

Simulation & Calcul haute performance : le défi de la chirurgie assistée par ordinateur

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Objectif : réduire les erreurs humaines

Exemple : Chirurgie en france

1 Erreur évitable grave / 109 actes

55 000 EEG / an

→ 150 EEG / jour

→ 1 EEG / 10 mn

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Exemple : Chirurgie en france

1 Erreur évitable grave /109 actes

Aeronautique mondiale

1 accident majeur / 1,6 M Flight

L'exemple de l'aéronautique



Simulation éducative



Réalité augmentée
Cartographie 3D



Prévision et suivi
météorologique

1^r élément: La carte 3D du patient



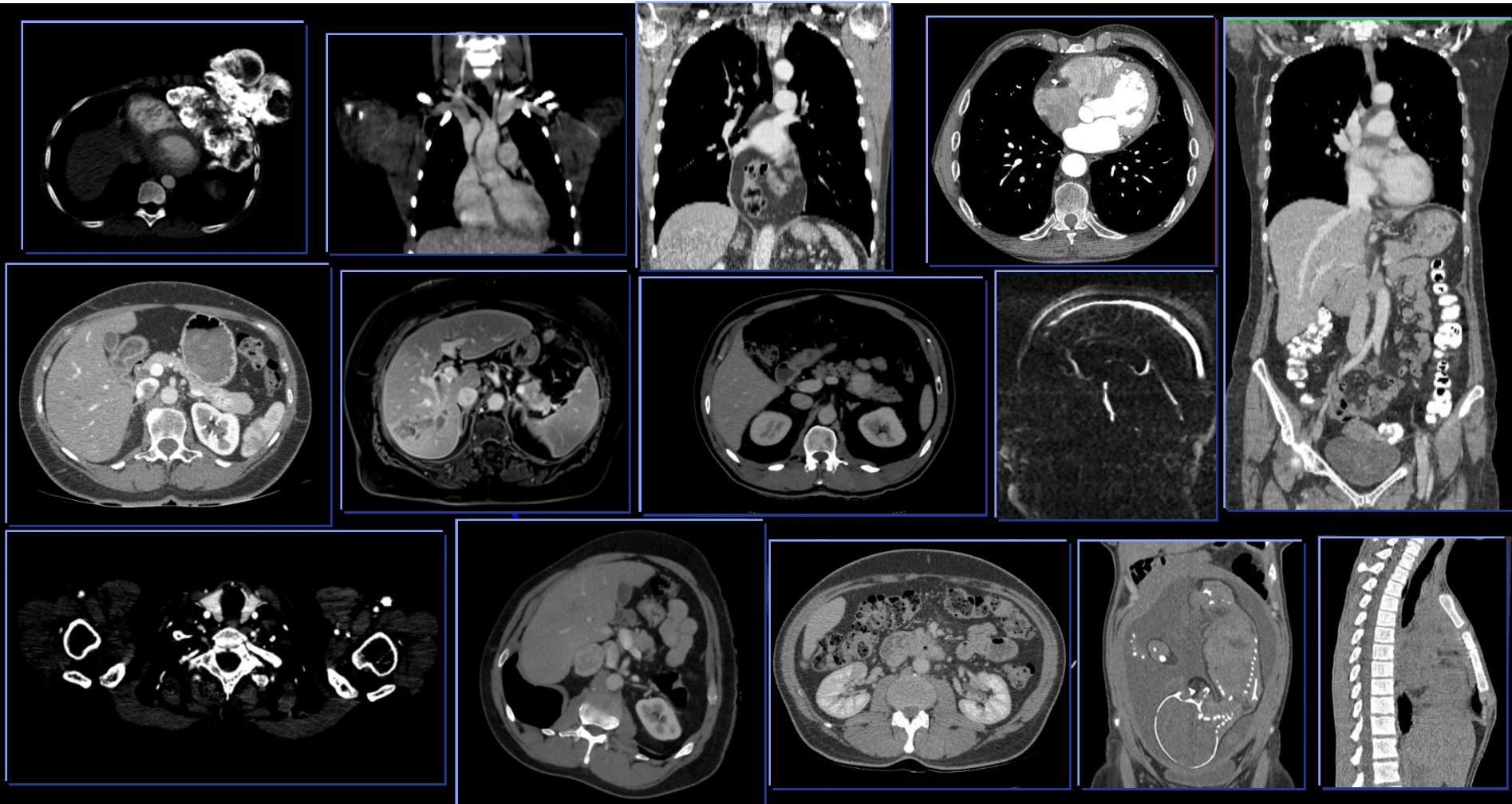
1 Planète... mais 7 milliard d'Humains

1^r élément: La carte 3D du patient



Vue satellite → Images Médicales

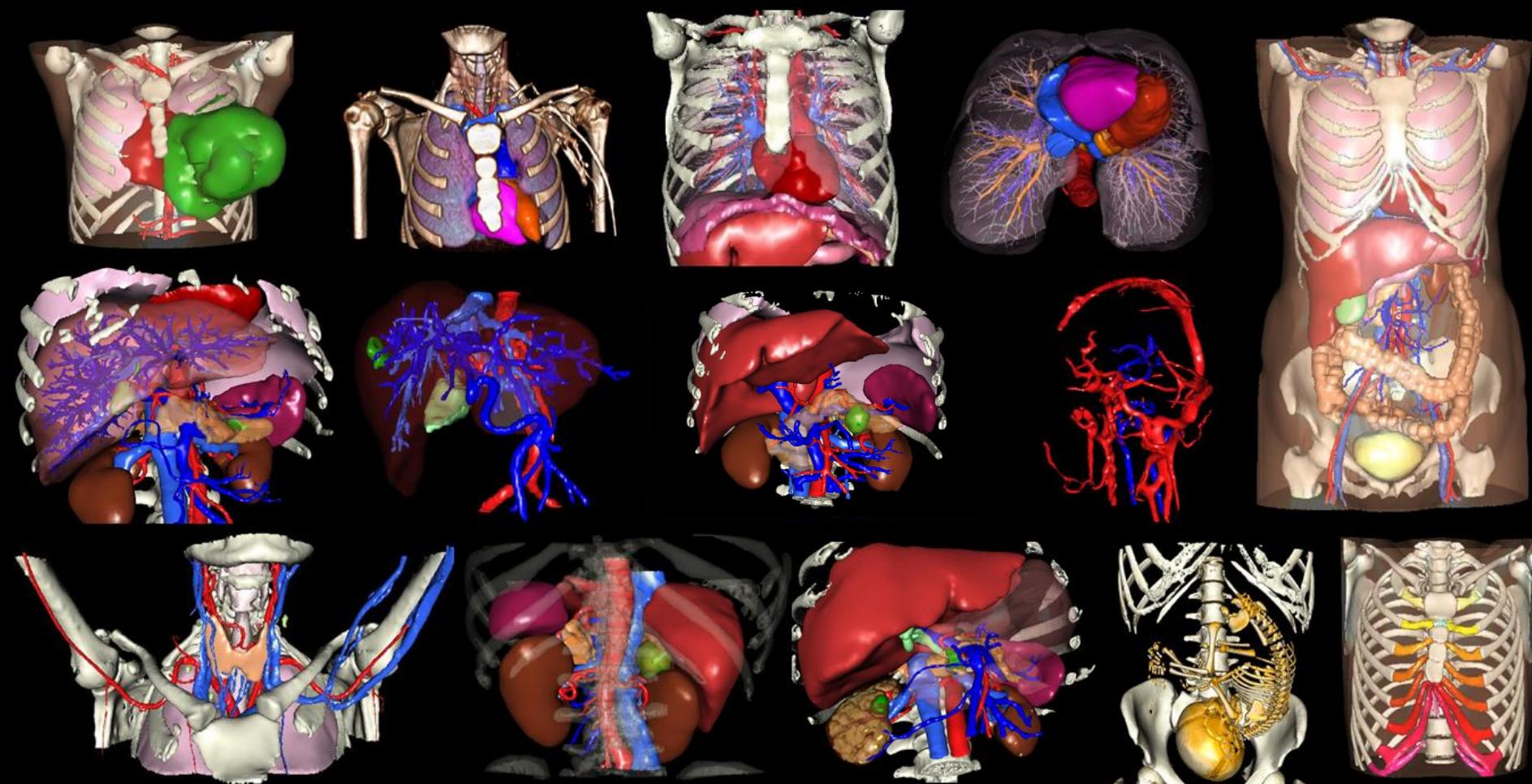
1: La carte 3D du patient



VR-Med © ircad 2010

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1: La carte 3D du patient



VR-Med © ircad 2010

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Simulation de 1^{ère} génération



VR-Render ©
ircad 2010

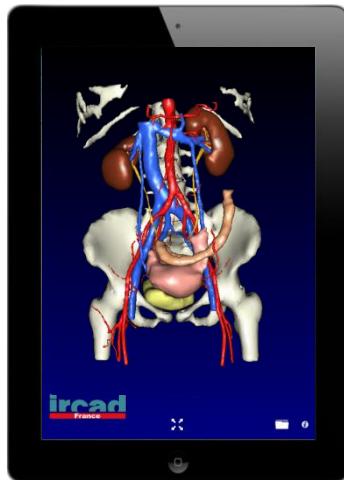
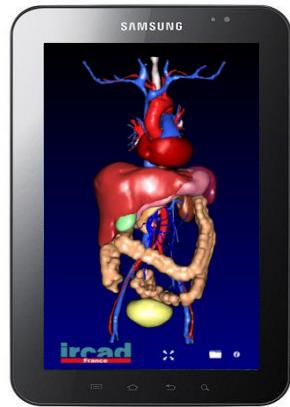
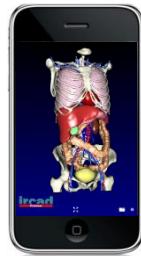
www.websurg.com/softwares
>13.000 users



VR-Planning ©
ircad 2010

MultiOS system
Windows / MacOS / Linux

Simulation de 1^{ère} génération



Visible Patient



www.visiblepatient.eu
> 15.000 users

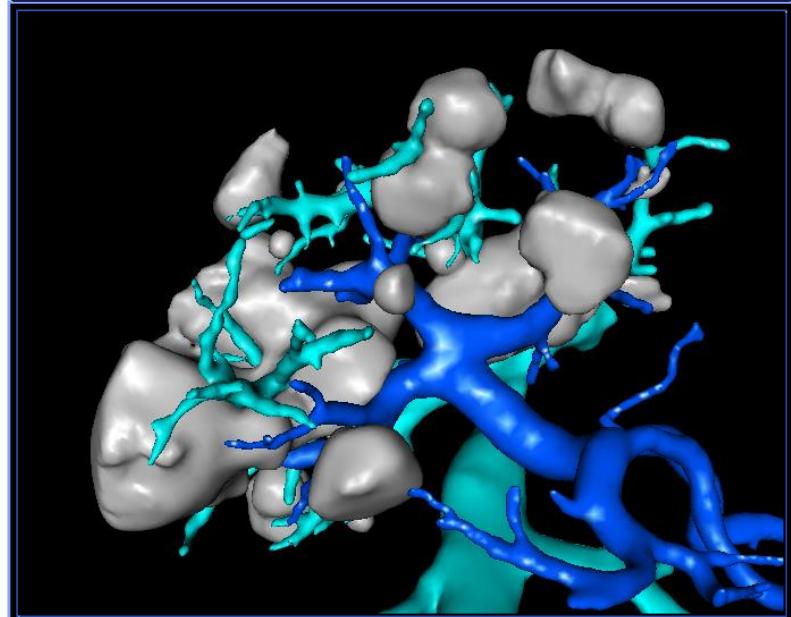


T3D Popview® 3D display

VR-Planning
© ircad 2010

2: Suivre l'évolution

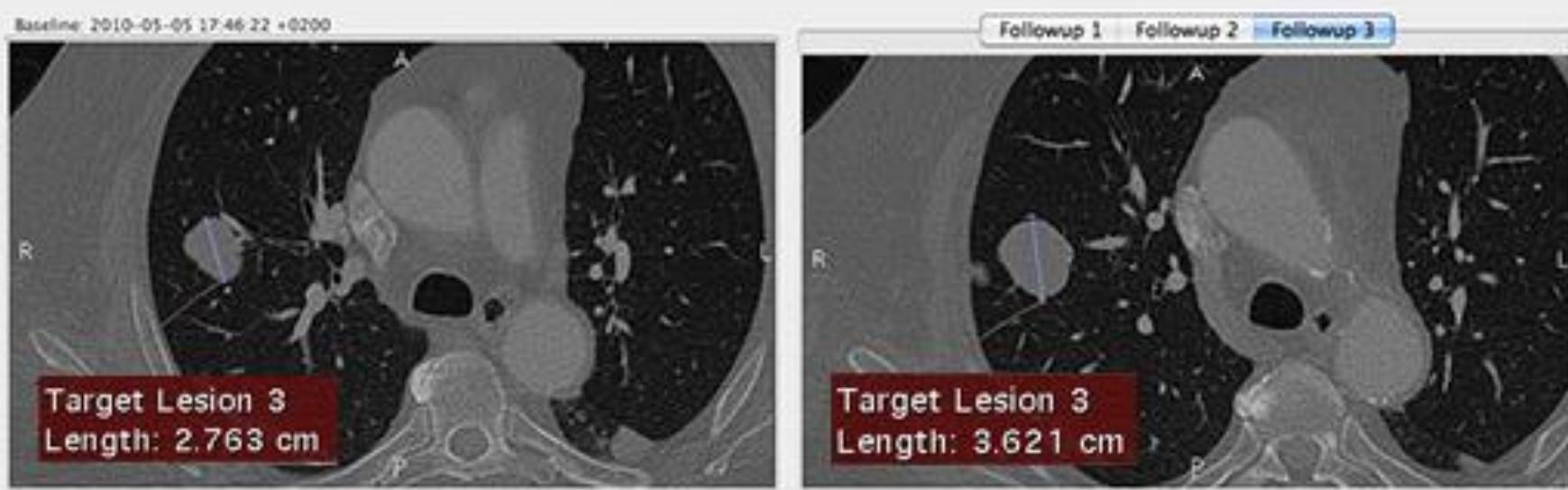
Sam.	Dim.	Lun.	Mar.
9 ° 4 °	9 ° 4 °	8 ° 6 °	9 ° 4 °



Météorologique → Pathologique

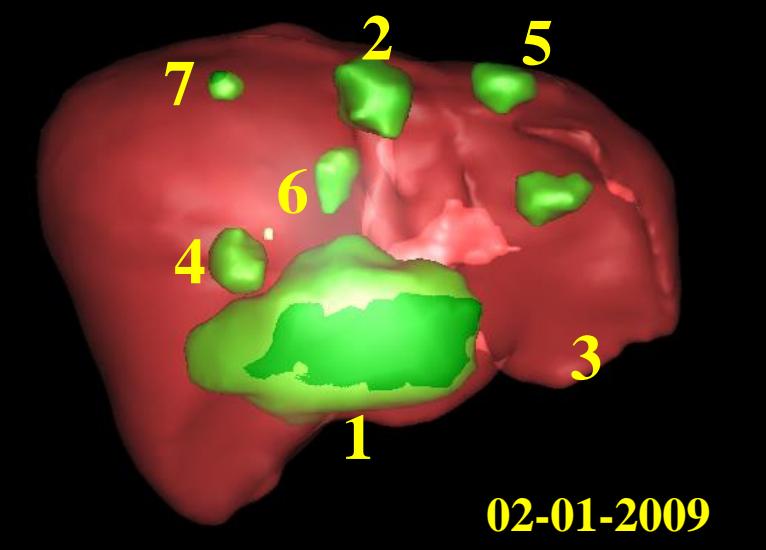
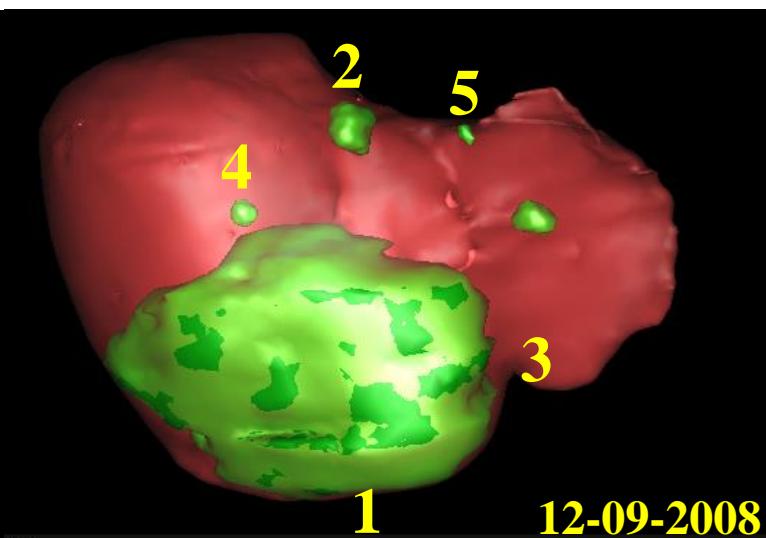
Suivi normé des tumeurs : RECIST

Uniquement 1D + t

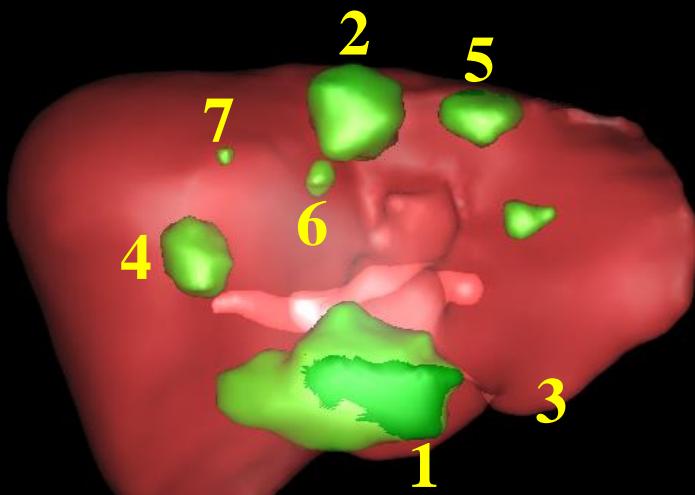


RECIST 1.1	Baseline	Followup 1	Followup 2	Followup 3
	2010-05-05 17:46:22 +0200	2010-07-13 13:47:04 +0200	2010-09-01 12:37:47 +0200	2010-10-21 12:24:01 +0200
RECIST absolut	119.51 mm	86.18 mm	83.44 mm	100.91 mm
Difference to Baseline in %	---	-27.89	-30.38	-15.56
Target Lesion 1	59.31 mm	45.51 mm	42.30 mm	46.63 mm
Target Lesion 2	14.41 mm	13.73 mm	11.61 mm	13.27 mm
Target Lesion 3	27.63 mm	17.27 mm	22.77 mm	36.21 mm
Target Lesion 4	18.16 mm	9.68 mm	6.77 mm	4.80 mm
Non-Target Lesion 1				28.28 mm
Non-Target Lesion 2				28.84 mm

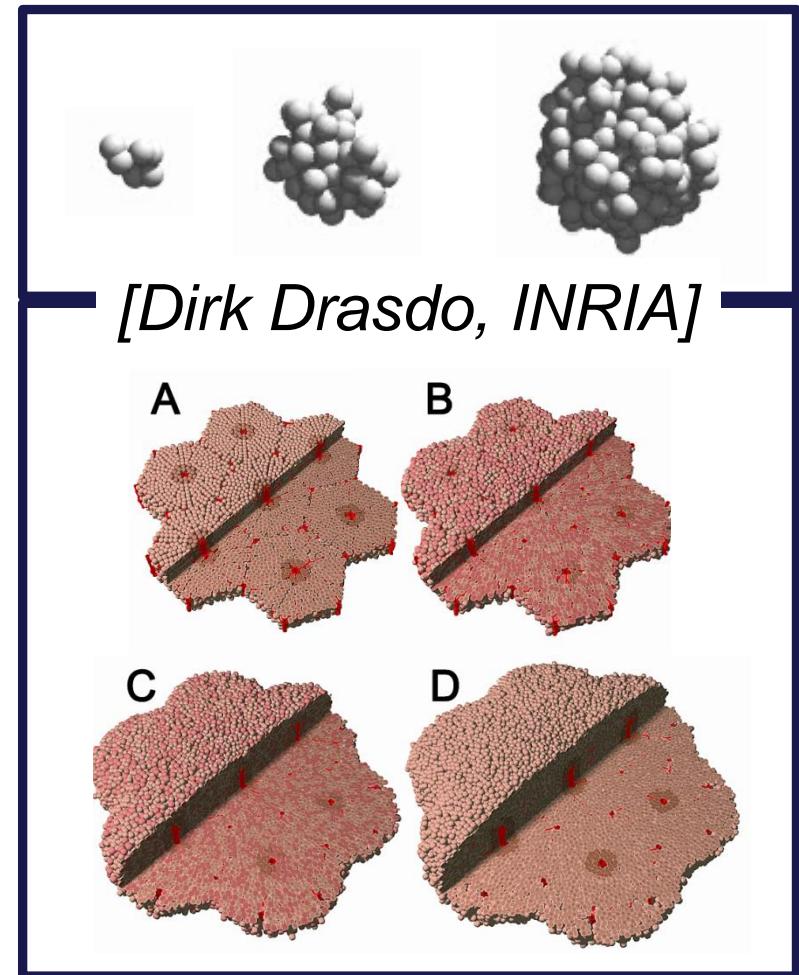
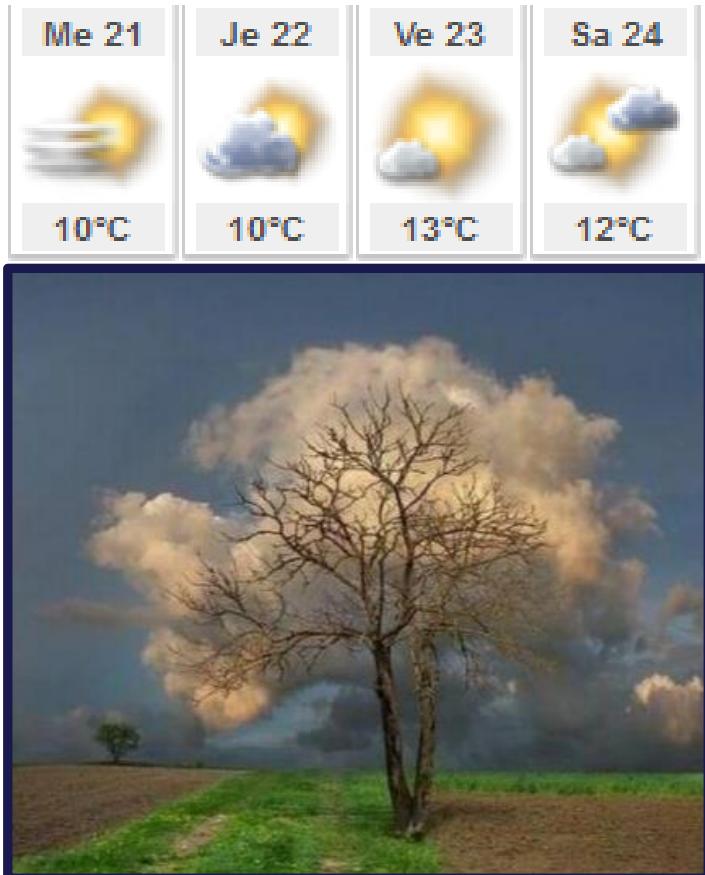
Suivi 4D = 3D + t > RECIST



Volumes en cc	12/09/2008	02/01/2009	03/04/2009	Evolution
Tumeur 1	420,00	82,60	41,00	↗ ↗
Tumeur 2	2,90	9,80	14,80	↗ ↗
Tumeur 3	1,10	3,50	1,12	↗ ↗
Tumeur 4	0,80	7,20	7,20	↗ ↗
Tumeur 5	0,10	2,60	4,10	↗ ↗
Tumeur 6	0,00	2,40	0,53	↗ ↗
Tumeur 7	0,00	0,30	0,08	↗ ↗
Total	424,90	108,40	68,83	↗ ↗



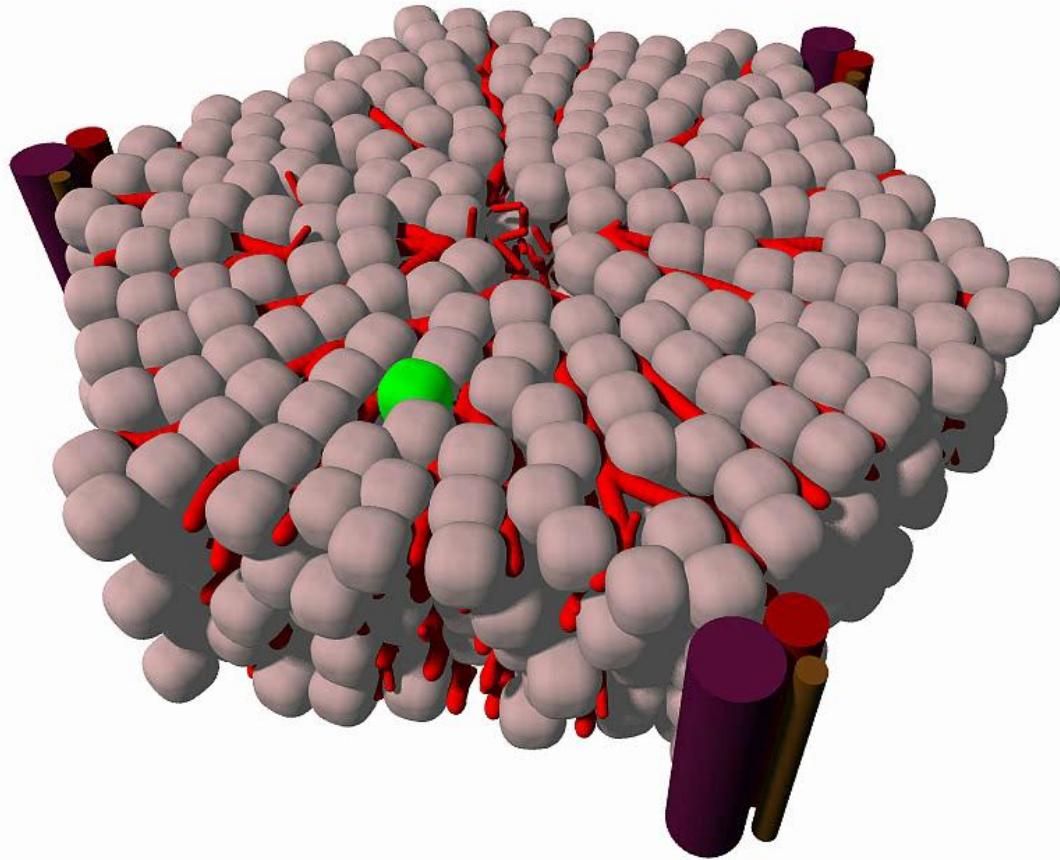
3: Prédire l'évolution



Météorologique →

Cellulaire

Simulation de 3ème génération

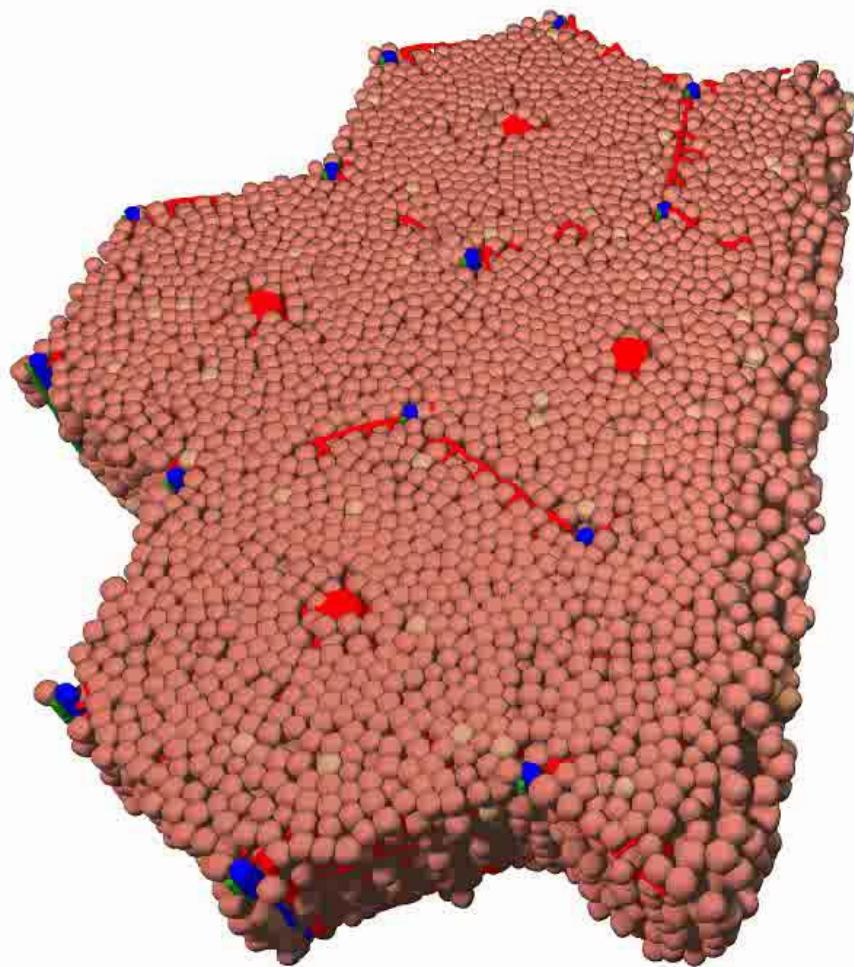


[Dirk Drasdo, INRIA]

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Simulation de 3ème génération

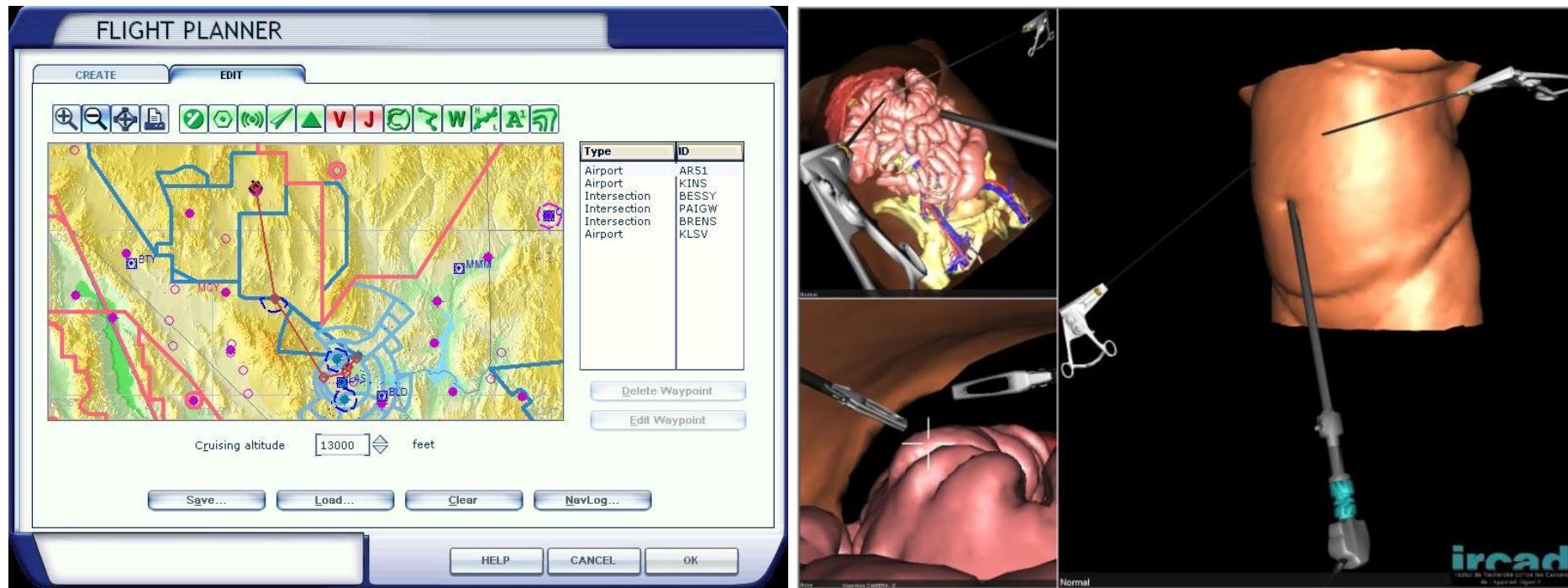
HOEHME - DRASDO - HENGSTLER
25032 cells / 3.02 days



[*Dirk Drasdo, INRIA*]

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4: Définir une stratégie



Plan de Vol

Planning
opératoire

5: Tester sa stratégie

Simulation préopératoire

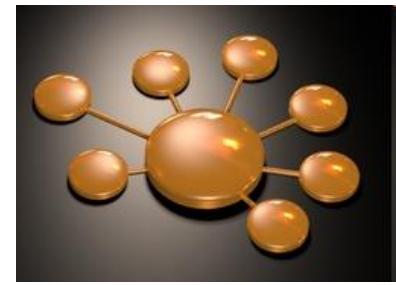


Airplane
+ Map



Surgical tools
+ Patient Map

Simulation de 2nd génération



SOFA
Open source
Framework
for Simulation



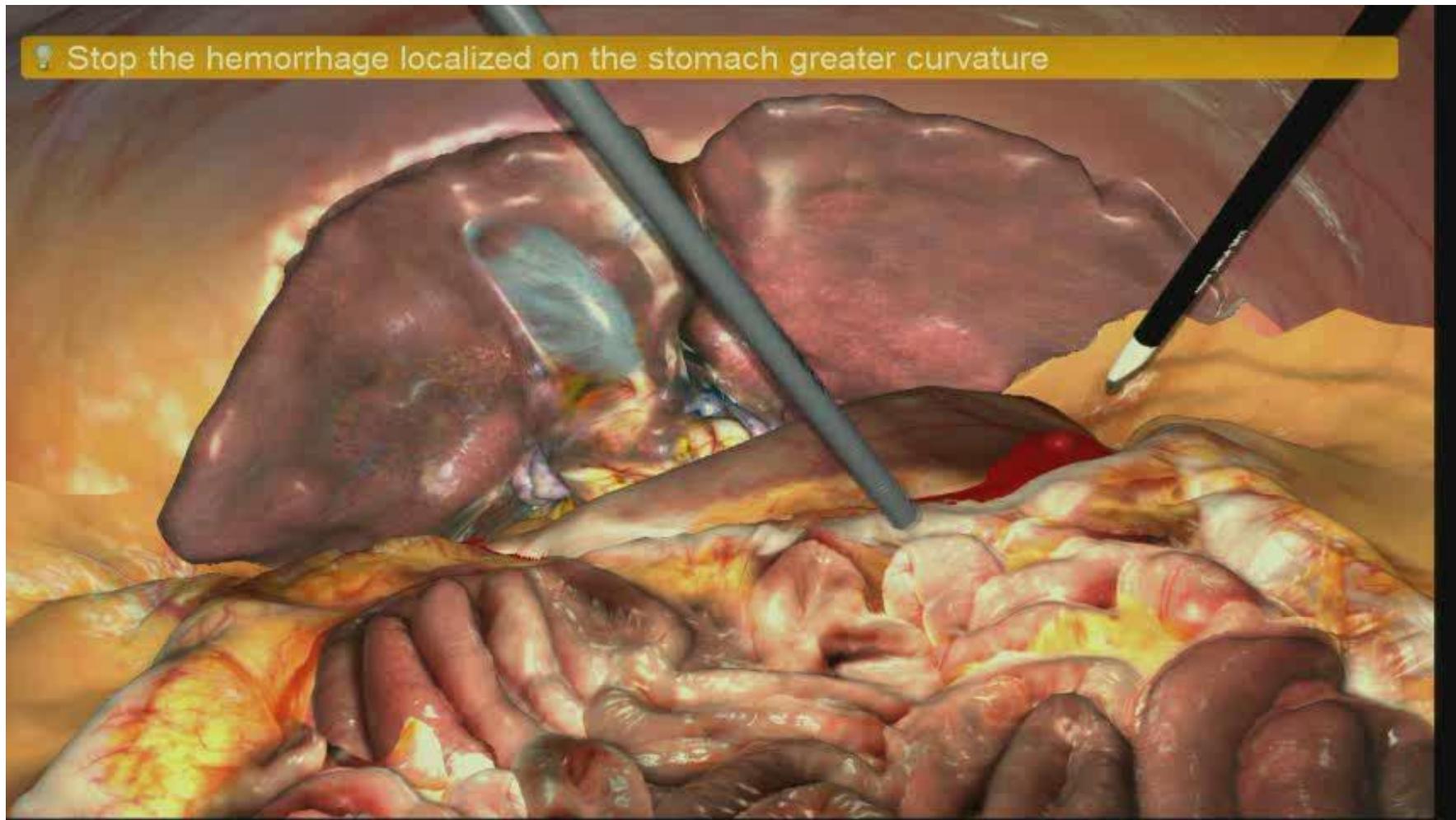
Donner vie au patient virtuel

Simulation de 2nd génération



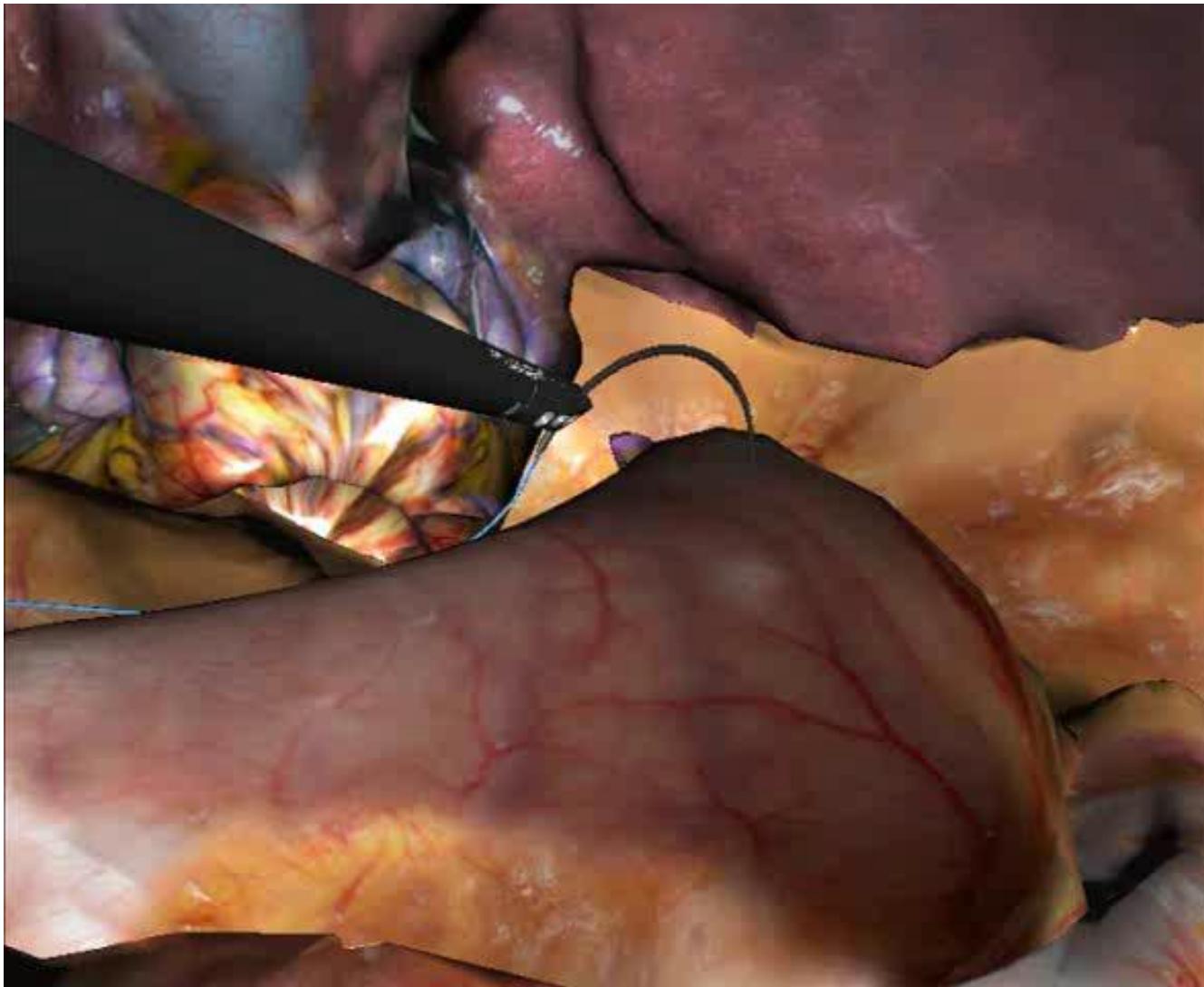
ULIS: Educative simulator

Simulation de 2nd génération



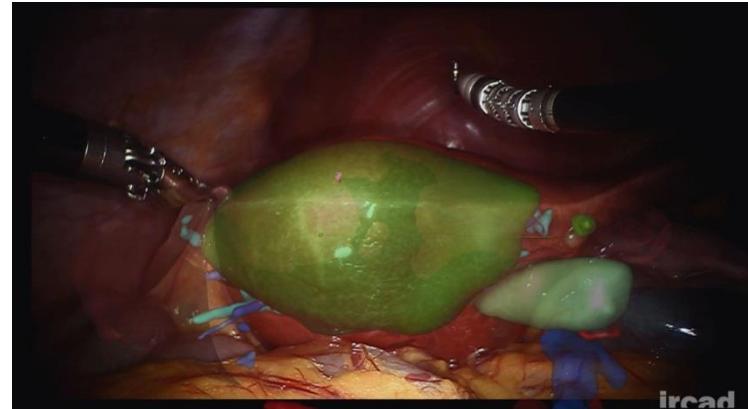
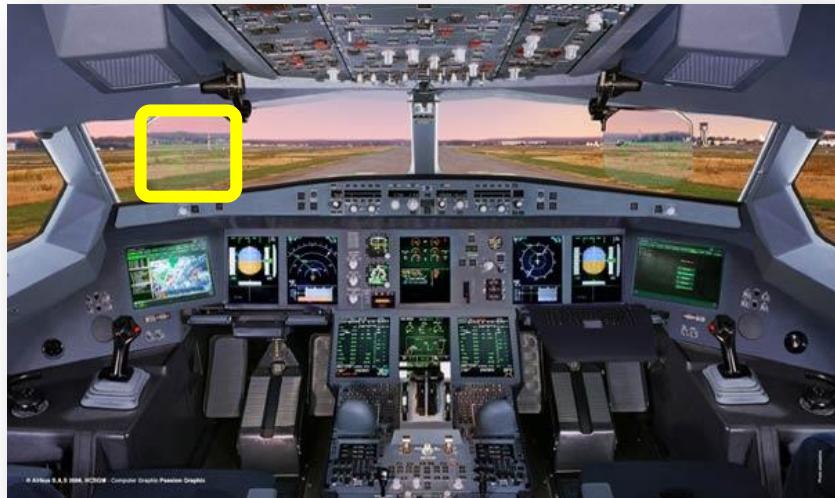
ULIS: Educative simulator

Simulation de 2nd génération



ULIS: Educative simulator

5: Guider par réalité augmentée !!!

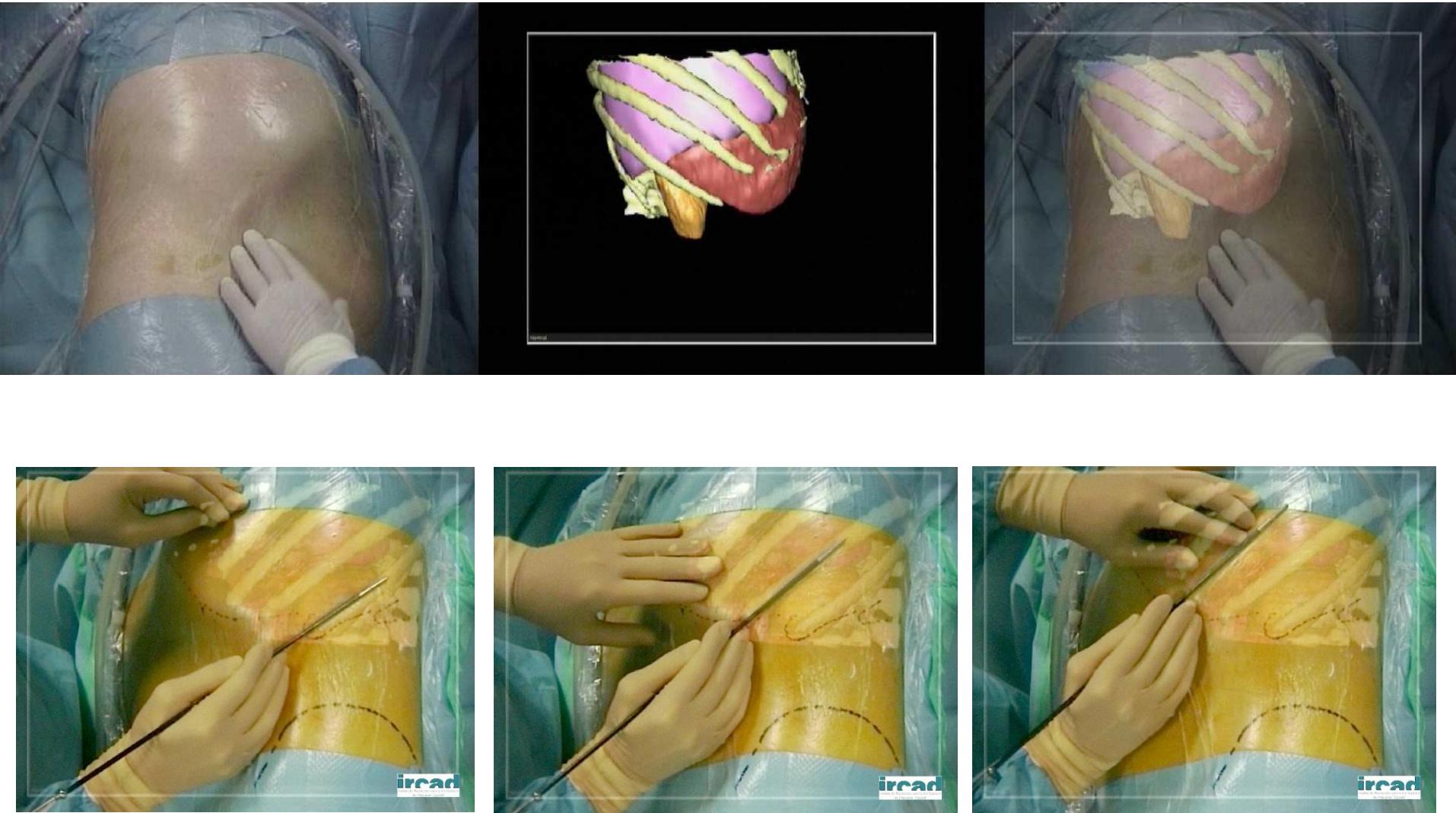


La simulation pour le guidage

Réalité Augmentée interactive



Réalité augmentée interactive



Utilisation de repères sur la peau (publié dans JAMA en 2004)

Réalité augmentée interactive

Hepatic surgery



Pancreatic Surgery



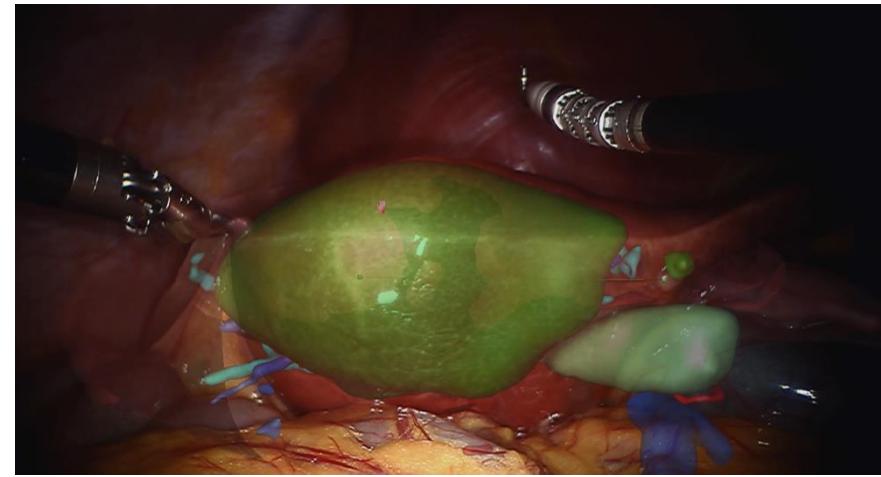
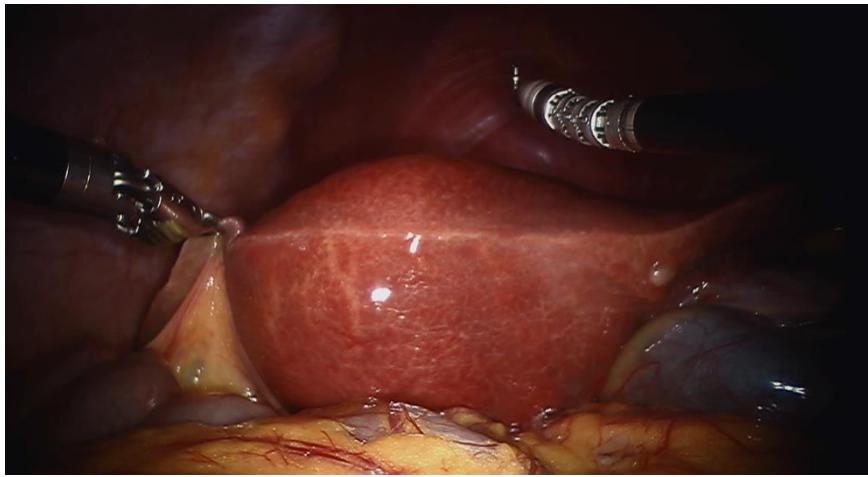
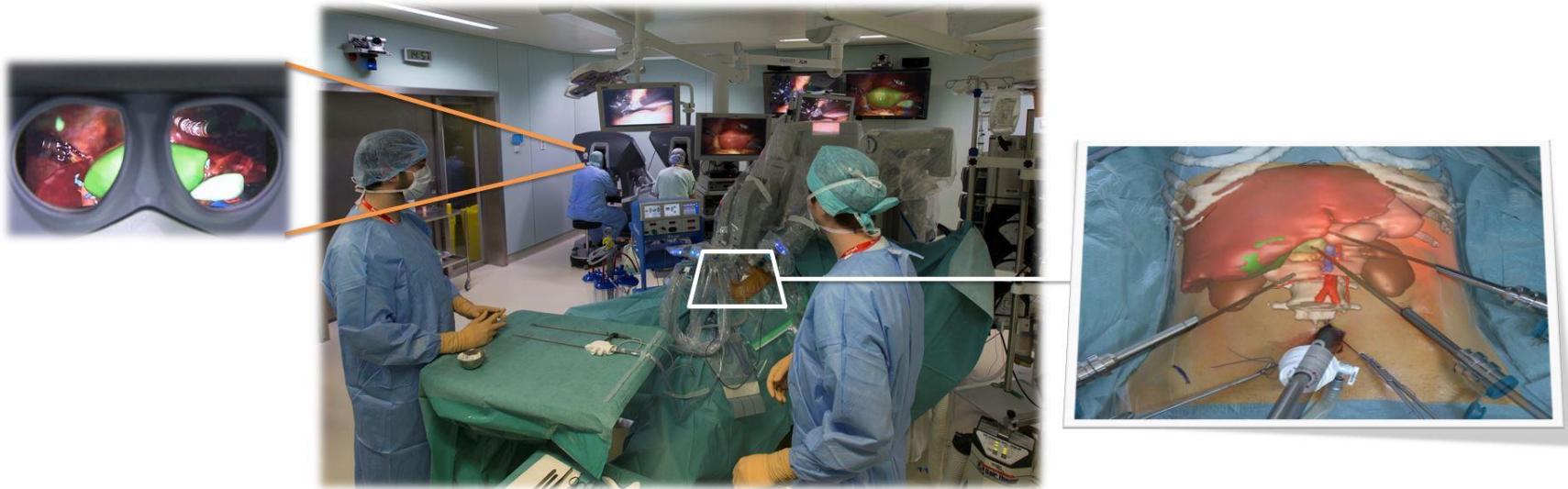
Parathyroid Surgery



AR-Surg©IRCAD 2010

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Robotique + Réalité Augmentée



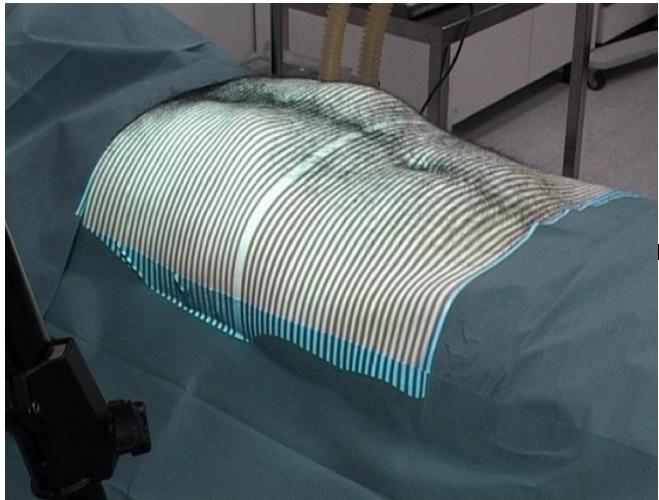
Robotic Liver Surgery, AR-Surg©IRCAD

Réalité Augmentée Automatique

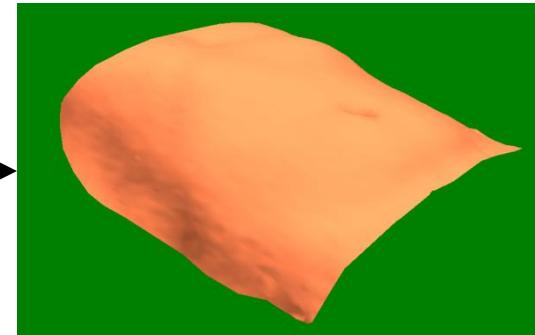


Application à la chirurgie hybride transluminale

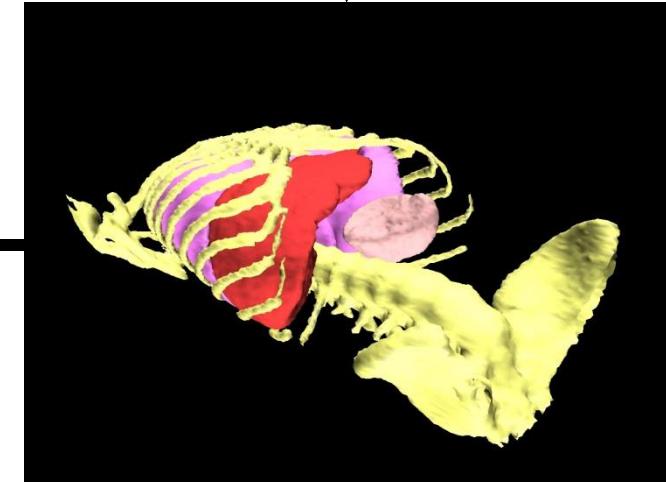
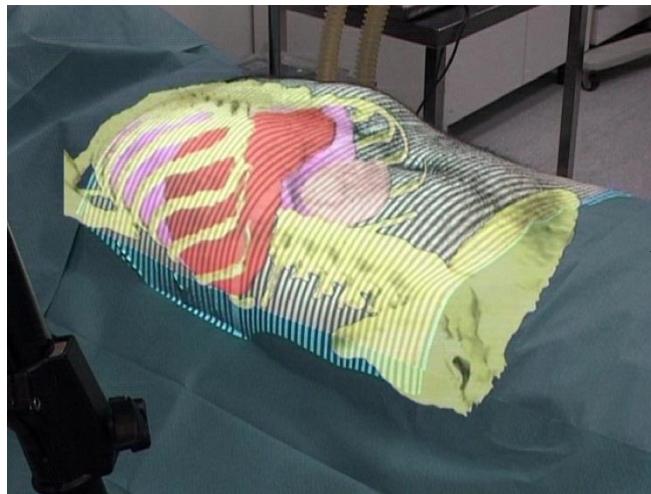
Réalité Augmentée Automatique



Filtrage des mouvements
respiratoire

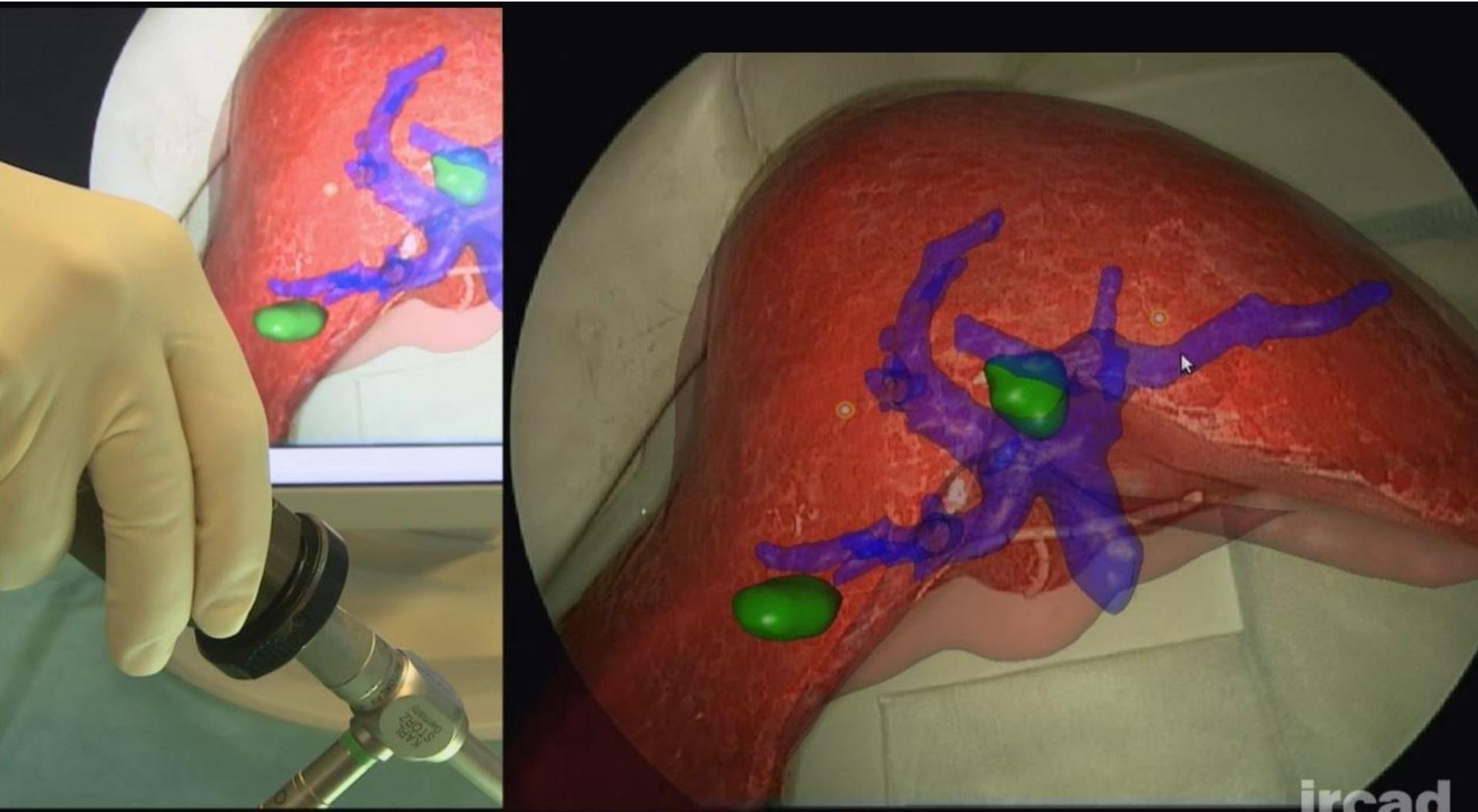


Recallage
automatique



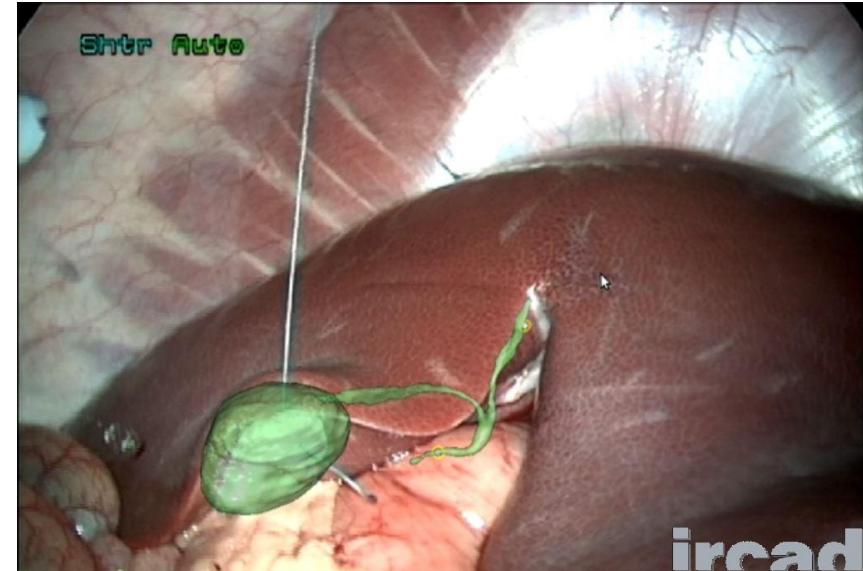
Liver : 2 mm accuracy / Kidney : 1.3 mm accuracy

Réalité Augmentée Automatique



Suivie automatique des mouvements internes

Réalité Augmentée Automatique

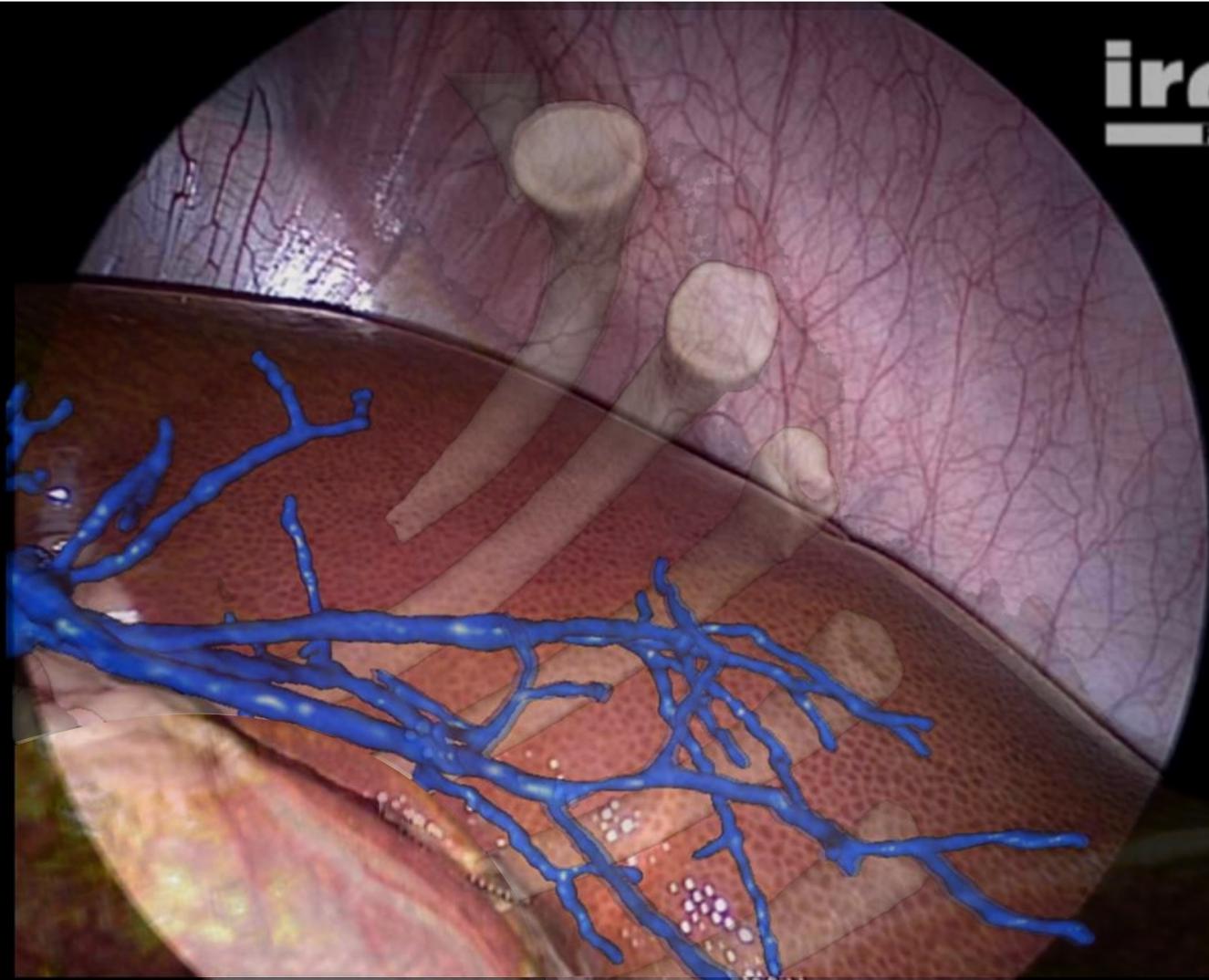


Suivie automatique des mouvements internes

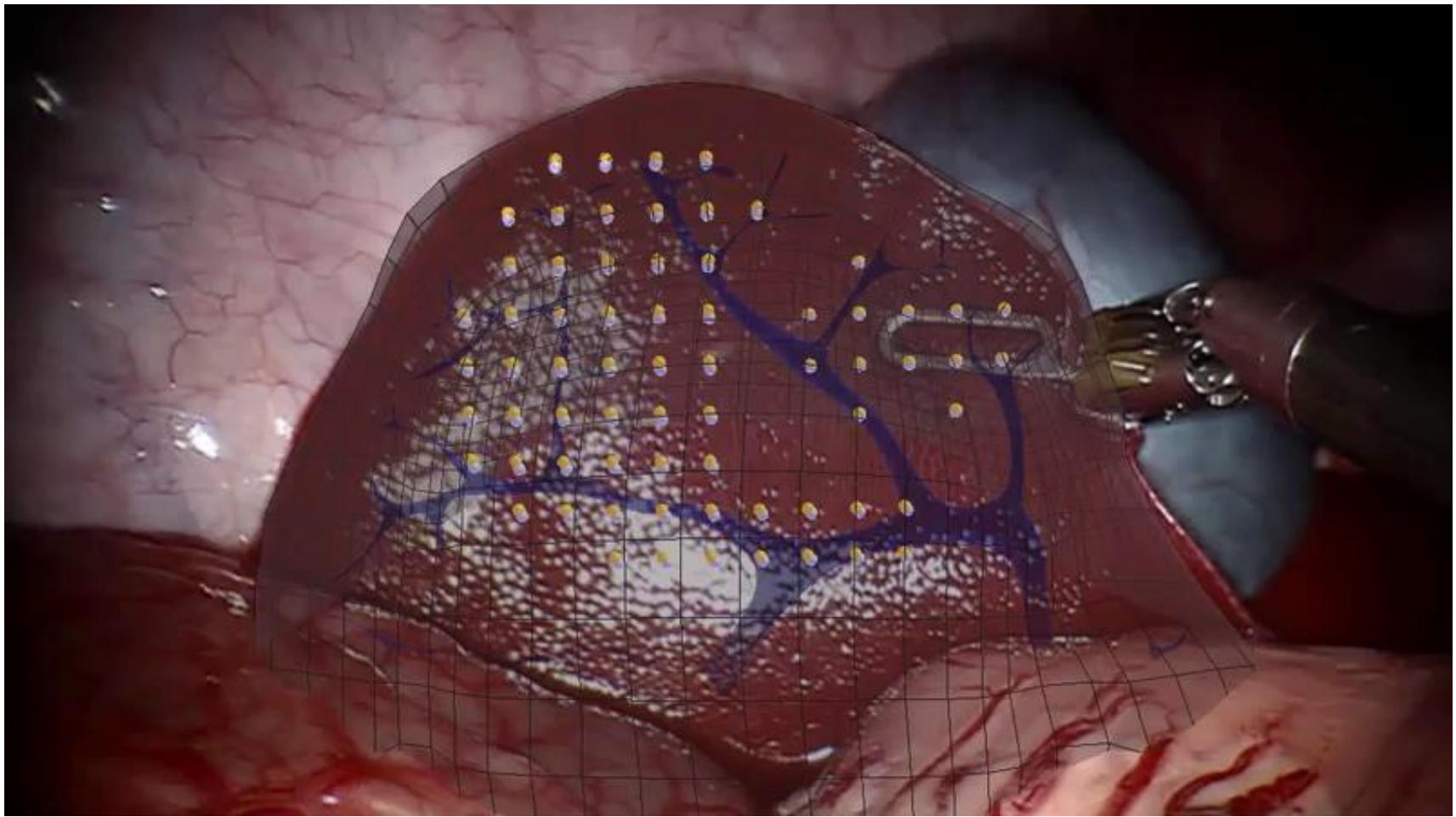
Recallage automatique

ihu
STRASBOURG

ircad
France



Déformation des organes



INRIA Shacra team of Stéphane Cotin

Future

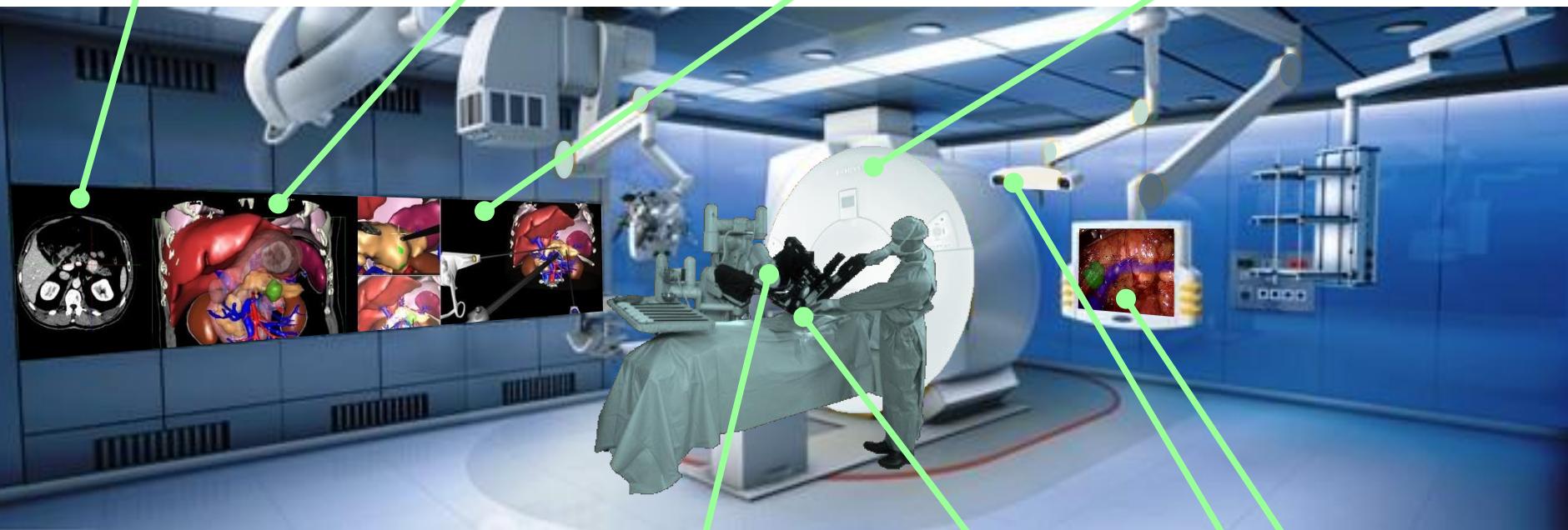
Databank : Digital & Biological Material

Pre-operative
Medical Imaging

Digital Patient
Modelling

Surgical Planning
& Simulation

Intra-operative
Medical Imaging



Education
& Network

Robotics &
Automation

New Surgical
Devices

Tracking &
Augmented reality

Système d'affichage de demain

Temps de latence minimal requis !!!



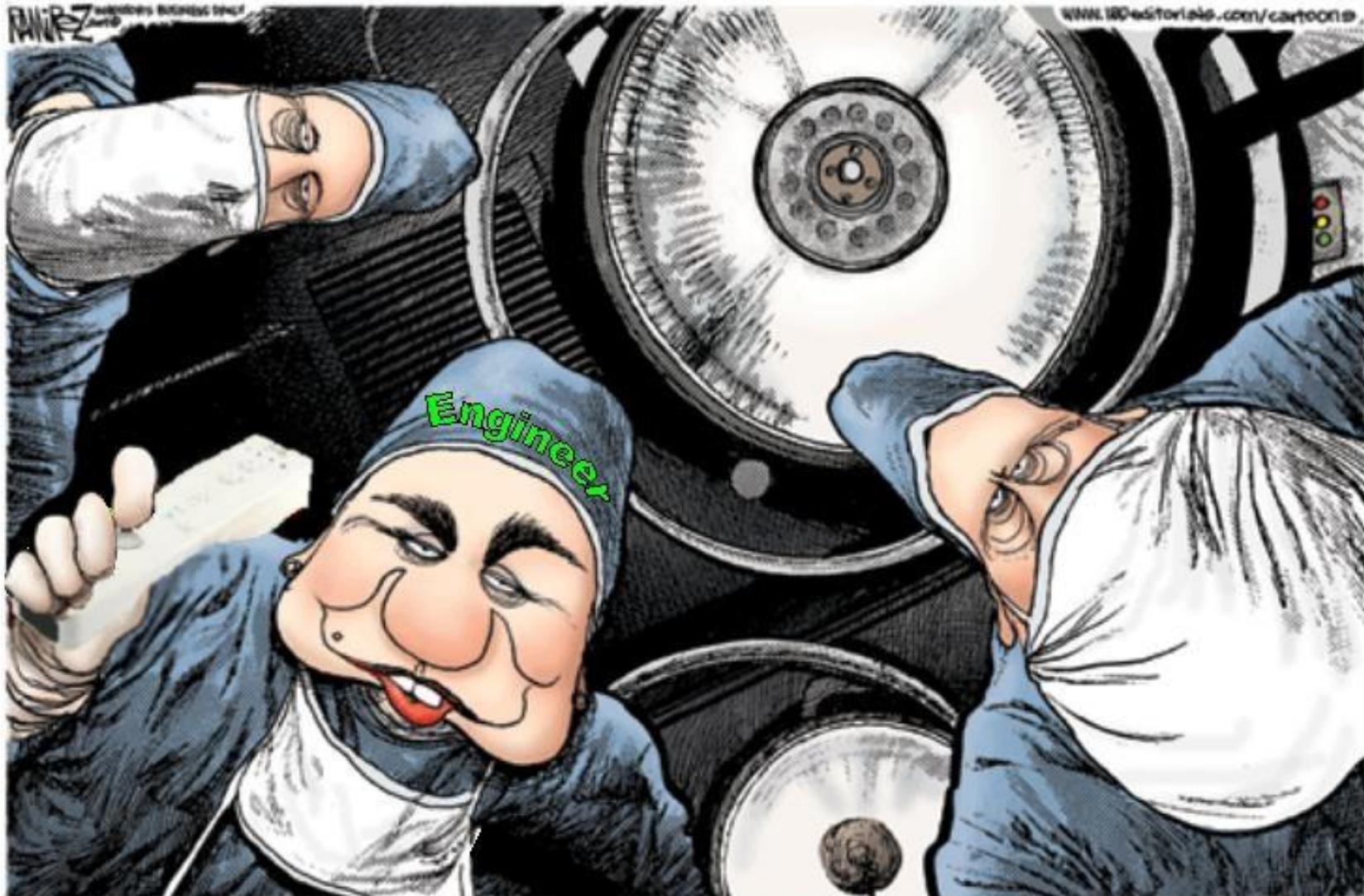
Optinvent



Laste Technology

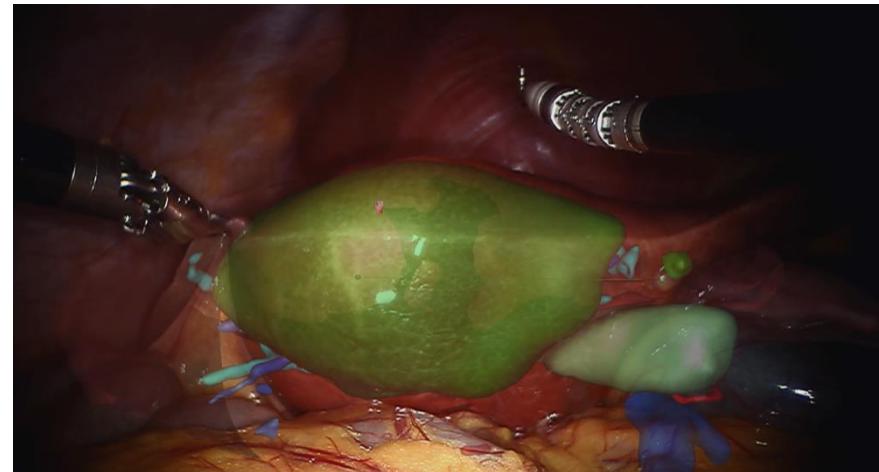
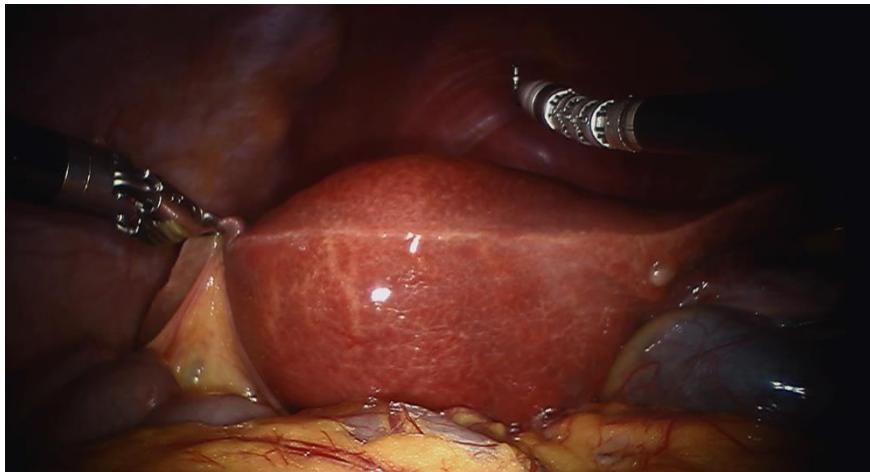
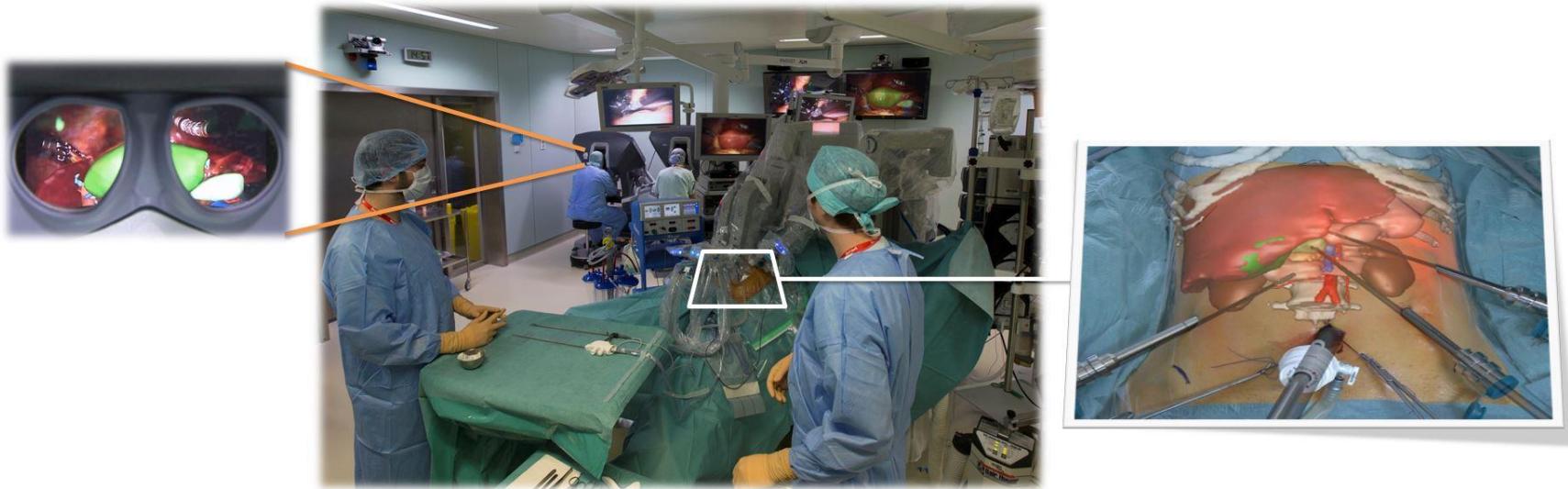
Lunettes de Réalité Augmentée

Le chirurgien de demain



Ne vous inquiétez pas, j'ai de l'expérience. Je ne suis pas chirurgien, mais je travaille avec un depuis plus de 15 ans.

Robotique + Réalité Augmentée



Robotic Liver Surgery, AR-Surg©IRCAD