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# Virtual thermal sensing

*Advanced software solutions for ePowertrain Thermal Management*

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NEWTWEN



The rise in complexity of electrification systems (mobility, industrial, space-tech, marine...) has highlighted the limits of current sensing technologies.

Traditional sensors are not enough anymore to cope with system complexity.

Let's focus our discussion on thermal sensing.



*Software-based sensing solutions replacement are rapidly rising*



Unfortunately, the current software technologies cannot really substitute physical sensors yet.

They are nowhere comparable in terms of:

**Accuracy**

**Reliability**

**Compliance**

Why is this important?

Why is this important?

**Blind spot**

## *ePowertrain development blind spot*

How is temperature calculated in real-time for derating strategies?



## *ePowertrain development blind*



How is temperature calculated in real-time for derating strategies?

NTCs & Hot spot correlation + Cautelative Safety Margin (up to 40%)

→ Why?

→ Why?



## *ePowertrain development blind spot*



How is temperature calculated in real-time for derating strategies?

NTCs & Hot spot correlation + Cautelative Safety Margin (**up to 40%**)

**This hinders design efforts, performance, safety and cost.**

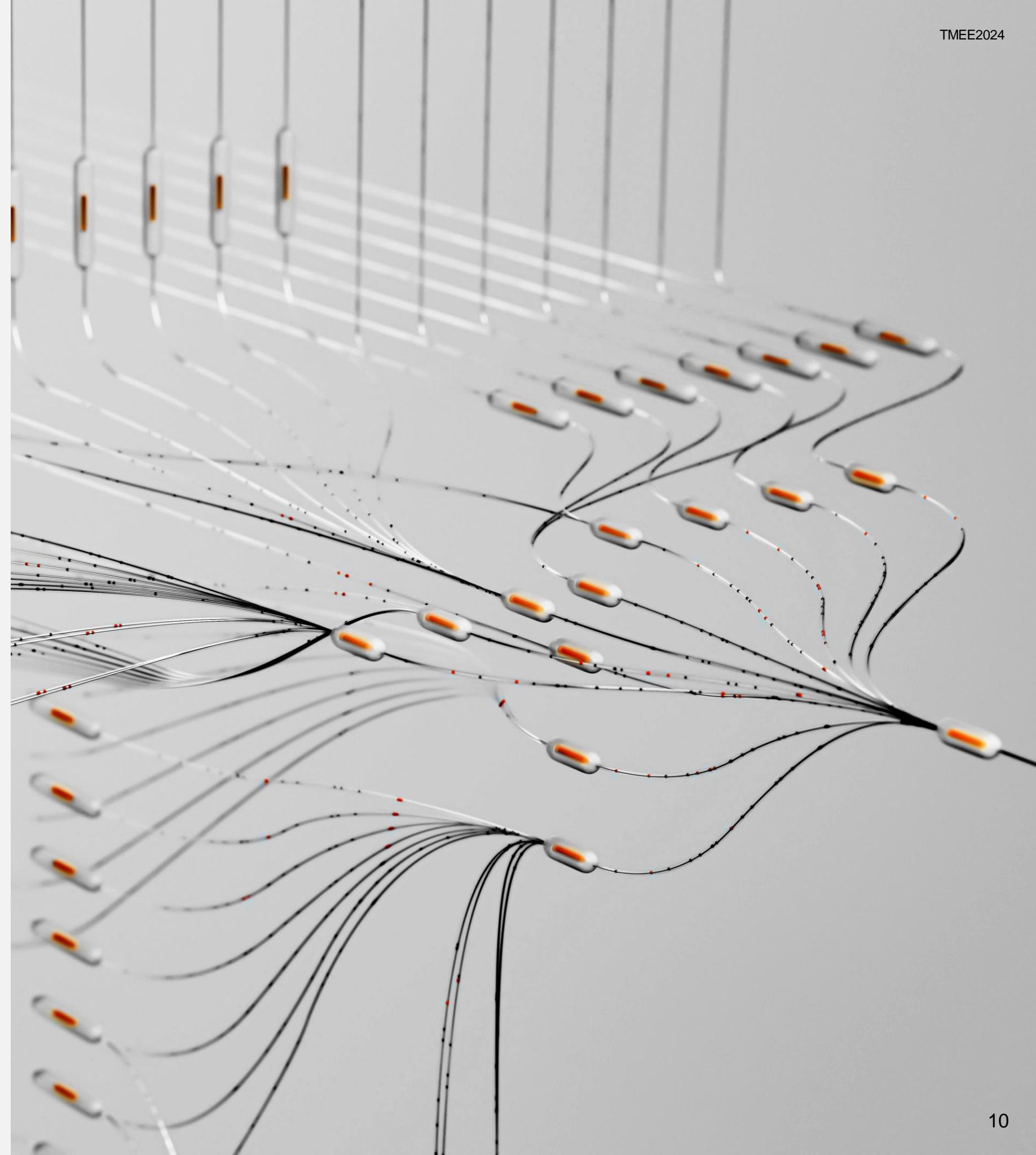




# What is a VTS?

## *What is a virtual thermal sensor?*

A software solution with no sensing placement limitations, capable of accurately estimating temperature dynamics and predicting future outcomes, **across the entire spectrum of operating conditions.**

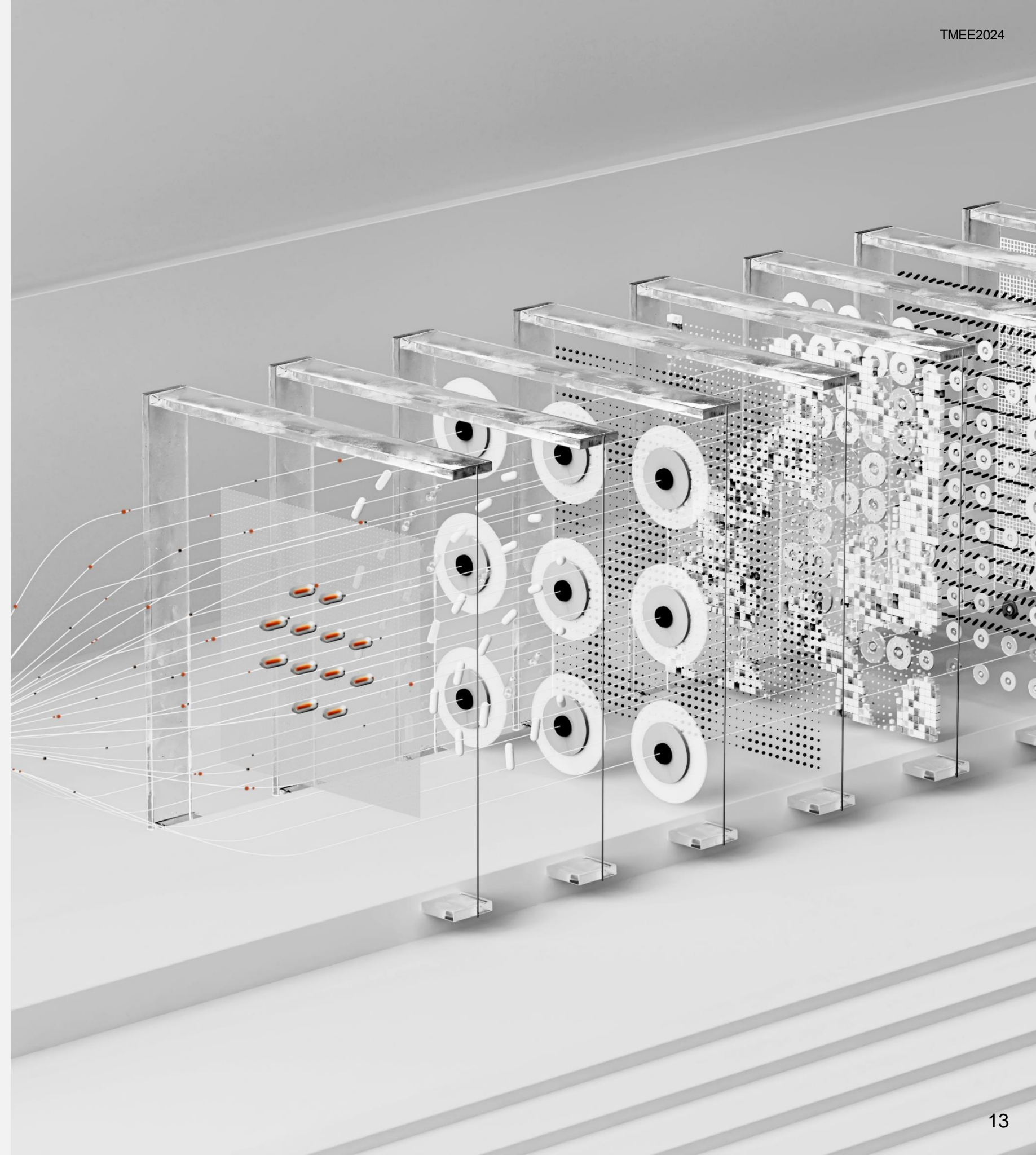


With virtual sensing technology it is possible to reduce safety margins while at the same time increasing the safety of the system

Why choosing VTS over  
other technologies?

# Why choosing VTS over other technologies?

- ✓ Accuracy
- ✓ Reliability
- ✓ Compliance



# What is the impact of a VTS?



## *Impact examples*



### **eMachines**

- Maximize peak torque duration (up to 5X)
- Boost nominal speed (up to 10%)
- Boost nominal torque (up to 16%)
- Increase maximum torque (up to 38%)
- Preserve efficiency avoiding demagnetization
- Enhanced insulation class of your e-machine



### **Power electronics**

- Increased nominal current (up to 10%)
- Increased peak current duration (up to 20%)
- Enhanced thermal protection via prediction capabilities



Everything is possible by maintaining the exact same hardware and just adding few rows of code to the firmware.

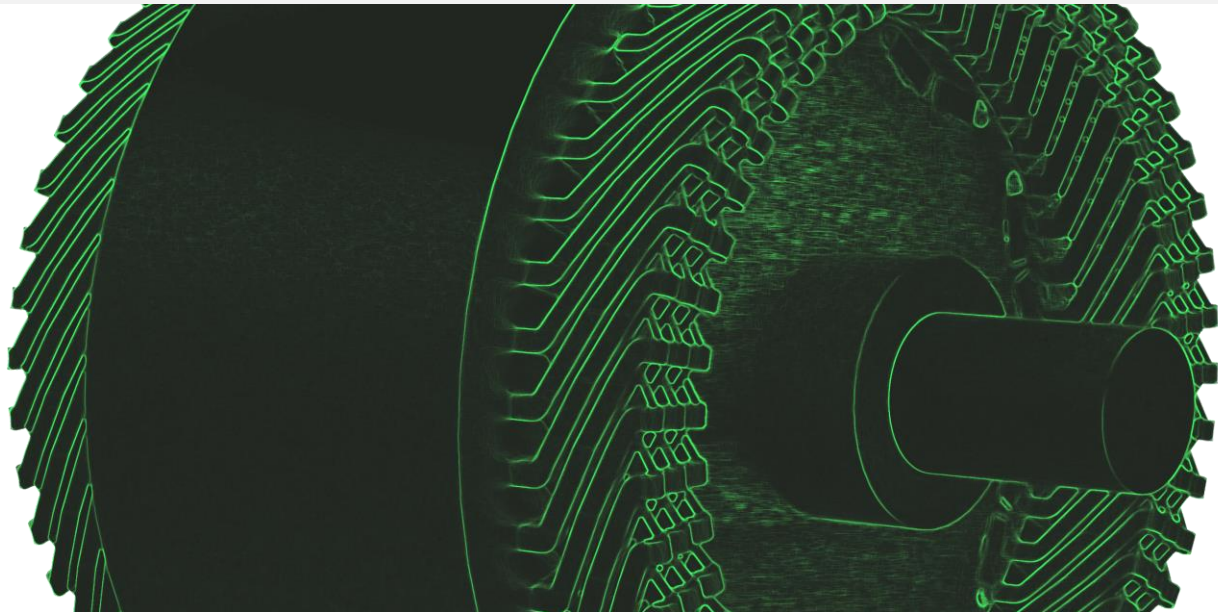
# Use cases



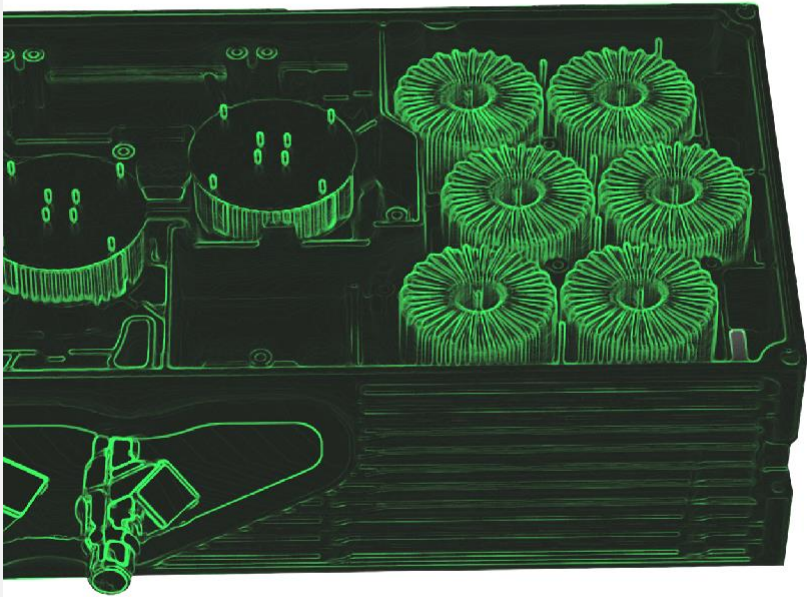
# Virtual Thermal Sensing use cases



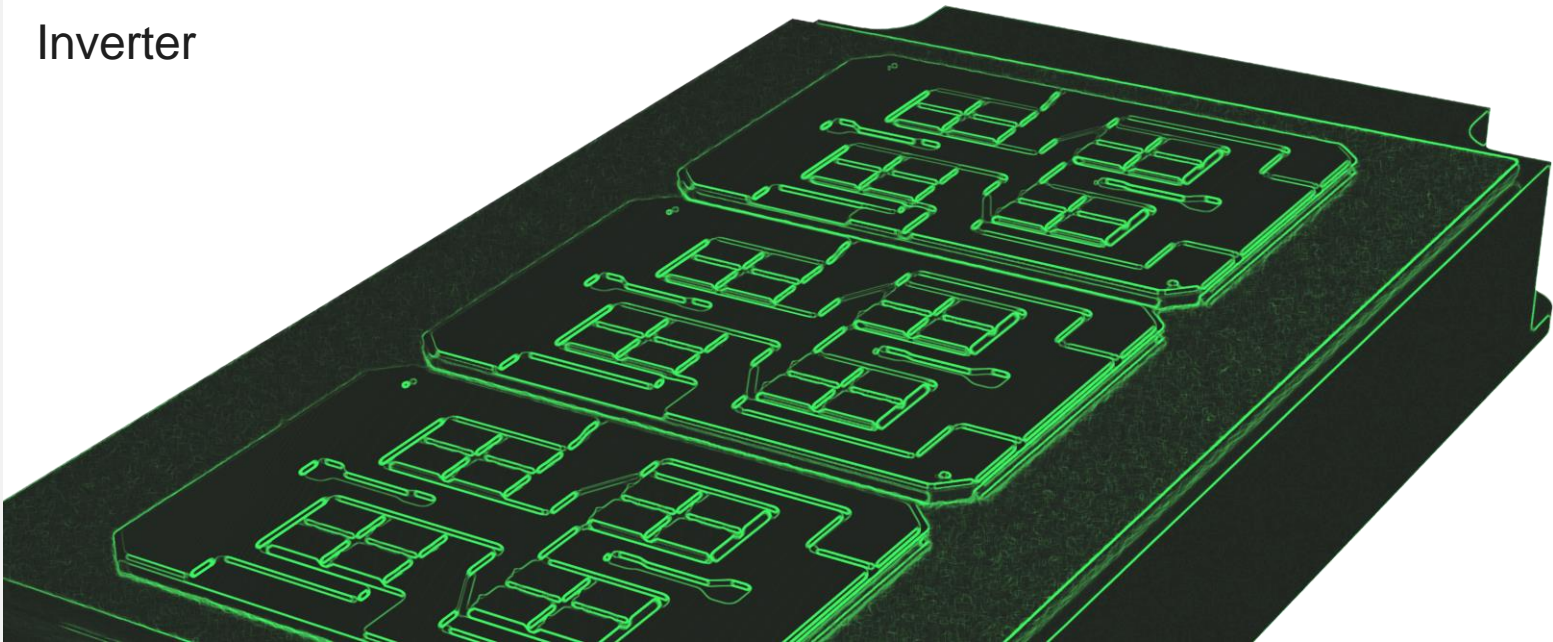
E-motors



On board charger



Inverter

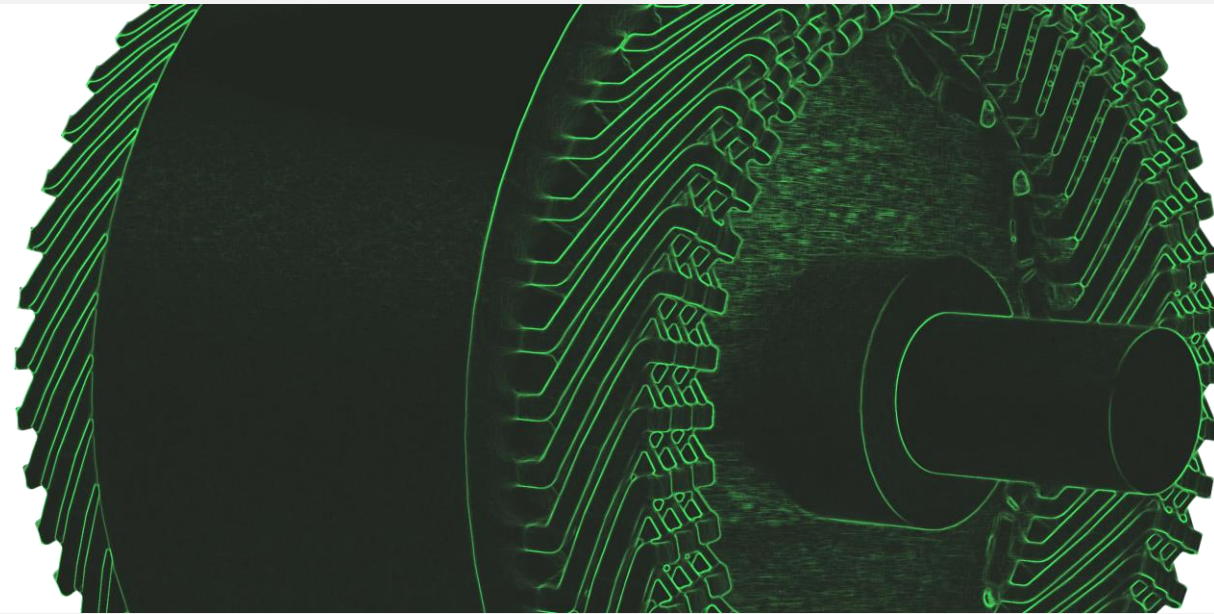


And more



# Virtual Thermal Sensing use cases

## E-motors

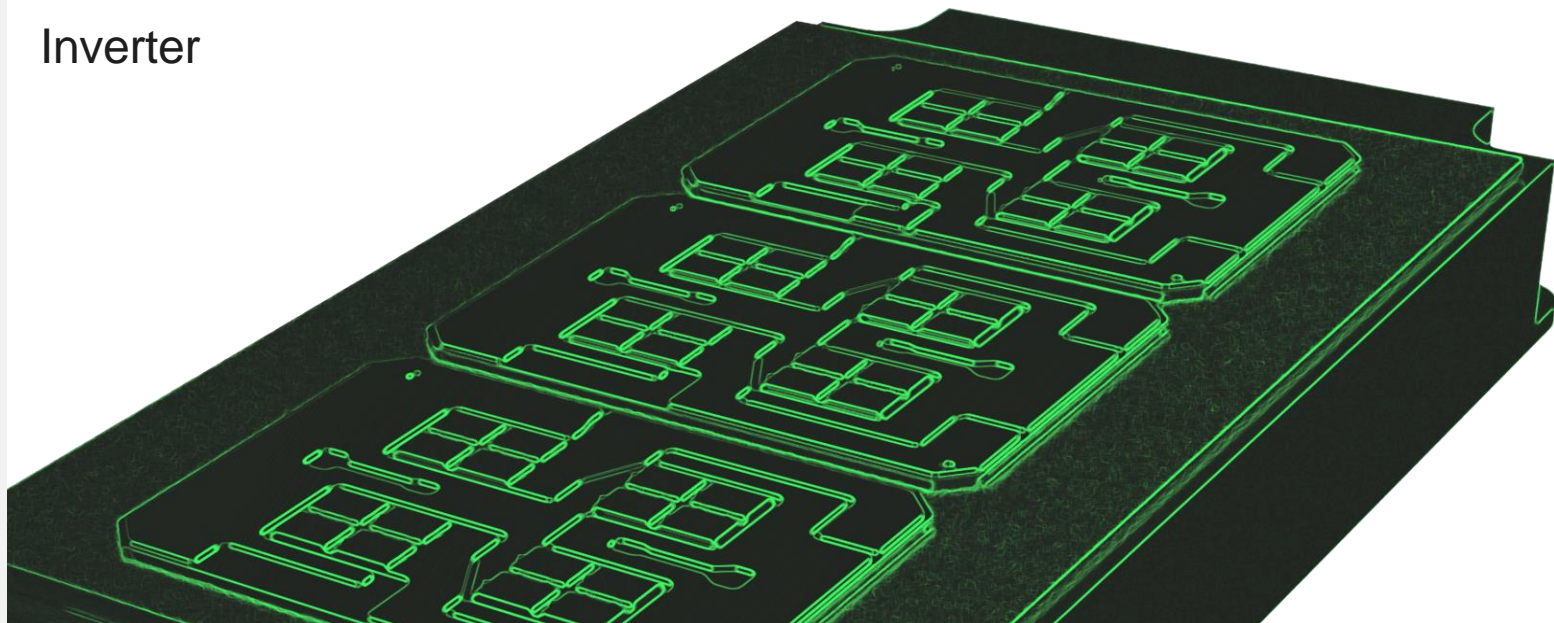


- Granular head winding temperatures
- Rotor magnets temperatures
- Bearings shaft temperatures



# Virtual Thermal Sensing use cases

Inverter

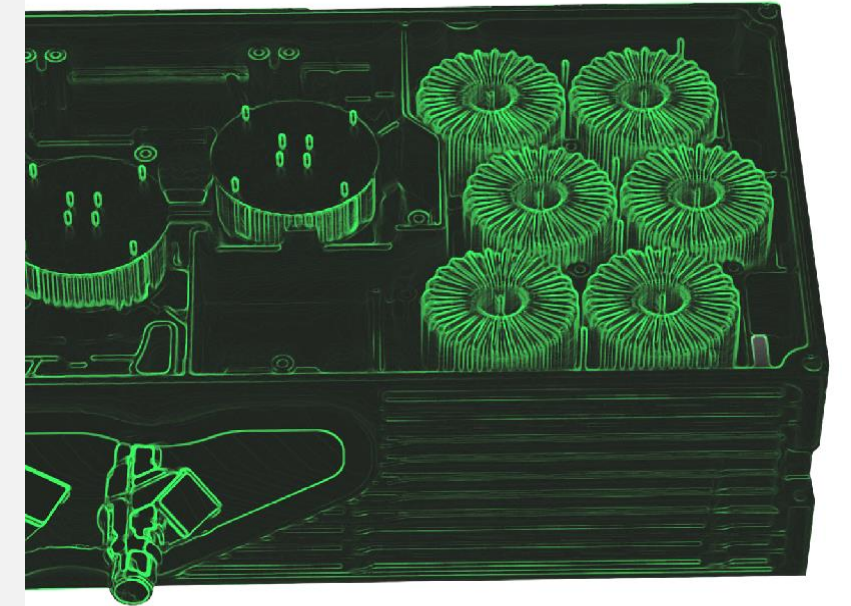


- Power module surface junction temperatures
- Coolant flow rate
- Coolant temperature
- Bus bar temperature

# Virtual Thermal Sensing use cases

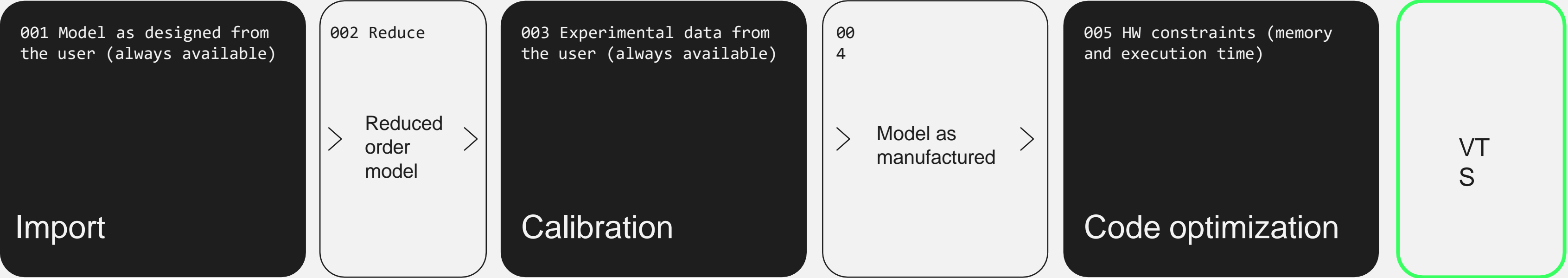
- Discrete power module surface junction temperatures
- Coolant flow rate
- Coolant temperature
- Film capacitor temperature

On board charger



# VTs methodology

# How to create a VTS



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**THERMAL**  
MANAGEMENT EXPO  
EUROPE