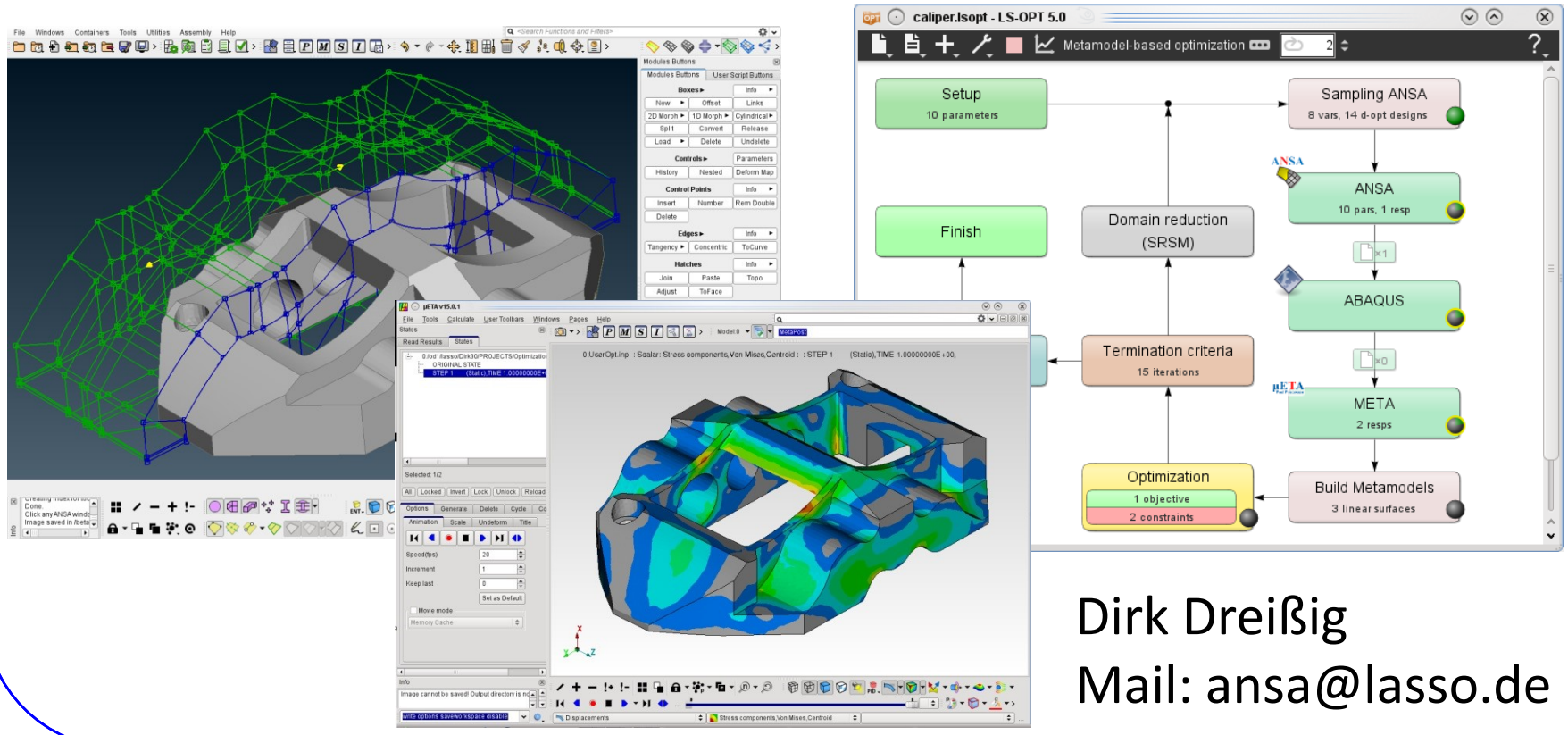
# Coupling ANSA and META to LS-OPT




Dirk Dreißig
Mail: ansa@lasso.de

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

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- **ANSA** for model-change according to design variables (everything besides LS-DYNA with *PARAMETER)

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- **Setup phase**
  - design variables defined in **ANSA** → transfer to **LS-OPT**
  - histories and responses defined in **META** → transfer to **LS-OPT**

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

- **ANSA** for model-change according to design variables (everything besides LS-DYNA with *PARAMETER)
- **META** for results extraction of arbitrary solvers (besides LS-DYNA)

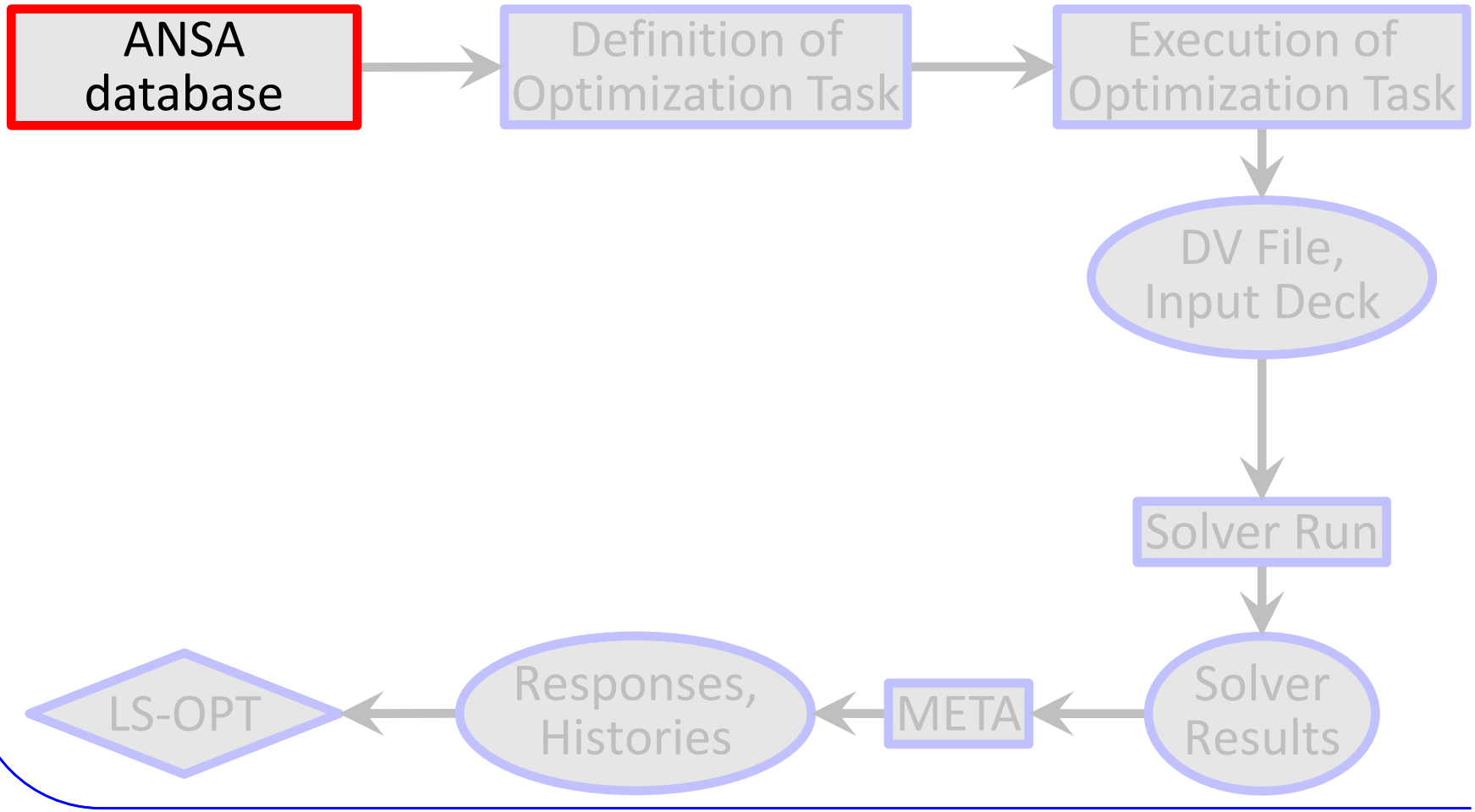
- **Setup phase**
  - design variables defined in **ANSA** → transfer to **LS-OPT**
  - histories and responses defined in **META** → transfer to **LS-OPT**
- **Optimization (Run) phase**
  - design variables controlled by **LS-OPT** → transfer to **ANSA**
  - histories and responses calculated by **META** → transfer to **LS-OPT**

# Optimization Setup

**ANSA** → Solver → META → LS-OPT

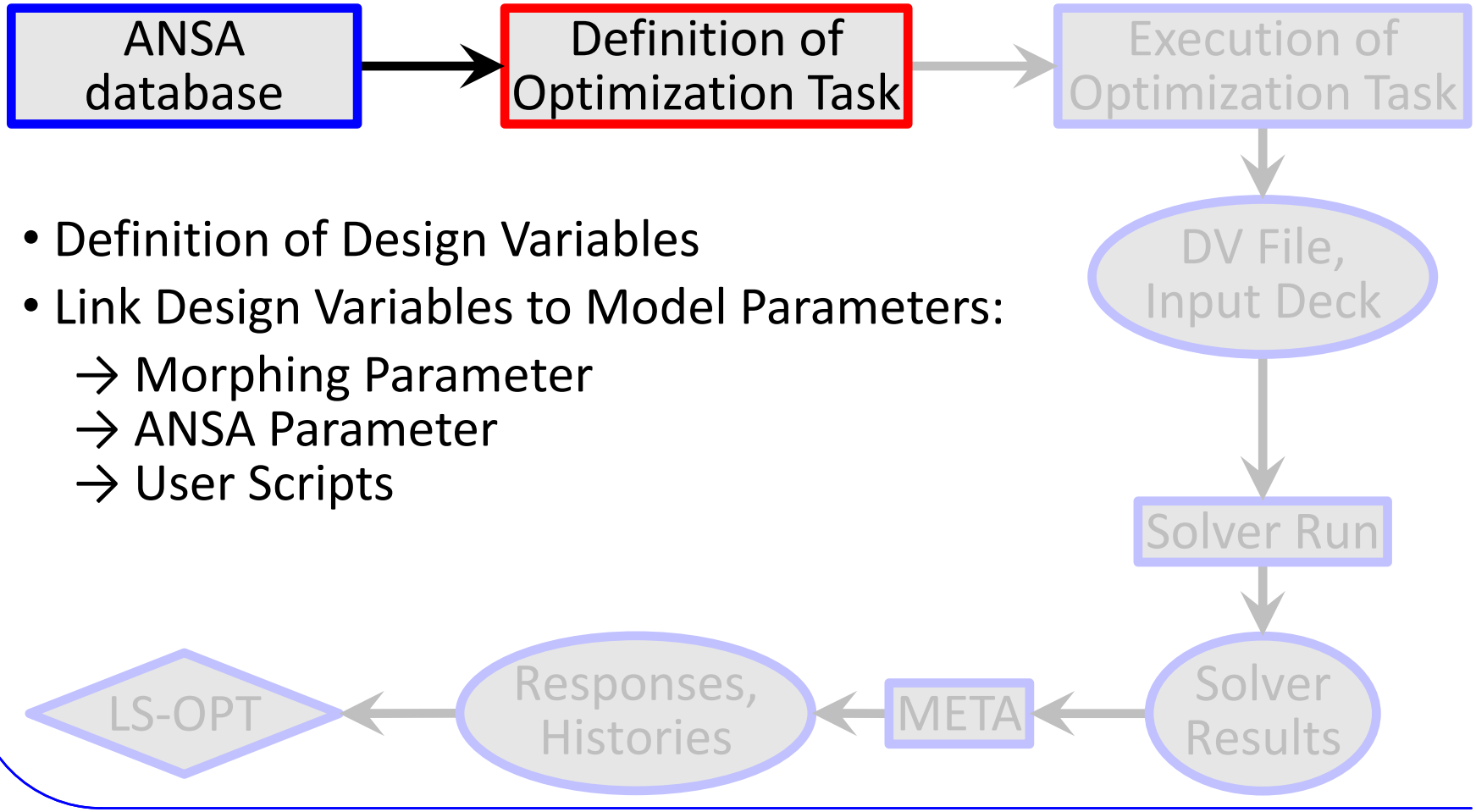
# Optimization Setup

**ANSA** → Solver → META → LS-OPT



# Optimization Setup

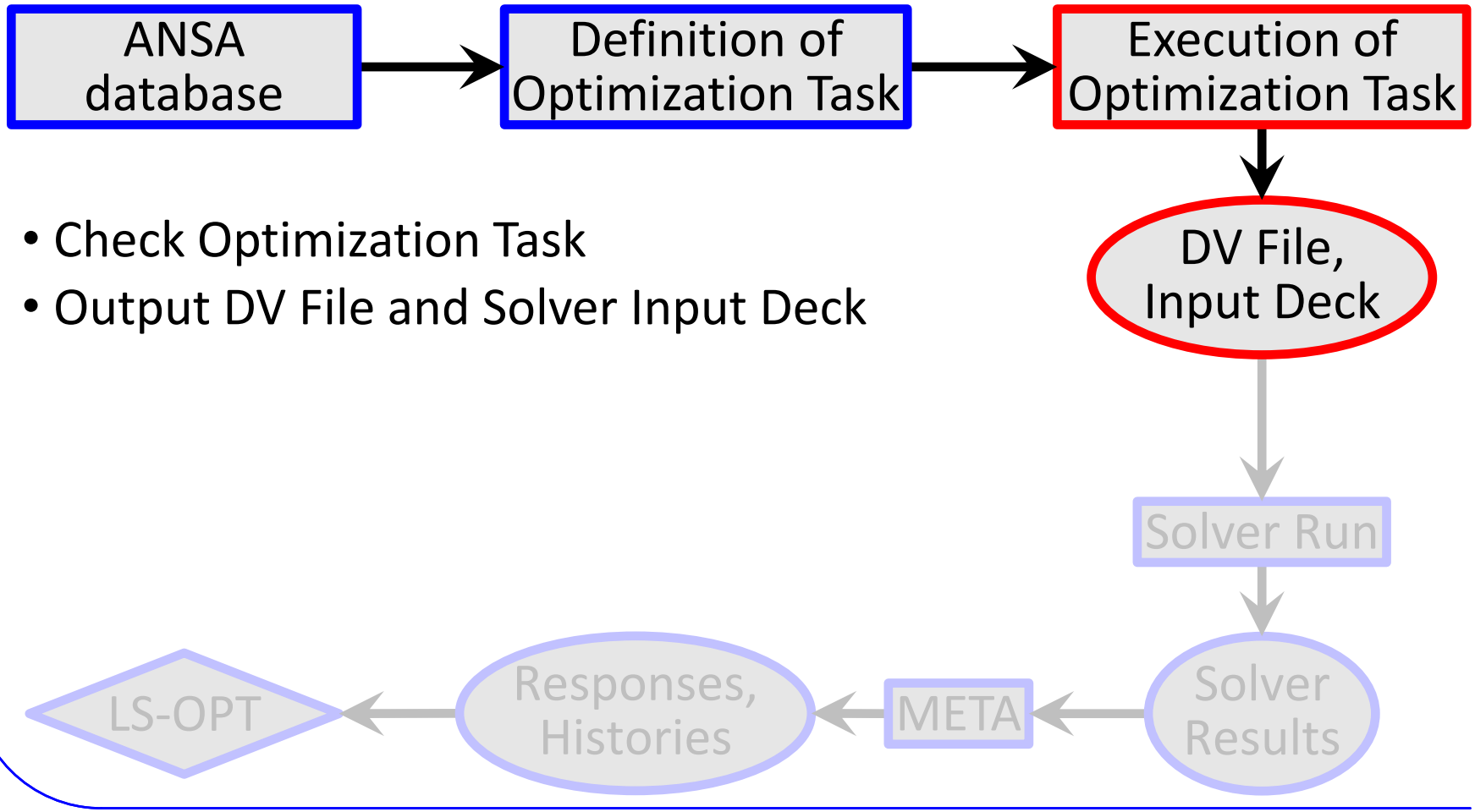
**ANSA** → Solver → META → LS-OPT




- Definition of Design Variables
- Link Design Variables to Model Parameters:
  - → Morphing Parameter
  - → ANSA Parameter
  - → User Scripts

# Optimization Setup

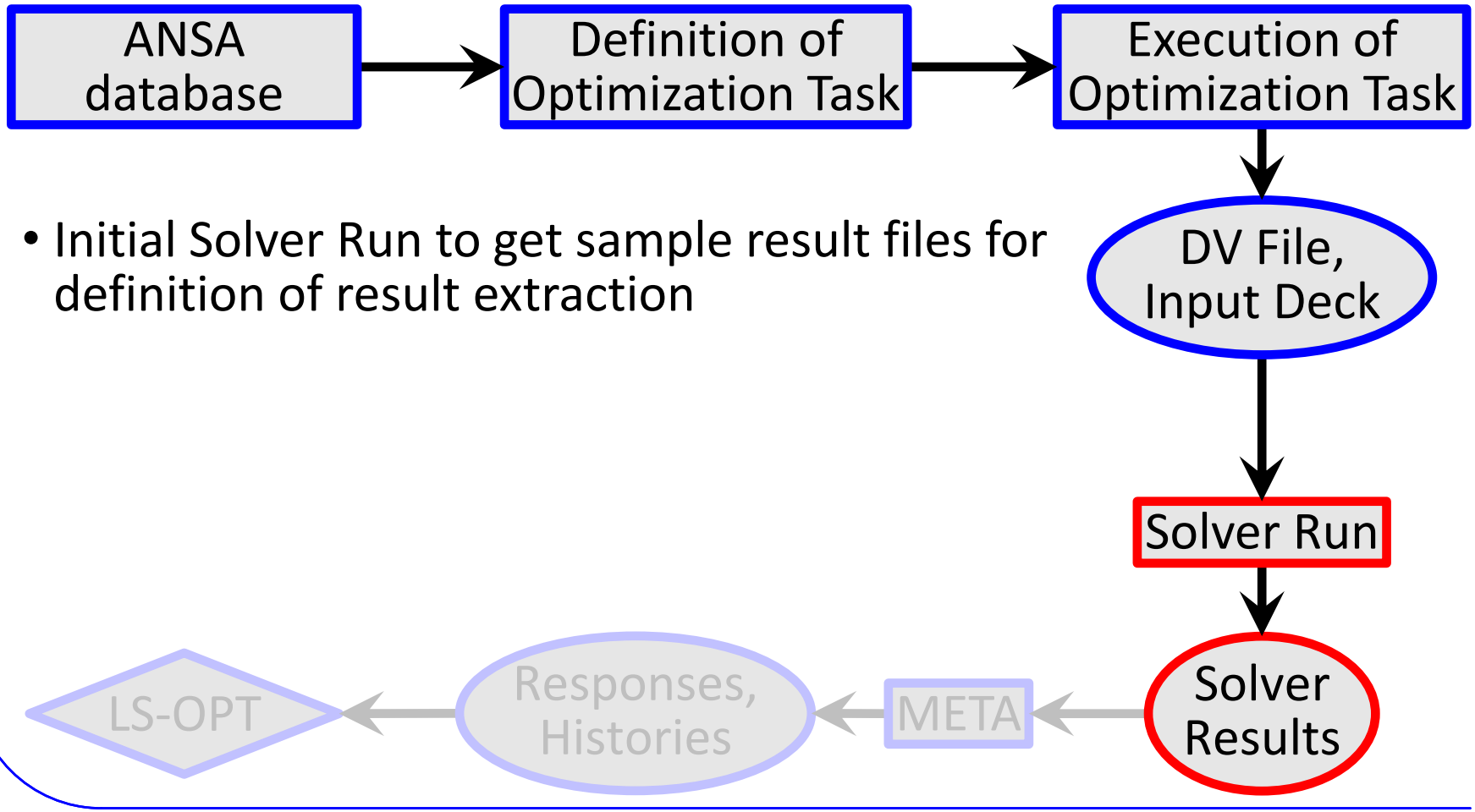
**ANSA** → Solver → META → LS-OPT




- Check Optimization Task
- Output DV File and Solver Input Deck

# Optimization Setup

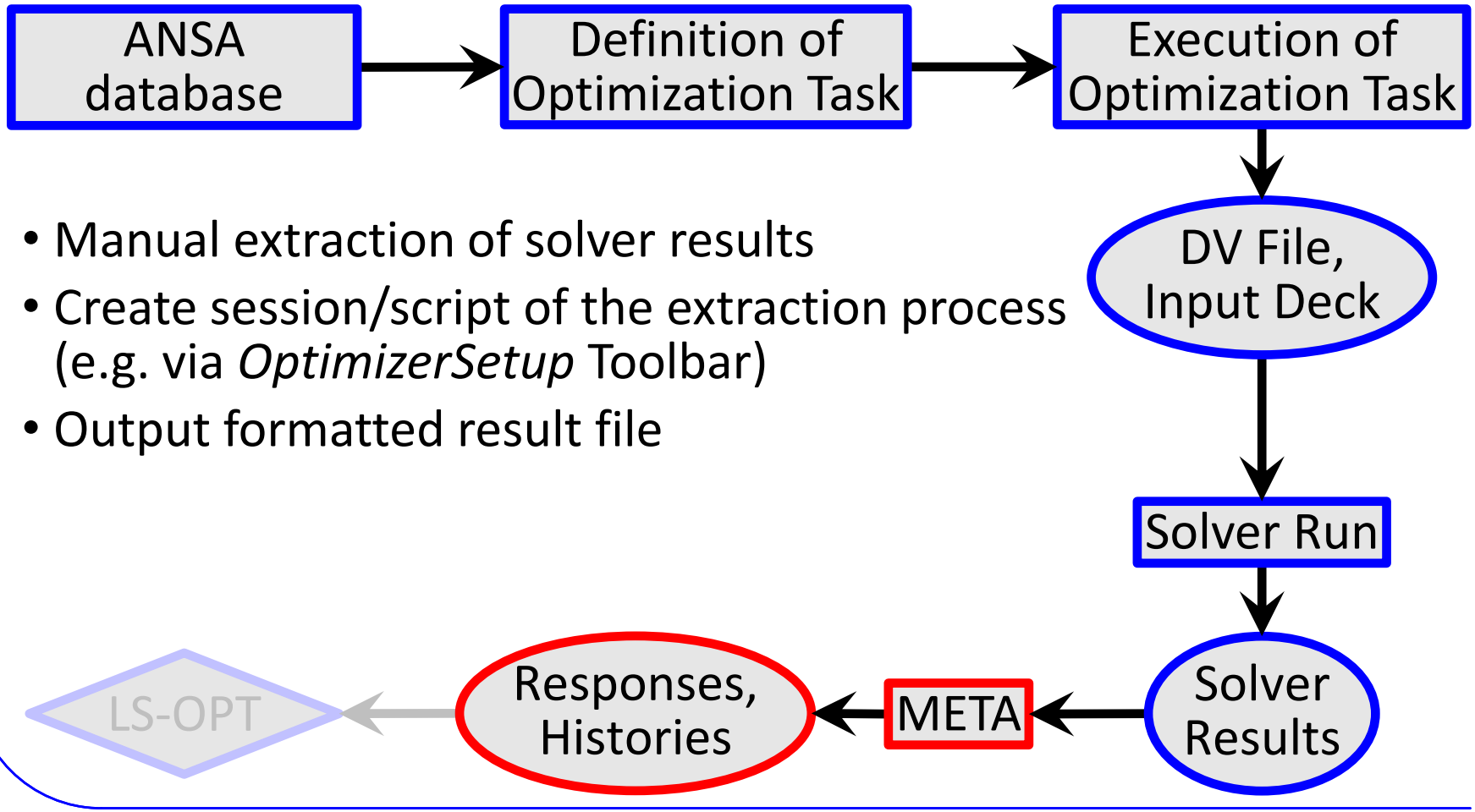
ANSA → **Solver** → META → LS-OPT




- Initial Solver Run to get sample result files for definition of result extraction

# Optimization Setup

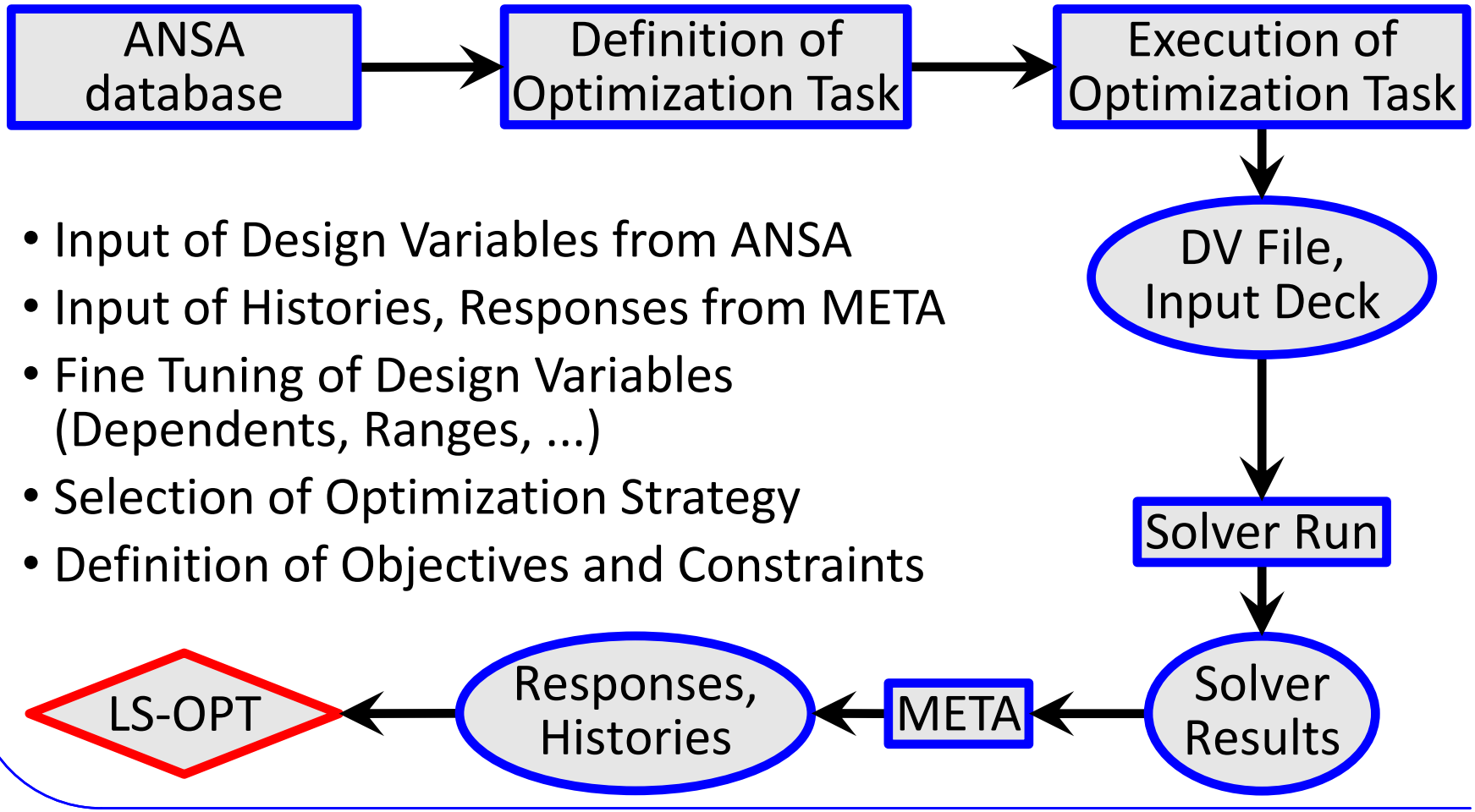
ANSA → Solver → **META** → LS-OPT




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

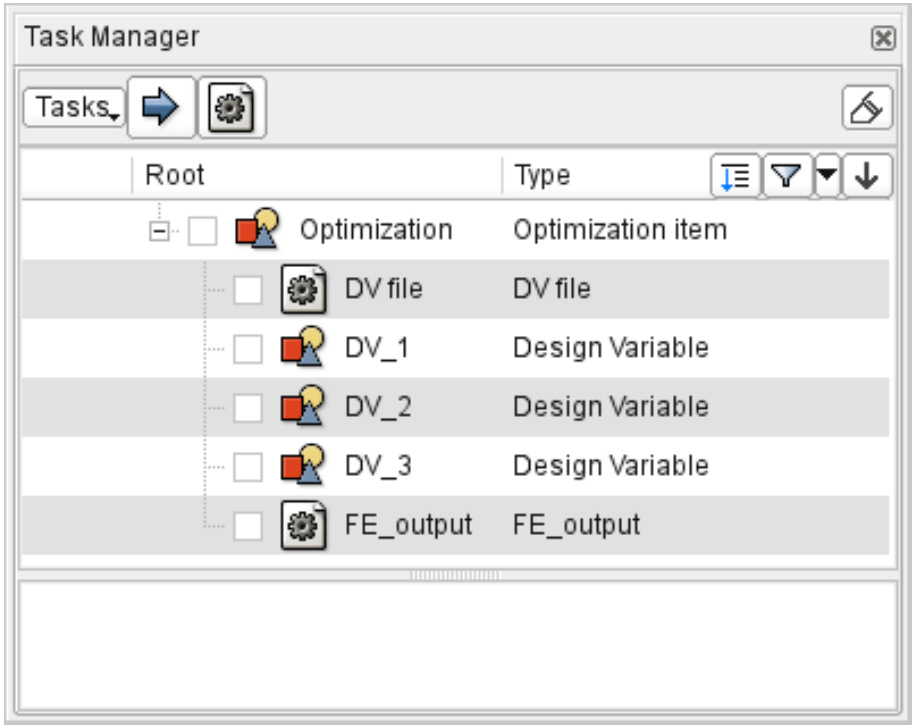
# Optimization Setup

ANSA → Solver → META → **LS-OPT**



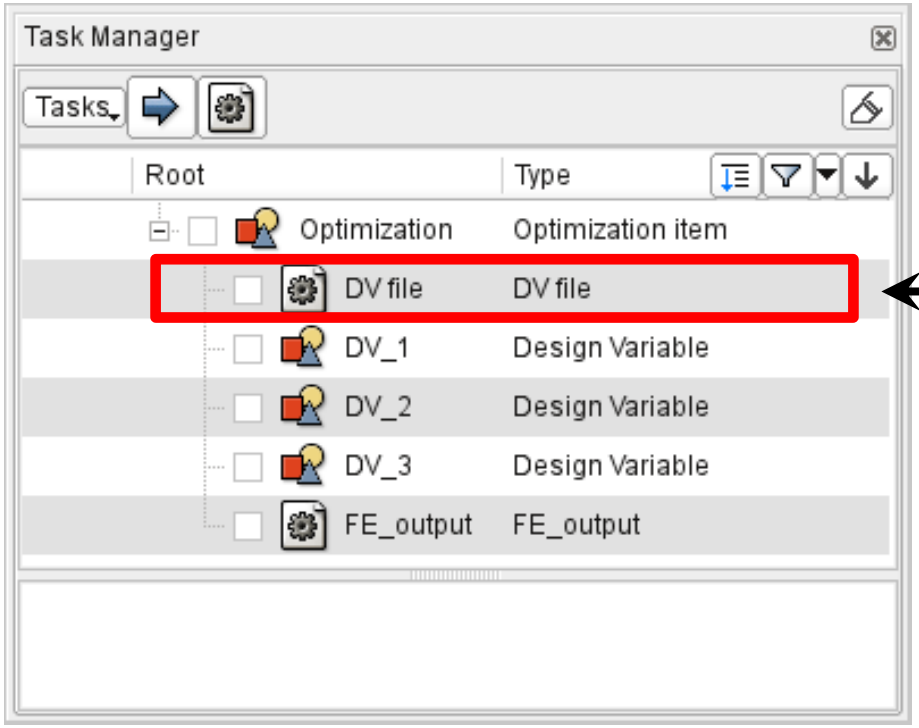

- Input of Design Variables from ANSA
- Input of Histories, Responses from META
- Fine Tuning of Design Variables (Dependents, Ranges, ...)
- Selection of Optimization Strategy
- Definition of Objectives and Constraints

# ANSA – Optimization Task




**3 main task items**

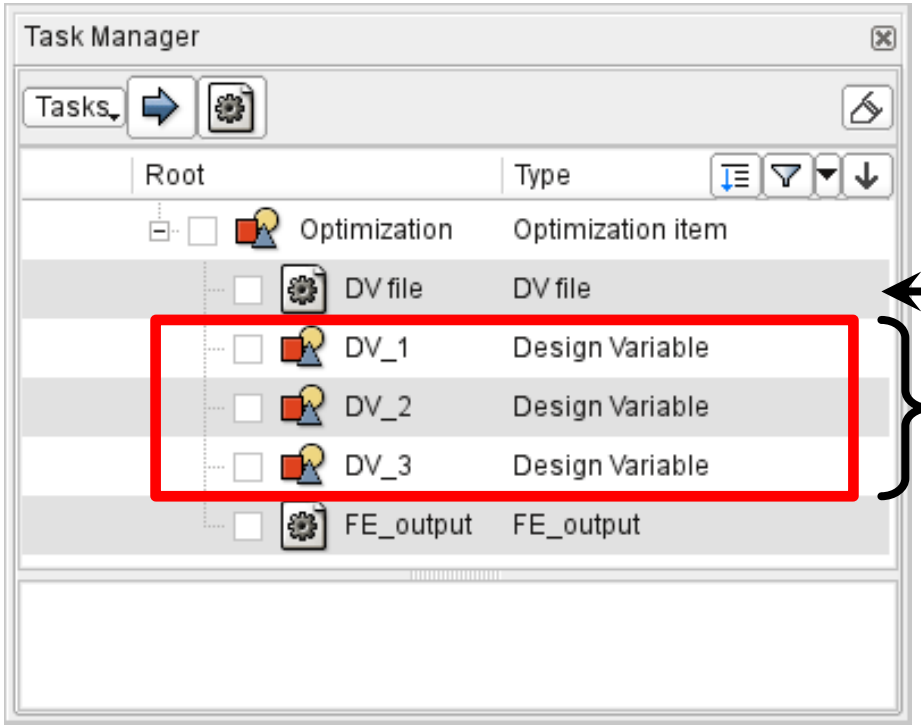
# ANSA – Optimization Task




**3 main task items**

1. Design Variable File

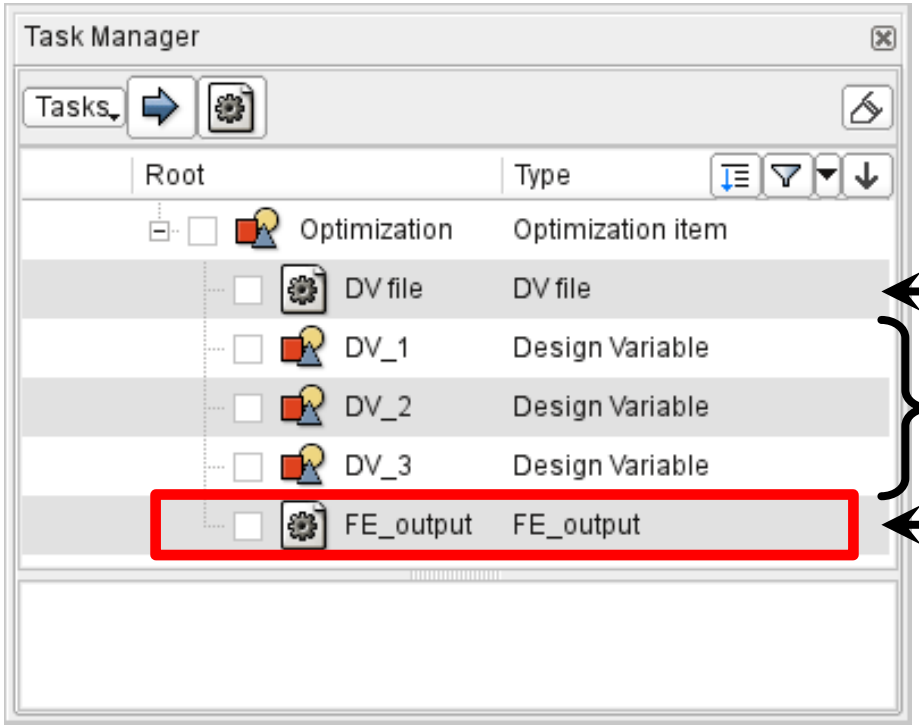
# ANSA – Optimization Task




**3 main task items**

1. Design Variable File
2. Design Variables

# ANSA – Optimization Task

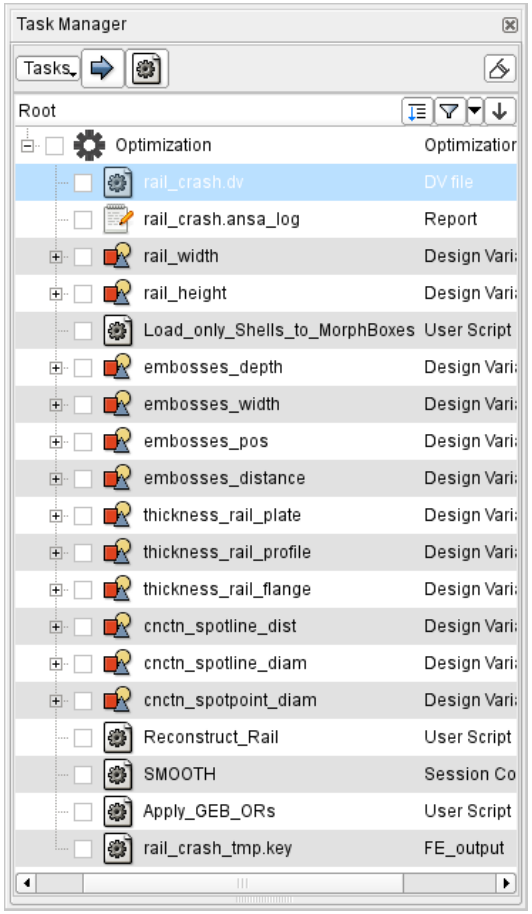



**3 main task items**

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

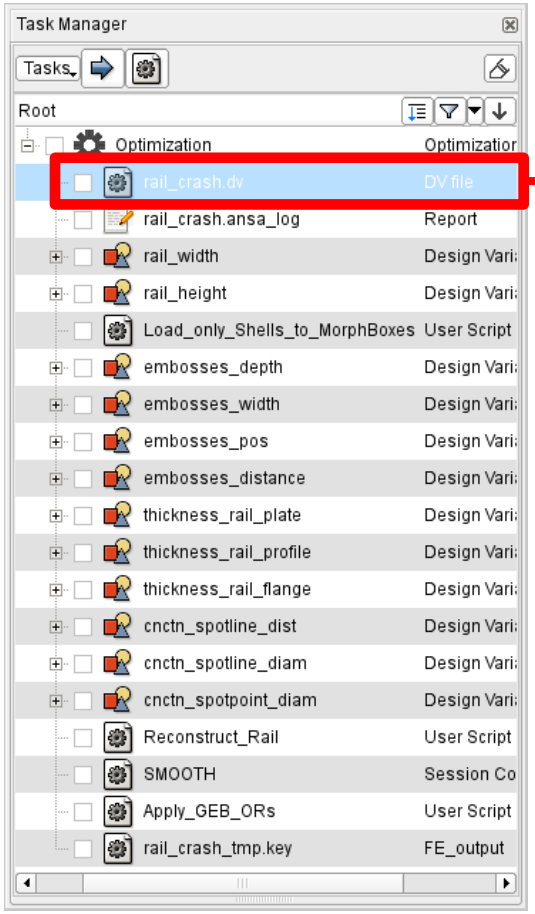
# ANSA – Optimization Task

## Design Variable File



# ANSA – Optimization Task

## Design Variable File

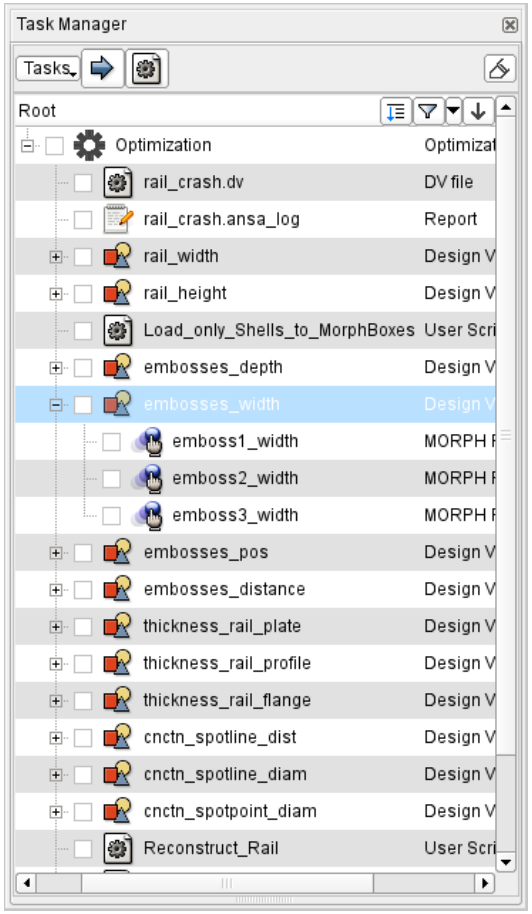



```
#
# ANSA_VERSION: 14.2.3
#
# file created by  A N S A  Mon Feb 17 17:13:25 2014
#
# Output from:
# /od1/lasso/Dirk30/PROJECTS/Optimierung_Rail_LS-OPT/Rail_MDO/rail_crash.ansa
#
# DESIGN VARIABLES
#-------------------------------------------------------------------------------------------------
# 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

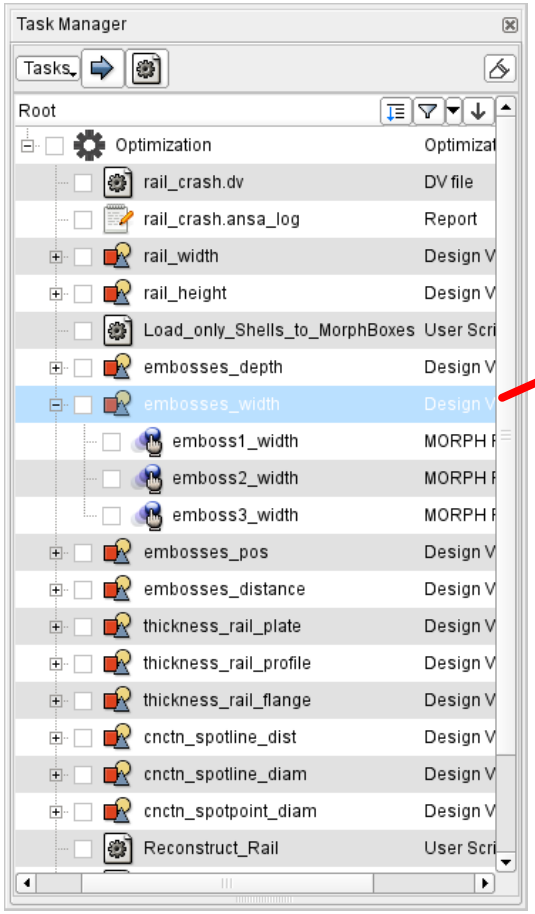
# ANSA – Optimization Task

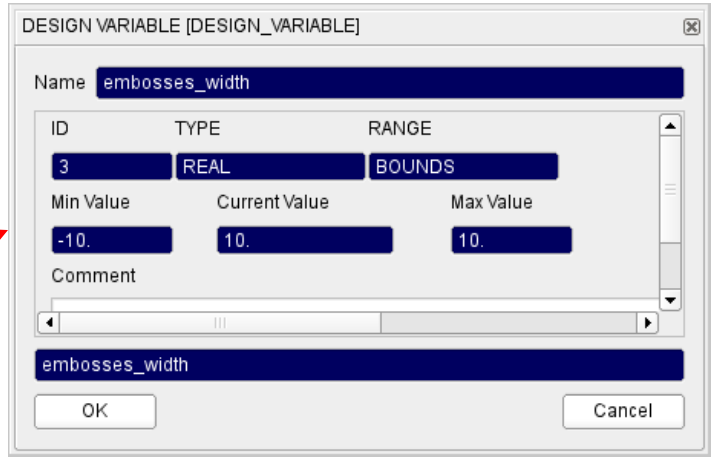
## Design Variables → Morphing Parameters



# ANSA – Optimization Task

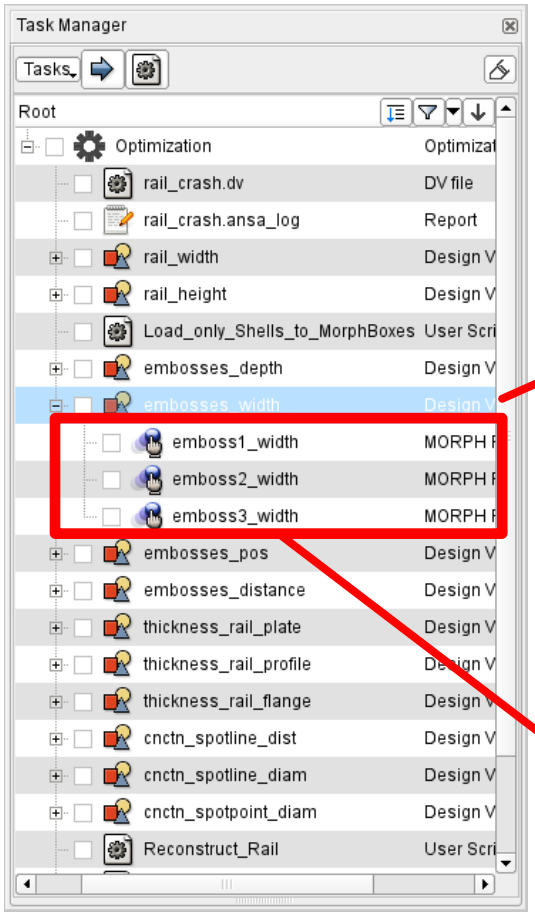
## Design Variables → Morphing Parameters

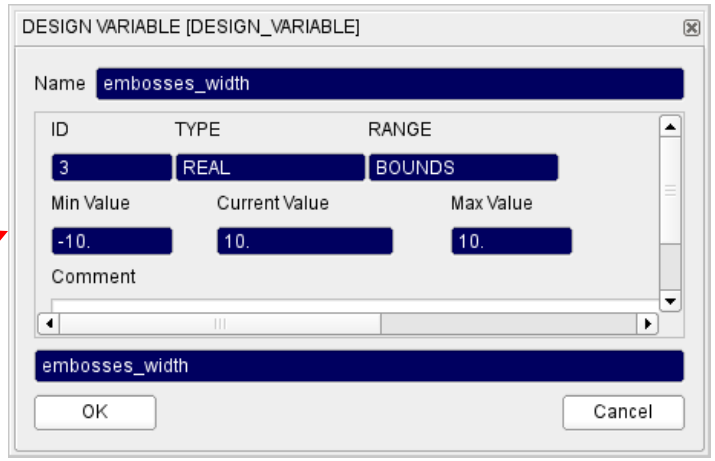


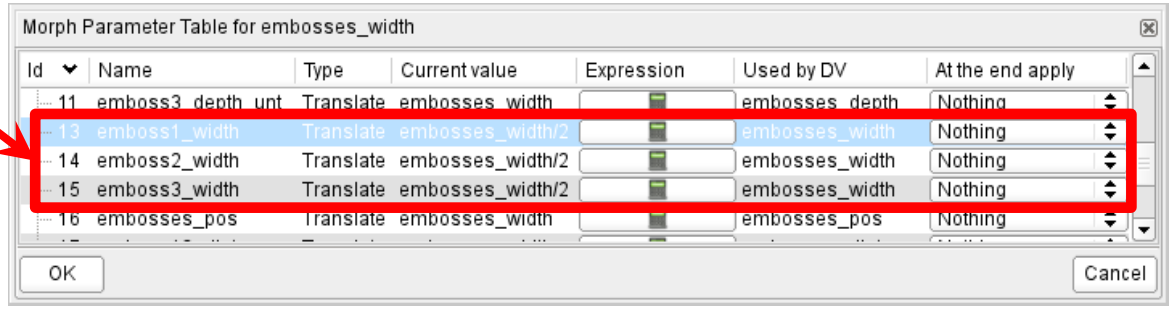



# ANSA – Optimization Task

## Design Variables → Morphing Parameters



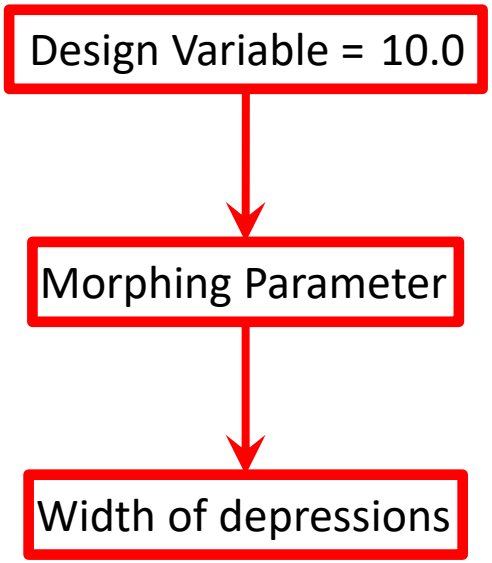



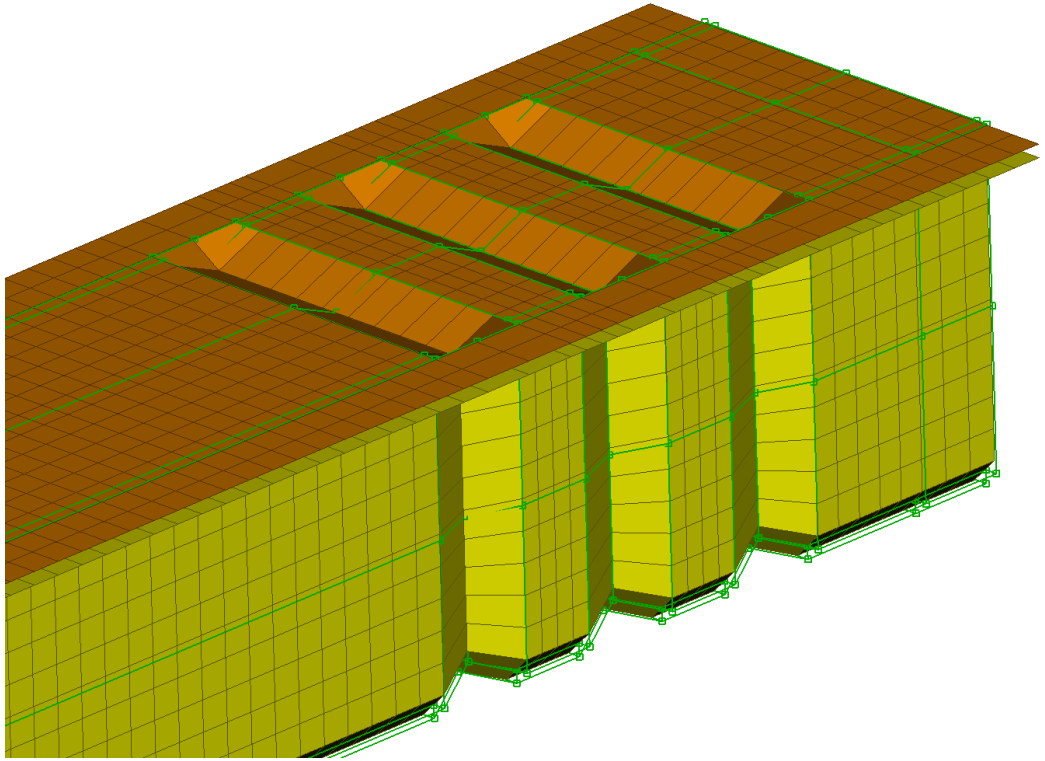



# ANSA – Optimization Task

## Design Variables → Morphing Parameters

### Shape modification



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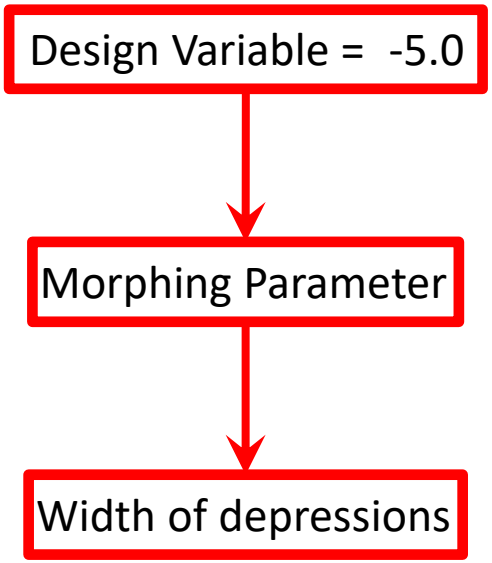
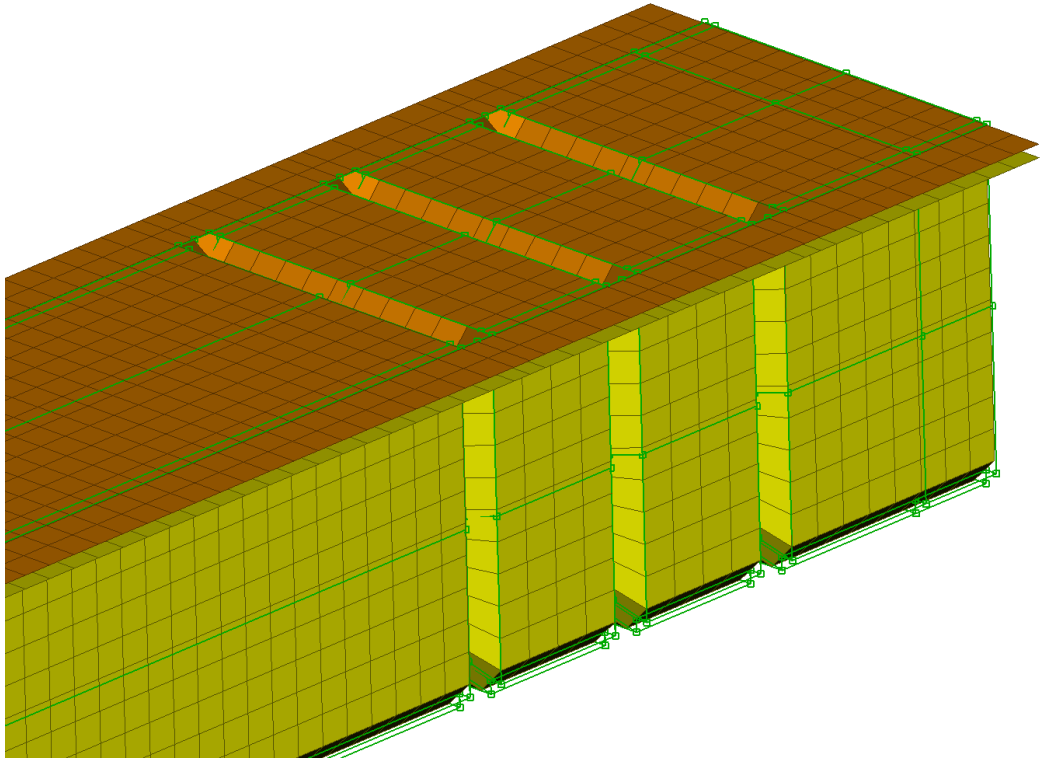
### Shape modification



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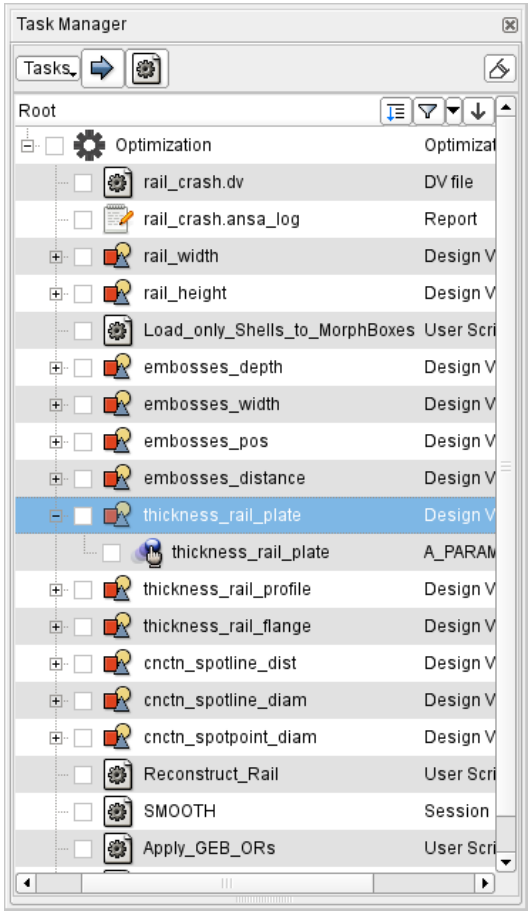
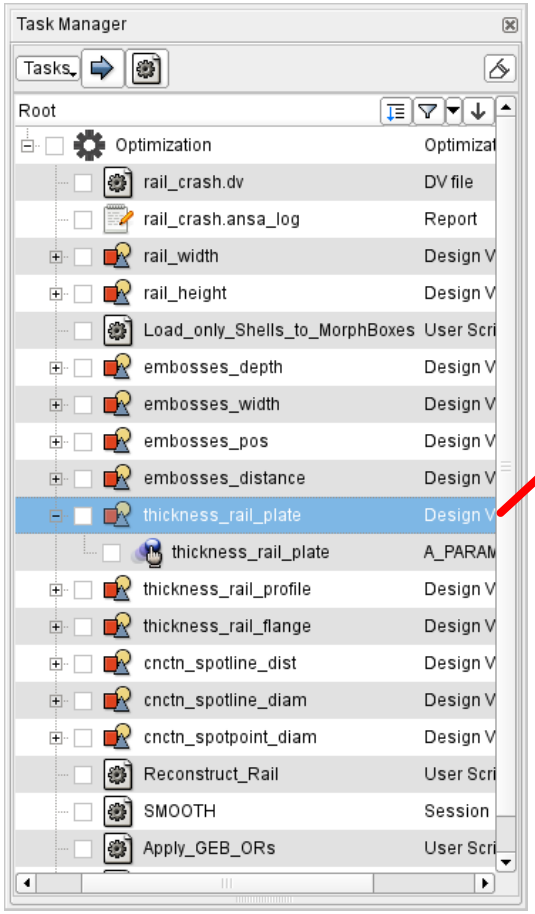
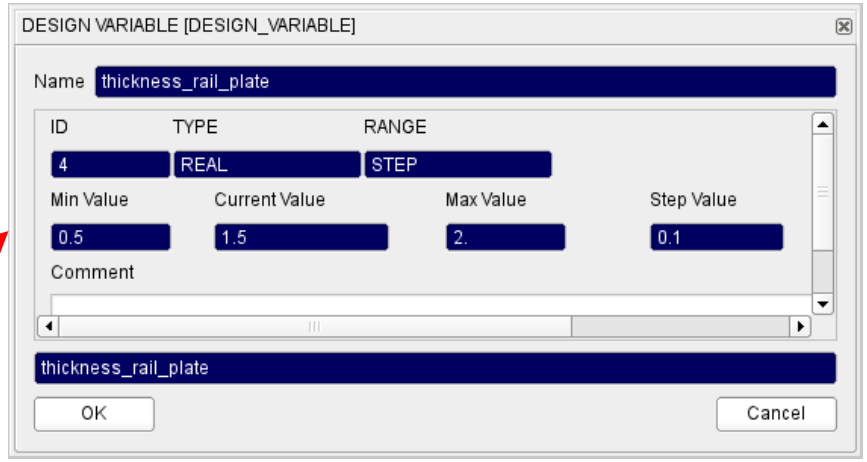
## Design Variables → ANSA Parameters



# ANSA – Optimization Task

## Design Variables → ANSA Parameters



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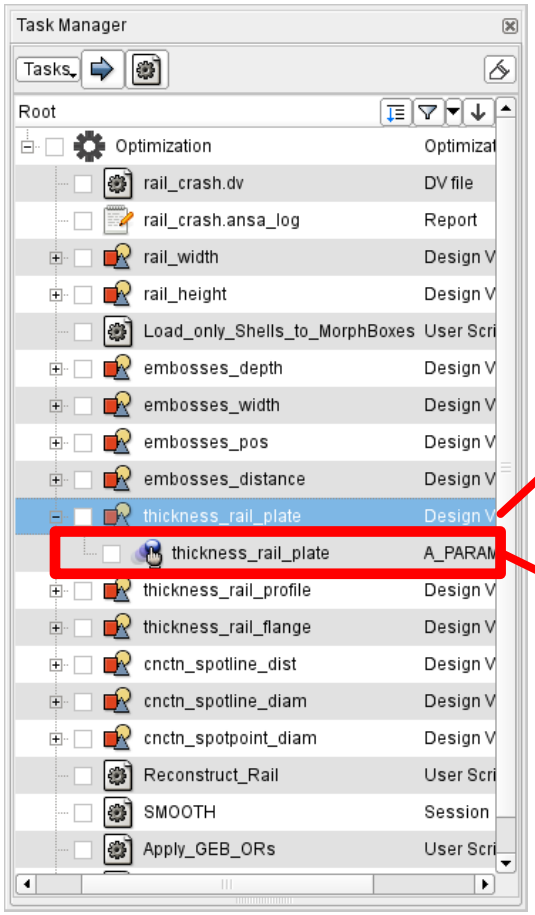
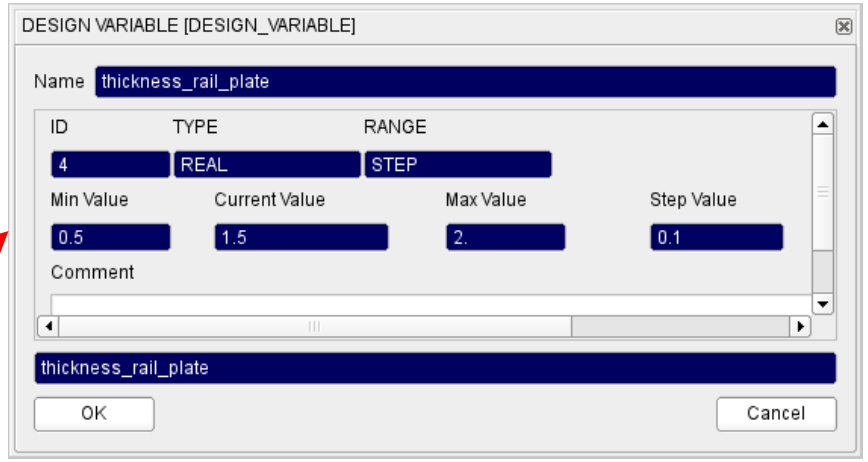
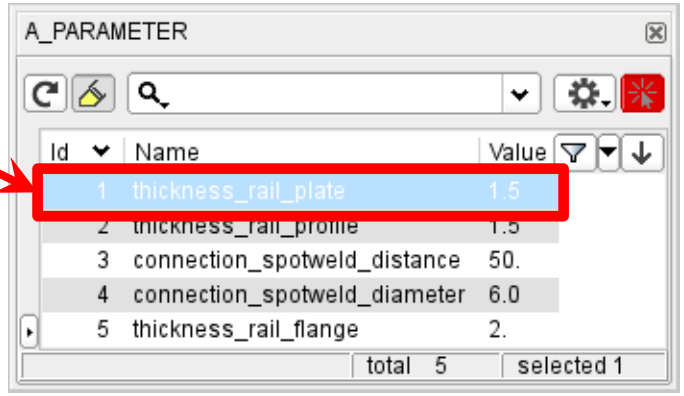
## Design Variables → ANSA Parameters



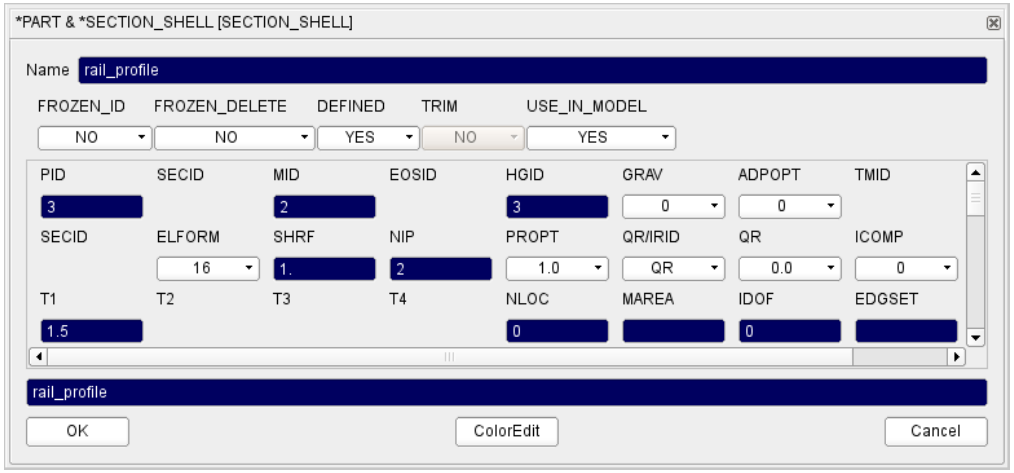



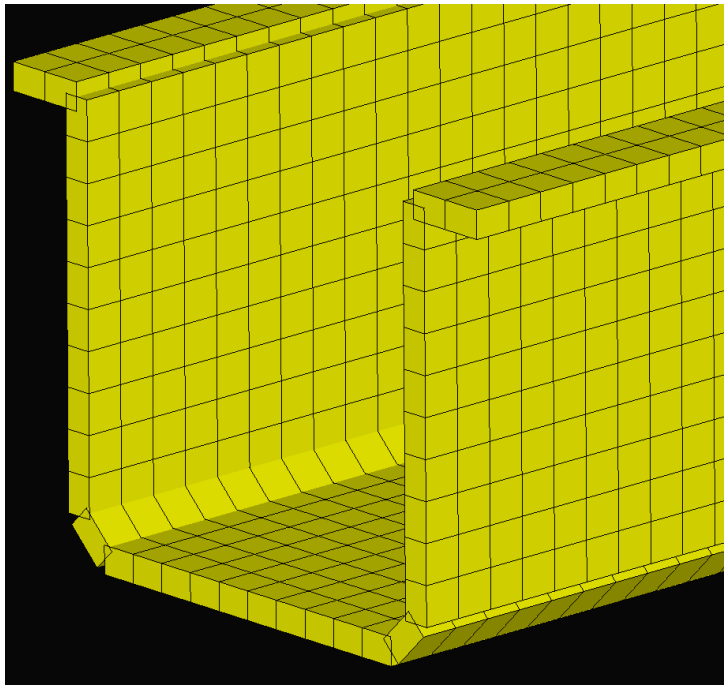



# ANSA – Optimization Task

## Design Variables → ANSA Parameters

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



# ANSA – Optimization Task

## Design Variables → ANSA Parameters

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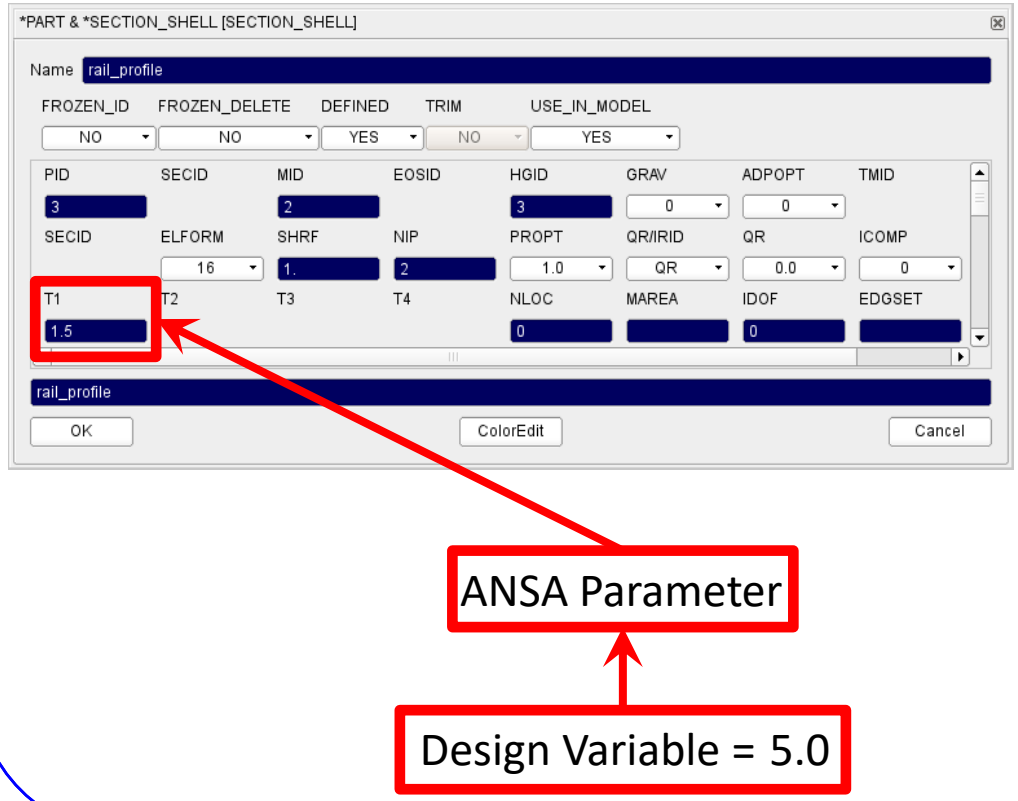


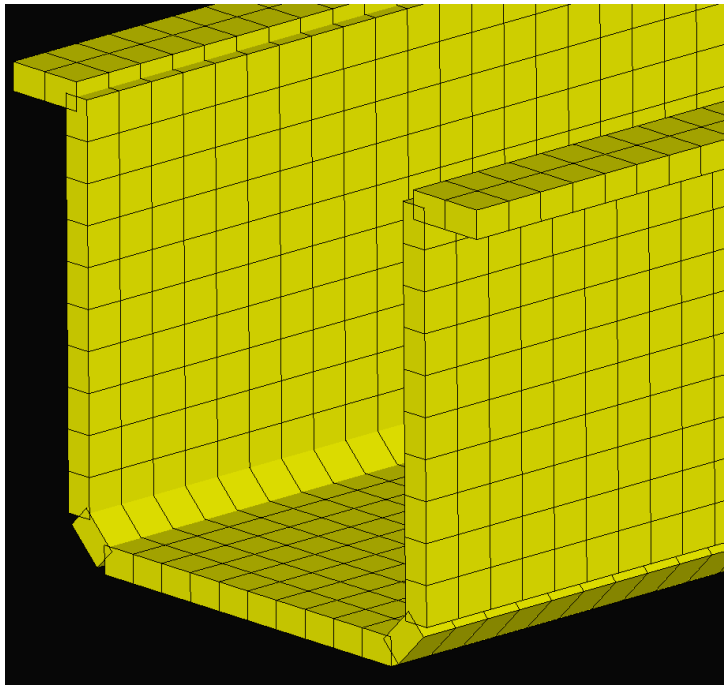

# ANSA – Optimization Task

## Design Variables → ANSA Parameters

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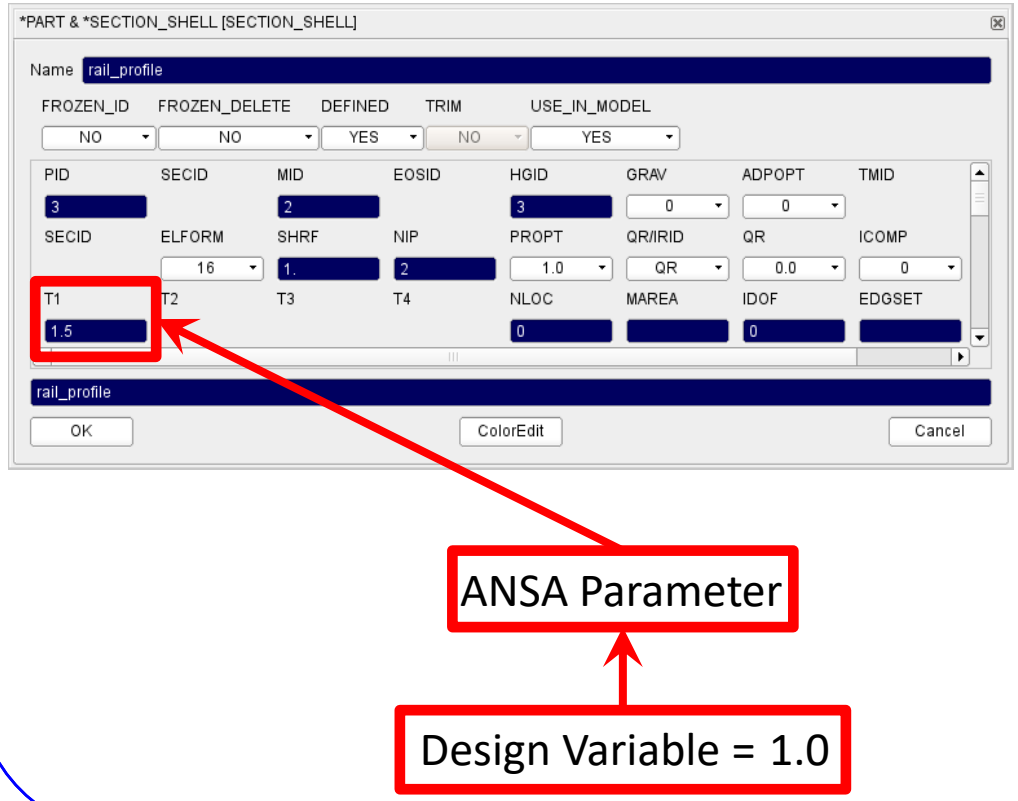
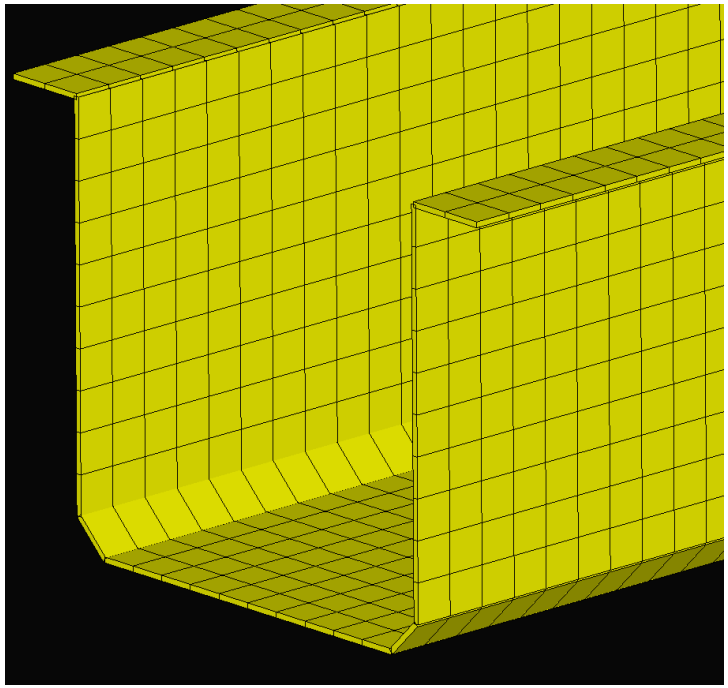
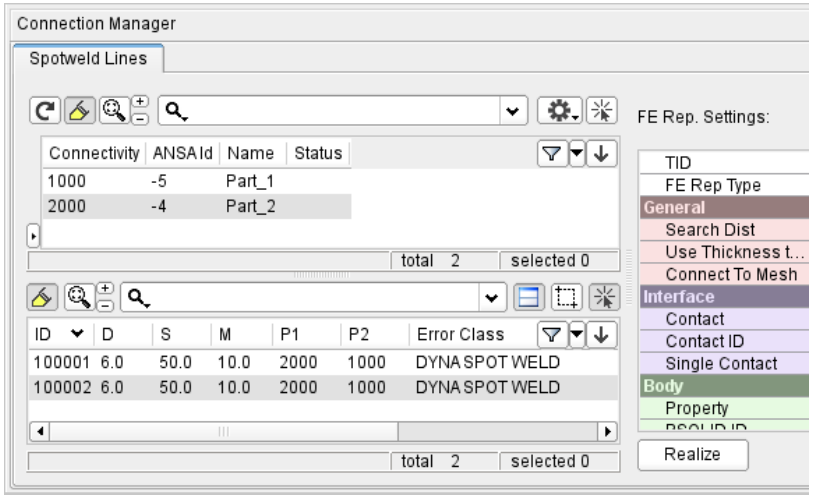


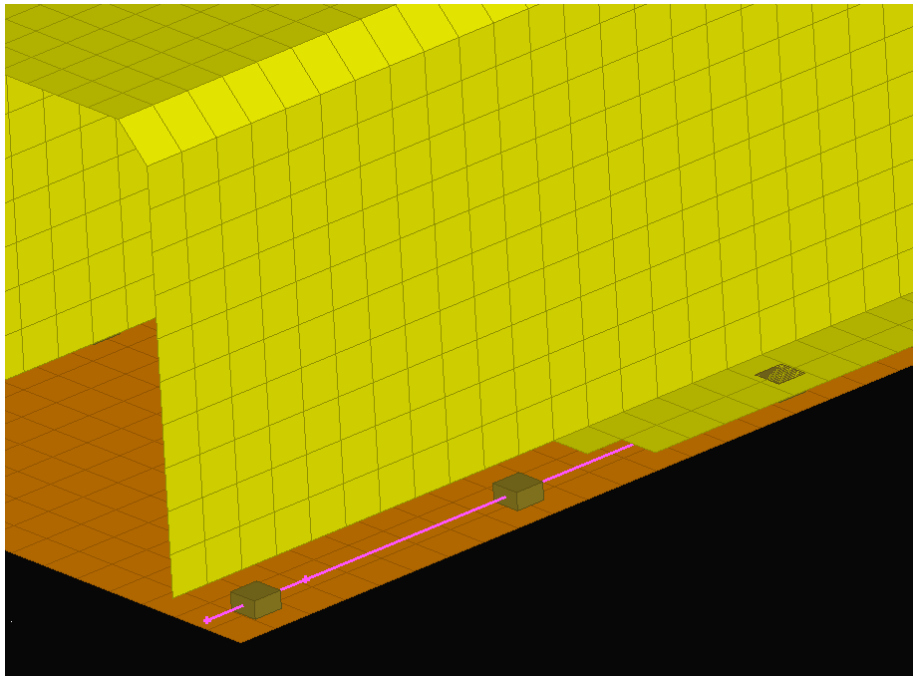



# ANSA – Optimization Task

## Design Variables → ANSA Parameters

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

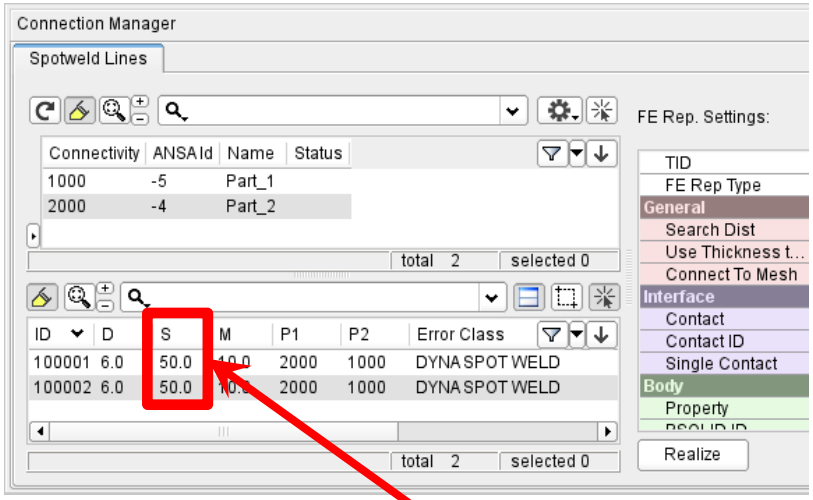


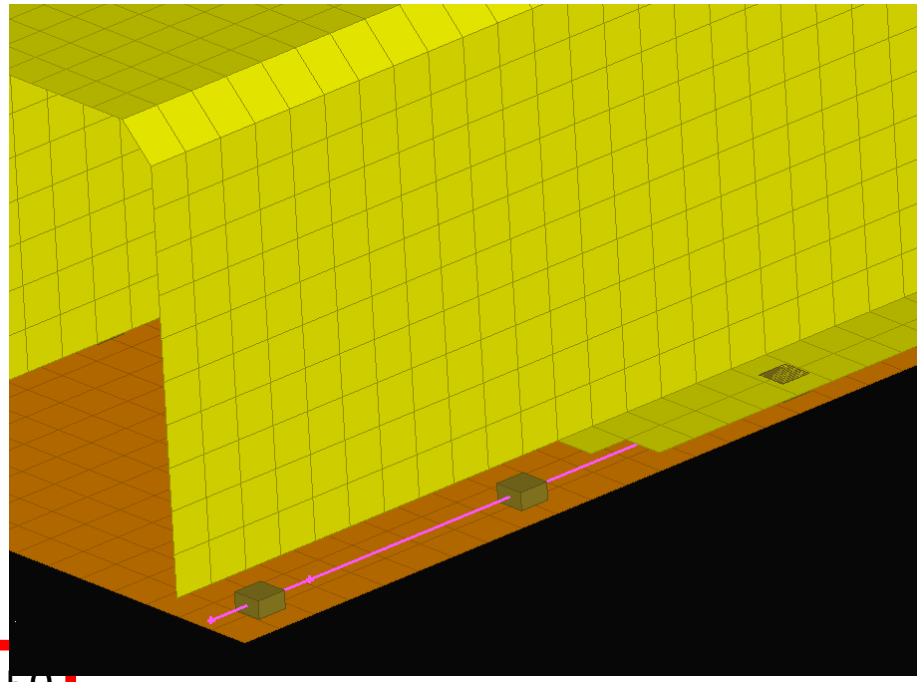



# ANSA – Optimization Task

## Design Variables → ANSA Parameters

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



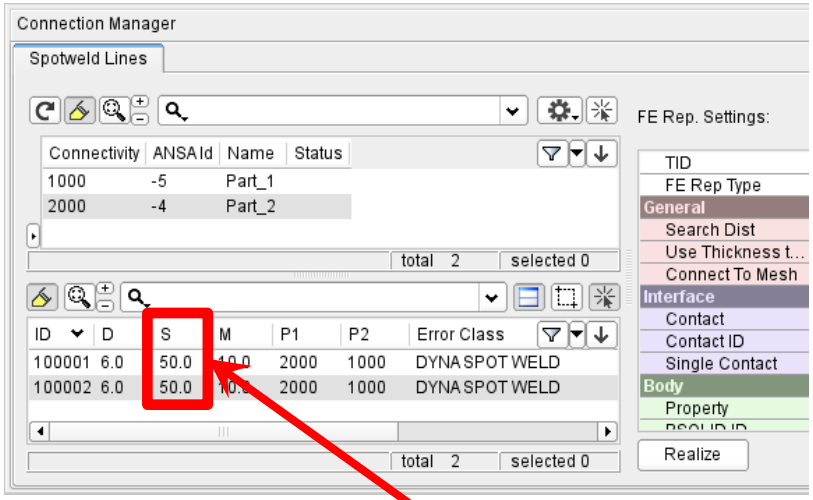
ANSA Parameter

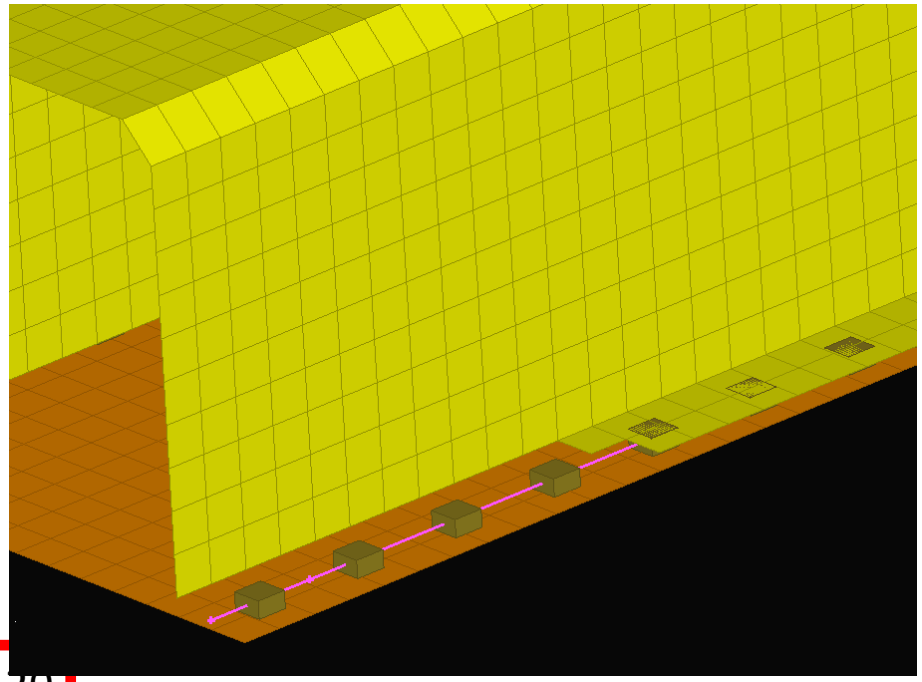
Design Variable (weld spot distance) = 50

# ANSA – Optimization Task

## Design Variables → ANSA Parameters

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



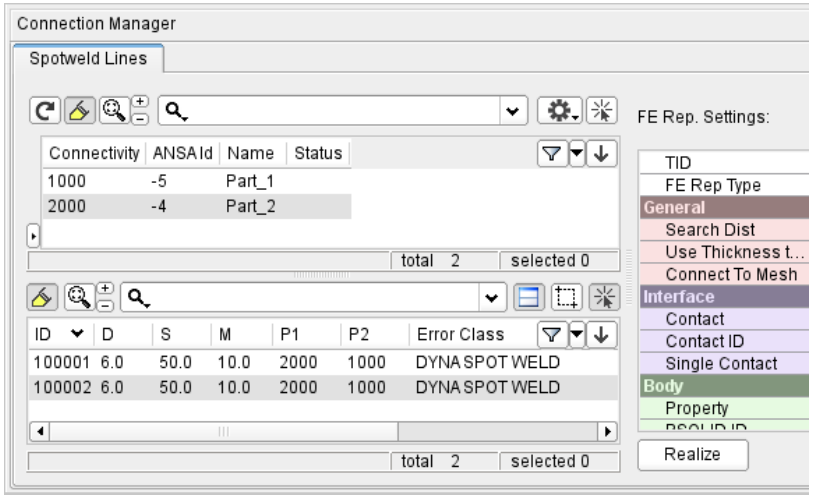
ANSA Parameter

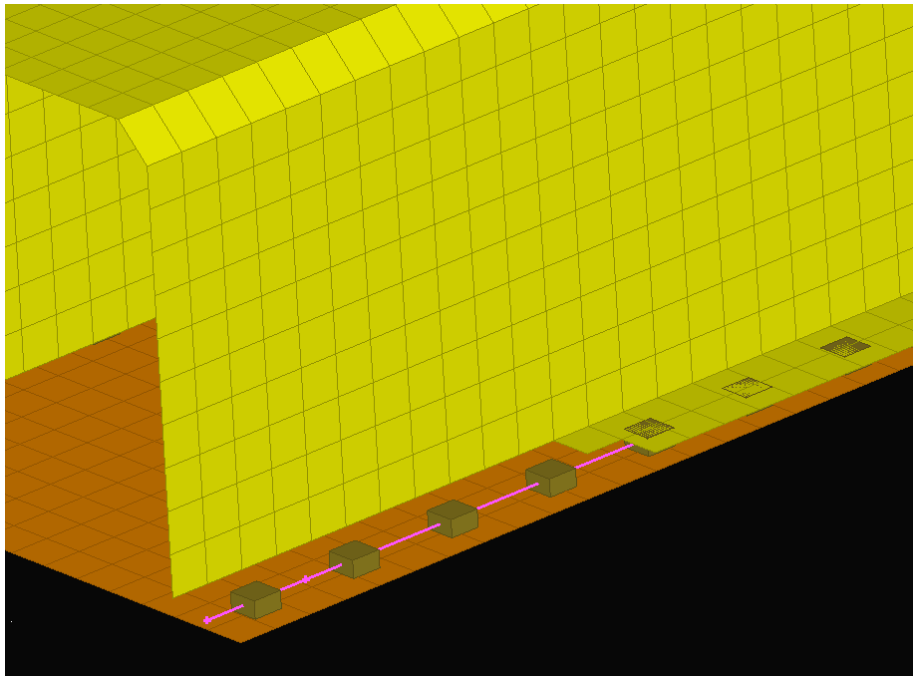
Design Variable (weld spot distance) = 20

# ANSA – Optimization Task

## Design Variables → ANSA Parameters

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

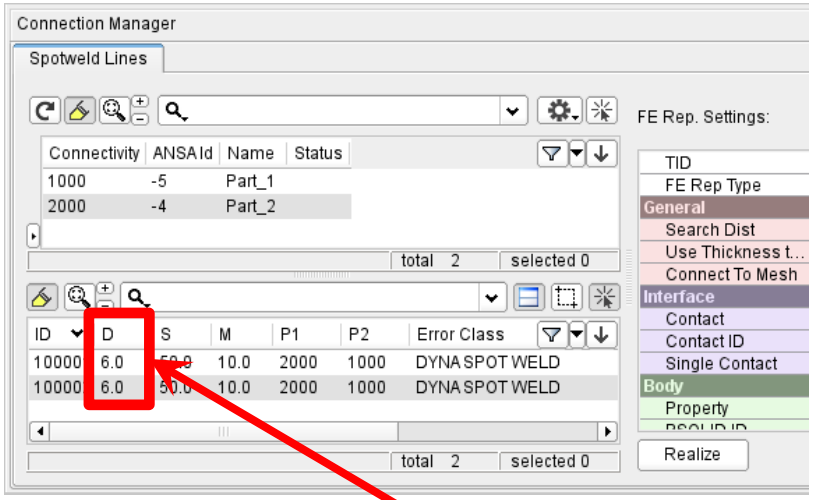


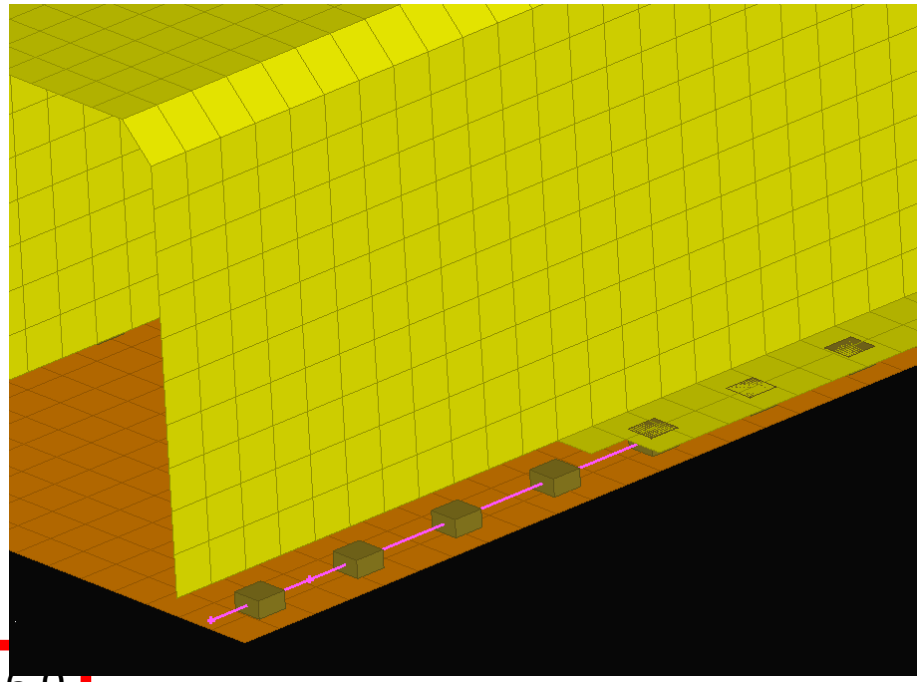



# ANSA – Optimization Task

## Design Variables → ANSA Parameters

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



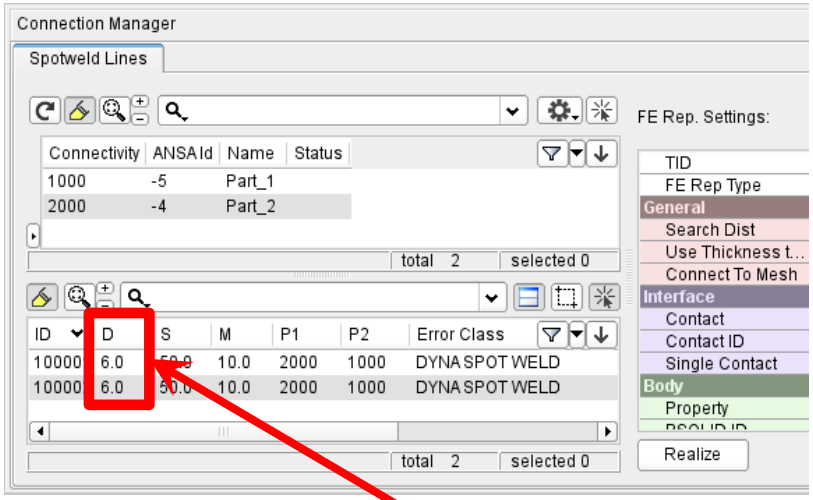
ANSA Parameter

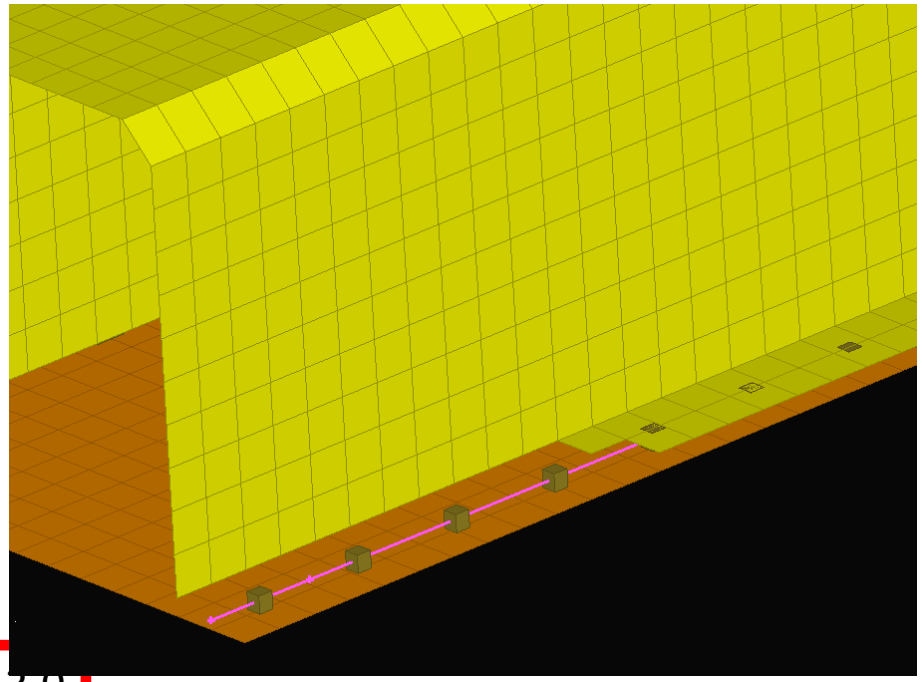
Design Variable (weld spot diameter) = 6.0

# ANSA – Optimization Task

## Design Variables → ANSA Parameters

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



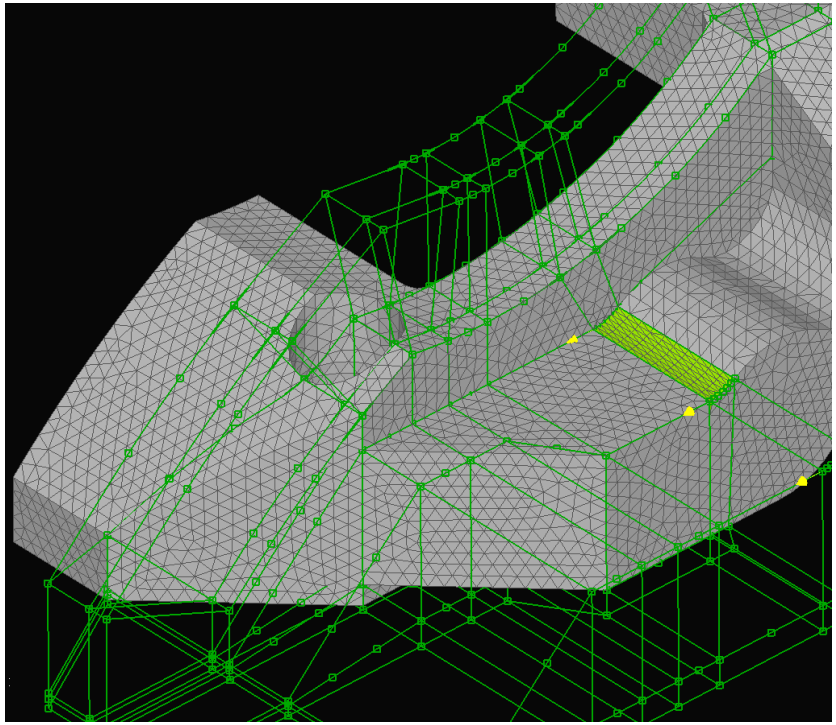
ANSA Parameter

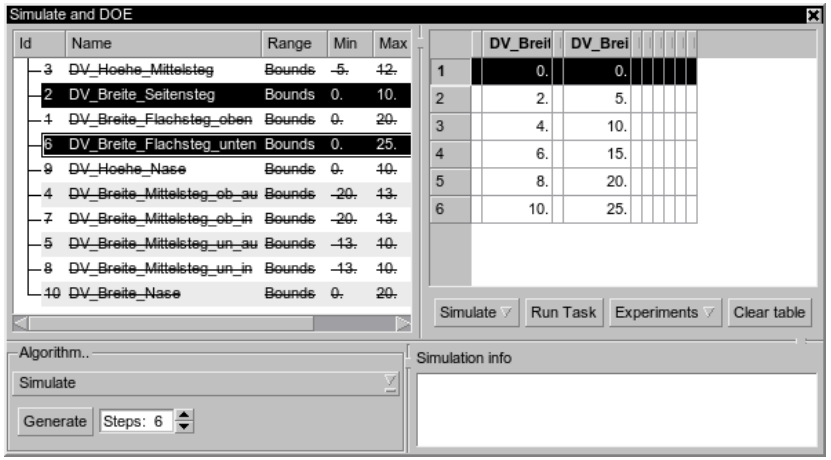
Design Variable (weld spot diameter) = 3.0

# ANSA – Optimization Task

## Simulation & DOE

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

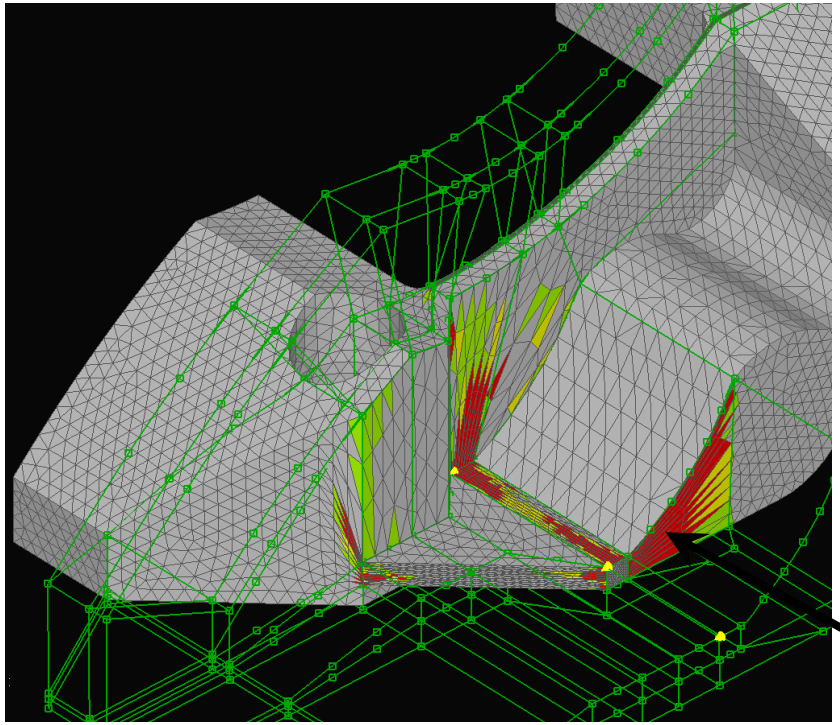


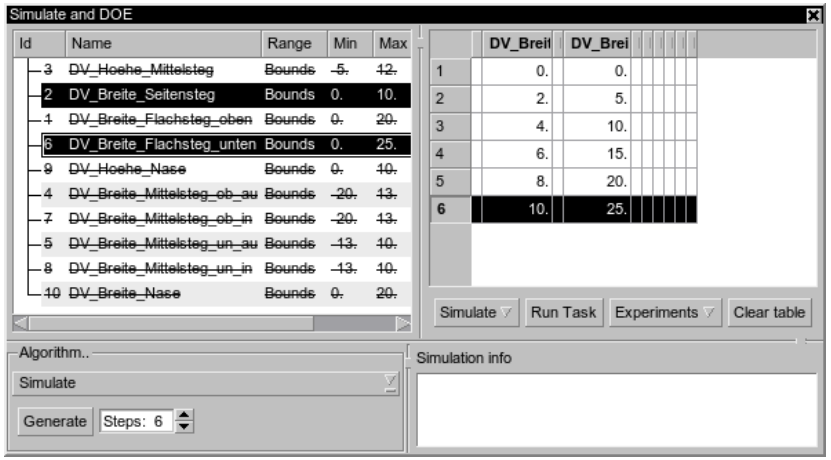


# ANSA – Optimization Task

## Simulation & DOE

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



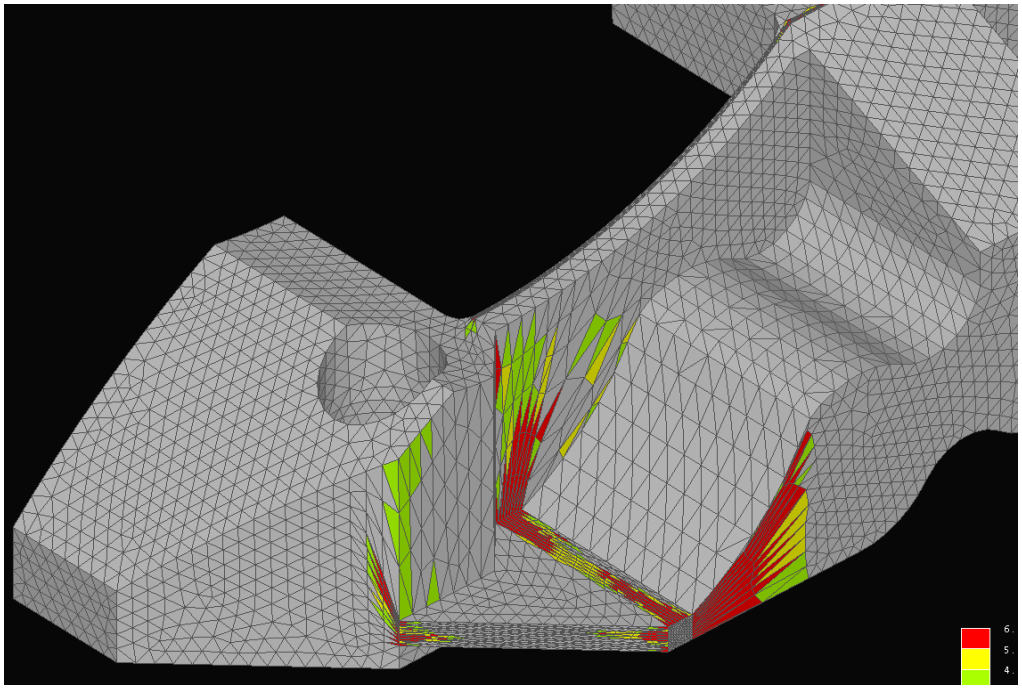


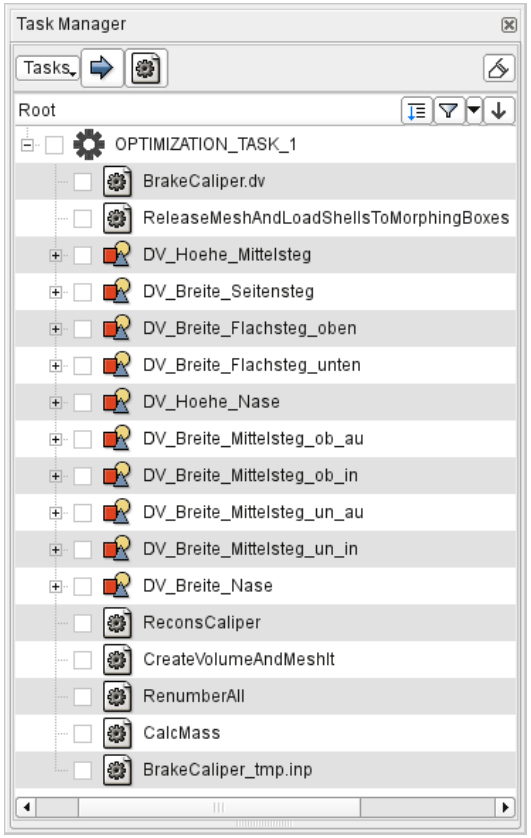

**Failed elements**

# ANSA – Optimization Task

## Additional commands for improving mesh quality

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

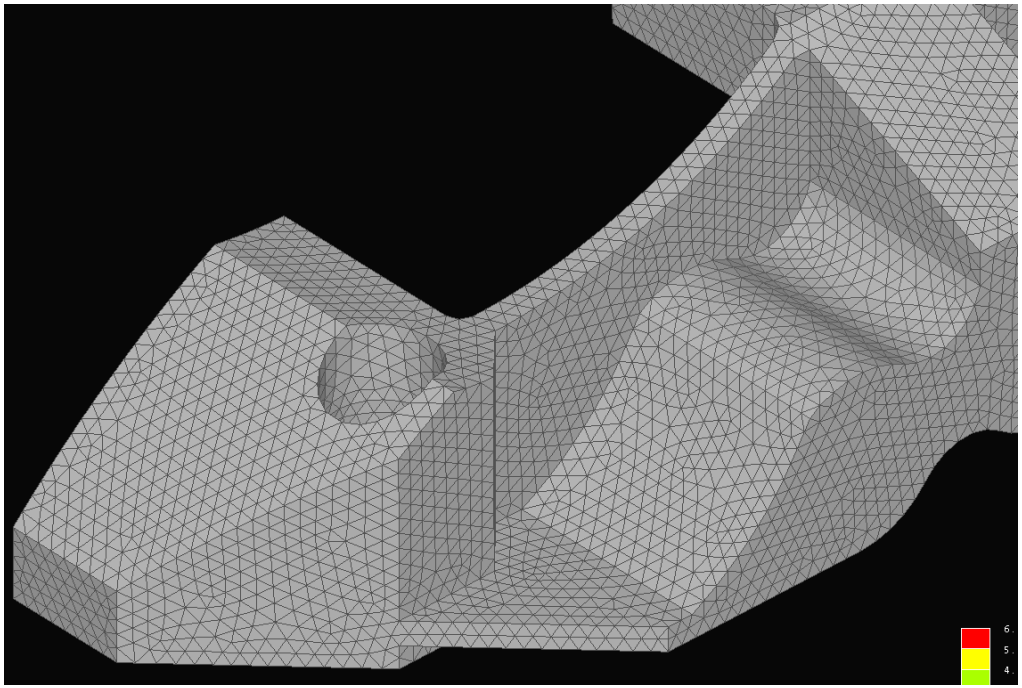


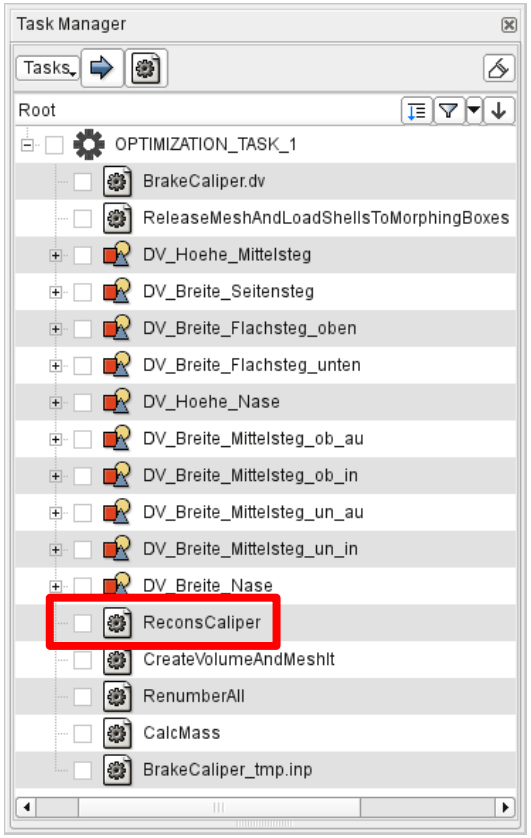


# ANSA – Optimization Task

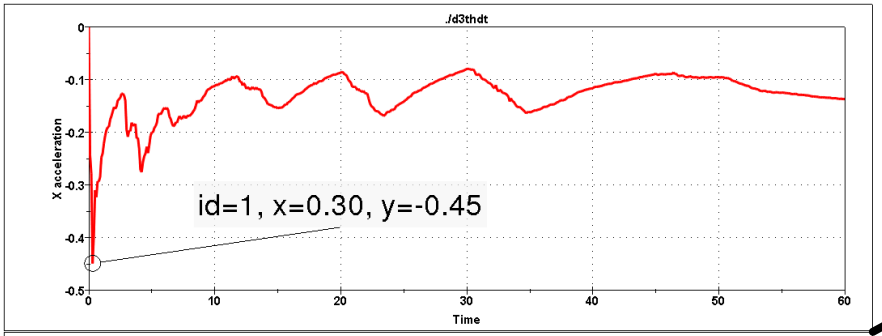
## Additional commands for improving mesh quality

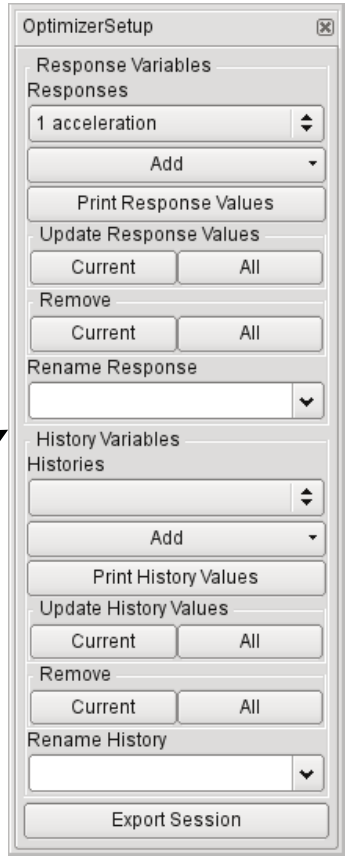
Fix Quality, Smooth, Reconstruct, etc. for morphed mesh





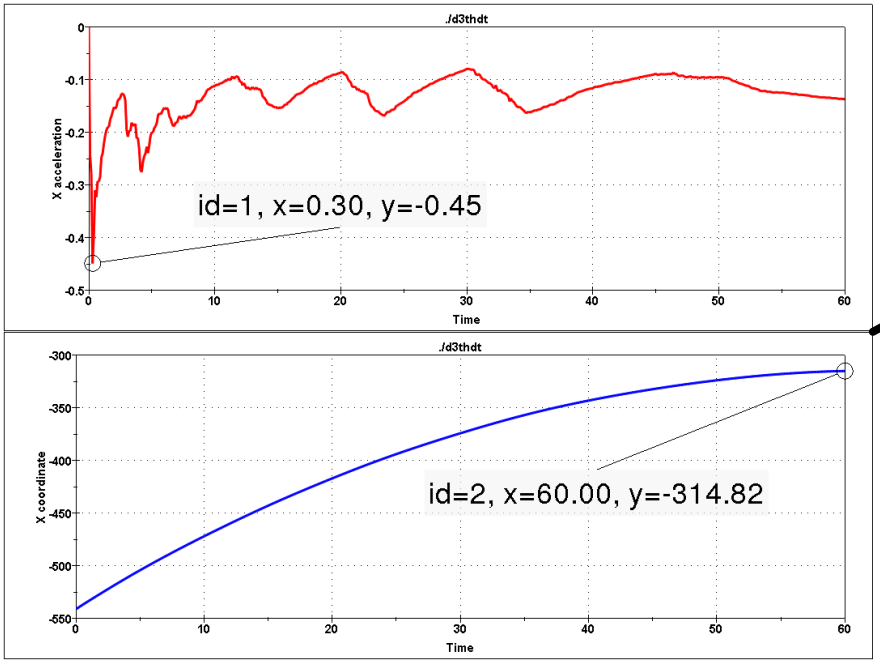
# META – OptimizerSetup Toolbar

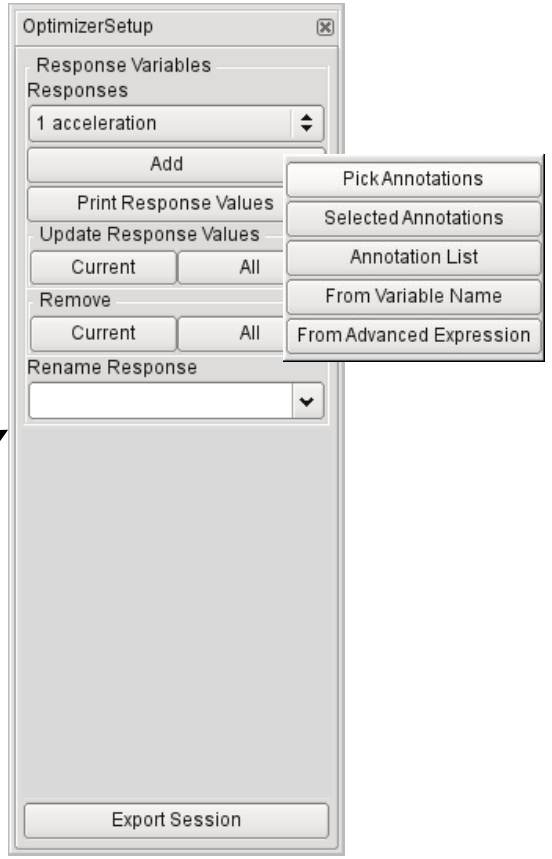


# META – OptimizerSetup Toolbar

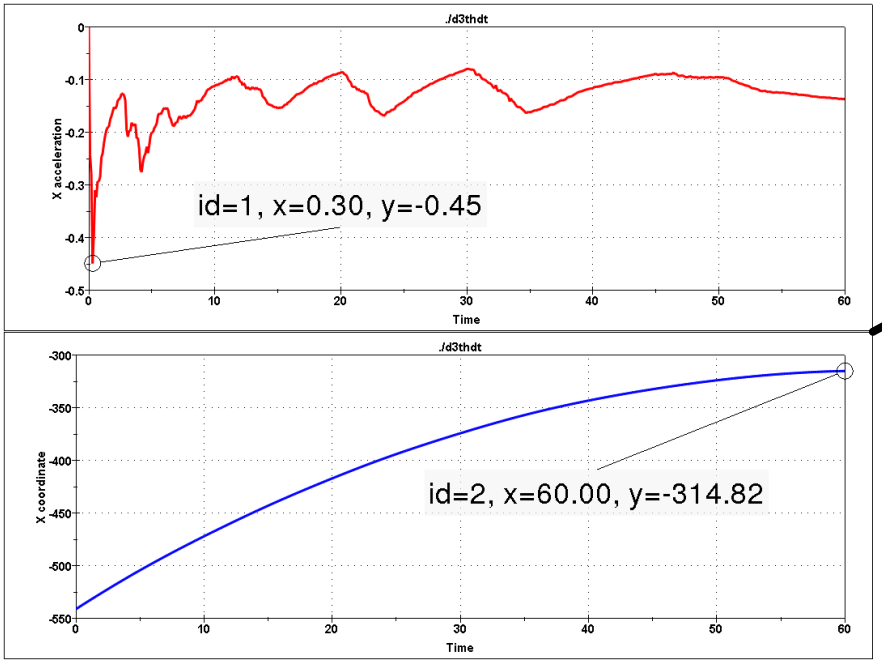
- Responses from annotations, variables, advanced expressions



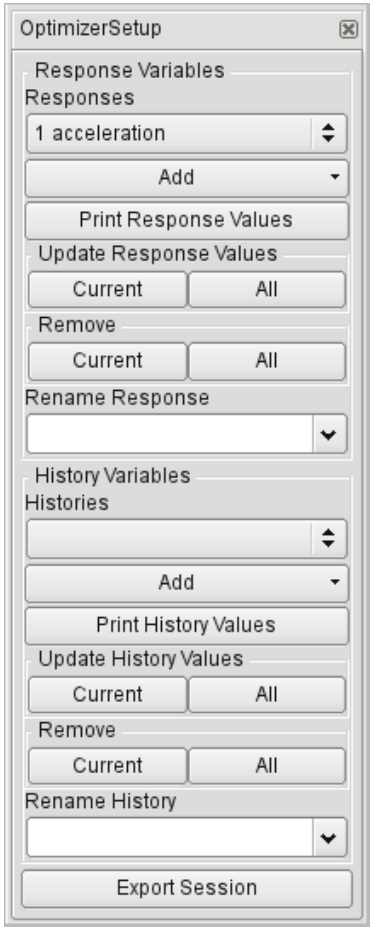



# META – OptimizerSetup Toolbar

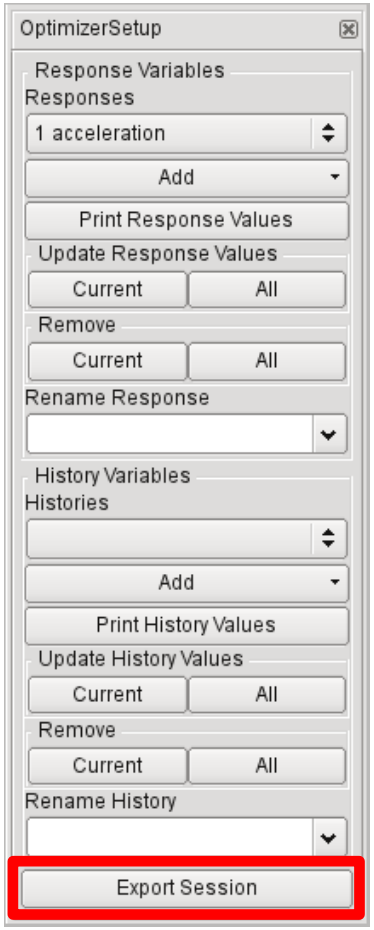
- Responses from annotations, variables, advanced expressions
- Histories from 2D plot curves




# META – OptimizerSetup Toolbar



# META – OptimizerSetup Toolbar




## Exports:

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

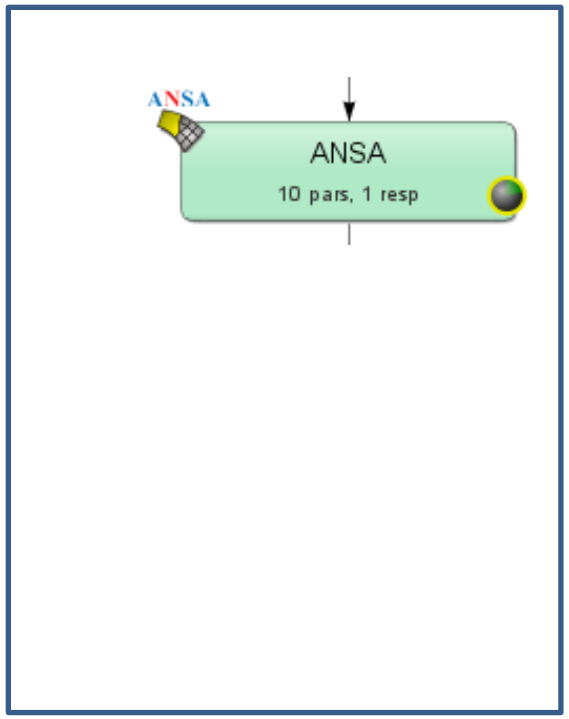
```
#OptimizerSetup Response & history File created by META post
RESPONSES
 1,acceleration,-1.18
 2,intrusion,-440.07
END
```

Correctly formatted for import in LS-OPT

# Connecting ANSA to LS-OPT

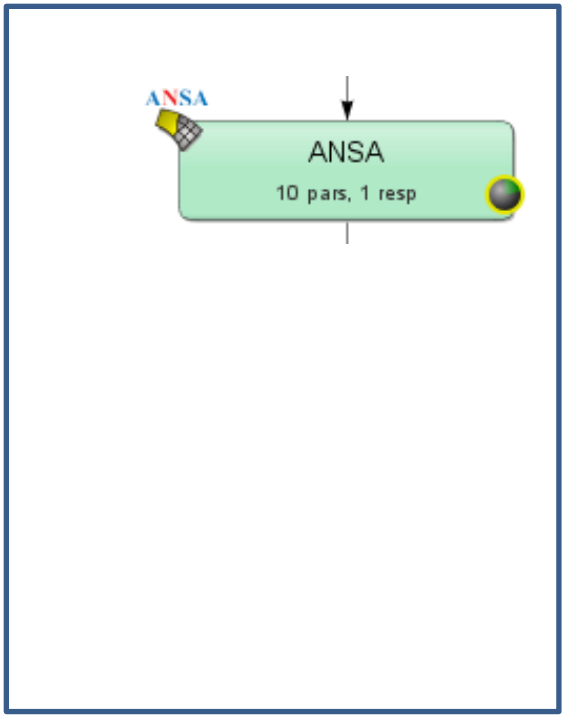
# Connecting ANSA to LS-OPT

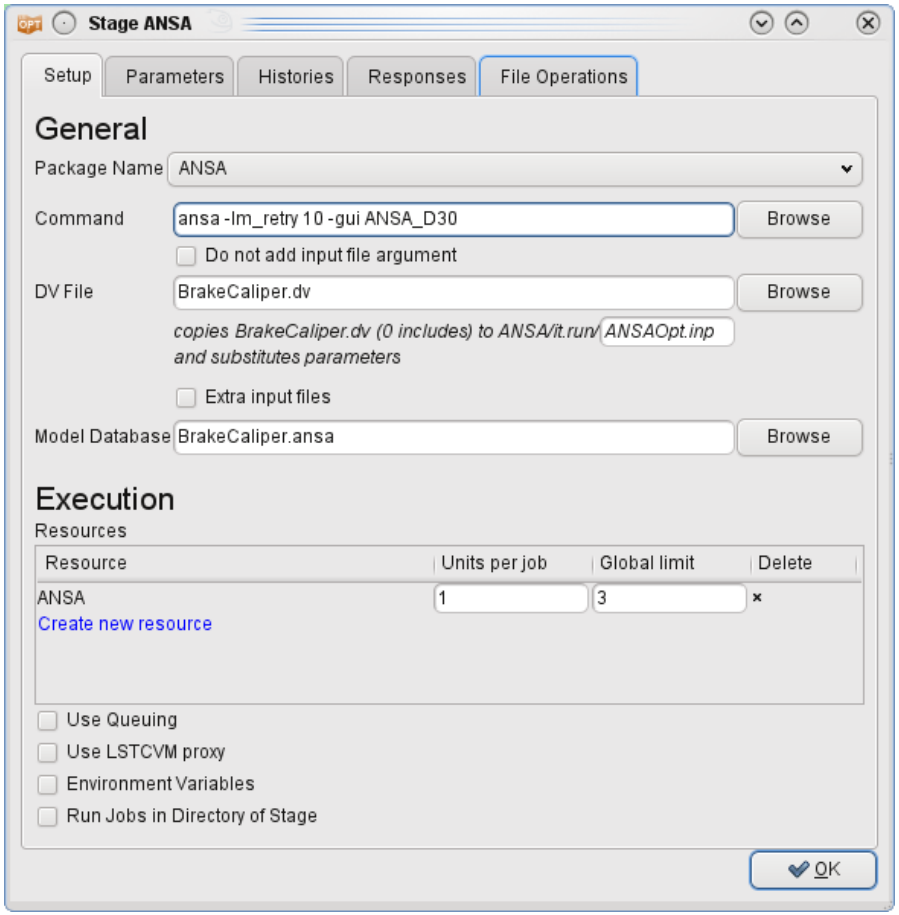
## Stage for ANSA



# Connecting ANSA to LS-OPT

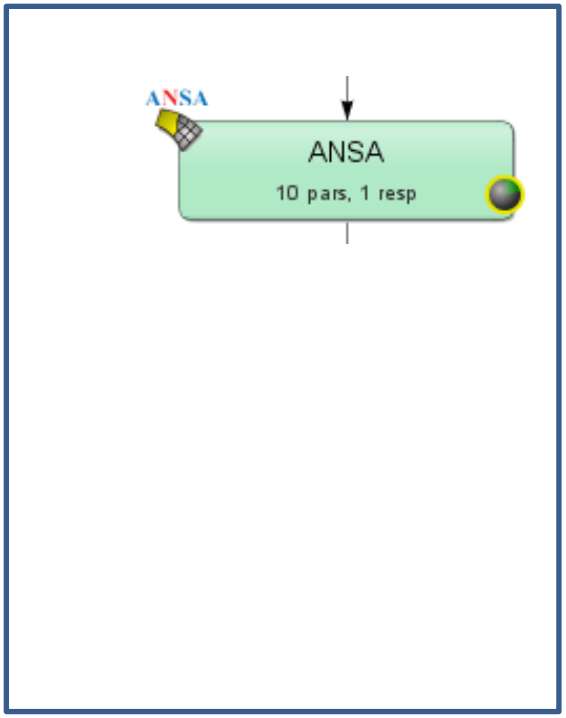
## Stage for ANSA

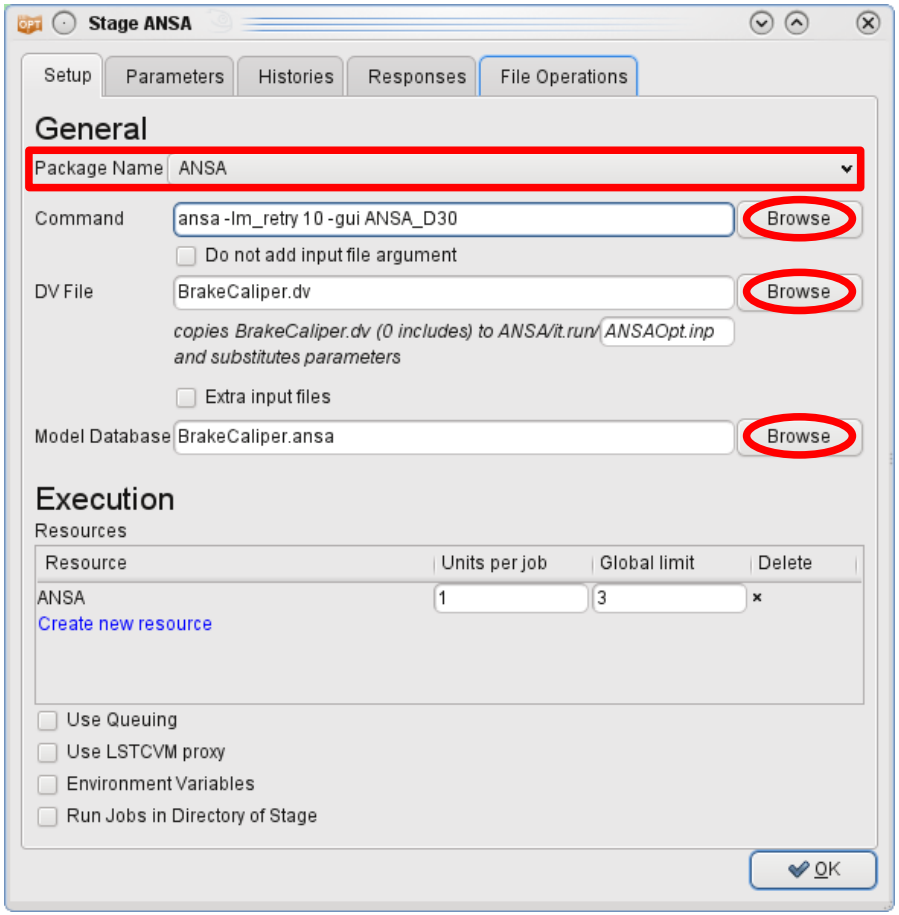


# Connecting ANSA to LS-OPT

## 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

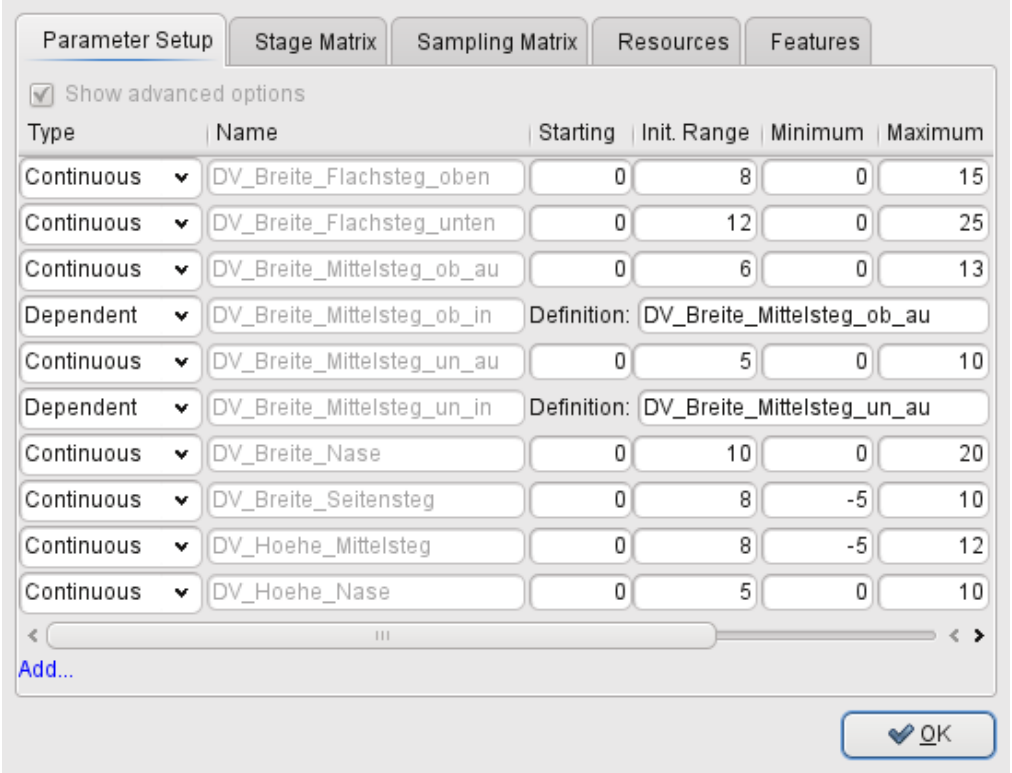
| Type | Name | Starting | Init. Range | Minimum | Maximum |
|---|---|---|---|---|---|
| Continuous | DV_Breite_Flachsteg_oben | 0 | | 0 | 15 |
| Continuous | DV_Breite_Flachsteg_unten | 0 | | 0 | 25 |
| Continuous | DV_Breite_Mittelsteg_ob_au | 0 | | 0 | 13 |
| Continuous | DV_Breite_Mittelsteg_ob_in | 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.

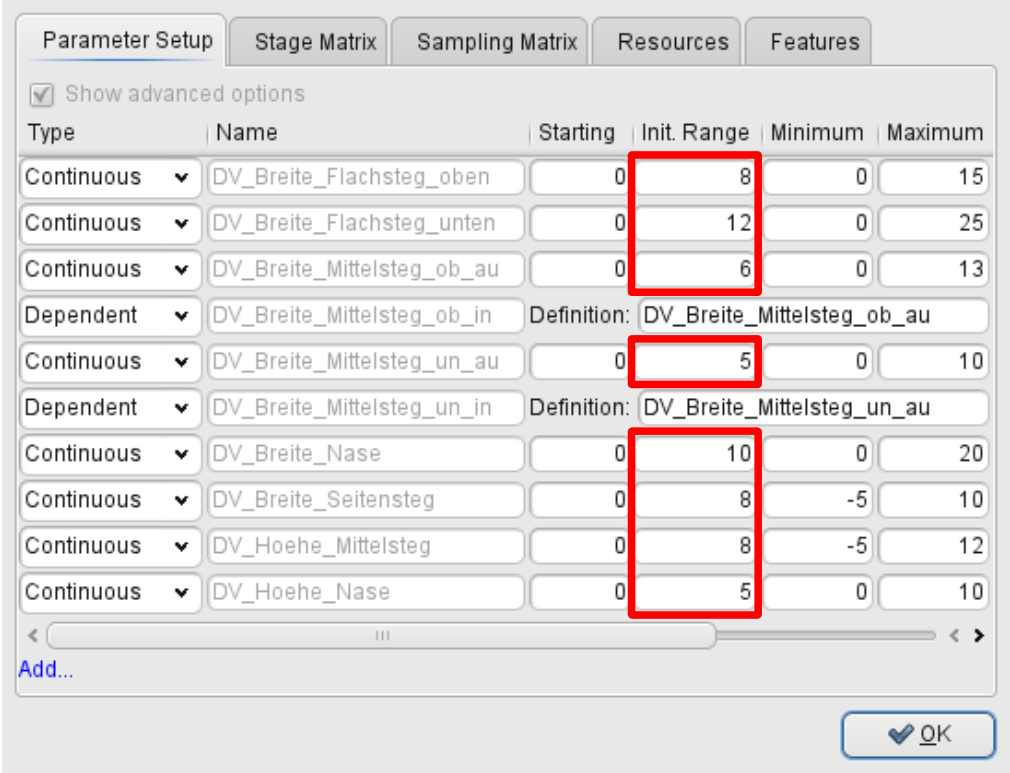



| Type | Name | Starting | Init. Range | Minimum | Maximum |
|---|---|---|---|---|---|
| Continuous | DV_Breite_Flachsteg_oben | 0 | 8 | 0 | 15 |
| Continuous | DV_Breite_Flachsteg_unten | 0 | 12 | 0 | 25 |
| Continuous | DV_Breite_Mittelsteg_ob_au | 0 | 6 | 0 | 13 |
| Dependent | DV_Breite_Mittelsteg_ob_in | 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.

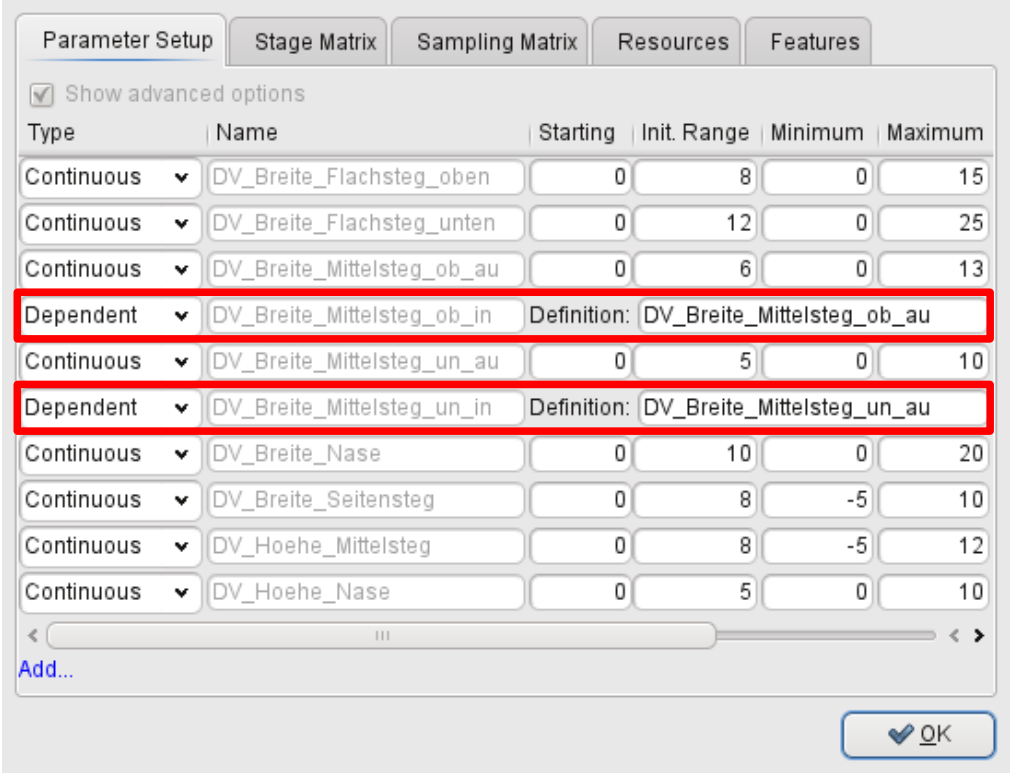
- Ranges



# Connecting ANSA to LS-OPT

Fine Tuning of Design Variables, e.g.

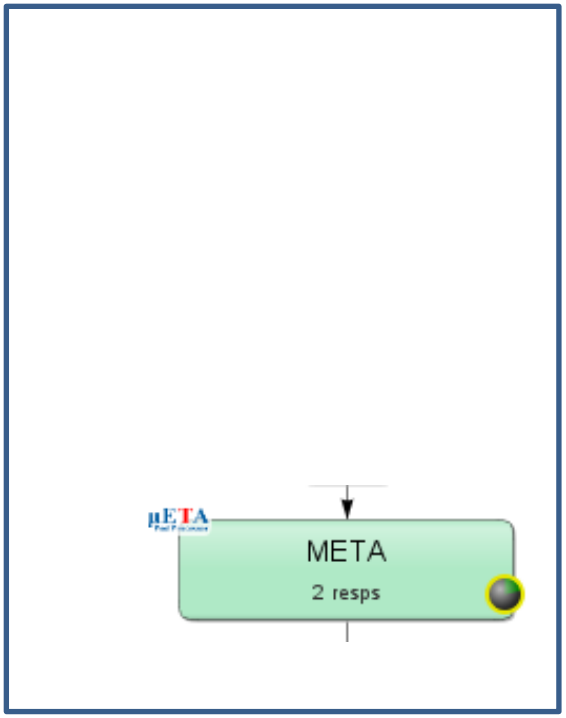
- Ranges
- Dependencies
- etc.



# Connecting META to LS-OPT

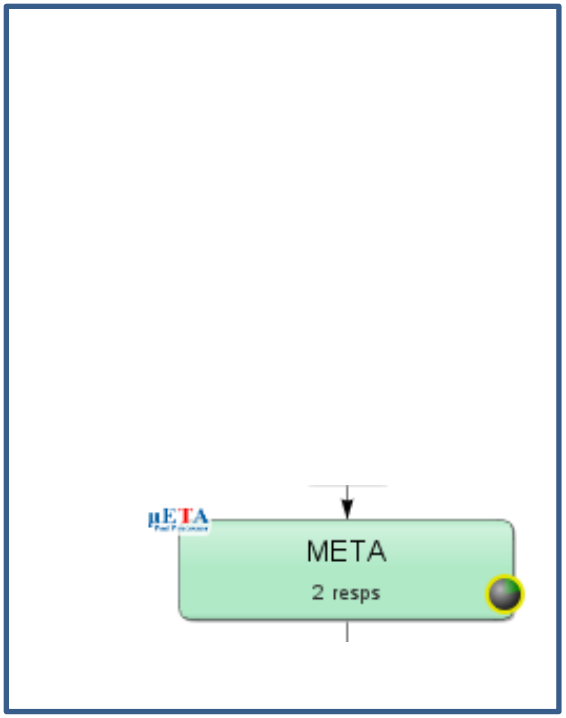
# Connecting META to LS-OPT

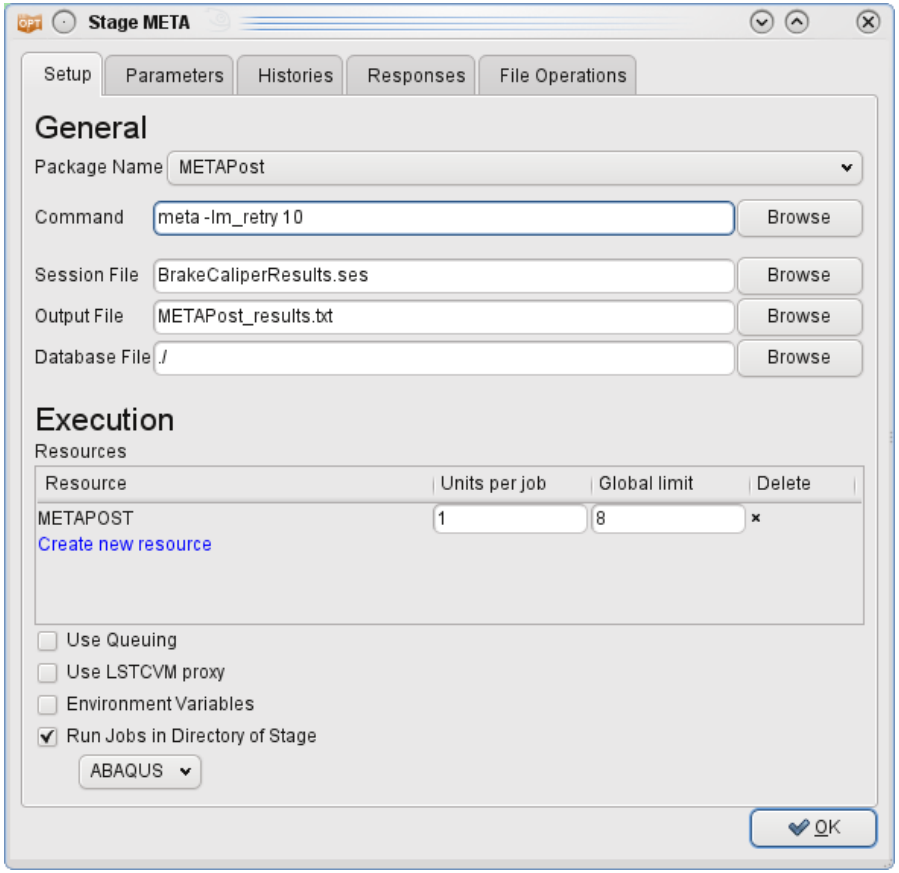
## Stage for META



# Connecting META to LS-OPT

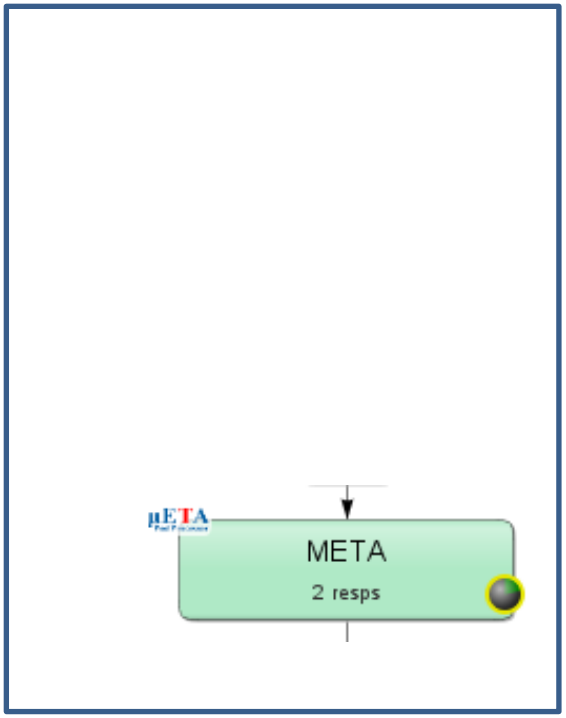
## Stage for META

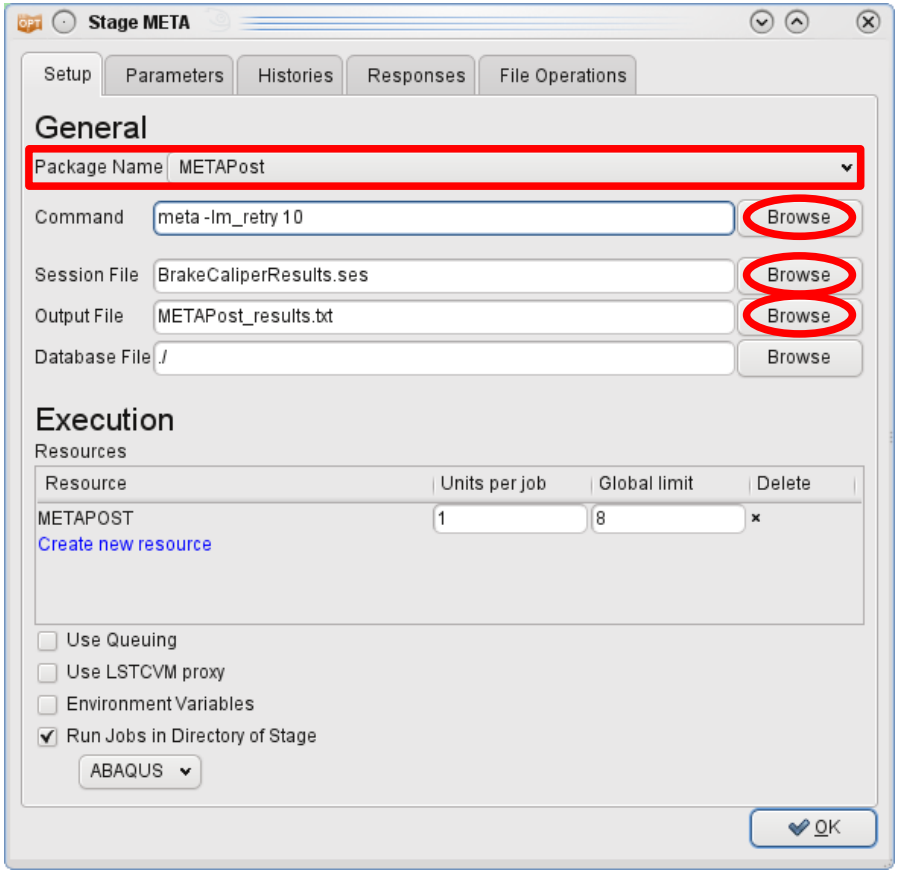


# Connecting META to LS-OPT

## Stage for META

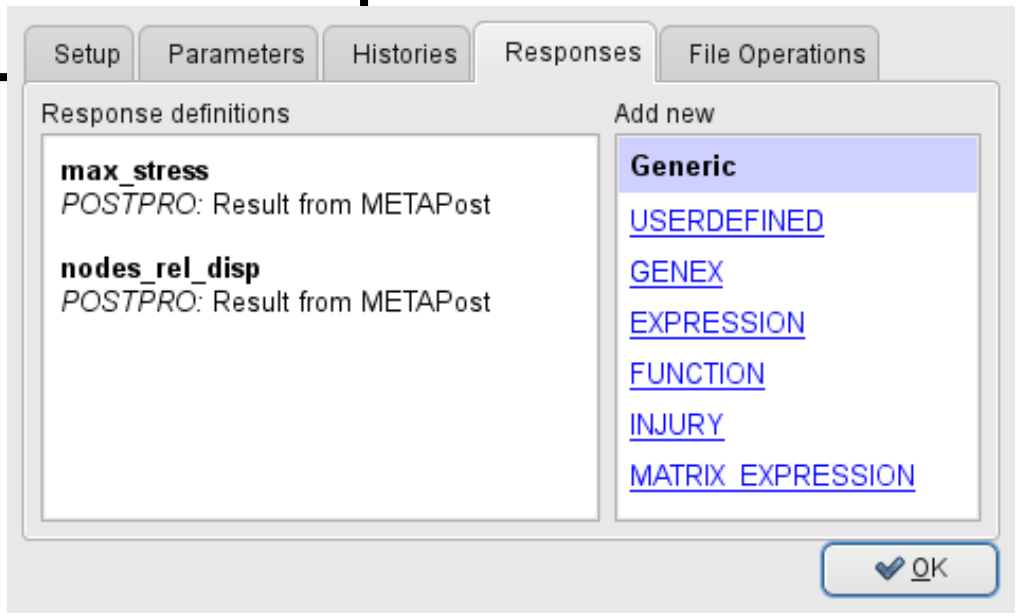


# Connecting META to LS-OPT

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

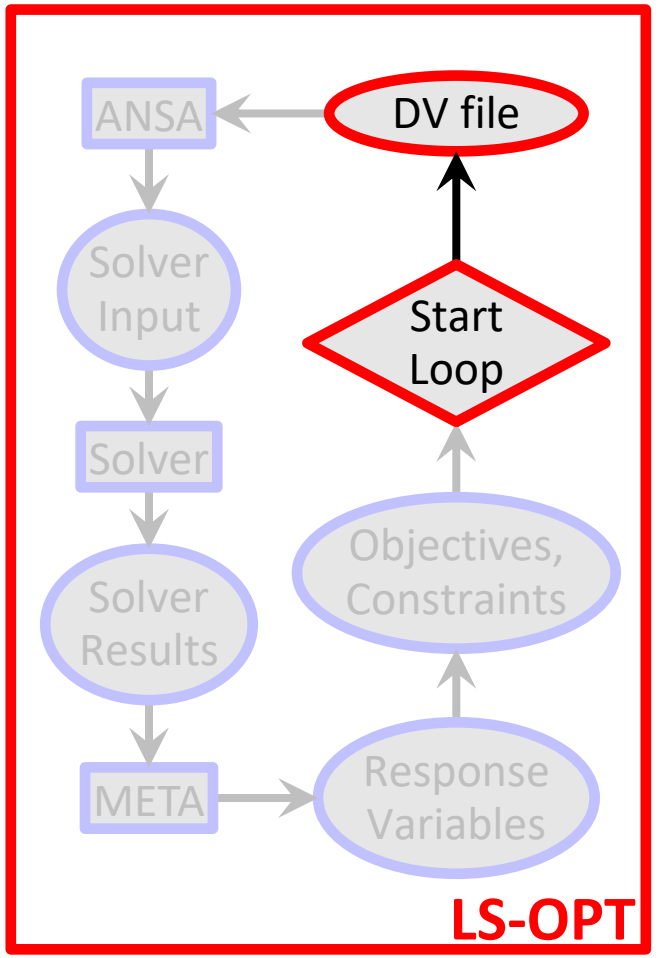
```
#OptimizerSetup Response & history File created by META post
RESPONSES
 1,nodes_rel_disp,0.174171448
 2,max_stress,169.780731
END
```



# Optimization Run

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

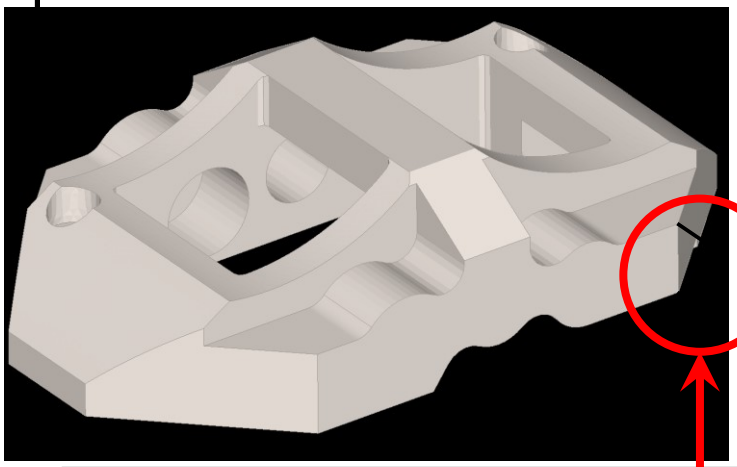
LS-OPT determines set of DV and outputs DV file



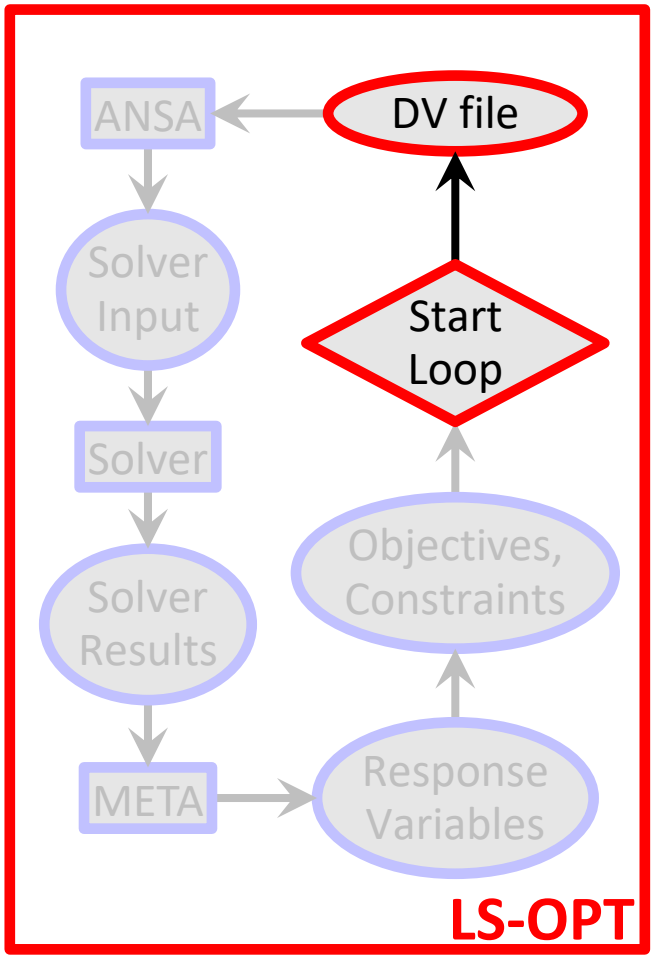
# Optimization Run

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

LS-OPT determines set of DV and outputs DV file



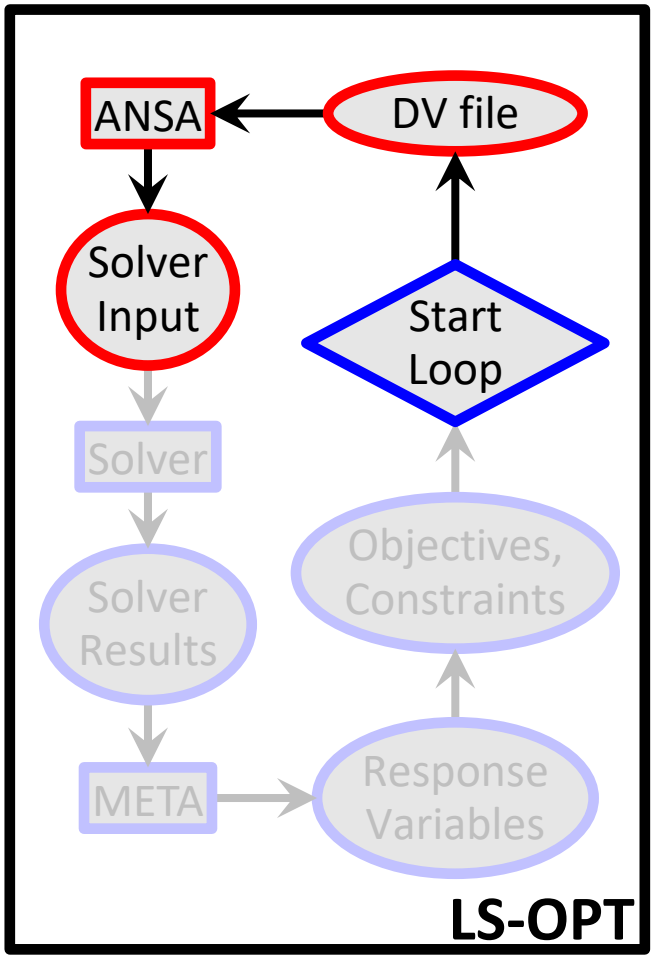
```
#-------------------------------------------------------------------------------
# ID | DESIGN VARIABLE NAME | TYPE | RANGE | CURRENT VALUE |  MIN VALUE
#-------------------------------------------------------------------------------
 3,  DV_Hoehe_Mittelsteg,  REAL,     BOUNDS,    0., -5., 12.
 2,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

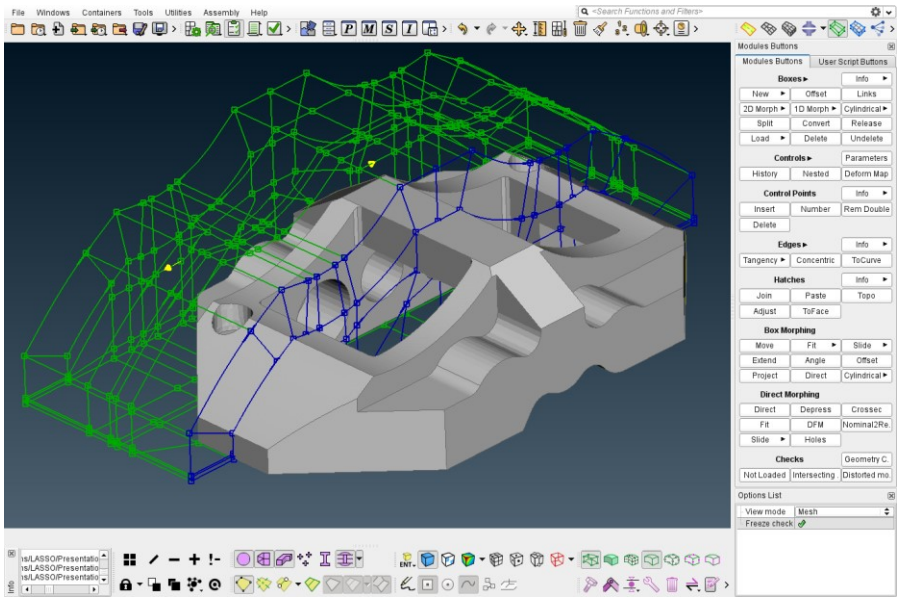
- ANSA reads DV from DV file,

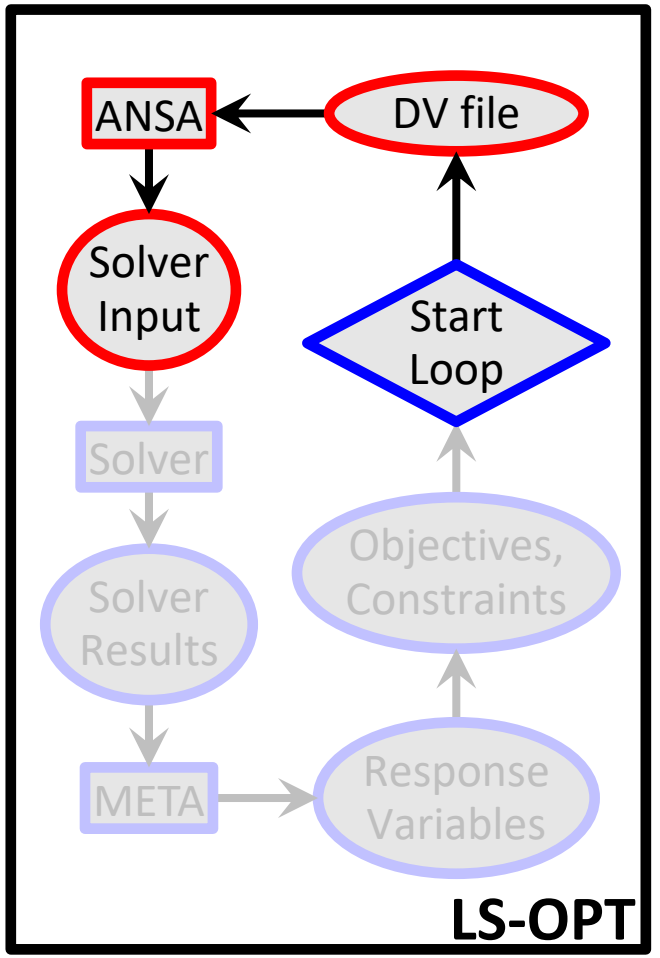


# Optimization Run

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

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

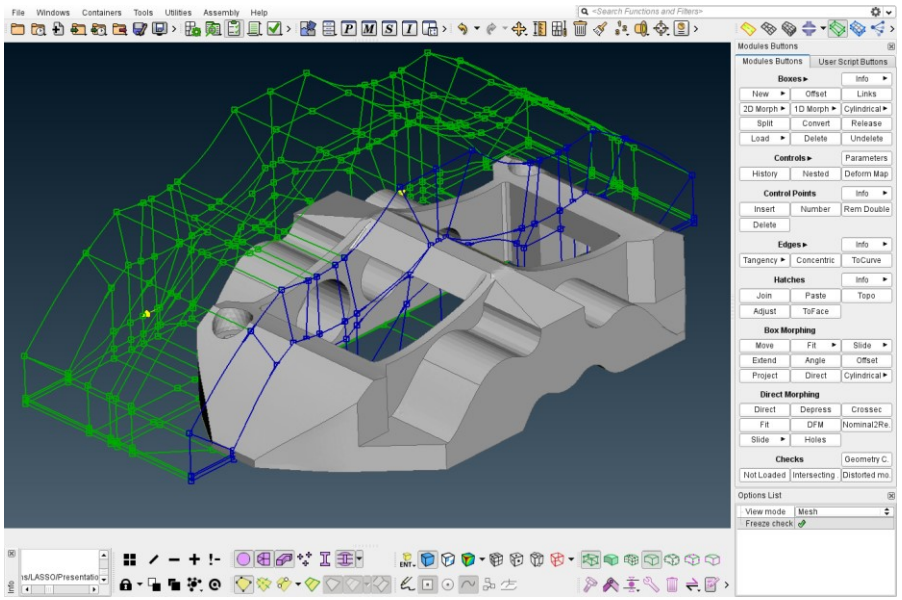


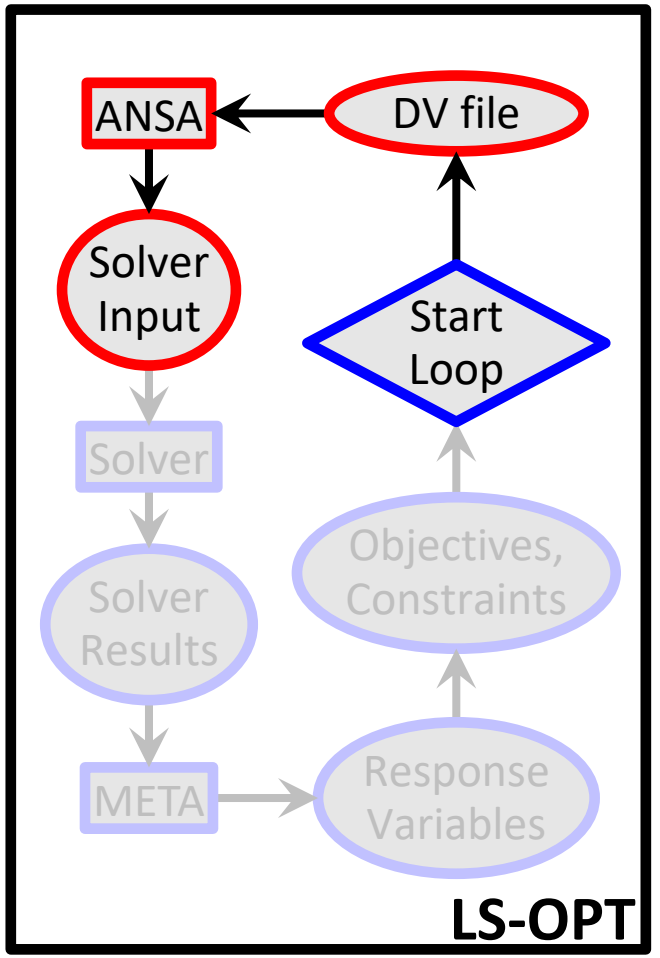


# Optimization Run

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

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

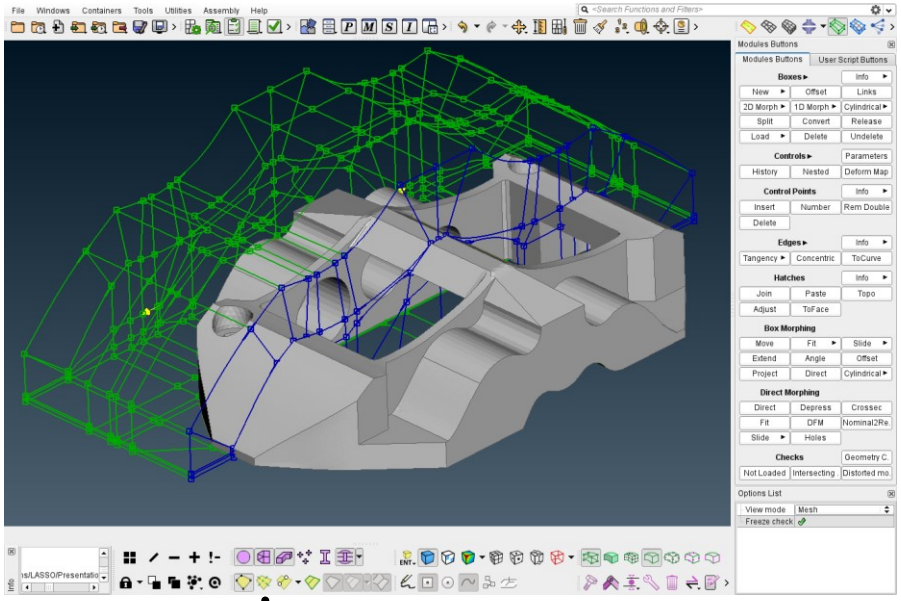




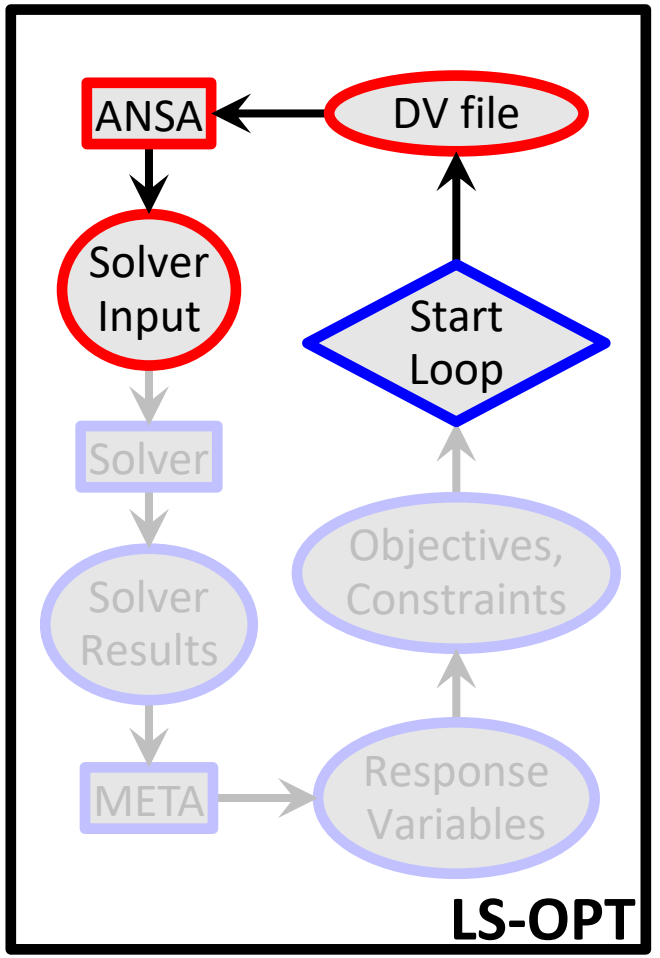
# Optimization Run

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

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



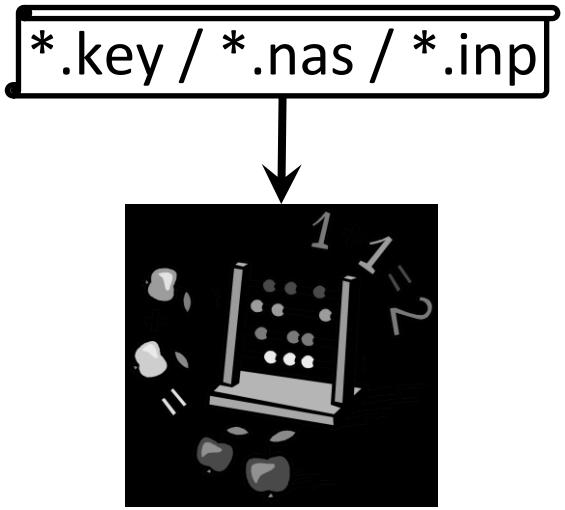
*.key / *.nas / *.inp

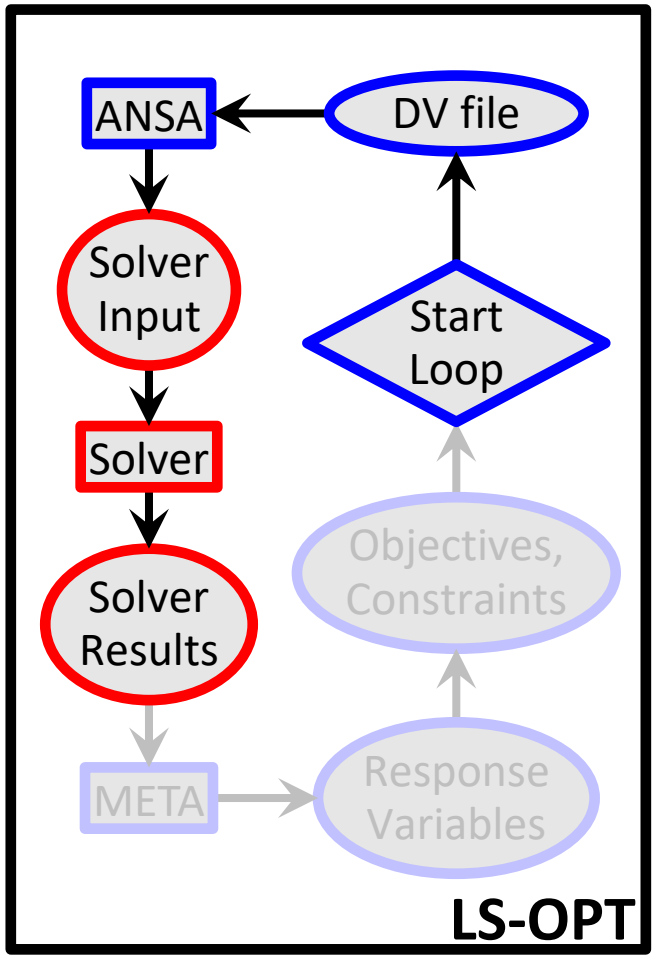


# Optimization Run

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

- LS-OPT invokes solver runs

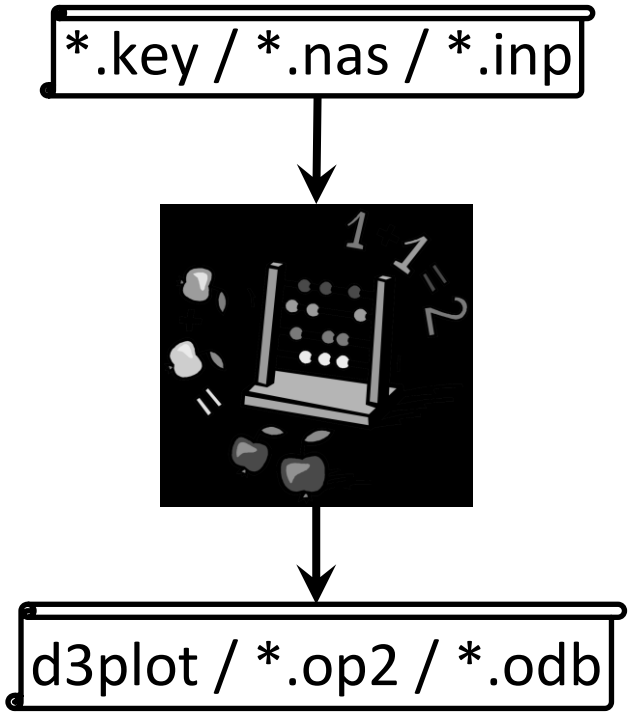


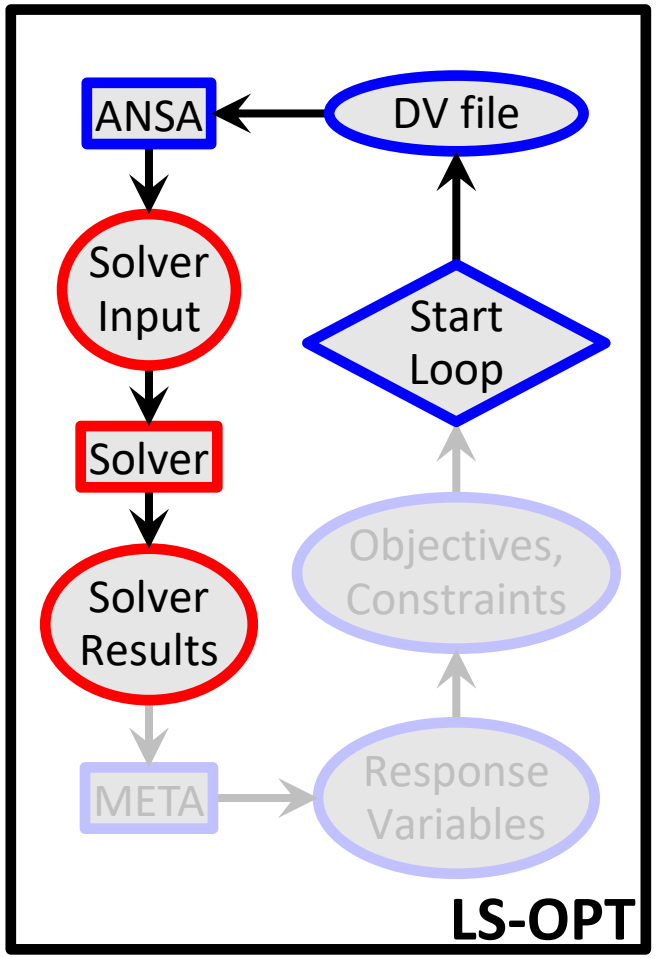



# Optimization Run

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

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



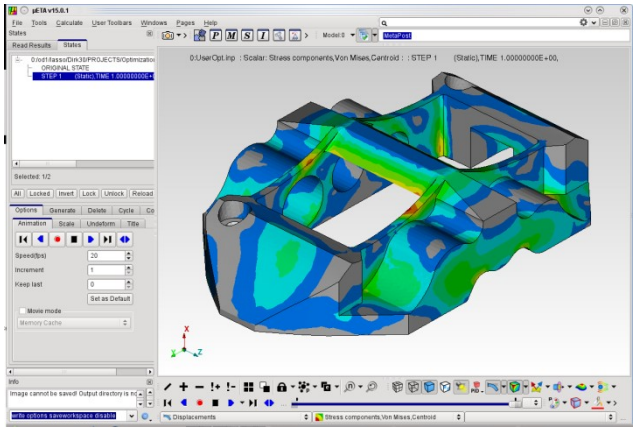



# Optimization Run

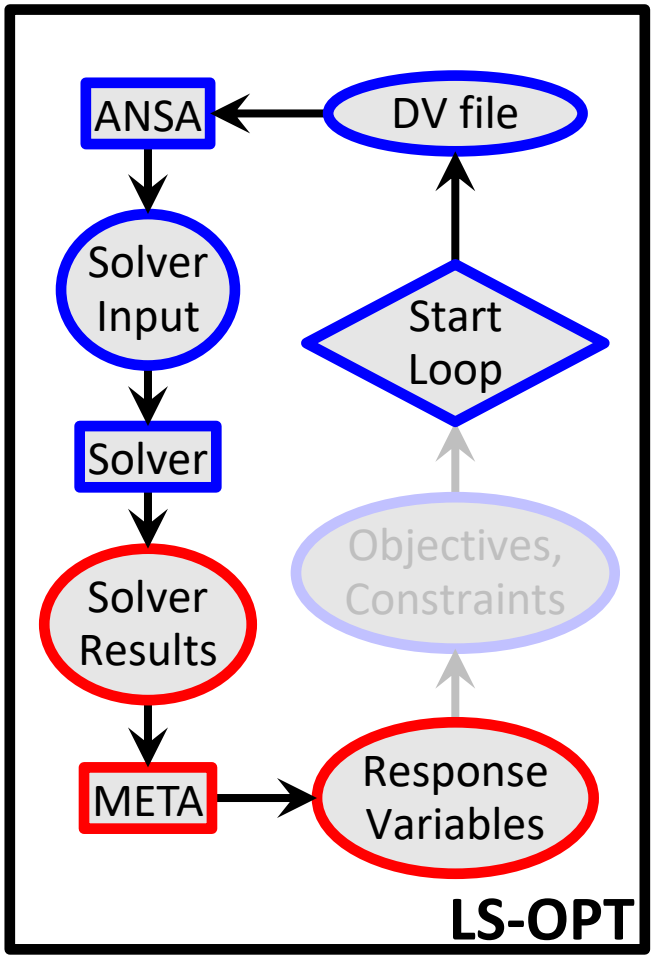
LS-OPT → ANSA → Solver → **META** → LS-OPT

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
```

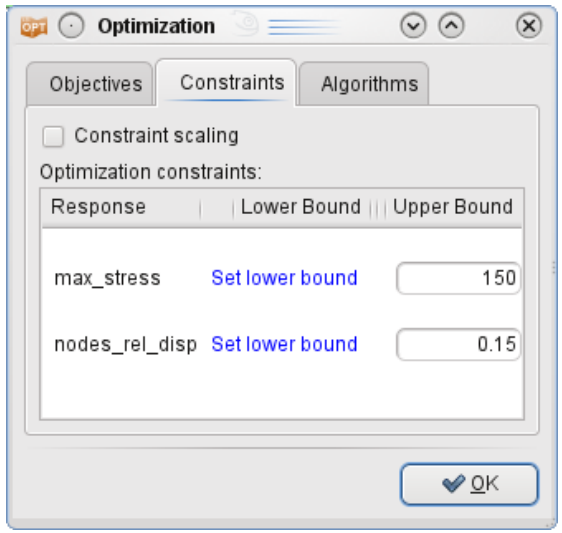


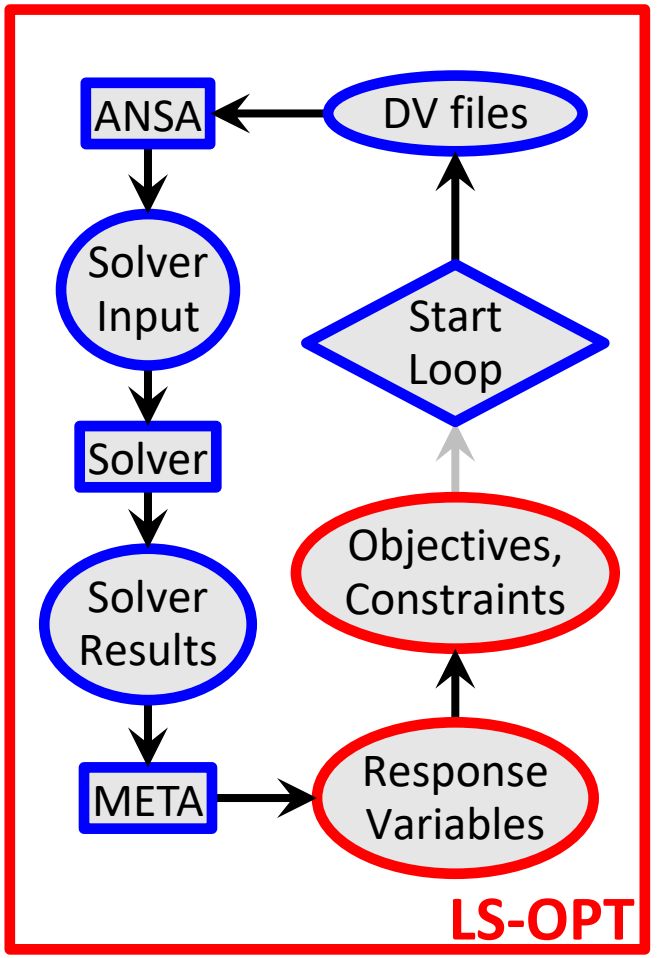
# Optimization Run

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

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
```

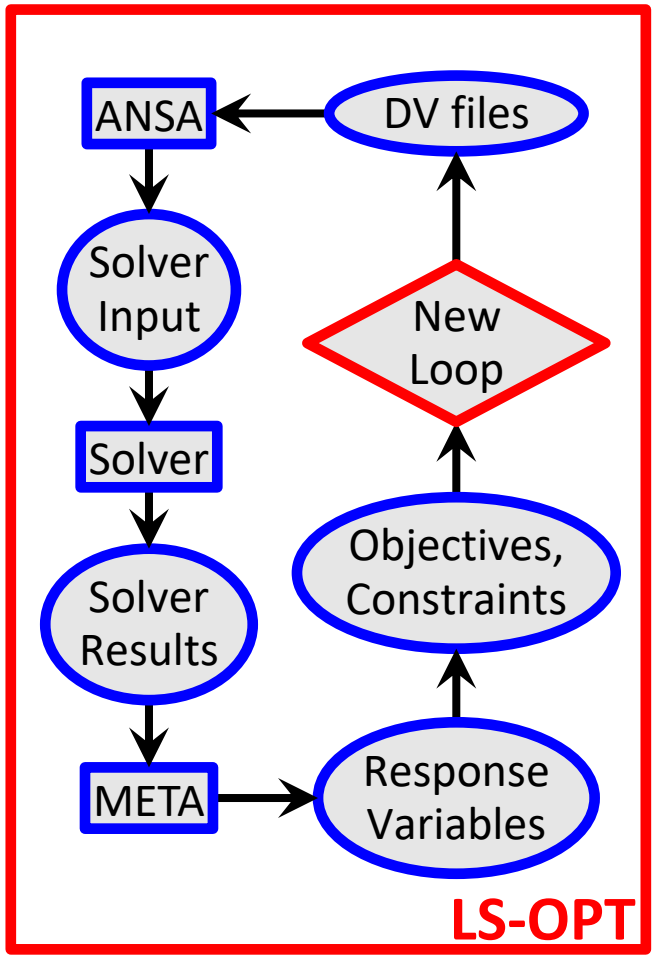


# Optimization Run

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

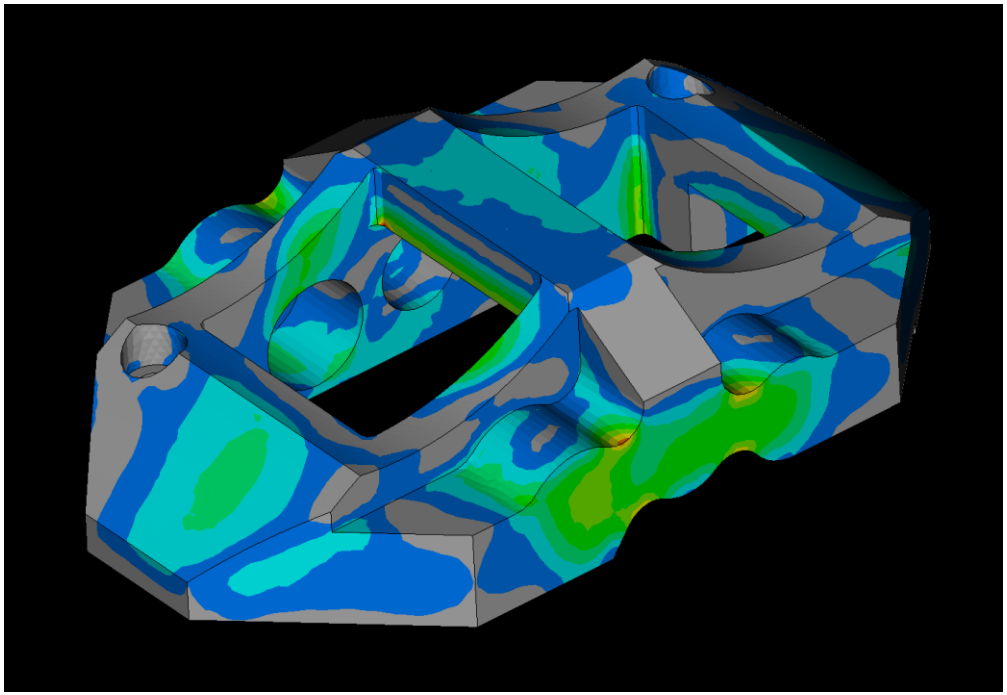
- LS-OPT calculates new values for DVs

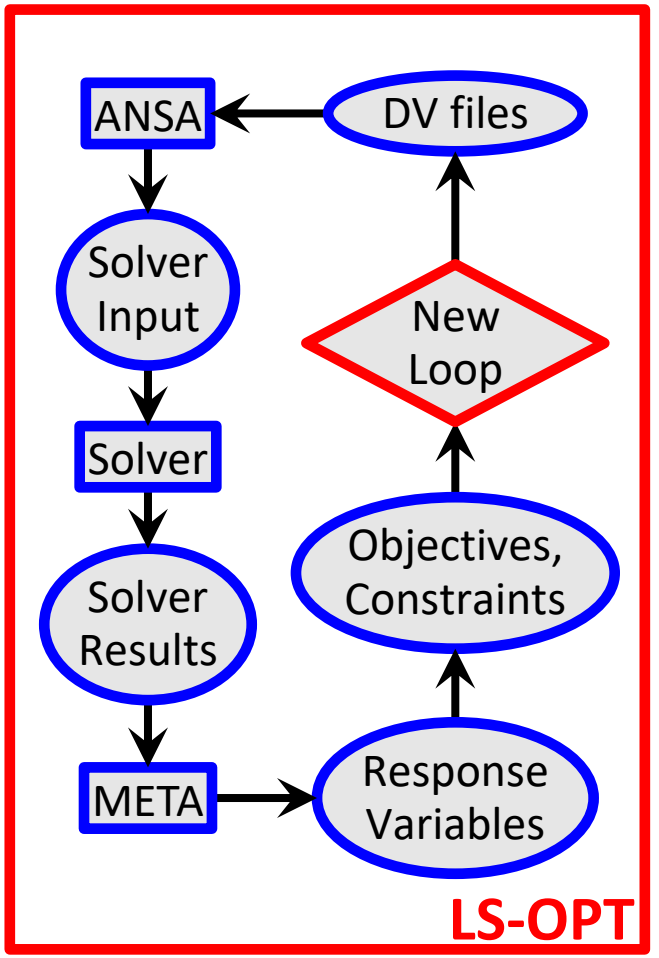


# Optimization Run

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

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

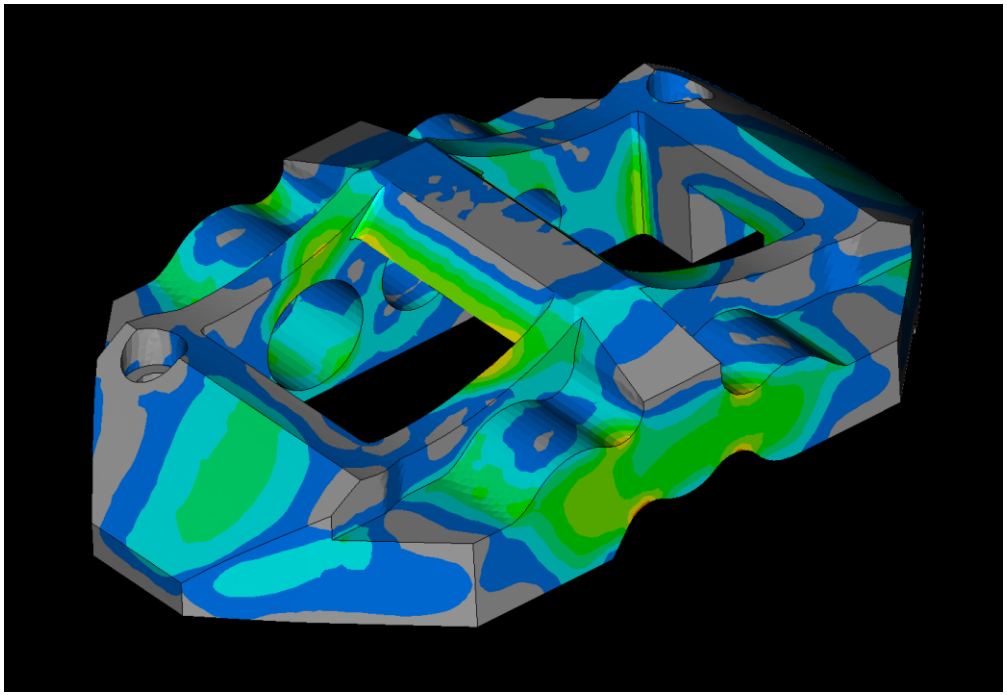


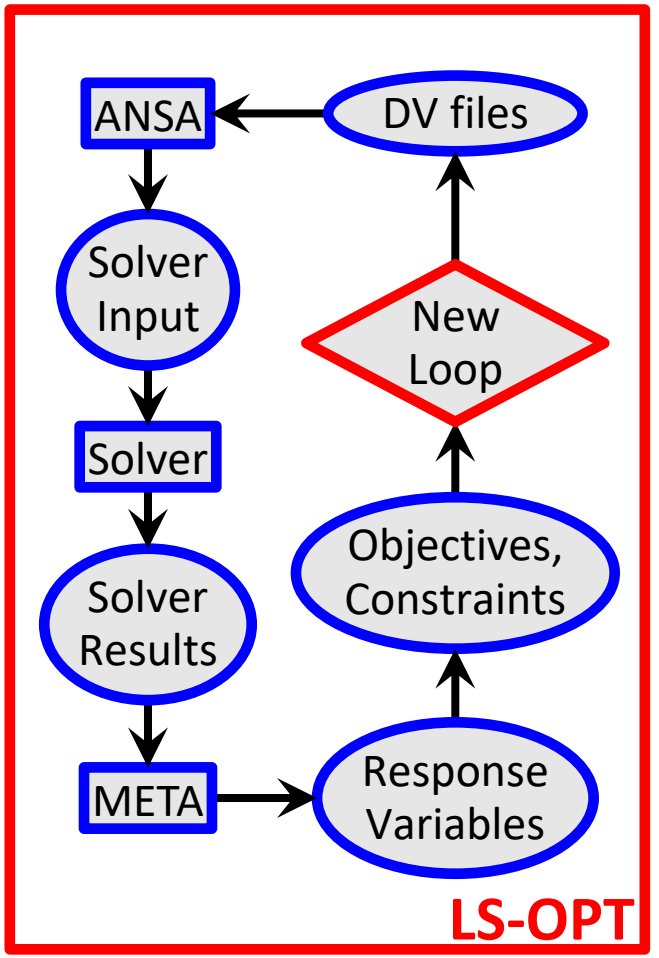


# Optimization Run

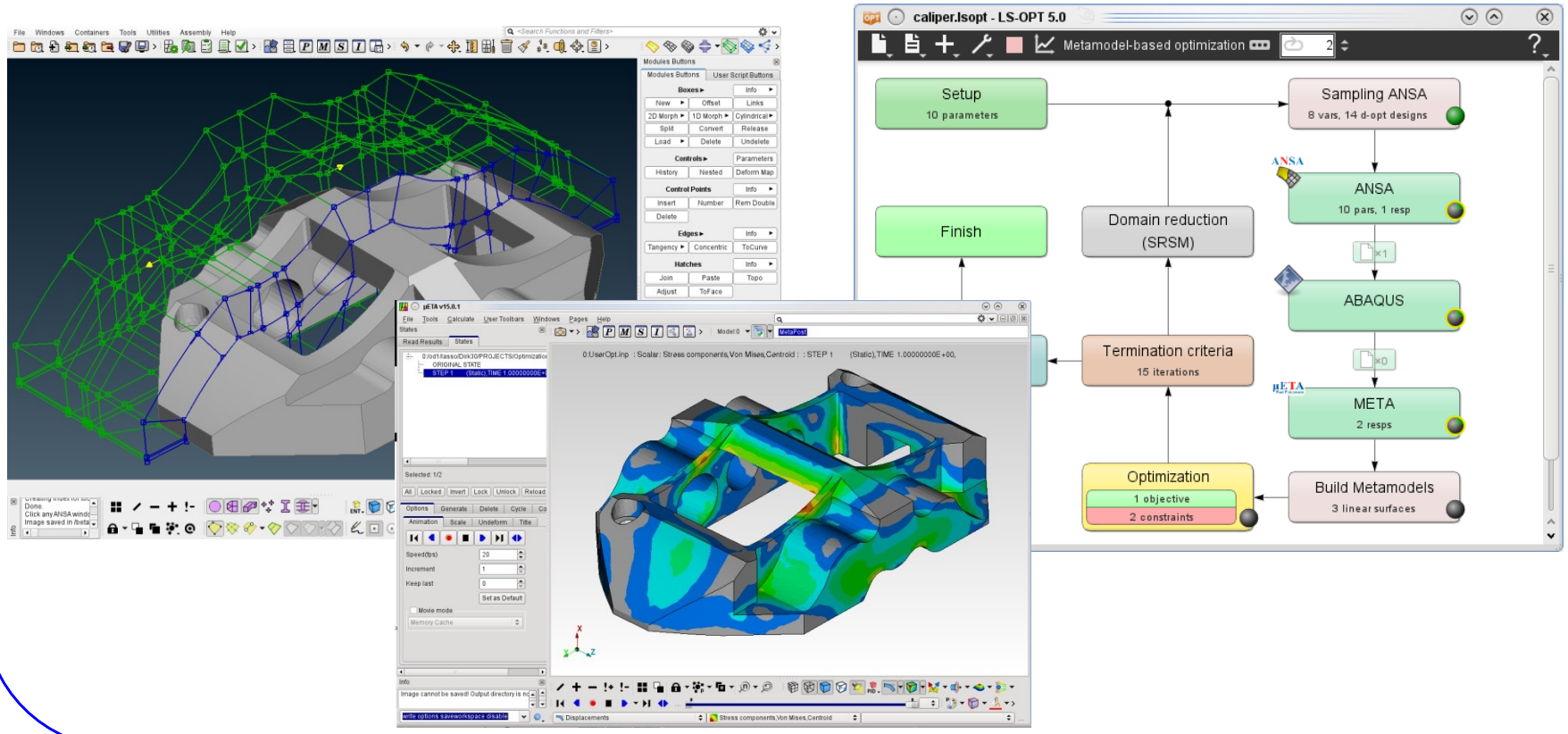
**LS-OPT** → ANSA → Solver → META → **LS-OPT**

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





# Ευχαριστώ πολύ



# Ευχαριστώ πολύ

More information and examples on
www.lsoptsupport.com

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