Infotag ANSA/LS-OPT/META

Shape optimization for CFD analysis using LS-OPT, ANSA and LS-DYNA ICFD
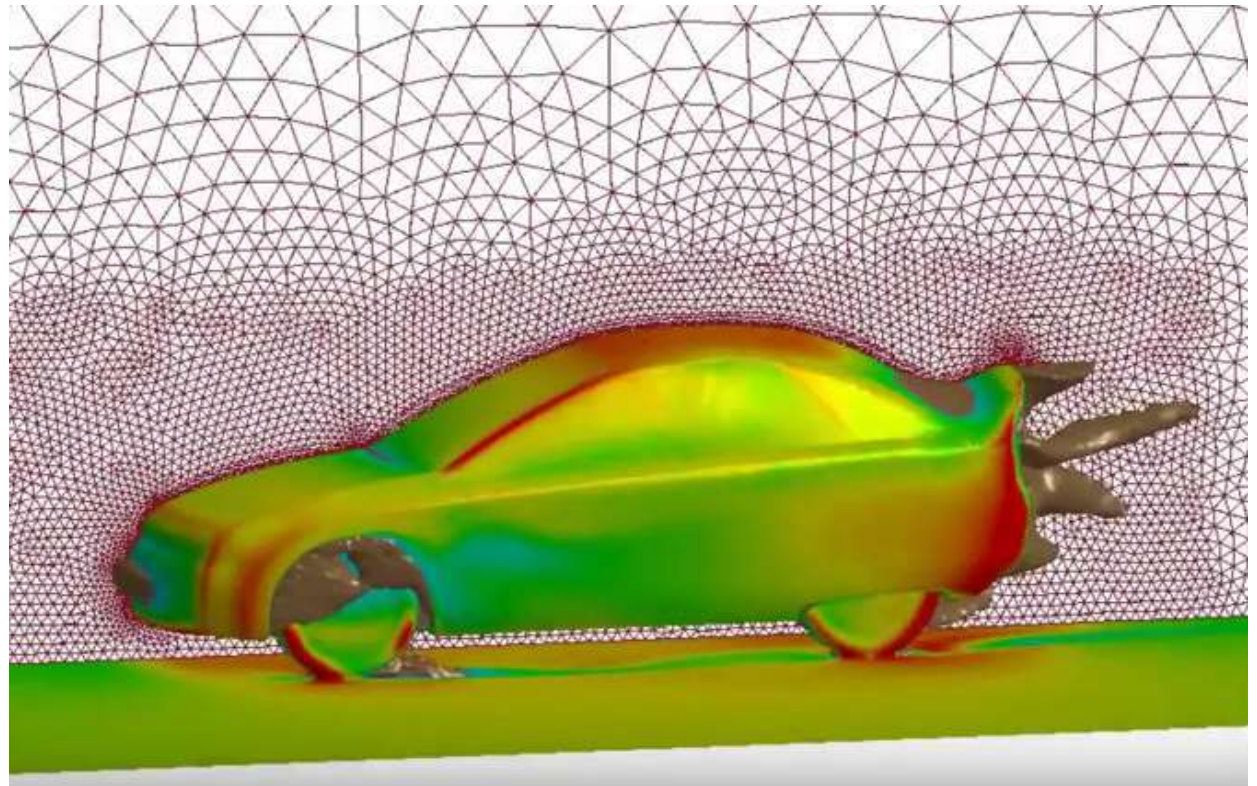
Facundo Del Pin (LSTC)

Katharina Witowski (DYNAmore GmbH)
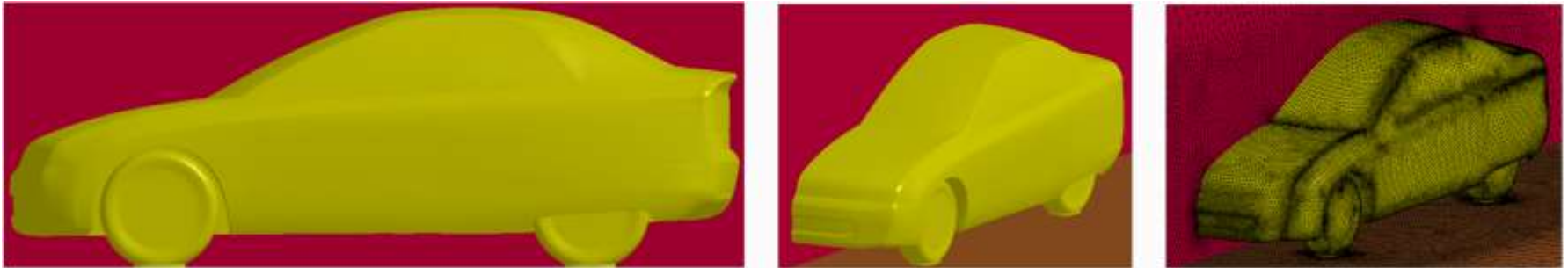
Stuttgart, 05.02.2018

Overview

- Problem description
- Setup in ANSA
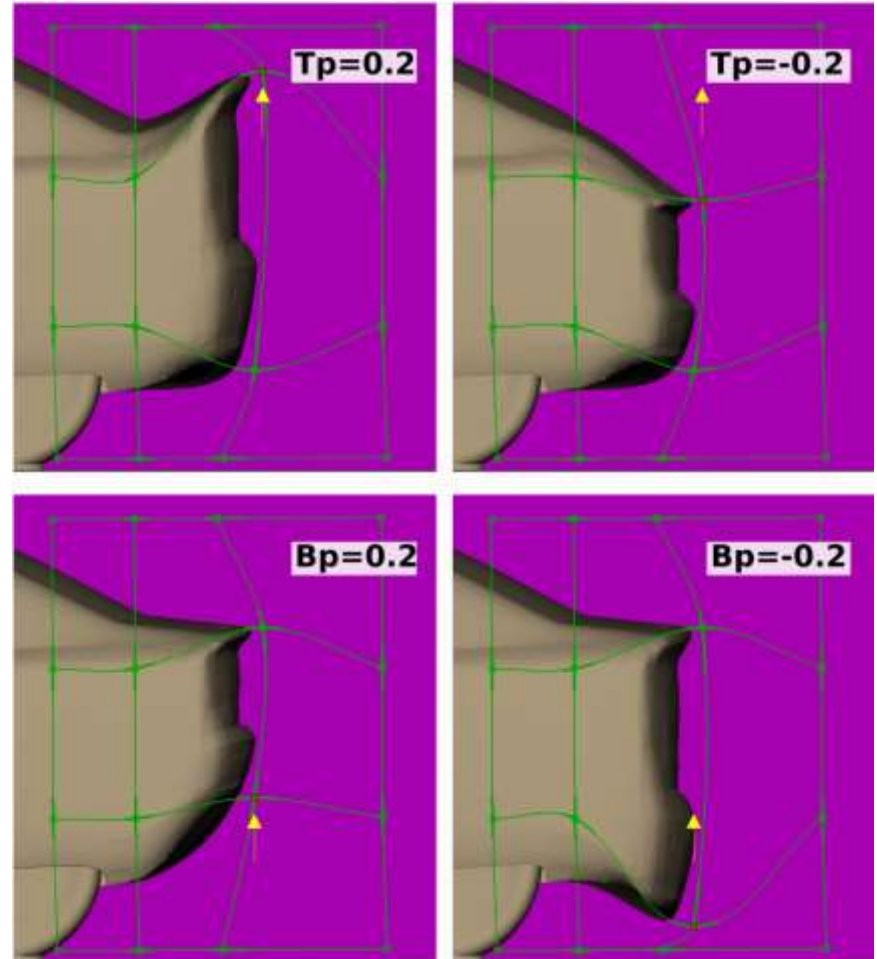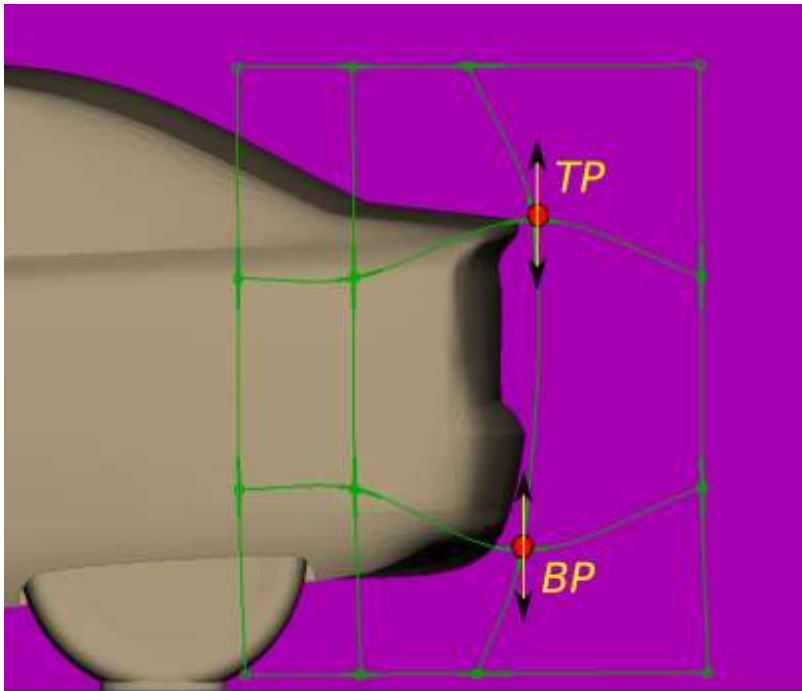- Setup in LS-OPT
- Results

Problem description

■ CFD model

■ External aerodynamics of a ground vehicle

■ Reynolds Number ~ 1.0e7

■ RANS turbulence model using realizable K-e

■ Objective: fuel efficiency
  → maximize down force and minimize drag force,
    more relevance to drag
  → Optimization objective function
    max(down force / drag force^2)

Parameters

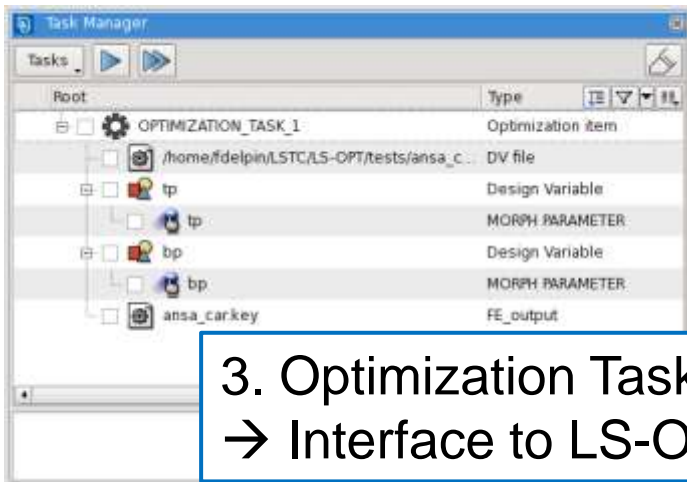- 2 Morphing Parameters
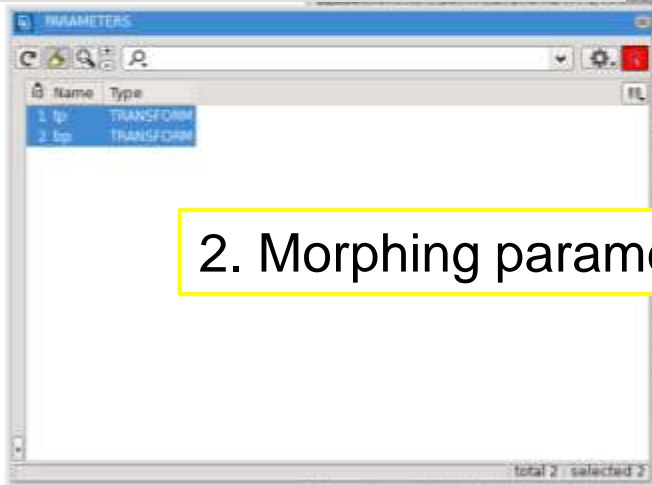 - TP: top point
  - BP: bottom point

Model modifications

- ANSA doesn't support LS-DYNA CFD input files
- Manual modifications:
  - *MESH_SURFACE_ELEMENT → *ELEMENT_SHELL (3D)
  - *MESH_SURFACE_ELEMENT → *ELEMENT_BEAM (2D)
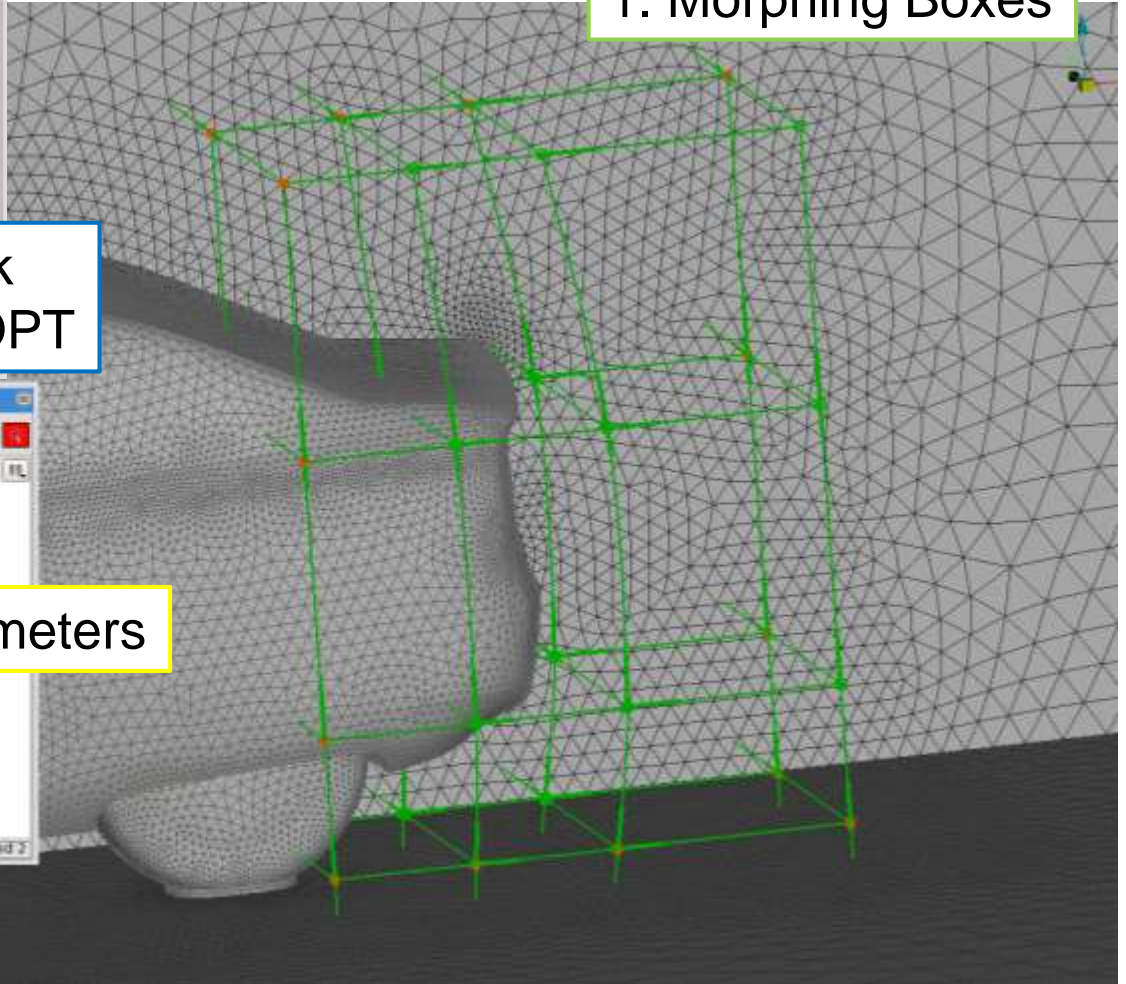 - *MESH_SURFACE_NODE → *NODE

Setup in ANSA

1. Morphing Boxes
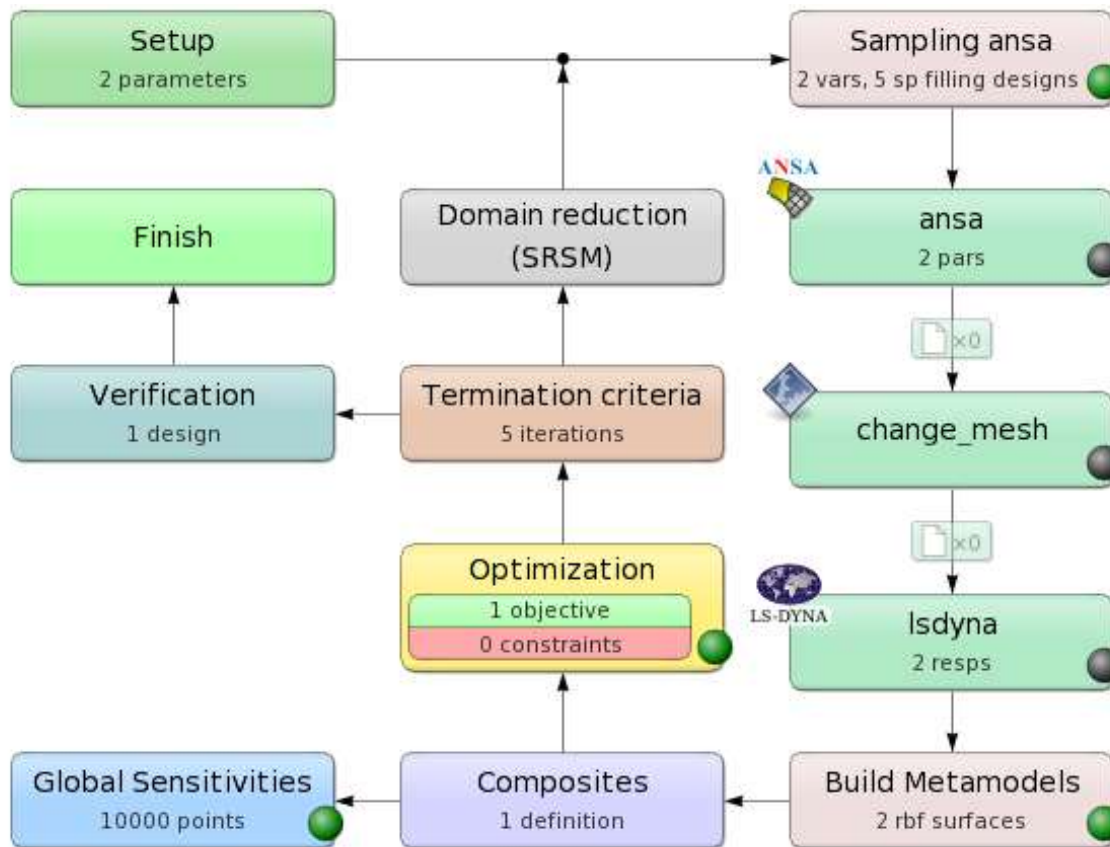
3. Optimization Task
→ Interface to LS-OPT

2. Morphing parameters

Setup in LS-OPT

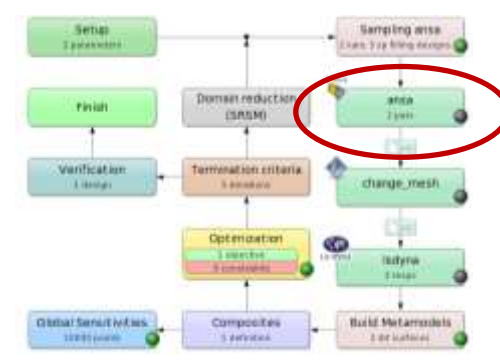- ## LS-OPT main GUI
  - Metamodel-based optimization, metamodel type RBF (Radial Basis Functions)
  - Strategy sequential with domain reduction, 5 iterations

Setup in LS-OPT

■ Stage ansa

Parameters read from ANSA DV file

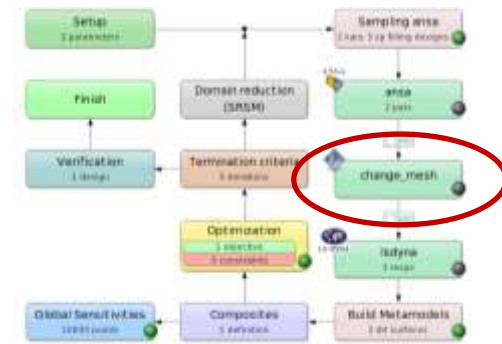Generate output in lsdyna directories

Setup in LS-OPT

■ Stage python

 ■ ANSA generates structural LS-DYNA input file

 ■ Python script converts to CFD input file

 ■ *ELEMENT_SHELL → *MESH_SURFACE_ELEMENT

 ■ *ELEMENT_BEAM → *MESH_SURFACE_ELEMENT

 ■ *NODE → *MESH_SURFACE_NODE

Stage change_mesh

| Setup | Parameters | Histories | Responses | File Operations |

General

Package Name | User-Defined

Command | python ${LSPROJHOME}/set_mesh_icfd.py ansa_car.k | Browse
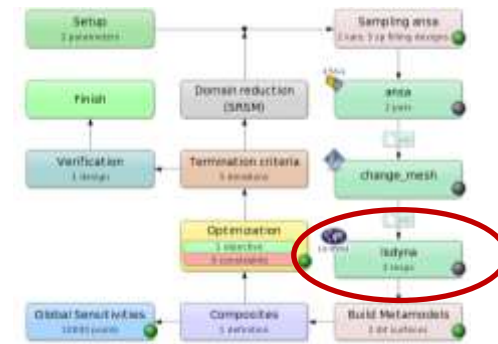
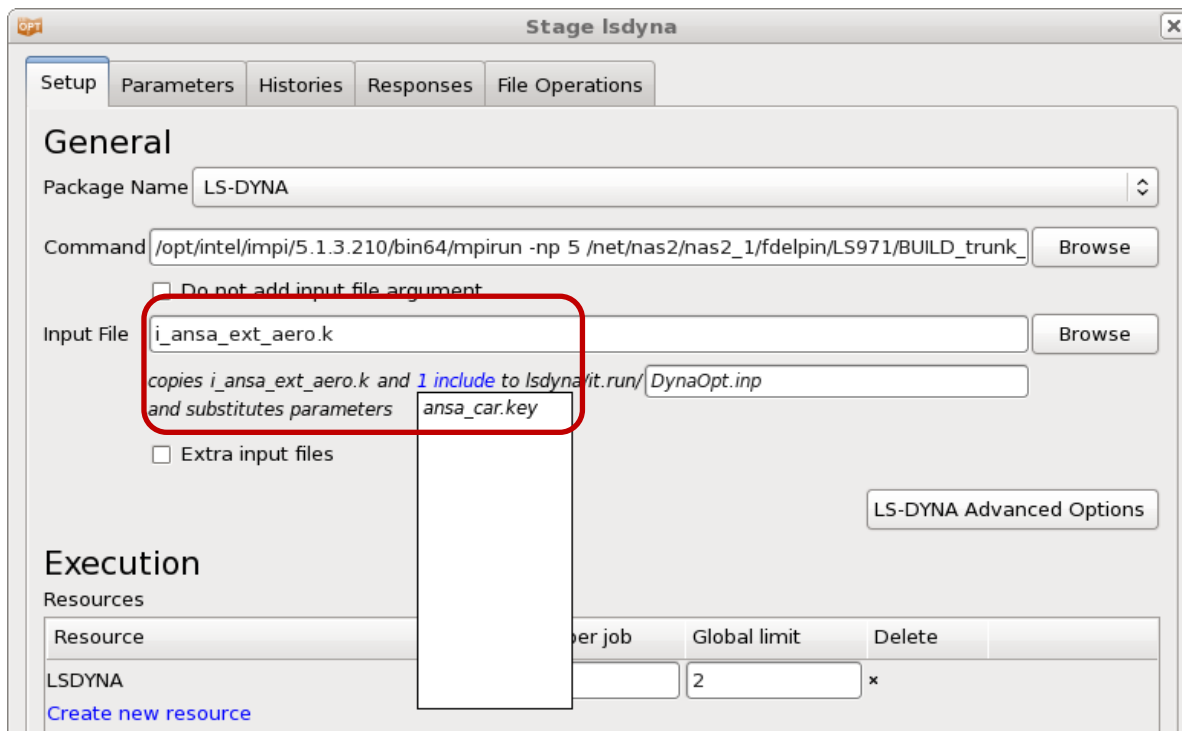☑ Do not add input file argument

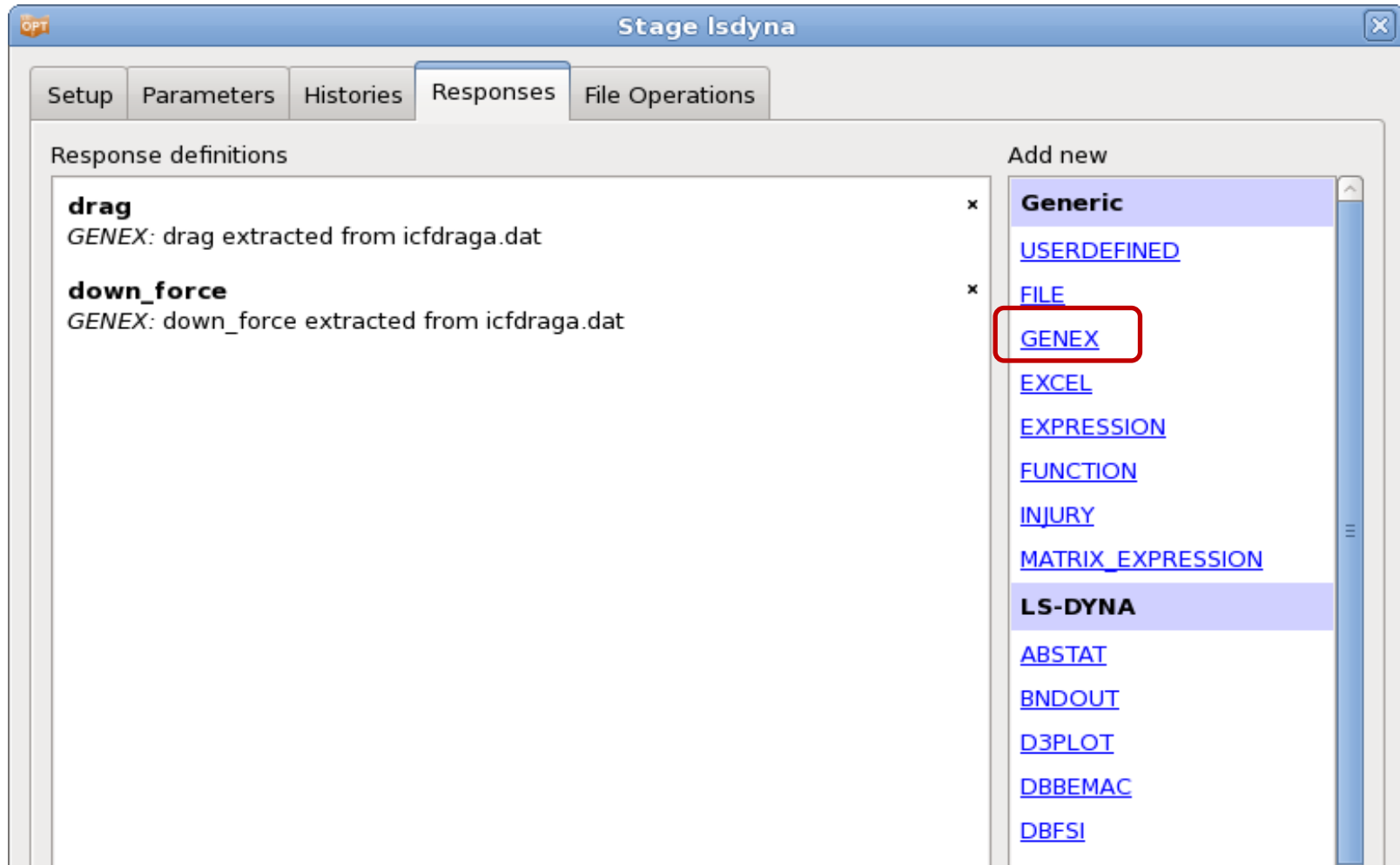Input File | | Browse

☐ Extra input files

Setup in LS-OPT

■ Stage LS-DYNA

    ■ ANSA output (modified by Python script) is include in main LS-DYNA input file
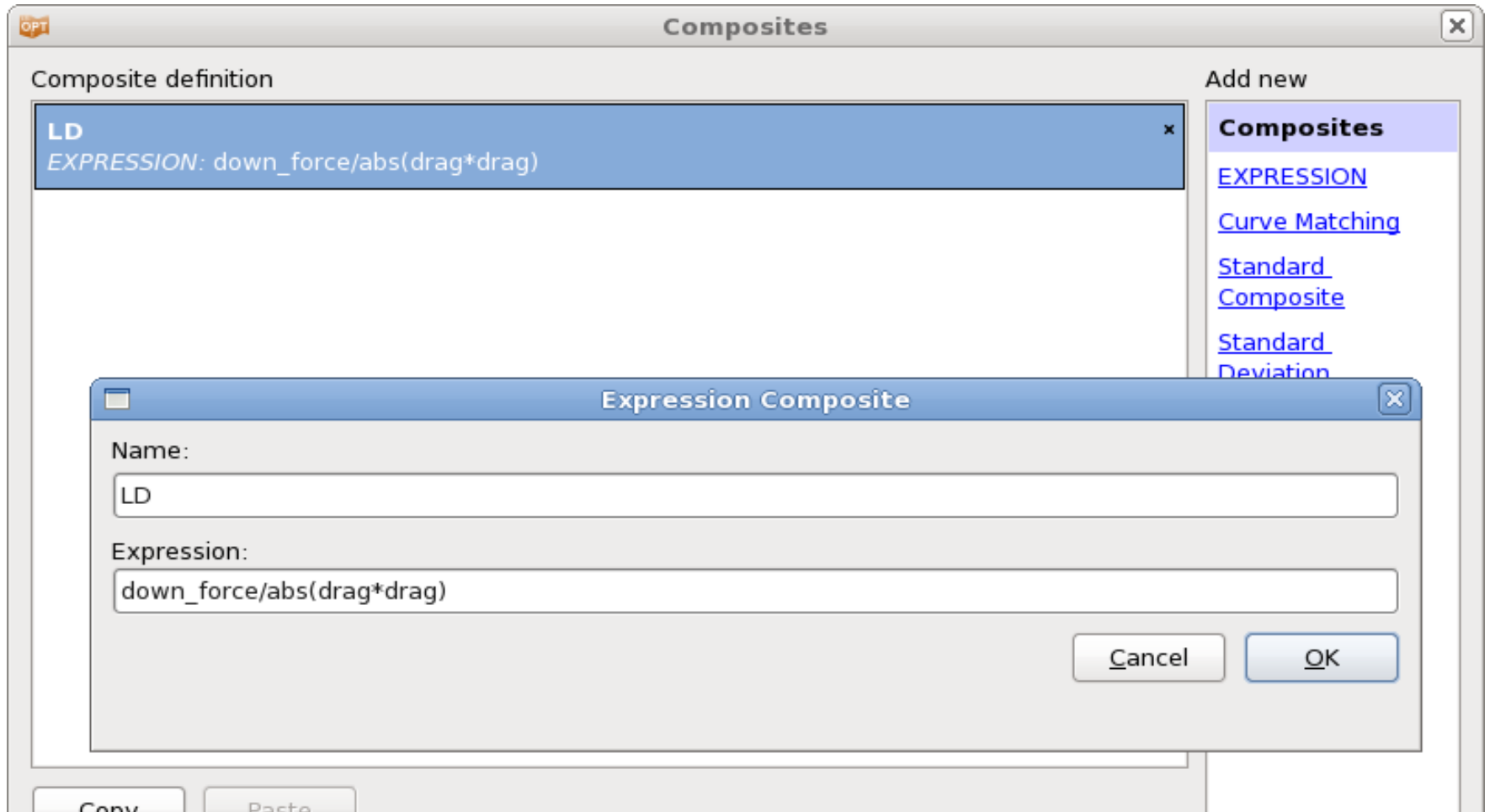
Setup in LS-OPT

■ CFD responses extracted using GENEX

Setup in LS-OPT

■ GENEX: extract data from ASCII file
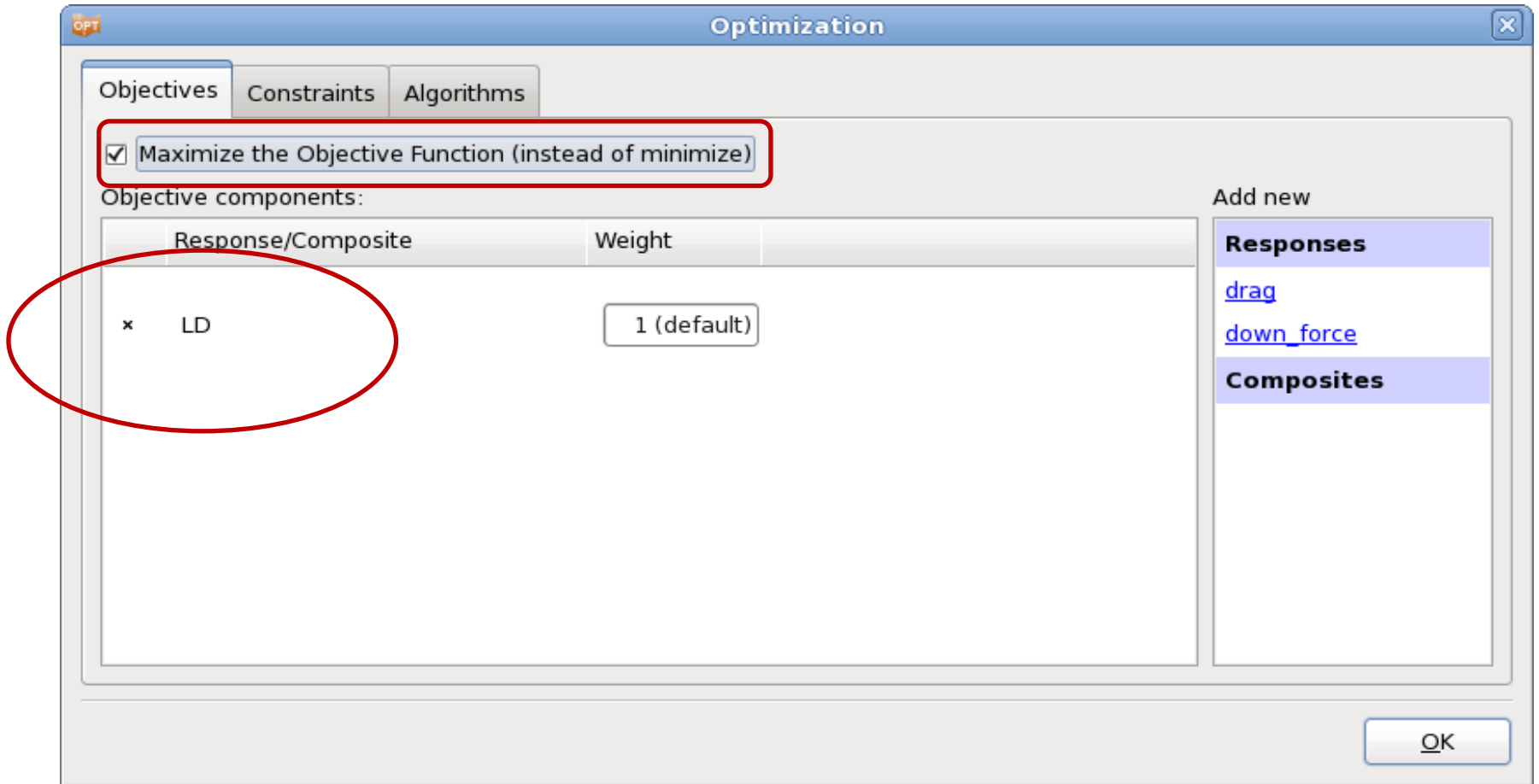

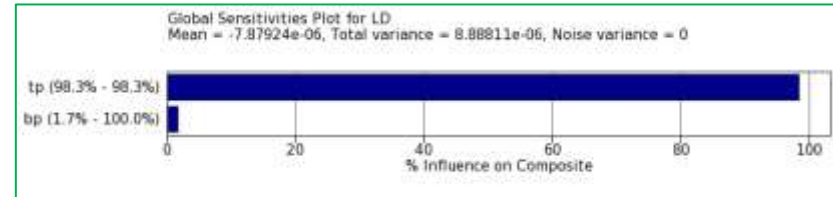value to be extracted

Setup in LS-OPT

- Composite Expression

Setup in LS-OPT

■ Objective function

Results

- Convergence: Optimization History

Global Sensitivities Plot for LD
Mean = -7.87924e-06, Total variance = 8.88811e-06, Noise variance = 0

tp (98.3% - 98.3%)
bp (1.7% - 100.0%)
% Influence on Composite

Optimization History for "bp"

bp

Optimal value
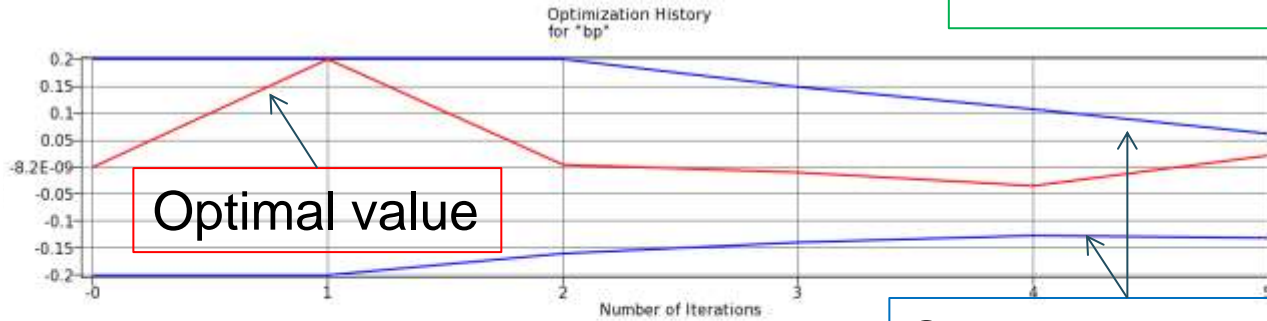
converged?
GSA → bp not significant

Subregion bounds

Number of Iterations

Optimization History for "tp"

tp

Number of Iterations

Optimization History for "LD"

LD

Predicted optimum

Computed optimum

—Predicted
—Computed

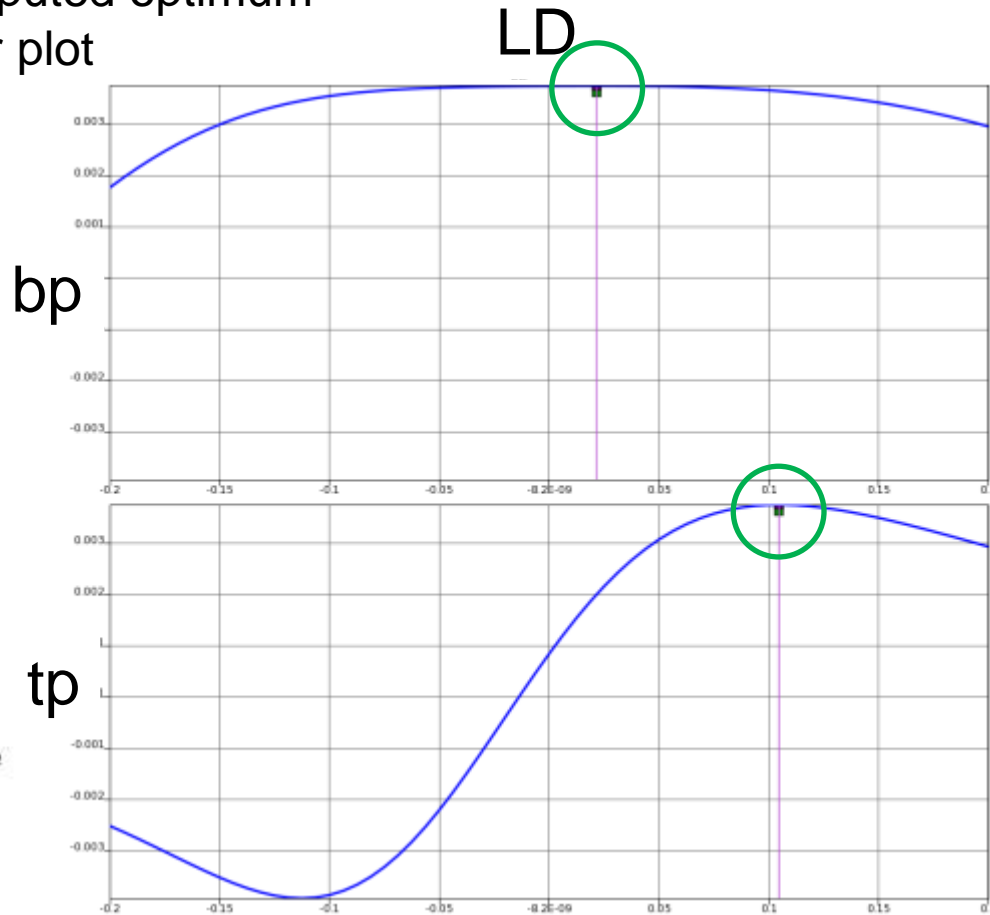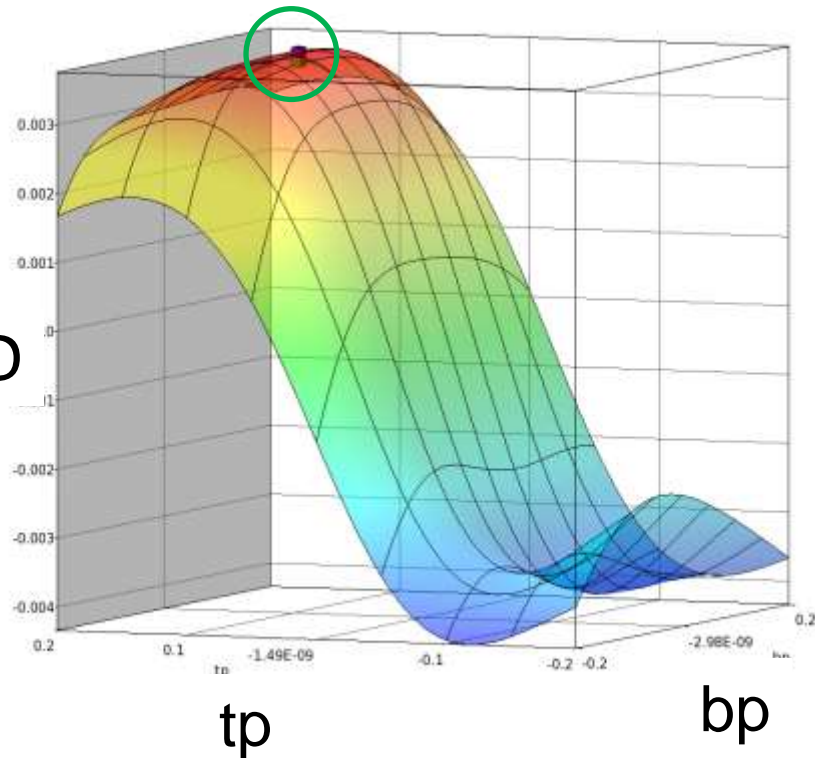Iteration
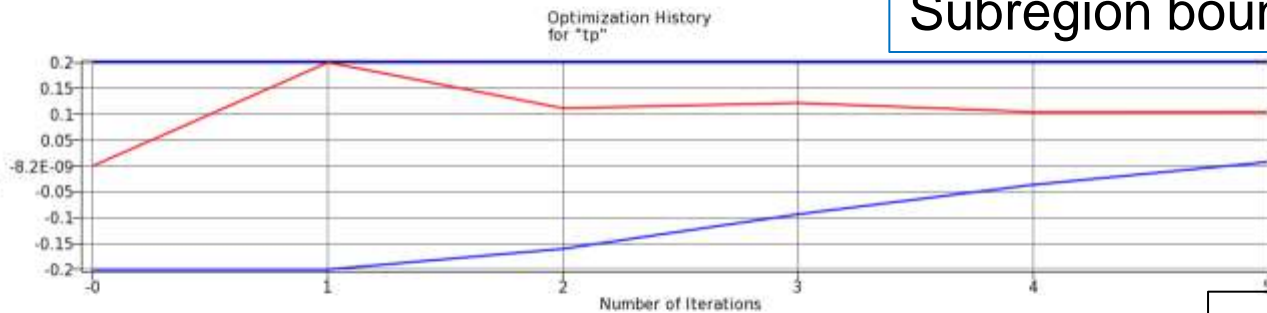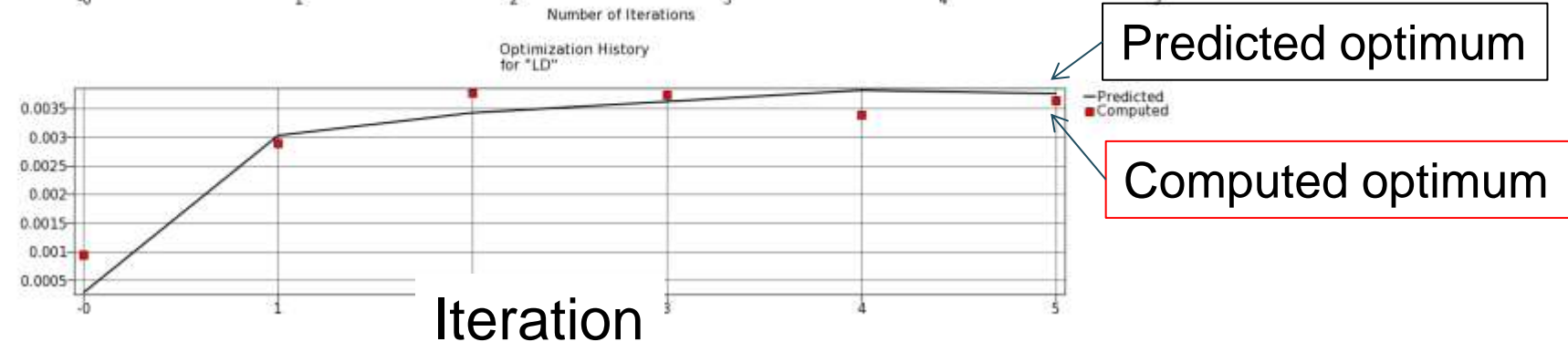
Results

■ Metamodel with predicted and computed optimum
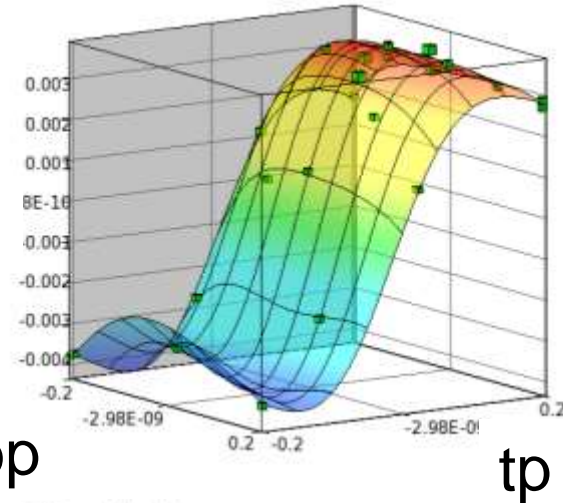3D Surface plot and 2D interpolator plot

Results

■ Metamodel accuracy

   ■ Surface plot with points

      ■ Points are close to surface

   ■ Error measures (only for responses)

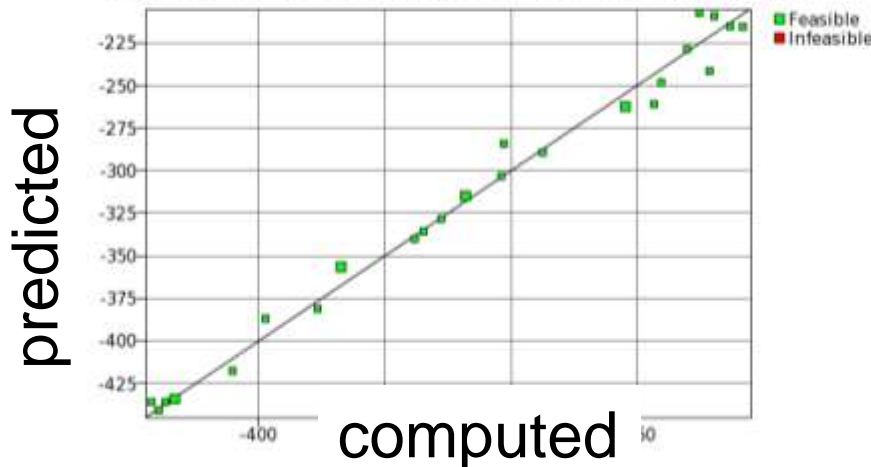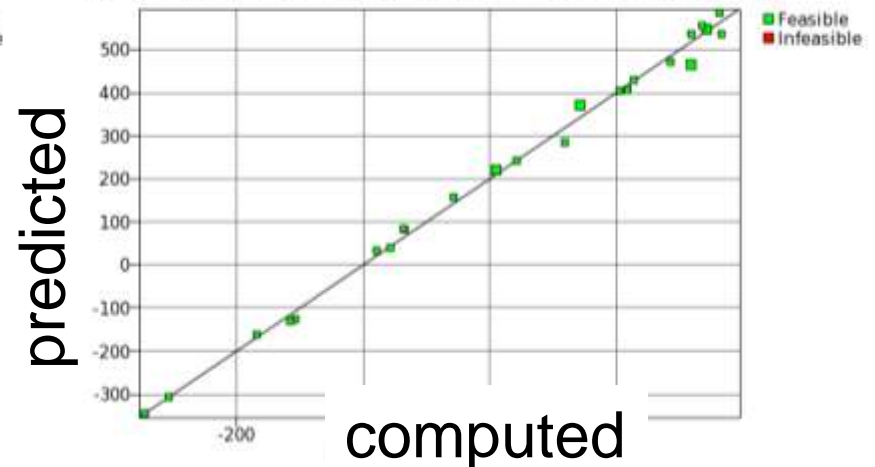   ■ RMS error

      ■ SPRESS → predictive capability!

LD

bp   tp

Metamodeling Accuracy
For Response Function "drag_avg"
RBF Net: RMS Err = 9.21 (2.92 %), Sqrt PRESS = 14.7 (4.65 %), R-sq = 0.968
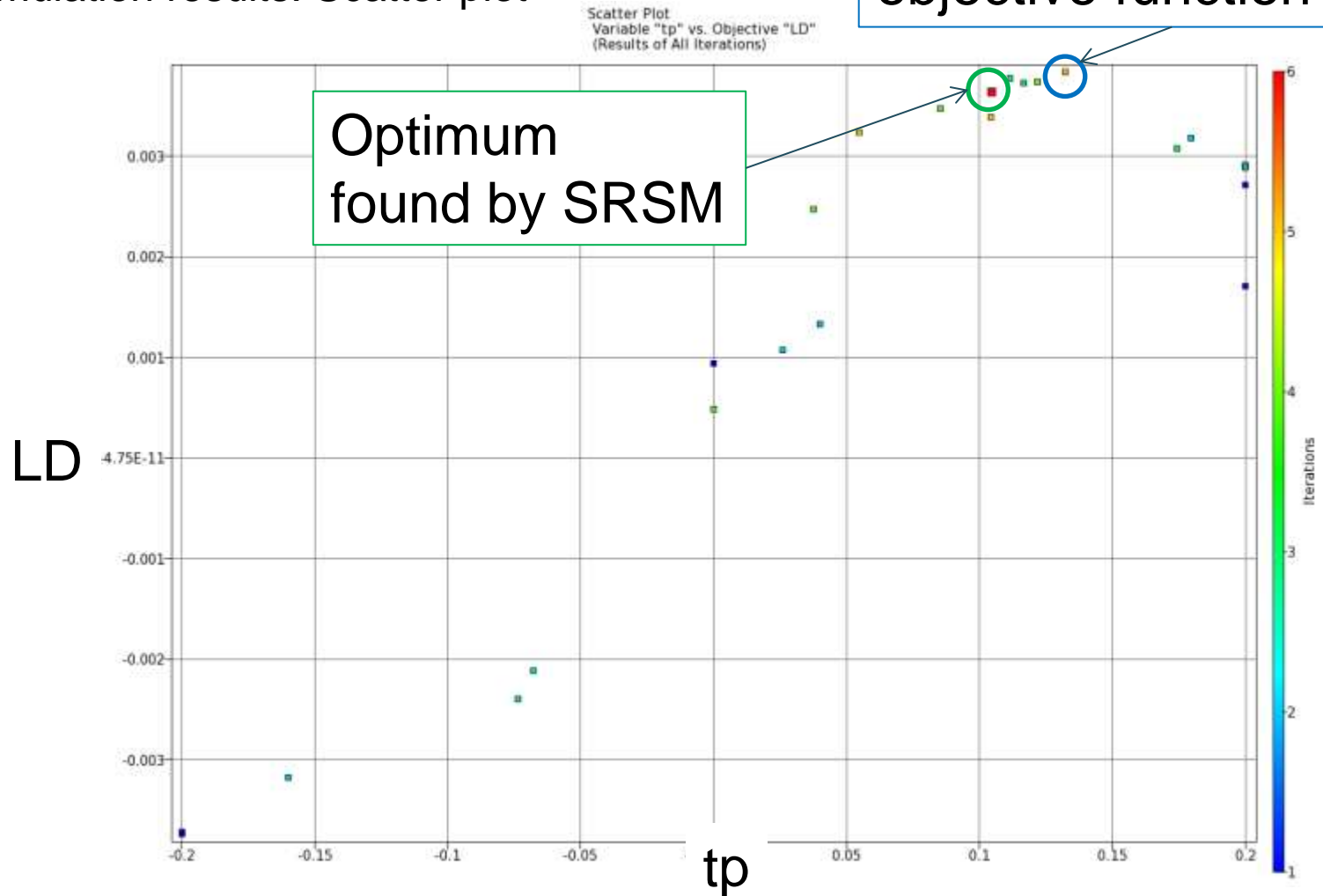

predicted / computed

Metamodeling Accuracy
For Response Function "lift_avg"
RBF Net: RMS Err = 19.4 (8.63 %), Sqrt PRESS = 44.3 (19.7 %), R-sq = 0.993

predicted / computed

Results

■ Simulation results: Scatter plot

Scatter Plot
Variable "tp" vs. Objective "LD"
(Results of All Iterations)

Point with highest
objective function value

Optimum
found by SRSM

Results

- Optimal design

	Initial design	Optimal design (6.1)	„Best" design (5.2)
bp	0.0	0.022	0.062
tp	0.0	0.105	0.132
LD predicted	-	0.00376	0.00366
LD computed	0.00094	0.00364	0.00384

Results

- Optimal design
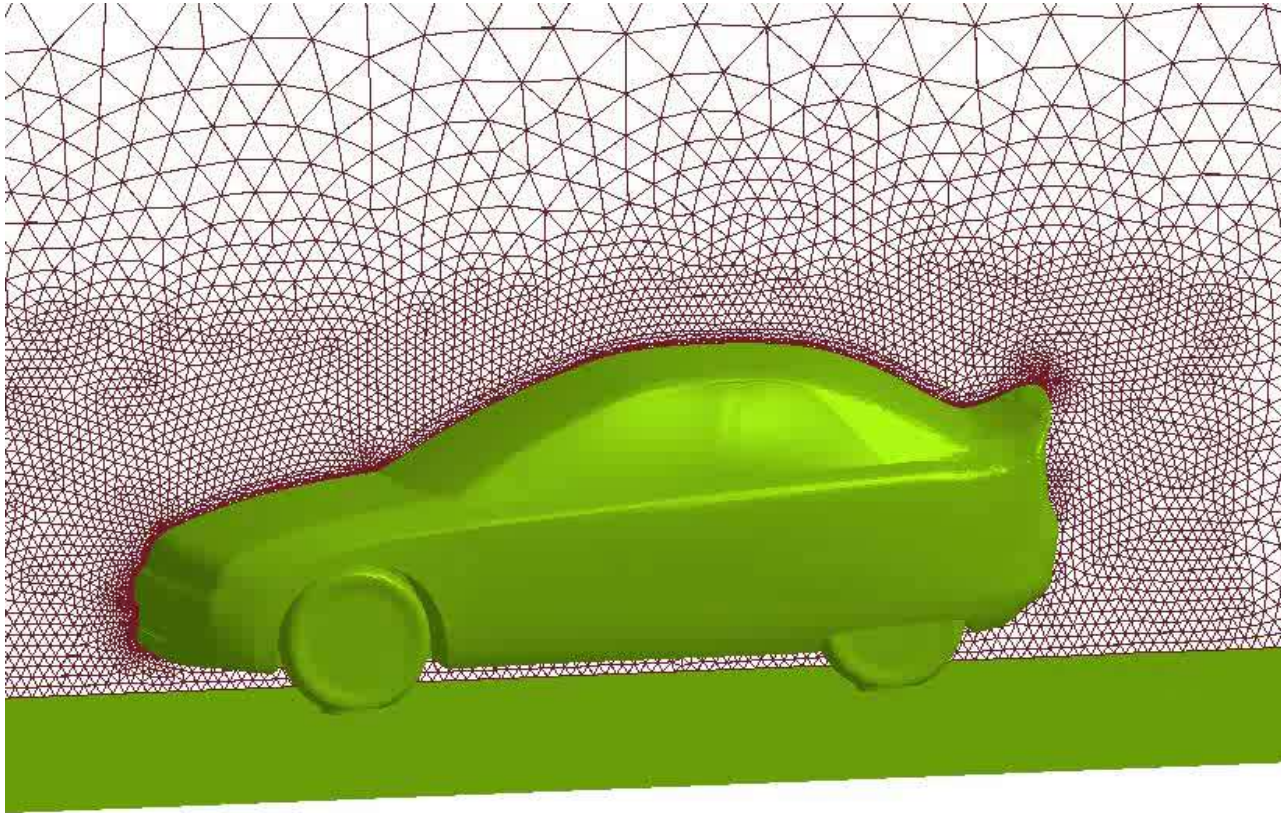
More Information on the LSTC Product Suite

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