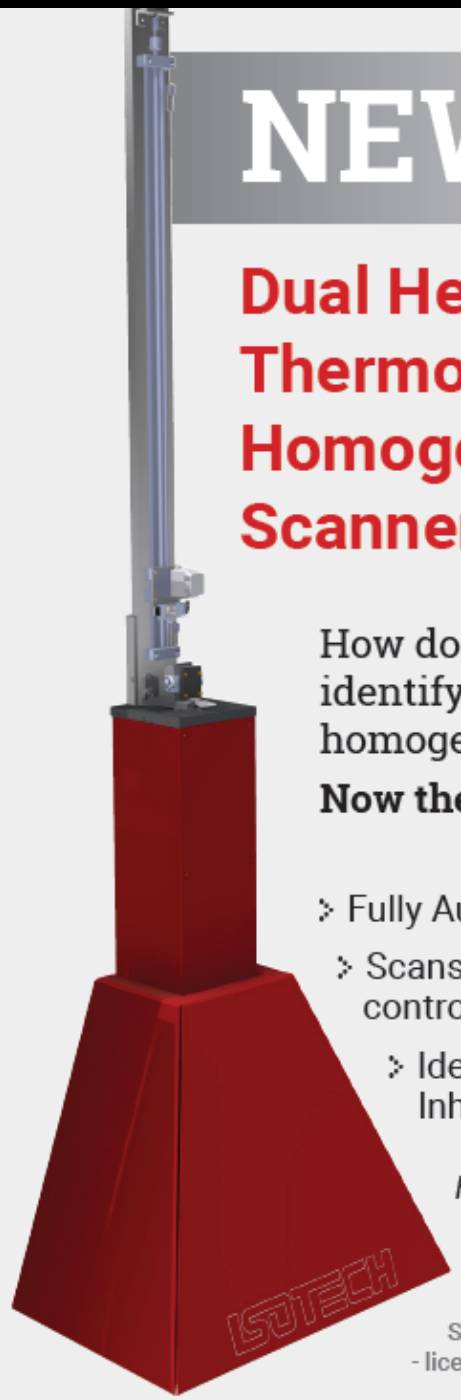
Model 881 Thermocouple Scanner

www.isotech.co.uk



NEW

Dual Heat Pipe Thermocouple Homogeneity Scanner

How does your laboratory identify thermocouple homogeneity effects?

Now there is a solution!

- Fully Automated
- Scans Thermocouples with full control of position and speed
- Identify Uncertainty due to Inhomogeneity

For more details visit:
www.isotech.co.uk/ths

Developed by the Measurement Standard Laboratory, New Zealand - licensed to Isotech

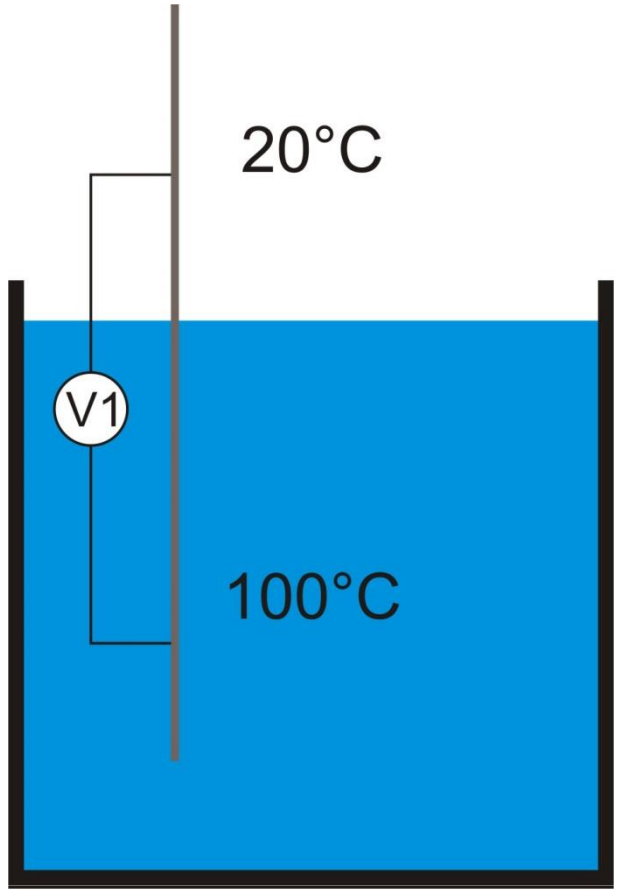
Thermocouple Theory: Seebeck Effect

Consider a wire in a bath at 100°C

- Gradient of 80°C
  - Mainly where the wire exits bath

The heat flow arising from the temperature gradient results in a ***Seebeck*** voltage

The Seebeck coefficient of a material is a measure of the magnitude of an induced thermoelectric voltage in response to a *temperature difference (gradient)* across that material

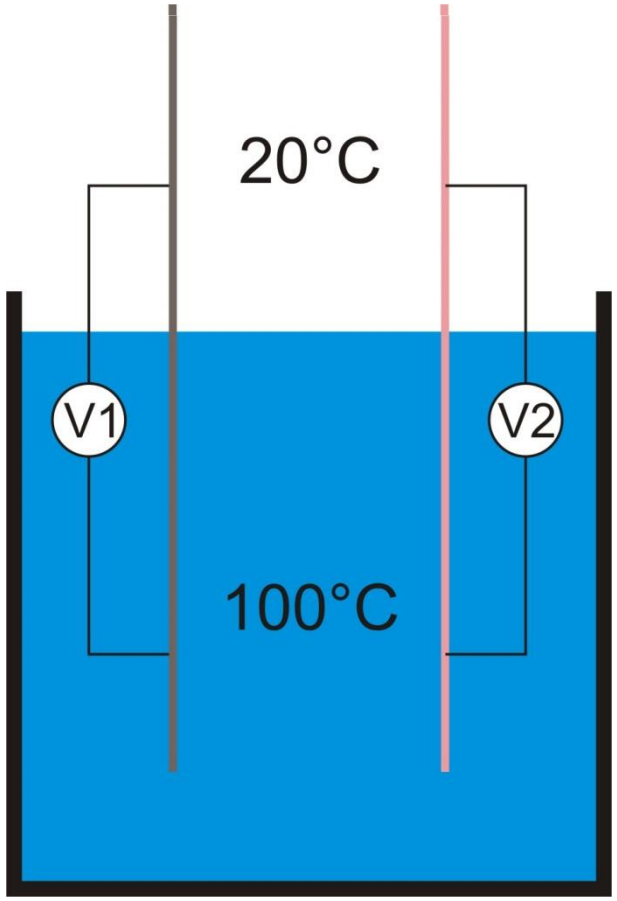


Thermocouple Theory

If we add a wire of a different metal

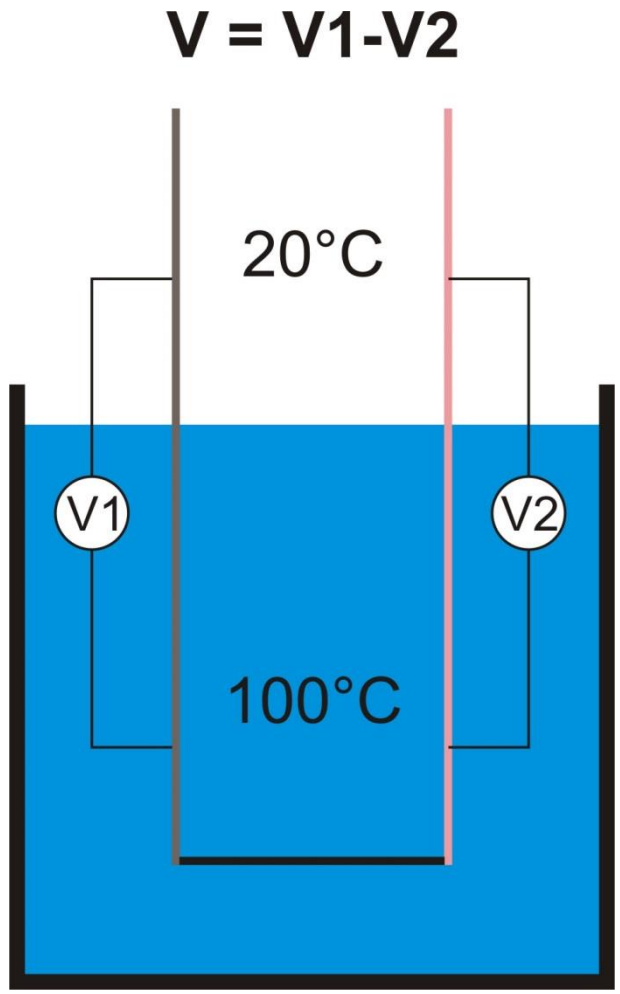
we get a different voltage

Different *Seebeck coefficient*



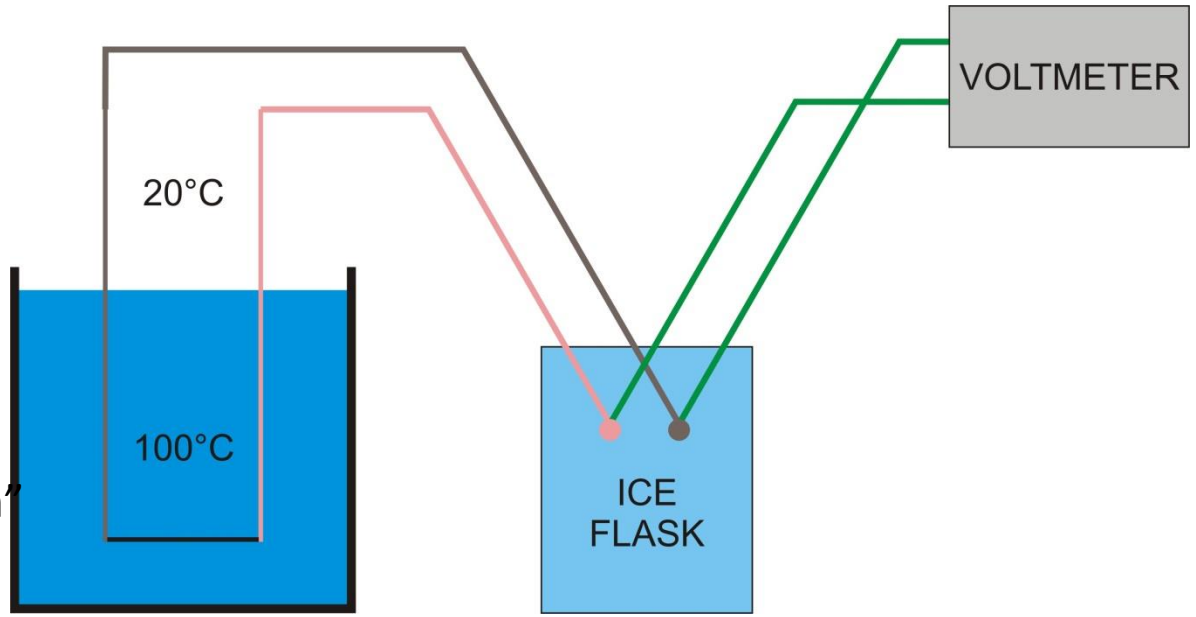
Thermocouple Theory

To measure the voltage we need to connect the wires to make a circuit



Thermocouple Theory

To measure temperature we need to know the temperature of the “cold junction”

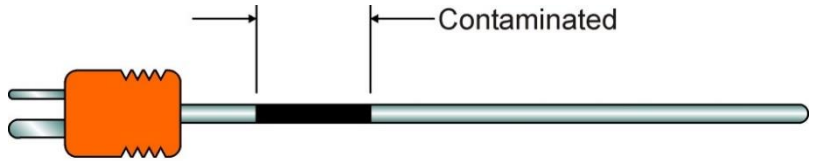


“Measuring Junction”

“Cold Junction”

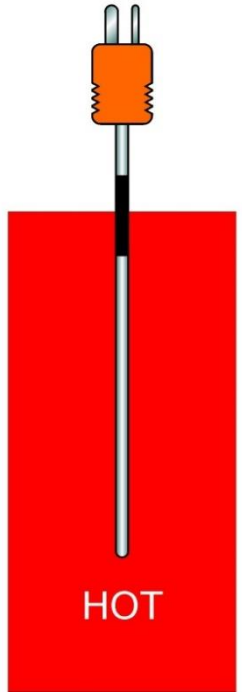
Seebeck Effect

KEY POINT: Voltage is not generated at the junction!



Seebeck Effect, wherever heat flows in a conductor, emf is generated

If the wire is not homogenous we will get errors



How to Check Homogeneity

Very important!

The EURAMET guide

"Guidelines on the Calibration of Thermocouples EURAMET Calibration Guide No. 8 Version 3." was updated last year and has new information about "the effect of inhomogeneity on the uncertainty"

Section 9.2

9.2 Inhomogeneity can be quantified by moving the measuring junction in an environment with homogenous temperature distribution (e.g. a stirred liquid bath or a fixed point cell, or specialised single gradient scanner [12]).

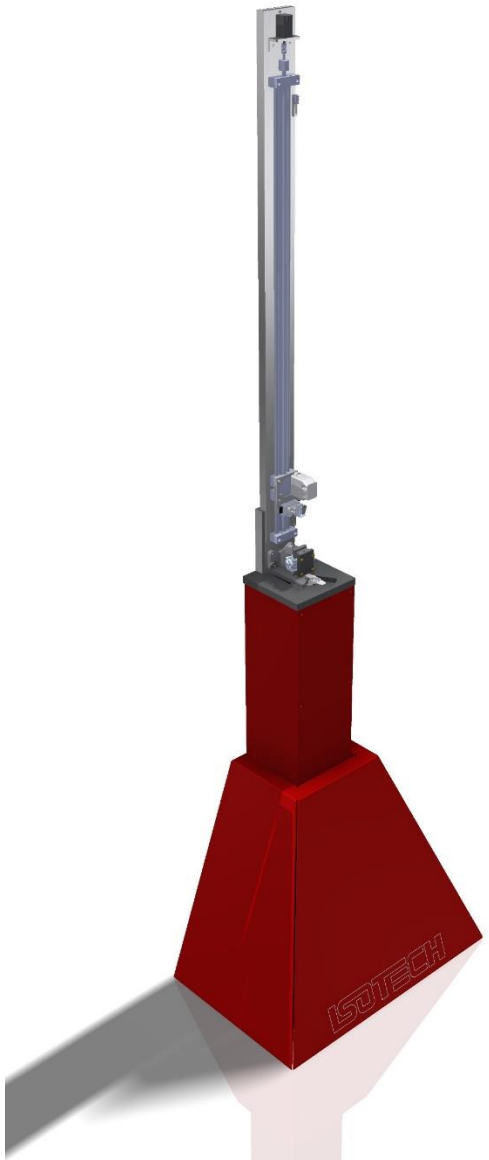
[12] Webster, E. and White, D.R., Thermocouple homogeneity scanning, Metrologia, Vol. 52 (2015) 130 – 144

Thermocouple Homogeneity Scanner

Isotech have licensed the thermocouple scanner designed by Emile Webster of the Measurement Standards Laboratory, New Zealand

[12] Webster, E. and White, D.R., Thermocouple homogeneity scanning, Metrologia, Vol. 52 (2015) 130 – 144

Benefits of the Thermocouple Scanner



When Calibrating Thermocouples -

Identify performance to allow uncertainty to be calculated rather than guessed (Type A uncertainties)

Allow a lower uncertainty to be offered to a thermocouple that has good performance

Determine if thermocouples submitted for calibration are worth calibrating

Be able to check if annealing of a thermocouple has been successful

Benefits of the Thermocouple Scanner

When Using Thermocouples -

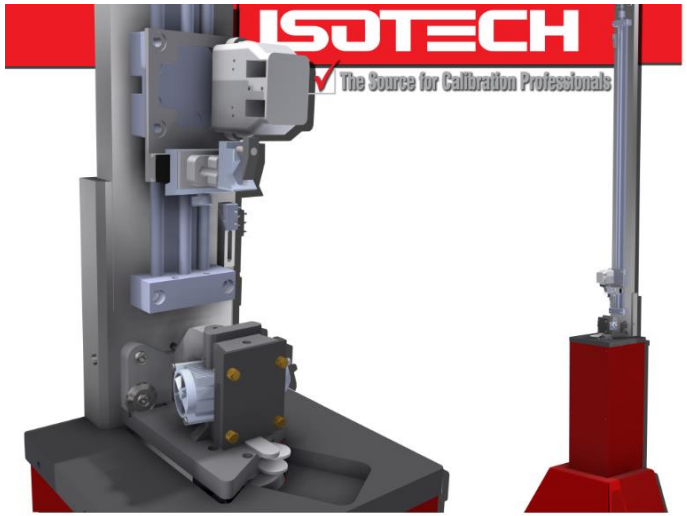
Have confidence in your laboratory thermocouple standards

Know when to calibrate

Check if a thermocouple has gone bad

Check when and how often to anneal your thermocouples

Know what region of your thermocouple to avoid



Benefits of the Thermocouple Scanner

When Manufacturing or Selecting Thermocouples -

Identify failures and defects in batches of thermocouples

Easily determine thermocouple quality

Identify variations in thermocouple wire when sourced from different suppliers or batches

ISOTECH Model 881Thermocouple Scanner

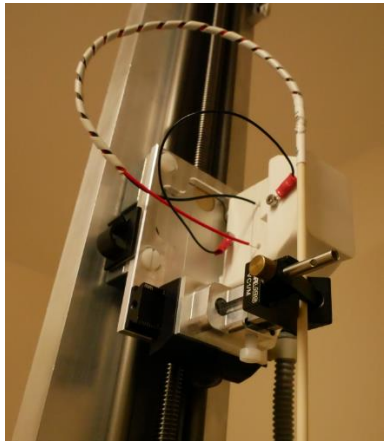
Designed by Measurement Standards Laboratory, NZ

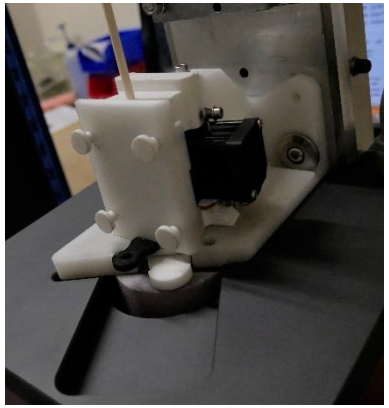
Utilises a unique dual heat-pipe arrangement

Scanning times reduced to less than 20 minutes

Scanning resolutions of between 2 mm and 5 mm

Fully automated motion and logging

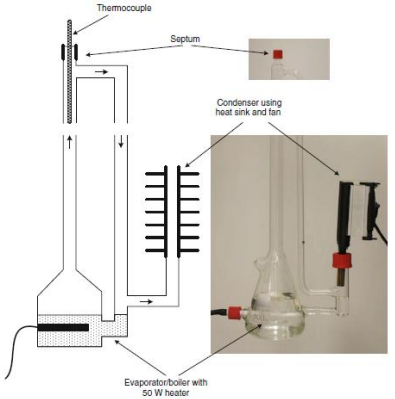




More than 10 years in development

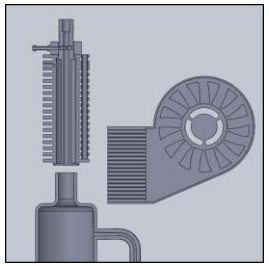
First MSL Prototype: 2008 – 2010

- Single water heat-pipe
- Continuous scanning using capstan roller
- Direct immersion into steam



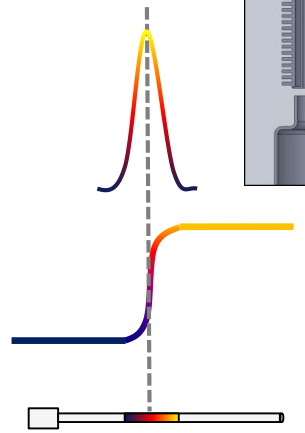
Refinement of Prototype: 2011 – 2016

- Second acetone heat-pipe added
- Worm driven linear actuator added
- Fully automated software system



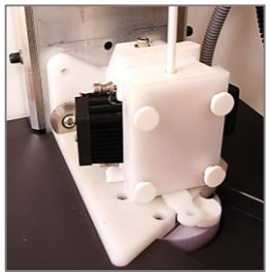
Development of Scanning theory: 2013 – 2015

- Modelling of temperature gradients
- Validation of single, rather than double gradient
- Use of convolution theory



Commercial Prototype: 2017 – 2018

- Development of Peltier unit for upper heat-pipe
- Use of isothermal connector block
- Optimisation of septum design



Based on world leading research

Greenen, A. and Webster, E. S. "Thermal recovery From cold-working in Type K bare wire thermocouples." *Int. J. Thermophys* 38 (2017): 1-13.

Webster, E. "The Type N Thermocouple: The Good, the Bad and the Ugly." Paper presented at the meeting of the Proc. MSA Conference Australasia, 2017.

Webster, E. S. "Seebeck Changes Due to Residual Cold-Work and Reversible Effects in Type K Bare-Wire Thermocouples." *Int. J. Thermophys*. 38 (2017): 1-18.

Webster, E. S. "Drift in Type K Bare-wire Thermocouples from Different Manufacturers." *Int. J. Thermophys*. 38 (2017): 1-14.

Webster, E. S. "Thermal Preconditioning of MIMS Type K Thermocouples to Reduce Drift." *Int. J. Thermophys*. 38 (2016): 1-14.

Webster, E. S. "Effect of annealing procedure in determining drift as a function of temperature between 170°C and 900°C in Type S thermocouples." *Int. J. Thermophys*. 36 (2015): 1909-1924.

Webster, E. S. "Low-temperature drift in MIMS base-metal thermocouples." *Int. J. Thermophys*. 35 (2014): 574-595.

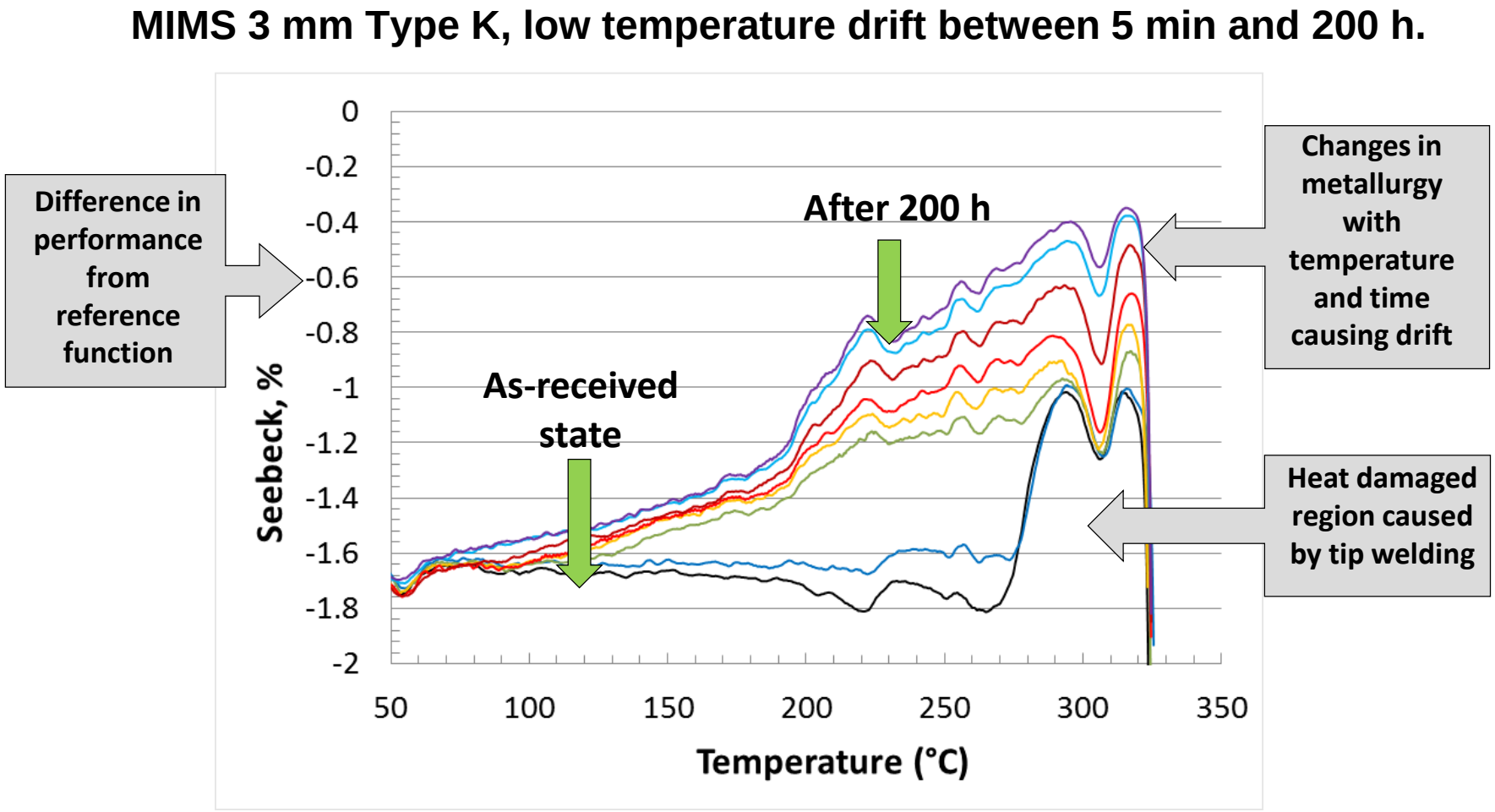
Webster, E. S. and Edler, F. "Drift as a function of temperature in platinum-rhodium-alloyed thermoelements." *Int. J. Thermophys*. 38 (2016): 1-14.

Webster, E. S. and White, D. R. "Thermocouple homogeneity scanning." *Metrologia* 52 (2015): 130-144.

Webster, E. S., White, D. R. and Edgar, H. "Measurement of inhomogeneities in MIMS thermocouples using a linear-gradient furnace and dual heat-pipe scanner." *Int. J. Thermophys*. 36 (2014): 444-466.

White, D. R. and Mason, R. S. "A Thermocouple Homogeneity Scanner Based On An Open Pressure-controlled Water Heatpipe." *Int. J. Thermophys*. 31 (2010): 1654-1662.

How bad could thermocouples be?



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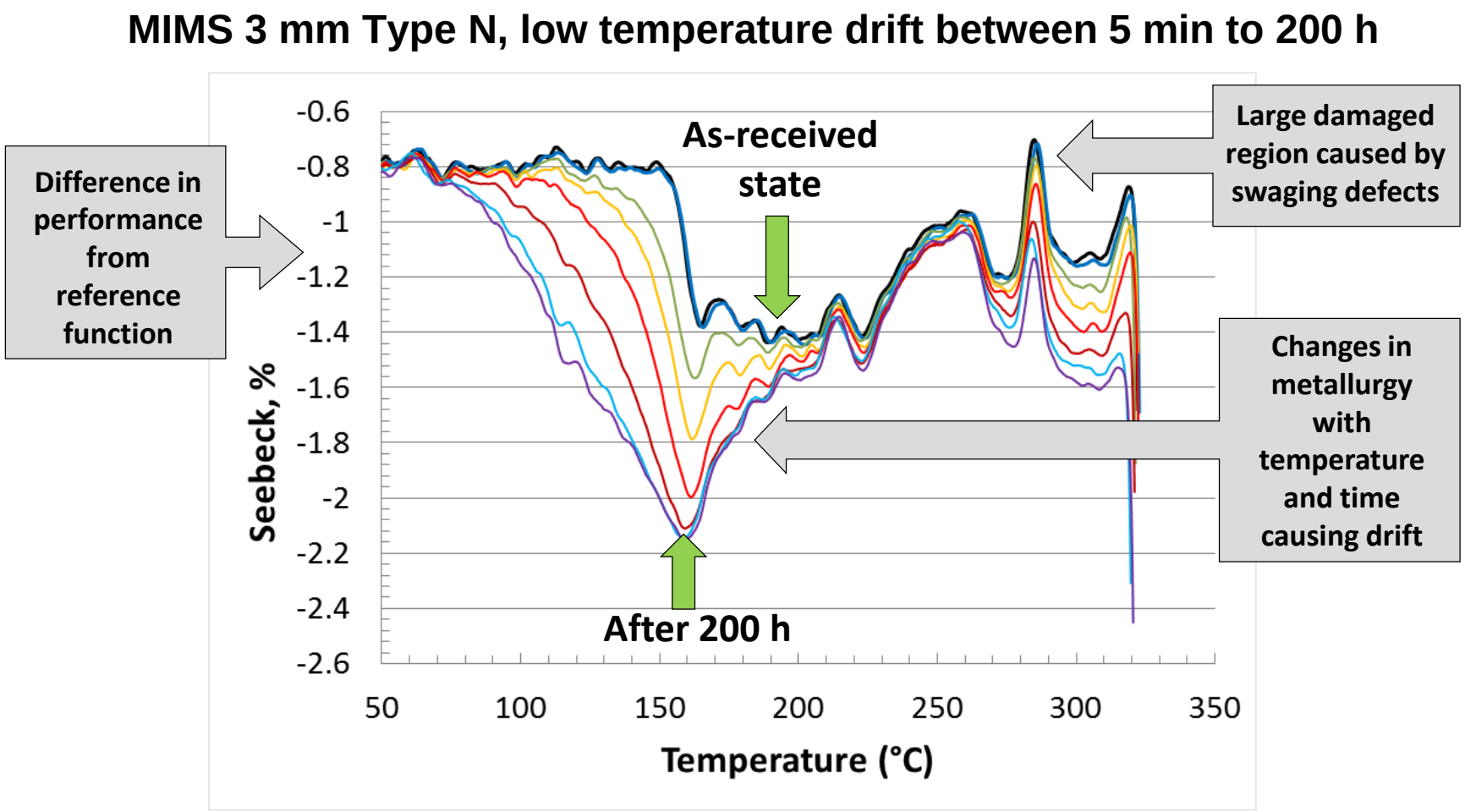


Achieve at least a three fold improvement in measurement accuracy

Most thermocouple uncertainty budgets rely on indicative type B assessments of inhomogeneity

Inhomogeneity is normally the largest uncertainty component, and therefore has the greatest effect on accuracy

Make real measurements of inhomogeneity to minimise its effect and maximise the potential of your thermocouples

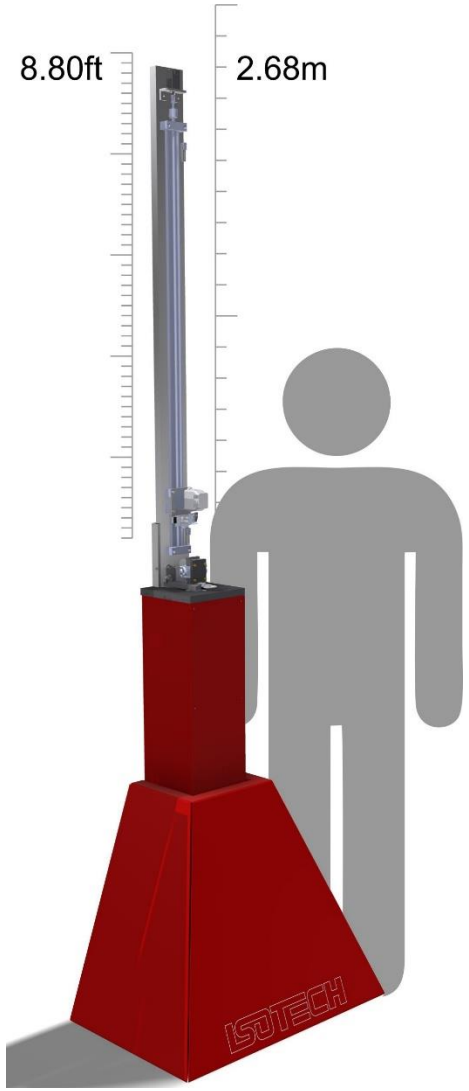
Identify bad thermocouples from a batch

Use the thermocouple scanner to rapidly pass or fail thermocouples

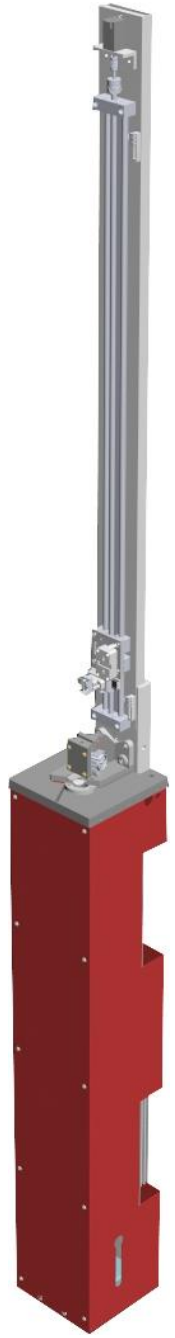
Don't unnecessarily pay for bad thermocouples

Using regular scanning to help decide when to replace thermocouples before the failures occur

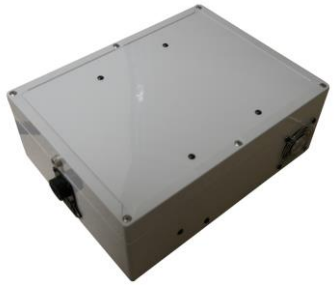
Use the scanner to help you decide who provides the best thermocouples for your application.



Scanner requires wall mounting

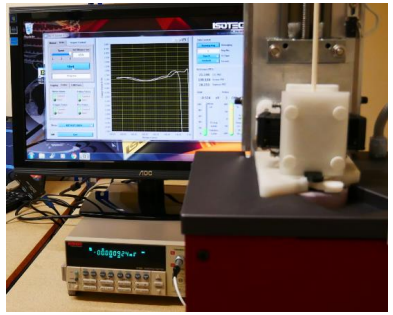


A separate control box contains the electronics

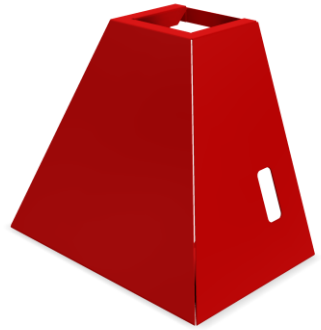


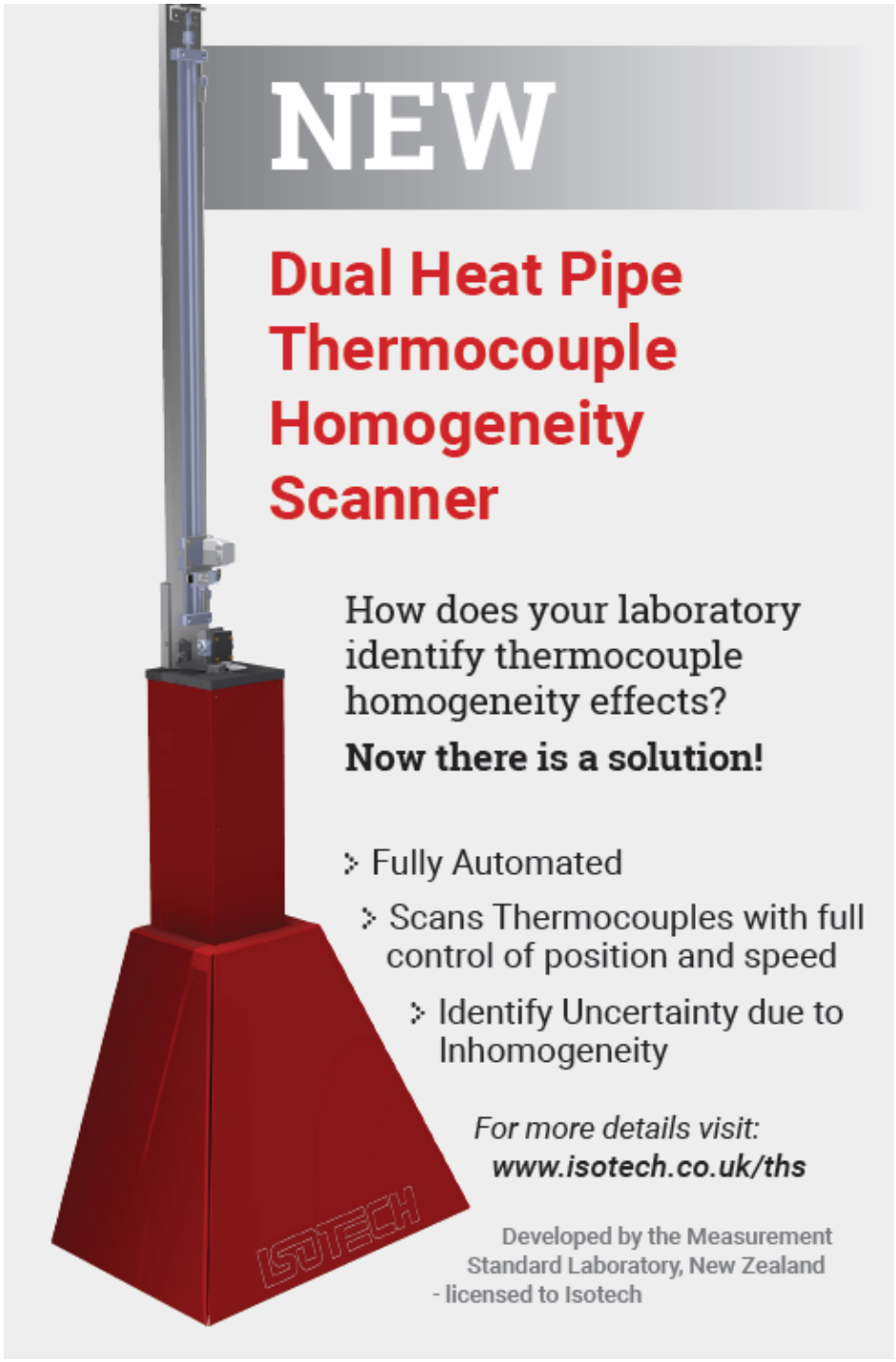
Also Required

- DVM
  - Recommend Keithley 2182A Nanovoltmeter
- PC
  - Windows 10



Or there is an optional base





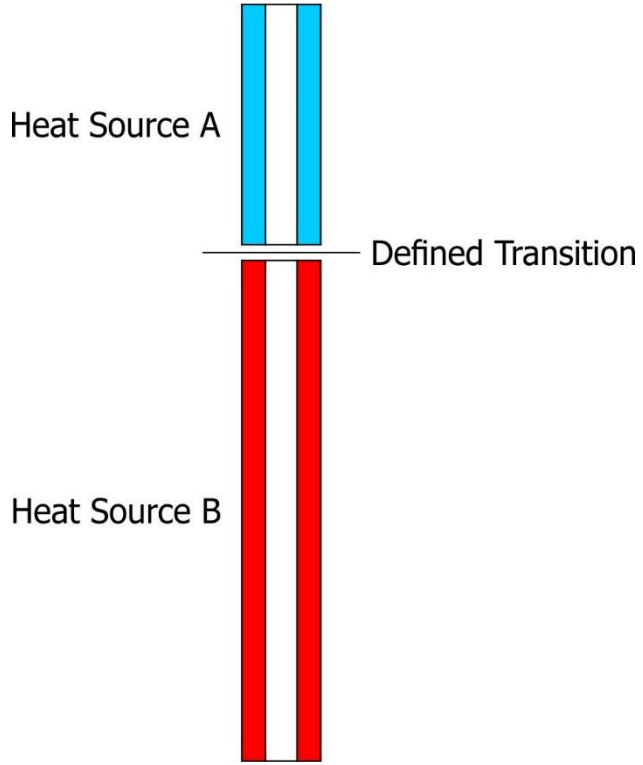
How does your laboratory identify homogeneity effects?

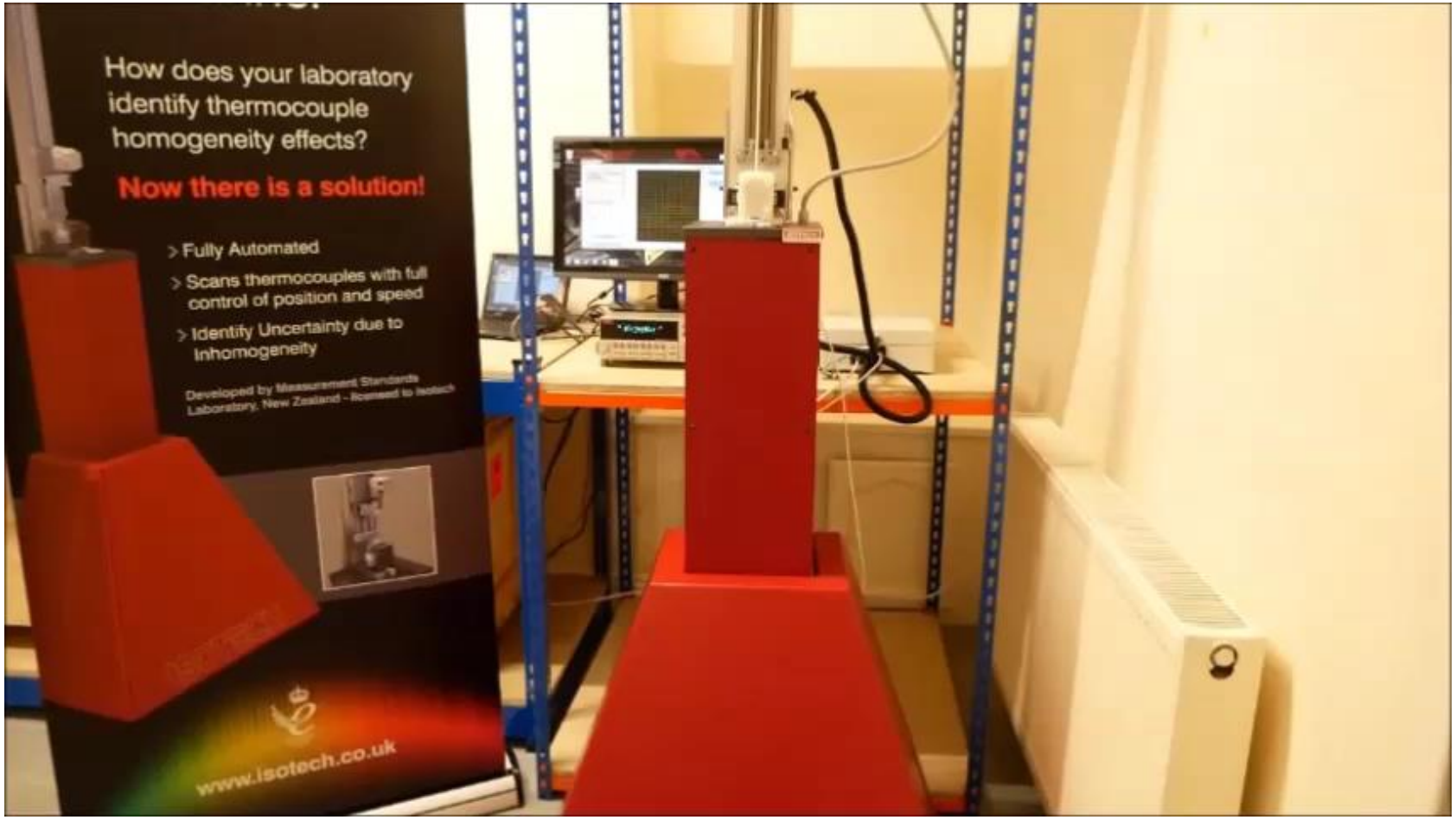
Now there is a solution

Can you afford to be without it?

Automatically Scan Thermocouples

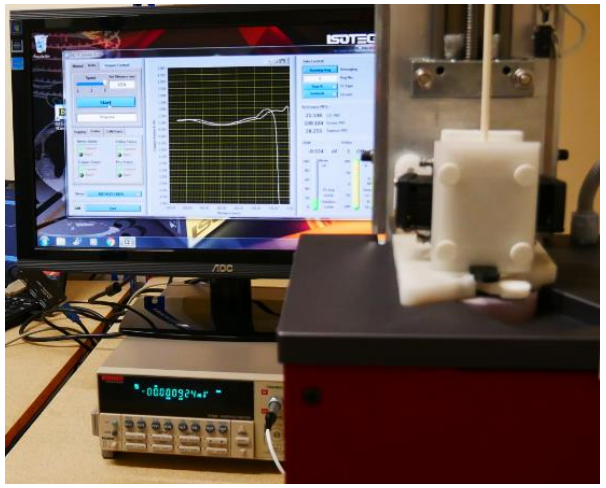
The test thermocouples are lowered and raised through a compressed knife edge gradient

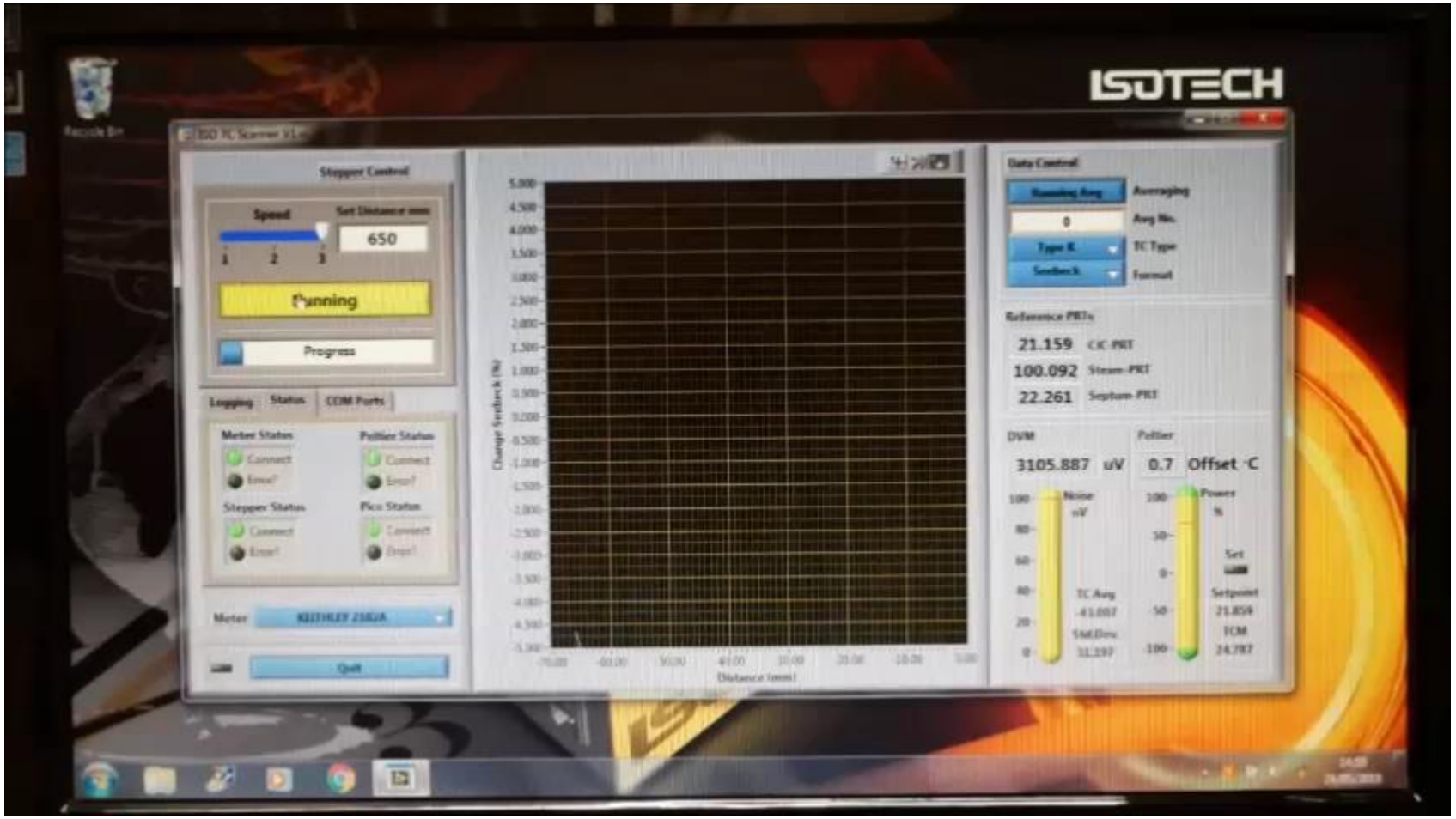




Automatically Scan Thermocouples

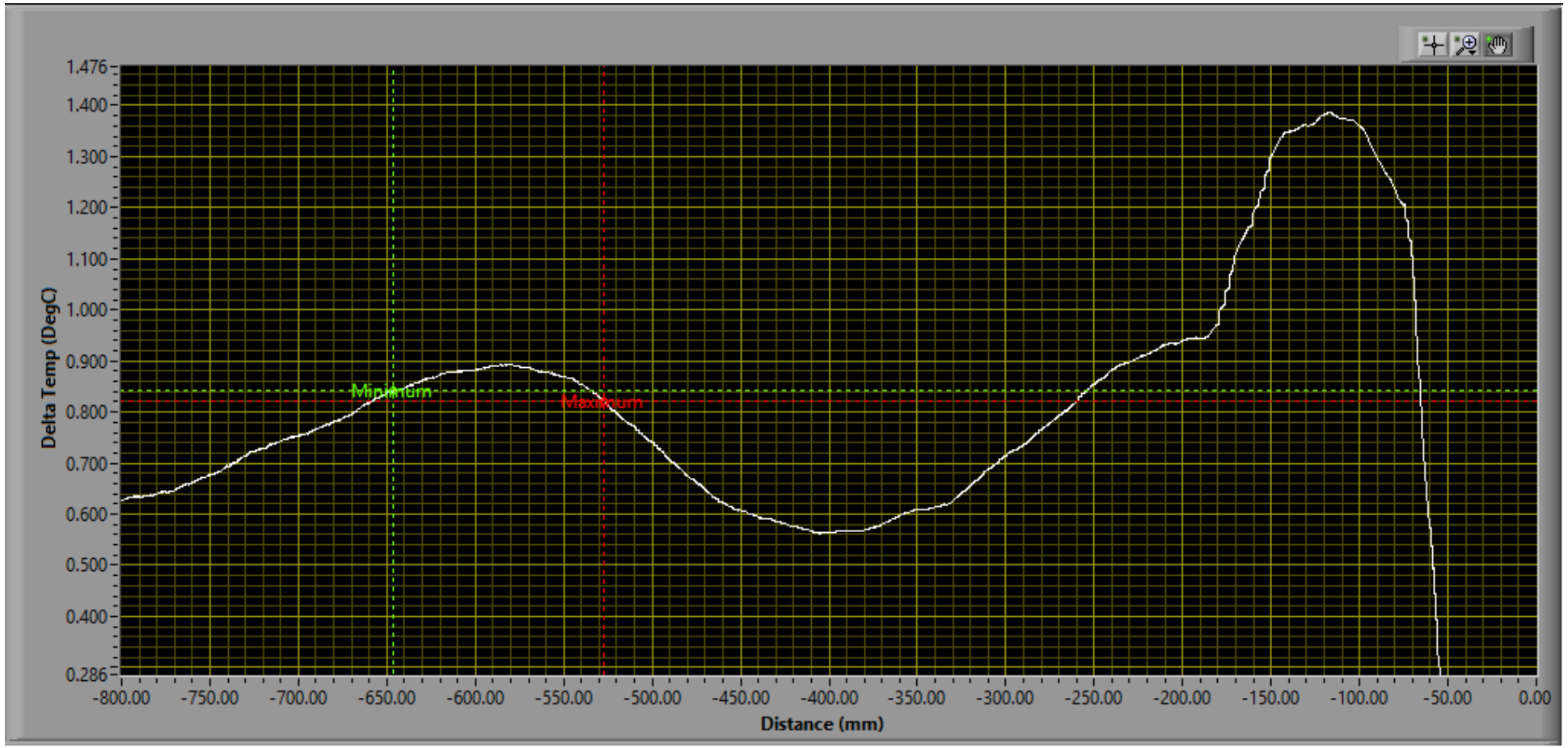
The software automatically controls the test, whilst recording the thermocouple voltage





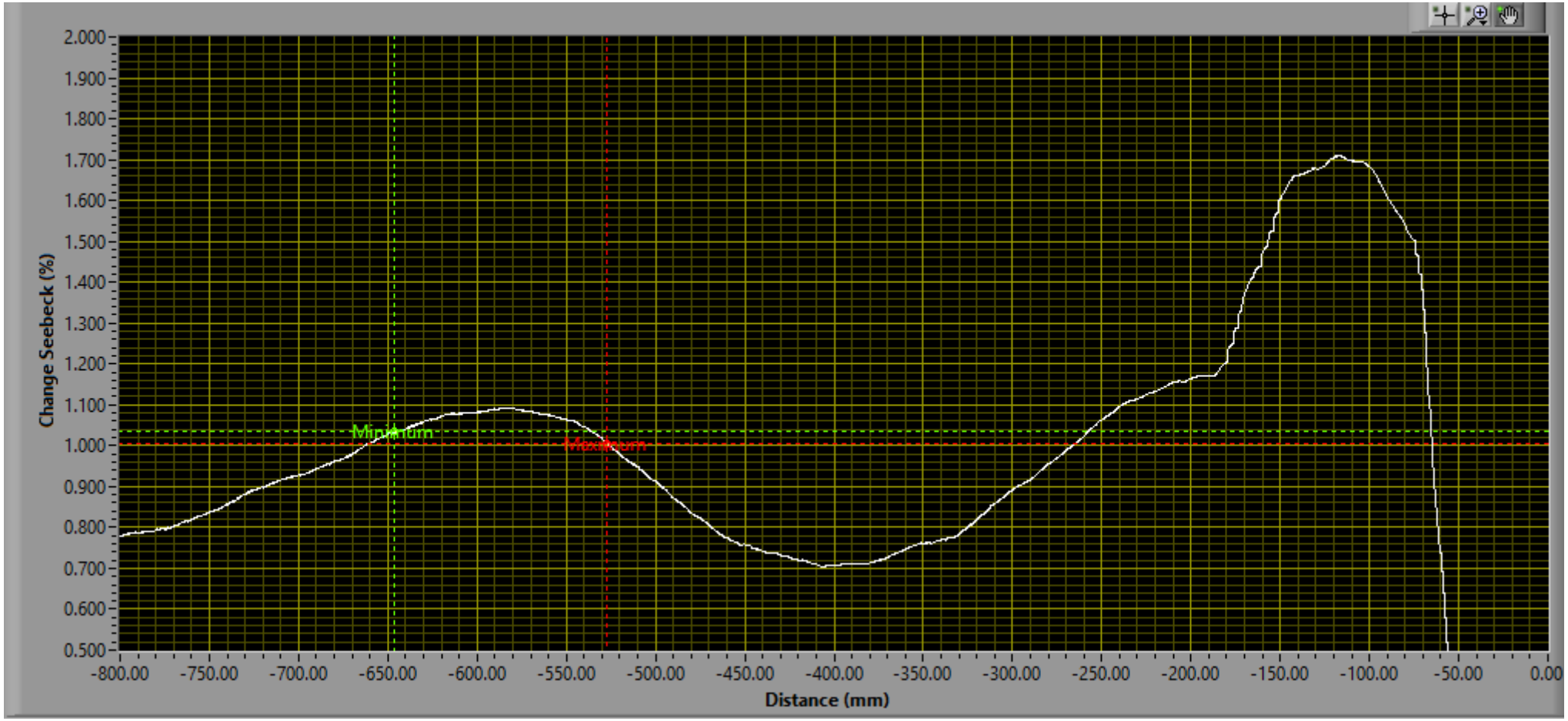
Some Results

Type K MIMS – change in temperature over length



Some Results

Type K MIMS – change in Seebeck Coefficient



More info?

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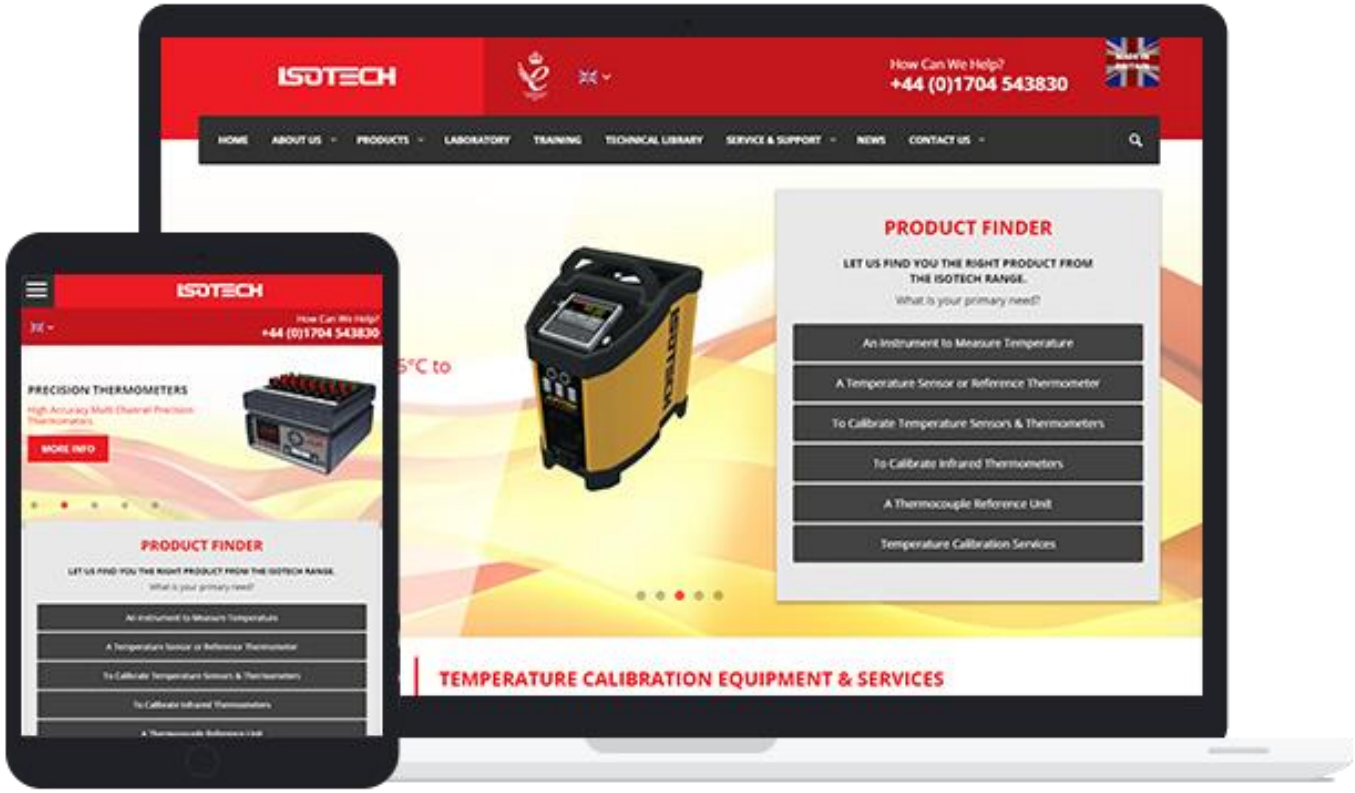

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