ASCENSION
Advancing Space Access Capabilities – Reusability and Multiple Satellite Injection

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PhD student – Early Stage Researcher (ESR13) Guidance, Navigation and Control (GNC) for launchers for multiple payload / multiple orbit delivery

About ASCenSIon

The purpose of the ASCenSIon project is to develop a programme that focuses on several specific areas of cutting-edge space access research, particularly on launcher systems that are (partially) reusable and capable of injecting multiple payloads into multiple orbits. More than providing design concepts, the network aims to identify and advance critical technologies to prove a feasibility of these concepts. Fields of research and training include propulsion technologies and their reusability; Guidance, Navigation and Control (GNC); aero-thermo-dynamics of re-entry and safe disposal. A variety of technologies will be advanced, including hybrid rocket engines, electric pump feeding and advanced nozzle configurations. Both computational and experimental (cold-flow and hot fire) techniques will ensure an efficient process and reliable results. The reuse of propulsion systems demands an assessment of their durability. It will be conducted by numerical simulations, system analysis with EcosimPro/ESPSS and experimental test runs. The development and integration of wireless sensor networks will allow health monitoring of these critical subsystems. Moreover, novel GNC strategies and processes have to be developed for the whole mission trajectory. This includes solutions for optimised flexibility w.r.t. the orbital insertion conditions as well as dedicated descend trajectories and GNC missionisation for re-entry. The models will cover various recovery concepts and the support of multiple landing sites. This requires an extensive examination of the aero-thermo-dynamics during re-entry as well as of the interactions between stage recovery and propulsion system layout. Ecological and economical sustainability will be addressed as new payload concepts including large constellations increase the demand for safe disposal and space debris mitigation to ensure an open access to space in the future. Furthermore, the utilisation of so called green propellants will be investigated.

The ASCenSIon consortium includes Technische Universität Dresden, German Aerospace Center, SITAEL, Sapienza Università di Roma, ONERA, Université libre de Bruxelles, Hochschule Bremen, Università Di Pisa, Technische Universität Braunschweig, Politecnico di Milano, DEIMOS Space, ArianeGroup, ESA, AVIO, OHB, D-Orbit, SpaceForest and Telematic Solutions

About the host organization

Politecnico di Milano (PoliMi) is a university, founded in 1863, that teaches technologies in a variety of innovative, specialised subjects as engineers and architects. POLIMI concentrates on quality and innovation in teaching and research training with high international standards, with 2740 enrolled staff members in all. In 2019, the students were 42453, 5840 of which are foreign. According to QS World University Rankings 2019, POLIMI ranked 7th worldwide in the mechanical and aerospace engineering, and 1st in Italy. The entity involved in the current project is the Dipartimento di Scienze e Tecnologie Aerospaziali (PoliMi-DAER), established as an autonomous institute in the 1950's. The main activity within the Department is education, and the Department hosts the Laurea (B.S.), in Aerospace Engineering, the Laurea Magistrale (M.S) in Space Engineering and Aeronauti-cal Engineering, and Dottorato di ricerca (Ph.D.) in Aerospace Engineering. Each year 350 students complete the B.S. courses, 200 the M.S. and 10 the Ph.D. The skills the Space group offers to the team are related to space systems design

and testing, and to its long experience in astrodynamics. According to the two areas, POLIMI-DAER has developed more than 50 space mission design stud-ies and has been involved in external funded collaborations being in charge of trajectory and mis-sion design for Earth and interplanetary missions, guidance navigation and control for satellites and launchers, space robotics. DAER is well equipped with numerical and experimental laboratories.

(https://www.polimi.it/en/home/)

Task description

Your PhD project:

The ESR will learn how to settle a multidisciplinary\multiobjective optimization problem with mixed variables. He\she will perform a comprehensive state of the art in the field of multistage launchers' trajectory definition, guidance design and control synthesis. Then he\she will start formalizing the problem of a multi-point orbital insertion from the trajectory design and guidance strategy perspective.

The candidate will then implement a simulator with increasing modeling complexity and degrees of freedom to shape the optimal guidance profile, taking into account different control strategies (i.e. high\low thrust). Then, sensitivity to the state vector reconstruction and estimation will be performed, to assess the robustness and weakness of the proposed strategy for the GNC chain.

Problem Definition:

While single orbit injection is the routine, multiple platforms in orbit insertion is available but the secondary payloads have to accept the injection in the main satellite trajectory neighbourhood. Thus, multiple platform injections in dedicated and different trajectories with high level of accuracy need novel GNC designs.

Research Objectives:

1) Identifying GNC solutions, which increase the launchers flexibility in terms of reachable final conditions
2) Modelling of the complex nonlinear & coupled dynamics of a multi-stage vehicle
3) Tuning of nonlinear dynamics control for the whole launcher stages history to minimize the fuel consumption to insertion & maximize different satellite cluster insertion feasibility, mission dependent
4) Taking into account the potential different propulsive solutions analysed in WP2-3 for identification of optimal control strategies

Expected Results:

The optimal GNC and path planning strategy for future launchers design, depending on the propulsion architecture, ensuring a large reusability and flexibility with respect to the range of the orbital insertion conditions requests.

Secondments:

Two secondments are foreseen to:

1) OHB, for a duration of 1 months, for the identification of industrial demands
2) DLR, for a duration of 6 months, to work on vehicle design verification & tuning, and propulsion performance modelling

Profile and requirements

Essential skills:

- MSc or equivalent in the field of aerospace engineering or mechanics engineering
- Applicants must have a solid knowledge of dynamics modelling, control basics; computer programming; basic knowledge in optimization and multi-body modelling
- Ability to work highly efficient and self-reliantly in a diverse inter-disciplinary and multi-cultural environment

- Ability to work in a team, as well as independently
- Ability to solve complex problems with adherence of strict deadlines
- Excellent communication skills (both written and verbal) in English to derive the full benefit from the network training
- Proactive attitude
- As secondments and events are foreseen, applicants must be ready to travel
- Applicants must be eligible to enroll on a PhD programme at the host institution http://www.dottorato.polimi.it/en/

Desired skills:

- Experience in laboratory work including the design, conduction and evaluation of experiments
- Project management
- Knowledge of the host institution language is a plus

Applicants can be of any nationality.

Candidates may apply prior to obligation their master's degree but cannot begin before having received it.

In addition:

H2020 MSCA Mobility Rule: researchers must not have resided or carried out their main activity (work, studies, etc.) in the country of the host organization (Italy) for more than 12 months in the 3 years immediately before the recruitment date. Compulsory national service, short stays such as holidays, and time spent as part of a procedure for obtaining refugee status are not taken into account.
Eligible researchers must not have spent more than 12 months in the 3 years immediately prior to the date of selection in the same appointing international organisation.

H2020 MSCA eligibility criteria: Early Stage Researchers (ESRs) must, at the date of recruitment by the host organization, be in the first four years (full-time equivalent research experience) of their research careers and have not been awarded a doctoral degree. Full- Time Equivalent Research Experience is measured from the date when the researcher obtained the degree entitling him/her to embark on a doctorate (either in the country in which the degree was obtained or in the country in which the researcher is recruited, even if a doctorate was never started or envisaged).

Applicants who do not fulfill these requirements CANNOT be considered for the research position.

Benefits

- You will be working within our international group of > 30 researchers with experience in a broad range of sciences
- You will get in contact with the other members of this international consortium and will benefit from the joint training platform to develop skills necessary for developing a thorough understanding of space transportation systems
- You will be employed by the host organization for 36 months
- A competitive salary plus allowances. Moreover, funding is available for technical and personal skills training and participation in international research events
- You will benefit from the well-structured training programme offered by the host organization and the consortium
- You will participate in international conferences and secondments to other organisations within the ASCenSIon network and in outreach activities targeted at a wide audience

Please find additional information in the Information package for Marie Curie fellows.

Selection procedure

For the selection procedure, the ASCenSIon consortium will appoint a Committee, consisting of at least three members: one main supervisor, two co-supervisors and the project coordinator from University of Dresden.The preliminary selection is made by review of the application documents specified below. The final selection will be made after interviews with the final candidates. The applicants will be informed about rejection or admission to an interview by end of May at the latest. The interviews will take place either in person at the host institution or via video-conference. The timeframe for the interviews is May - June.

Application

Interested candidates are invited to submit **one single PDF** containing the following documents in this exact order:

- Application form (see end of this document)
- Cover letter
- CV
- Educational and professional certificates (university degree(s) with marks, internships, workshops, languages, etc.)

Moreover, you must submit:

- Short video (max. 30 s.). The video must include: personal introduction, background, motivation to apply to the research position… show us why you are the ideal candidate!

All the application documents must be submitted via email to **ascension@tu-dresden.de**

The email subject must be "**Application for ESR13 position**".

The email size incl. attachments **must not exceed 30 MB** in total.

You will receive an automatic reply if we have received your email. Please avoid any questions on the status of the selection process. We will inform you as soon as there is an update.

Candidates whose application is not compliant with the requirements above will not be considered.

Application deadline: 19 May 2020 at 11:59 PM CET
Expected starting date: 1 October 2020

Applications and enclosures received after the deadline will not be considered.

Candidates can apply to more than one position.
More information and other vacant positions can be found at:

- Website (to be published within April): https://www.ascension-itn.eu/
- Facebook: https://www.facebook.com/ascensionitn/
- LinkedIn: https://www.linkedin.com/company/ascensionitn/

Additional information

We in the ASCenSIon consortium value diversity and we commit to equal treatment of all applicants irrespective of gender, sexuality, health status as well as social, cultural or religious background.

For additional information about the research project and this individual position, please contact:

ascension@tu-dresden.de

ASCenSIon ITN Application Form

Name and surname: **Applying for ESR No. 13**

Age:

Nationality:

Country of residency in the last 3 years (if more than one, state also for how long you resided in each country):	
Country where you carried out your main activity (study, work, etc.) **in the last 3 years** (if more than one, state also the duration of your activities):	
University and course degree:	
Master's degree final mark:	
Final thesis title:	
Thesis supervisor(s):	
Starting and ending year of your university studies (Bachelor and Master):	
Professional experiences carried out in the last 4 years, if any (internships, scholarships, free collaboration, research, work experience and/or internship abroad, participation in Erasmus + or Summer School programmes, etc.)**:**	
Professional experiences relevant to the research position you are applying for (specify up to three experiences in chronological order, starting from the most recent):	
Language skills (language and level):	
Relevant computer skills (software, programming, etc. and specify user level: basic, average, experienced):	

Please specify any relevant professional teamwork experience (and your role within the team)**:**	
State three aspects that would make you the ideal candidate for this position:	