Several devices dedicated to experimental characterization of human skin in vivo/ex vivo (Emmanuelle Jacquet)

Collaborations between : FEMTO-ST (DMA) (Jérôme Chambert, Patrick Sandoz)

INSERM CIC 1431 (Gwenael Rolin, Delphine Binda biologists)

CERT (Thomas Lihoreau, biomedical engineer)

maxillo-faciale surgery (Brice Chatelain)

Plastic and reconstructive surgery (Julien Pauchot)

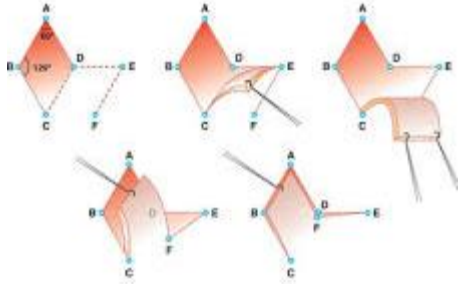
And PhD students, Fouad Khatyr and D. Remache

OPPORTUNITIES

Medical problematics *related to human skin mechanical behaviour*

- ❑ Cutis laxa – Aging – diagnosis
- ❑ Serious burns
- ❑ Flap surgeries
- ❑ Keloids or hypertrophic scars
- ❑ Virtual reality simulator – Simulator training and learning system
- ❑ Haptics
- ❑ Sensorial properties




Interest dealing with mechanics of the skin :

- ❑ Cutis laxa – Aging – diagnosis
- ❑ Serious burns
- ❑ Flap surgeries
- ❑ Keloids or hypertrophic scars
- ❑ Virtual reality simulator – Simulator training and learning system
- ❑ Haptics
- ❑ Sensorial properties

MECHANICAL IDENTIFICATION

EXTENSIBILITY

HYPERELASTICITY

TENSION

ANISOTROPY

IN VIVO and macroscopic scales

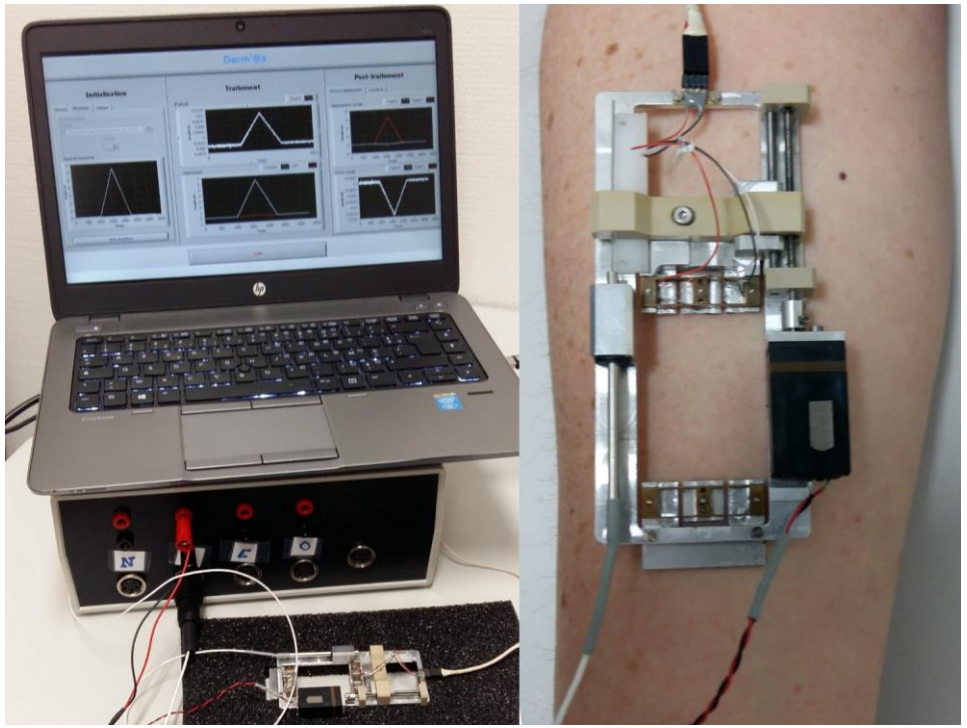
Microscopic and cellular scales

VISCOUS
And LIVING TISSUE

Thematics

- ❖ Tissue engineering
- ❖ Knowledge of pathology
- ❖ Modelisation
- ❖ Medical devices or Research device
- ❖ …

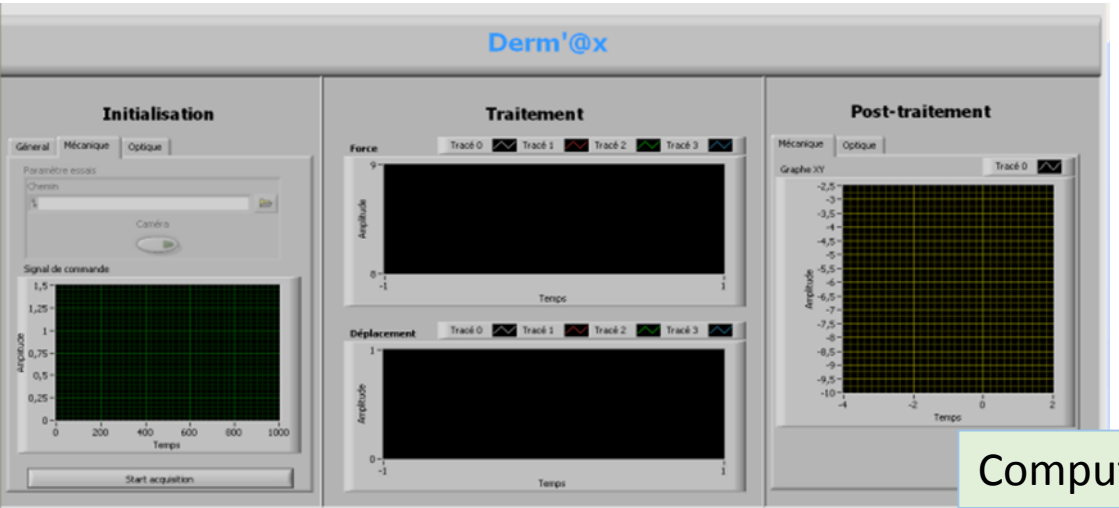
Standalone uniaxial extensometer in vivo

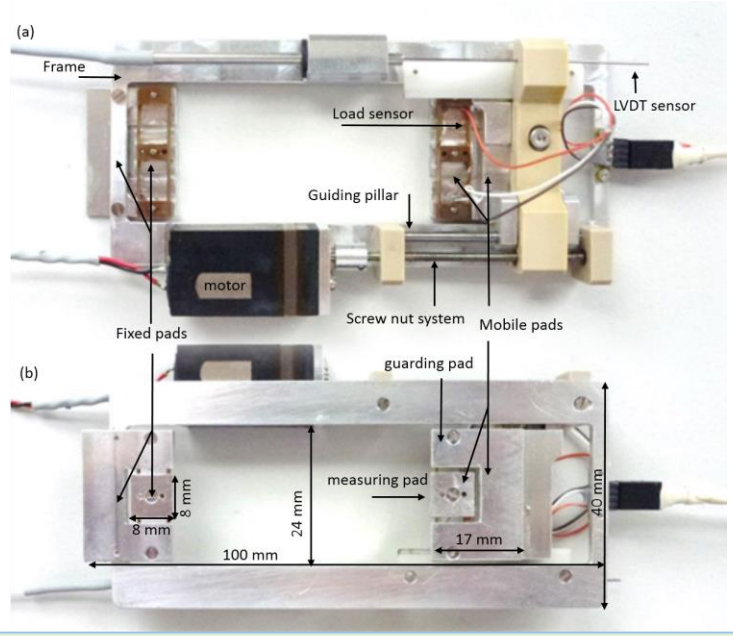


ULTRA-LIGHT

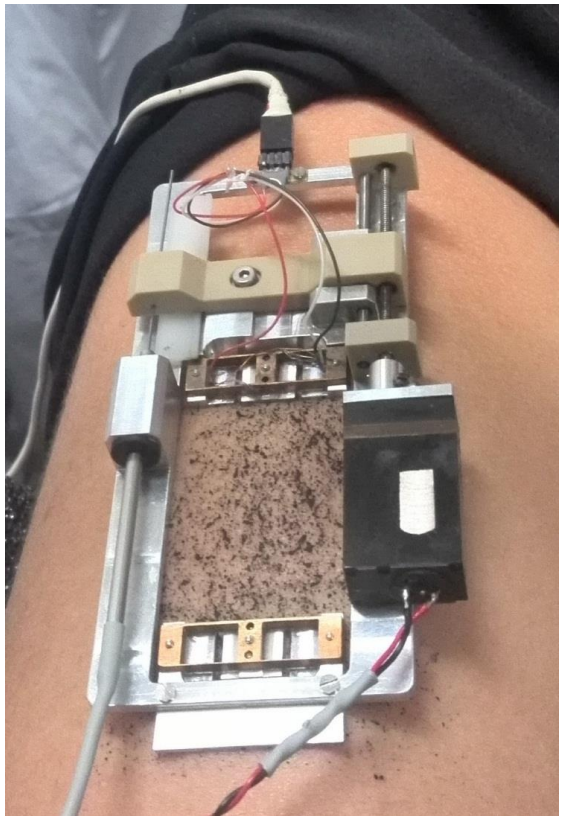
NUMEROUS ANATOMIC SITES

Technical specifications	Values
Size	100 x 40 x 6 mm^3
Mass	35g
Observable area	40 x 24 mm^2
Maximal strain	150%
Maximal load	10N
Effort sensor	5mN
Displacement sensor	38µm
Maximal displacement	17mm
Maximal speed	1,5mm/s



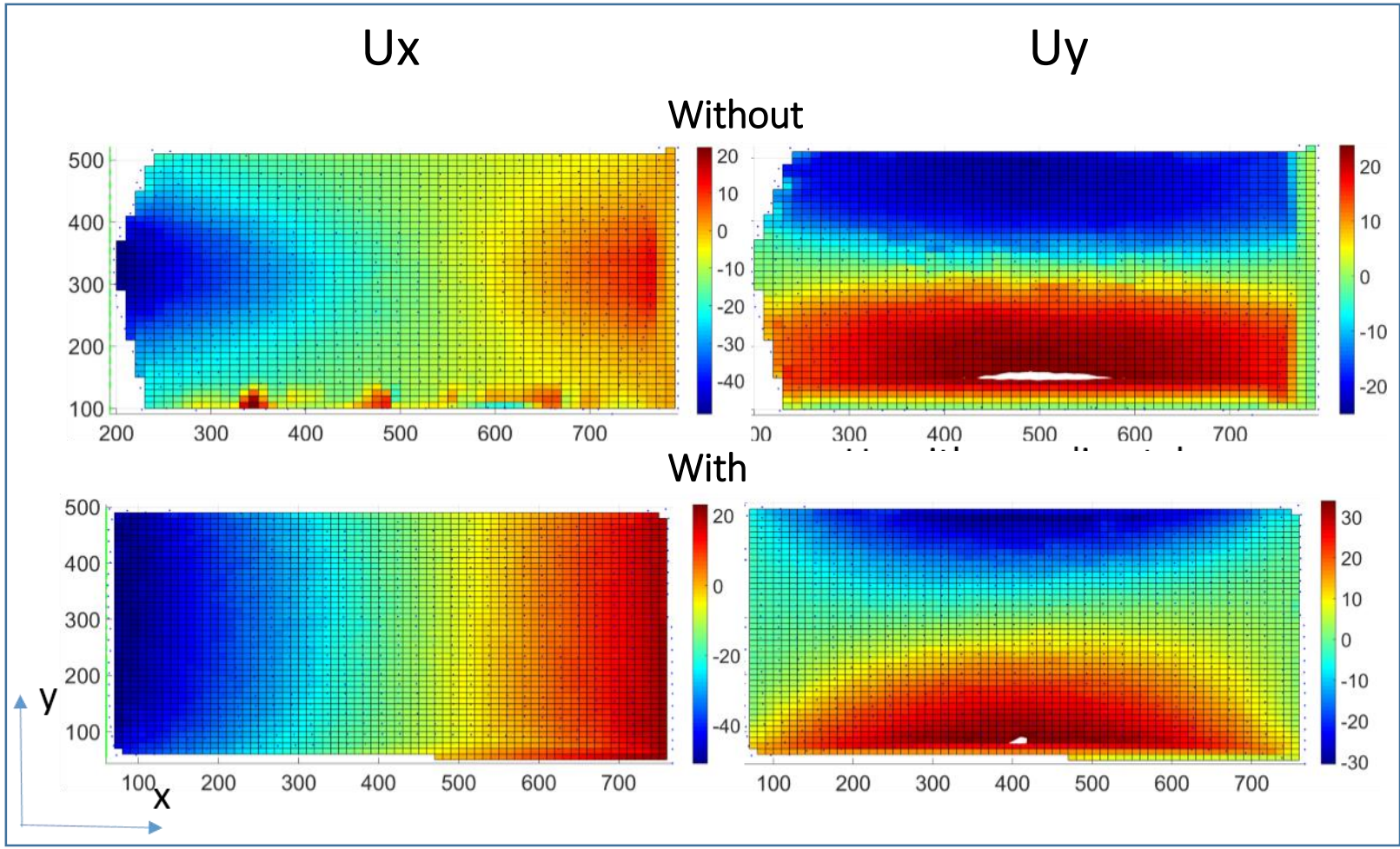


Standalone uniaxial extensometer in vivo

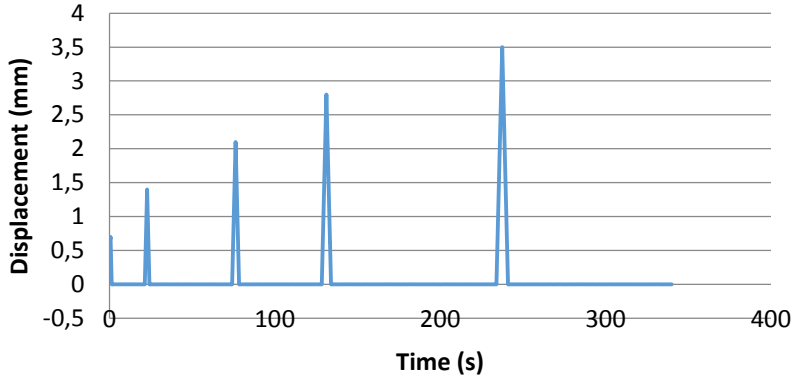


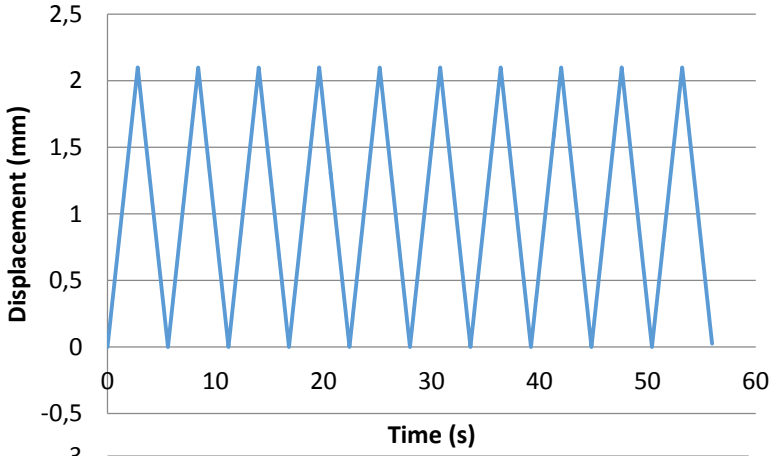
Slight disturbance according low gestures

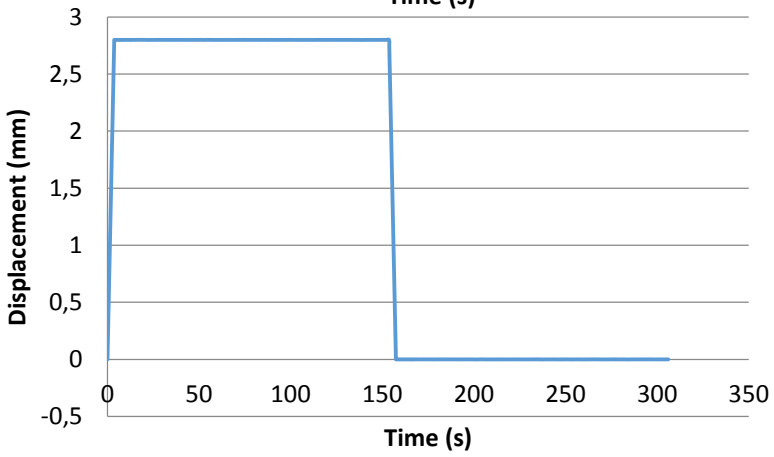
Imaging *device : Additionnal U-pads*
Digital Image Correlation (DIC)



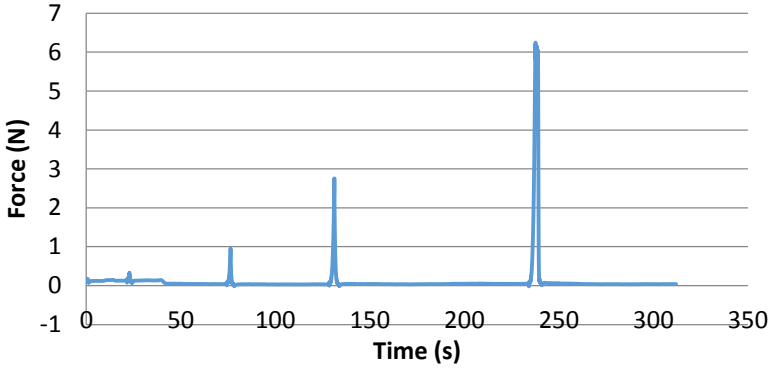
Command

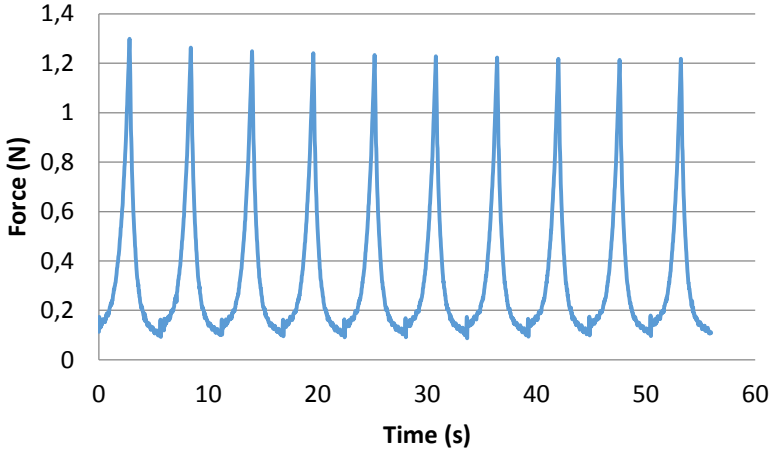


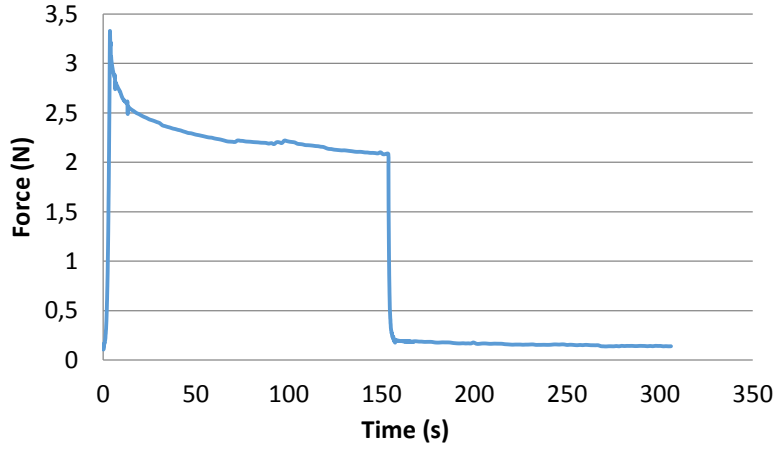




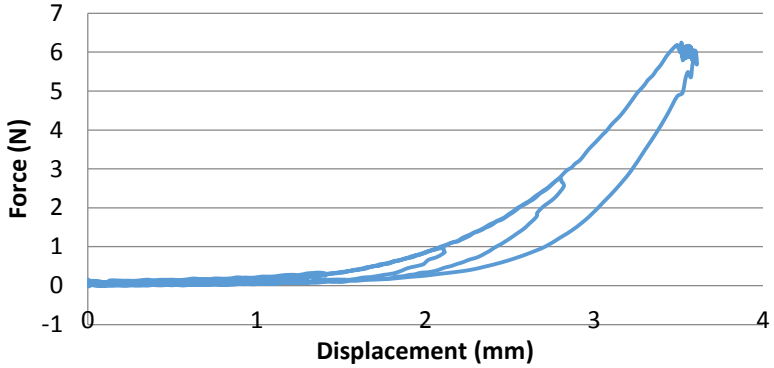
Force vs. Times

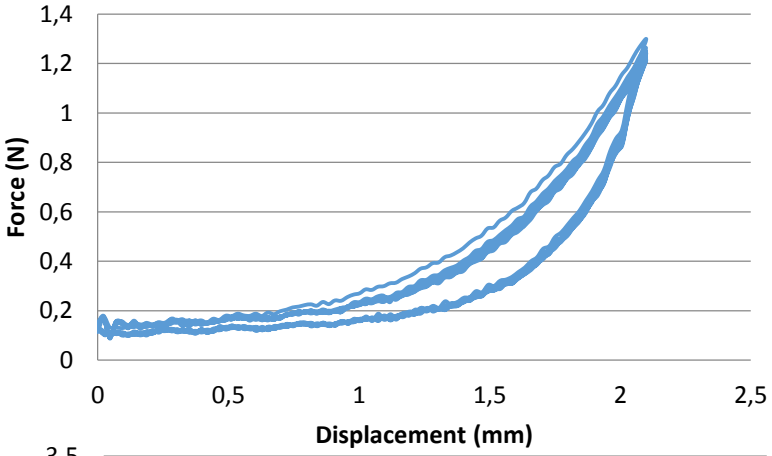


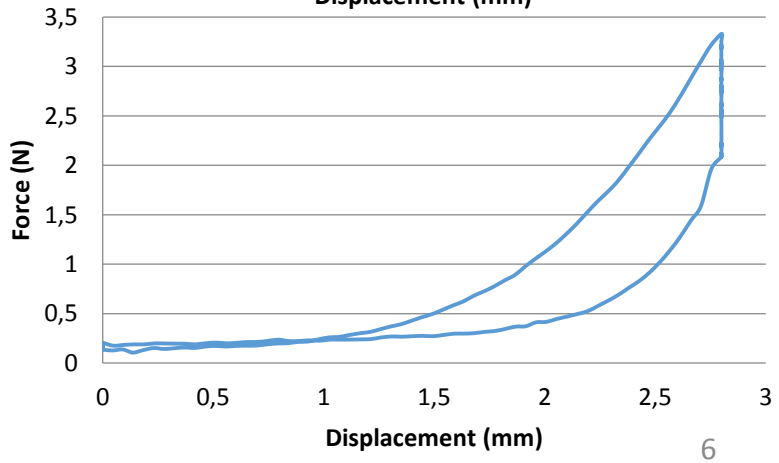




Force vs. Displacement

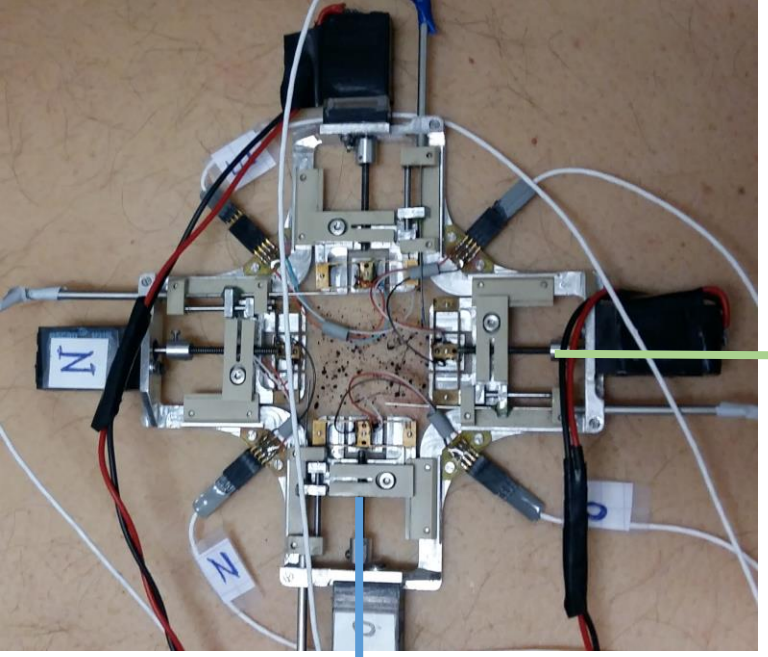






Standalone biaxial extensometer 3 in vivo

S. Joly, K. Rekik, J. Chambert, P. Sandoz 2016



COMMAND SOFTWARE

4 MOTORS

4 LVDT

4 FORCE SENSORS

UNUSABLE (MANY WIRES)

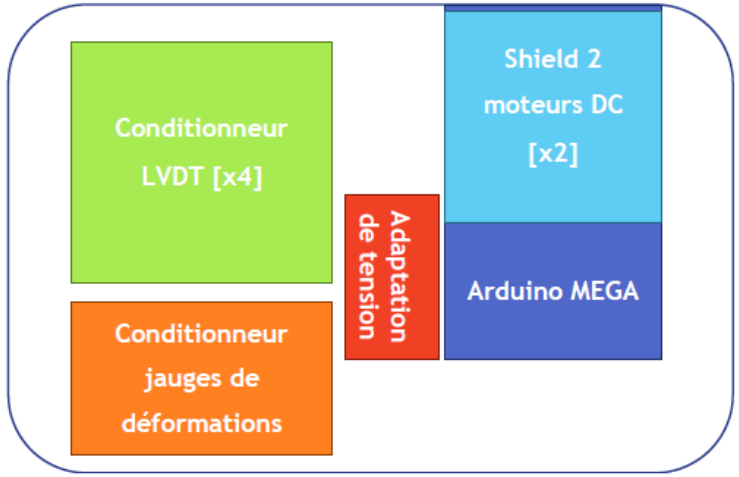
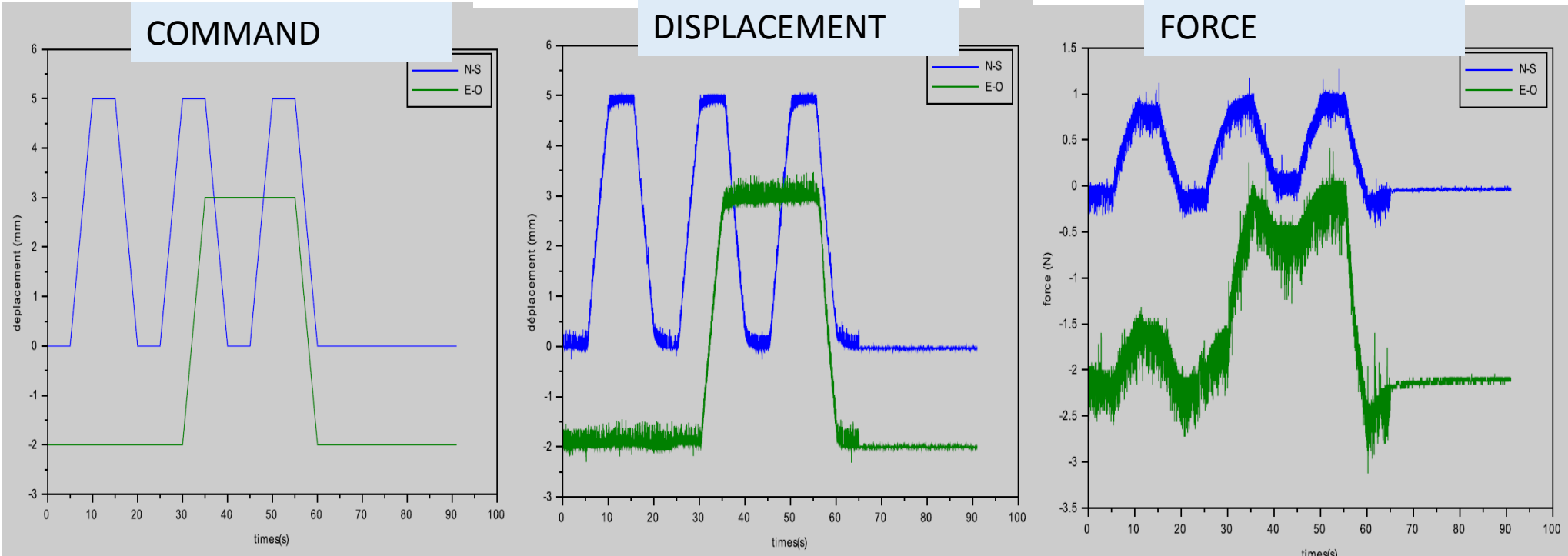
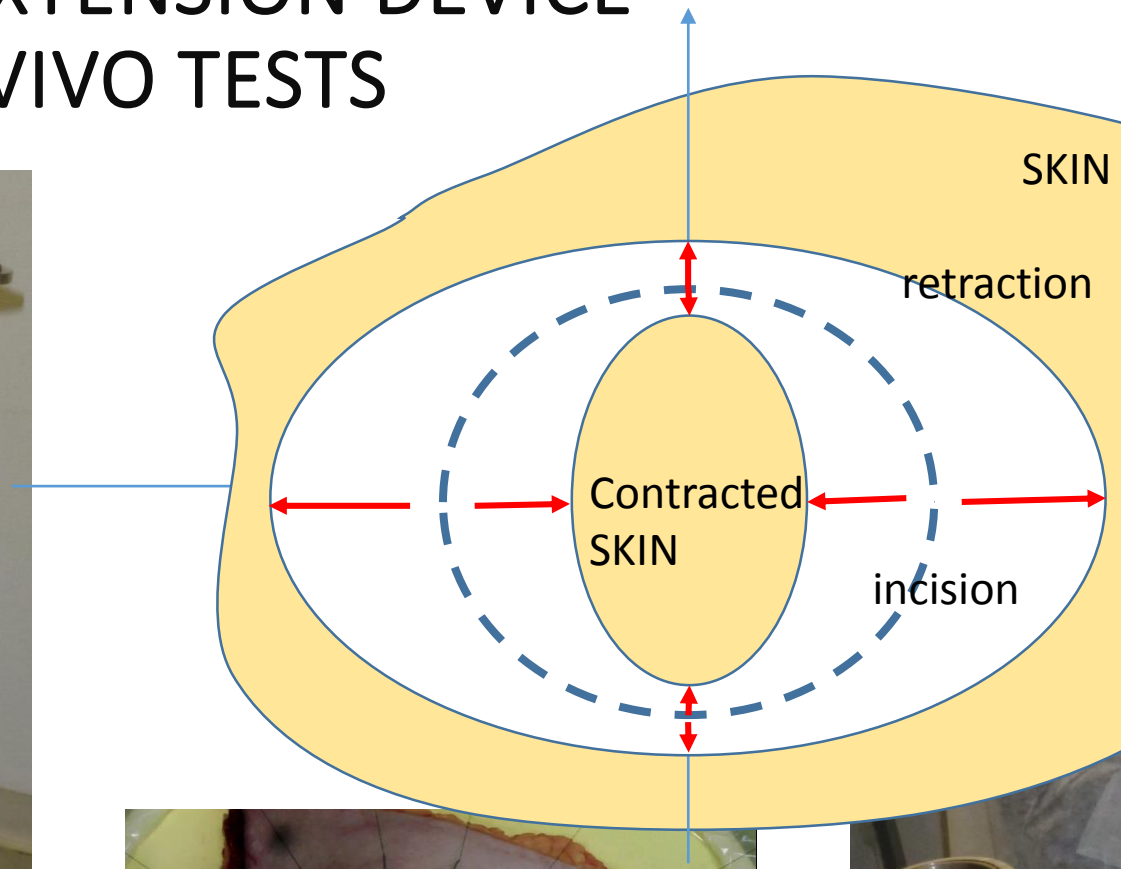
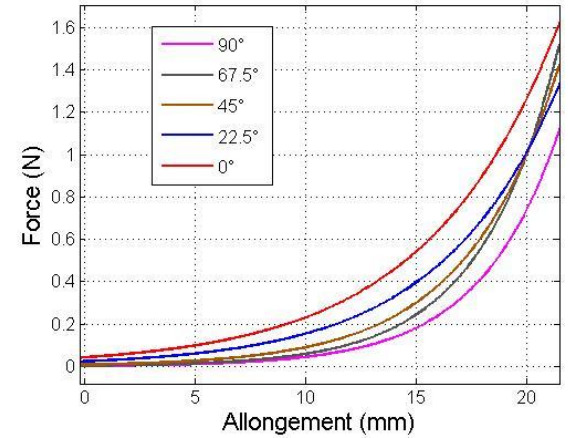


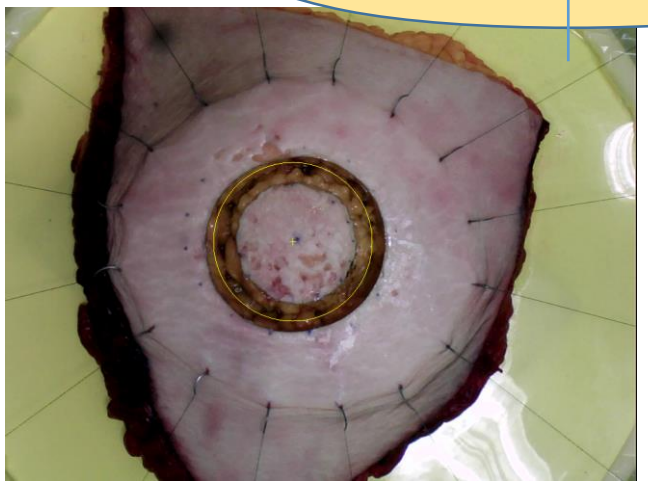
Figure 1 : Implantation cartes électroniques dans le boitier

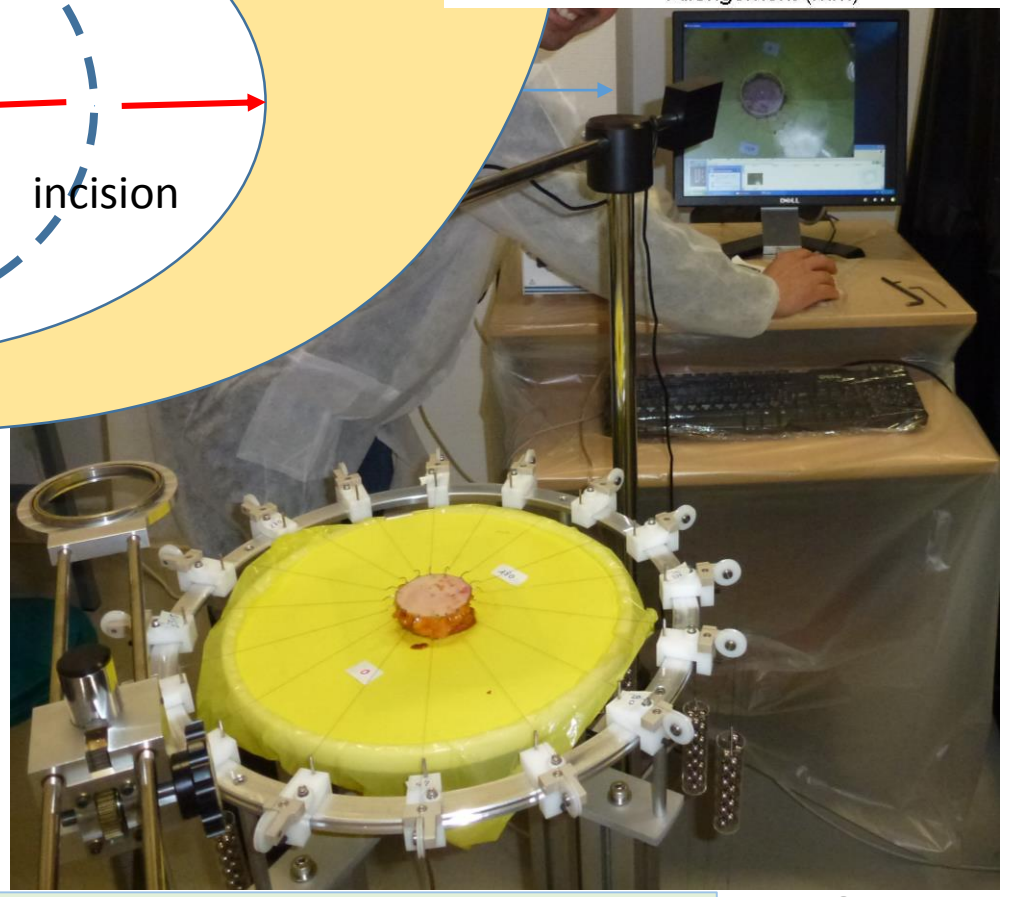


MULTIAXIAL EXTENSION DEVICE FOR EX VIVO TESTS









PRIORITIES

Remaining problems :

- High variability
- Unknown initial stress state

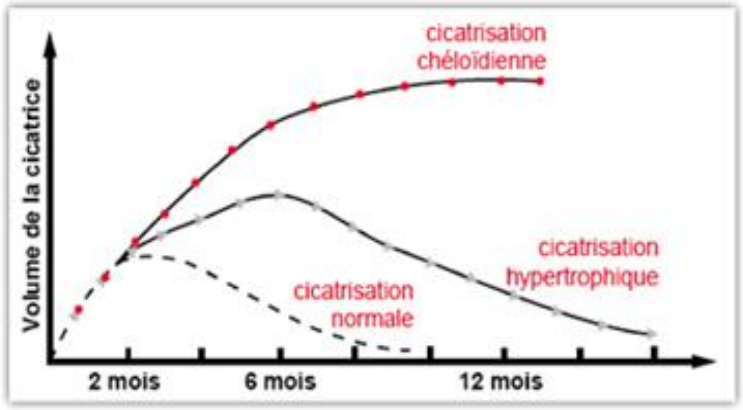
But also

- Initial and induced anisotropy
- viscoelasticity

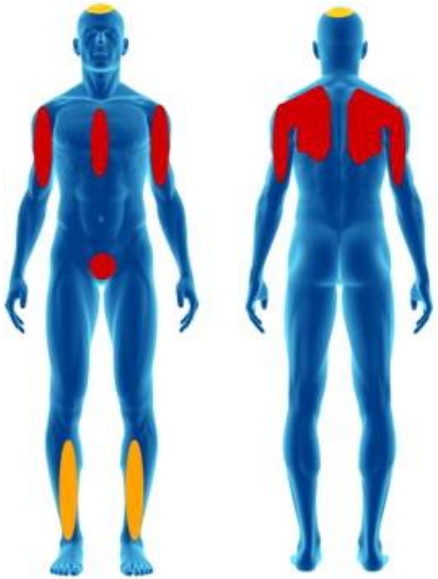
Project and priority:

Develop an useful tool for surgeon to characterize the tissue directly with intrinseque mechanical parameters

One model problem TRY to UNDERSTAND What HAPPENS mechanically in keloid scars



Medical aim : develop a stategy to mechanically prevent keloid growth

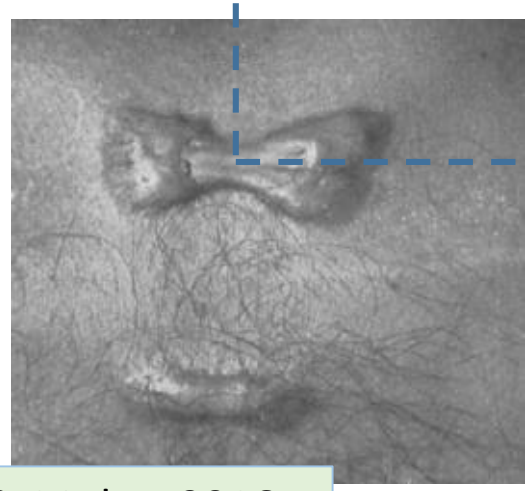


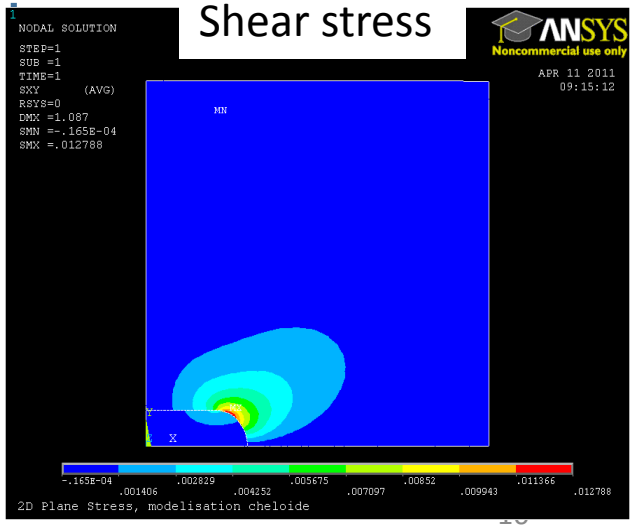
COMMON SITES OF KELOIDS

ANTERIOR CHEST
SHOULDER
SCAPULAR REGION
SUPRAPUBIC REGION

RARE SITES OF HEAVY SCARS

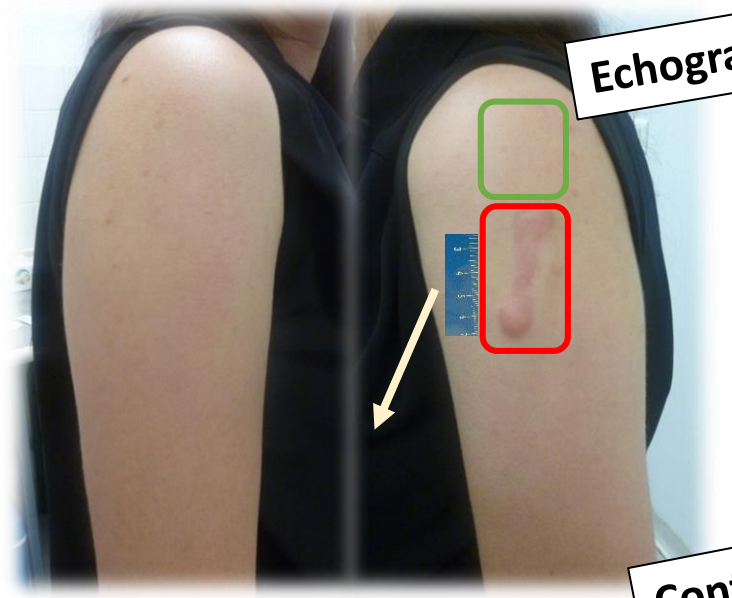
PARIETAL REGION
ANTERIOR LOWER LEG



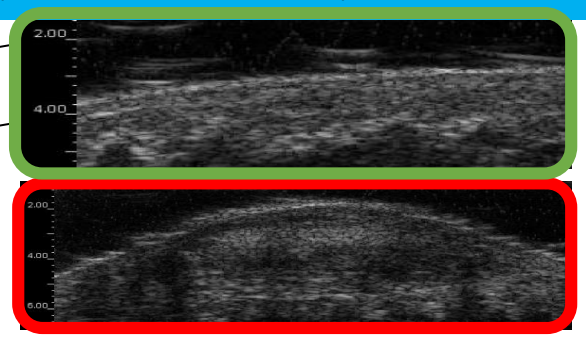


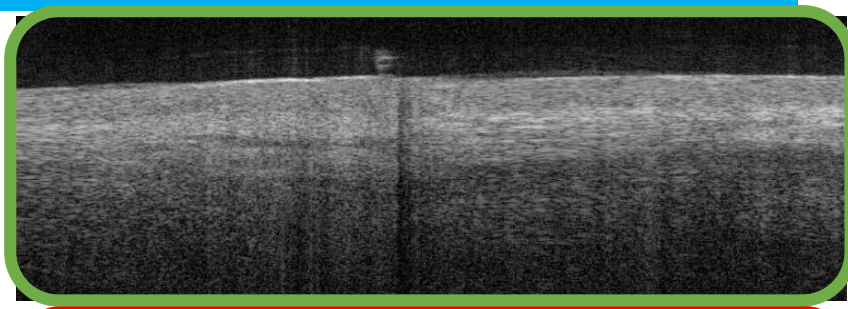
Various physical and biological observations, keloid versus healthy skin in vivo

Collaboration LIBC (Gwenael Rolin), CERT (Thomas Lihoreau), CHRU service de chirurgie maxillo-faciale (Brice Chatelain)

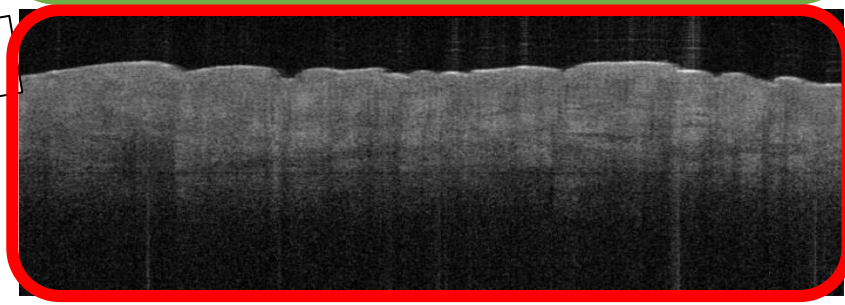


Echography

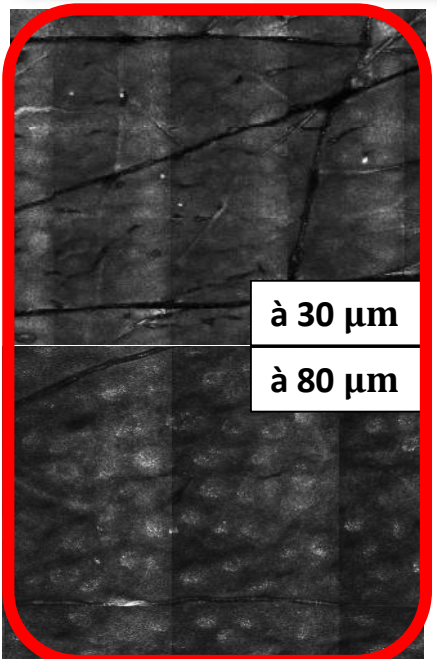


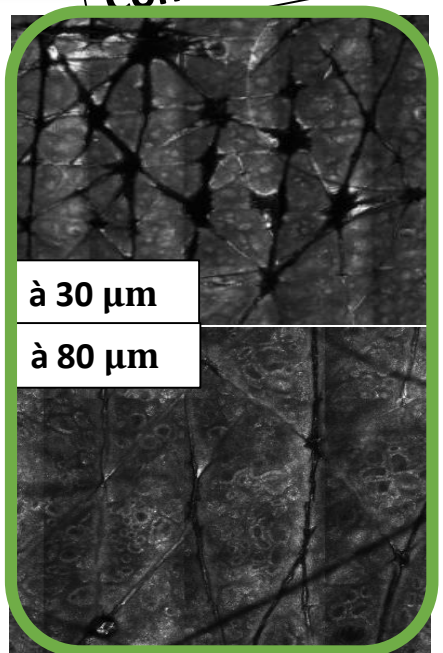


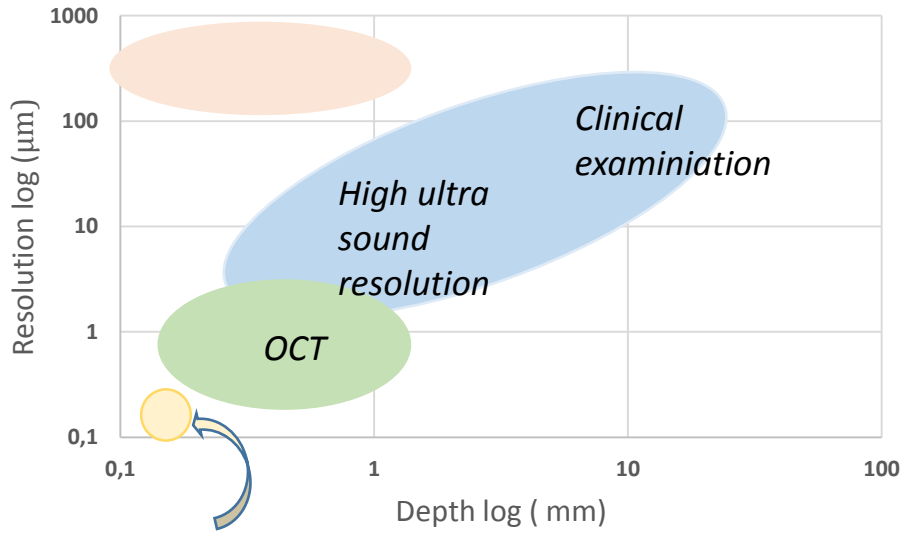
OCT



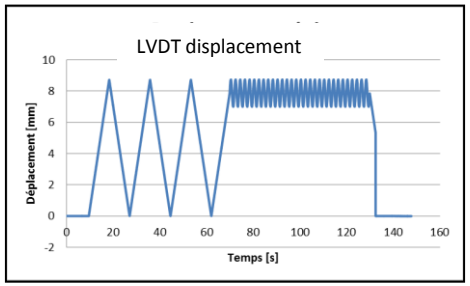
Confocal microscopy

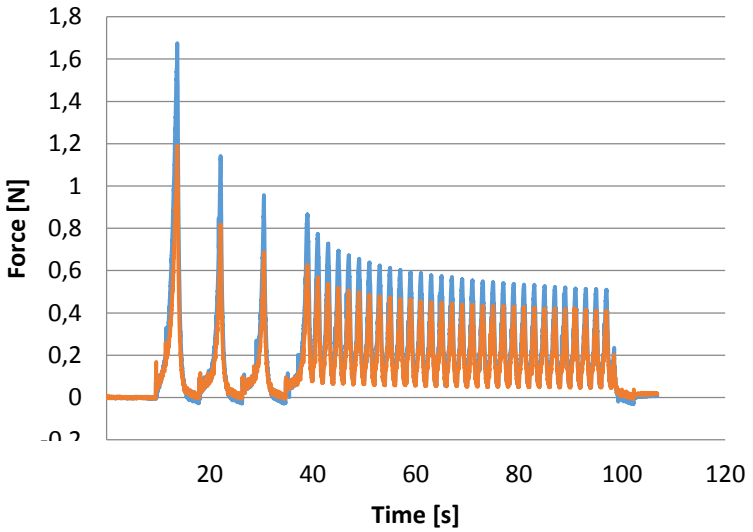


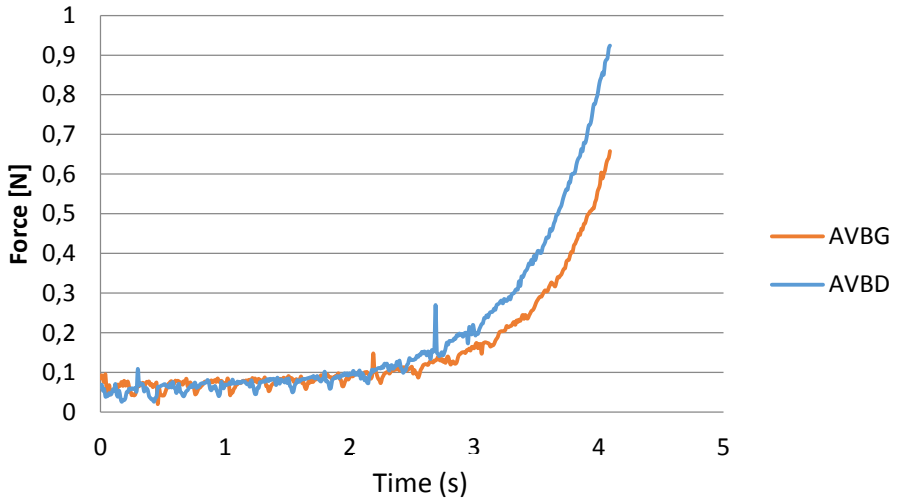




Mechanical uniaxial behaviour Right versus left forearm



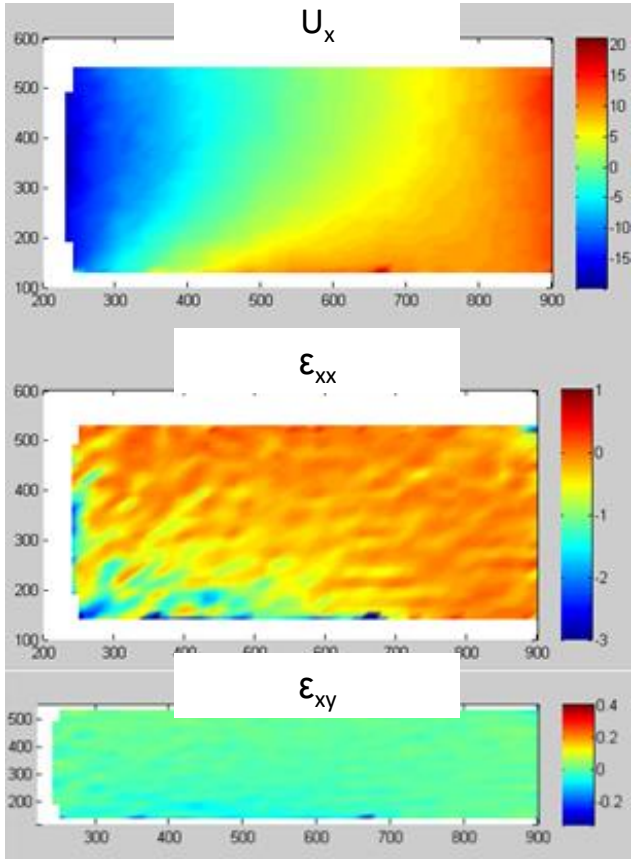


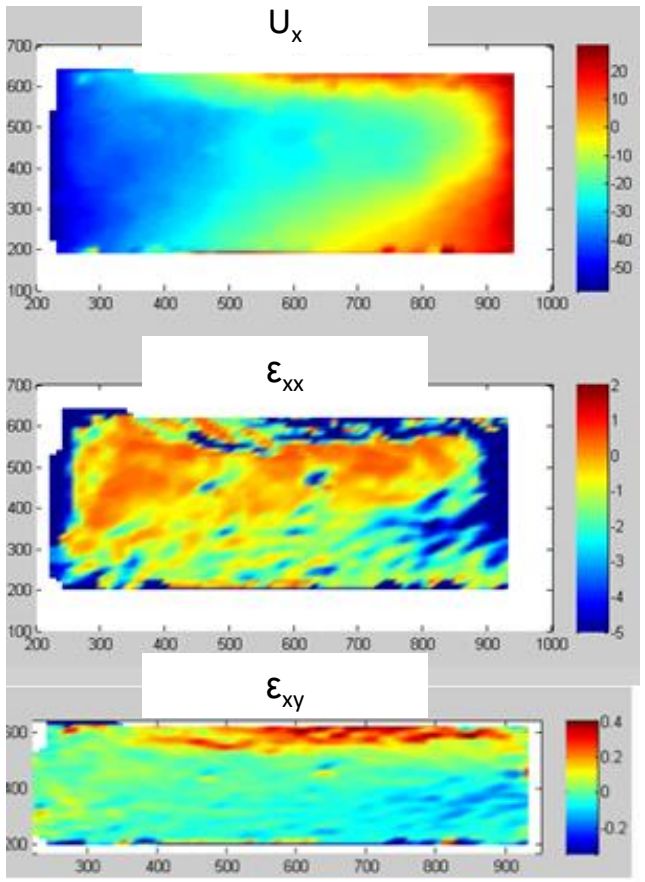


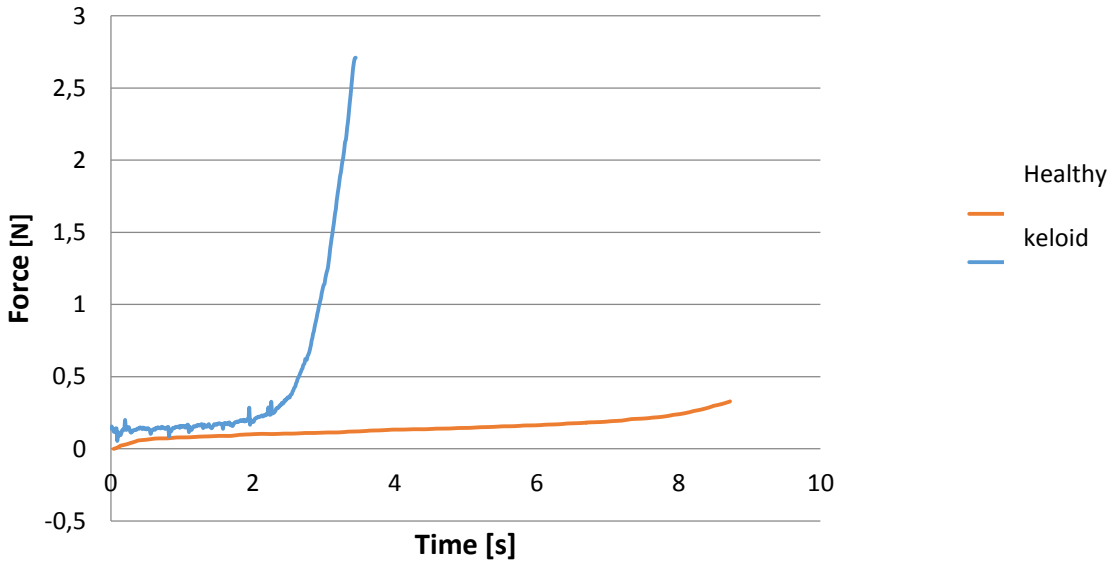
- Forearm
- Right and left
- Along Langer's lines

Healthy skin and Keloid

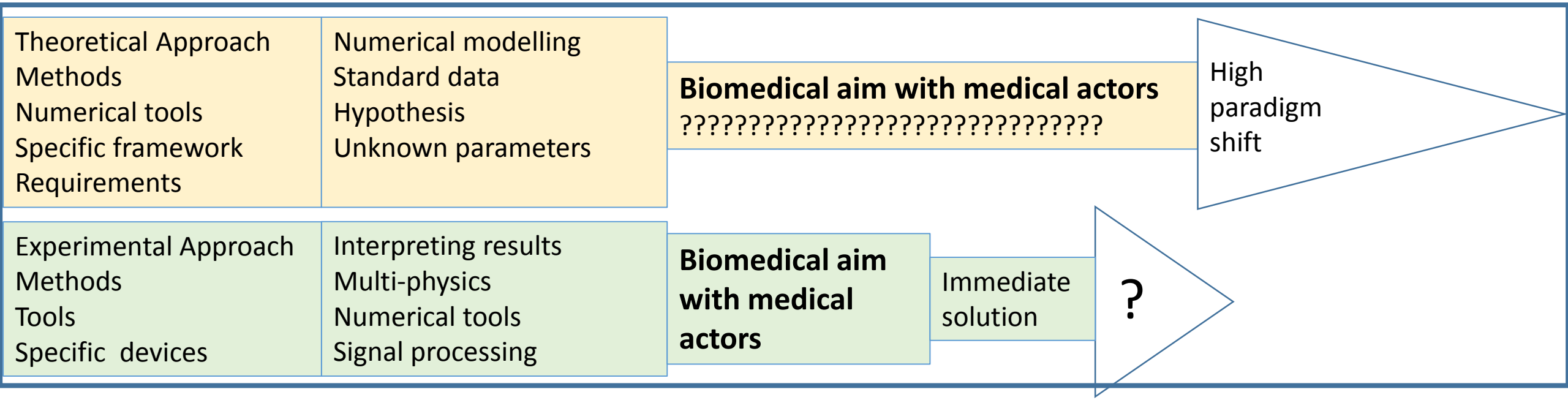
Comparison Keloid/Healthy skin



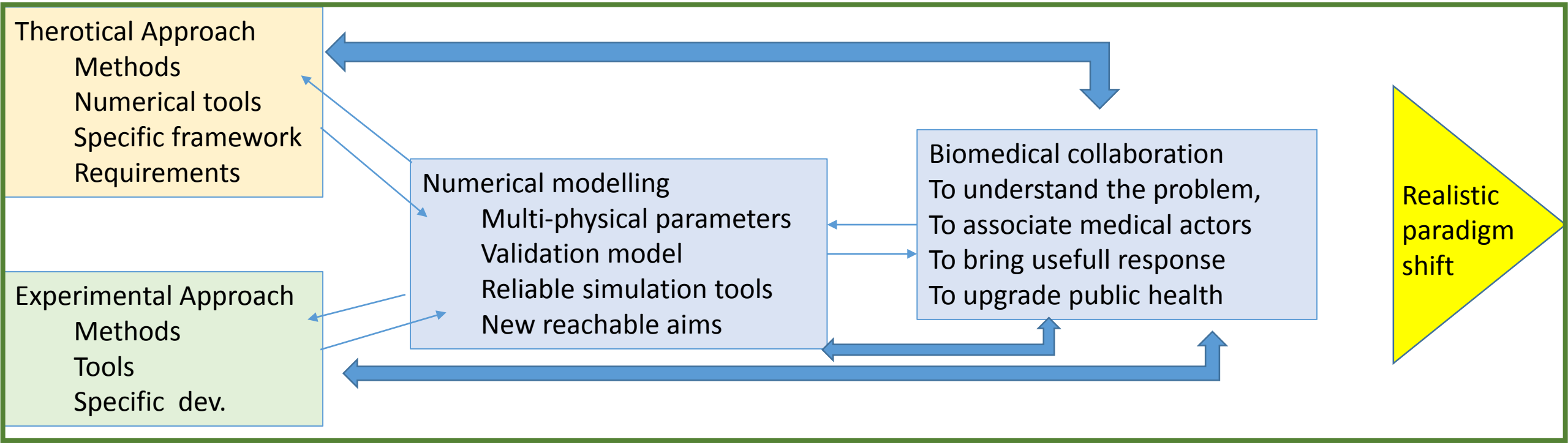




USUALLY now :


Theoretical Approach
Methods
Numerical tools
Specific framework
Requirements
Numerical modelling
Standard data
Hypothesis
Unknown parameters
Biomedical aim with medical actors
??????????????????????????????
High paradigm shift
Experimental Approach
Methods
Tools
Specific devices
Interpreting results
Multi-physics
Numerical tools
Signal processing
Biomedical aim with medical actors
Immediate solution
?

OUR CHALLENGE is like for now :



THANK YOU FOR YOUR ATTENTION