

The Space Debris Problem: environment overview

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The current environment

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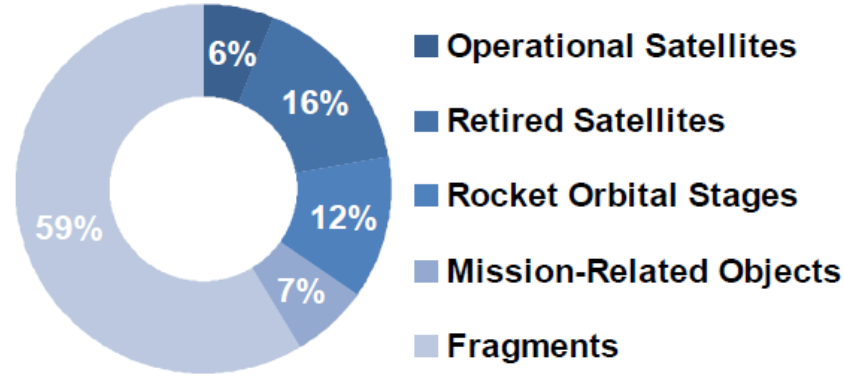
Distribution of Catalogued Objects



>1mm



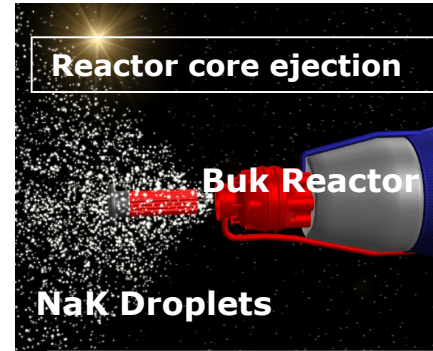
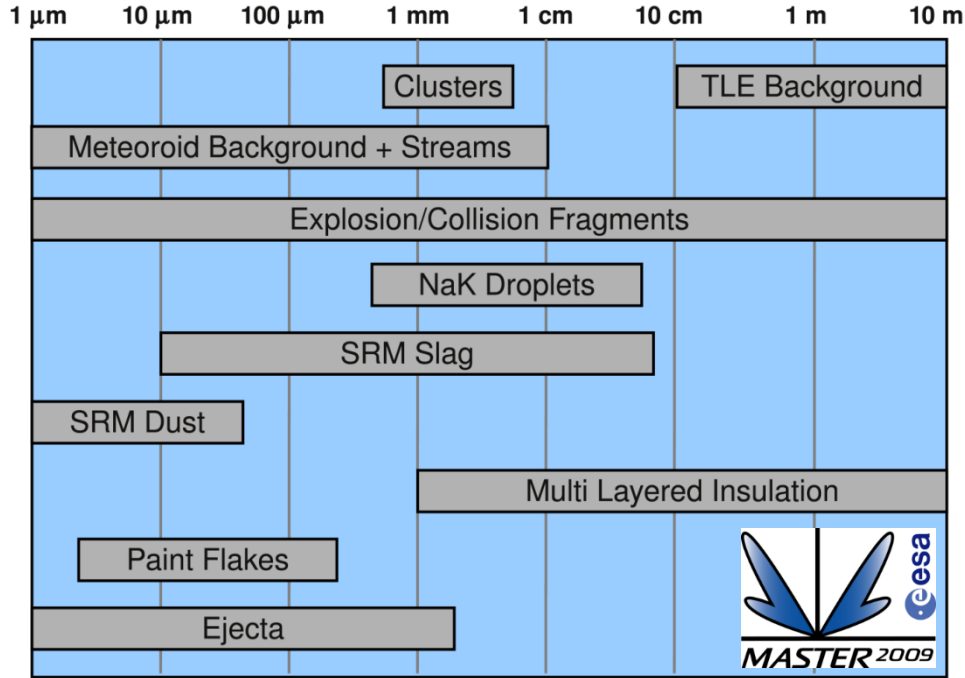
Composition of the Catalogue



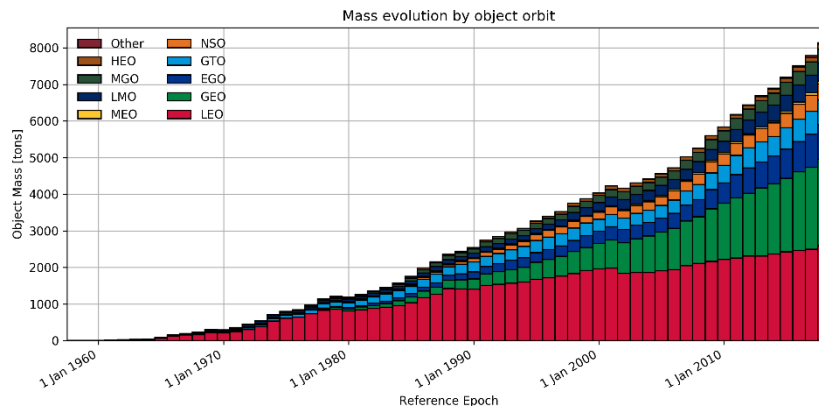
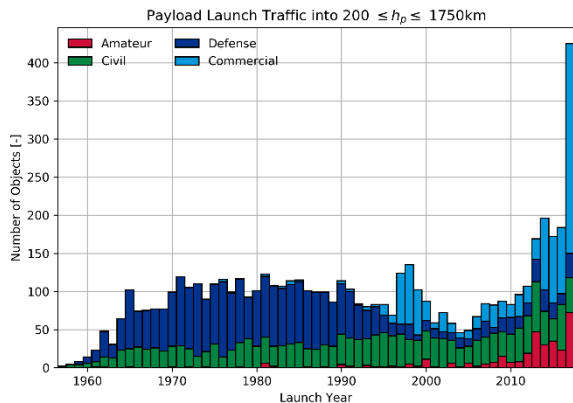
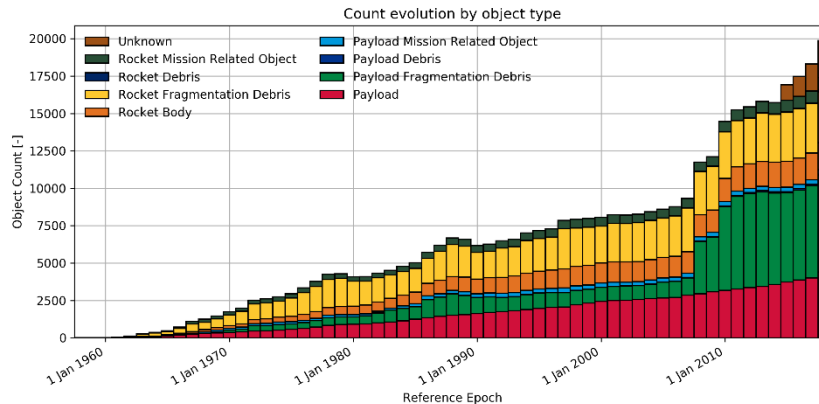
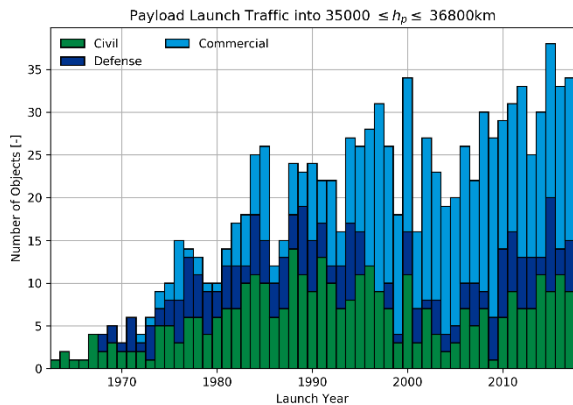
Space Debris = (orbital debris + re-entering objects)

Space debris are all man-made objects including fragments and elements thereof, in Earth orbit or re-entering the atmosphere, that are non-functional

Space debris size distribution



Evolution of the space debris environment



* as of August 20, 2018
ESA-DISCOS

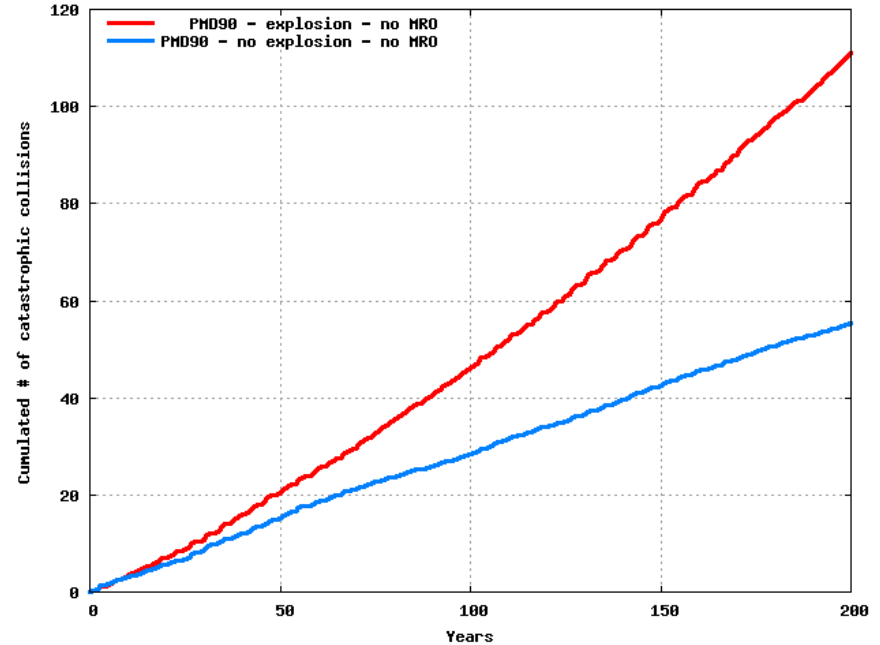
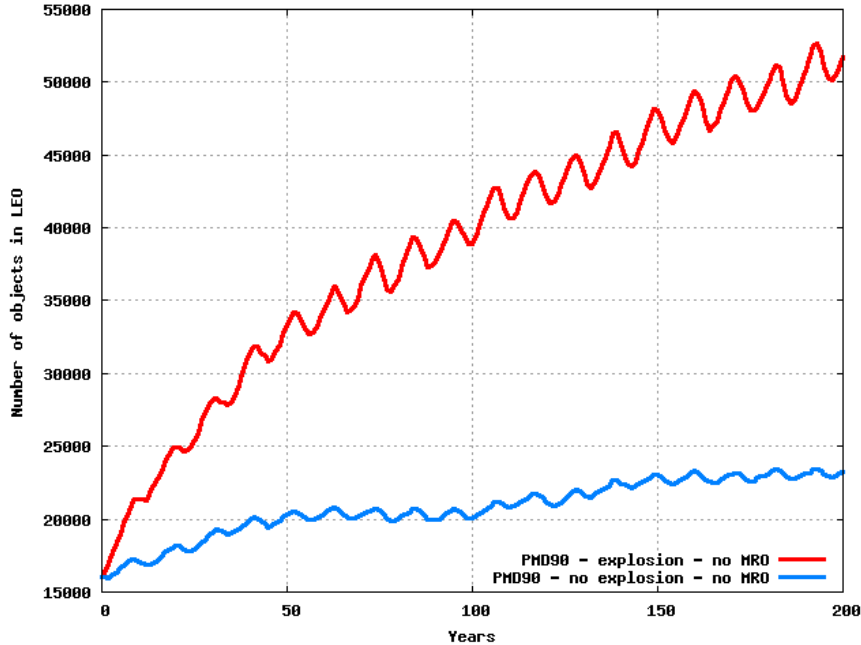


The future ahead of us

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"best case": PMD 90% and no-MRO

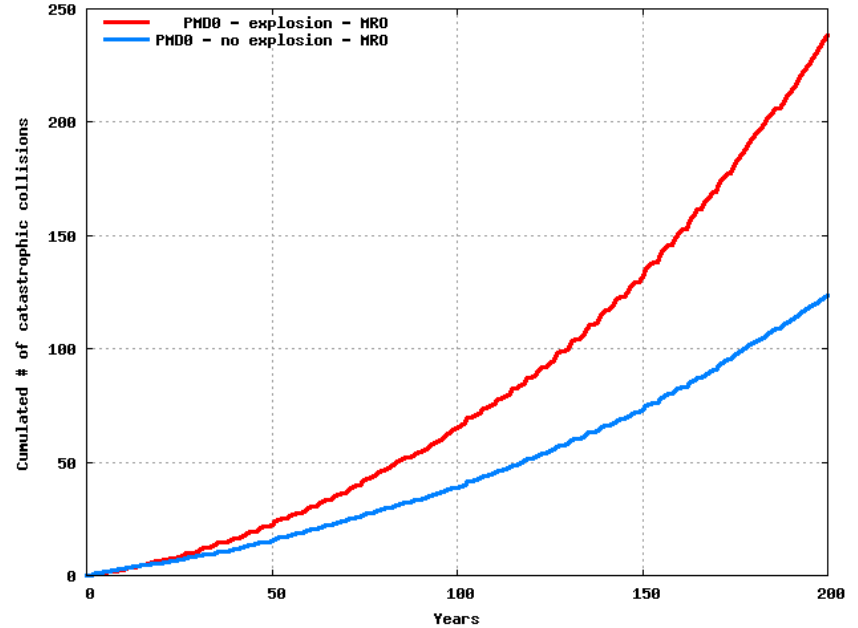
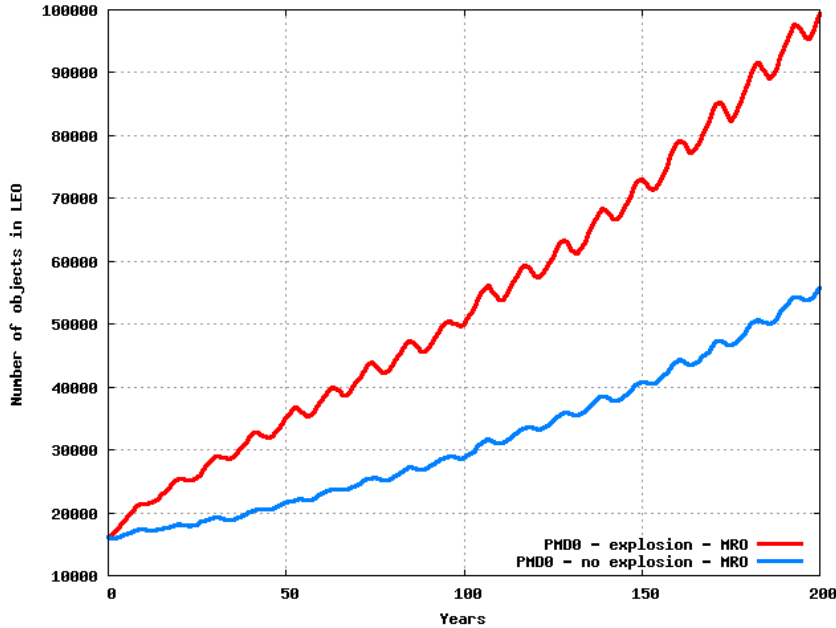


Current explosion rate worsens evolution of environment

90% PMD (post-mission disposal) is a very optimistic situation

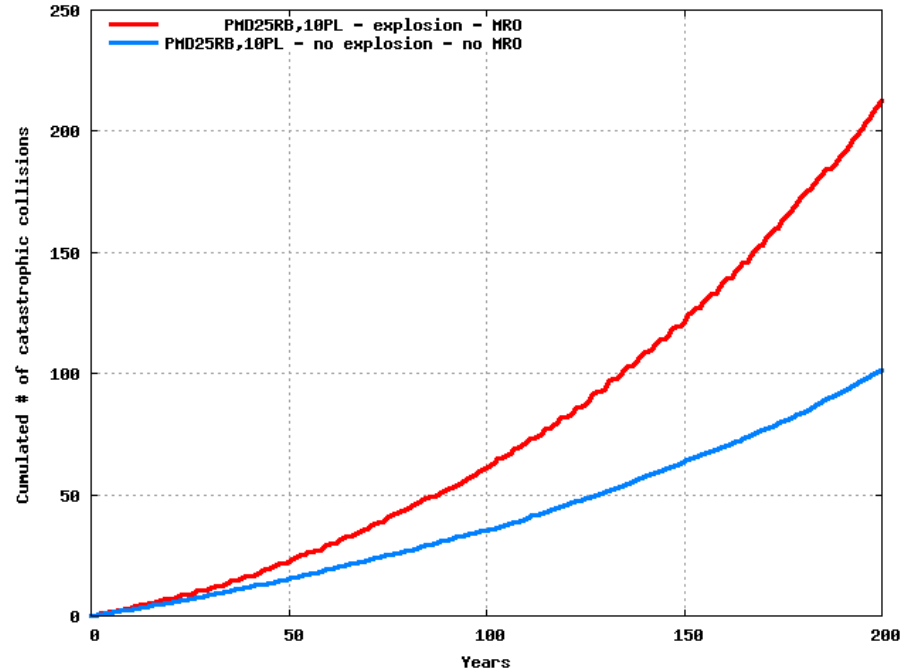
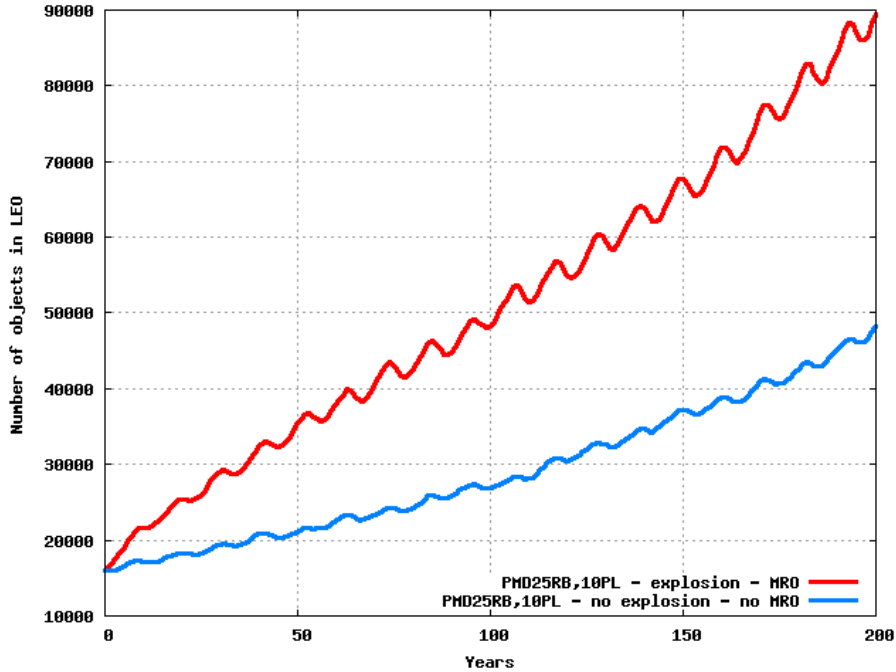


"worst case" PMD 0% and MRO



Exponential growth when explosions taken into account and PMD 0%
PMD 0% with no explosion reaches same values as PMD 90% with
explosions → **explosions take away benefits of PMD**

Current situation: PMD 25% for RB, 10% for PL



Current compliance situation is very low

Trend with current situation similar to not doing anything (PMD 0%)

Mega-Constellations

LEO & MEO Broadband Constellations

At least 15 companies have declared their intent to develop broadband satellite constellations in low Earth orbit (LEO) or medium Earth orbit (MEO), according to Northern Sky Research. Most of these companies intend to have their first-generation systems deployed within five years. O3b, which is nearing completion of a 20-satellite constellation begun in 2013, will add seven mPower second-generation broadband satellites starting in 2021.

PROGRESS KEY

- Constellation builder selected
- Launcher(s) identified
- Prototype satellite(s) launched
- Operational satellite(s) in orbit

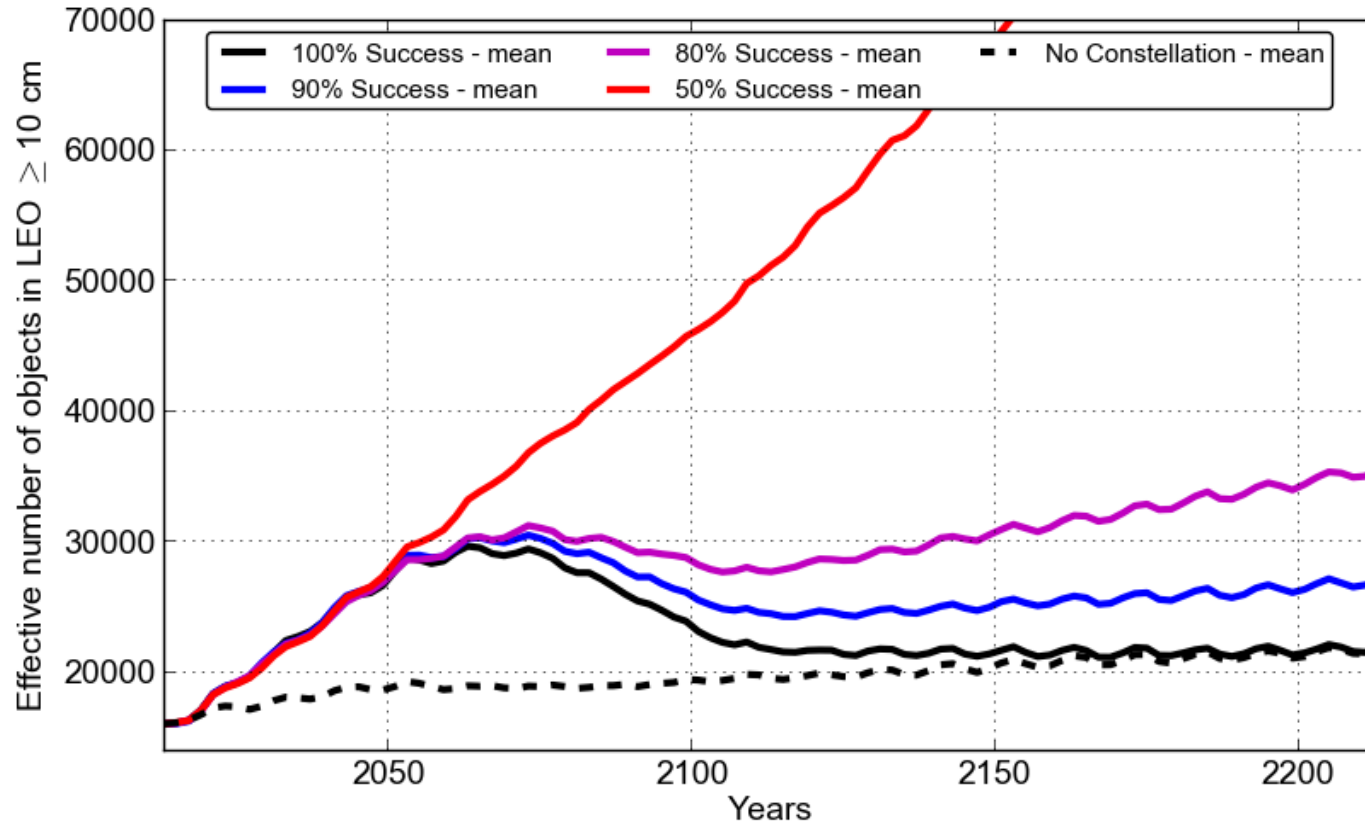
Source: Northern Sky Research

SPACE NEWS



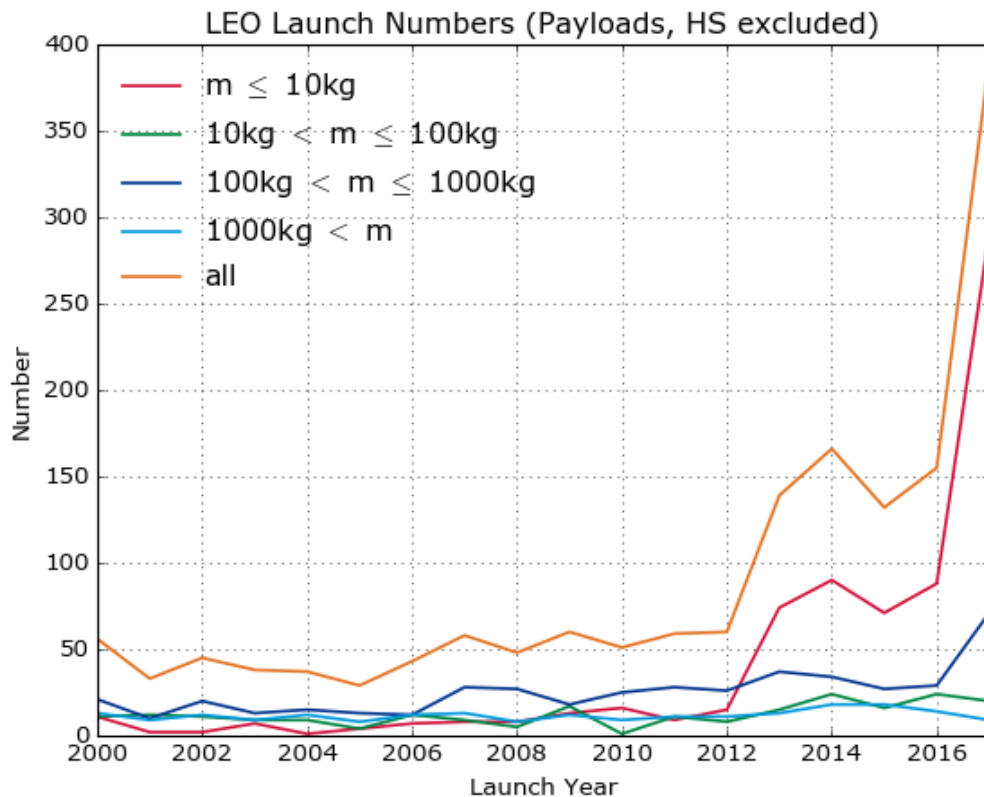
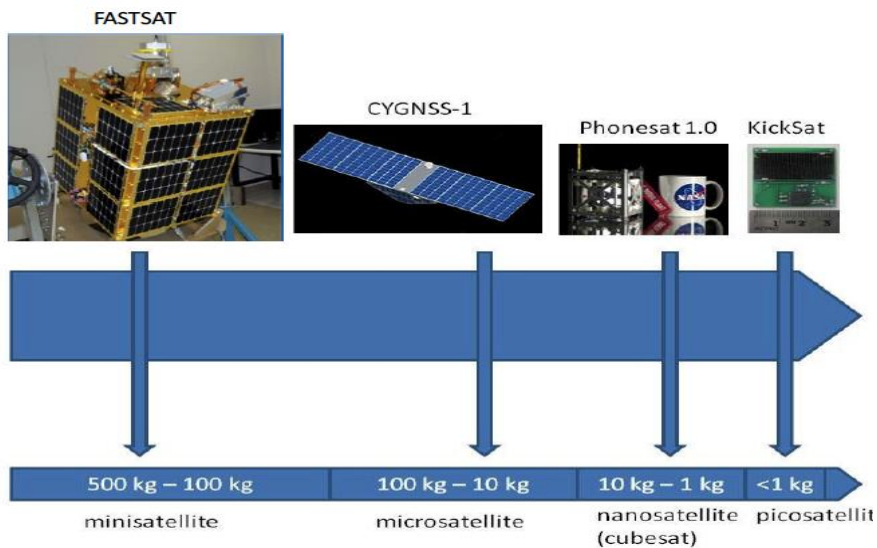
Source:
SpaceNews article

Mega-constellations in the future environment



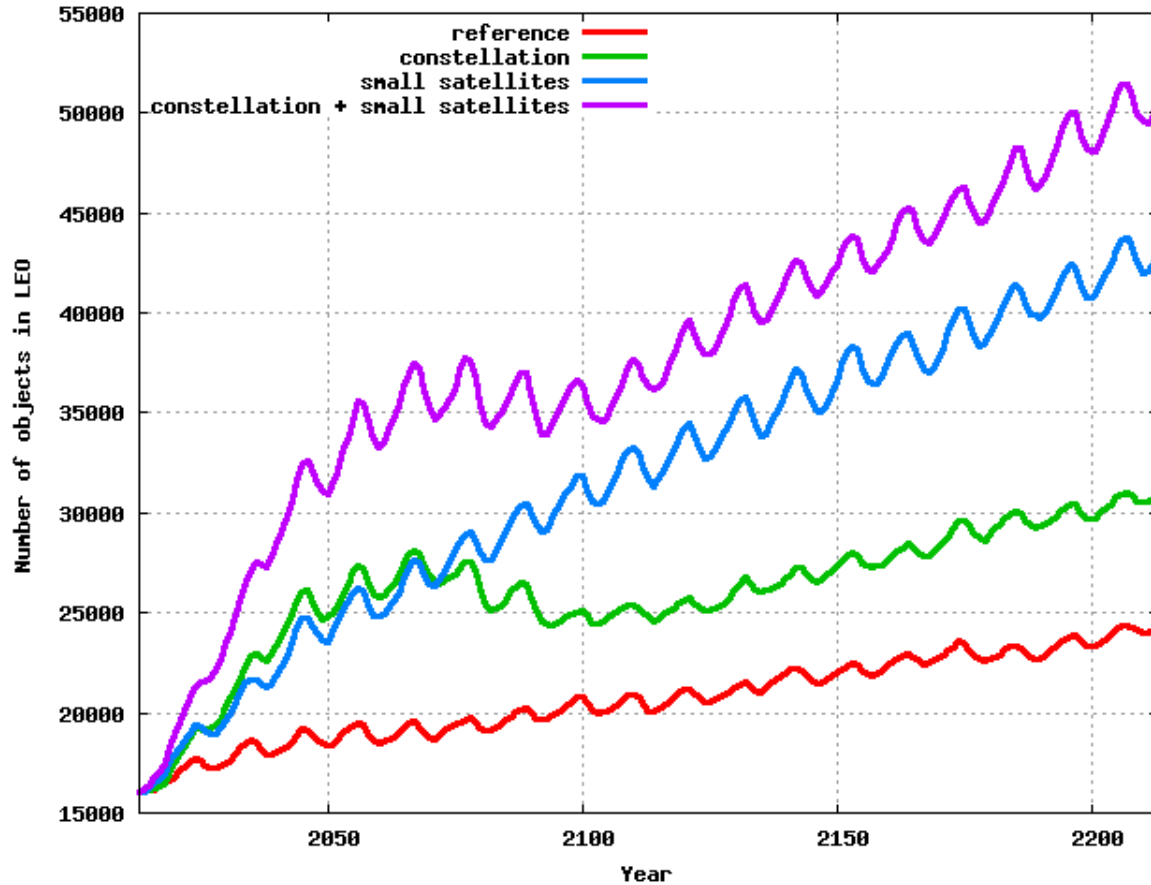
Small satellites

Latest trend in launch traffic
→ miniaturisation



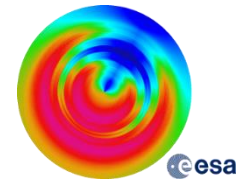
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Small satellites and mega-constellations

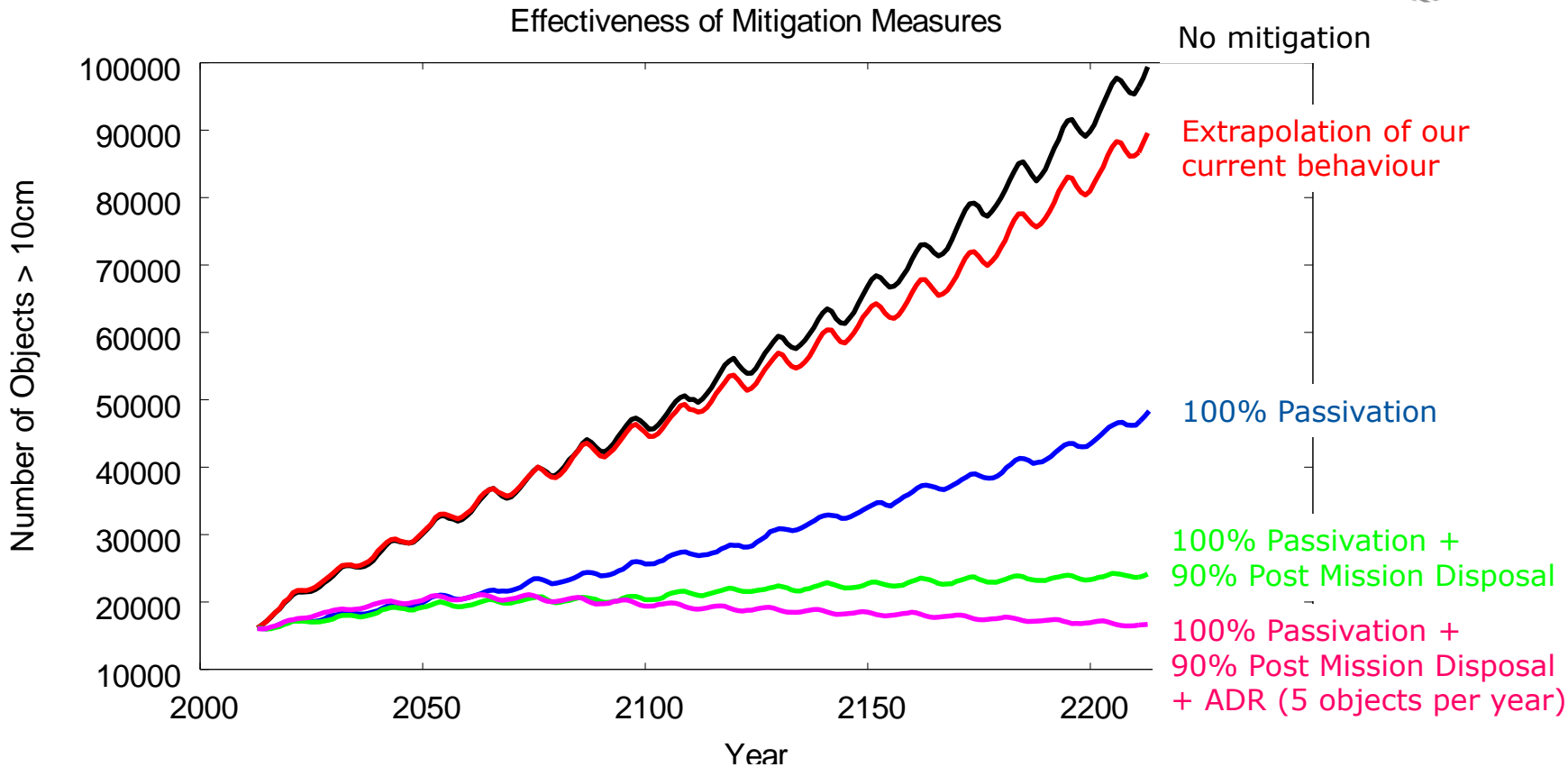




- **DRAMA**
- **MASTER**
- **Oriundo**
- Installers
- Patches
- Documentation



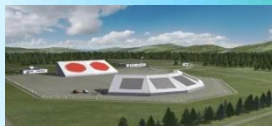
Effectiveness of Mitigation Measures



Dealing with Space Debris Hazards in Space Safety



Identify



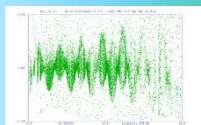
Surveillance radar



Robotic Telescopes



Fly-Eye



Laser Tracking

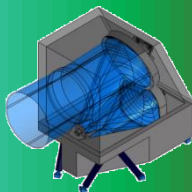
Analyse



Catalogue correlation technology

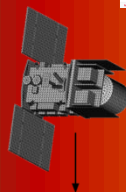


Space Debris Modelling

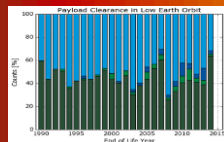


Space-based optical component

Recognise

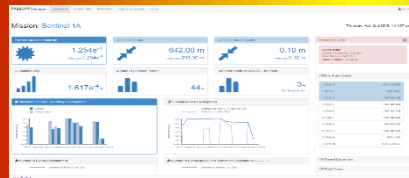


On-ground Risk Model



Implementation Control

Prevent



Automated Collision Avoidance



Cleasat Mitigation Technology

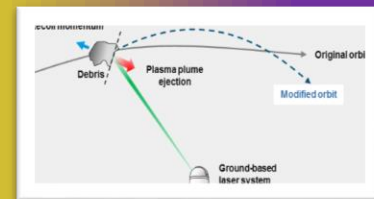


Protection

Respond



Remediation by active removal



Remediation by ground-based laser

Thanks for your attention

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<http://www.esa.int/debris>

<https://sdup.esoc.esa.int>