# Recent developments



the dynardo Team

# version 3.2

Goal of further software developments

- easy and safe to use -

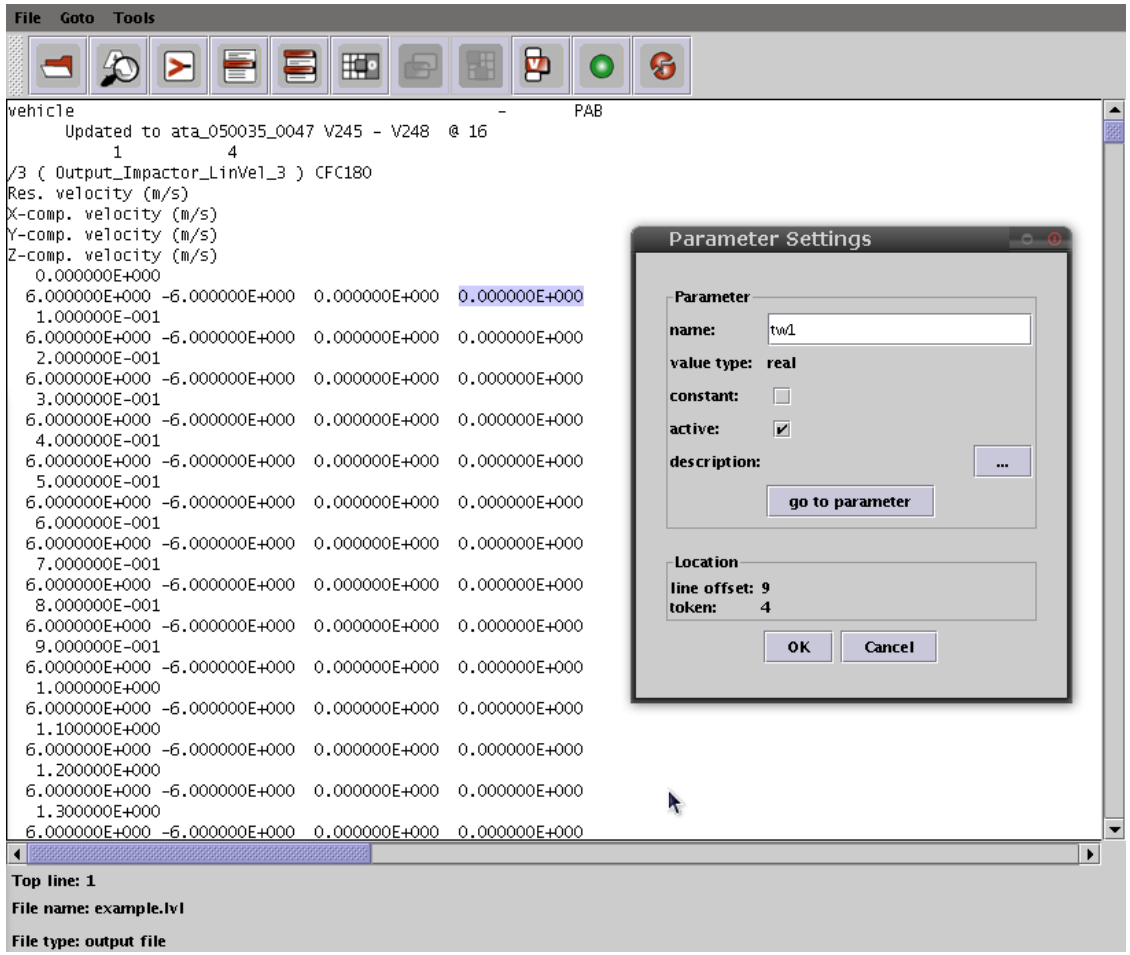
Steps in version 3.2

- Metamodels of optimized Prognosis (MOP) can be used as solver, including check of optimal design
- MOP/Coefficient of Prognosis (CoP) generation is improved using cross correlation
- Wizard for Nature-inspired (population based = GA, EA, PSO, Pareto) Optimization Algorithm (NOA)
- Improved Pre and Post Processing

# Pre Processing

- Token wise parsing

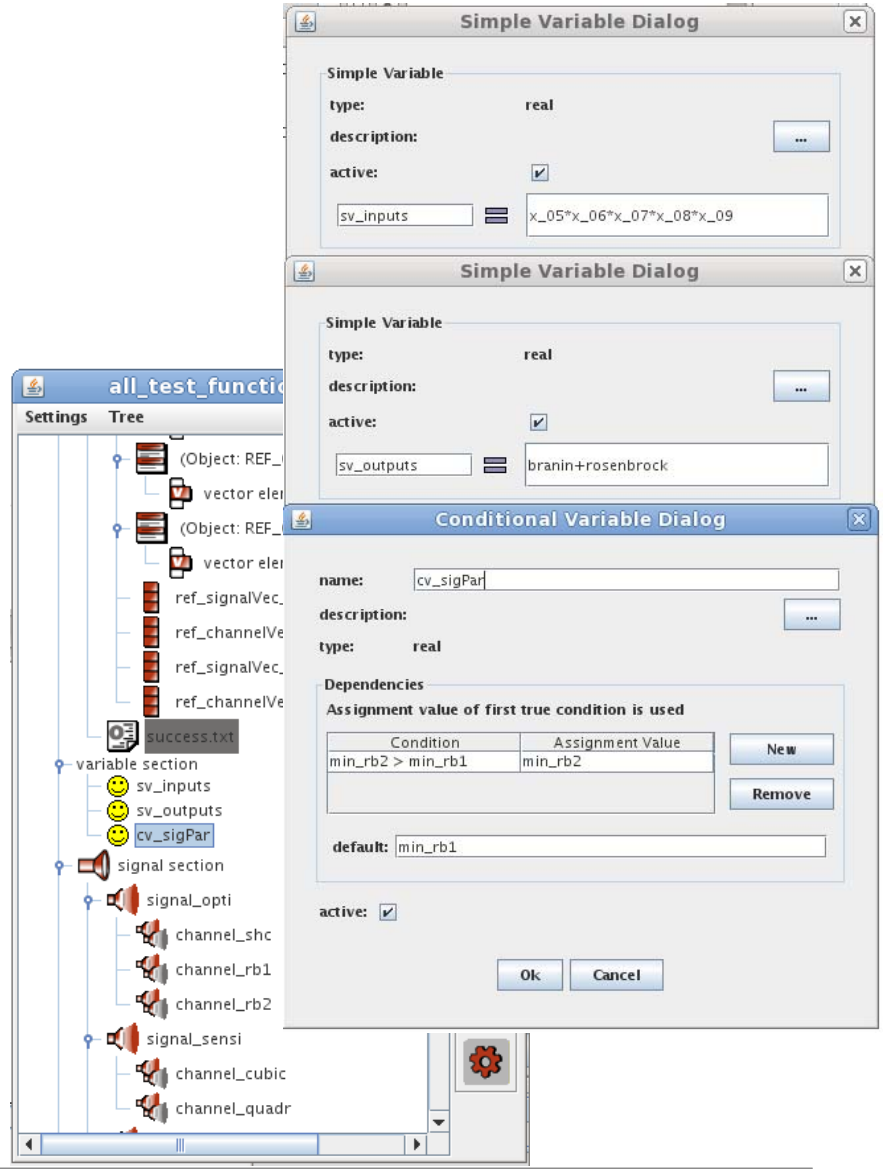
New: only numbers are considered and automatically identified



# Pre Processing

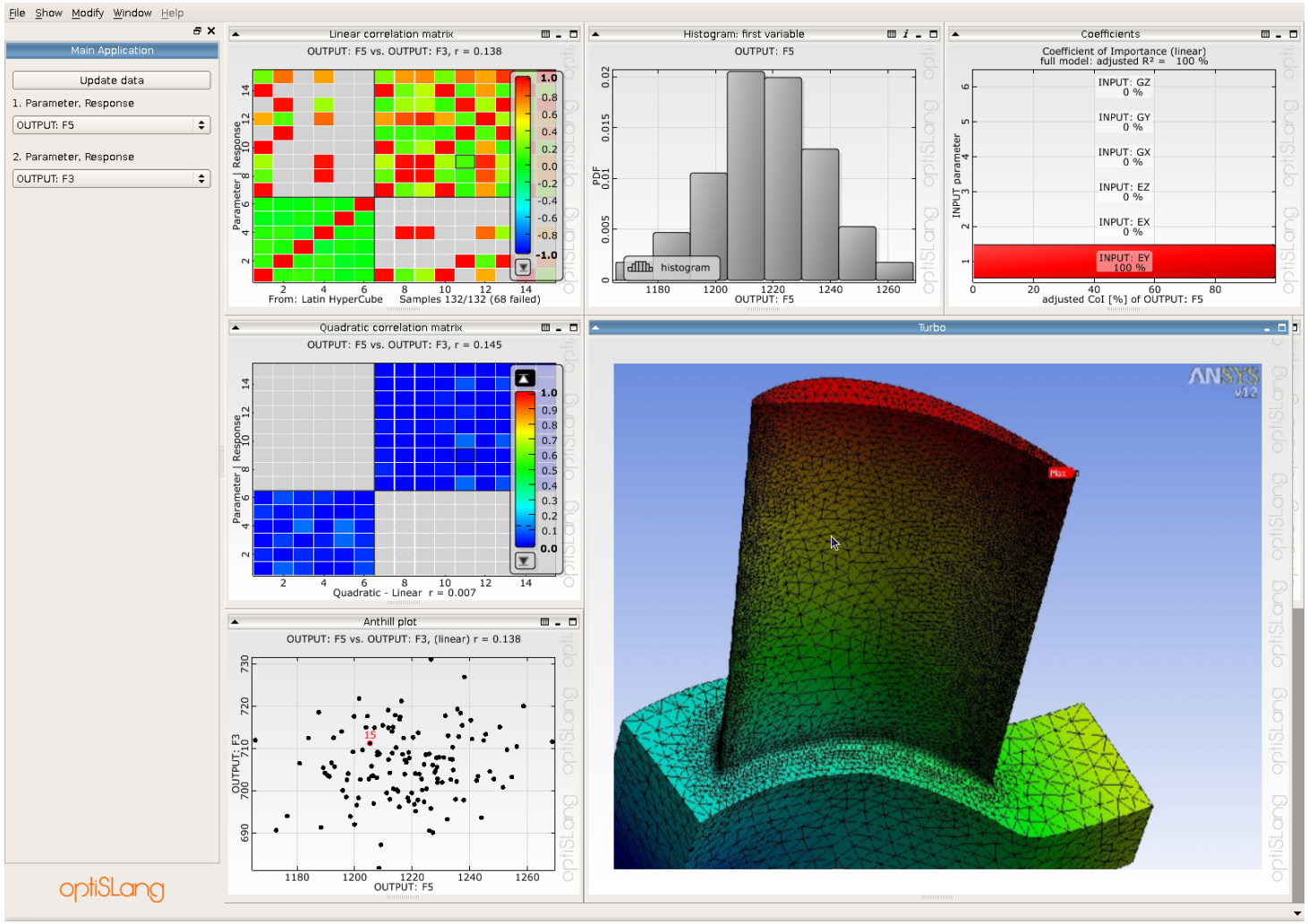
## Support of free variables

- The variable section within the parameter editor allows the definition of free variables
- simple variables can be defined by formulas, conditional variables by restrictions
- inputs, dependent input, output and signal parameters can be included.
- this can be useful for defining constraints, objectives and limit state functions.



# Post Processing

- add Image Plot Window to post processing




Supported formats:

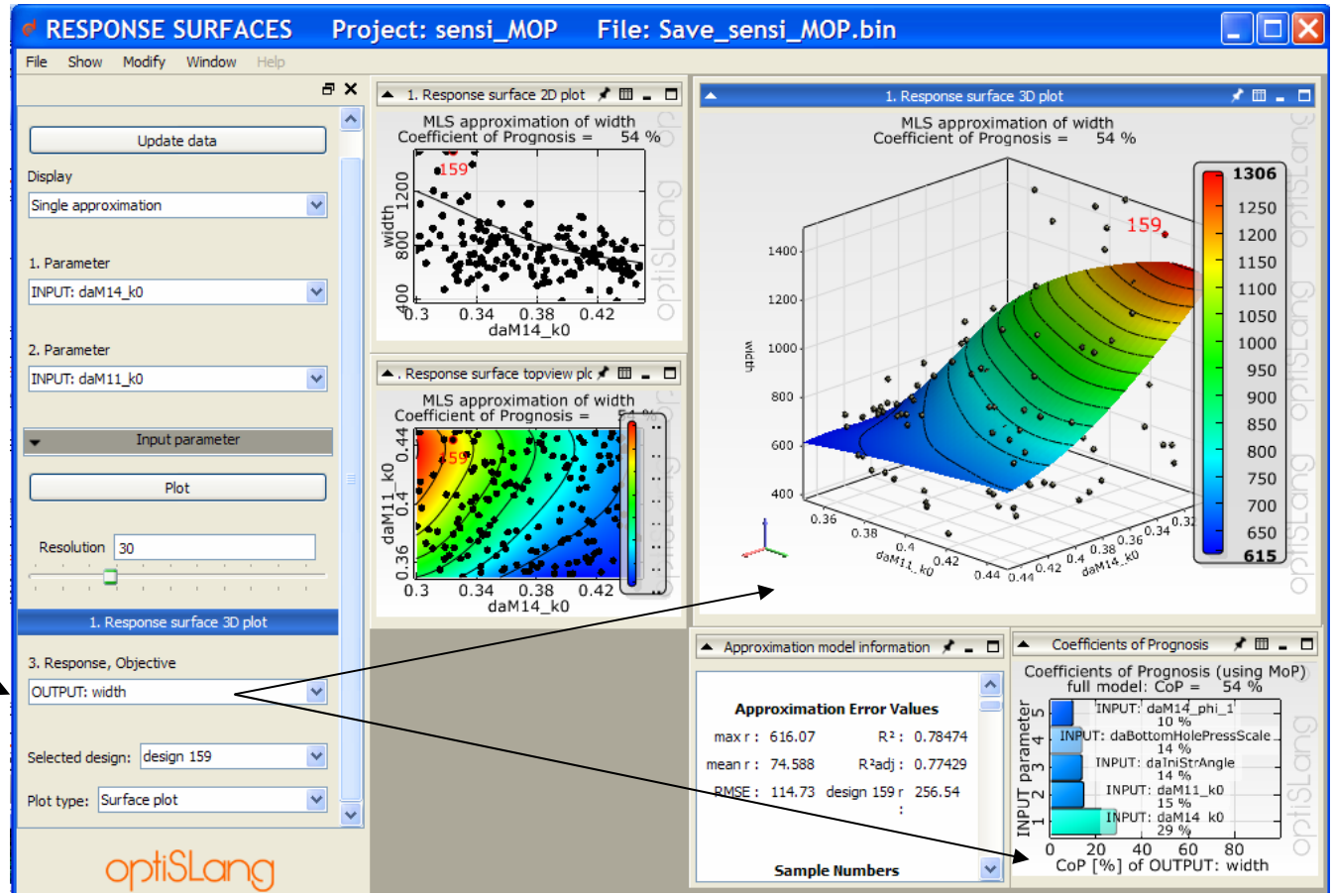
BMP
GIF
JPG
JPEG
PNG
PBM
PGM
PPM
TIFF
XBM
XPM

# Post Processing

- Improved approximation post processing mode for CoP/MoP

-CoP Plot now available at approximation post processing

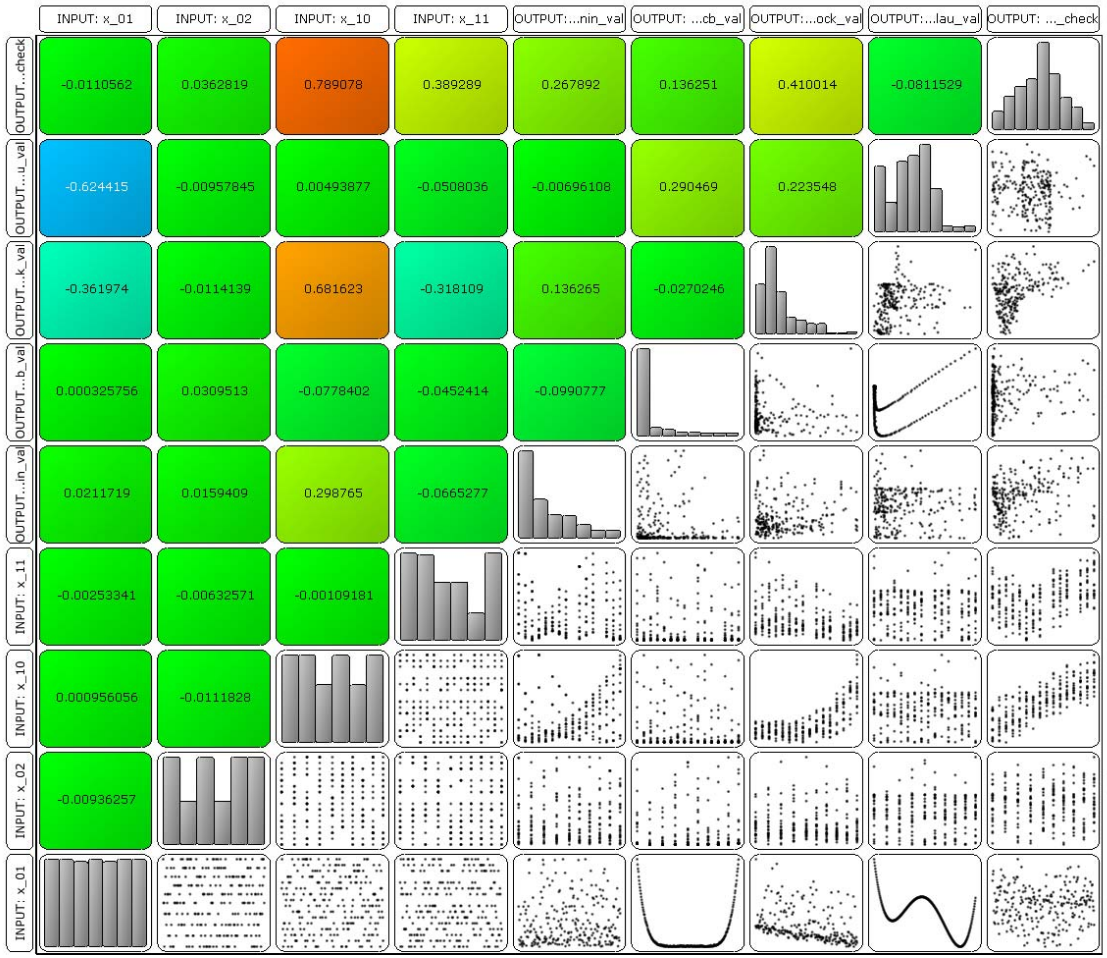
- with selection of the response CoP and MoP plot of the two most important variables are automatically updated



# Post Processing

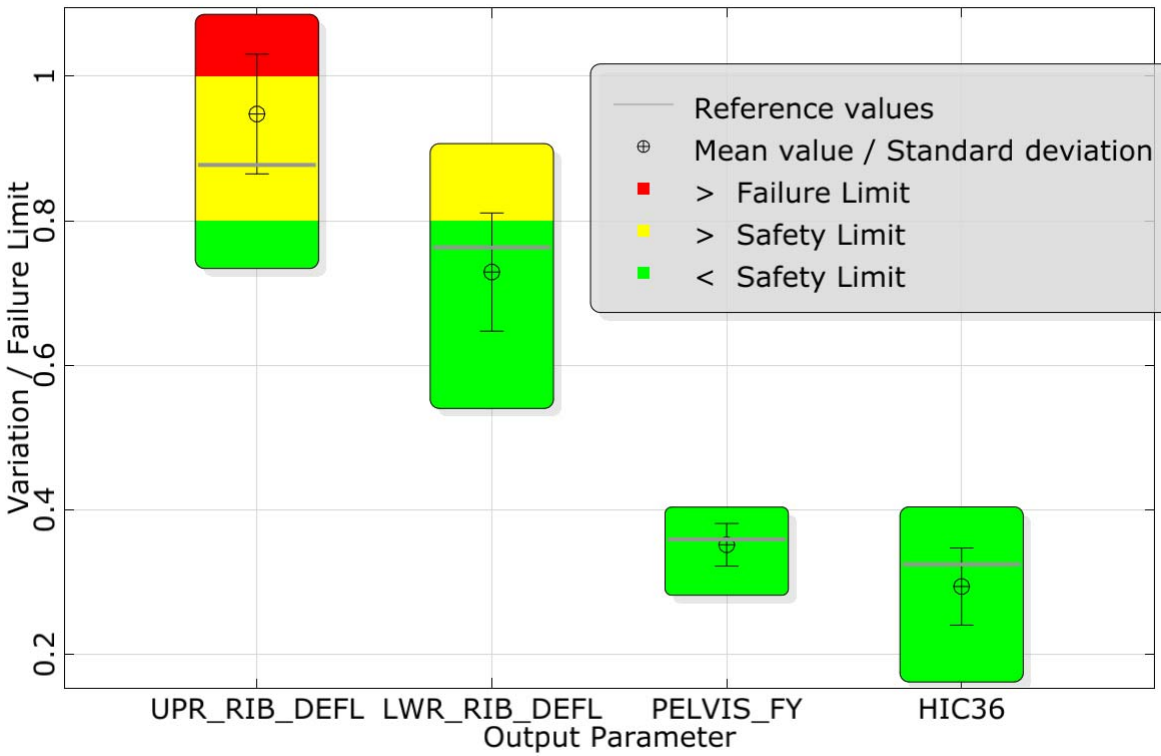
- Extended Correlation Matrix

- The matrix provides a overview of variation and pairwise linear correlation. The triangle above shows linear correlation coefficients and the diagonal represents histograms. The lower triangle presents 2d anthil plots for all pair-wise parameter combinations.



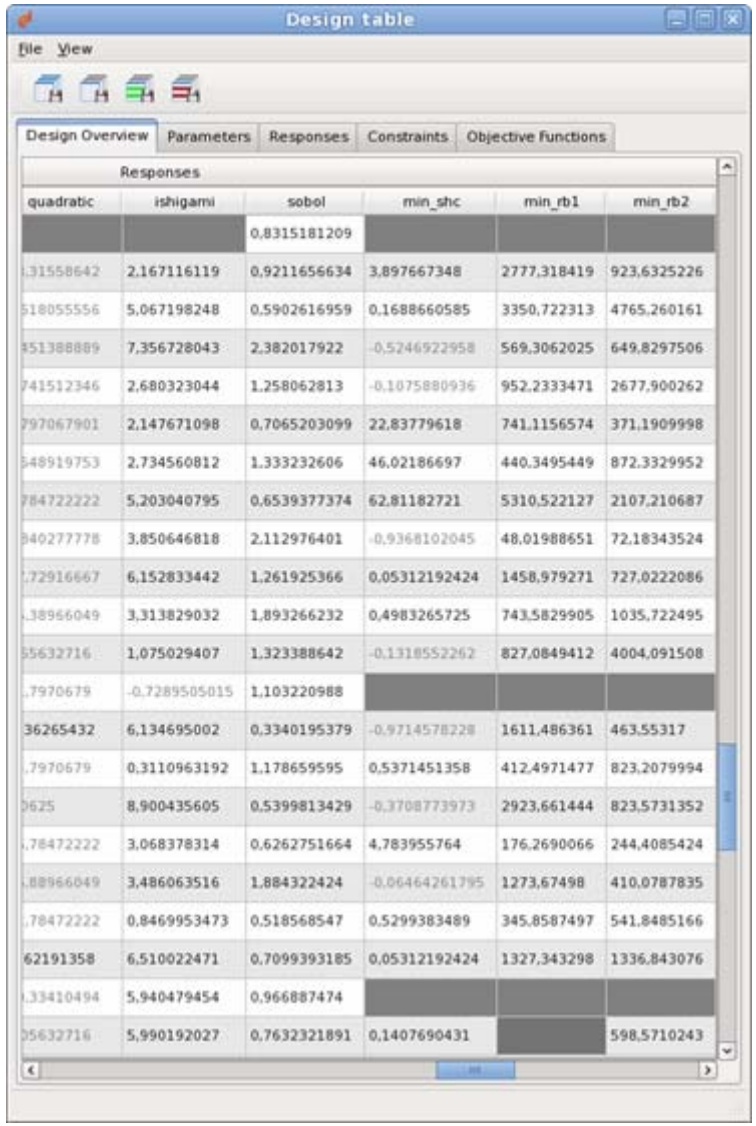
# Post Processing

- Traffic Light Plot
- the traffic light plot may serves as an indicator for safety and failure limit violations
- Mean value, standard deviation included



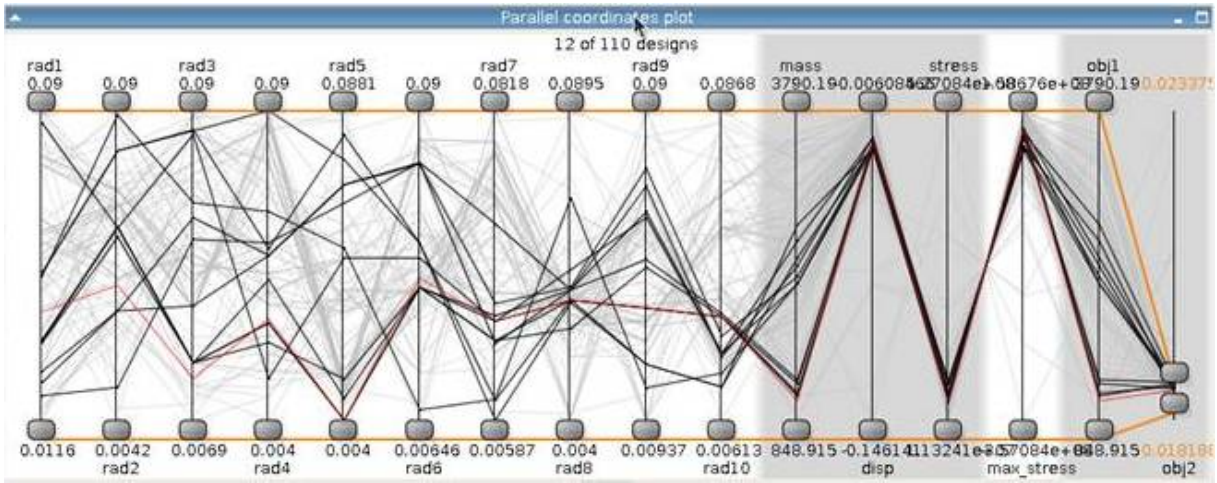
# Post Processing

- support for incomplete designs
- now incomplete designs are written to *bin files and can be used in statistic post processing
- NaN values are filtered out for statistical evaluation



# Post Processing

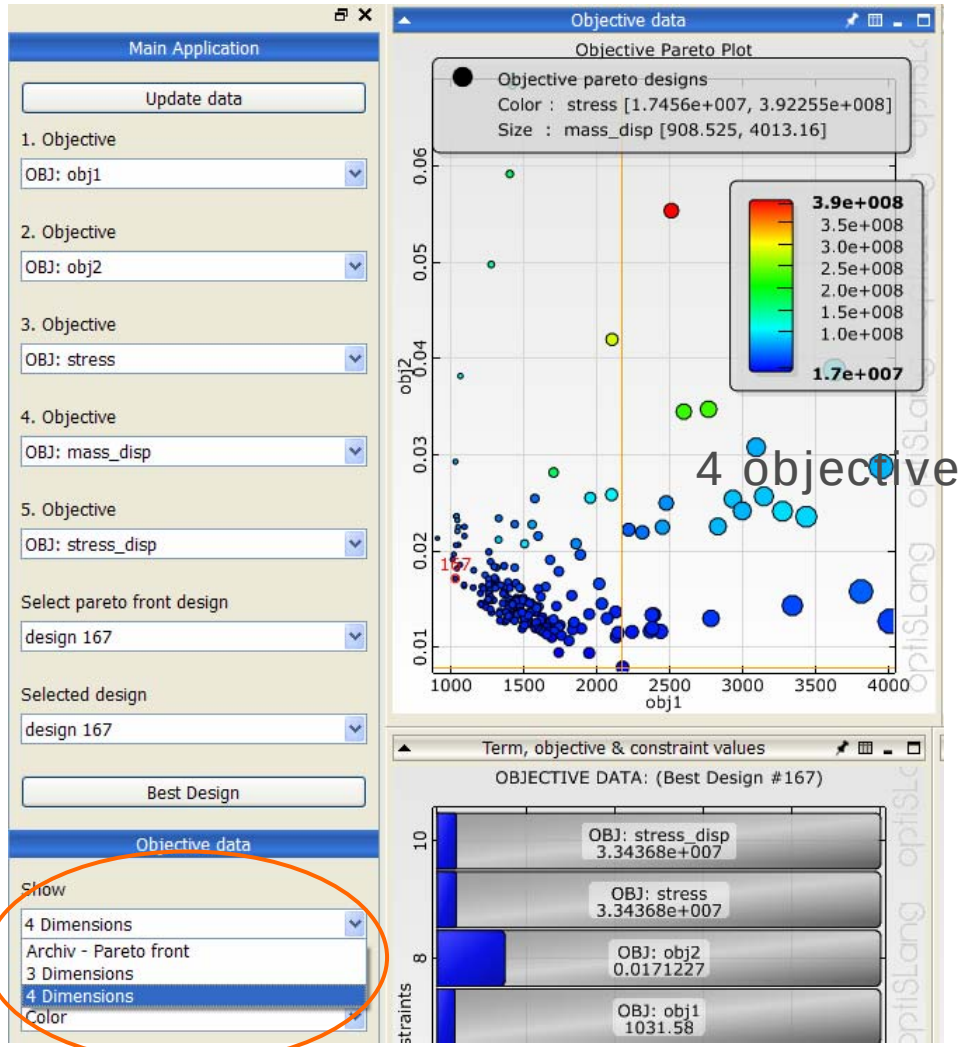
- Parallel Coordinate Plot and Control



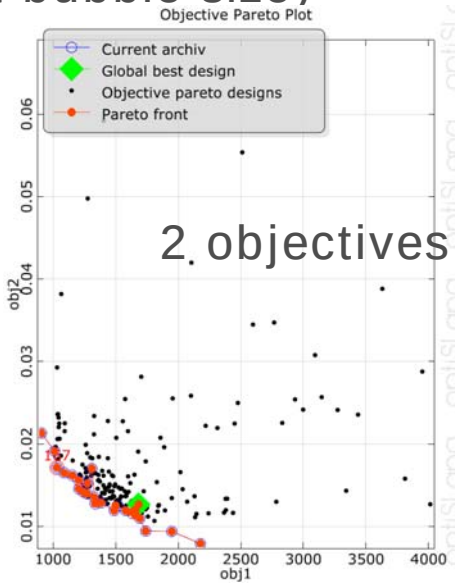

New: single Parameter, Responses, Constraints, Terms and objectives can be removed from the Window

# Post Processing

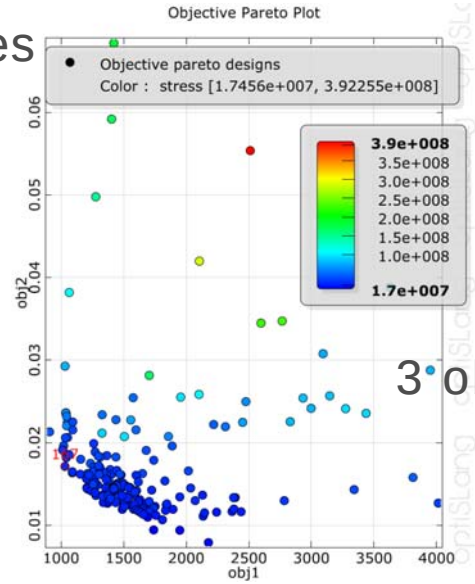
- 4 (2+2) and 5 (3+2) dimensional Pareto Plot (colour & bubble size)




4 objectives




2 objectives




3 objectives

# Coefficient of Prognosis (CoP) & Metamodel of best Prognosis (MoP)

# Definition - Coefficient of Prognosis

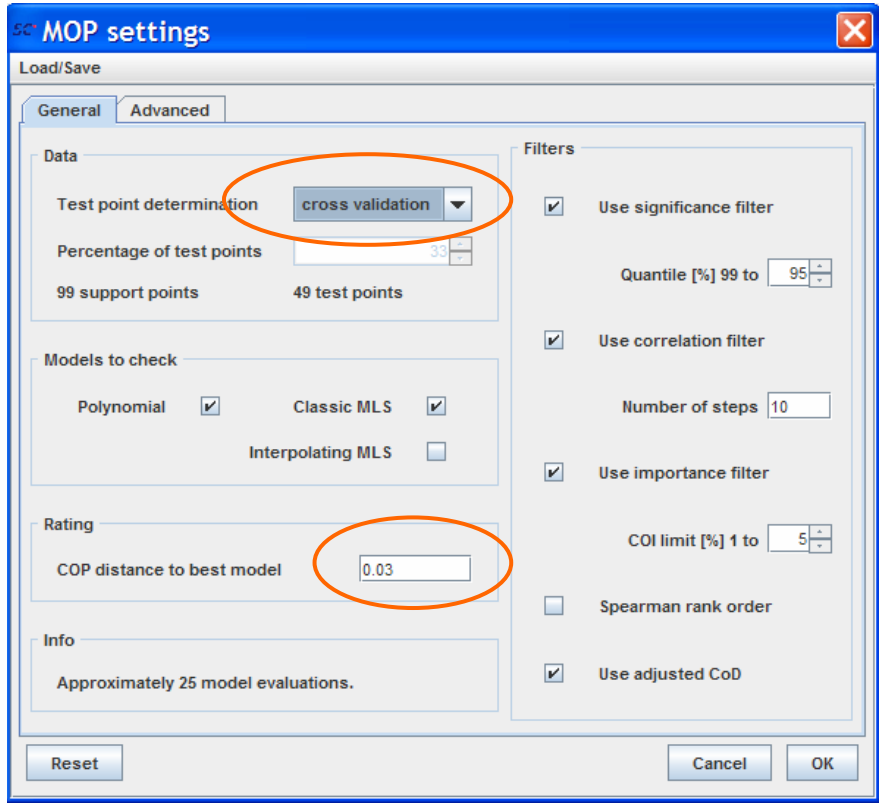
- What proportion of the variation of a response can be forecasted with identified arbitrary non-linear correlations to the input parameters?

CoP has three benefits

- we reduce the variable space with different filter = best subspace
- we check multiple correlation = best regression
-we split the sample set and check the forecast (prognosis) quality

New: version 3.2

- Cross validation
- iterative variable reduction and model complexity reduction
- improved variance based sensitivity indices for importance measurement (CoI/CoP)



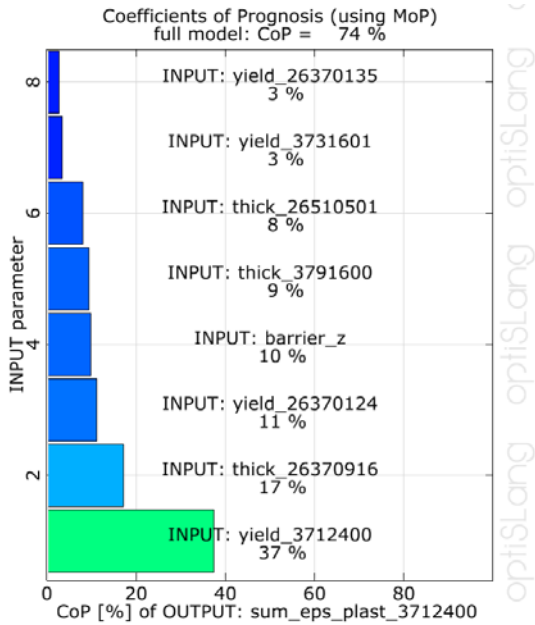
# Strategy “No Run to Much”

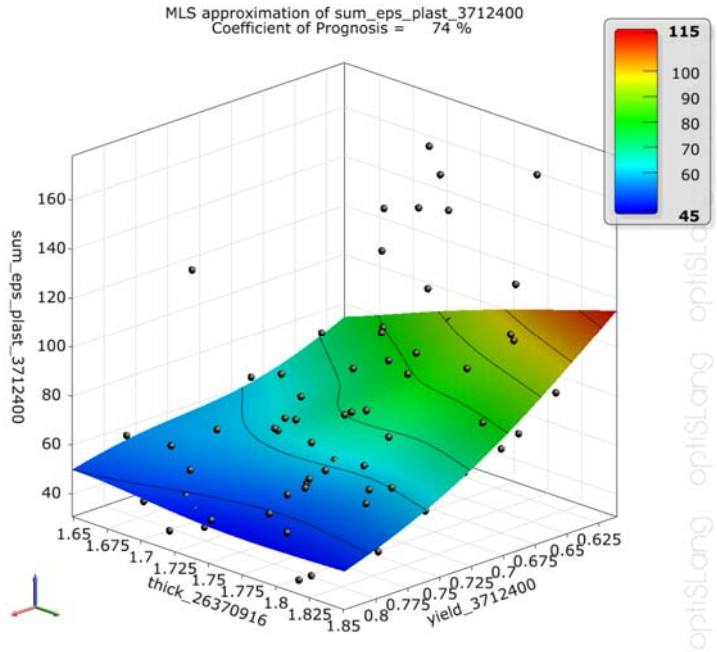
Using advanced LHS sampling, significance filter technology and forecast quality (CoP) we can check after ≈ 50 runs

⇒ can we explain the variation?

⇒ which input scatter is important?

⇒ how large is the amount of unexplainable scatter? (potentially noise, response extraction related or higher order non linearity)



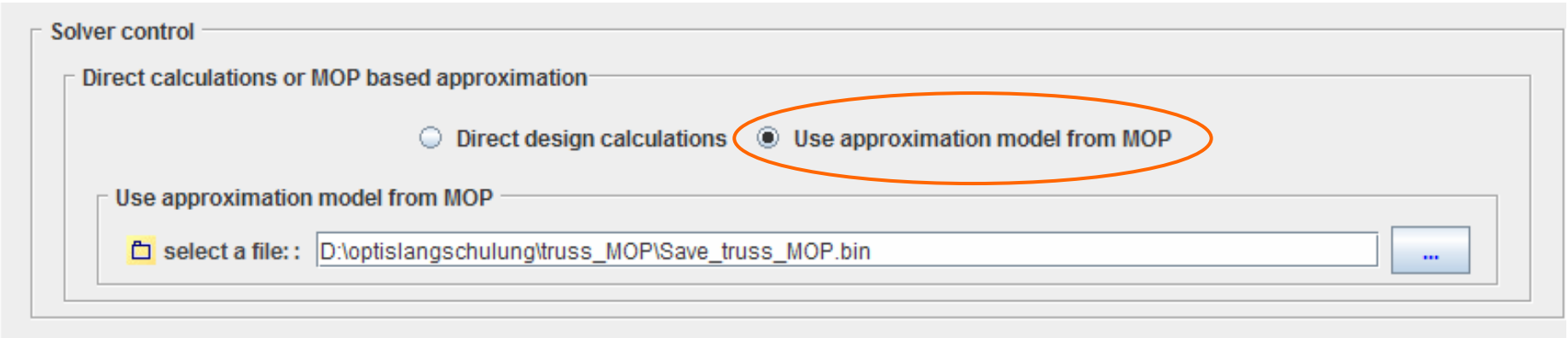
# MoP as solver

MoP's can now be used at optiSLang flows to replace external solver.

- Optimizer (Gradient, NOA [GA, ES, PSO], Pareto)
- Robust Design Optimization

- Sensitivity (DOE) and Robustness
- Reliability Analysis

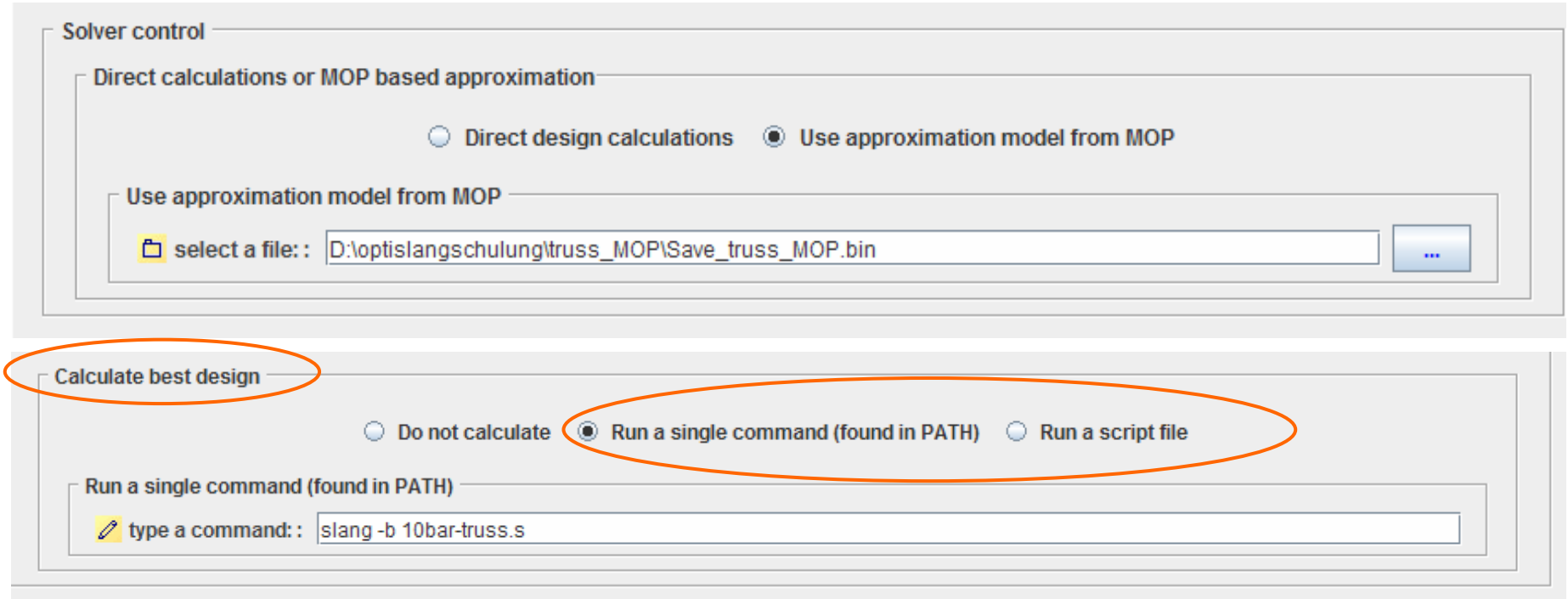
(Attention: There is no optimal design which can be checked in real space)



# Check optima at RSM/MOP

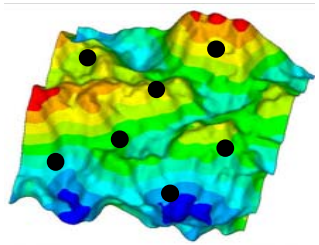
It is recommended to check the optima found at approximations (RSM or MOP) with solver run in real space!

That functionality is available in all flows with RSM/MOP. Post Processing will show the difference between optimal design at approximation and real space.

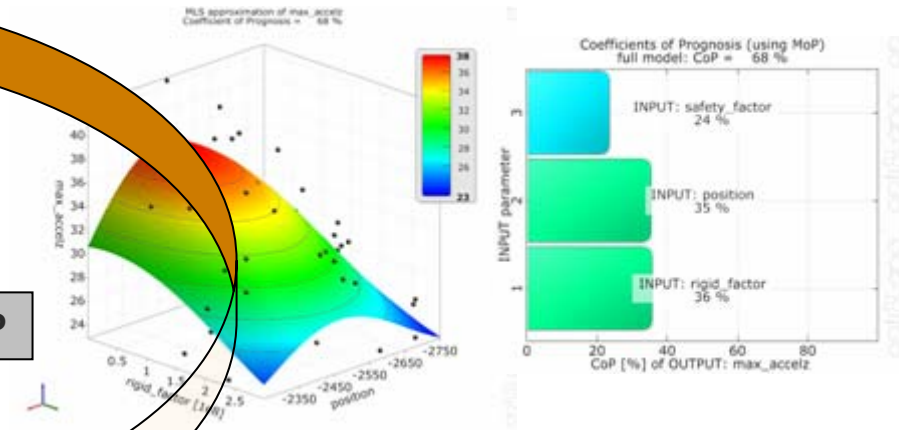


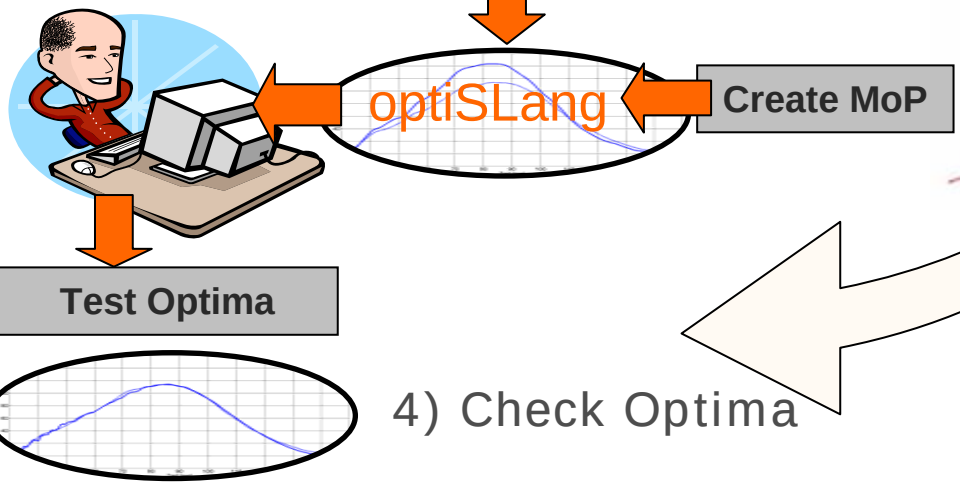
# From best practice to black box

1) Start with sensitivity study using LHS Sampling



2) Automatic search for the meta model of best prognosis at best sub space using the best meta model and checking the prognosis quality




3) Run Optimization at MOP

4) Check Optima

Goal: User friendly effective procedure using black box algorithm

# News on Optimization within optiSLang 3.2

Ease of use for Nature-inspired optimization algorithms (NOA)!

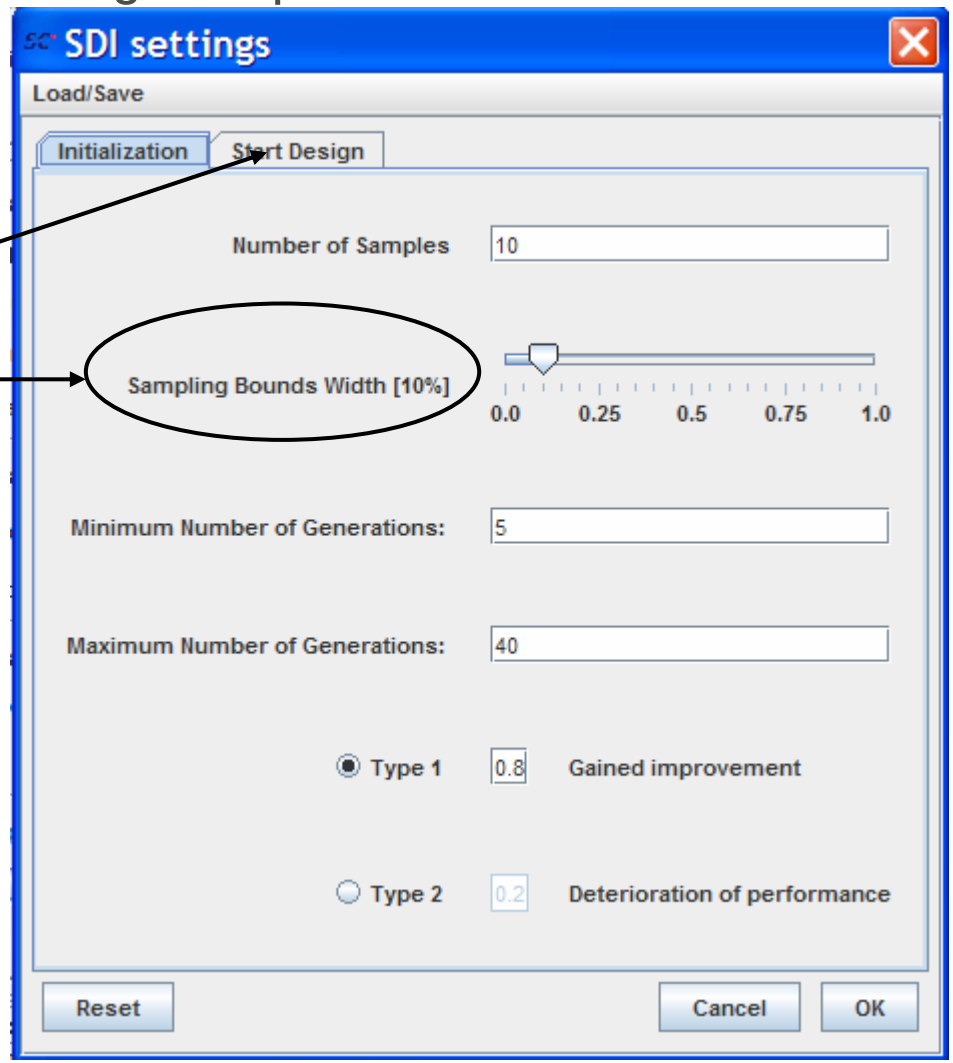
# Simple Design Improvement (SDI)

SDI also known as “Stochastic Design Improvement” was used in STORM for optimization

- former Storm user wanted to have that extremely simple to use strategy (only one start design is necessary input)
- basically a cloud of certain size are moved in the designs space

- SDI shows usually improvement in the first (5) iteration steps before improvement slows down

– main mechanism of the algorithm is the move of cloud center point

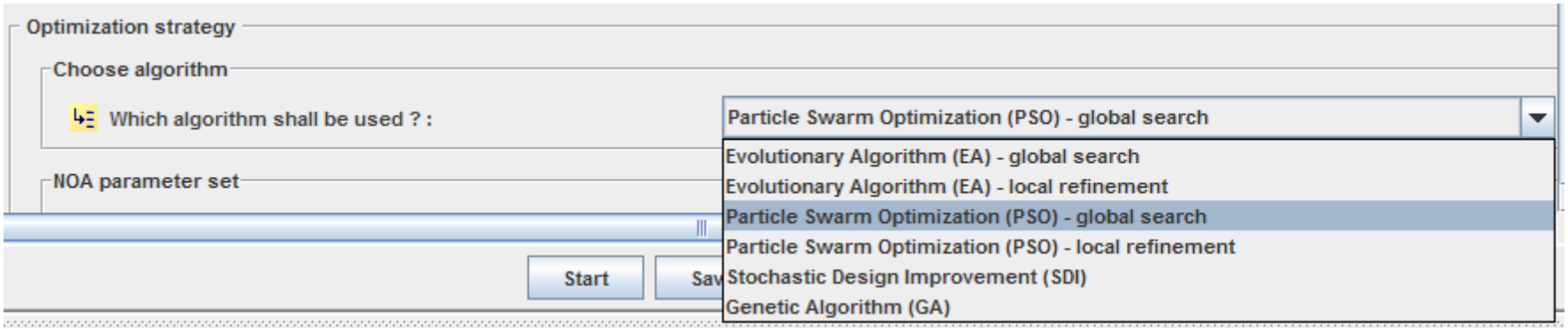


# NOA Wizard

Wizards help to select the appropriate single objective NOA

- First step in v3.2: wizard for Nature-inspired Optimization Algorithms unify 3 optiSLang flows
  - GA Flow
  - EA Flow with local improvement (ES) and global search (GA)
  - PSO Flow with local improvement, global search

  (Attention: see manual for decision tree)
- Next Step in 4.0: decision tree included in wizard



# Improved Mutation Strategies

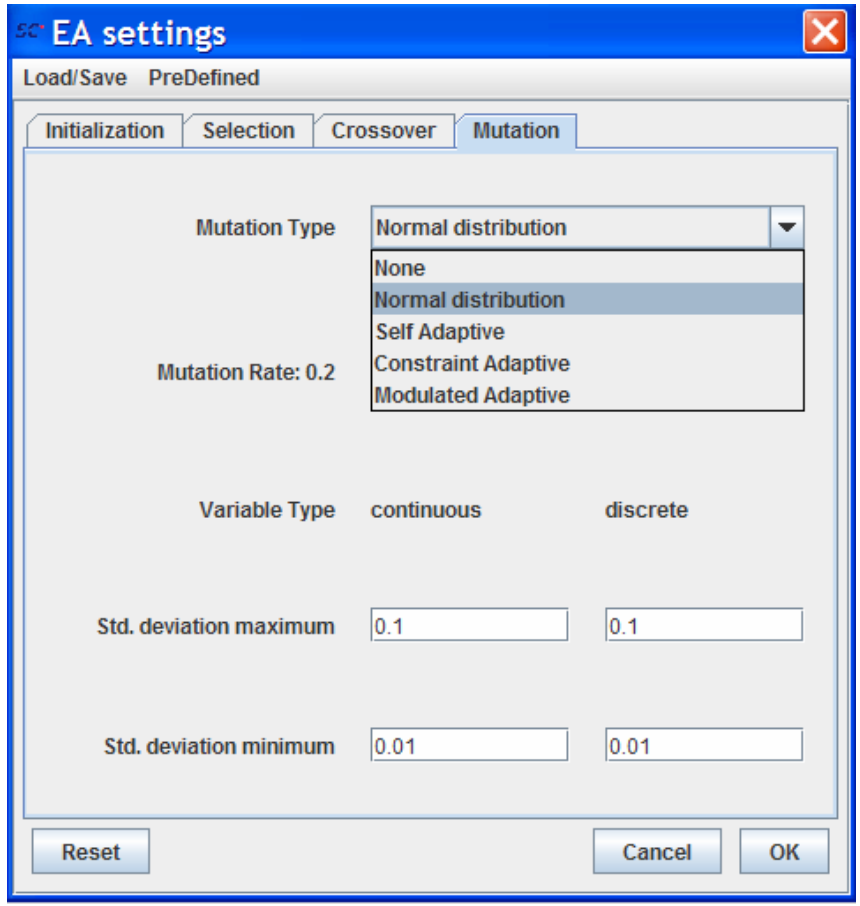
Available for single objective EA and PSO Algorithms


New:

- first choice: Self Adaptive (Bäck) = modifies mutation for single input variables

- Constraint Adaptive = decrease mutation of mutated variables which lead to constraint violation

- Modulated Adaptive = modifies distribution function due to successful mutations

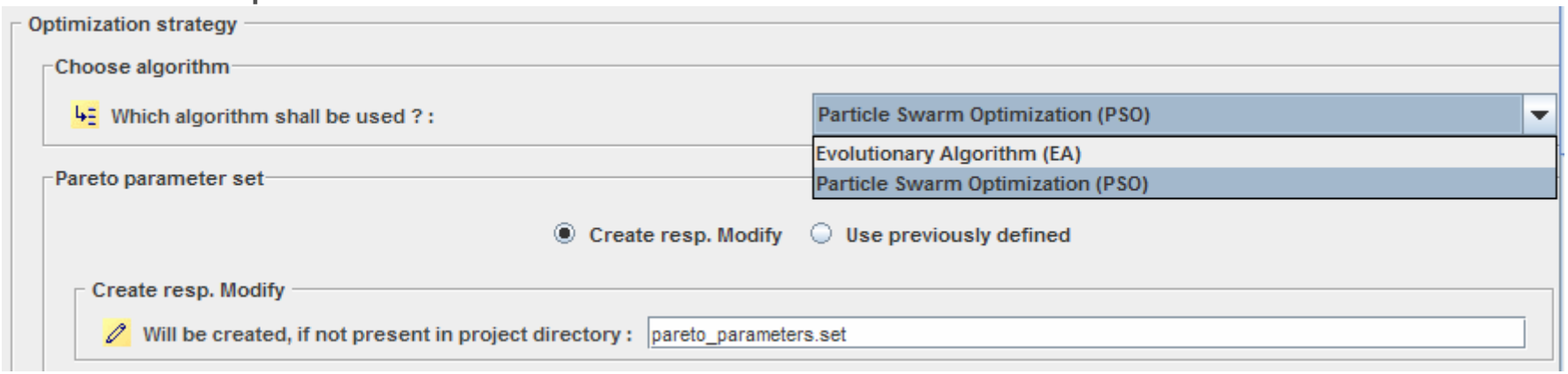


# Pareto Wizard

Wizards help to select the appropriate Pareto optimization algorithm

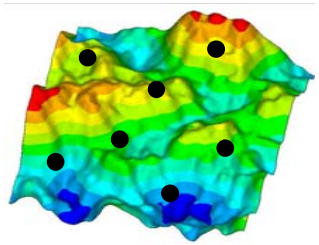
- First step in v3.2: wizard for Nature-inspired Pareto optimization algorithms unify 2 optiSLang flows
  - Pareto (SPEA2) optimization flow
  - Pareto capability of PSO Flow

  (Attention: see manual for decision tree)
- Next Step in 4.0: decision tree included in wizard

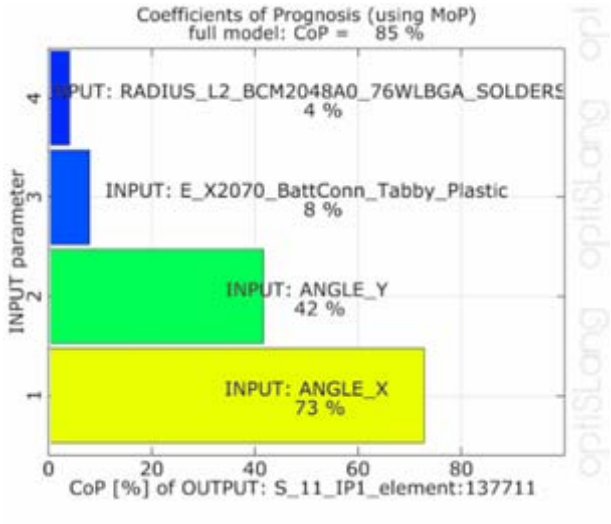


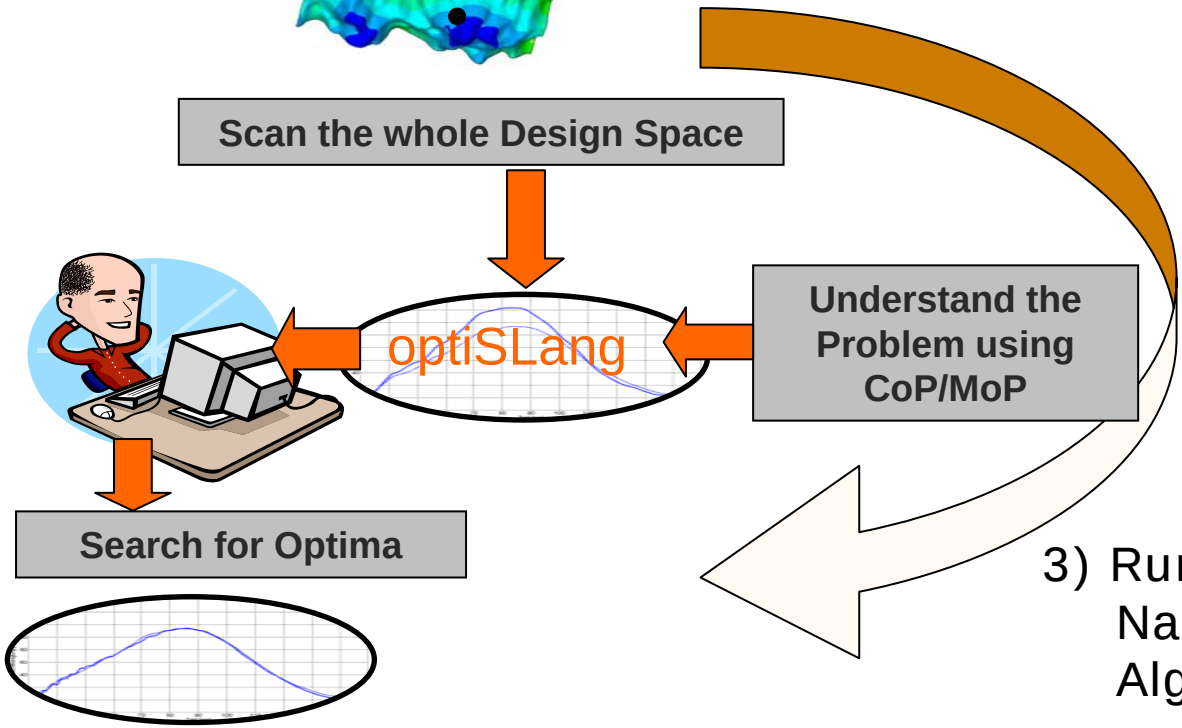
# Sensitivity Analysis and Optimization

1) Start with a sensitivity study using the LHS Sampling



2) Identify the important parameters and responses
- understand the problem
- use MOP for optima search



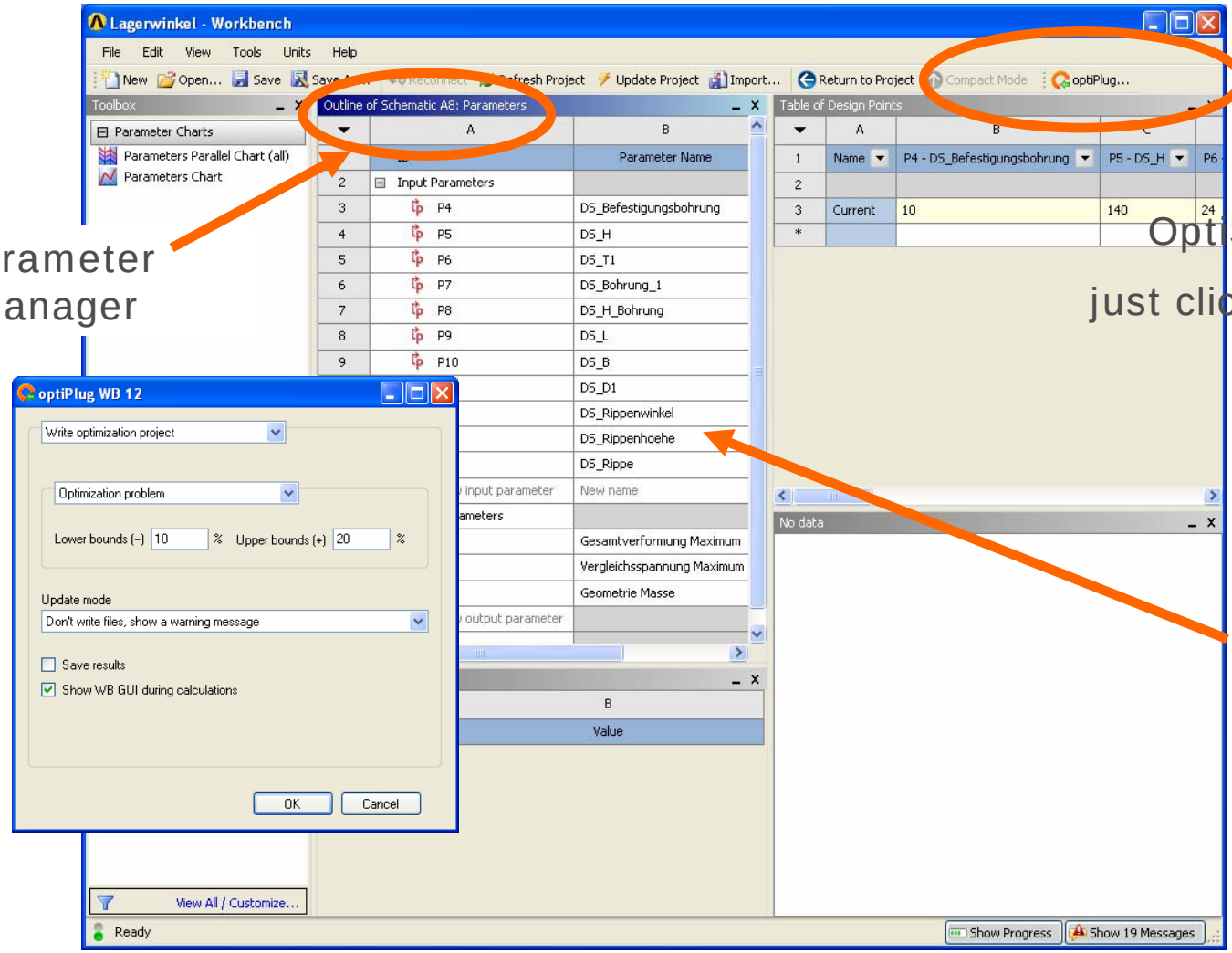

3) Run ARSM, gradient based or Nature-inspired Optimization Algorithms

4) Goal: user-friendly procedure needs as much automatism as possible

# optiSLang Integration Environment

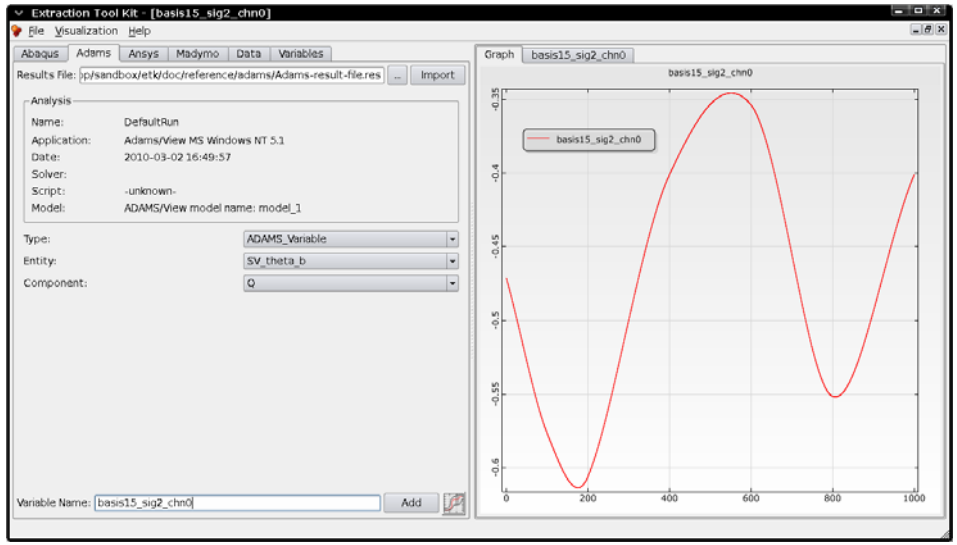
optiPlug
SoS - Statistics on Structure
ETK - Extraction Tool Kit

# ANSYS Workbench v12 optiSLang Interface



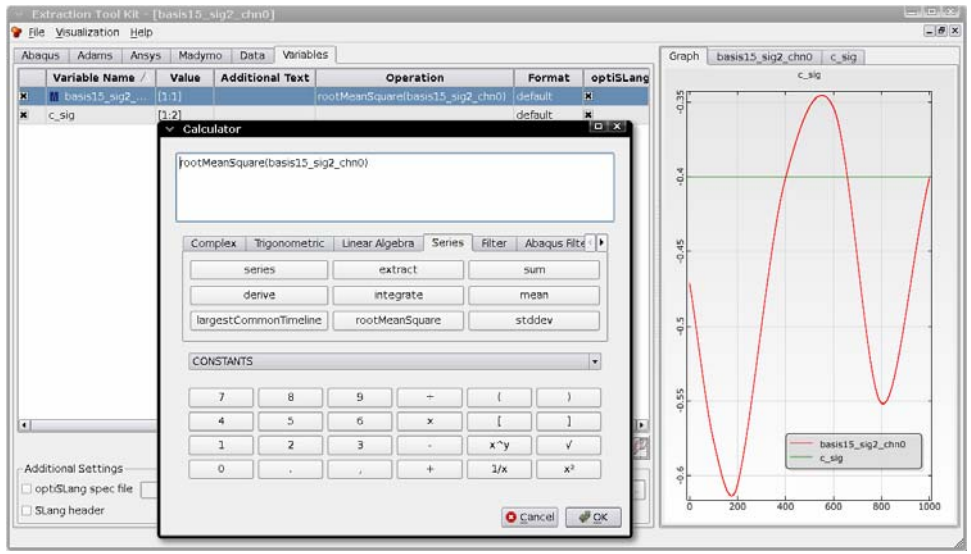
# Extraction Tool Kit

- Extraction toolkit to replace the scripting for result extraction and processing for ABAQUS, ADAMS, ANSYS & MADYMO




- Extraction
  - Single Value, vector, matrix, tensor

- Definition of free variables
- Processing
  - Mean value, MIN/MAX
  - Standard deviation, Integral
  - Improved Signal processing
  - Improved mathematics




- Batch execution mode
- Creates optiSLang *.pro file
- Available on Windows/Linux

# Why SoS and what is SoS ?

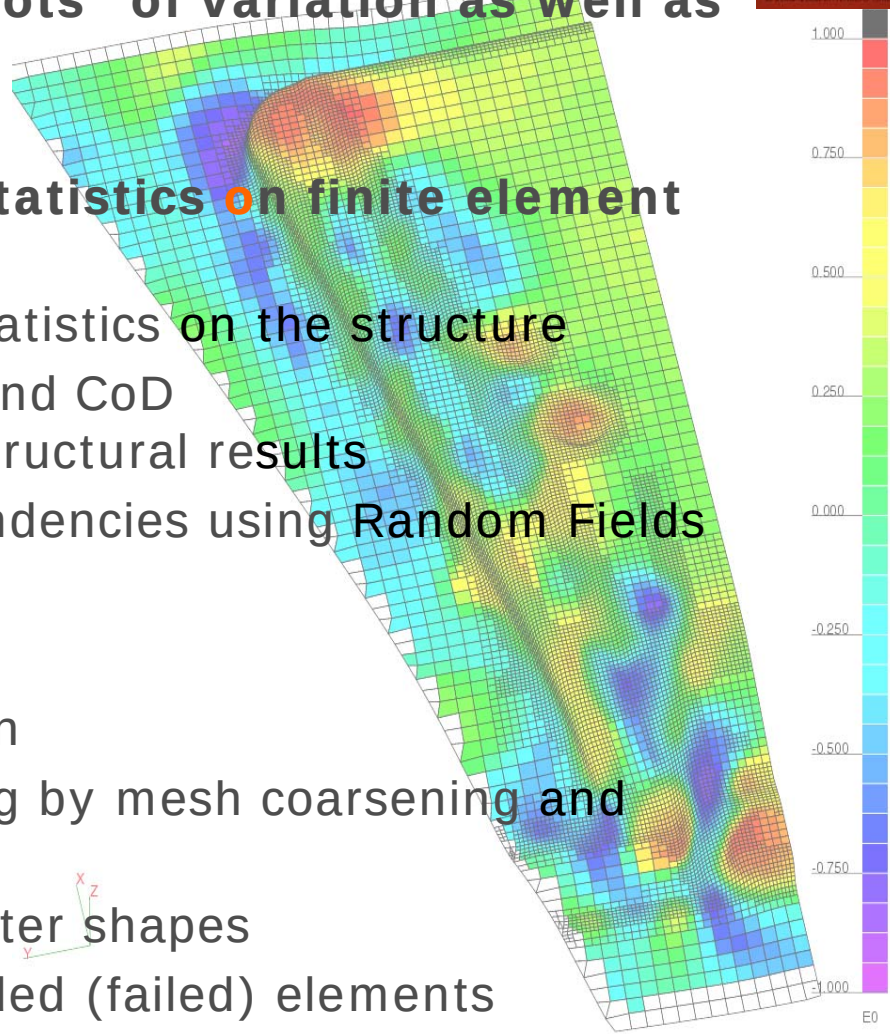

**Why: Engineers need to evaluate statistical data on the structure to locate „hot spots“ of variation as well as investigate correlations**

**What: A post processor for Statistics on finite element Structures**

- Visualization of descriptive statistics on the structure
- Visualization of correlations and CoD between random input and structural results
- Identification of spatial dependencies using Random Fields

**Key features**:

- Locate „hot spots“ of variation
- Data reduction and smoothing by mesh coarsening and random field projection
- Identification of relevant scatter shapes
- Visualization statistics of eroded (failed) elements



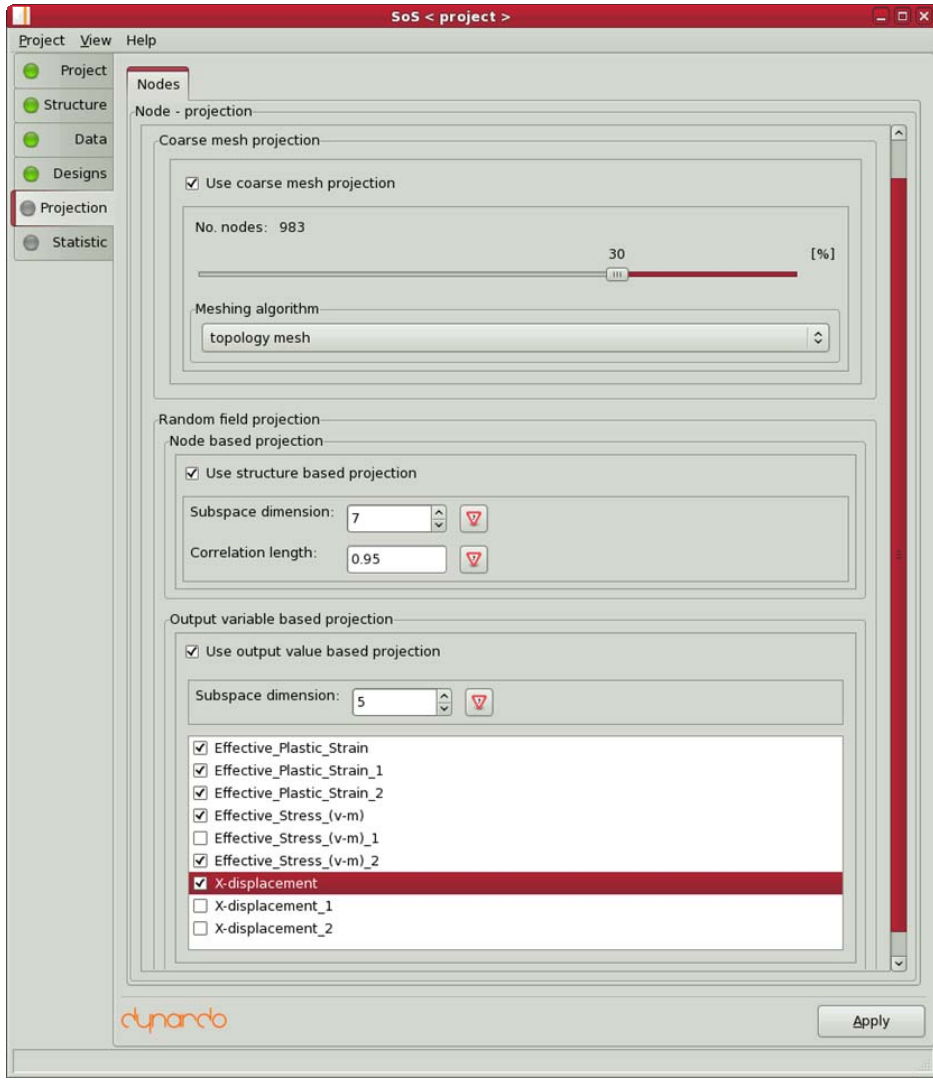
# SoS v2.3 – Developments new version

Interfacing

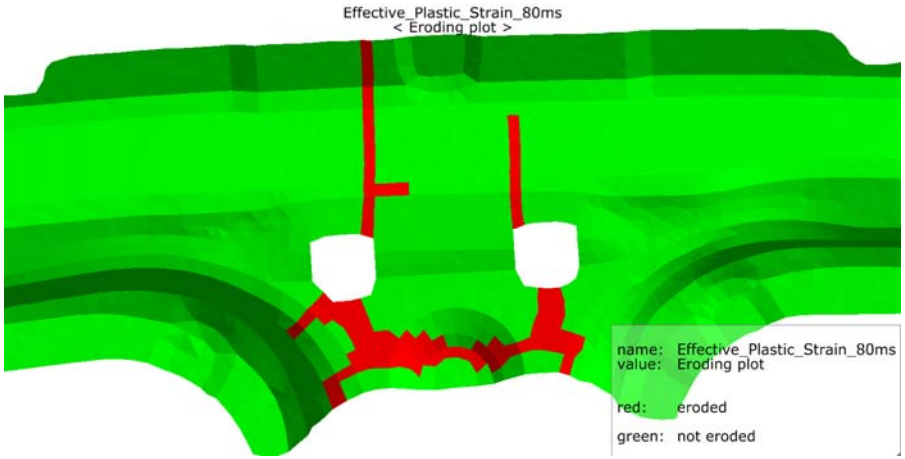
- ABAQUS (odb)
- Flexible user interface for other ASCII based Formats

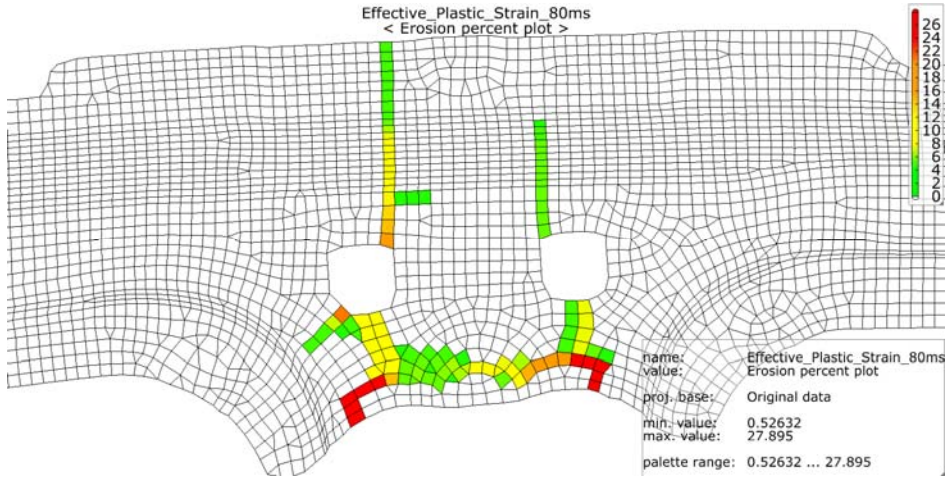
Statistical processing

- Handling of element eroding
- Mesh coarsening (uniform and topology)
- Result based generation of Random Fields
- Visualization of Random Fields (Modes) with Significance (variability)



# SoS - Eroding elements



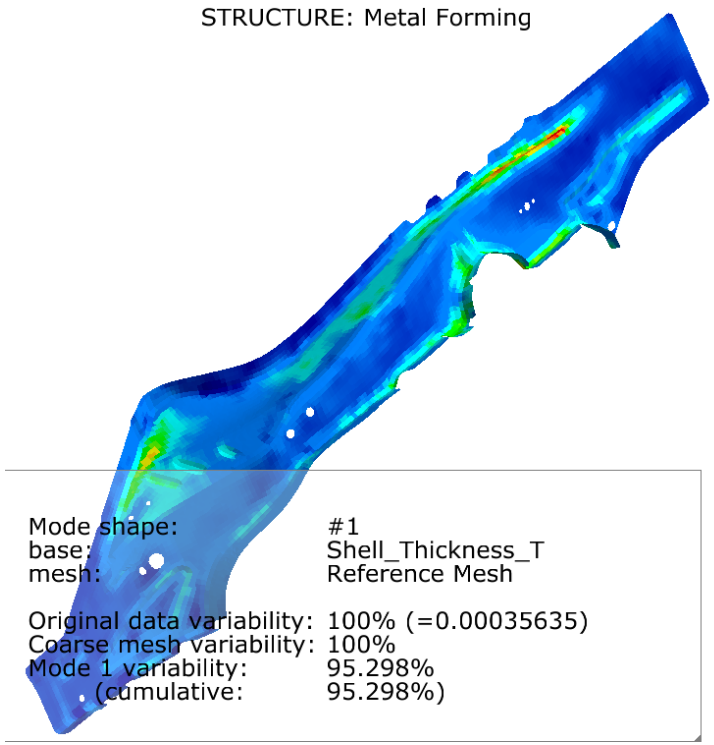

General eroding information.
Green area: no elements eroded.
Red area: there were eroded elements.

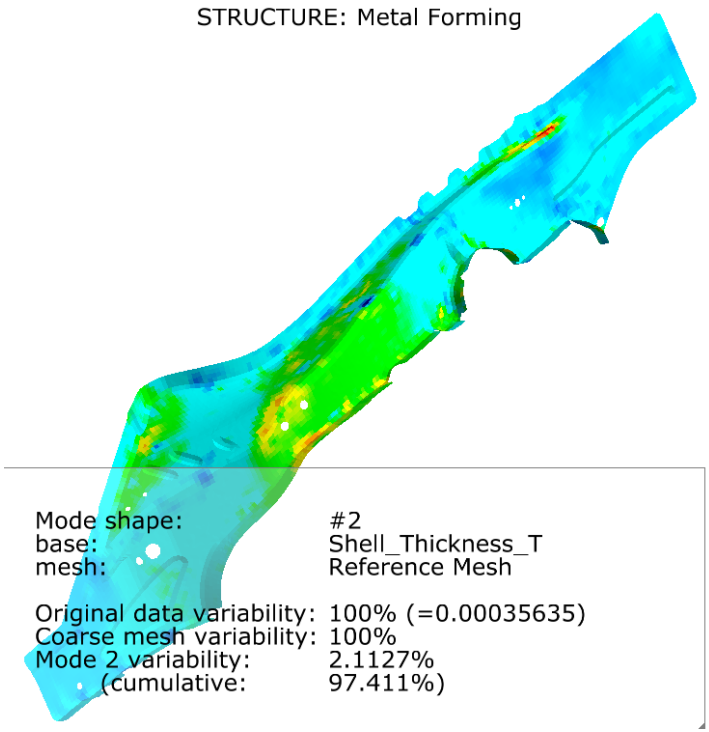
Eroding percent plot shows the percentage of eroded elements.

# SoS - Random Fields

New: output variable based projection

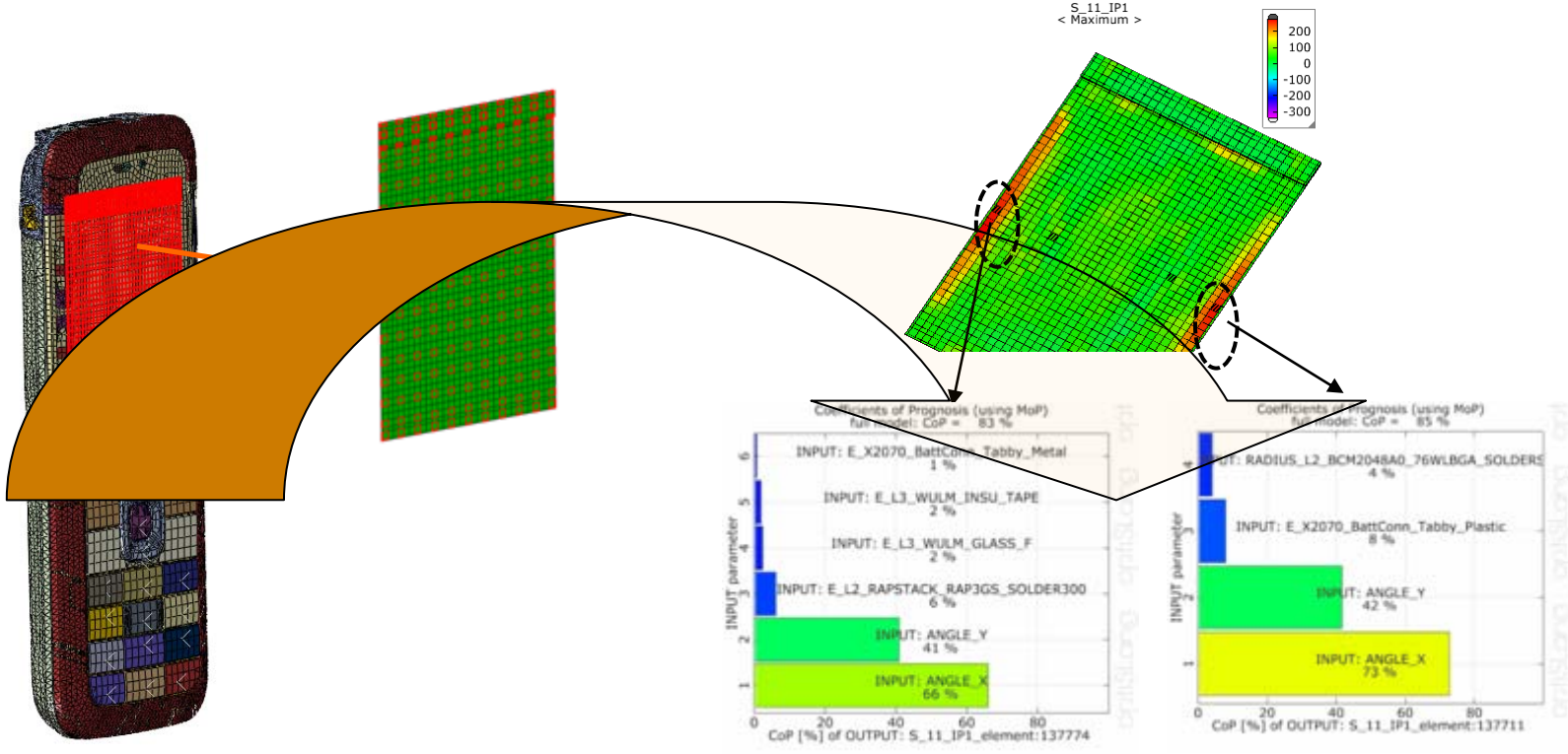
New: Visualization of single mode shapes including significance index [how much variation the mode contains].



# SoS - Applications

- use SoS for robustness evaluation of forming processes
- use SoS for visualization and hot spot investigation at robustness evaluations in crashworthiness or drop test applications




by courtesy of NOKIA

- use SoS for the identification of random fields from simulation or measurements