A visualization of space debris around Earth, showing a dense cloud of small grey dots representing debris particles in various orbits around a central Earth globe. The Earth is shown in a light blue and green color scheme.

Space Debris Activities at ESA in 2012

Heiner Klinkrad
ESA Space Debris Office

Introduction & Current Status

- 4,915 launches since Sputnik-1 produced ~16,967 (~23,000) tracked space objects by 2012 with an on-orbit mass of ~ 6,800 tonnes

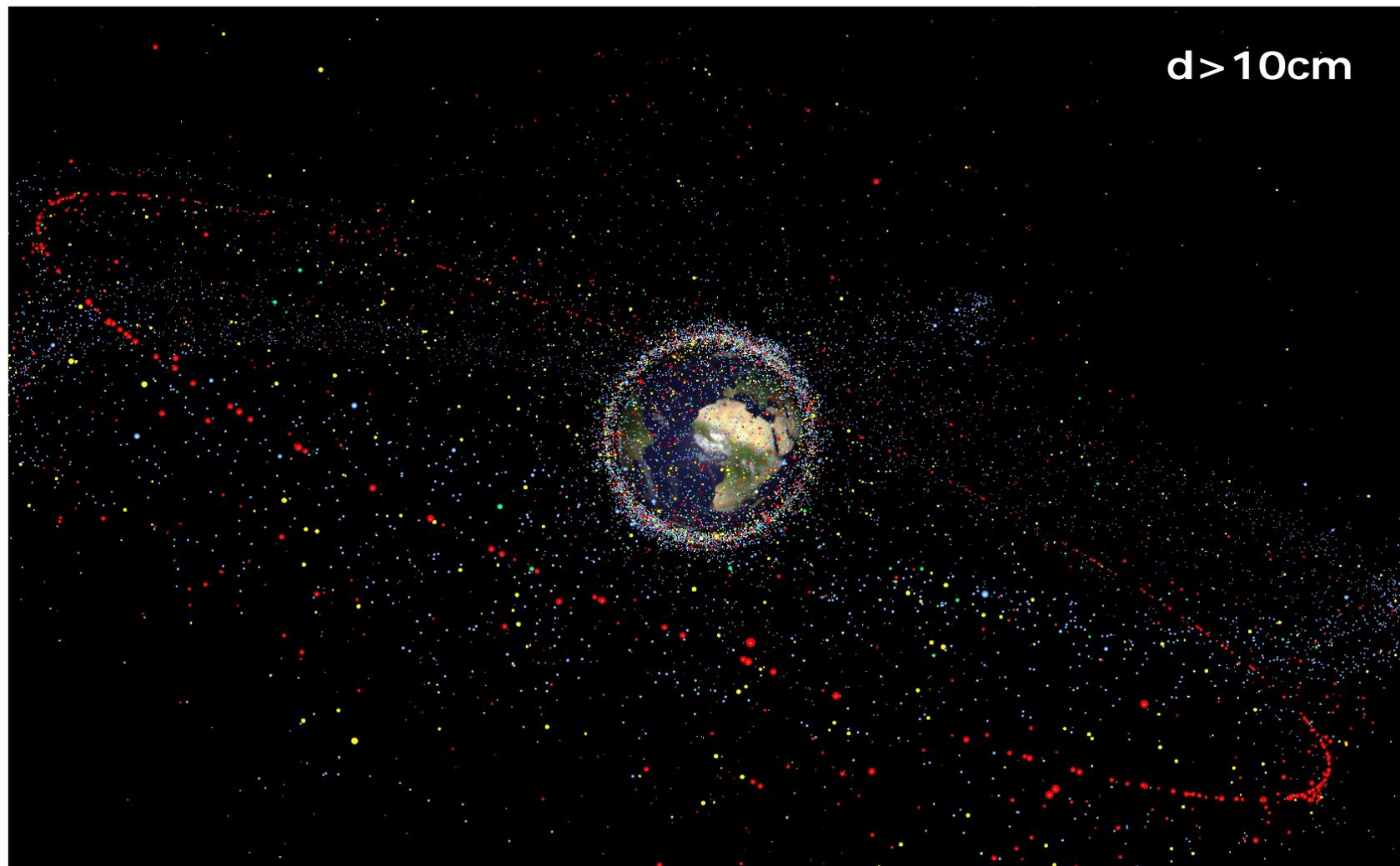
- sources of tracked & cataloged space objects:

- 60% explosion & collision fragments (~250 events)
⇒ break-up avoidance
- 6% active satellites + 16% retired satellites
⇒ end-of-mission disposal
- 11% spent orbital stages + 7% mission related objects
⇒ fewer mission-related objects



- tracking size threshold of operational surveillance networks ⇒ 10 cm
- 10 cm objects (~29,000) are likely to cause catastrophic break-ups

Distribution of Catalog-Size Space Objects



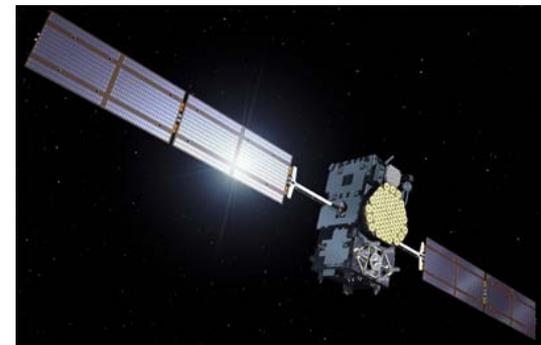
■ Vega maiden launch, 2012-006A-K (Feb.13, 2012, from CSG):

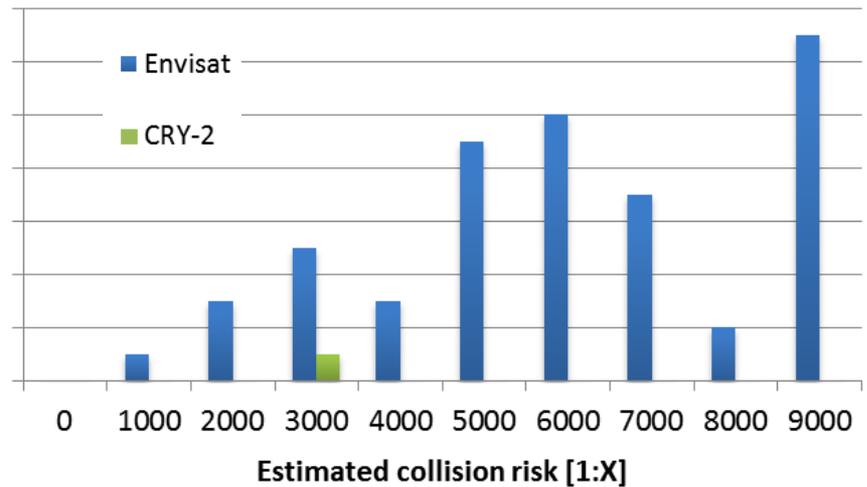
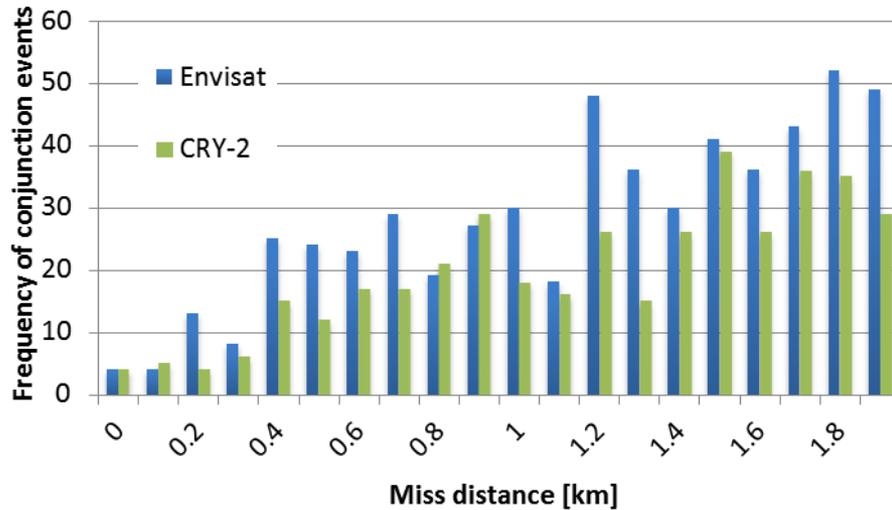
- main payload \Rightarrow LARES satellite (I); mission objective: space geodesy; orbit: 1426km x 1451km @ 69.49°; size & mass: 36.4cm \varnothing , 400kg
- secondary payloads \Rightarrow 8 CubeSat-type passengers (each ~1kg); orbits: 310km x 1440km @ 69.49°; orbit lifetimes: ~9 years
- Avum orbital stage \Rightarrow final orbit: 274km x 1430km @ 69.50°; size & mass: 1.7m x 2.3m \varnothing , 131kg (dry); orbit lifetime: ~9 years



■ Galileo IOV 3 & 4 launch, 2012-049A-B (Oct.21, 2012, from CSG):

- payloads \Rightarrow Galileo IOV 3 & 4; mission objective: navigation & timing services; orbits: 23,216km x 23,223km @ 55.3°; size & mass: 1.7m x 2.3m x 14.5m, 700kg
- one mission-related object was released and cataloged





■ conjunction statistics in 2012:

- Envisat ⇒ 21(9) conjunctions within 300m, and 53(24) conjunctions with a collision probability exceeding 1:10,000
- CryoSat-2 ⇒ 13 conjunctions within 300m, and 1 conjunction with a collision probability exceeding 1:10,000
- 68% (57%) of all events for Envisat (CryoSat-2) were associated with fragments of the Iridium-33/Cosmos-2251 and FengYun-1C collisions
- no evasive maneuvers were performed in 2012 for ESA satellites; Envisat was lost on April 8, 2012, following a spacecraft anomaly

■ Envisat anomaly:

- following the declaration of a “spacecraft emergency” extensive recovery attempts were initiated as of April 8, 2012; in spite of strong international support (particularly by the USA, France and Germany) the mission was declared lost on June 29, 2012
- since Envisat was approved in 1989 and designed in the 1990s, the mission is not compliant with the 25 year orbit lifetime limitation

■ ESA CleanSpace initiative:

- several aspects of a “sustainable access to and use of space” (ESA’s Agenda 2015) are addressed, with debris mitigation and environment remediation (mass removal from orbit) being part of this effort

■ ESA Requirements on Space Debris Mitigation:

- an updated set of instructions is in preparation as an “ESA IPOL” document, with close coherence to the ISO 24113 standard
- a supporting “mitigation handbook” and a related training curriculum for ESA Project engineers are being developed

■ background:

- ESA's report on the "Classification of GEO Objects" (issue 15, 2013) describes the orbital and operational status of tracked objects in or near GEO (for orbits with $e < 0.2$, $i < 70^\circ$, $0.9 < n < 1.1$ revs/d)
- orbit data are based on information from the USA (USAF/SpaceTrack) and from Russia (KIAM)
- the information is merged & processed by ESA's DISCOS database

■ GEO end-of-life disposals:

- based on orbit time histories and the termination of associated orbit/longitude maintenance maneuvers, spacecraft retirements are identified, and end-of-life disposal maneuvers are analyzed
- verification of the disposal status is done with spacecraft operators and orbit data providers

■ Availability of "Classification of GEO Objects" (issue 15, 2013):

- please send your e-mail request to ESA, c/o Dr. Tim Flohrer, ESA Space Debris Office (Tim.Flohrer@esa.int)

- **9 spacecraft were re-orbited above GEO+250km (IADC conformant):**
 - Intelsat VI F-2 (89087A, INTELSAT) ⇒ 336 km x 382 km
 - Inmarsat 2-F4 (92021B, INMARSAT) ⇒ 635 km x 697 km
 - AsiaSat 2 (95064A, Hongkong) ⇒ 247 km x 299 km
 - AMOS 1/Intelsat 24 (96030B, Israel/INTELSAT) ⇒ 867 km x 950 km
 - Telecom 2D (96044B, France) ⇒ 449 km x 591 km
 - Apstar 2R (97062A, China) ⇒ 257 km x 345 km
 - Zhongxing-22 (00003A, China) ⇒ 835 km x 860 km
 - Eutelsat W1 (00052A, EUTELSAT) ⇒ 564 km x 631 km
 - USA 111 (UFO F5) (95027A, USA) ⇒ 422 km x 443 km

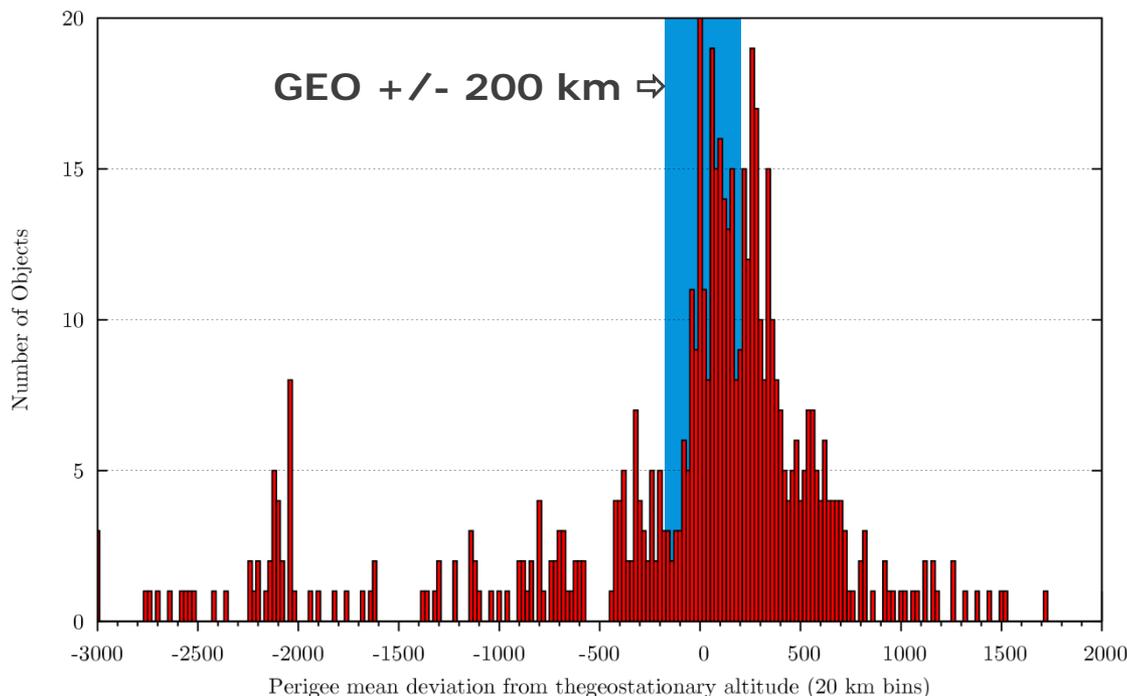
- **4 spacecraft were re-orbited too low:**
 - GOES 7 (87022A, USA) ⇒ 121 km x 89 km
 - Palapa C1 (96006A, Indonesia) ⇒ 156 km x 227 km
 - Insat 2E (99016A, India) ⇒ 149 km x 198 km
 - Beidou 3 (03021C, China) ⇒ 135 km x 145 km

■ 1 spacecraft was abandoned in GEO:

- Cakrawatra 1 (97071B, Indonesia) ⇒ abandoned in L1 libration

■ 2 rocket bodies/kick-motors launched in 2012 are within GEO±200km:

- FengYun 2F AKM (12002C, China) ⇒ 18 km x 480 km
- Proton-K/DM-2 4th stage (12012D, Russia) ⇒ -38 km x +58 km



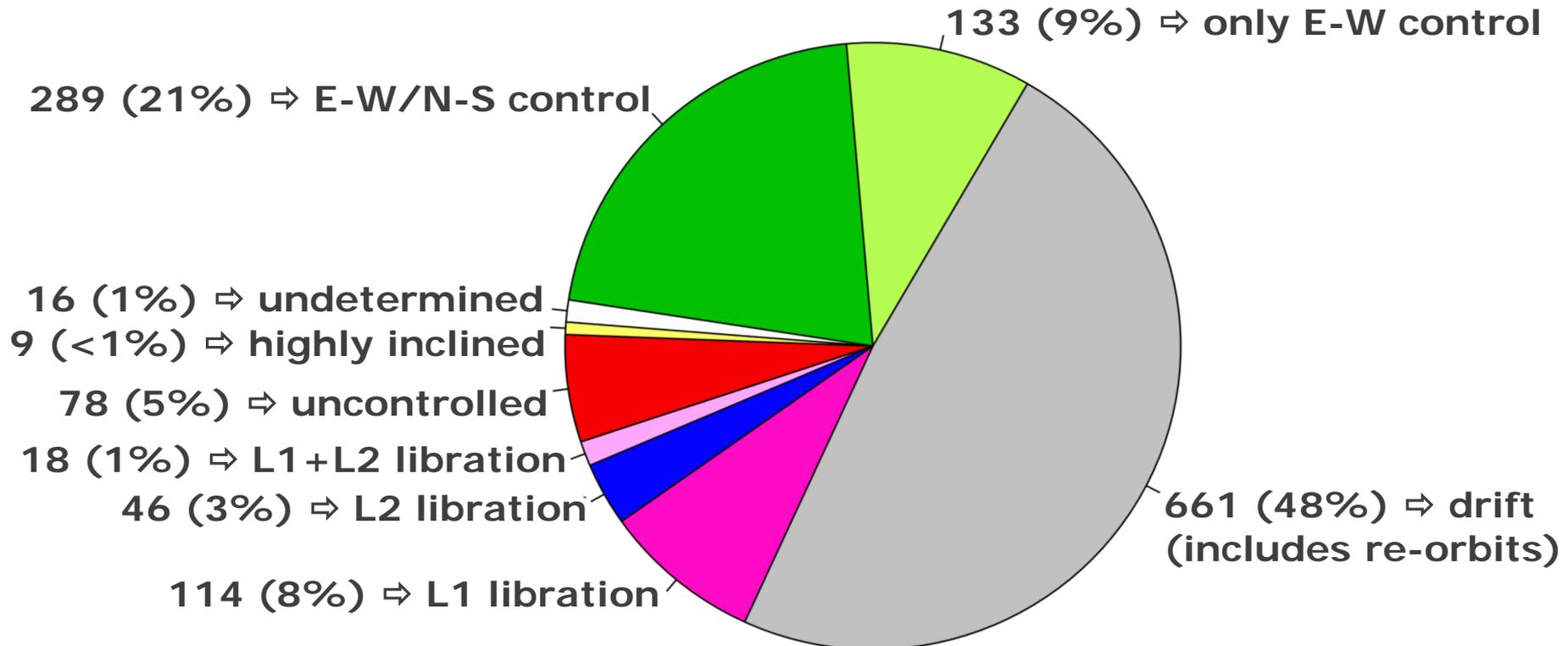
post-mission re-orbiting practices are discernible in the perigee altitude distribution near GEO

GEO Satellite Retirement Statistics



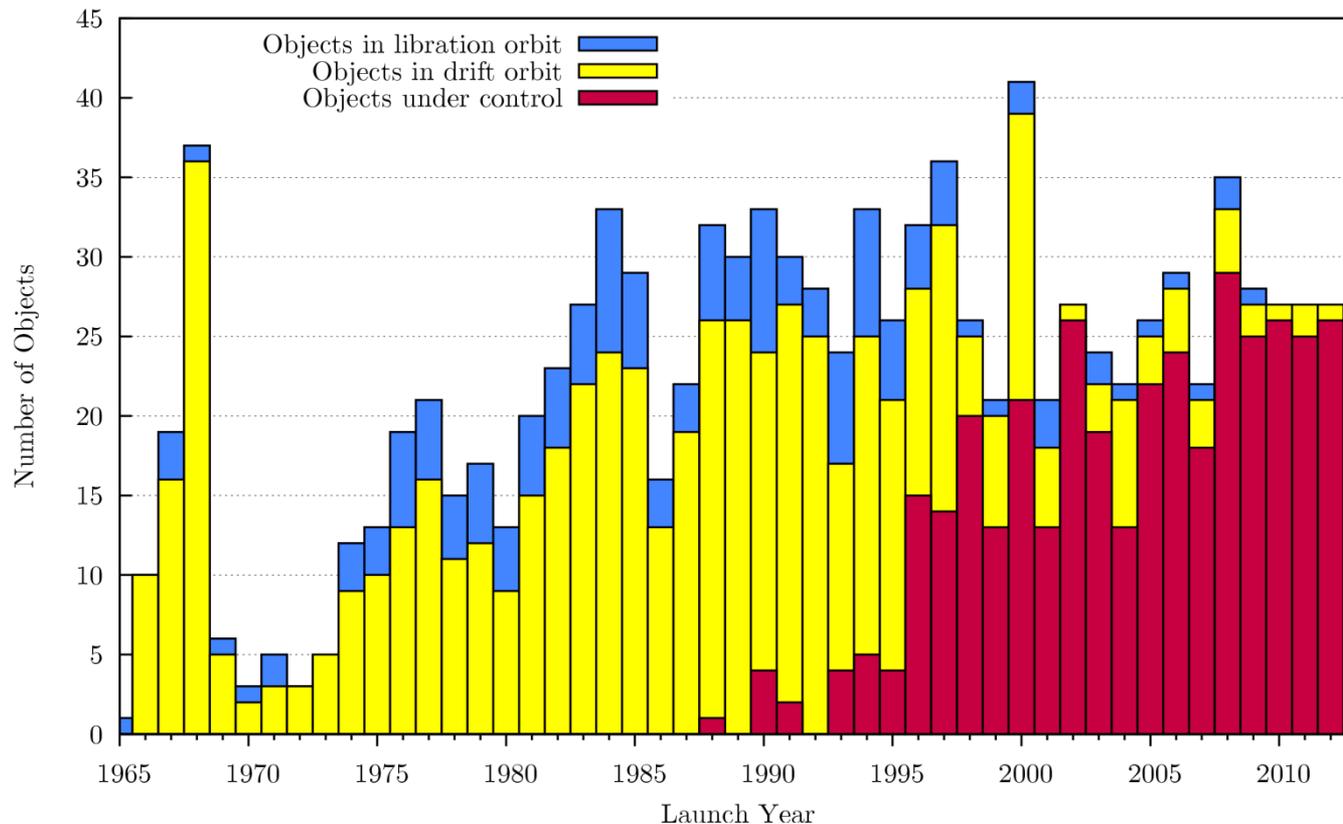
	'99-'02	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	Total
● Left at L ₁	14	–	2	1	2	1	2	3	1	–	1	27 (12.9%)
● Left at L ₂	4	1	1	1	1	–	1	–	–	–	–	9 (4.3%)
● Left at L ₁ /L ₂	2	–	–	1	–	–	1	–	–	–	–	4 (1.9%)
● Drift orbit (too low)	17	7	5	5	7	1	1	6	4	3	4	60 (28.9%)
● Drift orbit (compliant)	14	8	5	11	9	11	6	12	11	12	9	108 (51.9%)
Annual Total	51	16	13	19	19	13	11	21	16	15	14	208 (100%)

- compliance with GEO end-of-life re-orbit guidelines (e.g. from IADC) has improved from about 30% to more than 50% since 2002
- abandonment of GEO satellites at their end-of-life has been reduced from about 40% to less than 13% since 2002



- 1,117 TLE catalog objects met „near GEO“ criteria ($e < 0.2$, $0.9 < n < 1.1$ rev/d, $i < 70^\circ$); 247 more objects are known to be in this area
- controlled \Rightarrow 422 (289 thereof E-W/N-S); uncontrolled \Rightarrow 942

Status of GEO Objects vs. Launch Year



- 36 GEO objects were injected in 2012 (34 payloads + 2 rocket bodies)
- typical operational lifetimes of GEO satellites are about 15 years; the share of abandoned satellites has decrease since the late 1990s

- **the compliance with recommended post-mission disposal measures for GEO spacecraft has continued to improve during the past decade (from about 30% to more than 50% today)**
- **space debris mitigation is a necessary, but insufficient step; it must be accompanied by space debris environment remediation**
- **mass removal, particularly from the protected LEO orbit regime, is essential for long-term environment stability, and for a sustainable use of outer space; ESA supports related activities at the LTSSA WG of UNCOPUOS, and in ESA's CleanSpace initiative**
- **ESA is committed to debris mitigation and environment remediation in cooperation and coordination with international partners**