# POLITECNICO DI MILANO

# PhD in **INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 39th cycle**

**THEMATIC Research Field: OPTIMAL SENSOR TASKING FOR ON-ORBIT BREAKUP FORENSIC ASSESSMENT**

| Monthly net income of PhDscholarship (max 36 months) |
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| **€ 1400.0** |
| In case of a change of the welfare rates during the three-year period, the amount could be modified. |

| Context of the research activity | |
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| **Motivation and objectives of the research in this field** | In the last decades, in orbit population has become a problem of utmost immediate importance for space agencies and institutions worldwide. Among orbiting objects, just a small fraction is represented by co-operative satellites and the main part is composed by space debris, which include inactive satellites, rocket bodies, and fragments of all sizes. Space debris represent a threat to space activities (in orbit collision risk, for instance) and so different strategies have been implemented to guarantee safe operations. For this purpose, an international commitment is currently taking place in the Space Situational Awareness (SSA) field, with focus on the Space Surveillance and Tracking (SST) applications, which exploit measurements obtained through ground-based sensors: optical telescopes, radars and lasers. Among SST services, the fragmentation analysis has become of key importance, given the increasing number of on-orbit breakups, which are responsible for the space debris proliferation. For this reason, it is fundamental to monitor the fragments cloud generated by a breakup, implementing a successful strategy to task sensors and properly processing the acquired measurements. The research aims at developing optimal sensor tasking procedures to manage SST services, with particular focus on the cataloguing of the fragments generated by an on-orbit breakup. This focus requires to properly process the acquired measurements to characterize the fragmentation event, which in turn |

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| | would allow to refine the tasking of additional observations. |
| **Methods and techniques that will be developed and used to carry out the research** | The first objective of the research is to improve the procedures of sensor tasking. To this aim, the candidate will conduct a literature review and become familiar with the procedures and softwares already developed in Politecnico di Milano, as well as those established worldwide. Then, a strong knowledge will be acquired on uncertainty representation and propagation. This will allow the candidate to develop procedures to upgrade these softwares including the target uncertainty evolution during the no-show time period. Additional sensor tasking parameters, such as the sensors operating state, the weather conditions and the historical trend of the measurements quality will be included in the softwares upgrade, as will the progressive update and automatic re-tasking. The second objective is to assess the quality of the developed procedures. In this context, the candidate will develop an automatic procedure to assess the improvement of the sensor network performance to accomplish a specific SST service. Furthermore, the optimal parameters to conduct the upgrade of a given sensor will be identified, including the geographical position of a new station. The third objective is to focus on fragmentation events characterization. First, an optimal strategy to task sensors monitoring the fragments cloud evolution will be defined. Then, algorithms will be developed to associate the observational data to a specific breakup event, by also considering the measurements uncertainty effects. The candidate will also work on additional algorithms which aim at estimating the fragmentation epoch from observational data in the measurements space and considering the uncertainties effects. The fragmentation epoch identification would allow to refine the sensor tasking strategy, which in turn would allow to better characterize the breakup event. By this way, a virtuous circle will be generated, enhancing fragments cloud monitoring. Throughout all the activities, the candidate will have the chance to interact with the research group, which has gained a strong expertise in SSA and SST fields, and to take advantage of recent |

**POLITECNICO DI MILANO**

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| | advancements in the field enabled by the use of Artificial Intelligence (AI) techniques. |
| **Educational objectives** | The research concerns the SSA/SST field, which involves both civilian and military institutions at a national and an international level. The candidate will have the possibility to interact with the relevant stakeholders in this context, developing both technical and soft skills. From a technical point of view, the candidate will gain a deep knowledge regarding astrodynamics, numerical methods, uncertainty representation and propagation and computer programming. Moreover, the candidate will acquire valuable capabilities to perform a critical review of the relevant literauture. In addition, by joining the research team, the candidate will take part in progress meetings, presenting the work progress and writing reports. All these aspects will contribute to train a highly qualified researcher that will be able to tackle current space-related projects and to contribute to the enhancement of the space sector. |
| **Job opportunities** | Space Traffic Management (STM) is nowadays the focus of several companies, national agencies and universities. The skills acquired on the research topics will ensure the attractiveness of the candidate in the space community. The research will develop in parallel to the establishment of: 1. The European Space Surveillance and Tracking Support Framework. 2. ESA's Space Safety/Space Traffic Management programme. 3. The Italian Space Agency HW and SW infrastructure for Space Traffic Management 4. Any national initiatives aiming at establishing/improving a national SSA/STM capability. All programmes support the development of a network of European and national infrastructures to ensure the long-term availability of space surveillance services, including any existing/future SSA service. To this purpose, both programmes are fostering industrial and academic excellence in the field, which will need the long-term support of experienced professionals. |
| **Composition of the research group** | 0 Full Professors<br>2 Associated Professors<br>2 Assistant Professors |

## POLITECNICO DI MILANO

| | 8 PhD Students |
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| **Name of the research directors** | Prof. Pierluigi Di Lizia |

| Contacts |
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| Additional support - Financial aid per PhD student per year (gross amount) | |
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| **Housing - Foreign Students** | -- |
| **Housing - Out-of-town residents (more than 80Km out of Milano)** | -- |

| Scholarship Increase for a period abroad | |
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| **Amount monthly** | 700.0 € |
| **By number of months** | 6 |

| Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information |
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| The PhD candidate will receive a desk, possibly through a hot-desking procedure, and a personal computer, if needed. Apart from the compulsory ones, the PhD candidate will have the opportunity to follow additional courses and receive economic support to attend summer schools and participate in conferences. There will be the possibility of paid teaching assistantship. |