RUSH UNIVERSITY

Internship at the Rush University Medical Center

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INSTITUTE OF MACHINE AND INDUSTRIAL DESIGN
Faculty of Mechanical Engineering
Brno University of Technology

Brno, 27th February 2019

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Project Overview

International mobility of researchers at the Brno University of Technology

- **Rush University**
  - Rush University Medical Center
    - Department of Orthopedic Surgery
      - Human Motion Analysis and Tribology

  - 15 June 2018 – 15 December 2018
  - Supervisor: Prof. Markus A. Wimmer

- **Conferences**
  - 4th International Conference on BioTribology
  - 2018 STLE Tribology Frontiers Conference

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ICoBT 2018
4th International Conference on BioTribology
26-29 September 2018, Montreal, Canada

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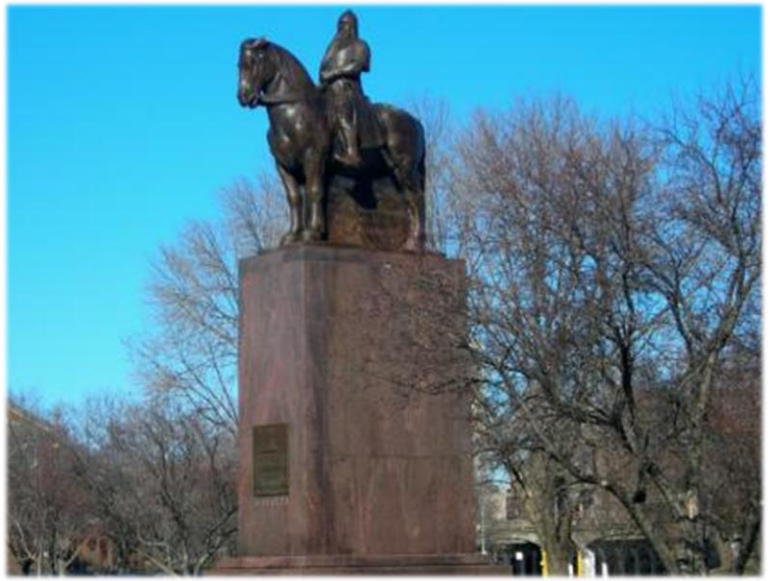
Chicago, Illinois, USA

- Area 606 km^2 (Brno230 km^2)
- Population of Chicago : 2,7 mil.
- 3th largest city in the US
- Great Chicago Fire of 1871
- Major of Chicago Anton Cermak (1931 – 1933)
- Statue of T.G.Masaryk in Midway Plaisance Park



Chicago, Illinois, USA

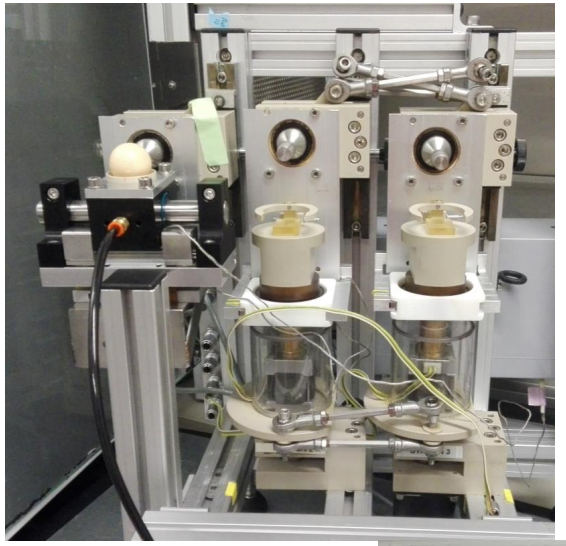
Internship at Rush University

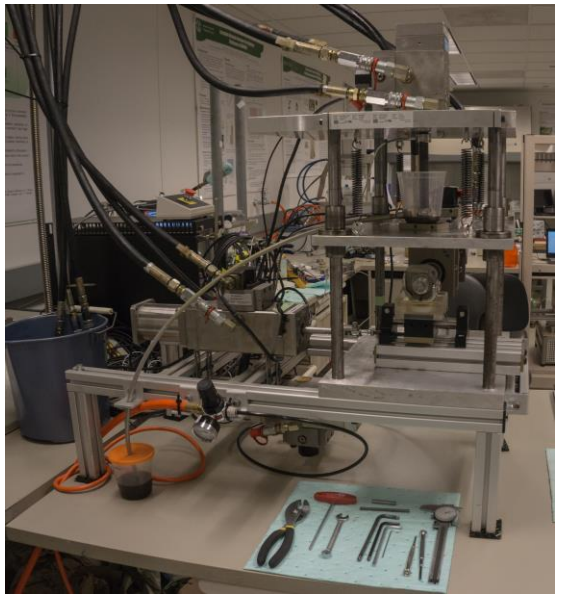
- Rush University Medical Center
  - Founded 1837
- Department of Orthopedics
- Supervisor: Prof. Markus A. Wimmer

- Biotribology group
- 10 members
- 5 international students

Research Plan

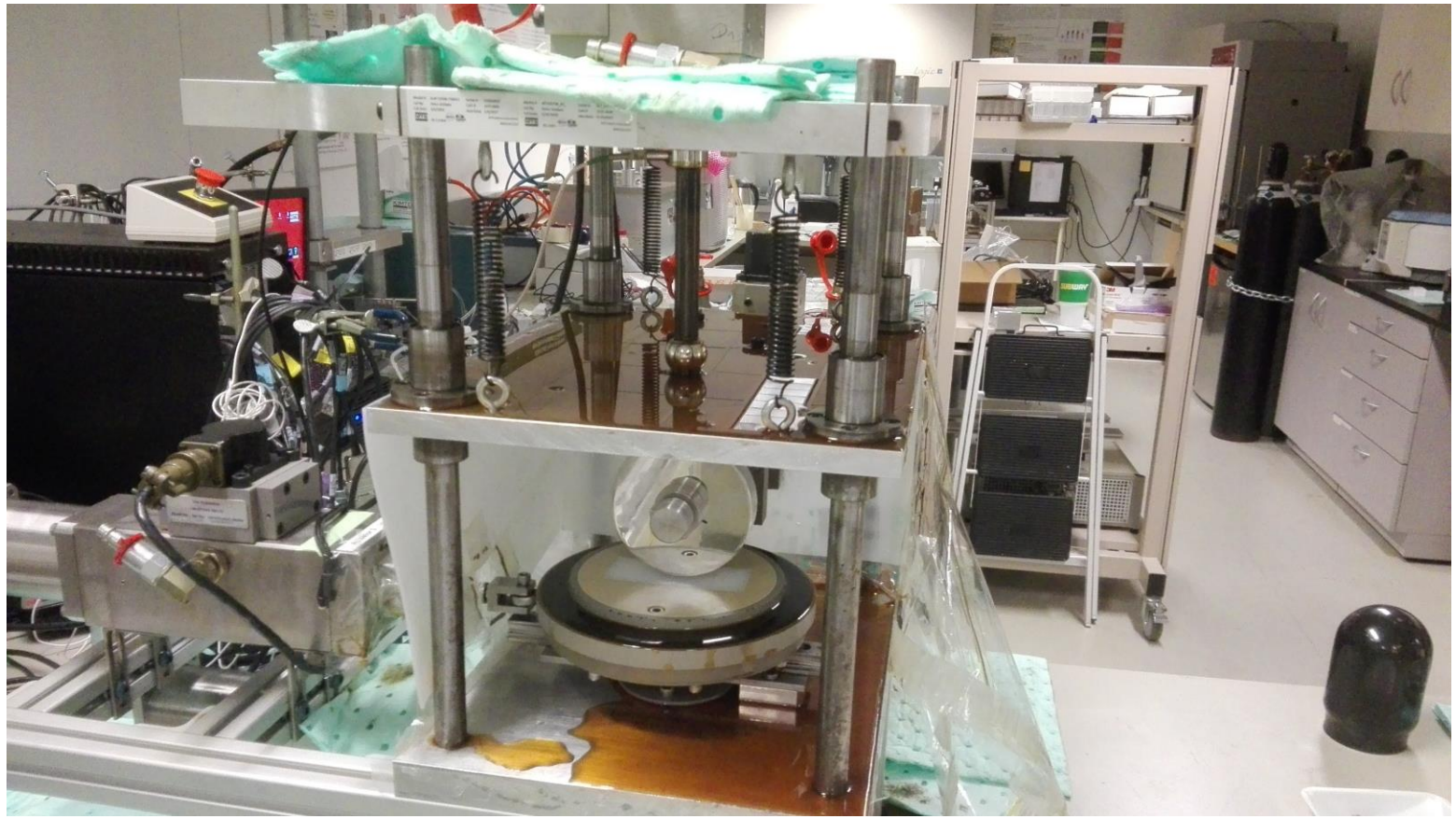
- Wheel on flat simulator
  - Analysis of coefficient of friction
- Design of Bioreactor
  - Cartilage tests
- Long-term knee test
  - Validation of numerical simulations





Wheel on Flat Simulator

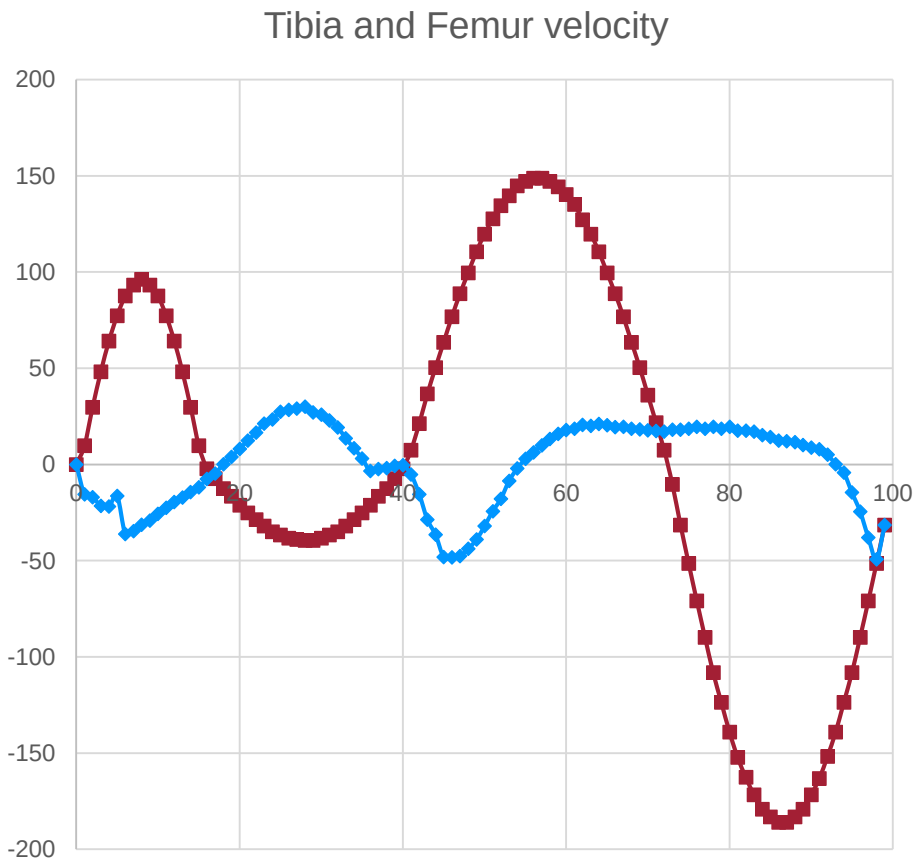
- Leaking of hydraulic oil
- Problem with sensors
- Problems with control system
- Metric - imperial issue

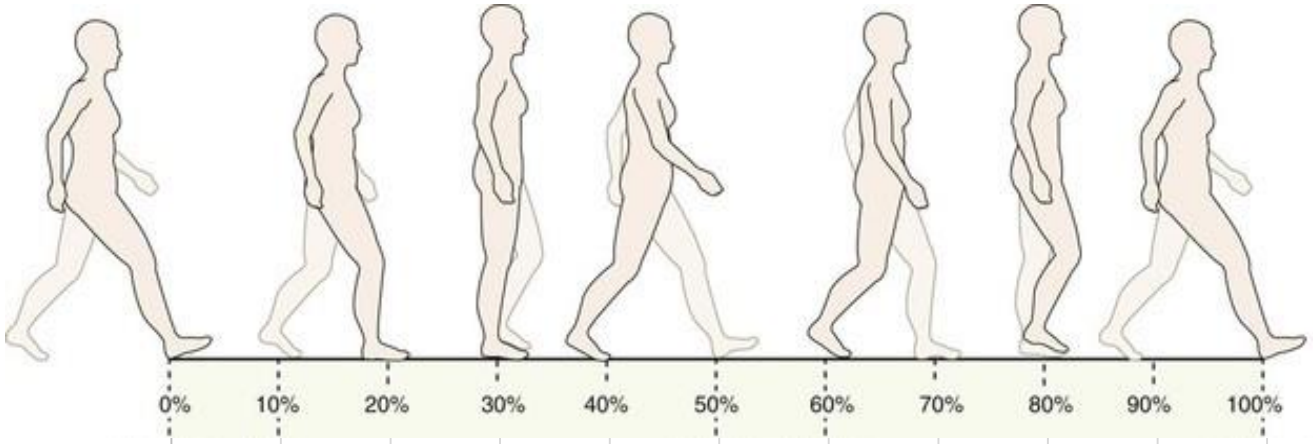


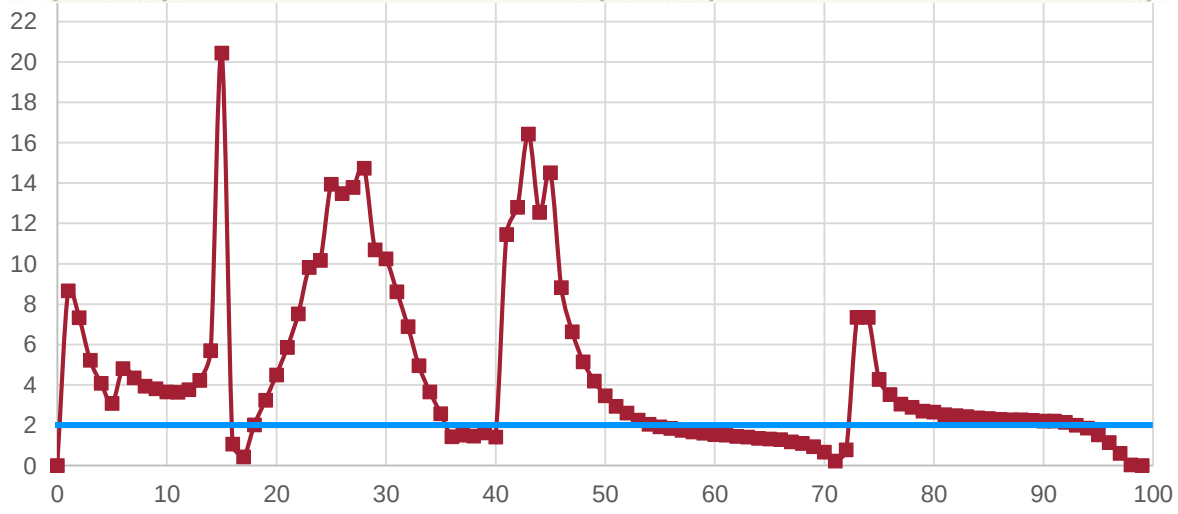
Long-term Knee Test

- 3 milions cycles
- ISO 14242
- Internal rotation 10 deg
- Input data for FME prediction
- Deviation around 5%

Bioreactor – Gait Analysis (ISO 14243)

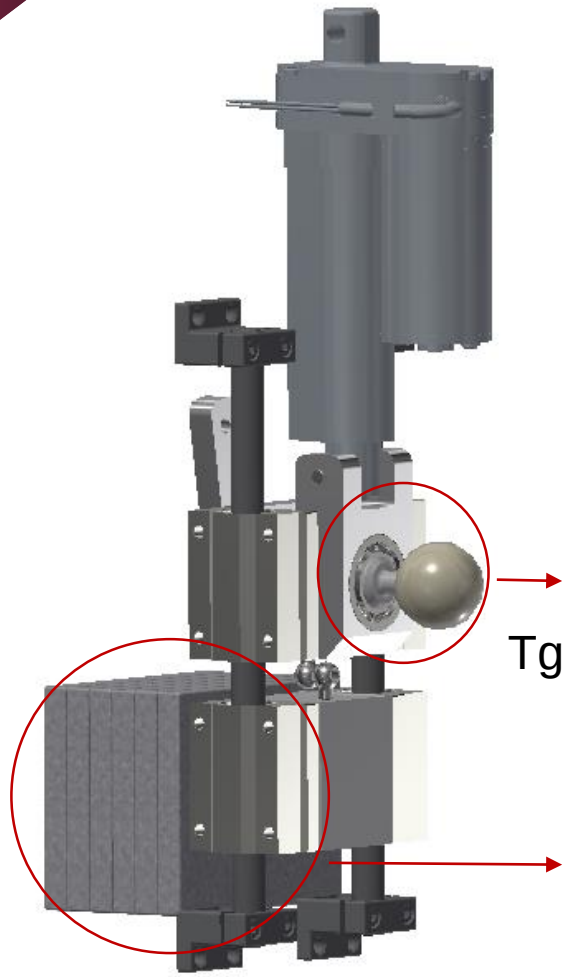


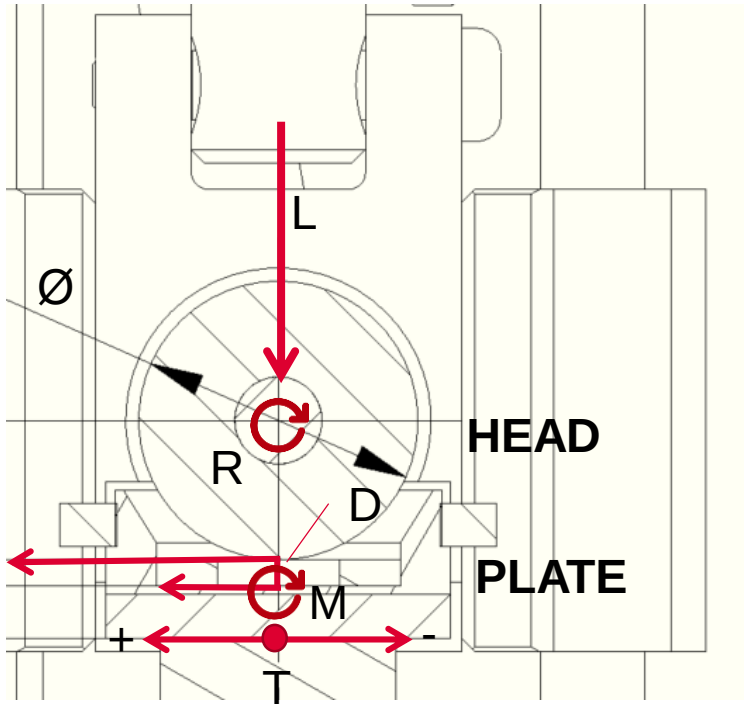




SRR (slide-to-roll ratio)

Bioreactor





4 kg
(6x300g)

- Load (L) 80 N
- Cofficient friction 0.05 (expected)
- Distance (D) 9 mm
- Tangential force (Tg) 4 N
- Torque (M) 0.036 Nm

- PLATE
  - Translation (T) ± 25 mm
  - Velocity 5 – 250 mm/s
  - Acceleration 3000 mm/s2
  - Positioning rep. 0.02 mm

- HEAD
  - Rotation of ball (R) ± 15 deg
  - Velocity (Vr) 186 mm/s
  - Angular velocity (ω) 11,62

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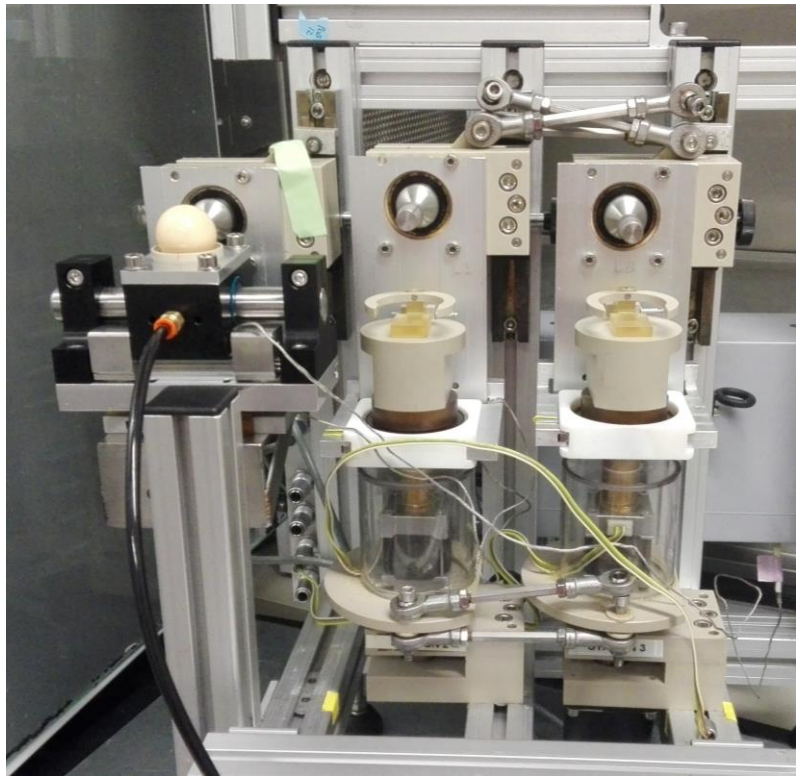
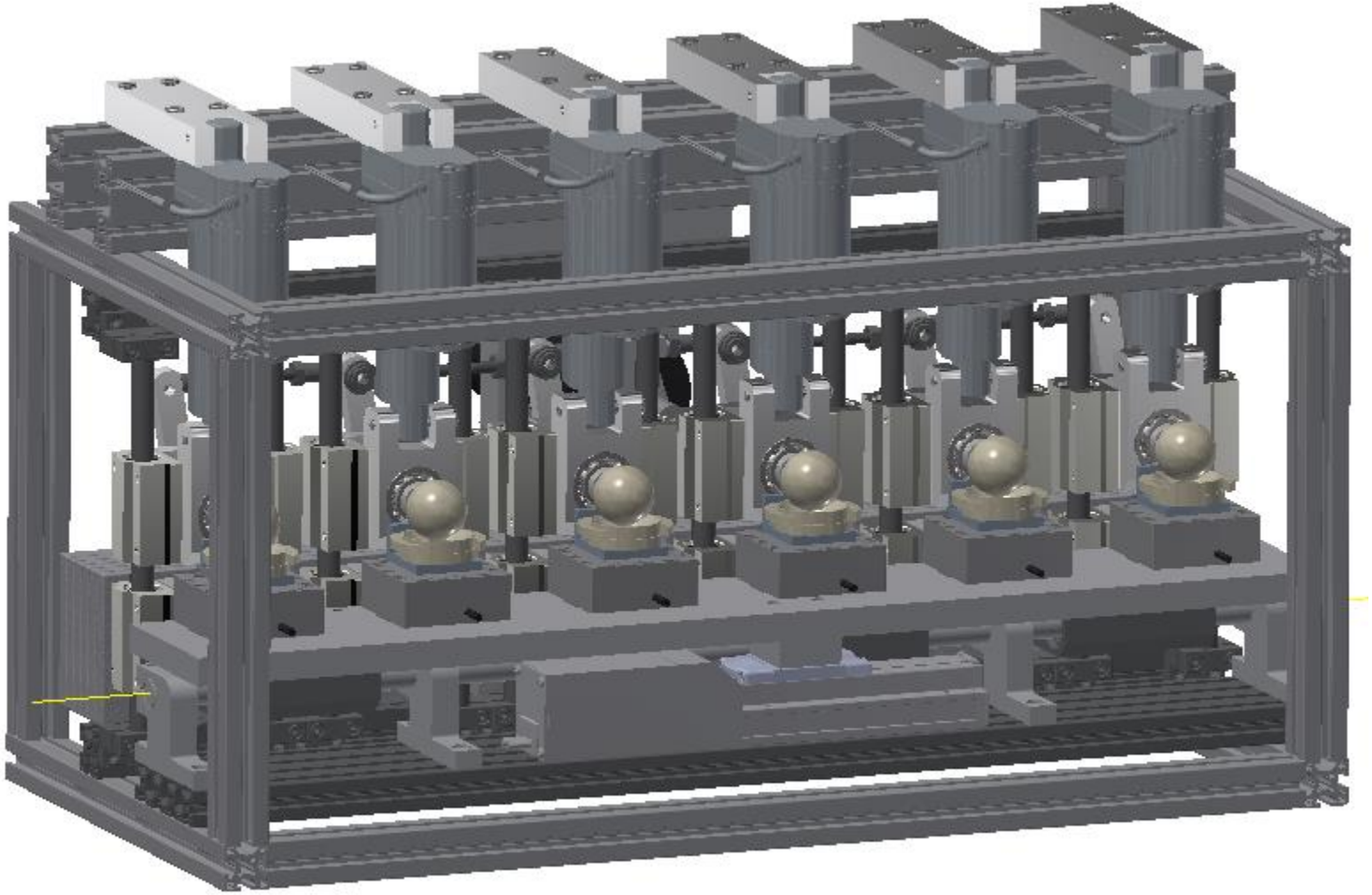
Bioreactor – New Design





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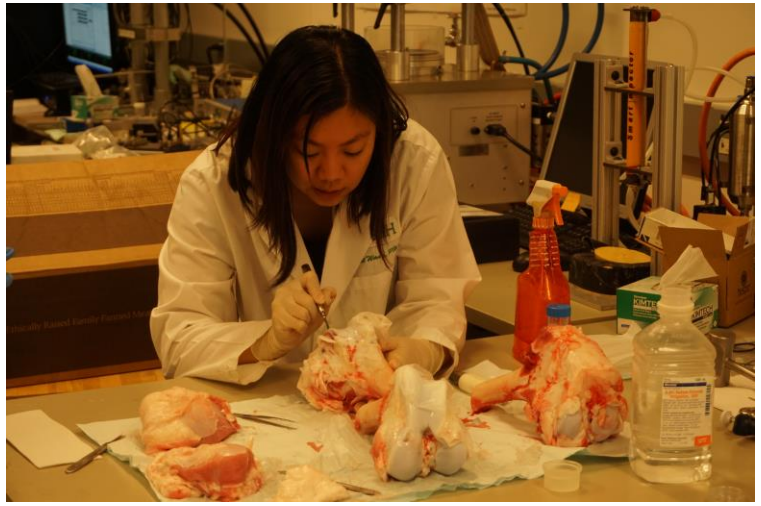
Preparation of Samples for Bioreactor



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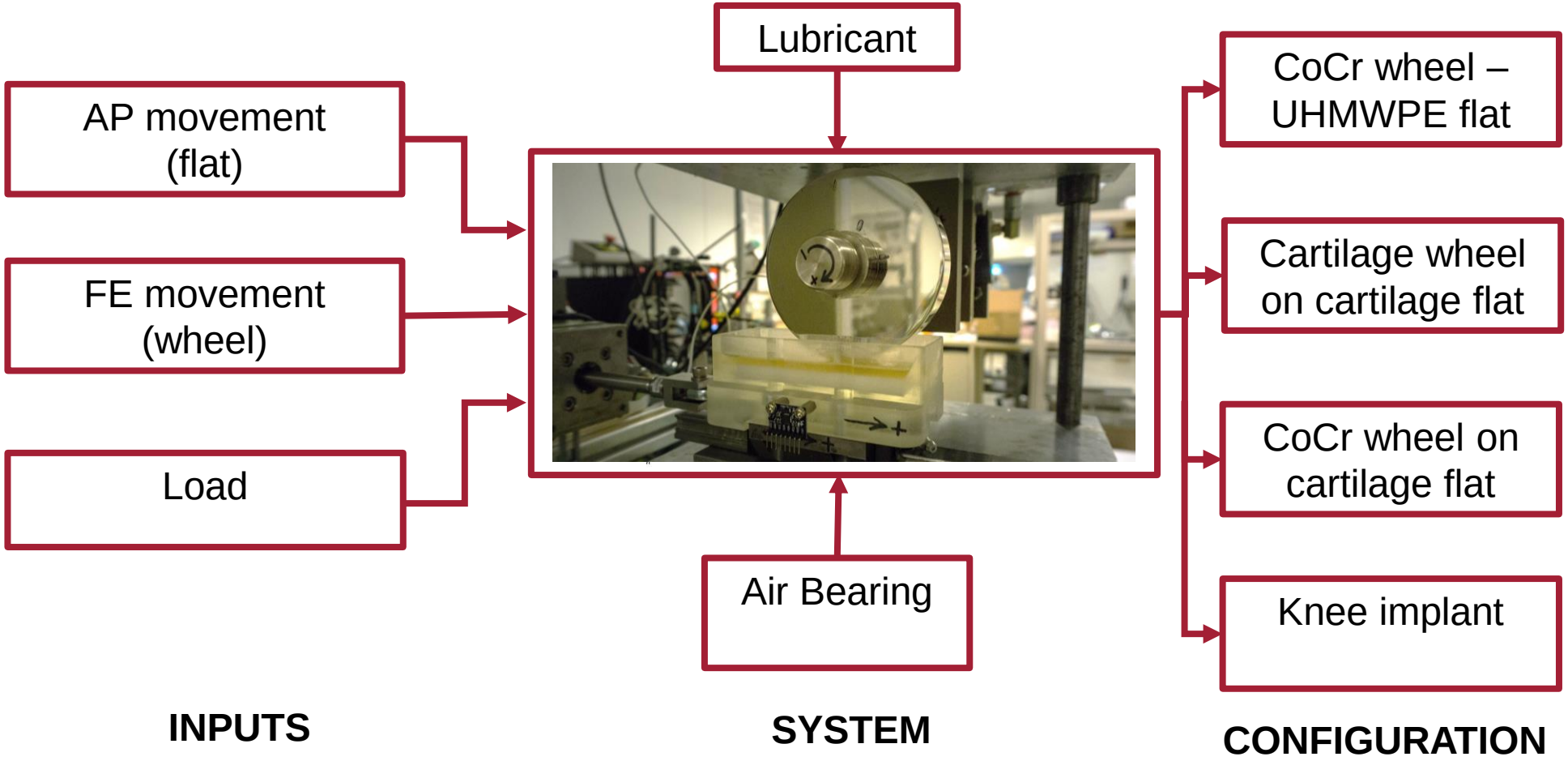
Wheel on Flat



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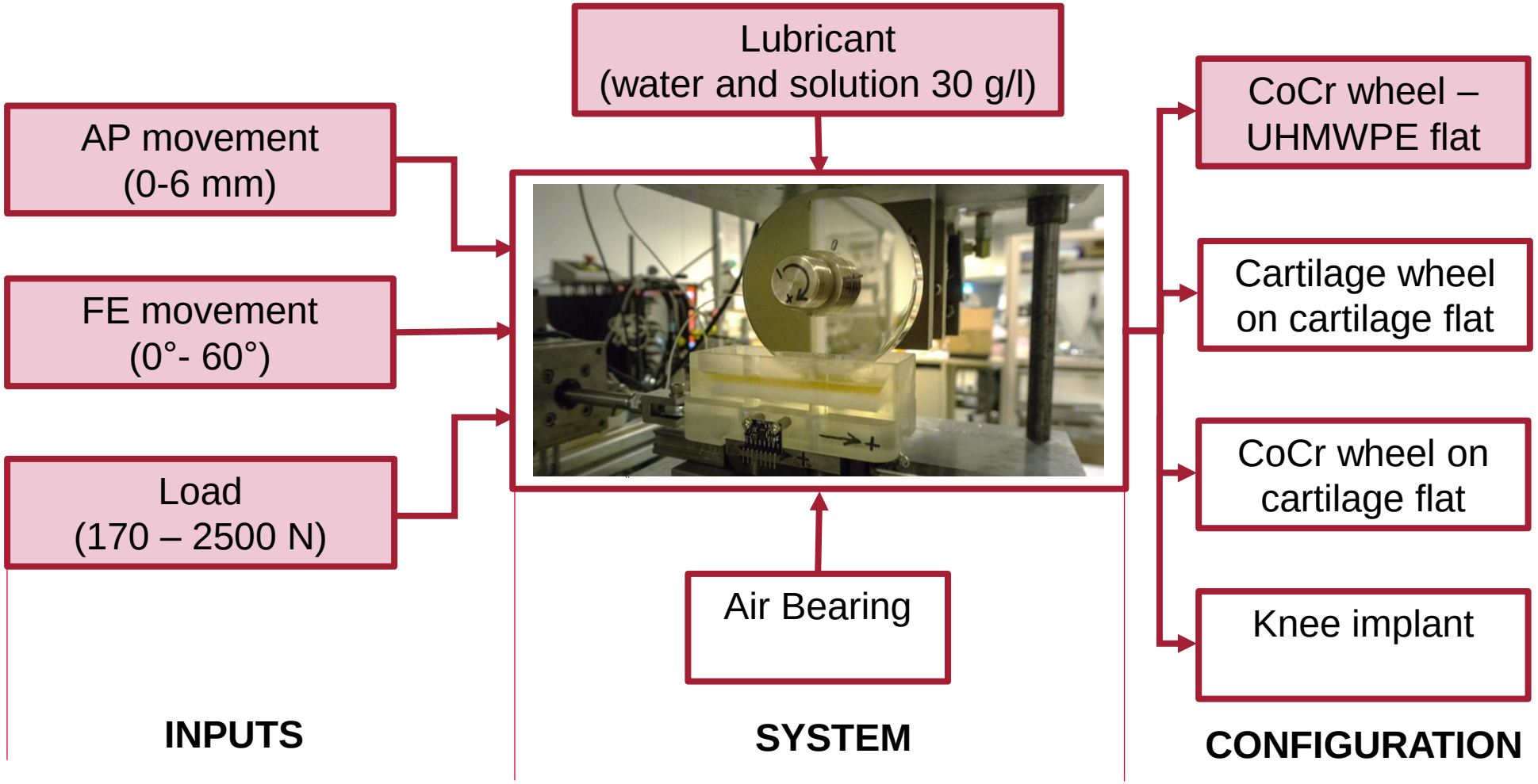
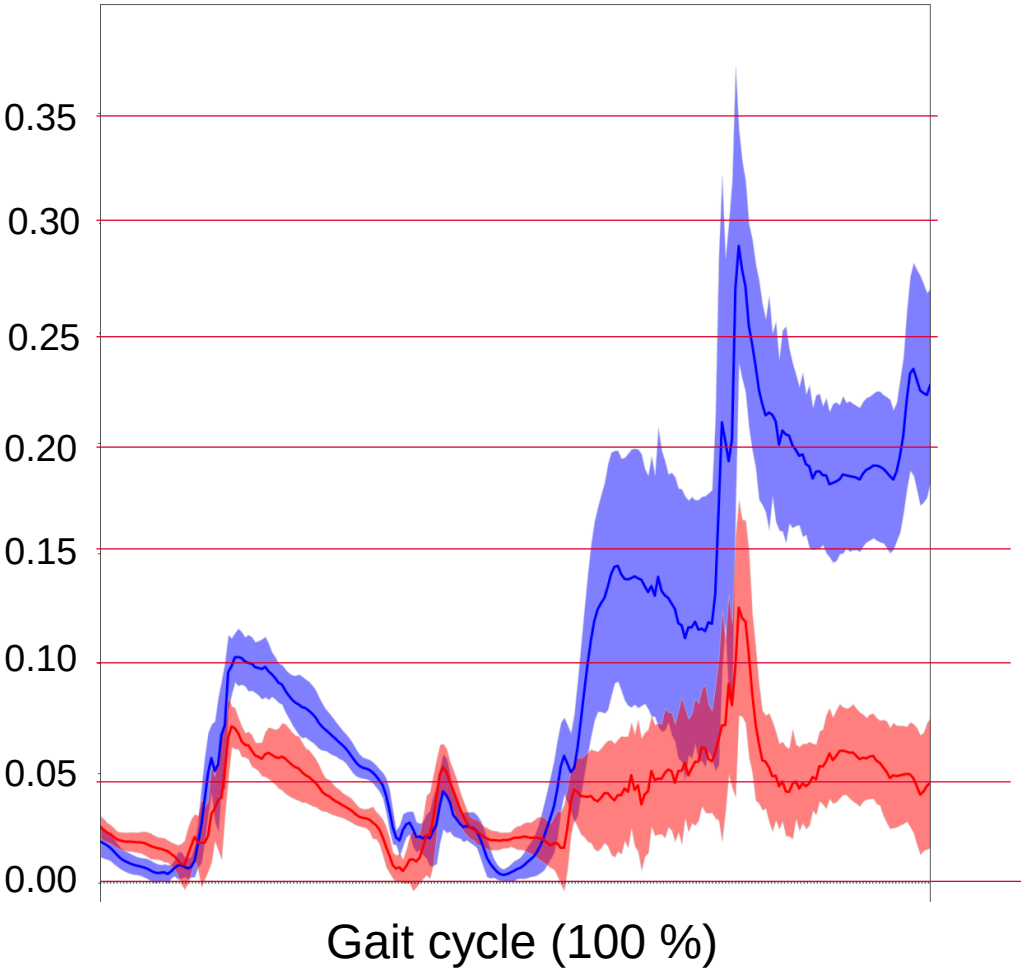
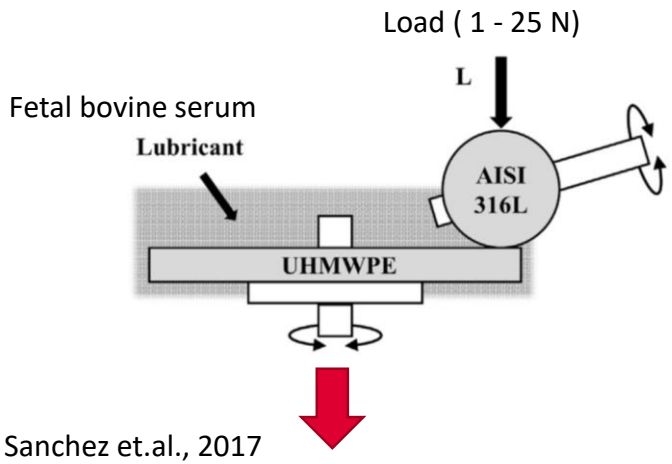
Wheel on Flat (CoCr on UHMWPE)



Results – ISO 14243 (new ISO without rotation)





Barceinas – Sanchez et.al., 2017

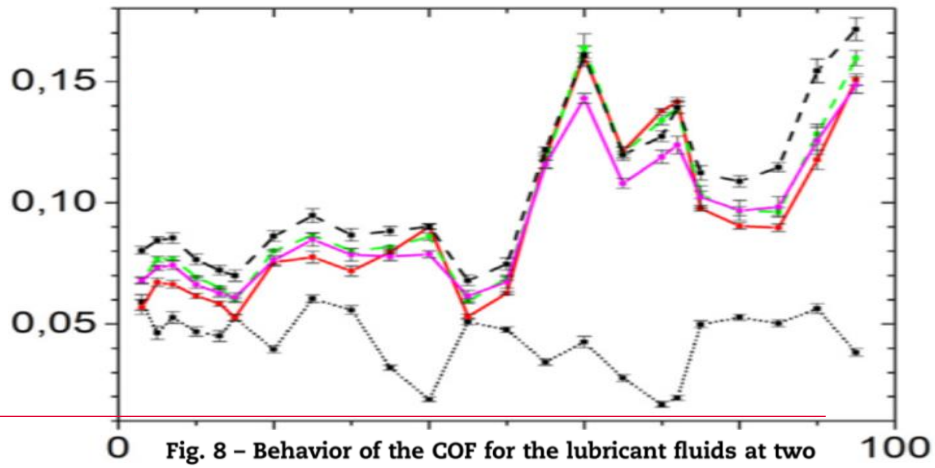


Fig. 8 – Behavior of the COF for the lubricant fluids at two concentrations: 36 g/L (undiluted) and 20 g/L (diluted), for the entire walking cycle.

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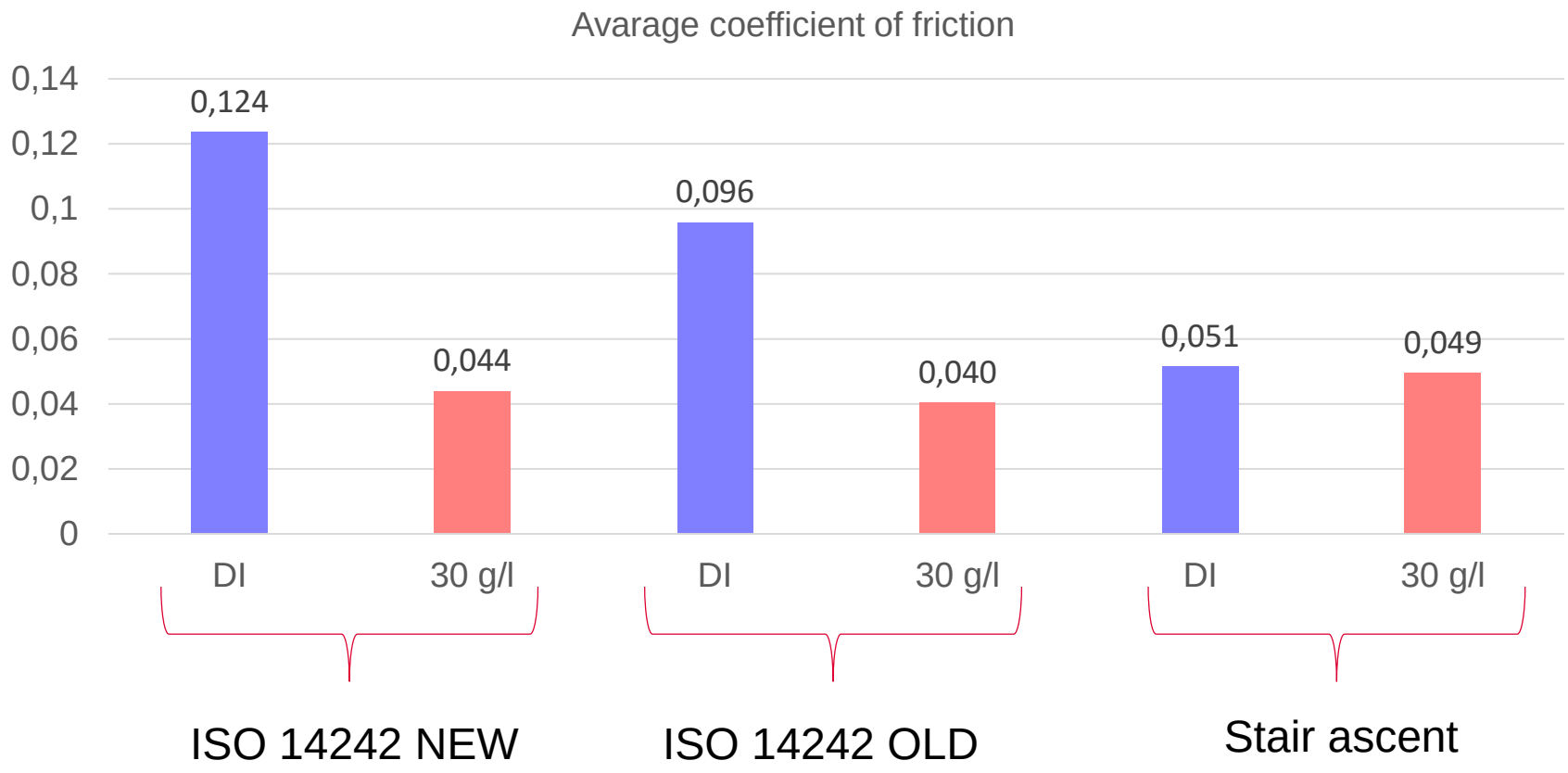
Results – Coefficient of Friction



Conditions

- Wheel on flat
- CoCr – UHMWPE
- 1 Hz

Load ↑ Coefficient of friction ↓

Coefficient friction development

- Input data for MKP model

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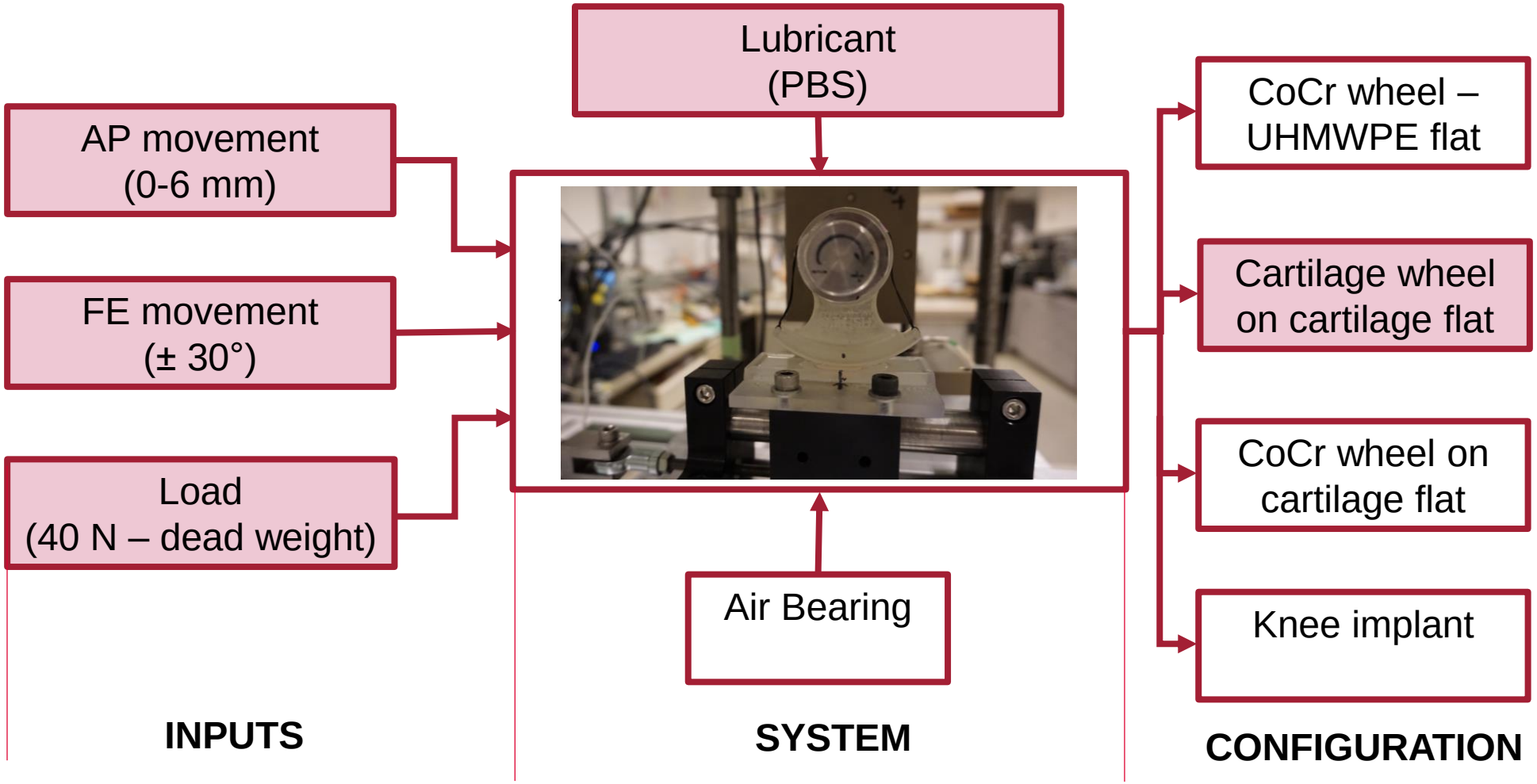
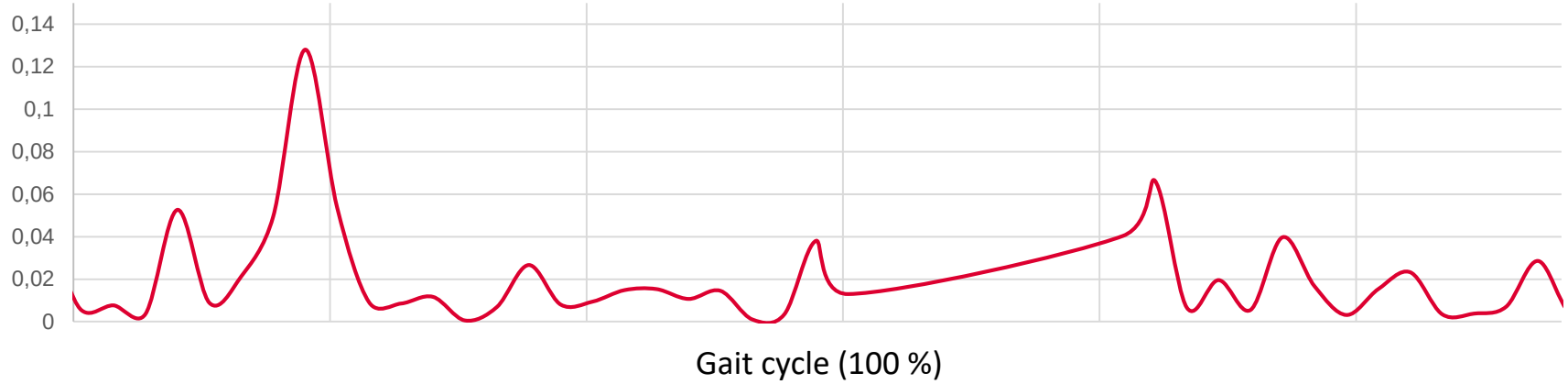
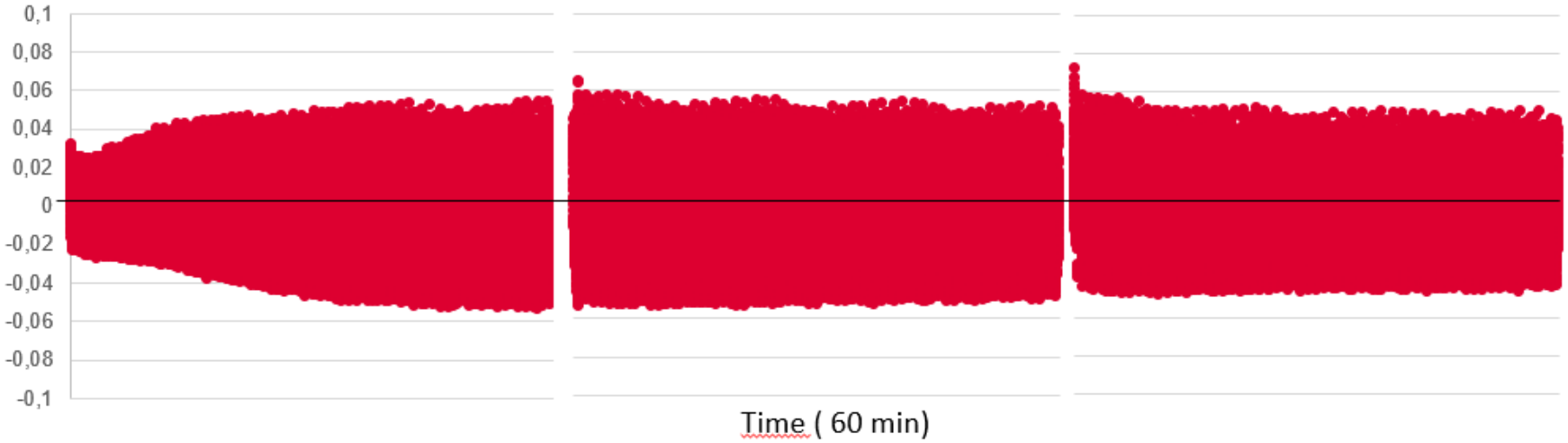
Wheel on Flat (Cartilage on Cartilage)



Results - Cartilage on Cartilage Tests





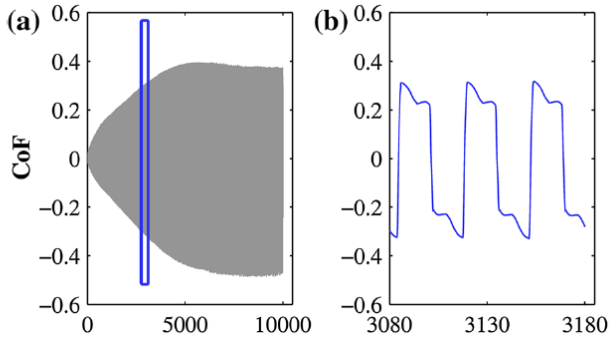
Conditions

- Cartilage strip on cartilage
- 60 minute test (3x 20 min)
- Lubricant PBS
- Without filtration of data
- 40 N – dead weight

Kinematic - bioreactor

- 1.24 Hz
- ± 9.6 deg – strip movement
- ± 3 mm – sample movement
- 4.2 mm/s - relative velocity

Whitney et.al.



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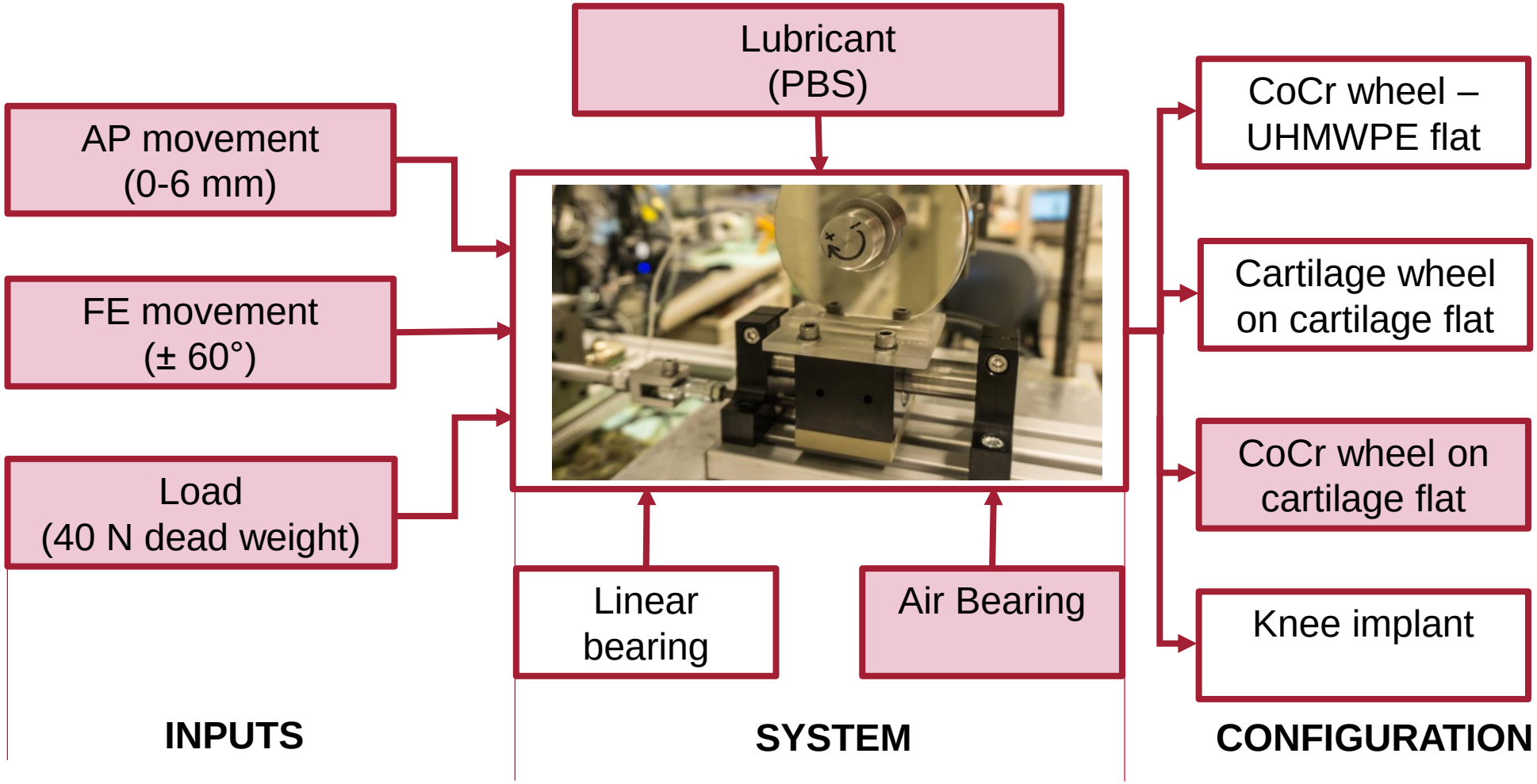
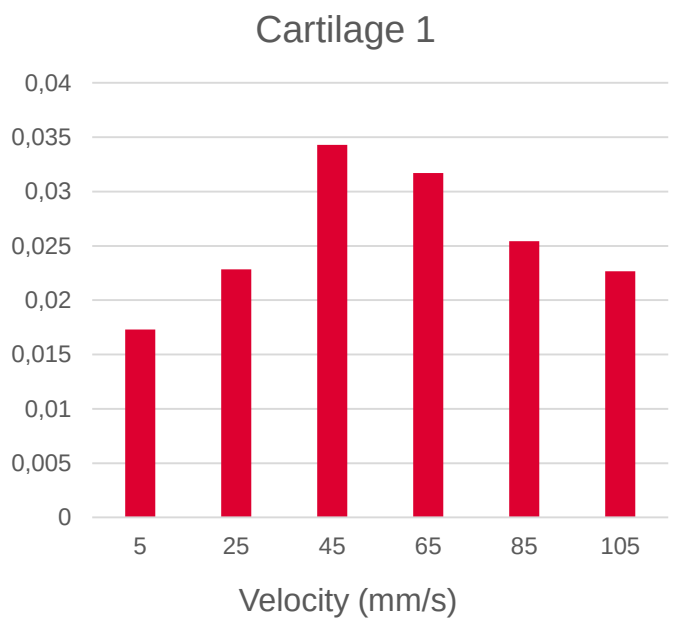
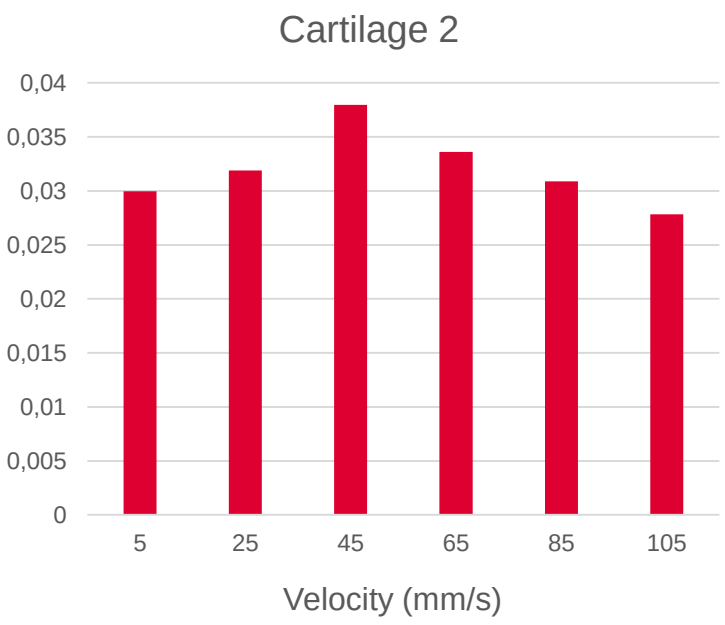
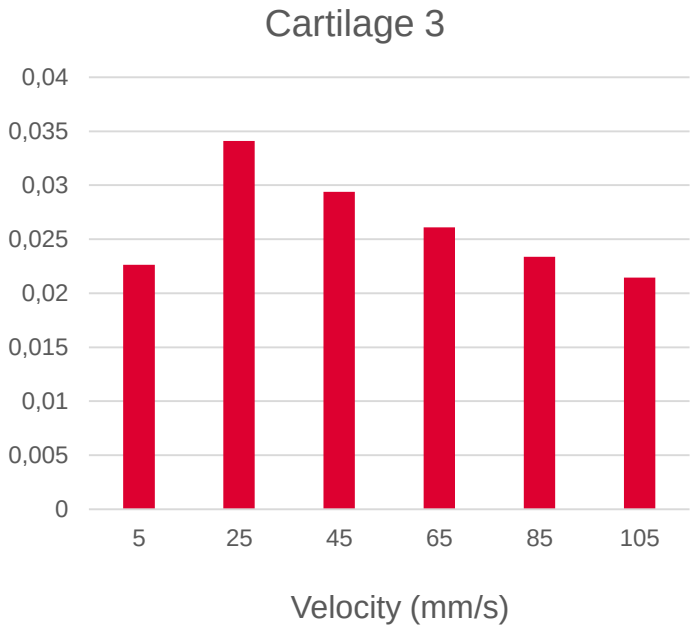
Wheel on Flat (CoCr on Cartilage)



Results - Wheel on Flat (CoCr on Cartilage)







Goodbye Party

USA

Nashville, Tennessee

Grand Canyon, Arizona

Mount Elbert 4401 m.n.m, Colorado

Monument Valley, Utah

El Capitan, California

Conclusion

- New contacts
- Possibilities for further cooperation
- Experiences with new devices
- Measurement technique
- Background in material science and biology
- New contacts from the conferences
- Publication

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Thank you.

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