ROBOTICS IN TOTAL KNEE ARTHROPLASTY RESEARCH
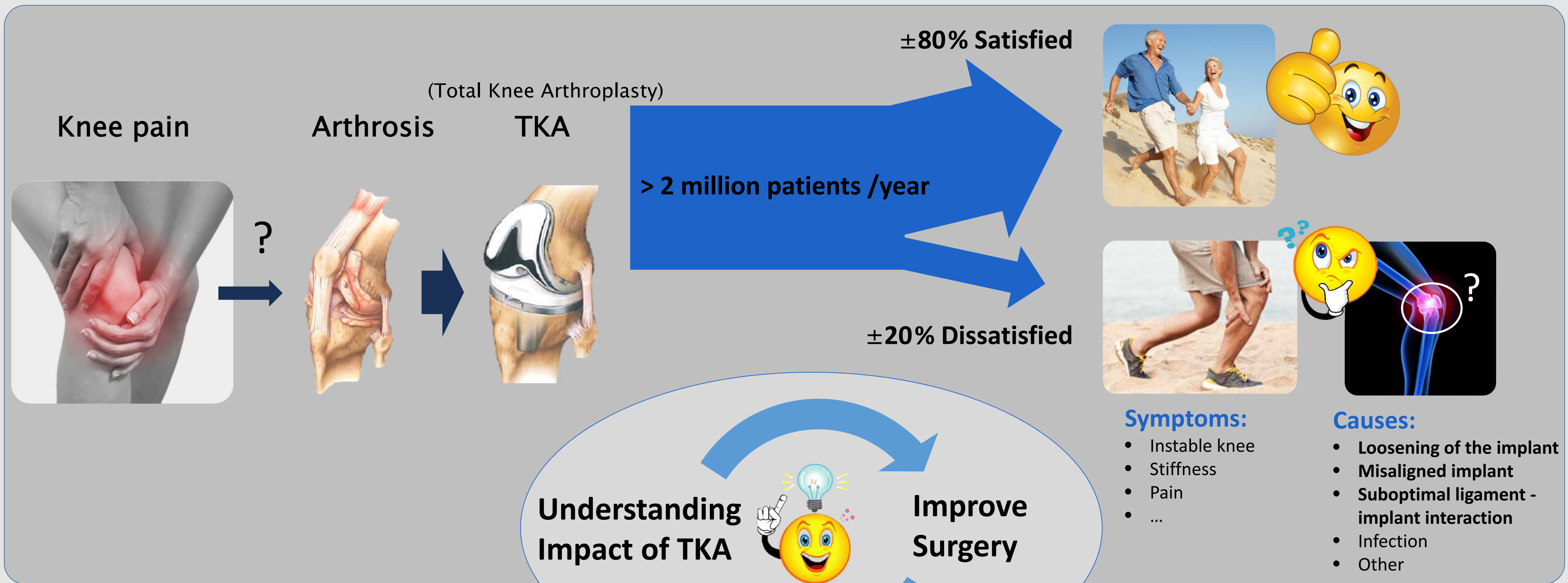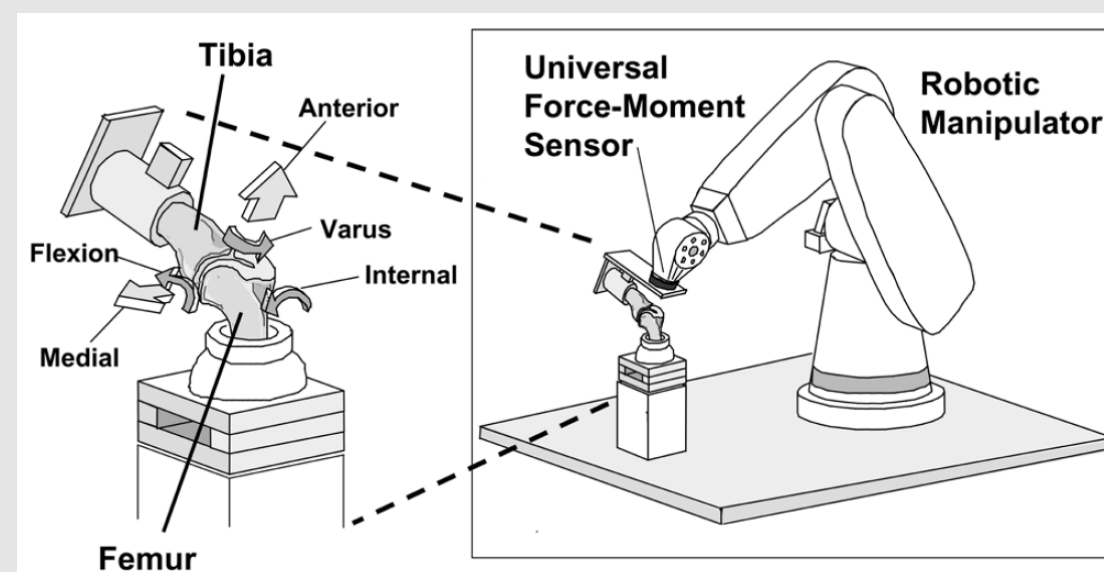
ir. Stijn Herregodts*,**, PhD ir. Matthias Verstraete**, Prof. Patrick De Baets*and Prof. Jan Victor**

Knee pain

?

Arthrosis

(Total Knee Arthroplasty)
TKA

> 2 million patients /year

±80% Satisfied

±20% Dissatisfied

Symptoms:
- Instable knee
- Stiffness
- Pain
- ...

Causes:
- **Loosening of the implant**
- **Misaligned implant**
- **Suboptimal ligament - implant interaction**
- Infection
- Other

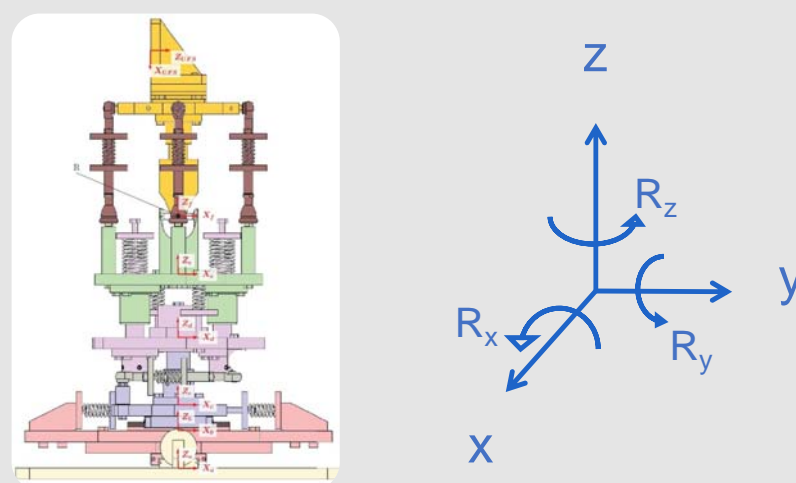**Understanding Impact of TKA** → **Improve Surgery**

Robotic Passive Laxity Testing

+ Testing joint in 6 degrees of freedom
+ Complex loading conditions
+ Automatic testing sequence

- Commercial force control packages are slow and have limited flexibility

Tibia — Anterior — Universal Force-Moment Sensor — Robotic Manipulator — Flexion — Varus — Internal — Medial — Femur

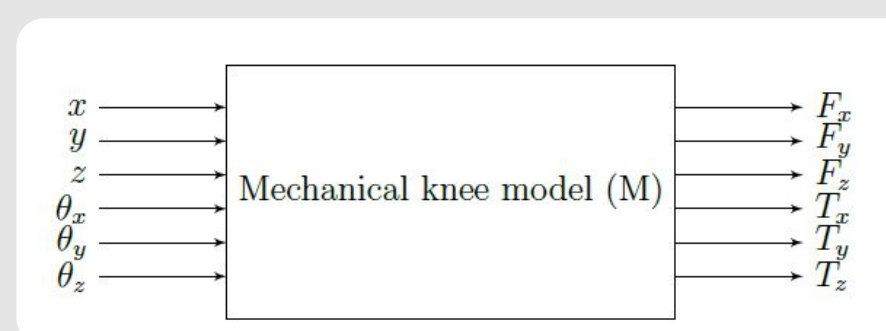**→ Development of performant hybrid force/displacement controller**

Mechanical knee model
- Adjustable stiffness in 6 DOF
- Adjustable coupling between DOF
- Adaptable mechanical dead zone
- Enables accurate numerical modelling
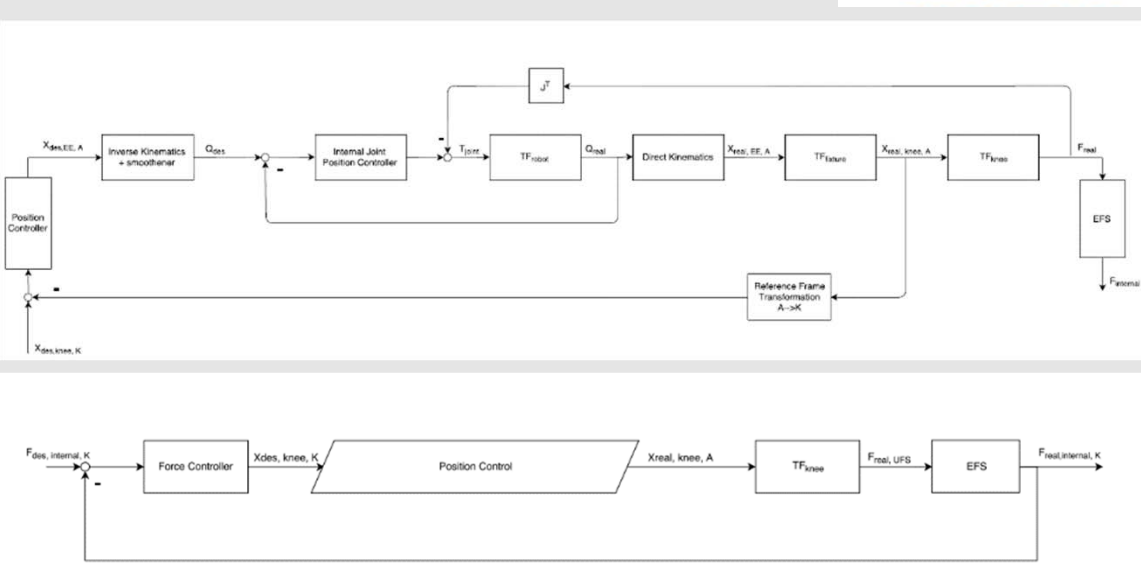
z, R_z, y, R_y, R_x, x

Modelling

Numerical knee Model
- In compliance with mechanical model
- Enables in silico design and optimisation of controller
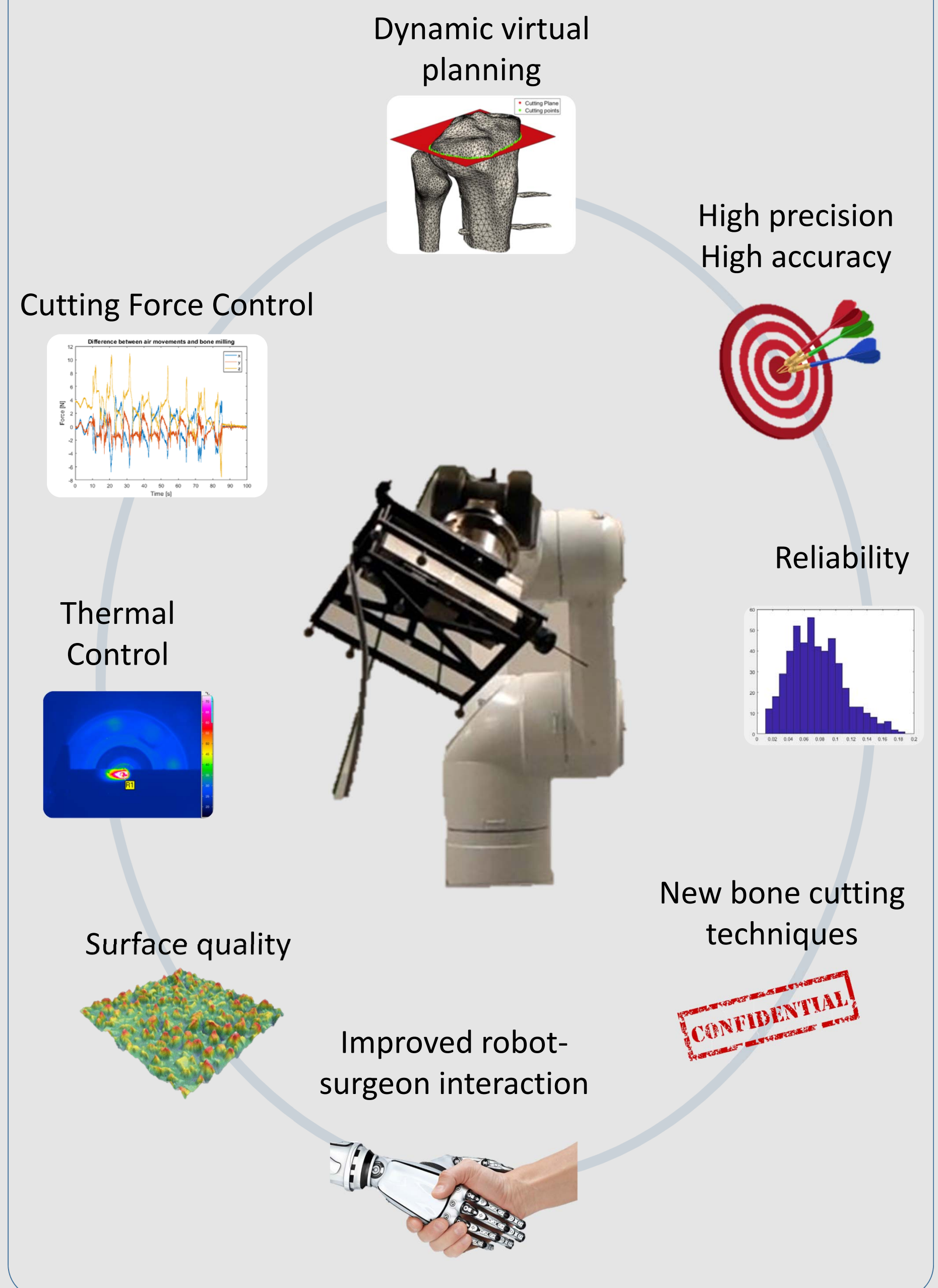- Efficient parametric simulation

x, y, z, θ_x, θ_y, θ_z → Mechanical knee model (M) → F_x, F_y, F_z, T_x, T_y, T_z

Development

Hybrid force/position controller
- Complex force/displacement loading conditions
- Adaptive to behaviour test object
- Robust and reliable

MATLAB & SIMULINK

6 DOF industrial robot

6 DOF Force sensor

Validation

Mechanical knee model

Smart Robotic Control of Surgical Tools

Dynamic virtual planning

High precision High accuracy

Cutting Force Control

Thermal Control

Reliability

Surface quality

Improved robot-surgeon interaction

New bone cutting techniques

CONFIDENTIAL

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