

**Location :** ISAE SUPAERO, Toulouse, France

**Department :** DMSM (Mécanique des Structures et Matériaux)

**Supervisor :** Yulia AKISHEVA, Yves GOURINAT

**Email :** [yulia.akisheva@isae-supaeero.fr](mailto:yulia.akisheva@isae-supaeero.fr) , [yves.gourinat@isae-supaeero.fr](mailto:yves.gourinat@isae-supaeero.fr)

## OFFER DESCRIPTION

**Title:** Thermal analysis of astronaut habitats made of lunar regolith

**Proposed duration and period:** 6 months, starting date in March/April 2023

### Context

All major space agencies are invested to support humanity's return to the surface of the Moon. For instance, the European Space Agency (ESA) is developing their Moon Village concept where sustainable exploration is largely based on in-situ resource utilisation (ISRU). The prime candidate for ISRU on the Moon is regolith, or the lunar soil. It is abundant and relatively easily accessible on the surface, thus becoming the perfect source of raw materials. One key utilisation of regolith is for habitat construction. Regolith can make up the bulk of a habitat structure, ultimately becoming the main load-carrier material as well as the radiation, thermal and micrometeoritic shield.

Within this context, ISAE-SUPAERO together with ESA and TRAD Tests & Radiations support the PhD project PURPLE: Protective Use of Regolith for Planetary and Lunar Exploration. PURPLE primarily focuses on radiation protection of astronauts inside lunar habitats, and aims to recommend the best use of regolith for this purpose. Additional materials that would be brought from Earth are also considered.

The best habitat wall design(s) will also be studied thermally. That is where this internship will support PURPLE. The aim is to assess thermal properties of the proposed design and ensure an ambient temperature inside, considering the environmental boundary conditions as well as the indoor heat sources. A preliminary study assessing thermal insulation properties of lunar regolith has already been performed (using MATLAB). The next steps, realised through this internship, will dive deeper into the thermal analysis of the proposed habitat wall, including materials other than regolith.

### Objectives and work

Your mission will be to:

- Make a simple 3D model of a hemispheric lunar habitat consisting of several layers of materials, mainly lunar regolith
- Perform a steady-state thermal analysis for the cases of the lunar day and the lunar night
- Perform a transient heat thermal analysis for the change in outside temperature between the lunar day and night
- Provide engineering recommendations for climate control inside the habitat (considering thermal insulation, ventilation and heat recovery)
- Conclude on the thermal properties of the selected habitat wall design

**Possibility to continue with a PhD (Yes/No) :** No

## REQUIRED APPLICANT PROFILE AND SKILLS

<b>Study level</b>	<input type="checkbox"/> Undergraduate students (3 <sup>rd</sup> or 4 <sup>th</sup> year) <input checked="" type="checkbox"/> Master students (1 <sup>st</sup> or 2 <sup>nd</sup> year) <input type="checkbox"/> PhD students
<b>Required profile and skills</b>	<p>You are a student in the last year of a MSc in Aerospace or Mechanical Engineering and you have the following qualities:</p> <ul style="list-style-type: none"> <li>• You have an extensive knowledge in the sciences of materials and structures</li> <li>• You are familiarized with the space environment or are willing to learn</li> <li>• You are familiarized with the FE Method</li> <li>• You are familiarized with ANSYS or another software to perform thermal analysis</li> <li>• <b>Languages:</b> Advanced English and/or French</li> </ul>
<b>Other useful information</b>	<p>Gratification is around 600 €/month depending on working days.  Do not hesitate to contact us!</p>