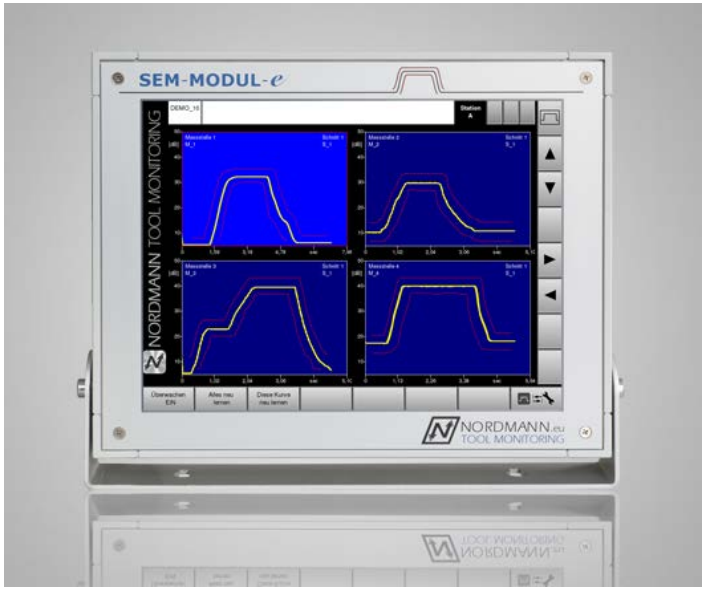
NORDMANN Tool Monitoring

Experience since 1989 in the field of tool monitoring and process control systems for all types of cutting machine tools



Our program:

- Control-integrated tool monitoring for open CNC control panels
- Sensors for monitoring micro tools
- Integrated acoustic work piece dimension control (patented)
- Gap elimination for grinding
- Non-contacting measurement technology (inductive and by radio waves)
- Acoustic emission measurement based on a jet of cooling lubricant acting as an acoustic wave conductor

NORDMANN TOOL MONITORING

Nordmann GmbH & Co. KG

50354 Hürth, Germany

Headquarters:

- Sensor production
- Custom-made products
- Central of distribution service
- Coordination and distribution further branch offices in USA, China, India and Korea

Nordmann International GmbH

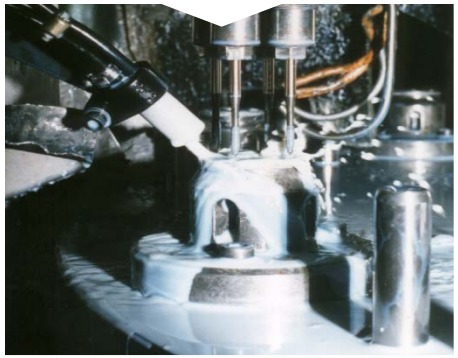
8808 Pfäffikon, Switzerland

Manufacturing:

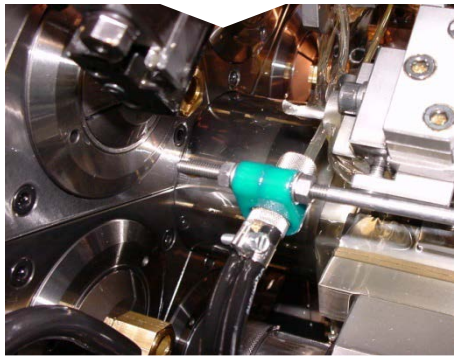
- Tool Monitor units (SEM-Modul, SEM-Profibus, SEM-Profibus)
- Effective power units (WLM-3, WLM-3V)
- Acoustic Emission Processor units (SEP)
- Distribution and service south Europe

Where tool monitoring happens (examples)

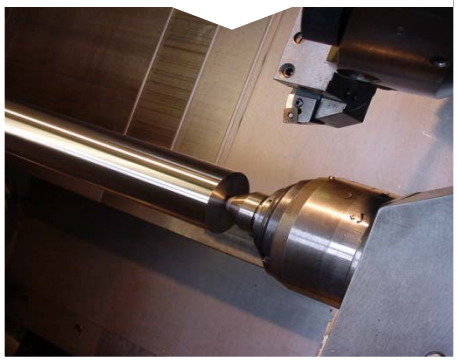
Multi-spindle drill heads



Automatic multi-spindle lathes

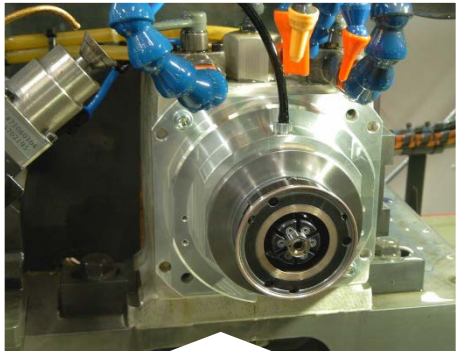


CNC lathes

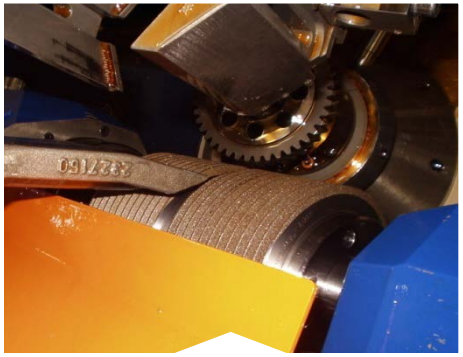


Rotary cycle machines

Machining centers



Dressing of grinding wheels



Roll grinding machines

Transfer lines

References (Examples)

The following list is a small selection of companies that trust Nordmann tool monitor systems.
We have sold more than 13445 systems worldwide (current status Oct. 2015). Our export share is 35%.

Machine tool manufacturer

- Buderus
- Carl Benzinger
- Chiron
- Citizen
- Gildemeister
- EMCO
- Ernst Grob
- Eubama
- EWAG
- Hage
- Höfler
- Hüller-Hille
- Imoberdorf
- Index
- I.T.S.
- Ixion
- Kapp
- Ketterer
- Klingelnberg
- Krause- Mauser
- Krause-Mauser
- Kummer
- Magdeburg
- Meccanicanova
- Mikron
- Overbeck
- Pfiffner
- Precitrame
- Riello
- Sala
- Schaudt Mikrosa
- Schütte
- Siemens
- Spinner
- Studer
- T-Mech
- Technica
- UVA
- Variomatic
- Vimacchine
- Witzig & Frank

Machine tool users

- Atlas Copco
- Audi
- Austrian Airlines
- Berger
- BMW
- BorgWarner
- Bosch
- Braun
- Brueninghaus
- Burgmaier
- Christian Weber
- Chopard
- Continental
- Daimler *
- Danfoss
- Delphi
- Deutsche Star
- Deutz AG
- Dom
- Erkert
- EVVA
- FAG
- Fertigungst. Nord
- Fischer Werke
- Ford
- Galsterer
- General Motors
- Getrag
- Geze
- GKN
- Häring
- Harley-Davidson
- Heimeier
- Hero Honda
- Hewlett Packard
- Harting
- Hilti
- INA
- ITT
- Keso
- Lego
- Lucas
- LuK
- Mahle
- MAN B+W Diesel
- Mesa
- Motomak
- NGK
- Oberndörfer
- Océ
- Oerlikon Enka Tecnica
- Opel
- Philips
- Quinn Scheuerle
- Rexroth Star
- Röhm
- Schäffler *
- Scheufele
- Schneeberger
- SFS
- Siemens
- SKF
- Spicer
- Stihl
- Straumann
- Textron
- Thyssen Guss
- TRW
- Viega
- Visteon
- Voss
- VW *
- Winkhaus
- ZF

*** We are listed in the user requirement specifications of these companies**

NORDMANN TOOL MONITORING

Car manufacturers place their trust in Nordmann

The following car manufacturers have included Nordmann in their “ Process Monitoring“ Functional Specifications:

VW Salzgitter

Mercedes Car Group

POS Powersystems

- Nordmann was chosen on the basis of comparative evaluations in respect of measured value quality, monitoring strategy, ease of use, operator acceptability, service response and price.

- Other VW plants plus Audi, BMW, Ford and GM (Opel) also use Nordmann, however without explicit reference to that effect in a functional specification.

System configuration

Measurement

- Digital drive data (torque, effective power, current)
- Effective power and torque
- Force
- Acoustic and vibration
- Tool length & work piece position control
- Work piece dimension control
- Tool position control

Profibus
Digital measurement

Analog measurement

Monitoring Units

Tool Monitor SEM-Modul, SEM-Profibus

Table unit

Panel unit

DIN-rail unit

Memory card Compactflash (Backup)

PC Software SemTerm (Backup & Upgrade)

CAN-Bus

USB
Ethernet
RS232

USB
Ethernet
RS232

Visualization

Tool Monitor SEM-Modul Flatdisplay

NC-Bedienfeld
(Siemens, Bosch Rexroth, Fanuc …)
with Software SinTerm

PC with Software SemTerm

NORDMANN TOOL MONITORING

Benefits of in-process tool monitoring and post-process tool monitoring

In-process tool monitoring

Indirect control during the metal cutting process of effective power, cutting force, or acoustic emission

Post-process tool monitoring

Geometry control of the tool cutting edge before or after the chip producing process with feelers, light barriers, or similar devices

- In-process tool monitoring does not extend the production time
- Machine is stopped at the moment of tool breakage
  (Protection of tool holders, machine and workpieces)
- No additional installations (e.g. control switch) are necessary near the tool.
- Wear-free sensors
- Allows maximizing feed and speed
- Gap elimination reduces time of air cutting
- Reduces tool costs by preventing premature tool changes
- Prevent sparks from excessively worn tools

Rule of thumb:
Tools should generally be controlled in-process. Small tools may also be controlled after the process or must be controlled after the process.

One for all

Only <u>one</u> system with only <u>one</u> user interface for all types of machines

- **for all types of machines** (e.g. CNC lathes, machining centers, multi-spindles, grinders)
- **for all sensors** (e.g. force, power, acoustic, laser)
- **for all monitoring strategies** (envelope curves, static and dynamic evaluation, etc.)

Identical user interface for the integration in PC operation computers (e.g. MMC 103 or PCU 50) and as stand alone tool monitor for controls with a PC operation computer.

Low expense for storage of the function modules and simple maintenance thanks to the use of identical components in the various structural shapes for the tool monitors.

Functions of the Tool Monitor for turning, drilling and milling

Tool and machine protection

- Tool breakage detection
- Tool wear detection
- Collision detection
- Unbalance check

More work pieces per hour

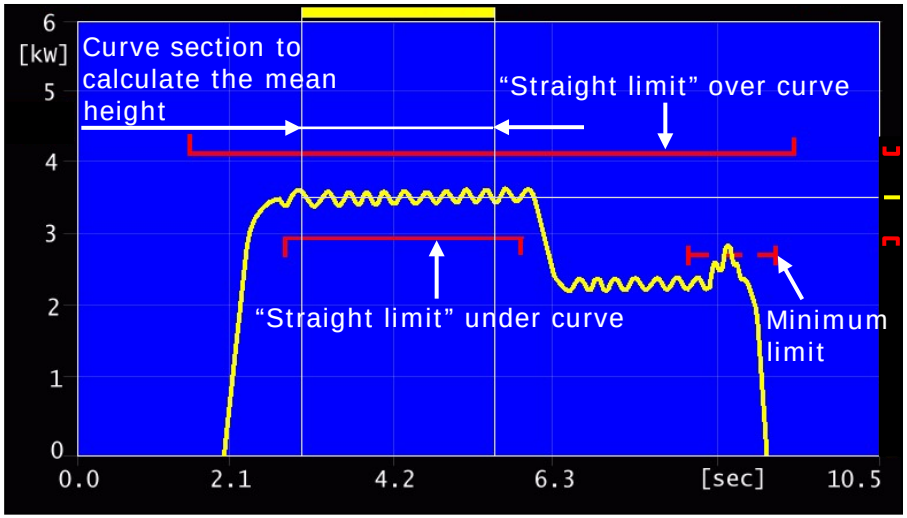
- Machining time reduction through the option of increasing the cut value without danger
- In-process breakage detection saves additional testing time
- Reduction in air cutting thanks to fast reacting detection of the start of the cut (main use is grinding)
- Triggering withdrawal of the tool when completion of the cut is detected (through holes, cutting through half-finished products)

Quality assurance and avoiding of scrap

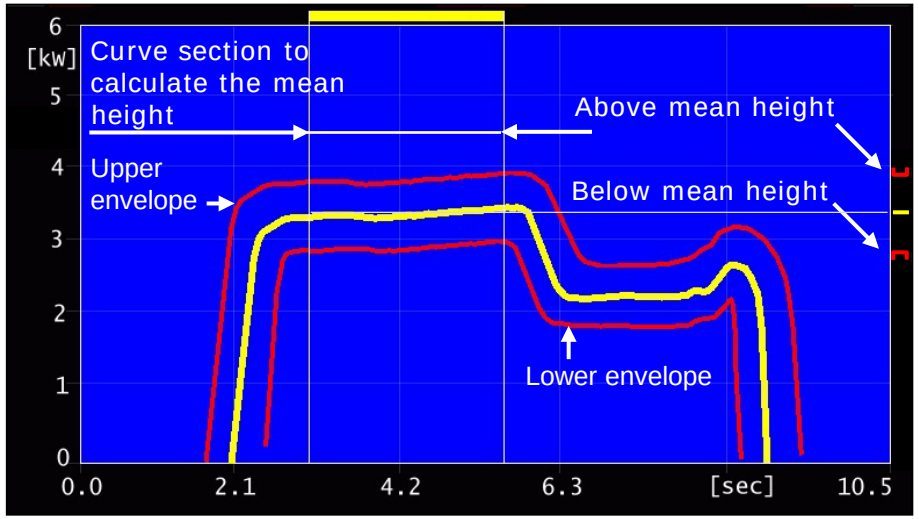
- Detection of incorrectly clamped work pieces.
- Detection of false blank dimensions.
- Dimension control of the finished part inside the machine.
- Envelope curves detects process deflections and can thereby avoid of scrap

Monitoring strategies and limit values for measured curves

Straight limits



Envelopes



Application of straight limits:

- ✓ Tool breakage detection
- ✓ Cut start recognition (for rapid air cutting monitoring, especially when grinding)
- ✓ Special minimum limit for checking whether tool is available

Application of envelopes:

- ✓ More precise tool breakage detection that with straight limits Specifically for monitoring mult-spindle drill heads with effective power measurement in conjunction with smooth envelope matching (Autolearn)

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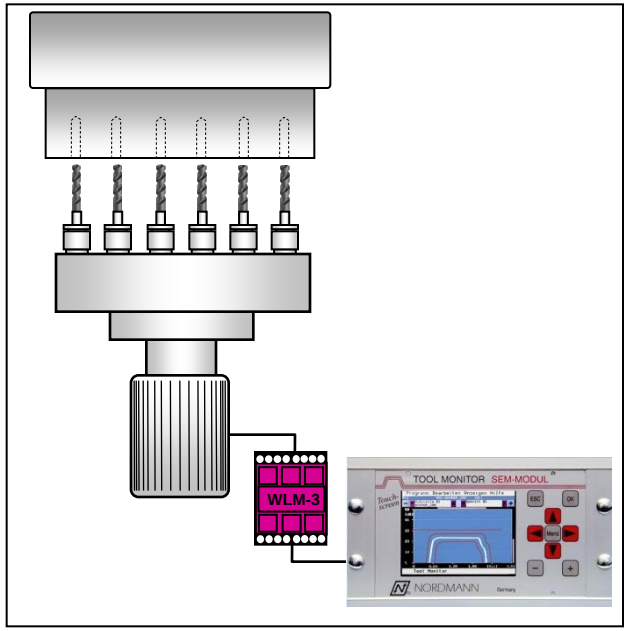
Gliding Reference Limit



Application example multi-spindle drill head:

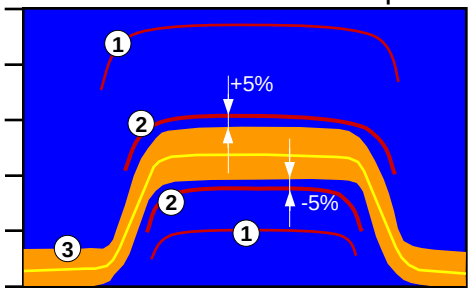
Allows for breakage monitoring of several drill bits driven by a common motor via effective power measurement.

Original problem: Changes in measured value height due to the breakage of a single drill bit are smaller than changes due to the wear of all drill bits. Thus, fixed envelopes are not violated.

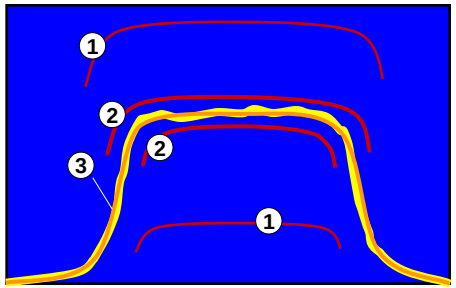
Solution: Gliding adjustment of the envelope limits from workpiece to workpiece to the changes in measurement curve height due to tool wear. This allows for a much smaller distance between envelope and measurement curve.

The envelope follows, at a percentage distance (e.g. ± 5 %), an "averaged measurement curve" obtained by averaging across the last workpieces.

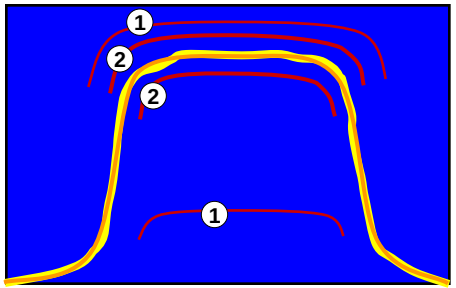
1. Workpiece
All 6 drill bits sharp



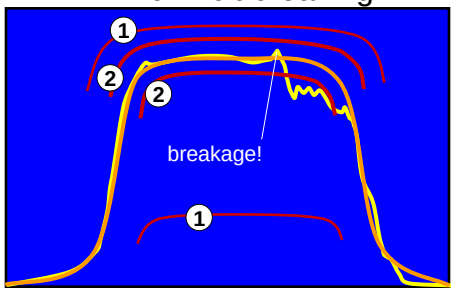
250. Workpiece
All 6 drill bits half blunt



500. Workpiece
All 6 drill bits blunt



502. Workpiece
All 6 drill bits blunt,
1 drill bit breaking



① Fixed envelopes
② Sliding envelopes continually readjust from workpiece to workpiece.
③ Averaged measurement curve (temporary enlarged after changing a new sharp tool)

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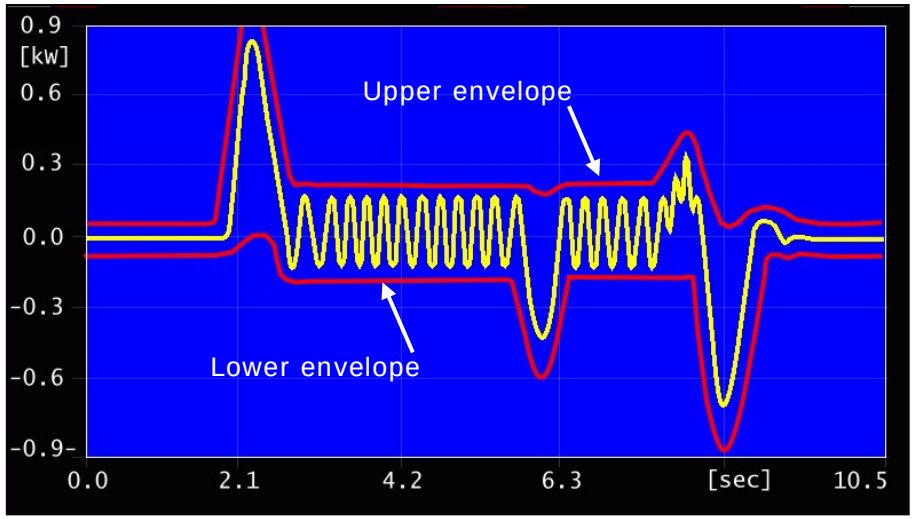
Scopes of Application of the Sliding Envelope

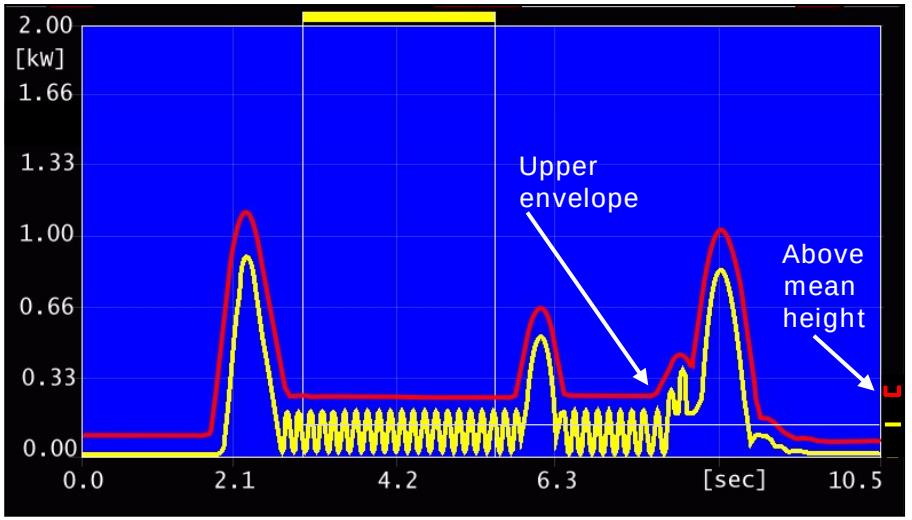
- ✓ Drill bit breakage detection in **multi-spindle drill heads** via effective power measurement
- ✓ **Monitoring from the first workpiece** with an initially rough limit distance which successively decreases from workpiece to workpiece (in combination with the "averaged curve")
- ✓ **Turning with great allowance deviations** (Recalculation of the envelope at each workpiece rotation based on the measurement curve of the previous rotation)

Monitoring jump-like changes and waviness

Dynamic portion (option)



Rectified dynamic portion (option)



Use of dynamic portion:

✓ Breakage recognition when turning with offset and hardness fluctuations, when a sudden measured value increase needs to be monitored independently of a measured value drop.

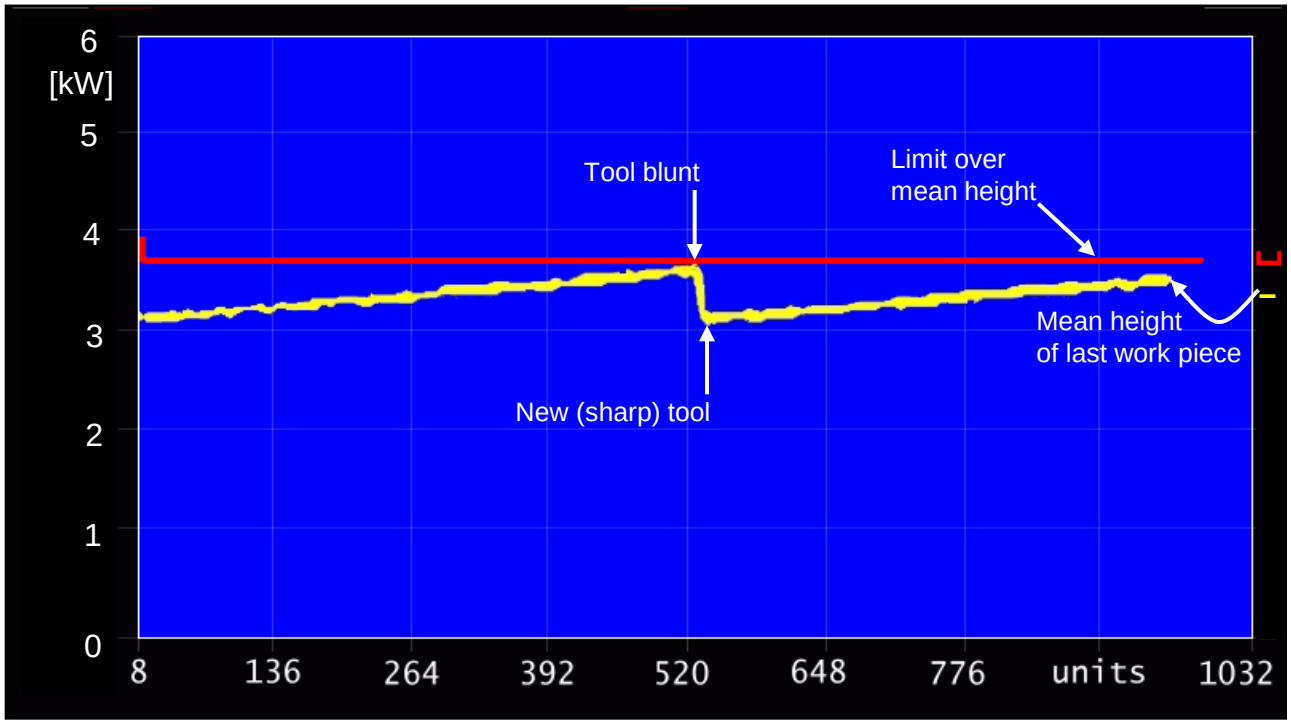
Use of rectified dynamic portion:

✓ Recognition of out-of-true running of a milling cutter due to individual tooth breakage.

✓ Chatter and undulation recognition during grinding.

✓ Breakage recognition when turning with offset and hardness fluctuations.

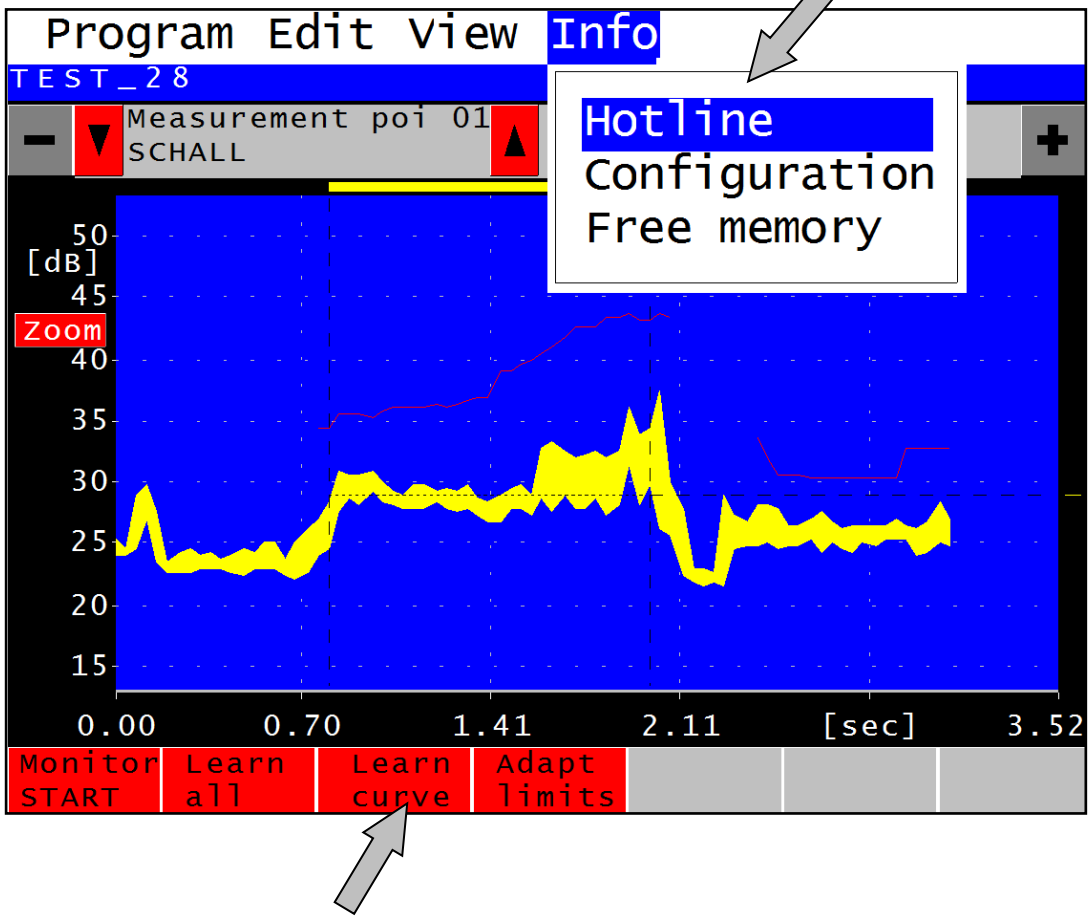
Trend display of the mean height (tool wear)



For better tracking of the behavior of the "mean height" across a larger number of workpieces, it can be represented as a "trend" over the number of machined workpieces. This makes it easier to determine whether a tool effects an even increase of the measured values with the number of workpieces produced, or whether it is necessary to add an averaging of the "mean height" across several workpieces.

Simple operation of the SEM-Modul with pull-down menus

Simple pull-down menues



Free selectable “Quick-Buttons“

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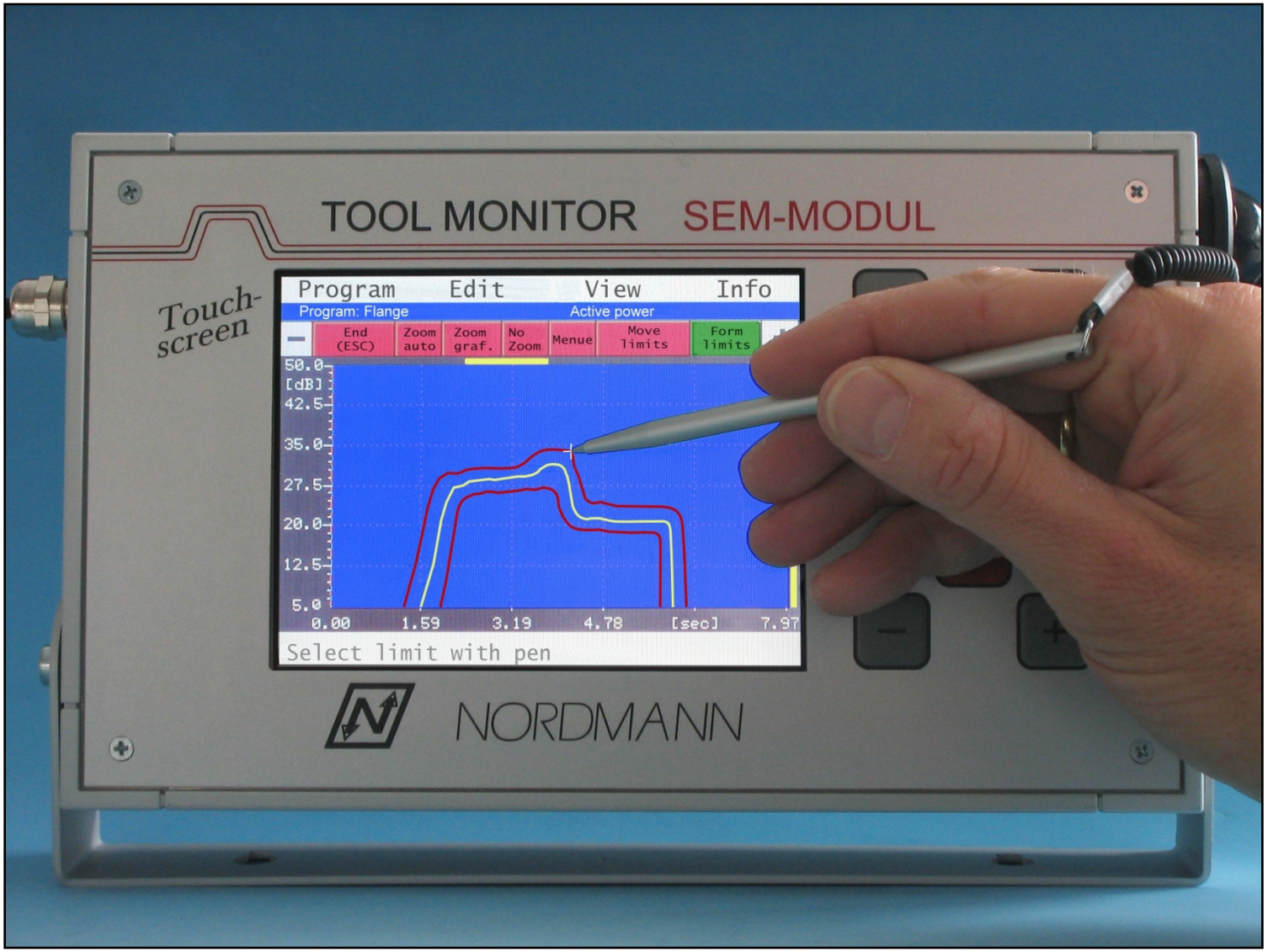
Manual adjustment of the envelope curves by a touchpen



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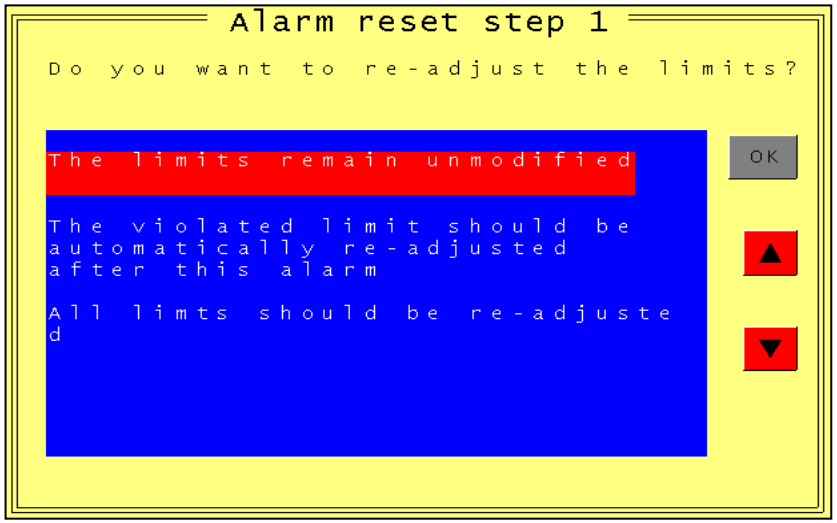
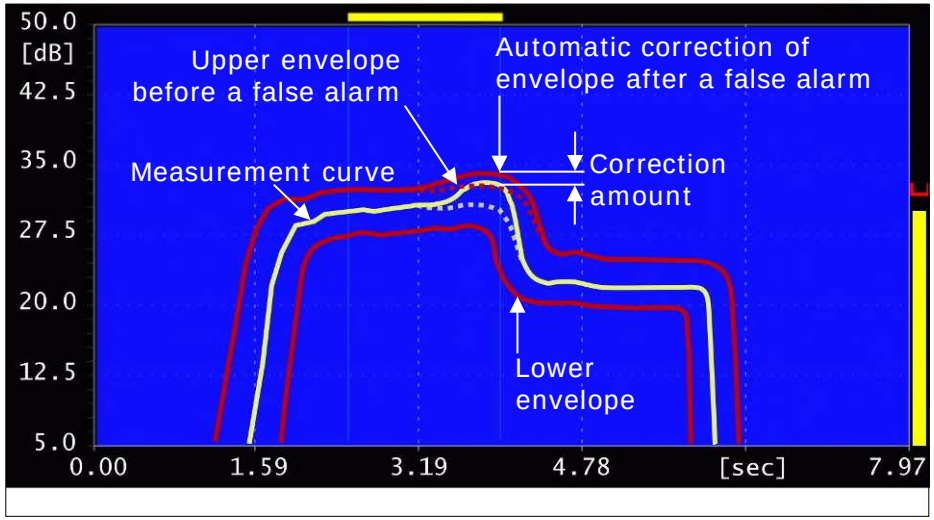
Automatic error detection and correction of limit values

Acknowledgment of a false alarm



Graphical correction of a false alarm



Advantages and possibilities for correcting limits graphically :

- ✓ Partial graphic adjustment of the limit in the envelope violation area, all other areas remain unchanged.
- ✓ Envelope form does not have to be learned again completely.
- ✓ Very easy limit correction through simple acknowledgement.

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Tool Monitoring Requirements

Constant conflict between user-friendliness and sensitivity

User-friendliness (general view)

- Few operating steps/options
- Few operating controls (“buttons“)
- Few indicator readings (black box)

Sensitivity

- Good measured values even with small tools
- Recognition of even most minimal tool breakages
- Reliable wear detection
- Irrespective of working material hardness or offset fluctuations
- Monitoring of individual drill bits in multi-spindle drill heads

Operator-friendliness and sensitivity “under the one hat“

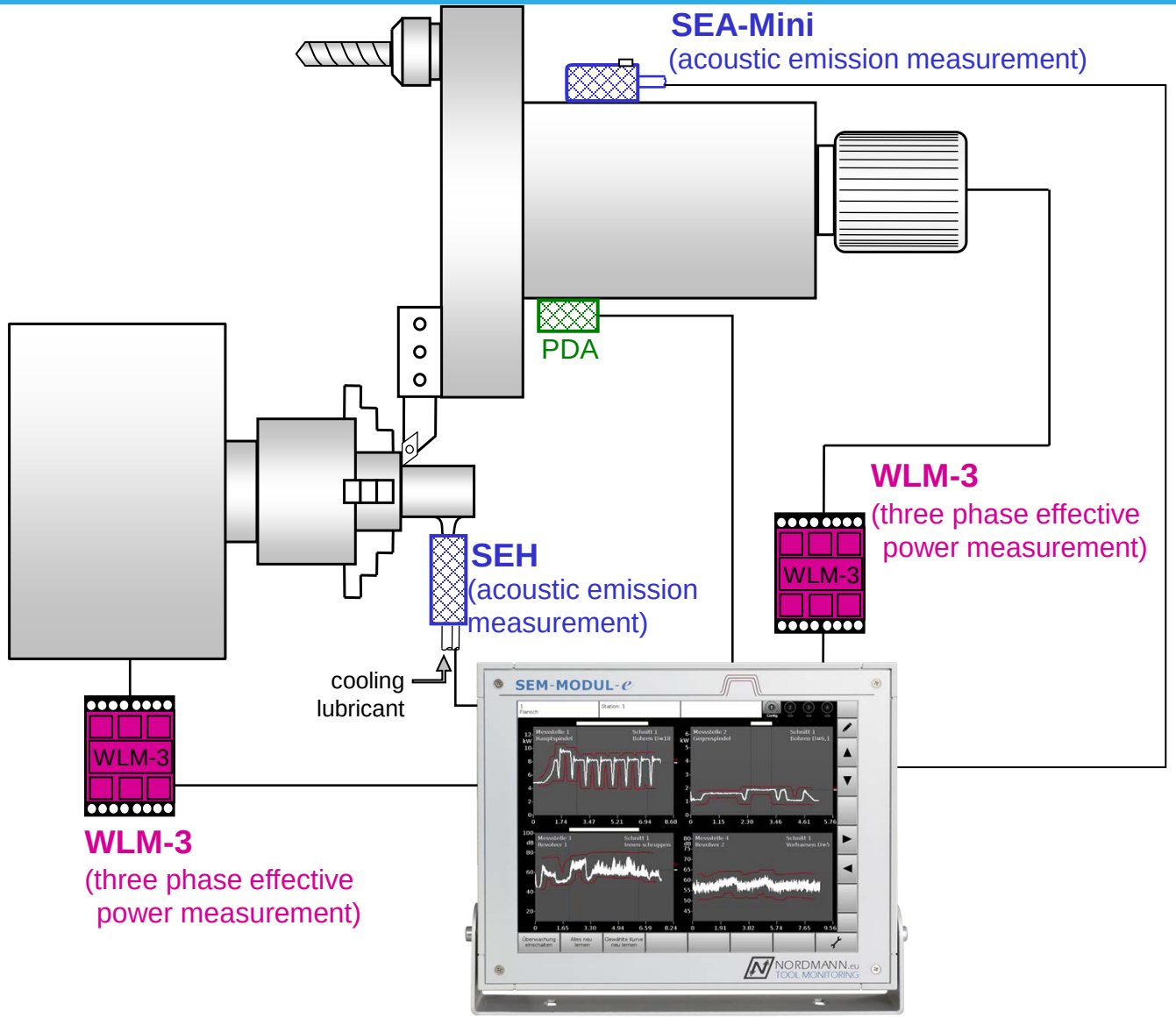
Operator-friendliness

- Self-explanatory pulldown menus
- Operator and task-related switching off (hiding) of unneeded menus
- Measurement curve display shows process errors at a mere glance
- Graphic settings option of limits using the mouse or touch pen in touch screen (edit image)
- Automatic limit value correction with acknowledgement of repeated false alarms

Sensitivity

- Sensors for monitoring the smallest tools (to Ø 0.05 mm)
- Envelopes as limits with or without automatic adjustment to creeping measured value changes
- Evaluation of static and dynamic signal sections each with its own measurement curve
- Wear detection with mean measurement curve height, averaged over several workpieces

Possible sensor positions for tool monitoring in CNC lathes



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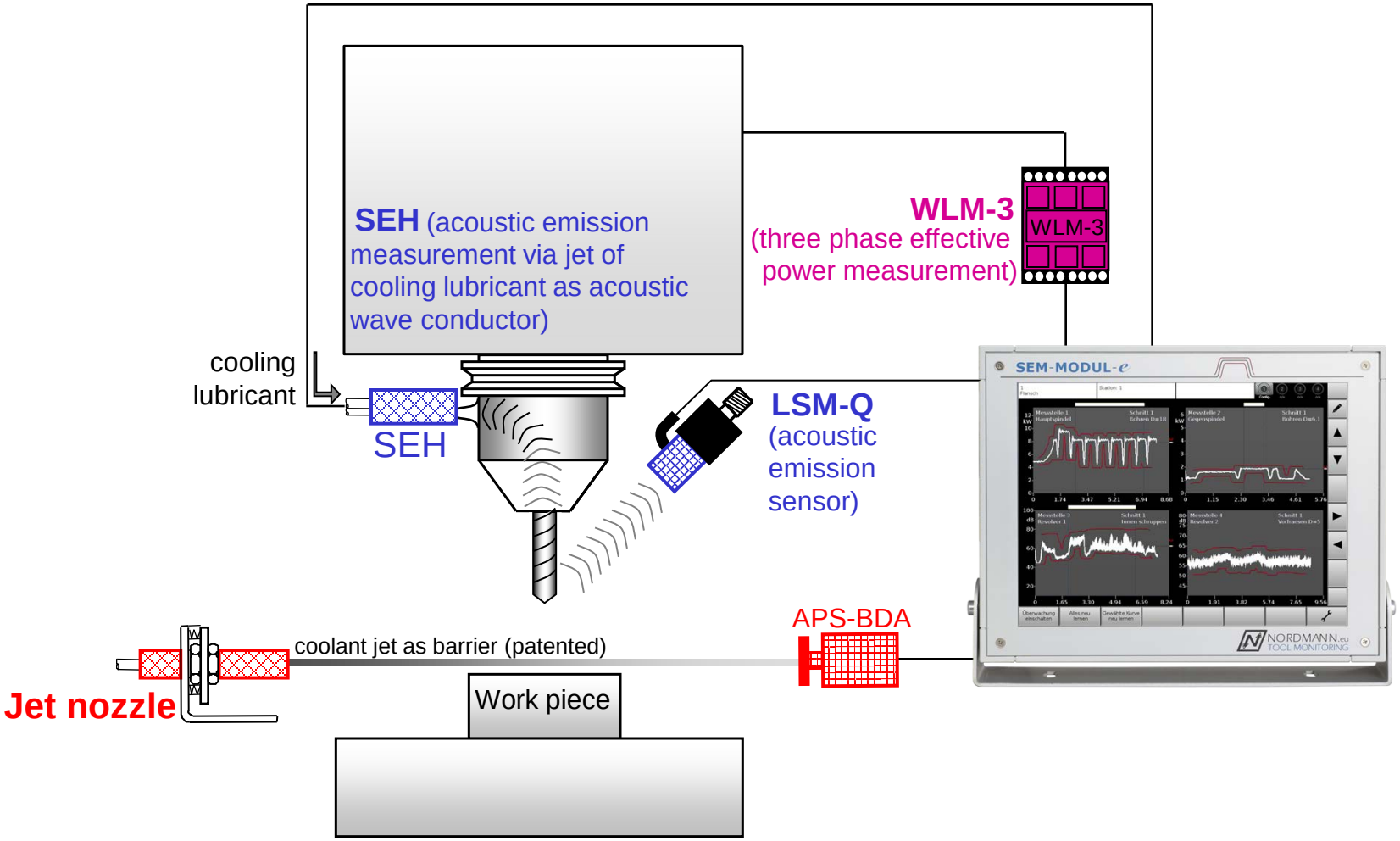
Possible sensor positions for tool monitoring in machining centers



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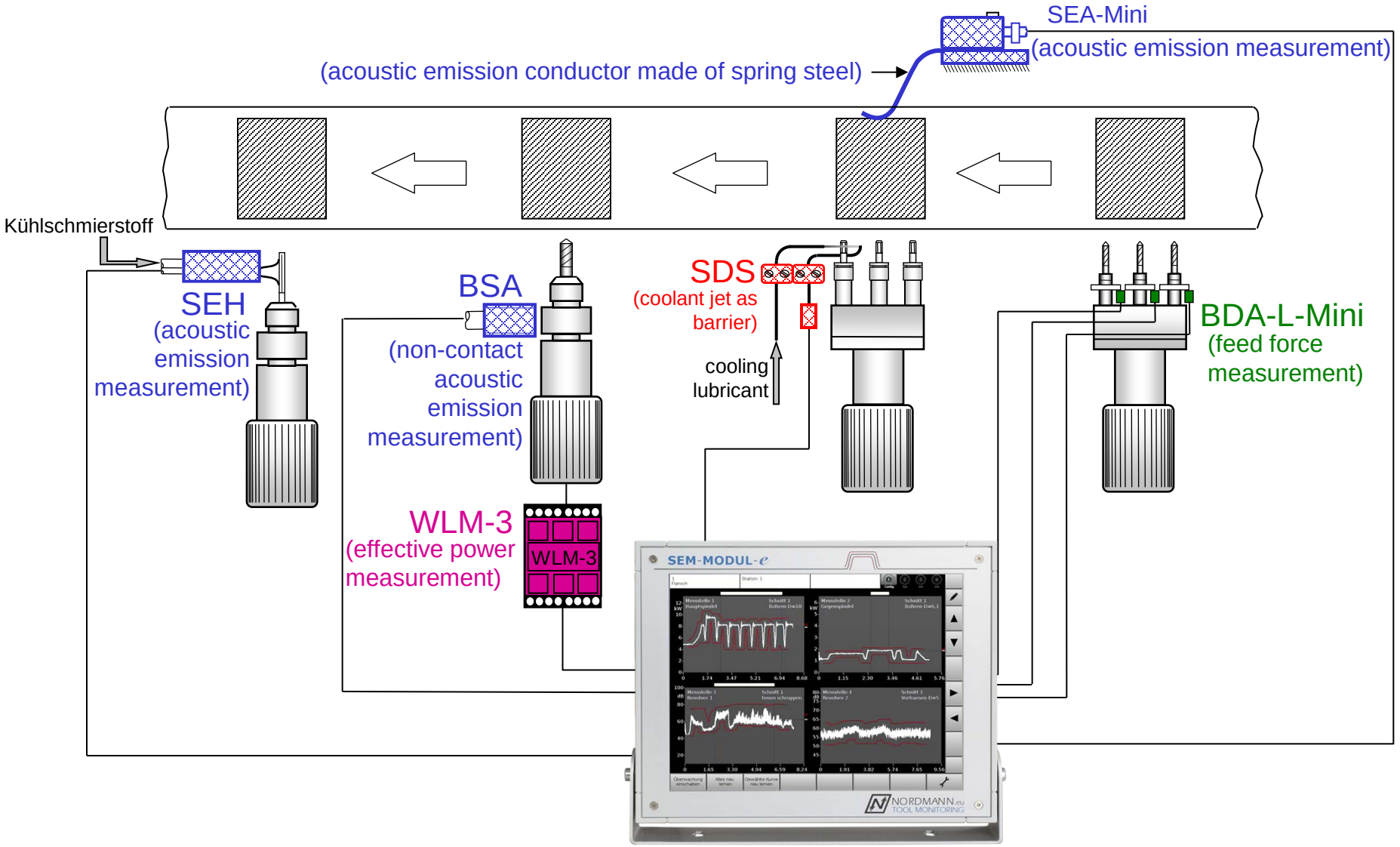
Possible sensor positions for tool monitoring in transfer lines and rotary transfer machines



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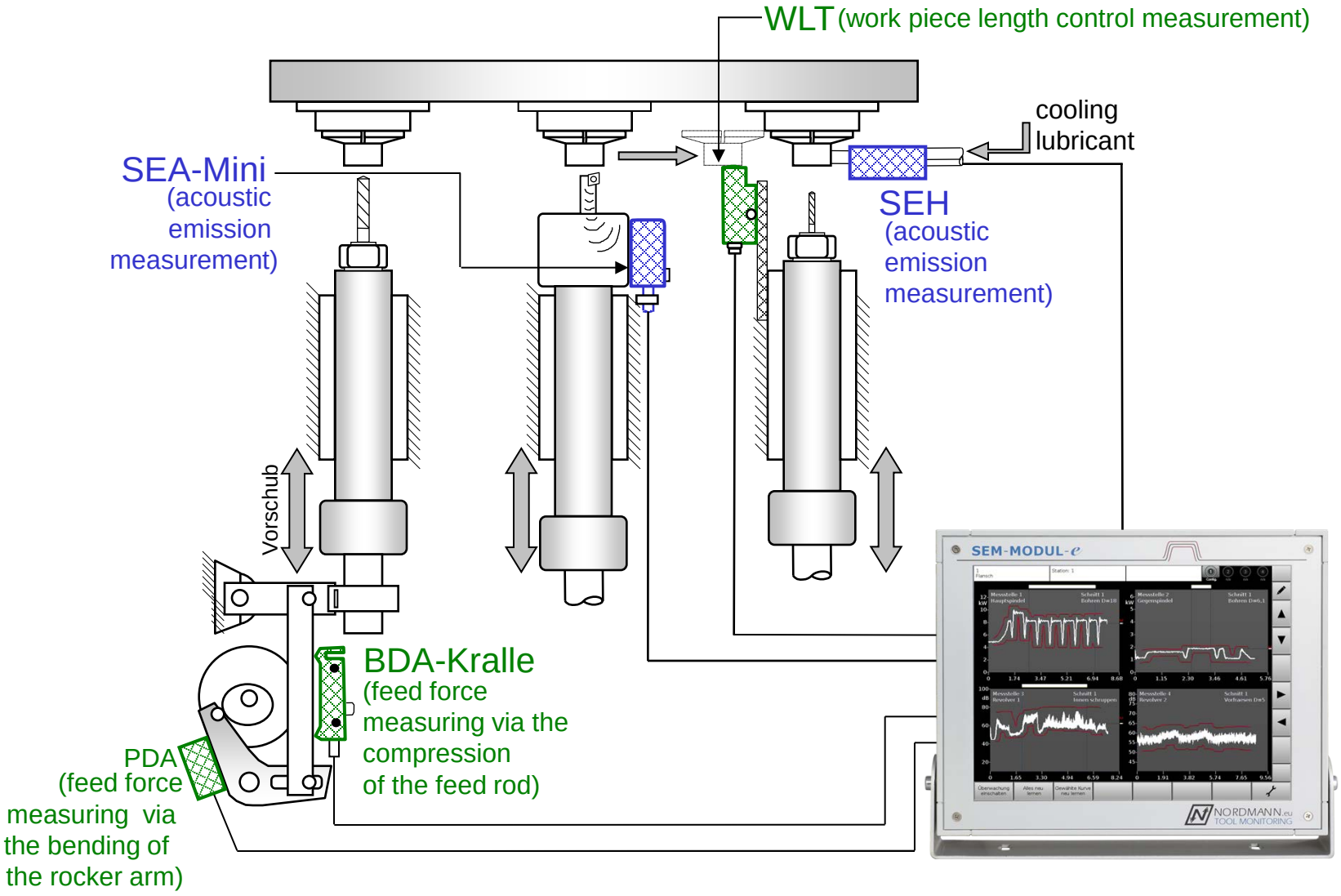
Possible sensor positions for tool monitoring in multi-spindle automatic lathes



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Tool monitoring system SEM-MODUL-e connected with the Profibus in sinumeric controls 840D(sl)

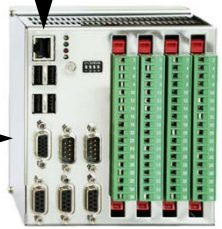
Software for viewing

Siemens-Sinumerik-HMI

Ethernet

Exchange of control signals and transmission of actual values for power, torque and current (8, 16 or 24 spindle and feed drives of 1 SEM-MODUL-e can be evaluated)

Profibus DP



Tool Monitor SEM-MODUL-e

Terminal block for 8 additional sensors for measuring force, acoustic emission, pressure, path distance, laser light shadowing and ultrasonic drill length control

Control software with additional technological function

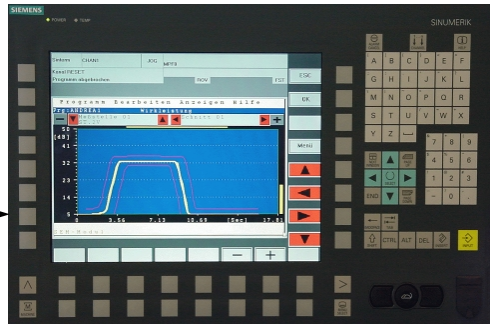
NCU 7x0

Siemens CNC-Unit

NORDMANN TOOL MONITORING

Tool monitoring system SEM-Profibus connected with the Profibus in sinumeric controls 840D(sl)

Software:
Sinterm

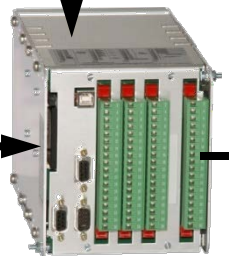


Siemens-Sinumerik-HMI

RS232, USB

Exchange of control signals and transmission of actual values for power, torque and current (8, 16 or 24 spindle and feed drives of 1 SEM-Profibus can be evaluated)

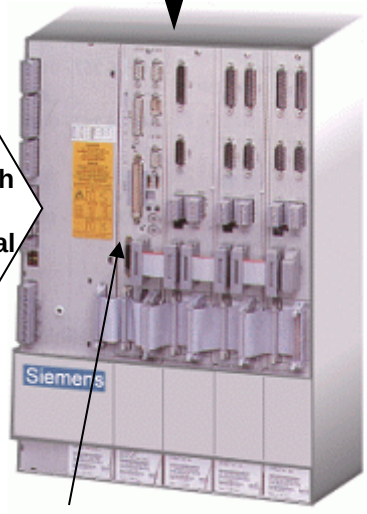
Profibus DP



Tool Monitor
SEM-Profibus

Terminal block for 8 additional sensors for measuring force, acoustic emission, pressure, path distance, laser light shadowing and ultrasonic drill length control

Control software with additional technological function

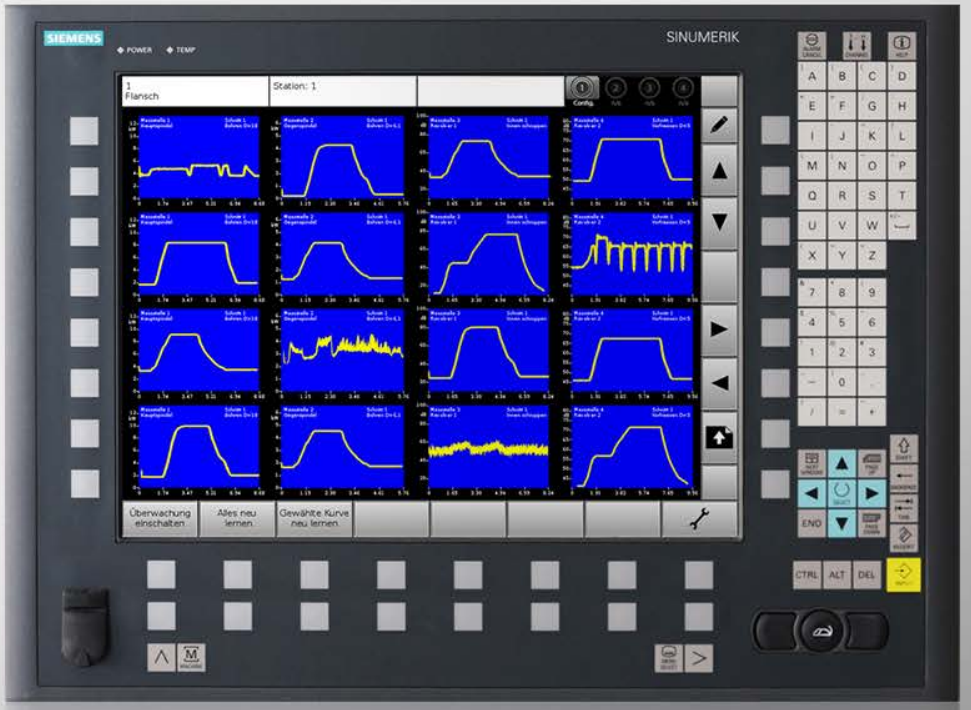


NCU 7x0

Siemens
CNC-Unit

Visualisation of the Tool Monitor SEM-MODUL-e on a Siemens Sinumerik 840 D

Tool Monitor
SEM-MODUL-*e*



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Comparison of open-loop/closed-loop tool monitoring

Open-loop tool monitoring

Closed-loop tool monitoring

Installation, Commissioning, NCU workload:

+ freedom of control panel design
- kein complete test of individual system control/tool monitoring posssible at tool control system manufacturer
- high level of sensitivity of overall machine to error fundtions of individual Profibus subscribers
- error search requires Profibus data logger
- NCU loading due to measured value output with any necessary extension of the IPO cycle

- less specialist knowledge needed
- no dependency on NC operating computer software state
- independent of tolerances of electrical control interfaces (USB, RS232, Ethernet, Profibus)
- clear separation from other control modules via an optocoupler and relay interface
- Higher hardware costs (approx. 400€ at BAZ)

Detection security in respect of tool breakage:

- Measured value rate tied to NCU interpolation cycle

- Messwert reagiert schneller auf Werkzeugbruch
- Welligkeitsauswertung zur Ausbrucherkennung bei Fräsern

Operation:

- Switching necessary between measured curve display and “Machine operation area “

- measured curve always in field of view
- quicker operation on ergonomic keyboard and touch screen
- Graphic envelope correction using touch pen

Spare parts reserve:

- less hardware (saving approx. 400€)

Lineup different kind of power and current measurements

Digital torque values send via Profibus from NC-Unit

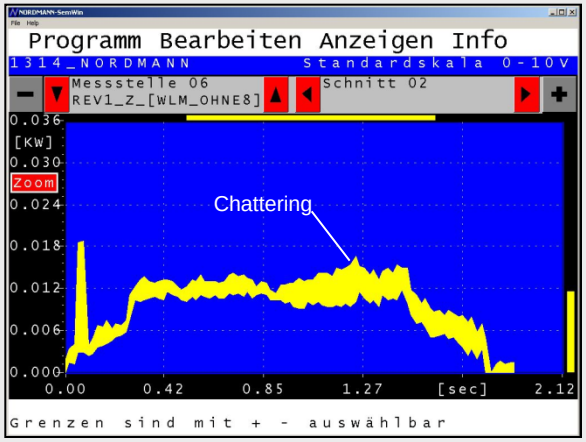
Process:

- Drill: Ø 8 mm
- Machine: Index ABC Speedline
- Measuring: z-axis

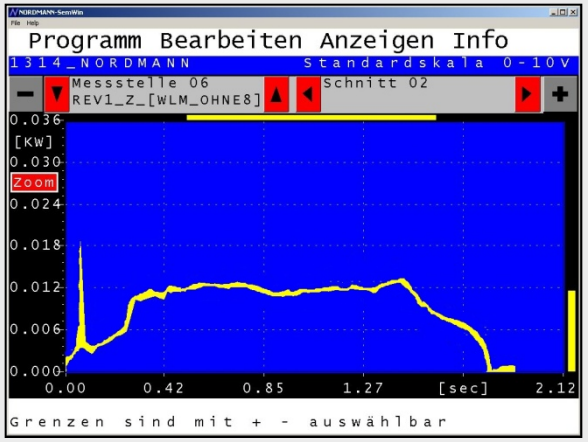
Finding:

Measuring directly from the machine via WLM-3 and especially CM-3 will getting much better results!

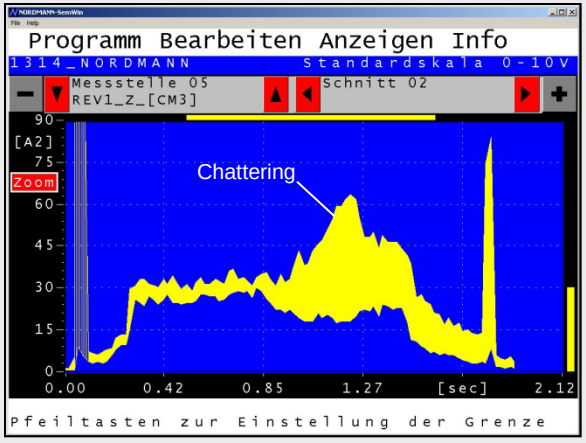
3-Phase power measuring with WLM-3)



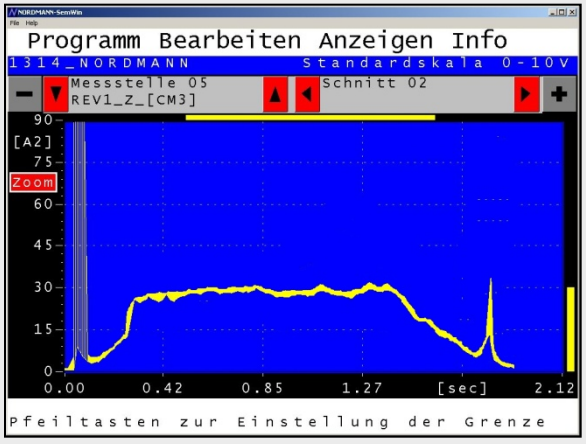
Smoothing



Square current measuring with CM-3

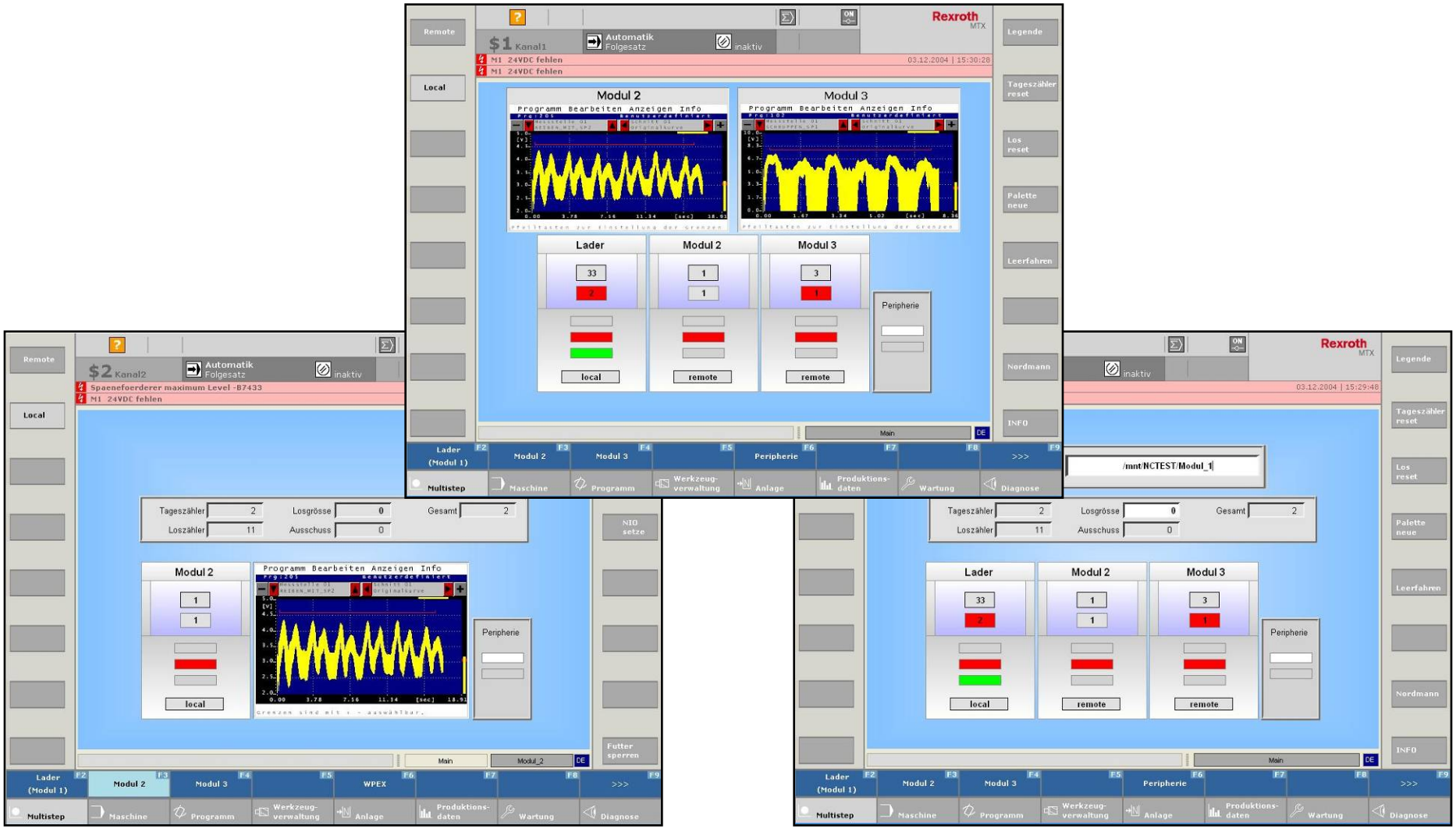


Smoothing



NORDMANN TOOL MONITORING

Tool Monitor SEM-Profibus integrated in Bosch-Rexroth MTX control on Mikron-Multistep



NORDMANN TOOL MONITORING

Versions of SEM-Modul, SEM-Profibus, SEM-Profibus for tool monitoring with few or no sensors

Panel unit

Tabletop unit

Flat display

(in connection with DIN-Rail module)

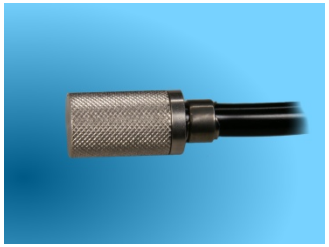
DIN-Rail modules

SEM-Profibus

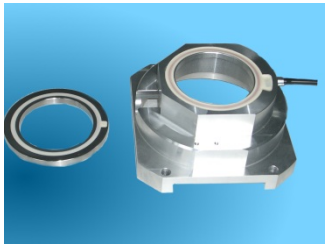
(for measurement curve viewing and operation via the monitor of the CNC control unit or by the flat display)

NORDMANN TOOL MONITORING

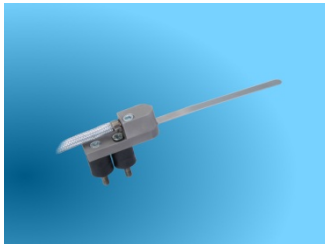
Acoustic and vibration



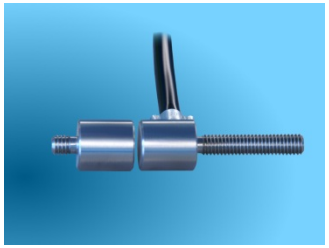
BSA Non-contact acoustic emission sensor



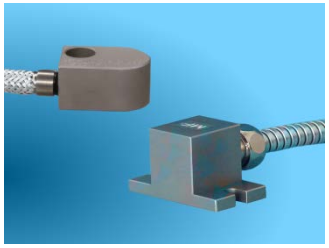
RSA-Ring Rotating sensor with non-contact transmission



SEA-Feder Acoustic emission Sensor with wave guide
Allows the acoustic emission measurement from work pieces, for example in rotary transfer machines and transfer lines to control multi-spindle heads.



RSA Rotating Acoustic Emission Sensor
Rotating piezo-electrical acoustic emission sensor with integrated transmitter. The acoustic emission value is inductively transmitted to a fixed receiver.

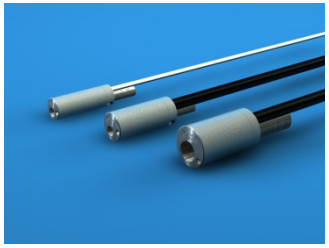


SEA Acoustic Emission Sensor
Low-noise acoustic emission sensor. Measurement dynamic: 110 dB, switchable frequency range up to 1 Mhz. Available in different designs

SEA-Wireless Acoustic emission sensor with wireless transmission

RSA-2 Rotating acoustic emission sensor
Rotating piezo-electrical acoustic emission sensor with integrated transmitter. The acoustic emission value is inductively transmitted to a fixed receiver.

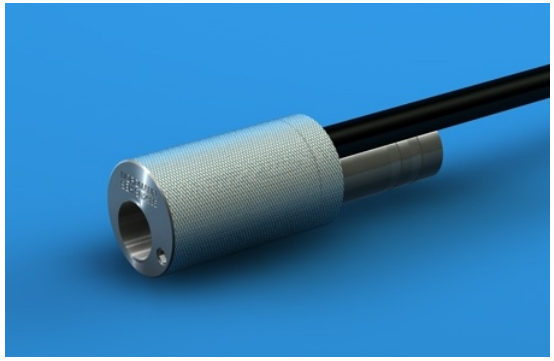
SNF-SEA Super low frequency vibration pickup
3D vibration sensor (measuring in 3 orthogonal directions). Measuring range switchable from 6g to 1,5g and from 10g to 2,5g

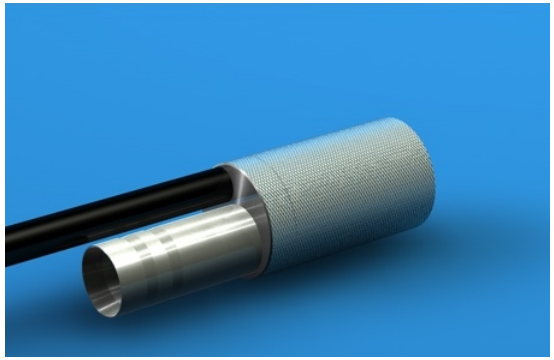


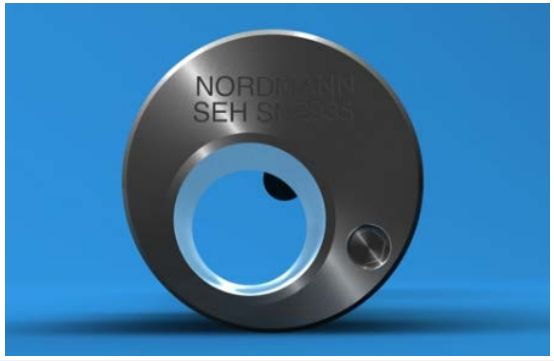
SEH Acoustic Emission Hydrophon
Monitoring acoustic emission using a cooling jet as wave guide. Allows tool breakage detection for the smallest tools. A very common application is also gap control for grinding machines.

SEH Acoustic Emission Hydrophon

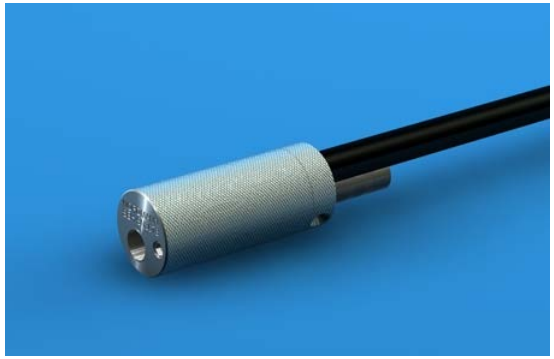
SEH (Maxi)

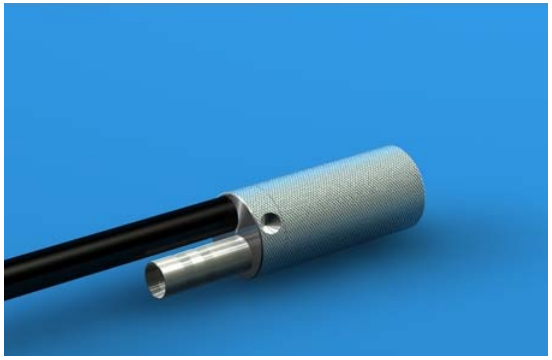




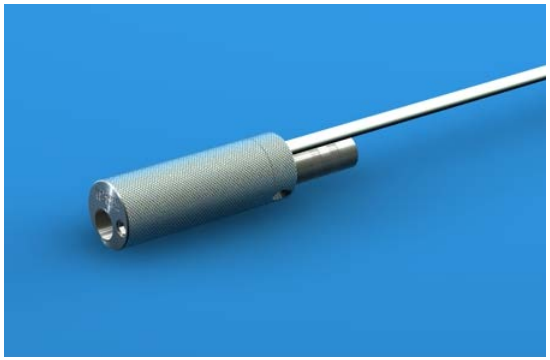


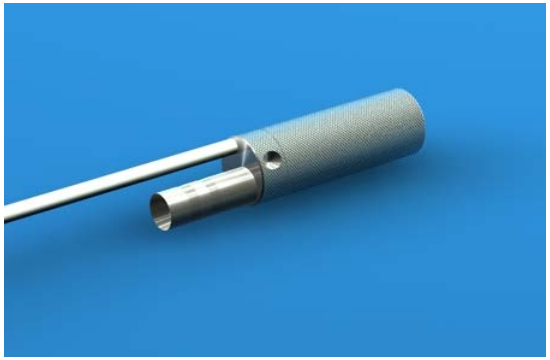
SEH (Standard)

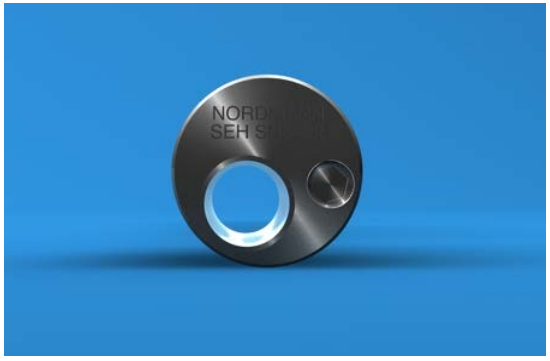




SEH (Mini)



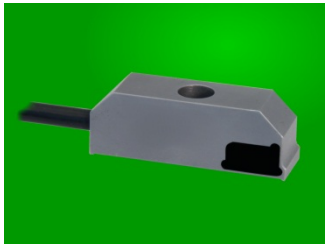




Force

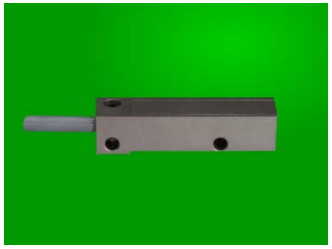
3D-KMS Measurement Piezo Quarz Orifice Plate

BDA-Kralle (patented) Strain Sensor in form of a claw
Very sensitve and easy to install strain sensor. Only needs a M5 screw for installation.



DMS-Kralle Strain Sensor
To monitor tool forces on DMS-basic. Same easy installation as the BDA-Kralle, but it is two times more sensitive and resistant against magnetic fields.

DA Pressure Transmitter
Pressure transmitter to monitor hydraulic feeds for cutting and forming operations.

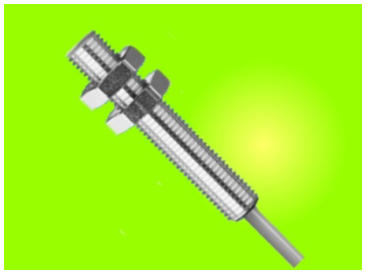


BDA-Q Strain Sensor
The BDA´s are very sensitive inductive distance sensors, distance changes of 1/100 µ can be detected

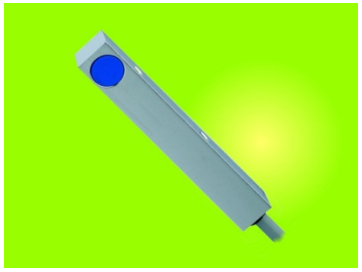
ADDM Sensor Adjustment Module
Particulary with linear and logarithmic output for automatic zero point alignment over an external 24V control signal, value rectifying and (adjustable) value smoothing

Distance and gap

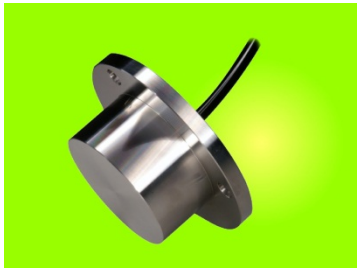
BDA-L Inductive Distance Sensor (longitudinal direction)
The BDA´s are very sensitive inductive distance sensors, distance changes of 1/100 µ can be detected.



BDA-L M8 x 50 Inductive Distance Sensor (longitudinal direction)
The BDA´s are very sensitive inductive distance sensors, distance changes of 1/100 µ can be detected. Very small amplifier included.

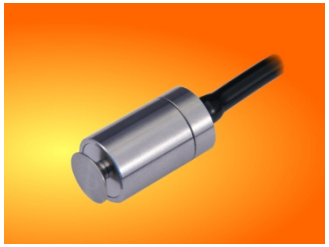


BDA-Q 8x8x50 Inductive Distance Sensor (trannsverse direction)
The BDA´s are very sensitive inductive distance sensors, distance changes of 1/100 µ can be detected.

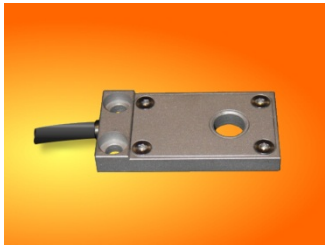


BDA-L-Maxi Inductive Distance Sensor (rugged and waterproof version)
The BDA-L-Maxi measures the distance from steel up to 50 mm. This sensor is used for controlling hard metall edges in tunnel drilling machines

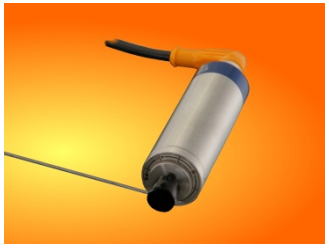
Tool length and work piece position control



APS-BDA Collision Sensor
Application: jet barriers out of coolant, water or pressured air, to monitor the shorter tools, caused by breakage, or the clamping position respectively the availability of the work pieces. (Alternative to the laser barrier)

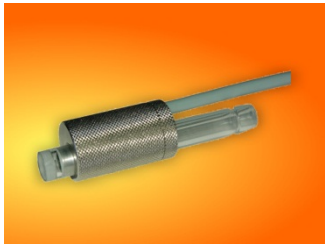


EMS-Dyn and EMS-Ind Electro Magnetic Sensor
Application: Electro magnetic sensor for non-contact detection of the dynamic portion of the torque while drilling. (=EMS-Dyn), respectively for tool length control while the tool is moving in or/and out of the sensor (=EMS-Ind).

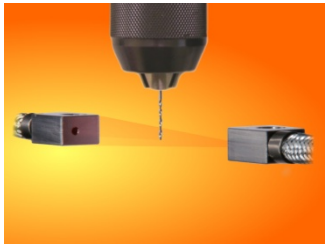


PCS-100 Positive contact sensor
Sensitiv sensor head with pivot arm for control workpiece length or workpiece position (control cut off).

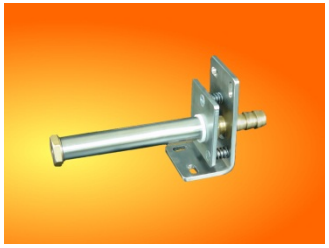
APS-Q , APS-L Acoustic Collison Sensor
Jet barriers out of coolant, water or pressured air, to monitor the shorter tools, caused by breakage, or the clamping position respectively the availability of the work pieces. (Alternative to the laser barrier)



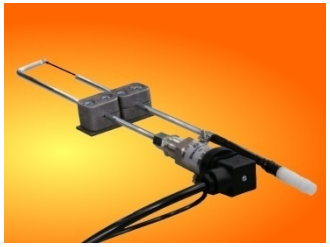
HDS Hydro Distance Sensor
Distance measurement by using a coolant jet. For tool length control. Independent of flow characteristic or temperature. Available in two versions.



LS-2 Laser light barrier
Application: Broken tool laser detection



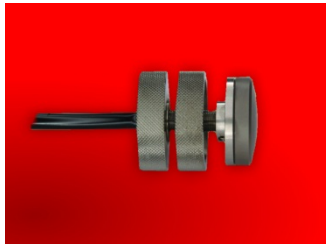
GUN Jet-Gun Jet barriers out of coolant, water or pressured air, to monitor the shorter tools, caused by breakage, or the clamping position respectively the availability of the work pieces. Positioning with fine adjustable holder



SDS (Typ C) Application: jet barriers out of coolant, water or pressured air, to monitor the shorter tools caused by breakage.

SDS (Typ I) Application: jet barriers out of coolant, water or pressured air, to monitor the shorter tools caused by breakage.

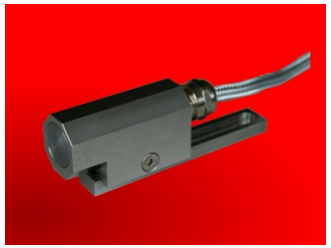
Work piece dimension and tool position control



BDA-Pilz Non-wear detection of the workpiece by using an elastic bedded and gas-nitrided calotte.

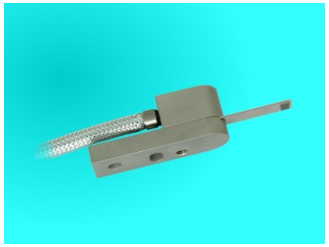
IND Pneumatical Inductive feeler
Inductive feeler with measuring lift between 5 and 20 mm (Typ: IND) and pneumatic adjustment (Typ IND-Pneu) with SEP

XYZ-Gauging Element
Measurement principle: Acoustic detection of friction noise that is generated by a tool touching a diamond surface. Implemented with diamond strips (PKD) in x-, y- and z-direction. Application: Machining centre
.



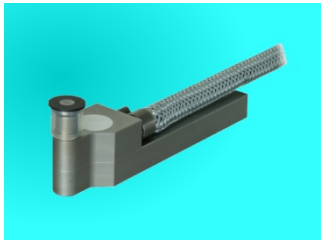
WLT Workpiece Length Detector
Very robust, but still high sensitive workpiece length detector for rotary transfer machines! The work piece length detector checks in the multi-spindle lathe between two sites along the workpiece as workpieces continue to cycle.

IND-Pneu Pneumatical Inductive feeler
Inductive feeler with measuring lift between 5 and 20 mm (Typ: IND) and pneumatic adjustment (Typ IND-Pneu) with SEP



X(Y,Z)-Gauging Element
Acoustic detection of friction noise that the rotating grinding wheel generates when touching the diamond surface. Implemented with a diamond surface on a spring steel element as a wave guide. Application: grinding machines (e.g. work piece grinding)

WLT Workpiece Length Detector (-mini)
Robust, a litte smaller then the normal WLT, but still high sensitive workpiece length detector for rotary transfer machines!



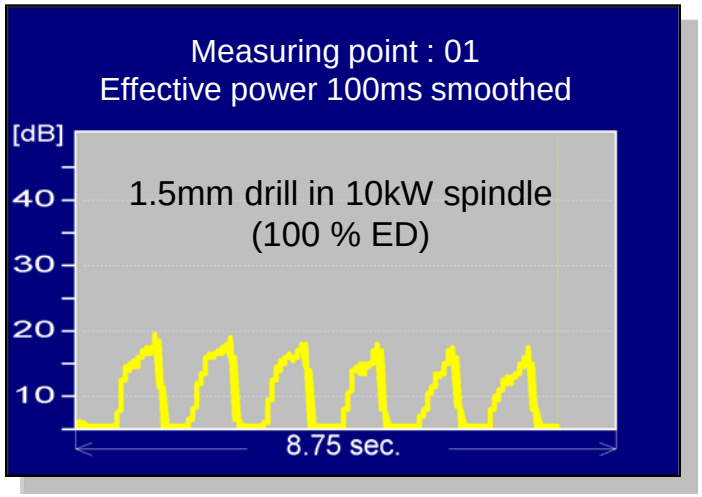
XY(+Z)-Gauging Element
Acoustic detection of friction noise that the rotating grinding wheel generates when touching the diamond surface. Implemented with a diamond surface on a spring steel element as a wave guide.

3 phase effective power unit (WLM-3)

Highly sensitive, fast-reacting measurement of effective power

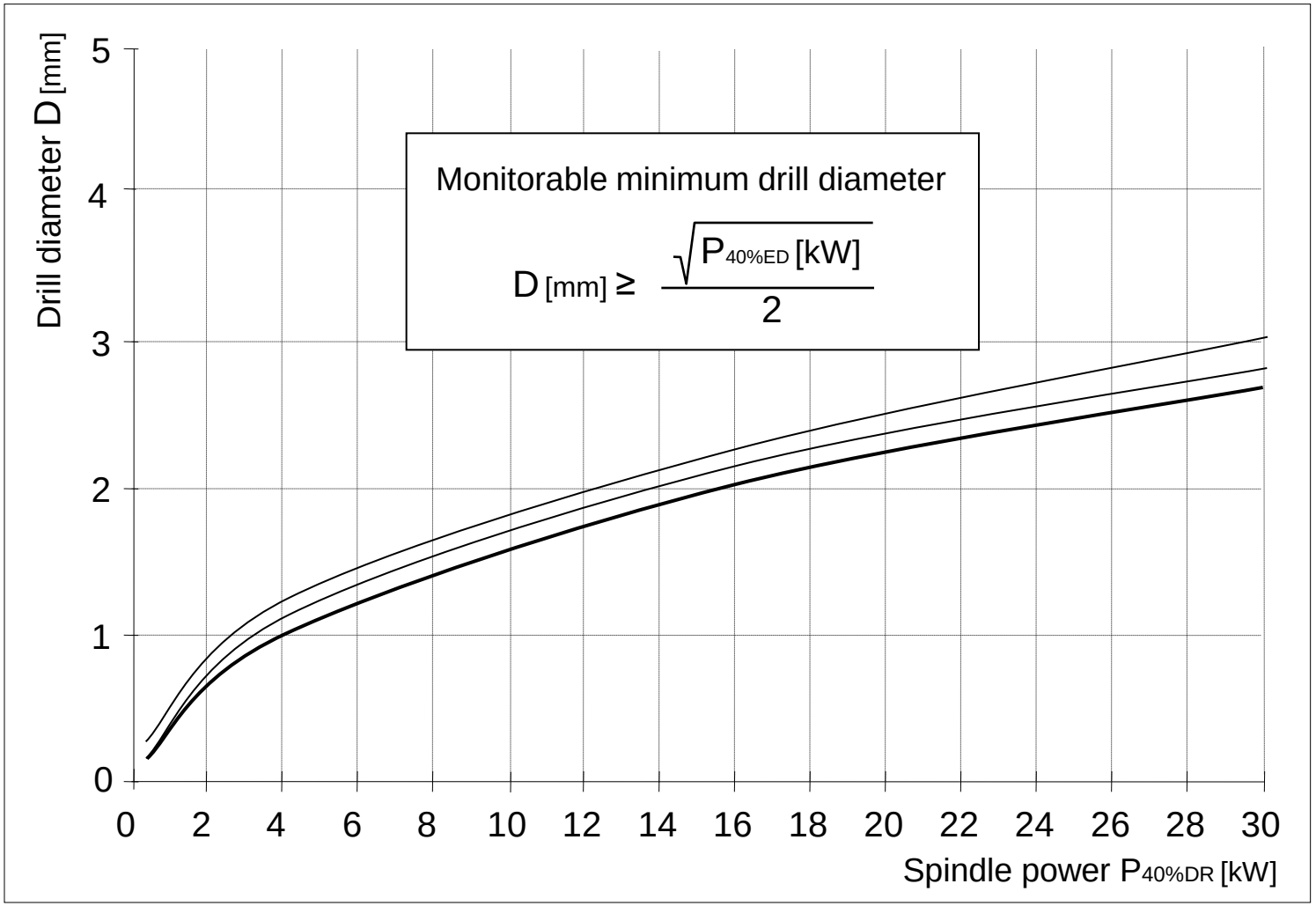
Examples of drill diameters that can be monitored:

Spiral drill Ø 1.8mm on 15kW spindle
Spiral drill Ø 1.5mm on 10kW spindle
Spiral drill Ø 0.75mm on 3.5kW spindle



NORDMANN TOOL MONITORING

Monitorable drill diameters for good motorspindles



NORDMANN TOOL MONITORING

Tool monitoring on an EMAG lathe

Monitored tools by effective power:

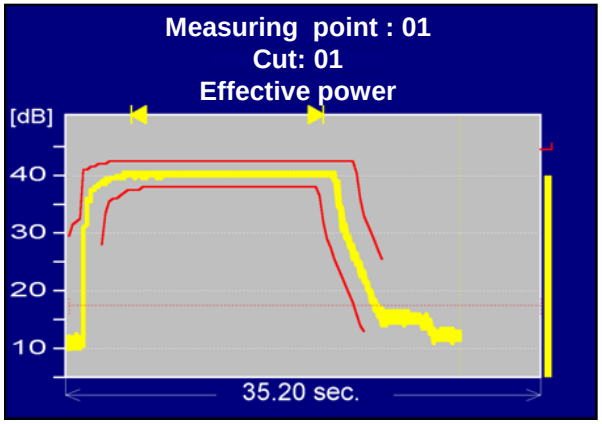
Multi-spindle drill head 3x Ø 5,5mm
1 drill Ø 6,5 mm
1 drill Ø 7,0 mm

Sensor selection for different kind of machine tools

	In-process measuring method					Post-process measuring method	
Sensor / Machine-tool	**Effective power**	**Torque**	**Force**	**Acoustic emission**	**Acoustic emission (contactless)**	**Jet barrier by using laser, air or cooling lubricant**	**Other**
CNC lathes	WLM-3 or sensorless via Profibus	sensorless via Profibus	3D-KMS, DMS-Kralle	SEA-Mini, SEA-Feder,	SEH, RSA-Ring	SDS-Fork Typ U, SDS-Fork Typ C, APS-L or –Q, APS-BDA	PCS-100
Multi-spindle automatic lathes	WLM-3 or sensorless via Profibus	DMA, EMS-Dyn or sensorless via Profibus	BDA-Q, BDA-Kralle, DMS-Kralle	SEA-Mini	SEH	SDS-Fork Typ U, SDS-Fork Typ C, APS-L or –Q, APS-BDA	PCS-100, EMS-Ind
Machining centers	WLM-3 or sensorless via Profibus	sensorless via Profibus	DMS-Kralle (collision measurement)	SEA-Mini, SEA-Feder, SNF-SEA,	SEH, LSM	Jet nozzle, LS-S/-E, APS-L or –Q, APS-BDA	PCS-100, EMS-Ind
Transfer lines, Rotary transfer machines	WLM-3 or sensorless via Profibus	DMA EMS-Dyn or sensorless Via Profibus	BDA-L-Mini, BDA-Kralle, DMS-Kralle	SEA-Feder	SEH, BSA	SDS-Fork Typ U, SDS-Fork Typ C, APS-L or –Q, APS-BDA	PCS-100, EMS-Ind
Grinding machines	WLM-3 or sensorless via Profibus	(not required)	BDA-L-Mini, DMS-Kralle	SEA-Mini	SEH, BSA, RSA (-2) or RSA-Ring	SDS-Fork Typ U, SDS-Fork Typ C APS-L or –Q, APS-BDA	PCS-100

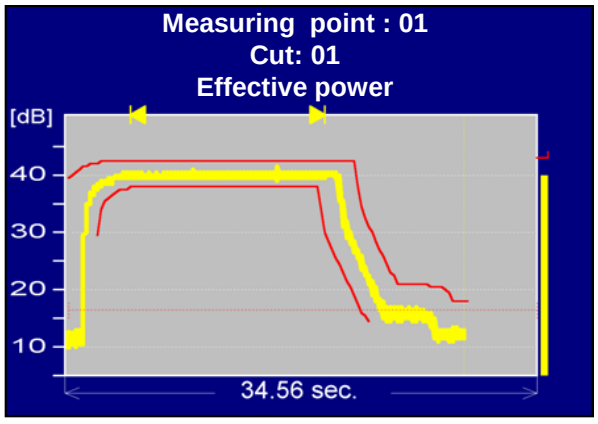
Evaluation of the dynamic of the effective power to detect milling head tooth breakage

Effective power of the spindle motor



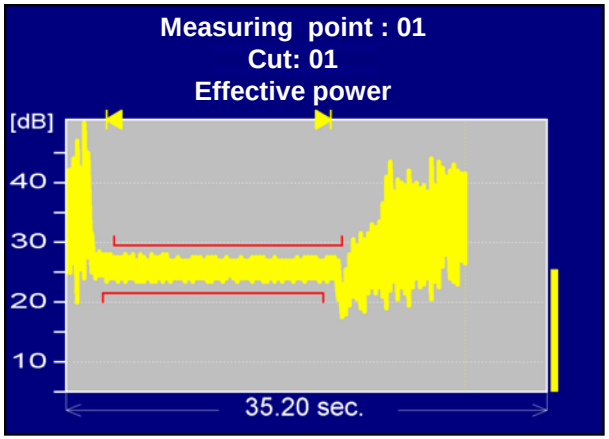
Milling head dull, but no tooth broken

8 blade cutter head of Ø 80mm

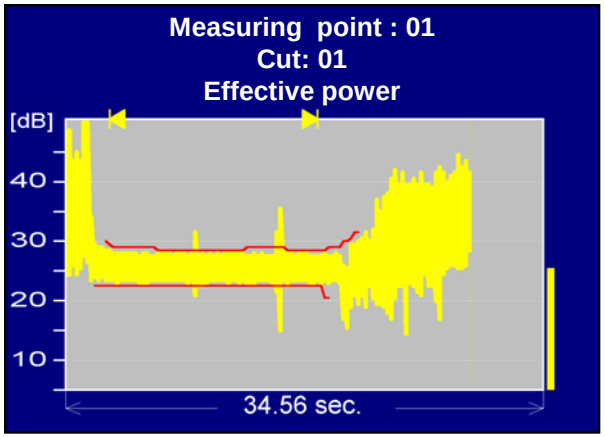


1 milling head tooth broken, breakage of other pieces during cutting

Dynamic portion of the effective power



Dynamic

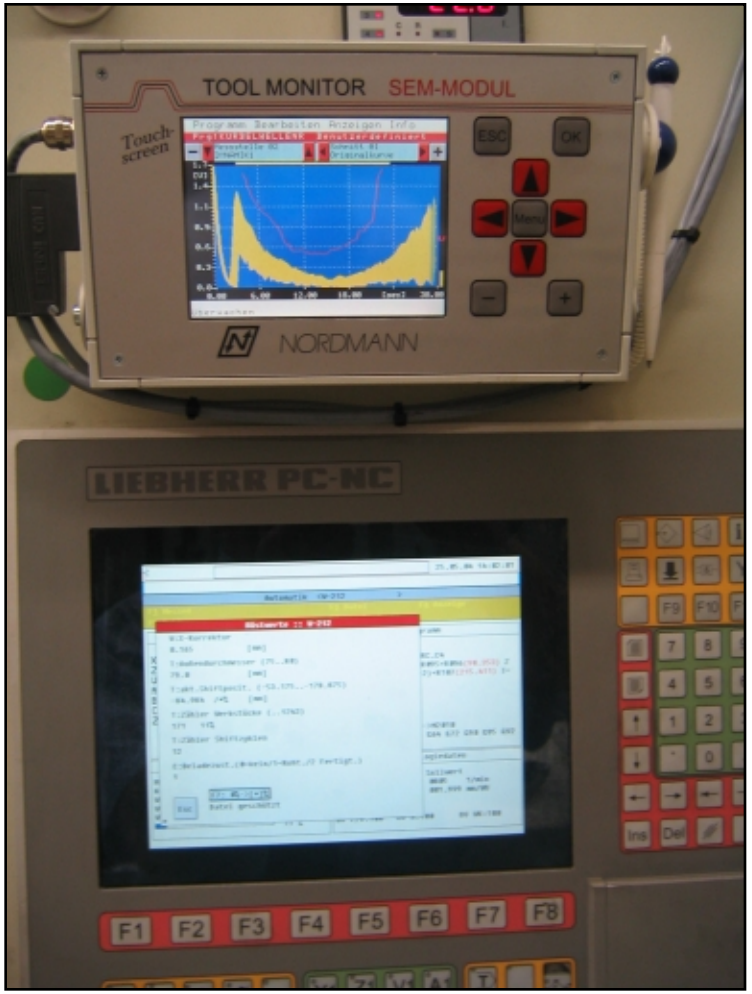


Dynamic

Tool monitoring on a Liebherr gear hobbing machine

Effective power measuring curve to detect wear by a gear hobbing

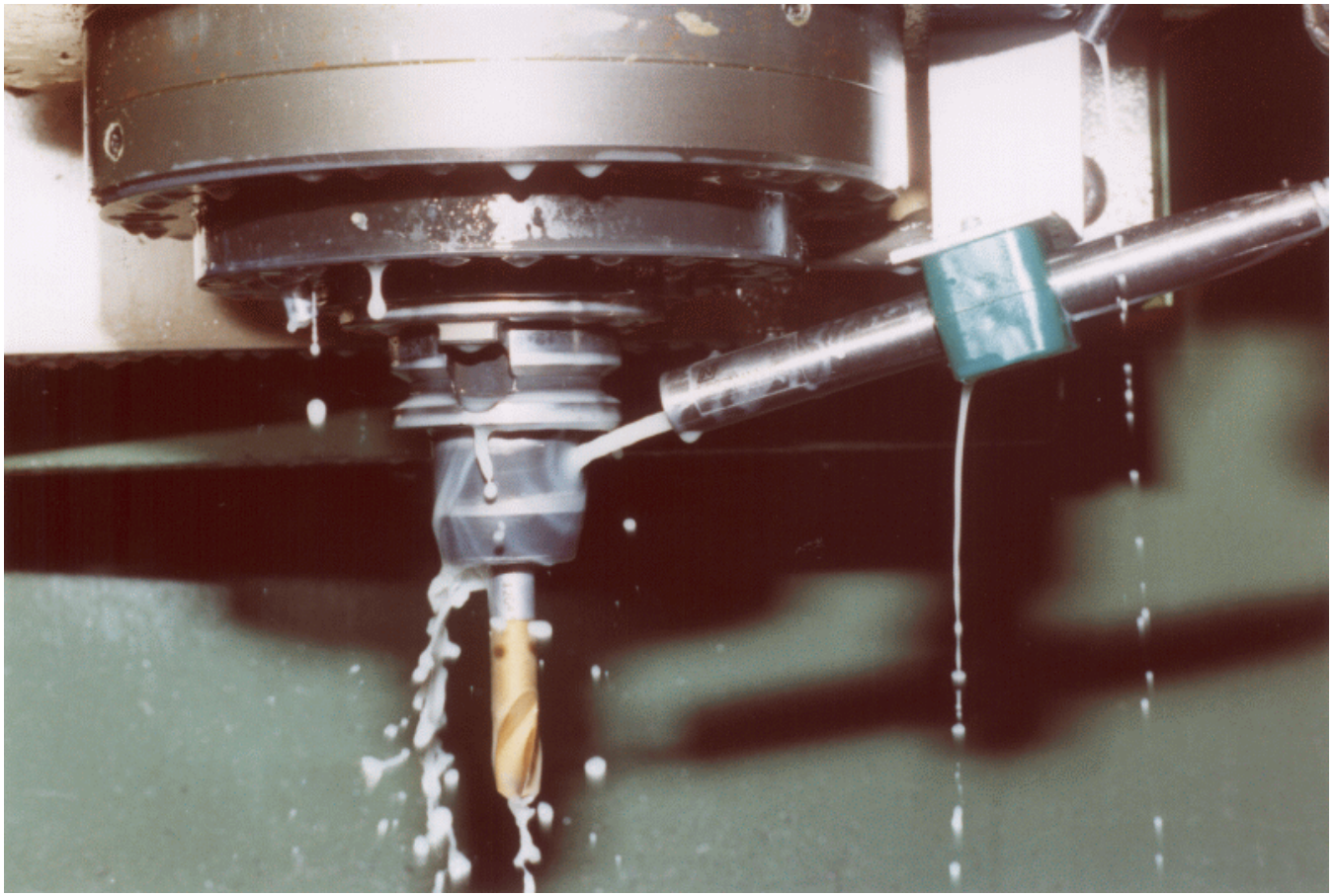
Dynamic of the effective power to detect tooth breakage



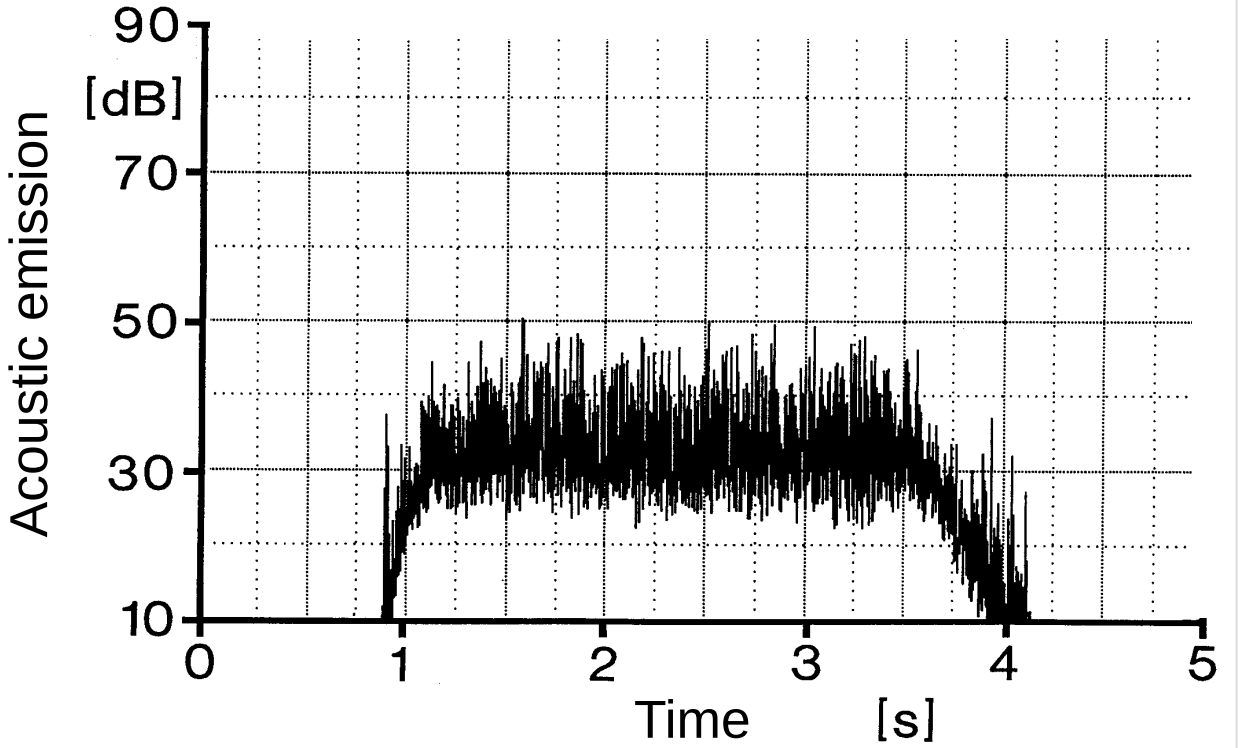
NORDMANN TOOL MONITORING

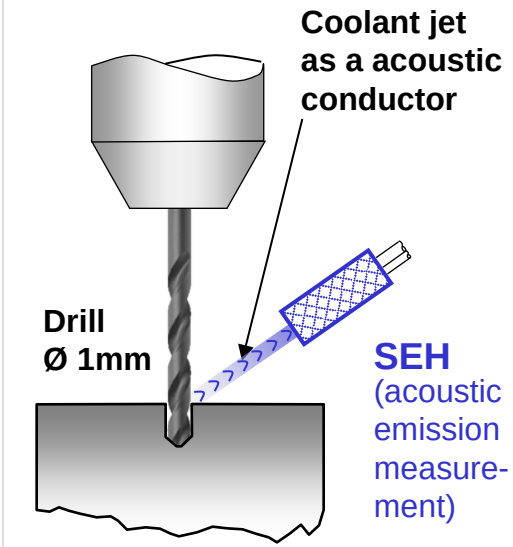
Acoustic emission measurement with SEH

Acoustic emission measurement on the tool holder with a jet of cooling lubricant as acoustic emission conductor (Sensor SEH)

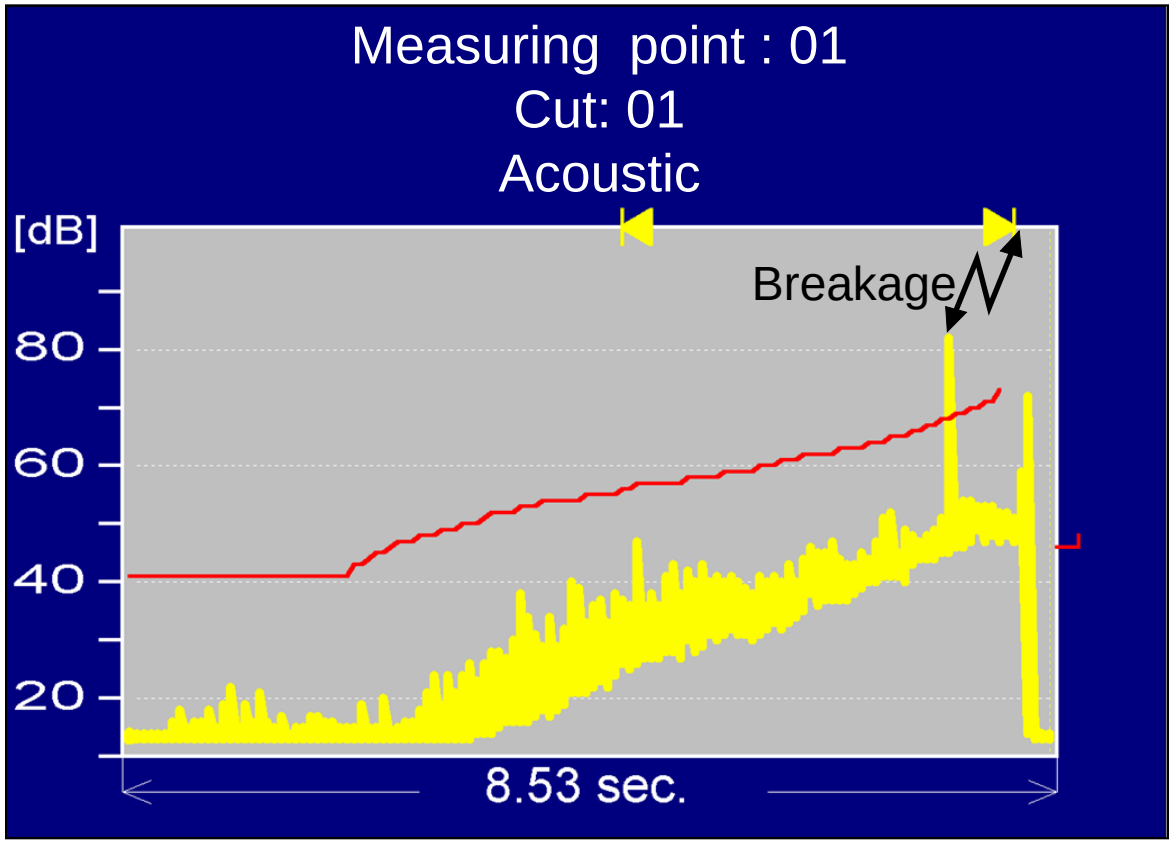


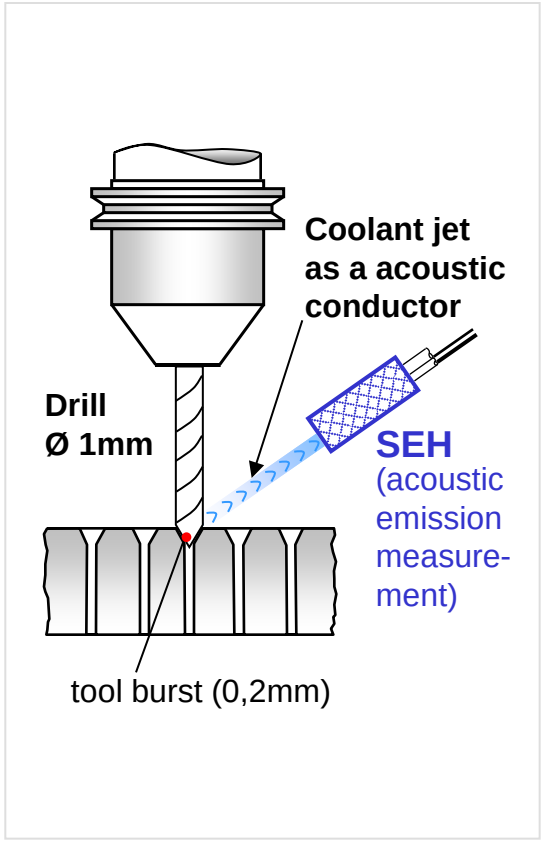
Chip removal signal measurement with an acoustic emission hydrophone on the drill





Measured value of the acoustic emission hydrophone during breakage of a 0.2mm piece of a conic nozzle drill

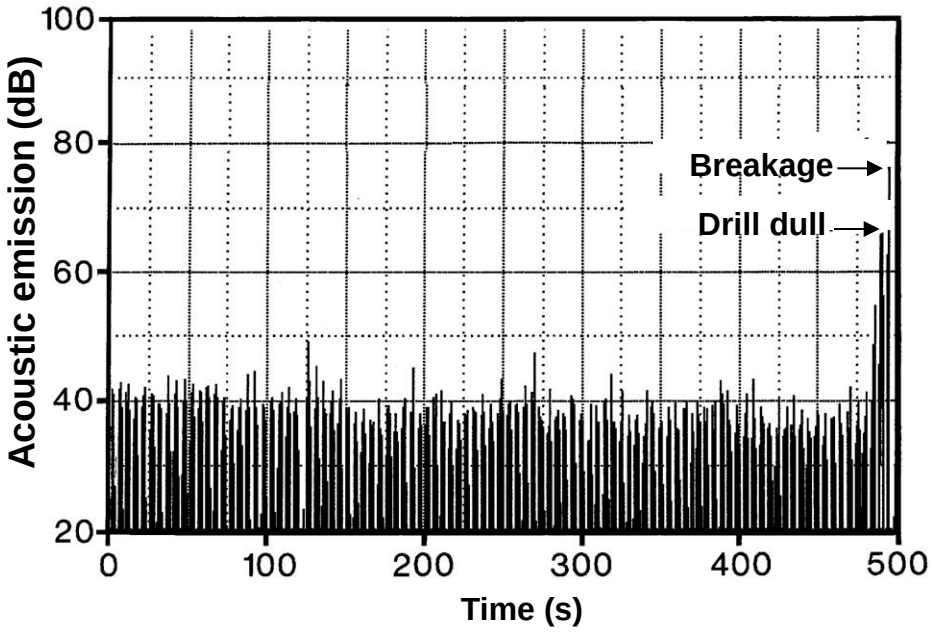


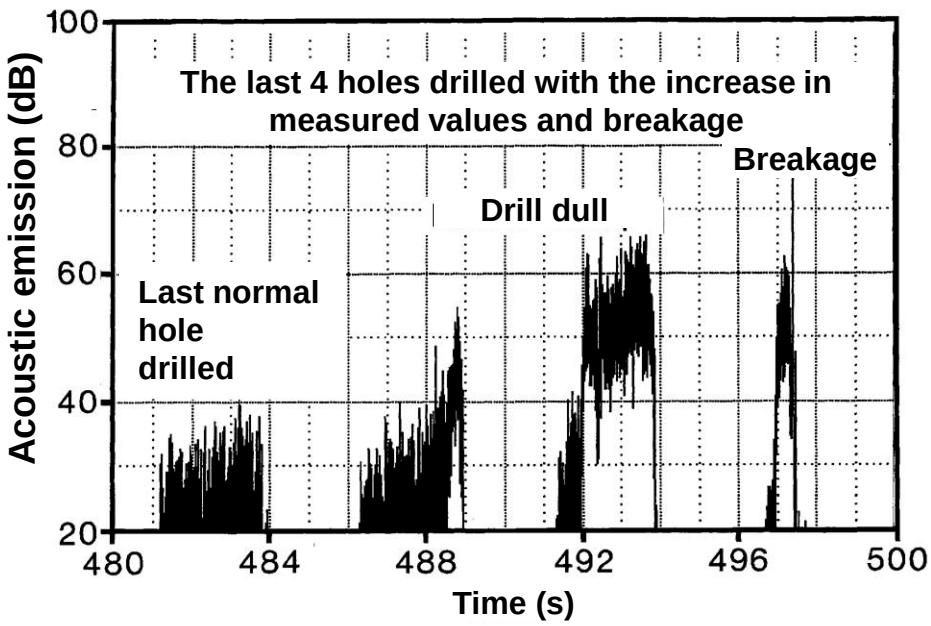


NORDMANN TOOL MONITORING

Development of acoustic emission until drill breaks

Example: Drill with Ø 3mm acoustic emission recording from machine table with SEA

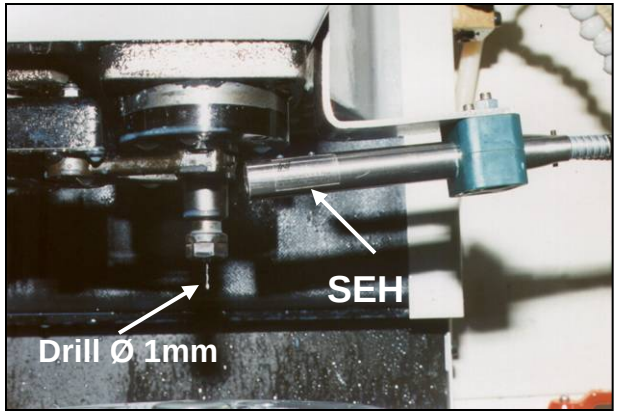




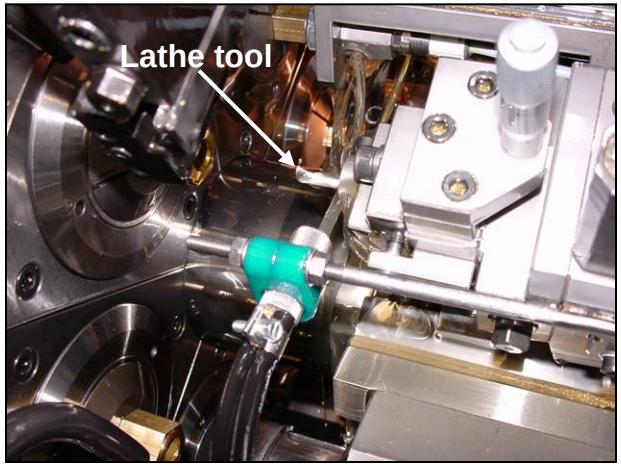
NORDMANN TOOL MONITORING

Acoustic emission measurement (sensor SEH) directly on the tool with a jet of cooling lubricant as acoustic wave conductor in various machines

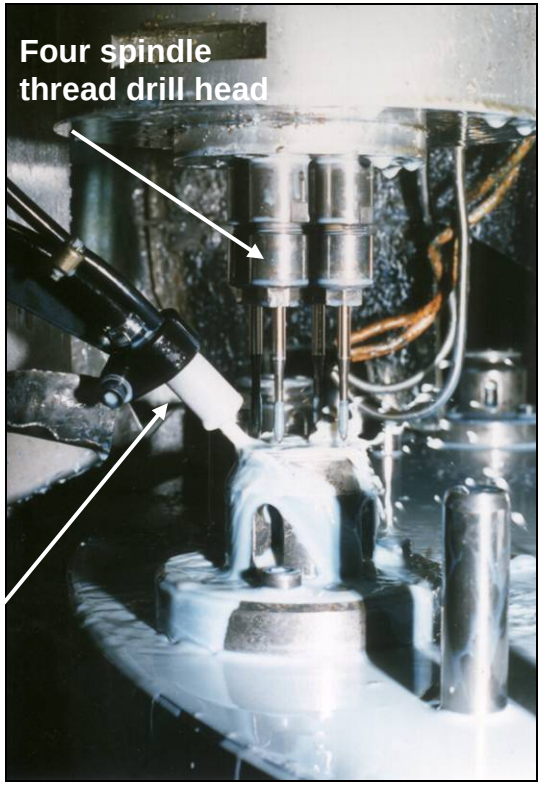
Machining center



Multi-spindle lathe

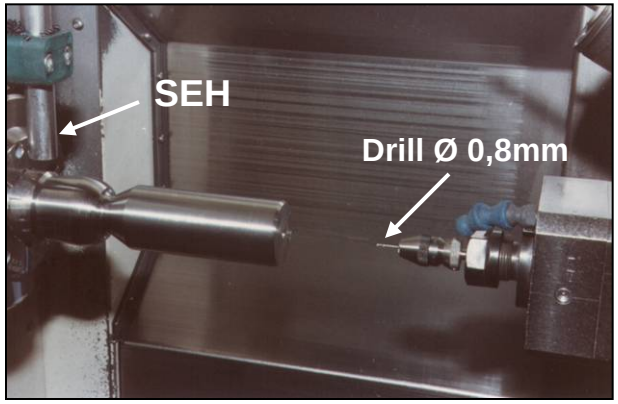


Rotary cycle machine

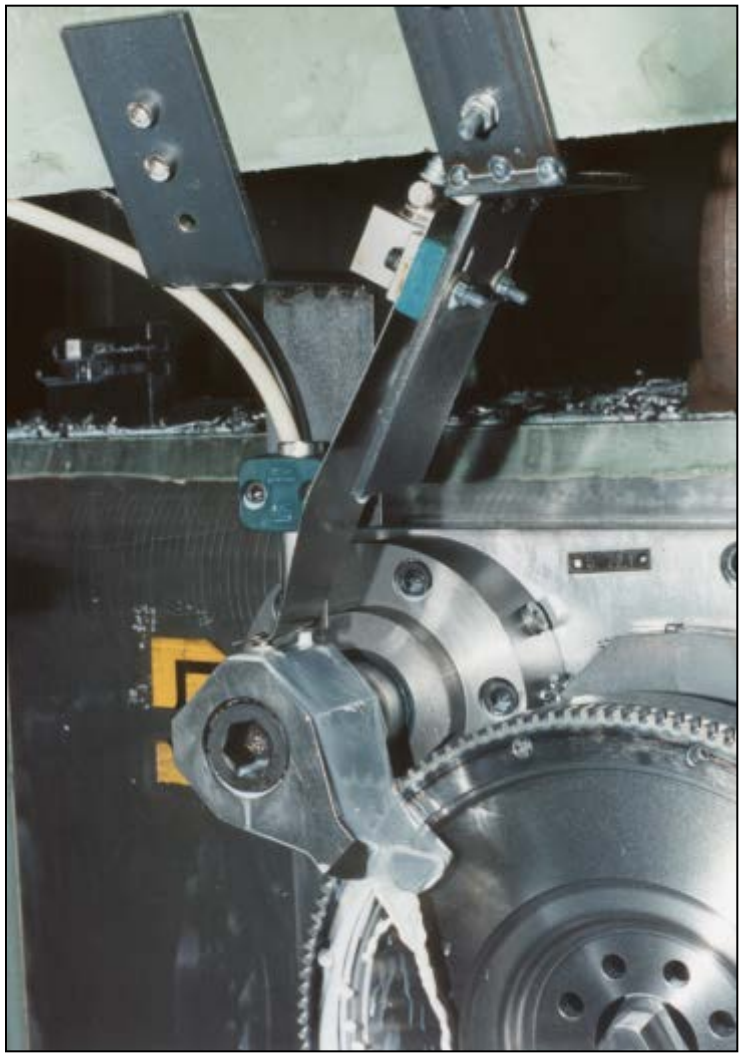


Sensor SEH: Acoustic emission measuring on the work piece with a jet of cooling lubricant as acoustic emission conductor

CNC lathe



Acoustic emission recording with spring steel as acoustic emission conductor (patented process)

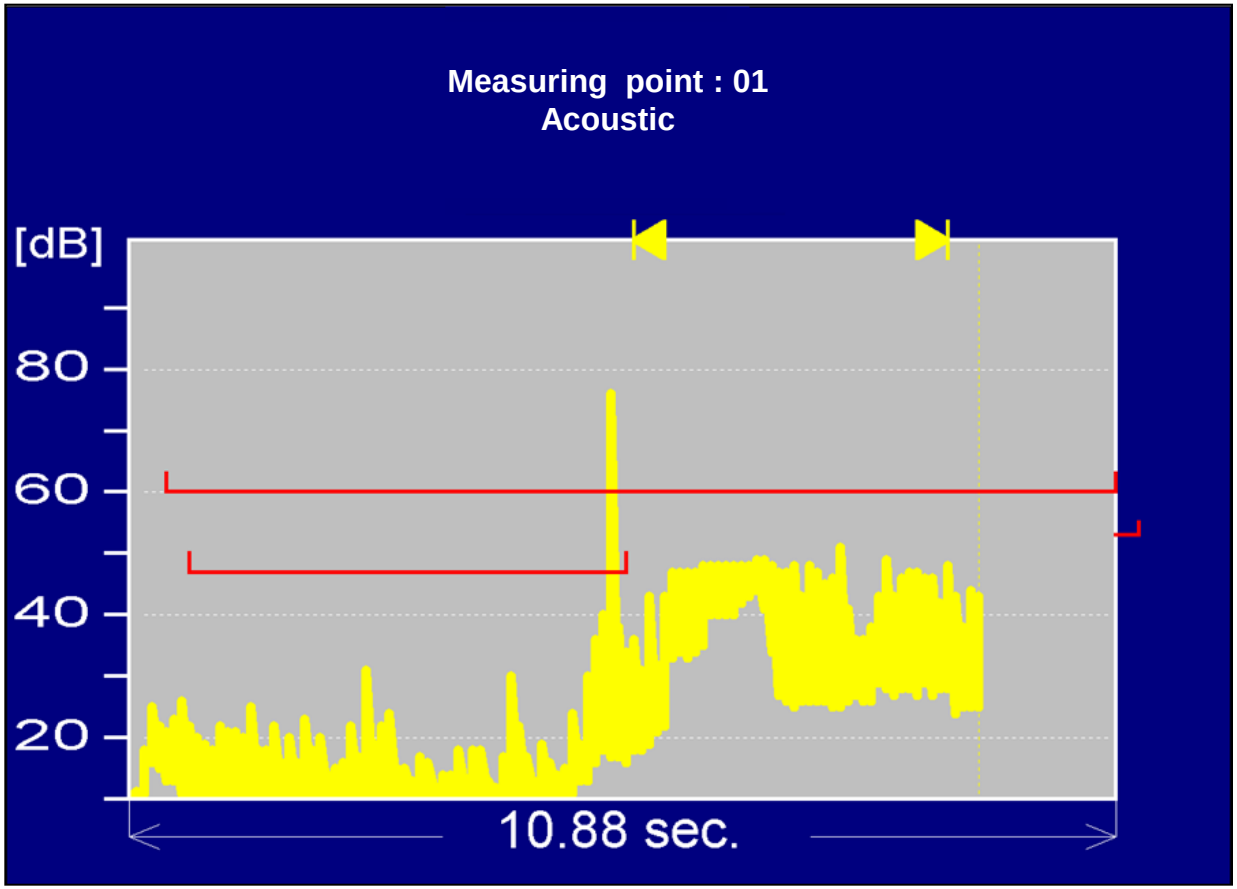


Monitoring a multi-spindle drill head

Example:

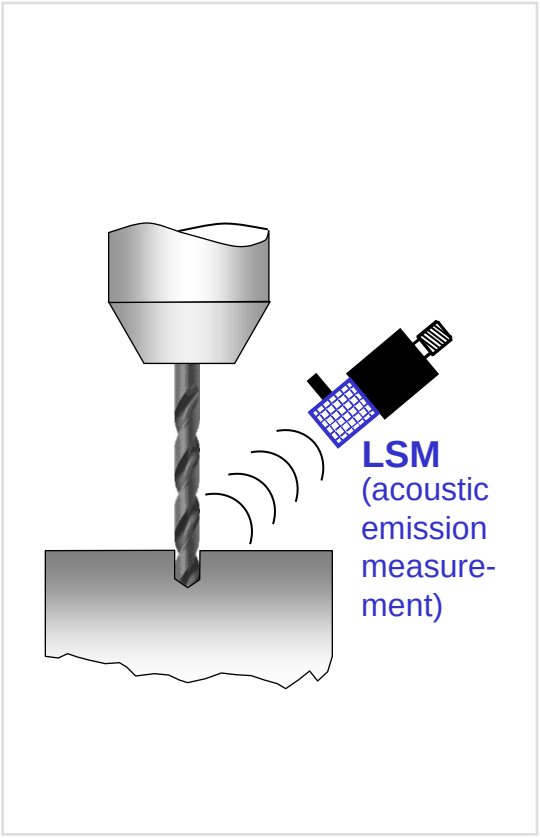
- 12 spindle threading drill head with HSS screw taps M8
- The acoustic emission measurement is done from the clamping claw of the work piece holder
- Even small breaks in single threads are detected

Measured value of the acoustic emission hydrophone during breakage of a 3mm drill in a 6-spindle drill head

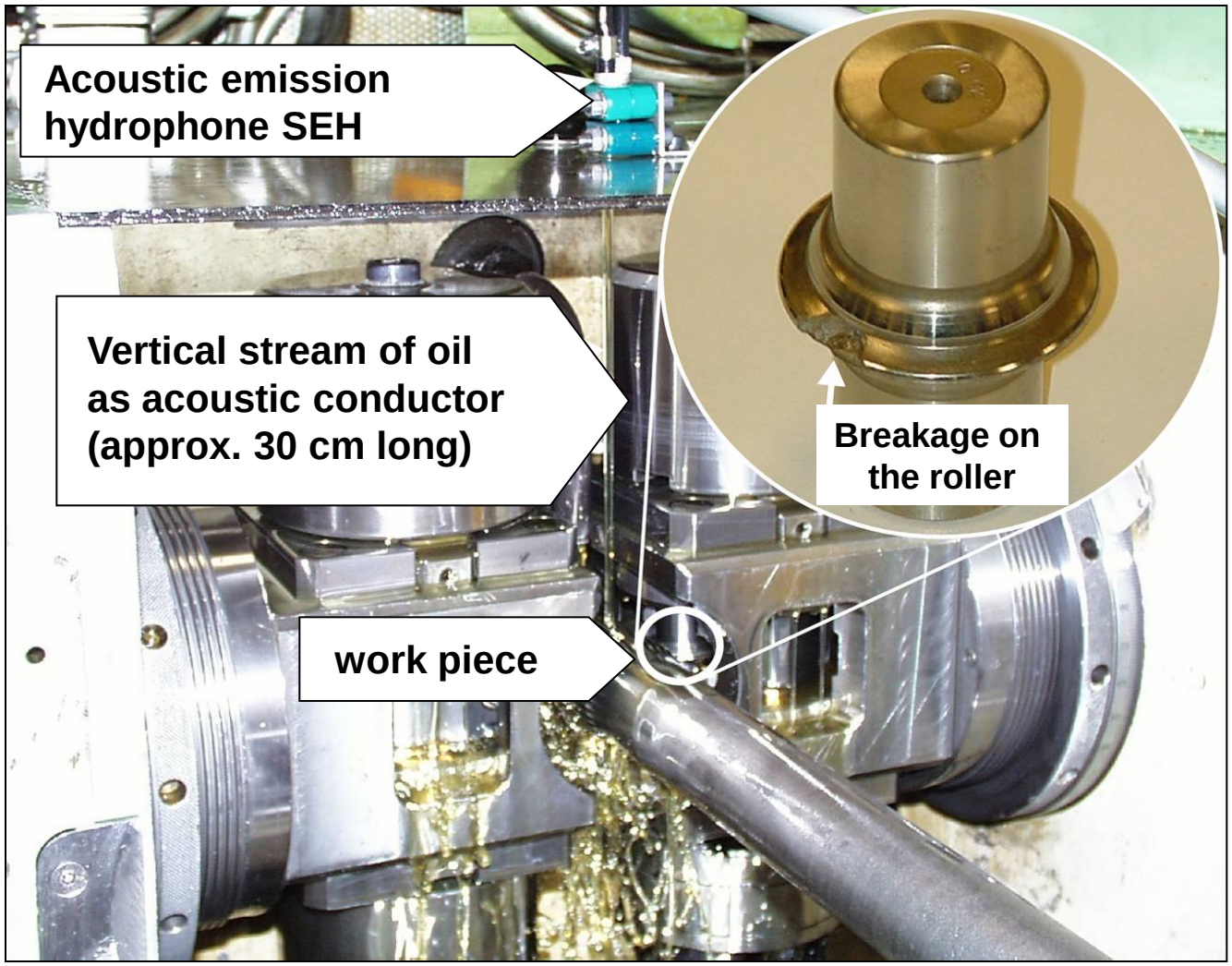


Acoustic emission with the jet of cooling lubricant from the work piece

Monitoring drills and milling tools by acoustic emission microphone LSM

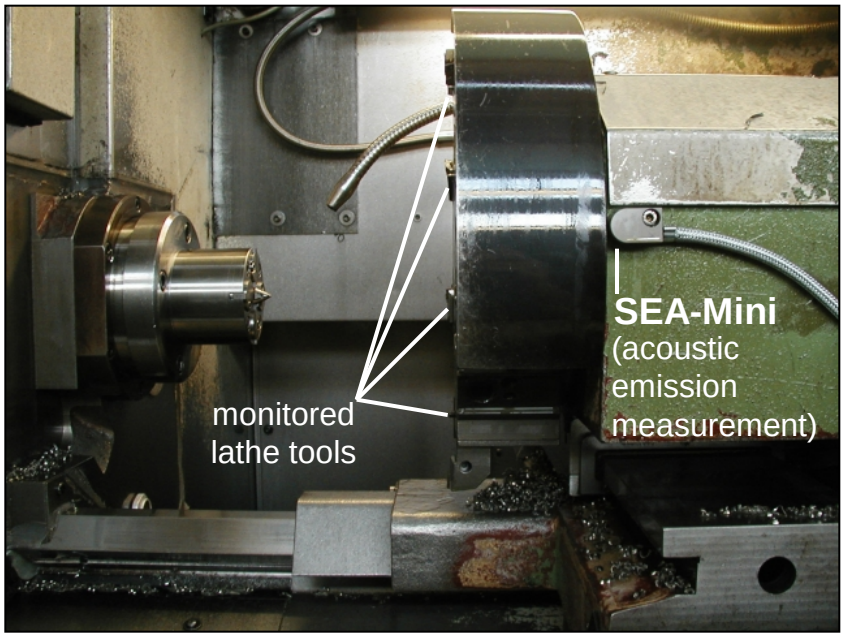


Detection of breakage on toothing hammer

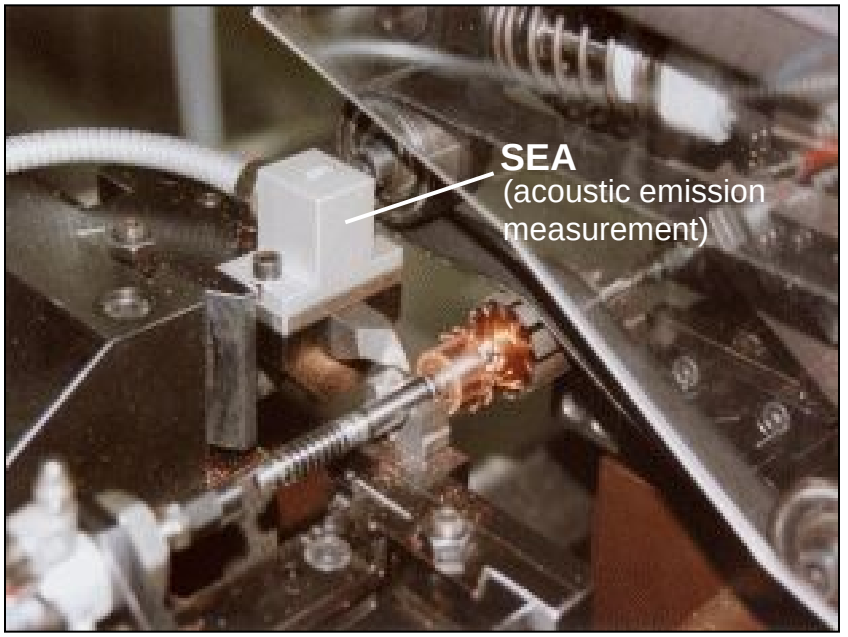


Acoustic emission measurement on tool with SEA sensor

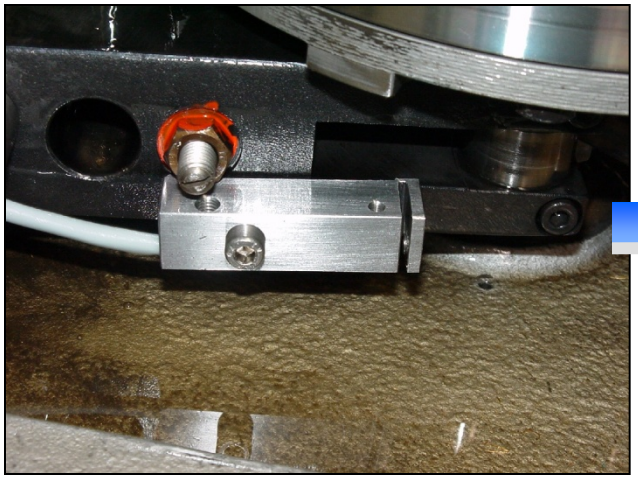
Acoustic emission sensor on the tool holder in an automatic multi-spindle lathe



Acoustic emission sensor directly on the tool during collector turning

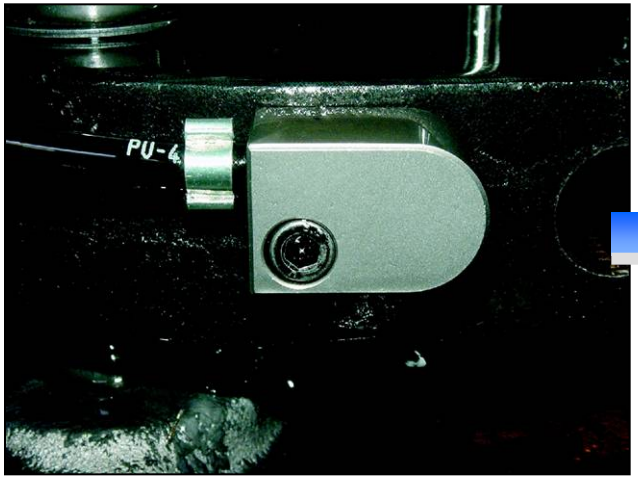


Force measurement on rocker arms in automatic multi-spindle lathes



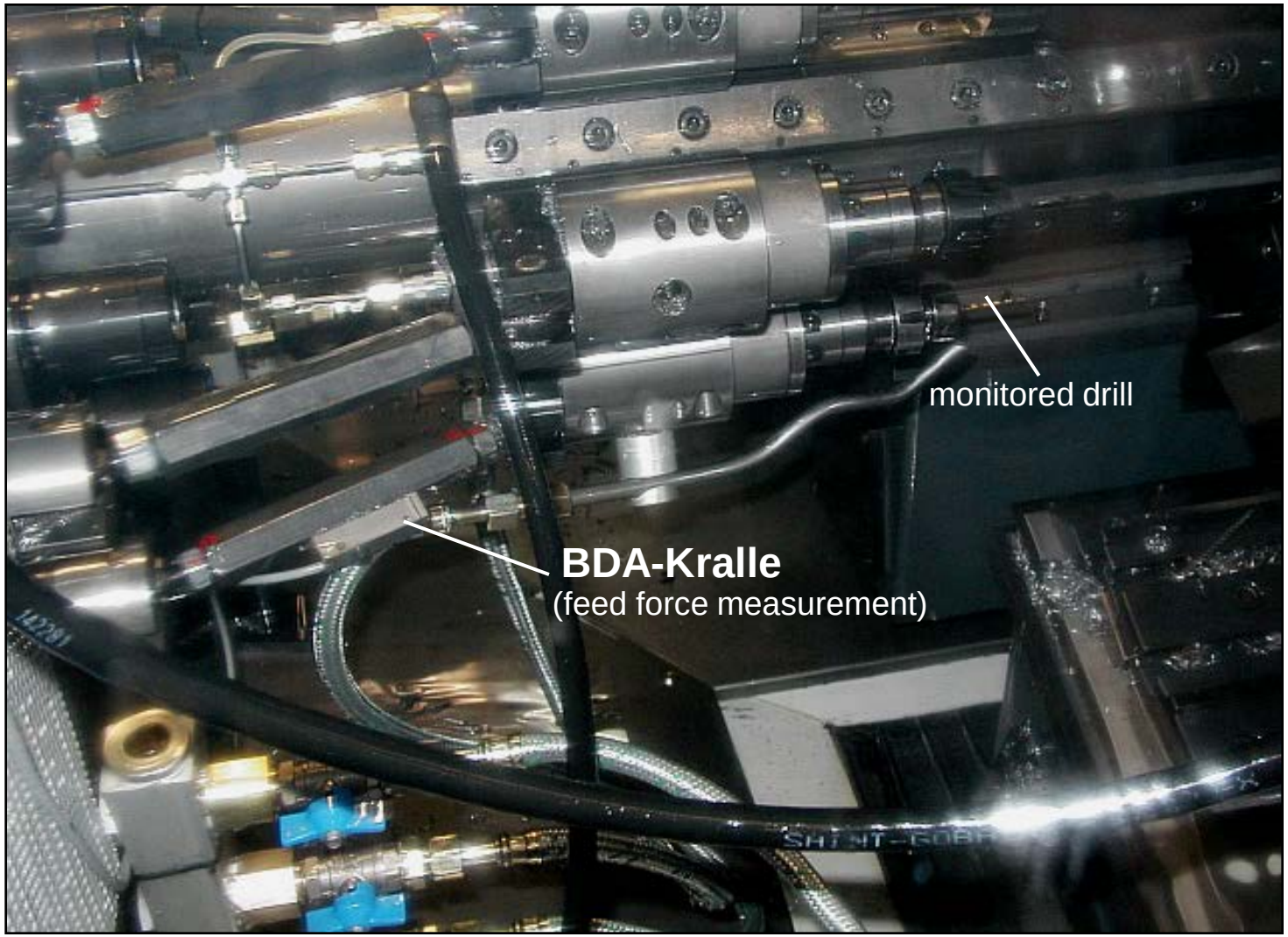
BDA-Kralle to measure strain (patented)

BDA-Q to measure bending

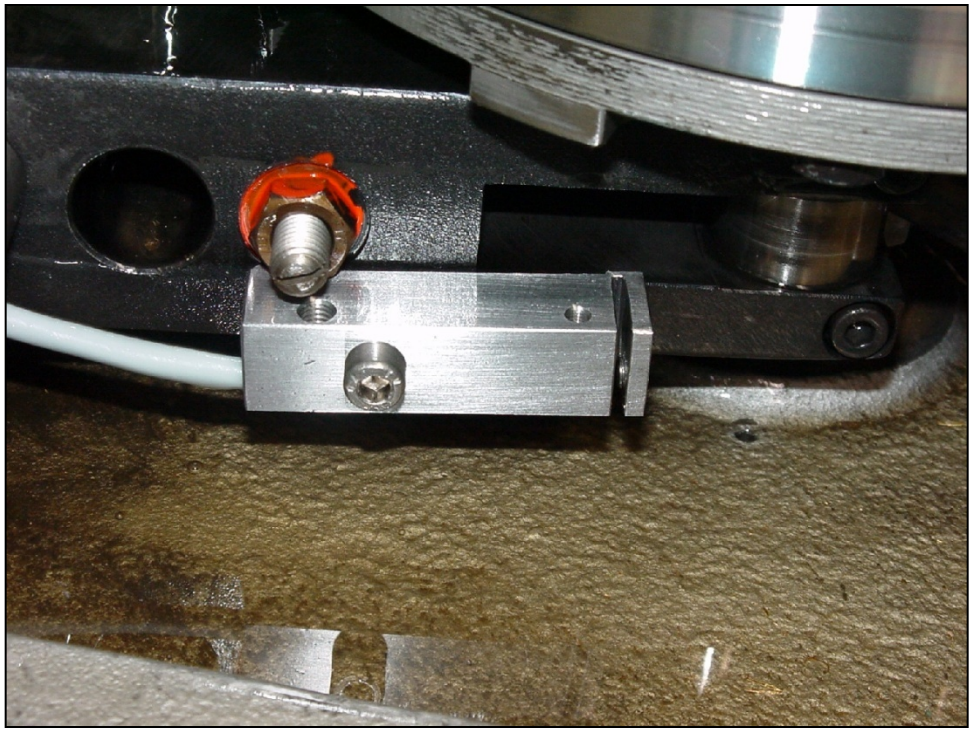


BDA-Dübel to measure transverse strain (patented)

Force measuring on the feed rod in multi-spindle automatic lathes

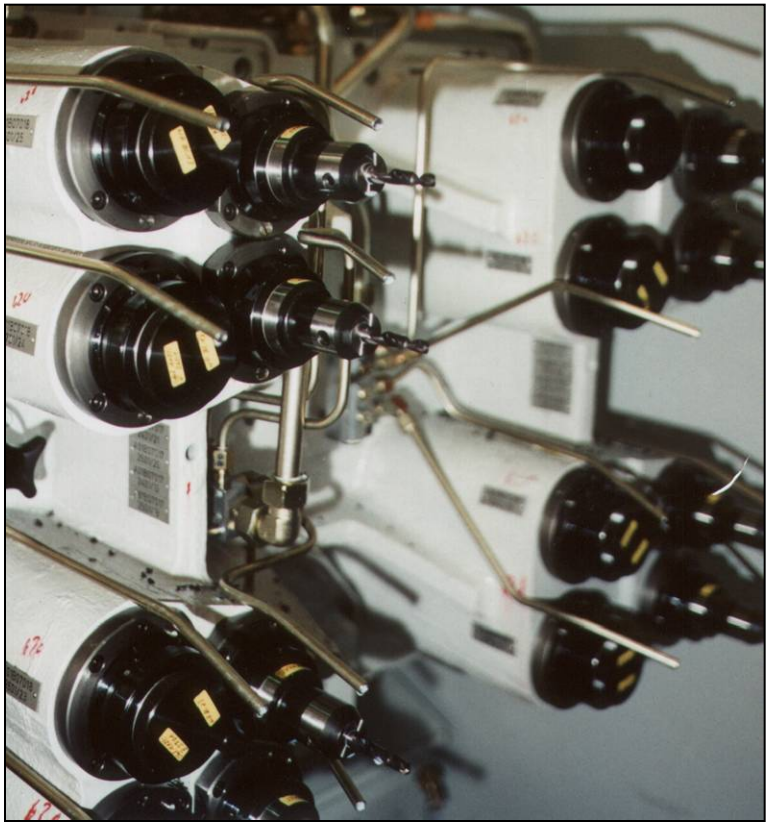


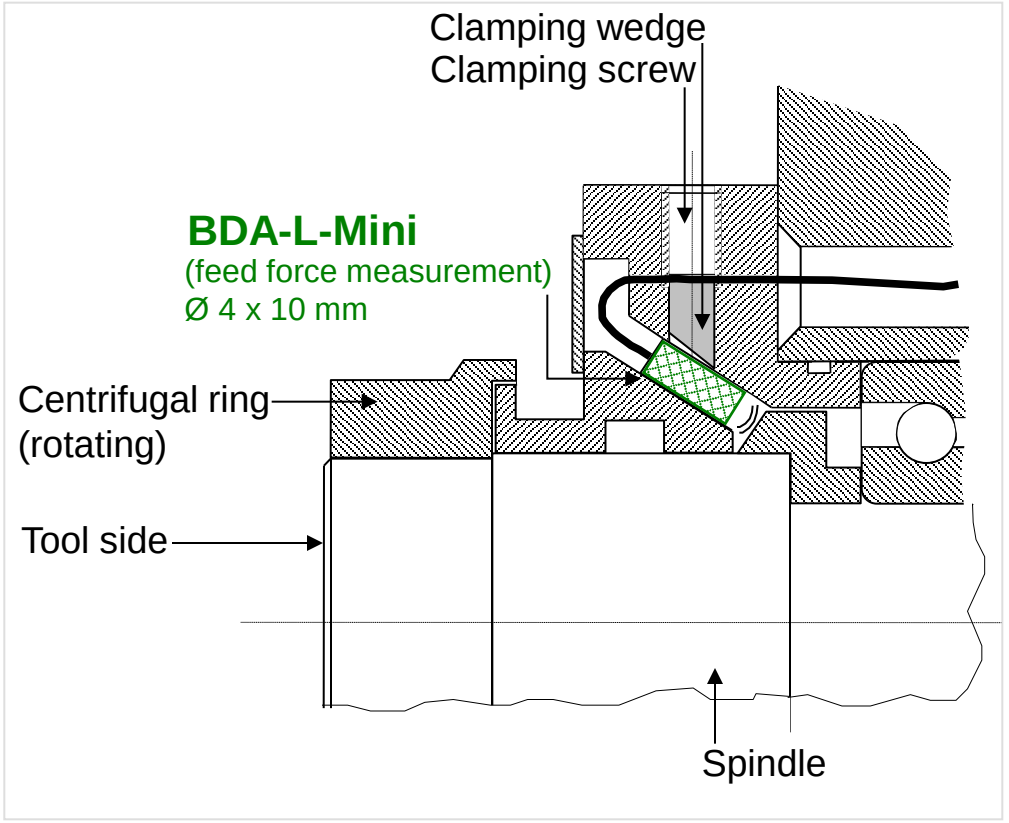
Advantages of the BDA-Kralle strain gauge



- ✓ Assembly surface does not need to be prepared
- ✓ Independent of the torque from the mounted screw (M5)
- ✓ Highly sensitive (1 nanometer)

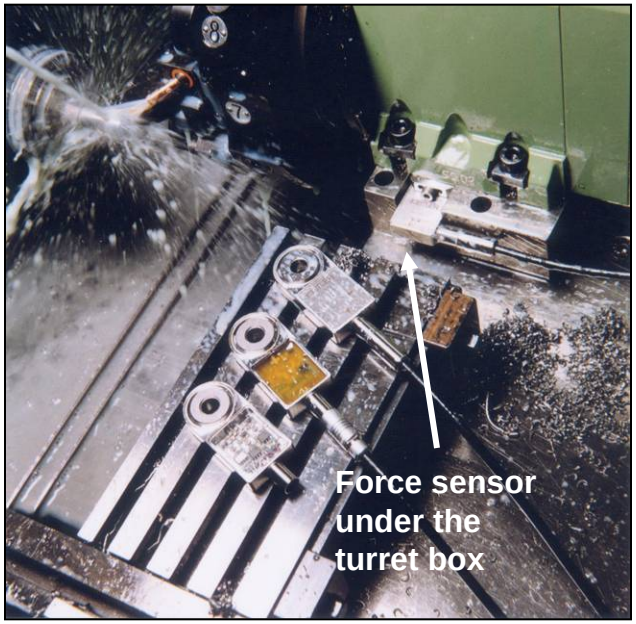
Feed force measurement in multi-spindle drill heads





Piezoelectric 3D force measurement

Installation under the turret box in CNC lathe

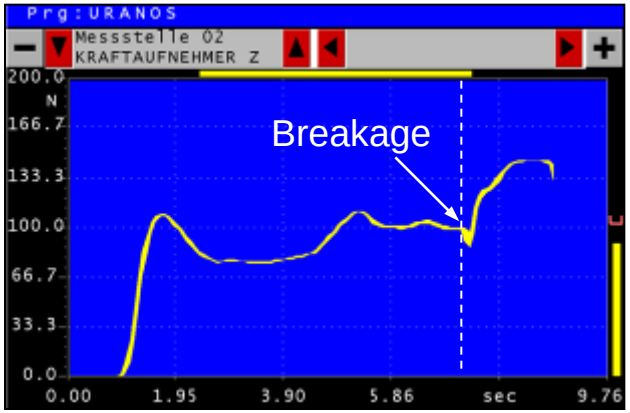


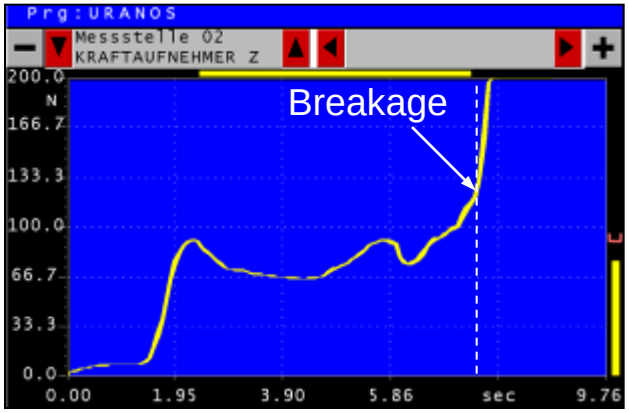
- ✓ Measurement in 3 dimensions increases monitoring security
- ✓ High level of inherent stiffness
- ✓ High degree of measurement sensitivity
- ✓ Integral 3 channel charge amplifier
- ✓ Initial stress via two opposing tensioned wedges

Two measurements to detect breakage during hard turning with force measurement

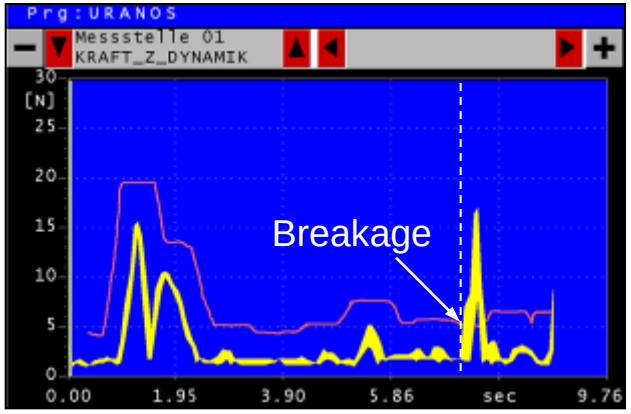
Breakage of two CBN plates with the resulting jump in diameter on the work piece

Passive force

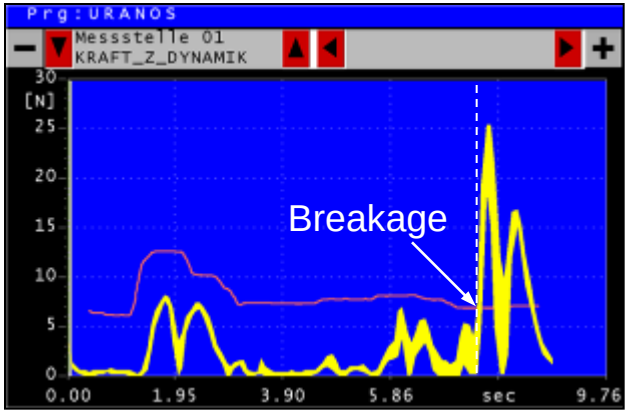




Dynamic portion of the passive force



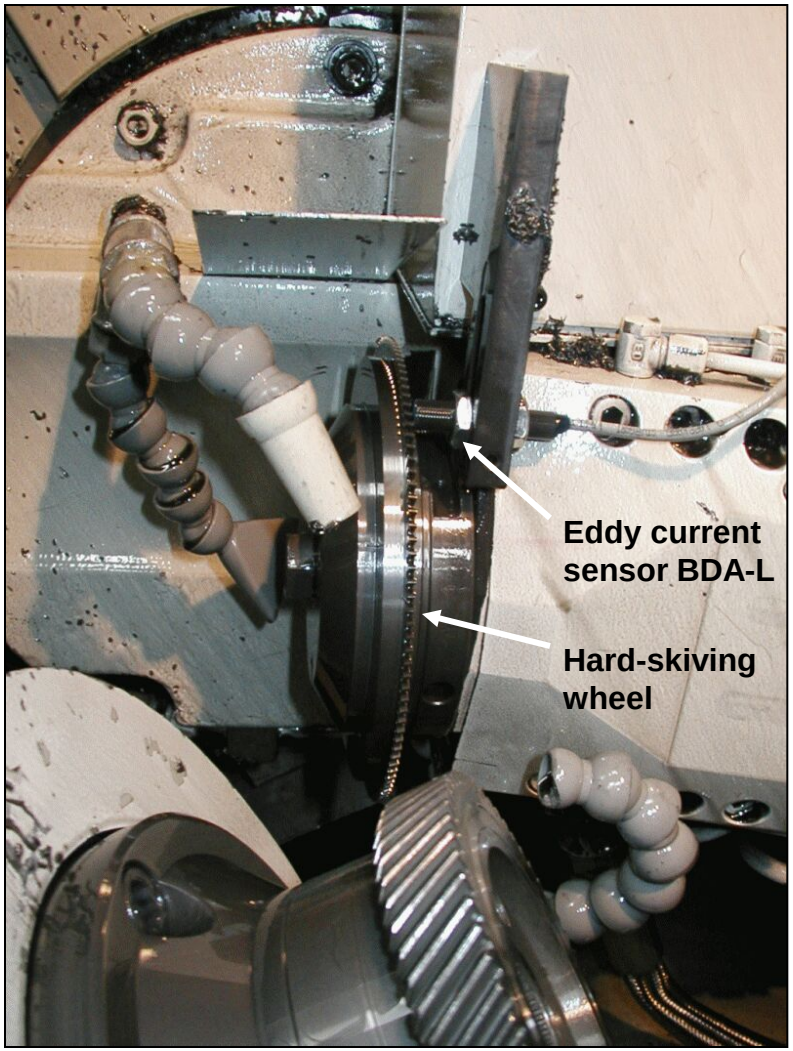
Diameter jumps 7µm (=step of 3.5µm)



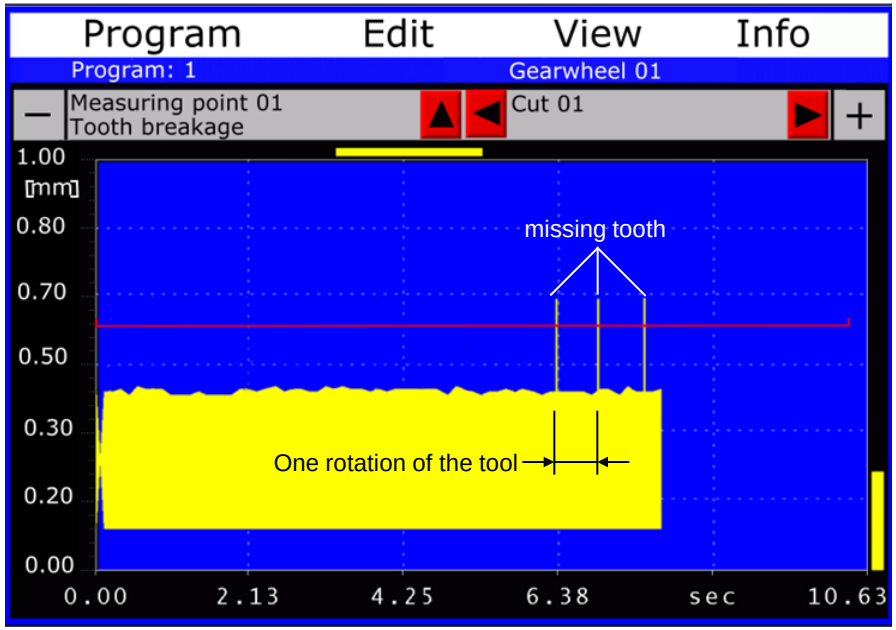
Diameter jumps 10µm (=step of 5µm)

NORDMANN TOOL MONITORING

Tooth breakage control for hard-skiving

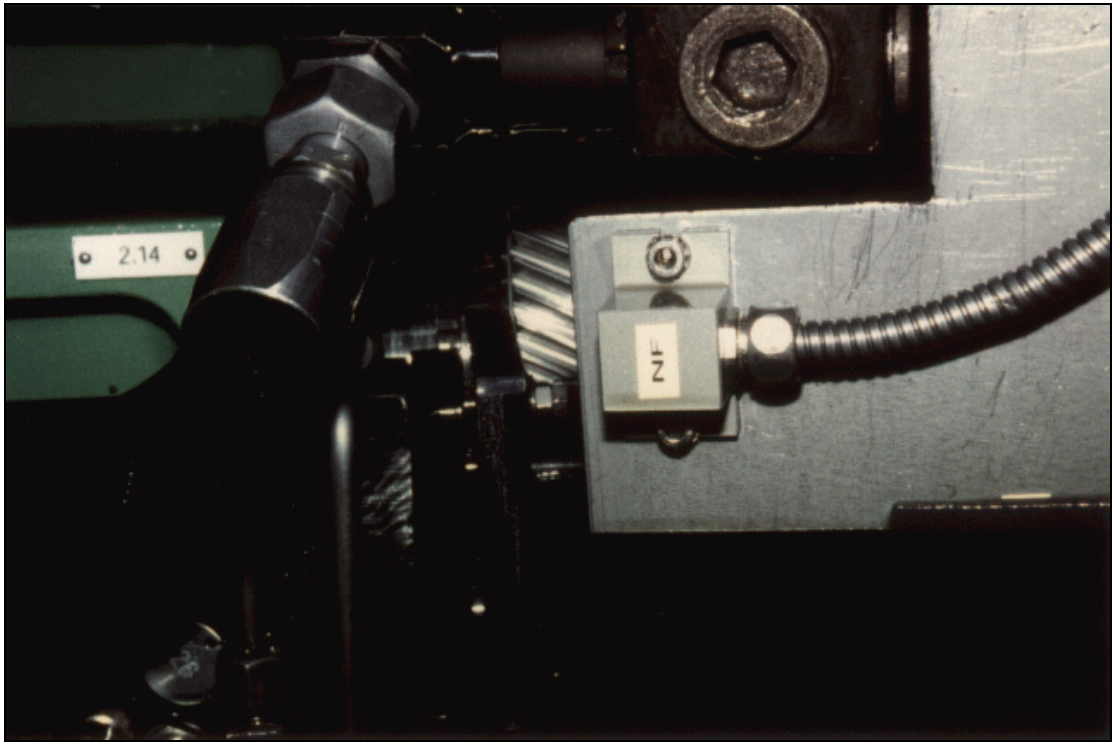


Control of the hard-skiving wheel for tooth breakage with the eddy current sensor BDA-L



NORDMANN TOOL MONITORING

Breakage control for honing on Hurth



Measuring principle:

Control of the crackling noise when the corindon particle impacts on the deflector plate in front and in back of the work piece.

Sensor:

Acoustic emission sensor NF-SEA

Monitor:

SEM-Module or SEM-Profibus

Monitoring and control of gear hobbing and gear grinding

Gear hobbing

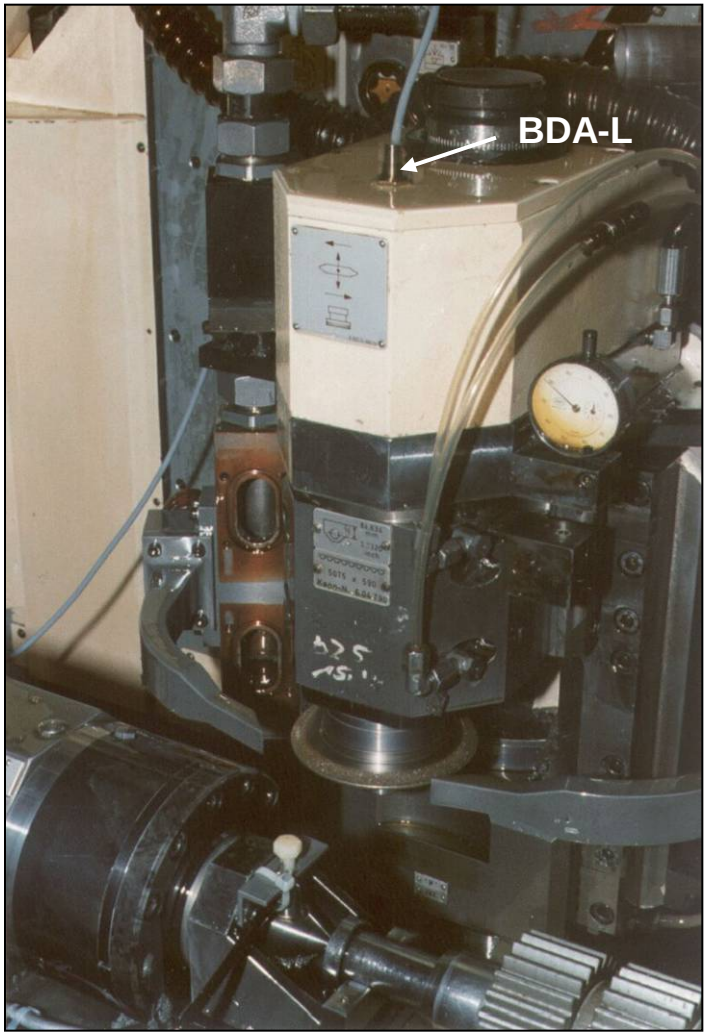
- Detection of wear
- Detection of breakage
- Control of incorrect blank diameter

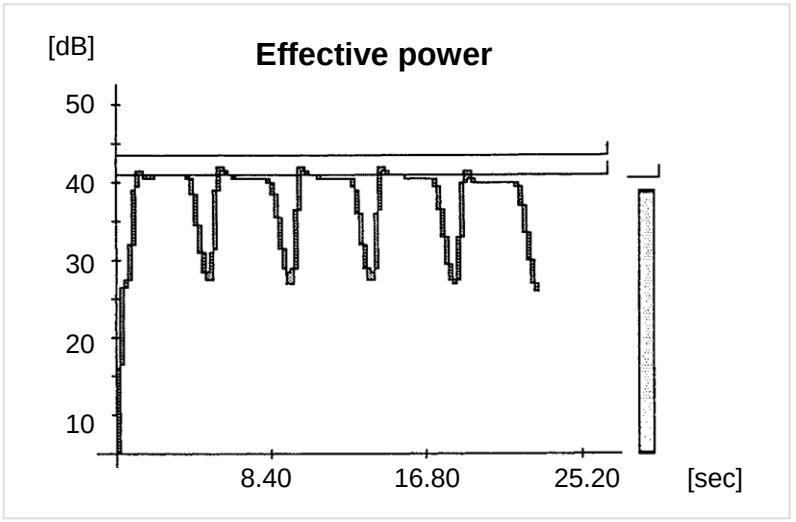
Gear grinding

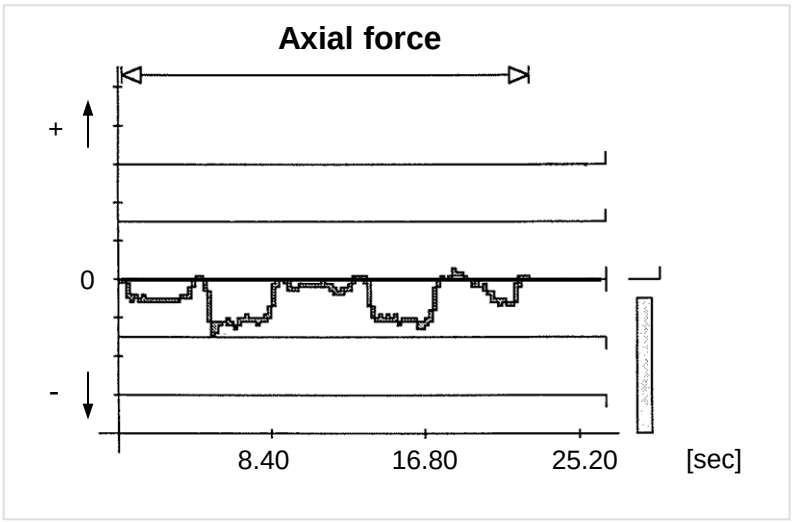
- Detection of wear
- Detection of breakage
- Control of centering
- Control of centering quality
- Avoidance of too high cutting volume
- Reduction in air cutting time
- Touch dressing monitoring

Monitoring for centering, stock to be removed and wear

Grinding 5 work pieces in one clamp

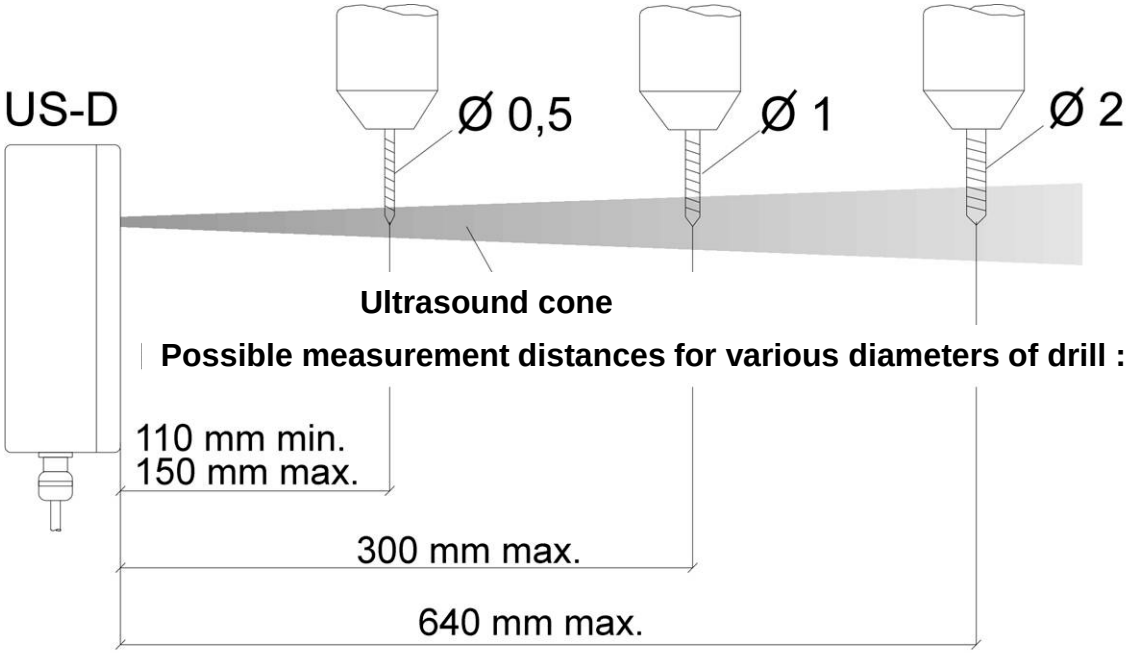






NORDMANN TOOL MONITORING

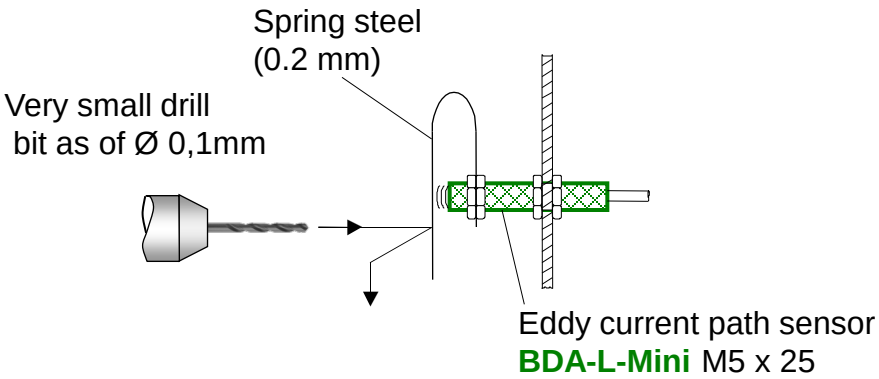
Drill breakage control with the ultrasound distance sensor US-D

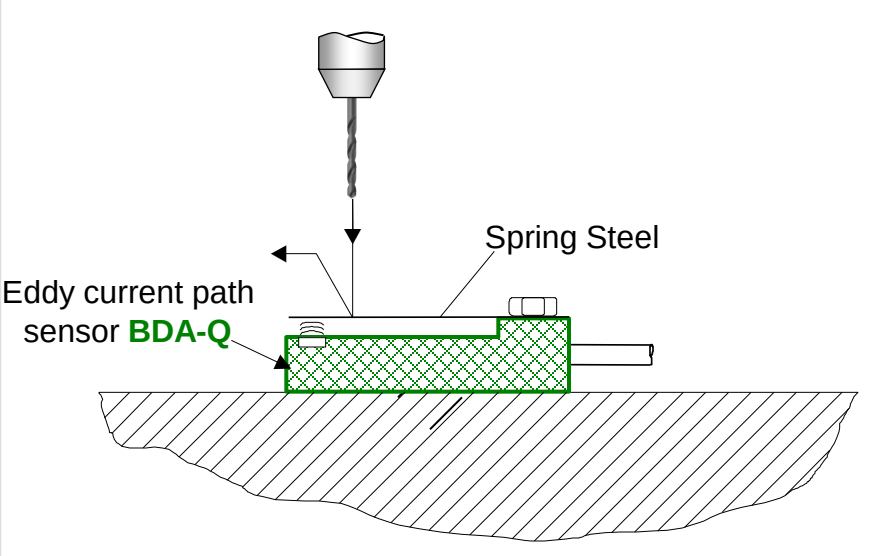


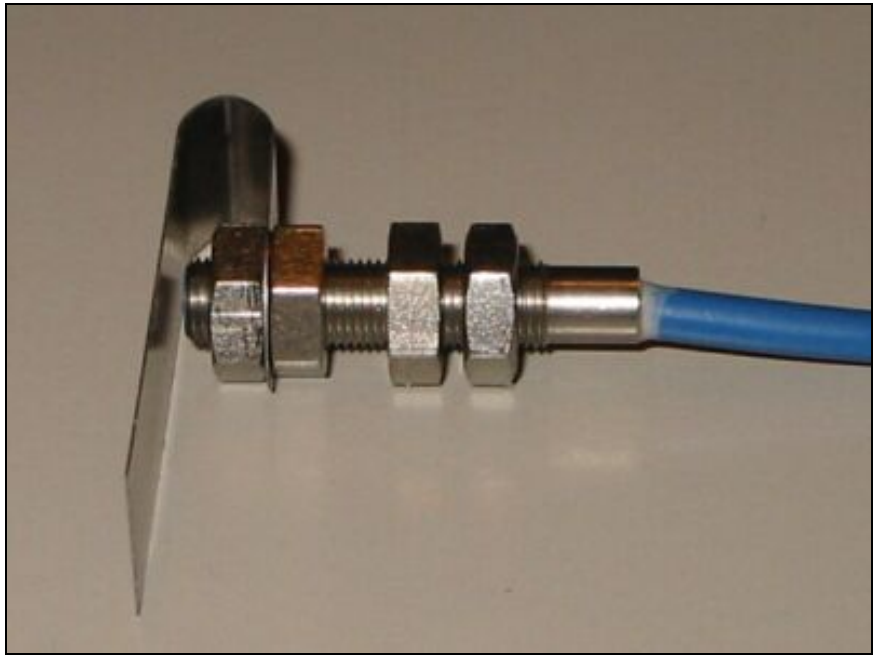
Advantage:

In contrast to the light barrier, only needs to be mounted on one side of the drill.

Tool length control BDA-Feder



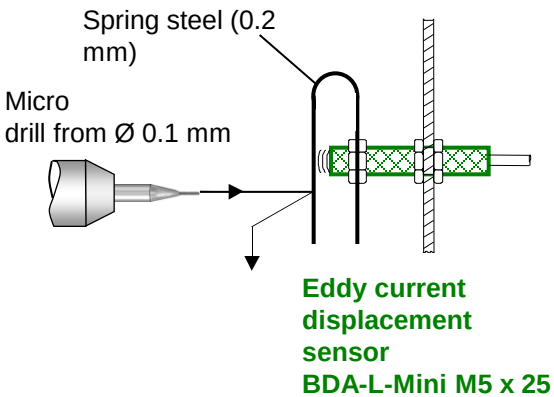




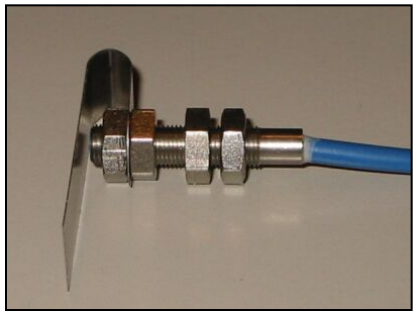
Special features:

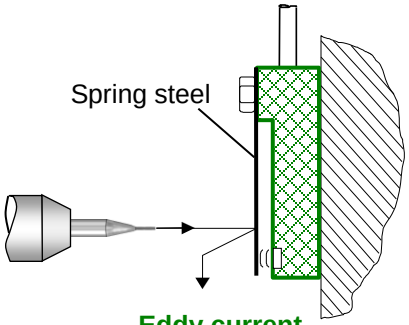
- ✓ Checks very small drill bits as of Ø 0,1mm
- ✓ Checks the drill in the machining center “in passing”, i.e. low test time
- ✓ Resolution in the µ range, i.e. also usable as a tool setter

Tool Length Sensor for Micro Drills

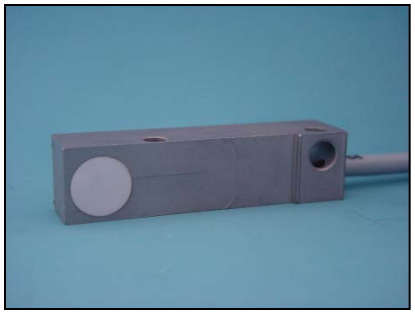


Eddy current displacement sensor BDA-L-Mini M5 x 25

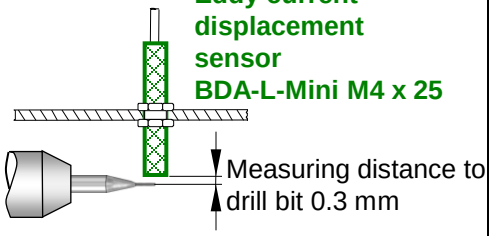




Eddy current displacement sensor BDA-Q



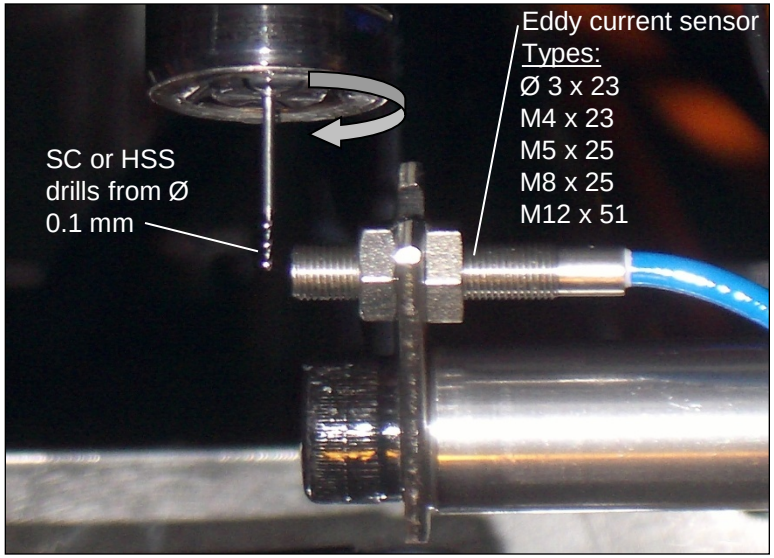
Eddy current displacement sensor BDA-L-Mini M4 x 25



Special features:

- ✓ Checking of micro drills from Ø 0.1 mm
- ✓ Fly-by checking of the drill in machining centers reduces checking periods
- ✓ Resolution in the µ range allows for use as tool setter

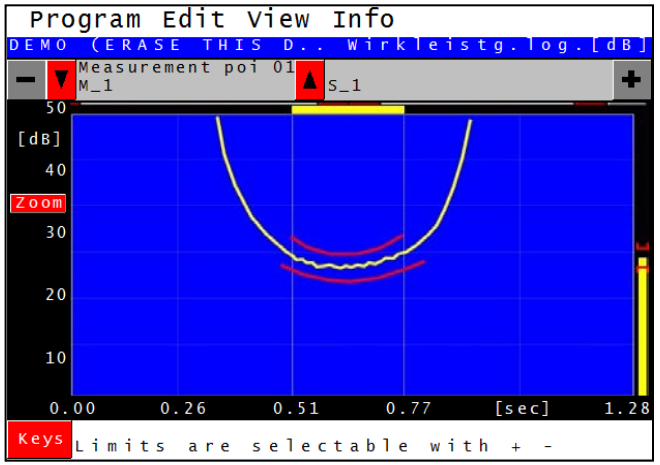
Checking for Breakage, Chipping, Runout, and Cutting Material



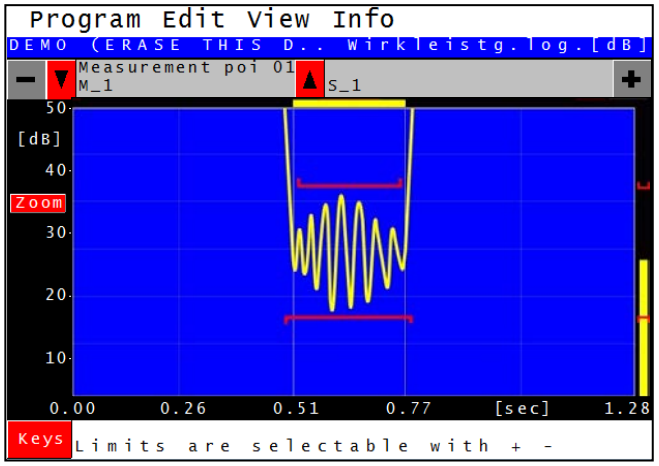
Priciple of measurement:

Checking of the drill bit using an eddy current sensor as the rotating drill passes sideways (e.g. in the machining center on the way to or from the magazine)

Measurement curve for checking for breakage, chipping, cutting material (HSS, SC)

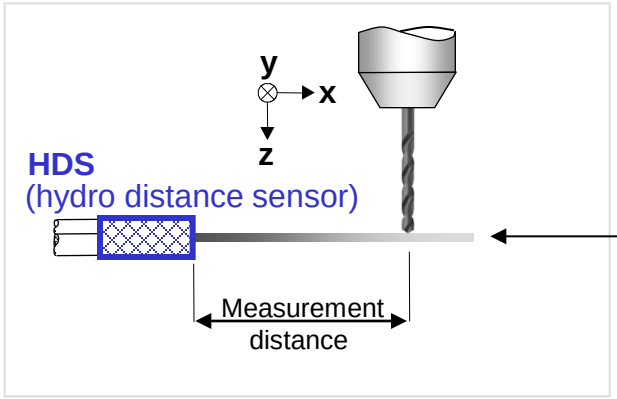


Measurement curve (dynamic portion) for runout control



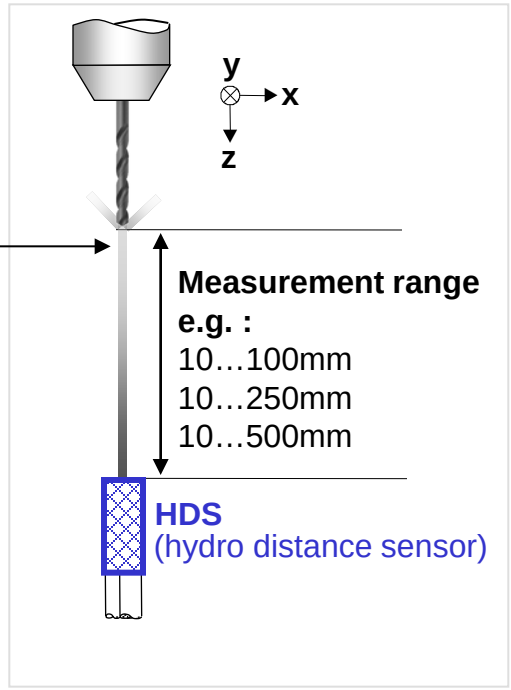
Hydro distance sensor HDS: Example for use in drill breakage control

Measurement transverse to drill (x or y direction)



Jet of cooling lubricant

Measurement axial to the drill (z direction)

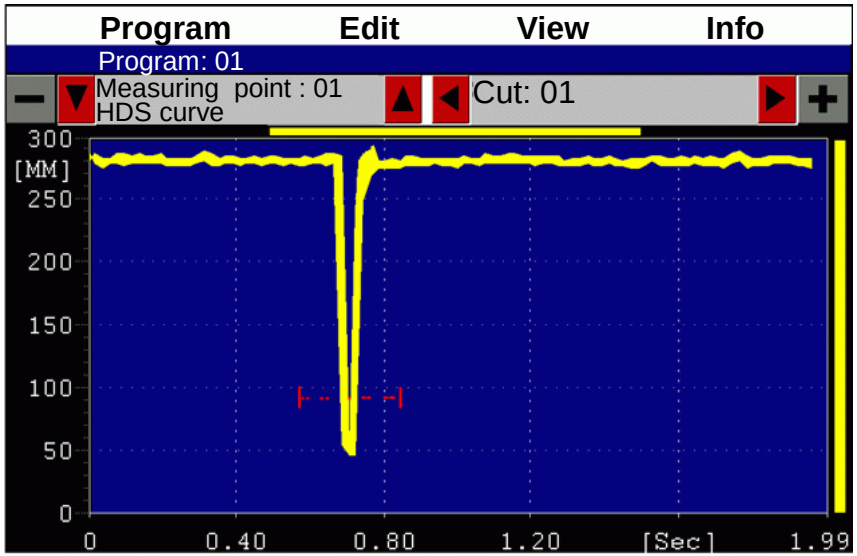


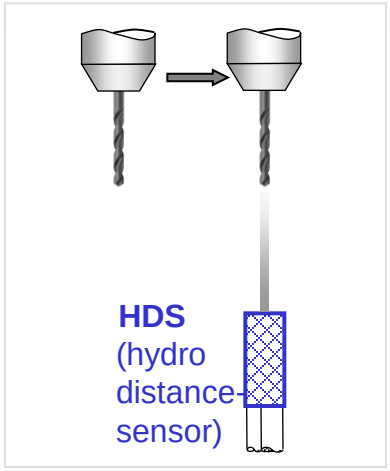
Special features:

- ✓ Supplies a proportional measured value to the tip of the drill as soon as the drill touches the jet
- ✓ Is mounted on only one side of the tool (in contrast to the light barrier)
- ✓ Minimum diameter of the drill Ø 0,1 mm
- ✓ Without mechanical wear
- ✓ Mechanical testing of the work piece in fast motion

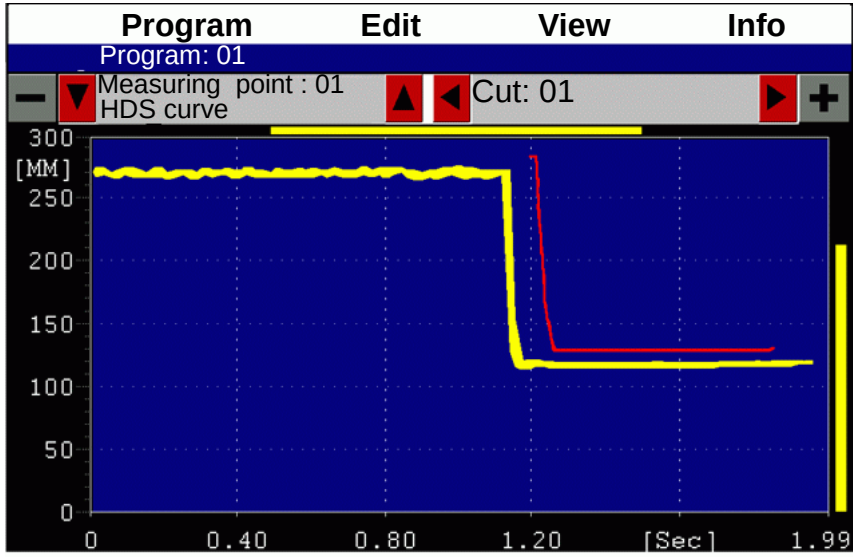
Measured values when testing the tool length with the hydro distance Sensor HDS

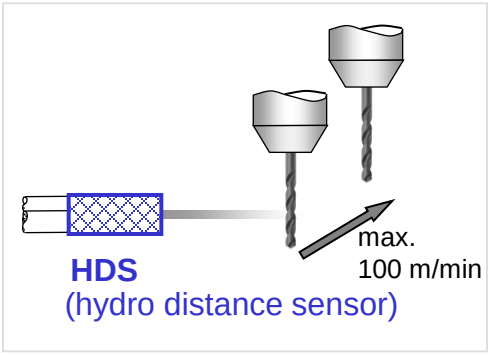
Testing in the magazine with the tool lengthwise





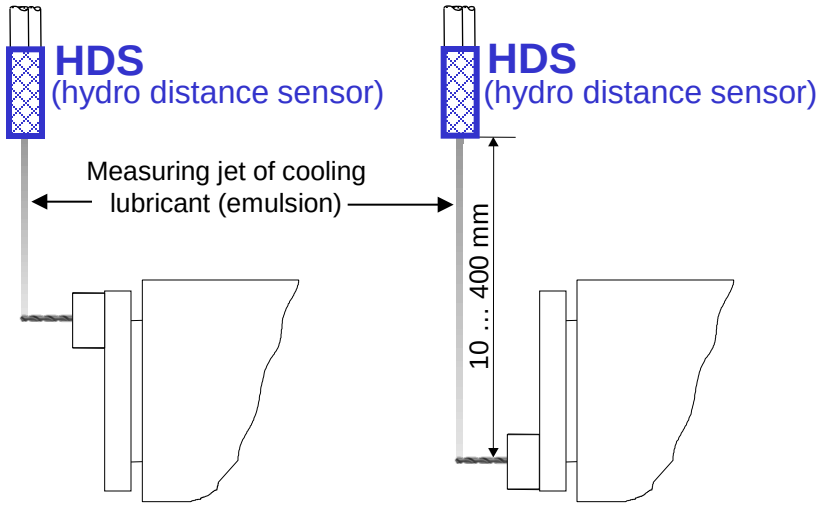
Crossing the test jet with the tool transverse



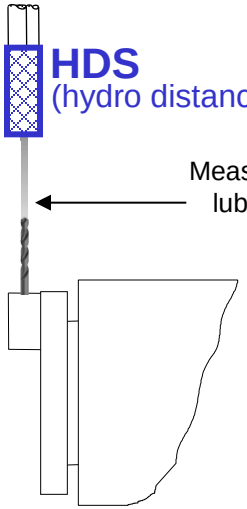


Hydro-Distance sensor HDS:
Application in post-process tool control in CNC lathes

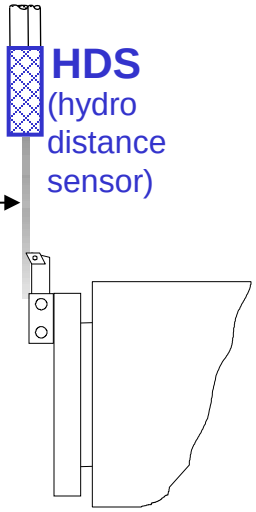
Measurement transverse to the drill above and below the turret box



Measurement axial to the drill



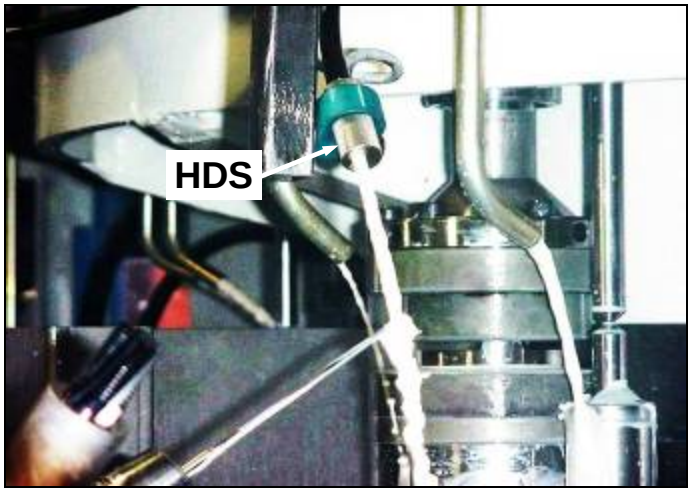
Measurement on the lathe tool (grazing cutter edge)



NORDMANN TOOL MONITORING

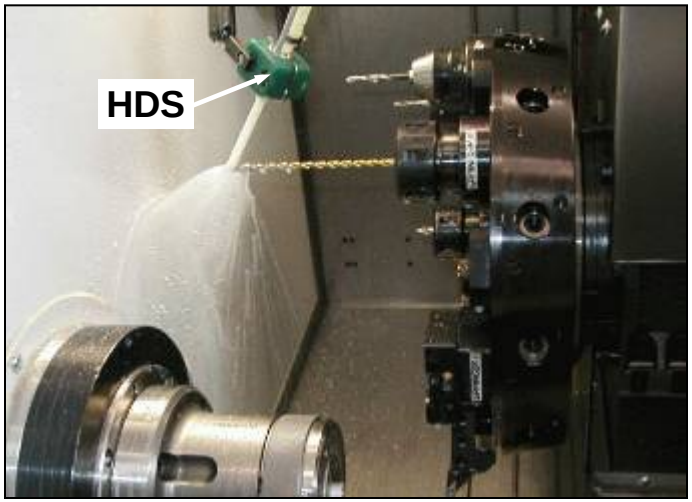
Tool length control with the Hydro-Distance sensor HDS

Rotary transfer machine

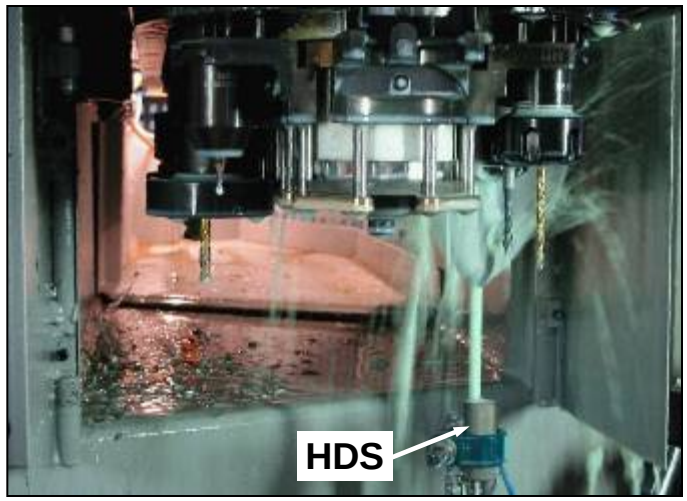


Machining center

CNC lathe

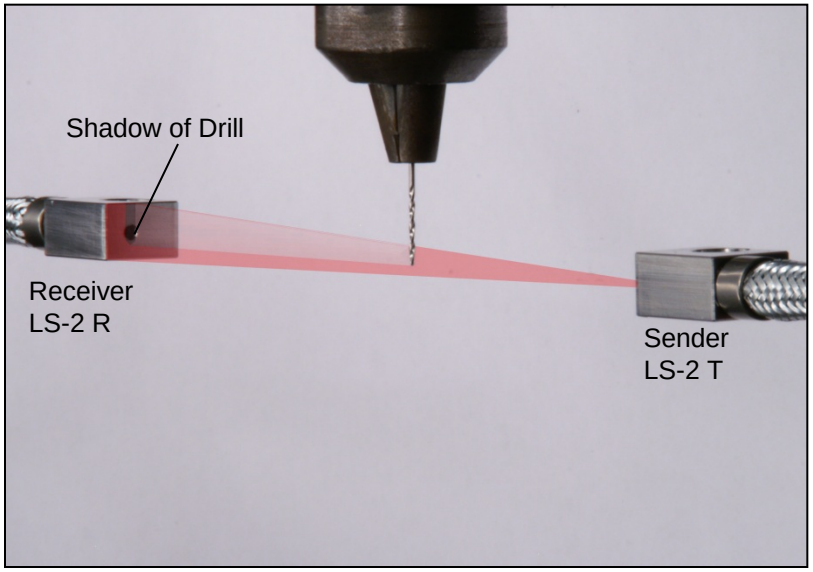


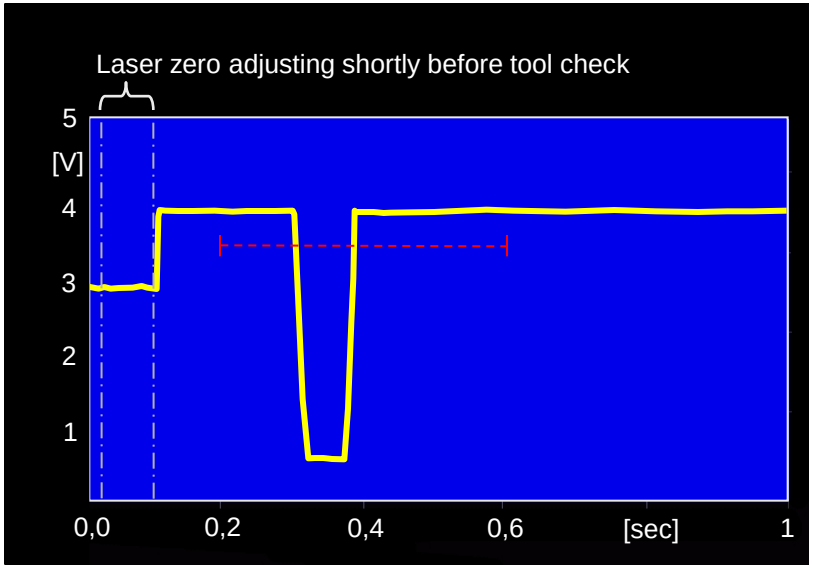
Tool magazine in machining center



NORDMANN TOOL MONITORING

Broken Tool Laser Detection LS-2



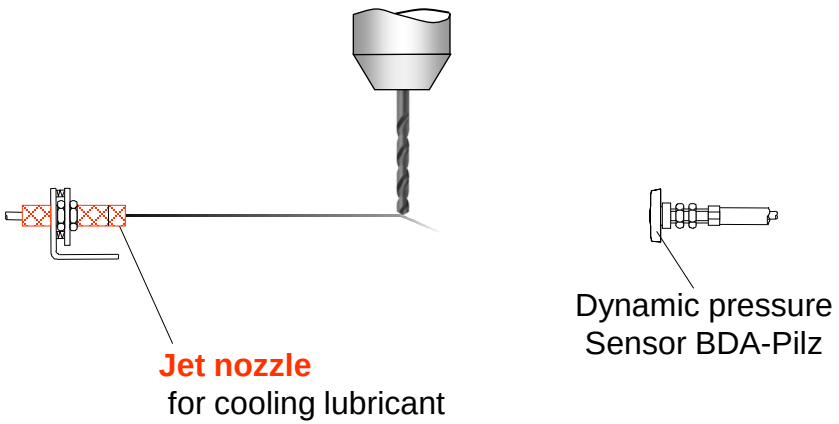


Besondere Eigenschaften:

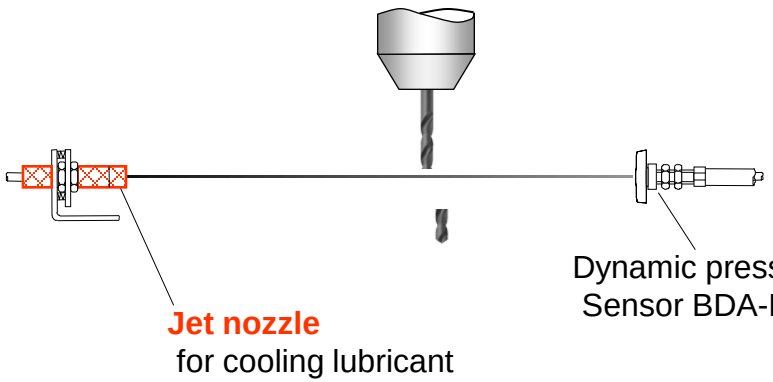
- Non focused laser beam insensitive to contamination
- Non compressed air or air controls required for cleaning or operation
- Uneffectedby ambient light (artifical or natural light)
- Installs in tight space. Sender and receiver each less than 15 mm x 10 mm x 20 mm (.600“ x .400“ x . 800“)
- A non contact option for drills, taps, reamers and end mills on lathes and machining centers

Drill breakage control with a barrier jet of cooling lubricant

Drill OK



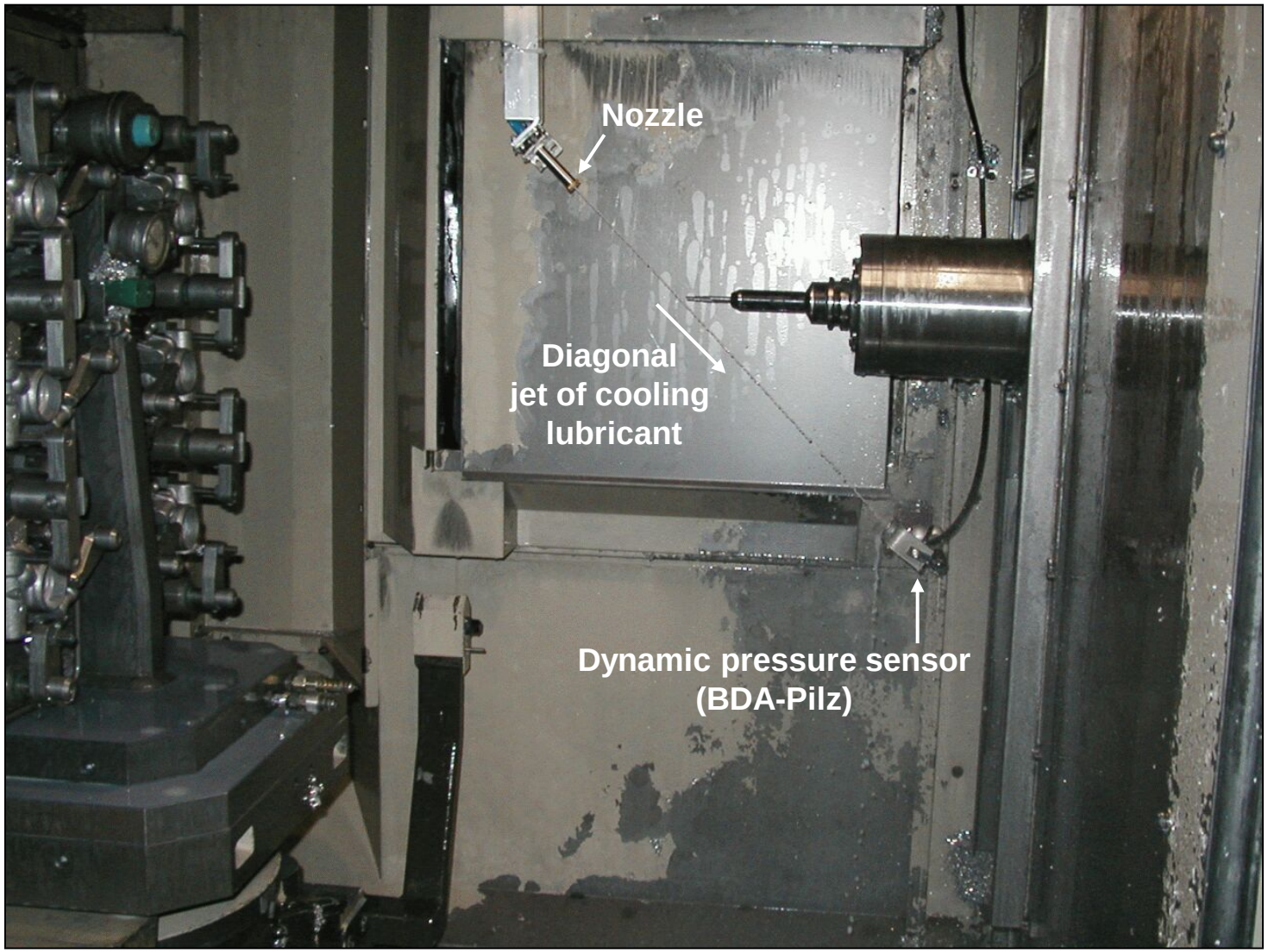
Drill broken or not in test jet



Special features:

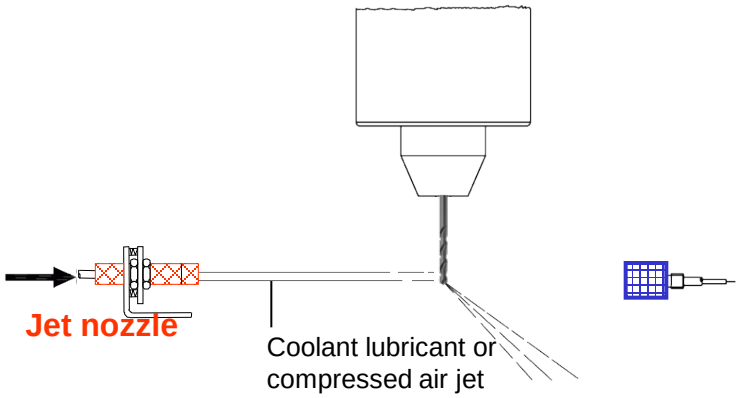
- ✓ Simple installation
- ✓ Free of wear and insensitive to dirt
- ✓ No disturbing test wire in the work space
- ✓ Very small drills from Ø 0.1mm can be checked
- ✓ Is not disturbed by the cooling lubricant leaving the drill
- ✓ Detects the drill even while passing through the test jet in rapid travel (up to 120 m/min)

Tool length control with the jet of cooling lubricant as barrier

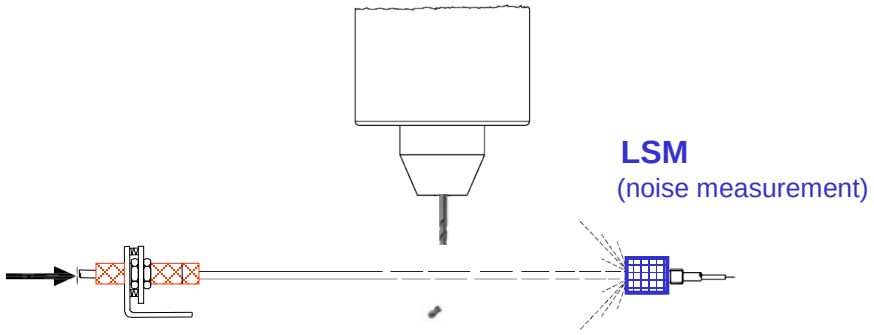


Jet barriers with measurement of impact noise at the sensor

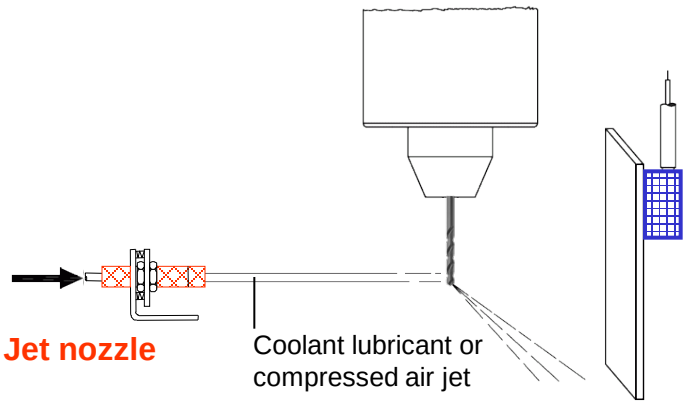
Drill OK



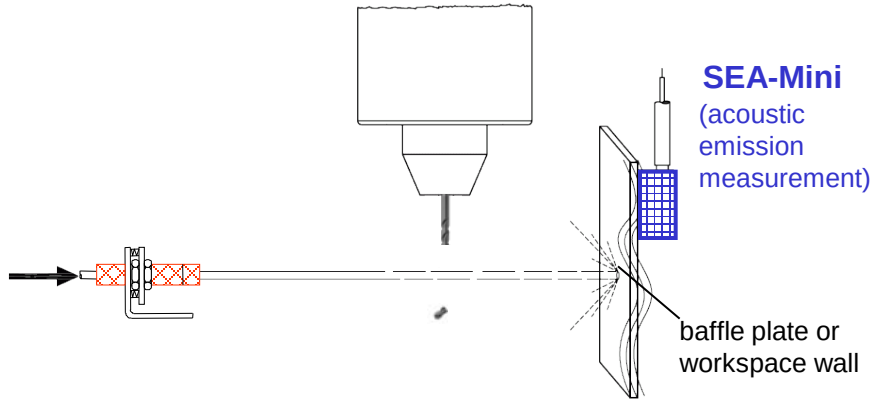
Drill broken or not in test jet



Drill OK



Drill broken or not in test jet

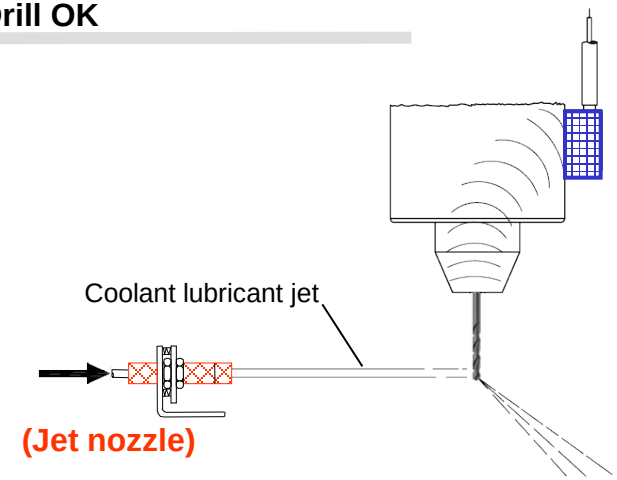


Applications

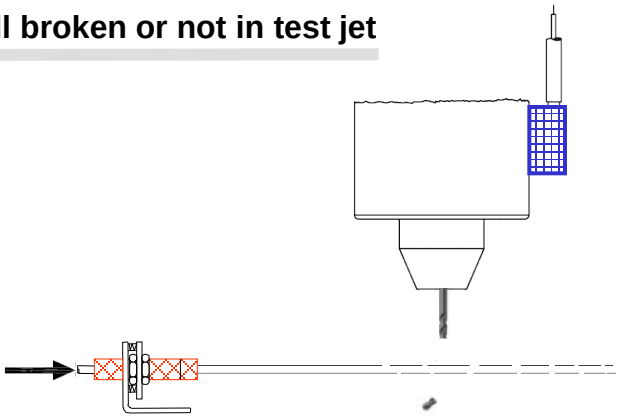
- Tool breakage detection directly after chipping including for miniature tools from Ø 0,1mm up
- Check for correct insertion of workpieces in turning centres
  (checking whether the workpiece inserted is still in the path of the jet)

Jet barriers with measurement of impact noise at the tool (or workpiece)

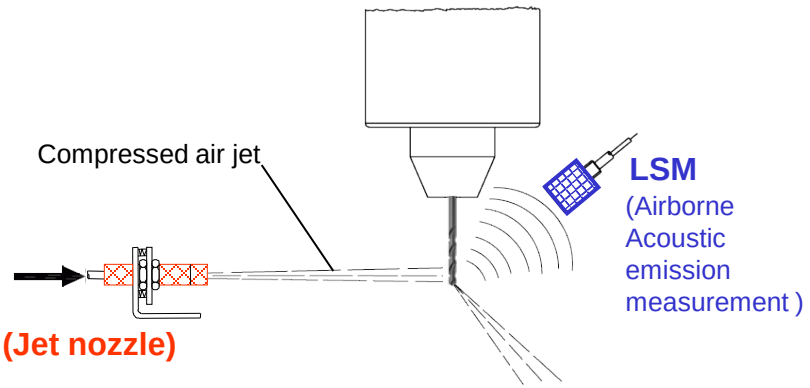
Drill OK



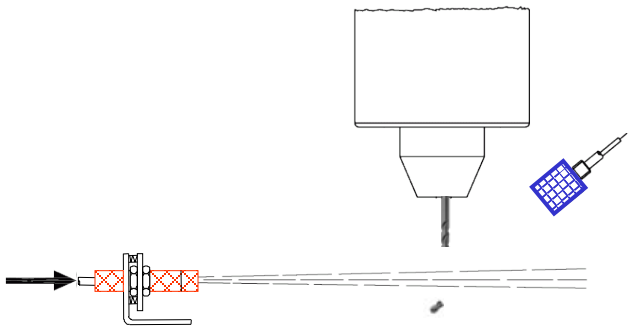
Drill broken or not in test jet



Drill OK



Drill broken or not in test jet



Applications

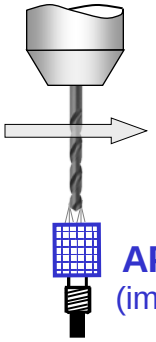
- Tool breakage detection immediately after chipping
- Check for correct insertion of workpieces in turning centres
  (checking whether the workpiece inserted is still in the path of the jet)

NORDMANN TOOL MONITORING

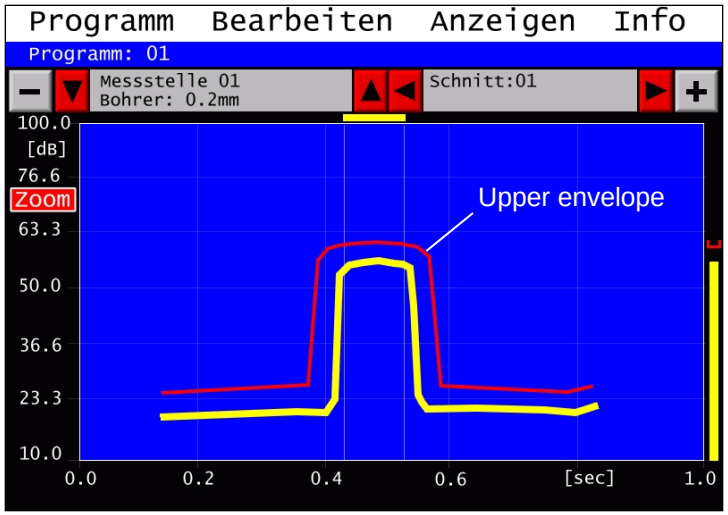
Using the Impact Noise of the Internal Cooling for Drill Breakage Detection

Drill OK

Impact noise measurement
with APS-L or SEA spring

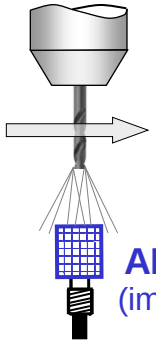


APS-L
(impact sensor)

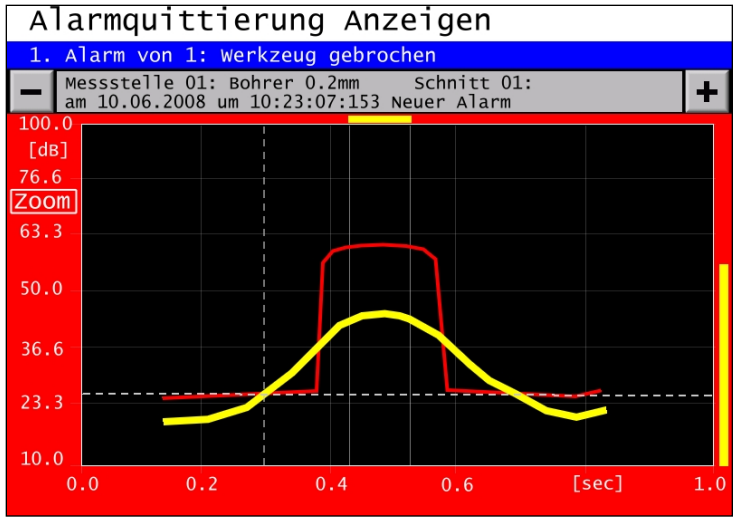


Drill broken

Detection of drill breakage
via the wider time course
of the impact noise
when passing the sensors

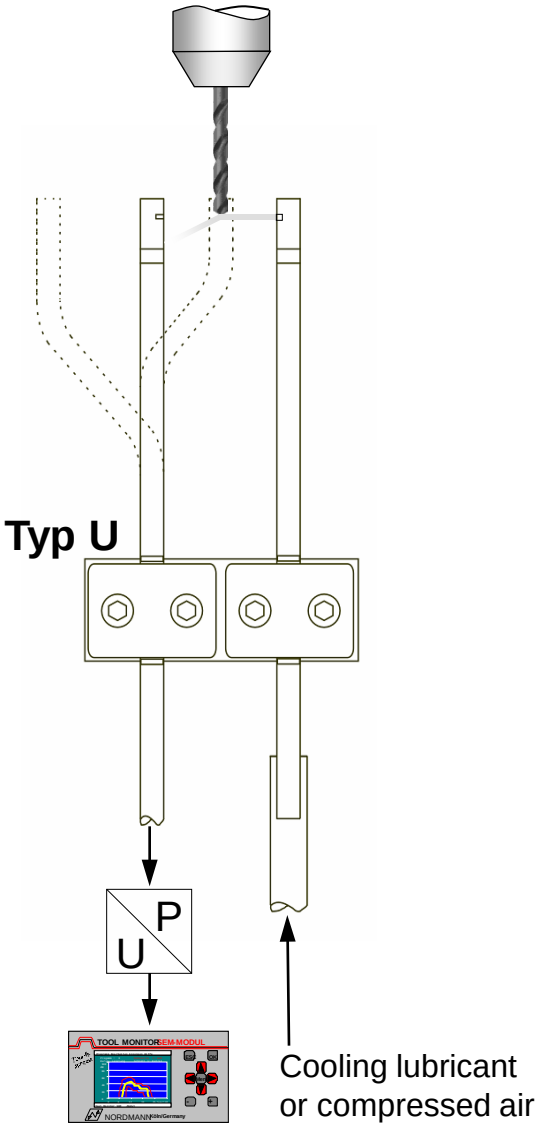


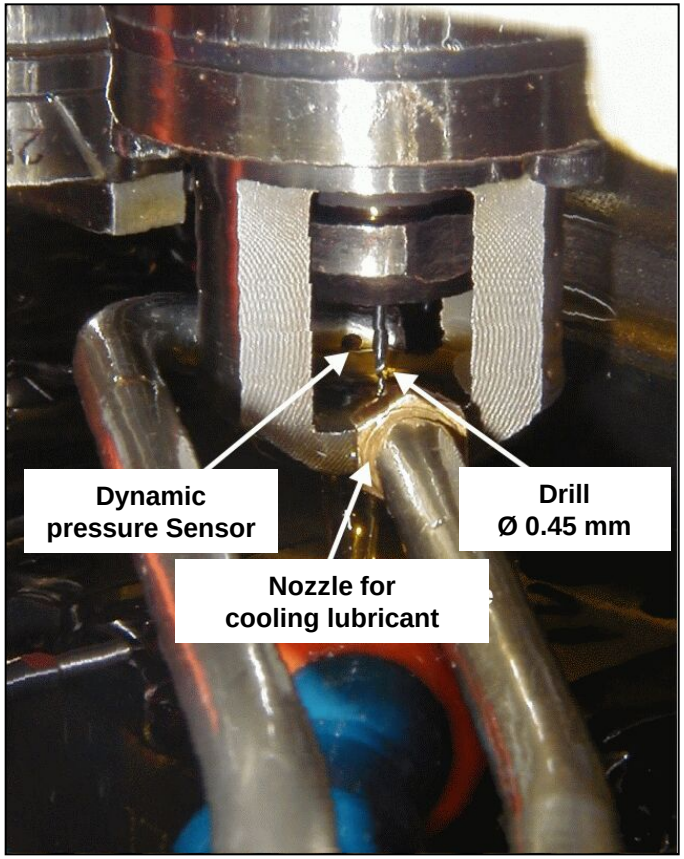
APS-L
(impact sensor)

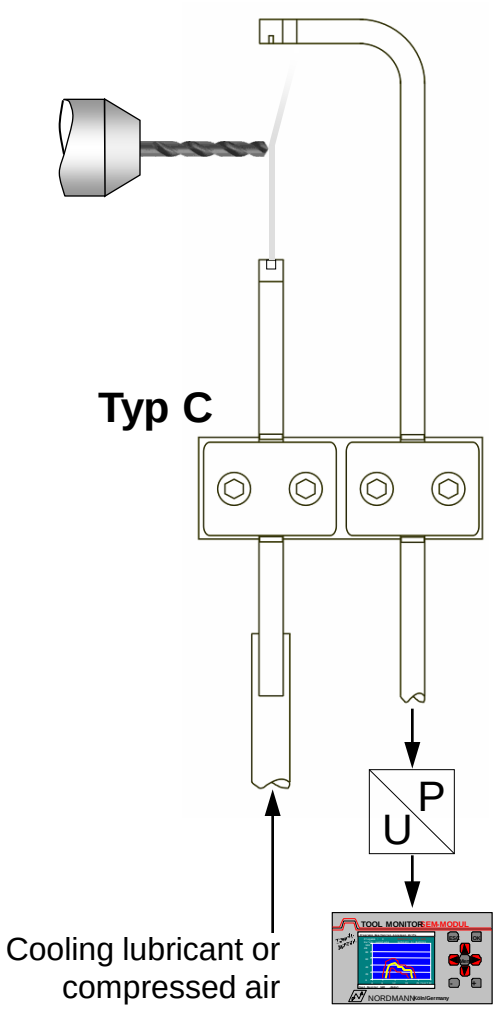


NORDMANN TOOL MONITORING

Dynamic pressure sensor SDS as jet barrier for cooling lubricant or compressed air







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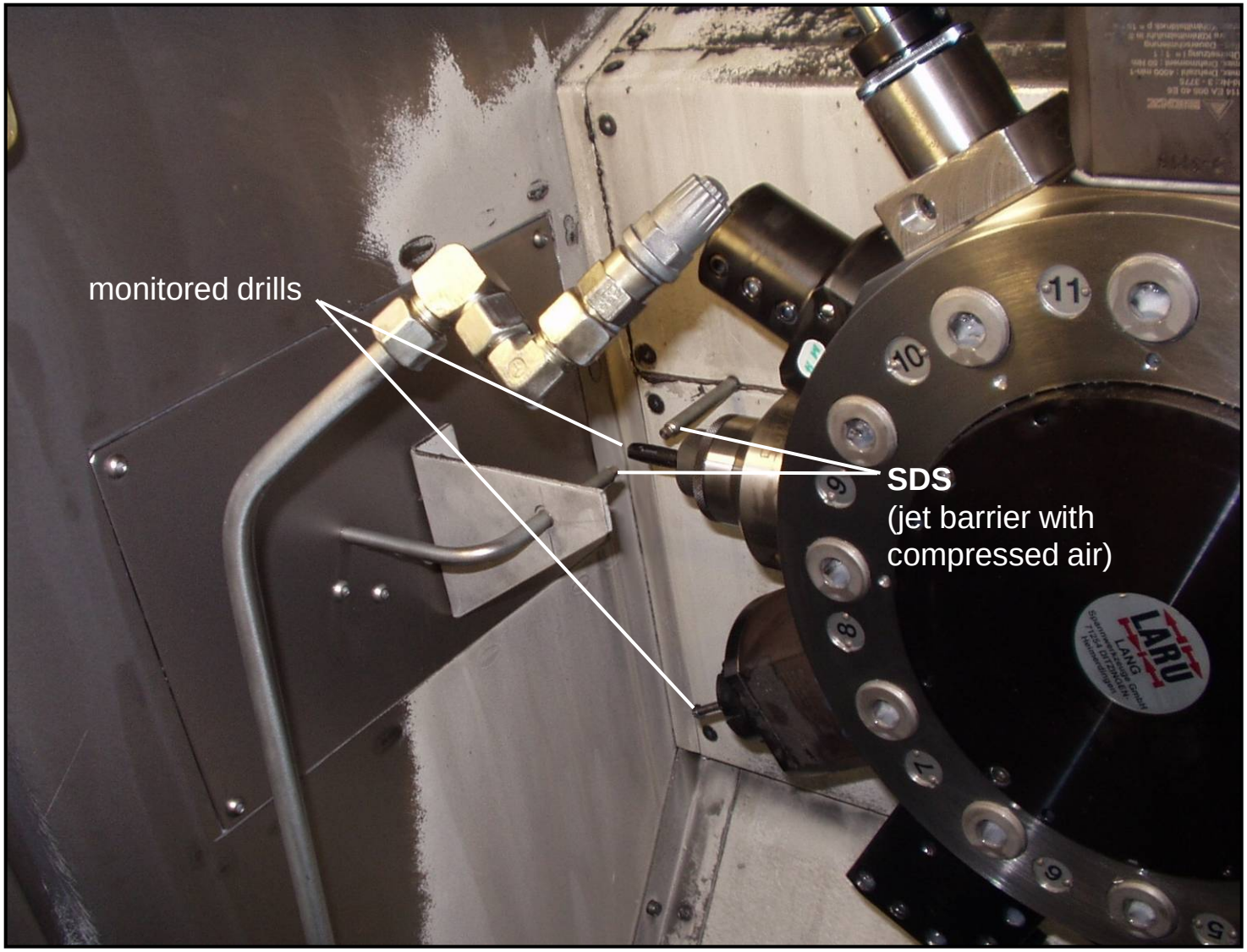
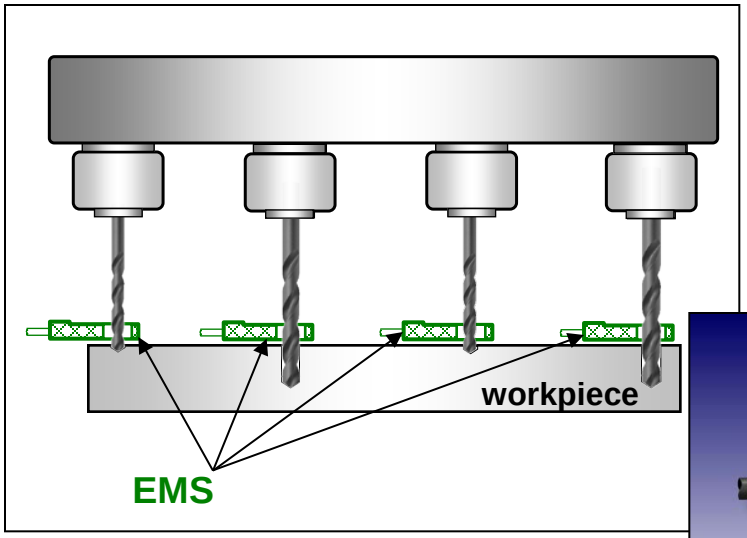
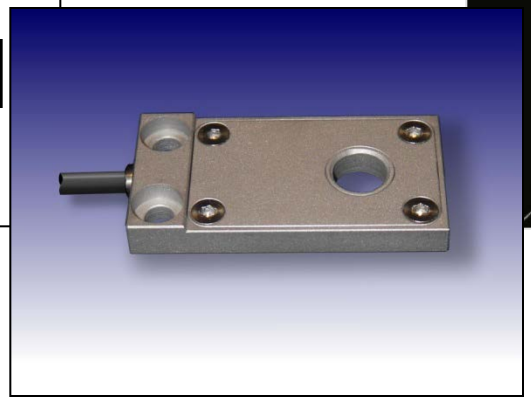
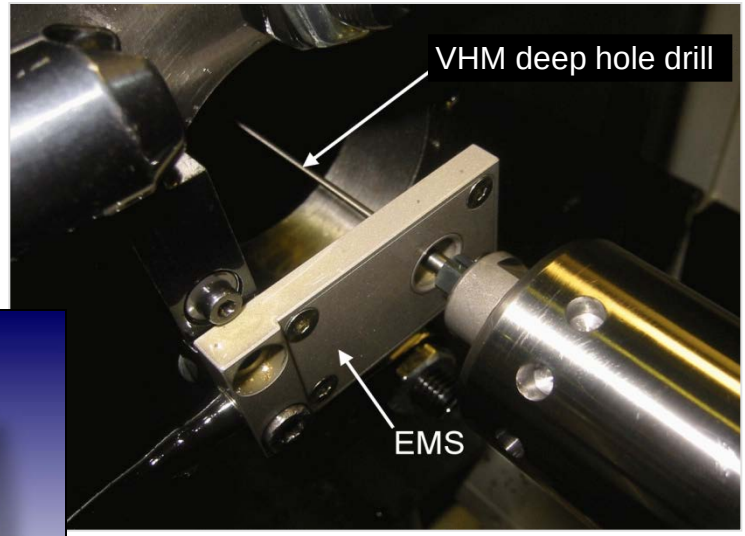
Jet barrier with compressed air



Drill bit breakage check with EMS electromagnetic sensor







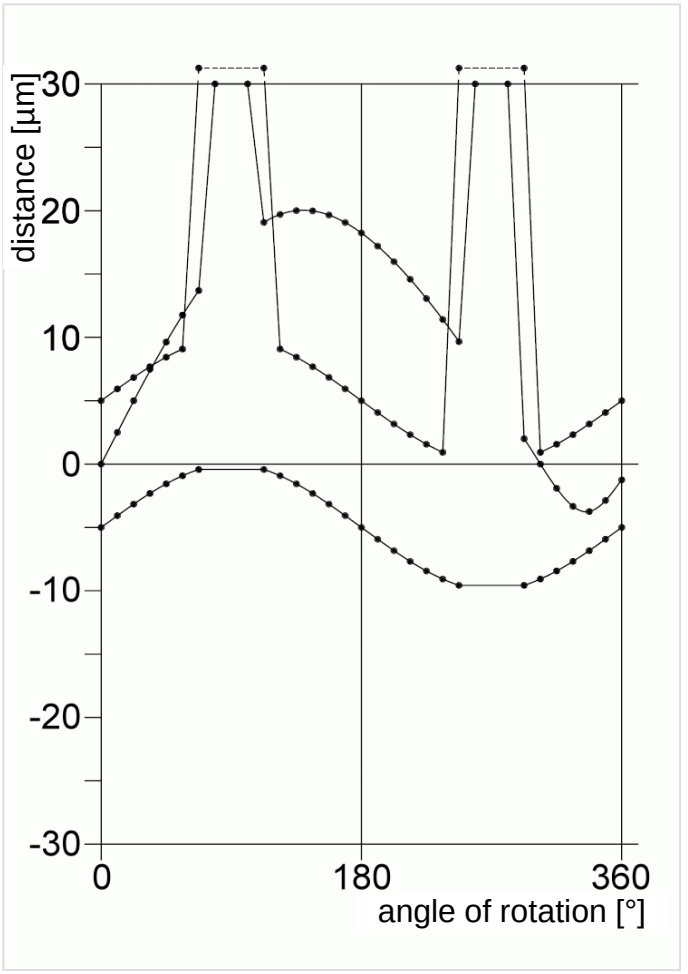
Measurement method / applications

- Version EMS-Dyn:
  Contactless check throughout the entire process of drill bit oscillations during drilling (magneto-elastic effect) to indicate chatter or breakage..
- Version EMS-Ind:
  In addition or also exclusive check of drill tip for presence during drill withdrawal movement (inductance measurement).
  Version: EMS-Ind.
- Up to 24 sensors for 24 drills in a drill head can be connected to a Tool Monitor.

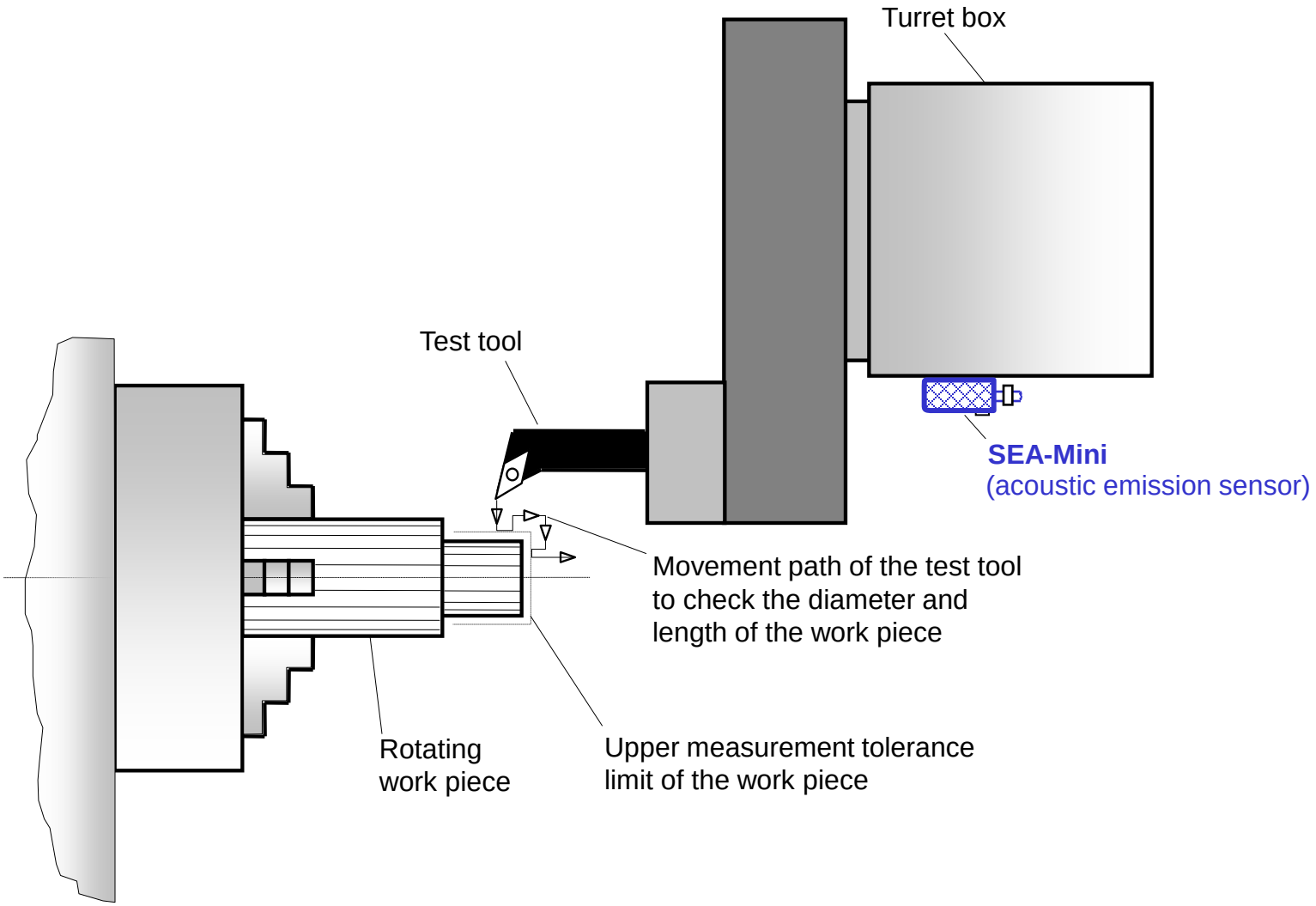
Check for debris (swarf) at the hollow shaft cone

Distance measurement at hollow shaft cone

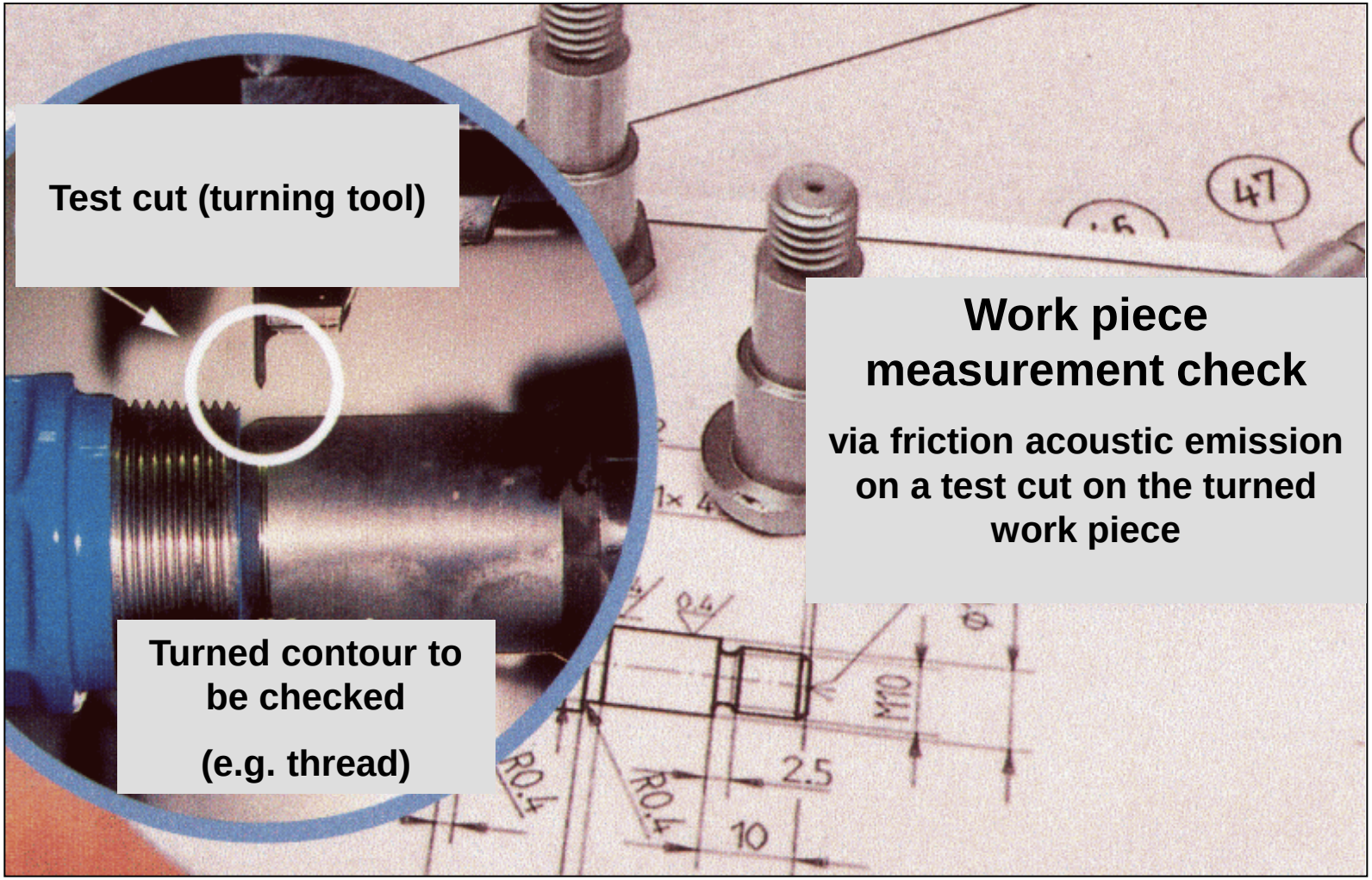
Measurement curve with 20-µm swarf on cone



Principle of acoustic work piece dimension control



Workpiece measurement check (patented procedure) using the example of a thread check



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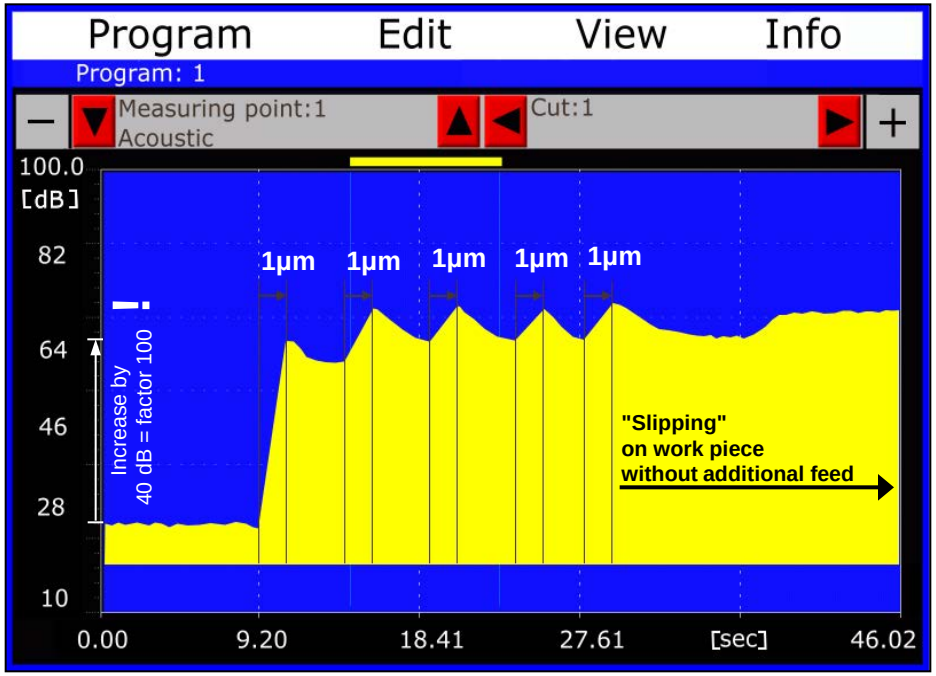
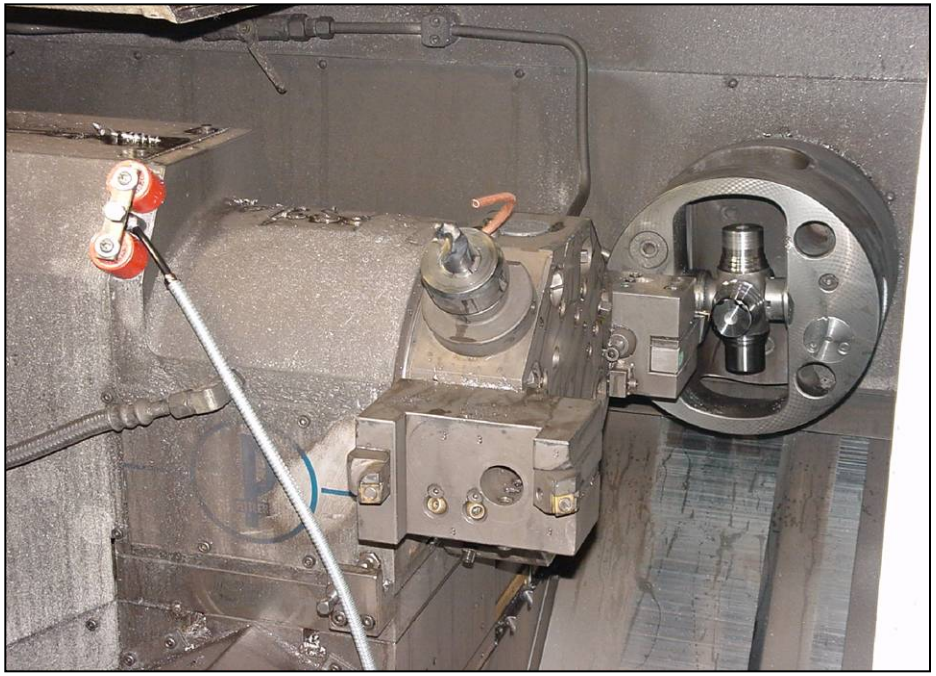
Acoustic work piece dimension control

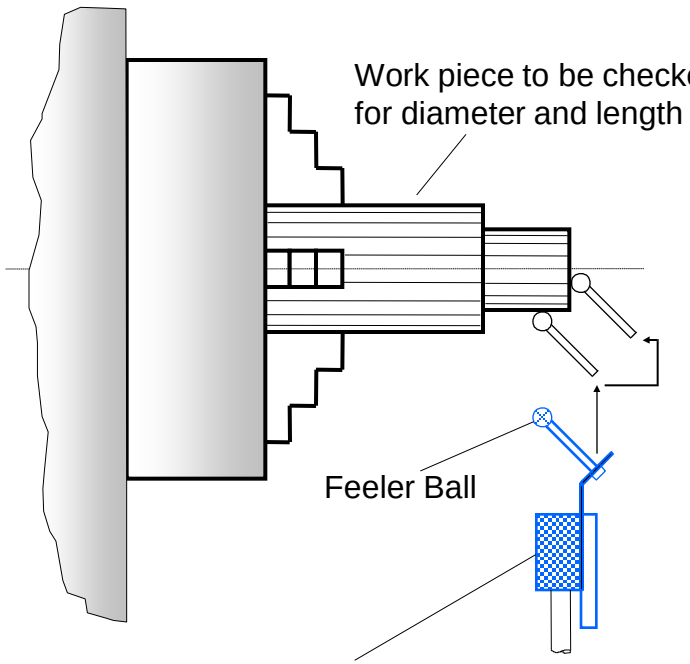
Measured value during scan



Scan in x-direction (lathe tool on rotating work piece)



Work piece dimension control with the acoustic friction sensor RST



Example with
45° sensor

Other versions:
0°, 90°,
various lengths

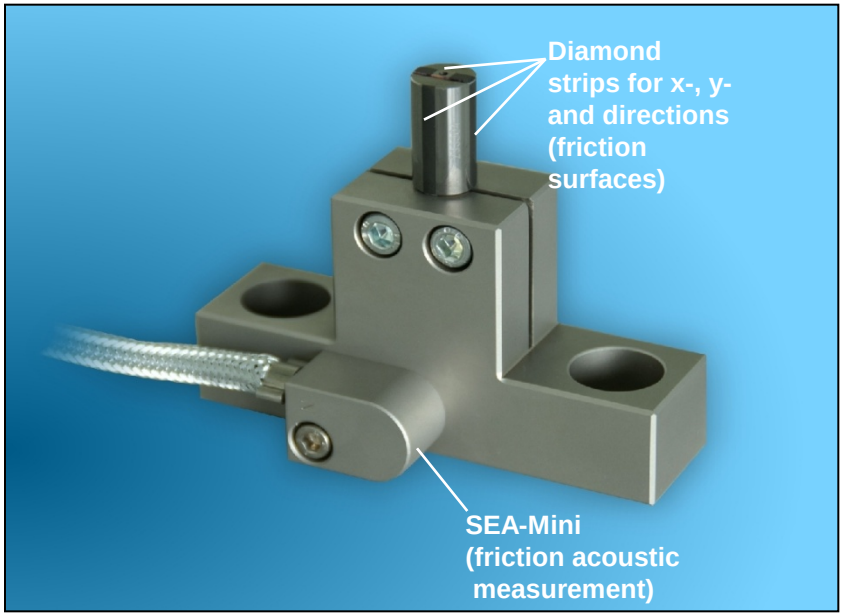
Advantages of acoustic work piece dimension control:

- ✓ Highest possible repetition accuracy (<< 1 µm) since the detection of contact contains no mechanical deflection and requires no mechanical shift process.
- ✓ No impairment through dirt particles on the sensor ball since measurement is made on the rotating work piece.
- ✓ Extremely small drill holes can be tested since no deflection of the sensor rod is required.

Contact elements for micrometer accuracy position finding of rotating tools relative to work piece fixing position

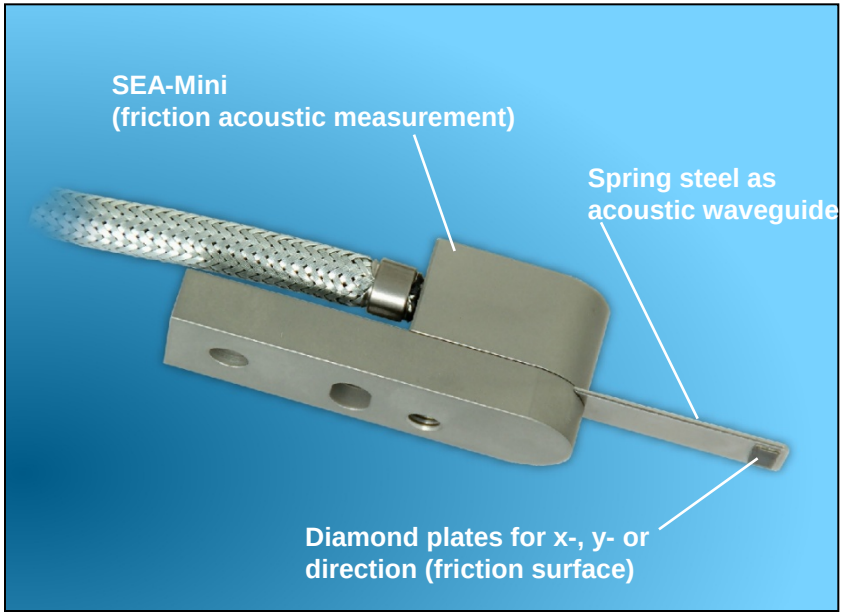
(patentiert)

XYZ contact element



Application: Machining centres

X(Y,Z) contact element



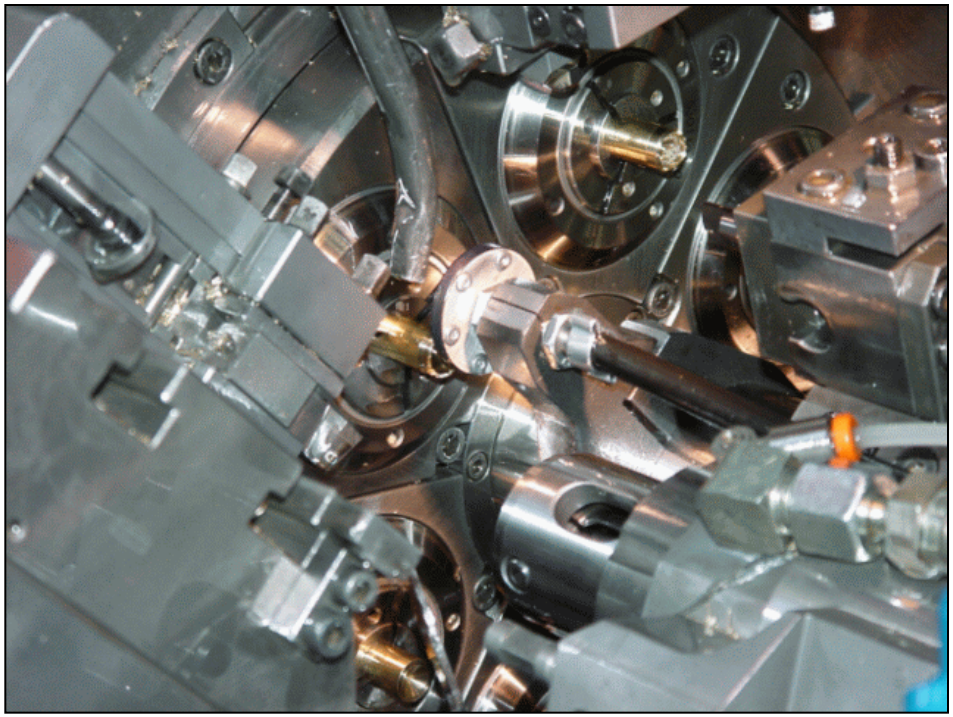
Application: grinding machines (e.g. work piece grinding)

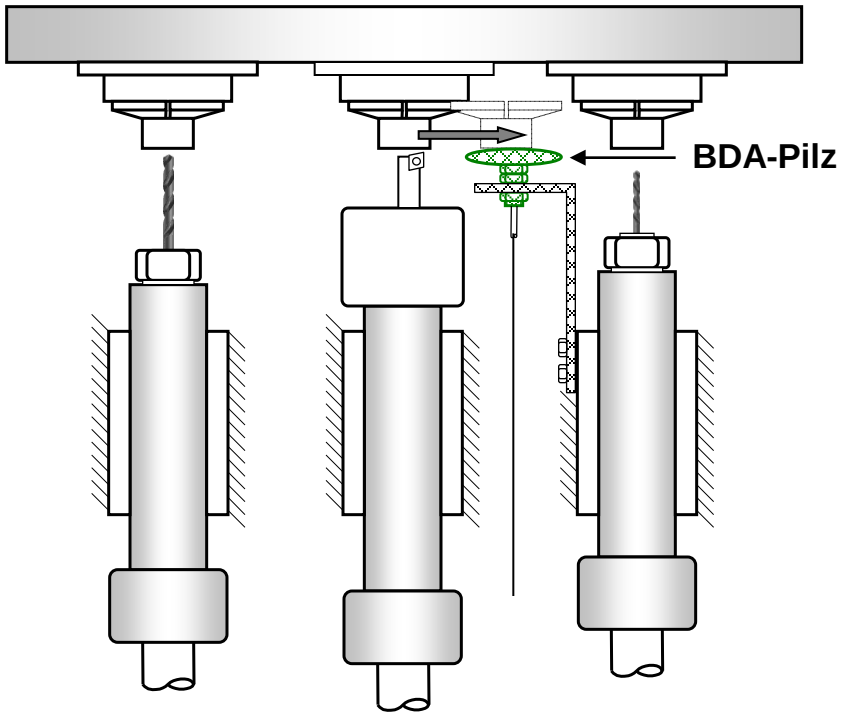
Measurement method: - acoustic detection of contact between rapidly rotating tool and contact surface and contact surface of polished whole diamond (detection of friction noise)

Advantages: - Measurement can take place with fully rotating tool, i.e the effective circle of rotation of outer cutting is detected, whereby the influences of centrifugal force and unbalance are taken into account.

- Measurement tolerance limit ±0.5µm

Work piece length control in multi-spindle automatic lathe using BDA-Pilz





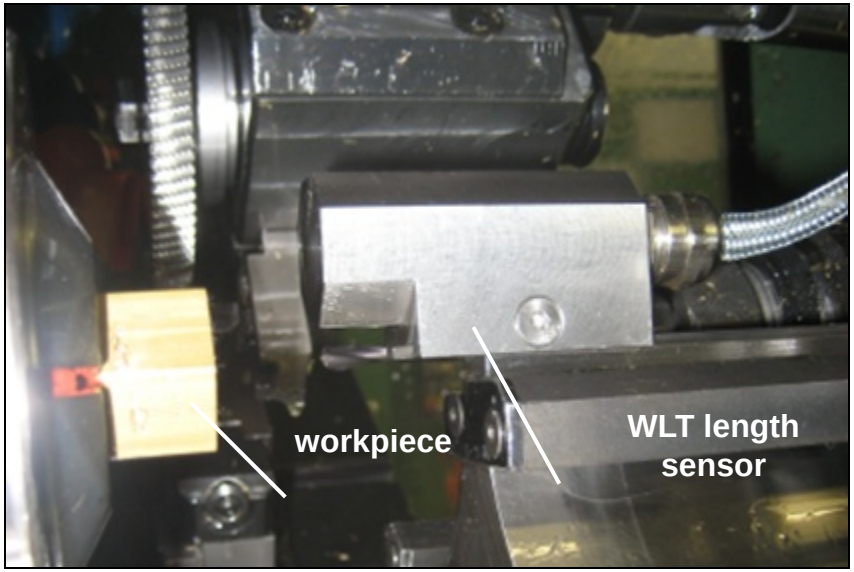
Measurement method:

The work piece length sensor checks the work piece length in the multi-spindle lathe between two sites as the work pieces continues to cycle. The work pieces here touch the convex forward edge of a sprung cap which can move backward accordingly against spring pressure along the work piece length.

Advantages:

- Detects insufficient feed of the bar
- Detects whether work pieces have been pressed into the chuck by machining
- no restriction of rearward spring action due to swarf
- more compact than the WLT length sensor

Work piece length control in the multi-spindle lathe using the WLT length sensor



Measurment method:

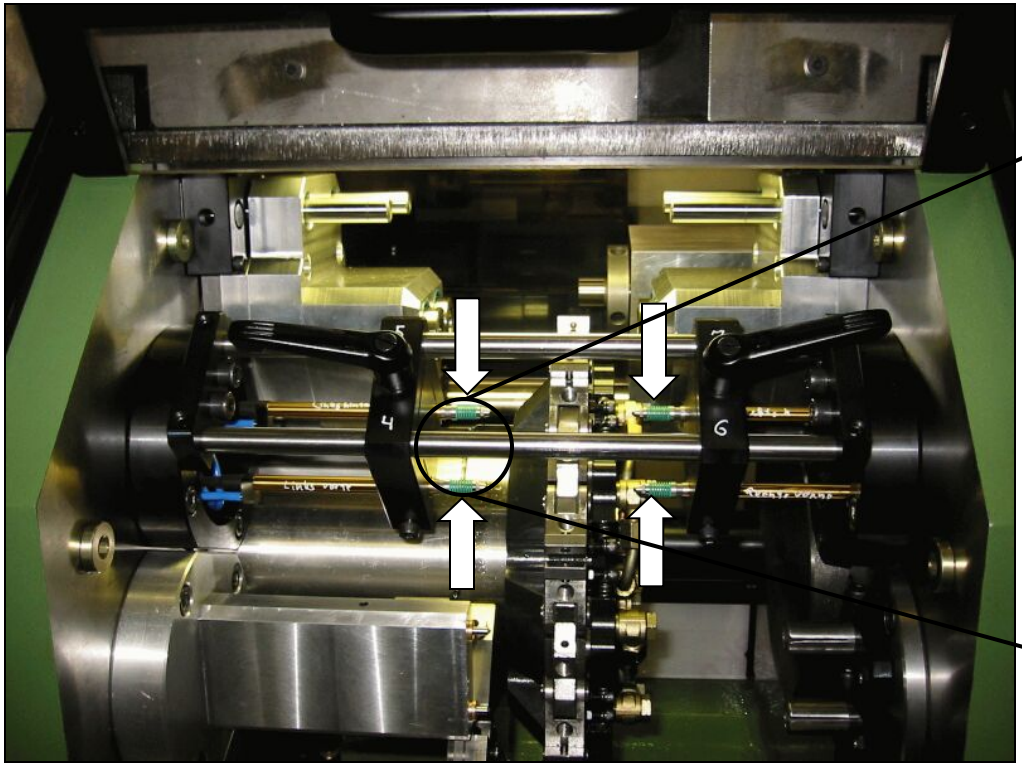
The work piece length sensor checks in the multi-spindle lathe between two sites along the workpiece as workpieces continue to cycle. Here the work pieces touch the convex forward edge of a spring-mounted measuring piston which is pressed backwards accordingly.

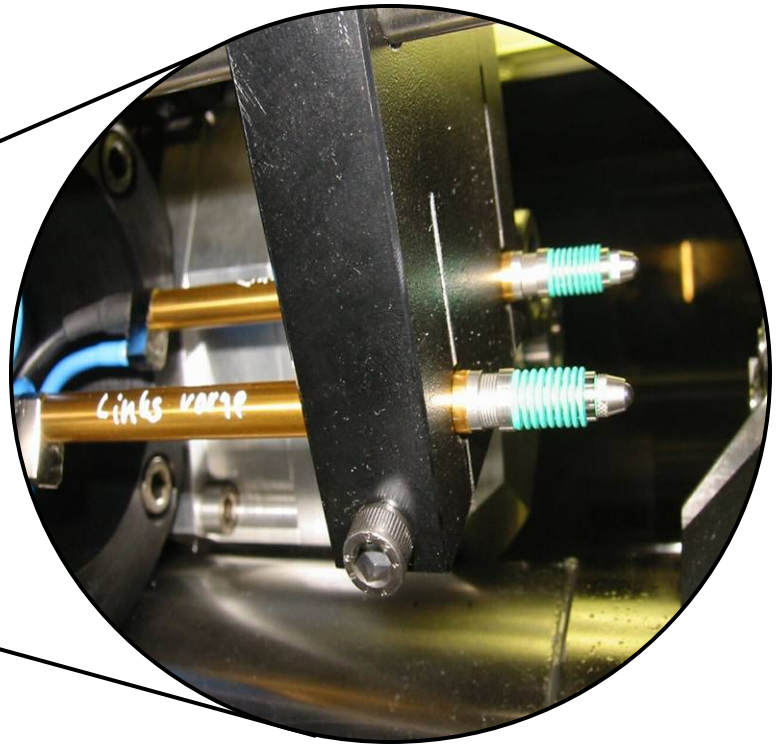
Advantages:

- Detects insufficient feed of the bar
- Detects whether work pieces have been pressed into chuck by machining
- Considerably more robust thand the BDA-Pilz work piece length sensor including specified breakage point in fixing screw
- Easily adjusted to different work piece lengths as mounted on a rail

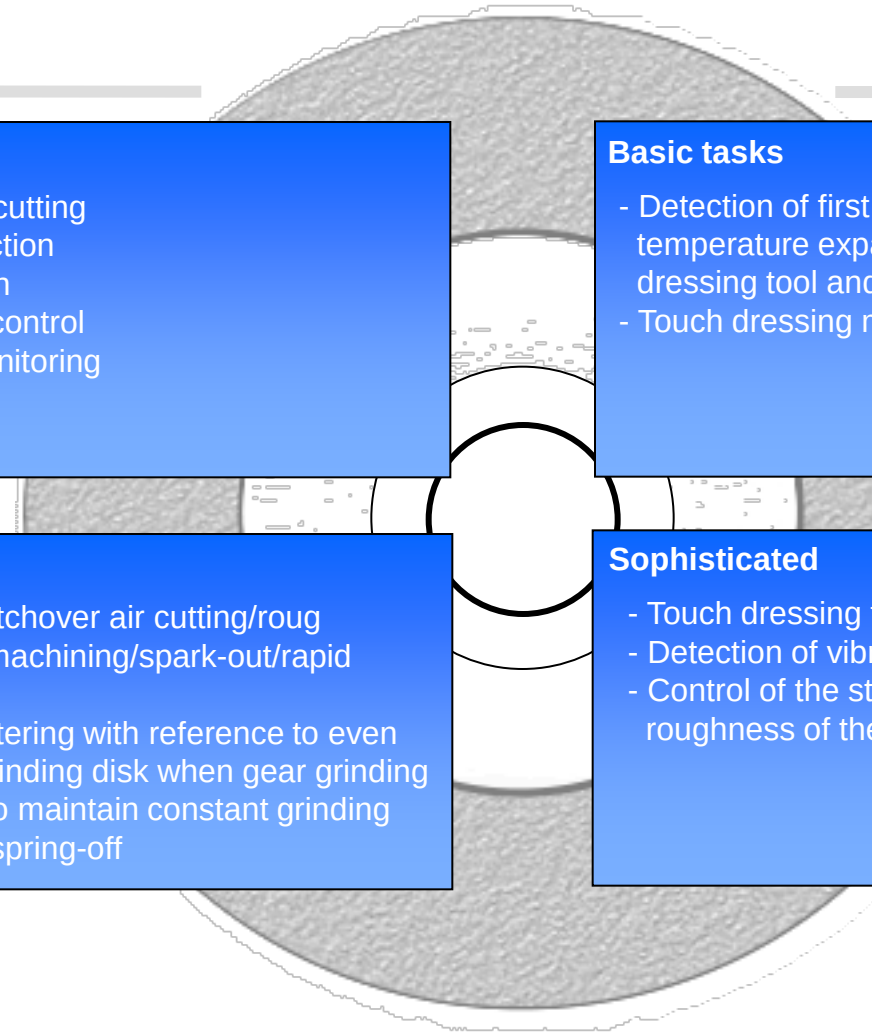
Work piece length control on 2 work pieces from both sides in rotary transfer machines

Inductive feeler with 10mm lift and pneumatic adjustment





Closed process diagram for grinding and dressing



Grinding

Basic tasks

- Reducing air cutting
- Collision detection
- Wear detection
- Concentricity control
- Imbalance monitoring

Sophisticated

- Controlled switchover air cutting/roug turning/finish machining/spark-out/rapid withdrawal
- Control of centering with reference to even wear on the grinding disk when gear grinding
- Feed control to maintain constant grinding pressure and spring-off

Dressing

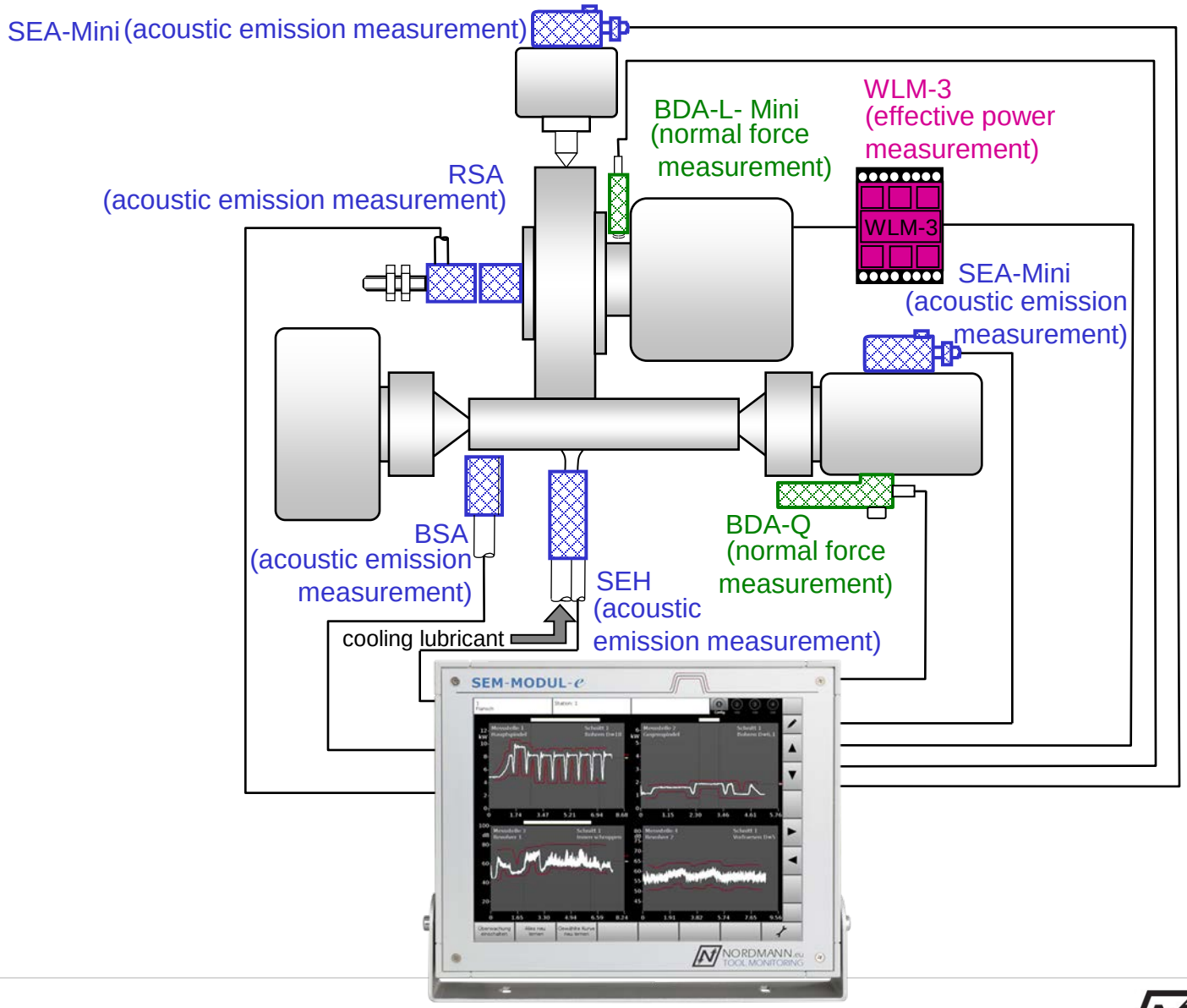
Basic tasks

- Detection of first contact to compensate for temperature expansion and wear of the dressing tool and grinding wheel
- Touch dressing monitoring

Sophisticated

- Touch dressing tool wear monitoring
- Detection of vibration of the dressing tool
- Control of the starting effective surface roughness of the grinding wheel

Possible sensor positions for monitoring grinding machines



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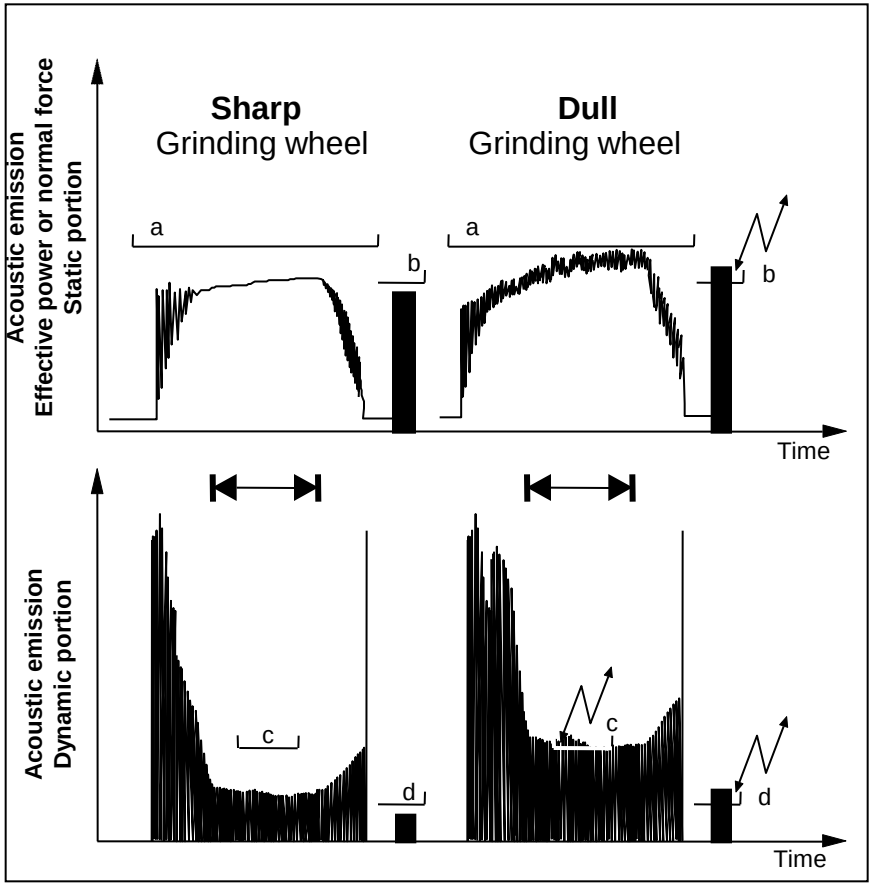
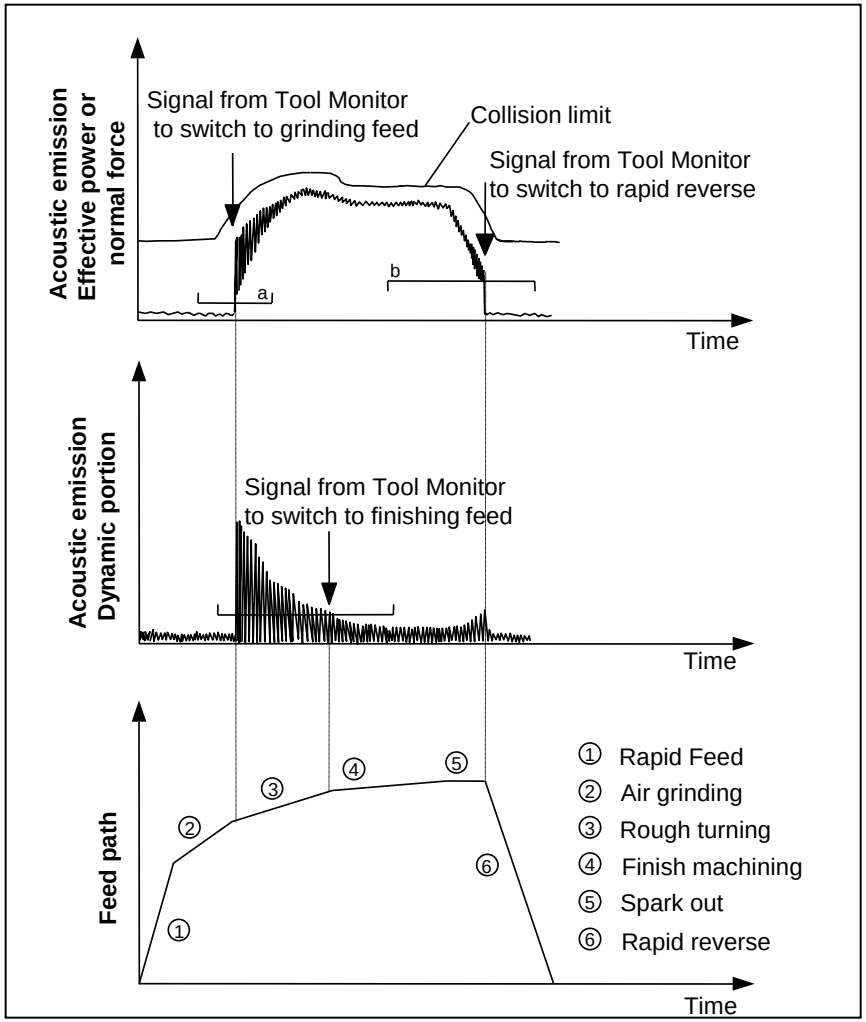
Examples for control and monitoring functions during grinding

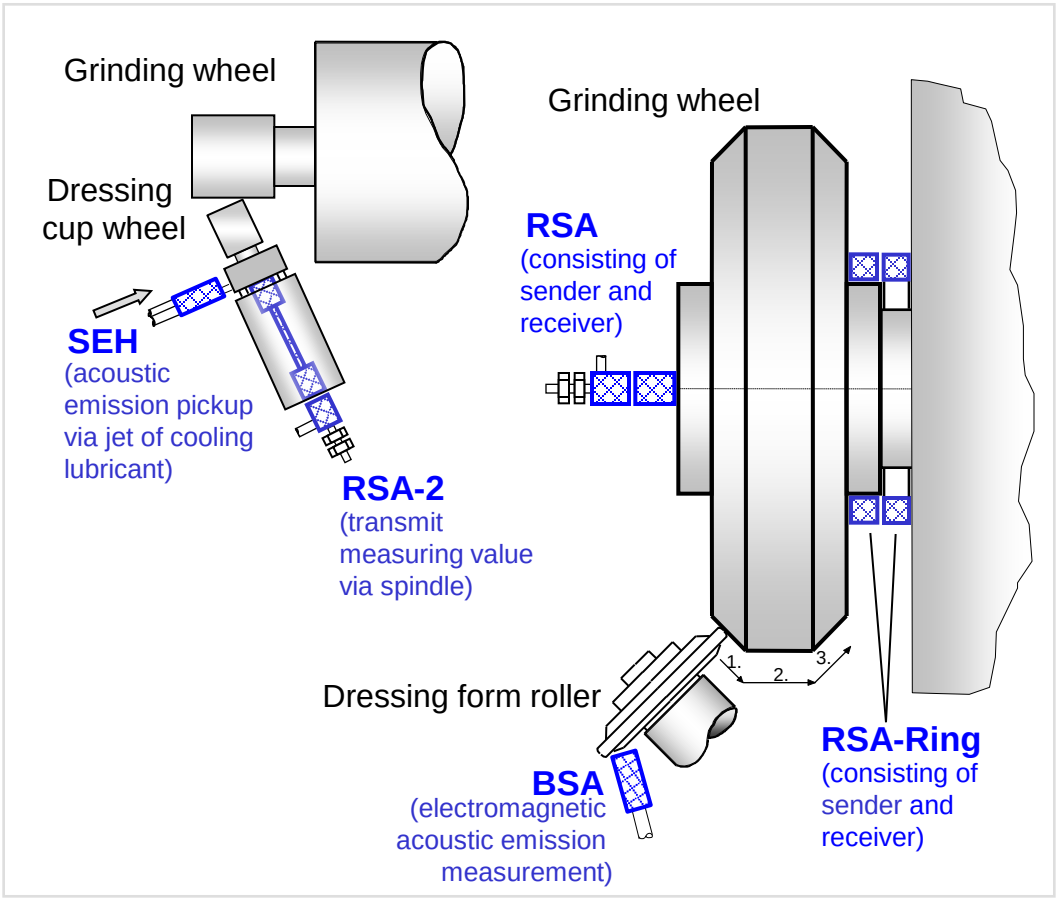




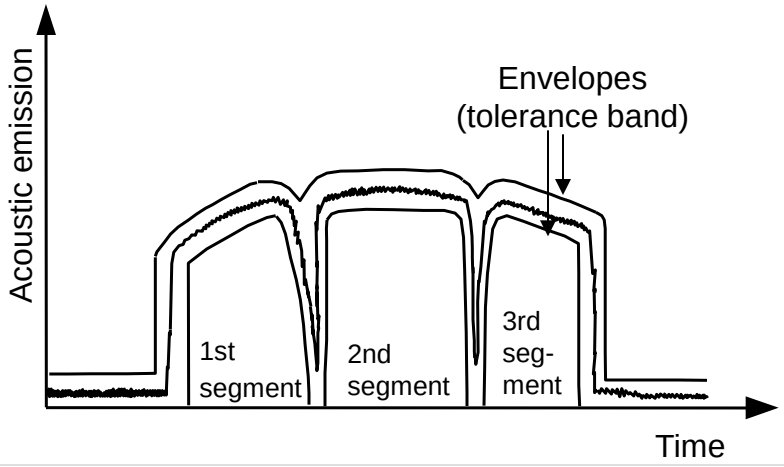
Limit values on the wear and process monitoring / examples:

a Limit for process degeneration (e.g. collision in rapid travel)
b Wear limit (monitoring of the mean height of the measurement curve)
c Limit for wear, waviness, and chatter
d Functions of this limit like c
(monitoring the mean height of
the dynamic portion of the measurement curve)

Different contactless sensors for measuring acoustic emissions at dressing



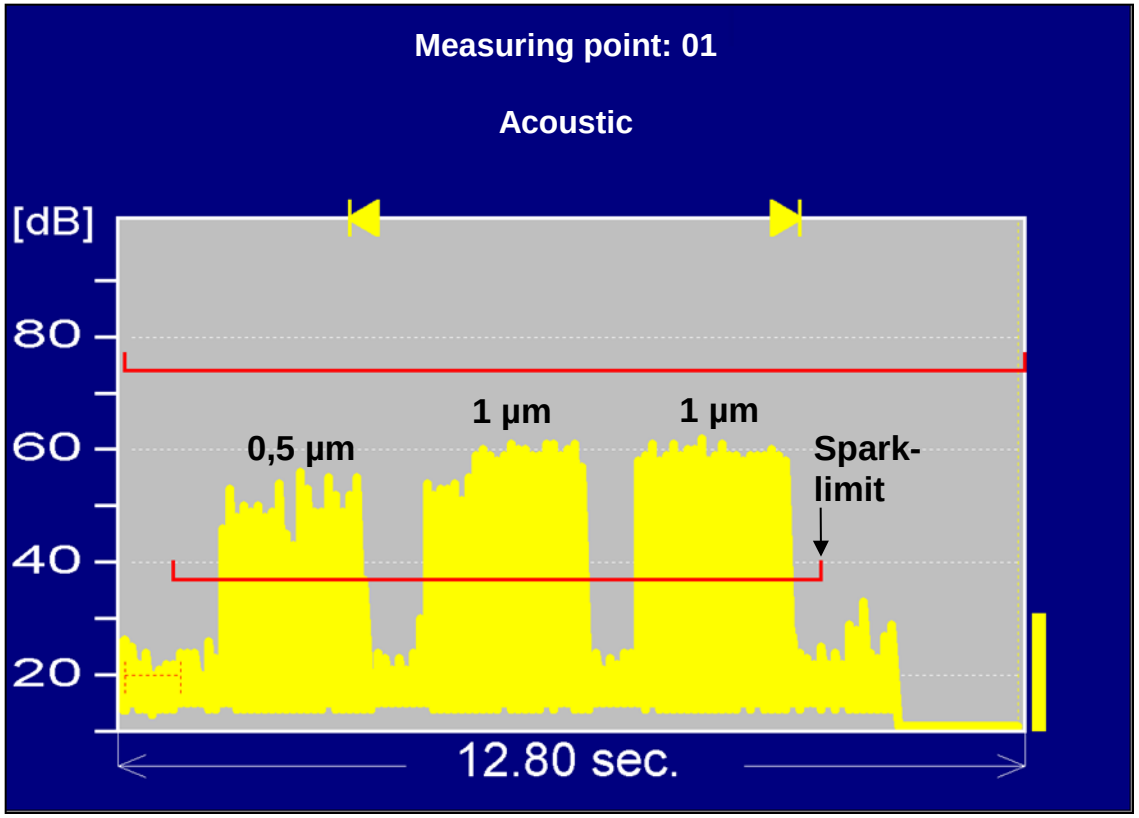
Touch dressing monitoring on the profiled grinding wheel shown:

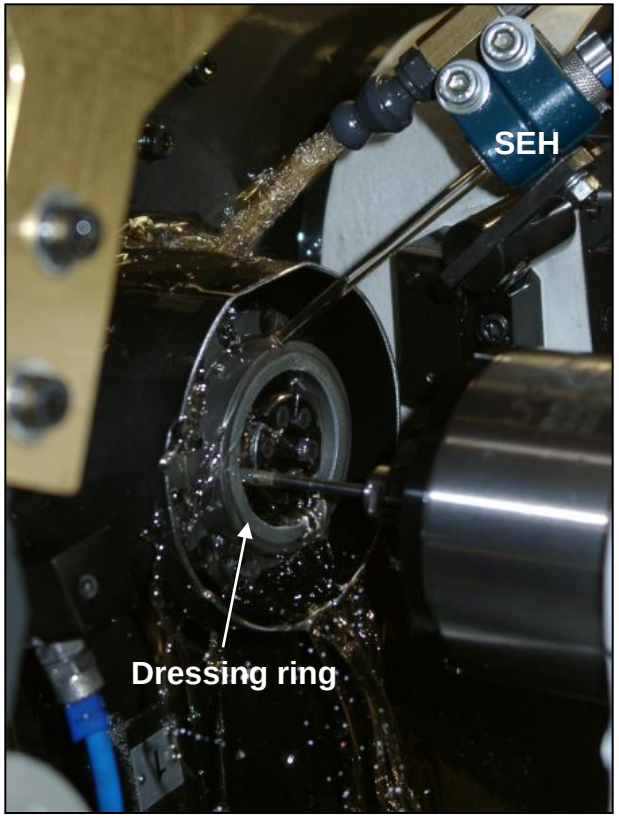


NORDMANN TOOL MONITORING

Acoustic emission picked up from the dressing ring with a jet of cooling lubricant to compensate the temperature expansion

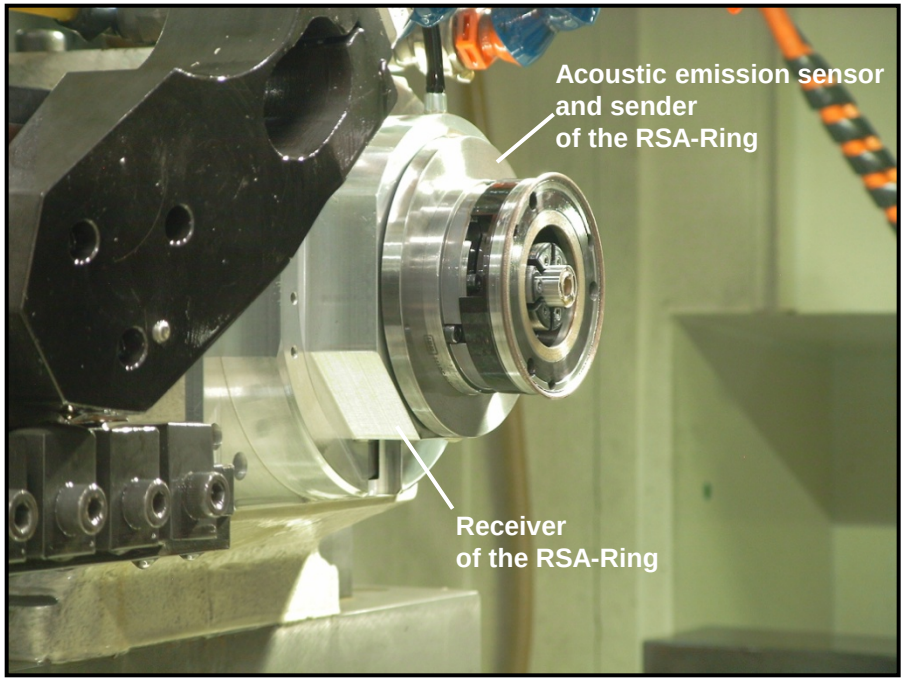
Acoustic emission pickup with a jet of cooling lubricant (Sensor SEH) from the dressing ring for very small feeds



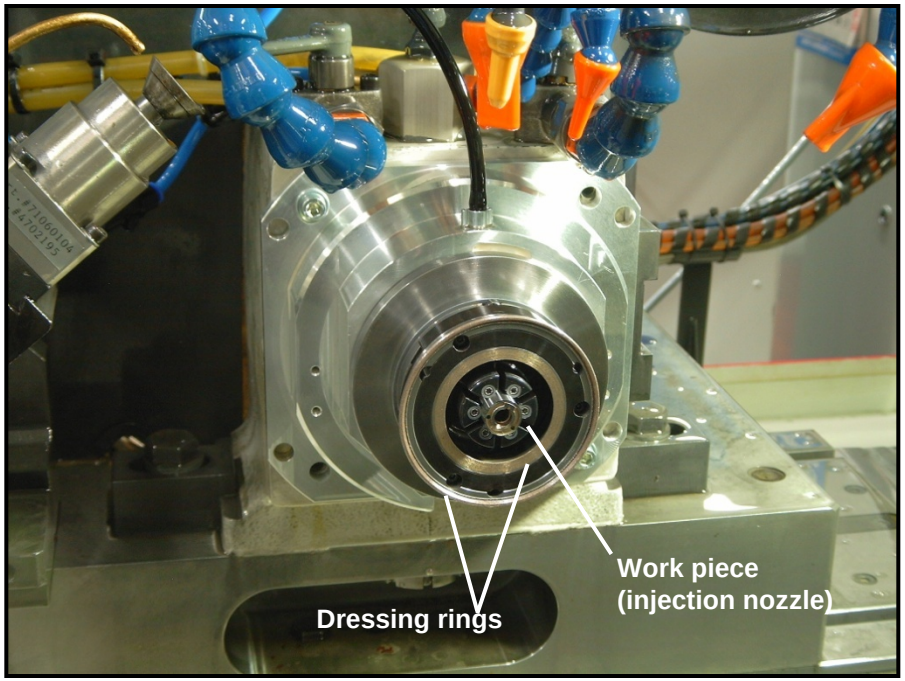


Acoustic emission sensor RSA-Ring on the work piece spindle for process controlling the grinding of injection nozzles

Side view

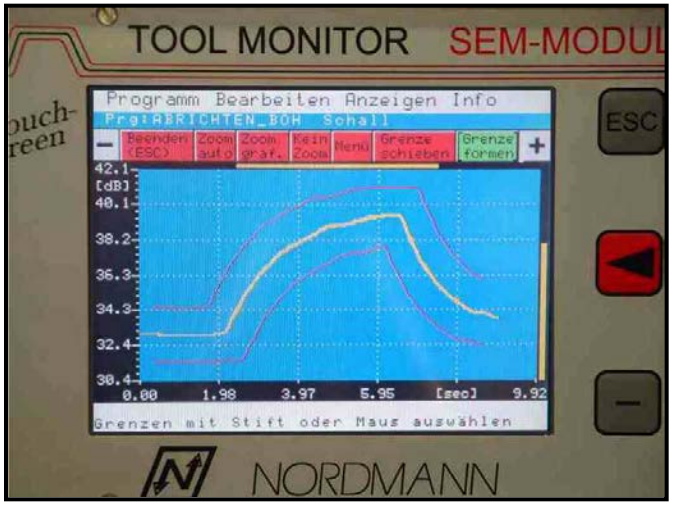


Front view

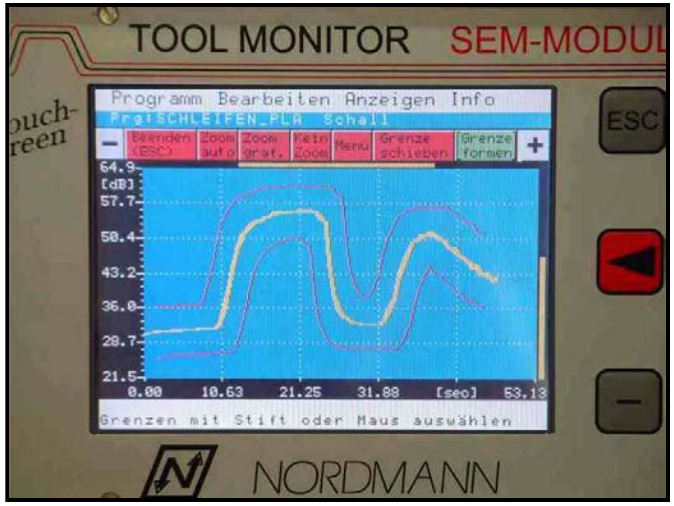


Measuring curves of the sensor RSA-Ring at dressing and grinding injection nozzles on UVA grinding machines

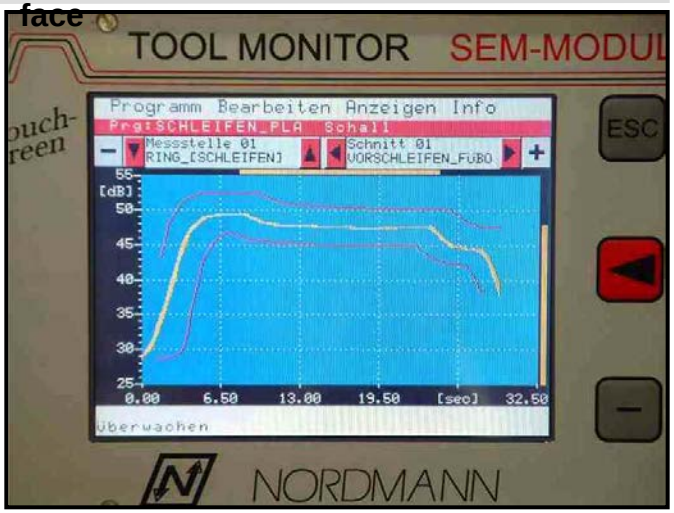
Dressing the drill hole grinding disc



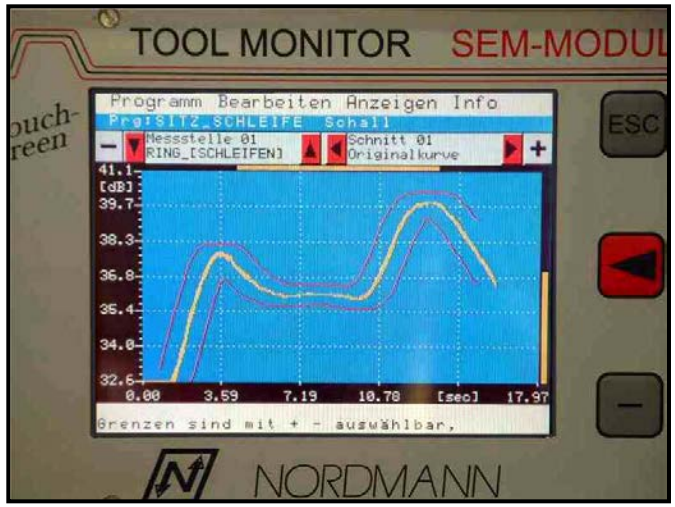
Grinding the drill hole



Grinding of the plane face

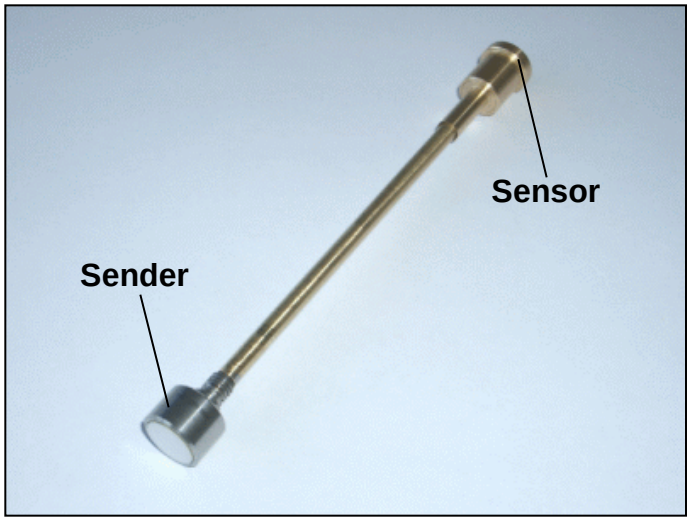


Grinding of the seat

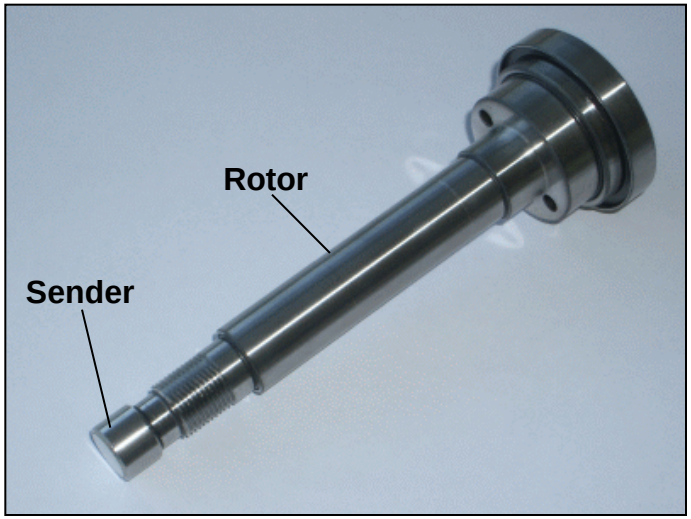


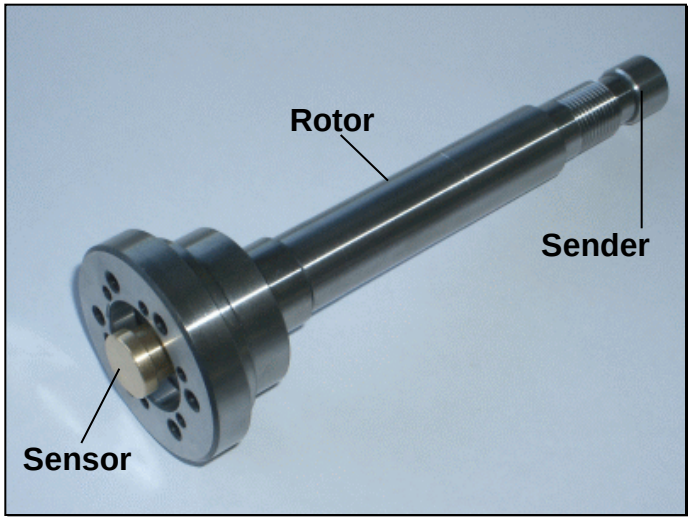
NORDMANN TOOL MONITORING

Rotating acoustic emission sensor RSA-2 for the rotor of the „Kaiser spindle“



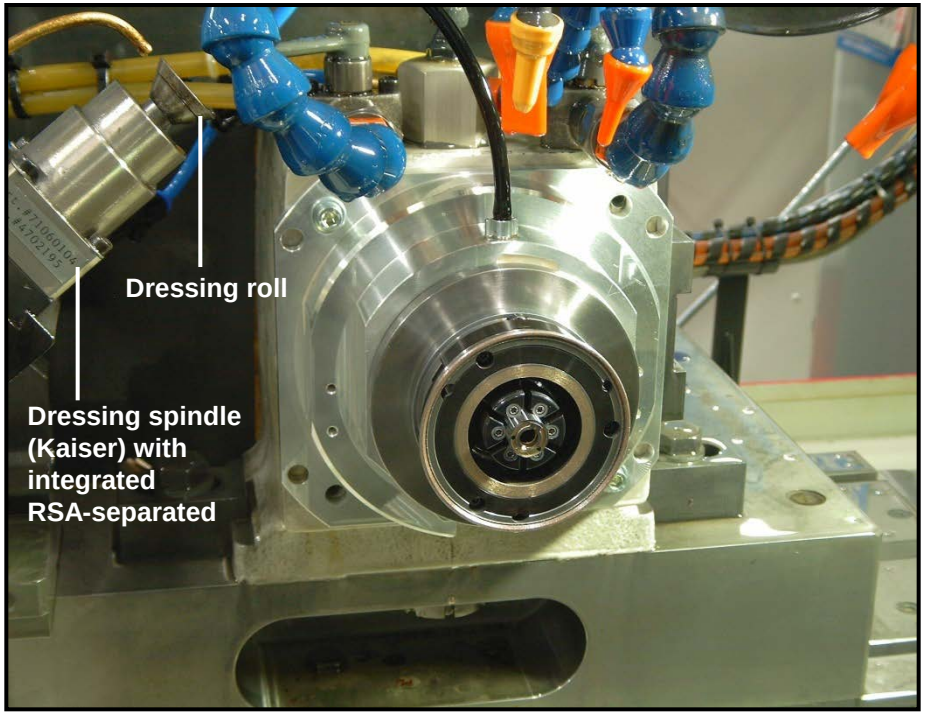
RSA-2 mounted in the Rotor



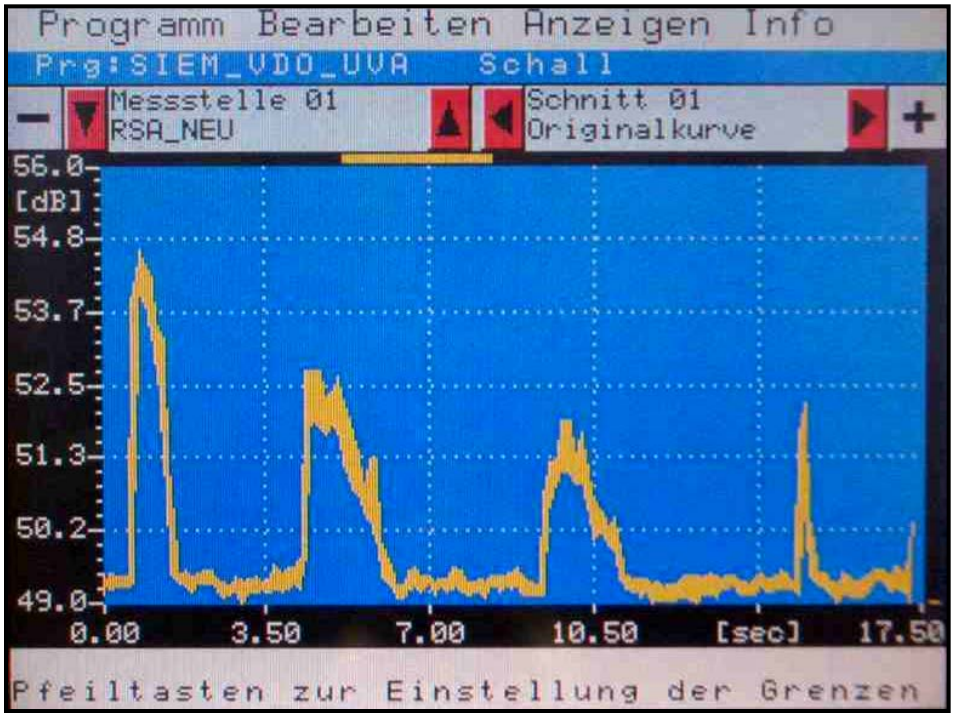


Measuring curves of the sensor RSA-2 in the rotating dressing roll spindle for dressing the seat contour (injection nozzle grinding)

Dressing spindle with integrated RSA-2

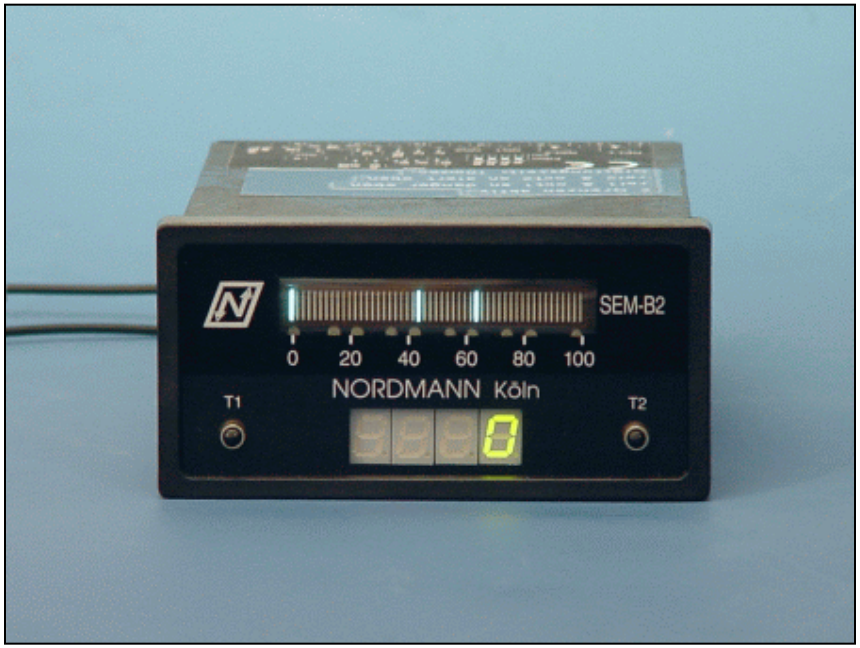


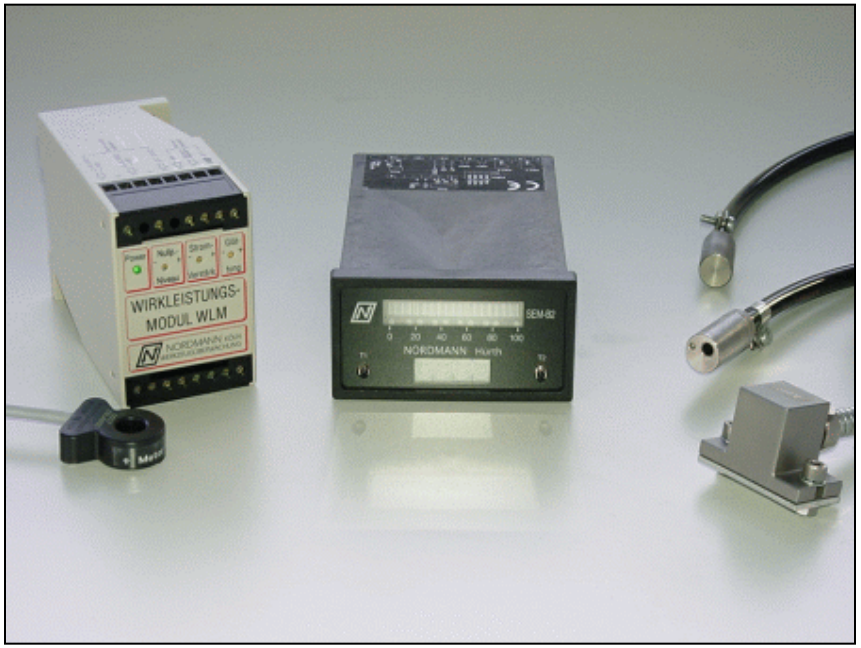
Dressing the seat area of the grinding wheel



NORDMANN TOOL MONITORING

Tool Monitor SEM-B2





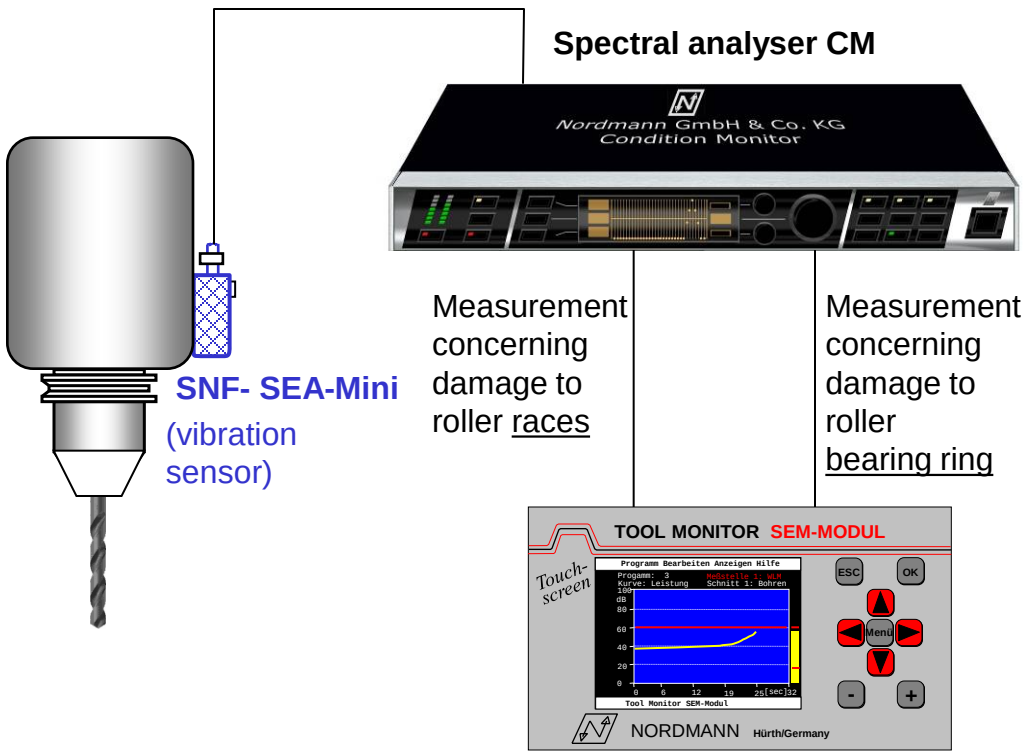
Din-Rail mounted device with Vacuum Fluorescence Display (VFD)

Control panel device with luminous band display of measured data.
Max. 4 separate limits, that react to overshooting and undershooting.

Common usages

Contact recognition grinding disc/work piece with feed switch for the accelerated bridging of air graining in connection with acoustic emission or real power measuring.

Tool MonitCondition Monitoring - Preventitive Maintenanceor SEM-B2



Advantages:

- Preventative maintenance of tool or work piece spindles, thus preventing unexpected machine down-time.
- Prevention of damage by unbalance monitoring.
- Timely, but also not too early installation of replacement spindles or roller bearings.

Realization:

- Frequency-selective evaluation of vibrations on the spindle housing, separated according to damage to the roller races and roller bearing rings.
- Trend display of the vibration levels filtered by the CM analyzer with regard to the number of produced work pieces.
- Generation of alarms when limit values are reached.

NORDMANN TOOL MONITORING

Special features of the NORDMANN sensor portfolio

Acoustic emission sensor via a cooling lubricant jet from the tool or work piece (patented). Thus even the smallest tools can be monitored (e.g. drill bit with Ø=0,1mm!), even in multi-spindle drill heads. Very good acoustic sensoring also when grinding, turning, hobbing and forming (hammering) directly from work pieces or tools.

Acoustic emission measuring via rotating and wireless sensors RSA, RSA-2 and RSA-Ring for grinding-, workpiece- and dressing-spindles.

Acoustic emission sensing via wireless SEA-Wireless sensor for fitting to work piece locating fixtures in machining centres or to the capstan head in lathes.

Acoustic emission sensor via a spring steel element directly from work pieces (patented especially for revolving and transfer lines).

Airborne noise emission microphone LSM-Q or LSM-L in vicinity of tool. Also acts as impact sensor for jet barriers on a coolant lubricant or compressed air operation basis.

Force sensor BDA-Q and BDA-Kralle for rocking lever in multi-spindle automatic lathes with particularly easy installation via only one M5-screw (both patented).

Force measurement on each individual spindle via the measurement of the elastic support of the spindle (for multi-spindle drill heads).

Work piece length sensors BDA-Pilz and WLT for multi-spindle lathes and rotary cycle machines.

Three-phase effective power measurements: Particularly fast reaction and for the smallest tools.

Hydro distance sensor HDS for breakage control of all cutting tools via a cooling lubricant jet which functions as a tool cutter sensor.

Spark-Sensor SPS for turning tool control at heigh offset oscillations via the spark sensor

Pyrosensor PYS for control of individual drill bits in multi-spindle drill heads, chipping temperature etc.

Dynamic pressure sensor SDS for breakage control via a cooling lubricant jet or air jet gate, also for miniature drill bits from Ø=0,1mm. Measurement distance of up to 2,5m in machining center. In comparison to the laser there is no need to wait for the cooling lubricant to run off and it is not affected by dirt.

Torque sensor EMS for single spindle and multi-spindle drill heads, as mounting part in the drive screw, in particular for the monitoring of tapping.

Special features of the NORDMANN Tool Monitors

Graphic correction possibility for envelopes in the area of recurrent, but localized rises in measurement values, in order to avoid repeated limit violations. Using the Nordmann touchscreen you can graphically correct the envelope with a pen (touch pen), i.e. it is drawn. A PC station screen is used to control corrections to the limit values via an arrow that can be moved on the envelope with the arrow buttons. The envelope can can be formed like a rubber band separately for its upper and lower limit.

Automatic adjustment of the envelope to a recurrent measurement curve outlier, if the user acknowledges this as a false alarm with automatic limit correction.

Sliding envelope calculation for monitoring multi-spindle drill heads with regard to the effective power up to a certain number of drills.

Dynamic analysis: Monitoring the waviness of measurement curves in order to recognise individual missing teeth in the cutter and to montor for stepwise changes in power and performance (breakage when turning).

Mathematic measuring: Permits the addition or subtraction of measurement curves. The subtraction of two measurement curves according to their previous logarithming results in the formation of a relationship, with which the changes in the direction of force can be monitored. The relationship formation is used to monitor internal driving values (feed and spindle values with regard to current, torque or effective power) and permits the monitoring of wear that is independent of the hardness of the material.

Many measuring channels: The standard Tool Monitor can control 8 analog and 20 digital measuring points. The analog measuring points are expandable up to 16.

In-process dimension controlling of work pieces and **deflection controlling of tools and work pieces** on an acoustic basis with resolution in the µ-field (patented).

Why do most new users decide on Nordmann tool monitoring?

- ✓ Extensive **sensor palette for the most divergent measurement values** and areas of application. Therefore even diffficult monitoring tasks can be solved (e.g. miniature tools, multi-spindle drill heads, machining in hardened material, grinding with the smallest abrasive pencil, machines with many work stations, etc.)
- ✓ Upgradable as **unified system on all machine controls**, independent of type and year of construction, whether with or without PC as a work station.
- ✓ **Universal Profibus interface**, configurable for all machine controls that can transfer internal driving data to the Profibus.
- ✓ Particularly good **monitoring strategy for the recognition of the smallest breakages** with turning, drilling and cutting
- ✓ Wear monitoring basically included in the system without extra charge.
- ✓ Highly **user-friendly** through clear menus, **graphic adjustment of the limit values** and **automatic envelope correction**
- ✓ Development, production, sale, mounting and service all **from one company**.
- ✓ **Service worldwide** and quick on-the-spot support

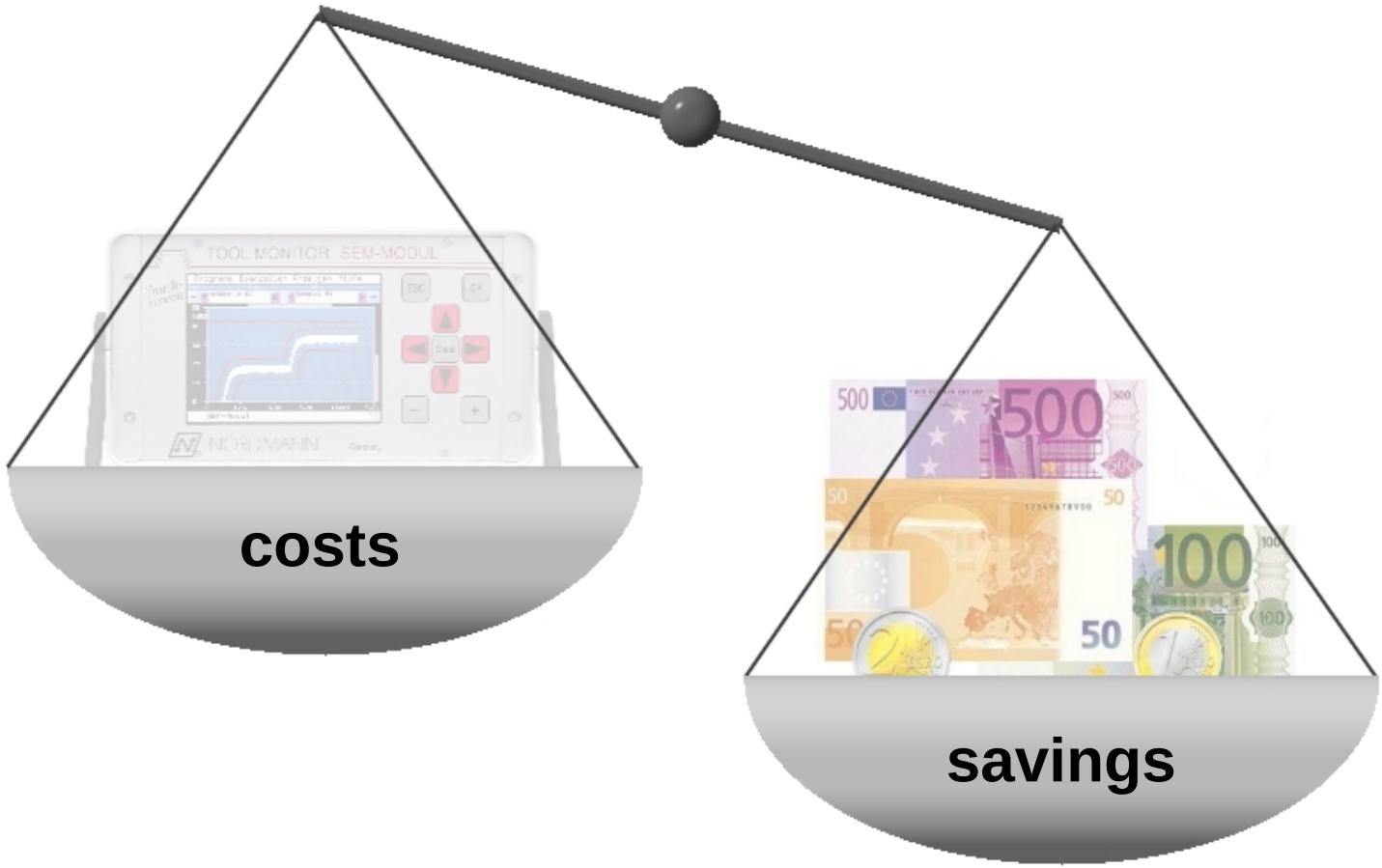
Savings from the use of Nordmann Tool Monitors

Main potentials	Base functions of the Tool Monitor	Savings
Tool cost reduction	- Extension of the tool change interval based on the ability to detect wear early.	**2 - 8%**
	- Ability to economically re-sharpening because of timely tool changes.	**0 - 5%**
	- Avoiding of tool breakage.	**0 - 3%**
	- Option of hazard-free experimentation with different tool types and grinding specifications.	**5 - 15%**
	- Ability to use more economical tools as premature tool life end is indicated as appropriate	**10 - 20%**
Increase in use of the machine tool (resulting in the need for fewer machine tools)	- Ability to have unsupervised runs during breaks or production in a semi-supervised 3rd shift.	**2 - 8%**
	- Lower main machining time per unit based safe increase in the feed values.	**0 - 5%**
	- Operation with few disturbances through avoidance of breakage and “clearing” on the following stations.	**5 - 15%**
	- Reduction in air cutting: reduction in machining time through the use of higher feed speeds until cutting begins (is especially common in grinding).	**10 - 20%**
	- Targeted elimination of reasons for standstill because of the recording of the reasons for faults with the integrated machine data acquisition.	**0 - 3%**
	- Measurement curve display covers premature switchover points from high-speed to working feed speed.	**0 - 7%**

Savings from the use of Nordmann Tool Monitors

Main potentials	Base functions of the Tool Monitor	Savings
Avoiding of scrap production and re-touching work	- In-process work piece dimension control with pneumatic measurement probes or a lathe tool or the RST as probes (acoustic contact detection via the slide noise on the rotating work piece).	**0 - 5%**
	- Detection of too small dimensions through increase or collapse in acoustic emission that comes too late.	**0 - 2%**
	- Improvement in surface quality through detection of chatter.	**0 - 2%**
	- In production tool wear and breakage control with immediate stop.	**0 - 3%**
	- The visualization of the process on the monitor often allows detection of irregularities just by looking at the measurement curve.	**0 - 3%**
Machine cost reduction	- Avoiding of machine fires (when using cutting oil)	**0 - 3%**
	- Protection of the machine when large tools break or during a crash	**0 - 3%**
Avoiding of complaints about sorting out bad parts	-Detection of short pieces due to other process irregularities and sorting them out with control of a scrap gate.	**0 - 5%**

Costs/savings by the use of a tool monitoring system



NORDMANN TOOL MONITORING

Thank you for your attention!