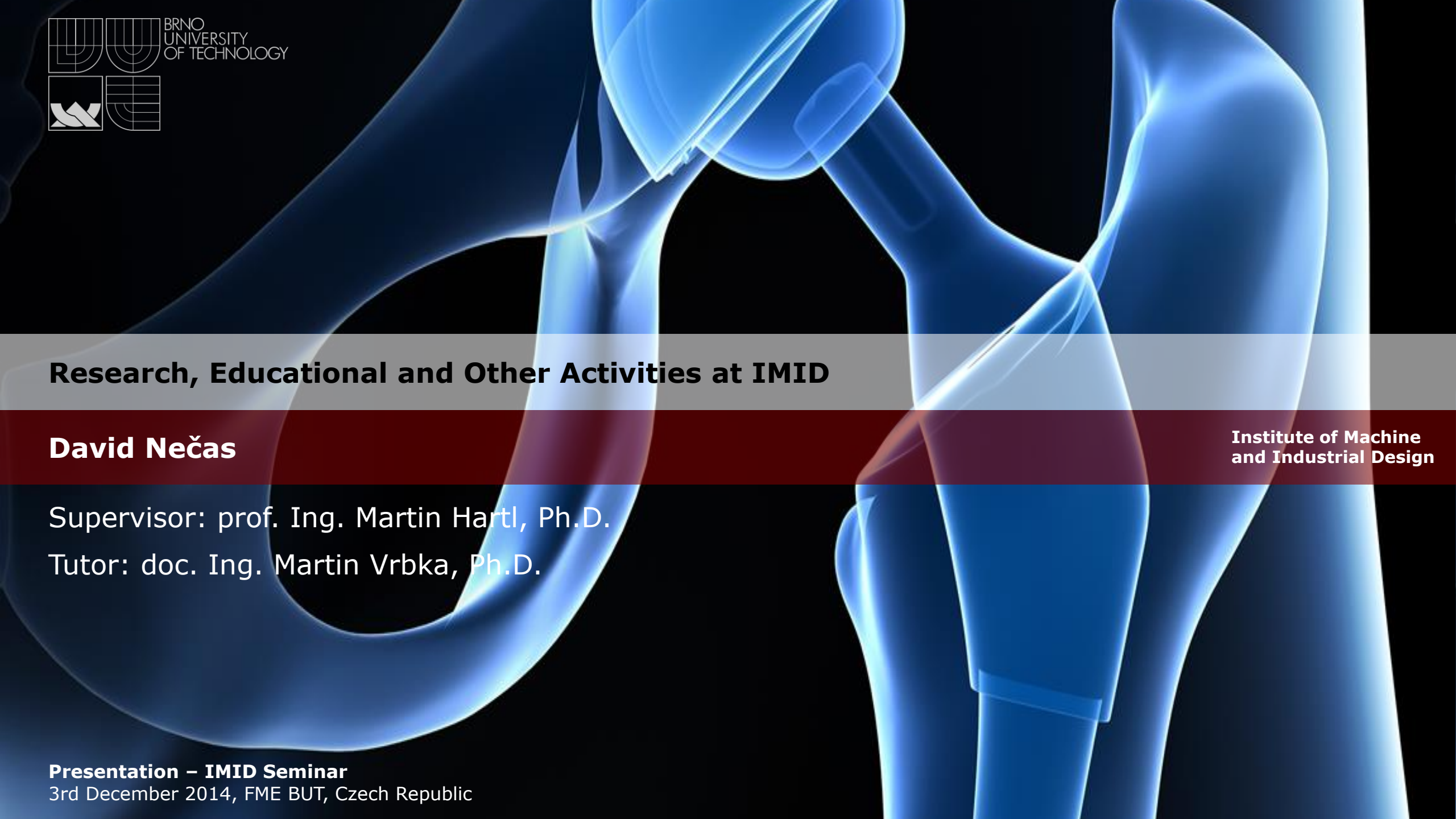


BRNO UNIVERSITY OF TECHNOLOGY

Research, Educational and Other Activities at IMID

David Nečas

Institute of Machine and Industrial Design

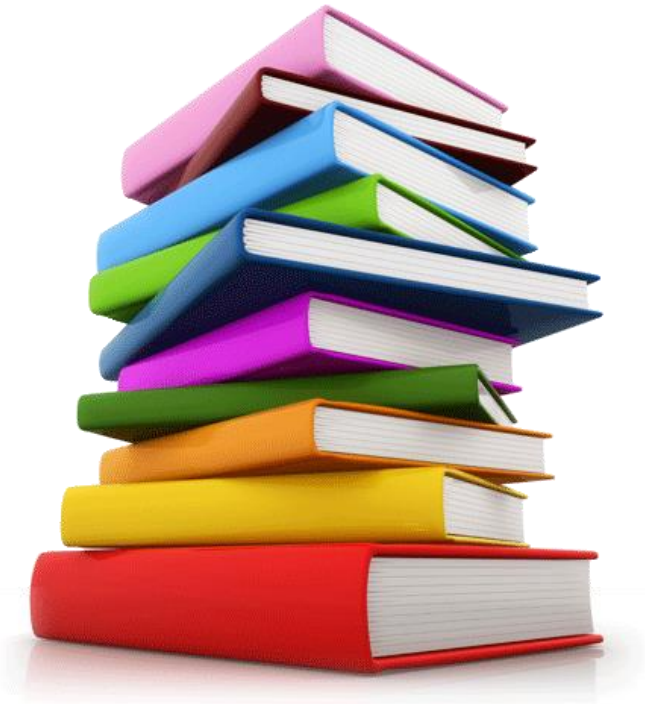
Supervisor: prof. Ing. Martin Hartl, Ph.D.

Tutor: doc. Ing. Martin Vrbka, Ph.D.

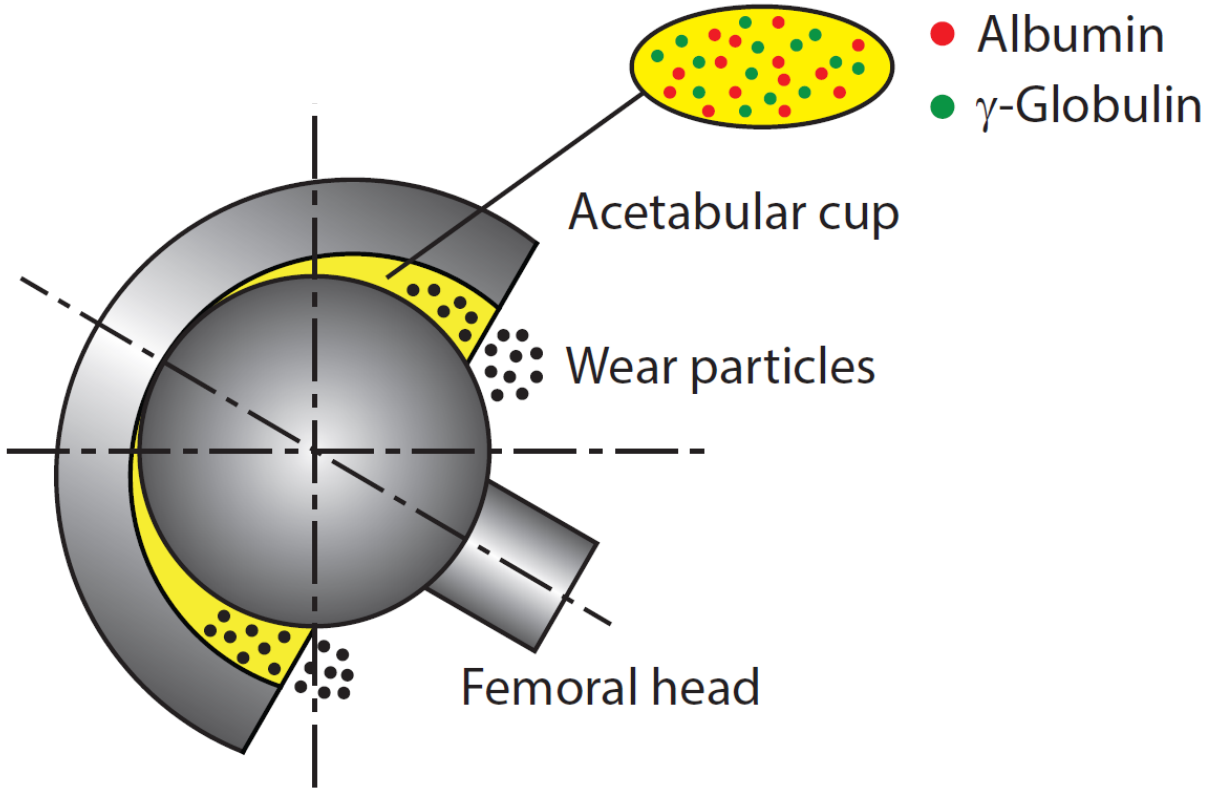
Presentation – IMID Seminar
3rd December 2014, FME BUT, Czech Republic

Contents

- Research activities
  - PhD thesis introduction
  - Experimental method
  - Internship at Kyushu University
  - Biotribology research
  - Publications
- Educational activities
- Other activities



- Topic: Analysis of lubricating film formation in hip joint replacements
  - Mavraki and Cann, 2011
  - Fan et al., 2011
  - Myant and Cann, 2013
  - Vrbka et al., 2014
  - Myant and Cann, 2014



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  - Mavraki and Cann, 2011
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  - Myant and Cann, 2013
  - Vrbka et al., 2014
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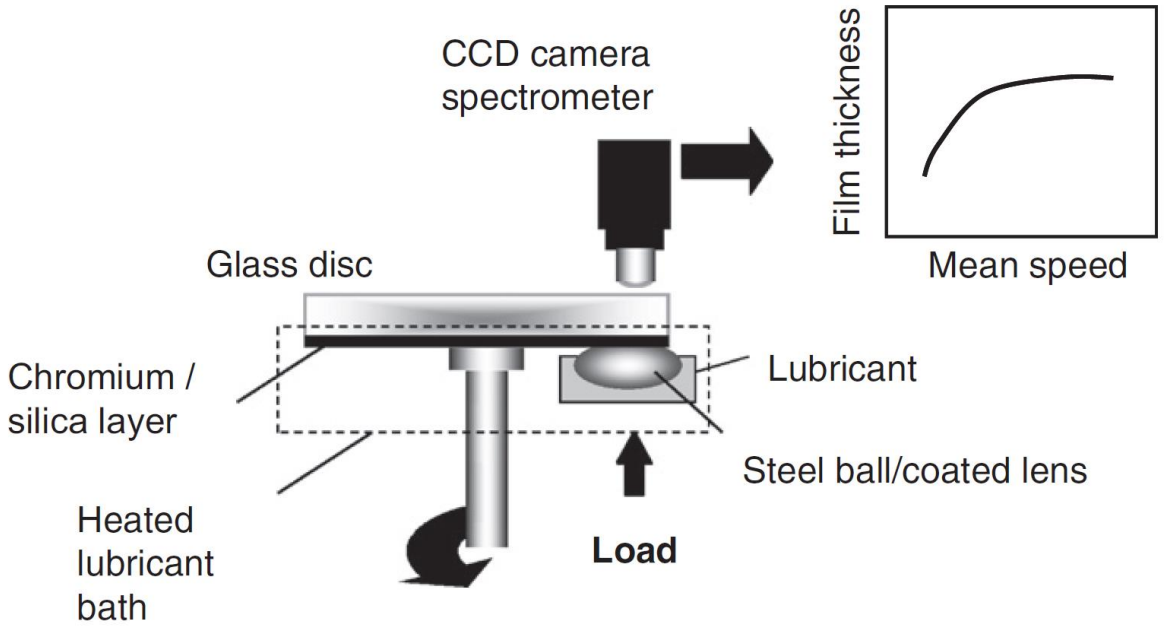
  - Contact lubricated by bovine serum (BS)
  - Non-newtonian fluid behavior



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  - Myant and Cann, 2013
  - Vrbka et al., 2014
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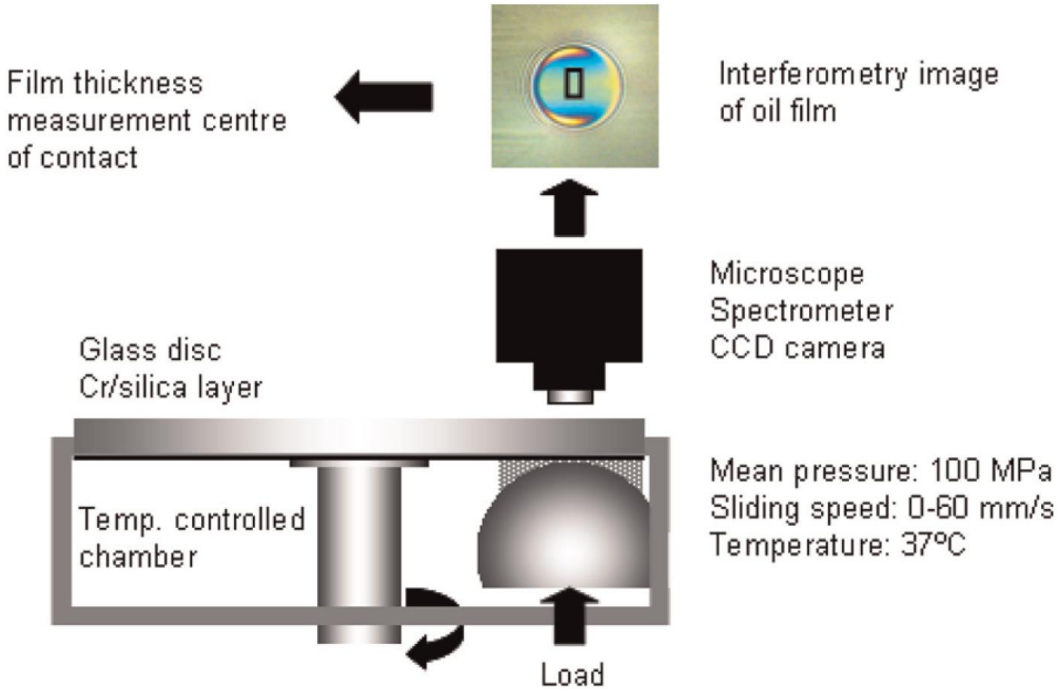
  - Real femoral head was investigated
  - Significant influence of lubricant composition



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  - Mavraki and Cann, 2011
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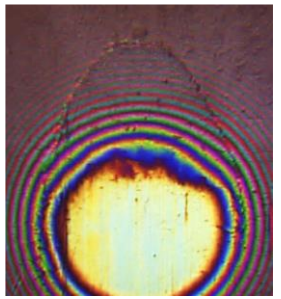
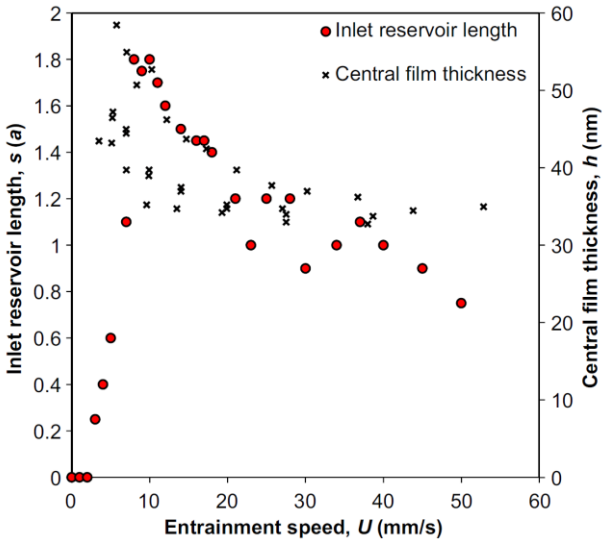
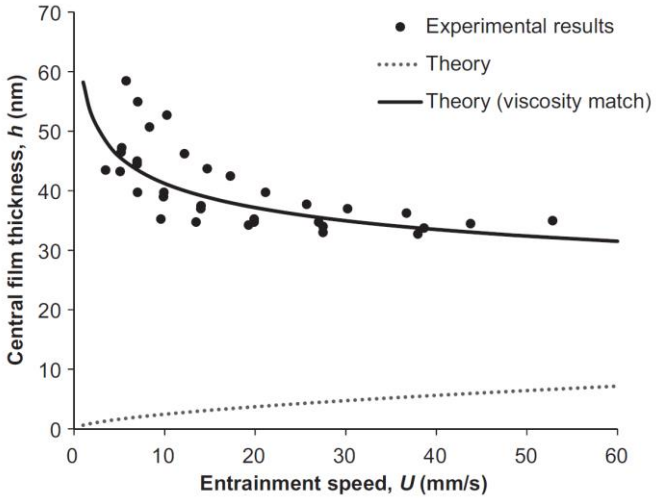
  - Myant and Cann, 2013
  - Vrbka et al., 2014
  - Myant and Cann, 2014
  - „Inlet phase" definition
  - Prediction with respect to shear thinning behavior of lubricant.







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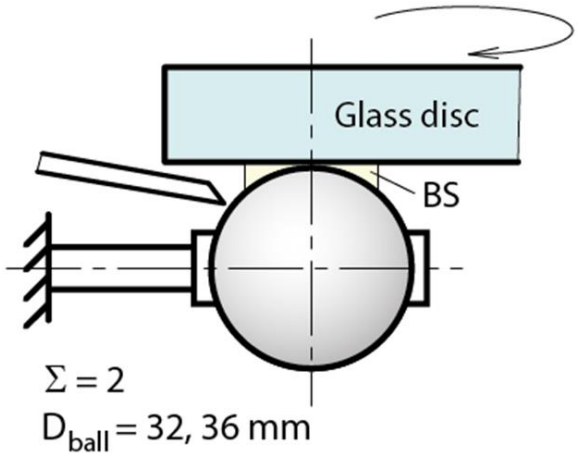
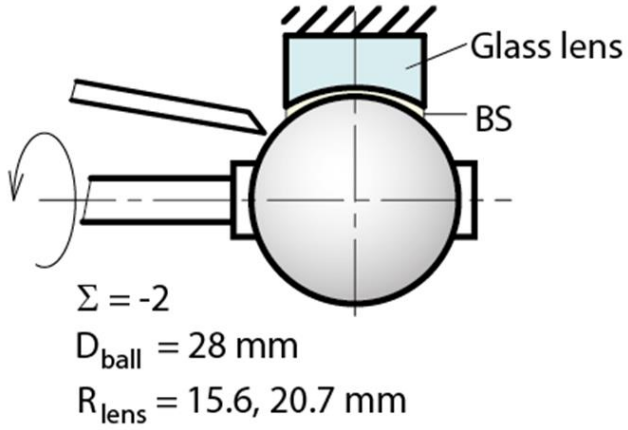
  - Myant and Cann, 2013
  - Vrbka et al., 2014
  - Myant and Cann, 2014

- Investigation of surface wettability
- Clear evidence of importance of conformity





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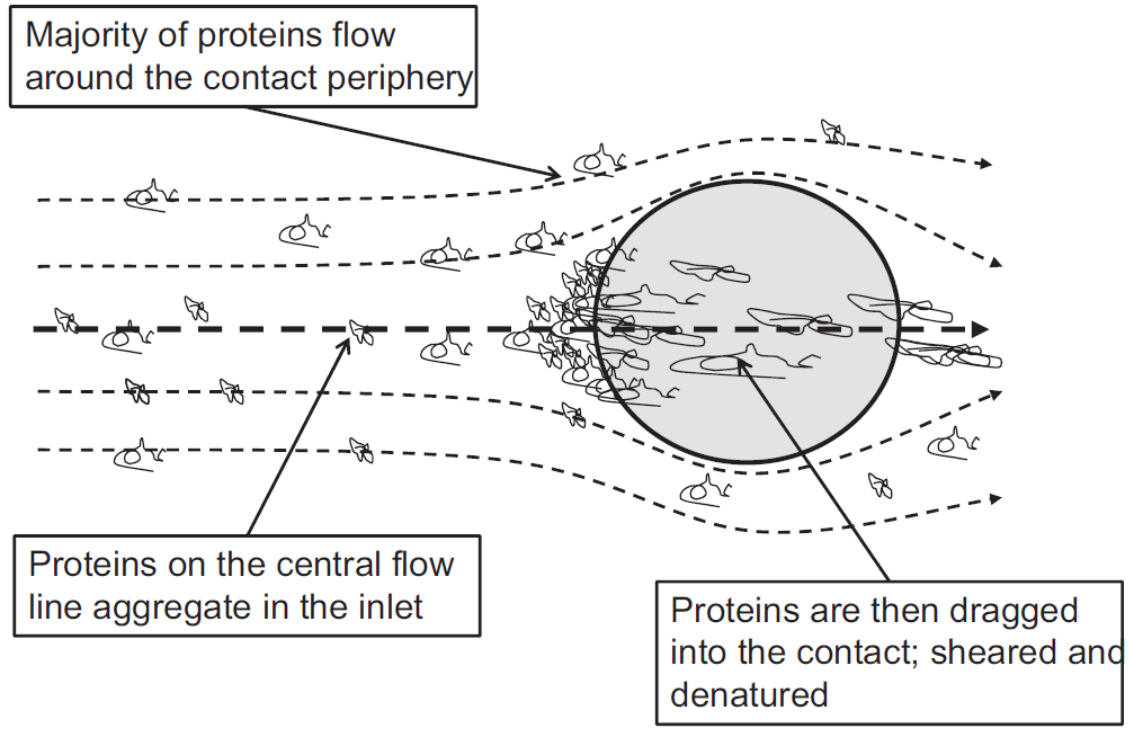
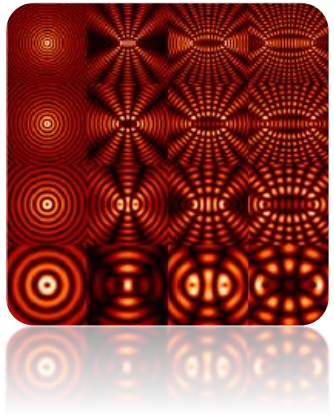
  - Mavraki and Cann, 2011
  - Fan et al., 2011
  - Myant and Cann, 2013
  - Vrbka et al., 2014
  - Myant and Cann, 2014
    - Protein aggregation lubrication „PAL“ definition
    - Fundamental difference against EHL.



- Aim of the thesis
  - The aim of the thesis is to describe protein film formation within artificial hip joints with emphasis on the influence of lubricant constituents
- Sub-aims
  - To choose and debug measurement method
  - To evaluate protein film formation
  - To analyze and generalize achieved results

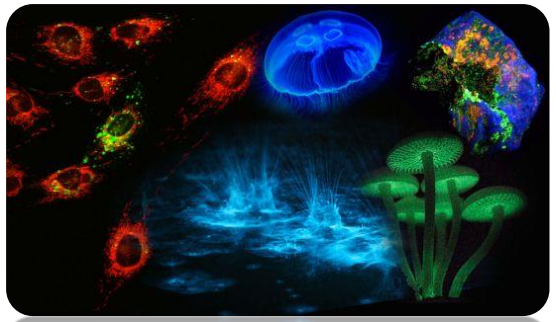
Experimental method

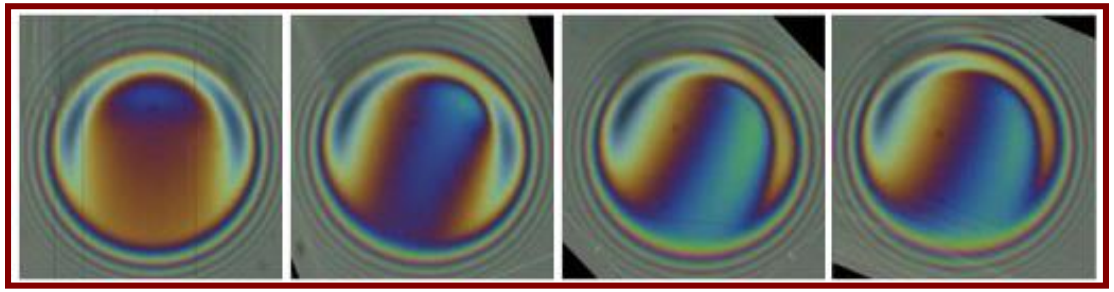
Optical interferometry



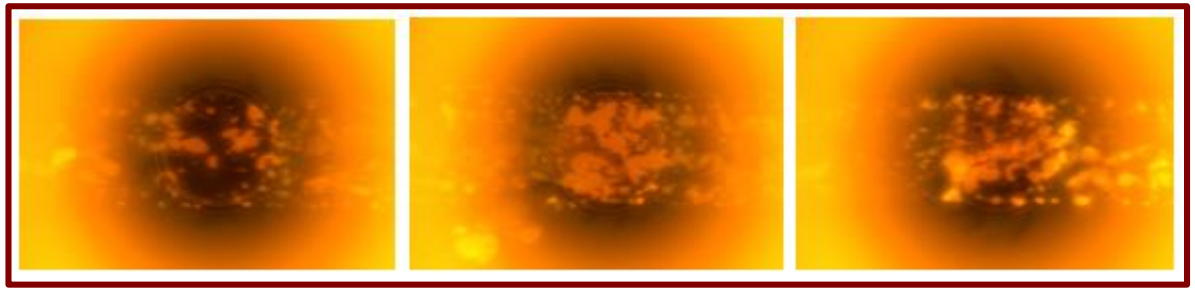
- \+ Film thickness evaluation
- \+ An insight into a contact
- − Lubricant constituents distinction
- − Analysis of non-reflective surfaces

Fluorescent microscopy



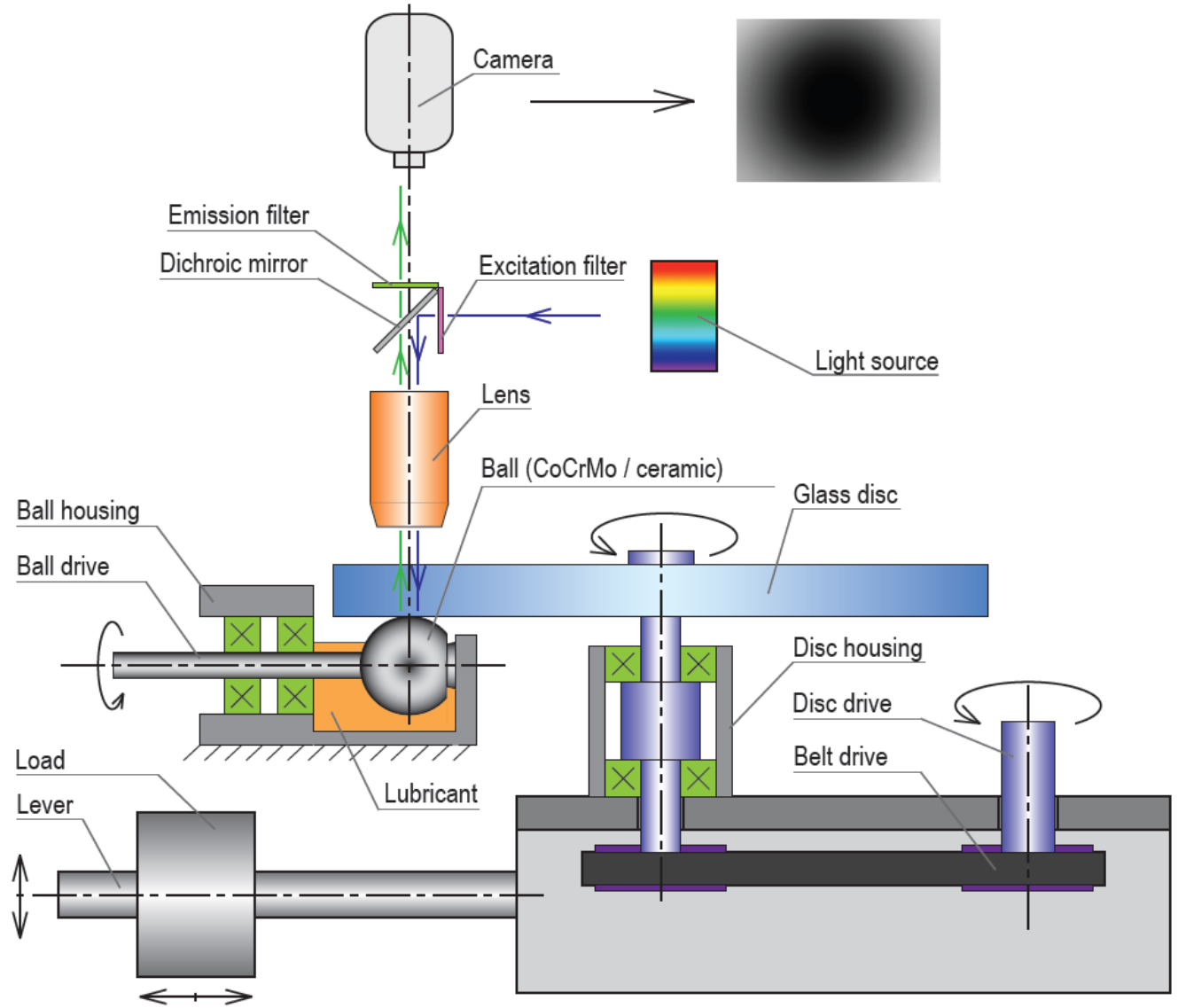


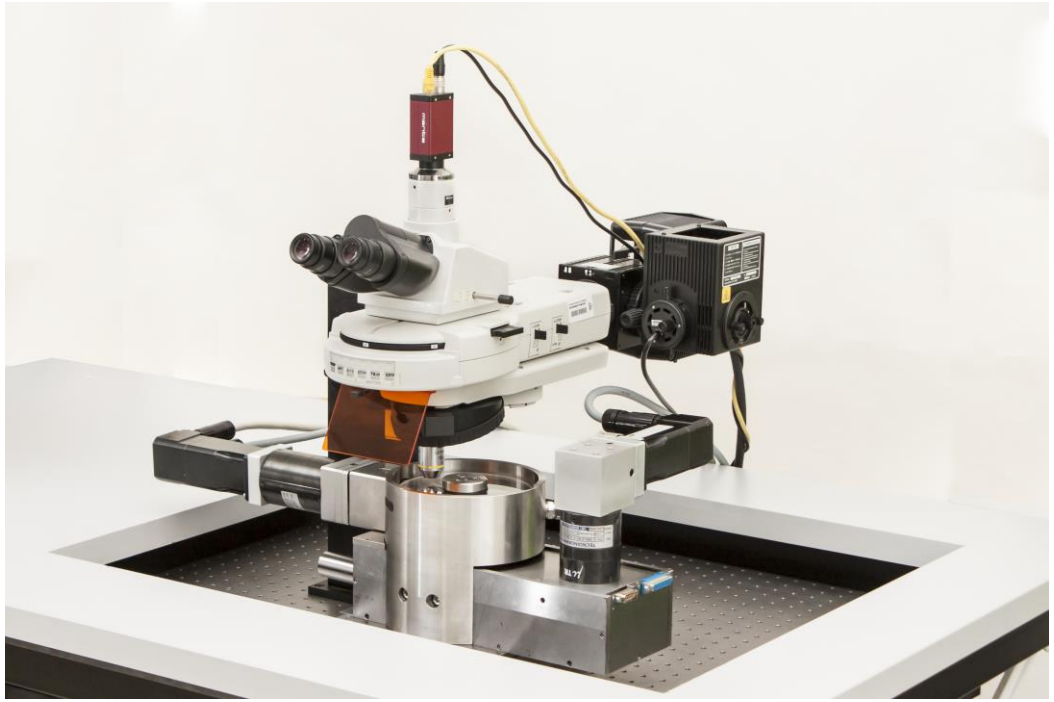
- The result is the gap between surfaces



- The result is the intensity of fluorescent dye

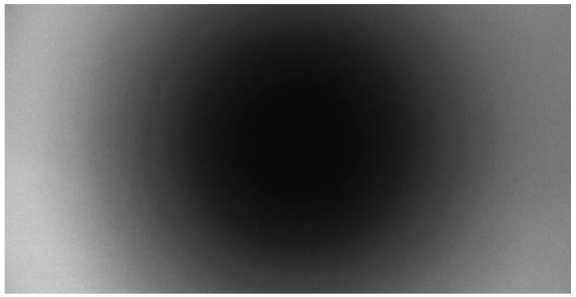
Experimental method - progress

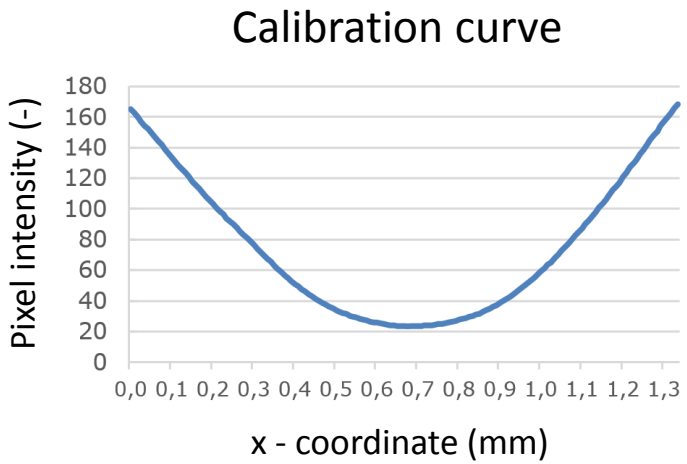


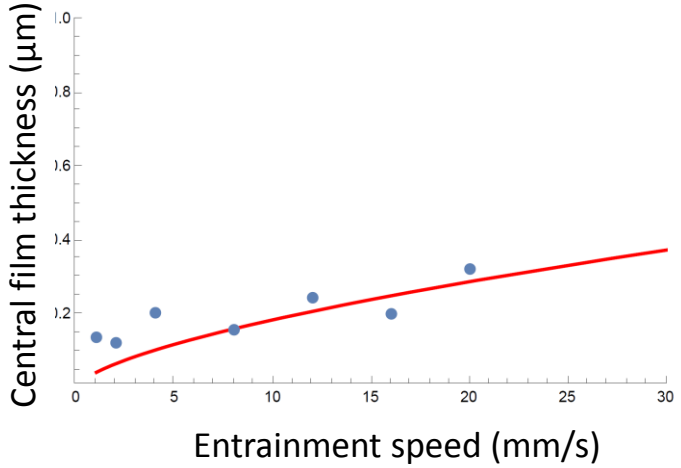


Experimental method - progress

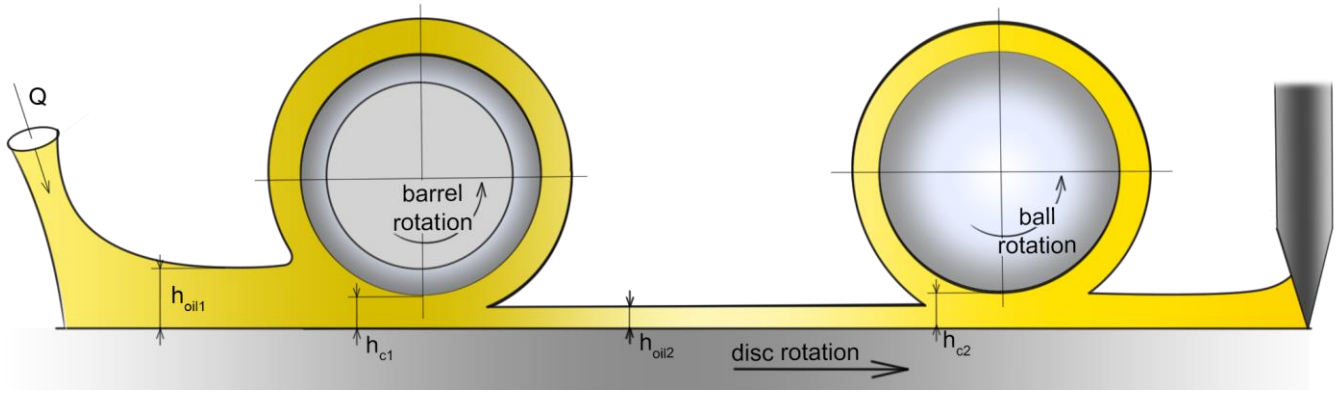
- Film thickness analysis of lubricated compliant bodies (diploma thesis)

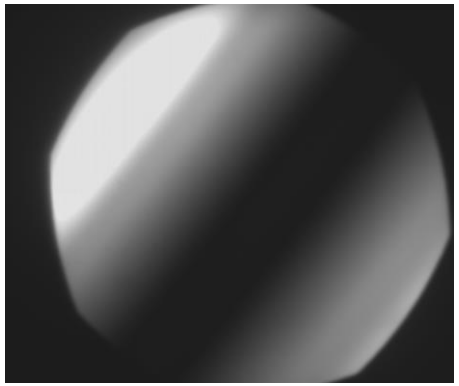


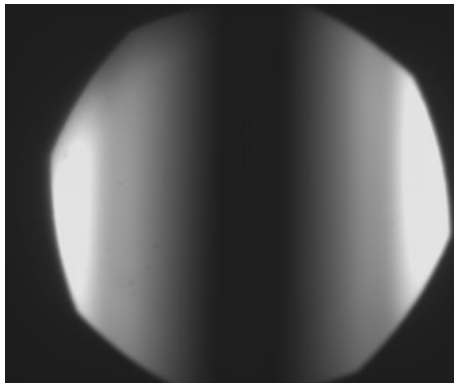




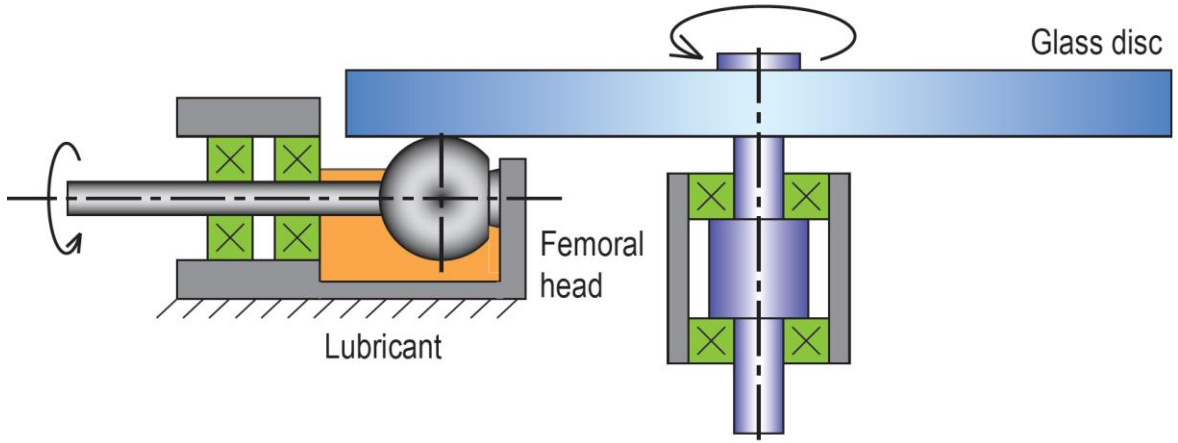
- Lubricant Division in EHL Contact Outlet





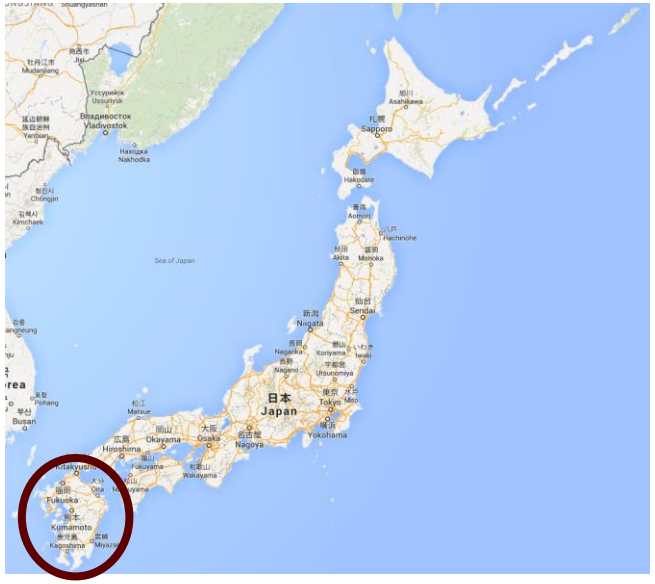


- Ball-on-disc model configuration – film thickness evaulation
  - CoCrMo x glass
  - CoCrMo x glass coated with Cr
  - Ceramic x glass
  - Ceramic x glass coated with Cr



- Model fluid composition
  - Usage of stained proteins (role of each protein on film formation)
- Influence of load and speed on protein film formation

Internship at Kyushu University

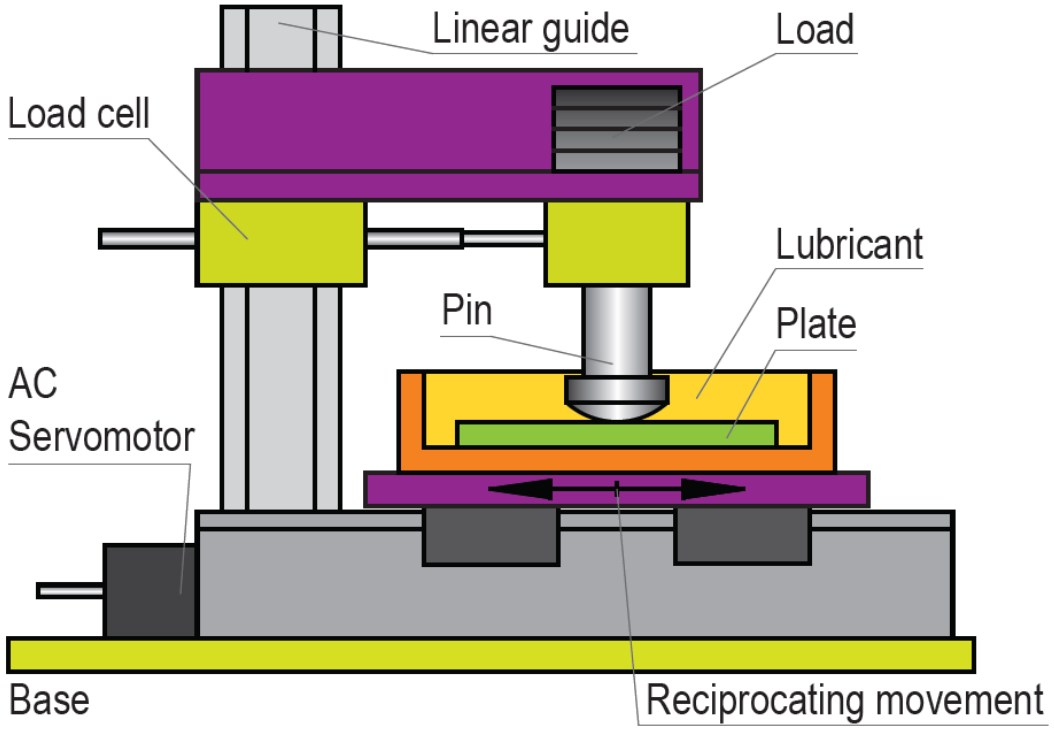


- Kyushu University
  - Fukuoka, Kyushu, Japan
  - ~ 2 300 Academic staff
  - ~ 20 000 Students
  - School of medicine, engineering, economics, …
  - 7th best university in Japan (~ 90 universities in total)

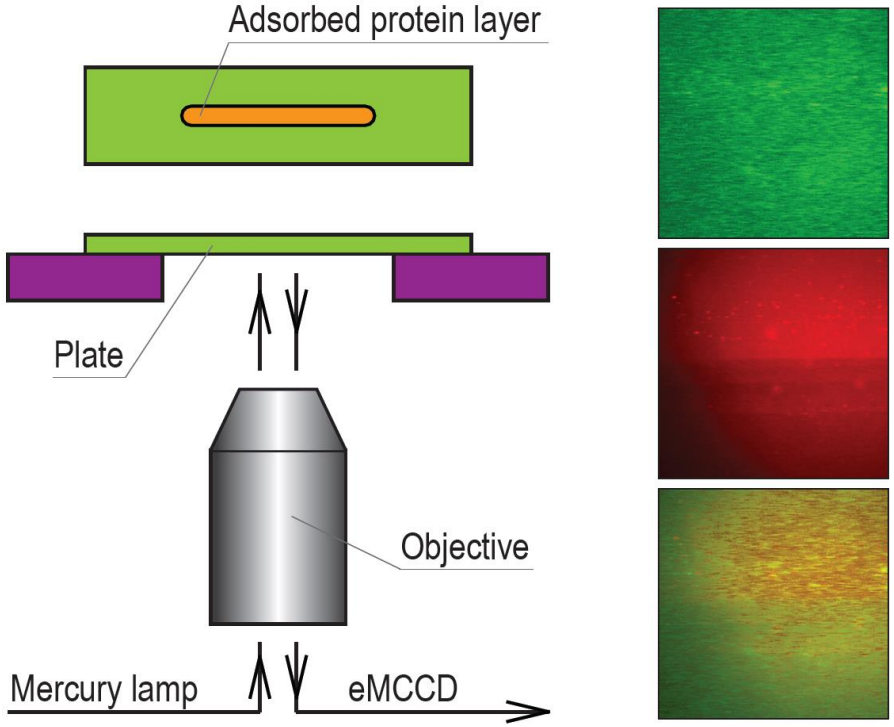
九州大学
KYUSHU UNIVERSITY

- Analysis of lubricant composition on coefficient of friction and protein adsorption on rubbing surfaces of artificial hip joints

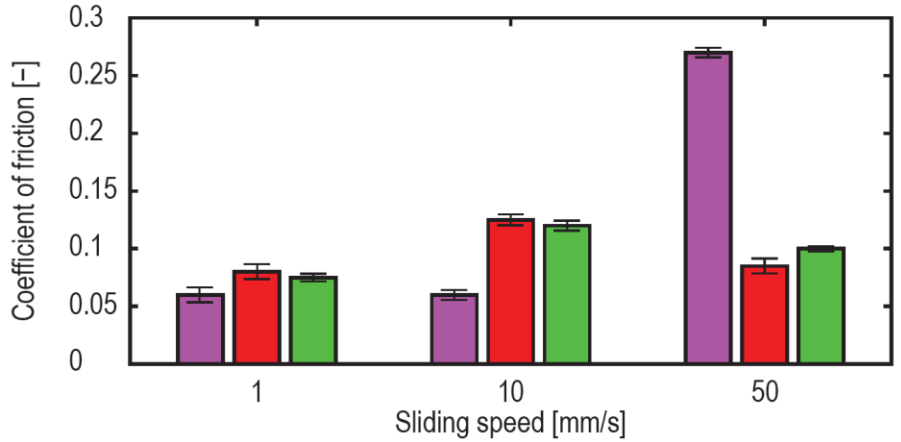
Pin-on-plate fiction test

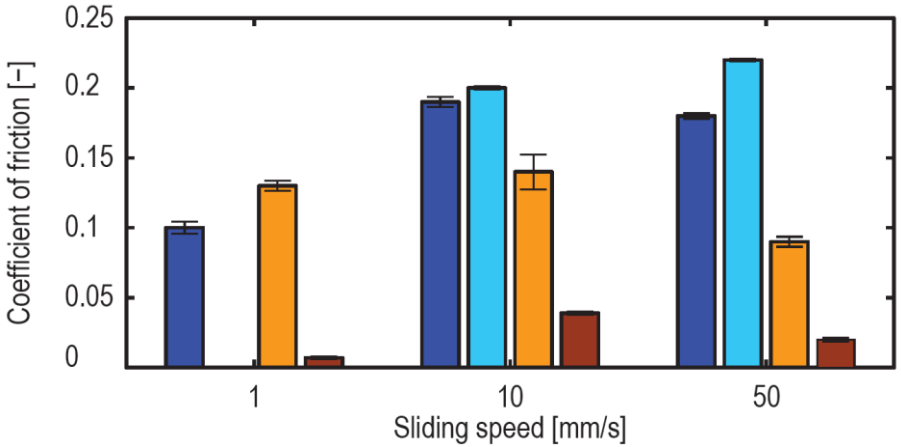


Fluorescence observation + ellipsometry

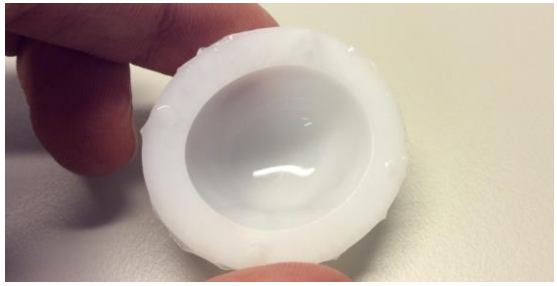


- Analysis of lubricant composition on coefficient of friction and protein adsorption on rubbing surfaces of artificial hip joints

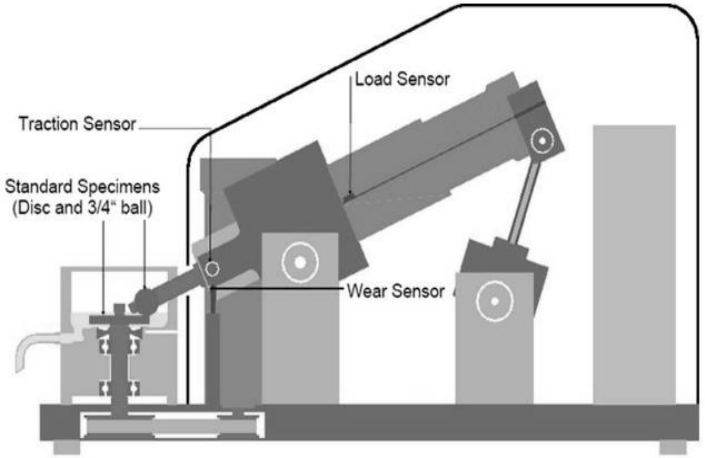




- PVA hydrogel research
  - ~ 85 % water content
  - One of the anticipating material for artificial cartilage



- Traction curves using MTM



ICMD 2014, Beroun
(presentation)

- Pendulum tests

ICoBT 2014, Toronto
(presentation)

Internship at Kyushu University – conlcuding remarks

- Experiences about protein film formation, protein labelling process
- Participation at Joint Forum of 2nd Japan-Singapore Exchange Seminar & ICT Farm Project, Kuju, Japan
- Cooperation establishment
- English improvement
- Japanese culture, food, people, amazing experience!

Biotribology research

- Cooperation with Orthopedic clinic, University Hospital Olomouc
  - Protein labelling (application of process learnt at Kyushu University)
  - Preparation of model fluids
- Plan of experiments (first experiments conducted)
- Cooperation with Institute of Materials Science and Engineering
  - Serhii Tkachenko, Ph.D.
  - Frictional properties of Ti-Si alloys for biomedical applications

Publications

VRBKA, M.; NEČAS, D.; HARTL, M.; KŘUPKA, I.; URBAN, F.; GALLO, J. Observation of thin films between artificial head and cup with respect to real geometry. SUBMITTED – Proc. IMechE, Part H: J. Engineering in Medicine

TKACHENKO, S.; NEČAS, D.; DATSKEVICH, O.; ČUPERA, J.; SPOTZ, Z.; VRBKA, M.; KULAK, L.; FORET, R. Microstructure and tribological behavior of hypoeutectic Ti-Si based alloys for potential biomedical applications. SUBMITTED - Wear

KOŠŤÁL, D.; NEČAS, D.; ŠPERKA, P.; SVOBODA, P.; KŘUPKA, I.; HARTL, M. Lubricant Division in EHL Contact Outlet. IN PREPARATION

NEČAS, D.; VRBKA, M.; ŠPERKA, P.; DRUCKMÜLLER, M.;SKLÁDAL, P.; ŠTARHA, P.; KŘUPKA, I.; HARTL, M. Qualitative Analysis of Film Thickness in Rolling EHD Contact by Fluorescence Technique. In Book of Proceedings of 54th International Conference of Machine Design Departments. Springer, 2013. s. 513-520. ISBN: 978-80-7372-986-8.

NEČAS, D.; VRBKA, M.; YARIMITSU, S.; NAKASHIMA, K.; SAWAE, Y.; ŠPERKA, P.; KŘUPKA, I.; HARTL, M. Frictional Properties of PVA Hydrogel. In 55th International Conference of Machine Design Departments. 2014. s. 147-152. ISBN: 978-80-01-05542-7.

TKACHENKO, S.; NEČAS, D.; DATSKEVICH, O.; ČUPERA, J.; SPOTZ, Z.; VRBKA, M.; KULAK, L.; FORET, R. Tribological behavior of Ti– Si based in situ composites under sliding. In Metal 2014. Ostrava: Tanger Ltd., 2014. s. 2704-2709. ISBN: 978-80-87294-52-9.

Joint Forum of 2nd Japan-Singapore Exchange Seminar & ICT Farm Project 2013, Kuju - Presentation

ICoBT 2014, Toronto – Presentation + poster

EORS 2014, Nantes – Poster

Tribology frontiers 2014, Chicago – 2 presentations

Educational activities

- 9AJ - English for Doctoral Degree Study
- 9MOP - Methodologies of Scientific Work
- 9VPR - Research Project and its Management
- 9EHD - Elastohydrodynamics
- 9EXT - Experimental Methods in Tribology

- **Doctoral exam (10/2014)**

Teaching activities

- Winter semester
  - 5KS – Machine Design – Machine Elements
  - ZKP – Team Project
  - ZSY-A – Finite Element Method – ANSYS Classic
    - New educational materials in English
- Summer semester
  - 6KT – Machine Design – Machine Drives
  - ZAW – Finite Element Method – ANSYS Workbench

Bachelor thesis supervising

- Design of the loading mechanism for low load
- Lubricants created by nature
- Methodological guide and digitization of gear pump
- A review of hip joint replacements in terms of wear

Diploma thesis supervising

- Analysis of lubricated compliant contact – final year
- FEM simulation of elastohydrodynamic contact – final year
- Laser induced fluorescence for studying compliant contacts – first year
- Experimental analysis of lubricant film formation in total hip joint replacements – first year

Other activities

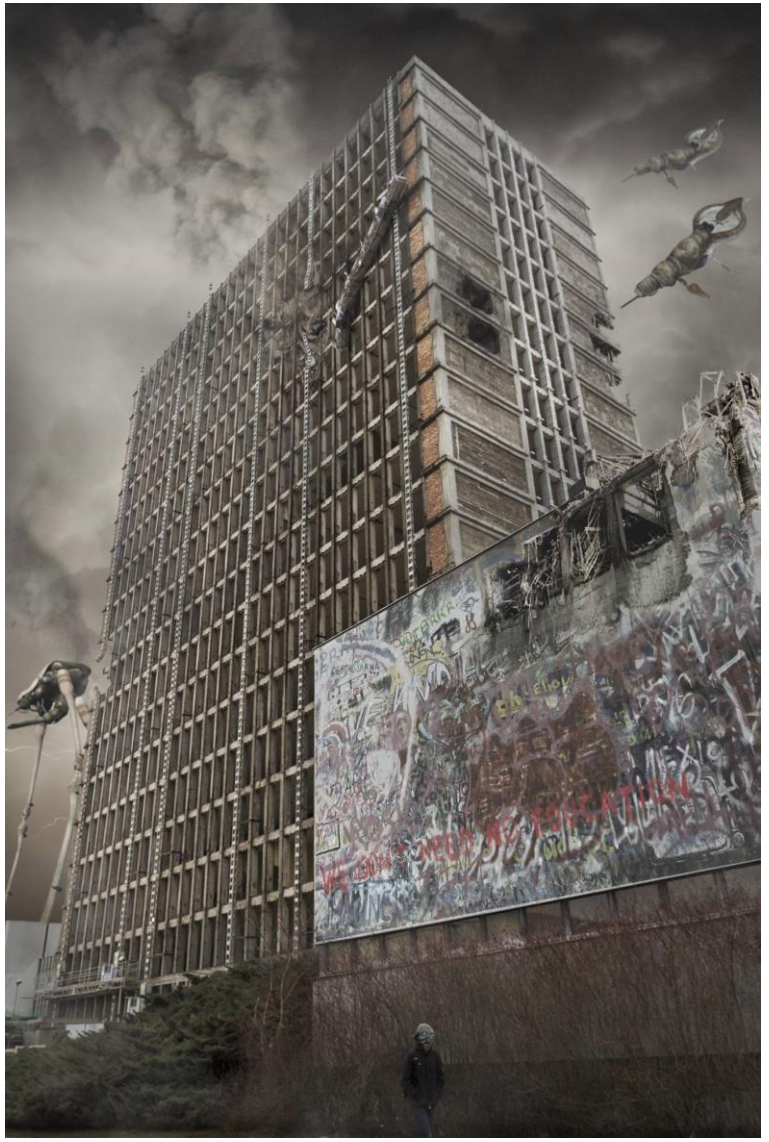
- Open days
- Meetings with students

- HS13457126
- HS13457060
- HS13457173

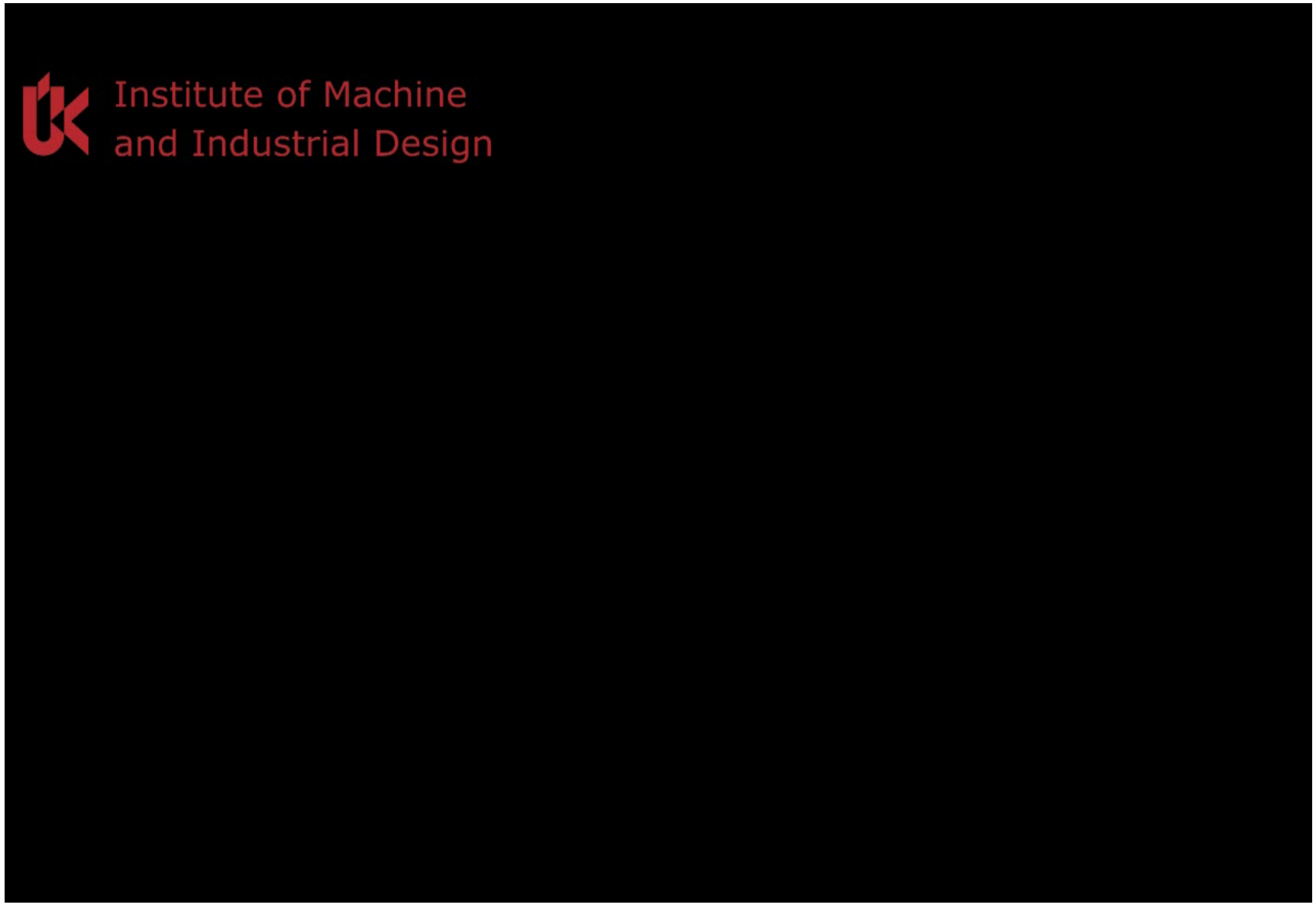
- Projects
  - IGA - The influence of joint fluid composition on formation of lubricating film in THA
  - Specific research – Analysis of friction, wear and lubrication of joint replacements

- Academic Senate member (from 11/2014)
  - Member of Financial Commission
  - Member of Commission for Science and Research

Other activities



Other activities



Thank you for your kind attention

David Nečas

Institute of Machine and Industrial Design