Three workshops organized every two years:
- Conjunction Assessment: next edition June 2019 (contact Monique.moury@cnes.fr)
- Satellite End of Life: next edition January 2020 (contact pierre.Omaly@cnes.fr)

General Statistics:
- Final: 125 Registered participants (room limitation!)
- 17 Countries
- 64 Presentations
  - 52 Oral (~2 cancelled)
  - 12 Posters (~2 No show)

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Session #1: Modeling for sustainability

#1.1 Space Traffic Management through the Control of the Space Environment’s Capacity
H. Krag, S. Lemmens, F. Letizia
ESA/ESOC, Darmstadt, Germany

#1.2 Analysis of Space Occupancy in Low Earth Orbit
C. Bombardelli¹, G. Falco², D. Amato³
¹Space Dynamics Group, Technical University of Madrid (UPM), Madrid, Spain, ²University of Naples Federico II, Naples, Italy, ³University of Arizona, Tucson, AZ, USA

#1.3 Representing Uncertainty in Space Situational Awareness
J. T. Kent¹, S. Bhattacharjee, M. K. Jah, D. McNeely
¹Department of Statistics, University of Leeds, Leeds, UK

#1.4 A non-averaged approach to the numerical cartography of the LEO region
D. Amato, A. J. Rosengren,
The University of Arizona, Tucson, AZ, USA

#1.5 Implications of small satellites and large constellation on the on-orbit collision risk
J. C. Dolado-Perez¹, B. Revelin²
¹Centre National d’Etudes Spatiales (CNES), Toulouse, France; ²CS-SI, Parc de la Plaine, Toulouse, France

#1.6 An Analytical Approach for Evaluating the Environmental Sustainability of Large Satellite Constellations in Low Earth Orbit
L. Anselmo, C. Pardini
Space Flight Dynamics Laboratory, ISTI/CNR, Pisa, Italy
Session #2: Economical and Legal aspects

#2.1 Funding the cleaning of space debris. A first economic proposal
Sylvain Béal¹, Marc Deschamps¹, Hervé Moulin²
¹CRESE EA3190, Univ. Bourgogne Franche-Comté, Besançon, France; ²University of Glasgow, Adam Smith Business School, Scotland

#2.2 The development of an orbital risk assessment capability for novel, disruptive systems
T. Harris,
Head of Orbital Systems, UK Space Agency, Didcot, Oxford, UK

#2.3 Integrating space debris modeling to environmental impact studies thanks to the Life Cycle Assessment (LCA) framework
T. Maury¹², C. Colombo³, M. Trisolini³, P. Loubet¹, A. Gallice², G. Sonnemann¹
¹CyVi group - ISM, Université de Bordeaux, Talence, France; ²ArianeGroup - Design for Environment, St Médard en Jalles, France; ³Politecnico di Milano – Aerospace department, Milan, Italy,

#2.4 Normative and legal implications of passive de-orbiting strategies
R. Popova¹, Y. Kim¹, A. Rossi², C. Colombo³, V. Schauss⁴, E.M. Alessi², G. Schettino², K. Tsiganis⁵, I. Gkolias³, D.K. Skoulidou⁵
¹Institute of Air and Space Law, University of Cologne, Germany; ²IFAC-CNR, Sesto Fiorentino, Italy; ³Politecnico di Milano, Milan, Italy; ⁴TU Braunschweig, Institute of Space Systems, Germany; ⁵Aristotle University, Thessaloniki, Greece

#2.5 The Surge in Small Satellites and Debris Remediation: Employing Lex Lata and Lex Ferenda for Regulation
K. Nair
McGill University, Montreal, Canada

#2.6 Insurance involvement on space debris remediation
C. Gaubert¹, S. Devouge²
¹Lawyer - Paris Bar, Paris, France; ²Contracts Specialist – Swiss Re Corporate Solutions, Paris, France
#3.1 REMOVEDEBRIS preliminary mission results
G. Aglietti¹, S. Fellowes¹, B. Taylor¹, T. Salmon², A. Hall³, T. Chabot⁴, A. Pisseloup⁵, S. Ainley⁶, D. Tye⁶, C. Bernal⁷, F. Chaumette⁸, Alexandre Pollini⁹, Willem Steyn¹⁰
¹Surrey Space Centre, University of Surrey, United Kingdom; ²Airbus Safran Launchers, France;
³Airbus Group, United Kingdom; ⁴Airbus Defence and Space (DS), France; ⁵Airbus Group, France;
⁶Surrey Satellite Technology Ltd (SSTL), United Kingdom; ⁷ISIS Bv, The Netherlands; ⁸INRIA, France;
⁹CSEM, Centre Suisse d'Electronique et de Microtechnique SA, Switzerland; ¹⁰Stellenbosch University, South Africa

#3.2 e.Deorbit – An Update ESA’s Active Debris Removal Mission
A. Wolahan, R. Biesbroek, L. Innocenti
ESA/ESTEC, Noordwijk, The Netherlands

#3.3 Status of the development of the CleanSpace One System and Mission
L. Piguet, M. Richard-Noca, M. Juillard
Space Engineering Center, Ecole Polytechnique Fédérale de Lausanne, Switzerland

#3.4 The Cycler: The affordable companion for Post Mission Disposal in massive constellations
D. Alary, A. Grasso, C. Tourneur, C. Pruvost
Airbus Defence & Space, Toulouse, France

#3.5 The D-SAT Mission: an In-Orbit Demonstration of an Autonomous and Reliable Satellite Removal Technology
D-ORBIT SRL, Fino Mornasco, Italy

#3.6 An Overview of ASTROSCALE and the ELSA-d Mission
J. Forshaw, C. Blackerby, N. Okada
ASTROSCALE, Didcot, Oxford, UK
Session #4: Modeling - Mitigation

#4.1 ORDEM 3.1 Development Status
P. Anz-Meador¹, A. Manis², M. Matney³
¹Jacobs, Houston, TX, USA; ²HX5-Jacobs JETS Contract, Houston, TX, USA; ³NASA Johnson Space Center, Houston, TX, USA

#4.2 The H2020 ReDSHIFT project: summary of the main results
¹IFAC-CNR, Sesto Fiorentino, Italy; ²Politecnico di Milano, Milan, Italy; ³Belstead Research Ltd, United Kingdom; ⁴Deimos Space, Madrid, Spain; ⁵Elecnor Deimos Satellite Systems, Puertollano, Spain; ⁶LuxSpace Sarl, Luxemburg; ⁷University of Southampton, United Kingdom; ⁸Aristotle University, Thessaloniki, Greece; ⁹TU Braunschweig, Institute of Space Systems, Germany; ¹⁰Institute of Air and Space Law, University of Cologne, Germany; ¹¹University of Padova, Italy; ¹²PHS Space Ltd, United Kingdom; ¹³DLR, German Aerospace Center, Germany

#4.3 Measuring the impact of the current level of adherence to Space Debris Mitigation guidelines
F. Letizia, S. Lemmens, H. Krag
ESA/ESOC, Darmstadt, Germany

#4.4 A long-term collision risk prediction tool for constellation design
R. Lucken¹, D. Giolito¹
¹Share My Space, Paris, France
²Laboratoire de Physique des Plasmas (LPP), UMR CNRS 764, Ecole Polytechnique, Palaiseau, France

#4.5 An Introduction to SOLEM---the Space Objects Long-term Evolution Model
Z. Yao
National Astronomical Observatories, Chinese Academy of Science, Beijing, China
Session #5: Modeling – Attitude

#5.1 Long-term Attitude Dynamics of Space Debris In Sun-synchronous Orbits: Cassini Cycles and Chaotic Stabilization
V.V. Sidorenko¹, S.S. Efimov², D.A. Pritykin² ³
¹Keldysh Institute of Applied Mathematics, Russian Academy of Science, Moscow, Russia; ²Moscow Institute of Physics and Technology, Dolgoprudny, Russia; ³Skolkovo Institute of Science and Technology, Moscow, Russia

#5.2 Contact Detumbling and Compliant Capture Control of a Spinning Space Debris
H. Zhang, W. Duan, S. Xu
Beijing Institute of Control and Engineering, Beijing, China

#5.3 Space Debris TOPEX/Poseidon Attitude Motion: Interplay of Conservative, Damping and Propelling Torques
D. Pritykin
Moscow Institute of Physics and Technology, Skolkovo Institute of Science and Technology

#5.4 Rapid assessment of rendezvous delta-ν between space debris
M. Li, X. Li, Y. Wang
National Space Science Center, Chinese Academy of Sciences; University of Chinese Academy of Sciences

#5.5 Eddy Currents Torque Acting on Space Debris: Analytical Expressions for Magnetic Tensors of Geometric Primitives
S. Efimov
Moscow Institute of Physics and Technology, Dolgoprudny, Russian Federation
Session #6: Modeling - Dynamics

#6.1 SRP Driven Transfers to Resonant Orbits
M. M. Pellegrino, D.J. Scheeres
Smead Aerospace Engineering Department, The University of Colorado Boulder, USA

#6.2 Orbital flips due to solar radiation pressure in the vicinity of GNSS region
E. Kuznetsov, Belkin Sergej
Ural Federal University, Yekaterinburg, Russia

#6.3 Dynamical Systems Approach to Debris Mitigation and Remediation
A. J. Rosengren¹, D. K. Skoulidou², K. Tsiganis², G. Voyatzis²
¹University of Arizona, Tucson, AZ, USA; ²Aristotle University of Thessaloniki, Thessaloniki, Greece

#6.4 Accurate collision warning using Gaussian mixture method in orbit uncertainty propagation
R. Yan, R. Wang, S. Liu, J. Gong
National Space Science Center, Chinese Academy of Sciences, Beijing, China
Session #7: Laser applications

#7.1 Feasibility Analysis on Active Debris Removal with Joule-class Space-based Laser System
W. Yang¹, Q. Yu², C. Chen², M. Li³, Z. Gong²
¹Beijing Institute of Spacecraft Environment Engineering, CAST, Beijing, China; ²National Key Laboratory of Science and Technology on Reliability and Environment Engineering, Beijing Institute of Spacecraft Environment Engineering, CAST, Beijing, China; ³China Academy of Space Technology, Beijing, China

#7.2 Remote maneuver of space debris using photon pressure for active collision avoidance
C. Smith EOS Space Systems Pty Ltd, Australia

#7.3 Study on the Influence of Geometry of Space Debris on Laser Ablation Impulse
C. Chen¹, W. Yang², Q. Yu¹, M. Li³, Z. Gong¹²
¹Beijing Institute of Spacecraft Environment Engineering, Science and Technology on Reliability and Environmental Engineering Laboratory, Beijing, China; ²Beijing Institute of Spacecraft Environment Engineering, Beijing, China; ³China Academy of Space Technology, Beijing, China

#7.4 Deorbiting Mission of cm-Sized Space Debris by Laser Ablation
T. Ebisuzaki, S. Wada
RIKEN, Wako, Japan

#7.5 Mission Planning and Simulation System Study on Active Debris Removal with Space-based Laser System
W. Yang¹, C. Chen², Q. Yu¹, M. Li³, Z. Gong¹²
¹National Key Laboratory of Science and Technology on Reliability and Environment Engineering, Beijing Institute of Spacecraft Environment Engineering, CAST, Beijing, China; ²Beijing Institute of Spacecraft Environment Engineering, Beijing, China; ³China Academy of Space Technology, Beijing, China

#7.6 Using Lasers for Large Debris Traffic Management
C. Phipps¹, C. Bonnal², F. Masson²
¹Photonic Associates, Santa Fe NM, USA; ²CNES, Direction des Lanceurs, Paris, France

#7.7 High average/peak powers laser architecture based on Coherent Beam Combining of fiber amplifiers for space applications
J.-C. Chanteloup¹, A. Heilmann¹, J. Le Dortz², L. Daniault¹, I. Fsaïles¹, S. Bellanger¹, M. Antier³, A. Brignon², J. Bourderionnet², E. Durand¹, E. Lallier², C. Larat², C. Simon-Boisson², G. Mourou⁴
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#7.8 A new laser driven relay small satellite constellation for space debris active removal
C. Chen¹, W. Yang², Q. Yu¹, M. Li³, Z. Gong¹²
¹Beijing Institute of Spacecraft Environment Engineering, Science and Technology on Reliability and Environmental Engineering Laboratory, Beijing, China; ²Beijing Institute of Spacecraft Environment Engineering, Beijing, China; ³China Academy of Space Technology, Beijing, China
Session #8: Modeling End-of-Life

#8.1 Death of a small satellite; demise test of a cubesat, and determining the demise impact of dragsail
James Beck¹, Ian Holbrough¹, Thorn Schleufter², Ali Guelhan²
¹Belstead Research Limited, Ashford, Kent, UK; ²DLR, Supersonic and Hypersonic Technologies Department, Cologne, Germany

#8.2 ReDSHIFT software tool for the design and computation of mission end-of-life disposal
F. Letterio¹, E.M. Alessi², I. Gkolas³, D.K. Skoulidou⁴, V. Shaus⁵, J. Beck⁶, G. Vicario de Miguel⁷, G. Schettino², A. Rossi², C. Colombo³, K. Tsiganis⁴, I. Holbrough⁵
¹Deimos Space, Madrid, Spain; ²IFAC-CNR, Sesto Fiorentino, Italy; ³Politecnico di Milano, Milan, Italy; ⁴Aristotle University, Thessaloniki, Greece; ⁵TU Braunschweig, Institute of Space Systems, Germany; ⁶Belstead Research Ltd, United Kingdom

#8.3 Surrogate Aerodynamic Models of Cuboidal Space Debris Objects During Atmospheric Entry
N. L. Donaldson
Osney Thermofluids Laboratory, University of Oxford, Oxford, Oxon, UK

#8.4 Megaconstellation re-entry and ISS conjunctions probability
A.Sita
Thales Alenia Space, Cannes, France

#8.5 Indication of break-up location and epoch from fragments using backwards spatial density propagation
S. Frey¹,², C. Colombo¹, S. Lemmens²
¹Politecnico di Milano, Milan, Italy; ²ESA/ESOC, Darmstadt, Germany

#8.6 Space Debris Refined Collision Risk Study
R. Wang, W. Liu, R. Yan, L. Shi, S. Liu
National Space Science Center, Chinese Academy of Sciences, Beijing, China
5th European Workshop on Space Debris Modelling and Remediation

Session #9: Remediation technologies

#9.1 Consideration on active debris removal target
S. Kawamoto,
*Research and Development Directorate, JAXA, Chofu, Tokyo, Japan*

#9.2 Space Debris: how to increase the active removal effectiveness via an altitude-shell-dependent approach
G. L. Somma¹, H. G. Lewis¹, C. Colombo²
¹*Faculty of Engineering and the Environment, University of Southampton, UK; ²Department of Aerospace Science and Technology, Politecnico di Milano, Italia*

#9.3 Progress-M spaceship as the basis of the vehicle for ADR missions
V. I. Trushlyakov, V. V. Yudintsev
*Omsk State Technical University, Russia*

#9.4 Interaction of passive de-orbiting devices with the space debris environment
C. Colombo¹, A. Rossi², F. Dalla Vedova³, A. Francesconi⁴, C. Bombardelli⁵, J. L. Gonzalo¹, P. Di Lizia¹, C. Giacomuzzo⁴, S. Bayajid Khan⁴, R. García-Pelayo⁵, V. Braun⁶, B. Bastida Vergili⁶, H. Krag⁶
¹*Politecnico di Milano, Italy; ²IFAC-CNR, Sesto Fiorentino (Fl), Italy; ³LuxSpace, Luxemburg; ⁴CISAS “G. Colombo” - University of Padova, Italy; ⁵Universidad Politécnica de Madrid, Spain; ⁶ESA/ESOC, Germany*

#9.5 Optimization of Accurate Rendezvous for Multiple Space Debris Mission
I. Sharf
*McGill University, Montreal, Canada*

#9.6 Multiscale modeling of fragmentation in solids upon hypervelocity impact
M. O. Steinhauer¹,²
¹*Fraunhofer-Institute for High-Speed Dynamics, Ernst-Mach-Institut, EMI, Freiburg, Germany; ²University of Basel, Faculty of Science, Department of Chemistry, Basel, Switzerland*
Posters

#P.1 OHB Space Debris Centre of Competence (SDCOC)
M. Fittock, C. Bewick
OHB, Bremen, Germany

#P.2 Study of Collision Probability Considering Non-Uniform Cloud of Space Debris
J. K. S. Formiga¹, D. P. S. Santos², A. F. B. A. Prado³
¹Institute of Science and Technology, ICT/UNESP, São José dos Campos (SP), Brazil; ²São Paulo State University, UNESP, São João da Boa Vista (SP), Brazil; ³National Institute for Space Research, INPE, Brazil

#P.3 Calculating collision rates within large constellations of satellites in long-term simulations using a deterministic approach
J. Radtke, E. Stoll
Technische Universität Braunschweig, Institute of Space Systems, Braunschweig, Germany

#P.4 Using deployable flexible beam for capturing of a tumbling large debris
V. S. Aslanov, V. V. Yudintsev,
Samara National Research University, Samara, Russia

#P.5 Removal of Small-Sized Space Debris by Laser-Ablative Momentum Generation
S. Scharring¹, R-A. Lorbeer¹, M. Zwilich¹, M. Zabic¹, L. Eisert¹, J. Wilken¹, D. Schumacher², M. Roth³, H-A. Eckel¹
¹German Aerospace Centre (DLR), Institute of Technical Physics, Stuttgart, Germany; ²GSI Helmholtzzentrum für Schwerionenforschung GmbH, Atomic, Plasma Physics and Application, Darmstadt, Germany; ³Technische Universität Darmstadt, Laser- & Plasmaphysik, Darmstadt, Germany

#P.6 Research on quasi-periodic resonance relative orbit control for active debris removal with space-based laser
Q. Gan, J. Fu, Y. Zhang, J. Cai
Academy of Opto-electronics, Chinese Academy of Science, Beijing, China
#P.7 Removal of Geostationary Debris In Light of Commercialized Space Activities
M. Cui, A. Hoenen, A. Payet, A. Weiss, N. Xu
*Institut Polytechnique des Sciences Avancées - IPSA, Ivry-sur-Seine, France*

#P.8 Symmetrical Hyperloop System for Management And Mitigation Of Space Debris In Low Earth Orbit
S. Ojha¹, U. Guven²
¹University of Petroleum and Energy Studies, Jaipur, India; ²UN Center for Space Science and Space Technology Education in Asia and Pacific

#P.9 Deorbiting CubeSats and Nanosatellites Using Inbuilt Tethers and Micro Thrusters
S. Ojha¹, U. Guven²
¹University of Petroleum and Energy Studies, Jaipur, India; ²UN Center for Space Science and Space Technology Education in Asia and Pacific

#P.10 Experimental investigation of laser and materials parameters for space debris removal by laser solutions
S.A.E. Boyer¹, S. Baton², E. Brambrink², L. Berthé³, J.-M. Chevalier⁴, L. Videau⁵, C. Rousseaux⁶, M. Boustie⁷, C. Phipps⁷, S. Scharring⁸, S. Oriol⁹, F. Masson⁹, C. Bonnal⁹
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#P.11 The implementation of the collision probability estimation method in SOLEM
Wang Xiaowei¹,²,³, Liu Jing¹,², Zhang Yao¹,²
¹National Astronomical Observatories, Chinese Academy of Sciences, Beijing, China, ²Space Debris Observation and Data Application Center, CNSA, Beijing, China, ³University of Chinese Academy of Sciences, Beijing, China

#P.12 An autonomous space debris chaser for on-orbit servicing
V. Marsat², F. Solt³, A. Avenas³, L. Lacaille³, C. Liu³, J. Song³, D. Giolito¹, R. Lucken¹
¹Share My Space, Paris, France; ²MASS Systems, Bougival, France; ³Ecole Polytechnique, Palaiseau, France; ⁴Laboratoire de Physique des Plasmas, UMR CNRS 764, Paris, France