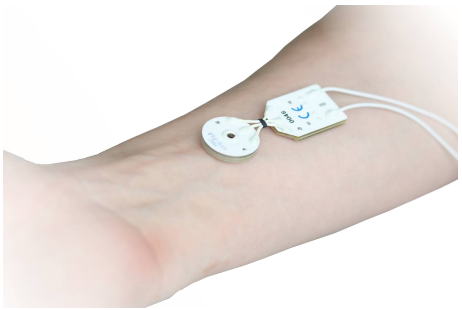
QST Portfolio

Tactile Stimulation

Thermal Stimulation

Electrical Stimulation



Pressure Stimulation

Contents

Our website

Quantitative sensory testing (QST)

QST is an examination method that enables a better diagnosis of nerve pain. It is based on the characteristically altered skin sensitivity in patients with neuropathic pain, often associated with an altered perception of sensation and pain stimuli. The analysis of these symptoms allows conclusions to be drawn about the biological mechanisms underlying the complaints and thus the causes of the pain.

MRC Systems GmbH

Since more than 25 years we develop, manufacture and distribute innovative products in various fields of medical and laser technology. We were founded in 1995 as a spin-off from the University of Heidelberg and the German Cancer Research Center (DKFZ). Our commitment to QST began as early as in 2010 with the PinPrick stimulators. In 2019 we complemented our QST portfolio with the German distributorship of the thermal stimulators of the Israel-based company Medoc. One year later we took over the production and sales of the von Frey filaments ("OptiHair2"). And with the new "EPS-P10" current stimulation electrodes, we are taking another step towards harmonizing the stimulation devices used in research and clinical applications.

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PinPrick stimulators

Essential functions

- Validated tactile stimulation according to DFNS protocol
- Calibrated tip geometries and weights
- Easy handling
- Age and gender specific reference values available

The stimulators were originally developed and introduced by Prof. Rolf-Detlef Treede and PD Dr. Walter Magerl (Chair of Neurophysiology, Medical Faculty of Heidelberg University). They have been manufactured and distributed by MRC Systems GmbH since more than 10 years.

Description

PinPrick stimulators have been used for many years in quantitative sensory testing (QST) of mechanical pain and sensitivity thresholds with defined stimulus intensities as well as for measurements with repeated stimuli ("wind-up"). They allow reproducible measurement and documentation of nociceptive activation of the skin. Thus, they allow a better diagnosis of symptoms in patients with neuropathic pain and the investigation of underlying causes in chronic pain disorders.

Applications

- Determination of the increase and decrease of mechanical-sensory functions
- Generation of quantitative data of mechanical sensation and pain thresholds as well as pain summation with repeated stimuli ("wind-up")
- Diagnosis of changes in pain sensitivity such as mechanical hyperalgesia or dynamic mechanical allodynia (associated with mild tactile stimuli)
- Investigation of the central irritability of A-fiber nociceptors
- Mechanism-based treatment of pain syndromes, validation of treatment concepts by standardized protocols and absolute reference values
- Generation of pinprick-evoked potentials ("PEPs", see also chapter on contact trigger, p. 6)

Technical specification

Stimulus intensities	Needle stimulators: SenseLab™ Brush-05: Cotton wand Böttger 09.143.9105: Cotton swab on plastic strips:	8, 16, 32, 64, 128, 256, 512 mN approx. 200-400 mN approx. 3 mN approx. 100 mN
Needle / tip shape	Flat contact surface (0.25 mm diameter), edge radius: 5 µm	
Guide sleeve	Diameter: 10 mm (MRI-compatible variant: 11 mm) Material: stainless steel (MRI-compatible variant: titanium)	

Scope of delivery

A complete set consists of seven pointed stimulators with graduated weights as well as accessories for stroking stimuli and a metronome. There are different variants:

- the widely used standard set for QST
- an MRI-compatible version with titanium needles and non-magnetic materials
- modified stimulators with contact triggers for synchronization with e.g. EEG devices

A disinfection unit is also available as an option, in which up to 7 Pinprick stimulators can be disinfected simultaneously.

Literature (Excerpt, further references are in the back of the brochure)

1. Geber C., Klein T., Azad S., Birklein F., Gierthmühlen J., Huge V., Lauchart M., Nitzsche D., Stengel M., Valet M., Baron R., Maier C., Tölle T., Treede R.D.: Test-retest and interobserver reliability of quantitative sensory testing according to the protocol of the German Research Network on Neuropathic Pain (DFNS): a multi-centre study. Pain (2011)
2. Magerl W., Fuchs P.N., Mayer R.A., Treede R.D.: Roles of capsaicin-insensitive nociceptors in pain and secondary hyperalgesia. Brain 124 (2001)
3. Magerl W., Krumova E.K., Baron R., Tölle T., Treede R.D., Maier C.: Reference data for quantitative sensory testing (QST): refined stratification for age and a novel method for statistical comparison of group data. Pain (2010)
4. Maier C., Baron R., Tölle T.R., Binder A., Birbaumer N., Birklein F., Gierthmühlen J., Flor H., Geber C., Huge V., Krumova E.K., Landwehrmeyer G.B., Magerl W., Maihöfner C., Richter H., Rolke R., Scherens A., Schwarz A., Sommer C., Tronnier V., Uçeyler N., Valet M., Wasner G., Treede R.D.: Quantitative sensory testing in the German Research Network on Neuropathic Pain (DFNS): somatosensory abnormalities in 1236 patients with different neuropathic pain syndromes. Pain (2010)
5. Ziegler E.A., Magerl W., Meyer R.A., Treede R.D.: Secondary hyperalgesia to punctate mechanical stimuli. Brain (1999)

Contact trigger for PinPrick

Essential functions

- Defined triggering of evoked potentials using pointed stimuli
- Precise measurement of stimulation timing
- Low latency (< 2 ms)
- Objectification of sensitive deficits
- Detection of signs of central sensitation

Description

The PinPrick stimulators with contact trigger are used to trigger evoked potentials ("PEPs" = pinprick evoked potentials) and therefore e.g. to determine conduction velocities. Their design allows well reproducible measurements with low latency: The measurement principle for the trigger circuit is based on a micro-interrupt switch inside the stimulator.

The switch is opened as soon as the needle moves inwards from the lower position. In this way, the signal is generated exactly when the stimulator develops its nominal force on the skin. The trigger signal is also output at this exact moment. There are different signal forms that can be connected to the input of a stopwatch, to an EEG registration or to other devices. LEDs above the trigger outputs indicate that a signal has been triggered.

Variations

The standard electronics has one channel for connecting a stimulator. In addition, versions with 2 and 6 channels are available. There is also a filter box for using the stimulators in MR environments.

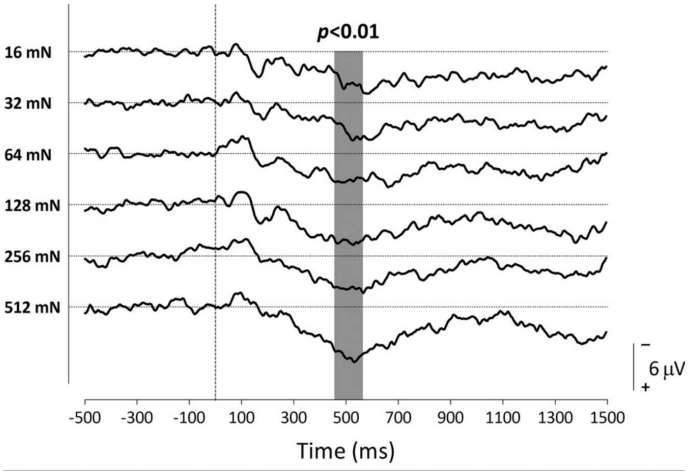
Technical specification

Stimulus intensities	32, 64, 128, 256, 512 mN (due to the additional weight of the switch, the stimulators with the smallest weights (8 and 16mN) are not available with trigger function)
Power supply	Li-Ion battery, nominal 3.7V, battery indicator including charger (5V, 0.8 A) and plug-in power supply unit
Cable on the stimulators	Flexible cable, length: 2 m (MRI-compatible version: 10 m)
Cable at the trigger output	Lemo to BNC, length: 4 m (of which 2 m opto-isolated)

Waveforms of the two trigger outputs:

TTL output 1: duration 10 ms, rising edge marks the beginning of the stimulus. This output should be used whenever a trigger pulse is needed.

TTL output 2: remains high as long as the stimulus is present.



The figure taken from van den Broeke et al., 2015, shows PEPs (pinprick evoked potentials) after stimulation on the arm of healthy subjects, recorded at a central EEG electrode. An NP complex can be seen in the time window 120 - 250 ms after the stimulus. The gray bar then marks a P wave with a peak at 400 - 600 ms. Different forces lead to different waveforms. The study also demonstrated the influence of hyperalgesia on the amplitudes.

Literature (Excerpt, further references are in the back of the brochure)

1. Ianetti G.D., Baumgaertner U., Tracey I., Treede R.D., Magerl W.: Pinprick-evoked brain potentials (PEPs): a novel tool to assess central sensitation of nociceptive pathways in humans. J Neurophysiol (2013)
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3. van den Broeke E., Lenoir C., Mouraux A.: Secondary hyperalgesia is mediated by heat-insensitive A-fibre nociceptors. J Physiol (2016)
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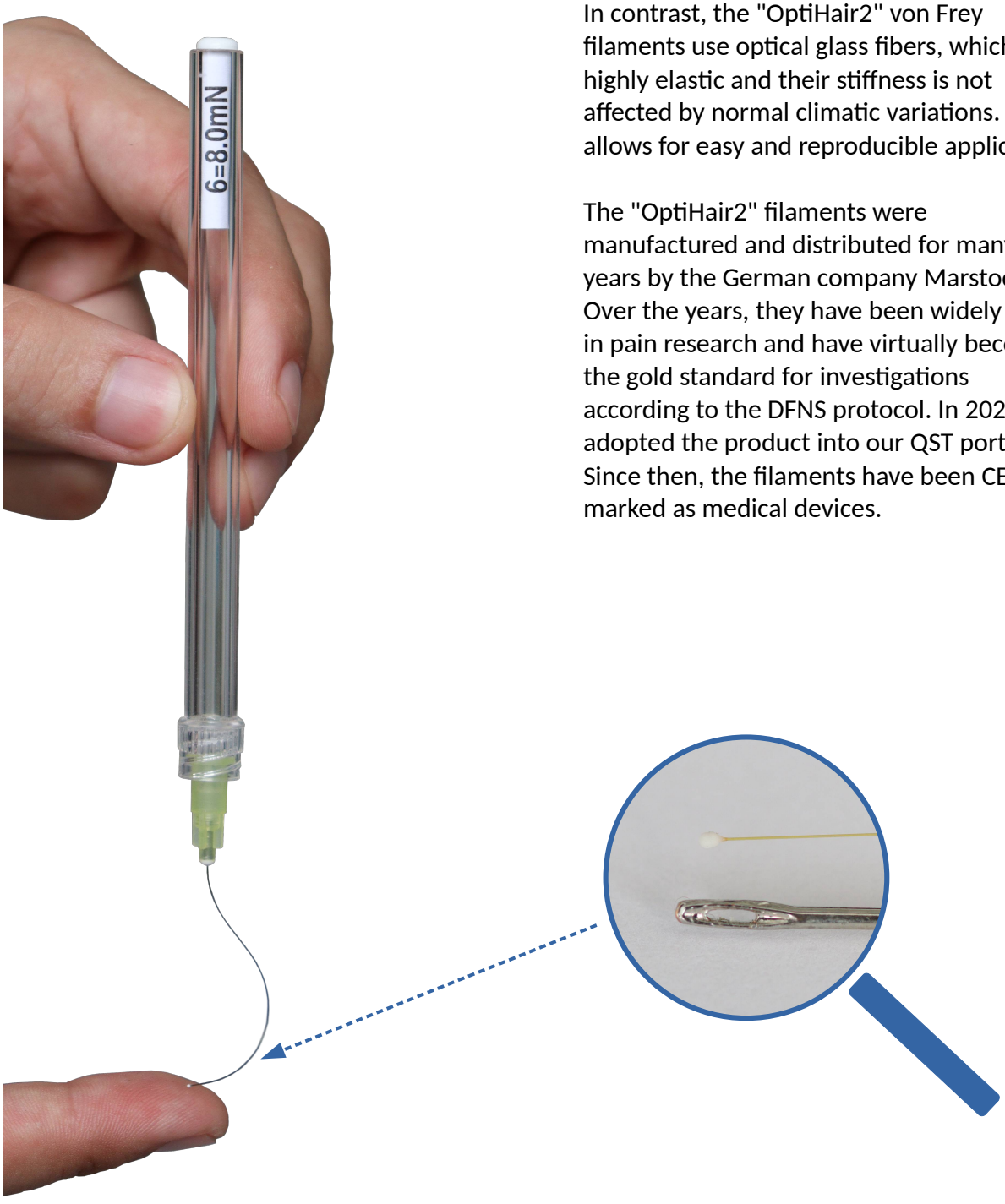
OptiHair2 – von-Frey filaments

Essential functions

- Validated determination of touch sensitivity thresholds
- Standardized fiber end with constant contact area
- Recommended by the German Neuropathic Pain Research Network (DFNS) for QST



Description

Developed in 1896 by Maximilian von Frey, human hair and animal bristles of varying lengths were originally used to achieve defined stimulation strengths. Today, synthetic fibers are often used, but they have plastic properties and are sensitive to changes in room temperature and humidity. In contrast, the "OptiHair2" von Frey filaments use optical glass fibers, which are highly elastic and their stiffness is not affected by normal climatic variations. This allows for easy and reproducible application.

The "OptiHair2" filaments were manufactured and distributed for many years by the German company Marstock. Over the years, they have been widely used in pain research and have virtually become the gold standard for investigations according to the DFNS protocol. In 2020, we adopted the product into our QST portfolio. Since then, the filaments have been CE marked as medical devices.

Technical specification

Forces	0.25, 0.5, 1, 2, 4, 8, 16, 32, 64, 128, 256, 512 mN, tolerance: ± 5 %
Material	Optical glass fibers with epoxy bead at fiber end diameter: 0.35 – 0.45 mm
Handle	Acrylic handle with LuerLock coupling

Unlike other products, the "OptiHair2" von-Frey filaments are attached longitudinally to the handle. This makes it easy to work with several filaments, which can be placed on the table and do not have to be put back into a holder. The handles of all filaments are equipped with a LuerLock coupling. The carriers of the filaments have a matching coupling and are screwed onto the handle like a cannula onto a syringe. The LuerLock connection allows easy replacement of defective filaments. After pulling off a protective sleeve, the filaments are immediately ready for use.

The standard set includes 12 logarithmically scaled filaments, where in the range of 0.25 to 512 mN the force increases by a factor of 2 with each step. Each "OptiHair2" filament is individually calibrated. The tolerance range is only ±5 % of the nominal force.

Literature (Excerpt, further references are in the back of the brochure)

1. Andrews K.: The effect of changes in temperature and humidity on the accuracy of von Frey hairs. J Neurosci Methods (1993)
2. Fruhstorfer H., Gross W., Selbmann O.: von Frey hairs: new materials for a new design. Eur J Pain (2001)
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EPS-P10 – Stimulation electrode

Essential functions

- Application of defined stimulation currents
- Cathode made of ten sturdy tungsten pins with a diameter of 0.25 mm and flat anode for safe current dissipation
- Used at leading centers as part of the European research project IMI-PainCare

Applications

The stimulation electrode "EPS-P10" is used to deliver stimulation current pulses from an external source through a subject's skin. Such stimulation current pulses can be used e.g. to reproducibly determine the individual perception or pain threshold for an electrical stimulus. Repeated pulses at intensities above the pain threshold can also be used to induce secondary hyperalgesia lasting for several hours, e.g. to mimic chronic hyper-sensitivity. In the literature, this method is often referred to as HFS or “high-frequency stimulation”.

A major advantage of the design with thin tungsten pins is the very local effect. Thus, even at low stimulation current intensities, the necessary current densities to excite free nerve endings of Aδ- and C-fibers in the skin can be achieved.

Technical specification

Cathode	Diameter: 21 mm / 10 pins on a circle with a diameter of 5 mm
Cathode pins	Thickness: 0.25 mm, protrusion over cathode surface: 0.8 mm Distance between center of cathode pins and anode: 20 mm Material: tungsten
Anode	Area: 480 mm^2, 24×20 mm^2
Cable	Highly flexible cable to connect cathode and anode Connecting cable with banana plugs
Accessories	Self-adhesive electrolytic conductive gel pads Double-sided insulating adhesive rings

The electrode is designed for multiple use and is easy to disinfect. The gel pads and adhesive rings are available as disposables also in larger quantities at a reasonable price. A stimulation current source is not included in the scope of delivery.

IMI-PainCare

The development of the electrode was supported by the European Union with funds from the Horizon 2020 program.

Literature (Excerpt, further references are in the back of the brochure)

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5. van den Broeke E.N., Mouraux A.: High-frequency electrical stimulation of the human skin induces heterotopical mechanical hyperalgesia, heat hyperalgesia, and enhanced responses to nonnociceptive vibrotactile input. J Neurophysiol (2014)

Contact

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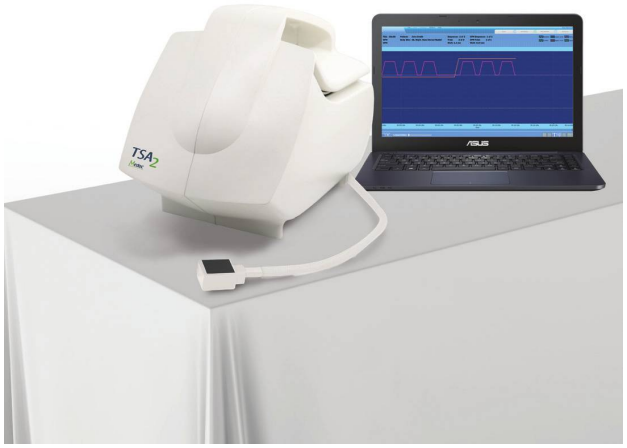
TSA2 / *Advanced Thermosensory Stimulator*

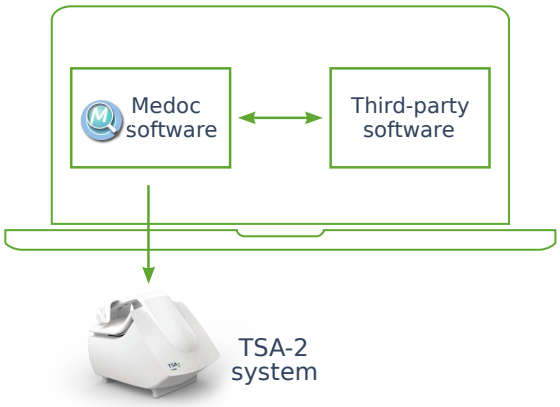
- Precise control of the simulation temperature
- External control option integrated as standard
- Temperature rates up to 13°C/s
- Configurations with one or two thermodes
- Can be used in fMRI
- Configurable for CHEPS stimuli

TSA2 / *Advanced Thermosensory Stimulator*

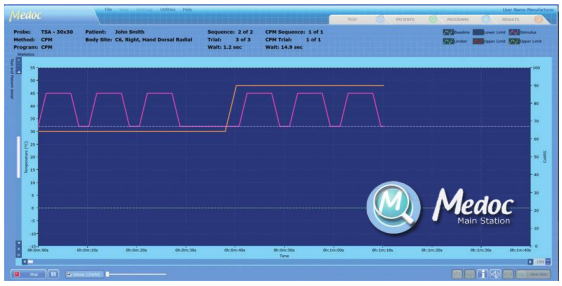
Control, precision and reliability for your research topics

- ✓ Dynamic protocols with MATLAB® and other platforms
- ✓ EEPROM for continuous monitoring the calibration in the thermode head
- ✓ Two thermode connectors for CPM or other protocols
- ✓ More than 15 years experience with MR-compatible solutions
- ✓ Various thermodes: 30x30mm², 16x16mm², intraoral, intravaginal, fMRI-compatible

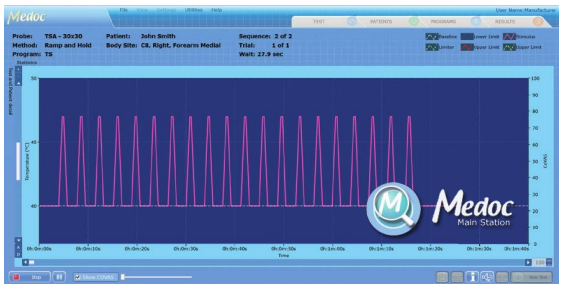




External control allows dynamic protocols.



CPM protocols with two thermodes



Examination of the temporal summation

TSA 2 AIR
Portable
Full Range QST

TSA 2 Air is the latest portable air-cooled quantitative sensory from cool/warm sensation to cold/heat pain.
testing (QST) device with the full range of thermal stimuli,

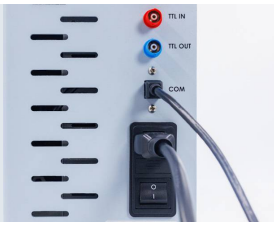
- All thermal modalities (Cold sensation, Cold pain, Warm sensation, Heat pain)
- Gold-standard 30x30 mm thermode
- Air cooled for easy maintenance
- Portable device
- TTL In and Out for synchronization with external devices
- External control through Matlab, Phyton, and other platforms

TSA AIR 2 Portable Full Range QST

Applications

Standard QST protocols including Limits, Levels and TSL

Signaling abilities for intricate protocols: TTL and external control



Noxious and non-noxious heat and cold

Can be used with CoVAS USB

Fits dynamic QST:

- **Conditioned pain modulation**
- **Temporal summation**
- **Offset analgesia**

About Medoc

Medoc has been developing and manufacturing QST devices in the thermal, pressure and vibratory modalities for over 30 years.

Among our clients are top hospitals, universities, and research institutions around the world. We have a strong drive for innovation and a longstanding reputation for reliability.

Q Sense | Small-Fiber Test

Easy to use • Quantitative • Affordable • Portable

Small-fiber neuropathies are not detectable
by traditional electrodiagnostic means

"Sensory modalities are more frequently affected than motor modalities and impairment of small nerve fibers could be the earliest detectable sign".

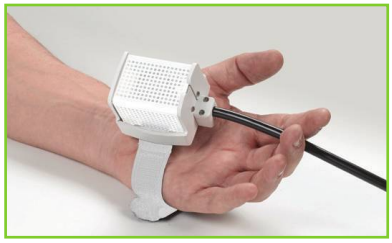
Papanas, Vinik, Ziegler; Nat Rev Endocrinol, 2011

Extended temperature rage of **16 to 50°C**

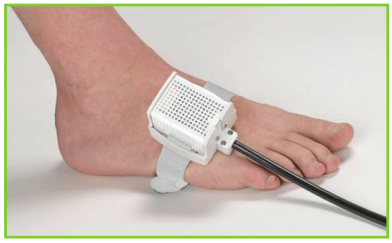
Small-Fiber Test

"Damage to small, unmyelinated C-fiber has the greatest impact on survival and quality of life".

Vinik et al, Exp Clin Endocrinol Diabetes, 2001



- Early Detection
  Subclinical detection may reduce severe neurological complications by making an earlier and more effective treatment course possible
- Monitor Response to Therapy
  Can serve as a biomarker for treatment and pharmacologic intervention
- Validated Measure
  Accepted by the scientific community, regulatory authorities and subjects



"Thermal hyperalgesia is a relevant clinical marker of early oxaliplatin neurotoxicity and may predict neuropathy".

Attal et al, PAIN, 2009

"The frequency of small fiber neuropathy found with the thermal threshold test was higher than large fiber neuropathy found with Nerve Conduction ($p<0.001$) and was found at an earlier stage".

Jimenez-Cohl et al, J. Diabetes Sci Technol, 2012

- Comparison to Normative Reference Data
- Easy-to-Interpret Clinical Test Report
- Versatile Patient Database & Export Utility
- Pre-programmed Test Algorithms
- Sensitive and Reproducible

Algomed | *Computerized Pressure AlgoMeter*

Computerized pressure Algometer for assessing deep tissue pain perception

Software-based REAL TIME visual and auditory feedback to control and monitor Applied pressure rates

- Real-time visual & auditory feedback
- Comprehensive test statistics
- Body site selection
- Patient Response Unit
- Calibration verification weight
- Ramp & Hold Protocol

AlgoMed | *Computerized Pressure AlgoMeter*

Hardware Advantages

- Ergonomic handle
- Rechargable 50 hour battery
- Support for various tip sizes

Software Capabilities

- Allows managing patiens, test paradigms and results
- Pressure units support includes KPa, Kgf/cm² abd lbs/in²
- Patient response to pressure threshold and tolerance can be recorded
- Body site selection
- Test results can be mapped according to a predefined body site
- Test results can be saved, exported to Excel and printed as a customizable report

Patient Repsonse Unit

Algometer test screen

Test Management

- Graphic display of test including applied pressure change rate
- Display test statistics according to selected test methods

Medoc
advanced medical systems

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Literature selection

PinPrick stimulators

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Contact trigger for PinPrick

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