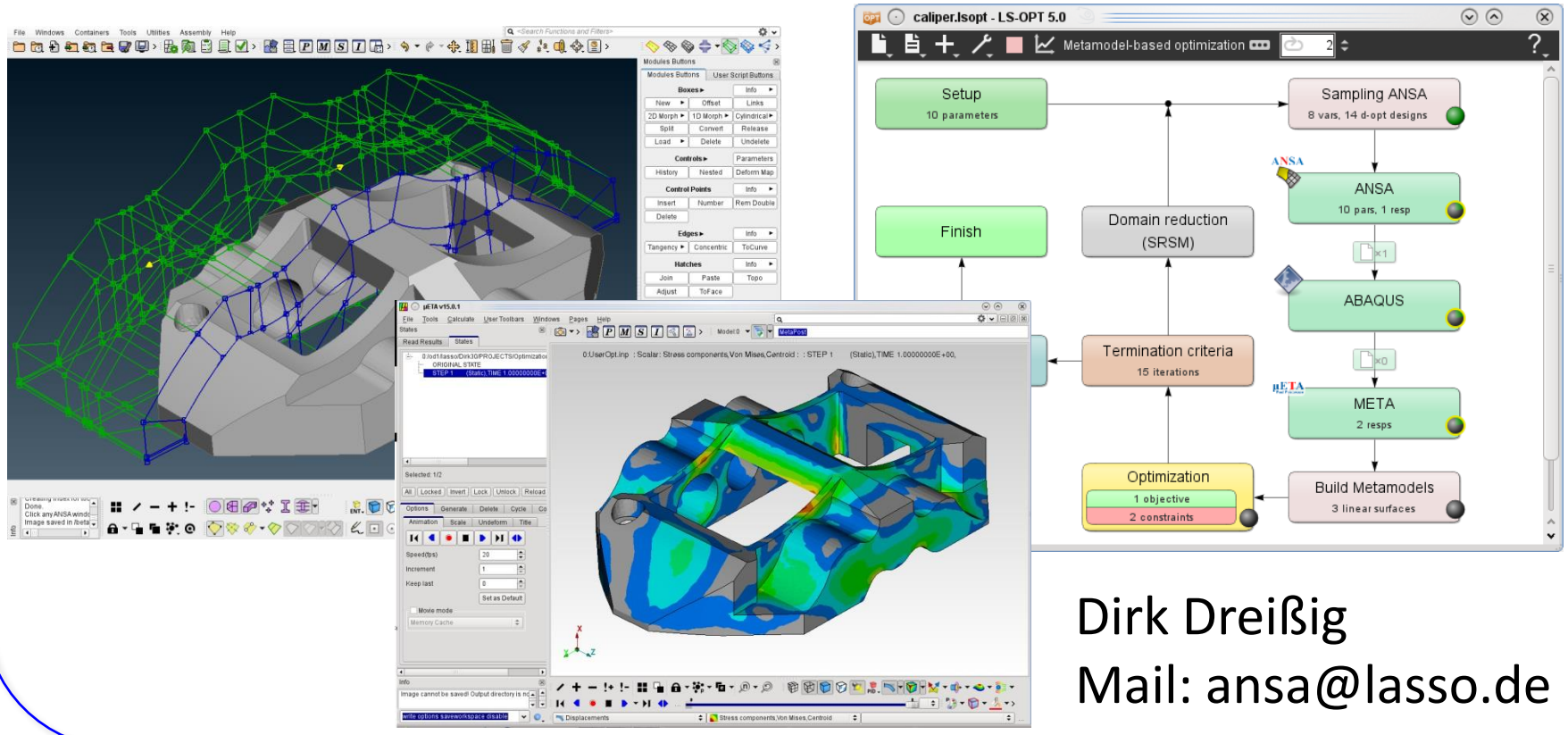
Coupling ANSA and META to LS-OPT



Dirk Dreißig
Mail: ansa@lasso.de

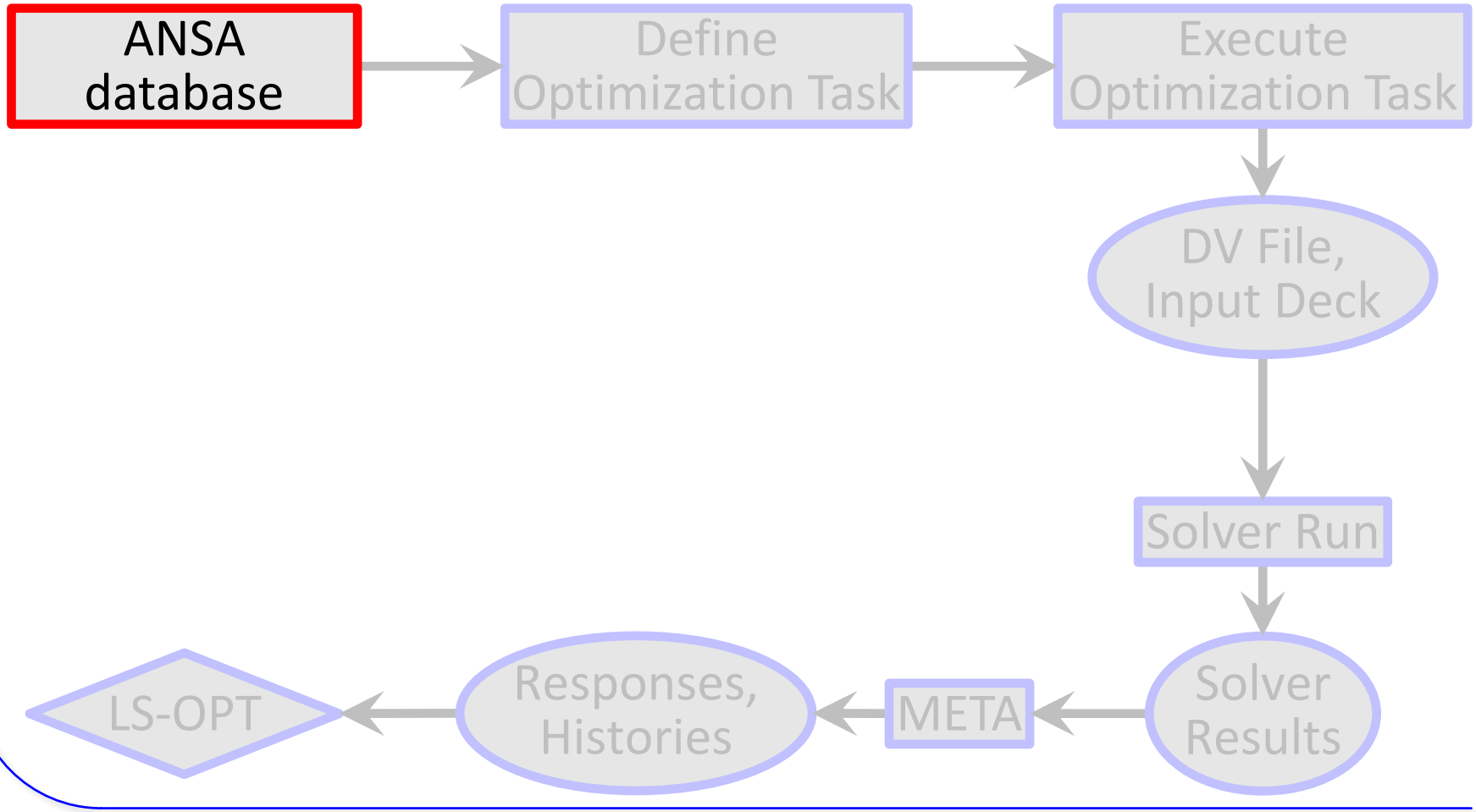
For what **ANSA** & **META**?

- **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**

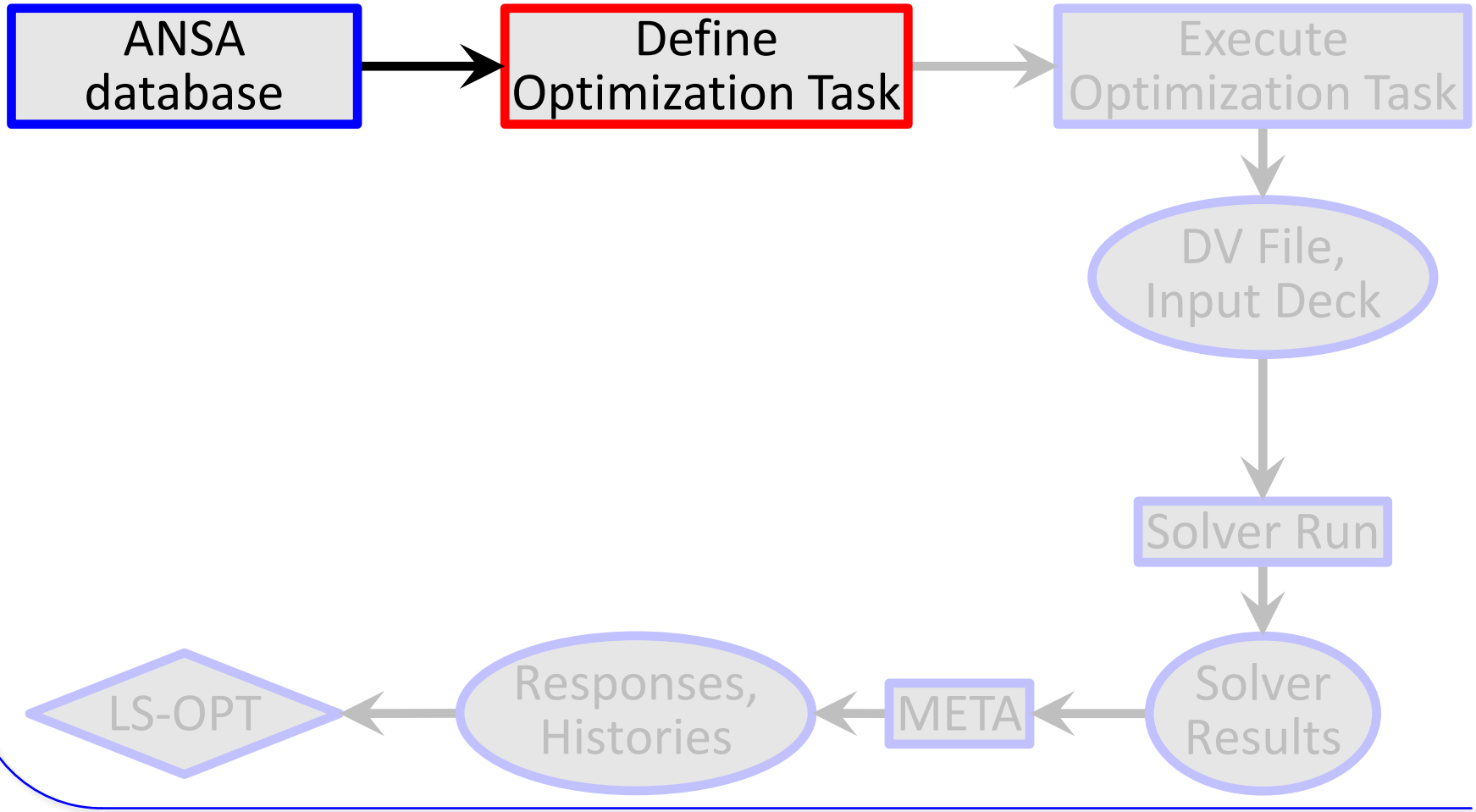
Optimization Setup

ANSA → Solver → META → LS-OPT



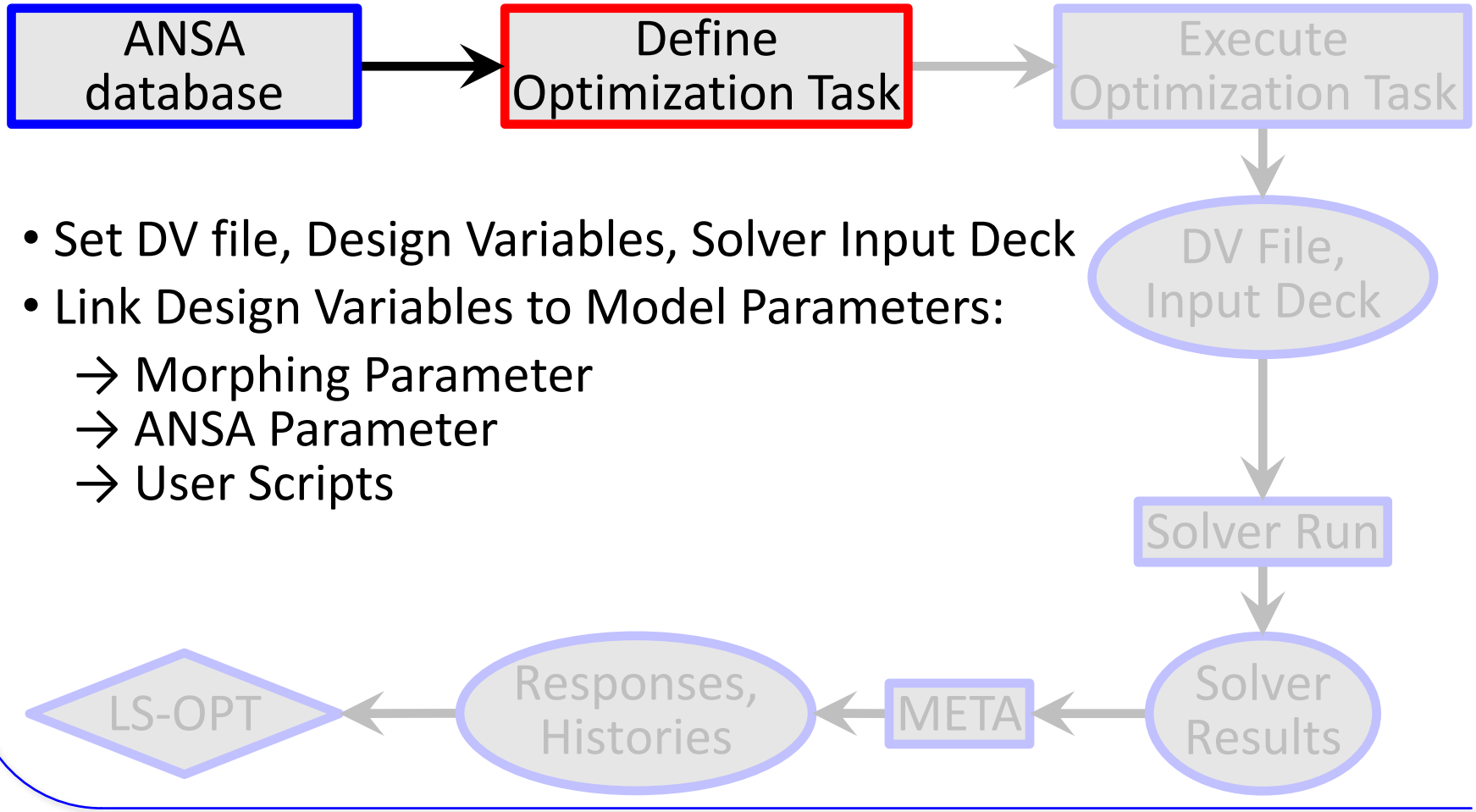
Optimization Setup

ANSA → Solver → META → LS-OPT



Optimization Setup

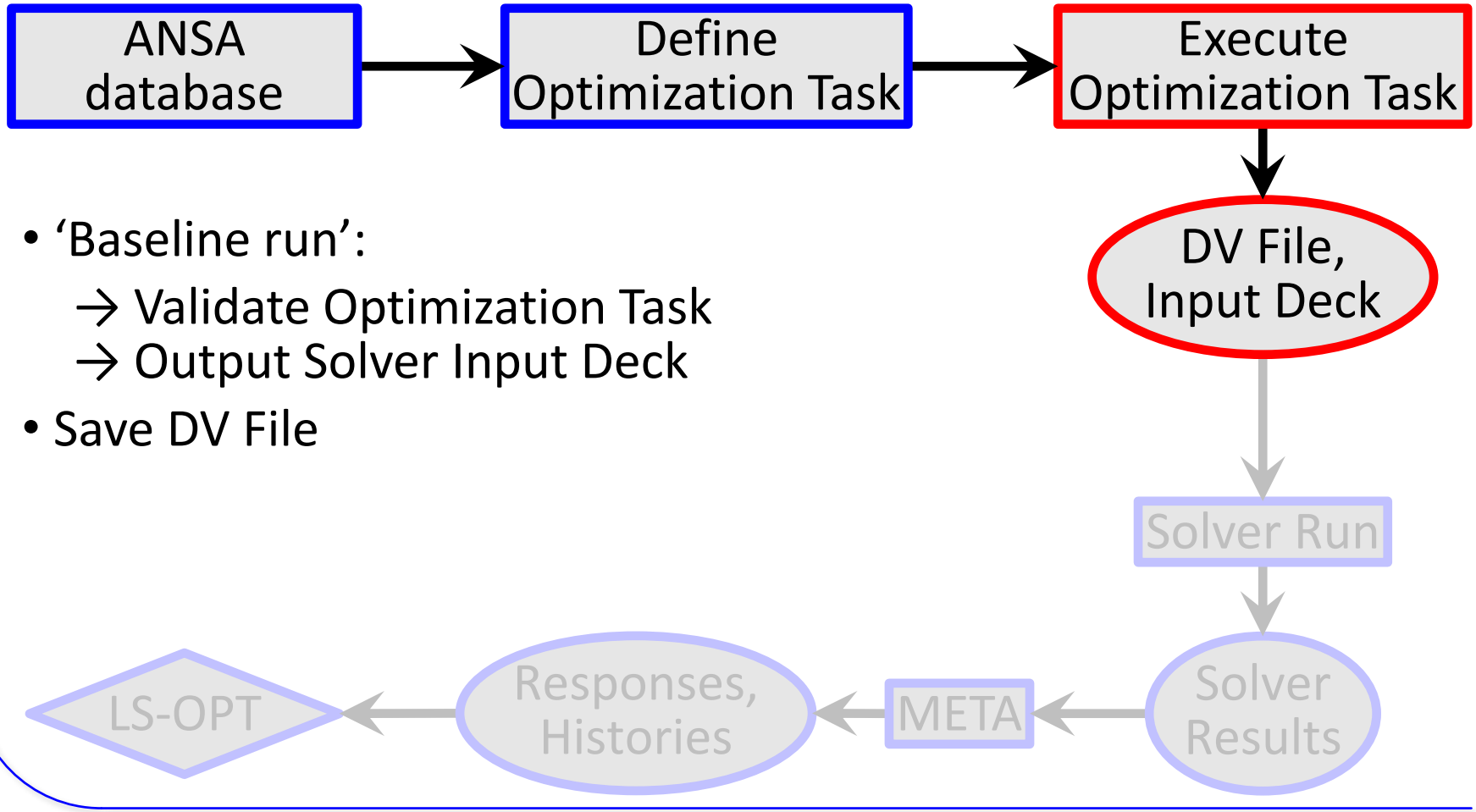
ANSA → Solver → META → LS-OPT



- Set DV file, Design Variables, Solver Input Deck
- Link Design Variables to Model Parameters:
  - → Morphing Parameter
  - → ANSA Parameter
  - → User Scripts

Optimization Setup

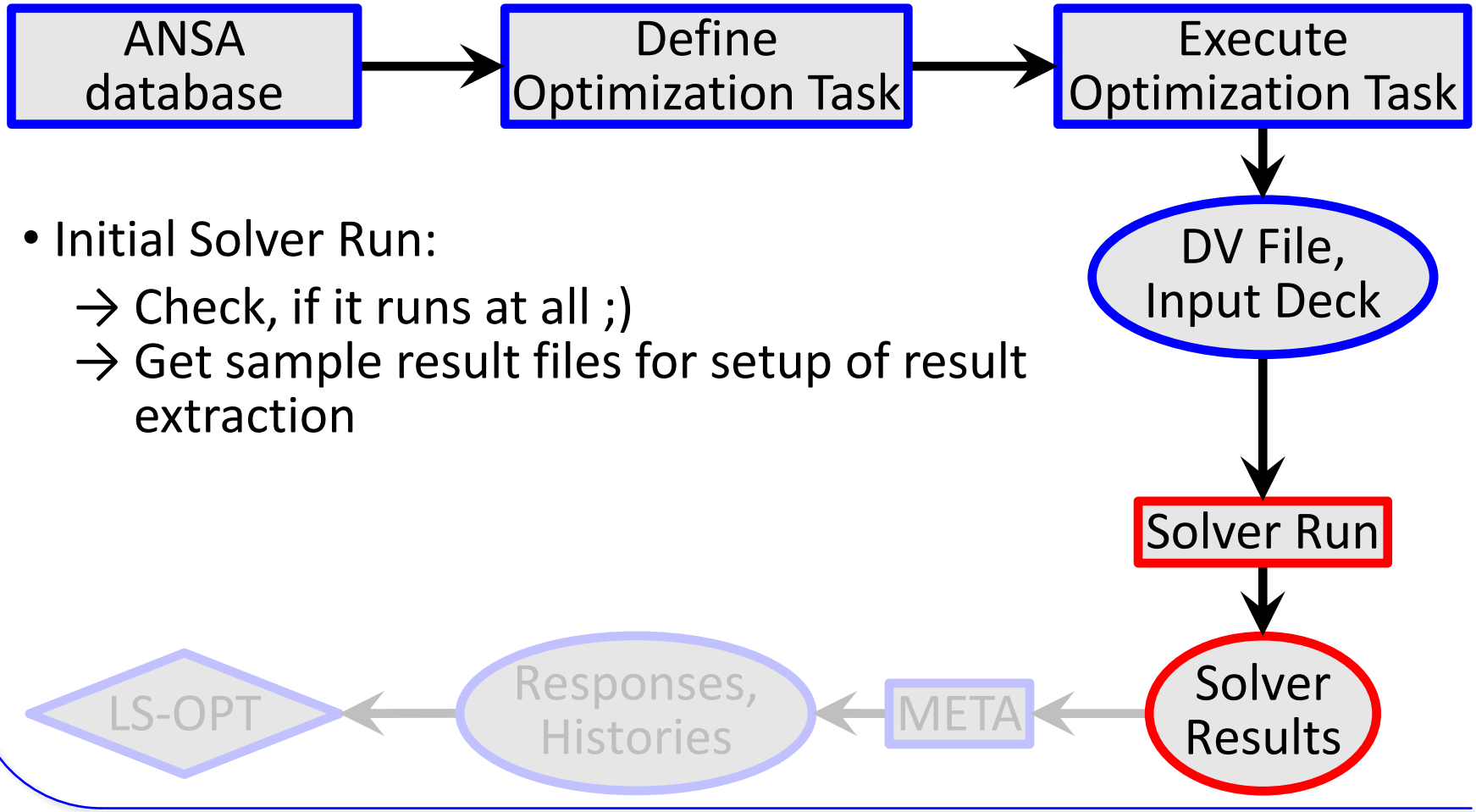
ANSA → Solver → META → LS-OPT



- 'Baseline run':
  - → Validate Optimization Task
  - → Output Solver Input Deck
- Save DV File

Optimization Setup

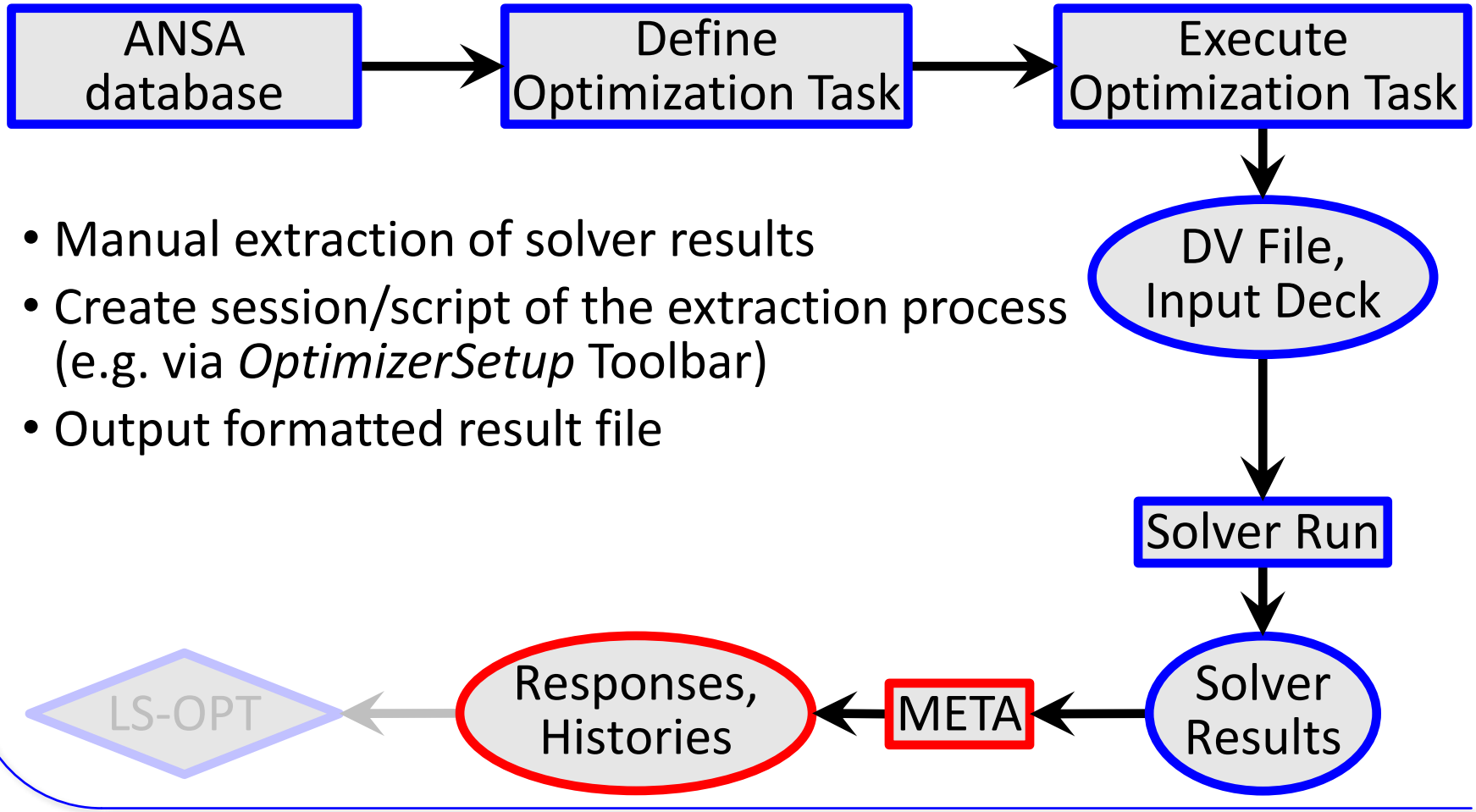
ANSA → **Solver** → META → LS-OPT



- Initial Solver Run:
  - → Check, if it runs at all ;)
  - → Get sample result files for setup of result extraction

Optimization Setup

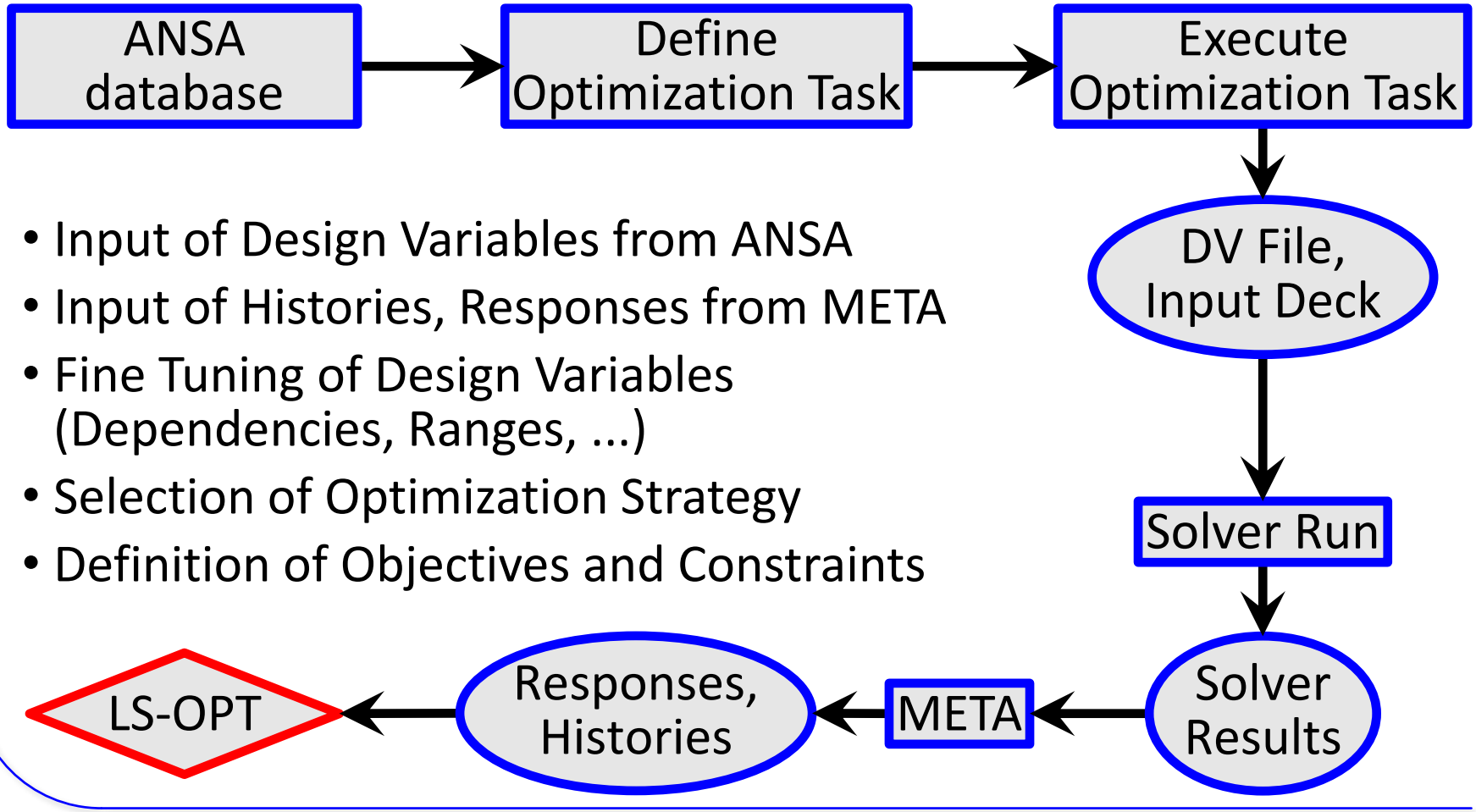
ANSA → Solver → **META** → LS-OPT



- Manual extraction of solver results
- Create session/script of the extraction process (e.g. via *OptimizerSetup* Toolbar)
- Output formatted result file

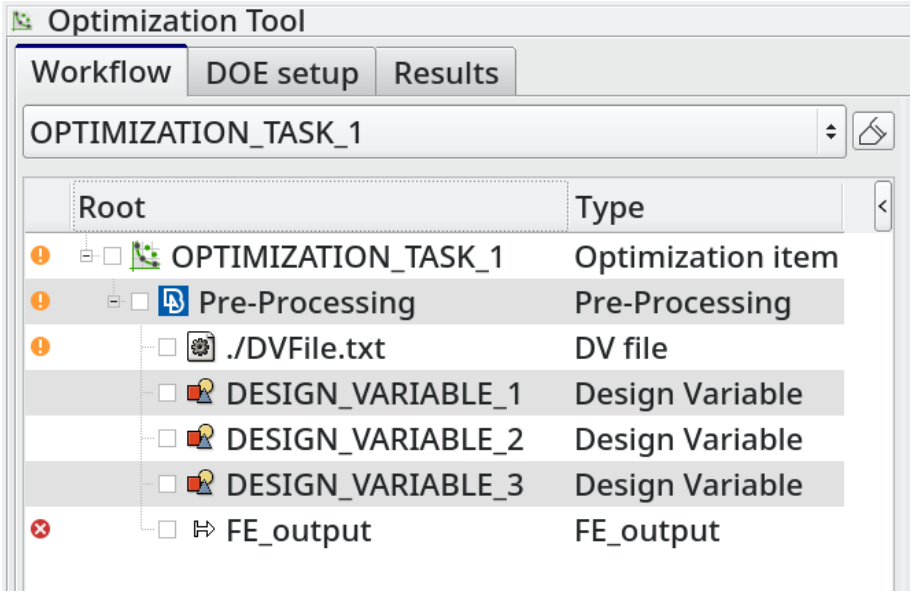
Optimization Setup

ANSA → Solver → META → **LS-OPT**



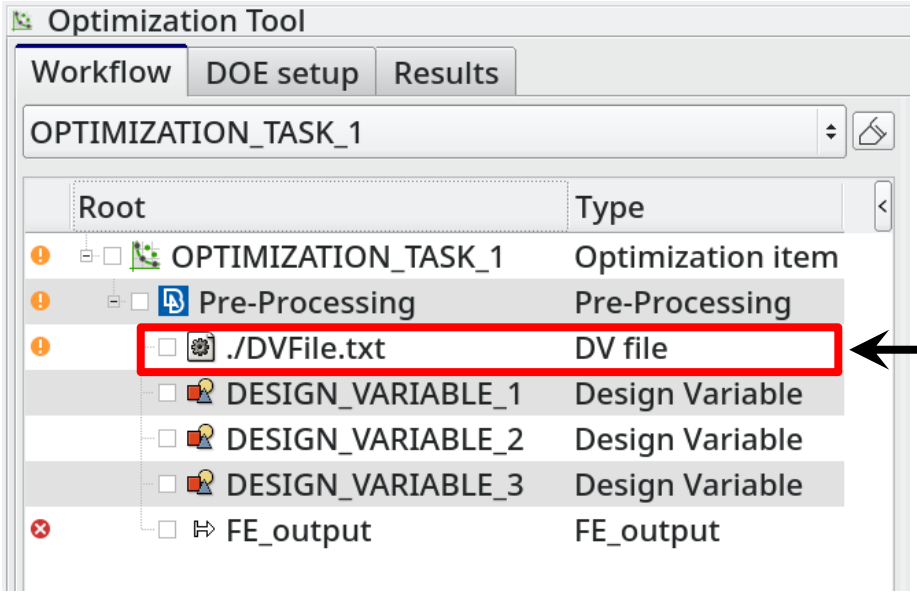
- Input of Design Variables from ANSA
- Input of Histories, Responses from META
- Fine Tuning of Design Variables (Dependencies, Ranges, ...)
- Selection of Optimization Strategy
- Definition of Objectives and Constraints

ANSA – Optimization Task



3 main task items

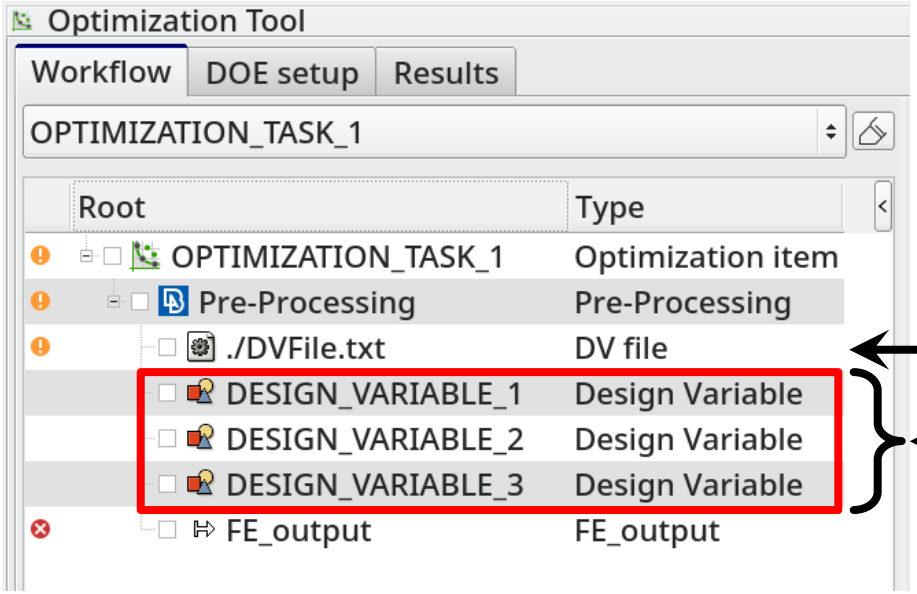
ANSA – Optimization Task



3 main task items

1. Design Variable File

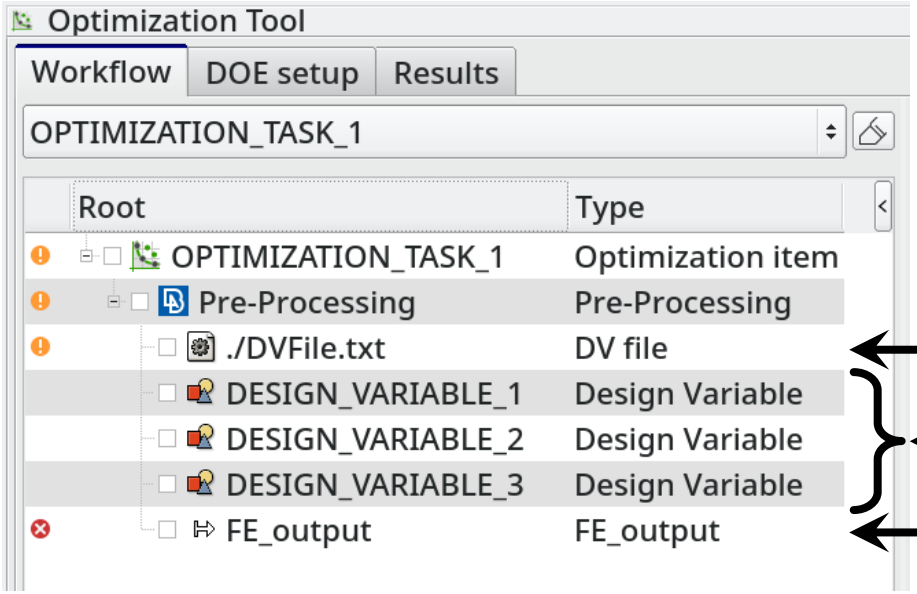
ANSA – Optimization Task



3 main task items

1. Design Variable File
2. Design Variables

ANSA – Optimization Task

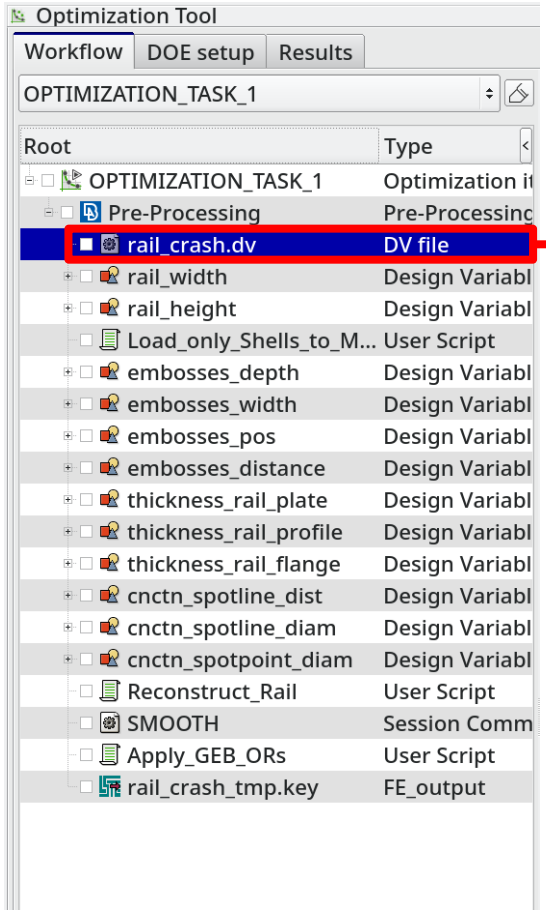


3 main task items

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

ANSA – Optimization Task

Design Variable File

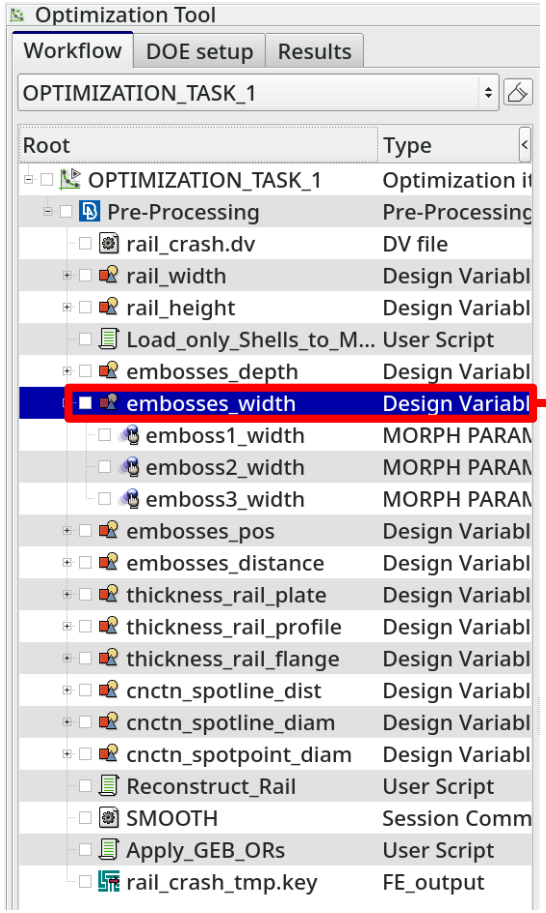


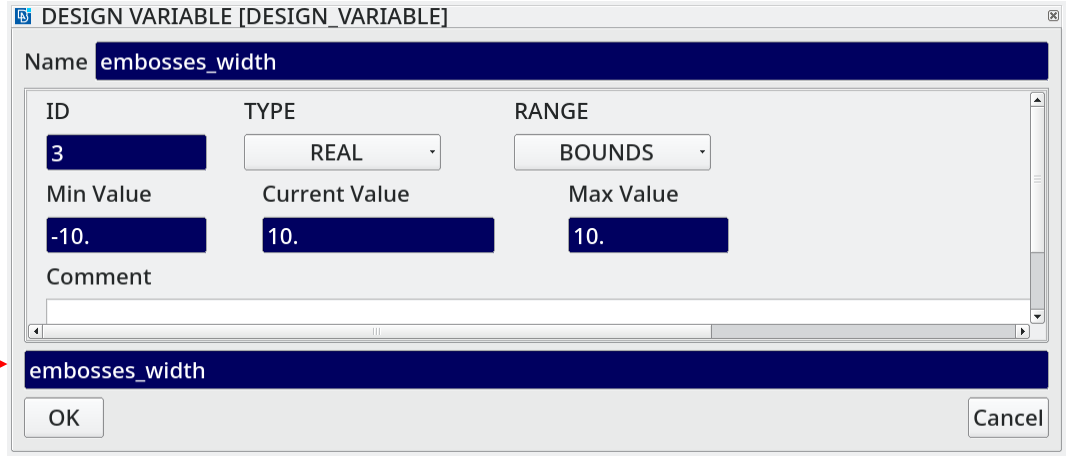

```
#
# ANSA_VERSION: 14.2.3
#
# file created by  A N S A  Mon Feb 17 17:13:25 2014
#
# Output from:
# /od1/lasso/Dirk30/PROJECTS/Optimierung_Rail_LS-OPT/Rail_MDO/rail_crash.ansa
#
# DESIGN VARIABLES
#-------------------------------------------------------------------------------------------------
# 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,  cnctn_spotline_dist,  REAL,     BOUNDS,    50., 20., 100.
 9,  cnctn_spotline_diam,  REAL,     STEP,      5., 2., 10.,  1.
 12,  cnctn_spotpoint_diam,  REAL,     STEP,      5., 2., 10.,  1.
#-------------------------------------------------------------------------------------------------
```

Correctly formatted for import in LS-OPT

ANSA – Optimization Task

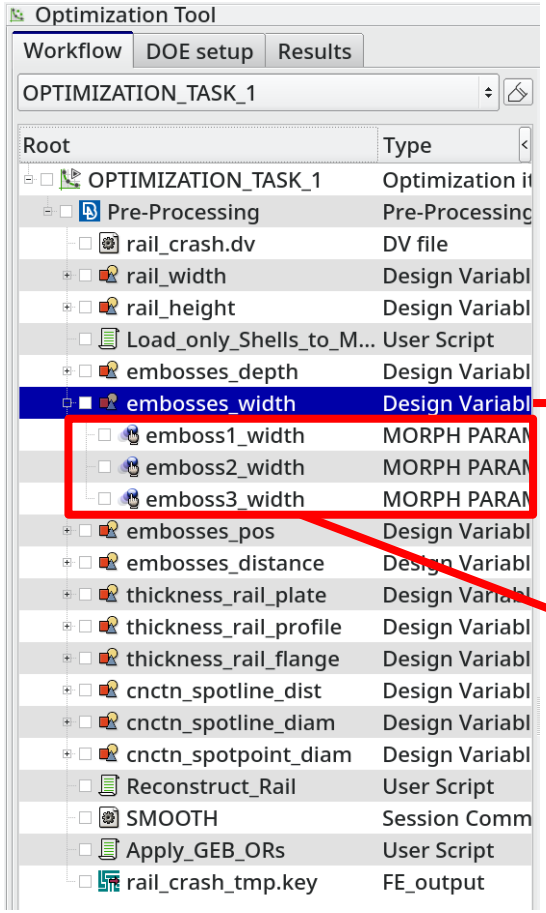
Design Variables → Morphing Parameters

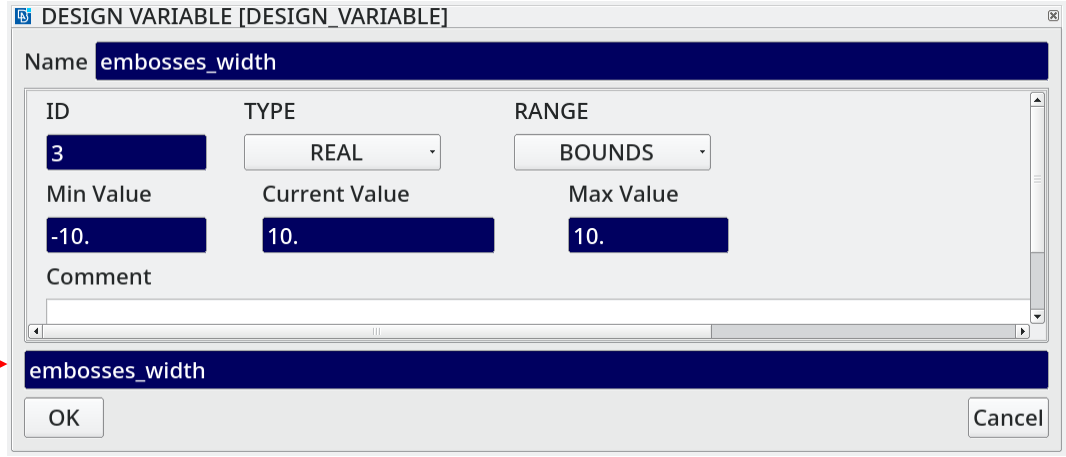


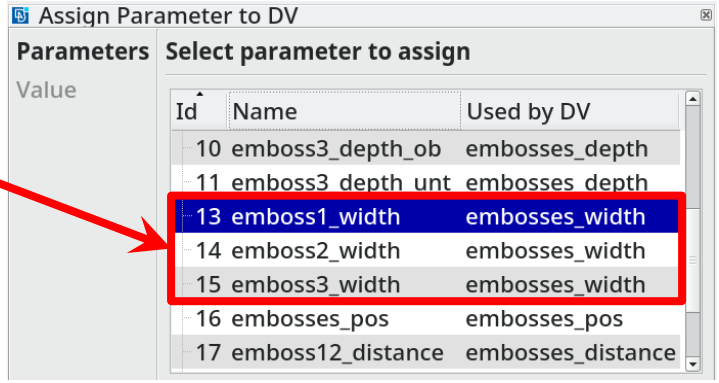


ANSA – Optimization Task

Design Variables → Morphing Parameters







ANSA – Optimization Task

Design Variables → Morphing Parameters

Shape modification

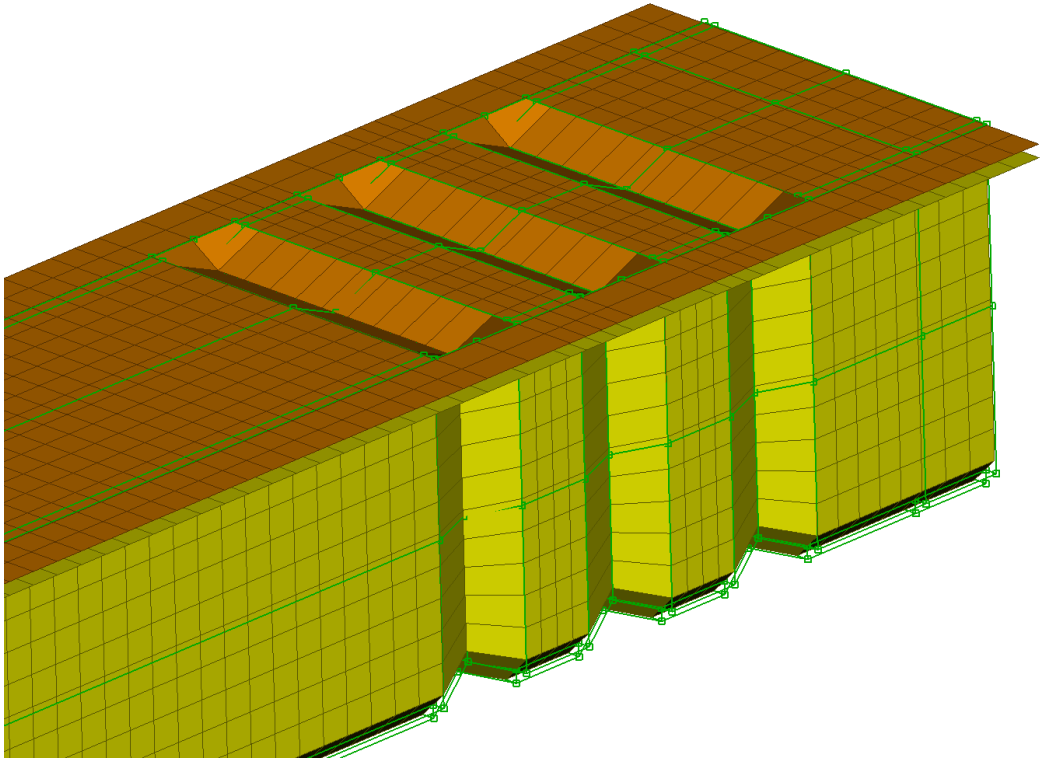
Design Variable = 10.0

↓

Morphing Parameter

↓

Width of depressions



ANSA – Optimization Task

Design Variables → Morphing Parameters

Shape modification

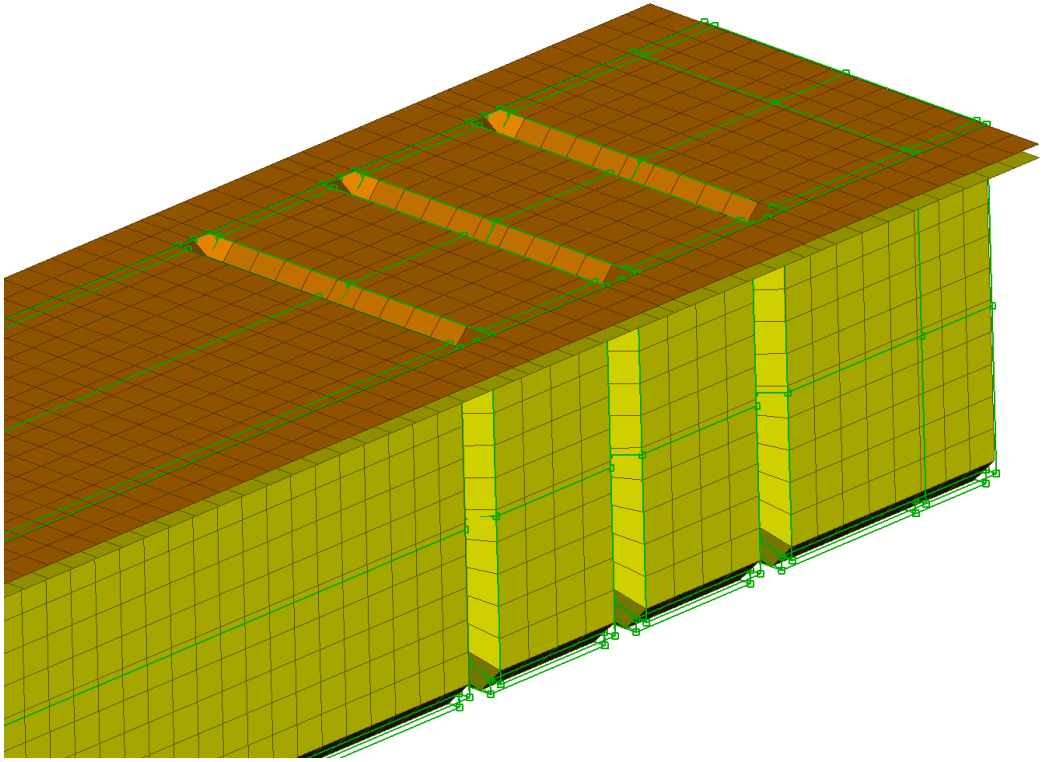
Design Variable = -5.0

↓

Morphing Parameter

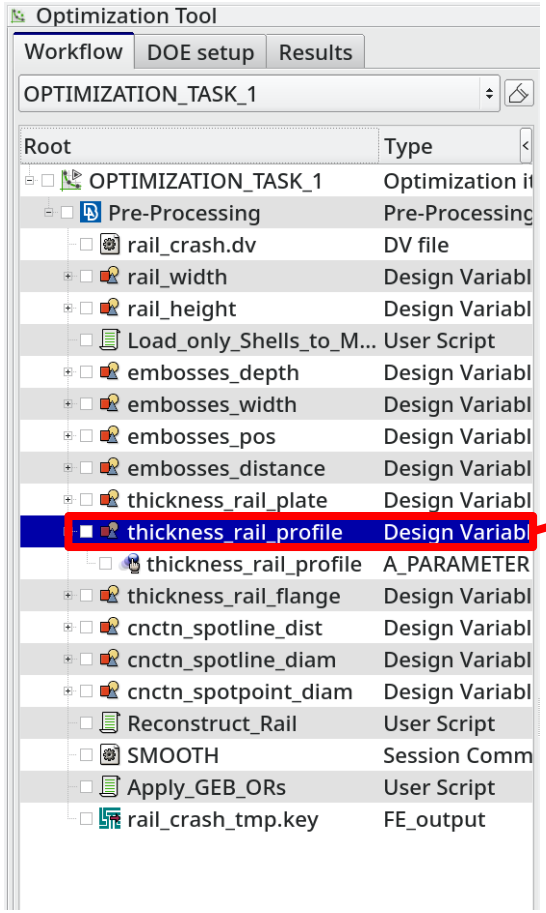
↓

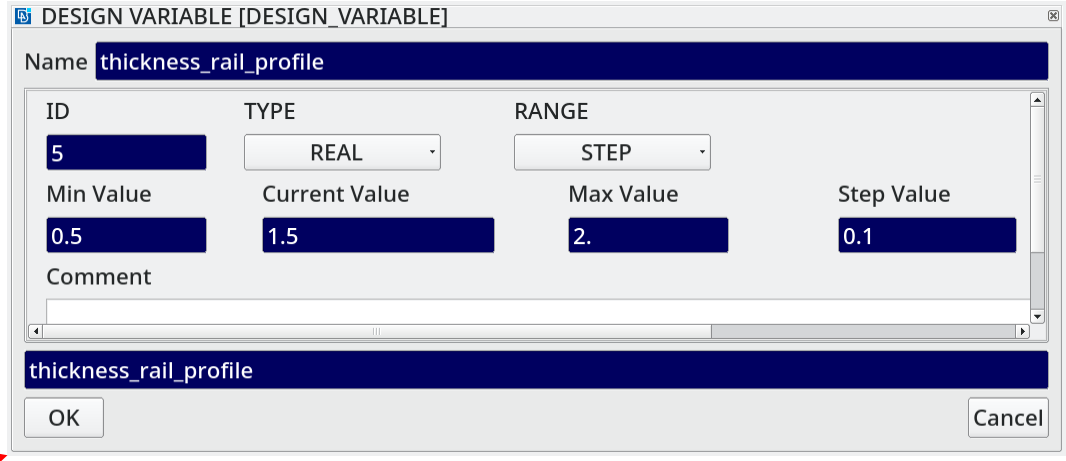
Width of depressions



ANSA – Optimization Task

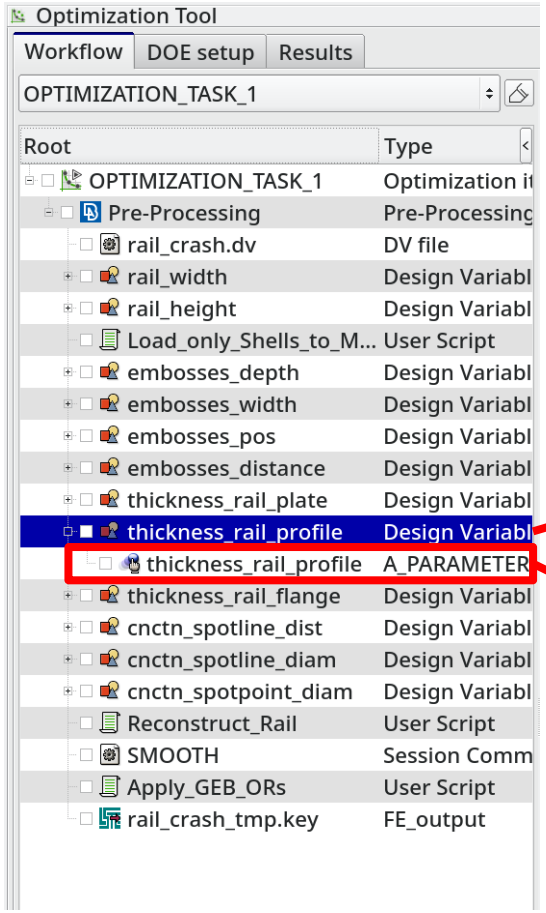
Design Variables → ANSA Parameters

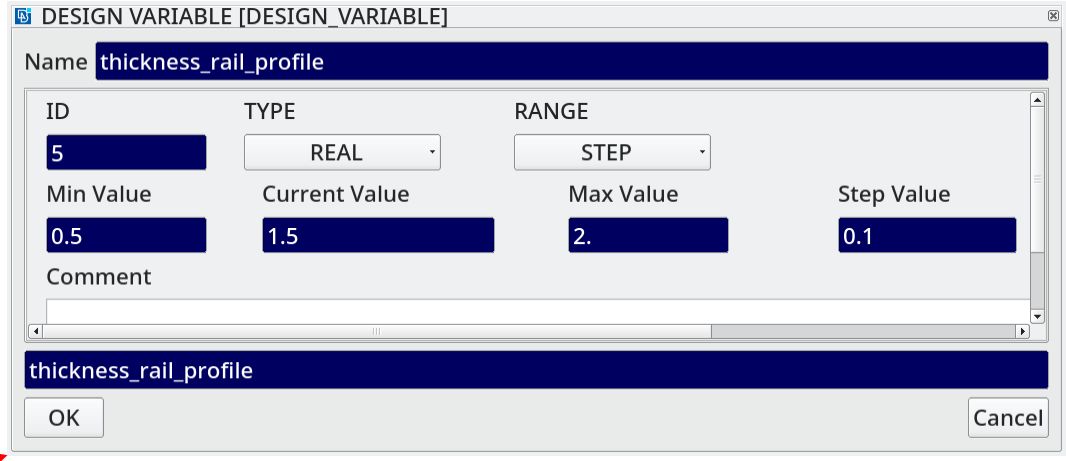


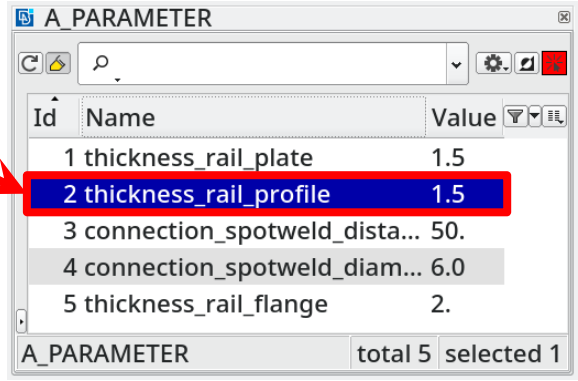


ANSA – Optimization Task

Design Variables → ANSA Parameters



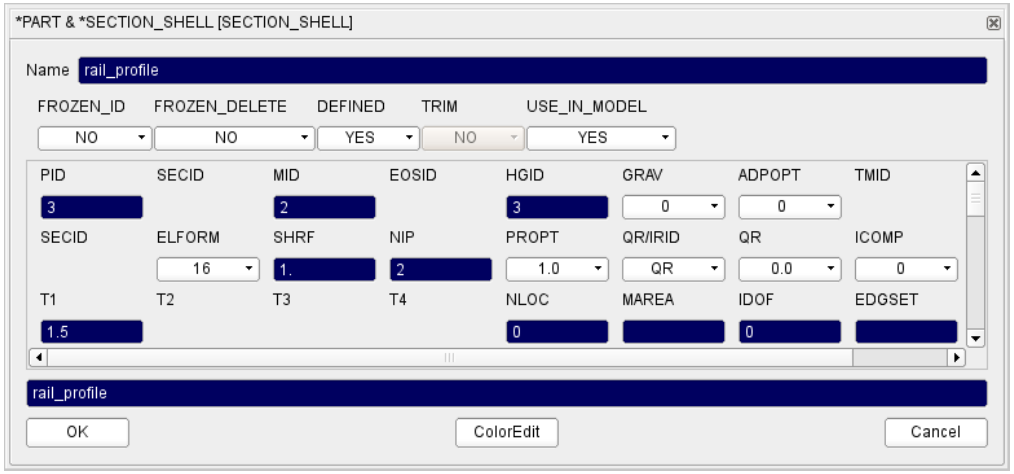


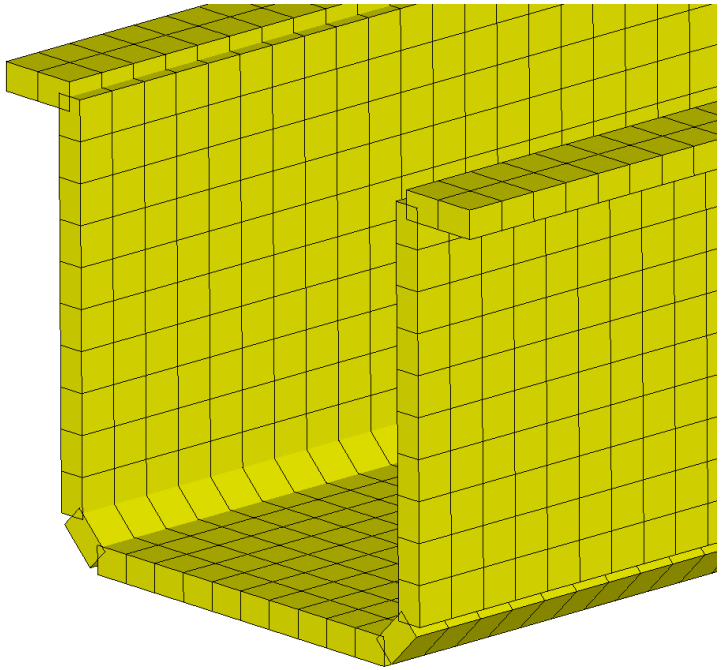


ANSA – Optimization Task

Design Variables → ANSA Parameters

Modification of **shell thicknesses**, materials, etc.

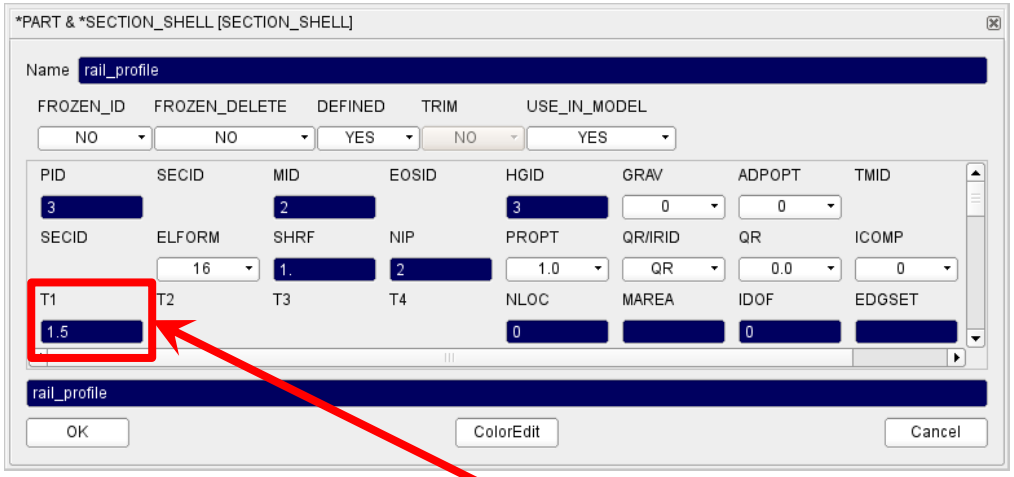


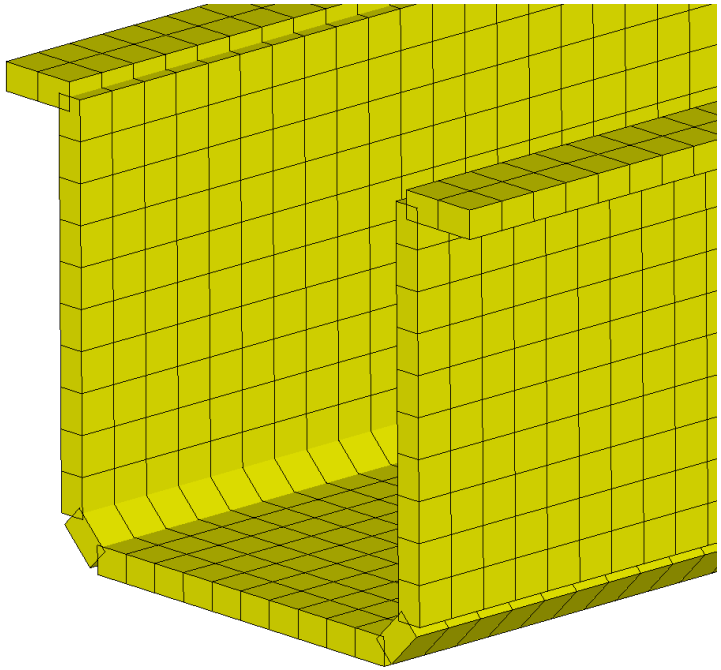


ANSA – Optimization Task

Design Variables → ANSA Parameters

Modification of **shell thicknesses**, materials, etc.





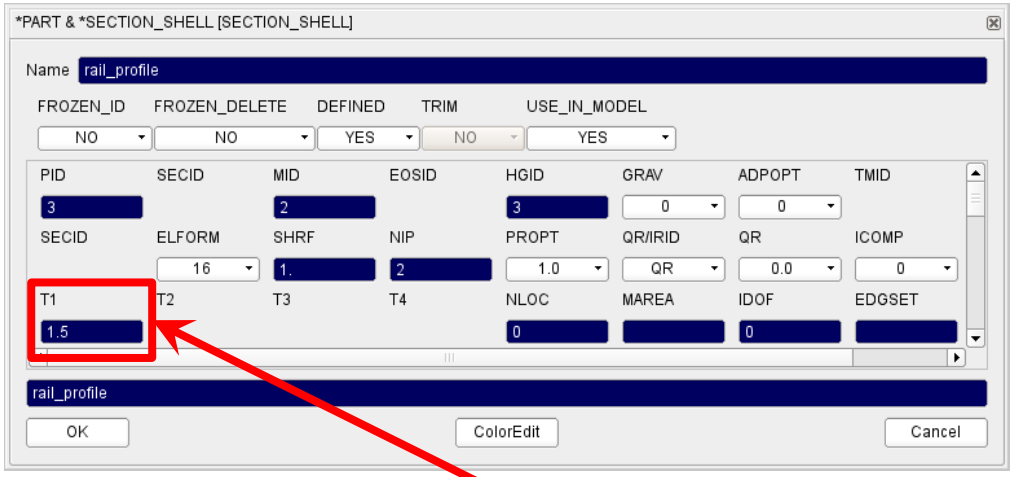
ANSA Parameter

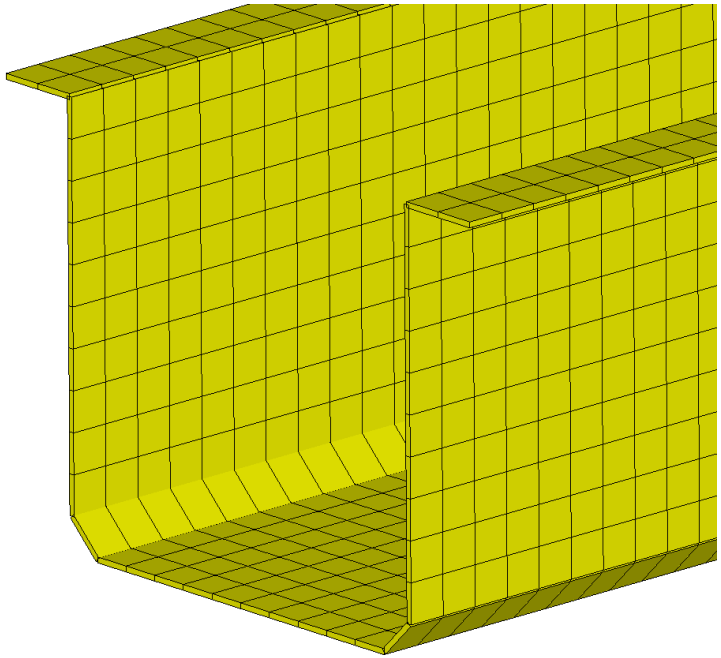
Design Variable = 5.0

ANSA – Optimization Task

Design Variables → ANSA Parameters

Modification of **shell thicknesses**, materials, etc.





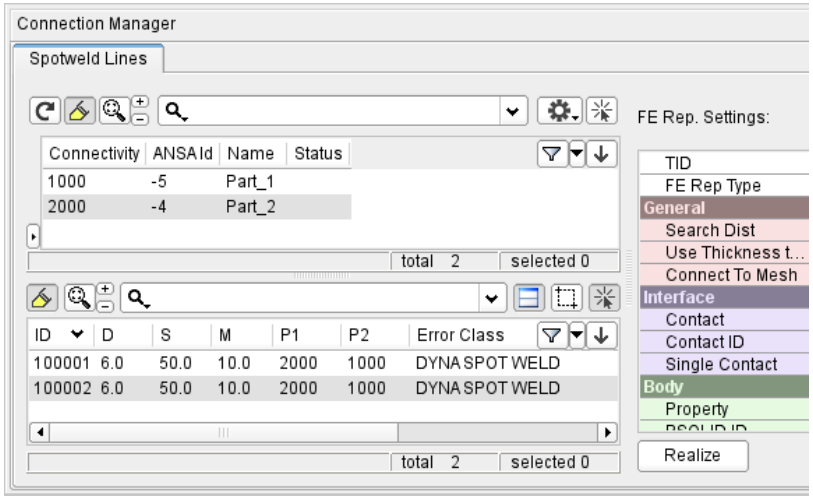
ANSA Parameter

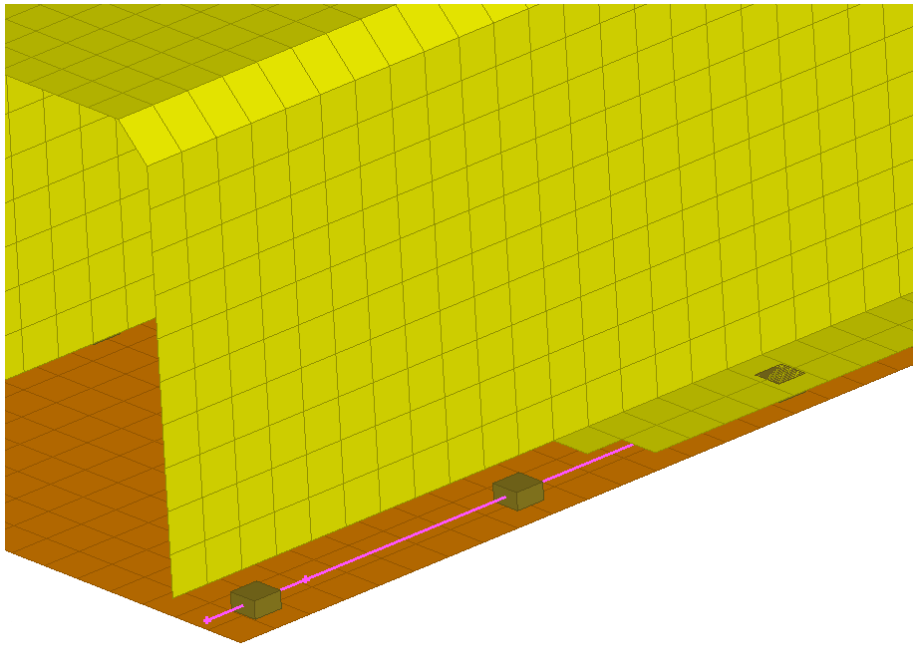
Design Variable = 1.0

ANSA – Optimization Task

Design Variables → ANSA Parameters

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

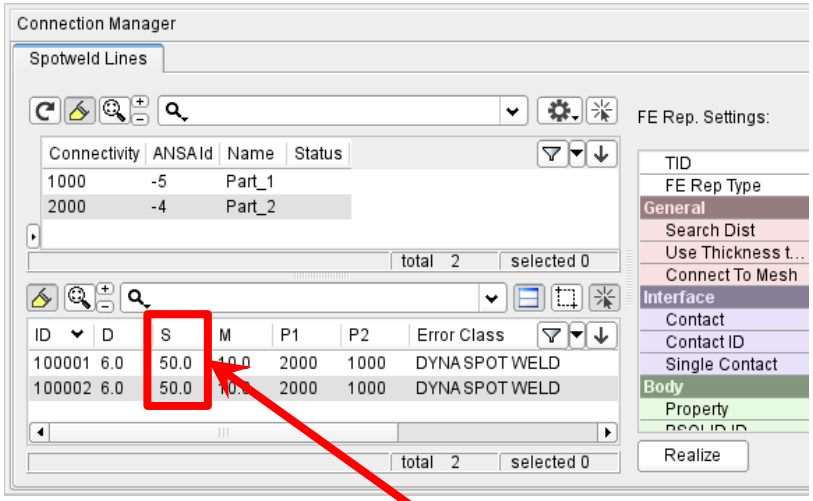


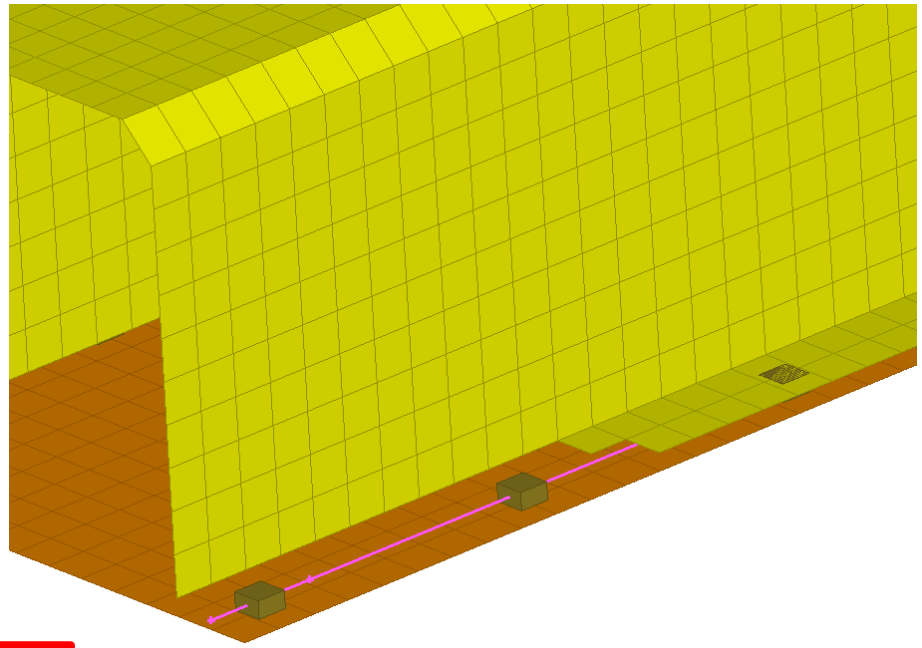


ANSA – Optimization Task

Design Variables → ANSA Parameters

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





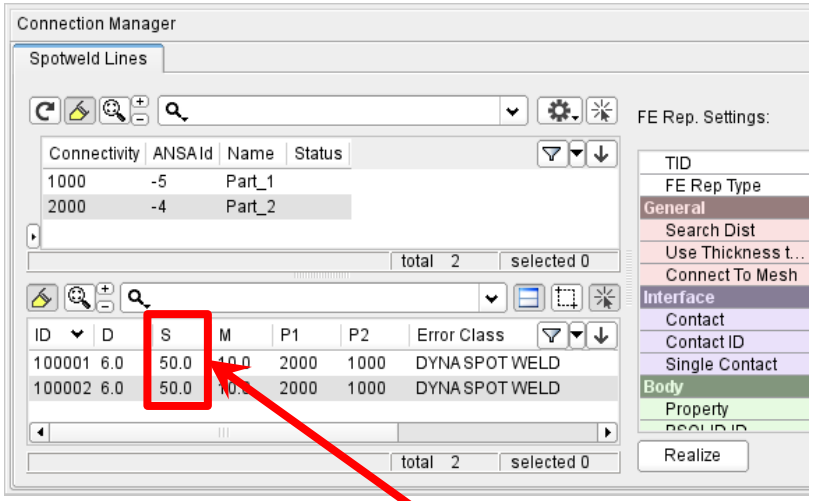
ANSA Parameter

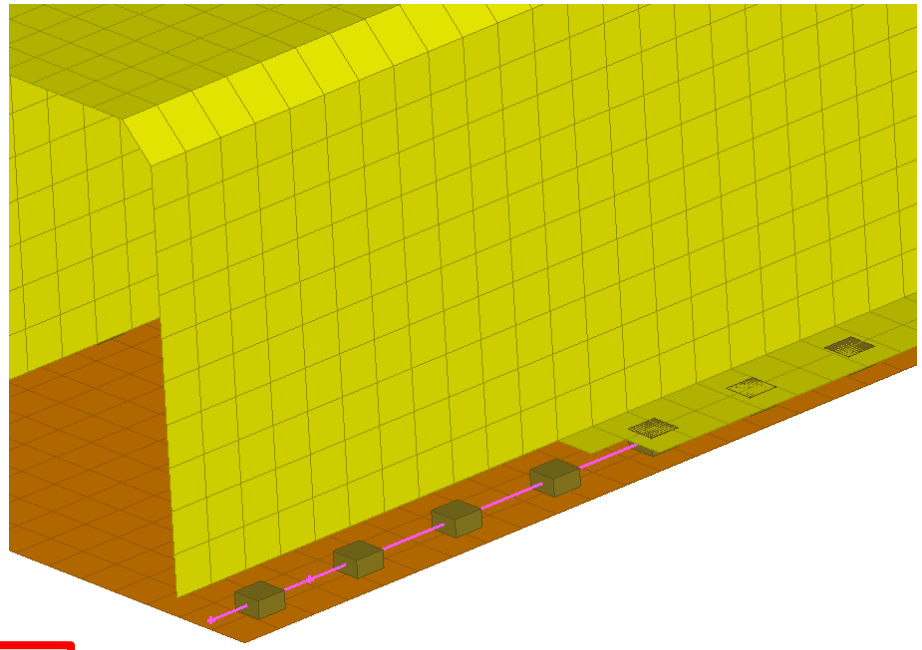
Design Variable (weld spot distance) = 50

ANSA – Optimization Task

Design Variables → ANSA Parameters

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





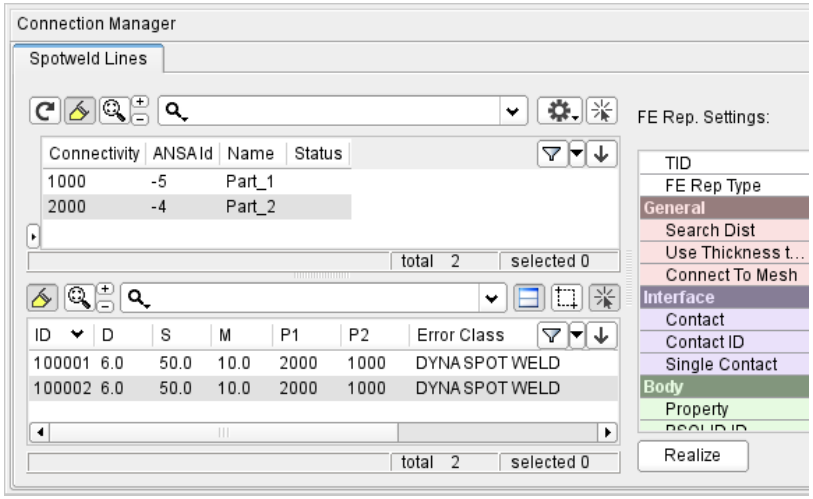
ANSA Parameter

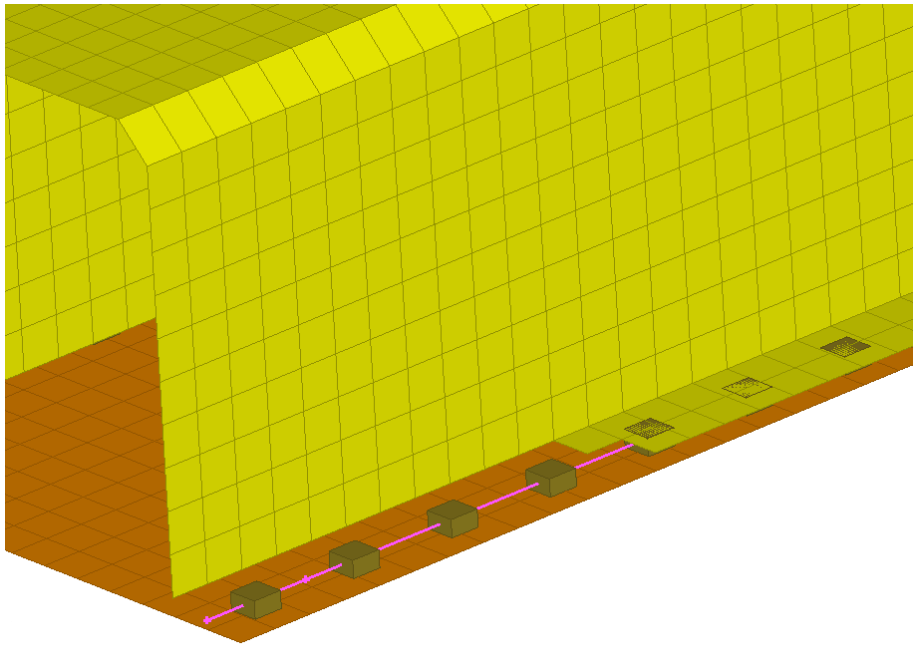
Design Variable (weld spot distance) = 20

ANSA – Optimization Task

Design Variables → ANSA Parameters

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

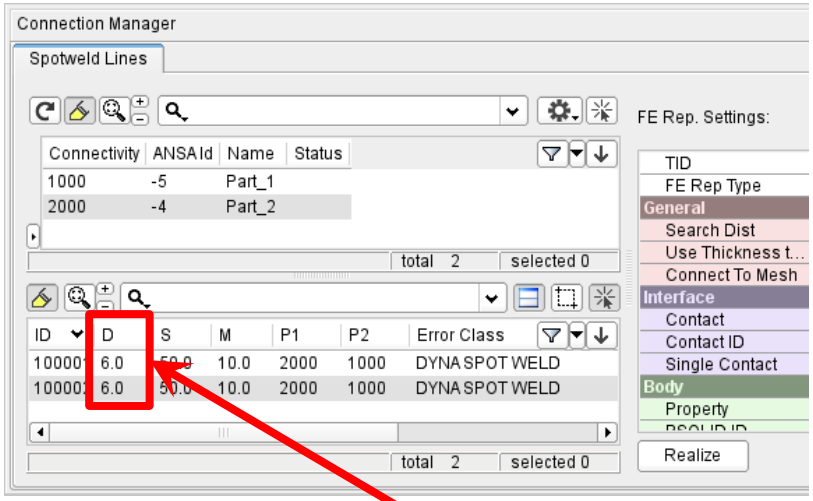


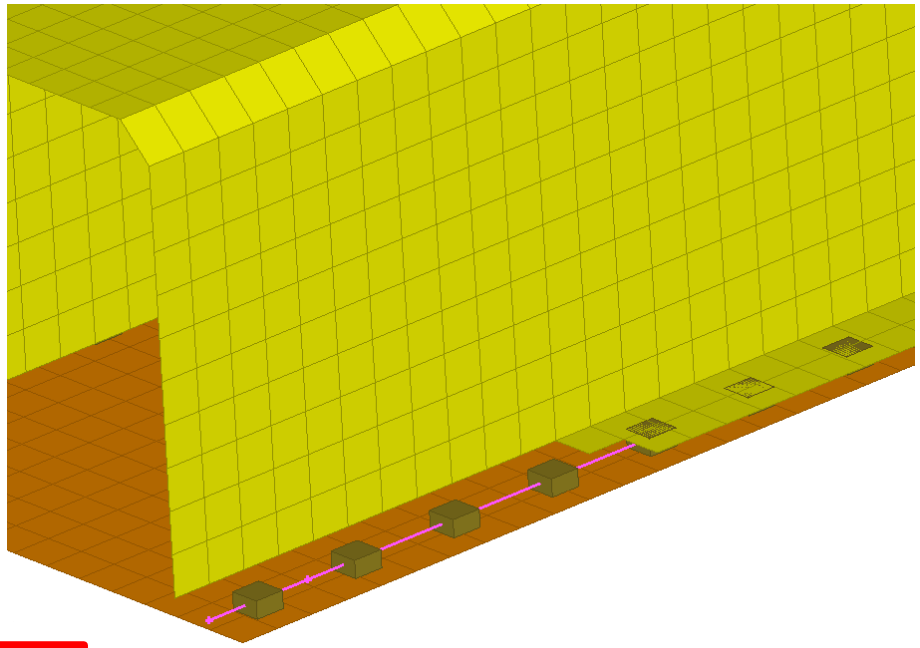


ANSA – Optimization Task

Design Variables → ANSA Parameters

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





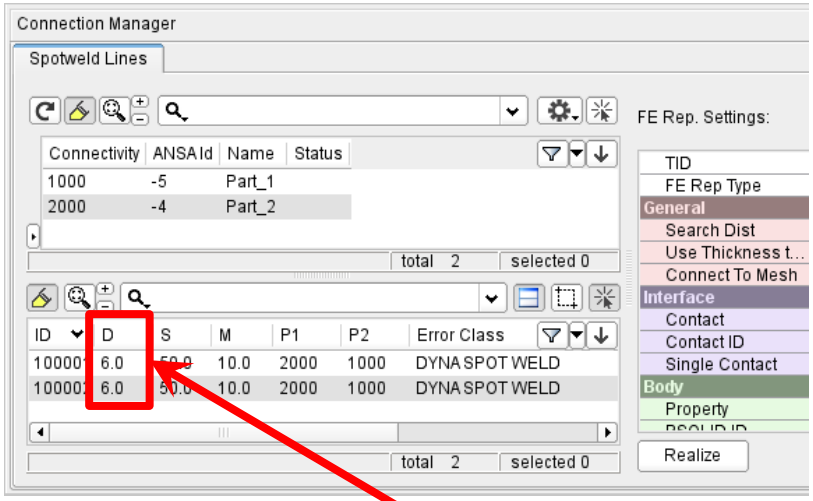
ANSA Parameter

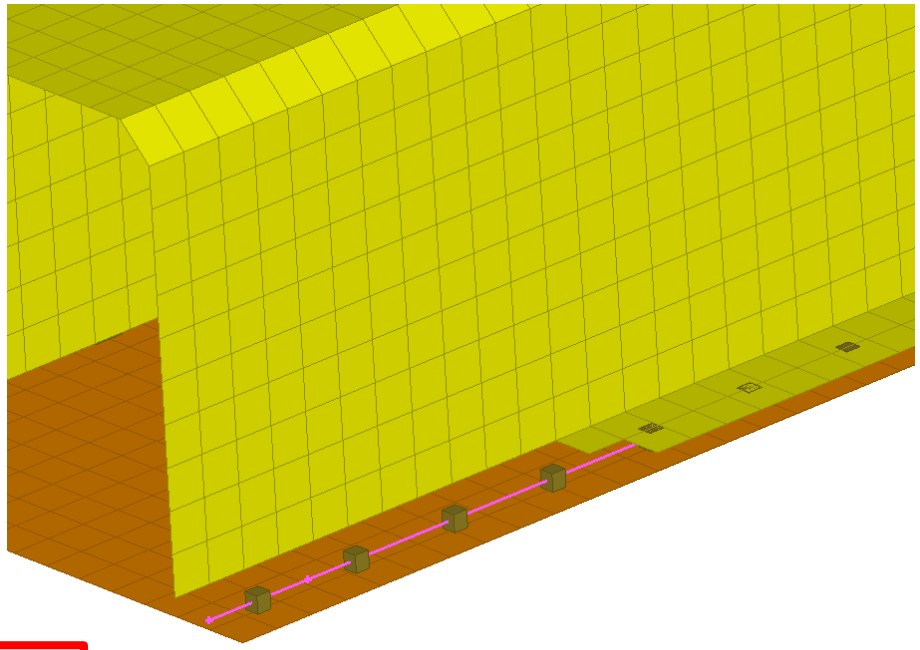
Design Variable (weld spot diameter) = 6.0

ANSA – Optimization Task

Design Variables → ANSA Parameters

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





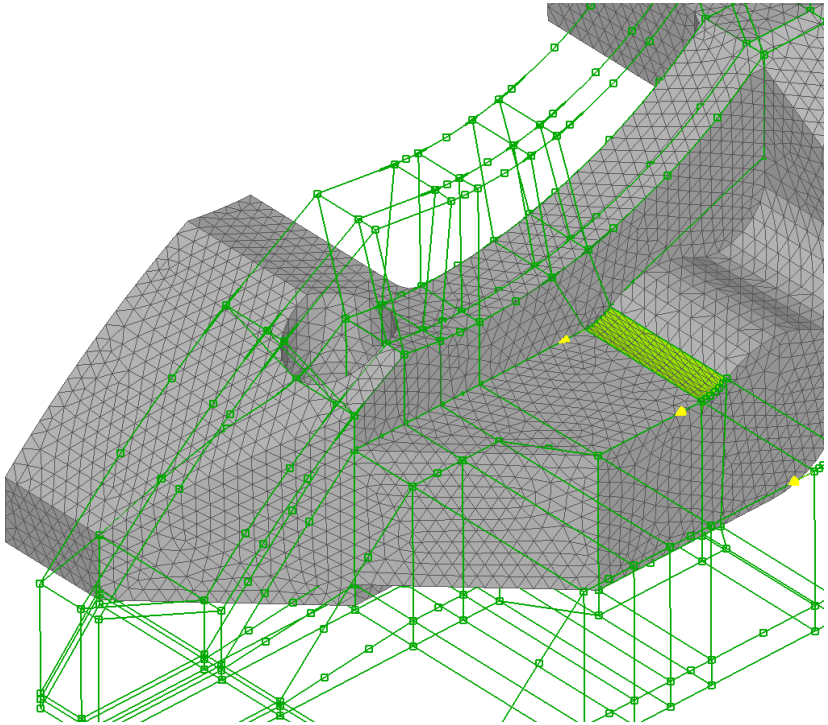
ANSA Parameter

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

Workflow | DOE setup | Results

Design variables

ID	Name	Min Value	Max Value
3	DV_Hoehe_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_Hoehe_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.

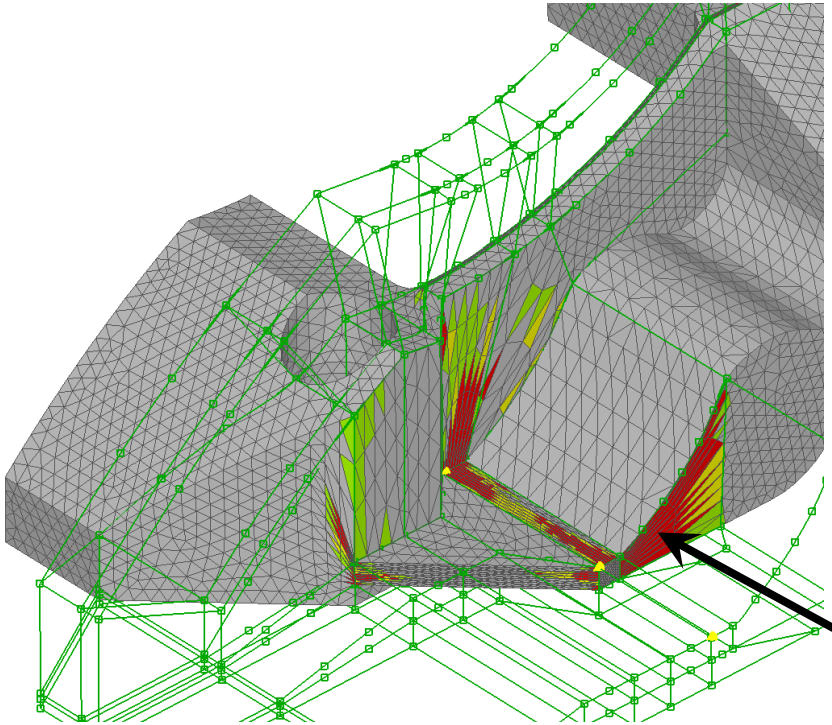
Experiments

	reite_Seite	a e_Flachste
1	0.	0.
2	2.	5.
3	4.	10.
4	6.	15.
5	8.	20.
6	10.	25.

ANSA – Optimization Task

DOE → Simulate

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



Failed elements

Optimization Tool

Workflow | DOE setup | Results

Design variables

ID	Name	Min Value	Max Value
3	DV_Hoehe_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_Hoehe_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.

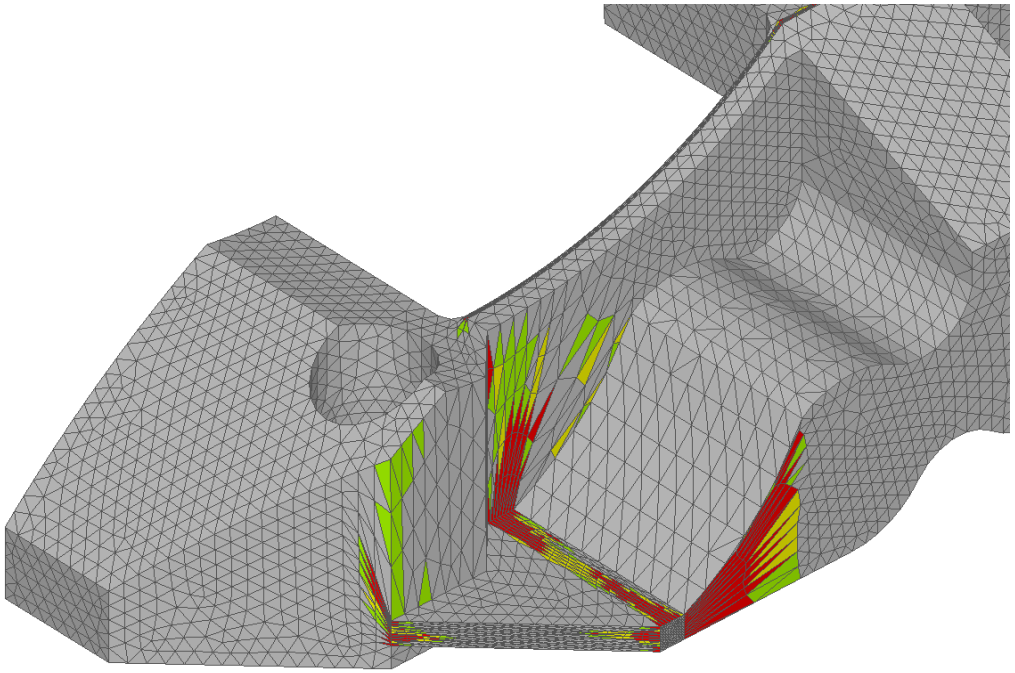
Experiments

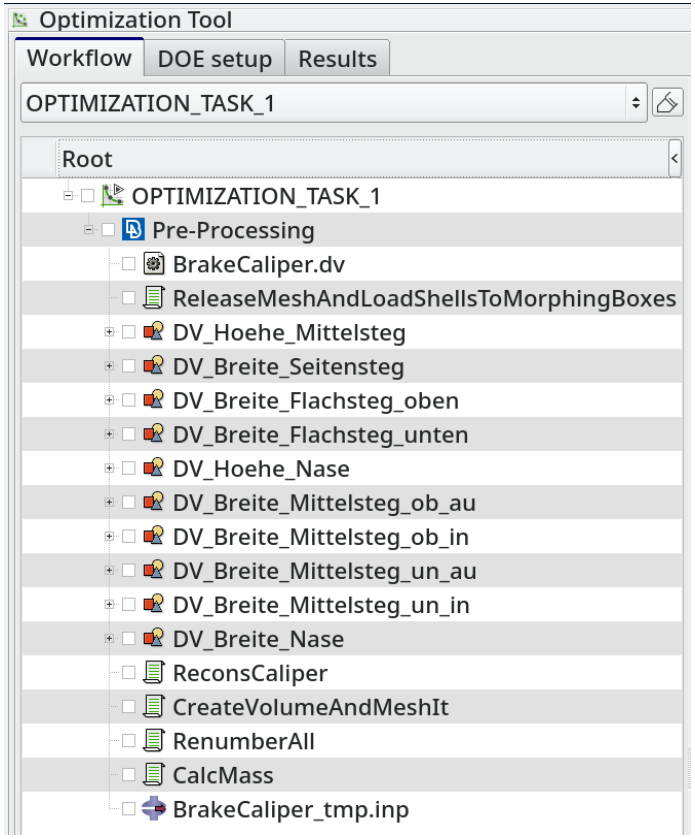
	reite_Seite	a e_Flachste
1	0.	0.
2	2.	5.
3	4.	10.
4	6.	15.
5	8.	20.
6	10.	25.

ANSA – Optimization Task

User Scripts / User Actions

For improving mesh quality

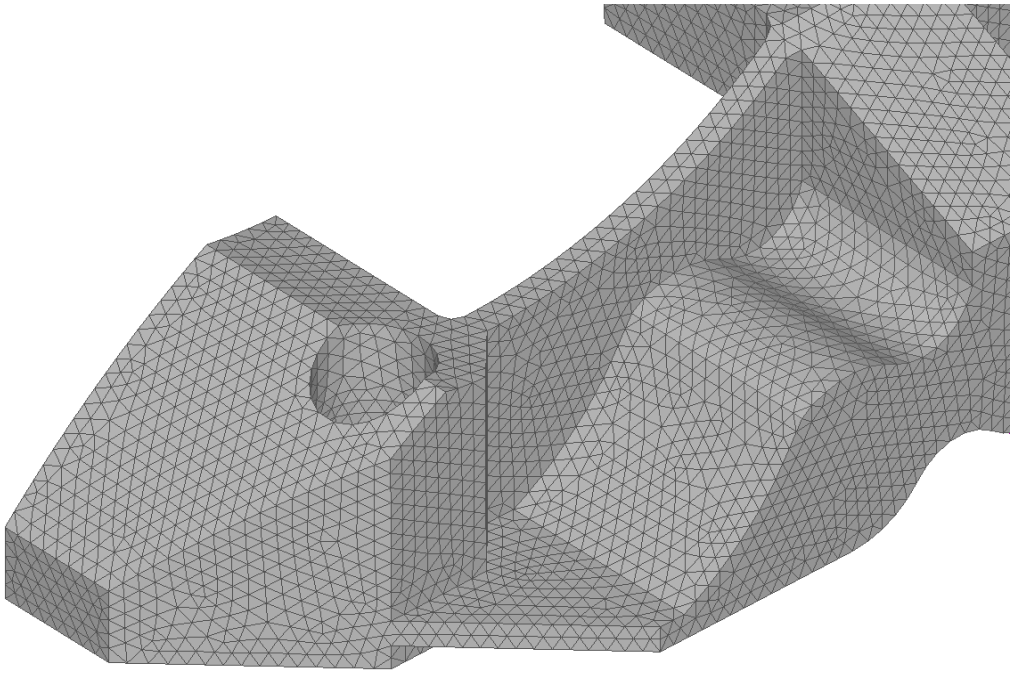


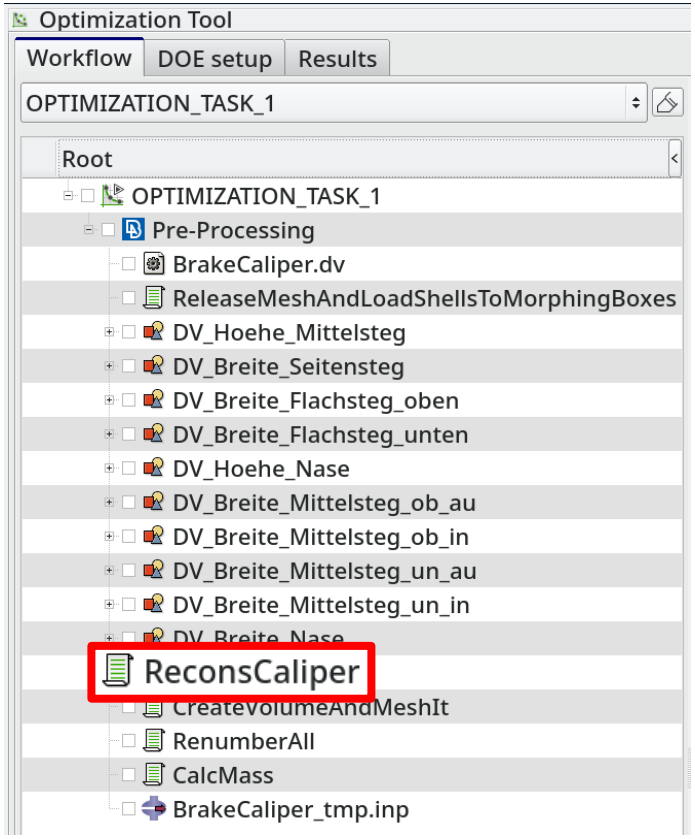


ANSA – Optimization Task

User Scripts / User Actions

For improving mesh quality

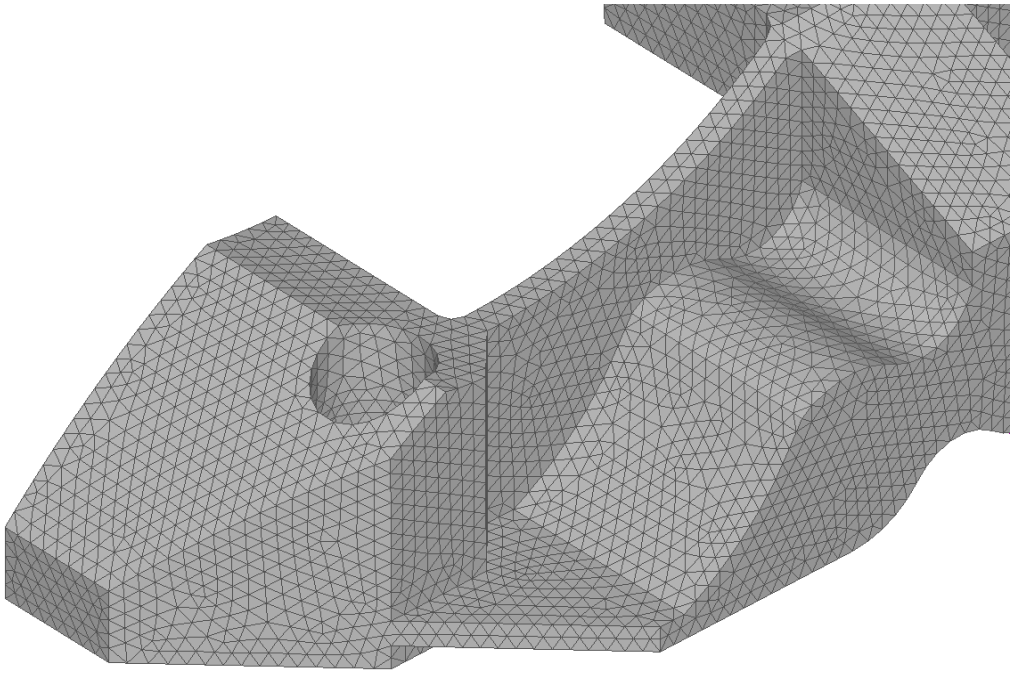


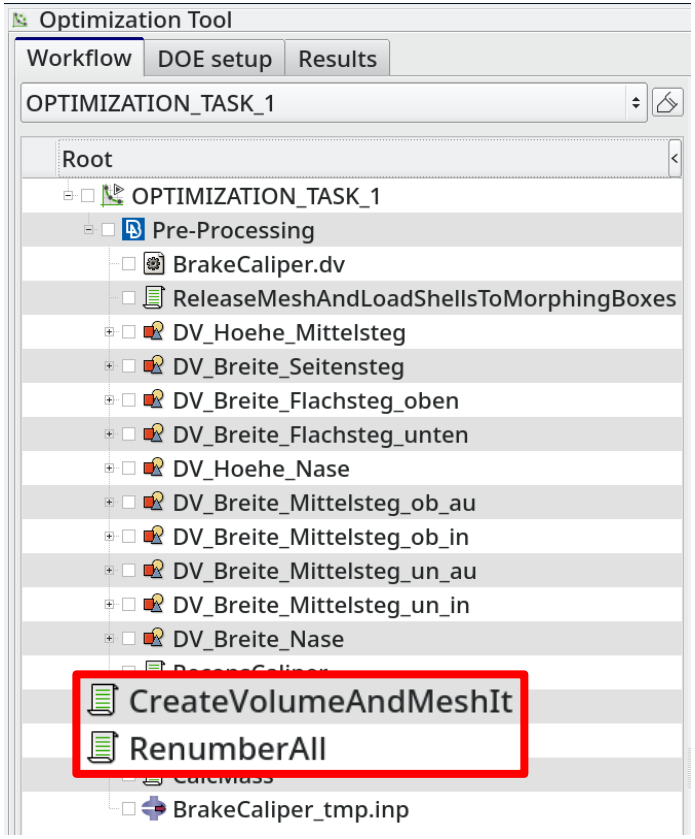


ANSA – Optimization Task

User Scripts / User Actions

For creating Volume Mesh, Renumber, …

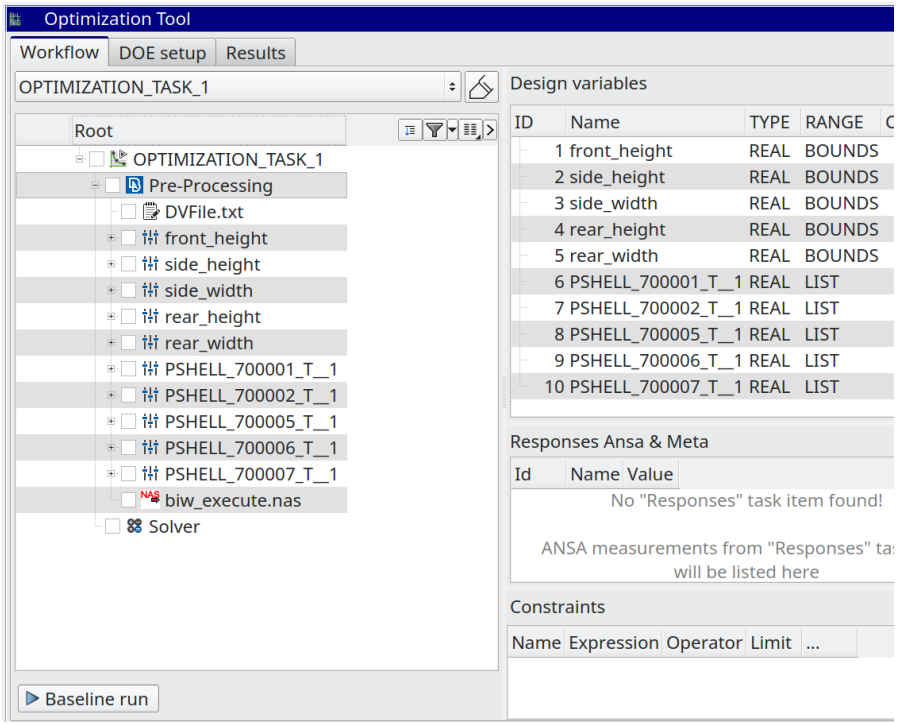




ANSA – Optimization Task

Responses

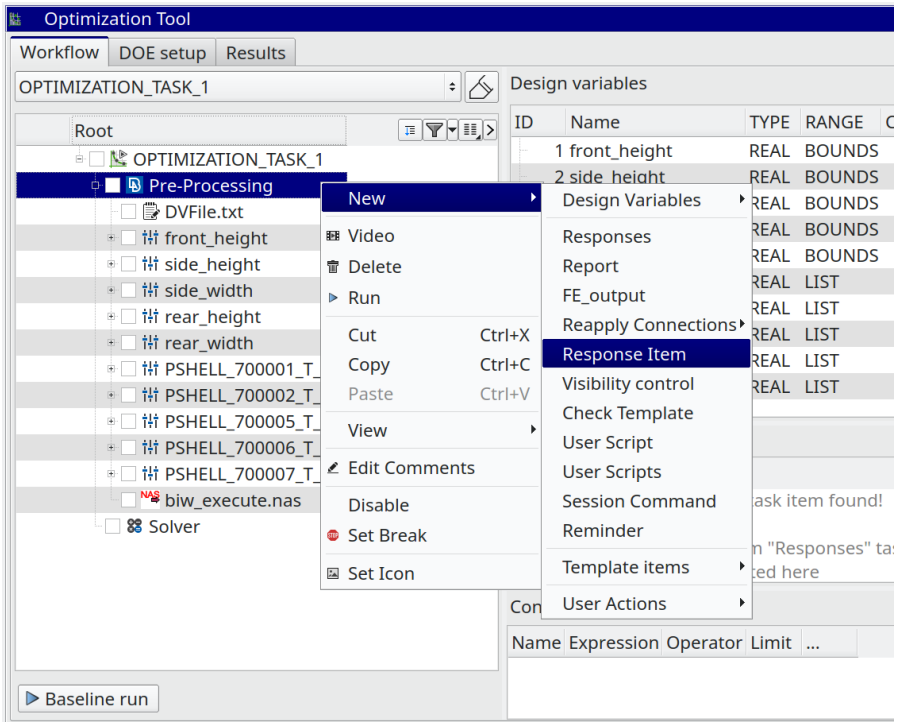
From card values or measurements (e.g. mass, distances after morphing)



ANSA – Optimization Task

Responses

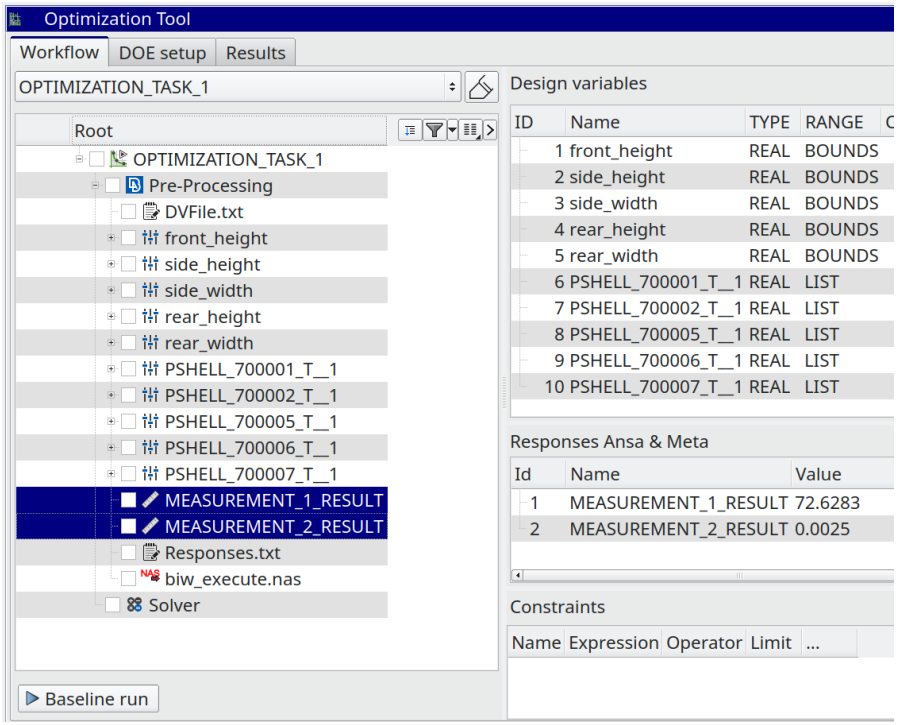
From card values or measurements (e.g. mass, distances after morphing)



ANSA – Optimization Task

Responses

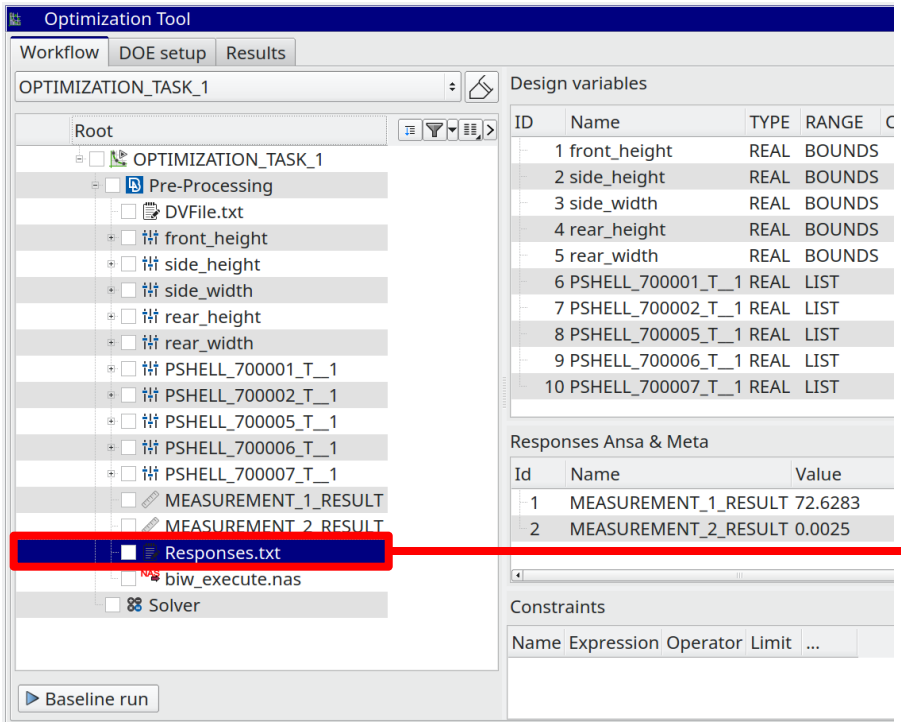
From card values or measurements (e.g. mass, distances after morphing)



ANSA – Optimization Task

Responses

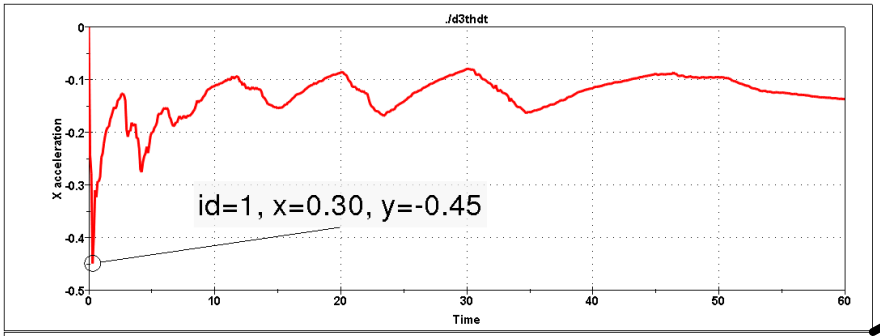
From card values or measurements (e.g. mass, distances after morphing)

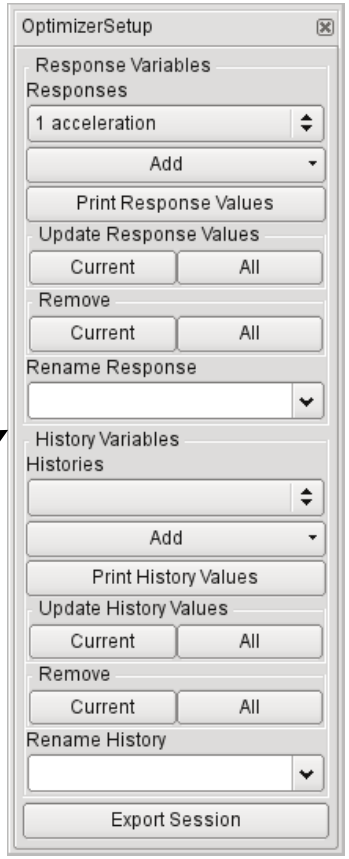



```
# RESPONSES
#-----------------------------------------------
#  Id   |      Name     |    Value
#-----------------------------------------------
1 , MEASUREMENT_1_RESULT, 72.62835287236592
2 , MEASUREMENT_2_RESULT, 0.0025455872783193 21
#-----------------------------------------------
```

Correctly formatted for import in LS-OPT

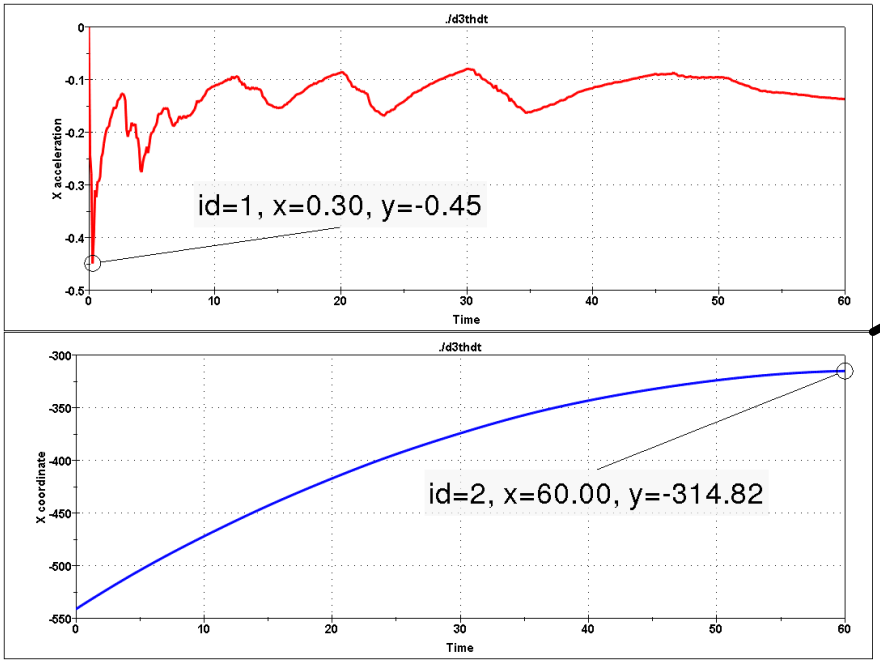
META – OptimizerSetup Toolbar

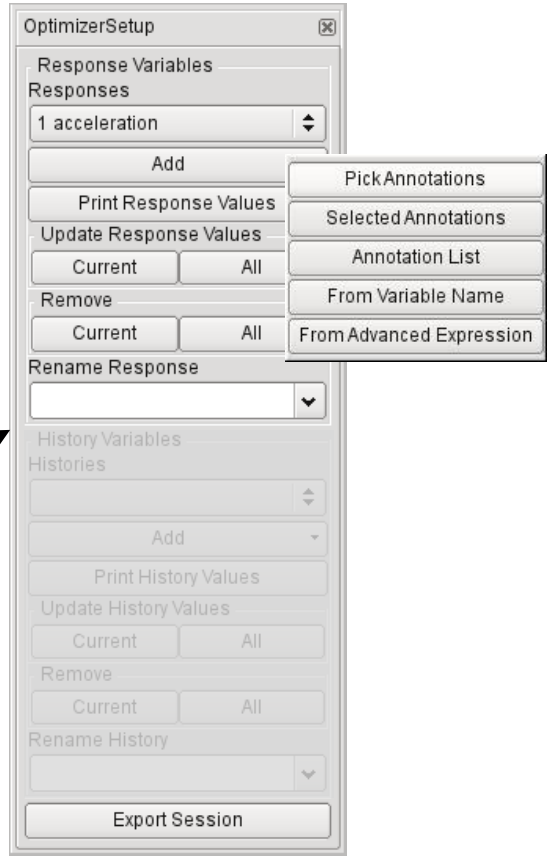




META – OptimizerSetup Toolbar

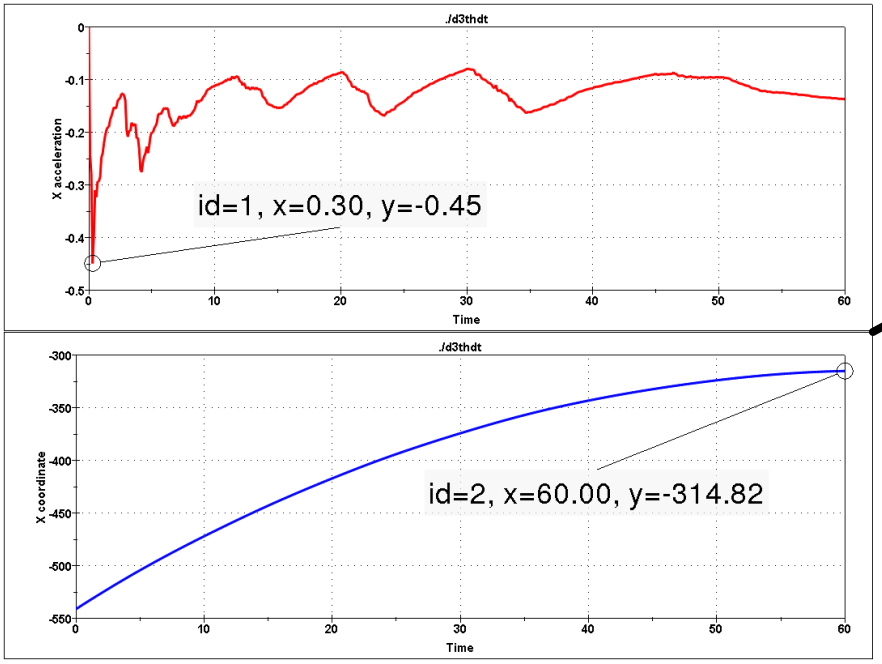
- Responses from annotations, variables, advanced expressions

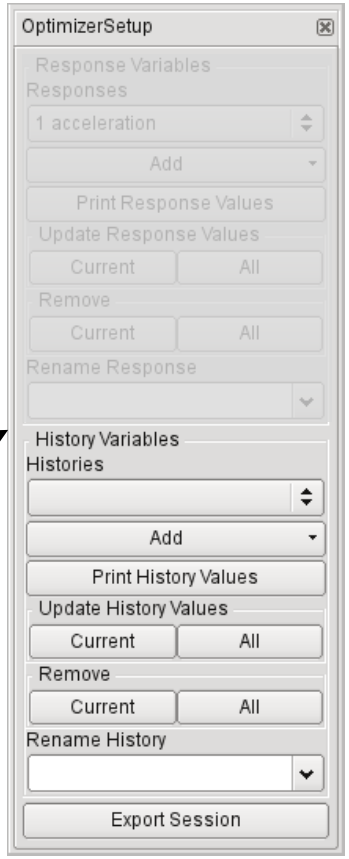




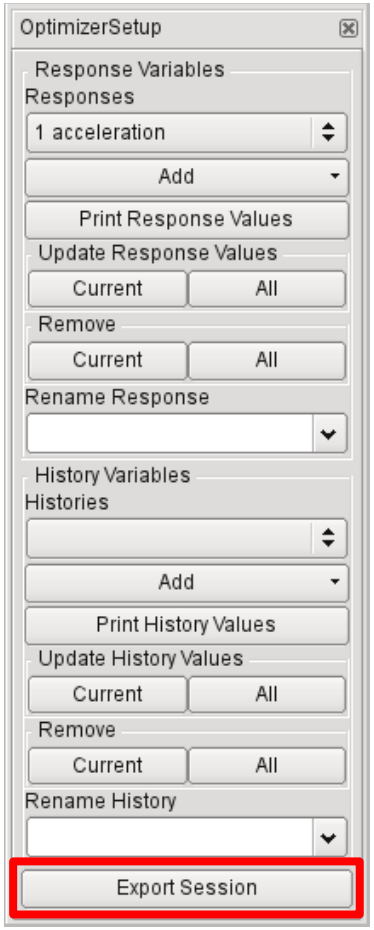
META – OptimizerSetup Toolbar

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





META – OptimizerSetup Toolbar



Exports:

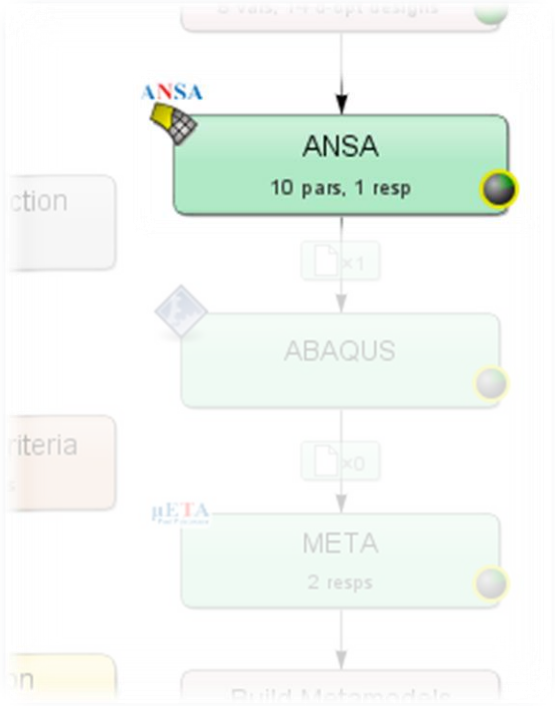
- Session file (for reproduction of results extraction)
- Output file, containing responses and histories

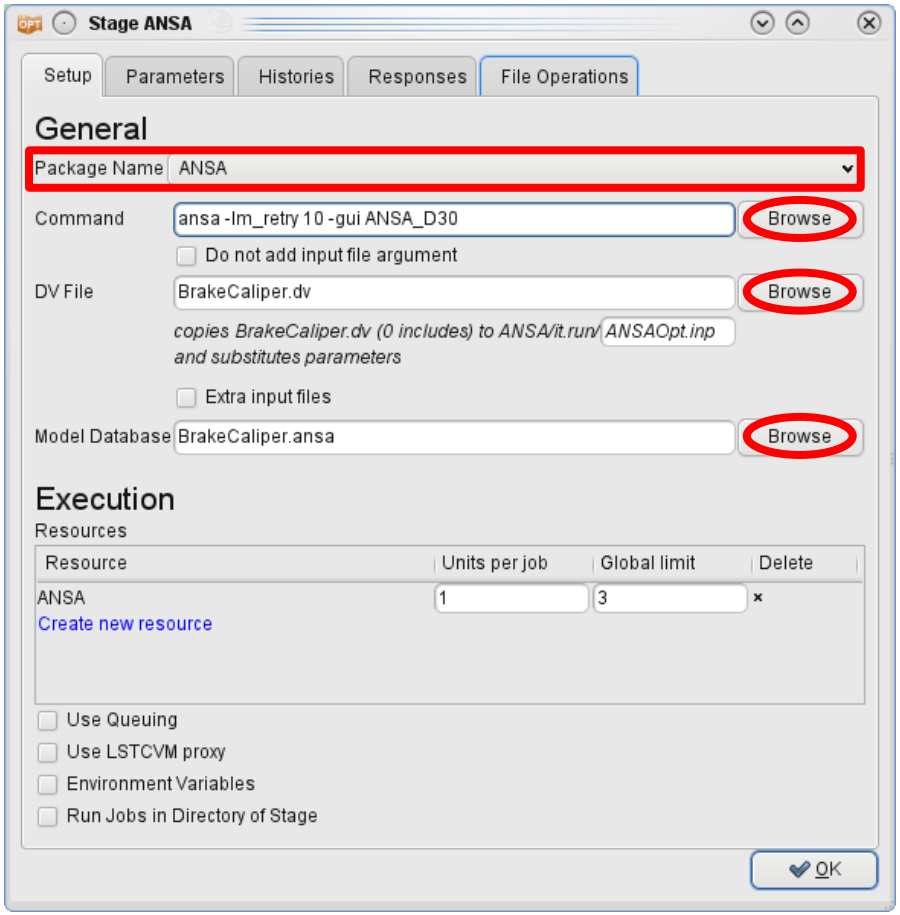
```
#OptimizerSetup Response & history File created by META post
RESPONSES
 1,acceleration,-1.18
 2,intrusion,-440.07
END
```

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  A N S A  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

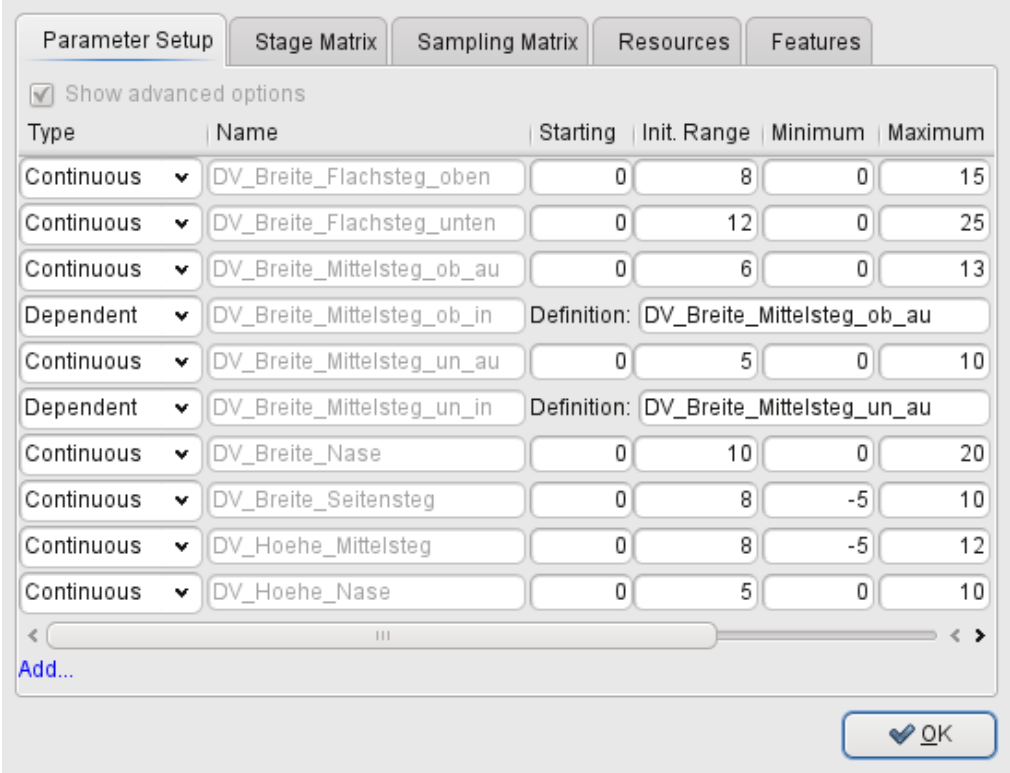
Type	Name	Starting	Init. Range	Minimum	Maximum
Continuous	DV_Breite_Flachsteg_oben	0		0	15
Continuous	DV_Breite_Flachsteg_unten	0		0	25
Continuous	DV_Breite_Mittelsteg_ob_au	0		0	13
Continuous	DV_Breite_Mittelsteg_ob_in	10		-20	13
Continuous	DV_Breite_Mittelsteg_un_au	0		0	10
Continuous	DV_Breite_Mittelsteg_un_in	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...

OK

Connecting ANSA to LS-OPT

Fine Tuning of Design Variables, e.g.

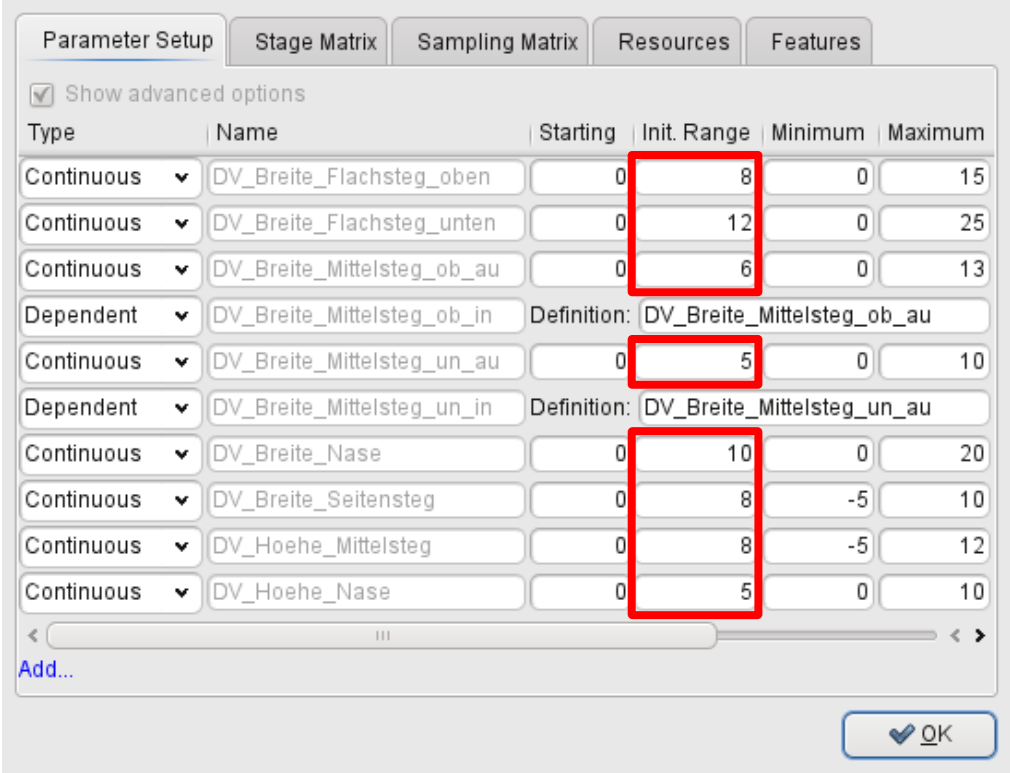


Type	Name	Starting	Init. Range	Minimum	Maximum
Continuous	DV_Breite_Flachsteg_oben	0	8	0	15
Continuous	DV_Breite_Flachsteg_unten	0	12	0	25
Continuous	DV_Breite_Mittelsteg_ob_au	0	6	0	13
Dependent	DV_Breite_Mittelsteg_ob_in	Definition:	DV_Breite_Mittelsteg_ob_au		
Continuous	DV_Breite_Mittelsteg_un_au	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 ANSA to LS-OPT

Fine Tuning of Design Variables, e.g.

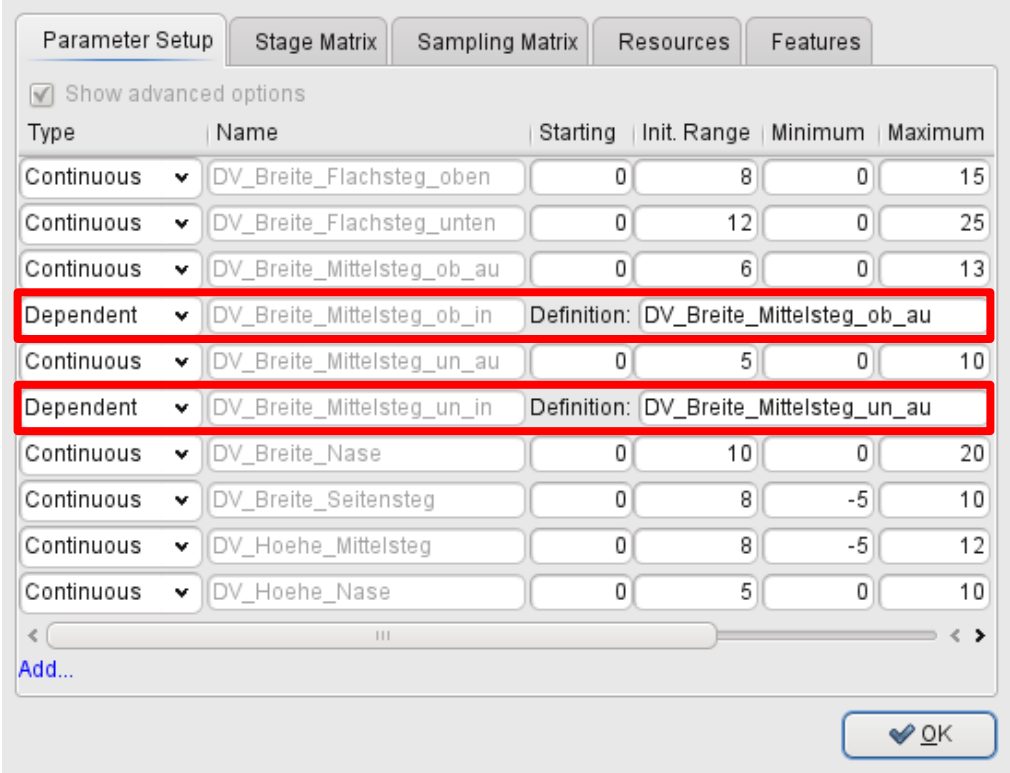
- Ranges



Connecting ANSA to LS-OPT

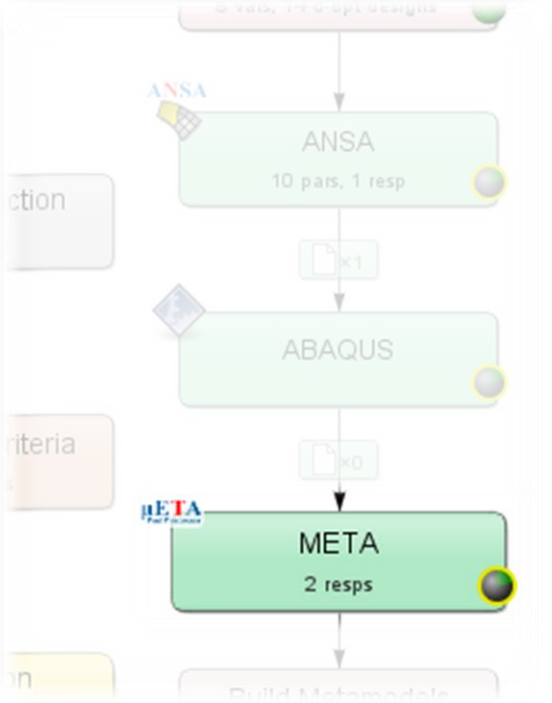
Fine Tuning of Design Variables, e.g.

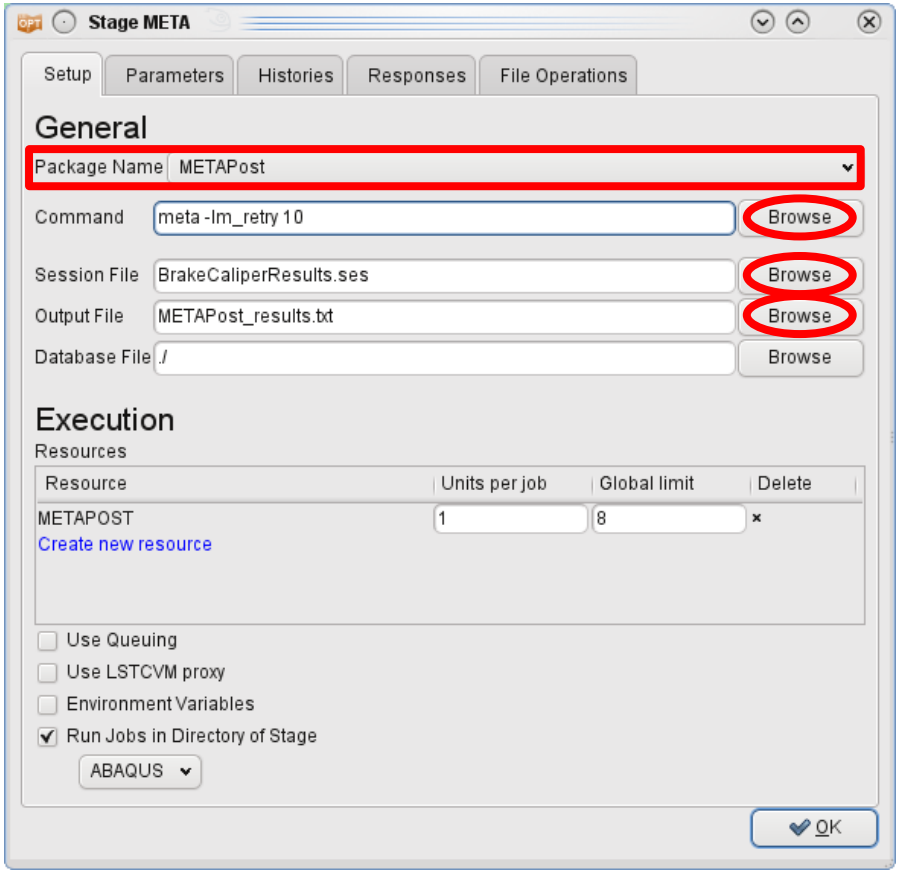
- Ranges
- Dependencies
- etc.



Connecting META to LS-OPT

Stage for META

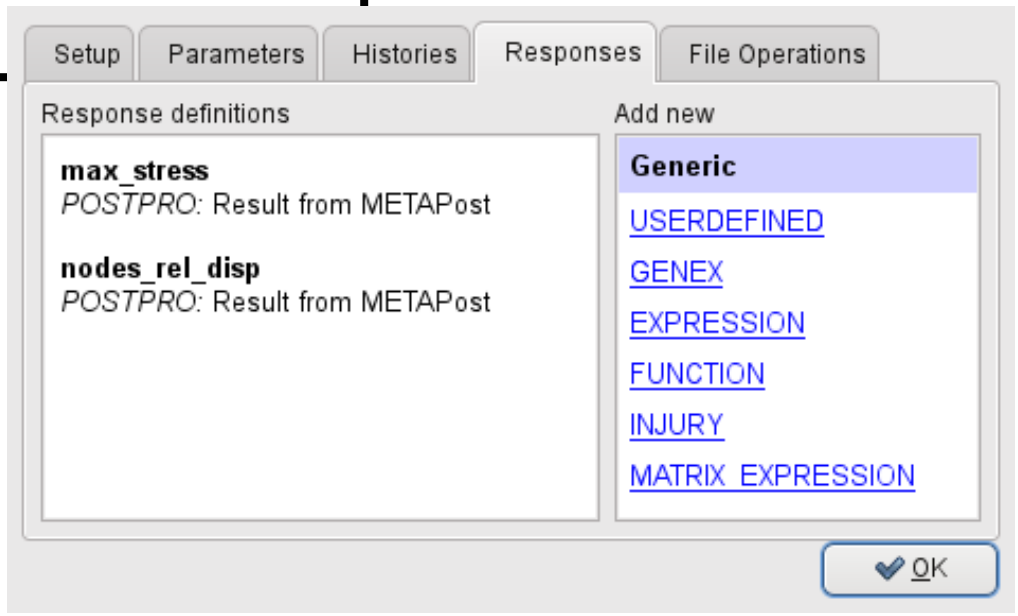




Connecting META to LS-OPT

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

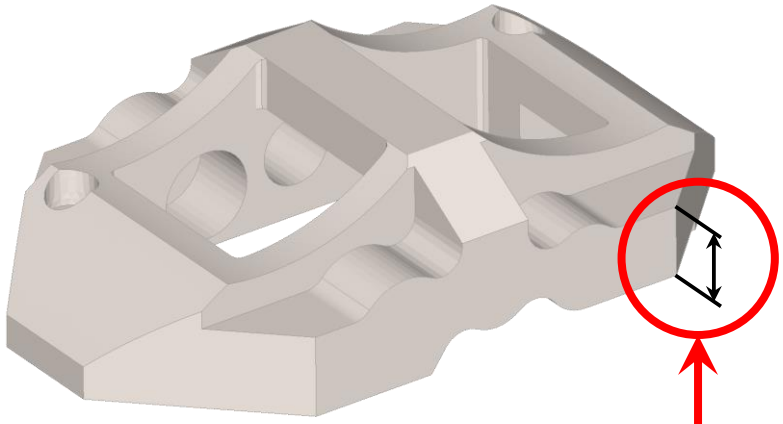
```
#OptimizerSetup Response & history File created by META post
RESPONSES
 1,nodes_rel_disp,0.174171448
 2,max_stress,169.780731
END
```



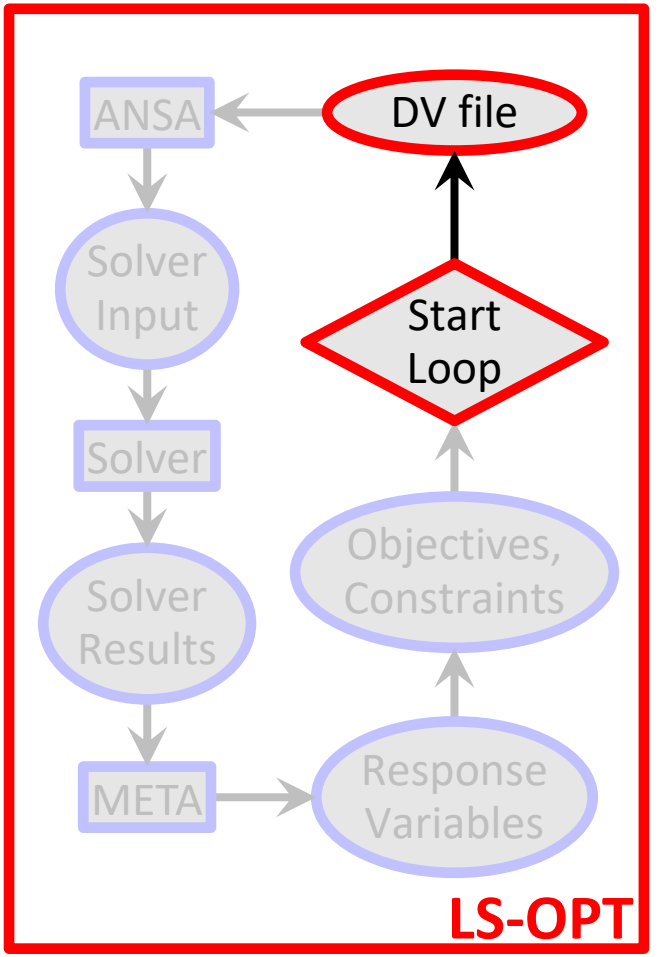
Optimization Run

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

LS-OPT determines set of DV and outputs DV file

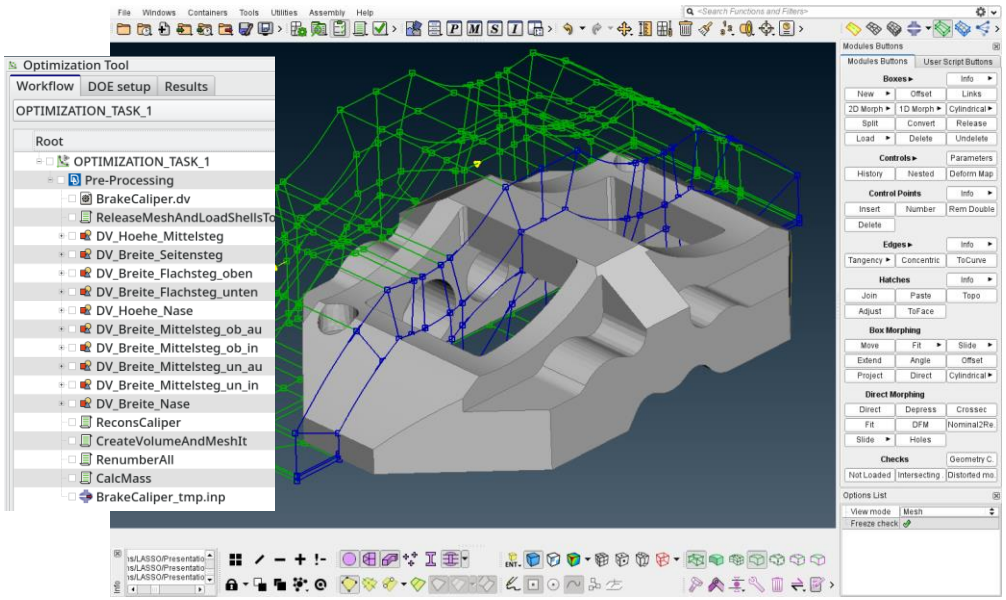


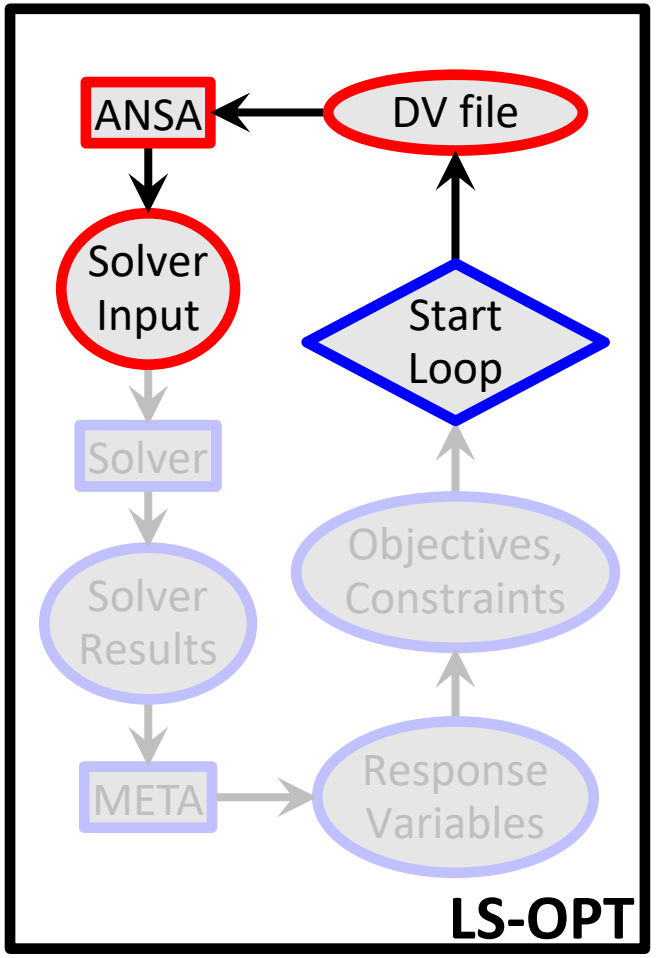
```
#-------------------------------------------------------------------------------
# ID | DESIGN VARIABLE NAME | TYPE | RANGE | CURRENT VALUE |  MIN VALUE
#-------------------------------------------------------------------------------
 3,  DV_Hoehe_Mittelsteg,  REAL,     BOUNDS,    0., -5., 12.
 2,  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_Hoehe_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

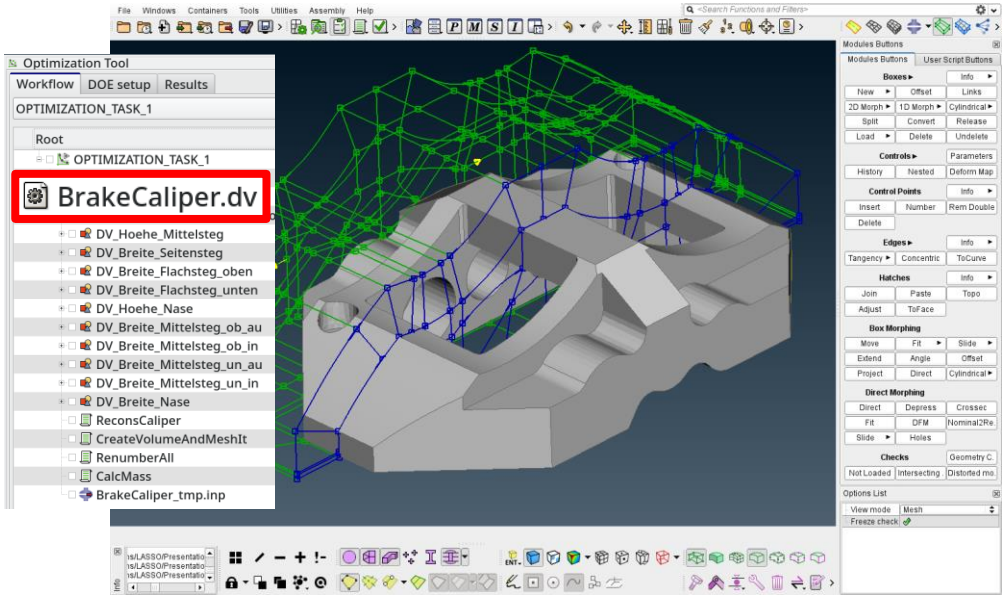


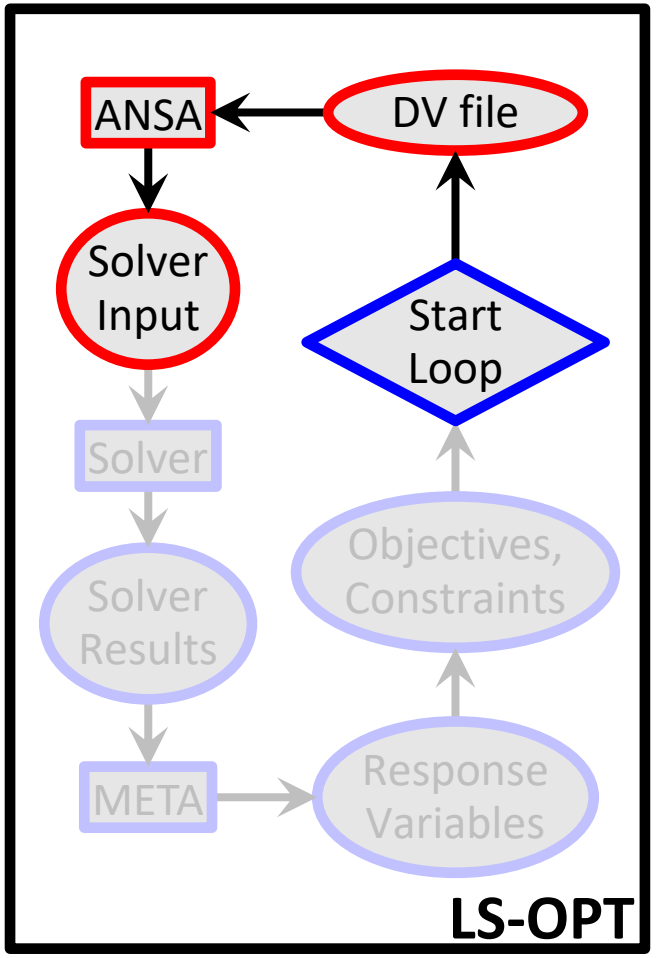


Optimization Run

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

- ANSA reads DV from DV file

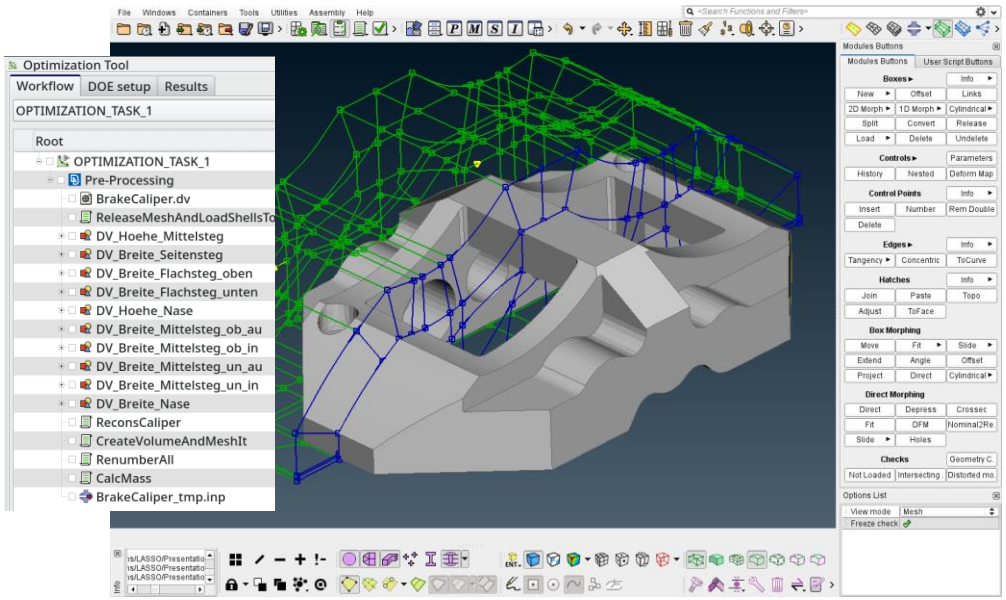


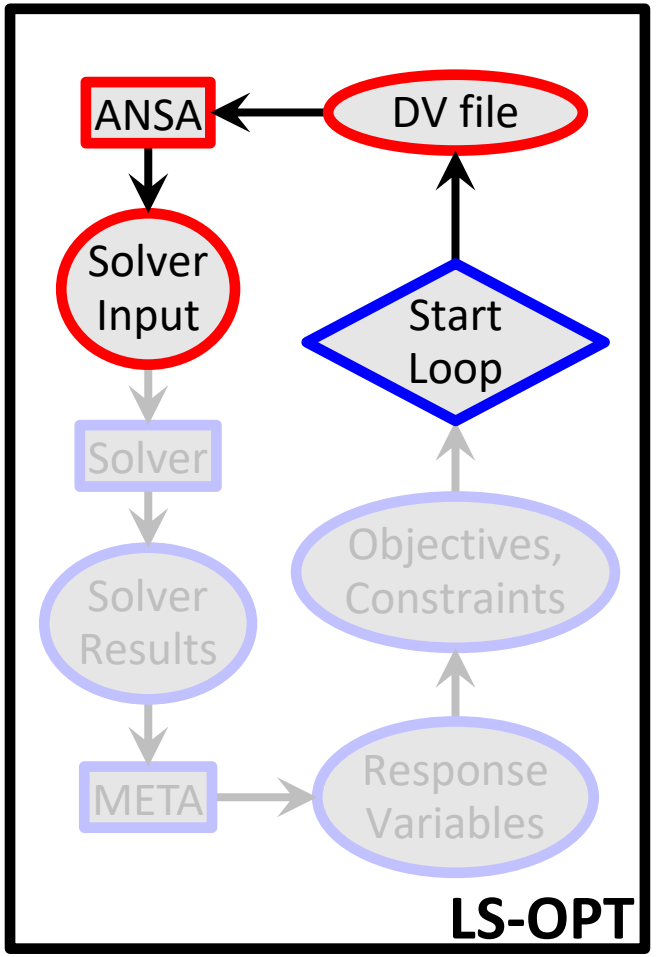


Optimization Run

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

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

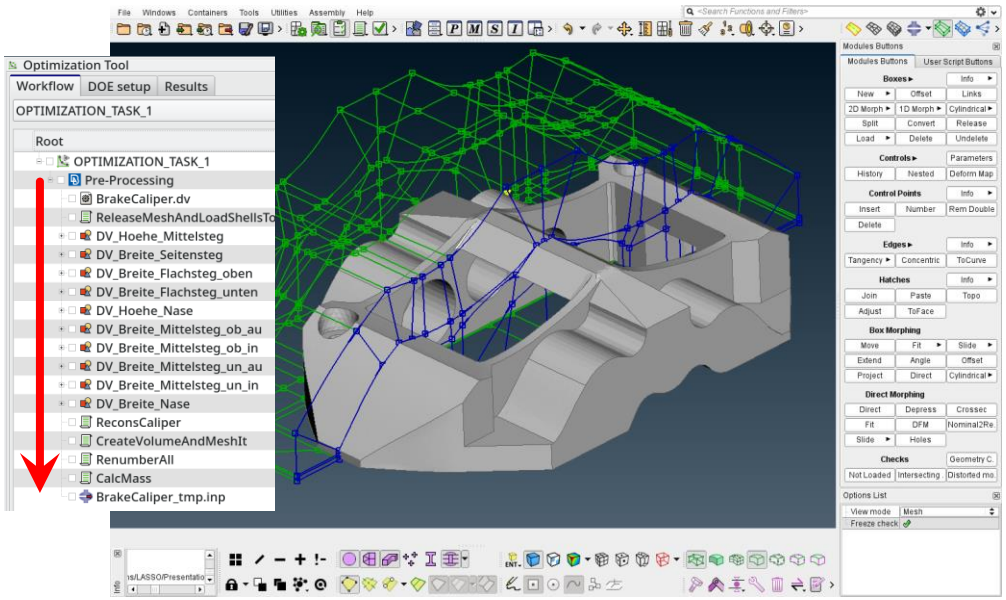


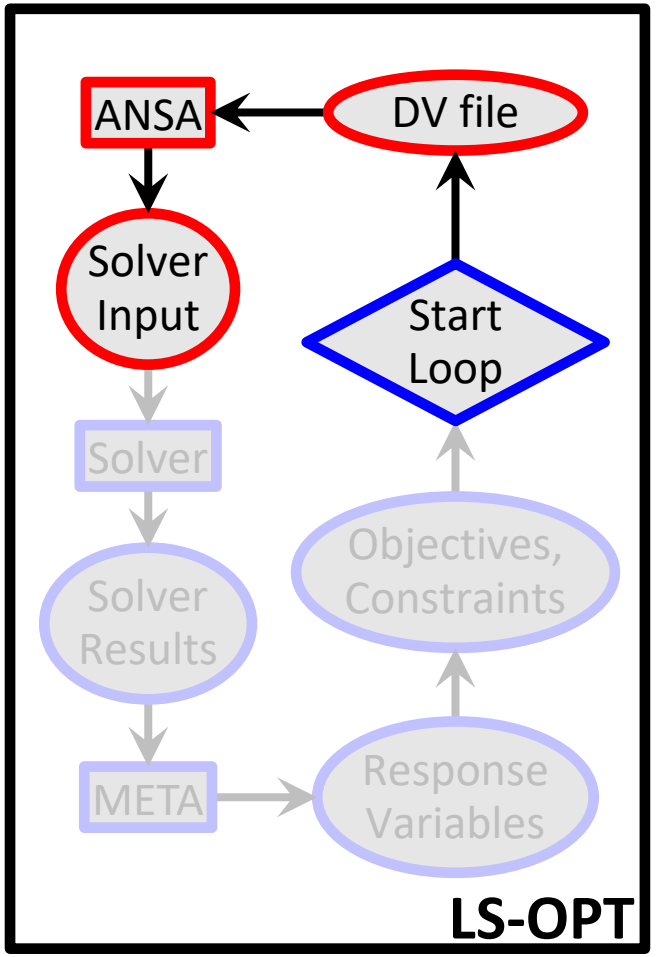


Optimization Run

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

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

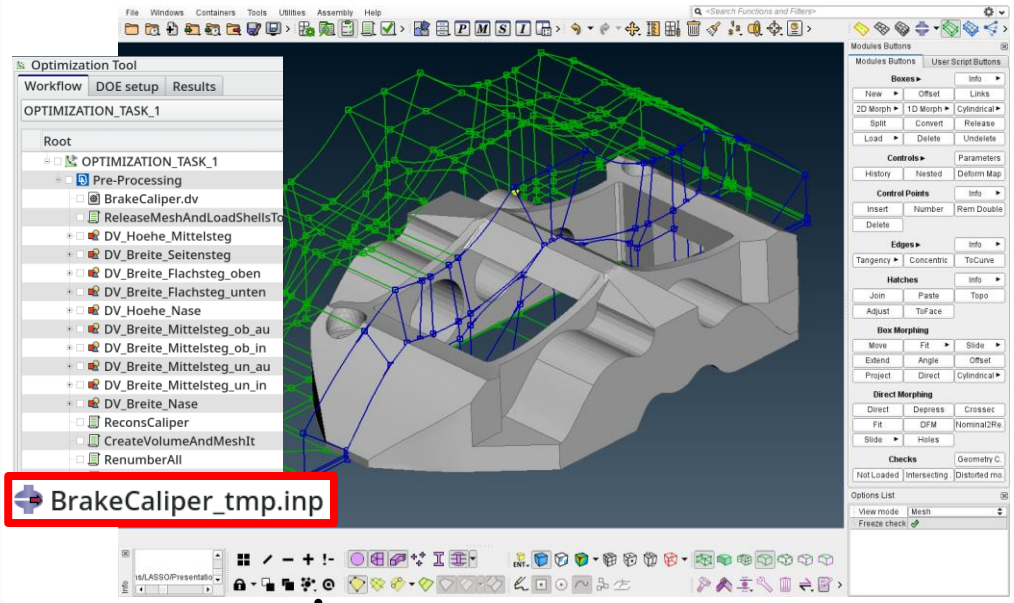


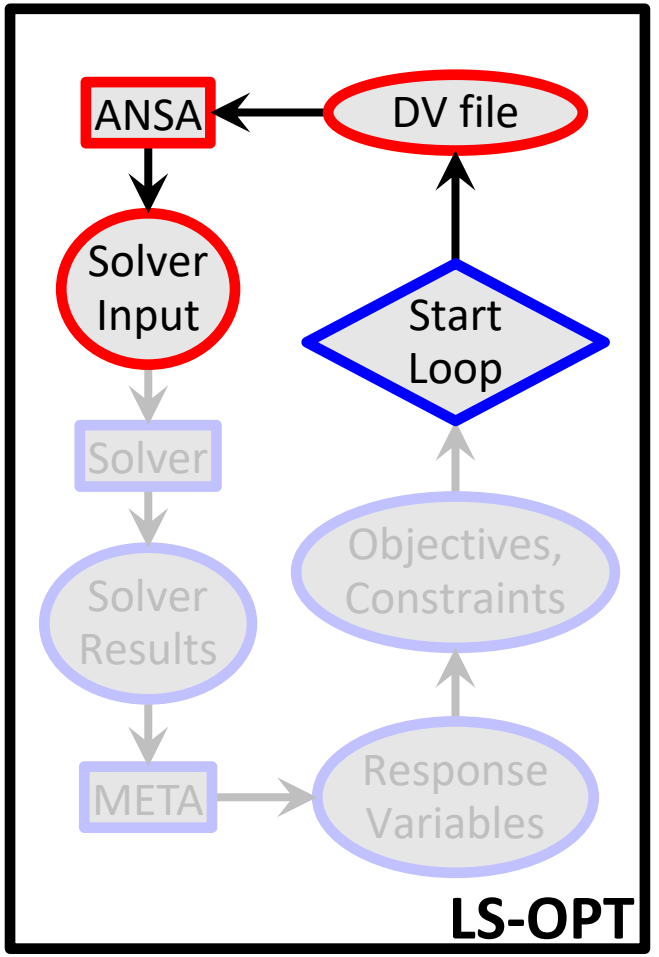


Optimization Run

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

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

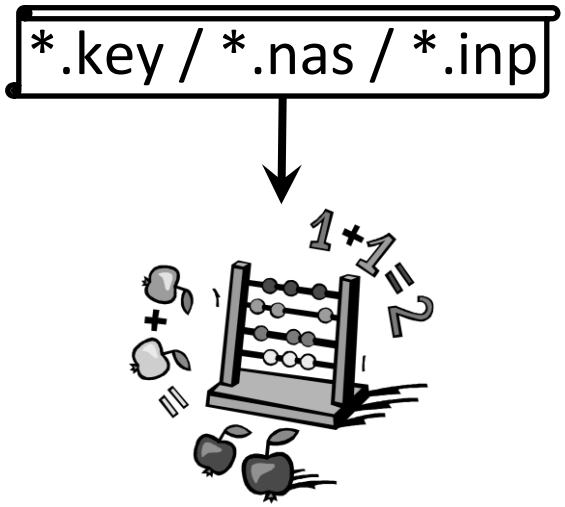


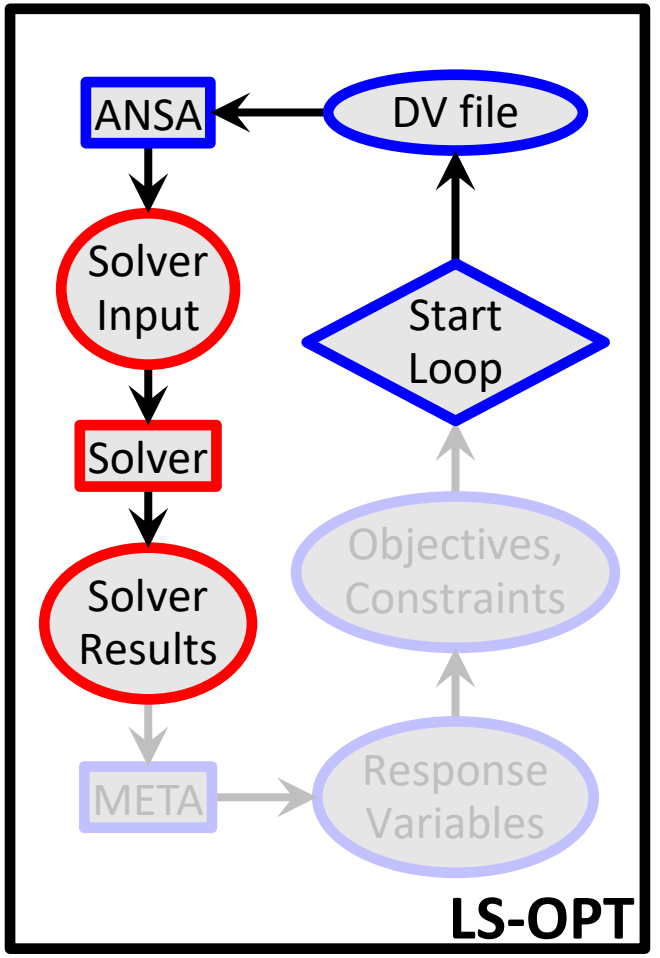


Optimization Run

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

- LS-OPT invokes solver runs

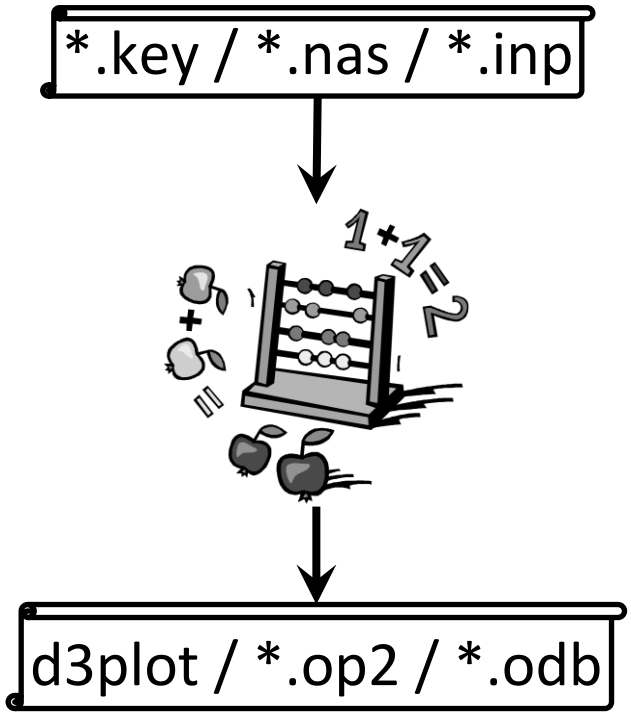


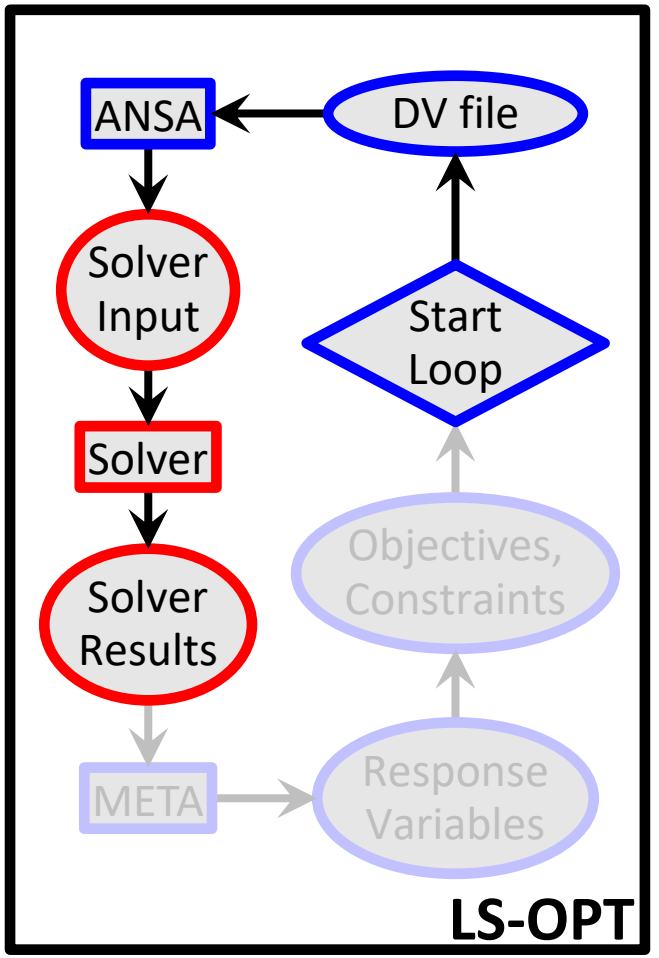


Optimization Run

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

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



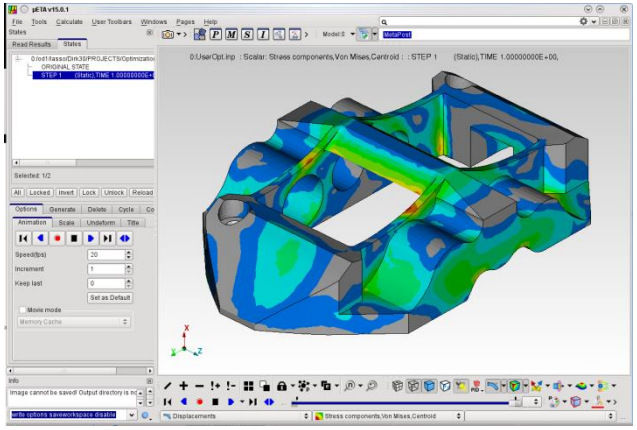


Optimization Run

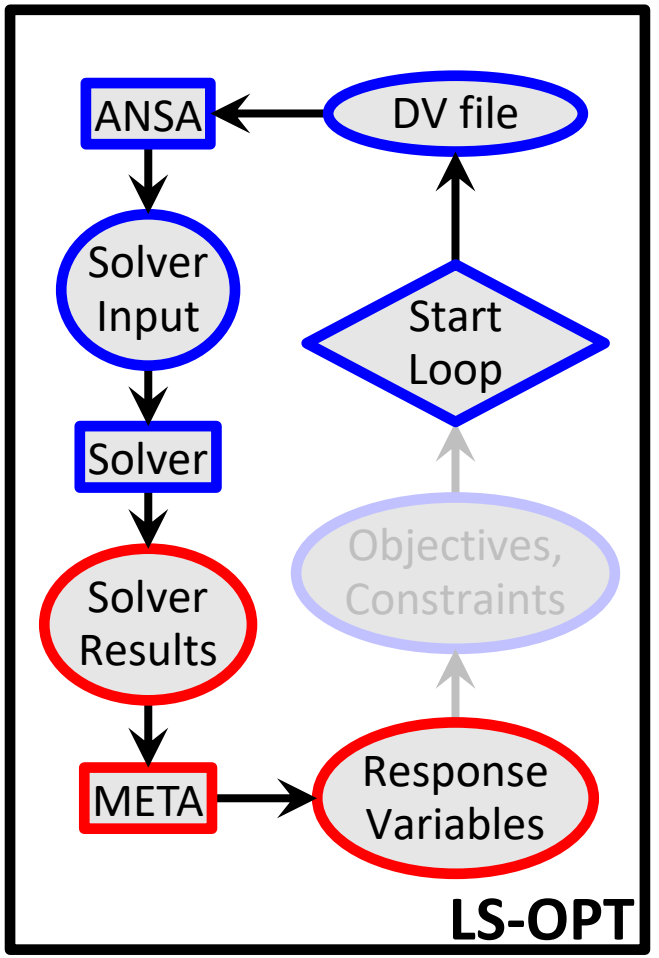
LS-OPT → ANSA → Solver → **META** → LS-OPT

META 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
```

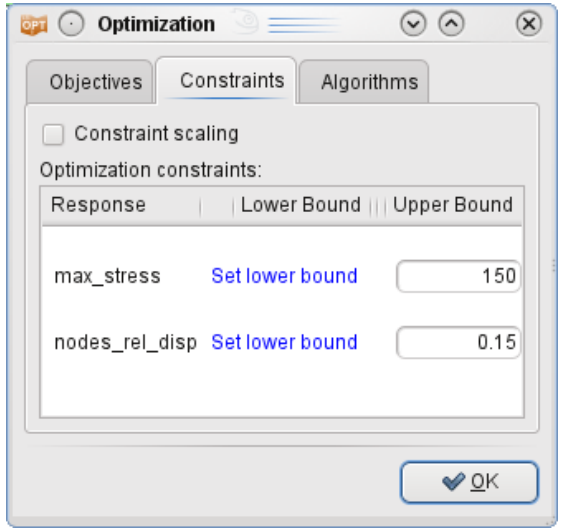


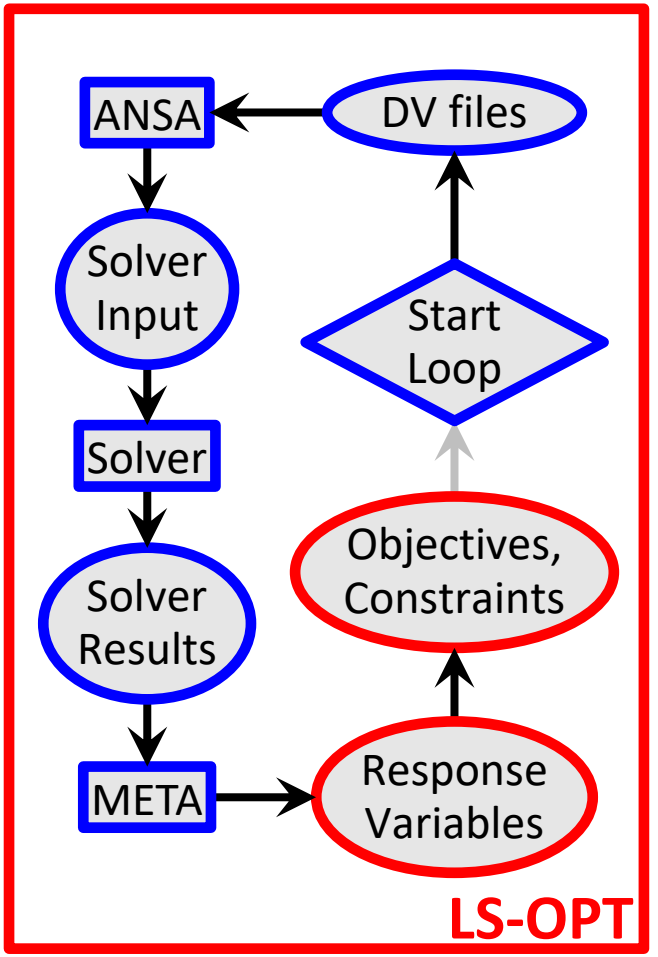
Optimization Run

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
```

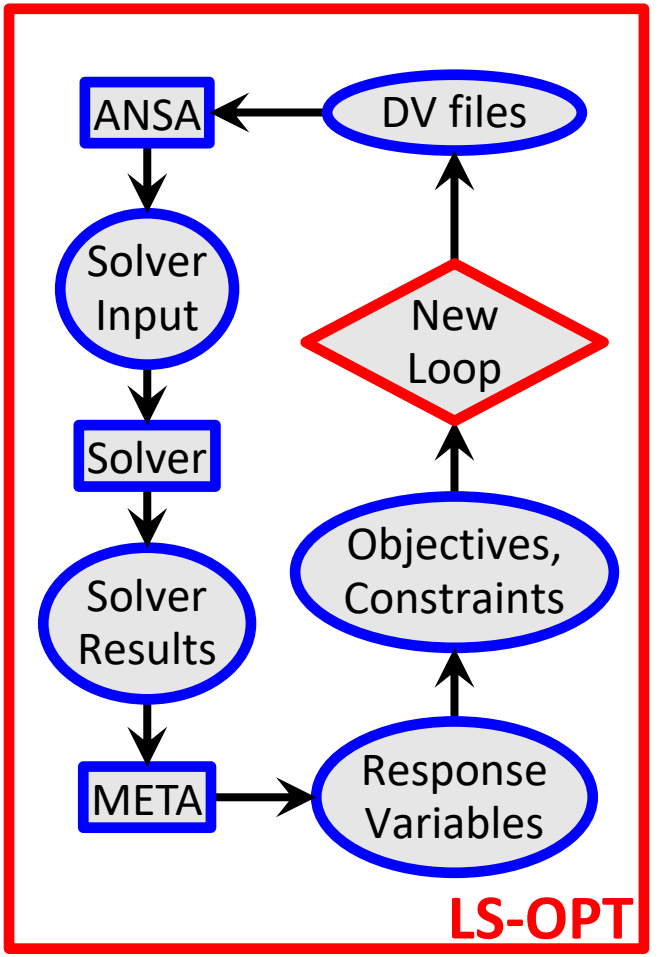




Optimization Run

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

- LS-OPT calculates new values for DVs

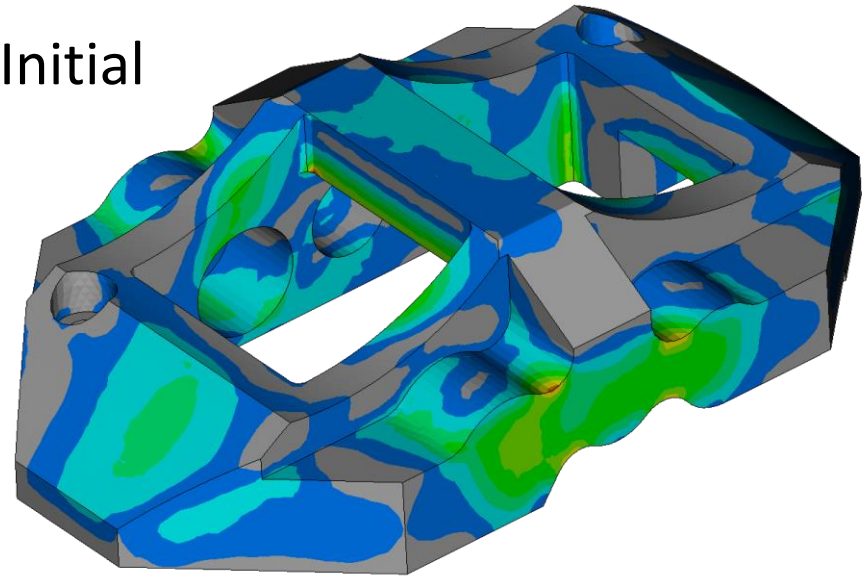


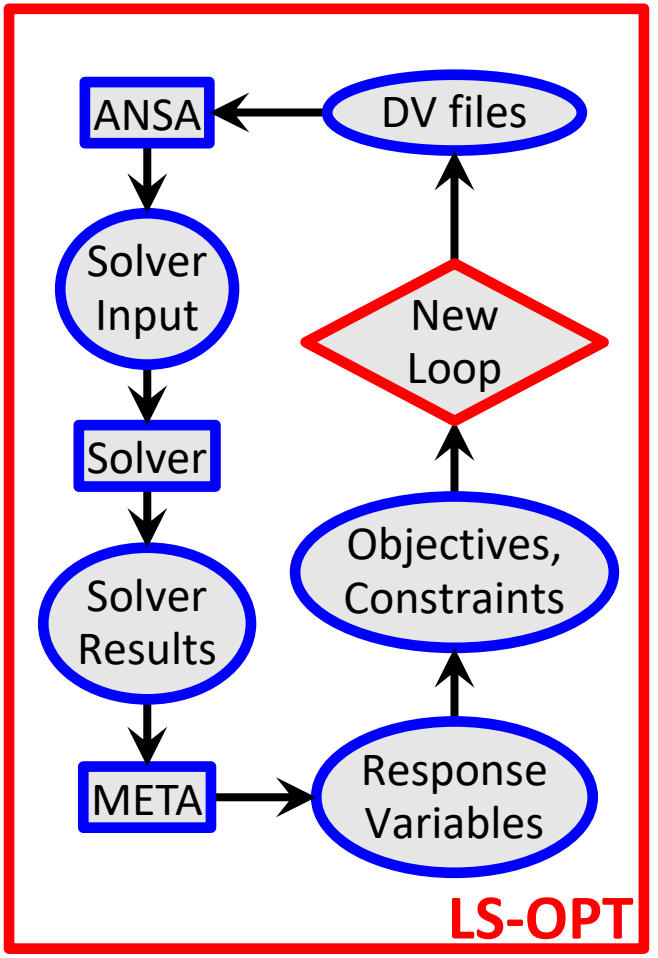
Optimization Run

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

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

Initial

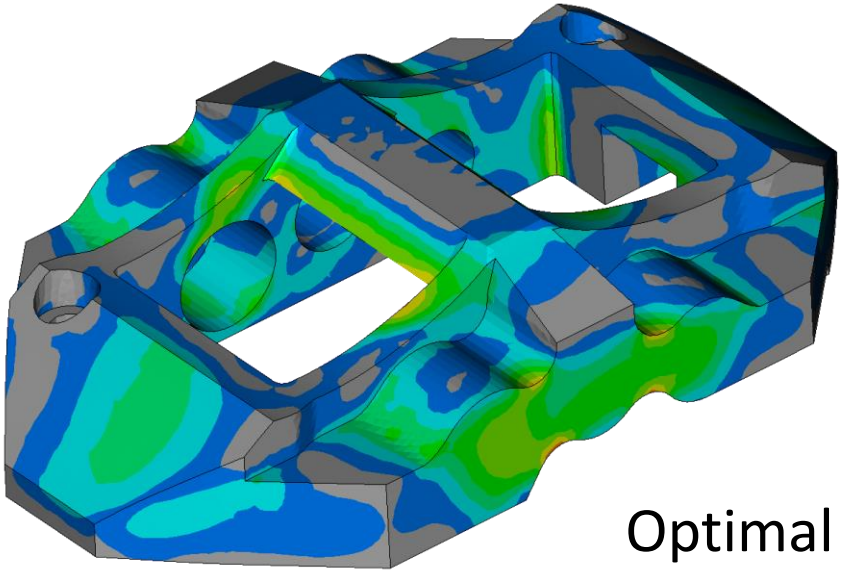




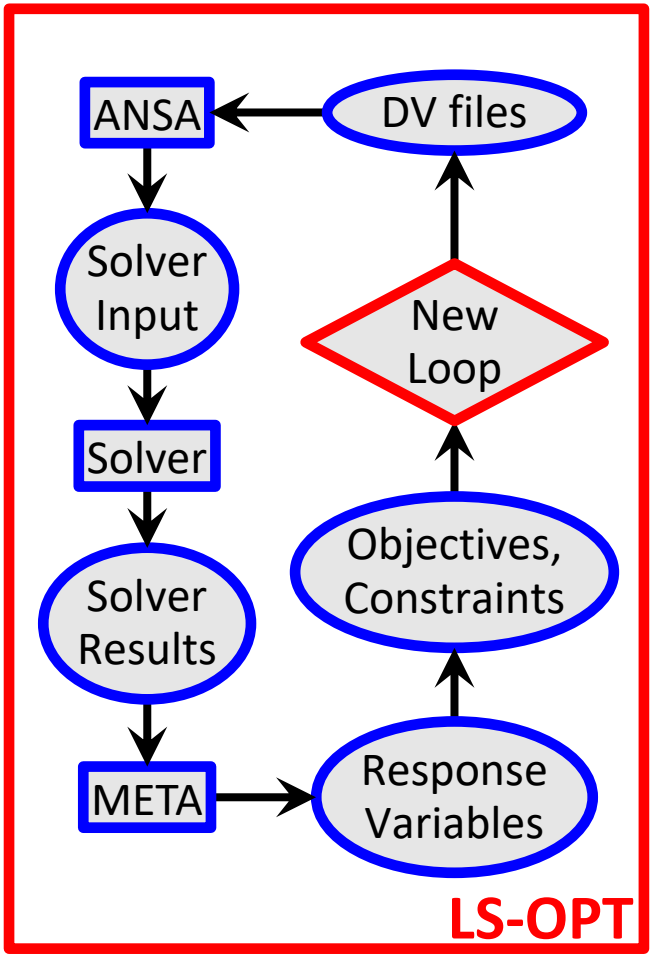
Optimization Run

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

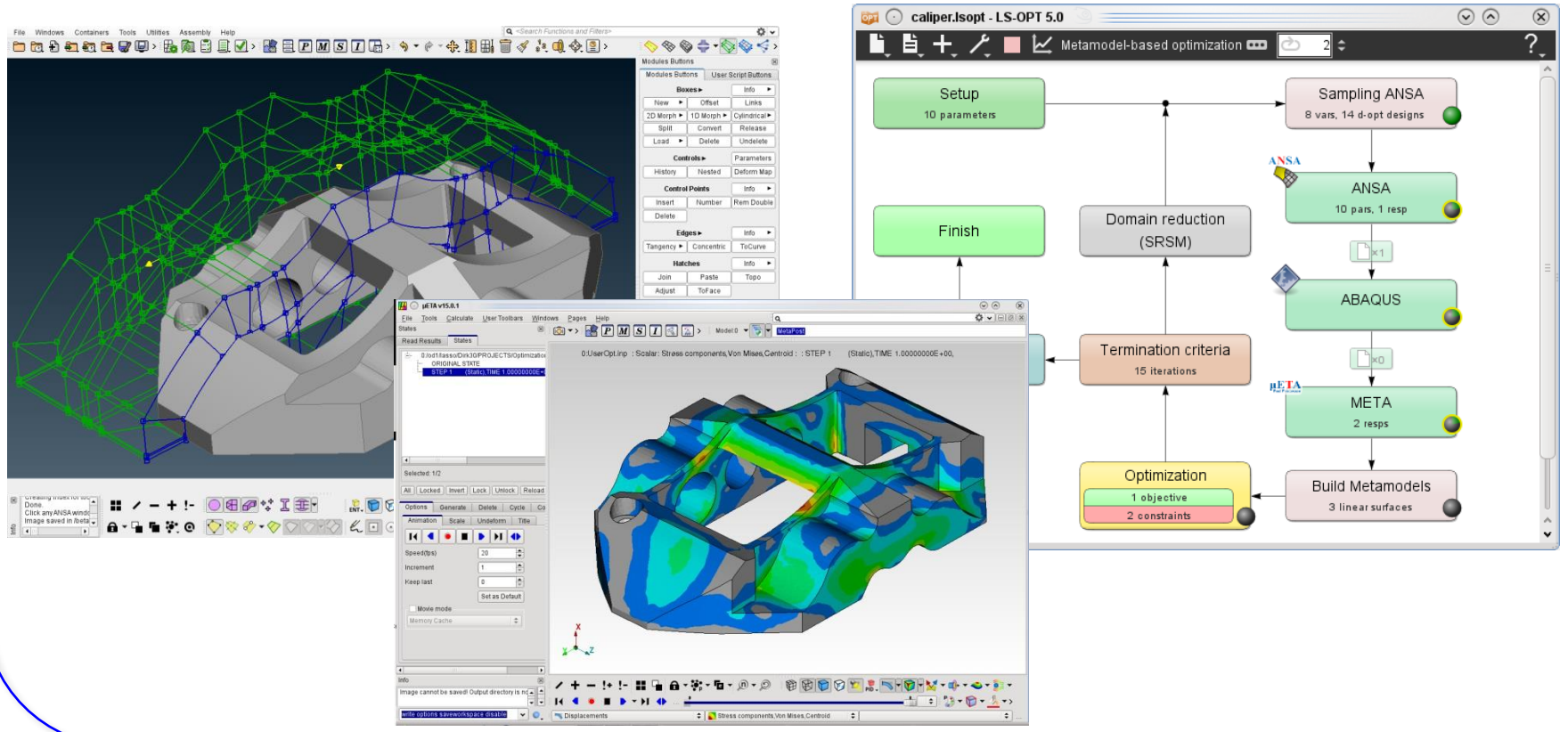
- LS-OPT calculates new values for DVs
- Whole process repeated until optimal solution



Optimal



Ευχαριστώ πολύ



Ευχαριστώ πολύ

More information and examples on
www.lsoptsupport.com

Mail: ansa@lasso.de