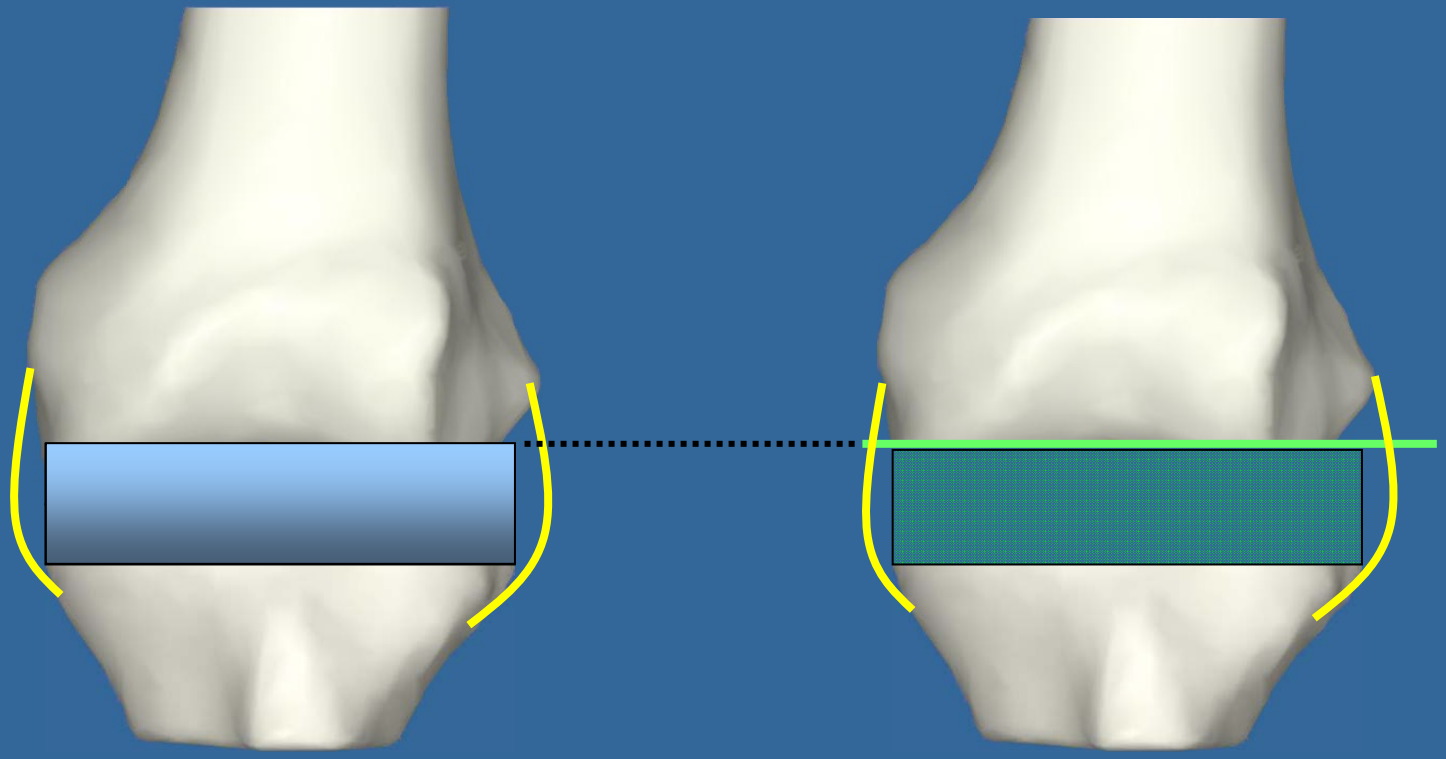
| Computer Assisted Orthopaedic Surgery |

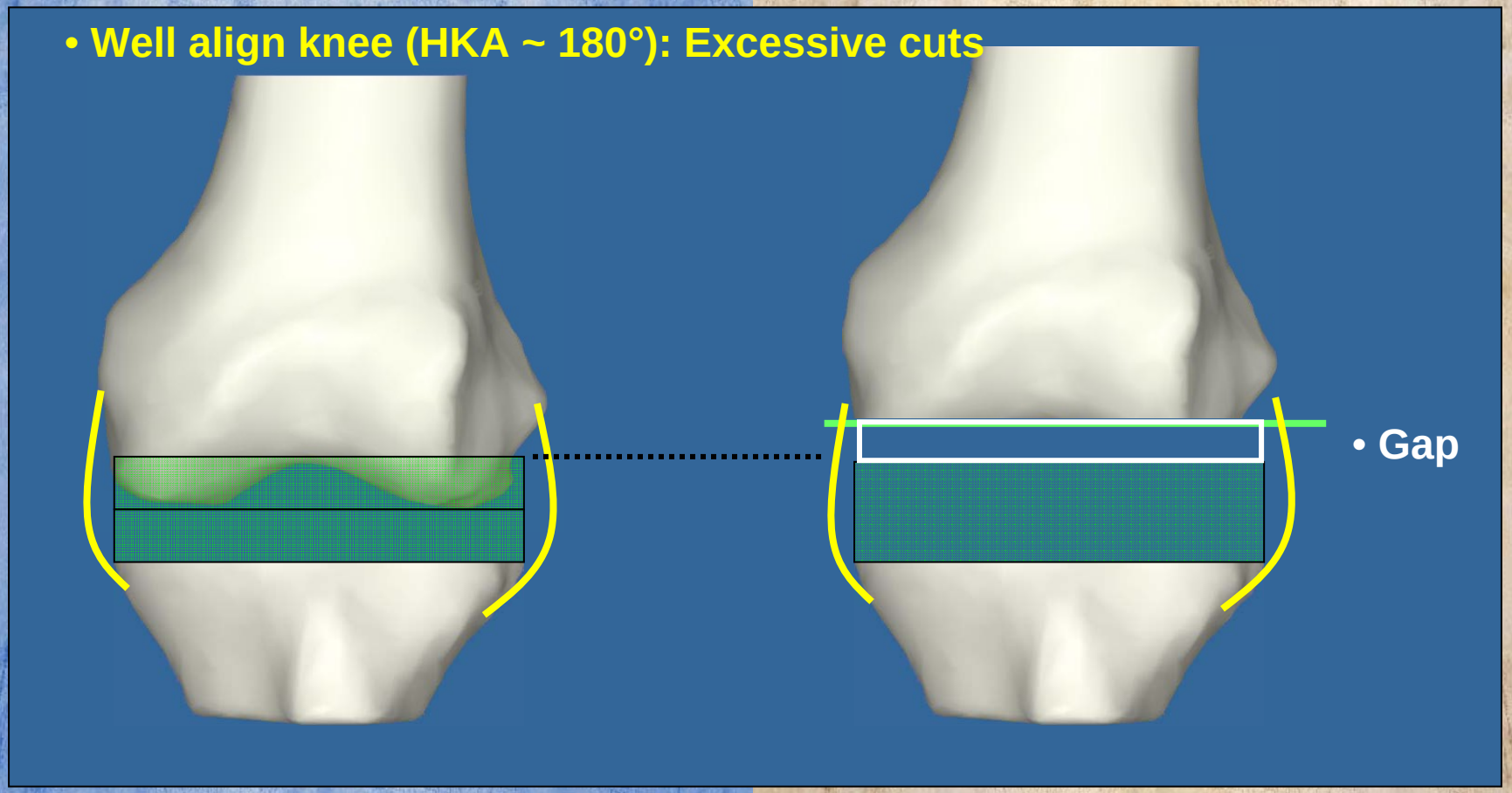
- Functional challenge
- Ligament balancing

- **Well align knee (HKA ~ 180°): Good cuts**



| Computer Assisted Orthopaedic Surgery |

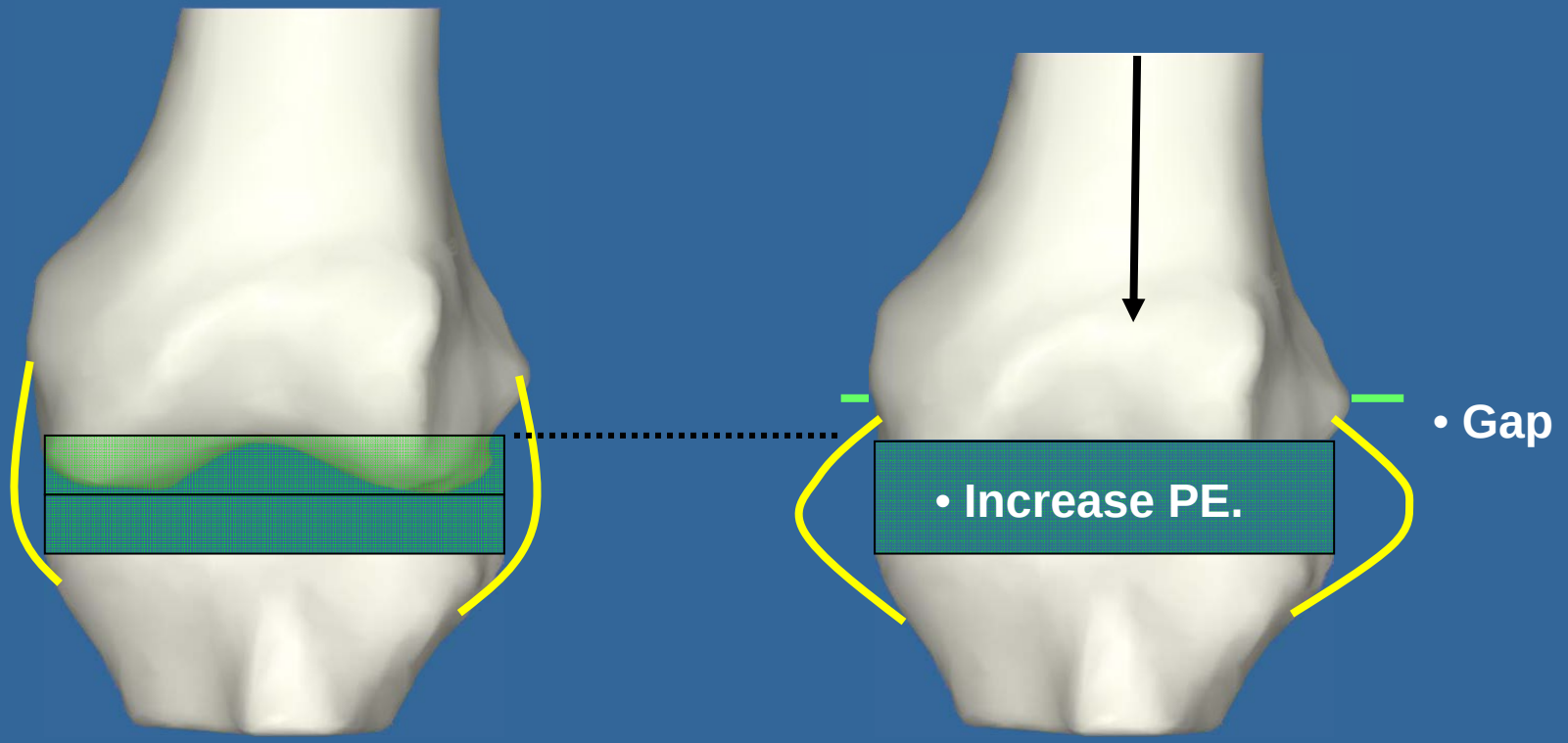
- Functional challenge
- Ligament balancing



| Computer Assisted Orthopaedic Surgery |

- Functional challenge
- Ligament balancing

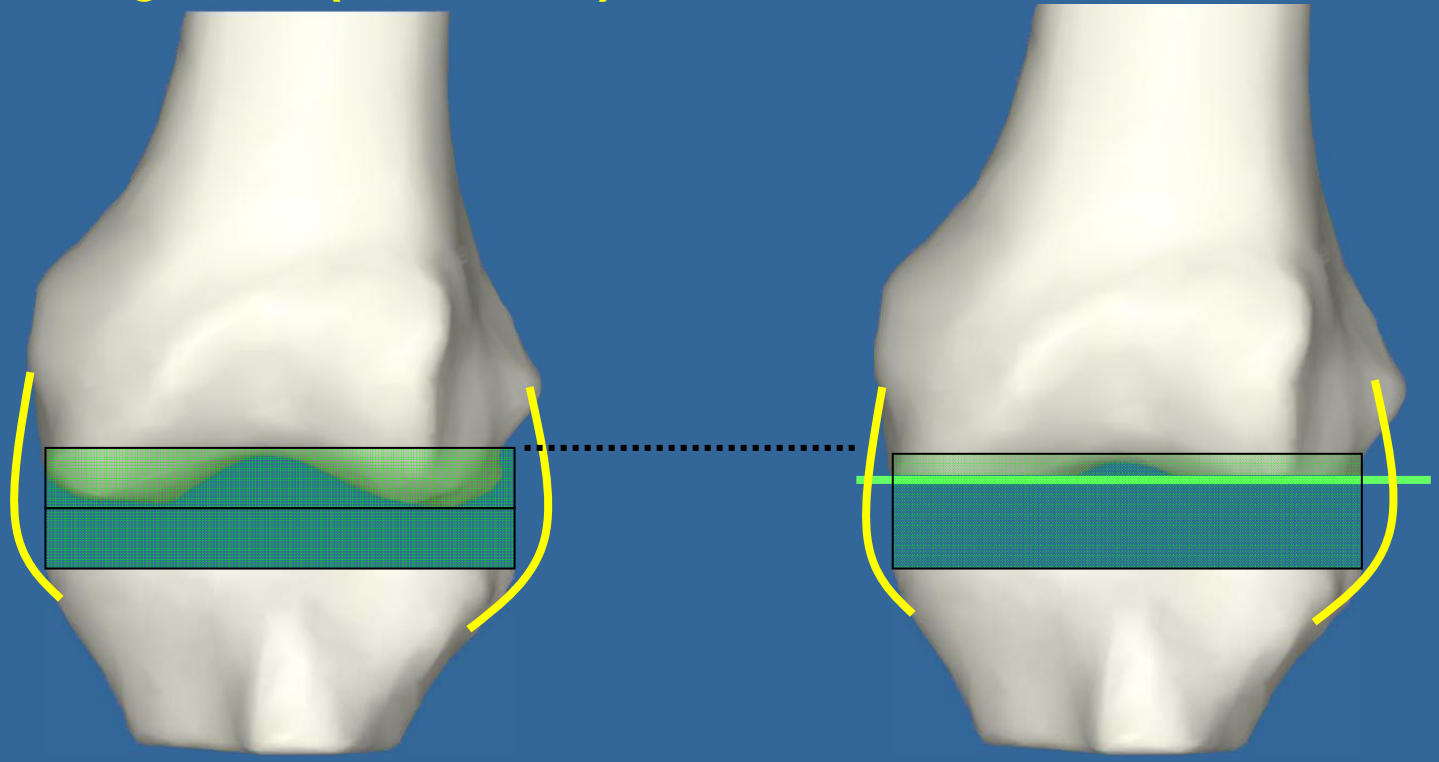
• Well align knee (HKA ~ 180°): Excessive cuts



| Computer Assisted Orthopaedic Surgery |

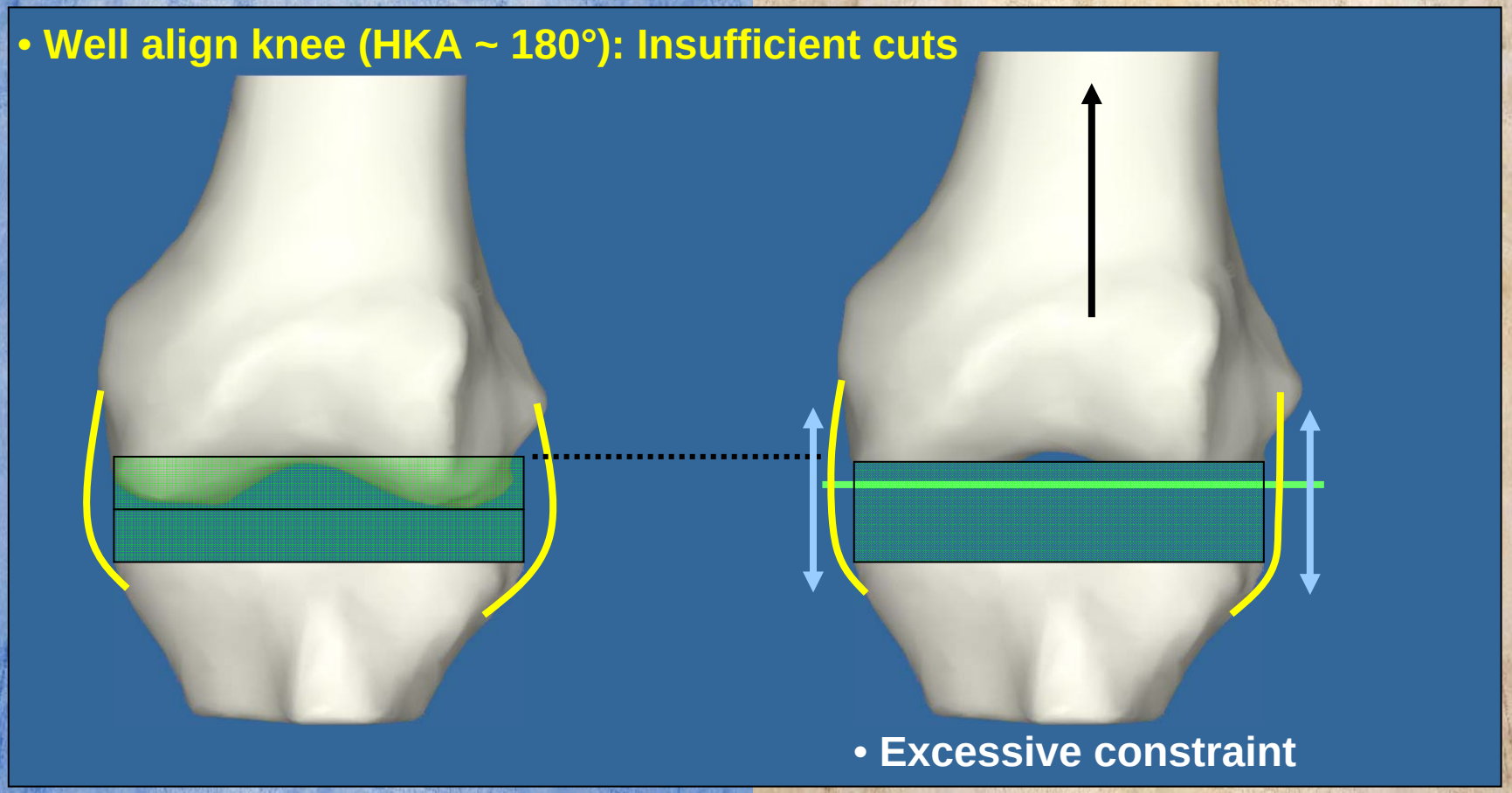
- Functional challenge
- Ligament balancing

• **Well align knee (HKA ~ 180°): Insufficient cuts**



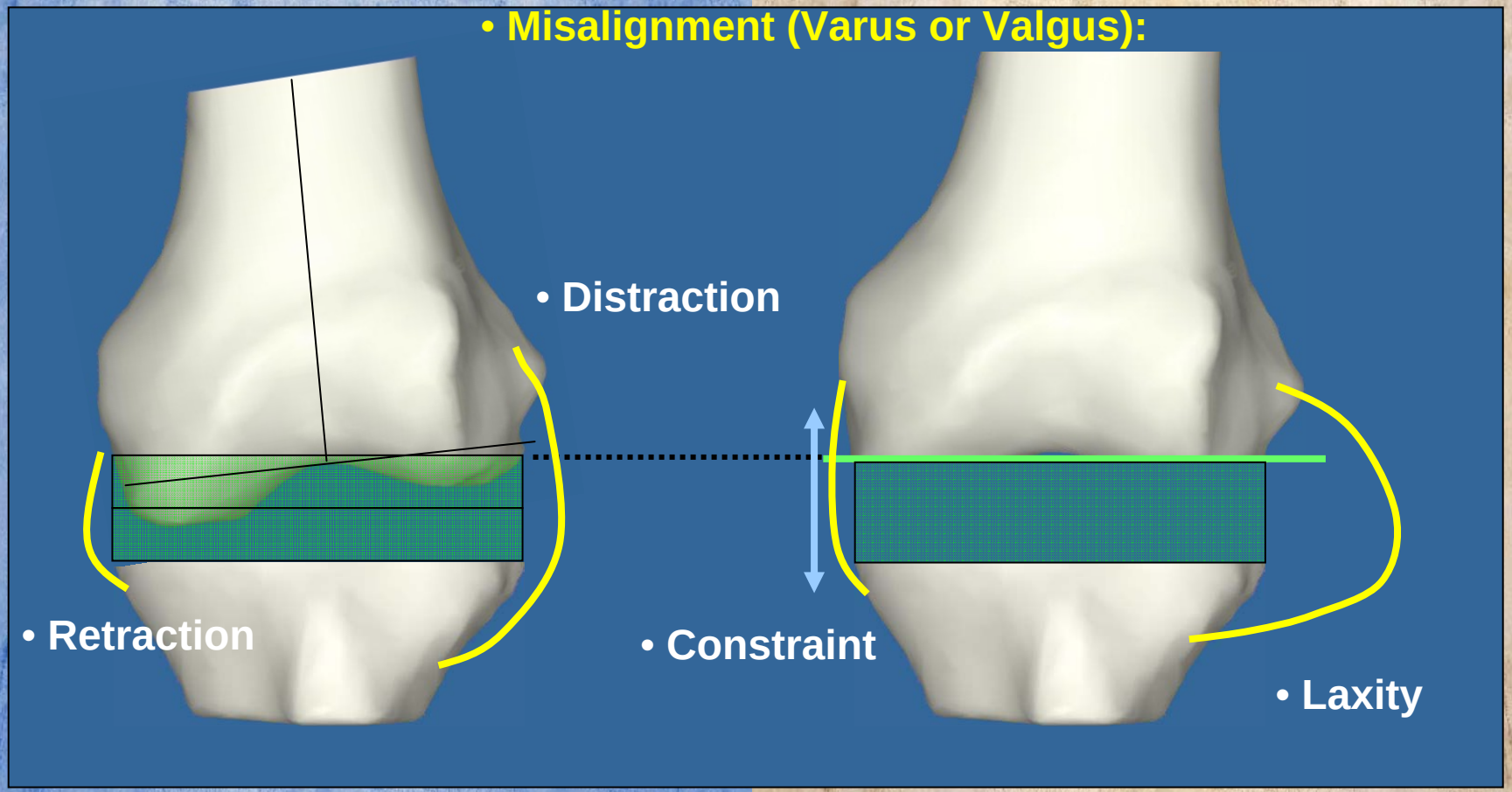
| Computer Assisted Orthopaedic Surgery |

- Functional challenge
- Ligament balancing



| Computer Assisted Orthopaedic Surgery |

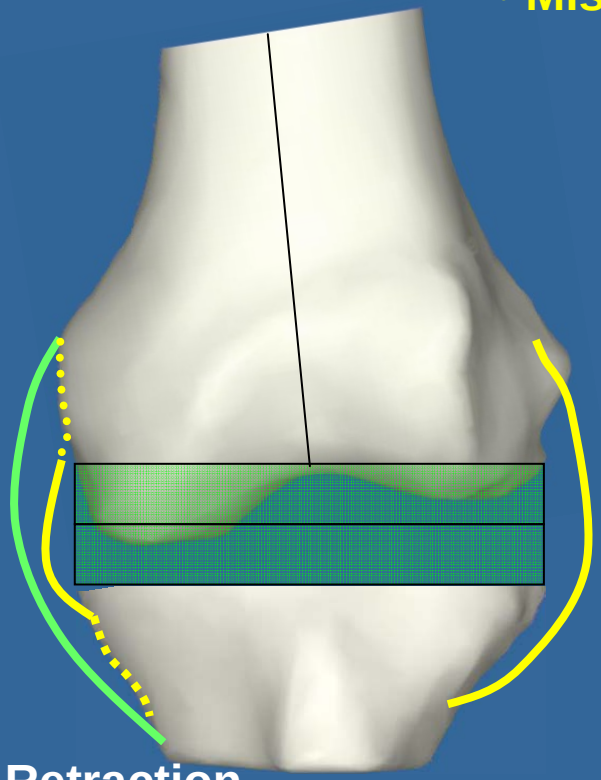
- Functional challenge
- Ligament balancing



| Computer Assisted Orthopaedic Surgery |

- Functional challenge
- Ligament balancing

• **Misalignment (Varus or Valgus):**

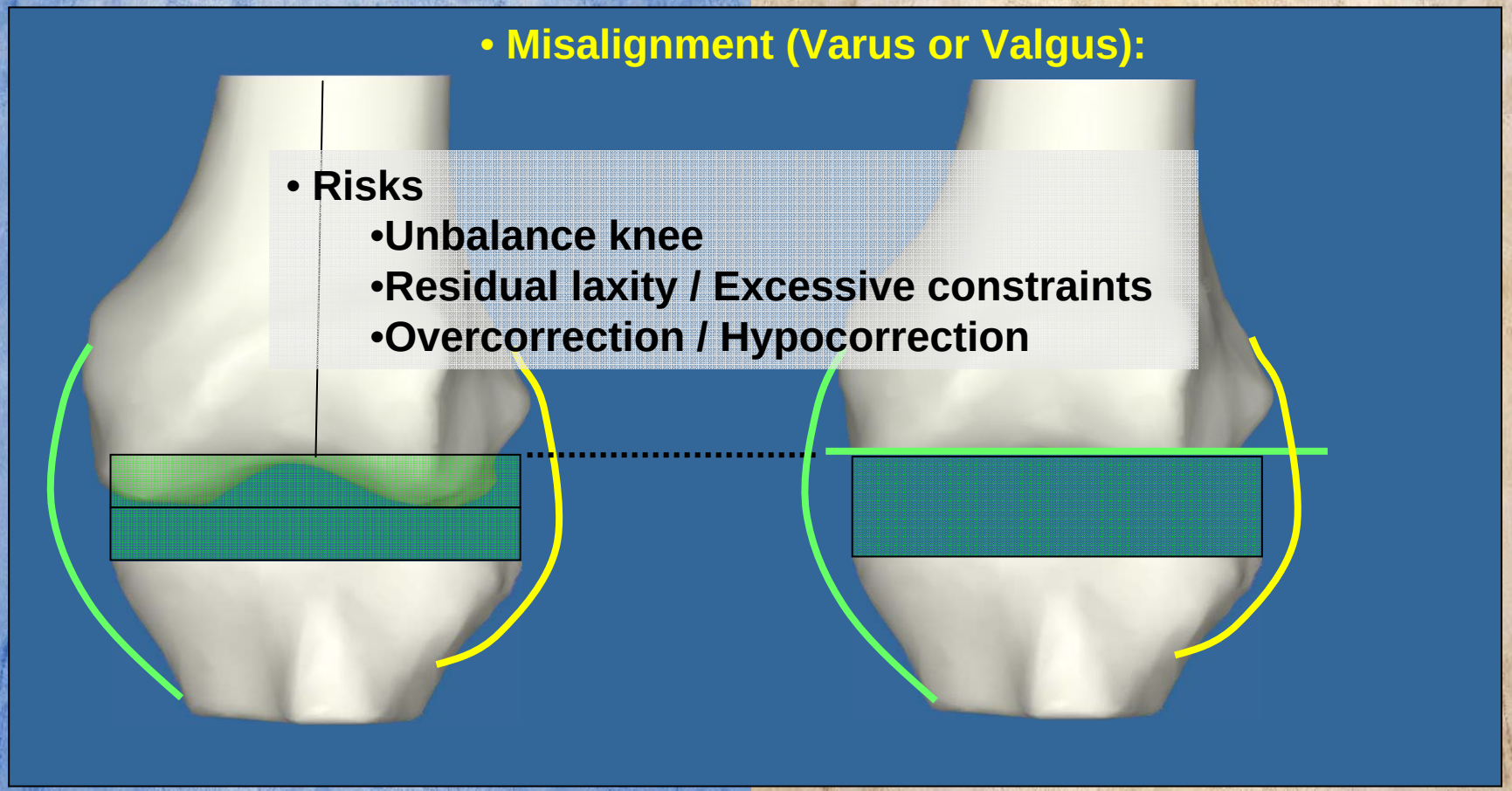


• **Retraction**

• **Release**

| Computer Assisted Orthopaedic Surgery |

- Functional challenge
- Ligament balancing



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Application : TKA

The solutions

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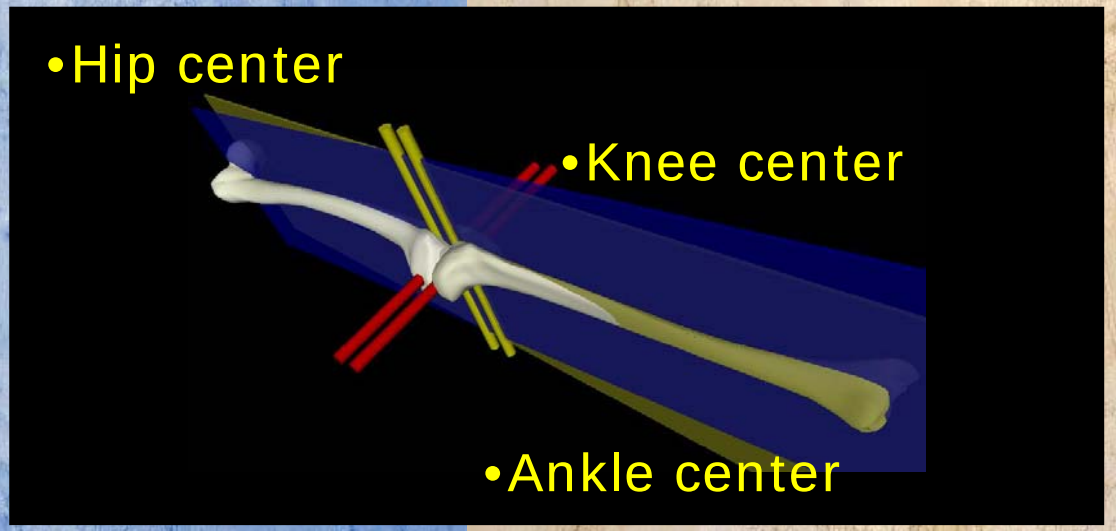
The solutions

Build a **SPECIFIC** model of the patient under surgery

- Build the specific GEOMETRY of this patient
- Align the prosthesis with respect to the patient axes



- Localize **in 3D** the joint centers
- Build reference planes

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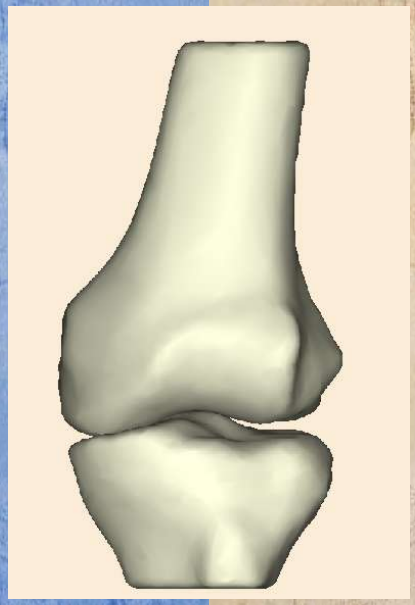
The solutions

Build a **SPECIFIC** model of the patient under surgery

- Build the specific MORPHOLOGY of this patient

Local adjustment to the bones
Ligament balance can only be made with local data



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The solutions

Pros and Cons

- CT based approach
  - Pre-operative planning
  - Cost – Radio protection issues
  - Archiving and communication of images : PACS
  - No increasing time for acquisition and planning
- CT including Hip – Knee - Ankle
- Setup time
- Intra-operative registration (time consuming/accuracy issues)

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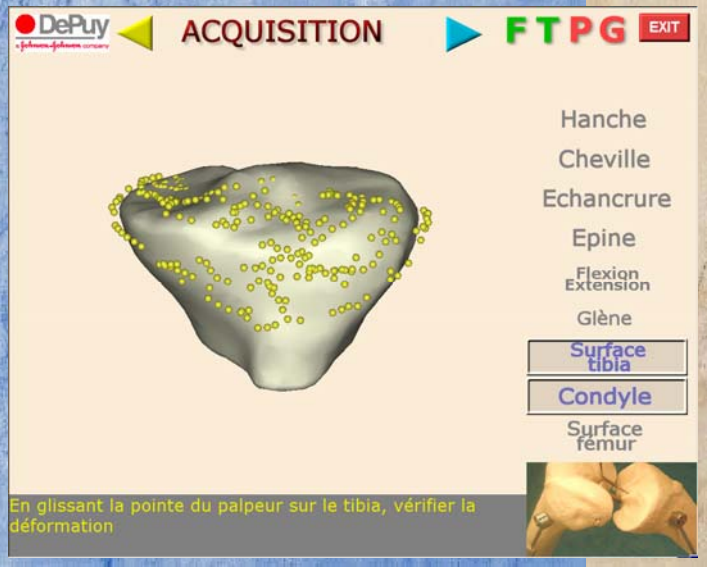
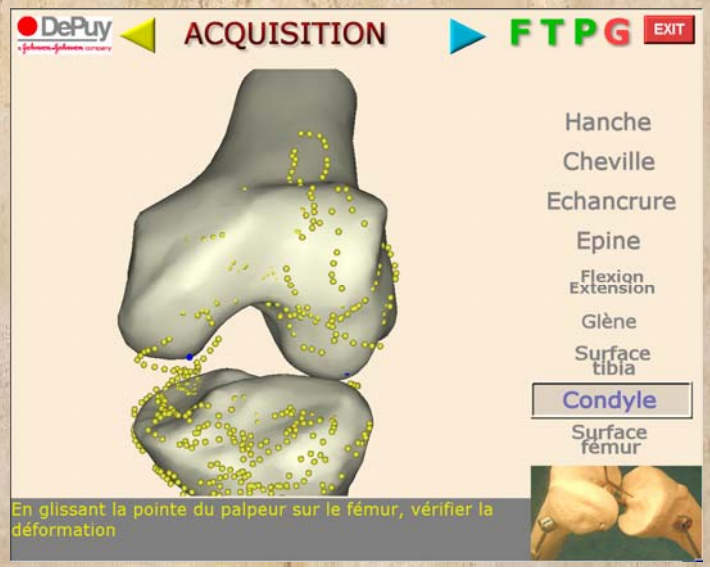
The solutions

Pros and Cons

- **Non image based system**
  - Simple
  - Low cost – No radiation
  - Integration of intra-operative data
  - No registration issue
  - Increase the operative time





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Non image based

| Computer Assisted Orthopaedic Surgery |

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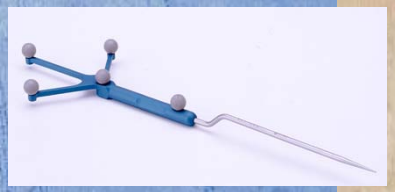
Perception

- **No pre-operative images**
- Build a specific model of the patient : Acquisition

- Geometric data
  - Axes
    - Hip center
    - Knee center
    - Ankle center



- Morphologic data
  - Bone surfaces

- **Digitization of points with a 3D probe**

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Perception

Hip center

- **None image based approach**

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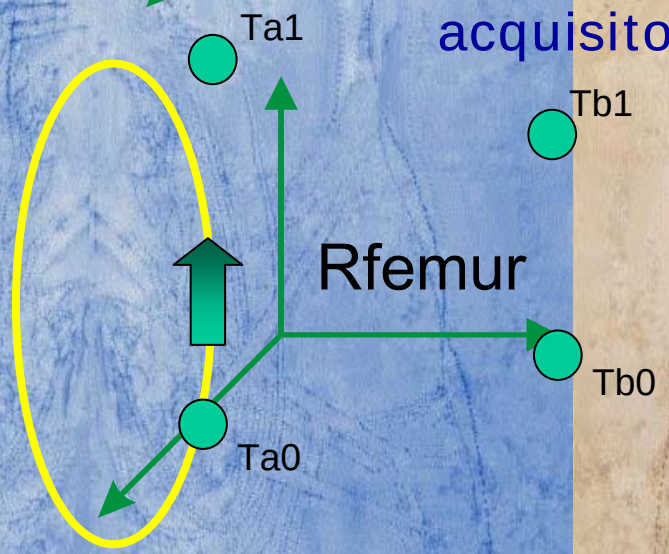
Perception

Hip center

- **None image based approach**
  - **-Kinematics approach**

- Search of a point C of R_{fem} with the minimum trajectory during the acquisiton motion



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Perception

Knee center

- **None image based approach**

Rpolaris

-Morphologic approach

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Perception

Ankle center

- **None image based approach**
- Percutaneous digitization of points

-Geometric approach

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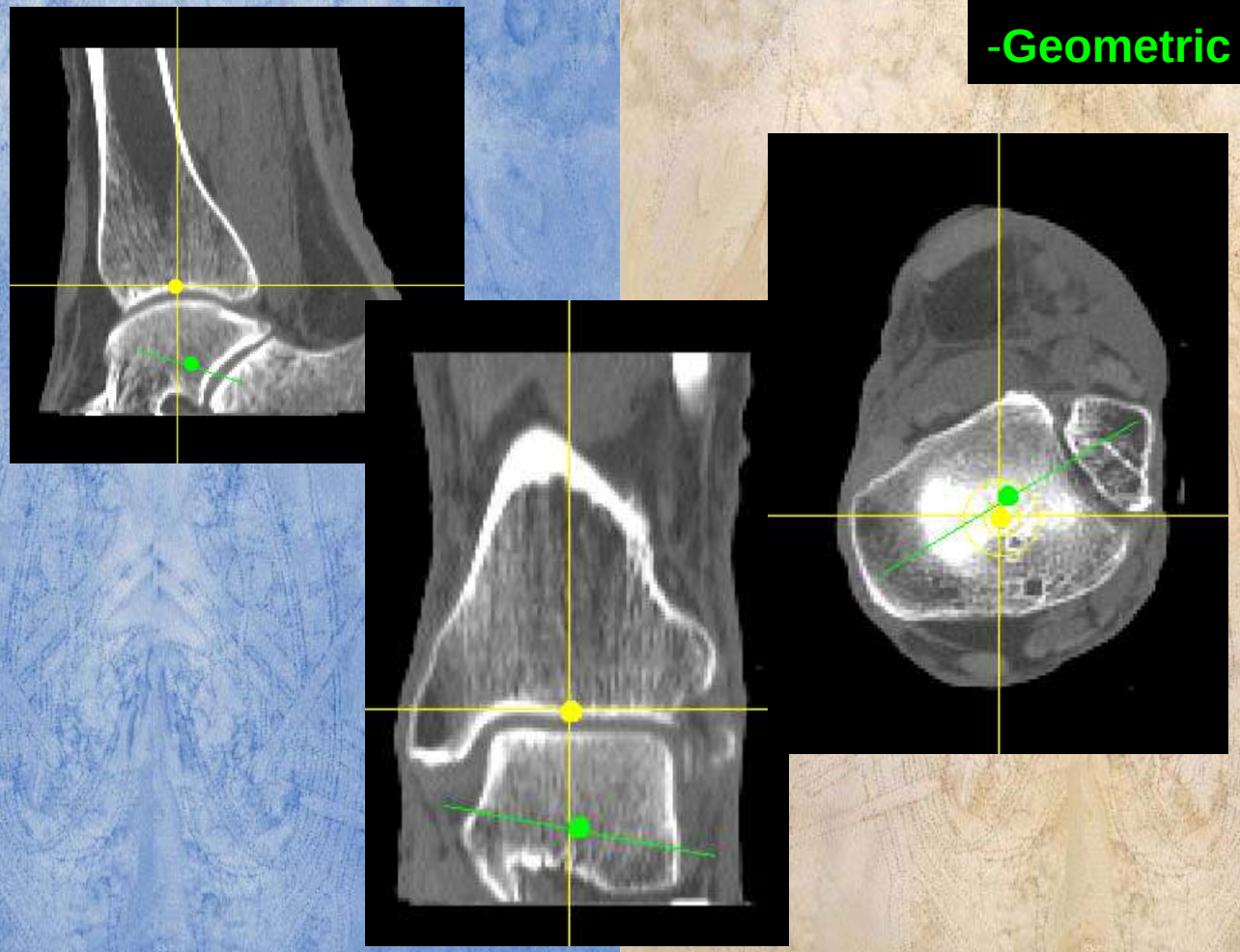
Perception

Ankle center

- **None image based approach**

-Geometric approach



- Error
- Slope
- Varus
- Valgus

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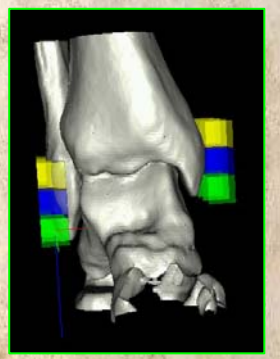
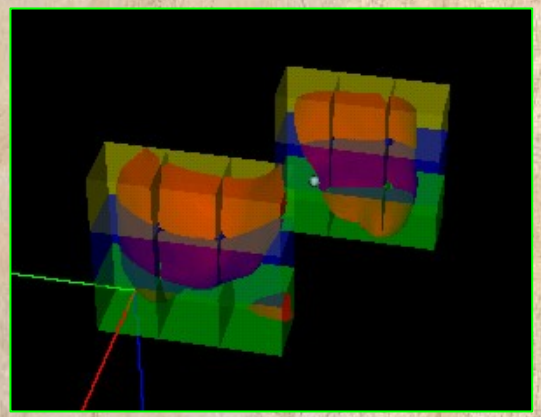
Perception

-Geometric approach

Ankle center





E. STINDEL, et Al., The center of the ankle in ct less based navigation system.
What is really important to detect?
CAOS Santa fee 19-22 Juin 2002.

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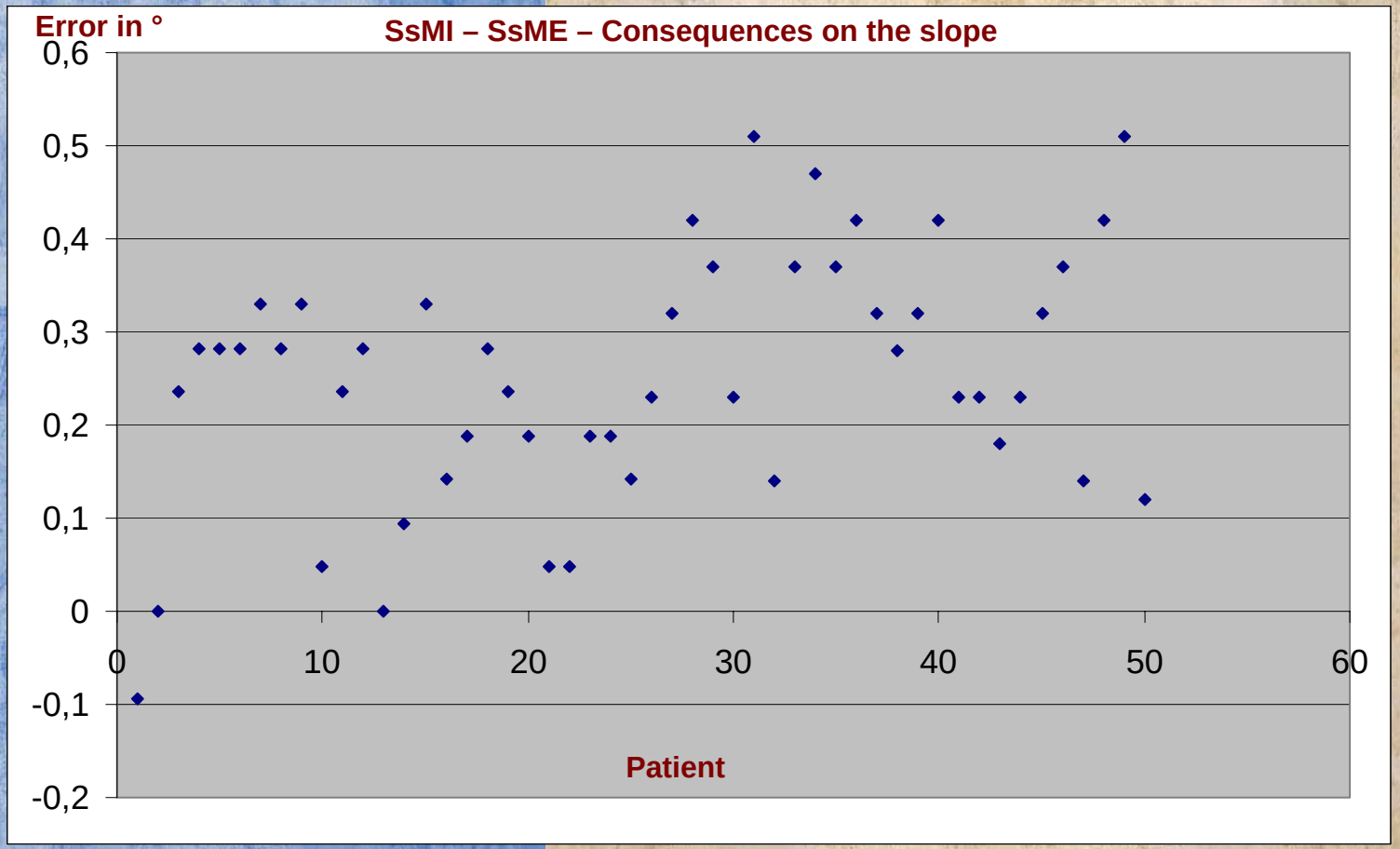
Ankle center

- **None image based approach**



| Computer Assisted Orthopaedic Surgery |

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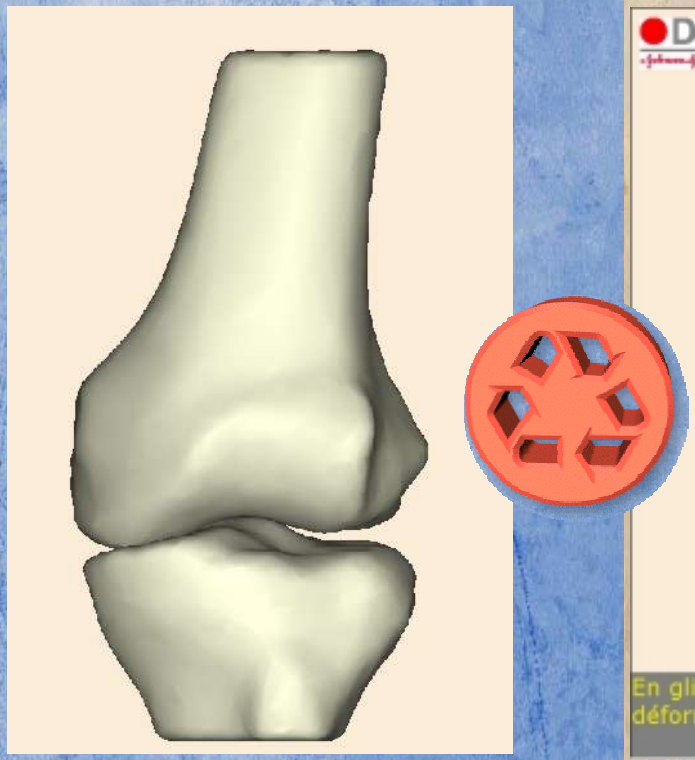
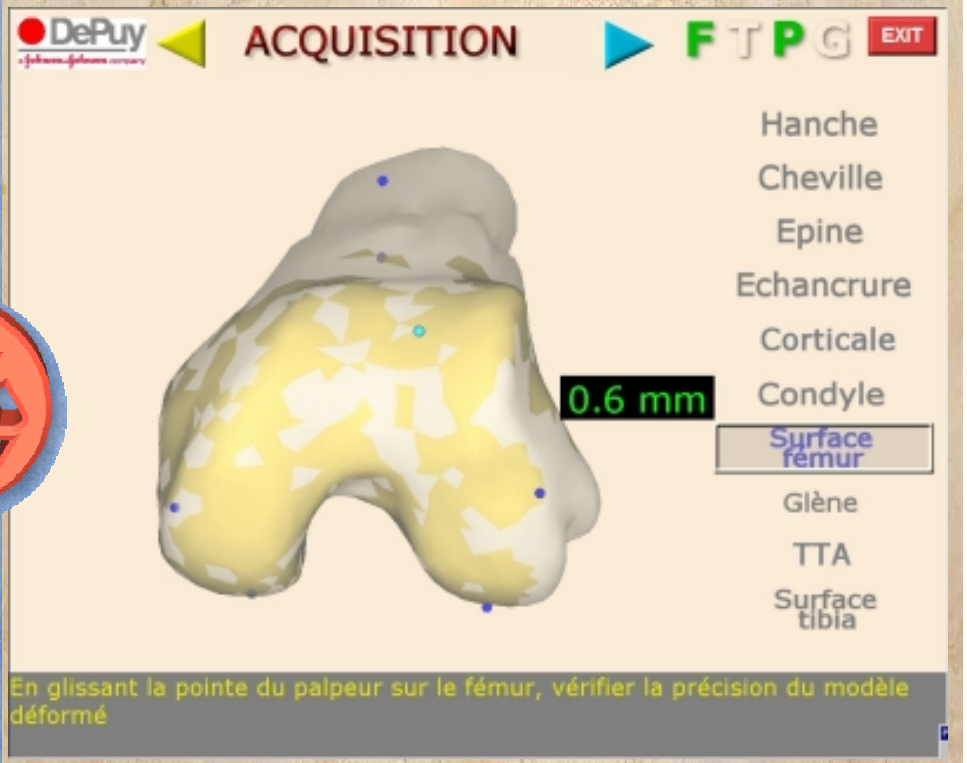
Morphology

- **Femoral and tibial shape : Bone morphing**
- Use of statistical deformable models





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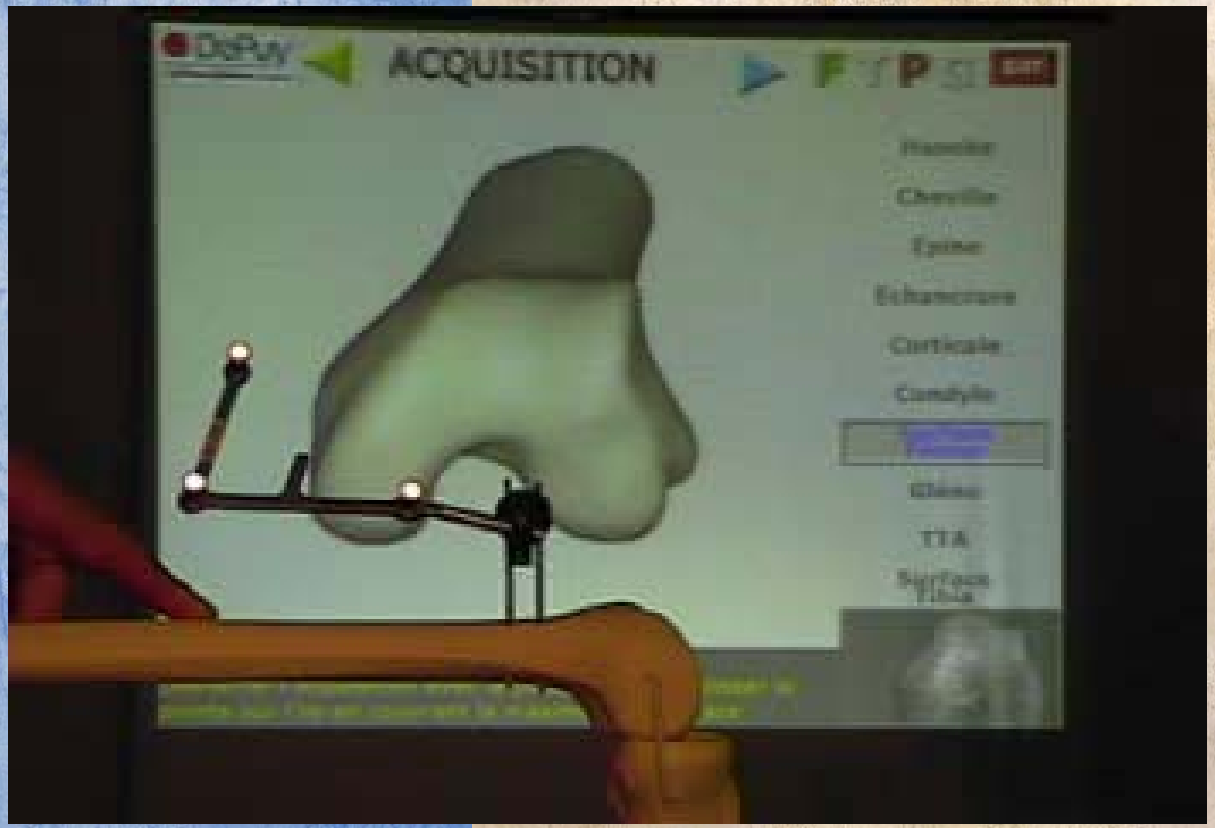
Morphology

- **Femoral shape : Bone morphing**
- Acquisition – Deformation – Quality control



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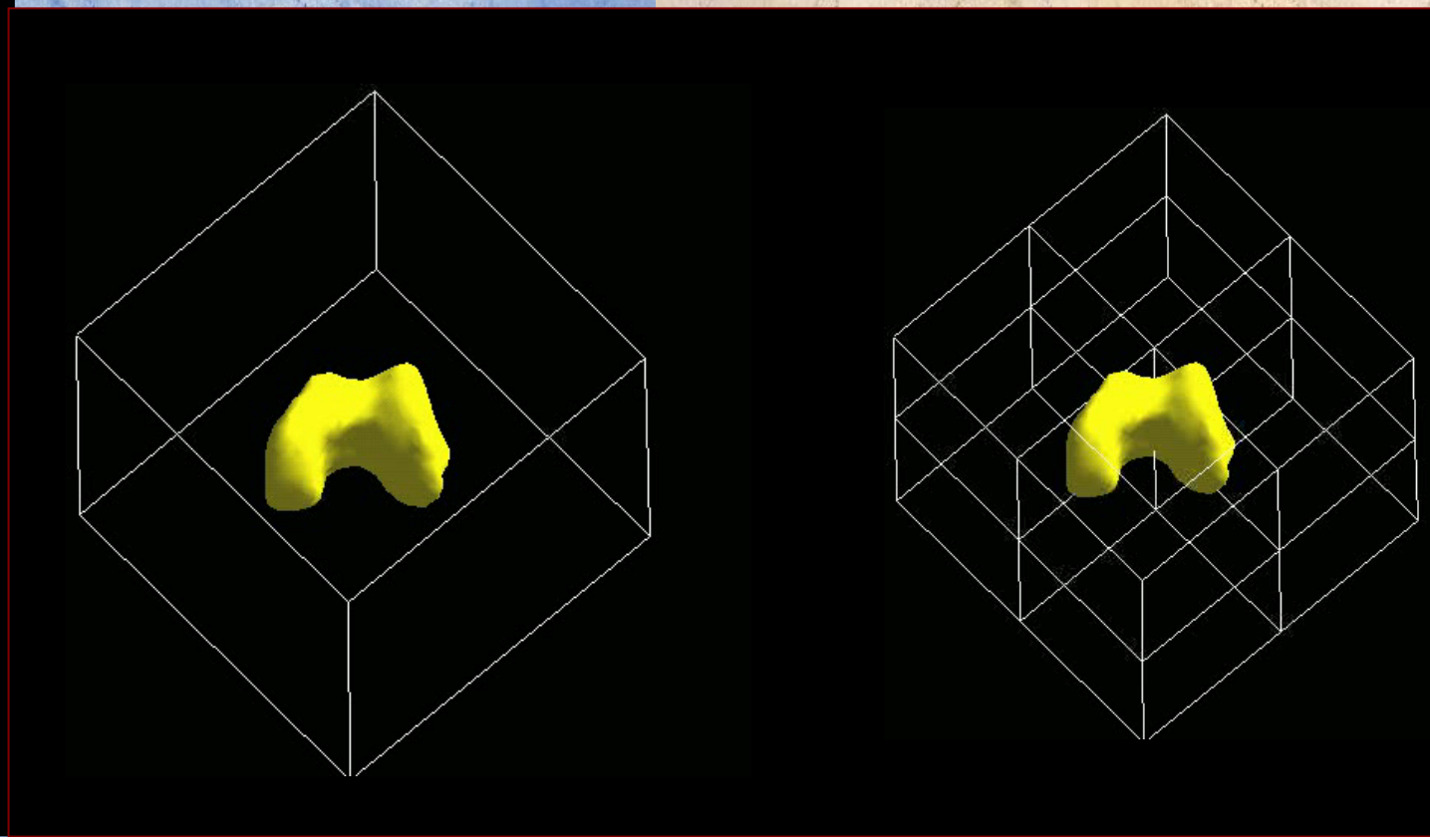
Morphology

- **Femoral shape : Bone morphing**
- Quadtree (Lavallée) : hierarchical division of the 3D volume to apply global and local deformation



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Non image based

Decision

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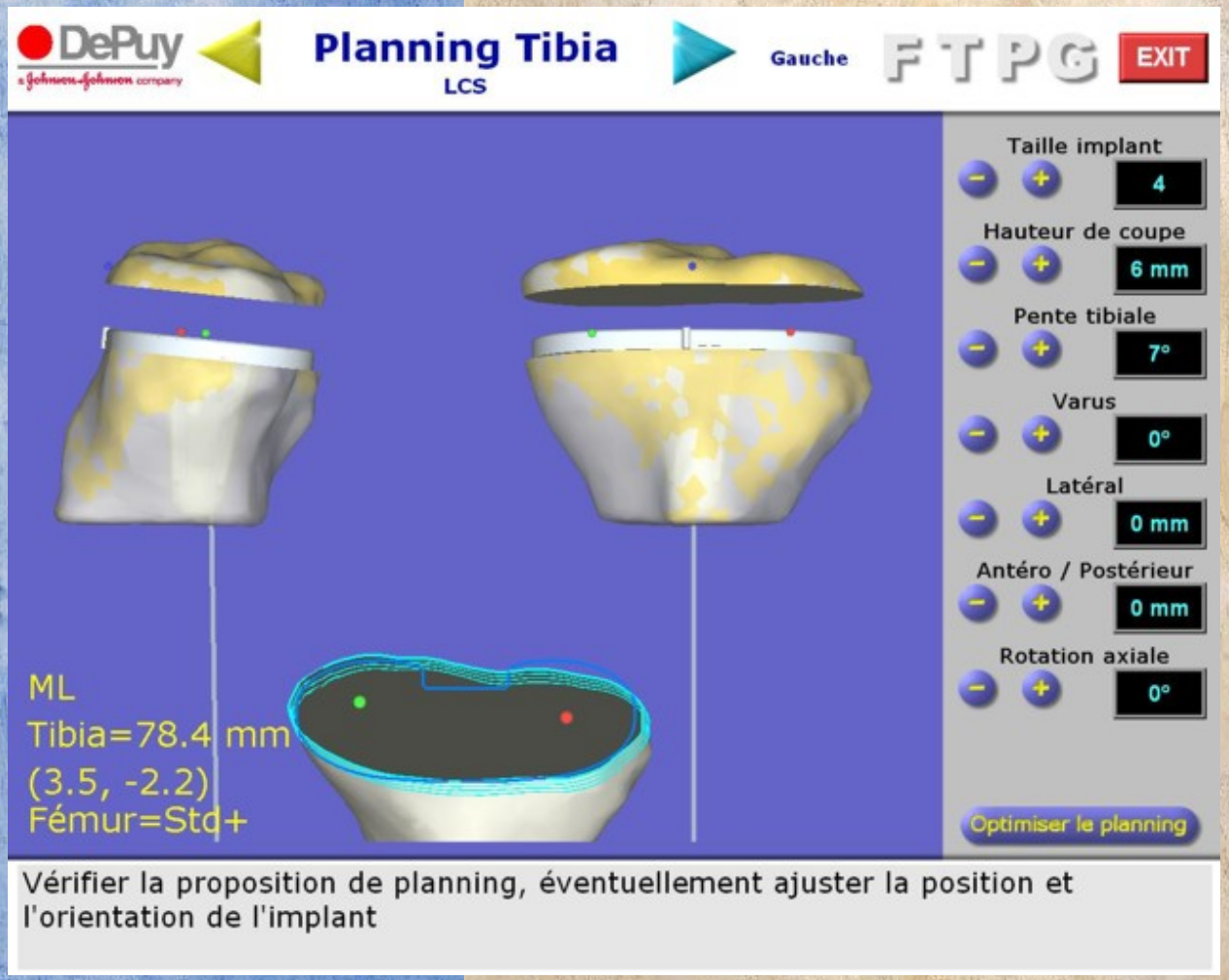
Decision

- **Level 1 : based on morphologic data**



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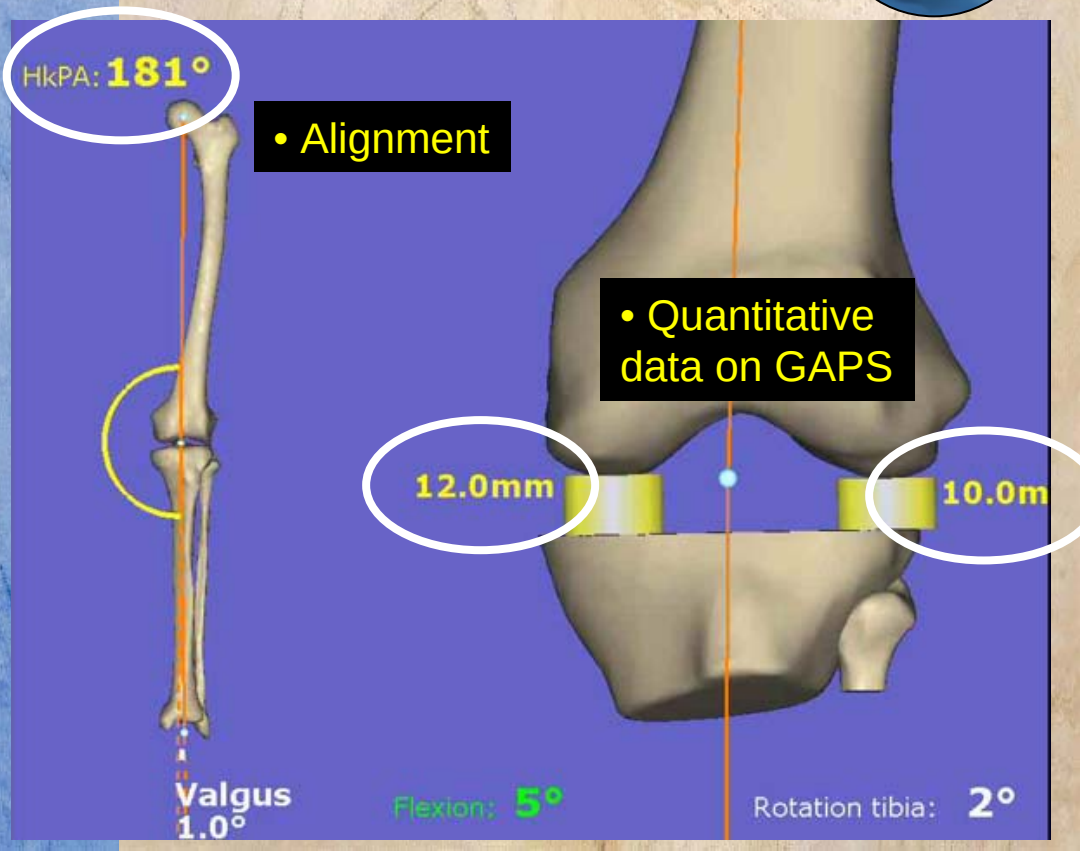
Decision

- **Level 2 : based on dynamic per-operative data**

Sensor

Software

Spacer



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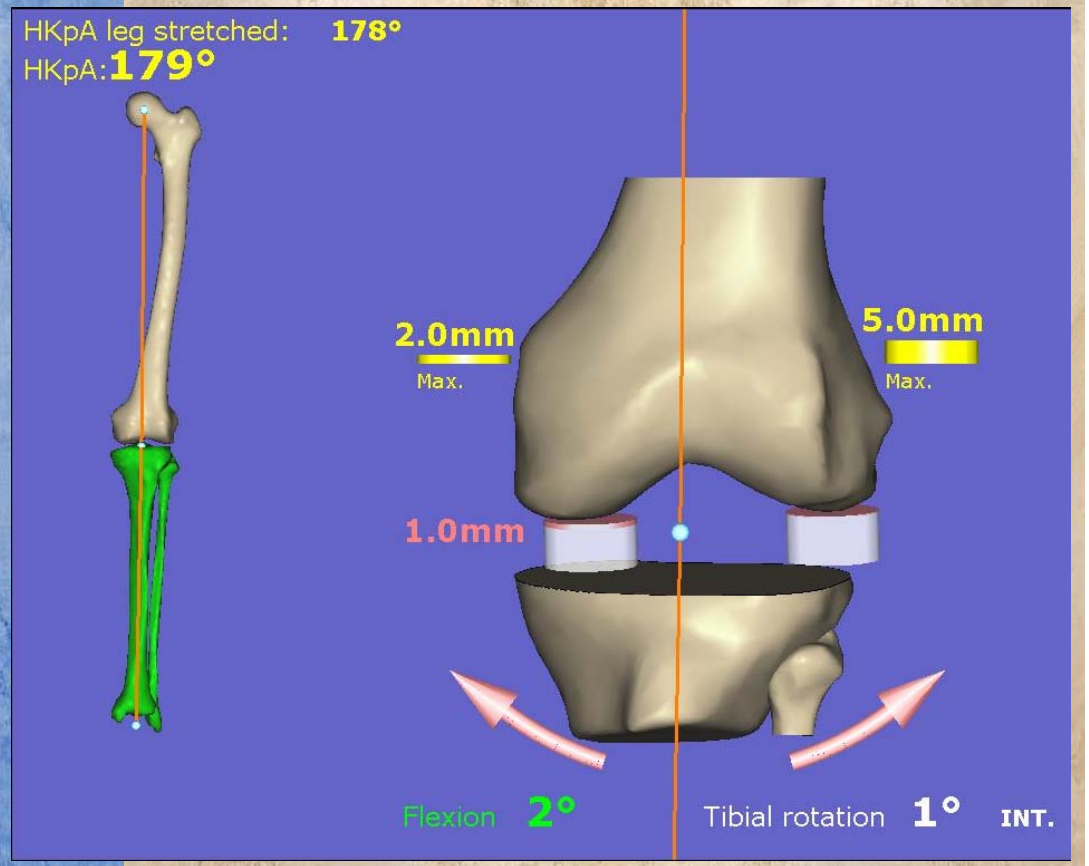
- **Level 2 : based on dynamic per-operative data**

- **Test residual laxity**
  - **Varus Max.**
  - **Valgus Max.**

- **If the residual laxity is over a threshold**



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Decision

- **Level 2 : based on dynamic per-operative data**
  - **Loop until the threshold is reached**