Lubricant starvation in large-size spinning contacts

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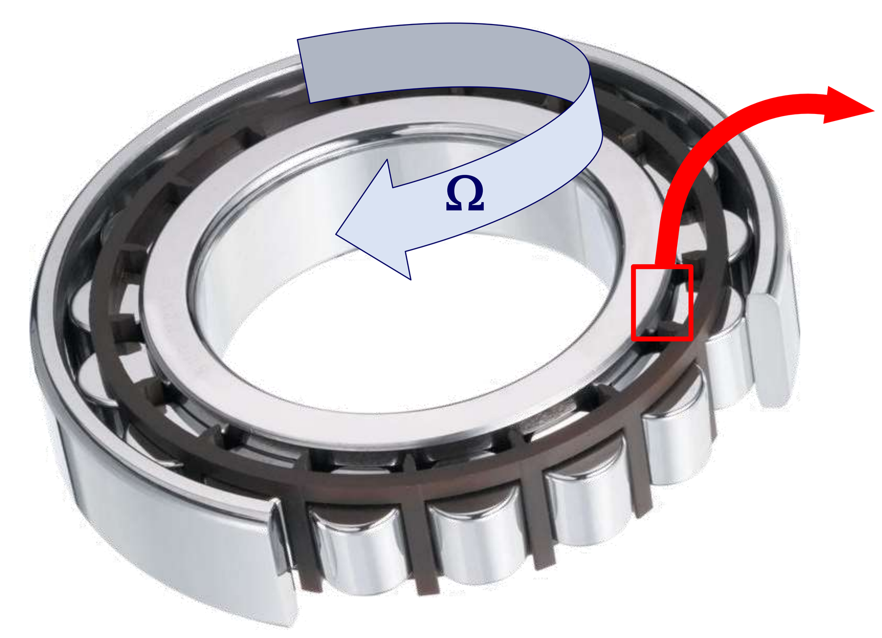
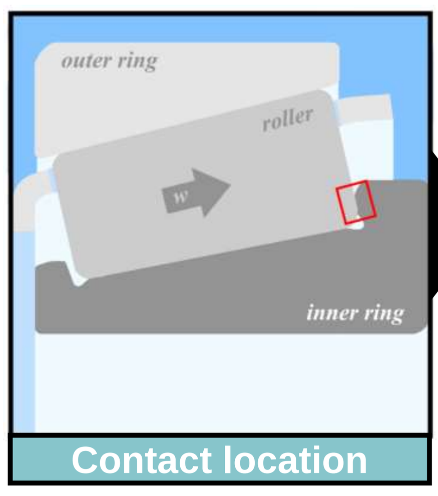
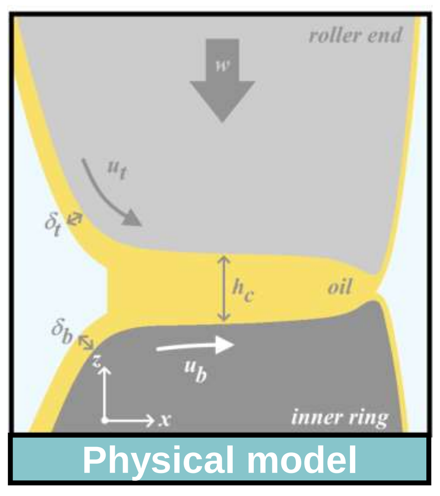
Industrial context & objectives

The roller-end / flange contact

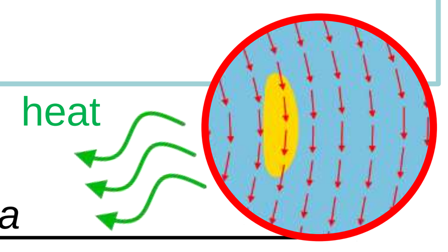






Aspects

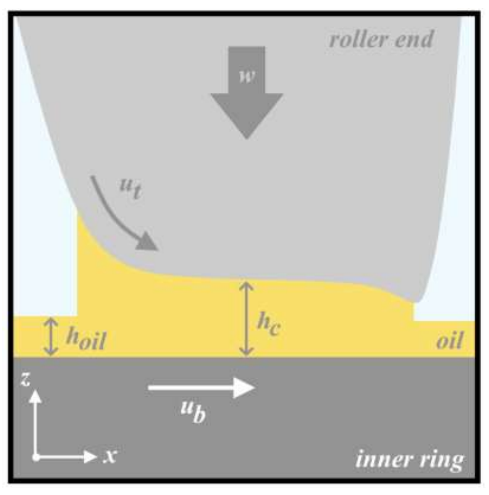
1. Complex kinematics
2. Low friction level
3. Geometry
4. High energy dissipation
5. **Difficult to lubricate**



Contact area

Typical contact conditions:
Rolling/sliding + spinning + obliquity

Starvation



Aspects

1. Film thickness reduction
2. Load-carrying capacity reduction
3. Temperature rise
4. Friction reduction

Goal

Improvement of **efficiency** and **service life** of bearings

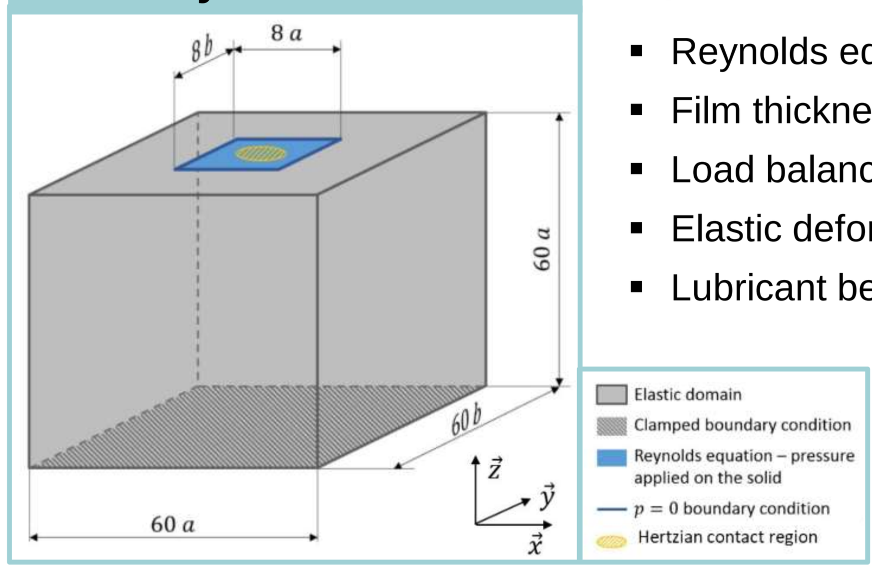
Timeline of spin-related thesis

- **2008** DORMOIS [1] — *Study of friction in large-sized EHD contacts*
- **2012** DOKI-THONON [2] — *Study of thermal effects in EHD spinning circular contacts*
- **2016** WHEELER [3] — *Study of non-elliptical point contacts (torus-on-plane)*
- **2020** PORRAS-VAZQUEZ — *Influence of lubricant starvation in large-sized EHD contacts*

Numerical approach

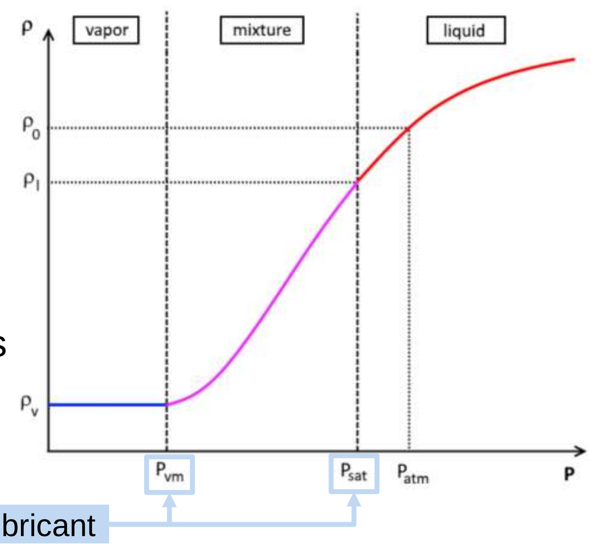
Numerical model

3D full-system model



Equations:

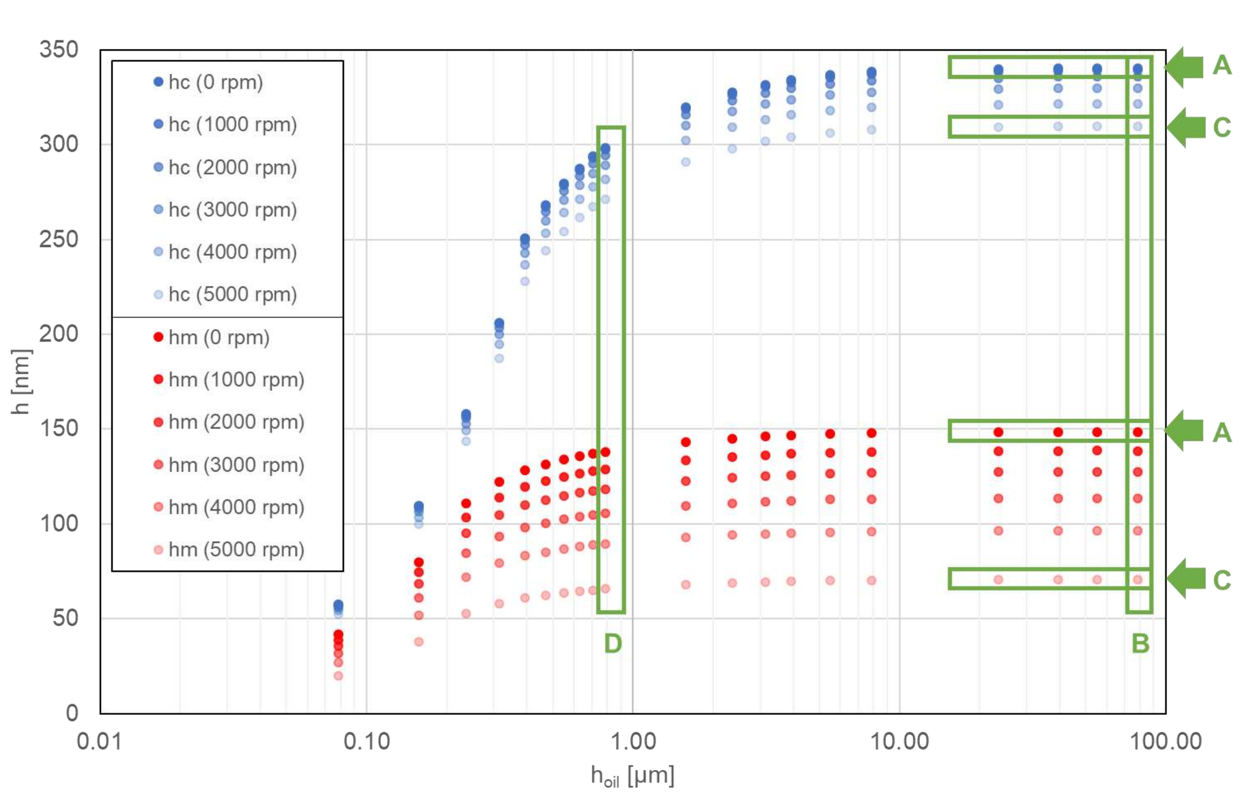
- Reynolds equation
- Film thickness equation
- Load balance equation
- Elastic deformation
- Lubricant behavior equations



Starvation introduced through gap density

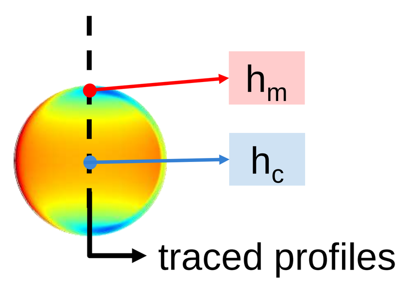
Numerical application

Film thickness variation with oil supply and spin

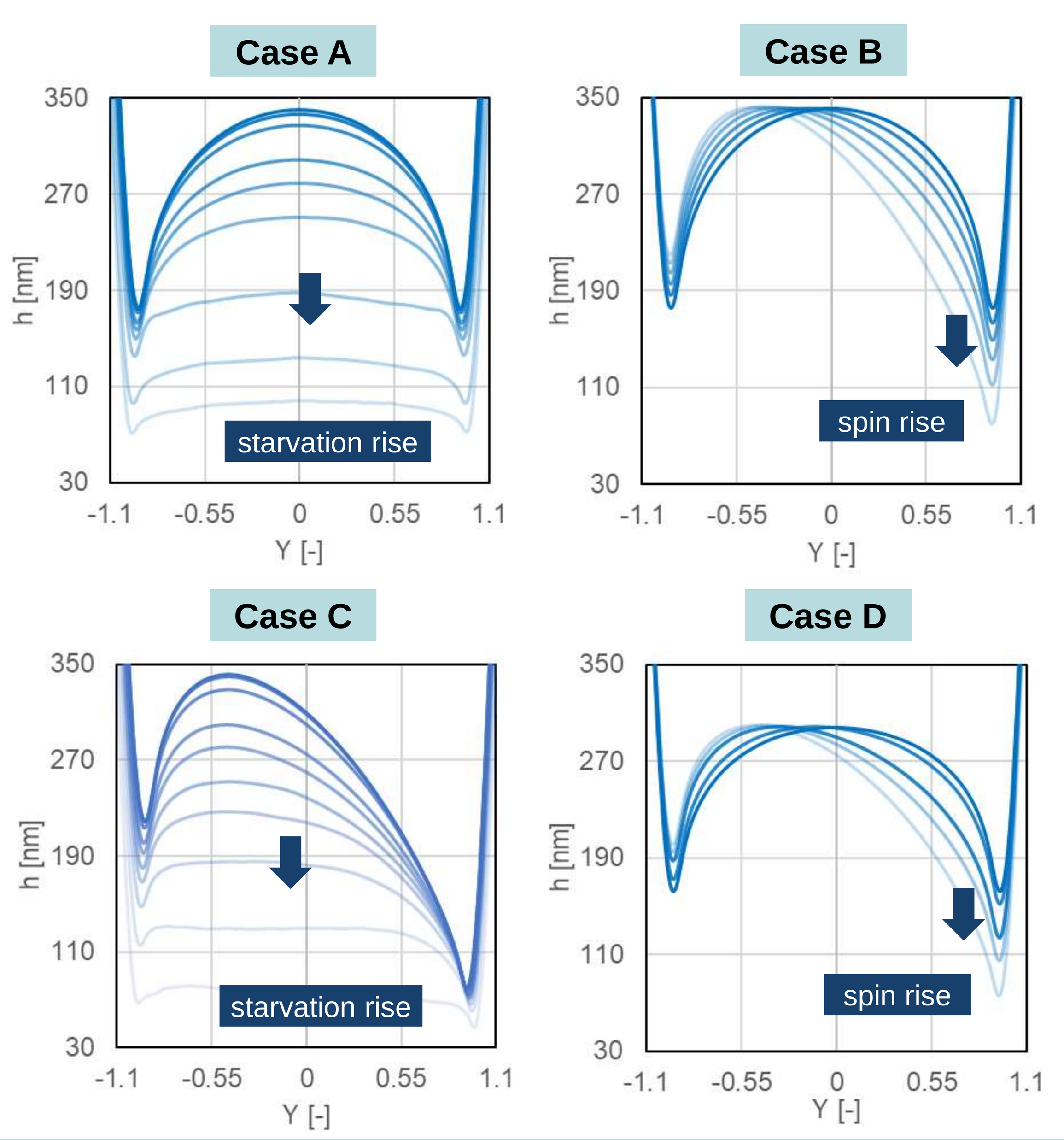


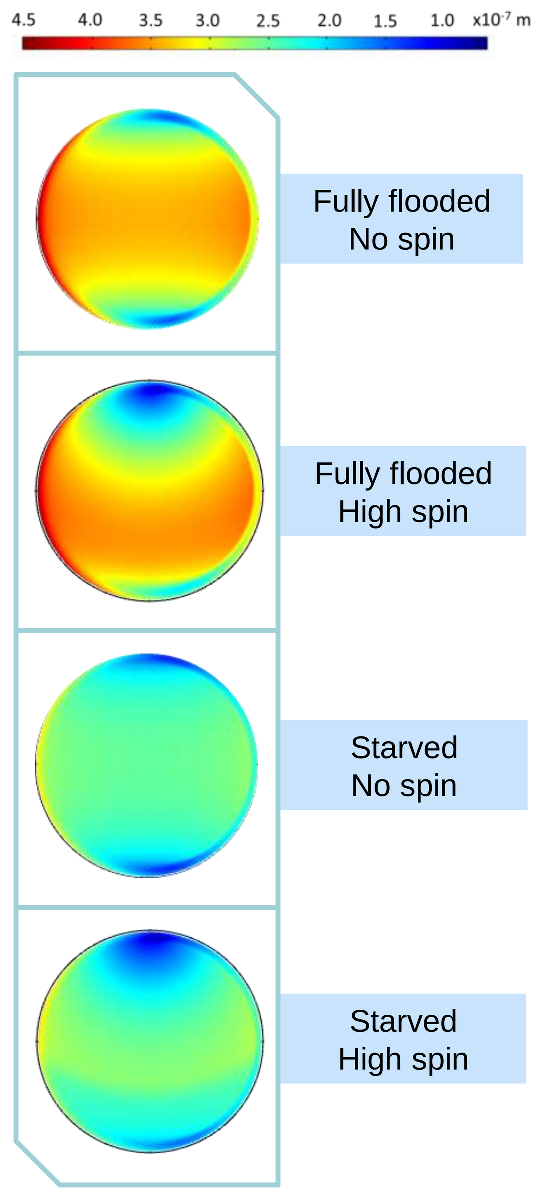
Operating conditions

- u_e = 2 m/s
- w = 800 N
- $R_x = R_y$ = 80 mm
- Steel / Steel contact
- Lubricant T9
  - μ_0 = 11.4 mPas
  - α^* = 0.221 GPa^{-1}
- Isothermal
- Newtonian
- Stationary



Transversal film thickness profiles

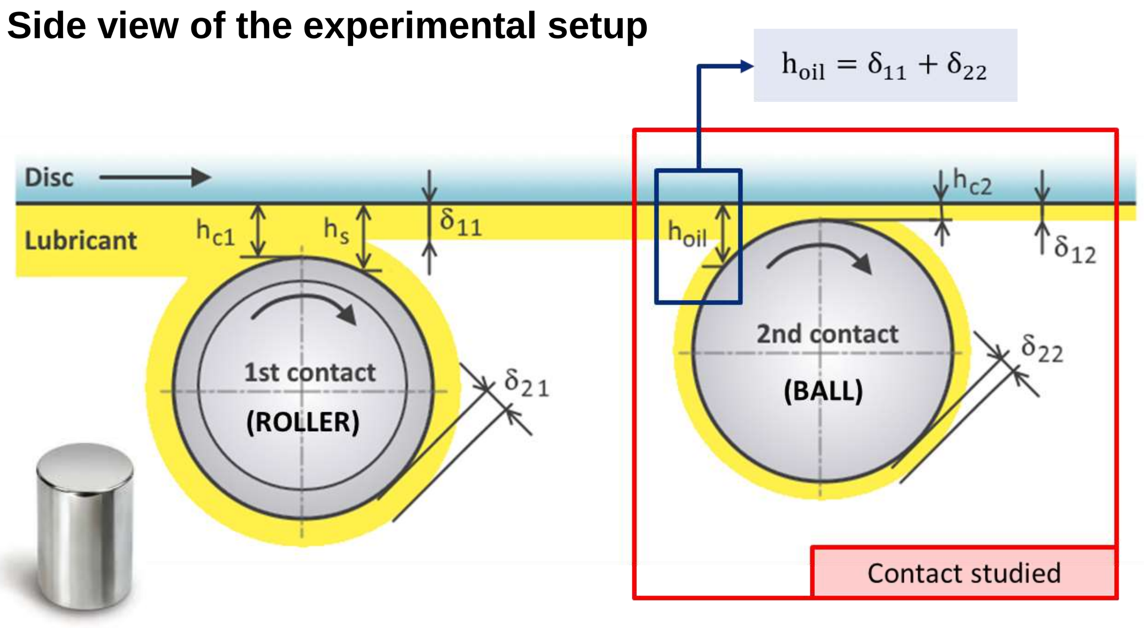




Experimental approach

Experimental strategy

Side view of the experimental setup



Advantages of the roller

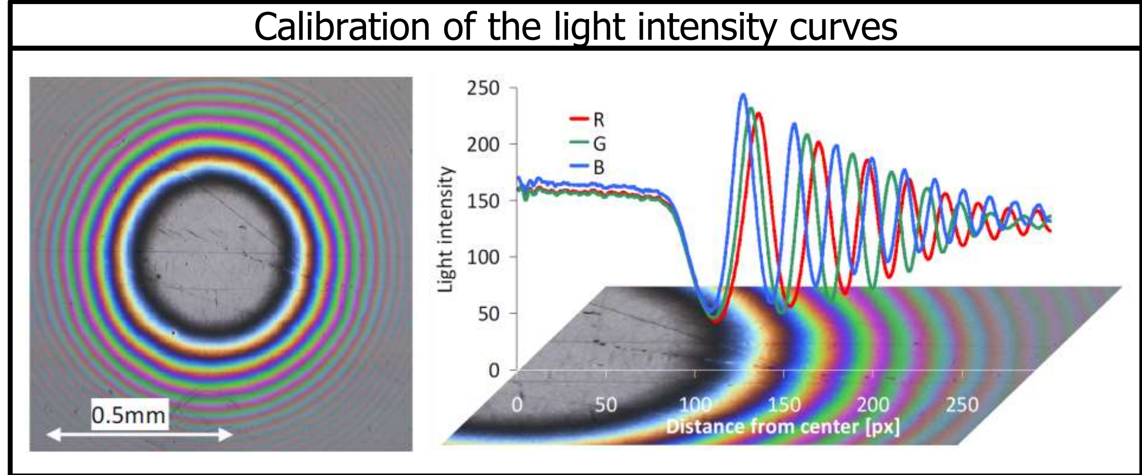
1. Uniform film thickness feeding the ball
2. Estimation of h_{oil}

- From roller: $\delta_{11} = \boxed{0.5} \cdot h_{c1} \cdot \frac{\rho_{c1}}{\rho_0}$
- From ball: $\delta_{22} = \boxed{0.5} \cdot h_{c2} \cdot \frac{\rho_{c2}}{\rho_0}$

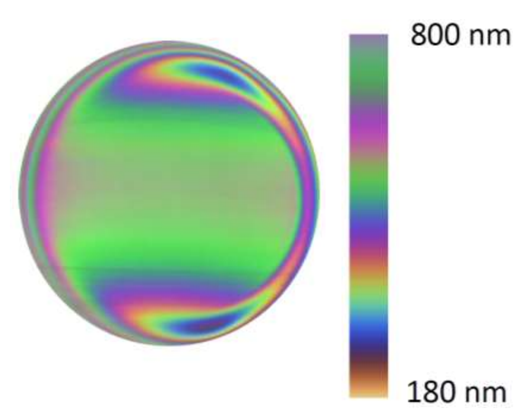
if SRR = 0

Film thickness estimation (optical interferometry)

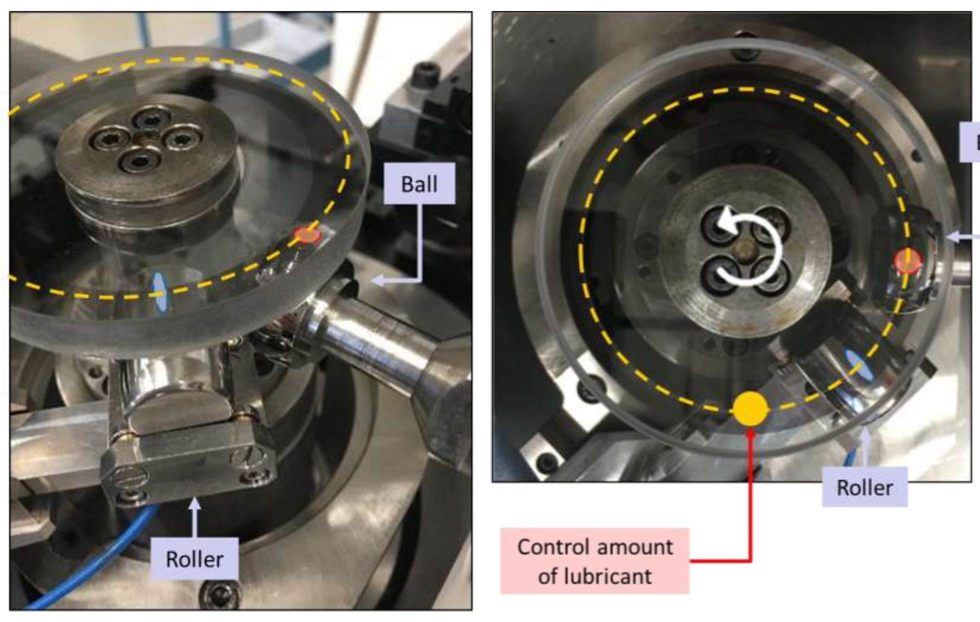
Calibration of the light intensity curves

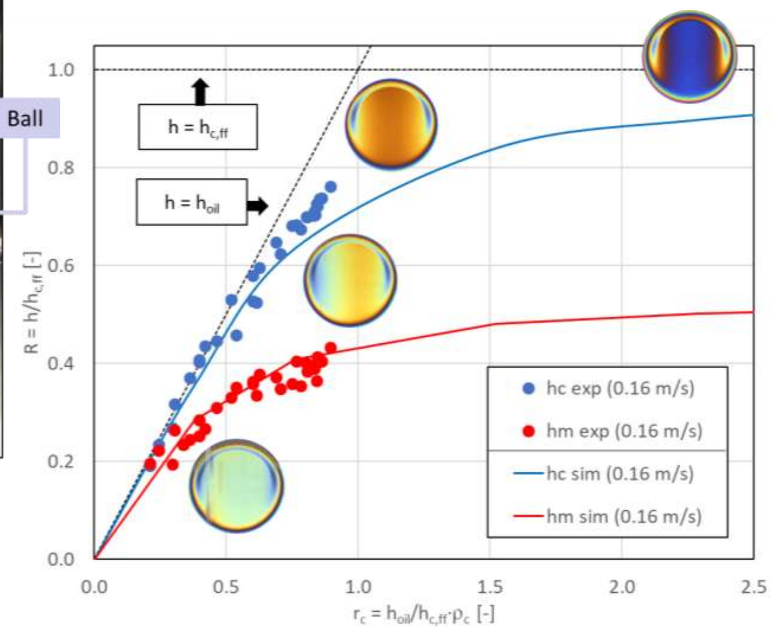


Correlation with film thickness

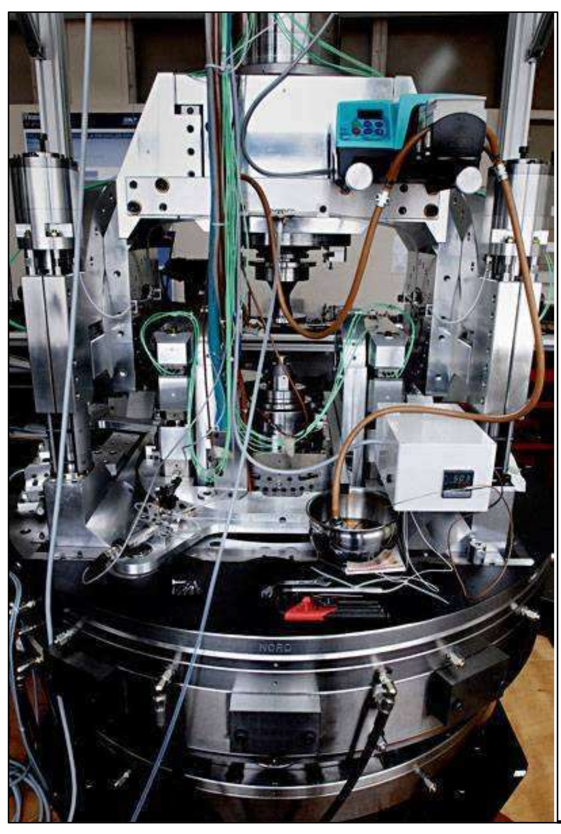


Jerotrib: starvation



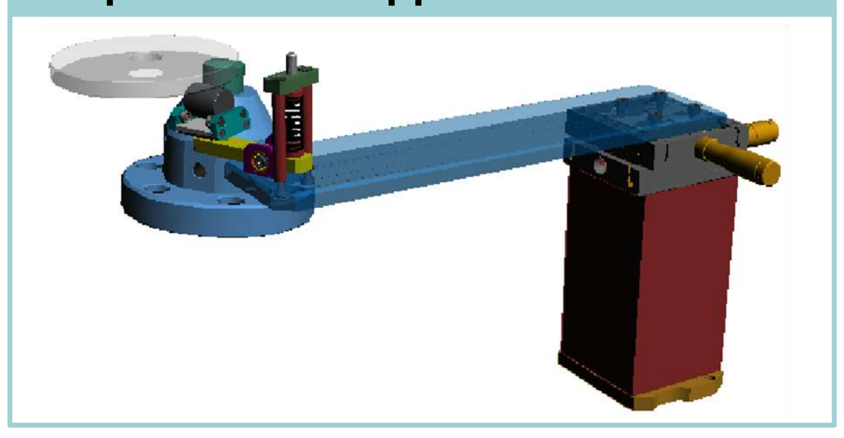


Tribogyr: starvation + spin



Original test rig

Adapted roller support



Industrial-like operating conditions

- High loads
- High entrainment velocities
- Large contact radii
- **Spin**

« LUBRICATED INTERFACES FOR THE FUTURE »

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