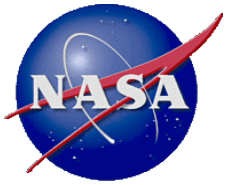
National Aeronautics and Space Administration



The NASA Orbital Debris Program Office and Orbital Debris Mitigation

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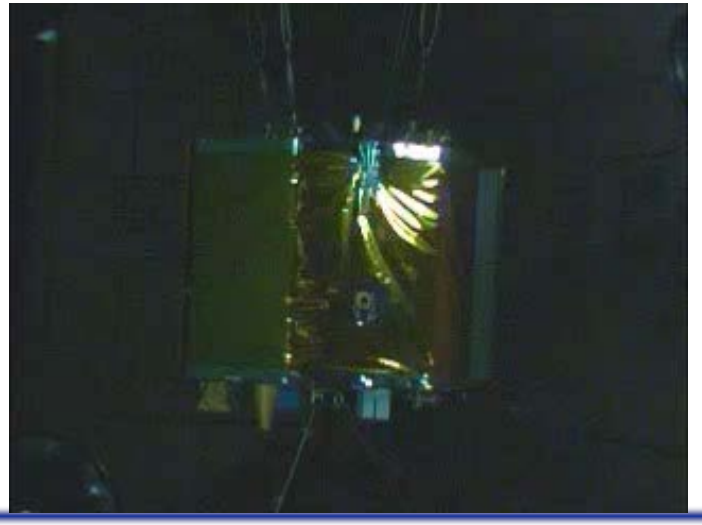
NASA Orbital Debris Program Office

NAS Panel on Orbital Debris
Washington DC, 1 May 2018

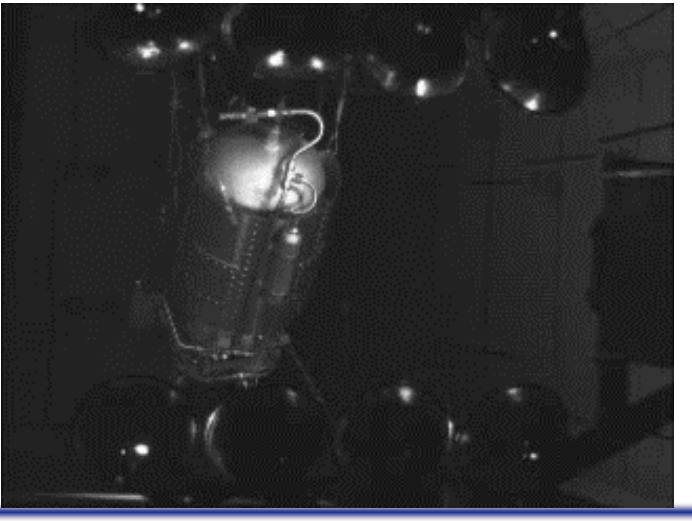
Outline

- **NASA Orbital Debris Program Office (ODPO)**
  - History and background
- **Orbital Debris (OD) Mitigation**
  - Space Situation Awareness (SSA)
  - History of orbital debris mitigation policy and guideline development
  - Challenges from Large and Small Debris

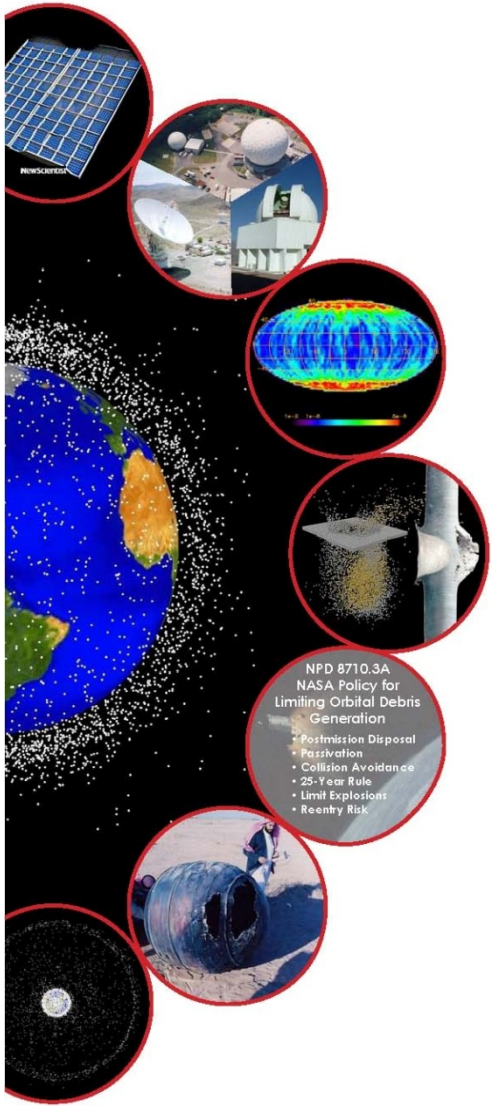
A 9 cm, 570-g projectile impacted DebriSat at 6.8 km/s (NASA)



A 9 cm, 598-g projectile impacted DebrisLV at 6.9 km/s (NASA)

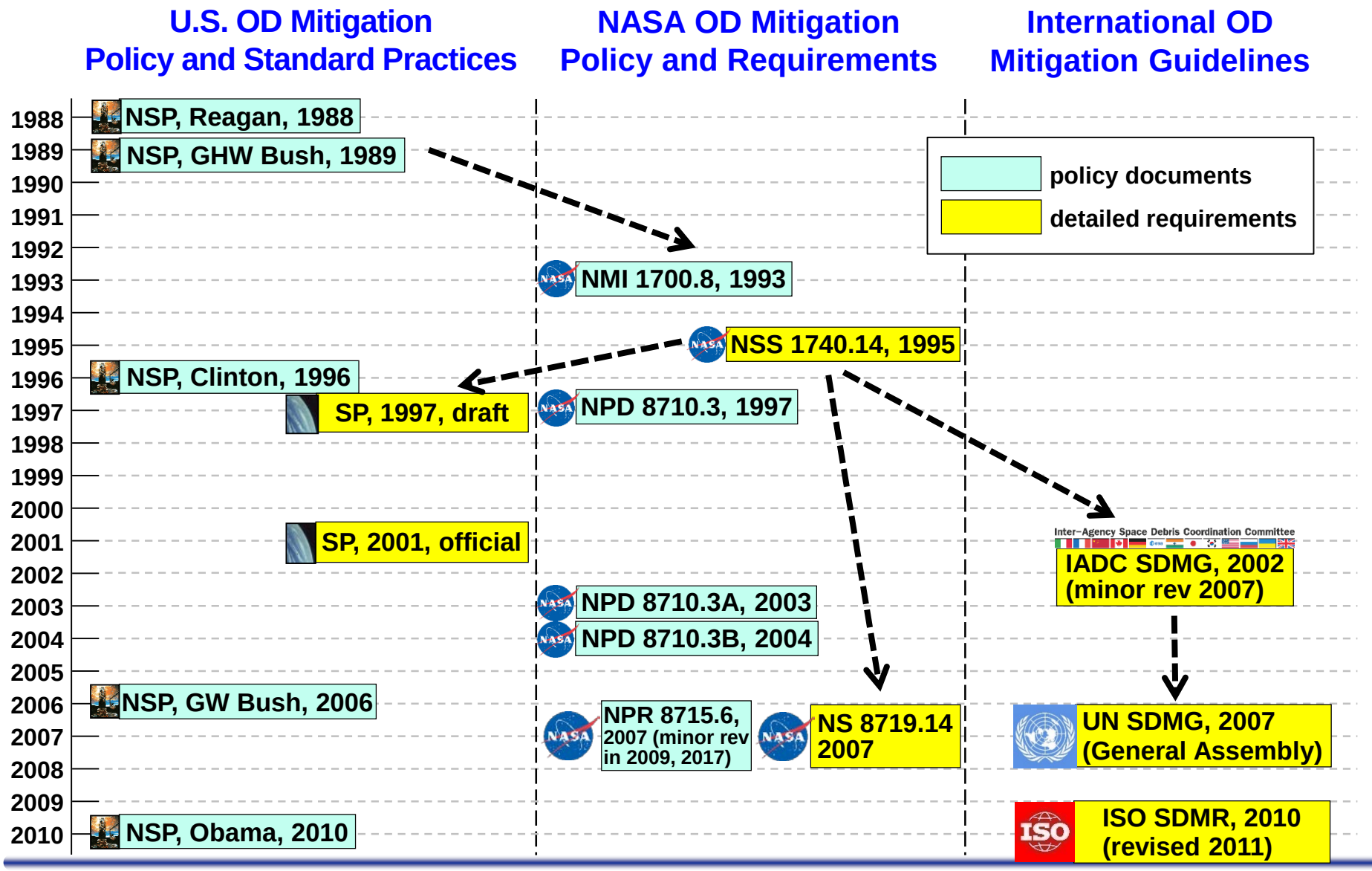


NASA Orbital Debris Program Office (ODPO)

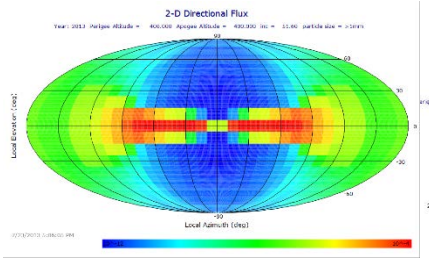


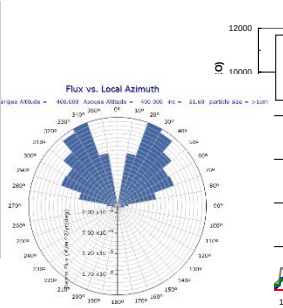
- **The ODPO is the only organization in the U.S. Government conducting a full range of research on orbital debris**
  - This unique NASA capability was established at JSC in 1979 (D. Kessler, J. Loftus, B. Cour-Palais, *etc*.)
  - ODPO's roles and responsibilities are defined in NASA Procedural Requirements NPR 8715.6B
- **ODPO provides technical and policy level support to NASA HQ, OSTP, and other U.S. Government and commercial organizations**
- **ODPO represents the U.S. Government in international fora (IADC, United Nations, *etc.*)**
- **ODPO is recognized as a pioneer and leader in environment definition and modeling, and in mitigation policy development**

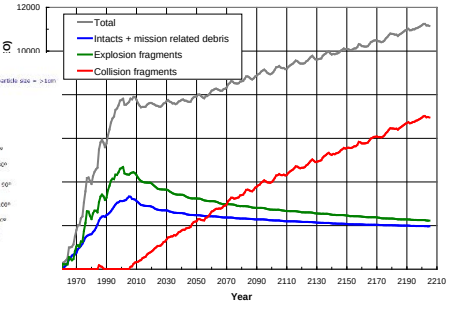
History of OD Mitigation Policies, Requirements, and Guidelines



End-to-End Orbital Debris Activities at ODPO







Mission Support

OD risk assessment tools for NASA missions (ORDEM, ORSAT, DAS, *etc*.)

ODAR/EOMP reviews

Measurements

Radar
Optical
In-situ
Laboratory

Modeling

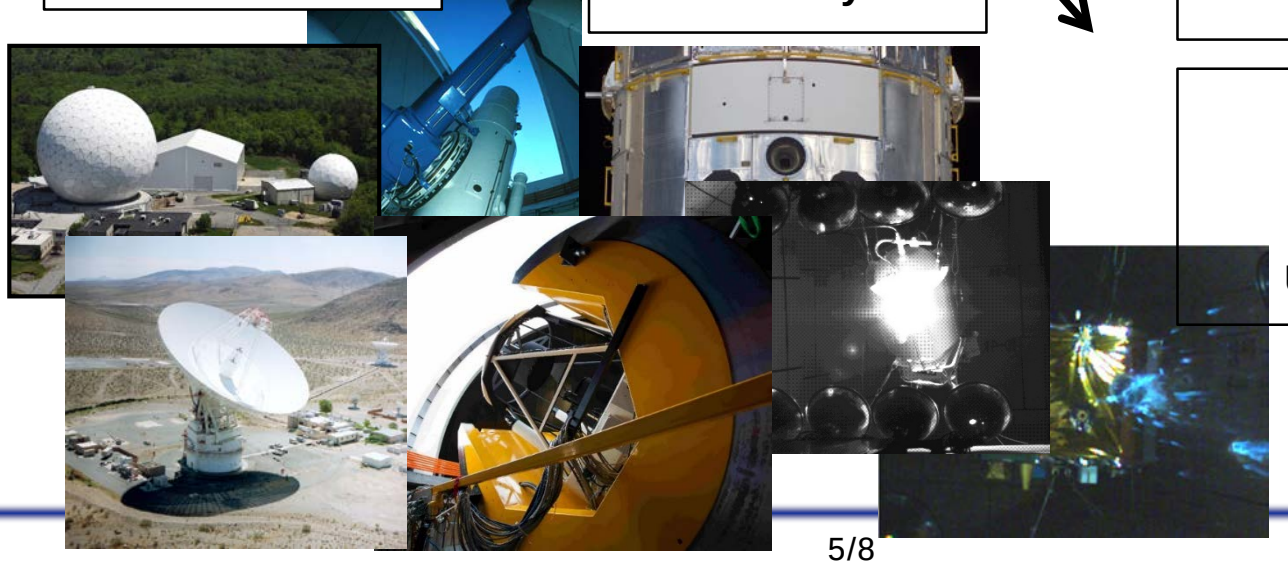
Breakup
Engineering
Evolutionary
Reentry

Environment Management

Mitigation
Remediation
Policy
Mission Requirements

Coordination

U.S. Government
IADC
United Nations, *etc*.



How Much Debris Is Currently in Earth Orbit?

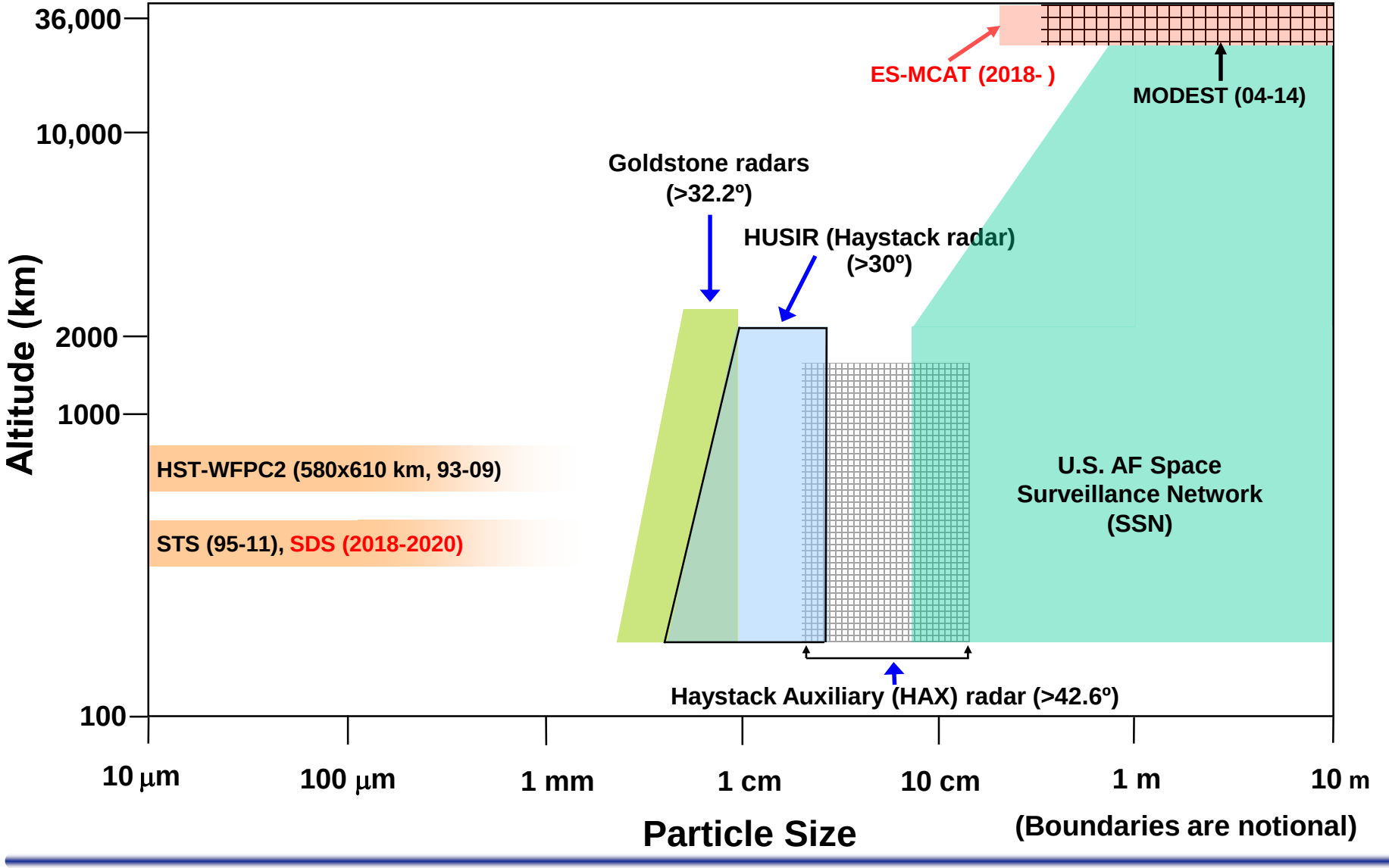
Baseball size or larger (≥10 cm): ~23,000
(tracked by the U.S. Space Surveillance Network, SSN)

Marble size or larger (≥1 cm): ~500,000

Dot or larger (≥1 mm): >100,000,000
(a grain of salt)

- **Due to high impact speed in space (~10 km/sec in LEO), even sub-millimeter debris pose a realistic threat to human spaceflight and robotic missions**
  - **10 km/sec = 22,000 miles per hour (the speed of a bullet ~1,500 miles per hour)**
- **Mission-ending threat is dominated by small (mm-to-cm sized) debris impacts**
- **Total mass: >7600 tons LEO-to-GEO (~2700 tons in LEO)**

SSN and NASA SSA Coverage



Mitigate the Risk from Orbital Debris

- **Most catastrophic collisions are caused by large debris (about ≥10 cm objects in LEO; about ≥80 cm objects in GEO)**
  - Current conjunction assessments and collision avoidance maneuvers against the tracked objects (which are typically 10 cm and larger) only address a small fraction (<1%) of the mission-ending risk from orbital debris
  - Improve the accuracy of object tracking and conjunction assessments
- **Most mission-ending collisions are caused by small debris (about ≥1 mm objects in LEO; about ≥8 mm objects in GEO)**
  - Extend tracking capability to objects smaller than 10 cm in LEO and objects smaller than 1 m in GEO
  - Conduct in-situ measurements and increase survey capability on millimeter-sized debris in LEO and centimeter-sized debris in GEO
    - **Direct measurement data on small debris are needed to better protect the safe operations of the current and future missions, which is key to the SSA and STM**
  - Develop and implement cost-effective protective measures for critical satellite subsystems (propulsion tanks, battery boxes, *etc*.)