



Introduction and Live Demonstration of LS-OPT® Version 5

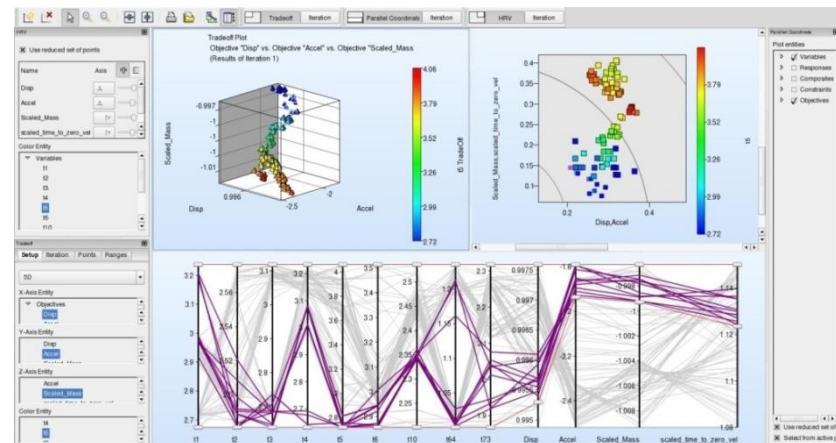
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Überblick

- Einführung LS-OPT
- LS-OPT 5 - Ziele und Anforderungen
- Aufsetzen einer DOE-Studie anhand eines Beispiels mit LS-OPT 5
 - Problembeschreibung
 - Definition von Variablen
 - Extraktion von Antworten
- Visualisierung der Optimierungsergebnisse
 - Simulationsdaten
 - Metamodelle
 - Sensitivitäten



Introduction / Features

➔ About LS-OPT

- Two main products LS-OPT and LS-TaSC
- LS-OPT can be **linked to any simulation code** – stand alone optimization software, but perfect suitable with LS-DYNA
- Current production version is LS-OPT 5.0
- LS-OPT Support web page -> www.isoptsupport.com

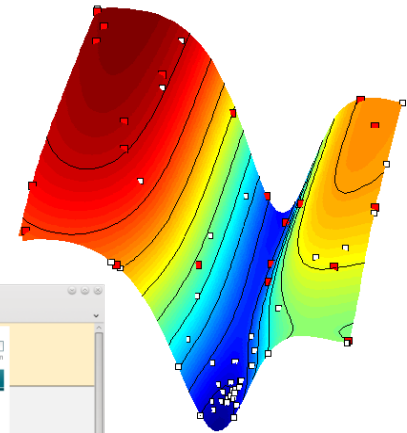
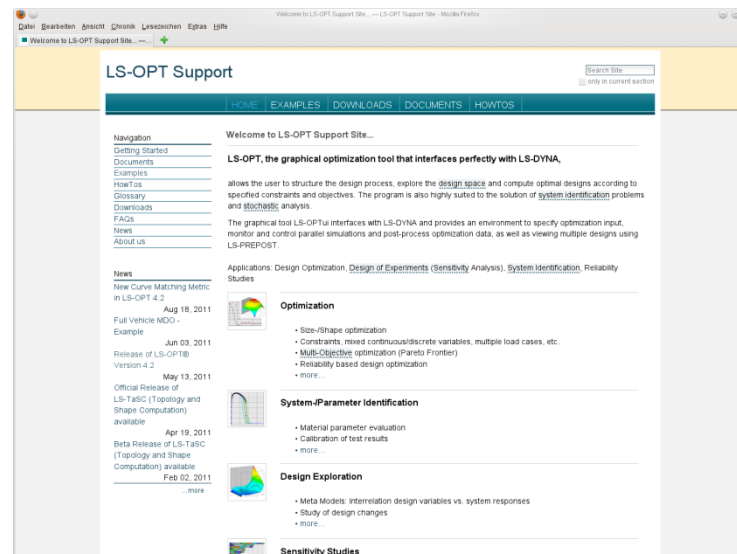
- *Download of Executables*

- *Tutorials*

- *HowTos / FAQs*

- *Documents*

-



Introduction / Features

LS-OPT – Overview Methodologies

■ Successive Response Surface Method (SRSM)

■ Meta-Models

■ *Polynomials*

■ *Radial Basis Functions*

■ *Neural Nets (FFNN)*

■ Genetic Algorithm (MOGA->NSGA-II)

■ Multidisciplinary optimization (MDO)

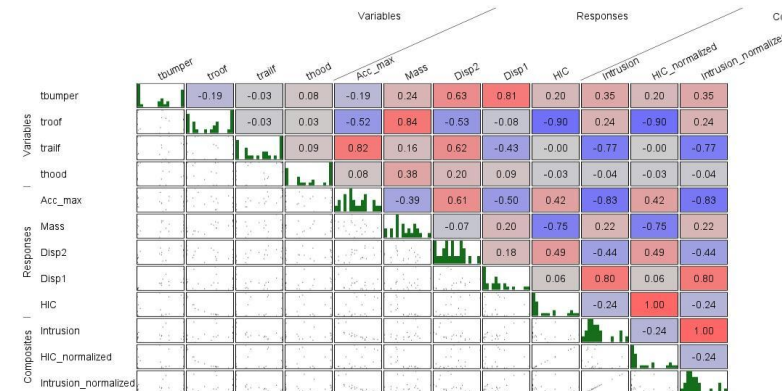
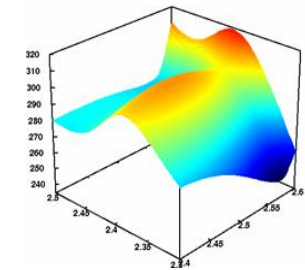
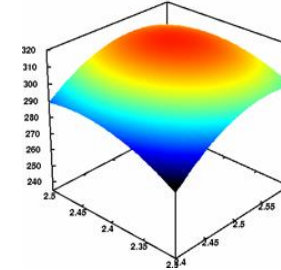
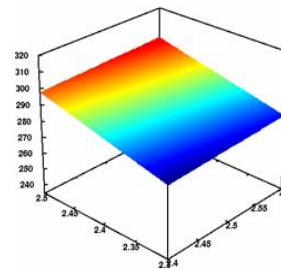
■ DOE-Studies (ANOVA, Sobol)

■ Stochastic/Probabilistic Analysis

■ *Evaluation of stochastic quantities:
mean, std.-dev., correl.-coeff.,*

■ *Confidence Intervals*

■ Monte Carlo Analysis using Meta-Models



Introduction / Features

LS-OPT – Overview Methodologies

■ Mixed Discrete-Continuous Optimization

- *Specify sets of discrete variables (e.g. sheet thicknesses)*

■ Robust Parameter Design (RDO)

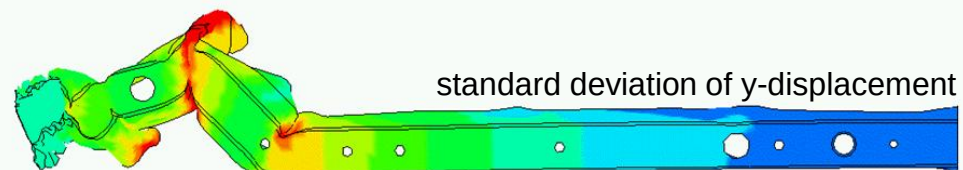
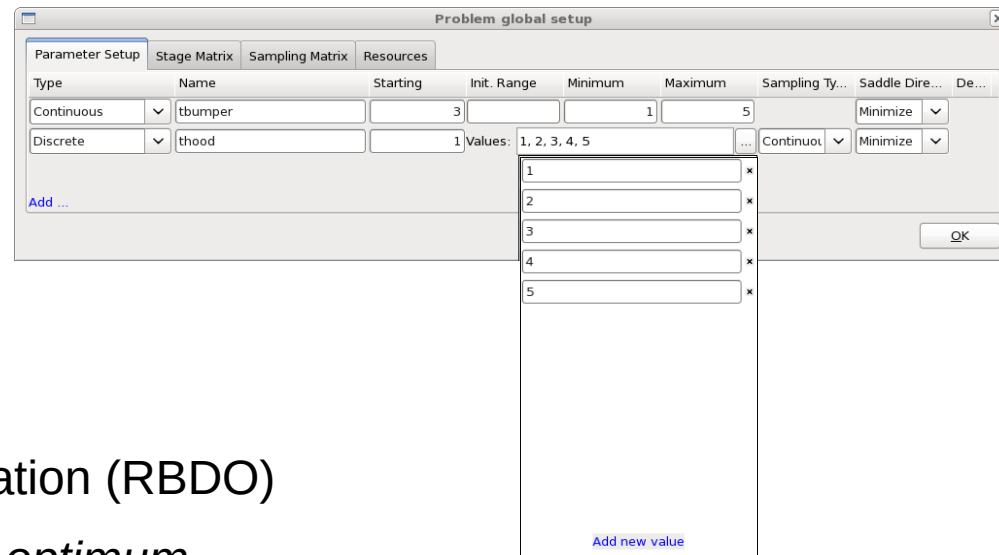
- *Improve/Maximizing the robustness of the optimum*

■ Reliability Based Design Optimization (RBDO)

- *Improve failure probability of optimum*

■ Visualization of Stochastic Results

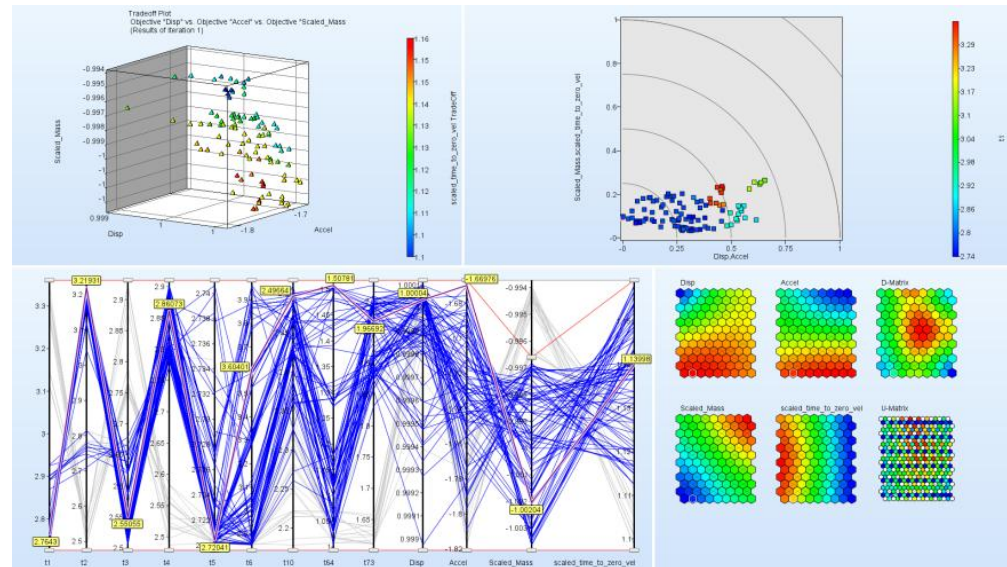
- *Fringe of statistic results on the FE-Model*



Introduction/Features

➔ LS-OPT – Multi-Objective Optimization

- Genetic Algorithm (MOGA->NSGA-II) for Multi Objective Optimization (Pareto Frontiers)
- Visualization Strategies for Pareto Optimal Data
 - Tradeoff Plot
 - Parallel Coordinate Plots
 - Hyper-Radial Visualization
 - Self Organizing Maps



Introduction / Features

➔ About LS-OPT

■ Parameter Identification Module

- *Handles "continuous" test curves*
- *Automated use of test results to calibrate materials/systems*
- *Simplify input for system identification applications*
- *Visualization of test and simulation curve to compare*
- *Confidence intervals for individual parameters in parameter identification*

$$\frac{1}{P} \sum_{p=1}^P W_i \left(\frac{F_i(\mathbf{x}) - G_i}{s_i} \right)^2$$

History matching composite

Name: MSE1

Algorithm:

- ☒ Mean Square Error (difference in curve Y values)
- ☐ Curve Mapping (size of area between curves)

Target curve: Test1 [add new file history](#)

Computed curve: F1_vs_d1

Regression points

- ☒ From target curve
- ☐ Fixed number (equidistant, interpolated)

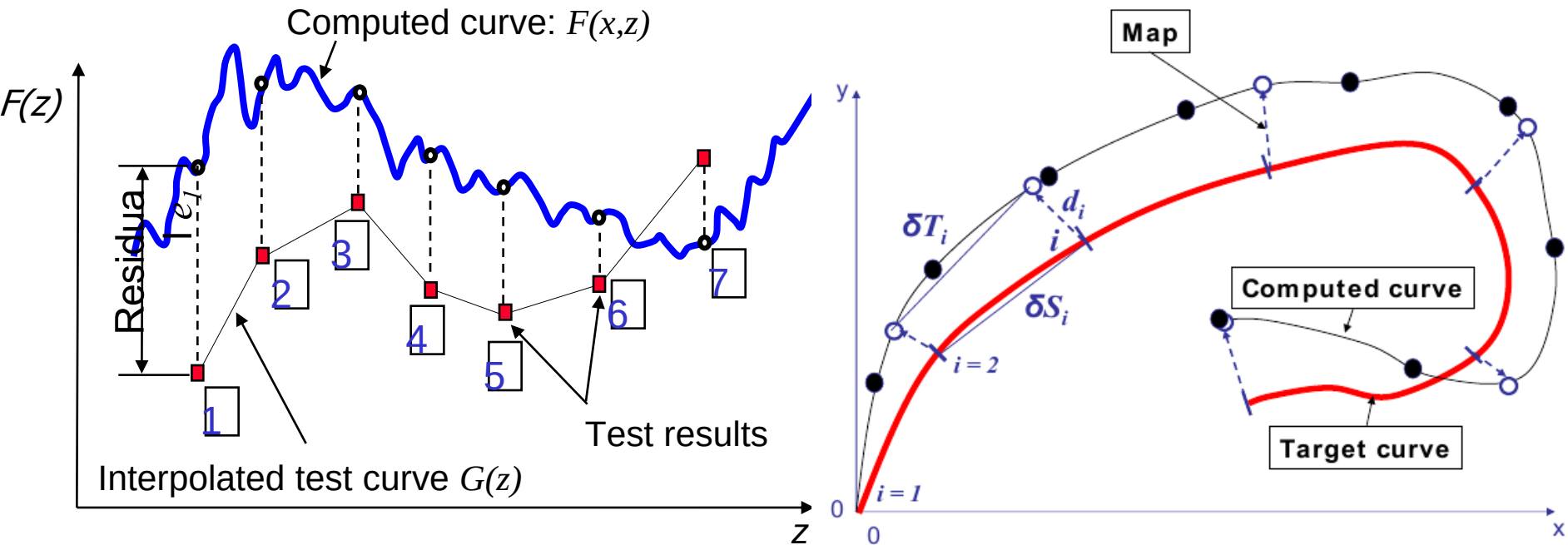
You can [convert this composite to an expression](#) for further fine-tuning.

OK

Introduction / Features

➔ About LS-OPT

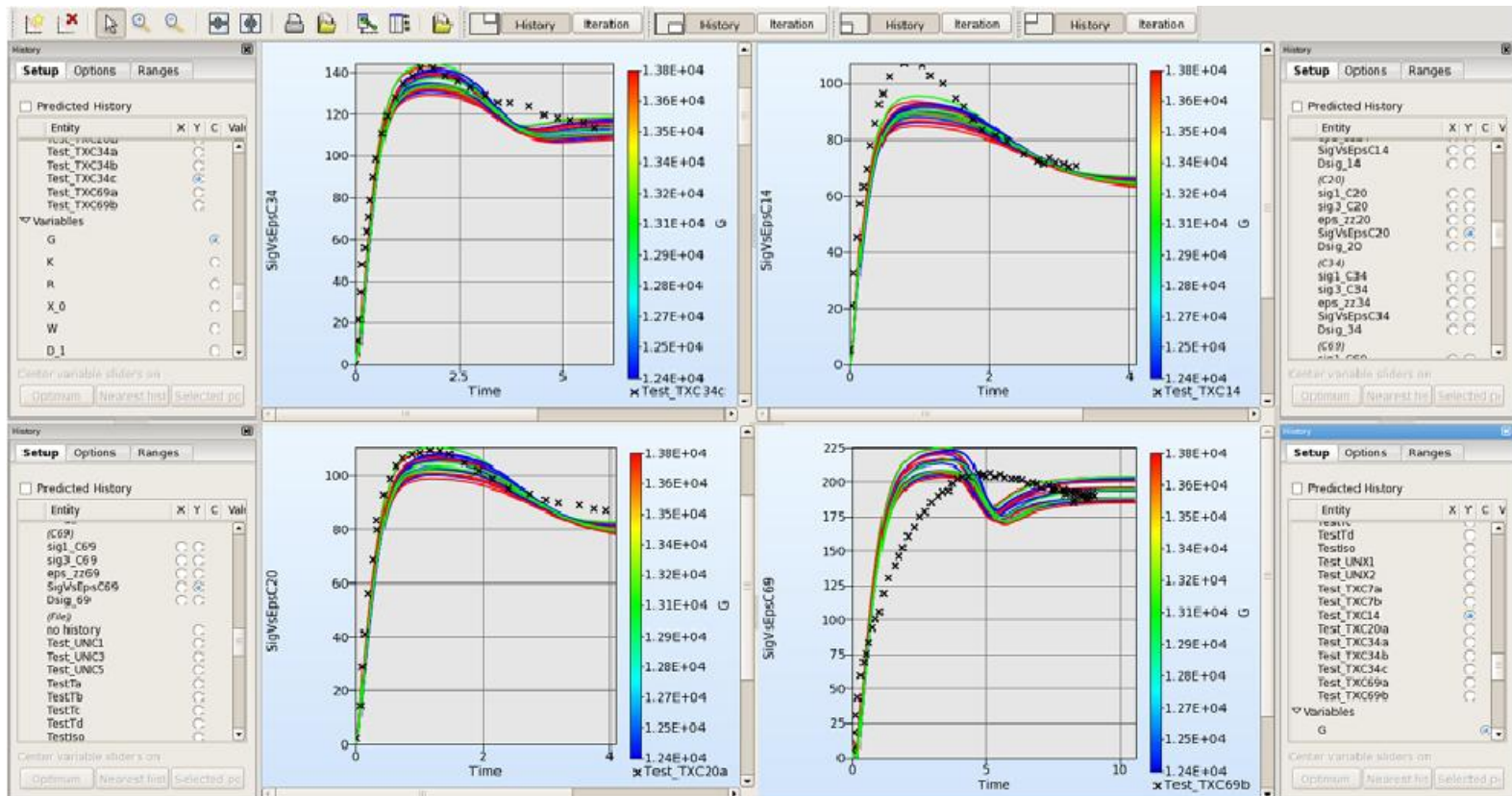
■ Parameter Identification with Test Curves



Introduction / Features

➔ About LS-OPT

- ## ■ Computed history curves vs. Target curves



Introduction / Features

➔ About LS-OPT – General Aspects

■ Job Distribution - Interface to Queuing Systems

■ *PBS, LSF, LoadLeveler, SLURM, AQS, etc.*

■ *Retry of failed queuing (abnormal termination)*

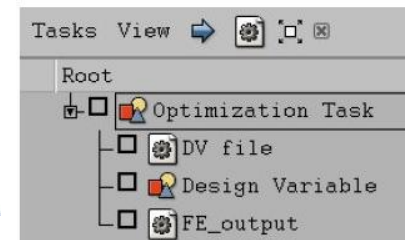
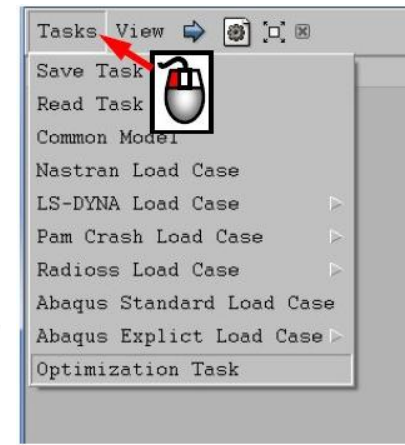
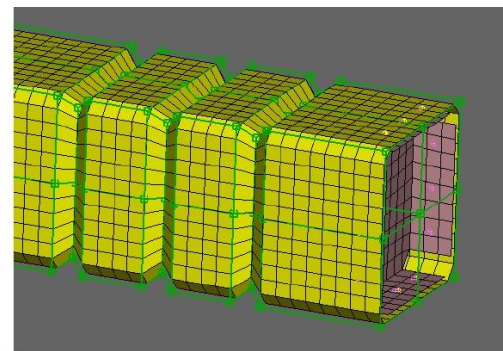
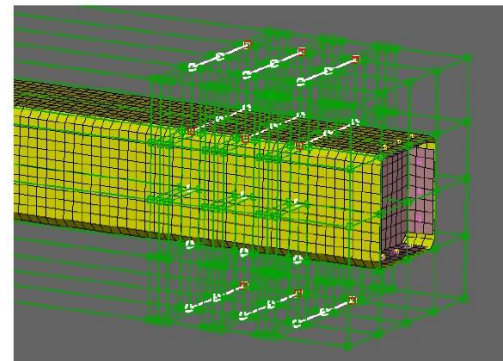
■ LS-OPT might be used as a “Process Manager”

■ Shape Optimization

■ *Interface to **ANSA**, HyperMorph, LS-PREPOST,*

■ META Post interface

■ *Allows extraction of results from any package (Abaqus, NASTRAN, ...) supported by META Post (ANSA package)*

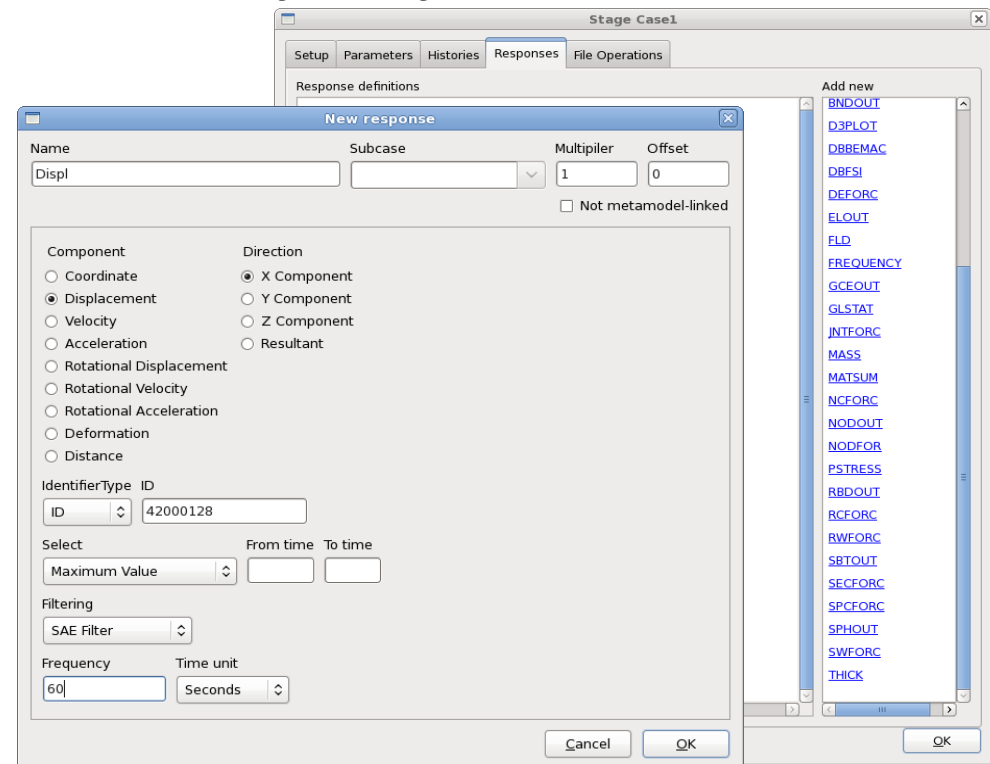


Introduction / Features

➔ About LS-OPT

■ LS-DYNA Integration

- *Checking of Dyna keyword files (*DATABASE_)*
- *Importation of design parameters from Dyna keyword files (*PARAMETER_)*
- *Monitoring of LS-DYNA progress*
- *Result extraction of most LS-DYNA response types*
- *D3plot compression (node and part selection)*



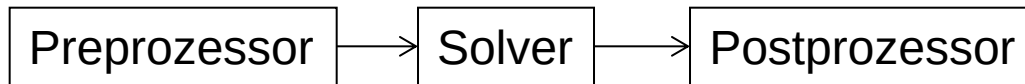


LS-OPT 5

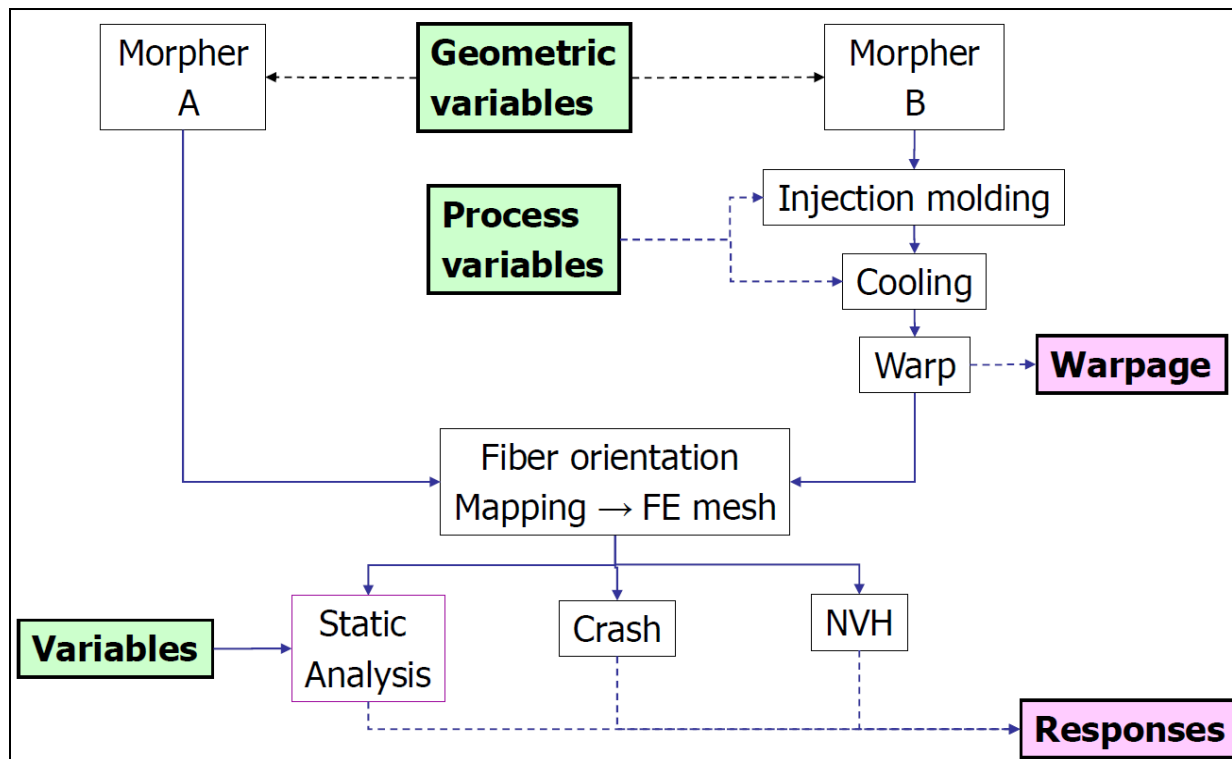
Ziele und Anforderungen

LS-OPT 5 – Ziele und Anforderungen

- Bisher mögliche Prozessketten innerhalb Optimierung mit LS-OPT:



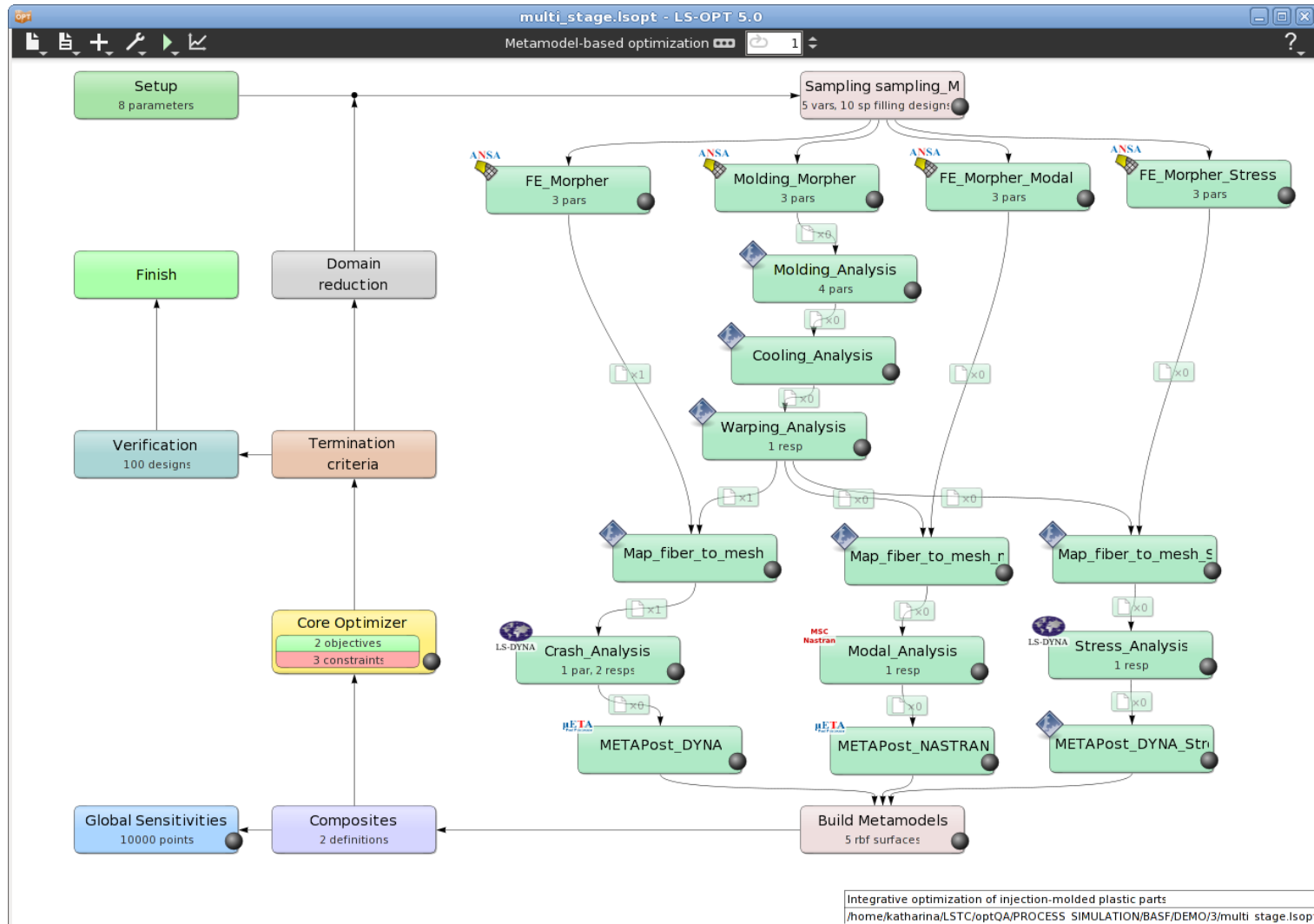
- Neue Anforderungen: längere Prozessketten, Verzweigungen



LS-OPT 5 – Ziele und Anforderungen

- Prozesssimulation & Optimierung
 - *Prozess-Ablauf mit Verzweigungen und Zusammenführen*
 - *Ausgabe-Dateien: kopieren, löschen, verschieben, ...*
- Schrittweise Ausführung möglich
 - *z.B. nur Sampling*
 - *oder einzelner Teilschritt der Prozesskette*
- Status der Berechnungen bzw. Optimierung wird dargestellt

LS-OPT 5 – neue graphische Oberfläche



LS-OPT 5 – neue Datenbasis

■ XML-Format

```
<lsoptproject version="5.0.0">
  <head>
    <title>Small car crash optimization problem: LINEAR</title>
    <meta name="generator" content="com2lsopt from LS-OPT 5.0 Revision 69327"/>
    <meta name="original-filename" content="com.iterate.correct"/>
  </head>
  <variables>
    <variable name="v_tbumper" value="3" min="1" max="5"/>
    <variable name="v_thood" value="1" min="1" max="5"/>
  </variables>
  <samplings>
    <sampling name="e_1">
      <design type="dopt"/>
      <metamodel type="polynomial" order="linear"/>
      <stages>
        <stage name="s_1" type="dyna960">
          <command>ls971_s_7600</command>
          <inputfile>main.k</inputfile>
          <scheduling concurrent="4"/>
          <responses>
            <response name="r_Disp2">BinoutResponse -res_type Nodout -cmp x_displacement -id 432 -select TIME </response>
            <response name="r_Disp1">BinoutResponse -res_type Nodout -cmp x_displacement -id 167 -select TIME </response>
            <response name="r_Acc_max">BinoutResponse -res_type Nodout -cmp x_acceleration -id 167 -select MAX -filter SAE -filter_freq 60</response>
            <response name="r_Mass">DynaMass 2 3 4 5 MASS</response>
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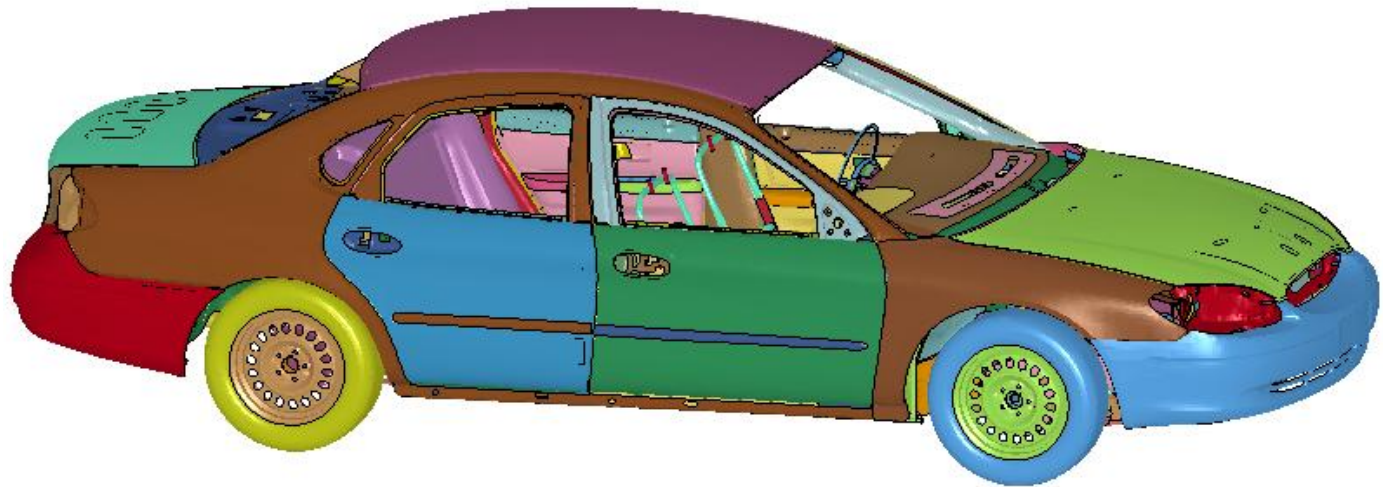


Beispiel

Example Problem - Model

- NCAC Model <http://www.ncac.gwu.edu/>, Ford Taurus

- *Number of Parts* 771
- *Number of Shells* 776209
- *Number of Nodes* 858117
- *Number of Beams* 4
- *Number of Solids* 48227
- *Number of Elements* 824452



Example Problem – Load Cases

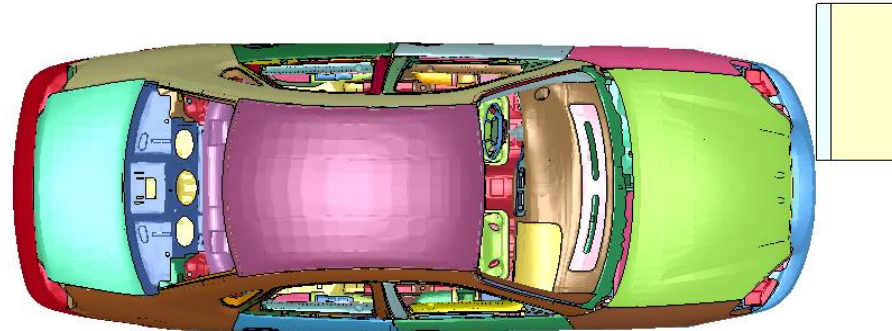
■ US-NCAP

- 56.6km/h



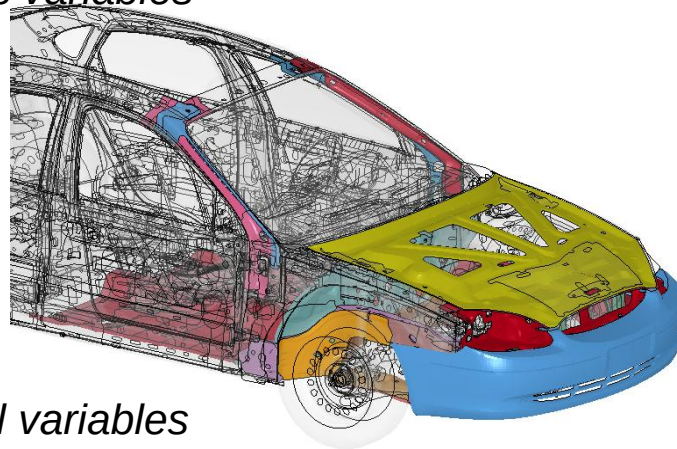
■ IIHS ODB

- 64.4 km/h
- 40% overlap

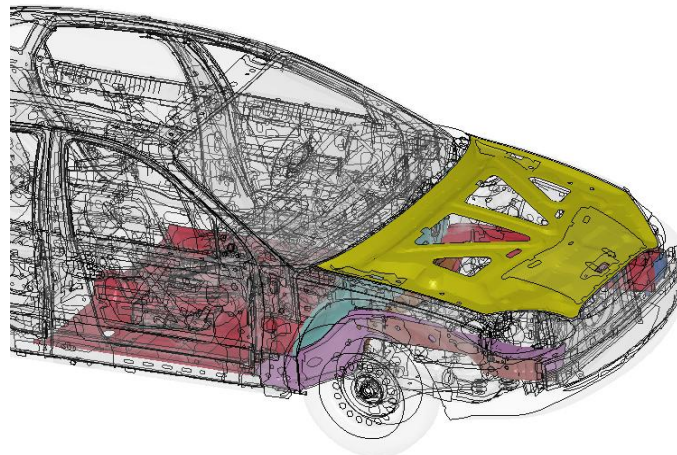


Example Problem - Variables

- 27 variables
 - 21 *sheet thickness variables*



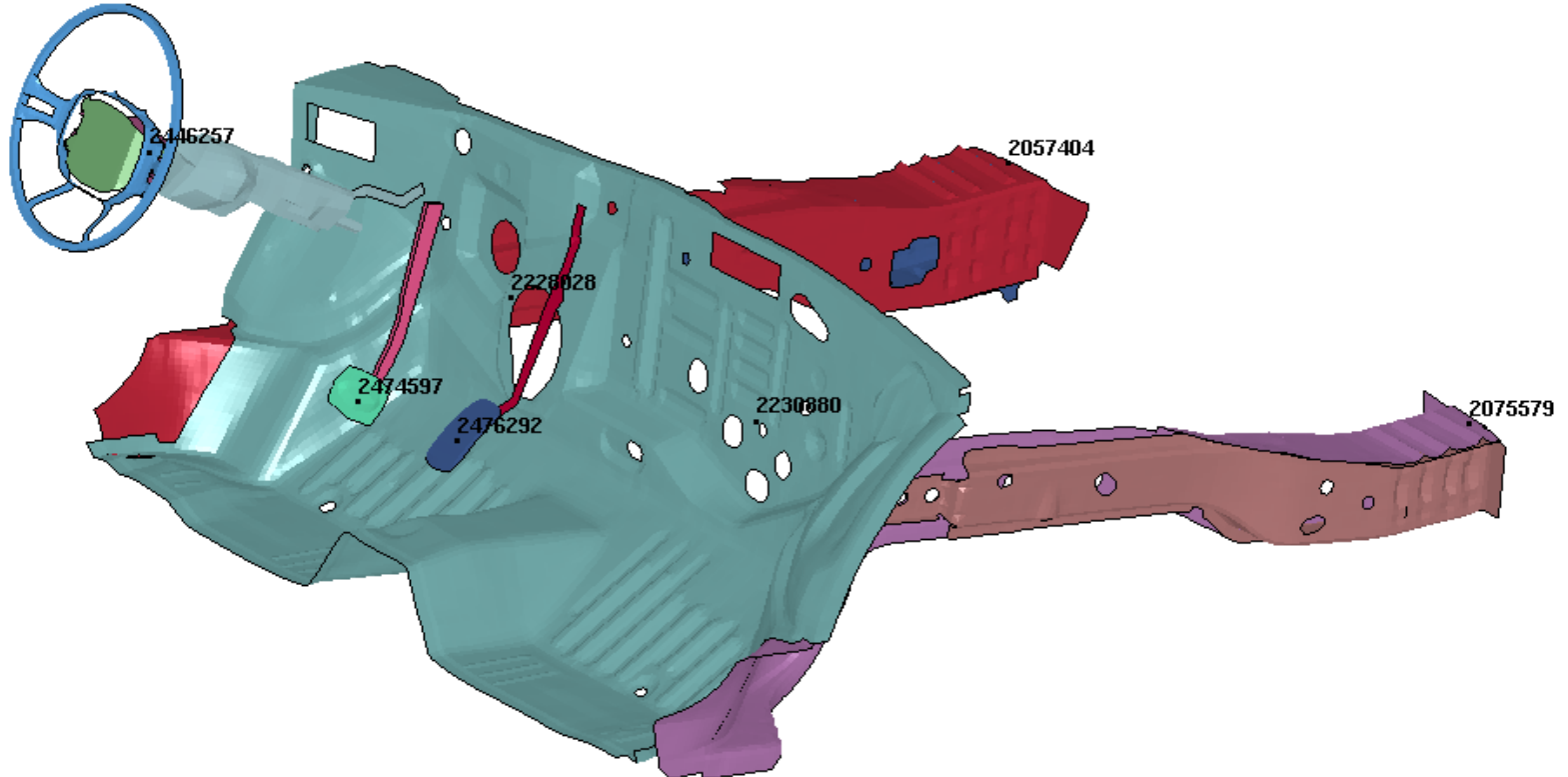
- 6 *discrete material variables*



Example Problem - Responses

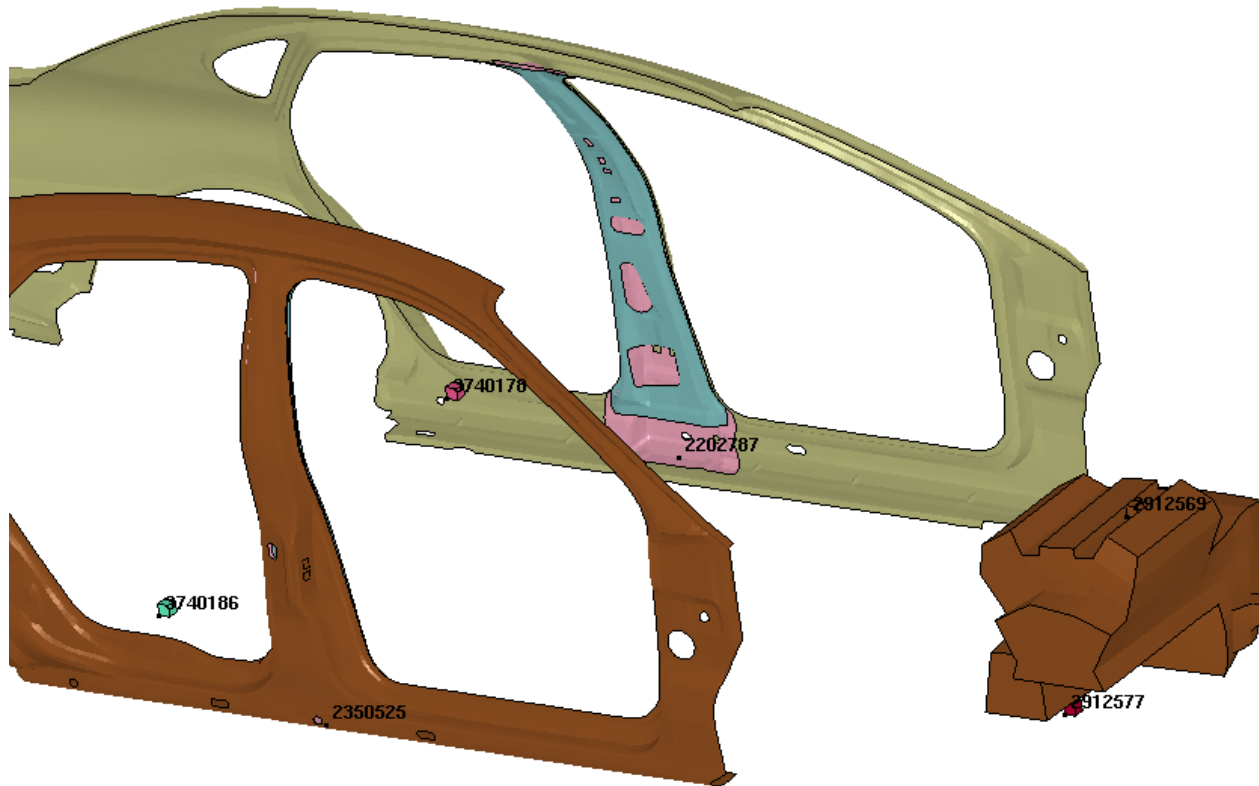
- Responses US-NCAP and IIHS ODB

- *Mass*
- *Intrusions*



Example Problem - Responses

- Responses US-NCAP and IIHS ODB
 - Accelerations

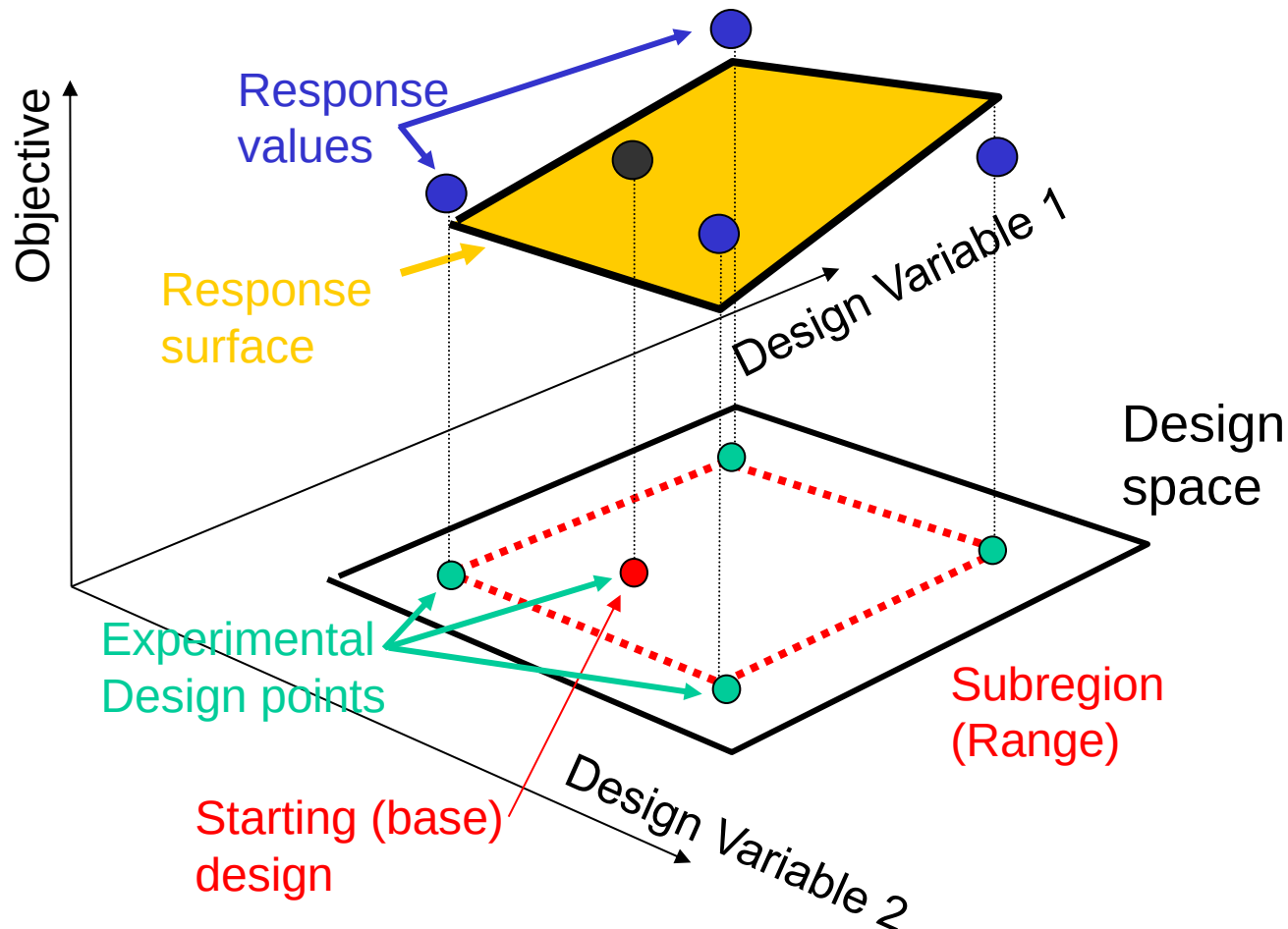




Einschub – Sequential Response Surface Method (SRSM)

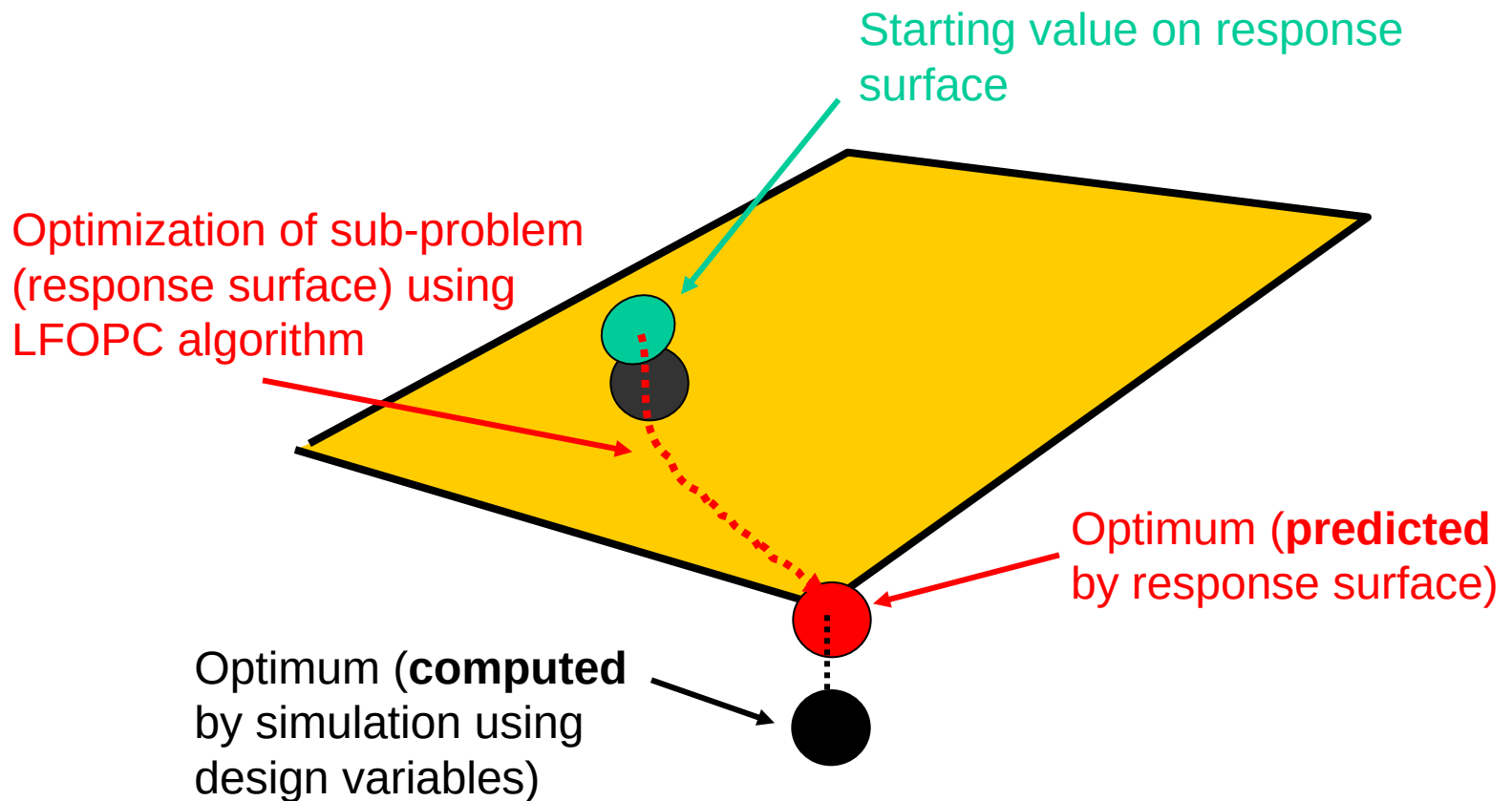
Methods - Optimization

Response Surface Methodology - Optimization Process

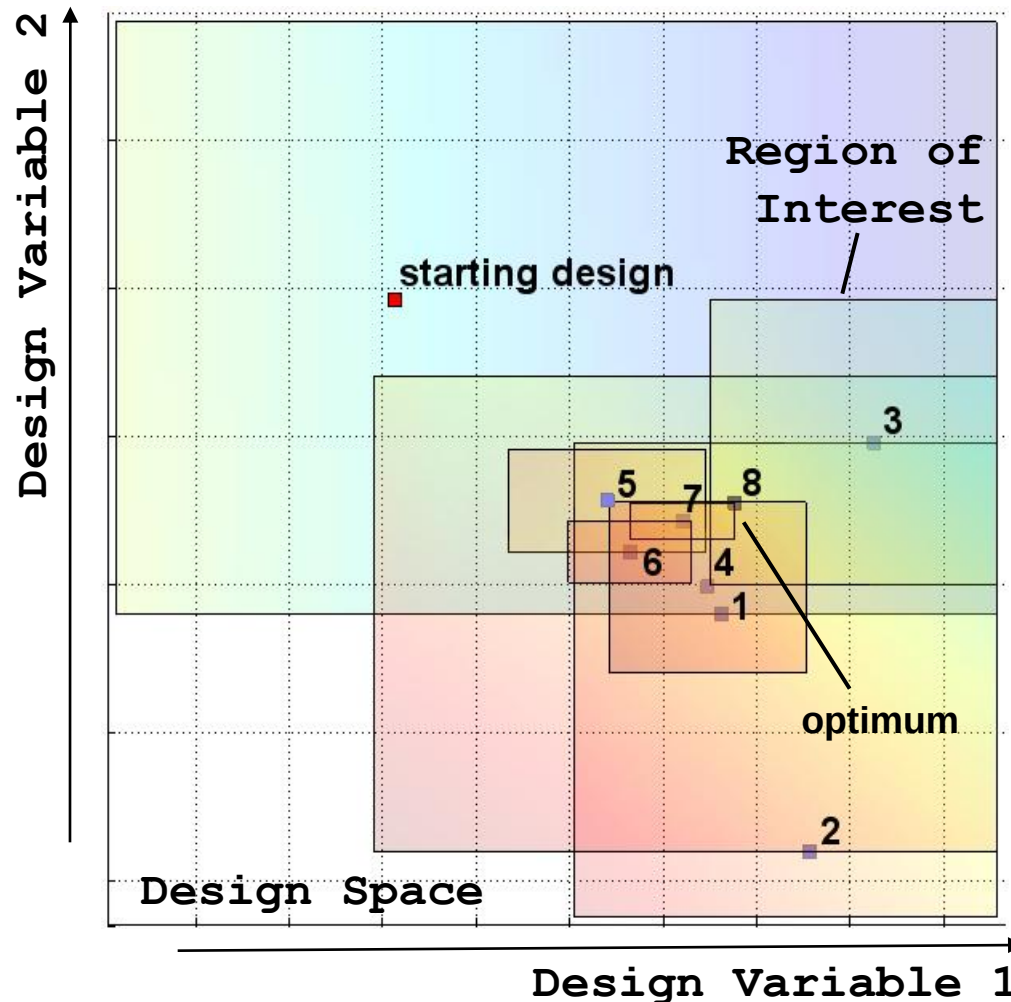


Methods - Optimization

Find an Optimum on the Response Surface (one iteration)



Successive Response Surface Methodology





LS-OPT 5 - Datenstruktur

- Früher „Solver“ → „Sampling“ und „Stage“ → neue Datenstruktur

