Twin Fabrica Software

From Simulation to Real-Time Virtual Sensors

NEWTWEN

Twin Fabrica

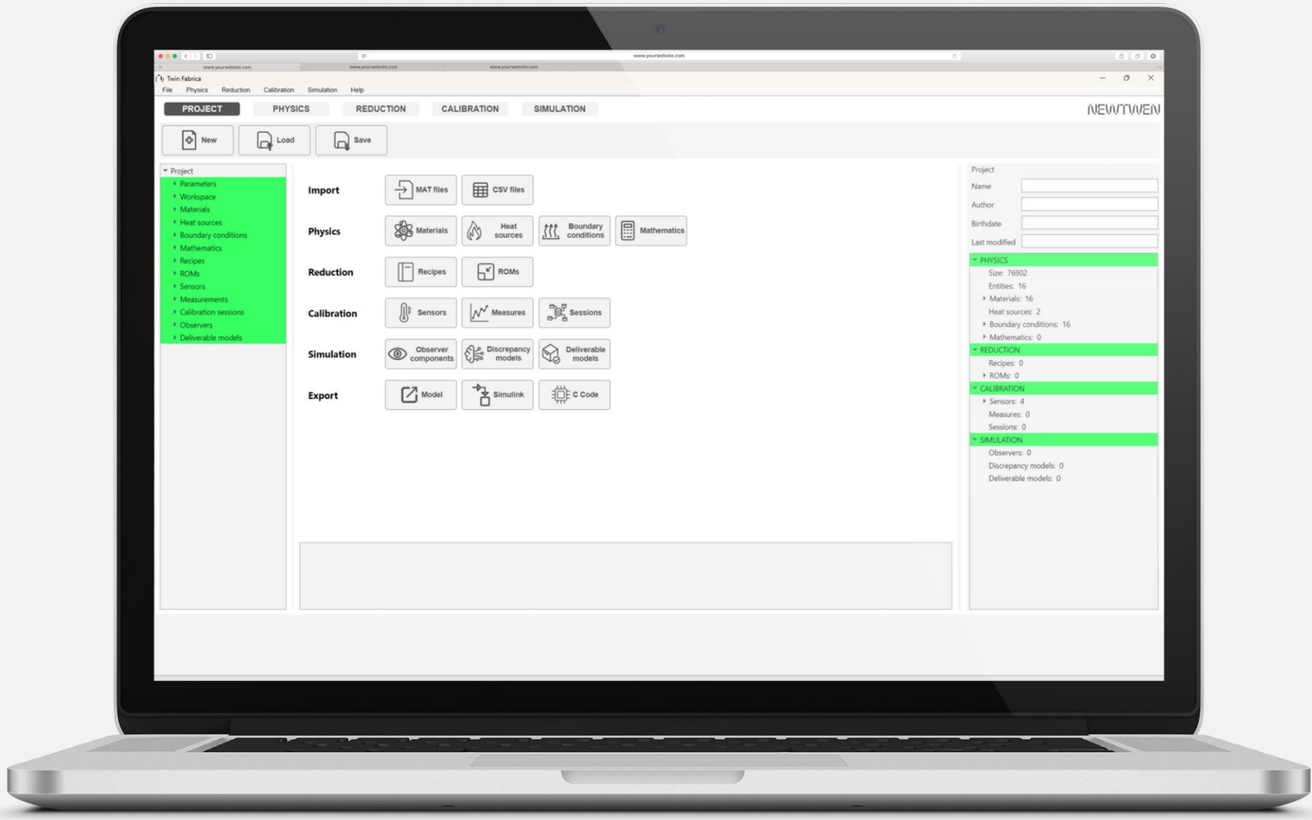
Challenges

- Inaccessible critical points of electrical and electronic components
- Limitation of traditional sensors and existing software solutions
- Lack of accuracy for effective control and derating strategies
- Existing software solutions require extensive expertise and are not scalable
- High computational demand (real-time unfeasibility)

Twin Fabrica

An all-in-one solution that bridges the gap between complex thermal simulations and real-world applications

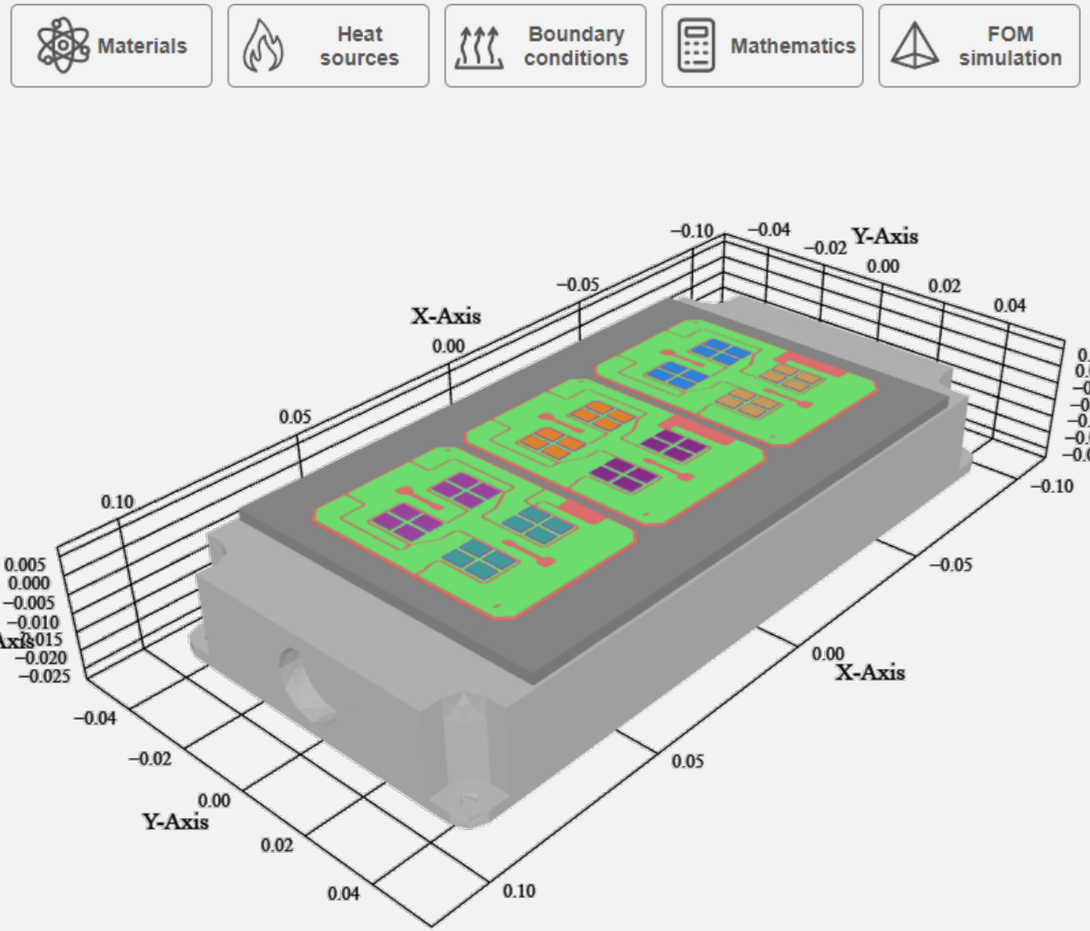
- End-to-end thermal modelling workflow from CAD to embedded code.
- Nonlinear parametric Model Order Reduction (MOR).
- Physics-based model calibration using experimental data.
- Automatic estimation of unknown thermal properties.
- AI-enhanced discrepancy model for unmodeled dynamics.
- Flexible virtual sensor definition and placement.
- White box export to Simulink, embedded C code, or state-space models.



Finite Element Analysis - Twin Fabrica

Our **built-in Finite Element Analysis engine** is fully integrated and easy to use:

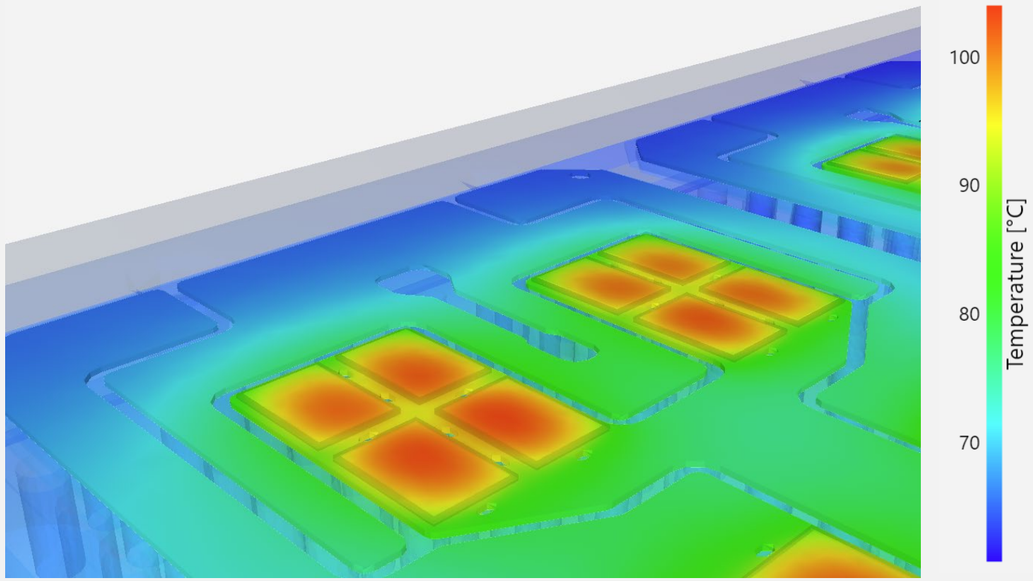
- **Load your 3D CAD Model** and use our built-in model mesh generator. Alternatively, upload directly **mesh files** from third-party platforms (COMSOL, Ansys, Gmsh, etc.).
- **Configure materials, heat sources, and boundary conditions.** These can be set as constant, space-dependent or temperature-dependent.
- **Create custom mathematical expression** to define complex dependencies or to apply scalar/vector fields.
- One click to **simulate steady-state or frequency-domain conditions.**
- **Visualize full 3D thermal solution in seconds**, even for complex component geometries.

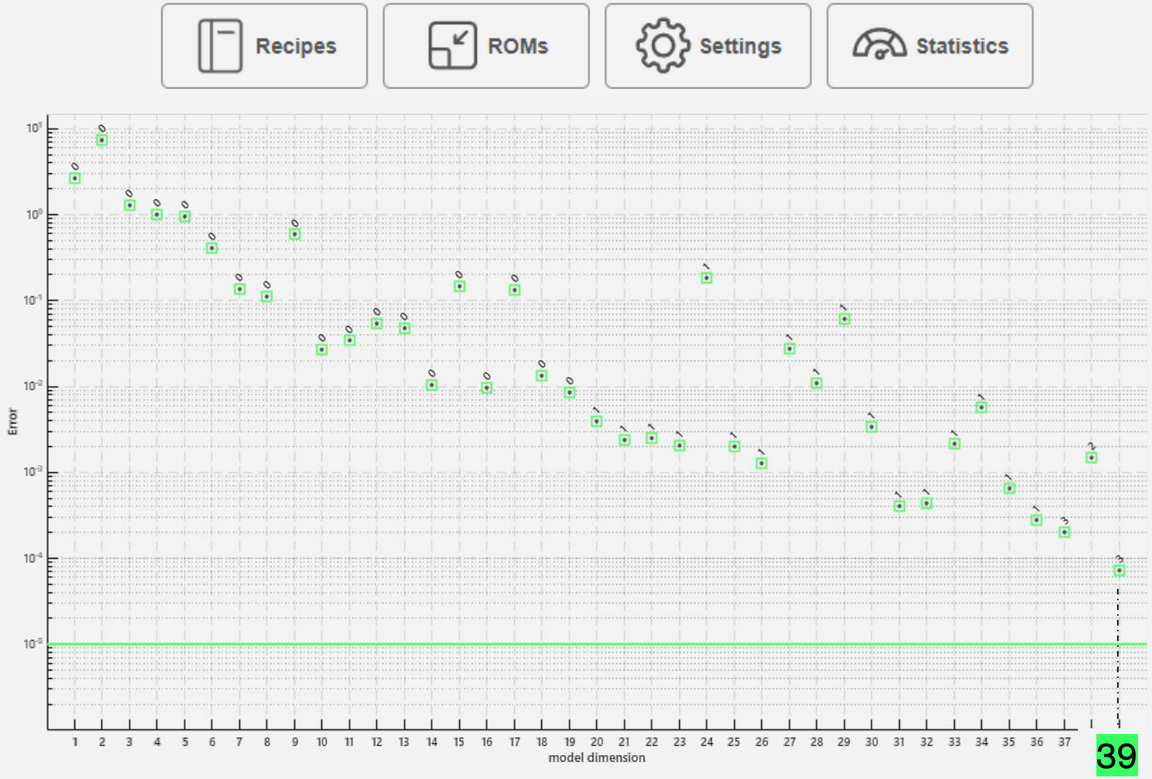


Model Order Reduction - Twin Fabrica

Twin Fabrica's proprietary MOR engine compresses massive FEA models into compact, real-time digital twin:

- From millions of equations in the Full-Order Model to just a few tenths in the Reduced Model.
- Supports complex physics: velocity-dependent advection, radiation, nonlinearities and temperature dependencies that have been defined by the user in the setup of FEM problem.
- Built with accuracy at its core, our reduced models are designed to retain the essential physics of the full-order simulations.





- Evaluate reduced order model performance accuracy both at geometry level and in the frequency domain
- With our unique MOR approach, we make high-fidelity thermal modeling scalable, fast, and ready for real-time execution, enabling precise temperature monitoring and optimized current derating strategies.

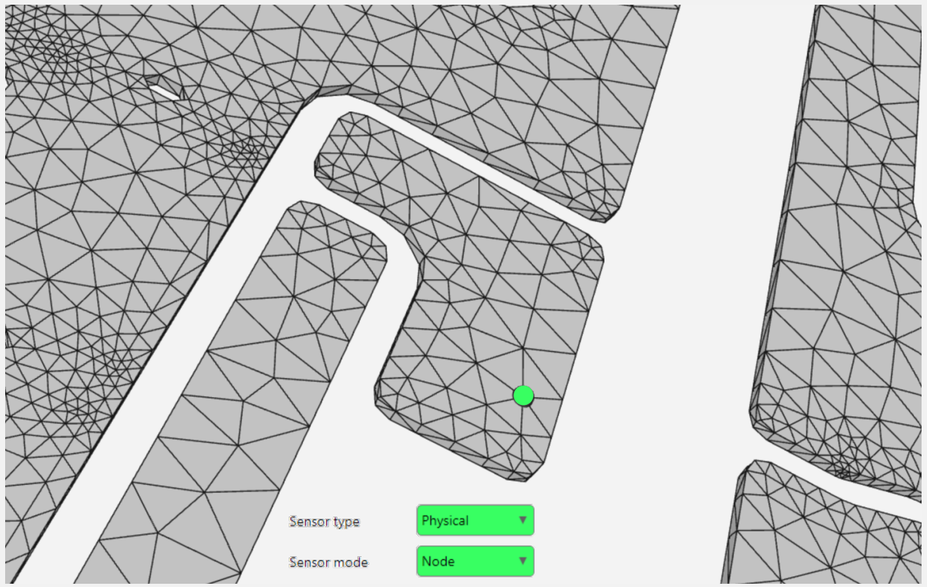
Physics-based calibration - Twin Fabrica

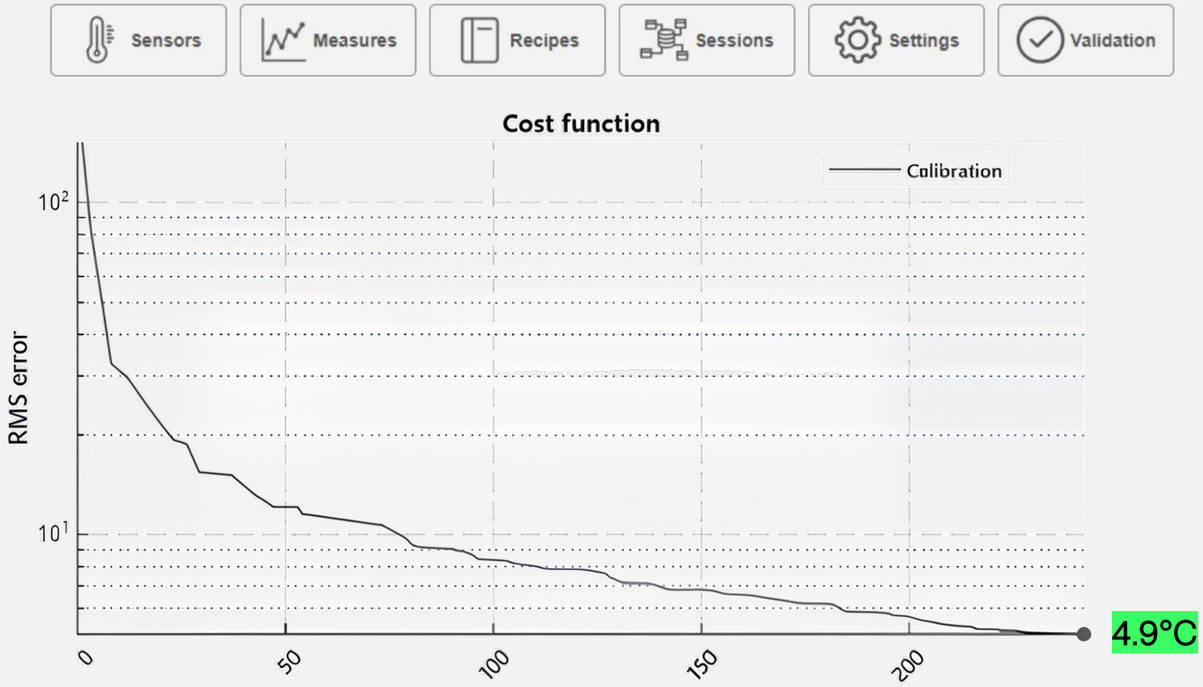
The Challenge

Simulations often diverge from real-world behavior due to uncertain or missing parameters, like **uncertain power losses distribution, time-varying boundary conditions, or missing inputs such as coolant flow or inlet temperature.**

Our Solution

Twin Fabrica uses real-world testbench data (from IR cameras, thermocouples, etc.) to automatically calibrate the model parameters – material properties, heat sources and boundary conditions – by solving an inverse problem.





The optimizer calibrates the model parameters until the cost function converges, thus **minimizing the error between the model thermal response and the real-world experimental measurements** uploaded into Twin Fabrica.

Core strength

Even when inputs are unknown, like power losses or inlet temperatures, Twin Fabrica identifies the optimal values that best replicate the real thermal response.

Discrepancy Model – Twin Fabrica

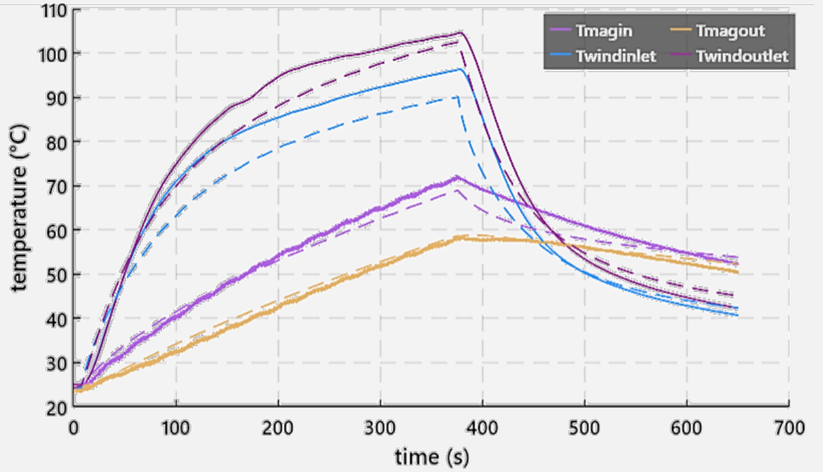
From "as-designed" to "as-manufactured" digital model
In the case that the physics-based calibration alone does not meet the required accuracy, Twin Fabrica implements a **proprietary Discrepancy Model** – a robust and lightweight neural network designed to guarantee stability – no machine learning expertise required, to refine model precision.

- The user defines 4 simple hyperparameters and **the network can be trained with a single mouse click.**
- It ensures **high accuracy under real-time operating variability**, due to nonlinear effects, time-varying boundary conditions or unmodelled effects.
- **Captures unmodelled dynamics** and disturbances not configured in the FEM problem definition.

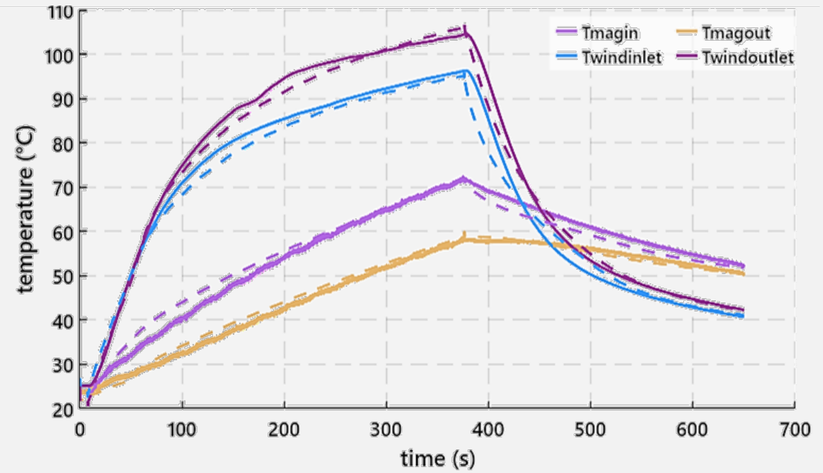
THE FINAL RESULT

A hybrid model – physics + AI – that delivers accurate performance in real-time, even in the most dynamic environments.

Results with the calibrated model

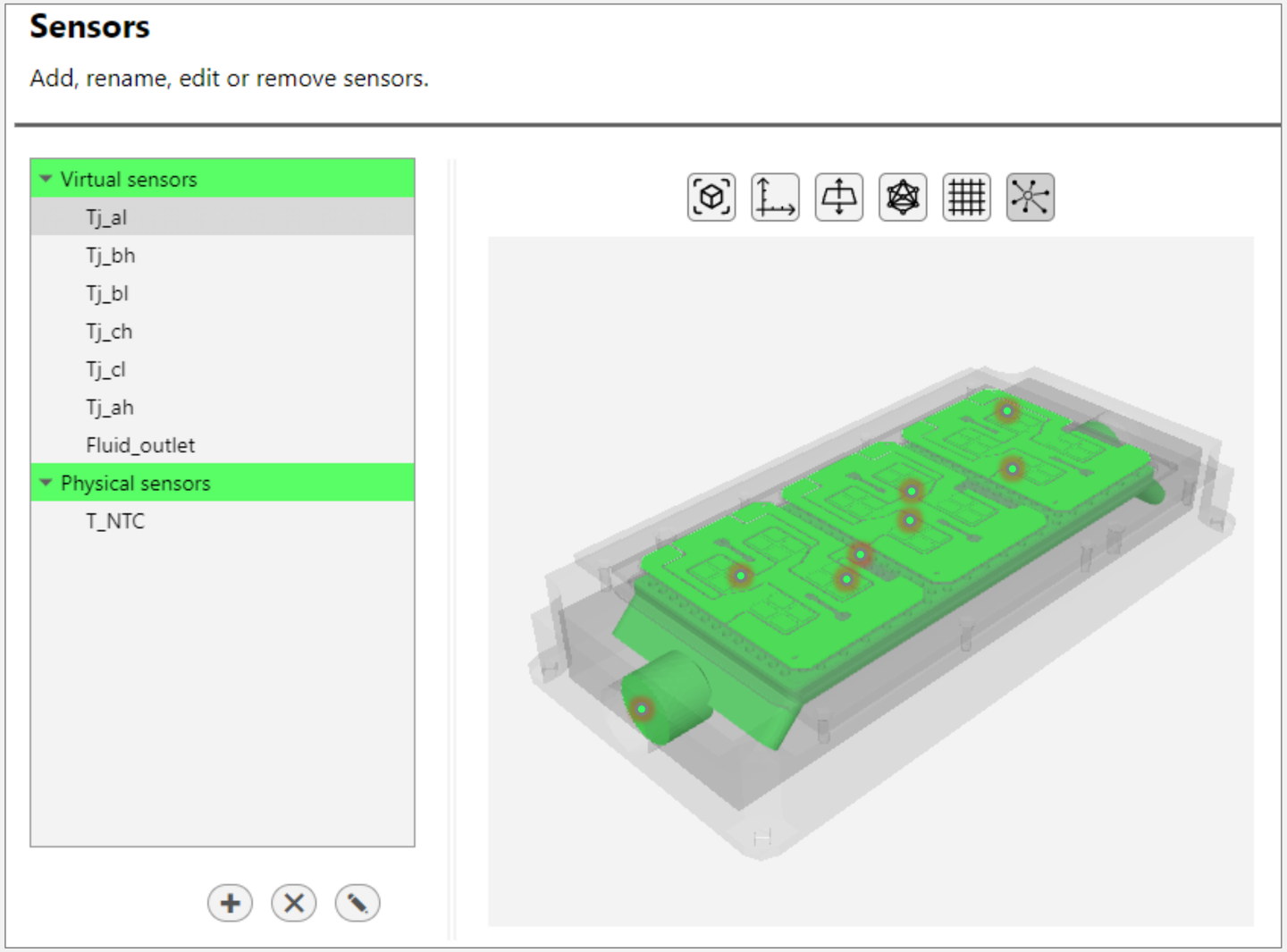


Results with discrepancy model



Physical measure Virtual sensor

Virtual Thermal Sensor Placement – Twin Fabrica



Twin Fabrica allows the user to insert Virtual Thermal Sensors anywhere in the component

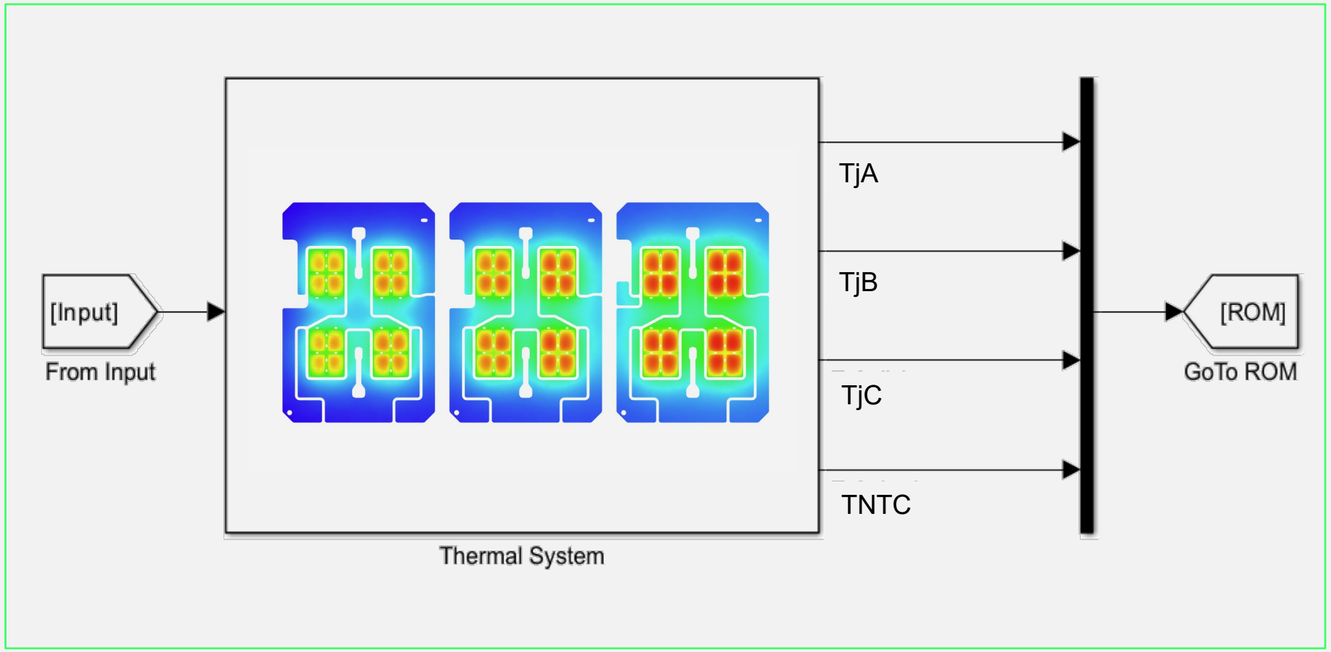
- Full control over sensor placement in spots in which it is physically impossible to place a sensor in production: **add, remove or reposition virtual sensors with a few clicks.**
- **Detailed temperature tracking** for enhanced analysis of the system's performance.
- Real-time monitoring of critical temperature **hotspots that define the component's current derating strategy.**

Seamless export options – Twin Fabrica

Export real-time feasible models in your format of choice:

- **Simulink white-box models** ready for integration within your simulation environment for model-based design.
- **Plug-and-Play optimized C Code** for embedded systems, which maximizes the execution efficiency. Ideal for testing your model under real-world conditions with real-time feedback.
- **Model Matrices in the state-space representation**, ready to be implemented on the target platform of choice.

Simulink Model generated

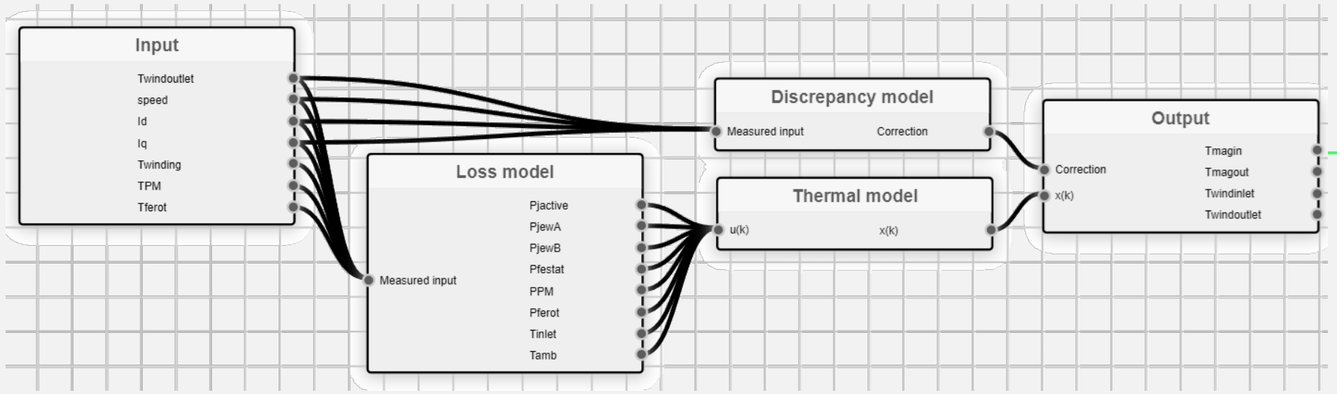


Twin Fabrica

Instant, production-ready C code for real-time embedded models
Twin Fabrica automatically converts your digital model into compact, highly-efficient C code, ready to deploy without manual optimization. Deliver a fully instrumented virtual sensor solution in minutes and verify performance under real-world conditions.

Key benefits
- High code performance: < 200 µs end-to-end loop
- Tiny footprint: < 45 kB FLASH, < 1 kB RAM
- Real-time feedback: built-in neural-network inference library
- Seamless integration: auto-generated headers & tables data
- Compliance: MISRA-C:2012

Virtual sensor software architecture




```
/* Nein application deliverable_Discrepancy file
 * The code is autogenerated with Newtwen Code Composer
 */
/* Application info */
/*
Application IO: 2e015e51-47e5-471c-2096-228129263cb1
Timestamp: 2025-05-15 10:50:27
Application name: deliverable_Discrepancy
Discretization time step: 0.1 s
Input number: 3
Output number: 4
State number: 39
Observer integration: false
Discrepancy integration: true
*/
```

Twin Fabrica Recap

Twin Fabrica offers:

- High-fidelity physics-based models
- Real-time capability through **Model Order Reduction (MOR)**
- Flexible virtual thermal sensor placement even in places in which it is physically unfeasible to place a real sensor
- Dual-level calibration with physical and data-driven methods that handles nonlinearities, unmodeled effects and time-varying boundary conditions
- Seamless export to Simulink, C code, or state-space representation of the model.

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