



USA Space Debris Environment and Operational Updates

**Presentation to the 46th Session of the
Scientific and Technical Subcommittee
Committee on the Peaceful Uses of Outer Space
United Nations**

9-20 February 2009



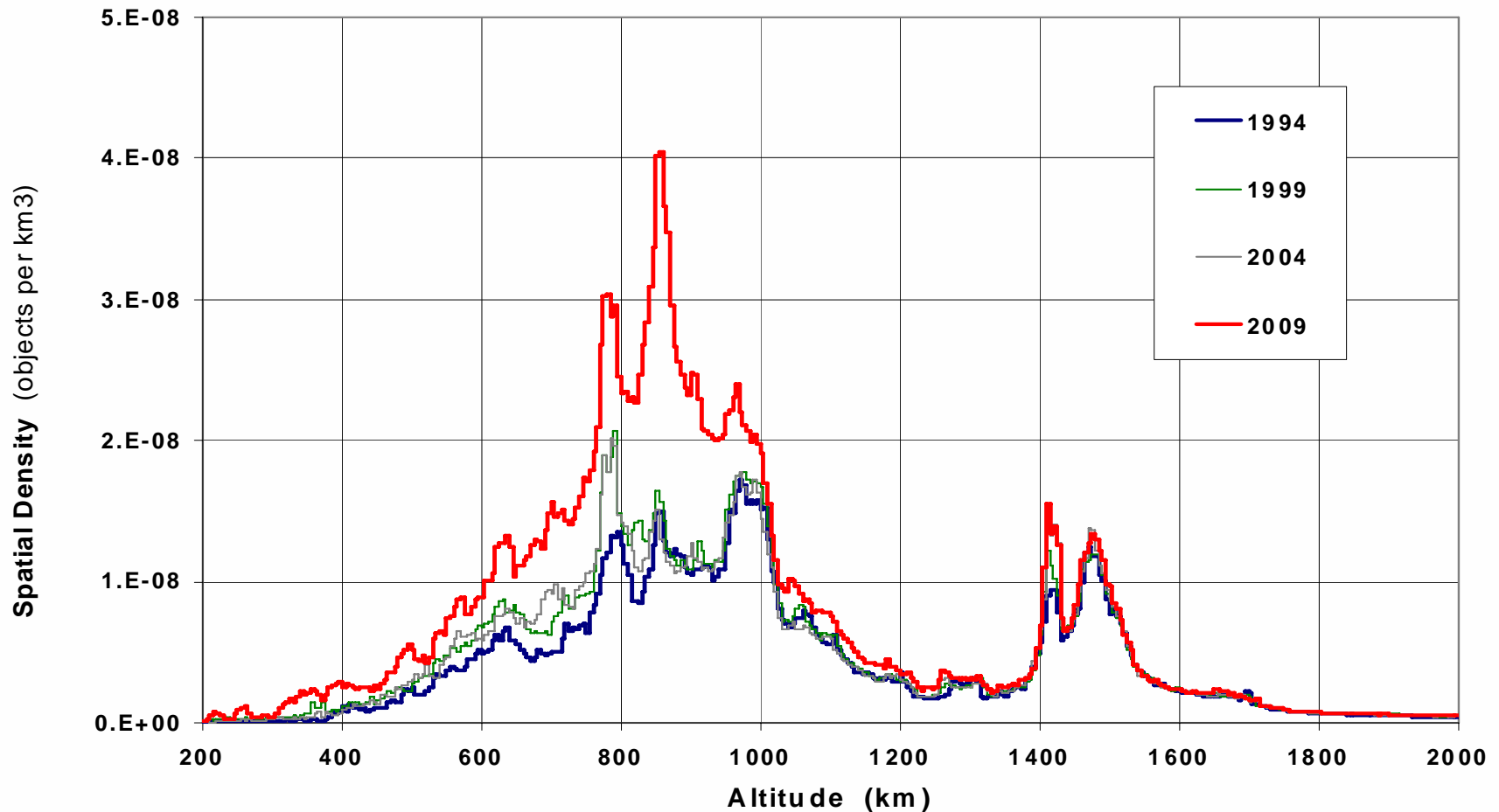
Presentation Outline

- **Evolution of Low Earth Orbit Satellite Population since 1994**
- **Satellite Launches and Reentries in 2008**
- **Collision Avoidance**
- **Retirement of USA LEO and GEO Spacecraft in 2008**
- **Satellite Fragmentations in 2008**
- **Recent Space Shuttle and ISS Space Debris Impacts**
- **New Meter-Class Autonomous Telescope (MCAT)**
- **Recent Satellite Collision**

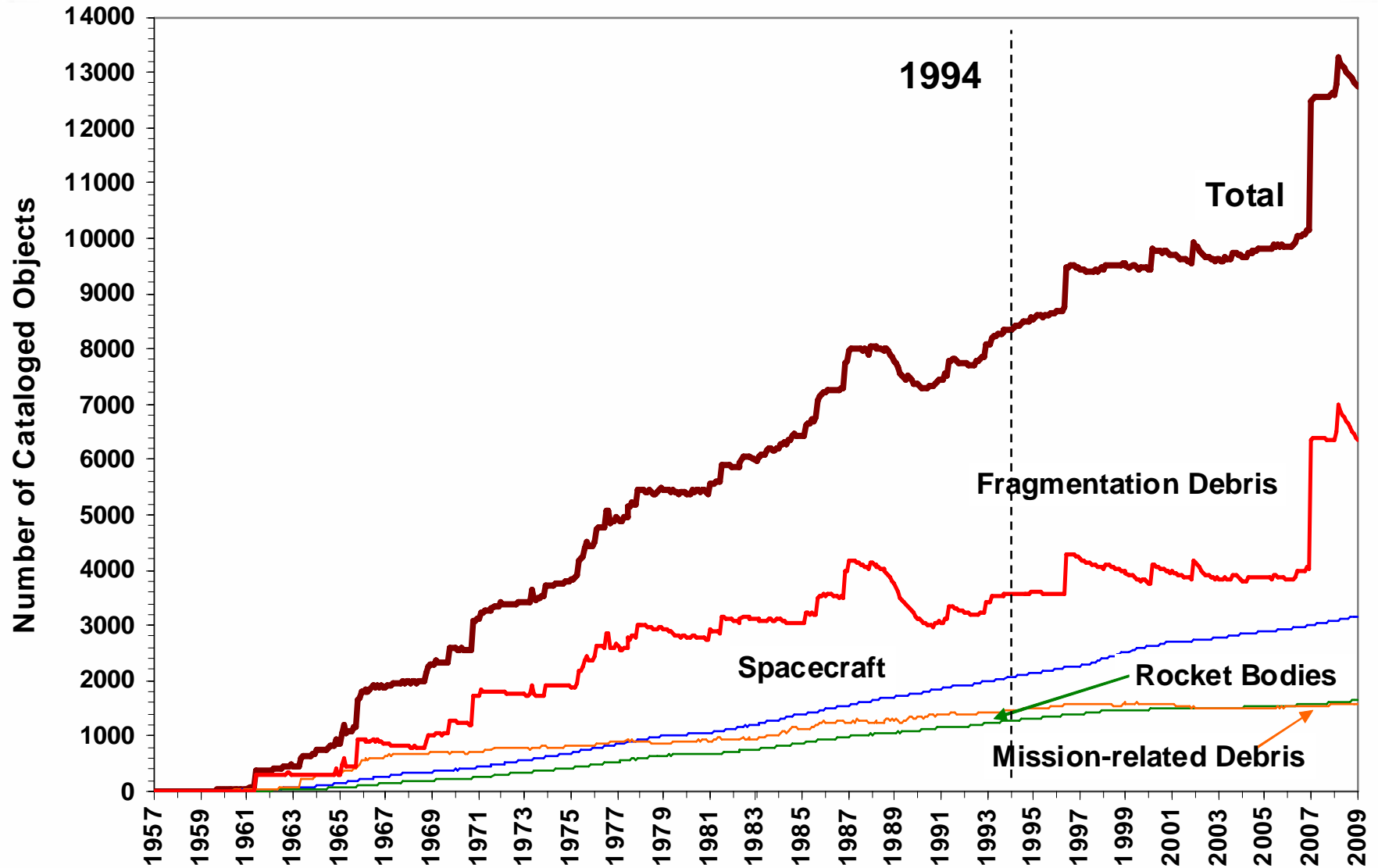


Growth of Satellites in Low Earth Orbit

- Since UN COPUOS STSC first included the topic of space debris on its agenda in 1994, the population and concentration of satellites in LEO has markedly increased.



Historical Growth of the Large Earth-Satellite Population

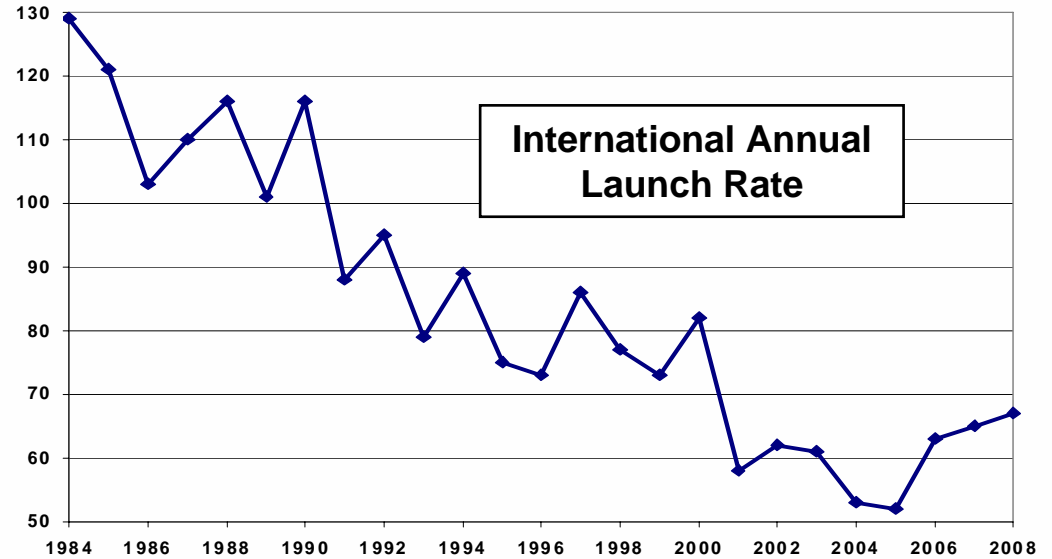




Satellite Launch Traffic in 2008

- The number of world-wide space launches in 2008 to reach Earth orbit or beyond was 67:

- Russian Federation 27
- USA 14
- China 11
- France 6
- India 3
- Japan 1
- SeaLaunch 5



- Cataloged Objects in Earth Orbit (from USA Space Surveillance Network):

	<u>Total</u>	<u>USA</u>
1 January 2008	12456	4200
1 January 2009	12743	4259



NASA Space Missions of 2008

- **Seven NASA space missions were undertaken in 2008.**

Mission	Launch Date	Destination	Other Objects Left in Earth Orbit
STS-122	07 February	LEO (ISS)	No objects left in Earth orbit
STS-123	11 March	LEO (ISS)	No objects left in Earth orbit
STS-124	31 May	LEO (ISS)	No objects left in Earth orbit
GLAST	11 June	LEO	One rocket body
JASON 2 (with France)	20 June	LEO	Rocket body left in disposal orbit above LEO
IBEX	19 October	Highly Elliptical Earth Orbit	Two rocket bodies and one debris
STS-126	15 November	LEO (ISS)	One picosat deployed

- **All spacecraft, rocket bodies, and mission-related debris residing in or passing through LEO have already reentered or will reenter within 25 years.**



Reentry of Satellites in 2008

- **Due to two significant low altitude satellite breakups, the number of known space object reentries was much higher in 2008, compared with recent years.**
 - However, total reentering mass was similar to that of 2006 and 2007.
- **A total of 743 spacecraft, launch vehicle orbital stages, and other cataloged debris reentered during the year.**
- **The total number of uncontrolled reentries was 730, including 6 payloads and 34 launch vehicle orbital stages with a total mass of about 80 metric tons.**

No instances of injuries or property damage were reported.



Reentry of the Jules Verne ATV

- **NASA and ESA conducted a joint observation campaign of the reentry of the Jules Verne ATV on 29 September 2008.**
 - Two aircraft collected a wide variety of data from vantage points over the Pacific Ocean near the reentry path of the Jules Verne.



**Jules Verne undocking on
5 September 2008**

**Reentry over
Pacific Ocean**





Jules Verne ATV Reentry Video

- Intensified optical imaging by NASA Johnson Space Center





Orbital Debris Collision Avoidance

- **Since 2007 NASA has required all of its maneuverable spacecraft in LEO or GEO to conduct satellite conjunction assessments on a routine basis to avoid accidental collisions with resident space objects.**
- **Using ESA's ATV-1 spacecraft, ISS conducted the eighth collision avoidance maneuver during its 10 years of operations.**

Spacecraft	Maneuver Date	Object Avoided
Aura	26-Jun-2008	TRIAD 1 debris
Cloudsat	20-Jul-2008	Delta rocket body debris
ISS	27-Aug-2008	Cosmos 2421 debris
TDRS 5	1-Oct-2008	Cosmos 1888
PARASOL (France)	19-Oct-2008	Fengyun-1C debris



Disposal of GEOSAT Follow-On (GFO)

- **The GEOSAT Follow-On (GFO) spacecraft was launched in 1998 on an eight-year mission to provide precision ocean surface topography.**
- **Operational orbit: 785 km circular orbit with 108 degree inclination.**
- **Following a highly successful mission, GFO was decommissioned and passivated in 2008.**
- **Although designed before LEO disposal recommendations were established, GFO was maneuvered to a lower orbit to ensure reentry within 25 years.**
 - 8 burns totaling 65 minutes
 - Final orbit: 455 km by 785 km
 - Estimated orbital lifetime: <15 years





Disposal of USA GEO Satellites in 2008

- **Five USA civil GEO spacecraft completed operations in 2008.**

Spacecraft	International Designator	Minimum Height above GEO	Maximum Height above GEO
MARISAT 2	1976-101A	330	1205
TELSTAR 11	1994-079A	380	580
ECHOSTAR 2	1996-055A	N/A ¹	N/A
PAS 6B	1998-075A	245	390
GALAXY 10R	2000-002A	165 ²	190

¹ A catastrophic spacecraft failure prevented a disposal maneuver

² The spacecraft suffered primary and secondary propulsion system failures prior to 2005

MARISAT 2, TELSTAR 11 and PAS 6B meet USA, IADC, and United Nations recommendations for GEO disposal and will not come within the GEO protected region during the next 200 years.



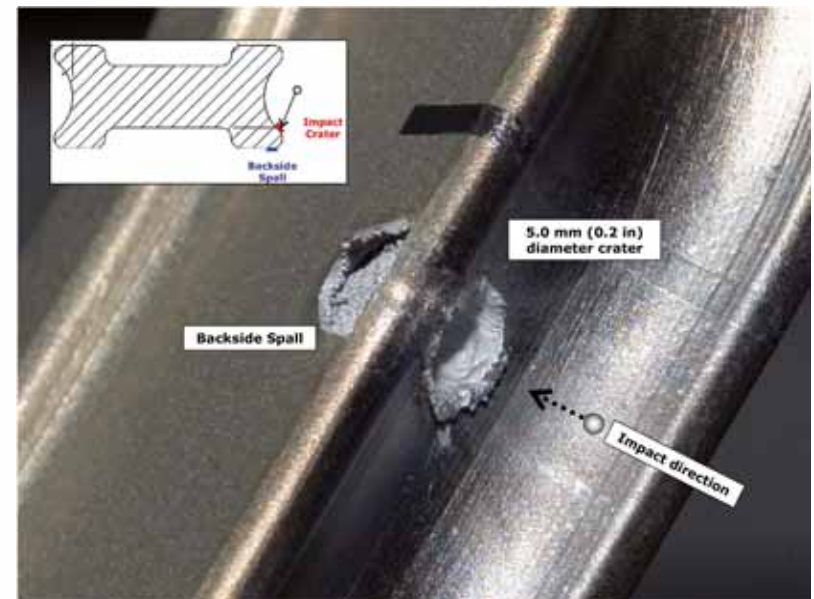
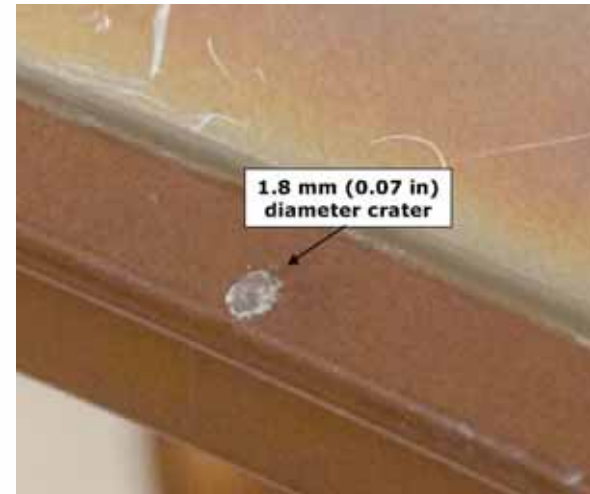
Satellite Fragmentations in 2008

- **USA 193:** This uncontrolled spacecraft was destroyed on 21 February shortly before reentry to prevent hazardous materials from reaching the surface of the Earth. No debris remain in orbit from this event.
- **Kosmos 2421:** This spacecraft, at an altitude of approximately 400 km, experienced at least three major fragmentation events during March-June, producing more than 500 large debris. The majority of the debris have already reentered the atmosphere.
 - The debris posed several close approaches to the International Space Station, resulting in one collision avoidance maneuver on 27 August.
- **Kosmos 1818:** This 21-year-old, decommissioned spacecraft with a nuclear power supply released dozens of small debris in early July at an altitude near 800 km. Preliminary radar observations indicate that some of the debris might be sodium-potassium coolant from the NPS.
 - The debris will likely be long-lived.



Recent Debris Impacts on ISS

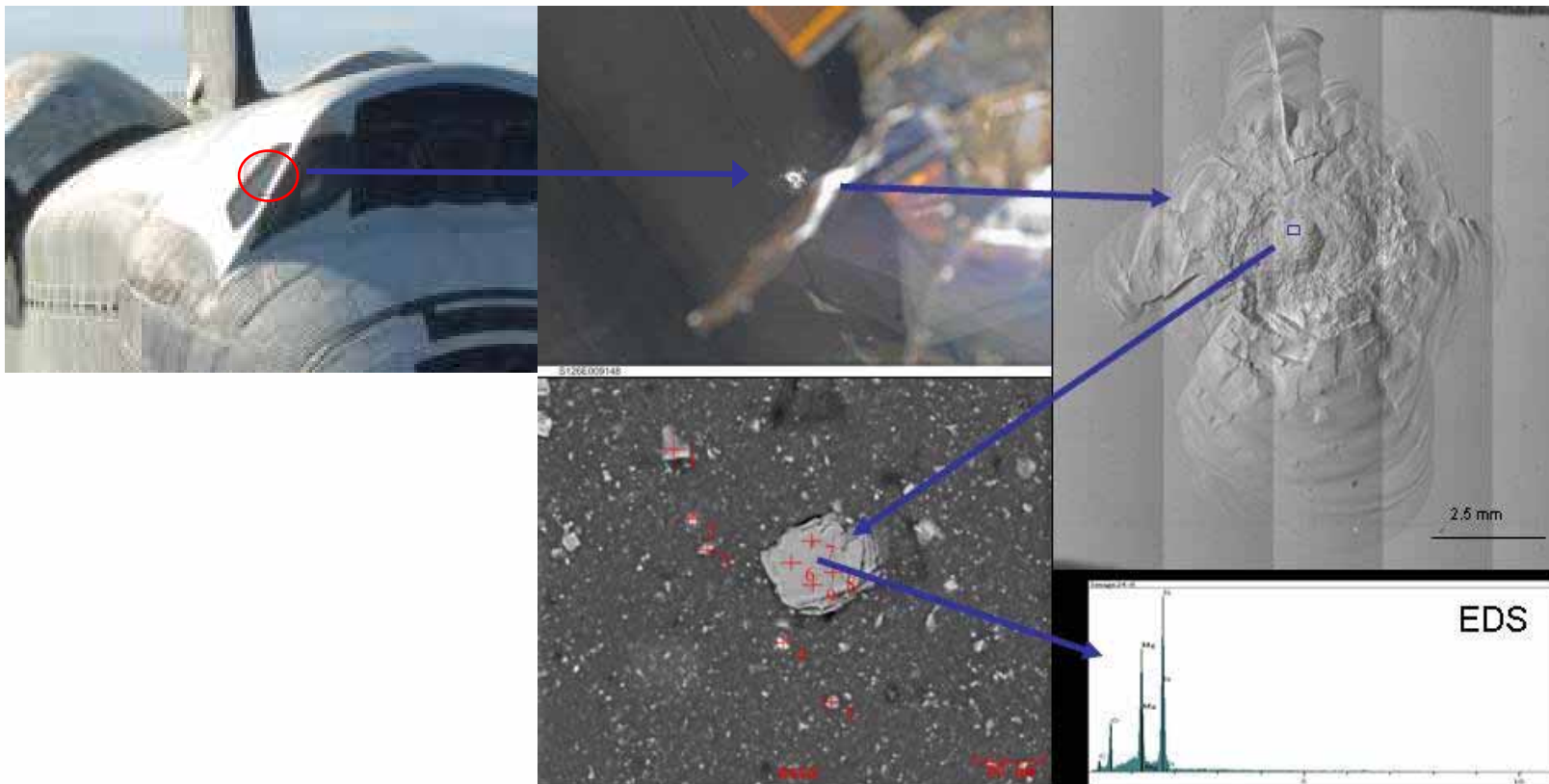
- During the STS-122 mission to ISS in February 2008, a crew member discovered a small impact crater (~2 mm diameter) on the US airlock hand rail. This ragged feature might have been the source for cuts found on some EVA suit gloves.
- During the STS-123 mission to ISS in March 2008, a larger 5 mm diameter impact crater was observed on an EVA tool which had been externally stored.





Recent Debris Impact on the Space Shuttle

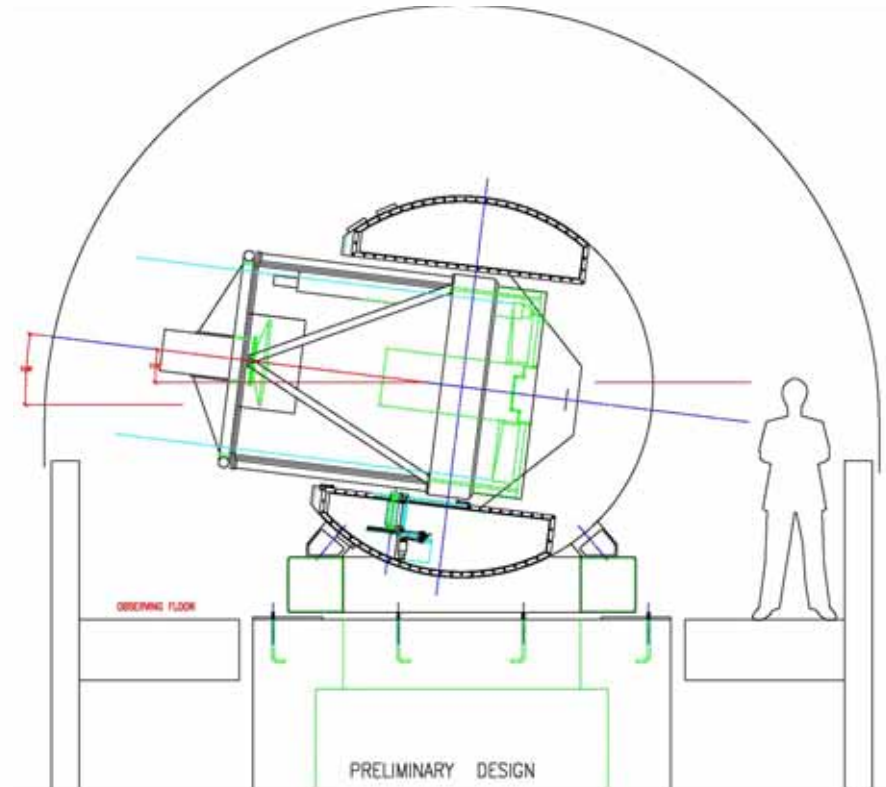
- During the STS-126 to ISS in November 2008, a small space debris particle impacted one of the pilot's windows, creating a 1-cm diameter crater. An investigation of the damage site revealed that the impacting particle was a micrometeoroid.





New Orbital Debris Telescope in Development

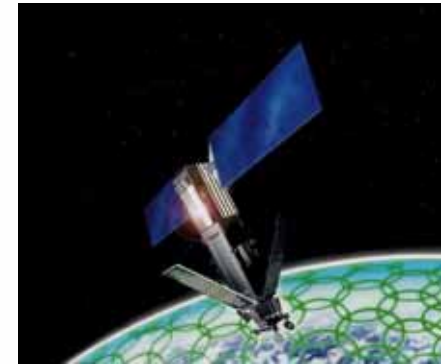
- **The Meter-Class Autonomous Telescope (MCAT) is intended to supplement current knowledge of the orbital debris environment in under-sampled orbital regimes: low inclinations from LEO to GEO**
- **The 1.3 m aperture f/4 system will be equipped with a 4K x 4K CCD camera**
 - Capable of detecting 10 cm target at GEO with 5 second exposure (0.1 albedo)
 - Wide field-of-view (0.96°) for debris searches
 - Economical autonomous operation (no dedicated operator)
- **Deployment will be on Legan Island, Kwajalein Atoll, Republic of the Marshall Islands, in September 2010**





Collision of Iridium 22 and Cosmos 2251

- **The first accidental hypervelocity collision of two intact satellites occurred on 10 February 2009 at an altitude of 790 km.**
- **Iridium 33 (1997-51C), an operational U.S. communications satellite, collided with Cosmos 2251 (1993-36A), a non-functional Russian communications satellite. The Iridium satellite ceased functioning at the time of the collision.**
- **The U.S. Space Surveillance Network is tracking hundreds of new debris in the orbital planes of the two spacecraft.**



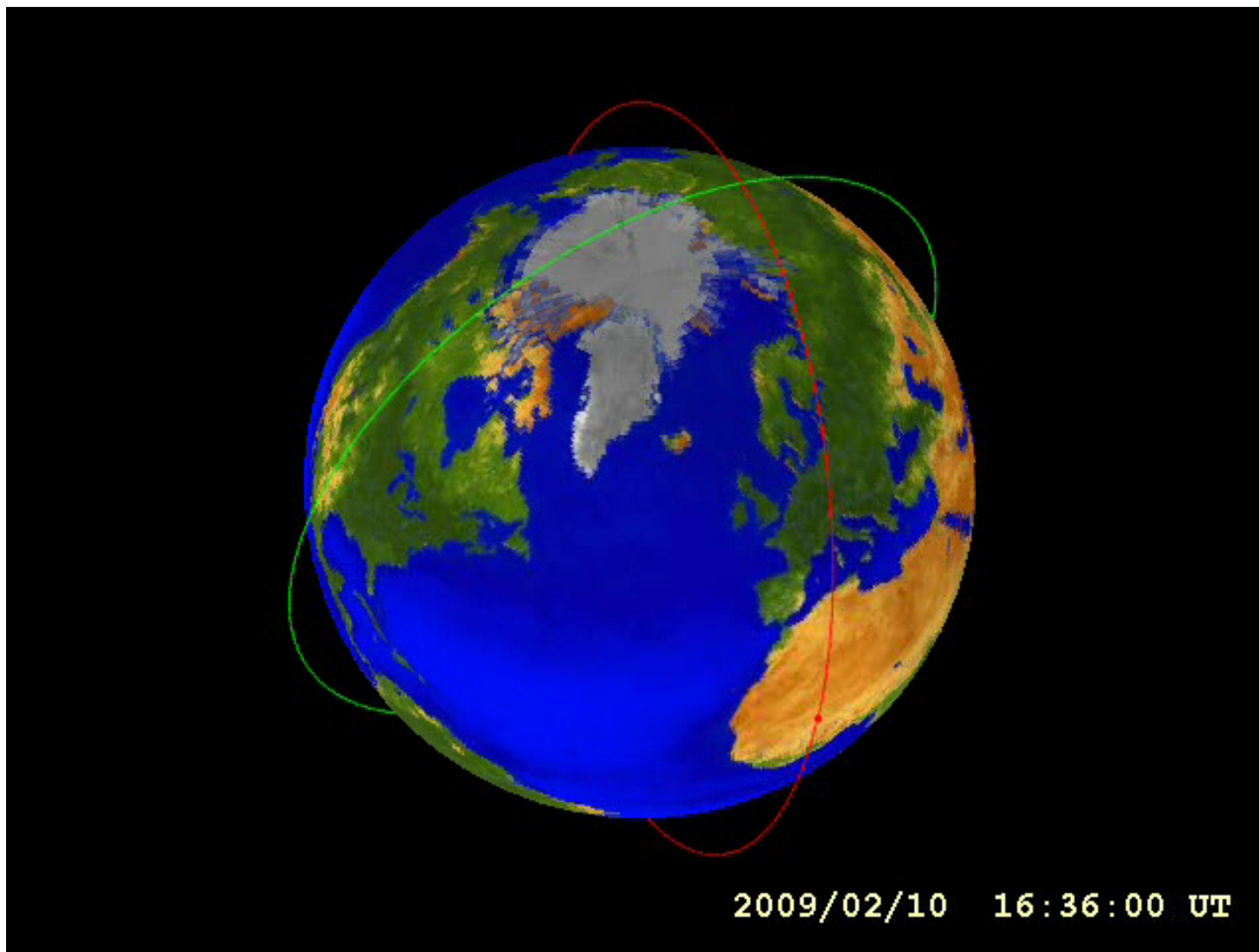
Iridium33



Cosmos 2251



Simulation of Debris Clouds





Known Accidental Hypervelocity Collisions

