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UN JUMEAU NUMÉRIQUE DE L'AORTE CONTRE LA RUPTURE D'ANÉVRISME

STÉPHANE AVRIL

IMT Atlantique Bretagne-Pays de la Loire École Mines-Télécom
IMT Lille Douai École Mines-Télécom IMT-Université de Lille
IMT Mines Albi-Carmaux École Mines-Télécom
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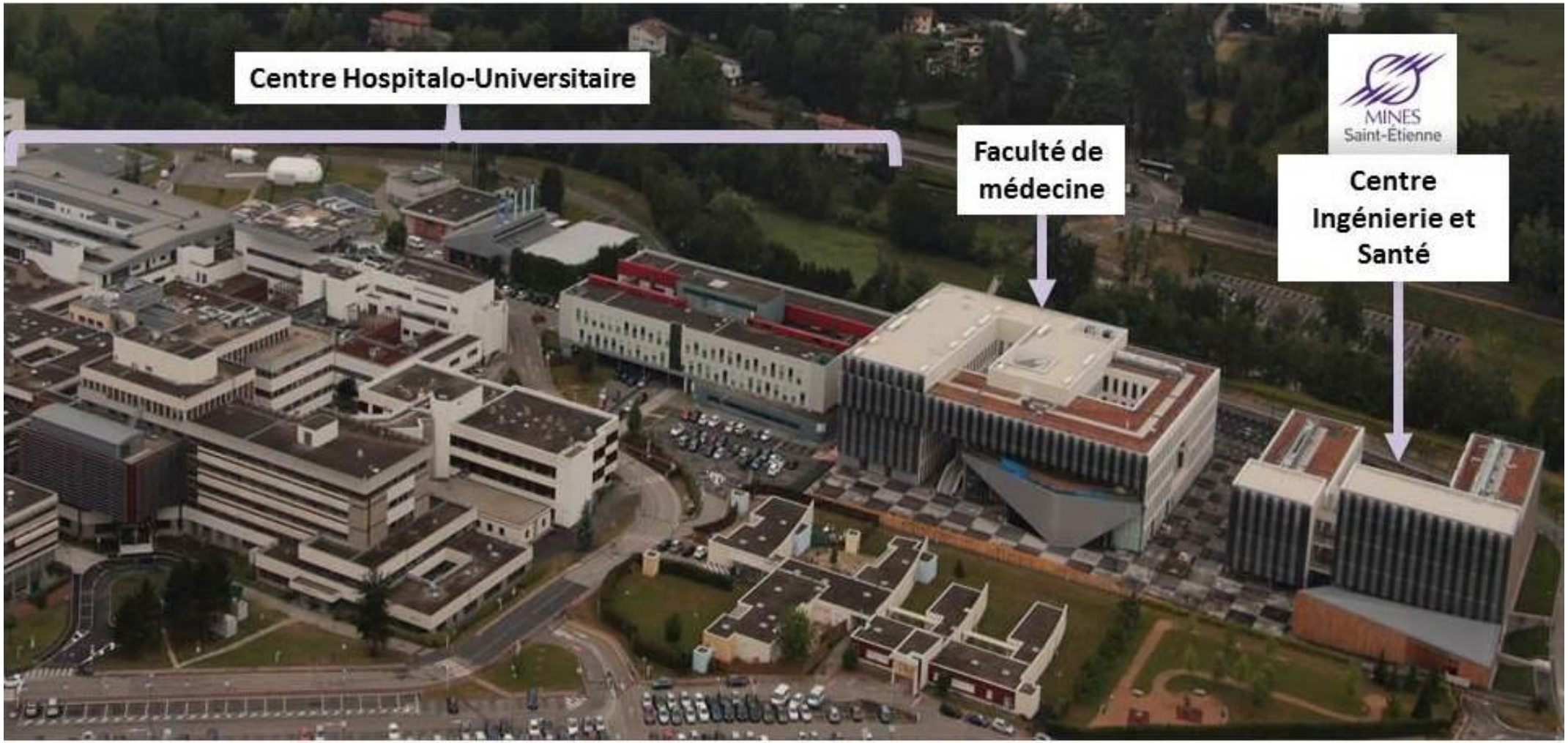
La recherche CARNOT pour l'innovation des entreprises

CENTRE INGÉNIERIE ET SANTÉ



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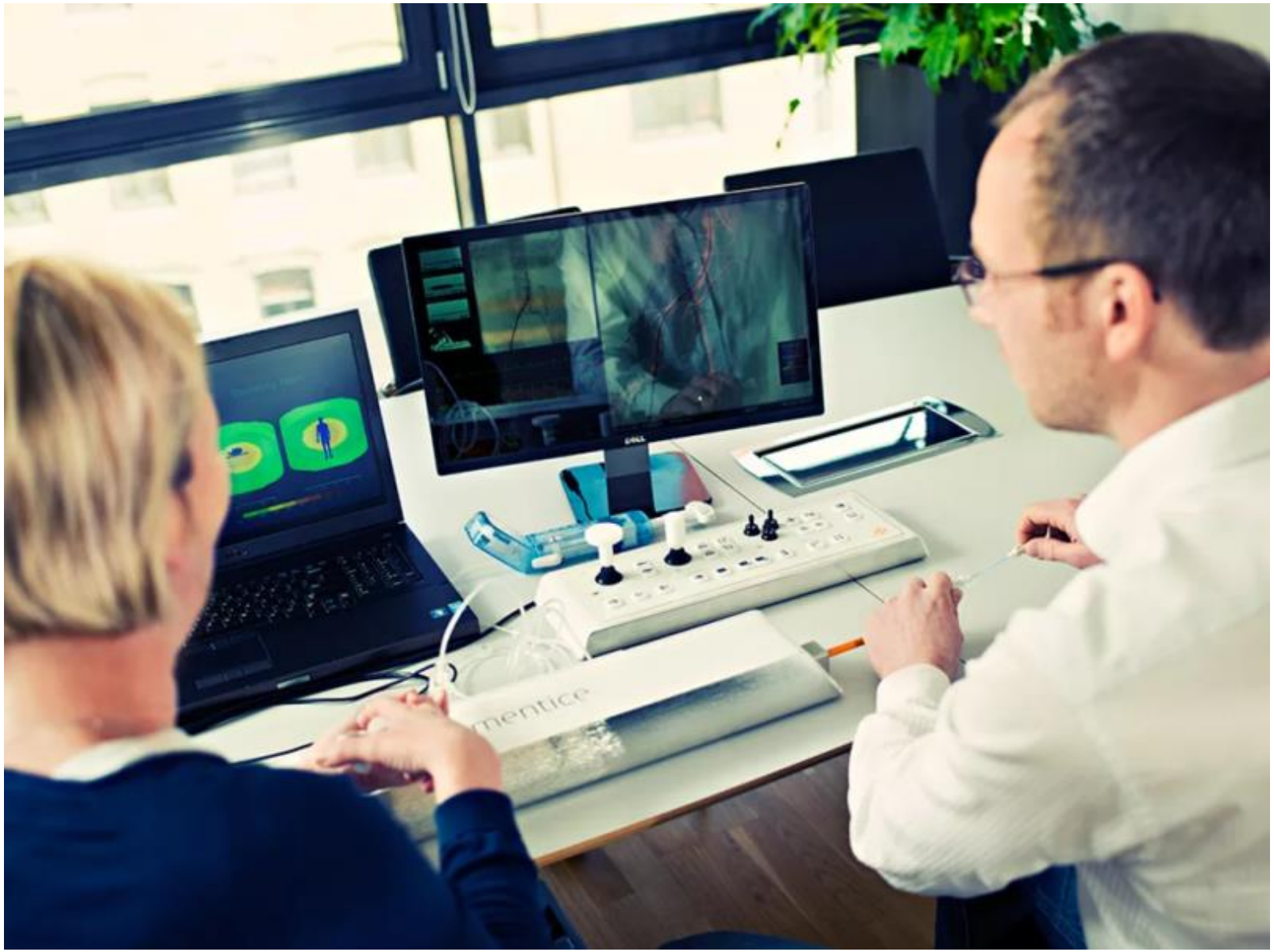
STRONG AND HISTORICAL COLLABORATIONS WITH CLINICIANS



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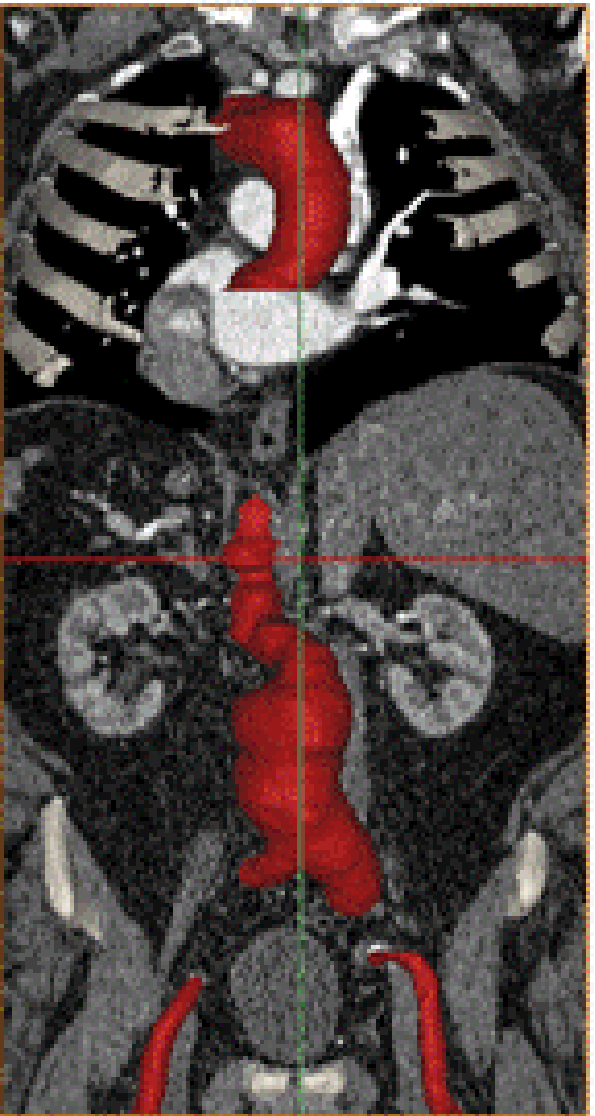
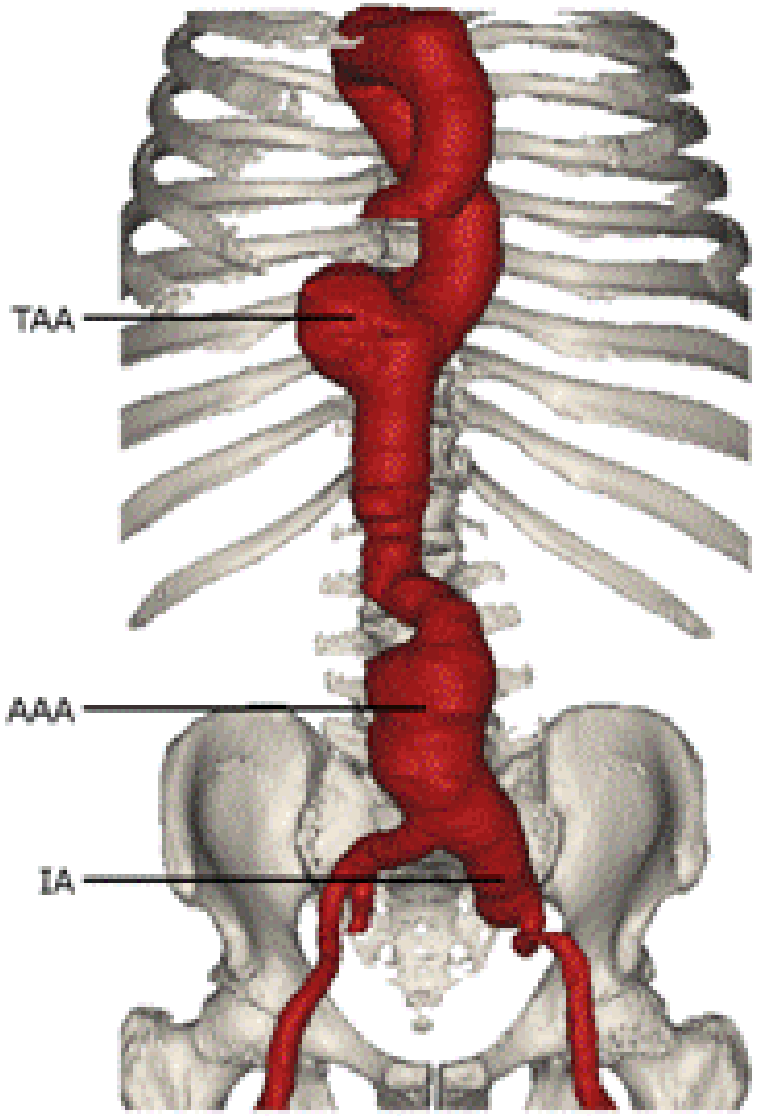
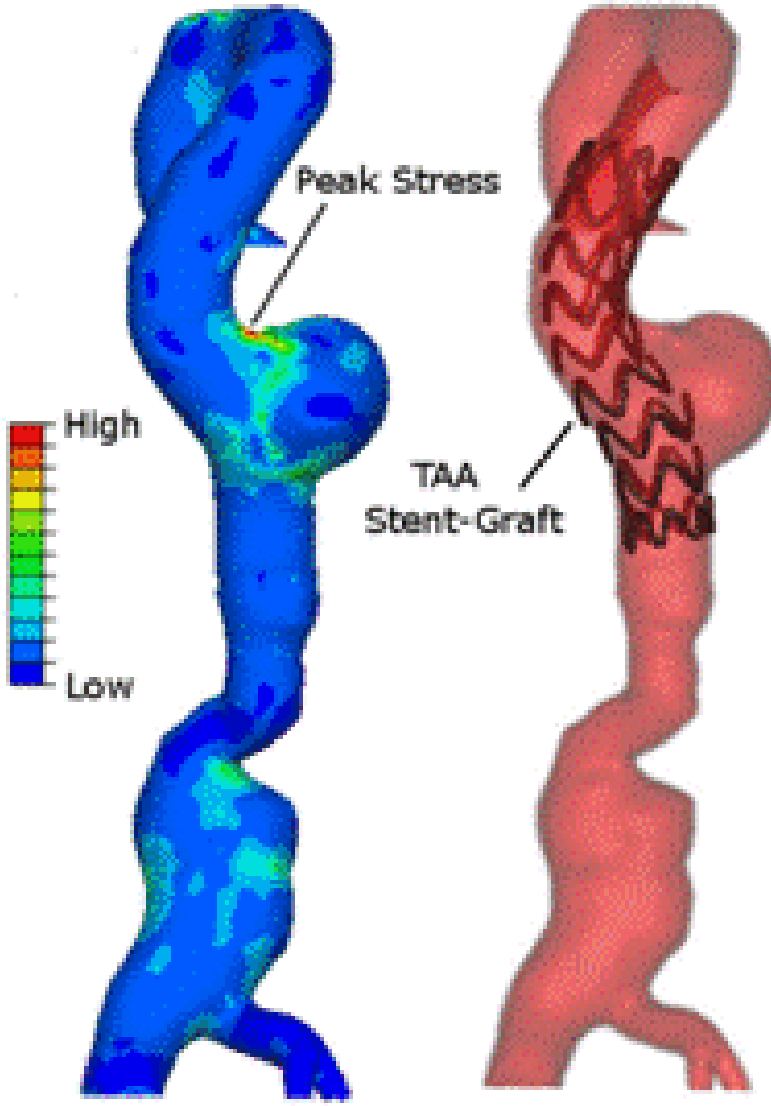
MINES Saint-Étienne
Une école de l'IMT

PrediSurge

The aortic lab







THE AORTIC LAB

Team of +20 researchers involving permanent faculty (biomechanics, vascular surgery), postdocs and PhD students.

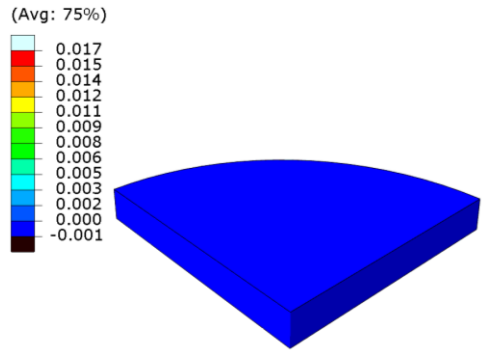
Financial support of the European Research Council (ERC) with grants of 3.5 million euros (ERC-2014-CoG BIOLOCHANICS and ERC-2014-StG AArteMIS).

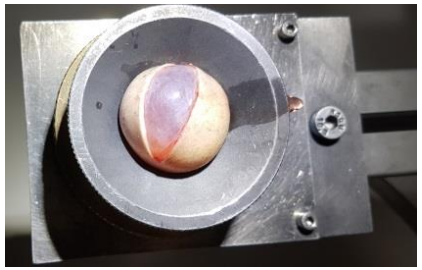
5 years project (2015-2020) which has the ambitious objective of predicting computationally the risk of rupture of aortic aneurysms for every patient.

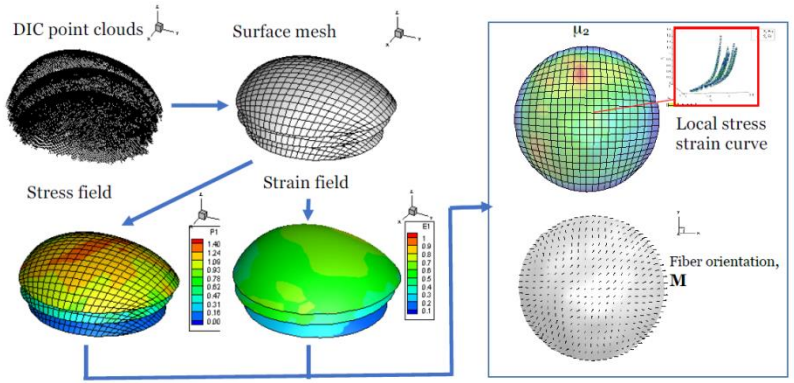
VISION OF AORTIC LAB

Our vision is that the mechanical properties, the strength, the wall stress of the aorta, and their evolutions during the growth of an aneurysm or after endovascular repair, can be predicted on a patient-specific basis by computational models.

We have been developing these computational models for 8 years and validating them on different cohorts.



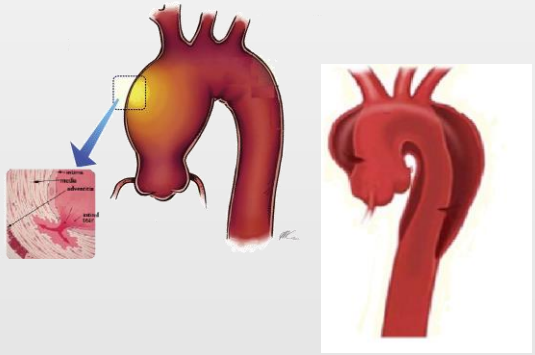




EXPERIMENTAL BIOMECHANICS

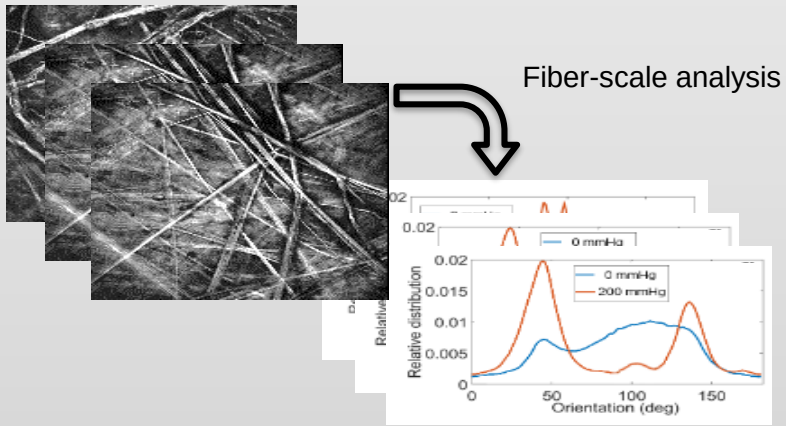
EXPERIMENTAL CHARACTERIZATION CAMPAIGN

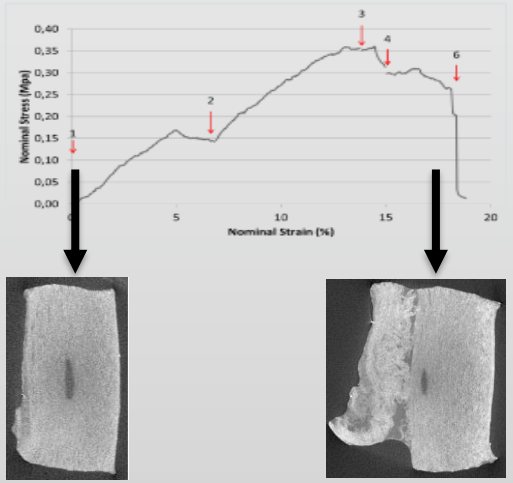
In situ mechanical testing



Multi-photon confocal microscopy

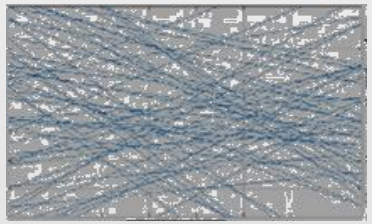
X-ray micro-tomography

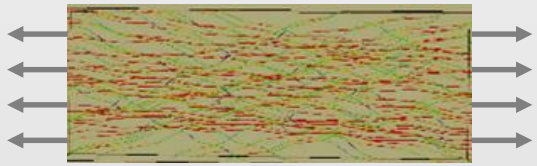


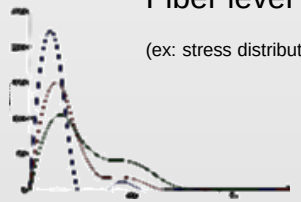


NUMERICAL MODELING ACROSS SCALES

Local mechanical modeling and analysis

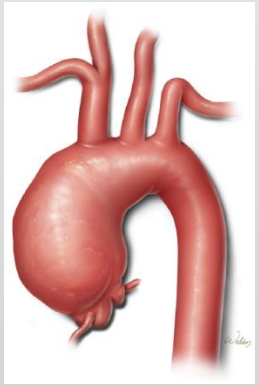


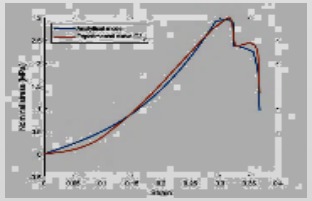


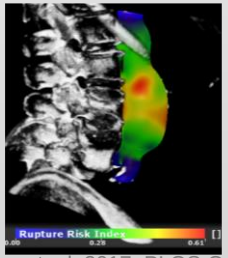


Fiber level analysis

(ex: stress distribution)







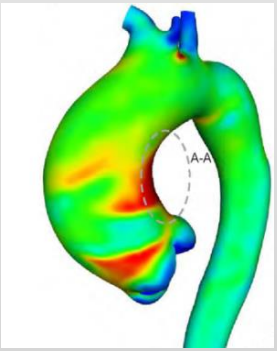
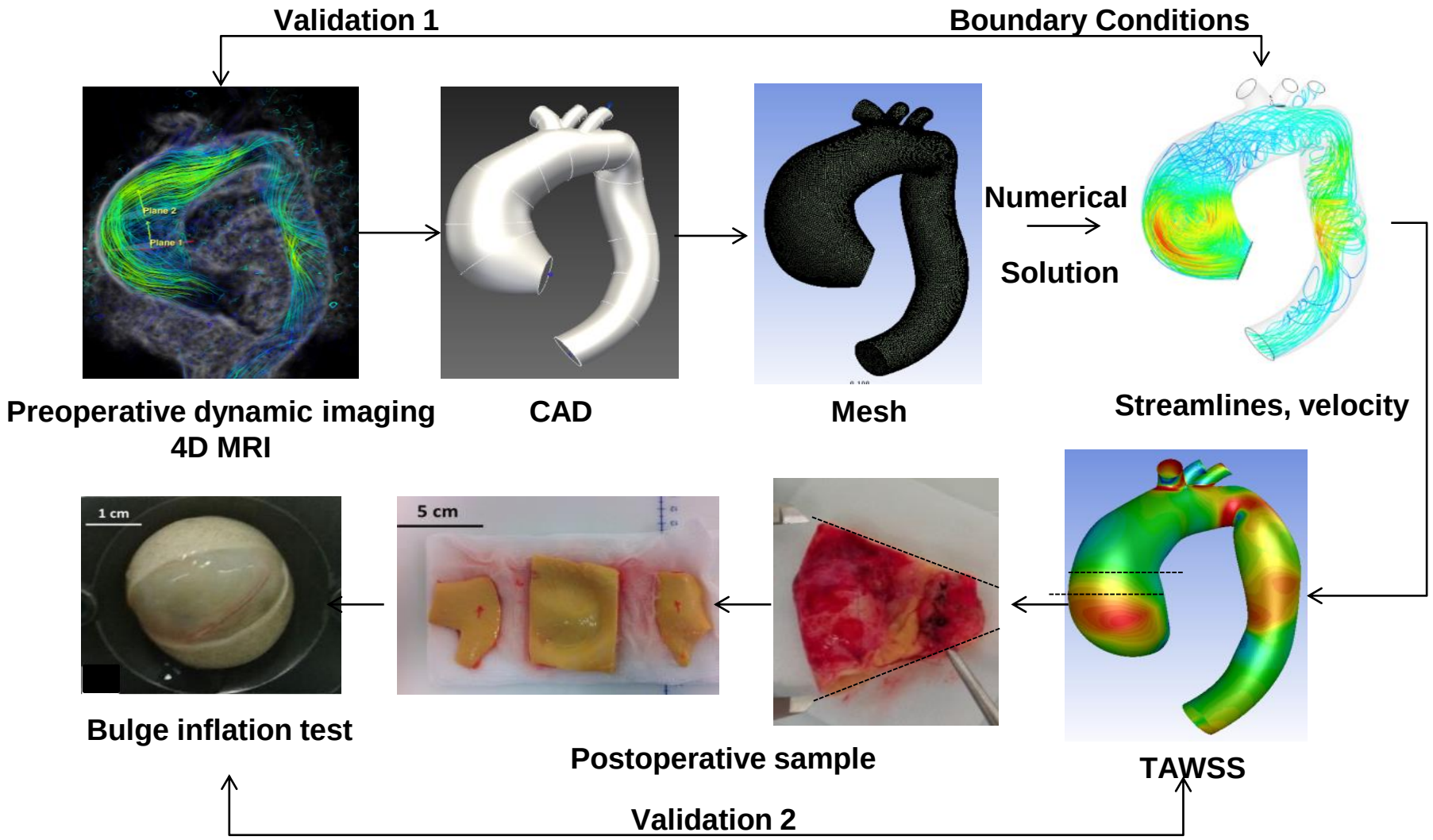
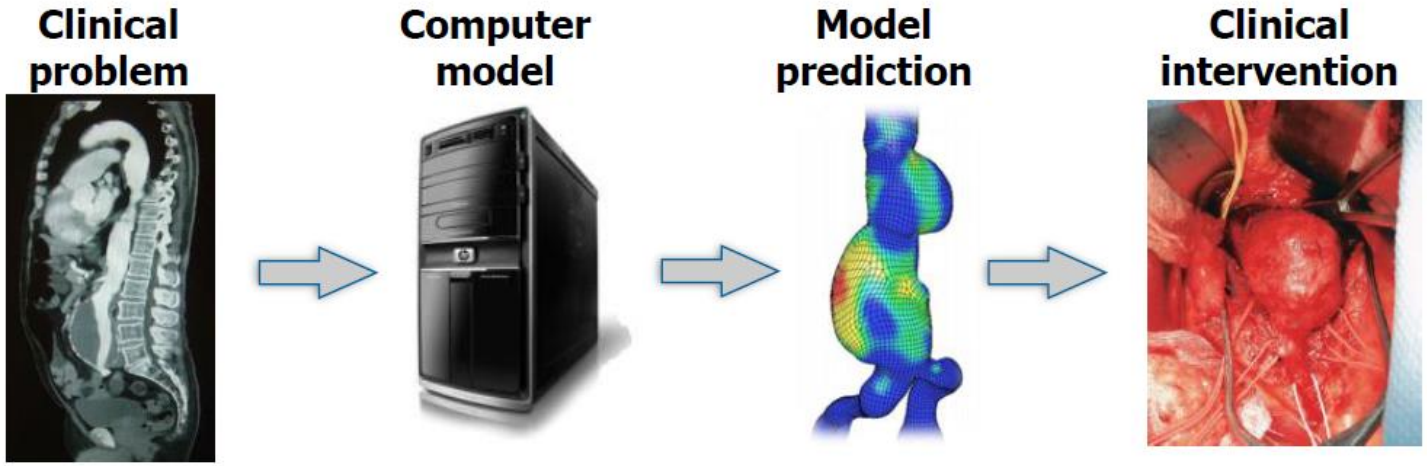


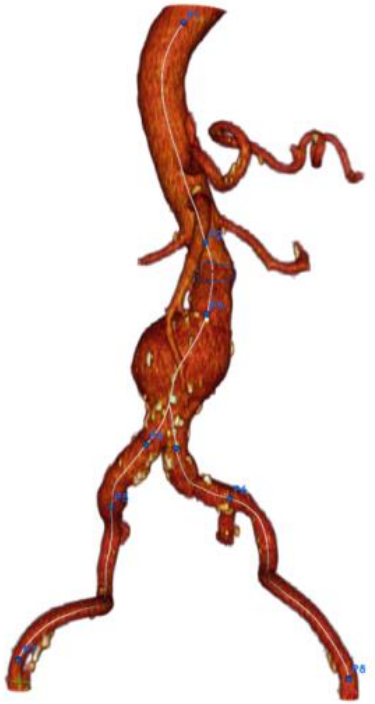
Image from [Stevens et. al. 2017, PLOS One]

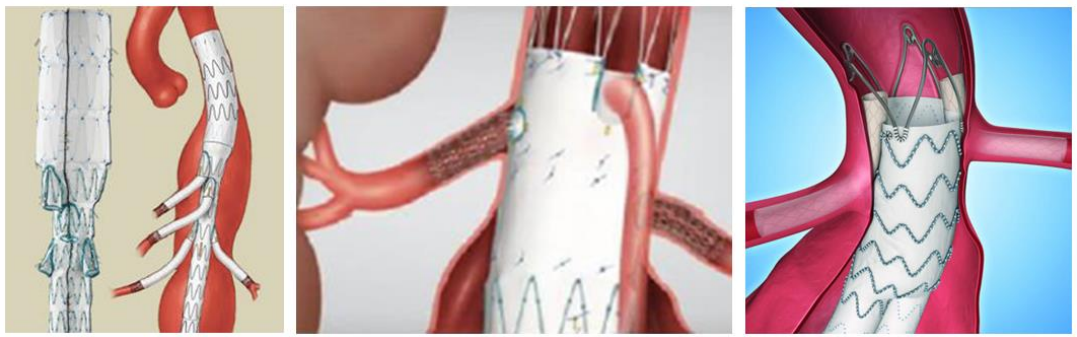
COMPUTATIONAL BIOMECHANICS



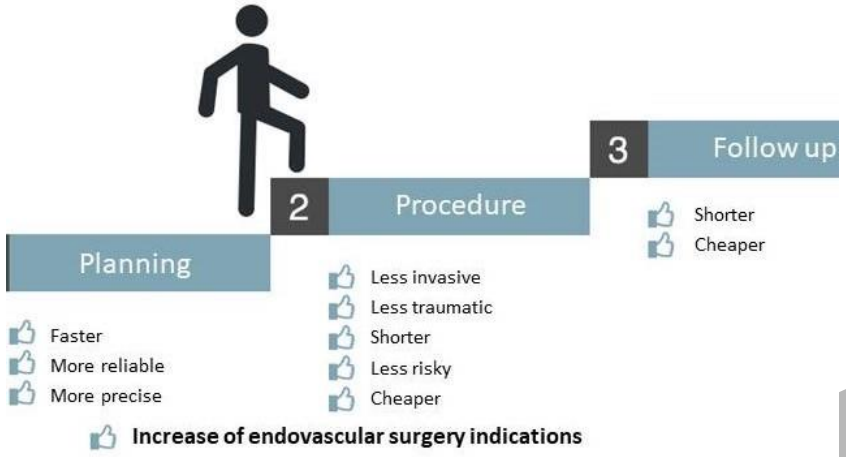
WORKFLOW







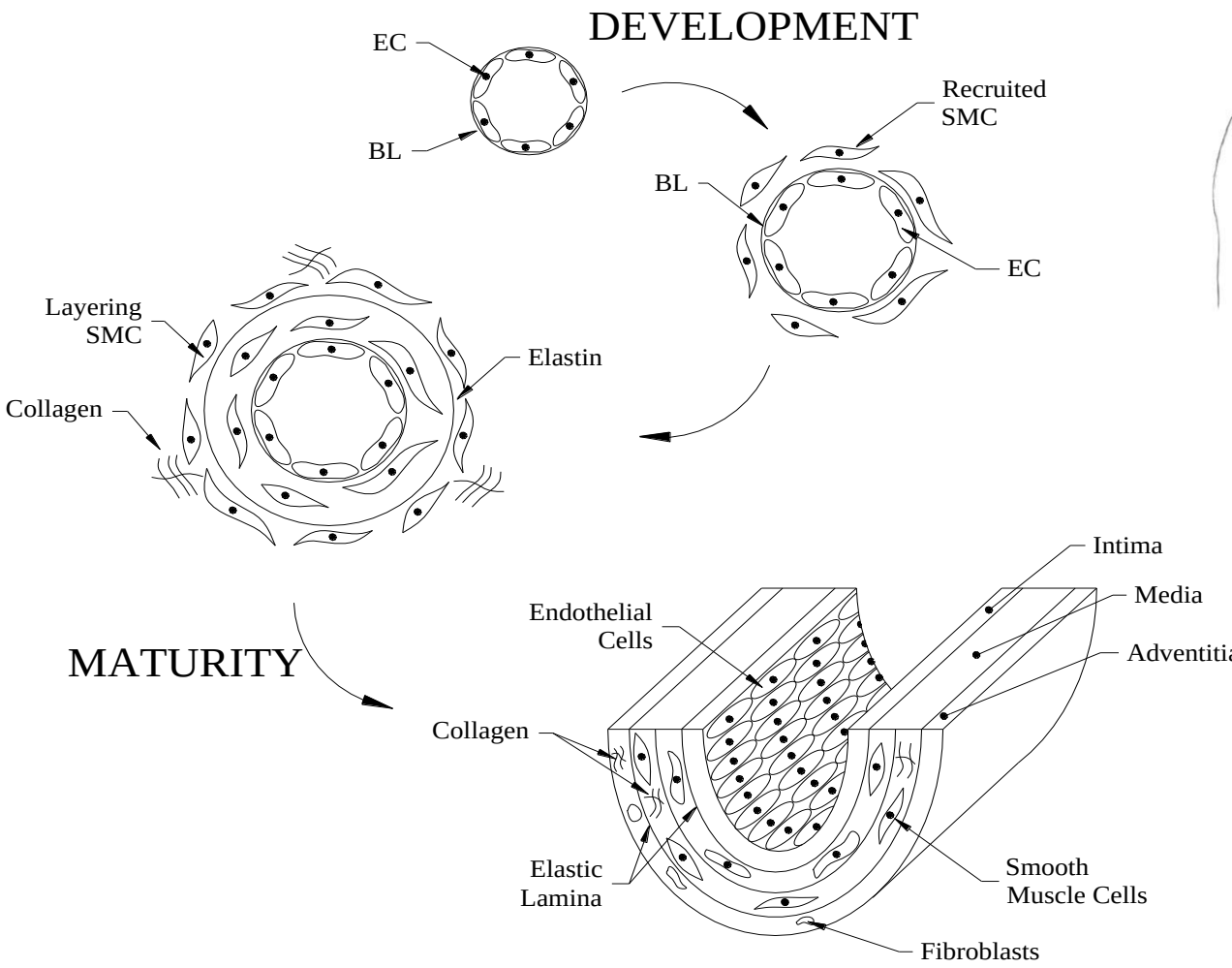
Branched stent (left), fenestrated stent (centre) and ChEVAR technique (right)

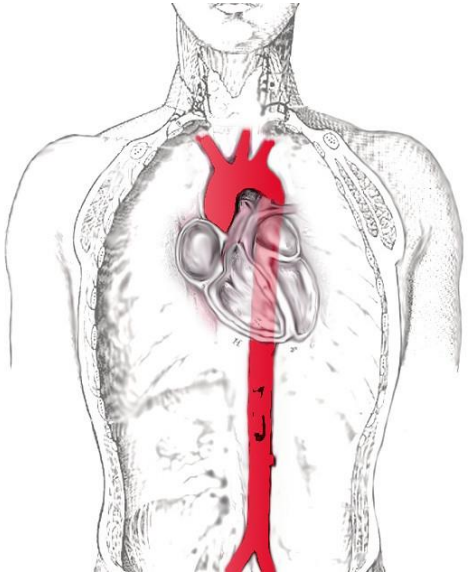


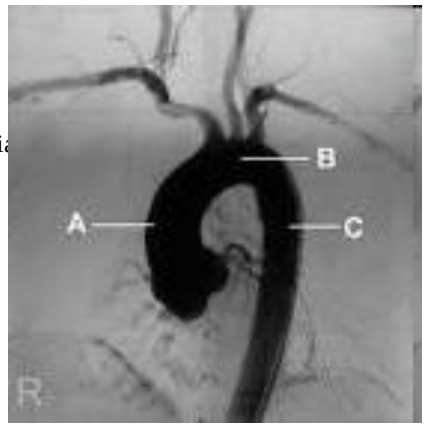
Start-up PrediSurge

Towards numerical assistance during vascular surgery

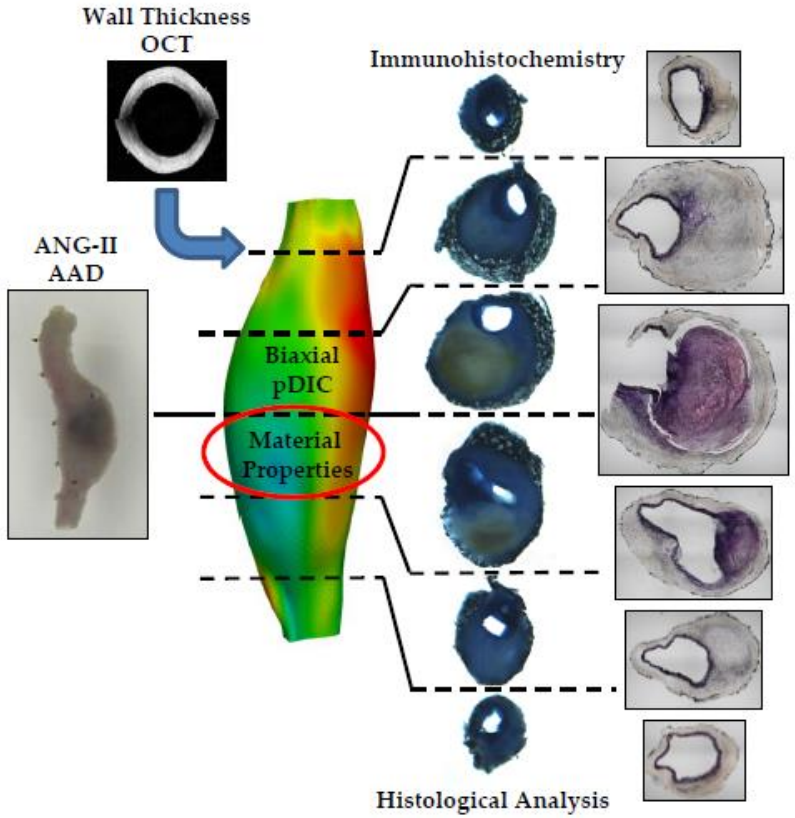
MECHANOBIOLOGY…



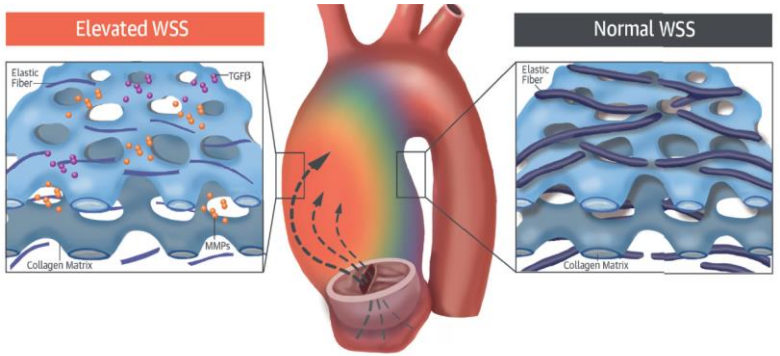




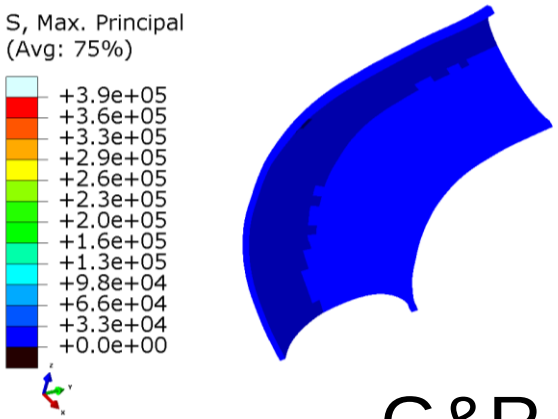
COMPUTATIONAL MECHANOBIOLOGY…



ECM regulation

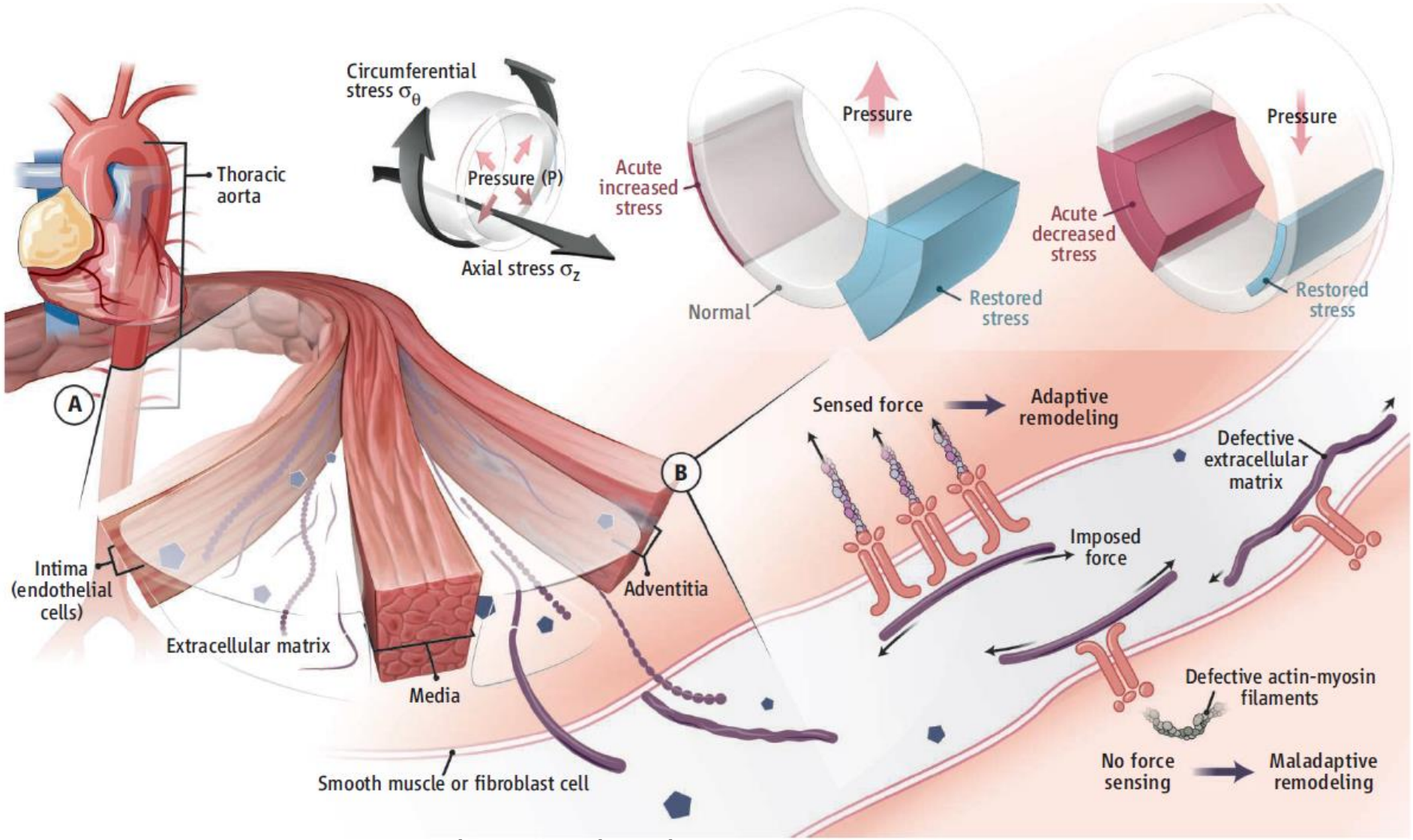


ECM proteolysis



G&R

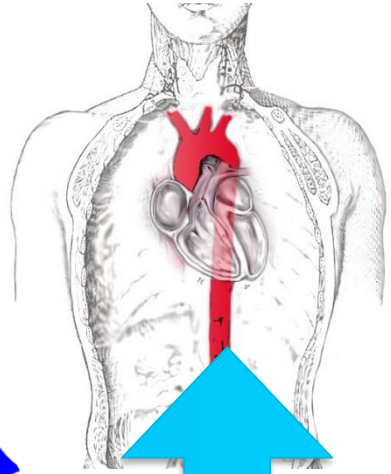
ROLE OF SMOOTH MUSCLE CELLS



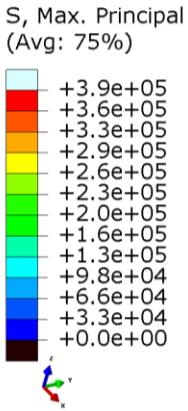
Humphrey et al, Science 2014

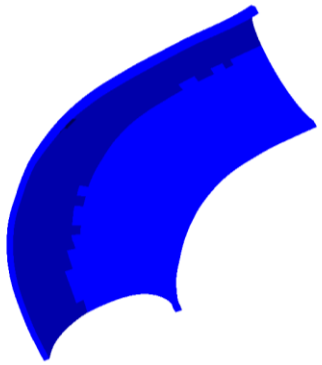
AMBITION / DREAM

Monitoring mechanical regulation and epigenetics

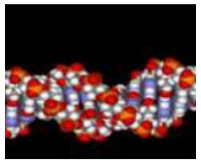


DIGITAL





TWIN



Predicting patient-specific pathophysiology and drug effects

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