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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IADC Chair

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 governmental forum for the worldwide coordination of activities related to the issues of human-made and natural debris in space.
- 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 (Russian Federal Space Agency)
  - SSAU (State Space Agency of Ukraine)
  - UK Space Agency (United Kingdom Space Agency)

Membership

- IADC members are countries or national or international space organizations that carry out space activities, either through manufacturing, launching, and operating spacecraft or manufacturing and launching rockets.
- IADC members should actively undertake space debris research activities and contribute to an increased understanding of space debris issues.
- The Korea Aerospace Research Institute (KARI) of the Republic of Korea became the latest IADC member in October 2014.

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.

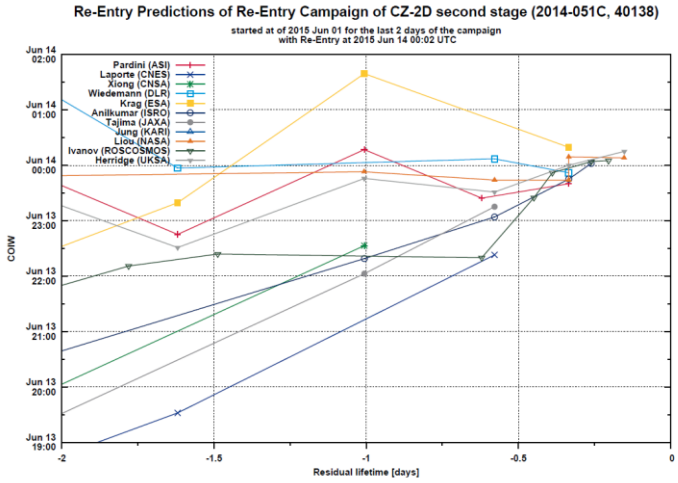
(IADC Terms of Reference, see http://www.iadc-online.org)

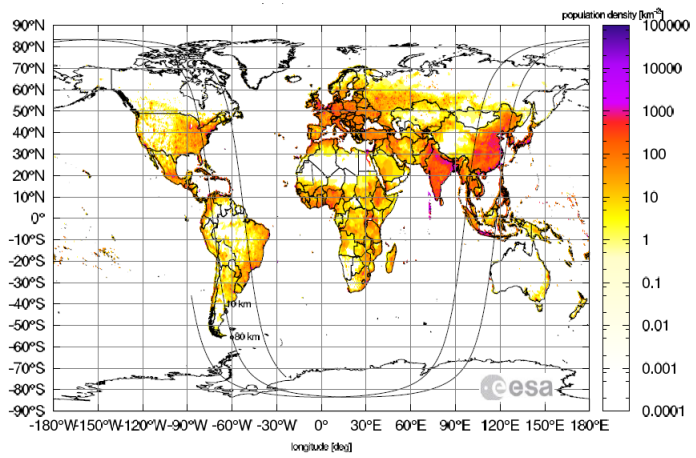
Annual Meetings

- 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.
  - CNSA hosted the meeting in Beijing, China in 2014.
  - NASA hosted the meeting in Houston, USA in 2015.
  - UKSA will host the next meeting in Harwell Oxford in March 2016

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 and coordination.
  - Eighteen campaigns have been conducted since 1998, including Cosmos 1939 in 2014 and CZ-2D second stage in 2015.





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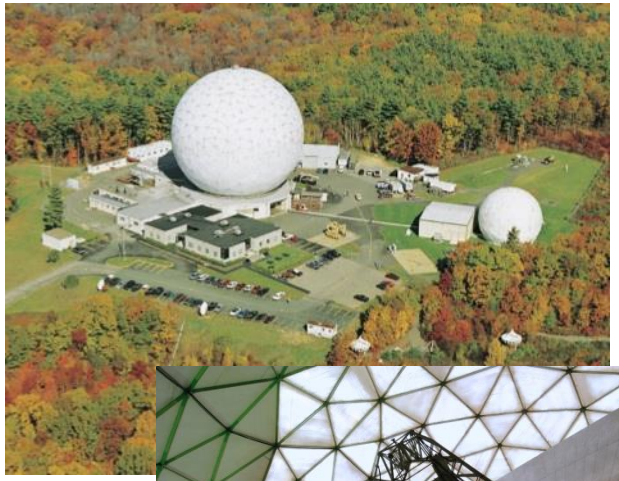
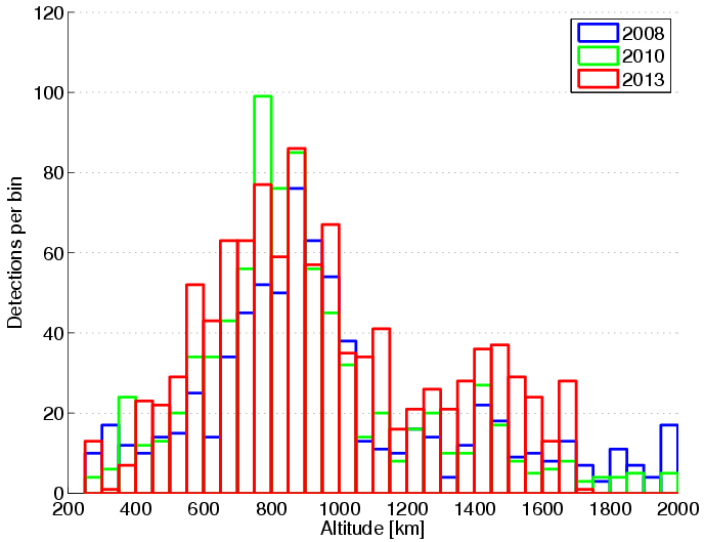
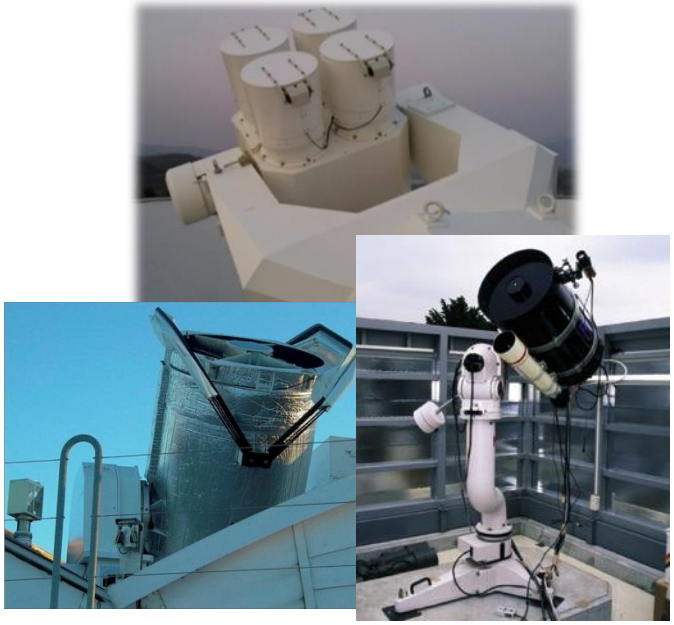
WG1: Measurements

Objective: identify, evaluate and recommend opportunities for cooperation

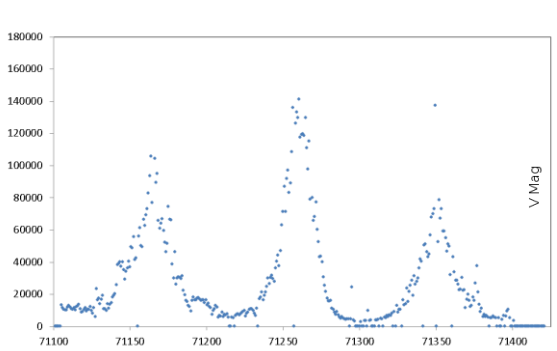


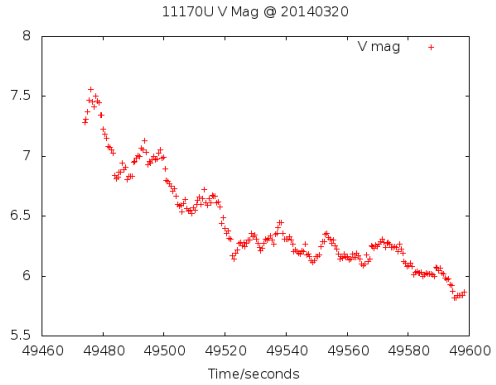
- 24 hour LEO radar beampark campaign
  - regular 24 hour radar survey of LEO population
  - snapshot of population > ~ 1 cm
  - monitor evolution of population



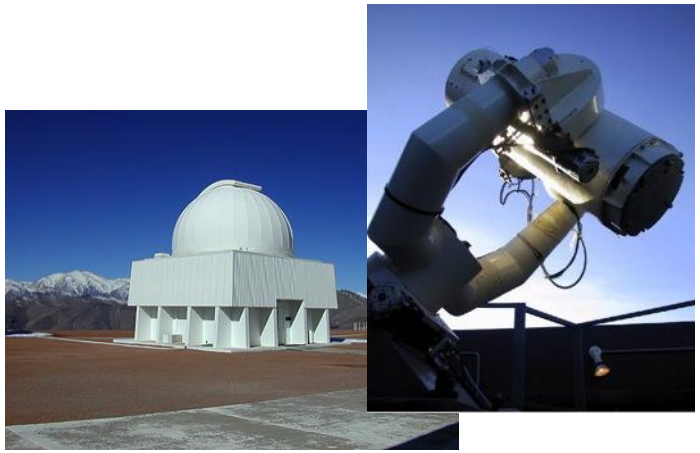


- optical lightcurves of massive LEO objects
  - attitude motion of launch upper stages
  - possible targets for remediation
  - test models of attitude evolution
  - develop common taxonomy





- optical survey of medium Earth orbit
  - no previous co-operative surveys by IADC
  - trial campaigns reviewed
  - Molniya apogee campaign to be proposed for 2016/7



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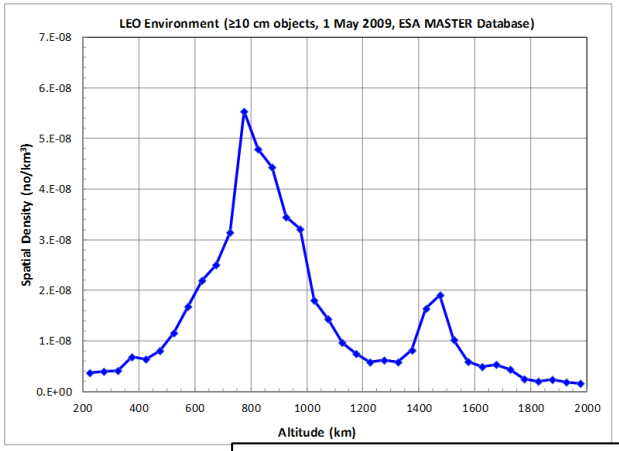
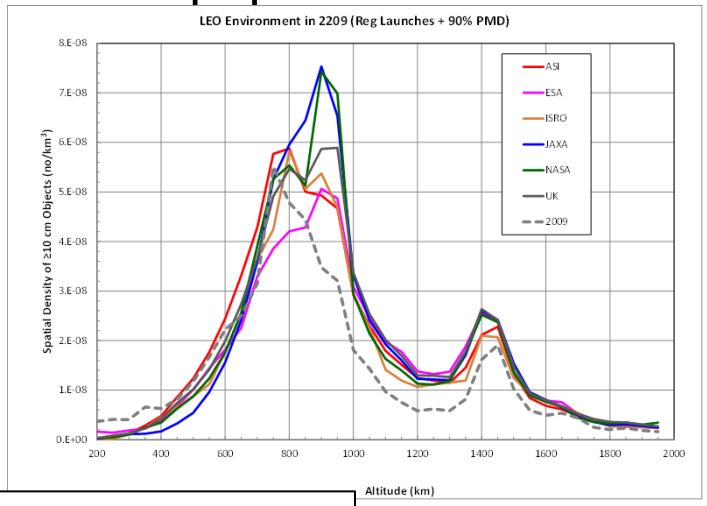
WG 2: Modelling

- Major study on the stability of the future LEO environment completed in 2013
  - "…confirm the instability of the current LEO debris population"
  - "…compliance of the mitigation measures, such as the 25-year rule, is the first defense against the OD population increase"





Study results, current and future populations

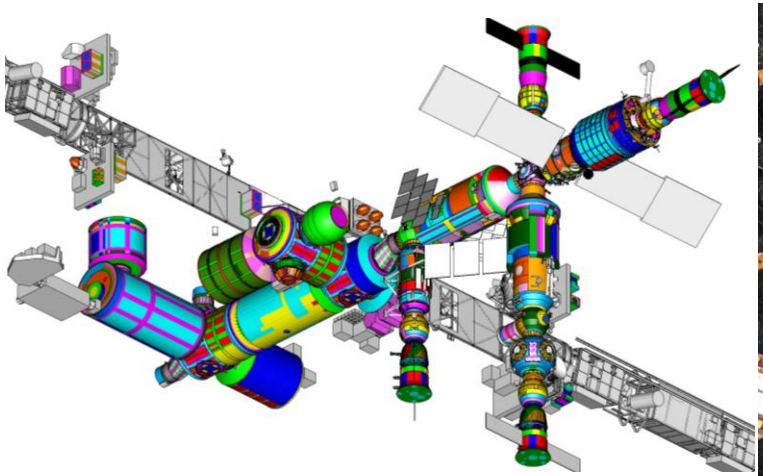
WG 2: Modelling

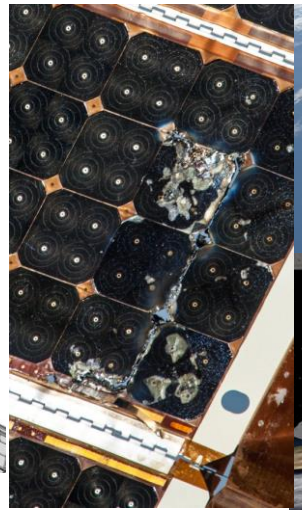
- Study to quantify the benefits of active debris removal initiated as a result of 2013 LEO stability report
- Companion studies in process to extend and clarify main study results
  - Characterise the uncertainties in future environment projections from uncertainties including propagation, solar activity,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

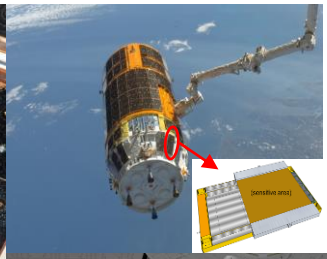
WG 3: Protection

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.







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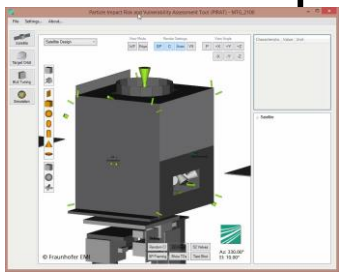
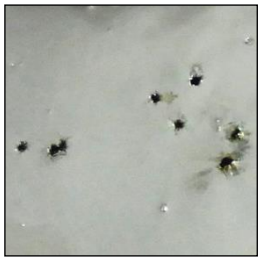
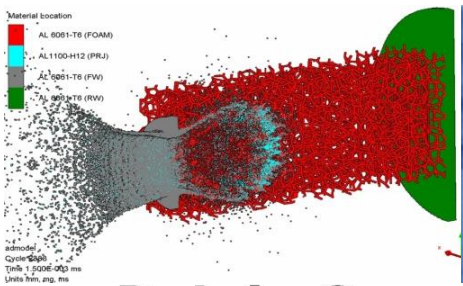
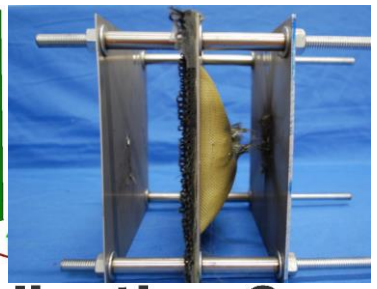
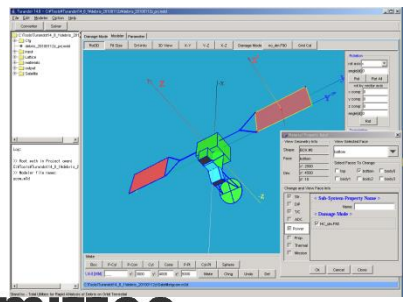
New ISS vision debris damage inspection system to be launched in 2020.

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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WG 4: Mitigation

- Reports were presented regarding :
  - LEO and GEO situation
  - GTO injection altitude
- Discussions are ongoing for several subjects of interest :
  - End of life for different orbital regimes
  - Licensing and jurisdictional aspects
  - Remediation, orbit and attitude determination
- New important topics of discussion :
  - Commercial space transportation
  - Small satellites and mega constellations

They will change the future space environment, and guidelines have to be adapted to keep a sustainable Space

WG 4: Mitigation

- Several numerical figures have been discussed and approved, to give a quantitative value to inform some qualitative Guidelines :
  - on-ground casualty expectation for re-entry events
  - maximum long-term presence tolerated in GEO region

  These will be introduced in next revision of IADC Mitigation Guidelines and support document.

- Some other aspects of Guidelines need to be quantified:
  - Probability of success for disposal operations
  - Minimum size for mission related debris
  - Probability of break-up during operational phase

  To be discussed during next meeting. Action Item opened

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.
- In the meantime, it is worthwhile re-iterating the essential aspects of the IADC and UN debris mitigation guidelines:

Key Aspects of Space Debris Mitigation Guidelines

- Spacecraft and orbital stages should be designed not to release debris during normal operations
- The potential for break-ups during all phases of mission minimised
- Spacecraft or orbital stages that are terminating their operational phases in orbits that pass through the LEO region should be de-orbited or where appropriate manoeuvred into an orbit with a reduced lifetime (studies have found 25 years to be a reasonable lifetime limit).
- If a spacecraft or orbital stage is to be disposed of by re-entry into the atmosphere, debris that survives to reach the surface of the Earth should not pose an undue risk.
- Missions should estimate and limit the probability of accidental collision during the orbital lifetime. Avoidance manoeuvres for spacecraft/co-ordination of launch windows should be considered.

Initial Observations

- 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.
  - Commentary Paper IADC-15-03 available

Conclusions

- IADC is the internationally recognized technical 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