Evaluation of a Seat Crossmember Study by using Multidisciplinary Optimization

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Agenda

1. Introduction
2. Load cases
3. SFE CONCEPT
4. Design variables
5. Geometrical constraints
6. MDO
7. Results
8. Summary

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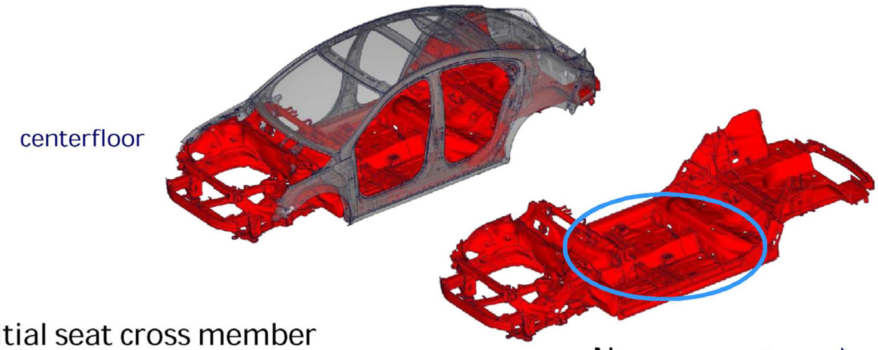
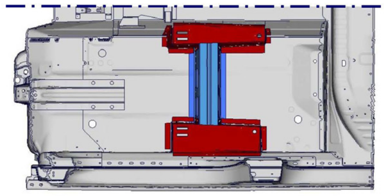
1. Introduction

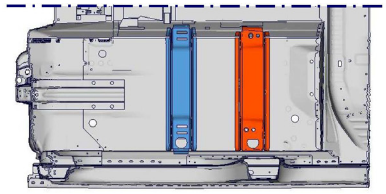
Concept study of the seat crossmembers



Initial seat cross member design

New concept ⇨ Better?
⇨ MDO





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2. Load cases

load case	FEM code	requirement
Side pole impact	LS-DYNA	Upper bound for intrusion
Fatigue	OptiStruct	Stiffness bound in linear auxiliary loadcase
Tearing out	OptiStruct	Stiffness bound in linear auxiliary loadcase
Vibration	OptiStruct	Stiffness bound in linear auxiliary loadcase

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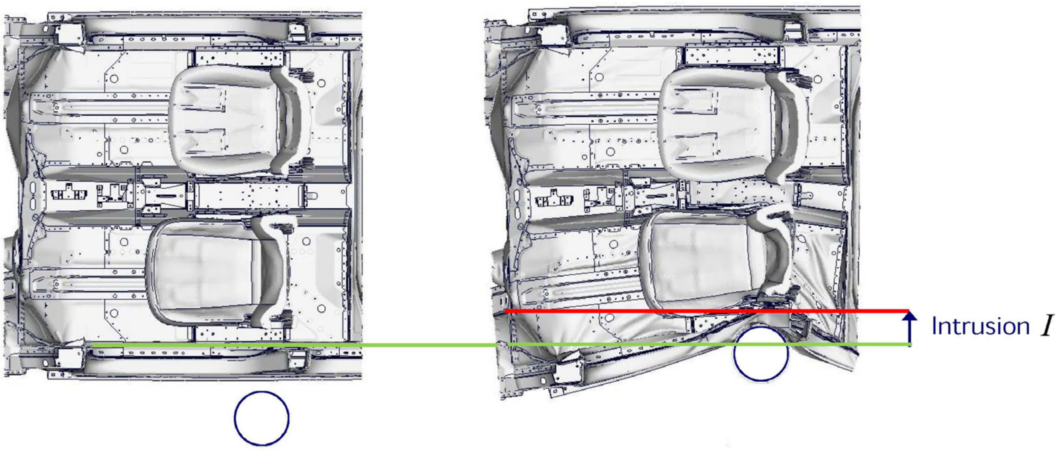
Load case „side impact pole“



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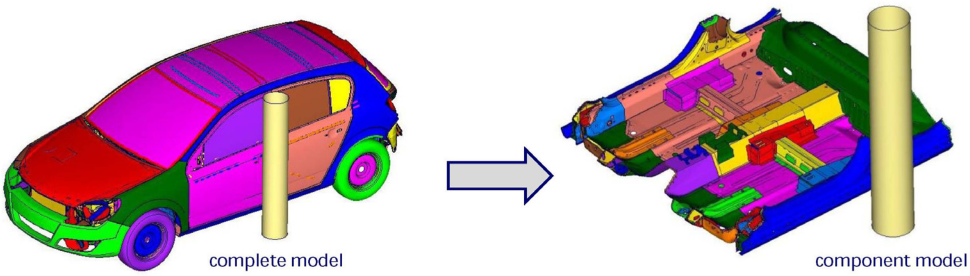
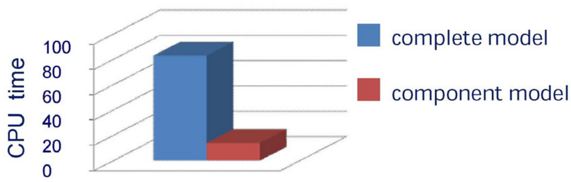
CPU time for LS-DYNA FE-model





Reduction of CPU time = 83%

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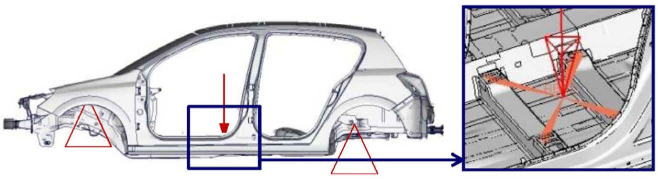
OptiStruct FE-model

Auxiliary linear load case for loadcase „seat attachment"



- No reduction of the model
  - ➔CPU ~1h
    - ~1/14 CPU time of Crash-component model

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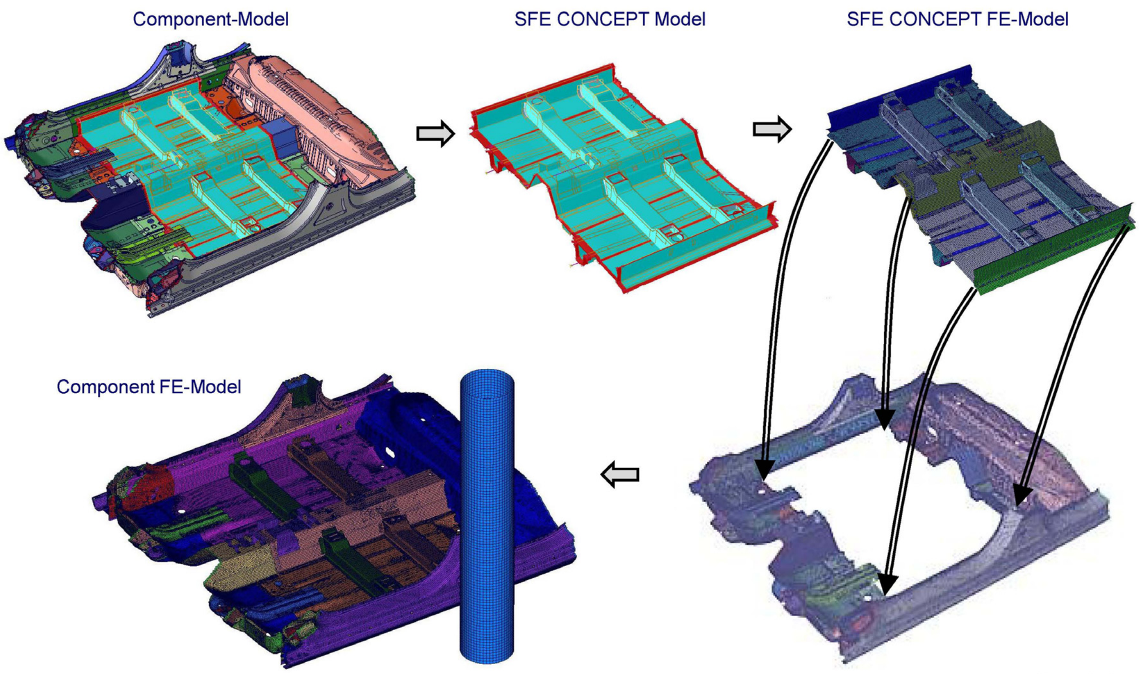
3. SFE CONCEPT



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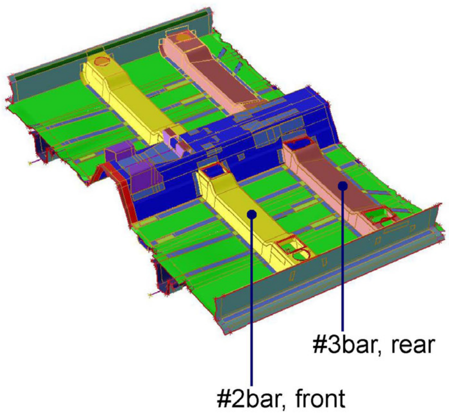
4. Design variables (Gauge)



$$\vec{x} = \begin{pmatrix} x_{FG} \\ x_{RG} \\ x_{FHF} \\ x_{FHR} \\ x_{FW} \\ x_{RW} \\ x_{FL} \\ x_{RL} \end{pmatrix}$$

thickness

x_{FG} front

x_{RG} rear

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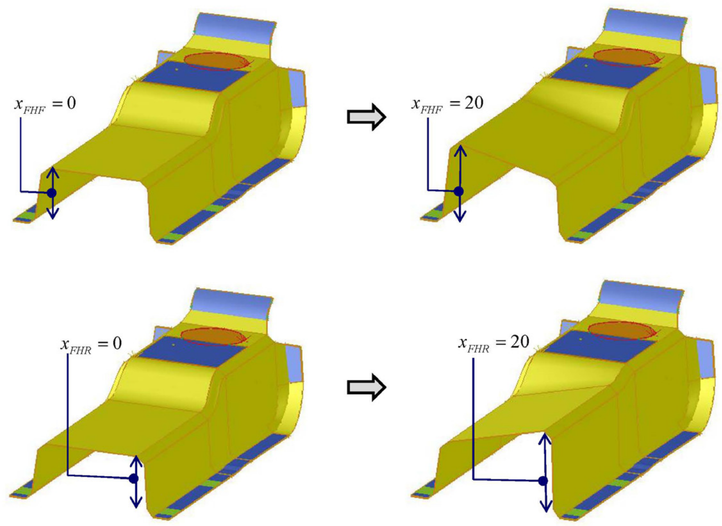
4. Design variables (Shape)

$$\vec{x} = \begin{pmatrix} x_{FG} \\ x_{RG} \\ x_{FHF} \\ x_{FHR} \\ x_{FW} \\ x_{RW} \\ x_{FL} \\ x_{RL} \end{pmatrix}$$



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4. Design variables (Shape)

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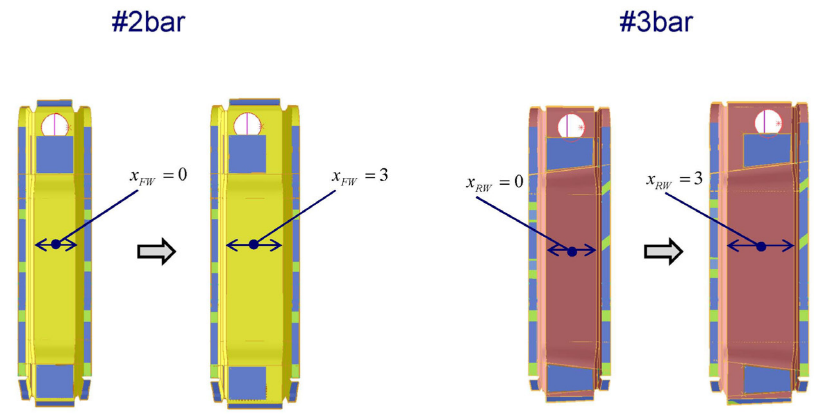

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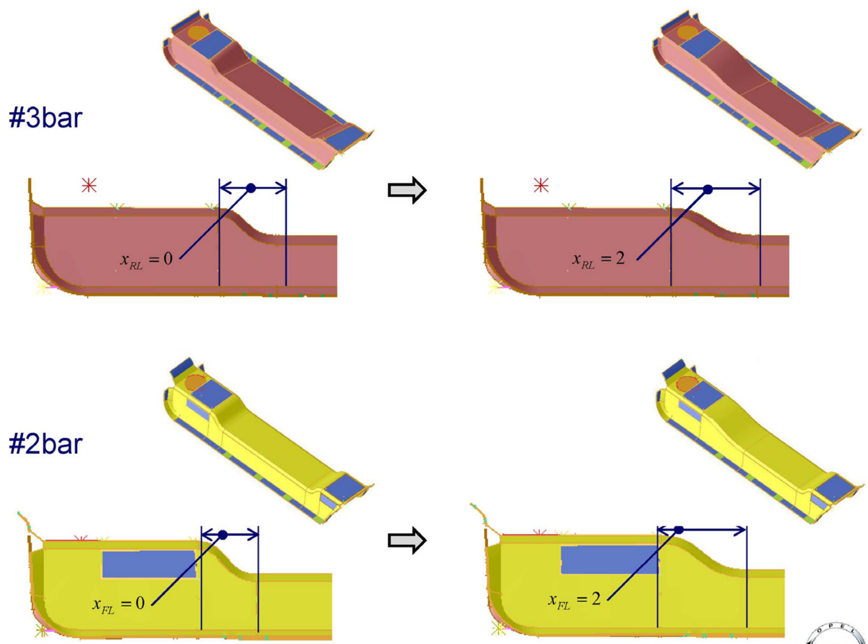

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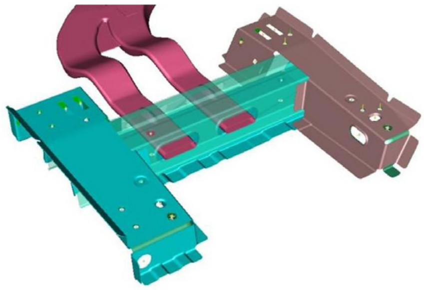
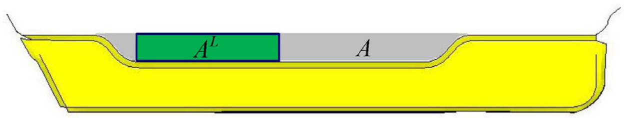
5. Geometrical constraint





$$A^L \leq A(\vec{x})$$

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6. MDO

Optimization problem to be solved

$$\min W(\vec{x})$$

subject to	$S^L \leq S(\vec{x})$	Stiffness constraint
	$I(\vec{x}) \leq I^U$	Intrusion constraint
	$A_F^L \leq A_F(\vec{x})$	geometrical constraints
	$A_R^L \leq A_R(\vec{x})$	

$$\vec{x}^L \leq \vec{x} \leq \vec{x}^U$$

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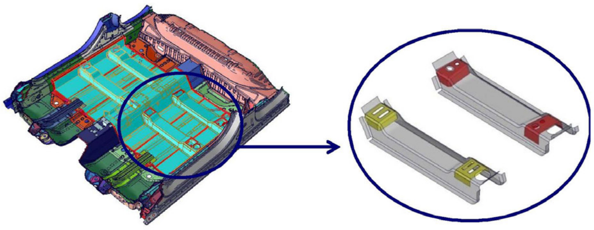
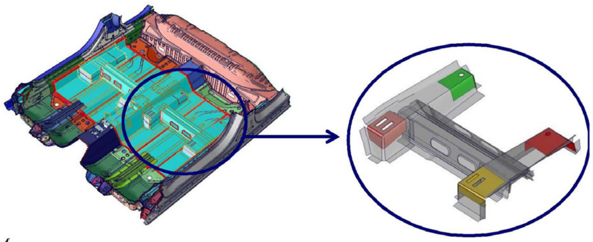
Three optimization runs with different intrusion bounds

$I(\vec{x}) \leq I^U$ new concept idea of the crossmembers



Run 1: $I^U = I^H_{KM} =$ Intrusion of h-beam structure



Run 2: $I^U = I^{NK}_{KM}$ Between I^H_{KM} and I^T_{KM}

Run 3: $I^U = I^T_{KM} =$ Borderline

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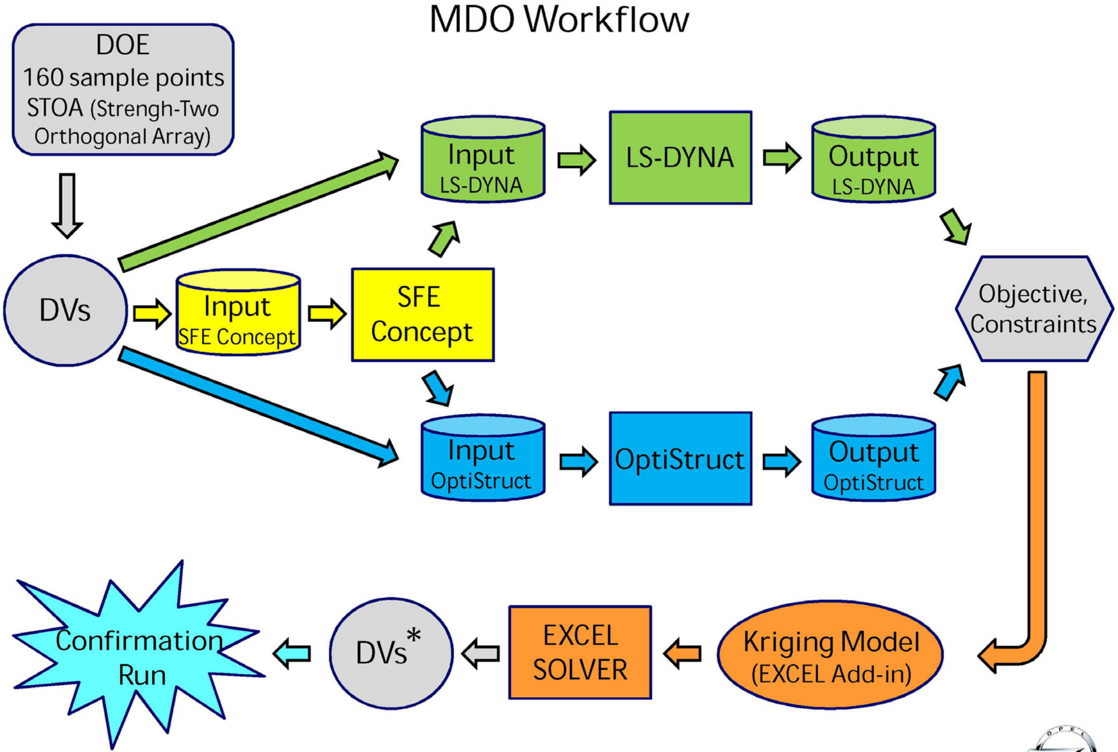
MDO Workflow



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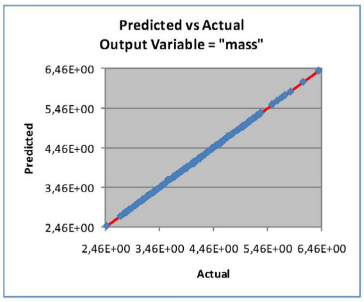
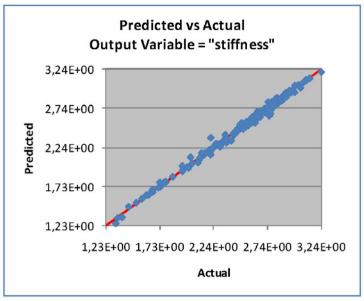
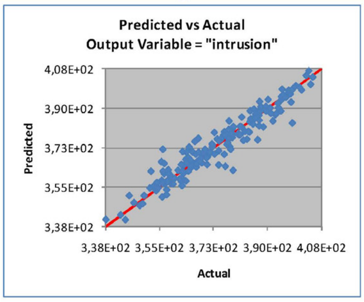
Quality Check of Kriging model







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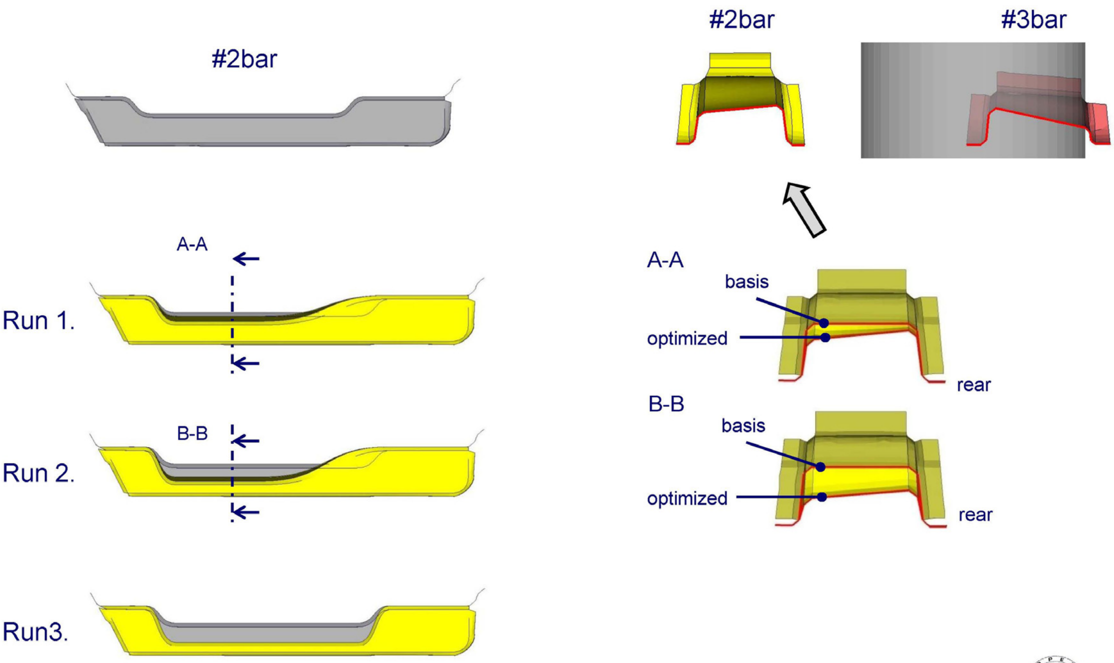
7. Results



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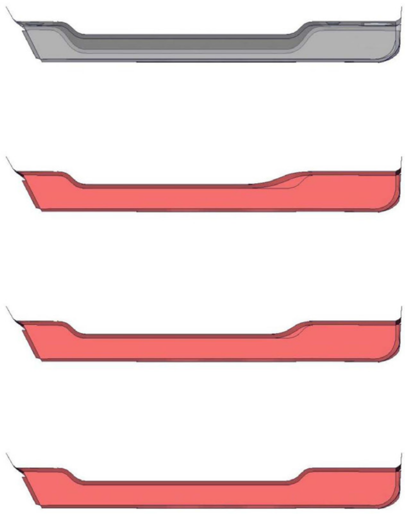
7. Results

#3bar $x_{RG} =$



#3bar		1.15
Run 1.		1.92
Run 2.		1.21
Run 3.		1.04

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Confirmation Runs

	Run 1			Run 2			Run 3		
	$W(\vec{x}^*)$	$I(\vec{x}^*)$	$S(\vec{x}^*)$	$W(\vec{x}^*)$	$I(\vec{x}^*)$	$S(\vec{x}^*)$	$W(\vec{x}^*)$	$I(\vec{x}^*)$	$S(\vec{x}^*)$
Deviation [%]	-0.05	2.19	0.30	0.17	-1.05	0.54	1.21	-1.66	1.13

Weight Reduction

	Weight Reduction [%]
Run 1	-10.99
Run 2	-47.19
Run 3	-54.07

⇨ New concept is promising

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8. Summary

- New design has potential for weight reduction
- MDO enables evaluation of new concept
- SFE CONCEPT is useful tool for creating shape variations
- Global Response Surface Approach (GRSA) was successfully applied
- Evaluation of LS-OPT and comparison to GRSA is planed in future

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