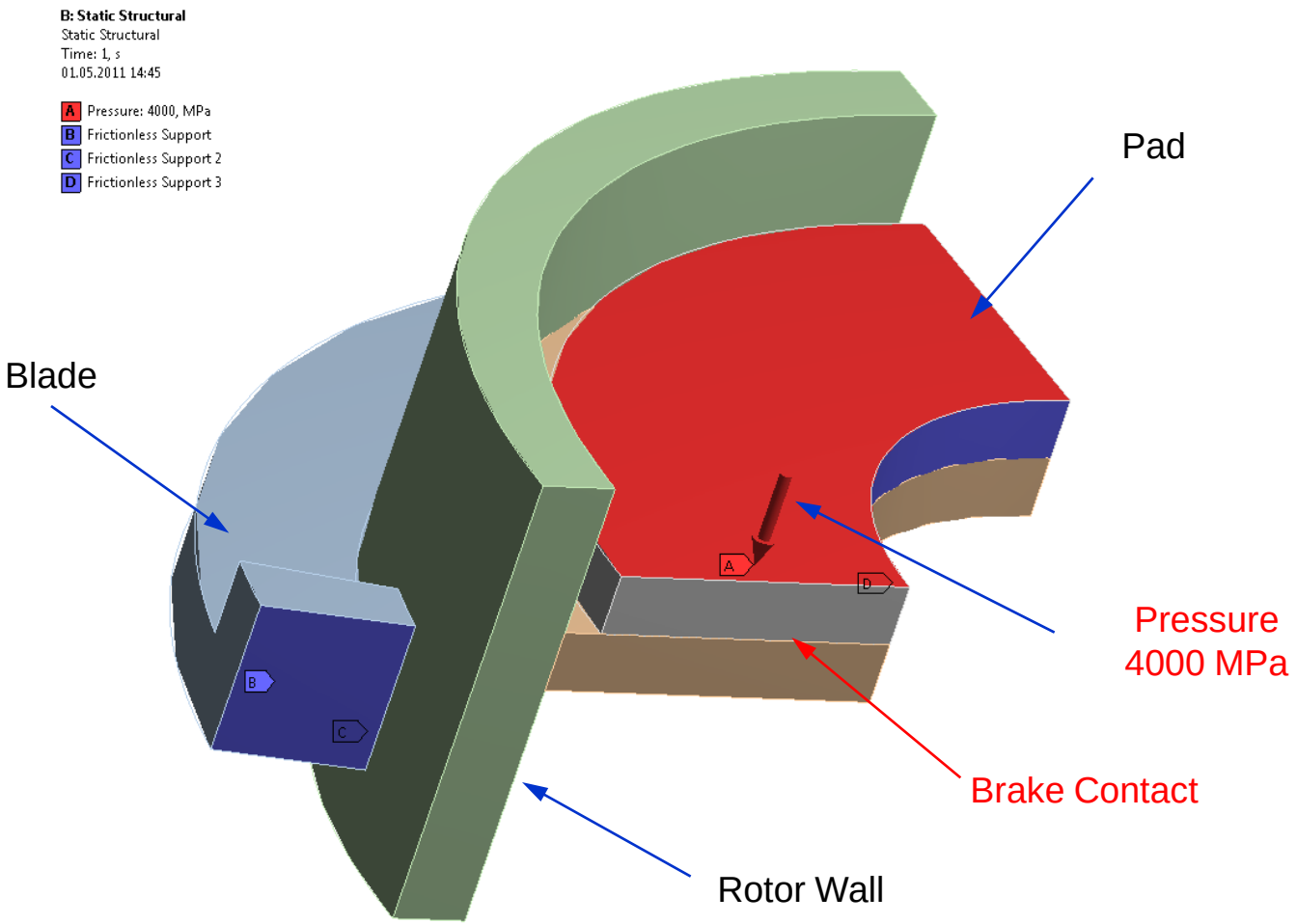
Sensitivity Study
Design Optimization
Probabilistic Analysis
of a
Rotor Brake System

OptiY GmbH - Germany

Rotor Brake System



Design Specifications

Design Parameter Space:

- Wall High = [6, 10] mm
- Pad Thickness = [0.8, 1.2] mm
- Brake Thickness = [0.8, 1.2] mm

Geometry Tolerances = 0.1 mm
With Normal Distribution

Fix Process or Environment Parameters:

- Operating Temperature = 100 ± 50 °C
- Ambient Temperature = 22 ± 20 °C
- Material Density = 7850 ± 150 kg m^-3
- Thermal Expansion = 1.2E-5 ± 3E-7 °C^-1
- Young´s Modulus = 2E11 ± 5E9 Pa

Functional Requirements:

- Contact Pressure = maximal as possible

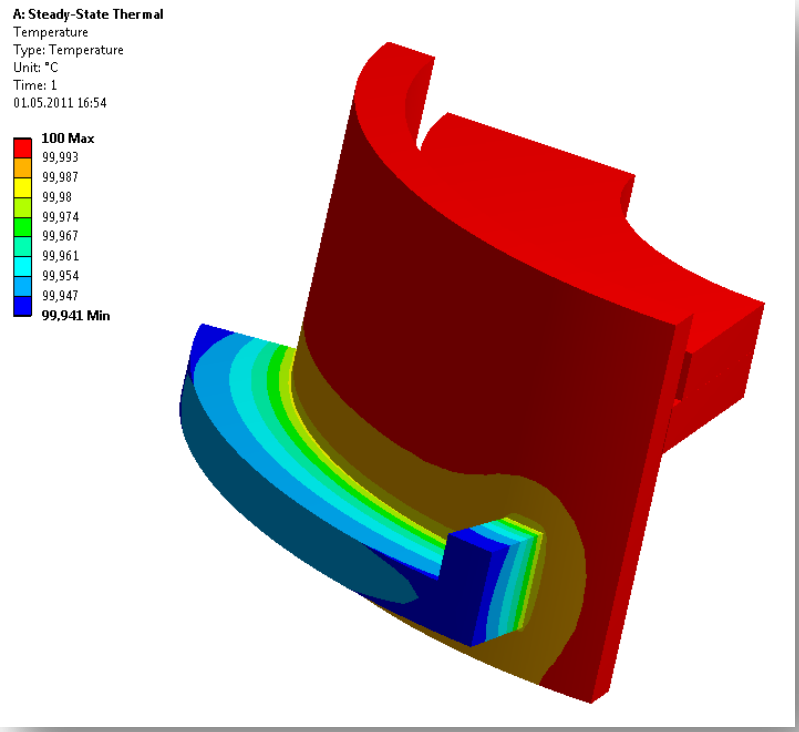
Initial Nominal Parameters

Design Parameters

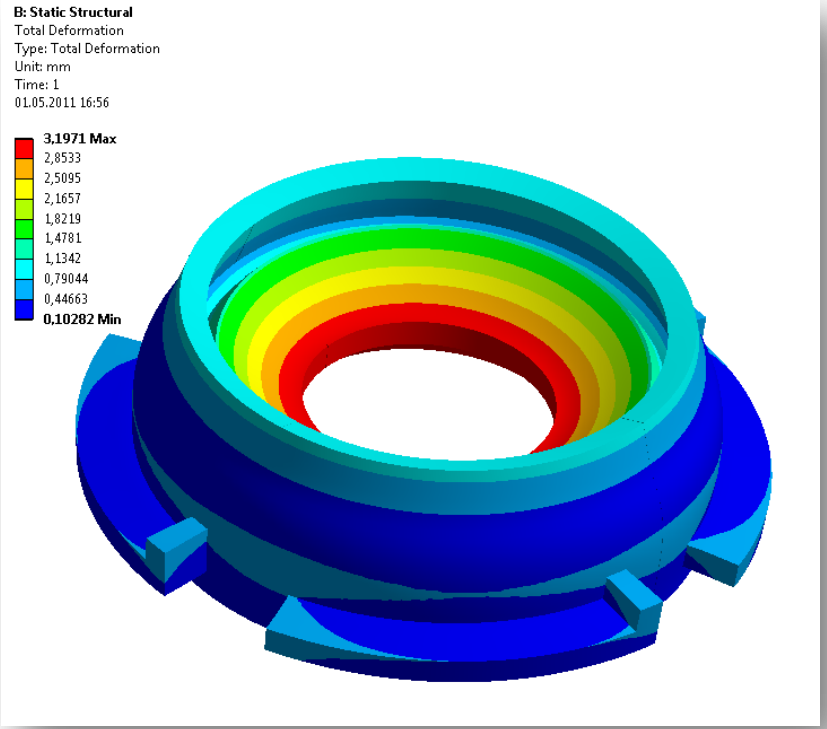
Name	Nominal	Tolerance	Unit
Operating Temperature	100	100	°C
Ambient Temperature	22	40	°C
Wall High	8	4	mm
Pad Thickness	1	0.4	mm
Brake Thickness	1	0.4	mm
Density	7850	300	kg m^-3
Thermal Expansion	1.2e-005	6e-007	°C^-1
Youngs Modulus	2e+011	1e+010	Pa

Nominal FE-Simulation

Temperature
Operating Point = 100 °C

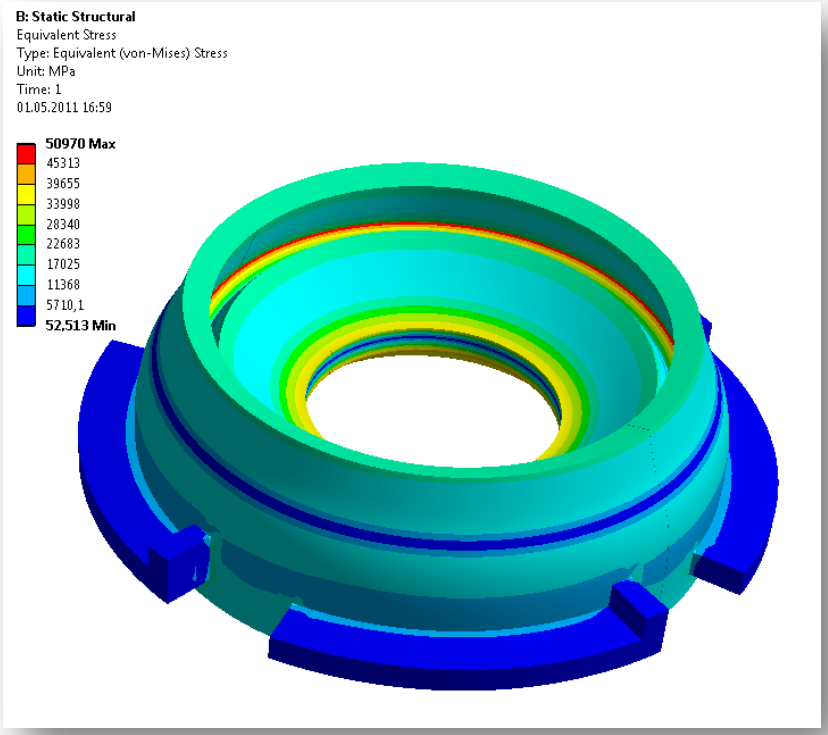


Total Deformation
Max = 3,19 mm

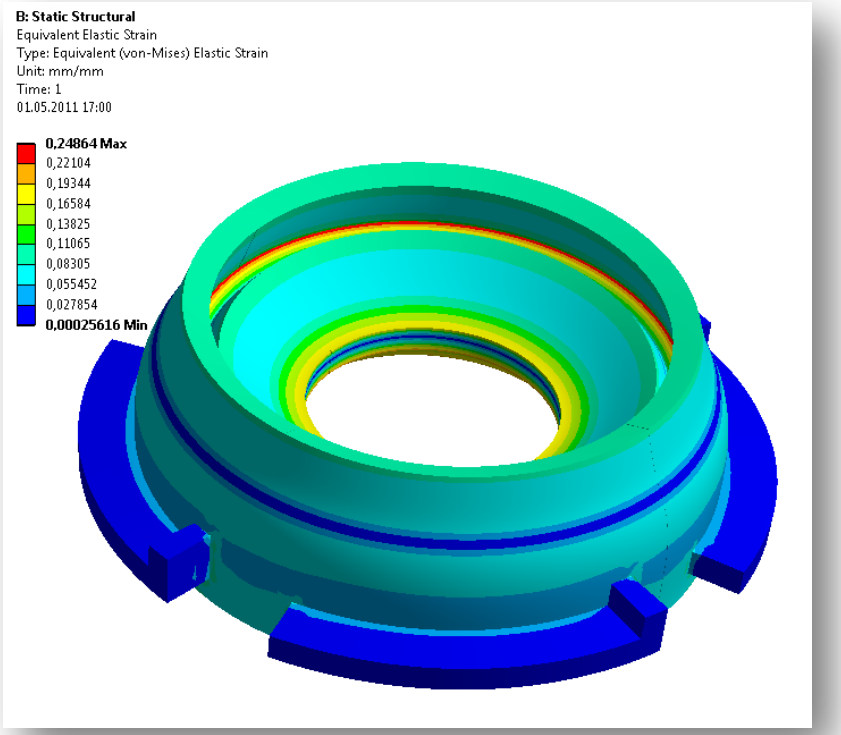


Nominal FE-Simulation

Equivalent Stress
Max = 50970 MPa

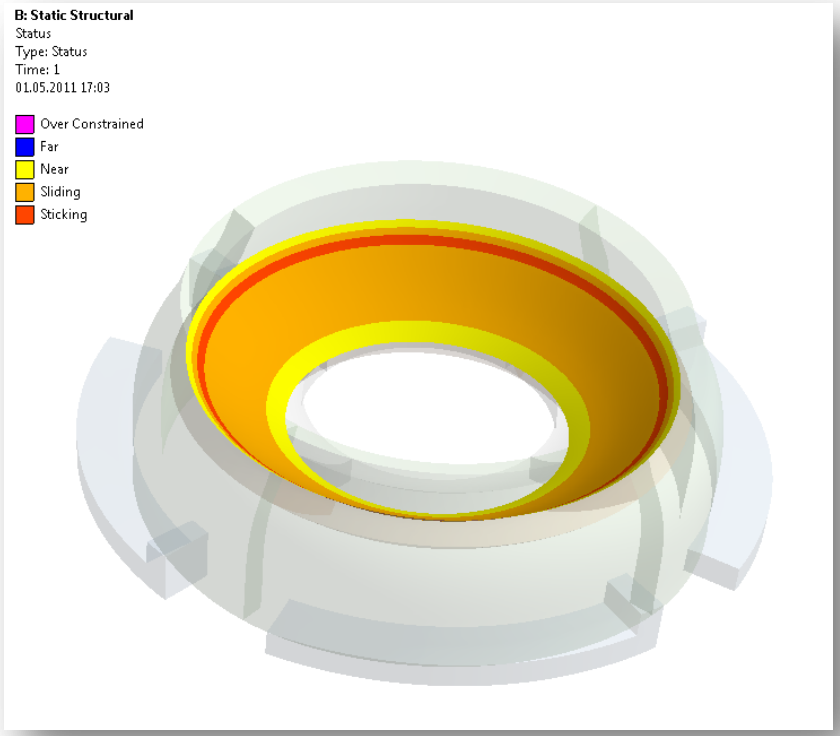


Equivalent Strain
Max = 0.24

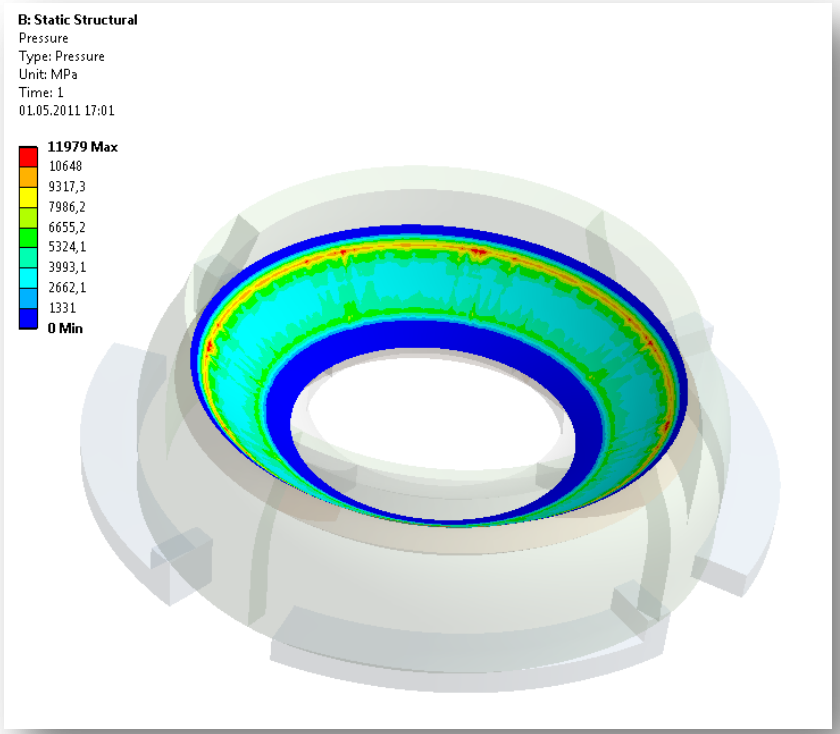


Nominal FE-Simulation

Contact Status

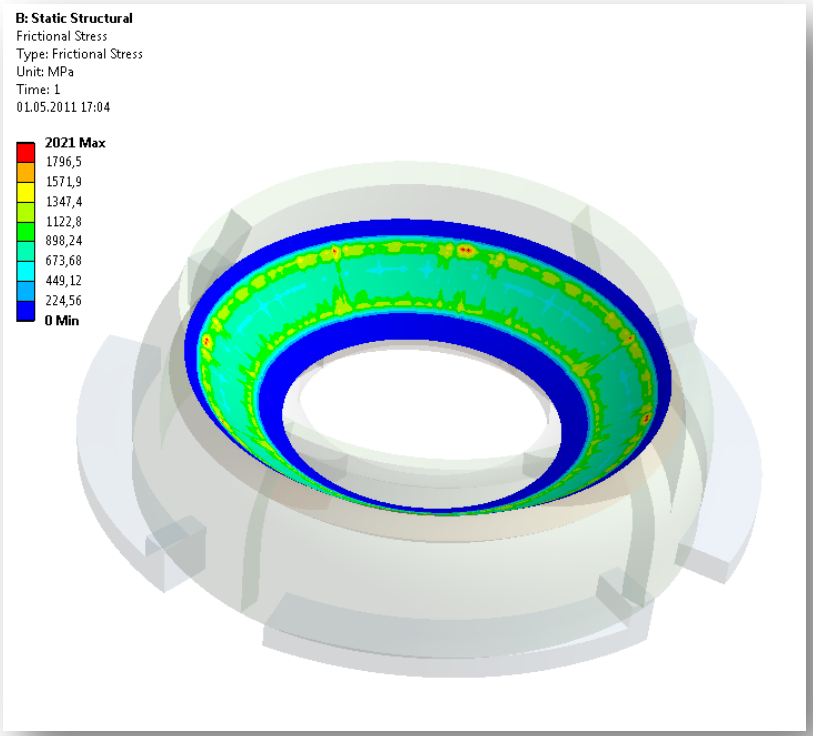


Contact Pressure
Max = 11979 MPa

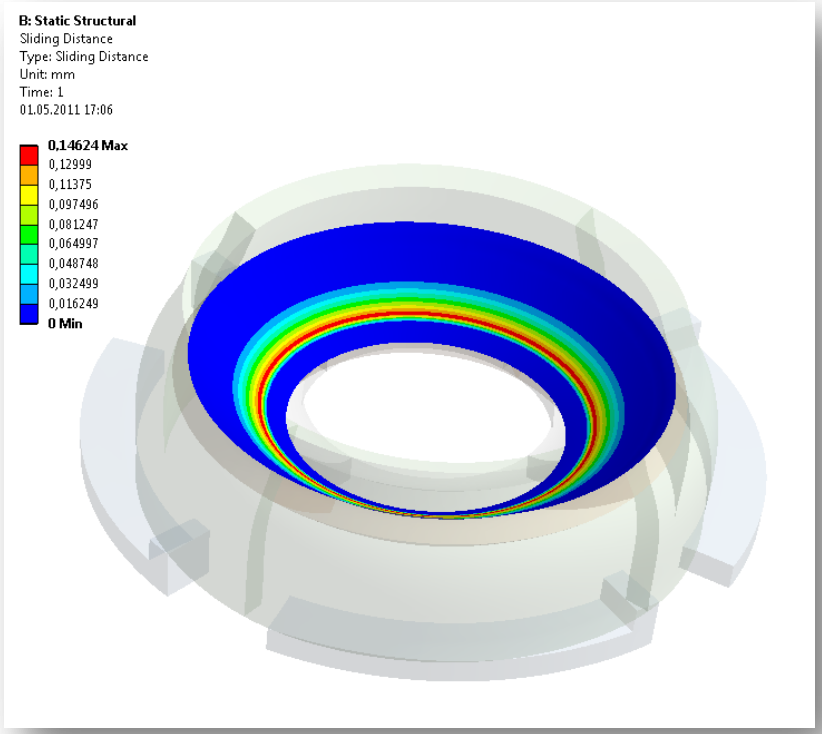


Nominal FE-Simulation

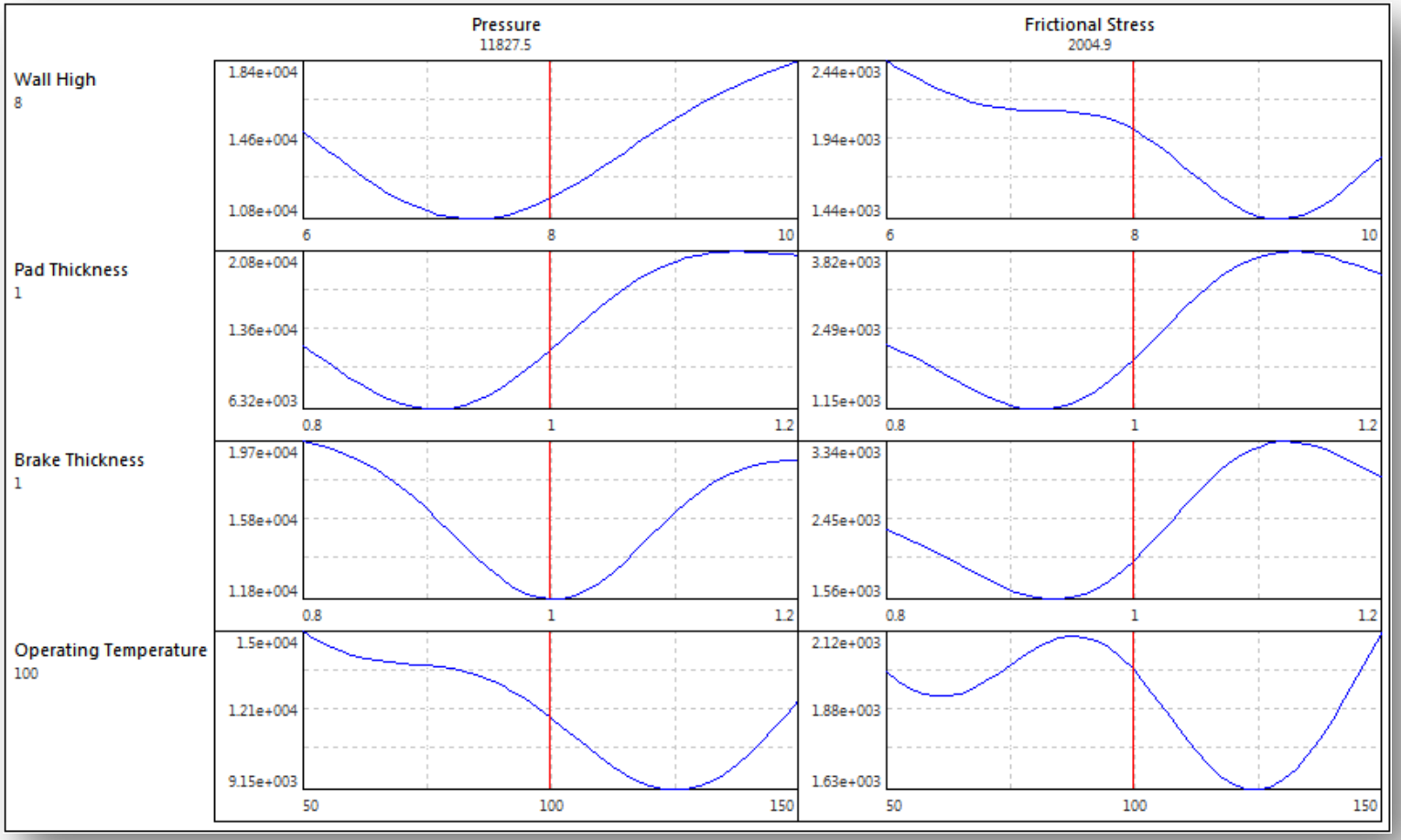
Frictional Stress
Max = 2021 MPa



Sliding Distance
Max = 0.146 mm

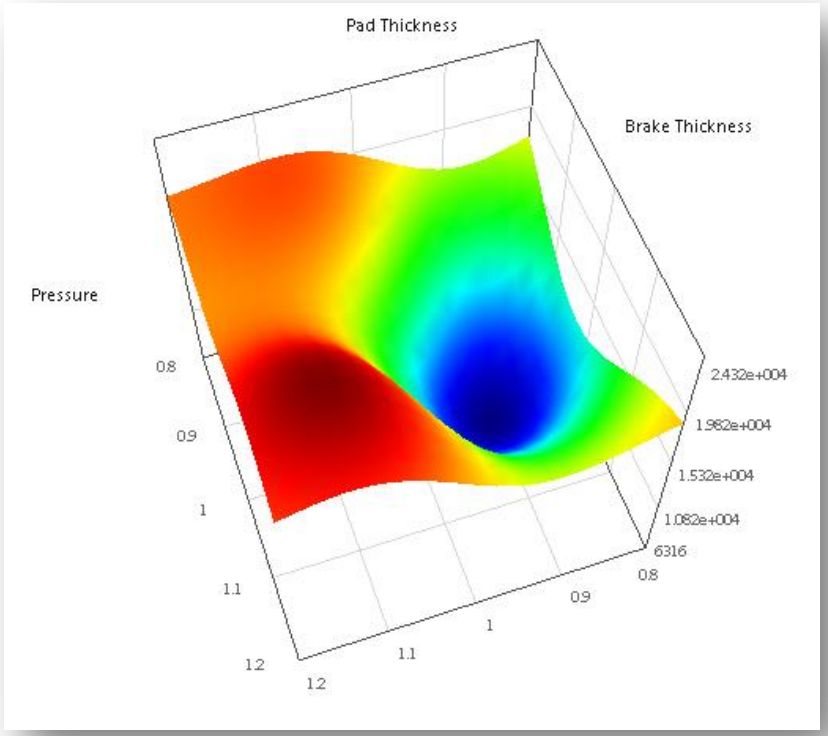


Design Space: 2D Section Diagrams

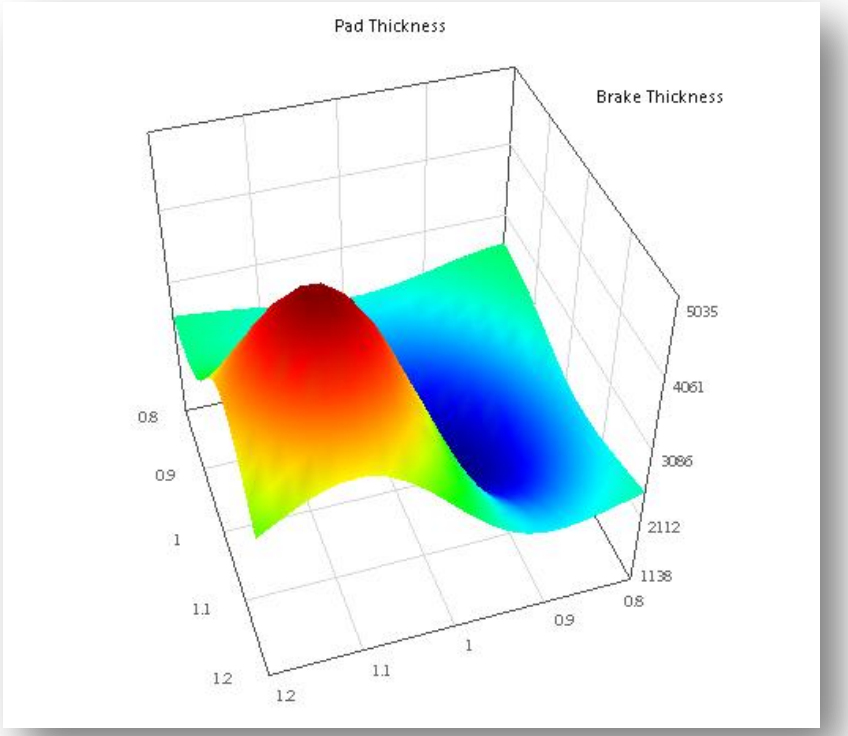


Design Space: 3D Graphics

Contact Pressure

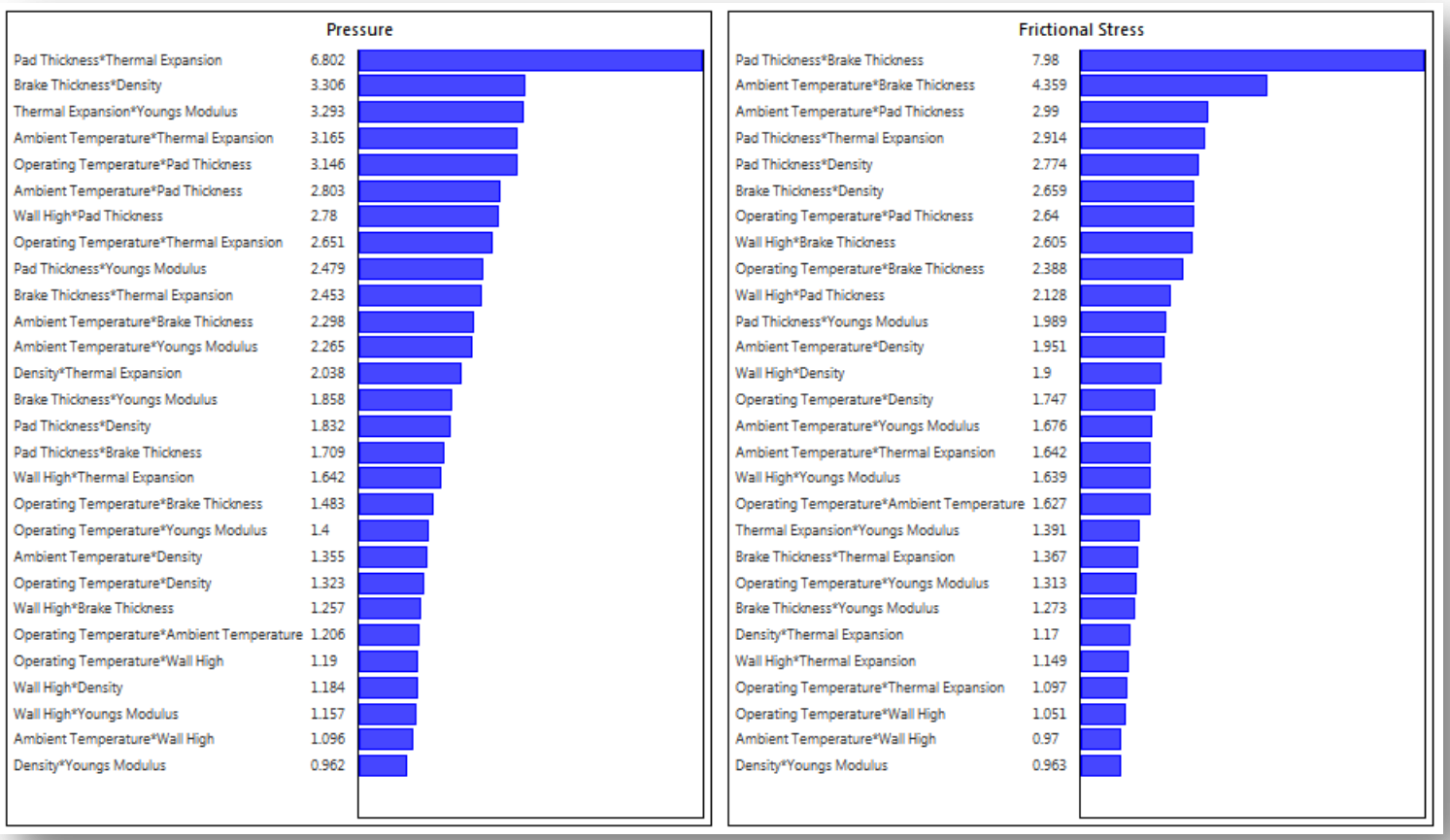


Contact Frictional Stress

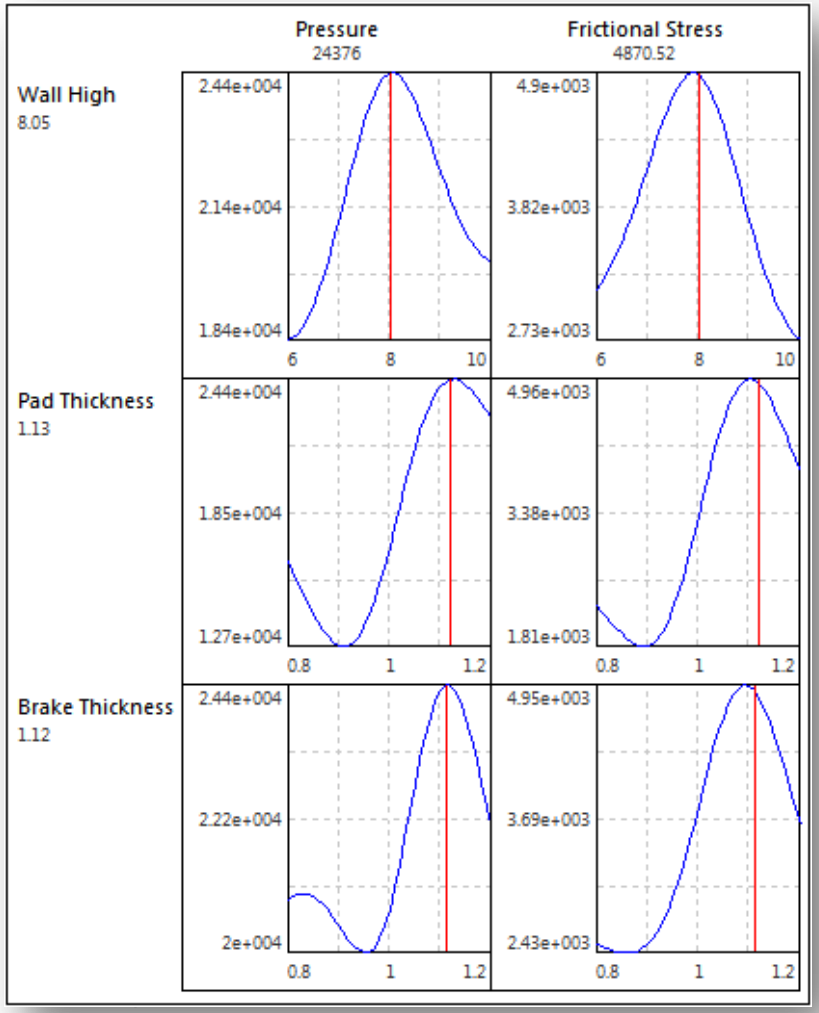


Global Sensitivity: Parameter Importance [%]

Global Sensitivity: Parameter Interaction [%]



Nominal Design Optimization



Optimization Goal:

- Criteria: Maximize the Contact Pressure

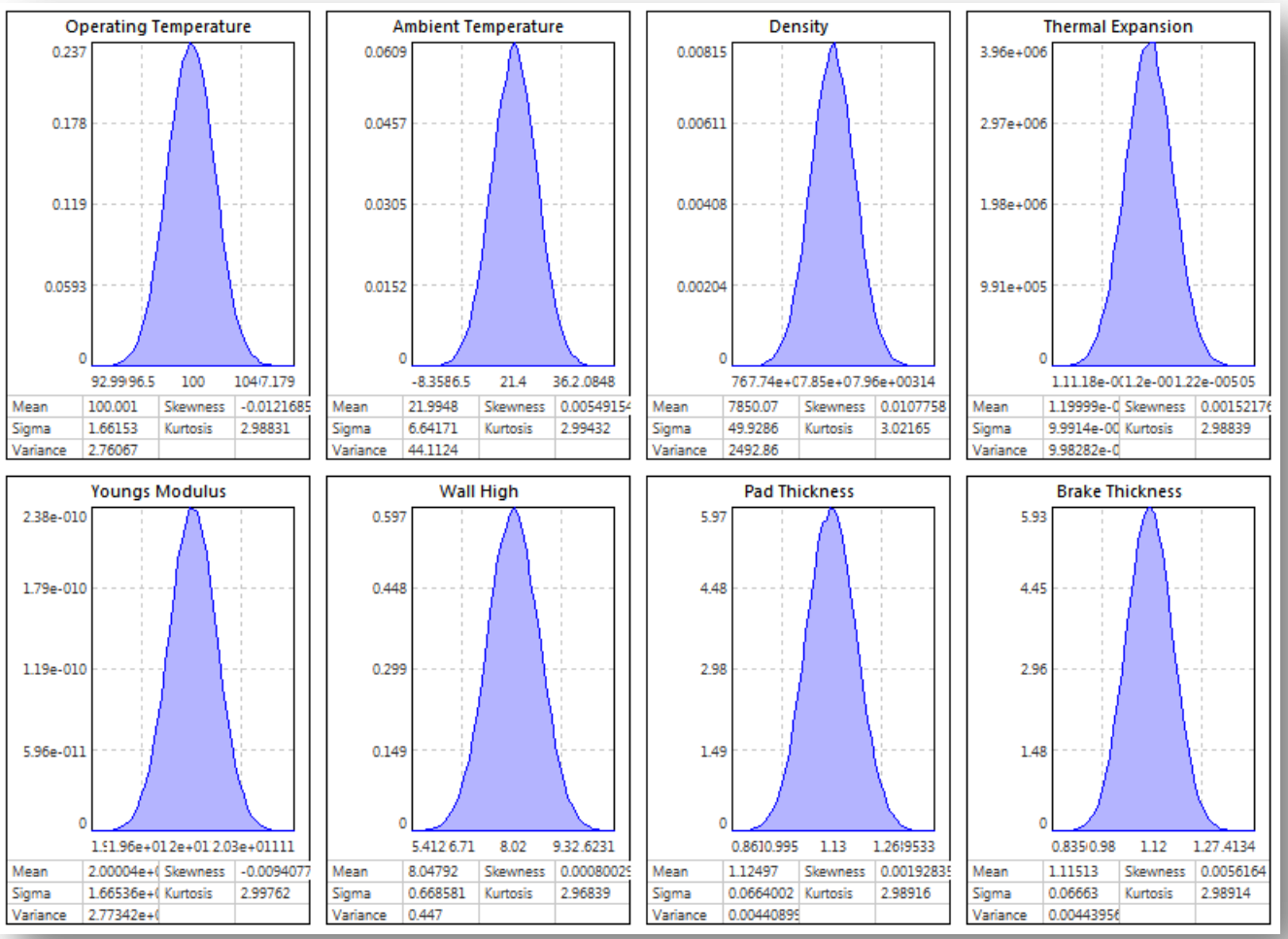
Nominal Design:

- Contact Pressure = 24376 MPa
- Contact Frictional Stress = 4870 MPa

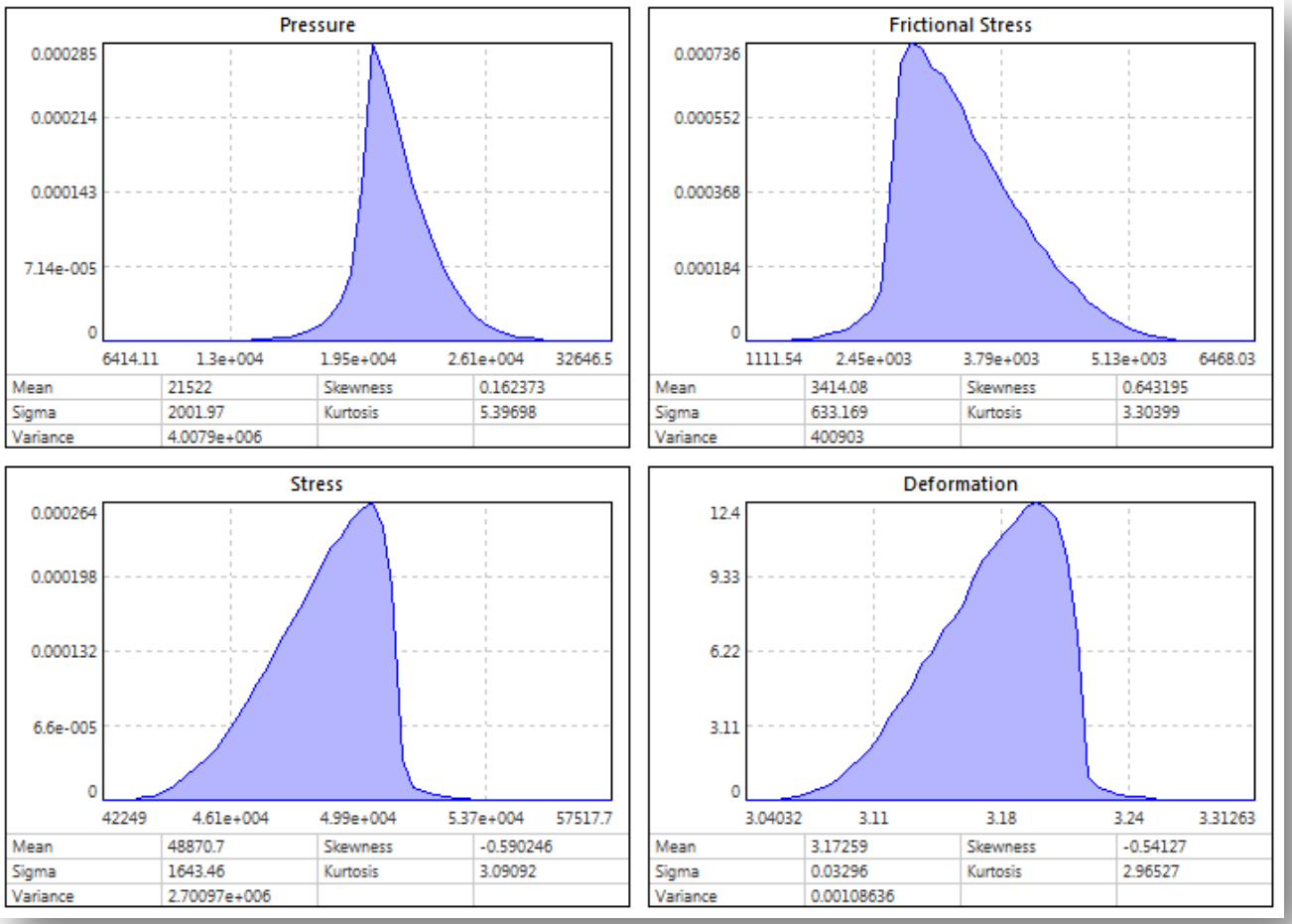
Design Parameters

Name	Nominal	Tolerance	Unit
Operating Temperature	100	10	°C
Ambient Temperature	22	40	°C
Wall High	8.05	4	mm
Pad Thickness	1.125	0.4	mm
Brake Thickness	1.115	0.4	mm
Density	7850	300	kg m^-3
Thermal Expansion	1.2e-005	6e-007	°C^-1
Youngs Modulus	2e+011	1e+010	Pa

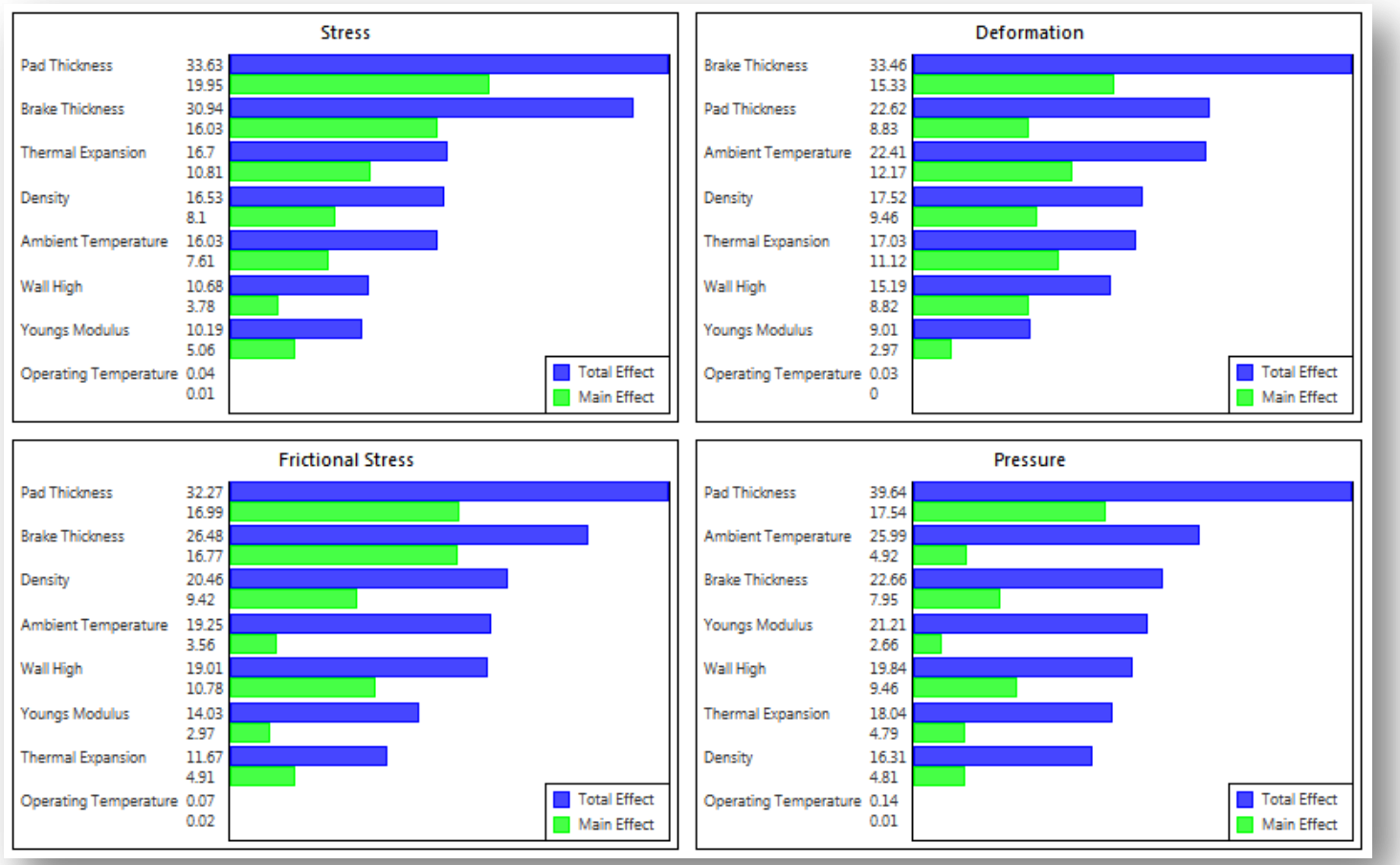
Uncertainty Parameters and Tolerances



Probabilistic Analysis



Design Sensitivity



Conclusion

Global sensitivity study based on the nonlinear meta model identifies significant design, environment or process parameters and its interactions.

Design optimization based on the meta model using adaptive Gaussian process is very fast and efficient.

Considering uncertainty parameters and tolerances, probabilistic analysis computes the stochastic distributions of the design goals. The design sensitivity shows the cause-effect-chain for the variability of the contact pressure.

OptiY® is the leading software platform for design optimization of all engineering fields using different commercial CAD/CAE-software or in-house codes.