Thesis Topics & Projects 2023
Biomech@DEIB
Th-lab

Th-Lab - Shear-mediated platelet biology

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Research group

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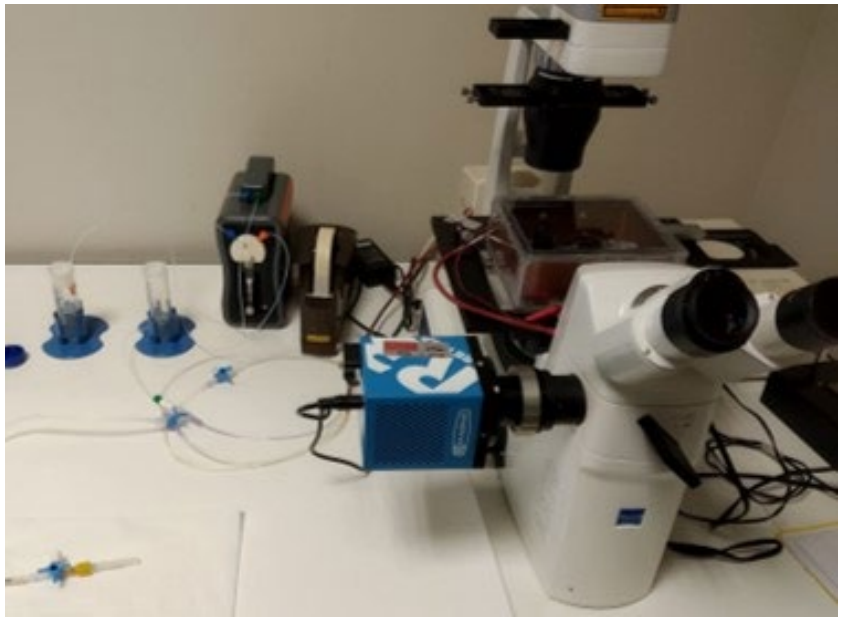
Research fellow

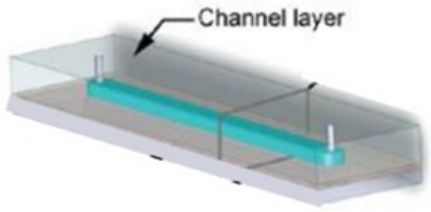
In-vitro microvascular model to study blood and endothelial cells interaction

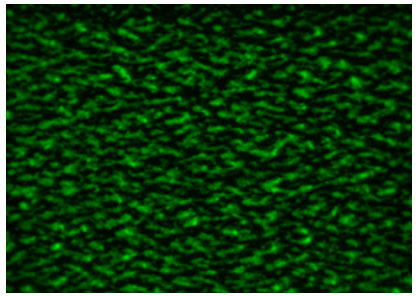
Fondazione IRCCS Ca' Granda Ospedale Maggiore Policlinico

Primary aims

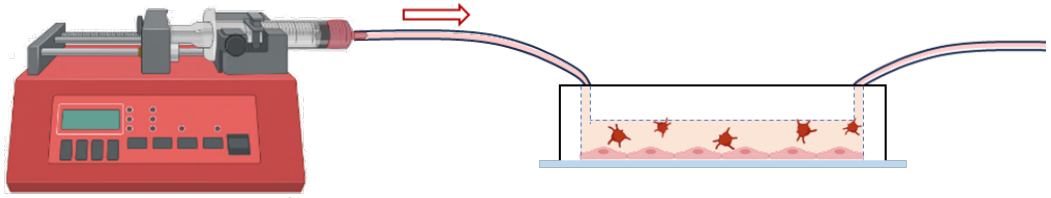
- Design and validation of a micro-vasculature model on-chip
- Study of platelet dysfunction in cyrrhotic patients and rare diseases (e.g. thrombocytopenic purpura)
- Add the cellular component: platelets-endothelial cells interaction

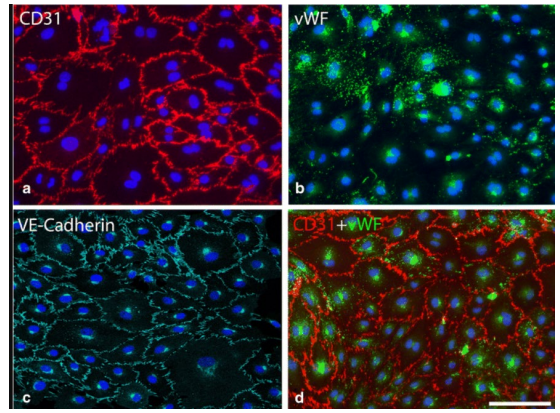






Fluorescence imaging (platelets)





Immunochemistry and immunofluorescence

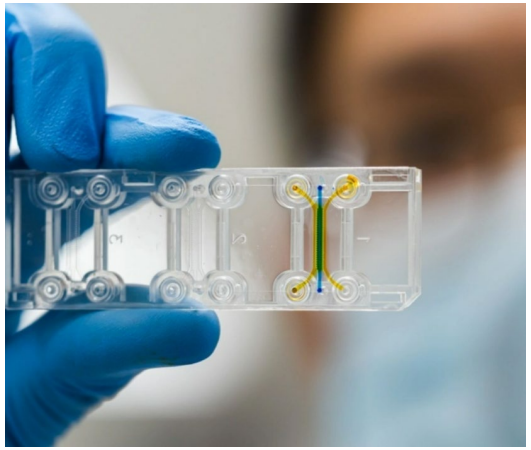
On-chip micro-vasculature for the study of the antiphospholipid syndrome (APS) and drug screening

ISTITUTO AUXOLOGICO ITALIANO
Istituto di ricovero e cura a carattere scientifico

Primary aims

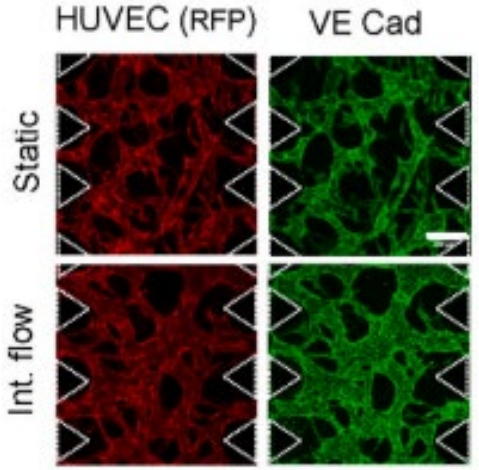
- Design and validation of a micro-vasculature model on-chip based on angiogenesis (endothelial cells + fibroblasts)
- Evaluation of the cellular responses to APS-autoantibodies to investigate the dynamics of the pathology
- Drug screening on an APS pathological endothelial model

PDMS Microfluidic chip production and design optimization

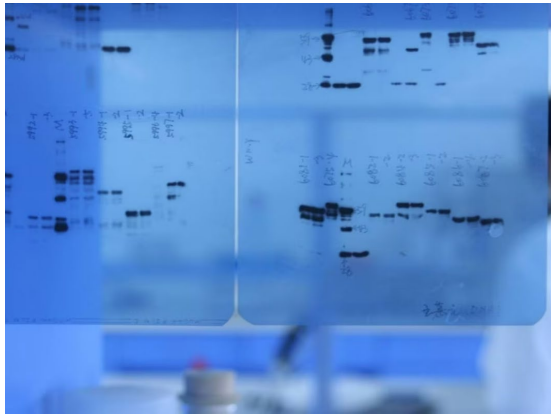


Cell cultures

Study of cellular responses



Immunochemistry and immunofluorescence

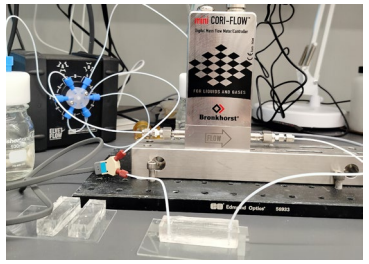


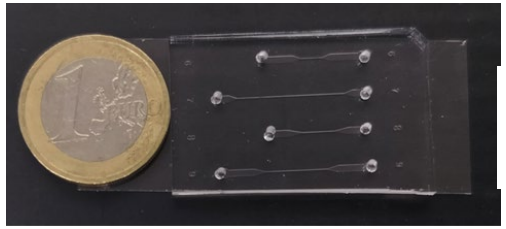
Western Blot

Microfluidic assessment of platelet dysfunction in the context of ventricular assist devices

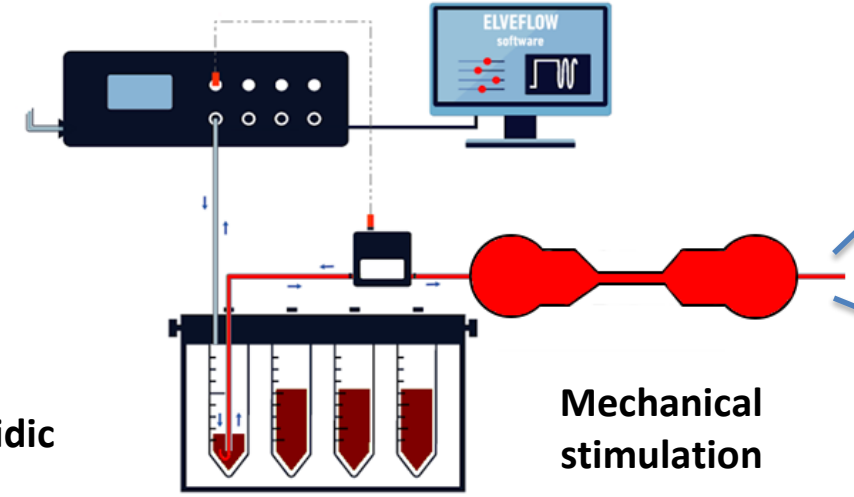
Actual project

- Design microchannels with specific values of stress accumulation (SA) and shear rate (SR)
- Define experimental protocol (T_{res} , flow rate, …)
- Quantifying platelet dysfunction by platelet morphology assessment and flow cytometry analysis

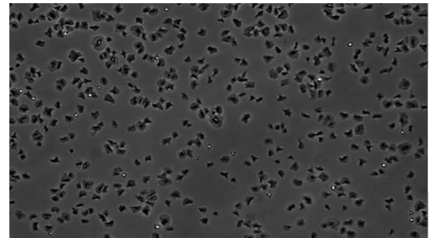




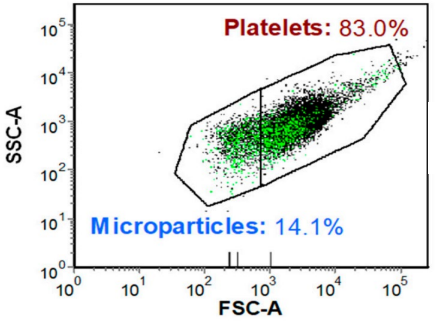
Microfluidic chip



Mechanical stimulation



Platelet morphology



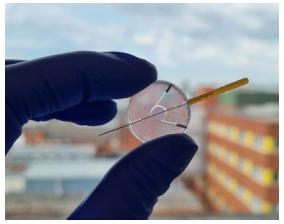
Flow cytometry

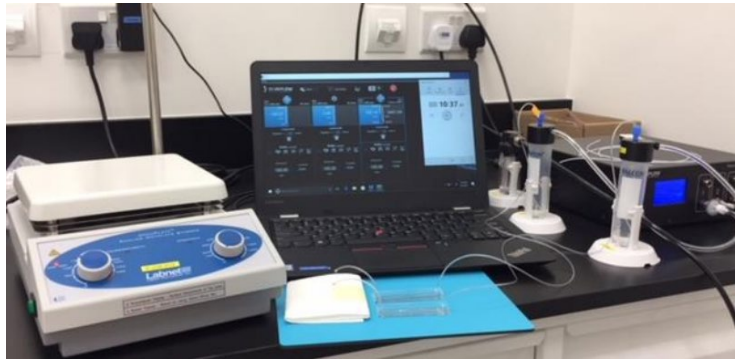
3D Perfusable vessel-on-chip

NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

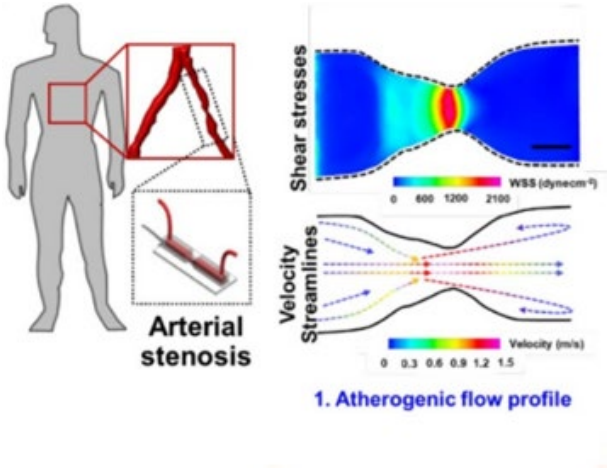
Actual project

- Comparison between circular and rectangular cross-section of the microchannels
- Evaluating platelets and leukocytes adhesion in an endothelialized stenotic channel with coating of different proteins

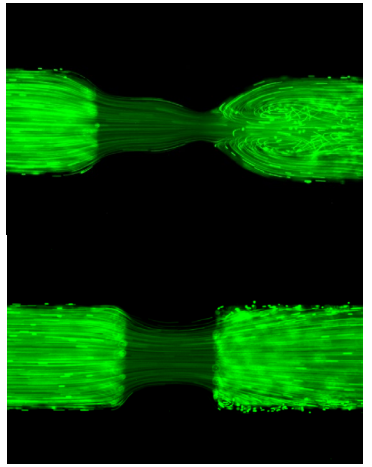




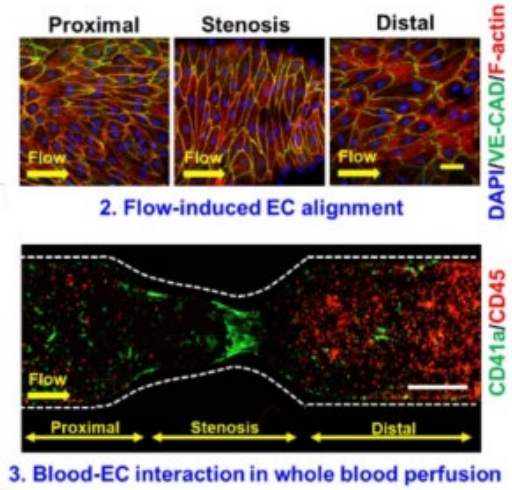
Experimental set-up



Stenosis-on-chip and blood flow disturbance



Beads perfusion

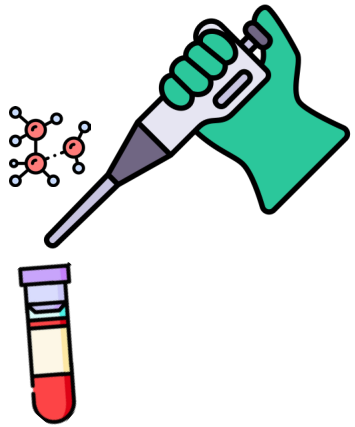


Platelets and leukocytes adhesion

Platelet stiffness

Actual project

- Chemotherapeutic drugs (inhibitors of cell division) --> effect on platelets
- Flow cytometry and AFM to evaluate platelet stiffness and activation markers variations after stimulation with chemotherapeutic drugs
- Test in microfluidic channels to evaluate platelet functionality in thrombus formation



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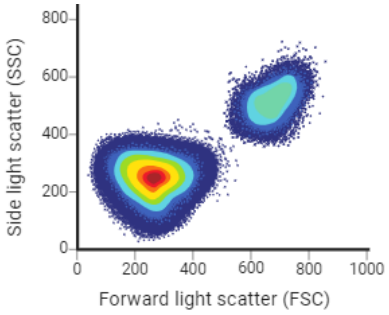
w cytometry



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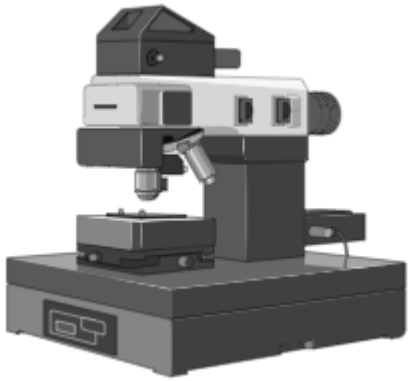

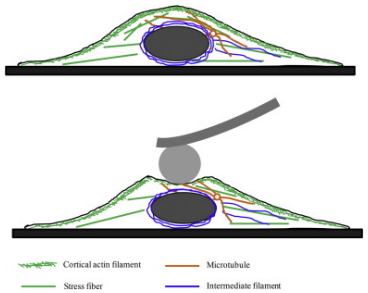

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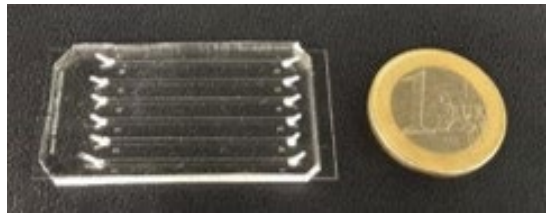
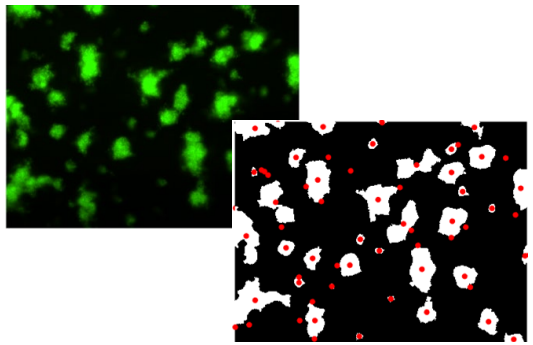
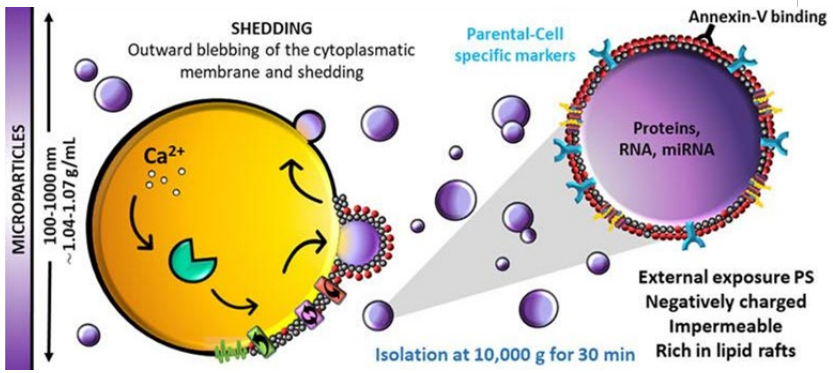


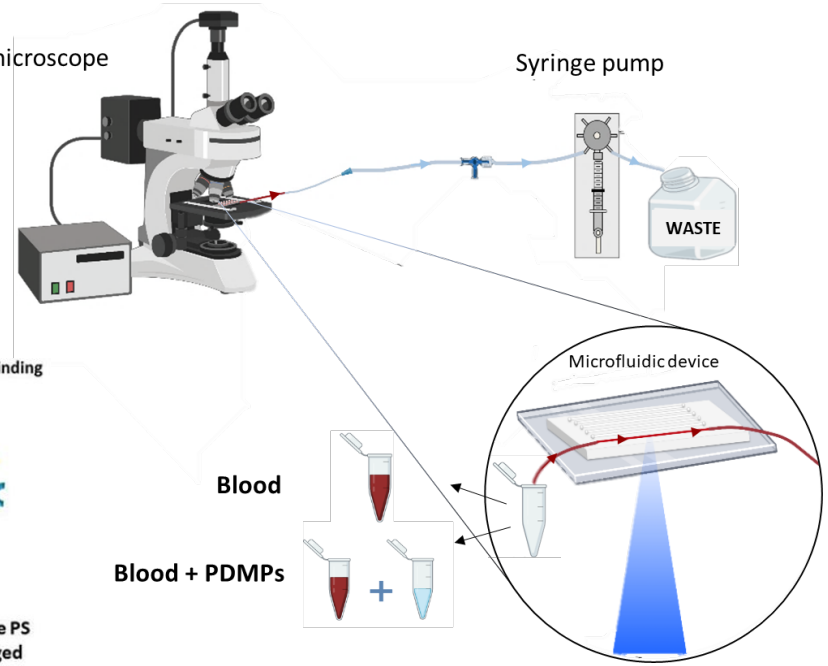


Platelet-derived microparticles (PMPs)

Past project

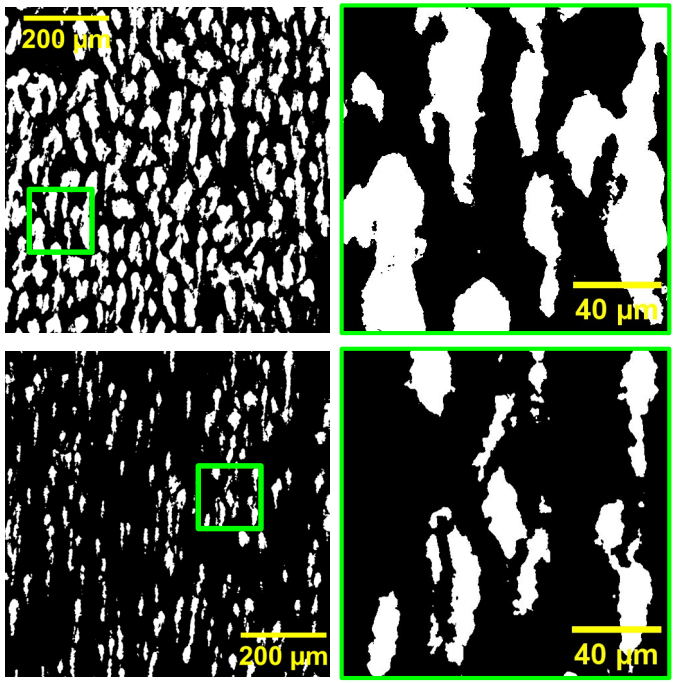
- Study of thrombus formation in flowing blood, on different protein substrates
- Investigate the effect of platelet-derived microparticles on thrombus formation
- Image analysis (Matlab, ImageJ)



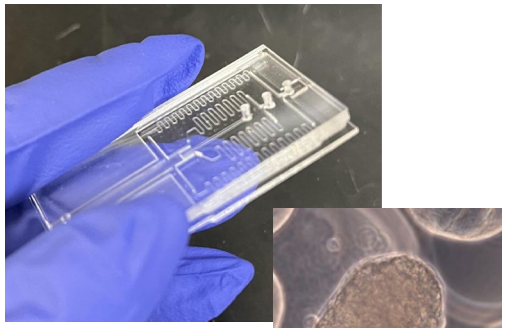


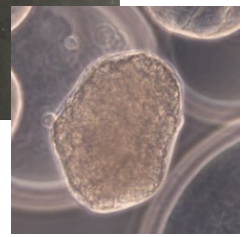
whole blood

whole blood + PMPs



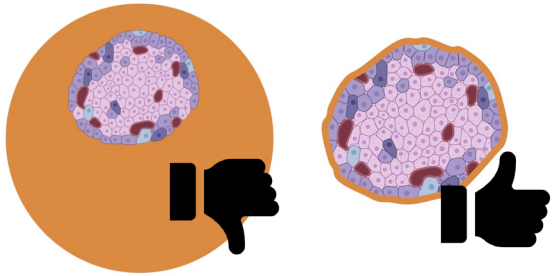
Conformal encapsulation of pancreatic islets and islet functionality assessment





Encapsulation may allow islets transplantation without immunosuppression

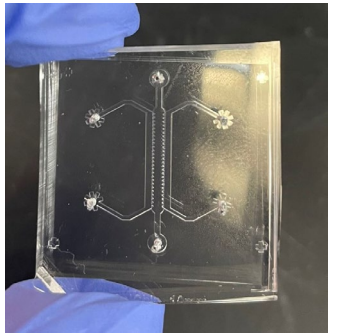
Microcapsules may have failed because of transport issues associated with capsule **size**

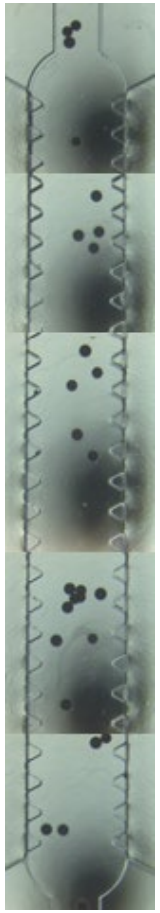


Conformal Coating encapsulation addresses all the transport issues associated with capsule size

Islets must be **functional**

Assessment of islets' functionality in a physiologically relevant microenvironment prior to the implantation





- = islet

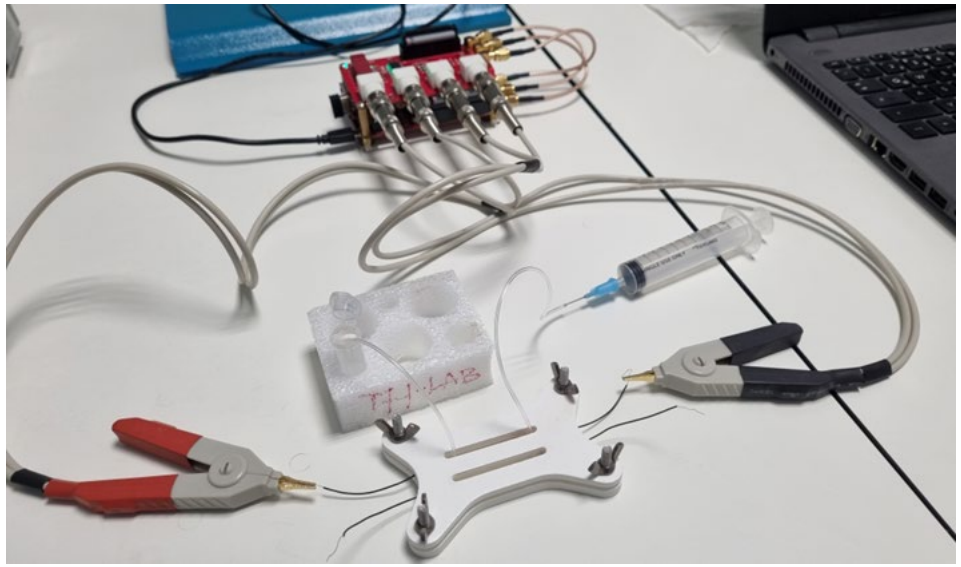
- CAD software (SolidWorks, autoCAD)
- Lab work (cell culture, flow loop, microscopy)

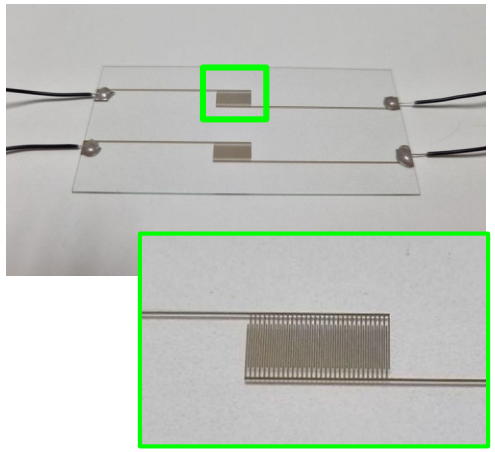
- Lab work (cell culture, gel prep)
- Lab assays (microscopy, FRAP, ELISA)

Real-time monitoring of platelet function

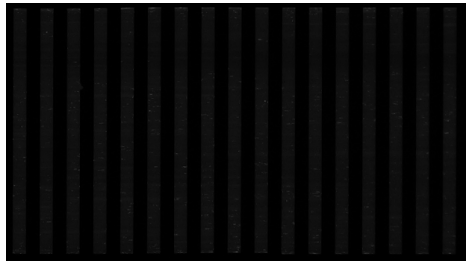
Actual project

- Investigate platelet aggregation in flow conditions
- Microfluidic channels equipped with surface electrodes: validation against fluorescence image analysis (standard)
- Stimulation with different ADP concentrations and flow rates





T = 0



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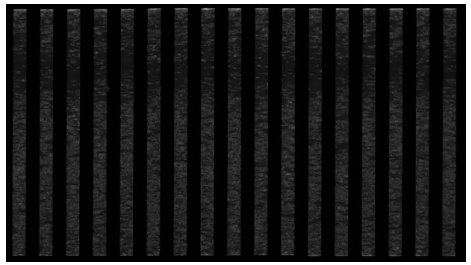

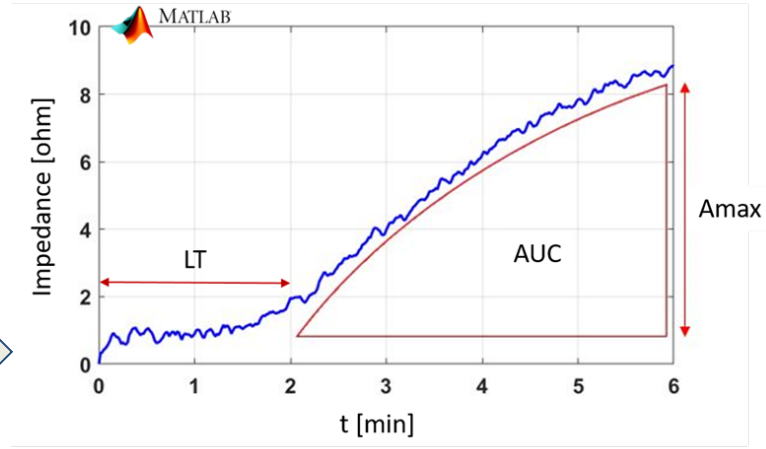

Active collaborations and thesis abroad