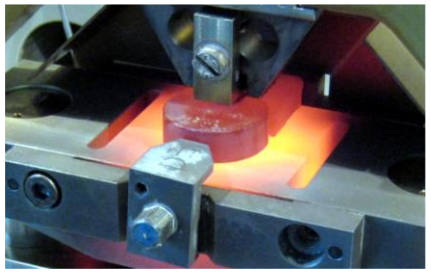
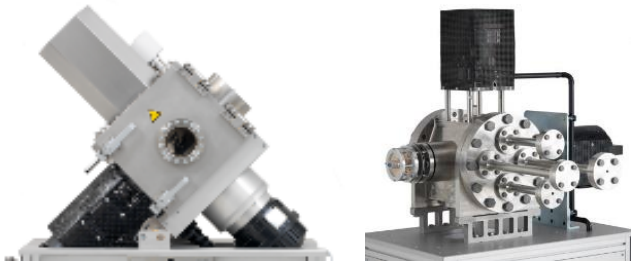
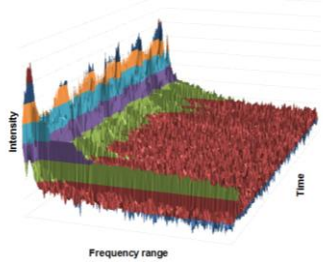
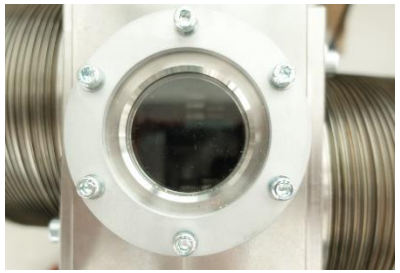




OPTIMOL
INSTRUMENTS

Your competent partner in tribology

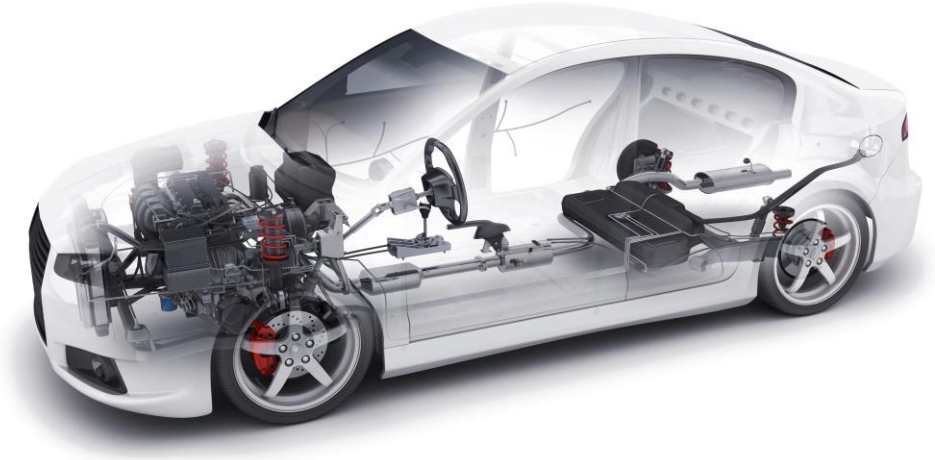




About Optimol Instruments

- International staff (chemist, physicists, mechanical engineer, electricians, …) → Support customers daily with their tribological issue
- All suppliers based in Germany
- Distributors in India, USA, China, Korea, Europe, Japan
- 435 SRV® tribometers worldwide
- Application field of OIP tribometers

  - Lubricants and additive industry
  - Research and development
  - Automotive industry
  - Mechanical engineering
  - Materials research and development
  - Coatings and layers
  - Test institutes



Our tribometers: Designed for your needs

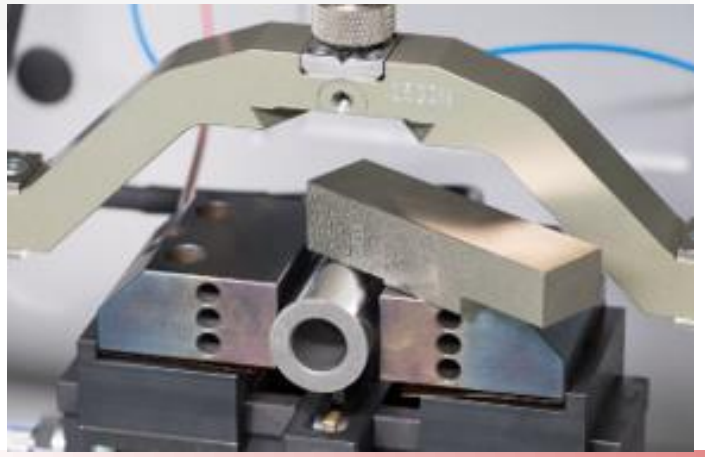
OPTIMOL INSTRUMENTS

2disk

- > Rolling movements w/o slip
- > Component testing
- > High simulation and analysis potential

SRV®

- > Oscillation + Rotation + 3-Axes movements
- > Standard tests
- > Component testing
- > High simulation and analysis potential



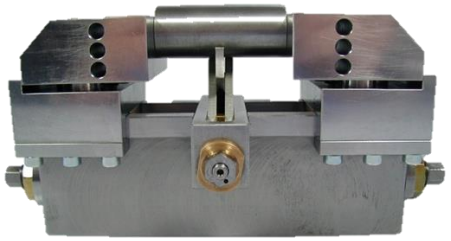
ETS

- > Oscillation
- > Friction and wear measurement
- > For quick product screenings

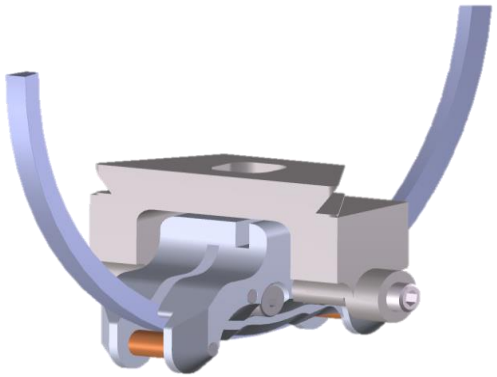
SRV®5: Extremely versatile

Some examples from the wide range of applications of the

Oscillation Holders and Adapters



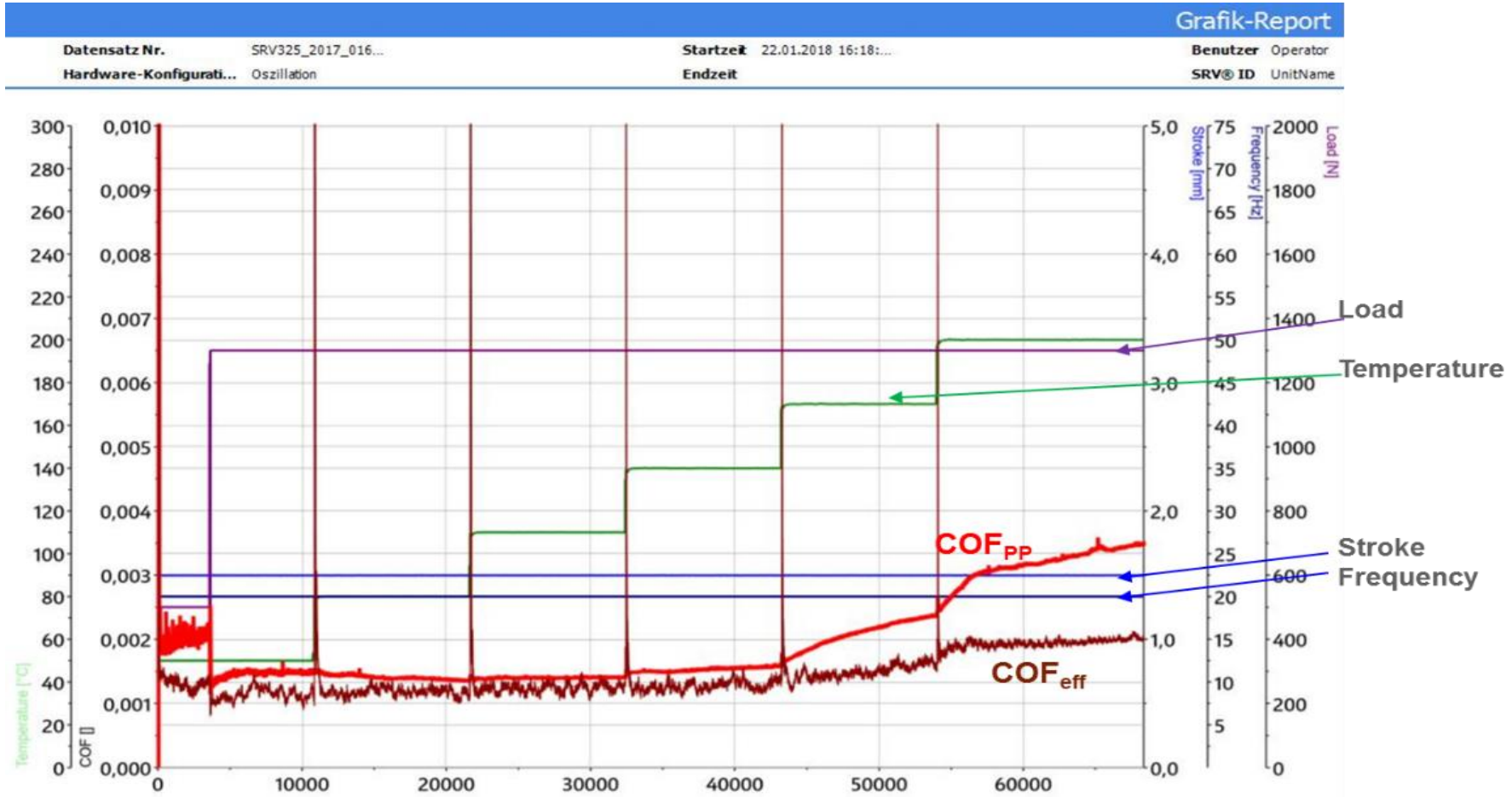
By choosing the test **pieces/specimens** corresponding to real contact geometries and controlled tests conditions → SRV® model tests are mostly close to **application terms** → Get deep understanding of your tribosysytem



Wide range of contact pressure → 0,02 to > 10.000 Mpa

Indicating the test parameters

In most cases the right parameters can be easily determined by using the so-called step program

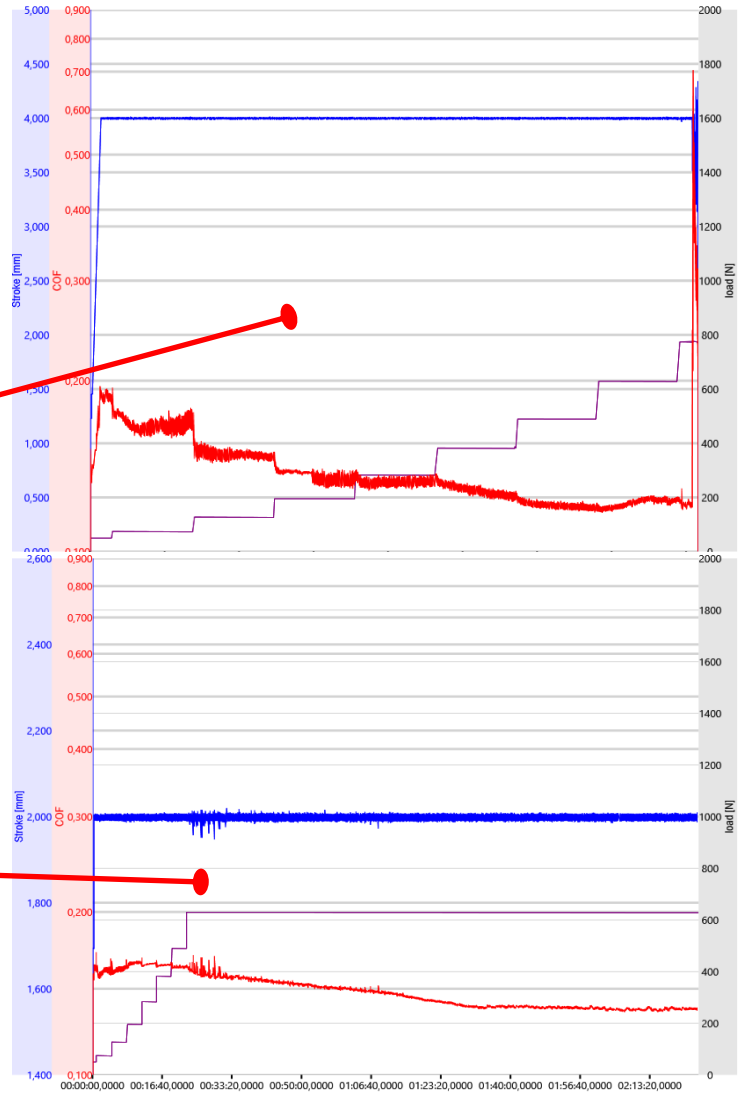


Gear Oil – Prescreening (Roller-on-disk)

The two tests at **T= 98°C** are executed similarly to DIN 51834-4/D8316 (**roller-on-flat**) using SRV 4&5 models and composed of:

a. **Extreme pressure load step test** (Δx= 4 mm, ν= 50 Hz),
Load steps of ~150 MPa every 217 s: 7 N, 28 N, 73 N, 126 N, 195 N, 282 N, 381 N, 489 N, 628 N, 774 N, 934 N, 1107 N, 1360 N, 1538 N, 1742 N, 1985 N (up to 2244 N)
[*Note: each SRV load step corresponds to one FZG load stage!*]
and, as second test,

b. **Friction and wear endurance test** under one load step below O.K. load (Δx= 2 mm, ν= 50 Hz, 2 h)



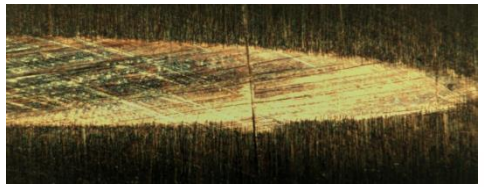
Gear Oil – Prescreening

Sample ID	Kinematic viscosity at 100°C [mm²/s]	VI	Density [kg/m³]	Base oil	FZG-Test, Failure step	SRV result, successfully passed load stage
4.12*			880	Mineral	7	8
1.14	37,4	166	860	Synthetic base oil	>13	12
2.14	56	240	1060	Polyalkylen-glycol	>12	14

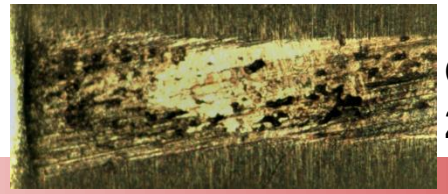
*calibration oil for FZG

Evaluation of the wear scar on the upper specimen

- **For good friction behavior: the edges of the wear scar taper off**
- **For bad friction behavior: the cylinder roller tilts due to adhesive moments, therefore the wear scar shows widened edges**

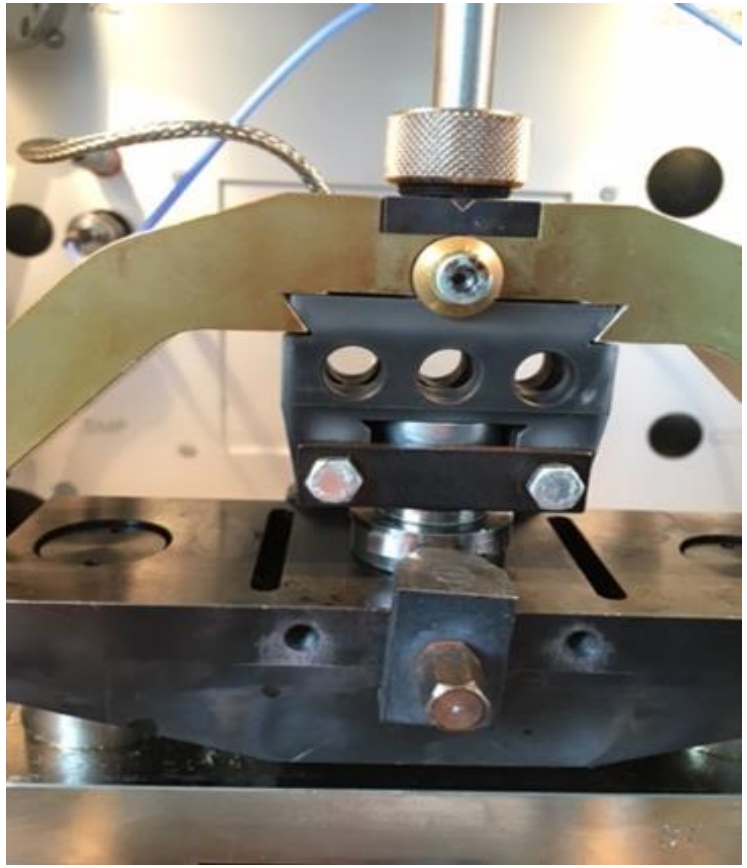


Oil 1.14: 98°C, 1841 N, 2 mm, 50 Hz, 2h

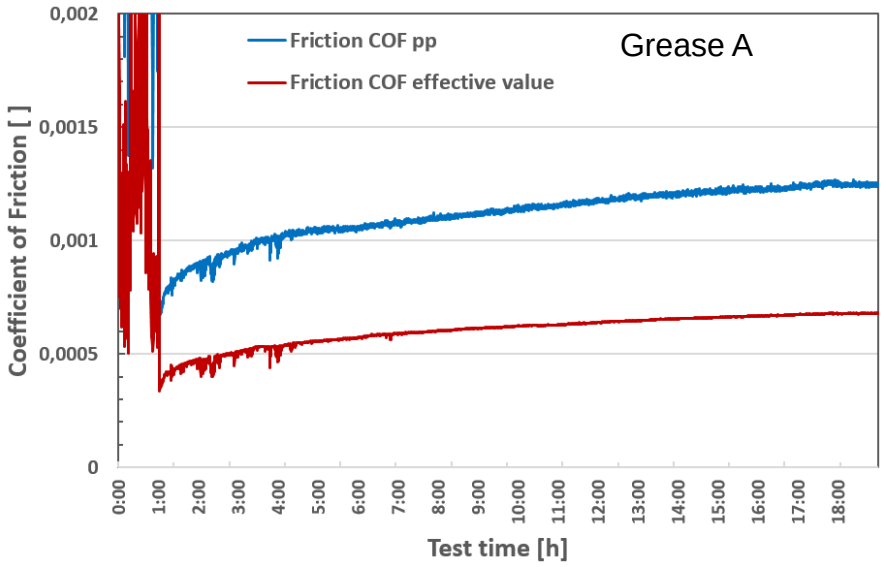


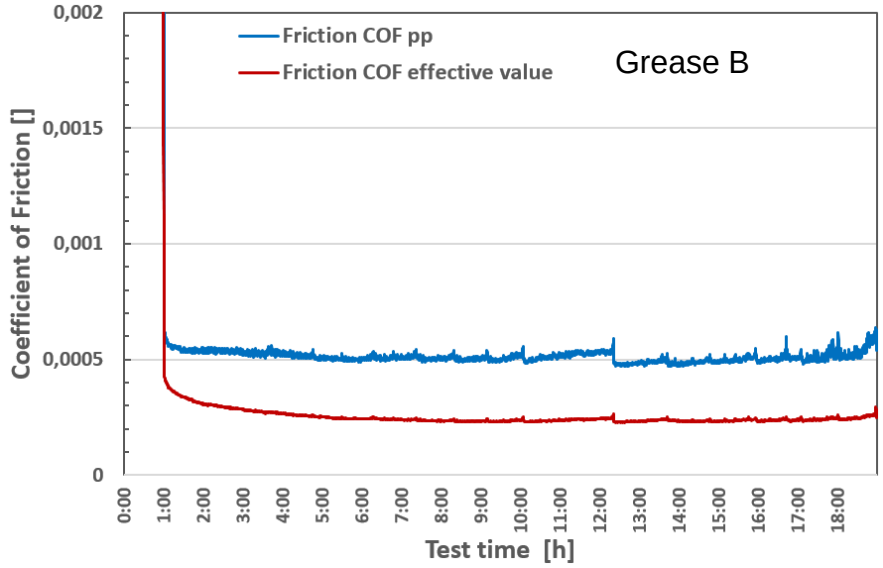
Oil 4.12: 98°C, 1386 N, 2 mm, 50 Hz, 2h

Rolling friction and wear of greases

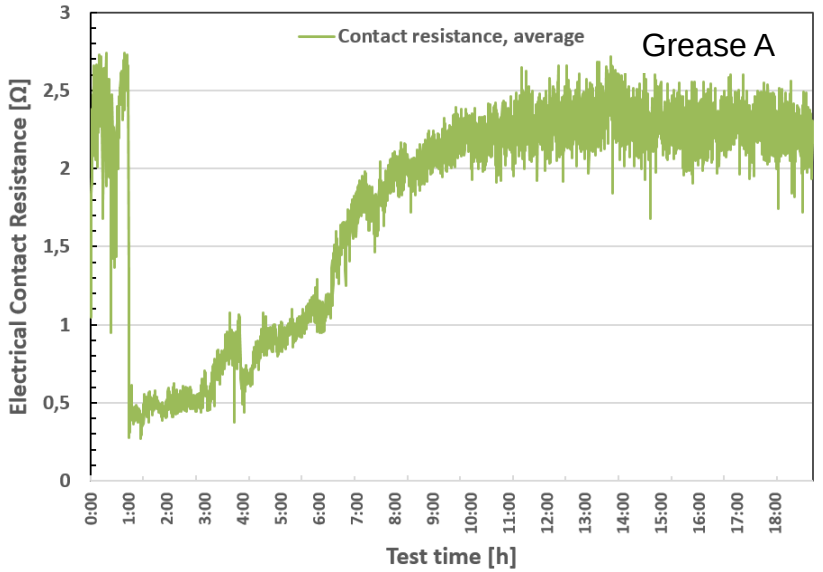


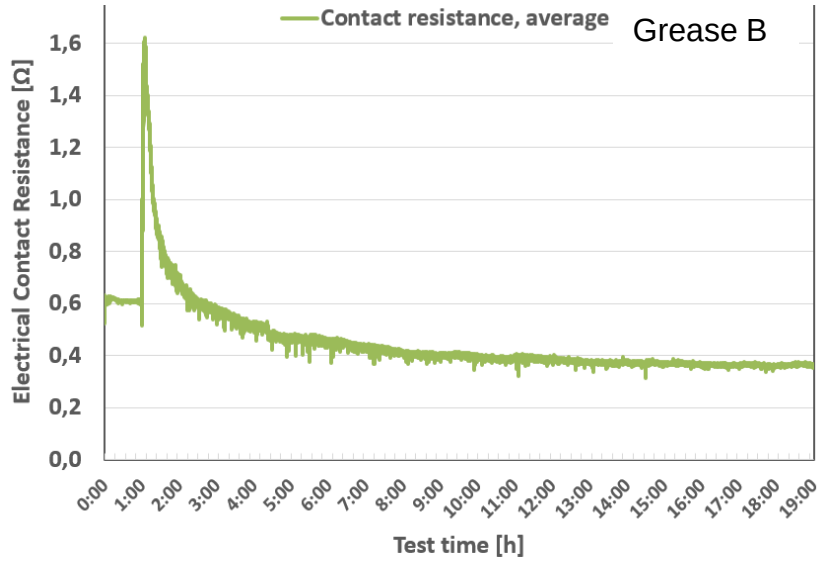
Rolling Friction of Greases acc. to WK71194





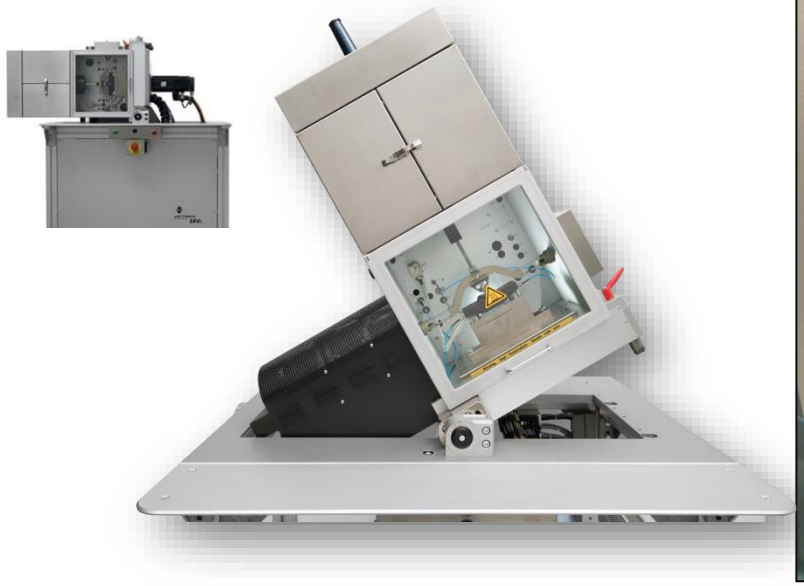
Comparison of "electrical resistance of greases" @ T= 100°C during the rolling friction test



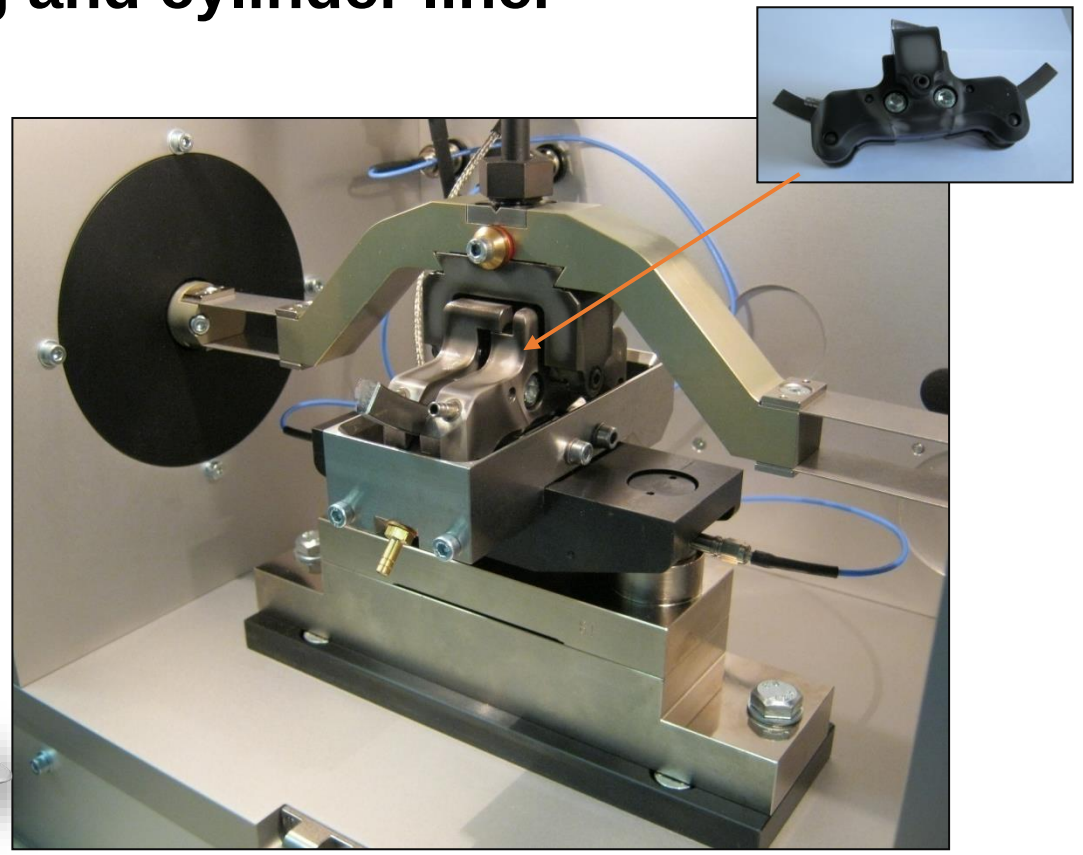


Piston ring – cylinder liner in SRV®

Holder and oil baths for piston ring and cylinder liner segments

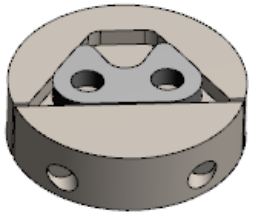


Inclination of the complete test chamber from horizontal (0°) to vertical (90°)

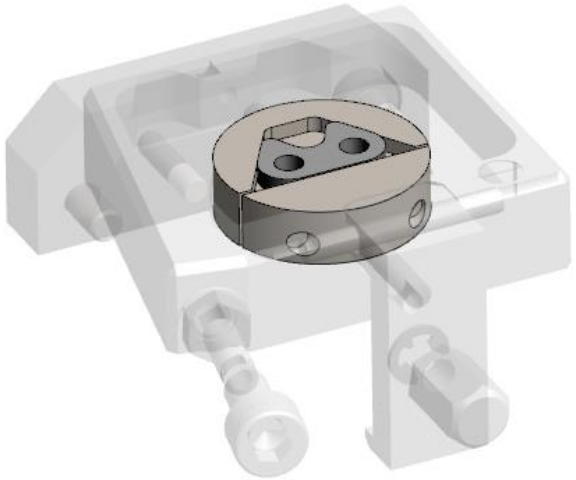


Screening of chain wear properties

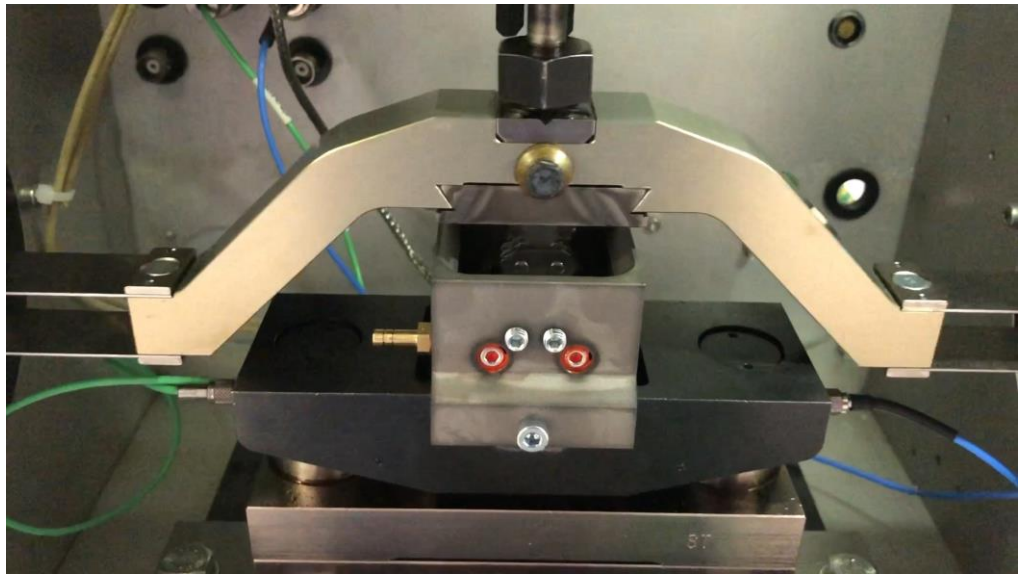
Original chain pin against chain link



Holder for the chain link



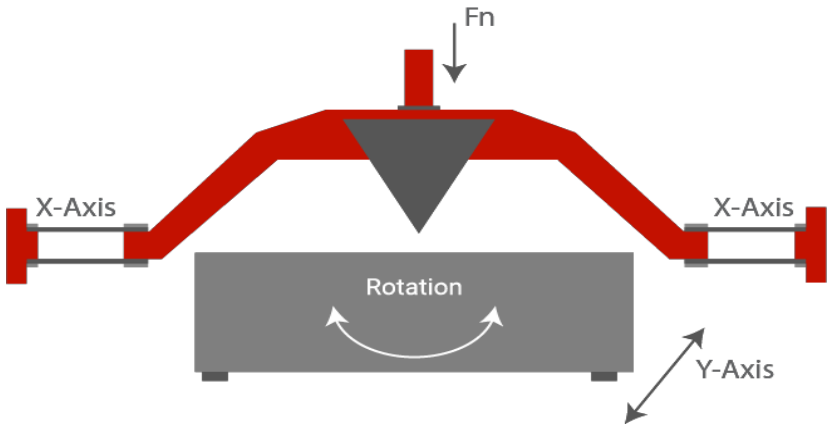
Holder for the chain link installed in a fluid bath



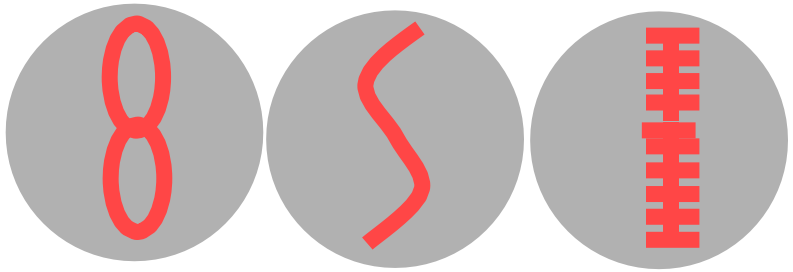
Entire setup

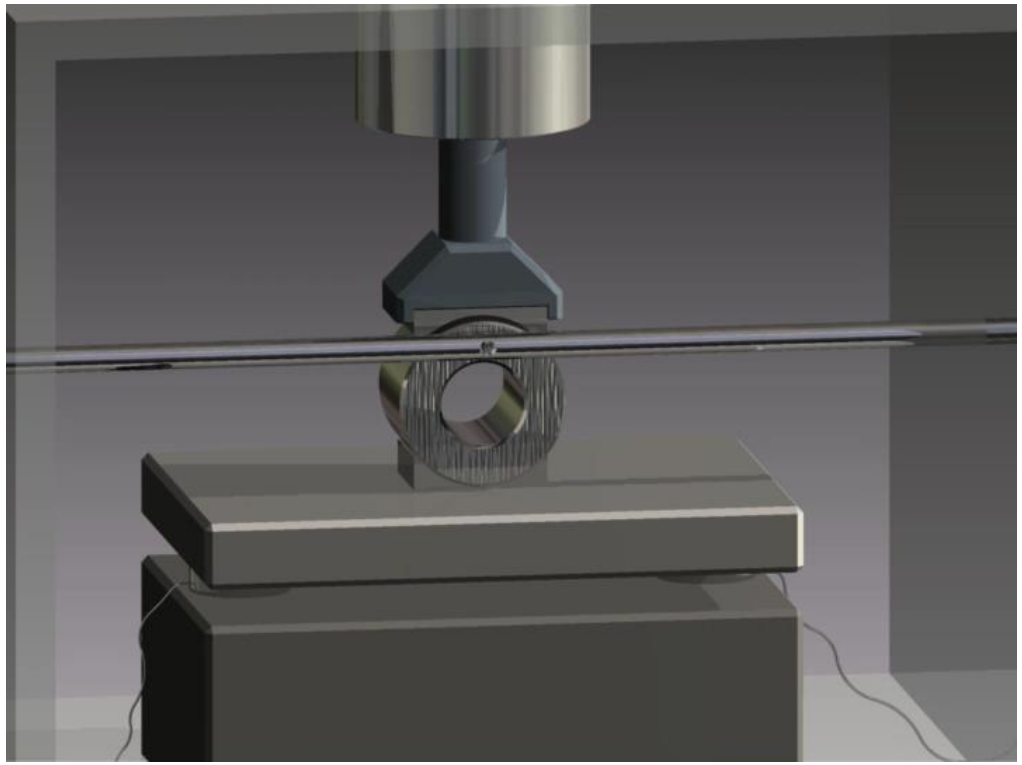
Combi Drive for practical movements

Combi-Drive allows the simultaneous realization of multiple movement types which occur in practical tribosystems by any combination of oscillation (x-axis), rotation and y-axis shift.



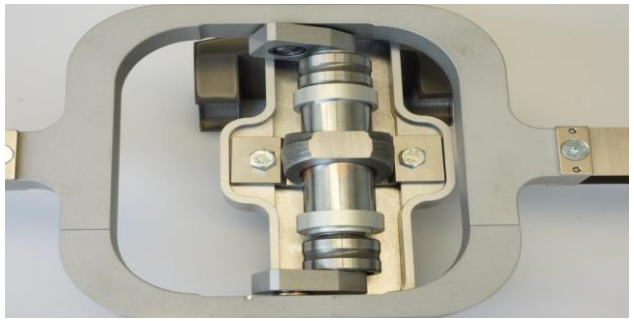
Shapes of movements

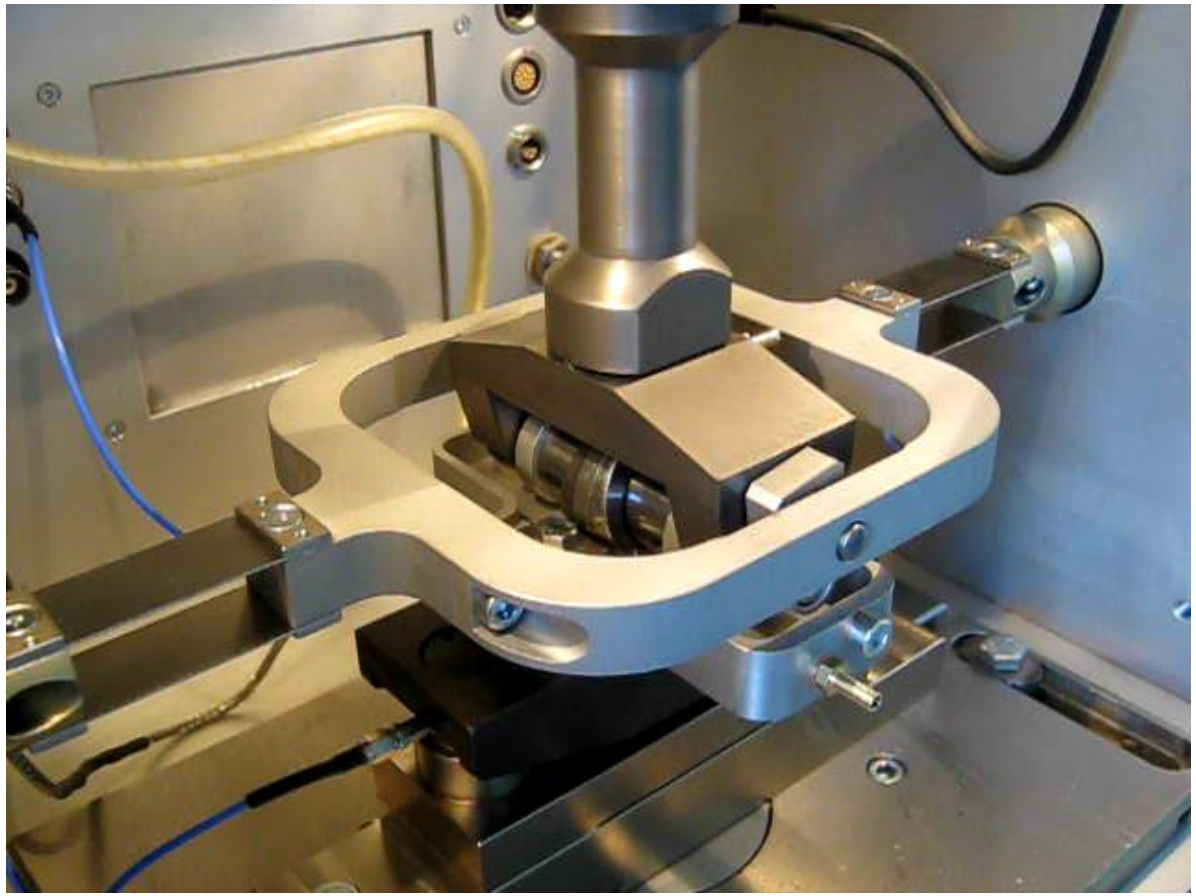




Engine applications

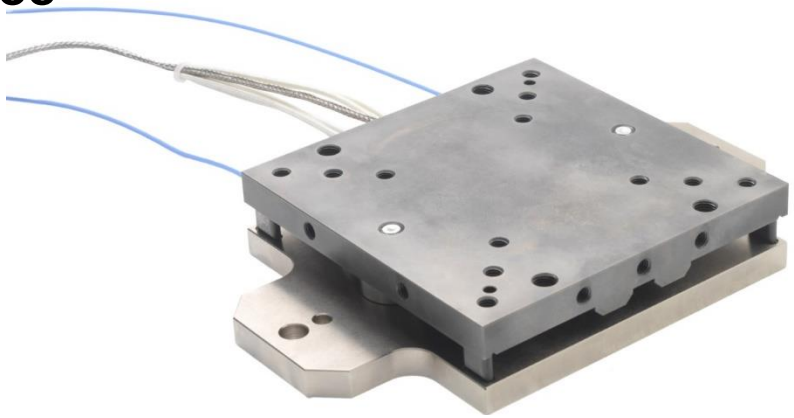
Assembly of engine components:
Radial piston bearing, piston pin, connecting rod eye





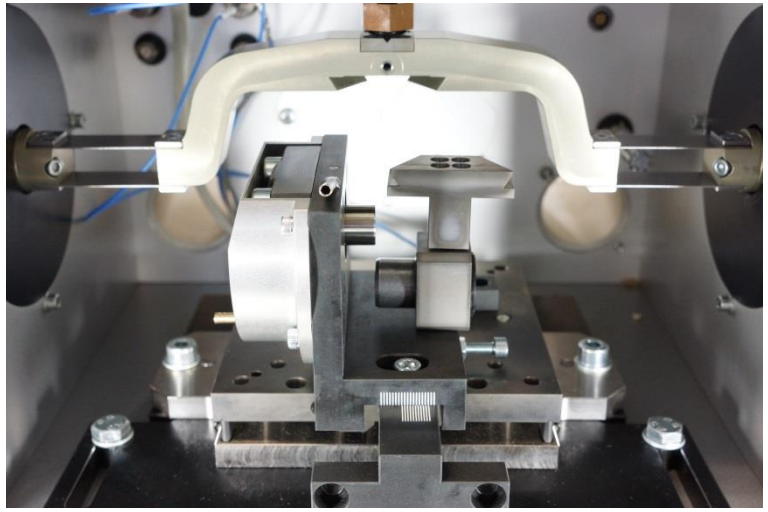
Multifunctional block

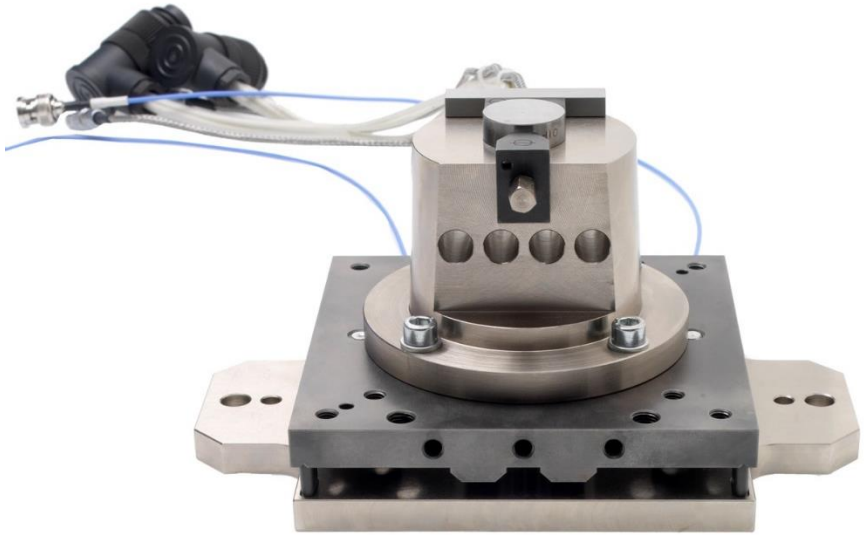
- Replaces standard block (can be switched by user)
- Large receiving plate with 130 x 130 mm² surface
- Height 32 mm, only
- Maximum temperature 500°C
- Calibration setup as an option



Applications:

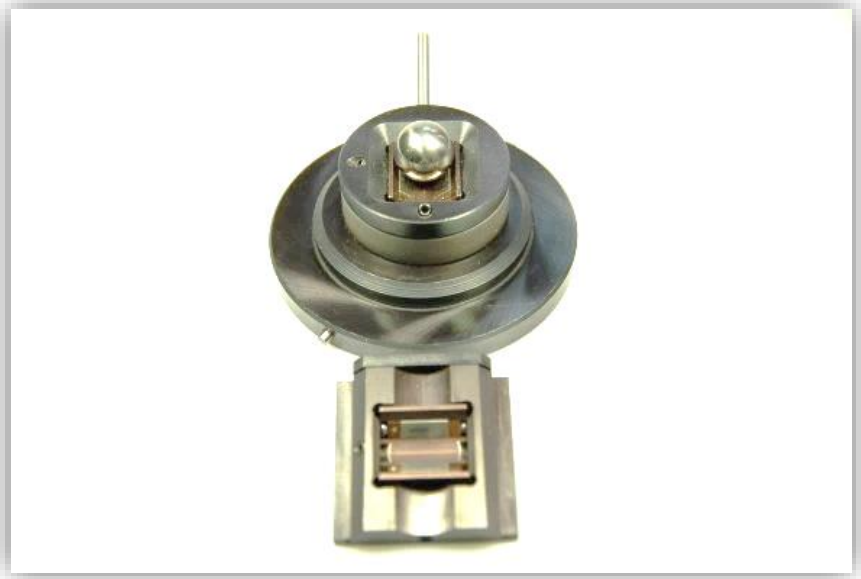
- Component tests

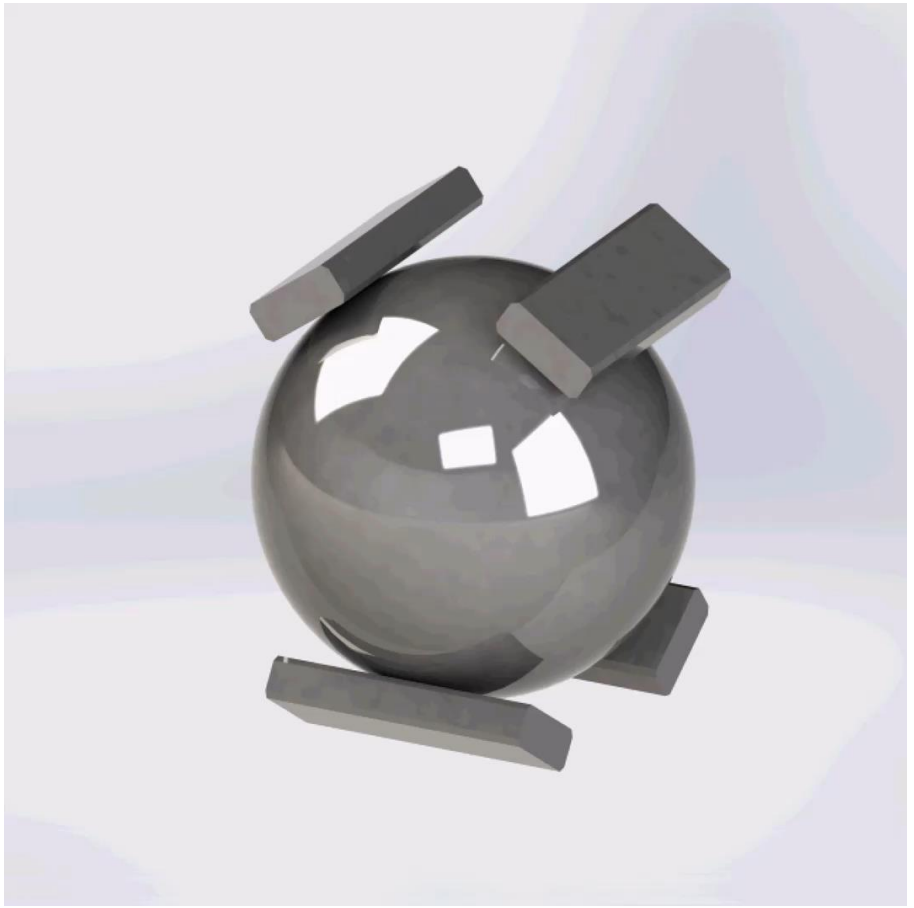




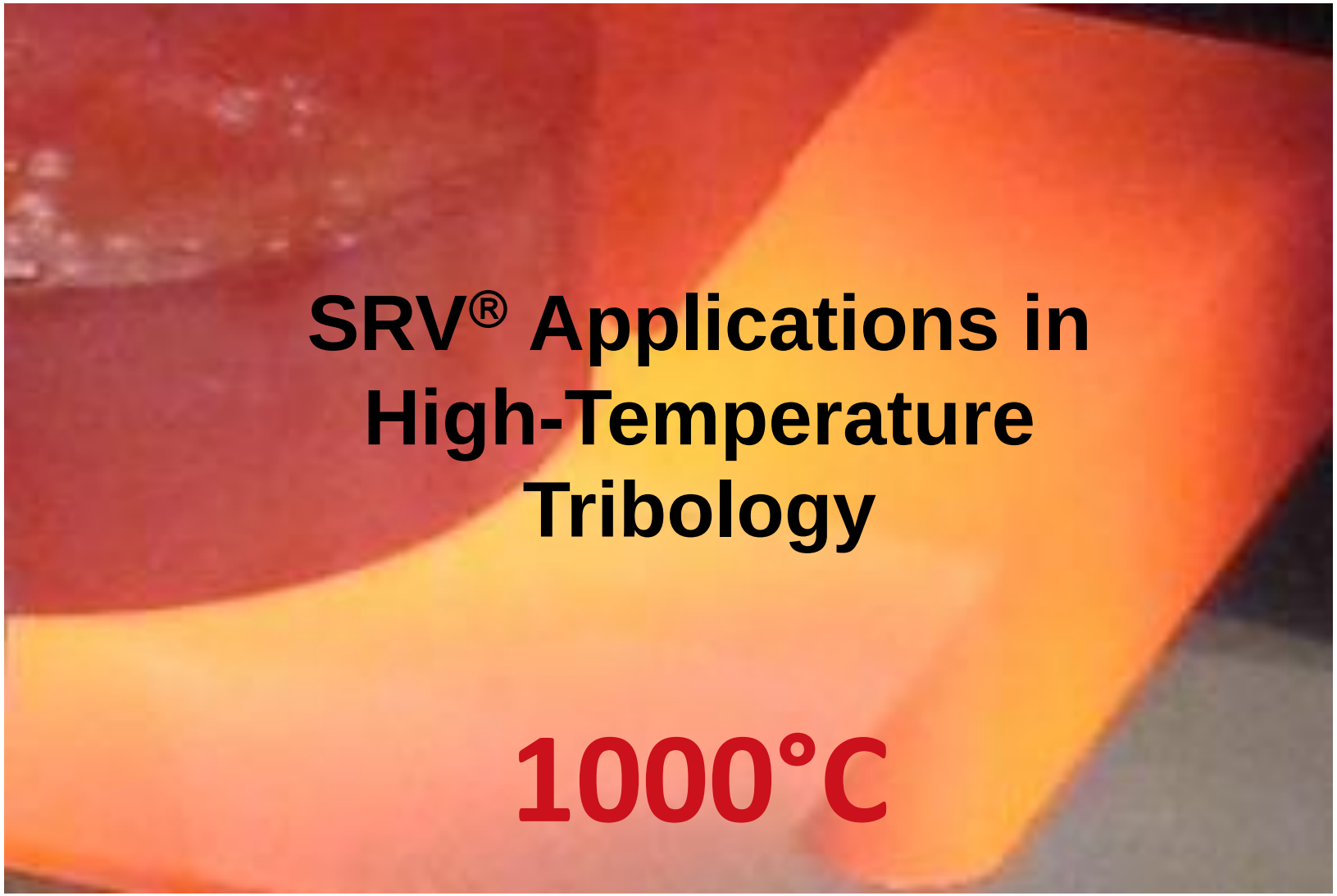
Wear Tests for CVT / Cardan joint Grease

(Rotation modus)





- Special wear test for CVT greases in which the movement of one ball in a cardan joint is simulated
- Specialty of this movement is the overlay of linear and rolling movement


SRV® Applications in
High-Temperature
Tribology
1000°C

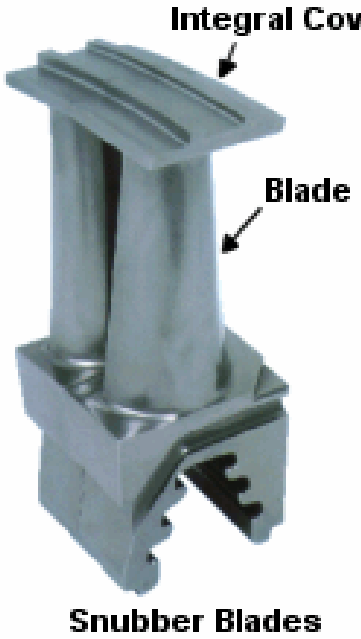
Typical machine elements under high-temperatures

(some examples)

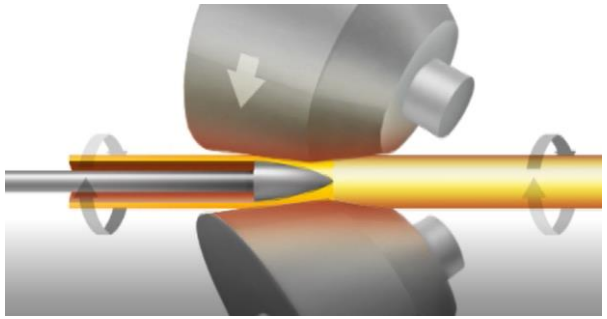
Exhaust valve seat inserts

Variable vane geometry and wastegate mechanisms in Turbocharger

Turbine blades

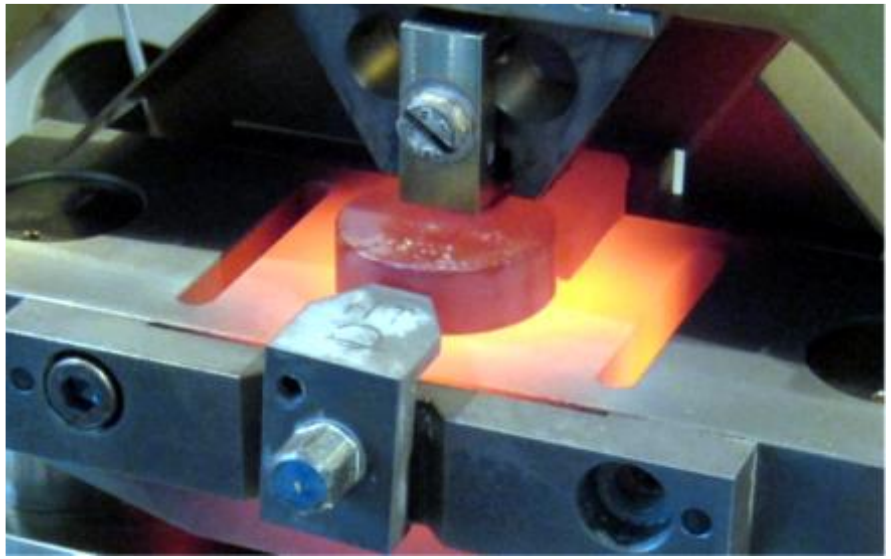


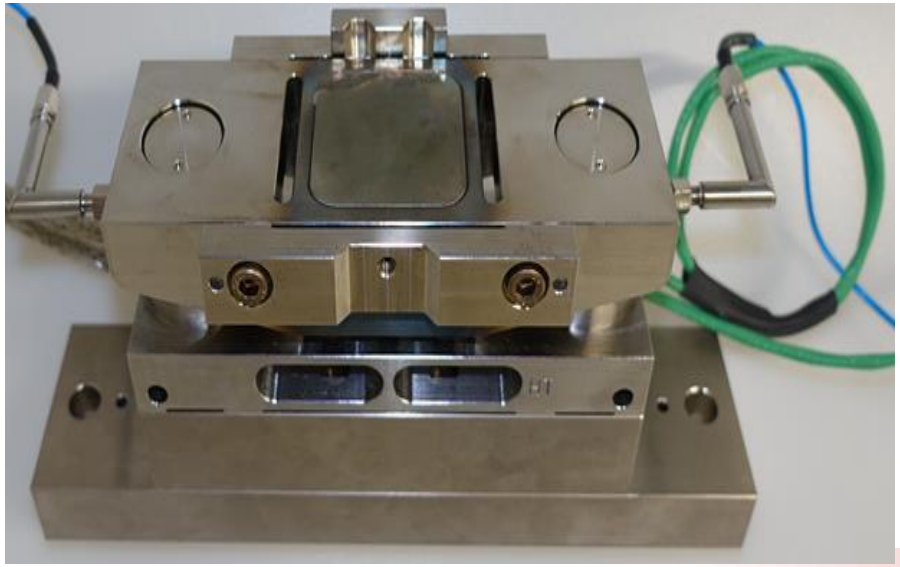
Hot rolling and piercing of seamless tubes



Deep drawing of high strength boron and press hardening steels

High Temperature Unit RT to 1000 °C





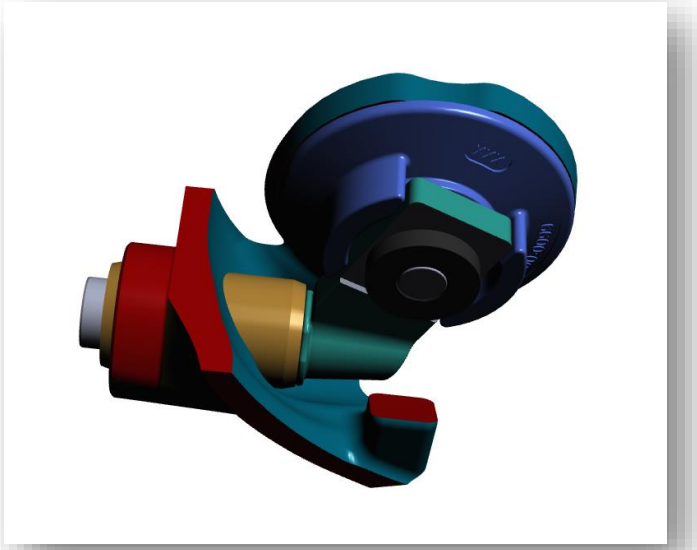
- replaces standard block (can be switched by user)
- made from high temperature resistant material (Inconel 600)
- allows block temperatures of 1000 °C
- requires HT resistant holders, adapters and clamps
- includes ball holder (10 mm) and 2 sets of clamps (centric and eccentric),
- as well as two protective metal sheets

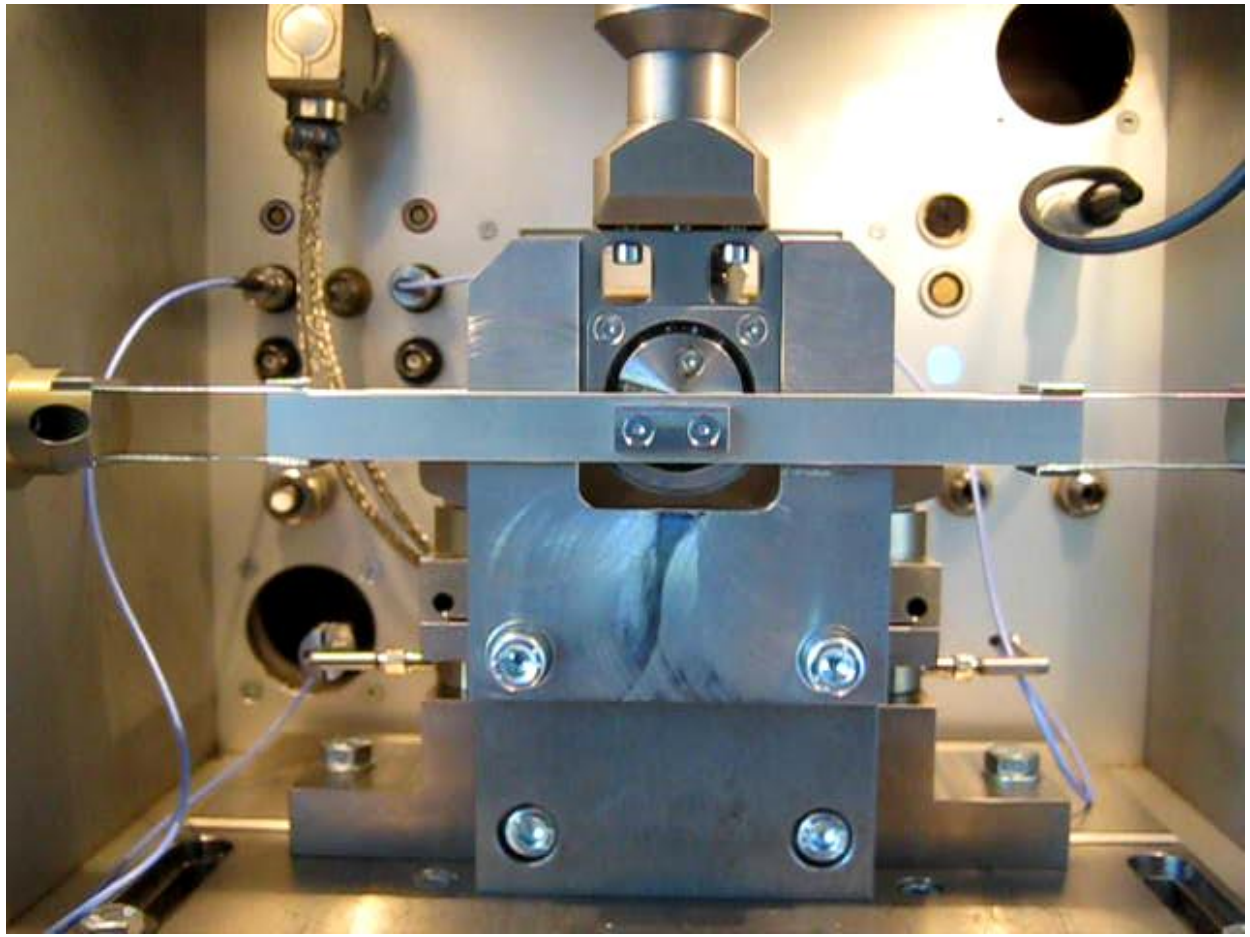
Applications:

- material tests
- component tests

High Temperature Component

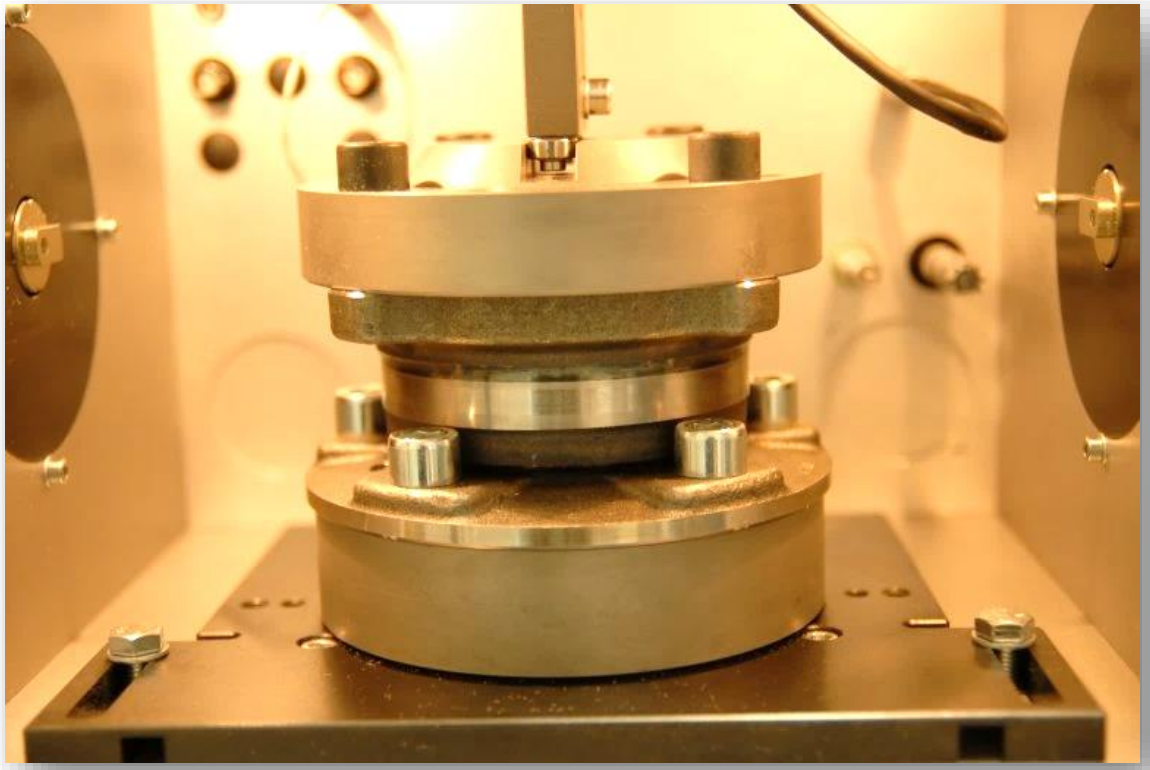
plain bearings





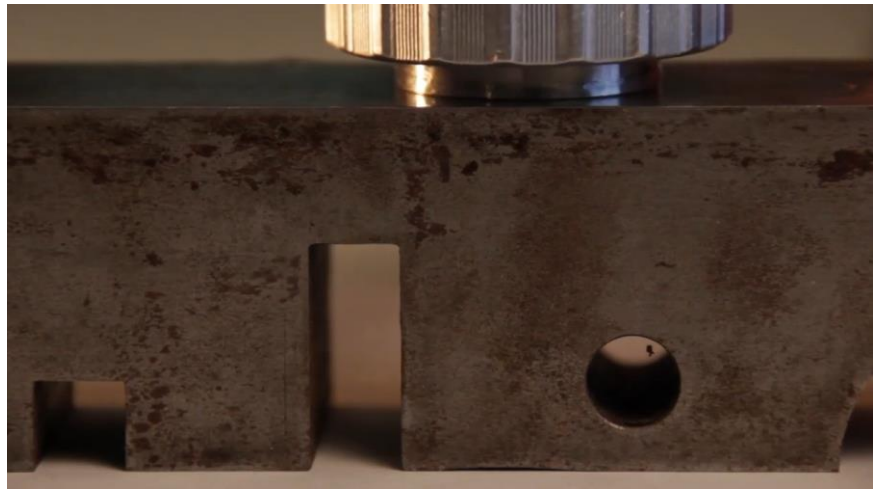
Rotation Applications

Friction moment in wheel bearings (tested with variable temperature and speed profiles)



Application of AE Sensor and SRV®5

- **Acoustic emission provides information about the condition of tribosystems, e.g.:**
- **ultrasound material testing**



- **Noise vibration harshness / stick slip aspects of tribosystems**

SRV® as industry standard

Industry Specification

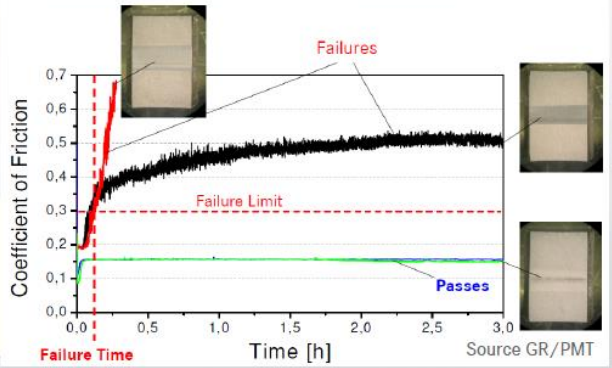
Mercedes-Benz

3 New Oil Tests

Load Carrying Capacity of Al-Si-Cylinder Liners in the new MB SRV-Test

SRV-Test = Schwing-Reib-Verschleiss-Test acc. to MB Standard MBN 10474, 2011-04-08 (GR/PMT)

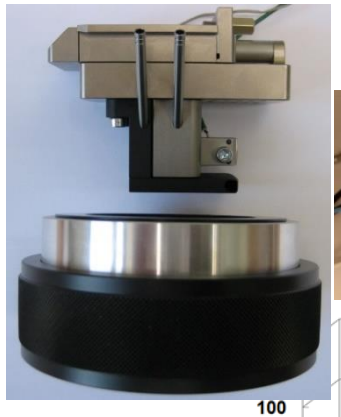
- **Goals:** + Compatibility with Al-Si-Liner Technology + Prevention of Wash Board Wear
- **Test Hardware:** SRV Tribometer SRV®4 (Optimol Instruments Prüftechnik GmbH) Orig. Piston Ring Segment & Cyl. Liner Segment
- **Test Development:** Daimler Group Research, Tribology, GR/PMT, Ulm
- **Test Parameters:** + Load Carrying Capacity (LCC) as average of 5 test runs + Coefficient of friction
- **Test Details:** MBN 10474: Test length 3 h, Frequency 20Hz, Stroke 3 mm, Constant load up to 200N, Oil bath temp. 130°C, tests with fresh & aged oils
- **Test Labs:** APL Landau & ISP Salzbergen

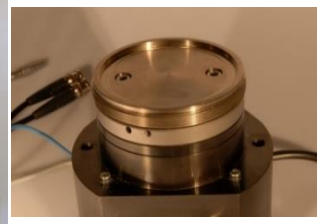


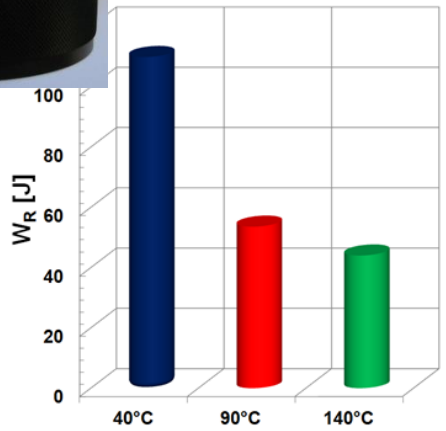
Schenk & Dr. Andorf, Daimler AG — New Engine Oil Requirements for MB Engines — 10

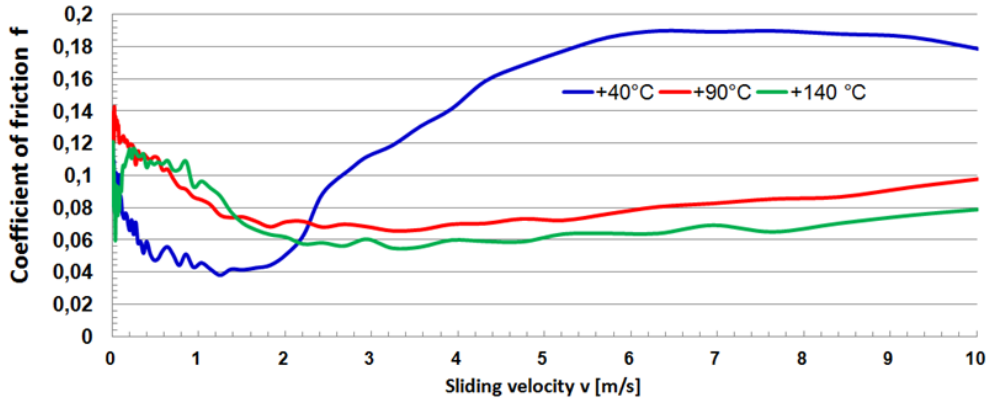
SRV® as industry standard

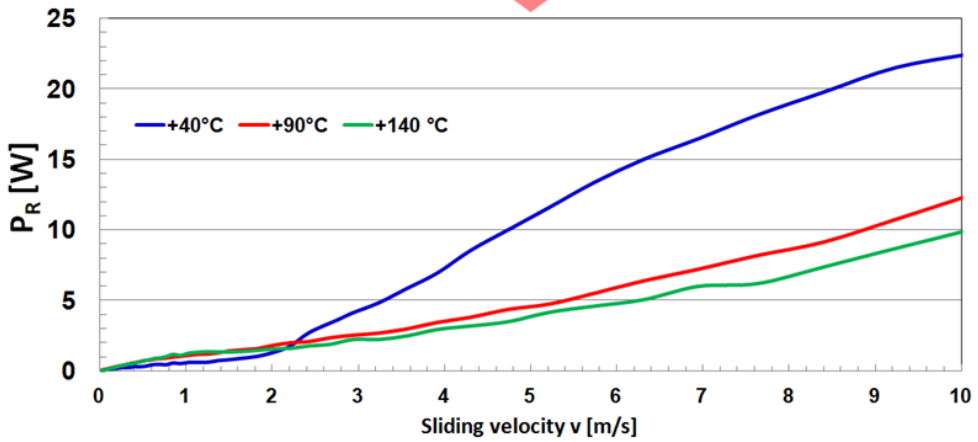
Stribeck-type Curves of Alternative Engine Oils
Part 2: AlSi17Cu4 Liners











Derivation of friction work from Stribeck-type curve

Falk Hannemann
Niklas Berberich
Holger Ziegele

Mathias Woydt
Norbert Kelling

BMW Group

BAM

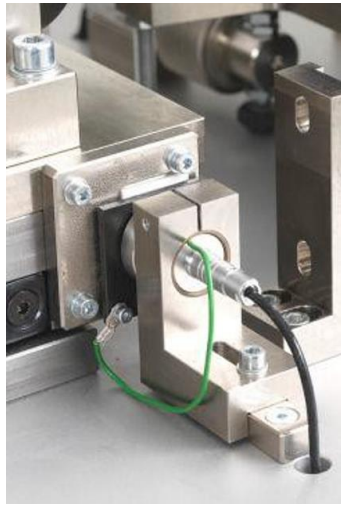
2disk made by OIP

For evaluating the friction and wear behavior of slip-rolling contacts

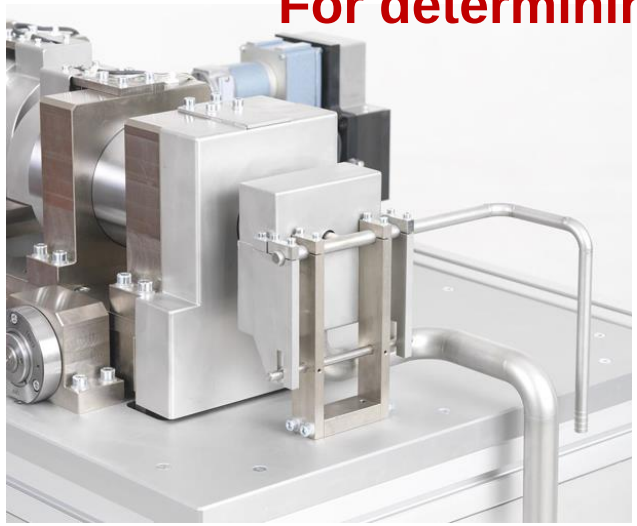
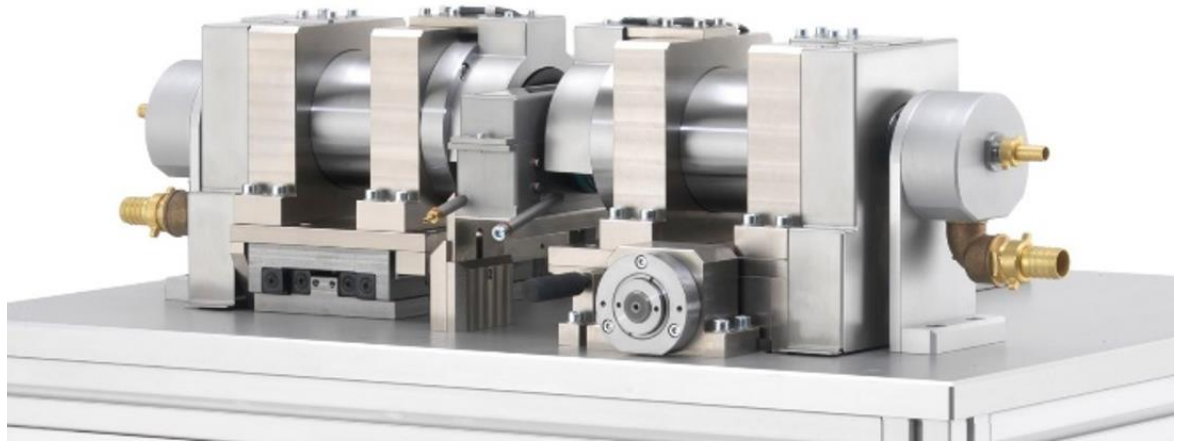
OPTIMOL INSTRUMENTS

2disk

2disk made by OIP

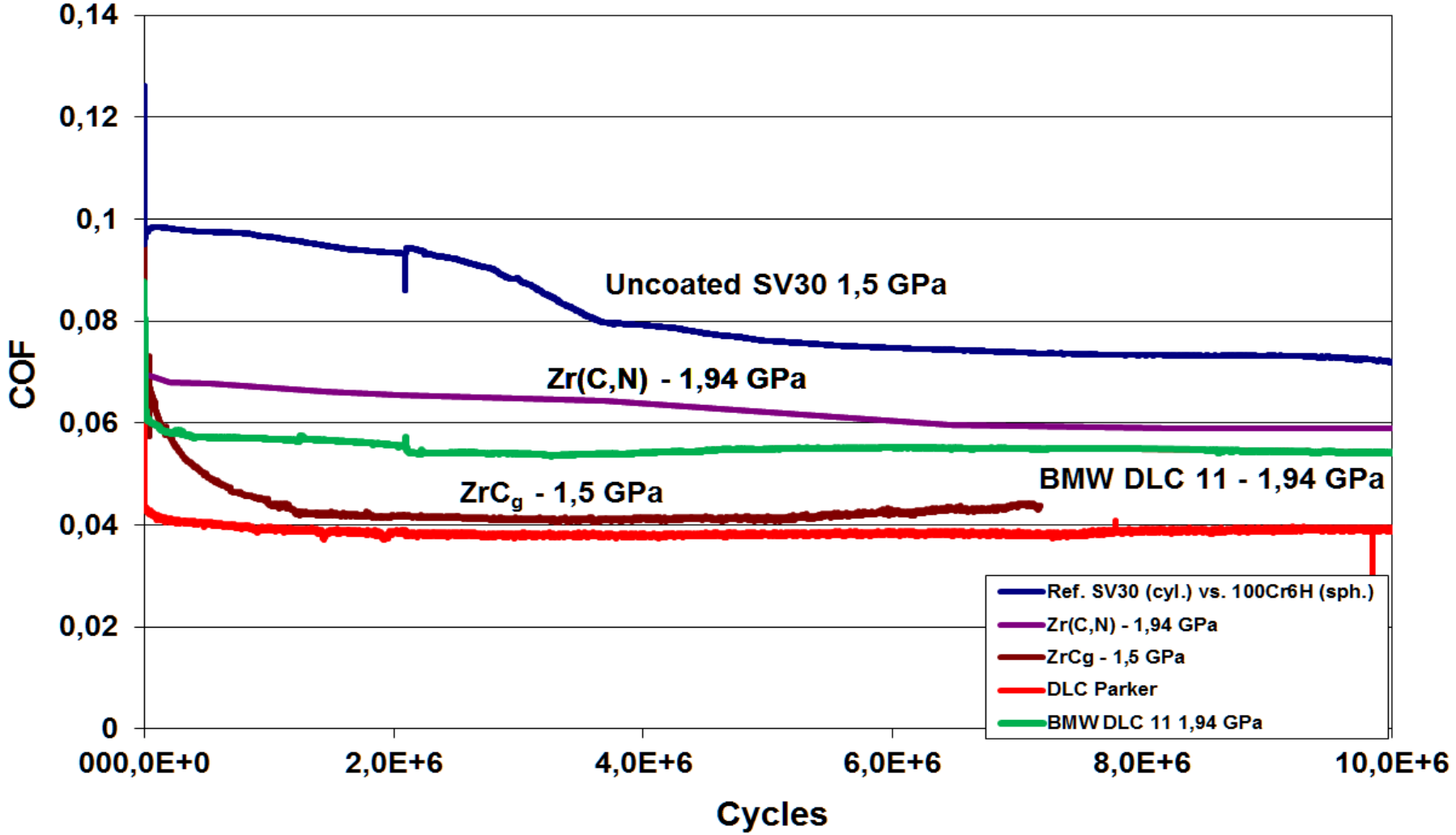



For determining the tribological profile under slip-rolling

Example of testing coatings

Friction reduction and slip-rolling resistance of thin film coatings in BMW FF SAE 0W-30 VP1 (modified) at T= +120°C and P_{0mean} = 1.5 GPa (P_{0max} = 2.25 GPa)



Functional benchmark of alloys

Example: Slip-rolling resistance by light optical microscopic images of wear tracks (P_{0mean} = 1.5 GPa, 1.94 GPa, 2.5 GPa and 2.62 GPa) of 2disk testing at 120°C in factory fill oil 0W-30

Material	1.5 GPa (930 N)		1.94 GPa (2,000 N)		2.5 GPa (4,400 N)		2.62 GPa (5,000 N)	
	Counter Body	Test Sample	Counter Body	Test Sample	Counter Body	Test Sample	Counter Body	Test Sample
AISI 52100	10^7 cycles		10^7 cycles		$6.75 \cdot 10^6$ cycles		Material failure at 2.5 GPa	Material failure at 2.5 GPa
Cronidur 30 (1.4108)	10^7 cycles		10^7 cycles		10^7 cycles		10^7 cycles	
36NiCrMoV 1-5-7	$9.59 \cdot 10^6$ cycles		10^7 cycles		10^7 cycles		10^7 cycles	
20MnCr5 (1.7131)	10^7 cycles		10^7 cycles		10^7 cycles			

Ref. M. Woydt, in ASTM STP 1580, http://dx.doi.org/10.1520/mpc20130022

New benchtop tribometer from Optimol Instruments

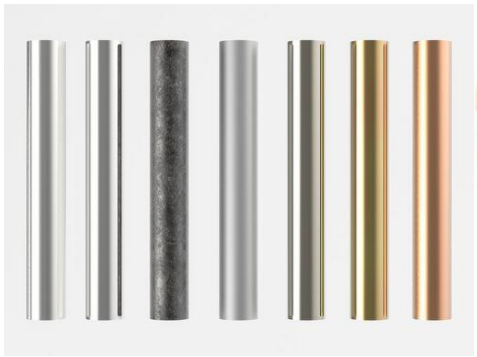
Easy Tribology Screener

Your smart tool for friction and wear screening

ETS – Wear properties

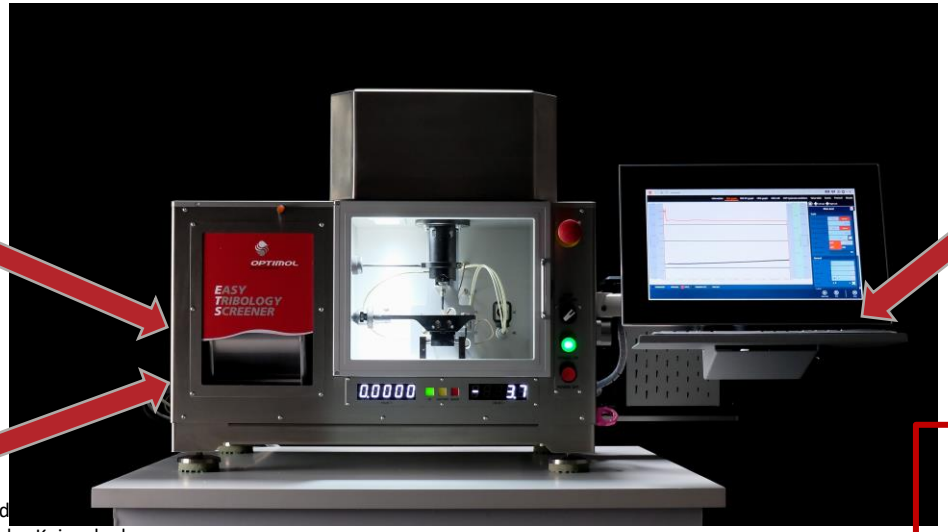
http://www.dlc-coating.ca/oneseven/index.php/projects/cutting-tools

Screen and rate technical coatings



https://www.orthozentrum.ch/d
Knie/Knieprothese-das-kuenstliche-Kniegelenk

https://www.lampe.de/magazin/lampen-material-vor-und-nachteile-der-meistverwendeten-werkstoffe/



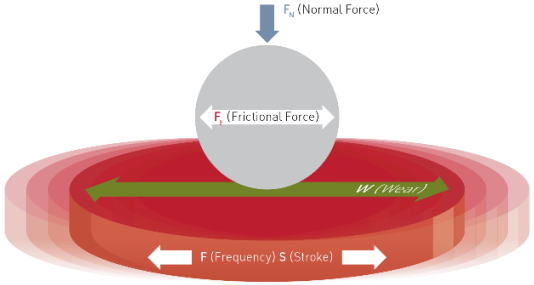
Tribology research

Evaluate wear properties of materials

Easy and quick testing of friction and wear performance with the *E*asy *T*ribology *S*creener

ETS – Some technical parameters/facts

Table-top device
Electromagnetic linear drive, x-axis
Movement pattern: Sinusoidal
Test chamber with glass door, lighting
Complies with relevant EU safety regulations

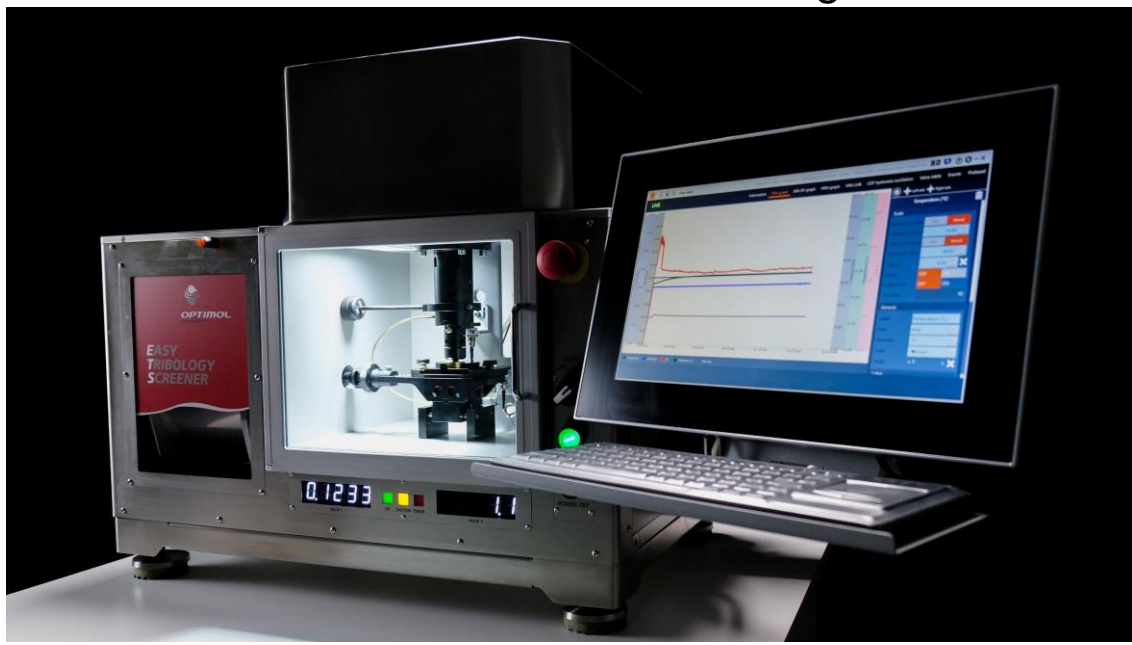


Range of parameters

- **Coefficient of friction:** **0.001 - 0.5**
- **Normal force:** **1.0 - 300 N**
- **Stroke:** **0.01 - 3.00 mm**
- **Frequency:** **10 – 70 Hz**
- **Temperature:** **RT – 200°C**

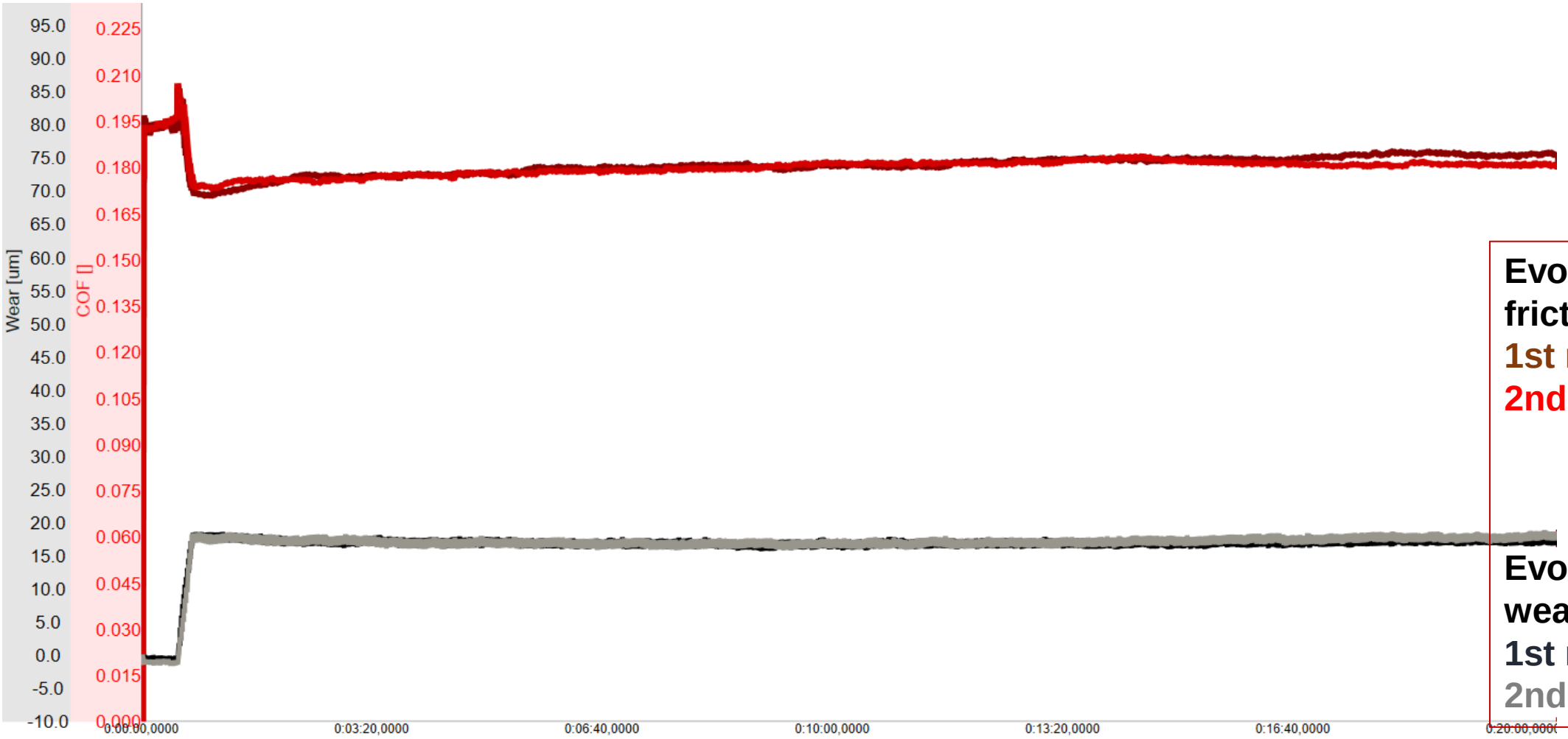
Online wear measurement via differential eddy current measurement with 0.1 µm resolution.

Industrial PC and touchscreen monitor
mounted on a tilting table



Height: approx. 72 cm
Length: approx. 122 cm
Width: approx. 58 cm

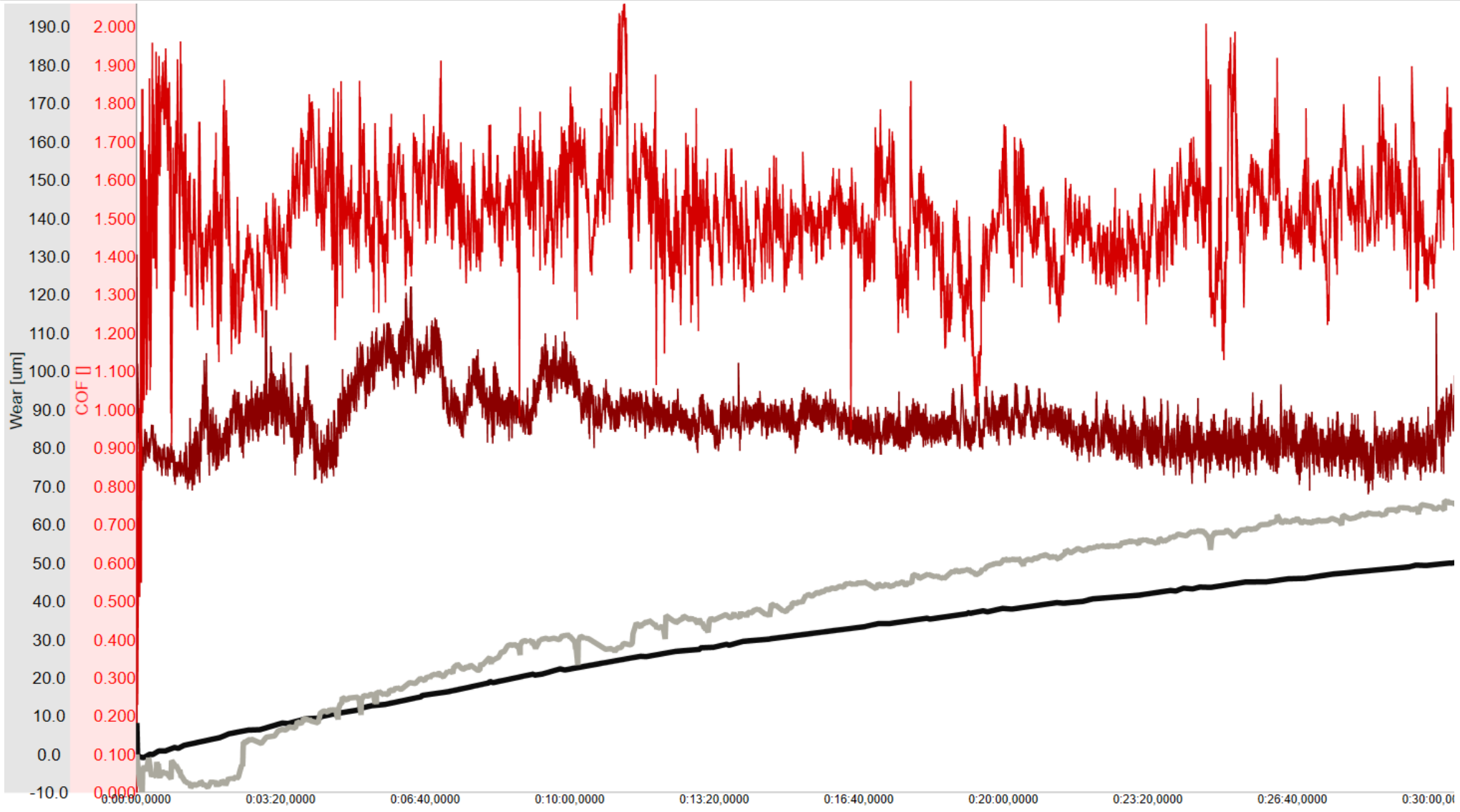
ETS – Repeatability of test results



Evolution of the friction values:
1st measurement
2nd measurement

Evolution of the wear values:
1st measurement
2nd measurement

ETS – Tribological performances of Materials



Evolution of the friction values:
Steel vs. aluminum
Steel vs. steel

Evolution of the wear values:
Steel vs. aluminum
Steel vs steel

Collaboration – Opportunities with

Joint ZIM projects on topics related to

- **evaluation of friction and wear performance in the model up to the component range**
- **development of inline measurement methods for tribological effects**
- **development of test rigs for special tribological issues**
- **tribological evaluation software using AI**

Supply of test rigs and services for projects

- **Rental or leasing test equipment**
- **Tribotesting consultation**
- **IoT connectivity via OPC-UA**
- **Automated evaluation and databases**

OPTIMOL INSTRUMENTS

Thank you

Competence in tribological modeling, simulation and analysis

Today's technology for tomorrow's challenges

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Smart tribotesting tools