Gantner Instruments GmbH

Founded 2004, private owned
86 Employees, 55 Engineers

Applications
Test Automation, Process Monitoring

Products
Data Acquisition Solutions
Temperature, Strain, Speed
Standard and High Isolation (e-drive)

Customers
Automotive, Aerospace, Energy

Some Aerospace Applications

Safran Turbomeca, engine test

Safran Snecma, outdoor turbine test

Airbus Helicopters, fatigue test

Airbus, stress less assembling

Liebherr, auxiliary engine test

Liebherr, landing gear test

MTU, material test on blades

Simulation of Space Conditions

Temperature measurement
in a wide range from 100 K to 400 K
50000 thermal cycles

Strain measurement because of effects based on vacuum (some mbar) and high temperature gradients.

Measurements under special conditions


Picture: Intespace

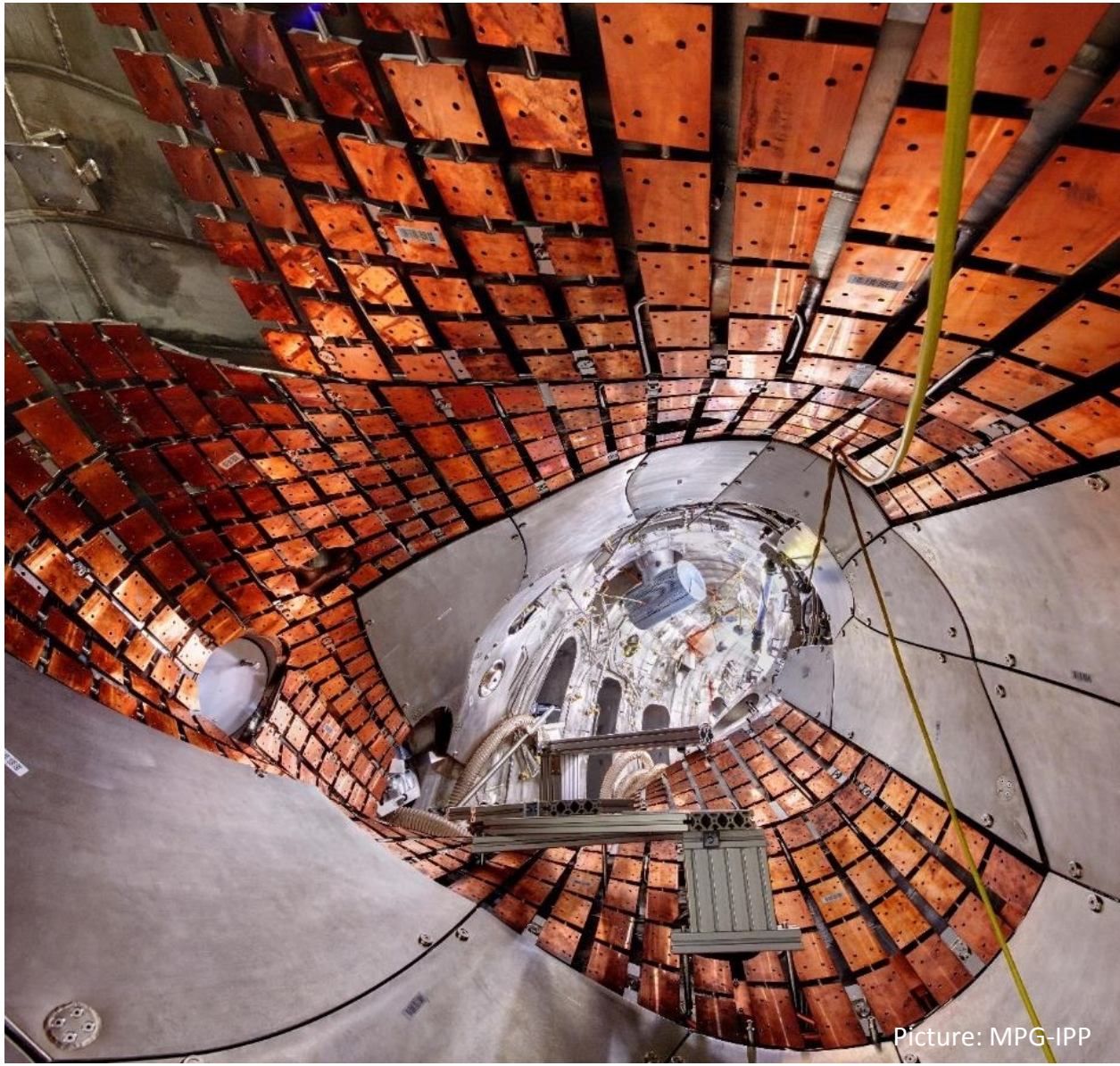
Basic Technology

developed in cooperation with

Max-Planck Gesellschaft
Institute of Plasma Physics
Greifswald

Fusion Reaktor Wendelstein 7X

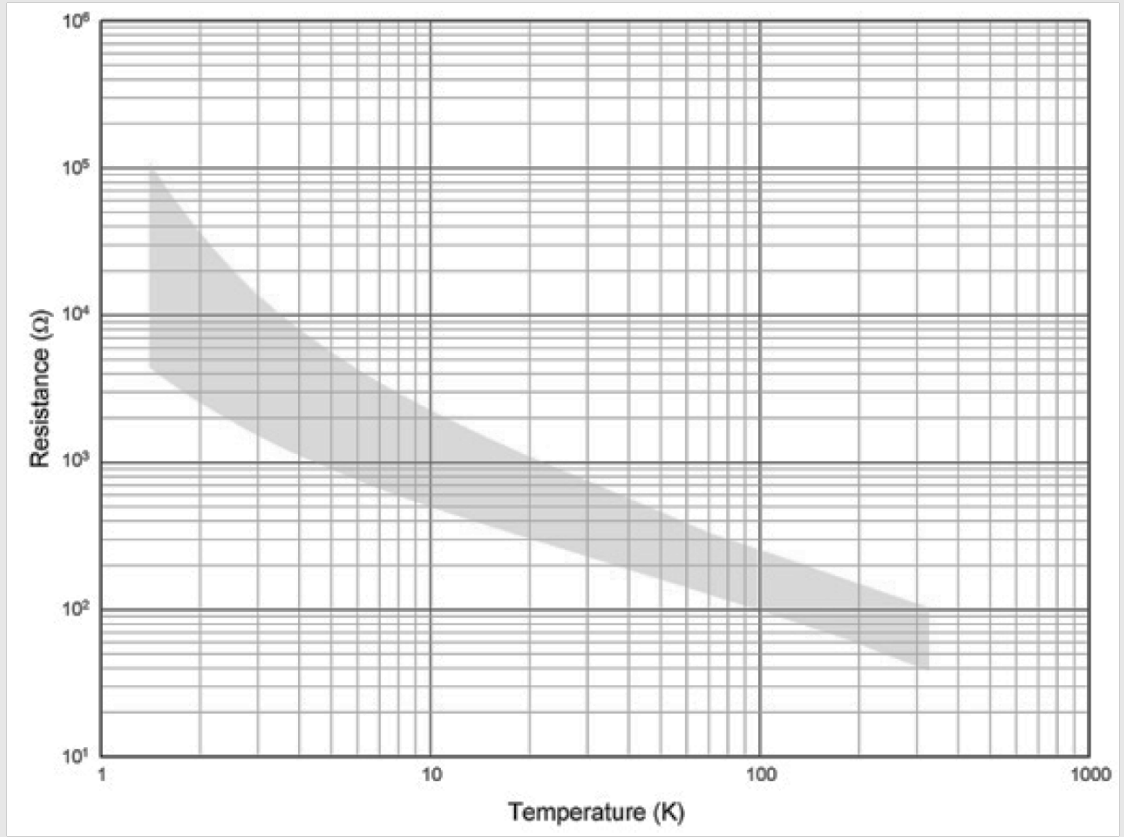
Since 2015 2500 channels in use


Picture: MPG-IPP

Temperature Measurement

Requirements:

- **Use of cryogen sensors Type Cernox or TVO**
- Just a minimum (better no) application of energy into the sensor
- Temperatures range 3 K to 400 K without range adjustment
- Max. deviation 1 K within the entire range
- Linearization of each individual sensor characteristic



Cernox

Sensor characteristic

3 K:	10000 Ω
10 K:	1000 Ω
100 K:	150 Ω
400 K:	70 Ω

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Standard excitation for thermistor is 1 mA,
with 10000 Ω the power consumption is

$P = I^2 * R = 10\ mW$

target power consumption <1 µW

Solution:

excitation current of 7.5 µA,
power consumption is

$P = I^2 * R =$ 563 nW

about factor 18000 less power

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$U = I * R$

Excitation constant current	7.5 µA
Sensor resistance at 3 K	10000 Ω
Measuring voltage at 3 K	75 mV
Sensor resistance at 400 K	70 Ω
Sensor resistance at 400 K	525 µV

Full scale span

525 µV to 75 mV

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Full Scale Span

525 µV to 75 mV

Max. acceptable deviation 1 K

In a 400 K range 1 K correlates with

525 µV / 400 = 1,3 µV in a full scale range of 75 mV

= 0.00175 %

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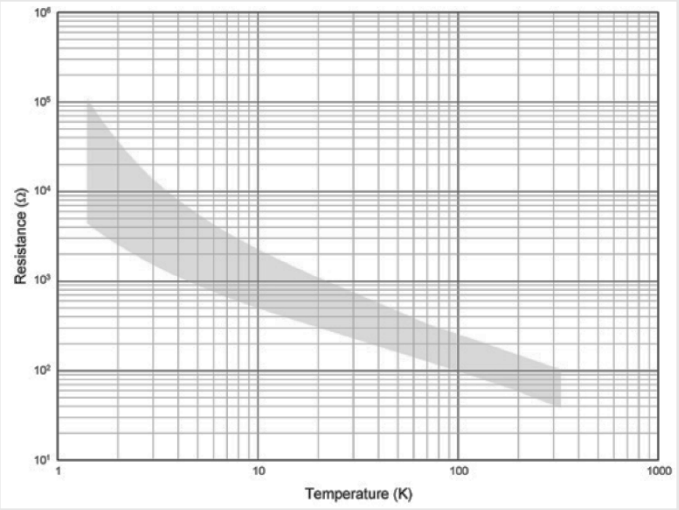
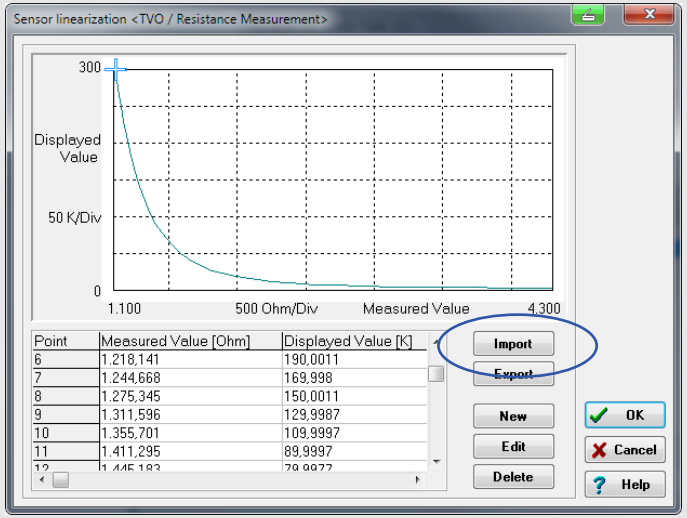




Strain Measurement

To evaluate impacts from

- high temperature gradients,
- vacuum and
- acceleration

on the specimen.

Strain signals in a range of

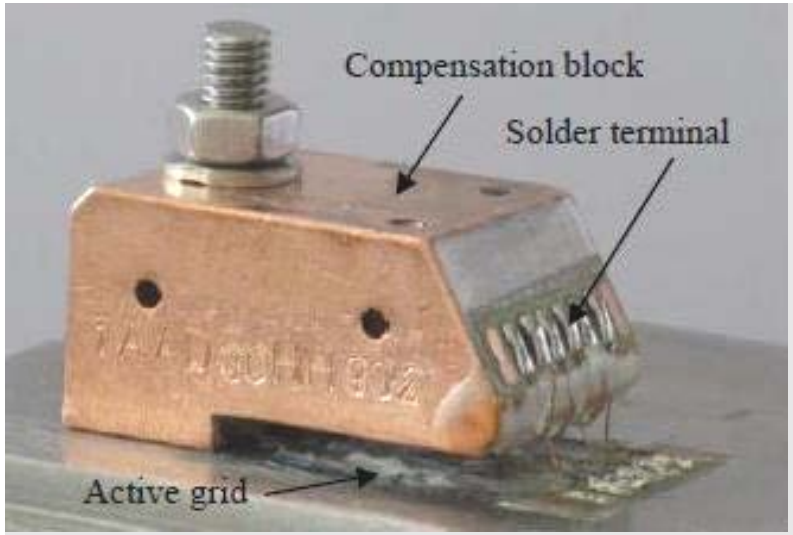
1 µm/m to 10000 µm/m

Picture: IABG

Strain Measurement

Requirements:

- **Use low temperature strain gauges**
- Just a minimum (better no) application of energy into the sensor
- Intermitted excitation with just low gradients dV/dt to avoid microphone effects
- Parasite thermos voltages and cable effects
- Solution



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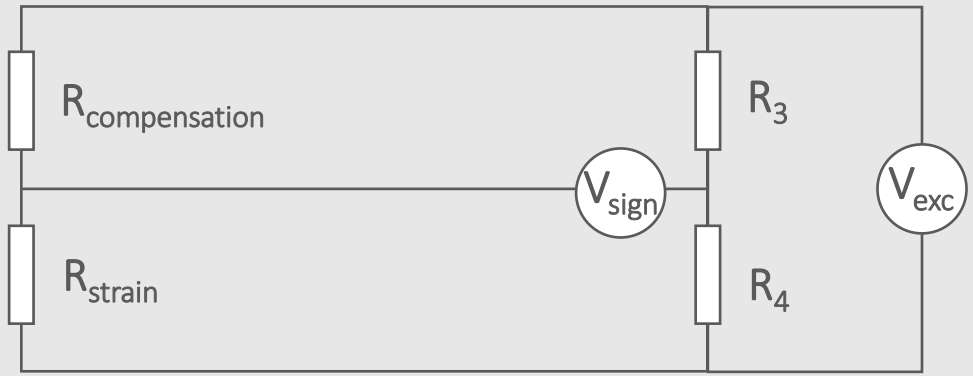

Resistance Wheatstone Bridge	350 Ω
Bridge excitation voltage	2.5 V
Power consumption is	9 mW

Reducing just the excitation is not a solution because of the bad signal to noise ratio.

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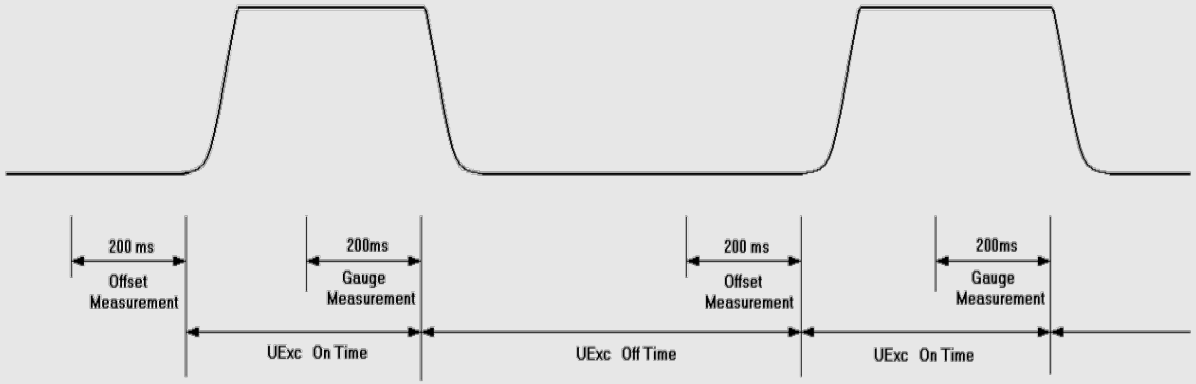
A intermitted bridge excitation…

… but a high gradient dV/dt will show microphone effects in magnetic fields

adapted ON/OFF of the excitation voltage

selectable ON/OFF duty cycle from 1:10 to 1:100

power consumption 900 µW to 90 µW



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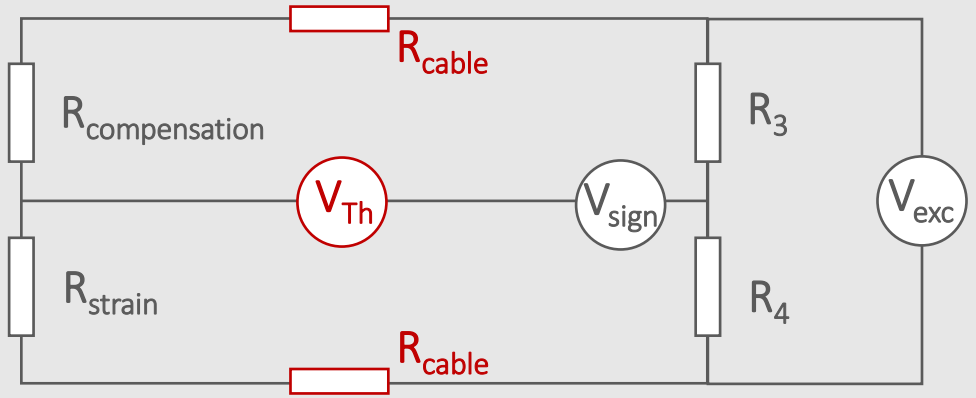

Unfortunately not just copper can be used as cable from DAC to the sensor.

Because of the low temperature special alloys within the cold area and special vacuum feedthrough elements has to be used.

This results in high thermos voltages at all material junctions points and a higher cable resistance.

Strain Measurement

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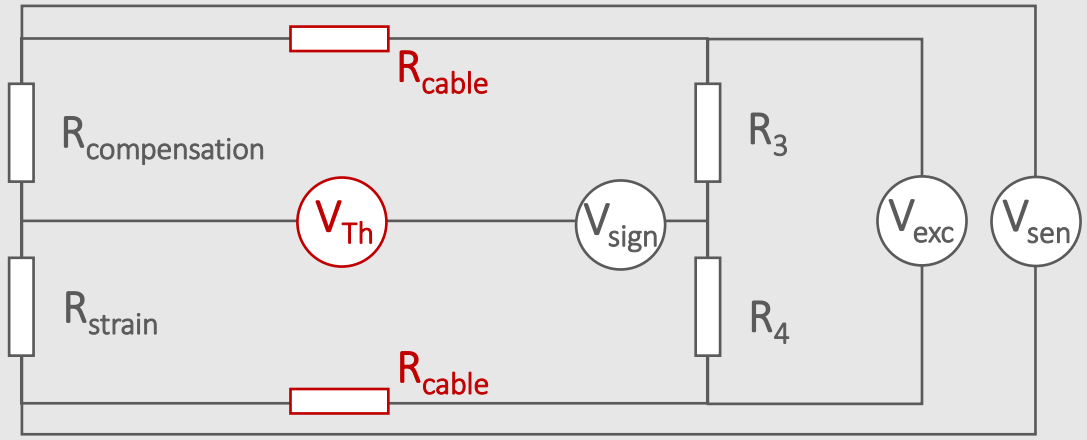

Measurement in 3 phases

- Excitation ON, measure the bridge excitation
- Excitation ON, measure the strain signal
- Excitation OFF, measure the thermovoltage

The right allocation of this 3 measurements will provide an accurate strain signal

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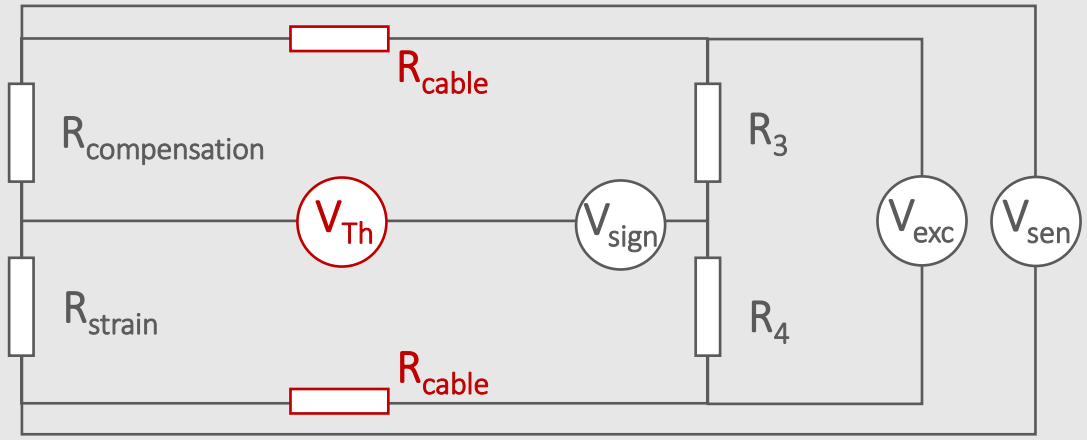

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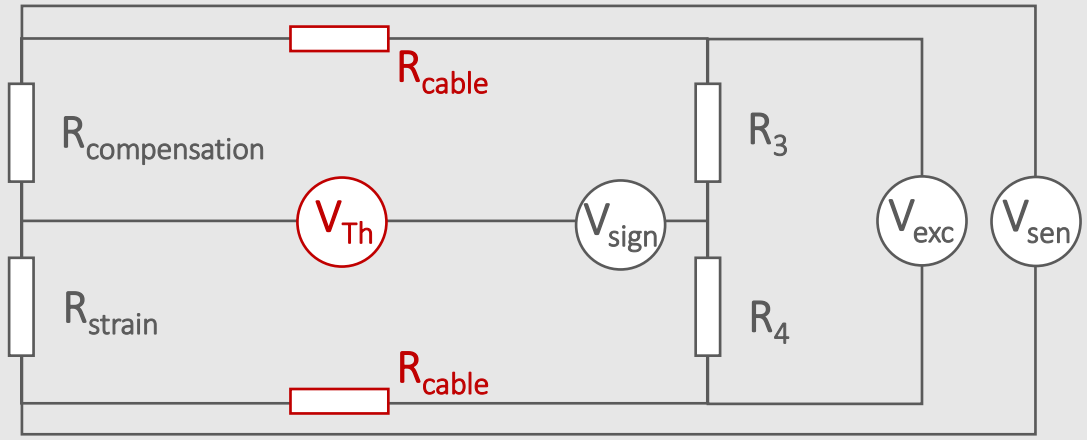

$$\frac{\Delta R}{\Delta R + R} * \frac{{V_{exc}}^2}{V_{sens}} - \frac{1}{2} Vexc - VTh = Vstr_{ain}$$

Very simple,

but it works well under all conditions

Thank you
for your attention

Gantner instruments

Test and Measurements Technology.
Designed for You.

Picture: ESTEC