Training Opportunity for Portuguese Trainees

Reference	Title	Duty Station
PT-2017-TEC-QTC	MEMS & MEMS Advanced Manufacturing for space applications	ESTEC

Overview of the unit's mission:

The ESA Component Technology section covers Electrical, Electronic and Electromechanical (EEE) components Technology with focus on components development, reliability assessment, industrialisation and is responsible for the technical management of materials and components space evaluation & qualification. The work proposed by this trainee opportunity will offer involvement in the different tasks just afore mentioned and will typically involve activities such as:

- Technology trend analysis, literature surveys, specification development
- Component test and test data analysis including environmental testing
- Development of test hardware and/or software for electrical and functional characterisation
- Reverse engineering and EEE parts physical analysis under adequate monitoring
- Device modelling and simulation (failure modes, physic of failure)
- Support to Radiation test of EEE Components on-site and at external test facilities;

The specific EEE technology domain covered by this opportunity supports the Miniaturisation of space systems and sub-systems and include the following component families:

MEMS: RF, AOCS, MOEMS, micropropulsion, pressure sensors, etc but also MEMS packaging & stacking. **Advanced manufacturing** techniques such as for example 3D printing when applied to miniaturisation and MEMS prototyping are also covered by the section
Nanotechnologies: CNTs and their application in space: thermal, mechanical, electrical and radiation;
While also approaching:
VLSI technologies: FPGA, ASIC, Memory devices, etc including Deep Sub Micron Technologies
Hybrid circuit and technologies: thick and thin films and Packaging techniques

Overview of the field of activity proposed:

The Trainee opportunity will include 2 major tasks to be performed in parallel:

1) Support to Portuguese Industry: space evaluation of a MEMS Magnetometer (Technology Pull)
2) MEMS advanced manufacturing for space application (Technology Push)

Task 1: Support to Portuguese Industry: space evaluation of a MEMS Magnetometer

Over the last 3 years, the Portuguese Company Lusospace based in Lisbon has initiated the development of a MEMS Magnetometer (MMG project) in collaboration with the university of Minho. The project is reaching maturity and the MEMS magnetometer chips have been validated and accepted with respect to their performance at room temperature.
This milestone being achieved, it is now time to access the reliability of the MEMS Magnetometer in representative space environment.
The trainee will therefore be in charge of:

- Define the functional and reliability testing to be performed to assess suitability of the MEMS chip magnetometer with respect to radiation (support the radiation testing of the MMG on-site and at external test facilities), temperature cycling, mechanical shocks and vibrations, temperature storage, long life operation (up to 17 years), outgassing, etc
- Performance of physical analysis will also be required on a number of samples.
- Performance of components space evaluation by executing the above defined test plans.
- Performance of failure analysis of MEMS Magnetometer which degraded during the evaluation

Considering that the MEMS magnetometer has been validated using discrete electronic, ESA and Lusospace are planning to engage on the development of the associated ASIC development and the trainee will also support the design and prototyping of the command and control ASIC by industry

For that Task 1, environmental test facilities present at ESA such as Thermal Cycling, mechanical shock and vibration, humidity as well as Co60 radiation facilities will be used by the Portuguese Trainee. The student will also perform the associated failure analysis of the MEMS that degraded during space evaluation testing; as part

of that the student will become familiar with SEM, FIB, SAM, Profilometers, etc available at ESA .

This Task will be performed in full collaboration with Lusospace and Minho (the MMG project manager at Lusospace being himself a former Portuguese Trainee at ESA)

Task 2: MEMS advanced manufacturing for space application

The baseline thematic of this task will be to look at the advantages and possibilities to use additive (micro) manufacturing to produce MEMS devices for space applications.

Today MEMS are essentially produced from Bulk or Surface micromachining techniques but when using those techniques for space, processes are always costly and usually complexed, long to establish and difficult to qualify for space applications. The activity to be undertaken here will consist in looking at the potential of additive manufacturing to fabricate new alternative MEMS devices. At that stage , first reports coming from US show that a company like MICROFABRICA located in Califiornia has been capable to use additive manufacturing process that yields complex metal structures and assemblies at a scale not previously possible for batch fabrication of sub-millimetric tools and devices with inner mobile parts, by electrochemical (EFAB) additive manufacturing. The Portuguese trainee will therefore has to survey the usage of additive manufacturing to build 3D MEMS object. In particular those techniques available at MICROFABRICA US may not be available from European suppliers in a one to one approach but it is established that other equivalent additive manufacturing techniques should be available from major European Technology Center (IMEC, LIST., EPFL, IAF, LETI, VTT etc) and the student will be in charge of investigating those European AM techniques. Those techniques are usually published or advertised when associated with Metal MEMS fabrication so the trainee will also have to look at the potential of such type of MEMS for space applications: advantages and drawbacks, potential suppliers, etc, It is then expected that the trainee will work on establishing cooperation with European AM centres capable of providing such services and possibilities for early prototyping and testing will be investigated.

As such the trainee will be expected to procure AM MEMS samples and to submit them to typical space environment conditions, meaning that practical work such as radiation testing, temperature life test, thermal cycling , vacuum tests and others will have to be performed.

Depending on the outcomes of the European Processing capabilities, it is not excluded that the trainee could actively participate to the AM MEMS fabrication activities in case the European supplier like those listed previously has already cooperation agreement with ESA.

Deliverables for Tasks 1 and 2;

Final report and Final presentation at completion of the training in presence of industry.

Required education:

Applicants should have completed their University course at Masters Level (or equivalent) in Electrical Engineering or Electronics with one or more of the following specialisations: Semiconductor Technology, Micro-electronics, MNT, Test Engineering, Process Engineering related to EEE Ideally, applicants should also demonstrate a minimum of experience with laboratory activities in terms of device environmental as well as some knowledge of major failure mechanisms for MEMS components.

Applicants should have good interpersonal and communication skills and should be able to work in a multi-cultural environment, both independently and as part of a team.

Applicants must be fluent in English and/or French, the working languages of the Agency. A good proficiency in English is required.