National Aeronautics and Space Administration

Orbital Debris Quarterly News

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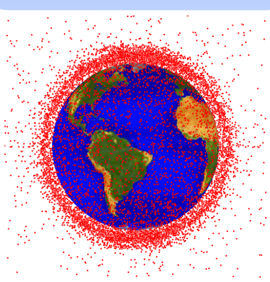
Inside...



A publication of the NASA Orbital Debris Program Office

Flurry of Small Breakups in First Half of 2014

Seven small suspected and confirmed breakups have occurred in low Earth orbit since late March. The first was Cosmos 1867 (International Designator 1987-060A, U.S. Strategic Command [USSTRATCOM] Space Surveillance Network [SSN] catalog number 18187), a *Plazma-A*-class spacecraft launched by the former Soviet Union to test a new, advanced nuclear power supply. Cosmos 1867 is a sister to Cosmos 1818, which created a similar debris cloud in July 2008 (see ODQN, January 2009, p. 1 and Figure 1). As with Cosmos 1818, the cause of the breakup is unknown, although six objects identified as "coolant" were added to the SSN catalog of orbiting objects. It is suspected that the debris are leaked sodium potassium coolant released either through a hypervelocity impact of a small particle or some other breach in a coolant tube through thermal cycling. Cosmos 1867 was in a 775 x 800 km orbit at a 65° inclination at the time of the breakup.

A Delta 2 second-stage rocket body (International Designator 1999-008D, SSN# 25637) experienced a possible breakup on 30 April that resulted in six additional objects entering the SSN catalog. The Delta 2 launched from Vandenberg Air Force Base in February 1999 and carried the Advanced Research and Global Observation Satellite (ARGOS) and two secondary payloads; ØRSTED, the first Danish satellite, and SUNSAT, a South African satellite, into orbit. The rocket body was in a 96.5° inclined 635 x 840 km orbit.

In the first decades of the space age, a number of Delta second stages exploded due to the inadvertent mixing of residual propellant left in their fuel tanks. However, since 1982, Delta 2 upper stages have been fully passivated, making a small MMOD strike a more likely cause of this breakup.

On 10 May, Cosmos 2428 (International Designator 2007-029A, SSN# 31792) experienced a small breakup. Approximately 15 – 17 objects were detected and 4 made it into the SSN catalog. Although the parent body was in an 845 x 860 km, 71° orbit, the pieces displayed very high decay rates. As a result, many have reentered the Earth's atmosphere including two of the four cataloged objects. Cosmos 2428 was the last of the *Tselina-2*-class electronic intelligence satellite and was launched in late June 2007.

Note that each of the three parent objects related to these breakups orbited at altitudes that include the most densely populated region from 750 to 850 km. Although it is difficult to assign a cause to each breakup conclusively, the number and attributes of the resulting debris are consistent with

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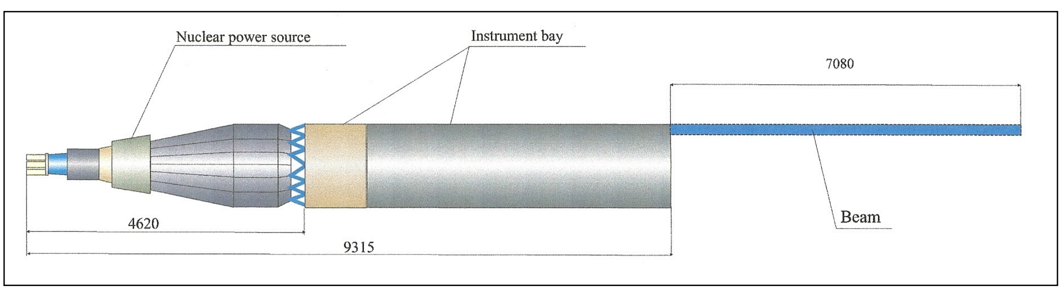

Figure 1. Simplified illustration of Cosmos 1818 and Cosmos 1867. The dimensional units are millimeters.

Breakups in 2014

continued from page 1

impacts of small hypervelocity particles, either meteoroid or orbital debris.

Three additional breakups occurred during early- to mid-May. Two of these were SOZ ullage motors from separate Proton Block DM fourth stages. Ullage motors, used to settle propellants prior to an engine restart, are routinely ejected after the Block DM stage ignites for the final time. The two breakups were the 40th and 41st known fragmentations of this type of object since 1984. SSN# 23402 (International Designator 1994-076G) fragmented on 8 May. It was in a 420 x 18,990 km elliptical orbit at a 65° inclination. The SSN has detected about 15 pieces.

The other SOZ ullage motor was SSN# 33385 (International Designator 2008-046H) from a Proton Block DM fourth stage. It was in an 865 x 18,720 km elliptical orbit at a 65° inclination. Five to seven objects were detected and two have been added to the SSN catalog. Both Proton rockets were used to launch three Russian global positioning navigation system (GLONASS) satellites.

The next minor breakup was debris from Cosmos 862 (International Designator 1976-105F, SSN# 9889). This piece of debris was in a decaying elliptical orbit of 110 x 14,990 km with an inclination of 62°. Two additional objects were detected, but not cataloged. The breakup was likely caused by aerodynamic failure and the debris were short-lived. The Cosmos 862 parent object reentered the Earth's atmosphere on 29 May 2014.

Finally, on 4 June at approximately 02:38 UT, a provisional breakup of a Titan 3C Transtage rocket body (SSN# 3692, International Designator 1969-013B) occurred more than 45 years after its launch (rocket body is shown in Figure 2). The breakup has reportedly produced about five fragments. The parent body was in a near geosynchronous orbit of 35,970 x 37,130 km and 8.7° inclination.

This is the fourth breakup of this class of rocket body. Two of the breakups occurred within a day of their launch, SSN# 1822 (1965-082DM) and SSN# 1863 (1965-108A). However, the third occurred more than 23 years after launch. SSN# 3432 (1968-081E) fragmented in a near geosynchronous orbit in 1992. Satellite 3432 was one of only two confirmed breakups in the geosynchronous region prior to this event. ♦

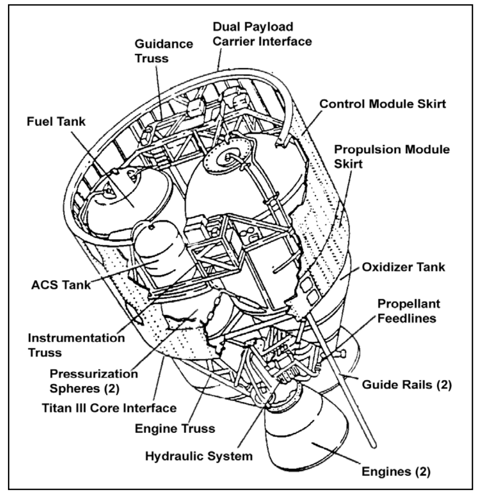

Figure 2. Titan 3C Transtage rocket body. (Titan III Commercial Launch Services Customer Handbook, Martin Marietta Commercial Titan, Inc., December 1987, p. 1-8).

Dr. Jer Chyi (J.-C.) Liou is New NASA Chief Scientist for Orbital Debris

Dr. Jer Chyi (J.-C.) Liou was selected as the NASA Chief Scientist for Orbital Debris in early June, succeeding Mr. Nicholas Johnson who retired in March 2014 (ODQN, April 2014, pp. 2). While the Chief Scientist is officially part of the Orbital Debris Program Office (ODPO), he is chartered with representing the integrated orbital debris interests of the Agency, the ODPO, and the hypervelocity impact team (HVIT), serving interactions with outside agencies and organizations for policy development and NASA's strategic plans related to understanding the orbital debris environment, debris mitigation, risk assessments, and spacecraft protection.

Dr. Liou has been a member of the NASA ODPO at the NASA Johnson Space Center (JSC) in Houston, Texas, since 2008. In 1994, Dr. Liou came to NASA JSC as a National Research Council post-doctoral research fellow working with the late Herbert Zook on interplanetary dust, asteroids, and the Kuiper Belt dust disk. He began his orbital debris career as a GB Tech contractor supporting the NASA ODPO in 1997, later serving as the Lockheed Martin project manager for the orbital debris contractor team, and then as the Jacobs/ESCG/ERC section manager for the orbital debris and hypervelocity impact contractor teams prior to joining the NASA ODPO.

Dr. Liou led the development of the NASA Orbital Debris Engineering Model, ORDEM2000, and NASA's LEO to GEO Environment Debris evolutionary model (LEGEND). He has led several key NASA and international studies to investigate the instability of the orbital debris population in LEO and to quantify the effectiveness of environment remediation options. In addition, Dr. Liou directed the ODPO development of new technologies for micrometeoroid and orbital debris in-situ impact detection, including the DRAGONS system, and served as the Principal Investigator and Co-Investigator of Science Mission Directorate-funded sensor development projects. He is currently the lead for DebriSat, a project employing laboratory-based hypervelocity impact experiments to improve satellite breakup models and space situational awareness.

Dr. Liou has authored approximately 100 technical publications, including more than 40 papers in peer-reviewed journals (Science, Astrophysical Journal, Astronomical Journal, ICARUS, Advances in Space Research, Acta Astronautica, etc.). He was the Technical Editor for the NASA Orbital Debris Quarterly News between 2003 and 2014 and served as the Chief Technologist for the JSC ARES Directorate between 2009 and 2014.

Dr. Liou received several major Lockheed Martin and Jacobs/ESCG/ERC awards in 2002-2006, the NASA astronaut's Silver Snoopy Award in 2003, the JSC Director's Commendation Award in 2011, and the NASA Exceptional Engineering Achievement Medal in 2012.

Dr. Liou earned a B.S. in Physics from the National Central University in Taiwan, and an M.S. (1991) and Ph.D. (1993) in Astronomy from the University of Florida. ♦

KickSat Reenters

On 19 April, KickSat (International Designator 2014-022F, SSN# 39685) was deployed during the SpaceX Dragon CRS 3 cargo resupply mission to the International Space Station (ISS). The 3U (30×10×10 cm) CubeSat was to deploy 104 Sprites into low Earth orbit (visualized in Figure 1). Each Sprite consisted of a 3.5-cm-square circuit board, as shown in Figure 2. The Sprite was developed by a graduate student in Aerospace Engineering at Cornell University and a KickStarter website campaign was used to fund the project.

Safety requirements levied by the ISS required that KickSat delay the release of the Sprites for 16 days after being deployed from Dragon. An anomaly, potentially due to radiation exposure, caused the timer to reset and the satellite failed to deploy the Sprites prior to its reentry in the early hours of 14 May. ♦

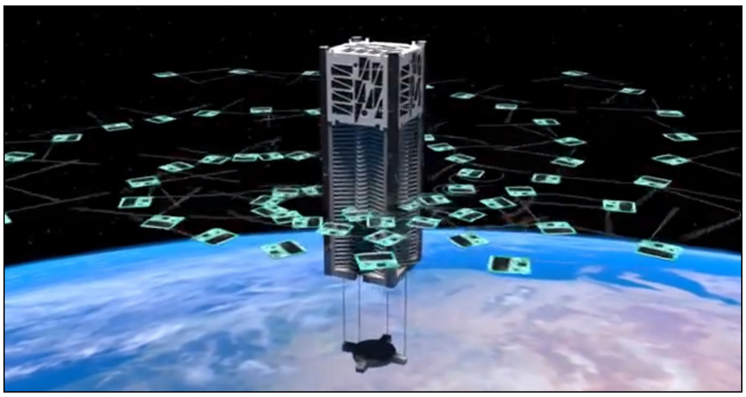

Figure 1. Artist conception of Sprite deployment from the KickSat satellite. (Image courtesy KickSat.com as shown at www.spaceflight101.com - Patrick Blau).

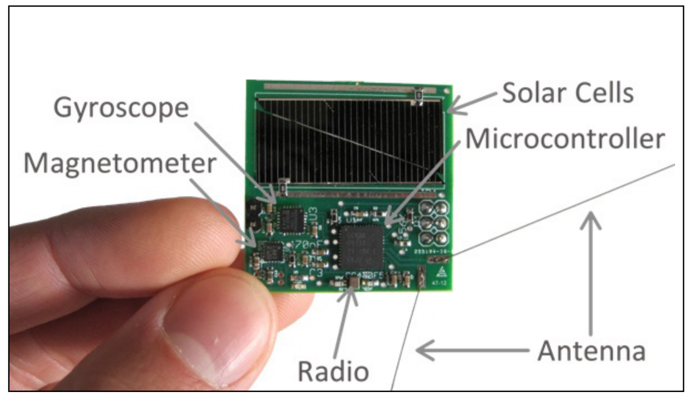

Figure 2. Image of the Sprite ChipSat. (Image courtesy KickSat.com as shown at www.spaceflight101.com - Patrick Blau).

PROJECT REVIEW

Successful Hypervelocity Impacts of DebrisLV and DebriSat

J.-C. LIOU, J. OPIELA, H. COWARDIN, T. HUYNH, M. SORGE, C. GRIFFICE, P. SHEAFFER, N. FITZ-COY, M. WILSON, R. RUSHING, B. HOFF, M. NOLEN, M. POLK, B. ROEBUCK, AND D. WOODS

Background

The DebriSat project is a collaboration of the NASA Orbital Debris Program Office (ODPO), the Air Force Space and Missile Systems Center (SMC), The Aerospace Corporation (Aerospace), the University of Florida, and the Air Force Arnold Engineering Development Complex (AEDC). The project's goal is to design and fabricate a 50-kg class spacecraft ("DebriSat") representative of modern payloads in the low Earth orbit (LEO) environment, conduct a hypervelocity impact test to catastrophically break it up, collect fragments as small as 2 millimeters in size, measure and characterize the fragment properties, and then use the data to improve space situational awareness and satellite breakup models.

A key impact test series, Satellite Orbital debris Characterization Impact Test (SOCIT), was conducted by the Department of Defense and NASA at AEDC in 1992 to support the development of satellite breakup models. The main target for SOCIT was a fully functional U.S. Navy Transit satellite. The DoD and NASA breakup models based on the SOCIT data have supported many applications and matched on-orbit events reasonably well over the years. As new materials and construction

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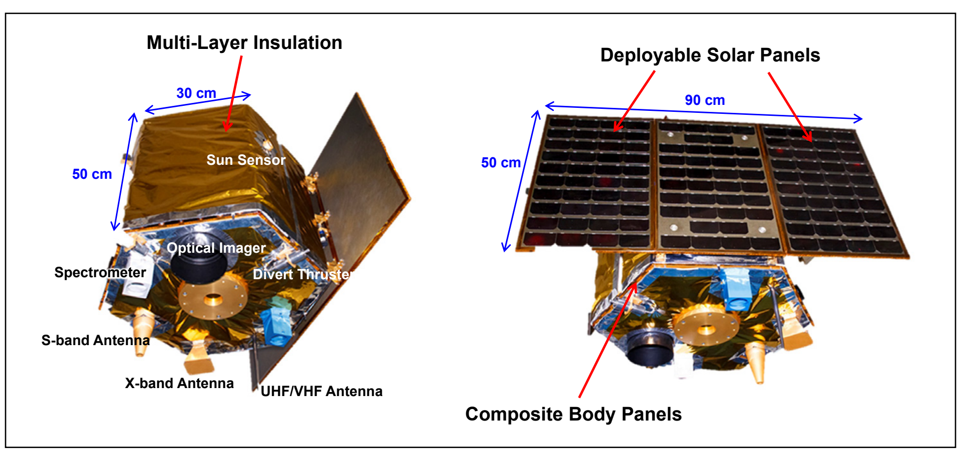

Figure 1. Two views of DebriSat.

DebriSat

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techniques are developed for modern satellites, however, there is a need for new laboratory-based tests to acquire data to improve the existing DoD and NASA breakup models. The need for such tests is also supported by discrepancies between model predictions and observations of fragments generated from the breakup of modern satellites (e.g., ODQN, July 2009, pp. 5-6).

The DebriSat design was based on a survey of modern satellites in LEO [1, 2]. All major design decisions, including the selection of components, subsystems, mass fractions, structure, and construction methods were reviewed and approved by Aerospace subject matter experts. In addition, the DebriSat body was covered with multi-layer insulation (MLI) and three solar panels were attached to one side of the main body (Figure 1).

To reduce the project cost, a decision was made to emulate the majority of components. The emulated components were based on existing designs of flight hardware, including structure, dimensions, materials, and connection mechanisms. At the end of the assembly, DebriSat was subjected to a standard vibration test to ensure the integrity of the structure.

Table 1 is a comparison of DebriSat and Transit. To increase the project's benefits further, Aerospace designed and built a target resembling a launch vehicle upper stage ("DebrisLV") for the pre-test shot. DebrisLV had a mass of 17.1 kg with body dimensions of 35 cm (diameter) × 88 cm (length). Figure 2 shows the mounting of DebrisLV inside the target chamber.

Hypervelocity Impact Tests

A key element for the DebriSat impact test was the design and installation of a soft-catch system inside the target chamber that would slow down and capture fragments after the projectile impact similar to the original SOCIT test series. Several polyurethane foam stacks, consisting of panels with different densities (0.06, 0.096, and 0.192 g/cm^3) and with a total thickness of up to 25 cm, were used in the downrange and sideways directions during the SOCIT test series.

For DebriSat, the same foam material with three different densities (0.048, 0.096, and 0.192 g/cm^3) was used but with an increased thickness up to 61 cm. In addition, the interior of the target chamber was fully covered with the soft-catch foam panels to prevent any fragments from impacting the chamber walls, which would produce secondary damage not associated with the breakup.

The hypervelocity impacts of DebrisLV and DebriSat were conducted at the Range G facility at AEDC. Range G operates the largest two-stage light gas gun in the United States. To maximize the projectile mass at the 7 km/sec impact speed without a sabot, the AEDC team developed a special projectile design featuring a hollow aluminum cylinder embedded in a nylon cap. The nylon cap served as a bore rider for the aluminum cylinder to prevent hydrogen leakage and also to protect the barrel. The DebrisLV and DebriSat impacts were successfully carried out at AEDC Range G on 1 April and 15 April, respectively. Figures 3 and 4 show the impact sequences of DebrisLV and DebriSat, in that order. Portions of the rear nylon cap fragmented and trailed the aluminum cylinder during flight, but this did not affect the planned catastrophic outcome of the impact.

Fragment Collection, Processing, and Future Measurement Plan

After the impact of DebrisLV, all intact foam panels, broken foam pieces, loose fragments, and dust were carefully collected, processed, documented, and placed in bags or plastic containers for shipping to a storage facility. The same process was repeated after the DebriSat impact. The remaining activities for fiscal year 2014 will include x-ray scanning the foam panels and foam pieces to identify the locations of embedded 2 mm and larger fragments and then, the extraction of those fragments. Simple, ballpark estimates based on the current NASA Breakup Model indicate the number of 2 mm (and larger) fragments from DebriSat and DebrisLV are approximately 85,000 and 35,000, respectively. The effort to process the foam panels and to extract fragments will be a major challenge for the team this fall. Once the fragments are available for measurements, each piece's three orthogonal dimensions and mass will be measured with a description of its major compositions and shape classification. The data will be processed and analyzed to improve the satellite breakup model for collisions.

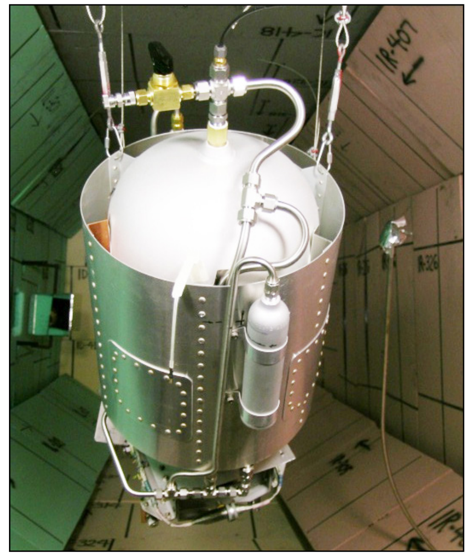

Figure 2. DebrisLV inside the target chamber.

Representative fragments also will be selected for 3-D scanning measurements to obtain cross-sectional area and volume data for area-to-mass ratio, volume, and density distributions. Additional representative fragments will be selected and subjected to laboratory radar and optical measurements to improve the radar debris size estimation model, to develop an optical debris size estimation model, and to bridge the interpretation between the ground-based radar and optical observations of debris populations in space.

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Table 1. A comparison between Transit and DebriSat

	Transit (SOCIT)	DebriSat
Target body dimensions	46 cm (dia) × 30 cm (ht)	60 cm (dia) × 50 cm (ht)
Target mass	34.5 kg	56 kg
MLI and solar panel	No	Yes
Projectile	Al sphere	Hollow Al cylinder
Projectile dimension, mass	4.7 cm (dia), 150 g	8.6 cm × 9 cm, 570 g
Impact speed	6.1 km/sec	6.8 km/sec
Impact energy to target mass ratio	78 J/g (2.7 MJ total impact energy)	235 J/g (13.2 MJ total impact energy)

DebriSat

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References

1. Werremeyer, M., Design of Subsystems for a Representative Modern LEO Satellite, Dissertation, University of Florida, 2013.

2. Clark, S., Design of a Representative LEO Satellite and Hypervelocity Impact Test to Improve the NASA Standard Breakup Model., Dissertation, University of Florida, 2013. ♦

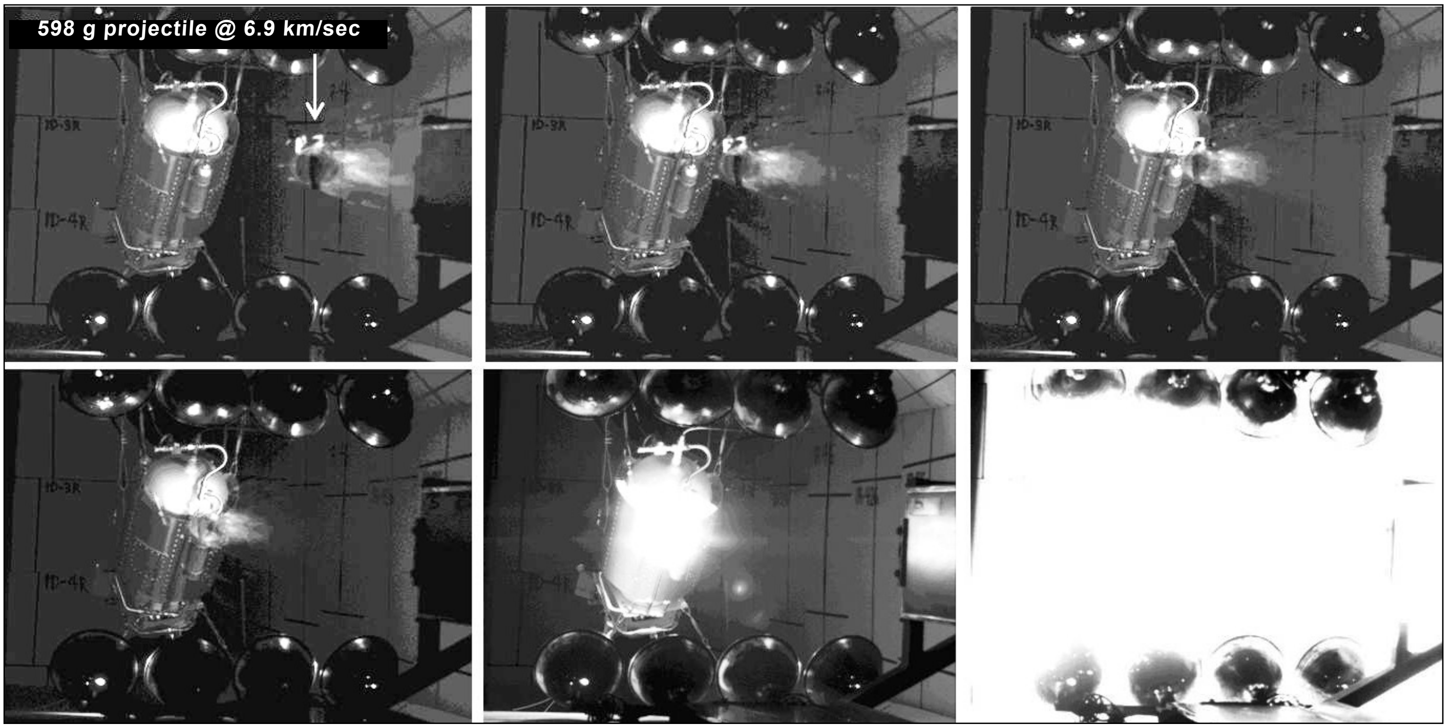

Figure 3. Impact sequences of DebrisLV.

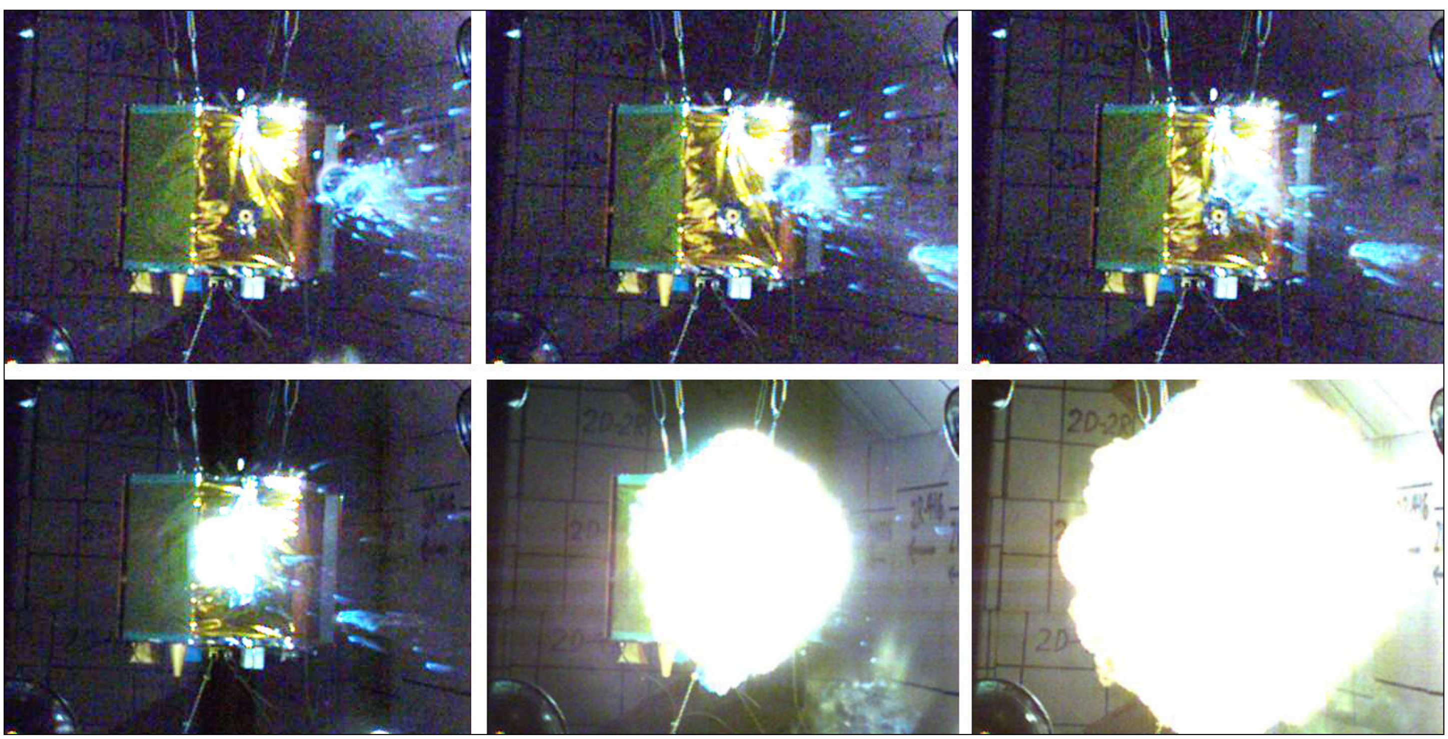

Figure 4. Impact sequences of DebrisSat.

MEETING REPORTS

The 16th NASA DoD Working Group Meeting
21 April 2014, Houston, Texas

After a one-year hiatus, NASA's Orbital Debris Program Office (ODPO) and Department of Defense (DoD) stakeholders concerned with orbital debris resumed the annual NASA-DoD Orbital Debris Working Group (ODWG) meeting series on 21 April 2014. The ODWG originated in recommendations by interagency panels, who reviewed U.S. Government orbital debris activities in the late 1980s and early 1990s.

The one-day meeting reviews activities and research in OD of mutual interest to both NASA and the DoD. Conducted in a virtual meeting setting, NASA was represented by ODPO civil servant, Jacobs, and subcontractor staff as well as other interested parties, Goddard Space Flight Center civil servants and contractors, Marshall Space Flight Center's Meteoroid Environment Office, and NASA Headquarters' Office of Safety and Mission Assurance (HQ OSMA). Participants from HQ Air Force Space Command (HQ AFSPC) and DoD contractors formed the DoD contingent.

Following welcomes and introductions, the morning session featured four DoD presentations and one NASA presentation. The topics were: (1) the C-band Radar Relocation Project; (2) the Space Fence Program; (3) the Space Surveillance Telescope (SST); (4) Space Surveillance Network (SSN) Site Performance Metrics; and (5) the release of the NASA Orbital Debris Engineering Model (ORDEM) 3.0.

The first presentation, discussing the co-location of a C-band (4-8 GHz) radar and the SST when deployed to Australia, was of particular interest from the standpoint of joint OD observations at radar and optical wavelengths. Such observations may provide a pathway to an optical size estimation model (SEM) for OD fragments, or a broadband SEM to supplement or supplant the current radar-based SEM.

Following a short discussion, ODPO offered to assist with the SST concept of operations development. Discussions of SSN performance metrics concentrated on two questions. The first was why the number of conjunctions has increased while the size of the space catalog has decreased; currently, more assets are dedicated to collision avoidance, hence the number of assessed conjunctions has increased. The second question dealt with the administrative decay of objects in the SSN catalog. In answer, the Joint Space Operations Center (JSpOC) indicated that objects are no longer administratively decayed due to the potential for error and miscataloging.

The morning ended with a presentation on ODPO's release of the ORDEM 3.0 computer model. In addition to the technical aspects of this updated and enhanced model of the OD environment in Earth orbit, information was provided on accessing the model from the ODPO website (http://orbitaldebris.jsc.nasa.gov/model/engrmodel.html).

The afternoon session of seven NASA presentations consisted of (1) the FY06-12 Radar Data collection report recently released by ODPO; (2) status and plans for the Meter Class Autonomous Telescope (MCAT); (3) status and plans for DebriSat; (4) status and plans for the Debris Resistive/Acoustic Grid Orbital Navy-NASA Sensor (DRAGONS) and collaboration with the U.S. Naval Academy; (5) a summary of OD issues at the United Nations' Committee on the Peaceful Uses of Outer Space (COPUOS) Scientific and Technical Subcommittee meeting and the Interagency Space Debris Coordination Committee (IADC); (6) a meteor shower update; and (7) a report on bistatic optical observations of objects in geosynchronous orbit (GEO). A general discussion followed and closed the day.

The afternoon session's first and second presentations recently have been reported in this publication (see ODQNs Vol. 17 No. 4 [October 2013] "NASA Develops Report on Radar Observations of Small Debris Populations", p. 4, and Vol. 18 No. 2 [April 2014] "NASA MCAT's New Destination is Ascension Island", p. 4, respectively), while DebriSat test results are discussed in this issue.

The DRAGONS sensor is being developed by a NASA ODPO-led consortium 1) to measure the size, velocity, and impact orientation of small particles and, by extension, differentiate between micrometeoroids and orbital debris via velocity selection and 2) to estimate the orbital parameters of OD impactors. The ODPO is currently developing the DRAGONS sensor into flight-capable equipment.

The NASA Meteoroid Environments Office briefed the audience on the May 2014 Camelopardalis meteor shower. Finally, attendees were briefed on recent developments and operations for observing GEO OD with multiple telescopes.

Two major action item discussions ended the meeting. The status of the Memorandum of Agreement (MOA) between HQ AFSPC and NASA for OD data collection was discussed. The ODPO will review the MOA and submit it to HQ AFSPC for coordination and further cooperation. The Orbital Debris Work Plan was drafted by ODPO for coordination with HQ AFSPC.

Featuring many lively discussions, the meeting summarized the very active past two years of individual and joint OD-related activities, and showcased the projects and tools that form the basis of U.S. Government OD modeling, measurements, and mitigation activities. ♦

Third European Workshop on Space Debris Modeling and Remediation
16-18 June 2014, Paris, France

The third European Workshop on Space Debris Modeling and Remediation was hosted by CNES at its Headquarters in Paris on 16-18 June. The scope of this bi-annual event was expanded to include environment modeling this year. More than 130 participants from 15 countries attended the workshop that included 45 oral presentations, 10 posters, and 8 roundtable discussions.

The agenda on the first day focused on the difficulties and uncertainties in future

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Third European Workshop

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environment modeling, identification of potential removal targets, and overviews of mission concept studies. The second day included several Phase 0 and Phase A debris removal studies funded by the European Space Agency and the European Union. Laser removal technologies were also presented. The third day's activities included technology development on GNC and proximity operations as well as discussions on non-technical challenges for active debris removal.

Overall, this was a very successful workshop. It brought technical experts from different communities together for cross-disciplinary discussions on issues and progress related to environment modeling and remediation. ♦

UPCOMING MEETINGS

2-10 August 2014: The 40th Committee on Space Research (COSPAR) Scientific Assembly, Moscow, Russia

The main theme of the Panel on Potentially Environmentally Detrimental Activities in Space (PEDAS) for the 40th COSPAR is "Space Debris – Responding to a Dynamic Environment." The PEDAS sessions will cover areas such as advances in ground- and space-based observations and methods for their exploitation; in-situ measurement techniques; debris and meteoroid environment models; debris flux and collision risk for space missions; on-orbit collision assessment, re-entry risk assessments, debris mitigation and debris environment remediation techniques and their effectiveness with regard to long-term environment stability; national and international debris mitigation standards and guidelines; hypervelocity accelerator technologies; and on-orbit shielding concepts. Four half-day sessions are planned. Additional details of the 40th COSPAR are available at: <https://www.cospar-assembly.org/>.

9-12 September 2014: The 15th Advanced Maui Optical and Space Surveillance Technologies Conference (AMOS), Maui, Hawaii

The technical program of the 15th Advanced Maui Optical and Space Surveillance Technologies Conference (AMOS) will focus on subjects that are mission critical to Space Situational Awareness. Beginning with a Conjunction Assessment panel discussion, the technical sessions include papers and posters on Space Situational Awareness, Astrodynamics, and Non-resolved Object Characterization.

One of the technical sessions is dedicated to orbital debris. Additional information about the conference is available at <http://www.amostech.com/>.

29 Sep - 3 Oct 2014: The 65th International Astronautical Congress (IAC), Toronto, Canada

The Canadian Aeronautics and Space Institute will host the 65th IAC with a theme of "Our World Needs Space." Just like the previous IACs, the 2014 Congress will include a Space Debris Symposium to address the complete spectrum of technical issues of space debris measurements, modeling, risk assessments, reentry, hypervelocity impacts and protection, mitigation and standards, and space situational awareness. Seven sessions have been planned to cover these topics. In addition, a joint session with the Space Security Committee on the policy, legal, and economic aspects of space debris will also be held. Additional details of the Congress are available at: <http://www.iafastro.com/index.php/events/iac/iac-2014>.

20-22 Oct 2014: The 7th International Association for Advancement of Space Safety (IAASS) Conference, Friedrichshafen, Germany

The 7th IAASS Conference, "Space Safety Is No Accident," is an invitation to reflect and exchange information on a number of topics in space safety and sustainability of national and international interest. The 2014 conference will dedicate a set of specialized sessions on orbital debris, including space debris remediation, reentry safety, space situational awareness and international space traffic control, and commercial human spaceflight safety. Additional details of the Conference are available at: <http://iaassconference2014.space-safety.org/>.

SATELLITE BOX SCORE

(as of 2 July 2014, cataloged by the U.S. SPACE SURVEILLANCE NETWORK)

Country/ Organization	Payloads	Rocket Bodies & Debris	Total
CHINA	158	3558	3716
CIS	1445	4935	6380
ESA	47	46	93
FRANCE	59	447	506
INDIA	55	120	175
JAPAN	133	80	213
USA	1228	3780	5008
OTHER	687	122	809
TOTAL	3812	13088	16900

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www.orbitaldebris.jsc.nasa.gov

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INTERNATIONAL SPACE MISSIONS
1 April 2014 – 30 June 2014

International Designator	Payloads	Country/ Organization	Perigee Altitude (KM)	Apogee Altitude (KM)	Inclination (DEG)	Earth Orbital Rocket Bodies	Other Cataloged Debris
2014-015A	DMSP 5D-3 F19 (USA 249)	USA	838	855	98.8	0	2
2014-016A	SENTINEL 1A	ESA	691	964	98.2	0	0
2014-017A	IRNSS 1B	INDIA	35689	35885	30.9	1	0
2014-018A	PROGRESS-M 23M	RUSSIA	413	418	51.6	1	0
2014-019A	OFEQ 10	ISRAEL	412	577	140.9	1	0
2014-020A	USA 250	USA	NO ELEMS. AVAILABLE			1	0
2014-021A	EGYPTSAT 2	EGYPT	708	714	51.6	1	0
2014-022A	DRAGON CRS-3	USA	398	410	51.6	0	2
2014-022B	SPORESAT	USA	151	153	51.6		
2014-022C	TSAT	USA	153	167	51.6		
2014-022D	ALL STAR/THEIA	USA	154	156	51.6		
2014-022E	PHONESAT 2.5	USA	109	119	51.6		
2014-022F	KICKSAT	USA	160	175	51.6		
2014-023A	LUCH 5V	RUSSIA	35774	35795	4.7	1	1
2014-023B	KAZSAT 3	KAZAKHSTAN	35781	35791	0.0		
2014-024A	KAZEOSAT 1	KAZAKHSTAN	751	753	98.5	0	0
2014-025A	COSMOS 2495	RUSSIA	206	261	81.4	1	0
2014-026A	NAVSTAR 70 (USA 251)	USA	20174	20188	55.1	1	14
2014-027A	USA 252	USA	NO ELEMS. AVAILABLE			0	0
2014-028A	COSMOS 2496	RUSSIA	1480	1511	82.5	1	0
2014-028B	COSMOS 2497	RUSSIA	1478	1510	82.5		
2014-028C	COSMOS 2498	RUSSIA	1477	1509	82.5		
2014-028E	OBJECT E	RUSSIA	1477	1509	82.5		
2014-029A	ALOS 2	JAPAN	630	632	97.9	1	1
2014-029B	UNIFORM 1	JAPAN	621	629	97.9		
2014-029C	SOCRATES	JAPAN	619	627	97.9		
2014-029D	RISING 2	JAPAN	625	631	97.9		
2014-029E	SPROUT	JAPAN	615	627	97.9		
2014-030A	EUTE 3B	EUTELSAT	35777	35795	0.1	1	0
2014-031A	SOYUZ-TMA 13M	RUSSIA	413	418	51.6	1	0
2014-032A	COSMOS 2500 (GLONASS)	RUSSIA	19115	19145	64.8	1	0
2014-033A	KAZEOSAT 2	KAZAKHSTAN	611	637	98.0	1	2
2014-033B	HODOYOSHI 4	JAPAN	612	651	98.0		
2014-033C	UNISAT 6	ITALY	614	700	98.0		
2014-033D	DEIMOS 2	SPAIN	597	619	98.0		
2014-033E	BUGSAT 1	ARGENTINA	571	616	98.0		
2014-033F	HODOYOSHI 3	JAPAN	612	666	98.0		
2014-033G	SAUDISAT 4	SAUDI ARABIA	613	682	98.0		
2014-033H	TABLETSAT AURORA	RUSSIA	584	617	98.0		
2014-033J	APRIZESAT 9	USA	613	716	98.0		
2014-033K	APRIZESAT 10	USA	613	734	98.0		
2014-033	(27 ADDITIONAL PAYLOADS)	(VARIOUS)					
2014-034A	SPOT 7	FRANCE	688	691	98.2	1	0
2014-034B	AISAT	GERMANY	643	660	98.3		
2014-034C	NLS 7.1/CANX 4	CANADA	641	660	98.3		
2014-034D	NLS 7.2/CANX 5	CANADA	642	657	98.3		
2014-034E	VELOX 1	SINGAPORE	641	656	98.3		