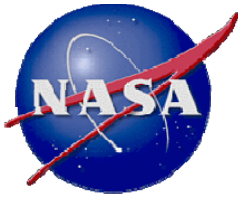
National Aeronautics and Space Administration



USA Space Debris Environment, Operations, and Research Updates

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Committee on the Peaceful Uses of Outer Space, United Nations
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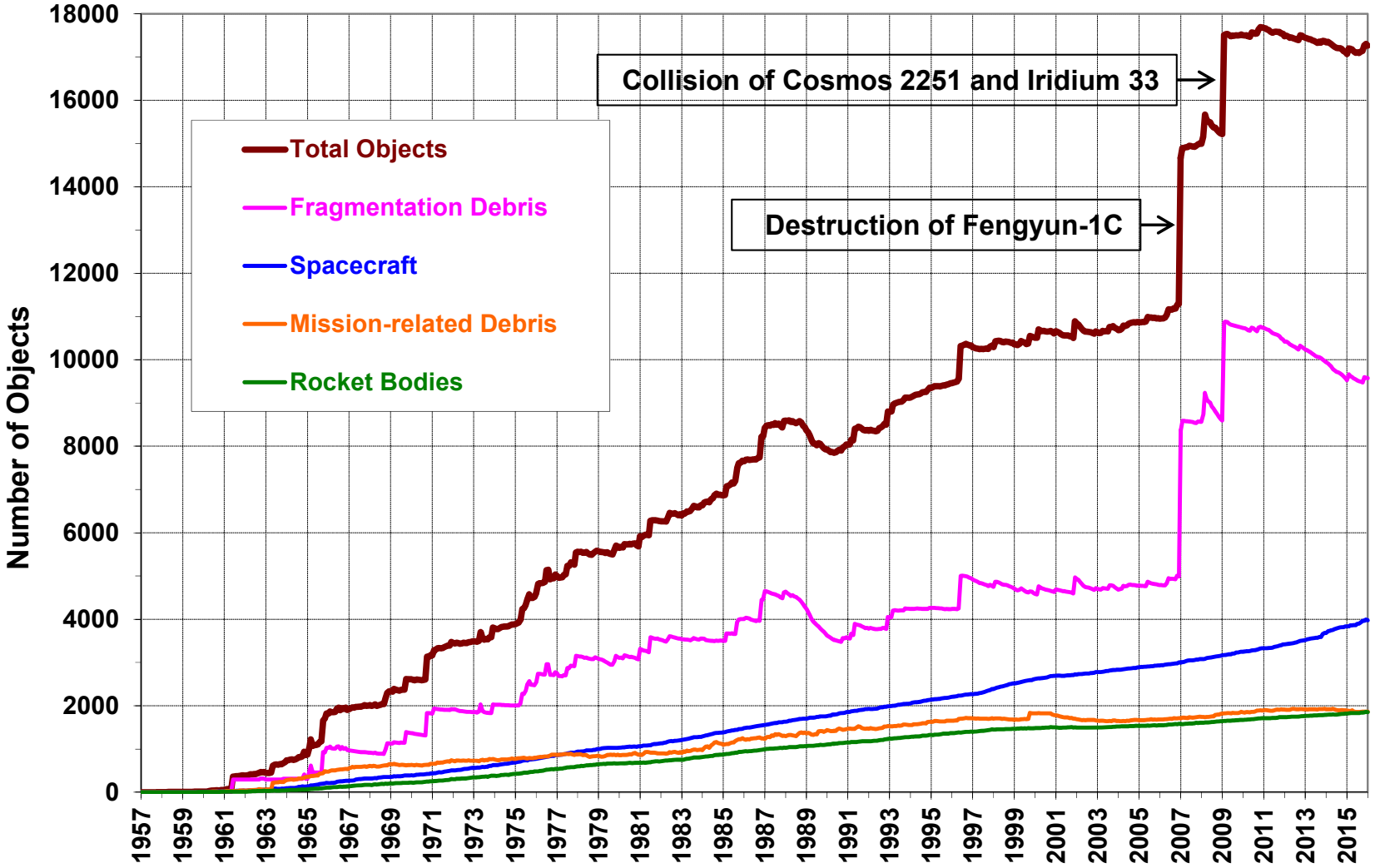
Presentation Outline

- **Earth Satellite Population**
- **Space Missions in 2014**
- **Satellite Fragmentations**
- **Collision Avoidance Maneuvers**
- **Satellite Reentries**
- **2015 IADC Meeting and MCAT**

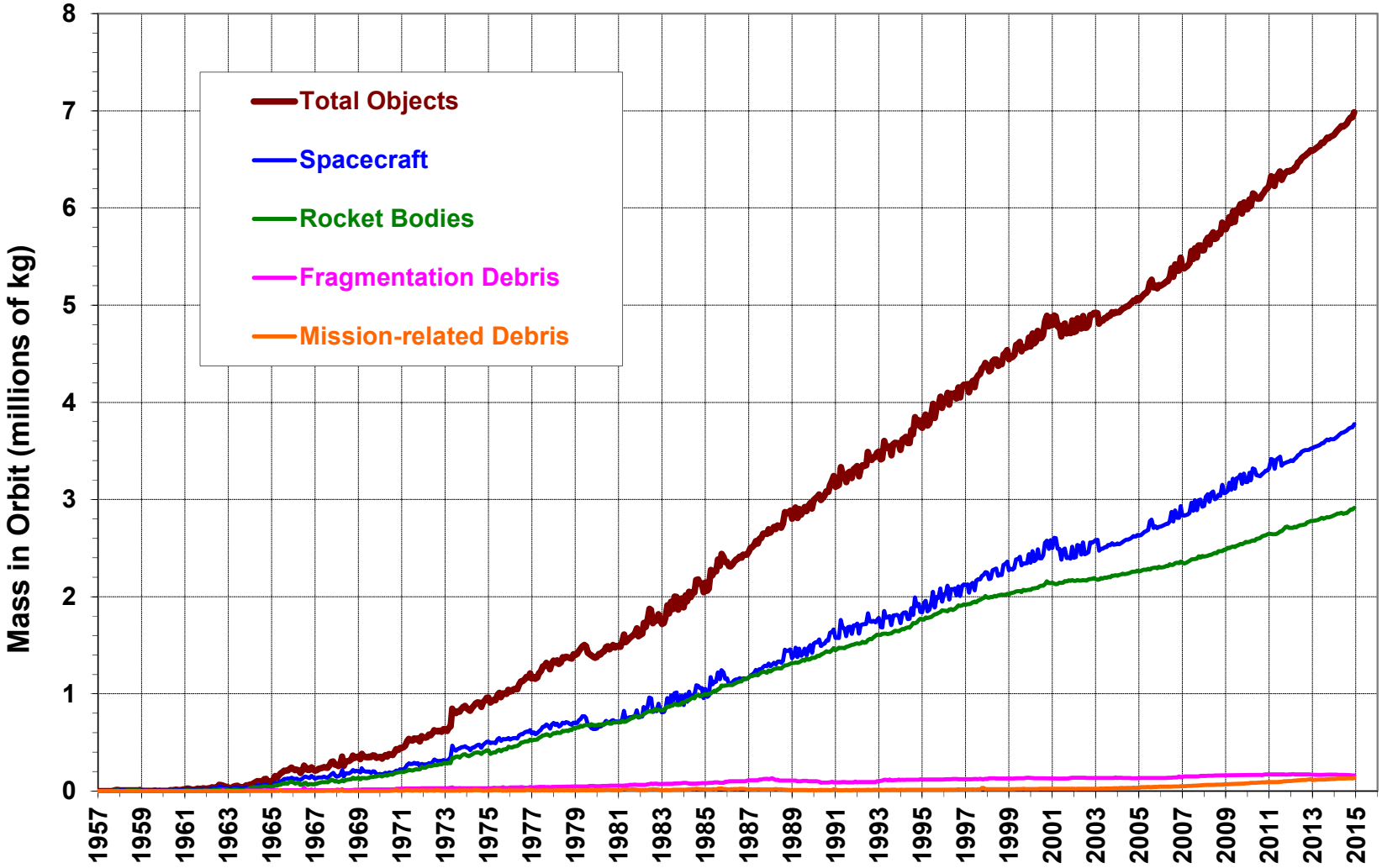
Evolution of the Cataloged Satellite Population

- **According to the U.S. Satellite Catalog, the number of 10 cm and larger objects in Earth orbit increased slightly in 2015.**



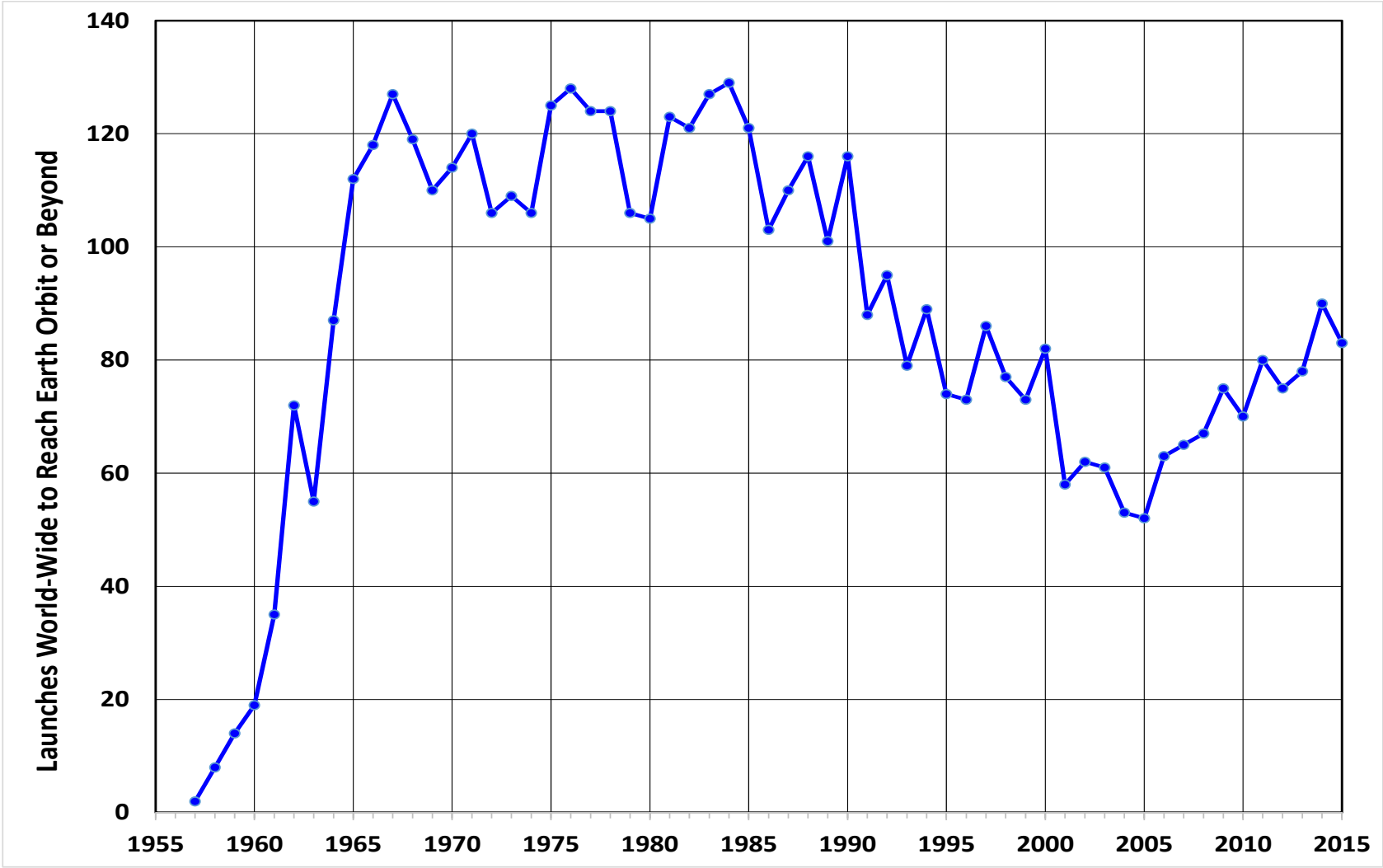
Mass in Near-Earth Space Continued to Increase

- **The material mass in Earth orbit continued to increase and exceeded 7000 metric tons in 2015.**

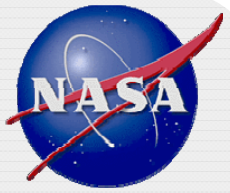


World-Wide Space Activity in 2015

- **A total of 83 space launches placed more than 200 spacecraft into Earth orbits during 2015, following the trend of increase over the past decade.**



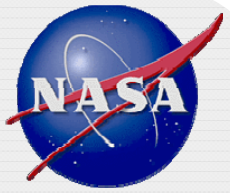
Satellite Fragmentations During 2015



- **Six satellite fragmentations were detected by the U.S. Space Surveillance Network during 2015.**
  - The two most significant breakups (DMSP 5D-2/F13, NOAA 16) were associated with old spacecraft designed/approved prior to when orbital debris mitigation requirements were established in the United States.
  - These two breakups illustrate the importance of following the current orbital debris mitigation policies/guidelines/requirements at the national and international levels to limit the generation of orbital debris in the future.

Common Name	International Designator	Perigee Altitude (km)	Apogee Altitude (km)	Detected Debris	Cause
DMSP 5D-2/F13	1995-015A	849	875	164	Likely battery
Soyuz 2.1a 3rd Stage	2015-024B	175	175	20	Unknown
Breeze-M Tank	2014-064C	100	4690	90	Aerodynamic
SL-23 DEB	2011-037B	428	3600	24	Unknown
NOAA 16	2000-055A	840	850	136	Unknown
Breeze-M rocket body	2012-026B	10,377	34,622	9	Unknown

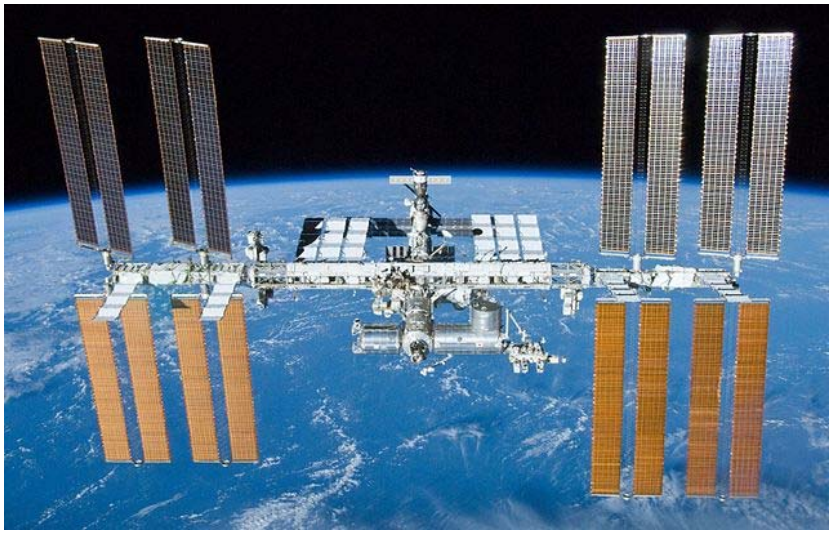
Robotic Spacecraft Collision Avoidance Maneuvers

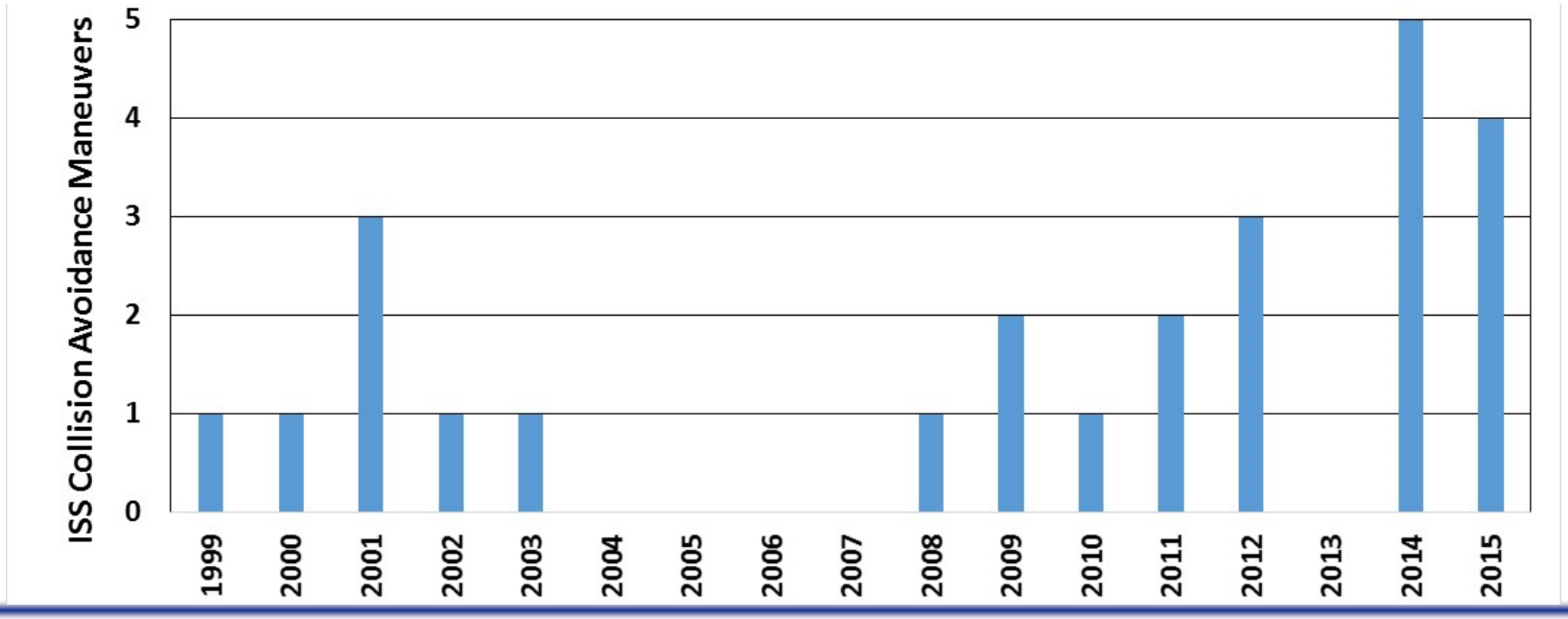


- **Since 2007 NASA has required frequent satellite conjunction assessments for all of its maneuverable spacecraft in LEO and GEO to avoid accidental collisions with objects tracked by the U.S. Space Surveillance Network.**
- **NASA also assists other U.S. government and foreign spacecraft owners with conjunction assessments and subsequent maneuvers.**
- **During 2015 NASA executed or assisted in the execution of 26 collision avoidance maneuvers by robotic spacecraft.**
  - 5 maneuvers were conducted to avoid debris from Fengyun-1C.
  - 8 maneuvers were conducted to avoid debris from the collision of Cosmos 2251 and Iridium 33.

ISS Collision Avoidance Maneuvers

- **The International Space Station (ISS) conducted 4 debris collision avoidance maneuvers in 2015.**
- **In addition, due to a late notification of a high probability conjunction, the crew was directed to "shelter-in-Soyuz" on July 16th.**
  - Fortunately the conjunction did not lead to a collision.





Satellite Reentries in 2015

- **More than 450 reentries of spacecraft, launch vehicle upper stages, and other cataloged debris were recorded by the U.S. Space Surveillance Network during 2015.**
  - Spacecraft: 76; upper stages: 40; other debris: 339 (including 163 reentries of the Fengyun 1C, Iridium 33, and Cosmos 2251 fragmentation debris).
  - The oldest spacecraft that reentered was Molniya 1/42, a first-generation Russian communications satellite which was launched into a highly eccentric orbit in 1978.
  - The oldest debris that reentered was a piece of fragment associated with the U.S. Vanguard 3, which was launched in 1959.

Sketch of Molniya 1/42

- **The total mass of the 2015 reentries was more than 75 metric tons.**
- **No accounts of personal injury or significant property damage were reported.**

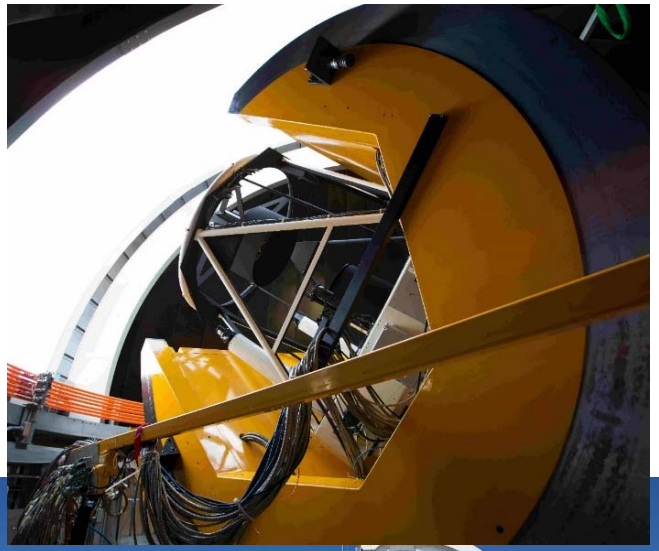
2015 IADC Meeting

- **The Inter-Agency Space Debris Coordination Committee (IADC) is the internationally recognized technical authority on orbital debris.**
  - The13 IADC member agencies include ASI, CNES, CNSA, CSA, DLR, ESA, ISRO, JAXA, KARI, NASA, ROSCOSMOS, SSAU, and UKSA.
- **NASA hosted the 2015 IADC meeting in Houston, Texas.**
  - More than 100 orbital debris technical experts from the member agencies attended the meeting to exchange information on orbital debris research activities.

Inter–Agency Space Debris Coordination Committee

Meter Class Autonomous Telescope (MCAT)

- **A NASA, U.S. Air Force, and Air Force Research Laboratory joint project.**
- **The facility is located on Ascension Island (7° 58' S, 14° 24' W).**
- **The two instruments are a 1.3-m telescope (MCAT) and a 0.4-m Mini-CAT telescope.**
  - MCAT: a double horse-shoe DFM telescope with a field-of-view of 41' × 41'
  - Mini-CAT: an Officina Stellare telescope with a field-of-view of 44' × 44'
- **Objectives for Operations**
  - Conduct GEO and LEO statistical surveys
  - Detect debris as small as ~13 cm in GEO
  - Characterize low inclination objects in LEO
  - Provide rapid break-up response
  - Support Space Situational Awareness (SSA) coverage



MCAT Timeline

Systems Testing

- July 2013: Telescope testing
- Aug 2013-June 2014: Software/Hardware integration testing

Construction

- Sept 2014: Ground-breaking
- Sept-March/April 2015: Main facility construction
- March-April 2015: Dome installation
- April-June 2015: Telescope installation

Acceptance Testing

- June 2, 2015: Engineering First Light
- June17: Camera failure
- Site Acceptance Test (SAT) for all except camera-specific tasks
- Aug: 1st Light, alt camera satellite, debris tracking
- Nov: Prime camera fix
- Dec: Camera SAT

Full Integration/ Data Collection

- **Jan 2016: Begin fully integrated systems testing and data collection**
- **Apr/May 2015: miniCAT installation testing**
- **Full operations expected to continue for 20+ years**

Orion nebula (MCAT)