Medizinische Fakultät



Klinik und Poliklinik für Orthopädie, Unfallchirurgie und Plastische Chirurgie Geschäftsführender Direktor: Prof. Dr. med. C. Josten

# Measurement System For Determining The Joint Centered Leg Length During Total Hip Replacement Surgery

Grunert R<sup>1,3</sup>, Schmidt M<sup>1</sup>, Wendler T<sup>1</sup>, Maschke R<sup>4</sup>, Hammer N<sup>2</sup>, Schleifenbaum S<sup>1</sup>, Rotsch C<sup>3</sup>, Prietzel T<sup>1</sup>

<sup>1</sup> Clinic and Polyclinic for Orthopedics, Traumatology and Plastic Surgery, University of Leipzig
<sup>2</sup> Institute of Anatomy, University of Leipzig

<sup>3</sup> Fraunhofer Institute for Machine Tools and Forming Technology

<sup>4</sup> University of Applied Sciences Zwickau, Faculty of Applied Physics and Computer Sciences

## **Introduction & Objectives**

- More than 200.000 total hip arthroplasties (THA) are performed per year in Germany
- High quality challenges of THA:
  - High expectations of patients
  - Increasing physical activity of elderly patients

- The functional recovery for everyday life and for limited physical activity is becoming more and more important after THA
- Objective information on the leg length and the position of the hip rotation center is important for realistic reconstruction of biomechanics
- Prevention of leg length differences

### **Materials & Methods**

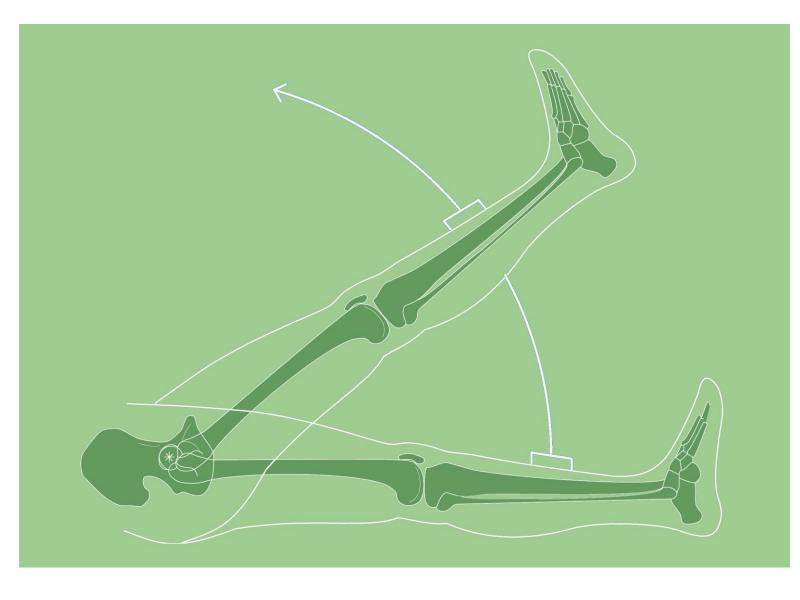
- The measurement system comprises of:
  - A measurement box including an inertial measurement unit (IMU), a
     Bluetooth mate, LEDs and an accumulator (Fig. 1, right side)
  - An industrial camera (HD, 55 fps) (Fig. 1, left side)
  - A measurement computer with LabVIEW-based data acquisition, calculation and evaluation
- Bluetooth connection between the measurement box and the measurement computer
- Evaluation of the measurement system on a realistic model, which is connected via a ball joint with a plate
- Measurement expiration:
  - The measurement box is fitted into place
  - It is attached to the shin of the subject by means of adhesive electrodes
  - The software is started
  - A straight leg raise is performed from the heel (Fig. 2)
  - The camera detects changes in the position of the LEDs during movement (Fig. 3)
  - The inertial sensor system monitors the lateral deviation of the leg and guides the user
  - The software calculates the parameters and outputs (Fig. 4)



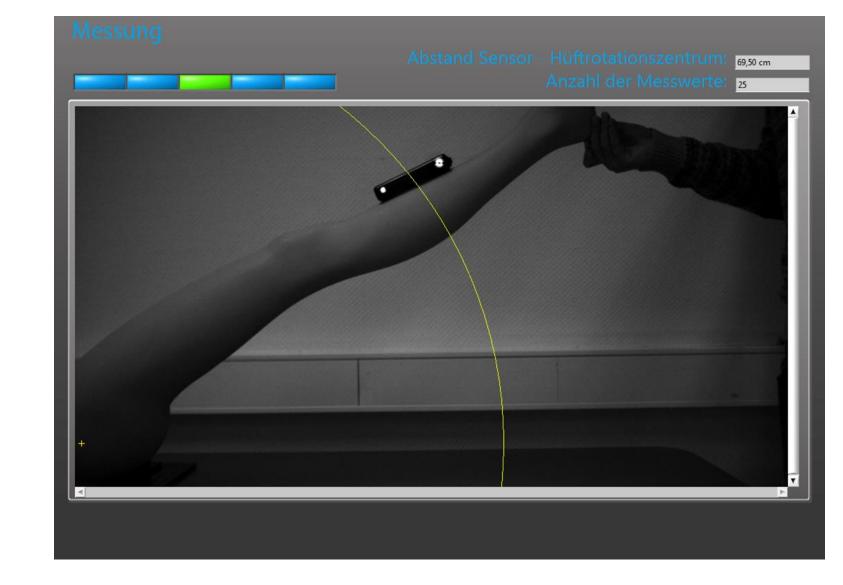
▲ Fig. 1: Industrial camera (HD) and developed measurement box



▲ Fig. 2: Measurement box placed on the lower leg



▲ Fig. 3: Generated orbit by rotating the complete leg into the hip joint



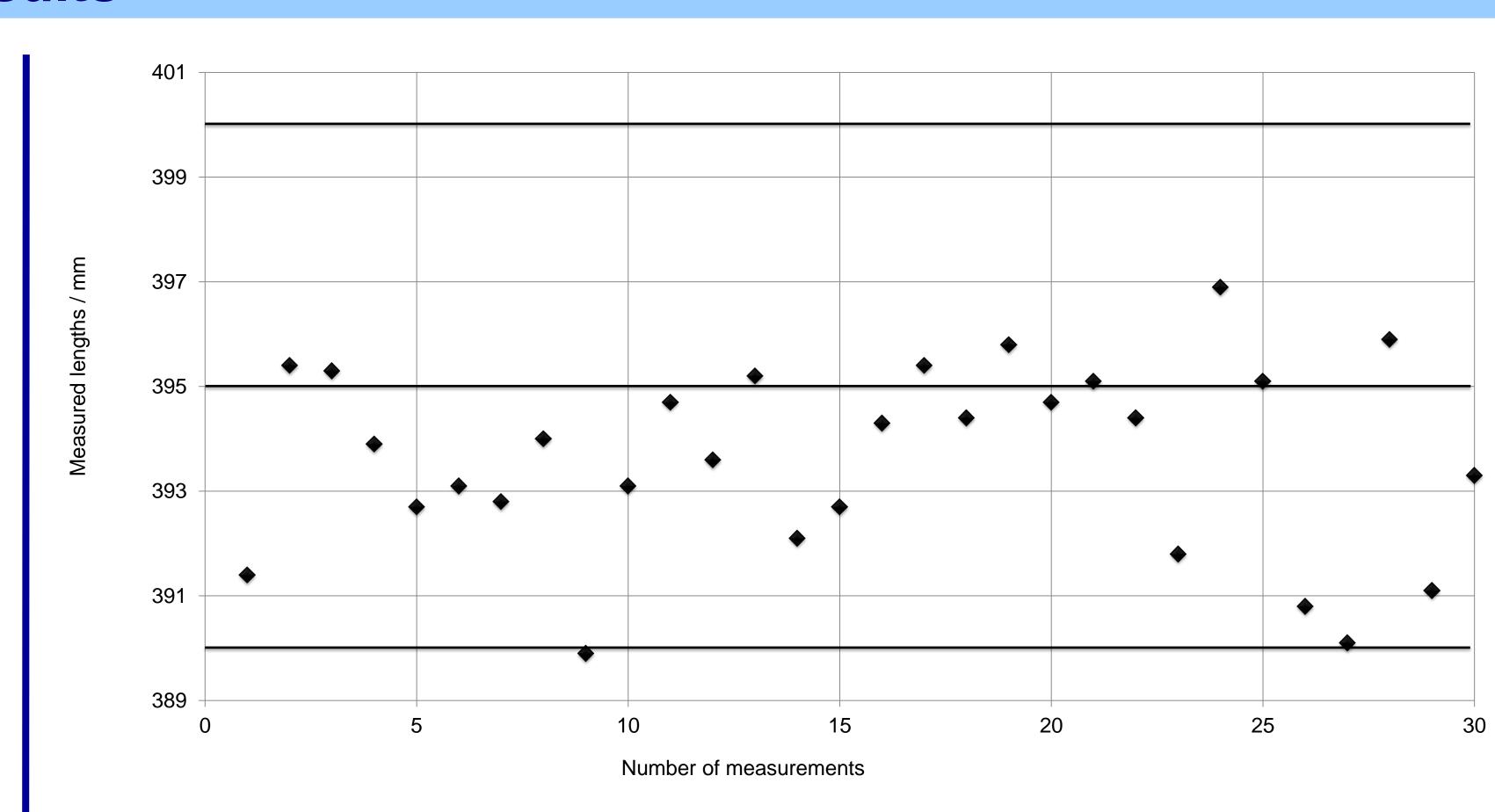
▲ Fig. 4: Screenshot of the operating surface

#### Results

- Development of a measurement system for the objective determination of the leg length and the hip rotation center for THA surgeries
- A test series was conducted to evaluate the system (n = 30) (Fig. 5)
- The required clinical measurement accuracy of 5 mm was reached with the model (Tab. 1)

▼ Tab. 1: Measured and calculated values in mm

Mean (actual value)	393.60
Set-value	395.00
Minimum	389.90
Maximum	396.90
Standard deviation	1.78
2x Standard deviation	3.56
Mean deviation	1.49



▲ Fig. 5: Measurement distribution

## Conclusion

- The technical accuracy of the measurement system enables precise measurements and can therefore represent a useful additional objective quality assurance tool for THA
- Assessment of the accuracy in clinical use should be carried out in future studies