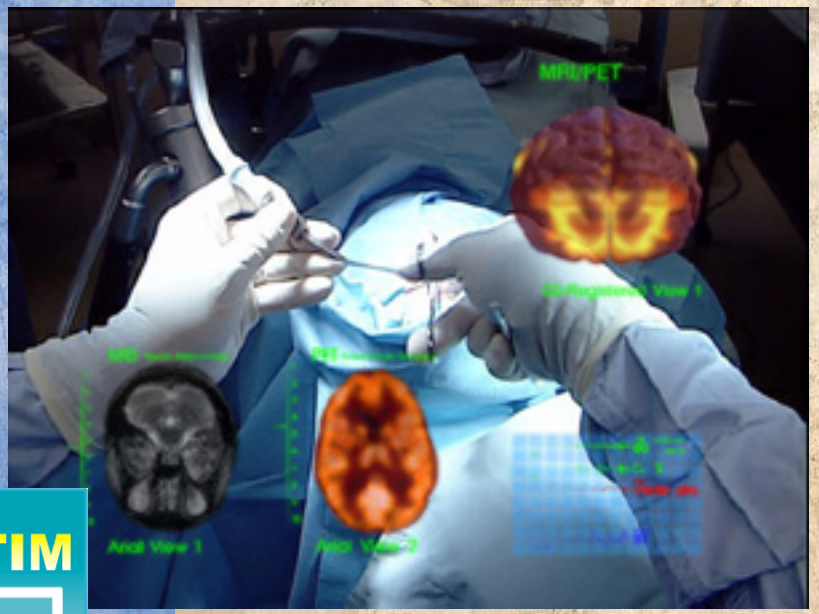
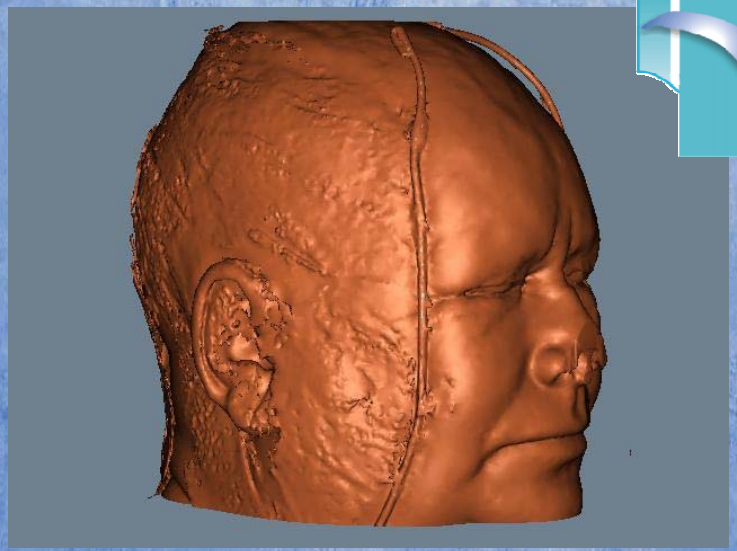
| Computer Assisted Orthopaedic Surgery |



L@TIM



université de bretagne occidentale

Eric STINDEL, M.D. Ph.D.

| Computer Assisted Orthopaedic Surgery |

Introduction

History

Basics

TKA

HTO

ACL

THA

Conclusion

Introduction

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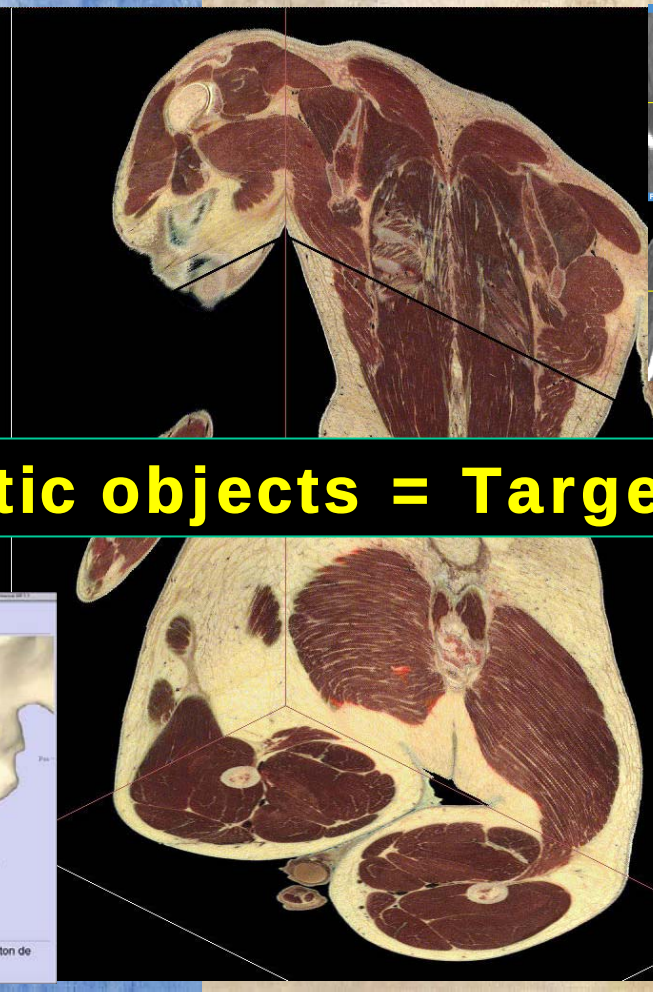
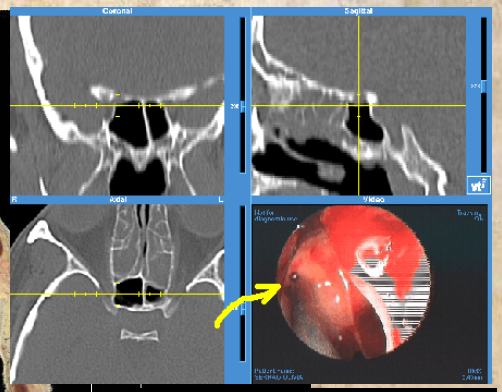
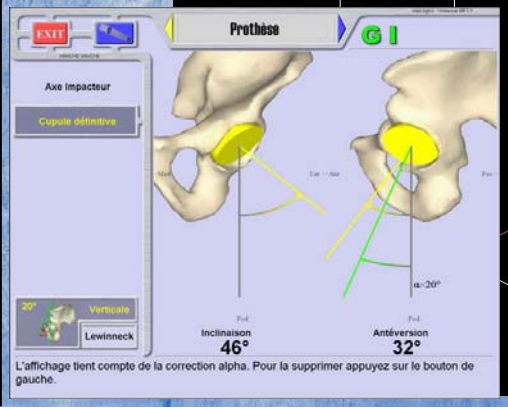
« Perform 3D actions in a 3D space on a 3D Object: a human being »





Therapeutic objects = Targets



| Computer Assisted Orthopaedic Surgery |

History

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Neurosurgery

Frame based Stereotaxy : Clarke et Horsley - 1806

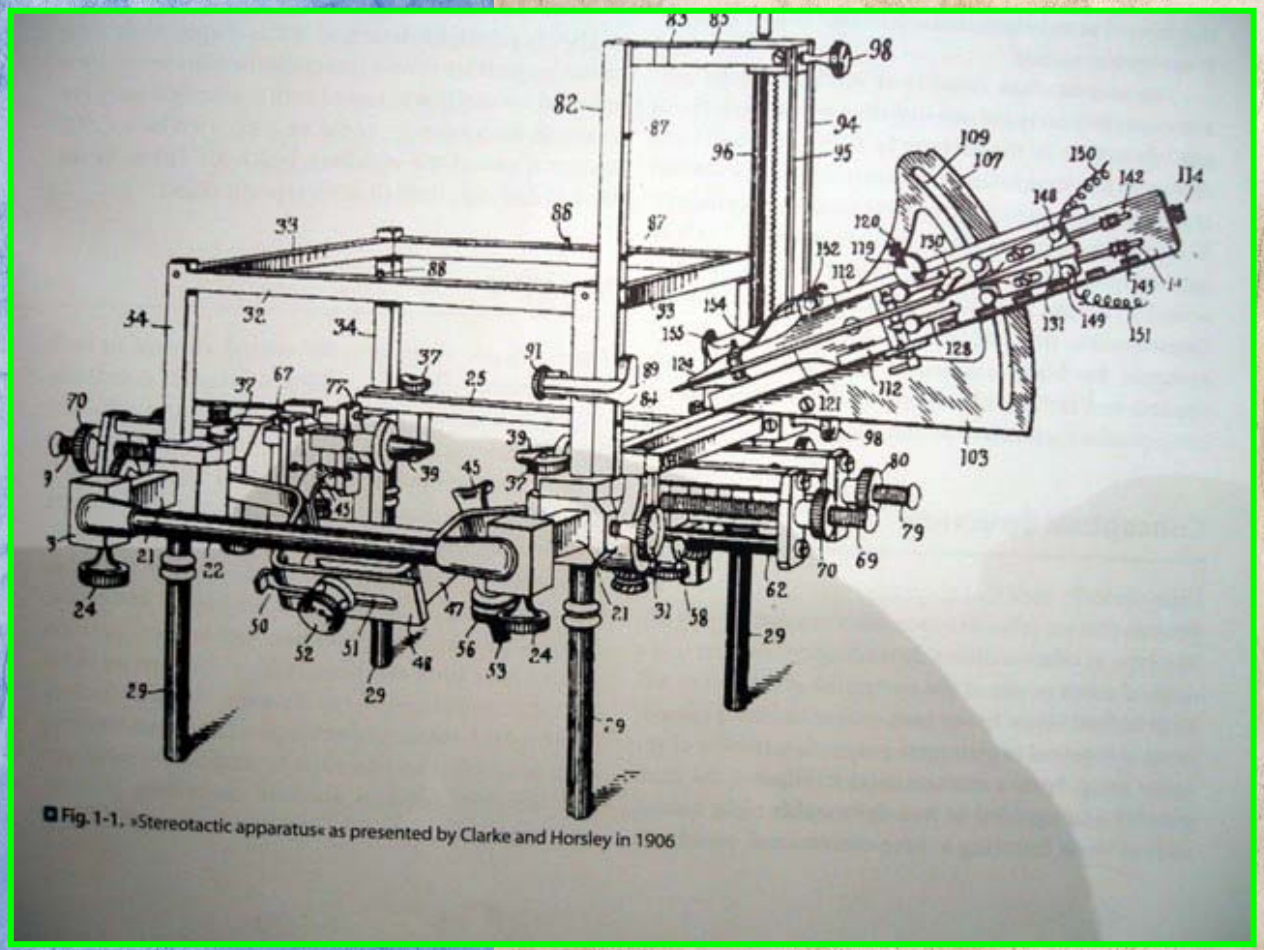

Fig. 1-1. »Stereotactic apparatus« as presented by Clarke and Horsley in 1906

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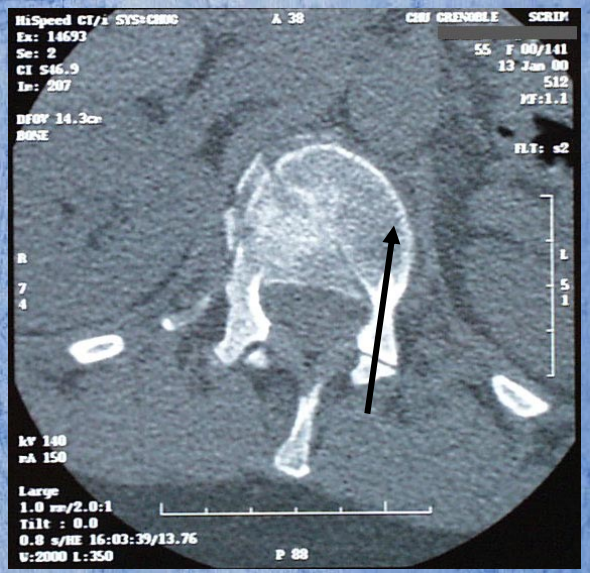
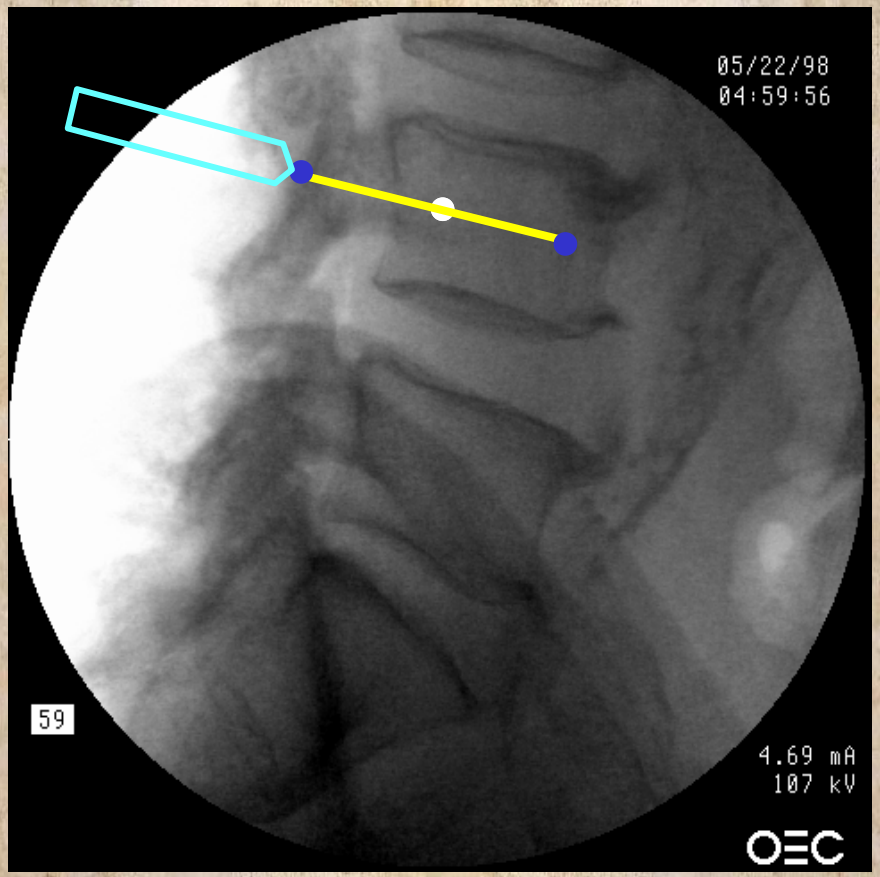
1990 1995 2000

Spine Surgery

Pedicular screwing





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1990 1995 2000

Robots for Hip

First generation : ROBODOC and CASPAR

Femoral drilling

Out of business

Cost

Invasiveness

No added value

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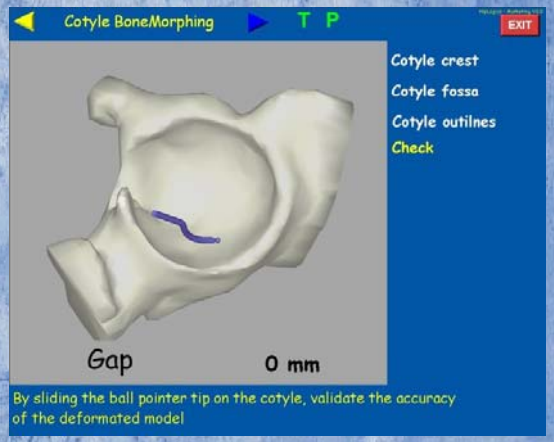
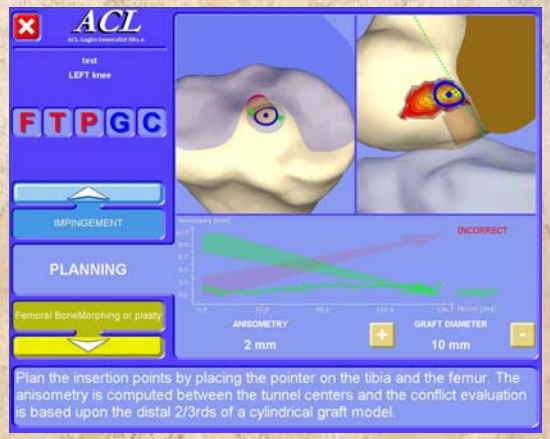
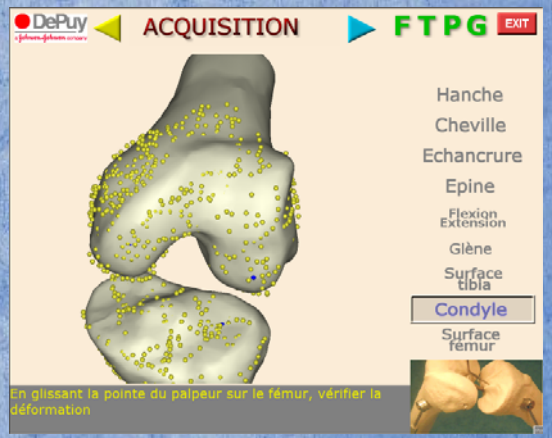
1990 1995 2000

Orthopaedic Surgery







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Basics

The Perception – Decision – Action loop

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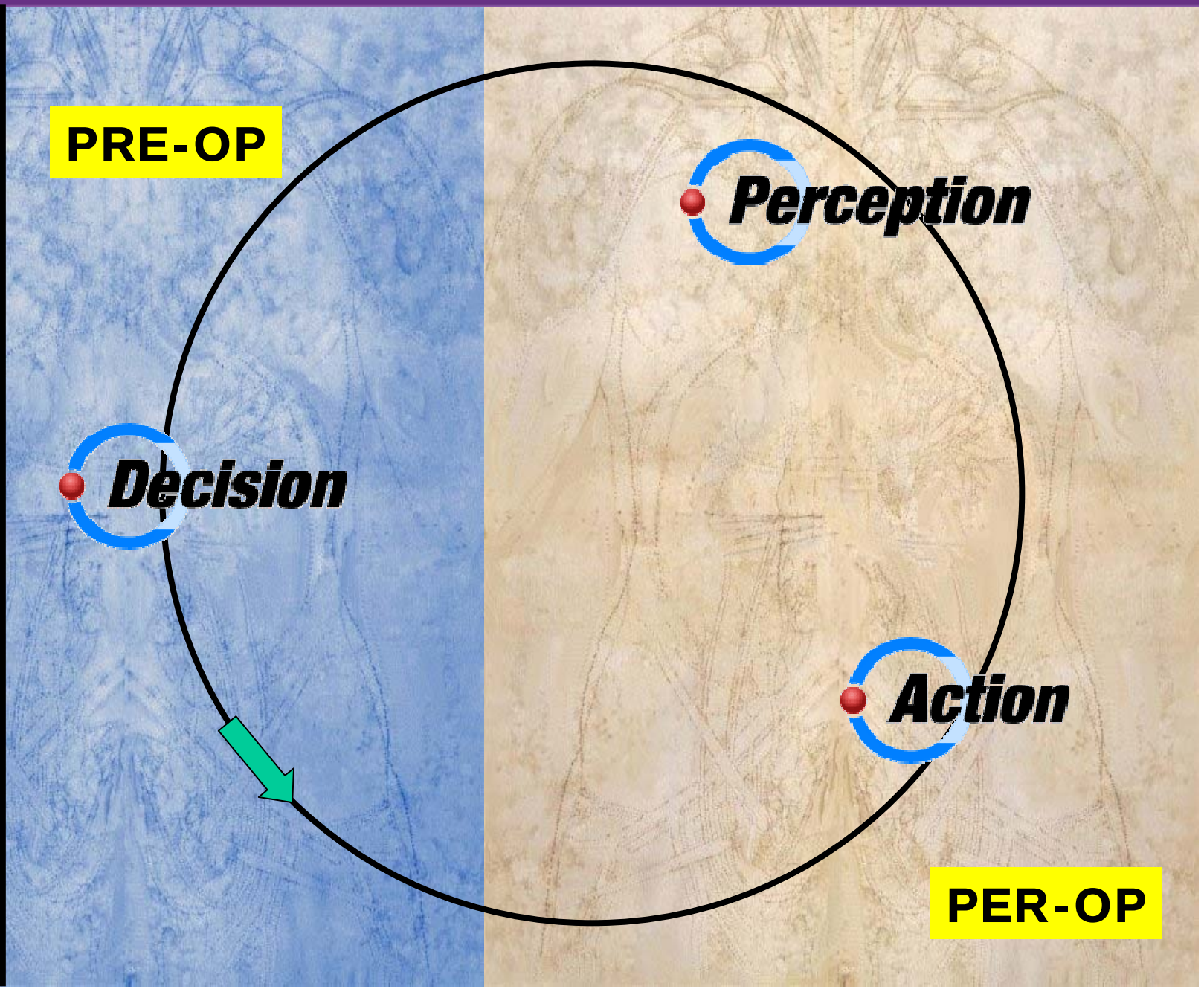

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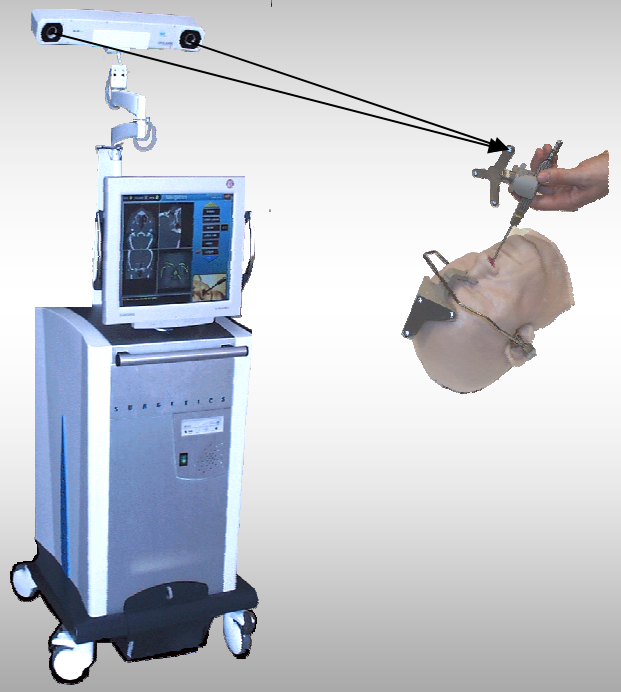
Action

PASSIVE SYSTEMS
Navigation systems

Guiding systems



3D localizers

Real-time feed back on the location of :

-Therapeutic objects

- Surgical instruments

| Computer Assisted Orthopaedic Surgery |

Action

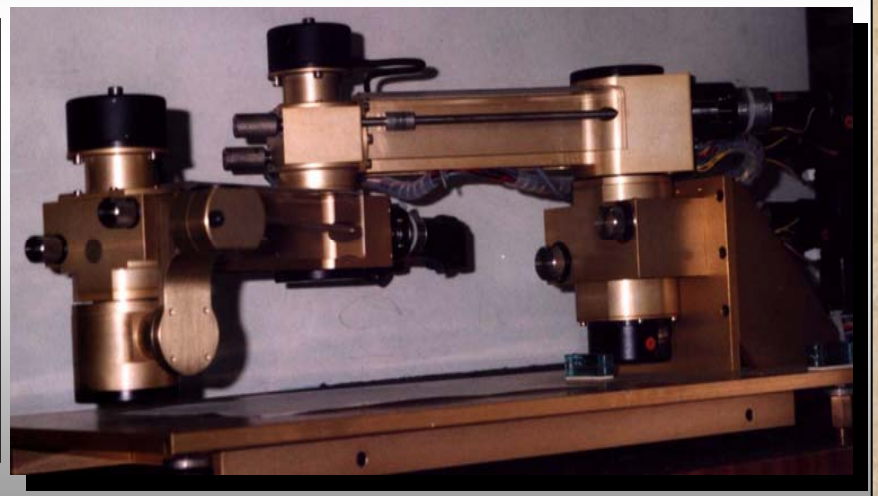
Guiding systems → **SEMI-ACTIVE SYSTEMS**
The surgeon is guided in a restricted volume

Padyc

Synergistic robots

Collaborative robots

Impeachment robots



http://www-timc.imag.fr/

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Action

ACTIVE SYSTEMS
Active robots which performs
Part of the surgical procedure

Guiding systems

Active robots

Perform parts of the procedure

Based on per-op planning

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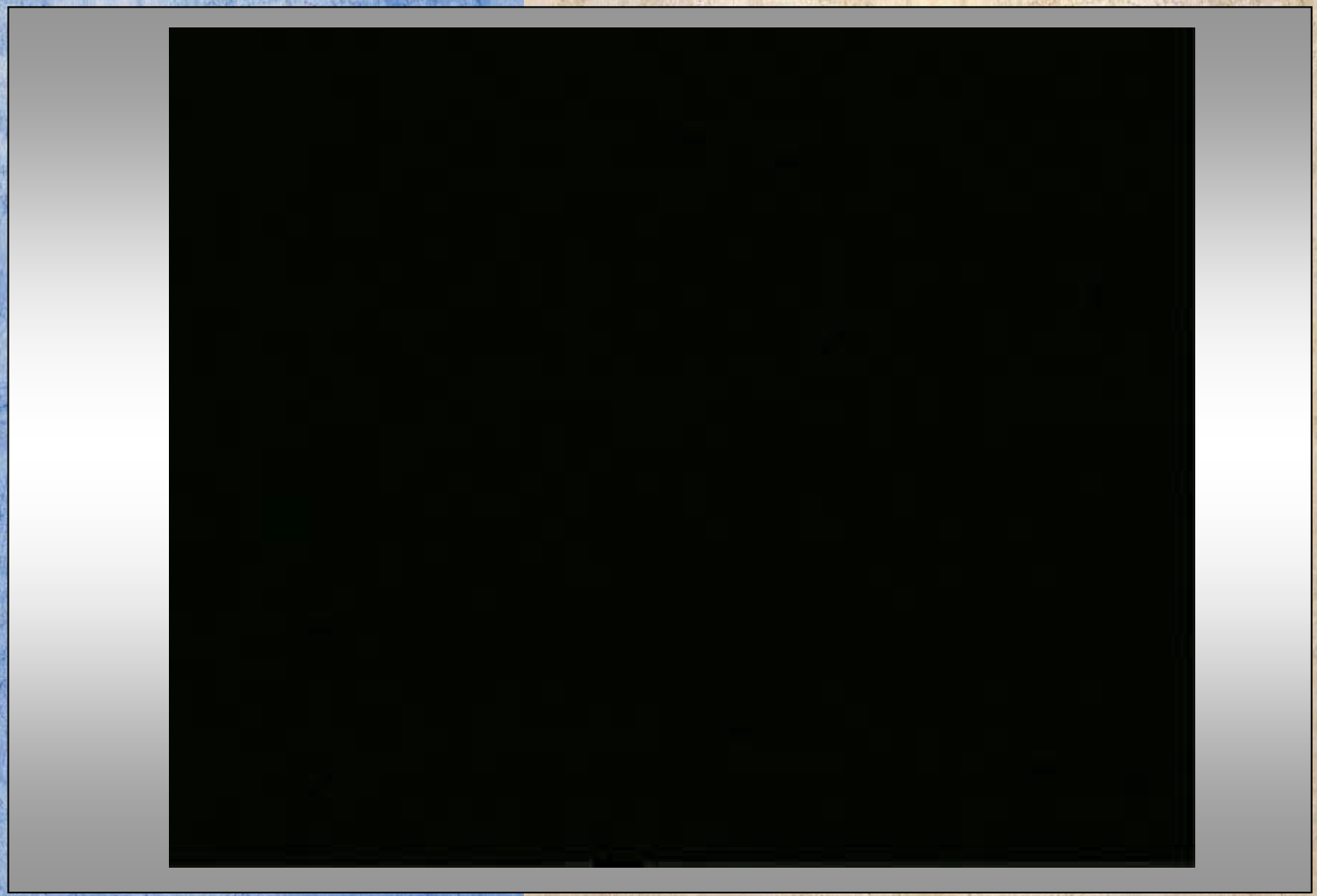

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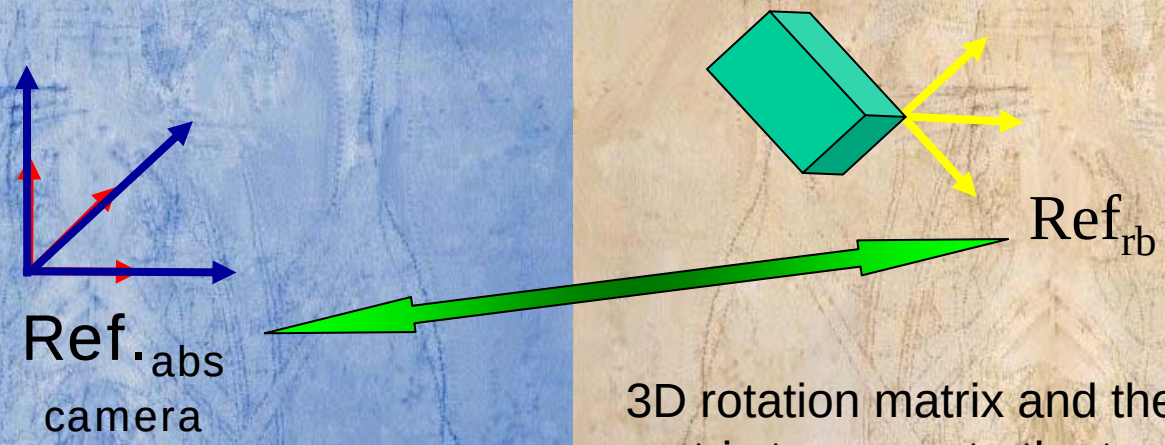
3D Localizers

Localization : non deformable Objects

- Bones or surgical tools
  - Location
  - Orientation



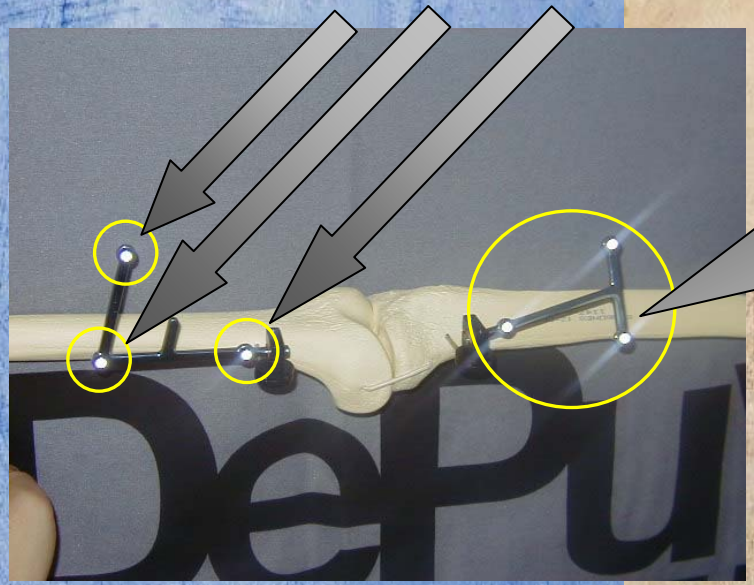
3D rotation matrix and the translation matrix to compute the transformation from Ref_{abs} to Ref_{rb}

3D Localizers

Non deformable Objects

- Bony structures : therapeutic objects
- Surgical tools

- **Dynamic reference base** (DRB)

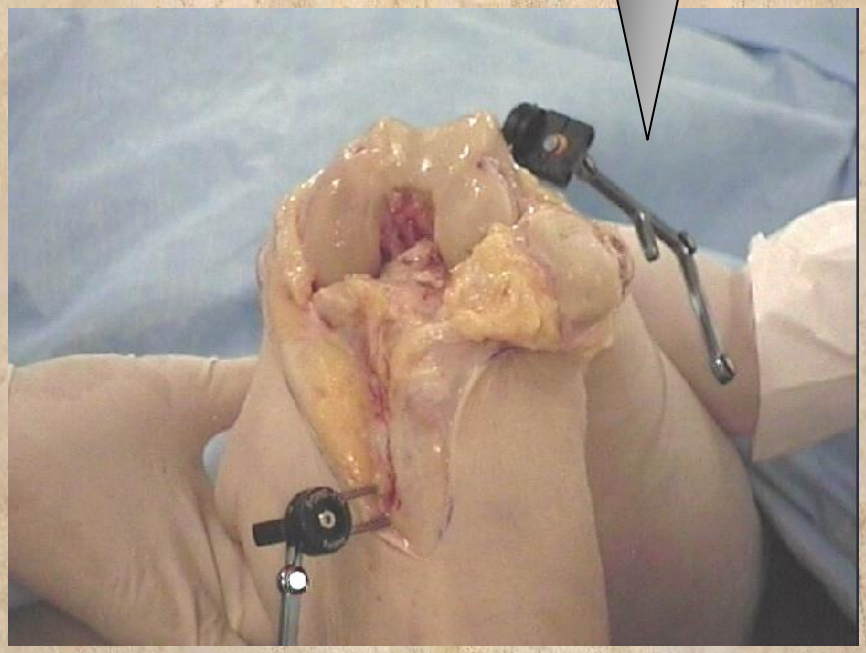


3D Localizers

Non deformable Objects

- DRB attached to :
  - Bony structures : therapeutic objects
  - Surgical tools

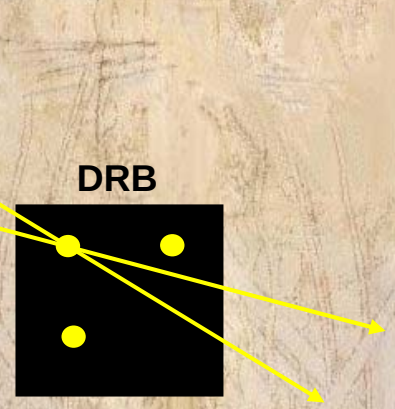
- **Dynamic reference base** (DRB)



3D Localizers

Localizer = 1 Source + 1 Sensor

- Optical localizer with two 2 Dimensional sensors



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3D Localizers

Localizer = 1 Source + 1 Sensor

- Polaris :

POLARIS® - Technical Specifications

Accuracy	
0.35 mm 3D RMS(1)	
Workstation Interface	
Interface	RS-232/422
Max. Data Rate	115 kBaud
Position Sensor	
Weight	2 kg
Mounting	1/4" thread tripod mount
Dimensions	590 mm x 80 mm x 120 mm
enhanced Tool Interface Unit	
Weight	5 kg
Dimensions	320 mm x 130 mm x 300 mm
Power Requirements	
hybrid	100/120/220/240 V, 50/60 Hz, 2.5 A
passive	100-250 V, 50/60 Hz, 0.8 A
*Above weights and dimensions are approximate	

3D Localizers

Optical systems

- Infra-red sensors

Basics

Emitted by the DRB

Reflected by the DRB

Wave length **880 nm**

In the OR one can find
70 000 Lux
400 et 500 nm

3D Localizers

Optical systems

- Active systems

Active emission of light
= source of energy

Drawbacks

- Cables on the operating field
- Batteries
- Weight
- Sterilization issues

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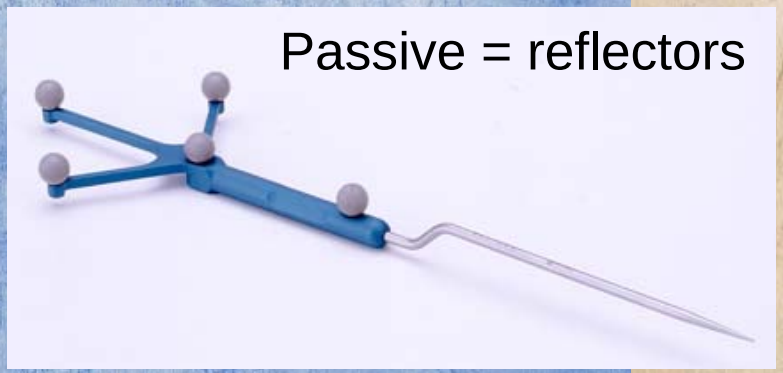
3D Localizers

Optical systems

- Passive system



Drawbacks

Single use

Sensitive to surrounding light

Pros

Cheap

Light

Can be set on any type of instrument

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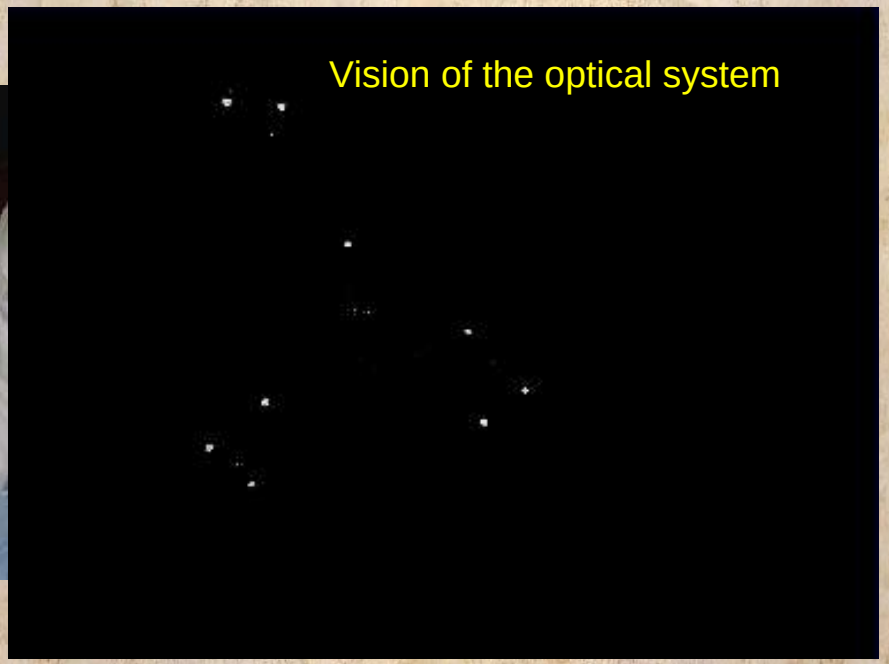
3D Localizers

Optical systems

- Vision of the camera

Surgical scene



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Application : TKA

40 000 TKA / Year / France

8 000 Uni / Year / France

The challenges

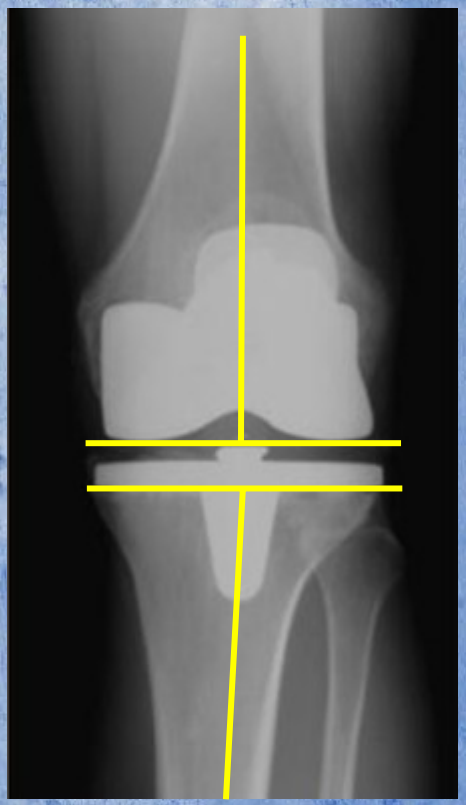
- The challenges : two faces

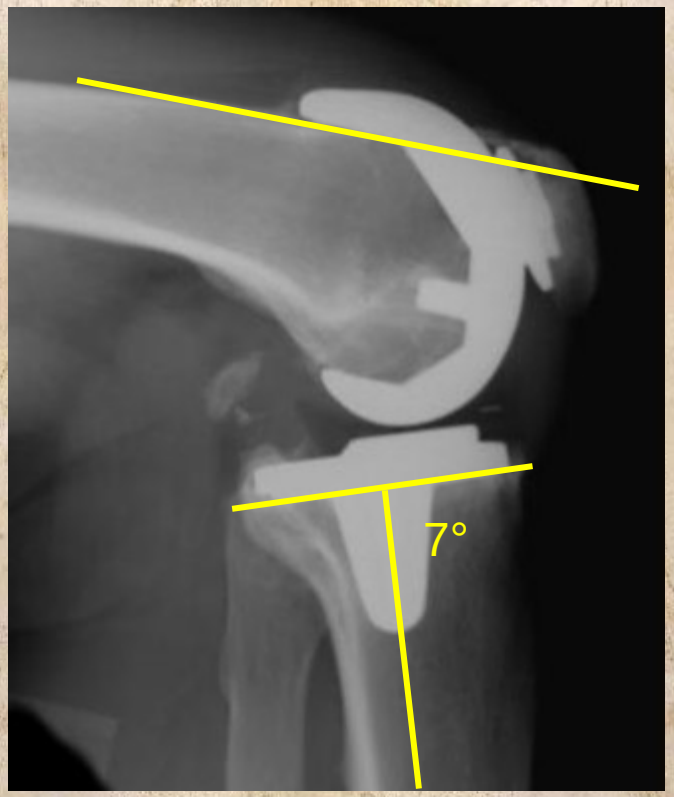
- Geometric challenge
  - Align the implants with respect to mechanical axes

- Functional challenge
  - Perform a good ligament balance
  - Enough mobility
  - Enough stability

The challenges

- The challenges : two faces
- Mechanical axes :





The challenges

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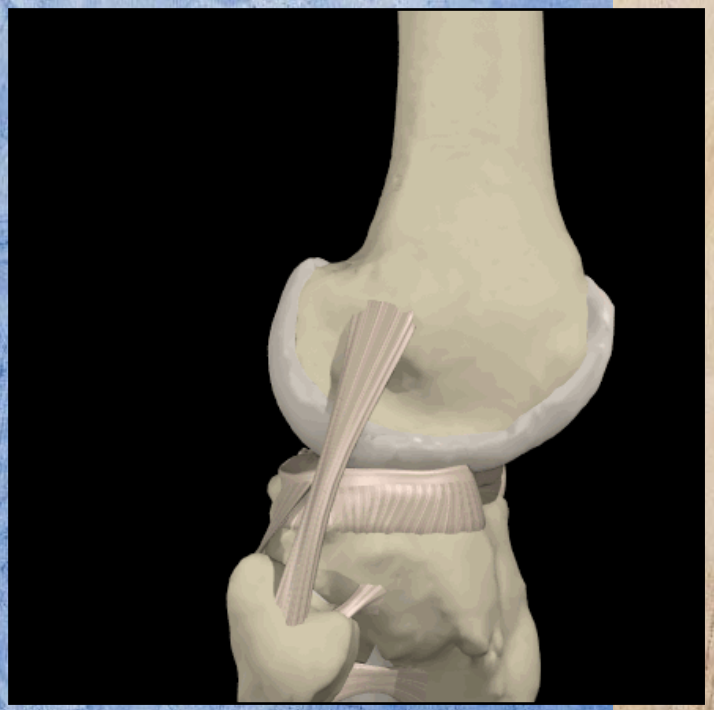
The challenges

- Functional challenge
- Ligament balancing



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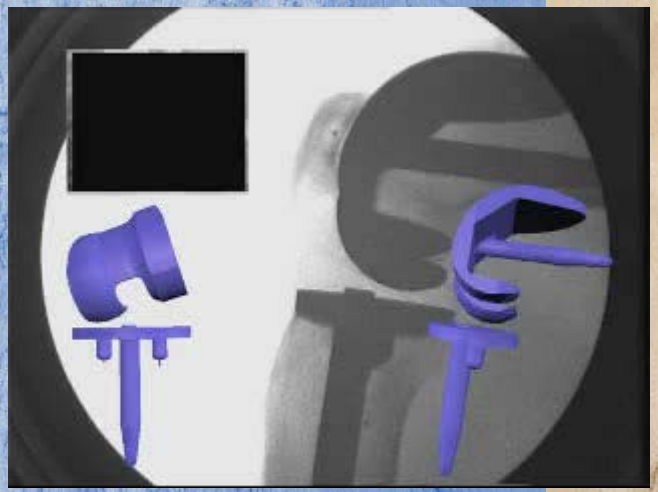
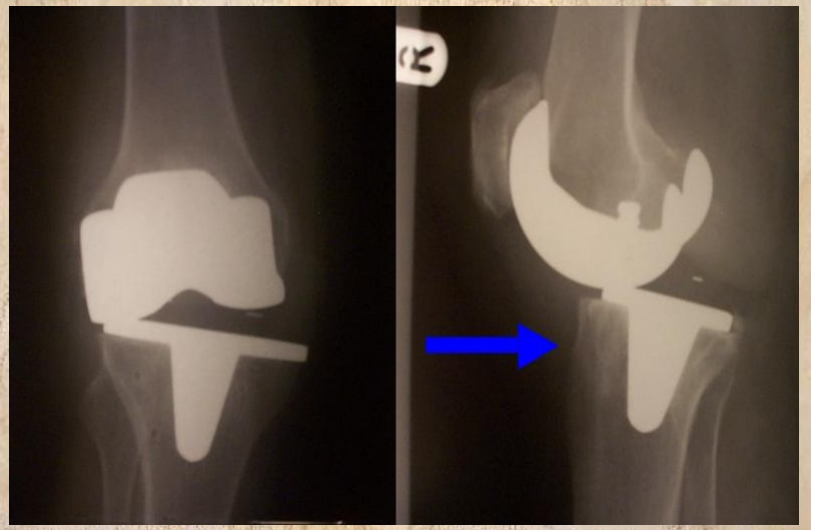
The challenges

- Functional challenge
- Ligament balancing



- Lift-off = wear



- Instability