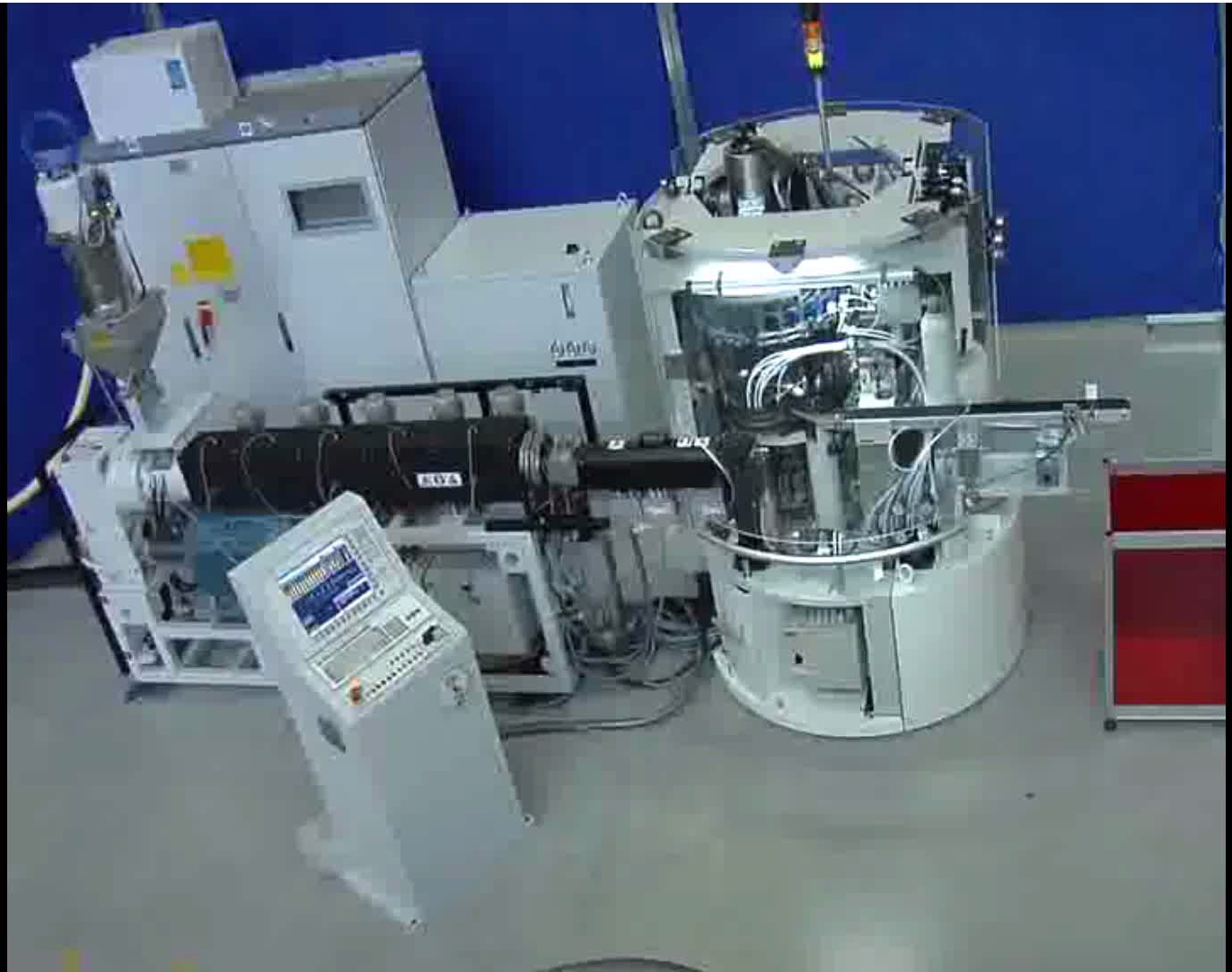
23-october-2012

Mechanical optimization of the injection system in a compression molding machine.

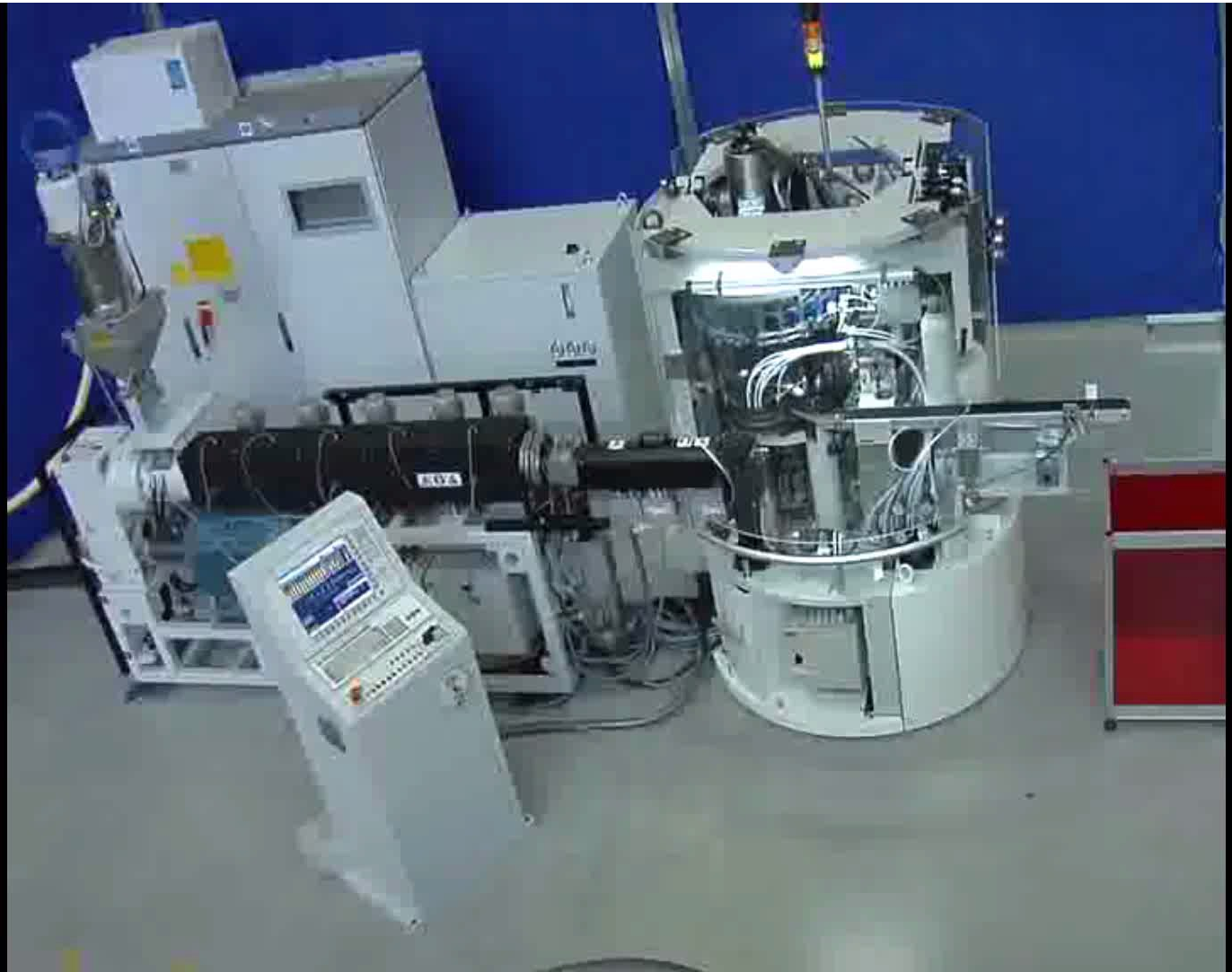
SACMI

Andrea Minardi

What our machine do…

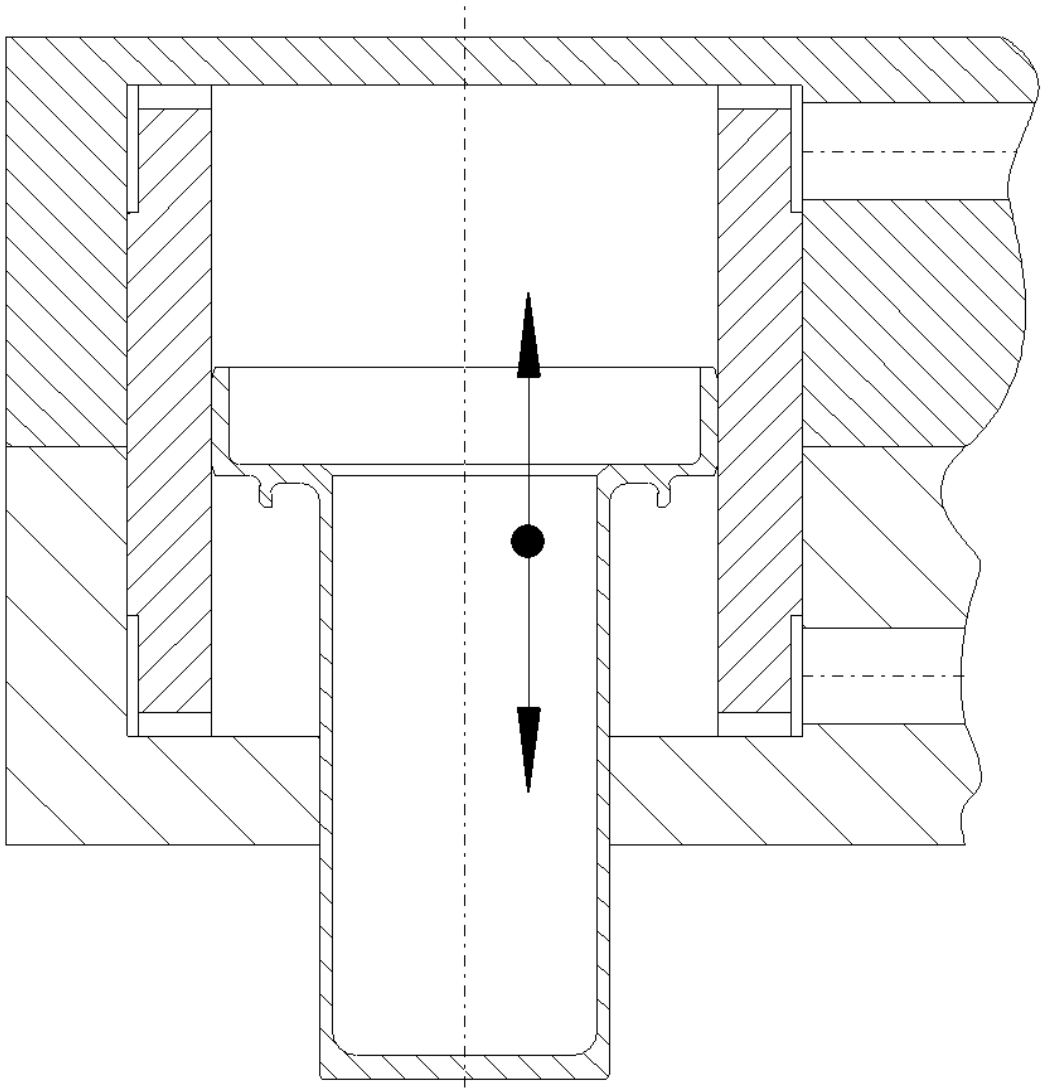


What our machine do…



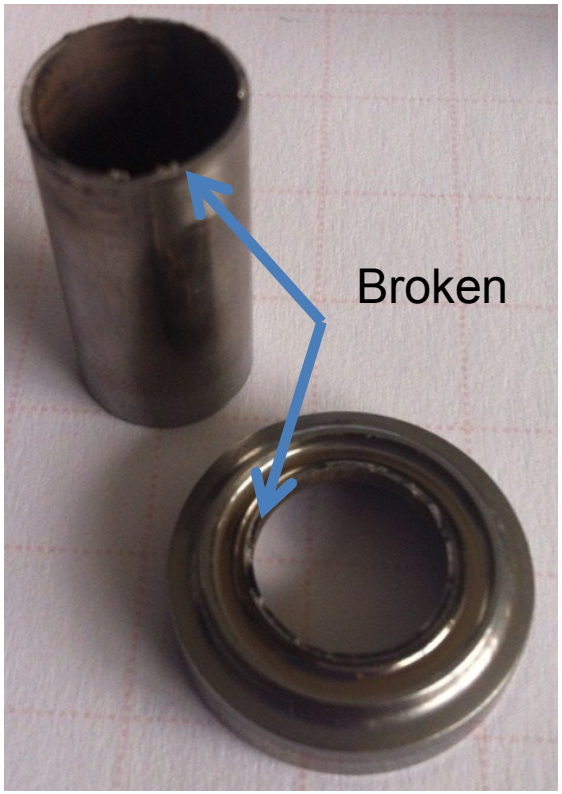
My case of study:

Optimization of the pneumatic piston in the injection system.



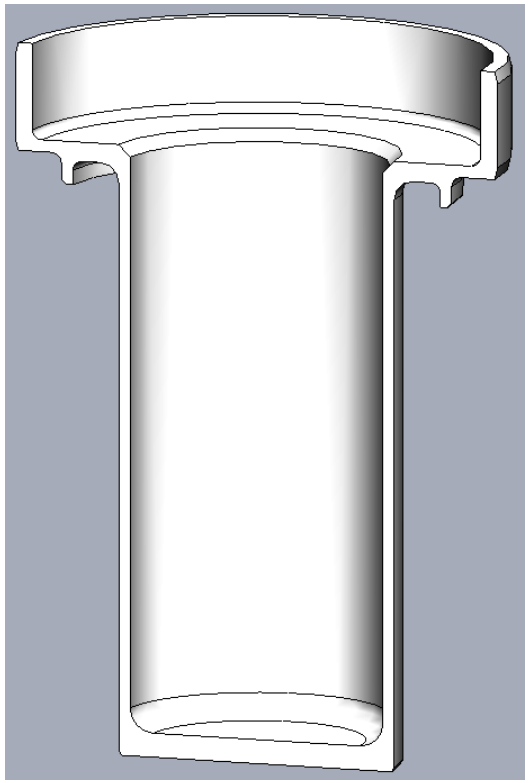
Three years ago…

Sometimes we had feedback from the customers about pneumatic piston broken.

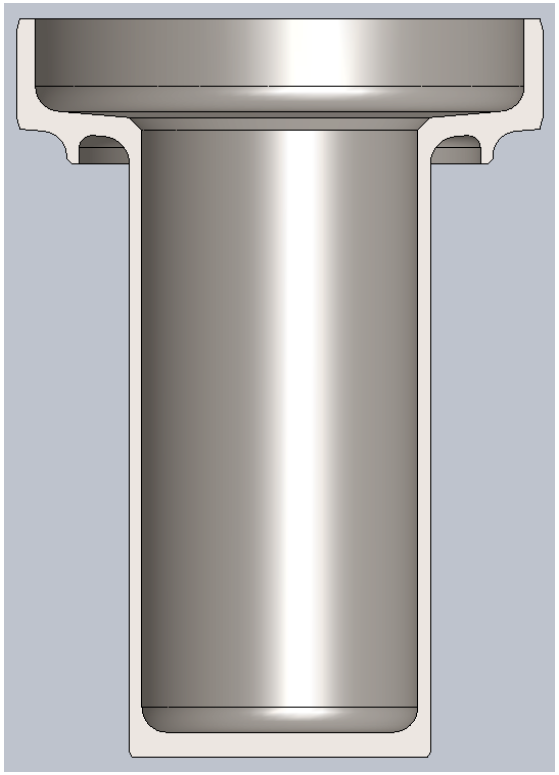


…my job was to find a geometry able to work in this condition without broken. My instrument was Solidworks & Ansys.

After

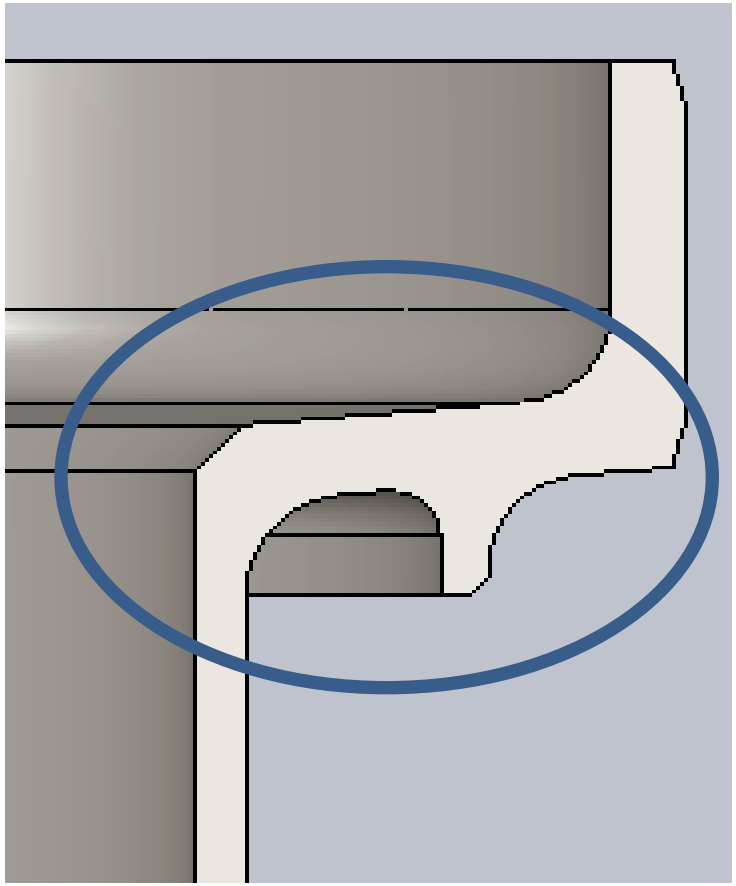


Before



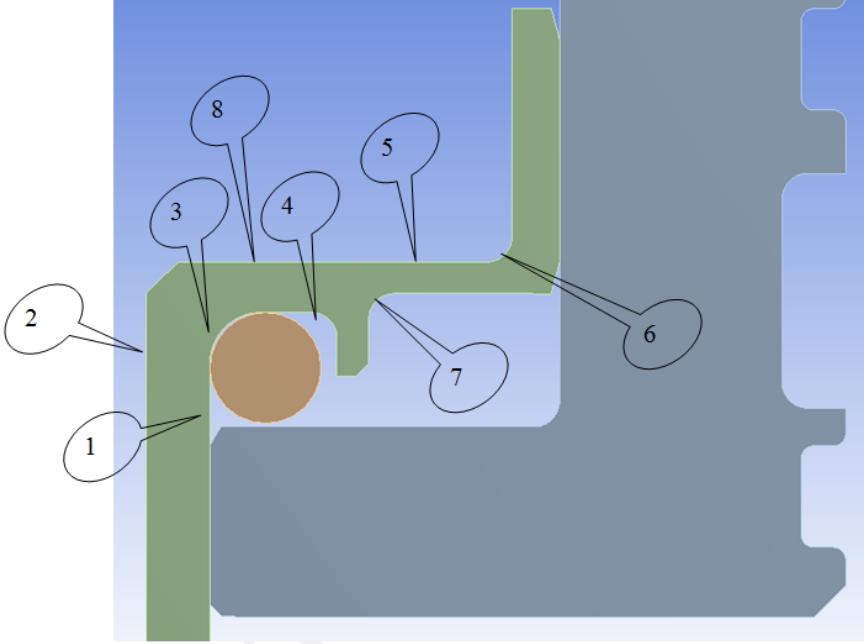
My “manual” optimization consist to model my piston with a tapered geometry in the broken regions. the piston.

! Other target of my optimization is to not increase the weight of the piston, to avoid the possibility to damage the surrounding parts.



…the results…

…increment of the safety factor from 0.9 to 1.2 about **+33%**



Calcolo del Coefficiente di Sicurezza per cicli a fatica

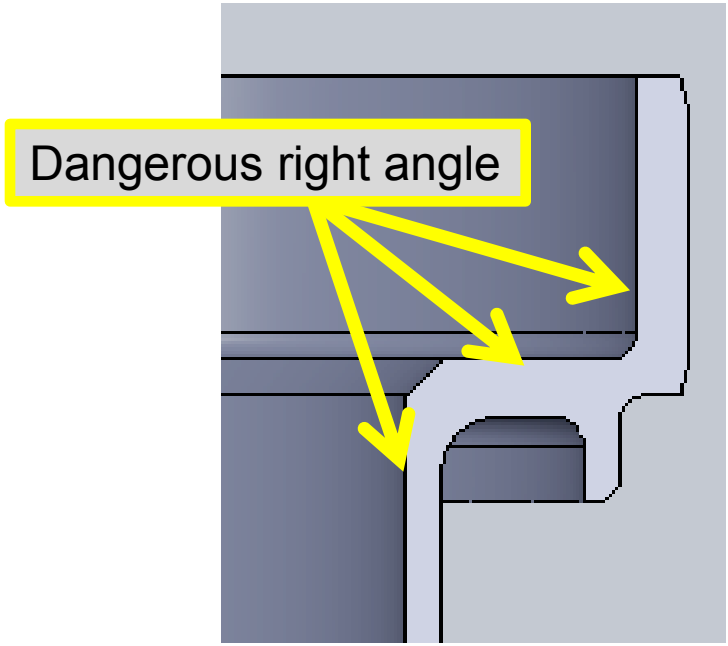
$\sigma_{rottura}$	1100	N/mm²
$\sigma_{snervamento}$	910	N/mm²
$\sigma_{limite\ della\ fatica}$	484	N/mm²

	Ø12mm old			12mm new		
region	$\sigma_{massima}$	σ_{minima}	C. S.	$\sigma_{massima}$	σ_{minima}	C. S.
1	134 N/mm²	-624 N/mm²	1,0	158 N/mm²	-249 N/mm²	2,2
2	680 N/mm²	-243 N/mm²	0,9	27[illegible] N/mm²	-156 N/mm²	2,0
3	234 N/mm²	-680 N/mm²	0,9	244 N/mm²	-452 N/mm²	1,2
4	206 N/mm²	-138 N/mm²	2,6	108 N/mm²	-73 N/mm²	4,9
5	226 N/mm²	-623 N/mm²	0,9	98 N/mm²	-163 N/mm²	3,3
6	245 N/mm²	-654 N/mm²	0,9	149 N/mm²	-275 N/mm²	2,0
7	227 N/mm²	-328 N/mm²	1,6	99 N/mm²	-97 N/mm²	4,9
8	352 N/mm²	-107 N/mm²	1,7	108 N/mm²	-75 N/mm²	4,9

…now…

…diameter 16mm piston need to be optimized…

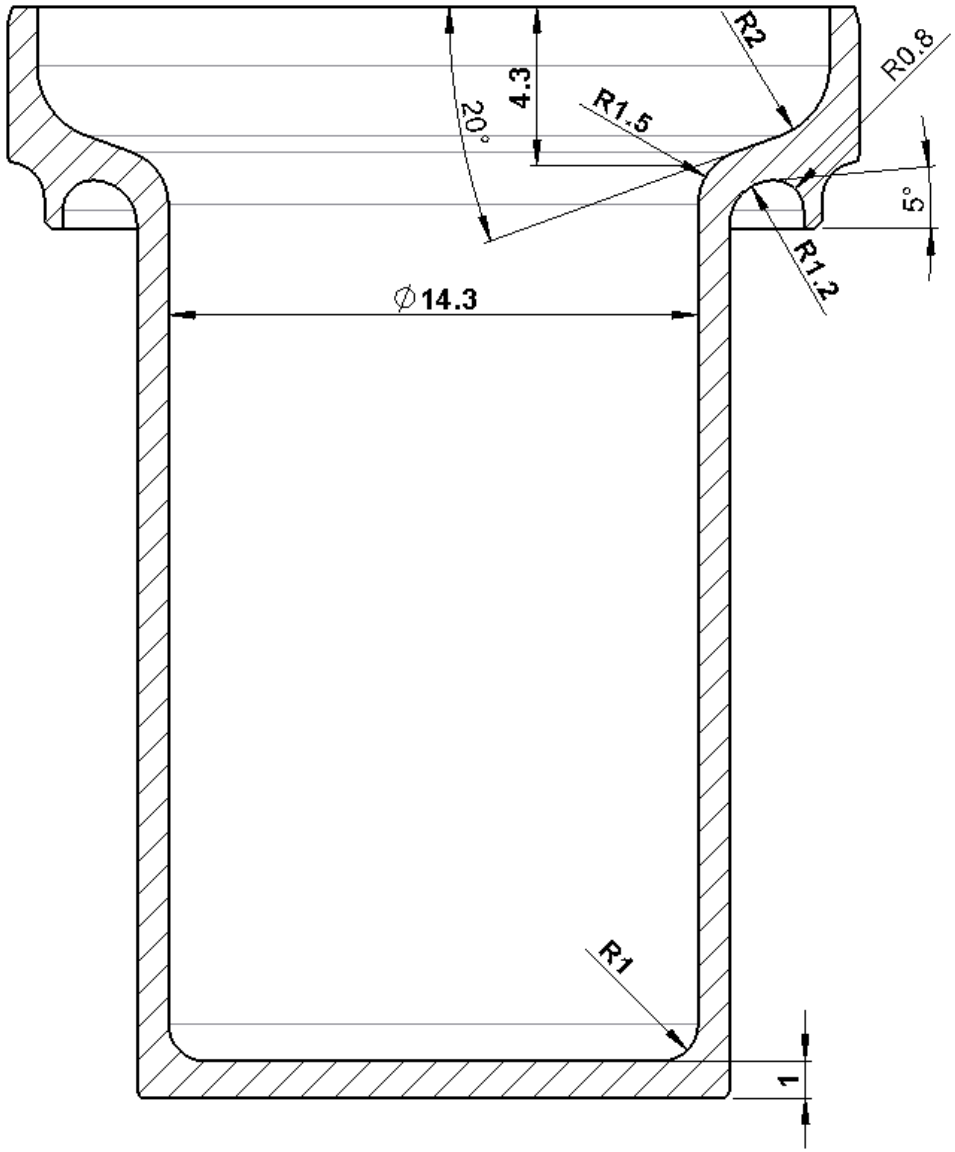
The old 16mm piston was been designed like the old 12mm piston...



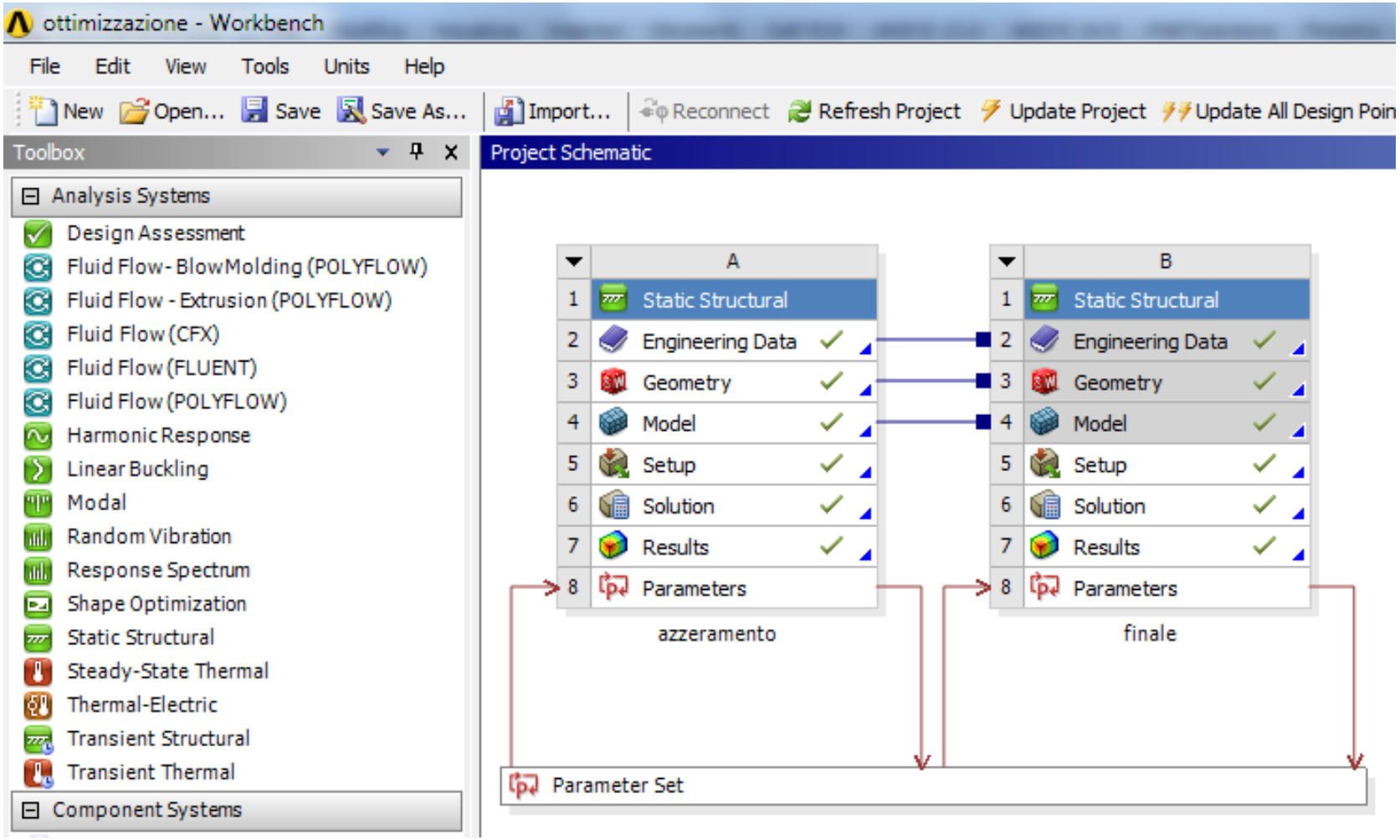
…but now I’ve one more software available…

ModeFRONTIER.

Parameter of my simulatio



The setting of my simulation in ANSYS



The structure of my optimization:

Parameters

DOE Parameters

Sobol Algorithm with 16 Designs

Optimizer

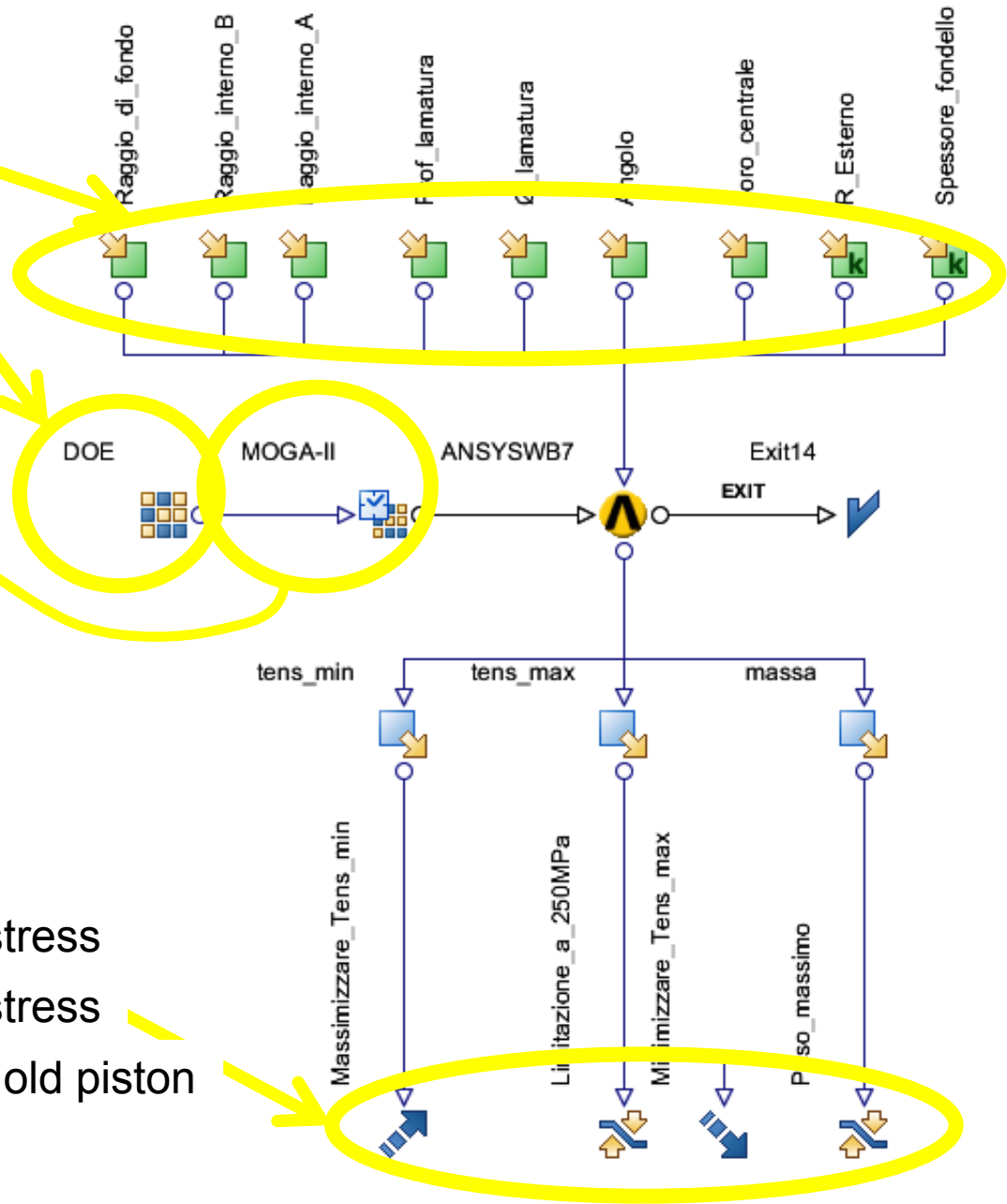
Moga II algorithm with 50 iterations

My Targets

1° Minimize the maximal principal stress

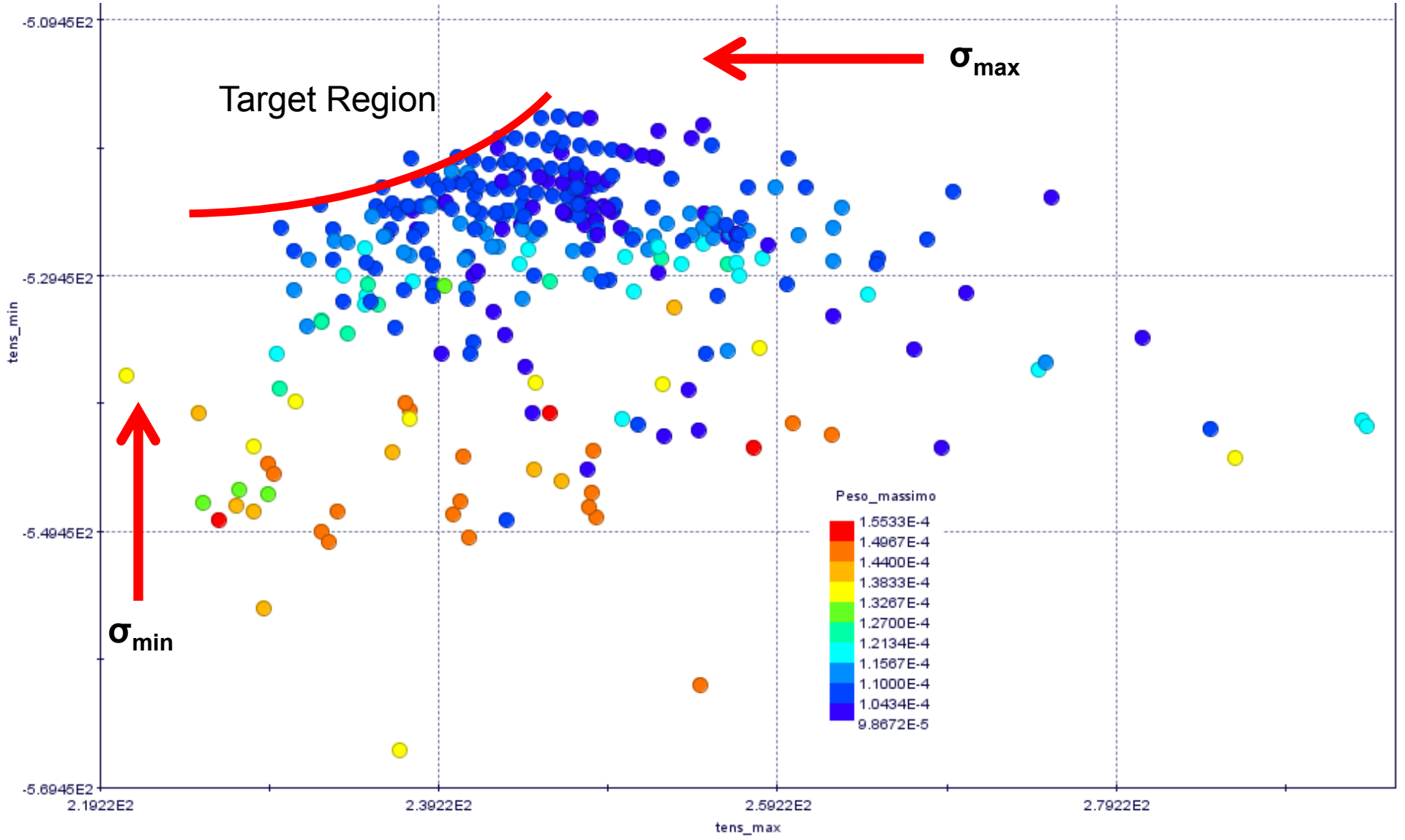
2° Maximize the minimal principal stress

3° Maintain the same weight of the old piston



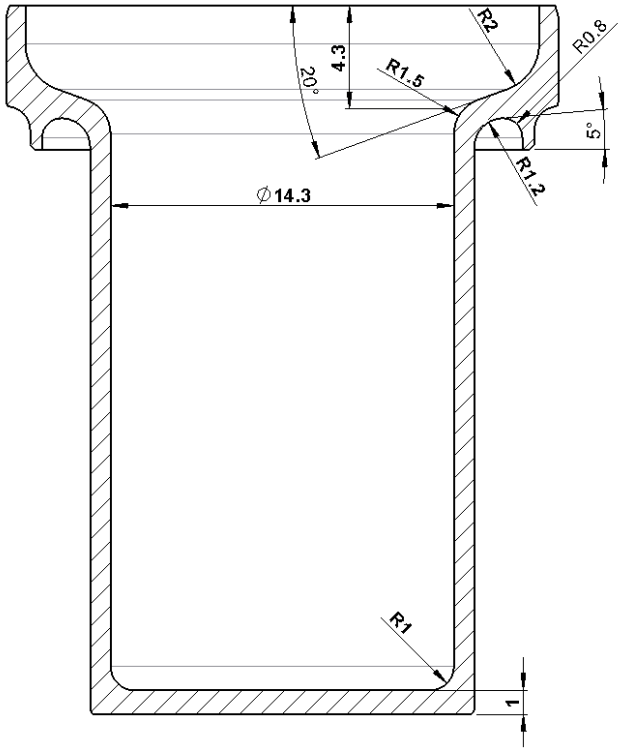
…the results…

After 800 runs (elapsed time about 24hrs)

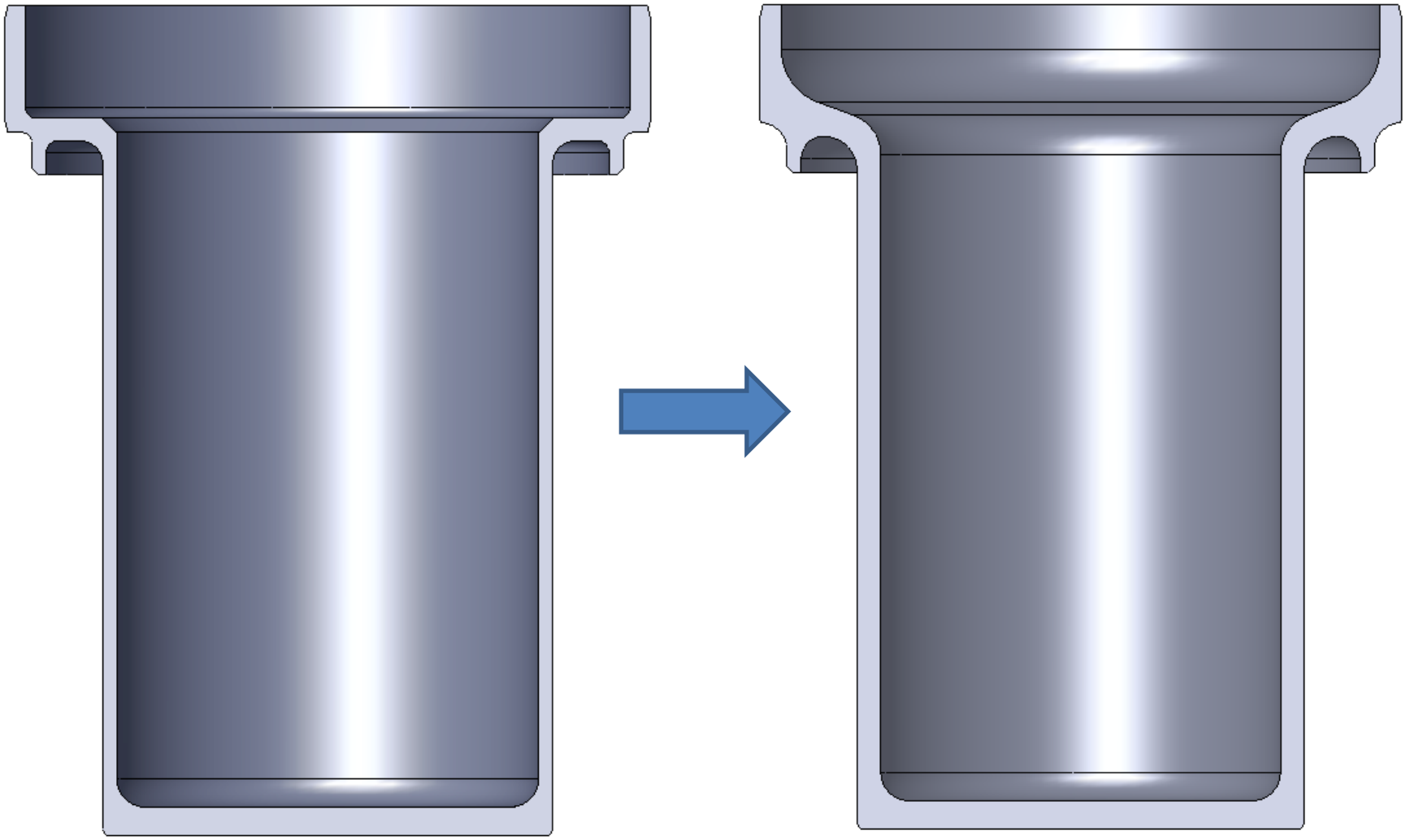


…about correlation matrix

The influence of the parameters on targets.



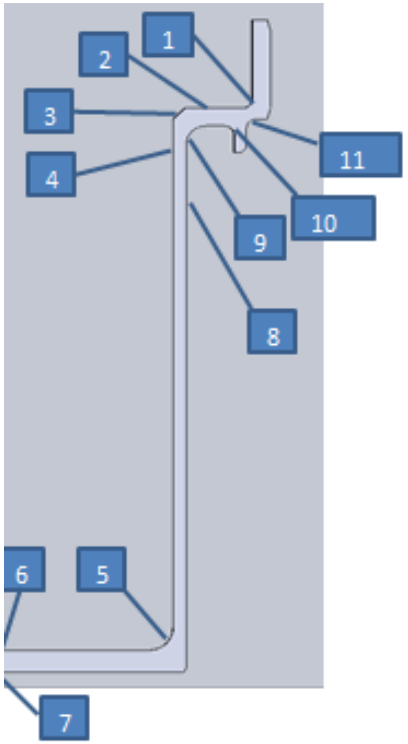
Geometry comparison



For manufacturing necessity some performing solution has been discarded

…the improvement in “number”…

increment of the safety factor from 0.9 to 1.3
about **+44%**



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	Ø16mm old			16mm new		
region	$\sigma_{massima}$	σ_{minima}	C. S.	$\sigma_{massima}$	σ_{minima}	C. S.
1	0 N/mm^2	-713 N/mm^2	***0,9***	0 N/mm^2	-355 N/mm^2	**1,9**
2	196 N/mm^2	0 N/mm^2	**3,4**	[illegible] N/mm^2	0 N/mm^2	**16,0**
3	175 N/mm^2	0 N/mm^2	**3,8**	256 N/mm^2	0 N/mm^2	**2,6**
4	456 N/mm^2	-130 N/mm^2	**1,3**	256 N/mm^2	0 N/mm^2	**2,6**
5	0 N/mm^2	-131 N/mm^2	**5,1**	50 N/mm^2	-288 N/mm^2	**2,2**
6	81 N/mm^2	0 N/mm^2	**8,3**	130 N/mm^2	0 N/mm^2	**5,2**
7	0 N/mm^2	-95 N/mm^2	**7,1**	0 N/mm^2	-149 N/mm^2	**4,5**
8	0 N/mm^2	-594 N/mm^2	**1,1**	0 N/mm^2	-420 N/mm^2	**1,6**
9	0 N/mm^2	-712 N/mm^2	**0,9**	0 N/mm^2	-526 N/mm^2	***1,3***
10	206 N/mm^2	0 N/mm^2	**3,3**	118 N/mm^2	0 N/mm^2	**5,7**
11	528 N/mm^2	0 N/mm^2	**1,3**	83 N/mm^2	0 N/mm^2	**8,1**

To take a summary and comparison

	“Manual Optimization”	Mode Frontier
Number of running	About 30	800
Improvement obtained	+30%	+44%
Total time employed	20 days	3 days + 1 day of calculation

Thanks for the attention

Andrea Minardi

A particularly thanks to all my co-workers, especially Loreti S. and Morsiani R. for all their support during this optimization

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