



# **Promoting Space Sustainability**

**Scientific research  
activities on Space  
Debris**

**Italian Space Agency  
30/03/2021**

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## **Implementation of the Guidelines for the Long-term Sustainability (LTS) of Outer Space Activities of the Committee on the Peaceful Uses of Outer Space**

### **Operational Case Studies**

#### **I. Short description of the outer space activity**

The Italian Space Agency (ASI) was established in 1988 to coordinate the national activities in the space field. The main objectives of ASI are related to the development of space technologies for space transportation, human spaceflight, exploration of the Solar System and the observation of Earth and Universe. To achieve these goals, ASI supports both the national industry and the scientific research communities, promoting their participation to European and international projects. In this context, ASI has developed numerous space programmes by taking advantage of the Italian long-standing tradition in cooperating with other Countries. In particular, Italy is a founding Member of COPUOS (1958) and of the European Space Agency (ESA, 1975), and ASI has signed numerous bilateral and multilateral agreements with other space agencies for successful challenging projects.

The global scenario of the current Space Era shows a fast growth of space activities, comprising the contributes from new emerging Countries and the development of commercial services based on large satellite constellations. In this context, ASI is paying great attention to the problem of space debris, by contributing to the activities of several international forums. In particular, ASI is a Member of the European Union Space Surveillance and Tracking (EU SST) Consortium, currently joined by seven space agencies (or equivalent governmental entities), that aims to protect space and ground-based infrastructures by developing three main services devoted to the re-entry, fragmentation and collision avoidance. ASI also participates to the ESA Space Safety Programme (S2P), whose main goal is to protect both space assets and our planet from hazards coming from space. In this case, both man-made objects, such as space debris, and natural phenomena, such as space weather and Near-Earth-Objects (NEOs), are considered.

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ASI is also a Member of the Inter-Agency Space Debris Coordination Committee (IADC) and supports the national experts that participate in the different Working Groups.

## II. Connection with the LTS Guidelines

The ASI activities described above strongly support the implementation of the LTS guidelines related to the sharing of information on space objects and orbital events (B.1, B.2, B.3), as well as on space weather (B.6, B.7), by promoting the international cooperation (C1, C2).

In the following “case study” we present the national activities supported by ASI to **“Promote the collection, sharing and dissemination of space debris monitoring information (B.3)”**. This guideline suggests to *“encourage the development and use of relevant technologies for the measurement, monitoring and characterization of the orbital and physical properties of space debris”* and to *“promote the sharing and dissemination of derived data products and methodologies in support of research and international scientific cooperation on the evolution of the orbital debris population”*.

In order to support the scientific research on space debris, an agreement has been signed by ASI and the National Institute for Astrophysics (INAF), with the participation of numerous national research institutes and universities. This Agreement takes into account a large number of research activities relating to the space objects population, from the data collection to the development of theoretical models. In particular, to collect data, both optical and radio telescopes have been used to observe objects in Low-Earth-Orbits (LEOs) and Geostationary Orbit (GEO). For instance, wide-field (several squared degrees) optical telescopes have been mainly used for LEO surveys (Fig.1), while small field-of-view (few squared arcminutes) telescopes have been operated to collect data of GEO objects. For the LEO regions the data collection includes the observations of the INAF “Northen Cross” radiotelescope (Fig.2). In this way, complementary information on space debris have been provided.



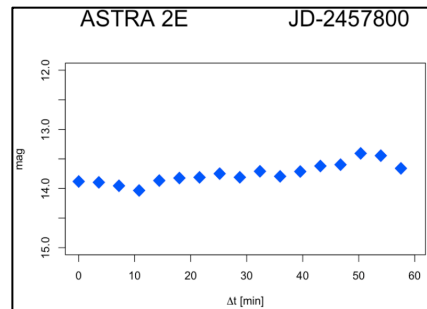
Fig. 1: ASI SPADE (SPAcE DEbris) optical telescope.



Fig. 2: "Northen Cross" radiotelescope (Courtesy of INAF)

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The observational data analysis includes the orbit determination of space debris, as well as the multi-band photometry. In the latter, the research is focused on the characterization of the space debris surface materials, by combining the magnitudes measured with different optical filters<sup>1</sup> (Fig.3).



**Fig. 3 ASTRA 2E GEO satellite observed in V Johnson band.**

The ASI-INAF Agreement also supports theoretical research activities, by considering the following main topics:

- development of break-up models following spontaneous events;
- simulations of fragmentations due to in-orbit collisions with both low-mass impactors and large objects;
- development of re-entry prediction models, as well as validation during observational campaigns of re-entry of uncontrolled objects;
- simulations of the current and future evolution of the space debris population, considering also the impact of the adoption of different mitigation guidelines.

The scientific results of these activities are shared in international contexts by ASI, as well as directly by the national experts thanks to their participation in the IADC working groups (as ASI delegates), as well in other international conferences and Committees. ASI also promotes the dissemination of the results supporting academic lecturers and outreach activities.

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<sup>1</sup> Di Cecco, A. et al, *Multi-band photometric observations of GEO satellites: preliminary results*, Proc. of the 7th European Conference on Space Debris, 2017, published by ESA SpaceDebris Office;  
<https://conference.sdo.esoc.esa.int/proceedings/sdc7/paper/732/SDC7-paper732.pdf>

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### **III. Lessons learned**

The national agreement between ASI and INAF has turned out to be a powerful tool for bringing out the national scientific resources and infrastructures for the investigation of space debris. In this context, national research activities have been coordinated in order to efficiently support the Italian expertise in different contexts.

The participation of numerous research teams increases the opportunities to cover a wide spectrum of interests, from the observations in LEO and GEO regions, to the development of theoretical models to investigate the space debris population. In particular, to collect data, both optical and radio telescopes have been used. For the theoretical investigations indeed, the break-up and fragmentation models, as well as the re-entry predictions and the evolution of space environment are being considered. Several specific tasks are focused on supporting ASI in the European and international contexts of EU SST and IADC.

Thanks to the coordination of the activities, the Italian contributions to the international projects on space debris have increased. The collected information and results have been disseminated by ASI, as well as directly by national researchers participating in international conferences and Committees.

A key factor to enhance the national capacity building has been the occurrence of numerous internal meetings among the involved teams. This opportunity has created new synergies among different research topics, for example supporting the data-fusion activity between the radio and optical datasets. Moreover, the involvement of doctoral and post-doctoral students has provided a boost to the scientific activities, also encouraging younger researchers to continue their interest in the space field.