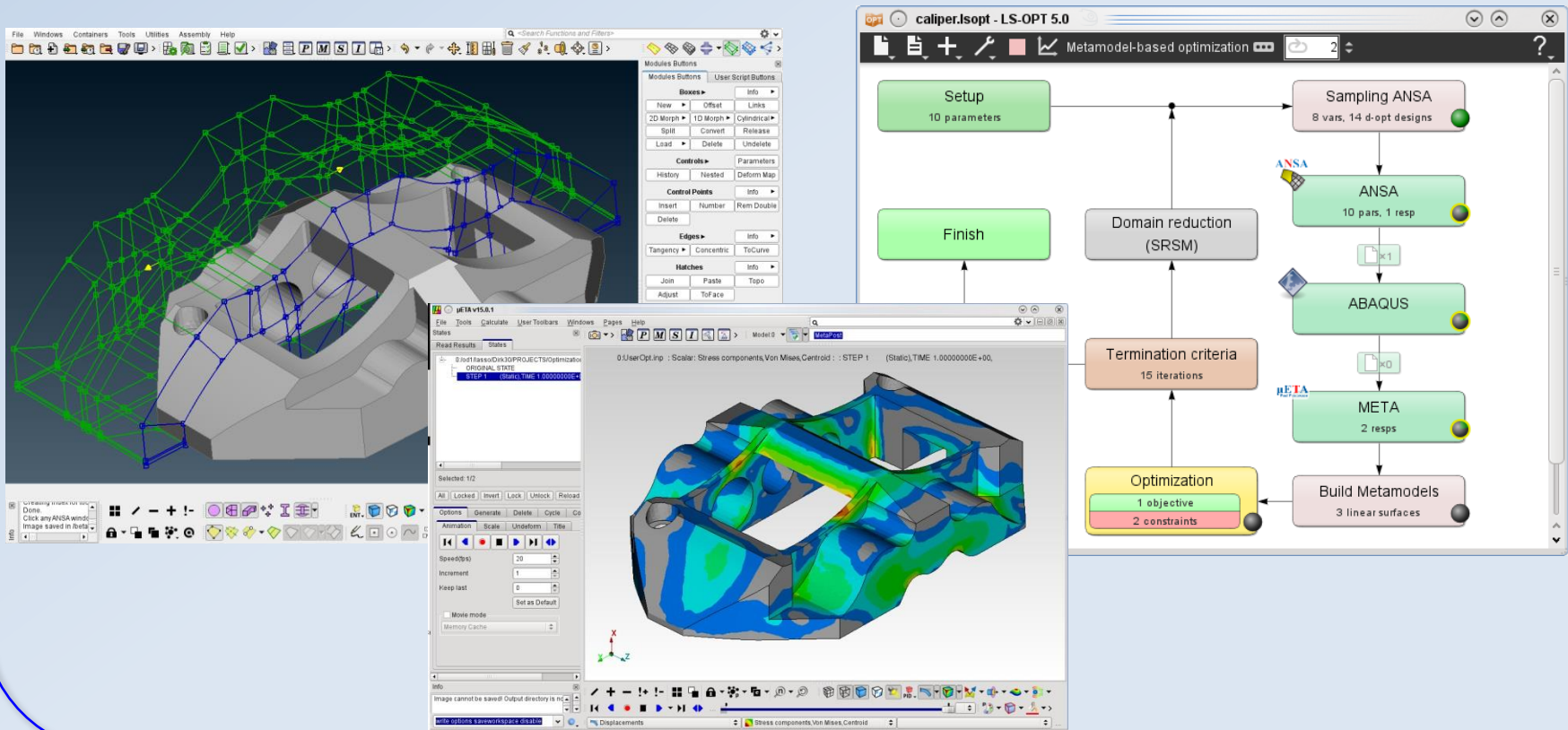


The interaction between LS-OPT, ANSA and μ ETA

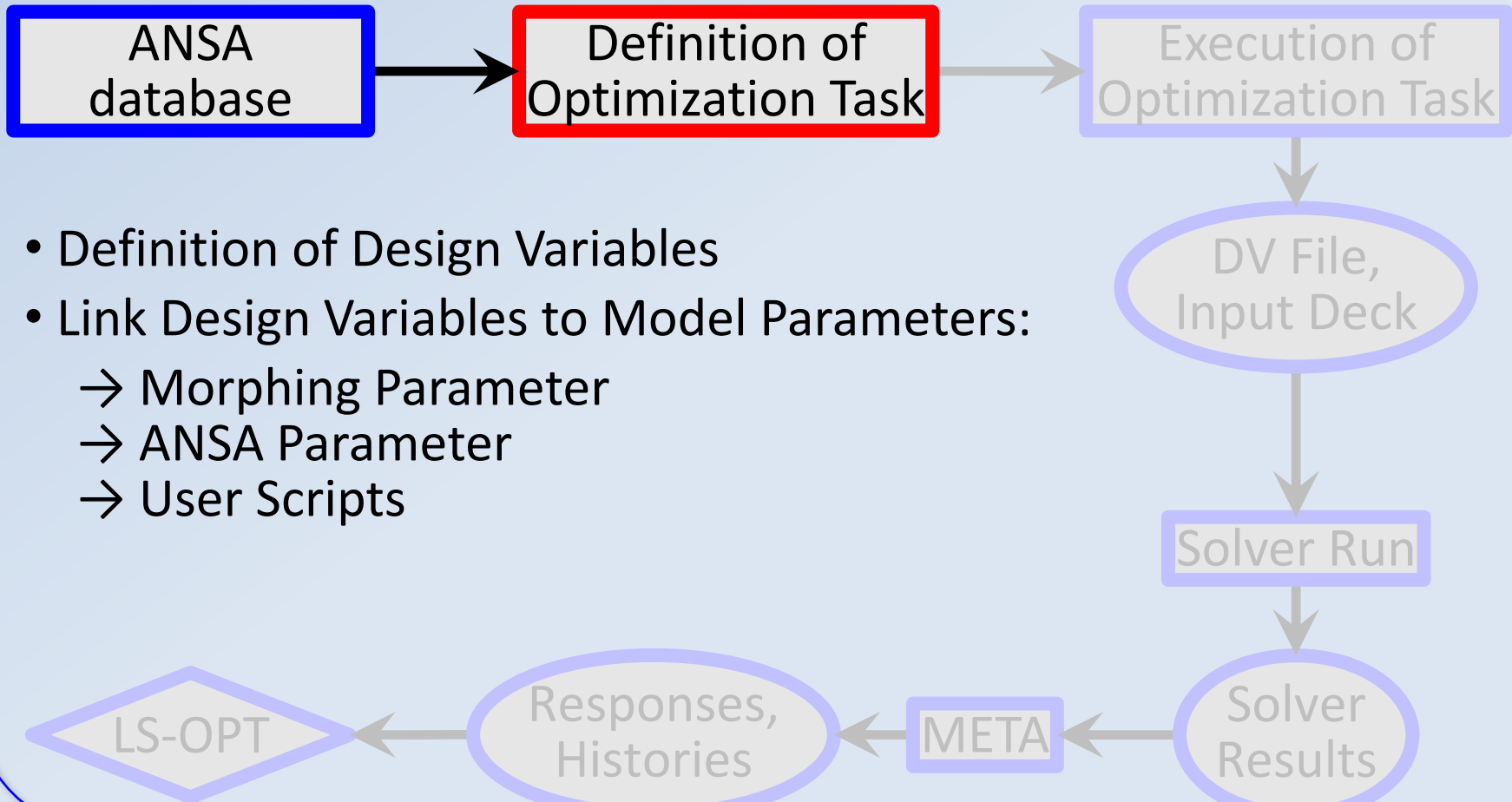


For what ANSA & μETA?

- **ANSA** for model-change according to design variables (everything besides LS-DYNA with *PARAMETER)
- **μETA** for results extraction of arbitrary (supported) solvers (besides LS-DYNA)
- **Setup phase**
 - design variables defined in **ANSA** → transfer to LS-OPT
 - histories and responses defined in **μETA** → transfer to LS-OPT
- **Optimization (Run) phase**
 - design variables controlled by LS-OPT → transfer to **ANSA**
 - histories and responses calculated by **μETA** → transfer to LS-OPT

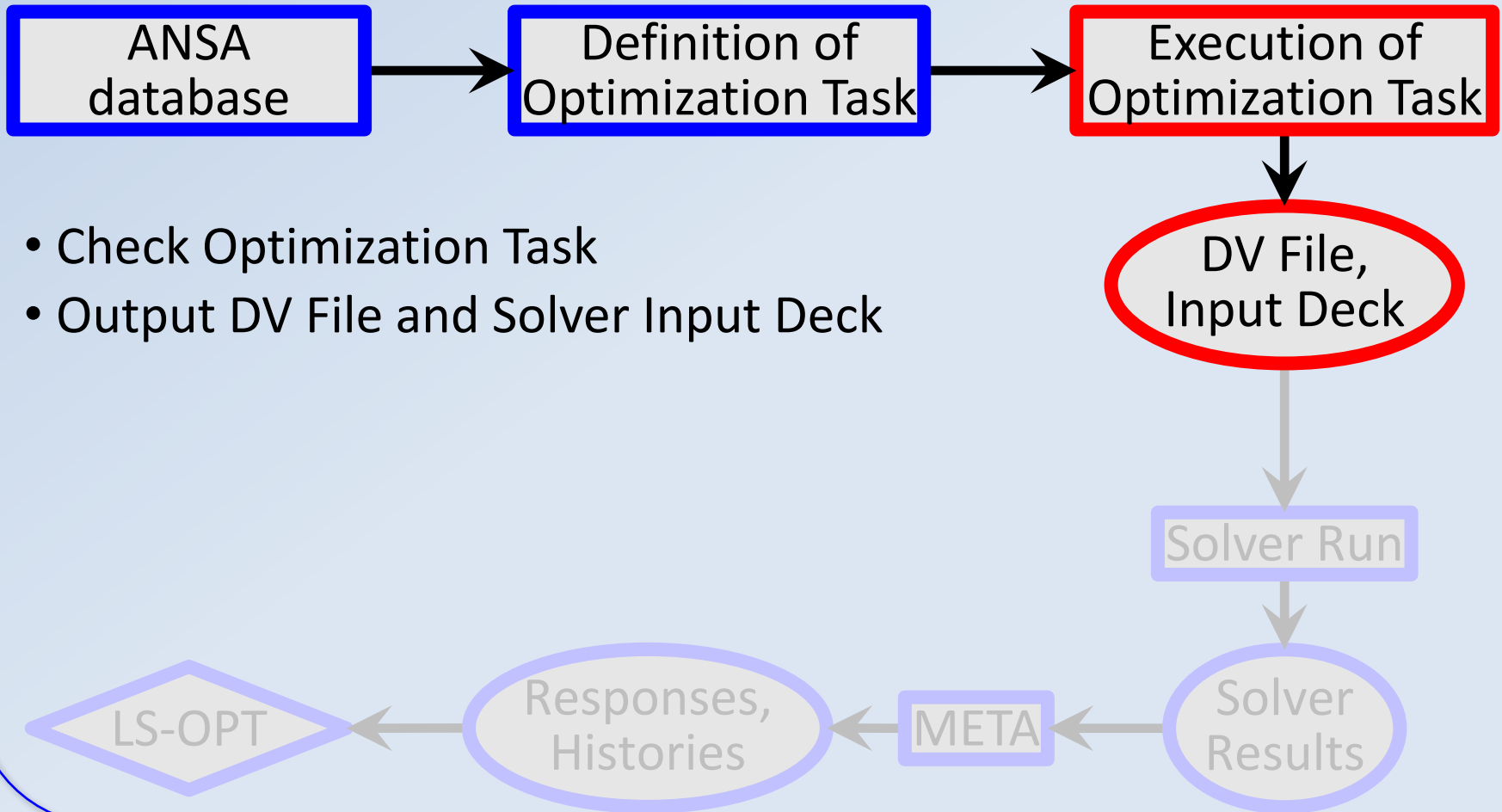
Optimization Setup

ANSA → Solver → META → LS-OPT



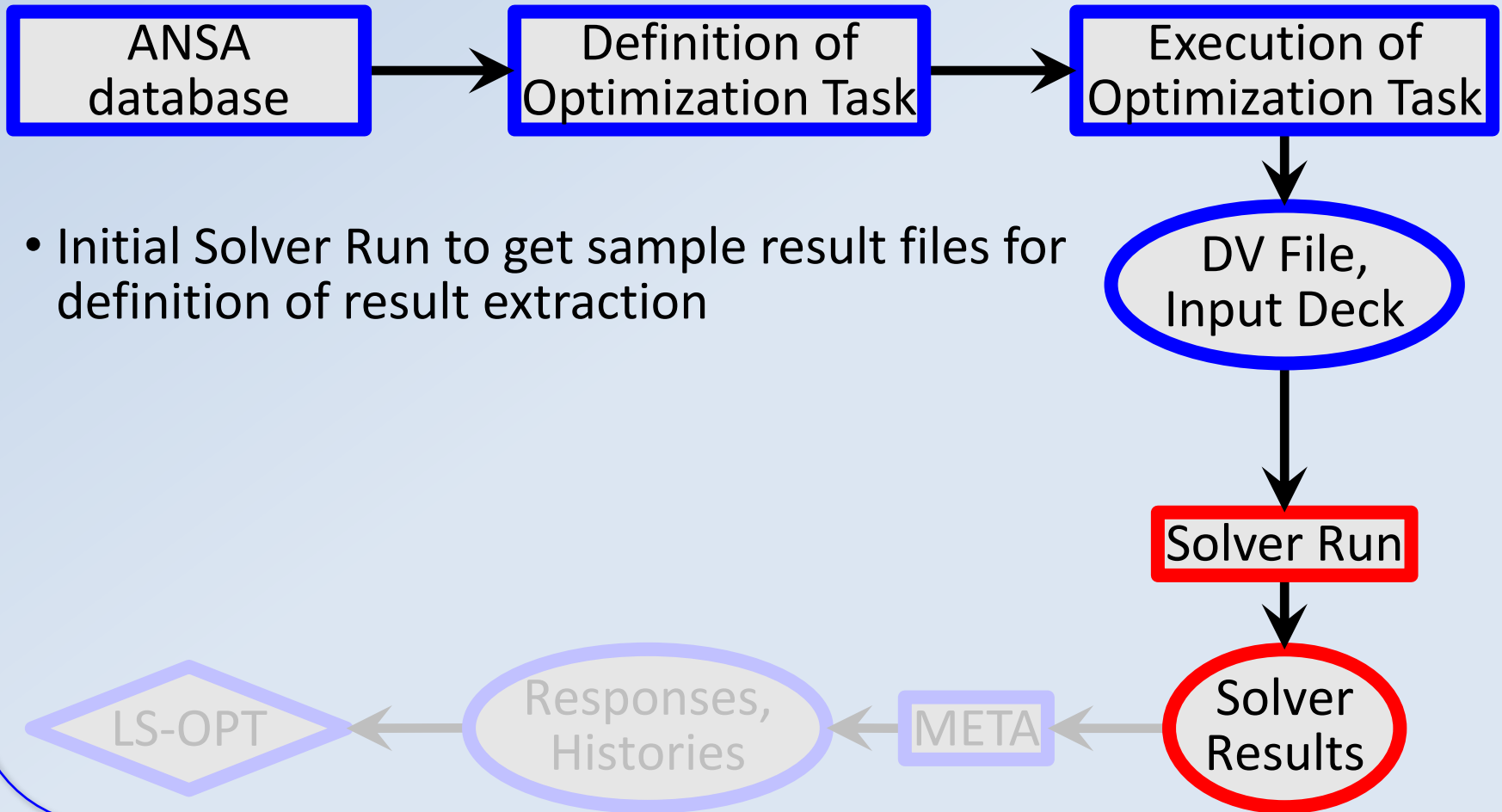
Optimization Setup

ANSA → Solver → META → LS-OPT



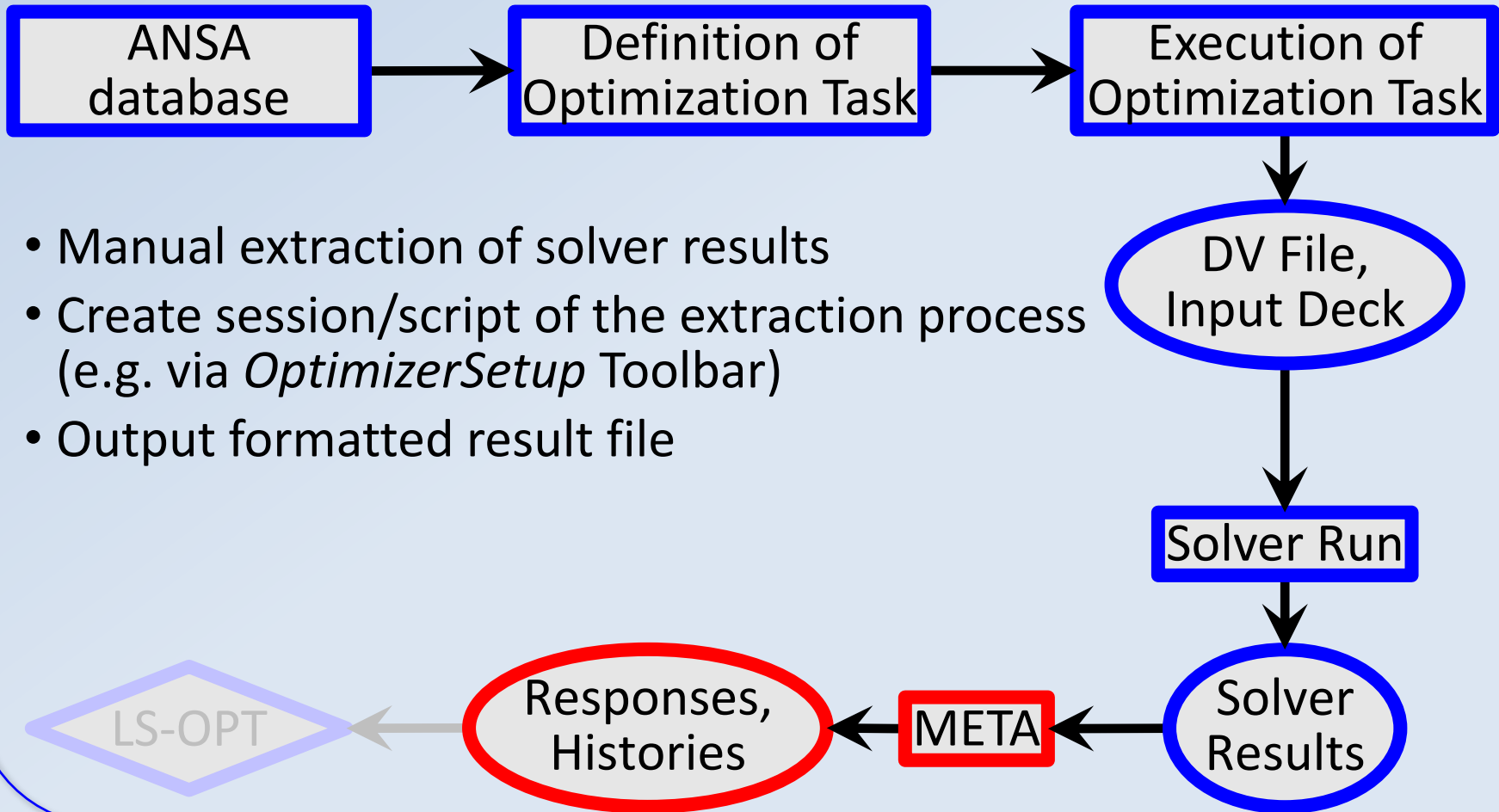
Optimization Setup

ANSA → **Solver** → META → LS-OPT



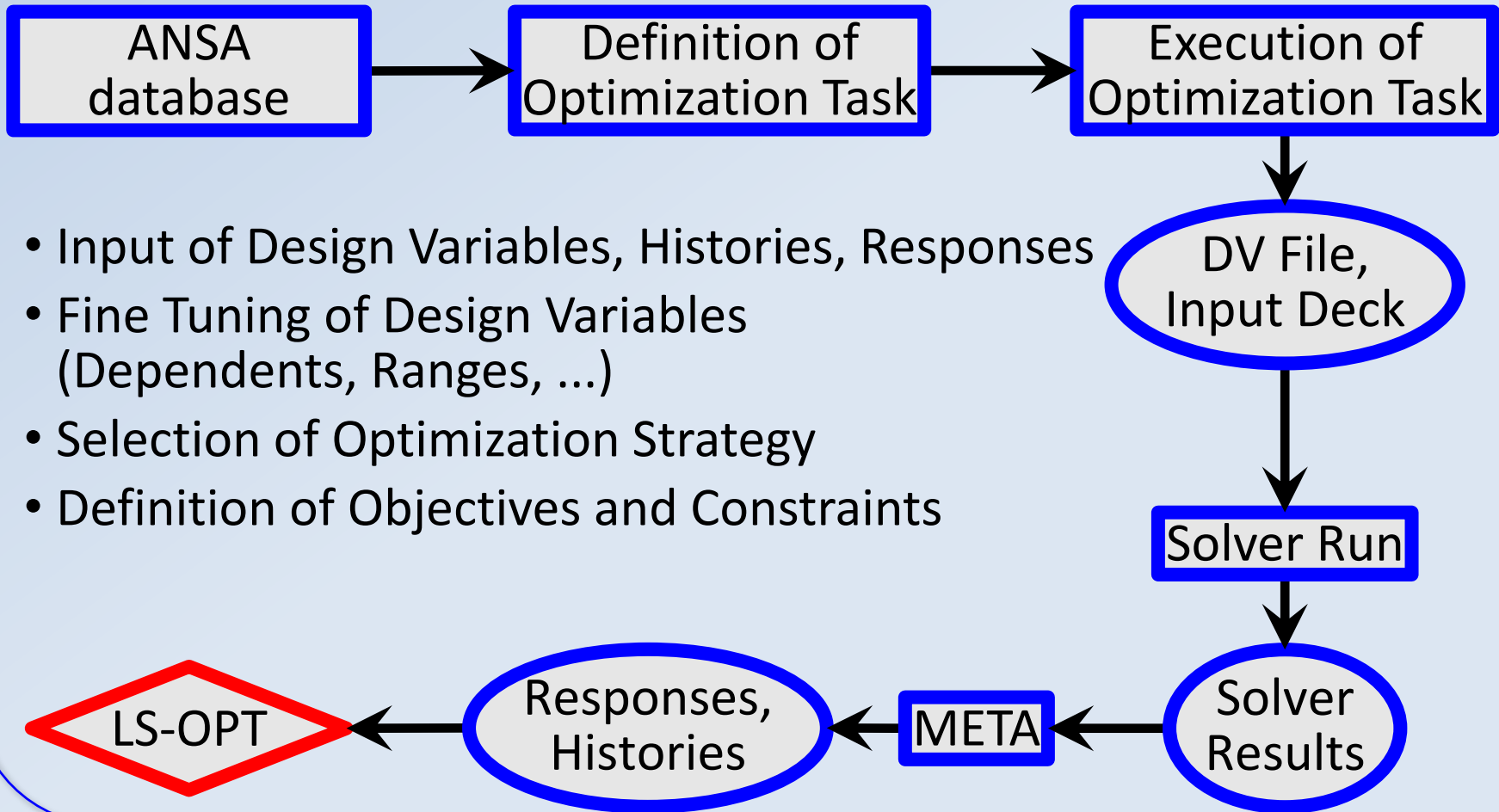
Optimization Setup

ANSA → Solver → **META** → LS-OPT



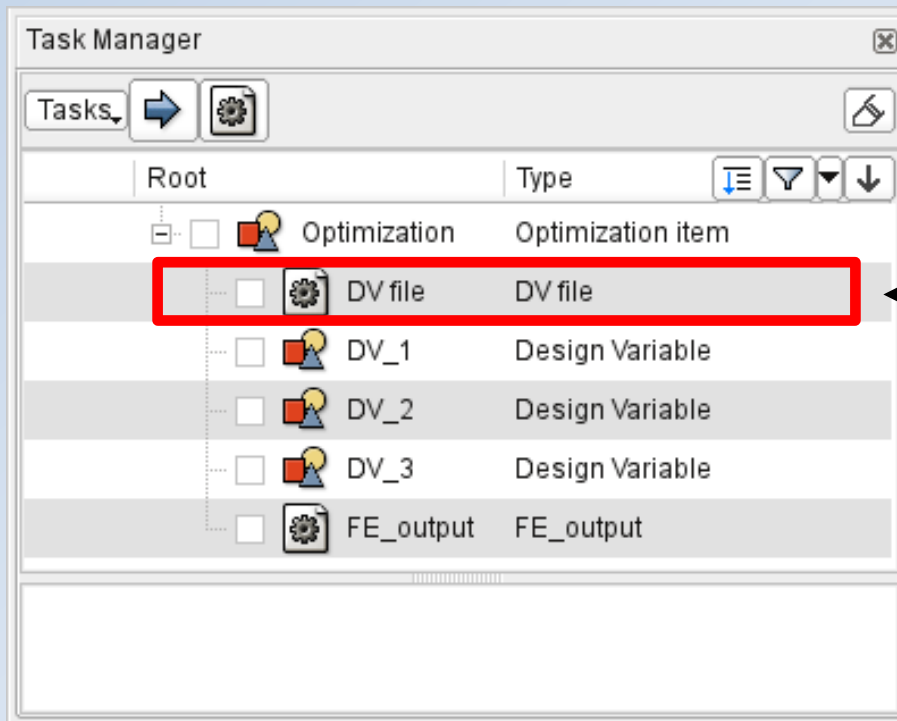
Optimization Setup

ANSA → Solver → META → **LS-OPT**



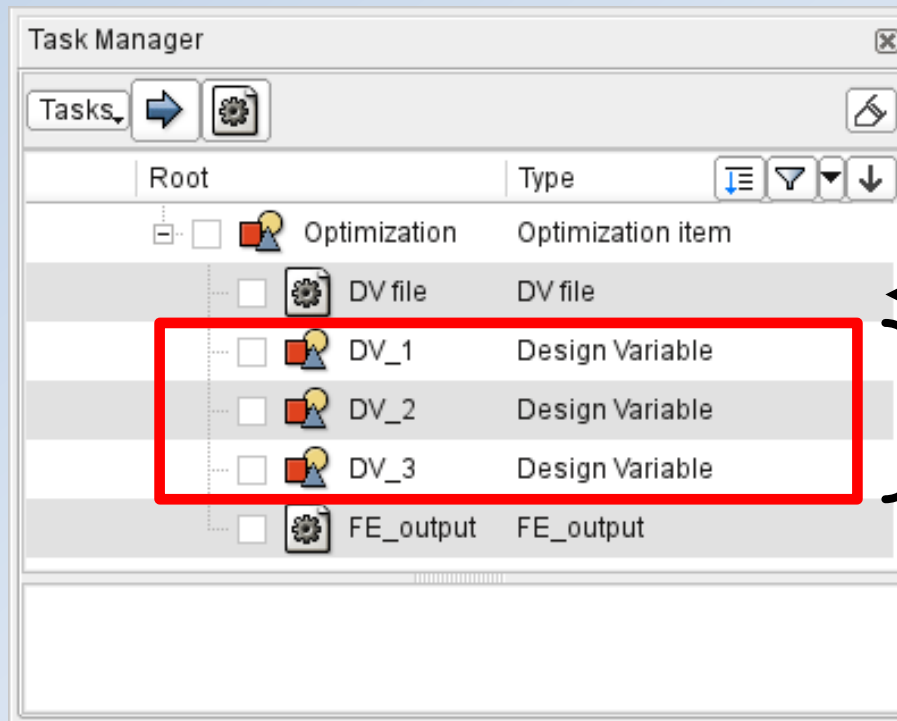
ANSA – Optimization Task

3 main task items



1. Design Variable File

ANSA – Optimization Task



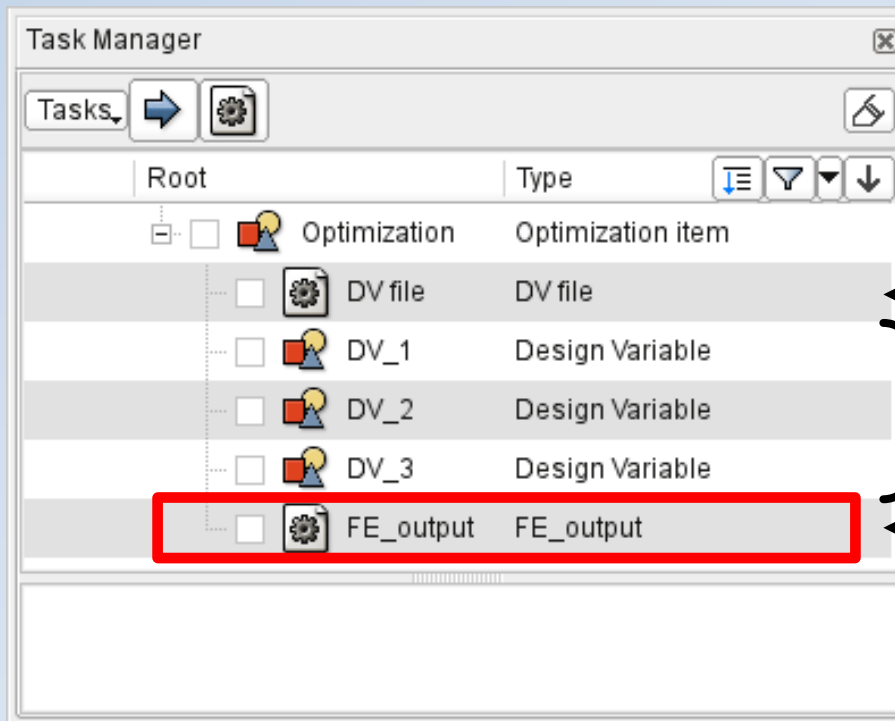
3 main task items

1. Design Variable File

2. Design Variables

ANSA – Optimization Task

3 main task items



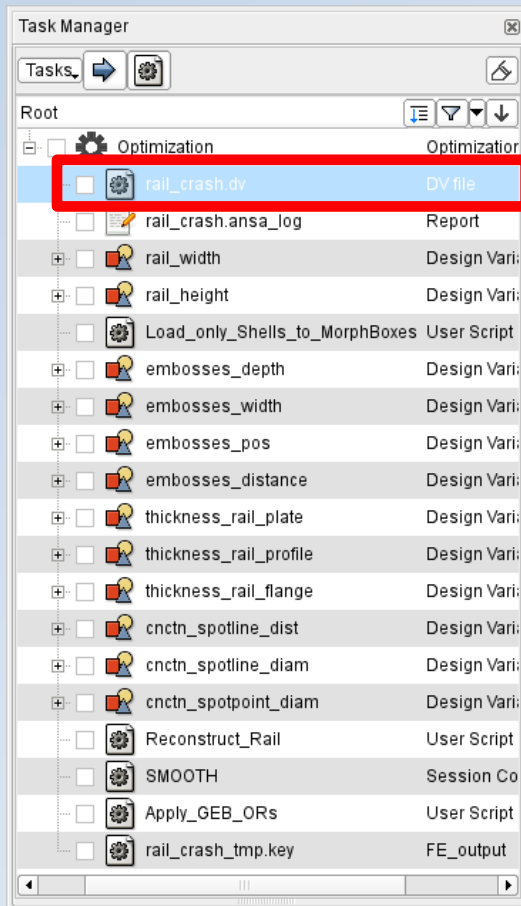
1. Design Variable File

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,  cncntn_spotline_dist, REAL,    BOUNDS,    50., 20., 100.
9,  cncntn_spotline_diam, REAL,    STEP,      5., 2., 10., 1.
12, cncntn_spotpoint_diam, REAL,    STEP,      5., 2., 10., 1.
#-----
```

Correctly formatted for
import in LS-OPT

ANSA – Optimization Task

Design Variables → Morphing Parameters

Task Manager

Tasks

Root

- Optimization
- rail_crash.dv (DV file)
- rail_crash.ansa_log (Report)
- rail_width (Design V)
- rail_height (Design V)
- Load_only_Shells_to_MorphBoxes (User Scri)
- embosses_depth (Design V)
- embosses_width (Design V)**
- emboss1_width (MORPH P)
- emboss2_width (MORPH P)
- emboss3_width (MORPH P)
- embosses_pos (Design V)
- embosses_distance (Design V)
- thickness_rail_plate (Design V)
- thickness_rail_profile (Design V)
- thickness_rail_flange (Design V)
- cnctn_spotline_dist (Design V)
- cnctn_spotline_diam (Design V)
- cnctn_spotpoint_diam (Design V)
- Reconstruct_Rail (User Scri)

DESIGN VARIABLE [DESIGN_VARIABLE]

Name: **embosses_width**

ID	TYPE	RANGE
3	REAL	BOUNDS

Min Value: -10 Current Value: 10 Max Value: 10

Comment: **embosses_width**

OK Cancel

Morph Parameter Table for embosses_width

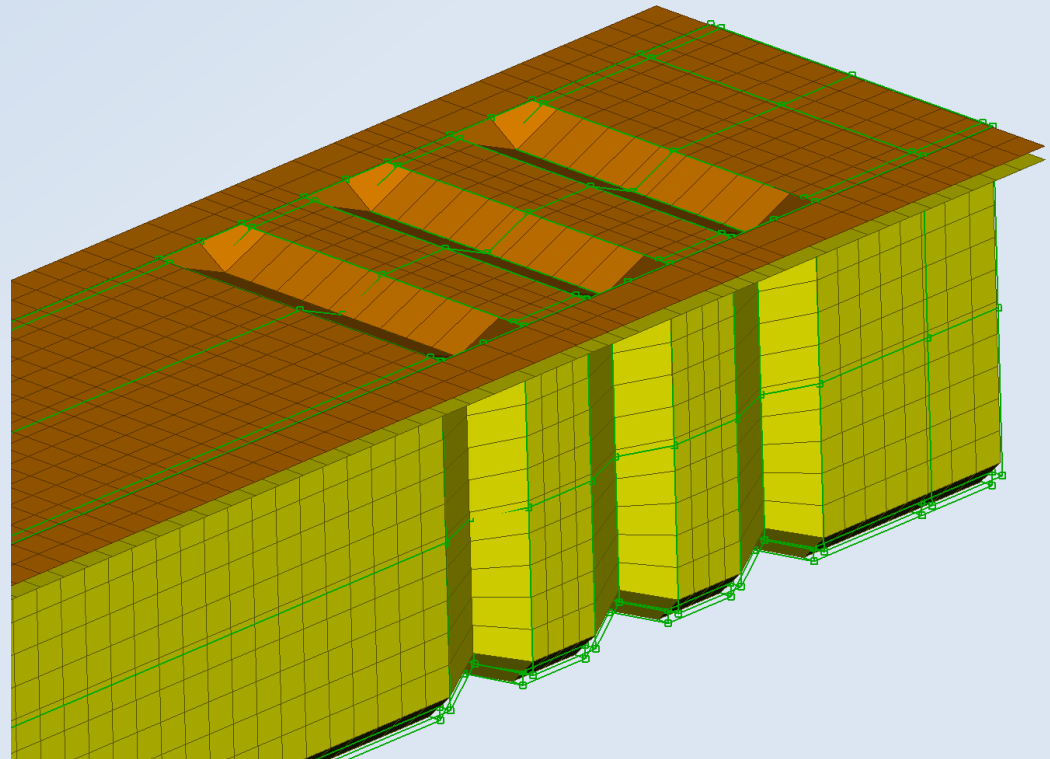
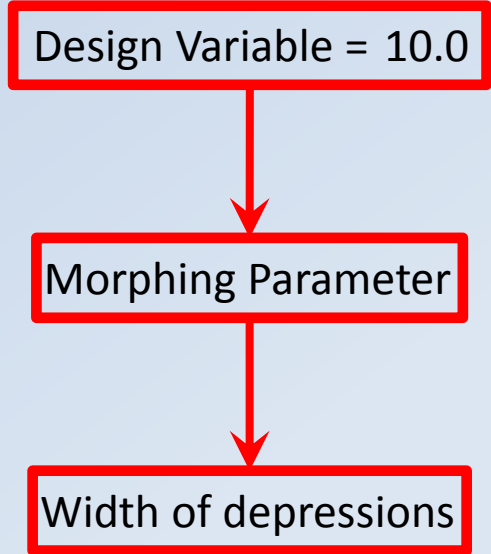
Id	Name	Type	Current value	Expression	Used by DV	At the end apply
11	emboss3_depth unt	Translate	embosses_width		embosses_depth	Nothing
13	emboss1_width	Translate	embosses_width/2		embosses_width	Nothing
14	emboss2_width	Translate	embosses_width/2		embosses_width	Nothing
15	emboss3_width	Translate	embosses_width/2		embosses_width	Nothing
16	embosses_pos	Translate	embosses_width		embosses_pos	Nothing

OK Cancel

ANSA – Optimization Task

Design Variables → Morphing Parameters

Shape modification



ANSA – Optimization Task

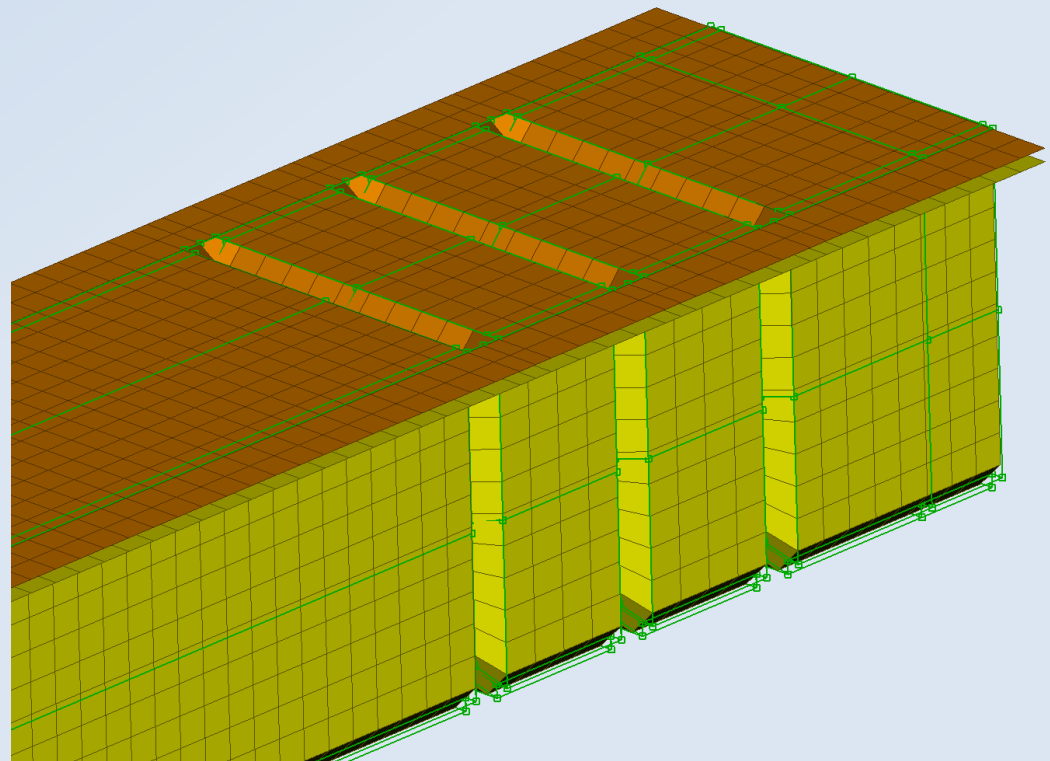
Design Variables → Morphing Parameters

Shape modification

Design Variable = -5.0

Morphing Parameter

Width of depressions



ANSA – Optimization Task

Design Variables → ANSA Parameters

Task Manager window showing a list of design variables. The 'thickness_rail_plate' variable is highlighted in blue, and its corresponding 'A_PARAM' entry is highlighted with a red box.

DESIGN VARIABLE [DESIGN_VARIABLE] dialog box. It shows the configuration for the 'thickness_rail_plate' variable, including ID 4, REAL type, STEP range, and values for Min Value (0.5), Current Value (1.5), Max Value (2.), and Step Value (0.1).

A_PARAMETER dialog box showing a table of parameters. The first row, '1 thickness_rail_plate 1.5', is highlighted with a red box.

Id	Name	Value
1	thickness_rail_plate	1.5
2	thickness_rail_profile	1.5
3	connection_spotweld_distance	50.
4	connection_spotweld_diameter	6.0
5	thickness_rail_flange	2.

ANSA – Optimization Task

Design Variables → ANSA Parameters

Modification of shell thicknesses, materials, etc.

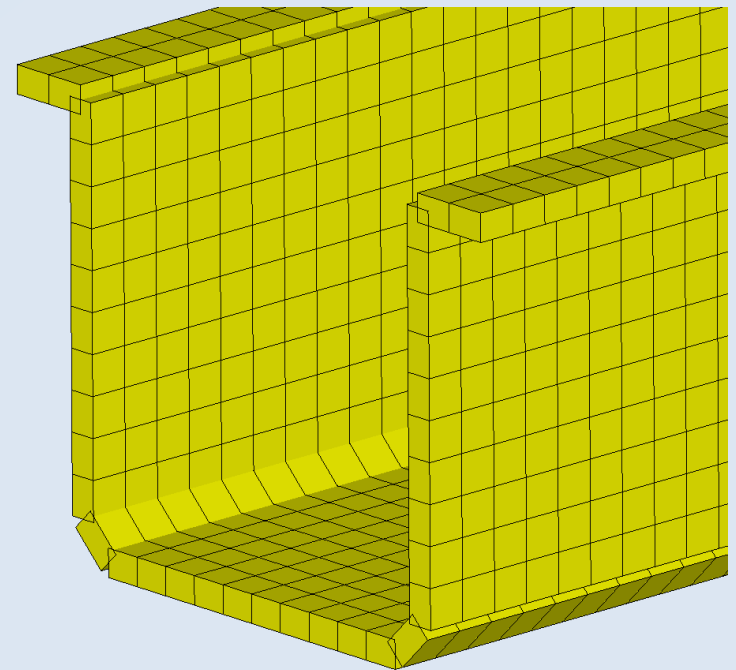
*PART & *SECTION_SHELL [SECTION_SHELL]

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 = 5.0

ANSA – Optimization Task

Design Variables → ANSA Parameters

Modification of shell thicknesses, materials, etc.

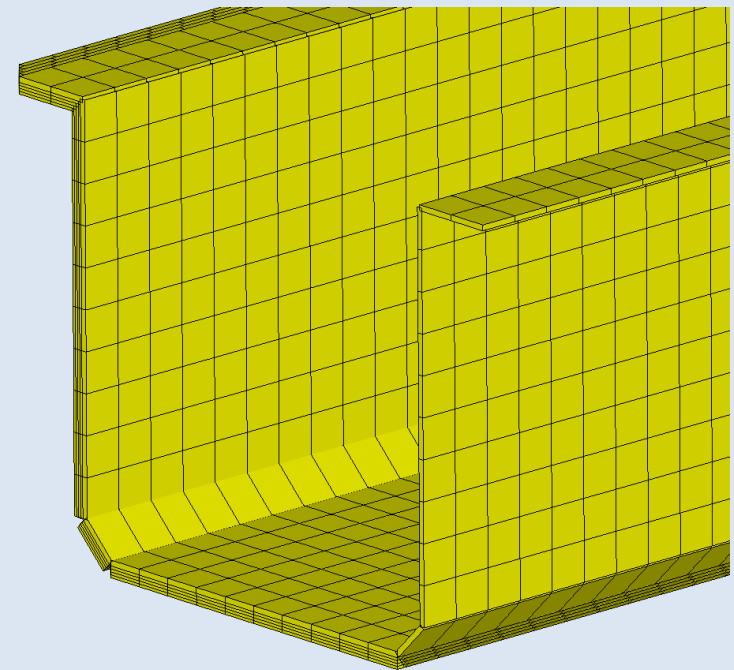
*PART & *SECTION_SHELL [SECTION_SHELL]

Name: rail_profile

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

PID	SECID	MID	EOSID	HGID	GRAV	ADDOPT	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



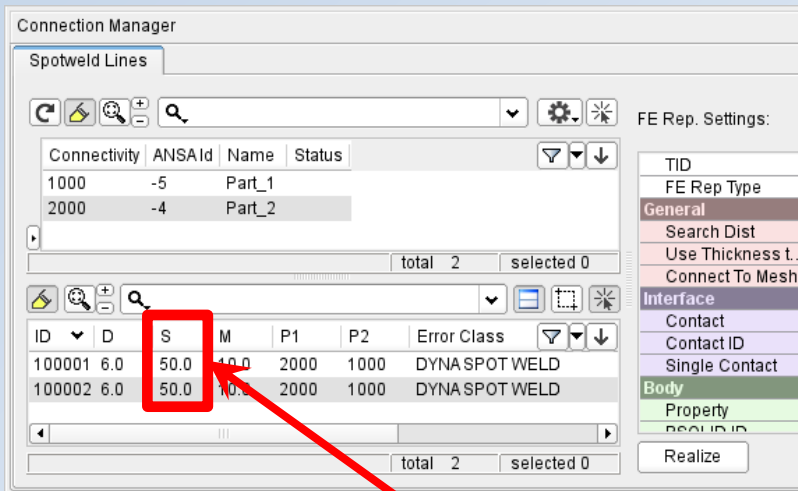
ANSA Parameter

Design Variable = 1.0

ANSA – Optimization Task

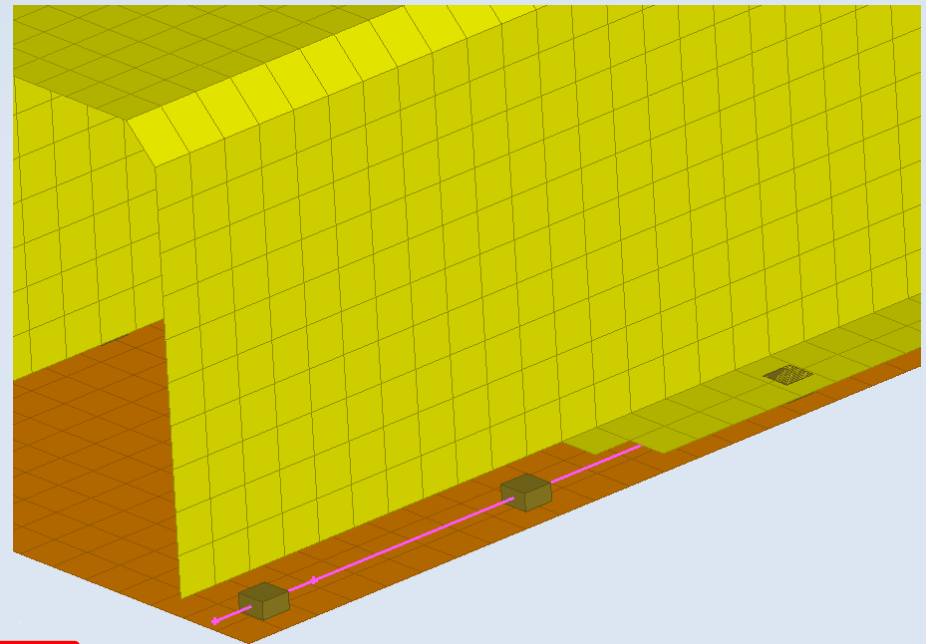
Design Variables → ANSA Parameters

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



ANSA Parameter

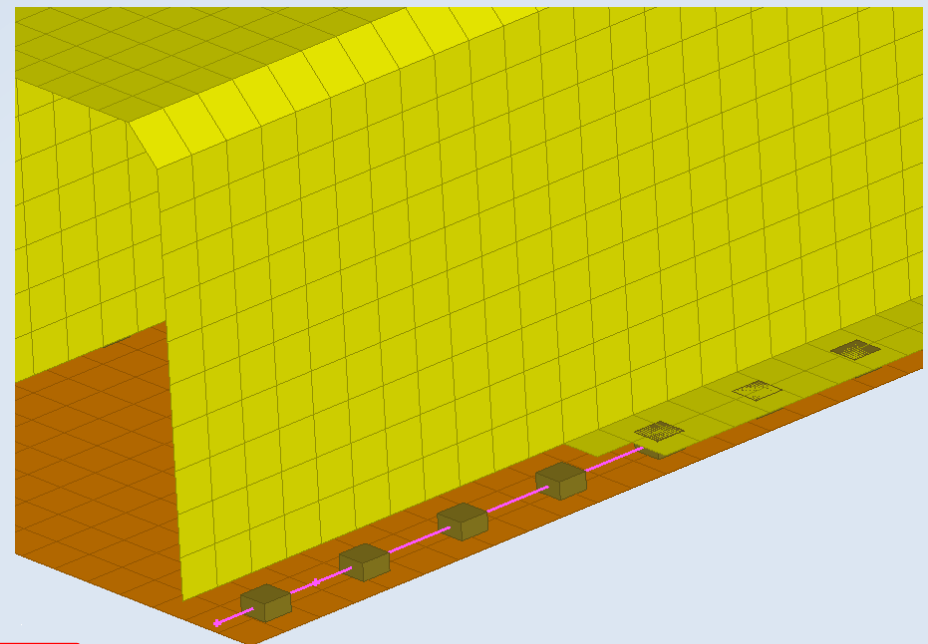
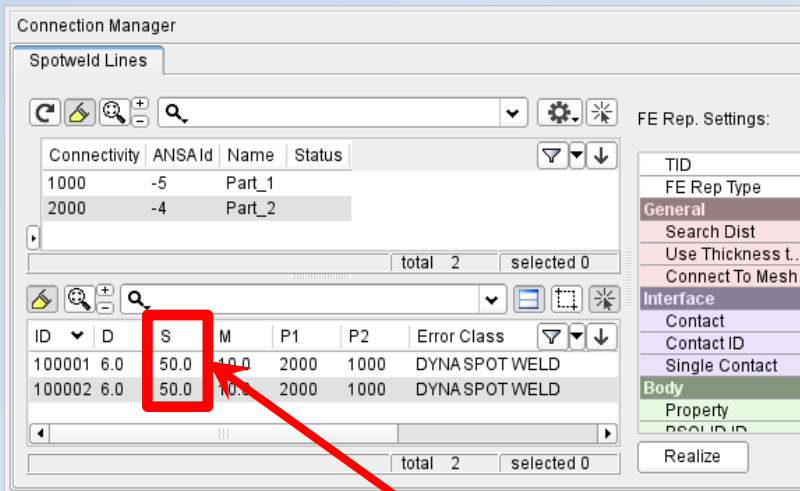
Design Variable (weld spot distance) = 50



ANSA – Optimization Task

Design Variables → ANSA Parameters

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



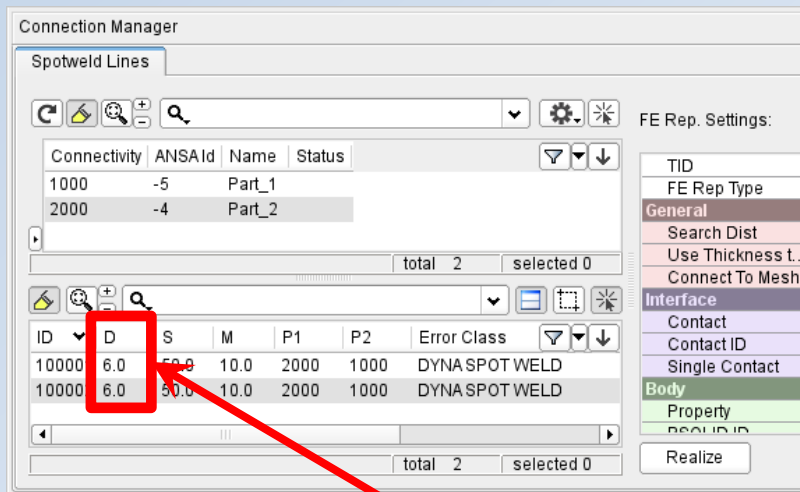
ANSA Parameter

Design Variable (weld spot distance) = 20

ANSA – Optimization Task

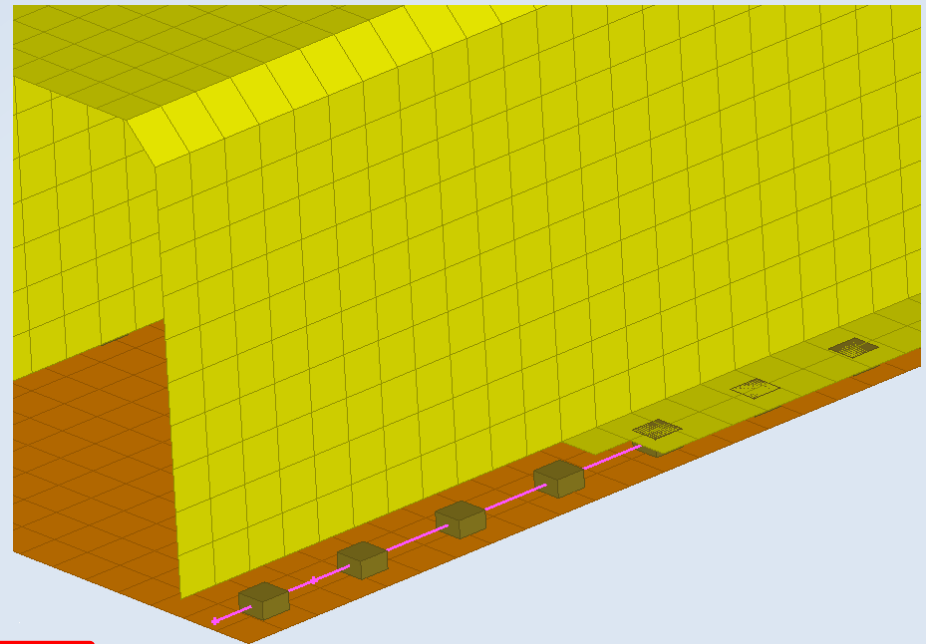
Design Variables → ANSA Parameters

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



ANSA Parameter

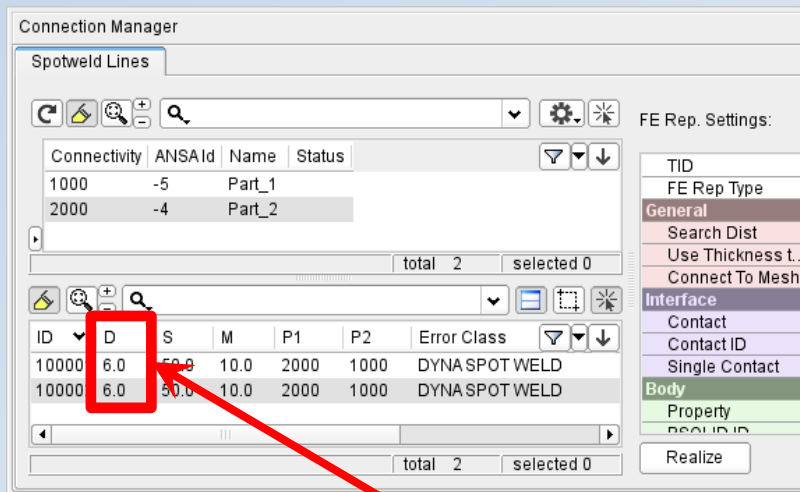
Design Variable (weld spot diameter) = 6.0



ANSA – Optimization Task

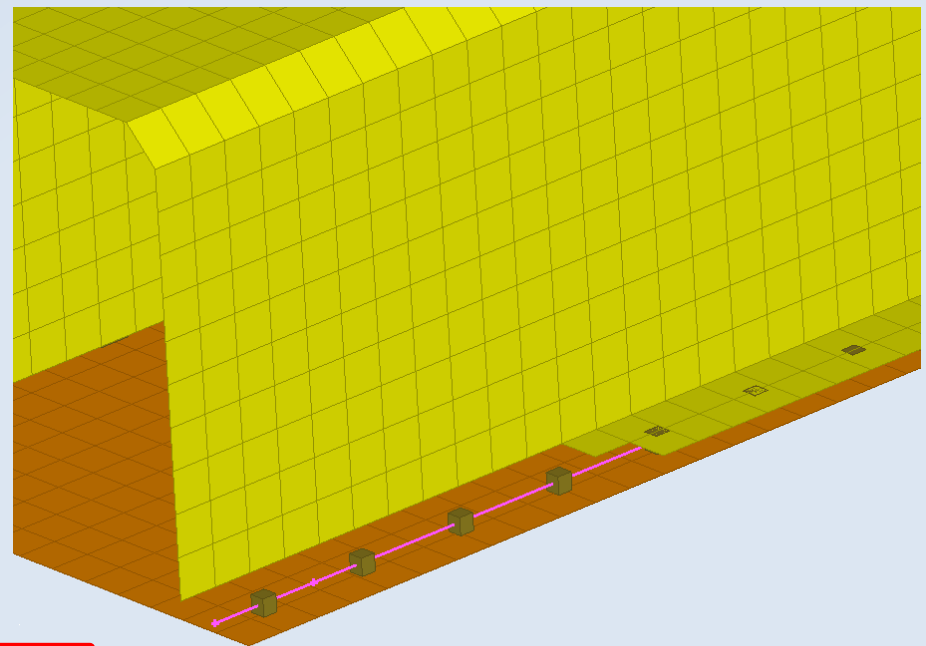
Design Variables → ANSA Parameters

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



ANSA Parameter

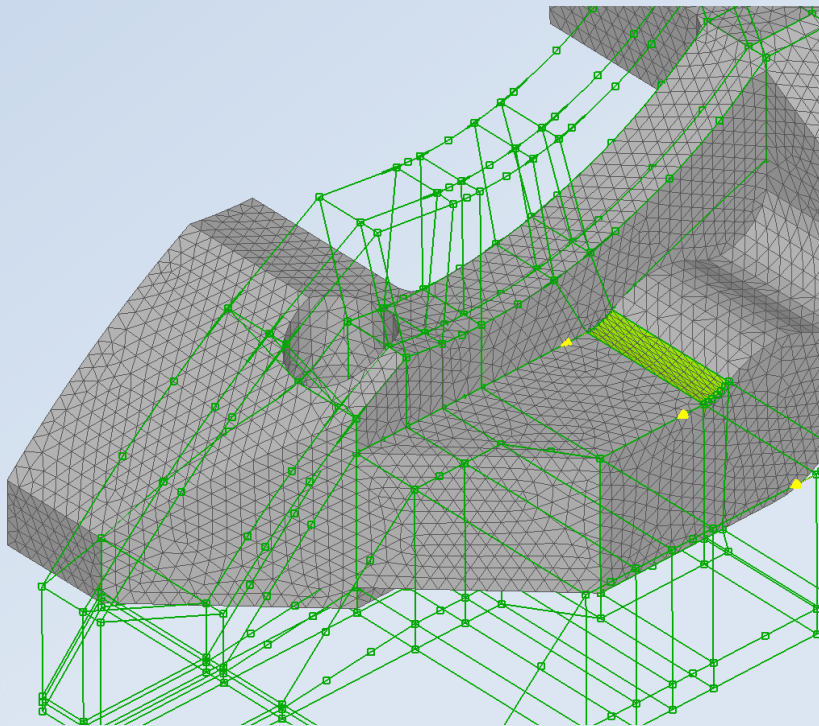
Design Variable (weld spot diameter) = 3.0



ANSA – Optimization Task

Simulation & DOE

- Checking Combinations of DV (Full Factorial) → Model Validity
- Checking Element Criteria



Simulate and DOE

Id	Name	Range	Min	Max
3	DV_Hoehe_Mittelsteg	Bounds	-5.	12.
2	DV_Breite_Seitensteg	Bounds	0.	10.
1	DV_Breite_Flachsteg_oben	Bounds	0.	20.
6	DV_Breite_Flachsteg_unten	Bounds	0.	25.
9	DV_Hoehe_Nase	Bounds	0.	10.
4	DV_Breite_Mittelsteg_ob_au	Bounds	-20.	13.
7	DV_Breite_Mittelsteg_ob_in	Bounds	-20.	13.
5	DV_Breite_Mittelsteg_un_au	Bounds	-13.	10.
8	DV_Breite_Mittelsteg_un_in	Bounds	-13.	10.
10	DV_Breite_Nase	Bounds	0.	20.

	DV_Breit	DV_Brei							
1	0.	0.							
2	2.	5.							
3	4.	10.							
4	6.	15.							
5	8.	20.							
6	10.	25.							

Simulate Run Task Experiments Clear table

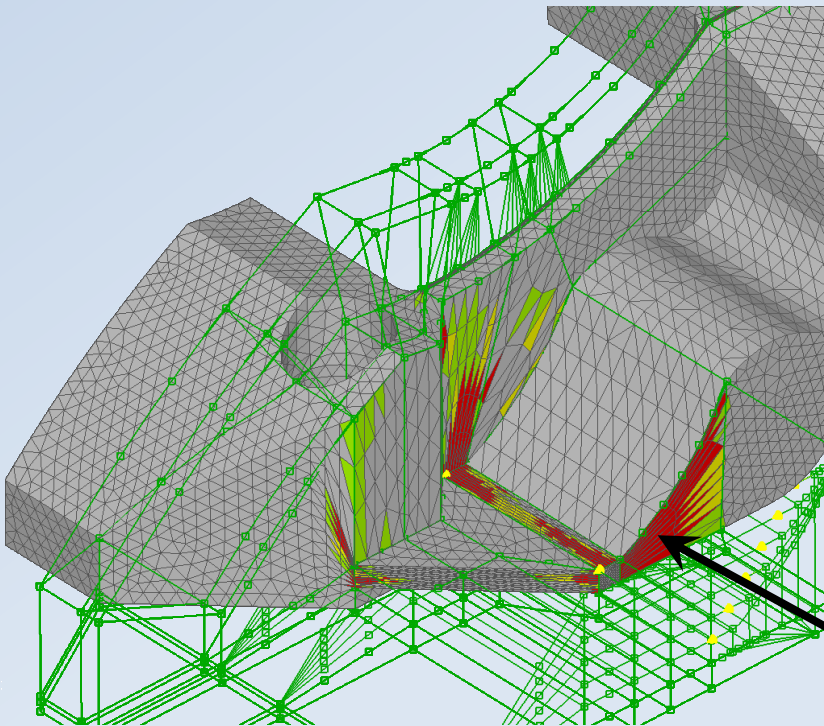
Algorithm..
Simulate
Generate Steps: 6

Simulation info

ANSA – Optimization Task

Simulation & DOE

- Checking Combinations of DV (Full Factorial) → Model Validity
- Checking Element Criteria



Simulate and DOE

Id	Name	Range	Min	Max
3	DV_Hoehe_Mittelsteg	Bounds	-5.	12.
2	DV_Breite_Seitensteg	Bounds	0.	10.
1	DV_Breite_Flachsteg_oben	Bounds	0.	20.
6	DV_Breite_Flachsteg_unten	Bounds	0.	25.
9	DV_Hoehe_Nase	Bounds	0.	10.
4	DV_Breite_Mittelsteg_ob_au	Bounds	-20.	13.
7	DV_Breite_Mittelsteg_ob_in	Bounds	-20.	13.
5	DV_Breite_Mittelsteg_un_au	Bounds	-13.	10.
8	DV_Breite_Mittelsteg_un_in	Bounds	-13.	10.
10	DV_Breite_Nase	Bounds	0.	20.

	DV_Breit	DV_Brei							
1	0.	0.							
2	2.	5.							
3	4.	10.							
4	6.	15.							
5	8.	20.							
6	10.	25.							

Simulate Run Task Experiments Clear table

Algorithm..
Simulate
Generate Steps: 6

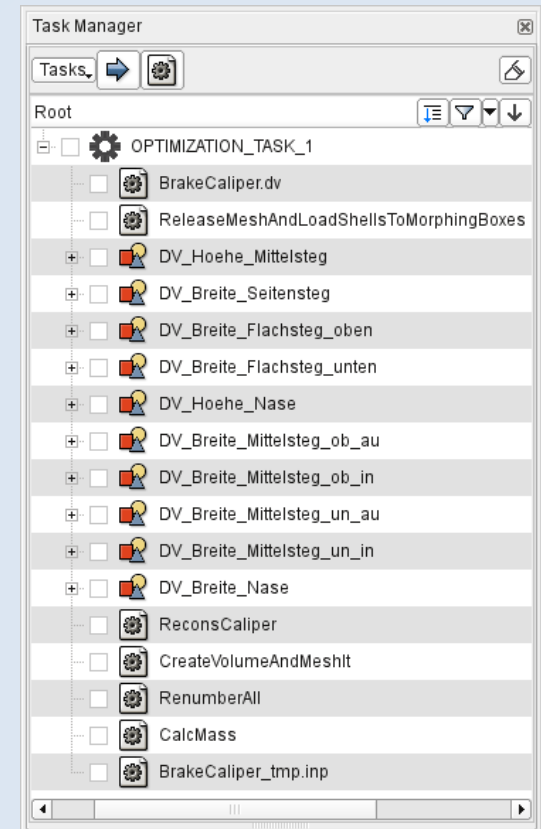
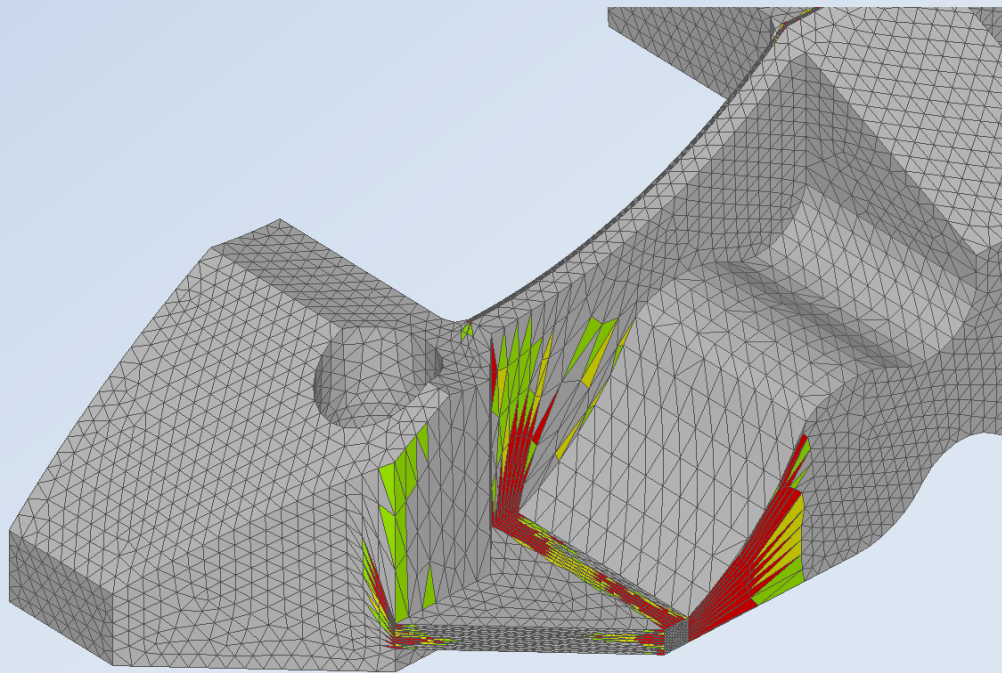
Simulation info

Failed elements

ANSA – Optimization Task

Additional commands for improving mesh quality

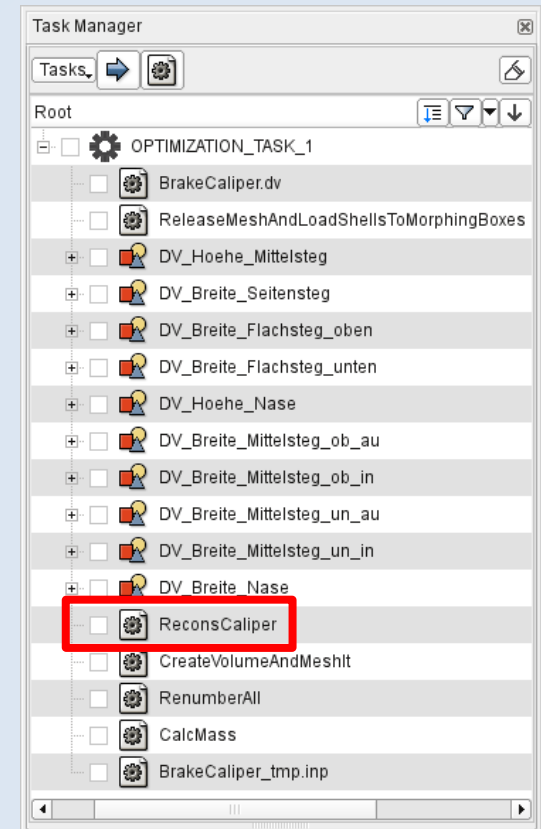
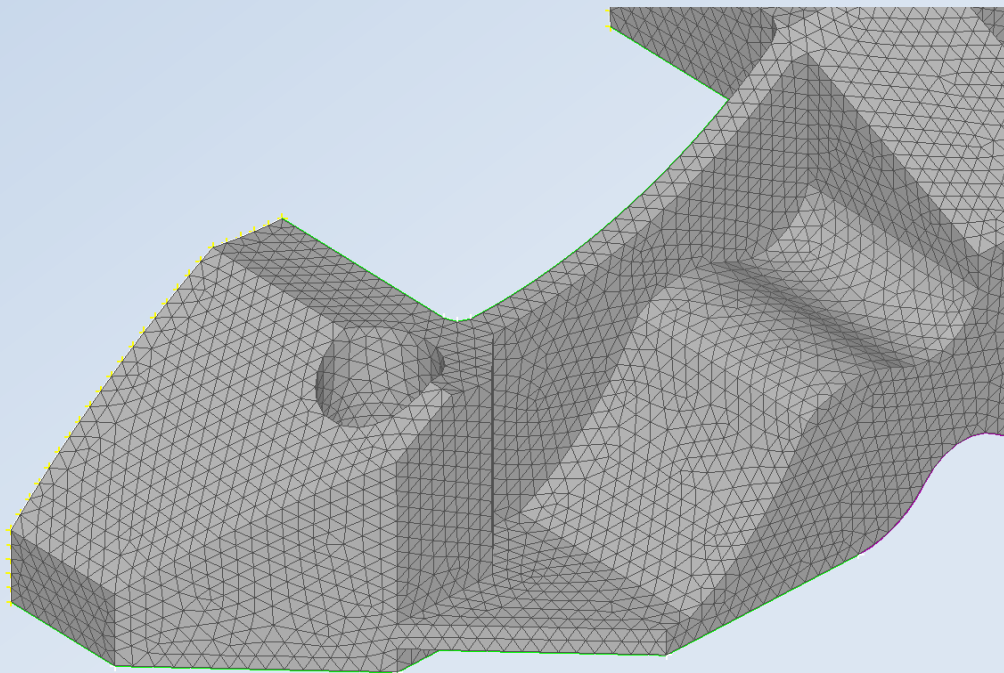
Fix Quality, Smooth, Reconstruct, etc. for morphed mesh



ANSA – Optimization Task

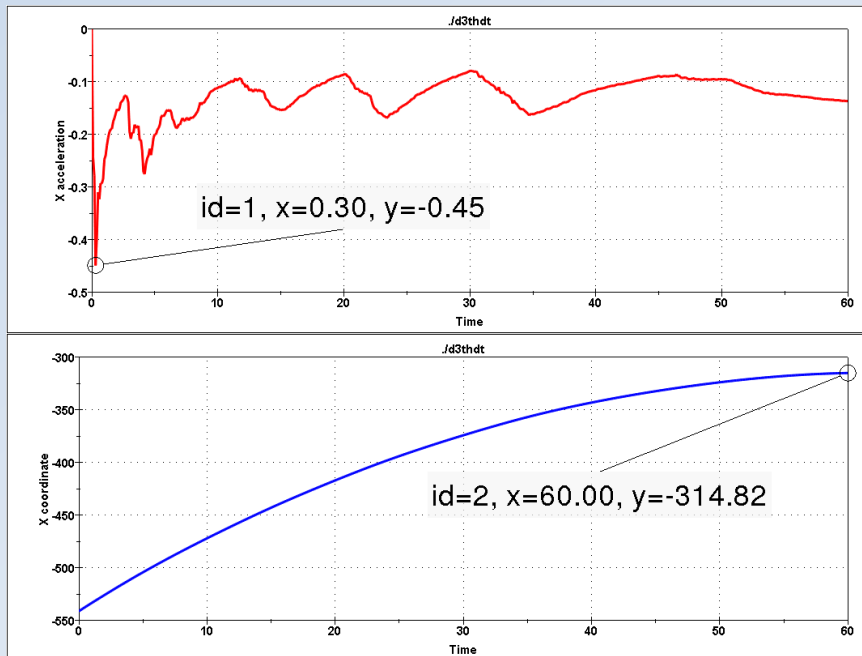
Additional commands for improving mesh quality

Fix Quality, Smooth, Reconstruct, etc. for morphed mesh



μ ETA – OptimizerSetup Toolbar

- Responses from annotations, variables, advanced expressions



The screenshot shows the 'OptimizerSetup' toolbar with the following sections and controls:

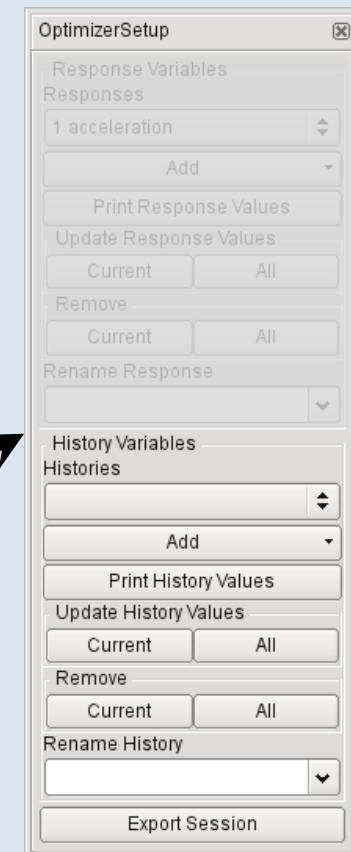
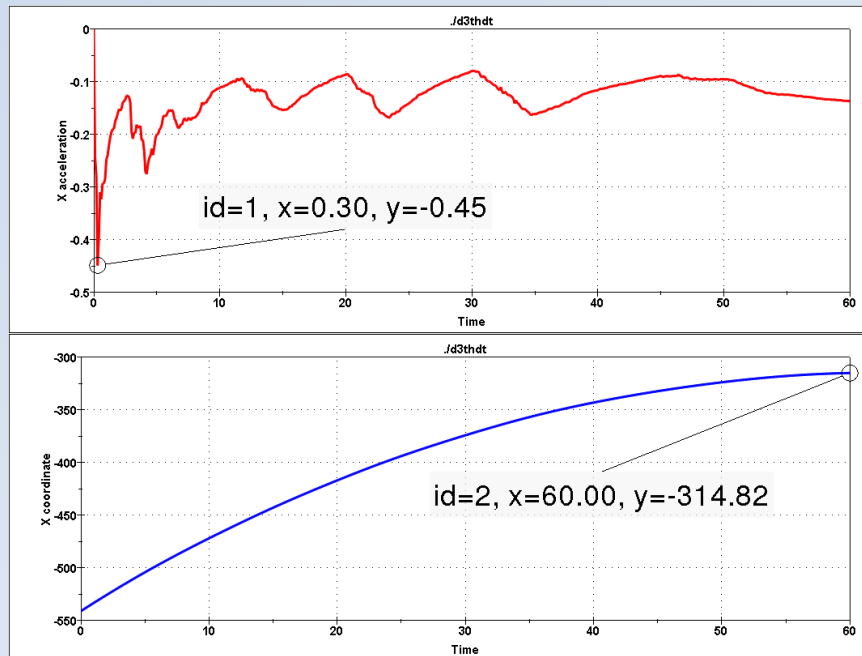
- Response Variables**
 - Responses: 1 acceleration
 - Add
 - Print Response Values
 - Update Response Values: Current, All
 - Remove: Current, All
 - Rename Response
- History Variables**
 - Histories
 - Add
 - Print History Values
 - Update History Values: Current, All
 - Remove: Current, All
 - Rename History
- Export Session**

A secondary toolbar is visible on the right side of the main toolbar, containing the following buttons:

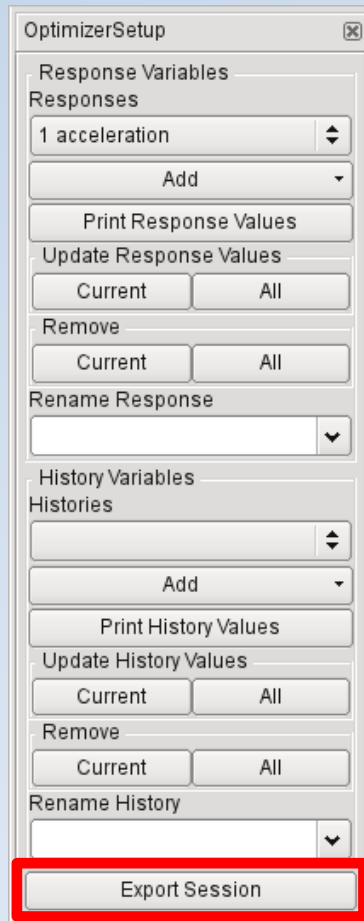
- Pick Annotations
- Selected Annotations
- Annotation List
- From Variable Name
- From Advanced Expression

μ ETA – OptimizerSetup Toolbar

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



μETA – OptimizerSetup Toolbar



Exports:

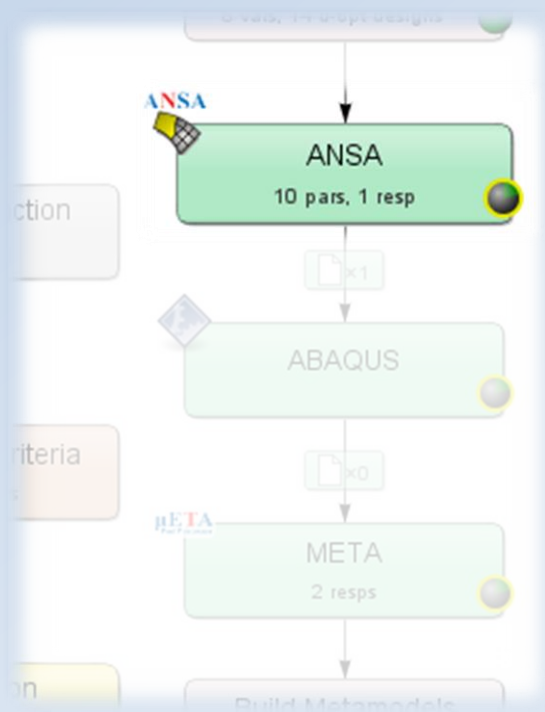
- Session file (for reproduction of results extraction)
- Output file, containing responses and histories

```
#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



The screenshot shows the 'Stage ANSA' configuration window. The 'General' tab is active, and the 'Package Name' is set to 'ANSA'. The 'Command' field contains 'ansa -lm_retry 10 -gui ANSA_D30'. The 'DV File' field contains 'BrakeCaliper.dv'. The 'Model Database' field contains 'BrakeCaliper.ansa'. The 'Execution' section shows a table of resources.

Resource	Units per job	Global limit	Delete
ANSA	1	3	x

Additional options in the 'Execution' section include:

- Use Queuing
- Use LSTCVM proxy
- Environment Variables
- Run Jobs in Directory of Stage

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.,
6, DV_Breite_Flachsteg_unten, REAL, BOUNDS, 0.
9, DV_Hoehe_Nase, REAL, BOUNDS, 0., 0., 10.
4, DV_Breite_Mittelsteg_ob_au, REAL, BOUNDS,
7, DV_Breite_Mittelsteg_ob_in, REAL, BOUNDS,
5, DV_Breite_Mittelsteg_un_au, REAL, BOUNDS,
8, DV_Breite_Mittelsteg_un_in, REAL, BOUNDS,
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...](#)

Connecting ANSA to LS-OPT

Fine Tuning of Design Variables, e.g.

- Ranges

The screenshot shows the 'Parameter Setup' dialog box in ANSA. The 'Show advanced options' checkbox is checked. The dialog displays a table of design variables with their types, names, starting values, initial ranges, and minimum/maximum values. Several initial range values are highlighted with red boxes.

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

At the bottom right of the dialog, there is an 'OK' button with a checkmark icon.

Connecting ANSA to LS-OPT

Fine Tuning of Design Variables, e.g.

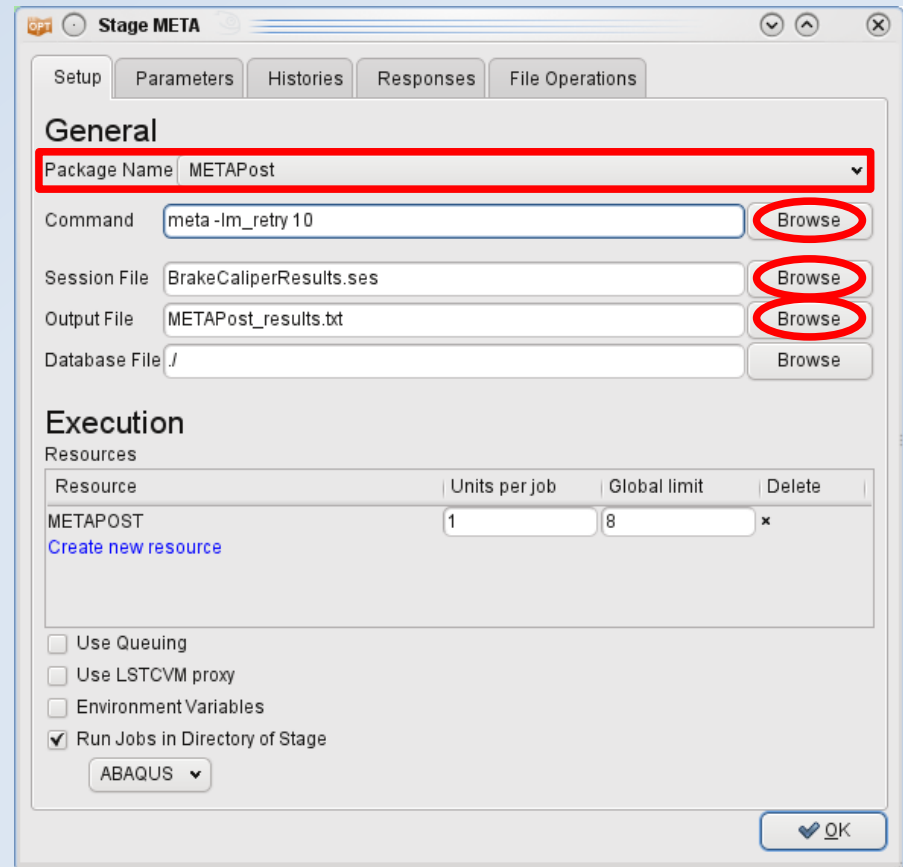
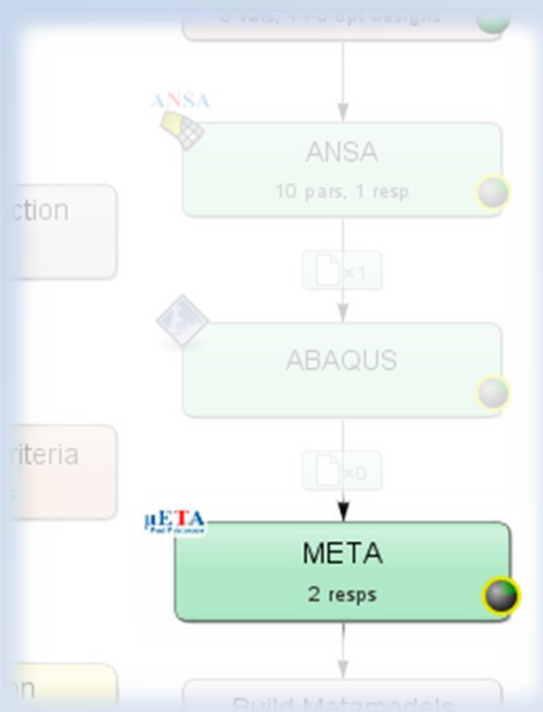
- Ranges
- Dependencies
- etc.

The screenshot shows the 'Parameter Setup' dialog box in ANSA. It has tabs for 'Parameter Setup', 'Stage Matrix', 'Sampling Matrix', 'Resources', and 'Features'. The 'Parameter Setup' tab is active, and 'Show advanced options' is checked. A table lists design variables with their types, names, starting values, initial ranges, and minimum/maximum values. Two rows are highlighted with red boxes: 'DV_Breite_Mittelsteg_ob_in' (Dependent, Definition: DV_Breite_Mittelsteg_ob_au) and 'DV_Breite_Mittelsteg_un_in' (Dependent, Definition: DV_Breite_Mittelsteg_un_au). The dialog also includes a scroll bar, an 'Add...' button, and an 'OK' button.

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

Connecting μ ETA to LS-OPT

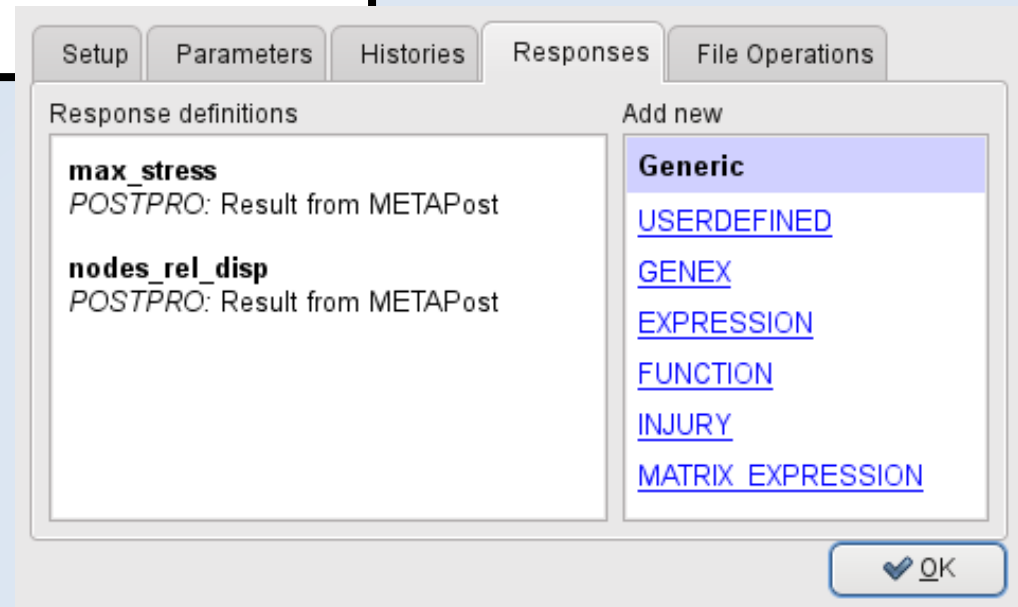
Stage for μ ETA



Connecting μ ETA to LS-OPT

μ ETA → Output file → Responses and Histories in LS-OPT

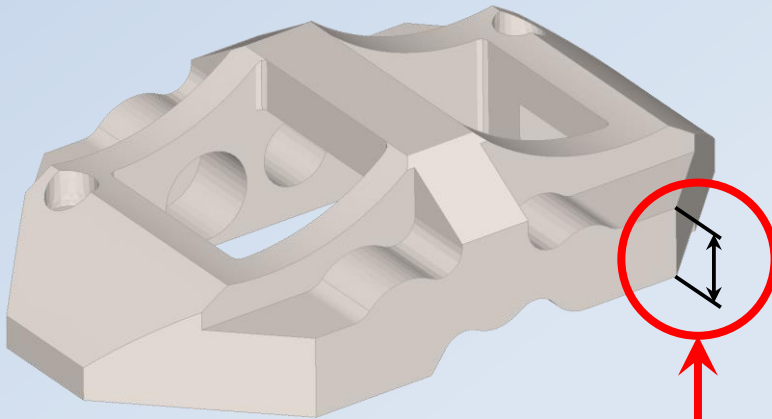
```
#OptimizerSetup Response & history File created by META post  
RESPONSES  
1,nodes_rel_disp,0.174171448  
2,max_stress,169.780731  
END
```



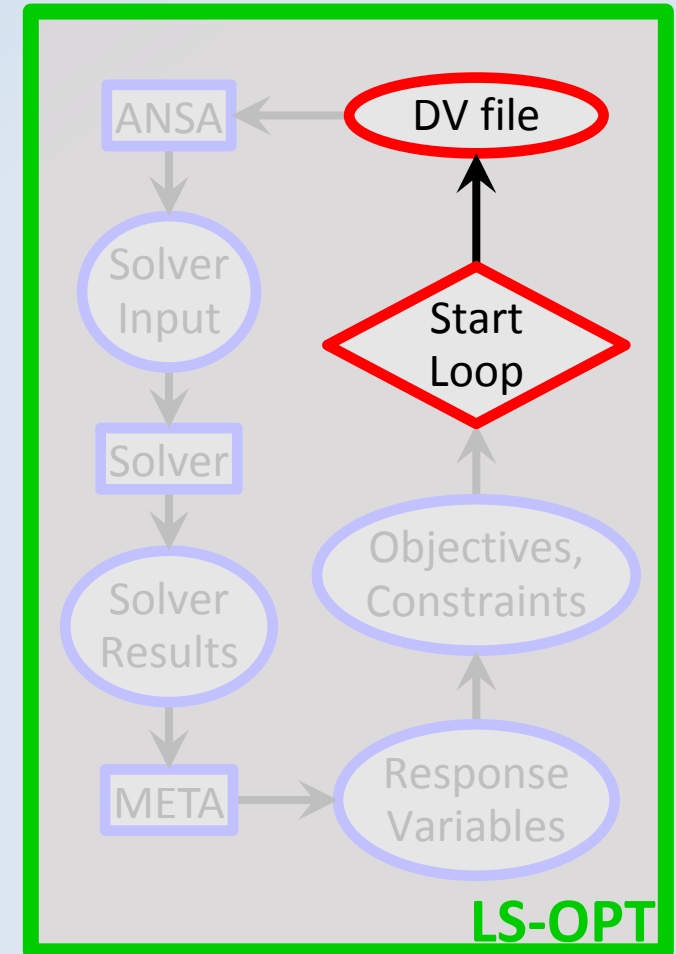
Optimization Run

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

LS-OPT determines set of DV and outputs DV file



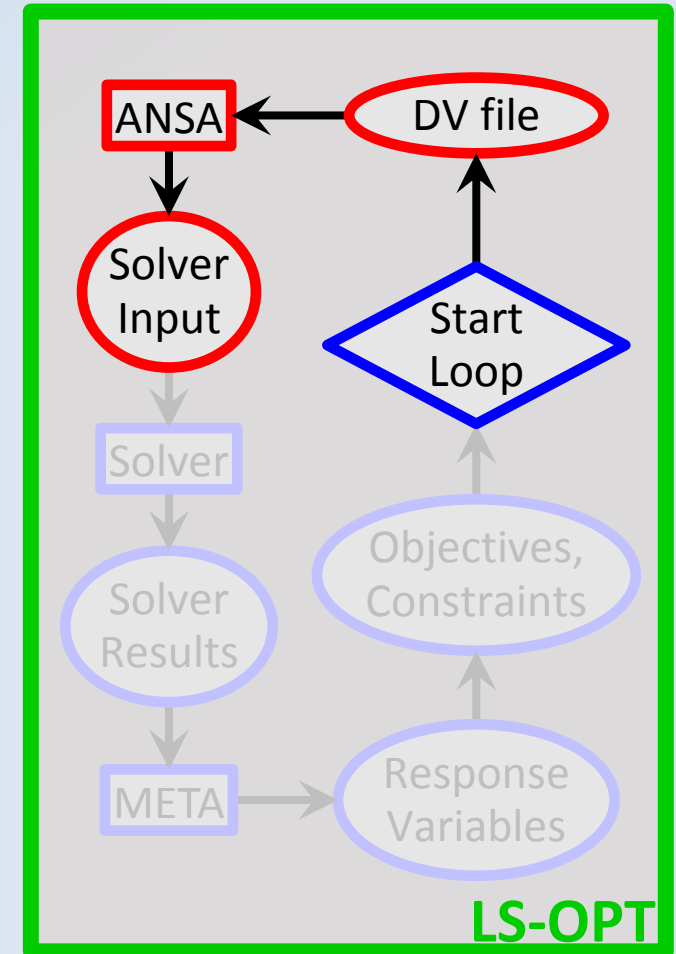
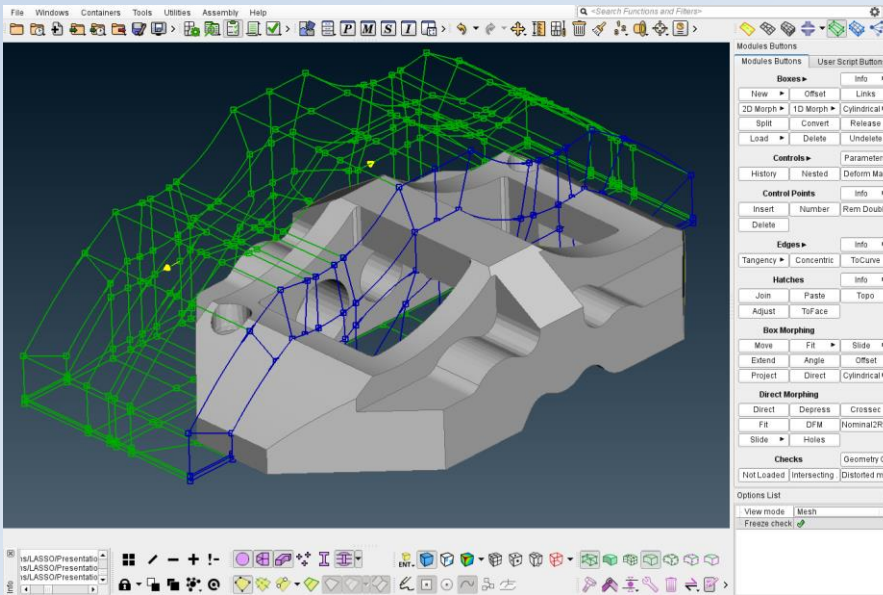
#	ID	DESIGN VARIABLE NAME	TYPE	RANGE	CURRENT VALUE	MIN VALUE
3	DV_Hoeh	DV_Hoeh	REAL	BOUNDS	0., -5., 12.	
2	DV_Breite	DV_Breite	REAL	BOUNDS	0., -5., 10.	
1	DV_Breite	DV_Breite	REAL	BOUNDS	0., 0., 20.	
6	DV_Breite	DV_Breite	REAL	BOUNDS	0., 0., 25.	
9	DV_Hoeh	DV_Hoeh	REAL	BOUNDS	0., 0., 10.	
4	DV_Breite	DV_Breite	REAL	BOUNDS	0., -20., 13.	
7	DV_Breite	DV_Breite	REAL	BOUNDS	0., -20., 13.	
5	DV_Breite	DV_Breite	REAL	BOUNDS	0., -13., 10.	
8	DV_Breite	DV_Breite	REAL	BOUNDS	0., -13., 10.	
10	DV_Breite	DV_Breite	REAL	BOUNDS	0., 0., 20.	



Optimization Run

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

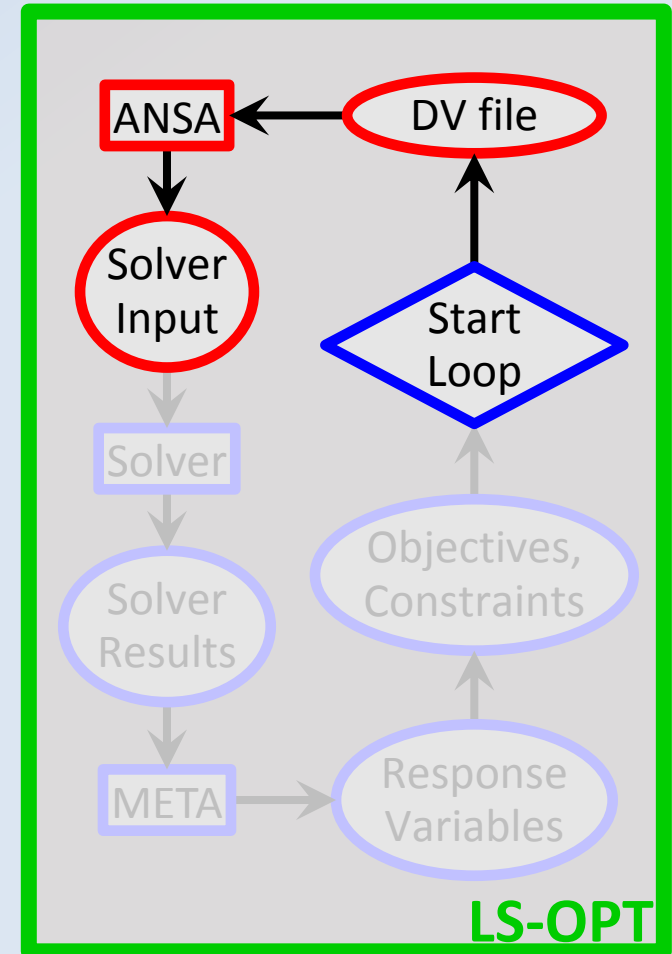
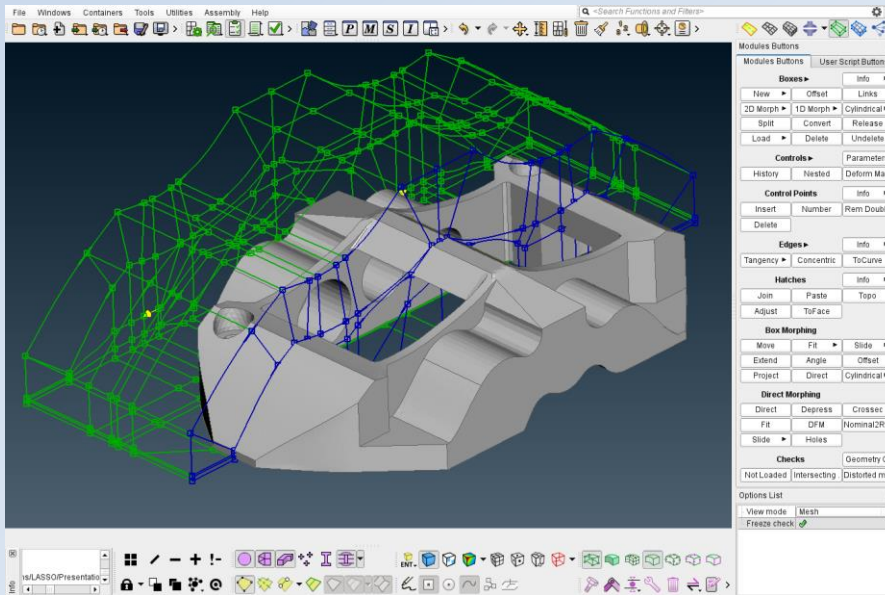
- ANSA reads DV from DV file,
- executes Optimization Task sequence



Optimization Run

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

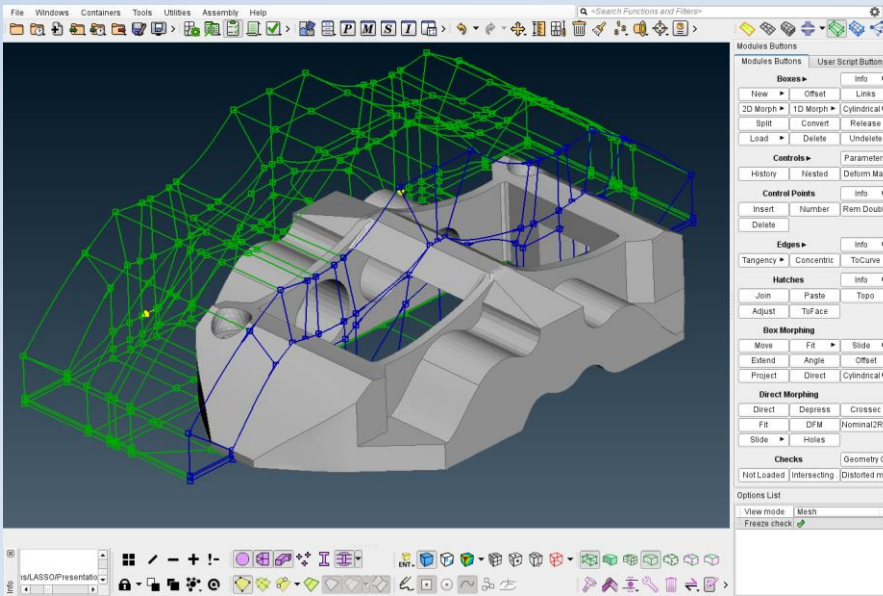
- ANSA reads DV from DV file,
- executes Optimization Task sequence



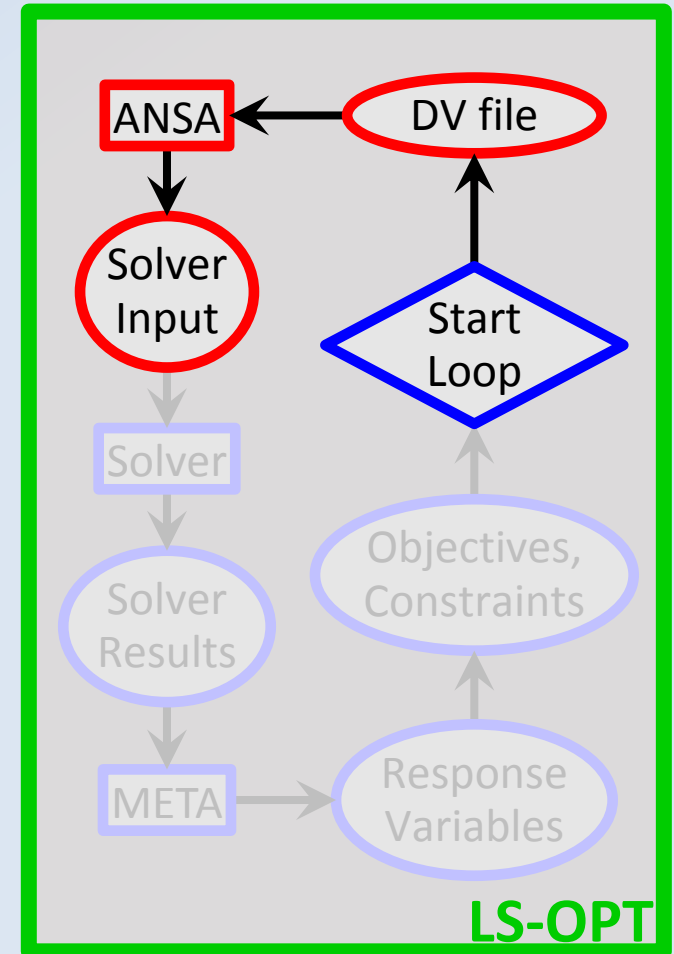
Optimization Run

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

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



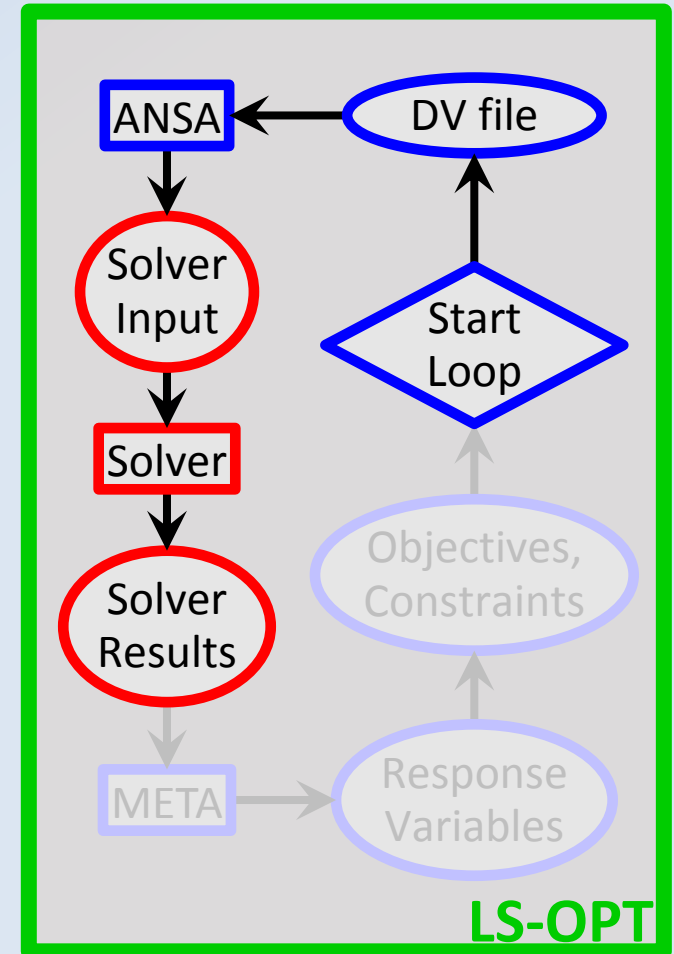
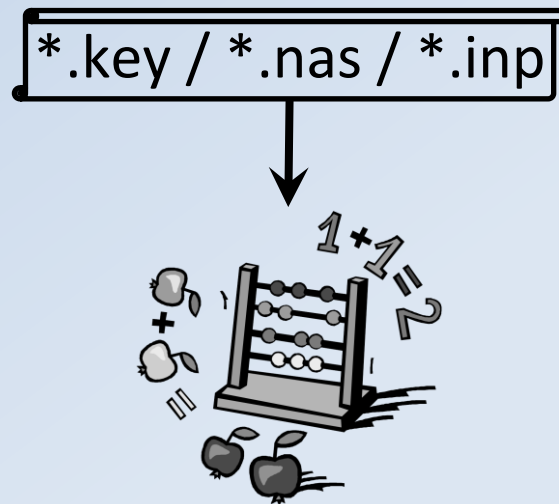
*.key / *.nas / *.inp



Optimization Run

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

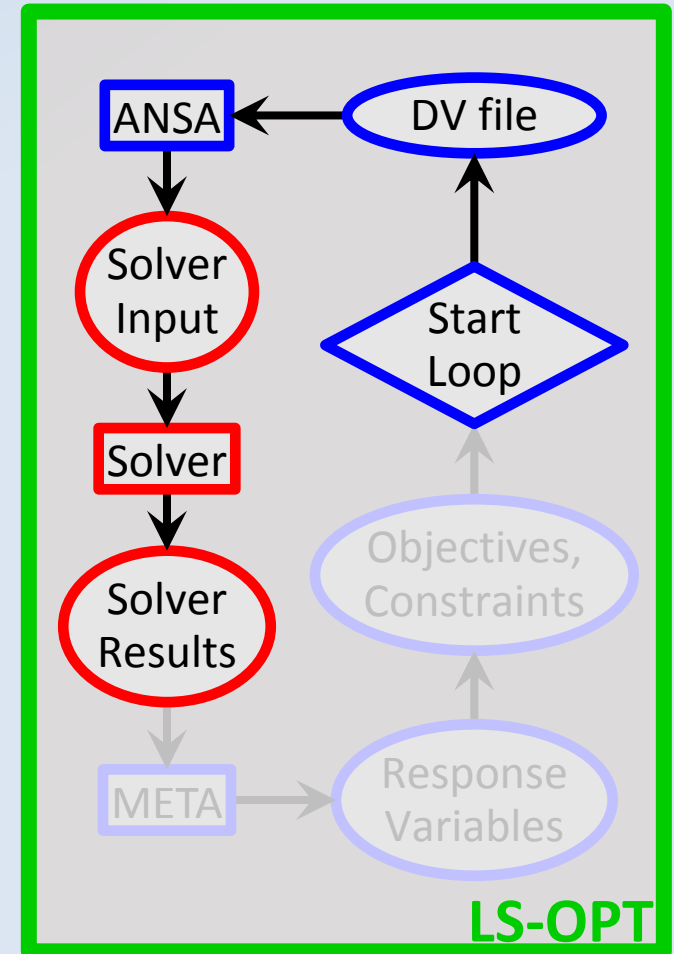
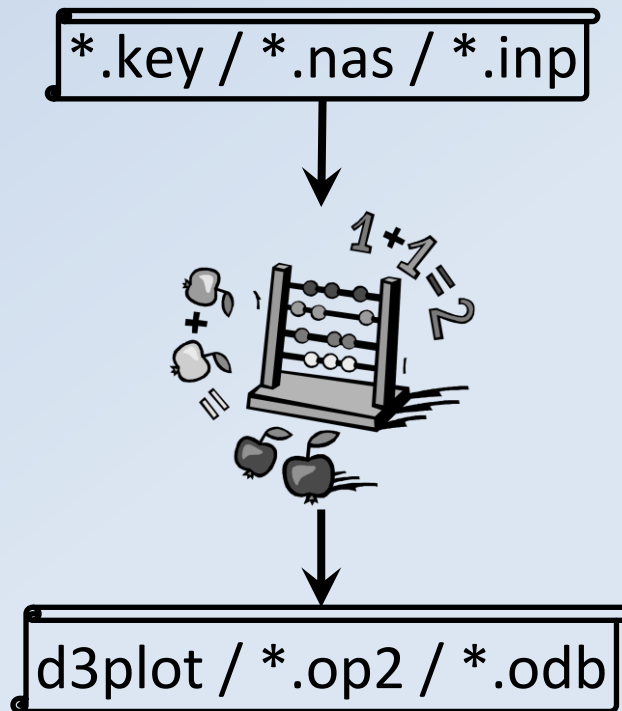
- LS-OPT invokes solver runs



Optimization Run

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

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

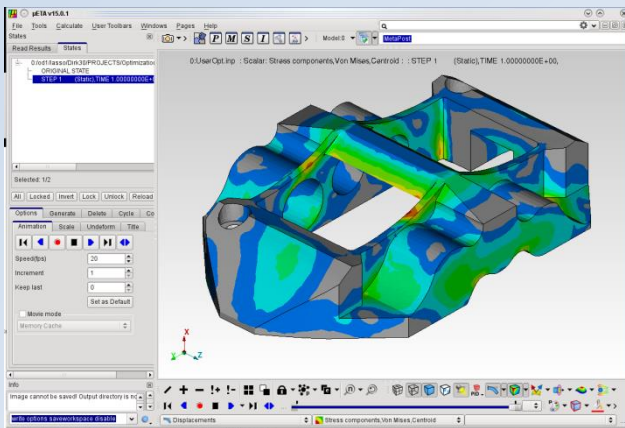


Optimization Run

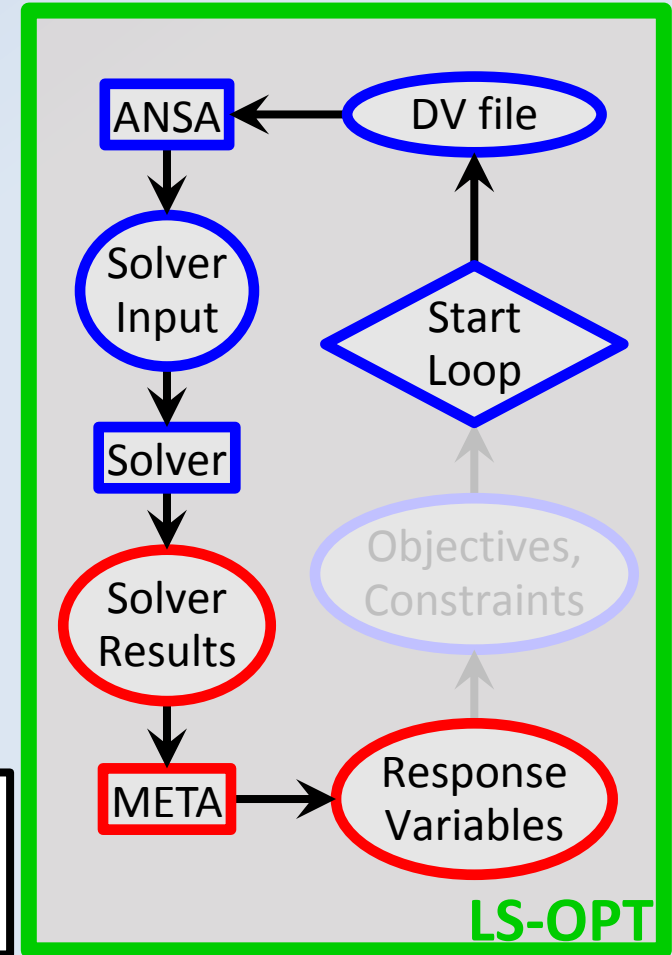
LS-OPT → ANSA → Solver → **META** → LS-OPT

META extracts responses from solver result files

d3plot / *.op2 / *.odb



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

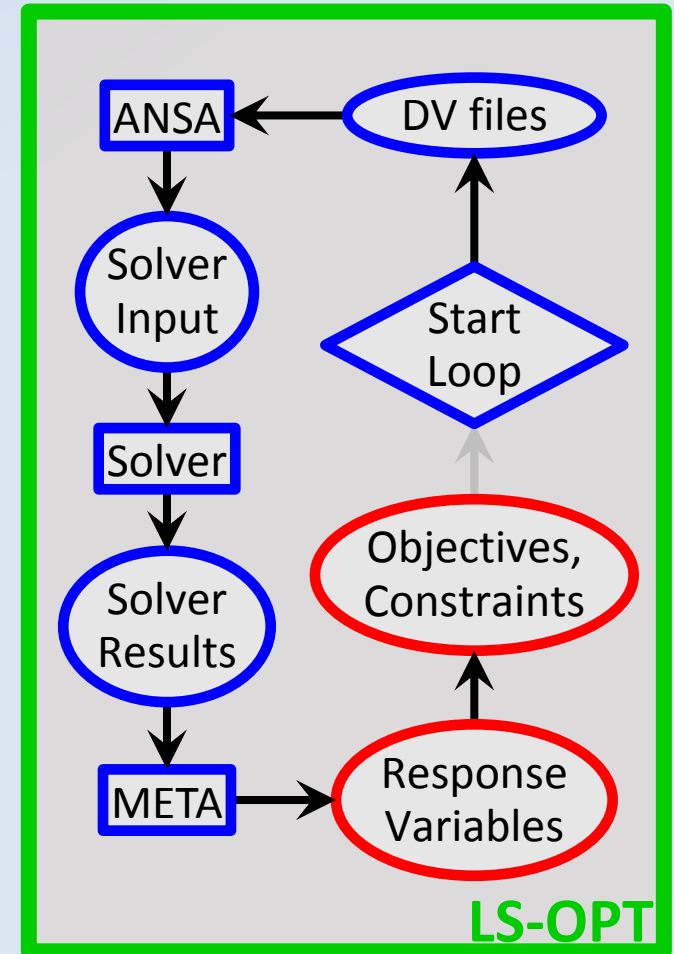
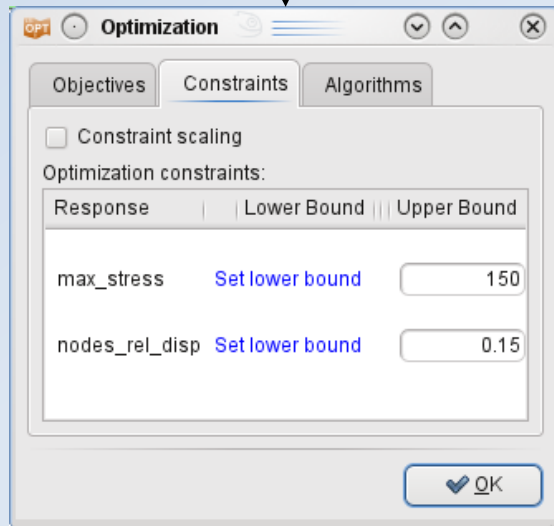


Optimization Run

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

Determine objectives and constraints

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

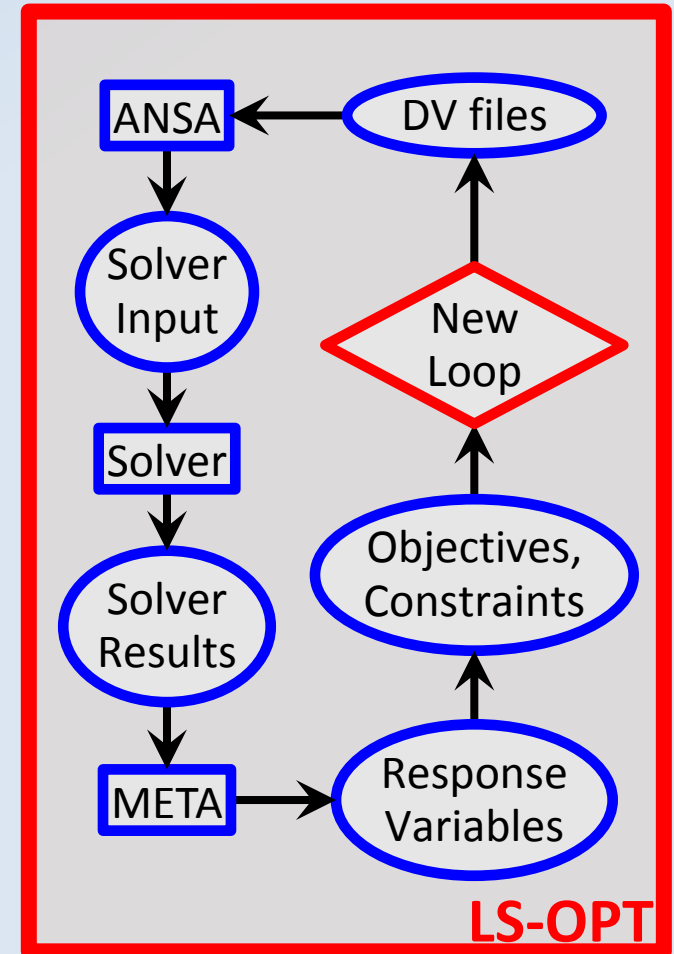
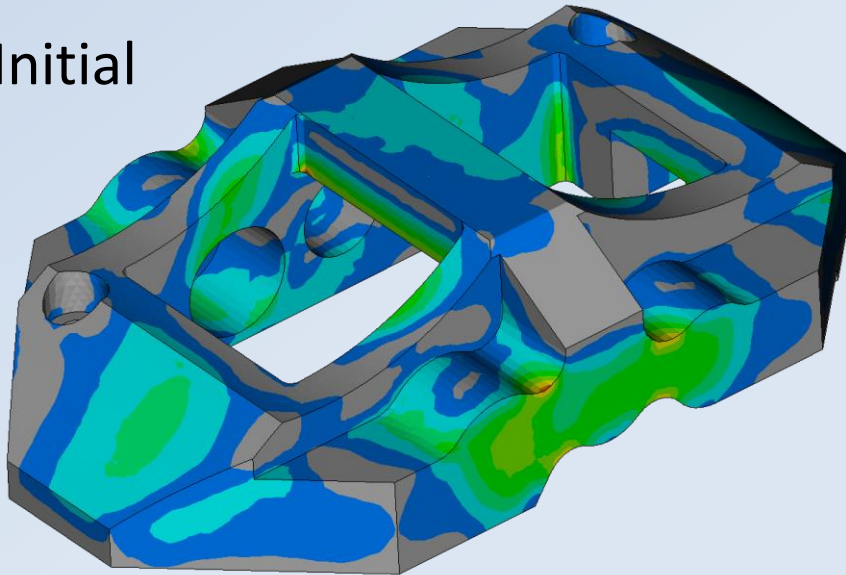


Optimization Run

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

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

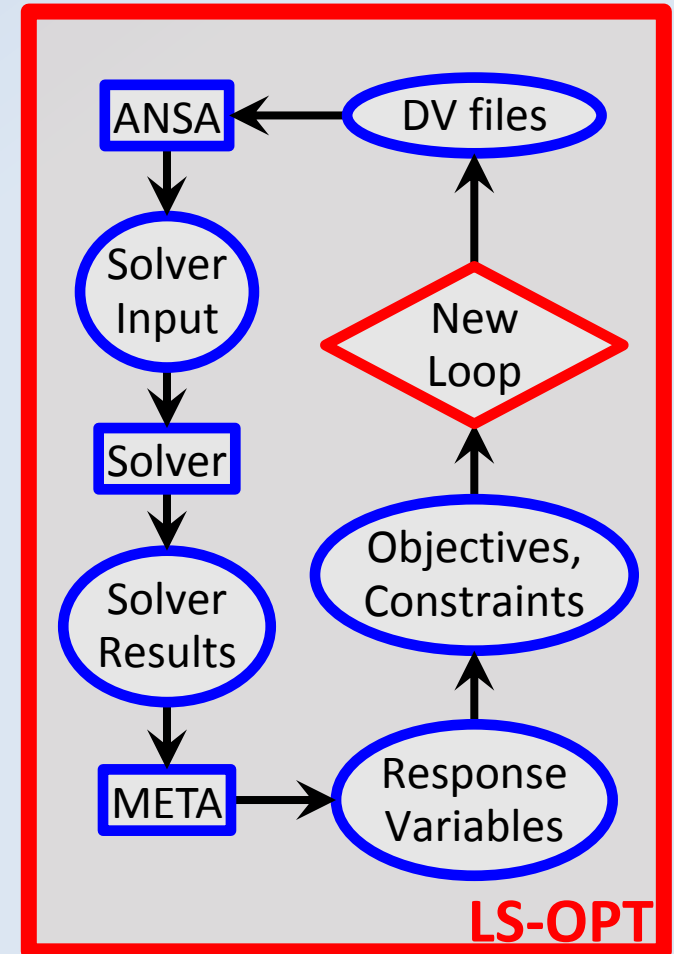
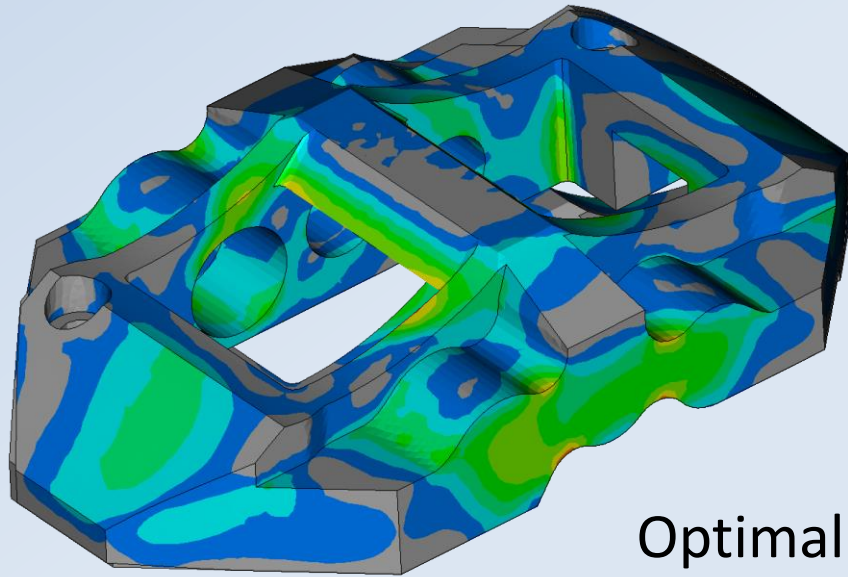
Initial



Optimization Run

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

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



Ευχαριστώ πολύ

