Computer Assisted Abdominal Surgery and NOTES

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In the past ...

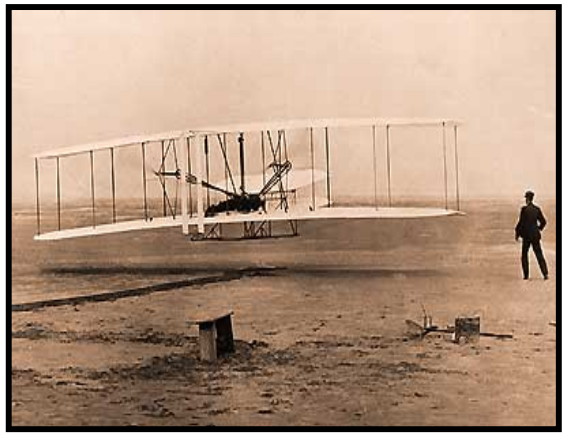
IRCAD Strasbourg + Taiwain

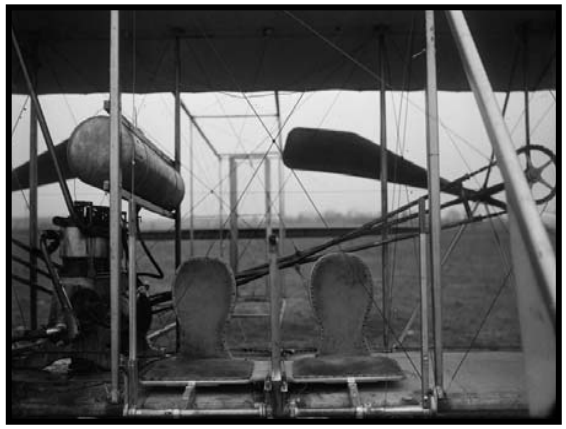
More than 3.000 surgeons trained per year, 300 for robotics

From OP-Room to WebSurg

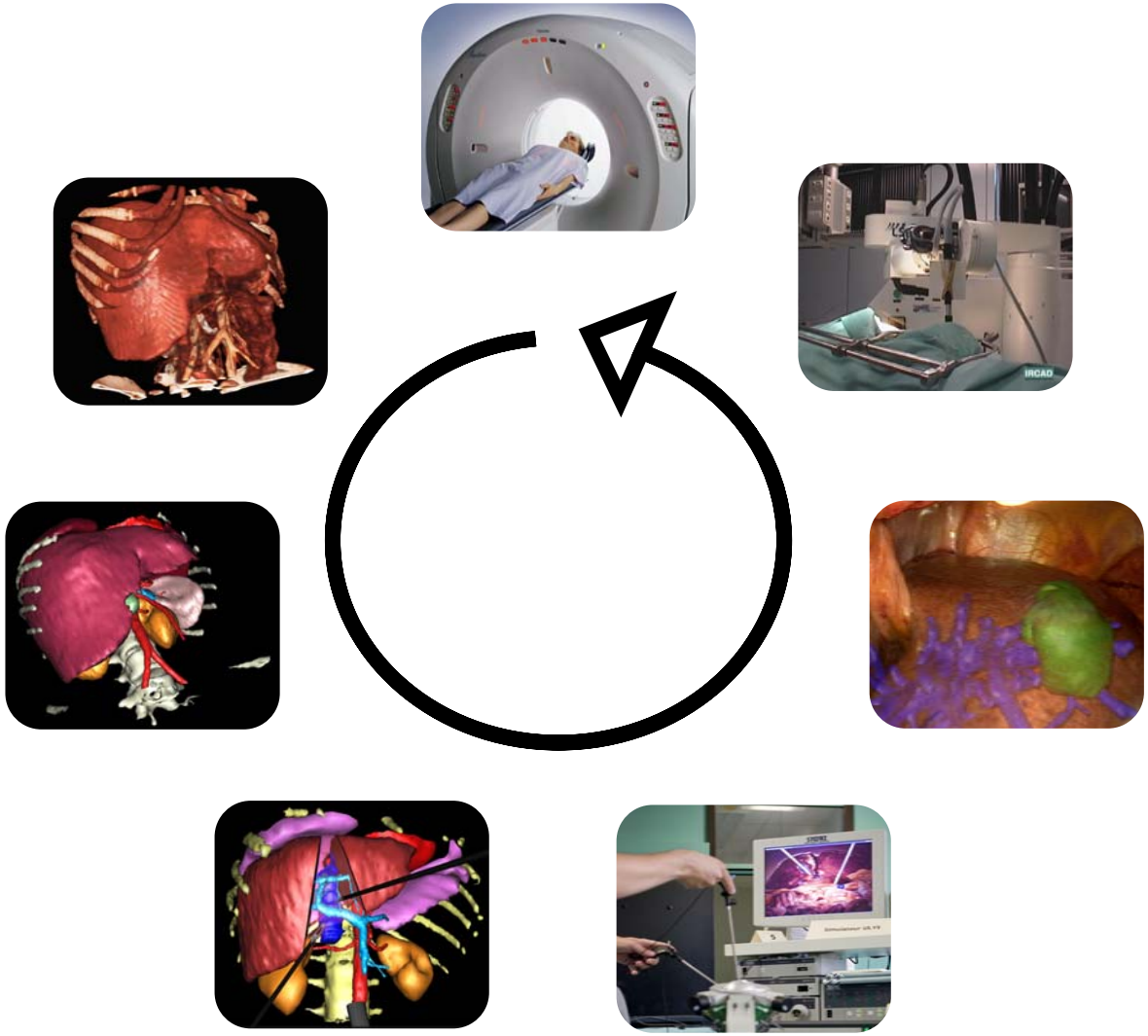
WebSurg : FREE ➔ www.websurg.com

Future based onto known success





Computer Assisted Surgery



IRCAD R&D team

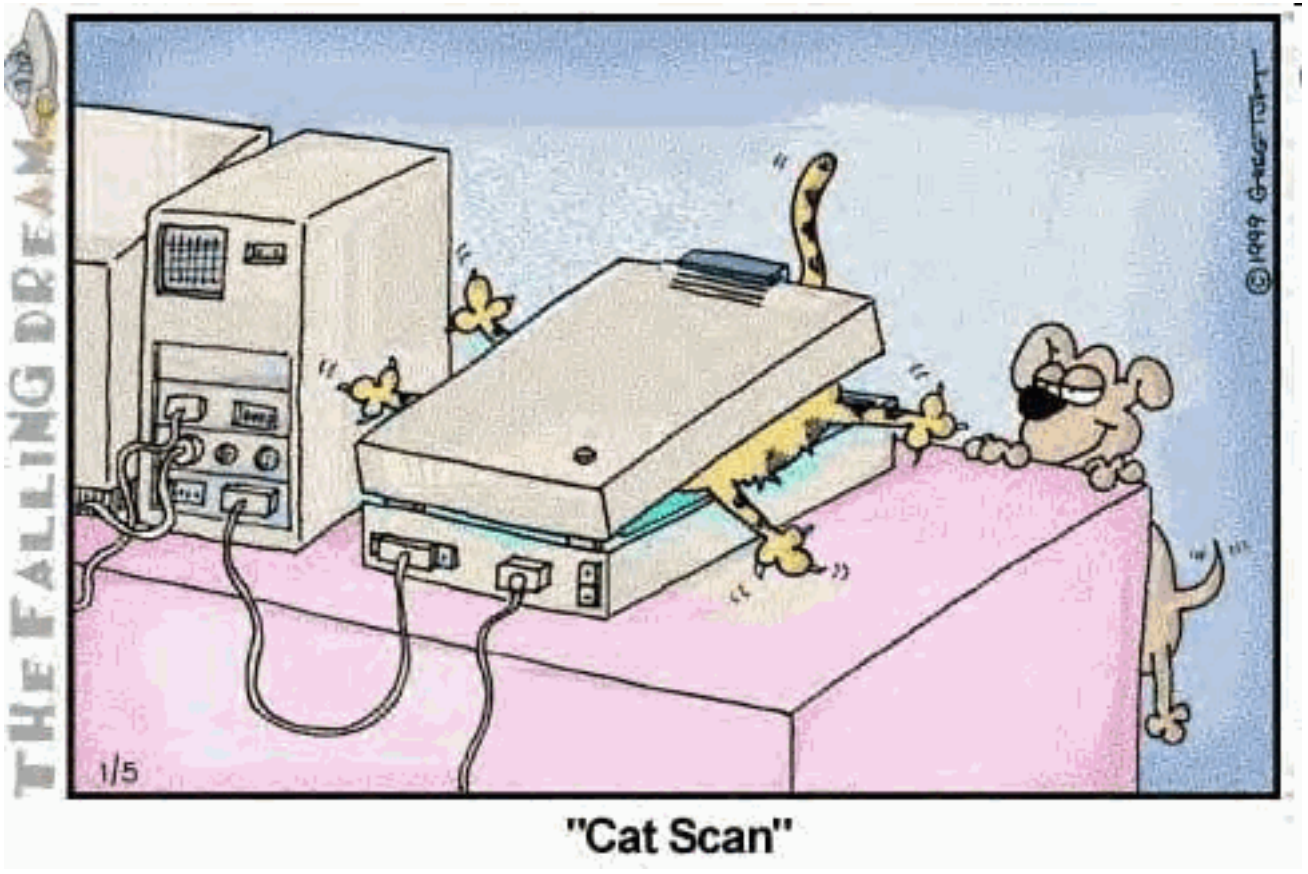
Ratdiology / R&D / Network IRCAD's team, December 2008

2009/2010 : 2 post-doctoral position (1500€/month)

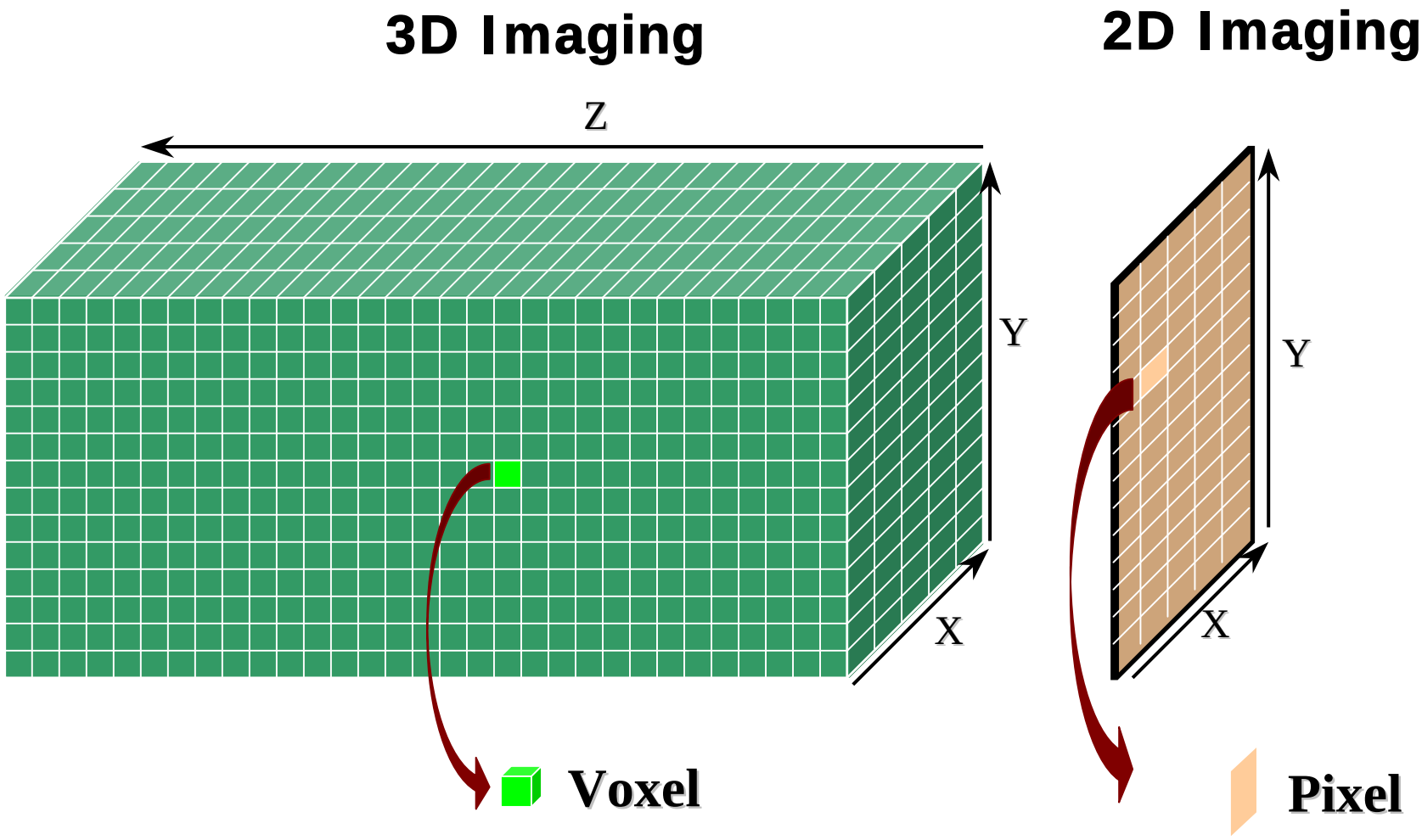
Step 0: Medical Image

Medical Imaging system

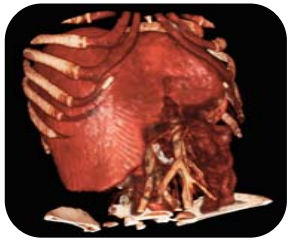
DICOM Image ➔ « Normalized » Numerical Format

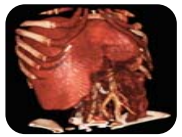


Definition



Step 1: 3D Direct Visualisation





VR-Render : Direct visualisation

www.ircad.org

➢18.000 downloads
Since october 2008
Mac OS / Windows/ Linux

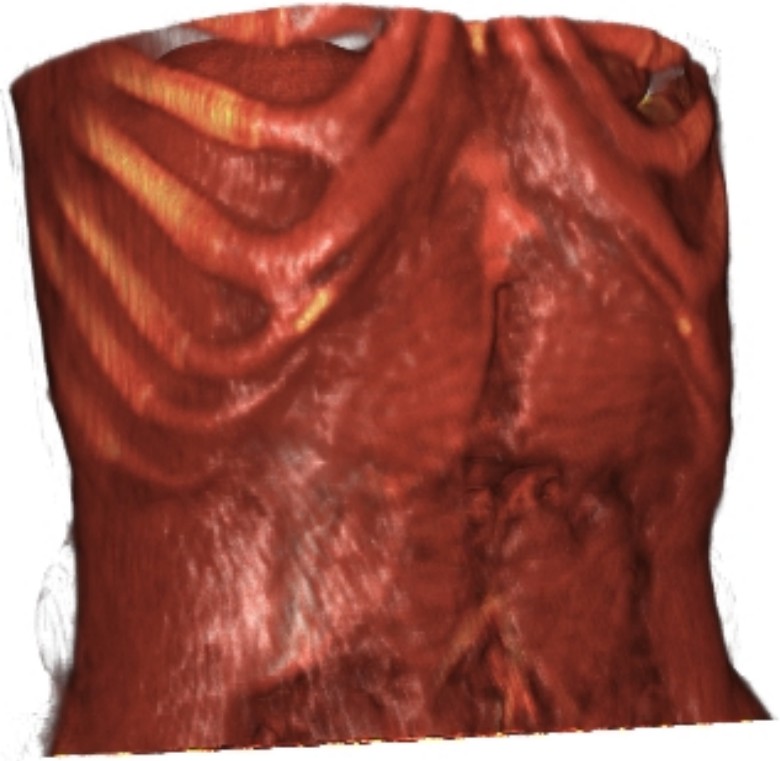
2D view of patient
Axial/Frontal/Sagittal

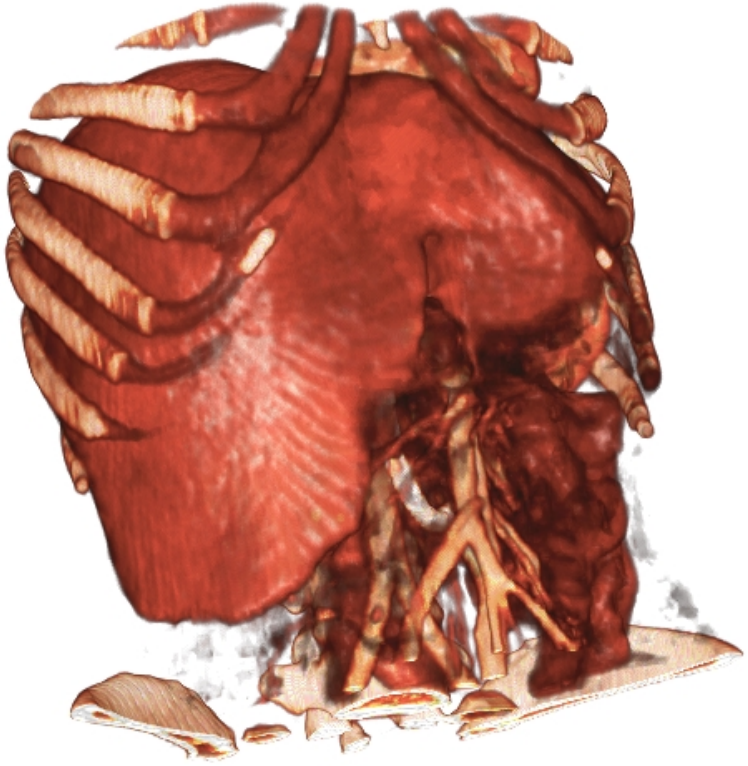
+ 3D volume rendering
FREE !!!

VR-Render : Direct visualisation

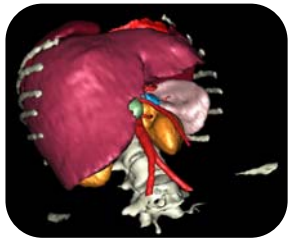
Sample of Direct Volume Rendering

VR-Render (IRCAD 2008)



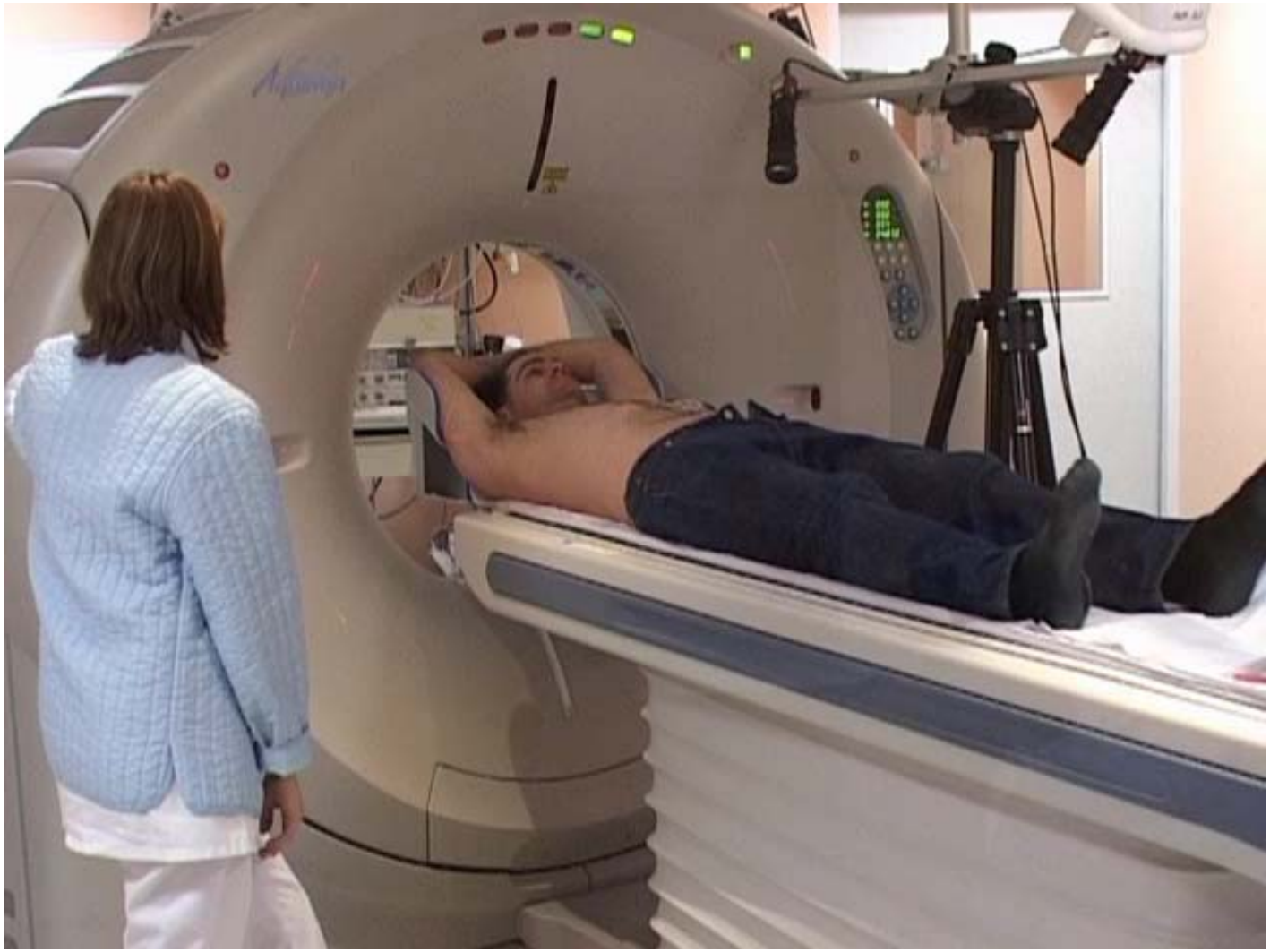


Step 2 : 3D Patient Modelling



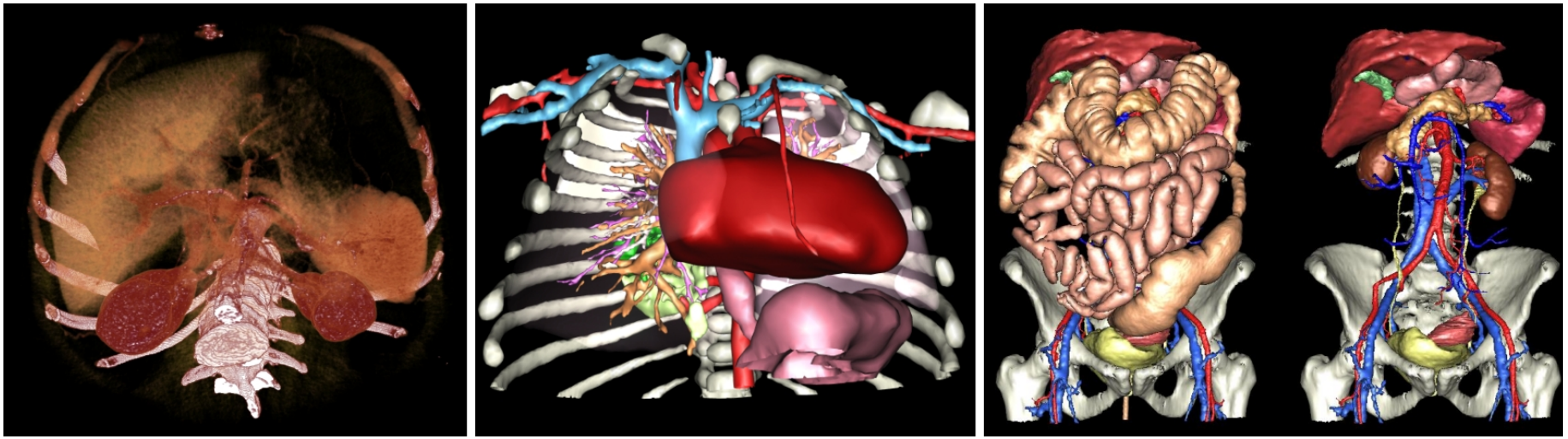
3D Modeling of Patients

IRCAD R&D Modelling service

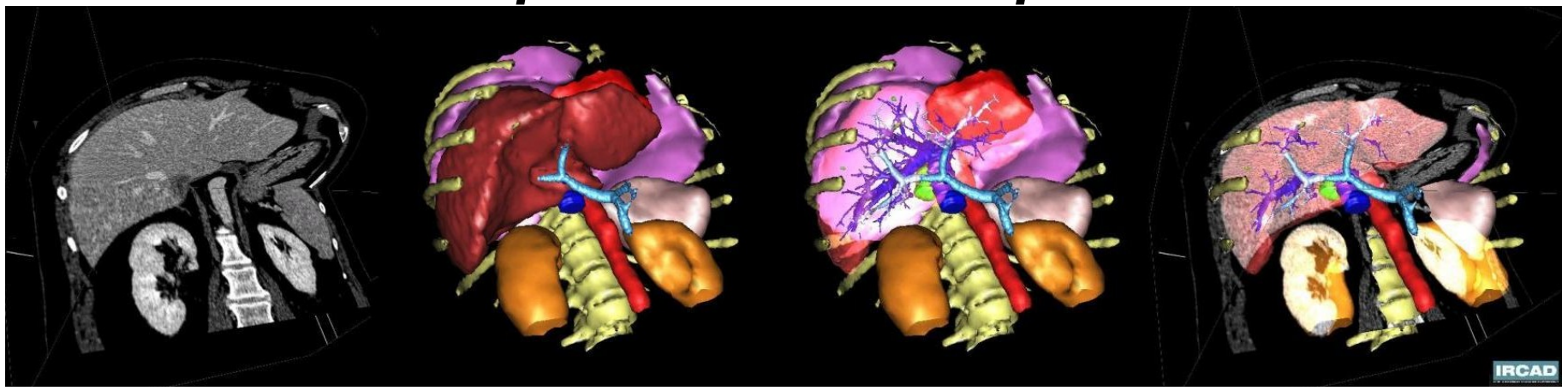


3D Modeling of Patients

IRCAD R&D Modelling service



More than 600 patients from 7 hospitals since 2005



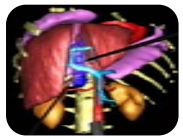
LIMITS

- Interactive = Time processing
- Automatic : Not enough robust
- Not yet all organs

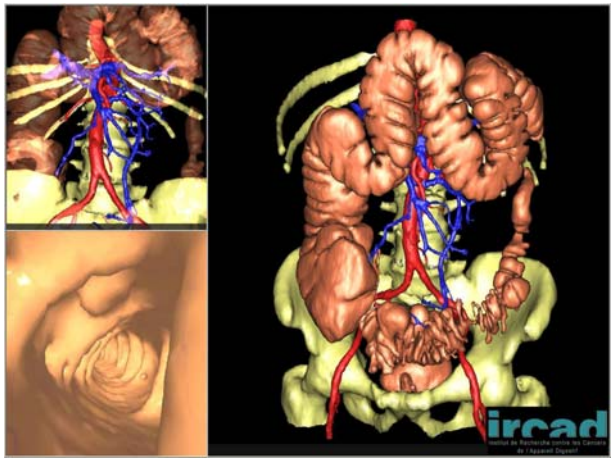
But

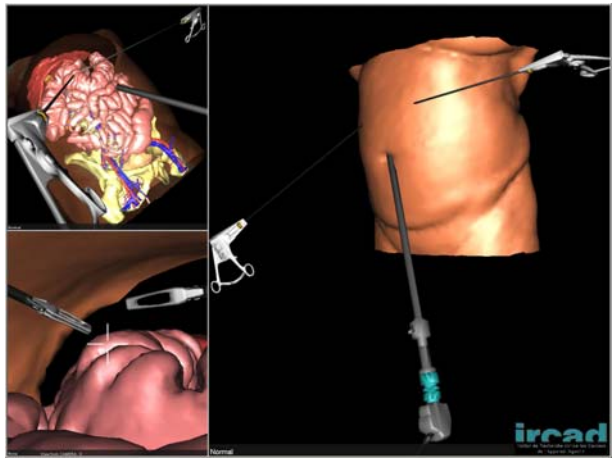
- Allreally efficient in routine
- Existing services such as Mevis Service

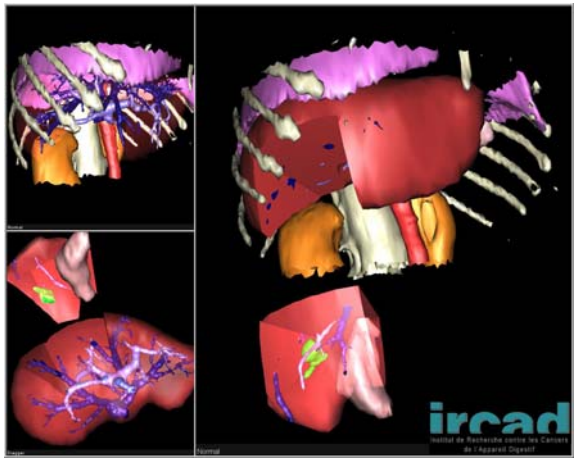
Step 3 : Surgical Planning



Surgical Planning





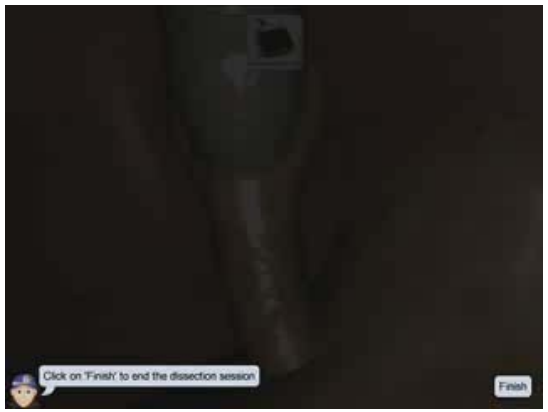


- Virtual navigation
- Virtual surgical tool positioning
- Virtual organ resection
- Volume computations

Step 4 : Surgical Simulation

Existing Surgical Simulators

©Surgical Science



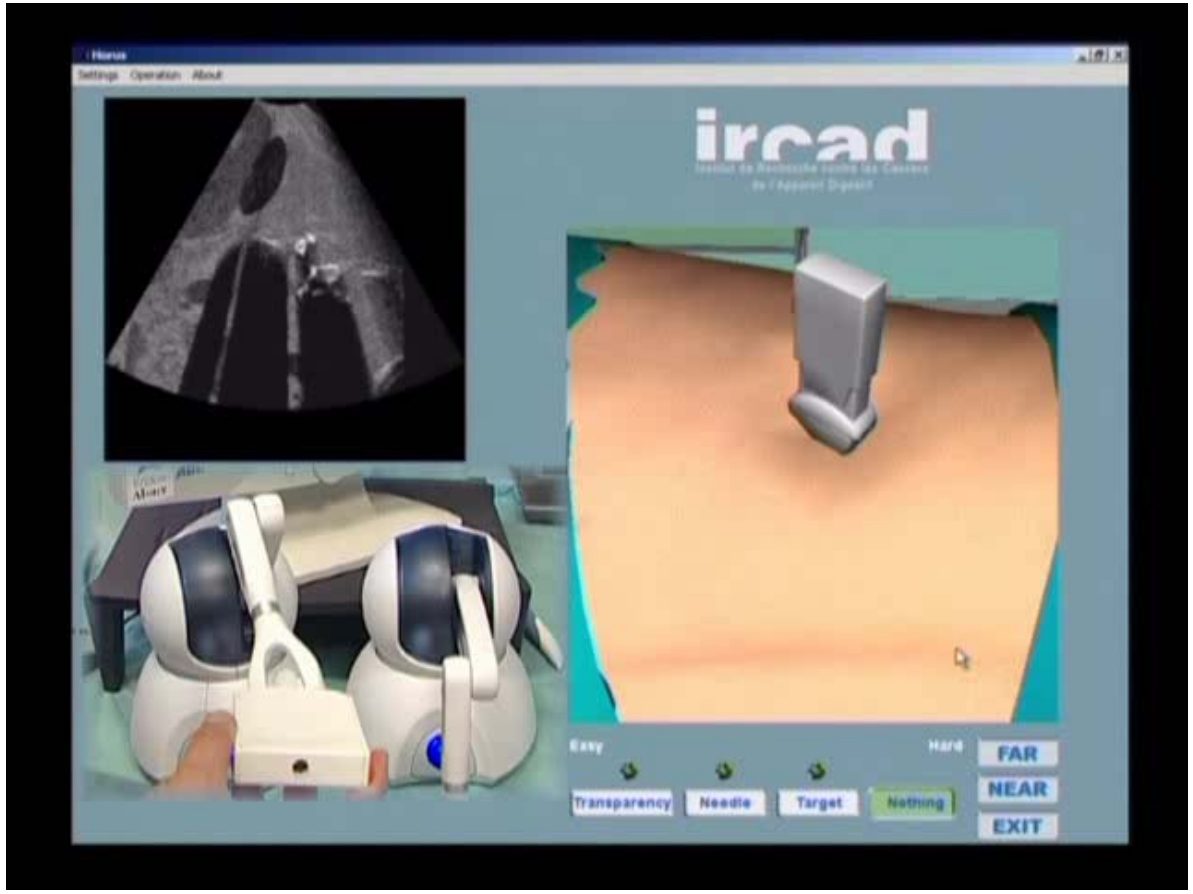
©SimSurgery

©Mimics

- Good but not realistic enough rendering
- Good variety of possible Surgical gestures
- Automatic evaluation

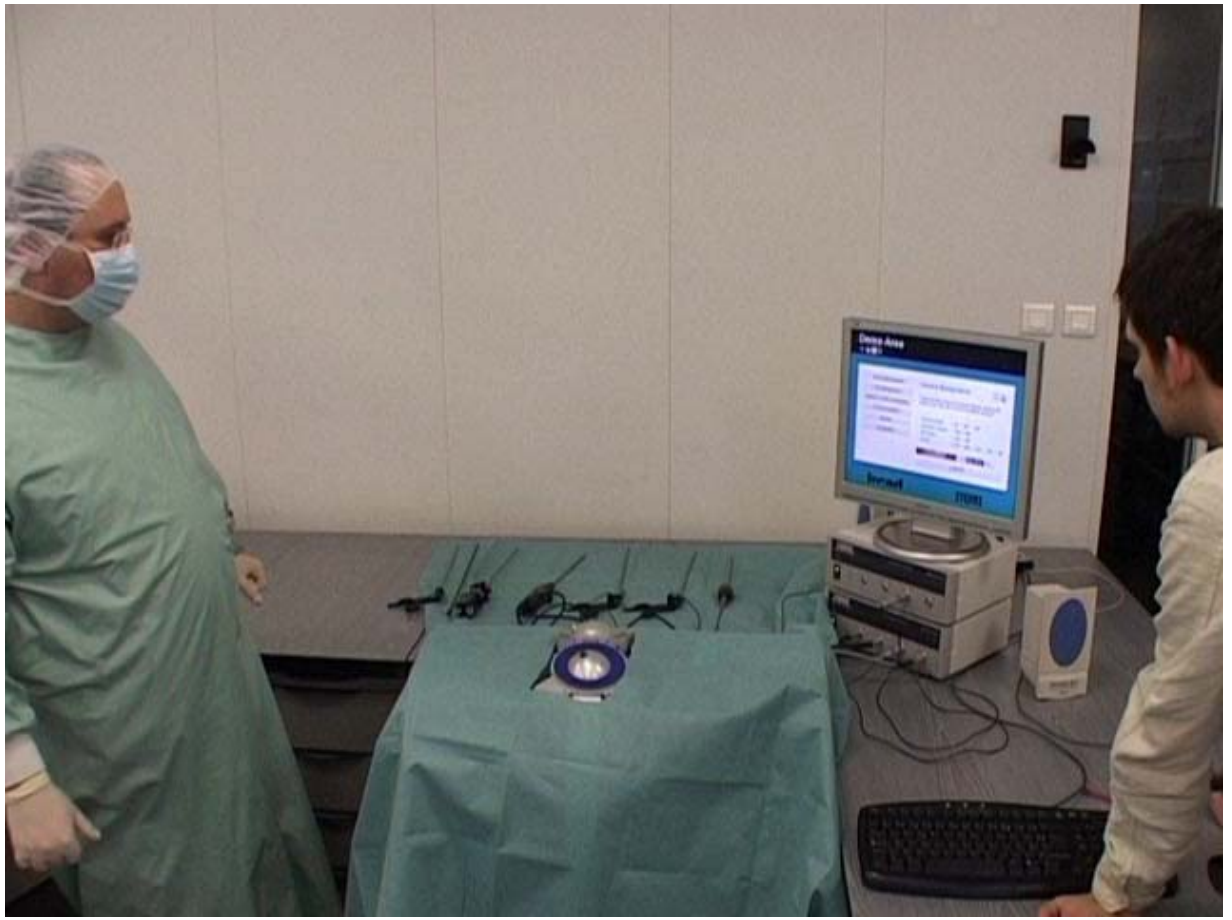
➔ **BUT : Not Patient specific**

HORUS : Ultrasonography simulator



Ultrasonographic guided procedure
from patient CT-Scan

ULIS : Laparoscopic Simulator

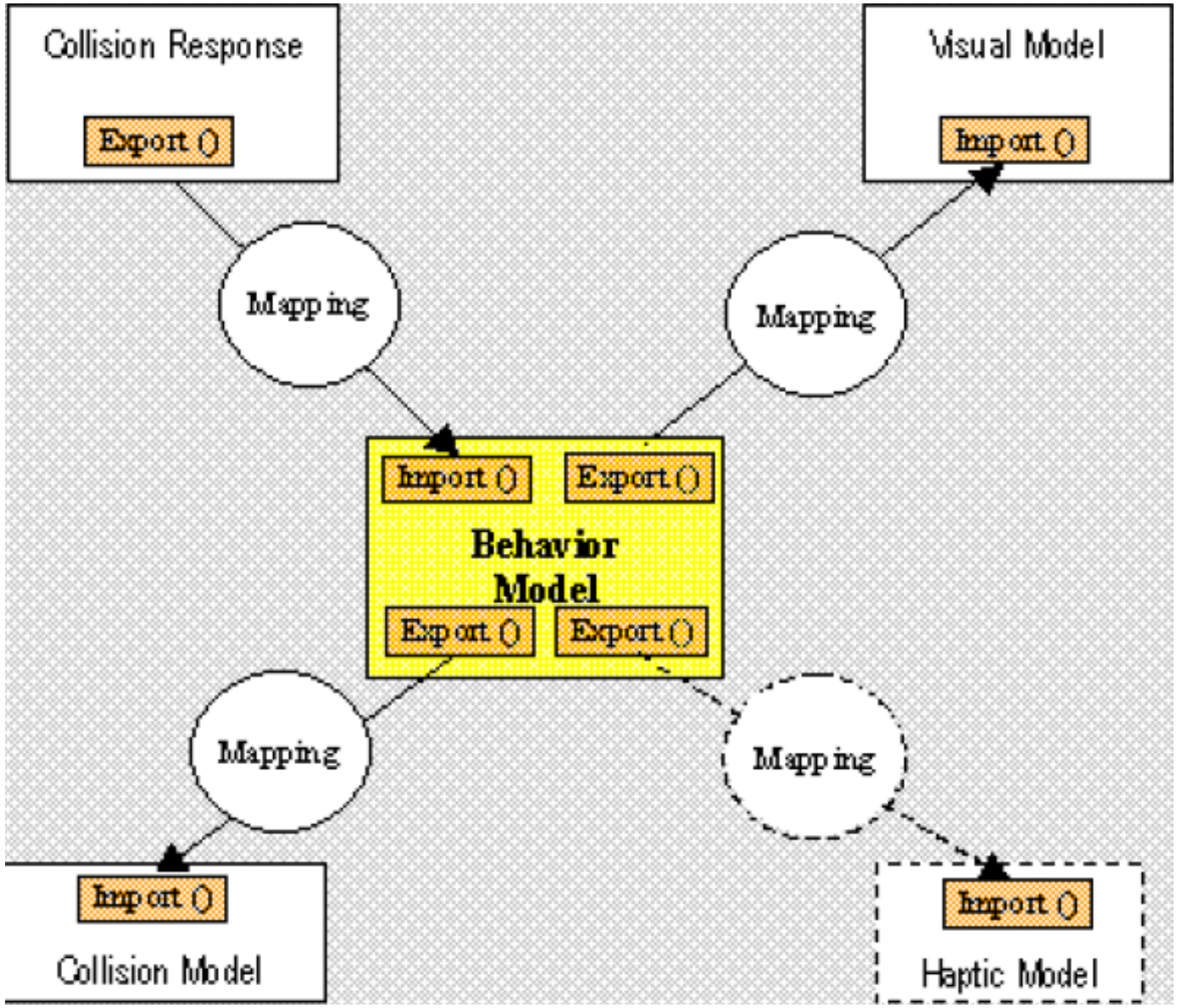


IRCAD's Spin-off : Digital Trainers

Educative Surgical Simulators

Patient-specific laparoscopic simulator

SOFA : www.sofa-framework.org



Patient Specific Simulators

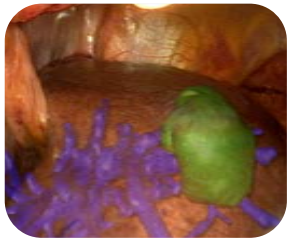
LIMITS

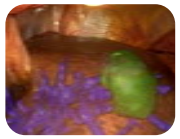
- Patient specific only in Morphology
- Do not include interstitial tissue or nerves
- Not mechacially patient specific

But

- Allready interresting for basic training
- Elastography : next step of patient specific

Step 5 : Augmented Reality

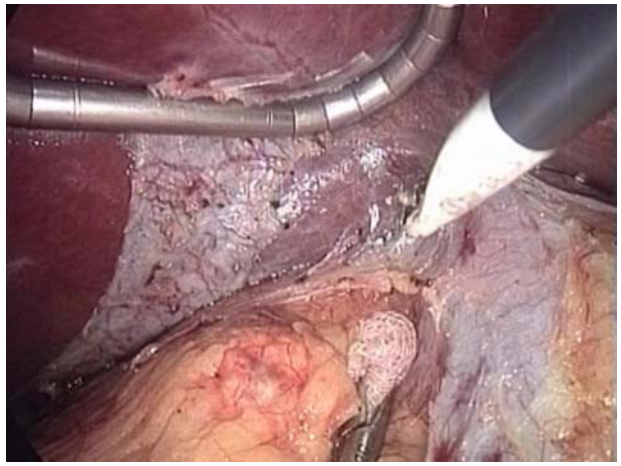




Augmented Reality

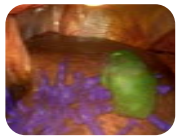
Real Views

Out **In**



Virtual Views

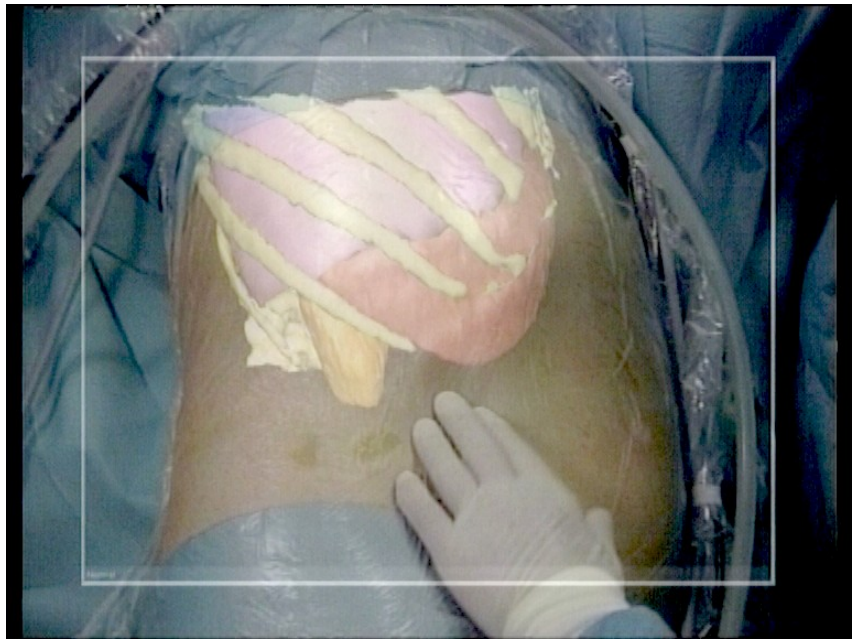
Out **In**



Augmented Reality

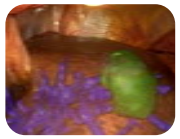
Augmented Reality Views

Out

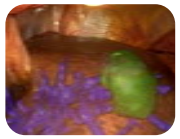


In

Data Fusion



Interactive Augmented Reality

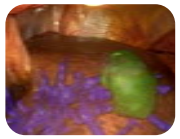


Interactive Augmented Reality

Adrenal Surgery : JAMA November 2004

Interactive Augmented Reality

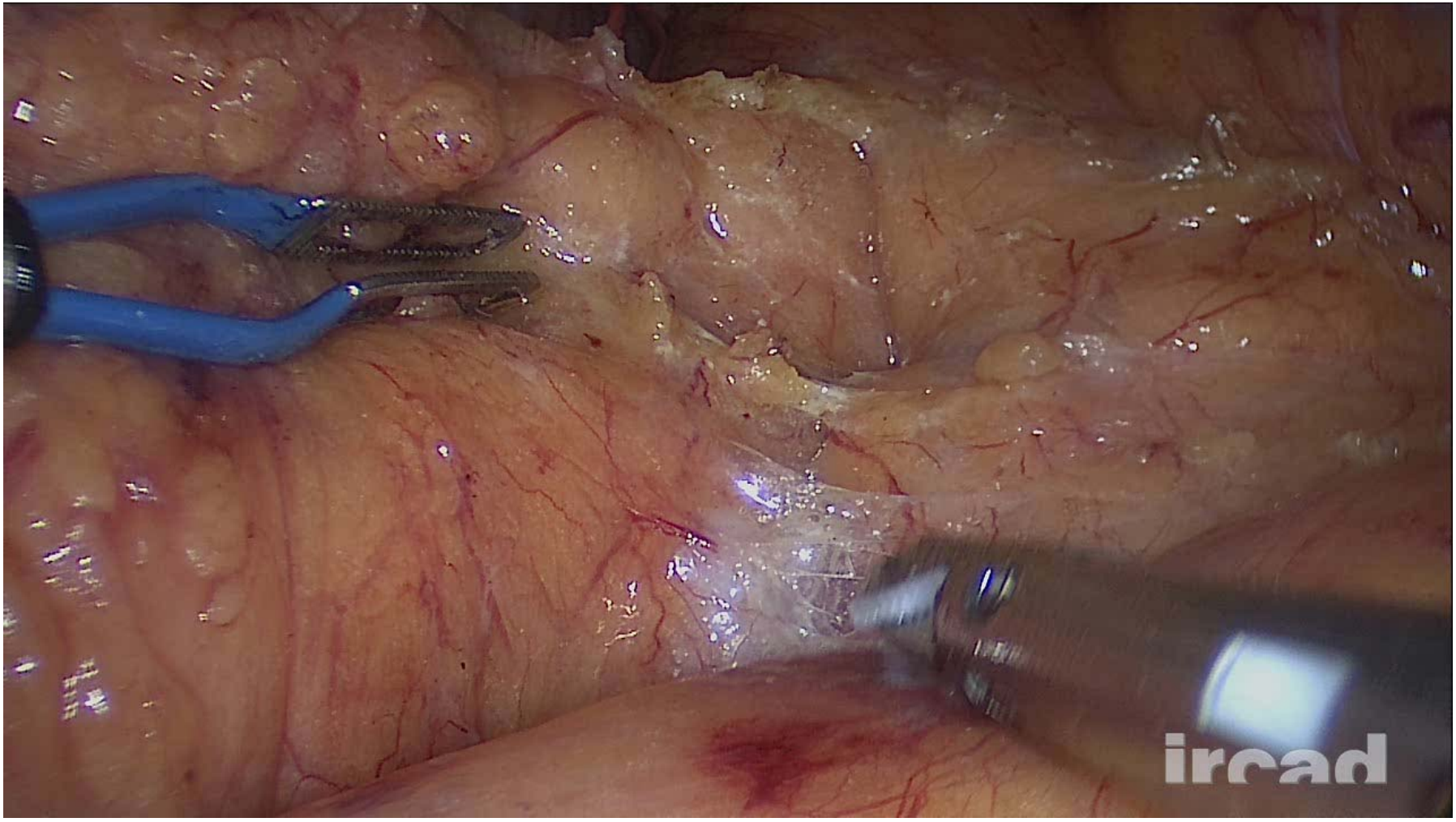
Liver Surgery, IRCAD 2008



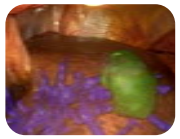
Interactive Augmented Reality

Cirrhotic Liver Surgery, IRCAD 2009

Interactive Augmented Reality



Pancreas Surgery, IRCAD 2008



Interactive Augmented Reality

LIMITS

User dependent system

No reproductibility

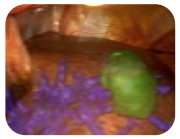
No secured accuracy

Rigid registration for deformable organs

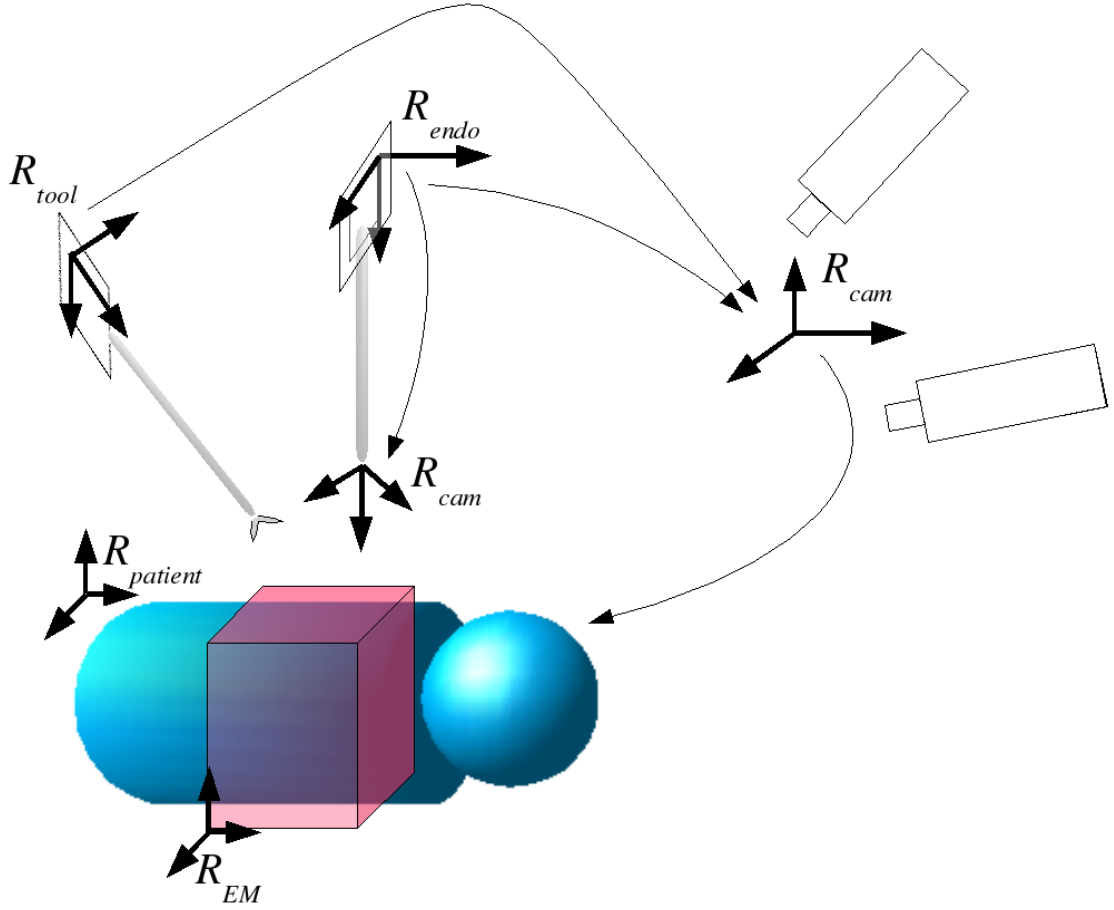
But

Really efficient with expert user

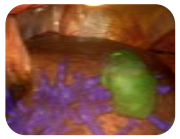
A first answer to surgeons request



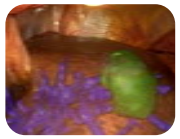
Automated Augmented Reality



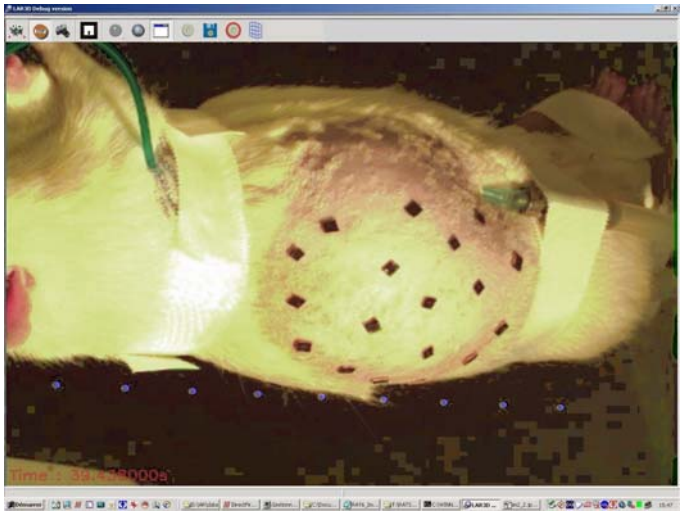
2 axes ➔ Calibration & Registration

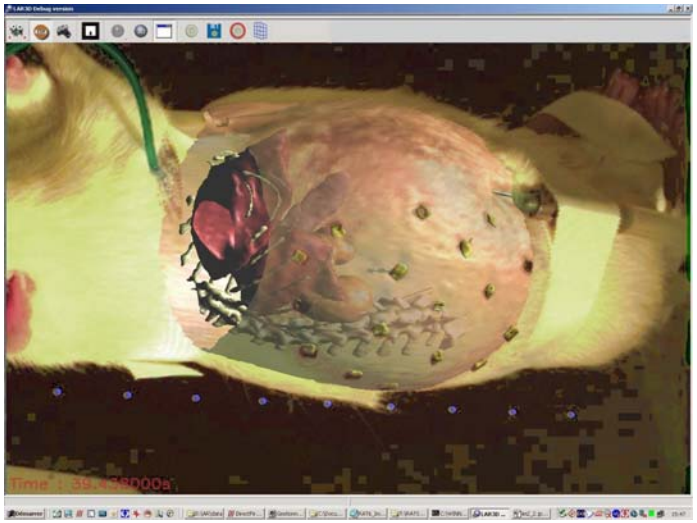


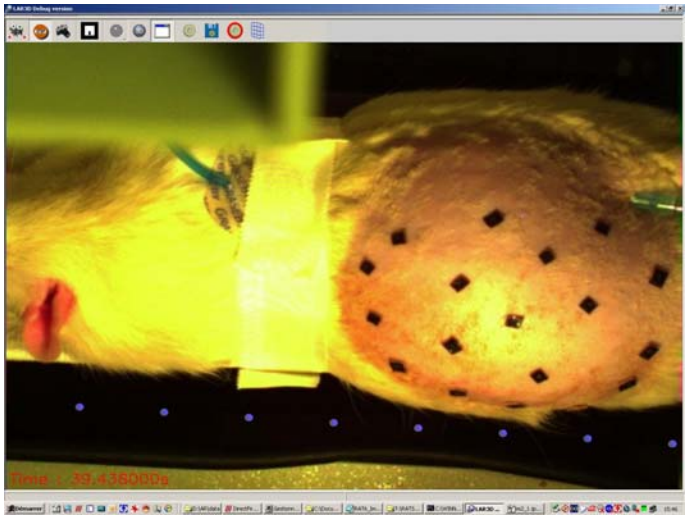
Automatic Augmented Reality

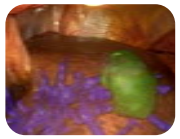


Automatic Augmented Reality









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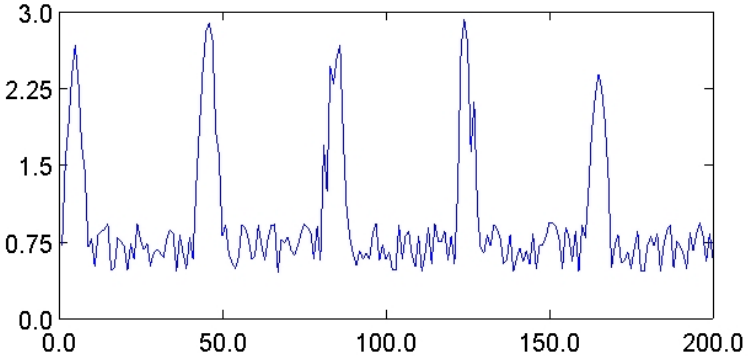
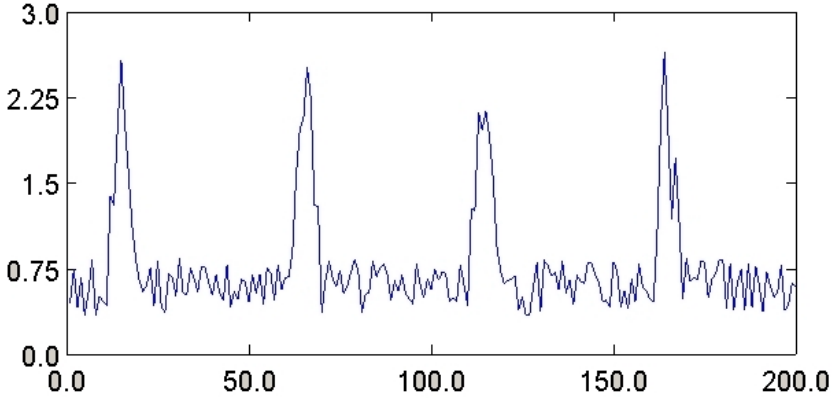
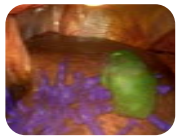


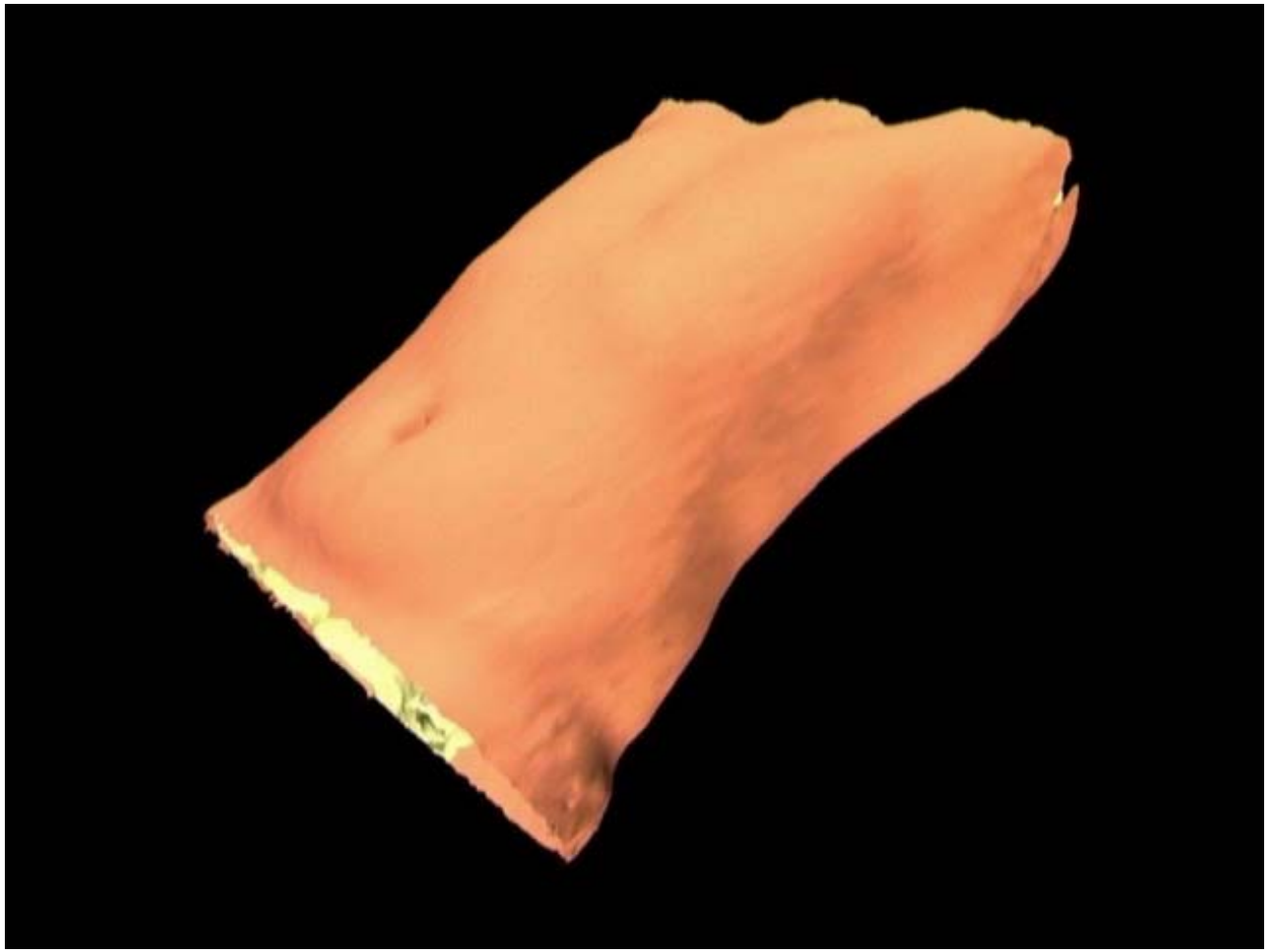


Rat number	1	2	3	4	5
System error (mm)	0.76 ± 0.06	0.85 ± 0.05	0.63 ± 0.04	0.82 ± 0.04	0.68 ± 0.05

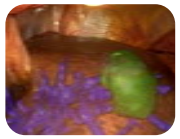
Average system error of 0.75 mm



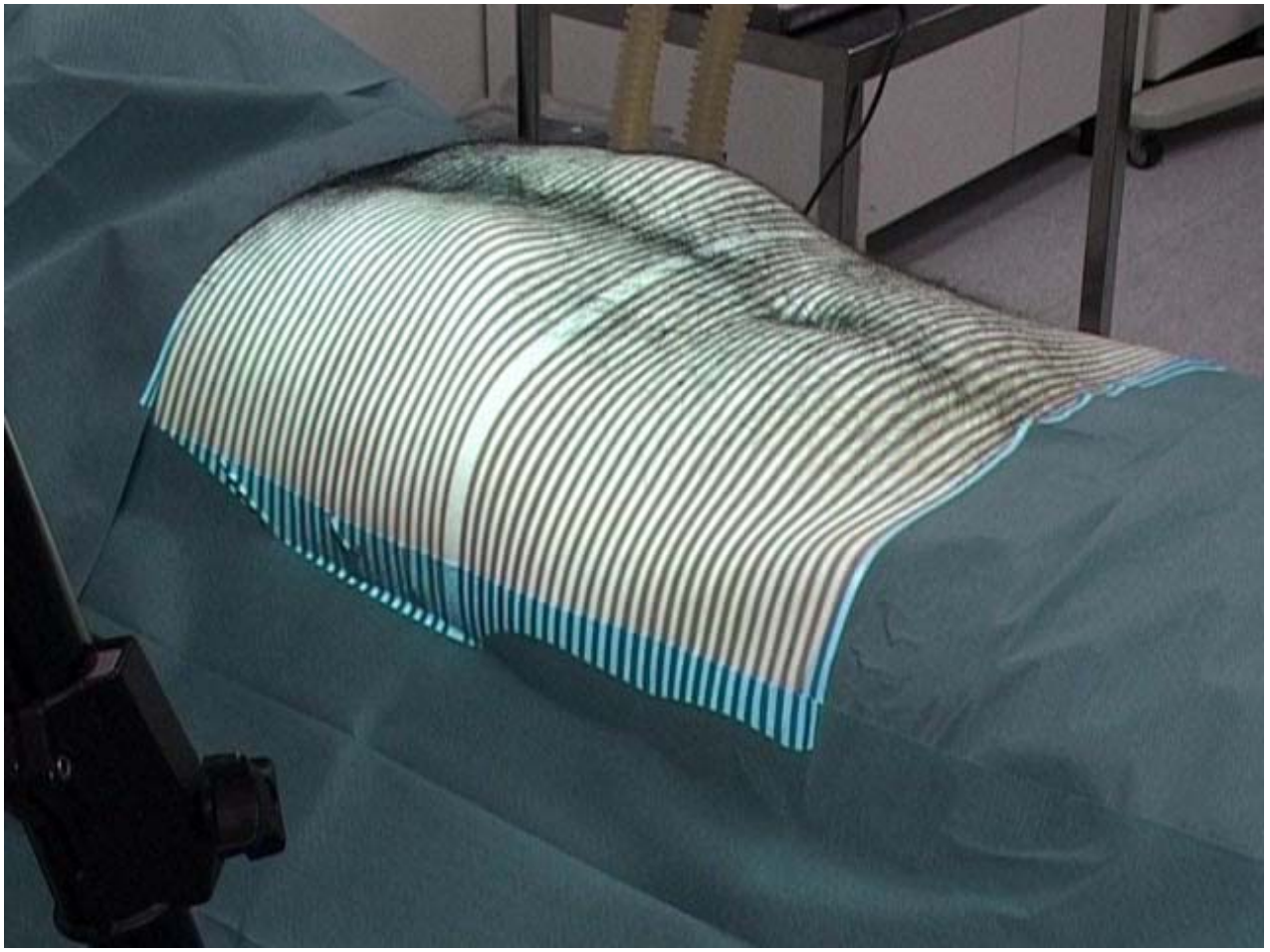
Breath movement simulation



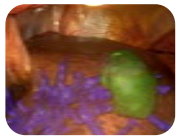
Patient-specific organ motion simulation



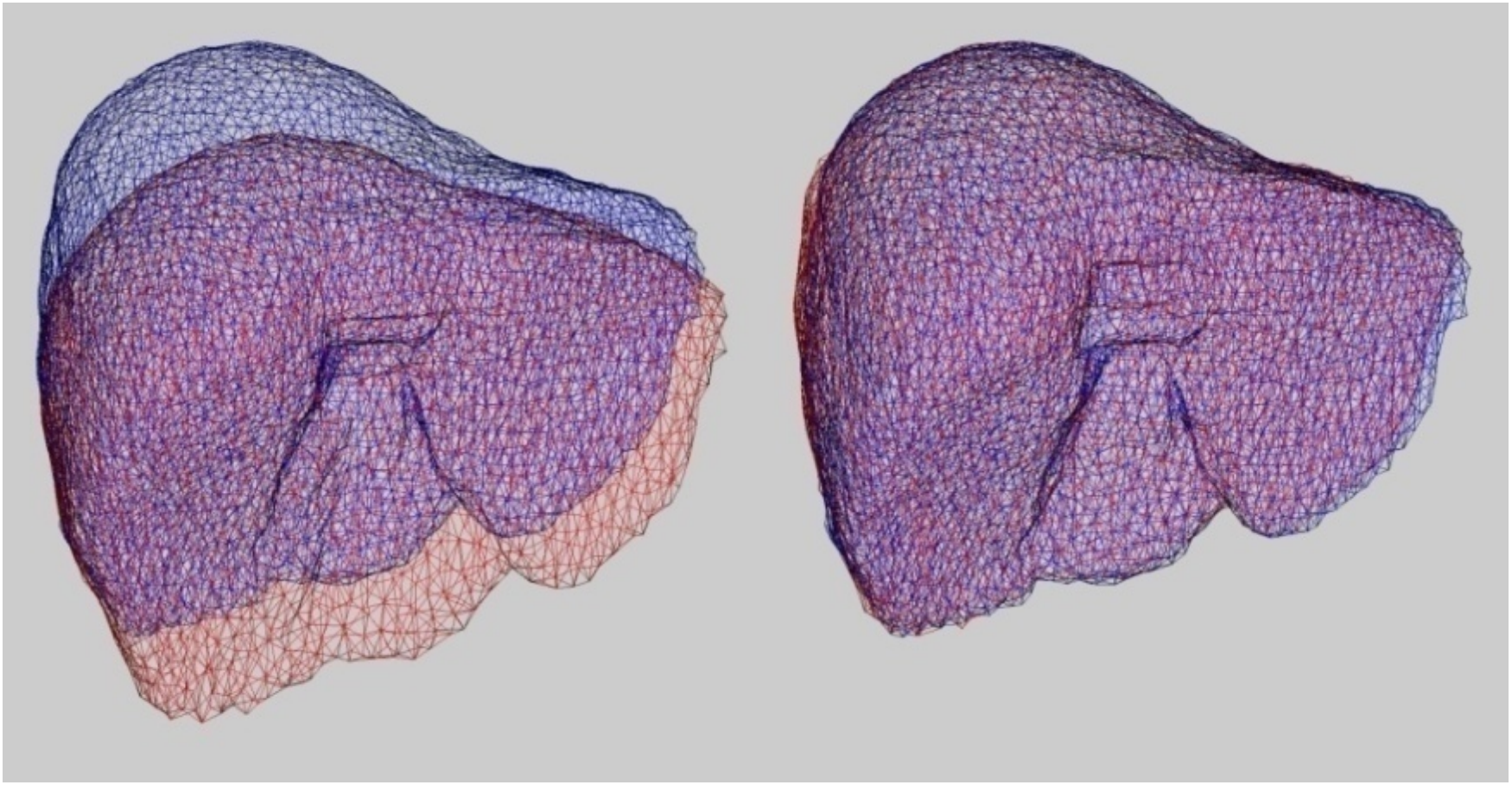
Automatic Augmented Reality



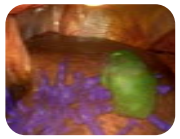
Predictive simulation



Breath simulation



Accuracy = 2 mm for liver (1.3 for kidneys)



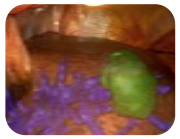
Automated Augmented rreality

LIMITS

- Not yet sufficient for abdominal organs
- Time process too long for tracking and analysis of organs mouvements

But

- Current system efficient for Radiotherapy and interventional radiology
- Next step : add better mechanical modelling and intraoperative image analysis



Automated Augmented Reality

Future Works

Real-time tracking of organ deformation

Use of U.S. / MRI / Structured light / ...

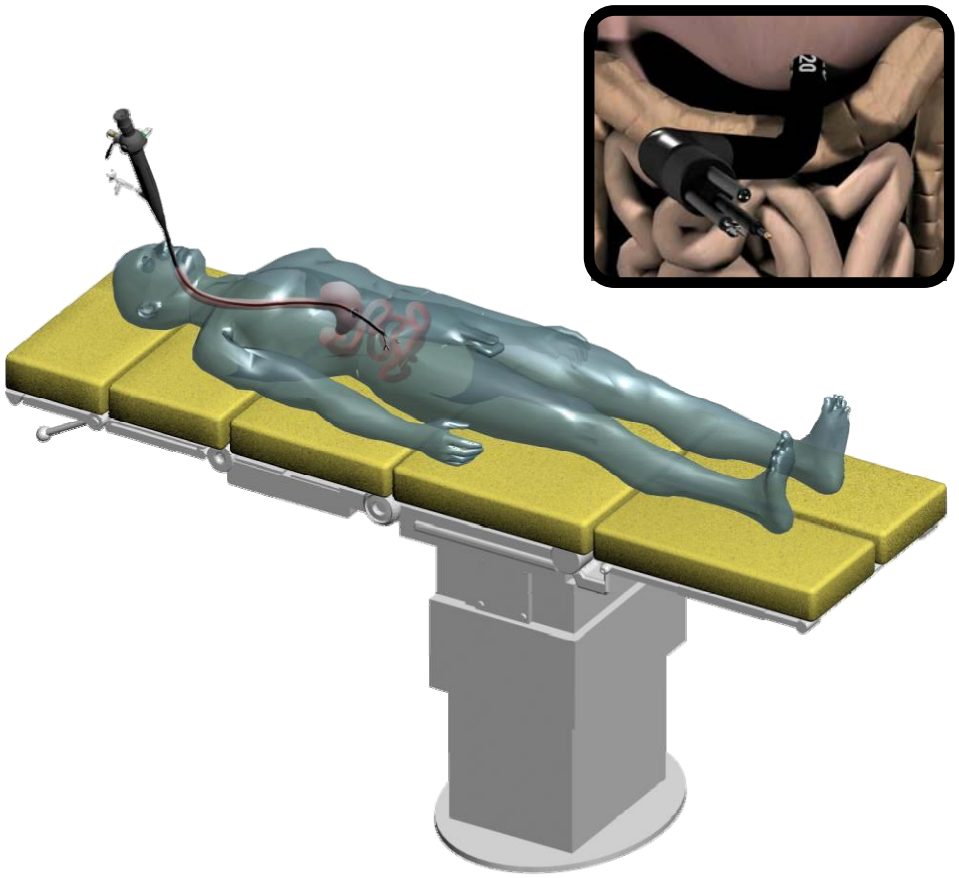
Use new flexible tracking systems

Patient-specific deformation

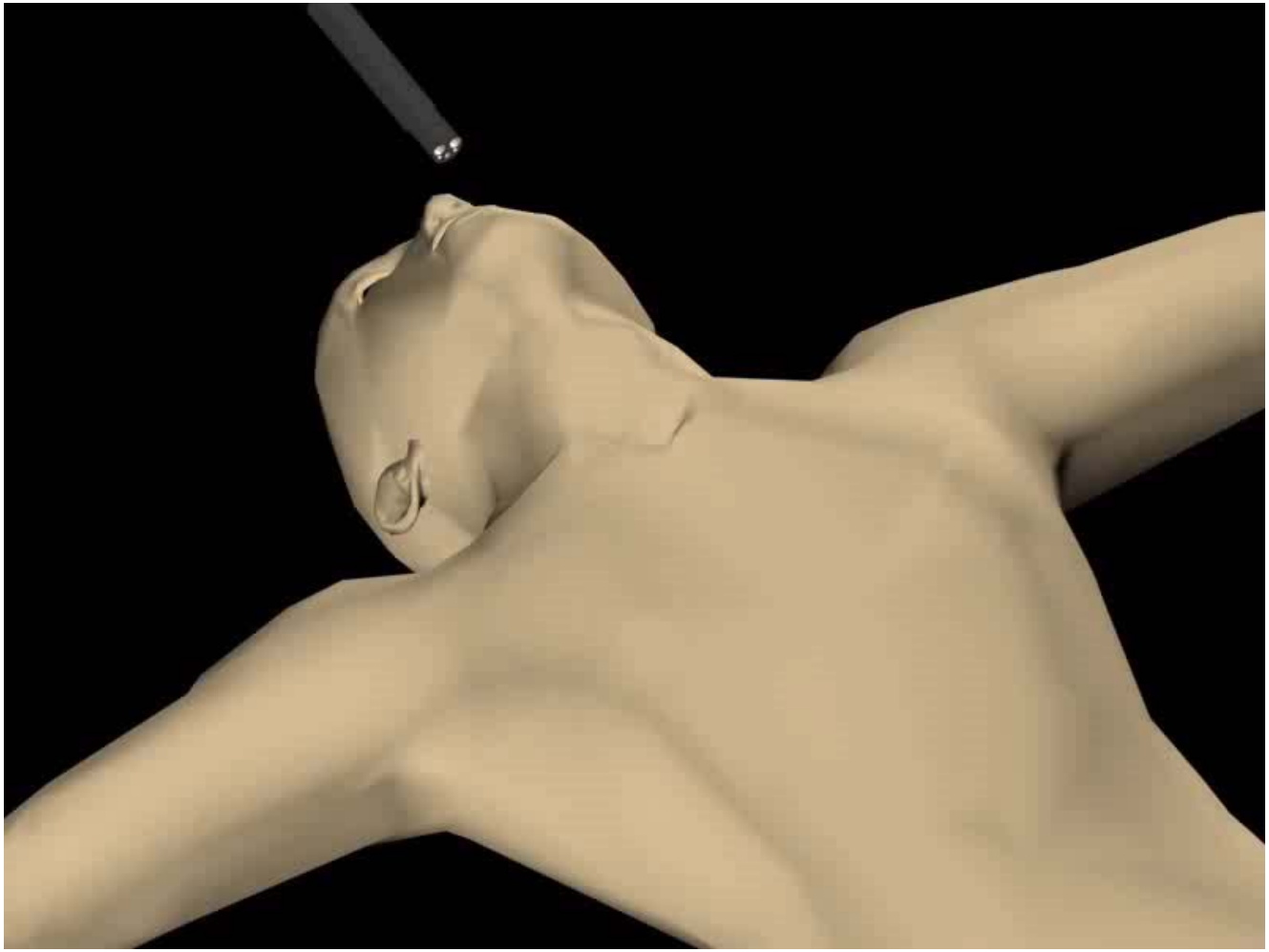
Automated Accuracy control

VR, AR & Robotics applied to NOTES

ANUBIS Project : 2005-2008



Natural Orifice Transluminale Endoscopic Surgery



No scare Surgery

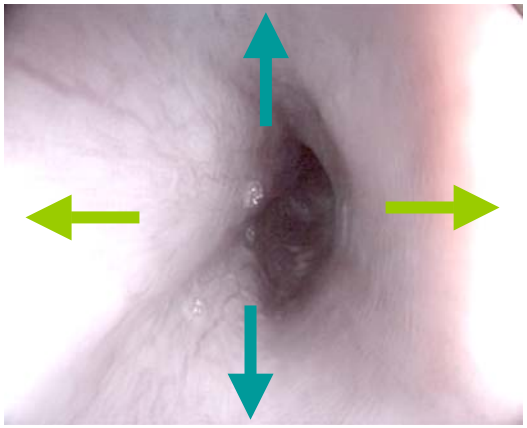
First Human Transluminal Surgery

April 2007: Transvaginal Cholecystectomy

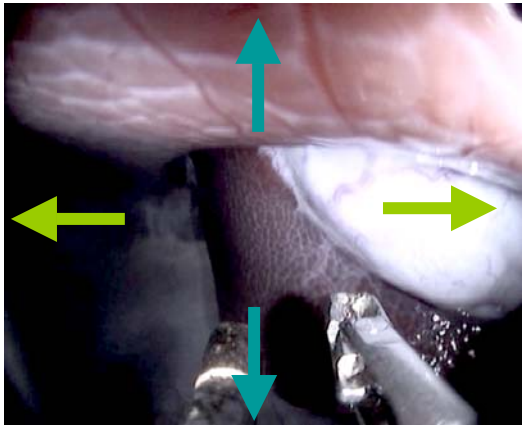
Aim : Improve instruments & control

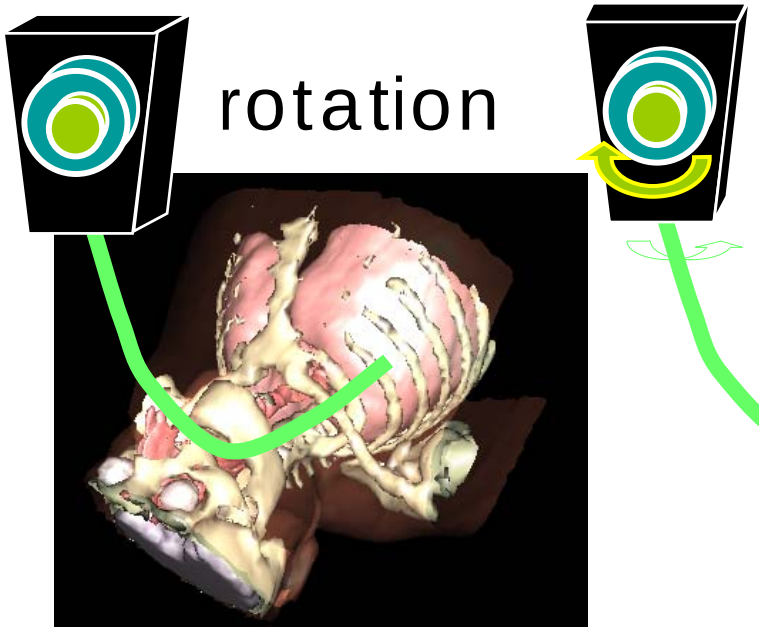
Why is it difficult to control endoscope?

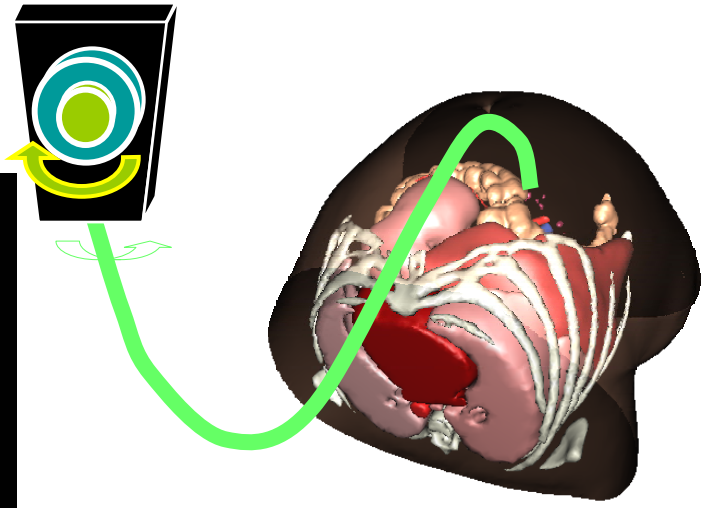
Left of the patient

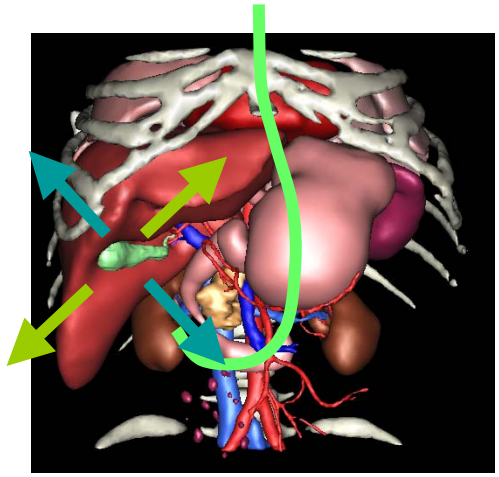


Right of the patient

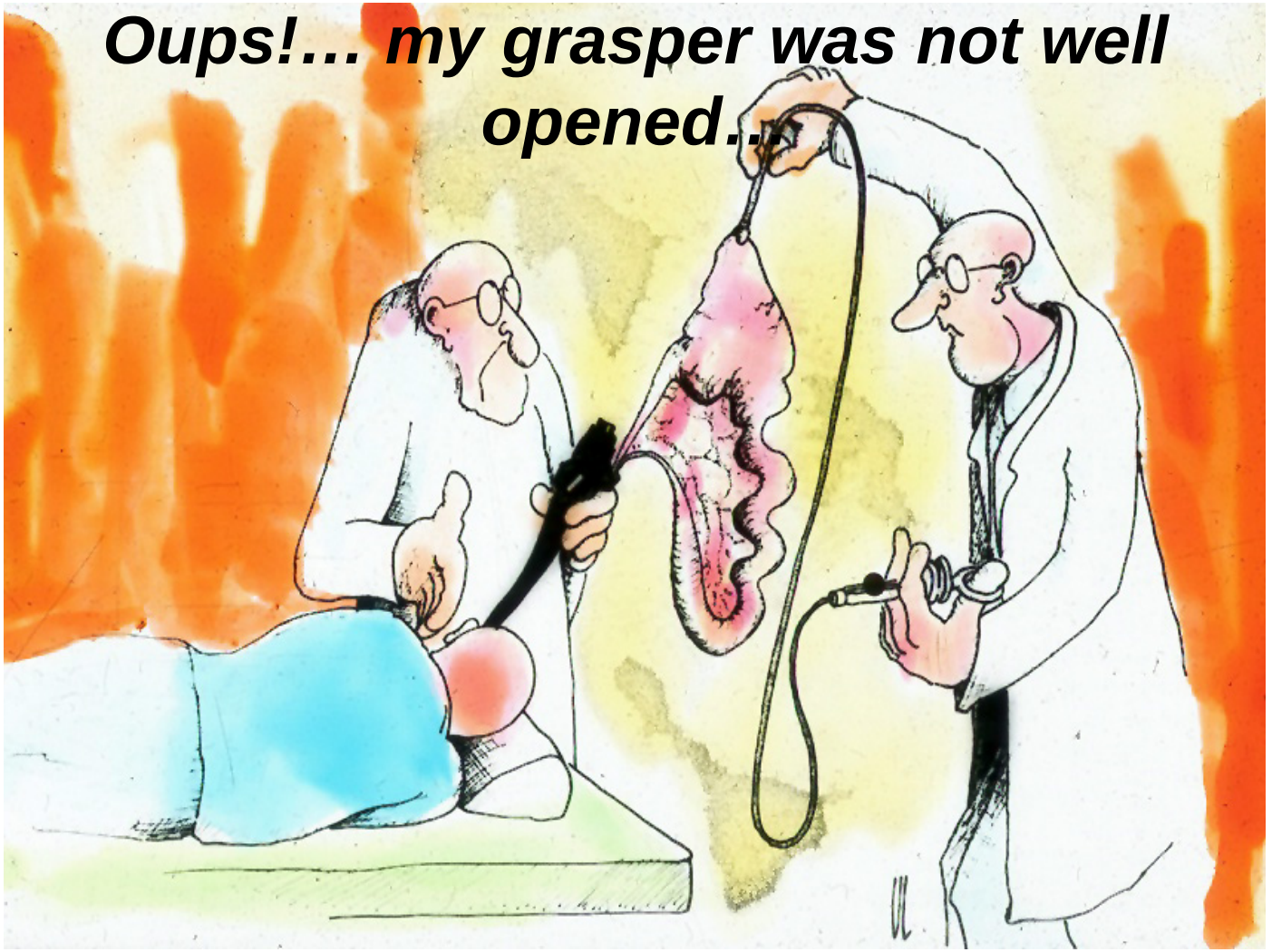








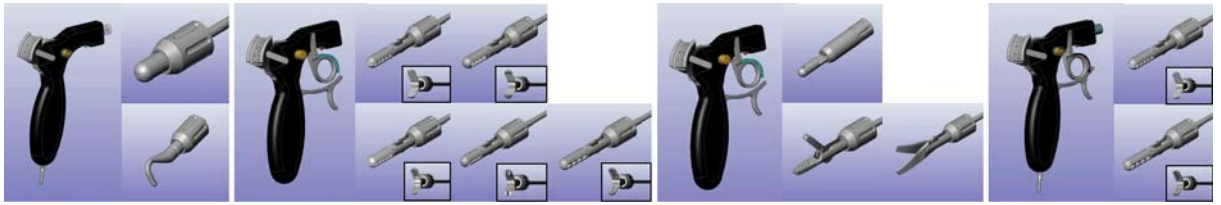
Aim : Improve instruments & control



Aim : Improve instruments & control

Before ...

Now ...



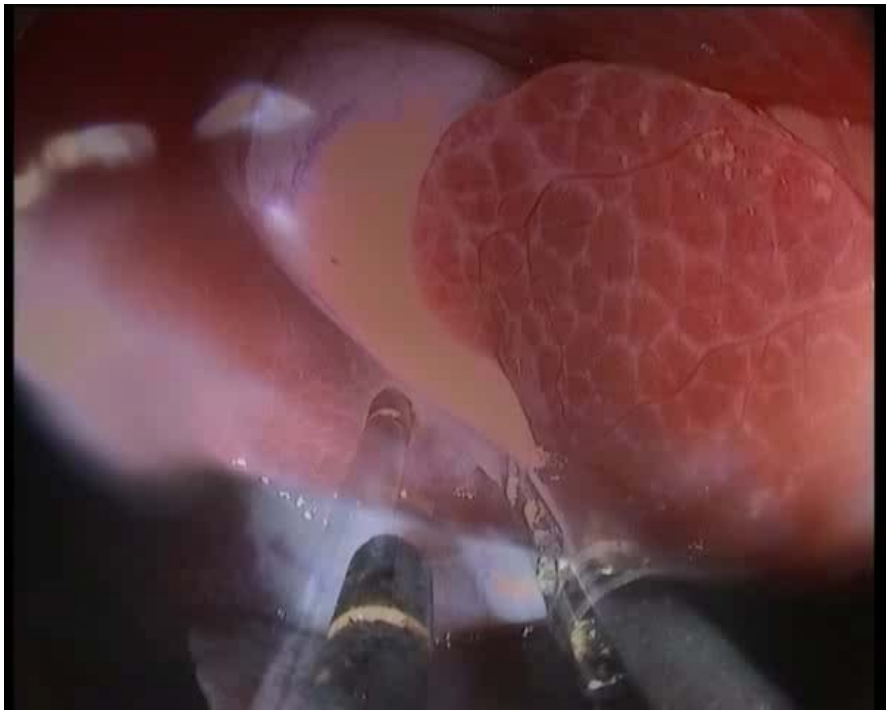
Aim : Improve instruments & control

Before ...

Now ...

Aim : Improve instruments & control

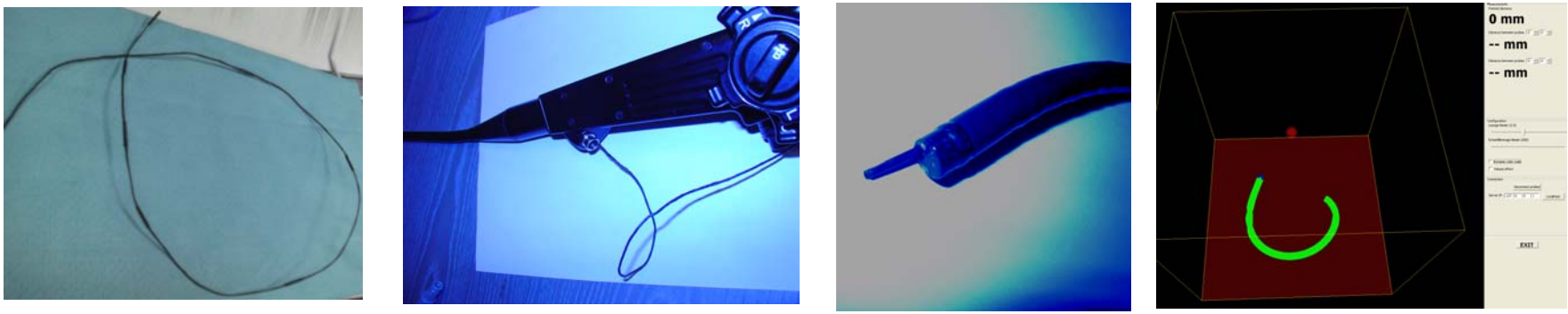
Before ...



Now ...

METRIS

8 x 5 DOF Electromagnetic sensor coils
in a flexible tube of max 2.5 mm Ø

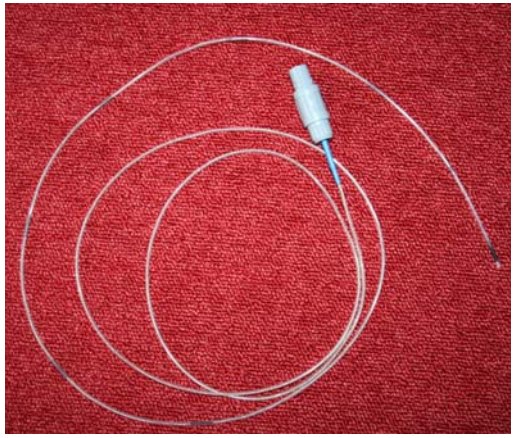


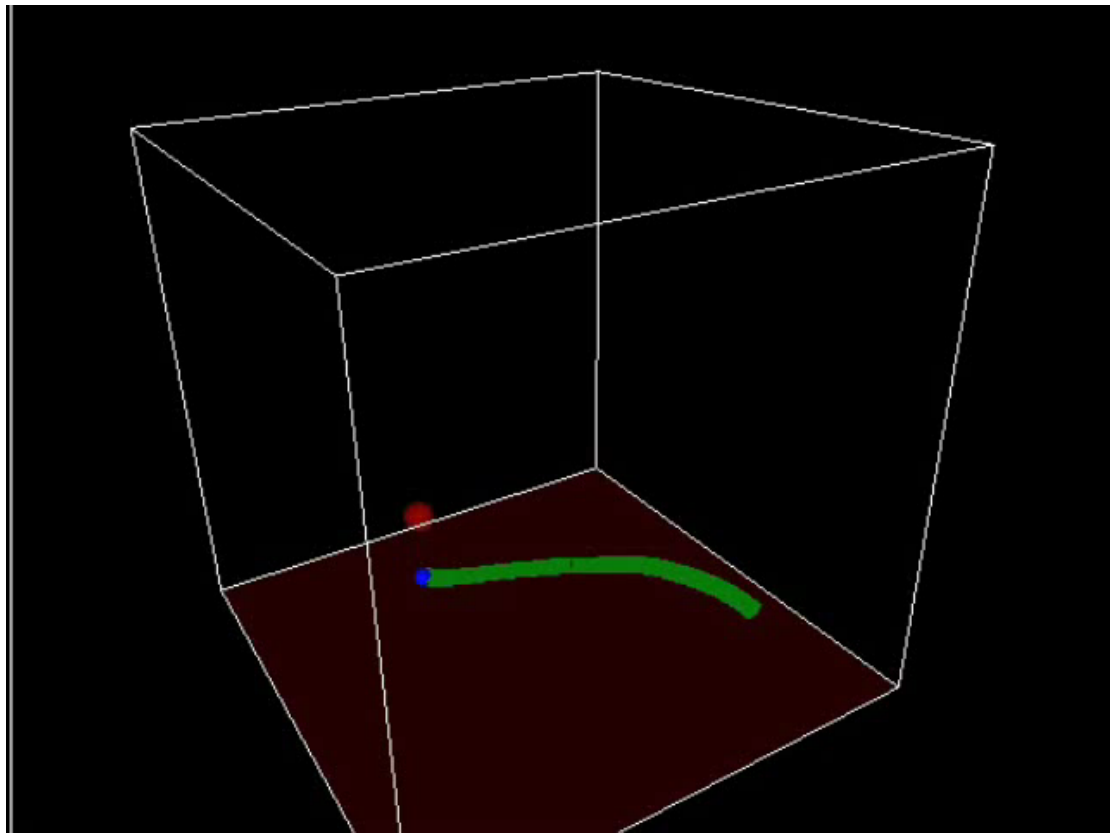
The system provides :

-Distance between 2 selected positions
- 3D Shape of the flexible tube in real-time

VR & AR : Simplest instrument control

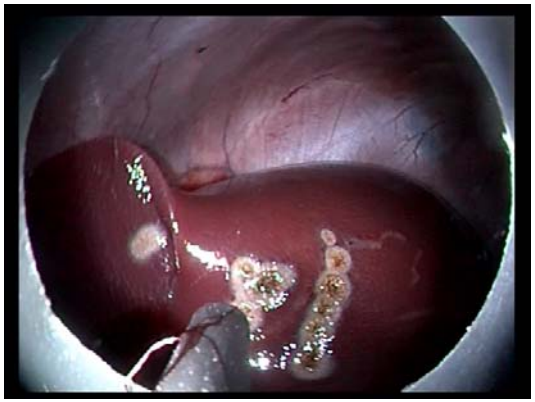
3D View of the flexible endoscope





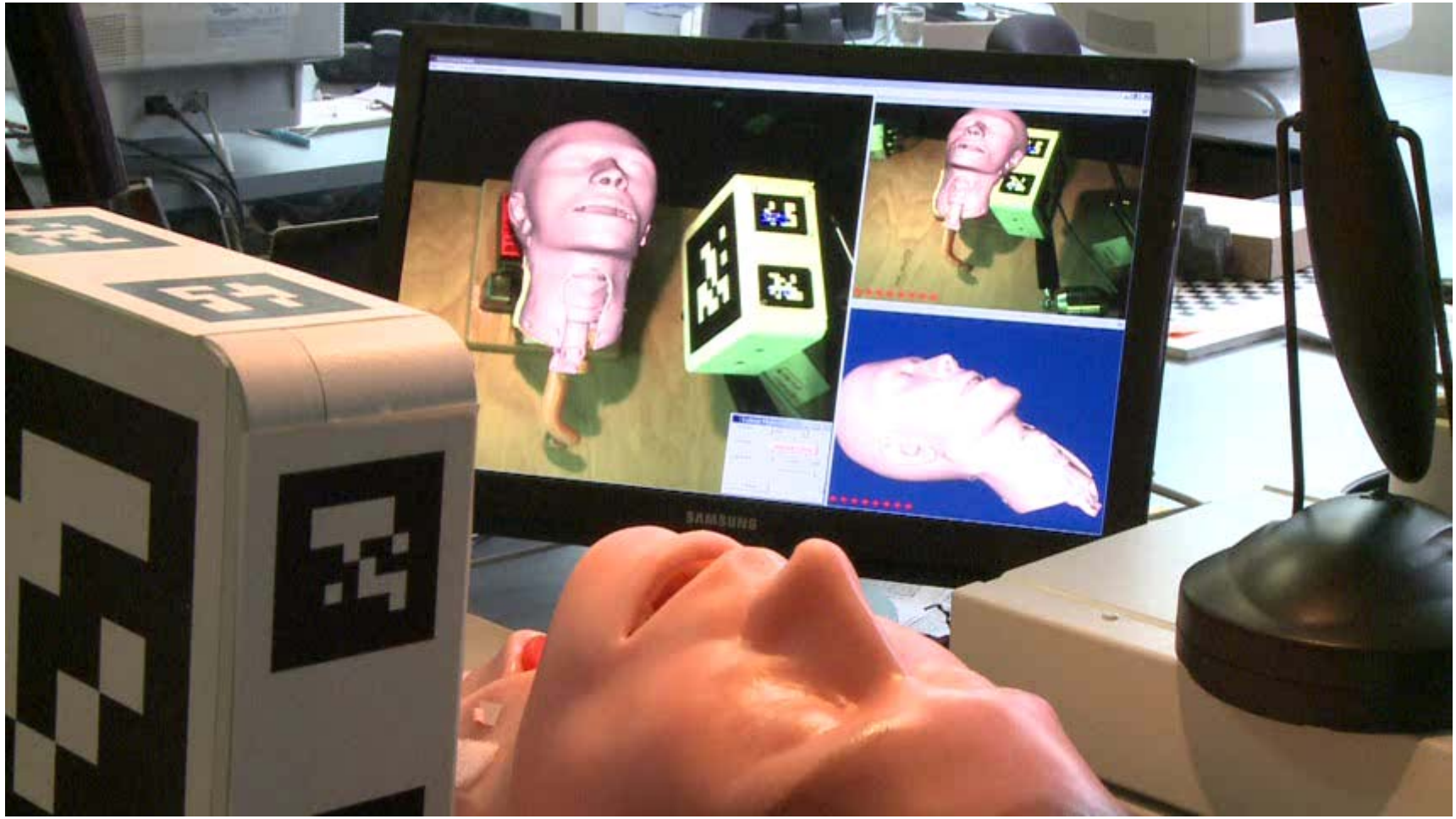
METRIS ➔ 1mm of precision

In vivo evaluation of measure precision



en mm	METRIS 1	REGLE 1	METRIS 2	REGLE 2
MARQUE 1	7.1	8	5.2	6
MARQUE 2	15.2	16	13.4	14.3

VR & AR : Simplest instrument control



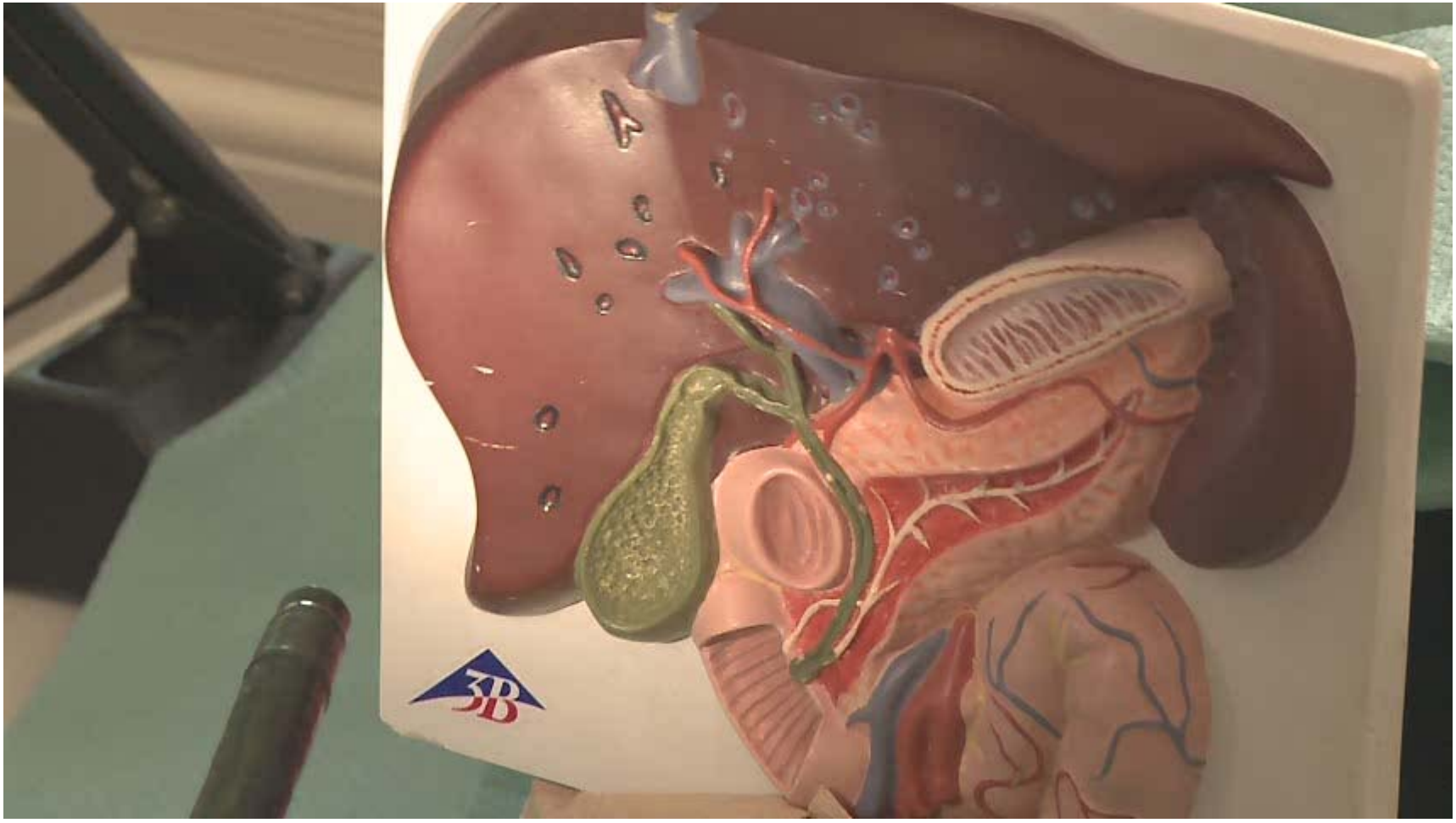
VR & AR : Simplest instrument control

Robotics : Simplest instrument control

Easy interactive flexible endoscope control

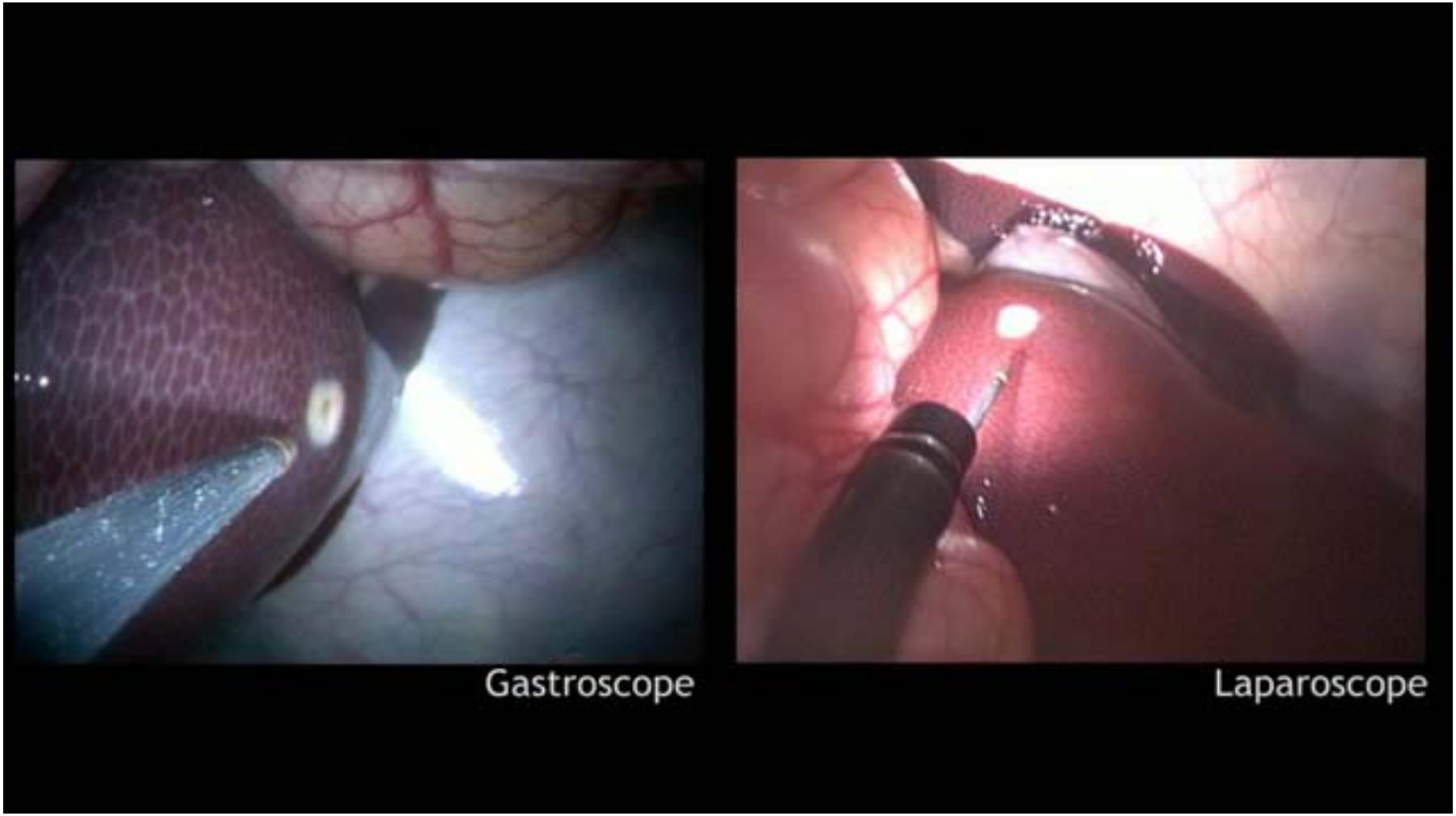
Robotics : Automatic instrument control

Easy Automated flexible endoscope control



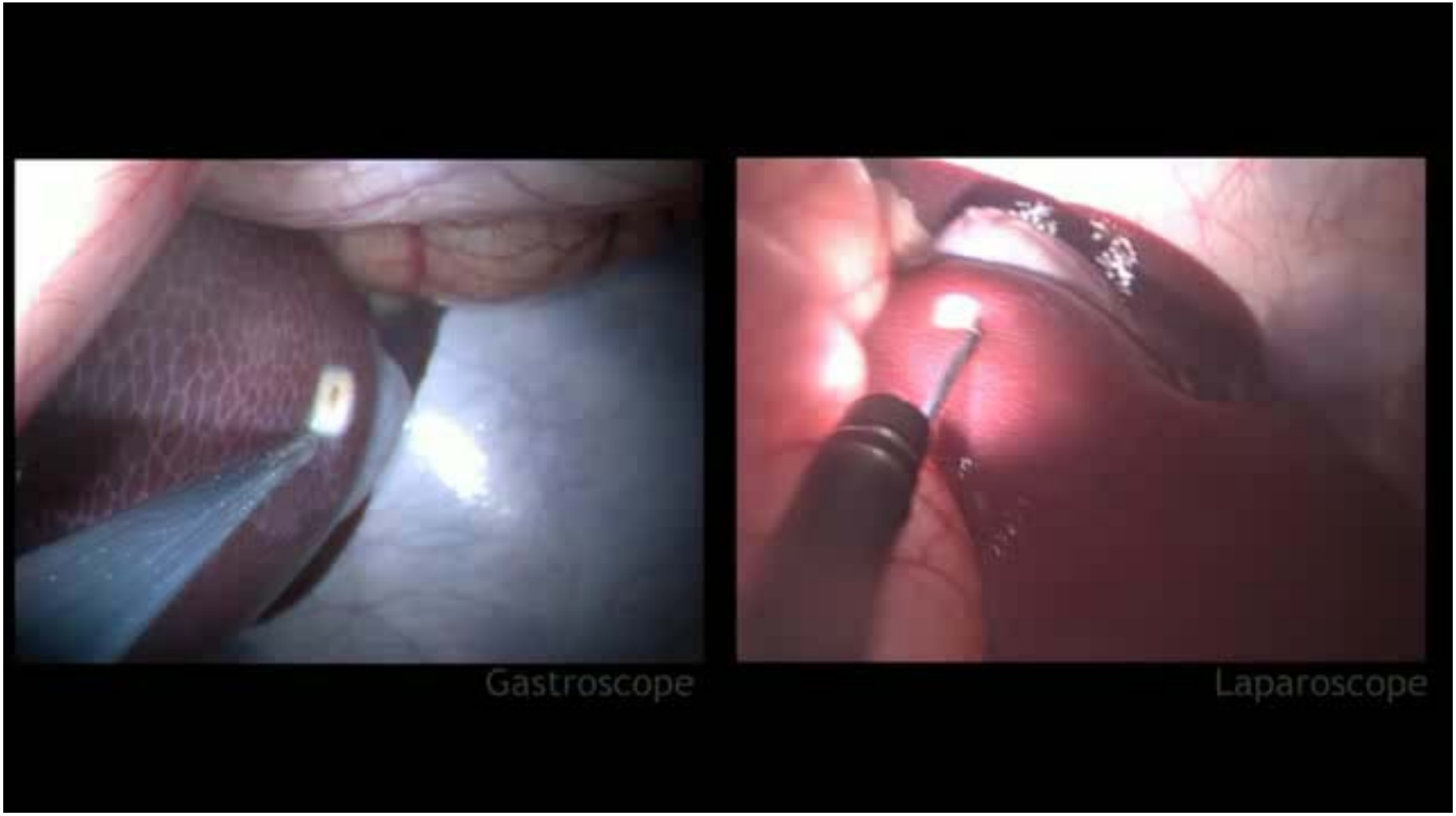
Robotics : Automatic instrument control

WITHOUT Automatic Flexible endoscope control



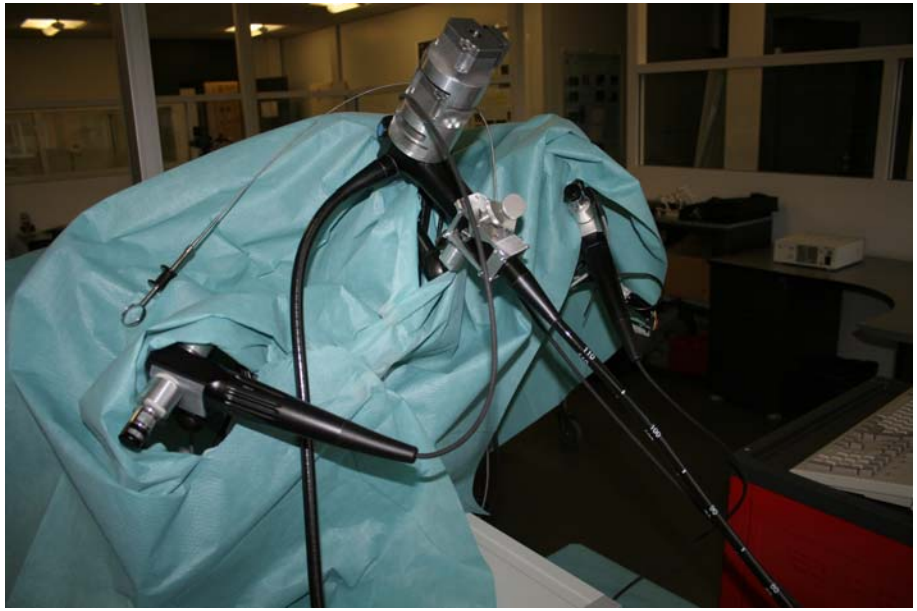
Robotics : Automatic instrument control

WITH Automatic Flexible endoscope control



External Motors : Endoscope Robot

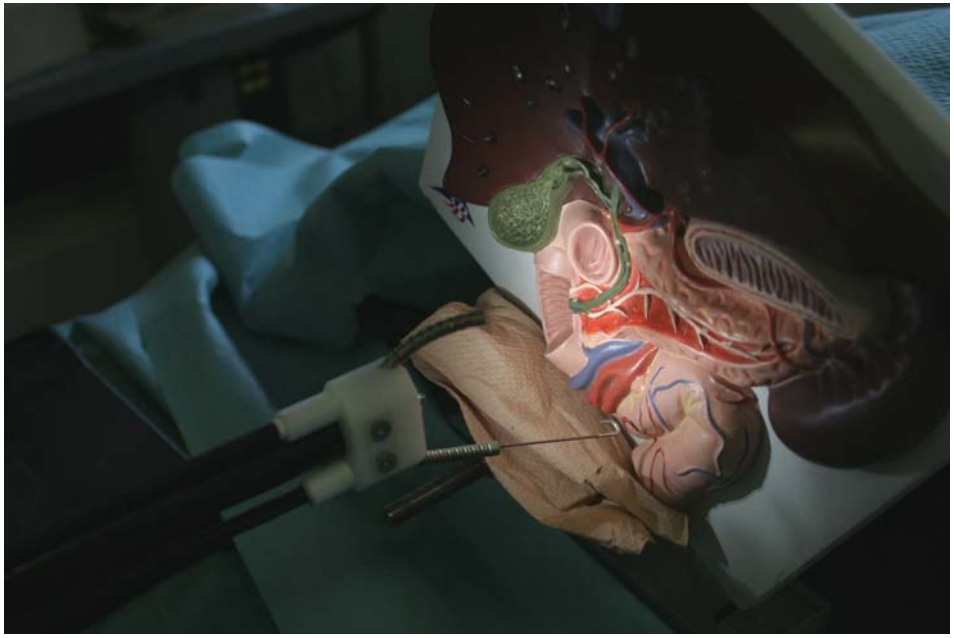
Single user Master Slaves NOTES Robot



LSIIT Robotic team of Michel de Mathelin, IRCAD/ Strasbourg university

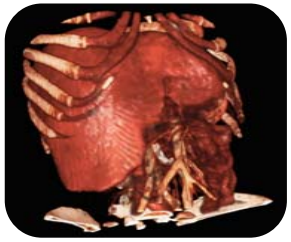
External Motors : Endoscope Robot

Single user Master Slaves NOTES Robot



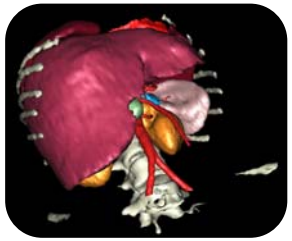
LSIIT Robotic team of Michel de Mathelin, IRCAD/ Strasbourg university

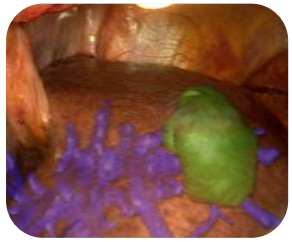
Conclusion



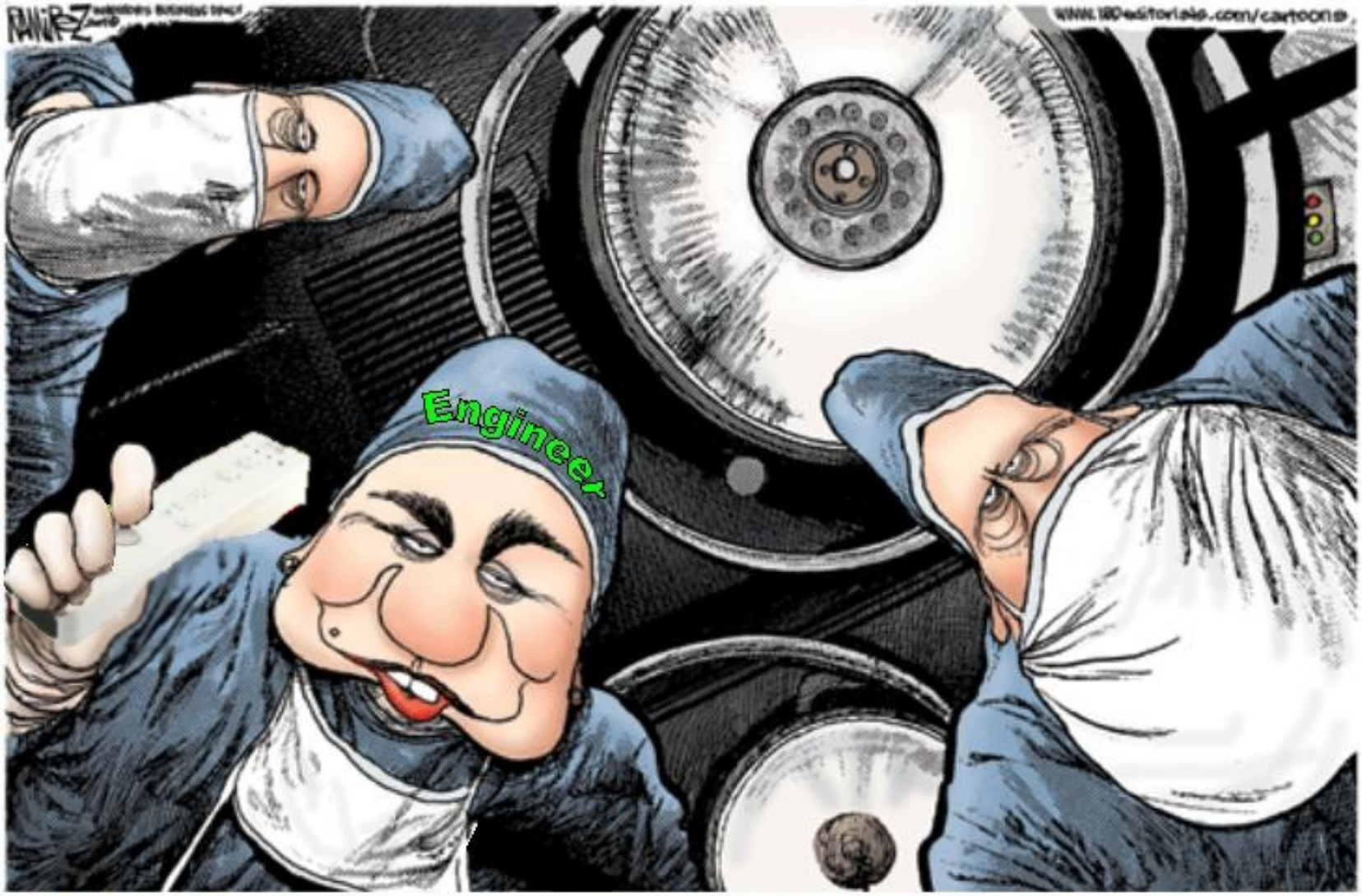
“Have Fun”

Russel Taylor
Winter School MRCIIS 2009





Thanks for your attention



Don’t worry, I have experience. I’m not a surgeon but I work for one since 10 years