Inter-Agency Space Debris Coordination Committee

The Inter-Agency Space Debris Coordination Committee (IADC)

– An overview of the IADC annual activities

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www.iadc-online.org

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United Nations Committee on the Peaceful Uses of Outer Space

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Overview of IADC

- IADC is an international forum of national and international Space Agencies for the worldwide technical/scientific coordination of activities related to the issues of space debris in Earth orbit and provides technical recommendations

- The 13 IADC member agencies are:
  - ASI (Agenzia Spaziale Italiana)
  - CNES (Centre National d'Etudes Spatiales)
  - CNSA (China National Space Administration)
  - CSA (Canadian Space Agency)
  - DLR (German Aerospace Center)
  - ESA (European Space Agency)
  - ISRO (Indian Space Research Organisation)
  - JAXA (Japan Aerospace Exploration Agency)
  - KARI (Korea Aerospace Research Institute)
  - NASA (National Aeronautics and Space Administration)
  - ROSCOSMOS (State Space Corporation “ROSCOSMOS”)
  - SSAU (State Space Agency of Ukraine)
  - UK Space Agency (United Kingdom Space Agency)

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Membership

- IADC members are national or international space and state organizations that carry out space activities, through planning, designing, launching, or operating space objects.

- IADC members should actively undertake space debris research activities and contribute to an increased understanding of space debris issues for the preservation of the orbital environment

Structure and Purposes of IADC

- IADC consists of a Steering Group and four specified Working Groups (WGs) covering measurements (WG1), environment and database (WG2), protection (WG3), and mitigation (WG4).
- The primary purposes of the IADC are
  - to exchange information on space debris research activities between member space agencies.
  - to facilitate opportunities for cooperation in space debris research.
  - to review the progress of ongoing cooperative activities.
  - to identify debris mitigation options.

(IADC Terms of Reference, see http://www.iadc-online.org)

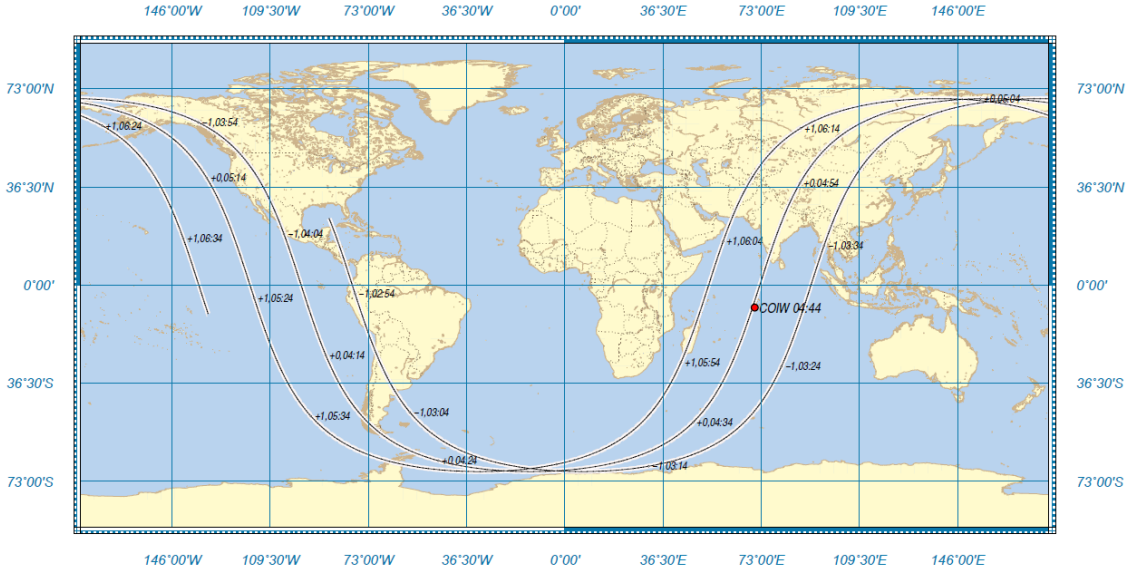
- IADC provides technical recommendations to the international space community. IADC is not a regulatory organization

Annual Meetings

- More than 100 technical experts from member agencies participate in the annual meetings to share information, address issues, and define and conduct studies on all aspects of space debris – measurements, modeling, protection, and mitigation.
  - NASA hosted the meeting in Houston, USA in 2015.
  - UKSA hosted the meeting in Harwell Oxford, UK in 2016
  - ESA will host the next meeting in Darmstadt, Germany, in April 2017

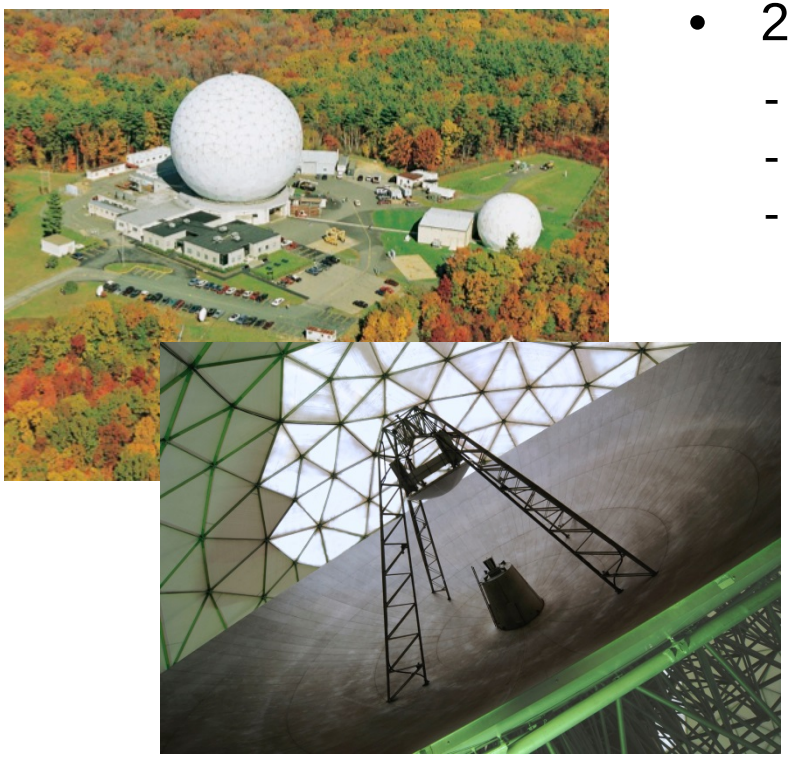
Re-entry Prediction Campaigns

- To prepare for and respond to high risk re-entry events, the IADC members conduct annual object re-entry prediction campaigns for data sharing exercises and improvement of the prediction techniques.
  - 20 campaigns have been conducted since 1998, including a CZ-2C second stage and a VEGA/AVUM stage in 2016.



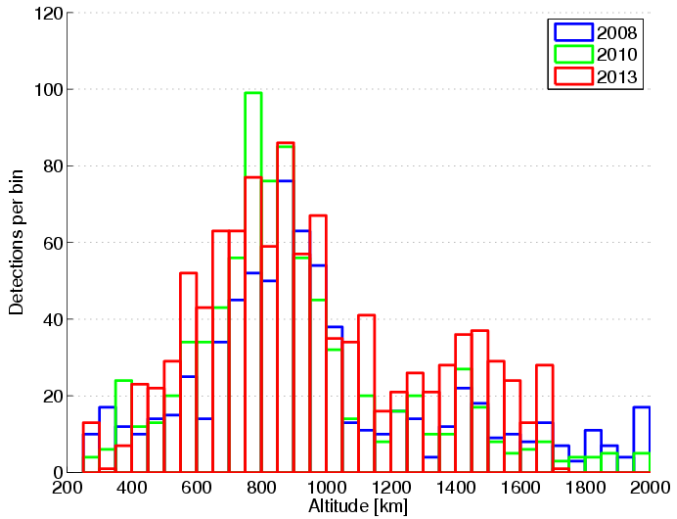
WG1: Measurements

Objective: identify, evaluate and recommend opportunities for cooperation



Haystack radar

- 24 hour LEO radar beampark campaign
  - regular 24 hour radar survey of LEO population
  - snapshot of population > ~ 1 cm
  - monitor evolution of population



Altitude distributions of detected objects

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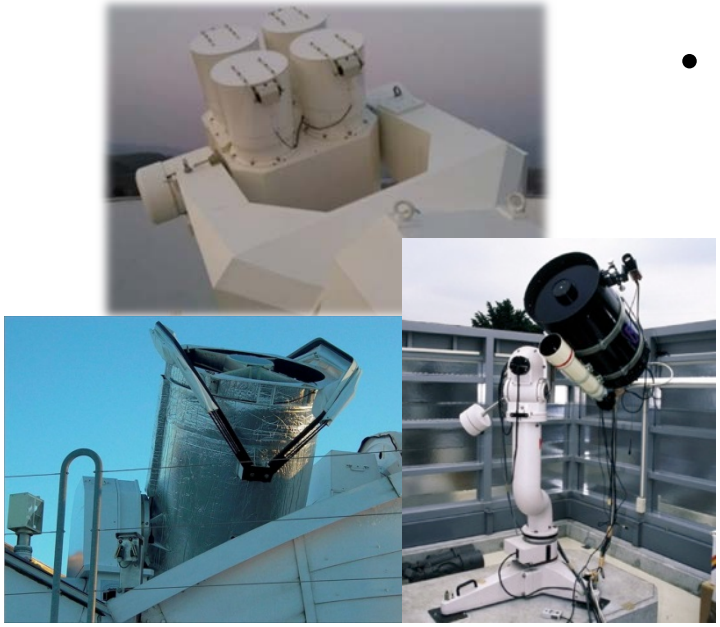
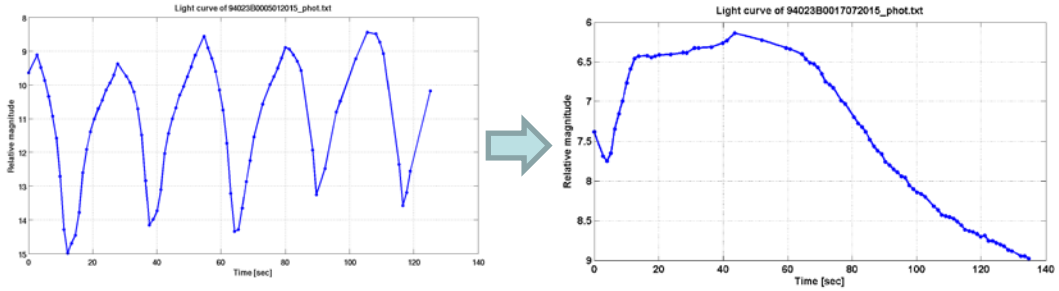
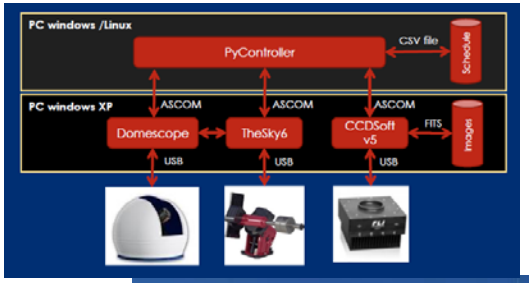


Sensors used for the lightcurve observations. CNSA(upper), ESA(left), and JAXA(right).

- Optical lightcurves of massive LEO objects
  - objective: understand the motion of ADR targets for long duration
  - campaign observations were carried out (ESA, CNSA, NASA, JAXA)





SPADE of ASI

MCAT of NASA

- Information exchange of current status of each delegation
  - ASI is developing the optical observation network
  - NASA started the observation using MCAT
  - CMOS sensor will be the next sensor for space debris observation

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WG 2: Modelling

- Study to quantify the benefits of active debris removal initiated as a result of 2013 LEO stability report
- Companion studies in process to extend and clarify main study results
  - Characterise the uncertainties in future environment projections from uncertainties including propagation, solar activity, fragmentation
  - Quantify the effect of differences/unknowns in the future launch traffic such as small satellite proliferation and increases in launch rates
- Consideration of space sustainability from large constellations of satellites

WG2: Status

- Extensive bibliographic research identified and prioritized sources of uncertainty and selected these to be revisited
- Three sources of uncertainties, whose effect on the long term evolution of the population has to be reassessed, have been identified
  - Solar activity
  - Long term propagation
  - Debris generation model

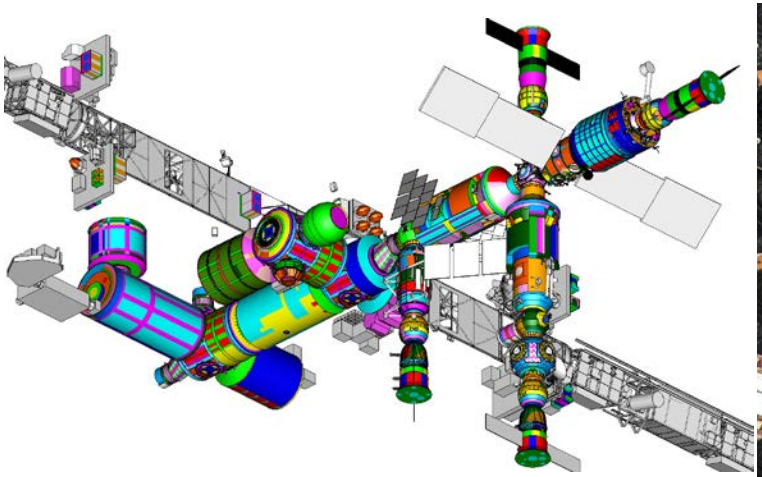
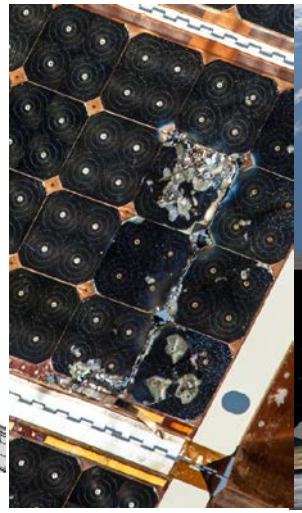
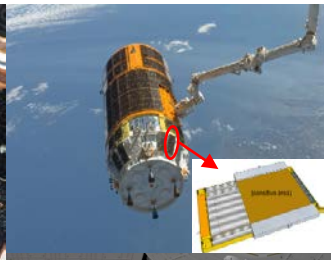
- Documentation of launch traffic model implementation agreed: 9 scenarios (half and double launch rate and varying number, mass, area and area/mass of spacecraft launched)

WG 3: Protection

Action Item: Delivery of IADC Protection Manual v. 7

- Development of impact facilities to launch projectiles approaching orbital debris speeds.
- ISS and visiting vehicle debris damage detection, inspection & repair.

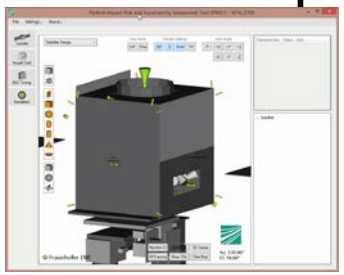
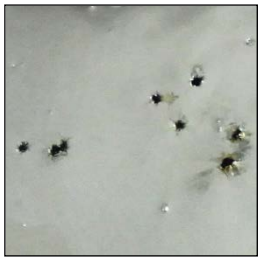
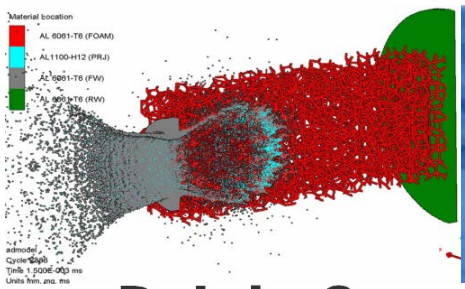


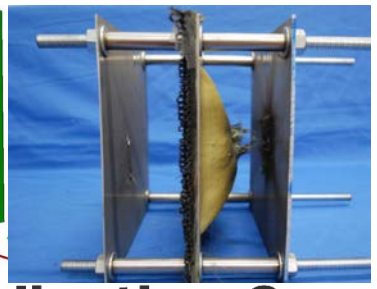
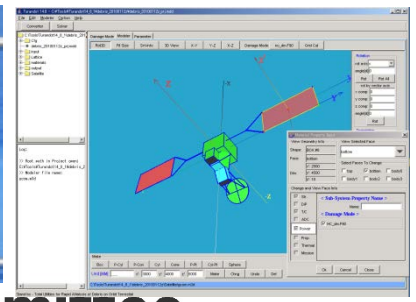





WG 3: Protection

Action Item: Threshold debris impact conditions for satellite components.

- Components being documented include solar arrays, batteries, pressure vessels, electronic boxes, structures, multi-layer insulation, transparent materials, fluid lines, and cables.
- Development of new protective shields for satellites.
- Development and validation of particle impact risks and component vulnerability assessment tools.

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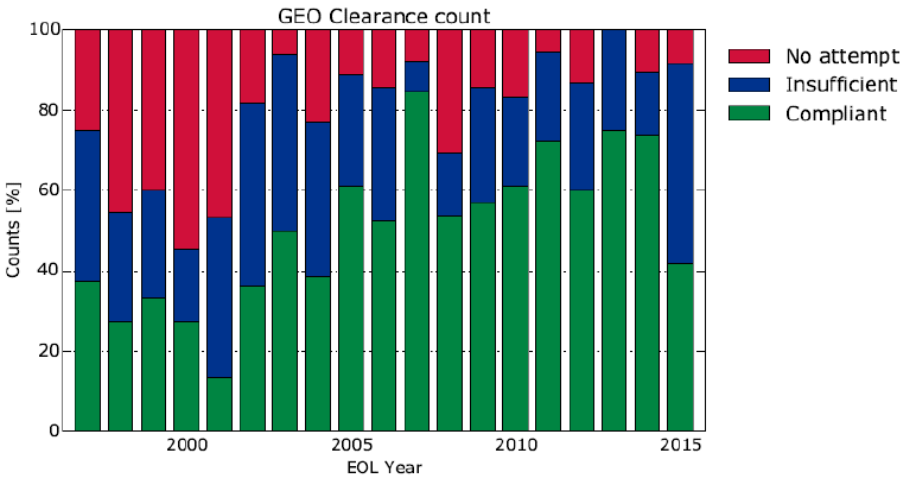
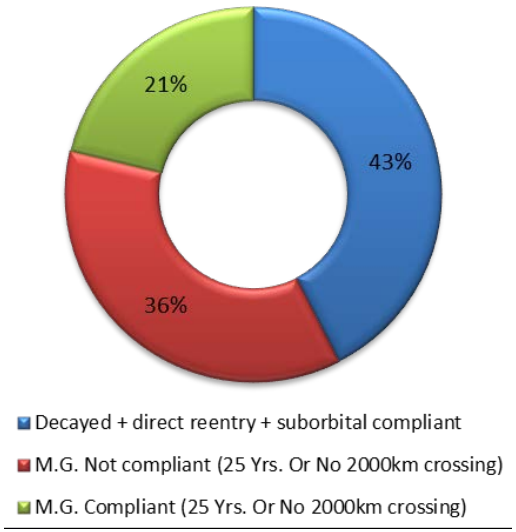
WG4 : Mitigation

- Mitigation Guidelines compliance in 2015:
  - High number of fragmentations in Low Earth Orbit (12)
  - 40% of GEO satellites properly reorbited (compared to ca. 75% in 2014)
  - 65% of objects in LEO comply with the commonly adopted 25 year rule with no visible improvement over the past years



LEO compliance rate 2000-2015



WG4 : Mitigation

- Modification of Guidelines and Support Document under study:
  - provide numerical figures and rationale for several key points such as :
    - On-ground casualty expectation for re-entry events
    - Maximum long-term presence tolerated in GEO region
    - Probability of success for disposal operations
    - Minimum size for mission related debris
    - Probability of break-up during operational phase

- Large Constellation :
  - Confirm the need to decrease altitude at end of life (= not use 2000 km region as a disposal zone)
  - Analyse impact of post mission disposal success rates

- Other topics :
  - Commercial launches, attitude / orbit determination help, MEO objects…

Current Adherence to Mitigation Guidelines

- Members of the IADC use surveillance data to analyse global trends in the adherence to mitigation guidelines:
- GEO:
  - UN/IADC guidelines request a disposal of the space object into a graveyard orbit after completion of the mission
  - ➢ a trend towards satisfactory levels of successful re-orbiting activities has been observed over the past years
- LEO:
  - UN/IADC guidelines request to dispose the space object such that it limits the orbital lifetime in the LEO region
  - ➢ the current implementation level is considered insufficient and no apparent trend towards a better implementation is observed

Small Satellites and Large Constellations

- New Action Item agreed in Houston involving WG2/WG4:
  - Identify the trend in the proliferation of small satellites and review plans for large constellations.
  - Determine the potential inadequacies of the existing IADC Space Debris Mitigation Guidelines for the proliferation of small satellites and those large constellations.
  - Consider the potential risks presented by such systems.
  - Propose possible additional measures to mitigate the identified risks.
  - Work is ongoing and will take several years to complete.
- A first Commentary Paper IADC-15-03 available

Small Satellites and Large Constellations

- New activity to propose possible additional measures in response to small satellites and large constellations
- The numbers of satellites envisaged in the planned constellation architectures represent a step change in the number of satellites operating in the low Earth orbit regime.
- There is also a question regarding the robustness of the existing debris mitigation guidelines to effectively manage the new constellations and their impact on the orbital environment in a sustainable manner (e.g. limiting residence times in orbit).
- Another key consideration is the reliability of critical systems and functionality such as end of life disposal. It is clear that significant improvements in the reliability of the disposal function at end of life will be needed for the new constellations compared with that currently demonstrated by space systems on orbit.

Conclusions

- IADC is the internationally recognized technical/scientific authority on space debris.
- IADC participates in and contributes to the UN space debris activities via the Scientific and Technical Subcommittee (STSC) of the Committee on the Peaceful Uses of Outer Space (COPUOS).
- IADC will continue to advance the knowledge of space debris and to develop environment management strategies to preserve the near-Earth space for future generations
  - http://www.iadc-online.org/index.cgi?item=docs_pub