Heat Flux Sensor

by Meerstetter

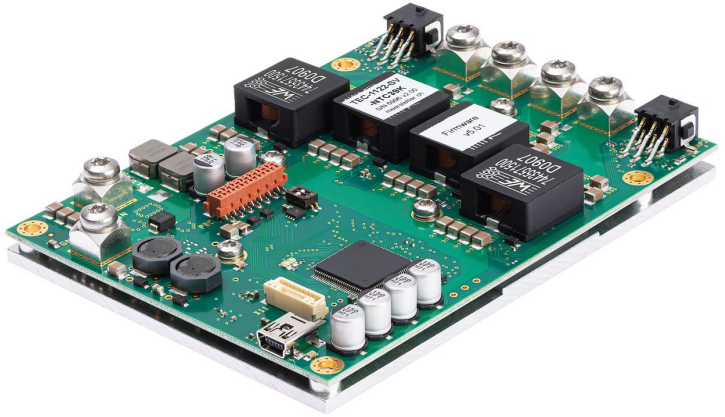
Technology overview

meerstetter engineering

Member of Berndorf Group

Company profile

- 30+ years of experience | part of Berndorf Group since 2018
- Rubigen (BE), Switzerland
- ISO 9001:2015 certified
- Design & manufacture of Laser Diode Drivers (**LDD**) and bipolar Thermoelectric Controllers (**TEC**) including in-house firmware, custom data acquisition & control software
- Products deployed in **medical, industrial, research & space** equipment (ISS payloads, PCR, laser tools, optics calibration, etc.)



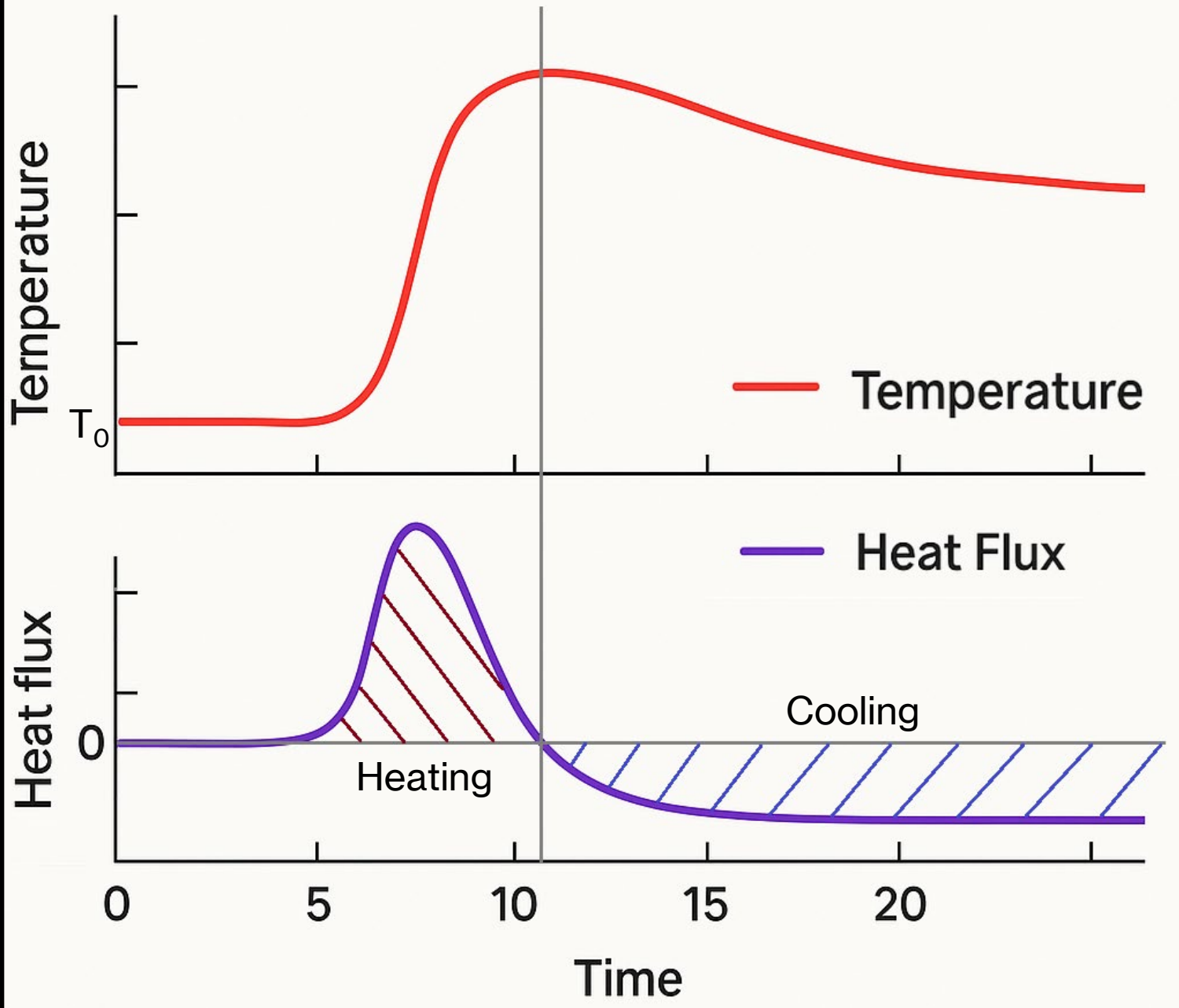
Why Measure Heat Flux?

Temperature vs. Heat Flux:

- **Temperature**: delayed response, accumulation of heat – like the distance traveled over time.
- **Heat Flux**: instantaneous value, current rate of heat transfer – like the velocity of travel.

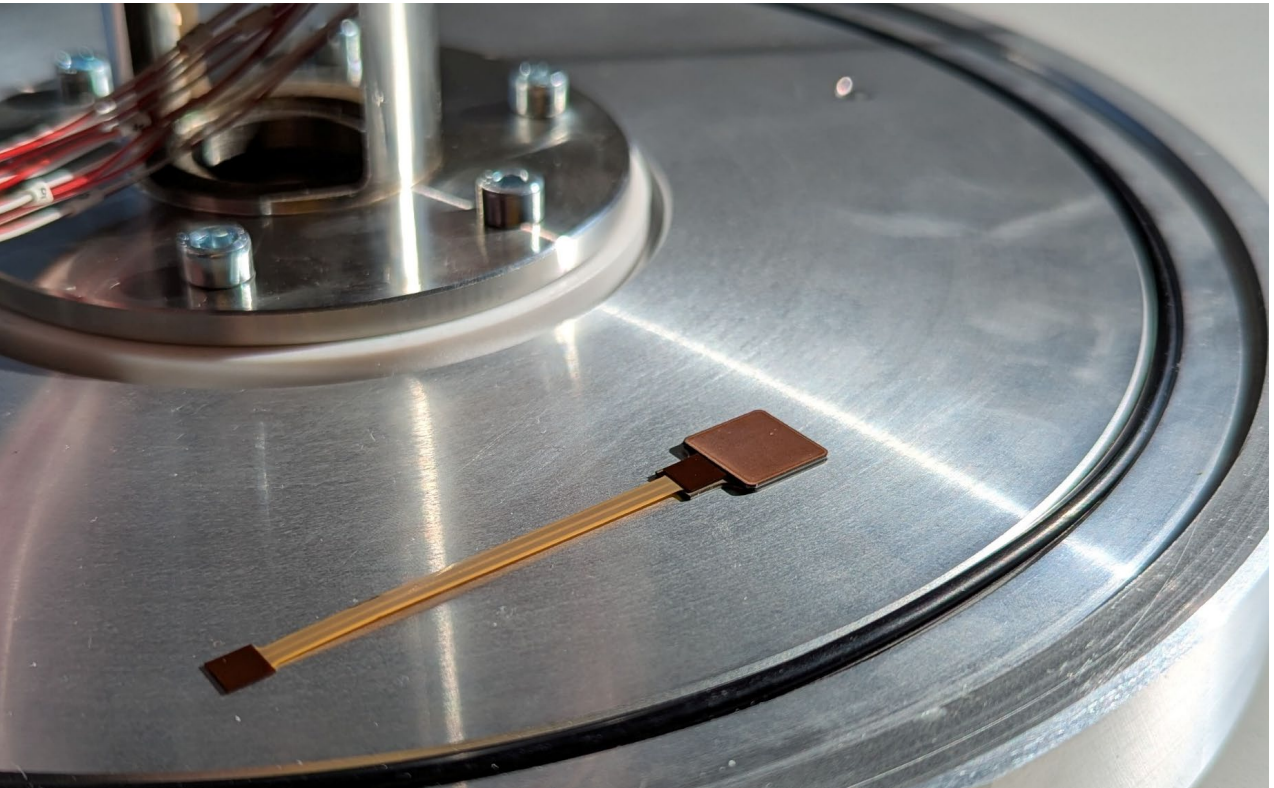
Benefits of heat flux measurement:

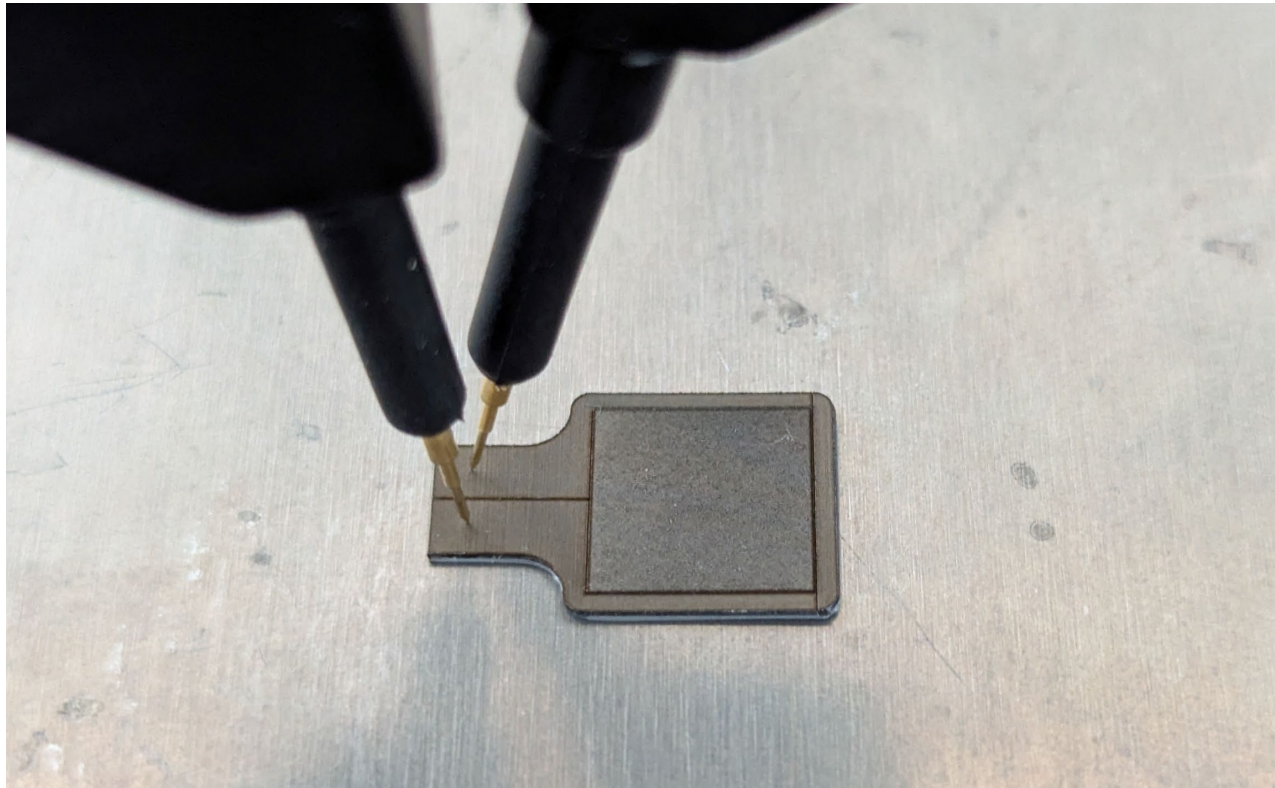
- Directly quantifies energy transfer, not just stored heat
- Reveals real thermal dynamics that temperature alone cannot capture
- Critical in dynamic or non-uniform systems, e.g. power electronics, aerospace thermal loads, manufacturing processes, or phase-change heat transfer



Meerstetter Advanced Heat Flux Sensor

- A solid-state thermoelectric heat-flux sensor using engineered composite for direct, ultrafast energy flow measurement
- Positioned for precise heat flux measurement
- Designed for challenging applications



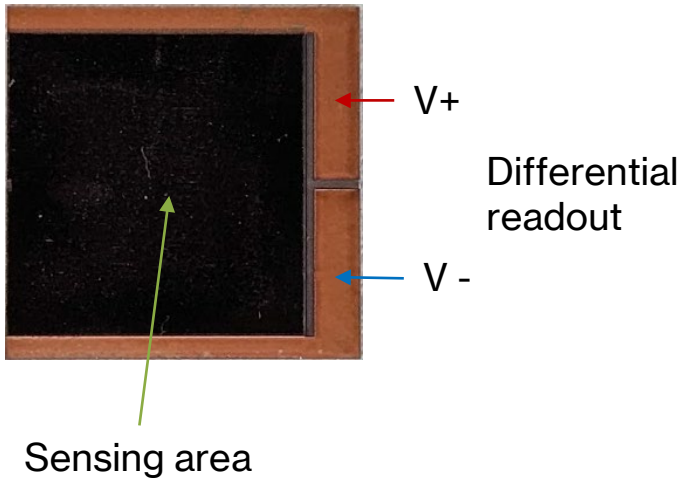


HFS overview

Sensing element architecture:

- **Ultra-thin sensing layer (≈30 µm)** to minimize thermal mass and response time
- **High-conductivity ceramic substrate (0.3–0.8 mm)** ensuring defined, one-dimensional heat flow
- **Optional ceramic protection layer (0.3–0.8 mm)** for harsh or high-temperature environments
- **Variable size**, currently 5x5 to 20x20 mm

Sensing element:



Assembled HFS:

Meerstetter HFS technology advantages

From physics-driven design to industrial-scale sensing

Performance

- Ultra-fast response time (nanoseconds)
- High thermal conductivity (150 W/mK) with minimal thickness
- Low internal electrical resistance

Robustness

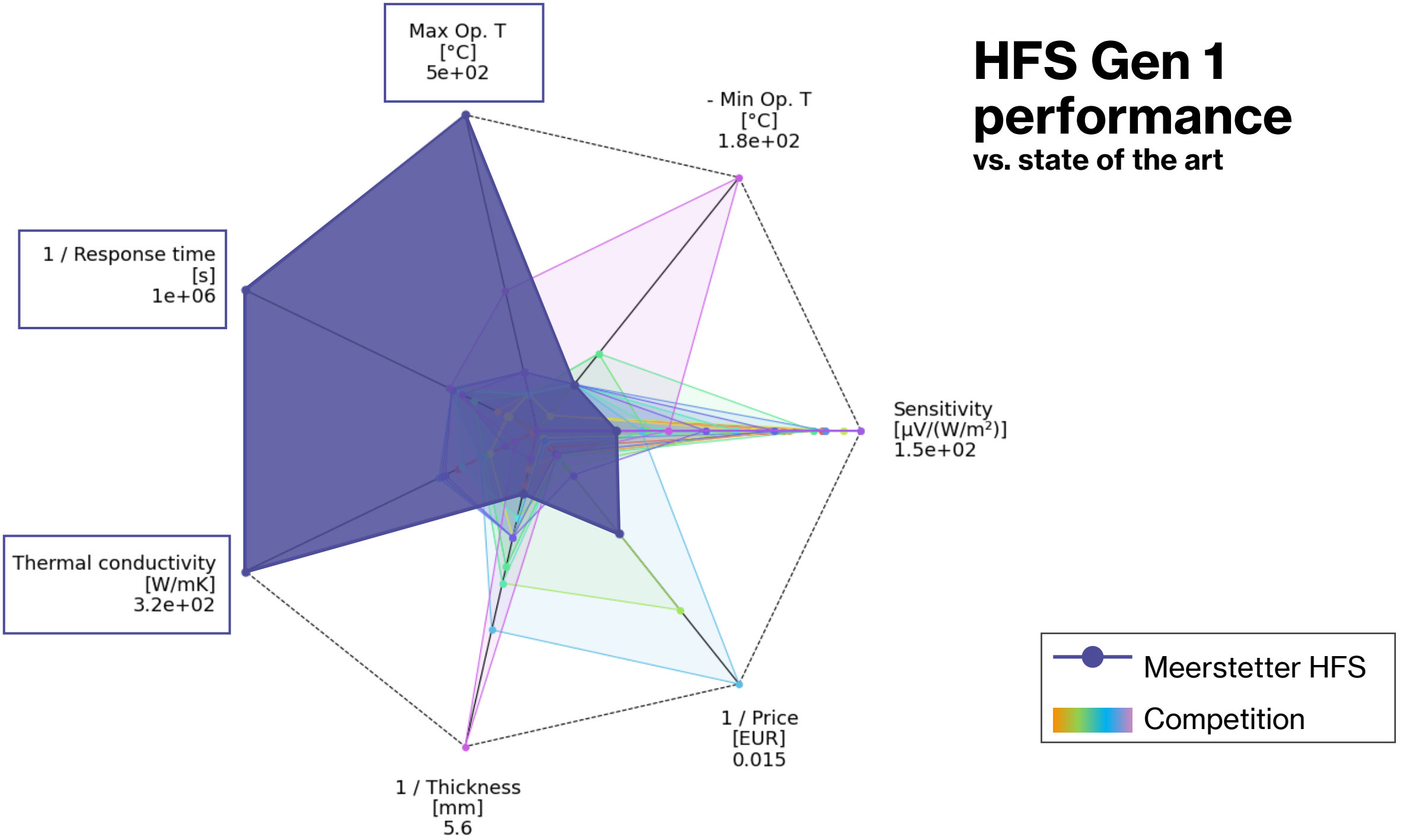
- Stable operation in extreme environments
- High-temperature capability up to 1300 K (material-dependent), 700 K standard
- In-situ self-calibration capability (under development)

Integration & scalability

- Simple architecture based on a single thermoelectric composite
- Customizable geometry and multi-sensor layouts
- Integrates with Meerstetter electronics and software
- Scalable and cost-effective for distributed sensing

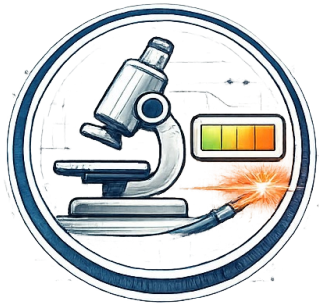
HFS Gen 1 performance

vs. state of the art



Demonstrated Meerstetter HFS applications

Validated across research, industrial and extreme environments



Advanced Research & Sensing

- Turbine Blade Experiments
- Li-Ion Battery SoH Monitoring
- Laser Power Measurement
- Fire Detection Sensor Development
- Photosynthesis Heat Flux Measurement
- Phase Change Phenomena

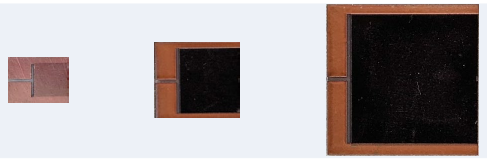
Energy & Power Systems

- 160 MW Turbogenerator Heat Flux
- IGBT Modules Thermal Management
- Permanent Magnet Motor Thermal Control
- Nuclear Fuel Storage Heat Transfer Monitoring

Industrial Processes & Reactors

- Boiler Combustion Control Process
- Chemical Reactor Monitoring
- Pulp and Paper Mill Reactors
- Diesel Engine Cylinder Monitoring
- Machining Processes Monitoring

Gen 1 Factsheet

Key Properties	Value
Sensing plate size	from 5x5 to 20x20 mm, larger sizes on-demand 
Thickness	0.8 mm standard, 0.5 mm possible
Working temperature	-50°C to 500°C
Sensitivity	5 - 20 µV/W (area dependent)
Thermal conductivity	~300 W/(m*K)
Response time	Validated down to 10 ns in laboratory conditions for sensor plate [1]
Additional options	Available upon request

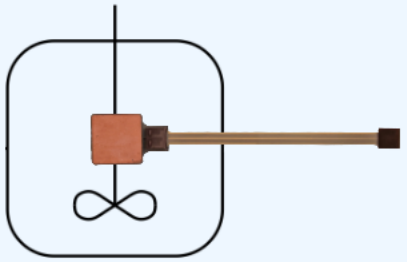
[1] Response time refers to intrinsic sensing layer under controlled laboratory conditions. System-level response may be affected by mounting and readout.

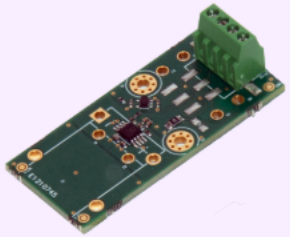
Application

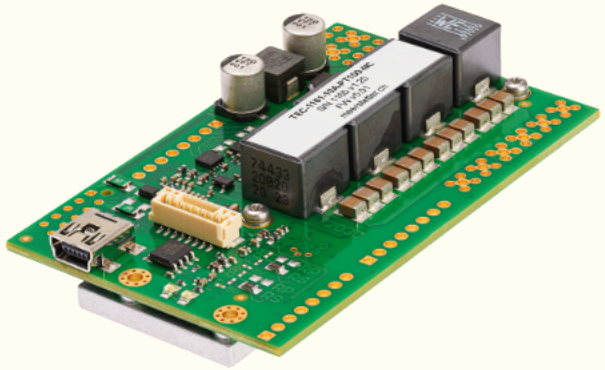
Signal conditioning / amplification

Meerstetter Controller or DAQ

PC







Integrated Meerstetter HFS

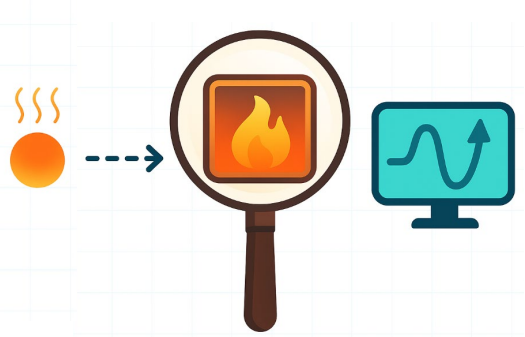
TEC-1161-10A (e.g.)

Integration with Meerstetter ecosystem

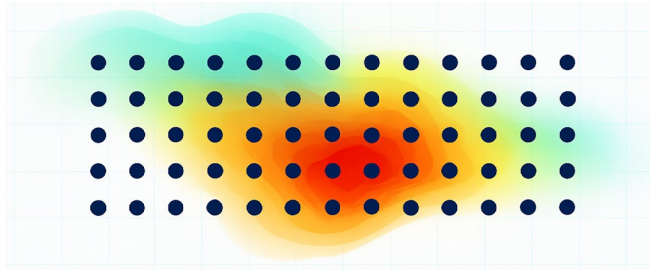
- **Native integration with Meerstetter data acquisition and control systems**
- **Standard electrical readout** – compatible with any sufficiently precise voltmeter or multimeter
- **Application-specific integration support** – mechanical, electrical, and software interfaces adapted as needed
- **End-to-end support** – covering integration, commissioning, and operation

Meerstetter HFS development pipeline

Increased sensitivity



Spatially-resolved measurements



In-situ recalibration

Thank you for your attention

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