WHAT IS BARRLIER ?

- An environment for virtual RRS testing
- Database management
  - Impactors
  - Test sets (EN1317)
- Design space
  - Automatic LSDYNA input generation
  - Test condition variability
  - RRS parameter variability
    - *Material, thickness*
    - *Geometry*
    - *…*
  - Specific post processing
    - *EN1317 parameters (ASI, THIV, deflection*
    - *Advanced time history analysis*
    - *Advanced statistical analysis*

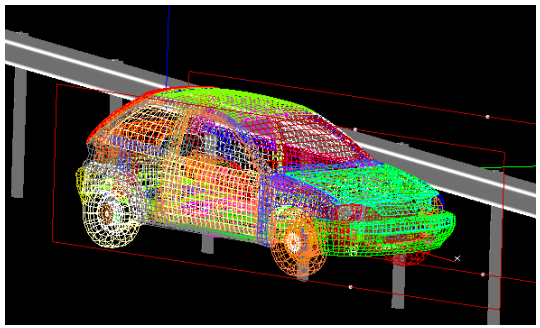
BARRLIER IS AN ENKIDOU® APPLICATION

ENKIDOU: Java-based library for the development of custom software

ANALYSIS

- PARAMETRIC
- TOPOLOGY
- ANALYSIS

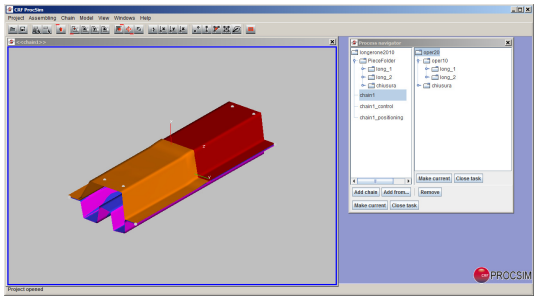
CAE MODEL
EXTERNAL SOLVERS



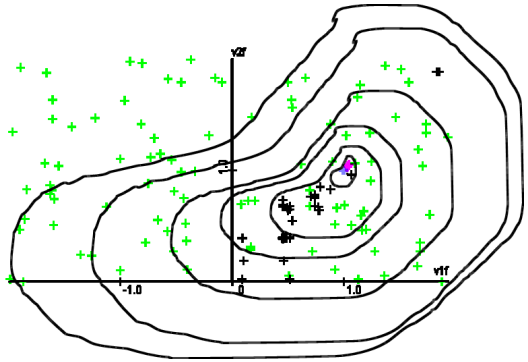
PROCESS
AUTOMATION

OBJECT ORIENTED
DATABASE

OPTIMIZATION
(VARIABILITY)

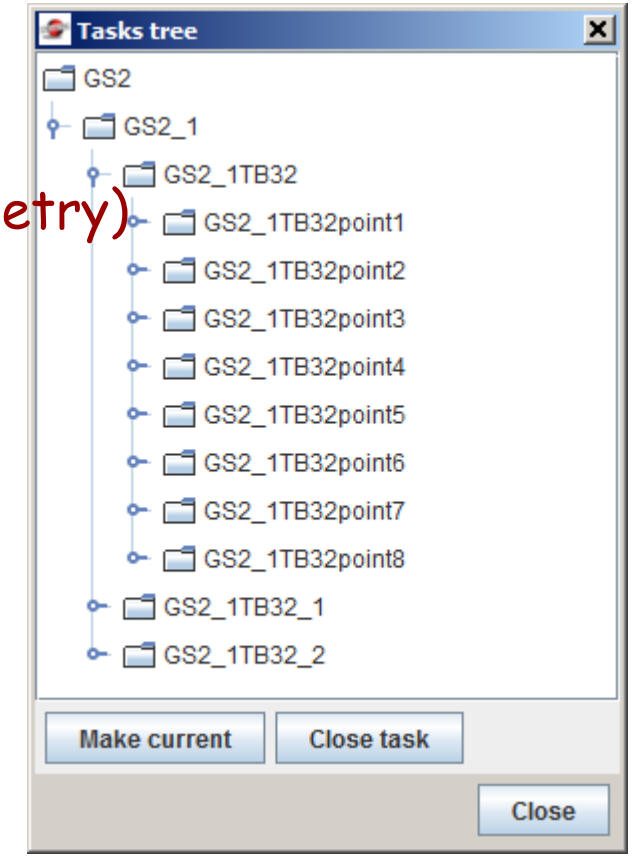


2D – 3D GRAPHICS
GUI

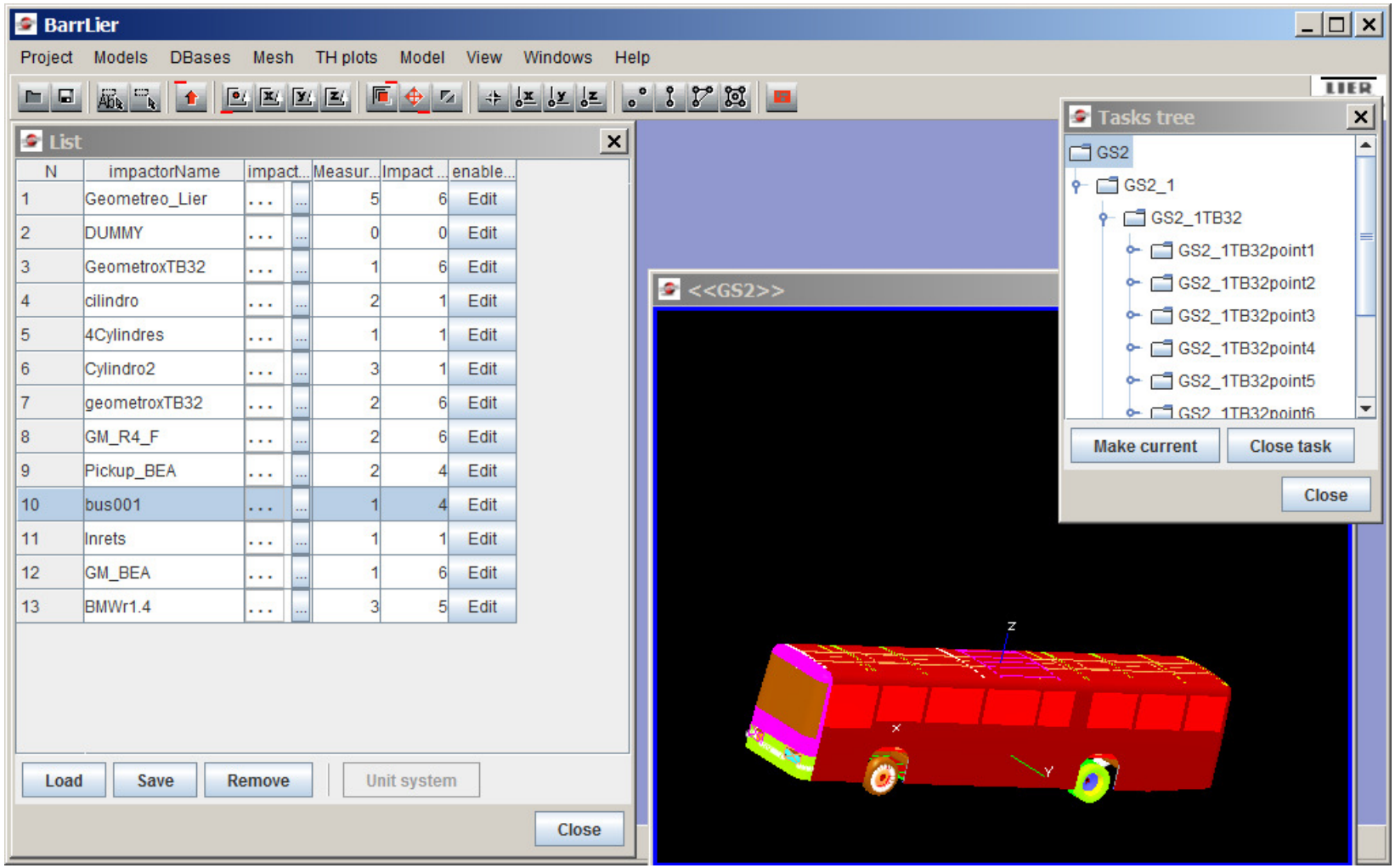


BARRLIER PROJECT TREE STRUCTURE

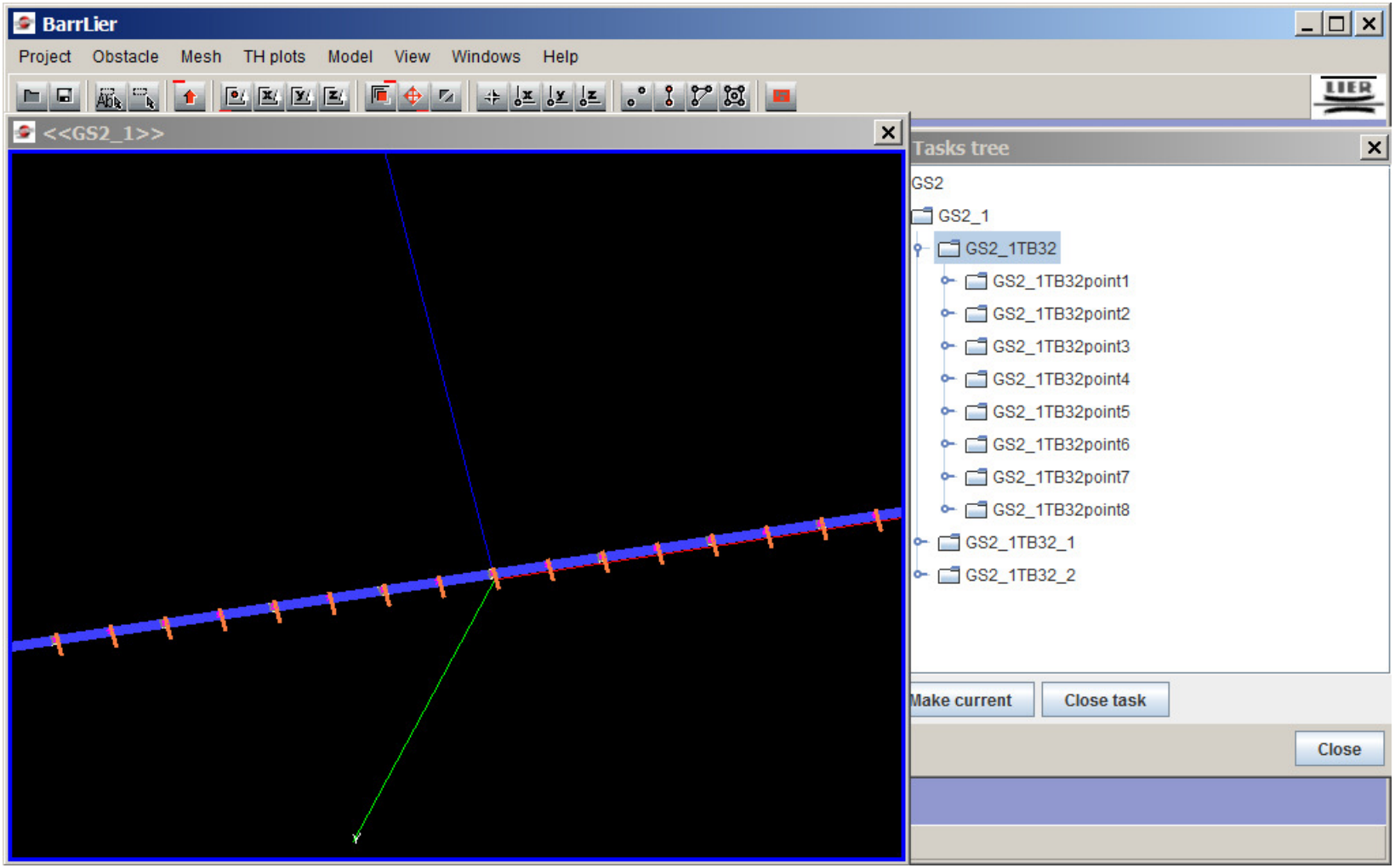
- Project level:
  - database management (impactor, TBs, …)
  - unit system definition
  - barrier input
- Obstacle (barrier) level:
  - barrier modification (e.g. geometry)
  - TB definition
- TestSet level:
  - variability analysis
  - set post processing
  - set statistics
- Shot level: actual crash computation



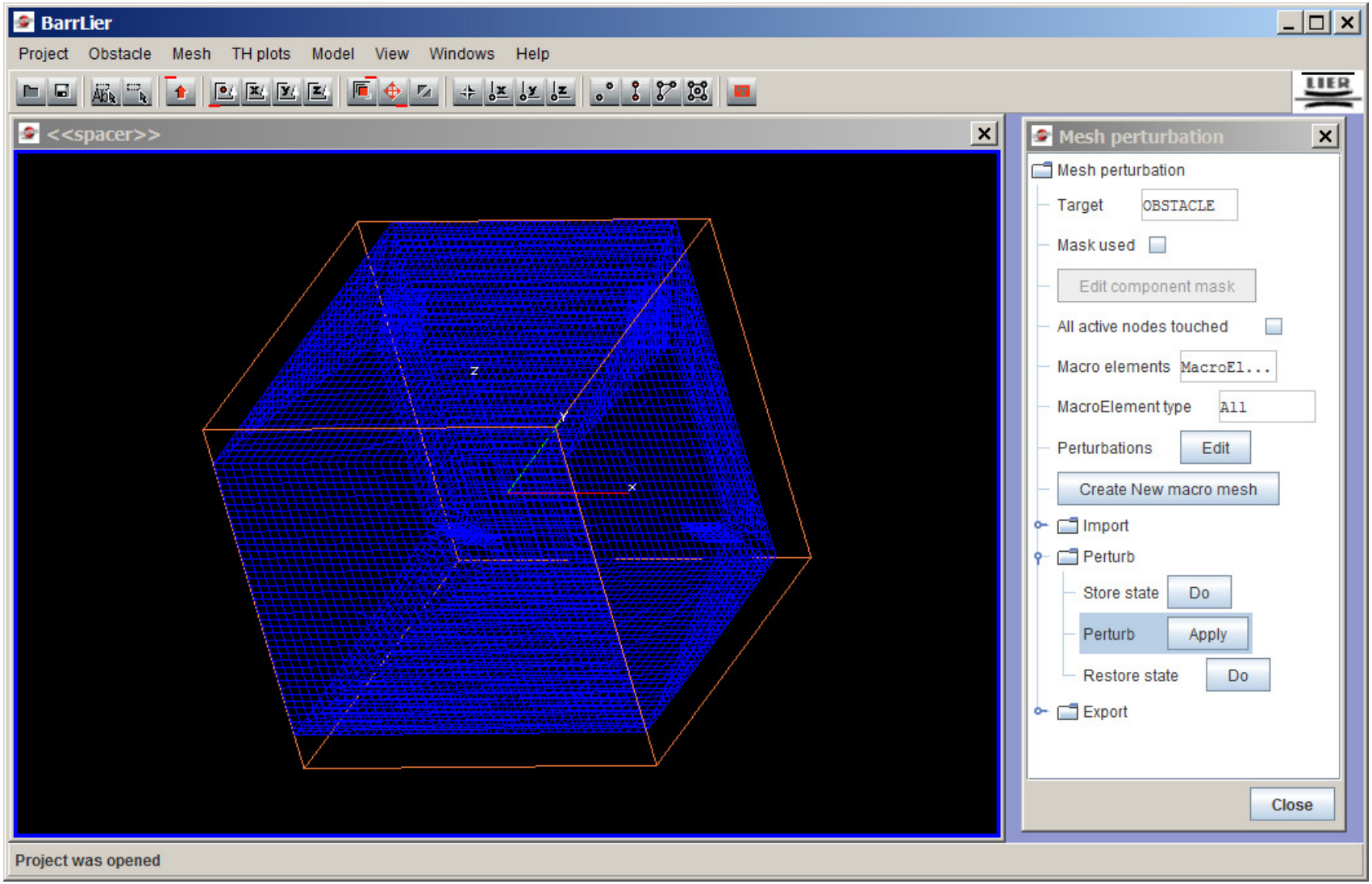
PROJECT LEVEL databases



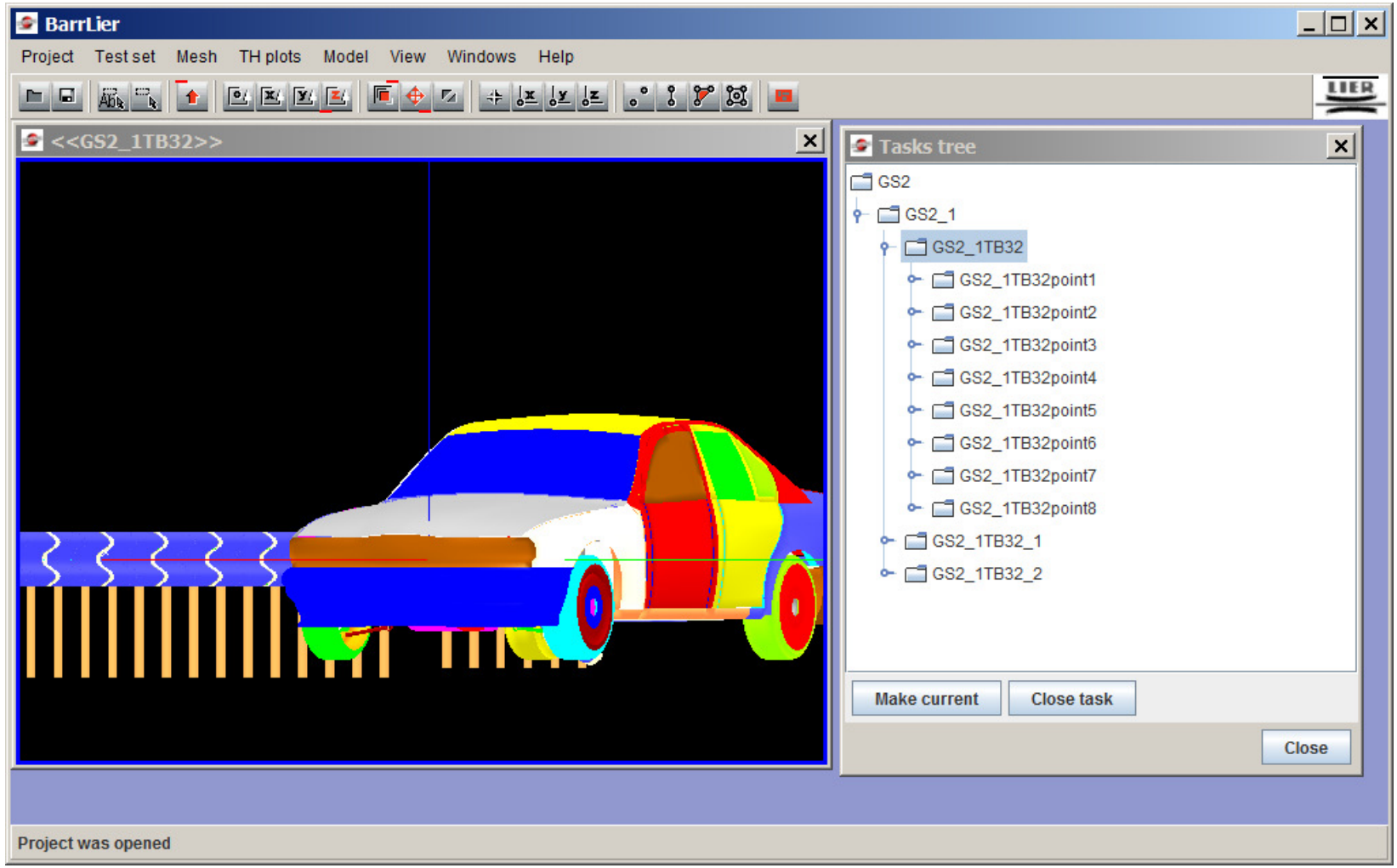
OBSTACLE (BARRIER) LEVEL
barrier import



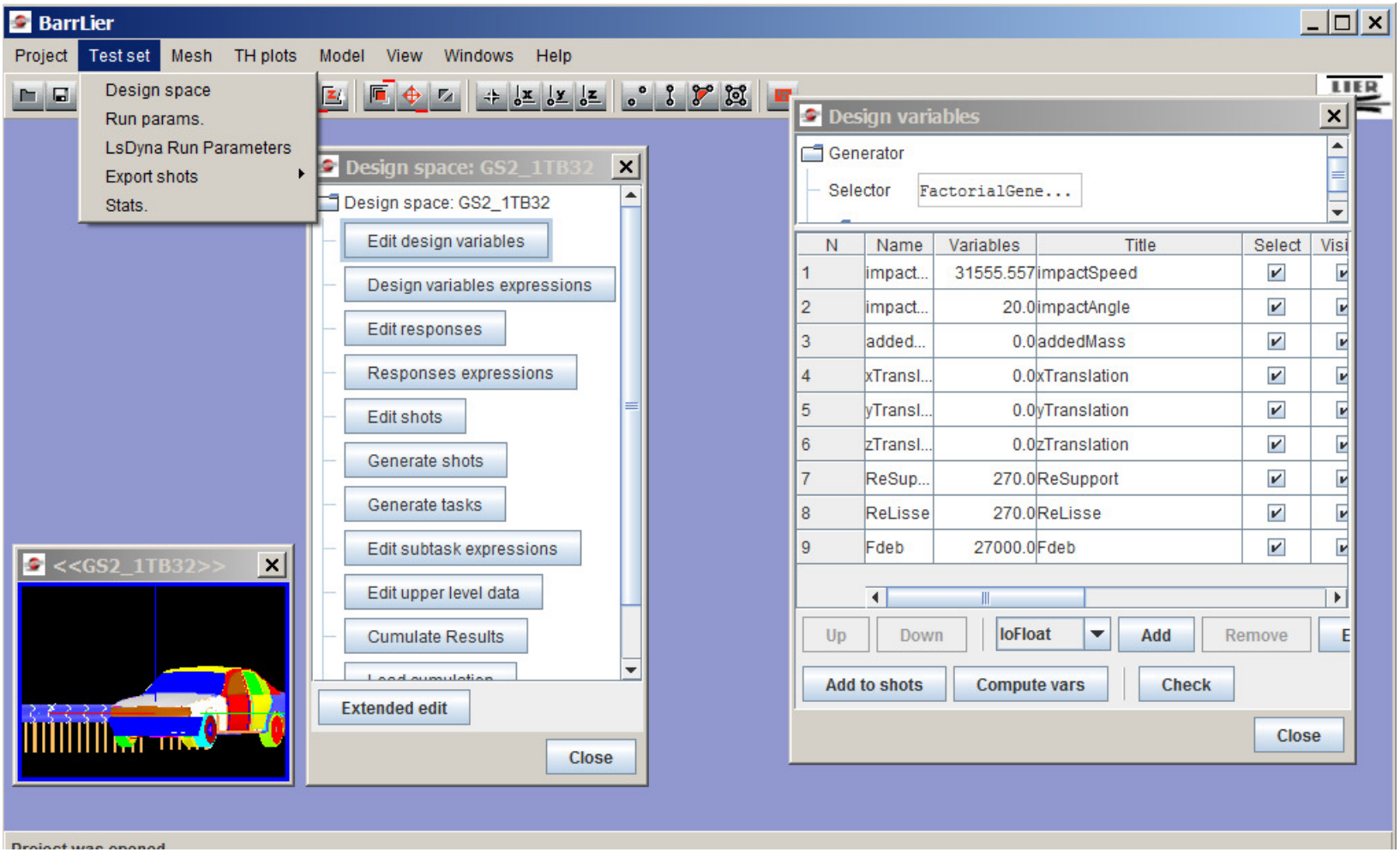
OBSTACLE (BARRIER) LEVEL shape modifications



TEST SET LEVEL
vehicle positioning

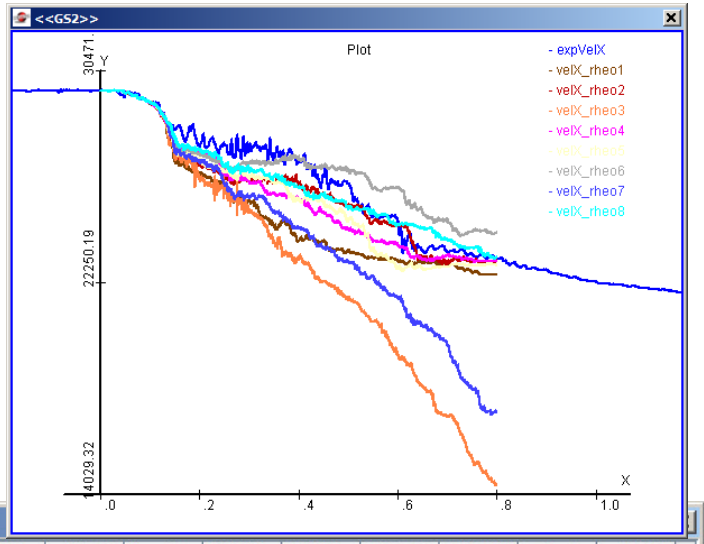


TEST SET LEVEL
design space



POST-PROCESSING time series

- LSDYNA, ISO, EXCEL files …
- TestSet results management
- EN1317 post processing
- Correlation – comparison (metrics)
- Moving – fixed frame transformations
- ……



BulkTimeSeriesSet

TIME_BASES
VALUES
ENTITIES
SCALAR_SERIES
PROCESSED_RESULTS_TO add
AUX_RESULTS_TO tmp
function
Compute
ENTITY_CHOICE single
TARGET_ID <none>
generalFunction

SERIES	expVelX	velX_rh...	velX_rh...	velX_rh...	velX_rh...	velX_rh...	velX_rh...	velX_rh...	velX_rh...	Correla...	DELTA...	ERRO...	t-Scale	t-SHIFT	v-Scale	v-SHIFT
expVelX	1.0	0.9083...	0.9731...	0.9818...	0.9611...	0.9765...	0.9562...	0.9793...	0.9657...	1.0	0.0	0.0				
velX_r...	0.9083...	1.0	0.9530...	0.9217...	0.9847...	0.9626...	0.9208...	0.9241...	0.9771...	0.9083...	-1364....	978.86...				
velX_r...	0.9731...	0.9530...	1.0	0.9710...	0.9796...	0.9824...	0.9891...	0.9722...	0.9874...	0.9731...	-525.5...	483.18...				
velX_r...	0.9818...	0.9217...	0.9710...	1.0	0.9632...	0.9648...	0.9586...	0.9981...	0.9778...	0.9818...	-3406....	2429.8...				
velX_r...	0.9611...	0.9847...	0.9796...	0.9632...	1.0	0.9894...	0.9491...	0.9635...	0.9923...	0.9611...	-740.1...	604.25...				
velX_r...	0.9765...	0.9626...	0.9824...	0.9648...	0.9894...	1.0	0.9554...	0.9631...	0.9846...	0.9765...	-793.5...	511.16...				
velX_r...	0.9562...	0.9208...	0.9891...	0.9586...	0.9491...	0.9554...	1.0	0.9635...	0.9700...	0.9562...	294.02...	747.64...				
velX_r...	0.9793...	0.9241...	0.9722...	0.9981...	0.9635...	0.9631...	0.9635...	1.0	0.9802...	0.9793...	-2214....	1578.6...				
velX_r...	0.9657...	0.9771...	0.9874...	0.9778...	0.9923...	0.9846...	0.9700...	0.9802...	1.0	0.9657...	-249.0...	559.04...				

SET_AS_REF | correlation | REFRESH | Draw | PUT_BACK

Close

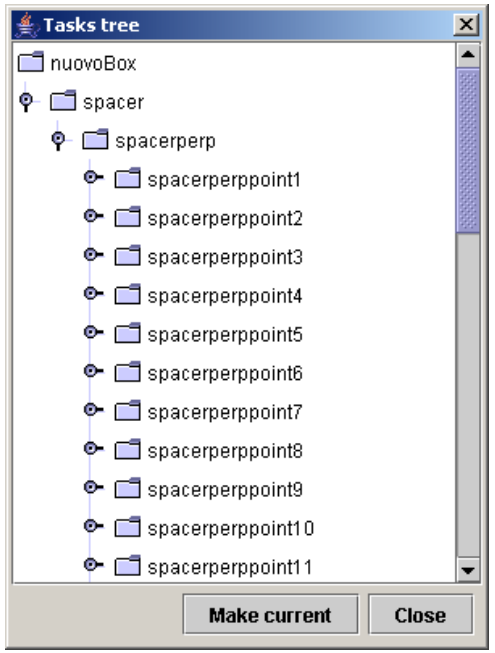
THANKYOU FOR YOUR ATTENTION

EXAMPLE OF BARRLIER PROJECT SET UP

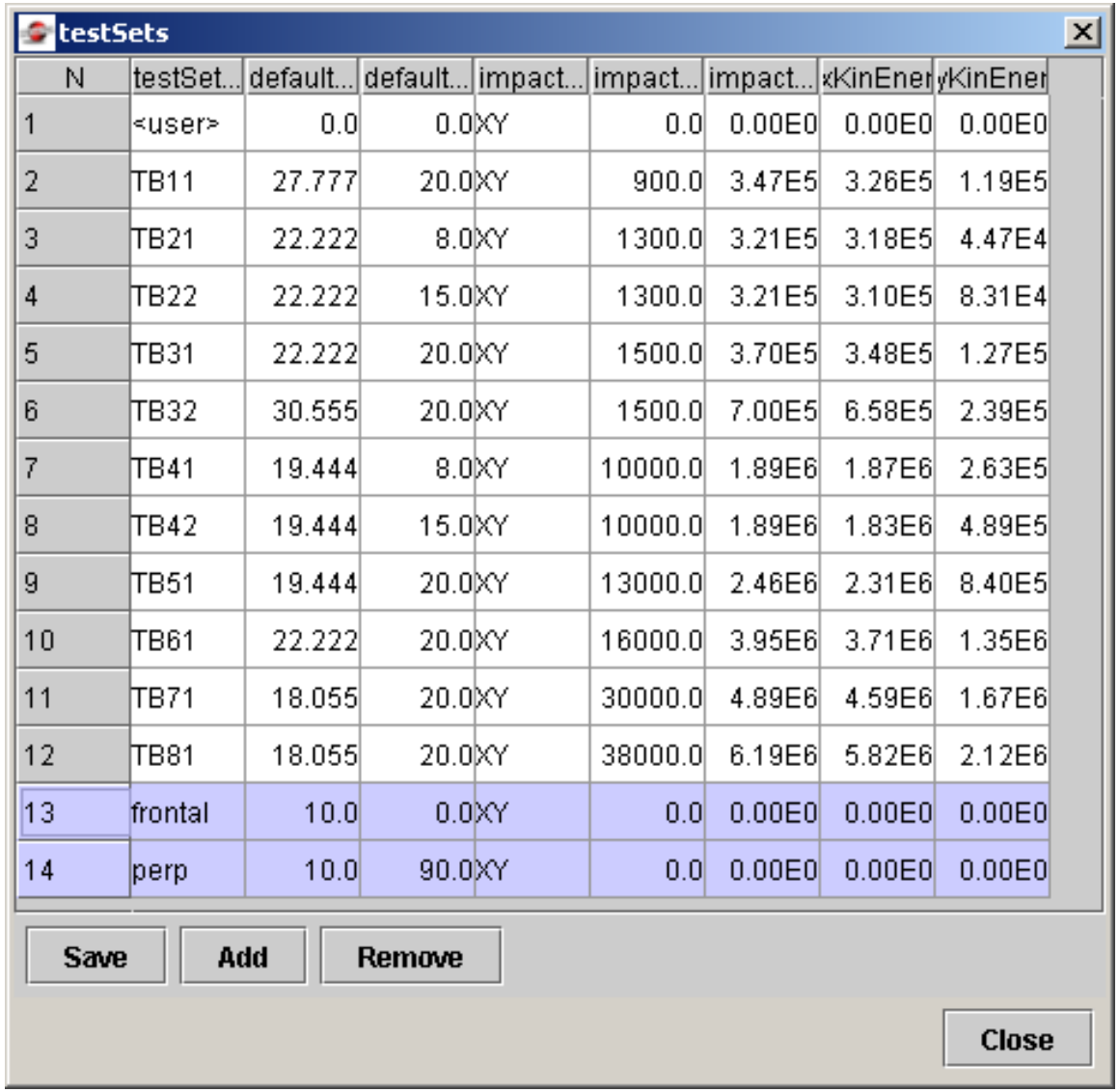
nuovoBox (BarrLier Project)

- Example of relatively complex project
- Macro elements for geometry modifications and design variables
- Design space: link to model, macro elements and LSDYNA computations

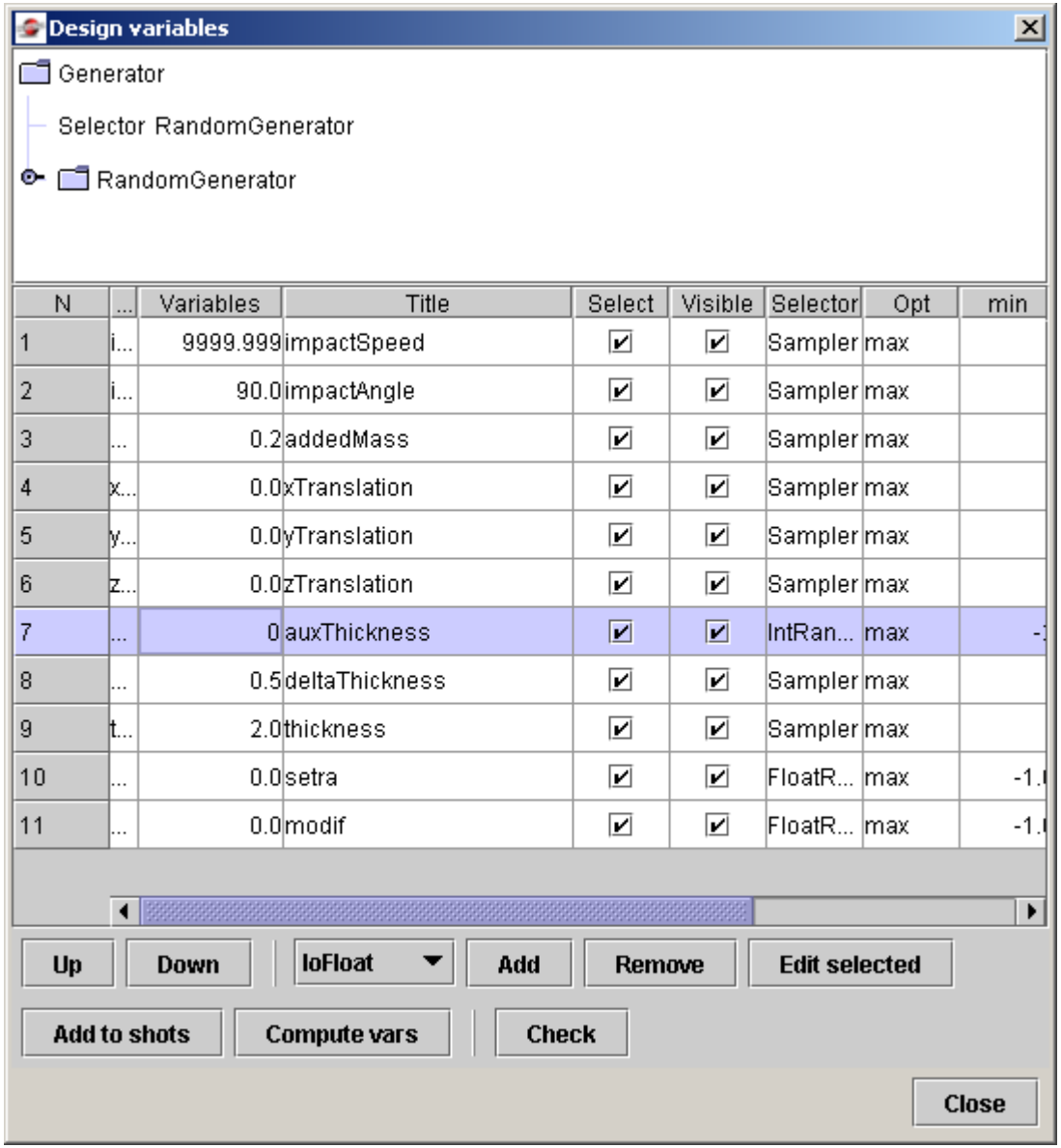
  - Design variables:
    - Spacer thickness (discrete)
    - 2 shape variables
  - Responses
    - Cylinder ASI
    - Cylinder stroke
    - Spacer mass



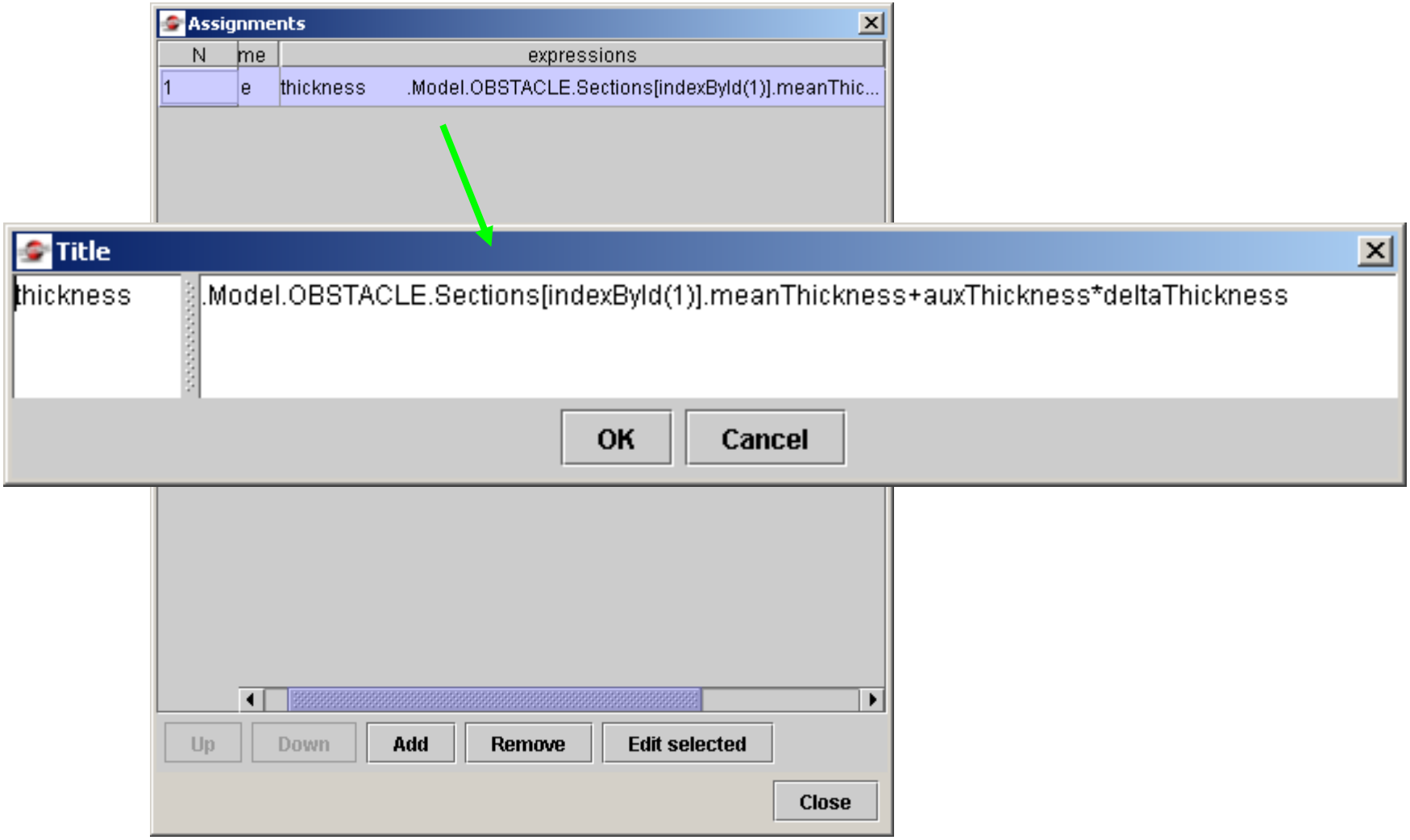
ADD NEW TEST SETS



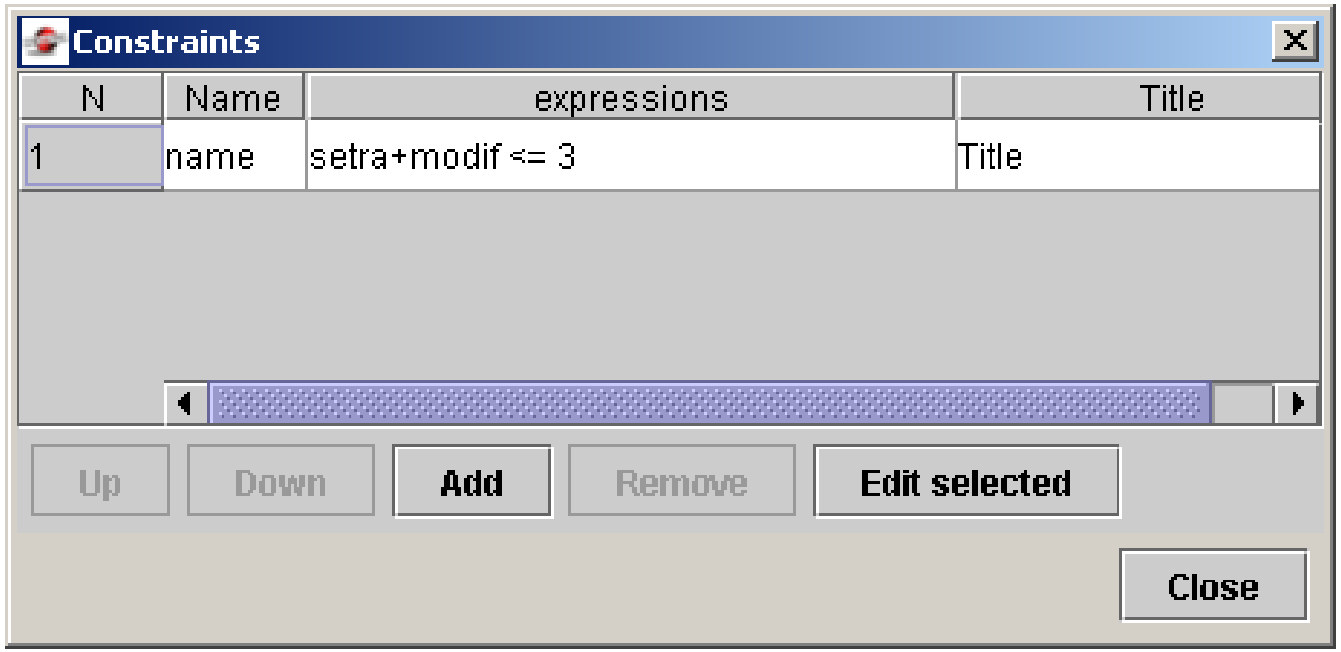
DESIGN VARIABLES DEFINITION



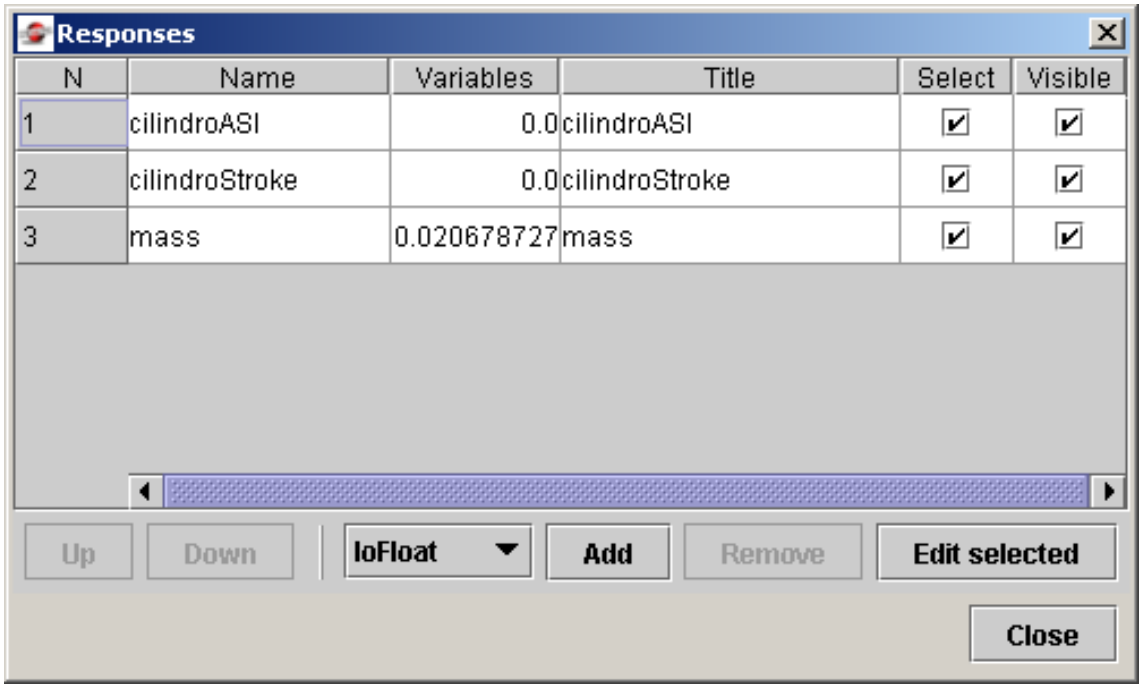
DESIGN VARIABLES EXPRESSIONS 1: ASSIGNMENTS



DESIGN VARIABLES EXPRESSIONS 2: CONSTRAINTS

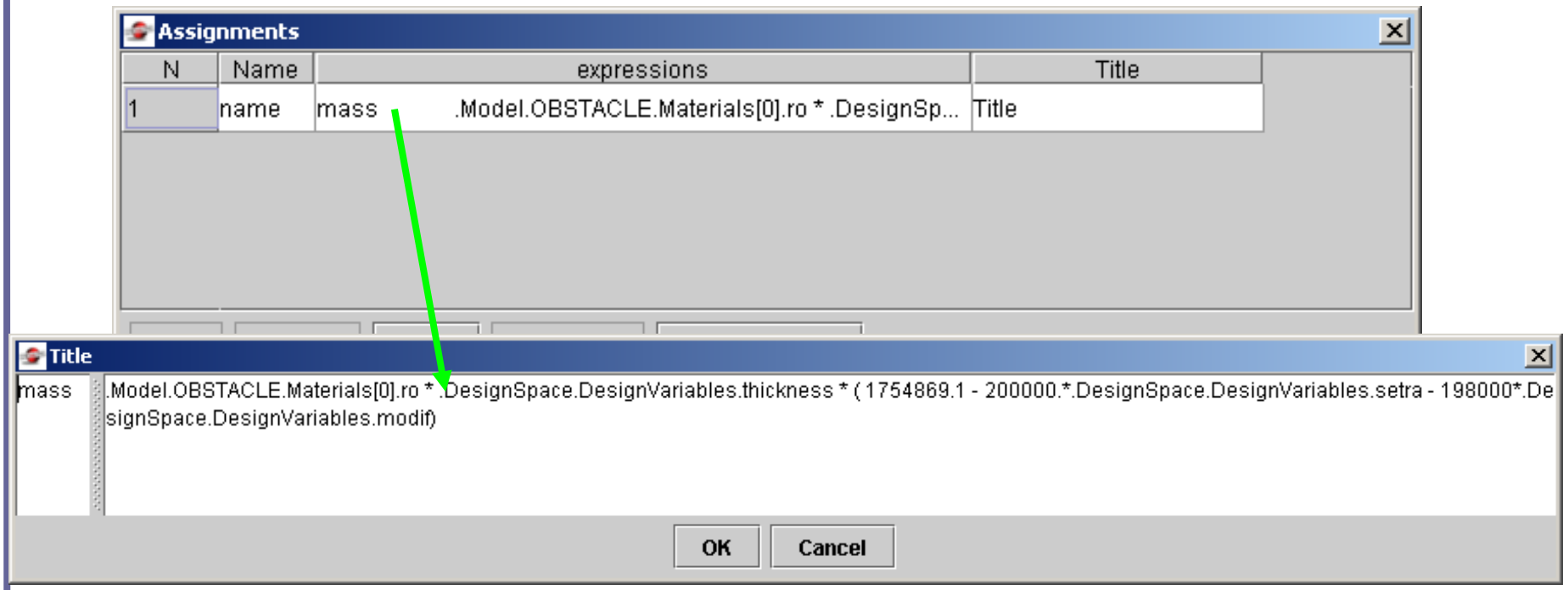


RESPONSE DEFINITION



- Responses are automatically defined from measure points

RESPONSE EXPRESSIONS 1: ASSIGNMENTS



- Forget about response constraints for the time being

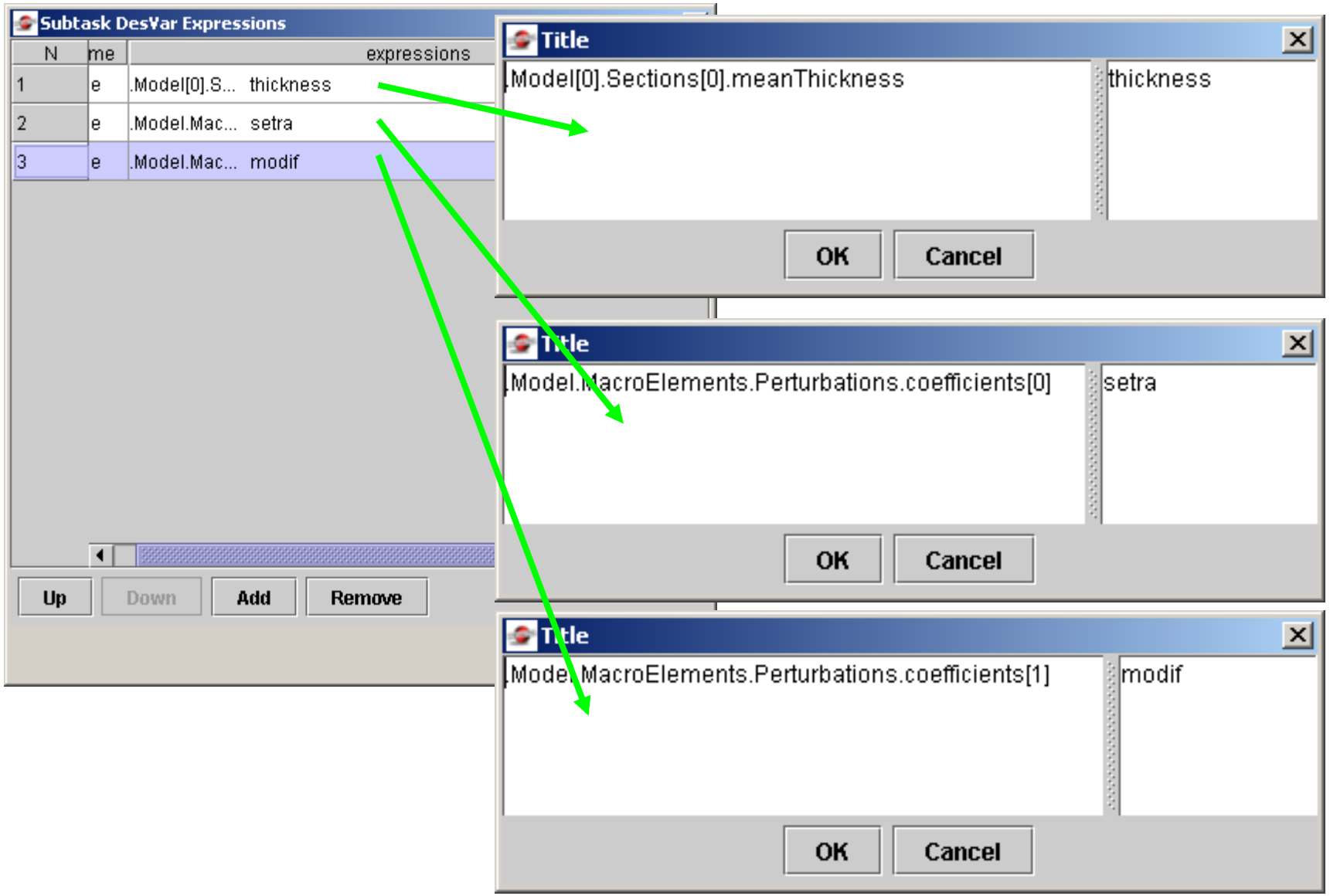
DESVAR AND RESPONSE EXPRESSIONS

- Design variables and response expressions are executed when a shot is created
- No external computation is carried out
- If the design variable constraints are not satified, no shot is created

SUBTASK EXPRESSIONS

- Are executed at the subtask level, when the crash computation is created
- Use of automatic prolongation is tricky, because BarrLier gives you the prolongations for the test set, whereas the actual model is different:
- OBSTACLE mesh is still [0], but it is the merging of OBSTACLE and IMPACTOR
- MACROELEMENT mesh (when it exist) is [1]

SUBTASK EXPRESSIONS



Geometry design variables

Perturbations

N	IDs	Name	COEFF..	Min	Max	Vectors
1	1	Setra	0.0	-1000.0	1000.0	Edit
2	2	Modif	0.0	-1000.0	1000.0	Edit

Add | Remove | Close

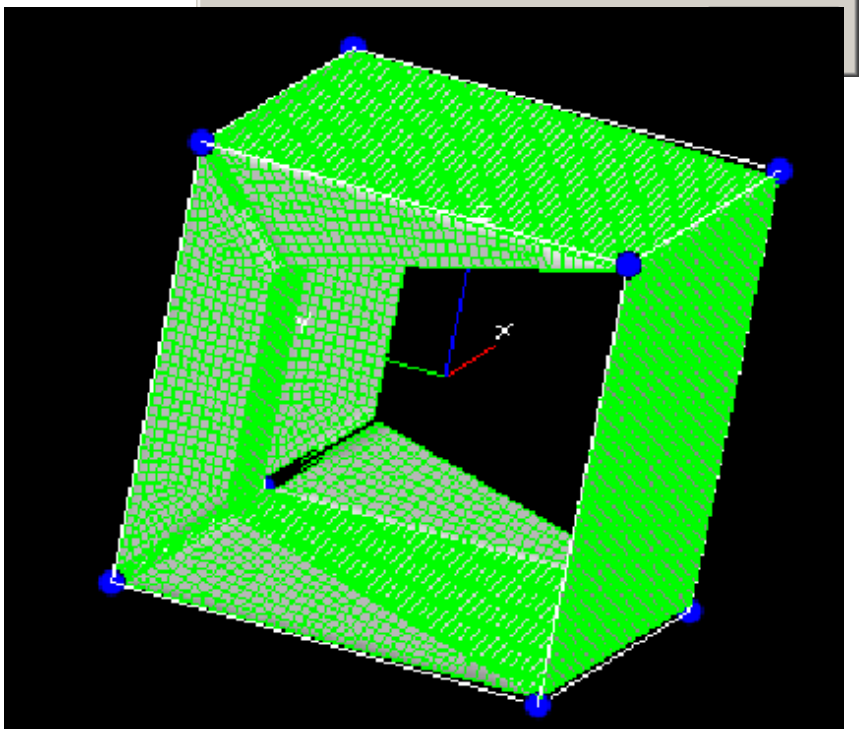
Setra

N	IDs	Selected	Setra1	Setra2	Setra3
1	18804	☐	50.96	0.0	-0.0
2	18806	☐	0.0	0.0	-50.96
3	18808	☐	50.96	0.0	0.0
4	18809	☐	0.0	0.0	50.96
5	18810	☐	-50.96	0.0	-0.0
6	18811	☐	-0.0	0.0	-50.96
7	18812	☐	-50.96	0.0	0.0
8	18813	☐	0.0	0.0	50.96

Modif

N	IDs	Selected	Modif1	Modif2	Modif3
1	18804	☐	21.0	0.0	-21.0
2	18806	☐	21.0	0.0	-21.0
3	18808	☐	21.0	0.0	21.0
4	18809	☐	21.0	0.0	21.0
5	18810	☐	-21.0	0.0	-21.0
6	18811	☐	-21.0	0.0	-21.0
7	18812	☐	-21.0	0.0	21.0
8	18813	☐	-21.0	0.0	21.0

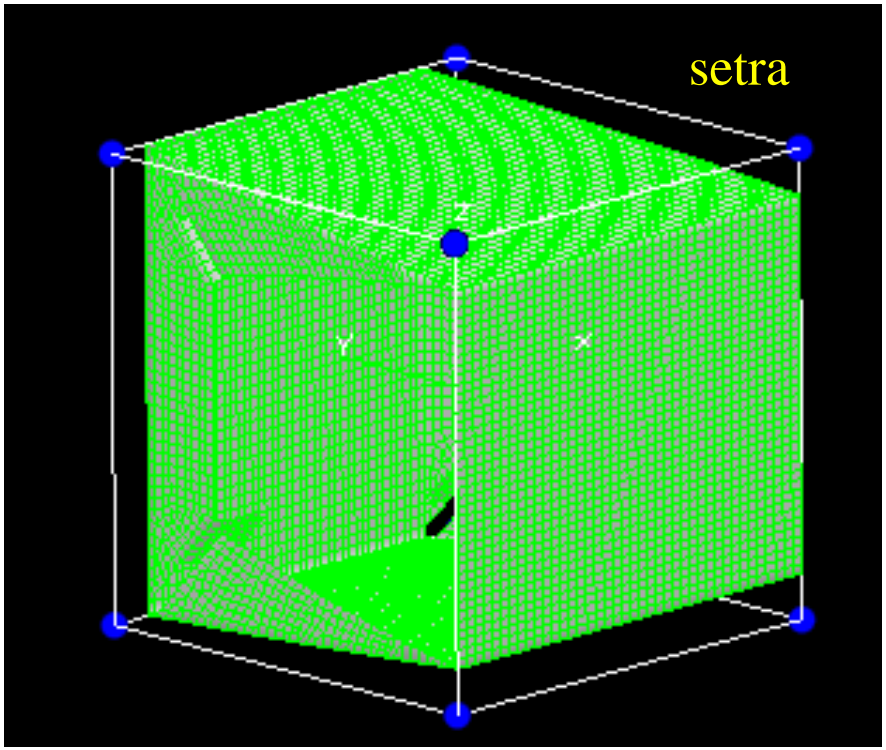
Close

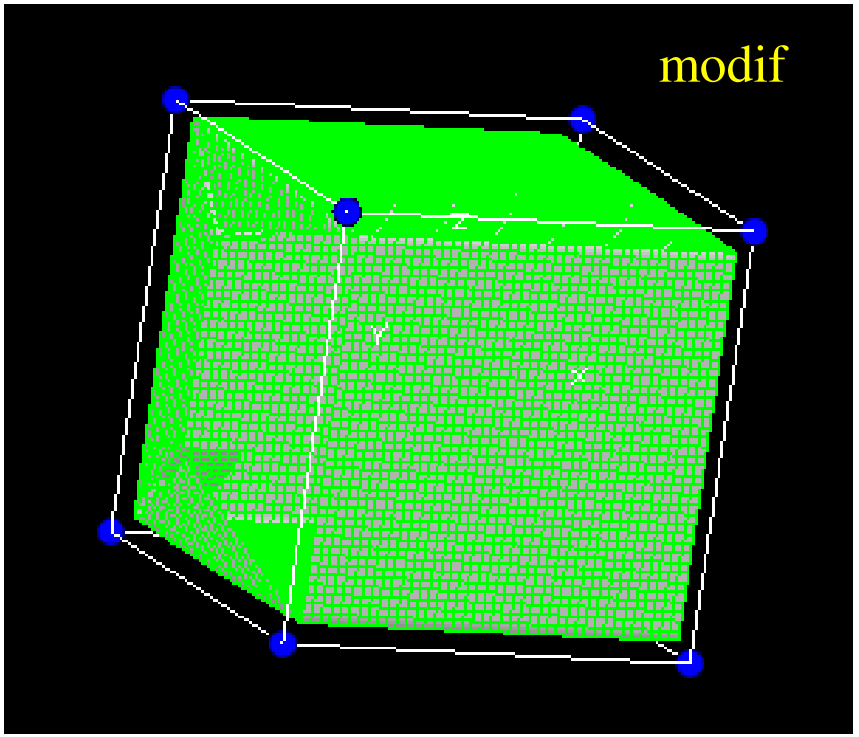


Base shape is contained in a HEXA macro-element.

Shape function defines a displacement for each of the macro nodes.

- Design variable 1 (setra) morphes the box into a standard French spacer.
- Design variable 2 (modif) scales up and down the size of the box.





Constraints on design variables

Design variables

Generator

selector RandomGe...

Generator

Shots maximum 50

N	Variables	Title	selector	Opt	min	max
1	9999.999	impactSpeed	Sampler	max		
2	90.0	impactAngle	Sampler	max		
3	0.2	addedMass	Sampler	max		
4	0.0	xTranslation	Sampler	max		
5	0.0	yTranslation	Sampler	max		
6	0.0	zTranslation	Sampler	max		
7	0	auxThickness	IntRandom...	max	-2	2
8	0.5	deltaThickness	Sampler	max		
9	3.0	thickness	Sampler	max		
10	2.6293612	setra	FloatRand...	max	-1.0	3.0
11	2.3374093	modif	FloatRand...	max	-1.0	3.0

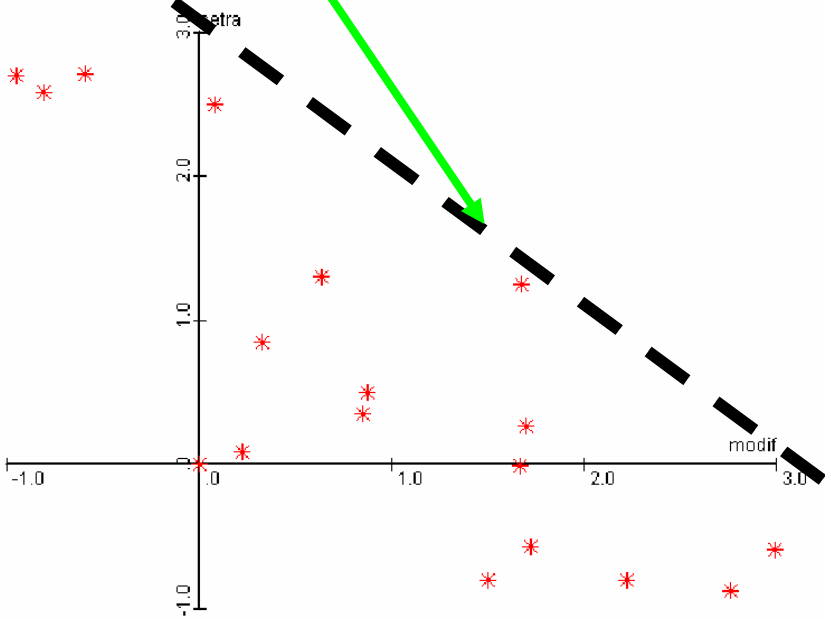
Up | Down | loFloat | Add | Remove | Edit selected

Add to shots | Compute vars

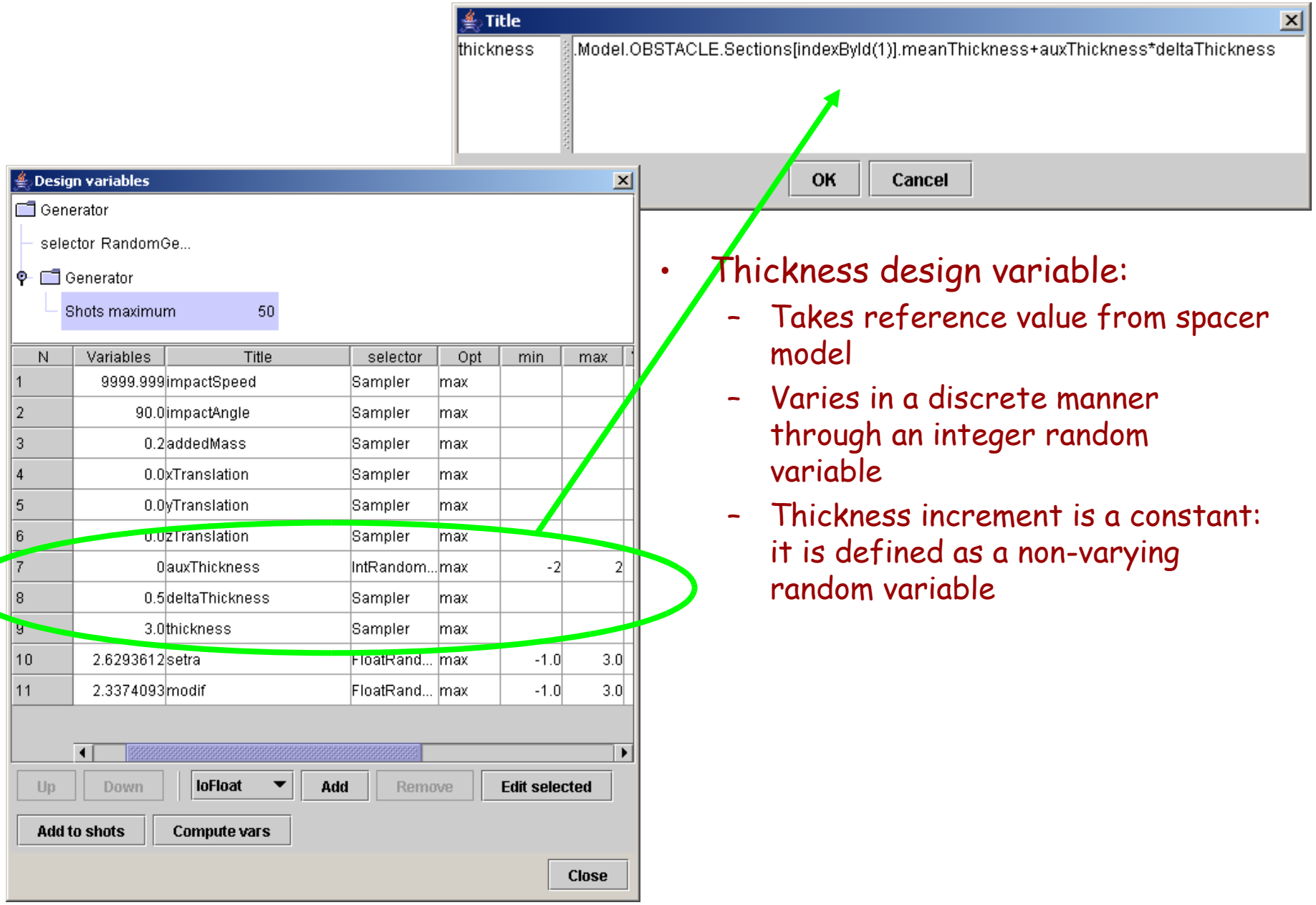
Close

Constraints

N	Name	expressions	Title
1	name	setra+modif <= 3	Title



Link between model and design variables



- Thickness design variable:
  - Takes reference value from spacer model
  - Varies in a discrete manner through an integer random variable
  - Thickness increment is a constant: it is defined as a non-varying random variable

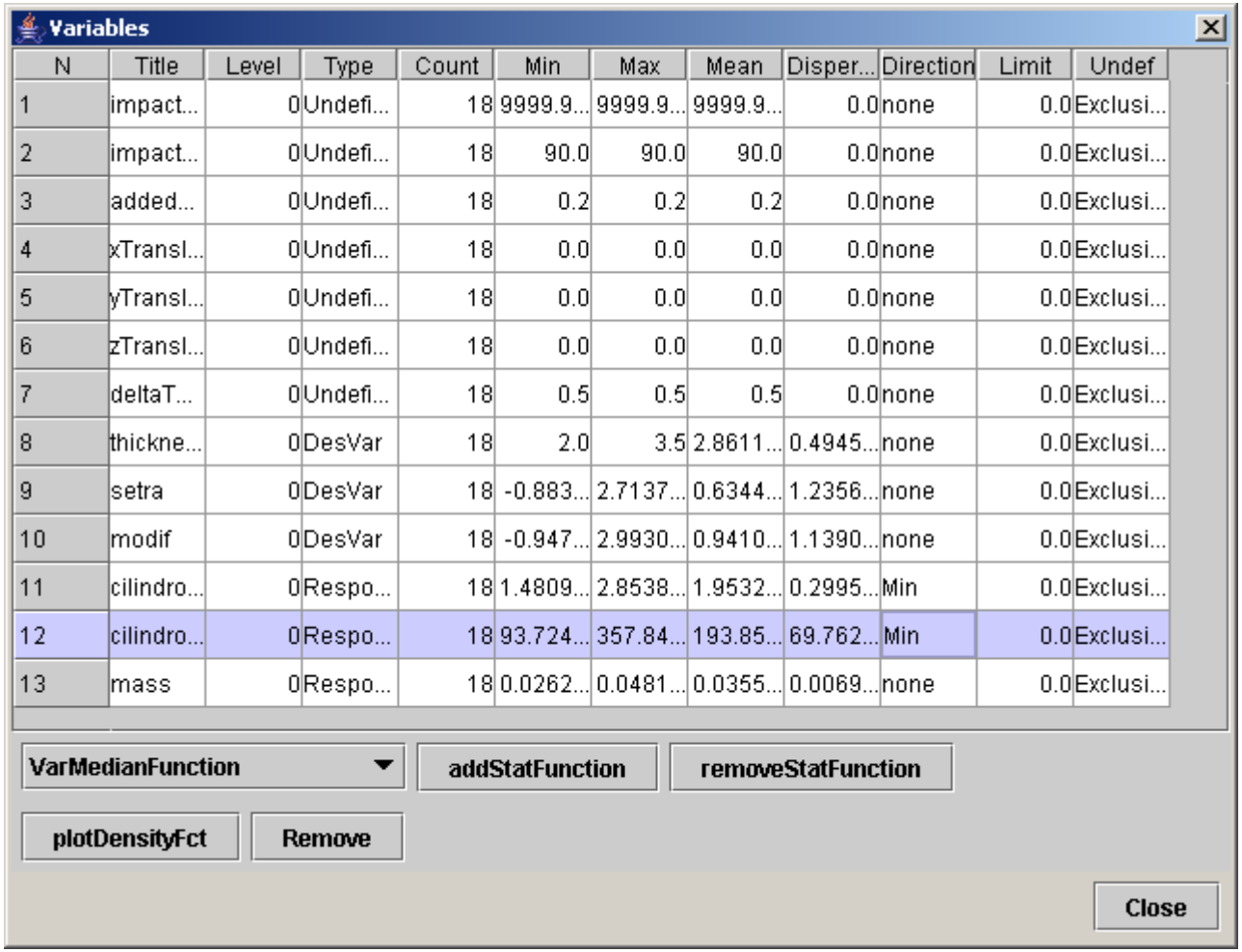
Correlation matrix

corr

Title	impact...	impact...	added...	xTransl...	yTransl...	zTransl...	deltaT...	thickne...	setra	modif	cilindro...	cilindro...	mass
impactSpeed	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
impactAngle	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
addedMass	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
xTranslation	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
yTranslation	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
zTranslation	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
deltaThickness	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
thickness	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.4739...	-0.372...	0.0515...	-0.139...	0.1656...
setra	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4739...	1.0	-0.812...	-0.043...	-0.008...	0.0330...
modif	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.372...	-0.812...	1.0	0.2076...	0.0359...	-0.208...
cilindroASI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0515...	-0.043...	0.2076...	1.0	-0.596...	0.1889...
cilindroStroke	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.139...	-0.008...	0.0359...	-0.596...	1.0	-0.694...
mass	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1656...	0.0330...	-0.208...	0.1889...	-0.694...	1.0

Close

Statistics on variables/responses



Pareto analysis

corr

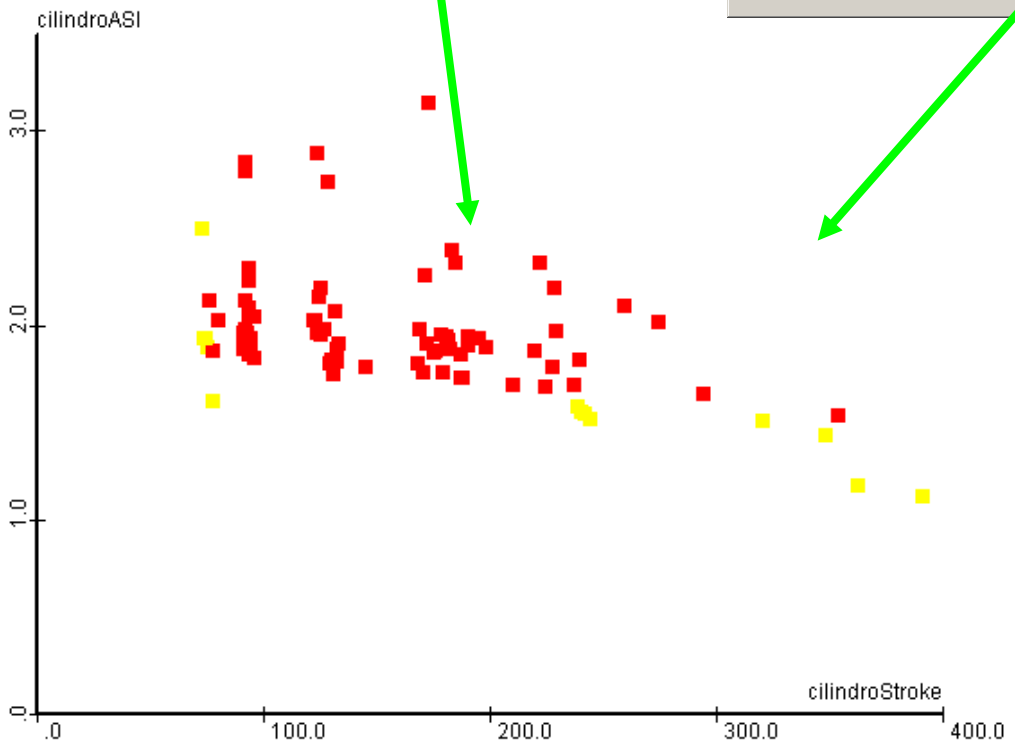
Title	impact...	impact...	added...	xTransl...	yTransl...	zTransl...	deltaT...	thickne...	setra	modif	cilindro...	cilindro...	mass
impactSpeed	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
impactAngle	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
addedMass	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
xTranslation	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
yTranslation	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
zTranslation	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
deltaThickness	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
thickness	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.4739...	-0.372...	0.0515...	-0.139...	0.1656...
setra	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4739...	1.0	-0.812...	-0.043...	-0.008...	0.0330...
modif	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.372...	-0.812...	1.0	0.207...	0.0359...	-0.208...
cilindroASI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0515...	-0.043...	0.2076...	1.0	-0.696...	0.1889...
cilindroStroke	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.139...	-0.008...	0.0359...	-0.696...	1.0	0.694...
mass	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1656...	0.0330...	-0.208...	0.1889...	-0.694...	1.0

Close

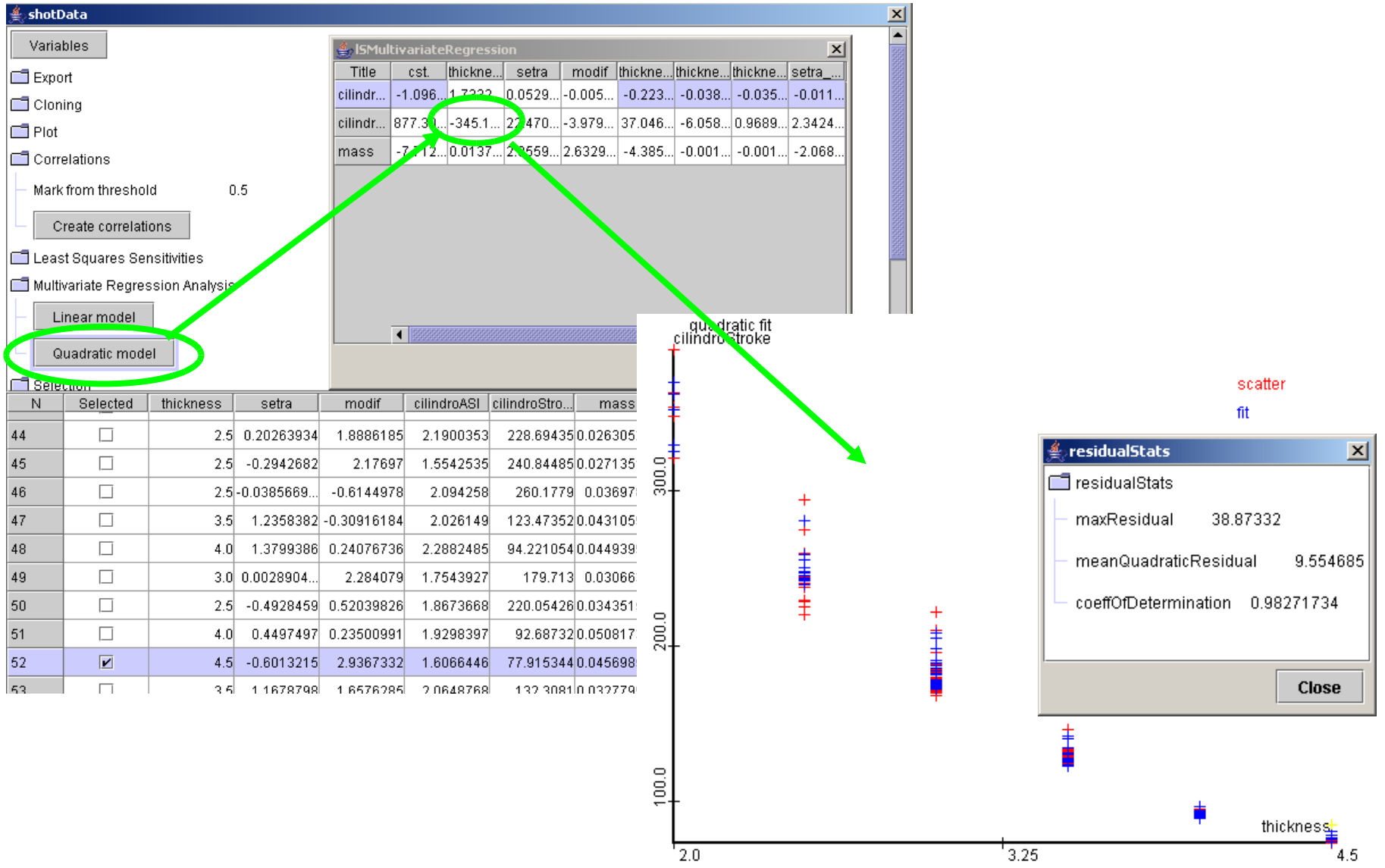
Variables

N	Title	Level	Type	Count	Min	Max	Mean	Disper...	Direction	Limit	Undef
1	impact...	0	Undefi...	18	9999.9...	9999.9...	9999.9...	0.0	none	0.0	Exclusi...
2	impact...	0	Undefi...	18	90.0	90.0	90.0	0.0	none	0.0	Exclusi...
3	added...	0	Undefi...	18	0.2	0.2	0.2	0.0	none	0.0	Exclusi...
4	xTransl...	0	Undefi...	18	0.0	0.0	0.0	0.0	none	0.0	Exclusi...
5	yTransl...	0	Undefi...	18	0.0	0.0	0.0	0.0	none	0.0	Exclusi...
6	zTransl...	0	Undefi...	18	0.0	0.0	0.0	0.0	none	0.0	Exclusi...
7	deltaT...	0	Undefi...	18	0.5	0.5	0.5	0.0	none	0.0	Exclusi...
8	thickne...	0	DesVar	18	2.0	3.5	2.8611...	0.4945...	none	0.0	Exclusi...
9	setra	0	DesVar	18	-0.883...	2.7137...	0.6344...	1.2356...	none	0.0	Exclusi...
10	modif	0	DesVar	18	-0.947...	2.9930...	0.9410...	1.1390...		0.0	Exclusi...
11	cilindro...	0	Respo...	18	1.4809...	2.8538...	1.9532...	0.29...	Min	0.0	Exclusi...
12	cilindro...	0	Respo...	18	93.724...	357.84...	193.85...	69.76...	Min	0.0	Exclusi...
13	mass	0	Respo...	18	0.0262...	0.0481...	0.0355...	0.0...	none	0.0	Exclusi...

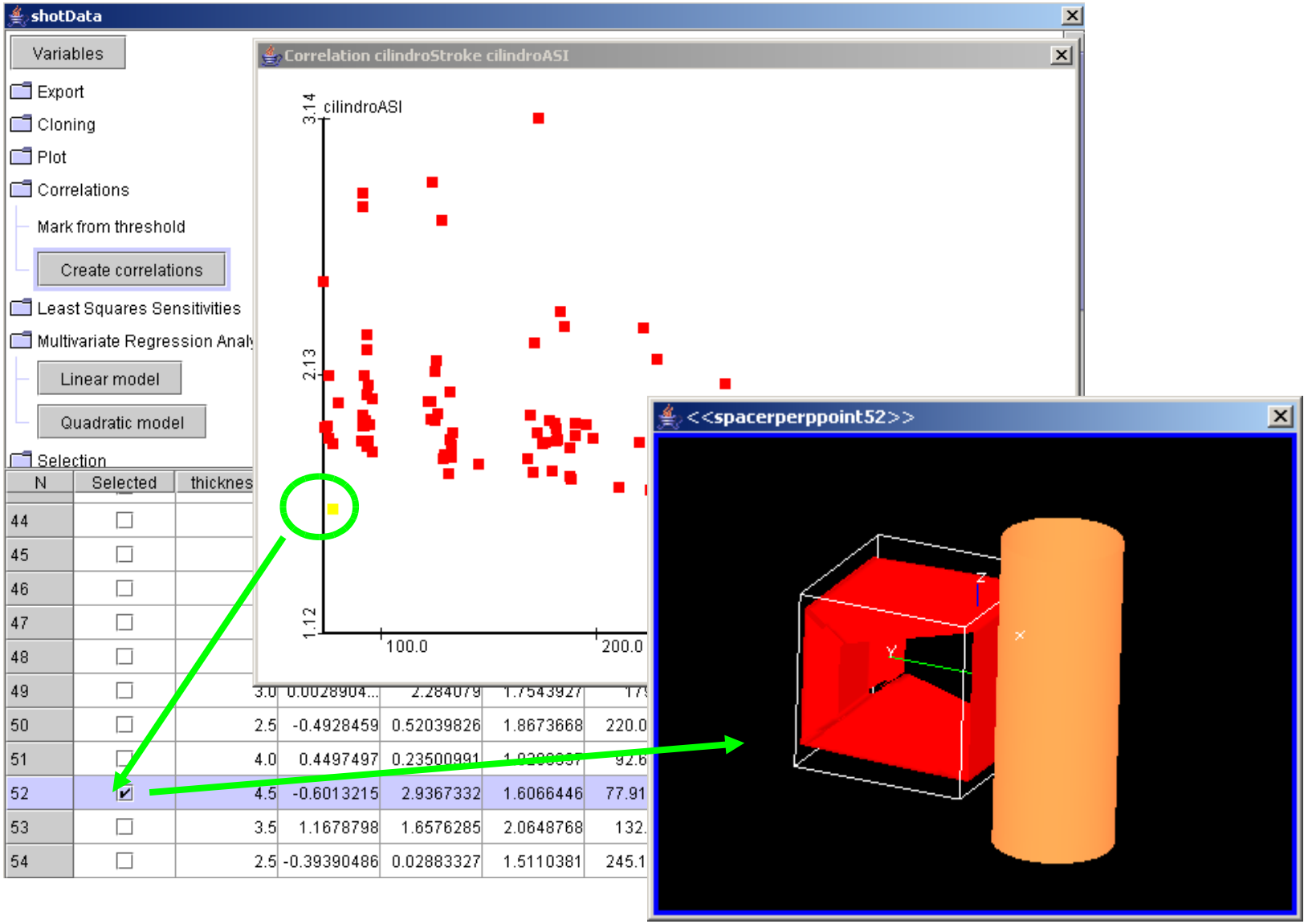
VarMedianFunction | addStatFunction | remoteStatFunction | plotDensityFct | Remove | Close



Correlation analysis



Link between graphics, statistics and computations



N	Selected	thicknes				
44	☐					
45	☐					
46	☐					
47	☐					
48	☐					
49	☐		3.0	0.0028904...	2.284079	1.7543927	17
50	☐		2.5	-0.4928459	0.52039826	1.8673668	220.0
51	☐		4.0	0.4497497	0.23500991	1.8388687	92.6
52	☑		4.5	-0.6013215	2.9367332	1.6066446	77.91
53	☐		3.5	1.1678798	1.6576285	2.0648768	132.
54	☐		2.5	-0.39390486	0.02883327	1.5110381	245.1