

Infotag ANSA/LS-OPT/META

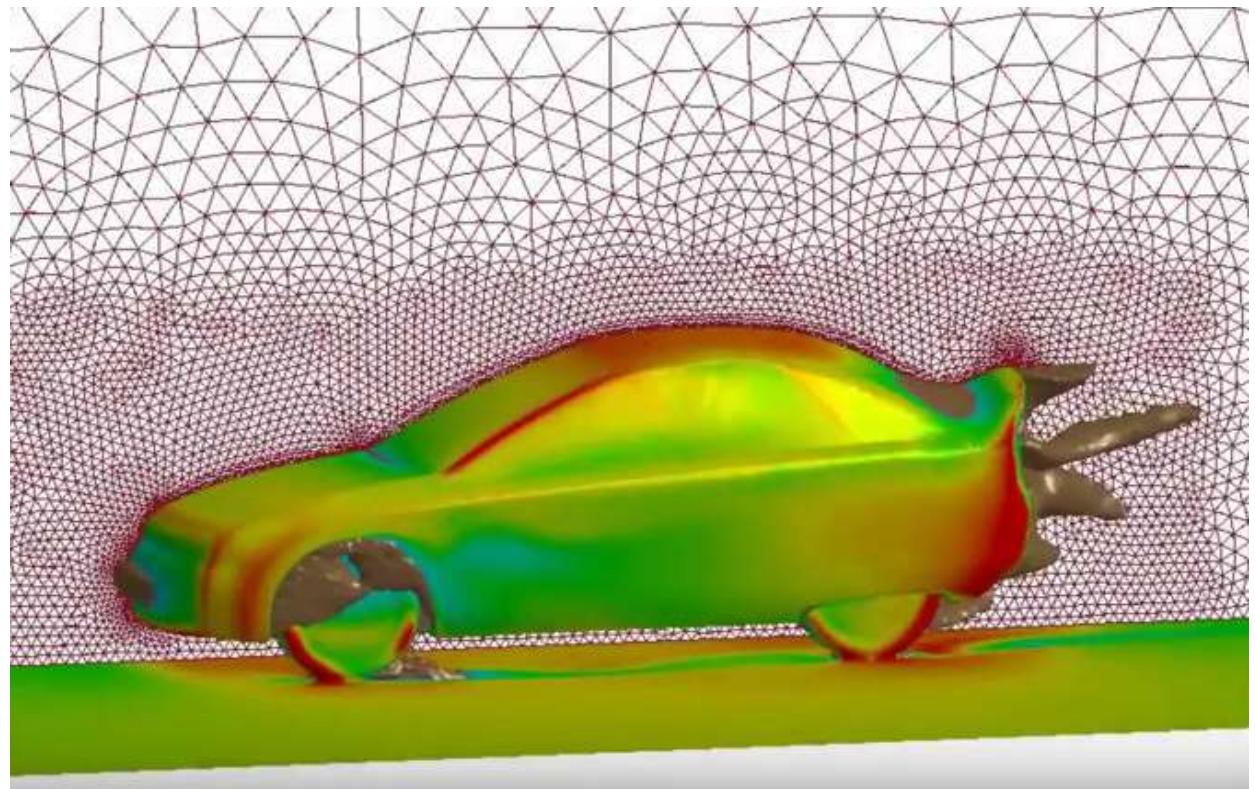
Shape optimization for CFD analysis using LS-OPT, ANSA and LS-DYNA ICFD

Facundo Del Pin (LSTC)
Katharina Witowski (DYNAmore GmbH)

Stuttgart, 05.02.2018

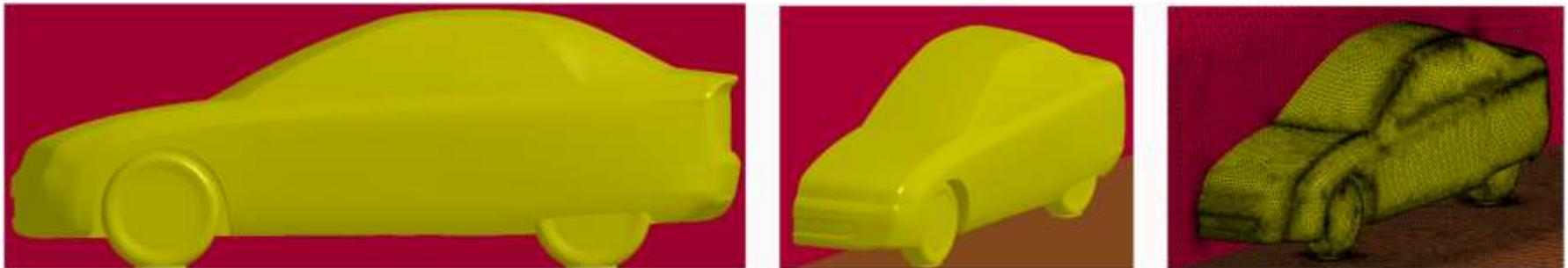
Overview

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



Problem description

- CFD model

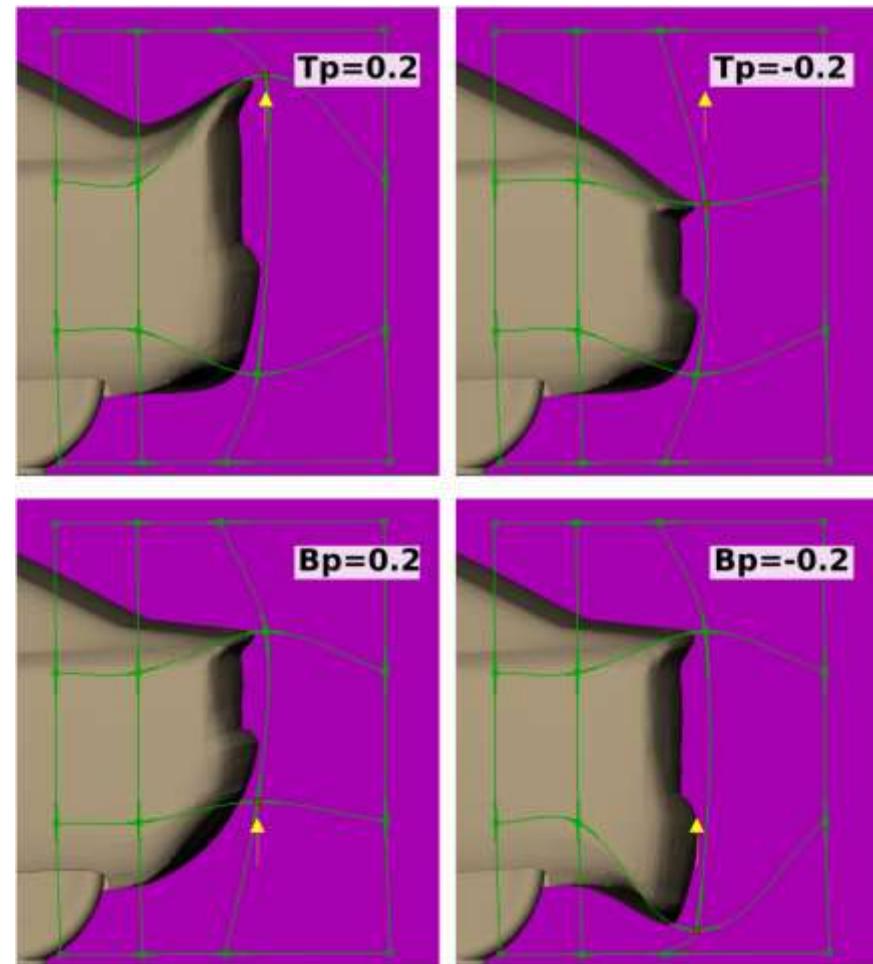
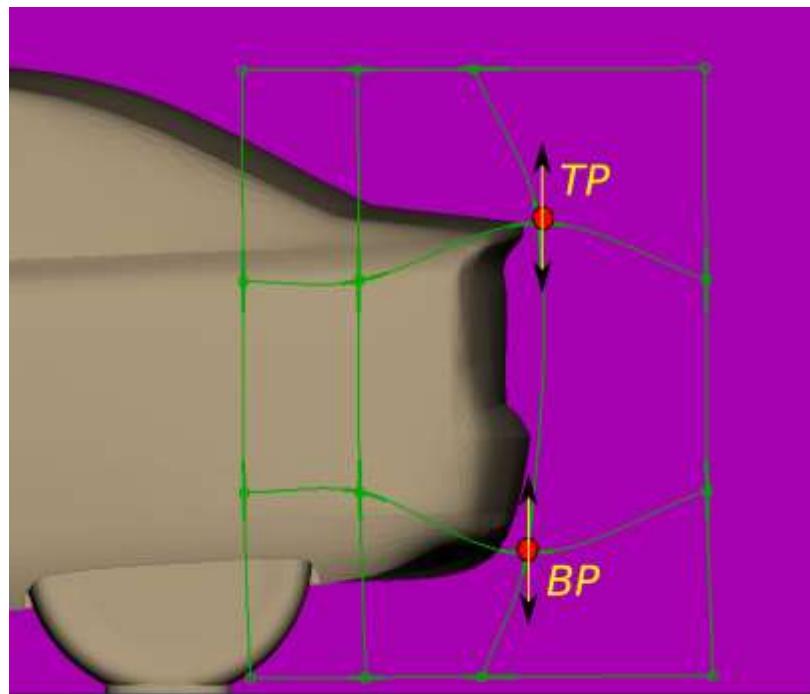


- External aerodynamics of a ground vehicle
- Reynolds Number $\sim 1.0 \times 10^7$
- RANS turbulence model using realizable K-e
- Objective: fuel efficiency
 - maximize down force and minimize drag force,
more relevance to drag
 - Optimization objective function
max(down force / drag force²)

Parameters

■ 2 Morphing Parameters

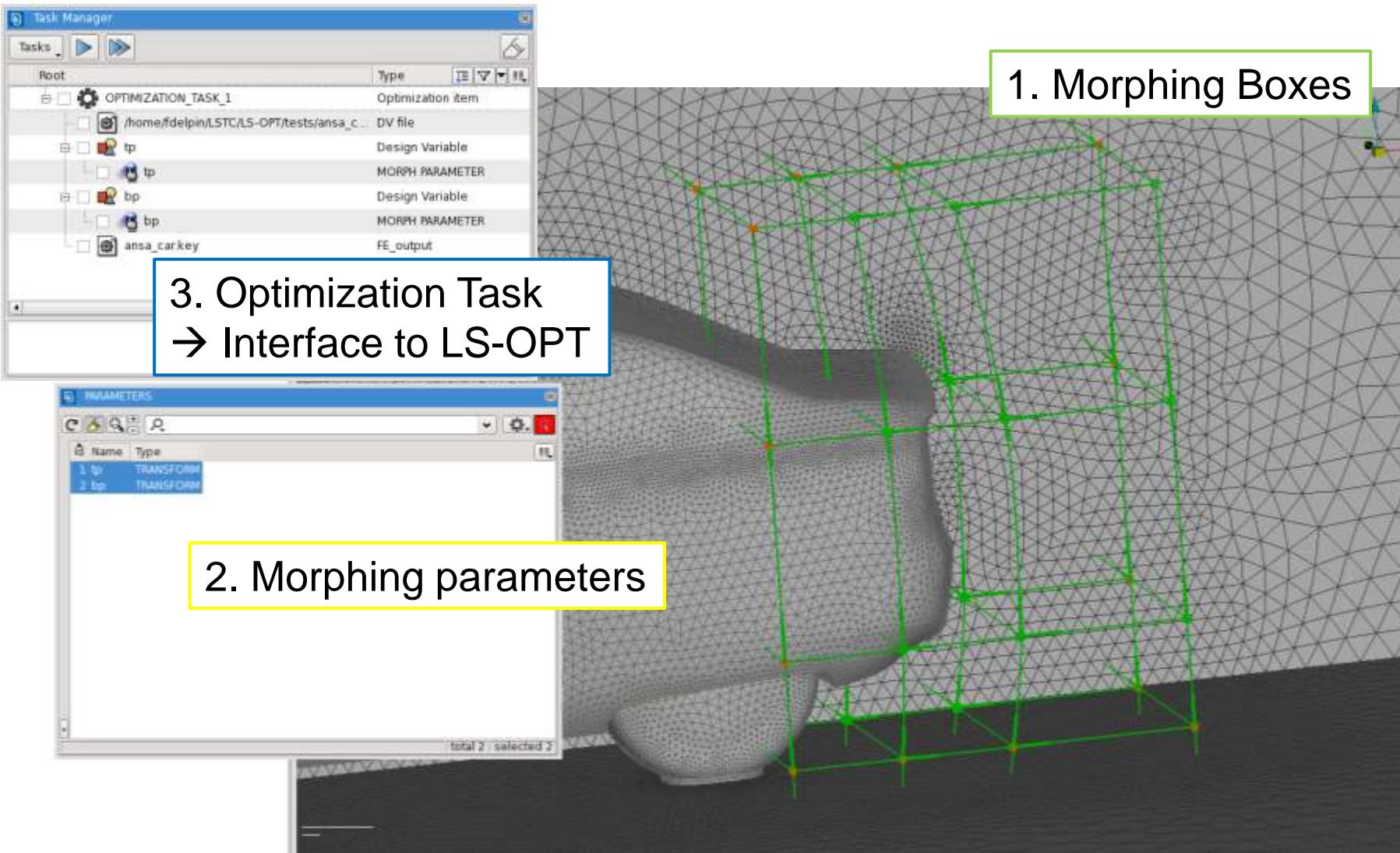
- TP: top point
- BP: bottom point



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

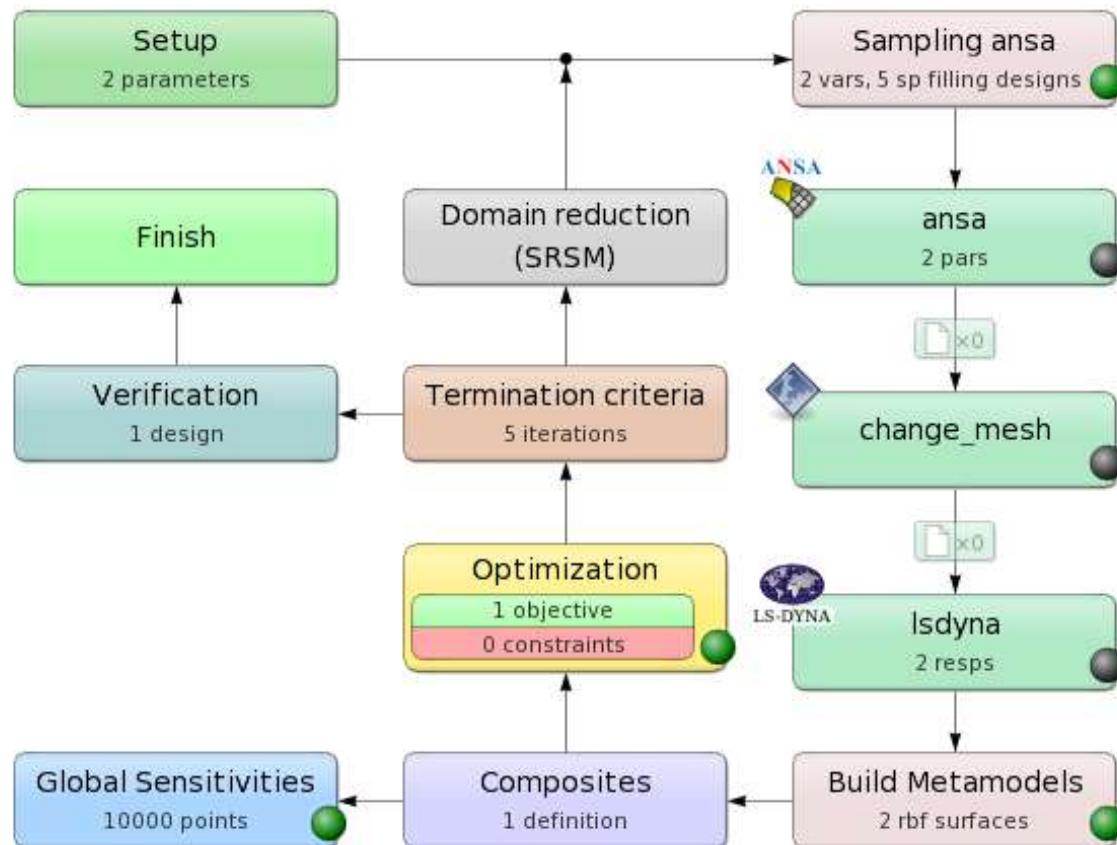
Setup in ANSA



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

Stage ansa

General

Package Name: ANSA

Command: /home/fdelpin/SOFT/BETA_CAE_Systems/ansa_v18.0.1/ansa64.sh -lm_retry 60

Do not add input file argument

DV File: ansa_car_DV.txt

copies ansa_car_DV.txt (0 includes) to ansa/it.run/ ANSAOpt.inp
and substitutes parameters

Extra input files

Model Database: \${LSPROJHOME}/ansa_car.ansa

Execution

Resources

Resource	Units per job	Global limit	Delete
ANSA	1	1	x

[Create new resource](#)

Use Queuing

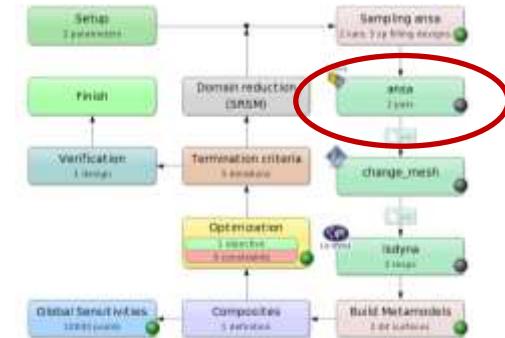
Use LSTCVM proxy

Environment Variables

Run Jobs in Directory of Stage

Isdyna

Generate output in Isdyna directories



Stage ansa

Parameters

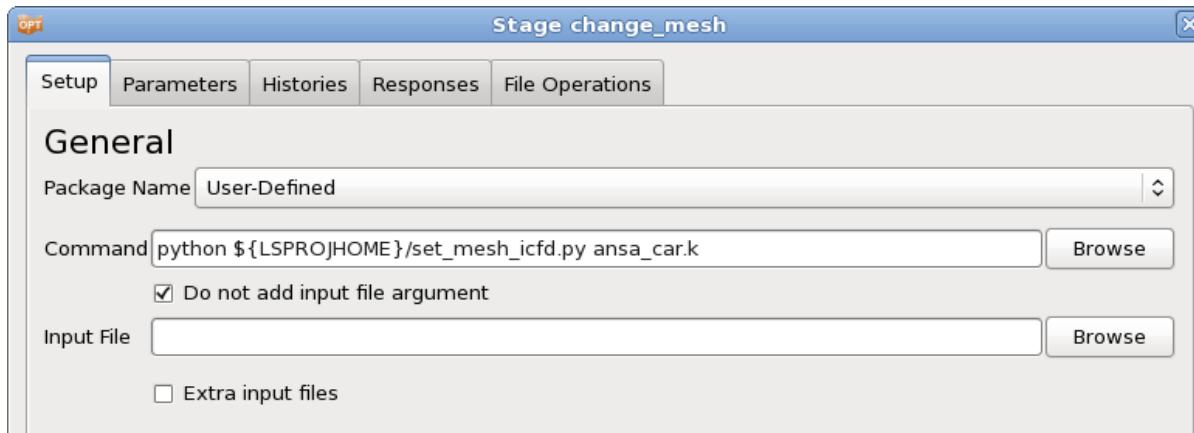
Name	Found in file(s)
tp	ansa_car_DV.txt
bp	ansa_car_DV.txt

Parameters read from ANSA DV file

Setup in LS-OPT

■ Stage python

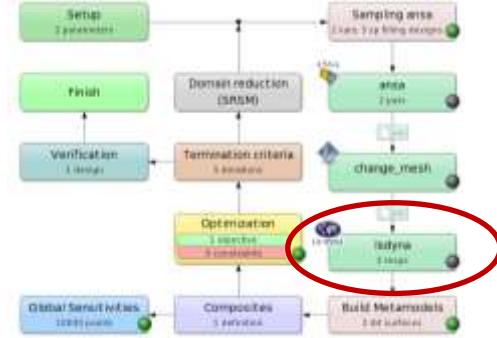
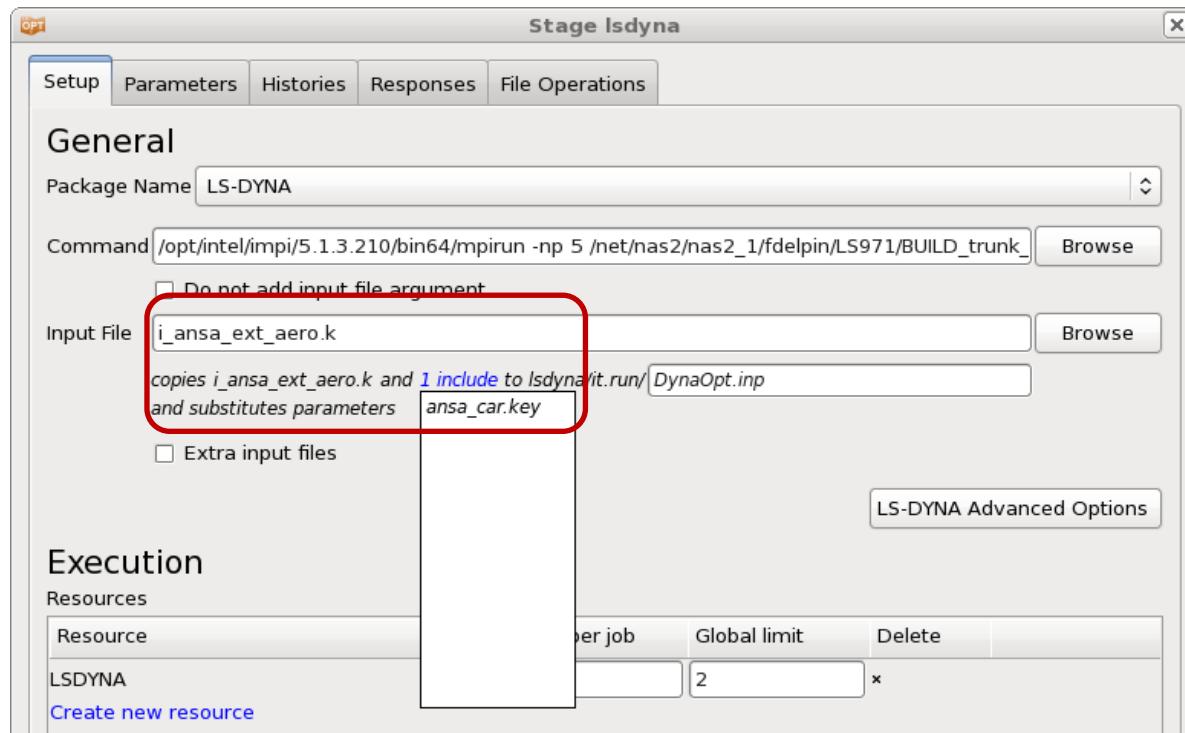
- ANSA generates structural LS-DYNA input file
- Python script converts to CFD input file
- *ELEMENT_SHELL → *MESH_SURFACE_ELEMENT
- *ELEMENT_BEAM → *MESH_SURFACE_ELEMENT
- *NODE → *MESH_SURFACE_NODE



Setup in LS-OPT

■ Stage LS-DYNA

- ANSA output (modified by Python script) is included in main LS-DYNA input file



Setup in LS-OPT

■ CFD responses extracted using GENEX

The screenshot shows the LS-OPT software interface with the title bar "Stage lsdyna". The top menu bar includes "OPT", "Stage lsdyna", "File", "Edit", "View", "Setup", "Parameters", "Histories", "Responses" (which is selected and highlighted in blue), and "File Operations".

The main window is divided into two main sections:

- Response definitions:** This section lists the responses defined in the project:
 - drag**: GENEX: drag extracted from icfdraga.dat
 - down_force**: GENEX: down_force extracted from icfdraga.dat
- Add new:** This section lists various response types, with "GENEX" highlighted and enclosed in a red rectangle:
 - Generic
 - USERDEFINED
 - FILE
 - GENEX** (highlighted and circled in red)
 - EXCEL
 - EXPRESSION
 - FUNCTION
 - INJURY
 - MATRIX_EXPRESSION
 - LS-DYNA**
 - ABSTAT
 - BNDOUT
 - D3PLOT
 - DBBEMAC
 - DBFSI

Setup in LS-OPT

■ GENEX: extract data from ASCII file

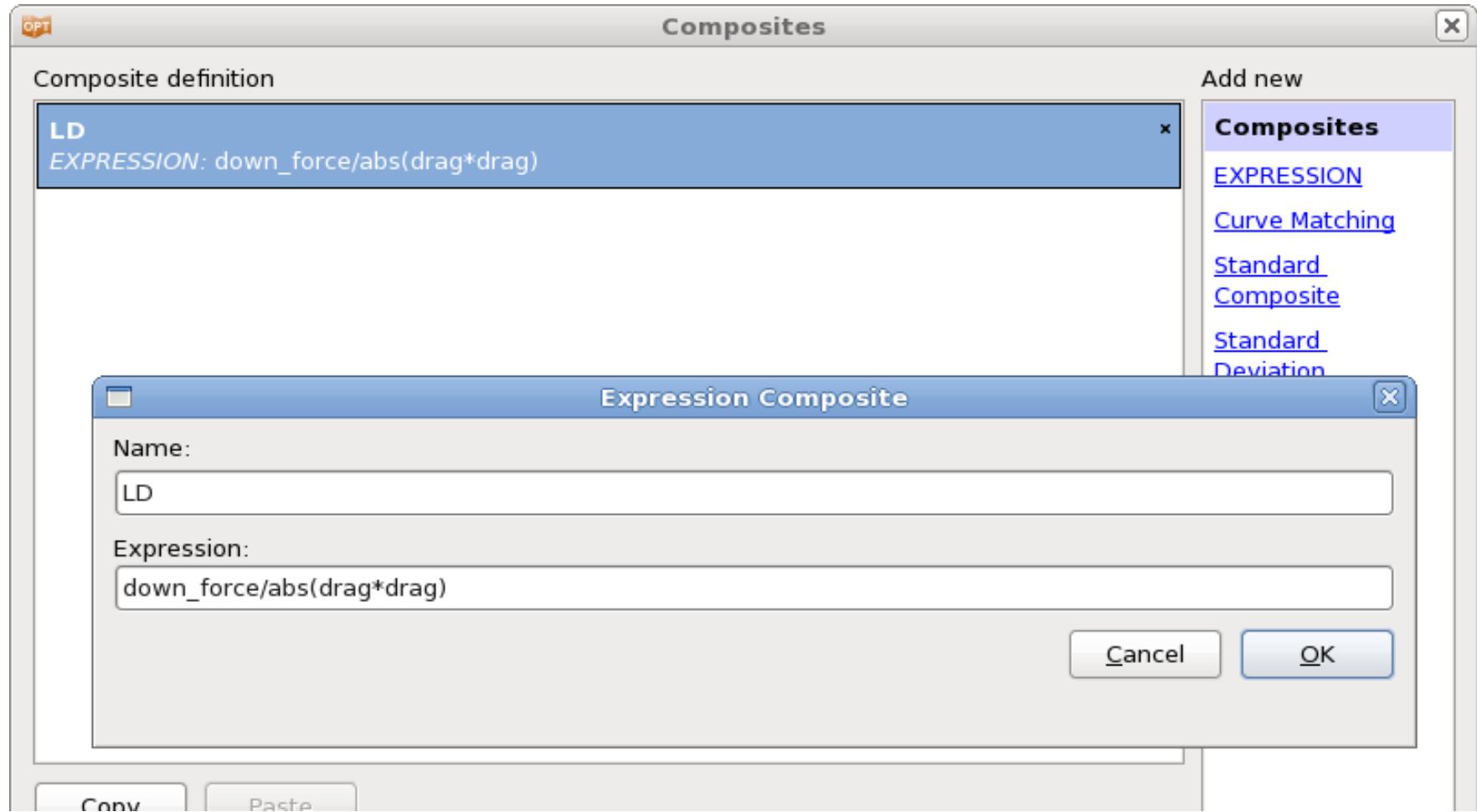
The screenshot shows the LS-OPT interface with the "Edit response" dialog open. The dialog is titled "Edit response" and contains fields for "Name" (drag), "Subcase" (n/a), "Multiplier" (n/a), and "Offset" (n/a). There are checkboxes for "Not metamodel-linked" and "Dump formula file". Below these are input fields for "Input GenEx file" (drag.g6) and "Input data file" (icfdraga.dat). The "Entities" list is populated with "drag". A "Reread entities" button is available. At the bottom are "Cancel" and "OK" buttons.

The main window displays a table of data extracted from the file icfdraga.dat. The table has columns for various indices and values. A red box highlights the value "3.79097E-01" at index 3, which is labeled "value to be extracted". The right side of the window contains configuration settings for Entity name (drag), Origin (End of File), Type of entity (Scalar), Number format (Decimal separator: ., Exponent character: E), Thousands separators (None), Relative location (-1 lines), Column separators (Tab, Space, Whitespace), Maximum length (100 characters), and Anchor to repeat.

	9.954600E+01	-5.809115E-01	-3.295651E-03	0.000000E+00	-1.854156E-01	-1.216126E-01
0.952600E+01	-5.807932E-01	-1.002760E-03	0.000000E+00	-1.853072E-01	-1.189255E-01	
0.955600E+01	-5.806774E-01	1.000250E-03	0.000000E+00	-1.853790E-01	-1.186352E-01	
0.957600E+01	-5.805643E-01	3.291740E-03	0.000000E+00	-1.853607E-01	-1.186729E-01	
0.958600E+01	-5.804540E-01	5.484022E-03	0.000000E+00	-1.853427E-01	-1.189442E-01	
0.959600E+01	-5.803447E-01	7.676300E-03	0.000000E+00	-1.853248E-01	-1.189958E-01	
0.960600E+01	-5.802354E-01	9.868570E-03	0.000000E+00	-1.853067E-01	-1.059487E-01	
0.961600E+01	-5.801261E-01	1.205130E-02	0.000000E+00	-1.852885E-01	-1.026498E-01	
0.962600E+01	-5.800168E-01	1.423400E-02	0.000000E+00	-1.852721E-01	-1.000254E-01	
0.963600E+01	-5.799075E-01	1.641670E-02	0.000000E+00	-1.852548E-01	-9.737166E-02	
0.964600E+01	-5.797982E-01	1.859940E-02	0.000000E+00	-1.852377E-01	-9.459955E-02	
0.965600E+01	-5.796889E-01	2.078210E-02	0.000000E+00	-1.852206E-01	-9.182256E-02	
0.966600E+01	-5.795796E-01	2.296480E-02	0.000000E+00	-1.852034E-01	-8.902799E-02	
0.967600E+01	-5.794703E-01	2.514750E-02	0.000000E+00	-1.851876E-01	-8.622039E-02	
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0.978600E+01	-5.782680E-01	4.915720E-02	0.000000E+00	-1.850197E-01	-5.457150E-02	
0.979600E+01	-5.781587E-01	5.134000E-02	0.000000E+00	-1.850034E-01	-5.103574E-02	
0.980600E+01	-5.780494E-01	5.352270E-02	0.000000E+00	-1.849871E-01	-4.868737E-02	
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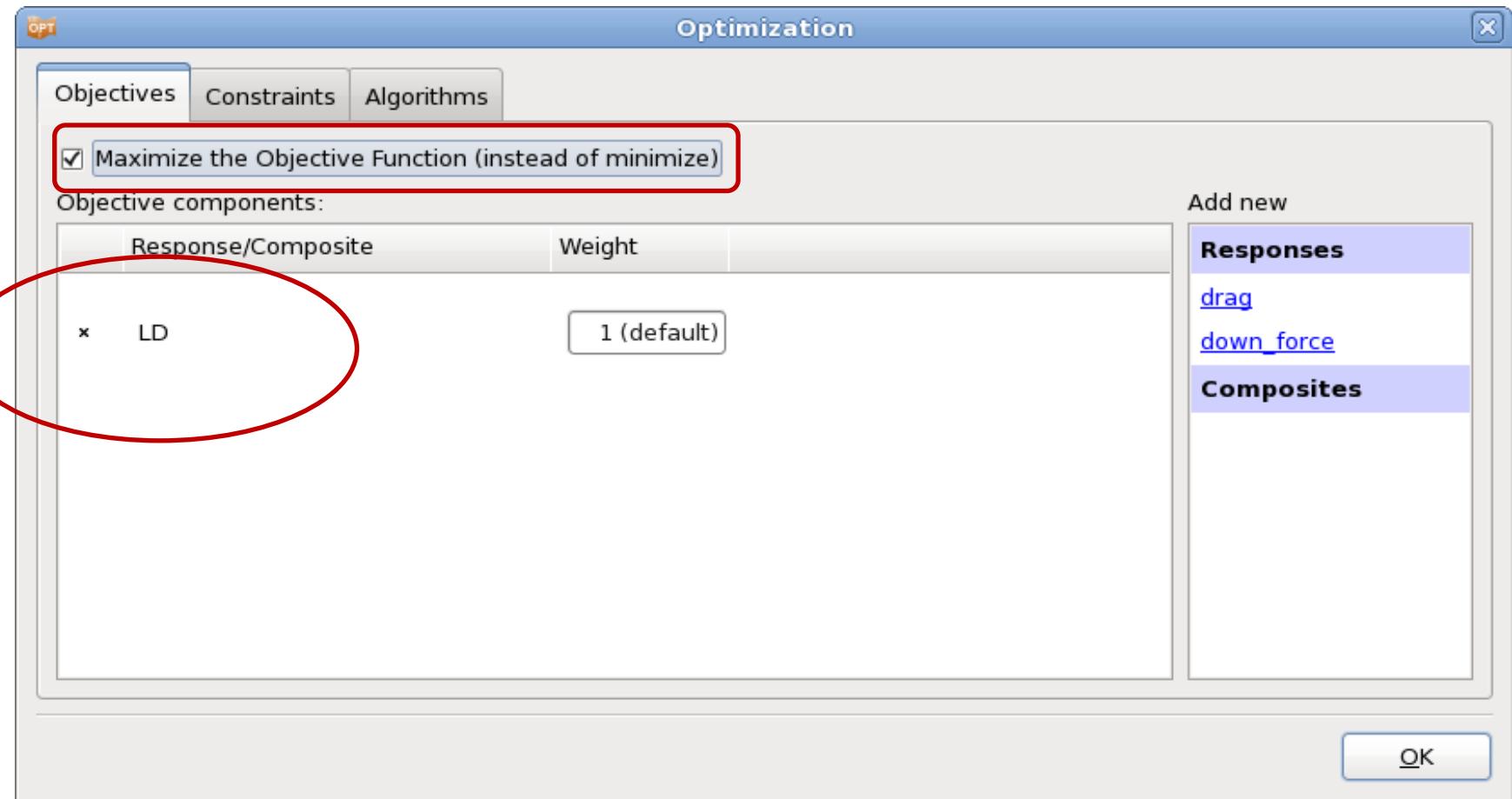
Setup in LS-OPT

■ Composite Expression



Setup in LS-OPT

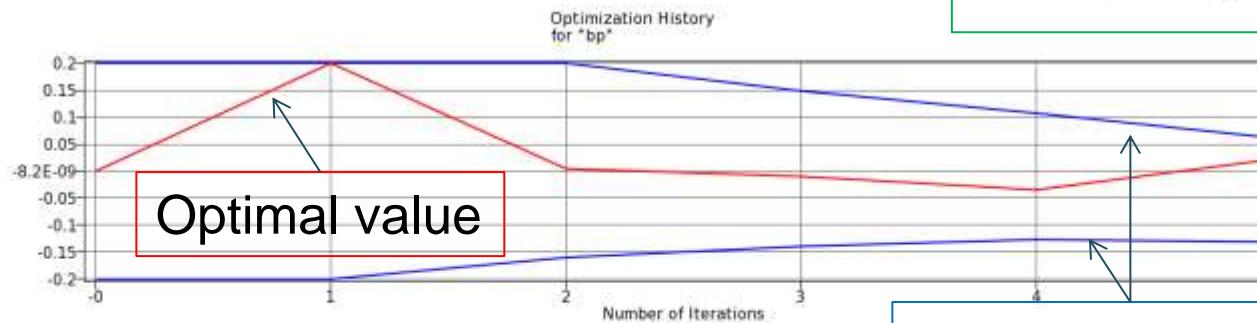
■ Objective function



Results

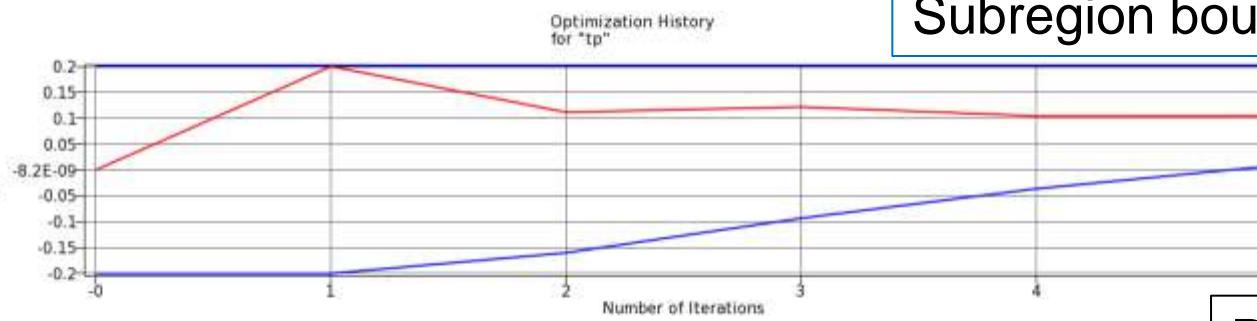
Convergence: Optimization History

bp

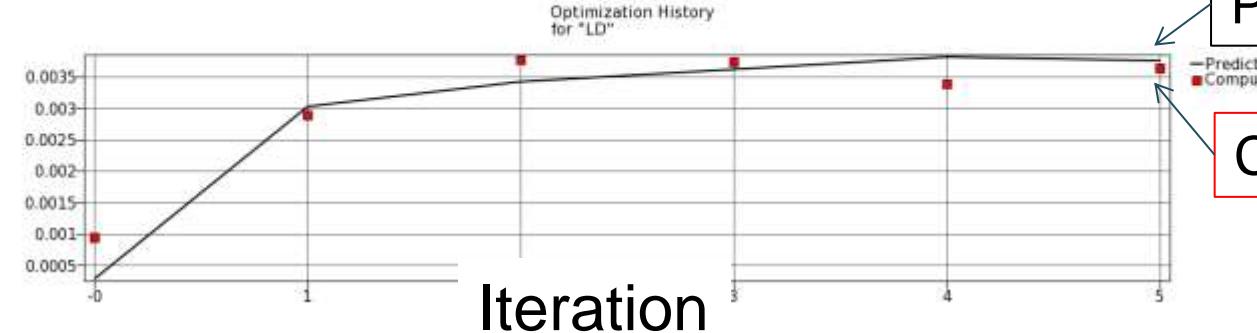


converged?
GSA → bp not significant

tp

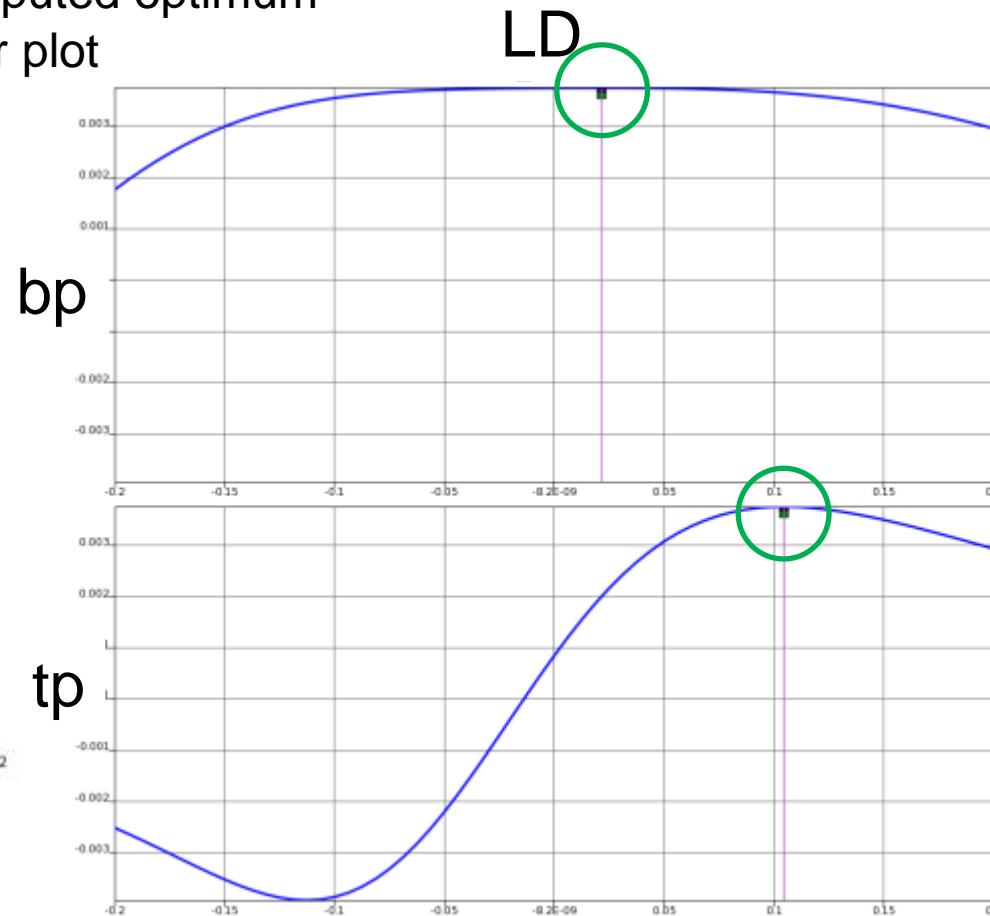
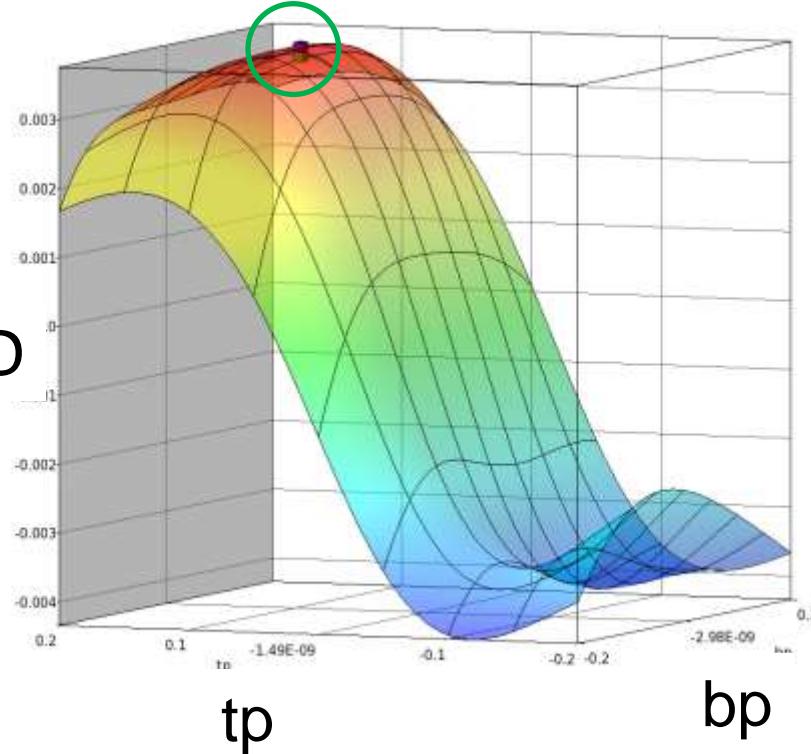


LD



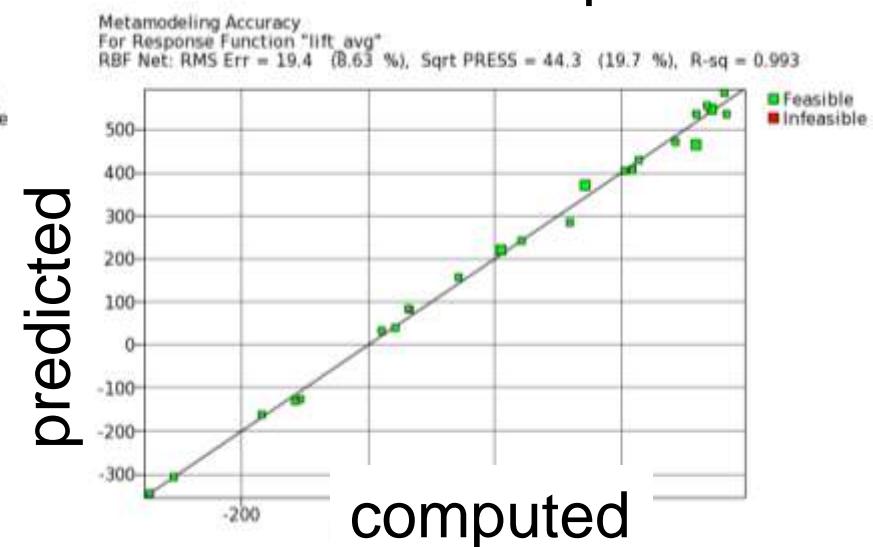
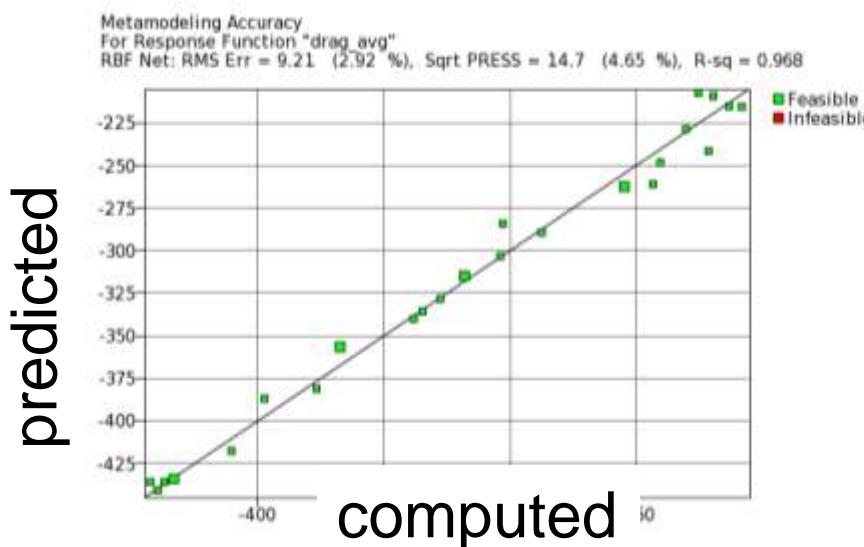
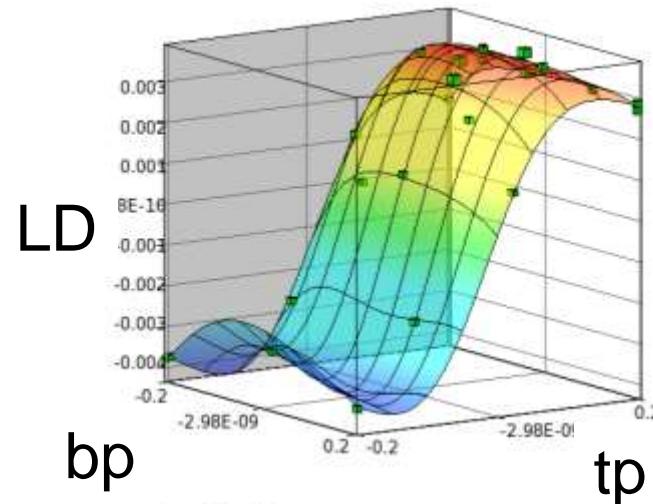
Results

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



Results

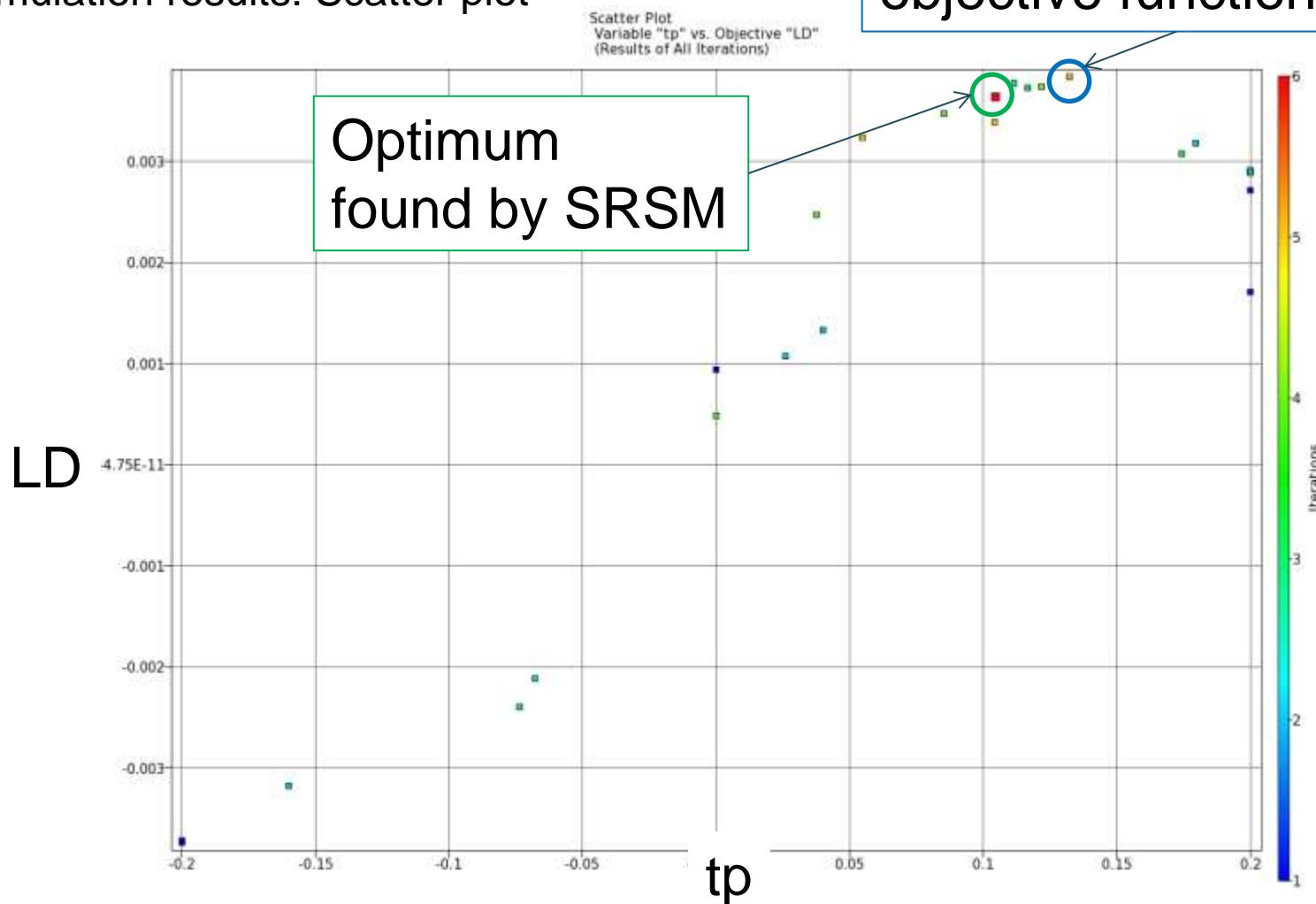
- Metamodel accuracy
 - Surface plot with points
 - Points are close to surface
 - Error measures (only for responses)
 - RMS error
 - SPRESS → predictive capability!



Results

■ Simulation results: Scatter plot

Point with highest objective function value



Results

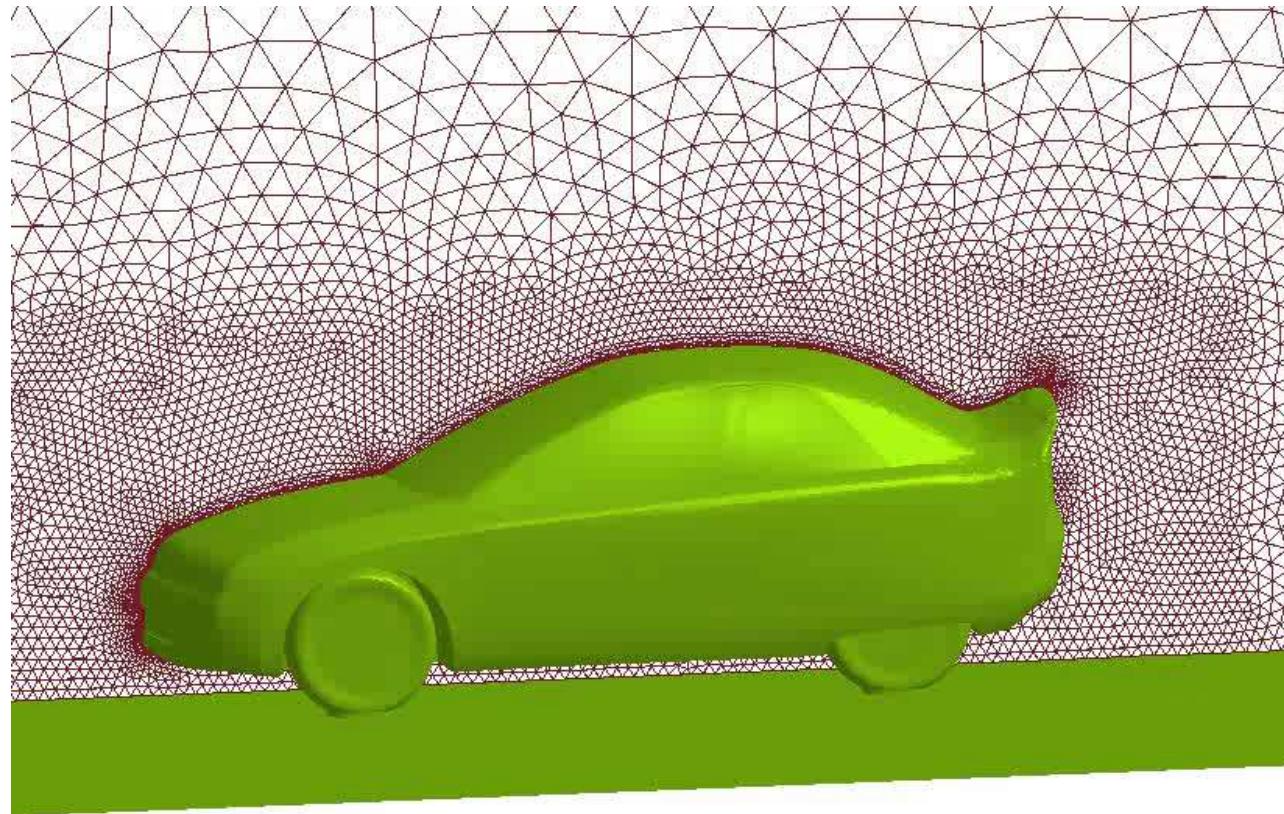
■ Optimal design

	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

■ Livermore Software Technology Corp. (LSTC)

www.lstc.com

■ LS-DYNA

■ Support / Tutorials / Examples / FAQ

www.dynasupport.com

■ More Examples

www.dynaexamples.com

■ Conference Papers

www.dynalook.com

■ European Master Distributor

www.dynamore.de

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