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**Internship opportunity**

**Title**: Flame spread over cylindrical samples in microgravity: mapping soot temperature and concentration.

**Terms**: Applicants should be motivated individuals and pursue a graduate degree in Mechanical Engineering and/or Physics.
The position is expected to start from Spring 2016 and will last 4/6 months.
The monthly allowance is 450€.

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**Topic context:** The main objective that drives the current projects dealing with fire safety for manned spacecraft is to create a comprehensive data set to enable a suitable paradigm for fire safety in spacecraft and space infrastructure. To face this challenge within the context of the future manned mission to Mars, a topical team gathering experts from NASA, CNES, JAXA, ESA, and ROSCOSMOS, has started working on the definition of a complete series of demonstration and validation experiments.[1] These experiments must capture the fundamental science of ignition, spread and extinction of a flame in both normal and microgravity and enable demonstration of the fire sensing and growth prediction tool that will be developed along the project. The experimental investigation aims for a final validation data set gathered in-situ through a series of large-scale experiments that are being designed for the Cygnus Spacecraft together with those that will be delivered onboard the International Space Station (ISS) in 2017.
In the absence of gravity, radiative heat transfer plays a major role in the spread of a fire. As a result, understanding the production of soot, whose spectrum dominates the radiative properties of such a fire, is crucial.[2]

**Scientific objectives**: The specific internship objective is to develop an optical diagnostics that will allow the soot temperature and concentration to be mapped along the spread of a flame established over the coating of electrical wires. This diagnostics is to be boarded in parabolic flights. Although no parabolic flights are scheduled within the period of the internship, the student will contribute to set up the optical arrangement inside the rig on ground (mechanical setup and calibration), develop the processing of the imaging, and validate the methodology. This methodology will be applied on flame spread at normal gravity. The fields obtained will be contrasted with those obtained later on in microgravity.

**Expected progress:** The student will join a team of experimentalists at Institut Jean le Rond d'Alembert (Sorbonne Université, Saint Cyr l'Ecole campus). The experimental core of this work is a rig that has been developed at Institut d'Alembert.[3] It especially enables the study of flame spread over cylindrical wires both on ground and onboard the Airbus ZeroG. The student will have to develop the optical diagnostics and conduct experiments at normal gravity. The student will work on an innovative technique to include a more powerful camera in the current setup, and hence get access to more information about the flames studied. This will require a focus on both hardware and software.

**References:**
[1] G. Jomaas, J.L. Torero, C. Eigenbrod, J. Niehaus, S.L. Olson, P.V. Ferkul, G. Legros, C. Fernandez-Pello, A.J. Cowlard, S. Rouvreau, N.N. Smirnov, O. Fujita, J.S. T'ien, G.A. Ruff, and D.L. Urban. Fire Safety in Space - Beyond Flammability Testing of Small Samples, *Acta Astronautica* **109**, p.208-216, 2015.
[2] G. Legros, J.L. Torero, Phenomenological model of soot production inside a non-buoyant laminar diffusion flame, *Proc. Combust. Inst.* **35**, p.2545-2553, 2015.
[3] See the story of the Sorbonne Université's rig's 1st parabola perfomed in October 2014: http://www.dalembert.upmc.fr/home/legros/index.php/component/content/article/14-articles-exemples/75-flame-propagation-in-microgravity-small-scale-experiments