

# *Chirurgie du futur guidée par l'image numérique*

J. Marescaux - MD, FACS, HonFRCS, HonFJSES



IRCAD France – University of Strasbourg

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# IRCAD disclosure

- Medtronic
- Karl STORZ Endoscopy
- Intuitive Surgical
- Visible Patient
- Siemens

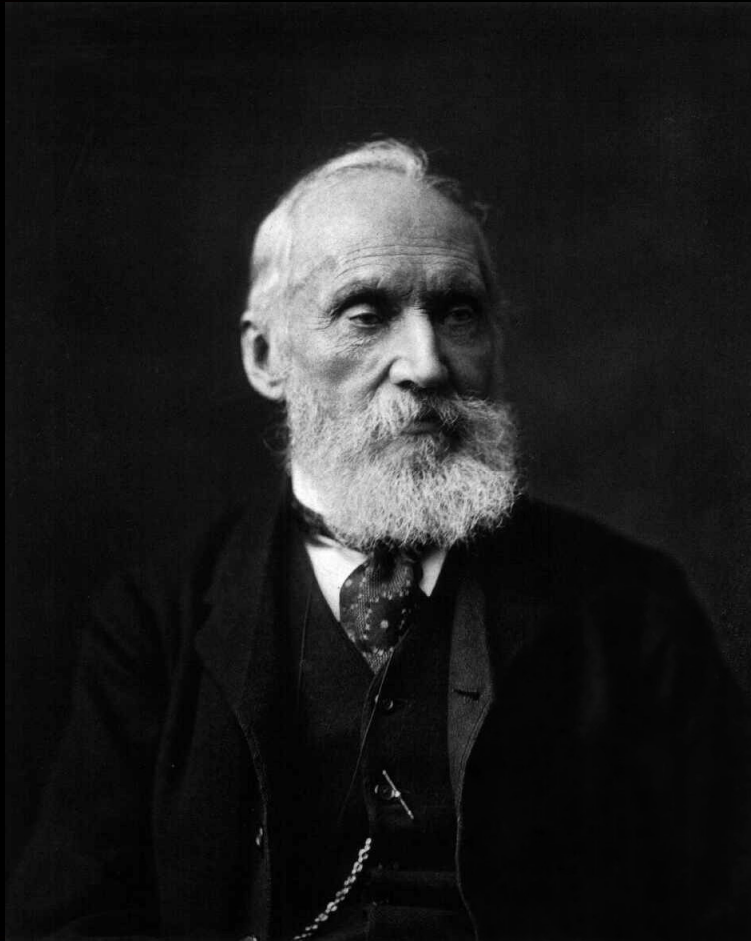


*There are no experts  
on the Future*

J. Folkman, MD

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About radio...



*Radio has no future*

Lord Kelvin - 1897

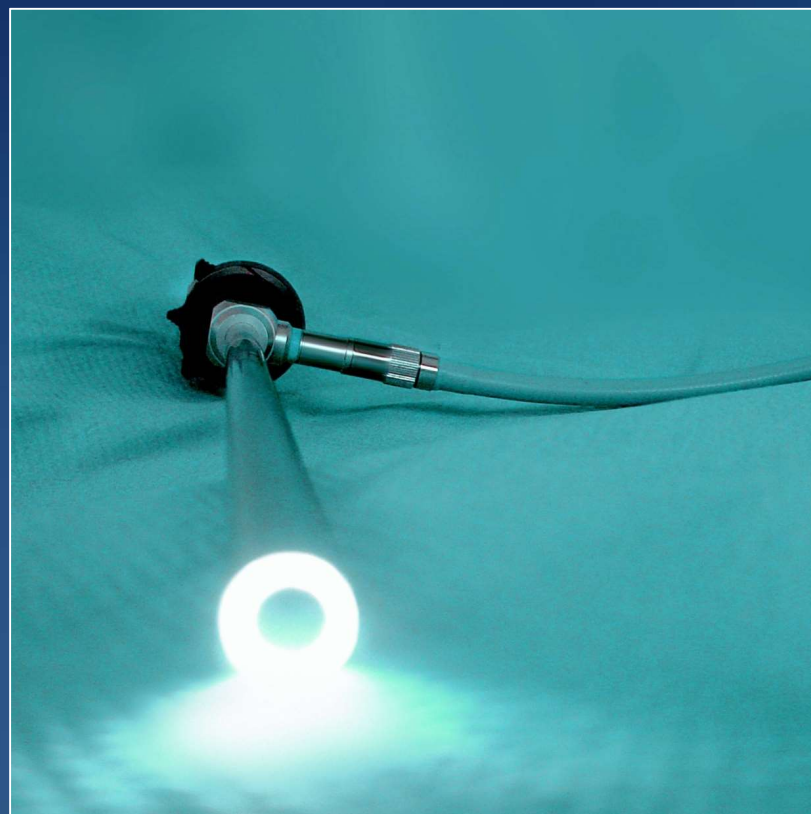
Scottish mathematician and physicist,  
former president of the Royal Society

About computers...

*There is no reason for any individual  
to have a computer in their home.*

Kenneth OLSEN  
President and founder  
Of Digital Equipment Corp., 1977

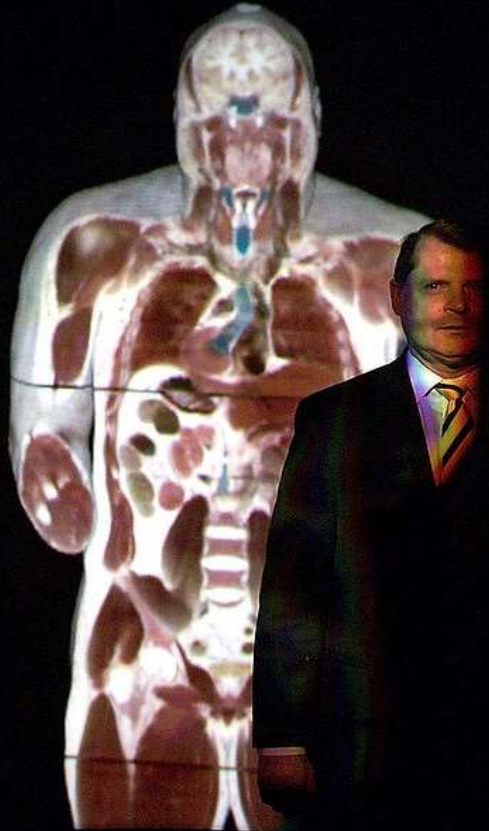
At the exact time: birth of MIS



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# Taking advantage of a great idea

R. Satava (1991)



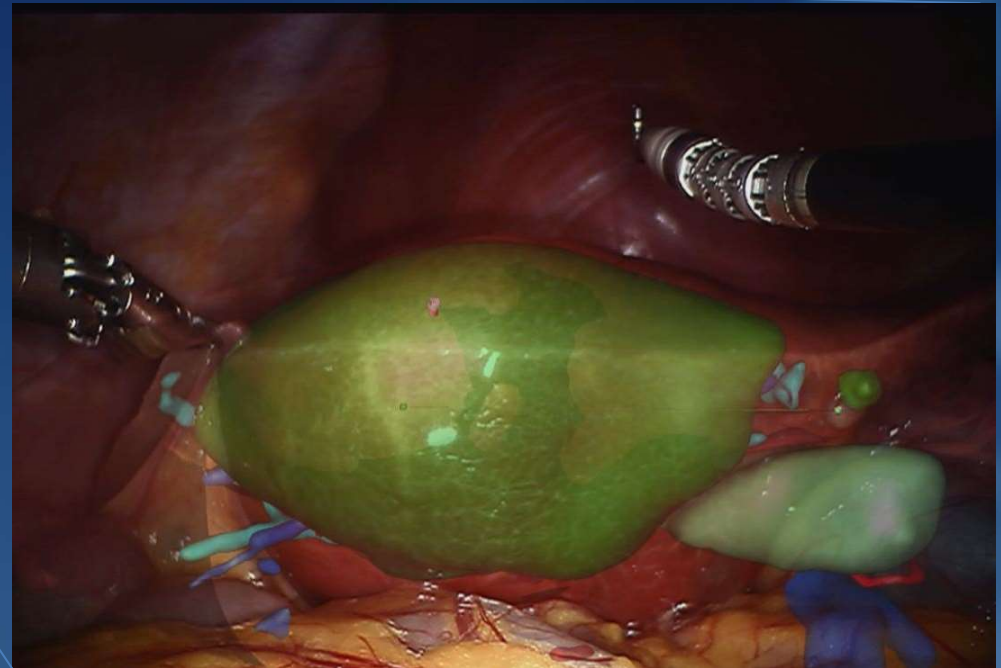
*« Medicine will switch  
from Industrial Age  
to Information Age »*

# Taking advantage of a great environment

**UNIVERSITY of STRASBOURG: among top 100 worldwide** (Shanghai ranking)

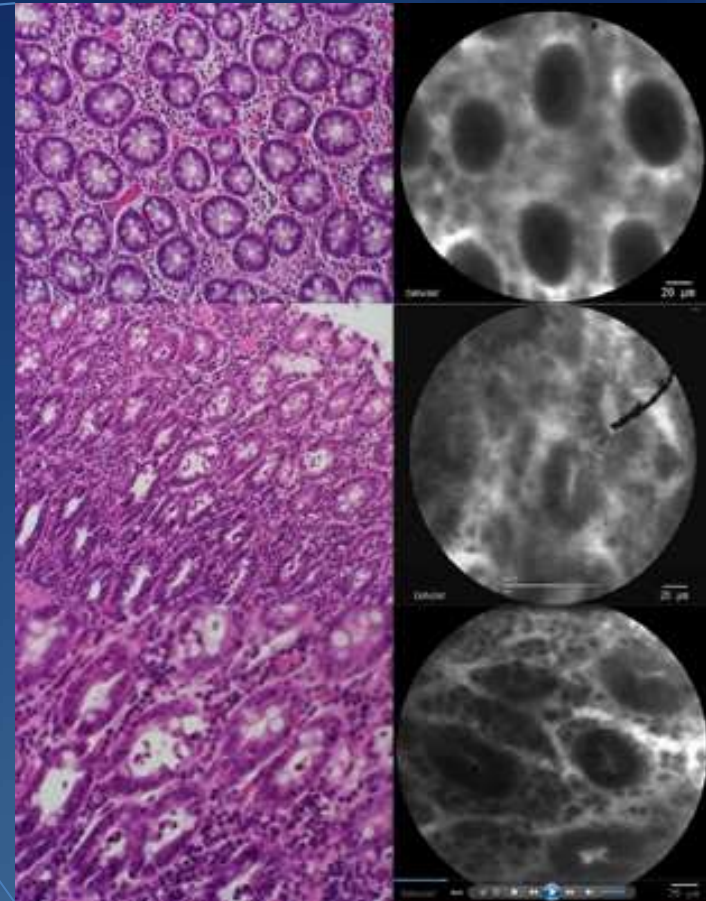


## Towards “cybernetic surgery”



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## Towards “cybernetic surgery”

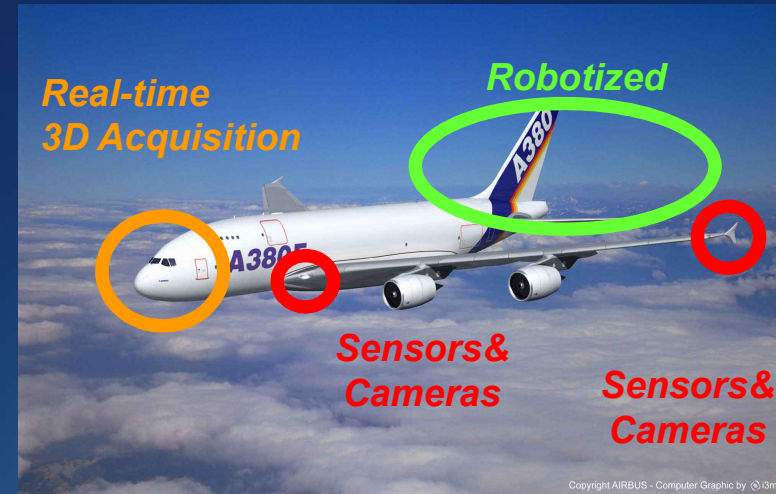


## Towards “cybernetic surgery”



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# The new challenge: Surgery should meet Aeronautics



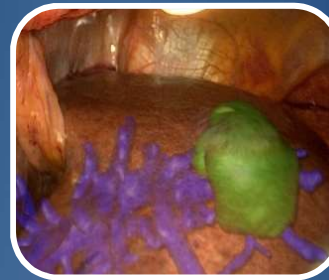
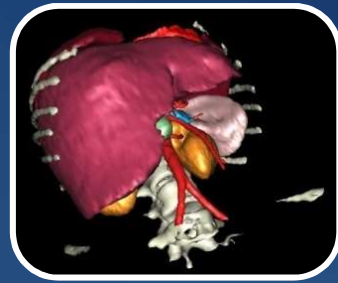
Operating Room of the Future ?

1<sup>st</sup> challenge

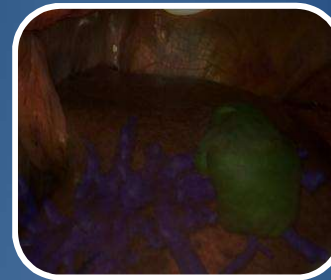
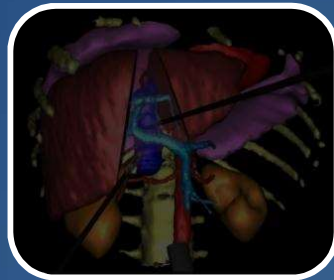
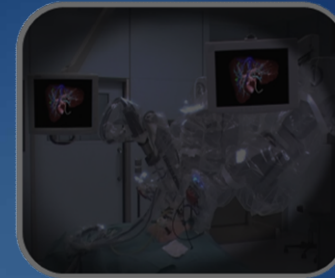
Optimize imaging  
for personalized surgery:

Virtual & Augmented Reality

# Virtual reality: the pathway



# Step 1: Virtual planning



# 3D Patient Specific Anatomy: Virtual **preop** planning



N. Engl. J. Med. 2012

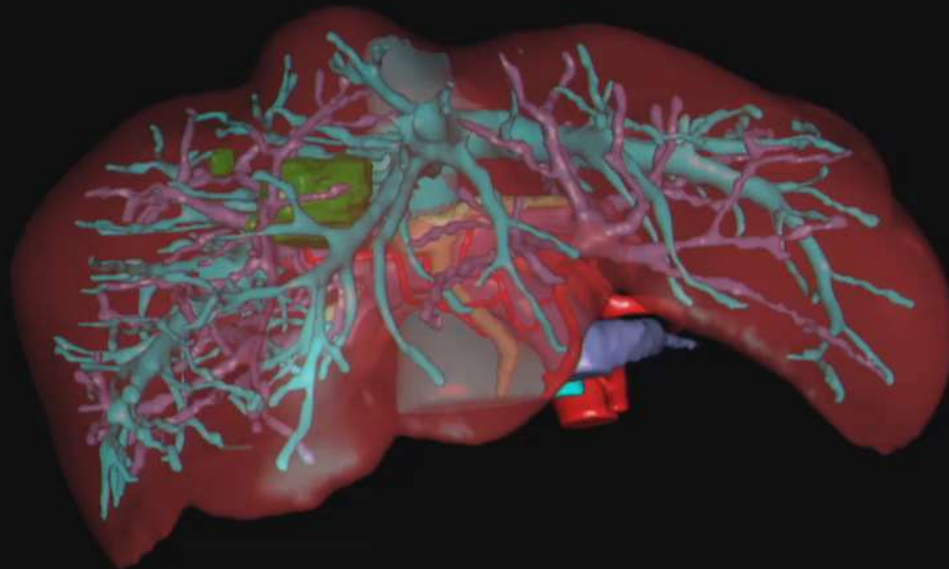
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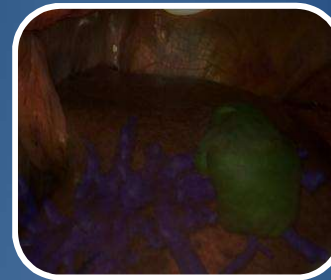
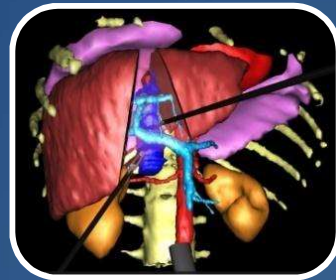
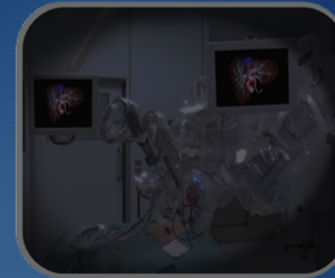
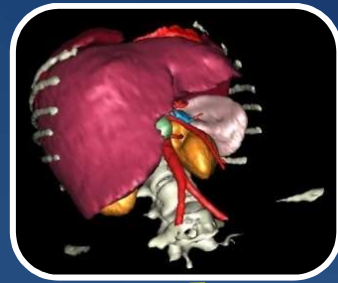
# 3D Patient Specific Anatomy: Virtual **preop** planning



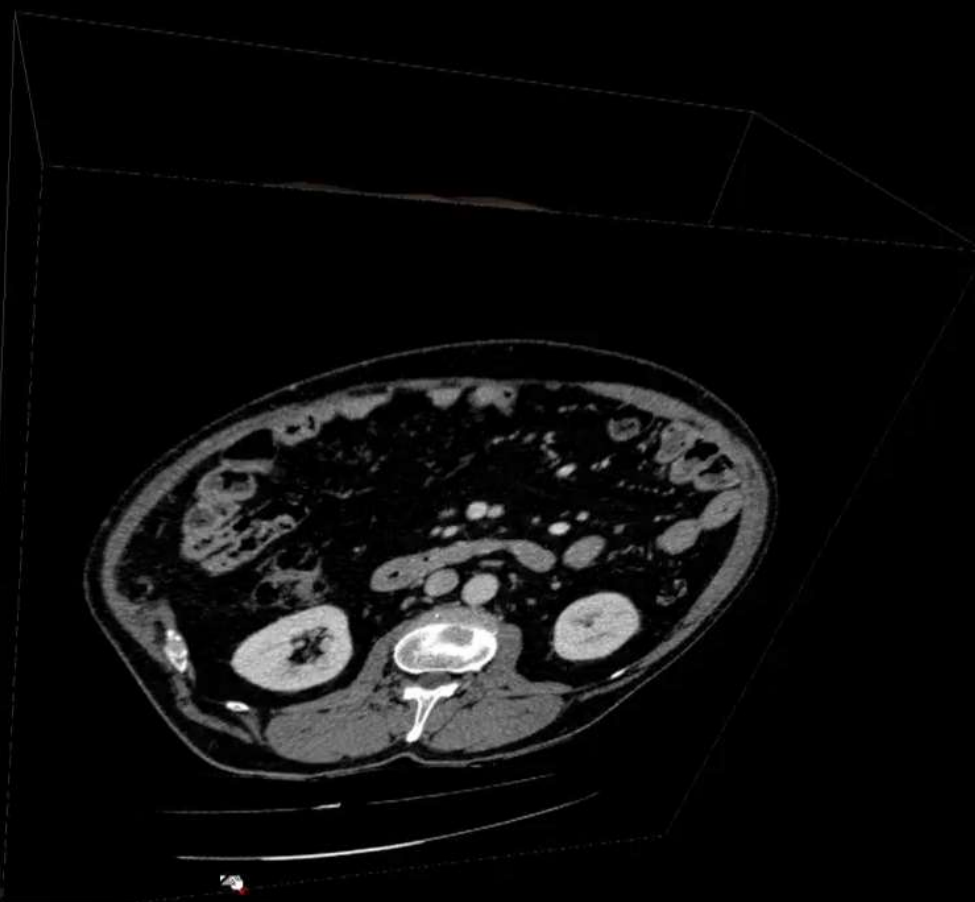
# Preoperative virtual « physiological » planning



## Step2: Preoperative Simulation



# Preoperative Simulation



Tracer

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# Preoperative Simulation



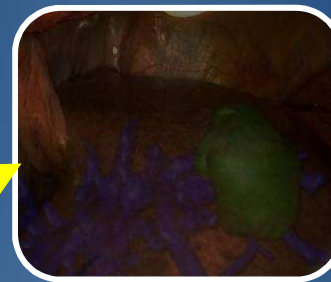
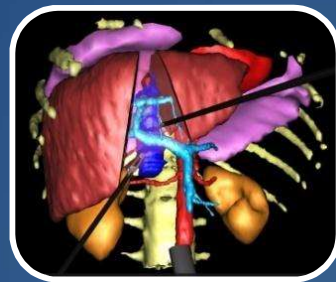
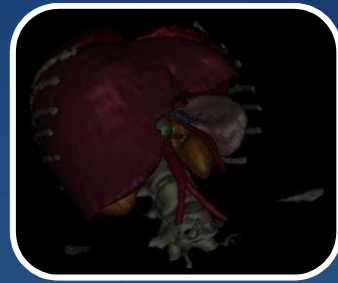
## Current virtual intraop planning



## Future: 3D virtual intraop planning - touchless control



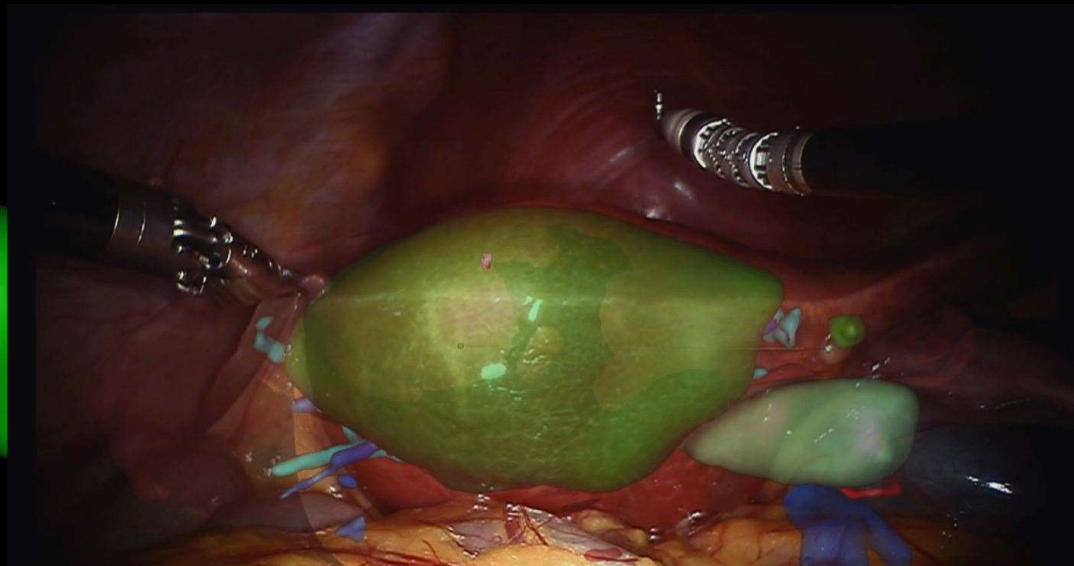
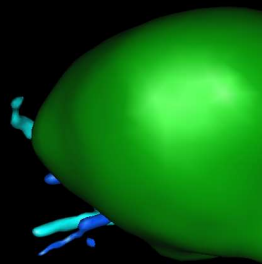
# Step3: Augmented Reality





# Augmented Reality ?

## FUSION



3D virtual Image + Video Image

Augmented Reality

# Manual Real-time Augmented Reality



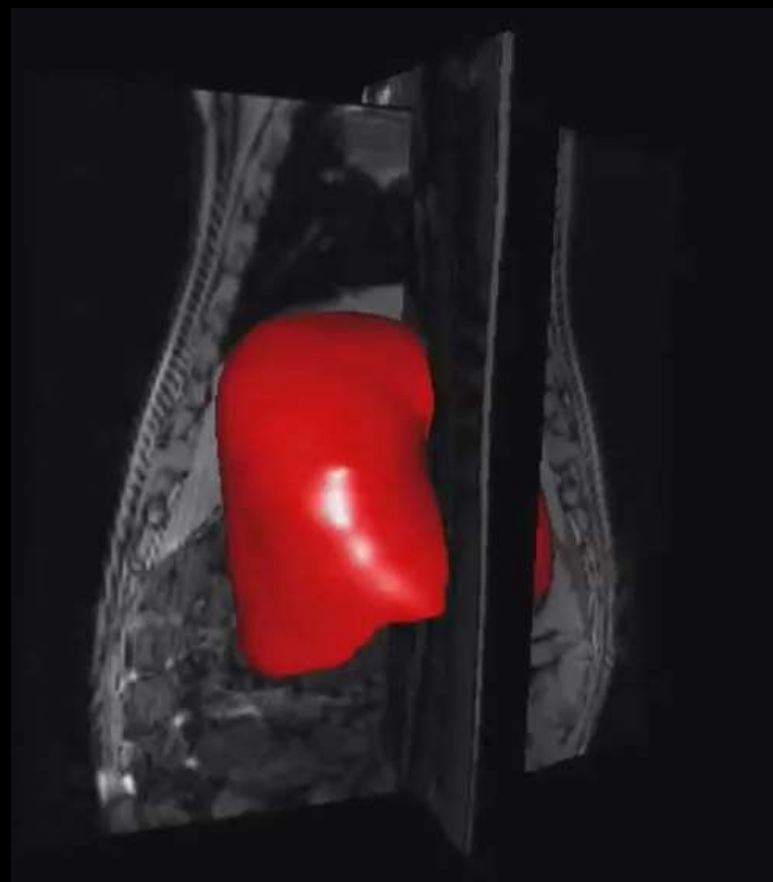
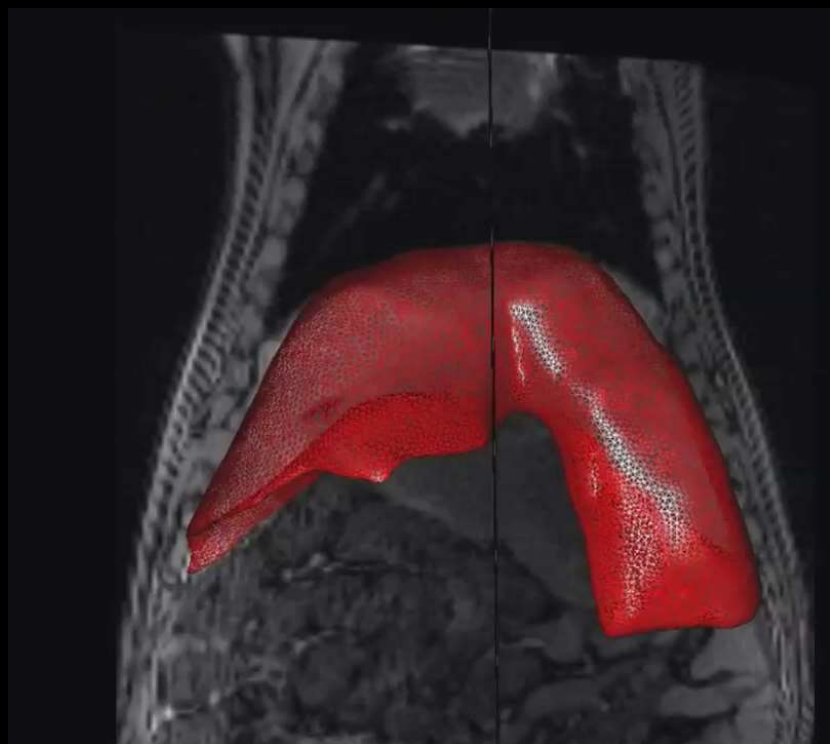
**JAMA 2004**

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# Real-time Augmented Reality

Limiting factor  
=  
Rigid deformation

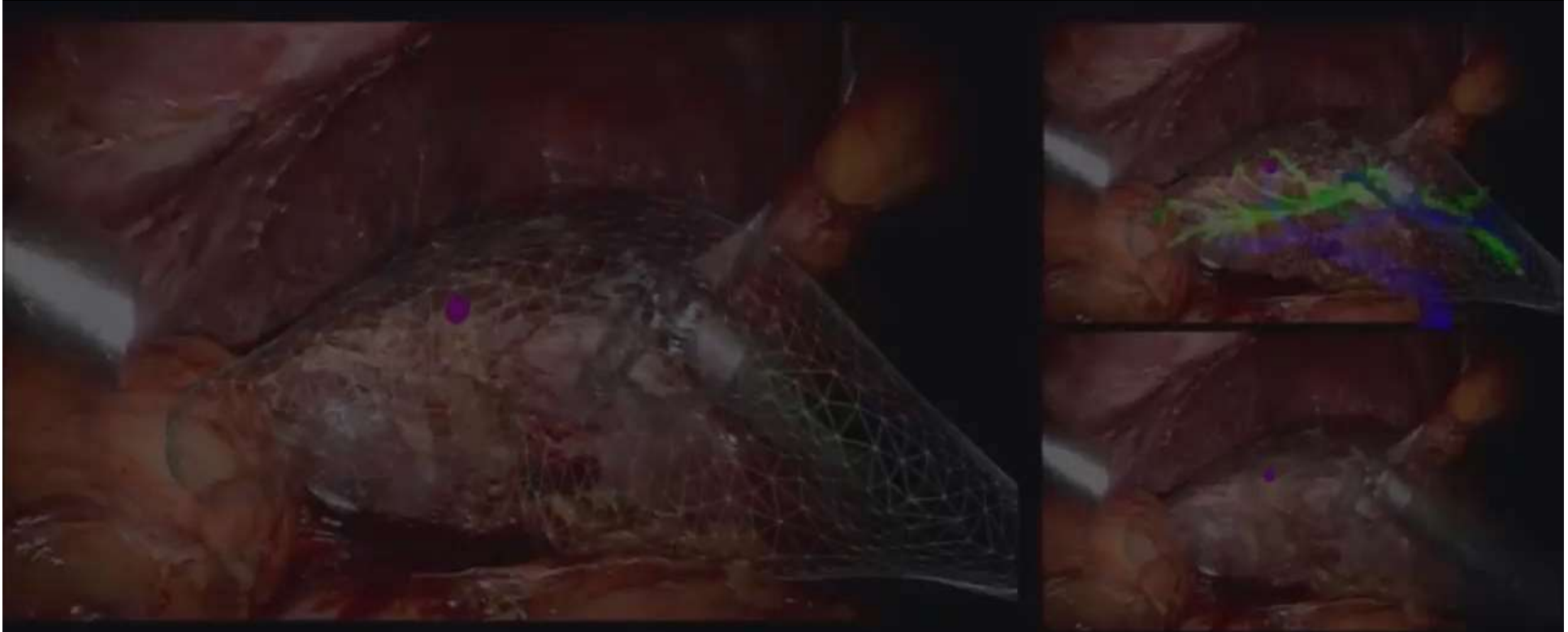
# Liver Registration Dynamic MRI



S. Cotin – INRIA, IHU Strasbourg

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# Augmented Reality with Deformable Model



S. Cotin – INRIA, IHU Strasbourg

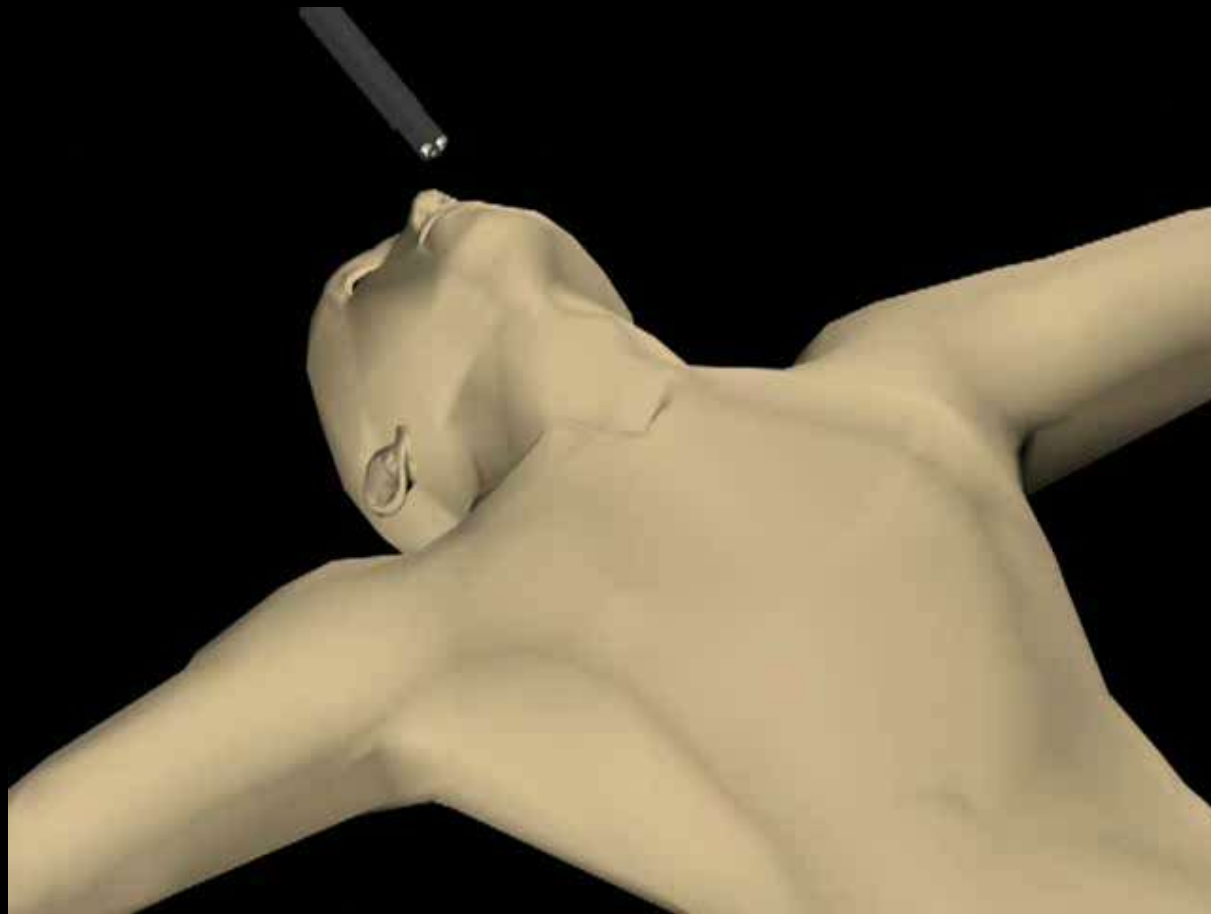
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2nd challenge

Improve Minimally  
Invasive Access:

NOTES

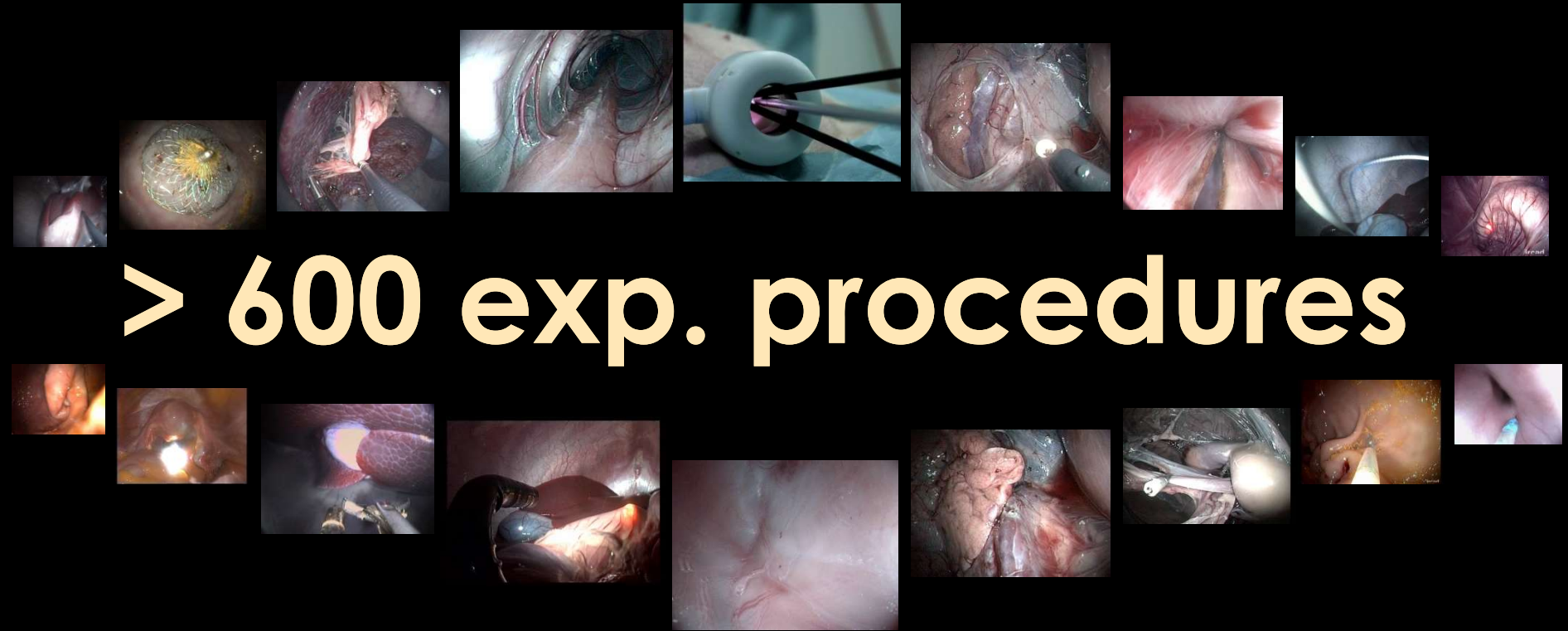
N.O.T.E.S.



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# N.O.T.E.S. R&D IRCAD 2005 - 2013

**> 600 exp. procedures**





# N.O.T.E.S.: technological limits



# Platform: ANUBISCOPE<sup>®</sup> (2007)



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N.O.T.E.S.

# Human application

## Past: No Scar cholecystectomy



NOTES :

JAMA surgery 2007

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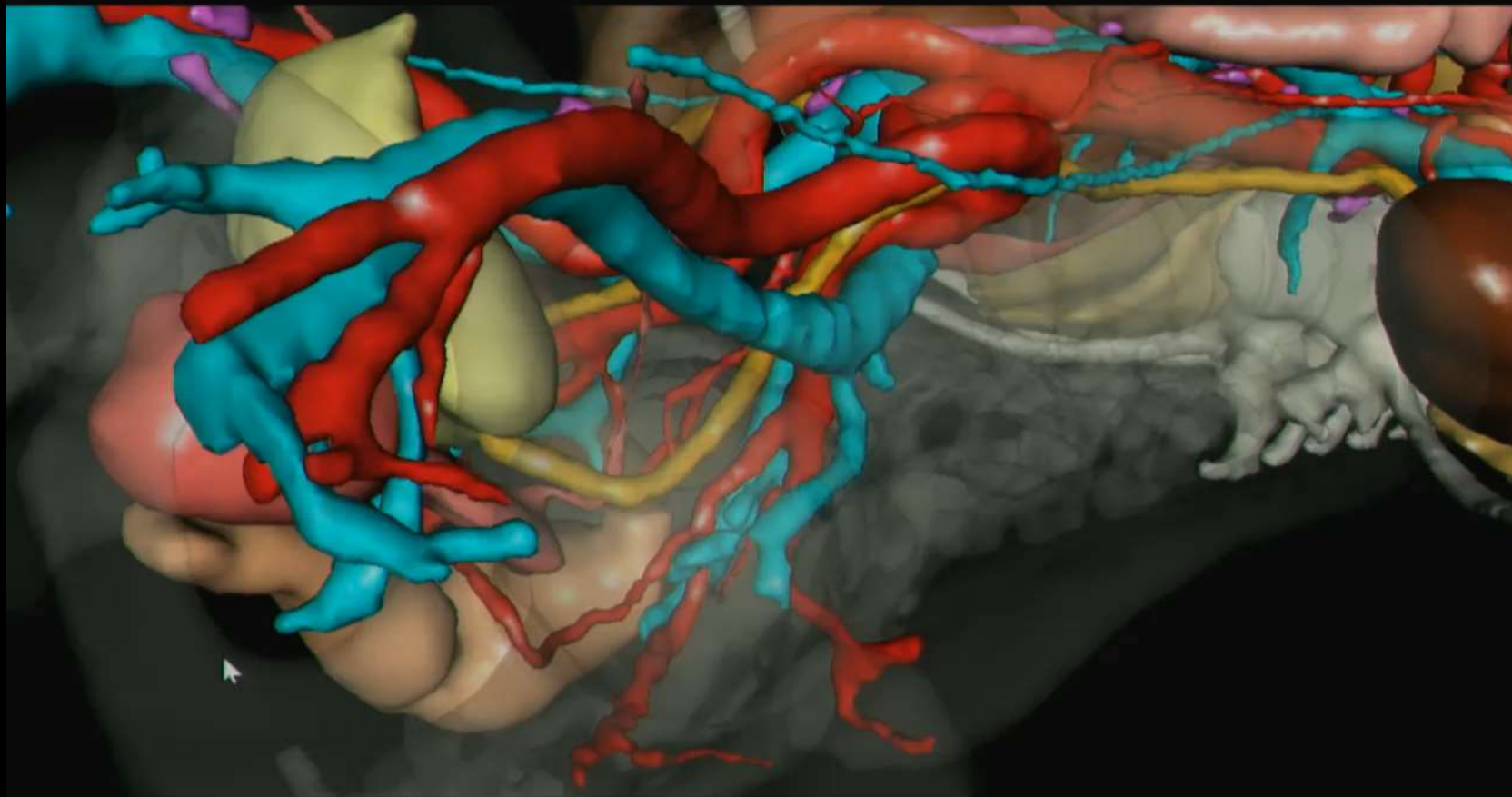
## **Future** : TME/TEM (J Leroy)



**JAMA surgery 2012**

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# Pelvic surgery: **Virtual** transanal approach



3<sup>rd</sup> challenge

# Improve Robotics

# Robotics & Long Distance Surgery



7<sup>th</sup> September 2001

Lindbergh OP: **NATURE 2001**

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# Lindbergh Operation



# Lindbergh Operation



# Lindbergh Operation



NATURE 2001

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# NOTES & Robotics



NOTES :

# Robotics & S.I.L.S.

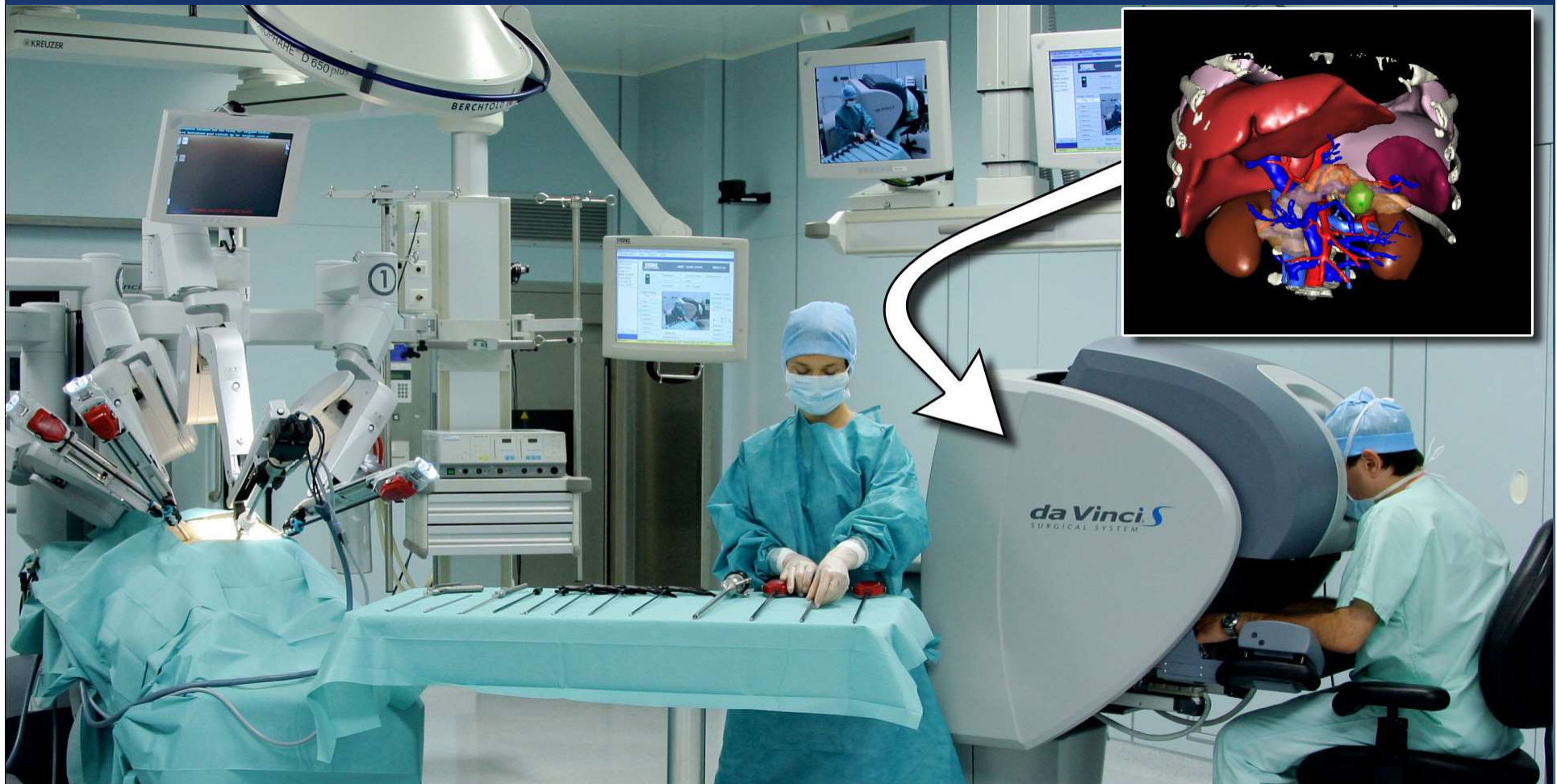
*Umbilicus is a natural scar  
of a natural orifice...*

# Singleport & flexible Robotics



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# Robotics & A.R.



# Robotics & A.R.

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# Robotic pancreatotomy



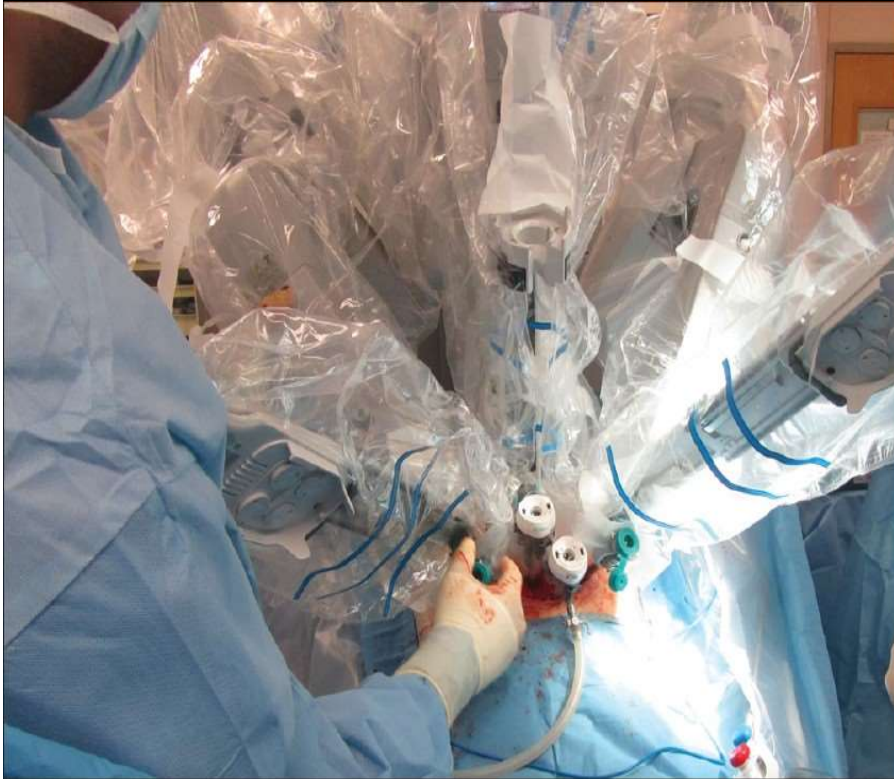
# Robotic TME



Fenestrated Bipolar

Monopolar Curved Scissors

# Current limitations of the robot



# Towards reduction of size



Hard drive in 1956  
< 1kb



Memory  
Stick in 2006  
4 Gb



Memory  
Stick in 2014  
256 Gb

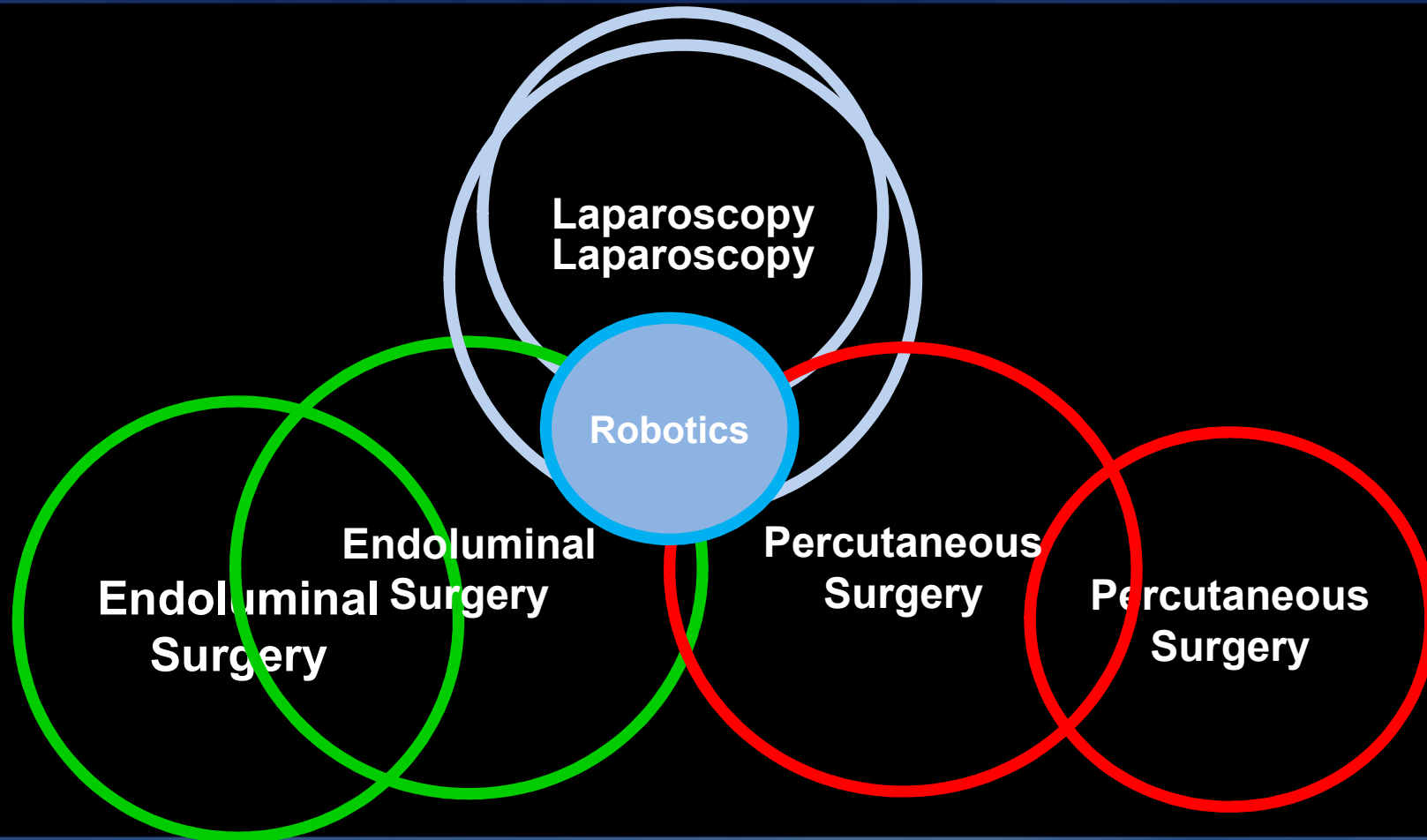
# Towards reduction of size ?



Outcome of this work

Birth of a new specialty:  
Image-Guided Surgery

# From MIS to hybrid MIS



# Image Guided Minimally Invasive Surgery Institute

8 clinical Hybrid ORs  
4 experimental Hybrid ORs  
Budget: 220 M€  
Opening autumn 2015



Hybrid OR

MRI

CT-Scan

C-Arm

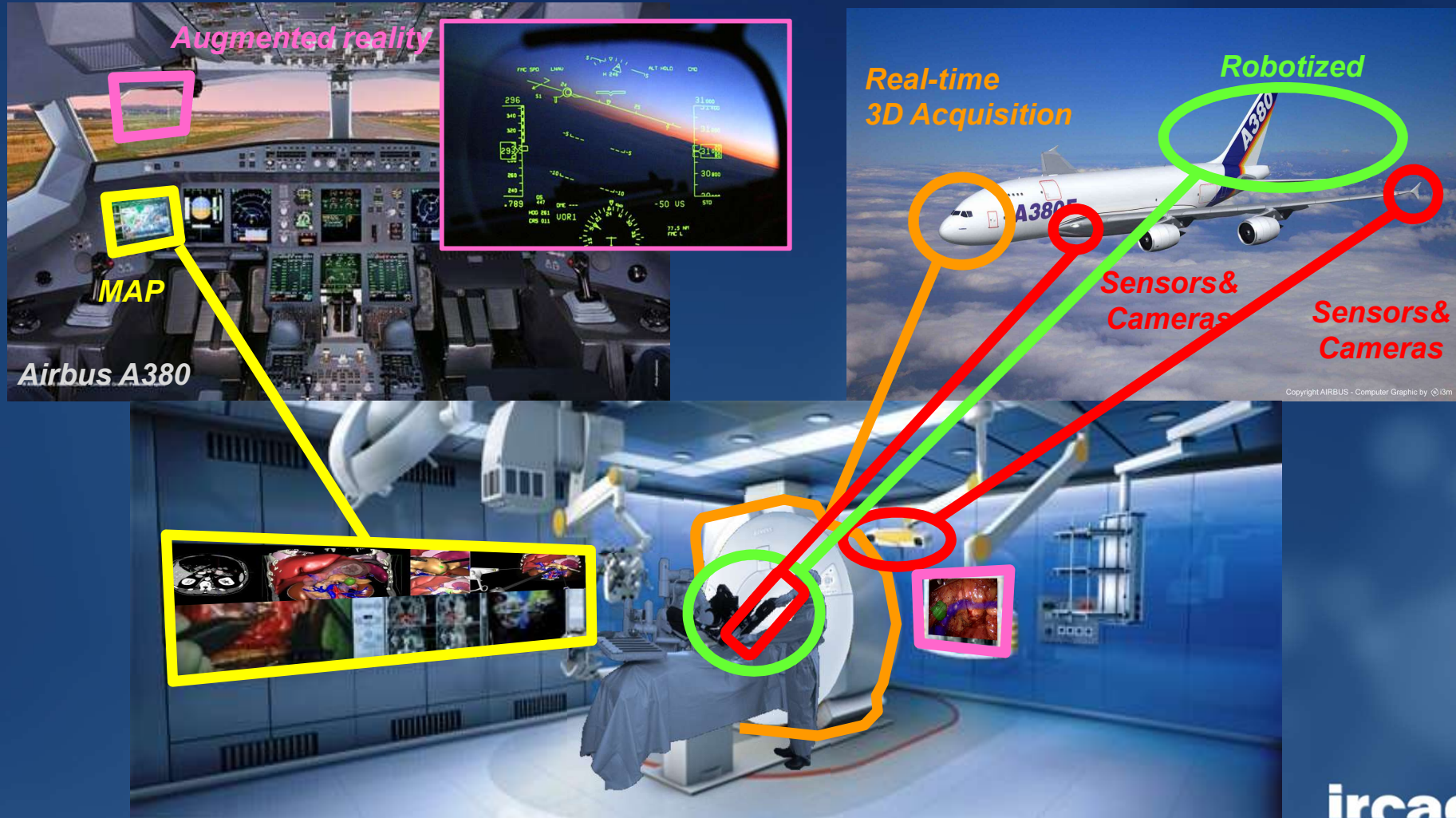
U.S.

ZEEGO

SYNGO



# The new challenge: Surgery should meet Aeronautics

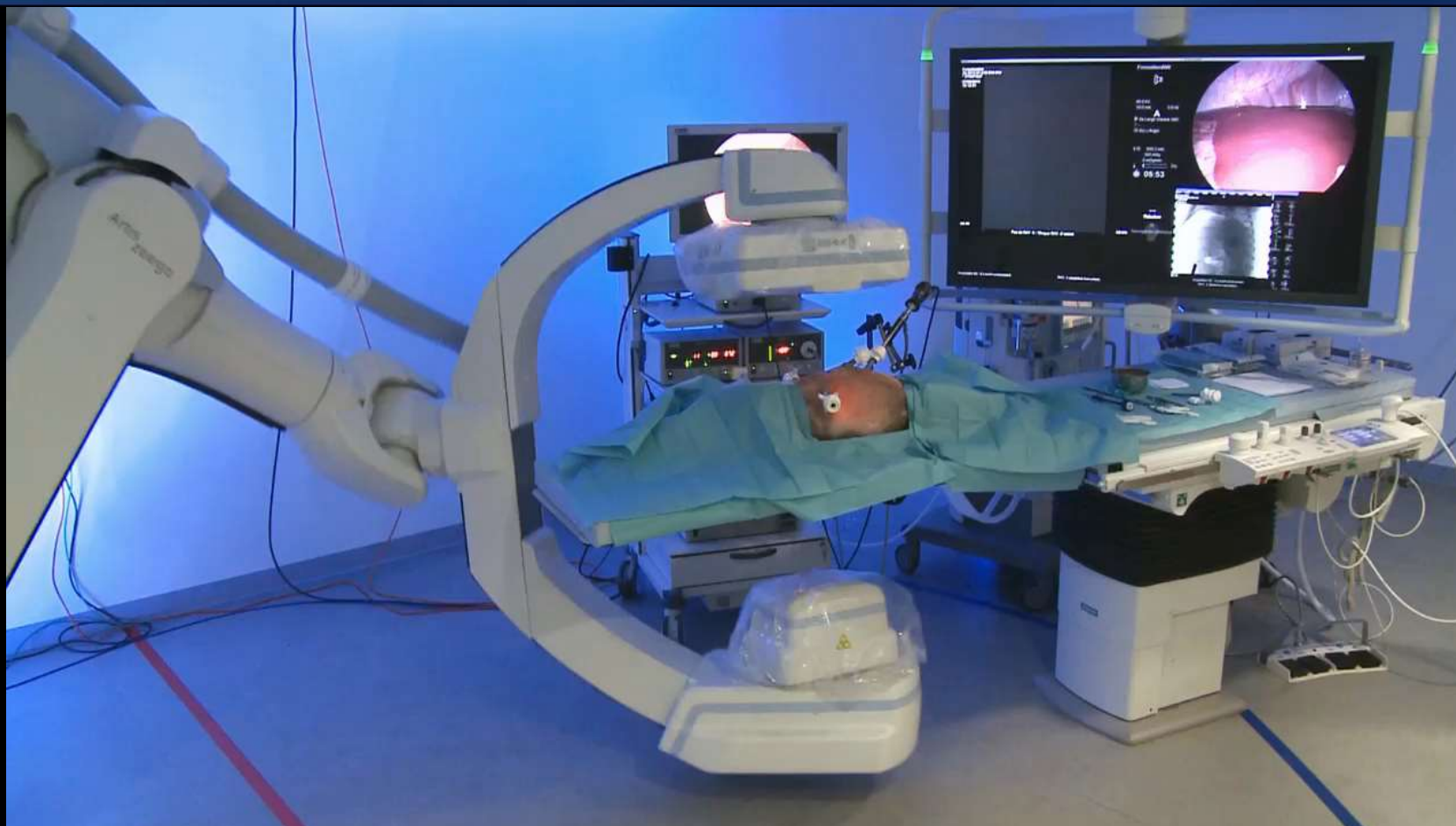


# Hybrid platform: pelvic surgery

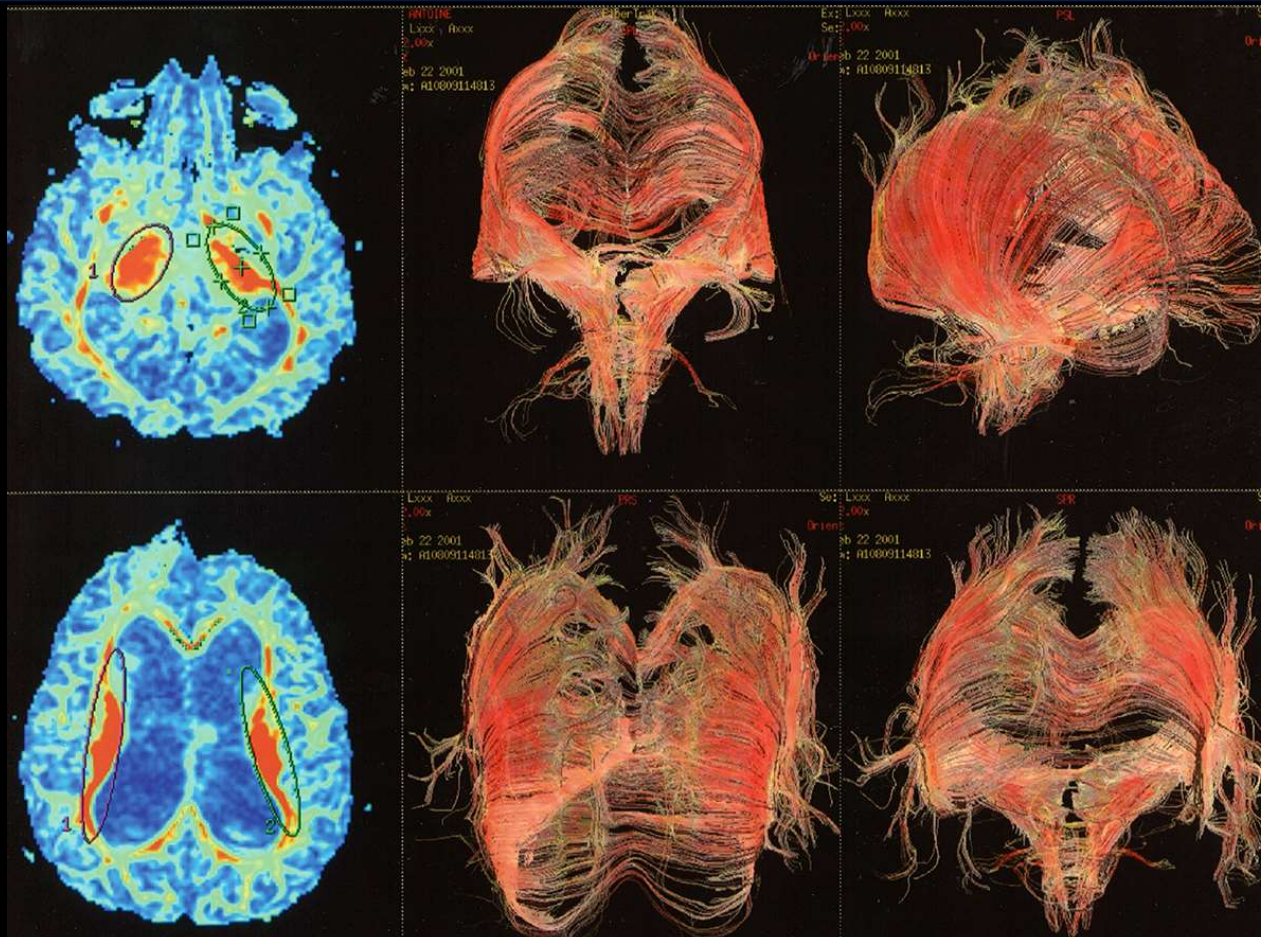
## THE NEW HYBRID OPERATING ROOM



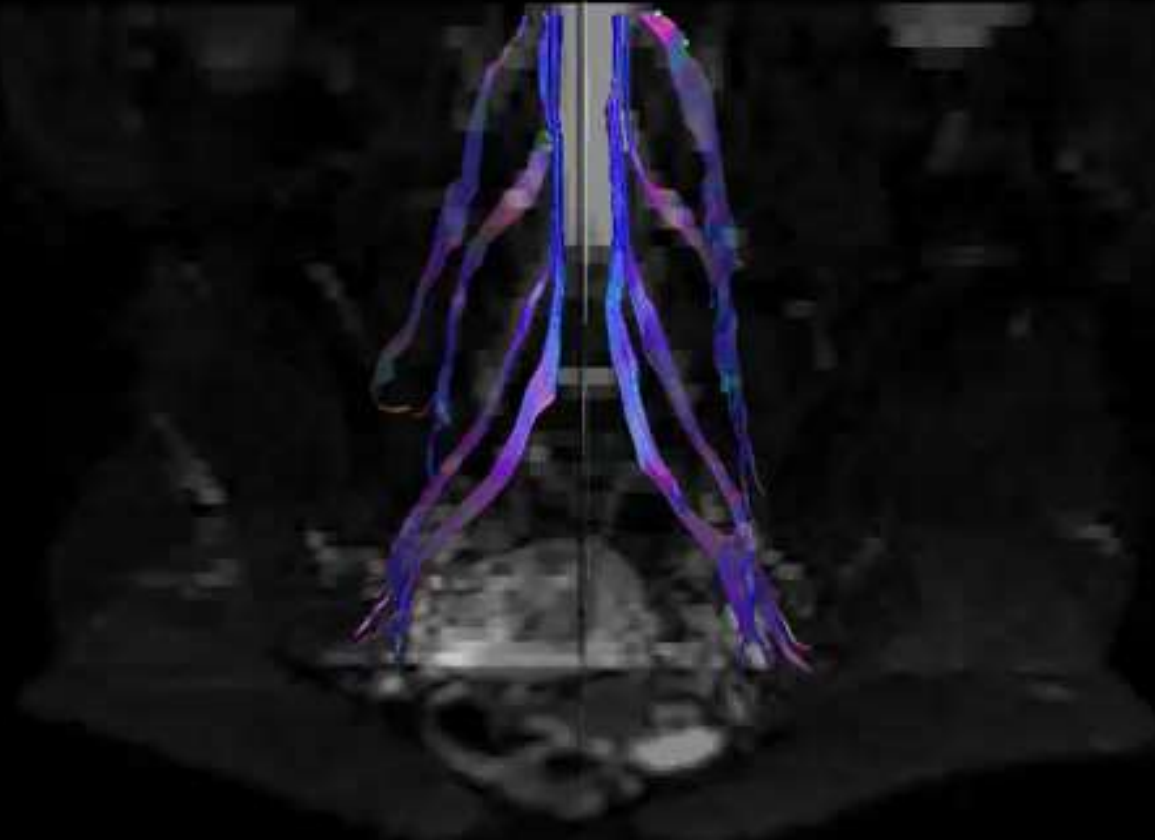
# Hybrid platform



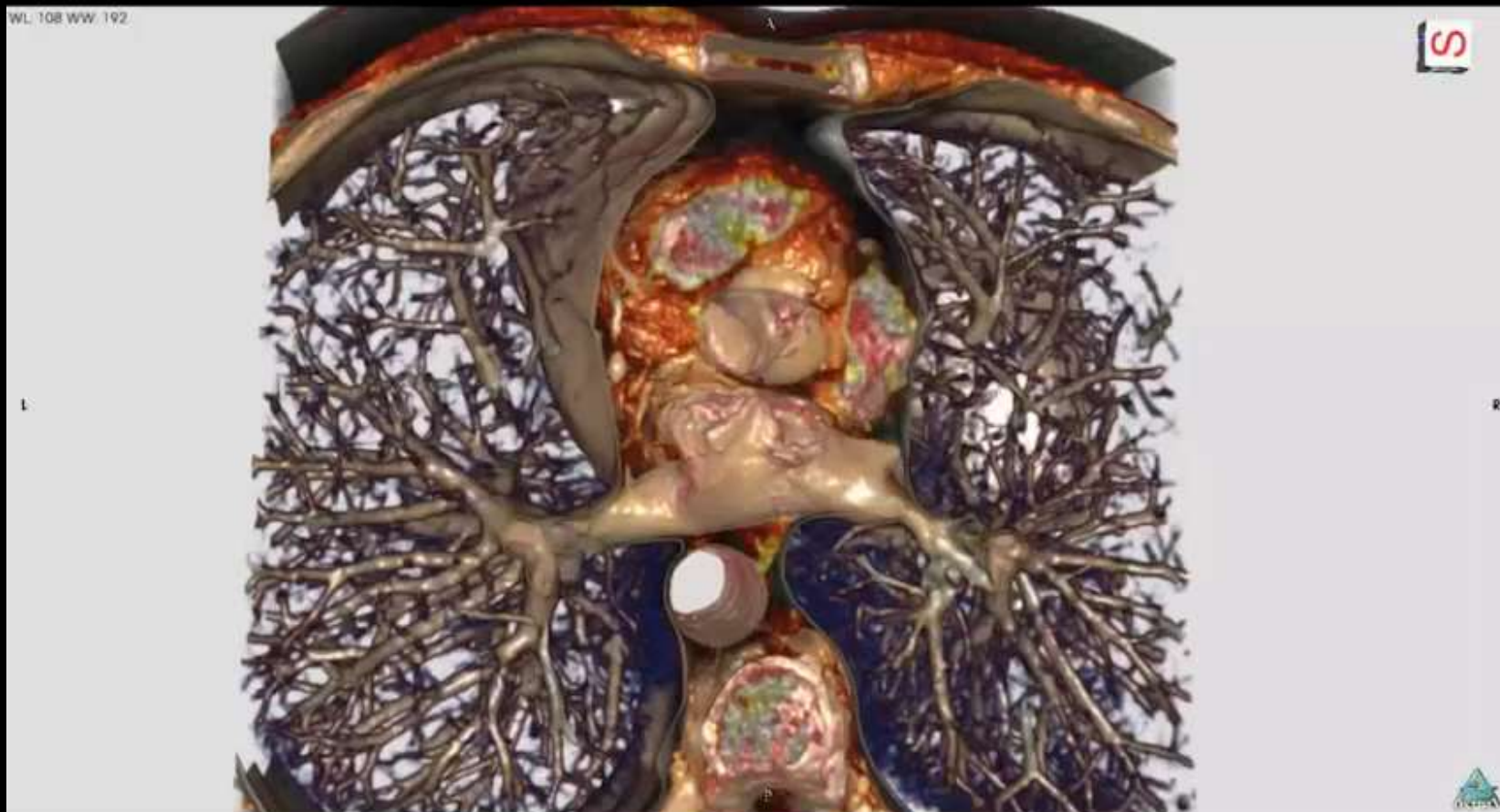
# Hybrid Platform – Tractography (DTI)



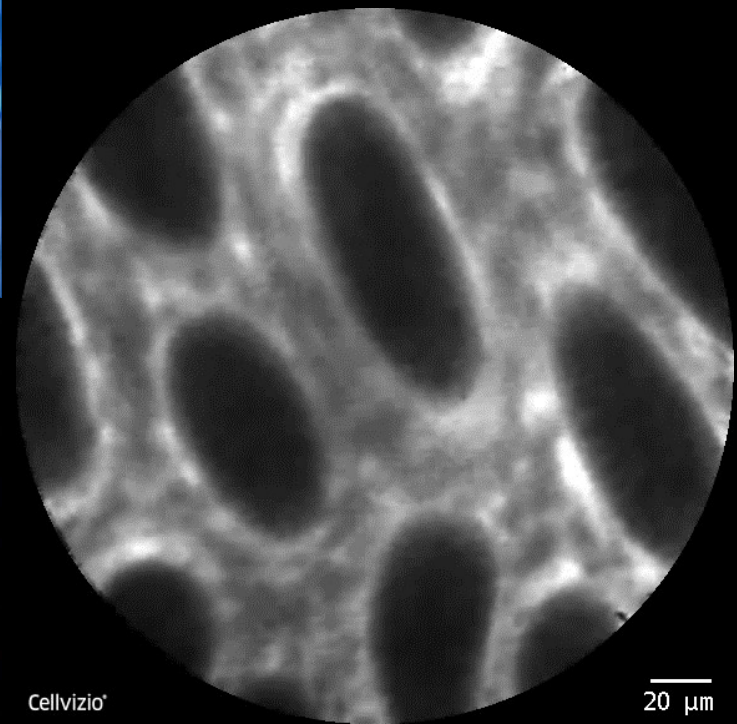
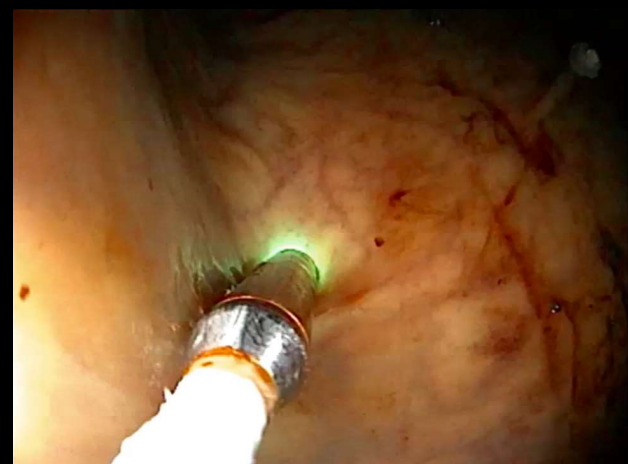
# Hybrid Platform – Tractography (DTI)



# 4D CT-Scan



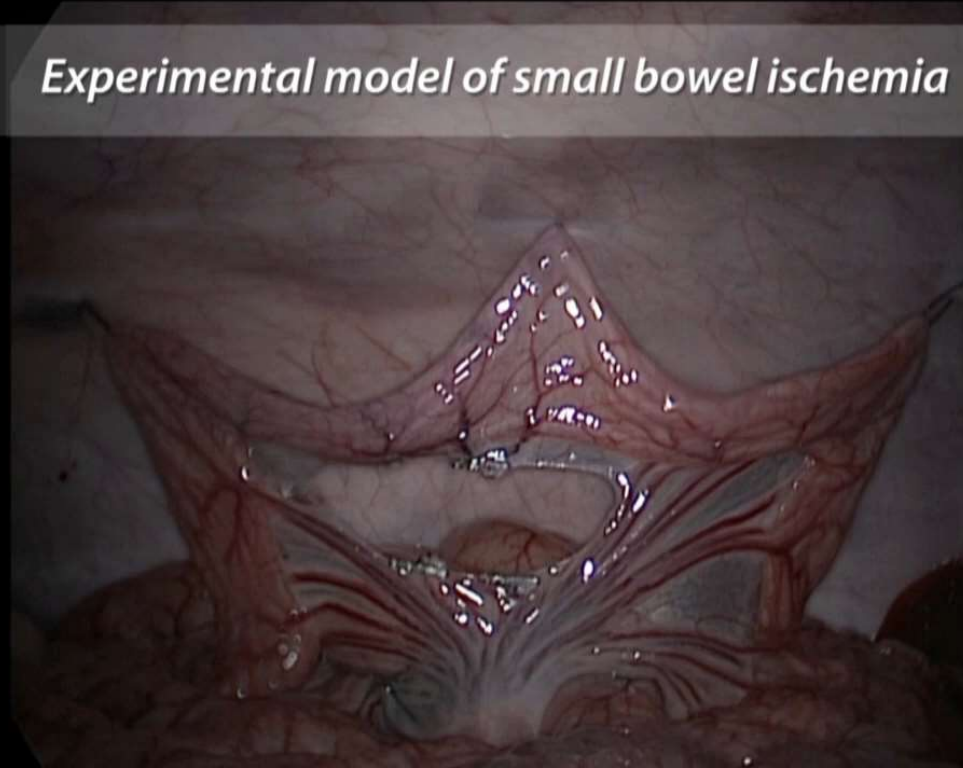
# « Augmented eye » See the microscopic



# « Augmented eye » See the invisible



*Experimental model of small bowel ischemia*







# Training Centers

## IRCAD concept

Institut de Recherche de l'An...

# Laparoscopic training courses



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# Robotic training platform



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# Virtual globalization of education: WEBSURG



The image shows a screenshot of the WEBSURG website, which is a platform for virtual surgical education. The website features a dark header with the WEBSURG logo and navigation links. Below the header, there is a banner for a partnership between COVIDIEN and IRCAD. The main content area is divided into two columns: 'BROWSE VIRTUAL UNIVERSITY' and 'WEBSURG HD'. The 'BROWSE VIRTUAL UNIVERSITY' section includes a 3D anatomical model of a stomach and a list of 'Latest publications'. The 'WEBSURG HD' section features a grid of video thumbnails and a list of 'HD videos for purchase and download'. On the left and right sides of the website screenshot, there are images of various surgical instruments, including forceps and a stapler.

**WEBSURG**  
THE e-surgical reference

SEARCH FOR something on WEBSURG

BROWSE THE WORLD'S VIRTUAL UNIVERSITY

HOME PAGE PARENT

COVIDIEN | IRCAD

A UNIQUE PARTNERSHIP AGREEMENT BETWEEN IRCAD AND COVIDIEN

BROWSE VIRTUAL UNIVERSITY

12 mm

WEBSURG HD

Latest publications

VIDEOS

- Original full laparoscopic reversal of Hartmann's procedure after open subtotal colectomy
- Laparoscopic transgastric splenectomy for common bile duct stones
- Tip's tricks: gastric pouch creation during redo gastric bypass

LECTURES

HD videos for purchase and download

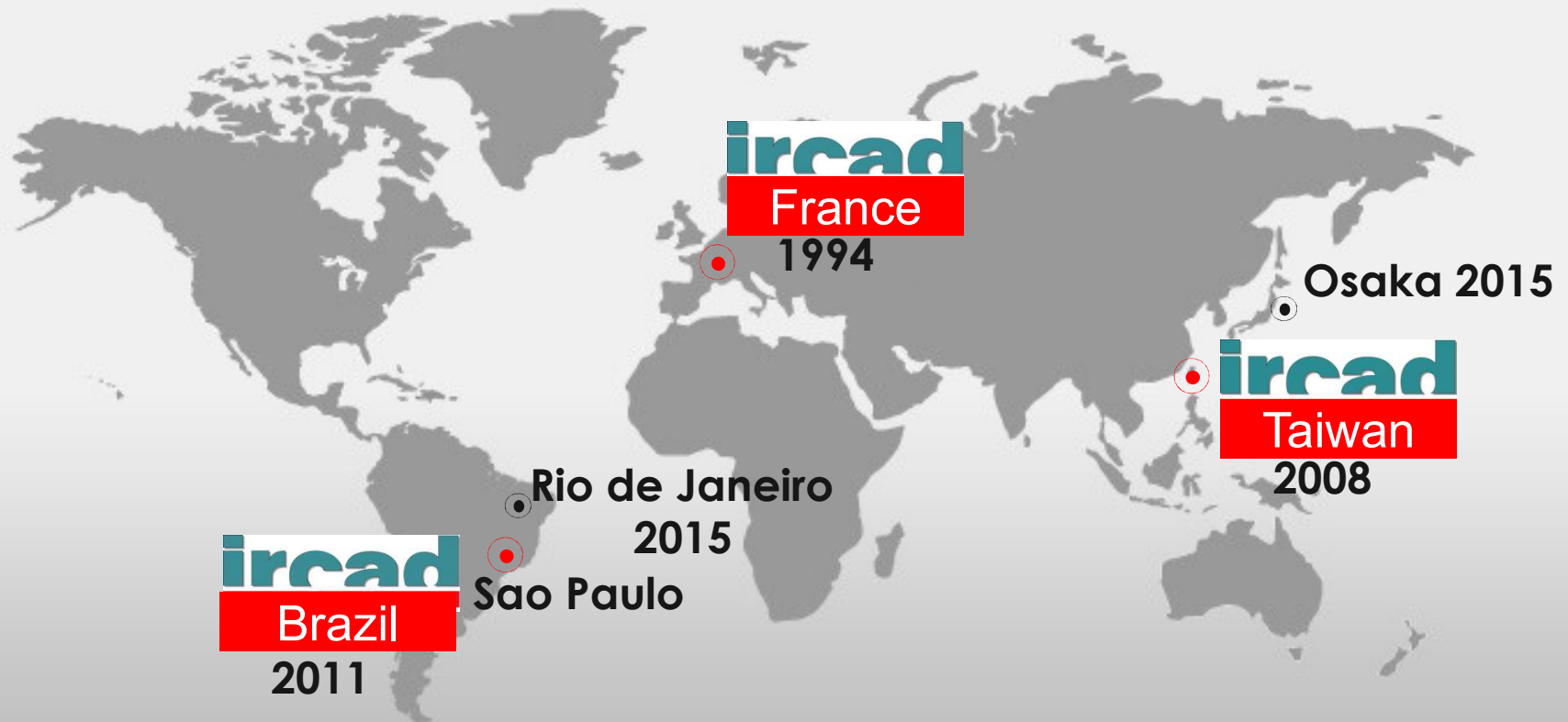
VIDEOS

- Enucleation of a pancreatic neuroendocrine tumor complicated by a perforative duodenal ulcer
- Basic identification and ORPD laparoscopic resection and ileocecal anastomosis
- Divergence de l'estomac et RGD

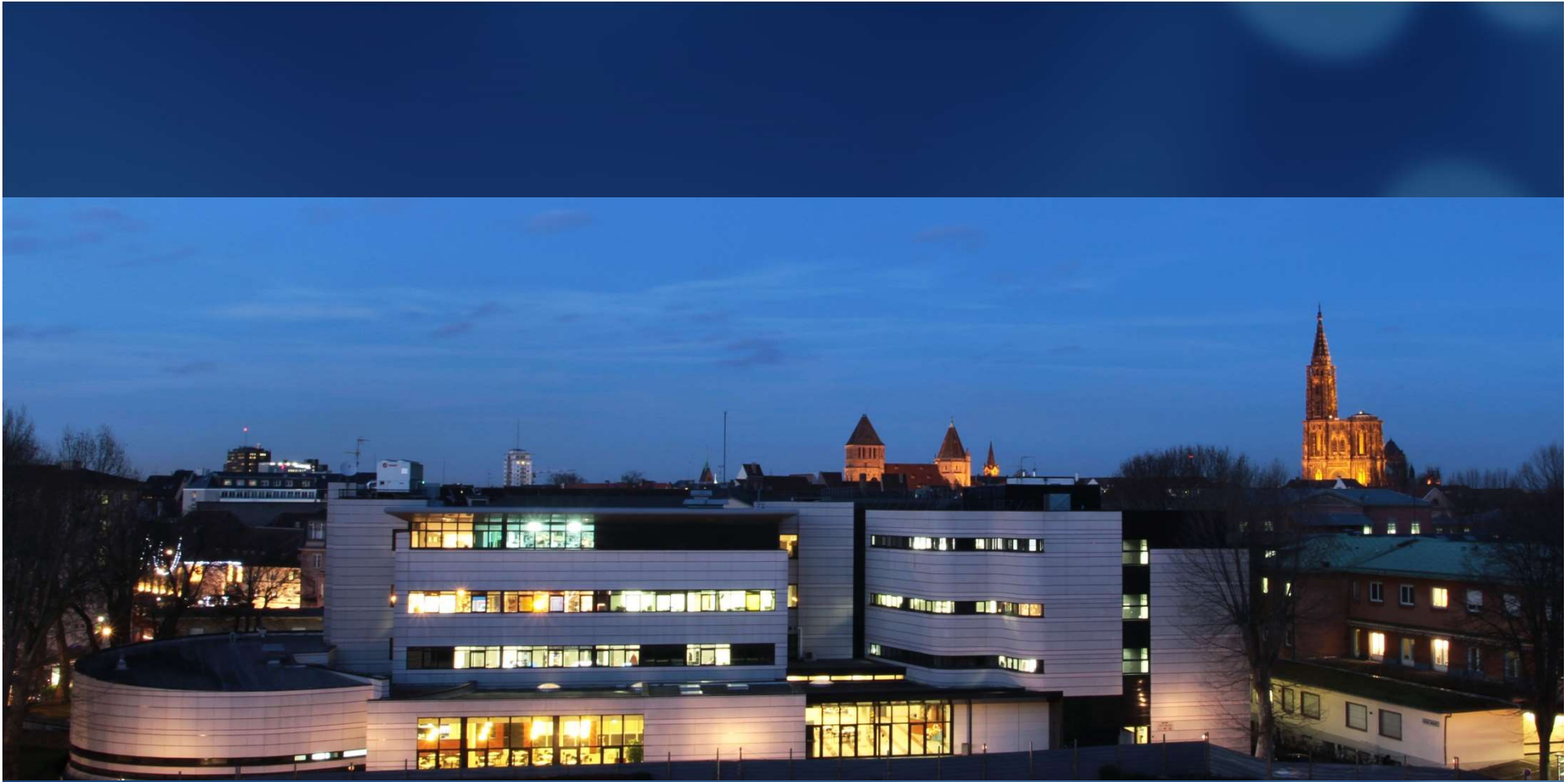
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# Globalization of the concept

# IRCAD Globalization: the Network



# Inventing the Future in Surgery



*Thank you for your attention*

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