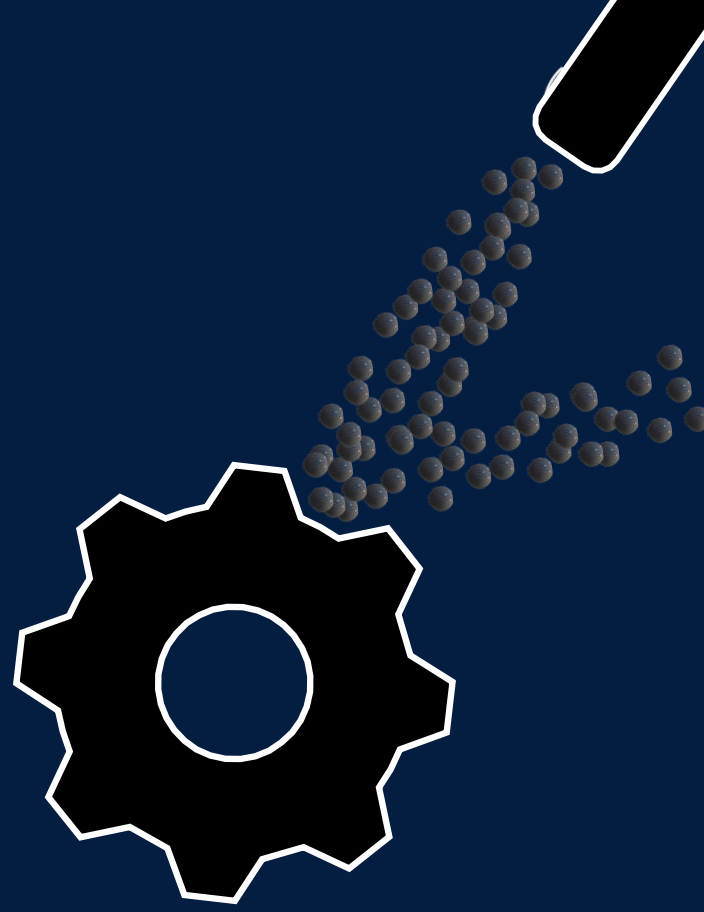
SHOT PEENING PROCESS OPTIMIZATION



SOPHIA FÁTIMA MONTEIRO

MECHANICAL ENGINEERING - ENGINEERING DESIGN AND PRODUCT DEVELOPMENT

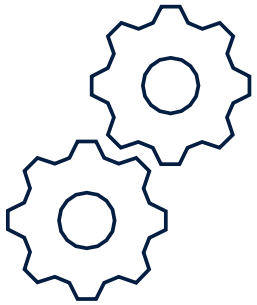
LINKÖPING UNIVERSITY

SCANIA

Agenda:

- Introduction
- Objective
- Method
- Models
- Results
- Discussion
- Conclusion

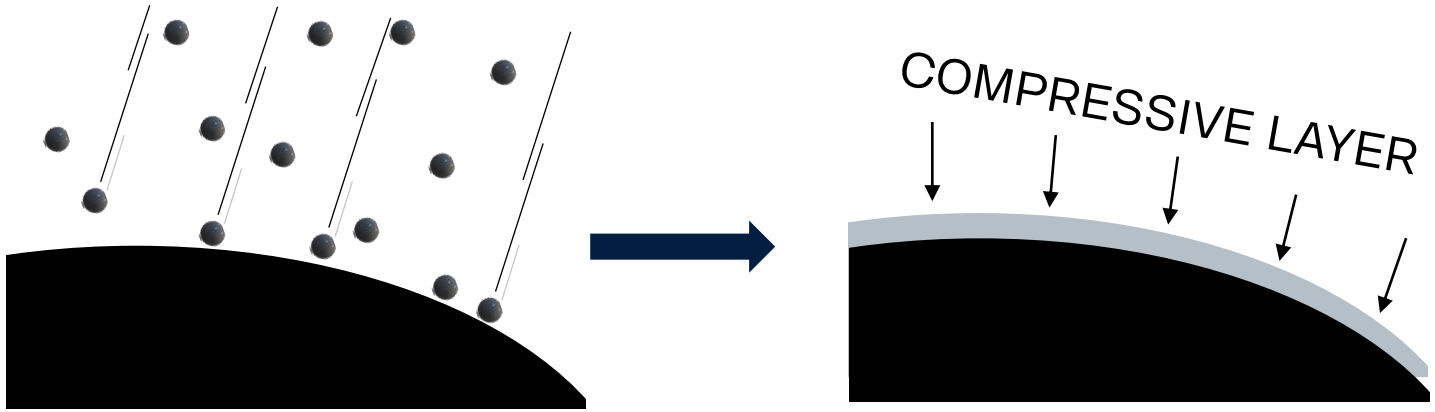
Introduction:



- The thesis work is conducted with the department of heat treatment (DXTMH) at Scania
- Optimize the gear shot peening process
- What is shot peening?
- Why it is used in Scania
- Why thesis is conducted - thesis purpose

Theoretical Information

- Shot Peening Parameters
  - Peening time (CT)
  - Peening pressure /velocity
  - Shot size
  - Shot material hardness
  - Gear material hardness



Objectives

1. Find optimal parameter settings for compressed air type machine to obtain Class 3 specification requirements (double shot peening)

2. Investigate the influence of parameters on strength of gears.

3. Validate results by conducting experimental test

4. Analyse the results obtained

METHODS

METHODS AND TOOLS USED AND HOW THEY ARE CONNECTED

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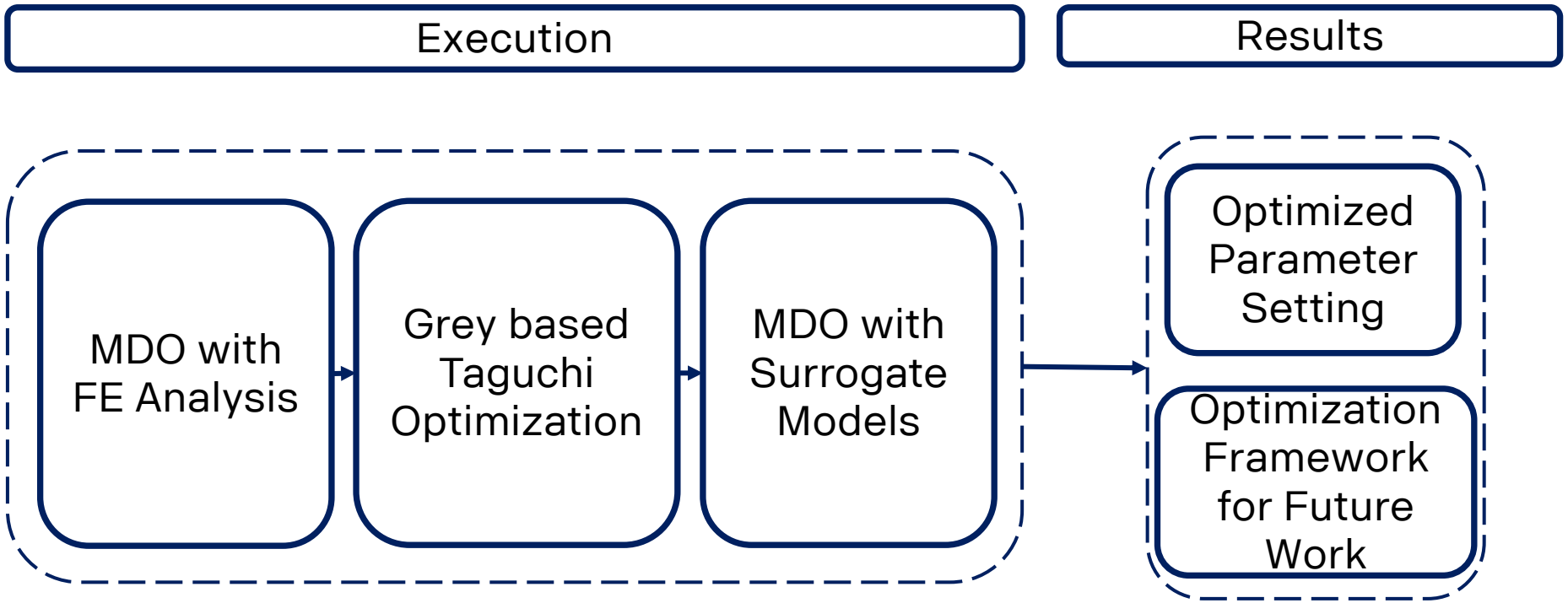
Workflow


Execution
Results
MDO with FE Analysis
Grey based Taguchi Optimization
MDO with Surrogate Models
Optimized Parameter Setting
Optimization Framework for Future Work

MDO USING FE ANALYSIS

FIRST OPTIMIZATION

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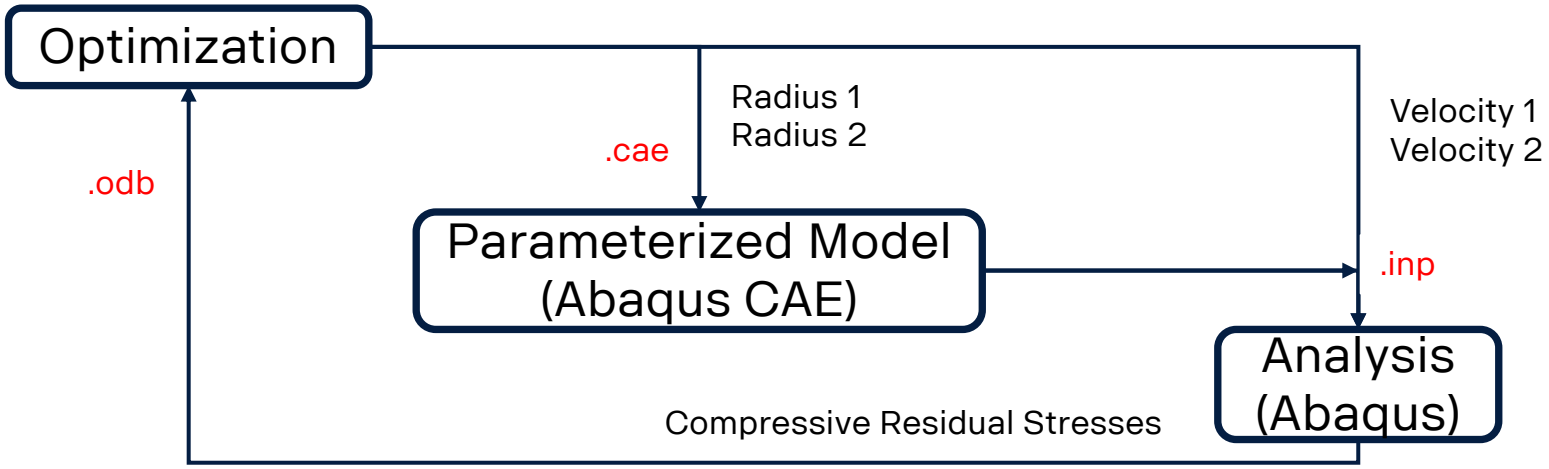
Multidisciplinary Design Optimization using FEA

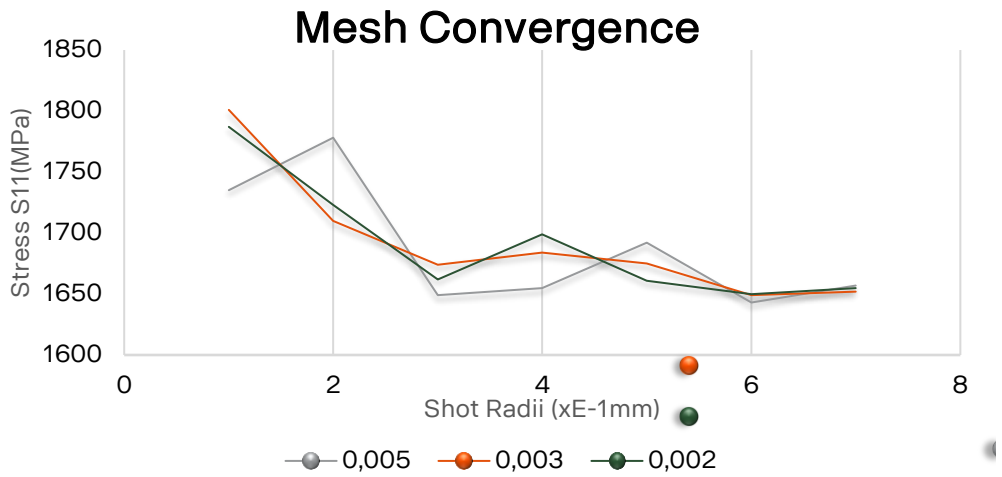
- Tools used: HEEDS
- Optimization Algorithm: SHERPA
- Number of evaluations: 150
- Parameter Settings based on machine specification

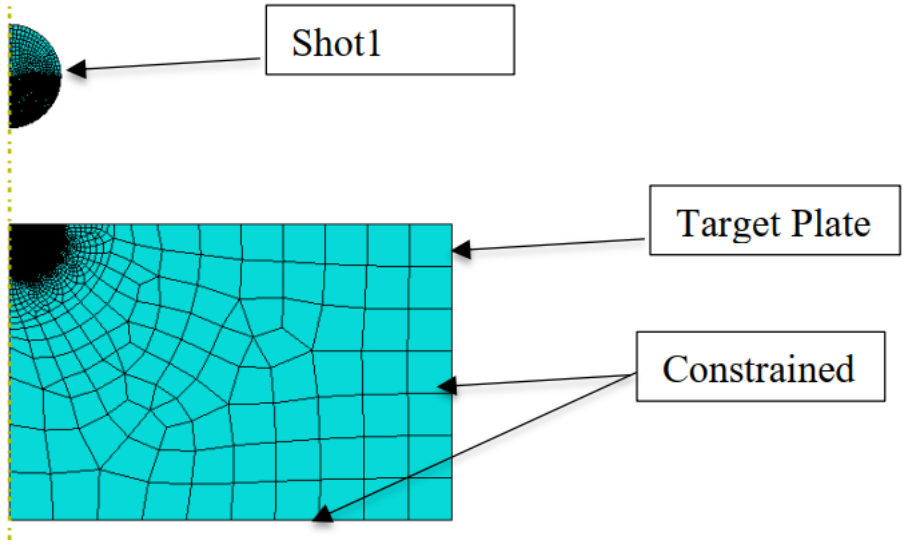


min f(x) = Stress
Subject to: f(x) $\leq$ -1700MPa

Parameterized Model and Stress Analysis :

- Tools used: Abaqus Explicit
- Modelling: Axisymmetric Model
- Assumption: Rectangular target plate instead of gear profile
- Mesh Study
- Validation





MDO USING SURROGATE MODELS

THIRD OPTIMIZATION

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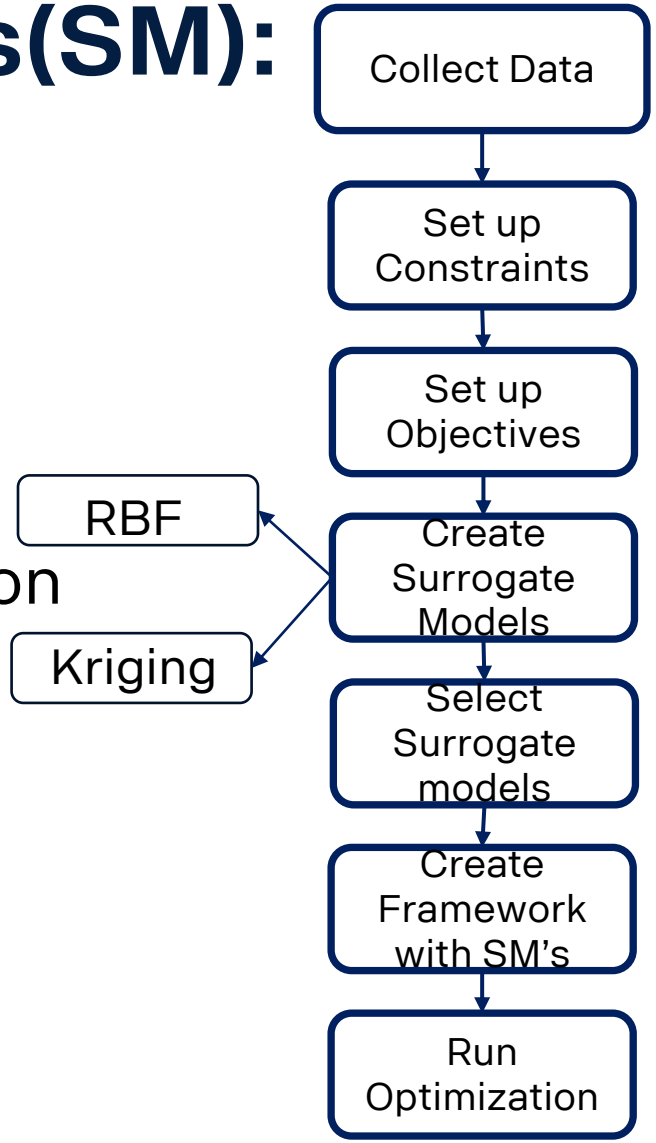
Optimization using Surrogate Models(SM):

- Tools used: HEEDS
- Optimization Algorithm: SHERPA
- Number of evaluations: 300
- Parameter Settings based on machine specification
- Prediction accuracy: 96%

max f(x) = CRS_0
max g(x) = CRS_20
max h(x) = CRS_50

Subject to: f1 MPa $\leq$ f(x) $\leq$ f2 MPa
Subject to: g1 MPa $\leq$ g(x) $\leq$ g2 MPa
Subject to: h1 MPa $\leq$ h(x) $\leq$ h2 MPa



RESULTS

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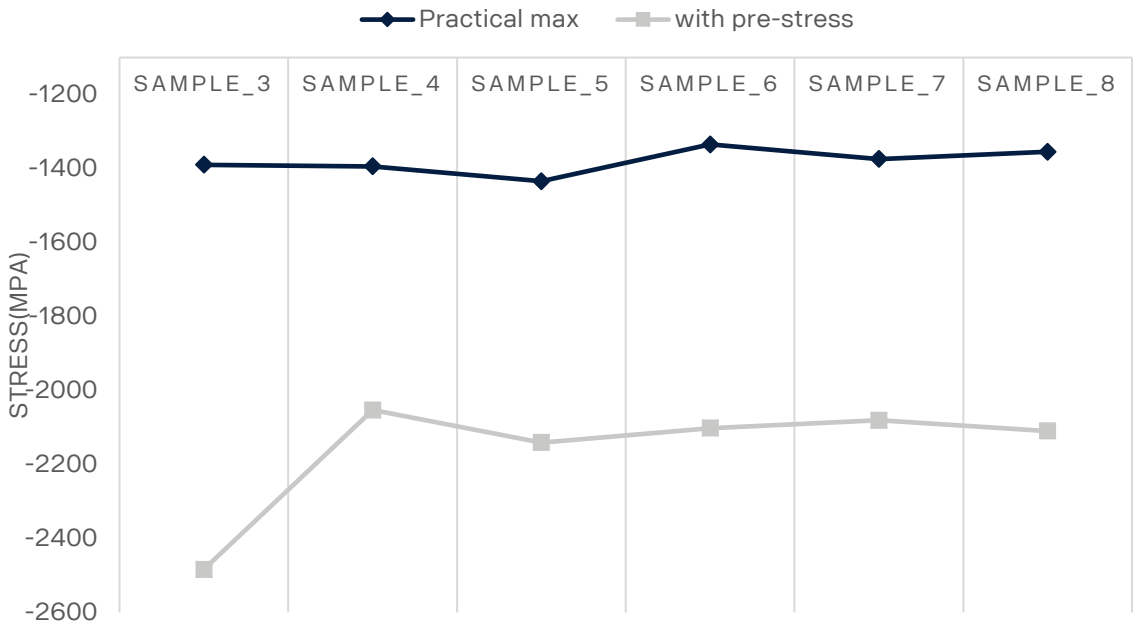
MDO using FE Analysis

- Computational time: 50hrs
- Shot 2 has largest impact on stress

Correlation Matrix

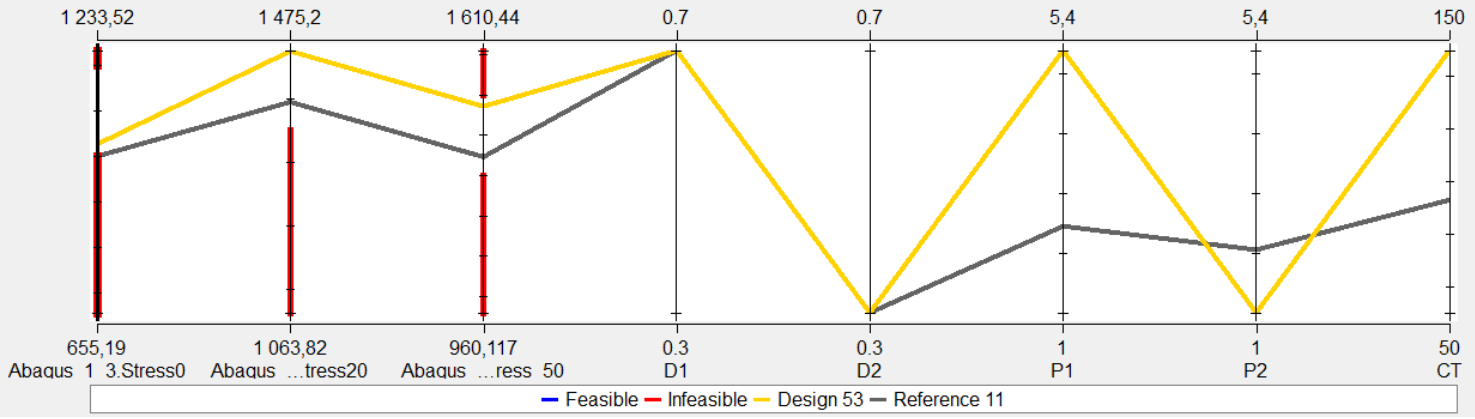
COMPARISON BETWEEN FEA AND PRACTICAL RESULTS

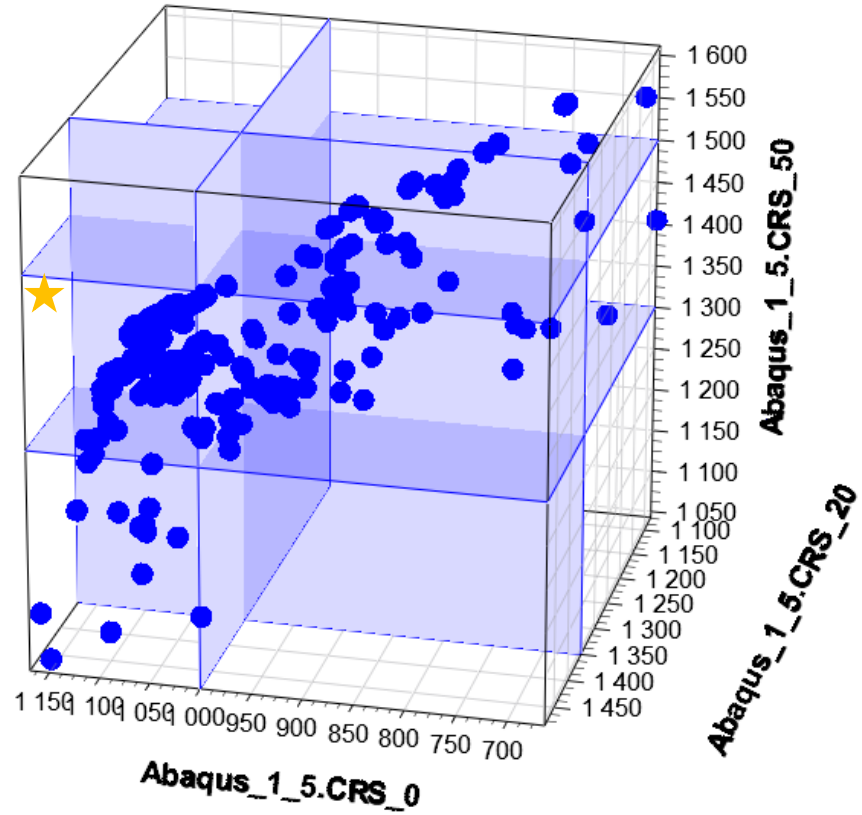
	Sample_3	Sample_4	Sample_5	Sample_6	Sample_7	Sample_8
	0,7mm 1bar 30m/s. 0,3mm 5,2bar 79,5m/s	0,7mm 1bar 30m/s. 0,7mm 3,8bar 67,5m/s	0,3mm 1,1bar 31m/s. 0,3mm 5bar 76,5m/s	0,3mm 1bar 30m/s. 0,7mm 5.1bar 77,5m/s	0,3mm 3,7bar 63m/s. 0,7mm 3,8bar 67,5m/s	0,3mm 1bar 30m/s. 0,7mm 5,4bar 80m/s
Experimental max (MPa)	-1390	-1394,2	-1434,7	-1335,2	-1374,4	-1355,1
Analysis (MPa)	-2484	-2053	-2141	-2102	-2081	-2110



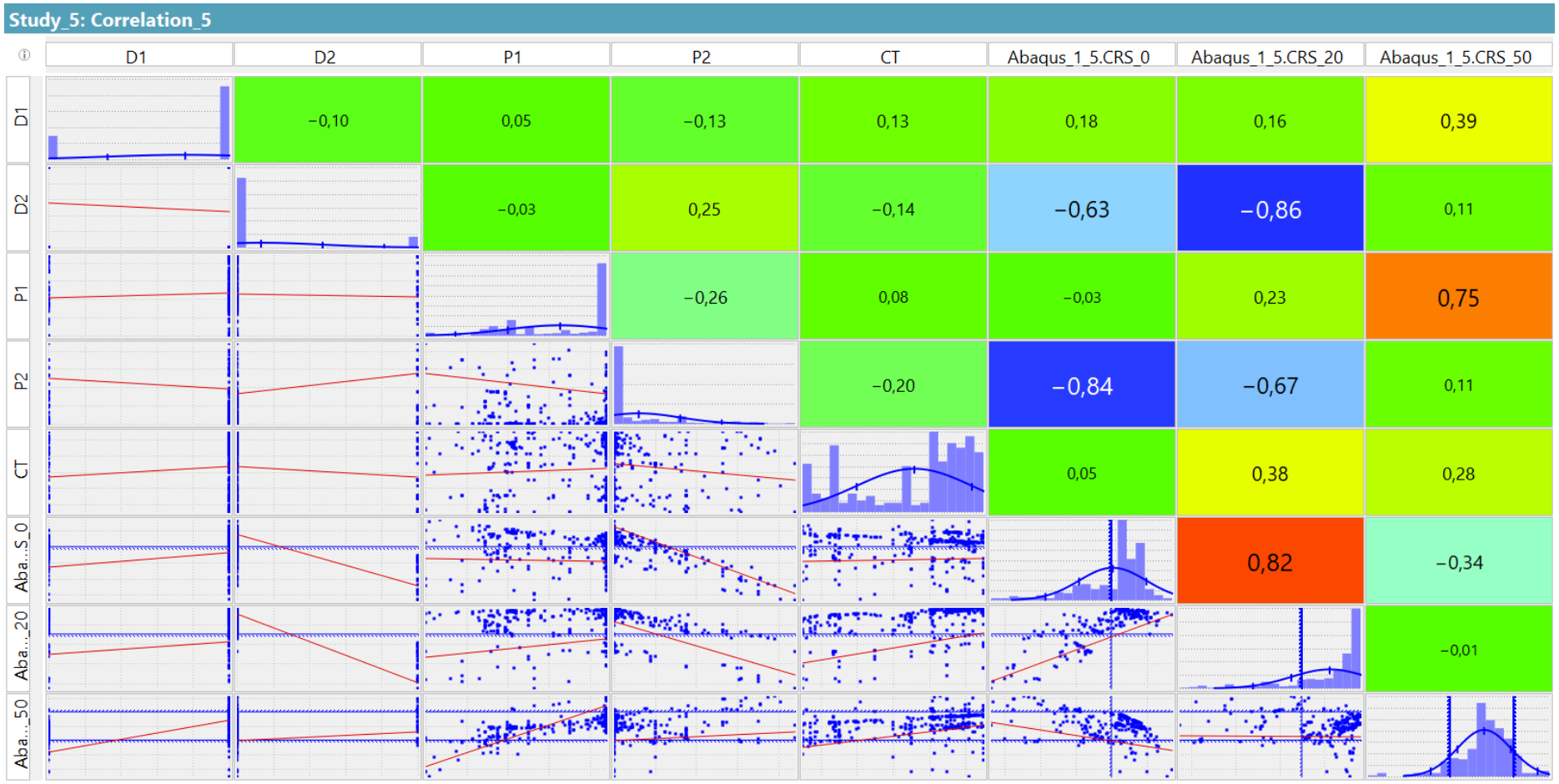
MDO using Surrogate Models:

- computational time: 1 hr
- CRS_0 : increase by 1.2%
- CRS_20 : increase by 3.7%
- CRS_50 : increase by 4.7%





MDO using Surrogate Models:



DISCUSSION

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Discusion :

- Difference in the analysis and experimental results can be due to:
  - simplified axi- symmetric model
  - single shot impact
  - reading stress results along symmetric line VS XRD averaging
- Larger shots and pressures cause larger CRS deeper into the peened component
- Smaller shots and pressures cause larger CRS on surface and 20µm deep
- CRS at 50µm is mainly influenced by shot 1
- CRS at 0µm and 20µm is mainly influenced by shot 2

CONCLUSION

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Conclusion :

Optimal parameter setting- D1:0.7mm D2:0.3mm P1:5.4bar P2:1bar CT:150%

Shot 2 parameters have maximum influence on CRS_0 and CRS_20

Shot 1 parameters have maximum influence on CRS_50

CT has small influence on CRS

Future Work:

Focus on building a FE model to simulate random shot impacts

Include more parameters in the optimization process

Cost of shot peening should be taken into consideration

THANK YOU!

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