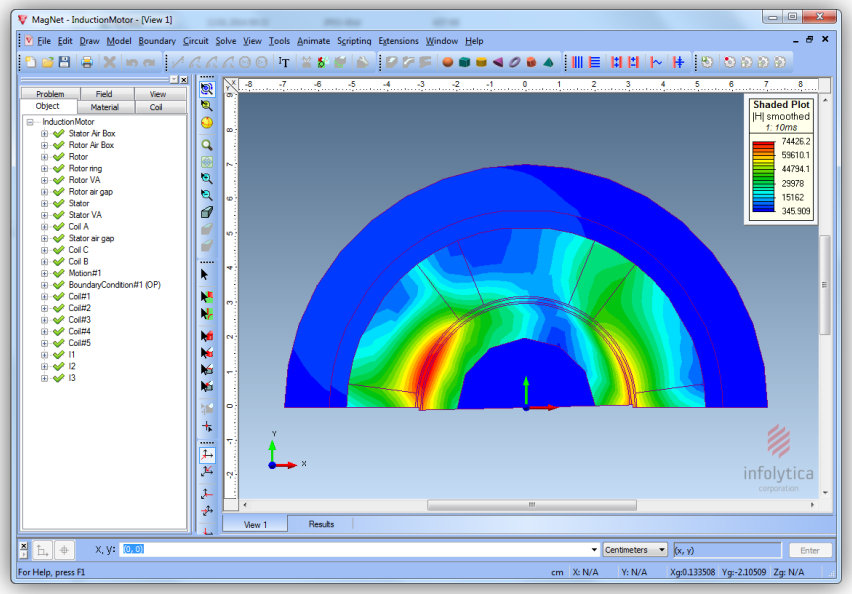
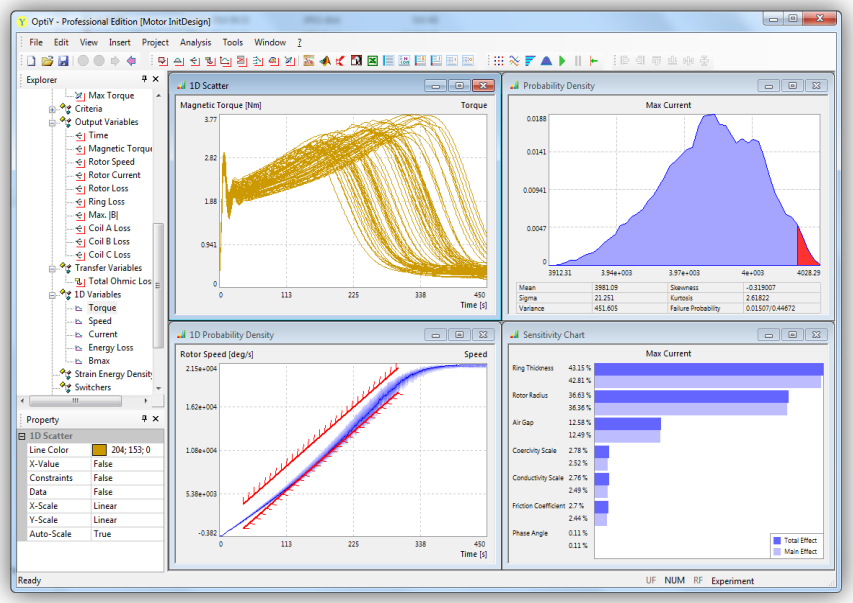
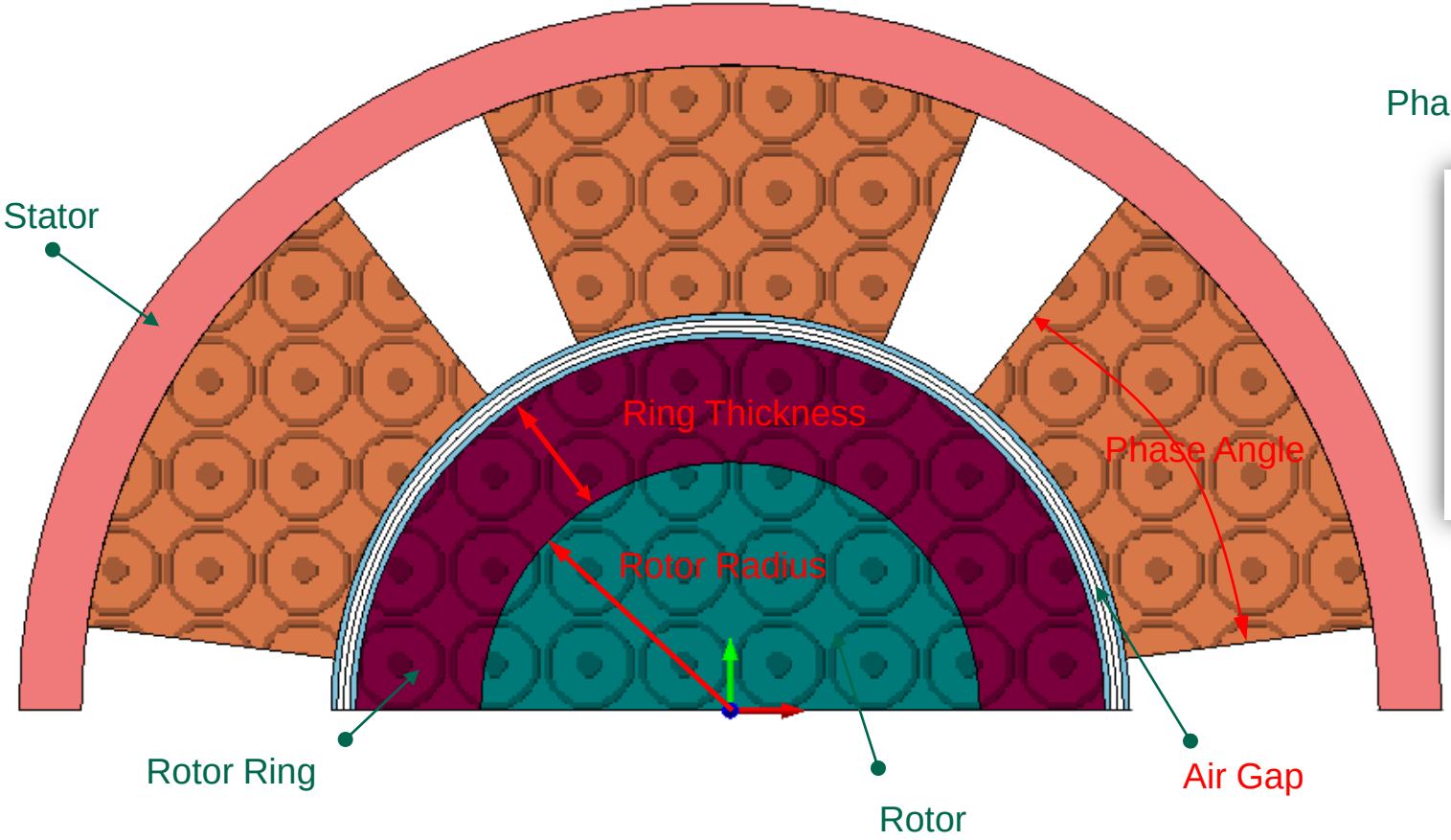
Robust Design of Induction Motor

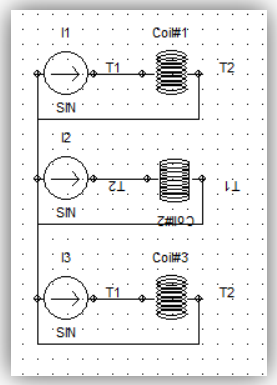




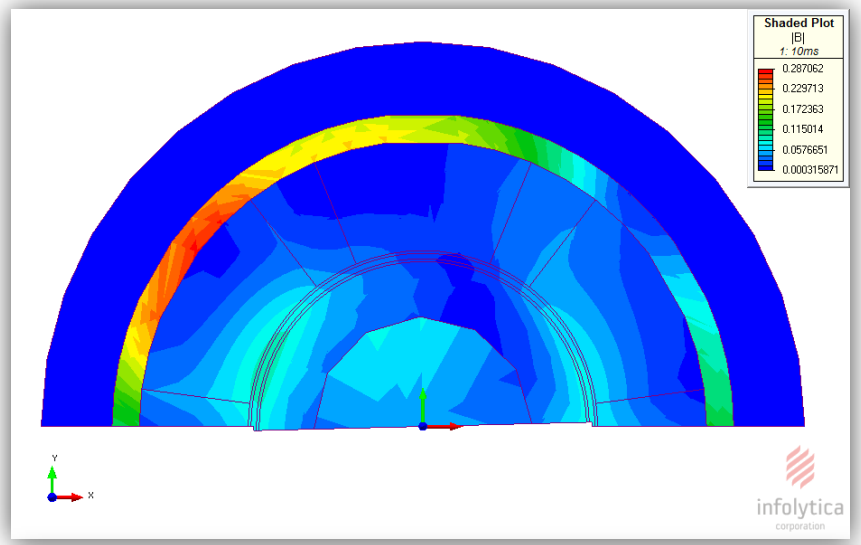
Design of Three Phase Induction Motor

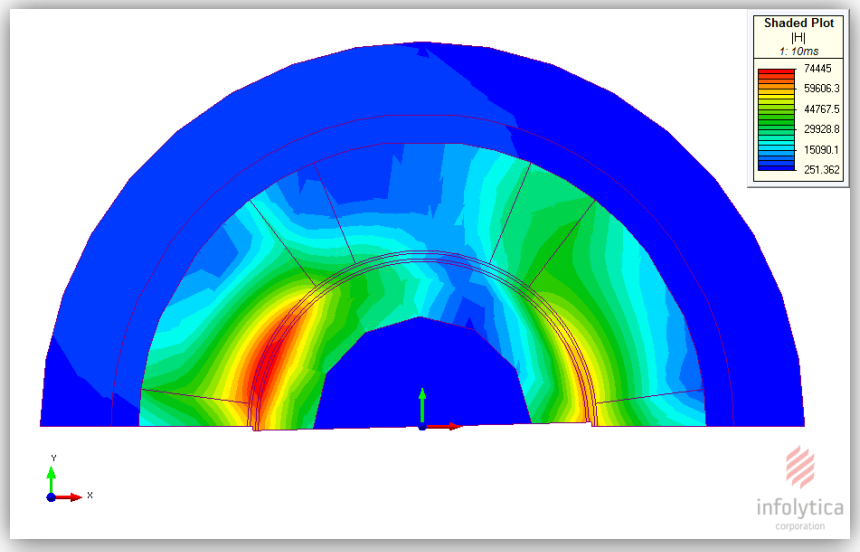


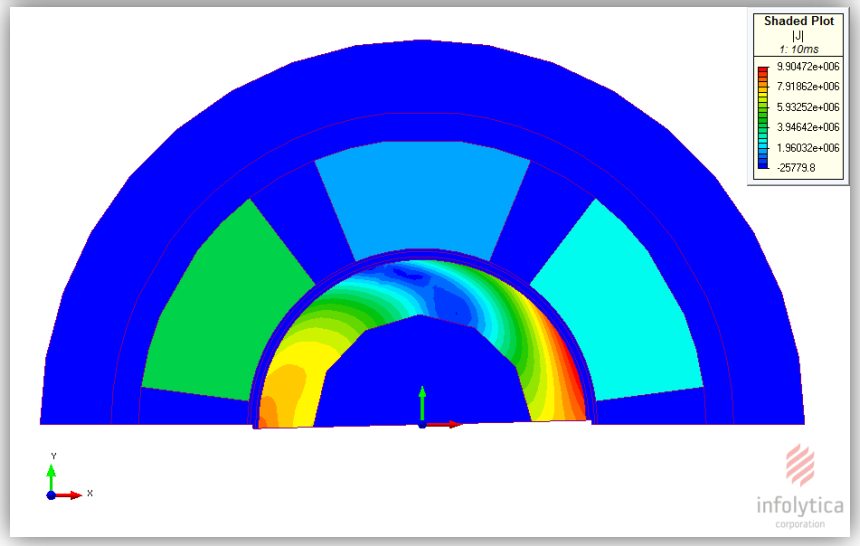
Coil Winding
Phase Group A, B, C

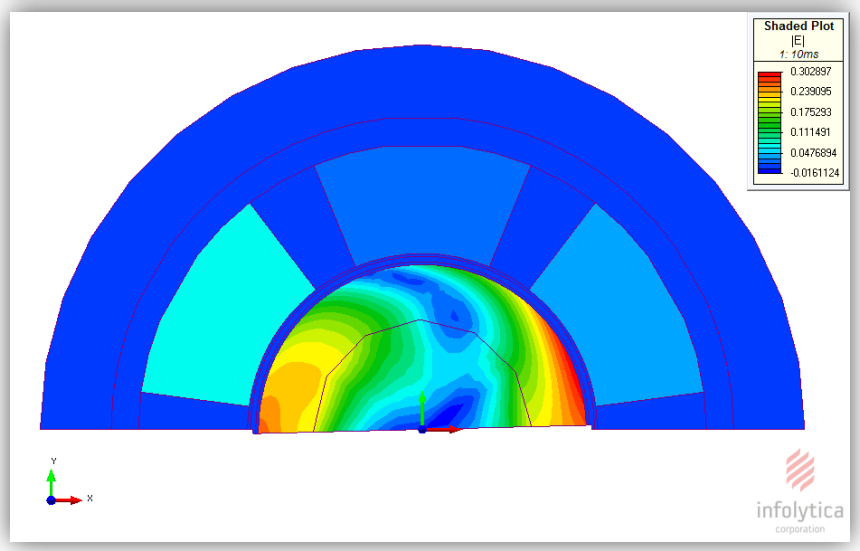


Field Simulation in Infolytica-MagNet

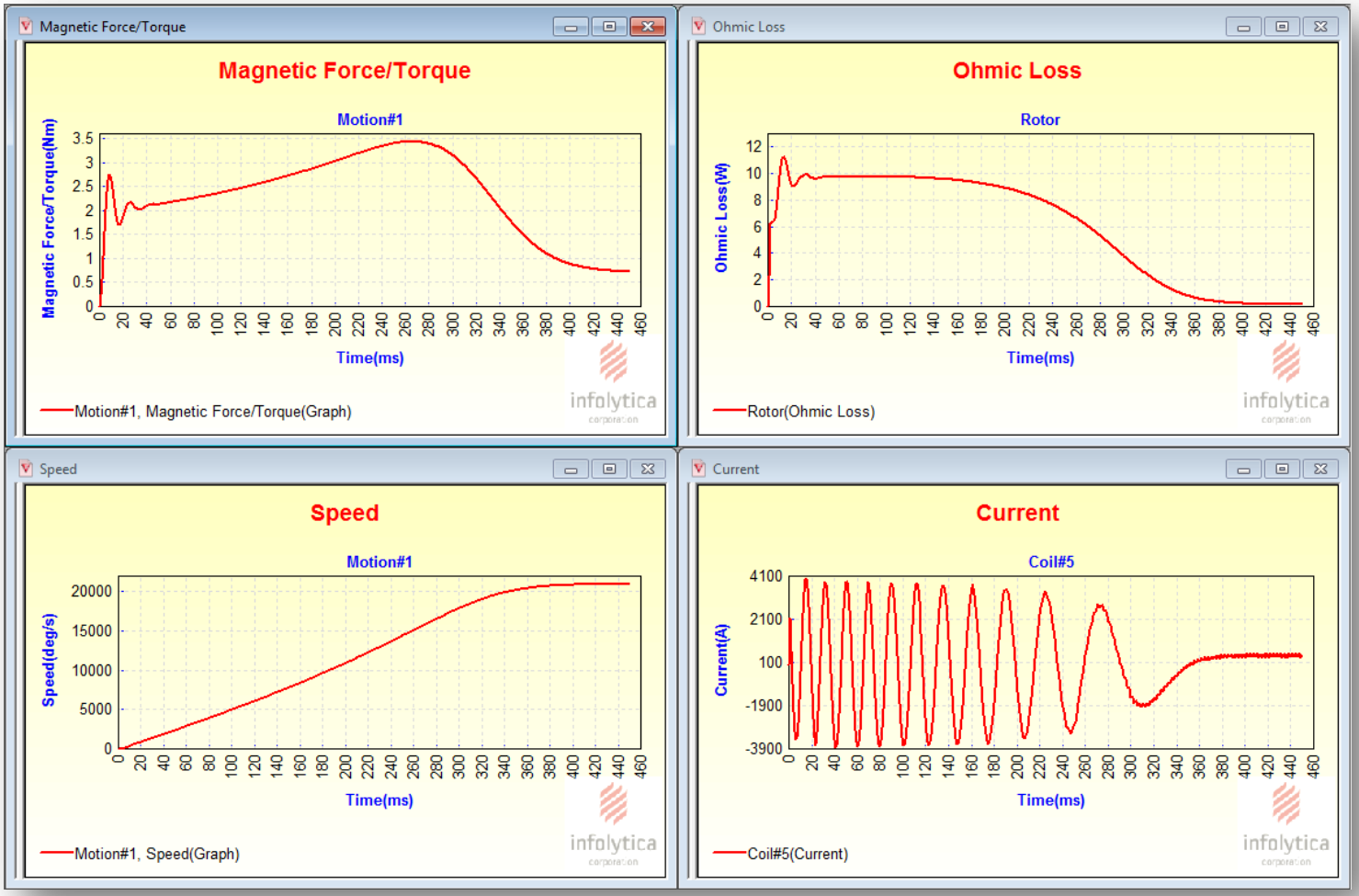




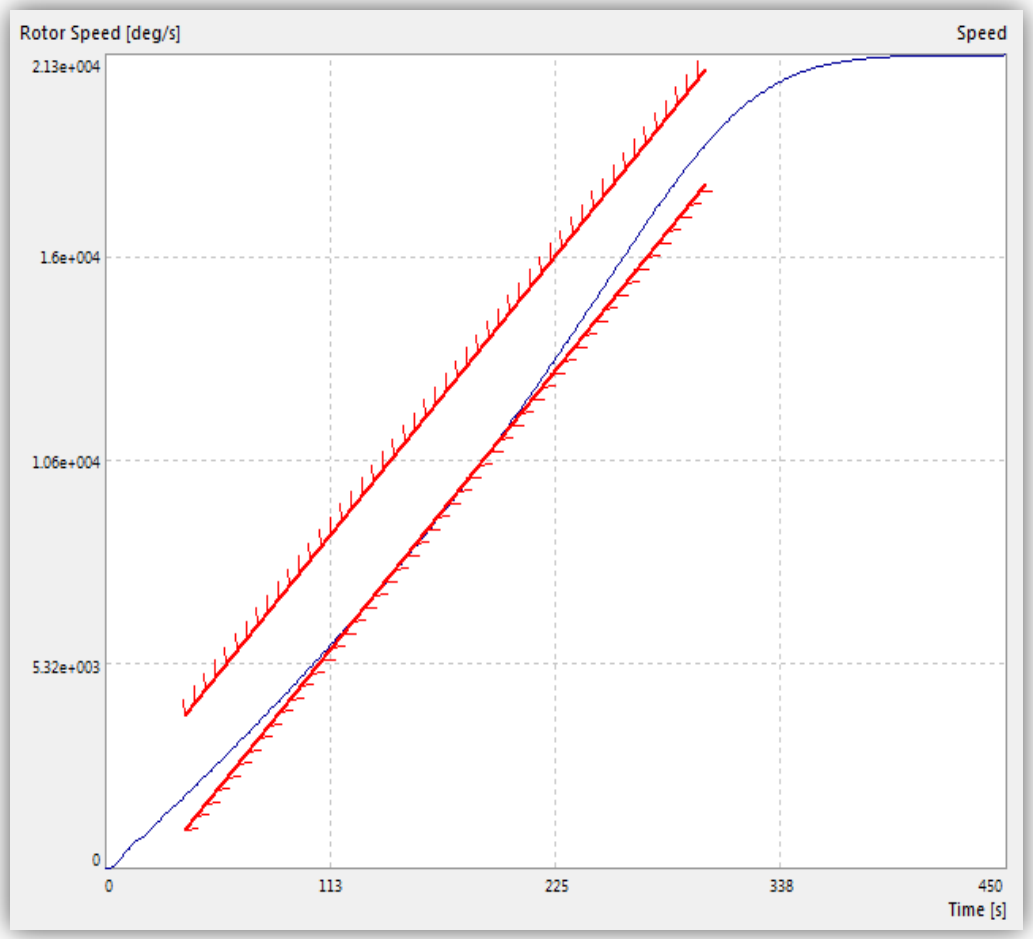




Dynamical Simulation in Infolytica-MagNet



Design Specifications



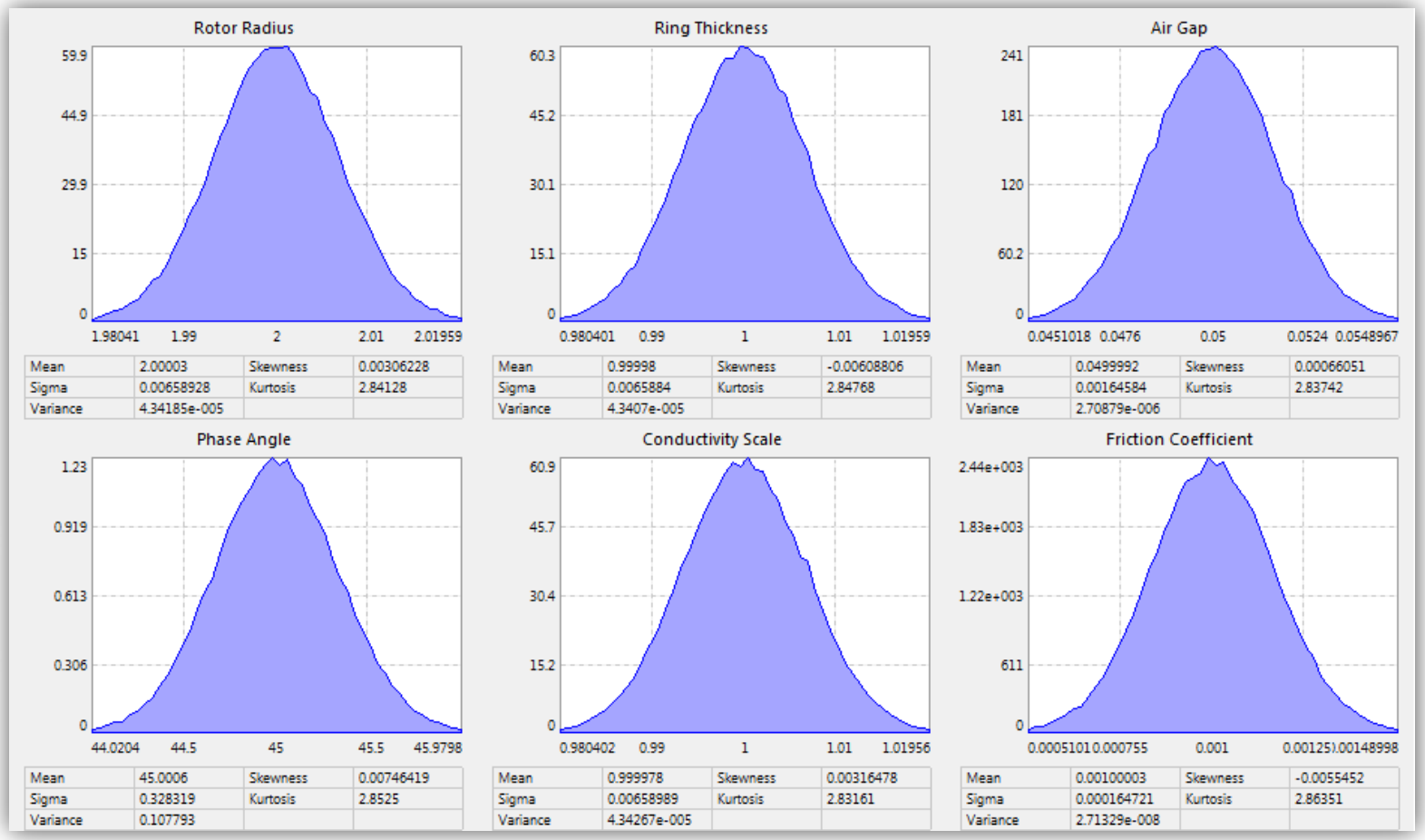
Initial Design Parameters with its Uncertainty

Design Parameters

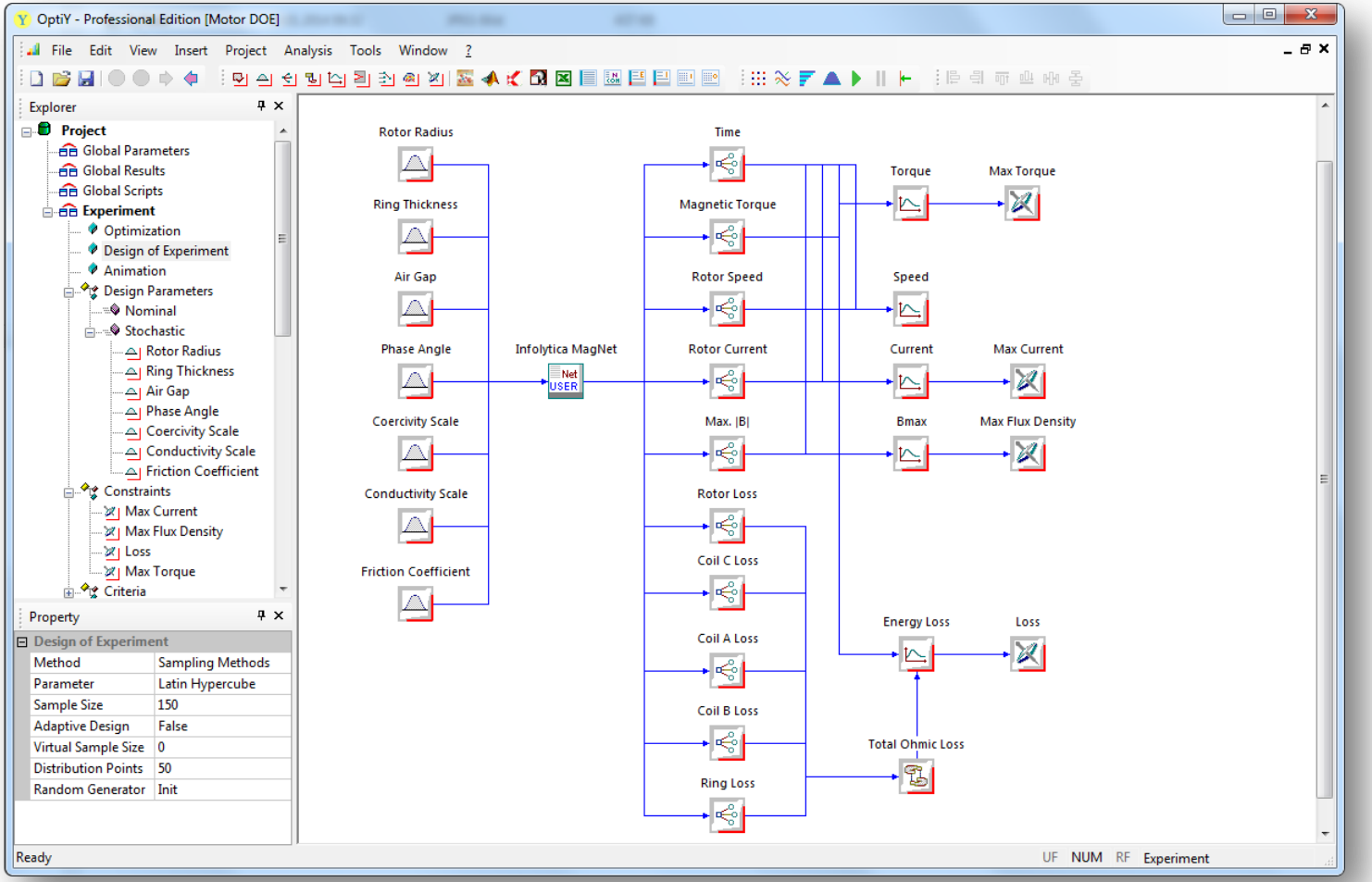
Name	Nominal	Tolerance	Unit
Rotor Radius	2	0.04	cm
Ring Thickness	1	0.04	cm
Air Gap	0.05	0.01	cm
Phase Angle	45	2	deg
Coercivity Scale	1	0.04	
Conductivity Scale	1	0.04	
Friction Coefficient	0.001	0.001	Nms/rad

- Max. Torque ≤ 3.6 N*m
- Max. Current ≤ 4020 A
- Max. Flux Density ≤ 0.115 T
- Max Energy Loss ≤ 345.000 W*s
- Corridor for Rotor Speed
  - Rising = 65 deg/s^2
  - Bandwidth = 3000 deg/s

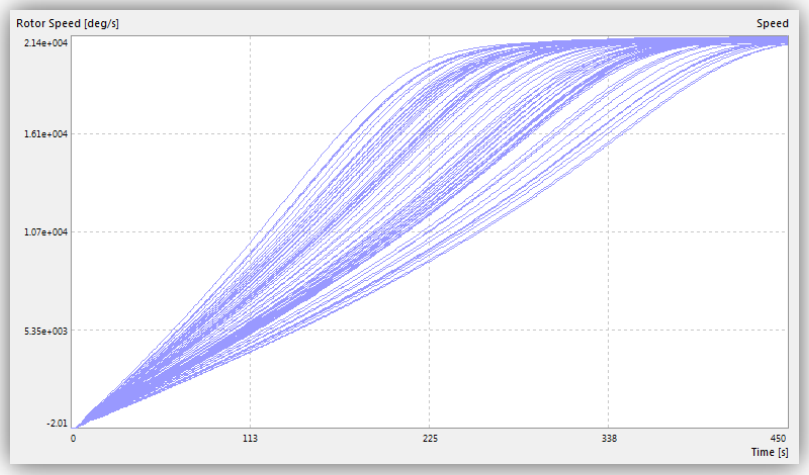
Stochastic Distributions of Design Parameters

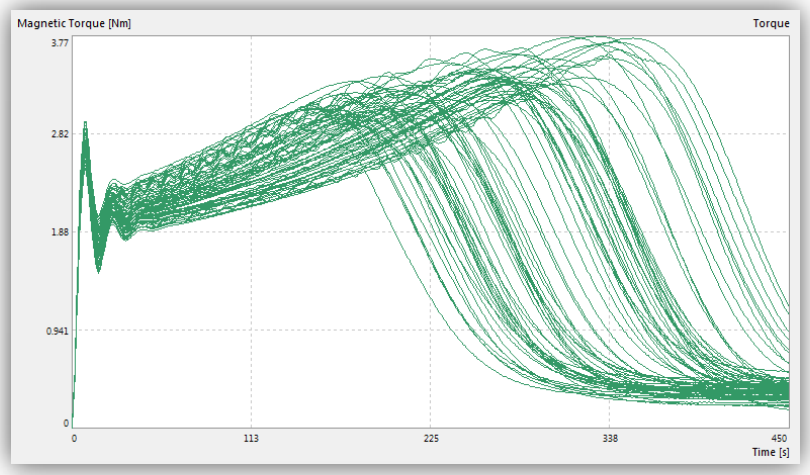


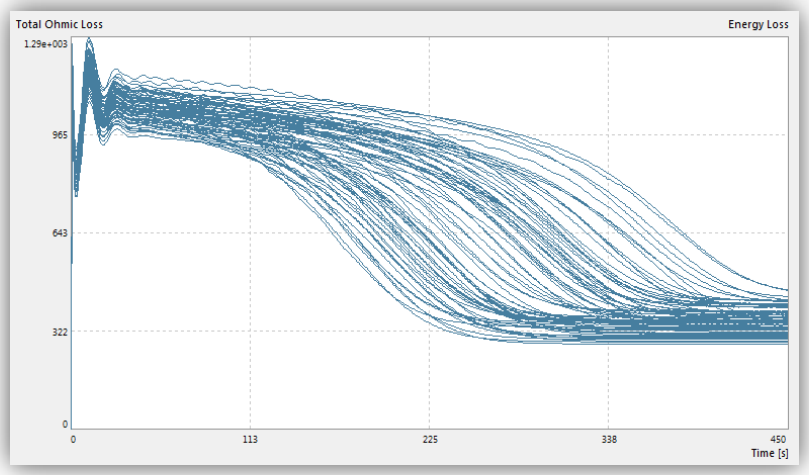
OptiY Process Work Flow

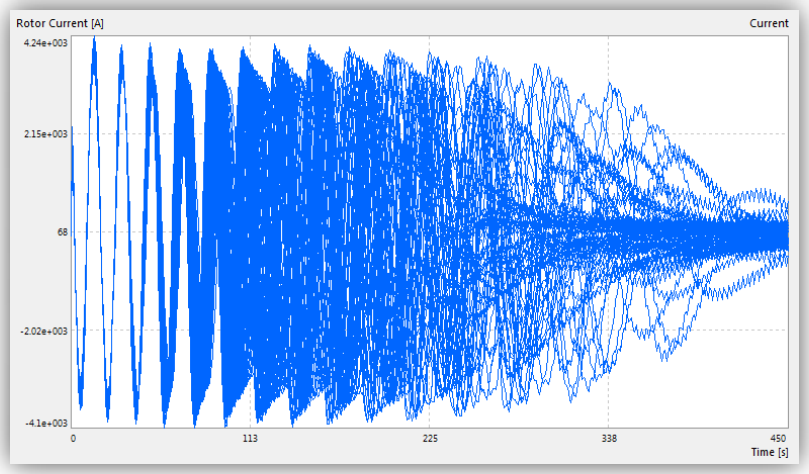


Design of Experiment



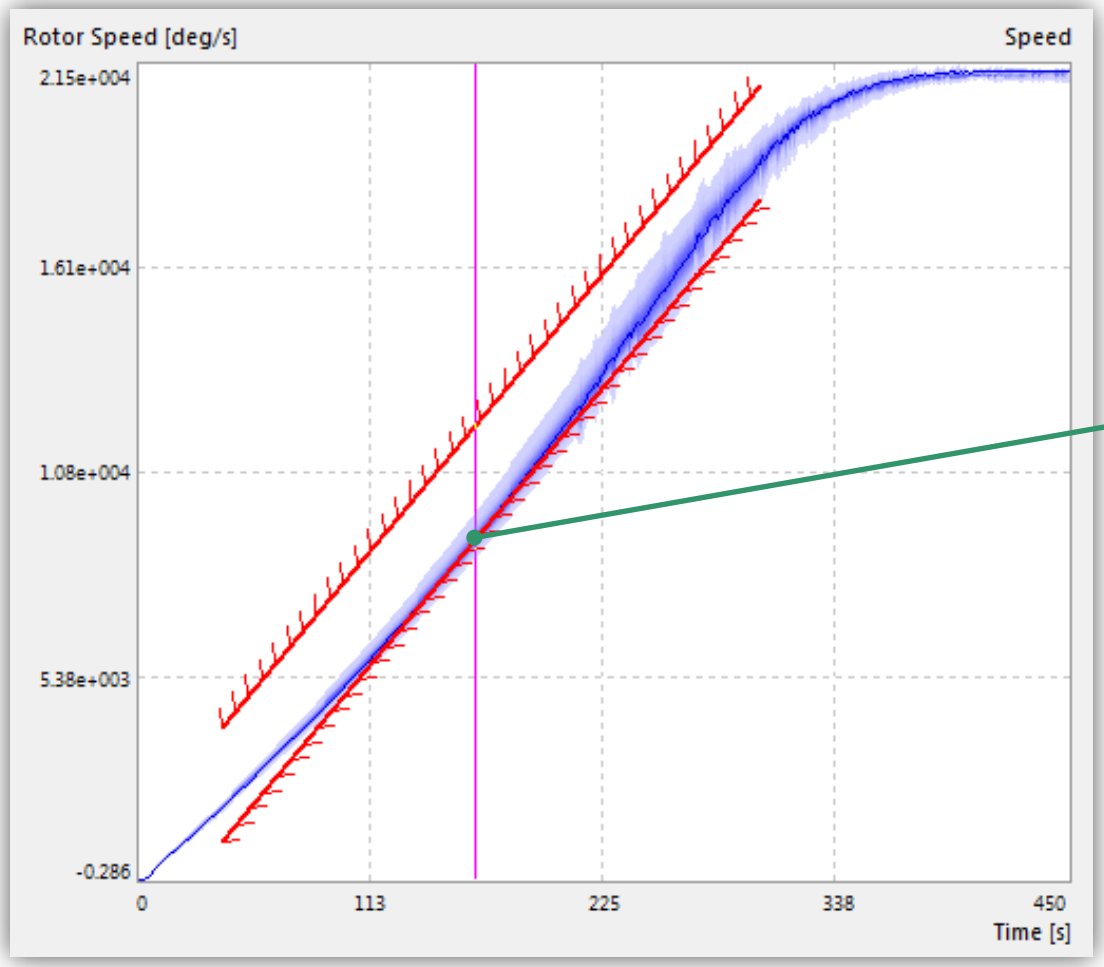






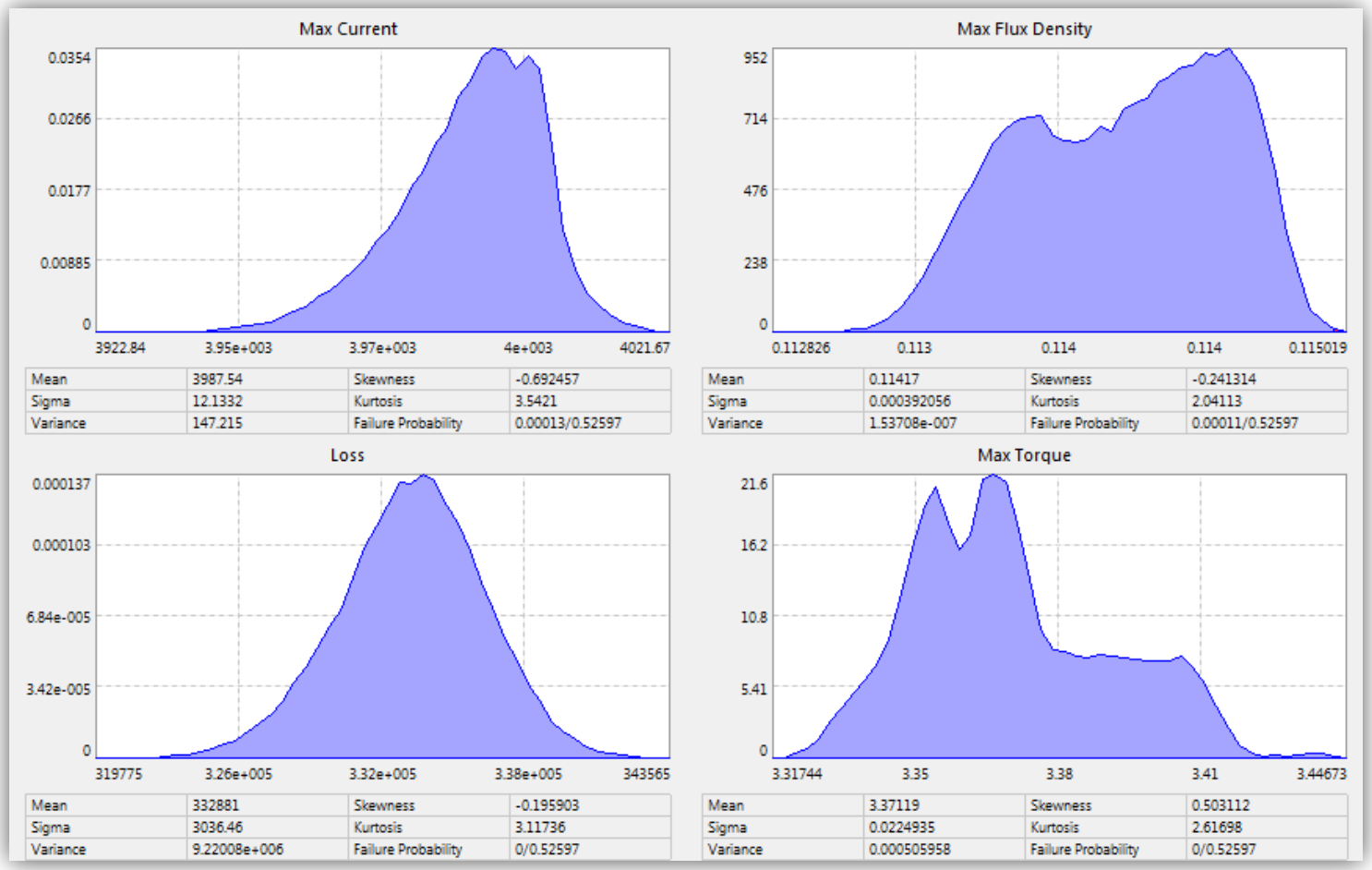
75 Calculations of Original Model in MagNet

Probabilistic Simulation for Initial Design

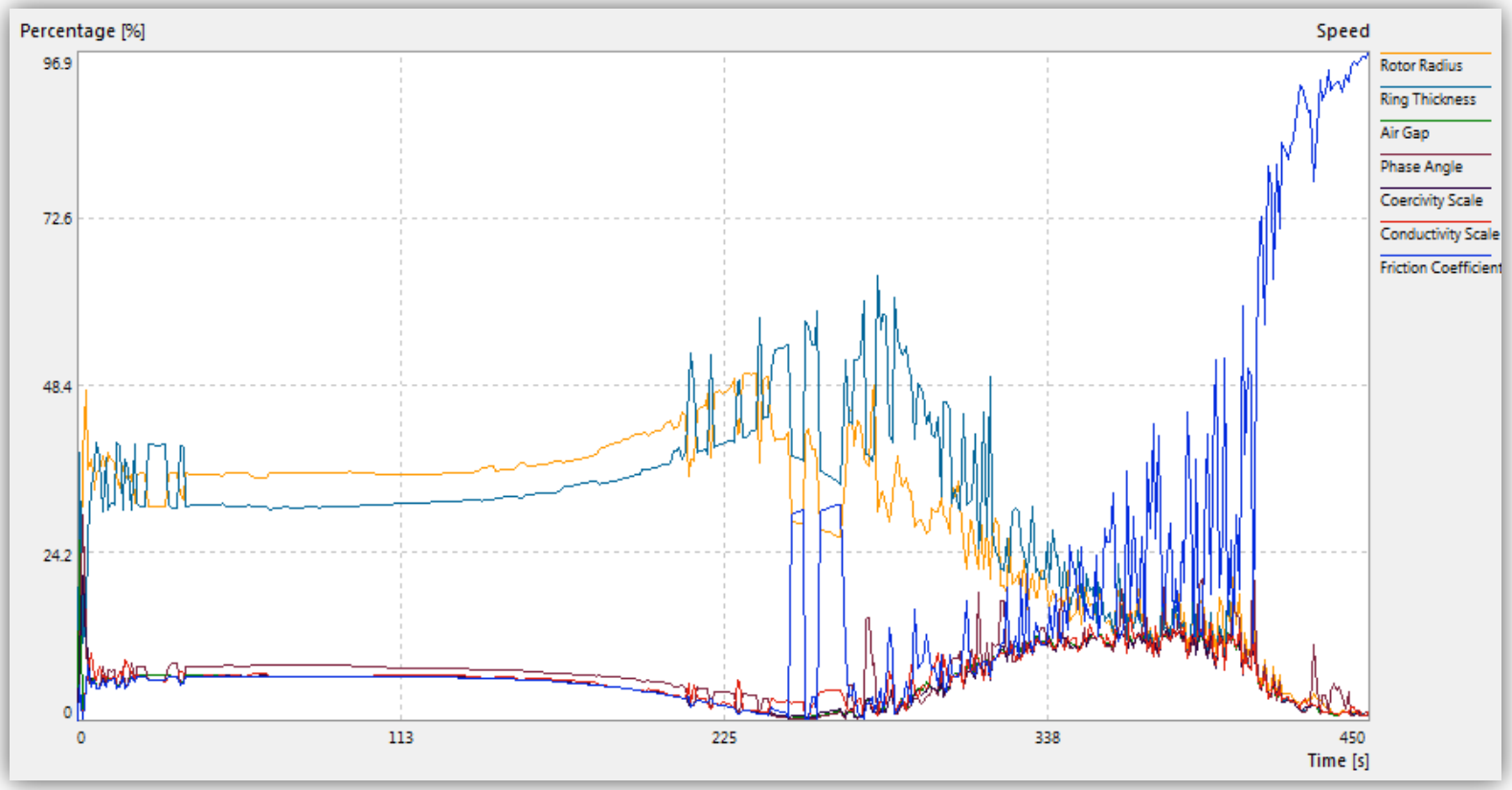


Total Failure Probability = 52.597%

Probabilistic Simulation for Initial Design

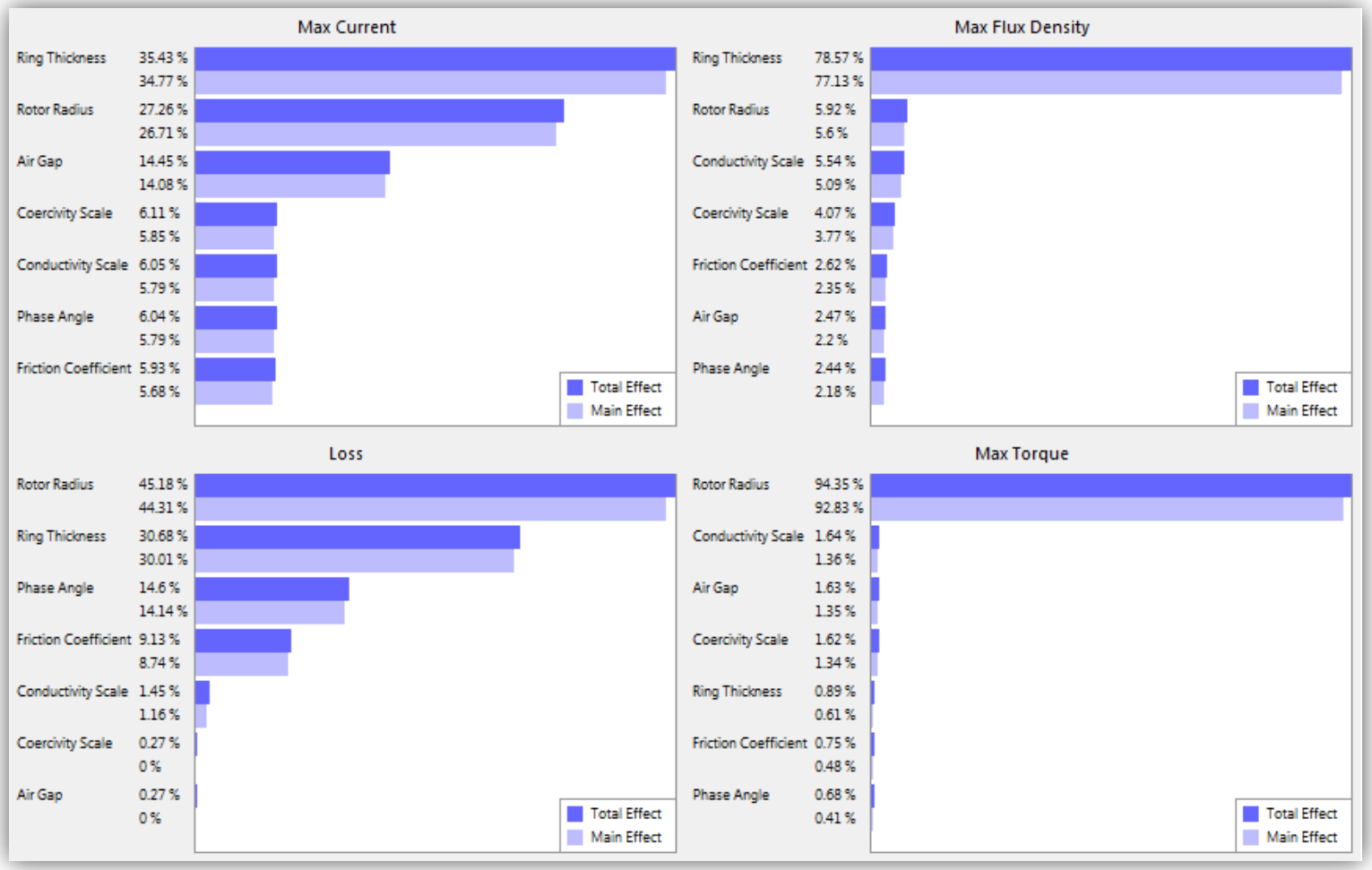


Sensitivity Study for Initial Design

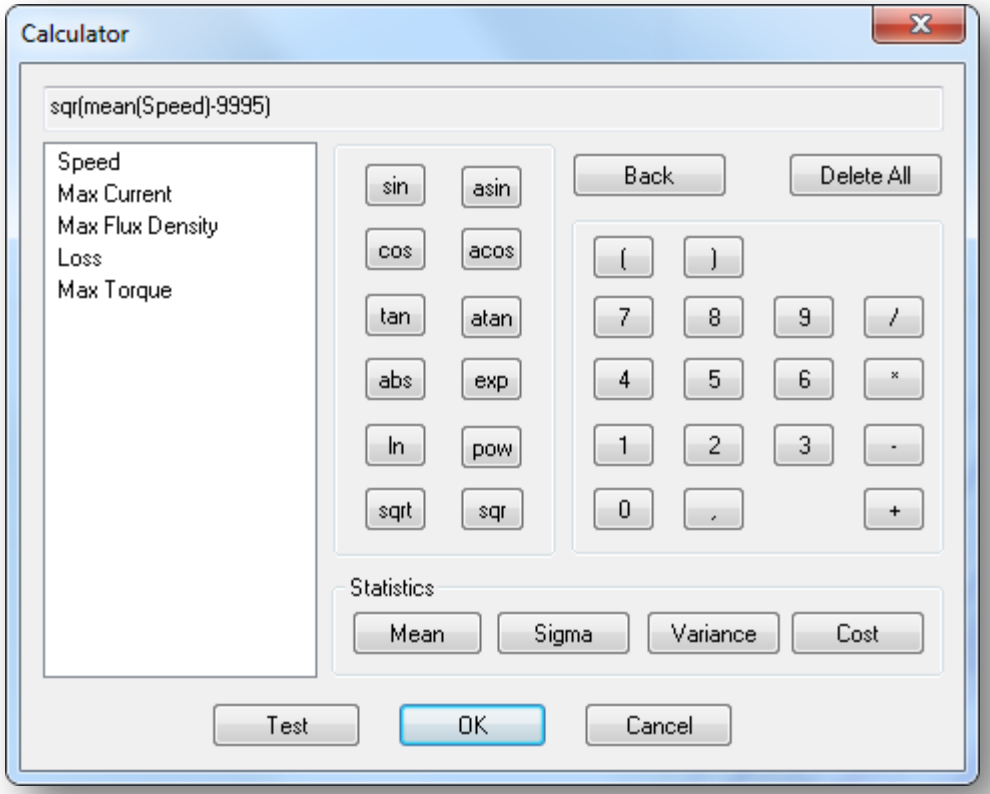


- Rotor radius and ring thickness have most influence on rotor acceleration
- Friction coefficient is the most important factor on constant rotor speed

Sensitivity Study for Initial Design



Robust Design Optimization



Optimization Results:

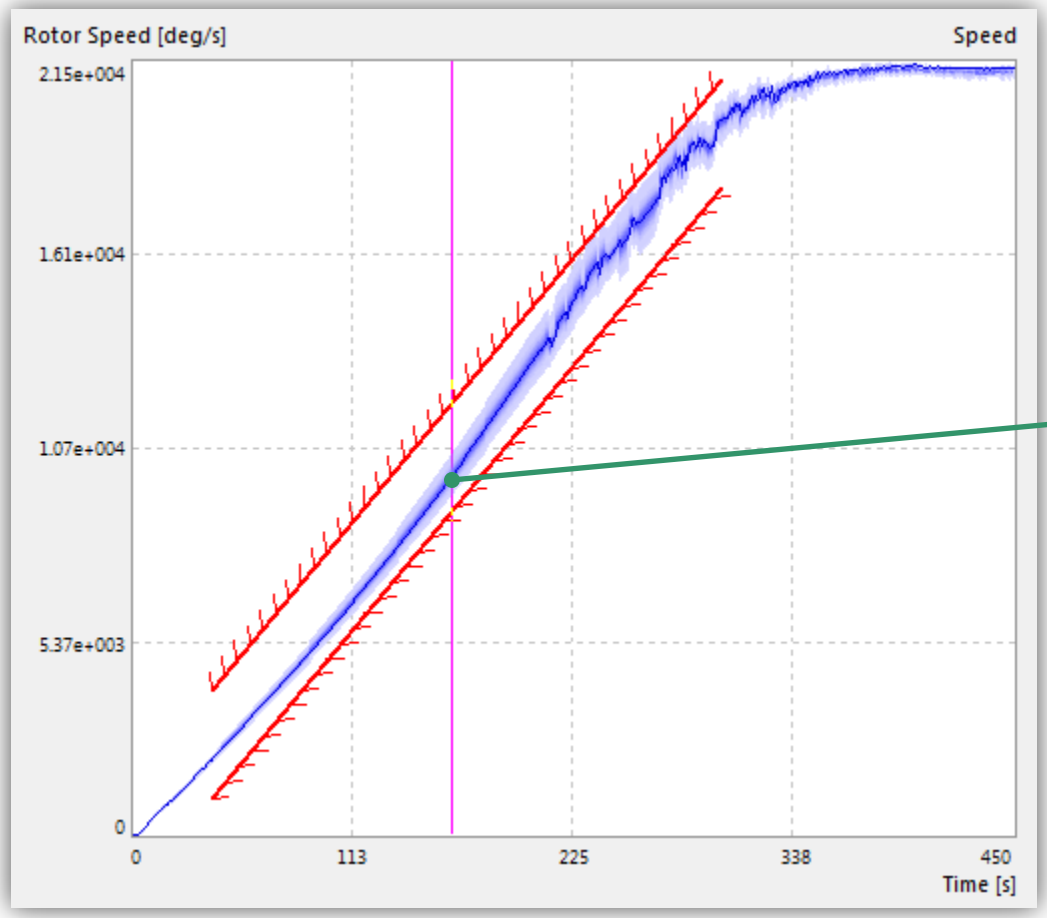
Robust Design Parameters
with its Uncertainty

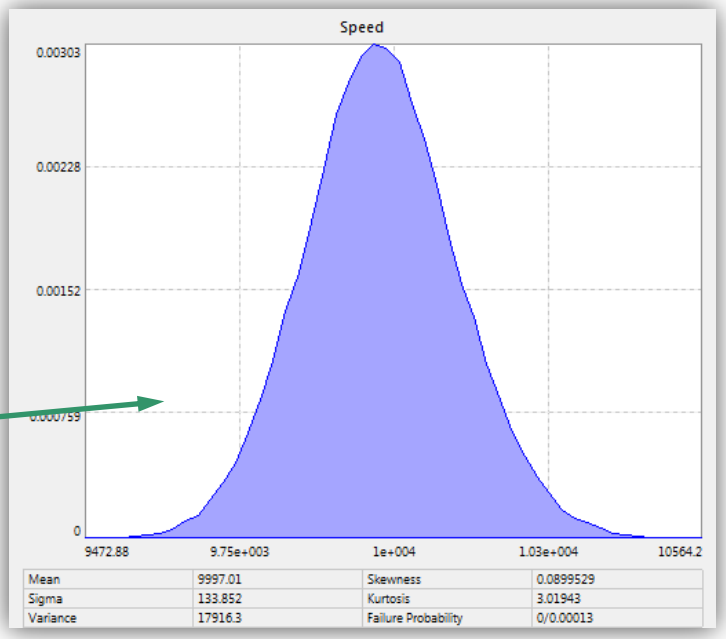
Design Parameters

Name	Nominal	Tolerance	Unit
Rotor Radius	1.87606281	0.04	cm
Ring Thickness	1.06458141	0.04	cm
Air Gap	0.0419933476	0.01	cm
Phase Angle	45.9295363	2	deg
Coercivity Scale	1	0.04	
Conductivity Scale	1	0.04	
Friction Coefficient	0.001	0.001	Nms/rad

Robust Design Goal to Minimize the Failure Probability

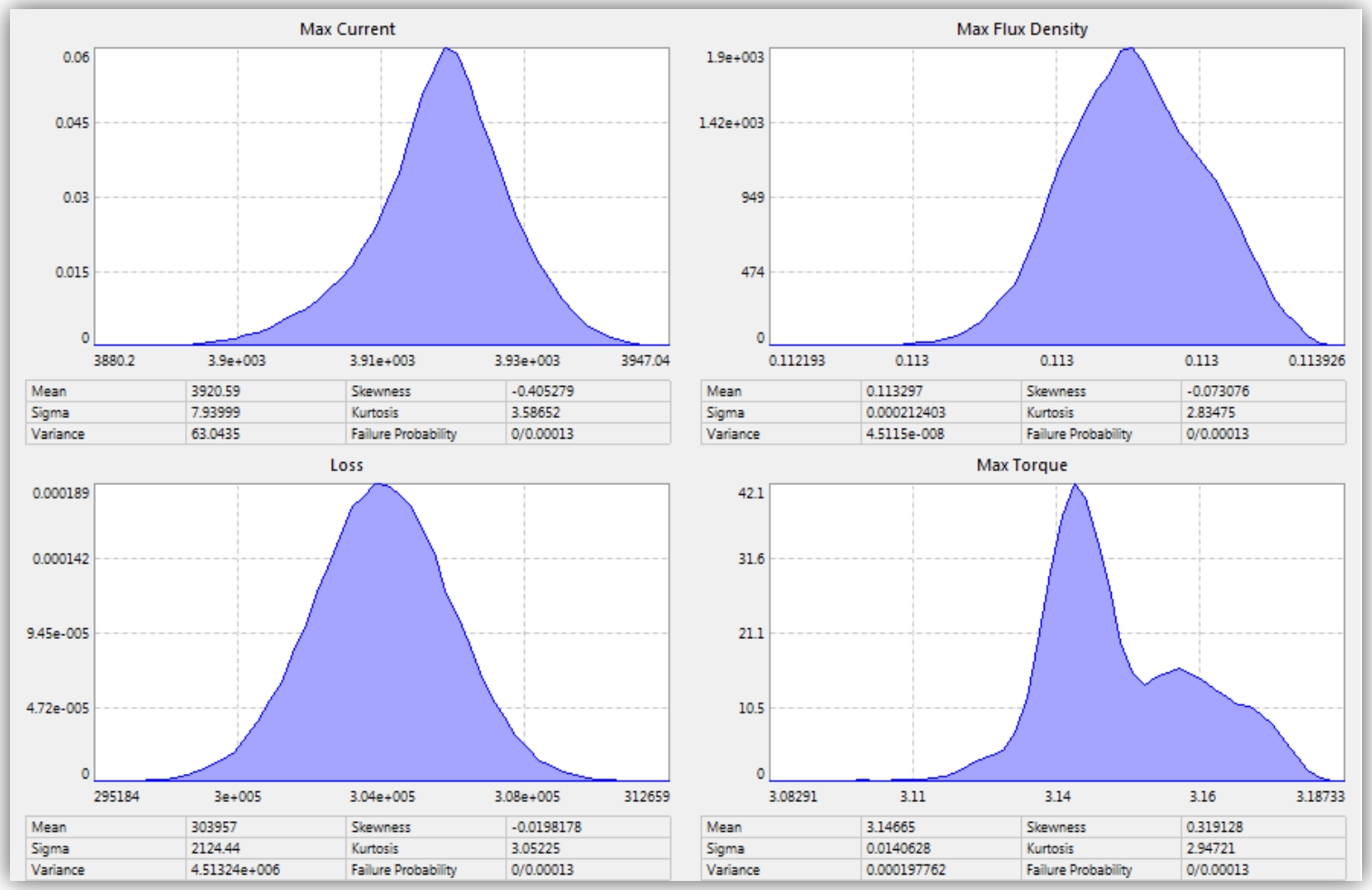
Probabilistic Simulation for Robust Design



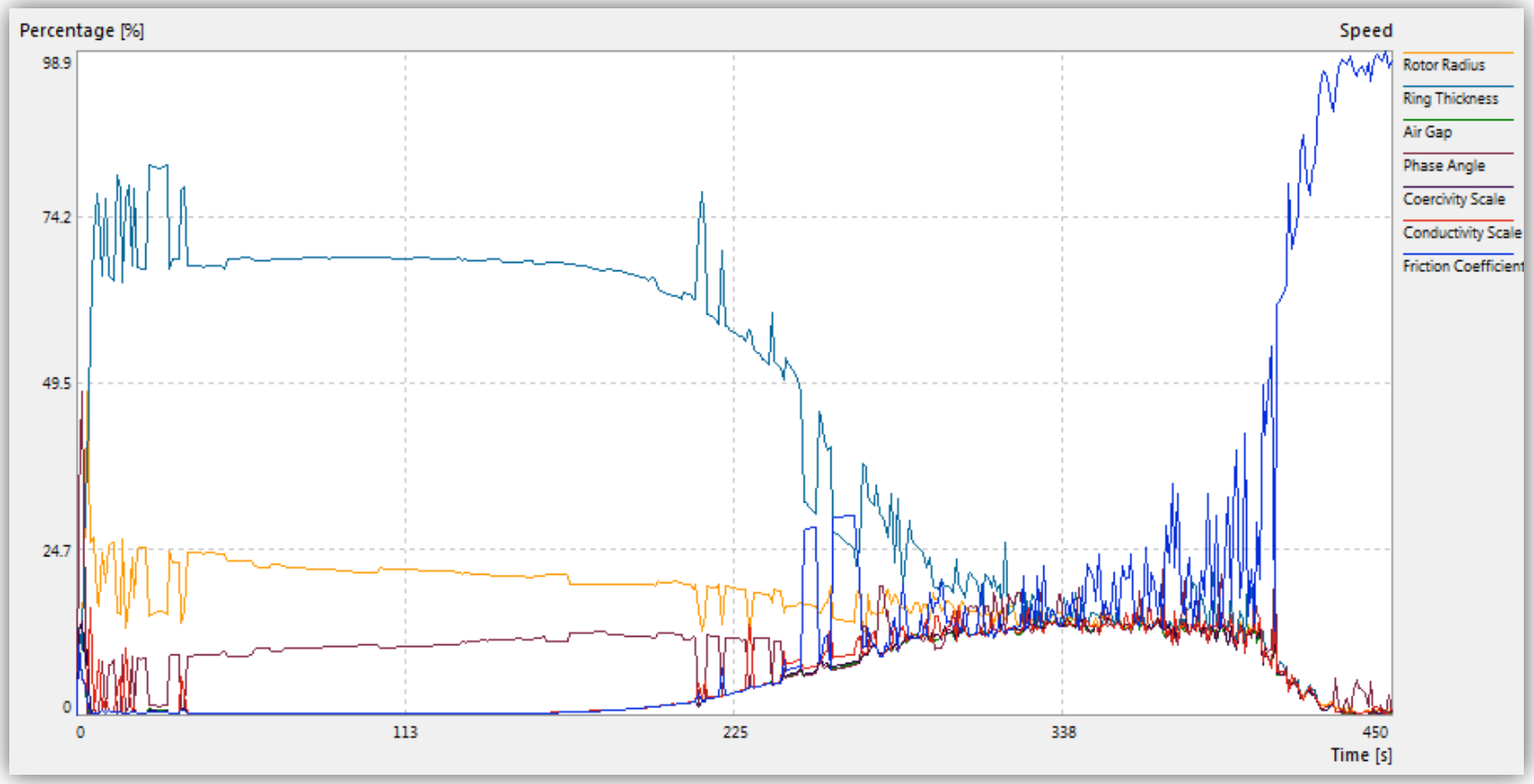


Total Failure Probability = 0.013%

Probabilistic Simulation for Robust Design

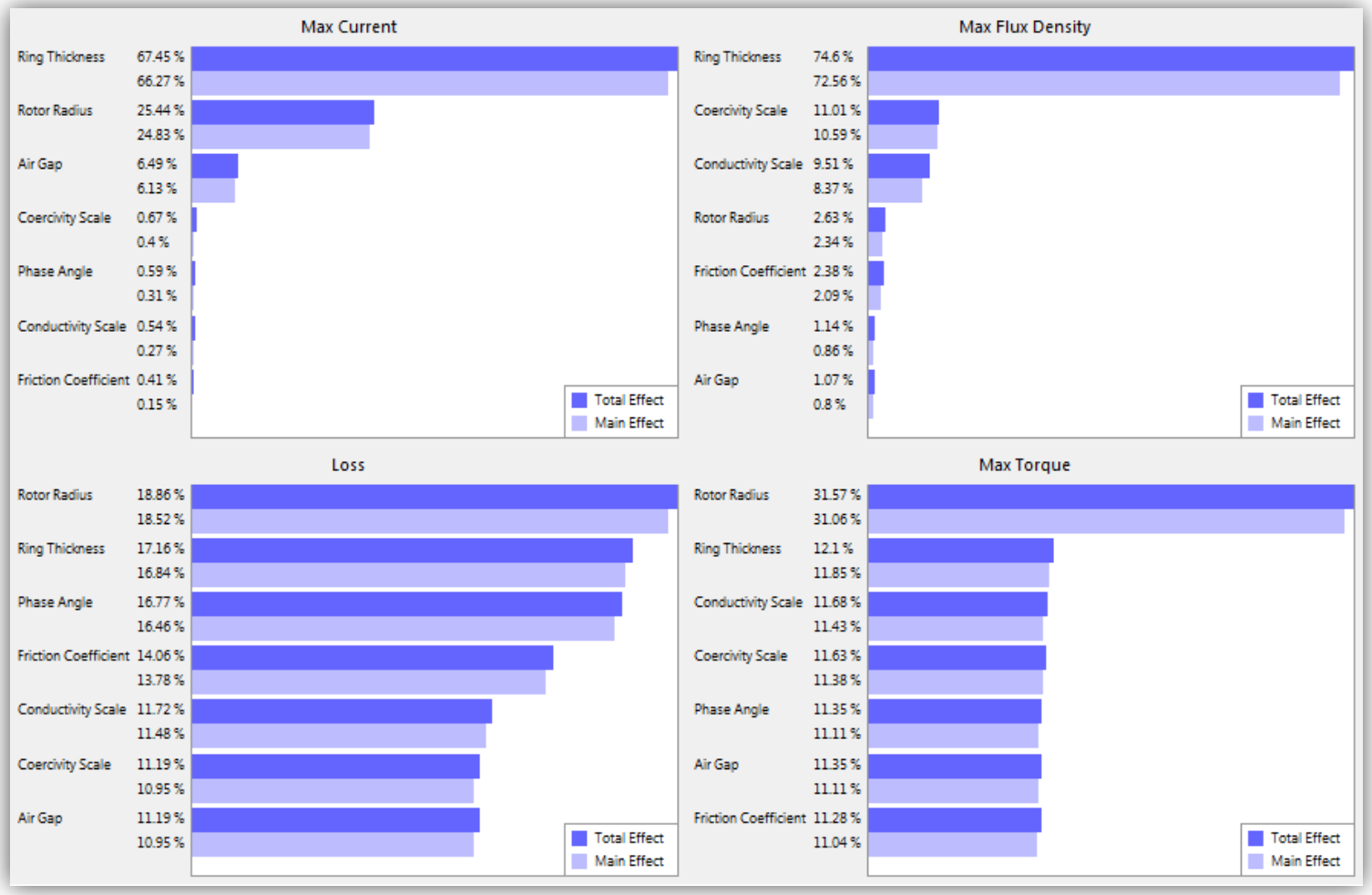


Sensitivity Study for Robust Design



- Ring thickness has most influence on rotor acceleration
- Friction coefficient is the most important factor on constant rotor speed

Sensitivity Study for Robust Design



Conclusion

Nominal design using classical nominal simulation cannot warranty the reliability and quality of the products, because the nominal parameters are only one fix value.

Robust design is a power-full tool for design of reliable and quality product in the early design stage without any cost. It considers the uncertainty parameters as stochastic distributions.

In the case of the induction motor, the failure probability has been reduced from **52,597% to 0,013%** for the mass manufacturing.

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