



Sensitivity Studies for the Development of Laser Machines

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Agenda

- TRUMPF
- Challenges for the development of laser cutting machines
- Sensitivity studies
 - Laser & machine's dynamic
 - Optical system
- Summary



About us



We are a high-tech company that focuses on manufacturing technology, laser technology and medical technology.

We offer our customers both innovative and high-quality products.

We are represented in all world markets, close to our customers with 58 subsidiaries.

We are a family business established in 1923 and our goal is to stay economically independent.








At a glance

		2011/12	Change in percent
Sales	mil. EUR	2,328.2	+15.0
Income before Taxes	mil. EUR	210.9	+13.8
Expenditure on Fixed Assets	mil. EUR	152,5	+151.2
R+D Expenditures	mil. EUR	193.4	+ 22.4
Employees as of June 30	number	9,555	+11.8



TRUMPF Group Business Divisions

Machine Tools		Laser Technology/ Electronics		Medical Technology	
Machine Tools		Laser Technology	Electronics	Medical Technology	
 					
Machine tools for flexible sheet metal and tube processing, Power tools for sheet metal processing		Lasers for production technology	Power supplies for induction heating, plasma and CO ₂ laser excitation	Surgical lights, operating tables, video solutions, supply systems	
Sales (mil €)	1,890	Sales (mil €)	727	Sales (mil €)	184
Employees	5,918	Employees	2,330	Employees	713

End of fiscal year: June 30, 2012; consolidated within the business division; figures rounded



TRUMPF Historie – eine Innovationsgeschichte von der Komponente zum High-end System

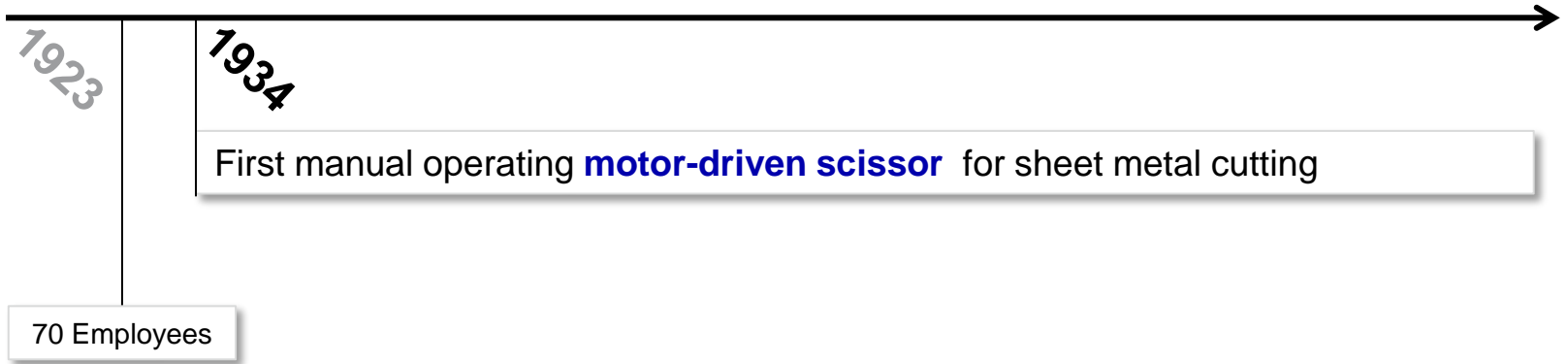


1923

Christian TRUMPF acquires the mechanical shop Julius Geiger.
Flexible shafts for medical application and printers

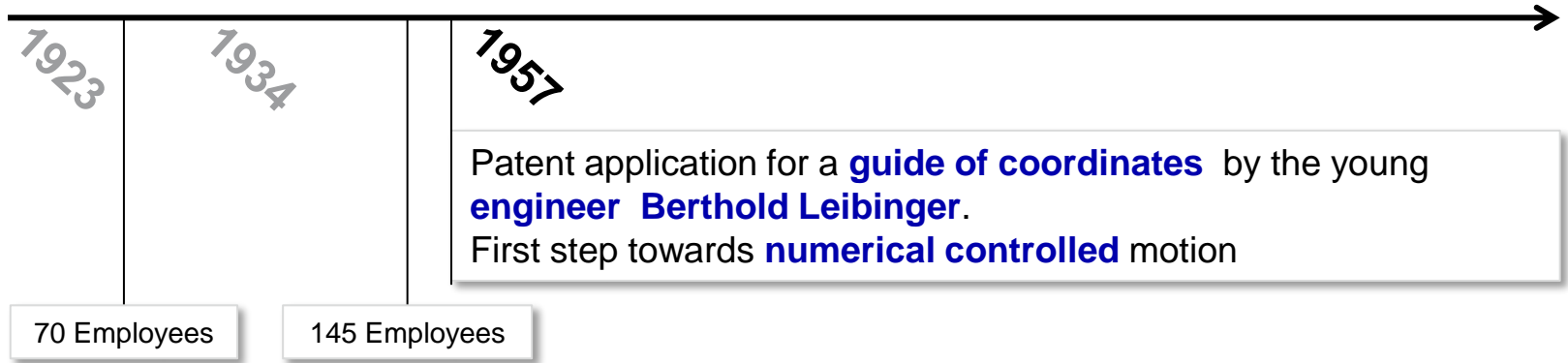


TRUMPF – a success story from a single component to high-end systems



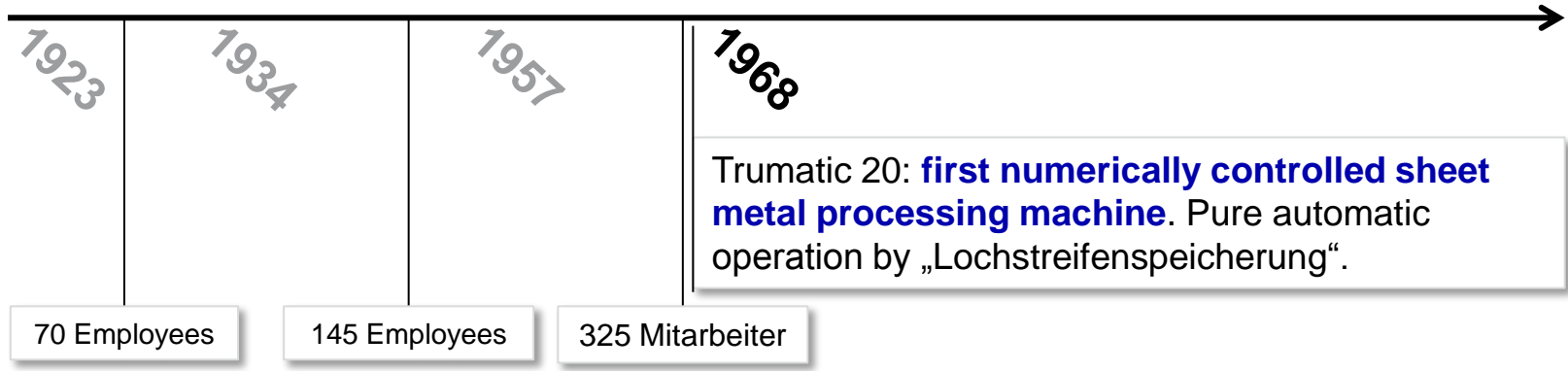


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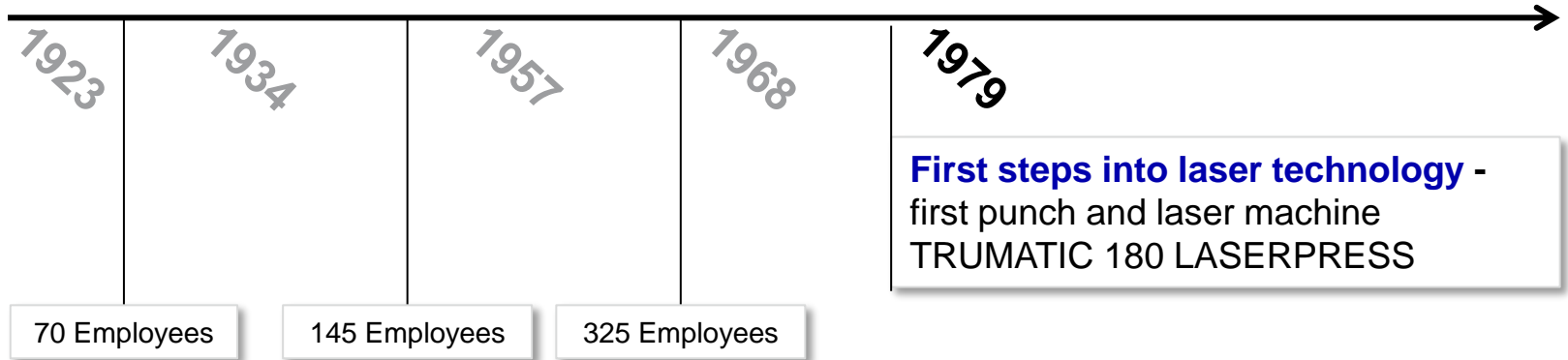


TRUMPF Historie – eine Innovationsgeschichte von der Komponente zum High-end System



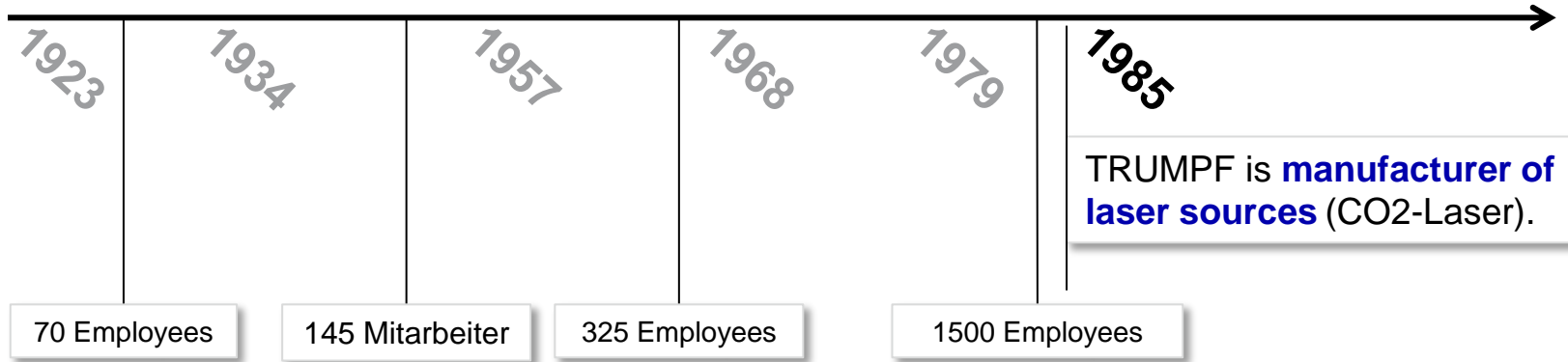


TRUMPF – a success story from a single component to high-end systems





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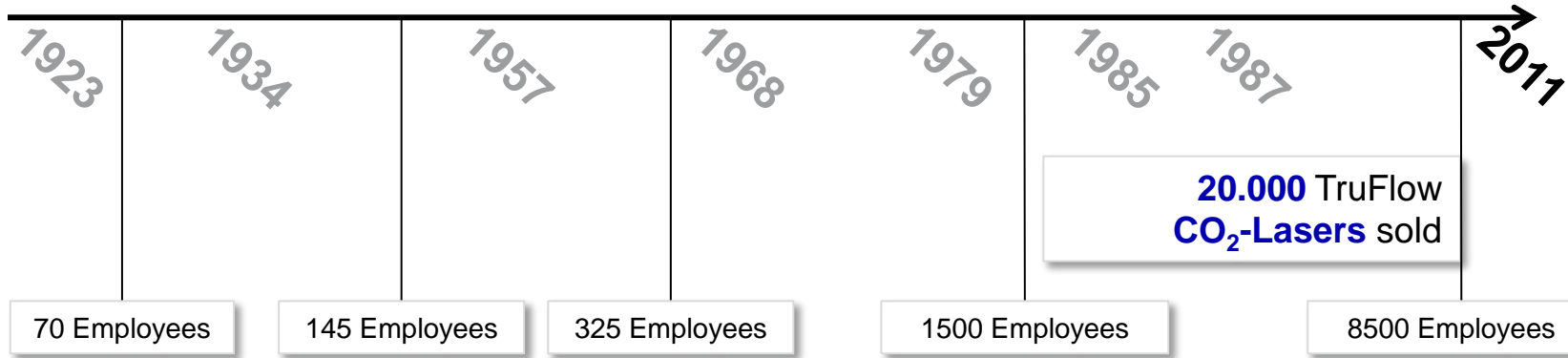
TRUMPF – a success story from a single component to high-end systems



First **2D-laser cutting machine**
TRUMATIC L3000

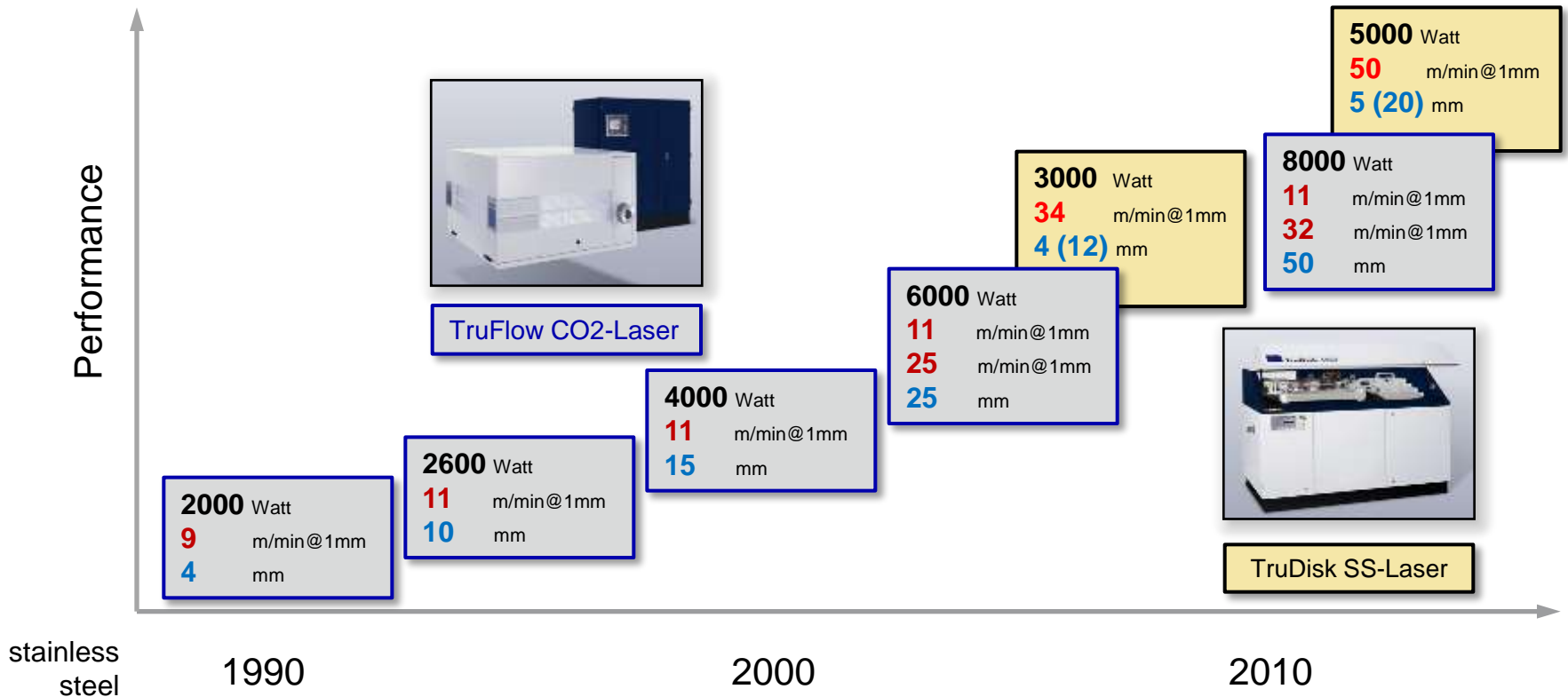


TRUMPF – a success story from a single component to high-end systems





Cutting and laser technology define the performance progress





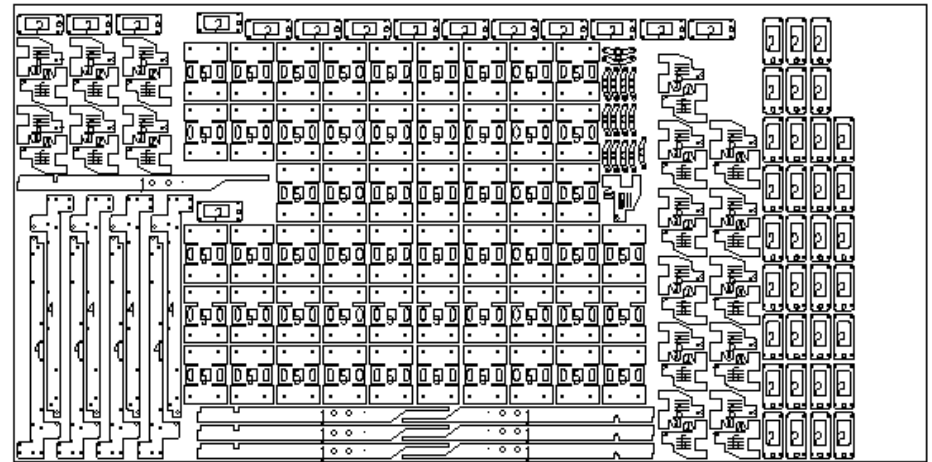
Solid state lasers almost doubled the portfolio





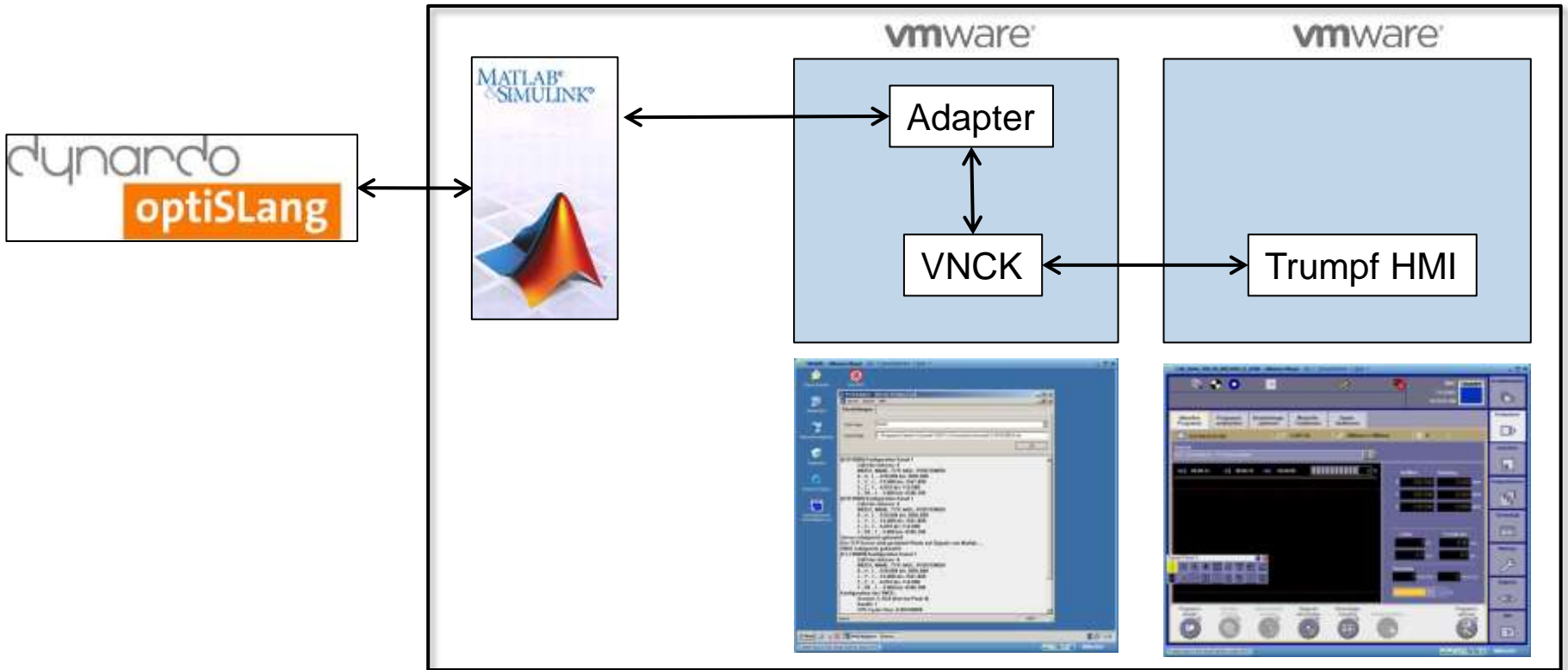
Sensitivity studies help to find efficient laser - machine combinations

- Input parameter laser
 - Forward feed
- Input parameter of the machine's dynamic
 - Acceleration
 - Jerk
- Output
 - Average velocity
 - Duration of production
- Test case
 - Sheet metal 2.500x1.250 mm²
 - 169 parts
 - TruLaser 3030 → 33 minutes



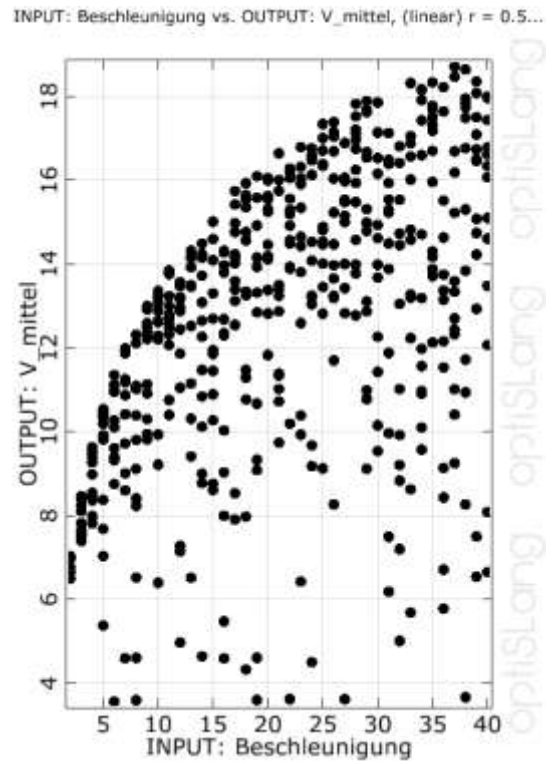
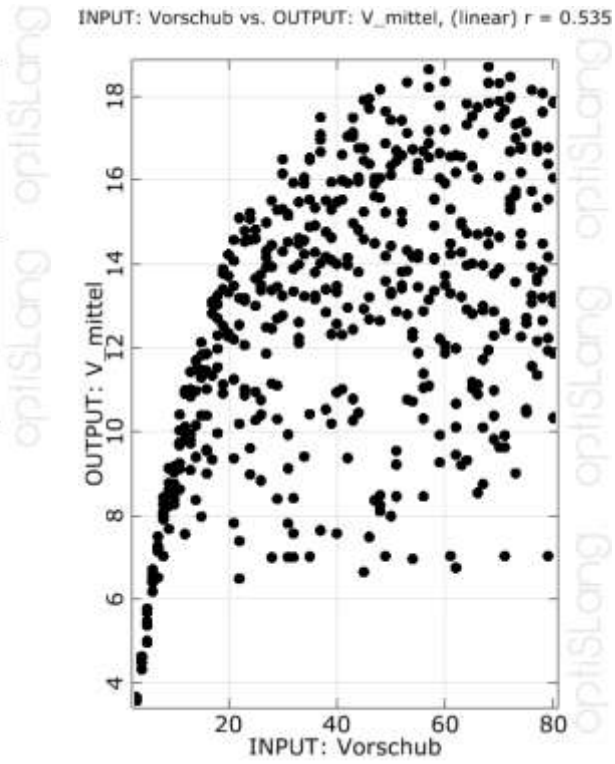
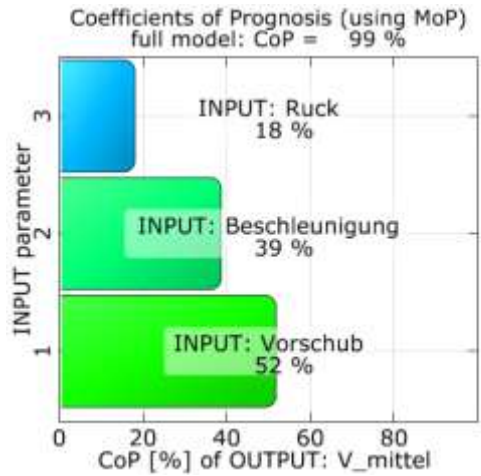


Virtual control unit as basic model VNCK “virtueller NC-Kern” by Siemens





Results (1)

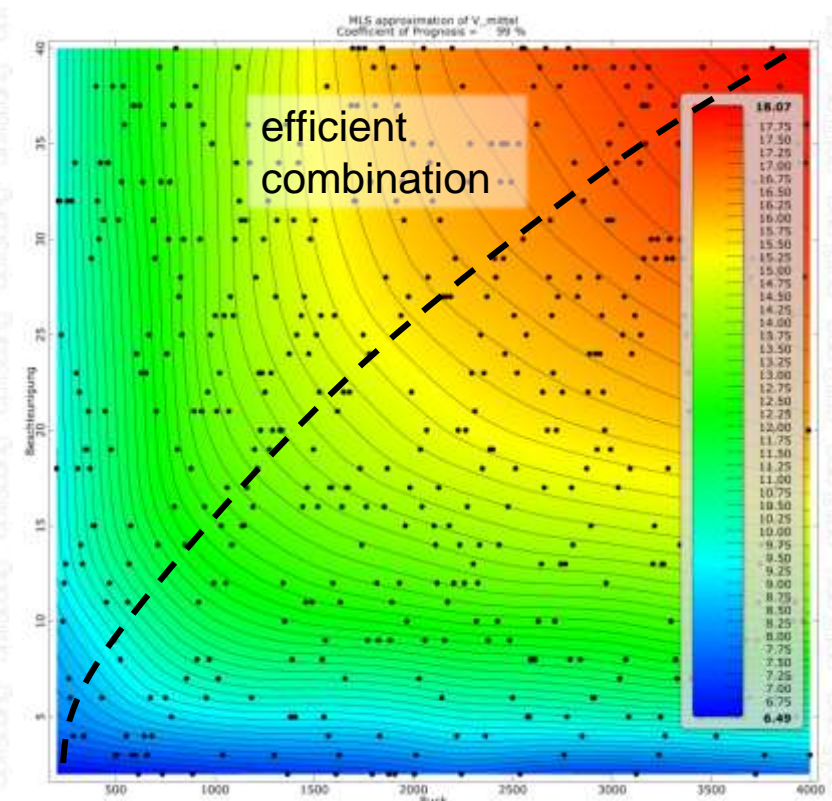
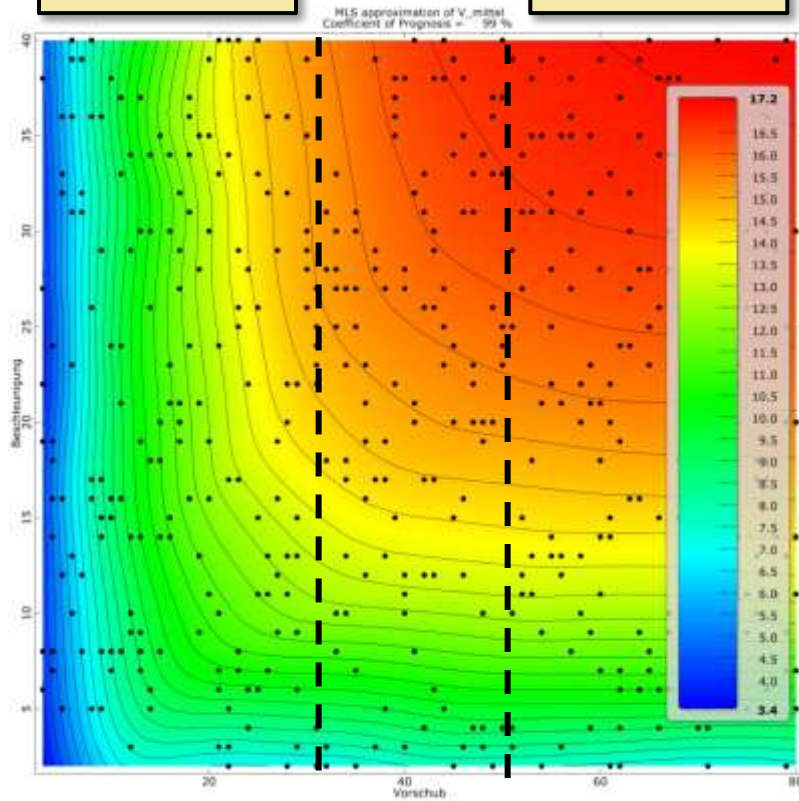




Results (2)

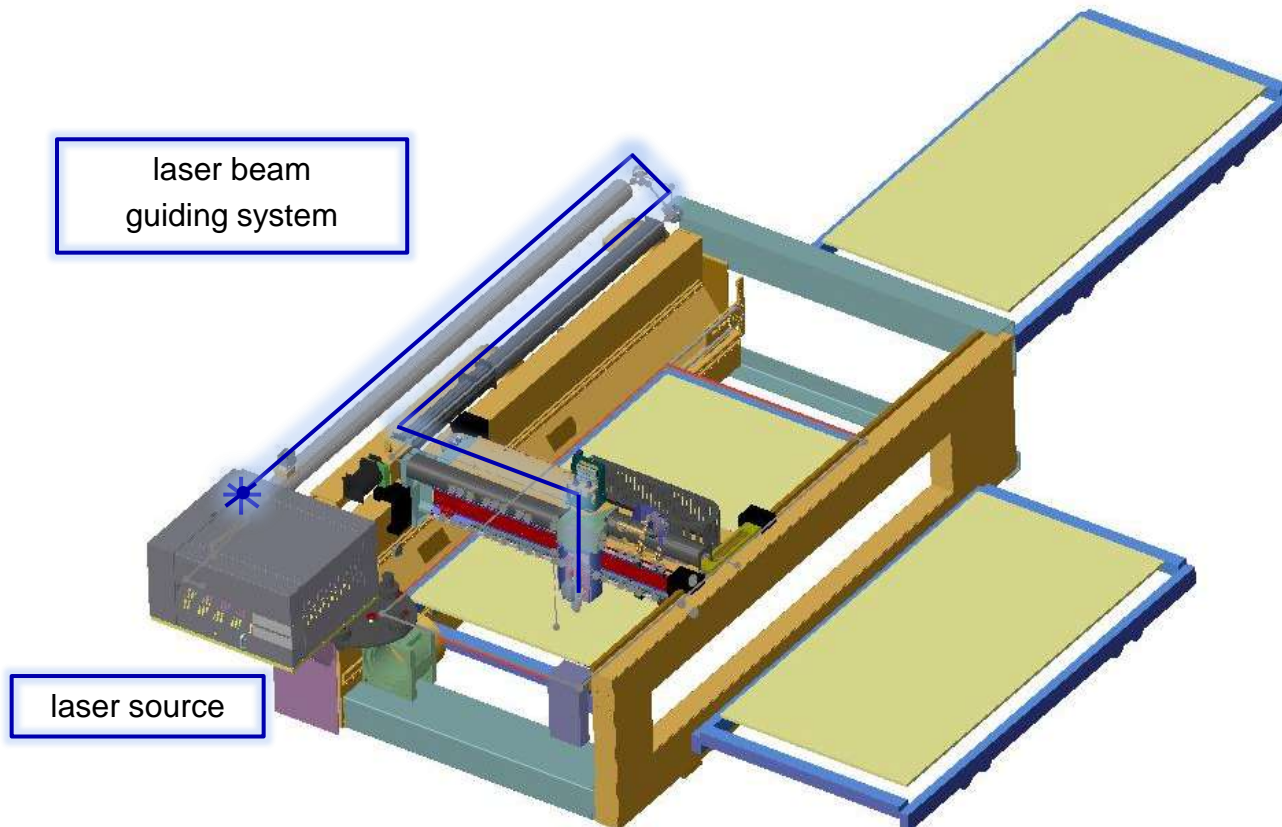
3000 Watt
34 m/min@1mm

5000 Watt
50 m/min@1mm



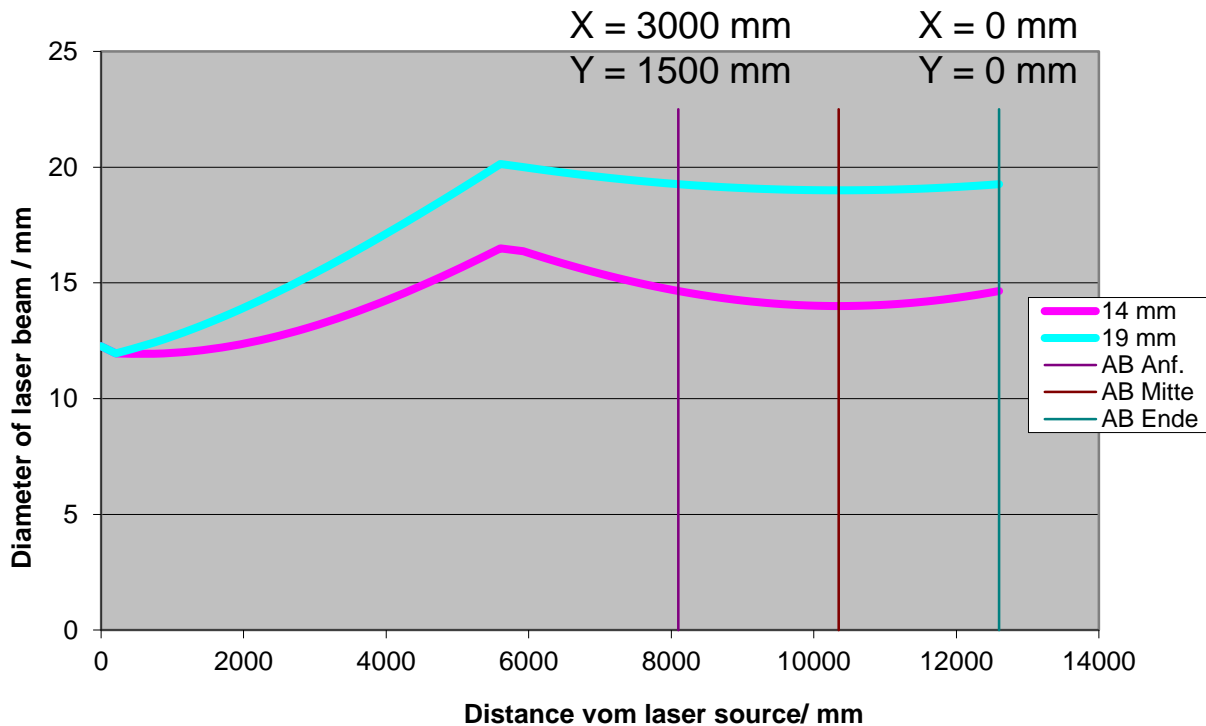


High quality laser cutting requires several parameters in a certain range





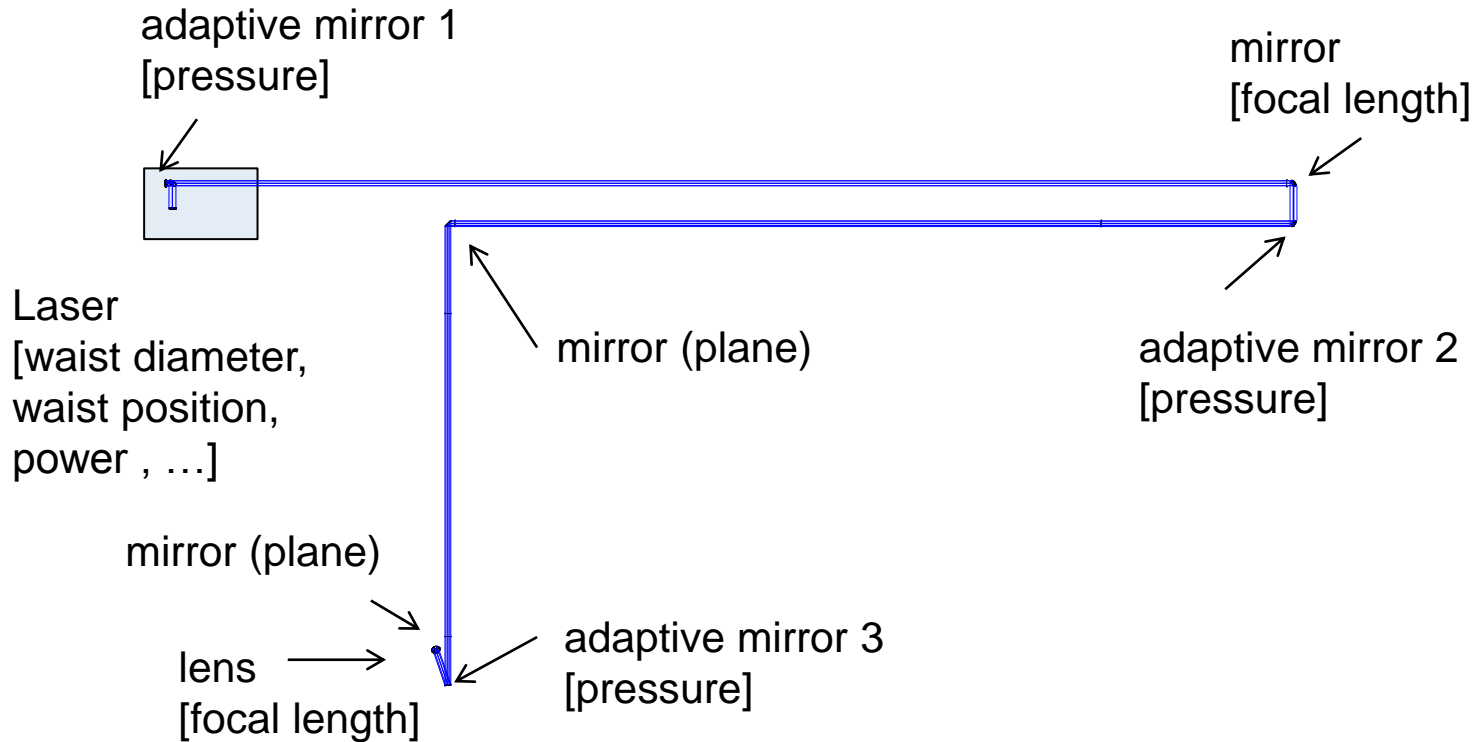
Basic optical design calculated with ZEMAX



For both beam diameters, the beam waist is placed be in the centre of the machine

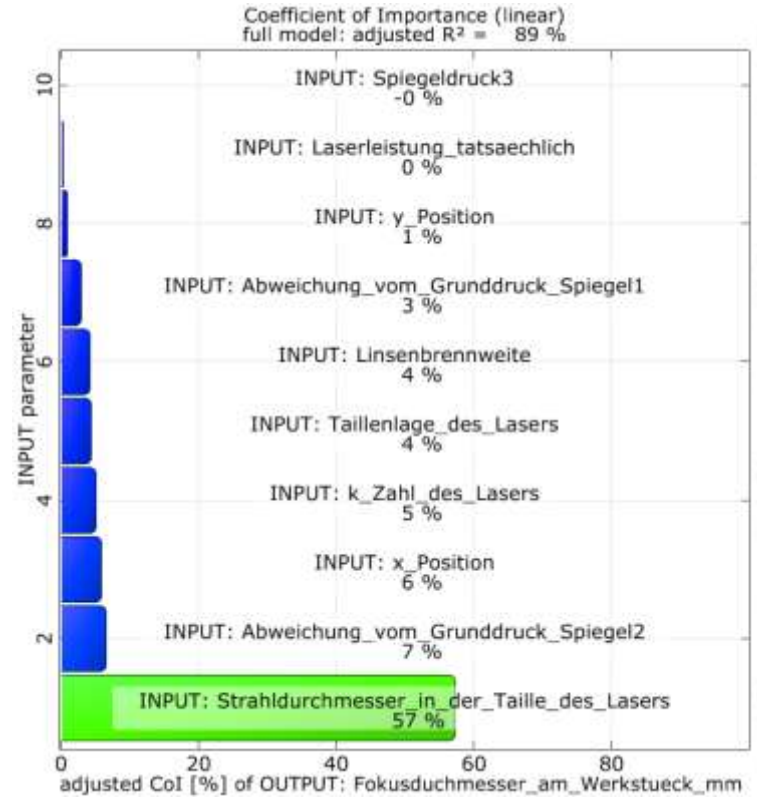
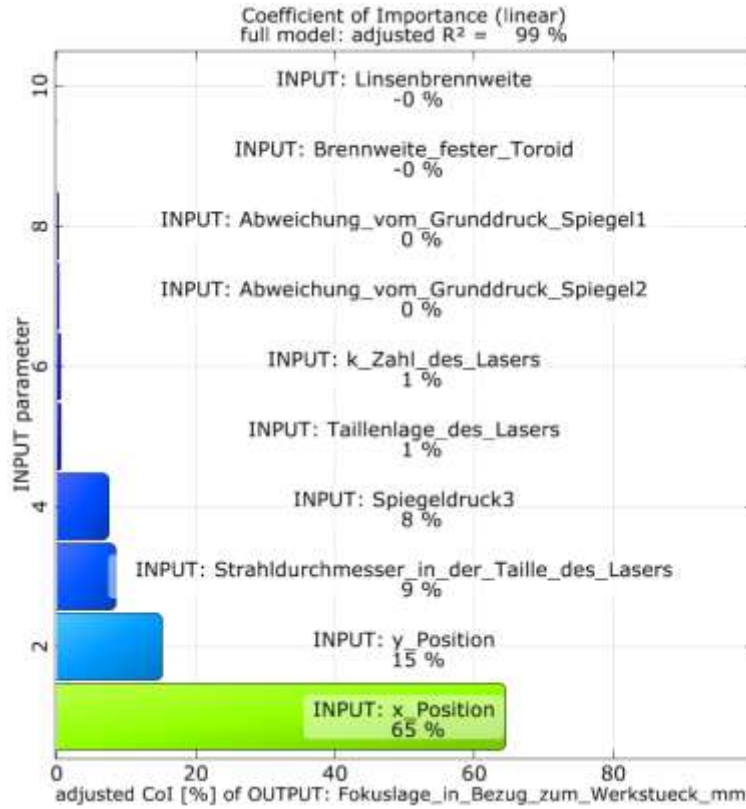


Optical components and it's parameters for sensitivity study



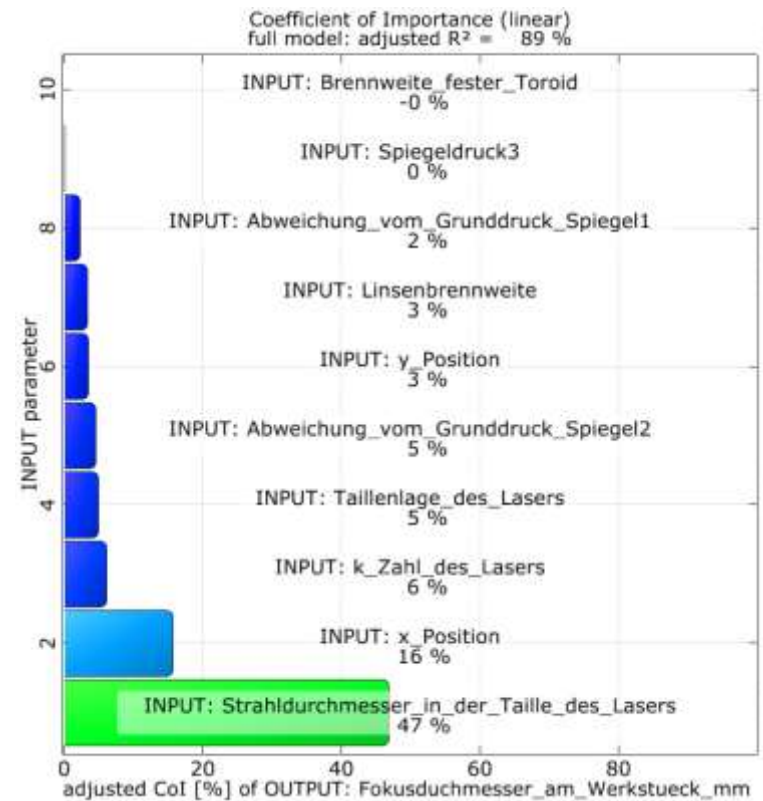
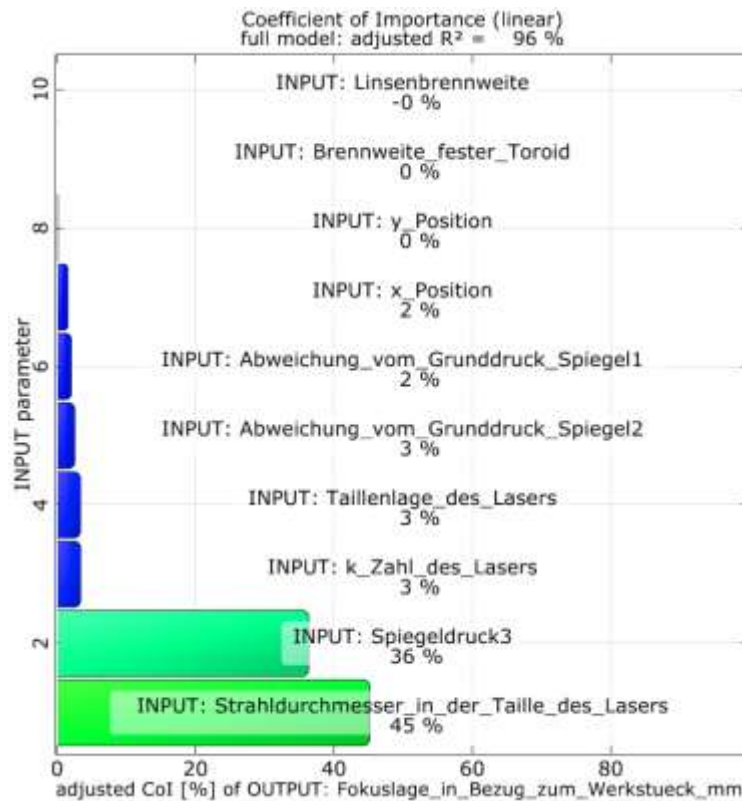


Results





Results with active compensation (mirror 3)





Summary

- First steps towards the field of CAE based robust design
- Sensitivity analysis are already helpful
- For simple models only a minor improvements can be achieved
- Knowing the technology and the simulation model is a huge benefit