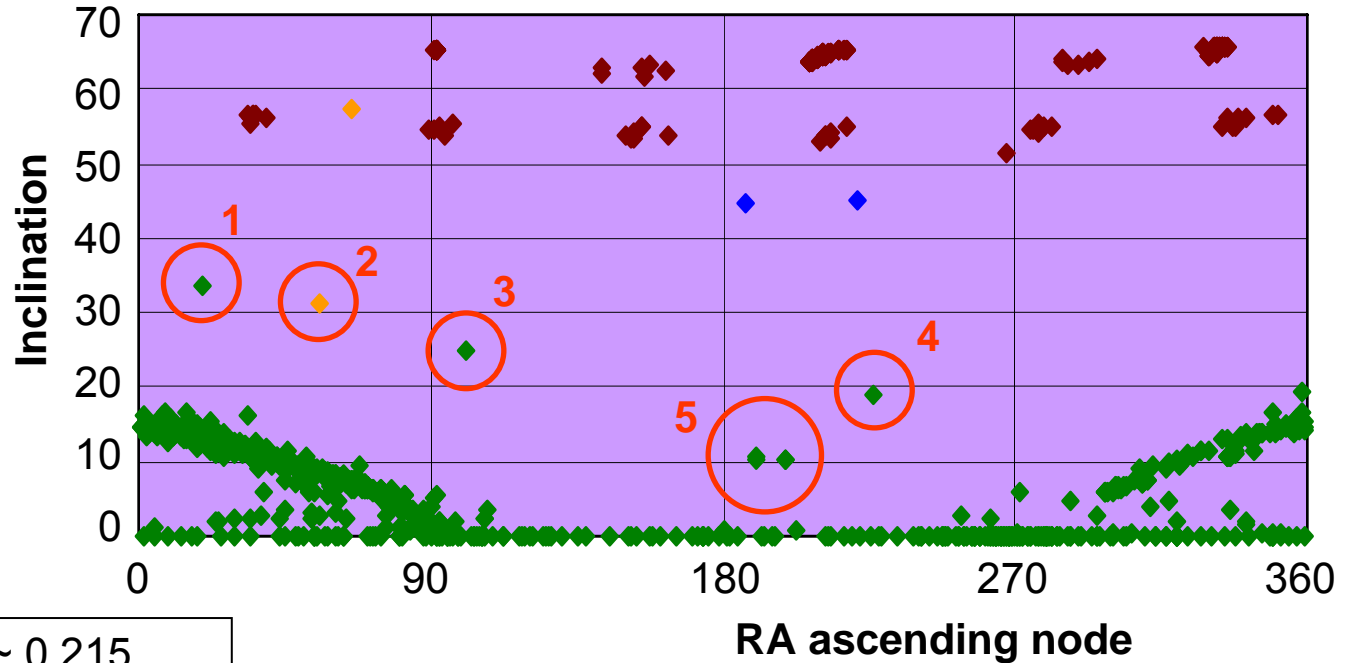
Wide range of visual magnitudes from ~ 6 to ~ 14

# Inclination – Node

– UCTs with circular orbit assumption



# NASA catalogued circular orbits (less than 5 revs/day)



- ◆ rpd ~ 0.215
- ◆ 0.85 < rpd < 1.2
- ◆ 1.8 < rpd < 2.2
- ◆ rpd ~ 4

■ Small number of unusual orbits

## “Unusual” circular orbits

			revs/day	Incl.	$\Omega$
<b>1</b>	1963-004A	Syncom 1	1.00946	33.5	20.1
<b>2</b>	1970-027A	Vela 12	0.215	56.2	31.2
<b>3</b>	1963-031A	Syncom 2	1.00249	33.5	100.7
<b>4</b>	1993-015A	USA 98	0.9925	19.2	226.7
<b>5</b>	1976-023A	LES 8 and	1.00273	10.5	190.1
	1976-023J	debris	0.9826	10.2	199.2

### Note

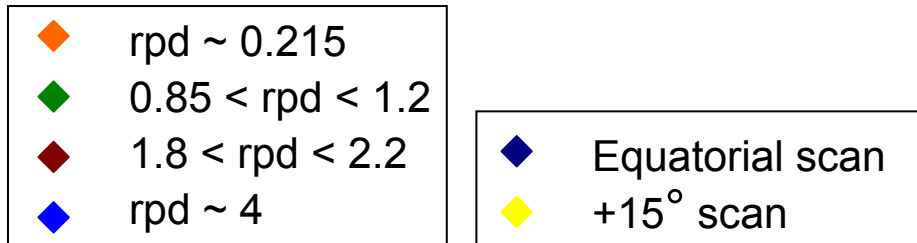
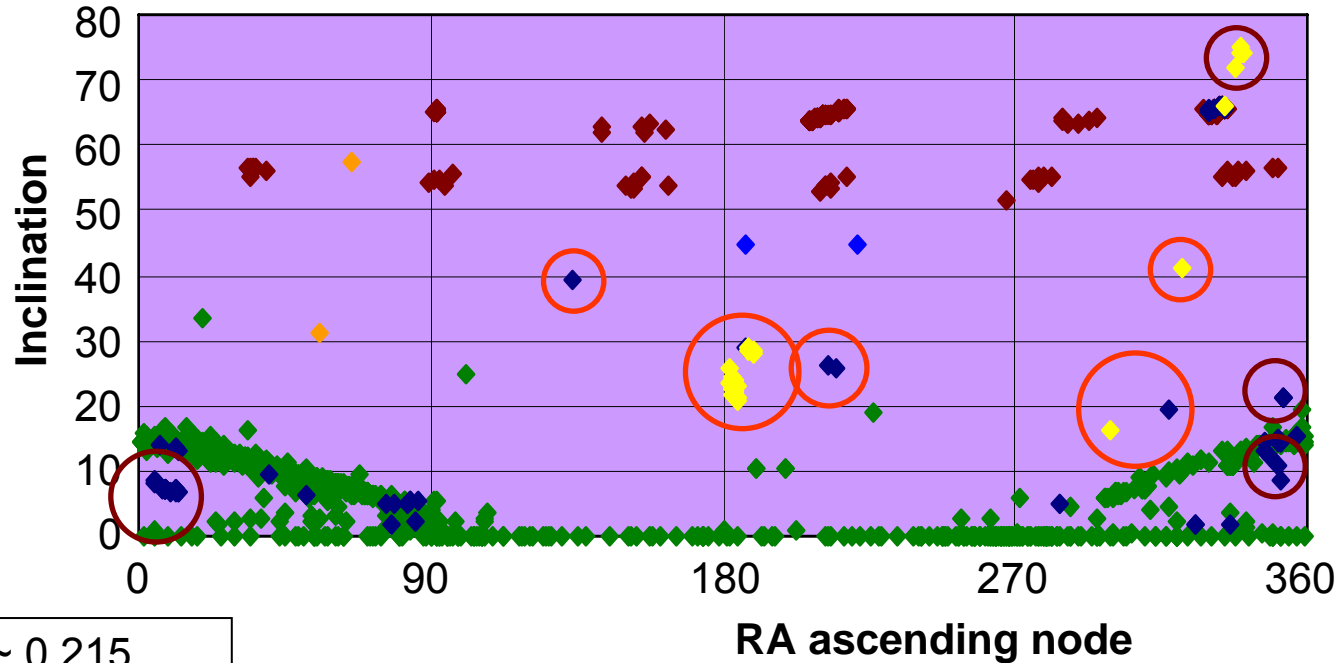
... there are no **circular** orbits with

$$0.215 < \text{revs/day} < 0.85$$

$$1.2 < \text{revs/day} < 1.8$$

$$2.2 < \text{revs/day} < 4$$

# Comparison of UCTs with NASA catalogue circular orbits

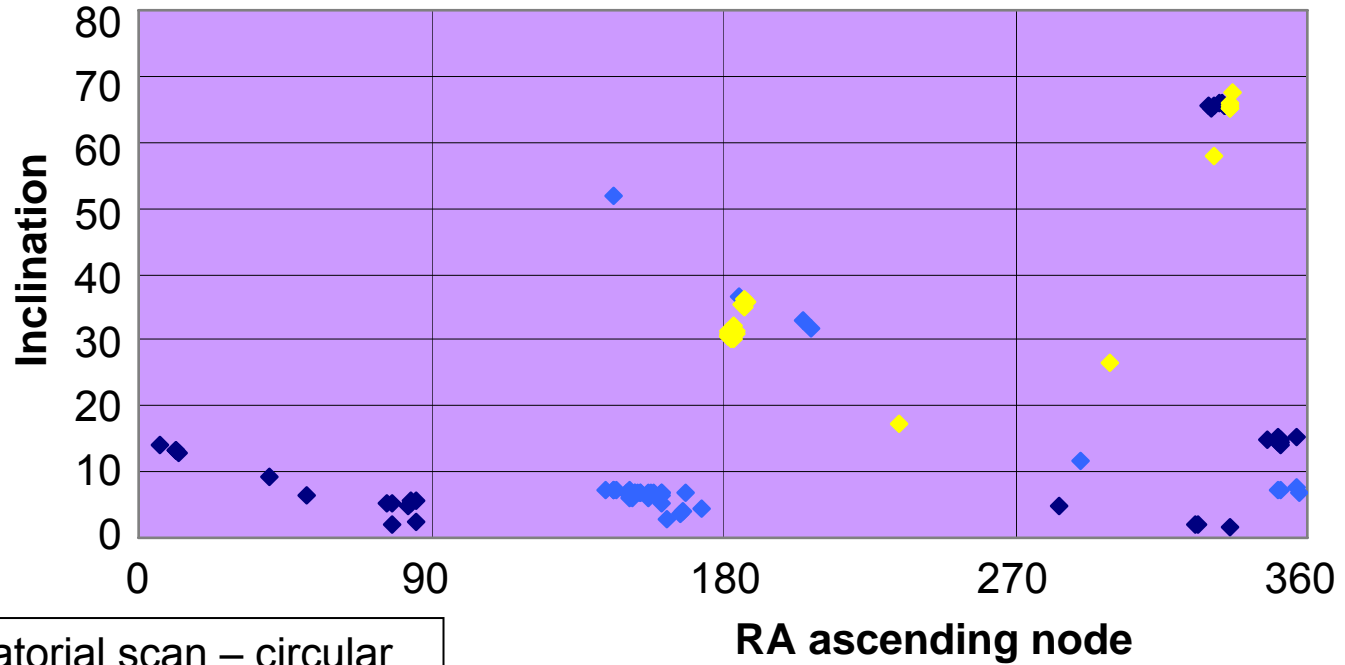


Catalogued objects

Uncorrelated objects

# Inclination – Node

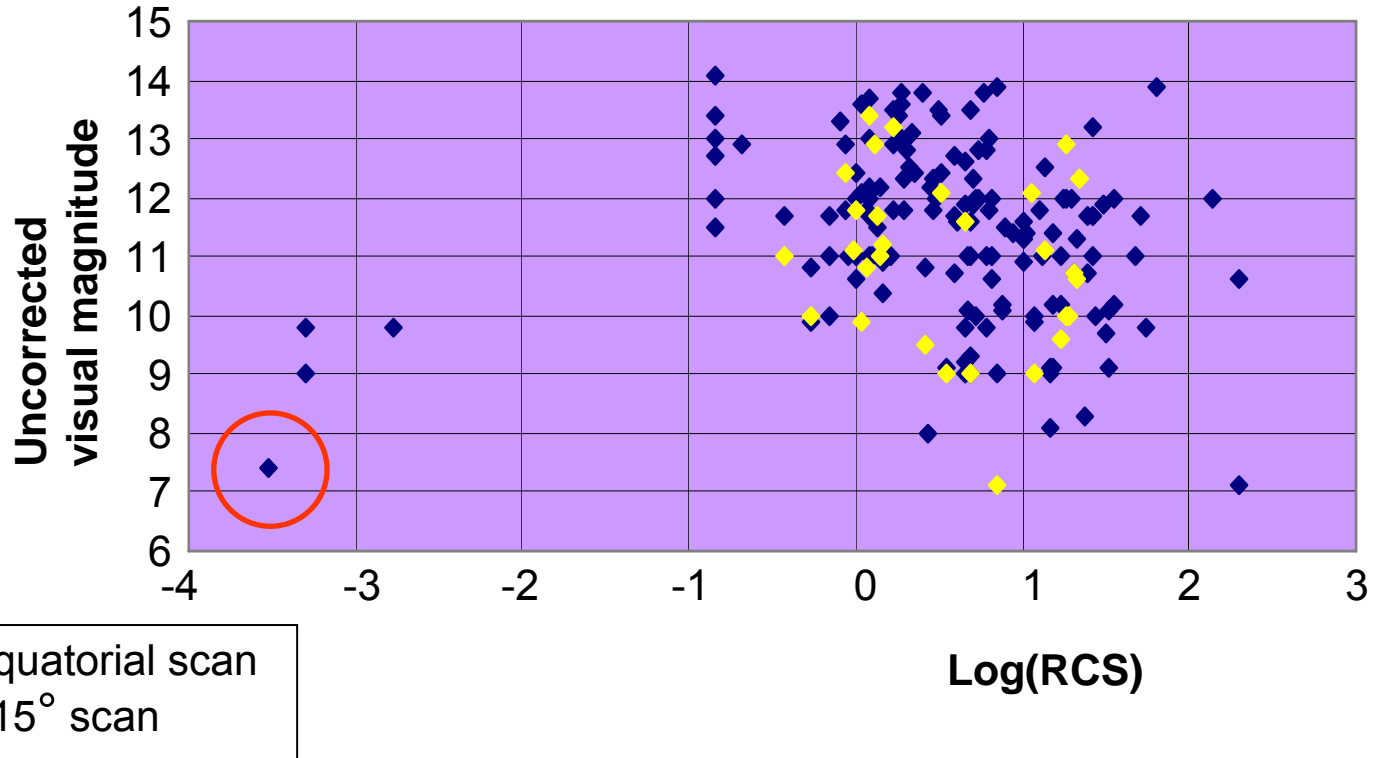
– UCTs with best guess orbits



- ◆ Equatorial scan – circular
- ◆ Equatorial scan – elliptical
- ◆ +15° scan – elliptical

# Magnitude – Log(RCS)

– correlated objects

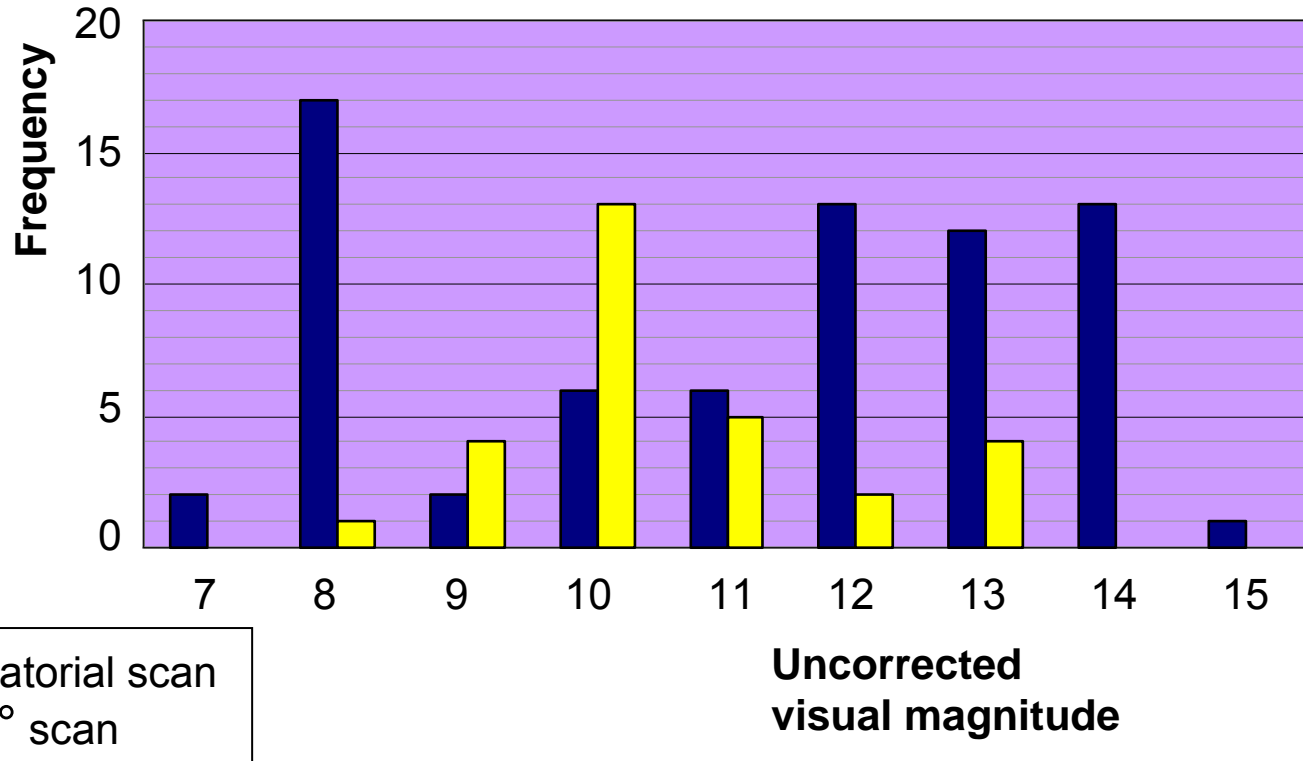


**2000-025A USA 150, GPS satellite  
box (1.5 x 1.9 x 1.9m) with 19m solar panels , RCS 0.0003!**

IADC 24,  
10-13 April 2006,  
Tsukuba, Japan

# Frequency of visual magnitudes

– uncorrelated objects





# Summary

## – uncorrelated objects

### Equatorial scans

- ~40% of objects GEOs
- ~50% transfer-type orbits, mostly with inclinations less than  $10^\circ$
- 7 MEOs with  $\Omega \sim 329^\circ - 335^\circ$ ,  $m_v \sim 6 - \sim 13$

### +15° scans

- 5 Molniya-type orbits
- All the rest transfer-type orbits, mostly with inclinations  $\sim 25^\circ - 35^\circ$
- no circular orbit objects

# Conclusions

- Trial MEO scans undertaken on known MEO plane
- Viable common observing strategy?
- MEOs observed at both equator crossing point and at 15° above equator

★ **Uncorrelated MEOs observed** ★