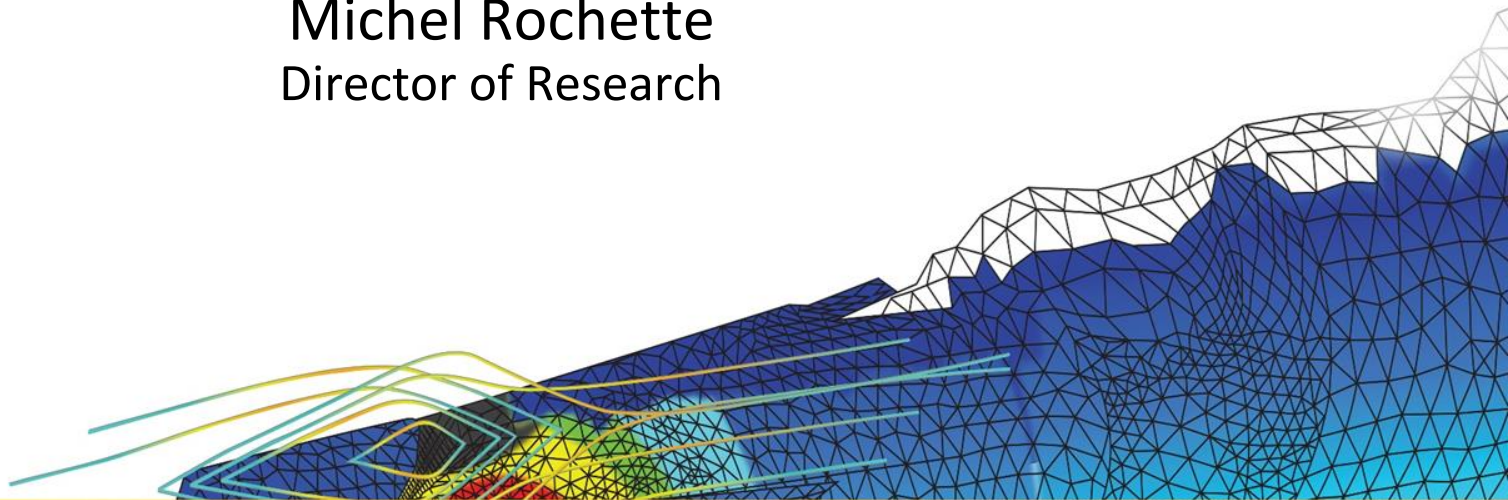


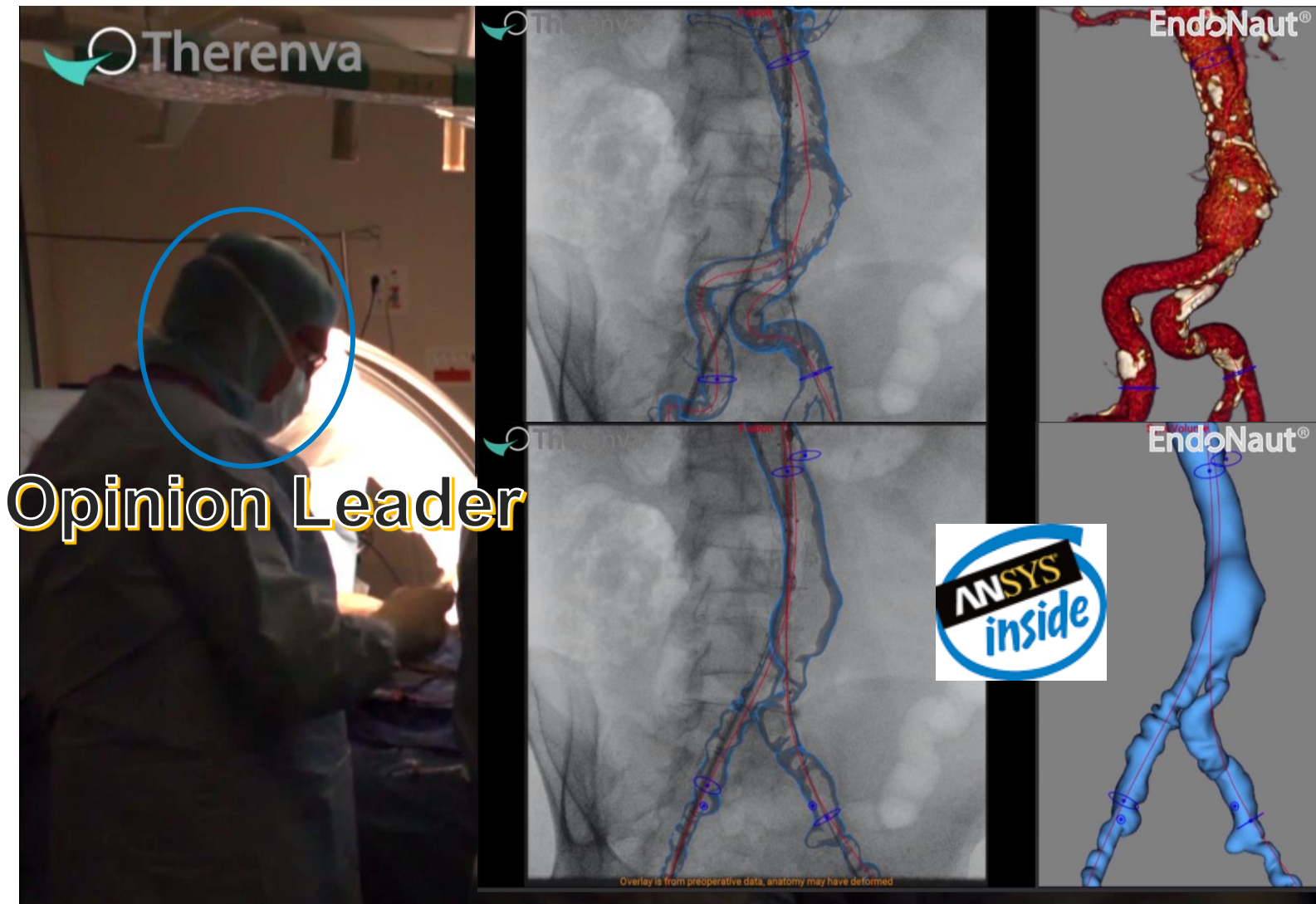


Clinical Applications Powered by Patient Specific Simulation

Michel Rochette
Director of Research



3D simulation in clinics ?



Global Engineering Simulation Leader

Only software company focused solely on simulation with 45 years of simulation software experience

- Approx. 3,000 employees / 60+ sales offices on 3 continents
- Network of sales channel partners in 40+ countries
 - 22 major development centers on 3 continents

2016 Revenues: \$980M

Market Cap: \$10B

||| 40,000 Total Customers

Including 97 of the top 100 Industrial Companies on the FORTUNE Global 500

315,000 Commercial Seats

290,000 University Seats

200 Channel Partners

160 Industry Partners

3M



P&G



EASTMAN



SONY



United Technologies



BOEING



JOHN DEERE



DUPONT



Rockwell Automation

ANSYS Research in Lyon

11 researchers (3 Senior, 8 PhD students)

Collaborative Research with Labs, Hospitals, Clinical SMEs
and Medical Companies

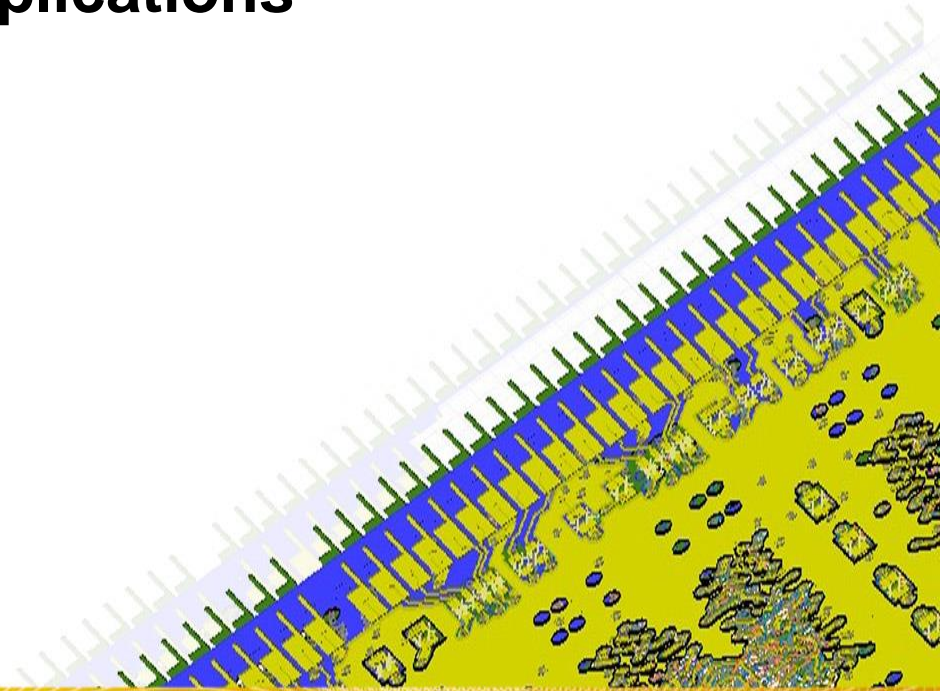
2 Research Topics

Engineering Simulation embedded into Clinical
Protocols

Reduced Order Modelling



Clinical Applications



Clinical Initiative Business Target: *'Pathology Specific Vertical Applications'*

3D simulation is used in any industry to drastically reduce product cost

In a few years 3D simulation will be embedded in clinical protocols and used by physicians for diagnostic and therapy

To create this huge business opportunity ANSYS develop Vertical Apps with partners

- **Developed** by / with medical software partners (start-up)
- **Validated** by early adopter clinicians with “large cohorts of patients”
- **Research protocol** with **ethical** committee review
- **Certification: CE** Marked and **FDA** Approved
- **Communication** helped by **opinion leader** clinicians
- **Marketed** (OEM) by partners:
 - Medical software vendors, medical device industry, medical imaging industry

Patient specific simulation part of medical protocols:
1 patient → 1 simulation!

ANSYS Clinical Apps Partners

- **Clinic**
 - Customer needs
 - Patient Data, Research Protocol and Ethical Committee review
 - Publications in medicine journals
 - Leads to Clinical Departments of Medical Device and Imaging companies
- **Academia**
 - State of the Art and Management of PhD students
 - Funded Research
 - Publications in engineering journals
- **SMEs**
 - Development of Vertical Apps
 - CE Marking & FDA Approval facilitation
 - Go to Market
- **Medical Device and Medical Imaging Companies**
 - Deployment for their internal needs
 - Deployment into clinical centers

A Virtuous Collaboration Circle



Startup Incubator & Academia



Therenva CEO



Specialty Software



R&D Team + Marketing Team



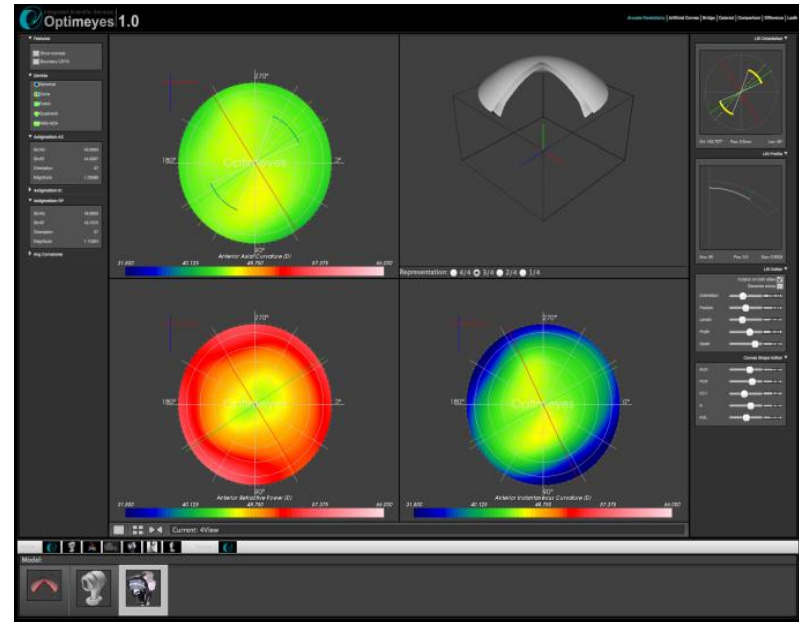
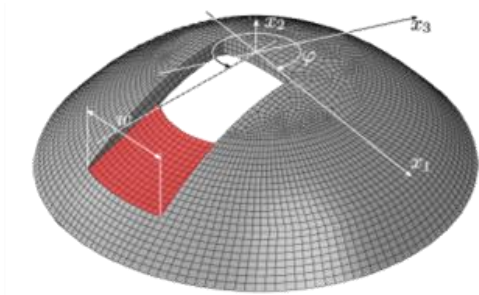
Opinion Leader



Medical Congress



Optimizing Eye Laser Surgery Parameters (Optimeyes)



Partners:

- Optimo Medical AG (Clinical Software Vendor)
- University of Bern
- Hospital of Zurich

Vertical App: ophthalmologic surgery planning: from cornea tomography to laser cut parameters through biomechanical simulation

Optimeyes Video

Optimeyes 1.0 (Beta 1)

File Edit Data Studios Arcuate Keratotomy Tools Network About

Integrated Scientific Services
Optimeyes 1.0

Arcuate Keratotomy | Avedro | Cataract | Lasik | Pocket | Artificial Cornea | Comparison | Difference

Identification

Model: 1

Eye Side:

Anterior Wavefront

- Spherical: 0.0000um
- Astigmatism: 0.0000um
- Coma: 0.0000um
- Trefoil: 0.0000um
- Tetrafoil: 0.0000um
- RMS-HOA: 0.0000um

Keratometric Values

SimKs: 43.72D

SimKf: 43.72D

Orientation: 45°

Cylinder: 0.00D

Refraction

Refractive Equivalent:

Average Curvature Profile

47 Curv. [D]

45

43

41

39

37

35

0.0 1.0 2.0 3.0 4.0 5.0

Rad. [mm]

Average Curvatures

Best-fit-sphere

ACS Radius: 0.00mm

PCS Radius: 0.00mm

Pachymetry

CCT: 545um

Anterior Curvature (D)

10.00 18.67 27.33 36.00 36.67 43.33 55.00 56.67 63.33 70.00 76.67 83.33 90.00

Representation: 4/4 3/4 2/4 1/4

Anterior Refractive Power (D)

10.00 18.67 27.33 36.00 36.67 43.33 55.00 56.67 63.33 70.00 76.67 83.33 90.00

Anterior Stigmatism Curvature (D)

10.00 18.67 27.33 36.00 36.67 43.33 55.00 56.67 63.33 70.00 76.67 83.33 90.00

LRI Orientation

Ori: 0.00° Pos: 3.50mm Len: 45.00°

LRI Profile

Ang: 90.00 Pos: 3.50 Dep: 0.90

LRI Editor

Depth (um): 502

Apply

Incision on one side only

Orientation: 0.00

Position: 3.50

Length: 45.00

Angle: 90.00

Depth: 0.90

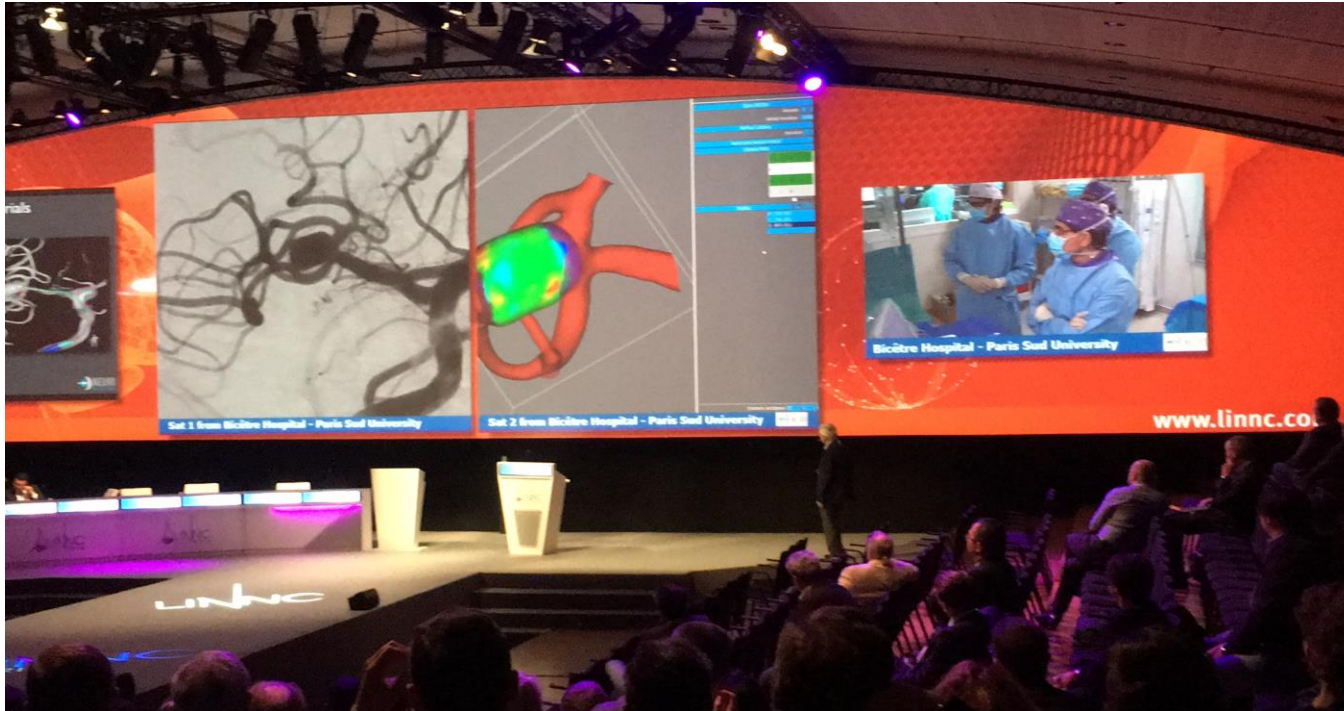
Imports [] Exports []

Audio 00:00:00

Press Ctrl+End to stop

ANSYS

Cerebral Aneurysm Repair Web Optimal Sizing Tool (WOST)



LINNC Conference in Paris
WOST in action in front of
800 clinicians

Partners:

- Hospital of Montpellier,
- Sim&Cure (Clinical Software Vendor)

Vertical App: WEB Stent sizing tool deployment of a cage inside the aneurysm

IDsize Video

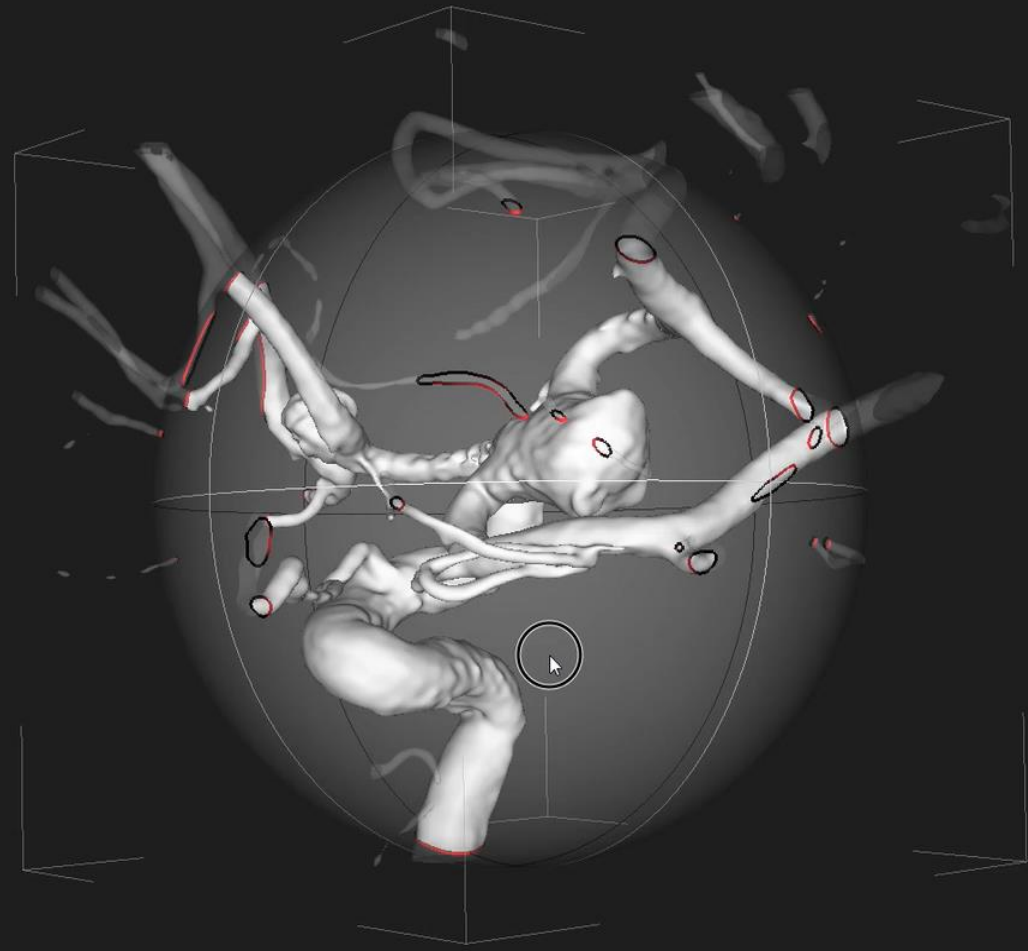
WOST-2.0.b9591.dev



WORK LIST CASE PLANIFICATION

NAME: Anonymized3
SERIES UID: 1.2.276.0.7230010.3.1.3.338144199.3280.1463740741.1187
SERIES DATE: 2014-05-22

Select the region of interest



<< Next >>

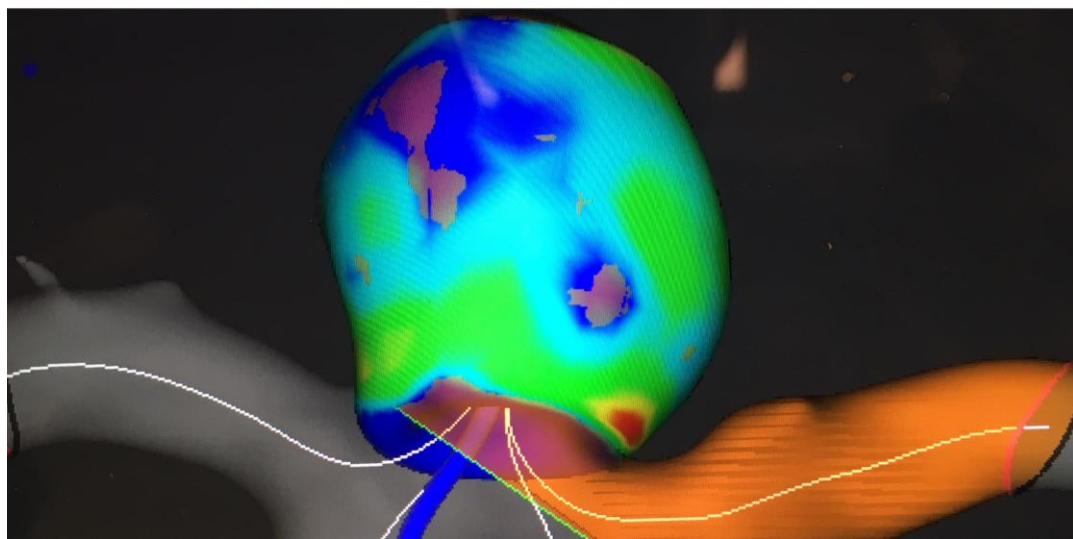
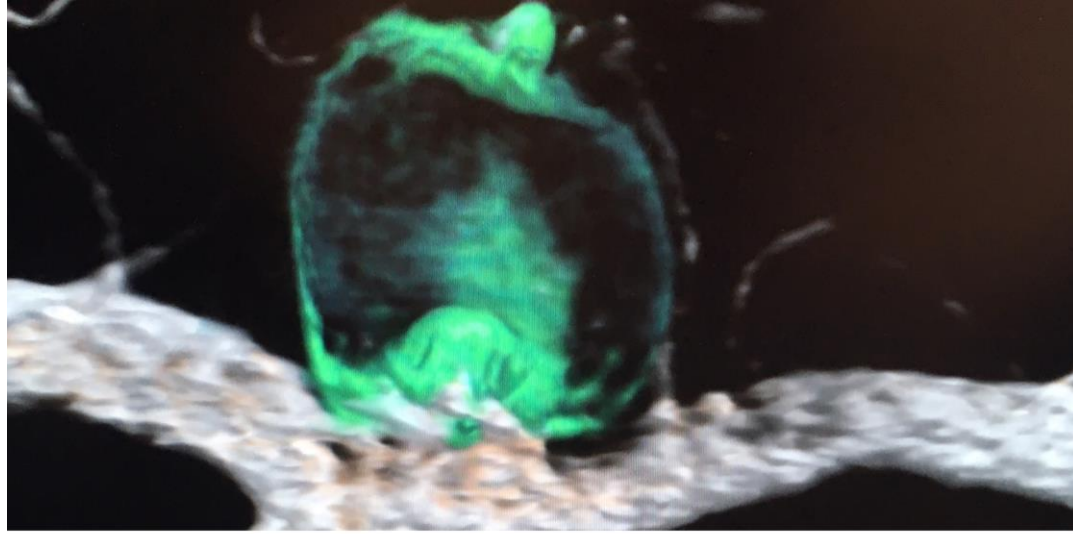
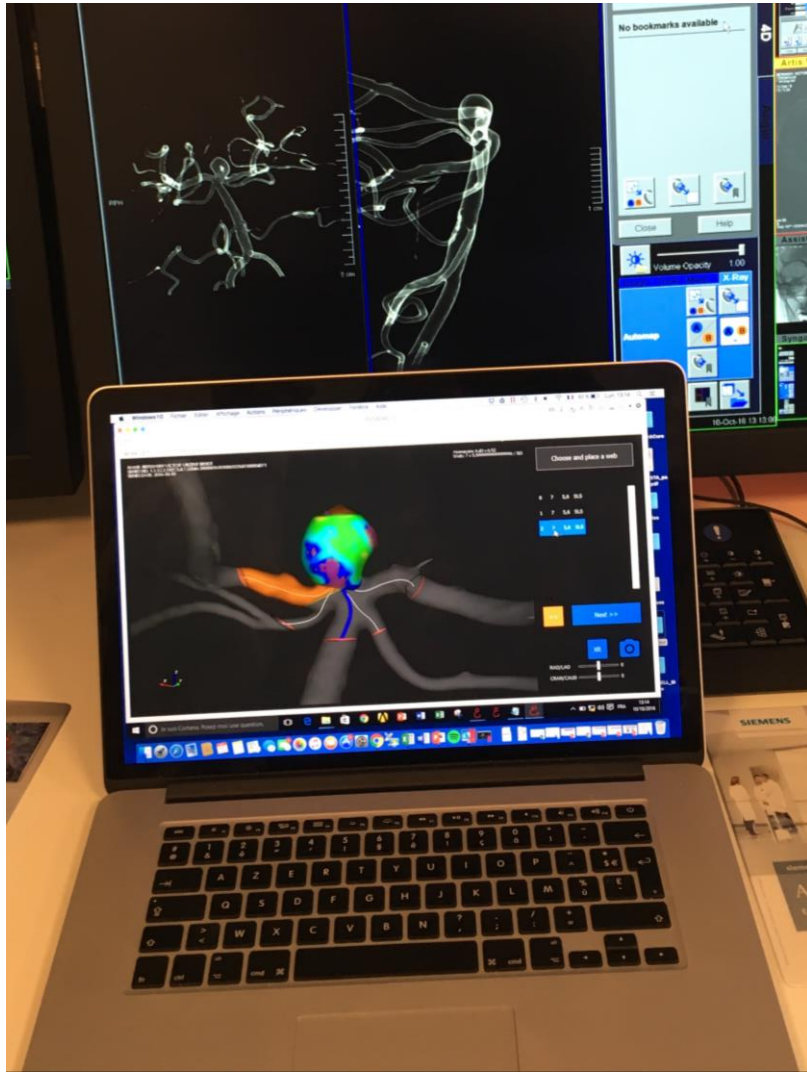


XR

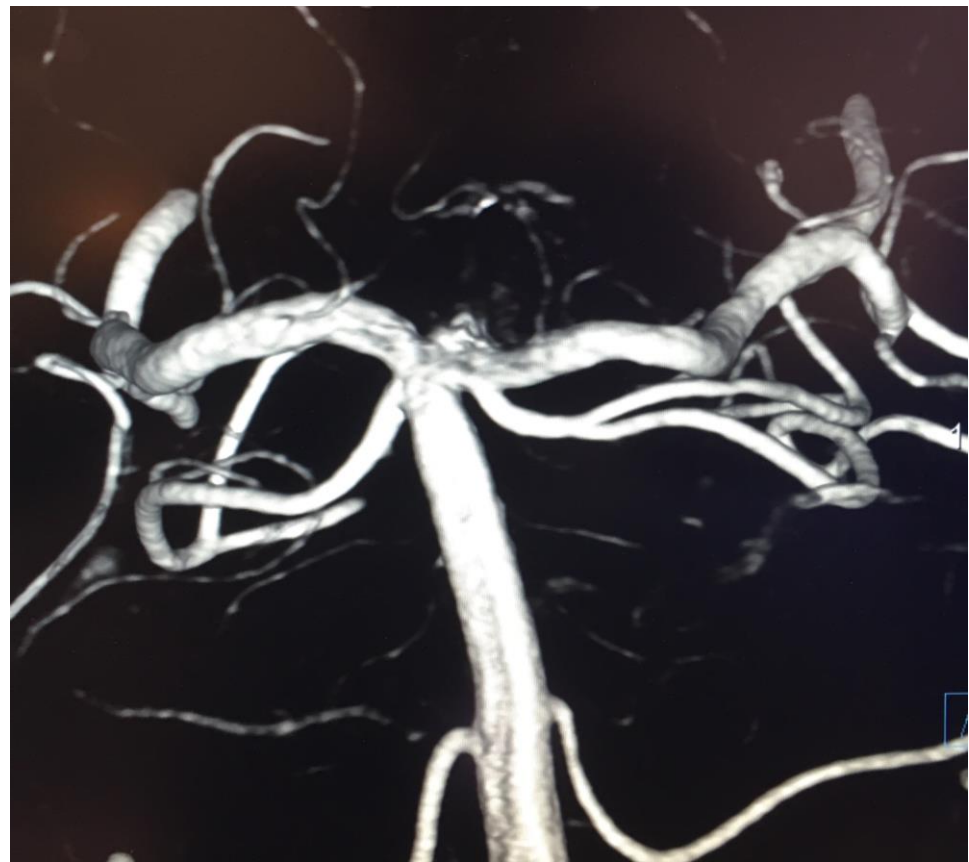
RAO/LAO 0

CRAN/CAUD 0

IDsize Prospective case



IDsize Prospective case



Patient-specific computations = faster, cheaper and more accurate

Prof. Costalat (Head neuroradiology Department Montpellier Hospital):
“Engineering simulation is a very promising technology to assist me when I’m working on my therapeutic planning. The results provided by simulation have proven to be reliable enough to help in the choice of the device.”

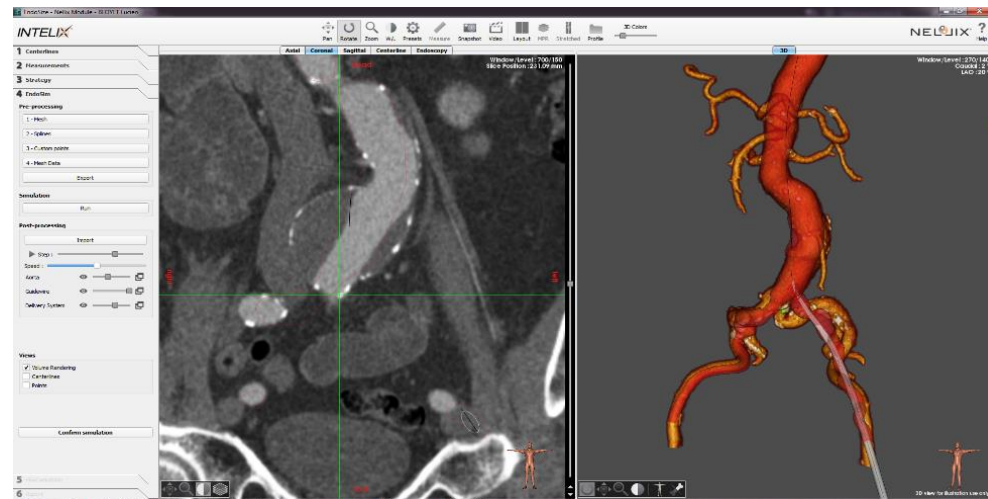
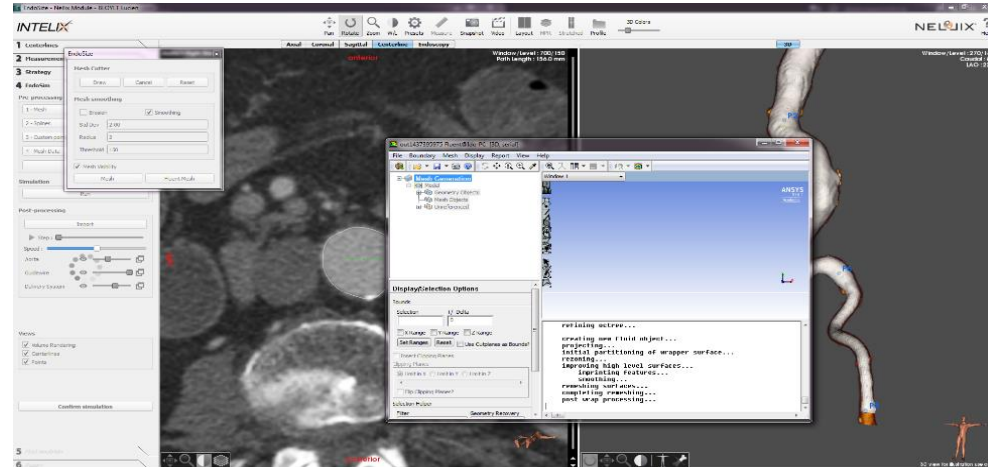
Aortic Abdominal Aneurysm Repair EndoSim

Partners:

- Hospital of Rennes
- LTSI (Lab, Image Processing)
- Therenva (Clinical Software Vendor)

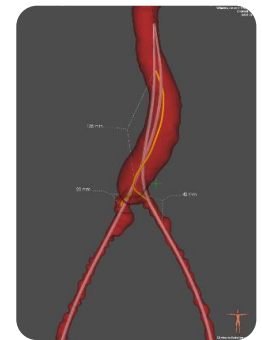
Vertical Apps:

1. Stiff Guidewire Introduction
2. Delivery System Introduction
3. Intra-operative assistance



Therenva Portfolio

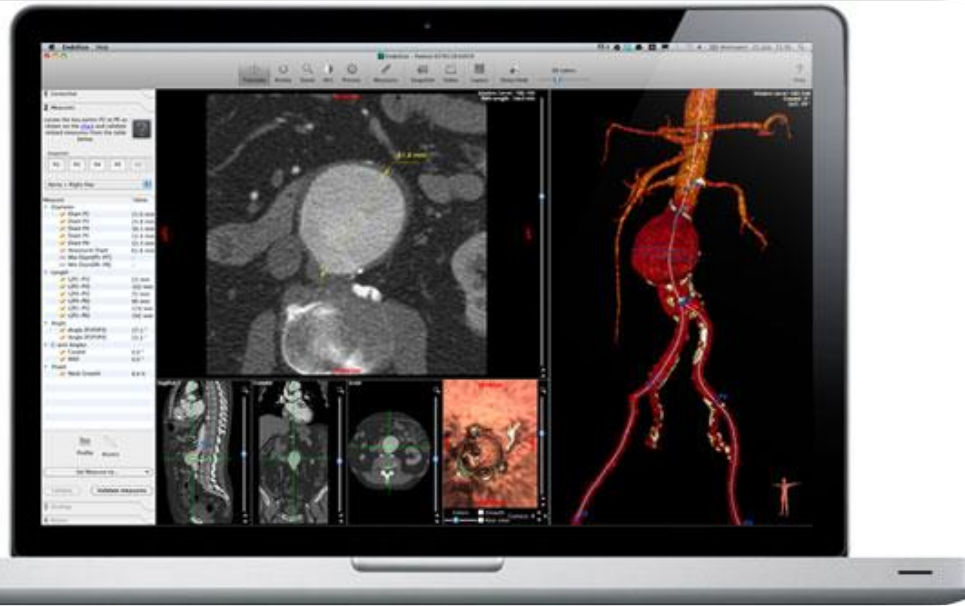
- **EndoSize** case planning software
- **EndoNaut** 3D intra-operative navigation system
- **EndoSim** advanced simulation plug-ins for EndoSize/EndoNaut



EndoSize®

Case planning solution for endovascular surgery

- EVAR, TEVAR, FEVAR, TAVI, PAD modules -



CE
CE Class IIa
CFDA
FDA 510(k)



Active License Base : 800+ licenses

EndoNaut®

Intra-operative 3D Navigation



- 3D Roadmap based on preoperative planning data extracted from EndoSize
- Compatible with any mobile C-arms
- Reduce X-ray dose and contrast agent
- Safer device positioning and deployment
- Low-cost solution for upgrading conventional OR into 3D environments



EndoNaut V1



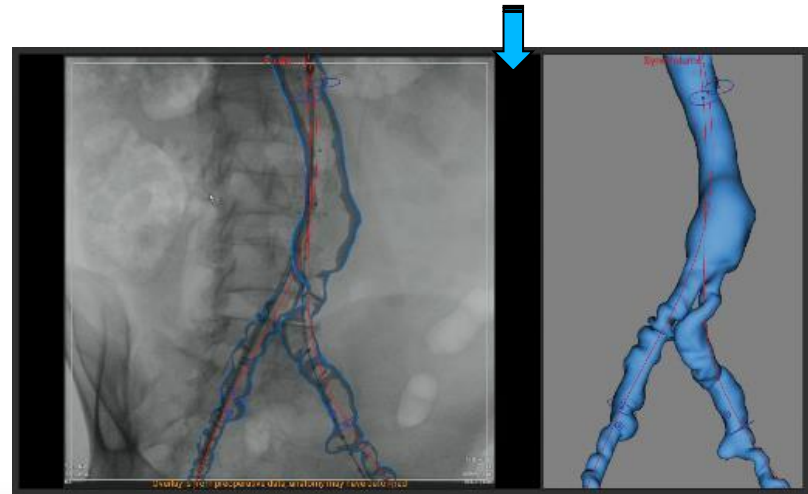
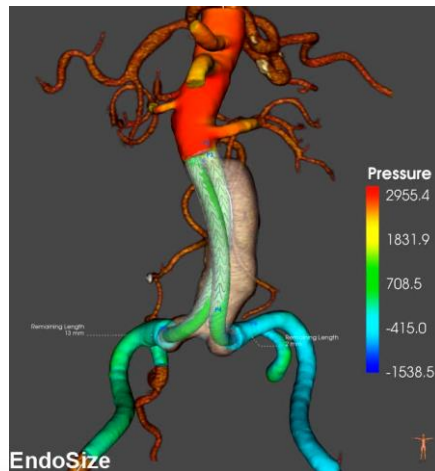
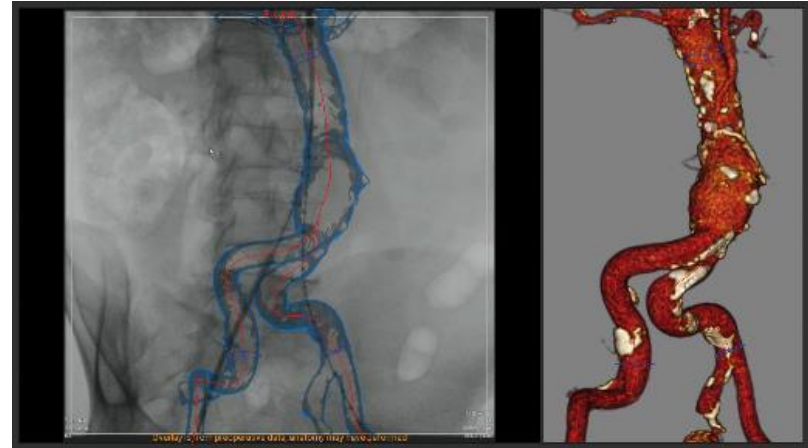
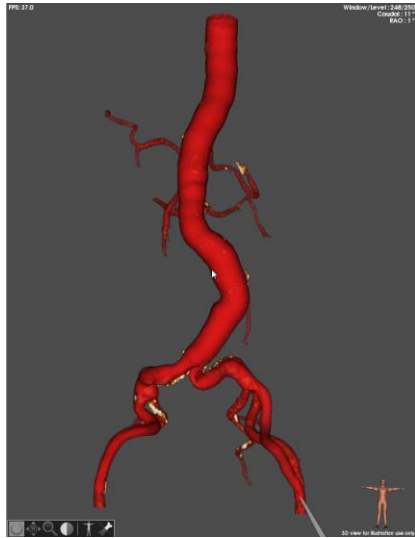
> Class IIb CE mark (received in April 2016)

ANSYS®

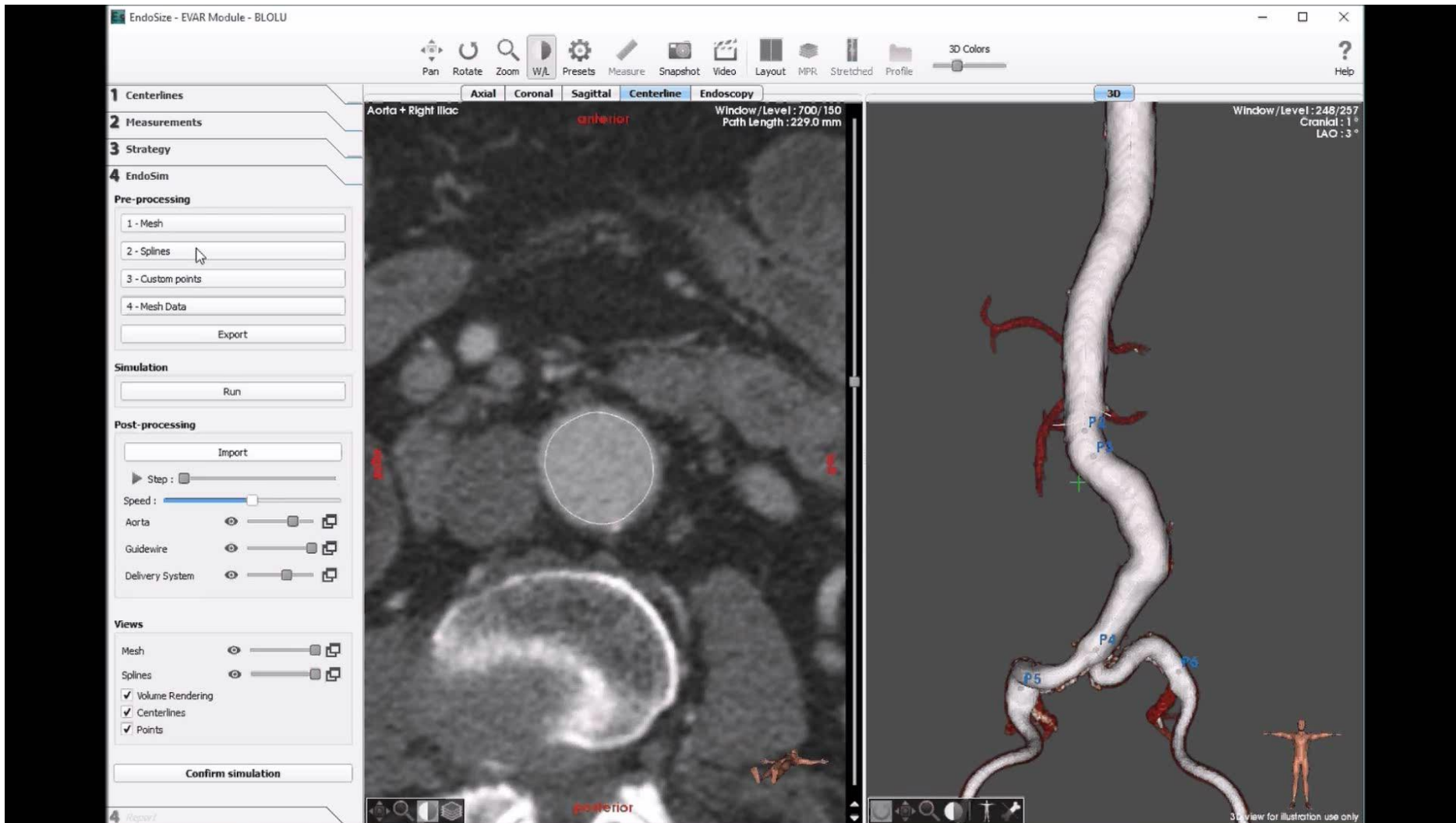
EndoSim Plug-ins for EndoSize

Biomechanical Simulation-based Planning

Aortic Abdominal Aneurysm Repair



EndoSim / EndoSize



EndoSim / EndoNaut



EndoNaut /EndoSim Clinical Benefits

Dr Adrien Kaladji (Vascular Surgeon Hospital of Rennes):

“Navigation within vascular structure is possible without iterative contrast injection. EndoSim-EndoNaut is fully compatible with the clinical workflow and offers a lot of information that were not available before and make endovascular imaging-based procedures much more easier.”

ANSYS[®]

Beating Heart

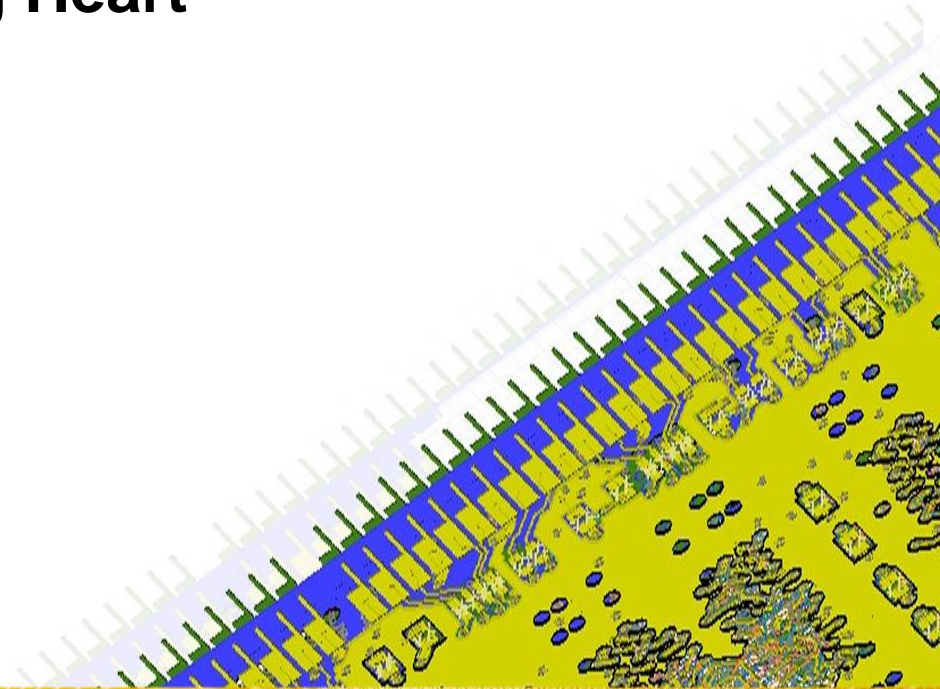
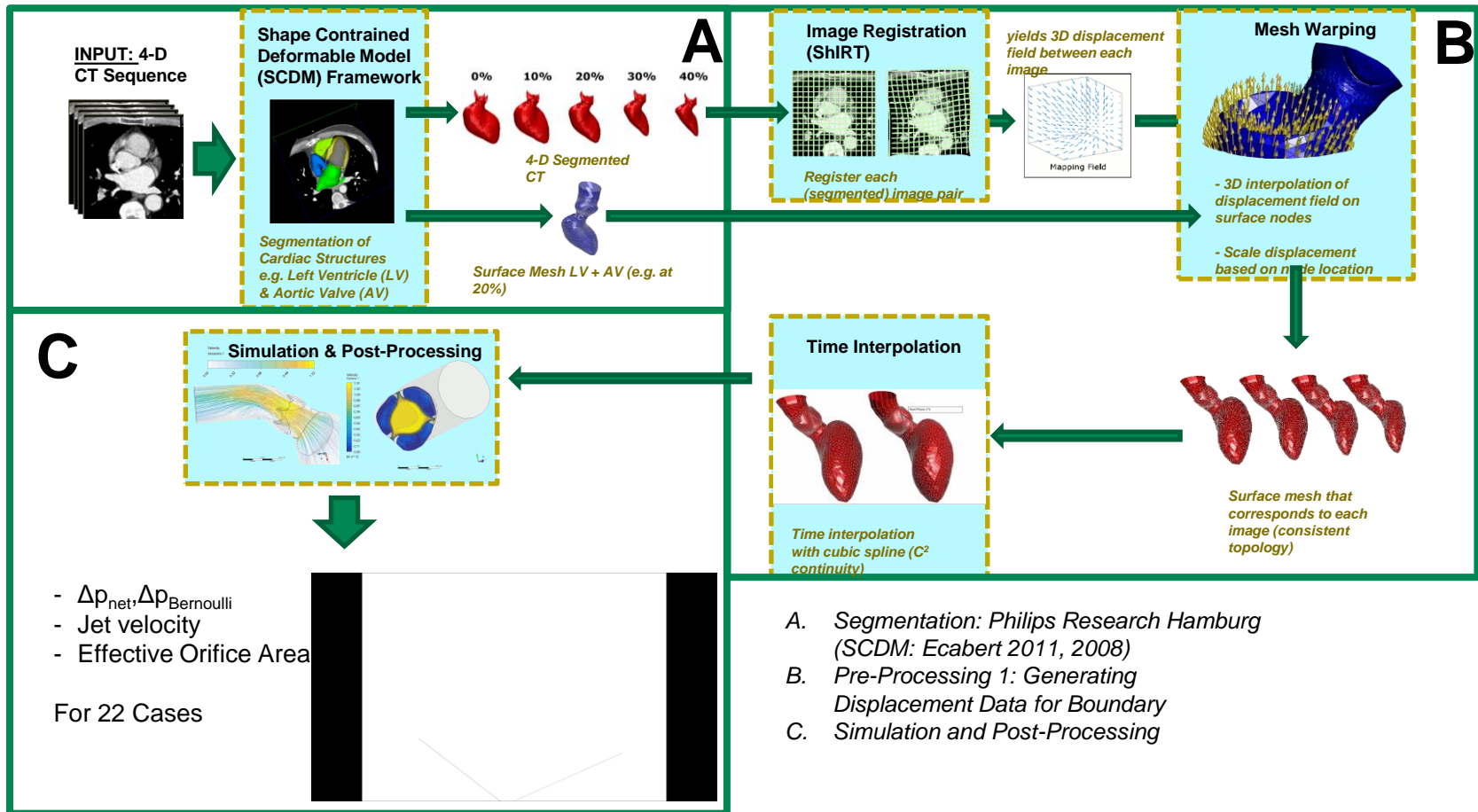
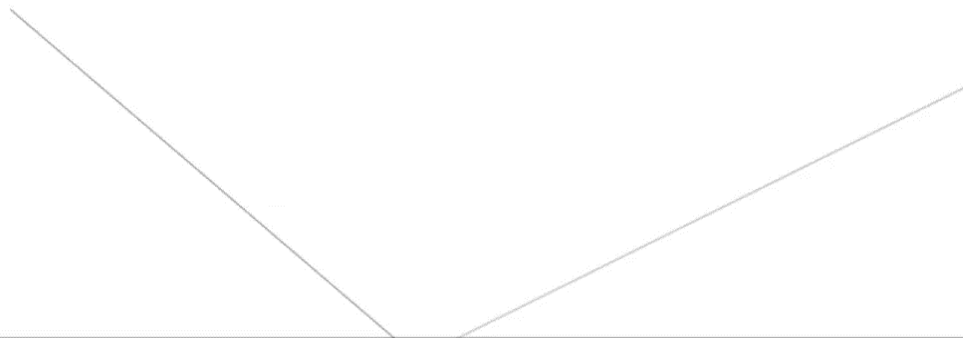


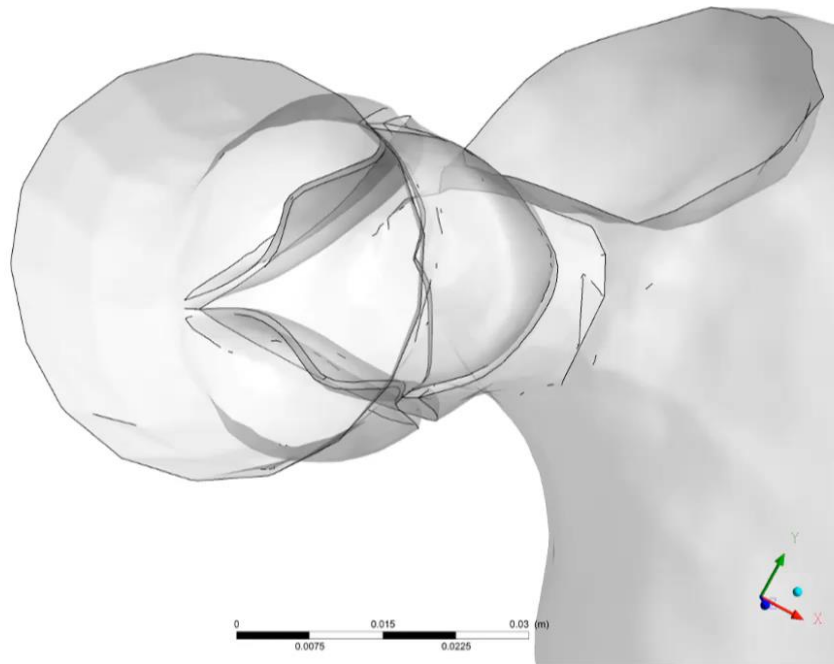
Image-Based Cardiac Hemodynamics





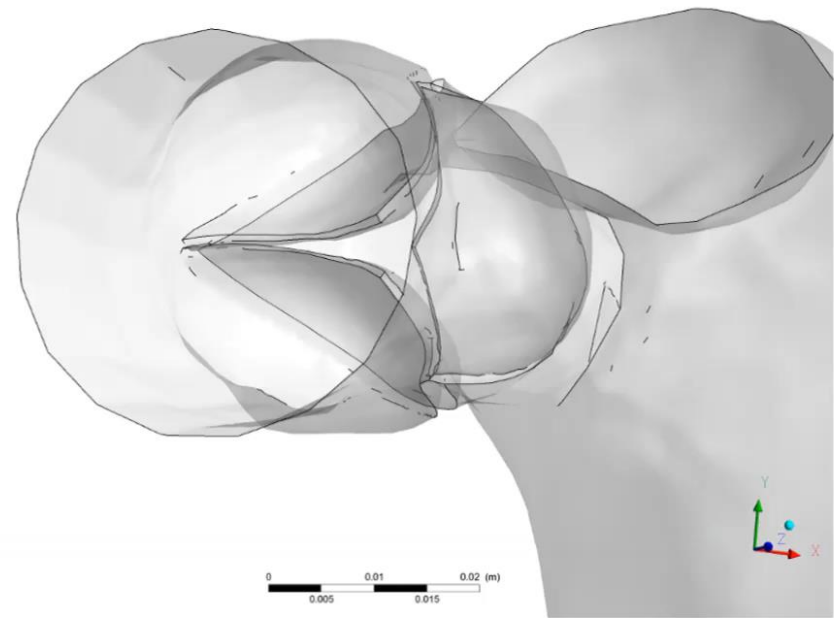
Healthy Valve

ANSYS
R16.2



Stenosed Valve

ANSYS
R16.2



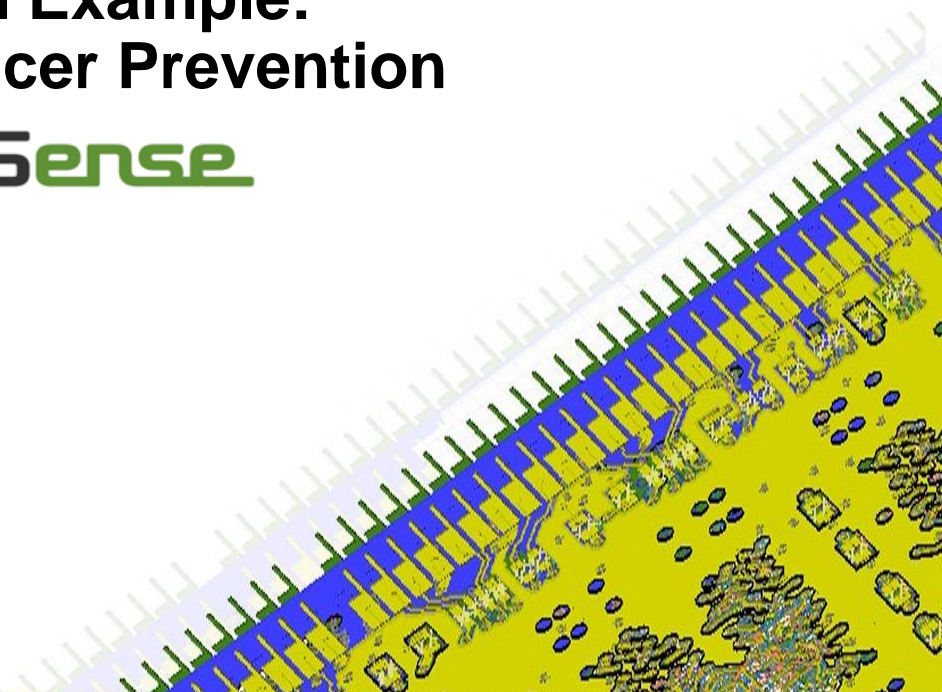
The ANSYS logo is displayed in a black rectangular box. The word "ANSYS" is written in a bold, sans-serif font. The letters "AN" are white, and "SYS" is gold. A registered trademark symbol (®) is located at the top right of the "S".

ANSYS®

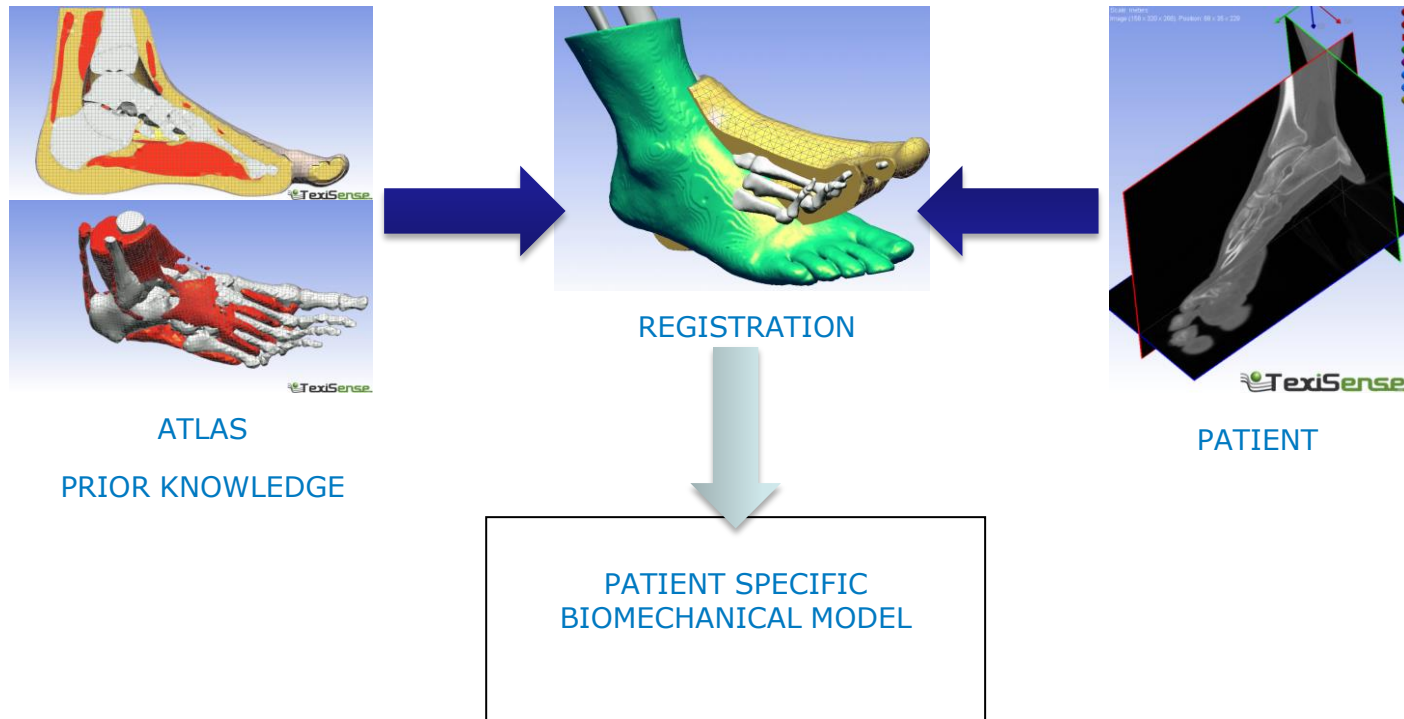
Digital Twin Example: Diabetic Foot Ulcer Prevention

The TexiSense logo features a stylized green icon on the left, consisting of three curved lines and a solid green circle. To the right of the icon, the word "TexiSense" is written in a green, sans-serif font.

TexiSense

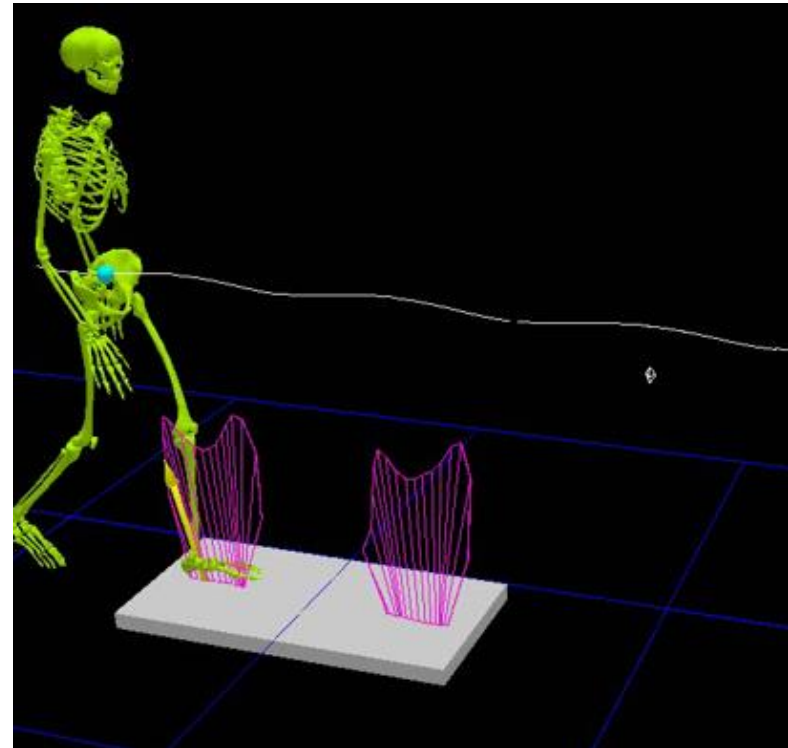


Patient Specific Biomechanical Model of the Foot



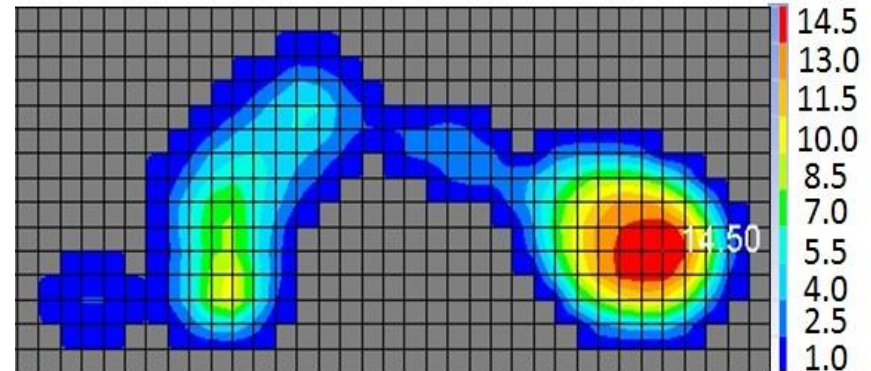
Diabetic Foot Ulcer Prevention

- **Challenge:**
Real time and embedded system with complex non linear model:
 - Each simulation takes about 2h30 on our simulation platform with a powerful desktop PC
 - Too slow and too heavy for real time prevention of pressure ulcers embedded on a micro processor...
- **Solution:**
Creation of a Reduced Order Model (ROM)



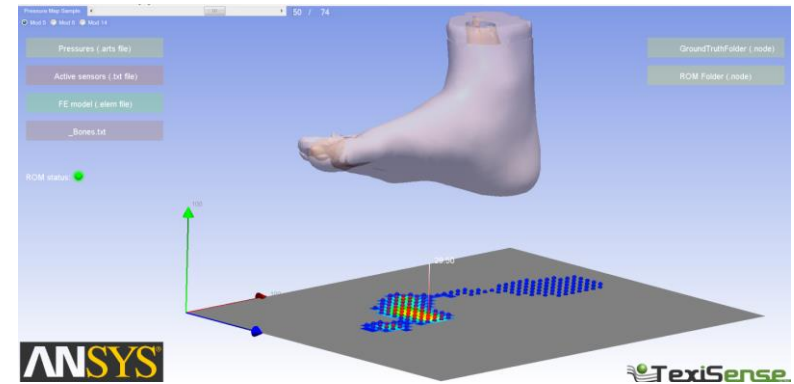
Reduced Order Model (ROM) Creation

- For the patient, acquisition of the pressure below his foot
- Lead to pressure fields for 75 time steps (from taligrade to digitigrade)
- Projection of these pressure fields in a base of 14 modes
- Computation of the deformation fields on the 75 time steps associated to the previous pressure fields.

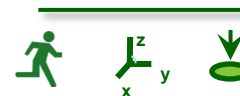


Using the Reduced Order Model (ROM) for Ulcer Prevention

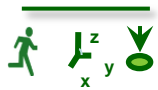
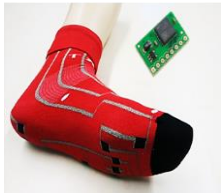
- For any pressure field (dynamic acquisition):
 - Projection of this pressure field in the base of n modes
 - Evaluation of the ROM for this input parameter (n scalar values)
- These 2 steps are quick and reliable
- Real time evaluation of the deformation field with respect to the pressure acquisition



Sensors in the Socks



ROM Evaluation in the IoT Environment



1.

**AQUIRING
DATA**



2.

**BLUETOOTH
TRANSMITS
DATA**



3.

**SMARTPHONE
COMPUTES ROM**



4.

**LOCAL
ALERT**



5.

**REMOTE
MONITORING**





Questions

