Training Opportunity for Swiss Trainees

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<td>CH-2017-TEC-EDC</td>
<td>MEMS &amp; Advanced Additive Manufacturing</td>
<td>ESTEC</td>
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Overview of the unit’s mission:
The ESA Components Section primarily covers Electrical, Electronic and Electromechanical (EEE) components Technology and in particular components development, reliability assessment, industrialisation. The section is also responsible for the technical management of components space evaluation qualification.

Examples of specific EEE components and technologies covered by the technology domain are:
- MEMS: RF, AOCS, MOEMS, micropropulsion, pressure sensors, etc but also MEMS packaging & stacking;
- Advanced manufacturing: 3D printing, EFAB, etc applied to EEE components
- Nanotechnologies: CNTs and their potential application in space: thermal, mechanical, electrical and radiation;
- Optoelectronics: laser diodes, optocouplers, CCDs, APS, etc;
- DeepSub Micron Technologies (65 nm and below);
- VLSI technologies: FPGA, ASIC, Memory devices, etc;
- Analogue electronics: op-amps, comparators, etc;
- Passive including Oscillators and Piezo actuator elements;
- Microwave Components/ Technologies discrete and MMIC devices: GaAs, GaN, SiC, SiGe, etc.
- Hybrid circuit and technologies: thick and thin films

The work proposed in this Training Opportunity will take place within the Components Section and will involve typical activities as listed below:

- Component test and test data analysis including environmental testing;
- Design and development of test hardware and/or software for electrical and functional characterisation;
- Technology trend analysis, literature surveys, specification development;
- 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;

Overview of the field of activity proposed:
The baseline thematic of this Swiss trainee opportunity will be of two fully complementary routes expected to be tackled in parallel during the training period:

a) Standard MEMS space evaluation addressing existing MEMS intended for space
b) Innovative approach consisting in exploring state of the art additive (micro) manufacturing technique such as for example ECPR (Electro Chemical Pattern Replication) for the production space MEMS sensors

More details about those two routes are provided below:

a) Standard MEMS space evaluation addressing existing MEMS intended for space
ESA is today engaged in several MEMS development for space applications. Two of them are of particular interest wrt this opportunity as the MEMS suppliers are both located in Neuchatel (CH) namely Sercalo for the production of 2D MEMS Mirrors and CSEM for the development of SiC MEMS pressure sensors. In both cases MEMS samples should be made available to ESA and the Swiss trainee will be asked to perform initial space evaluation of the two types of samples including:

- Definition of the functional and reliability testing to be performed to assess suitability of the MEMS sensors, 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 the 2 types of sensor space evaluation by executing the above defined test plans.
- Performance of failure analysis of MEMS Sensors which degraded during the evaluation
b) State of the art advanced additive (micro) manufacturing techniques for space MEMS sensors

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 advanced additive manufacturing to fabricate new alternative MEMS devices. At that stage, first reports coming from US show that a company like MICROFABRICA located in California 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 Swiss 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 but it is believed that other equivalent advanced 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. In particular, 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 advanced AM centers capable of providing such services and possibilities for early prototyping and testing will be investigated. Very early investigations at ESA performed by a Swiss Stagiaire from EPFL show that a simple structure like a switch beam cantilever may be a simple but efficient test vehicle to assess the suitability of Advanced Additive Manufacturing for producing space MEMS sensors.

The Swiss trainee will therefore be expected to procure advanced AM MEMS sensors and to have a detail analysis of the fabricated devices by usage of state of the art engineering techniques such as SEM, FIB, AUGER, etc and in a following step 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 by the candidate once familiar with the relevant standards.

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

Deliverables:

Final report and Final presentation on each of the 2 routes followed during the trainingat completion of the training in presence of industry, SSO and SSC

Required education:

Applicants should have just completed, or be in their final year of a 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, Advanced Manufacturing, Test Engineering, Process Engineering related to EEE. Ideally, applicants should also demonstrate a minimum of experience with laboratory activities in terms of device environmental testing as well as some knowledge of EEE components failure analysis techniques.

Applicants should have good interpersonal and communication skills and should be able to work in a multicultural 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.