Electronics Case Studies

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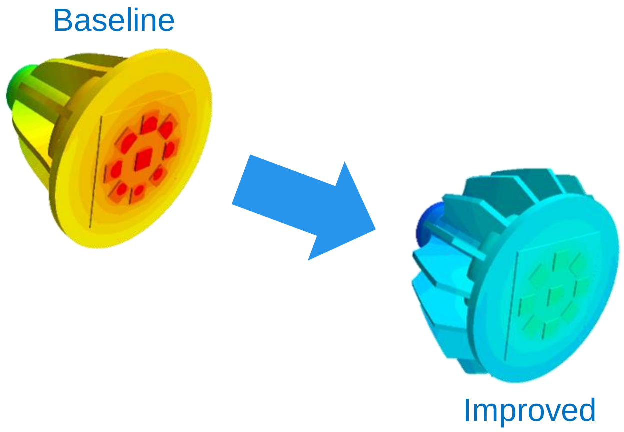
Applications:
- Thermal Management
- Semiconductor Manufacturing
- Lighting
- Avionics
- Telecommunications
- Computers
- Consumer Products

Results:
- Improved Performance
- Reduced Risk and Cost
- Greater Safety and Life
- Faster Design Turnaround
- More Robust Designs
- Increased Innovation

Customer Success: Lighting Heat Management

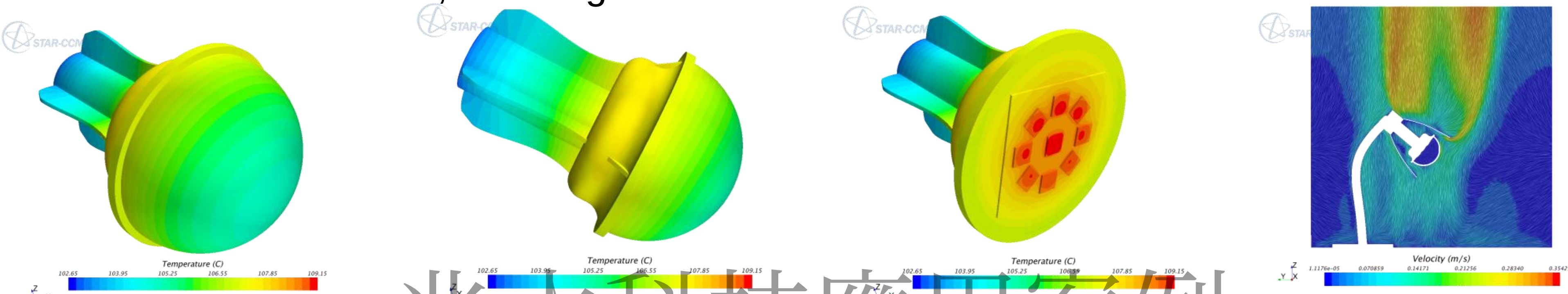
Challenge:

- Improve heat sink for indoor aluminum LED bulb (9 LEDs emitting 4.8W each)
  - Minimize heat sink mass
- Constraints
  - Temperature of bulb ≤ 100 C, ambient = 22C
- Design variables
  - Thickness, shape, fins of heat sink



Results:

- Identified lowest mass design per specifications
- Result obtained after 72 hours, 50 designs



Customer Success: LED Cooling Design Study

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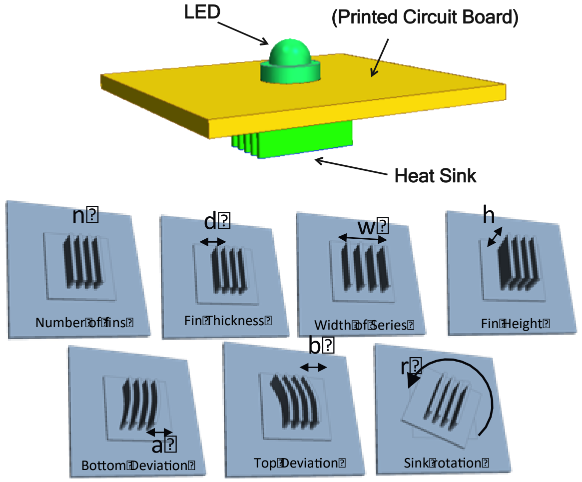
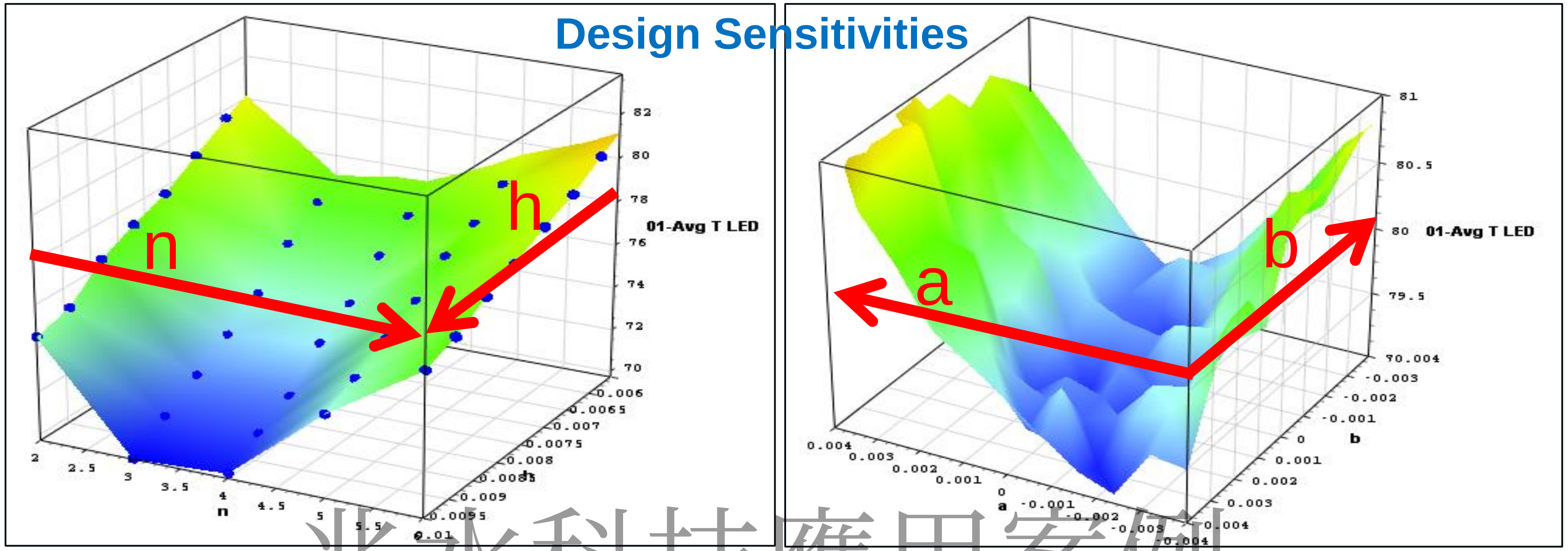
Challenge:

- Design a heat sink to minimize LED temperature
- Design variables (7): sink geometry



Results:

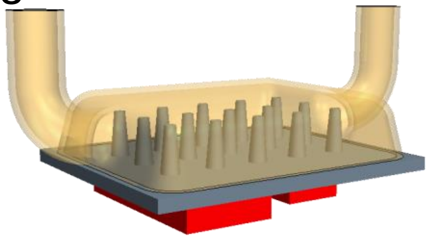
- 700 evaluations
- LED Temp reduced >21%



Customer Success: Electronics Cooling Design

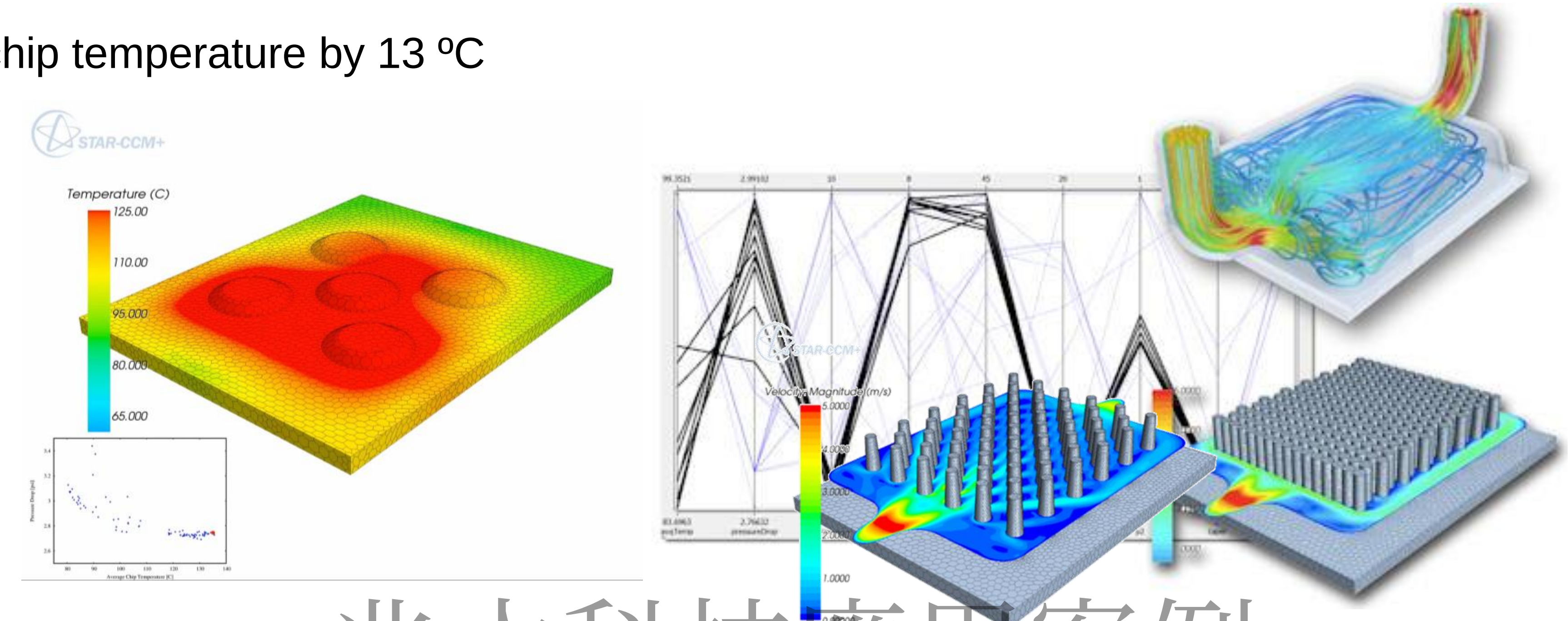
Challenge:

- Minimize chip temperature and pressure drop in ethylene glycol cooling fluid
- Design variables
  - Number, size, spacing, and taper of heat exchanger pins



Results:

- Reduced chip temperature by 13 ºC



Customer Success: Computer Cooling Design Study

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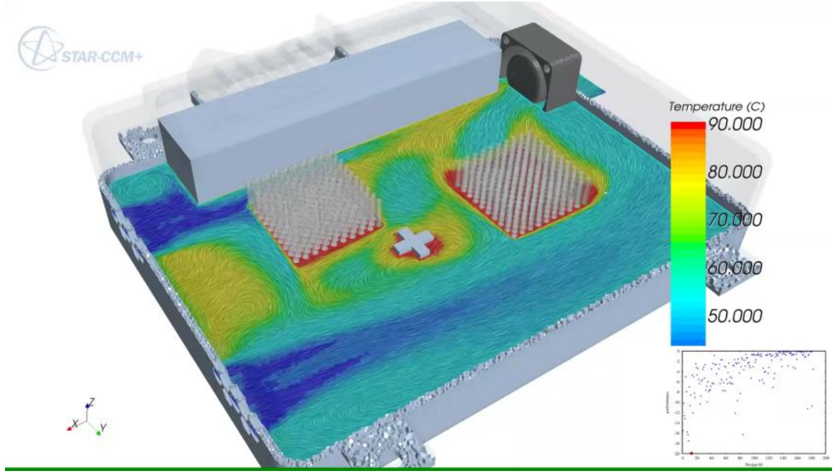
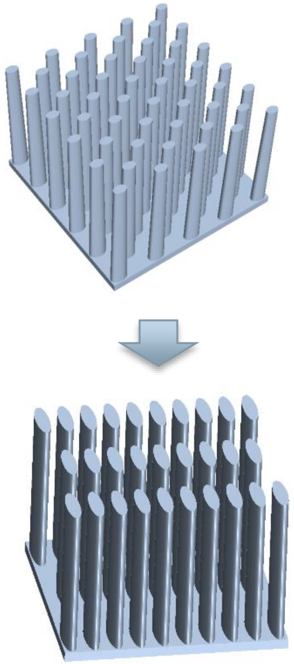
Challenge:

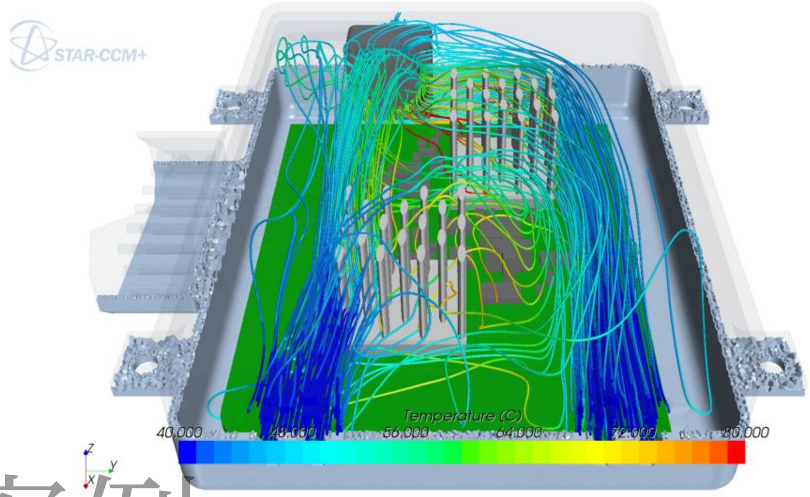
- Improve geometry of IC heat sink
  - Minimize heat sink mass (weighted 25%)
  - Minimize difference between temp and 85 deg. (75%)
- Constraints
  - Ambient temp = 40 deg.
  - Fixed fan speed
  - Maximum values for pin geometry
- Design variables
  - Pin height, radii, taper, density

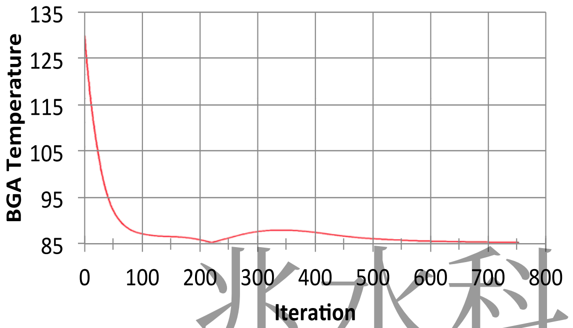
Results:

- Identified best cooling pin layout and fan location









Customer Success: Avionics Air Transport Rack Study

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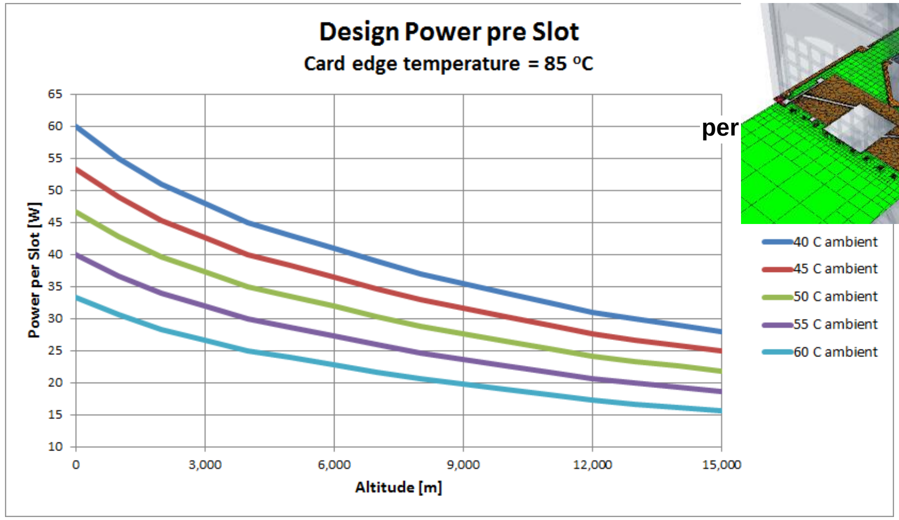
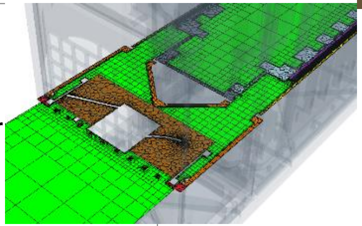
Challenge:

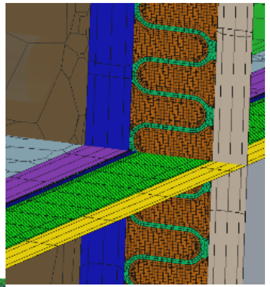
- Identify the maximum power per slot that can be used on an avionics Air Transport Rack (ATR) at different altitudes and temperatures

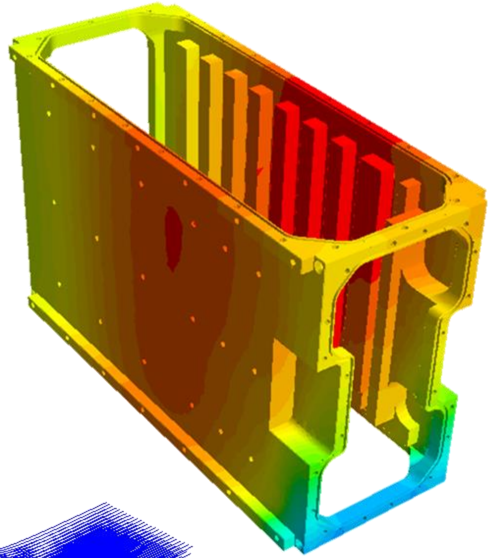
Results:

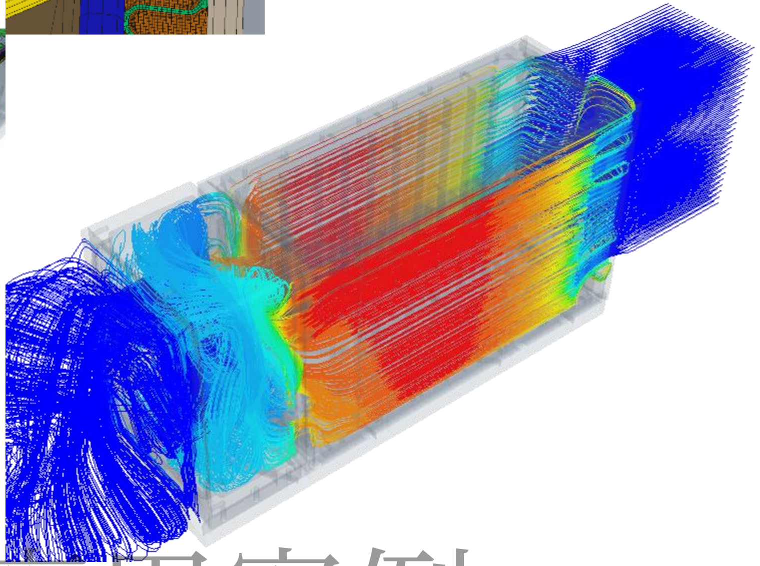
- Eliminated need for expensive testing
- Max power identified at every temp and altitude











Customer Success: Performance, Range & Comfort

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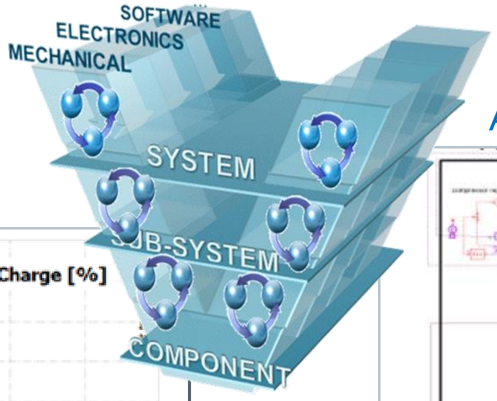
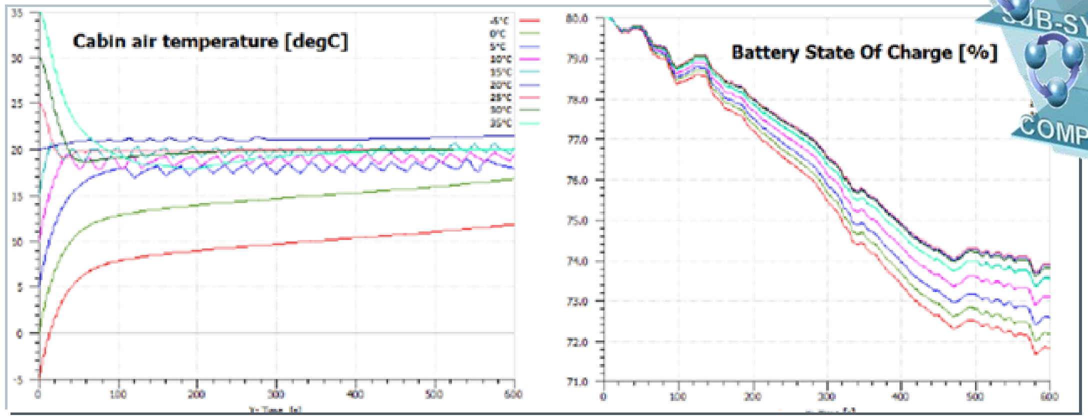
Challenge:

- Balance performance, range, and passenger comfort of an electric vehicle
- AMESim and Matlab/Simulink used to simulate 1D system behavior
- HEEDS adjust bypass orifice to improve system performance

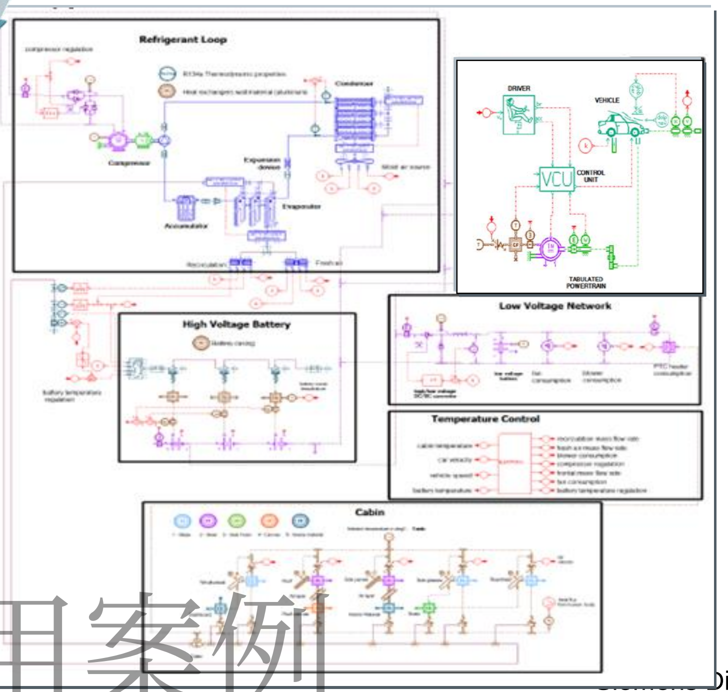
Results:

- Best balance achieved





AMESim 1-D Subsystem Models



Customer Success: Battery Performance Correlation

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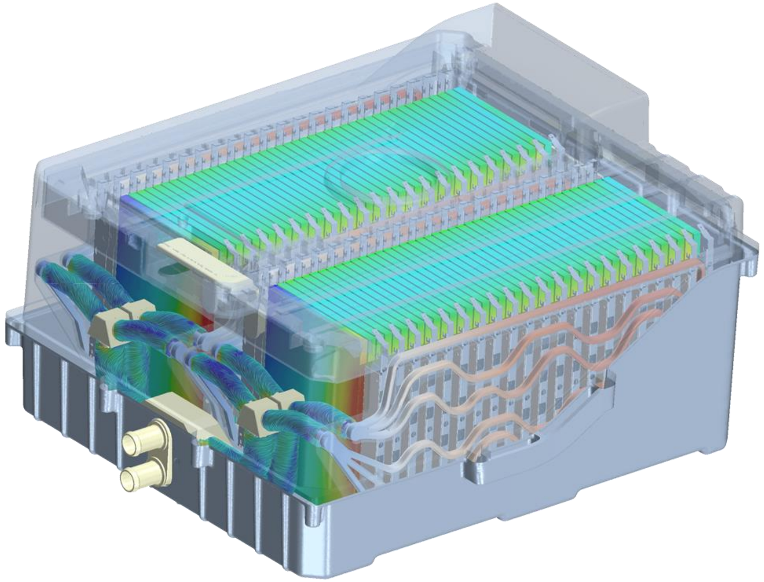
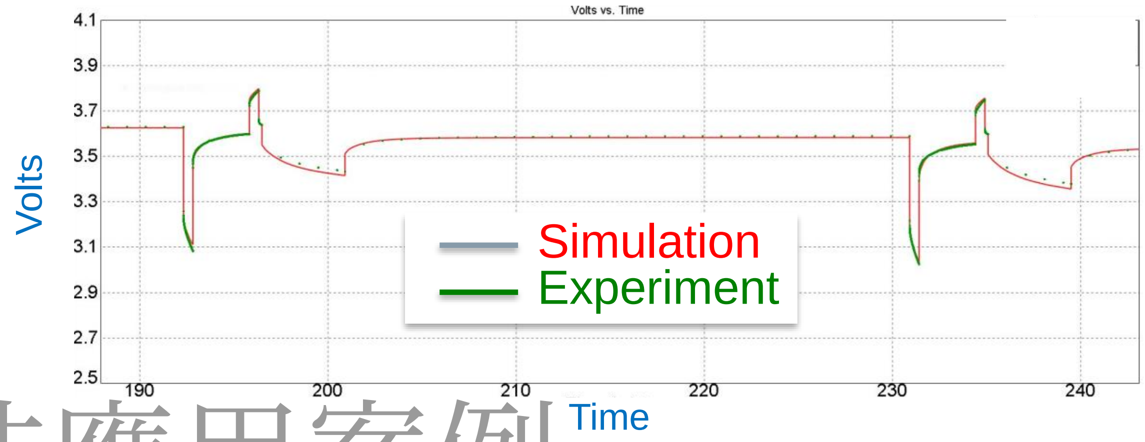
Challenge:
- Improve battery performance model
  - Minimize RMS error between simulation and test
  - Use Battery Design Studio simulation model
- Design variables (8)
  - NCA diffusion pre-exponential factor
  - Graphite diffusion pre-exponential factor
  - Surface area
  - Separator – MacMullin Number
  - Base Model Tortuosity Negative
  - Base Model Tortuosity Positive
  - SEI Pre-exponential factor

Results:
- Excellent correlation between simulation and experimental test results





Customer Success: Electric Motor Design Study

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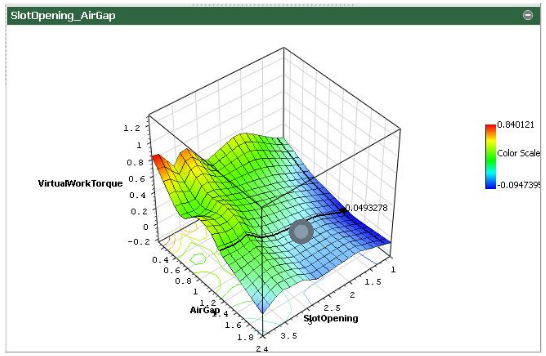
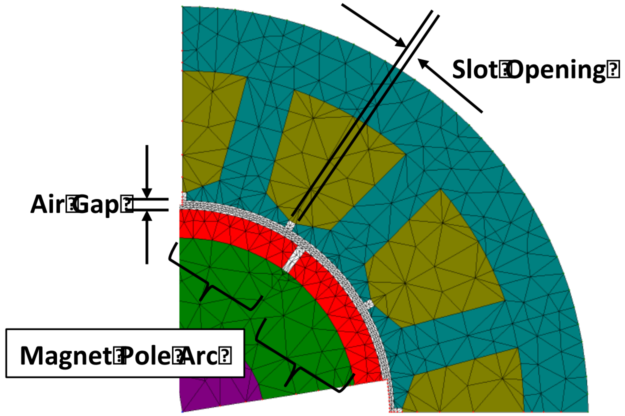
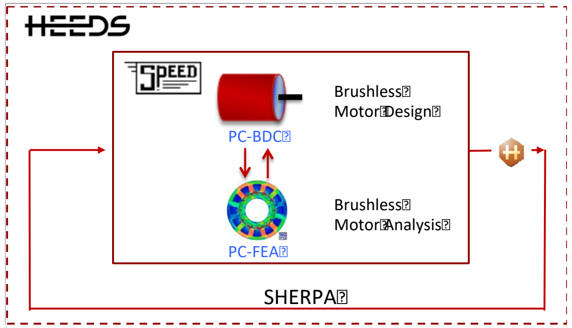
Challenge

- Minimize cogging torque
- Design variables
  - 100° < Magnet Pole Arc < 180°
  - 1 mm < Slot Opening (SO) < 4 mm
  - 0.3 mm < Air Gap (Gap) < 2 mm





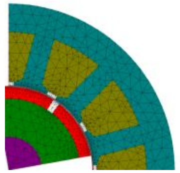


Results

- 99% lower cogging torque

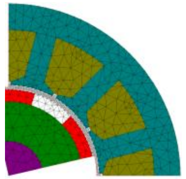
Baseline Design:

- Cogging Torque= 0.7185 Nm
- Magnet Pole Arc = 170°
- Slot Opening (SO) = 3.0 mm
- Air Gap (Gap) = 0.5 mm



Improved Design:

- Cogging Torque= 0.004 Nm
- Magnet Pole Arc = 123°
- Slot Opening (SO) = 1.15 mm
- Air Gap (Gap) = 1.35 mm



Customer Success: Electric Motor Design Study

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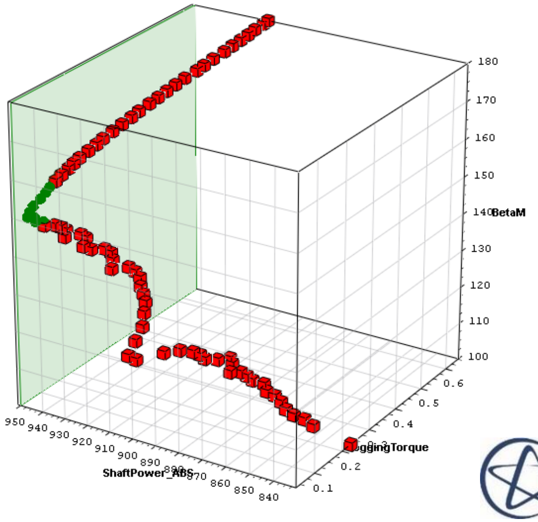
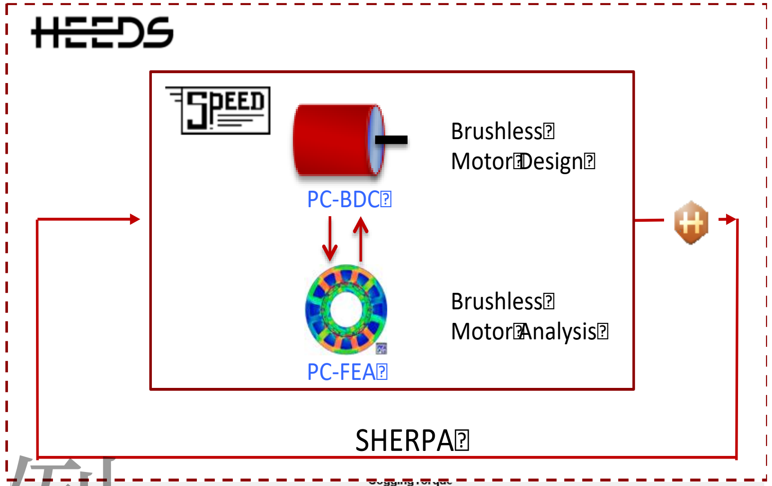
Challenge:

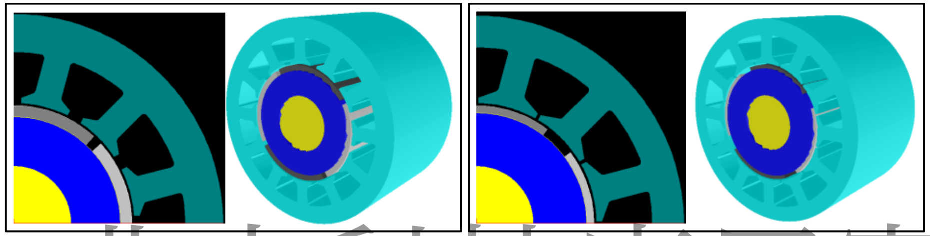
- Minimize cogging torque and magnet volume
- Constraints (8):
  - 950 W < Shaft Power < 1050 W
  - 190 V < Induced Voltage < 200 V
  - Copper Losses < 100 W
  - Iron Losses < 20 W
  - Total Losses < 120 W
  - 1.4 T < Stator Flux Density < 1.6T
  - 1.4 T < Stator Yoke Flux < 1.6T
  - Rotor Yoke Flux Density < 1.6T
- Design variables (10):
  - 100° ≤ Magnet Pole Arc ≤ 180°
  - 1 mm ≤ Slot Opening ≤ 4 mm
  - 0.3 mm ≤ Air Gap ≤ 2 mm
  - 10 mm ≤ Slot Depth ≤ 17 mm
  - 50 ≤ Number of Coils ≤ 150
  - 60 mm ≤ Stack Length ≤ 80 mm
  - 4 A ≤ Current Set Point ≤ 7 A
  - 5 mm ≤ Tooth Width ≤ 10 mm
  - 1 mm ≤ Magnet Thickness ≤ 5 mm
  - 26 mm ≤ Outer Rotor Radius ≤ 36 mm

Results:

- 94% reduction in cogging torque
- 46% reduction in magnet volume







Baseline   Optimized (46% Reduction in Magnet Volume)