Thermoline

Fundamentals of Heat Transfer

Overall didactic concept for targeted teaching on the fundamentals of heat transfer.

- accurate measurements
- software-controlled
- training software

The series for a simple introduction to a complex subject.

Overall Didactic Concept

Heat transfer between substances takes place whenever there is a temperature difference between these substances. This effect occurs constantly in everyday life.

Essentially there are three forms of heat transfer:

Convection
describes heat transfer in flowing liquids or gases

Conduction
describes heat transfer within a solid or a stationary fluid

Thermal Radiation
describes heat transfer by electromagnetic radiation

The different forms of heat transfer often occur together. The illustration of the fireplace shows all forms of heat transfer from a single heat source

Special experimental setups are required to investigate individual forms of heat transfer.

The Thermoline series allows you to conduct experiments for a detached analysis of the various forms of heat transfer, thereby establishing the necessary fundamental knowledge of thermal energy transfer.

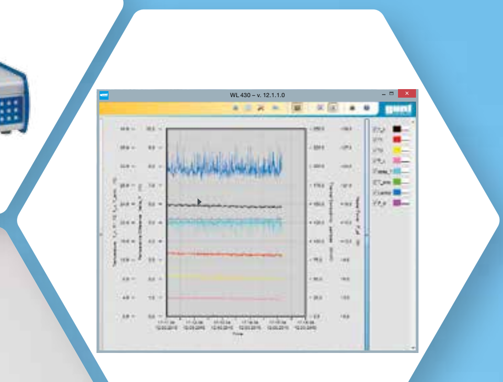
Using our educationally beneficial overall concept, we help you teach the fundamentals of heat transfer.

Our innovative and powerful software is an integral part of the training system for visualising the thermal processes in the various forms of heat transfer.

The software enables a unique form of representation and helps students to conduct and evaluate experiments. The software deliberately helps to create a link between practice and theory.

To complete our overall didactic concept, every experimental unit of the Thermoline series includes multimedia training software which supports students in the preparation and follow-up of experiments. The training software enables independent learning of the theoretical fundamentals and, through explanatory texts, illustrations and moving images, contributes to understanding of the topic.

Training system



Data acquisition

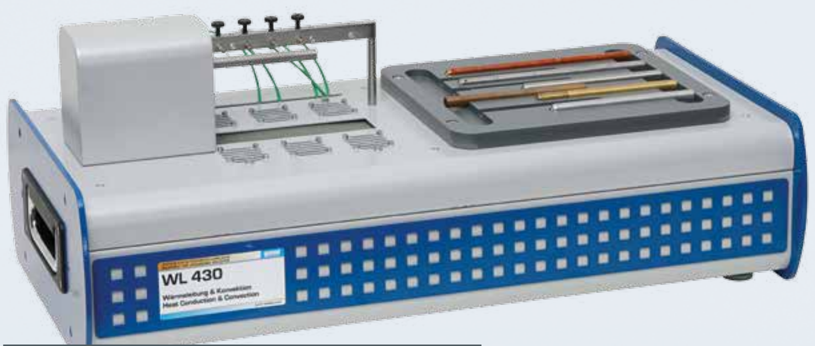
Training software

Real technical components

Connecting theory and practice creates the foundation for understanding complex technical relationships.

Thermoline:
Mechanisms for Heat Transfer

WL 420 Heat Conduction in Metals



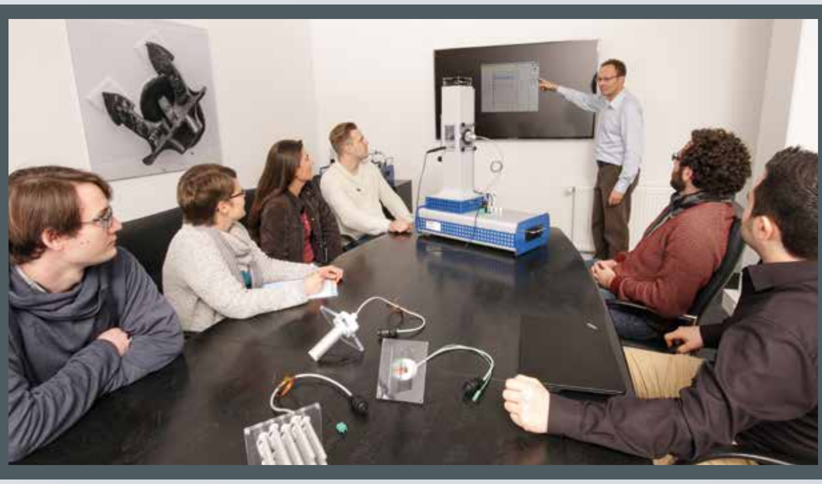
WL 430 Heat Conduction and Convection

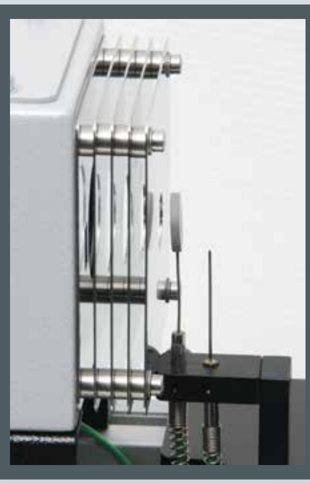
WL 460 Heat Transfer by Radiation

WL 422 Heat Conduction in Fluids

WL 440 Free and Forced Convection



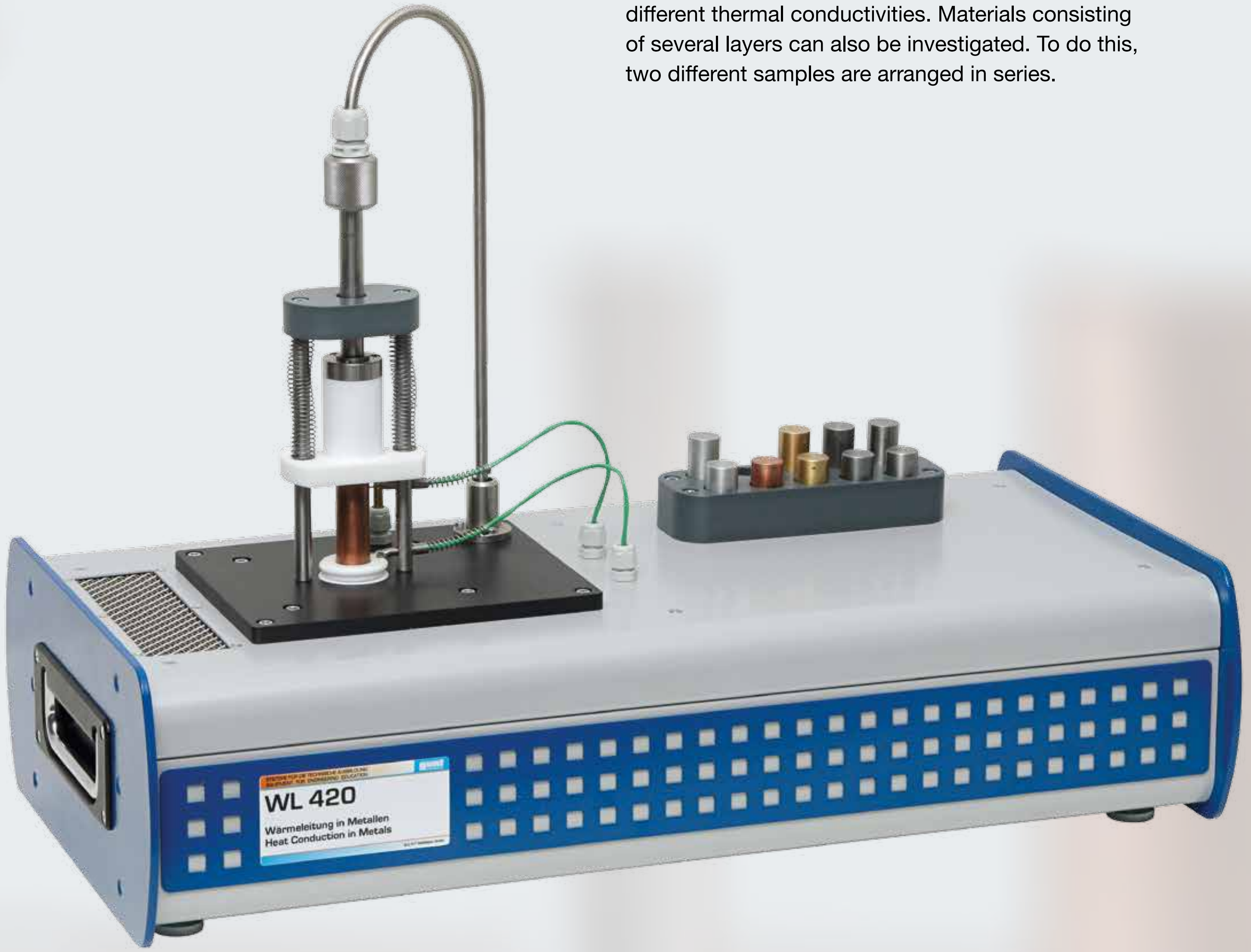


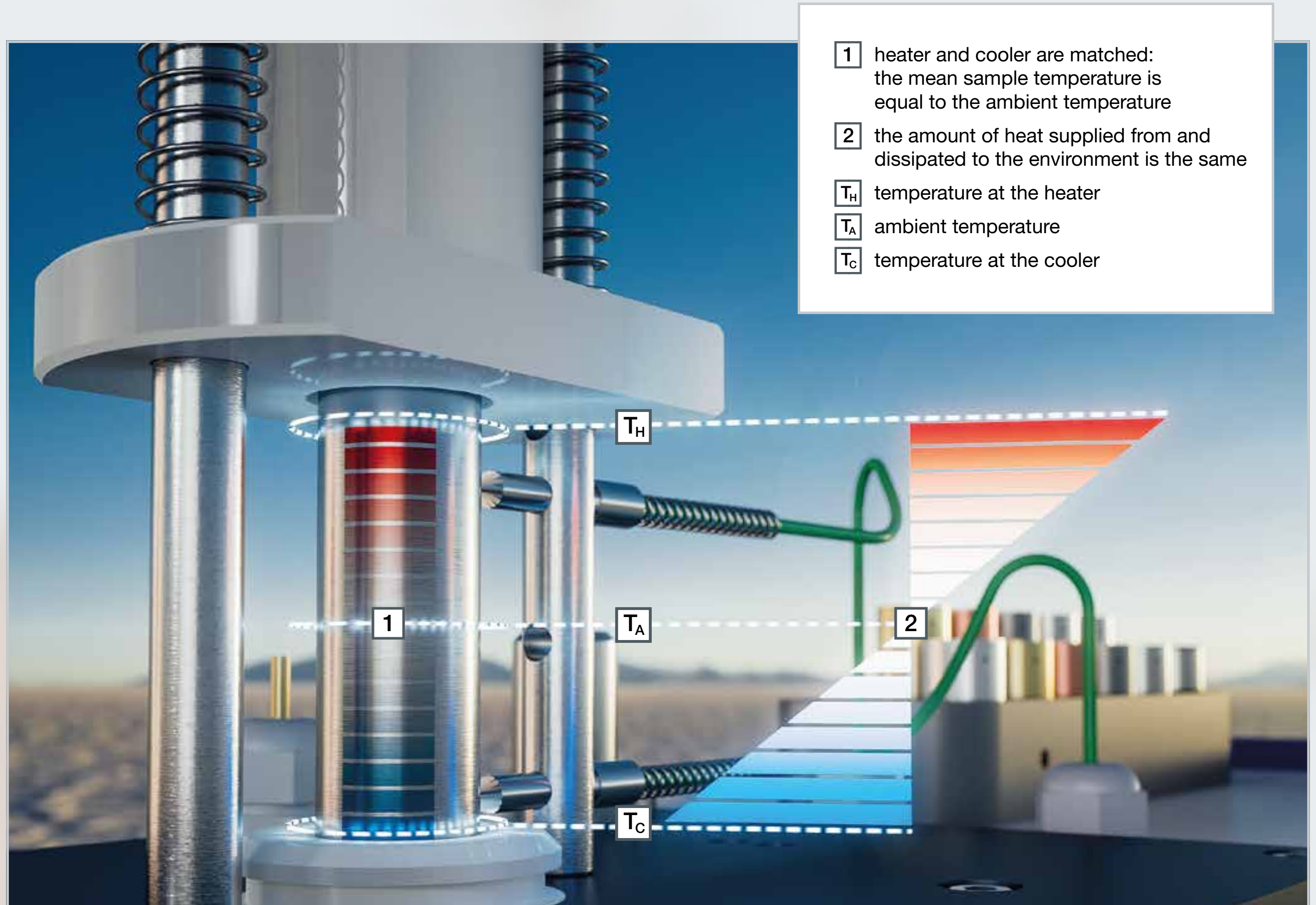
WL 420 Heat Conduction in Metals

The upper region of metallic samples is heated by an electrical heater and the lower section is cooled by a Peltier element. This results in a heat flux from the hot side to the cold.

A certain temperature difference is required to maintain the heat flux, depending on the thermal conductivity and length of the sample. The temperature difference is measured and is an indicator for the thermal conductivity.

The various metallic materials make it possible to determine different thermal conductivities. Materials consisting of several layers can also be investigated. To do this, two different samples are arranged in series.





Accurate measurement

- thermal disturbance variables are minimised

Quick experiments

- the required temperature difference is quickly reached thanks to active cooling
- no cooling water is required

Learning objectives/experiments

- time dependency until the steady state is reached
- determine thermal conductivity of various metals from measured values
- determine thermal resistance of an object
- study heat transfer with different materials connected in series

Product No.
060.42000
More details and technical data:
gunt.de/static/s5490_1.php

WL 422 Heat Conduction in Fluids

The measurement of heat conduction in fluids is very demanding due to the relatively poor conductivity and associated low heat fluxes.

Two cylinders form the main component of the experimental unit: an electrically heated inner cylinder situated in a water-cooled outer cylinder.

There is a concentric annular gap between the two cylinders. This annular gap is filled with the fluid being studied. The heat conduction occurs from the inner cylinder, through the fluid to the outer cylinder.

The narrow annular gap prevents the formation of a convective heat flux and allows a relatively large pass-through area while at the same time providing a homogeneous temperature distribution.

This method allows the thermal conductivity of liquid and gaseous fluids to be investigated.

Learning objectives/experiments

- determine thermal conductivity in fluids
- determine thermal resistance of fluids
- interpret transient states during heating and cooling
- introduction to transient heat conduction with the block capacity model

Accurate measurement

- special shaping of the inner cylinder and the water flow in the outer cylinder result in a homogeneous temperature distribution
- the special structure of the experimental setup leads to low parasitic heat fluxes and low disturbance variables

Quickly reach the steady state

- low masses of inner and outer cylinder allow rapid heating
- patented pressure balancing piston allows constant pressure in the fluid when heating

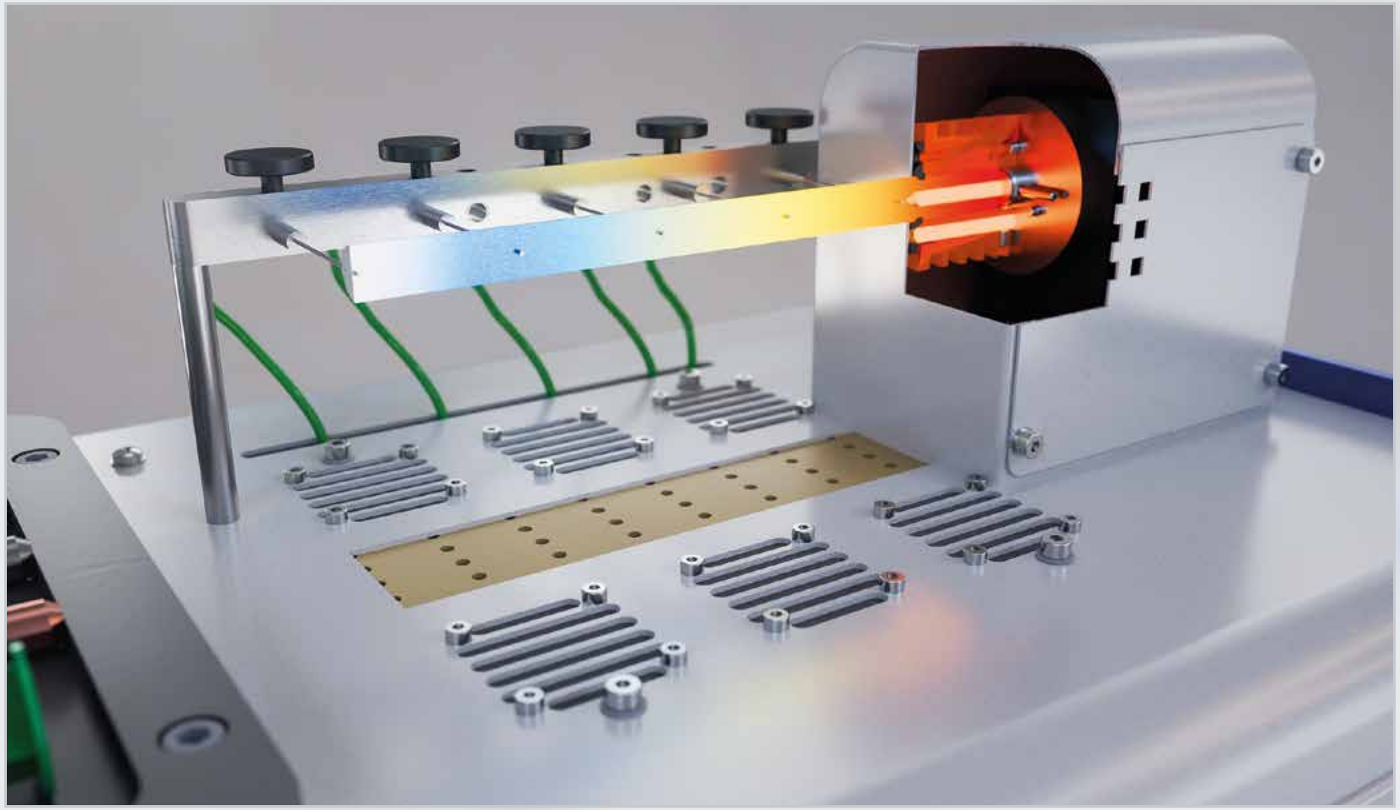
Product No.
060.42200
More details and technical data:
gunt.de/static/s5491_1.php

WL 430 Heat Conduction and Convection

The experimental unit demonstrates the combination of heat conduction and convection using the example of a cooling fin. The typical temperature profile along a cooling fin is shown.

A metal round rod heated on one side serves as a model for the cooling fin. The heat is conducted through the round rod and dissipated to the ambient air. In addition to performing the experiment with still air (free convection), experiments can be performed with flowing air (forced convection) by using a fan.

Different materials and dimensions of the round rods as well as freely selectable flow velocities allow for a wide variation of the essential parameters.

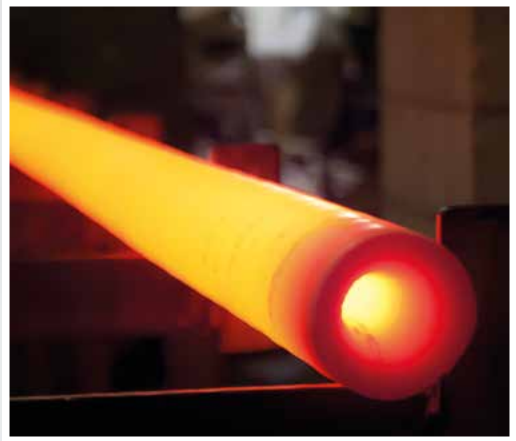


Accurate temperature measurements

- active thermal insulation of the heater reduces unwanted heat fluxes
- minimum interference of the flow and temperature field thanks to components matched to each other

Optimum experiment conditions

- position of the sample in an open environment allows for optimum realisation of free convection in still air



Learning objectives/experiments

- comparison of free and forced convection
- investigate convective heat transfer in flowing fluids
- investigate heat conduction in metallic materials with different thermal conductivities

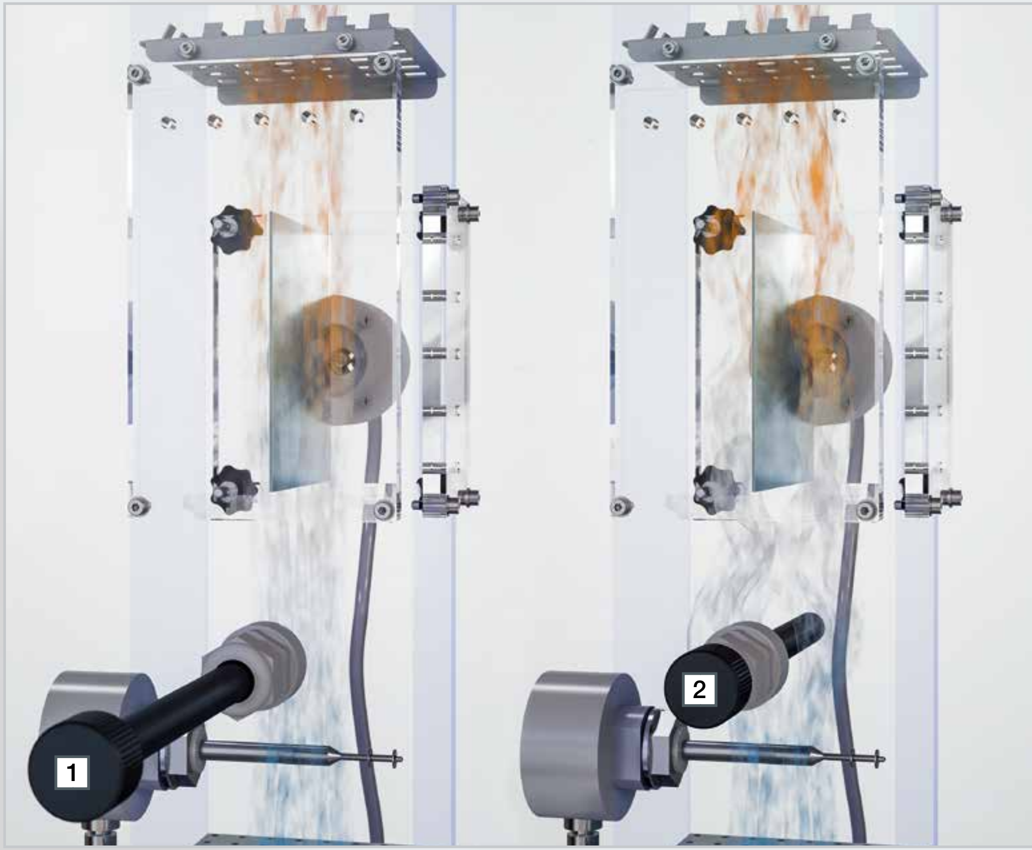
Product No.
060.43000
More details and technical data:
gunt.de/static/s5492_1.php

WL 440 Free and Forced Convection

A vertical air duct in which the convection processes occur is the central component of the experimental unit. A fan draws in ambient air at the bottom end of the duct and guides it through the air duct.

Four different heating elements can be used in the air duct, which transfer their heat to the air. The heating elements have typical geometries such as tube bundle, flat plate or cylinder. The experimental unit is designed in a way that all of the heat introduced from the heating element is transferred to the air.

The experiments on these heating elements demonstrate how flow formation affects the heat transfer. Baffle blocks can be used to demonstrate the effects of turbulent flow on heat transfer.



Incident flow of a flat plate

1 unhindered incident flow
2 incident flow hindered by baffle blocks

Optimum incident flow to the heating elements

- turbulence in the incident flow leads to improved heat dissipation in the more distant fluid layers

Quickly reach steady states

- special design of the heating elements ensures rapid heating

Accurate measurement

- controlled mixing zone behind the heating elements for accurate measurements of the mean air temperature
- virtually all of the heat from the heating elements is transferred to the air

Learning objectives/experiments

- convective heat transfer at various geometries
- experimental determination of the Nusselt number in the experiment
- calculate typical characteristic variables of heat transfer

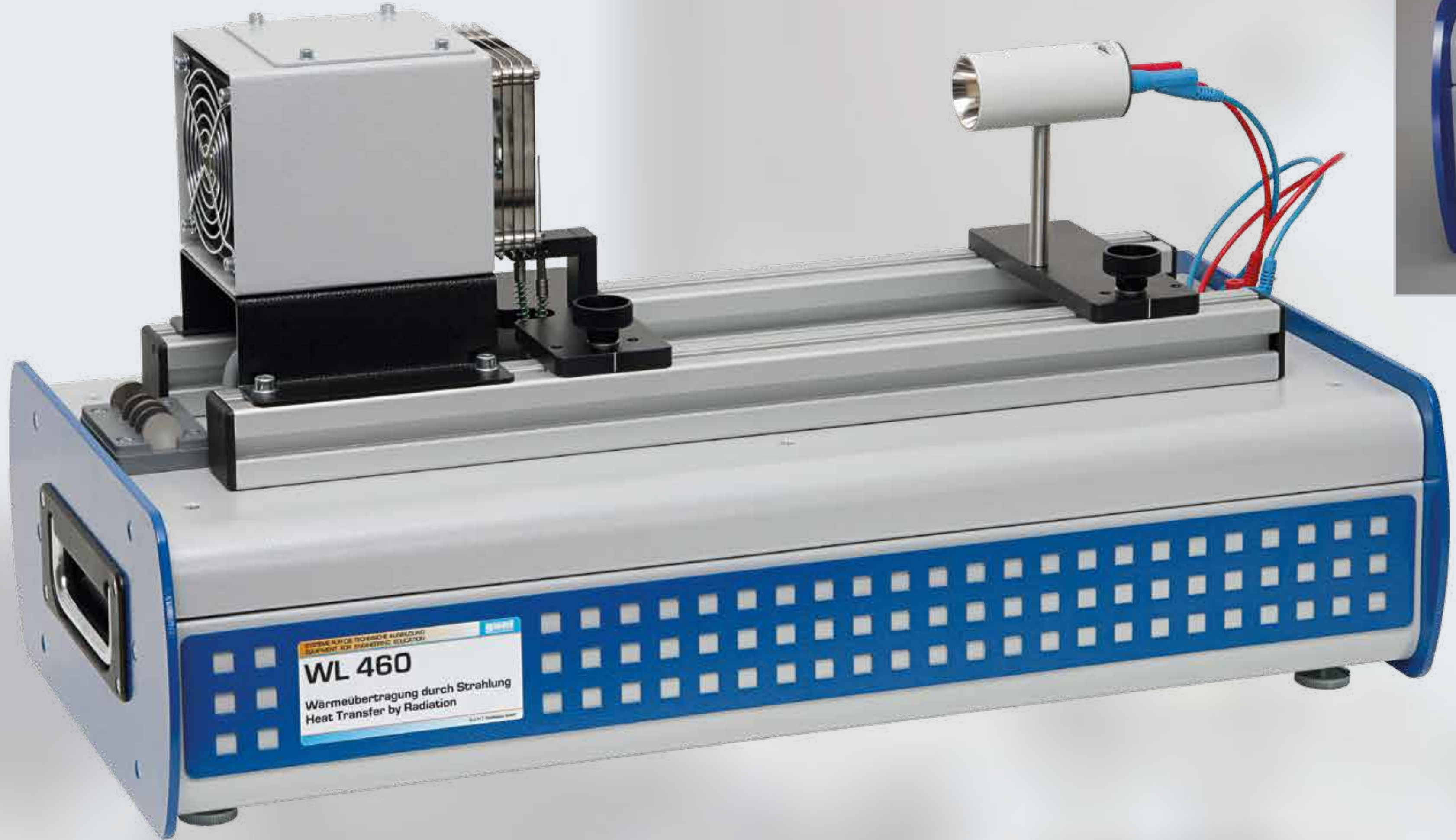
Product No.
060.44000
More details and technical data:
gunt.de/static/s5494_1.php

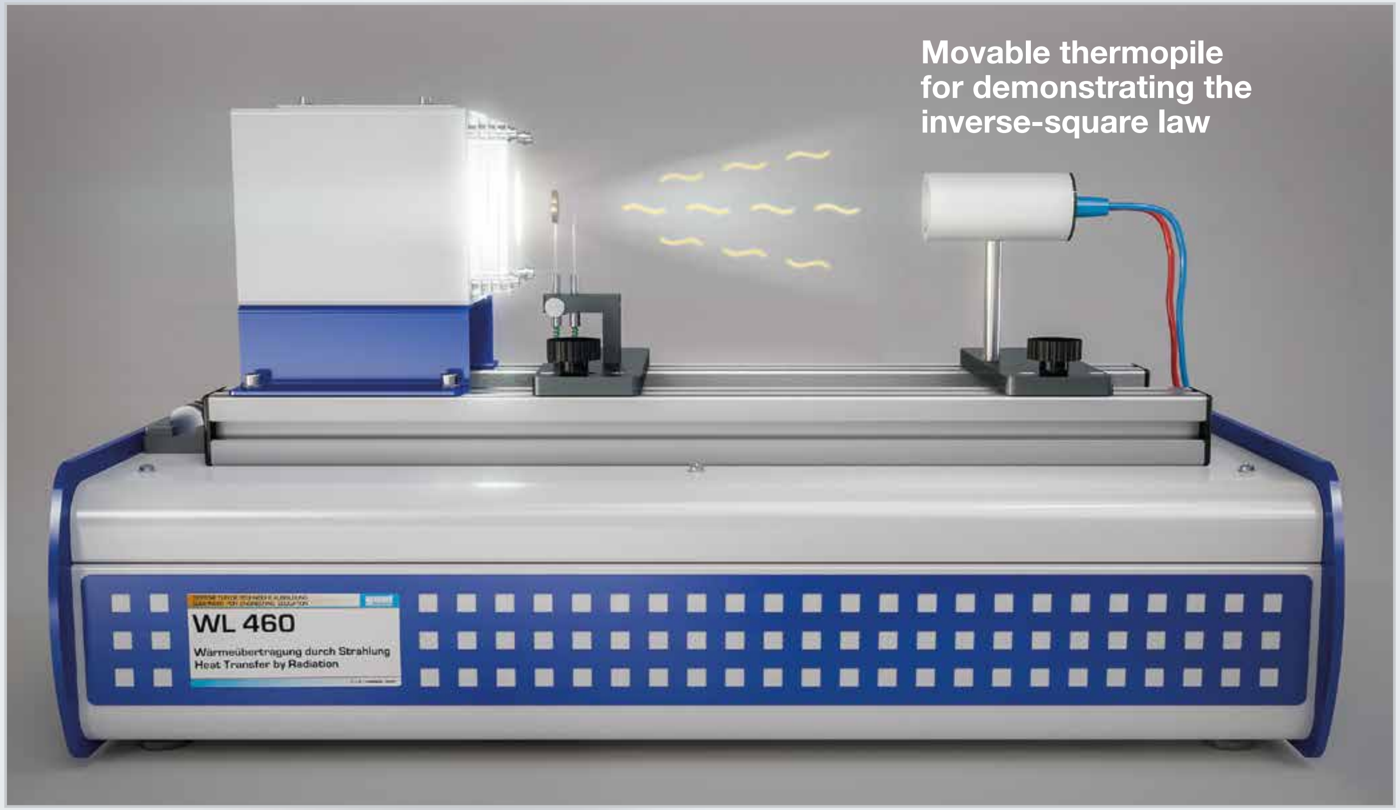
WL 460 Heat Transfer by Radiation

Experiments on heat radiation are demanding. In order to achieve sufficient radiant power, the radiating surfaces have to reach very high temperatures.

The main component of the experimental device is a thin, disc-shaped metal sample. One of different metallic samples is placed on a thermocouple and heated contact-free via a highly concentrated beam of light.

The thermal radiation emitted by the sample is measured by a thermopile. In order to be able to measure the radiation at different distances, the thermopile is mounted on a movable sled.





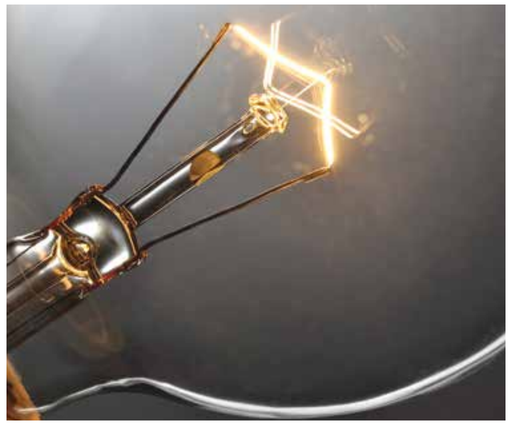
Movable thermopile for demonstrating the inverse-square law

Good measuring results

- minimisation of heat conduction at the samples
- insensitive to thermal disturbances from the environment

Quick experiments

- rapid heating of the samples by intensive heat radiation and small sample dimensions
- rapid cooling of the sample



Learning objectives/experiments

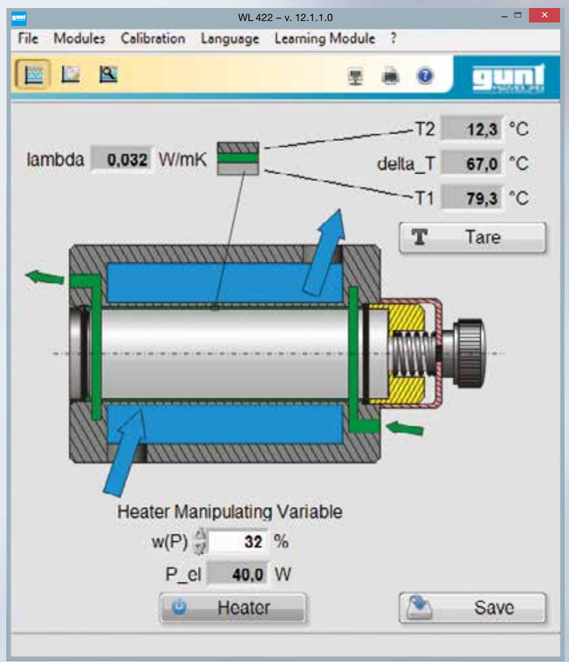
- Lambert's inverse-square law
- Stefan-Boltzmann law
- Kirchhoff's law
- study transient behaviour
- create power balances
- produce logarithmic diagrams

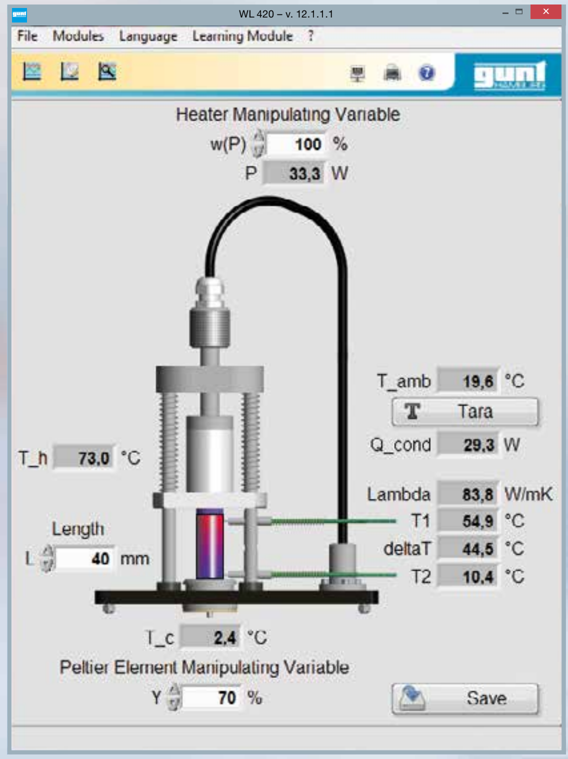
Product No.
060.46000
More details and technical data:
gunt.de/static/s5495_1.php

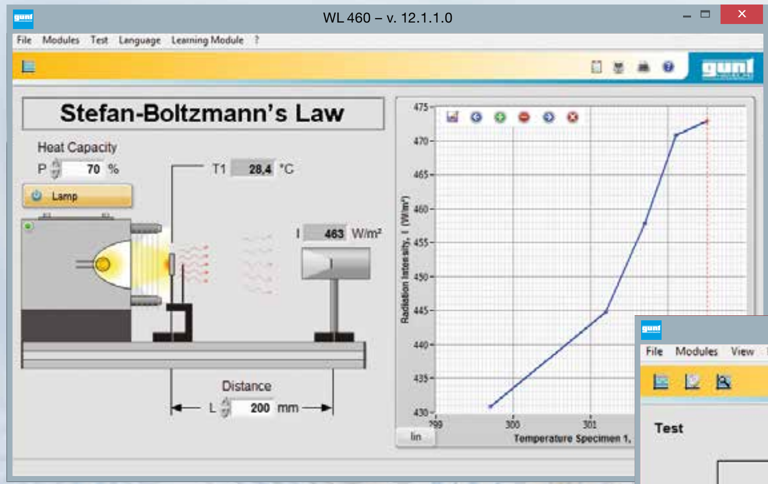
Operation and Data Acquisition

Operation

- simple operation of the system via the software
- adjust operating parameters via respective button icons
- check and read off measured values

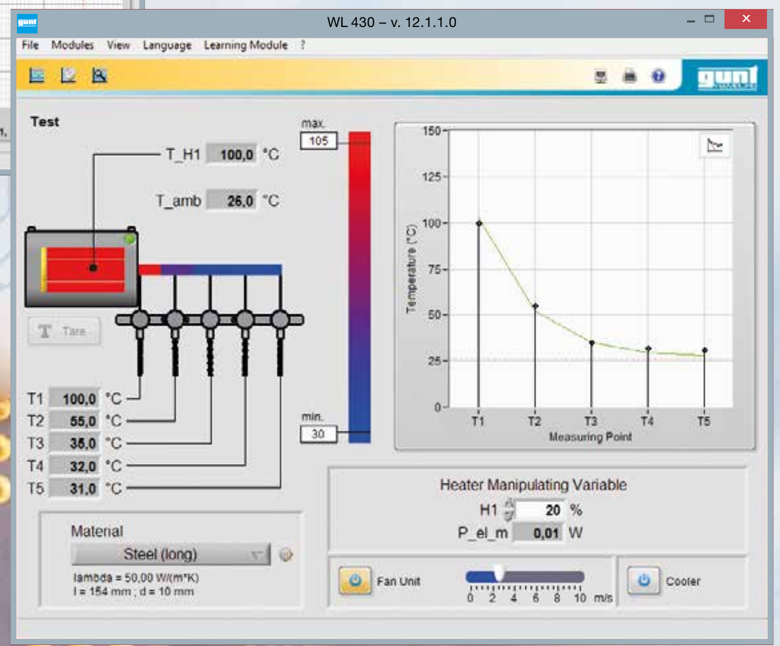


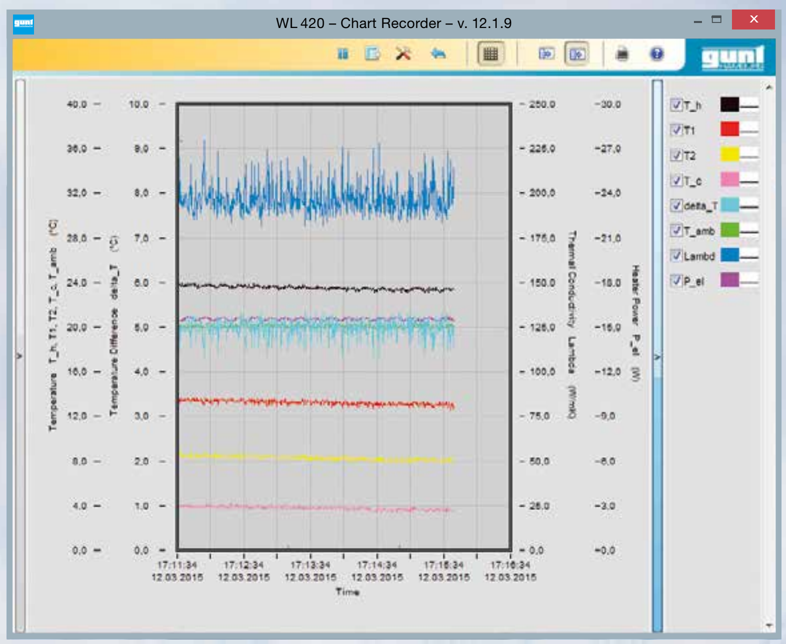




Geometric temperature curve

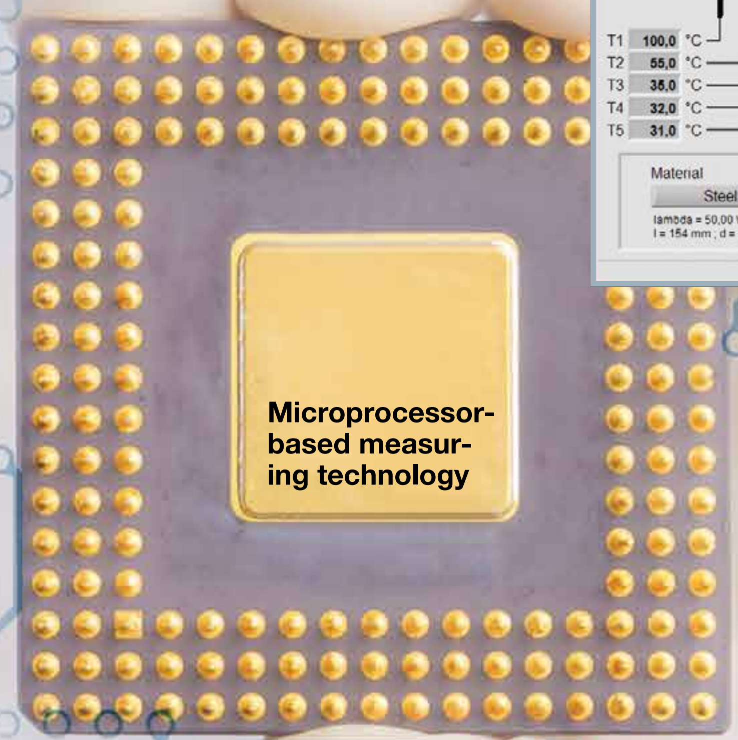
- representations of the temperature curves make it easier to understand the respective heat transfer mechanisms





Time dependency

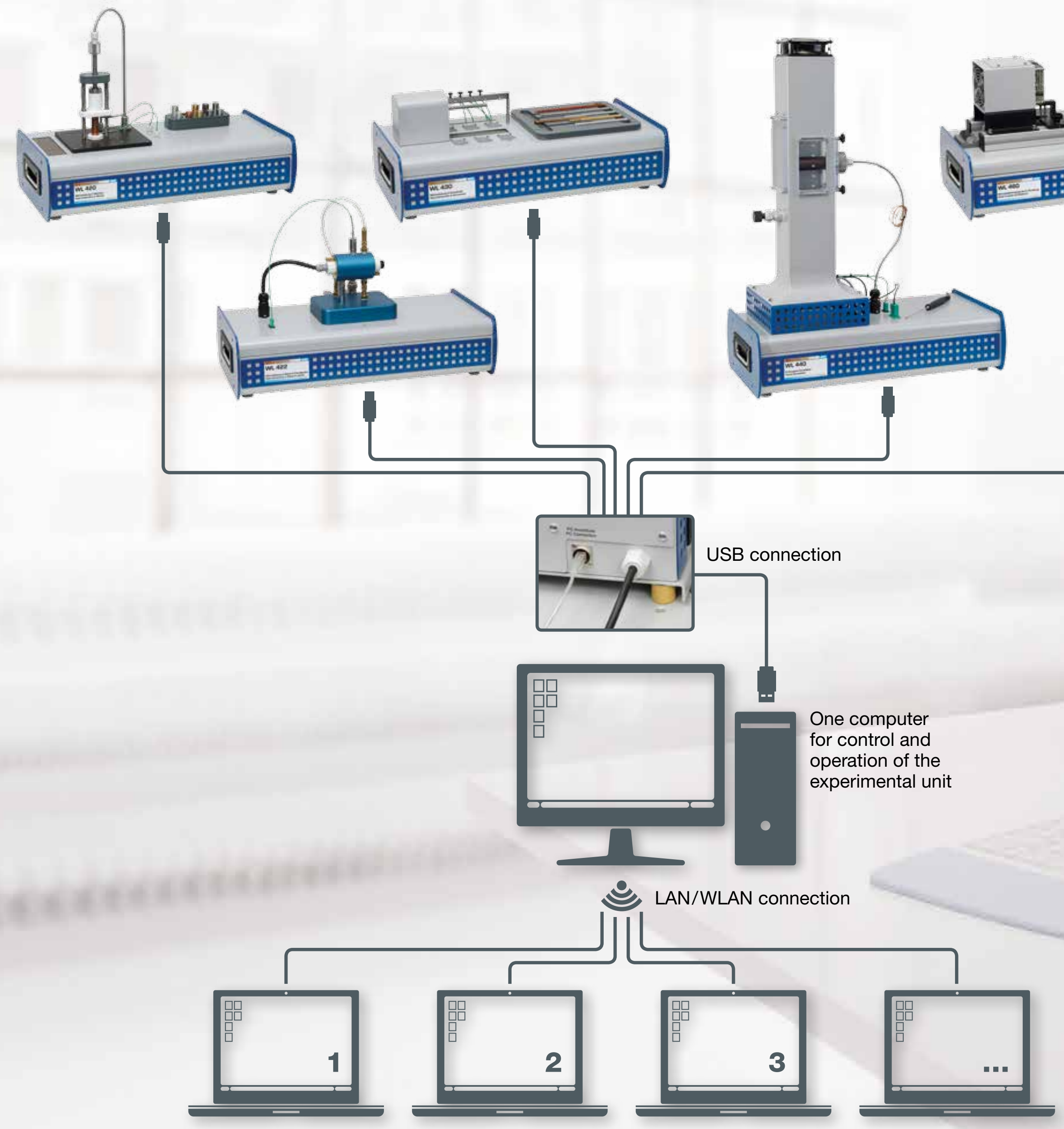
- representation of the measured values as a function of time
- plot and log your own characteristics
- freely selectable form of presentation of the measured values
  - measured values selection
  - resolution
  - colour
  - time intervals



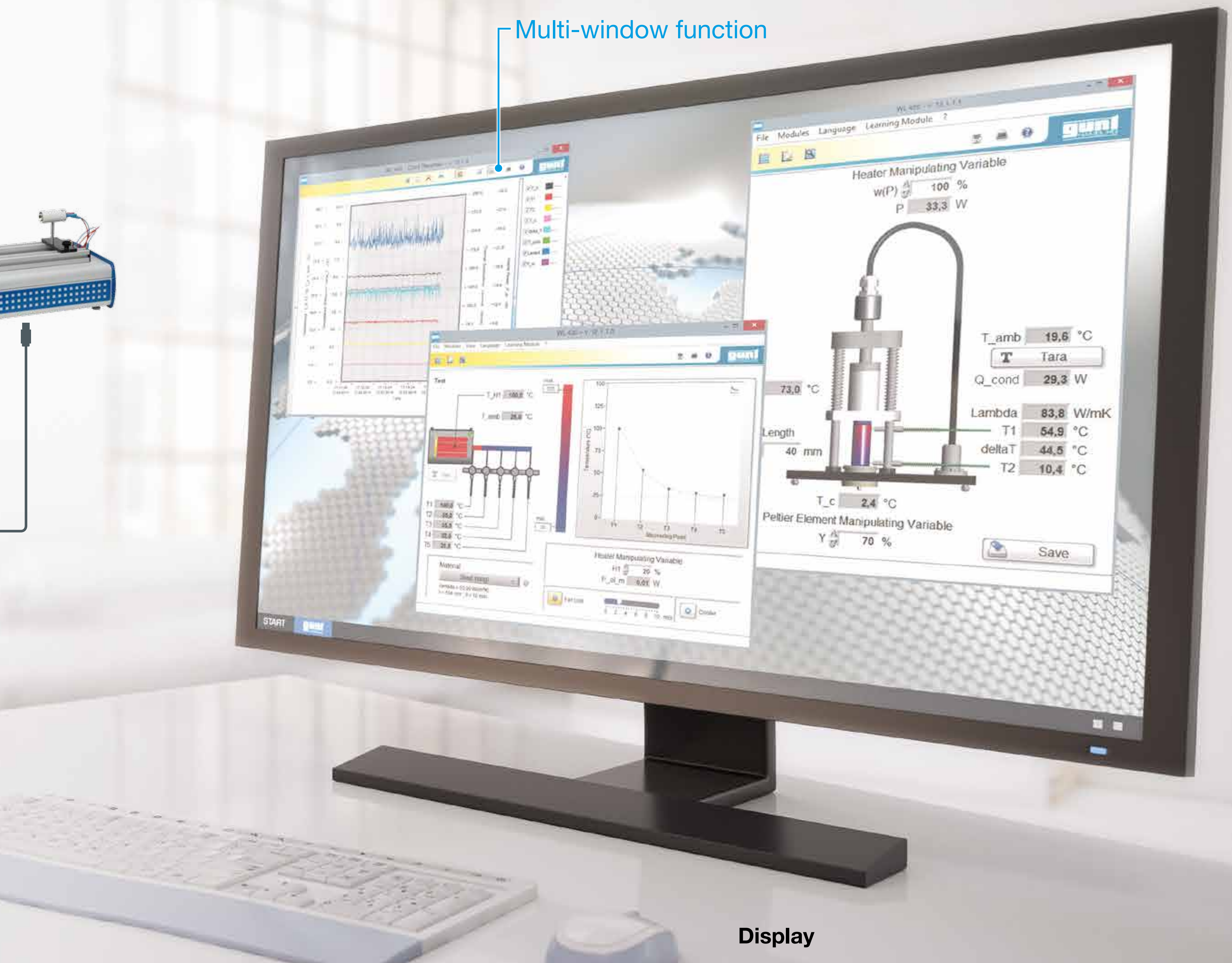
Operation and Data Acquisition

Network capability

- full network access to ongoing experiments by any number of external workstations
- experiments can be independently followed and evaluated by students at all workstations when using a single training system



...any number of workstations with GUNT software with just a single licence



Display

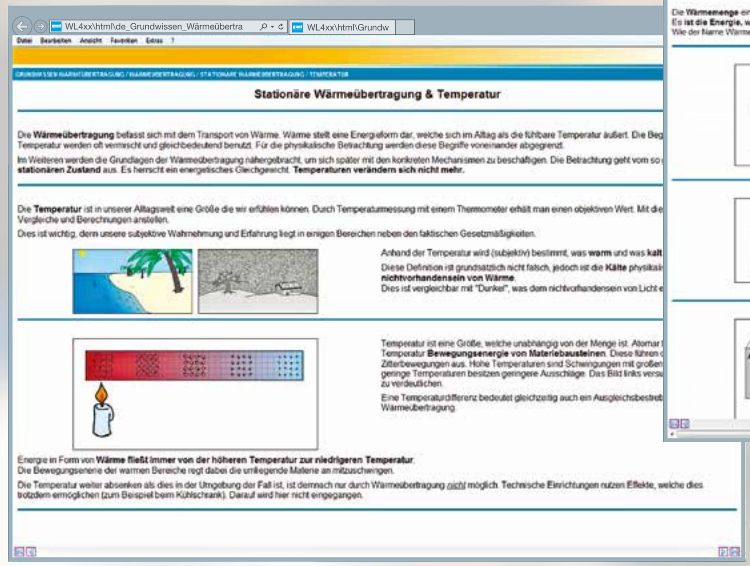
- flexibility in position and arrangement of the various program windows
- as many windows as required, visualising the operating behaviour of the system at the same time

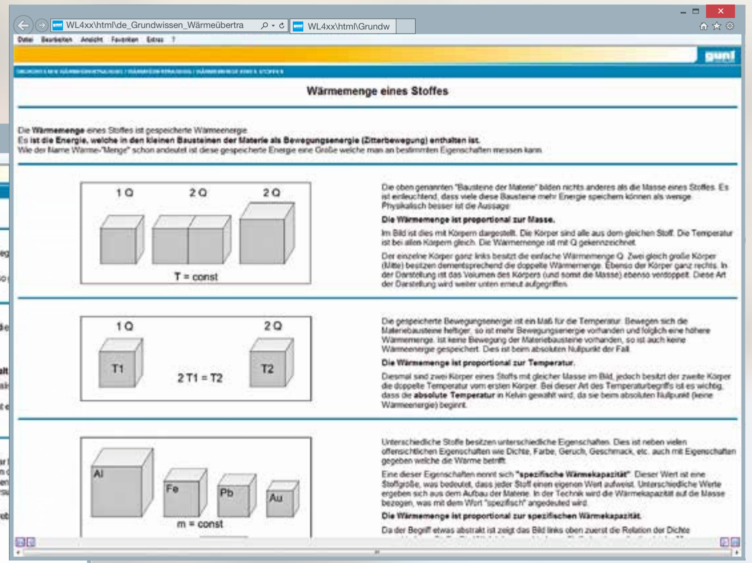
Training Software

An important component in addition to operation and data acquisition

Course in the fundamentals

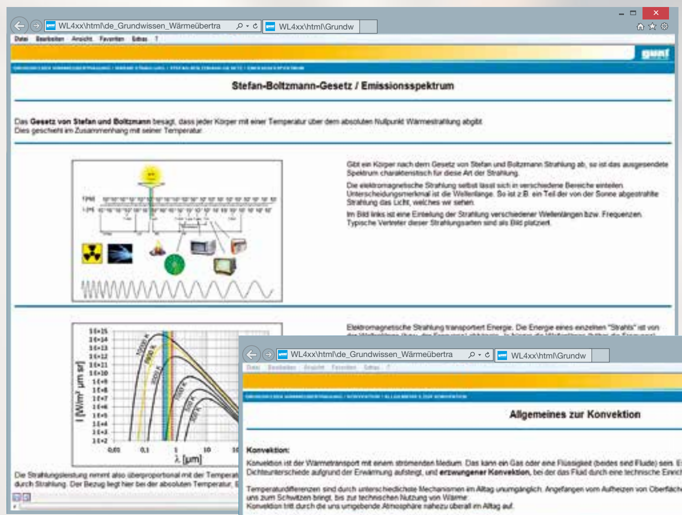
Educationally thought-out and media-rich learning content in the field of heat transfer

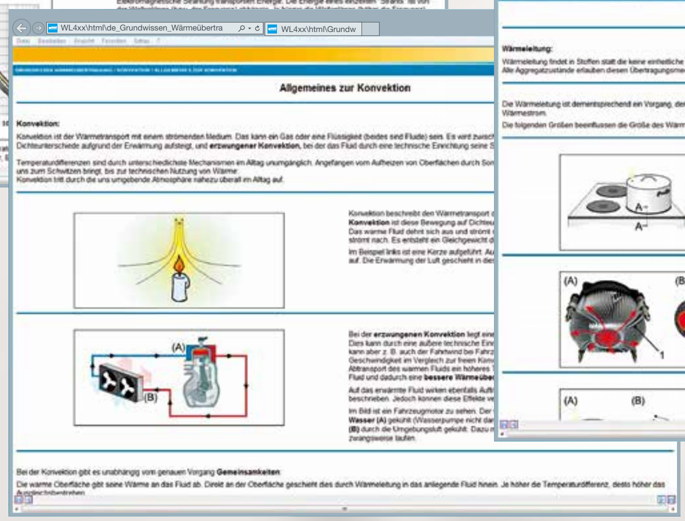




E-learning

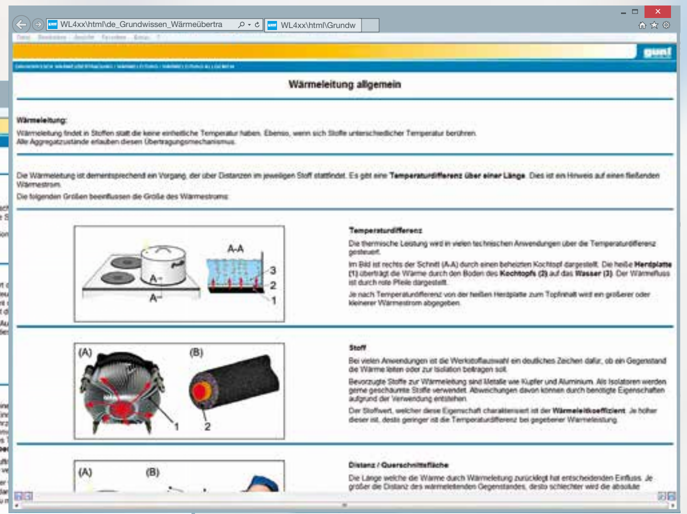
- multi-media course on home PC
- flexibility thanks to learning at your own pace, anywhere and at any time
- increased motivation through originality and playful approach to learning material
- ideal complement to the classroom

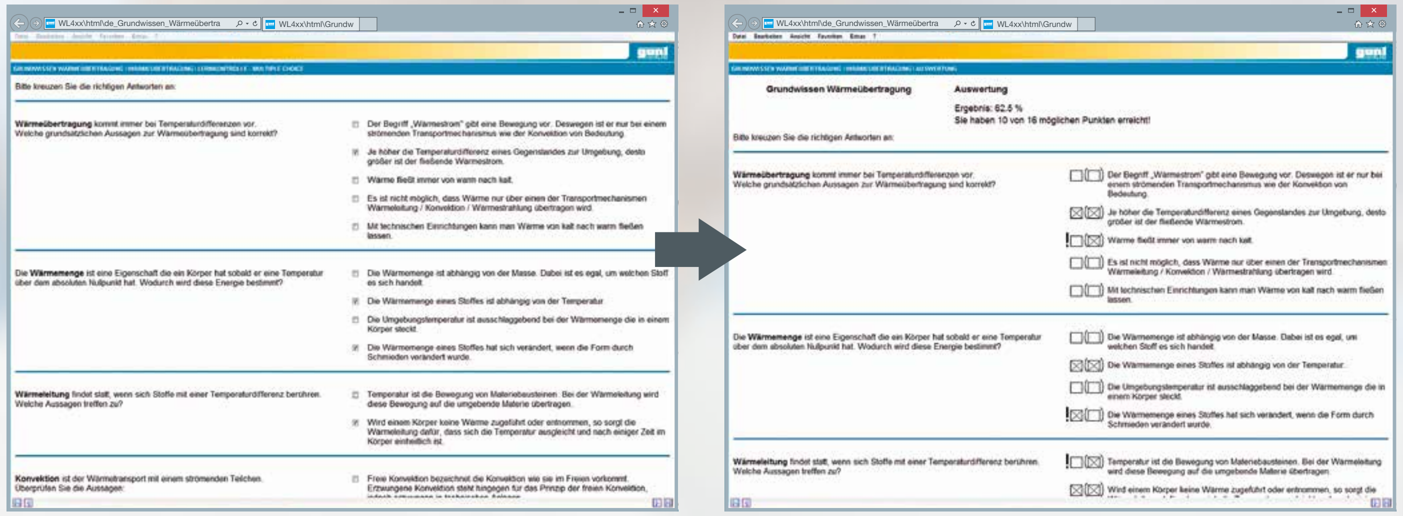




Detailed thematic courses

- the various forms of heat transfer are explained using concrete examples
- independent preparation for handling the equipment



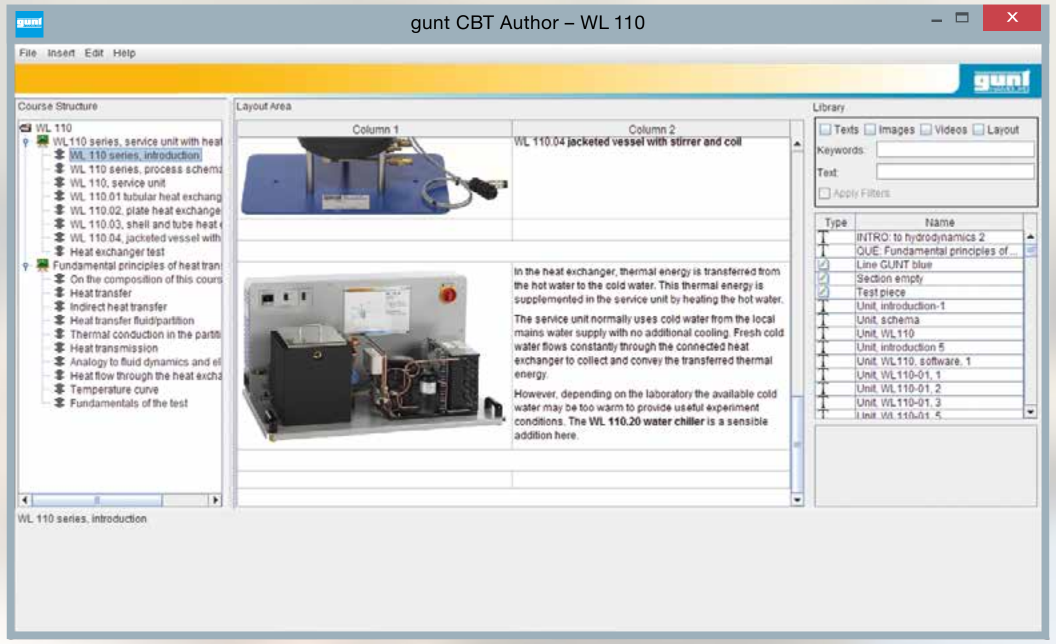


Targeted review of the learning content

- allows learning progress to be checked discreetly and automatically
- detect weaknesses and provide targeted support

Training Software

An important component in addition to operation and data acquisition



Design freedom with integration of your own learning content via the authoring system

- no HTML knowledge required
- separate editor for creating the learning content
- intuitive operation
- targeted integration of specific learning content in the software structure
- creation of individual performance assessments
- integration of video clips and animated graphics

Benefits at a glance

- flexibility thanks to self-determination of the time, duration and location of the learning unit
- allows learning progress to be checked discreetly and automatically
- focus points can be repeated as often as required
- improves the workstation capacity of colleges
- targeted integration of your own learning content in the software structure
- integration of multimedia learning methodology in your student’s day-to-day life

For years we have stood for the highest quality of our equipment and the accompanying instructional material.

Join us to take another step towards the future.

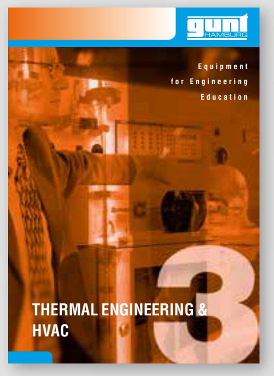
A Few Impressions

An impression from the GUNT training centre

In addition to the software, the printed instructional material forms an integral part of our concept

WP 300.09
Laboratory Trolley

forms a perfect base for a mobile training and experimental unit.



Do you need more in the field of thermal engineering and HVAC?

Then ask for our **Catalogue 3,** or visit gunt.de/static/s9_1.php

Laboratory Planning

We offer a comprehensive product range of outstanding systems for engineering education.

From convenient experimental units for the classroom, to trainers for your laboratory and a variety of sophisticated experimental plants.

We will gladly help design your laboratory and we look forward to your enquiry.