



Moving Technology.  
Inspiring Life.



## Modular Assistance System **ToolScope**





# The comprehensive Industry 4.0 solution

With the ToolScope Assistance System, TYROLIT and its partner Ceratizit Hannover (formerly Komet Brinkhaus) offer a comprehensive Industry 4.0 solution for grinding technology.

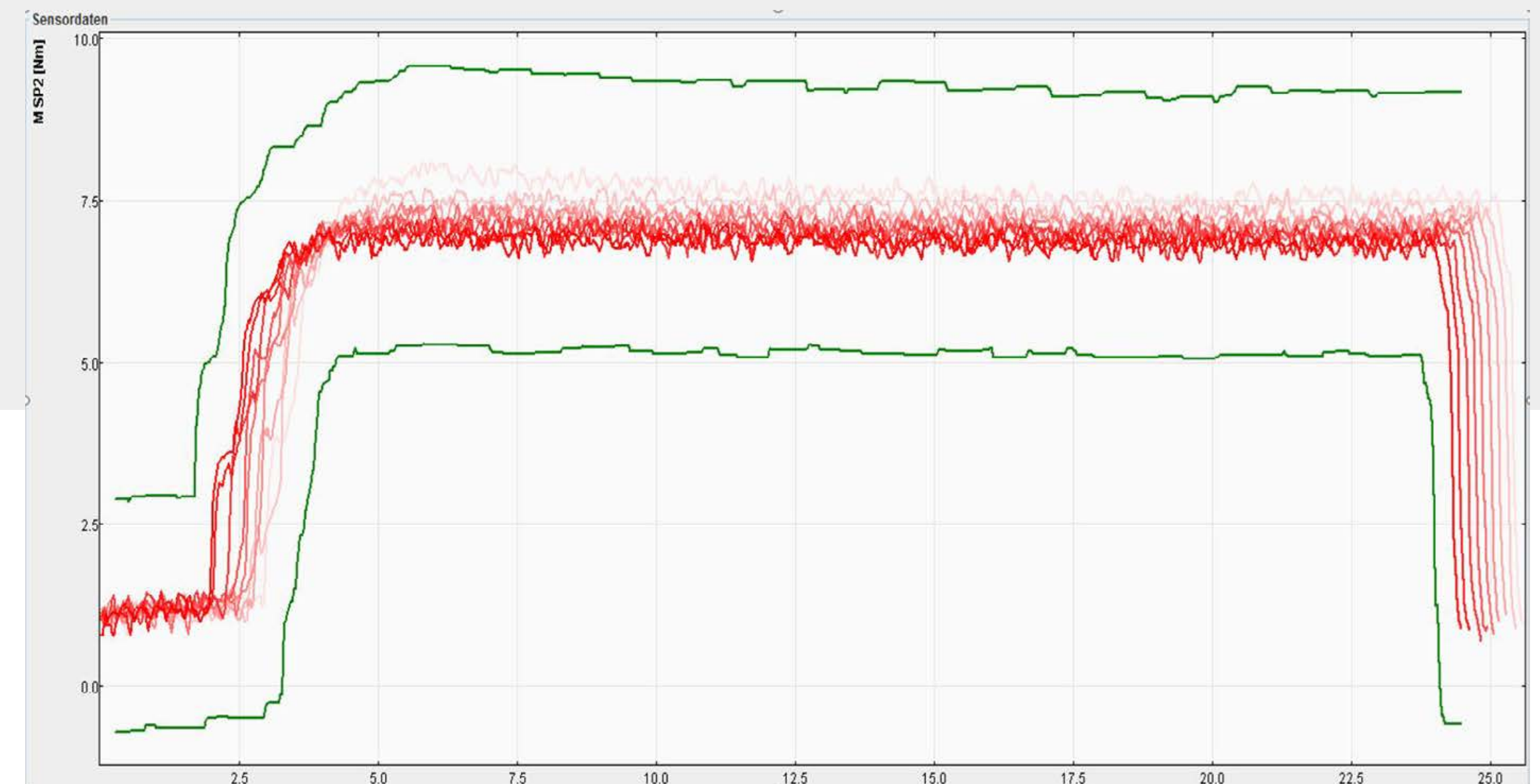
The ToolScope Assistance System supports grinding processes in your production. The combination of a hardware module with numerous software apps enables the user to easily access and make use of the acquired machine, operating and process data.

## The advantages of ToolScope

- Fast, data-based process and tool optimisation in combination with our application technology
- Individual assistance strategies, adaptable to every monitoring challenge
- All apps available on a modular basis
- Comprehensive process documentation, e.g. pdf
- From storage in internal memories (isolated memory mode) to online cloud storage
- In contrast to software solutions:
  - No adverse effects on the machine
  - Real-time capable data acquisition
  - Use of external sensors possible
- Up to 16 signals can be visualised and monitored in parallel

# The benefits of ToolScope

- Saved measuring data and status information can be read in via Excel
- Select exactly the right apps to safeguard and optimise your processes
- Signal profiles are analysed to reveal potential ways of optimising the NC program (peak time reduction)
- Rapid qualification of new tools, e.g. optimum wheel utilisation
- Remote connection/remote maintenance and networking worldwide via tablet, PC or laptop
- Customised programming
- Data analysis by ToolScope\_Net at the workstation/in the office

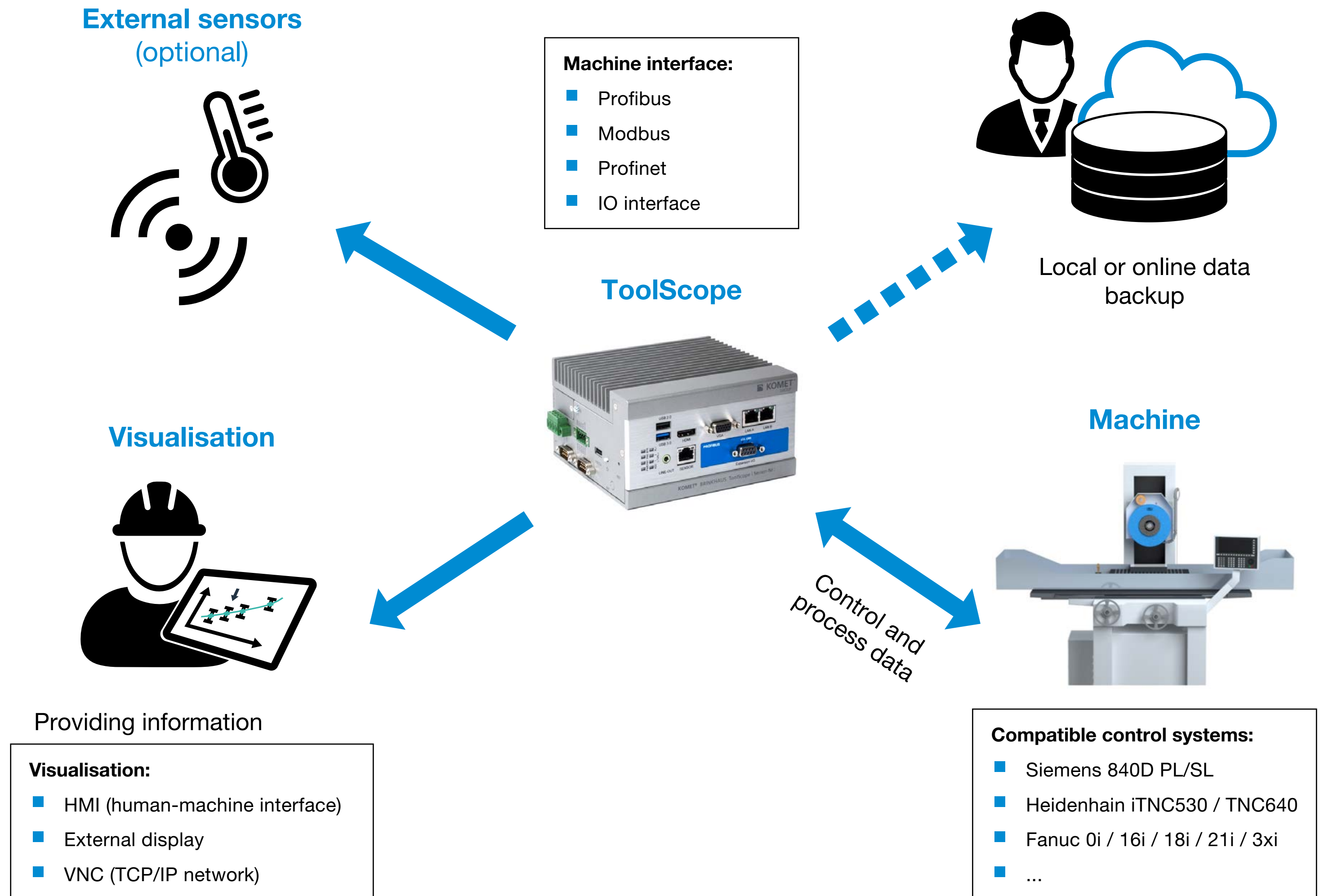


Simple visualisation of processes



# Integration in the control system

- **Control systems for which standard integrations are available:**
  - Siemens 840D PL/SL from 2002 (Profibus/ProfiNet)
  - Heidenhain iTNC530 from 2010 (Profibus only)
  - Fanuc 3xi (30i, 31i, etc.), visualisation via HMI with OPEN CNC only (Profibus/Modbus)
  - Bosch MTX from 2010 (Profibus only)
  - Further control systems on request
- **Visualisation can take place via:**
  - Human-machine interface (HMI)
  - External display (e.g. touchscreen)
  - Network connection (e.g. VNC)

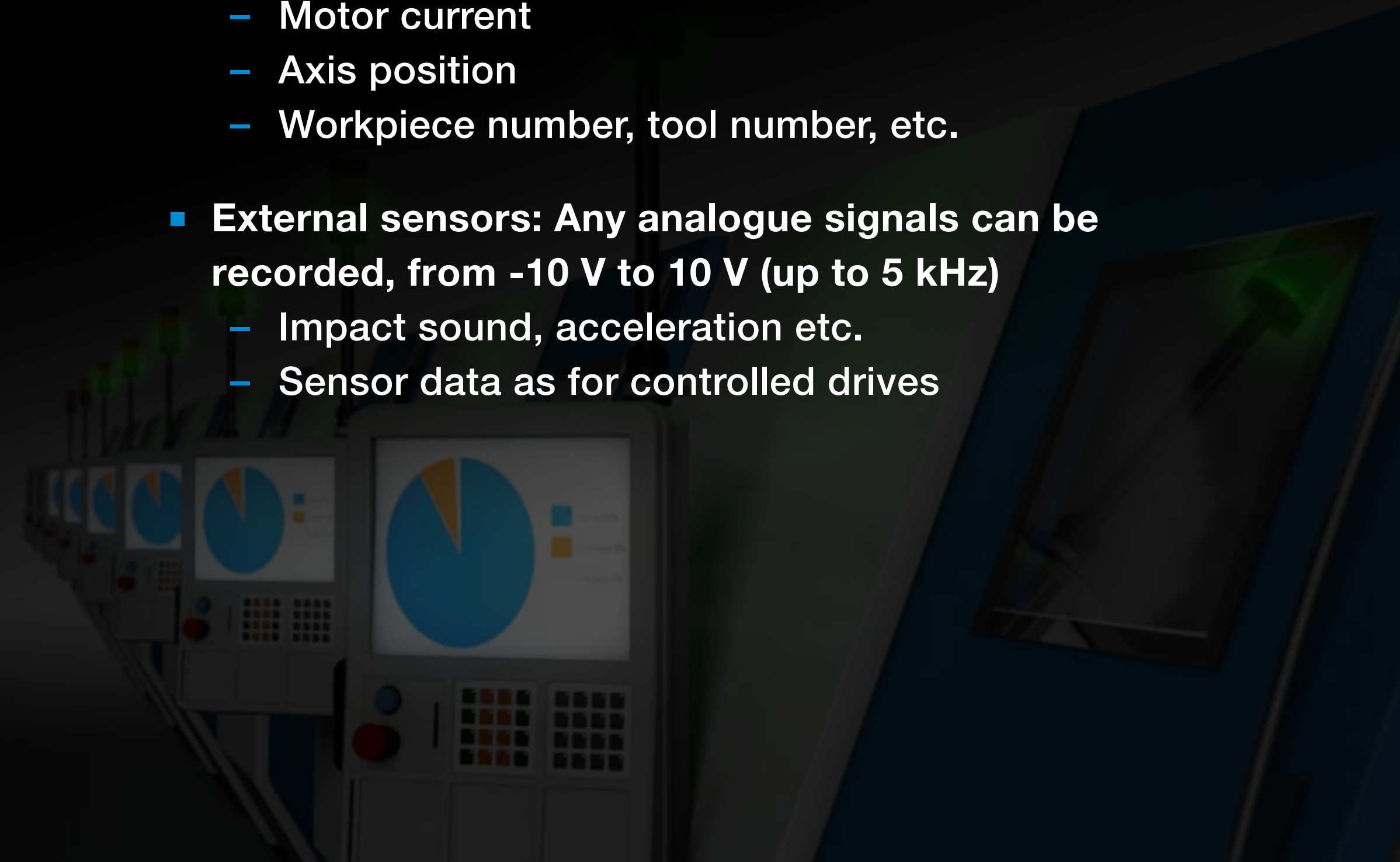


## Integration of external sensors and installation

- Integrate additional sensors at any time.
- Start and stop monitoring manually or automatically directly from the NC program using G and M codes.
- Control all system functions via the human-machine interface (HMI) or an external display.
- Installation and start-up takes approx. 1-2 days (machine downtime 3-6 hours).

## Sensors and data rates

- Digital readout of internal machine sensors direct from the control system (100 Hz in most cases)
  - Torque
  - Feed speed
  - Motor current
  - Axis position
  - Workpiece number, tool number, etc.
- External sensors: Any analogue signals can be recorded, from -10 V to 10 V (up to 5 kHz)
  - Impact sound, acceleration etc.
  - Sensor data as for controlled drives







# TS-PM app

Process and tool monitoring

## Your benefits

- + Process visualisation provides machine operators with rapid feedback
- + Detection of tool overload, missing workpieces, incorrectly clamped workpieces and faulty processes
- + Reduce scrap, rework and tool overload



# Benefits of self-learning process control

- The TS-PM app is self-learning and needs no manual adjustment.
- Using statistical methods, processes are compared with learned sample processes and critical deviations are determined.
- The methods used take the common manufacturing variations of a process into consideration.
- The system suggests monitoring or tolerance limits that can be manually adjusted if necessary.
- Using TS-PM, extremely narrow tolerances can be achieved, which adapt to the production process.

## Self-learning monitoring

### Monitoring limits after learning



## Fully automated tolerance limits

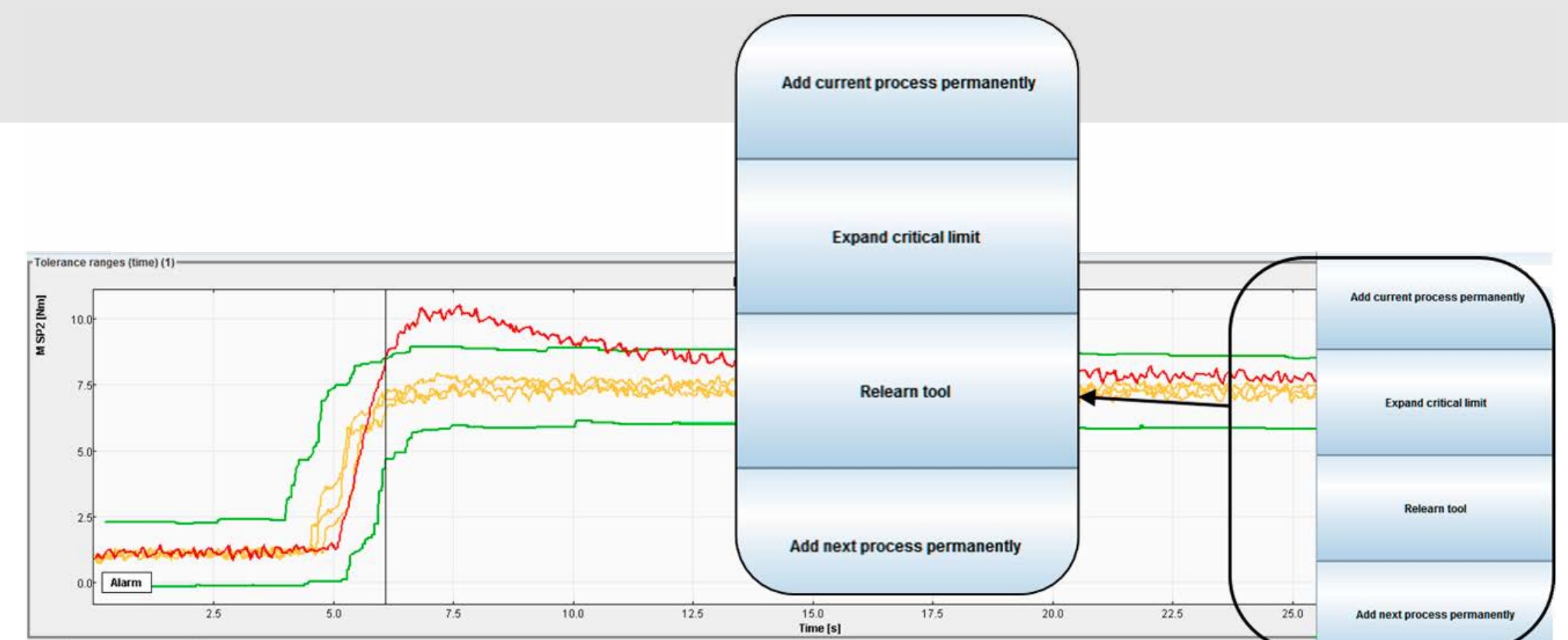
- When fully automated monitoring is selected, process limits are learned independently based on statistical process control.
- No parameter setting required.
- Fast and simple to start up and intuitive to use.
- Ideal for less complex standard processes/machines.

## Fixed and adaptive tolerance limits

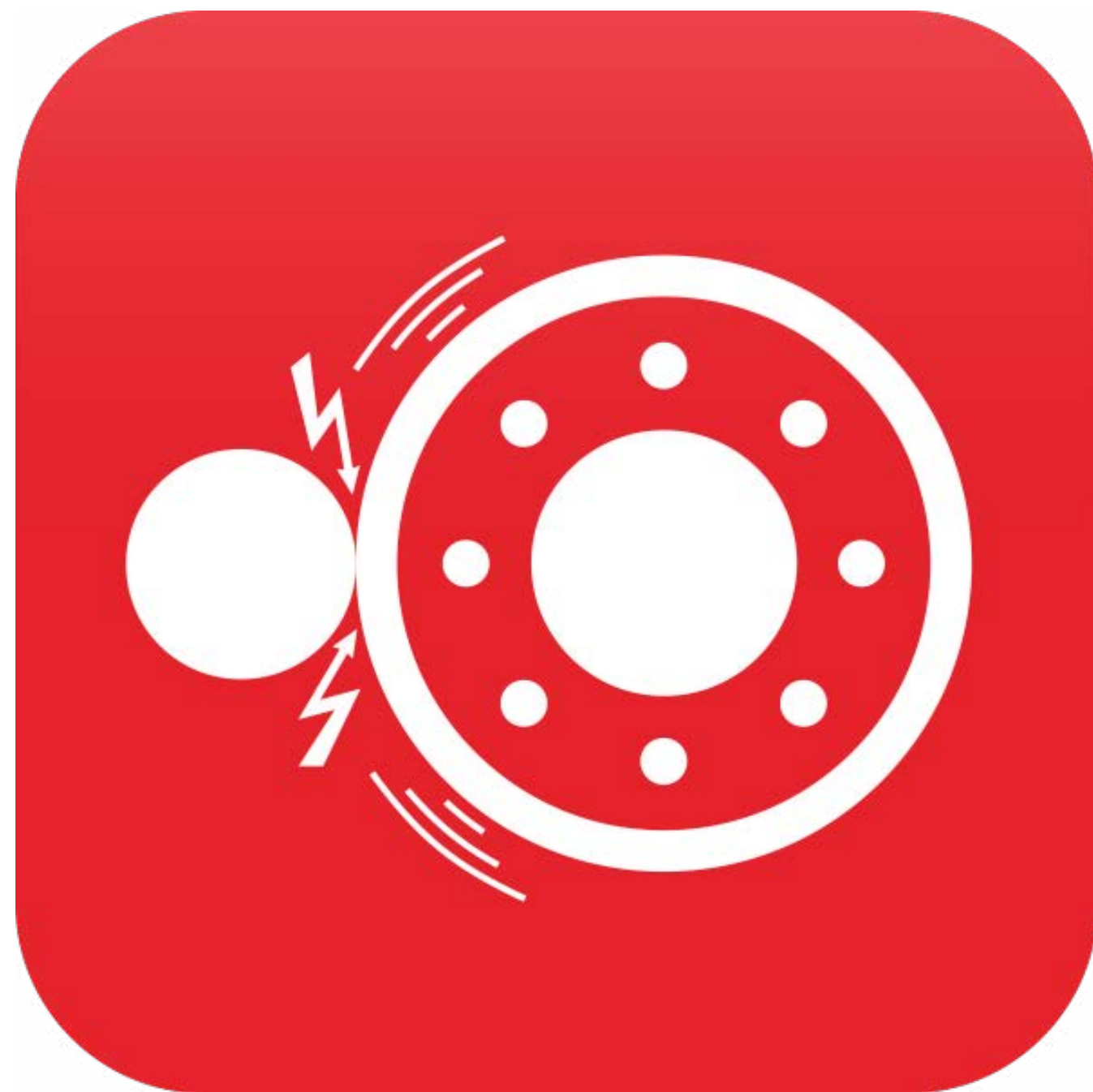
- Ideal upper and lower alarm limits are determined through the statistical analysis of learning curves.
- Method with fixed tolerance limits:
  - One-off learning of several process curves
  - Perfectly suitable for processes without major variations, e.g. machining with electroplated tools
- Process: adaptive tolerance limits
  - Continuous adaptation to the current process
  - Perfectly suitable for processes with systematic process variations, e.g. wear in grinding processes with dressable tools

## Relearning processes

Relearning processes is now also extremely simple. In the event of false alarms, the system does not need to relearn the entire process; instead, the process recognised as faulty can be added to the learning data.







# CD-xDim app

Collision detection

## Your benefits

- + Trigger on collisions
- + Reduce / Avoid repair costs
- + Reduce machine downtimes
- + Document collisions

# Function

- By triggering an emergency stop in the case of a collision, repair costs can be significantly reduced
- A vibration or strain sensor is used for rapid collision detection
- Collisions can be detected in several dimensions
- An emergency stop is triggered if a collision is detected
- The system reacts (signals an emergency stop to the machine) within 2 ms (without CD-xDim this is ~300 ms)
- Direct intervention in axis release without having to go through the machine control system
- Can be used as proof to reduce a machine's insurance premiums



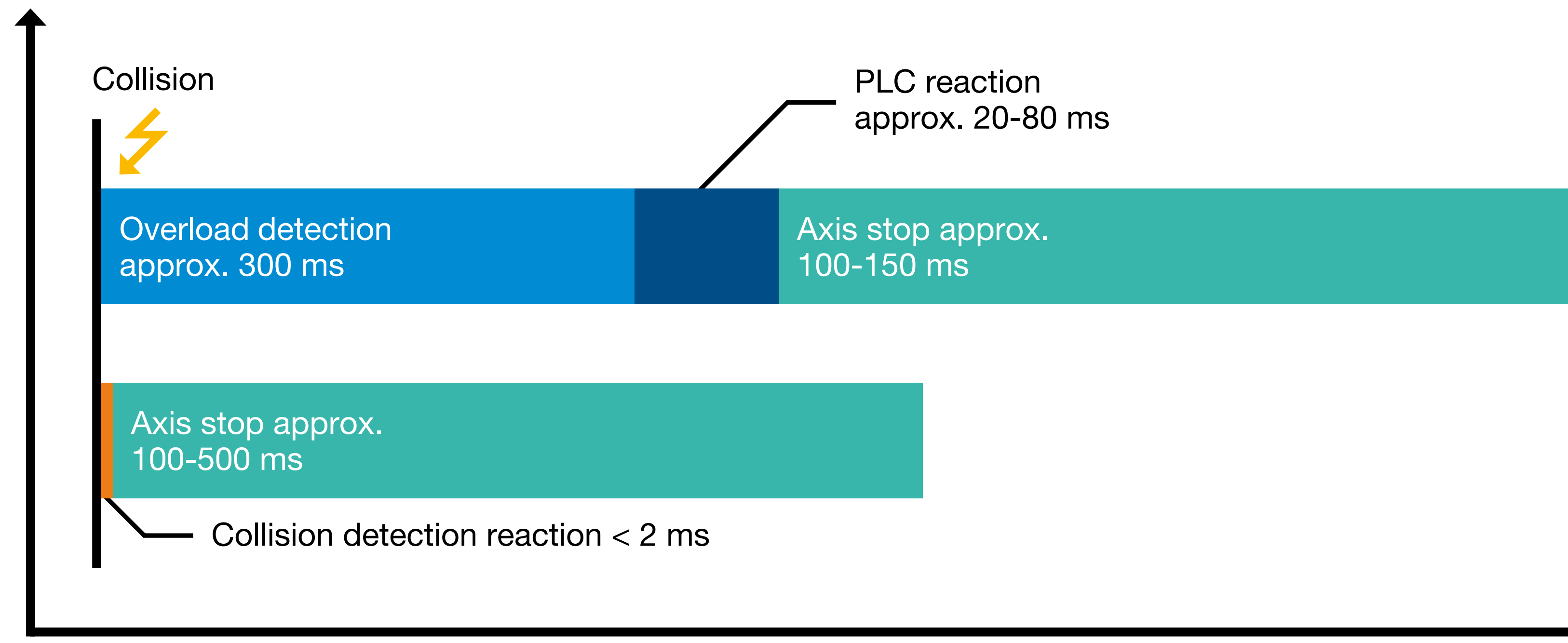
## CD303 evaluation unit

The CD303 sensor evaluation doesn't just detect a collision faster than conventional systems, it also makes the data visible in ToolScope and uses these sensor values for process analysis. Collision Detection is the only app that requires additional hardware.



# Application example

In comparison to a conventional overload detection the collision detection, having a major reduction of the reaction time, shows the big benefit. The CD-xDim app cuts consequential damages in the event of a collision both during the program routine and during manual operation of axes.





# TS-CM app

Condition monitoring

## Your benefits

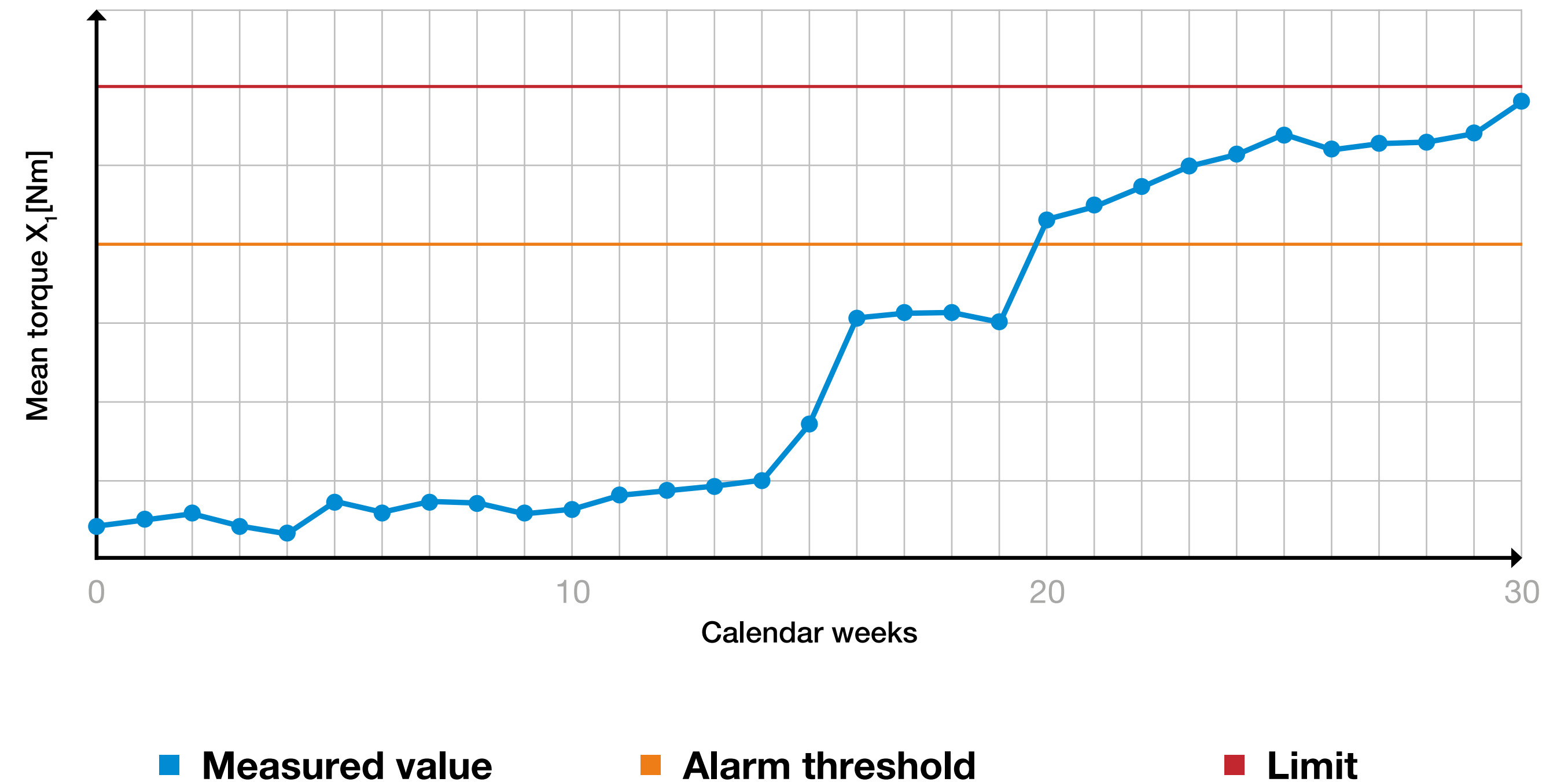
- + Visualisation of machine condition
- + Early detection of component wear and contamination
- + Support with troubleshooting
- + Enables predictive maintenance



# Function

- Internal machine sensor values are monitored based on a reference NC program
- Function
  - Cyclical progression through an NC program
  - Mean axis torques indicate the development of friction values
  - Trend recognition
- Standard: 5 axes
- Takes the "fingerprint" of a machine

## Trend for the constantly increasing contamination of a linear guide





# TS-AFC app

Adaptive feed control

## Your benefits

- + Save machining time
- + Tool protection on overload
- + Grinding tool is used to full capacity
- + Optimised grinding in the case of stock removal fluctuations
- + Optimised grinding with varying material properties



# Function

- Adaptive feed speed control enables the process parameter (e.g. torque) to be regulated.
- The controller's output variable is the override over the speed in percent. This override figure is transmitted directly to the control system.
- The limitation of the control variable to maximum and minimum values is freely configurable.
- All controller parameters can be adjusted based on processes. Control can be switched on and off using M codes.
- Control can also focus on different events, including:
  - Feed increase in idling phases
  - Feed reduction if stock removal is excessive
- In combination with a vibration sensor:
  - Fast/automatic reaction to high vibration amplitudes
- Various configurable signal processing mechanisms can be integrated upstream and downstream of the controller, which considerably increase its application range in machine tools.
- The controller's input variable can be freely selected from the ToolScope channels.
- The settings and profile of the control variable and override figure are continuously documented.

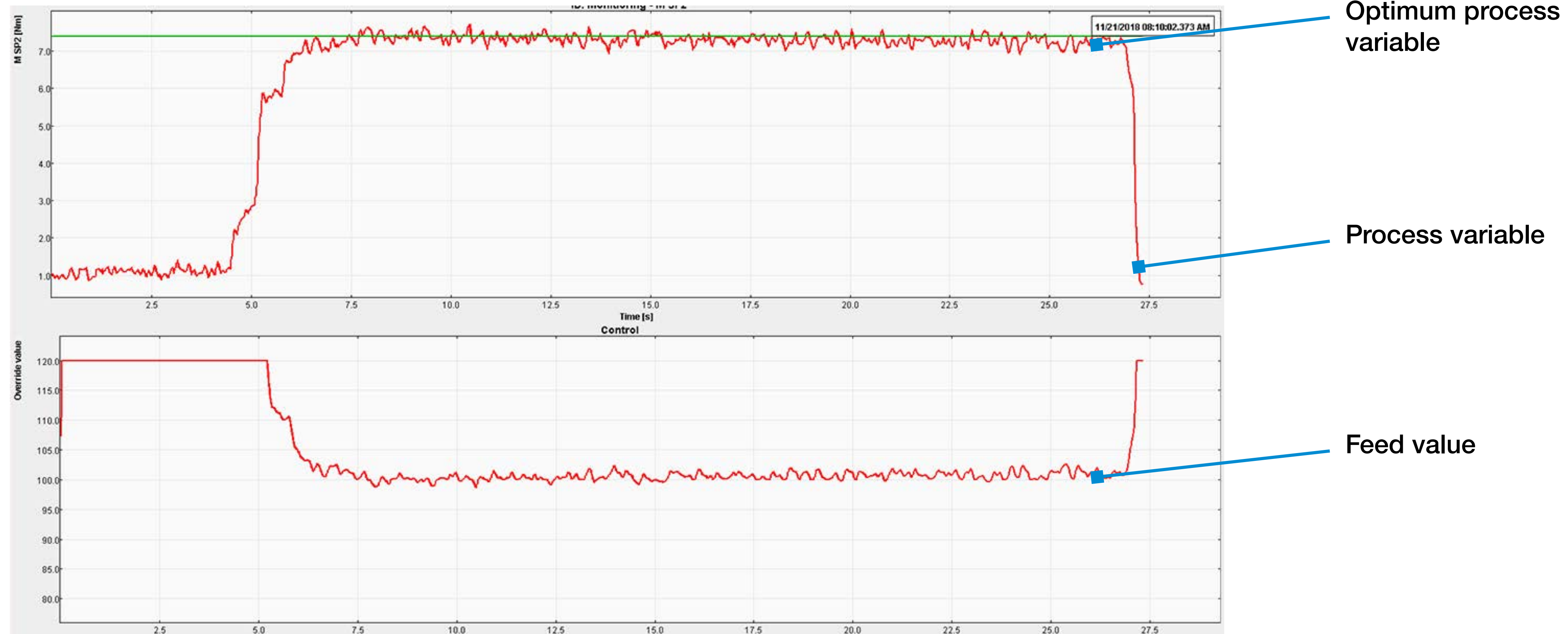
# Application example

In case of varying material stock you are able to reduce idle stroke during the approach and switch to work feed at the workpiece contact.



# Application example

To minimise process deviations it is even possible to adapt the work feed during the process. In case you have combined roughing and finishing it is possible to modify feed only during the roughing process and to keep the finishing on fixed feed parameters.







# Offline Analysis Tool

Process analysis on your computer (SoftScope)

## Your benefits

- + Analyse collected data offline
- + Test different monitoring scenarios
- + Optimise machining processes

# Application

- During initial installation and process modifications, only data can be logged and the variables to be monitored are selected offline.
- Even values that are not displayed can be selected subsequently and analysed.
- In the event of process problems, the tool can run through the data history again and flag up any issues in the process.



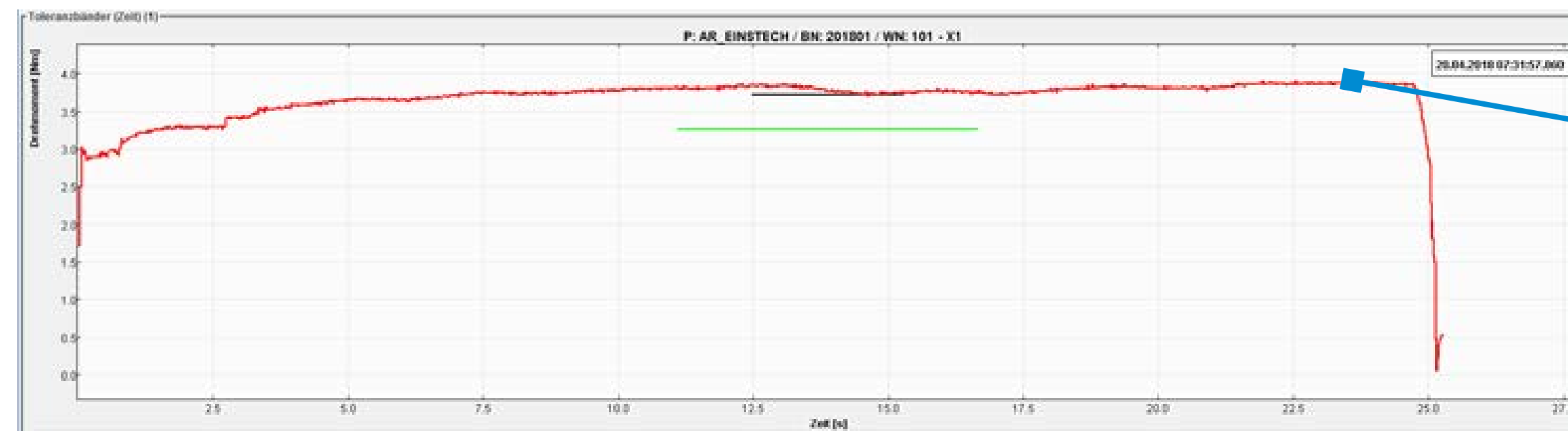
Visualisation of the processes on a external device

# Example of freely configurable monitoring variables

In the upper diagram, you can see that the torque of the feed axis is being monitored without any visible possibility of process monitoring

Monitoring signal can easily be changed in the monitoring windows

In this example, changing the monitoring variable from the feed axis torque to the spindle torque enables the system to monitor the parameter that is significant for this process.



Feed axis torque



Spindle torque





# TS-Wear app

Lifetime analysis of electroplated tools

## Your benefits

- + Analyse and optimise the lifetime of electroplated tools
- + Reserve display based on increasing process force
- + Optimisation and advance planning of tool changes

# Function

- The wear behavior of electroplated tools is similar to that of the defined cutting edge. With flattening grain layer, the process force increases and you can set a wear limit to prevent grinding burn or surface problems.

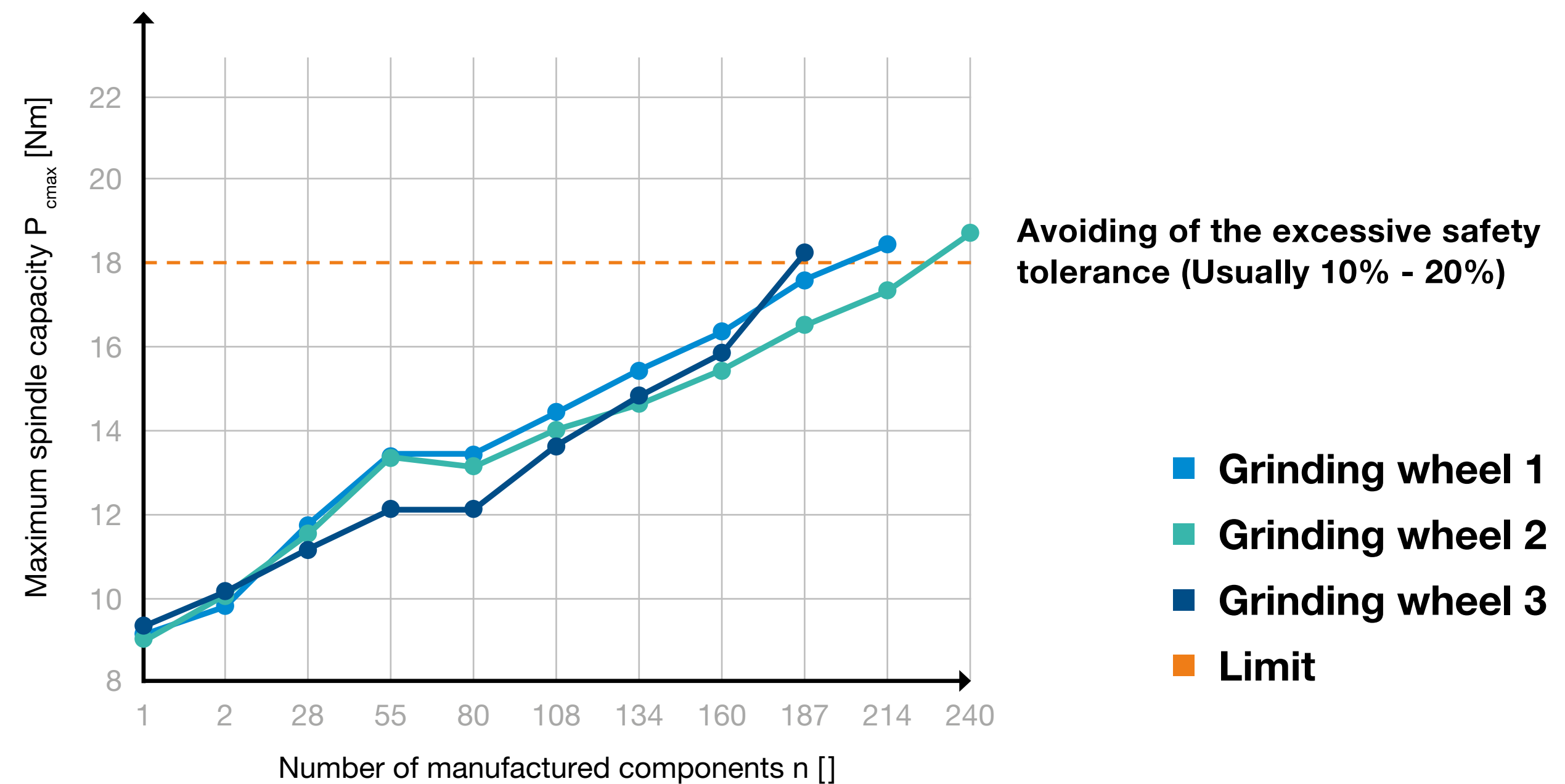
Benefits therefore:

- Compensating for statistical deviations
- Using of the grinding wheel to their wear maximum
- Avoiding the need of excessive safety tolerances

# Application example

## Maximum wheel utilisation

Due to the differing stock removal and statistical variance of grinding tools with a single coat, optimum utilisation of lifetime cannot be achieved using a numerical lifetime counter. However, monitoring spindle capacity can indicate the wear condition of the wheel in certain cases, enabling the maximum possible lifetime to be exploited to the full.





# TS-AD app

Adaptive dressing

## Your benefits

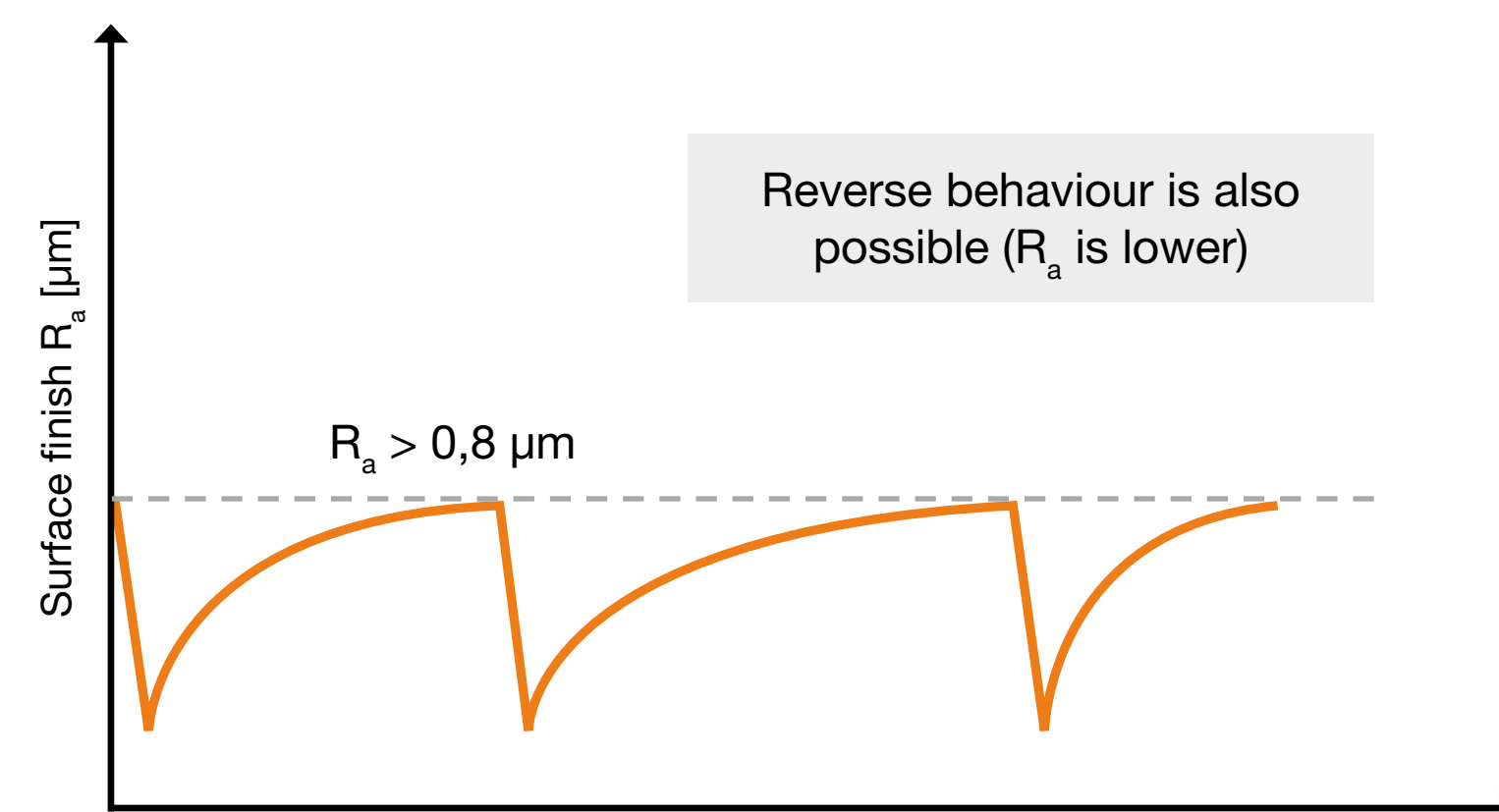
- + Evaluate and optimise the lifetime of dressable tools
- + Determine dressing-specific process parameters and resulting variable dressing cycles
- + Achieve optimum utilisation of tools and ensure process stability with regard to dressing times



# Function

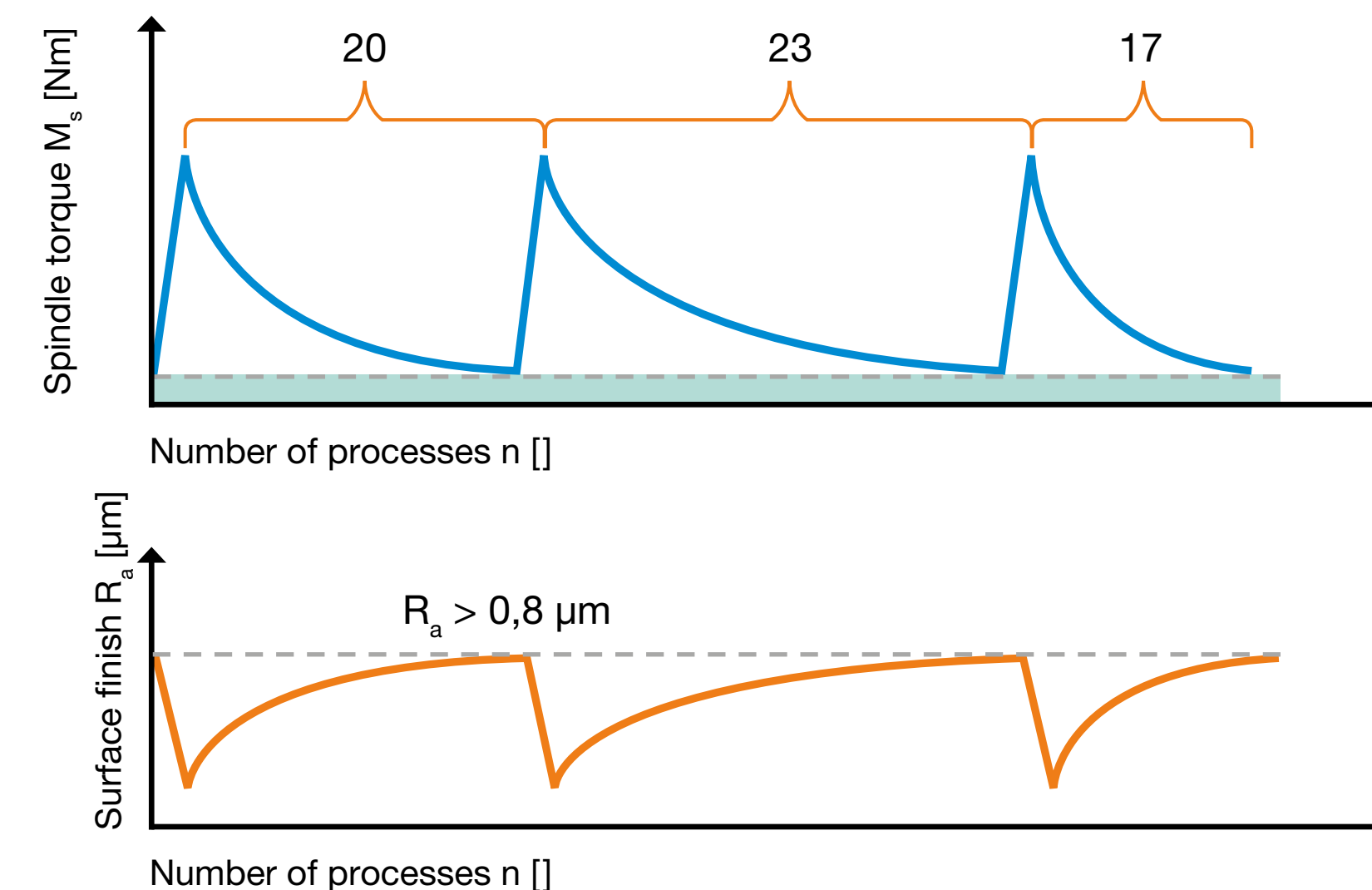
## Actual condition

- Each component is measured, to determine 3 cycles, for example
- To ensure process quality, the smallest cycle is chosen as a possible dressing interval
- Additional reliability (10%-20%), e.g. 15 in this case



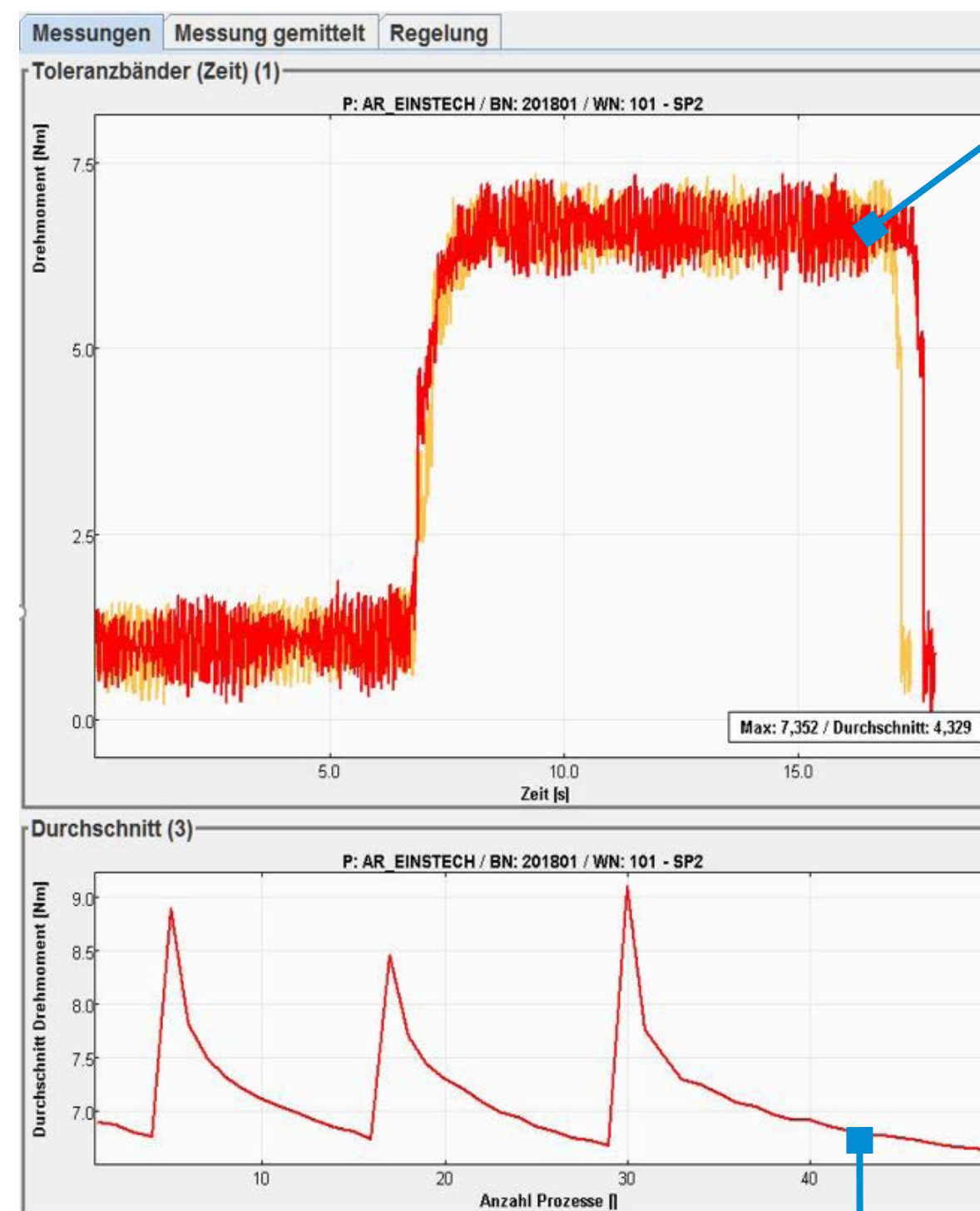
## Implementation

- Correlation between torque and ground workpiece surface
- Based on this, the torque can be established as the dressing-specific limit
- Dressing cycles are reduced by up to 20%, depending on the grinding process



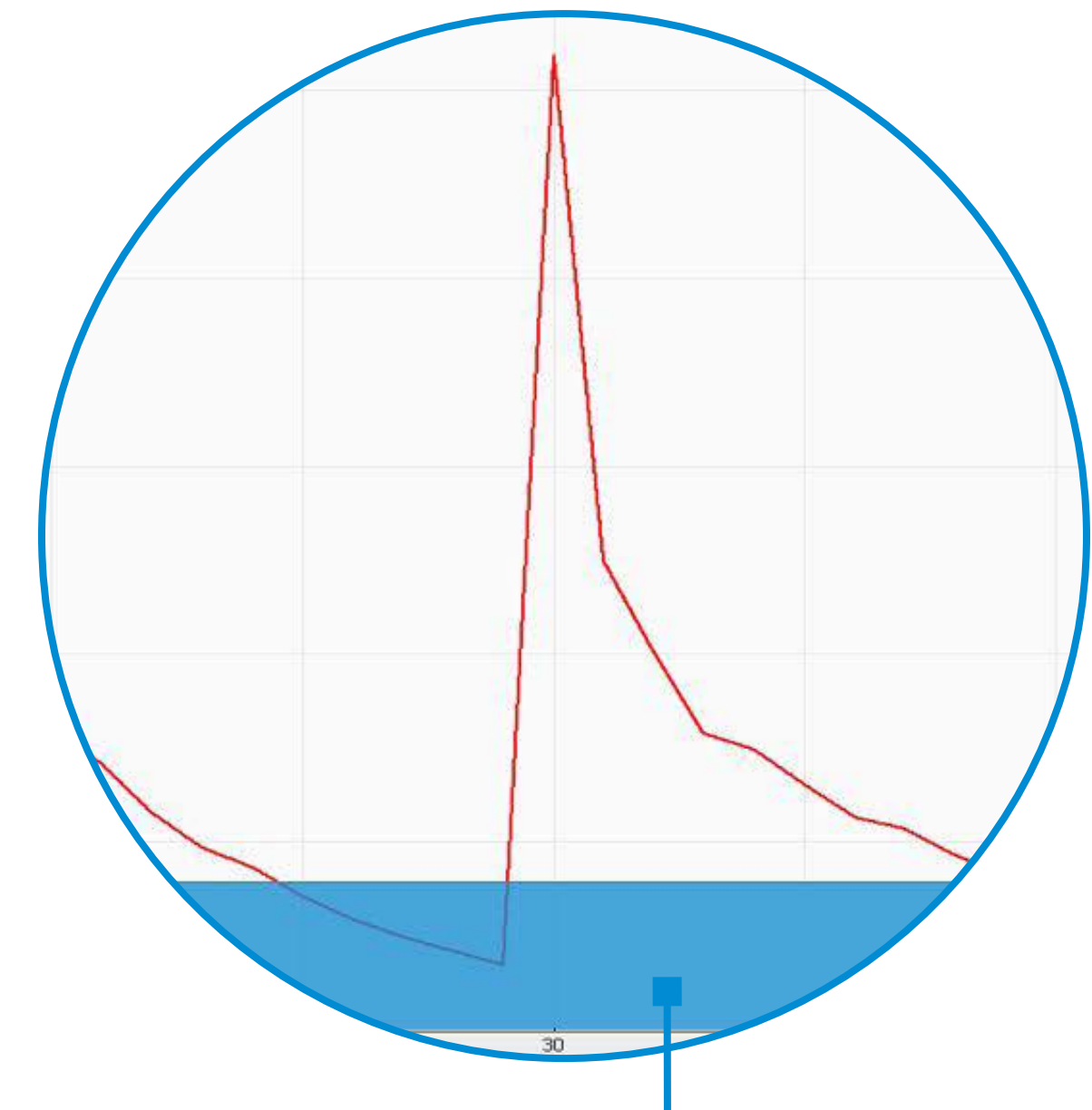
# Application example

- Dressing limits can be defined in ToolScope
- If they are exceeded, behaviour can be freely configured (alarm, automated dressing etc.)
- Dressing limits can rapidly be manually adjusted if required



Average value displayed on the number of processes

Grinding process



Due to bad surface finish, scrap production in the blue area:  
With applying a limit it can actively be avoided



# TS-TCLog app

Tool change log

## Your benefits

- + Digitalise the tool operation sheet
- + Flag up potential savings
- + Log tool change reasons in a simple manner
- + Combined with TS-Wear wear-related tool analysis



# Function

- Tool life/tool use counter (number of workpieces/no. of grinding cycles etc.)
- Tool change triggers are easily incorporated
- Wear-based tool analysis in combination with TS-Wear
- Digital replacement for the tool operation sheet
- Automatic analysis of tool lifetime/change triggers: graphical overview of lifetime distribution per tool and machine is possible over a longer period
- Potential savings quickly become clear
- With example Excels for your own analysis

# Application example

Sensor values	Hardware	Settings	Access	System messages	Alarm monitor	Backup	USB	File manager				
Date		Process				Reserve		Piece	Maximum			
12/04/2018 05:31:07 PM		T: FDM520R1-H962				<div><div></div></div> 16%		335.0	400.0			
01/08/2019 08:54:11 AM		T: FD3300YB0111R1-H72				<div><div></div></div> 92%		89.0	500.0			
01/08/2019 08:54:14 AM		T: H7B6XC2				<div><div></div></div> 93%		7.0	100.0			
01/08/2019 08:56:29 AM		T: H7B6YX8				<div><div></div></div> 53%		37.0	80.0			

Tool worn

Program/programming error

Change of type/workpiece

Installation of test tool

The integrated tool life counter gives you the opportunity to graphically display the reserve of a tool. By means of simple and configurable change reasons, one can hereby realise a digital tool card.



# TS-QRep app

Quality report

## Your benefits

- + Compile standardised documents with ease
- + Monitor critical parameters and ensure quality
- + Achieve uniform process documentation

# Function

With many processes, the quality of a production feature is what matters. This app helps with process documentation.

- Differences in quality are detected by recording signals from the machine control system
- A pdf document is generated for each monitoring process
- Customised upgrades of interfaces to QA systems

# Application example



## Monitoring log

ID	Monitoring	Tool	VA234-060718
Monitored signal	1	Min.-Value	0.366
Max.-Value	8.085	Average-Value	2.56
Monitored signal	2	Min.-Value	18.14
Max.-Value	19.972	Average-Value	19.21





# TS-MDA app

Machine data acquisition

## Your benefits

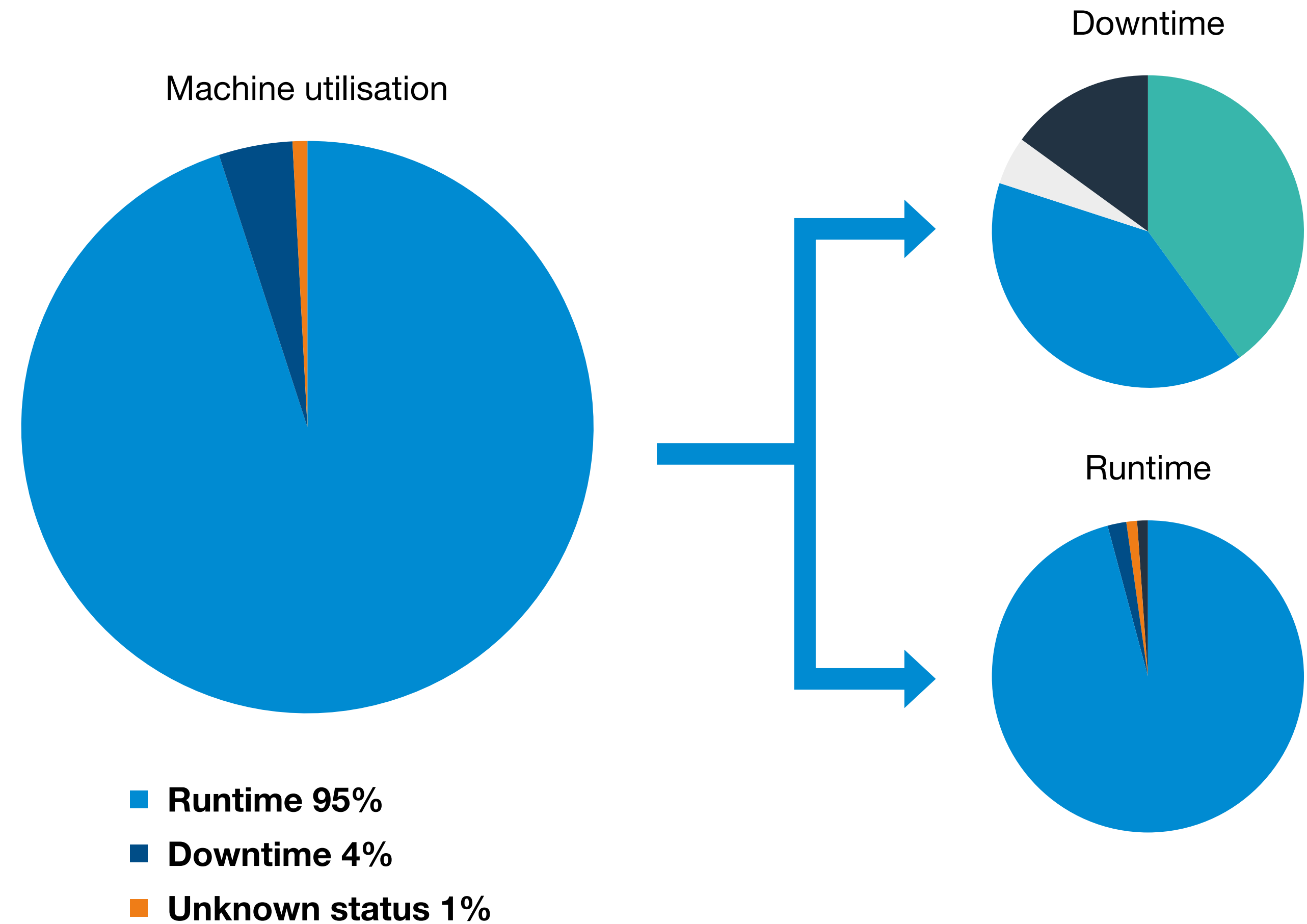
- + Analyse machine capacity
- + Identify potential savings
- + Optimise machine utilisation



# Evaluation

- Operating state data is provided in computer-readable format
- Log files can be imported into standard evaluation tools and databases
- Enables the evaluation of machine runtimes, downtimes, machine utilisation based on NC programs etc.
- With example Excls for analysing machine states

## Application example





# TS-Connect

Cloud database function

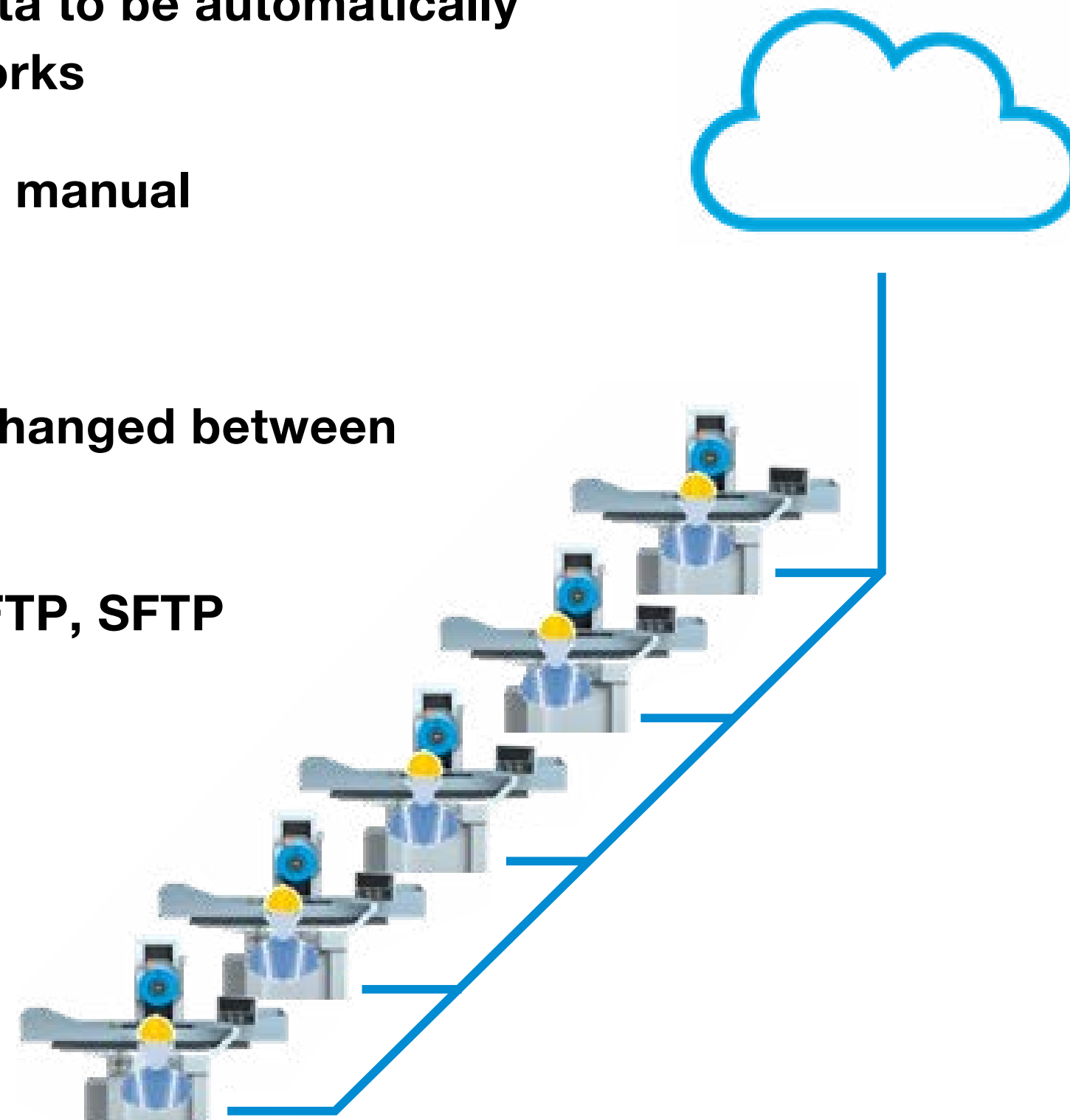
## Your benefits

- + Provide data via network push
- + Access all data via the network
- + Export data in standard format
- + Auto backup of ToolScope settings
- + Optional: Copy to the online cloud

# Function

The Cloud feature allows process data to be stored in a local or globally available external database.

- The app enables ToolScope data to be automatically downloaded to company networks
- Copy operations are cyclic and manual
- Auto backup of device settings
- Monitoring parameters are exchanged between machine and server
- Protocols: Windows network, FTP, SFTP



## The three stages of network connection

### LEVEL 1

Isolated, 200 GB internal memory

### LEVEL 2

Data push into company network

### LEVEL 3

Data memory in the cloud



# Service

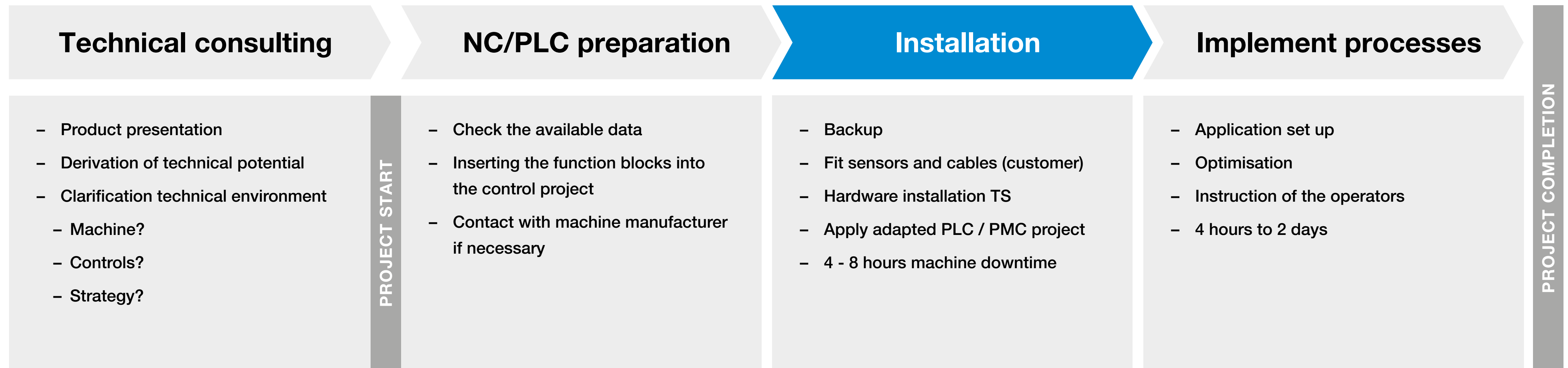
## Your benefits

- + Together with TYROLIT, tools can be further optimized with ToolScope, as well as reshaping processes and process flows
- + TYROLIT services your tools and assistance systems
- + Your cycle time is shortened by optimising the process

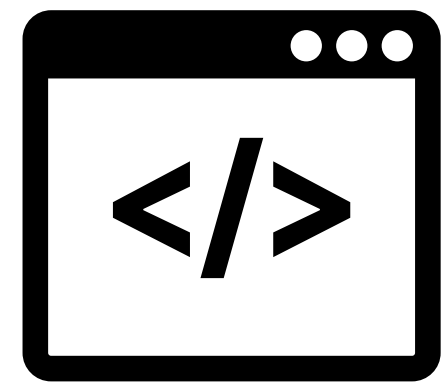


# Installation schedule

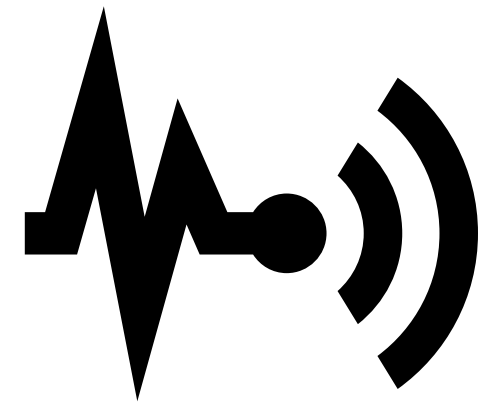
With the ToolScope modular assistance system, you can rely on Tyrolit to comprehensively optimise your grinding processes. With our experience of processes and tools, we are at your side and offer not just process expertise but also diverse service packages for tool and process monitoring and quality documentation.



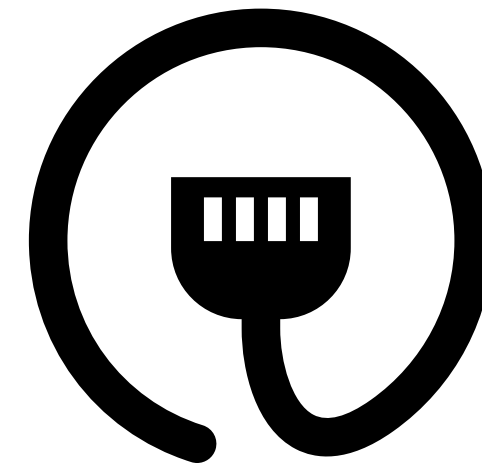
# Preparations by the customer



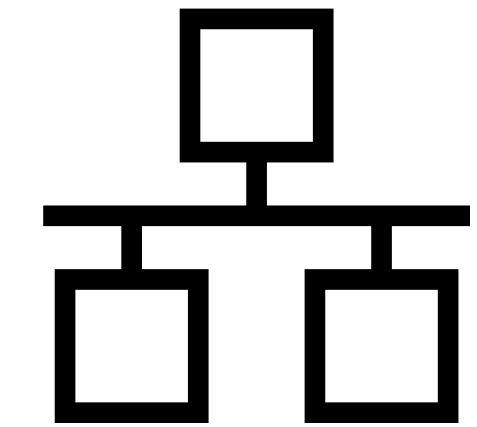
Procure PLC  
project



Fit sensors to the  
machine



Route cables into  
the machine



Prepare Ethernet  
connection

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