



Marie Curie Doctoral position at:

- Mines Saint- Étienne - Université de Lyon (France)
- Fondazione Toscana Gabriele Monasterio per la Ricerca Medica e di Sanità Pubblica (Italy)
- PrediSurge – Saint-Étienne (France)

ESR10 - Tissue characterization and endovascular aortic repair in a circulatory mock loop

Keywords: biomechanics, Aneurysm; Patient-specific Models, Fluid-Structure Interaction, 3D printing, 1D modeling, In-vitro testing.

General framework: 14 Early Stage Researchers (ESRs) will be offered doctoral positions as part of the MeDiTATe project, which is funded through the H2020 program: Marie Skłodowska-Curie Actions (MSCA) Innovative Training Networks – European Industrial Doctorate. The whole MeDiTATe project aims to develop state-of-the-art image based medical Digital Twins of cardiovascular districts for a patient specific prevention and treatment of aneurysms. The individual research projects of each ESR within MeDiTATe are defined across five research tracks: (1) High fidelity CAE multi-physics simulation with RBF mesh morphing; (2) Real time interaction with the digital twin by Augmented Reality, Haptic Devices and Reduced Order Models; (3) HPC tools, including GPUs, and cloud-based paradigms for fast and automated CAE processing of clinical database; (4) Big Data management for population of patients imaging data and high fidelity CAE twins; (5) Additive Manufacturing of physical mock-up for surgical planning and training to gain a comprehensive Industry 4.0 approach in a clinical scenario.

The work of each ESR, hired for two 18 months periods (industry + research) and enrolled in a PhD programme, will be driven by the multi-disciplinary and multi-sectoral needs of a multi-disciplinary research consortium (clinical, academic and industrial) which will offer the expertise of Participants to provide scientific support, secondments and training. Recruited researchers will become active players of a strategic sector of the European medical and simulation industry and will face the industrial and research challenges daily faced by clinical experts, engineering analysts and simulation software technology developers.

During their postgraduate studies they will be trained by the whole consortium receiving a flexible and competitive skill-set designed to address a career at the cutting edge of technological innovation in healthcare. The main objective of MeDiTATe is the production of high-level scientists with a strong experience of integration across academic, industrial and clinical areas, able to apply their skills to real life scenarios and capable to introduce advanced and innovative digital twin concepts in the clinic and healthcare sectors.

Description of the ESR project: The aim of this ESR programme is to develop a mock loop for in-vitro testing and in-silico model for ascending thoracic aortic aneurysm treatment to (i) validate the endovascular procedure and (ii) to analyse the effect of endograft implant in the fluid-dynamic environment by CFD. For the achievement of the objectives, 4 phases of the research activities are planned: mechanical characterization of aneurysmatic vessel tissue for ascending thoracic aortic district, morphological assessment of patient specific models for aneurysms, in-vitro simulation of the surgical implant with fluid-dynamic characterization through the mock loop and in-silico simulation of the surgical implant. For the first phase an ex-vivo fresh specimen is gathered from patient undergoing selective surgical procedure according to the best clinical practice, then a mechanical characterization (uniaxial/biaxial traction tests) is achieved and experimental data extraction and fitting via constitutive model with particular attention to anisotropic behaviour is carried. The second phase foresees a patient-specific images and data extraction from clinical FTGM Database, image post-



processing and segmentation for morphology definition and additive manufacturing of patient-specific models (rigid in a first step and then compliant according to experimental data). For the third phase the simulation of the implant deployment is carried and the evaluation of the implant performances on the patient-specific model by extracting the resulting experimental data (pressures, flows, etc.) is achieved. Last phase is completed by carrying CFD Simulations before, after and during endograft deployment and validating and comparing numerical results with experimental data from in-vitro simulation.

Additional Information:

ESR10 will be enrolled in the PhD programme of University of Lyon at Mines Saint-Etienne, France. The PhD thesis will take place at 2 different places: (a) Fondazione Toscana Gabriele Monasterio per la Ricerca Medica e di Sanità Pubblica (Italy), public entity specialized in healthcare and research activities of interest to the public health services (for pediatric and adult patients) in the field of cardiology, cardio-surgery, electrophysiology and for the treatment of cardiopulmonary diseases. FTGM performs interventional hemodynamics, heart surgery for neonatal, pediatric and adult patients, anesthesia and intensive therapy for neonatal, pediatric, and adult patients, advanced diagnostic imaging: radiodiagnostics, nuclear medicine, cardiac magnetic resonance, and laboratory medicine; (b) Predisurge, Saint Étienne (France) which aims at developing software solutions to achieve better training, preoperative planning and intervention in the cardiovascular domain. Predisurge is a spin-off of Mines Saint-Etienne (France) and is based in the CIS department, which conducts major international research projects in the field of soft tissue biomechanics, in particular aortic aneurysms. ESR10 will collaborate with other researchers of CIS involved in ERC projects (<https://www.mines-stetienne.fr/en/author/avril/>, <https://www.emse.fr/~badel/>). A one-month secondment will take place at Università Degli Studi di Roma Tor Vergata (Italy).

Benefits, salary and duration:

The selected candidate will receive a salary in accordance with the MSCA regulations for ESR. The gross salary includes a living allowance (€3,270 per month, subject to MSCA country correction coefficient, i.e. 115.7% for France and 104.4 % for Italy), a mobility allowance (€600 per month), and a family allowance (€500 per month, if the researcher has family by the date of recruitment, regardless of whether the family will move with the researcher or not). The guaranteed funding is for 36 months (i.e. EC funding).

Eligibility criteria:

Applicants can be of any nationality and must hold a Master of Science degree (or equivalent) in engineering. They need to fully respect both eligibility criteria (to be demonstrated in the Europass CV): (a) Early-Stage Researchers (ESRs) must, at the date of recruitment by the beneficiary, be in the first four years (full-time equivalent research experience) of their research careers and have not been awarded a doctoral degree. (b) Conditions of international mobility of researchers: Researchers are required to undertake trans-national mobility (i.e. move from one country to another) when taking up the appointment. At the time of selection by the host organization, researchers must not have resided or carried out their main activity (work, studies, etc.) in France for more than 12 months in the 3 years immediately prior to their recruitment. Short stays, such as holidays, are not taken into account.

Candidate profile: Candidates with background in Computational and Experimental Fluid Mechanics should apply for this position. Motivation and interest in Computer Modeling, Biomedical engineering and Experimental Work is preferable. Excellent knowledge of written and spoken English is required.

How to apply: Send CV, cover letter, BSc and MSc degrees, and letters of recommendation to all the following recipients: avril@emse.fr, simona.celi@ftgm.it and david.perrin@predisurge.com.