

Research, Educational and Other Activities at IMID

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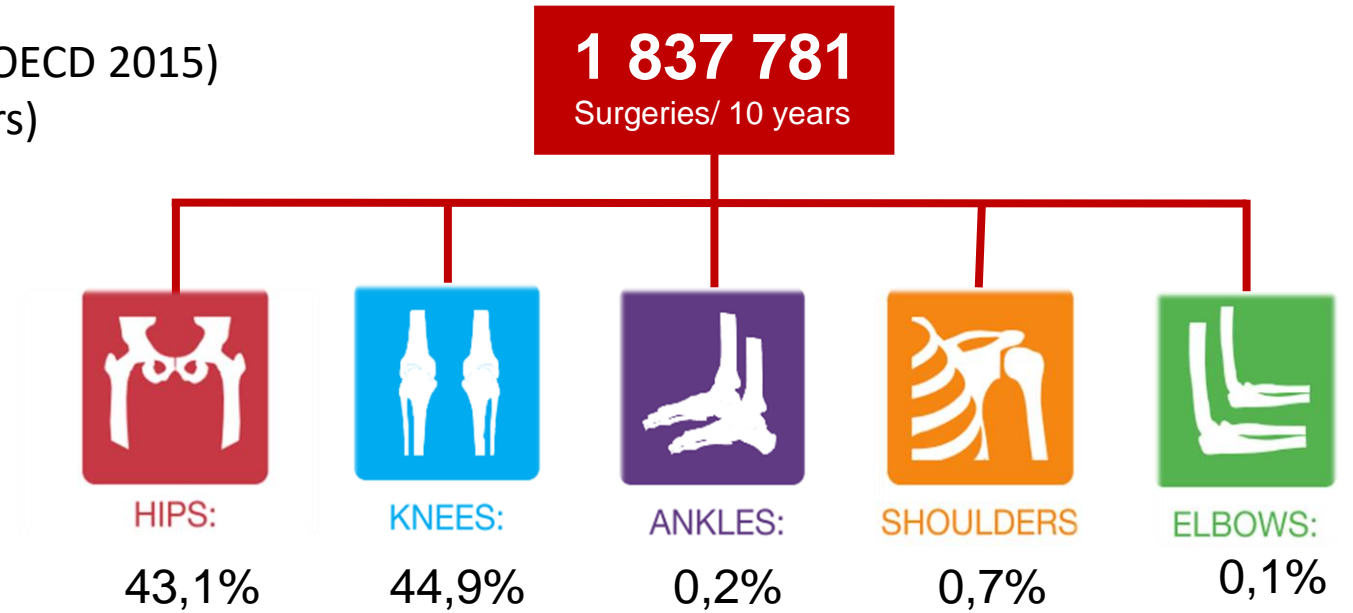
Brno, 4th April 2018

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Introduction and motivation

- Total hip replacement
 - Common and most successful surgeries
 - 161 surgeries per 100 000 population (OECD 2015)
 - Limited longevity of implants (5-15 years)



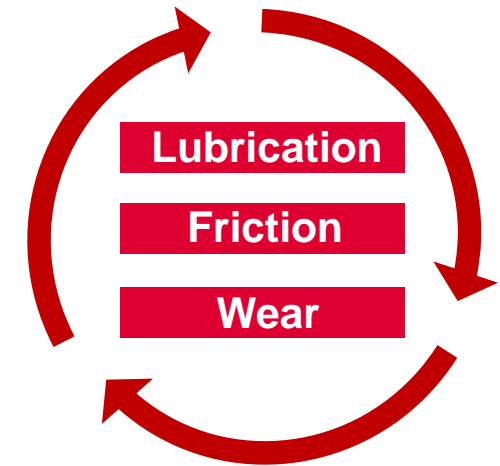
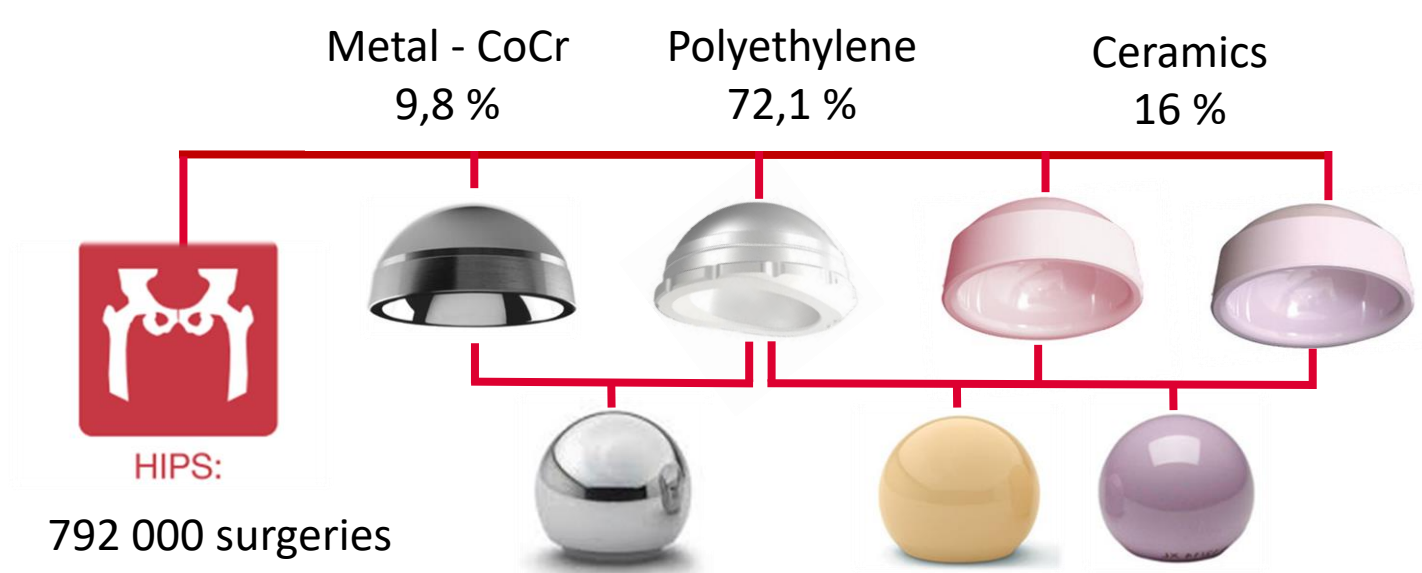
Introduction and motivation

- Total hip replacement
 - Common and most successful surgeries
 - 161 surgeries per 100 000 population (OECD 2015)
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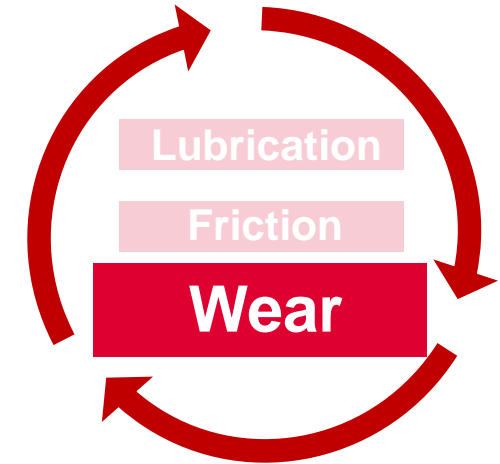
Material	Wear (mm ³ /year)
UHMWPE - Kov	56
Cross linked UHMWPE - Kov	2,8
Kov - Kov	0,9
Keramika- Keramika	0,004

Introduction and motivation

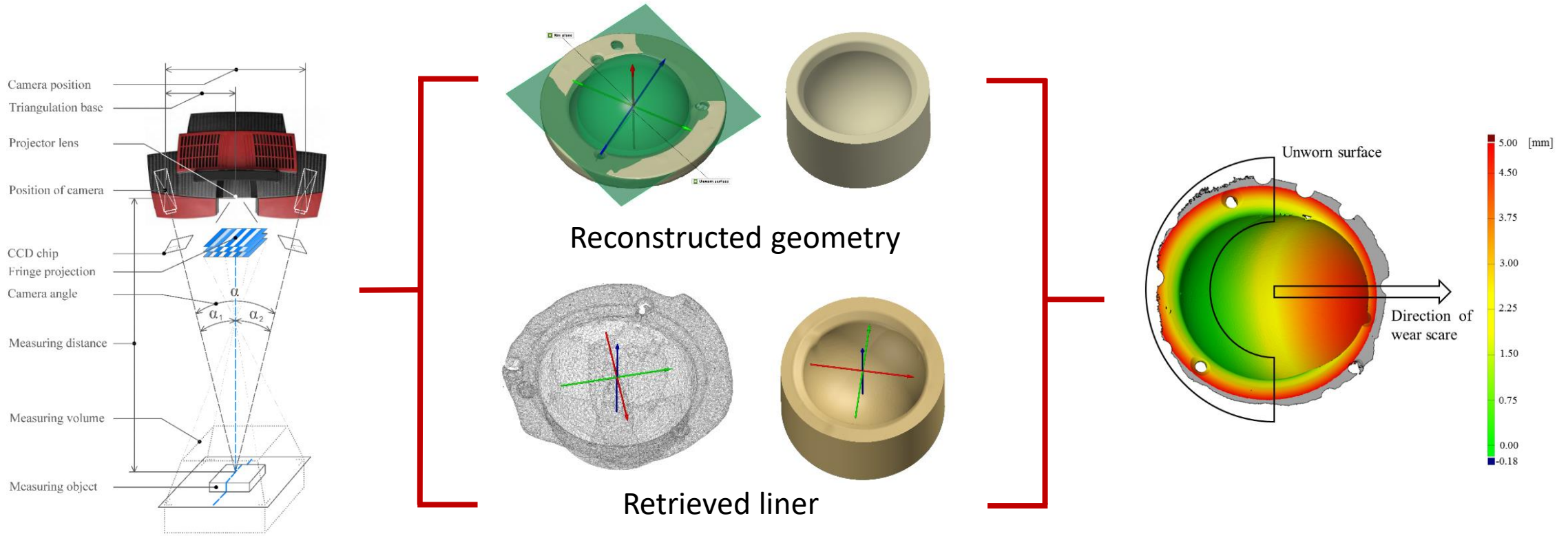


Introduction and motivation

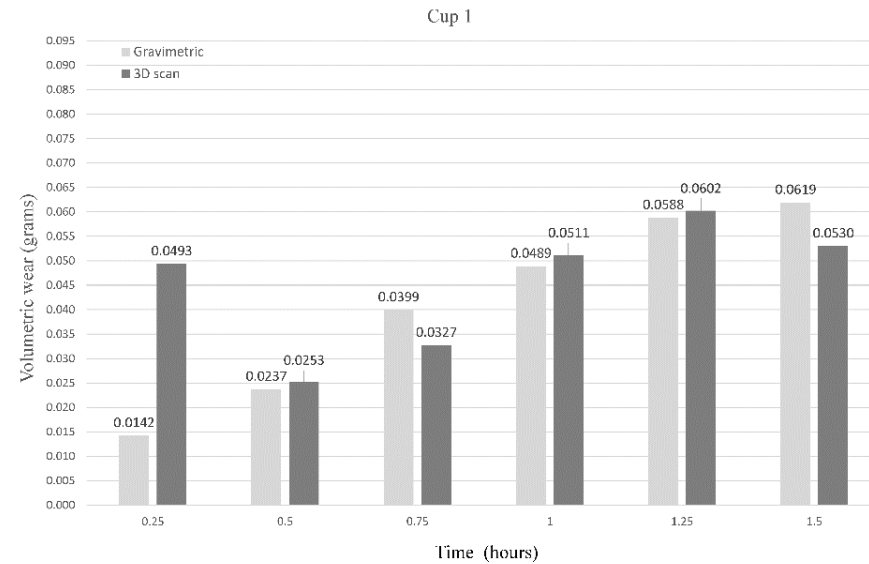
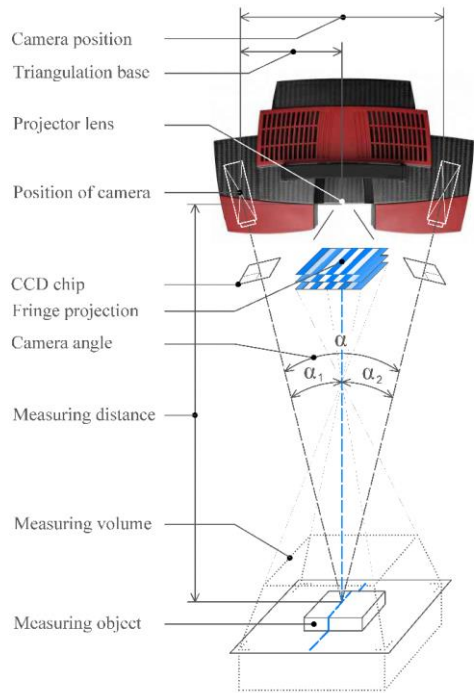
- Importance of wear analysis
 - Prediction of possible complications
 - Analysis of replacement failures
 - Influence of position on replacement failures



Background



Background



Validation

- 3 new implants
- According ISO 14242 – part 1
- Gravimetric validation
- Wear – 65 grams
- Differences \pm 4 milligrams

Metrology

Validation

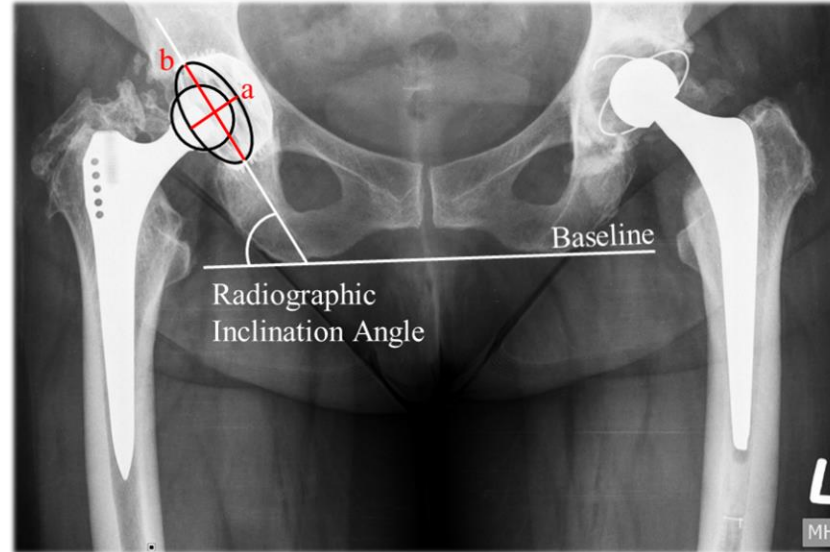
Application

Usability

Results



16 retrieved liners



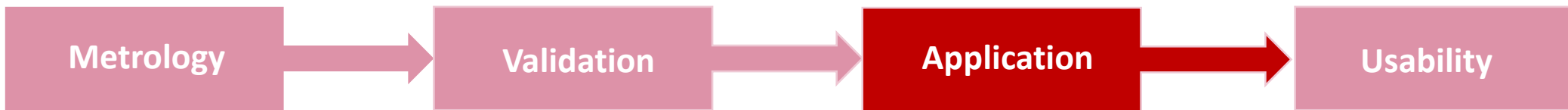
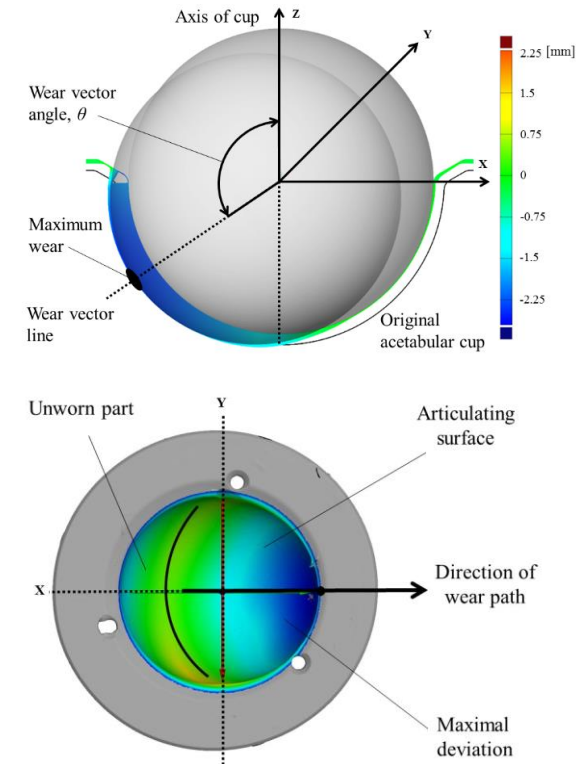
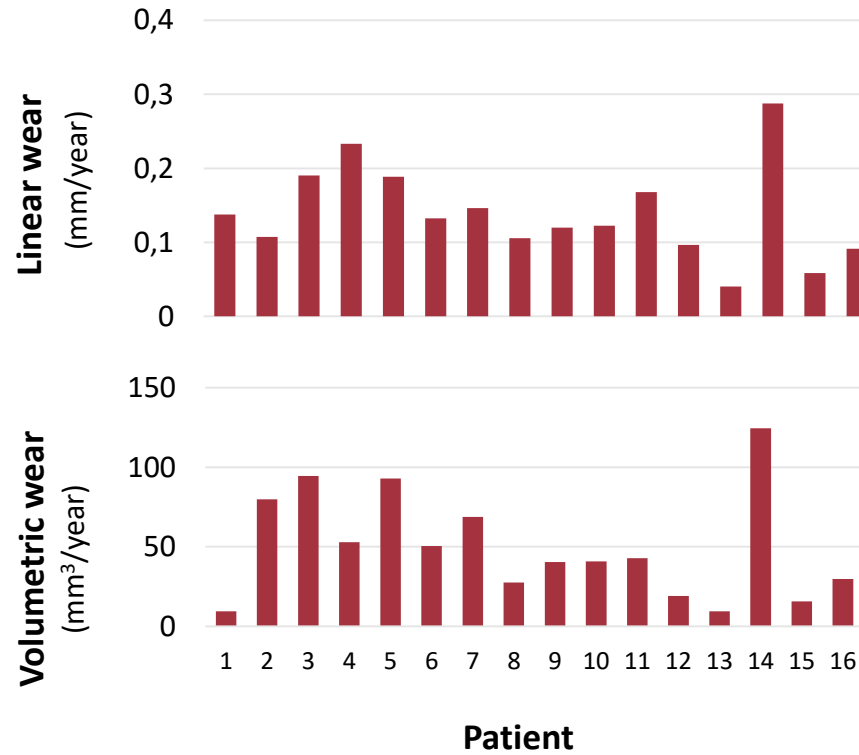
- 16 retrieved implants
- Clinical data
- Scanning method
- Analysis of surface
- Martell's method



Results



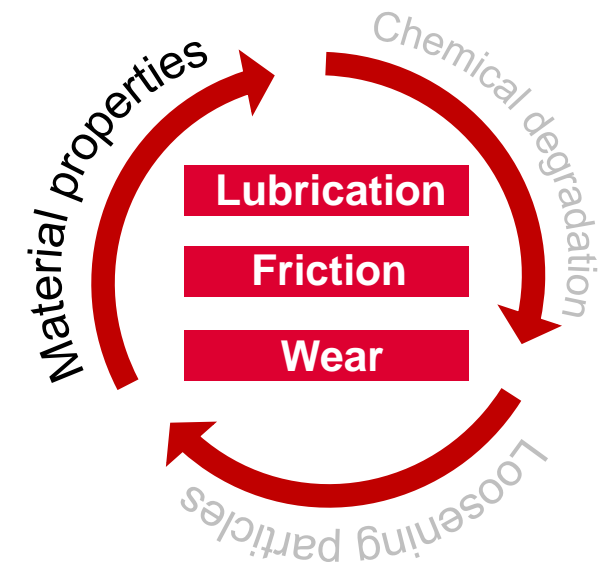
16 retrieved liners



Material properties



- Max load 3 kN
- 1Hz
- Flexion - extension $\pm 60^\circ$
- Rotation $\pm 10^\circ$
- Long term tests according ISO 14242



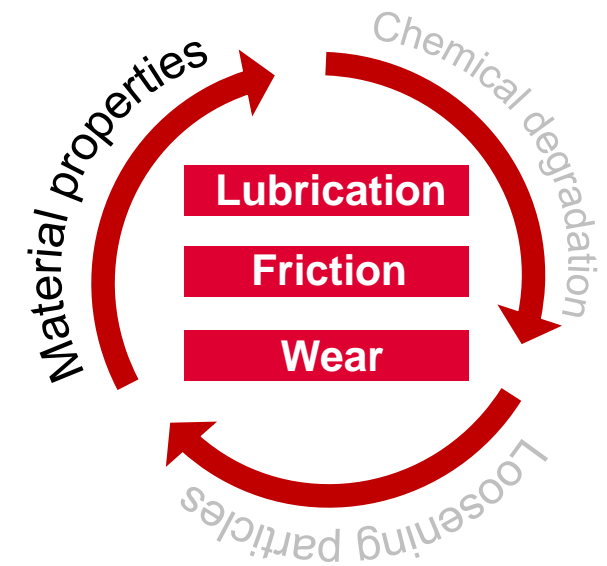
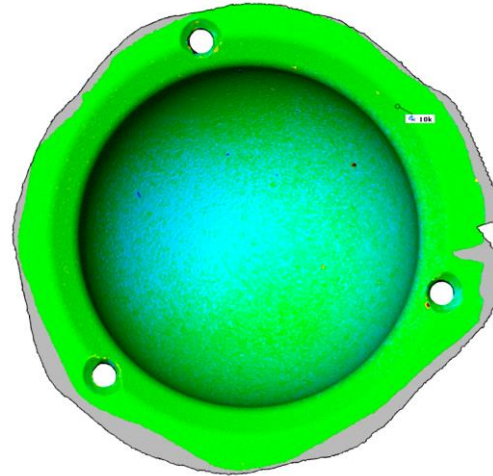
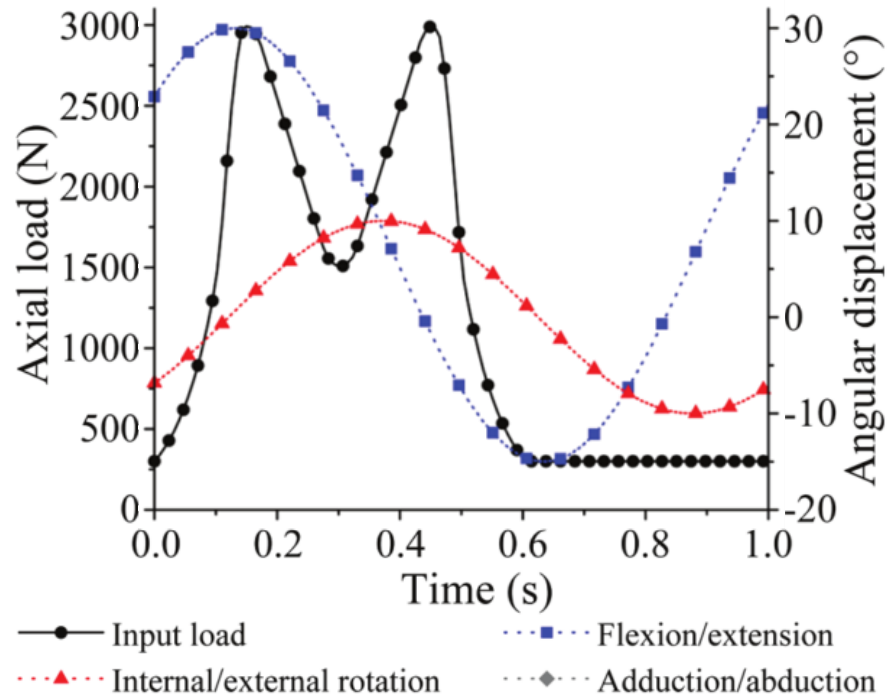
Metrology

Validation

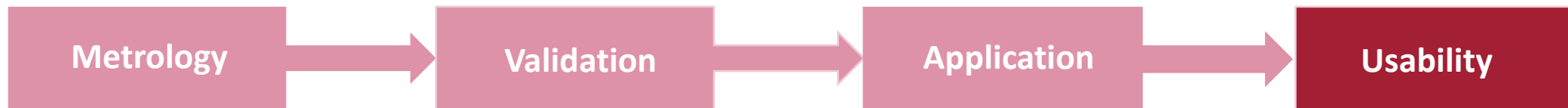
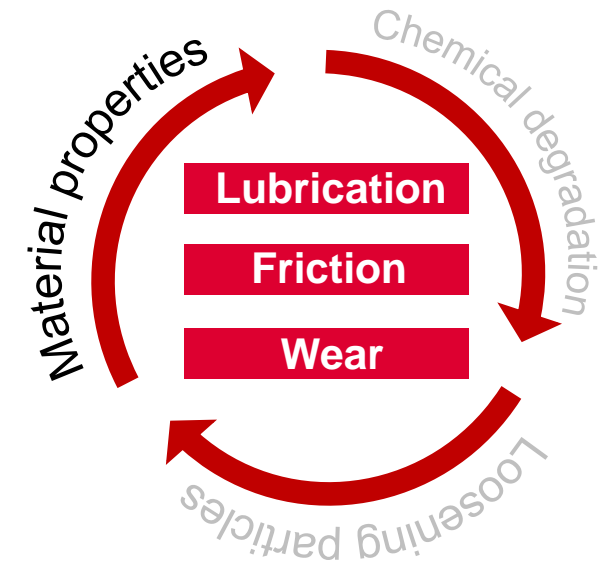
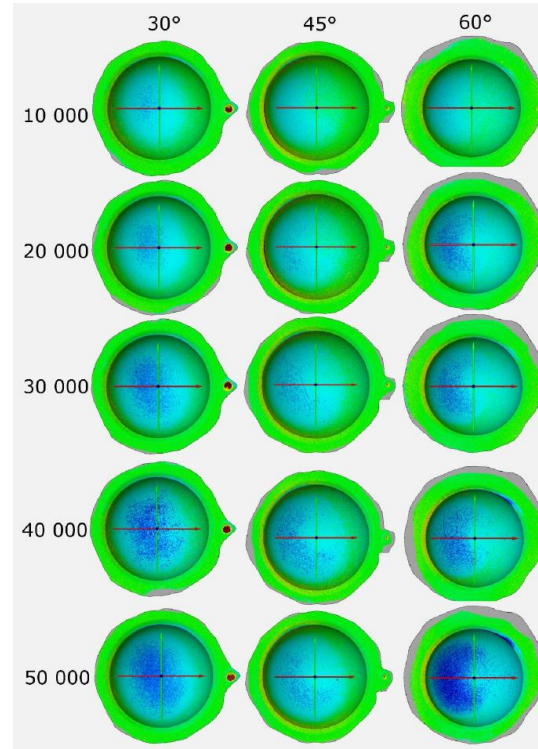
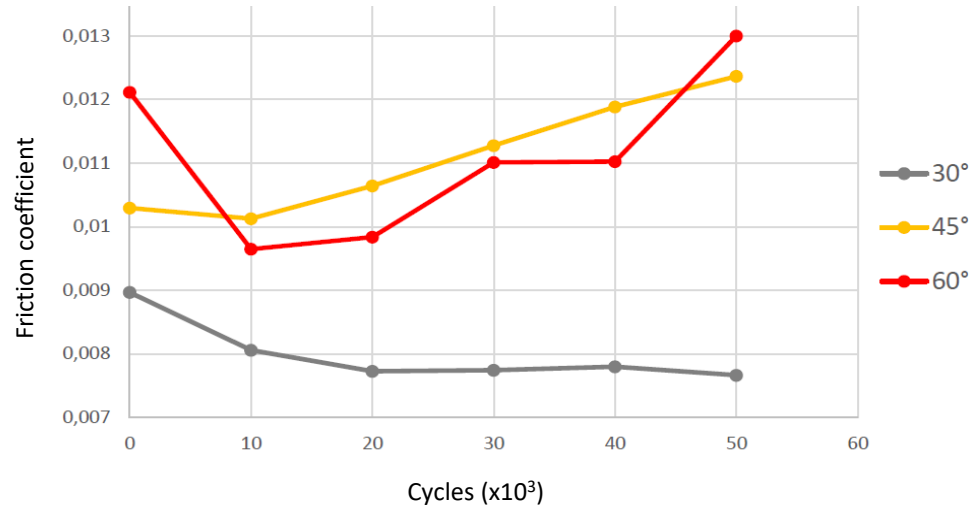
Application

Usability

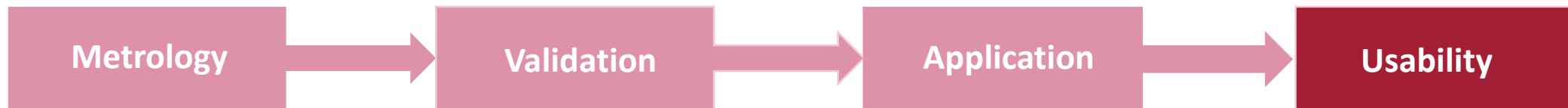
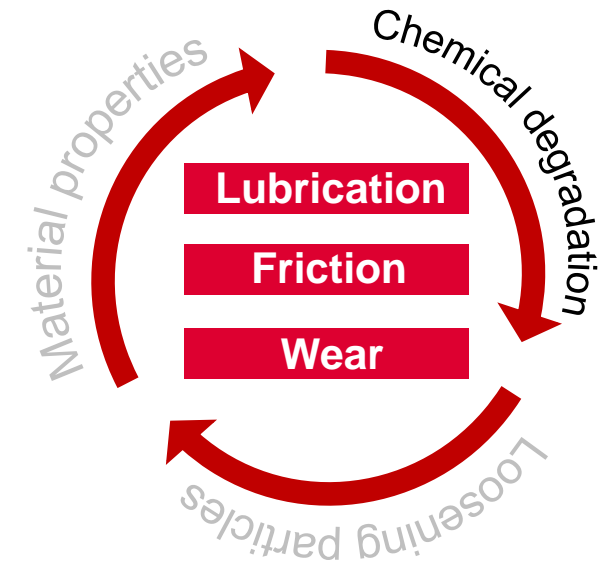
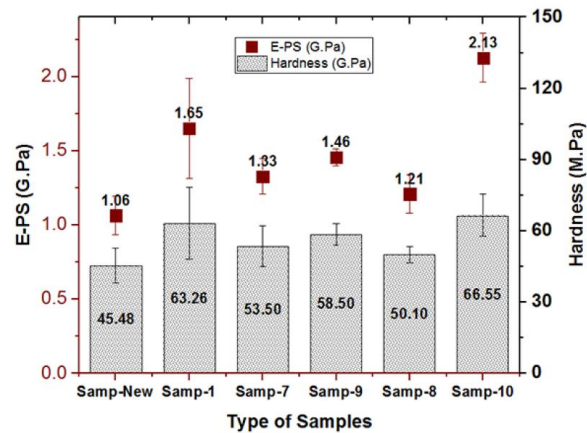
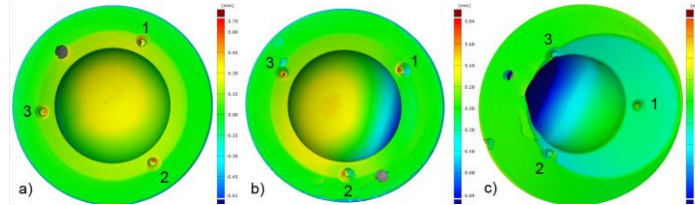
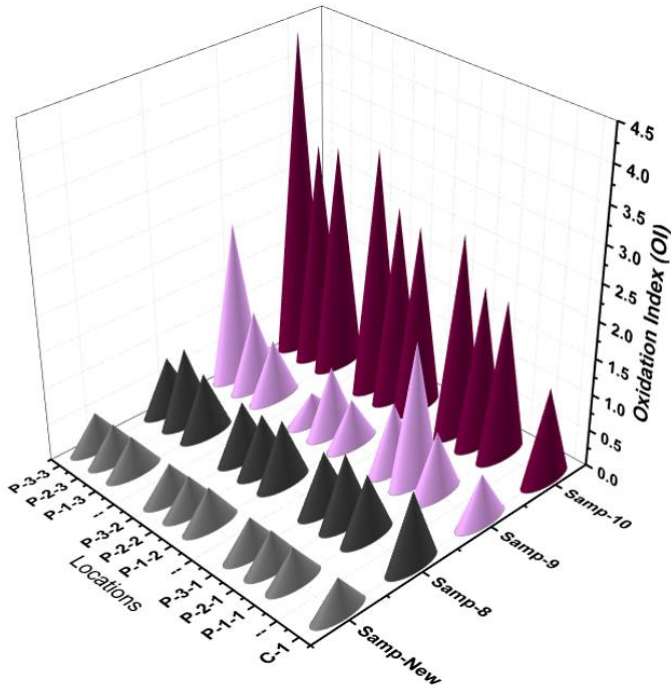
Material properties



Material properties



Chemical degradation



Conclusions and Vision

- **Conclusions**

Wear of liners depends mostly on:

- Inclination angle in pelvis
- Geometry of articulating surface
- Changes of surface structure
- Chemical degradation of surface

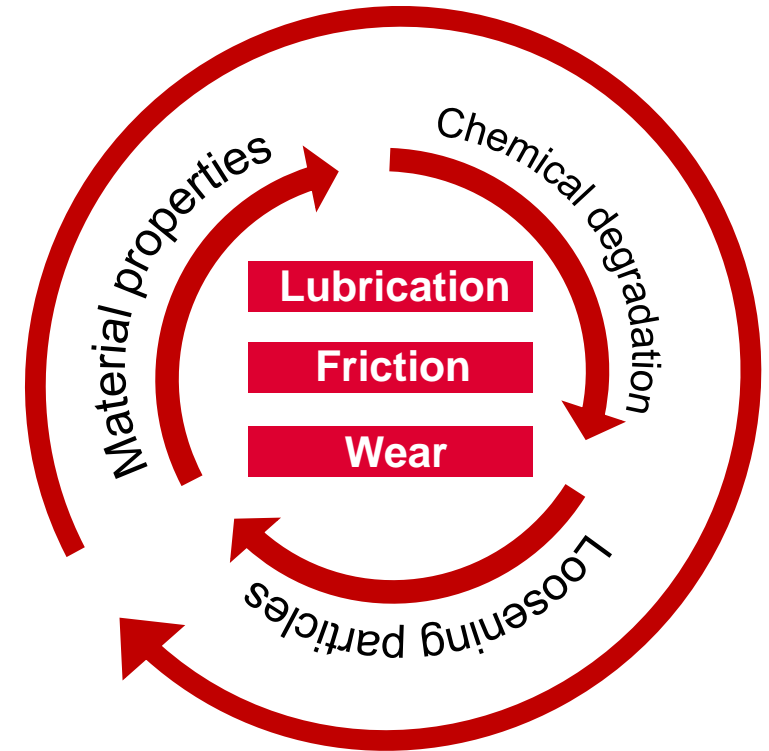
- **Consequences:**

- Particle loosening
- Delamination of surface
- Deformation of liner

} Revision surgeries

- **Visions**

- Understanding of chemical changeses
- Modification of geometry
- Influence of particles in interaction with lubrication



Research identifiers

CHOU DHURY, D.; RANUŠA, M.; FLEMING, R. A.; VRBKA, M.; KŘUPKA, I.; TEETER M. G.; GOSS, J.; ZOU, M. Mechanical Wear and Oxidative Degradation Analysis of Retrieved Ultra High Molecular Weight Polyethylene Acetabular Cups. Journal of the mechanical behavior of biomedical materials, 2018, roč. 79, č. 1, s. 314-323. ISSN: 1751-6161.

(IF 3,11 ; citation - 1)

RANUŠA, M.; GALLO, J.; HOBZA, M.; VRBKA, M.; NEČAS, D.; HARTL, M. Opotřebení a drsnost artikulačního povrchu u extrahovaných polyetylénů jamky Bicon- Plus. Acta Chirurgie Orthopaedicae et Traumatologie Českoslovaca, 2017, roč. 84, č. 3, s. 159-167. ISSN: 0001-5415.

(IF 0,56 ; citation - 2)

RANUŠA, M.; GALLO, J.; VRBKA, M.; HOBZA, M.; PALOUŠEK, D.; KŘUPKA, I.; HARTL, M. Wear Analysis of Extracted Polyethylene Acetabular Cups Using a 3D Optical Scanner. TRIBOLOGY TRANSACTIONS, 2016, roč. 60, č. 3, s. 437-447. ISSN: 1040-2004.

(IF 1,69 ; citation - 3)

RANUŠA, M.; ZEMAN, J.; GALLO, J.; VRBKA, M.; KŘUPKA, I.; HARTL, M. Experimental Determination of Effects of the Polyethylene Acetabular Positioning on the Run-in Phase of Wear and on the Surface Deformation. JOURNAL OF BIOMEDICAL MATERIALS RESEARCH PART B, APPLIED BIOMATERIALS.

(In progress, April 2018)

Other activities

Conferences

- **Frejks days 2015** (June, 25 - 26, Brno, Česká republika)
HOBZA, M.; RANUSA, M.
Valuation of Type and Wear of Retrieved Polyethylene Bicon Cups.
- **NORDTRIB 2016** (July, 14 -17, Hämeenlinna, Fínsko)
RANUSA, M.; VRBKA, M.; KŘUPKA, I.; HARTL, M.
Development and Validation of an Optical Scanning Method for Volumetric Wear Analysis
- **WTC 2017** (September, 17 – 22, Beijing, China)
RANUSA, M.; VRBKA, M.; GALLO, J.; KŘUPKA, I.; HARTL, M.
Influence of Acetabular Cup Inclination on Wear of UHMWPE Liners.



Cooperation

- **Waterloo University, Canada, Ontario** (prof. John B. Medley) internship, June, 6, 2016 – August 27, 2016
- **Anglian Ruskin University, England, Chelmsford** (Rajshree Hillstrom, PhD MBA)
- **Arkansas University, USA, Arkansas** (Dr. Dipankar Choudhury)

Educational activities

- ZKP – Team Project
- ZIP – Team Project
- ZTR – Tribology
- 6KT – Machine Design
- OZP – Aventisc Pneumobil Racing Team

Diploma theses supervision:

Bc. Jakub Zeman (5r)

Experimental Determination of Effects of the Polyethylene Acetabular Positioning on the Run-in Phase of Wear and on the Surface Deformation.

Bc. Samuel Seidl (4r)

Behavior of Polyethylene Particles in Contact Surfaces of Hip Joint Replacements

Pneumobil

Mission:

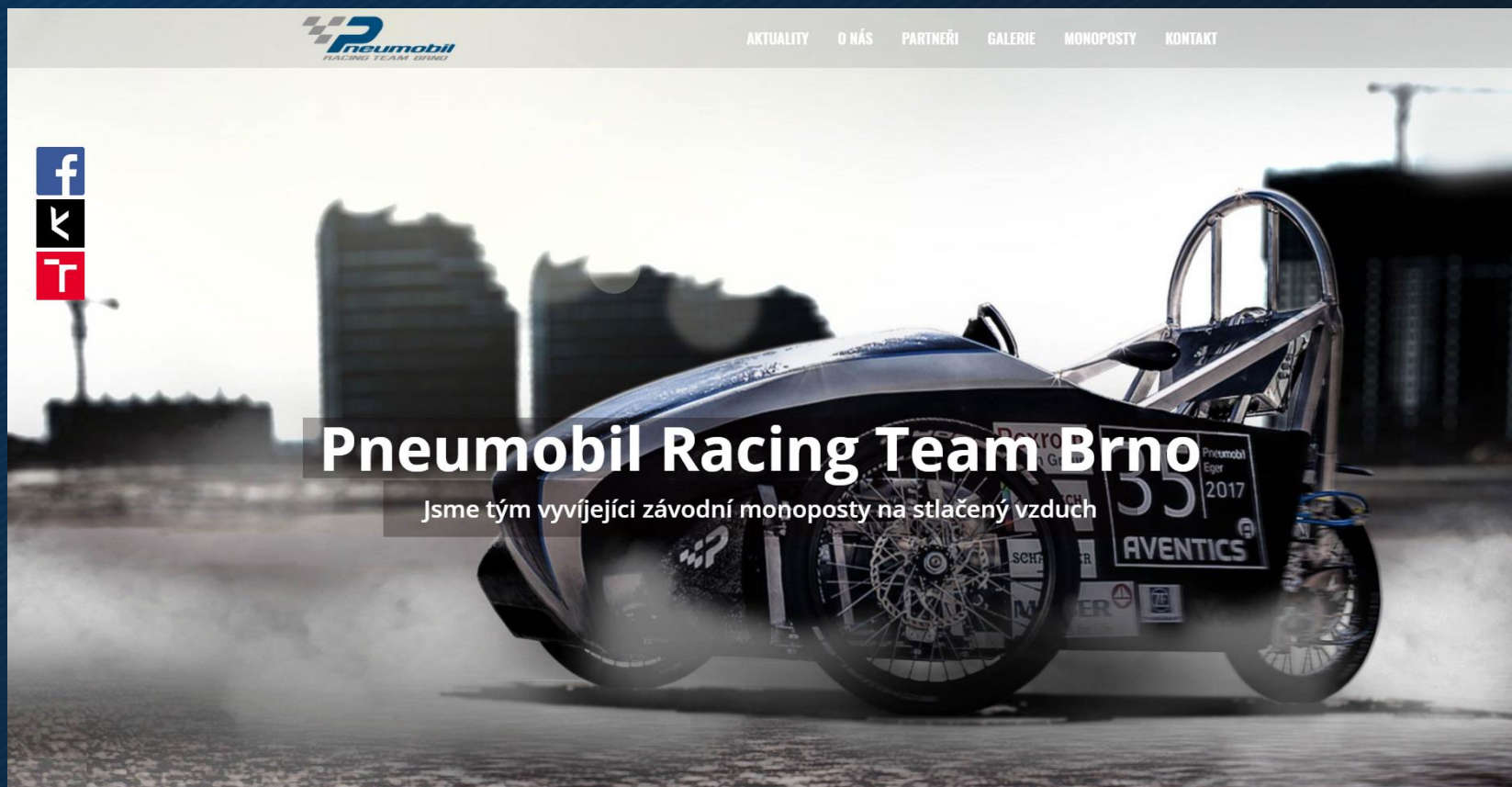
Learning by doing
Mentoring
Students working in a team
Promotion of BUT



Vision:

Interfaculty cooperation
Team structure
Win competitions







Thank you.

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