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Anywhere. Anytime.



# Thermal Digital Twin & Virtual Build: A new approach of understanding systems

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# Digital Twin

## Origin

- › The name „Digital Twin“ first appeared in a roadmap report of NASA back in 2010.
- › Nasa currently uses the Digital Twin for the **OSIRIS-REx** mission.
- › Digital Twins helps to understand, detect, predict and optimize missions.
- › By using real time data during the flight, it can be visualized what is actually happening on the asteroid “Bennu”, millions of kilometers away.



[OSIRIS-REx Mission Uses Digital Twin Technology - Bing video](#)

# Digital Twin

## Problem Statement



TIME TO  
MARKET



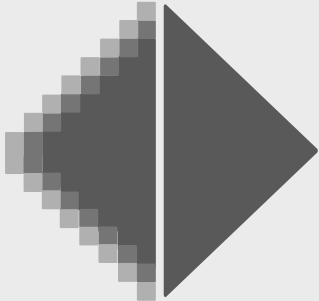
COST TO QUALITY  
RATIO



ENCLOSED  
DEVICE



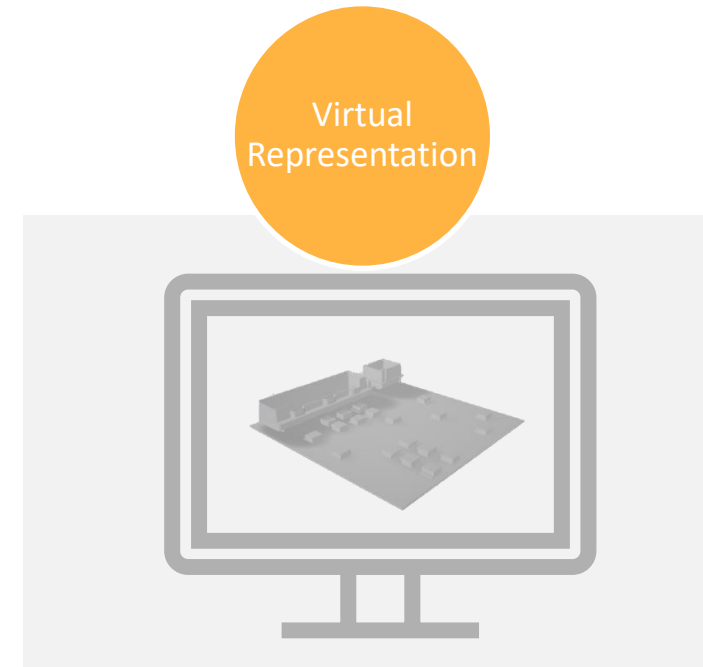
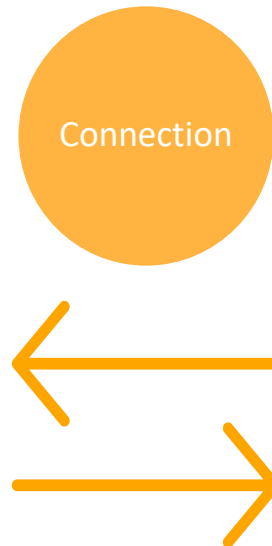
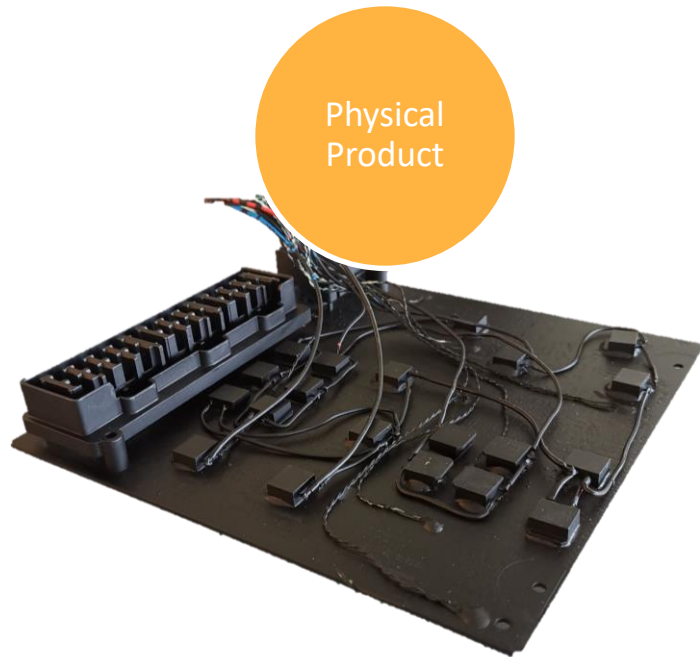
SYSTEM  
COMPLEXITY



LIMITED TEST  
RESOLUTION

# Digital Twin

## Definition



# Digital Twin

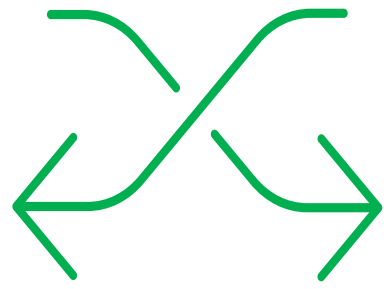
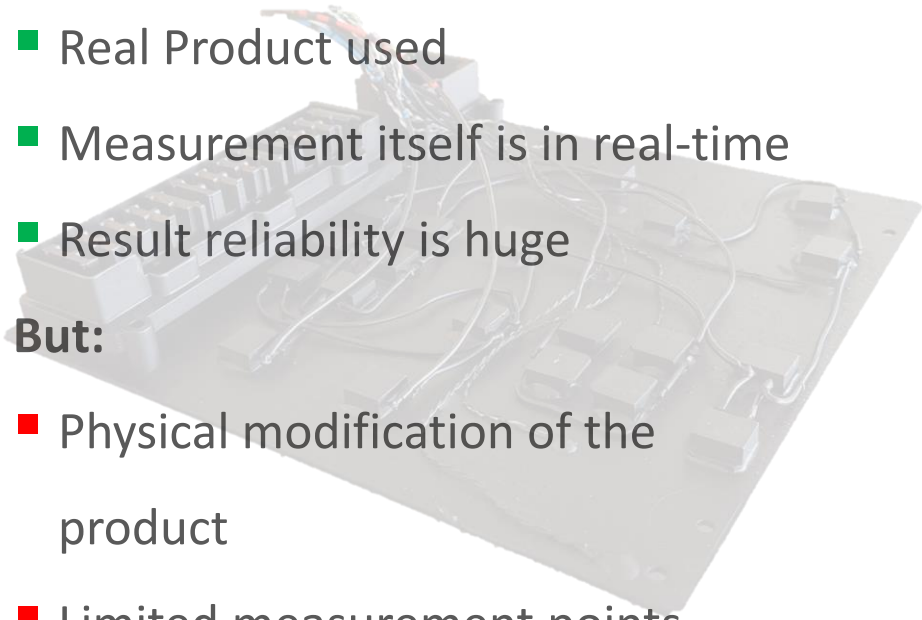
## Pros and cons of Test and Simulation

### TEST DEVICE

- Real Product used
- Measurement itself is in real-time
- Result reliability is huge

**But:**

- Physical modification of the product
- Limited measurement points



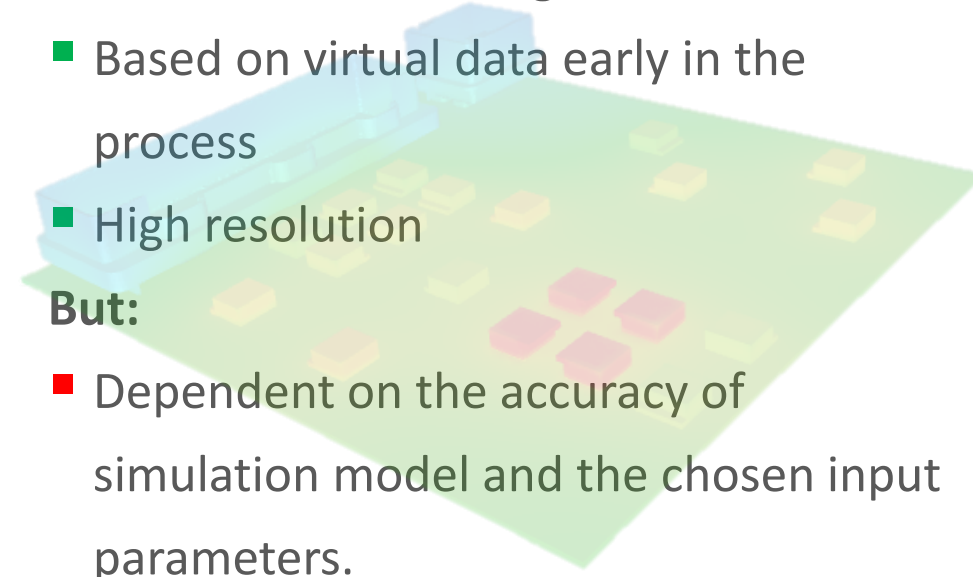
### SIMULATION MODEL

- Parametric modelling
- Based on virtual data early in the process

- High resolution

**But:**

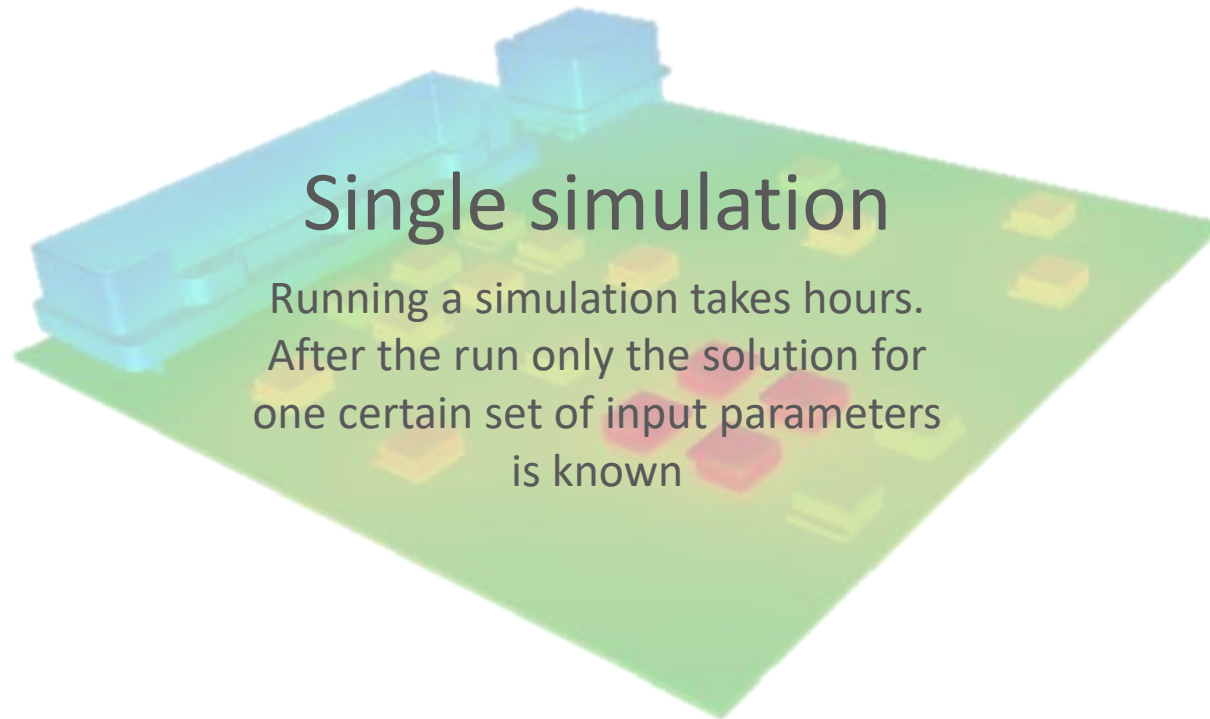
- Dependent on the accuracy of simulation model and the chosen input parameters.



› The **Digital Twin** combines the advantages of test and simulation, eliminating their disadvantages.

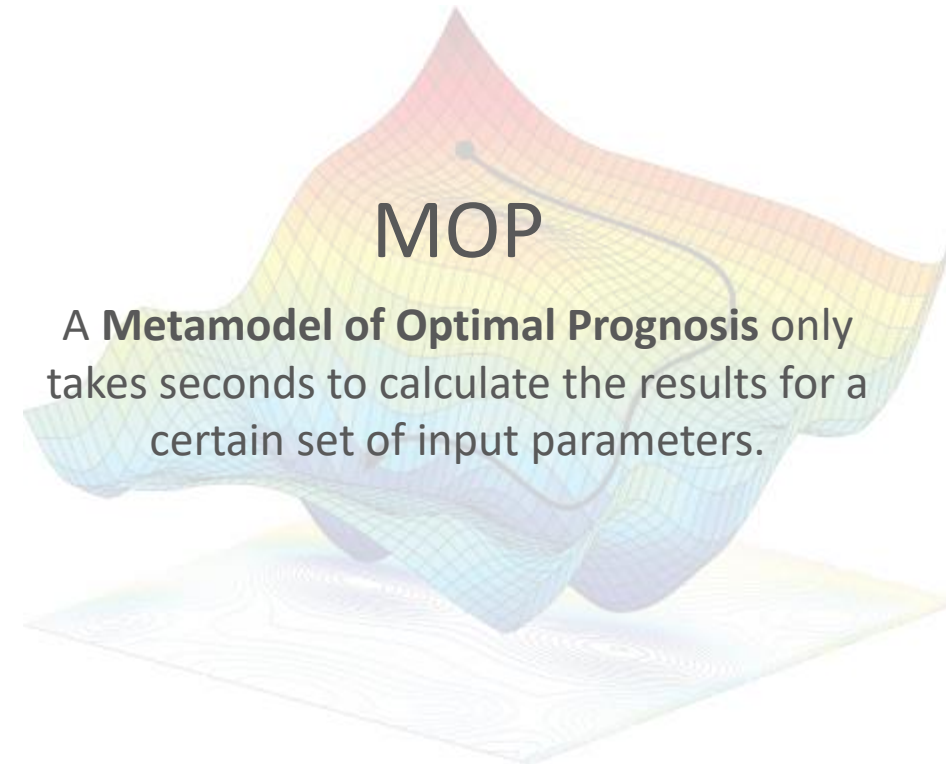
# Digital Twin

## Simulation Setup: Time-consuming variant



# Digital Twin

## Simulation Setup: Time-saving variant

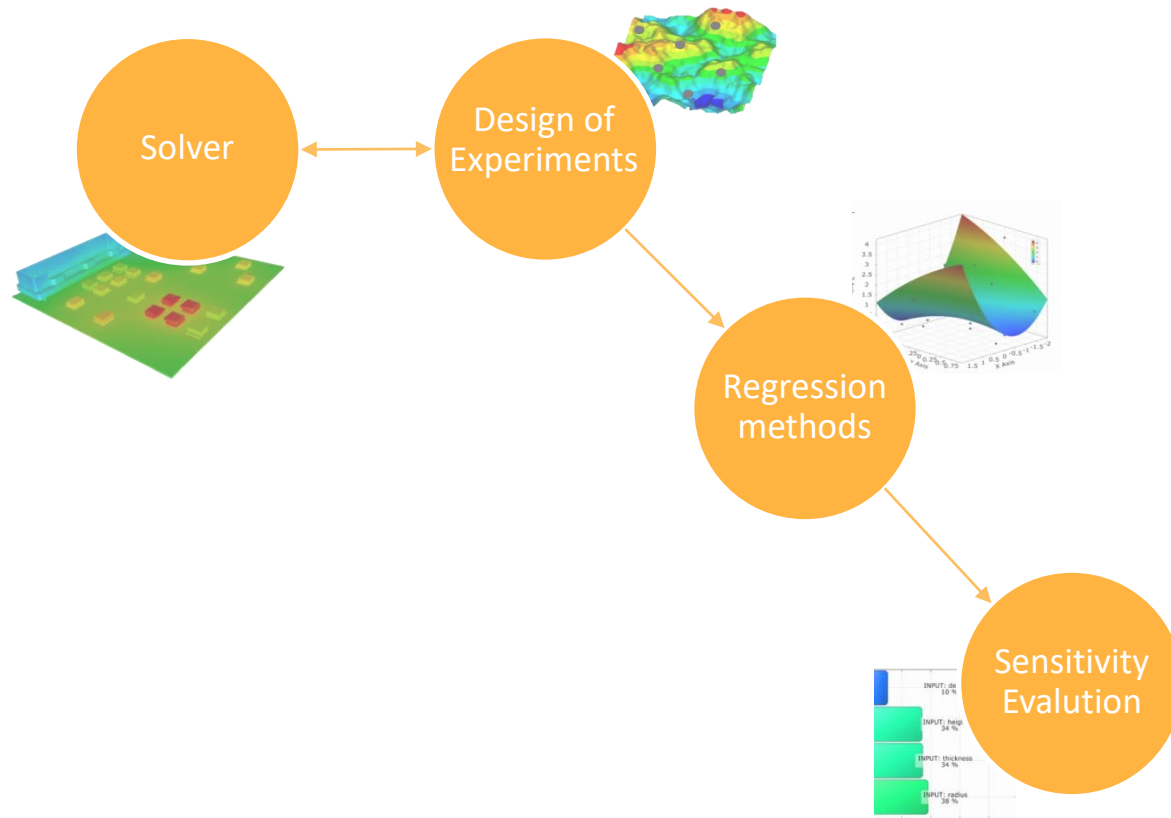


A **Metamodel of Optimal Prognosis** only takes seconds to calculate the results for a certain set of input parameters.



# Virtual Build

## Sensitivity analysis with OptiSLang



1. The Design of Experiments generates a specific number of designs which are evaluated by the solver.
2. Regression methods approximate the solver responses to understand and to assess its behavior.
3. The influence of the variables is quantified by the approximation functions.

## Virtual Build

What are the input parameters for the MOP?

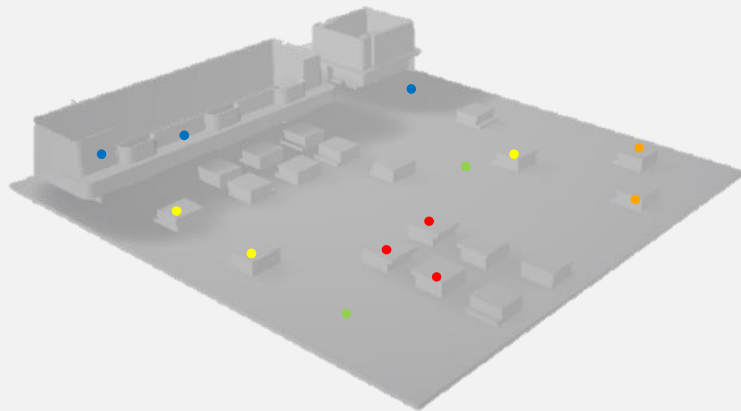


The temperature of every node/point of the simulation model is dependent on the powers of the components and the ambient temperature.

# Virtual Build

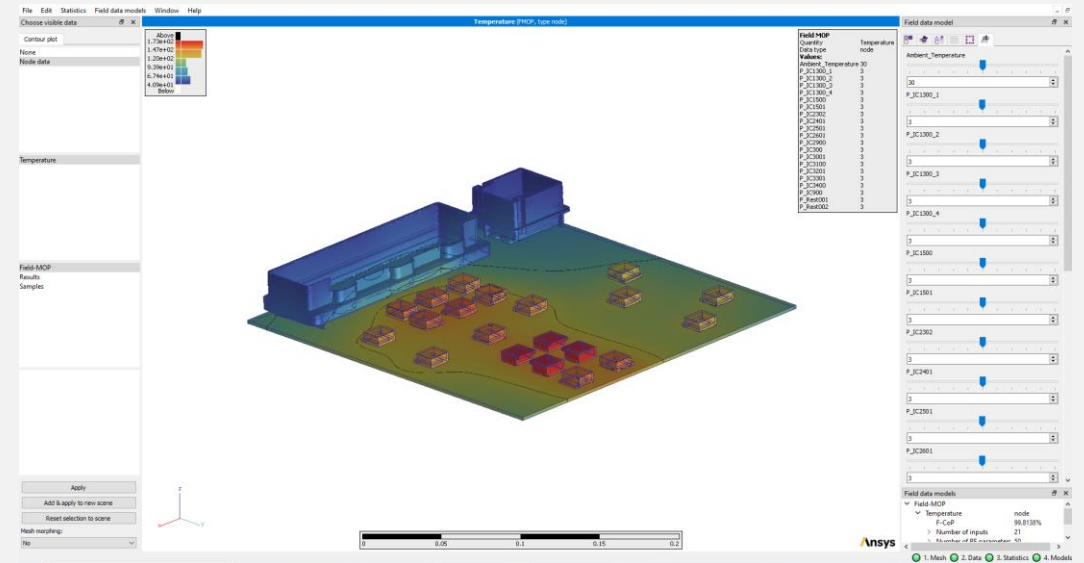
Is it possible to combine fast calculation and full visualization?

## MOP



Remark: Limit of Output points is ~400 point.

## Field-MOP

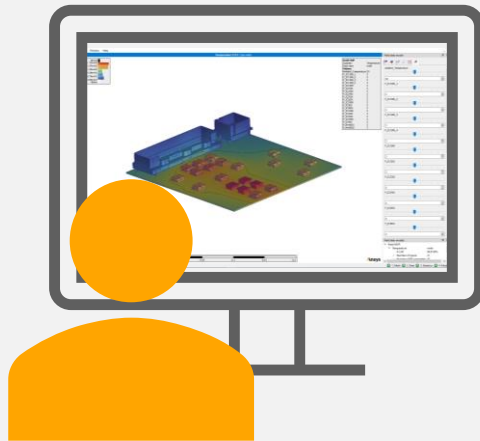


Remark: Limit of Output points is (theoretically) unlimited.

# Virtual Build

How can we make it accessible?

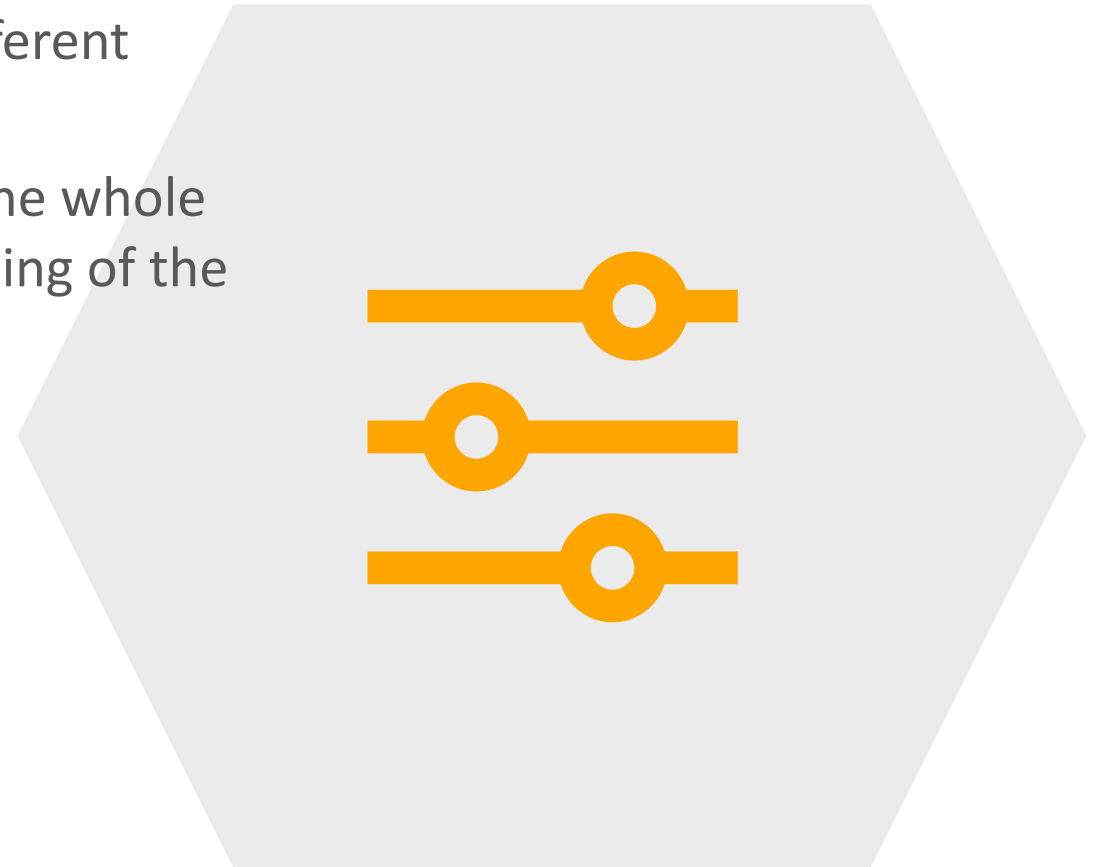
## Ansys optiSlang Web App



## Virtual Build

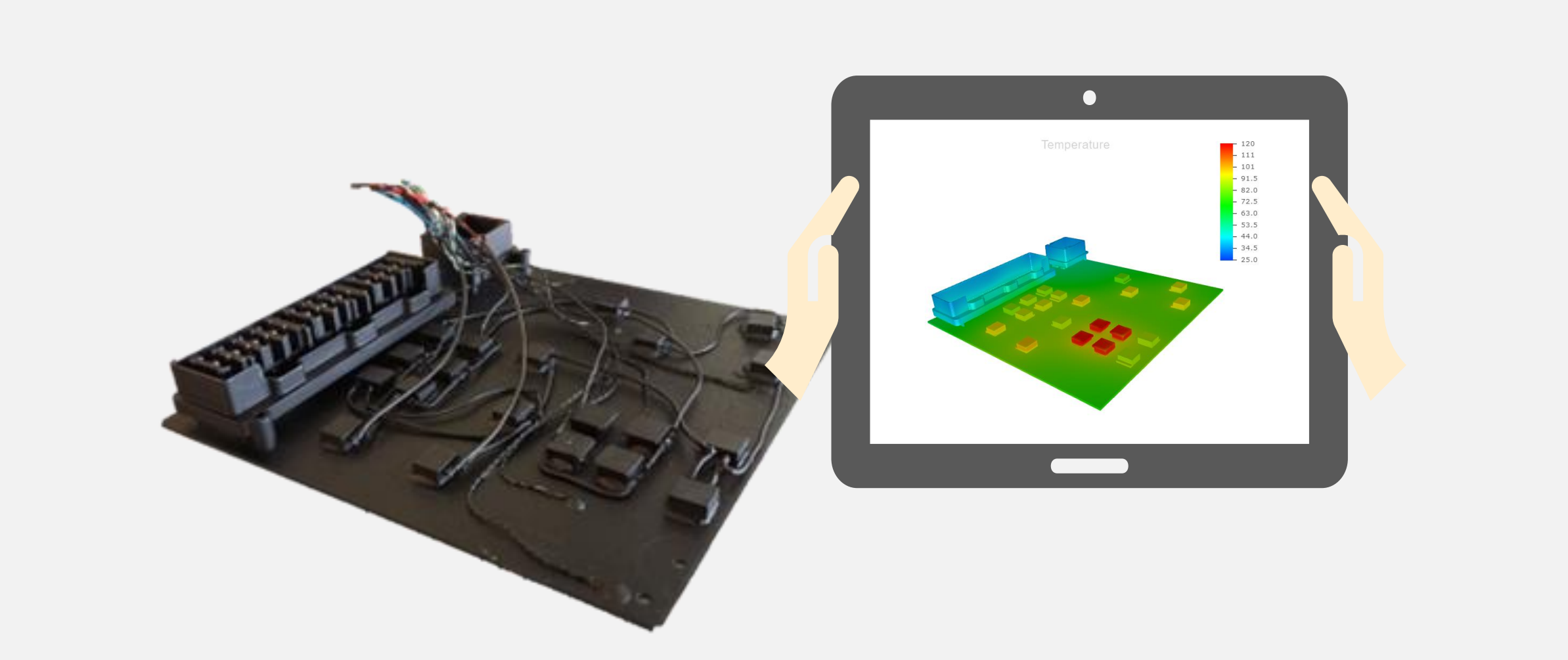
### Advantages of the Field-MOP

- › Based on simulation model → available early in the process.
- › Input Parameters can be changed easily, and the responses are calculated within seconds allowing to try a lot of different combinations.
- › Playing with parameters and seeing the results for the whole model on the structure leads to a better understanding of the system.
- › A **robust design** can be found early in the process.



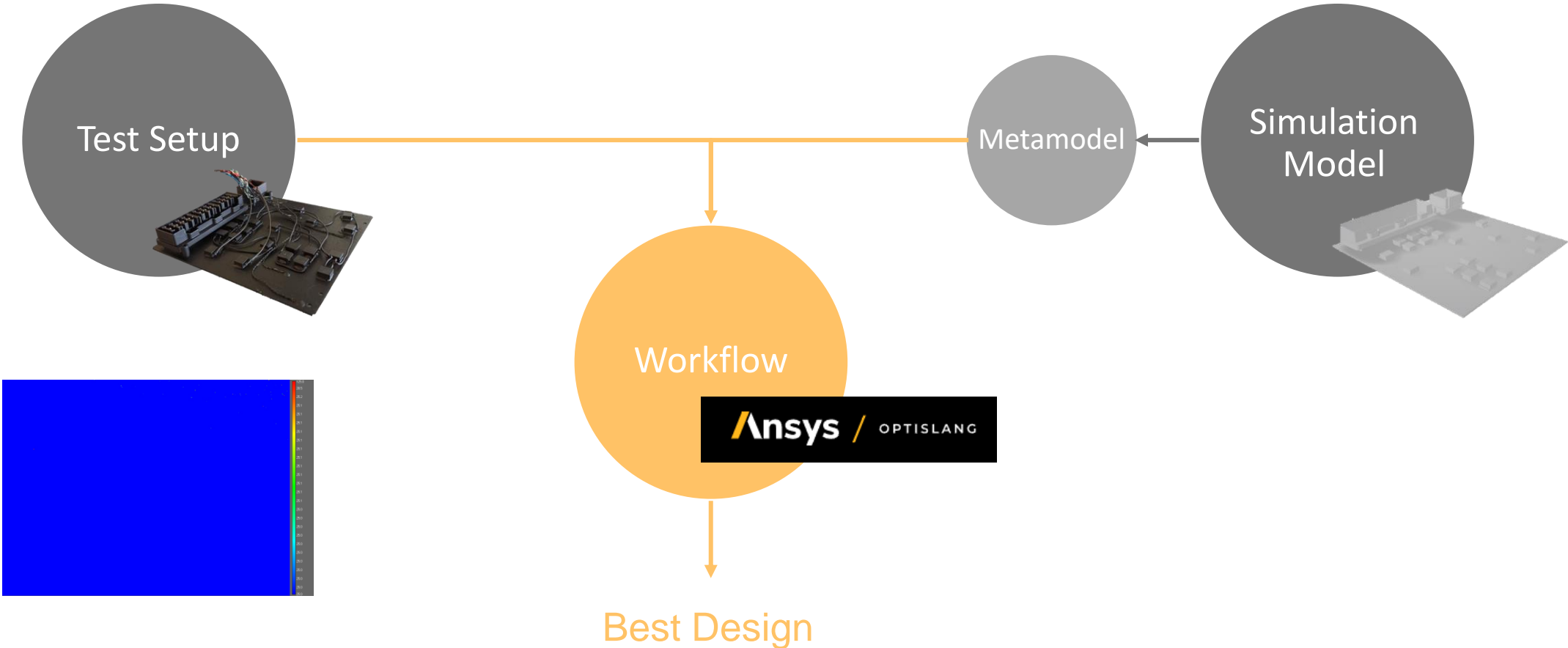
# Digital Twin

Connecting Virtual Build to real time test data



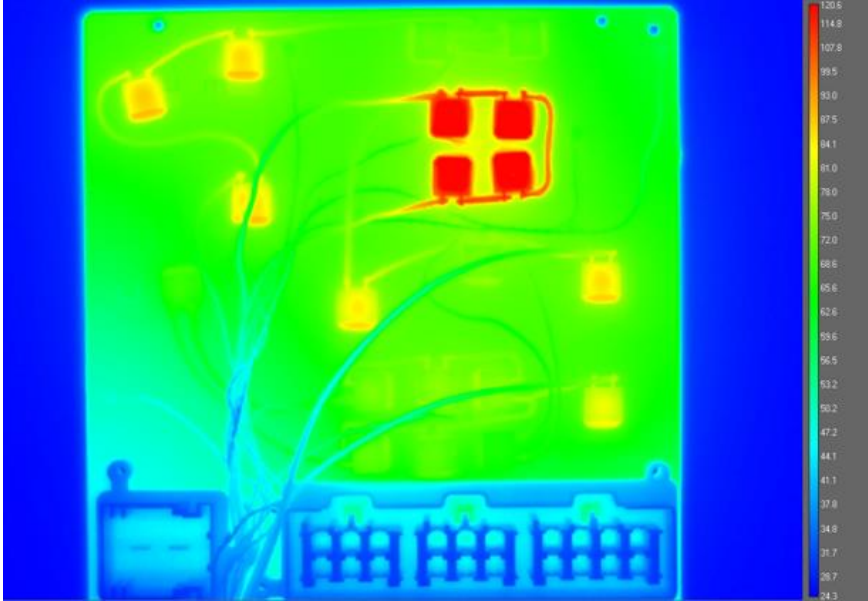
# Digital Twin

## Workflow

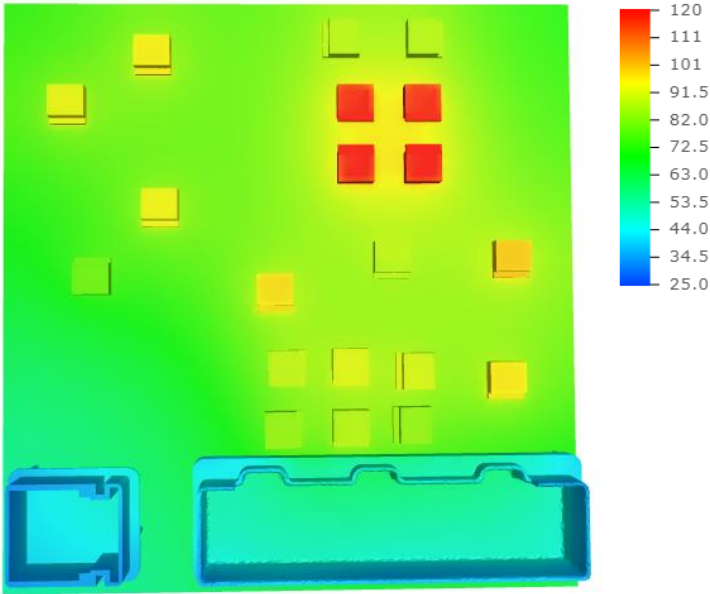


# Digital Twin

## Comparison IR Picture & Digital Twin



Test Setup - IR Picture



Digital Twin Result



# Digital Twin

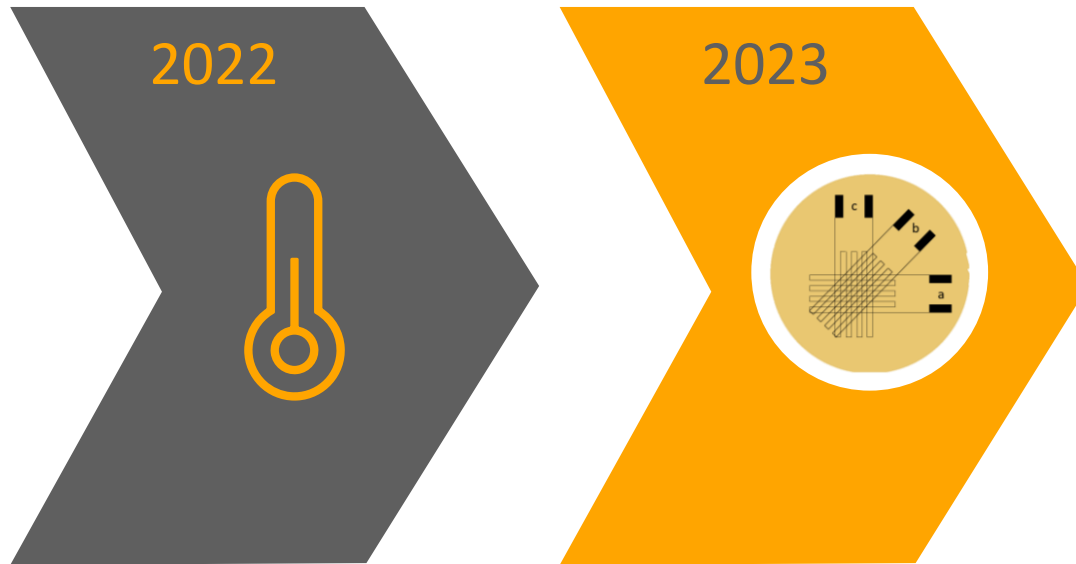
## What's next?



Thermal Digital Twin

# Digital Twin

What's next?

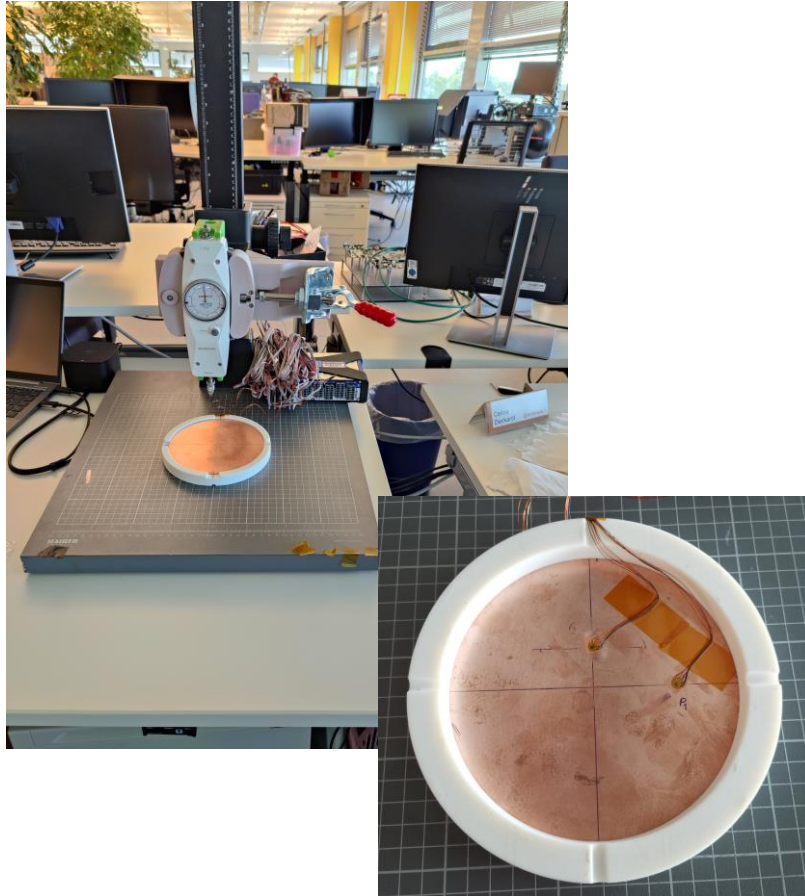


Thermal Digital Twin

Strain Digital Twin

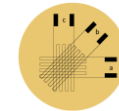
# Digital Twin

For strain measurements



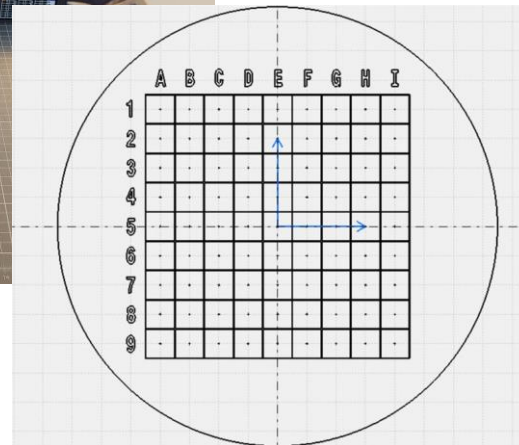
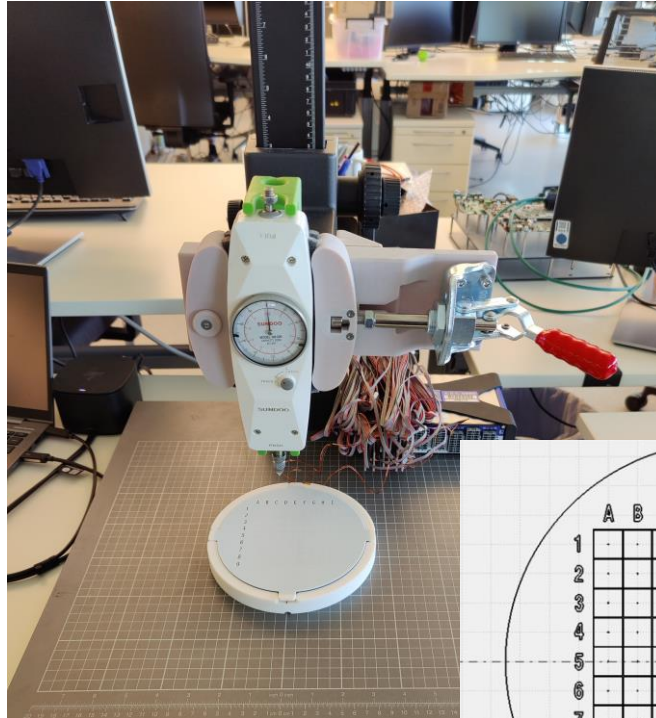
## Test Setup:

- › Round Plate
- › Two strain gauge rosettes



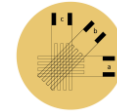
# Digital Twin

For strain measurements



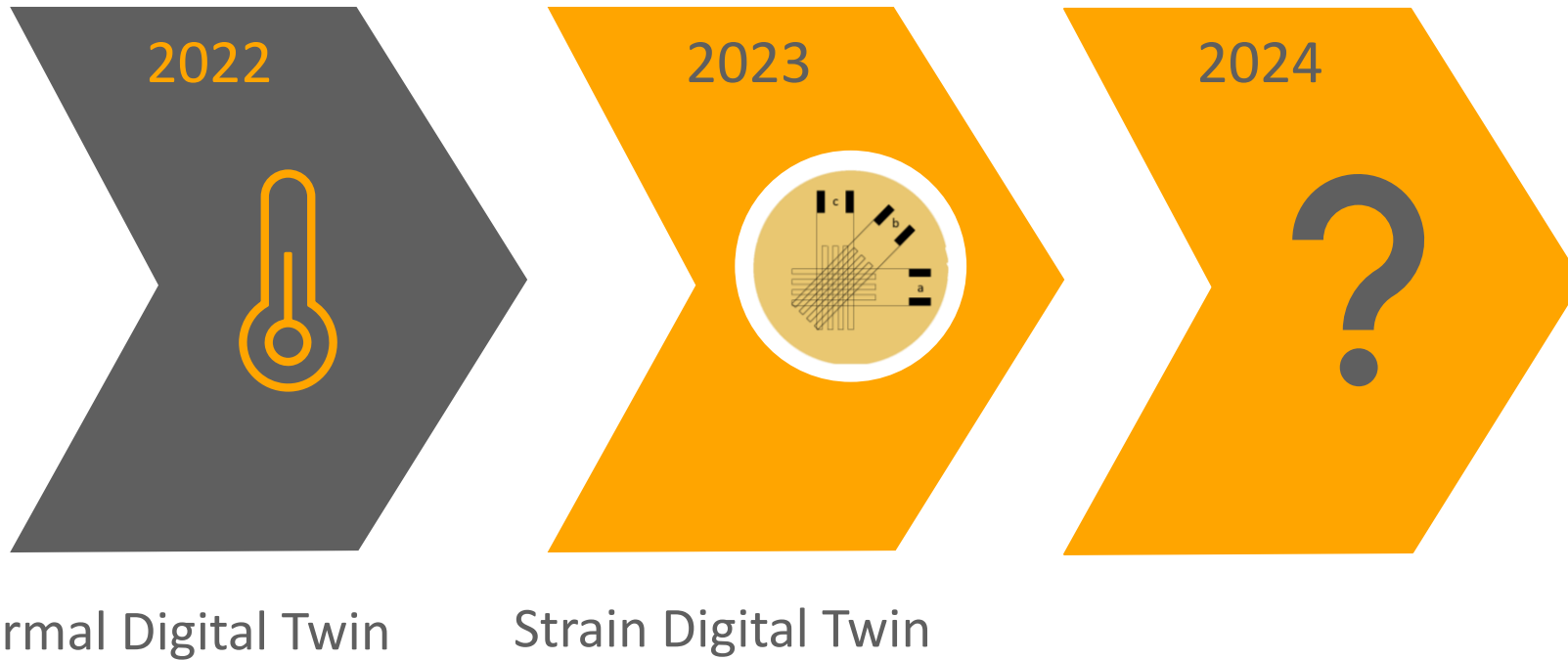
## Test Setup:

- › Round Plate
- › Two strain gauge rosettes
- › ‘Chessboard’ to align force



# Digital Twin

What's next?



Thank you  
for your attention!