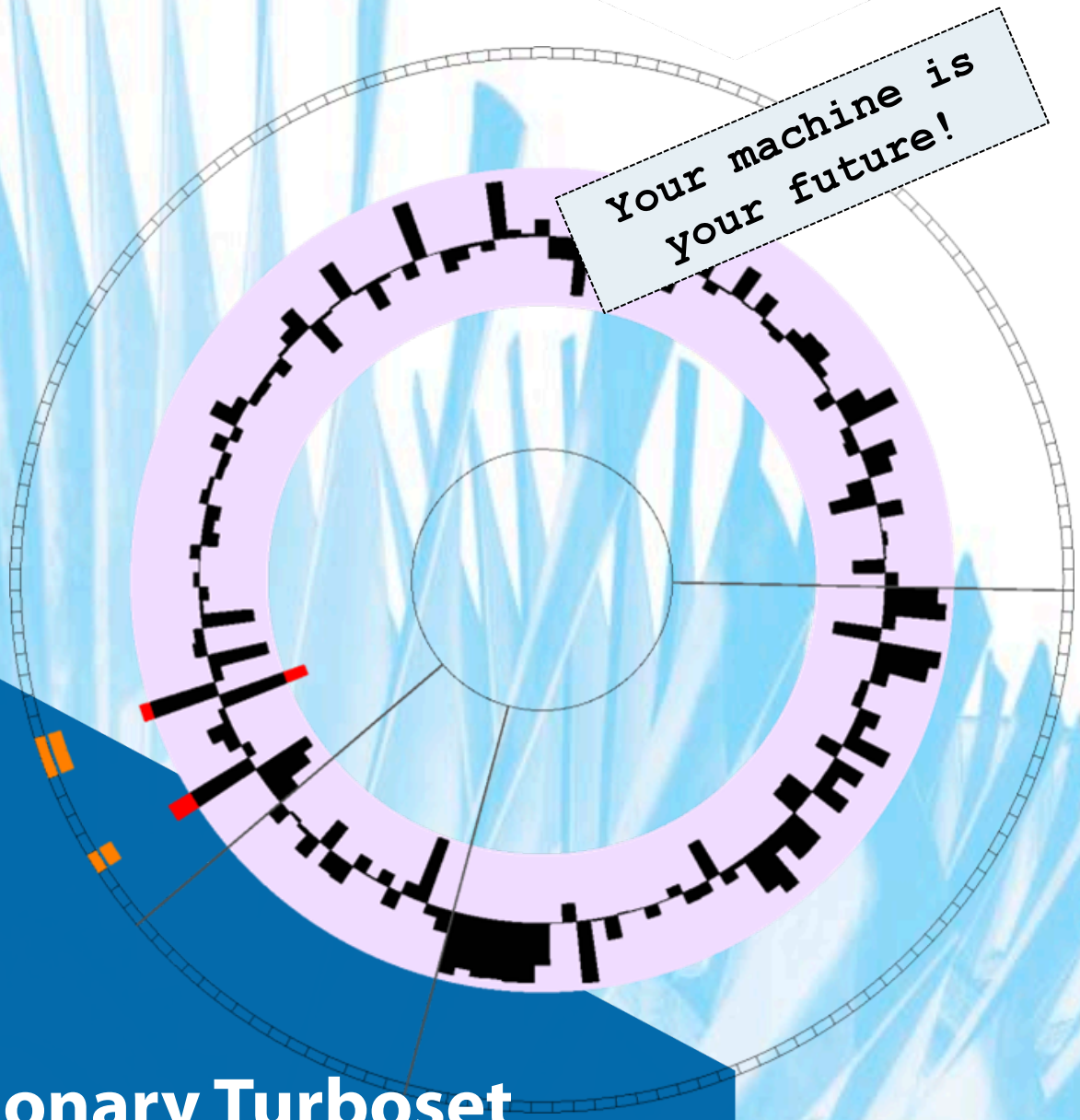


Stationary Turboset Diagnosis System STUDIS-SE

The new STUDIS-SE Condition Monitoring System combines intelligently networked data acquisition with self-learning data analysis to your ideal tool for early fault detection and damage prevention and thus protects the future of your Machine.

Siempelkamp

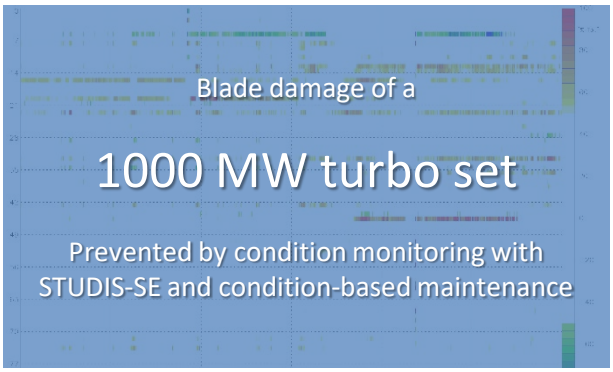
NIS Ingenieurgesellschaft

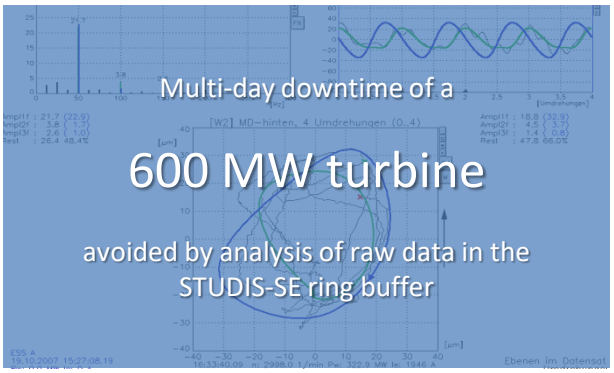
The generation of electrical energy is committed to supply security and economic efficiency. In order to achieve this, it is necessary to know the exact condition of your machines and to evaluate deviations from normal operating behaviour intelligently.

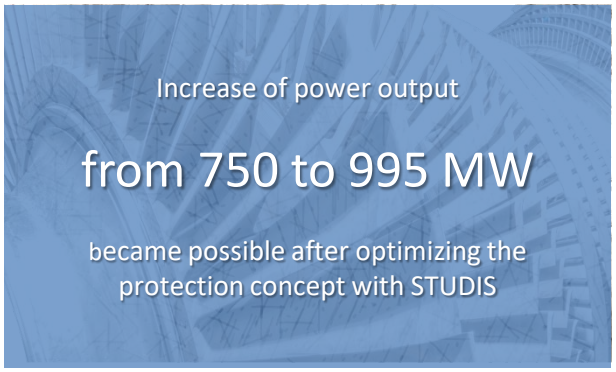
In addition to the main tasks of status assessment, early fault detection and fault analysis, STUDIS-SE supports you in operating the monitored systems optimally, avoiding undesirable operating states and thus enabling safe and economical operation.

In addition, the stored data can be accessed at any time to carry out analyses by experts.

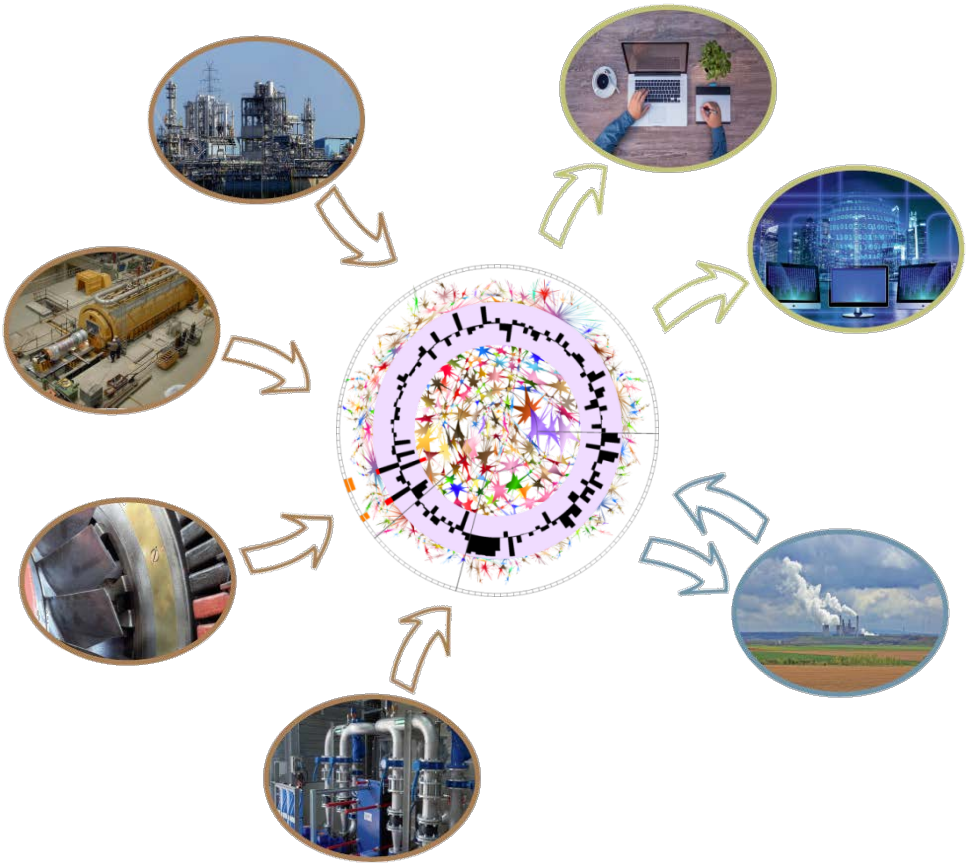
STUDIS-SE relieves you of routine evaluations of conditions whose appearance and cause-effect relationship are known. In this way you can make your work more effective.







Signal acquisition level



Through the clever networking of galvanically decoupled acquisition units, STUDIS-SE enables you to record vibration data decentrally close to your machine as well as centrally in the control room. Potential losses and interferences are thus reduced to a minimum. Evaluations can be carried out at any standard workstation without compromising the safety of your machine at risk.

In addition, by maintaining a connection to the Siempelkamp NIS service computer, our experts can perform online diagnostics at any time.

In addition to machine signals, process signals already available in the control system can be adapted to STUDIS-SE. The coupling of the control system level to STUDIS-SE is protected by the existing standard control system interfaces.

We have set high standards for the usability of STUDIS-SE: the untrained user can access the important information in just a few steps. The expert will find a very flexible and comprehensive toolbox that allows him to carry out detailed evaluations in a simple way.

Modular design

Modular scalable system

All modules can access the central core of STUDIS-SE. The structure of the modules is based on the function groups of your machine. Modules from other manufacturers' systems can also be integrated.
The modular structure of the systems is an ideal basis for planning the investment as well as for later extensions. The interfaces are open and comply with current standards.

The modular and scalable STUDIS-SE:

Data acquisition
Data qualification
Visualization
Analysis and Diagnosis

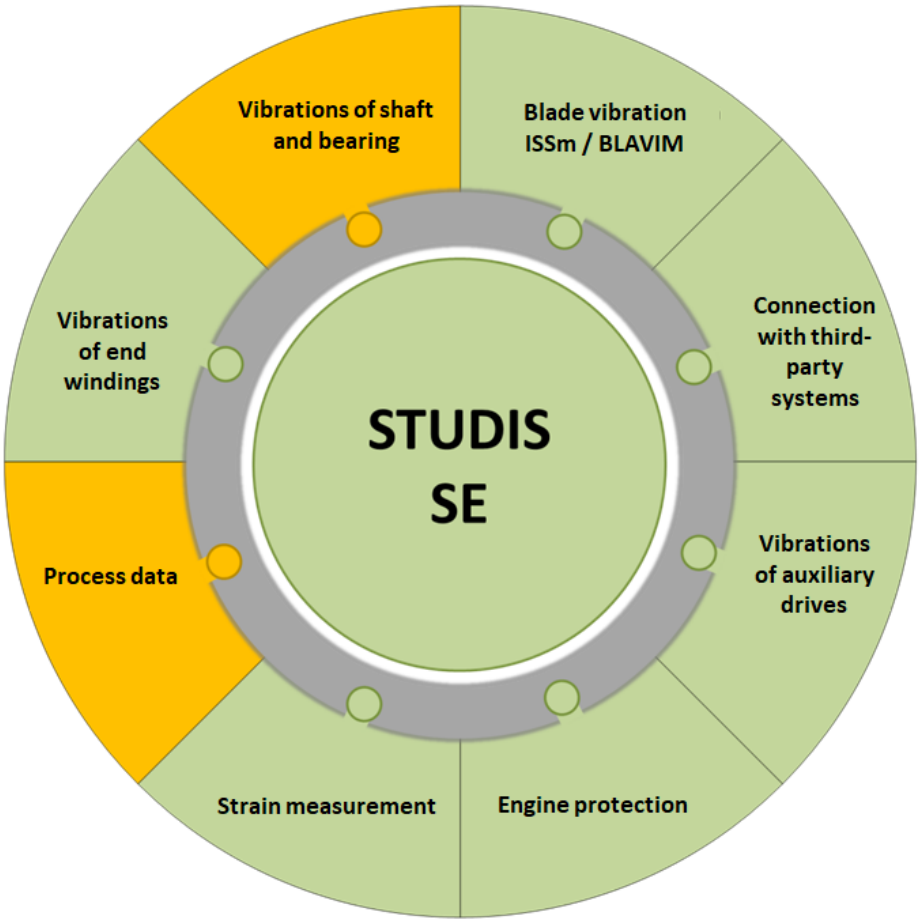


Figure 1: Modularly scalable structure

Acquisition hardware

Fast acquisition of measured values with the MDS-100 front end

The temporally demanding recording of vibration signals is carried/out by a front end that transmits its data to the STUDIS server via network. Measuring points that are used for operational monitoring on the control station can also be used for STUDIS-SE. The STUDIS-SE server is responsible for the further processing of the data as well as for visualisation, storage and diagnosis.

Continuous recording of measured values

The system is capable of continuously and simultaneously recording any number of analog channels via the control system interface or via a separate AD conversion. The vibration signal for rotating machines is continuously recorded with 256 samples per revolution. The scans are evenly distributed over one shaft rotation and are saved in a ring buffer which is controlled via a key phasor signal

Intelligent data compression

For long-term monitoring and to improve the reproducibility of the plant condition an intelligent operating point-dependent data compression takes place.
It is therefore possible for the behaviour of the machine to be documented for an unlimited period (depending on the mass storage device) and for fault-related slow changes to be recognize.
In addition, data records that are measured every second can parallelly be held in reserve for further indepth analyses.

Monitoring

Early fault detection and long-term monitoring

For optimum operational management, it is important to detect and assess subtle changes in measured variables. These do not necessarily have to be fault-related, but can be based on contamination, for example. In order to detect these subtle changes at an early stage, quality-assured operating point-adjusted assessment variables must be used over an appropriately long observation period. Since this is easily possible with STUDIS-SE, the operating personnel can be supported in choosing the optimum time for maintenance or cleaning. For the calculation of the remaining service life of highly stressed components of steam turbines, the operator has to provide information on the pressure and temperature load over time. With STUDIS-SE the stress and duration can be determined online. As a result, operators, manufacturers and assessors have very precise stress statistics at their disposal.

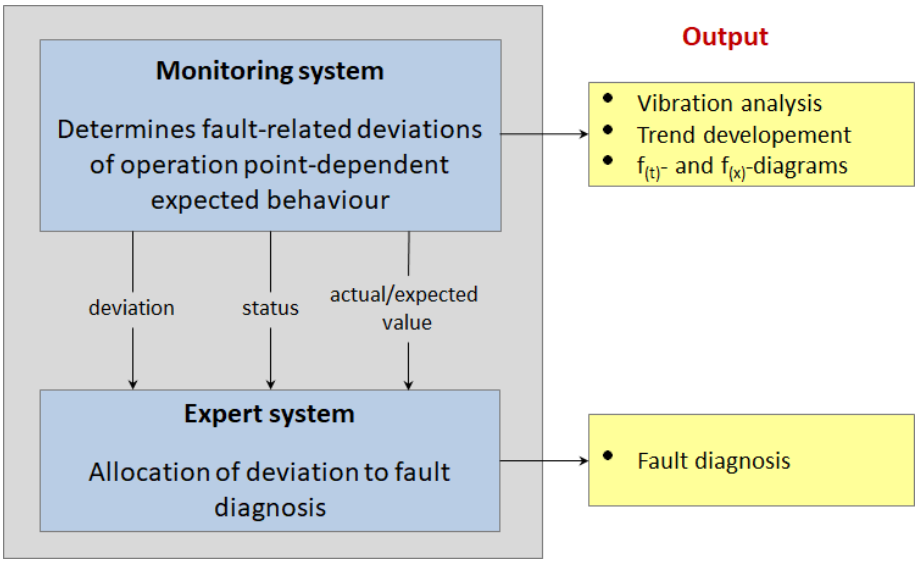


Figure 2: Relation between monitoring and diagnosis

Monitoring and diagnosis

The monitoring system records all measured values within a measurement cycle, generates frequency and order analyses and performs a quality check. Furthermore, the measured values are checked and evaluated and an operating point-dependent comparison between expected and actual behaviour is carried out. The results of the comparison are transmitted to the expert system. The expert system links the detected deviations to fault diagnoses using predefined rules.

Diagnosis with expert system

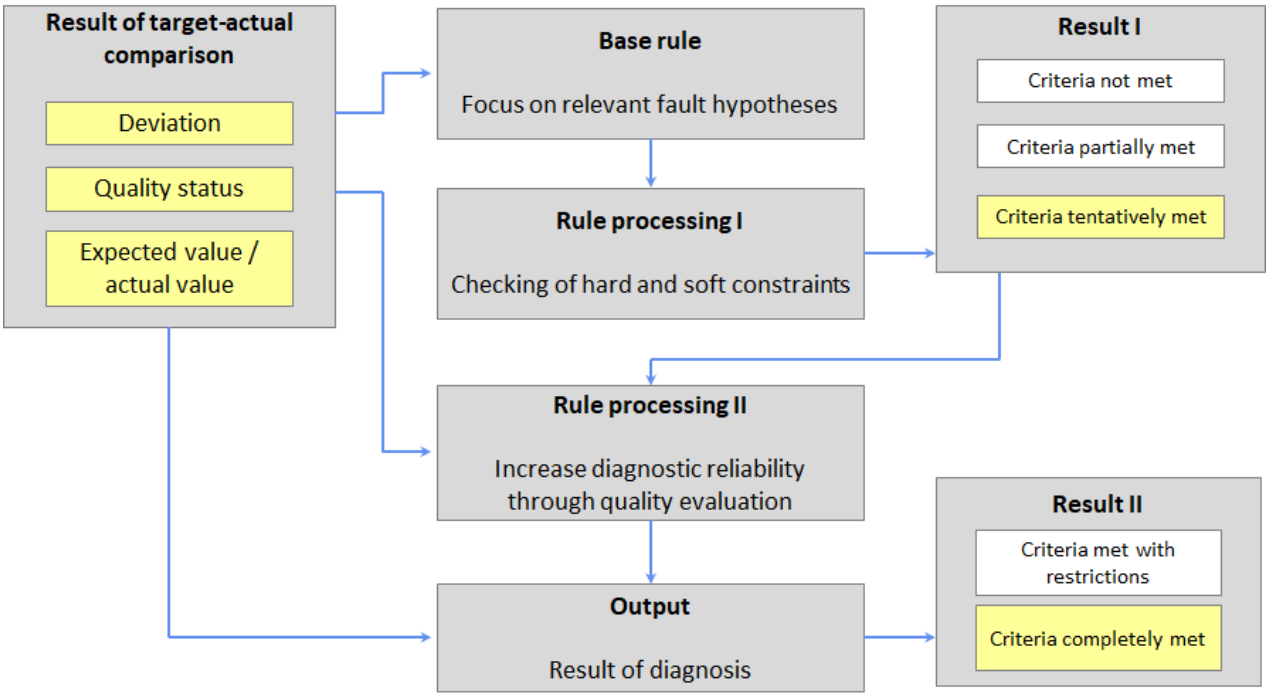


Figure 3: Schematic sequence diagnosis

Fault diagnosis with rule-based expert system

One of the essential features of STUDIS-SE is the rule-based expert system. In contrast to many diagnostic systems from other manufacturers, in which all error rules are processed event-controlled or time-controlled, STUDIS-SE only processes rules of error hypotheses whose premises have a significant deviation from the expected value. This allows error hypotheses to be confirmed online particularly effectively.

The processing is initially carried out for periods of stationary operation in a thermally balanced state. The measured and evaluated values are subject to a graduated quality control. The result is taken into account in the further evaluation of the diagnosis. For the evaluation by the expert, the diagnostic result is documented with all the information obtained during the diagnostic process. This makes it possible to trace the diagnosis or to adapt diagnostic rules to newly gained knowledge.

Highly compressed presentation of information

Evaluation of the machine behaviour

STUDIS-SE predominantly utilizes automatic systems for the detection of non expected machine behavior.
Criteria can be formulated by which the evaluation is controlled and messages are sent to authorized persons. If deviations occur, they can be evaluated with the powerful analysis tools of STUDIS-SE.

STUDIS “magic eye“

A highly compressed information display is used for online assessment of the current machine status, the "magic eye" (Figure 4), in which each configured value is displayed in a standardized manner with reference to its own tolerance band. The magic eye can display up to 1,200 variables with value, tolerance band and limit value exceedance. On the outer circle, coloured flags indicate that a limit value violation has occurred within the last 24 hours.

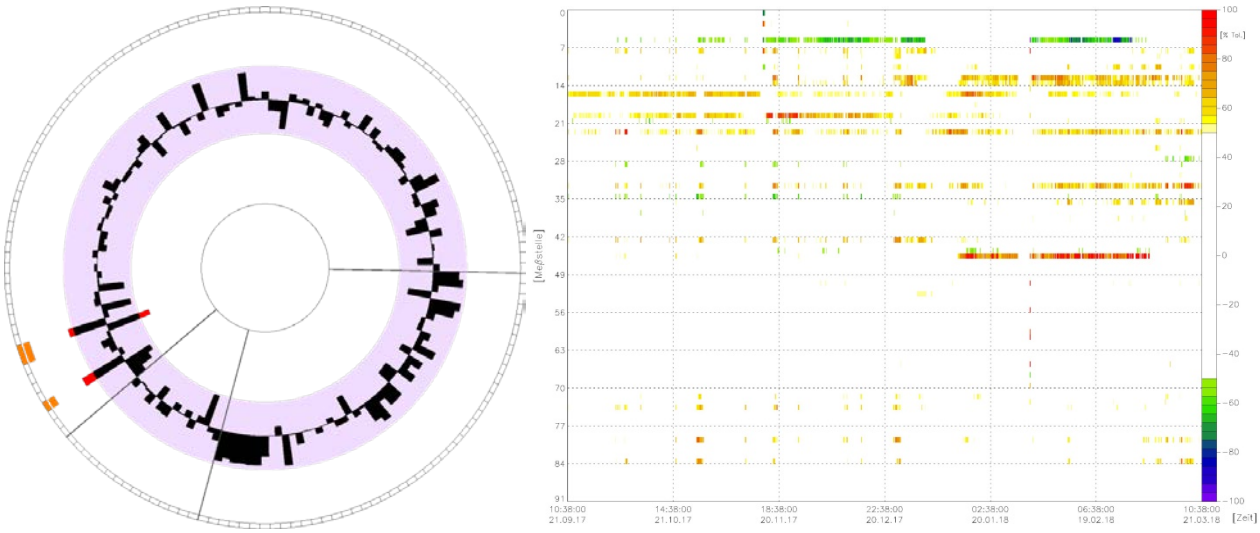


Figure 4: STUDIS-SE "magic eye

Operating point-dependent tolerance band

Measured and calculated values are normalized to the individually defined tolerance band around the operating point-dependent expected value. Due to the dynamic tolerance band monitoring, it is possible for you to detect even small fault-related deviations at an early stage.

Graphical report

In the graphical report, changes in the deviations from the expected value are highlighted in color.

For quantities whose values lie within the dynamic tolerance band, the corresponding area remains white.

Visualization examples

Modern visualization technology with high flexibility

All measurement and evaluation variables can be represented as a function of time or as a function of any other variable. The data can be visualized according to individual selection criteria, whereby characteristic curves and reference periods can be stored. Each generated image can be used again as a template for further freely configurable graphics.

Waterfall display

The waterfall diagram shows frequency analyses of vibration signals one after the other.
The view can be rotated in space as required.
Each line can be examined in a separate window.

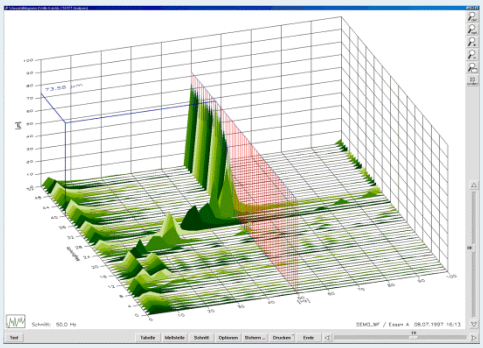


Figure 5: Waterfall display

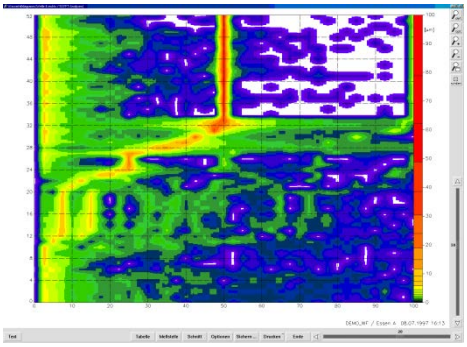


Figure 6: Spectrogram

Spectrogram

A characteristic of the waterfall diagram is the spectrogram, where the color gradient represents the amplitude height. The color scale can be selected logarithmic, square or exponential. The scale can be expanded by hand at a later date.

Weekly, monthly and quarterly reports

The weekly report shows deviations of the turboset parameters from the expected value, whereby the parameter and the reporting period can be freely defined.

Frequency Analysis

In the upper part of the diagram, the time signal or the frequency analysis can be displayed. In the lower area the trajectory of the theoretical centre of the wave during the wave-rotation shown. The trajectory can be set with displayed references, as online representation or animated over any period of time will be.

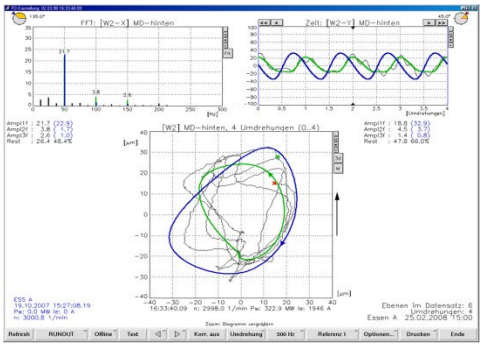


Figure 7: Frequency analysis

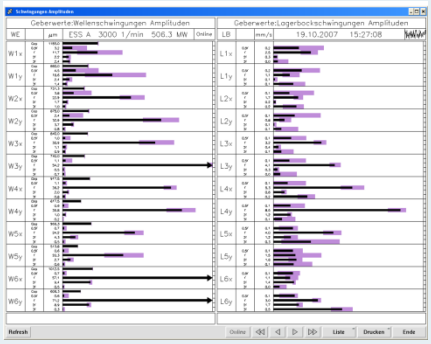


Figure 8: Bar chart

Bar chart

For each measuring plane, the variables Gap, 0.5f, 1f, 2f and 3f as well as the operating point-dependent tolerance bands and limit value exceedances are displayed for the shaft vibrations of the X and Y direction. You can also proceed in the same way with process variables.

Bode diagram

In the Bode diagram, vibration quantities with magnitude and phase can be displayed simultaneously as a function of speed. In addition, reference values and speed-dependent tolerance bands can be displayed.

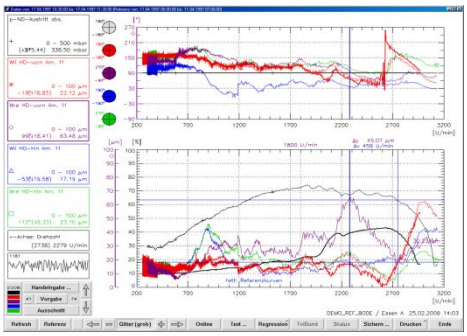


Figure 9: Bode diagram

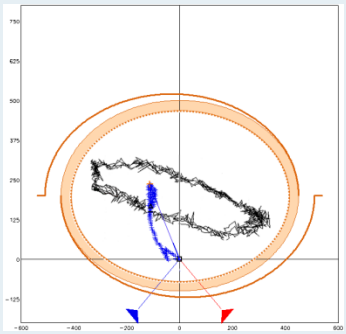


Figure 10: Shaft Centerline

Shaft Centerline

The shaft centerline, also known as static shaft position or Gümbel curve, represents the relative course of the shaft center to the bearing during run-up, run-down and operation. Together with the shaft orbit and bearing clearance, which is also shown, the distance of the shaft to the bearing shell can be determined and monitored.

Nyquist overview and locus curve display

In the Nyquist diagram or the locus display, each vibration signal is displayed with amount and phase. For assessment purposes a change pointer can be toggled.

In the Nyquist overview, the display of several measurement levels in a single picture is possible. For the online display tolerance bands can be displayed, if desired. In addition to the standard control panel there are tools for containment, marking and evaluation of the results available in the Nyquist diagram.

It is also possible to combine Locus curve display and display over time in a single display. The cursors in all views are synchronized.

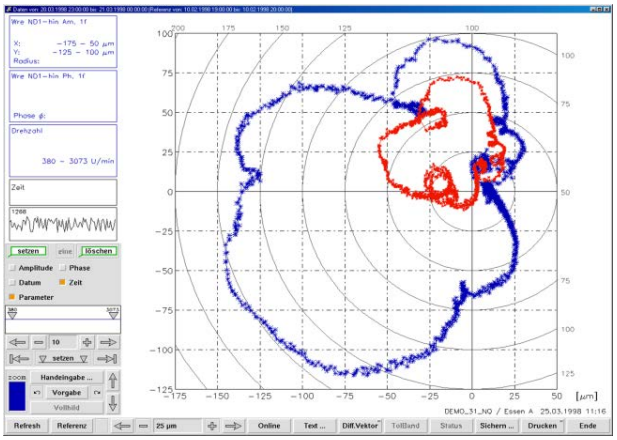


Figure 11: Location curve display

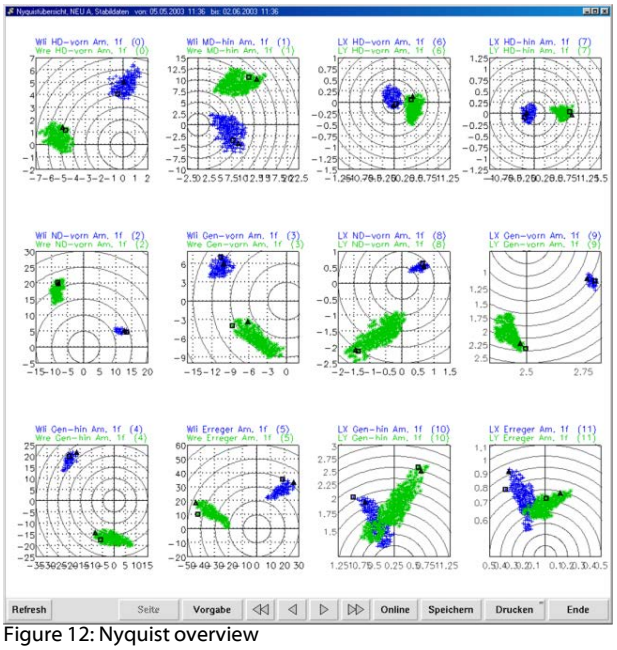
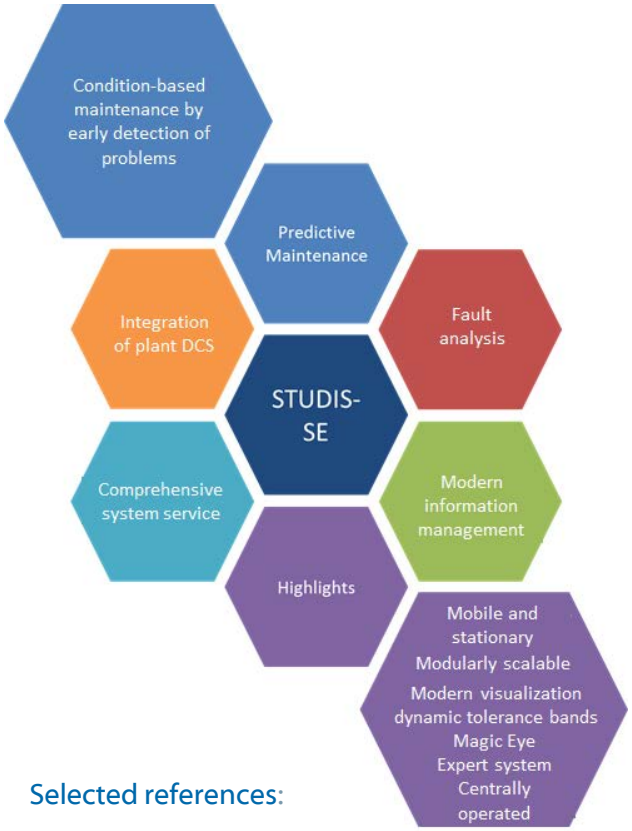


Figure 12: Nyquist overview



Selected references:

- KW Weisweiler
- KW Huckingen
- KW Gersteinwerk
- KW Emsland
- KW Westfalen
- KW Knappsacker Hügel
- KW Denizli
- KW Neurath
- KW Niederaussem
- GuD Bayer Dormagen
- KW Köln Niehl
- KW Ibbenbüren
- GuD BASF Ludwigshafen
- Solvay Ltd
- KW KEO Rüsselsheim
- KW Eemshaven
- KW Walsum

Technical details

- Modular system design
- Continuous vibration detection without time gaps
- Power supply 24 - 38 VDC
- Frontend buffer depth up to 256 seconds
- 4 fast and 4 slow inputs per frontend (MDS-100)
  - Fast inputs: 16,000 samples/second, 512 samples/revolution in keyphaser mode
  - Slow inputs: 4 samples/second
- Resolution 12 bit for slow inputs/ 16 bit for fast inputs
- 2 free process data inputs ±10 V/0...20 mA
- Input resistance 0.5 MΩ/1 MΩ at 30 pF Input capacitance
- Complete galvanic isolation of all inputs and outputs
- Network-oriented system, visualization at the workplace without additional software (rdp)
- Long term storage of the server data for more than 10 years
- Ring buffer for raw data (256 samples per revolution per Sensor) for several weeks
- Firmware updates and software modifications possible via network
- Further developments fully compatible to older systems

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Intelligent engineering
for future generations.

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