International Academy of Astronautics

IAA Committee on Space Debris

Paris, March 19th, 2014
1. IAA Committee on Space Debris

2. Lessons learned from Beijing 2013


4. Preparation of Space Debris Symposium for Jerusalem 2015

5. Actions

6. Information
1. IAA Committee on Space Debris

Follow-up of the IAA meetings held since 1991
Officially created as Permanent Committee within IAA in 2012

Terms of Reference (synthesis):

Scope

The IAA Committee on Space Debris is in charge of the coordination of all activities related to Space Debris within the Academy, covering the complete span of related topics including but not limited to: measurements, modeling, risk assessment in space and on the ground, reentry, hypervelocity impacts and protection, mitigation and standards, legal and policy, Active Debris Removal and Space Surveillance..

As such, its main tasks are:

- Organization of the IAA Symposium on Space Debris A6 for the International Astronautical Congress, mainly identification of the proposed sessions including scope, chairs and rapporteurs, proposals for joint sessions with other symposia, proposals for Keynote Lectures within the A6 Symposium, or Highlight Lectures in the more general IAC frame,

- Organization of any stand-alone conference on Space Debris on behalf the Academy, including nomination of the Program Committee,
1. IAA Committee on Space Debris

Terms of Reference (recall):

its main tasks are (ctd):

- **Coordination of the Academy sponsoring, participation and contribution to selected conferences dedicated to Space Debris**, such as for instance the ESA Darmstadt Conference,

- **Coordination of the Space Debris contribution in conferences not dedicated to Space Debris, but where some sessions may be devoted to the topic, sponsored by the Academy**,

- **Identification of potential studies on Space Debris** within Commission V or coordinated with any other Academy Commission, proposal of associated Cosmic Study and proposal for the corresponding Study Group,

- **Dissemination of information among the members of the Technical Committee**, mainly during regular TC meetings taking place twice a year, before the IAC and during the IAA March meetings in Paris. During these meetings, general information concerning past activities at international level on Space Debris shall be shared among the members, including debriefings from past conferences and major related actions (for instance IADC, COSPAR…). Practical aspects of the preparation of the upcoming Conferences, Symposia, Sessions are also dealt with during these meetings.
1. IAA Committee on Space Debris

Membership:

No need to be member of IAA!

- Members of the IAA A6 Symposium Program Committee (chairs & rapporteurs)
- Members of the Program Committee of other IAA sponsored conferences with Space Debris concerns
- Members of Space Debris related working groups (IADC, UNCOPUOS, COSPAR, ISO ...)
- Academics, Labs, Universities, Industrials... working on the topic

However, it is requested to be somehow “active”:
- Participation to the meetings
- Debriefing of activities during the meetings
- Cross information with other members

Two meetings per year:
- One just before each year’s IAC (Saturday is confirmed during the meeting)
  ↘ Includes the status of the sessions, workshops, round tables... of the week
- One just before or during the IAC March Meeting in Paris
  ↘ Includes the pre-selection of the abstracts for the following IAC

Proposal to have a LinkedIn web zone:
- Membership upon invitation = Committee membership
- Should enable efficient exchange between members
1. IAA Committee on Space Debris

Official membership:
Co-Chairs:
Christophe Bonnal
Heiner Klinkrad
Nicholas L. Johnson

Committee Membership:
Patrick Seitzer,
Vladimir Agapov,
Thomas Schildknecht,
Luciano Anselmo,
Carsten Wiedemann,
Toshiya Hanada,
James Hyde,
Alessandro Francesconi,
Frank Schaefer,
Fernand Alby,
John Hussey,
Fabrizio Piergentili,
Darren McKnight,
Seishiro Kibe,
Michael Yakovlev,

MYS. Prasad,
Walter Flury,
Lubos Perek,
Eddy Van Breukelen,
T.S. Kelsko,
Holger Krag,
Carmen Pardini,
Sergey Meshcheryakov,
Richard Crowther,
V. Adimurthy,
Phillip Anz-Meador,
Vladimir Kouprianov,
Mark Mulrooney,
Gene Stansbery,
Paula Krisko,
Mark Matney,
Eric Christiansen,
Jer-Chyi Liou,
A.S. Ganeshan,
Hedley Stokes,
Yasuhiro Akahoshi,
Gérard Brachet,
Bill Ailor
## 2. Lessons learned from Beijing 2013

### Statistics:

- Incomplete information for numerous Symposia
- Based on available information, 3rd most attended Symposia after C1 (Astrodynamics) and A3 (Space Exploration)
- Good work of the Chairs and Rapporteurs, with only 5% No-Show: best score of the Congress according to available information
- 16 papers proposed for publication in Acta Astronautica
- Note: it should have been a “low year” due to the 6th Darmstadt conference

### Meeting of the Committee in Beijing on 21 September 2013:

- Minutes are available on our page on the IAA web site (1 main document + 9 appendixes)
  
  [http://iaaweb.org/content/view/487/655/](http://iaaweb.org/content/view/487/655/)
2. Lessons learned from Beijing 2013

Results per Symposium:
Accepted abstracts vs rejected abstracts
2. Lessons learned from Beijing 2013

Students Participation per Symposium

![Bar chart showing students participation per symposium session.](chart.png)
Record breaking number of submissions!

Ever increasing interest in this Symposium

- Total of 225 submissions for a theoretical maximum of 72 slots
  ⇒ Theoretical need to reject 68% of the proposals
- Preliminary selection today
- Final selection tomorrow during IPC meeting

Good balance among sessions:

- A6.1: Measurements ⇒ 47 submissions
- A6.2: Modeling and Risk Analysis ⇒ 37 submissions
- A6.3: Hypervelocity Impacts and Protection ⇒ 24 submissions
- A6.4: Mitigation and Standards ⇒ 18 submissions
- A6.5: Space Debris Removal Issues ⇒ 29 submissions
- A6.6: Space Debris Removal Concepts ⇒ 37 submissions
- A6.7: Operations in Space Debris Environment, Situational Awareness ⇒ 13 submissions
- A6.8: (joint with Space Security Committee): Political, Legal, Institutional and Economic Aspects of Space Debris Mitigation and Removal ⇒ 18 submissions
- +2 not yet affected to specific session
  ⇒ Will lead to the selection of numerous Posters
  ⇒ Has led to the definition of a new Session A6.9 Modeling & Orbit Determination
3. Space Debris Symposium Toronto 2014

Technical Programme Overview

- 3,537 abstracts on 3 March 2014

-3.75% since Beijing, +14, 5% since Naples

Number of Abstracts Submitted: Evolution since 2008

- 2008: 2428
- 2009: 2442
- 2010: 2095
- 2011: 2483
- 2012: 3180
- 2013: 3675
- 2014: 3537
IAC 2014 Abstract Submission: Repartition per Regional Group

NORTH AMERICA
342 abstracts (2 countries) – 9.7%

EUROPE
756 abstracts (29 countries) – 21.4%

LATIN AMERICAN AND CARIBBEAN
101 abstracts (11 countries) – 2.9%

AFRICA
47 abstracts (8 countries) – 1.3%

ASIA-PACIFIC
2291 abstracts (24 countries) – 64.7%
IAC 2014 Abstract Submission: Repartition per Country

Western Europe ≈ 750
### Sessions scheduling 2/2

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*VF5 Social media ??*
A6: Space Debris Symposium
Johnson – Matney – Bonnal
The Symposium will address the complete spectrum of technical issues of space debris: measurements, modelling, risk assessment in space and on the ground, reentry, hypervelocity impacts and protection, mitigation and standards, and Space Surveillance.

A6.1: Measurements: Schildknecht – Agapov - Stansbery
This session will address advanced ground and space-based measurement techniques, relating processing methods, and results of space debris characterization.

A6.2: Modelling and Risk Analysis: Anselmo – Matney – Hanada
This session will address the characterization of the current and future debris population and methods for in-orbit and on-ground risk assessments. The in-orbit analysis will cover collision risk estimates based on statistical population models and deterministic catalogues, and active avoidance.

The session will address passive protection, shielding and damage predictions. Shielding aspects will be supported by experimental and computational results of HVI tests. Use of HVI techniques for debris mitigation.

A6.4: Mitigation and Standards: Cazaux – Klinkrad – Yakovlev
This session will focus on the definition and implementation of debris prevention and reduction measures and vehicle passive protection. The session will also address space debris mitigation guidelines and standards that exist already or are in preparation at the national or international level.
A6.5: Space Debris Removal Issues: Piergentili – Adimurthy – Bérend
This session will address active removal techniques “ground and space based”, review potential solutions and identify implementation difficulties.

This session will address active removal techniques “ground and space based”, review potential solutions and identify implementation difficulties.

A6.7: Operations in Space Debris Environment, Situational Awareness:
Kelso – Finkleman – Krisko
This session will address the multiple aspects associated to safe operations in Space dealing with Space Debris, including operational observations, orbit determination, catalogue build-up and maintenance, data aggregation from different sources, relevant data exchanges standards and conjunction analyses.

A6.8 (joint with Space Security Committee): Political, Legal, Institutional and Economic Aspects of Space Debris Mitigation and Removal
Biddington – McKnight – Mathieu
This session will deal with the non-technical aspect of space debris mitigation and removal. Political, legal and institutional aspects includes role of IADC and UNCOPUOS and other multilateral bodies. Economic issues including insurance, financial incentives and funding for space debris mitigation and removal. The role of international cooperation in addressing these issues will be considered.

A6.9: Modelling and Orbit Determination
Cowardin – Flegel – Lewis
This session will address aspects of space debris orbit determination related to assessment of raw and derived data accuracy, optical measurements processing and modelling and risk analysis of space debris.

A6.P: Posters, Bonnal

⇒ Modifications if any to be given to IAF secretary before the end of the week to implement on the web site
Recall of a few basic rules

⇒ **Selection process**
- Check for completeness of what you receive wrt web site
- Be sure all the abstracts submitted to A6 are finally allocated or rejected
- Check equilibrium and logic of your session:
  - Not to many Europeans, nor Americans, nor Chinese
  - No duplication of subjects, at least within one given session
  - Beware the “risky papers”, or choose one more than normal
- Avoid “political” papers or very general roadmaps
- Beware “classical” papers with no news expected
- Normally 9 abstracts per session, but 10 is recommended taking into account 1 or more “risky papers”
- In case of merger between papers, identify the “prime”
- Format should be available by Wednesday
- Posters: as many as you want, provided they are good
  - Dedicated zone
  - Total ≤ 400 for the complete congress
  - Competition for best posters
  - Be careful to follow the request of an author: O, P, or no precision
3. Space Debris Symposium Toronto 2014

Black list (= No show)

- A6.1: -
- A6.2: -
- A6.3: Higashide, Clements, Bauer
- A6.4: -
- A6.5: -
- A6.6: Pisseloup, Zhang
- A6.7: -
- A6.8: -

Grey list (= Withdrawn)

- A6.1: Voelker
- A6.2: -
- A6.3: -
- A6.4: -
- A6.5: Weisz, Ilin
- A6.6: Alary, Apulsson, Faber
- A6.7: Rokni
- A6.8: Konert, Palkovitz

Naples No-shows:
- A6.1: Subbarao
- A6.2: Novak
- A6.3: Dongyong Jia

Naples Withdrawn:
- A6.1: Liou
- A6.3: Shannon Ryan, Destefanis, Thurber, Abrar-Ul-Haq Khan Baluch
- A6.5: Pietras, Beibei Wu
- A6.6: Aditya Sharma

No specific message from IPC SG
- Use this information as you wish for your selection
- Suggested to give lower priority
A priori same structure as Toronto 2014 without the Toronto New Session

Structure confirmed today (Appendix 6)

- 7 sessions + 1 joint with Space Security Committee
- Additional session to be decided in March 2015 if needed
- Potential identification of other joint sessions ⇒ None, after discussion

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<th>Year</th>
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[Table continues with additional years and locations]
A6: Space Debris Symposium

Johnson – Matney – Bonnal

The Symposium will address the complete spectrum of technical issues of space debris: measurements, modelling, risk assessment in space and on the ground, reentry, hypervelocity impacts and protection, mitigation and standards, and Space Surveillance.

A6.1: Measurements: Cowardin – Schildknecht – Agapov
This session will address advanced ground and space-based measurement techniques, relating processing methods, and results of space debris characterization.

A6.2: Modelling and Risk Analysis: Pardini – Krisko – Flegel
This session will address the characterization of the current and future debris population and methods for in-orbit and on-ground risk assessments. The in-orbit analysis will cover collision risk estimates based on statistical population models and deterministic catalogues, and active avoidance.

The session will address passive protection, shielding and damage predictions. Shielding aspects will be supported by experimental and computational results of HVI tests. Use of HVI techniques for debris mitigation.

A6.4: Mitigation and Standards: Krag – Cazaux – Kato
This session will focus on the definition and implementation of debris prevention and reduction measures and vehicle passive protection. The session will also address space debris mitigation guidelines and standards that exist already or are in preparation at the national or international level.
A6.5: Space Debris Removal Issues: Prasad – Piergentili – Santoni
This session will address active removal techniques “ground and space based”, review potential solutions and identify implementation difficulties.

A6.6: Space Debris Removal Concepts: Berend – Kawamoto – Matney
This session will address active removal techniques “ground and space based”, review potential solutions and identify implementation difficulties.

A6.7: Operations in Space Debris Environment, Situational Awareness:
Kelso – Finkleman – Dolado-Perez
This session will address the multiple aspects associated to safe operations in Space dealing with Space Debris, including operational observations, orbit determination, catalogue build-up and maintenance, data aggregation from different sources, relevant data exchanges standards and conjunction analyses.

A6.8 (joint with Space Security Committee): Political, Legal, Institutional and Economic Aspects of Space Debris Mitigation and Removal
Biddington – McKnight – Mathieu
This session will deal with the non-technical aspect of space debris mitigation and removal. Political, legal and institutional aspects includes role of IADC and UNCOPUOS and other multilateral bodies. Economic issues including insurance, financial incentives and funding for space debris mitigation and removal. The role of international cooperation in addressing these issues will be considered.

A6.P: Posters, Bonnal
⇒ First draft to be given to IAF secretary before the end of the month
5. Actions

Noticeable past actions

Position Paper on Orbital Debris in 1993, revised in 2000
- Position Paper SG 5.1 on Space Debris Mitigation in 2006

Recent past

Publication of the SG 5.5 Space Debris Remediation

- Release on 2 December 2013
- 550 paper copies distributed to IAA
- Report accessible on IAA web site

Contribution to IAA Heads of Agencies Summit in Washington, 9-10 January 2014 (appendix 1 & 2)

- Two presentations:
  - “The Contribution of IAA Orbital Debris Initiatives Over the Last Twenty Years” by Darren McKnight
  - “Status Report on Space Debris” by Fernand Alby

⇒ Please, go through them quickly to give the Committee a flavor of the content!
⇒ Both will be annexed to the minutes of meeting of the 19 March
⇒ Good suggestion by Karl Doetsch to have them presented at UNCOPUOS STSC. Action on Chairs.

Proposal of a Plenary Event for Toronto 2014

- Has not been selected by the SG of the IPC on March 18 (see following page)
5. Actions

General program overview for Toronto: 7 Plenary Events, 3 HighLight Lectures, 1 Late Breaking News
Plenary Events for Toronto 2014: very tough selection of 7 PE out of 21 proposals

Plenary Programme Selection (4/5)

Following a challenging selection process, the IPC Steering Group asks the IAF Bureau to approve the following selection of Plenary Events and Highlight Lectures:

PE1 - Heads of Agency
PE3 - Commercial Human Spaceflight - Real Programs with Successes and Challenges
PE4 - Fresh Water for All - The Role of Space Assets
PE11 - Inspiration-Innovation-Impact. Global societal challenge as the key driver for space activities: the imperative for a new way to engage stakeholders
PE13 - ISS and beyond - the future of human activity in Low Earth Orbit
PE17 - The Cryosphere in Retreat
PE18 - The Next Generation Plenary – Innovations in Exploration
HLL1 - Chasing a Comet - Recent Results from the Rosetta Mission
HLL8 - HLL of Dr Sullivan, Administrator of NOAA

The third HLL still need to be selected among the following:

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<td>Reaching Mars - Challenges in India’s Mars Orbiter Mission Design, Planning and Implementation, and the Future Prospects</td>
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5. Actions

Ongoing actions

Contribution to SG 5.10 on Orbital Debris Removal: Policy, Legal, Political and Economic considerations
- Dedicated meeting of the SG this morning!

New action: SG 5.14 Space Debris Situation Report (Appendix 3 & 4)

- Timing
  - Proposed 22 September 2013
  - Approved 16 January 2014
  - Progress report sent to IAA 14 March 2014
  - First collection of contributions on 19 March 2014
  - First draft expected for Toronto meeting
  - Final draft for peer reviewing for Paris meeting in March 2015
  - Publication by Jerusalem meeting?

- General description
  - Reference status of the Space Debris problematic, acting as an update of the IAA Position Papers 1993 and Revision from 2001, taking into account the IAA Position Papers on Space Debris Mitigation (SG5.1) and on Space Debris Remediation (SG5.5). Available elements from on-going SG5.10 devoted to Policy, Legal and Economic Issues in Orbital Debris Removal will also be included.
New action: SG 5.14 Space Debris Situation Report (ctd)

- **Study Plan and Membership**
  
  - Introduction, recall of scope and past studies: C Bonnal & D. Mc Knight
  - Present status: Heiner Klinkrad
  - Measurements: Thomas Schildknecht & Vladimir Agapov
  - Space surveillance & collision: Fernand Alby & Dave Finkelman
  - Reentering space objects: Paula Krisko & Mark Matney
  - Future environment: Paula Krisko
  - Debris mitigation: Mark Matney & MYS Prasad
  - Remediation: Darren McKnight & Seishiro Kibe
  - Protection: Franck Schäfer
  - Legal: Tanja Masson-Zwaan
  - References & Standards: Christophe Bonnal
  - International aspects: Charlotte Mathieu & MYS Prasad

- **Current status**
  
  - As per today, 6 draft paragraph out of 12 have been provided, but only 1 in usable shape
  - Coming activities coordinated through LinkedIn forum (TBC)
6. Information

General information

- Status of ISO Guidelines (see following page)

Past events since last meeting

- 5th European Workshop on Satellites End of Life, 28 January 2014 (see dedicated presentation)

Upcoming events

- 3rd European workshop on Space Debris Modeling and Remediation (see following page)
- 7th IAASS Conference, Friedrichshafen, Germany, 20-22 October 2014 (see following page)
- 40th COSPAR Scientific Assembly will be held from 2–10 August 2014, in Moscow, Russia.
  Event PEDAS.1: "Space Debris - Responding to a Dynamic Environment"
  4 sessions (2 days):
    . Debris Measurements
    . Debris Environment Modeling
    . Debris Orbit Dynamics, Cataloging
    . Debris Mitigation and Remediation, SSA
- SPACE 2014 Conference (see following page)

Any Other Business

- Round Table among participants – Information exchange

Next meeting: Saturday 27 September 2014, Toronto, 10:00 – 13:00
6. Information

Status of ISO Guidelines

- 24113 / Primary Rqmts
  - MRO
    - 16127 Prevention of Break-up
      - Material degradation tbd?
  - EoL Disposal
    - 26872 GEO S/C Disposal
    - 16164 LEO S/C Disposal
    - 16699 LV LEO GEO Disposal
  - Conjunction / Collision
    - Add provisions in 24113?
  - Trackable
    - 27875 Re-entry mgmt
    - 16158 Collision avoidance
    - CCSDS Conjunction Data Message
    - 11233 Orbit determination?
  - Split untrackable?
    - 16126 S/C Survivability to MMOD
  - Improved Lifetime with STELA including GEO?
    - 27852 Orbit Lifetime
    - 23339 Propellant Estimation
  - Add provisions in 24113?
  - Replace with new std including uncertainties?
6. Information

General status of the ISO items

• Standards published: 7 (3 HP)
  – ISO 24113 - Space Debris Mitigation (HP, adopted by ECSS)
  – ISO 27875 - Re-entry risk management for Unmanned S/C and launch vehicle orbital stages
  – ISO 26872 - Disposal of satellites operating at geosynchronous altitude (HP)
  – ISO 23339 - Estimating the mass of remaining usable propellant
  – ISO 27852 - Estimation of orbit lifetime (HP)
  – ISO 11227 - Test procedures to evaluate S/C material ejecta upon hypervelocity impact
  – ISO 14200 - Guide to process-based implementation of meteoroid and debris environmental models

• Documents reaching FDIS (Final Draft International Standard): 3 (1 HP)
  – ISO 14222 - Earth Atmosphere density above 120 km (DIS passed 2012-02-14)
  – ISO 16126 - Survivability of Unmanned Spacecraft against Space Debris and Meteoroid Impacts
  – ISO 16127 - Prevention of Break-up of Unmanned Spacecraft (HP)
General status of the ISO items

• Documents in DIS (Draft International Standard): 2 (1 HP)
  – ISO 11233 - Orbit determination and estimation - Process for describing techniques (TS, DIS review ends 2012-07-27)
  – ISO 16699 - Disposal of orbital launch stages (HP, CD/C ends 2012-06-02)

• Documents in CD (Committee Draft): 2 (1 HP)
  – ISO 16158 - Avoiding collisions with orbiting objects (TR, to be reinstated for CD/V)
  – ISO 16164 - Disposal of satellites operating in or crossing LEO (HP, waiting for CD/V)

• Projects moving to WD: 2
  – ISO 18146 - Design and operation manual for spacecraft operated in the debris environment (Technical Report, HP)
  – ISO 16679 - Relative motion analysis elements after LV/SC Separation
6. Information

3rd European workshop on Space Debris Modeling and Remediation

- Every 2 years in CNES-HQ
- 16-18 June 2014 – No registration fees
- Content similar in principle to last two editions with some add-ons:
  - Modeling of future debris populations, influence of key parameters,
  - Active Debris Removal, system, sub-systems, GNC, …
  - Topic of smaller debris, with associated remediation solutions
  - Non technical aspects of debris remediation, legal, insurance, economics, intellectual property, national security, international cooperation...
- International Program Committee:
  - ESA-HQ (Luisa Innocenti), ESA-ESOC (Holger Krag), DLR (Manuel Metz), JAXA (Satomi Kawamoto), NASA-JSC (Jer-Chyi Liou), SWF (Brian Weeden) and Roscosmos (Valeriy Trushlyakov), in addition to 5 CNES, HQ (Pascal Faucher), Toulouse (Fernand Alby & Marie-Christine Desjean), Launchers (Jean-Marc Ruault & Christophe Bonnal).
- Abstracts are welcome until end of March 2014
- High quality Posters are also welcome
SPACE 2014 Conference

Connecting, Protecting, and Enhancing a Global Society

AIAA SPACE 2014 will examine the impacts of space activity on society. The forum will convene a global conversation around the important role our community plays in enabling a connected culture, monitoring our planet, expanding our boundaries beyond Earth, and advancing technology and innovation to address worldwide opportunities.

We would like a few panelists or speakers from nations representative of those with space capabilities and ambitions to discuss matters that facilitate or inhibit collaboration for mutual benefit and what kinds of cooperation are possible and feasible for "connecting, protecting, and enhancing a global society."

4 - 7 August 2014
Location: San Diego, California
Venue: Manchester Grand Hyatt