Proposal of topic of thesis 2016

Title of the topic	Control of fire spread in spacecraft: role of ambient conditions
CNES responsible of the topic	Christophe Delaroche
Host laboratory	Institut Jean le Rond d'Alembert (Université Pierre-et-Marie Curie-Paris6 / CNRS UMR 7190)
Responsible in the laboratory	Guillaume Legros guillaume.legros@upmc.fr
Financial partner	UPMC or CNRS
Profile of applicant	Engineer in Mechanics/Energetics
Short description of the topic : context of the spatial experience, applied methodology, expected results.	For several decades, many sound scientific works on fire growth and the movement of smoke and heat have been providing the engineers with the information and tools that are necessary in the design of fire detection and the definition of the subsequent procedures. However, due to the specific conditions encountered in spacecraft, the usual tools for normal gravity fire detection design needs to be at least assessed into realistic space conditions and probably modified according to the discrepancies among detection thresholds in 1g and 0g, that could lead to unappropriate procedures, then disasters, following a misdetection -or a non-detection- in microgravity. Along the Ph.D., the student will investigate flame spread over small cylindrical samples in microgravity. The experiments will take place on board the Novespace zeroG airplane. The experimental rig developped at UPMC allows for these experiments. The student will especially focus on setting detection systems that deliver relevant inputs to a fire spread control device. A specific attention will be paid to the control of the ambient atmosphere conditions (chemical composition, flow). These conditions are especially expected to deliver means of soot production control. Soot has been shown to play a key role into the radiative heat transfer which governs fire spread in the absence of buoyancy. A numerical study will be performed in order to complete the experimental analysis. The student will use an existing numerical tool developed at IUSTI (CNRS UMR 7343, Marseille, France) by Jean-Louis Consalvi and his co-workers. This code is well designed to model soot production and radiative heat transfer in microgravity laminar diffusion flames. It solves the elliptic governing equations in a low Mach formulation using the finite volume method, considers detailed gas-phase chemistry and complex thermal and transport properties, and the soot production is computed by an advanced PAH-based soot model. Radiative heat transfer is calculated using the Finite Volume Method coupled with the Full-Spectrum Correlated-k method to determine the radiative properties of the participating species. This Ph.D. is expected to contribute to the international project "Spacecraft Fire Safety Demonstration" lead by JAXA in close collaboration with European, American, and Russian partners. Within the framework of this project, experiments are scheduled in the japanese KIBO module onboard the International Space Station (ISS) in 2017.