

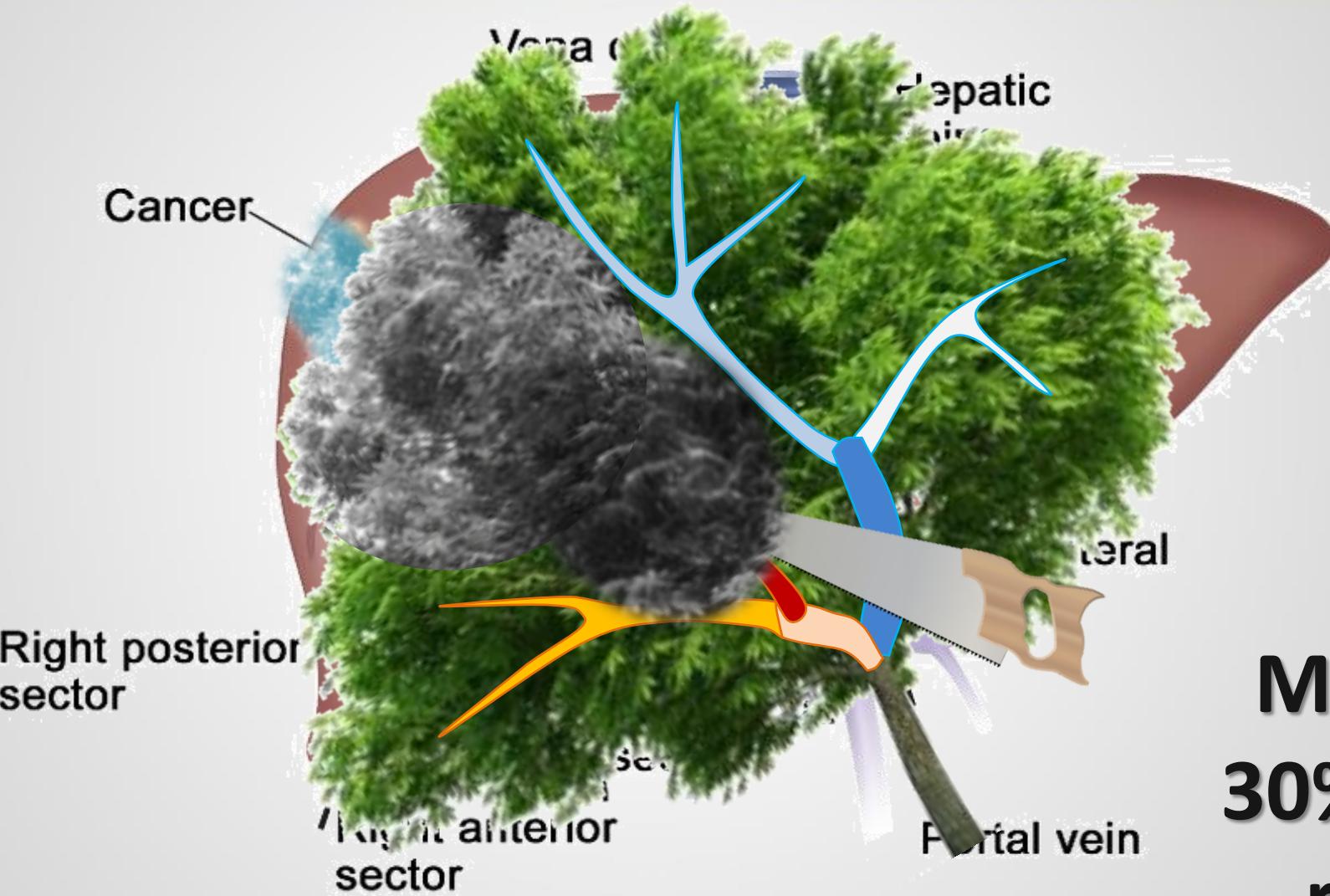
La chirurgie augmentée et le concept du “Visible Patient”

Prof. Luc SOLER,
IRCAD Scientific Director,
Visible Patient President.

Dr. Alexandre Hostettler,
Prof. Patrick Pessaux,
Prof. Didier Mutter,
Prof. Jacques Marescaux.

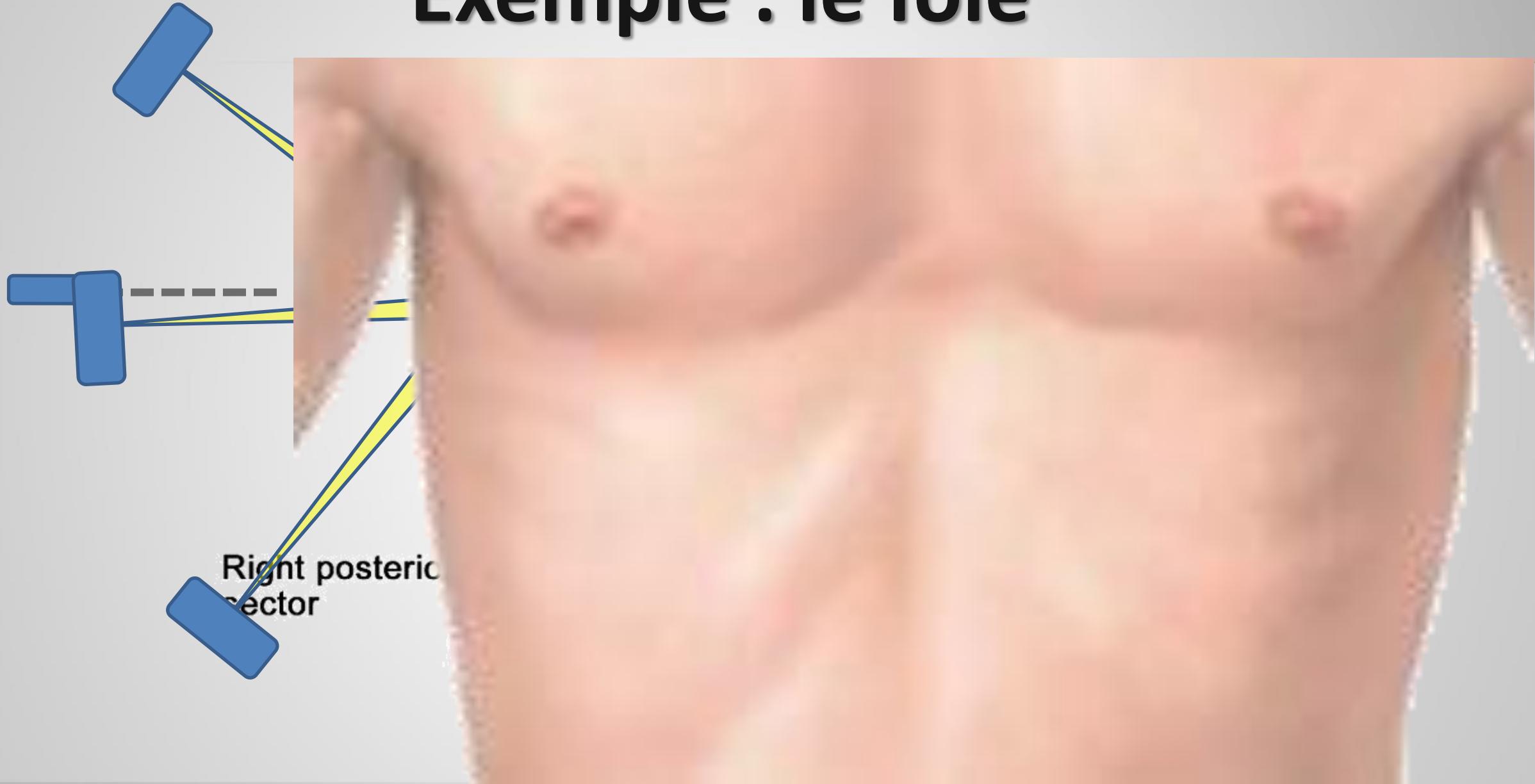


Exemple : le foie

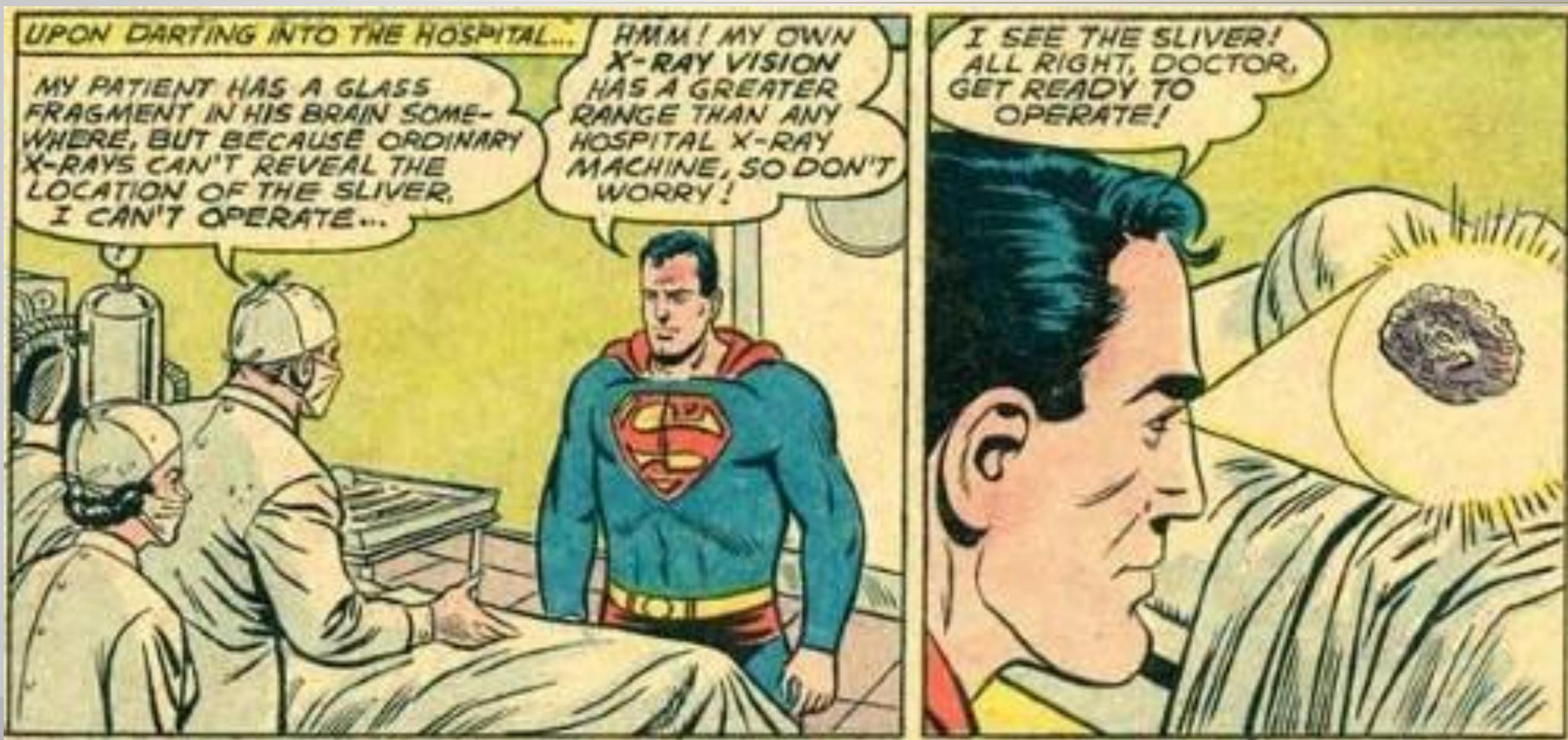


**Minimum
30% de foie
restant**

Exemple : le foie



Tout chirurgien voudrait être superman



Problème: capacités limitées de vision

Nos yeux ne voient que 16 niveaux de contraste

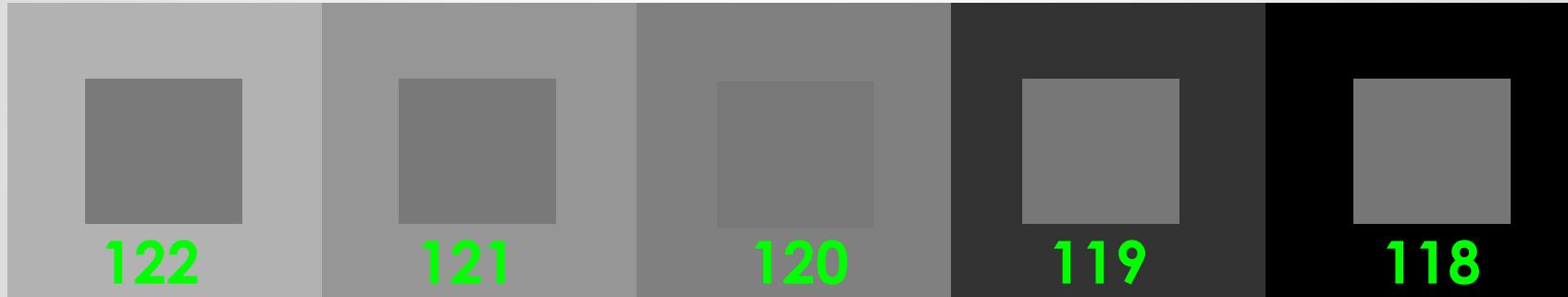
Densité 122



Densité 118

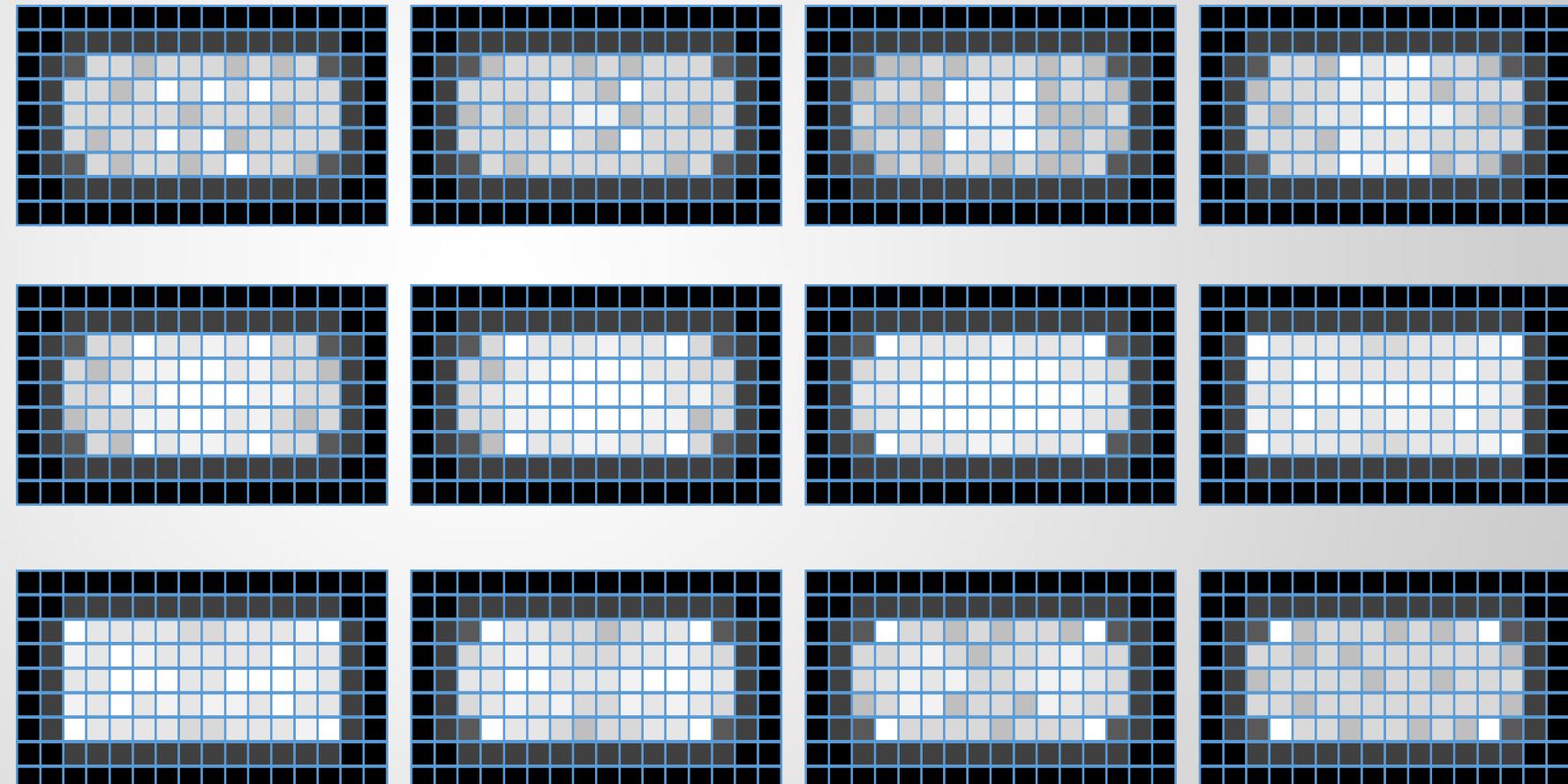
Problème: capacités limitées de vision

Nos yeux ne voient que 16 niveaux de contraste



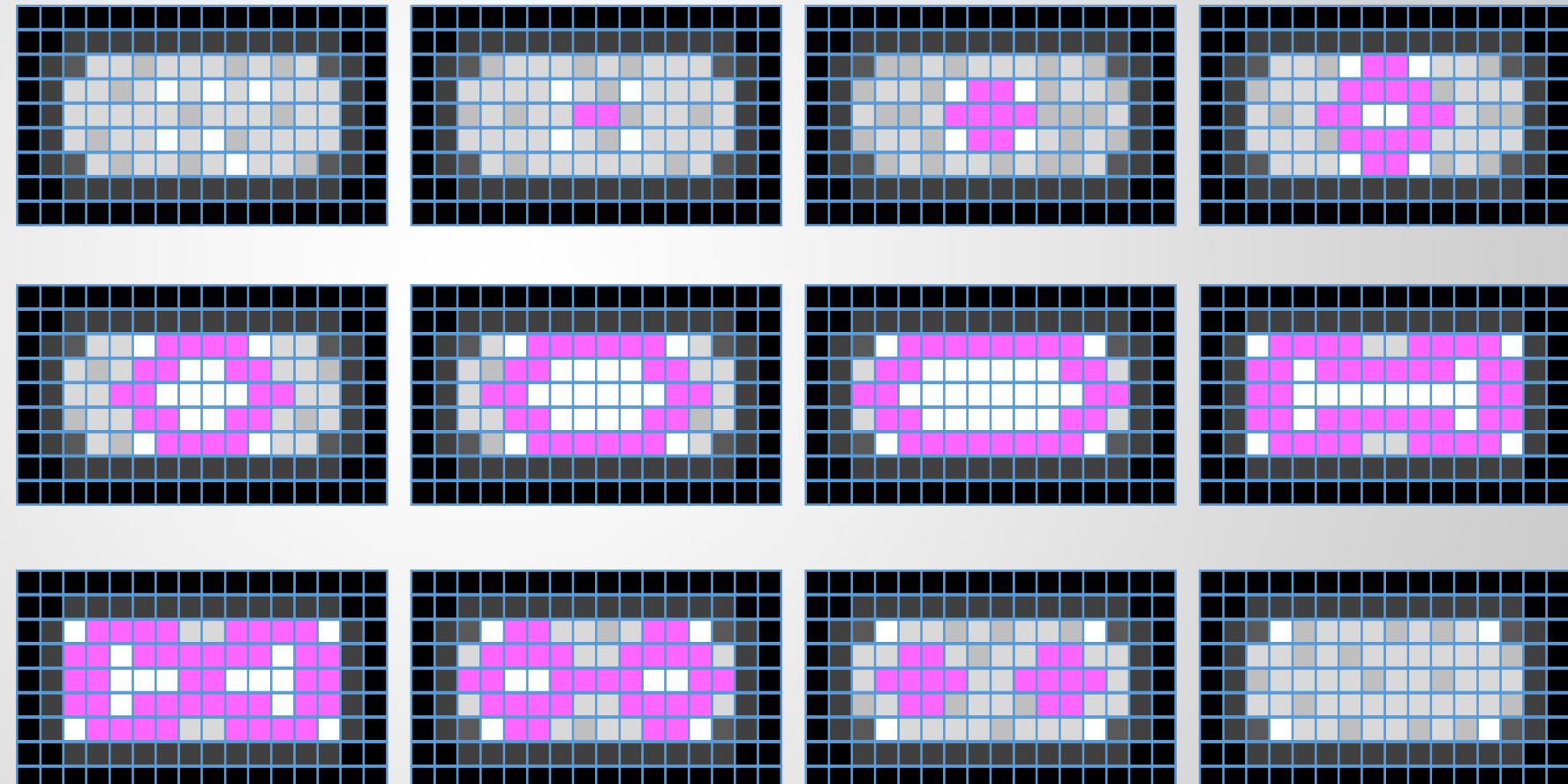
Problème: capacités limitées d'interprétation

Une image médicale 3D est en fait une série de coupes 2D

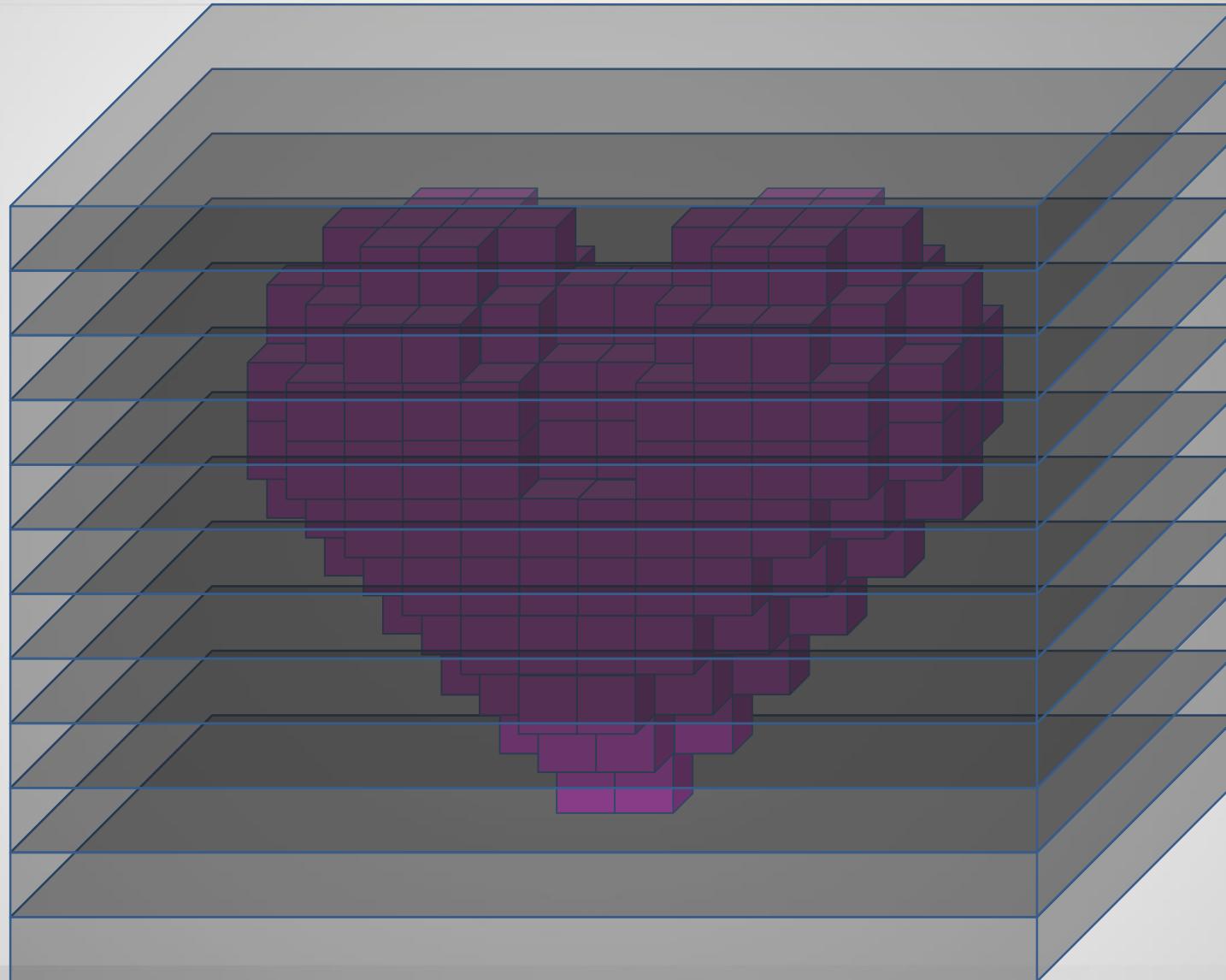


Problème: capacités limitées d'interprétation

Une image médicale 3D est en fait une série de coupes 2D



En 3D notre cerveau reconnaît facilement



**2012: enquête de la DRESS pour le
ministère de la santé**

**Entre 60.000 et 92.000
Erreurs évitables graves en chirurgie**

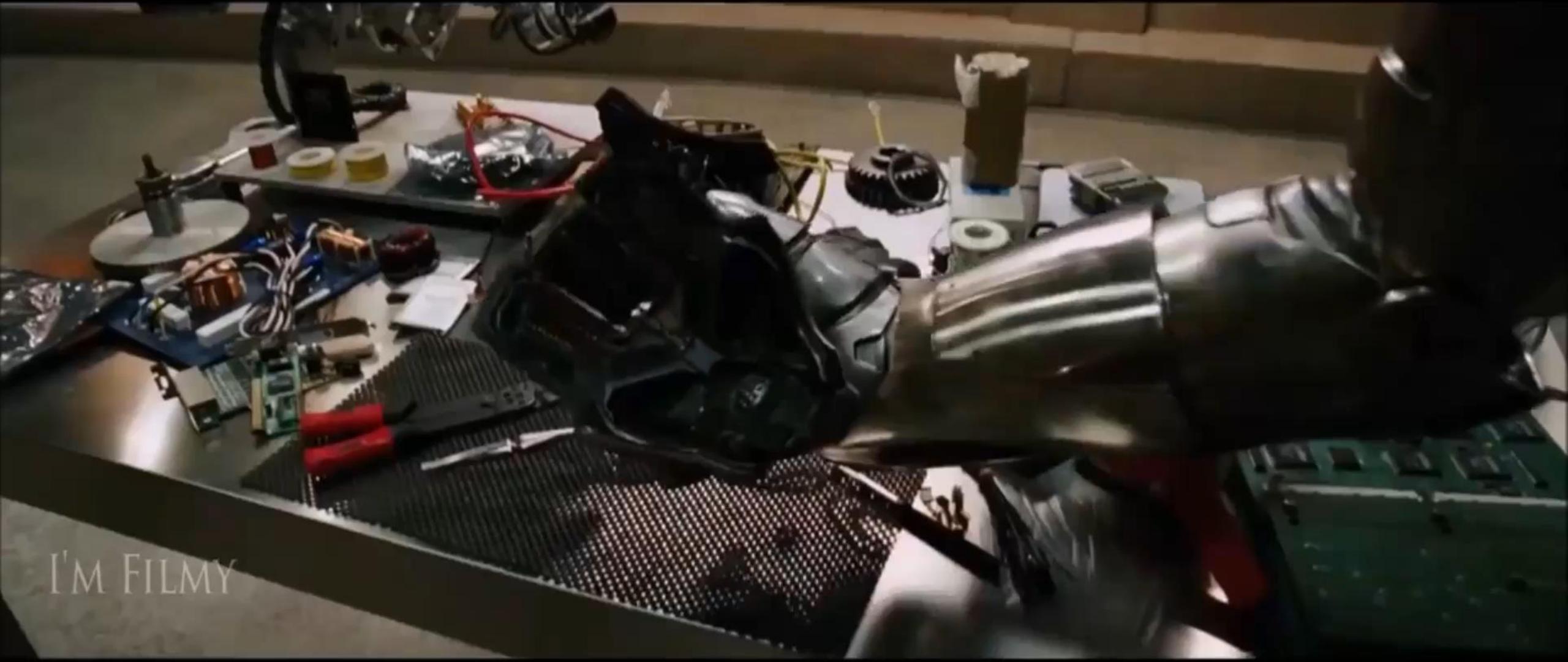
Sur 6 millions d'actes réalisés = 1%

20% de ces erreurs sont le fait

**D'une erreur de diagnostique
ou de choix thérapeutique**

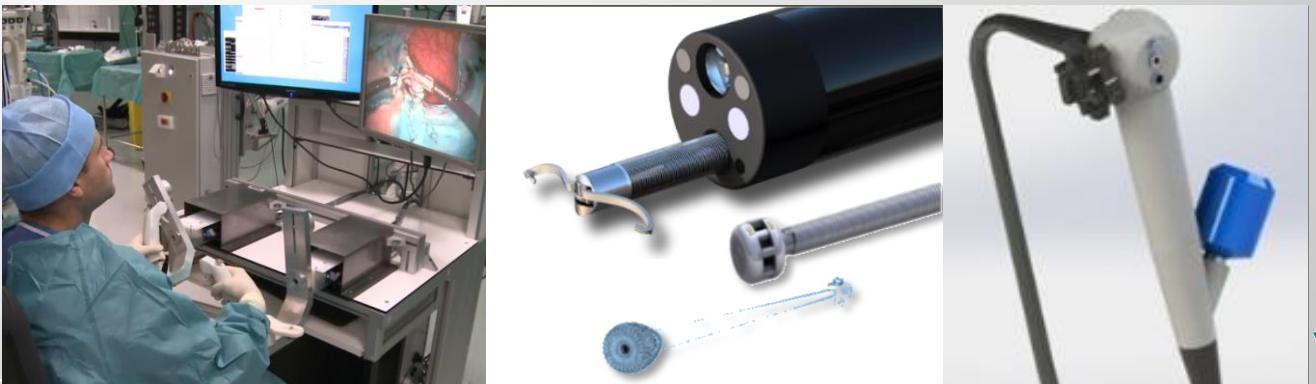
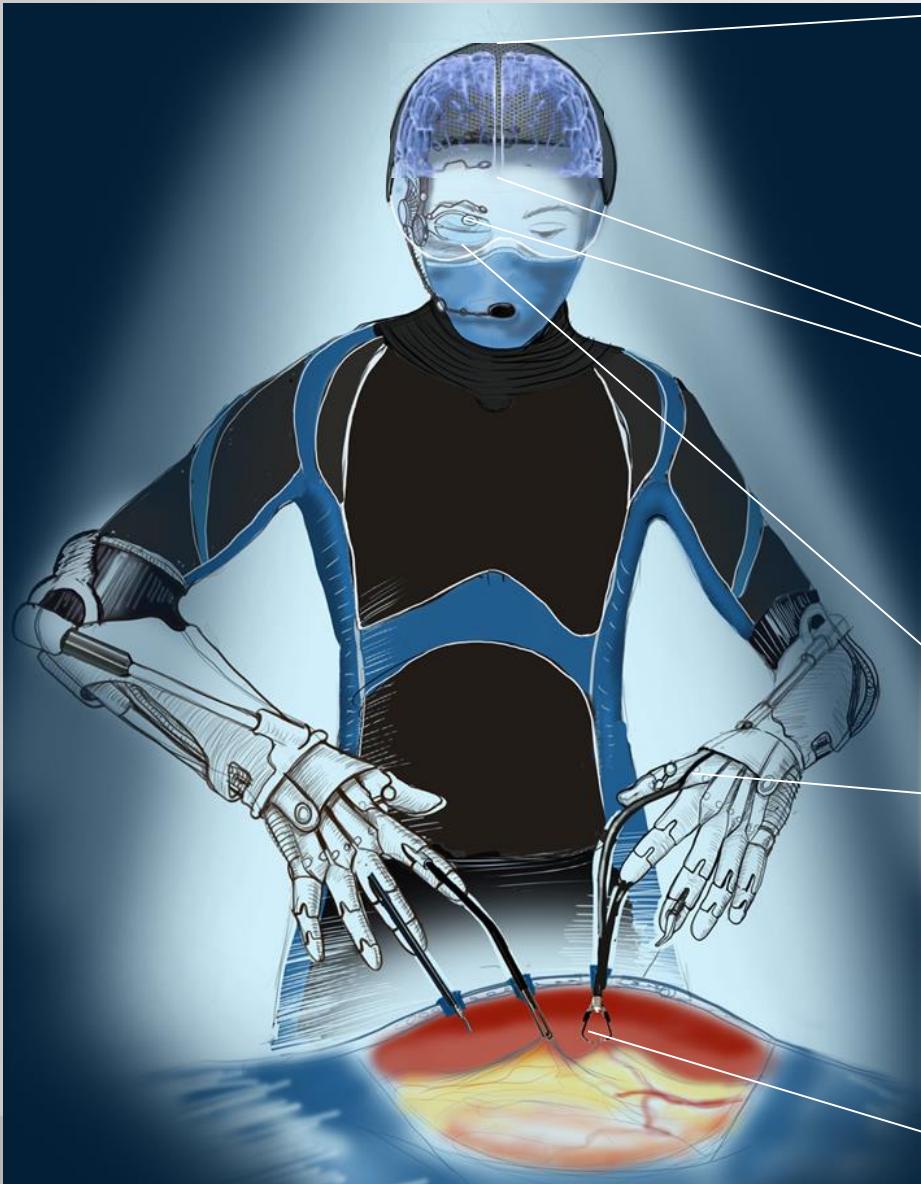
Alors que faire ?...

I'M FILMY



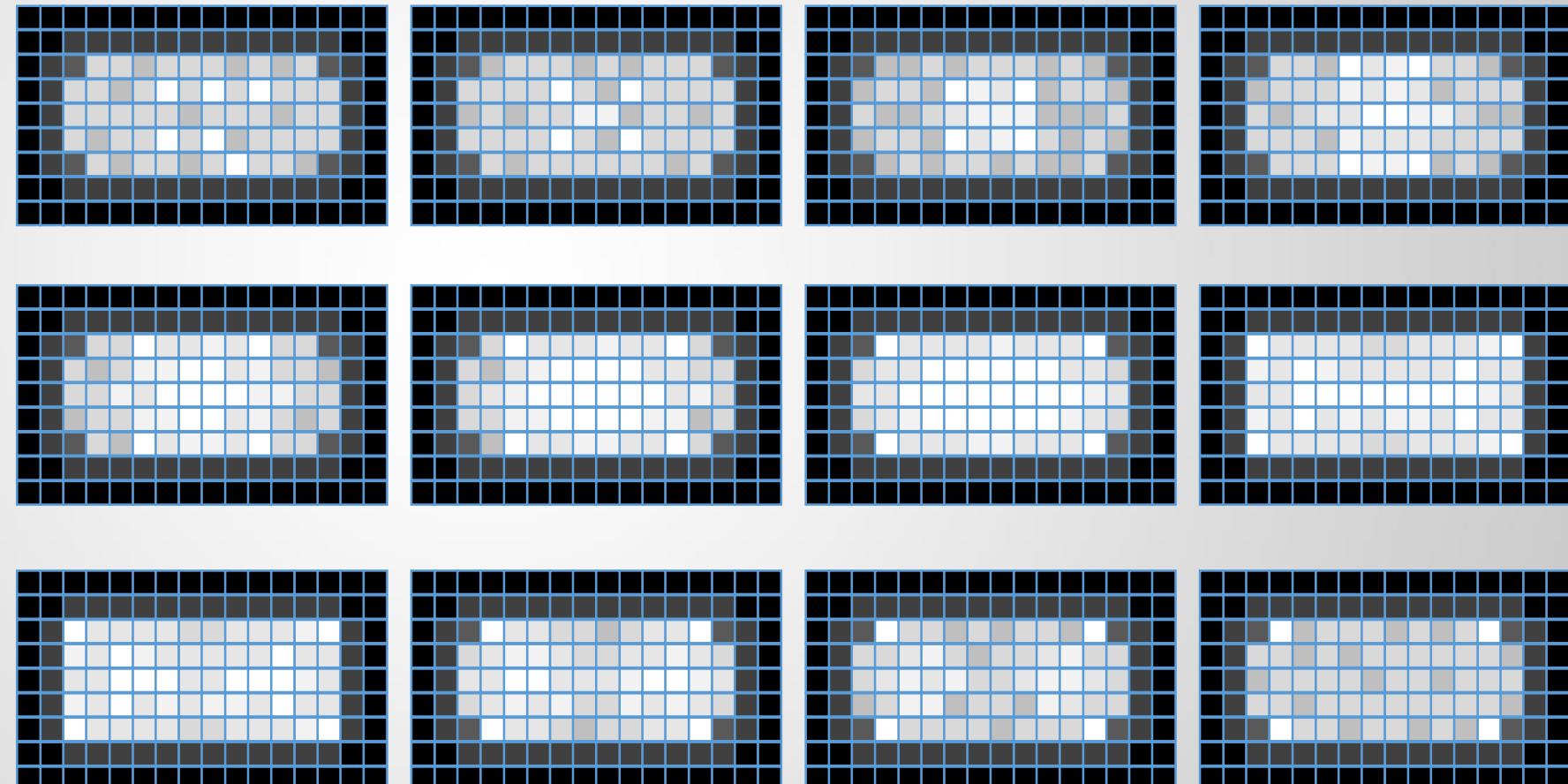
I'M FILMY

IRCAD: La chirurgie augmentée

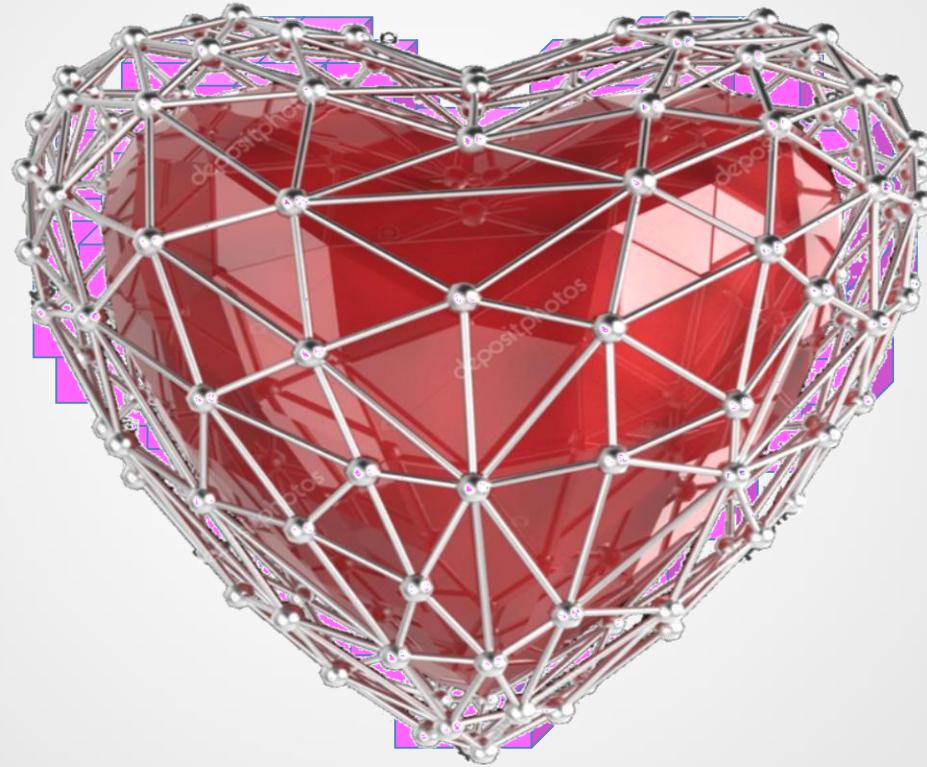


Problème: capacités limitées d'interprétation

Une image médicale 3D est en fait une série de coupes 2D



Solution: Modélisation 3D



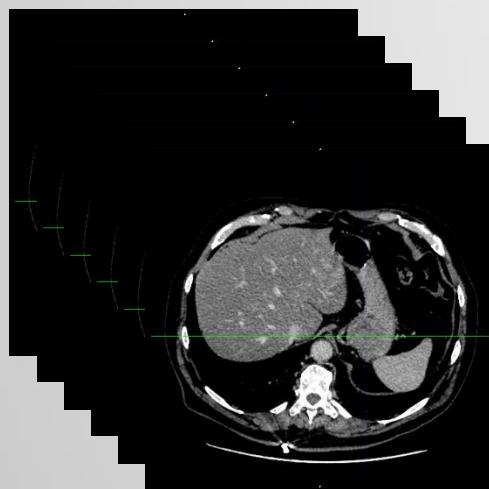
VISIBLE PATIENT



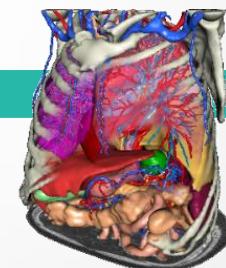
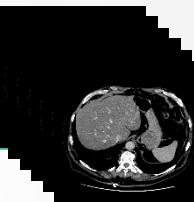
Routine clinical
MRI or CT-SCAN



DOCAPOST
Certified Medical
data storage

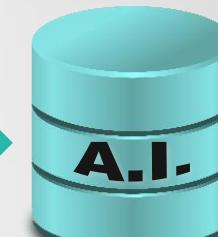


Costs for :
3D modelling
only

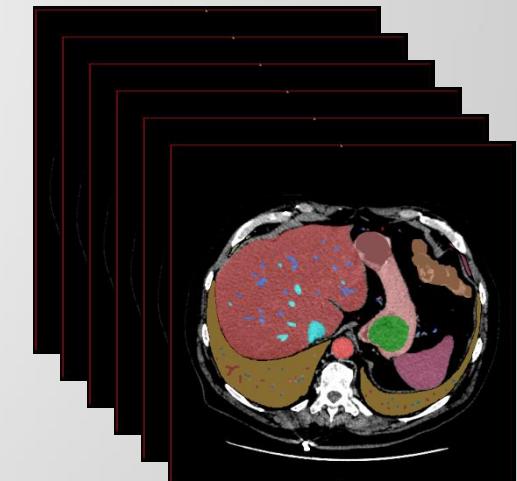


VISIBLE PATIENT

3D Modelling

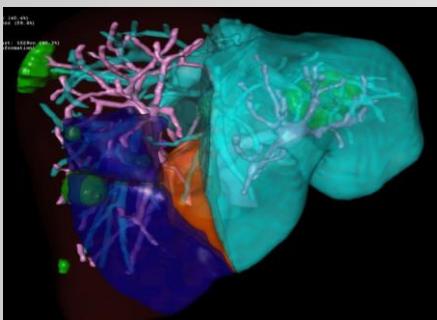


Quality: Double check

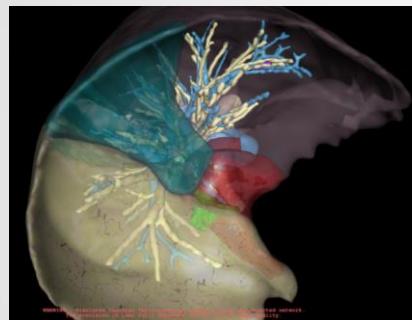


Any part of the Body : Today More than 3000 patients

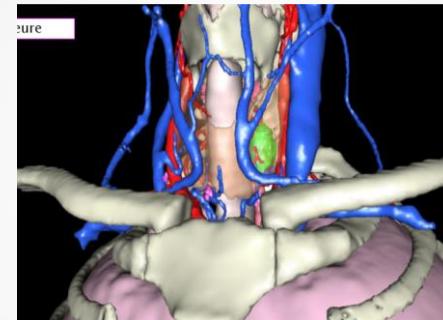
Liver



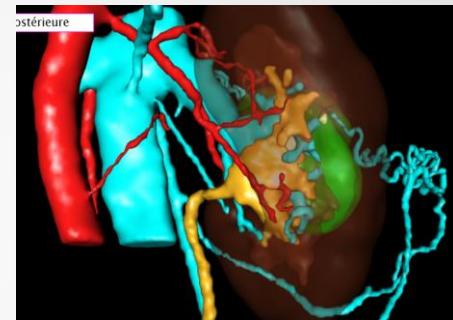
Lung



ParaThyroid



Kidneys



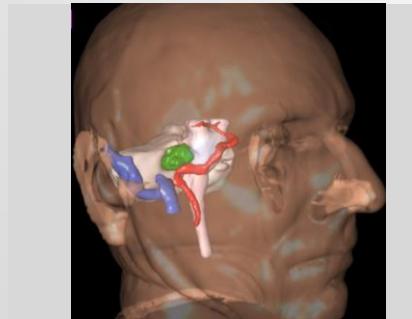
Pancreas



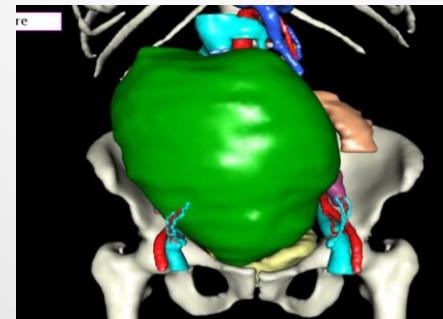
Prostate



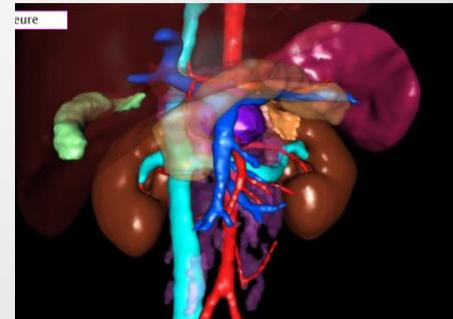
Brain



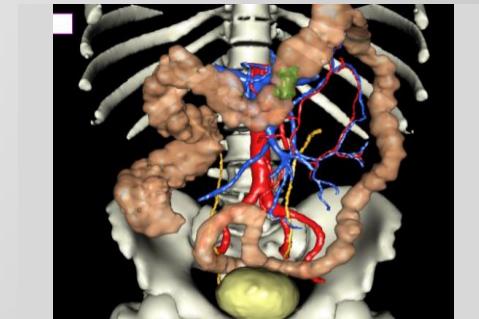
Gynaecology



Adrenal



Colorectal



Prise en charge par les assurances :

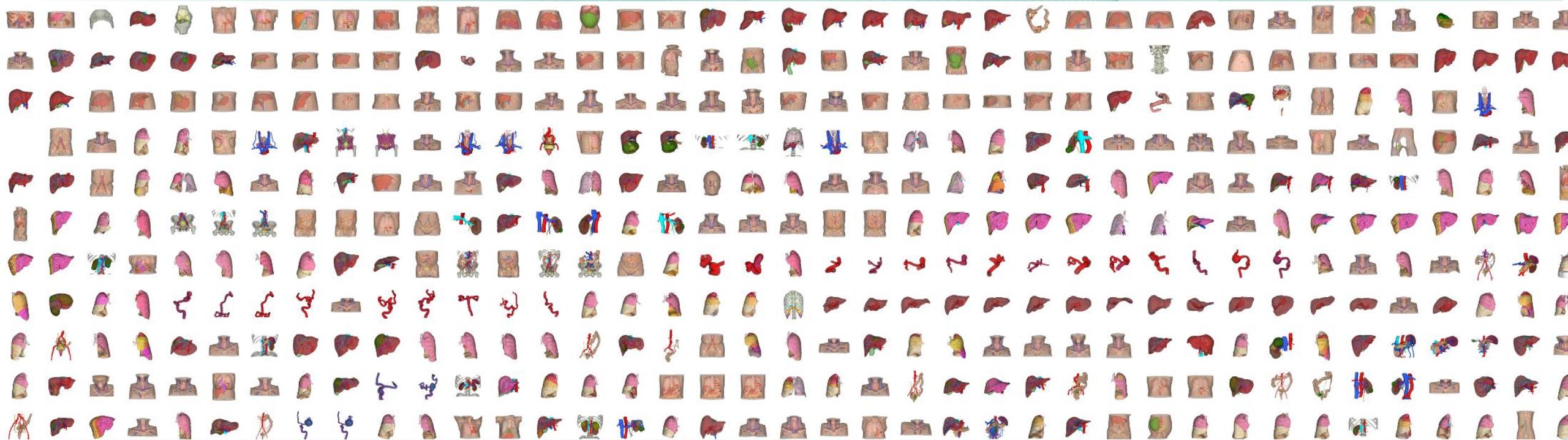
Assurances
Crédit Mutuel



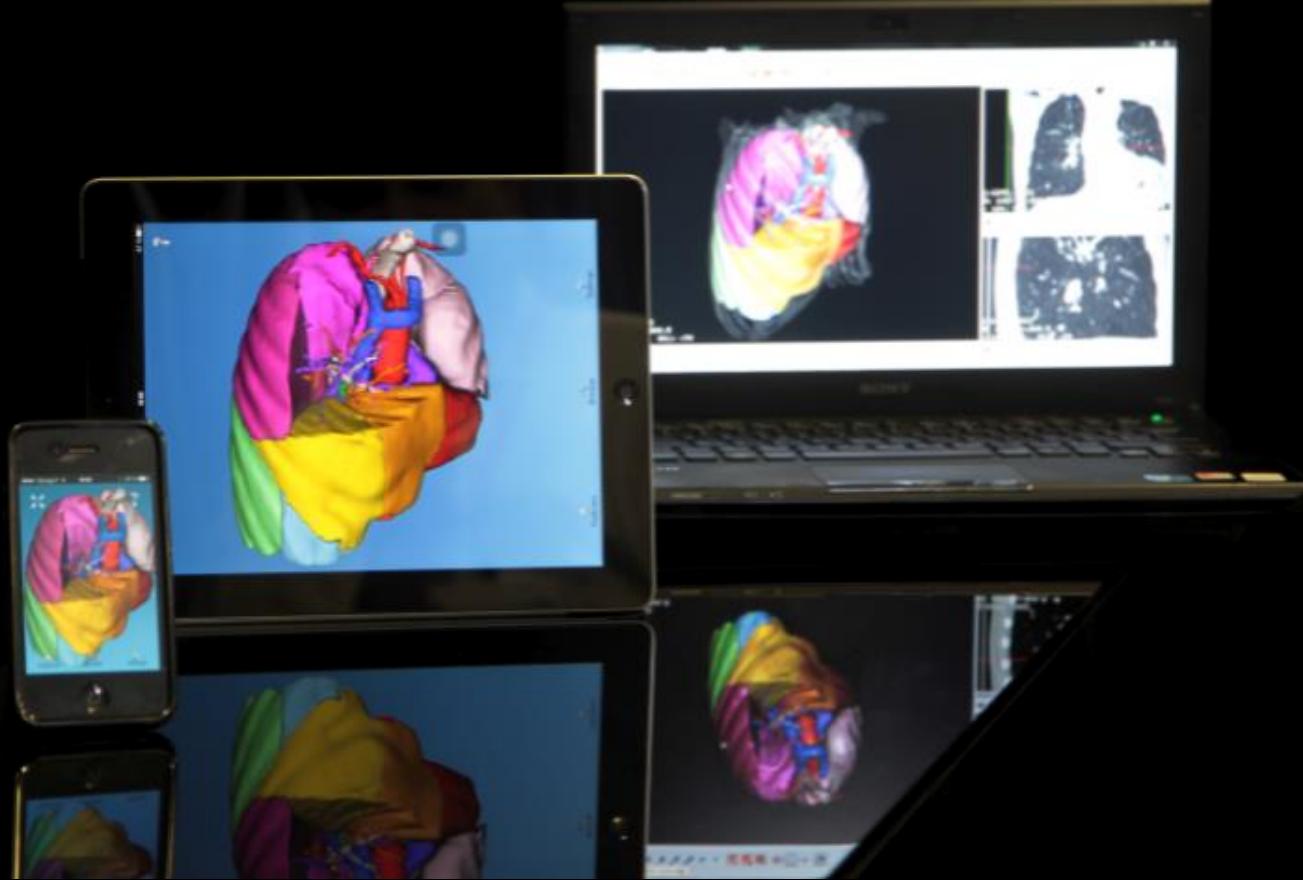
>17% de la population



Plus de 3000 patients ont en déjà bénéficié



3D Virtual Surgical planning & Simulation



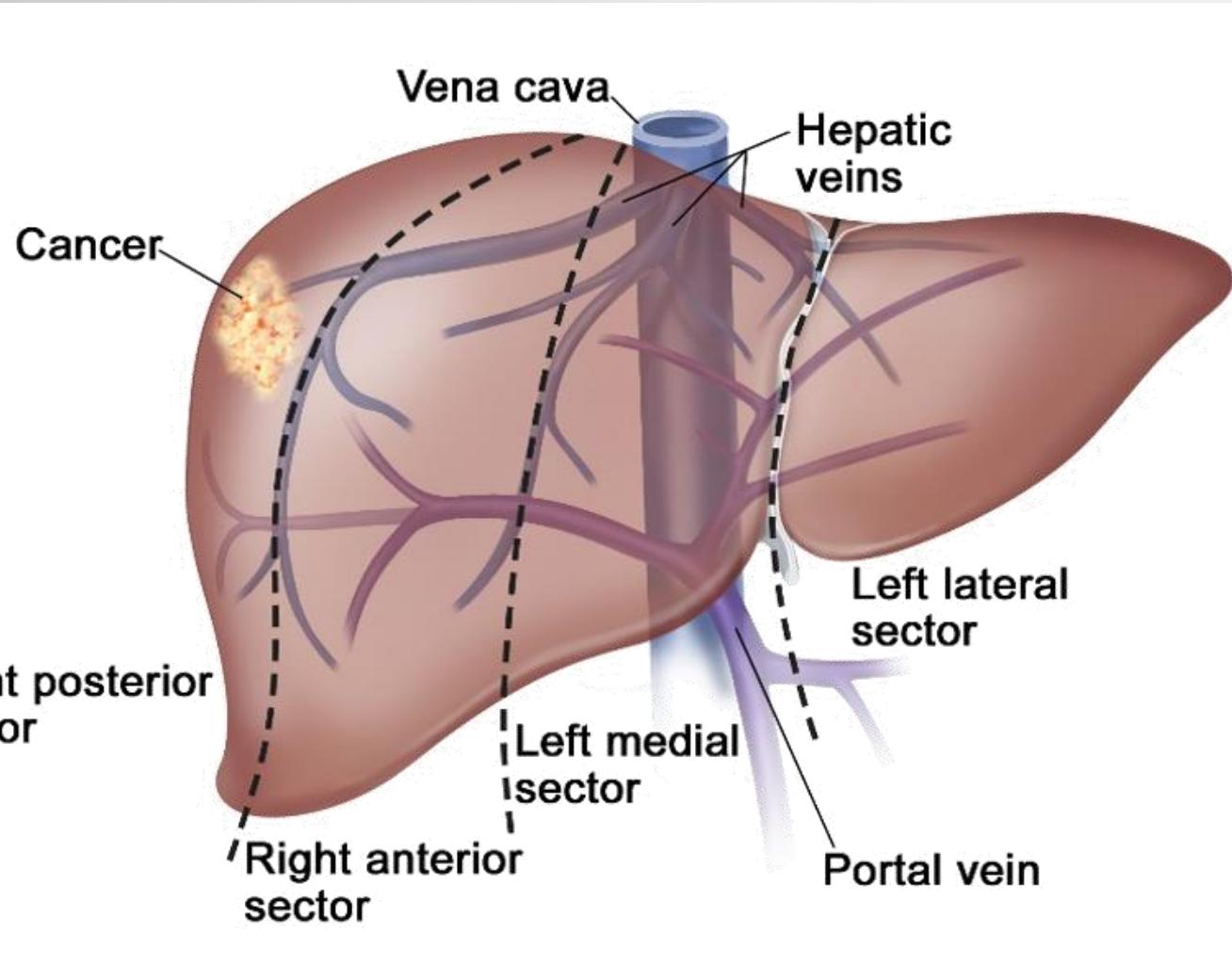
www.visiblepatient.com

Windows 64 bits / MacOS X / smartphone & Tablet



VISIABLE PATIENT

Exemple : le foie



**10.235 nouveaux
cas/an**

80% Homme

Survie à 5 ans: 12%

Simulation préopératoire: Chirurgie du foie



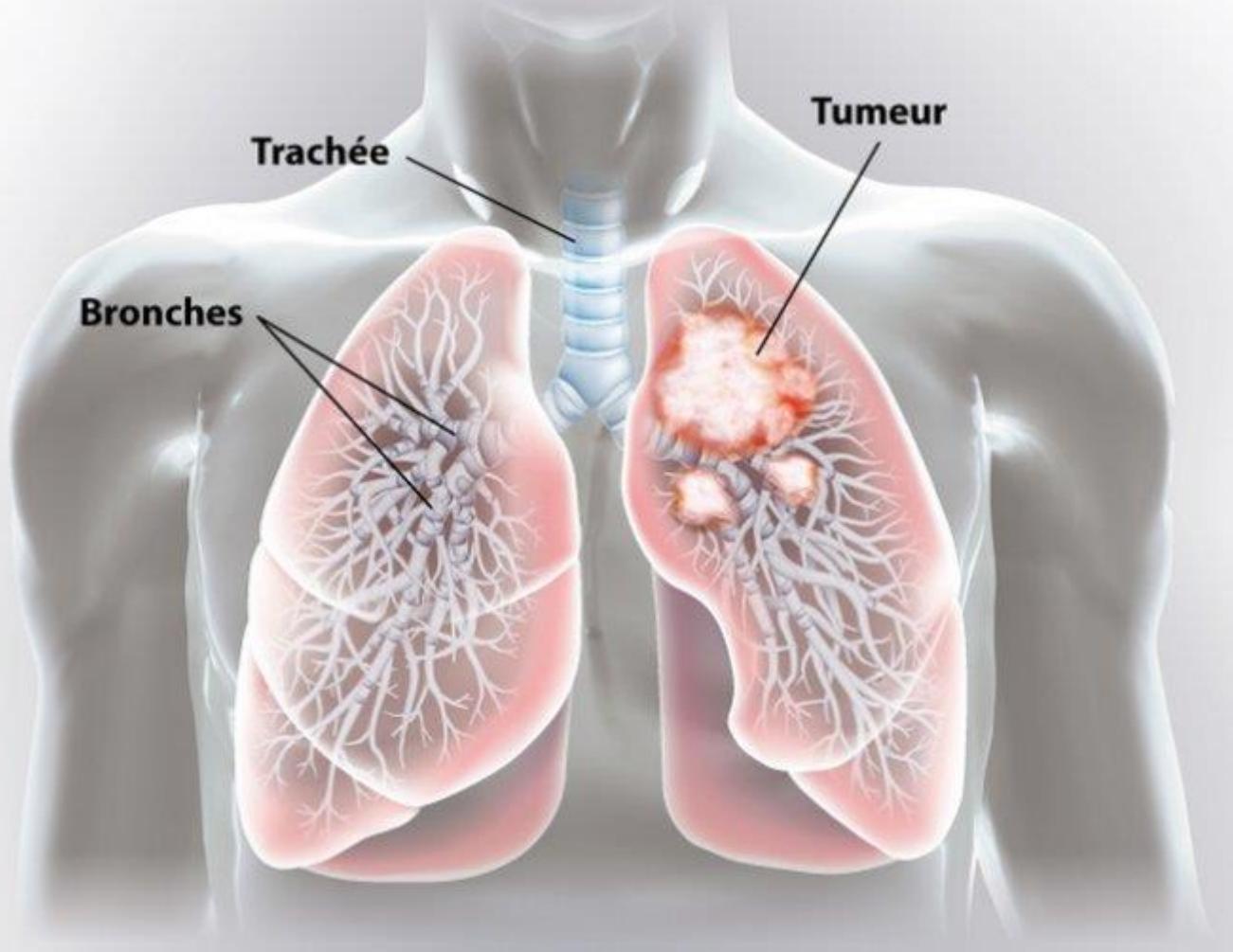
Où je dégotte une partie de la vie dans le jeu !

Les études menées ont montré que
jusqu'à 1/3 des opérations
sont ainsi améliorées

(+réduction du temps opératoire et des complications)

Et Visible Patient ne s'applique pas
qu'au foie... mais à tout le corps

Exemple : le cancer du Poumon

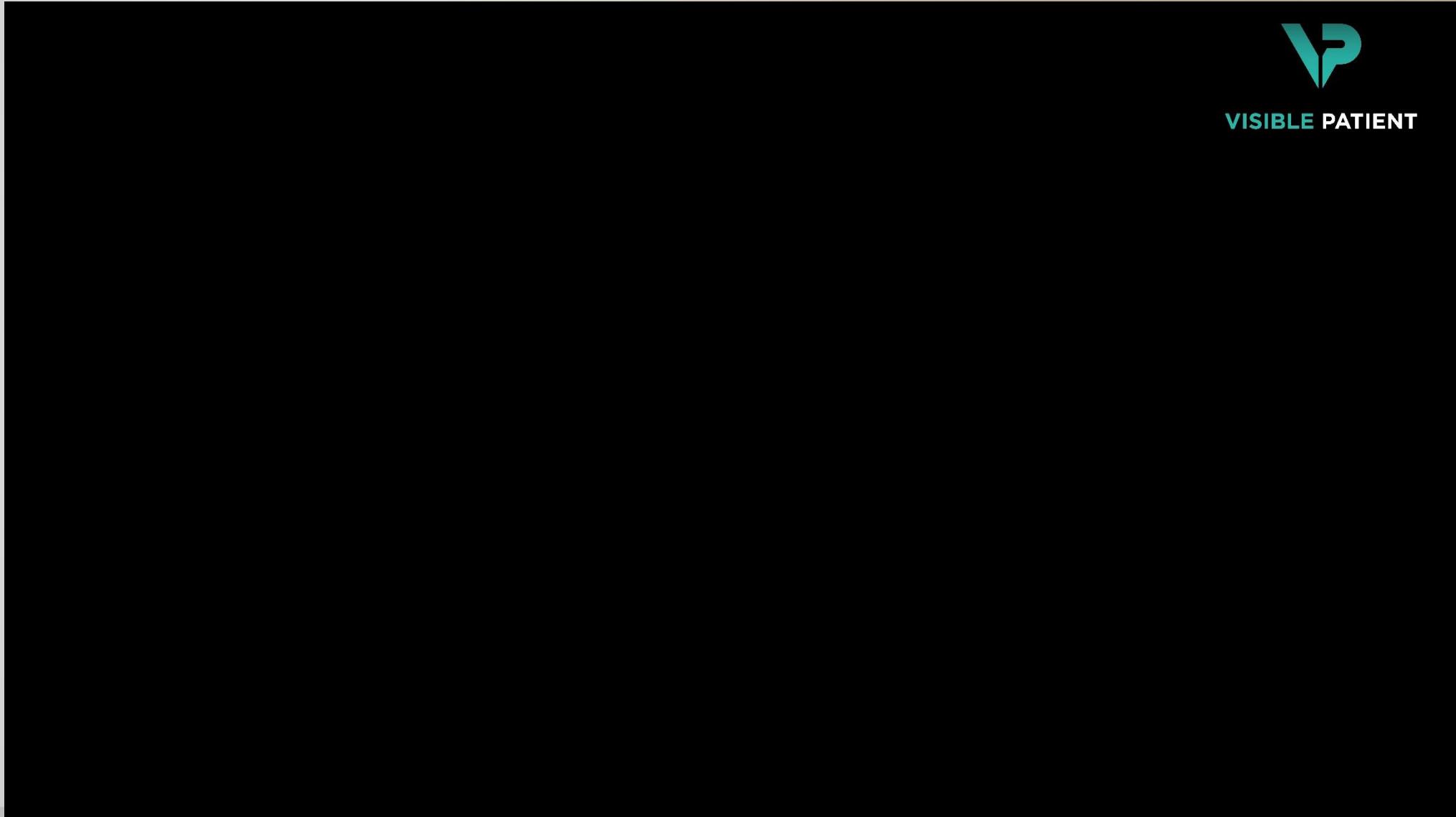


**49.000 nouveaux cas
/ an**

73% Homme

Survie à 5 ans: 14%

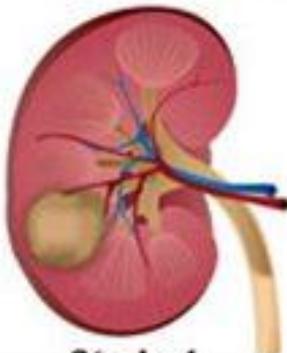
Simulation préopératoire : Chirurgie du poumon



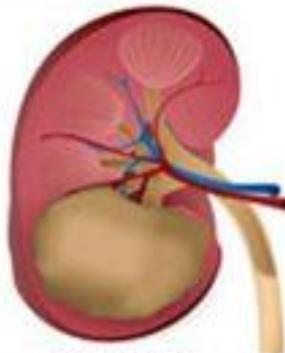
VISIBLE PATIENT

Exemple : le cancer du rein

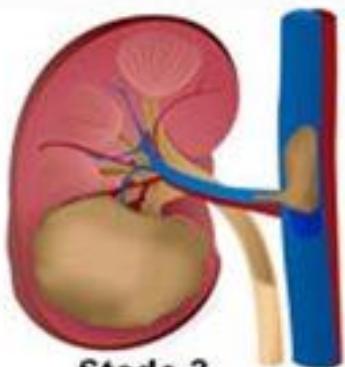
Stades du cancer du rein



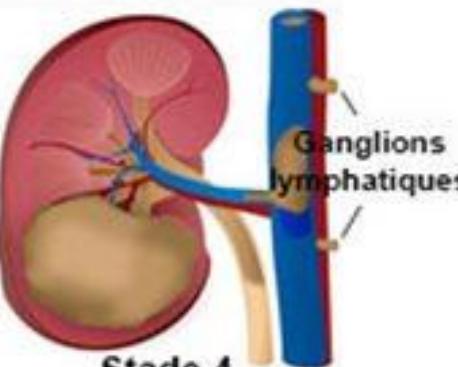
Stade 1
Cancer < 7cm



Stade 2
Cancer > 7 cm



Stade 3
Le cancer se développe dans les veines ou la glande surrénale



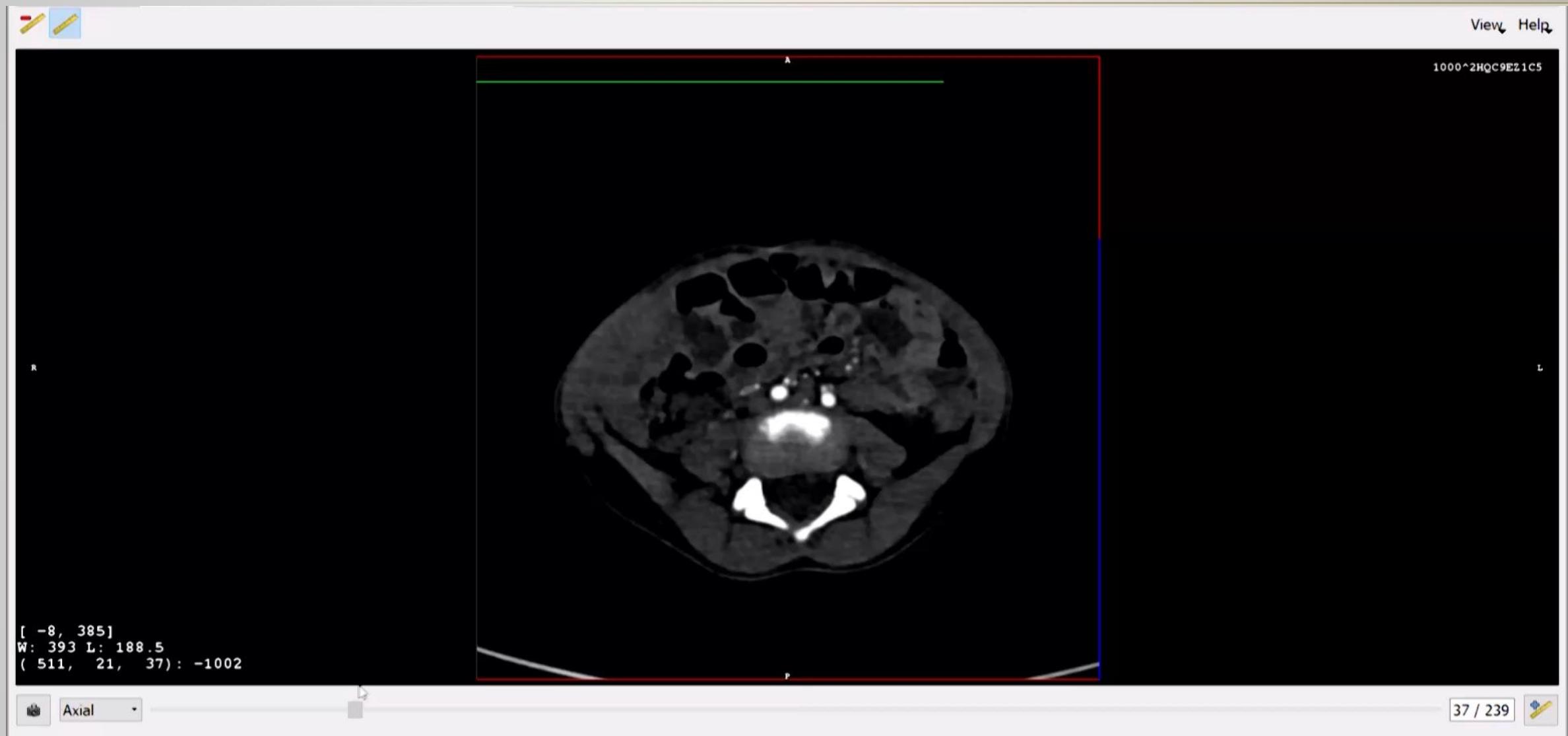
Stade 4
Des cellules cancéreuses se trouvent dans plusieurs ganglions lymphatiques

11.000 nouveaux cas / an

75% Homme

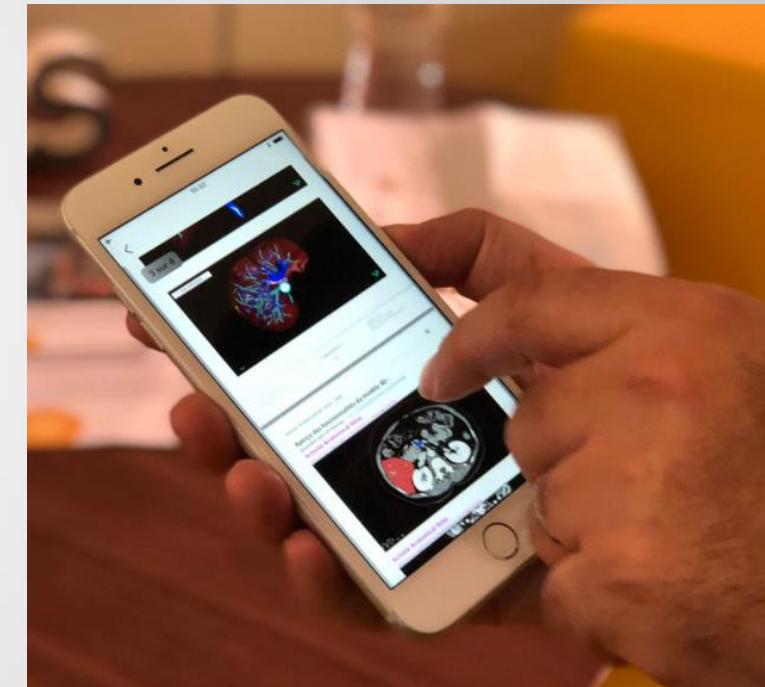
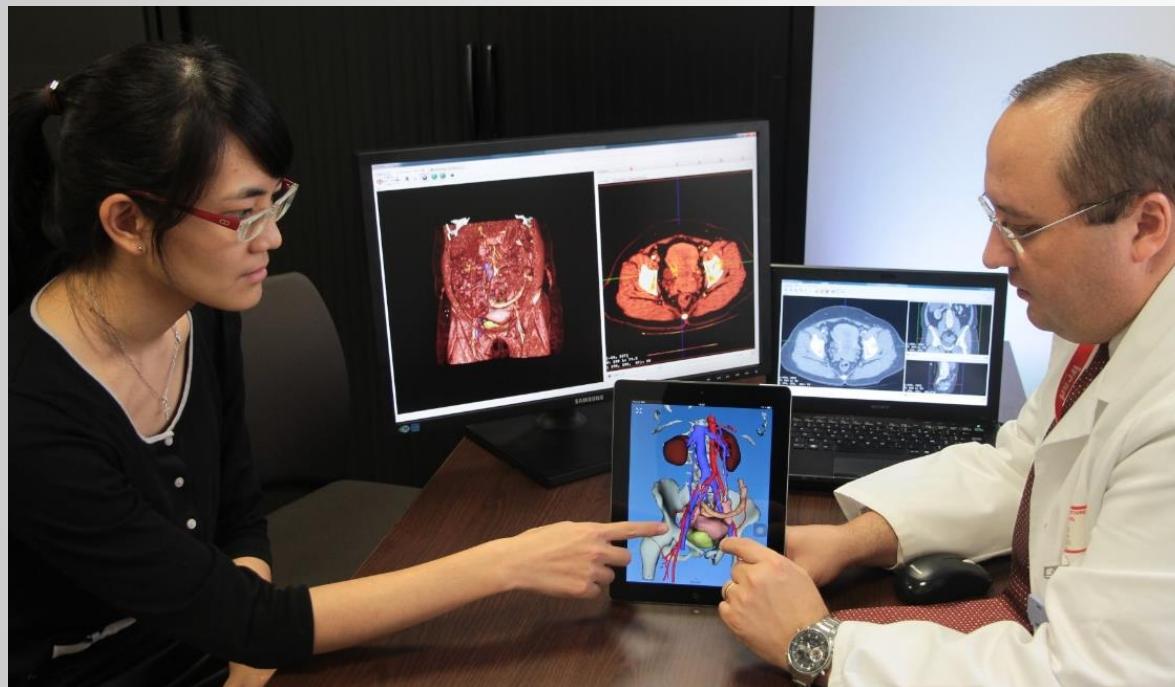
Survie à 5 ans >35%

Simulation préopératoire : Chirurgie du rein



Educative & Communication Benefits

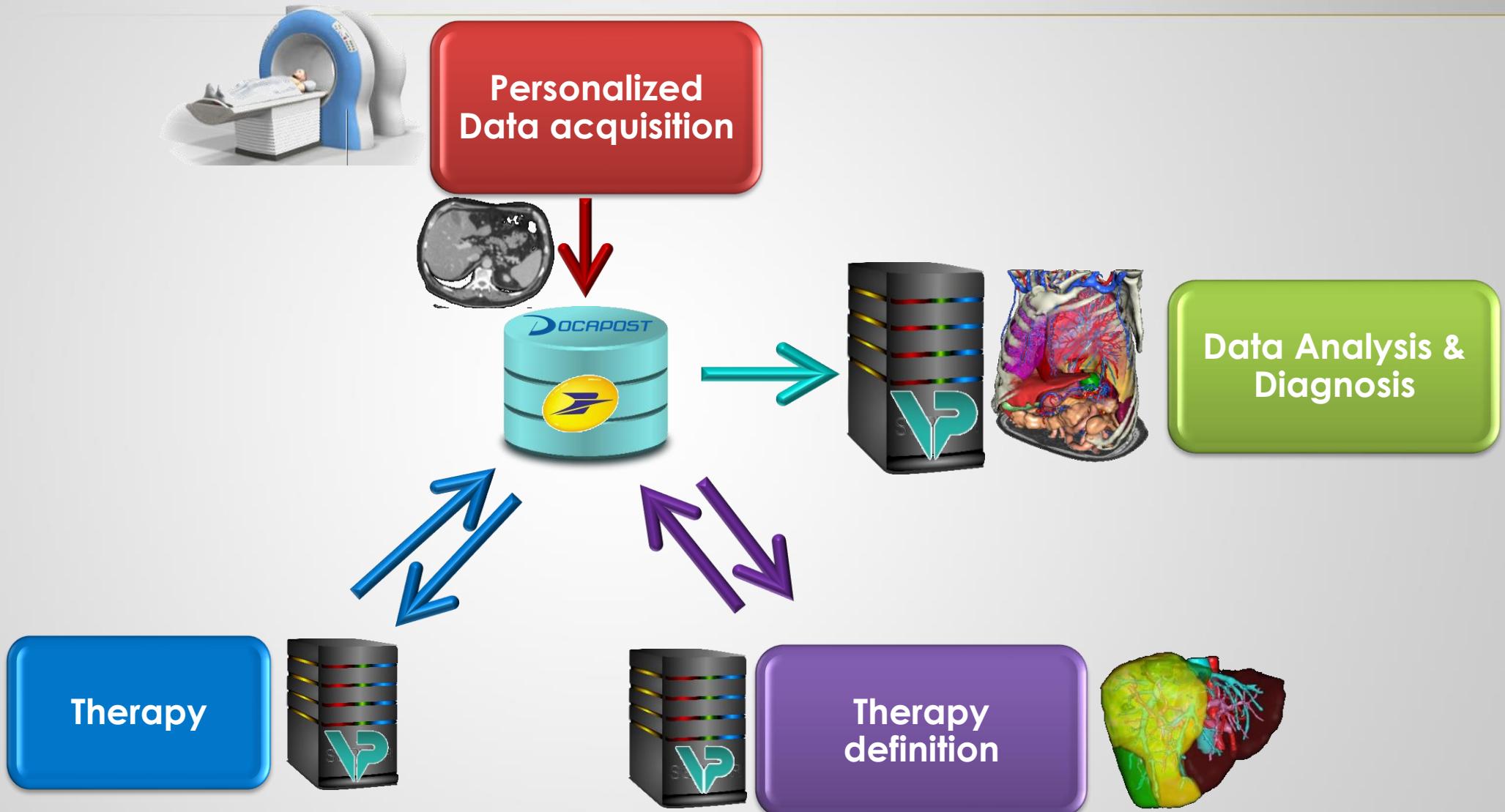
Better patient-physician communication



DOCAPOST
LA POSTE

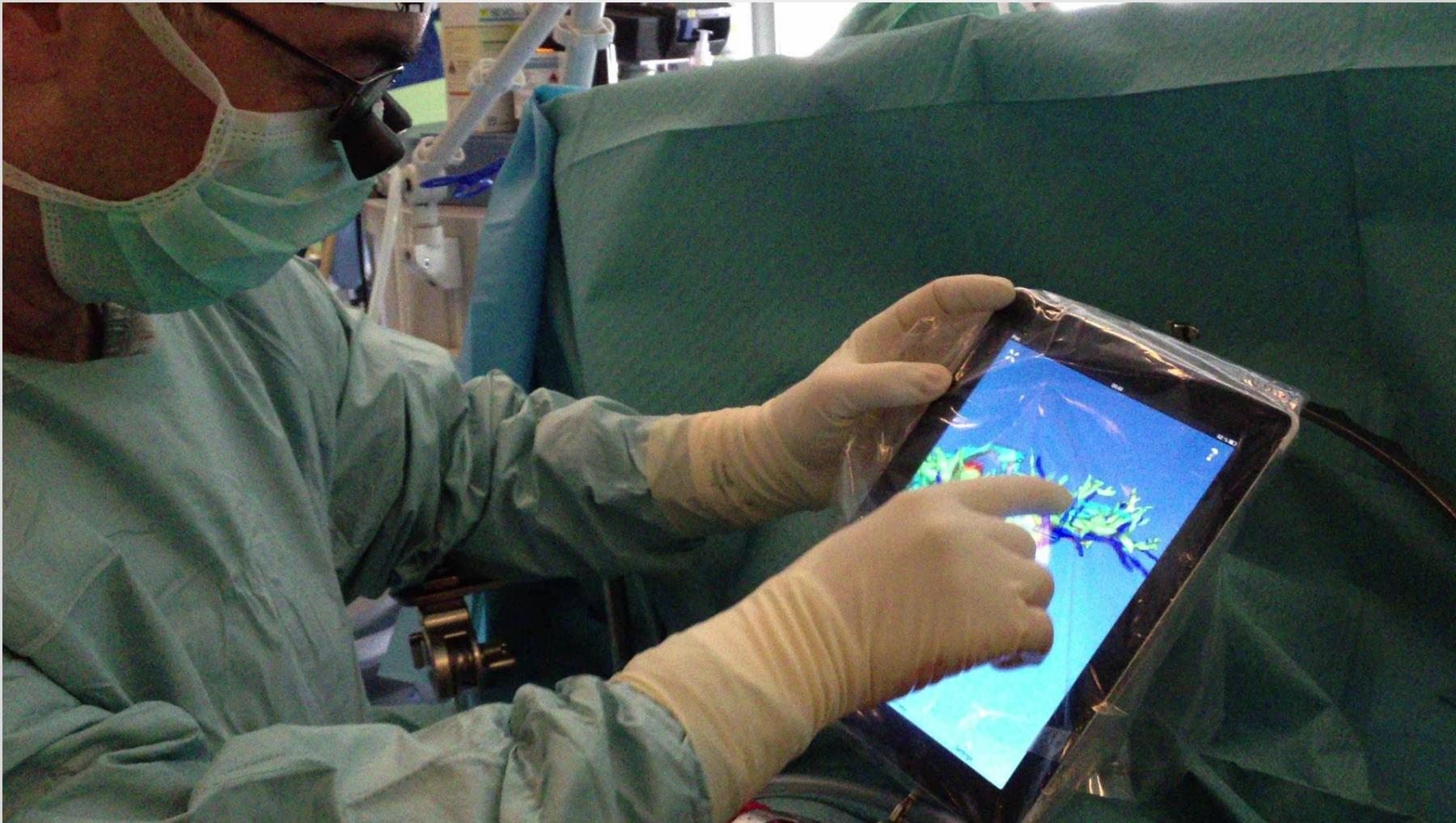
VISIBLE PATIENT

VISIBLE PATIENT assisted Surgery

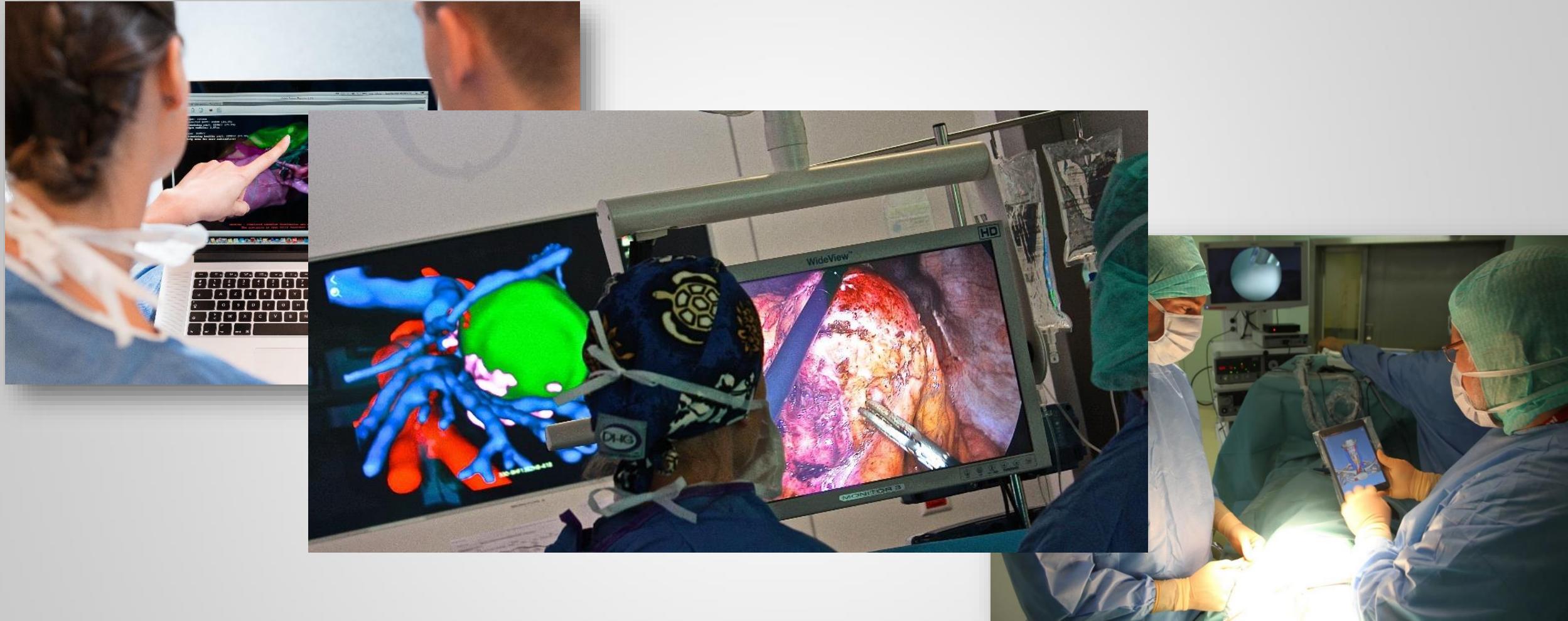


VISIBLE PATIENT

Easy 3D Modelling use in the OP-Room



Easy 3D Modelling use in the OP-Room



Visible Patient & Robotic Surgery: Plug & Play

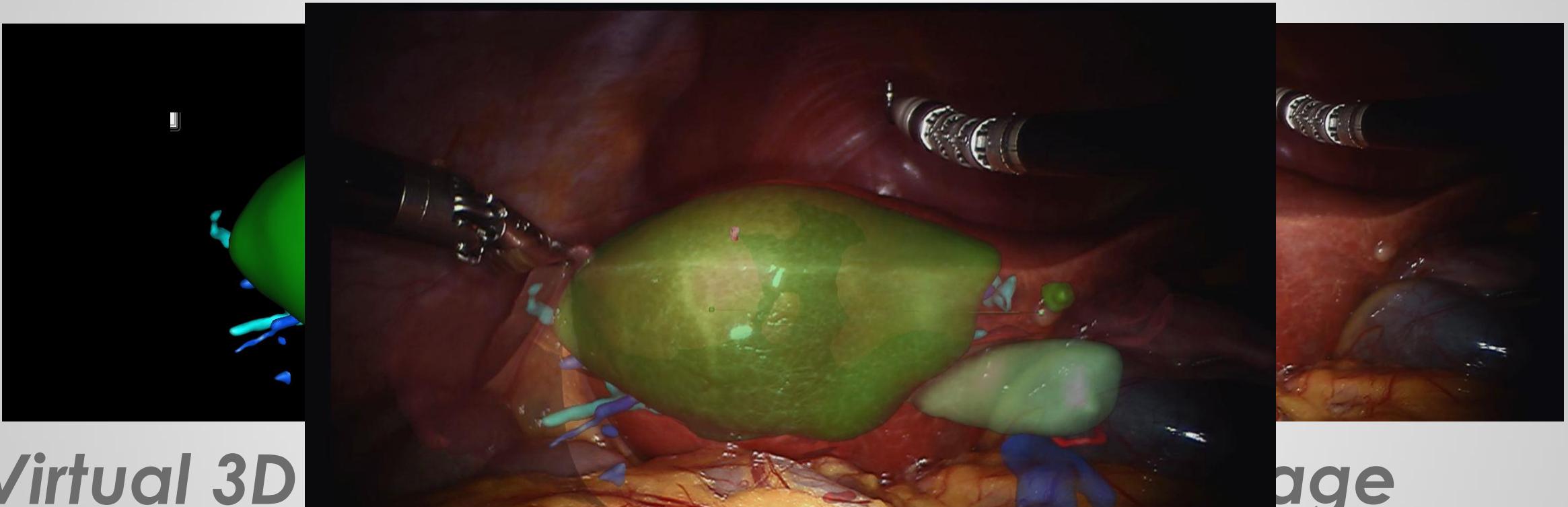


Prof. Armando Melani, Robotized colorectal Surgery, Brazil

ircad VP

Augmented Reality

FUSION



Virtual 3D
Image
= Augmented Reality

Interactive Augmented Reality

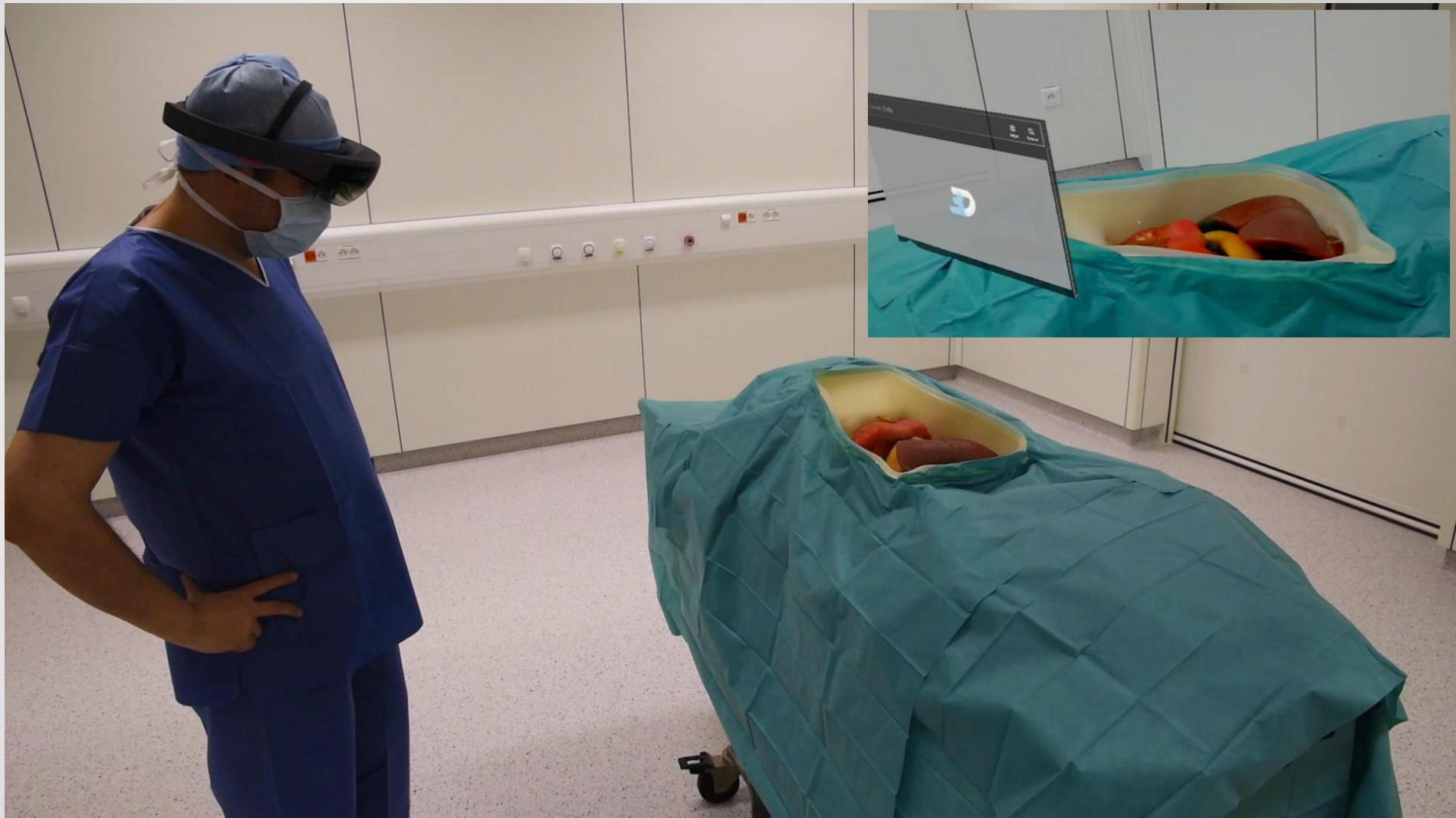


Trans-thoracic minimally invasive liver resection guided
by augmented reality, 2015

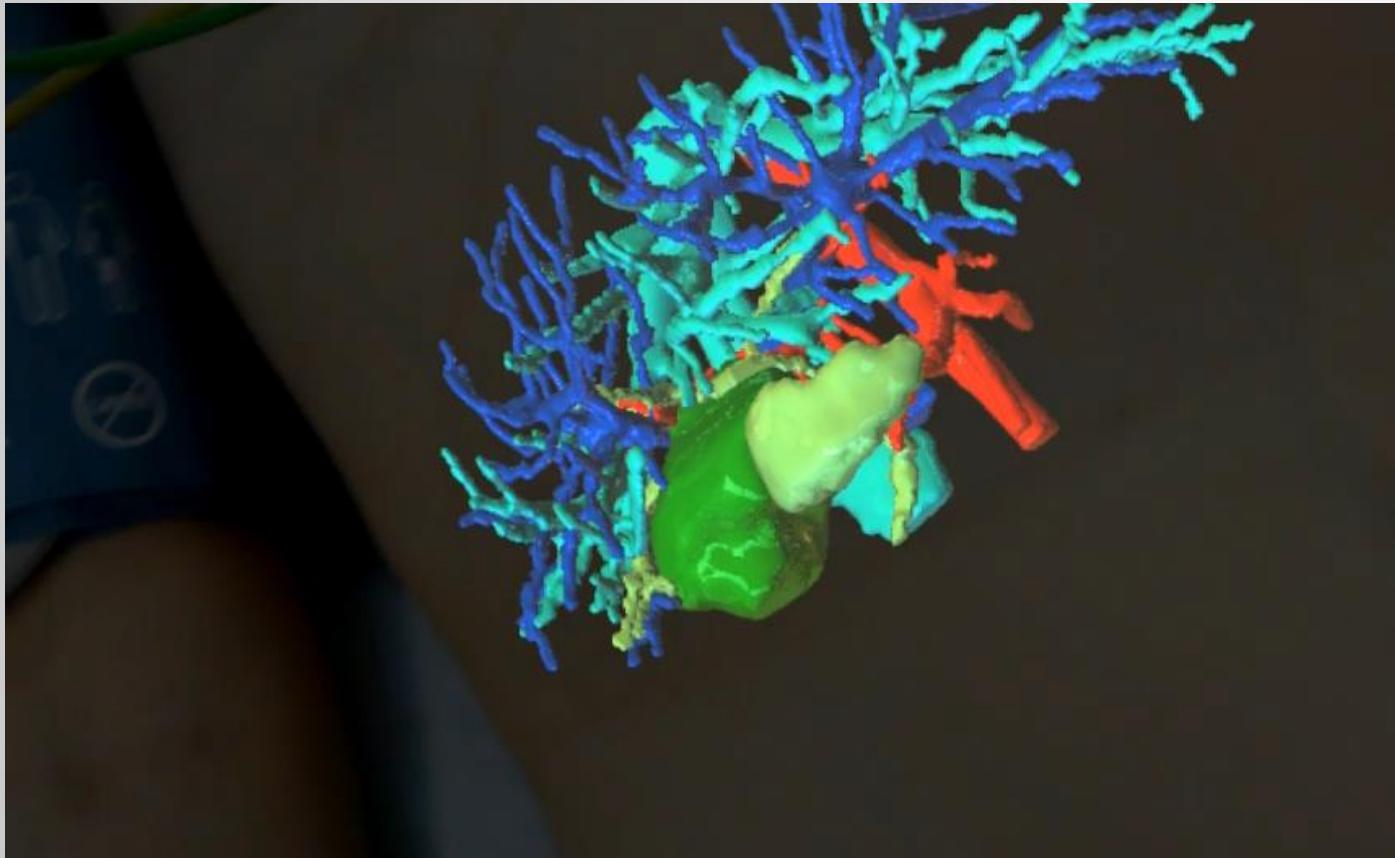
Interactive Registration + RGBD tracking



 Microsoft
HoloLens



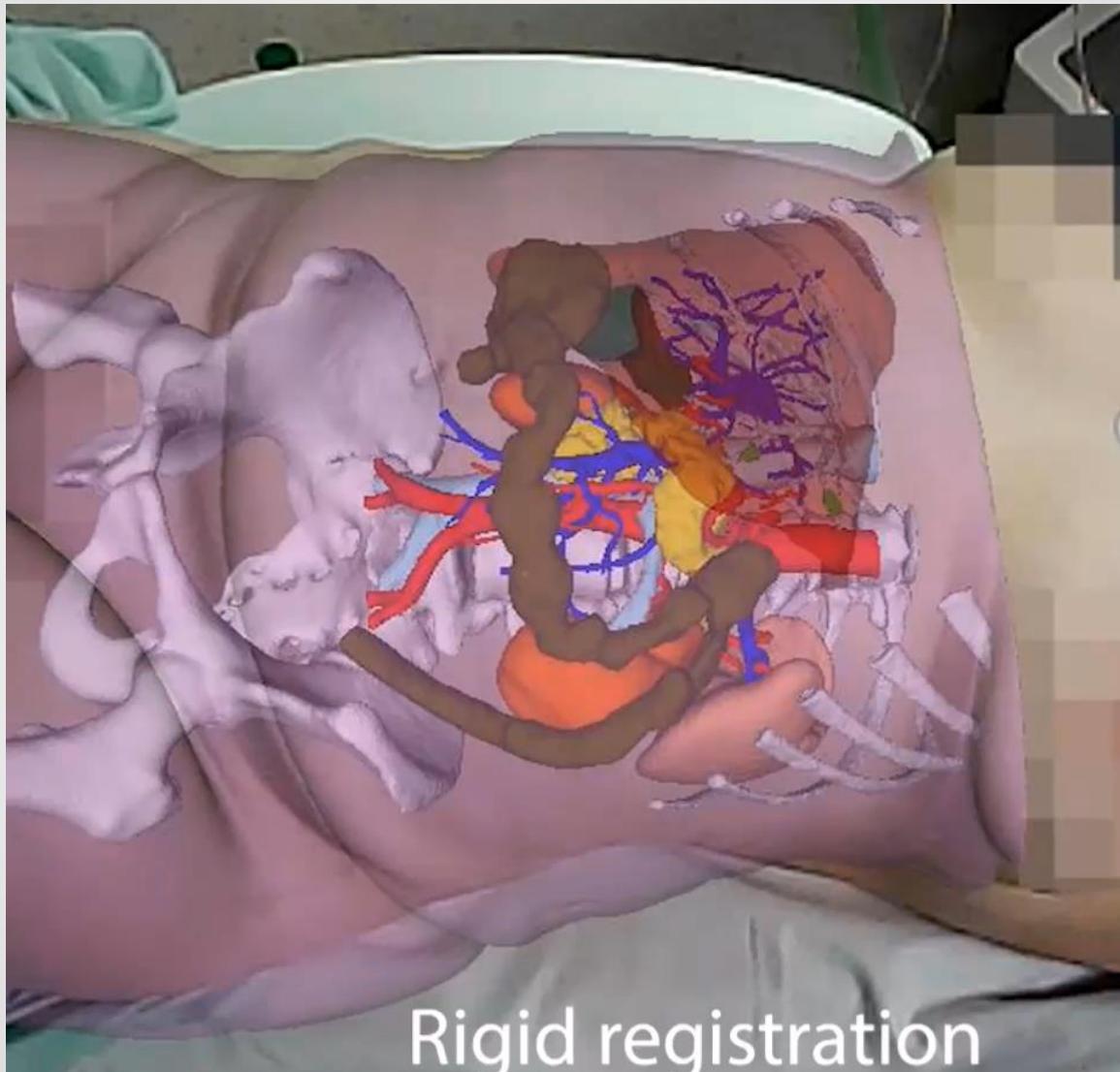
Interactive Registration + RGBD tracking



RGBD tracking for automatic registration

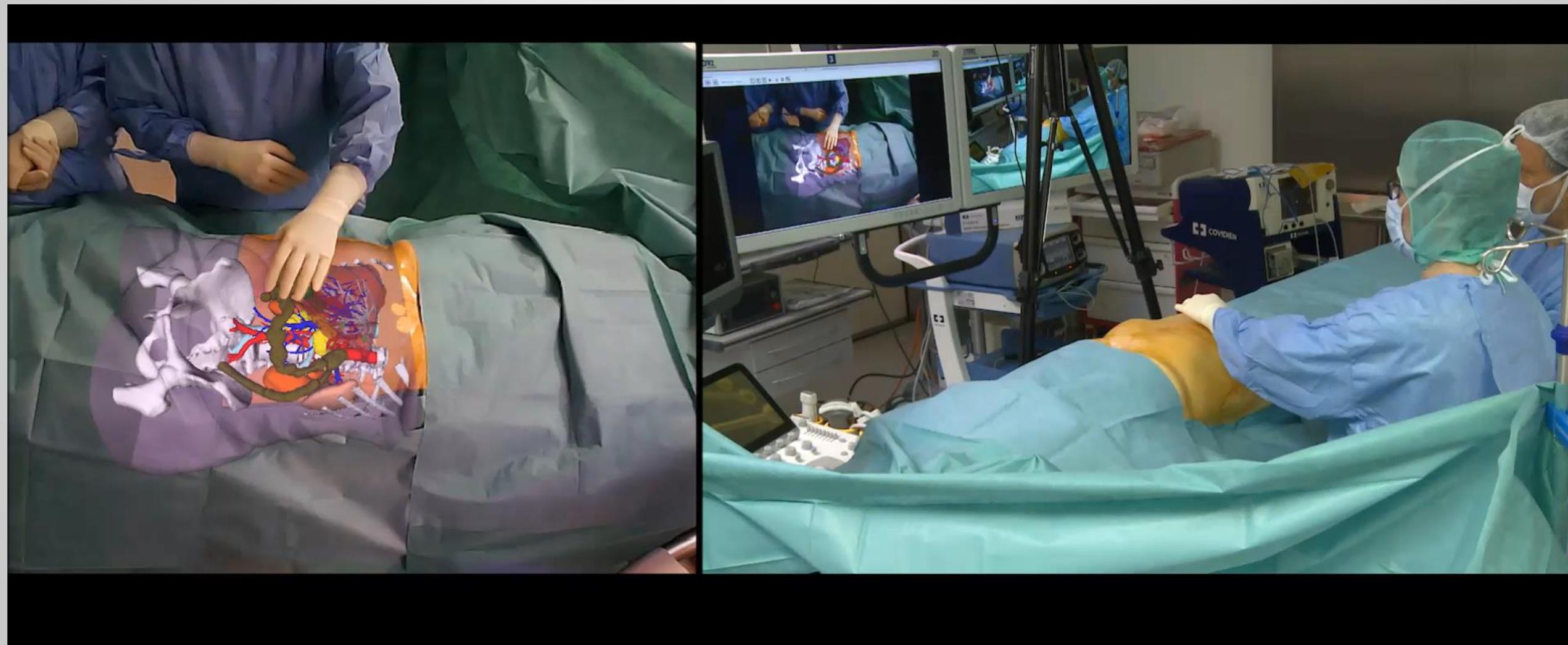


Automatic non rigid registration



Rigid registration

Intra-Operative AR Guidance - Registration



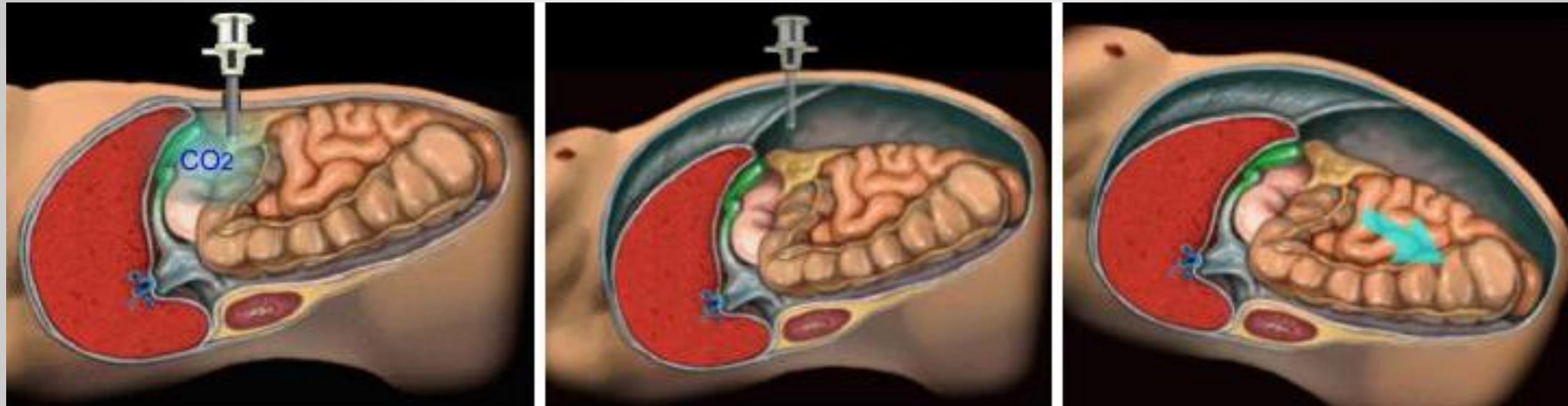
Prof. Mariano Gimenez & Prof. Patrick Pessaux

ircad 

Intra-Operative AR Guidance - Breathing Motion



Intra-Operative AR Guidance - Registration



*Shape & location modifications
due to surgical interaction
(Pneumoperitoneum, OP-Table displacement, etc.)*

Hybrid Operating Room Concept



Intraoperative image guidance

ircad 

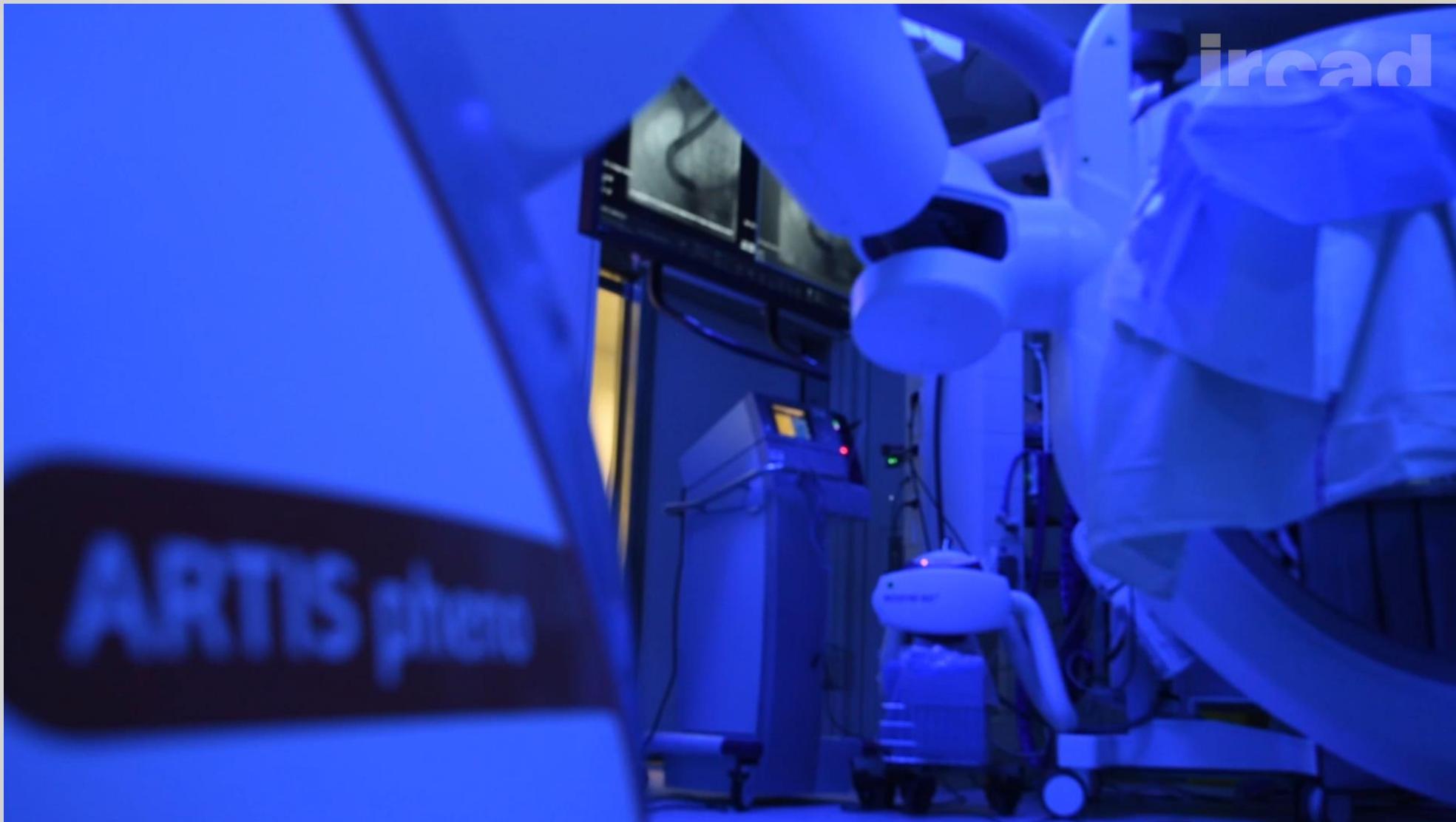
IHU Hybrid Operating Room



Intraoperative Image

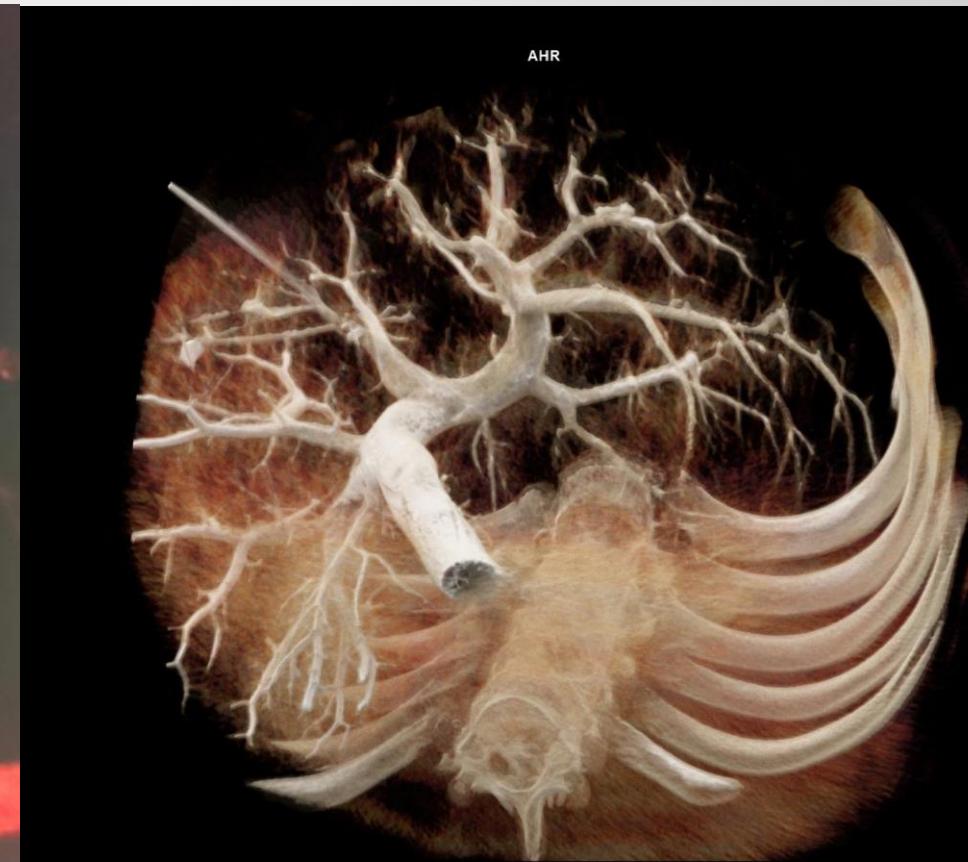
STORZ
KARL STORZ—ENDOSKOPE

SIEMENS



Intraoperative Image

SIEMENS



Daicim
Fundación

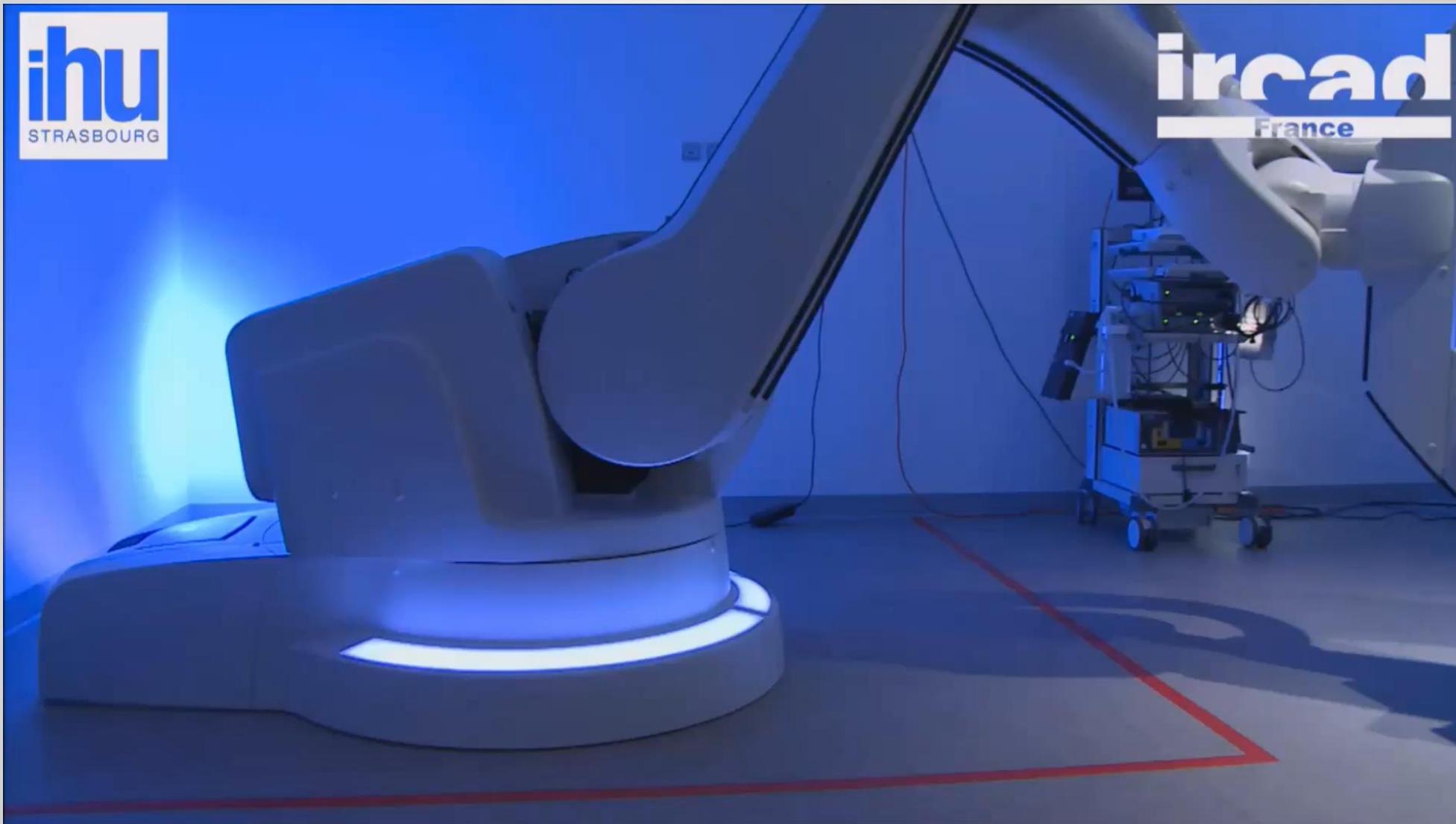
ihu ircad
France

ircad VP

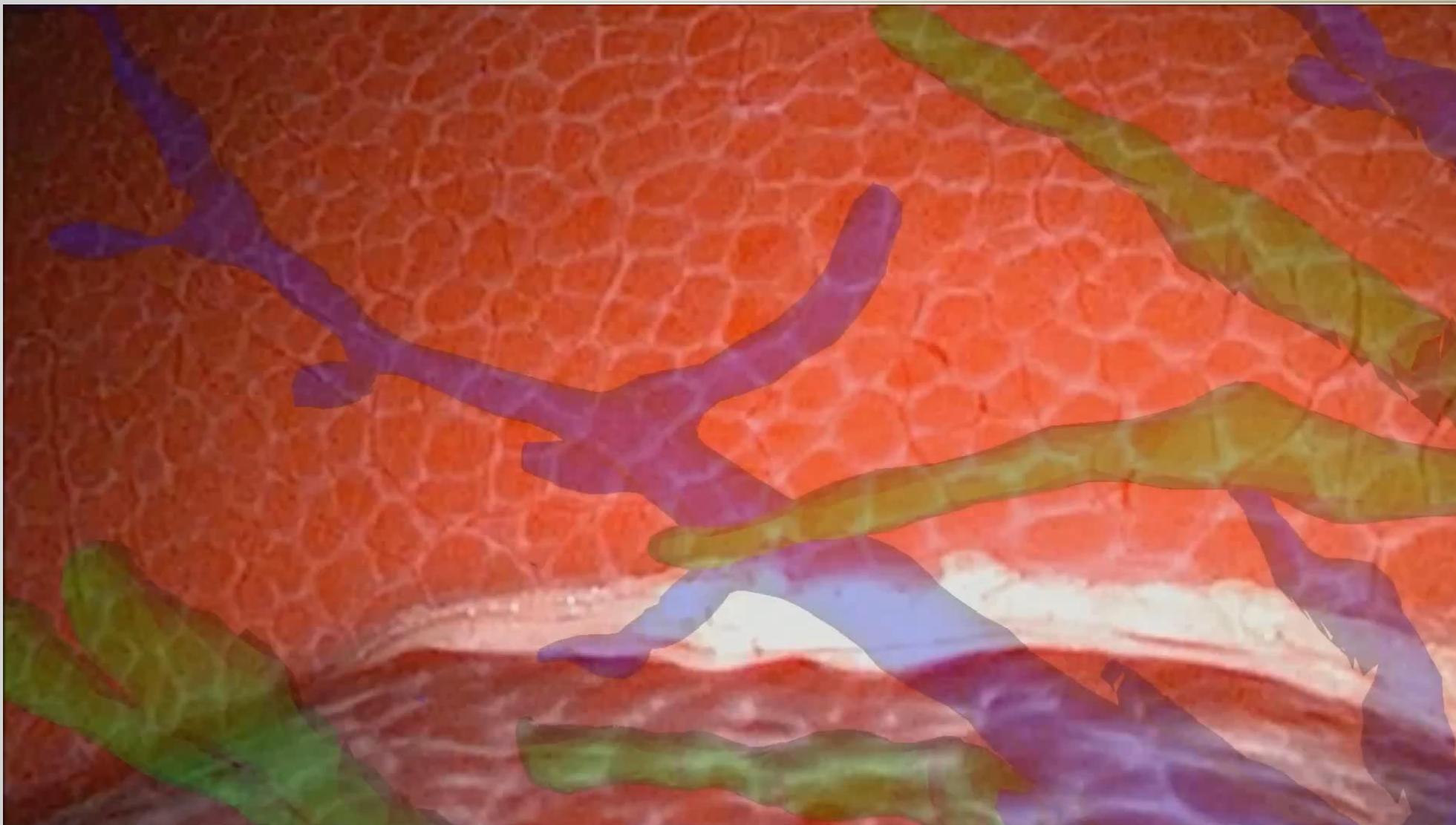
Intraoperative Image

STORZ
KARL STORZ—ENDOSKOPE

SIEMENS



Augmented Reality

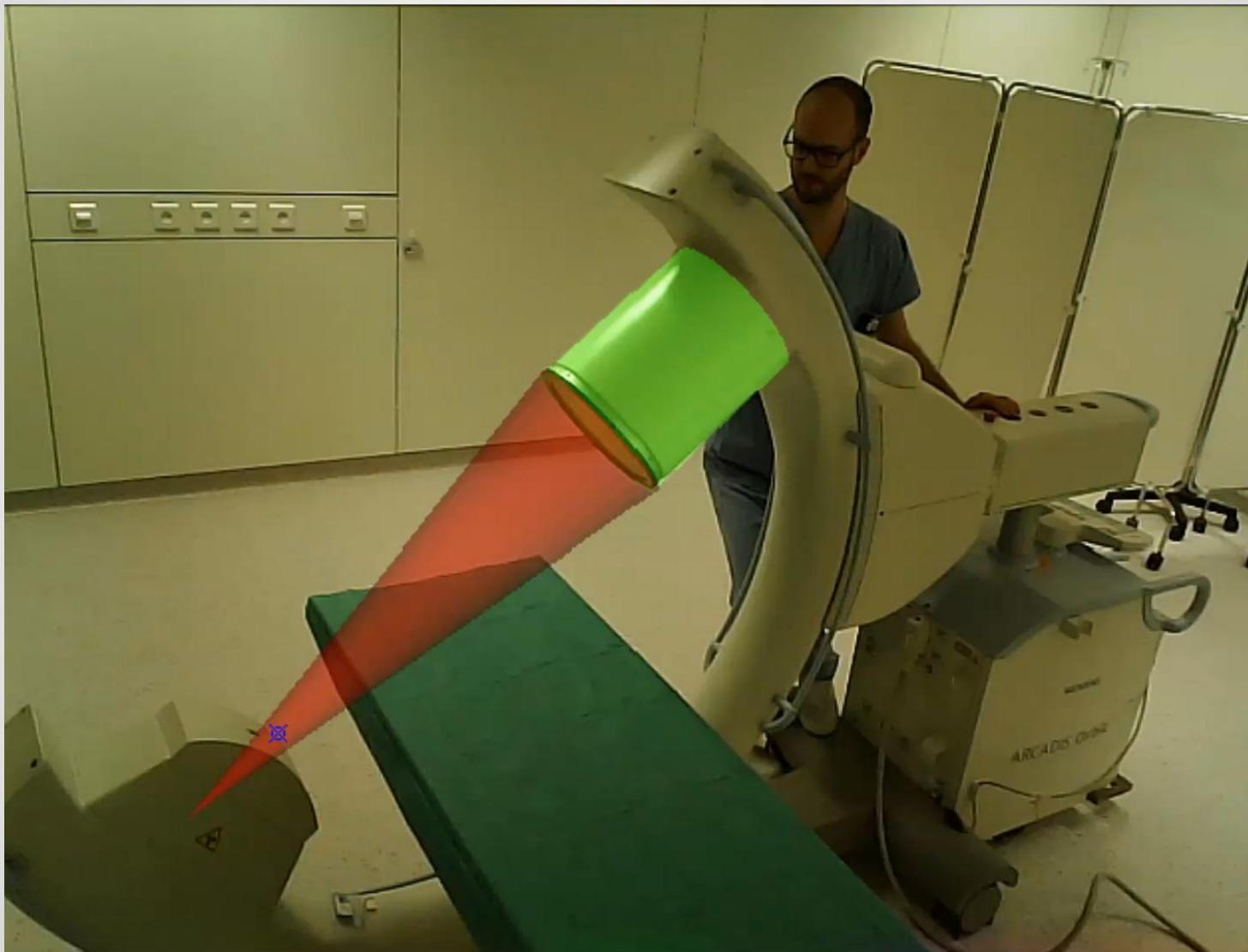


Mountney P et. al., An augmented reality framework for soft tissue surgery,
Med Image Comput Comput Assist Interv. 2014;17(Pt 1):423-31

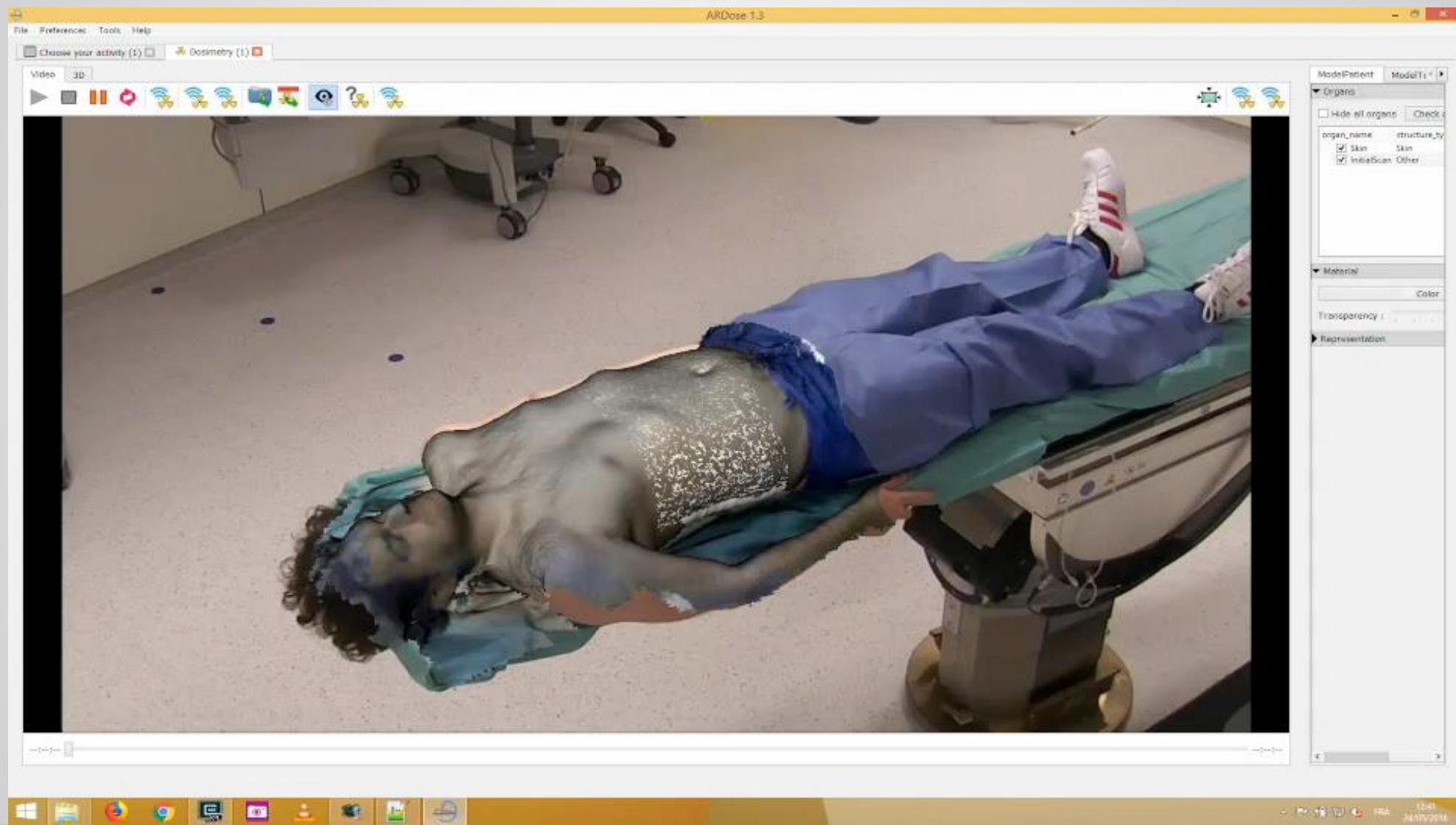
Motion Compensation



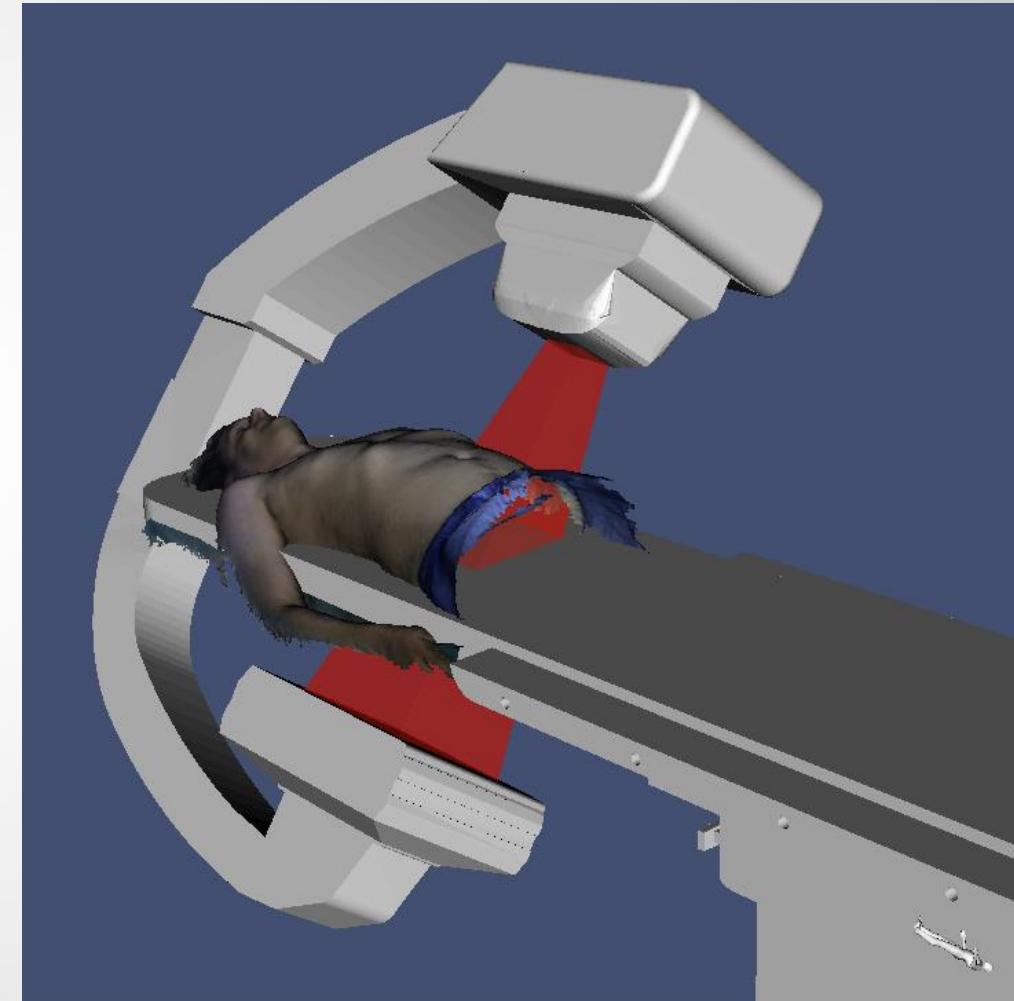
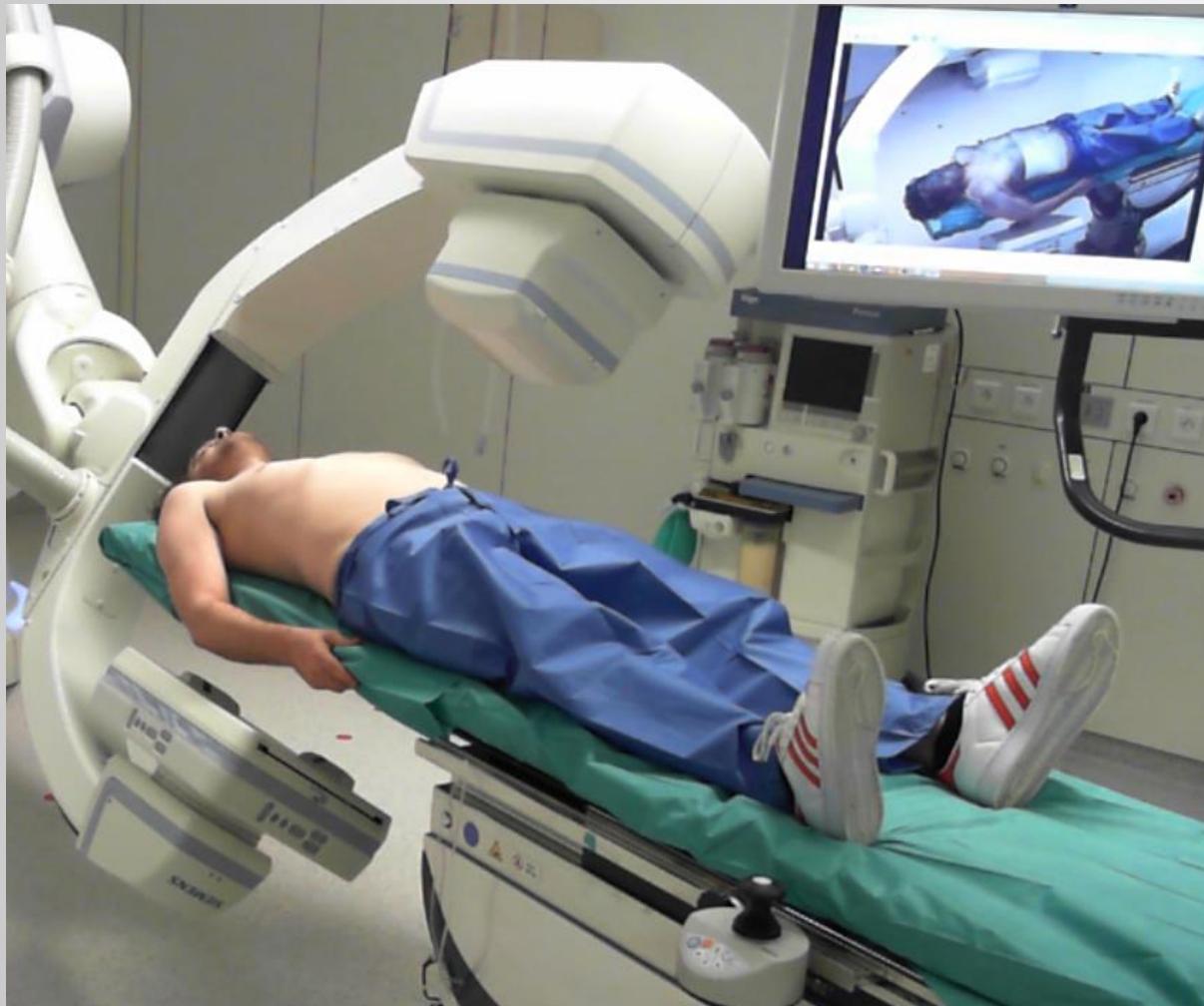
Beam Characterization (mobile C-Arm)



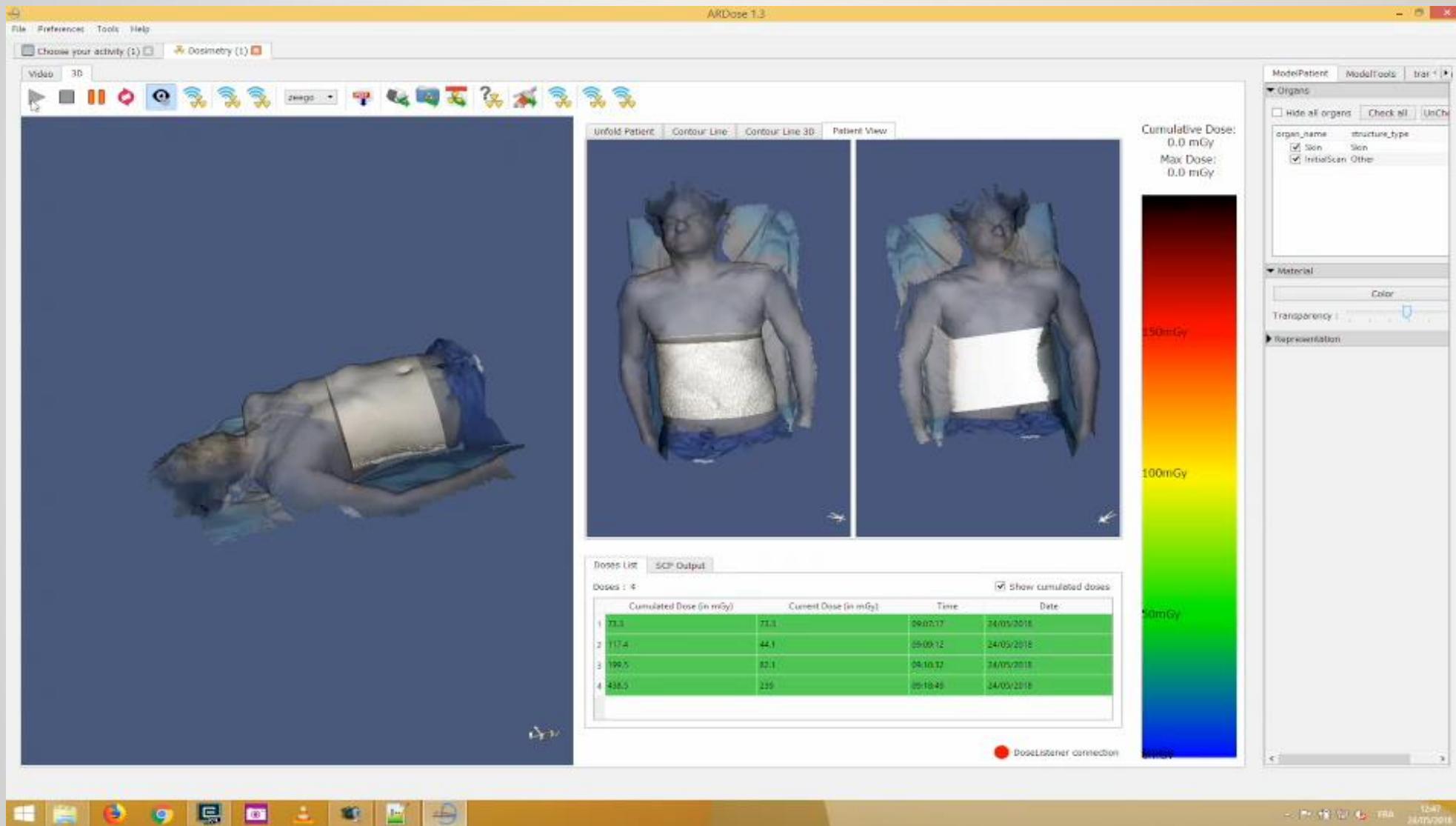
Beam-Patient Interaction



Beam-Patient Interaction



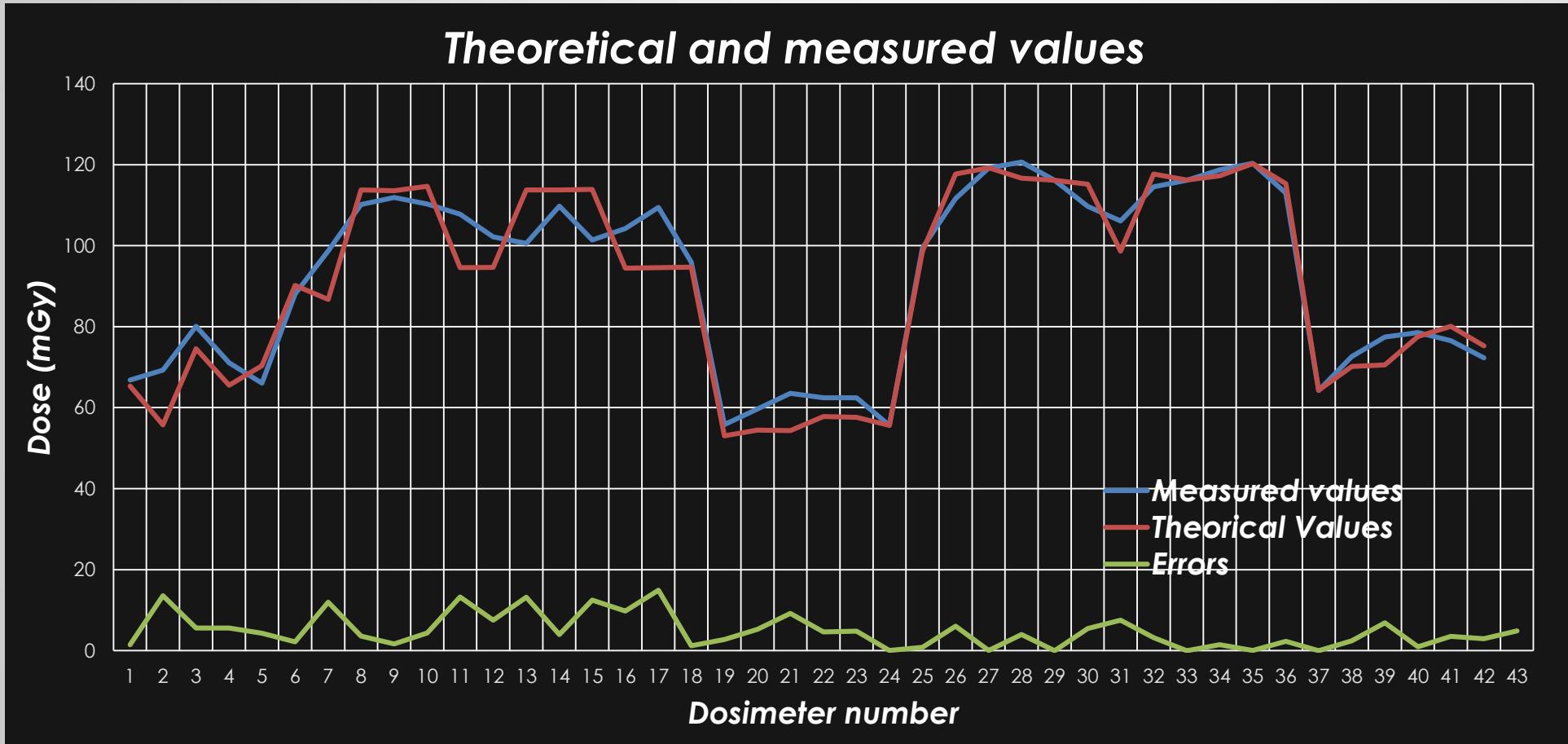
Beam-Patient Interaction



Evaluation



Comparison between theoretical & measured values



Average error
4.8 mGy

Expensive Equipment: What about US ?



Hardware

Siemens Acuson S3000, external probe



Electromagnetic field



Electromagnetic sensor

Intra-Operative AR Guidance - Registration



Prof. Mariano Gimenez & Prof. Patrick Pessaux

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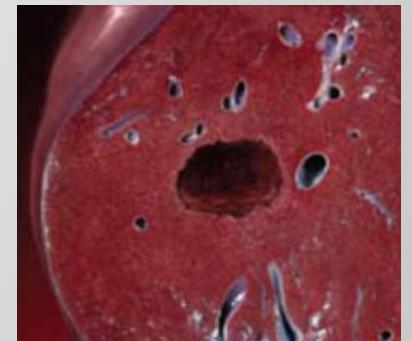
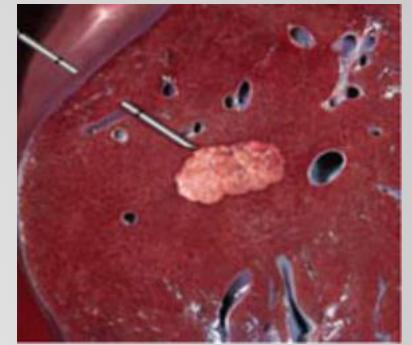
Percutaneous Surgery

Thermal ablation of hepatic tumours

Gold standard up to 3 cm diameter

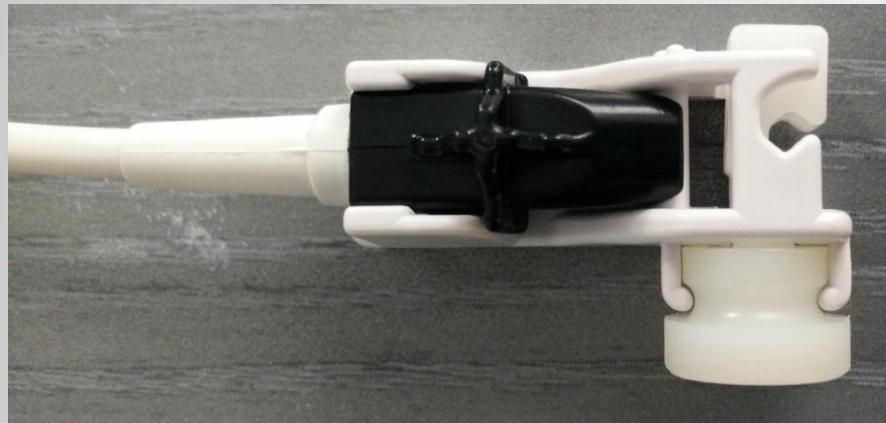
*Most frequently used technique is
Radio-Frequency Ablation (RFA)*

Performed percutaneously using a needle



VR for Guidance (Standard US)

virtuTRAX device



RFA needle

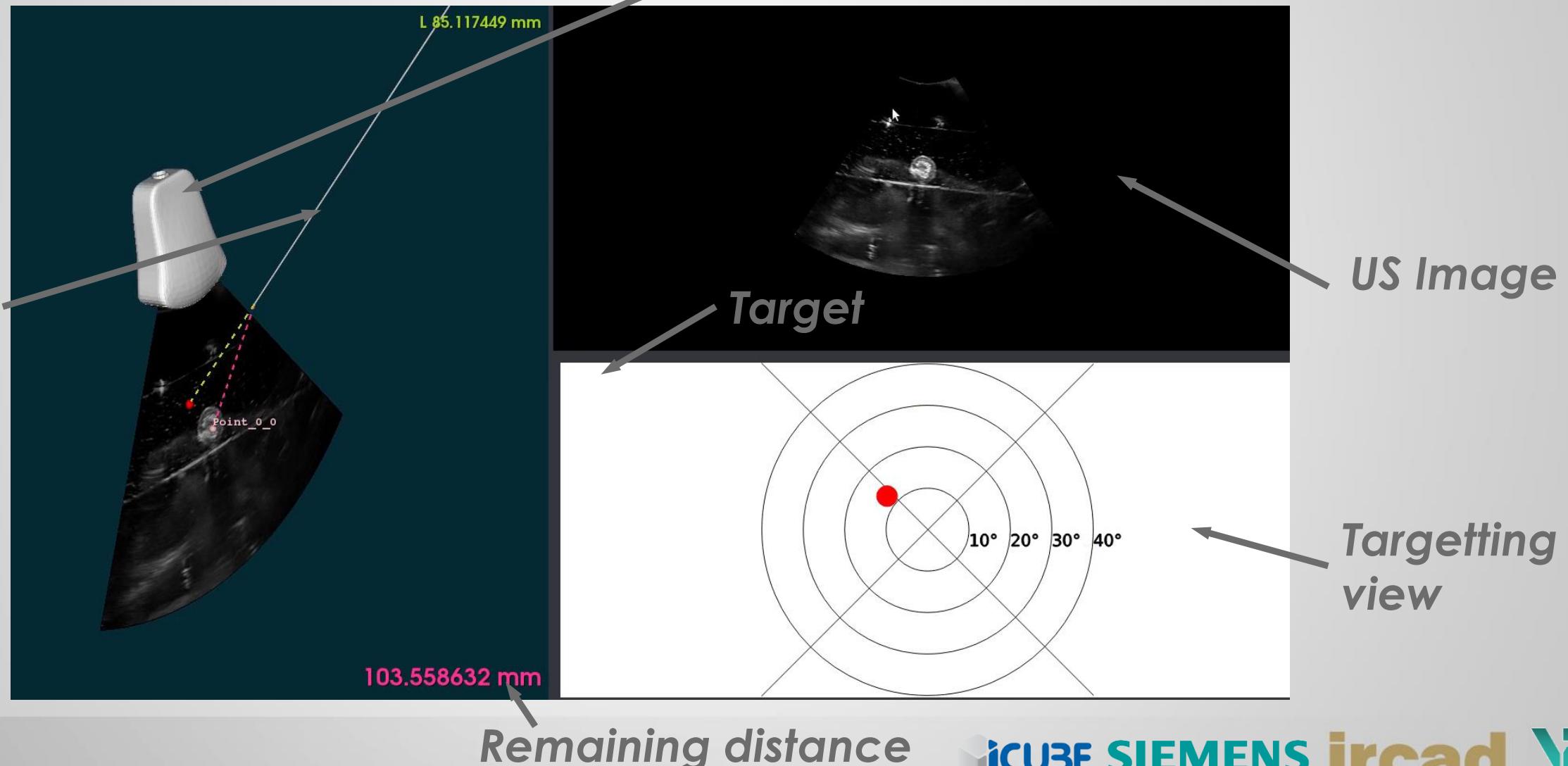


eTRAX needle

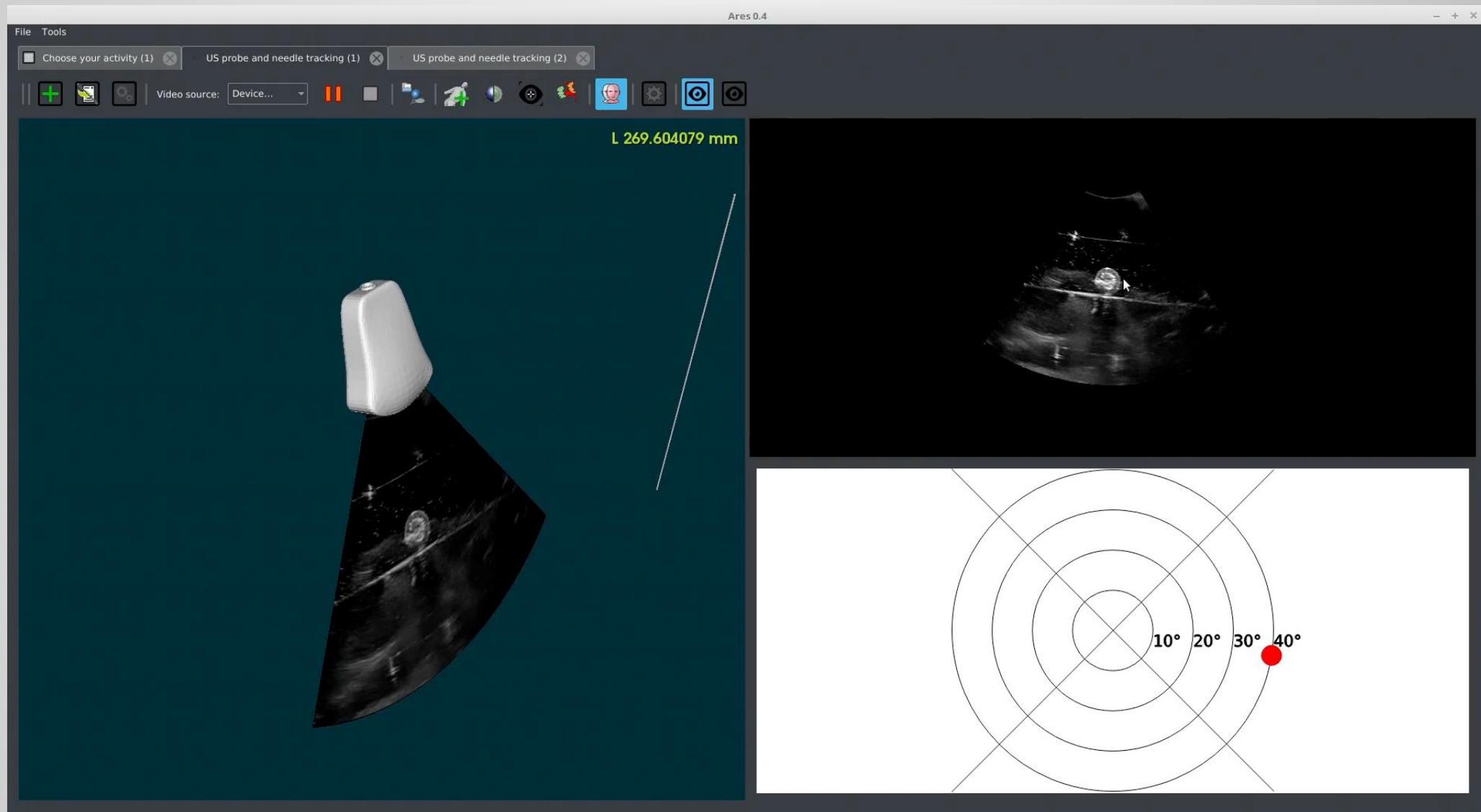


VR for Guidance (Standard US)

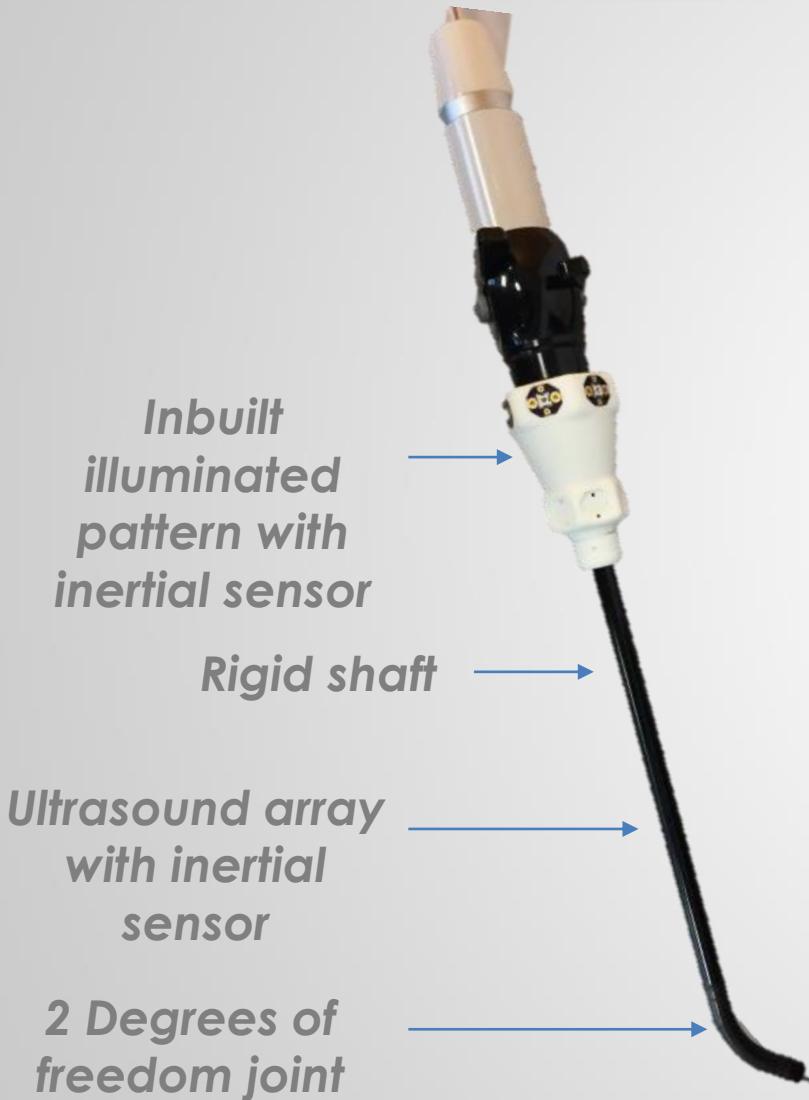
New 3D Interface



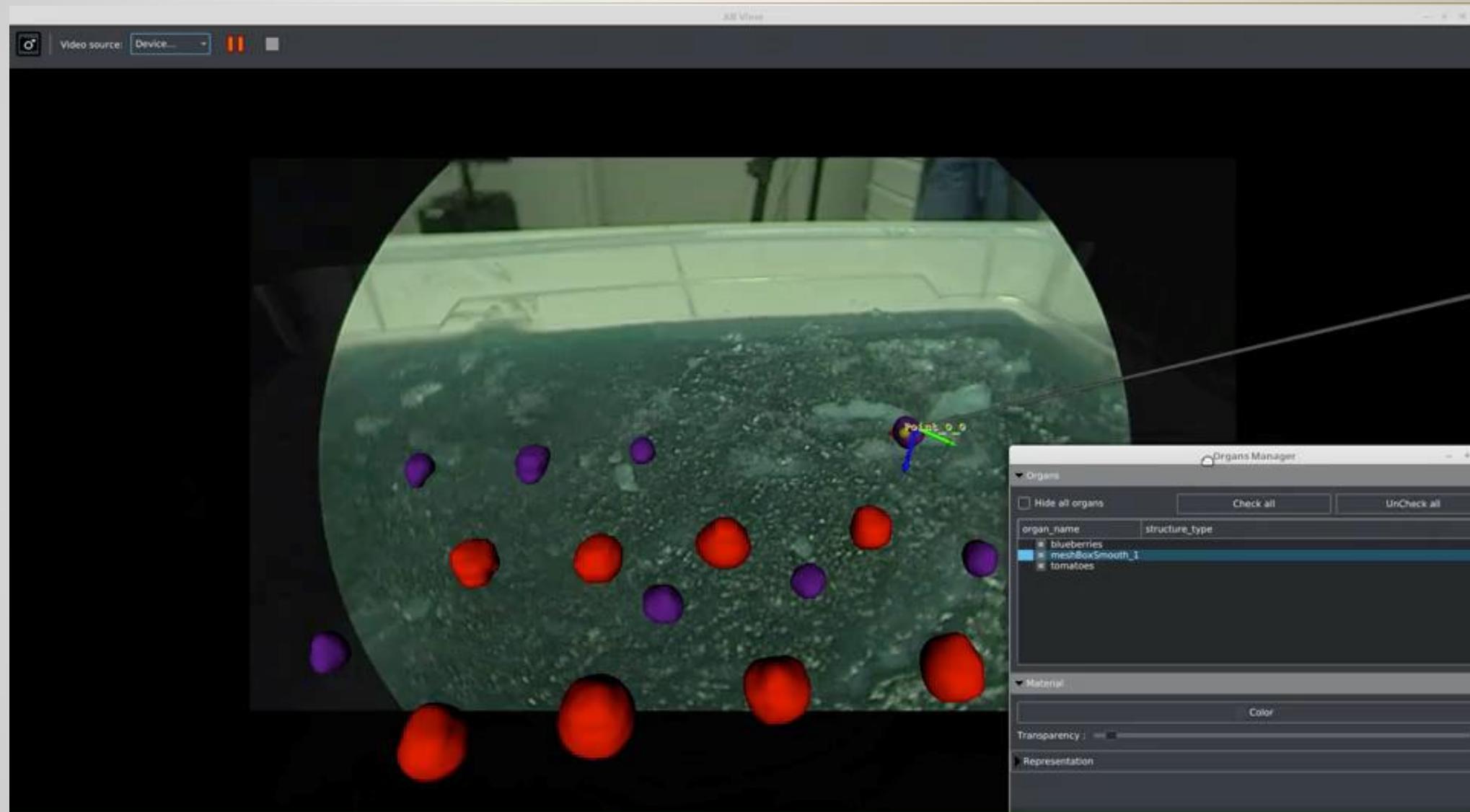
VR for Guidance (Standard US)



Hardware



AR for Guidance (laparoscopic US)



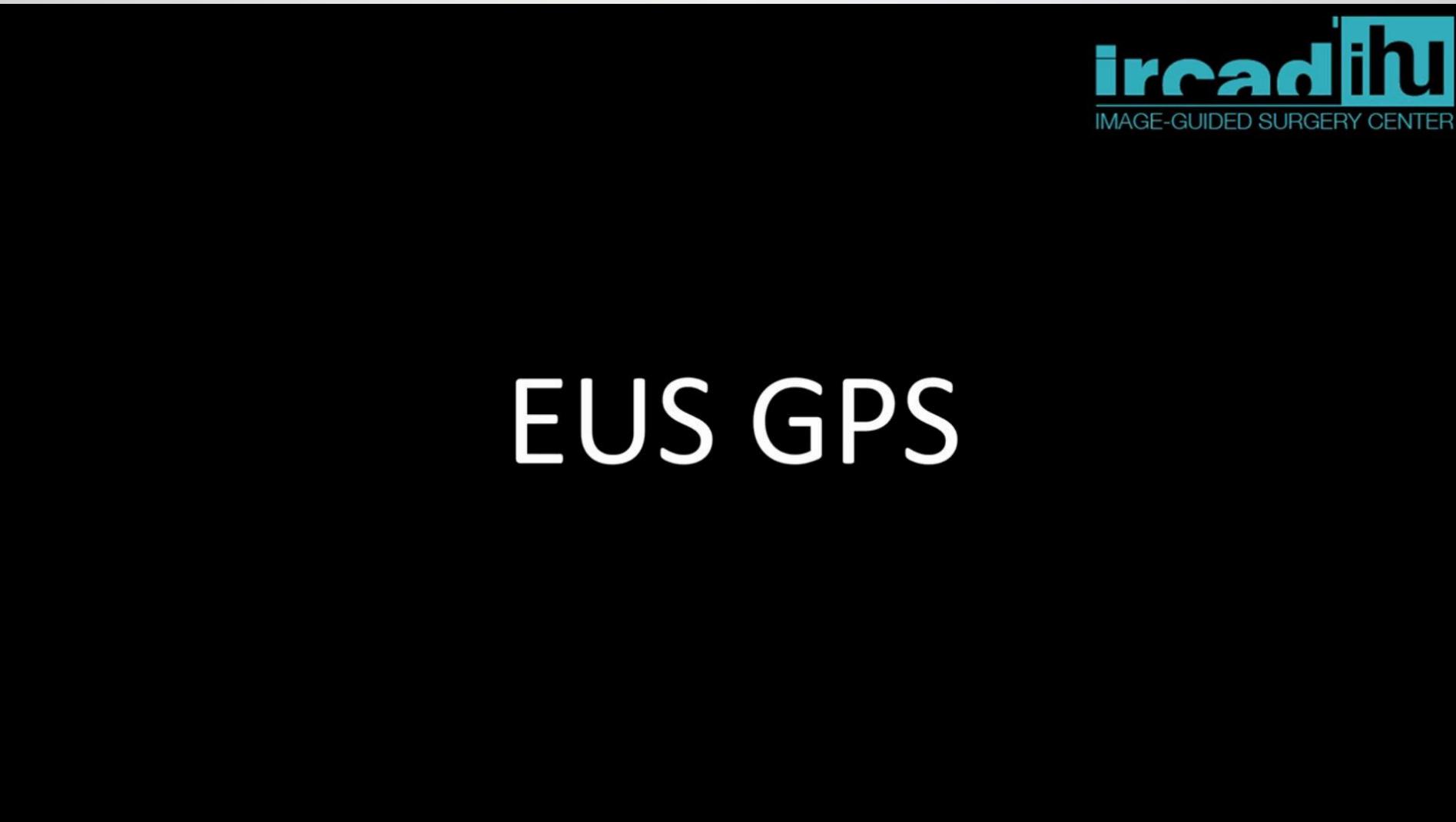
Project EUS-GPS

Technical solution

Equip EUS with **EM tracking**, provide **real-time, continuous 'global positioning'** of probe relative to pre-op 3D image or model



Project EUS-GPS



ircad'ihu
IMAGE-GUIDED SURGERY CENTER

Project EUS-GPS: live animal model



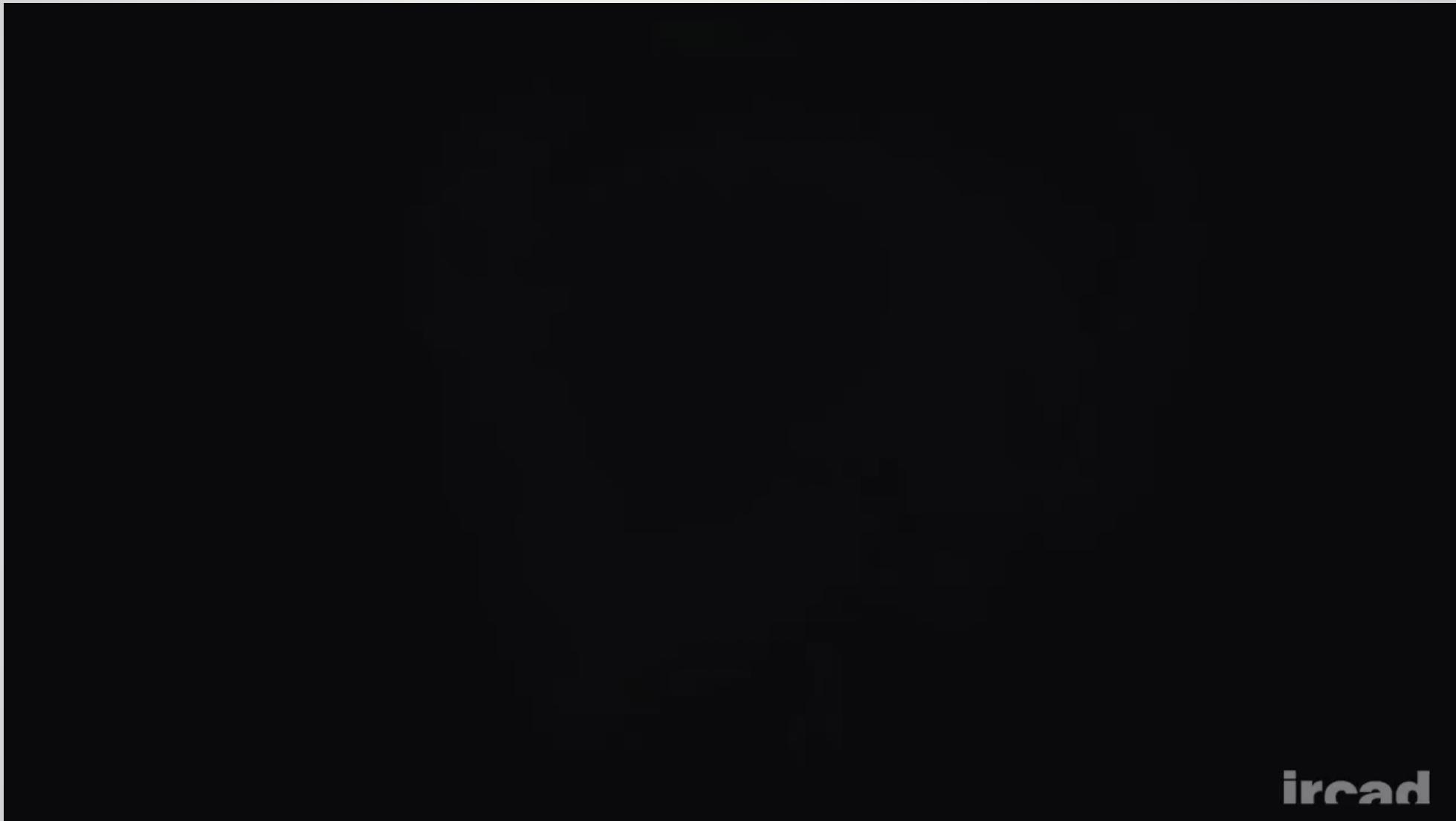
Hybrid Operating Room Concept



Robotics

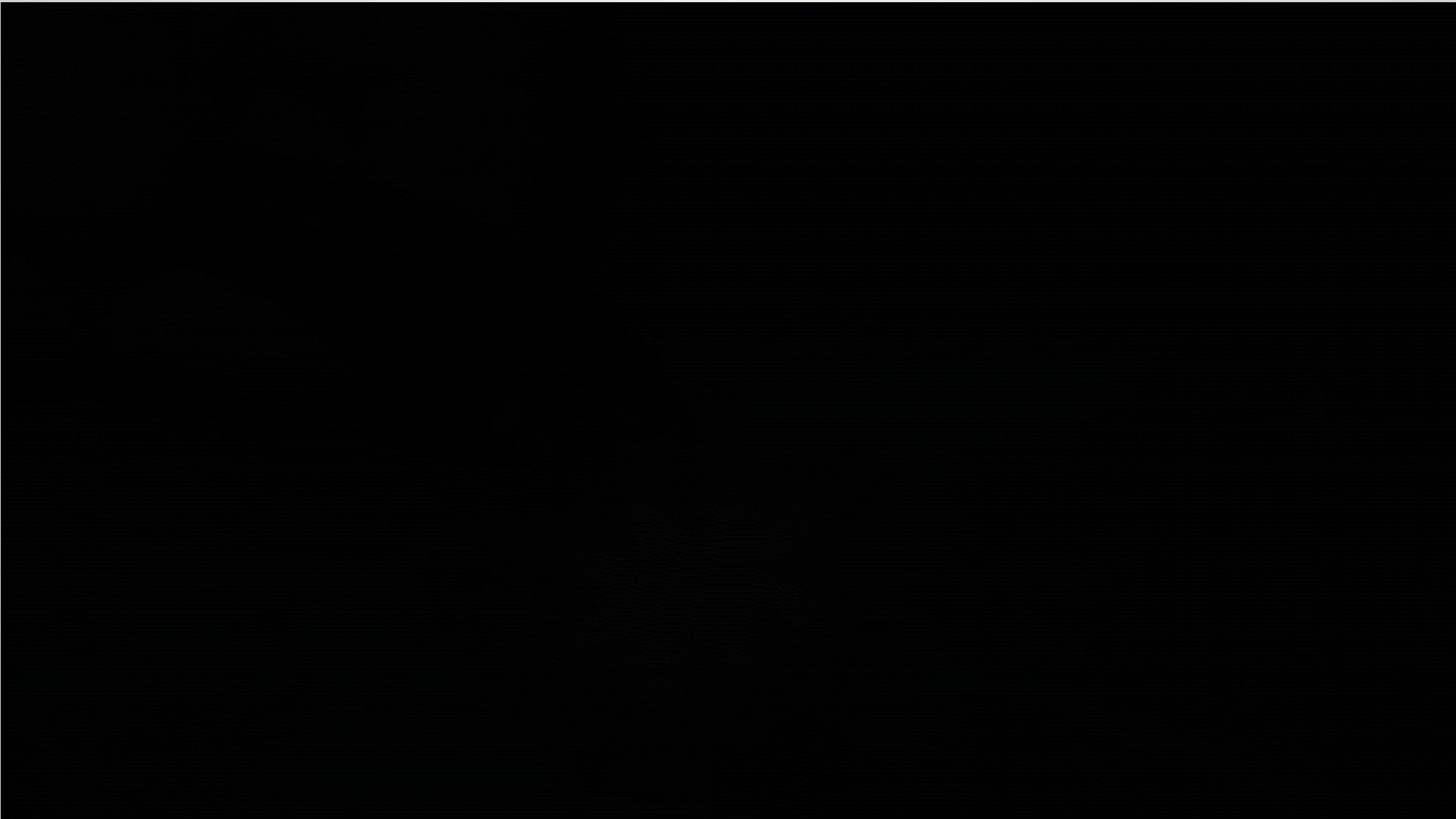
iread 

Robotics & Augmented Reality



ircad

ISISCOPE ® (icube)



Icube Robotic team (Strasbourg University) + IRCAD + Karl Storz

ircad VP

Next Step : Automation

WITHOUT Automatic Flexible endoscope control



Gastroscope



Laparoscope

Icube Robotic team Strasbourg University + IRCAD + Karl Storz

Next Step : Automation

WITH Automatic Flexible endoscope control



Gastroscope



Laparoscope

Icube Robotic team Strasbourg University + IRCAD + Karl Storz

Hybrid Operating Room Concept



Artificial Intelligence

ircad VP

Airport vs Hospital



Airport

- Check list
- Black box
- Control tower
- Normalized data



Hospital

A.I. & OP room



Airport Control Tower



Hybrid Control room

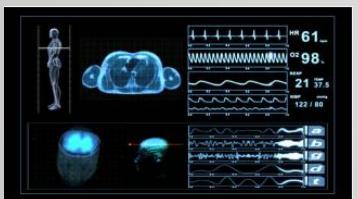
KARL STORZ AIDA®



SCENARA®



Control Tower



*Pre/Intraoperative
2D/3D Images*



*Ambient
Camera*



*Laparoscopic
Camera*



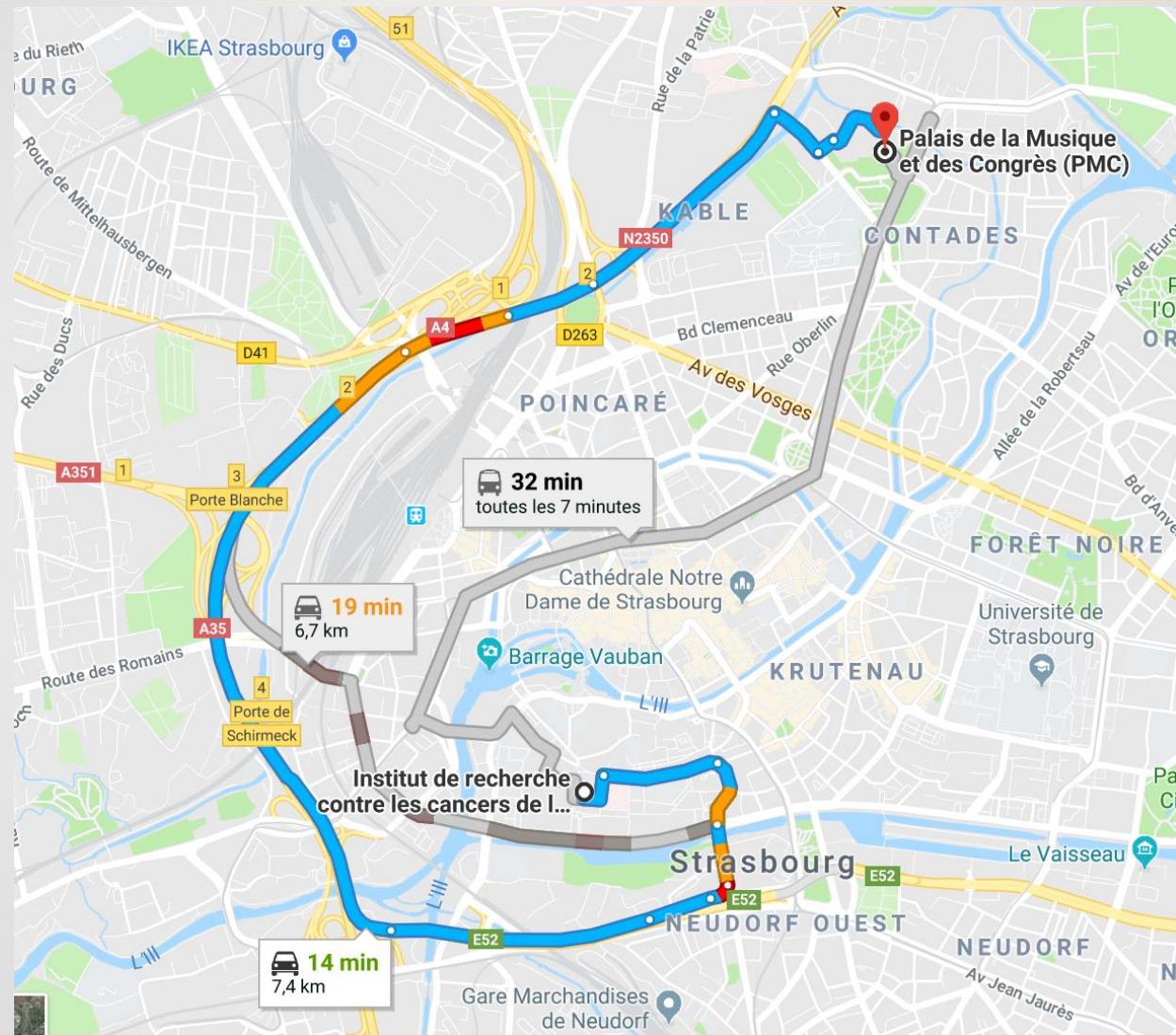
*Physiological
Signals*



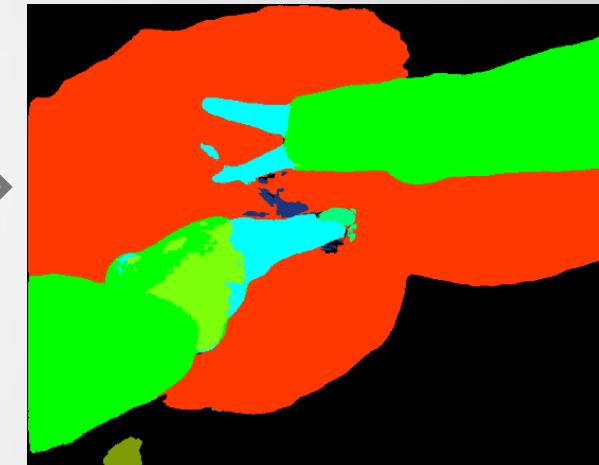
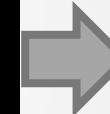
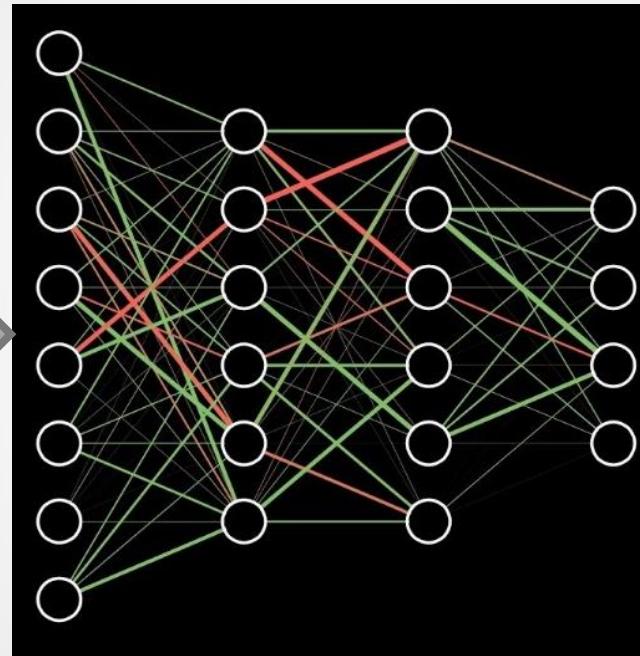
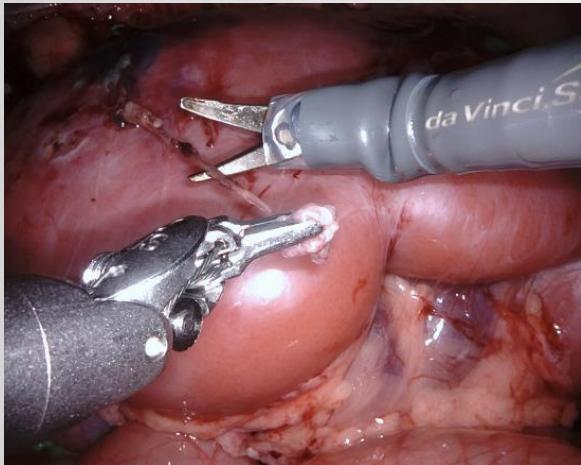
*Intraoperative Process
& Applications*



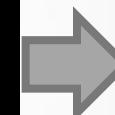
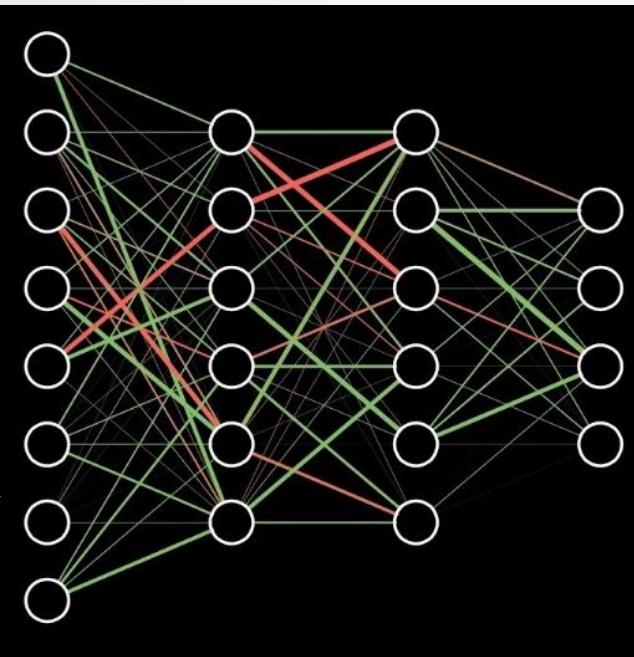
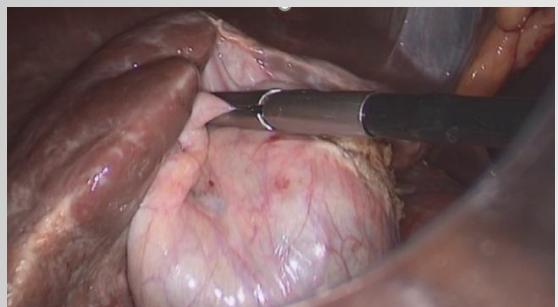
A real Surgeon GPS need more...



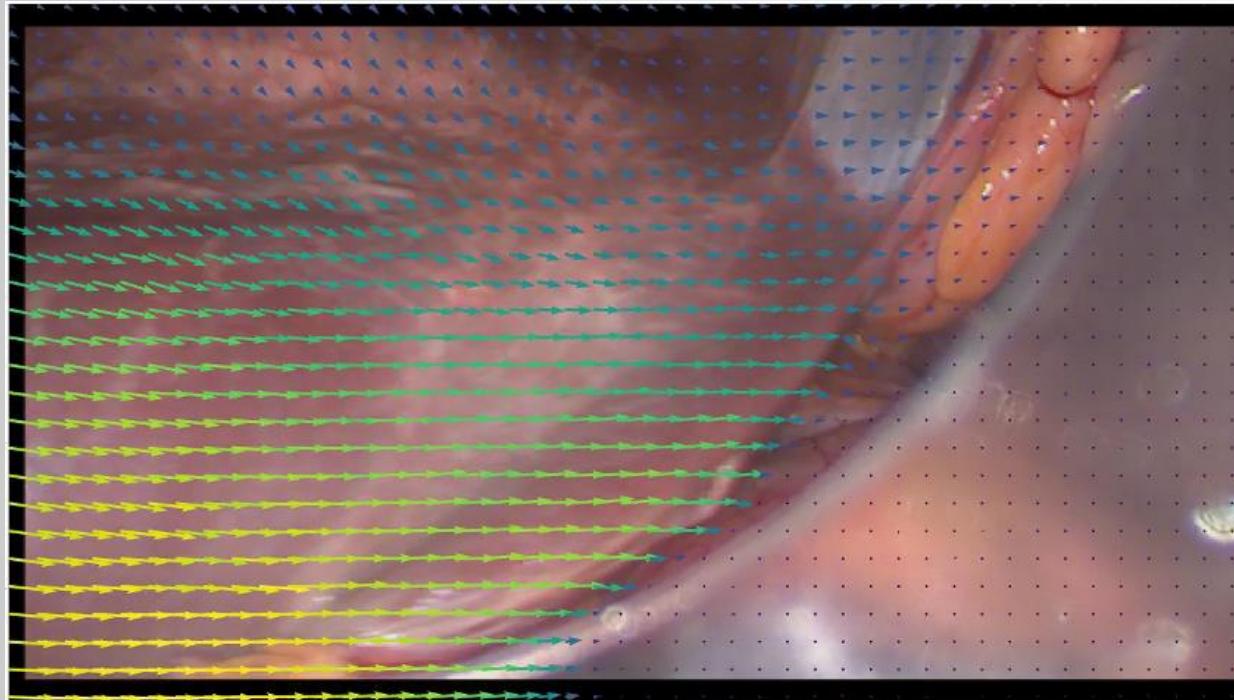
Scene Description with Deep Learning



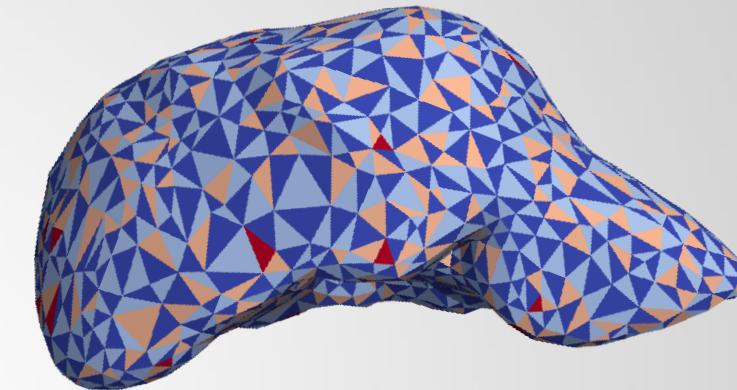
Soft organ registration with Deep Learning



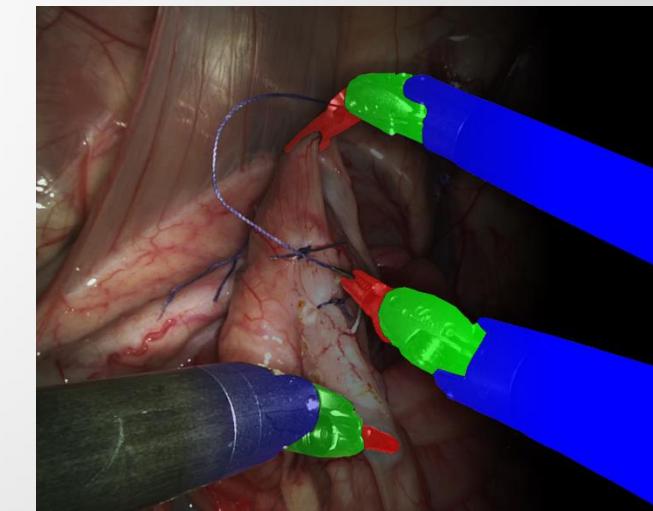
Soft organ registration: Putting it together in the next year



Tissue tracking



Biomechanical modelling



Instrument reasoning

Analyse automatique de l'opération: I.A.

List of detected tools

Current detected phase

Detected tools: Grasper Hook
Detected phase: Calot triangle dissection

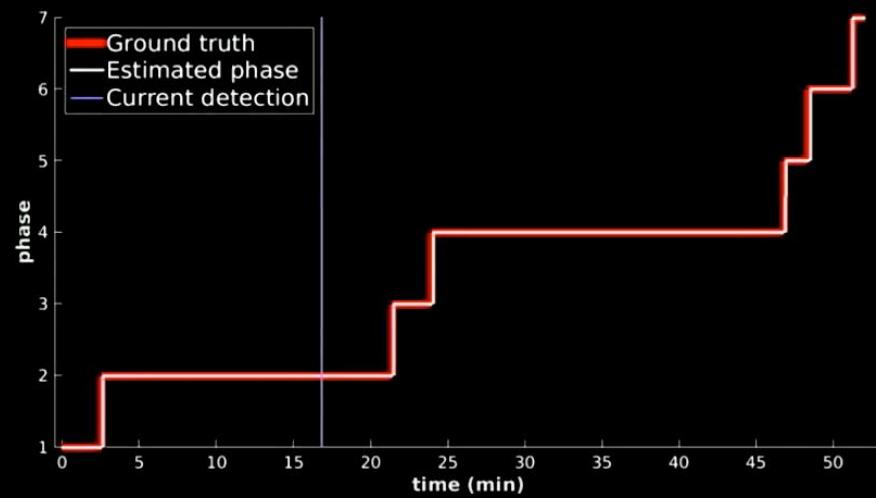
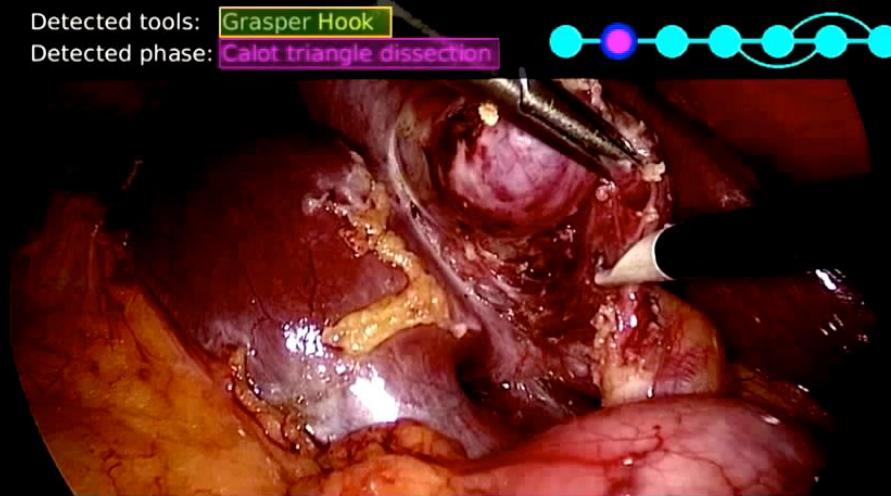
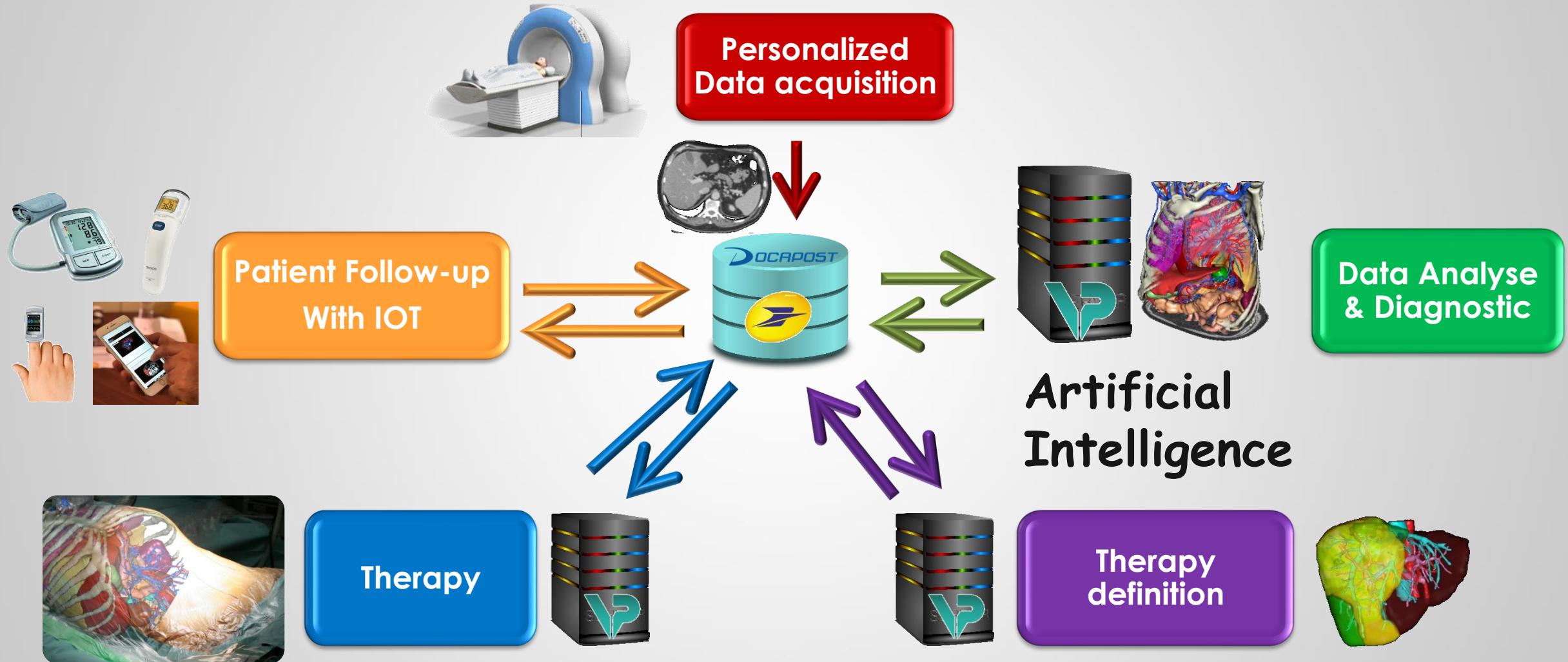


Image & data = the base of Computer Guidance



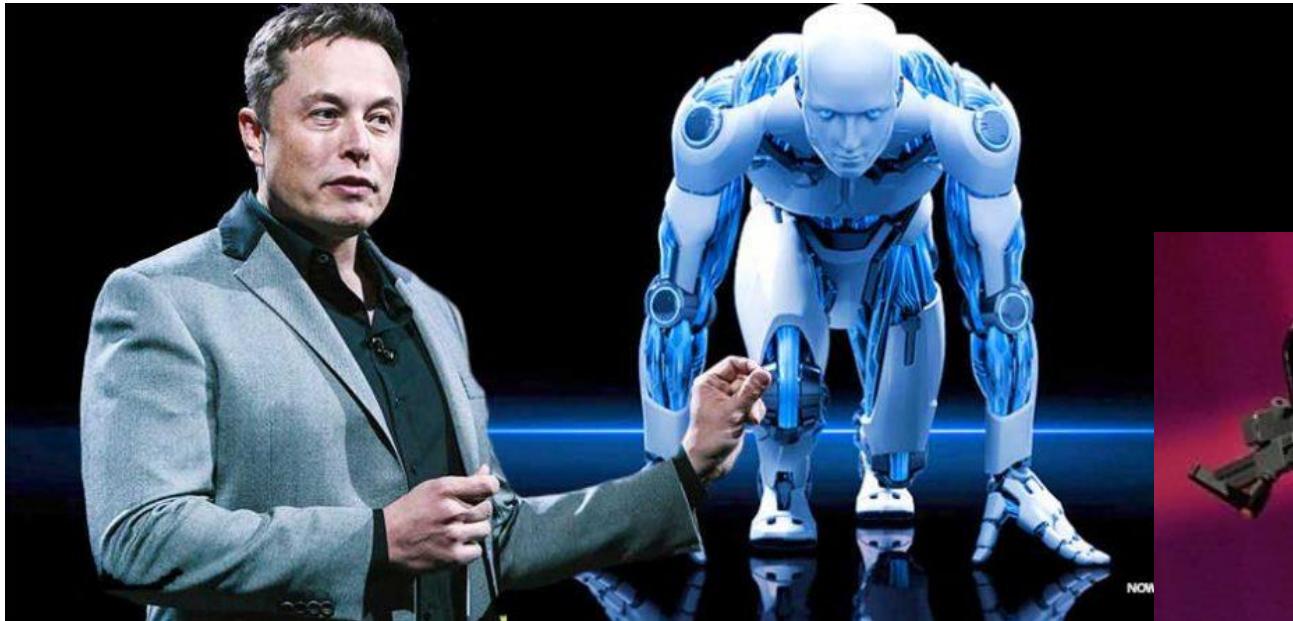
Augmented Surgery future : For any surgery !



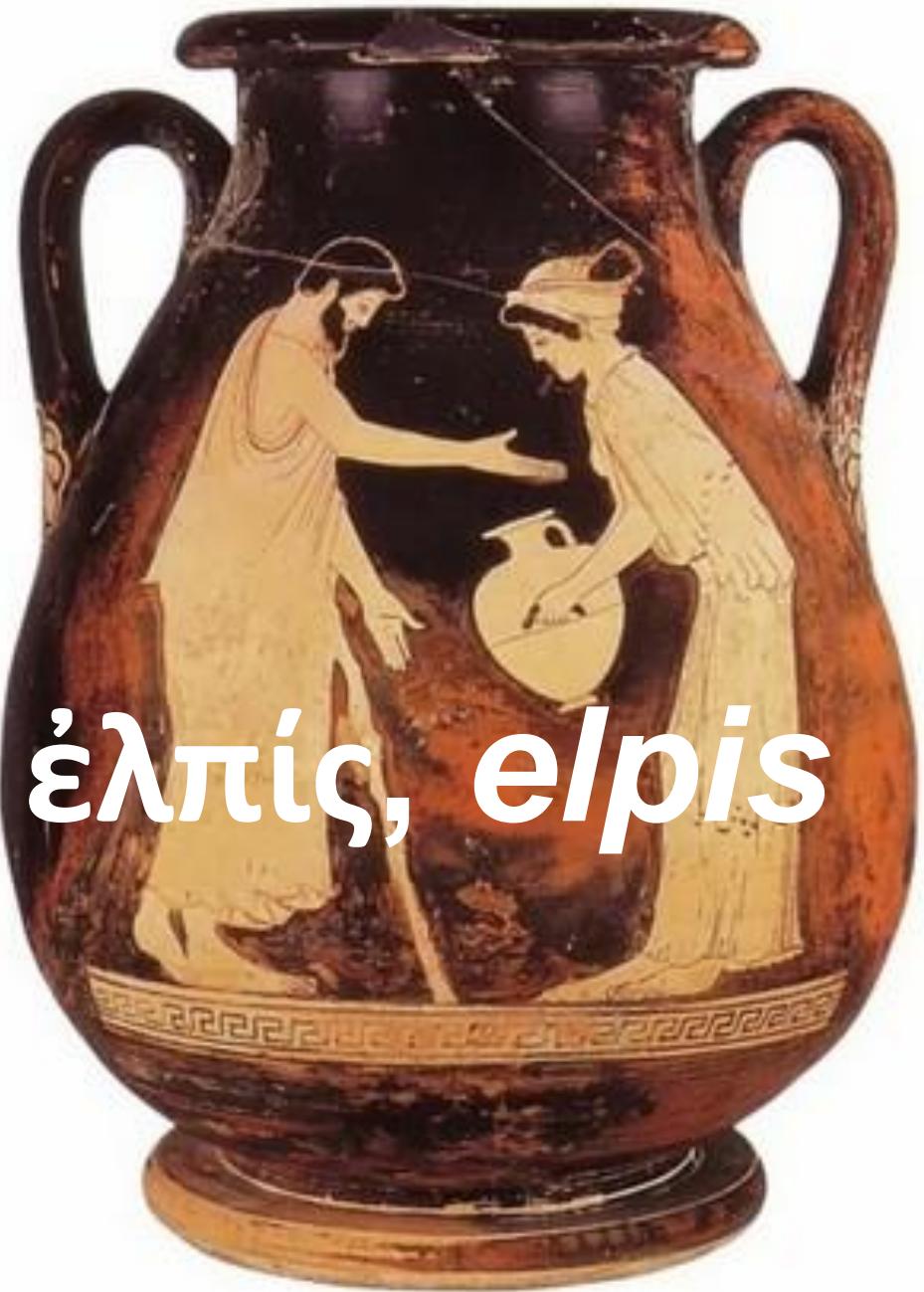
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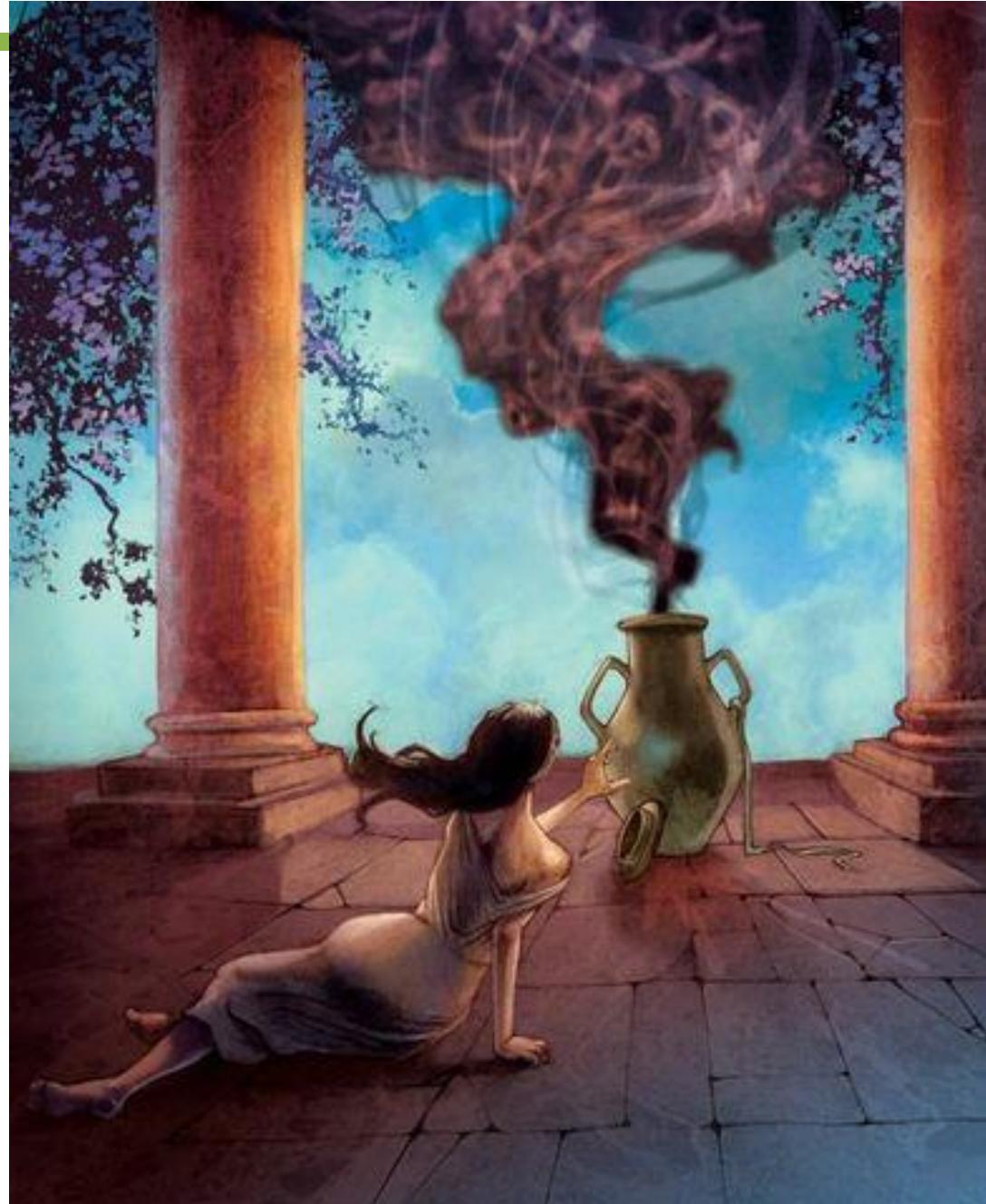
L'INTELLIGENCE ARTIFICIELLE = DANGER ?







έλπις, *elpis*





A young child with short, light-colored hair is shown from the chest up, looking upwards and slightly to the side with a thoughtful expression. The child is wearing a white t-shirt with a visible orange collar. They are holding a thick stack of approximately ten books against a plain, light green background.

Vivre c'est prendre des risques

L'intelligence c'est de les maîtriser

pour le bien de l'humanité

Thank you for your attention



Merci pour votre attention