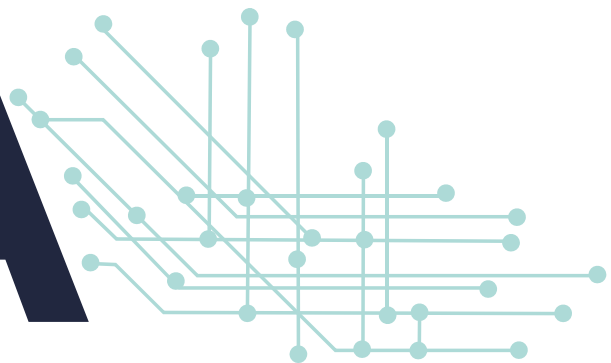


CPA



the application with Modlex3d

small data sets for big insights

SITUATION AND CHALLENGES



- CORRELATION BETWEEN PROCESS AND QUALITY PARAMETERS NOT DETECTABLE BY HUMANS
- ALGORITHMS SPECIALISED IN EVALUATING VERY LARGE SAMPLES, THAT ARE NOT AVAILABLE IN PRODUCTION
- APPLICATIONS REQUIRE SPECIFIC DATABASES AND STRUCTURES
- METHODS ARE LIMITED IN QUANTITY AND DIVERSITY (CURVES, SURFACES, DISCRETE VALUES) OF THE SIMULTANEOUSLY OBSERVED INPUT AND OUTPUT DATA
- **THE ADDED VALUE OF THE ANALYSIS MUST BE GREATER THAN THE COST OF DATA COLLECTION**

BENEFITS OF CPA ALGORITHM

POWERFUL DATA MODELING

- Very **low** sample sizes
- **Large** number of process variables

Shape-based visualization of causal relationships and compensation options

PRACTICAL VISUALIZATION

FLEXIBLE DATA PROCESSING

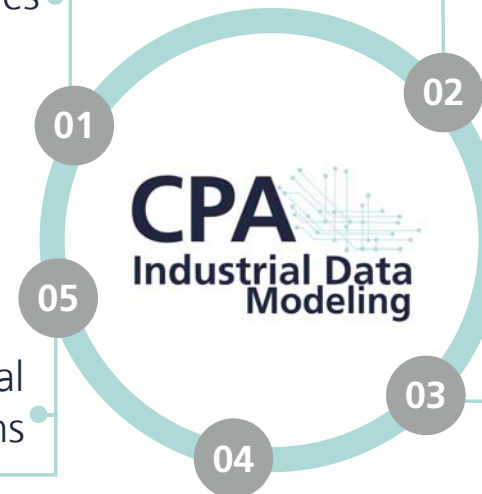
- Simulation / experimental data
- Single / **multi-stage** processes

FIELD-PROVEN

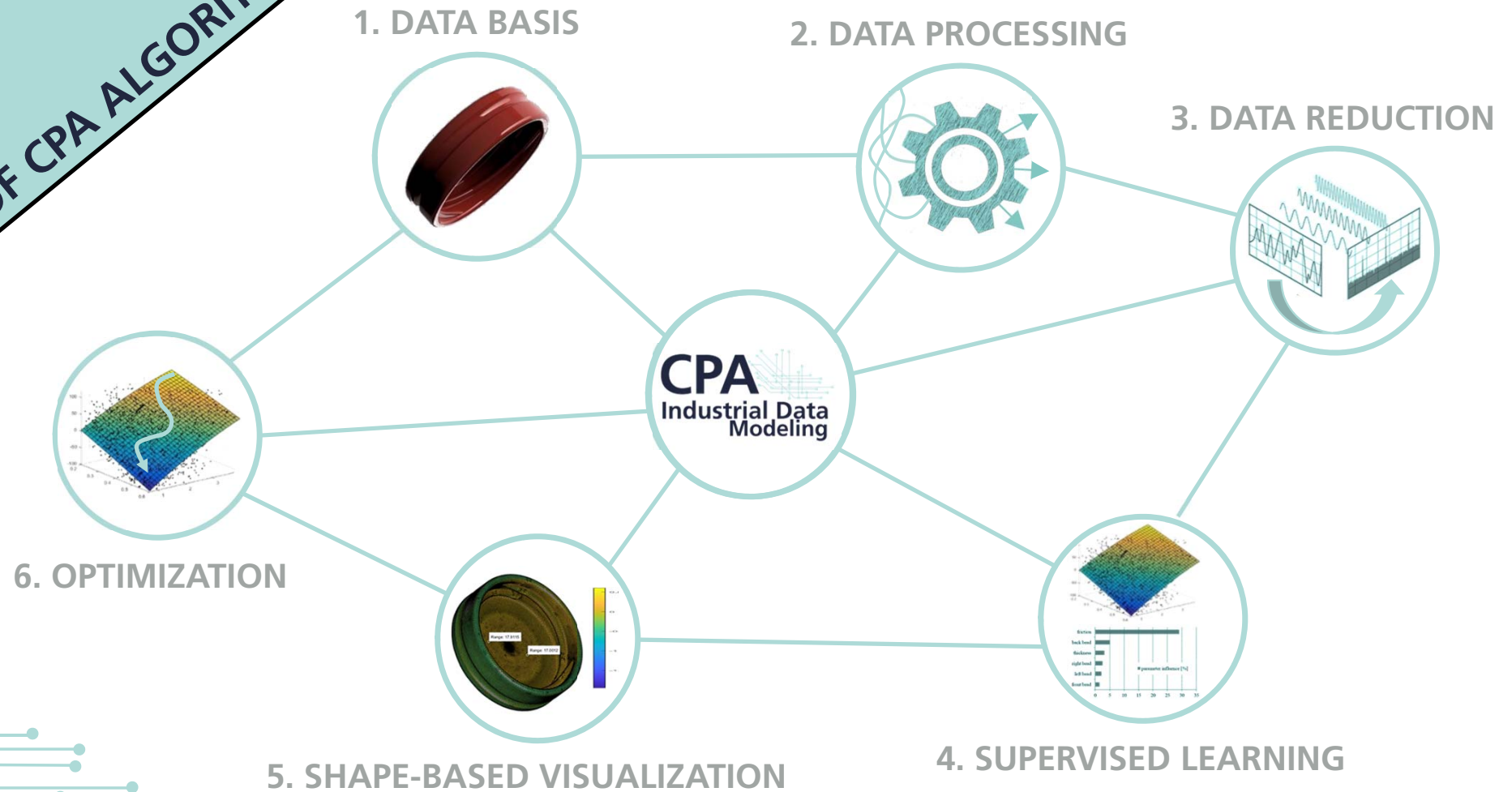
- Successfully tested **many times** in industrial environments

EFFICIENT OPTIMIZATION

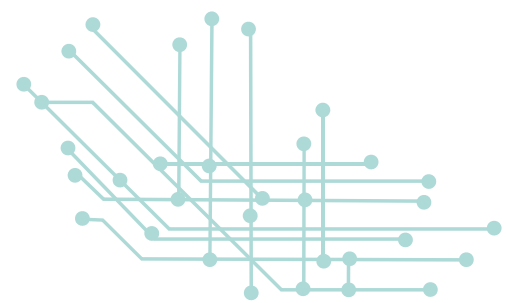
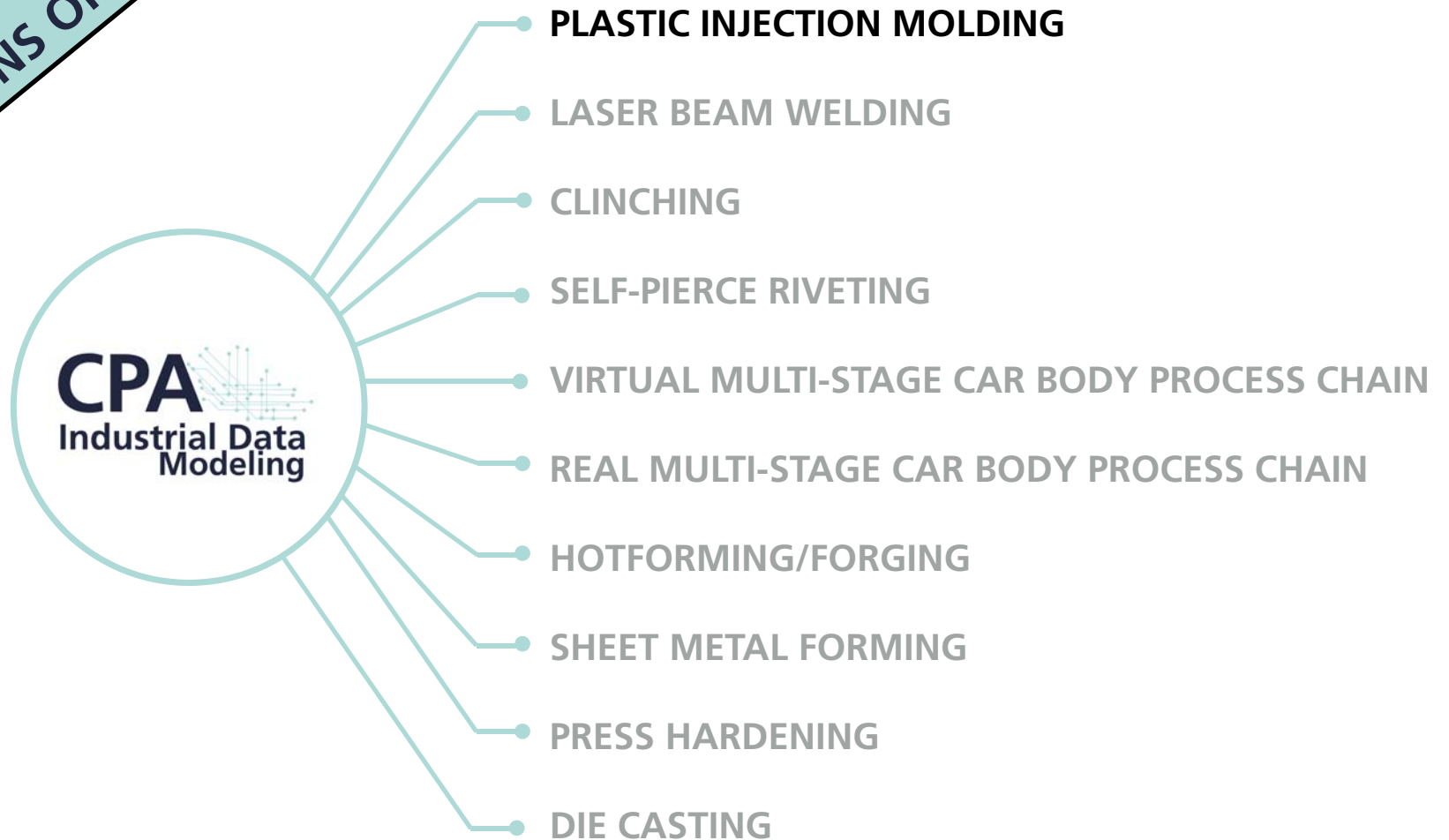
- **Cost-effective** improvement of the product quality



CONCEPT OF CPA ALGORITHM

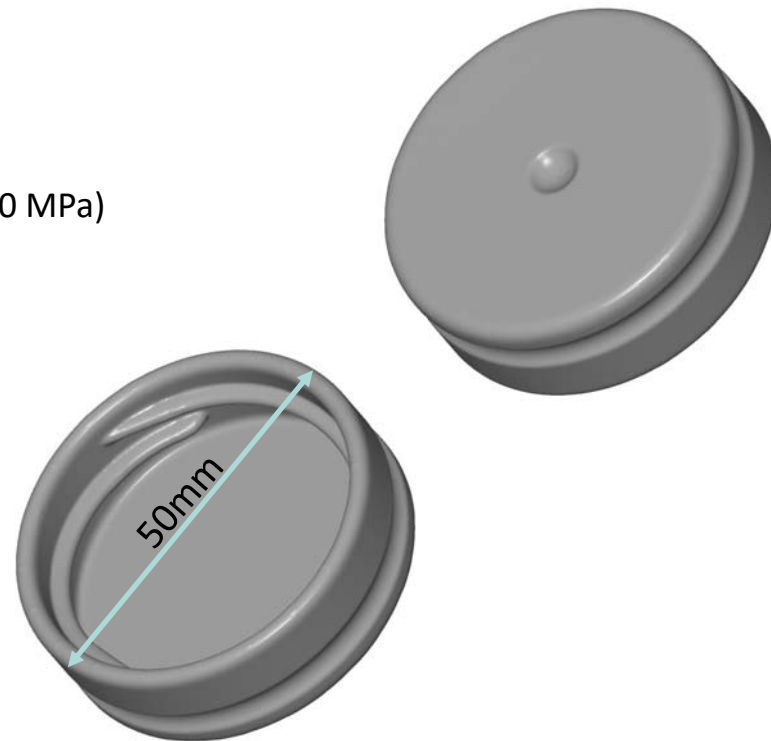


RECENT APPLICATIONS OF CPA



DATA BASIS

- **10** tool design parameters
 - total height (15 - 19 mm)
 - Gate (1 mm - 3 mm)
 - PP „Moplen EP240H“ (150 MPa) & PE „Lupolen 1800 S“ (1100 MPa)
 - tool temperature (25 °C - 50 °C)
 - melting temperature (190 °C - 260 °C)
 - holding pressure duration (5 s - 15 s)
 - holding pressure height (60 % - 100 %)
 - cooling time (5 s - 15 s)
 - injection time (0.5 s - 1 s)
 - switching point (92 % - 98 %)
- **30** simulation variants



PLASTIC INJECTION MOLDING

PLASTIC BOTTLE CAP



Live Demo

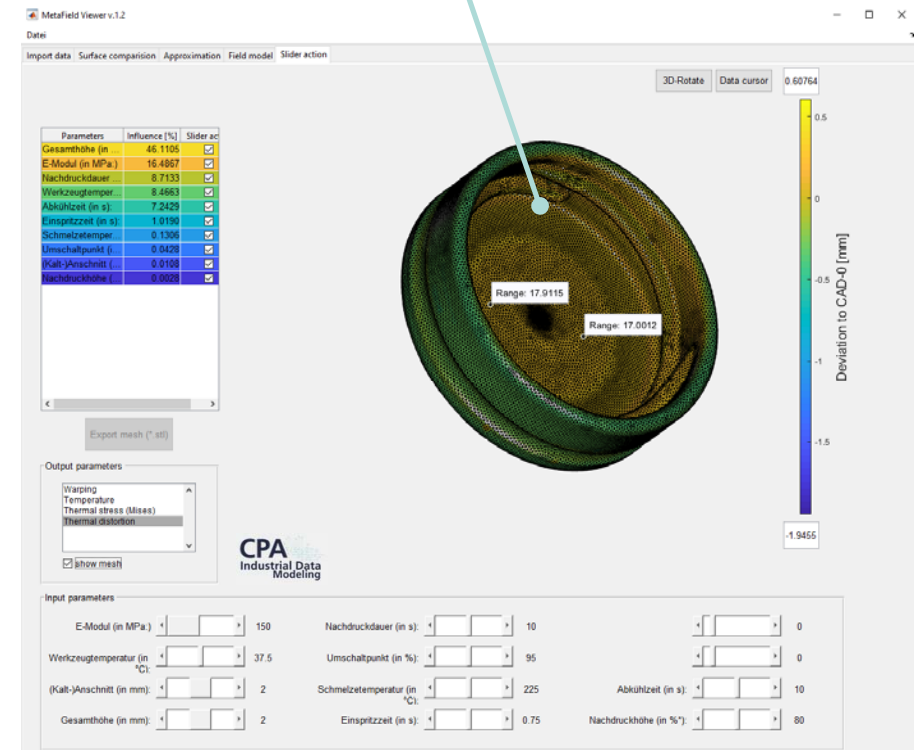
PLASTIC INJECTION MOLDING

TOOL OPTIMIZATION OF A PLASTIC BOTTLE CAP

RESULTS

- causal relationships in global and local resolution
- Prognosis-Error <0.02mm (Warping)
- manual (slider) and automated (algorithms) optimization possible
- usage as add-on software or fully integrated possible

3D output variable (distortion) predicted by the model



tool parameters

LASER BEAM WELDING

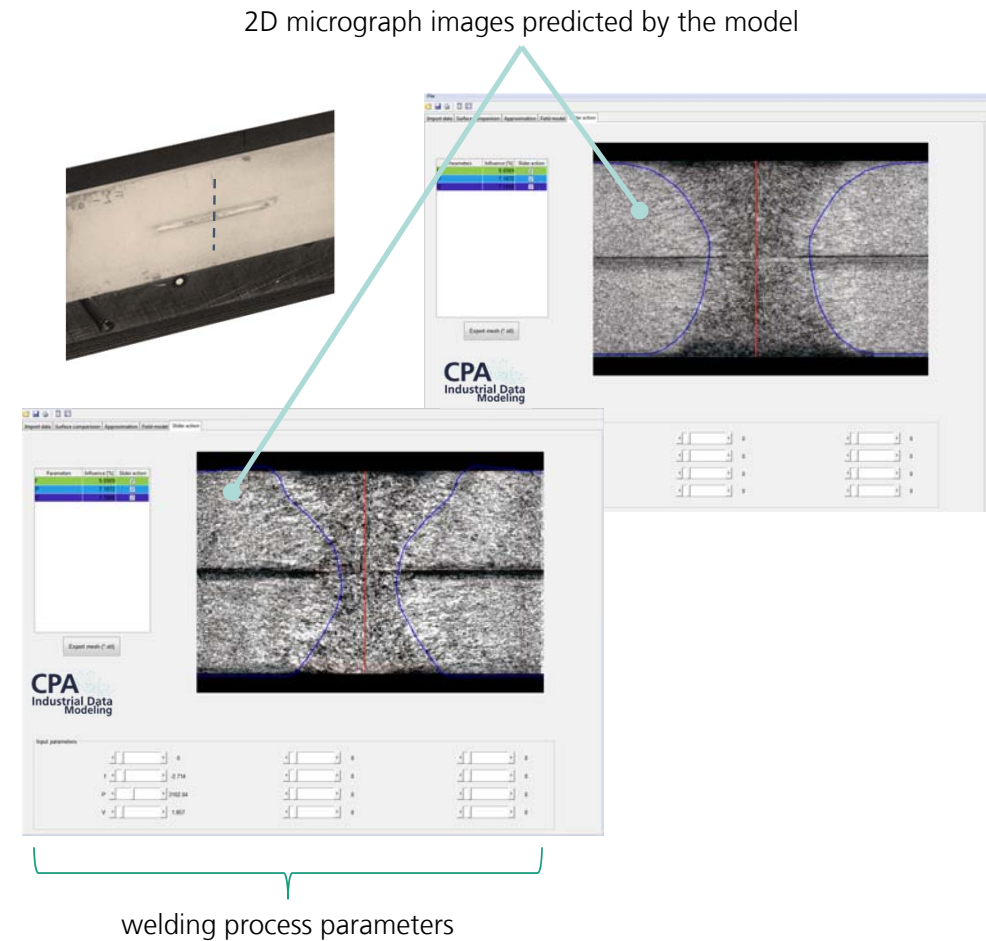
IMAGE-BASED ANALYSIS OF WELDING PARAMETERS

DATA BASIS

- **12** real micrographs
- **3** welding process parameters
(laser power, laser velocity, focus position)

RESULTS

- Model-based generation of a **2D image** (virtual micrograph) of the laser weld seam for various parameter combinations in real time.



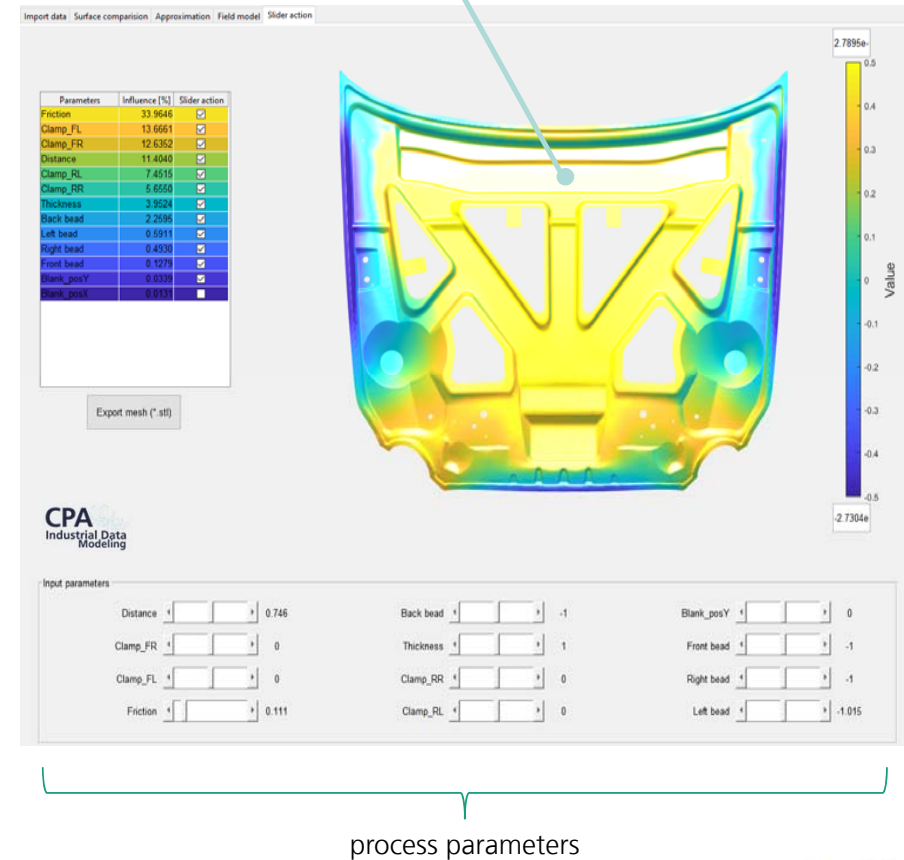
DATA BASIS

- Sheet metal forming simulation by **PAM-STAMP®**
- **13** process parameters
- **30** simulation variants

RESULTS

- After only a few simulations, the influences of the input parameters on the geometry of the drawn part, in the measuring fixture, could be represented completely (3D visualization) and with low uncertainty ($< 0.15\text{mm}$).

3D output variable (dimensional value) predicted by the model



VIRTUEL MULT-STAGE CAR BODY PROCESS CHAIN

SENSITIVITY ANALYSIS OF A CD PILLAR ASSEMBLY



PORSCHE

SAB

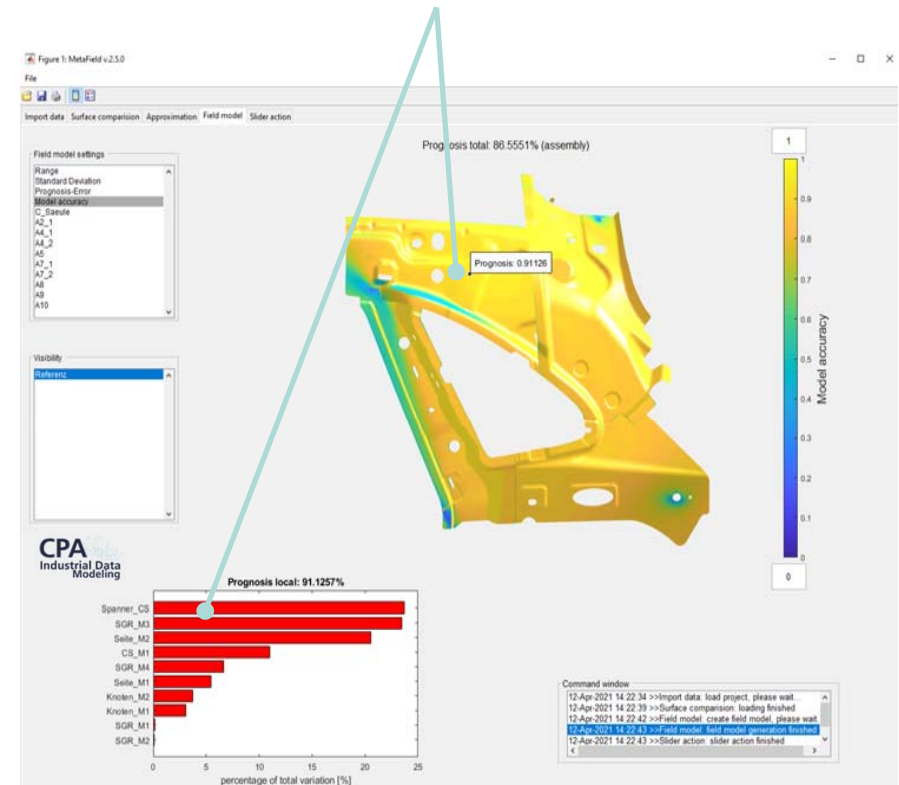
DATA BASIS

- Measurement data of single part tolerances AND assembly simulation by **PAM-STAMP**®
- **10** process parameters / **50** simulation variants

RESULTS

- Determination of the process parameter sensitivities on the dimensional accuracy of the final assembly along a virtual multi-stage car body process chain.
- **3D visualization** of the parameter effects on the assembly surface.

Prediction of local sensitivity effects of the process parameters



REAL MULT-STAGE CAR BODY PROCESS CHAIN

QUALITY CONTROL OF A BODY ASSEMBLY



PORSCHE

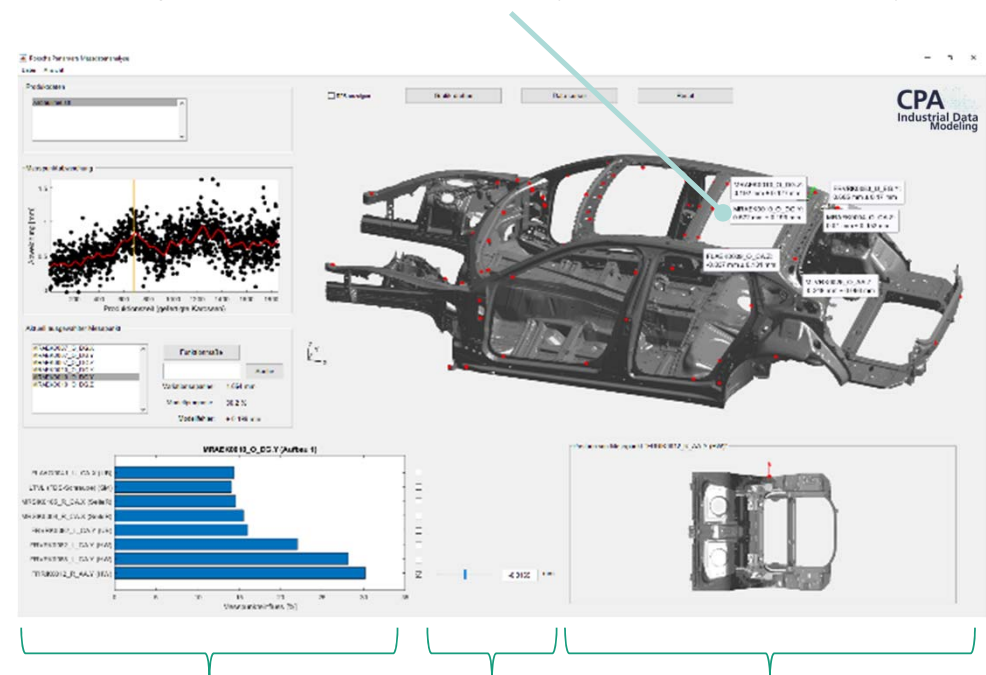
DATA BASIS

- Inline measurement data of Panamera / Bentley assembly line
- **>1800** measuring points in **7** substructure levels

RESULTS

- Prognosis of the dimensional accuracy of the finished vehicle body (uncertainty <0.2 mm)
- Representation of the compensation options for tolerance deviations (e.g. shimming)

Prognosis of the dimensional accuracy of the finished vehicle body



Parameters that significantly influence a selected quality criterion.

Manual influence query slider

Position of the selected influence point from a pre-process

CPA PROJECT TEAM



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