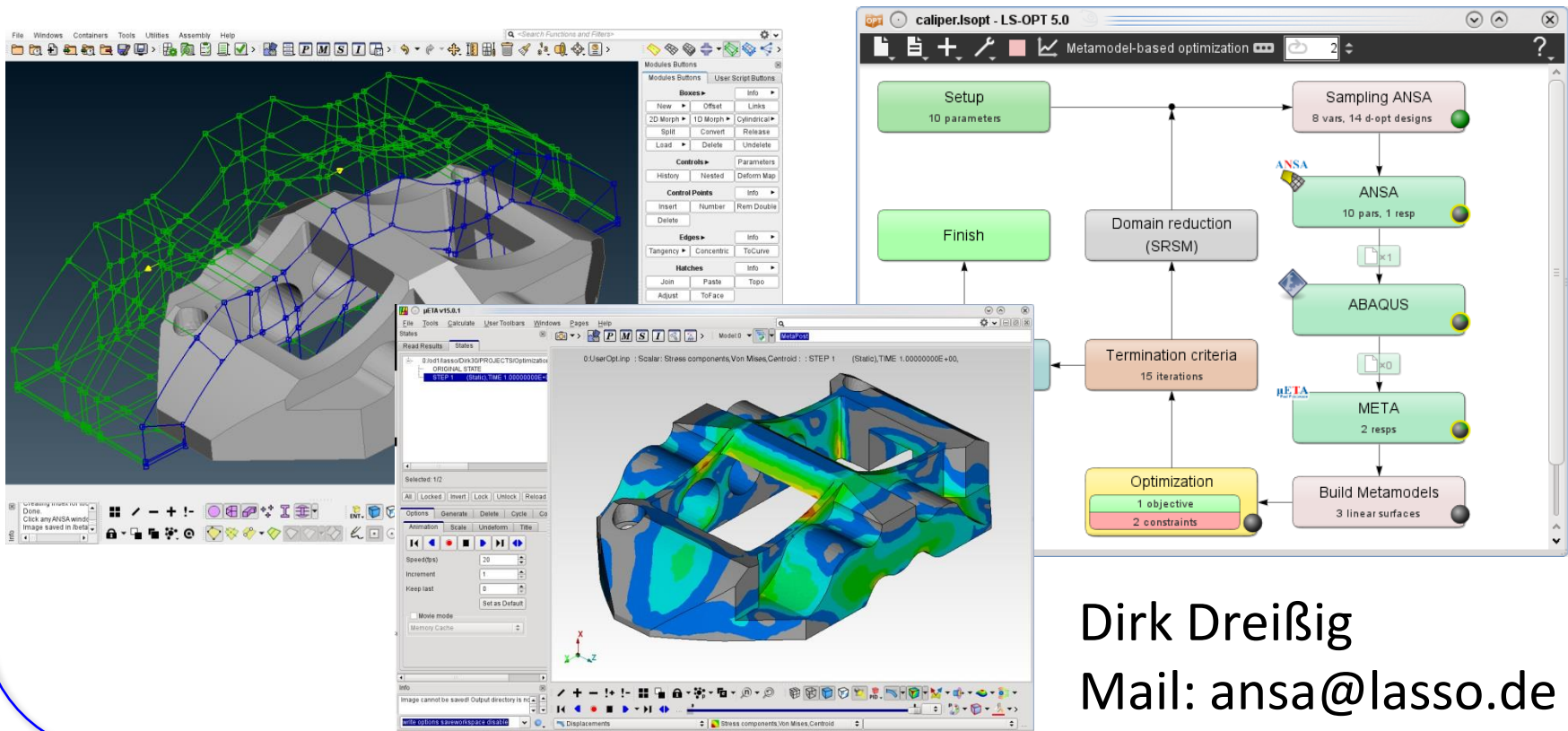


Coupling ANSA and META to LS-OPT



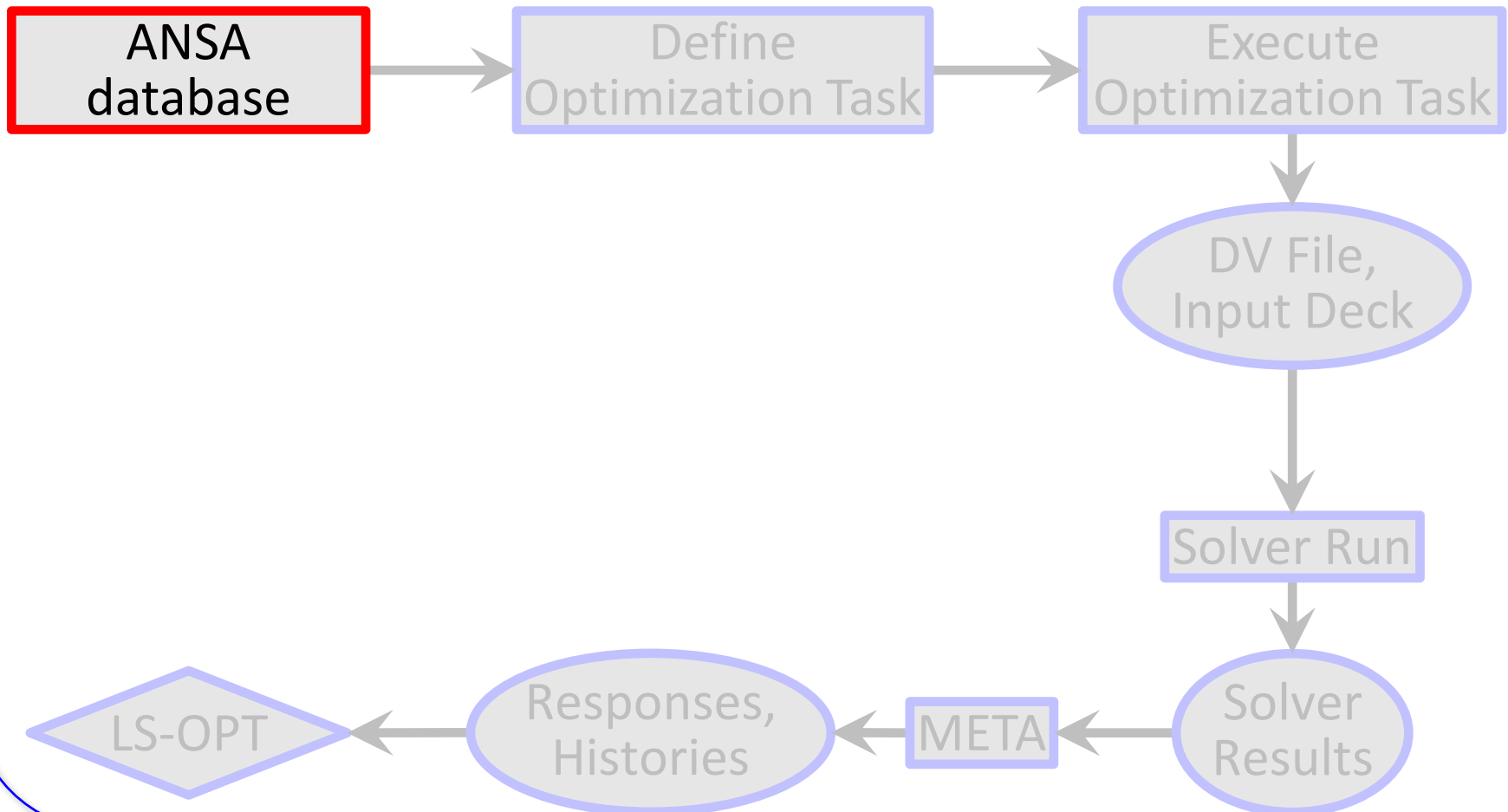
Dirk Dreißig
 Mail: ansa@lasso.de

For what **ANSA & META**?

- **ANSA** for model/shape change according to design variables (parameters in text files can be handled directly from LS-OPT)
- **META** for results extraction of arbitrary solvers (LS-DYNA results or text files can be handled directly)
- **Setup phase**
 - design variables defined in **ANSA** → transfer to **LS-OPT**
 - histories and responses defined in **META** → transfer to **LS-OPT**
- **Optimization (Run) phase**
 - design variables controlled by **LS-OPT** → transfer to **ANSA**
 - histories and responses calculated by **META** → transfer to **LS-OPT**

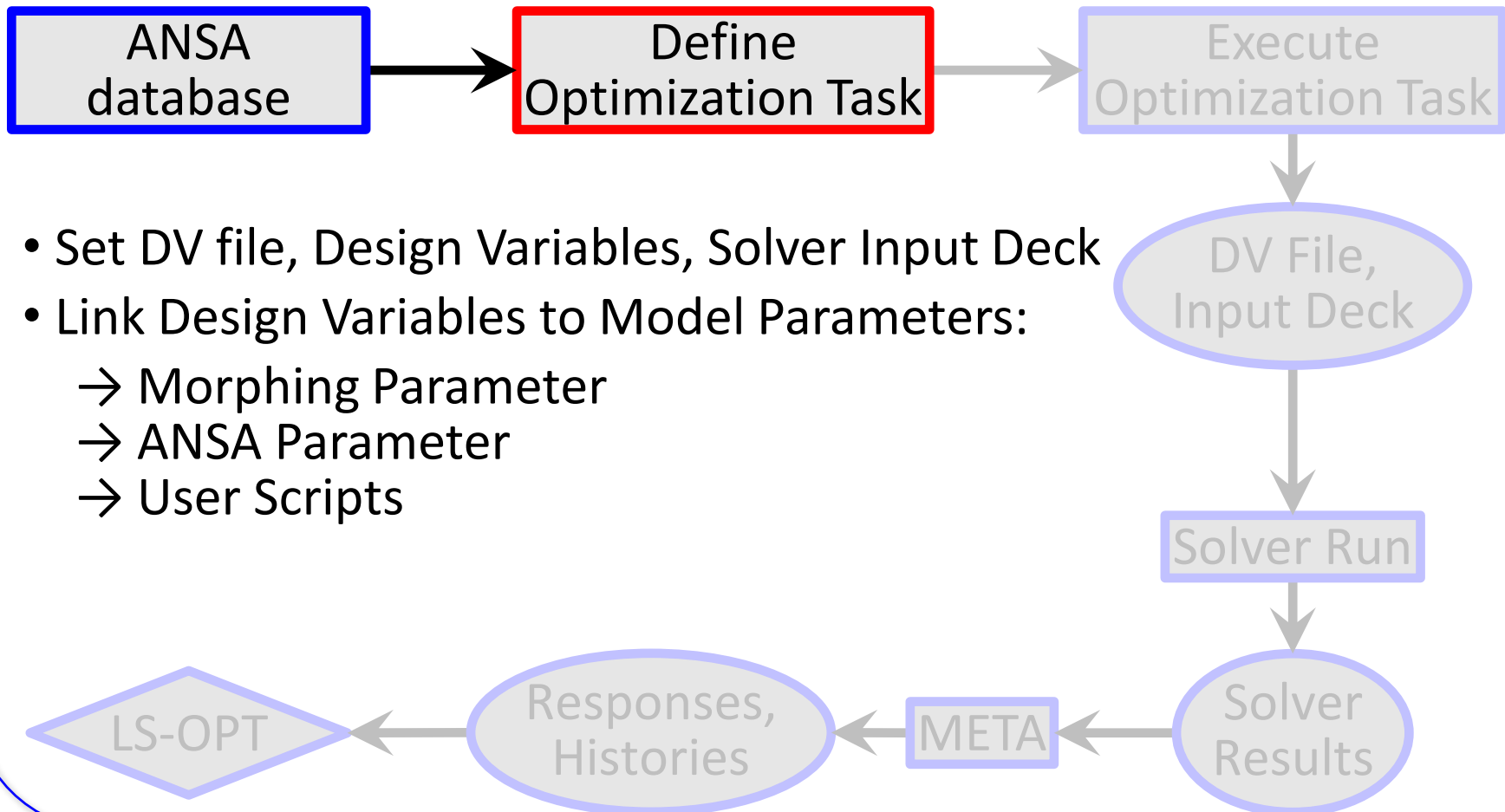
Optimization Setup

ANSA → Solver → META → LS-OPT



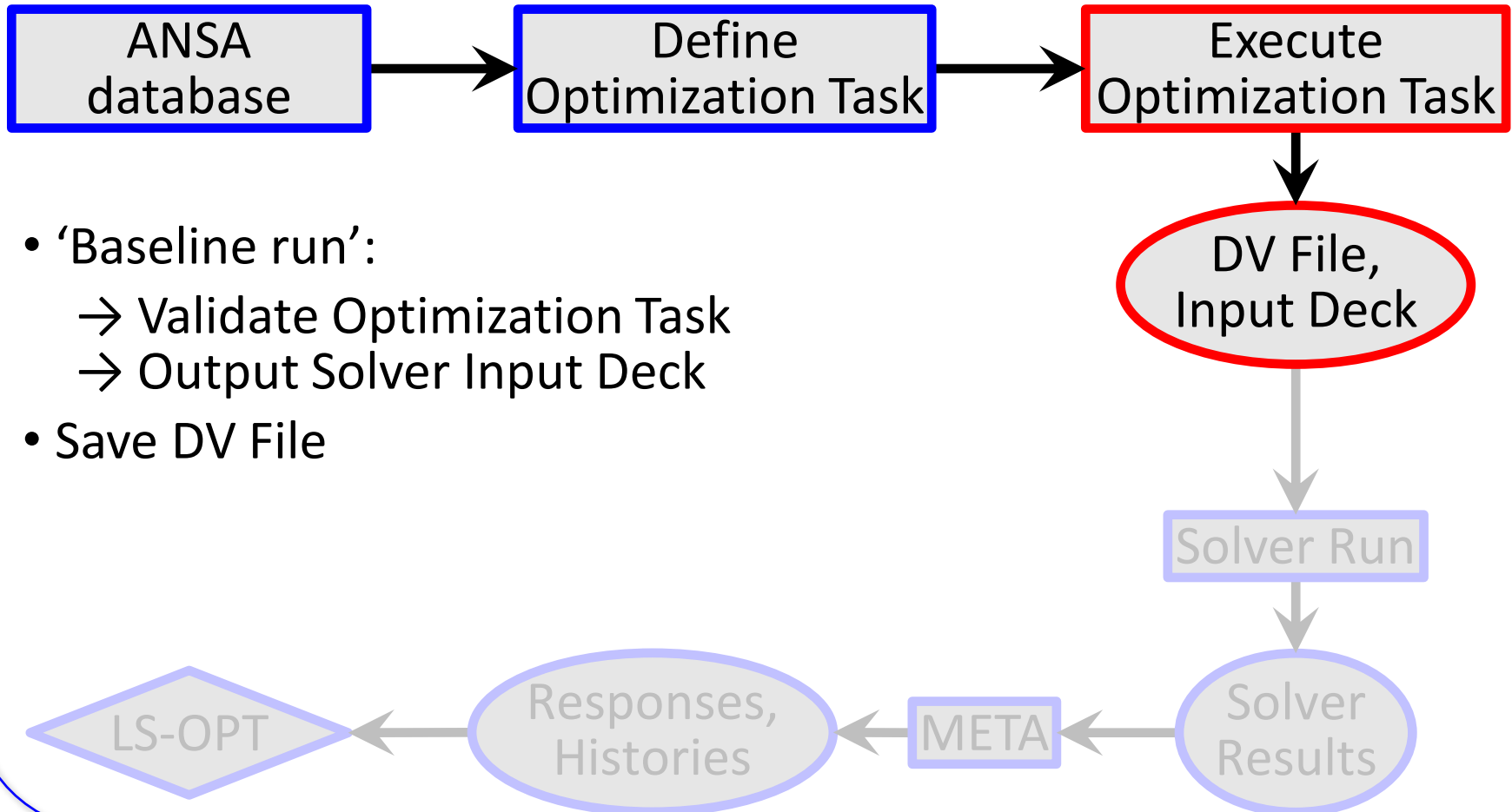
Optimization Setup

ANSA → Solver → META → LS-OPT



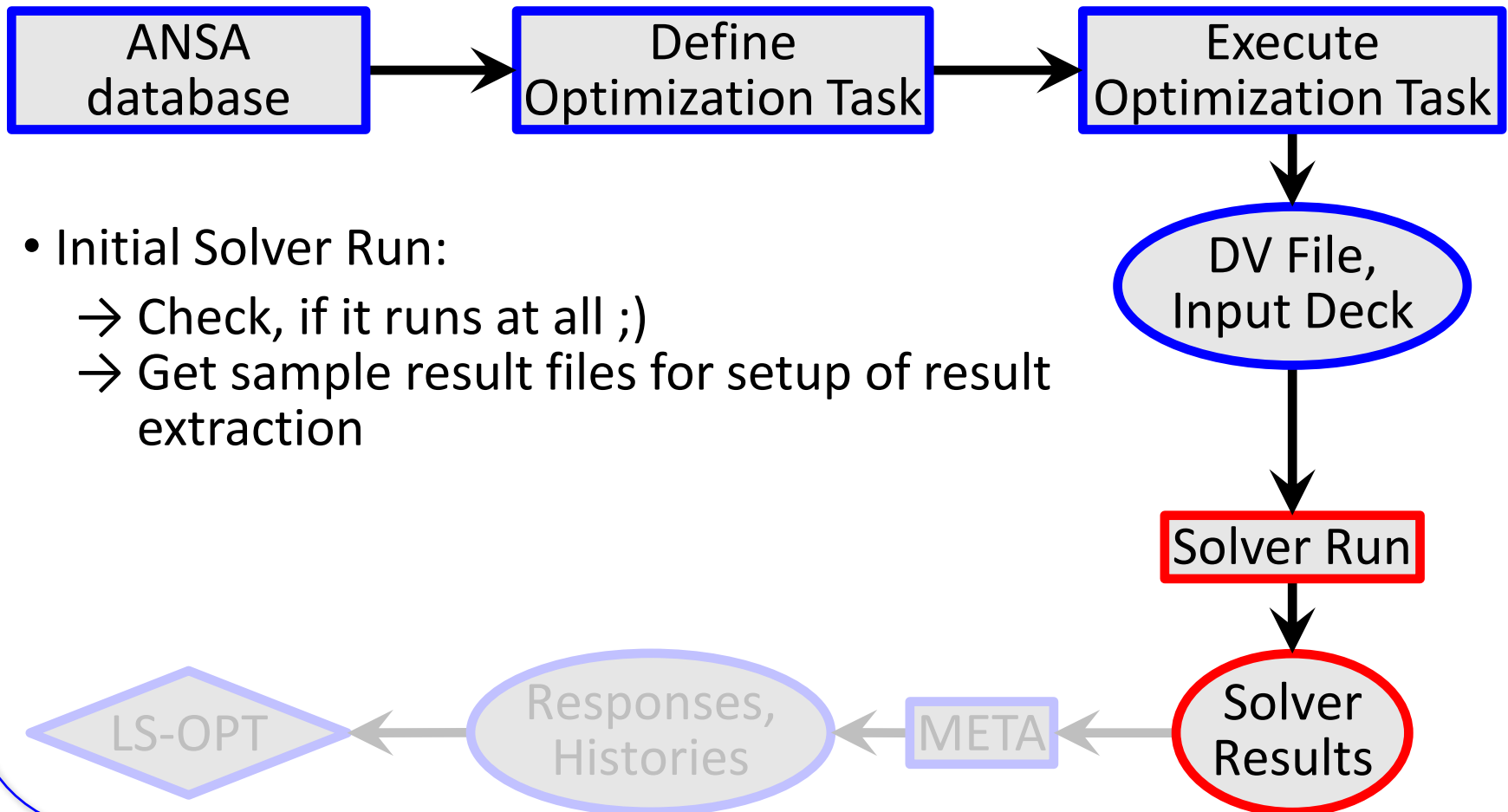
Optimization Setup

ANSA → Solver → META → LS-OPT



Optimization Setup

ANSA → **Solver** → META → LS-OPT

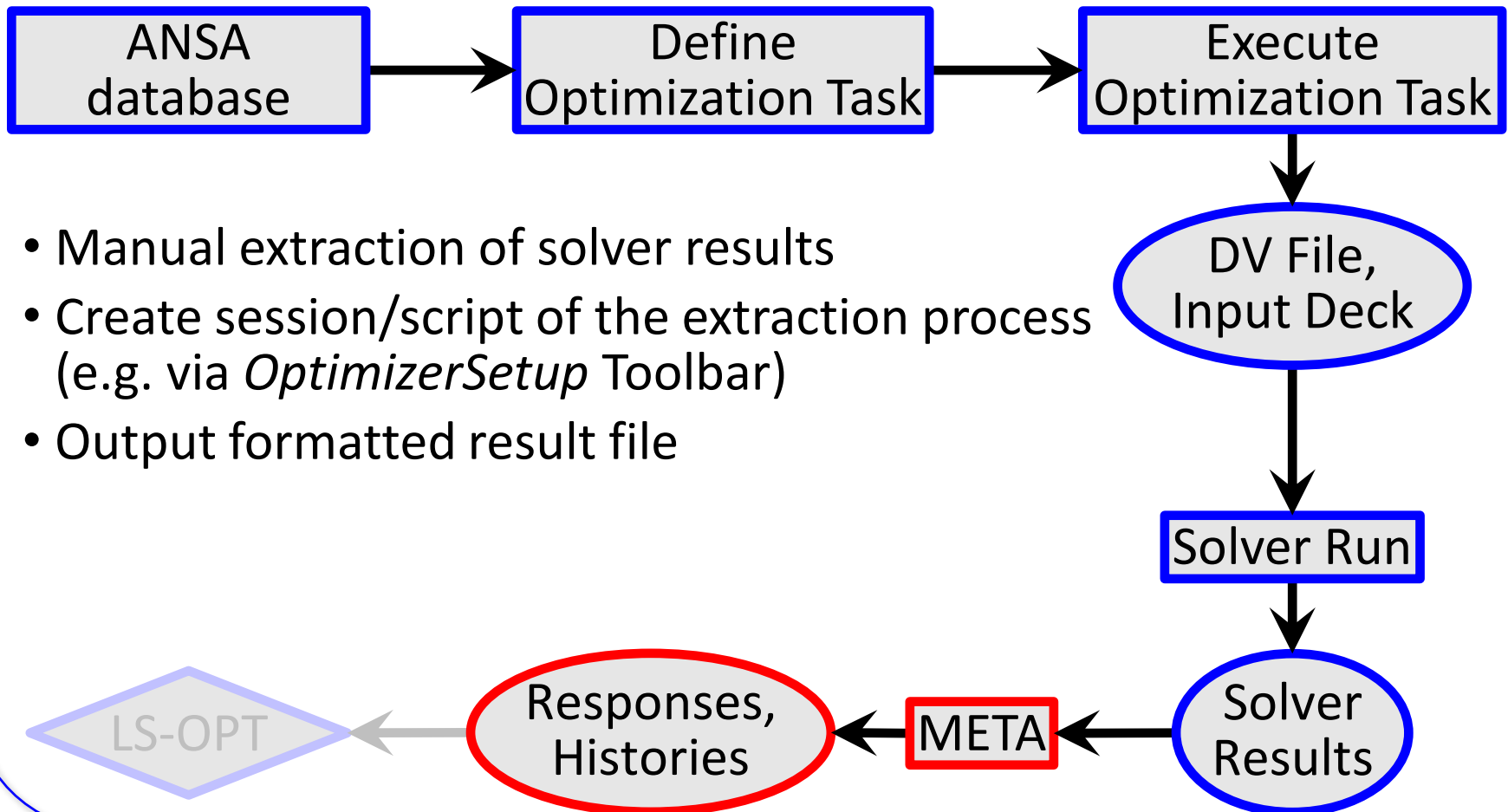


- Initial Solver Run:

- Check, if it runs at all ;)
- Get sample result files for setup of result extraction

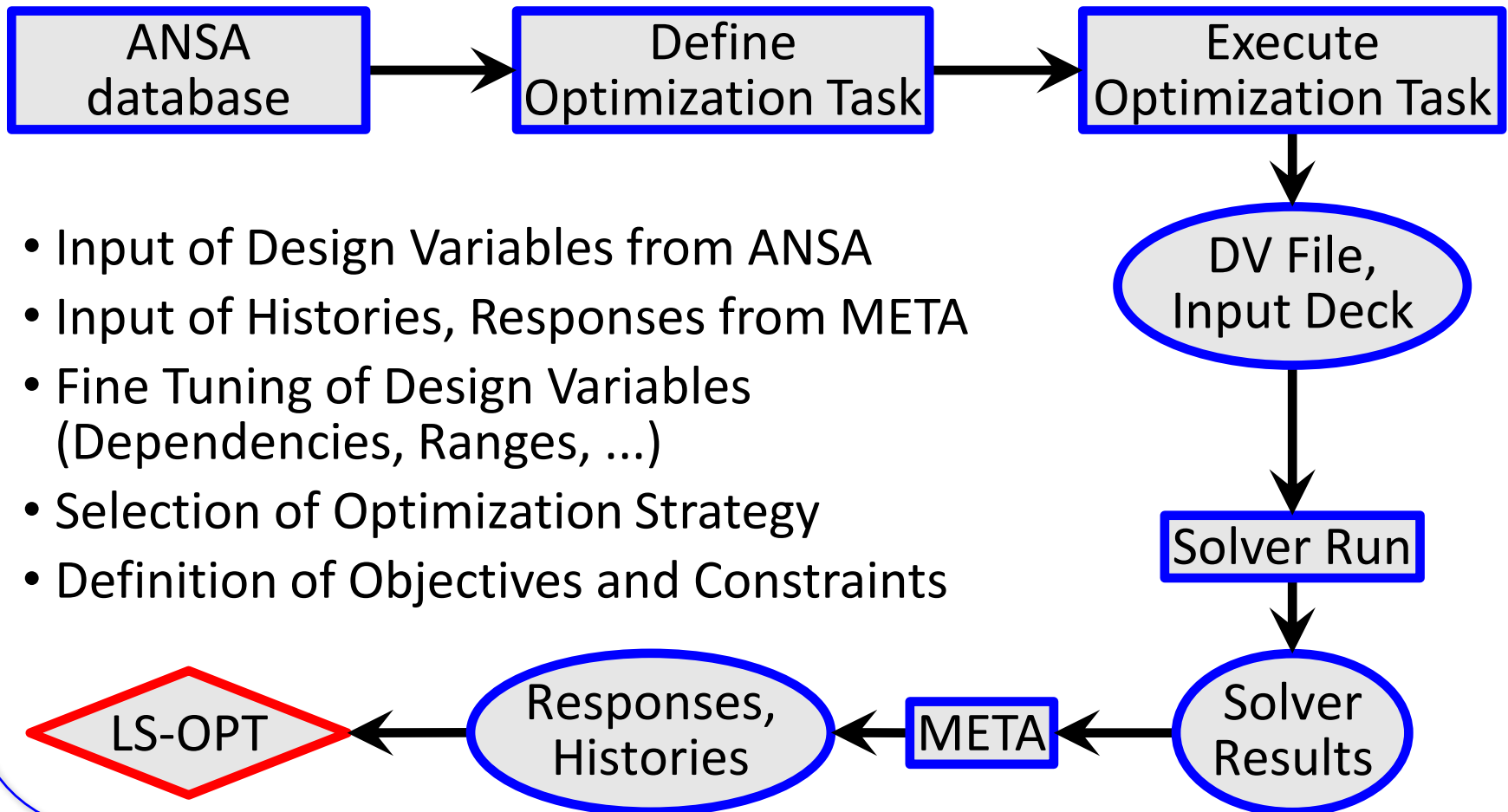
Optimization Setup

ANSA → Solver → **META** → LS-OPT



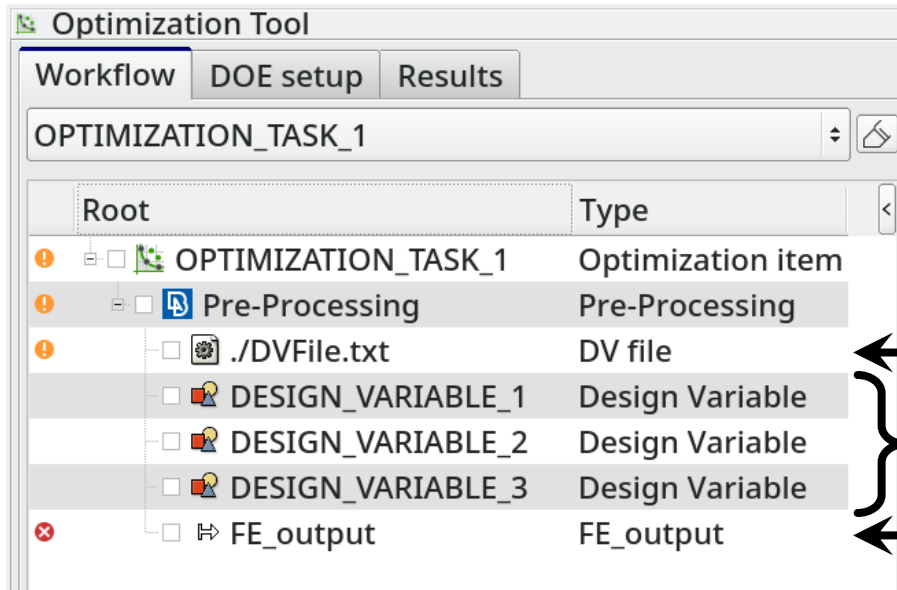
Optimization Setup

ANSA → Solver → META → **LS-OPT**



ANSA – Optimization Task

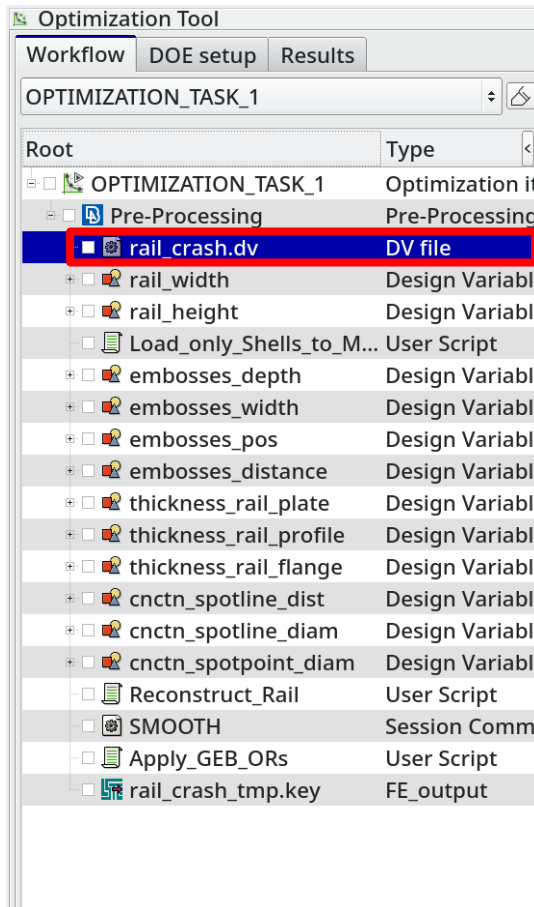
3 main task items



1. Design Variable File
2. Design Variables
3. Output Solver Deck

ANSA – Optimization Task

Design Variable File

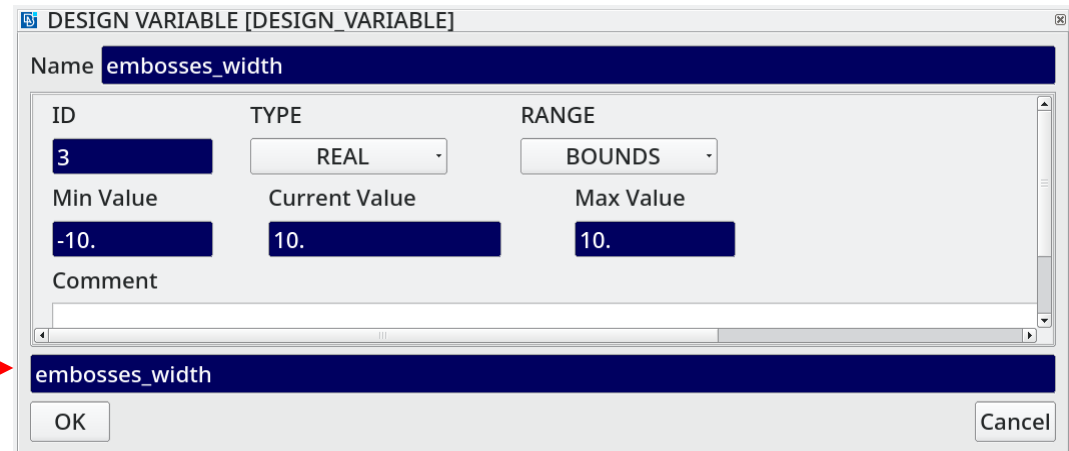
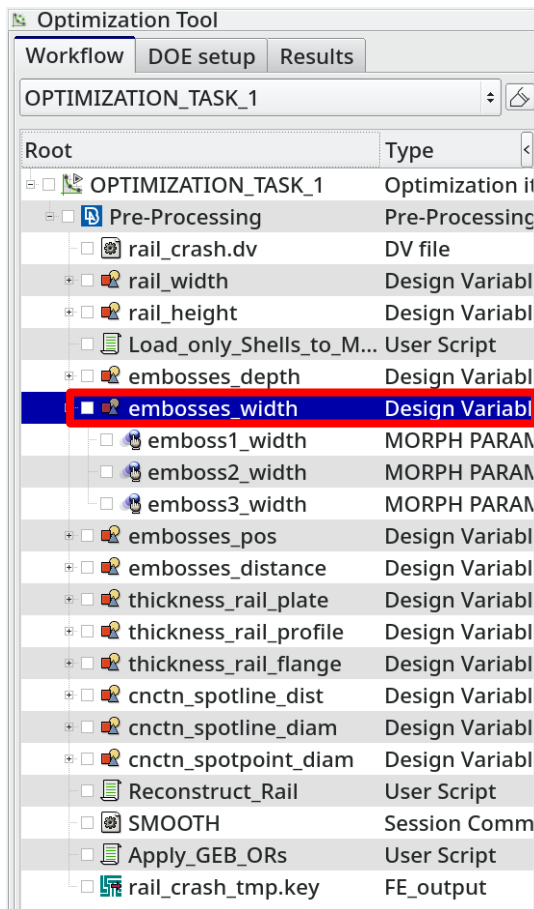


```
#
# ANSA_VERSION: 14.2.3
#
# file created by  A N S A  Mon Feb 17 17:13:25 2014
#
# Output from:
# /od1/lasso/Dirk30/PROJECTS/Optimierung_Rail_LS-OPT/Rail_MD0/rail_crash.ansa
#
# DESIGN VARIABLES
#-----
# ID | DESIGN VARIABLE NAME | TYPE | RANGE | CURRENT VALUE | MIN VALUE -->  MAX VALUE | STEP
#-----
10, rail_width, REAL,   BOUNDS,   10., -20., 20.
11, rail_height, REAL,   BOUNDS,   10., -20., 20.
1,  embosses_depth, REAL,   BOUNDS,    7.,  0.,  7.
3,  embosses_width, REAL,   BOUNDS,   10., -10., 10.
2,  embosses_pos, REAL,   BOUNDS,  -15., -50., 20.
7,  embosses_distance, REAL,   BOUNDS,  -15., -15., 50.
4,  thickness_rail_plate, REAL,   STEP,    1.5, 0.5, 2.,  0.1
5,  thickness_rail_profile, REAL,   STEP,    1.5, 0.5, 2.,  0.1
8,  thickness_rail_flange, REAL,   STEP,    1.5, 0.5, 3.,  0.1
6,  cncnt_spotline_dist, REAL,   BOUNDS,   50., 20., 100.
9,  cncnt_spotline_diam, REAL,   STEP,    5.,  2., 10.,  1.
12, cncnt_spotpoint_diam, REAL,   STEP,    5.,  2., 10.,  1.
#-----
```

Correctly formatted for
import in LS-OPT

ANSA – Optimization Task

Design Variables → Morphing Parameters



ANSA – Optimization Task

Design Variables → Morphing Parameters

Optimization Tool

Workflow DOE setup Results

OPTIMIZATION_TASK_1

Root	Type
OPTIMIZATION_TASK_1	Optimization it
Pre-Processing	Pre-Processing
rail_crash.dv	DV file
rail_width	Design Variabl
rail_height	Design Variabl
Load_only_Shells_to_M...	User Script
embosses_depth	Design Variabl
embosses_width	Design Variabl
emboss1_width	MORPH PARAM
emboss2_width	MORPH PARAM
emboss3_width	MORPH PARAM
embosses_pos	Design Variabl
embosses_distance	Design Variabl
thickness_rail_plate	Design Variabl
thickness_rail_profile	Design Variabl
thickness_rail_flange	Design Variabl
cnctn_spotline_dist	Design Variabl
cnctn_spotline_diam	Design Variabl
cnctn_spotpoint_diam	Design Variabl
Reconstruct_Rail	User Script
SMOOTH	Session Comm
Apply_GEB_ORs	User Script
rail_crash_tmp.key	FE_output

DESIGN VARIABLE [DESIGN_VARIABLE]

Name **embosses_width**

ID	TYPE	RANGE
3	REAL	BOUNDS
Min Value	Current Value	Max Value
-10.	10.	10.
Comment		

embosses_width

OK Cancel

Assign Parameter to DV

Parameters Select parameter to assign

Value	Id	Name	Used by DV
	10	emboss3_depth_ob	embosses_depth
	11	emboss3_depth unt	embosses depth
	13	emboss1_width	embosses_width
	14	emboss2_width	embosses_width
	15	emboss3_width	embosses_width
	16	embosses_pos	embosses_pos
	17	emboss12_distance	embosses_distance

ANSA – Optimization Task

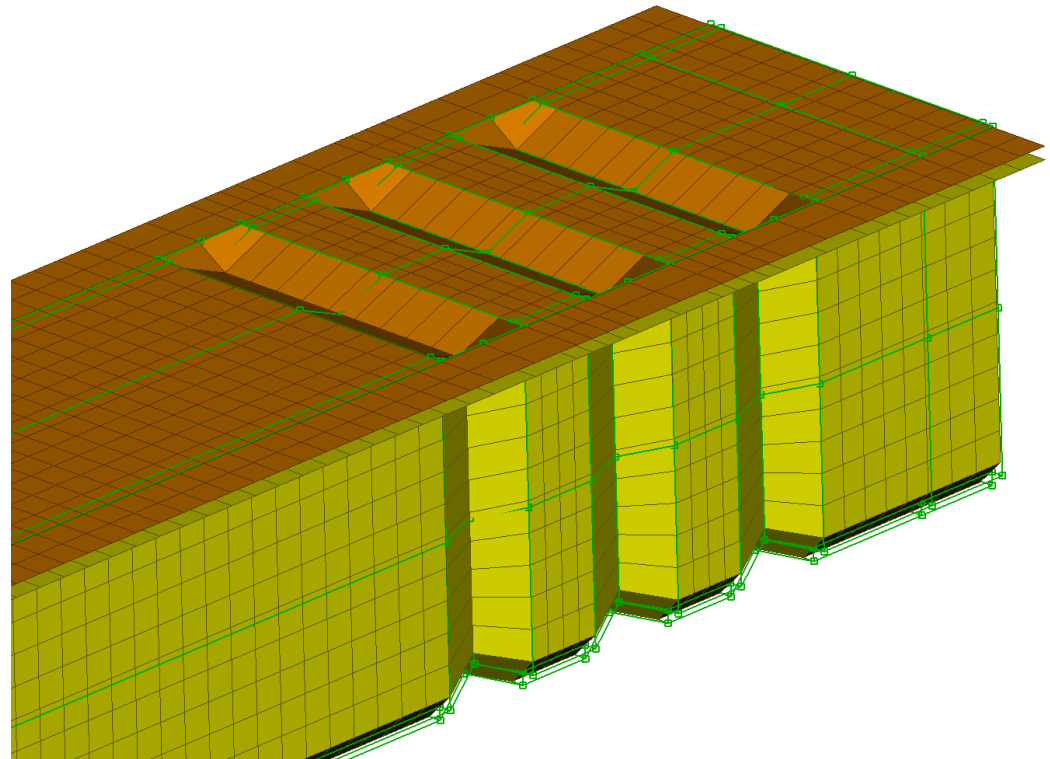
Design Variables \rightarrow Morphing Parameters

Shape modification

Design Variable = 10.0

Morphing Parameter

Width of depressions



ANSA – Optimization Task

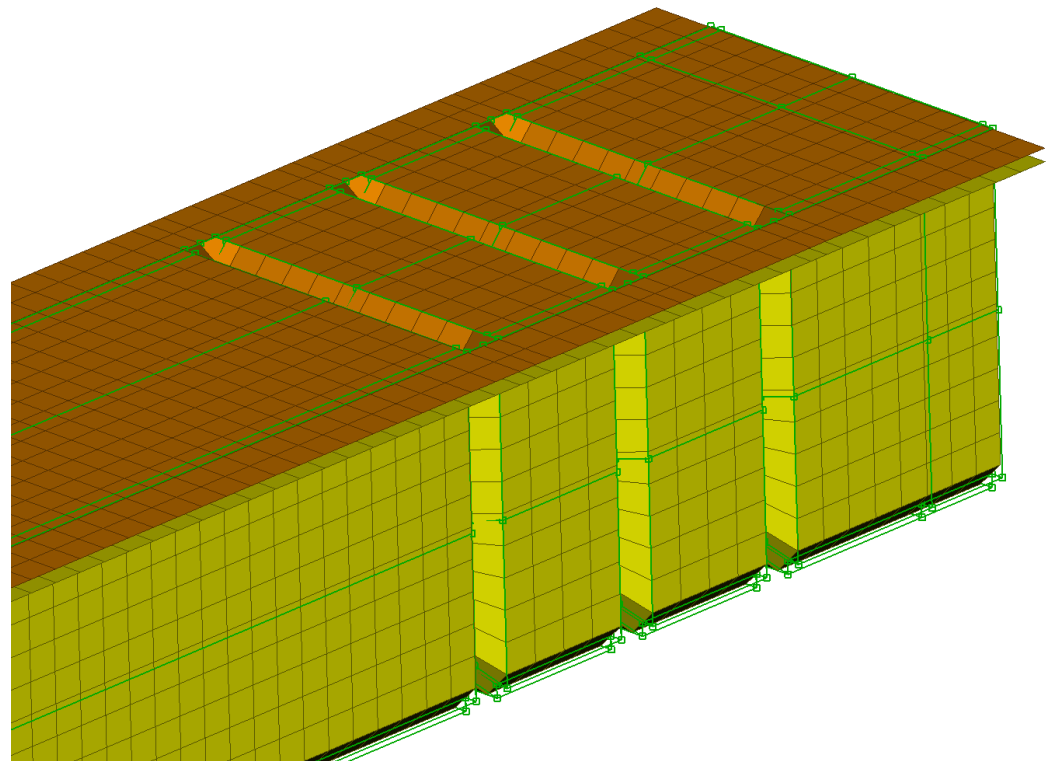
Design Variables \rightarrow Morphing Parameters

Shape modification

Design Variable = -5.0

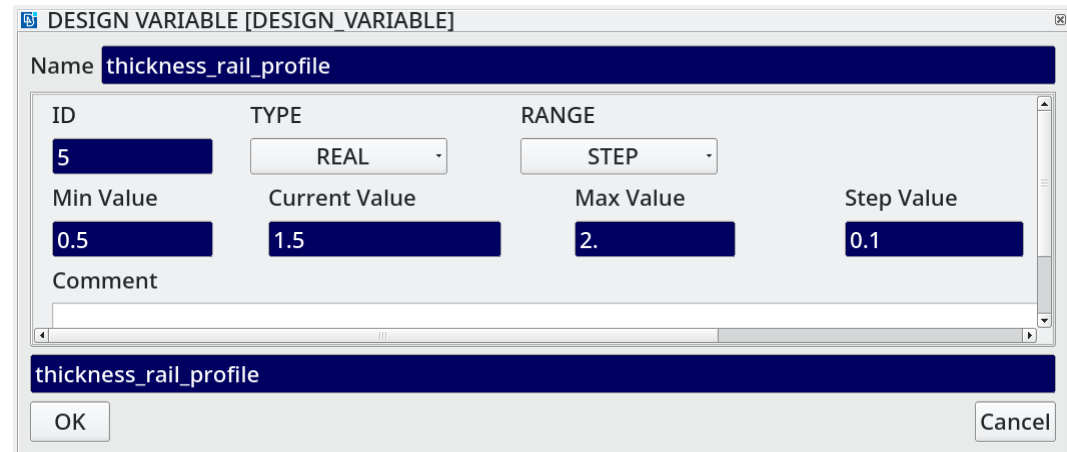
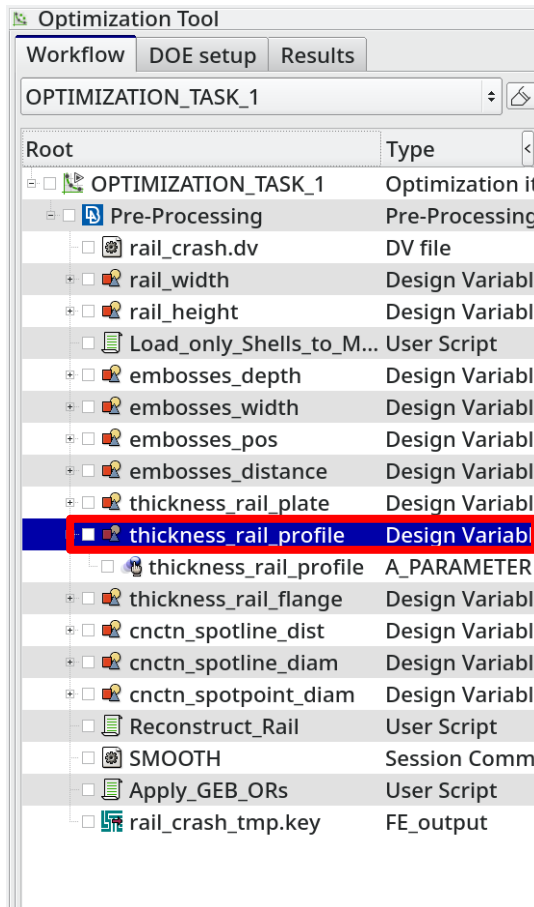
Morphing Parameter

Width of depressions



ANSA – Optimization Task

Design Variables → ANSA Parameters



ANSA – Optimization Task

Design Variables → ANSA Parameters

Optimization Tool

Workflow | DOE setup | Results

OPTIMIZATION_TASK_1

Root	Type
OPTIMIZATION_TASK_1	Optimization it
Pre-Processing	Pre-Processing
rail_crash.dv	DV file
rail_width	Design Variabl
rail_height	Design Variabl
Load_only_Shells_to_M...	User Script
embosses_depth	Design Variabl
embosses_width	Design Variabl
embosses_pos	Design Variabl
embosses_distance	Design Variabl
thickness_rail_plate	Design Variabl
thickness_rail_profile	Design Variabl
thickness_rail_profile	A_PARAMETER
thickness_rail_flange	Design Variabl
cnctn_spotline_dist	Design Variabl
cnctn_spotline_diam	Design Variabl
cnctn_spotpoint_diam	Design Variabl
Reconstruct_Rail	User Script
SMOOTH	Session Comm
Apply_GEB_ORs	User Script
rail_crash_tmp.key	FE_output

DESIGN VARIABLE [DESIGN_VARIABLE]

Name **thickness_rail_profile**

ID	TYPE	RANGE	
5	REAL	STEP	
Min Value	Current Value	Max Value	Step Value
0.5	1.5	2.	0.1
Comment			
thickness_rail_profile			

OK Cancel

A_PARAMETER

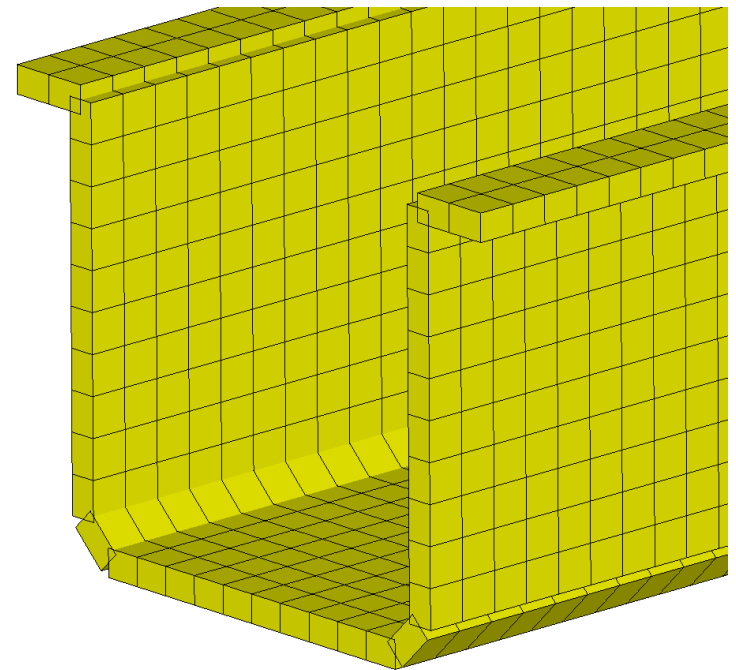
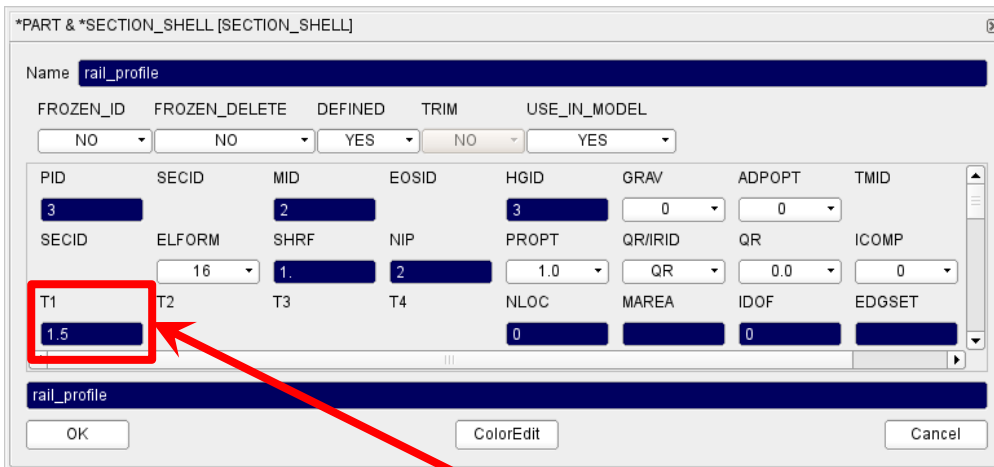
Id	Name	Value
1	thickness_rail_plate	1.5
2	thickness_rail_profile	1.5
3	connection_spotweld_dista...	50.
4	connection_spotweld_diam...	6.0
5	thickness_rail_flange	2.

A_PARAMETER total 5 selected 1

ANSA – Optimization Task

Design Variables → ANSA Parameters

Modification of shell thicknesses, materials, etc.



ANSA Parameter

Design Variable = 5.0

ANSA – Optimization Task

Design Variables → ANSA Parameters

Modification of shell thicknesses, materials, etc.

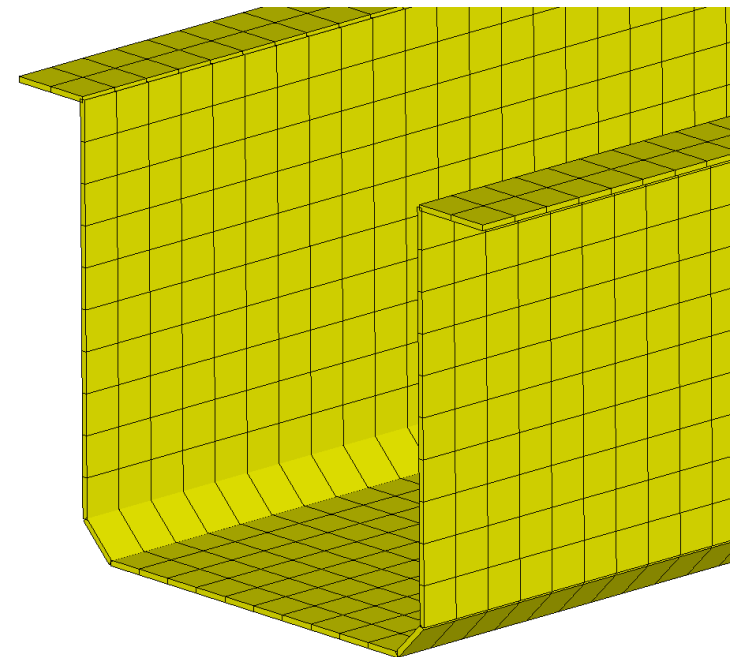
*PART & *SECTION_SHELL [SECTION_SHELL]

Name: rail_profile

FROZEN_ID: NO, FROZEN_DELETE: NO, DEFINED: YES, TRIM: NO, USE_IN_MODEL: YES

PID	SECID	MID	EOSID	HGID	GRAV	ADPOPT	TMID
3		2		3	0	0	
SECID	ELFORM	SHRF	NIP	PROPT	QR/IRID	QR	ICOMP
	16	1	2	1.0	QR	0.0	0
T1	T2	T3	T4	NLOC	MAREA	IDOF	EDGSET
1.5				0		0	

OK ColorEdit Cancel



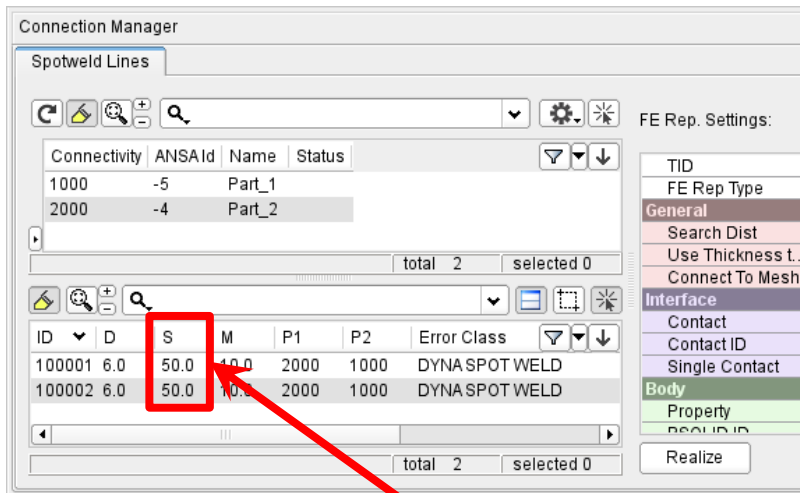
ANSA Parameter

Design Variable = 1.0

ANSA – Optimization Task

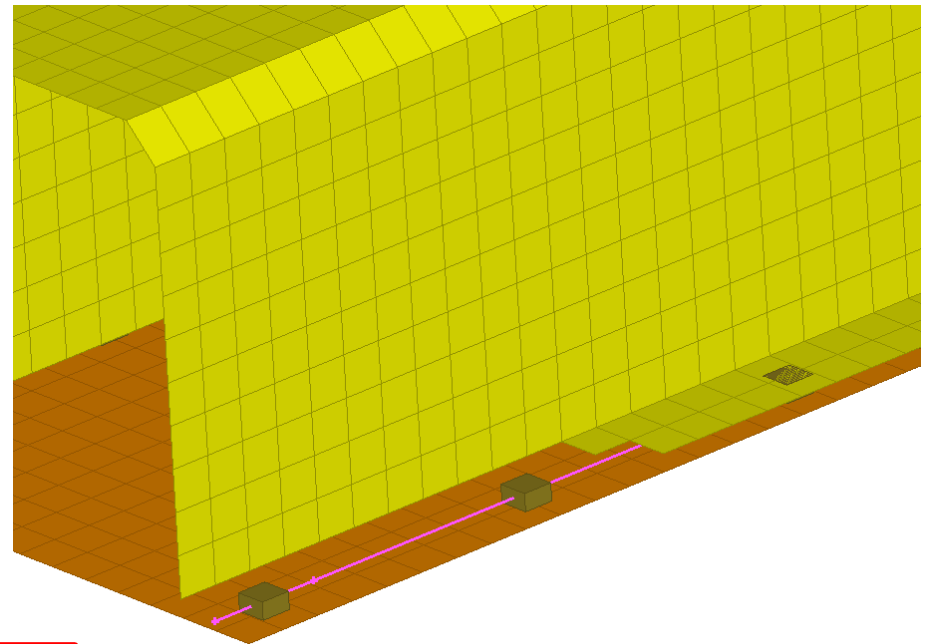
Design Variables → ANSA Parameters

Modification of connections (weld spot distance, diameter, etc.)



ANSA Parameter

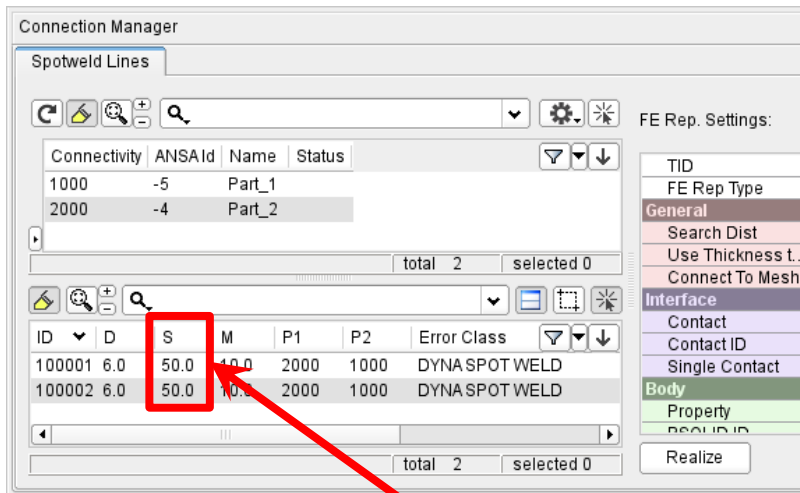
Design Variable (weld spot distance) = 50



ANSA – Optimization Task

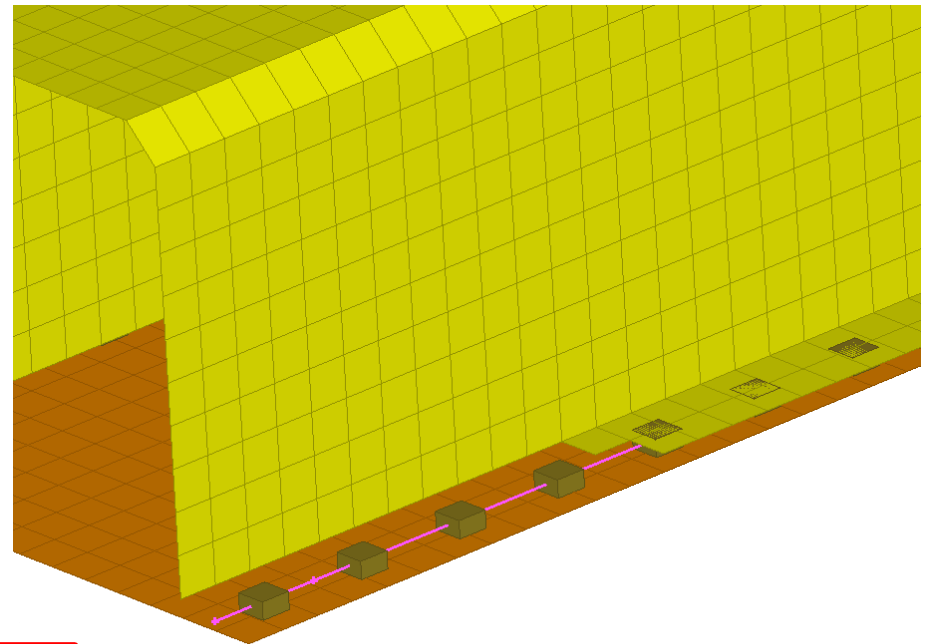
Design Variables → ANSA Parameters

Modification of connections (weld spot distance, diameter, etc.)



ANSA Parameter

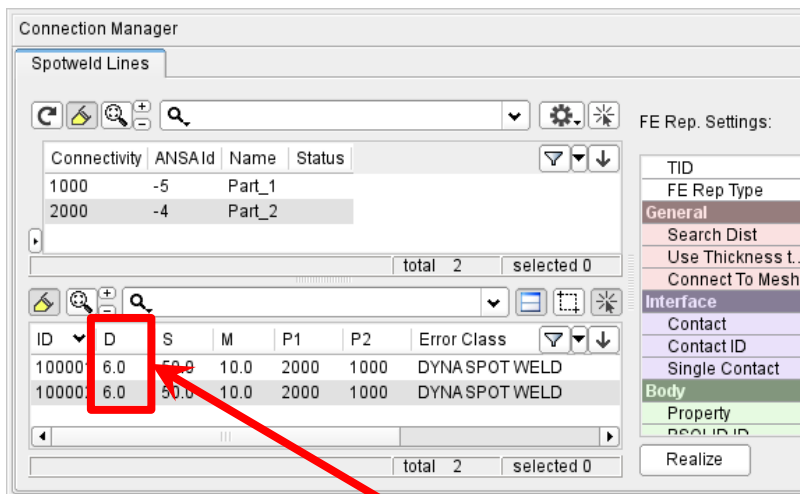
Design Variable (weld spot distance) = 20



ANSA – Optimization Task

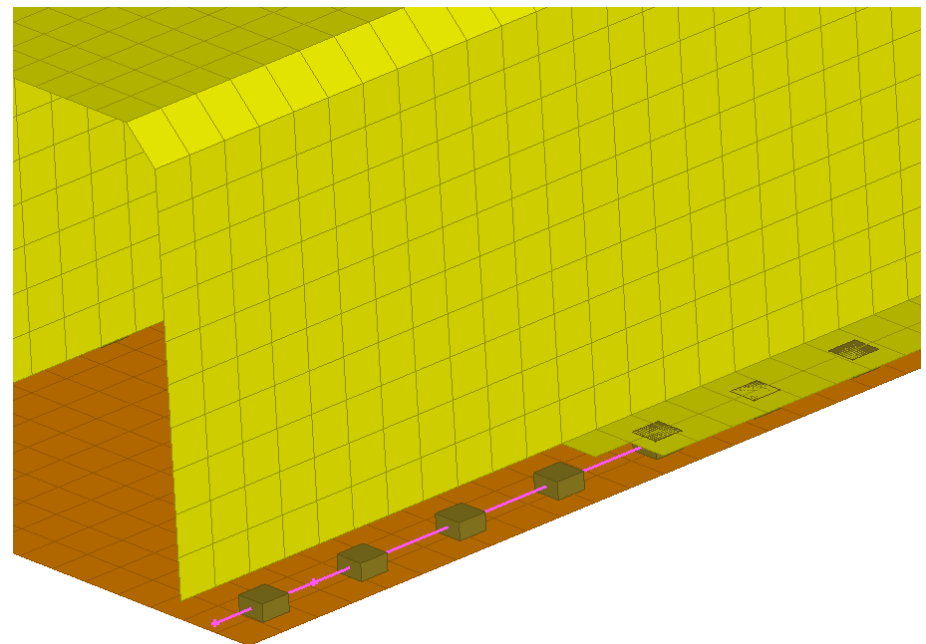
Design Variables → ANSA Parameters

Modification of connections (weld spot distance, diameter, etc.)



ANSA Parameter

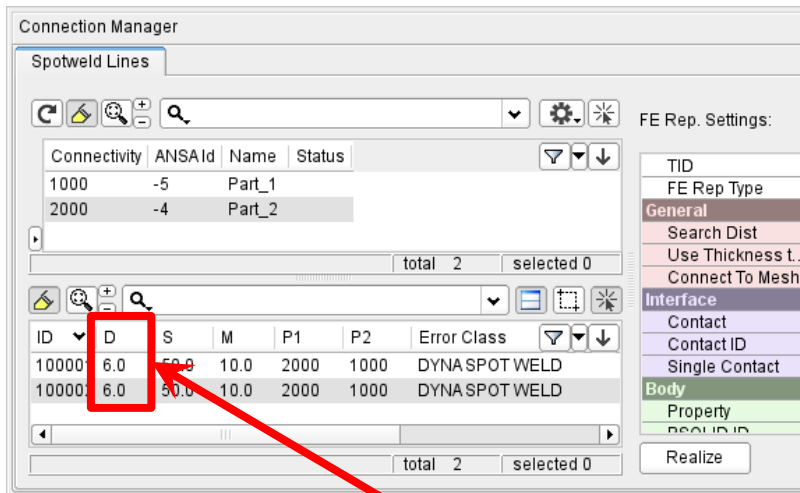
Design Variable (weld spot diameter) = 6.0



ANSA – Optimization Task

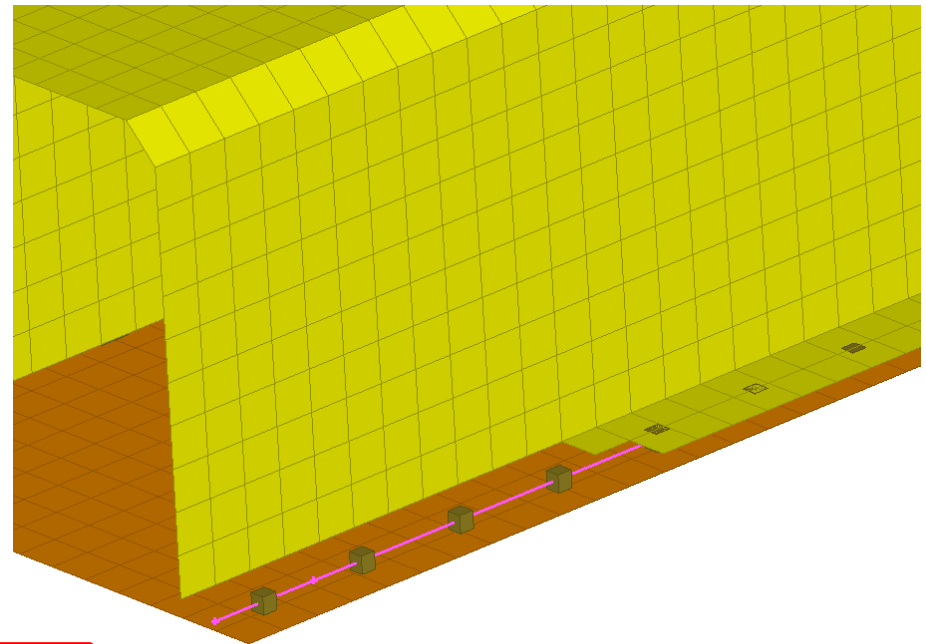
Design Variables → ANSA Parameters

Modification of connections (weld spot distance, diameter, etc.)



ANSA Parameter

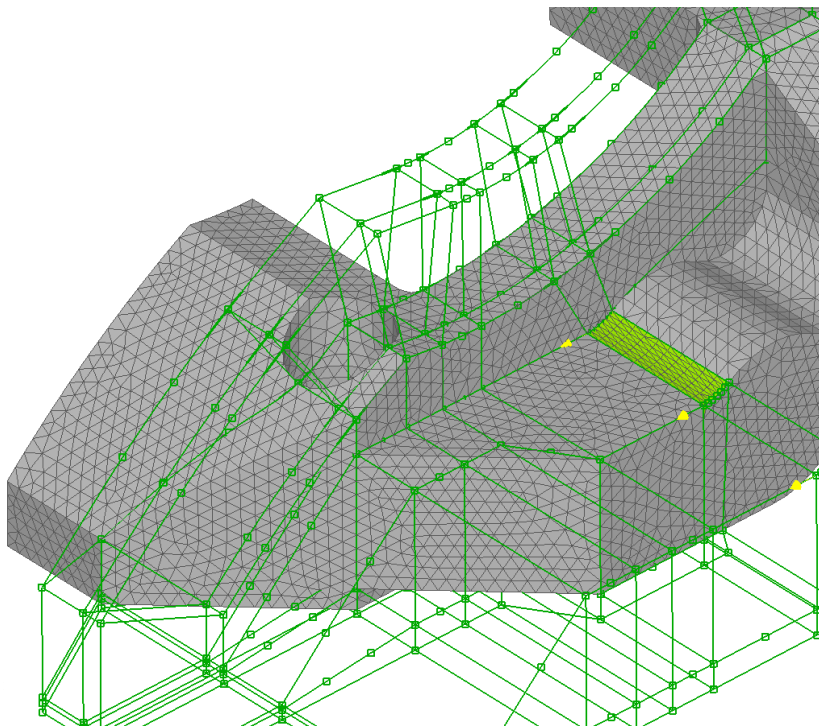
Design Variable (weld spot diameter) = 3.0



ANSA – Optimization Task

DOE → Simulate

- Checking DV combinations (e.g. Full Factorial) → Model Validity
- Checking Element Criteria

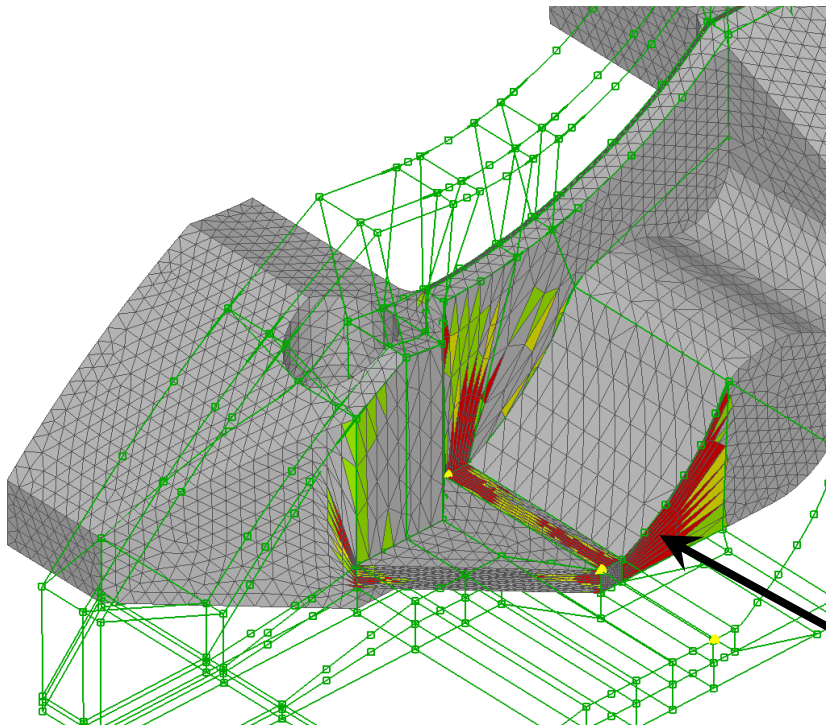


Optimization Tool				Experiments		
Workflow DOE setup Results						
Design variables						
ID	Name	Min Value	Max Value			
3	DV_Hoeh_e_Mittelsteg	-5.	12.	1	0.	0.
2	DV_Breite_Seitensteg	0	10.	2	2.	5.
1	DV_Breite_Flachsteg_oben	0.	20.	3	4.	10.
6	DV_Breite_Flachsteg_unten	0.	25.	4	6.	15.
9	DV_Hoeh_e_Nase	0.	10.	5	8.	20.
4	DV_Breite_Mittelsteg_ob_au	-20.	13.	6	10.	25.
7	DV_Breite_Mittelsteg_ob_in	-20.	13.			
5	DV_Breite_Mittelsteg_un_au	-13.	10.			
8	DV_Breite_Mittelsteg_un_in	-13.	10.			
10	DV_Breite_Nase	0.	20.			

ANSA – Optimization Task

DOE → Simulate

- Checking DV combinations (e.g. Full Factorial) → Model Validity
- Checking Element Criteria



Optimization Tool			
Workflow DOE setup Results			
Design variables			
ID	Name	Min Value	Max Value
3	DV_Hoeh_e_Mittelsteg	-5.	12.
2	DV_Breite_Seitensteg	0	10.
1	DV_Breite_Flachsteg_oben	0.	20.
6	DV_Breite_Flachsteg_unten	0.	25.
9	DV_Hoeh_e_Nase	0.	10.
4	DV_Breite_Mittelsteg_ob_au	-20.	13.
7	DV_Breite_Mittelsteg_ob_in	-20.	13.
5	DV_Breite_Mittelsteg_un_au	-13.	10.
8	DV_Breite_Mittelsteg_un_in	-13.	10.
10	DV_Breite_Nase	0.	20.

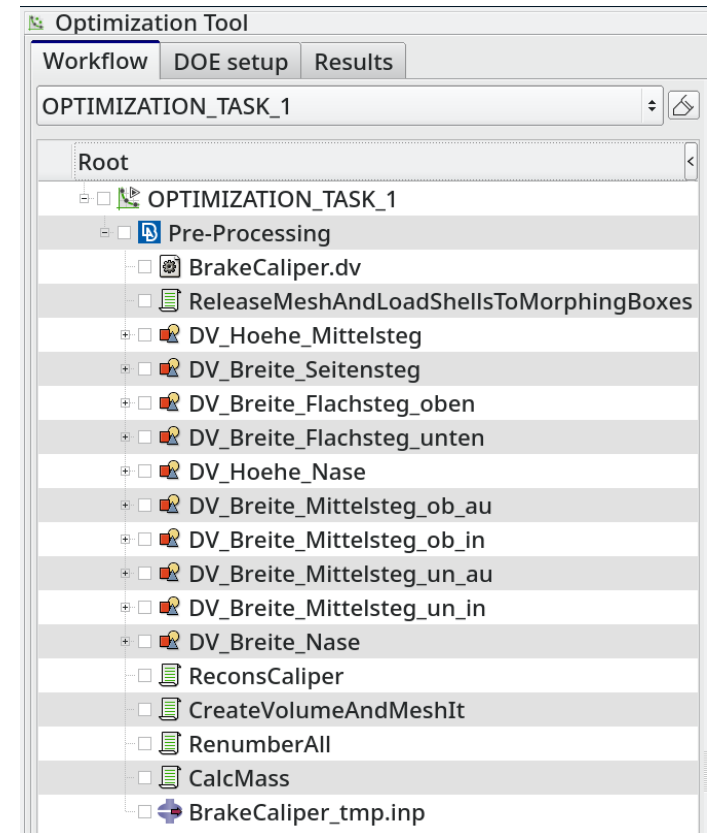
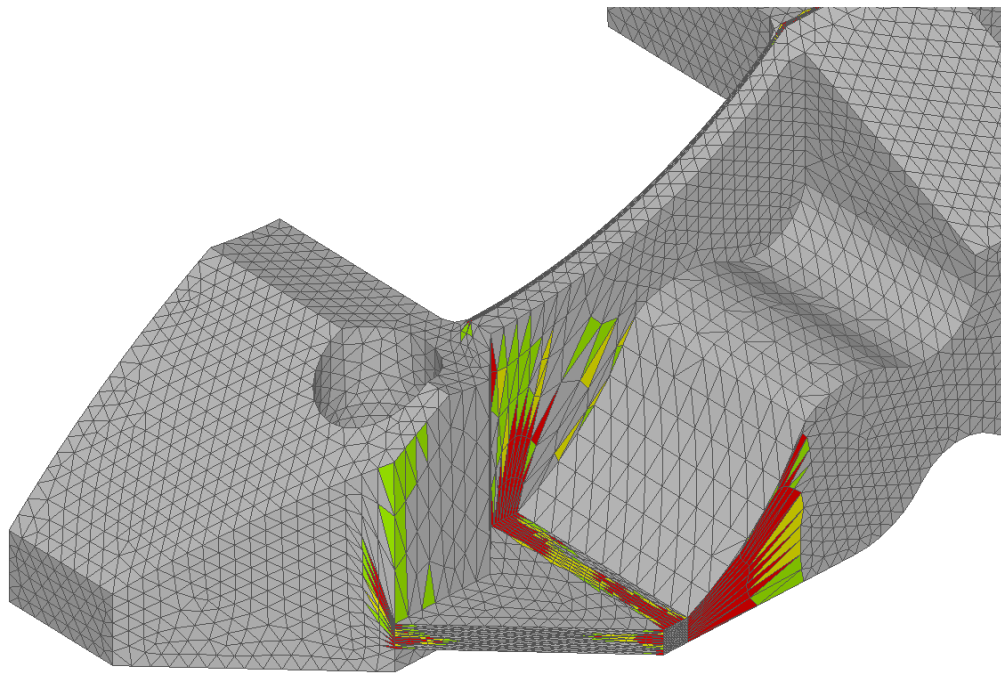
Experiments		
	_breite_Seitensteg	_breite_Flachsteg
1	0.	0.
2	2.	5.
3	4.	10.
4	6.	15.
5	8.	20.
6	10.	25.

Failed elements

ANSA – Optimization Task

User Scripts

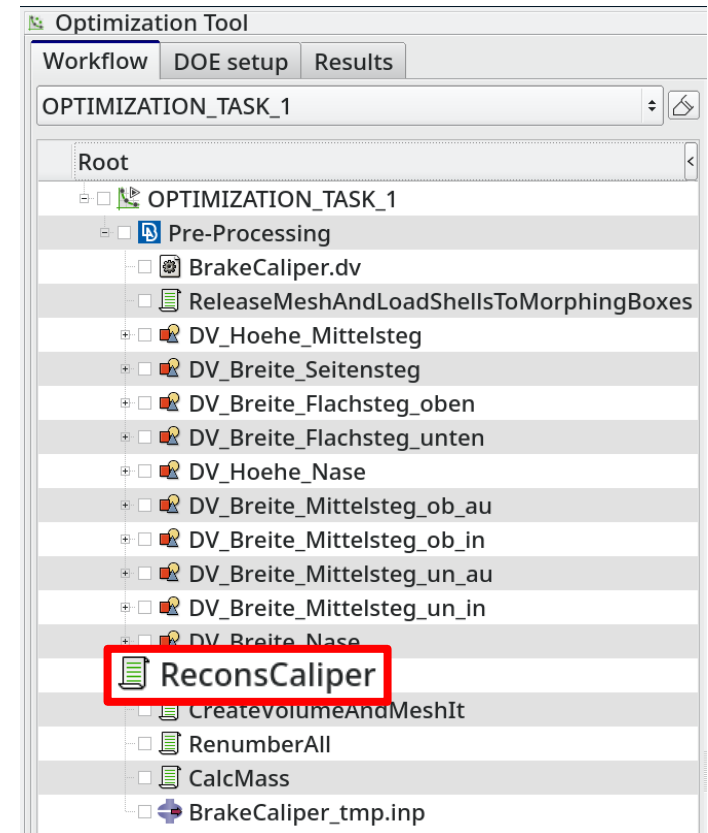
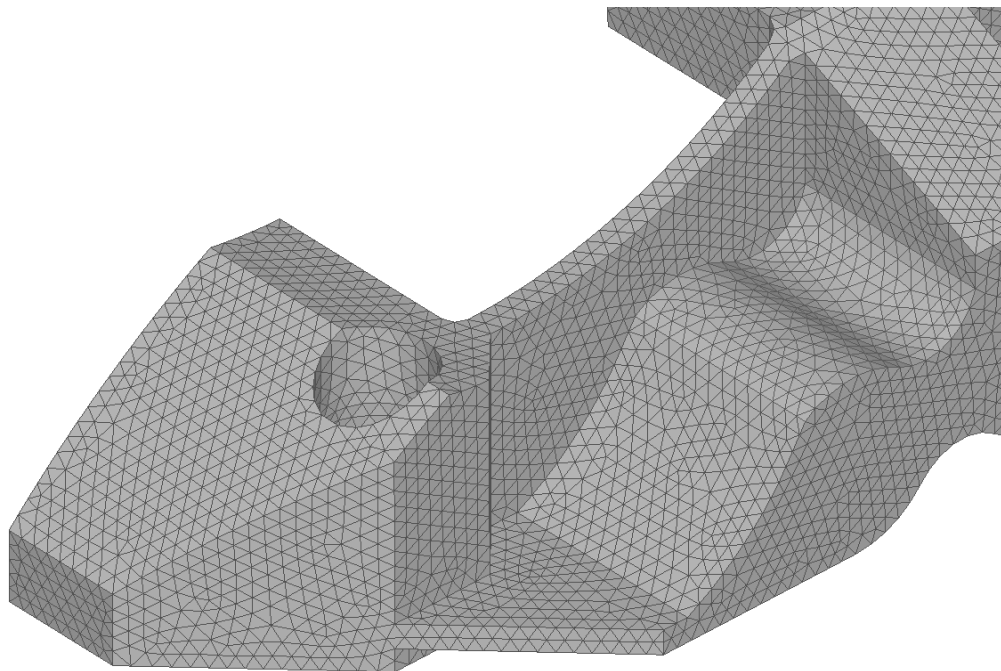
For improving mesh quality



ANSA – Optimization Task

User Scripts

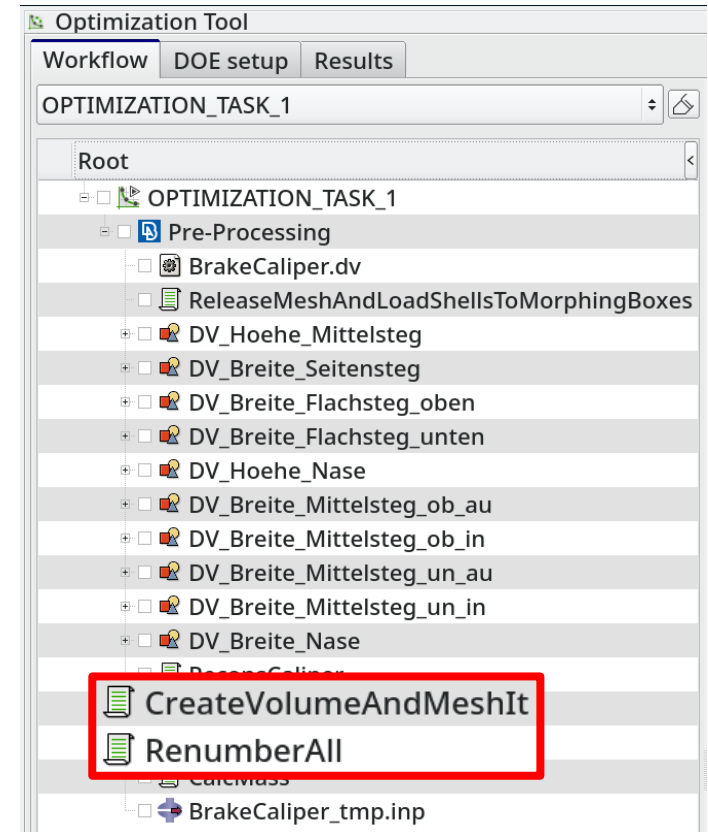
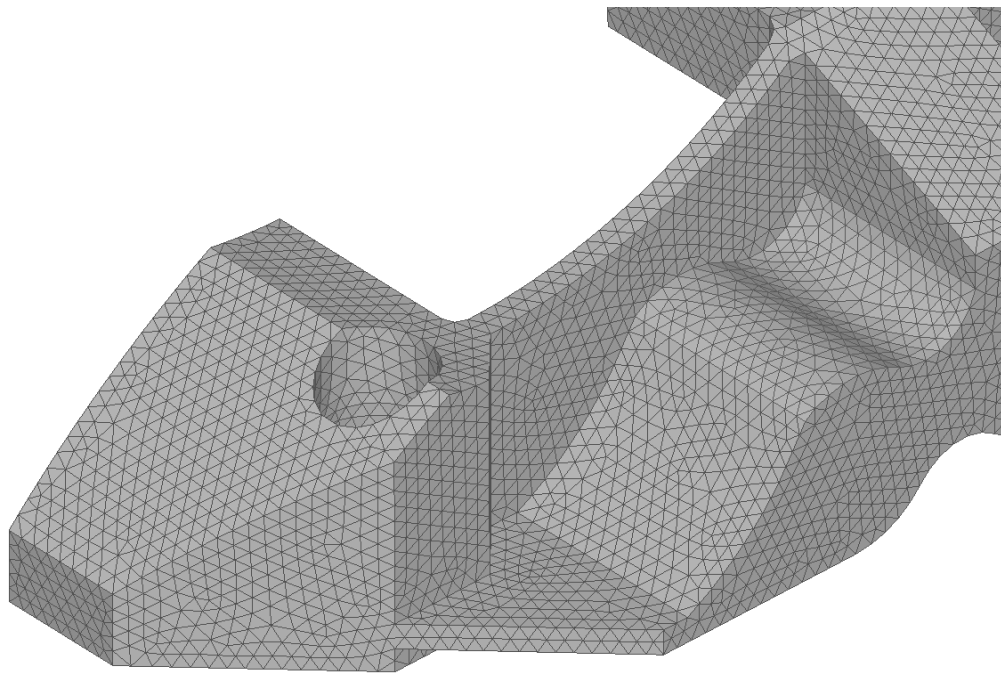
For improving mesh quality



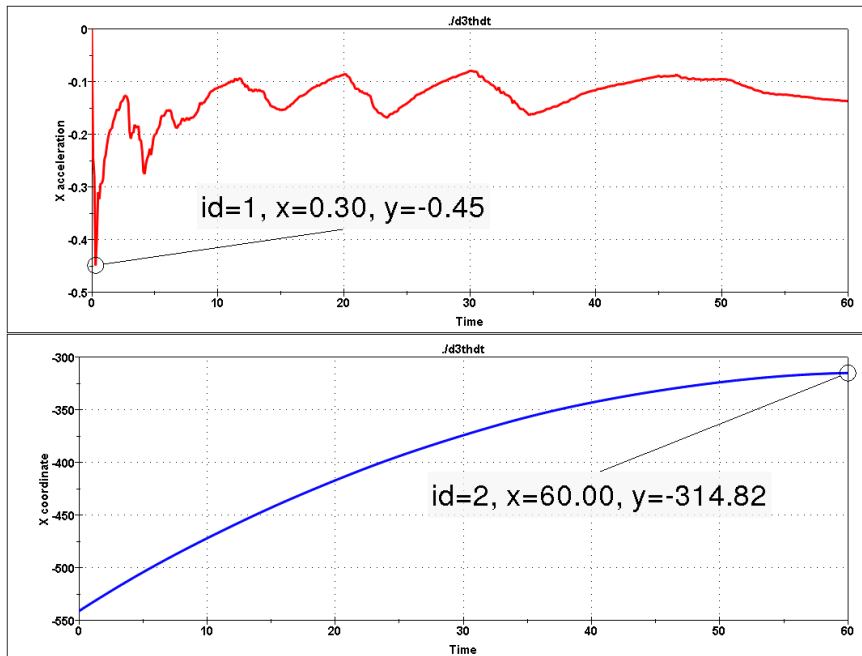
ANSA – Optimization Task

User Scripts

For creating Volume Mesh, Renumber, ...



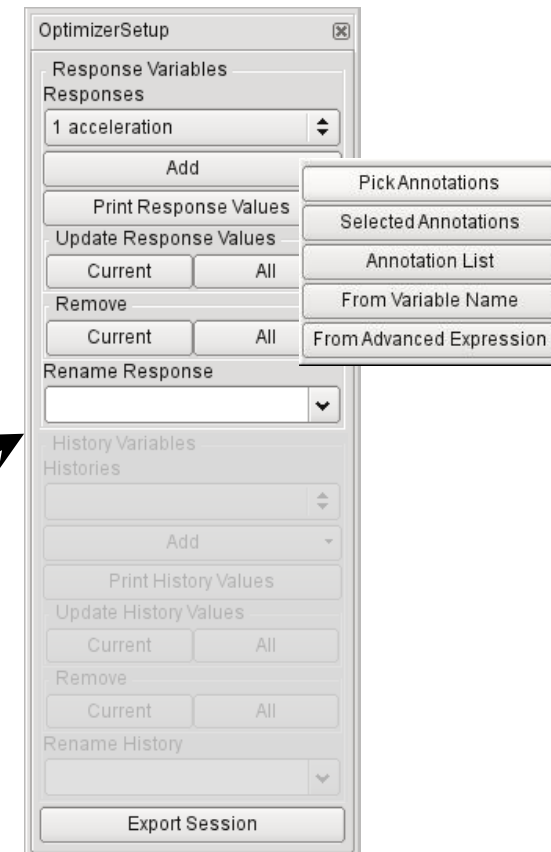
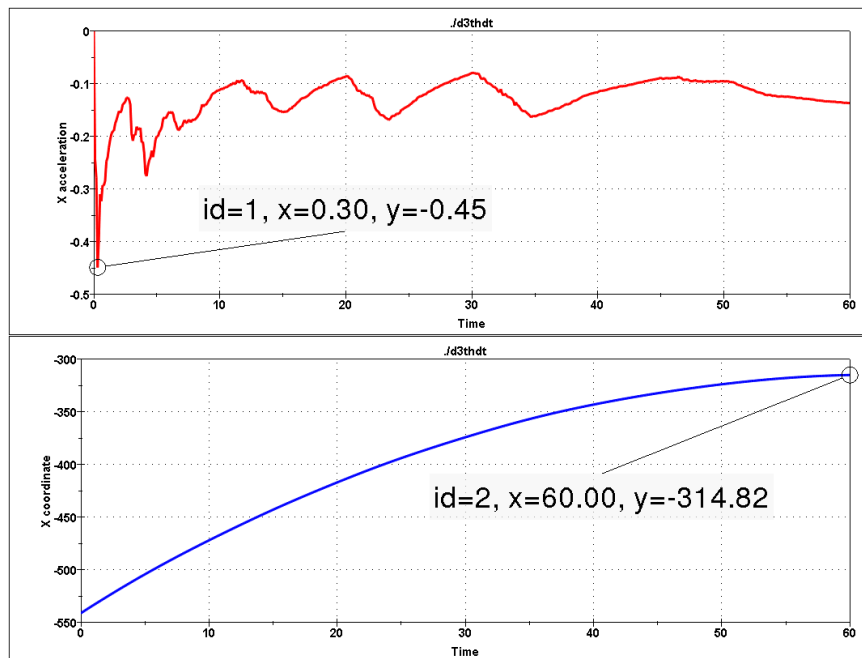
META – OptimizerSetup Toolbar



The screenshot shows the 'OptimizerSetup' dialog box. It is divided into two main sections: 'Response Variables' and 'History Variables'. Each section has a list of variables (currently empty), an 'Add' button, a 'Print' button, an 'Update' section with 'Current' and 'All' buttons, a 'Remove' section with 'Current' and 'All' buttons, and a 'Rename' section with a text input field and a dropdown arrow. At the bottom of the dialog is an 'Export Session' button. A black arrow points from the top graph to the 'Add' button in the 'Response Variables' section.

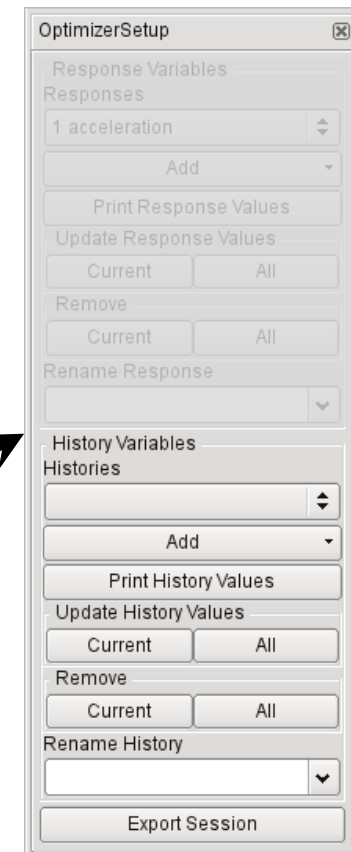
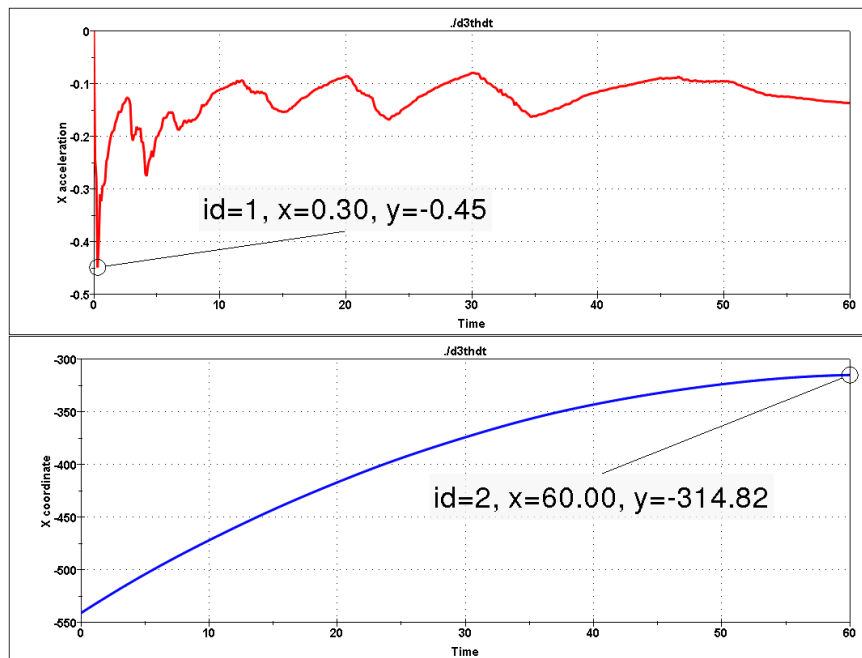
META – OptimizerSetup Toolbar

- Responses from annotations, variables, advanced expressions

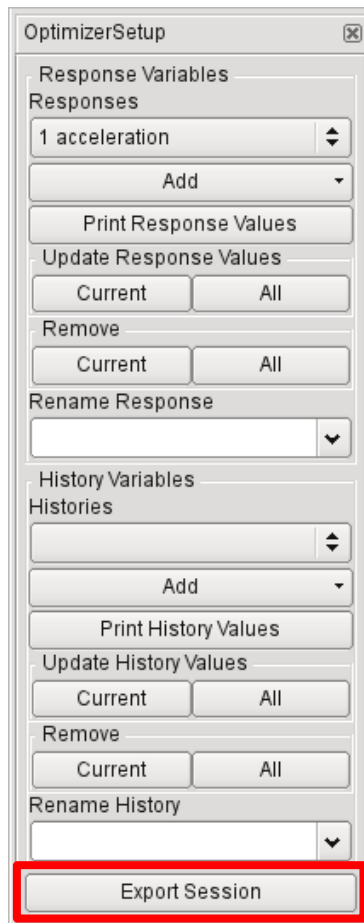


META – OptimizerSetup Toolbar

- Responses from annotations, variables, advanced expressions
- Histories from 2D plot curves



META – OptimizerSetup Toolbar



Exports:

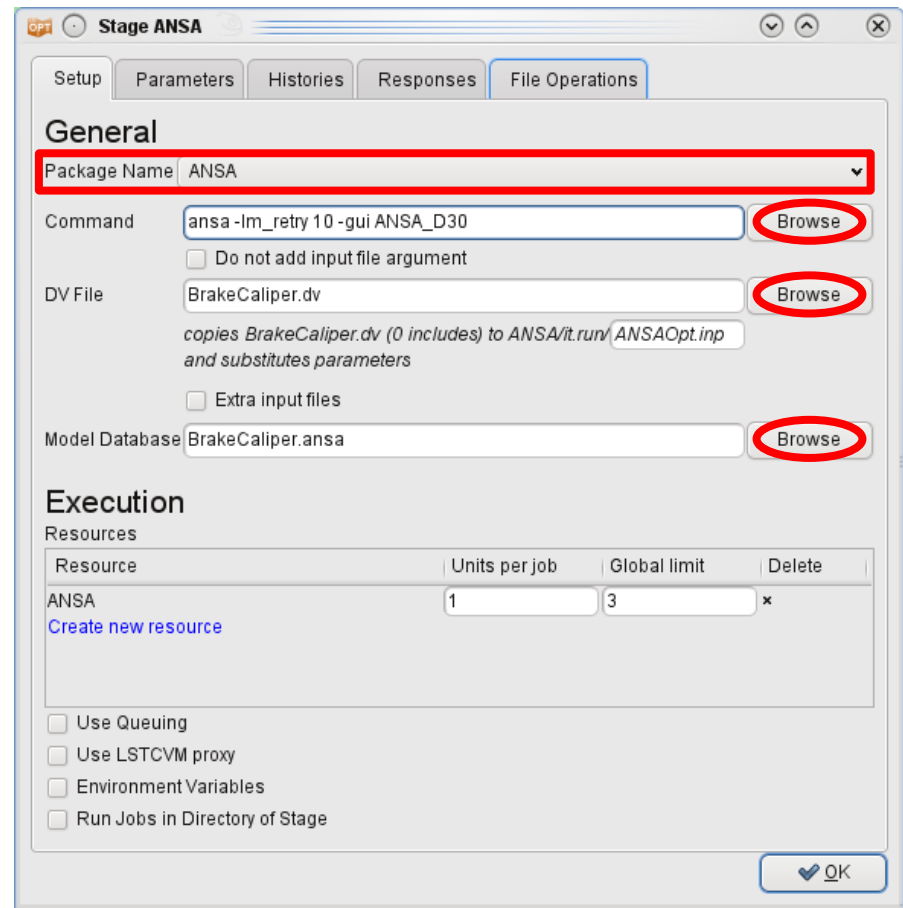
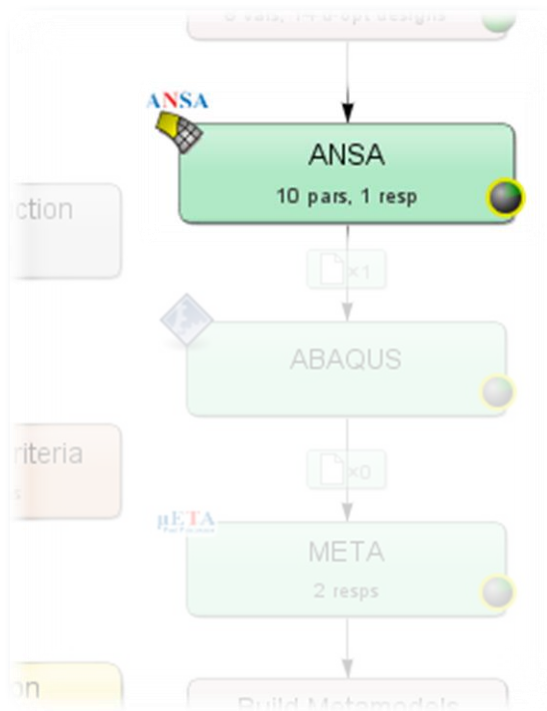
- Session file (for reproduction of results extraction)
- Output file, containing responses and histories

```
#OptimizerSetup Response & history File created by META post  
RESPONSES  
1, acceleration, -1.18  
2, intrusion, -440.07  
END
```

Correctly formatted for
import in LS-OPT

Connecting ANSA to LS-OPT

Stage for ANSA



Connecting ANSA to LS-OPT

ANSA → DV file → Design Variables in LS-OPT

```
#
# ANSA_VERSION: 15.0.1
#
# file created by ANSA Fri Feb 14 15:49:00 2014
#
# Output from:
# ansaout.ansa
#
# DESIGN VARIABLES
#-----
# ID | DESIGN VARIABLE NAME | TYPE | RANGE | CURRENT VA
#-----
3, DV_Hoehe_Mittelsteg, REAL, BOUNDS, 0., -5.
2, DV_Breite_Seitensteg, REAL, BOUNDS, 0., -5.
1, DV_Breite_Flachsteg_oben, REAL, BOUNDS, 0., -5.
6, DV_Breite_Flachsteg_unten, REAL, BOUNDS, 0., -5.
9, DV_Hoehe_Nase, REAL, BOUNDS, 0., 0., 10.
4, DV_Breite_Mittelsteg_ob_au, REAL, BOUNDS, 0., -5.
7, DV_Breite_Mittelsteg_ob_in, REAL, BOUNDS, 0., -5.
5, DV_Breite_Mittelsteg_un_au, REAL, BOUNDS, 0., -5.
8, DV_Breite_Mittelsteg_un_in, REAL, BOUNDS, 0., -5.
10, DV_Breite_Nase, REAL, BOUNDS, 0., 0., 20.
#-----
```

Parameter Setup Stage Matrix Sampling Matrix Resources Features

Show advanced options

Type	Name	Starting	Init. Range	Minimum	Maximum
Continuous	DV_Breite_Flachsteg_oben	0		0	15
Continuous	DV_Breite_Flachsteg_unten	0		0	25
Continuous	DV_Breite_Mittelsteg_ob_au	0		0	13
Continuous	DV_Breite_Mittelsteg_ob_in	10		-20	13
Continuous	DV_Breite_Mittelsteg_un_au	0		0	10
Continuous	DV_Breite_Mittelsteg_un_in	5		-13	10
Continuous	DV_Breite_Nase	0		0	20
Continuous	DV_Breite_Seitensteg	0		-5	10
Continuous	DV_Hoehe_Mittelsteg	0		-5	12
Continuous	DV_Hoehe_Nase	0		0	10

Add...

OK

Connecting ANSA to LS-OPT

Fine Tuning of Design Variables, e.g.

- Ranges

Type	Name	Starting	Init. Range	Minimum	Maximum
Continuous	DV_Breite_Flachsteg_oben	0	8	0	15
Continuous	DV_Breite_Flachsteg_unten	0	12	0	25
Continuous	DV_Breite_Mittelsteg_ob_au	0	6	0	13
Dependent	DV_Breite_Mittelsteg_ob_in	Definition: DV_Breite_Mittelsteg_ob_au			
Continuous	DV_Breite_Mittelsteg_un_au	0	5	0	10
Dependent	DV_Breite_Mittelsteg_un_in	Definition: DV_Breite_Mittelsteg_un_au			
Continuous	DV_Breite_Nase	0	10	0	20
Continuous	DV_Breite_Seitensteg	0	8	-5	10
Continuous	DV_Hoehe_Mittelsteg	0	8	-5	12
Continuous	DV_Hoehe_Nase	0	5	0	10

Add... OK

Connecting ANSA to LS-OPT

Fine Tuning of Design Variables, e.g.

- Ranges
- Dependencies
- etc.

Parameter Setup | Stage Matrix | Sampling Matrix | Resources | Features

Show advanced options

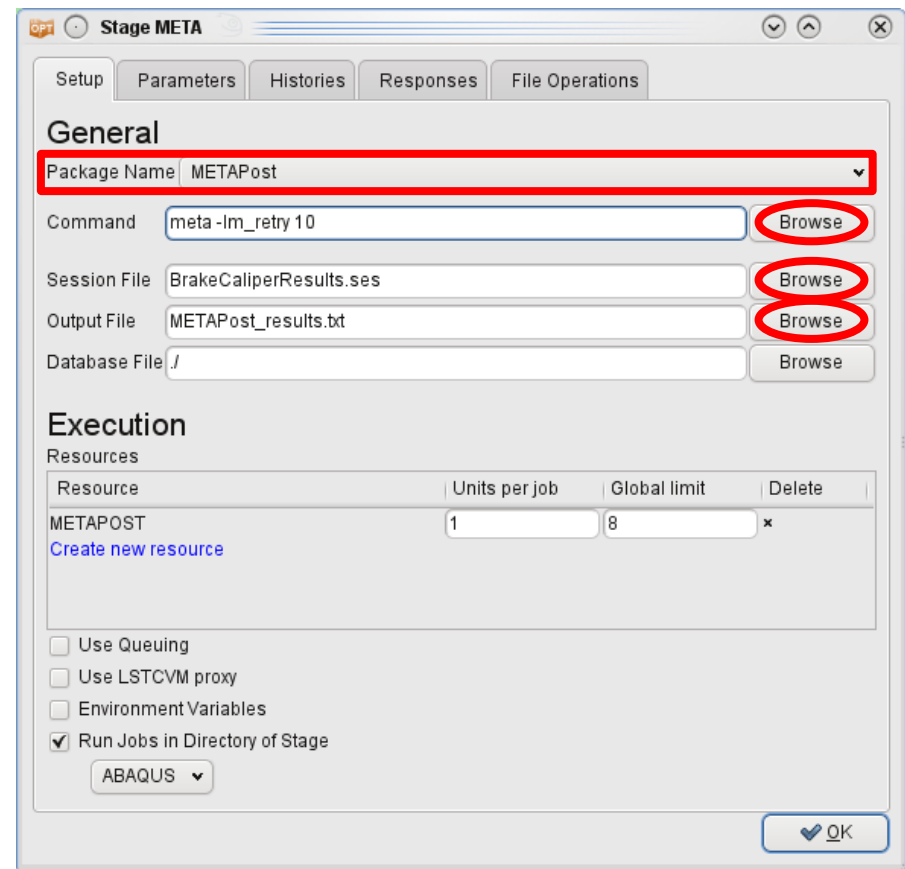
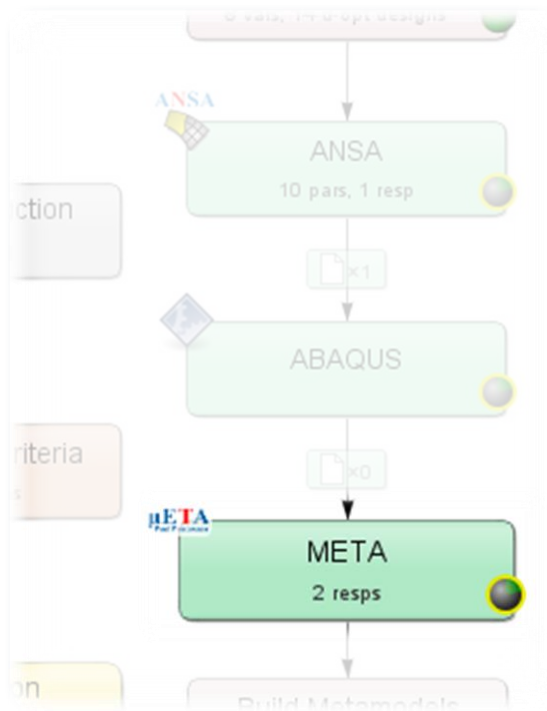
Type	Name	Starting	Init. Range	Minimum	Maximum
Continuous	DV_Breite_Flachsteg_oben	0	8	0	15
Continuous	DV_Breite_Flachsteg_unten	0	12	0	25
Continuous	DV_Breite_Mittelsteg_ob_au	0	6	0	13
Dependent	DV_Breite_Mittelsteg_ob_in	Definition: DV_Breite_Mittelsteg_ob_au			
Continuous	DV_Breite_Mittelsteg_un_au	0	5	0	10
Dependent	DV_Breite_Mittelsteg_un_in	Definition: DV_Breite_Mittelsteg_un_au			
Continuous	DV_Breite_Nase	0	10	0	20
Continuous	DV_Breite_Seitensteg	0	8	-5	10
Continuous	DV_Hoehe_Mittelsteg	0	8	-5	12
Continuous	DV_Hoehe_Nase	0	5	0	10

Add...

OK

Connecting META to LS-OPT

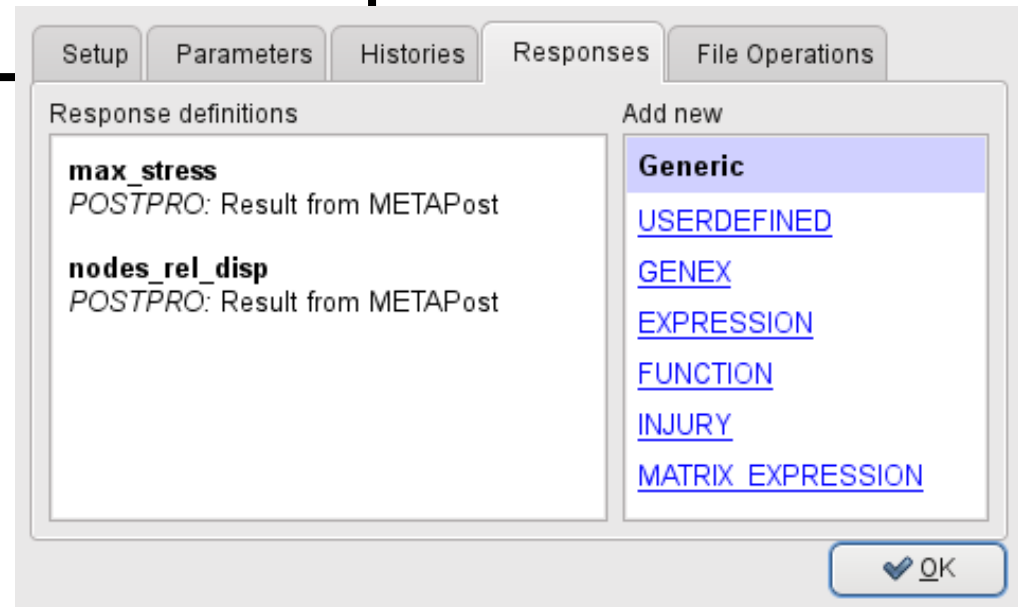
Stage for META



Connecting META to LS-OPT

META → Output file → Responses and Histories in LS-OPT

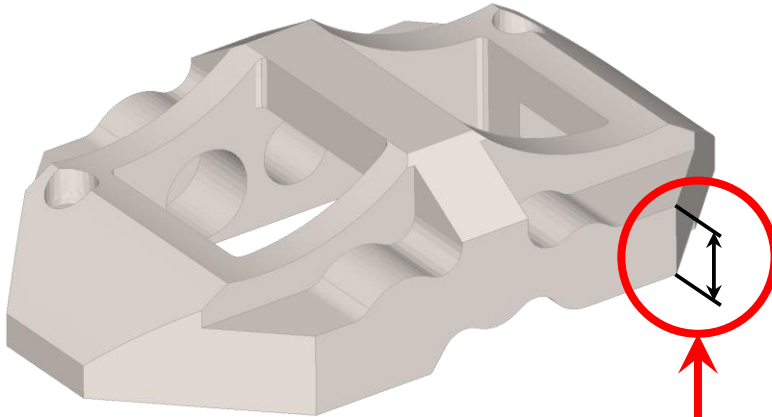
```
#OptimizerSetup Response & history File created by META post  
RESPONSES  
1,nodes_rel_disp,0.174171448  
2,max_stress,169.780731  
END
```



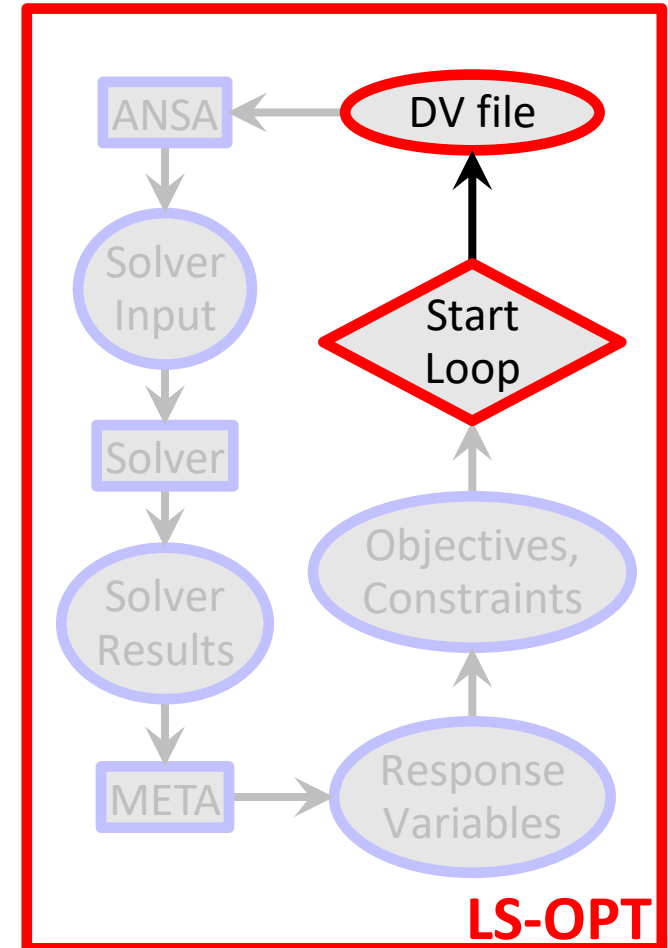
Optimization Run

LS-OPT → ANSA → Solver → META → LS-OPT

LS-OPT determines set of DV and outputs DV file

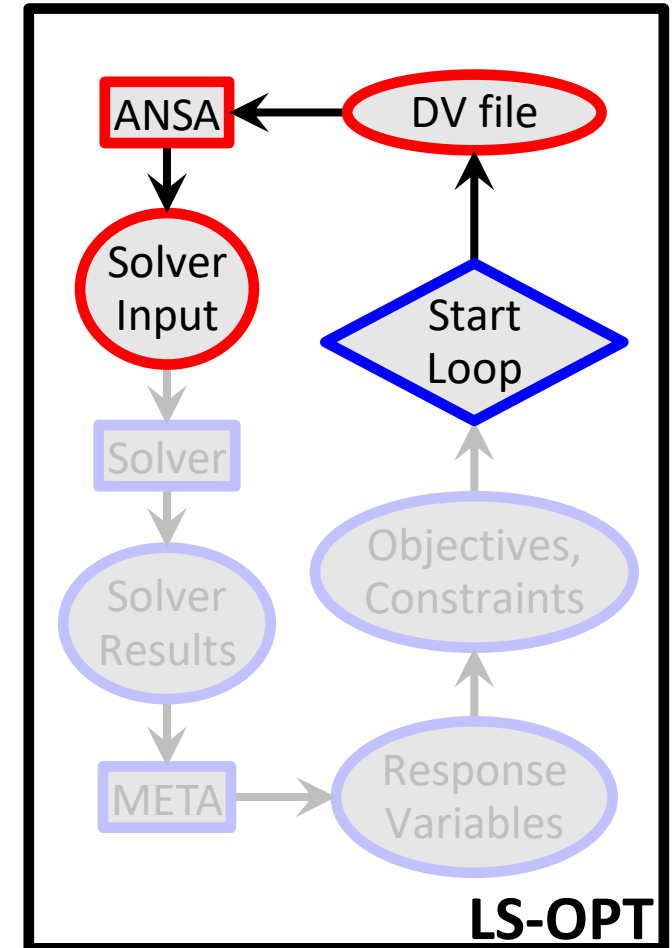
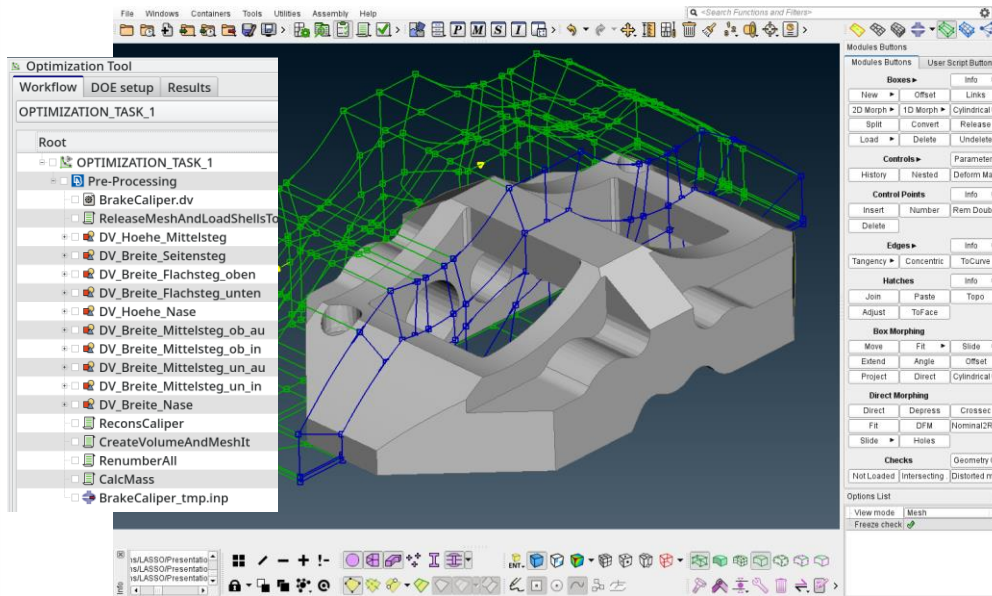


#	ID	DESIGN VARIABLE NAME	TYPE	RANGE	CURRENT VALUE	MIN VALUE
3	DV_Hoehne_Mittelsteg	REAL	BOUNDS	0., -5., 12.		
2	DV_Breite_Seitensteg	REAL	BOUNDS	0., -5., 10.		
1	DV_Breite_Flachsteg_oben	REAL	BOUNDS	0., 0., 20.		
6	DV_Breite_Flachsteg_unten	REAL	BOUNDS	0., 0., 25.		
9	DV_Hoehne_Nase	REAL	BOUNDS	0., 0., 10.		
4	DV_Breite_Mittelsteg_ob_au	REAL	BOUNDS	0., -20., 13.		
7	DV_Breite_Mittelsteg_ob_in	REAL	BOUNDS	0., -20., 13.		
5	DV_Breite_Mittelsteg_un_au	REAL	BOUNDS	0., -13., 10.		
8	DV_Breite_Mittelsteg_un_in	REAL	BOUNDS	0., -13., 10.		
10	DV_Breite_Nase	REAL	BOUNDS	0., 0., 20.		



Optimization Run

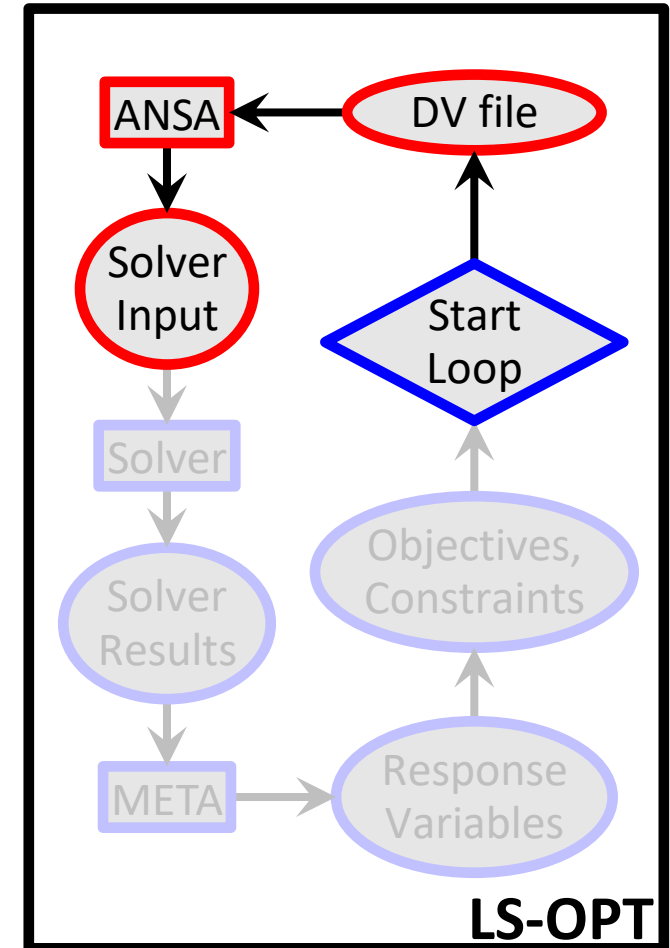
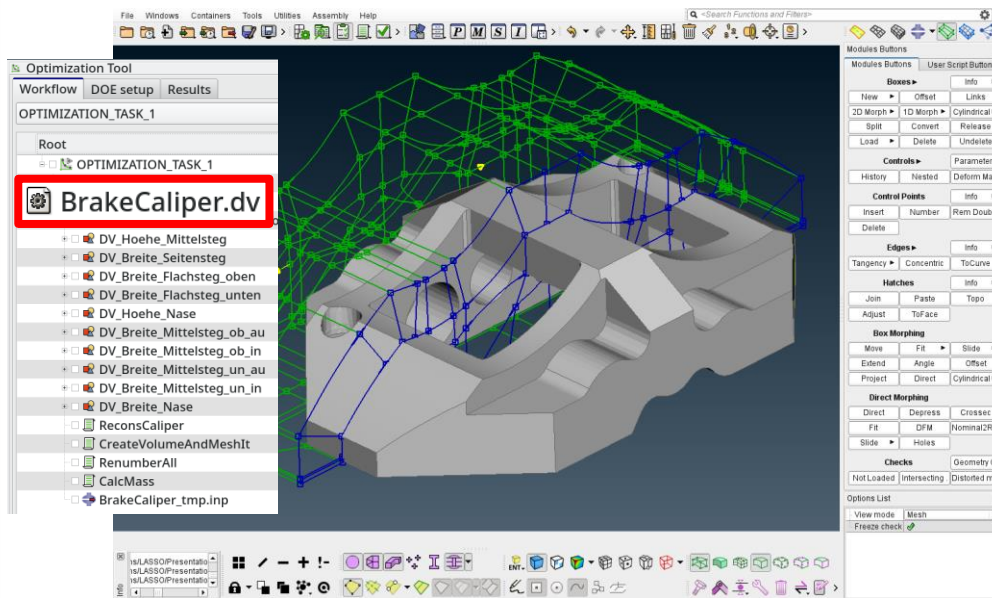
LS-OPT → **ANSA** → Solver → META → LS-OPT



Optimization Run

LS-OPT → **ANSA** → Solver → META → LS-OPT

- ANSA reads DV from DV file

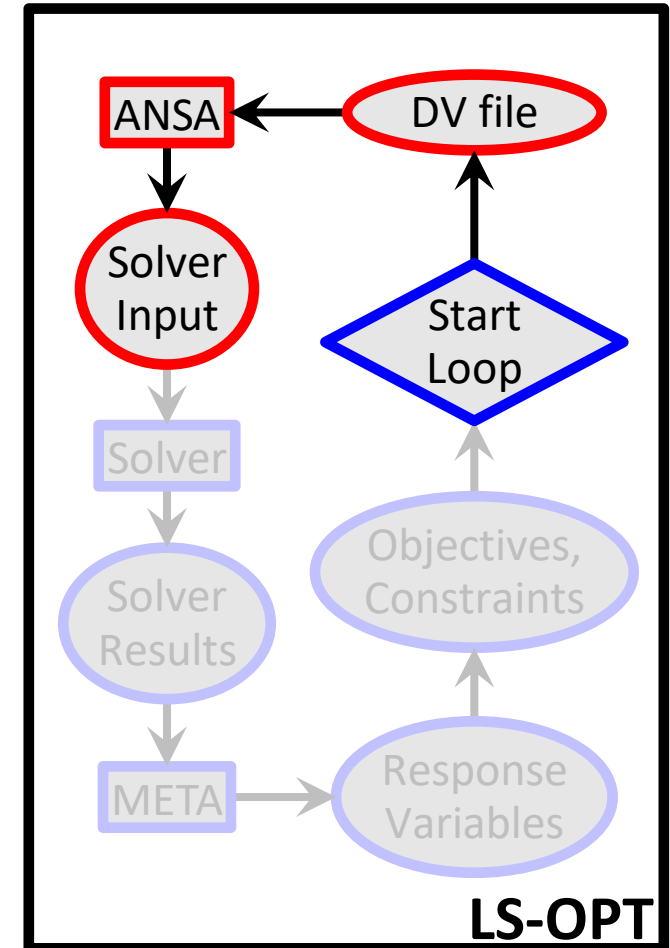
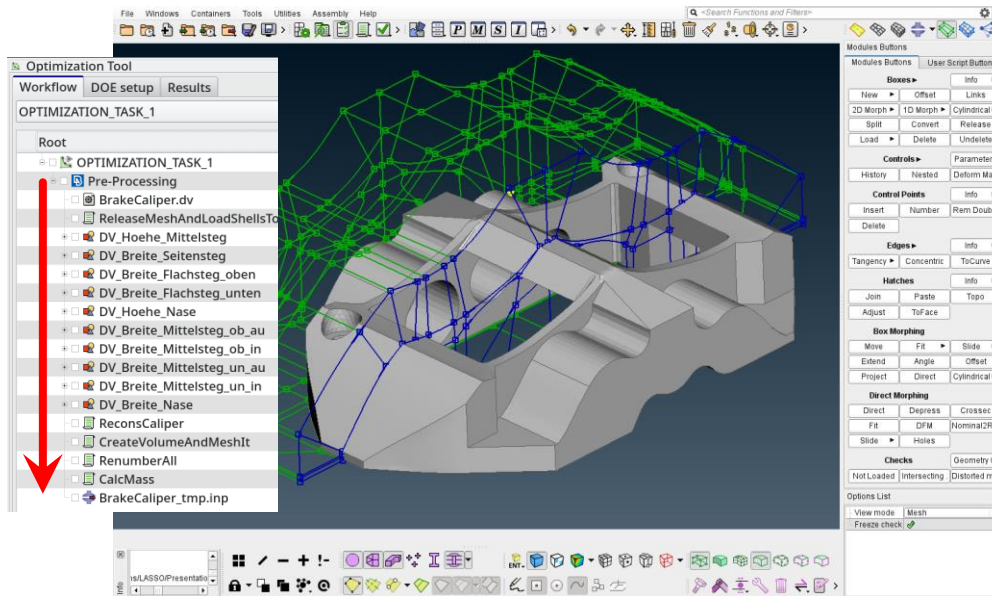


LS-OPT

Optimization Run

LS-OPT → **ANSA** → Solver → META → LS-OPT

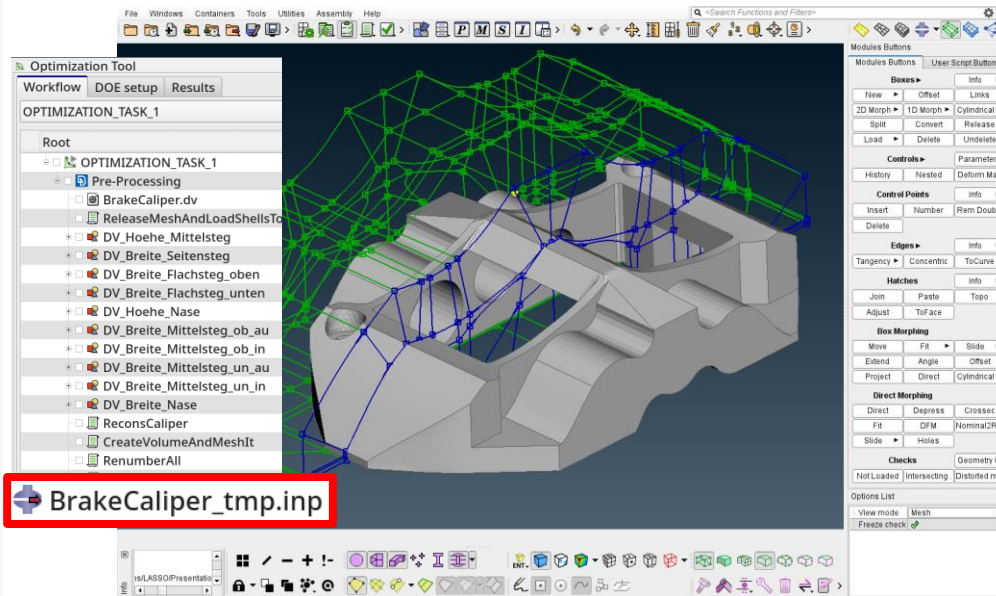
- ANSA reads DV from DV file
- executes Optimization Task sequence



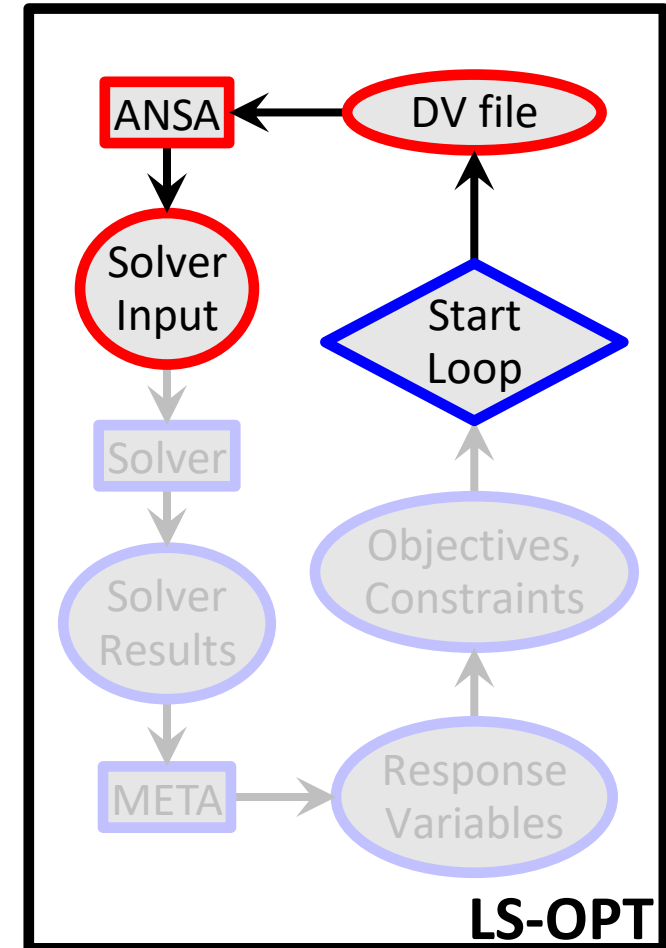
Optimization Run

LS-OPT → **ANSA** → Solver → META → LS-OPT

- ANSA reads DV from DV file
- executes Optimization Task sequence
- outputs solver input deck



***.key / *.nas / *.inp**



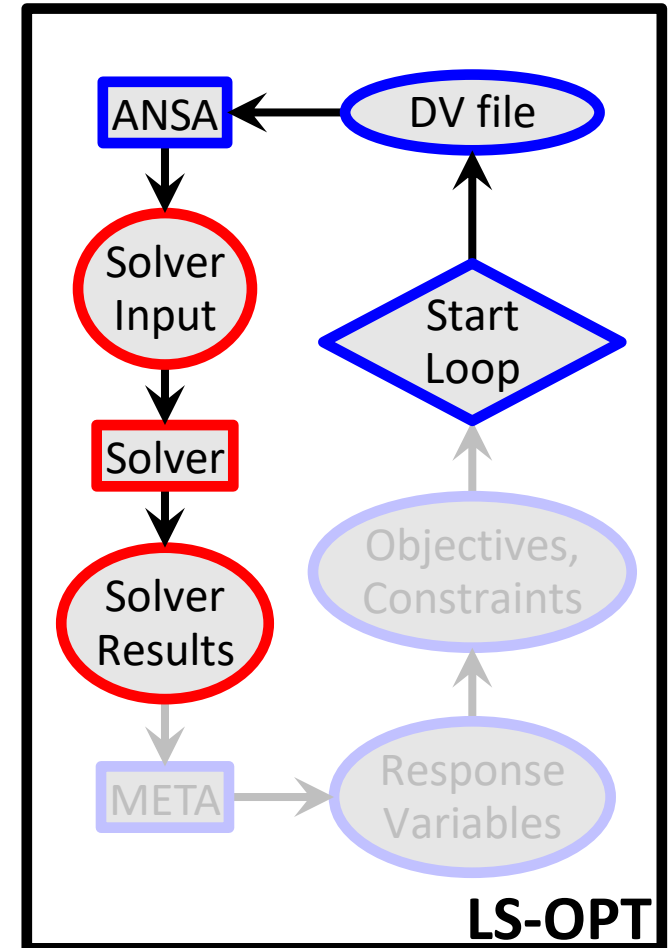
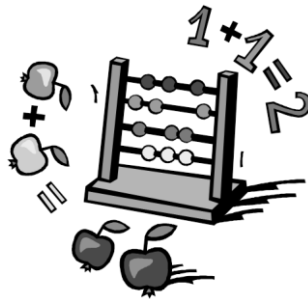
LS-OPT

Optimization Run

LS-OPT → ANSA → **Solver** → META → LS-OPT

- LS-OPT invokes solver runs

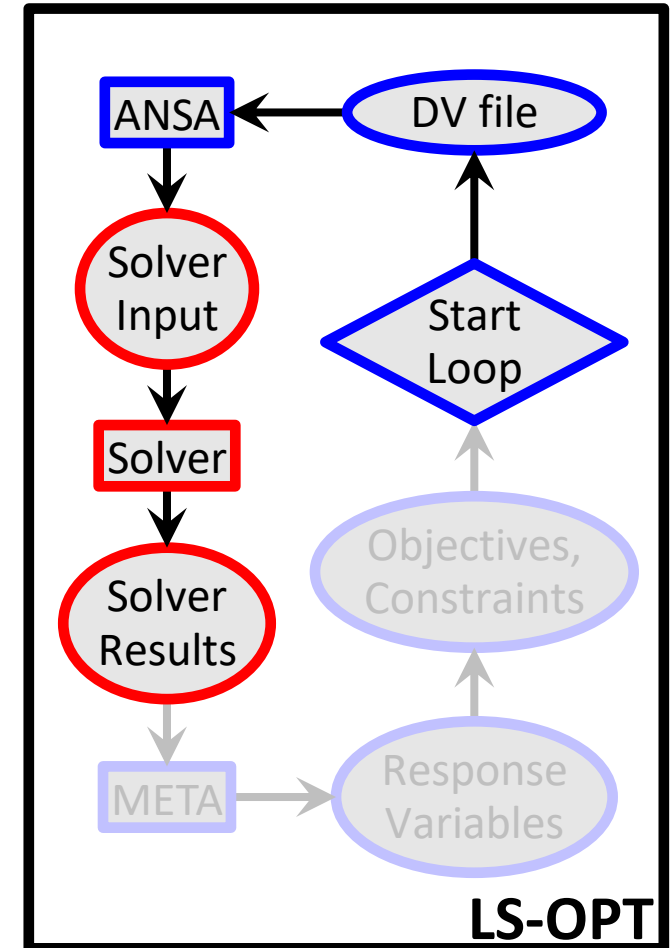
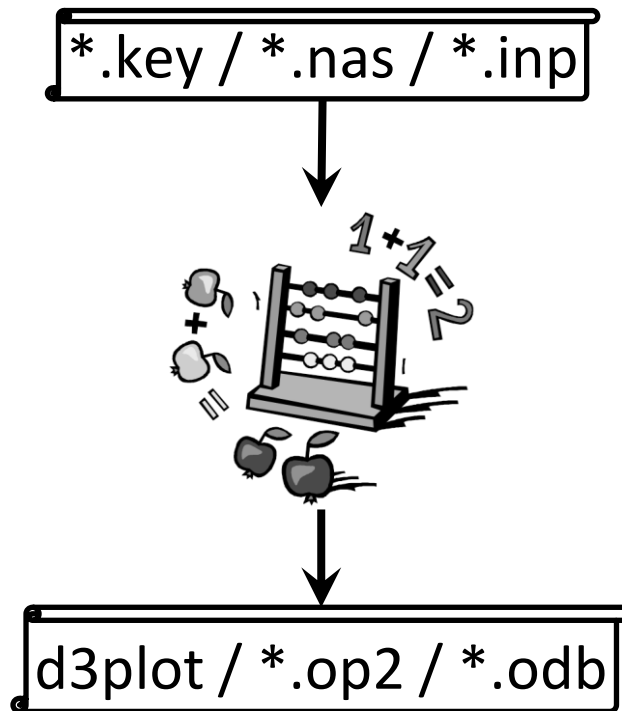
*.key / *.nas / *.inp



Optimization Run

LS-OPT → ANSA → **Solver** → META → LS-OPT

- LS-OPT invokes solver runs
- Solver produces result files

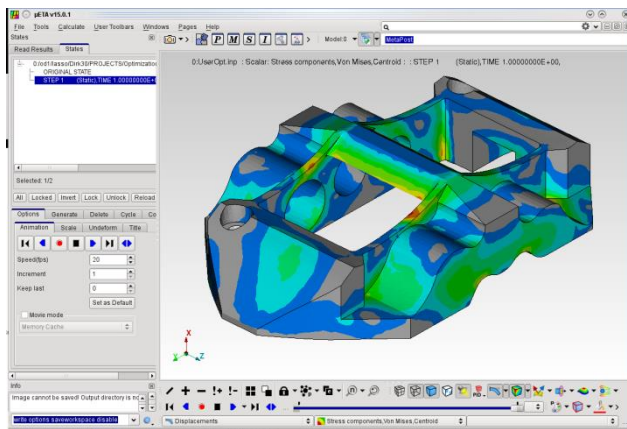


Optimization Run

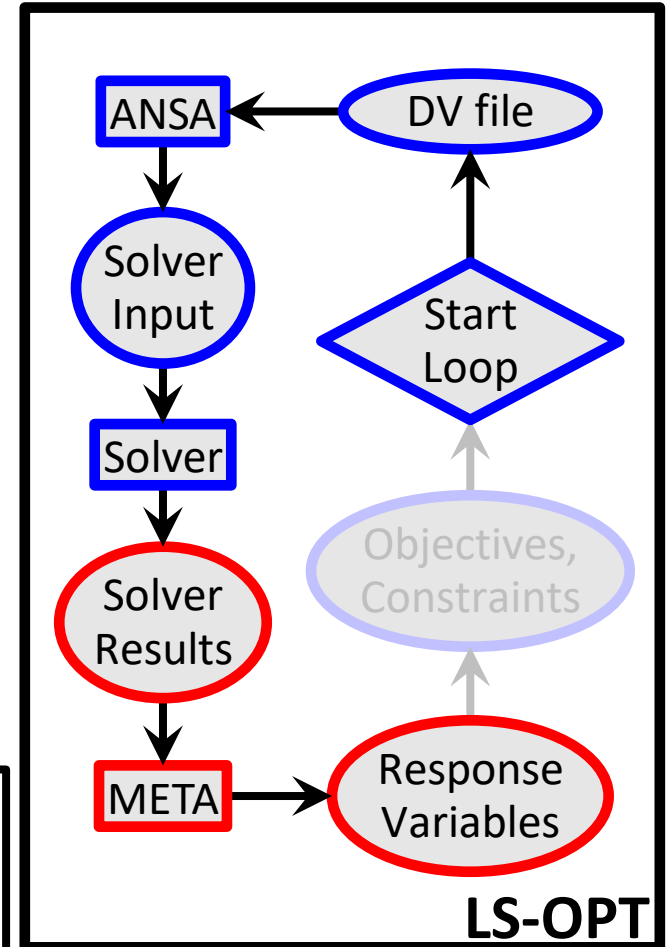
LS-OPT → ANSA → Solver → **META** → LS-OPT

META executes session file to extract responses from solver results

d3plot / *.op2 / *.odb



```
#OptimizerSetup Response & history File
RESPONSES
  1,nodes_rel_disp,0.174171448
  2,max_stress,169.780731
END
```

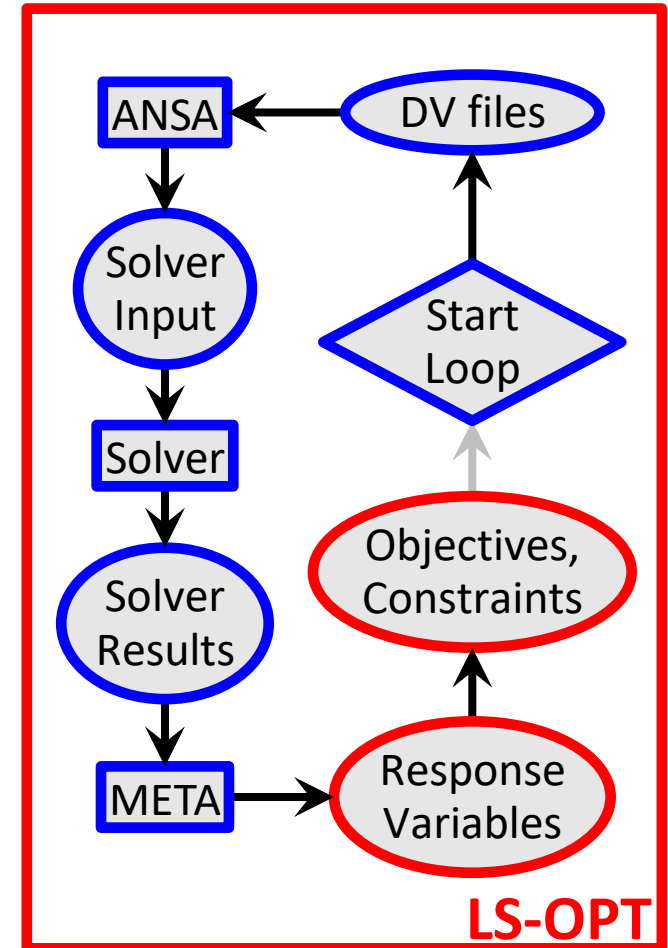
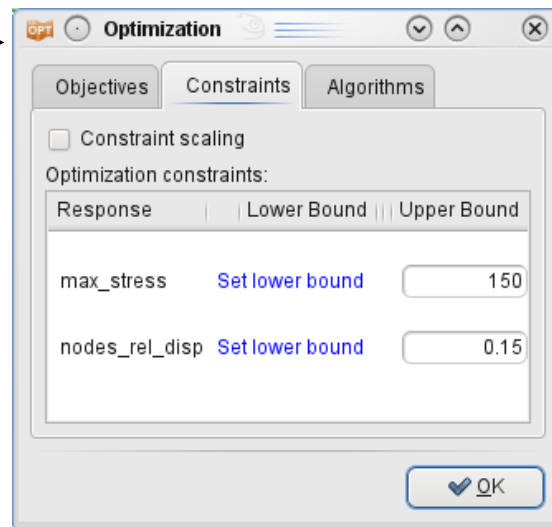


Optimization Run

LS-OPT → ANSA → Solver → META → **LS-OPT**

LS-OPT reads responses and evaluates objectives/constraints

```
#OptimizerSetup Response & history File
RESPONSES
1,nodes_rel_disp,0.174171448
2,max_stress,169.780731
END
```

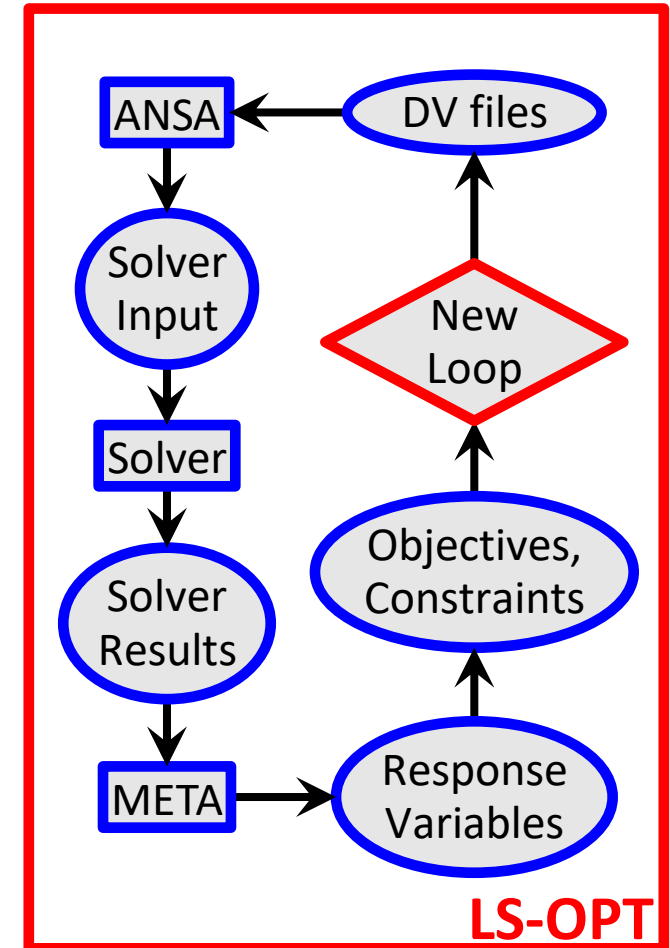
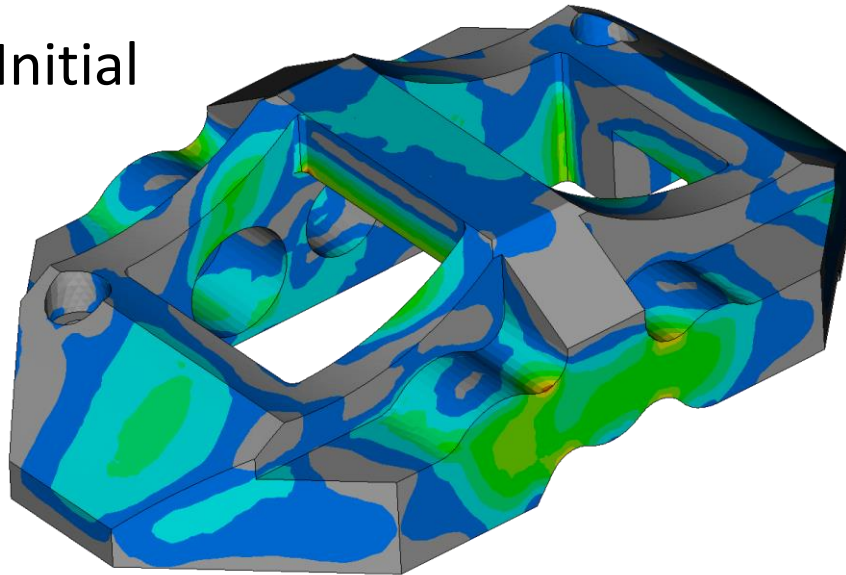


Optimization Run

LS-OPT → ANSA → Solver → META → **LS-OPT**

- LS-OPT calculates new values for DVs
- Whole process repeated until optimal solution

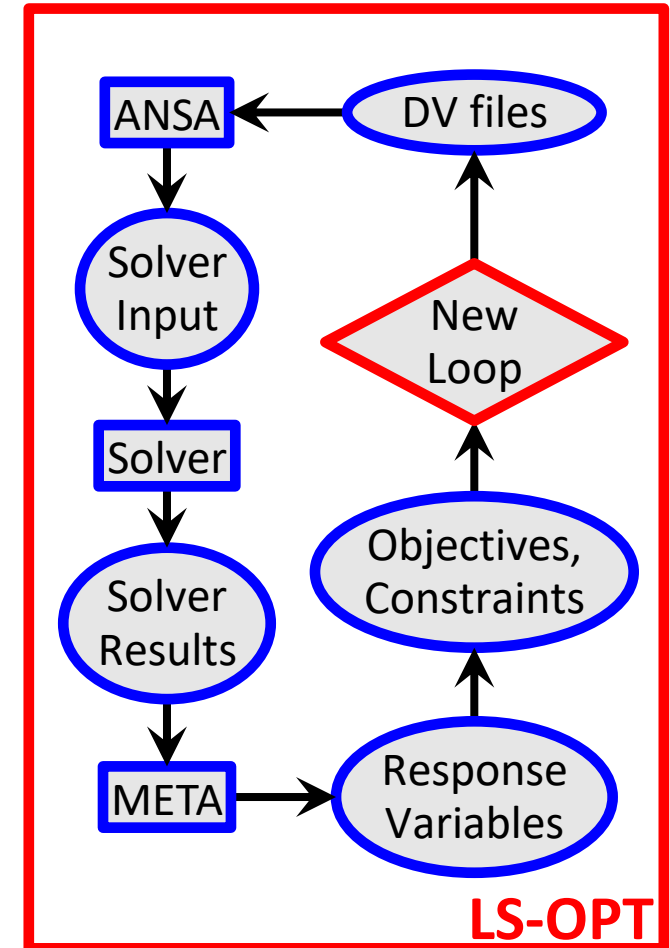
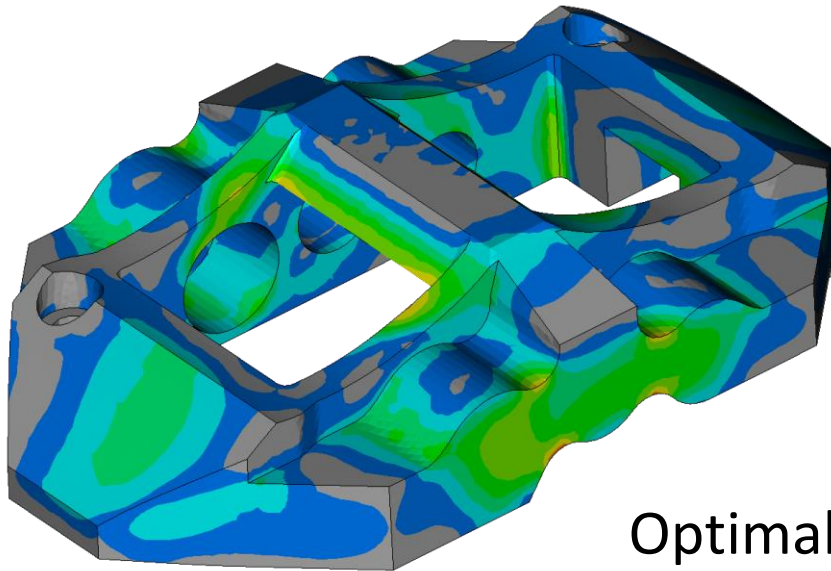
Initial



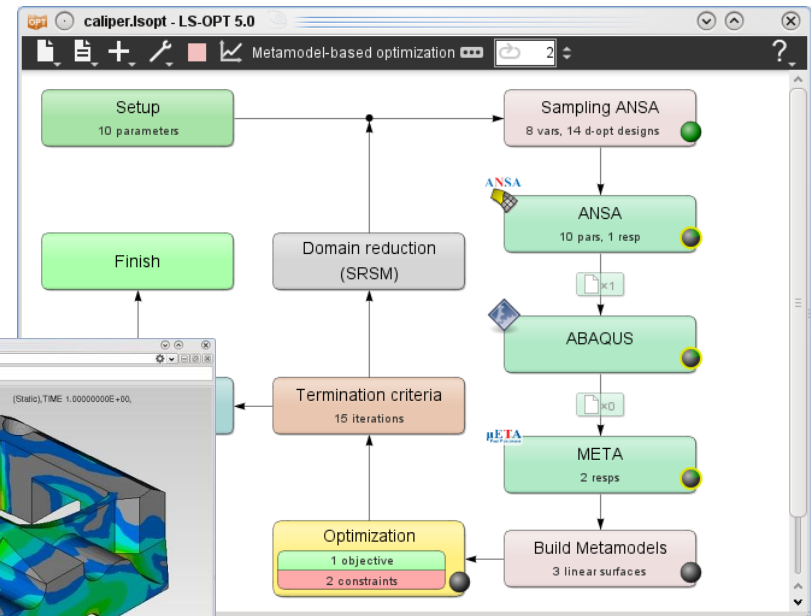
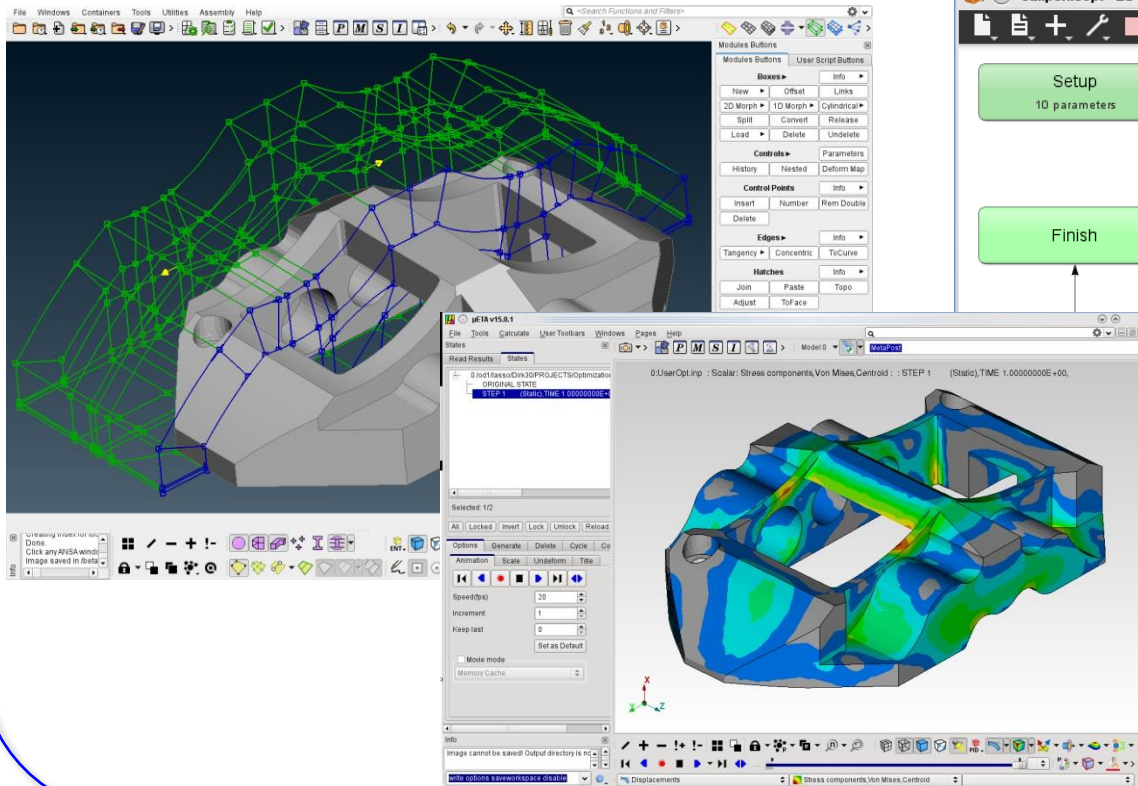
Optimization Run

LS-OPT → ANSA → Solver → META → **LS-OPT**

- LS-OPT calculates new values for DVs
- Whole process repeated until optimal solution



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