State of the Space Environment

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25/06/2019
$> 1\text{m}$

$> 10\text{cm}$

$> 1\text{cm}$

$> 1\text{mm}$
### Numbers & Effects

- **Log(Number)**
- **Mission termination likely, minor environmental contamination, shielding limit of ISS modules**
- **Structural failure, severe environmental contamination**

#### Log(Diameter)

- 1µm: Glass cover blinding
- 10µm: Plasma generation (perturbation of electric components), Penetrate space suits
- 100µm: Loss of payload, Tank-wall penetration
- 1mm: ≈130million
- 1cm: ≈910,000
- 10cm: ≈34,000
- 1m: ≈6,000
Spatial Density

Spatial Density = \frac{\text{Number of Objects}}{\text{Volume Unit}}

Man-made objects > 10cm
Impact on Sentinel-1A Solar Array (Aug. 23rd 2016)

Apr. 8th 2014

Aug. 29th 2016
Catalogued Objects

- Total objects
- Objects on-orbit

Object Count [\(*\)]

Reference Epoch

- 1 Jan 1960
- 1 Jan 1970
- 1 Jan 1980
- 1 Jan 1990
- 1 Jan 2000
- 1 Jan 2010
Launches

Payload Launch Traffic into $200 \leq h_p \leq 1750$km

- Amateur
- Civil
- Defense
- Commercial

Number of Objects

Launch Year


ESA UNCLASSIFIED - For Official Use
Fragmentation Events

Number Fragmentation Events

Event Year (5 year bins)

Number

Unknown
Collision
Accidental
Electrical
Aerodynamics
Deliberate
Anomalous
Propulsion

Late Effect of Design Flaws

- DMSP (Defence Meteorological Satellite Programme)
- Series 5D-2 (9 spacecraft, 7 broken-up)
- Battery fault

Break-Ups

Launching

1980 1990 2000 2010

27 fragments

84 fragments

235 fragments
ESA’s Annual Environment Report

Statistics on the success-rate of Post Mission Disposal Manoeuvres

Effectivity of Measures

Effectiveness of Mitigation Measures

Number of Objects > 10cm vs Year

- No mitigation
- Extrapolation of our current behaviour
- 100% Passivation
- 100% Passivation + 90% Post Mission Disposal
- 100% Passivation + 90% Post Mission Disposal + ADR (5 objects per year)
ESA’s Space Safety Programme

Laser Tracking of Space Debris

Active Removal/In-orbit Servicing as Industrial Service

Automation of Collision Avoidance

Technology for Debris Mitigation