Acoustic emission testing -

for early fault detection in rotating equipment

Mehr Wert.
Mehr Vertrauen.

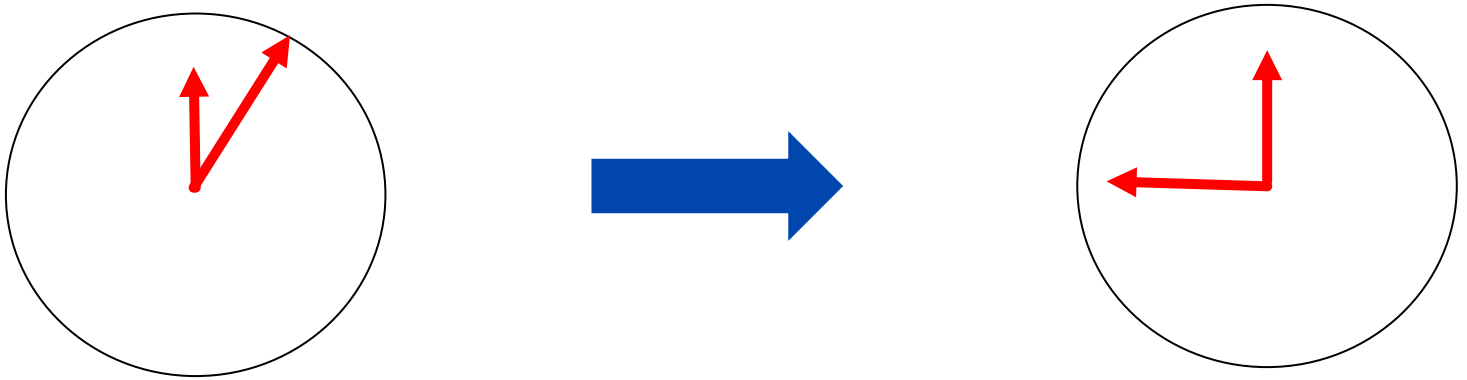
Add value.
Inspire trust.

EPSC Webinar
6th April 2022

Hermann Schubert
Head of Digital and Continuous Inspection

hermann.schubert@tuvsud.com
+49 151 2704 4928

TÜV SÜD Chemie Service goes DIGITAL



GOAL should be…. with the correct strategy …. Change the timing of fault detection!

TÜV SÜD Chemie Service goes DIGITAL

Drone with Cameras for VT (recording with HR)

UT-TM
Continuous measurements and reporting

Test concept

Monitoring with acoustic emission

Monitoring rotating equipments

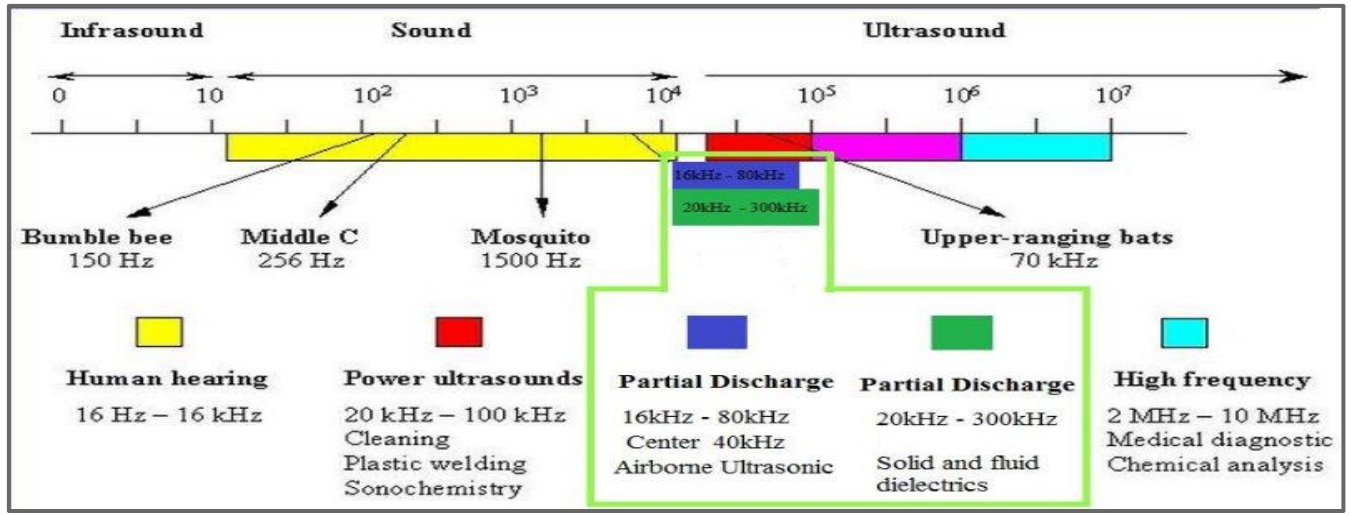
Part of

predictive maintenance

Objectives:

- What is **A**coustic Emission **T**esting (**AT**)
- Use of AT in rotating equipments
- Practical examples

What is acoustic emission testing (AT)?



https://www.quora.com/What-is-ultrasonic-welding-inspection

- NDT - according **ISO 1330-9 ->**
Acoustic emission is the phenomena whereby transient elastic waves are generated by e.g. plastic deformation, crack propagation, erosion, corrosion, impact, leakage

By using the correct equipment, sensors and parameters, you will be able to detect:

Crack propagation, metal mesh damage, spalling damage from the structure, leakage, poor sealing, impact forces, abrasion, friction, insufficient lubrication, etc.

Examples of AT application

REACTORS

- During testing at supplier (pressure test)

PRESSURE VESSEL

- In operation

STORAGE VESSEL

- For internal inspection

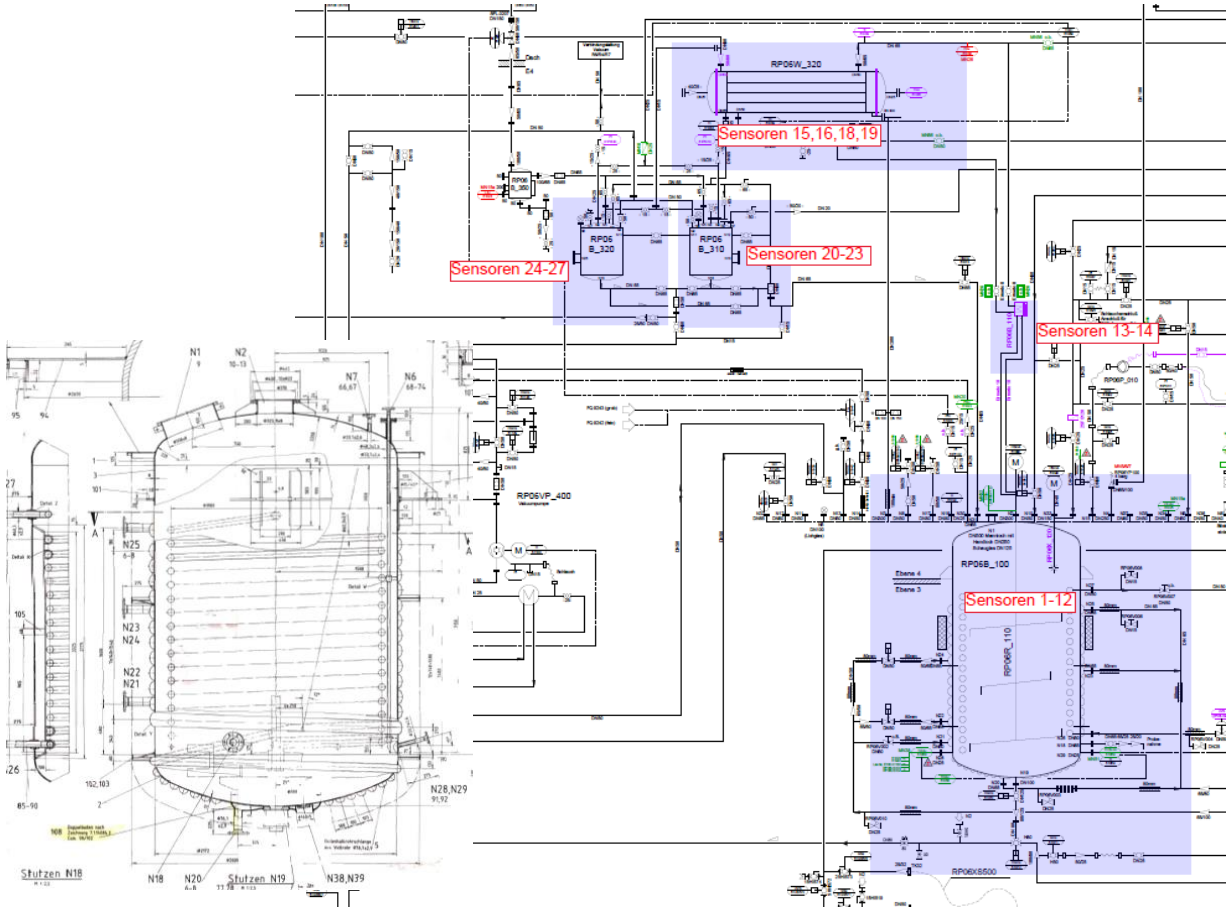
PROCESS COLUMN

- As safety reason during pressure test with gas or product

Interesting applications of AT

- Pyrophoric CAT can remain in the object
- Pressurisation can also be done with product or gas (>300 bar)
- Can be done on more then 1 pressure vessel simultaneously
- Little effort – all vessels tested with one pressurisation

- TEST CONCEPT needs to be developed!



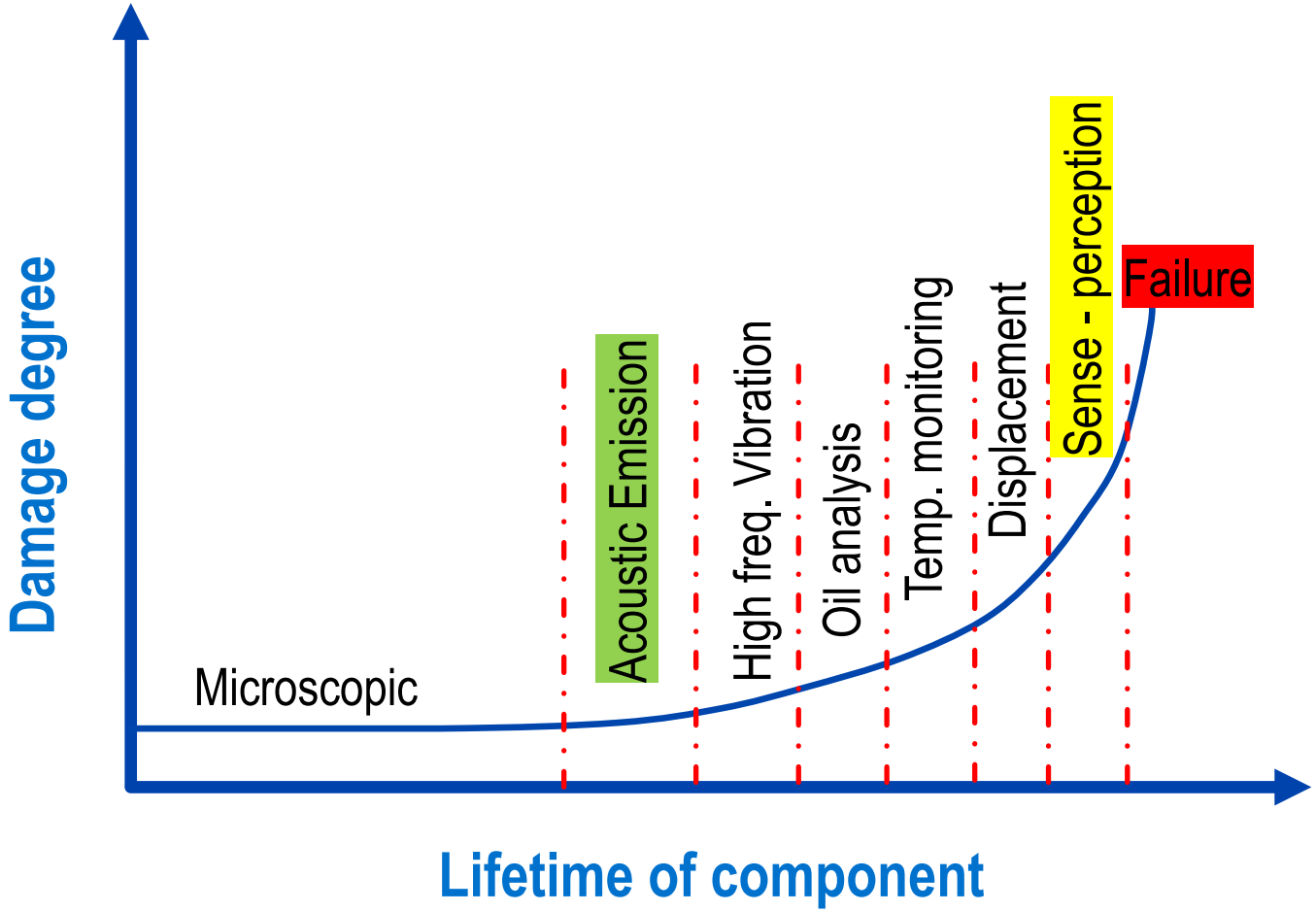
Common methods for fault diagnosis on rotating machinery:

What generates acoustic emission during inspection?

Crack propagation, metal mesh damage, spalling damage from the structure, leakage, …

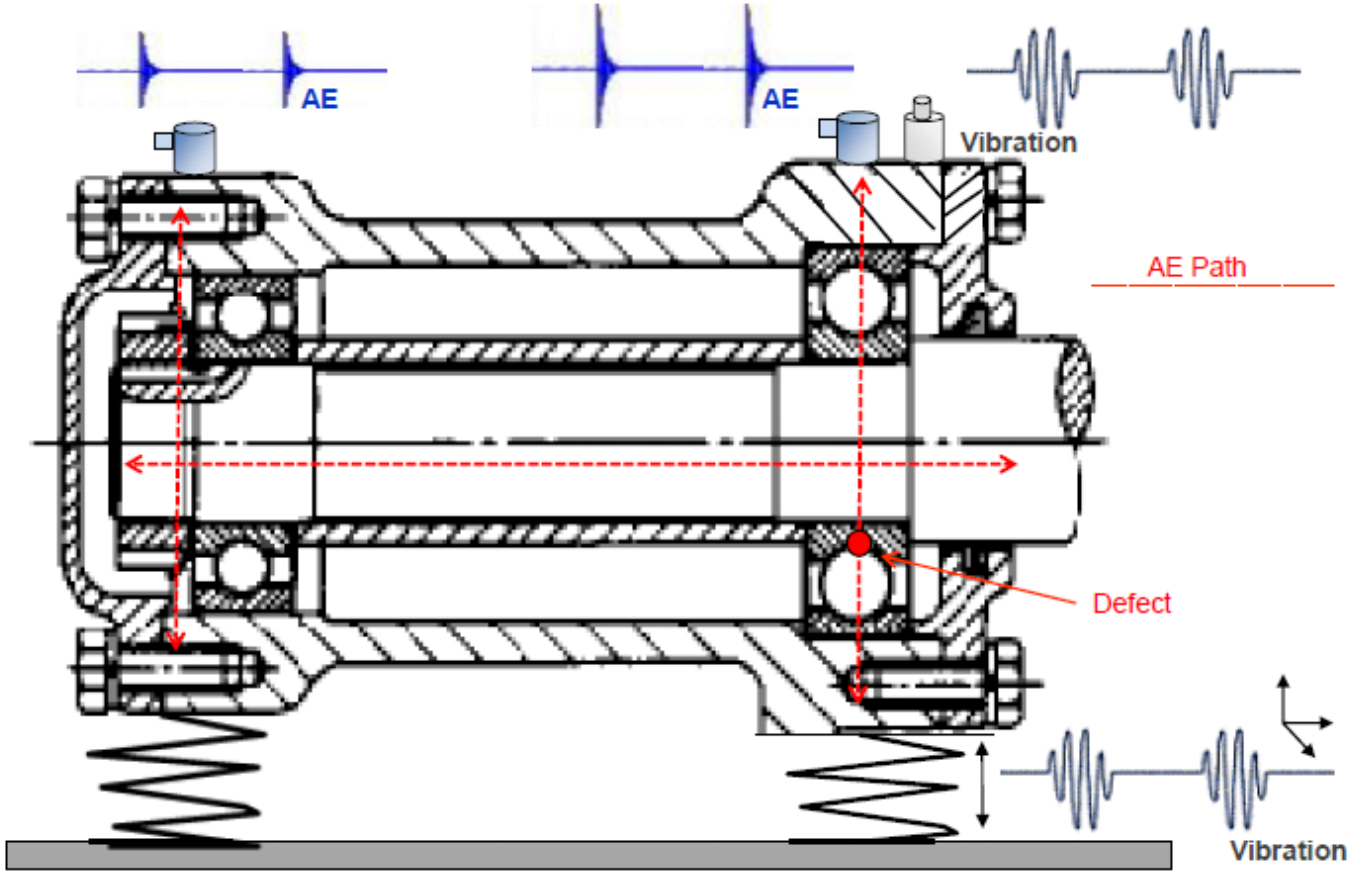
poor sealing, impact forces, abrasion, friction, insufficient lubrication, etc.

Common methods for fault diagnosis on rotating machinery:



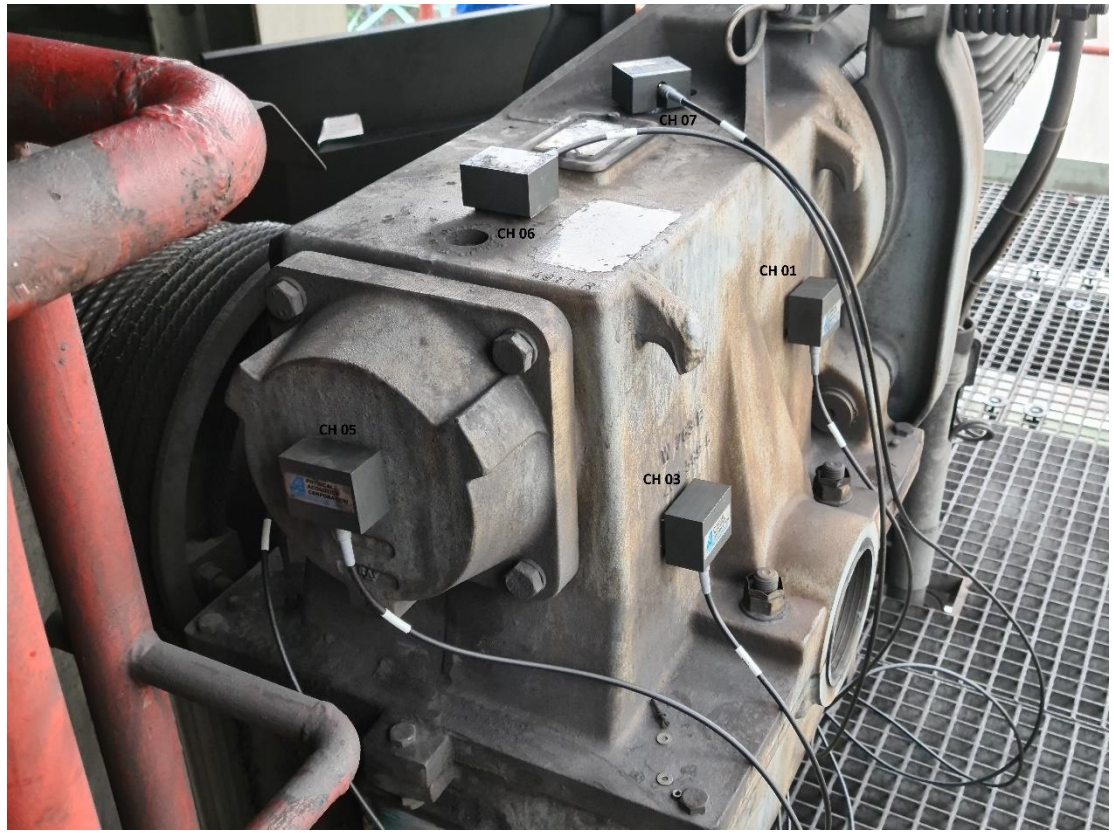
AT on rotating equipments

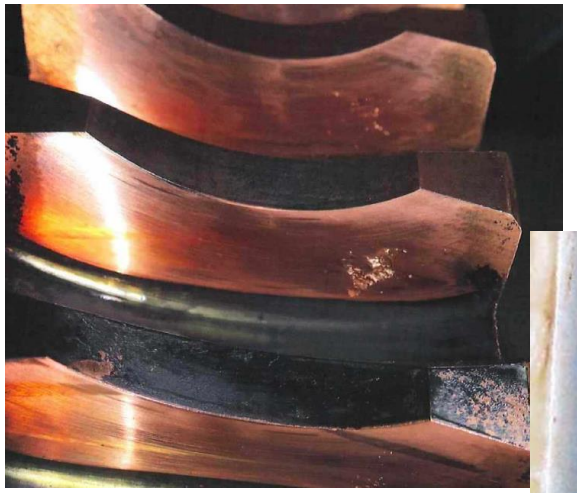
Wave propagation path



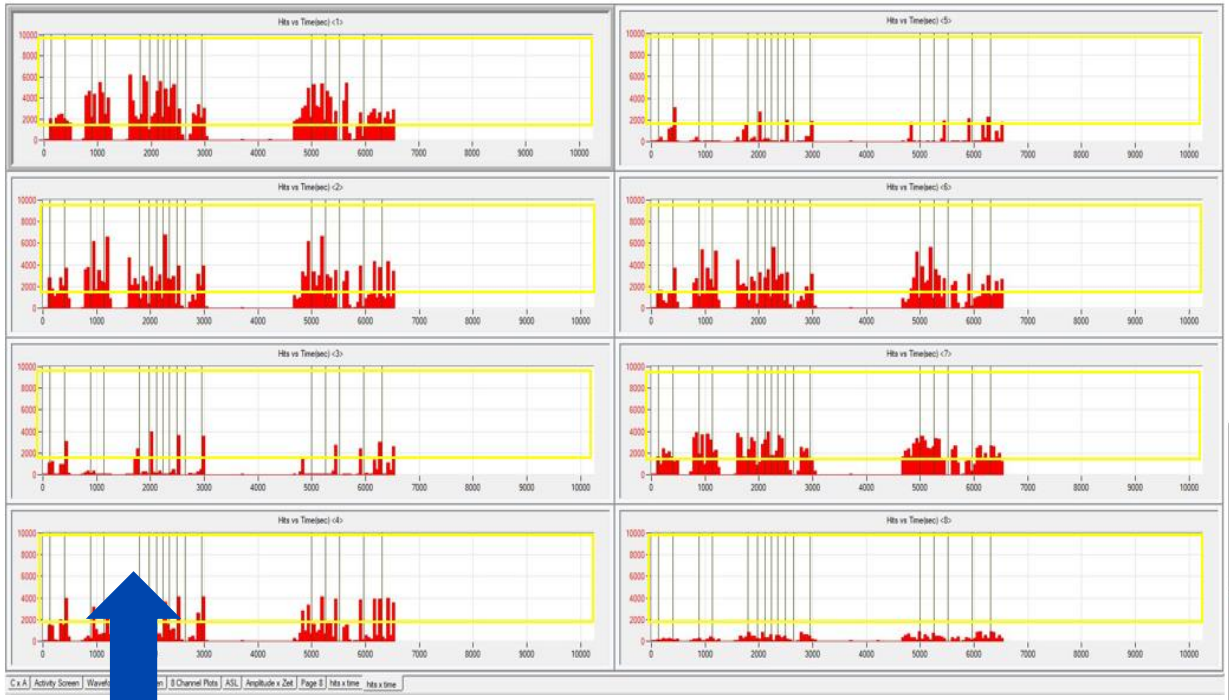
Mistras Presentation – AT on LSB (low speed bearing)

Practical example – AT on an elevator gearbox



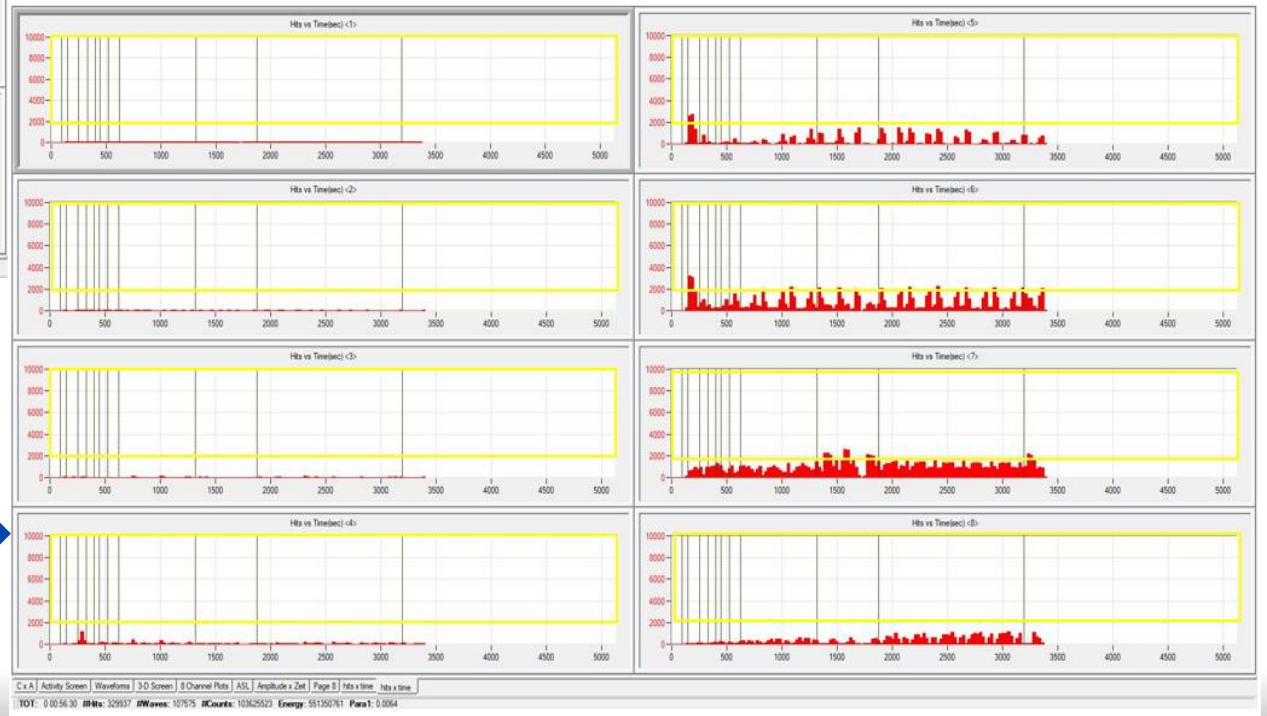


AT results – elevator gearbox

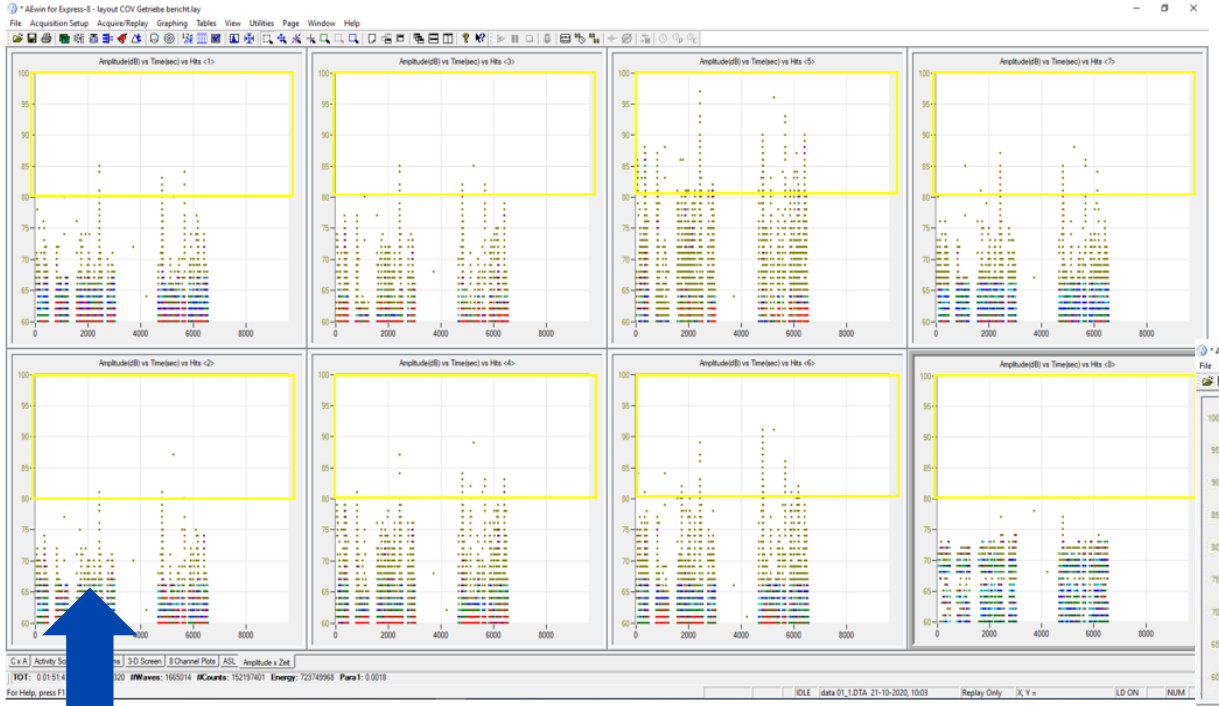


Measurement before maintenance

Measurement after maintenance – oil / cleaning

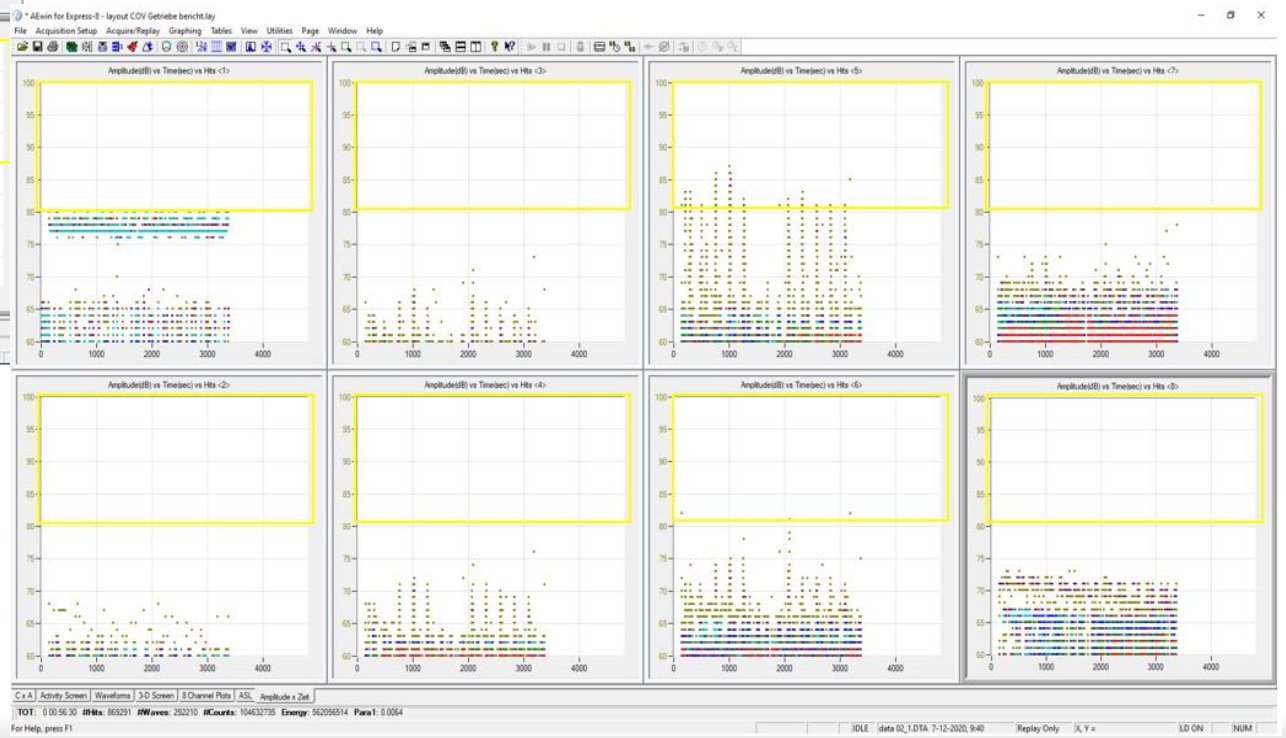


AT results – elevator gearbox

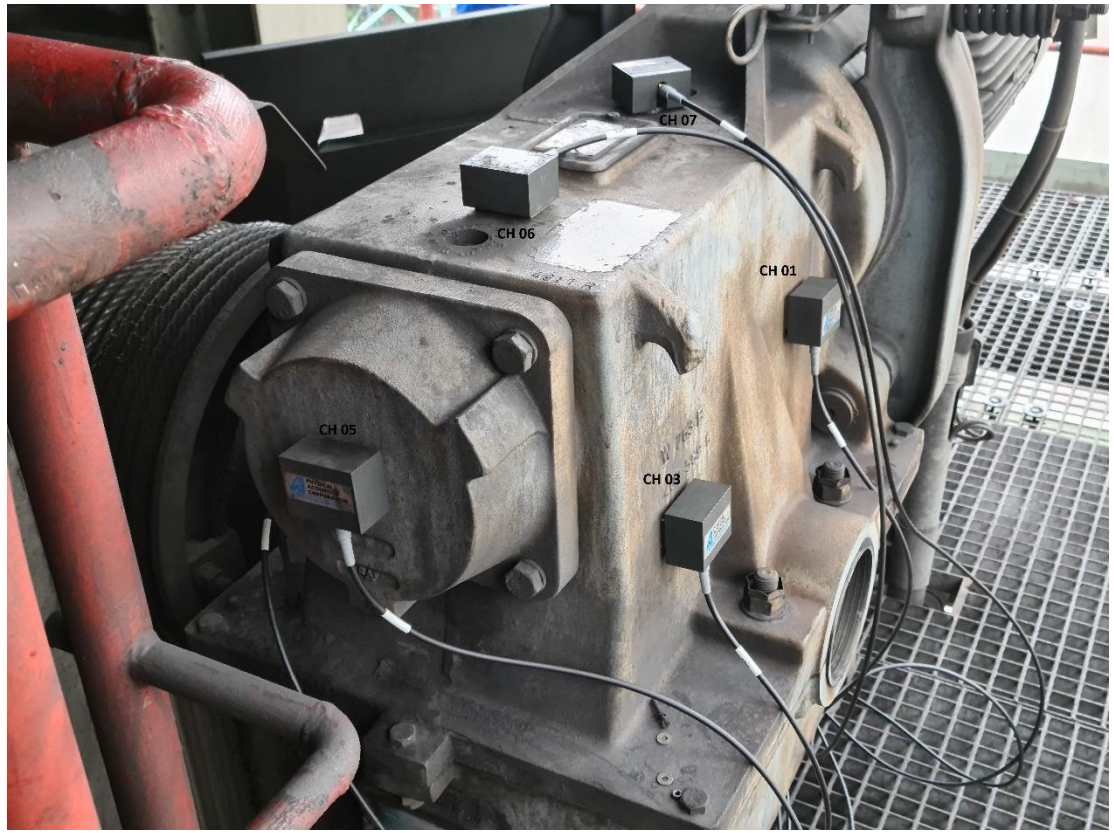


Measurement before maintenance

Measurement after maintenance – oil / cleaning



AT on an elevator gearbox



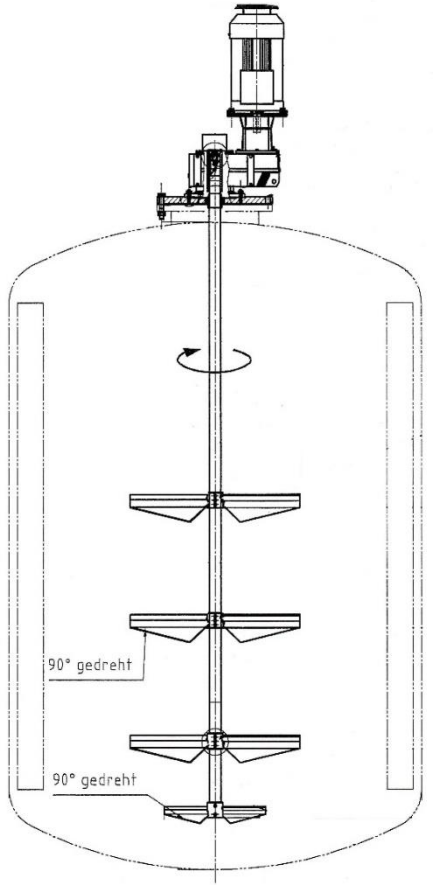
results:

- We could identify the damage
- After 1 year – same result
- Will be monitored in periodic intervals

Example of a gearbox from a mixer/agitator – chemical industry

Description:

- Motor/ gearbox / Agitator
- Used as mixer and buffer tank

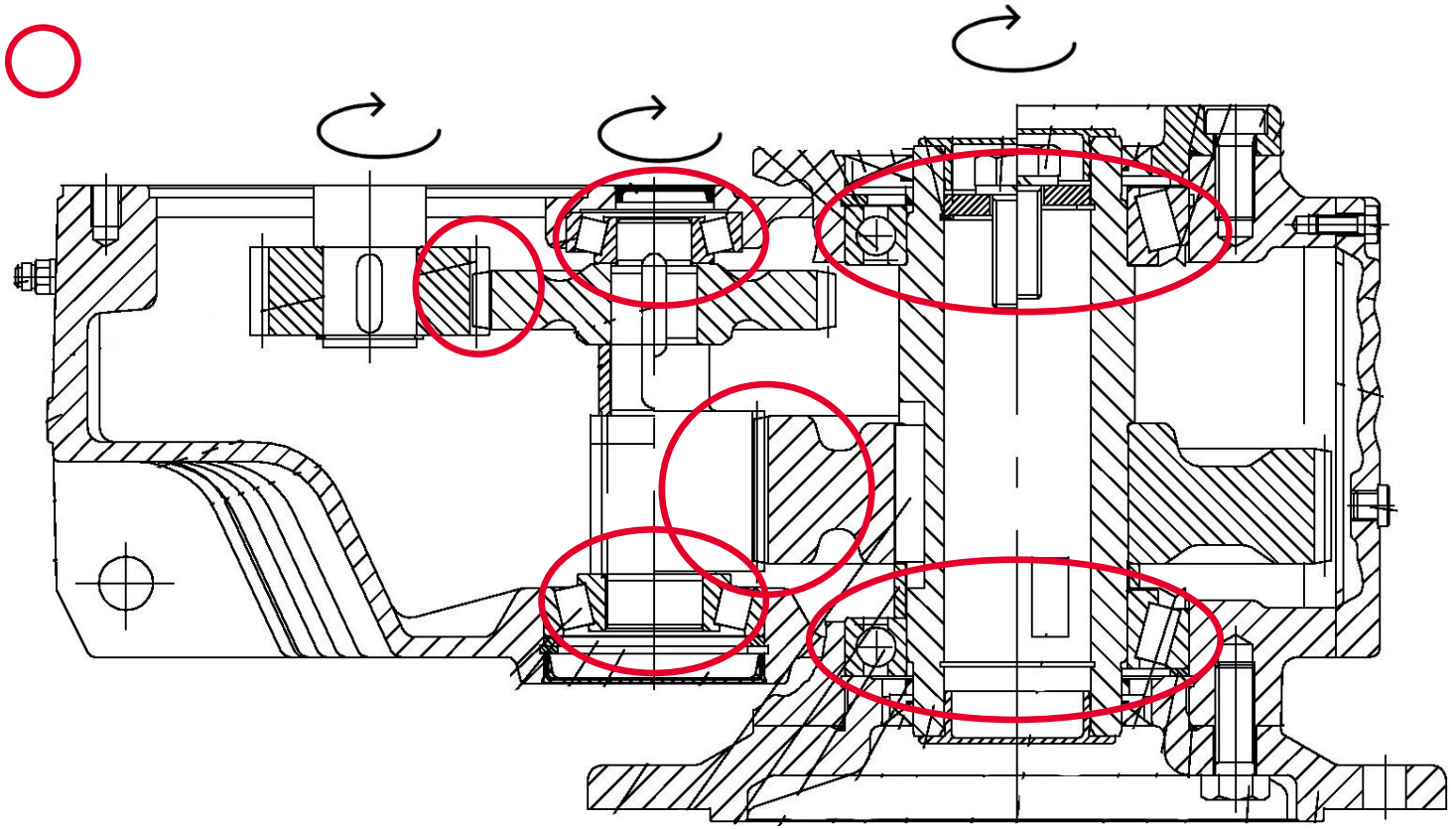


Source: system documentation / own

Overview of moving parts

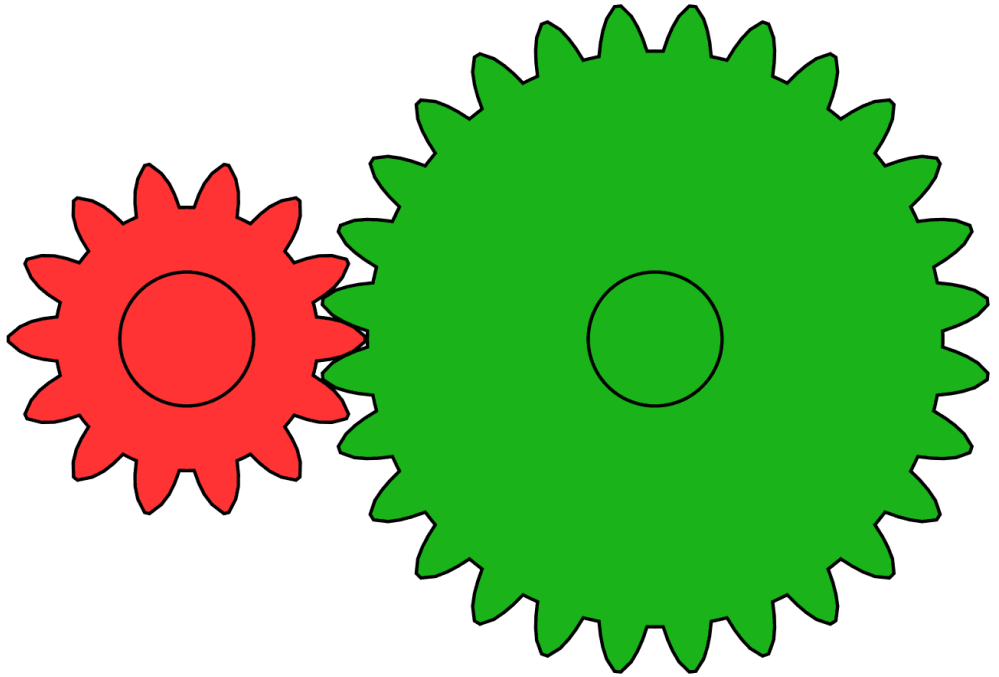
Quick view inside gearbox

- Moving parts
- Acoustic emission source



Gearbox – faults and AT

- Cause:
  - Fatigue cracks
  - Spalling
  - Pitting
- AE:
  - Movement of the crack
  - rollover
- Characteristic frequencies

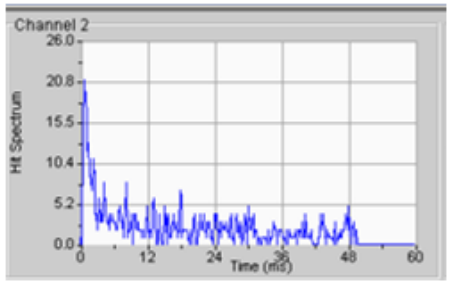


Quelle: Einfluss von prozessinduzierten Eigenspannungen auf die Zahnfußtragfähigkeit schergeschnittener Zahnräder | SpringerLink

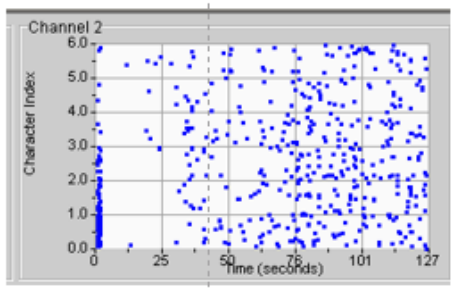
Gearbox – case study

AT and evaluation of the signals:

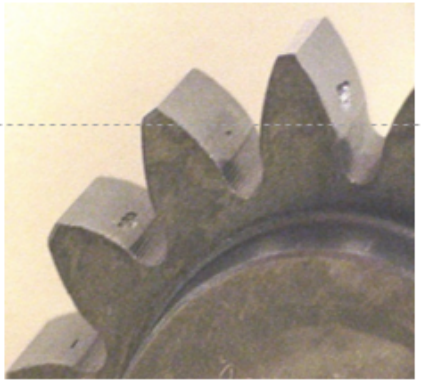
TAFI feature of 525500 fatigue cycles – No spalling



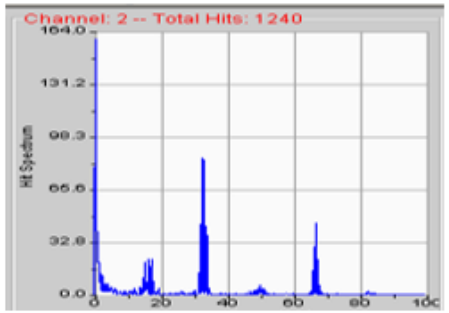
Hits vs. TAFI



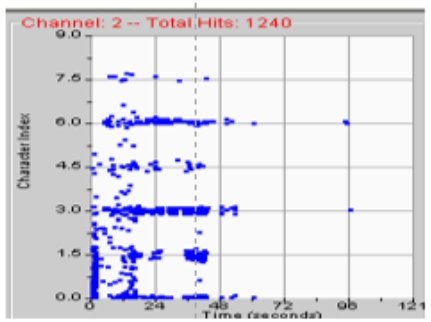
TAFI vs. Time



TAFI feature of 688500 fatigue cycles – With spalling



Hits vs. TAFI

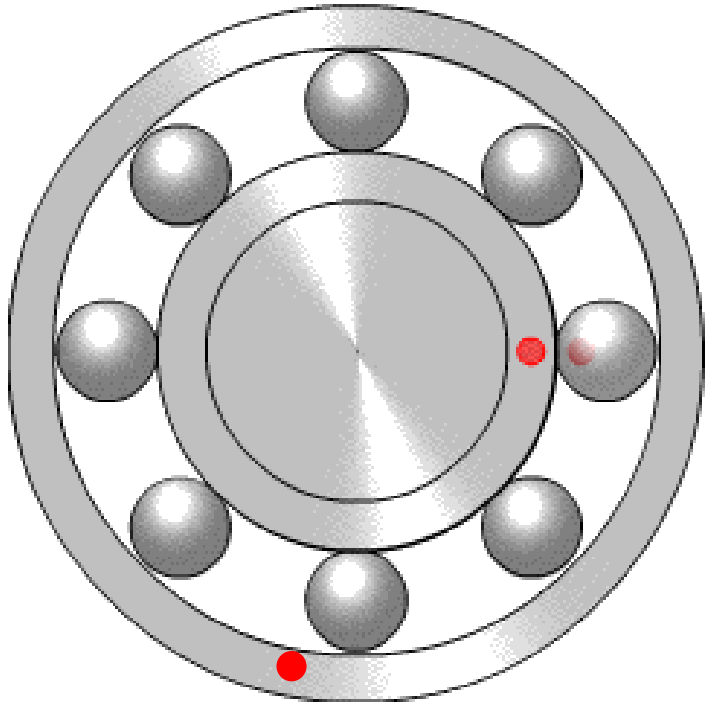


TAFI vs. Time

Mistras Presentation – AT for Rotating Machinery - 2015

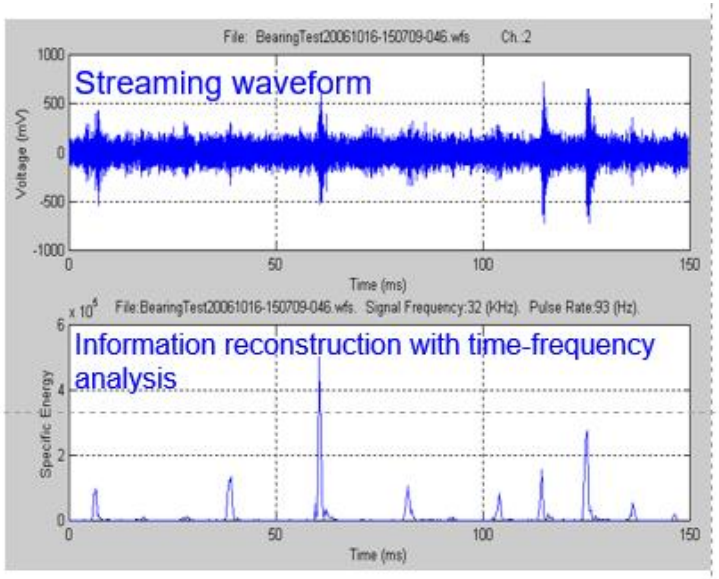
Bearing – faults and AT

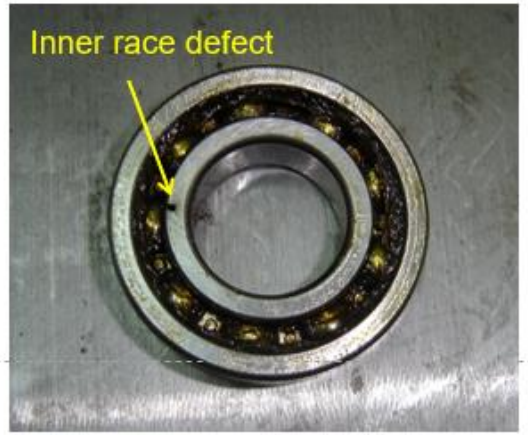
- Discontinuities
  - Cracks
  - Pittings
- Location
  - inner race
  - Out race
  - roller
- Acoustic emission during overturning
- Characteristic frequencies

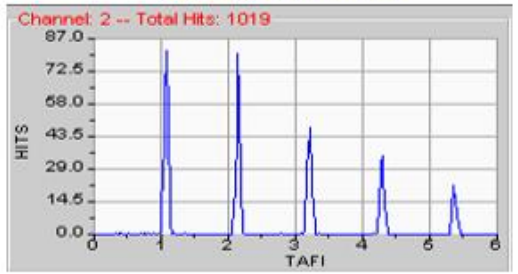


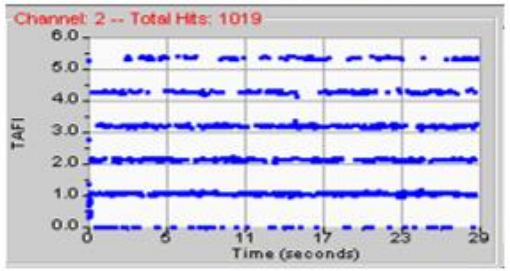
Bearing discontinuity:

Inner race defect







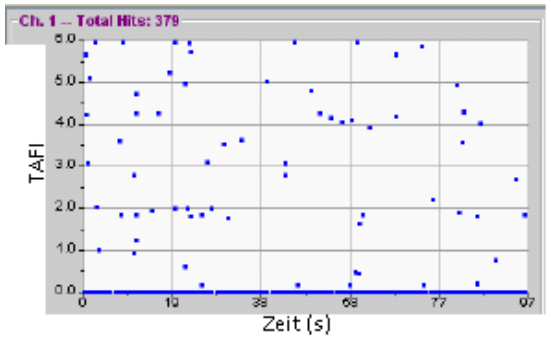


Mistras Presentation – AT for Rotating Machinery - 2015

Bearing discontinuity:

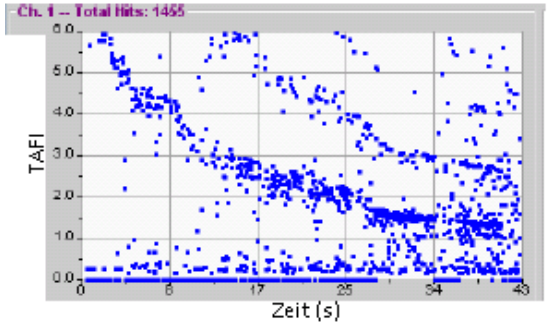
Small pits on roller is difficult to detect, even more under constant rolling speed.

With a different approach, doing the analysis variating the speed and looking for the time of arrival feature index (TAFI), you can recognize a pattern.



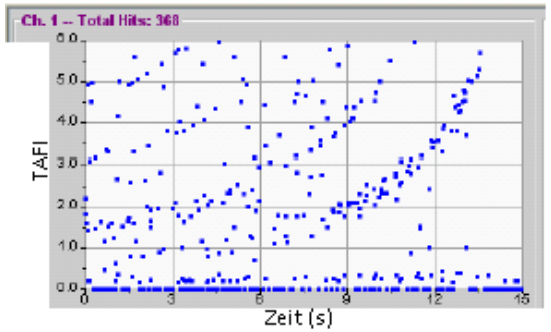
1200 RPM

TAFI vs. Time shows no clear pattern



Acceleration

TAFI vs. Time shows a pattern of decrease



Deceleration

TAFI vs. Time shows a pattern of increase

Pit on roller

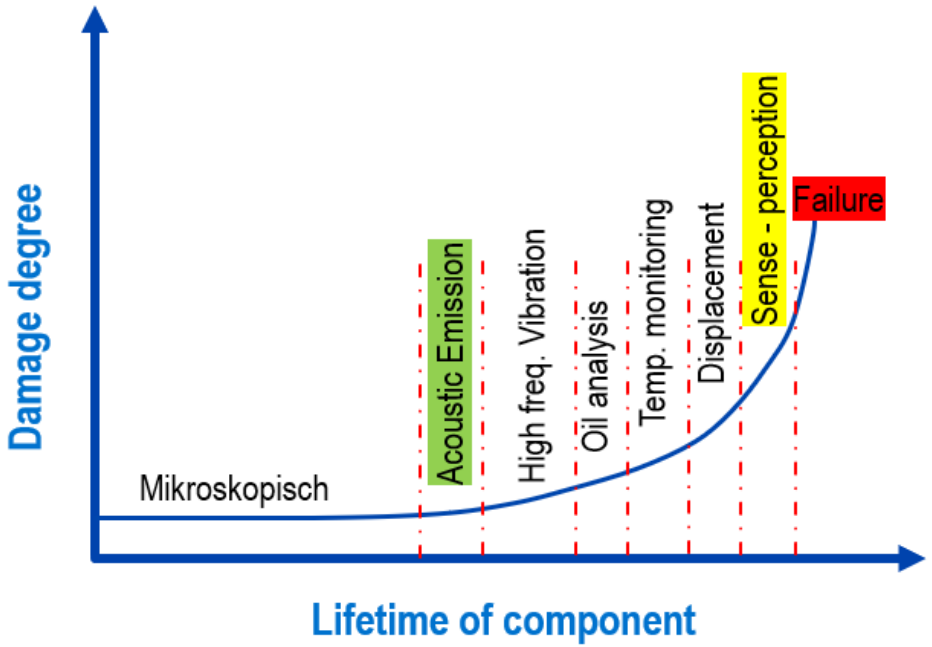
Mistras Presentation – AT for Rotating Machinery - 2015

Example on gearbox of a mixer/agitator – chemical industry

Results:

- No damage mechanisms has been detected
- On 2 from 10 gearboxes, VT has been performed and corroborated the AT
- Next inspection in 5 years, before next maintenance stop.

Conclusion: AT – *for early fault detection*



Results:

- Early fault detection has been confirmed compared to other methods
- Unlike other methods, can be also be used on low speed and heavy loaded machines.
- In some cases is desired/needed to have speed variation in order to determine the discontinuity.

Goal:

- Determination of remaining lifetime

Mehr Wert.
Mehr Vertrauen.

Add value.
Inspire trust.

Thank you!

Questions? Please contact us!

- Hermann Schubert
  Head of Digital and Continuous Inspection
  hermann.schubert@tuvsud.com
  +49 151 2347 6034

- Klaus-Michael Fischer
  Innovationsmanager
  KlausMichael.Fischer@tuvsud.com
  +49 151 7303 0898