PhD position: Experimental study of Hybrid Rocket Engines (HREs) with regression rate measurements within ASCenS lon project (ESR9)

- ORGANISATION/COMPANY
  Université libre de Bruxelles (ULB)

- RESEARCH FIELD
  Engineering › Electronic engineering
  Engineering › Mechanical engineering

- RESEARCHER PROFILE
  First Stage Researcher (R1)

- APPLICATION DEADLINE
  19/04/2020 23:00 - Europe/Brussels
- **LOCATION**
  Belgium › Bruxelles

- **TYPE OF CONTRACT**
  Temporary

- **JOB STATUS**
  Full-time

- **HOURS PER WEEK**
  40

- **OFFER STARTING DATE**
  01/10/2020

- **EU RESEARCH FRAMEWORK PROGRAMME**
  H2020 / Marie Skłodowska-Curie Actions

- **MARIE CURIE GRANT AGREEMENT NUMBER**
  860956

**About ASCenSlon**

The purpose of the ASCenSlon 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 ASCenSlon 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

Université libre de Bruxelles (ULB): 4 scientific Nobel Prizes, 1 Fields Medal, 3 Wolf Prizes and 2 Marie Curie Prizes are evidence of the University's longstanding tradition of excellence. ULB is an active member of the Research Area and is involved in almost 130 projects financed by FP7. Over the past few years, it has obtained 7 starting Grants from the ERC and 2 Advanced Grant. ULB has 12 faculties that cover all the disciplines, closely combining academic input and research. It offers almost 40 undergraduate programmes and 250 graduate programmes (among them 15 Masters fully taught in English). It also collaborates with 20 Doctoral schools, with almost 1,600 PhD in progress. One of ULB’s main aims is to give its students a solid foundation in critical thinking and a taste for research, while at the same time catering to the needs of new publics. ULB-ATM is specialized in low cost and reusable space access, through activities with ESA-ESTEC, NASA, EC FP programmes, Belgium-funded research activities and PhD research grants.
ULB-ATM developed expertise in the field of design and experimental testing of hybrid rocket engines that will be put forward and further developed in the ASCenSlon project. The research team at ULB-ATM comprises about 35 PhD students and post-doc researchers plus 7 technicians. (http://www.ulb.ac.be/ulb/presentation/uk.html)

**Your PhD project**

The PhD student at ULB will work on the further development of hybrid rocket engine (HRE) performance data bases, mainly based on experimental test data. One set of test data will certainly be obtained from the ULB HRE running on N20 oxidizer and paraffin fuel without or with doping particles, as well as from exchanges with ONERA Toulouse and their own experiments. The experimental facility of ULB will be used for these tests and probably further instrumented and improved on its data acquisition and visualization sides. Conference and journal paper publication will be requested during this PhD project.

**Problem Definition**

HREs could replace existing bi-liquid engines for new applications such as nano-launchers or orbital insertion of multiple payloads in various orbits as HREs offer much lower costs and large throttle ability. Drawbacks are related to the difficult to control oxidizer to fuel ratio during operation and to the residual inert mass.

**Research Objectives**

1. Improve in situ measurements of the regression rate using the two existing test facilities (one with optical access) of ULB-ATM
2. Development of the experimental data base obtained using various injection heads / systems
3. Generate validated experimental data for HRE using N20 as an oxidizer and paraffin or polyethylene as a fuel in support of the numerical simulation activities of ESR8

**Expected Results**

1. Validated and instrumented test facilities for sea level operated complete HREs
2. A robust technology to measure in situ the high regression rate of the fuel in these HREs
3. A database of validated experimental results with paraffin-fuelled HREs
4. Performance data restitution of all HRE experiments by performing the corresponding 1D computations at ONERA with ESR8

**Secondments**

Two secondments are foreseen to:

1. **ONERA Toulouse (France)**, for a duration of about 4 months during the 2nd year of PhD, to work on the restitution of the experimental data using 1D modelling code
2. **SpaceForest (Gdynia Poland)**, for a duration of about 3 months during the 1st year of PhD, for the design and operation of test facilities, and for a duration of about 3 months during the 3rd year of PhD, for comparative tests.