ACTIVITIES AT IMID (2022 – 2025)

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Brno University of Technology

Brno, 5.2.2025

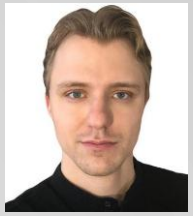
ÚSTAV
KONSTRUOVÁNÍ

Biotribology Research Group









Team Pneuracer




- Part-time job – 3 days

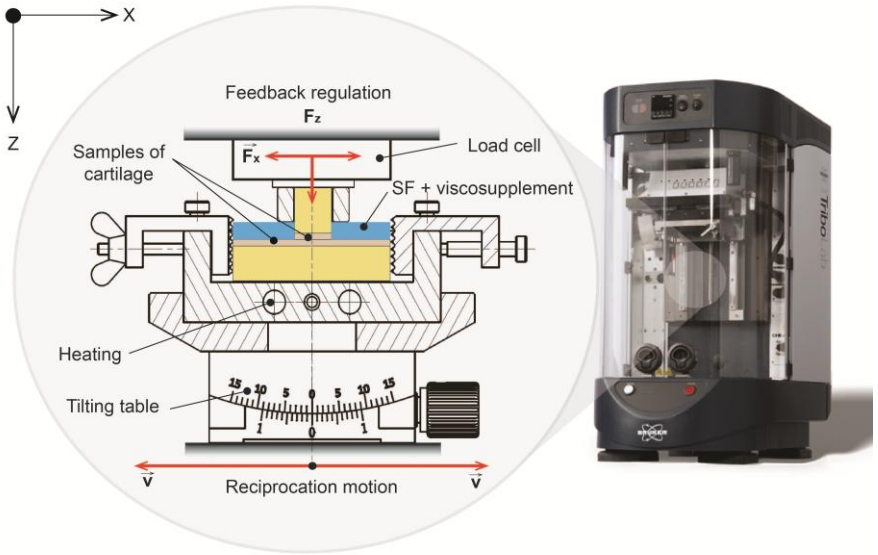
- 2 days - Research activities: Biotribology
- 1 day - Pneuracer

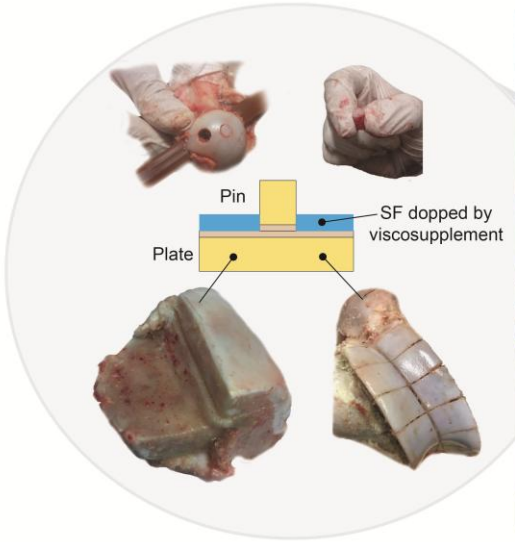
ÚSTAV
KONSTRUOVÁNÍ

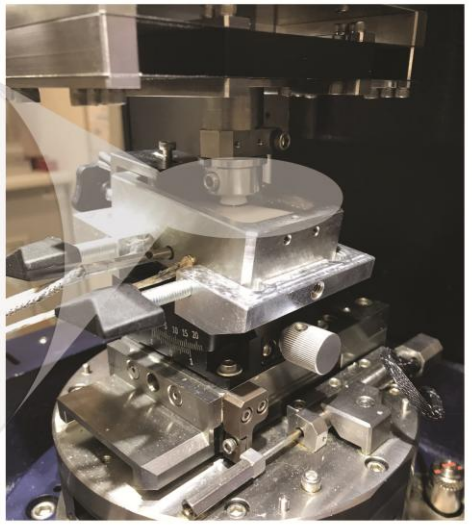
Project – GACR Viscosupplementation

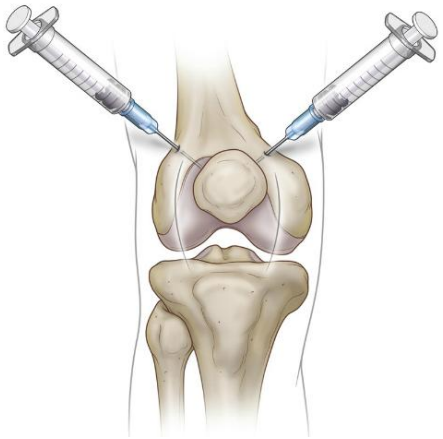
GACR - An investigation of joint fluid viscosupplementation and its impact on friction and lubrication (2019 – 2022)

Czech Science Foundation President's Award - awarded project in the field of technical sciences





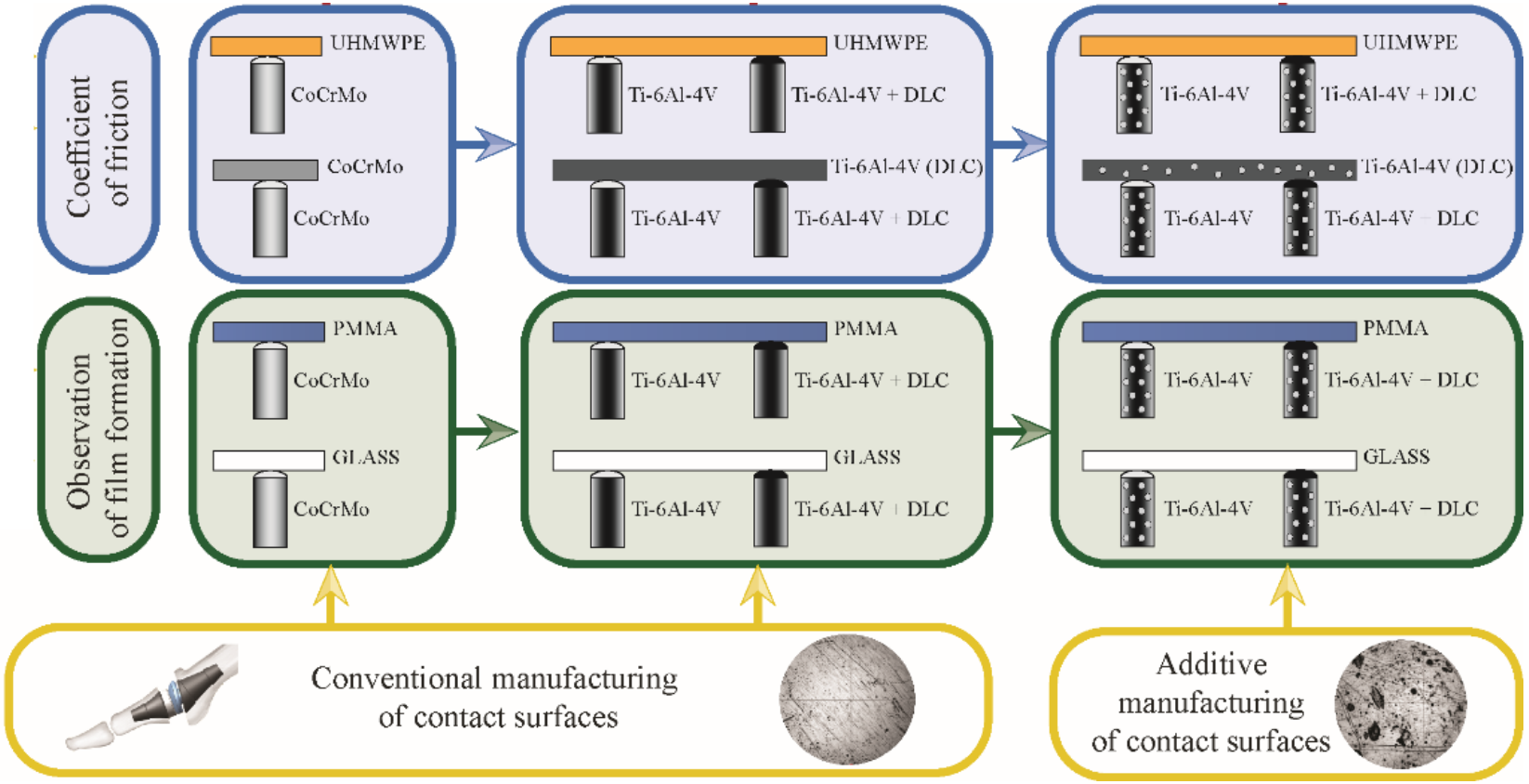




- A decrease in the COF was observed after application of the viscosupplements with a higher molecular weight.
- Viscosupplementation yields the most benefits for early stages of the osteoarthritis when most of the cartilage functions are still sound.

Project - GACR 3D printed implants

- **GACR -** Study of lubrication of small joint implants produced by 3D metal printing (2021 – 2024)



Project - GACR 3D printed implants

- **GACR -** Study of lubrication of small joint implants produced by 3D metal printing (2021 – 2024)

Conditions

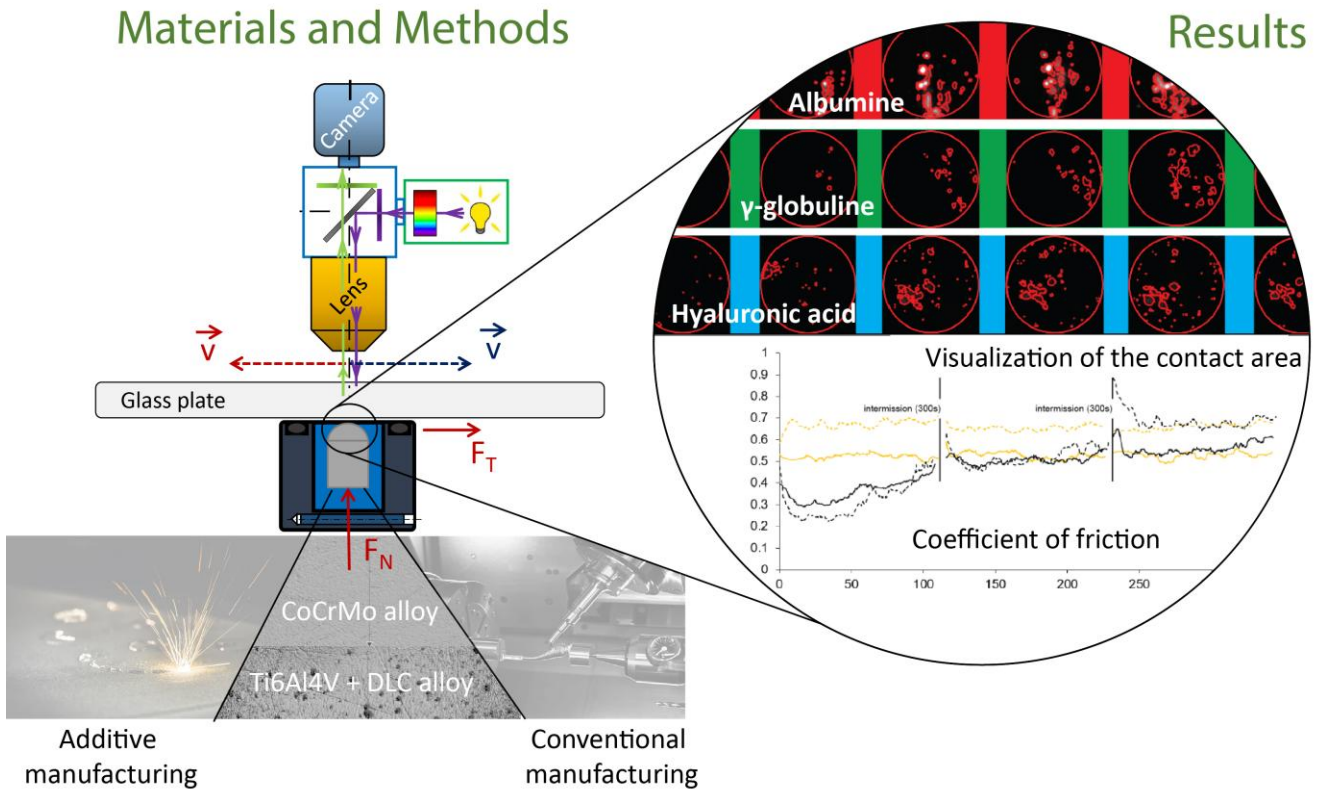
- Velocity 10 mm/s
- Load 0.1 N
- Contact pressure 45 – 53 MPa
- Total distance 3000 mm

Material combinations

- CoCrMo / Glass
- Ti6Al4V + DLC / Glass

Lubricant

Model synovial fluid
(Albumin, γ-Globulin, Phospholipids, HA)



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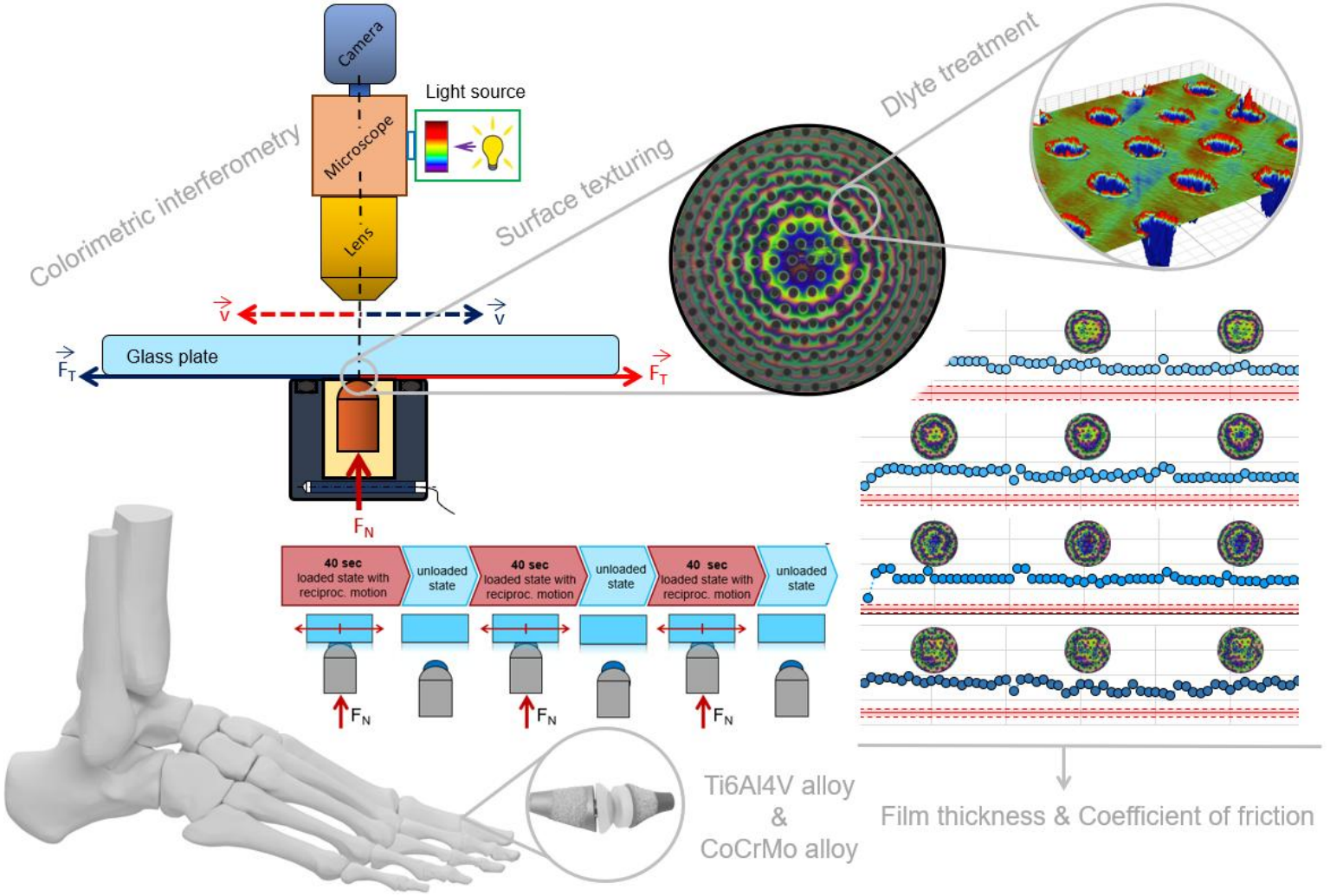
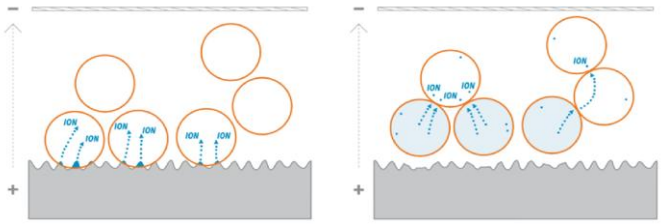
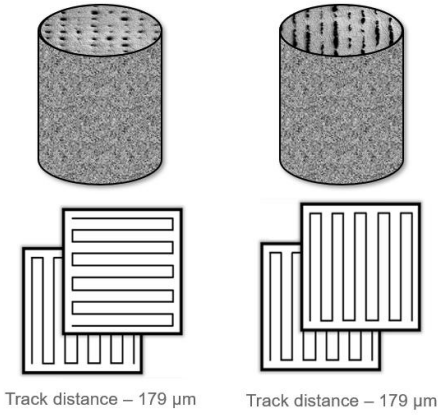
Project - GACR 3D printed implants



Application of electrolyte - 0.4 - 6 min





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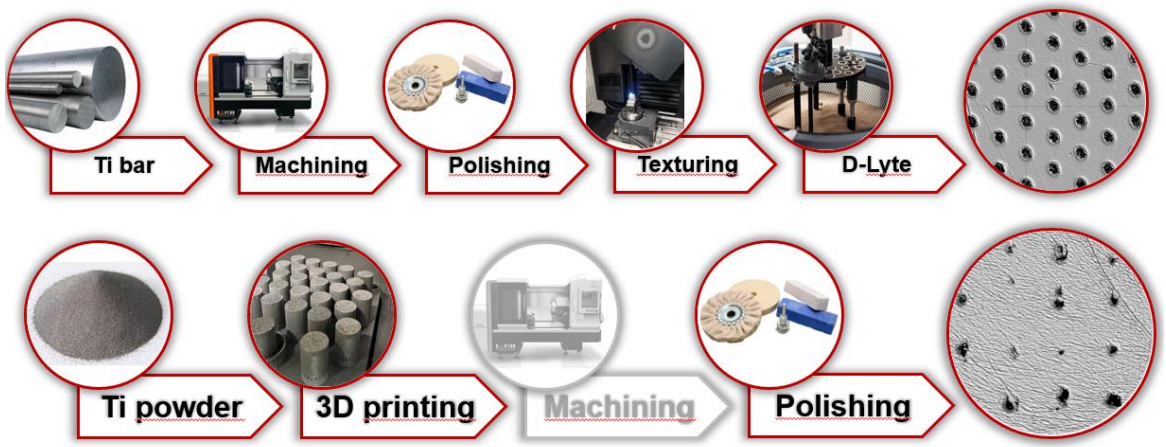
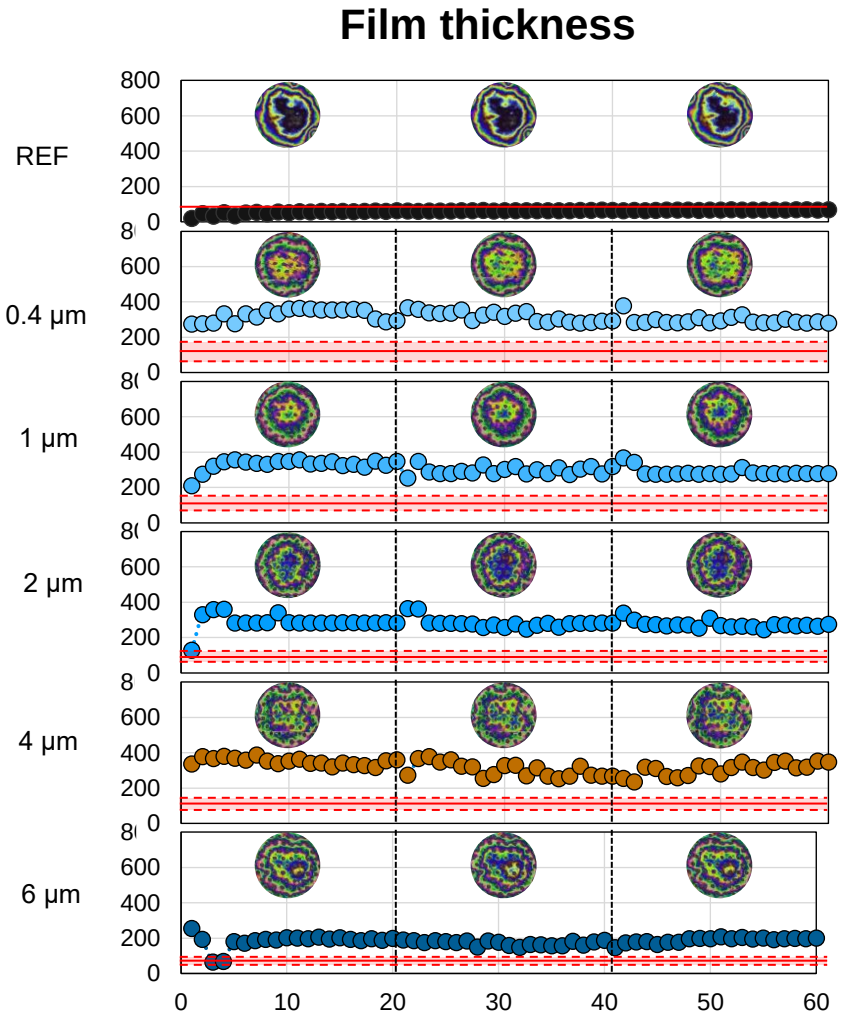
Project - GACR 3D printed implants

Ti6Al4V alloy

- complete separation of surfaces by a protein film
- reduction wear
- „protein lubrication regime“
- significantly increased proteins in textured and structured surfaces





INSTITUTE OF MACHINE AND INDUSTRIAL DESIGN

Publications

2024

RANUŠA, M.;ODEHNAL, L.; KUČERA, O.; NEČAS, D.; HARTL, M.; KŘUPKA. I.; VRBKA., M.;Effect of Surface Texturing on Friction and Lubrication of Ti6Al4V Biomaterials for Joint Implants. Tribology Letters, 73 (15), 2025. https://doi.org/10.1007 /s11249-024-01950-5. Accepted 04 December 2024
Q2,IF 2,9

ODEHNAL, L.; RANUŠA, M.; MALÝ, M.; KŘUPKA, I.; KOUTNÝ, D.; HARTL, M.; VRBKA, M.; Tribological behaviour of additively manufactured Ti6Al4V with controlled surface structure: An application in small joint implants Tribology International. 2024. Submitted 07 November 2024 (TRIBINT-D-24-04410); **Under review. Q1,IF 6,1**

NECAS. D.; GELNAR. A.; ROTHAMMER, B.; MARIAN, M.; RANUŠA, M.; WARTZACK, S.; VRBKA, M.; KŘUPKA, I.; HARTL, M. Frictional Behavior and Surface Topography Evolution of DLC-Coated Biomedical Alloys Biosurface and Biotribology. 2024. Submitted 10 December 2024 (BSB-2024-12-0027); **Under review, Q3,IF 1,6**

2023

ODEHNAL, L.; RANUŠA, M.; VRBKA, M.;. Tribological behavior of CoCrMo and Ti6Al4V alloys suitable for human joint implants: Application on first MTP joint. *Tribology International,* **Q1,IF 5,62**

REBENDA, D.; RANUŠA, M.; ČÍPEK, P.; TOROPITSYN, E.; VRBKA, M. In Situ Observation of Hyaluronan Molecular Weight Effectiveness within Articular Cartilage Lubrication. *Lubricants,* 2023, roč. 11, č. 1, ISSN: 2075-4442. **Q2, IF 3,584**

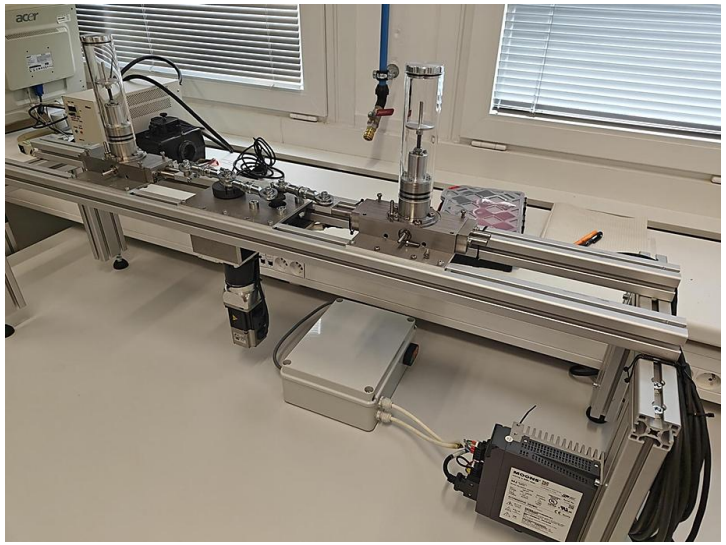
ODEHNAL, L.; RANUŠA, M.; WIMMER, M.; VRBKA, M.; KŘUPKA, I. Development of lubrication film and influence on friction in a total knee replacement during a gait cycle. *Tribology International,* 2023, roč. 178, č. Únor, s. 108073-108073. ISSN: 0301-679X. **Q1,IF 5,62**

2022

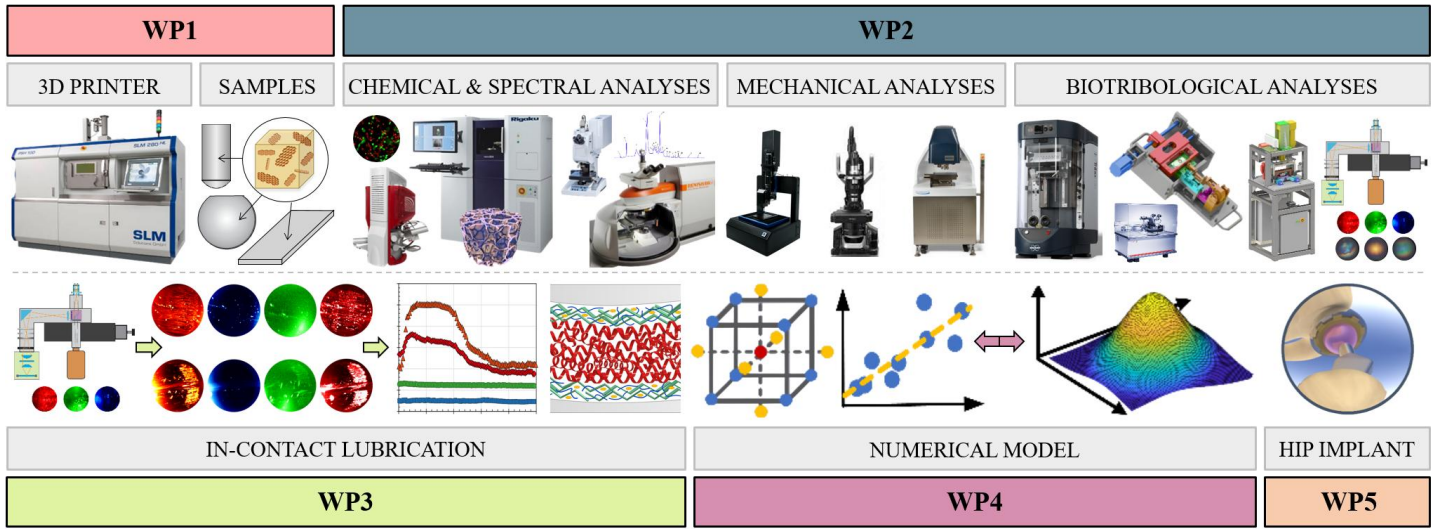
RANUŠA, M.; ONDRA, M.; REBENDA, D.; VRBKA, M.; GALLO, J.; KŘUPKA, I. Effects of Viscosupplementation on Tribological Behaviour of Articular Cartilage. *Lubricants,* 2022, roč. 10, č. 12, ISSN: 2075-4442. **Q2, IF 3,584**

RANUŠA, M.; ČÍPEK, P.; VRBKA, M.; PALOUŠEK, D.; KŘUPKA, I.; HARTL, M. Tribological behaviour of 3D printed materials for small joint implants: A pilot study. *Journal of the mechanical behavior of biomedical materials,* 2022, roč. 105274, č. 132, ISSN: 1751-6161. **Q2, IF 4,042**

Future plans



- Fluorescence observation of 3D printed surfaces
- the impact of the use of DLC coatings
- Wear analysis
- AZV project (in review)



- partial involvement in the project: 3D-printed composites with a metal matrix reinforced by 2D MXene nanolayers for next-generation biomedical implants. applicant doc. Nečas

Participation in research projects

Projects:

- GACR An investigation of joint fluid viscosupplementation and its impact on friction and lubrication 2019, applicant prof. Vrbka
  - Project successfully ended in 2022
- GACR Study of lubrication of small joint implants produced by 3D metal printing 2021, applicant prof. Vrbka
  - Project successfully ended in 2024
- TACR SIGMA 2023 - Study of lubrication of small joint implants produced by 3D metal printing, applicant Ranuša
  - Unfunded project
- TACR SIGMA 2024 - Development of a structured friction surface for a small joint implant manufactured using 3D printing, applicant Ranuša
  - Unfunded project
- AZV– (member of the research team)
  - Project in review
- GACR - 3D-printed composites with a metal matrix reinforced by 2D MXene nanolayers for next-generation biomedical implants
  - Partial involvement in the project

Other activities

Diploma Theses (2x)

Bc. Kučera 2024, Tření a mazání kloubní chrupavky

Bc. Martin Ondra 2022, Vliv viskosuplementace na mazání kloubní chrupavky

Bachelor Theses (6x)

Matyáš Heto 2024, Tření titanových povrchů v implantologii

Michael Koutný 2024, Struktury povrchů u implantátů vyrobených 3D tiskem

Mikuláš Křístek 2024, Laserová úprava povrchů malých kloubů člověka

Ondřej Kučera 2023, Dopad struktury povrchu implantátu na tření

Martin Matovič 2022, Vliv mikrostruktur povrchu implantátu na mazací procesy v kontaktu

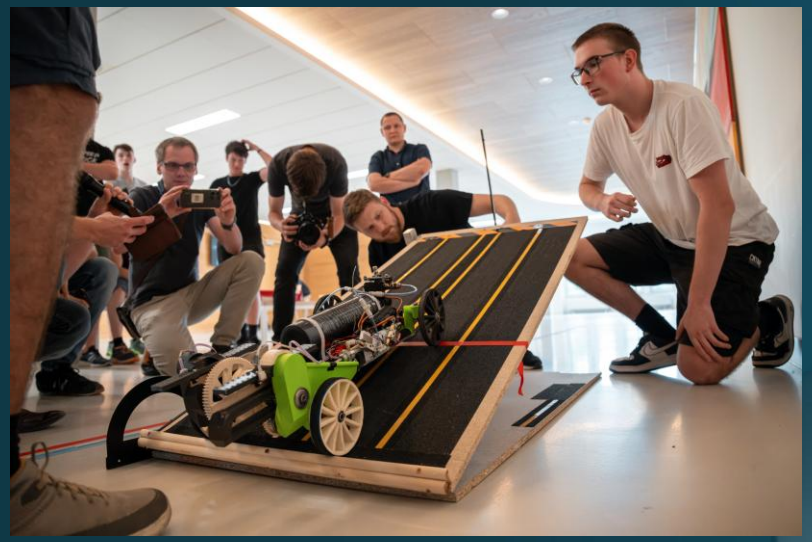
Jakub Montag 2022, Konstrukce vrtačky na ocelové trubky

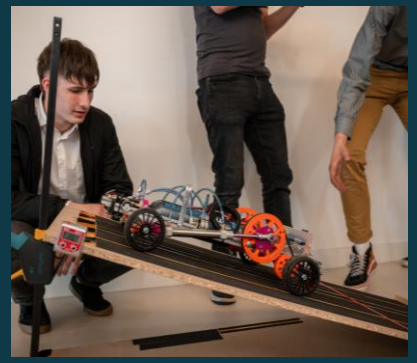
Teaching

0ZP – supervising, teaching

PNEURACER

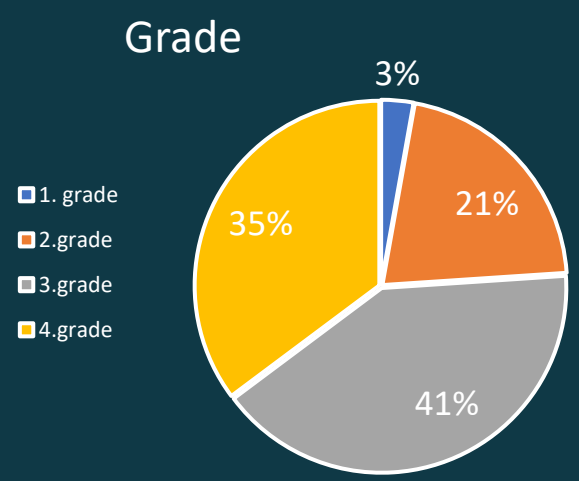
1st year of the competition

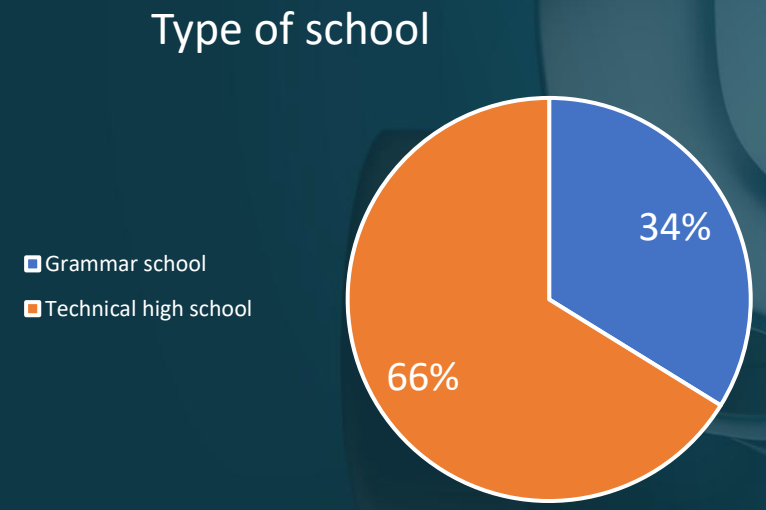




1st year of the competition

- 27 registred teams
- 17 advancing to the second round
- 10 finalists
- 71 students (10 students were admitted to VUT)
- 10 teachers

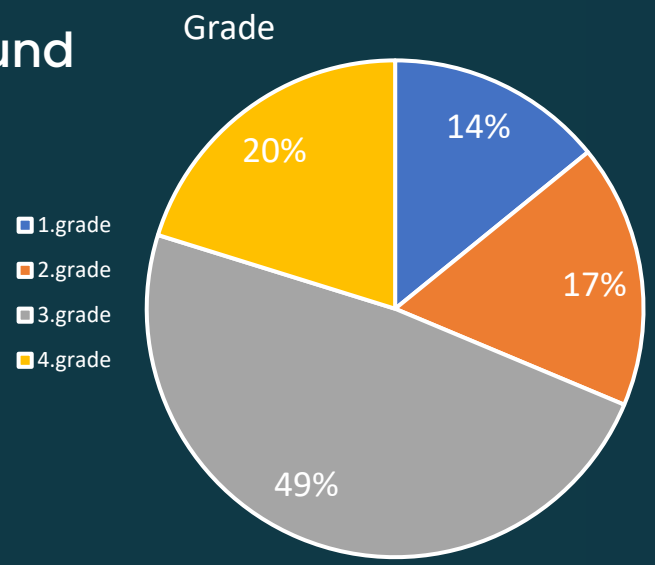


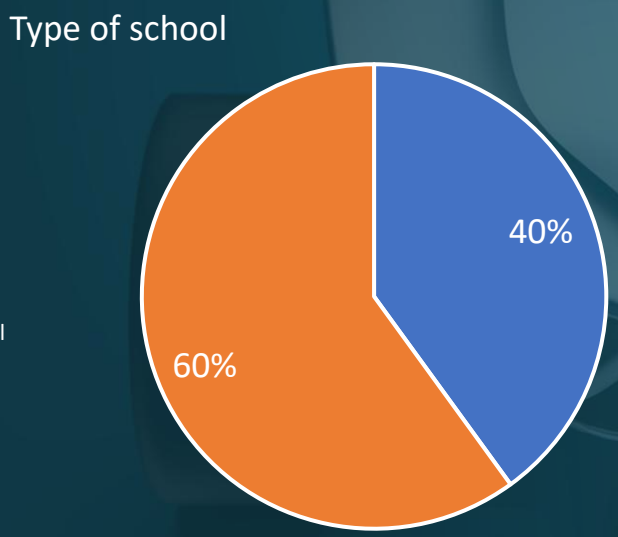


Goals set for the 2nd year

- To assess the sustainability of the current competition concept.
- To acquire more teams
- To improve the quality of advancing teams
- To fix the issues identified in the first year.

- 38 registred teams
- 25 advancing to the second round
- 15 finalists





PNEURACER

- Seznámíš se s pneumatickými systémy
- Otestuješ svého konstrukčního ducha
- Realizuješ své nápady

JOIN

Our team

FAKULTA STROJNÍHO INŽENÝRSTVÍ

ÚSTAV KONSTRUOVÁNÍ

SMC

strojLAB

Thank you ...

Matúš Ranuša

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