HydraSafe

FEA Mass Reduction

2023/12/11

Industrial Design

Mechanical Engineering

Electrical Engineering

Software Development

Material and Safety Factor

https://www.makeitfrom.com/material-properties/ASTM-Grade-LC2-1-J42215-Cast-Alloy-Steel

Points:
Yield Strength 91,000psi
Ultimate strength 120,000psi
Fatigue Strength 63,000psi @ 10M cycles
Elongation at break = 20%

Target:
Single load safety factor 3.5 (Verified by client)
See ASME A17.1 section 2.17.12.1
10M cycle safety factor 1.5

From: Timothy Toan <Tim.toan@elvatodesigns.com>
Sent: Monday, May 8, 2023 3:14 PM
To: Brian Mathews <bmathews@dimontegroup.com>; Michael Graef <mgraef@dimontegroup.com>
Cc: Kyle Toan <kyle.toan@elvatodesigns.com>; kevin <kevin@hydrasafebrake.com>
Subject: Re: New Hydrasafe Casting Design With End Plugs FEA

I found it. Here is the section of the code for elevator Safety devices. This is the safety factor we need to adhere to so we are good to go.

2.17.12 Minimum Factors of Safety and Stresses of
Safety Parts and Rope Connections
2.17.12.1 Parts of safeties, except springs, safety rope drums, leading sheaves, and their supporting brackets and safety-jaw gibs, shall have a factor of safety of not less than 3.5, and the materials used shall have an elongation of not less than 15% in a length of 50 mm (2 in.) when tested in accordance with ASTM E8. Forged, cast, or welded parts shall be stress relieved.

Tim

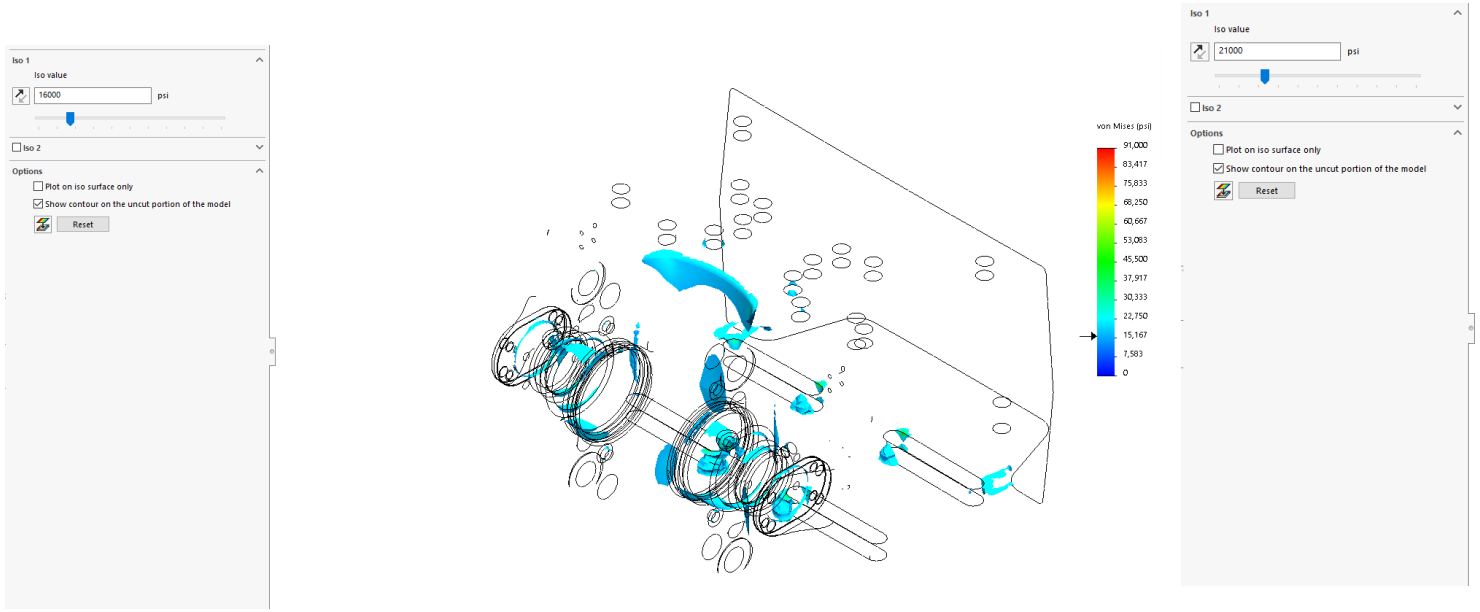
Timothy Toan
Lead Designer
Elevator Design Services
708-870-0370

2.17.12 Minimum Factors of Safety and Stresses of Safety Parts and Rope Connections

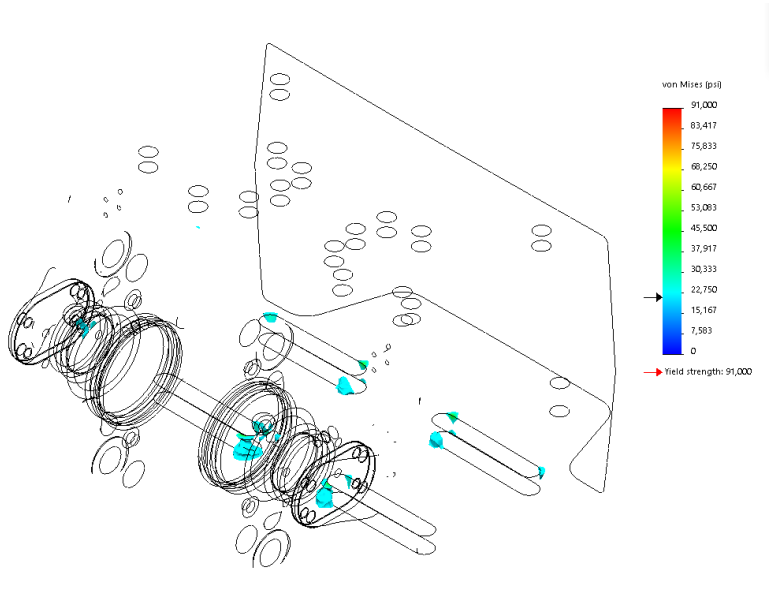
2.17.12.1 Parts of safeties, except springs, safety-rope drums, leading sheaves, and their supporting brackets and safety-jaw gibs, shall have a factor of safety of not less than 3.5, and the materials used shall have an elongation of not less than 15% in a length of 50 mm (2 in.) when tested in accordance with ASTM E8. Forged, cast, or welded parts shall be stress relieved.

10M Cycle Safety Factor

Fatigue strength 63,000 psi / 1.5X FOS = 42,000 psi limit.
Actual peak stress is ~16,000 psi - 21,000 psi
63,000 psi / 16,000 psi = **3.9** safety factor
63,000 psi / 21,000 psi = **3.0** safety factor

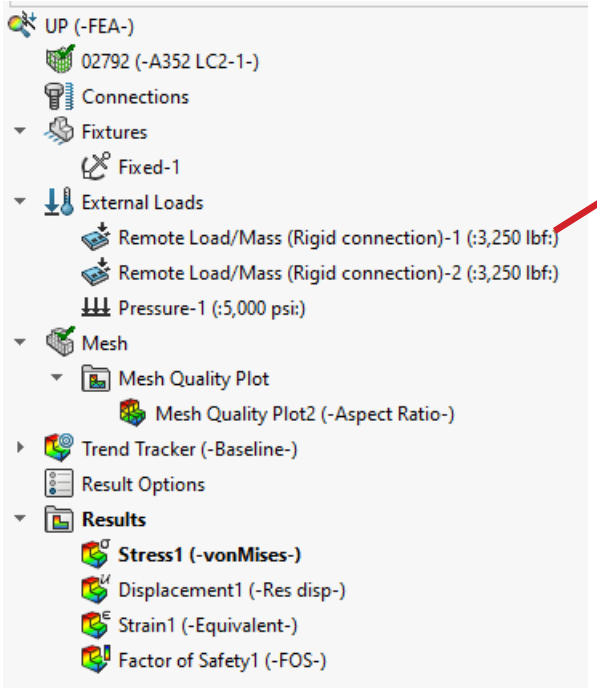


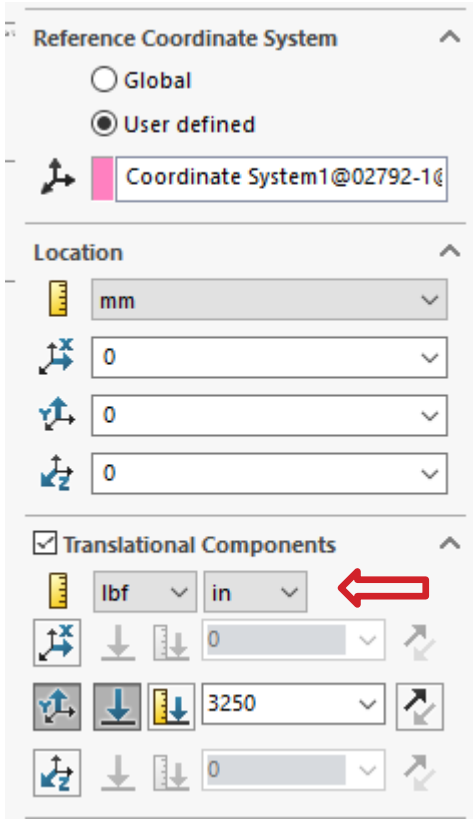
16,000psi

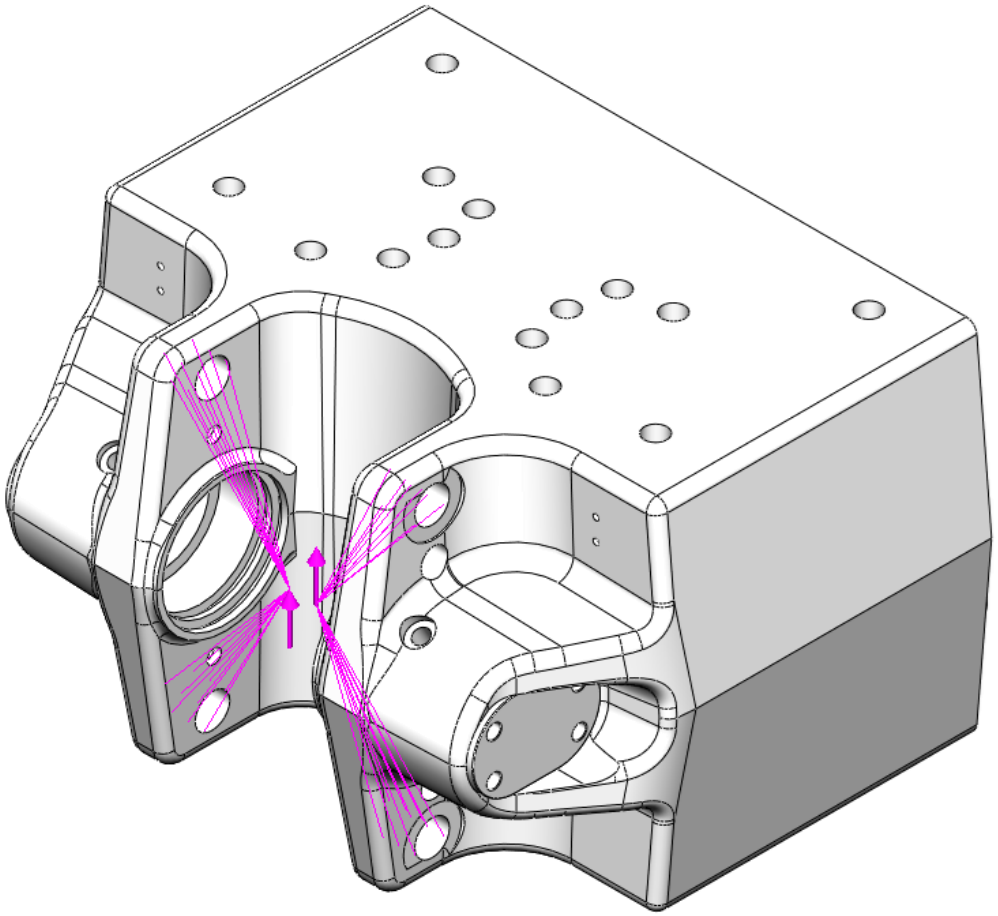


21,000psi

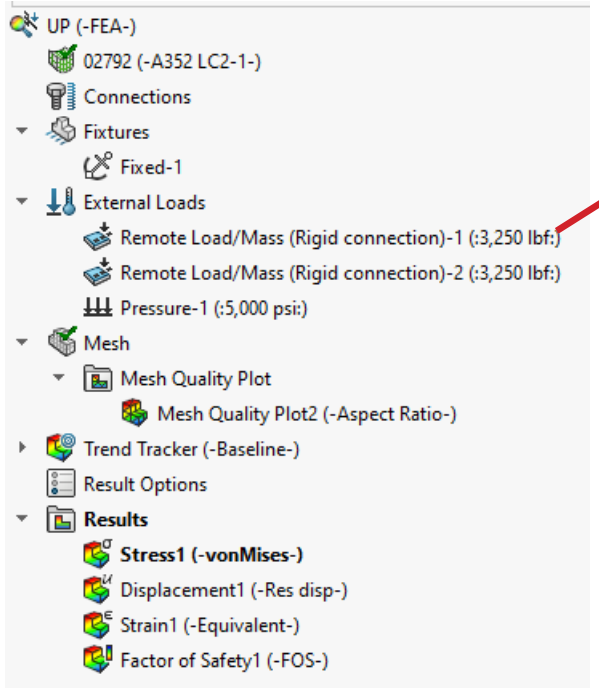
Setup – Loads – Upward Force

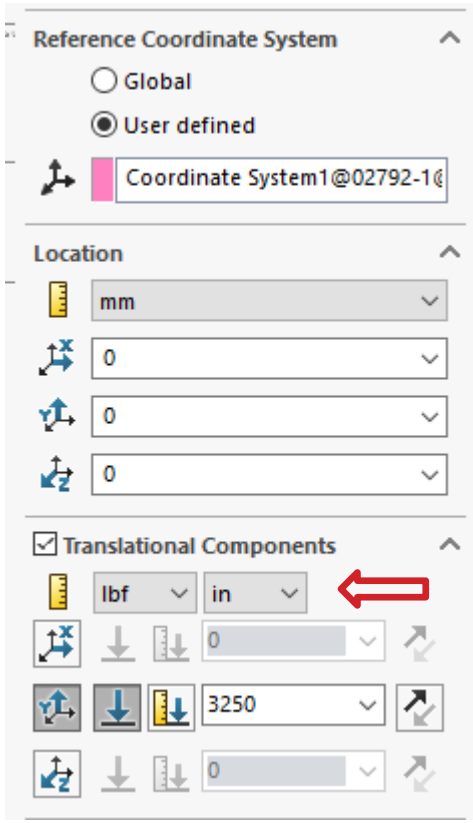


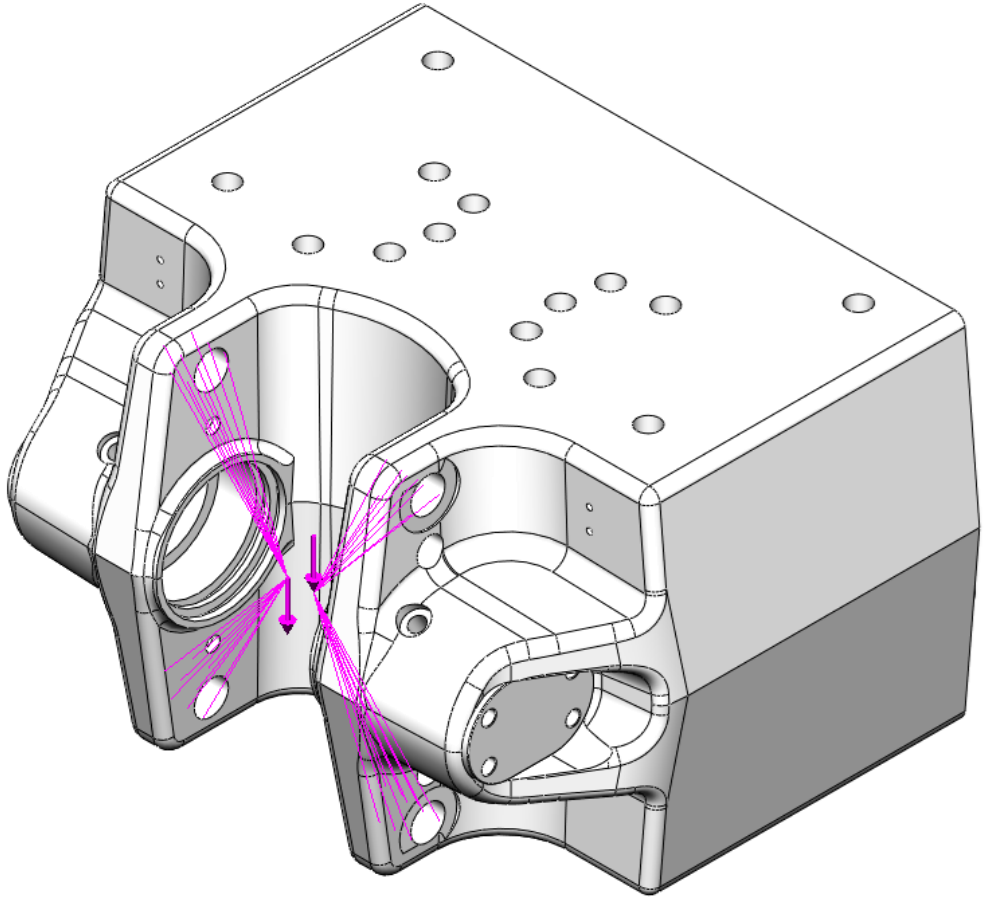




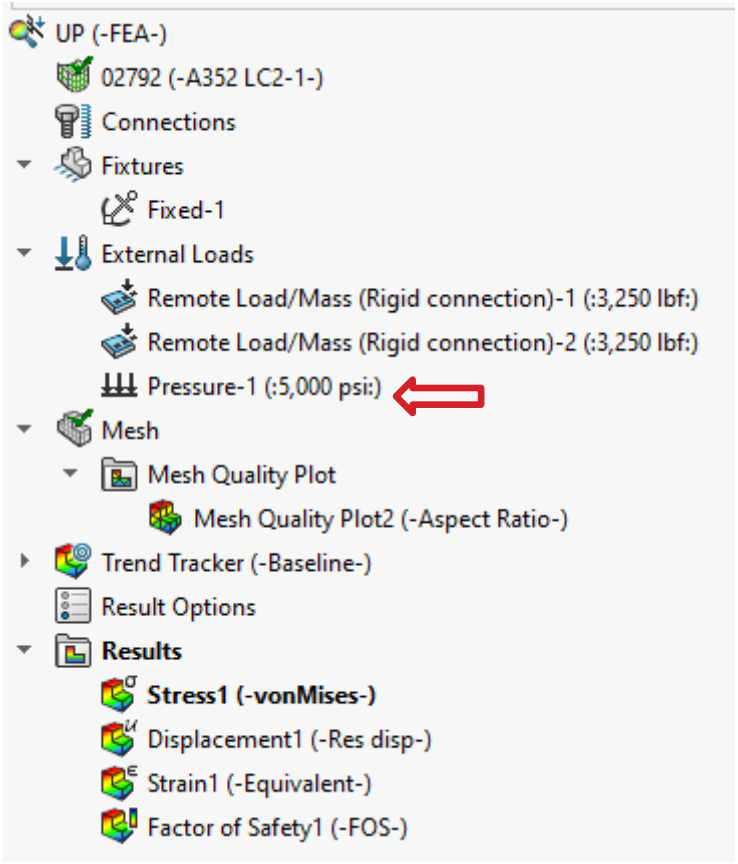
Setup – Loads – Downward Force

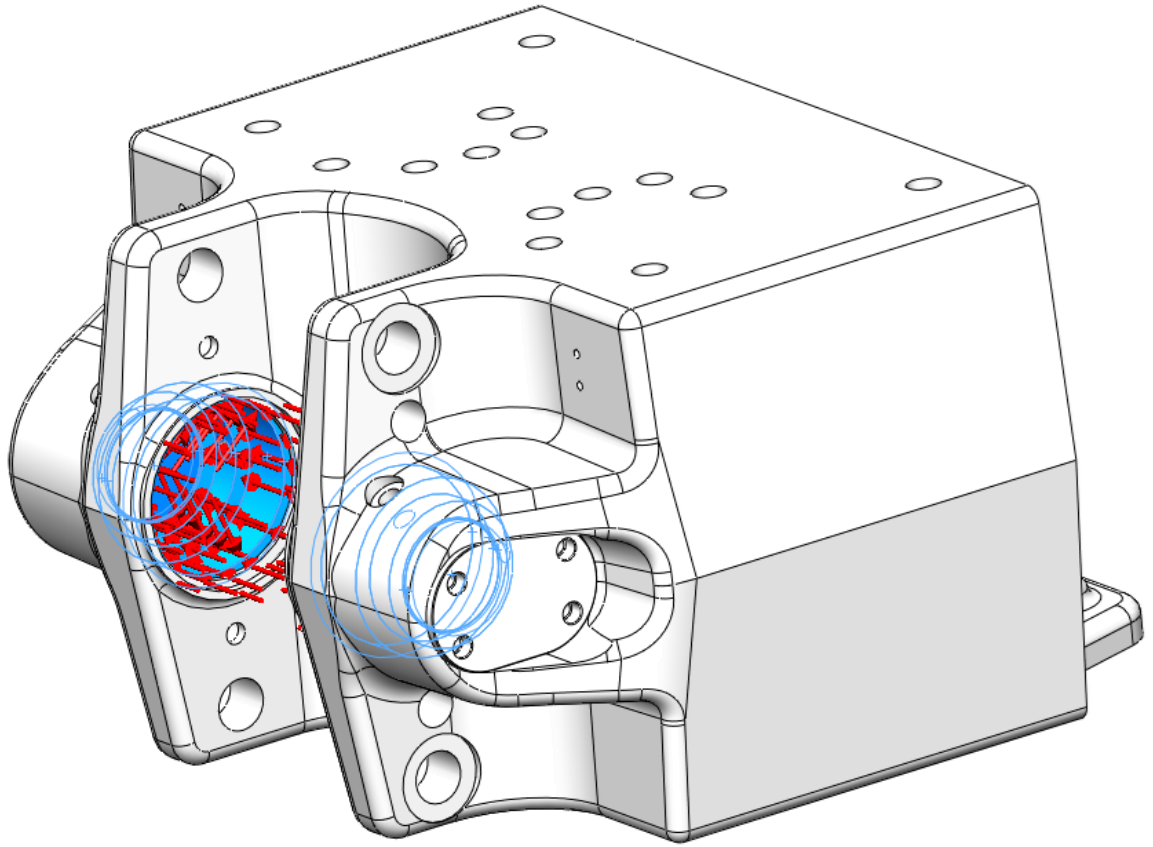






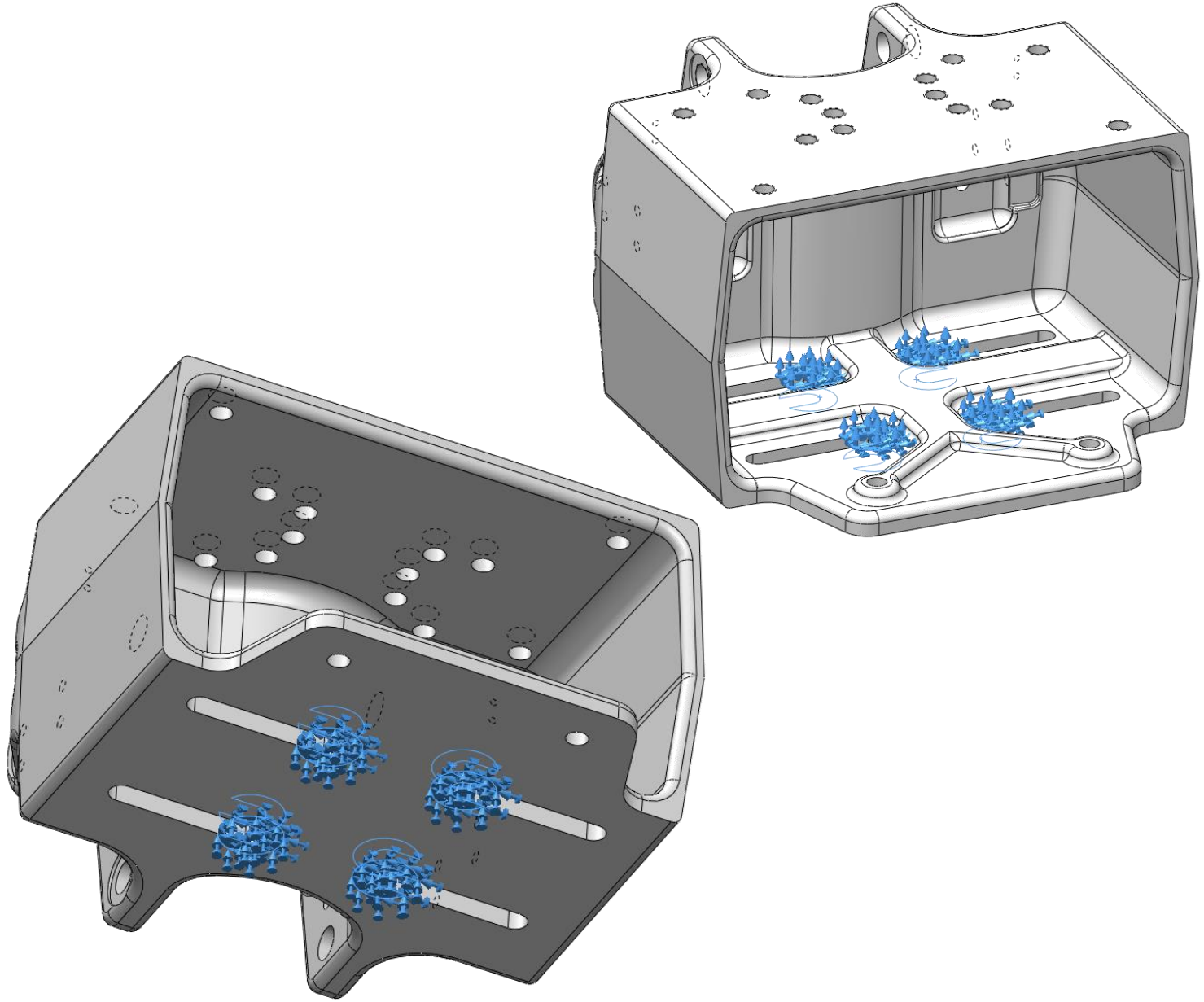
Setup – Pressure





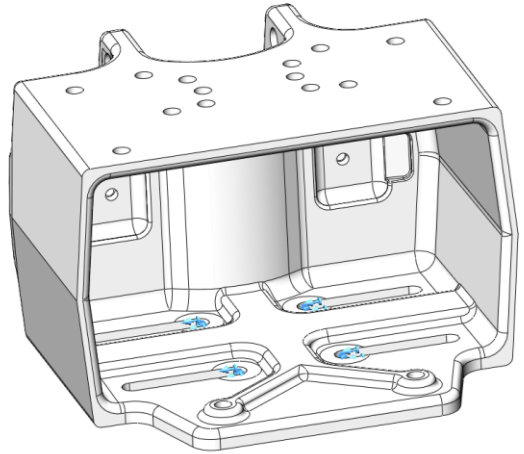
Setup - Fixtures

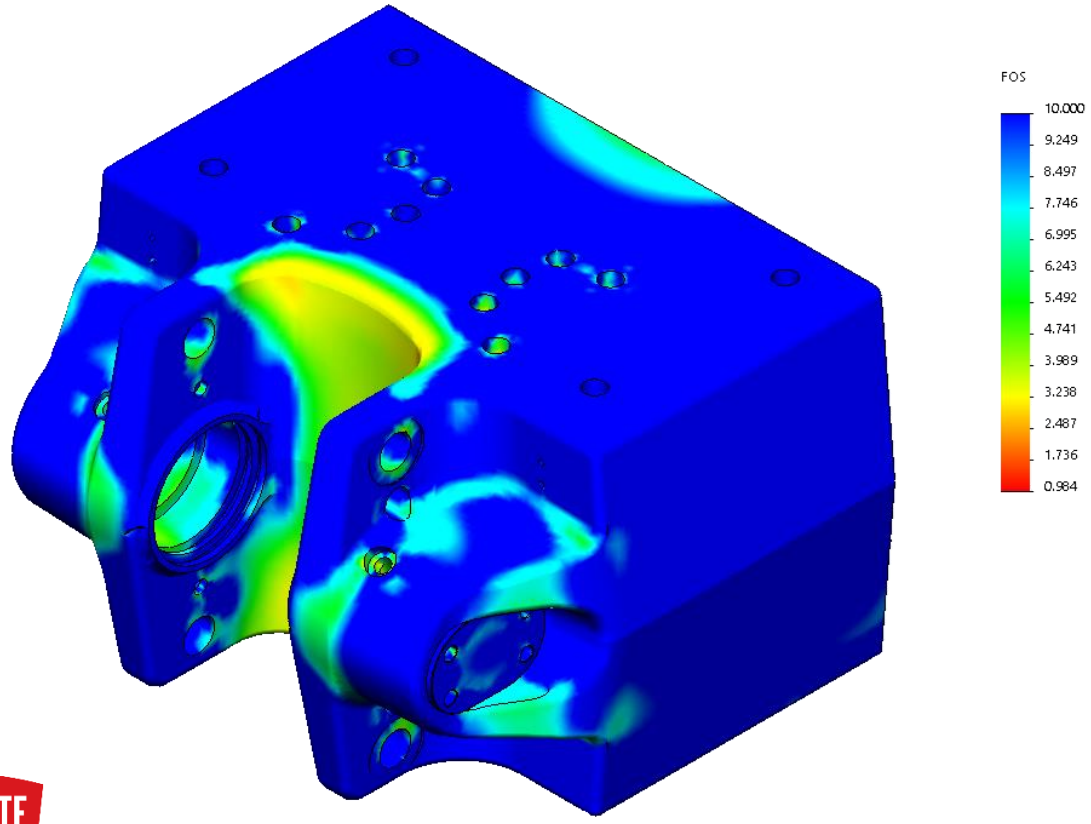
- UP (-FEA-)
  - 02792 (-A352 LC2-1-)
  - Connections
  - Fixtures
    - Fixed-1
  - External Loads
    - Remote Load/Mass (Rigid connection)-1 (:3,250 lbf:)
    - Remote Load/Mass (Rigid connection)-2 (:3,250 lbf:)
    - Pressure-1 (:5,000 psi:)
  - Mesh
    - Mesh Quality Plot
      - Mesh Quality Plot2 (-Aspect Ratio-)
  - Trend Tracker (-Baseline-)
  - Result Options
  - **Results**
    - **Stress1 (-vonMises-)**
    - Displacement1 (-Res disp-)
    - Strain1 (-Equivalent-)
    - Factor of Safety1 (-FOS-)

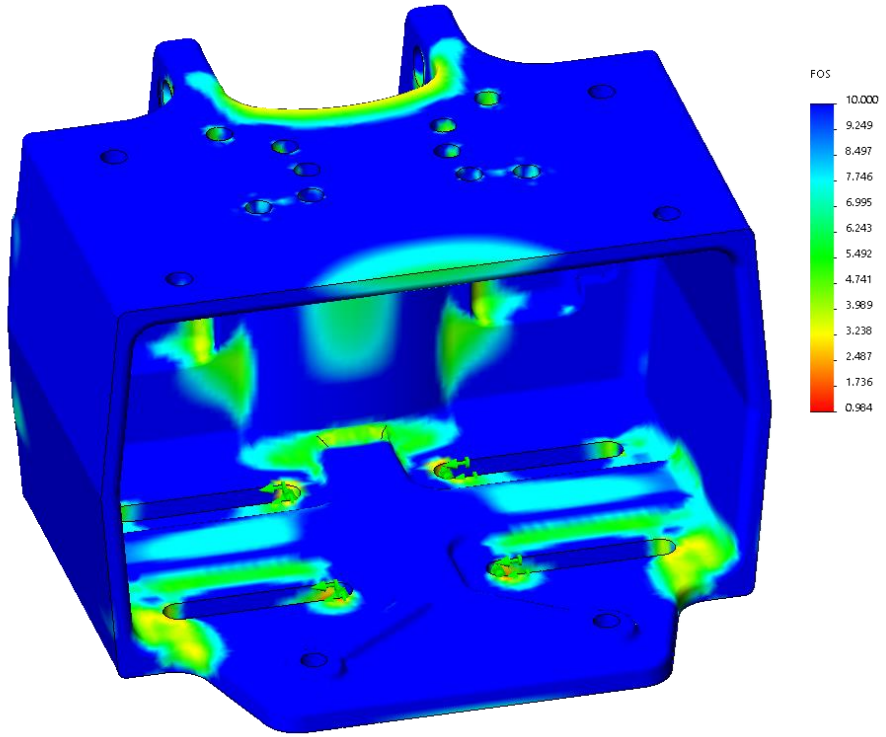


Original FEA from 2023/05/04

The original FEA was run with the inside of the slots selected for the fixed surfaces as well as having a 10X FOS applied.

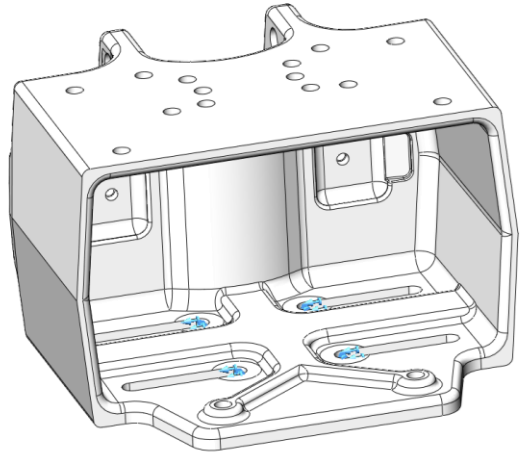


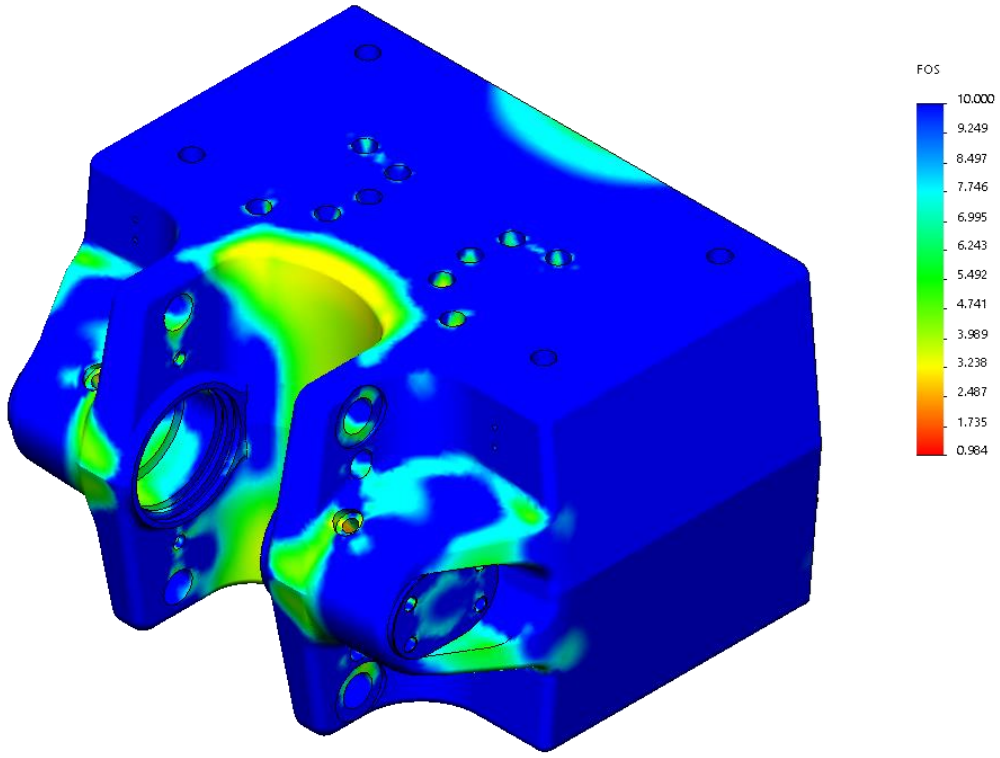


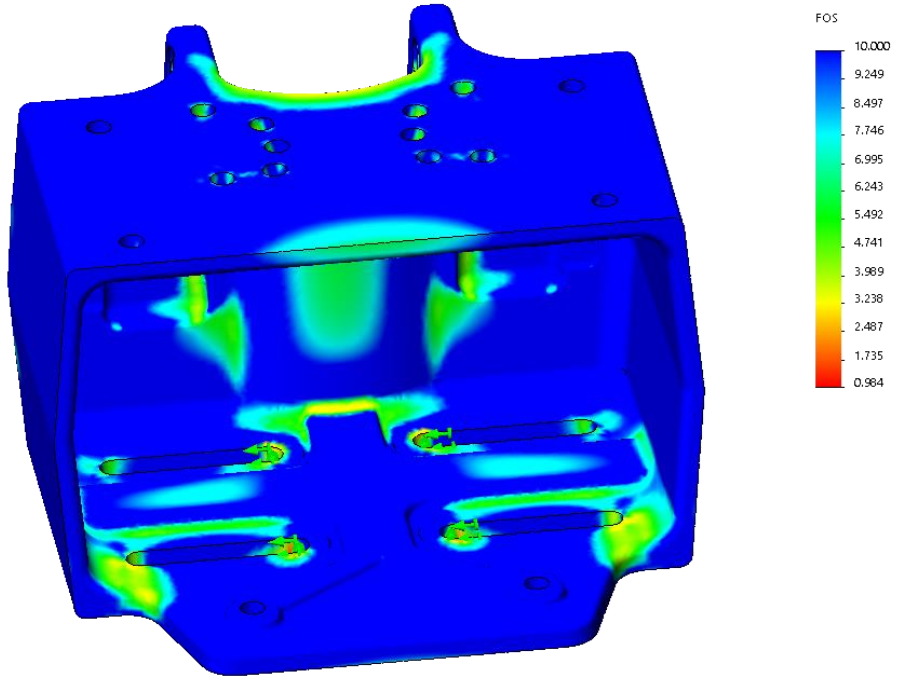


NEW FEA 10X Verification

The new FEA was run with the inside of the slots selected for the fixed surfaces as well as having a 10X FOS applied.



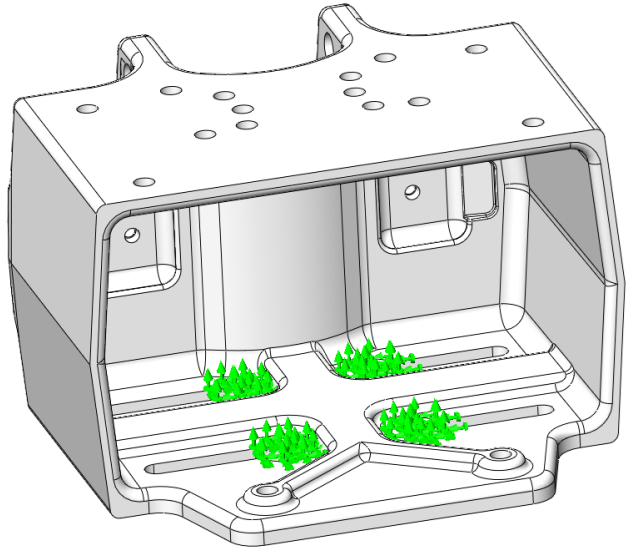


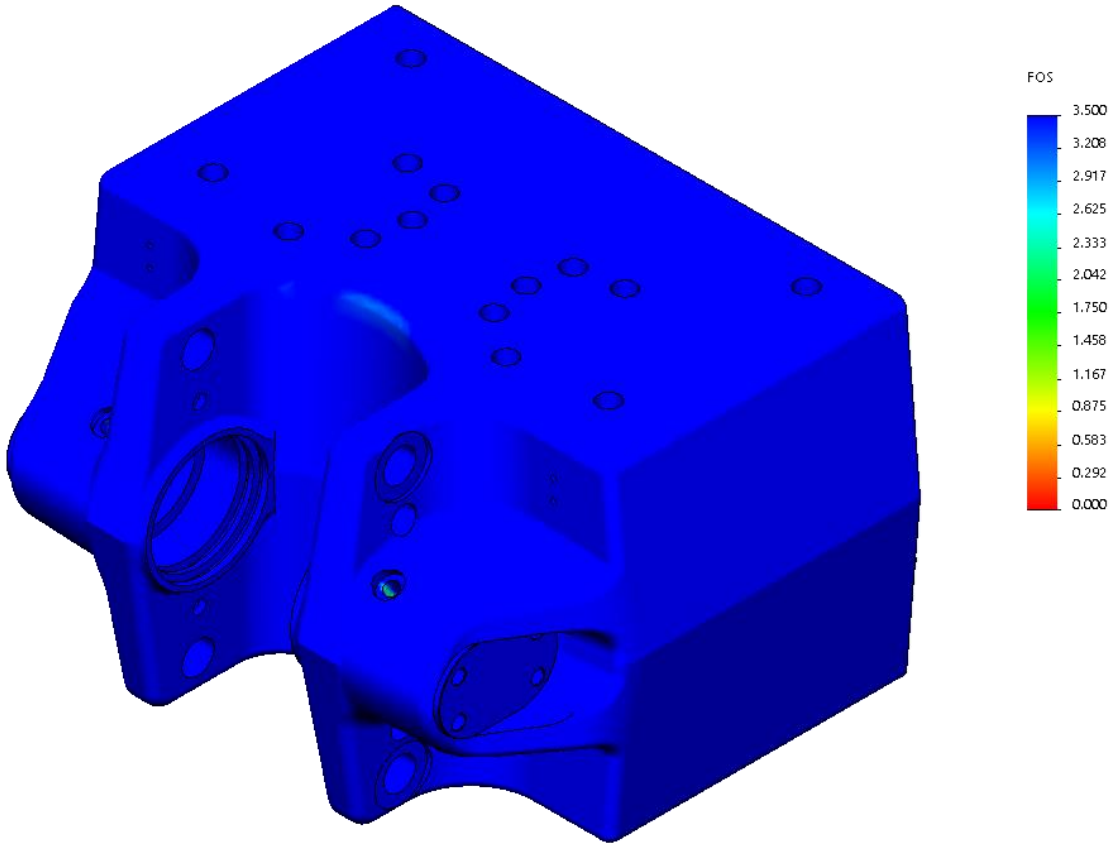


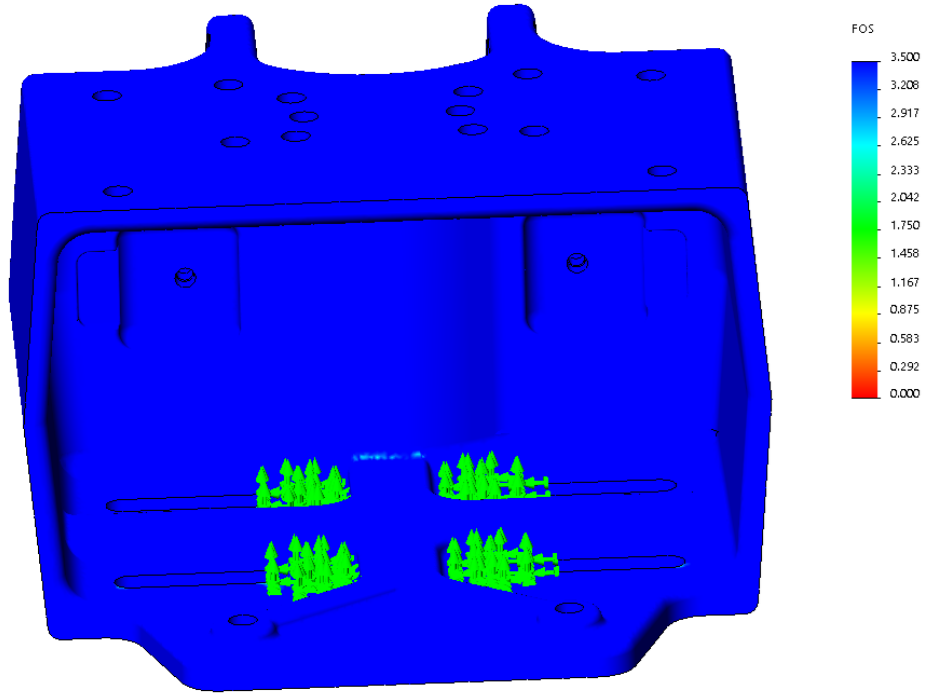
FEA Run With New Fixtures and 3.5 FOS

The new FEA's were ran with the fixed surfaces simulating a washer contact point on the top and bottom of the base feature. The FOS is also reduced to 3.5 from 10.

UPWARD FORCE

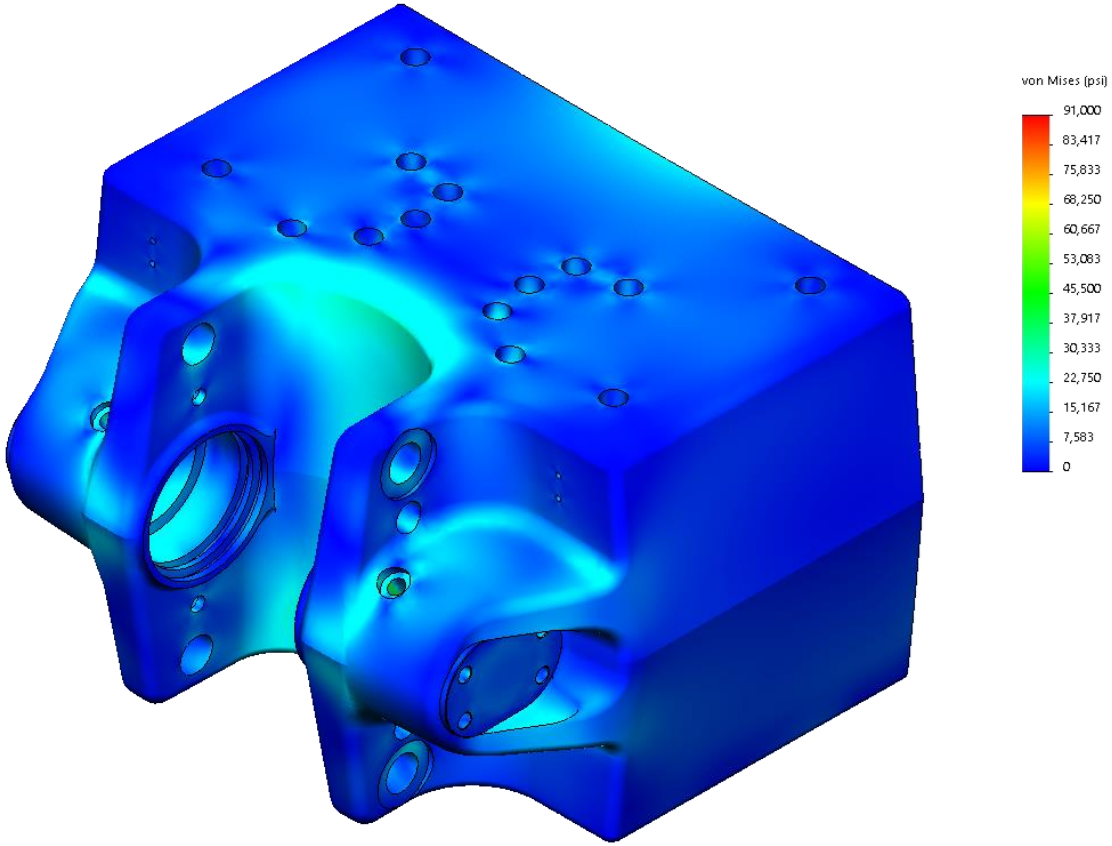


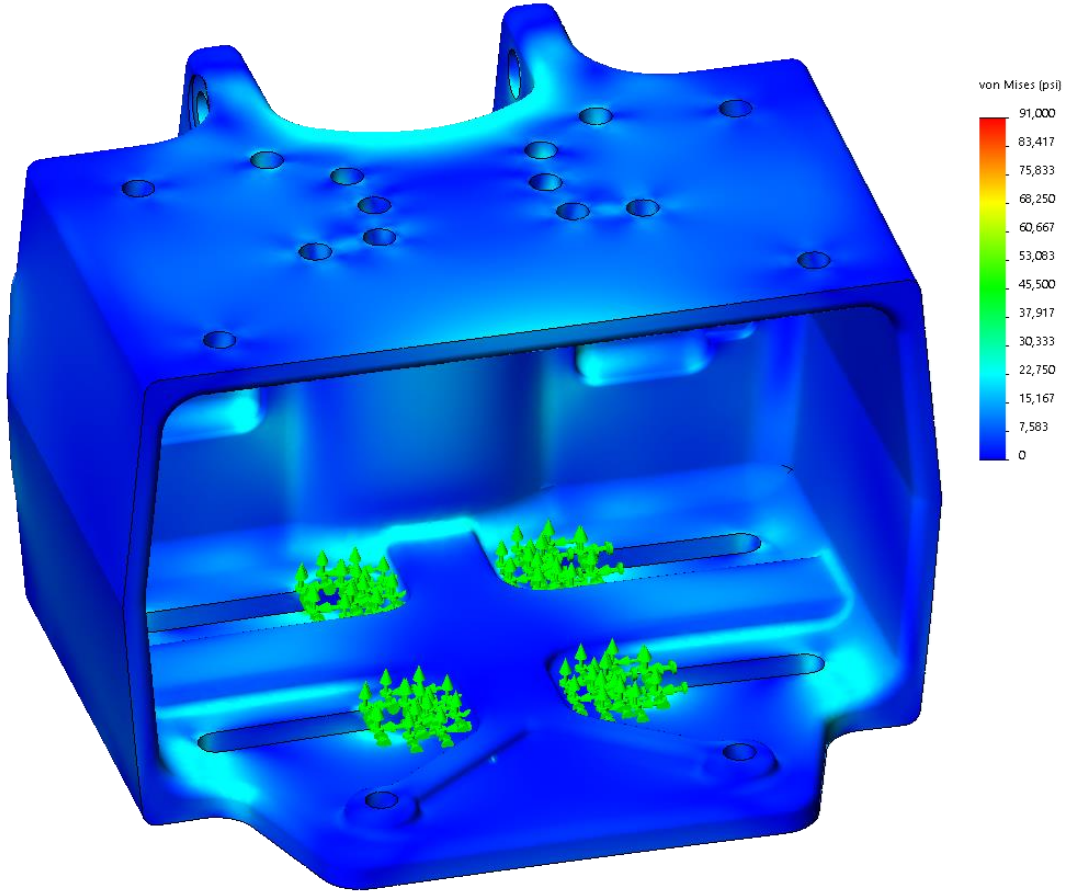




Initial FEA Stress Plots

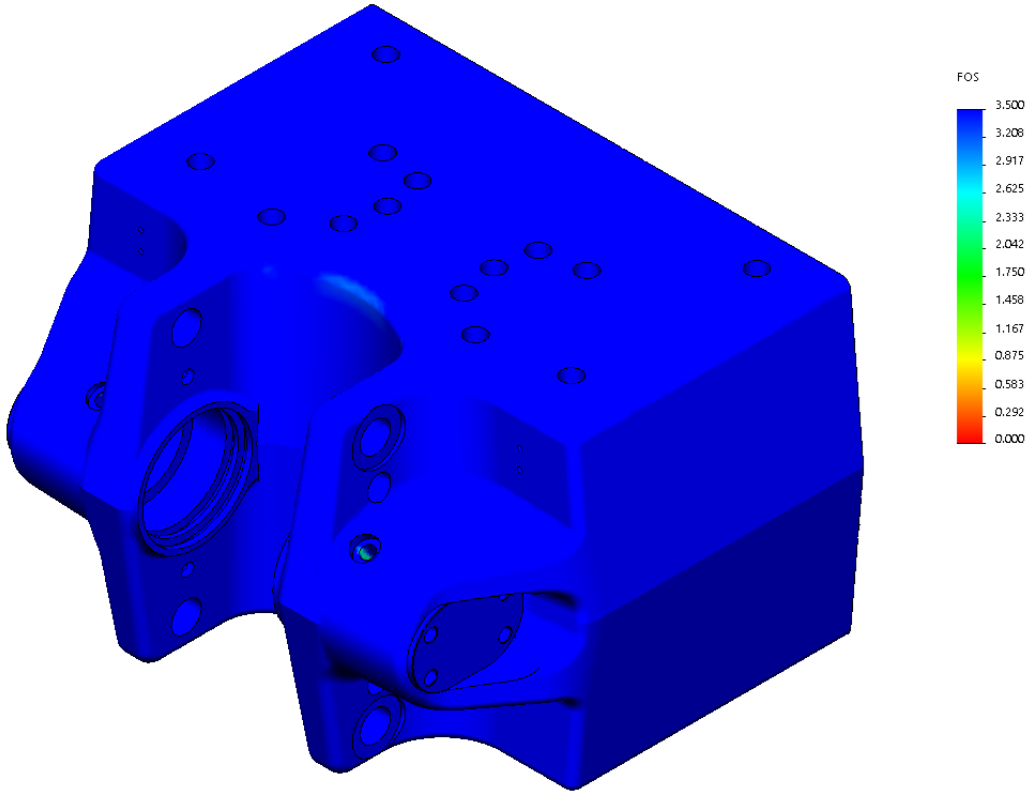
UPWARD FORCES

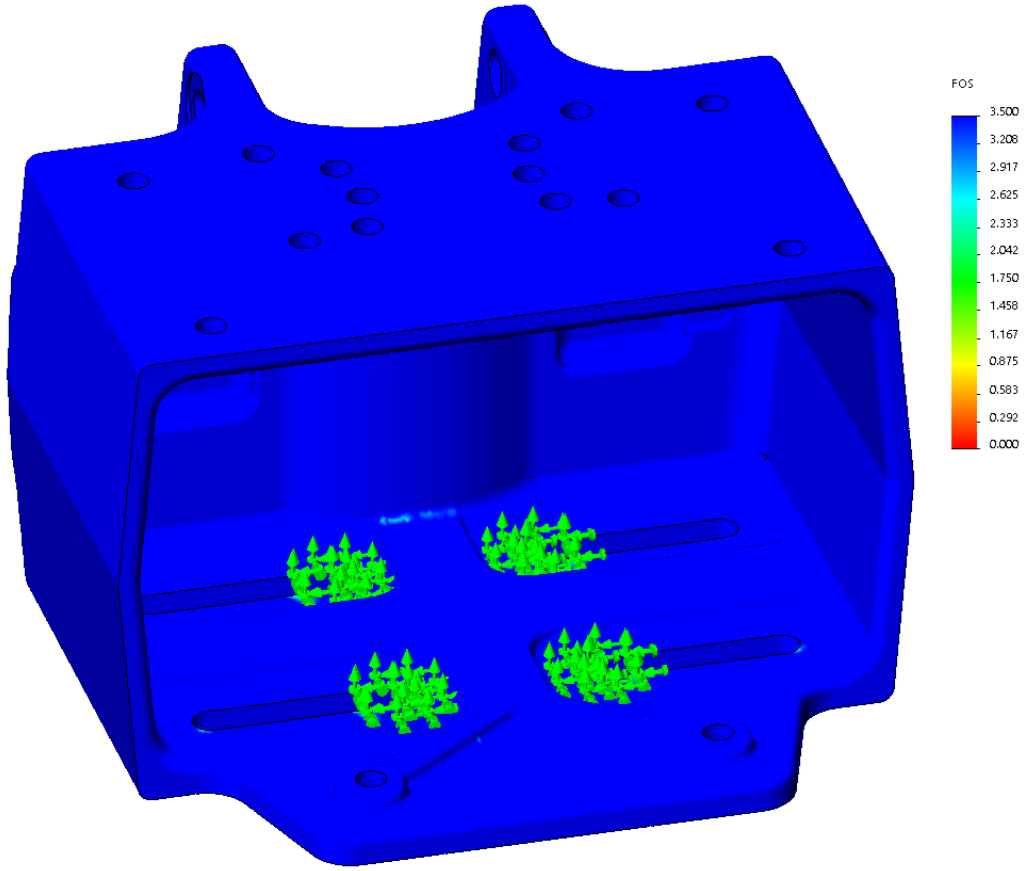




Initial FEA 3.5 FOS Plots

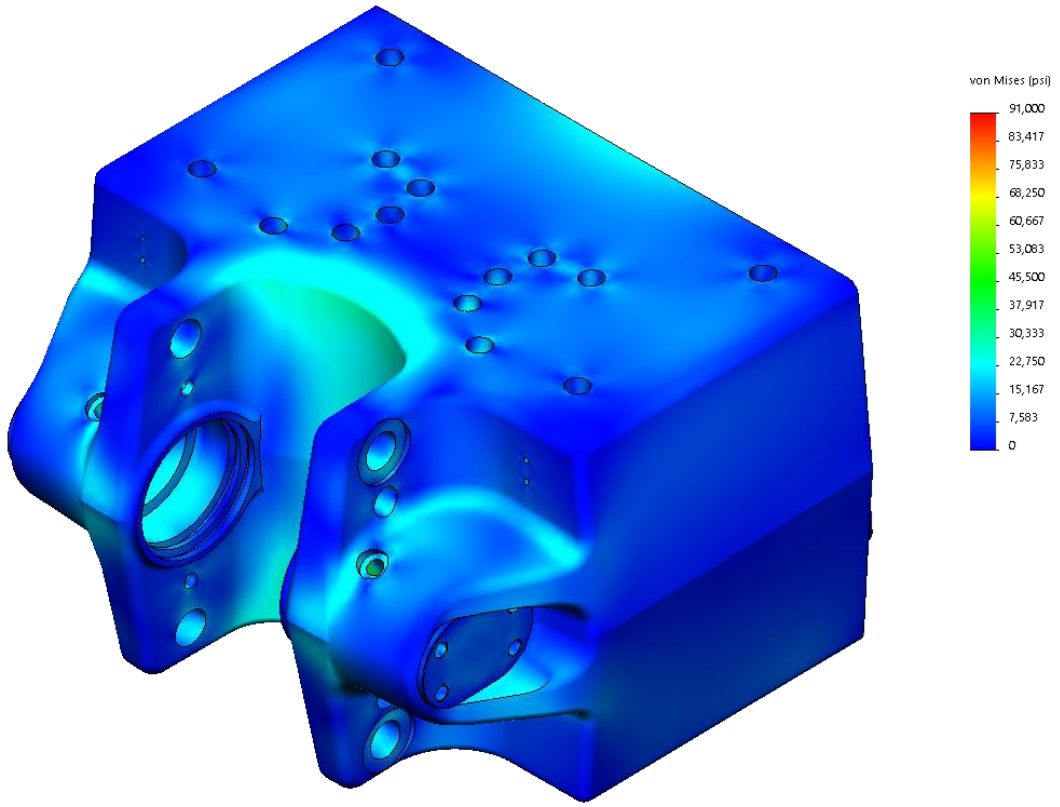
UPWARD FORCES

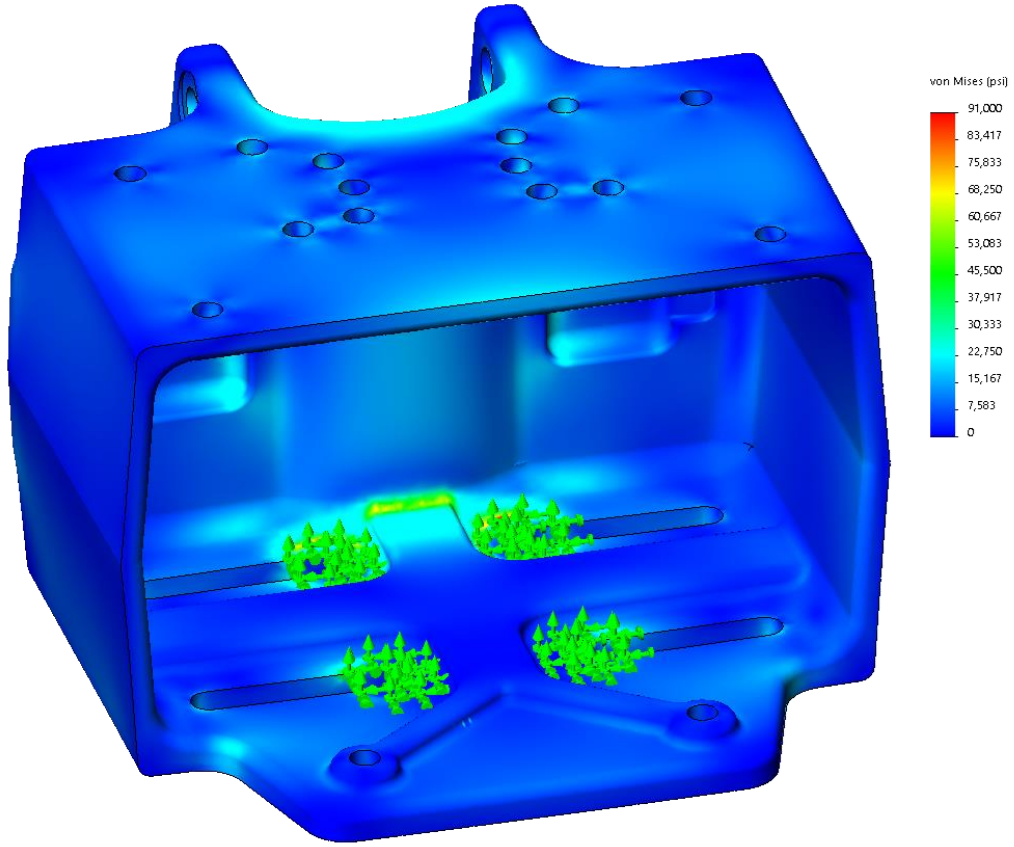




Initial FEA Stress Plots

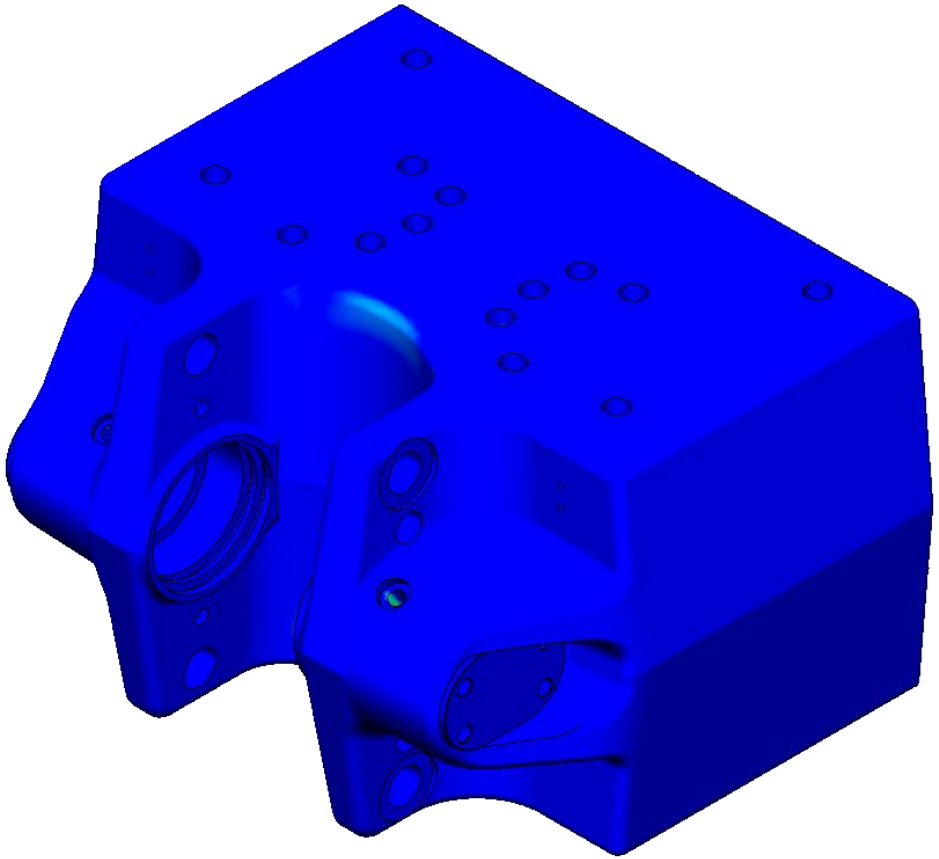
DOWNWARD FORCES

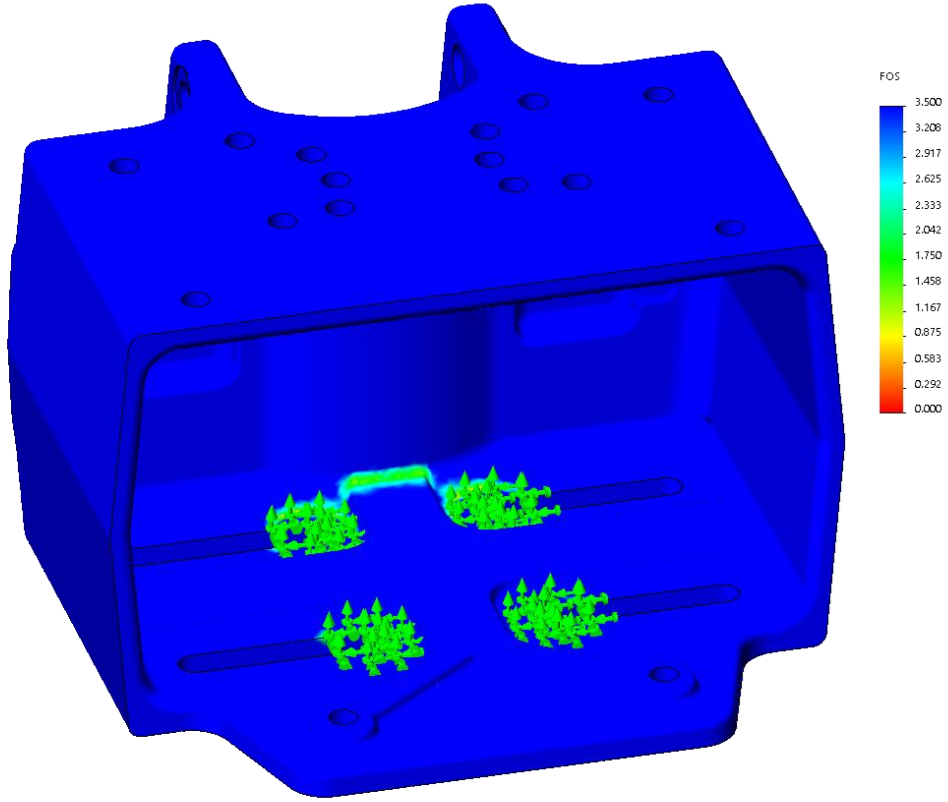




Initial FEA 3.5 FOS Plots

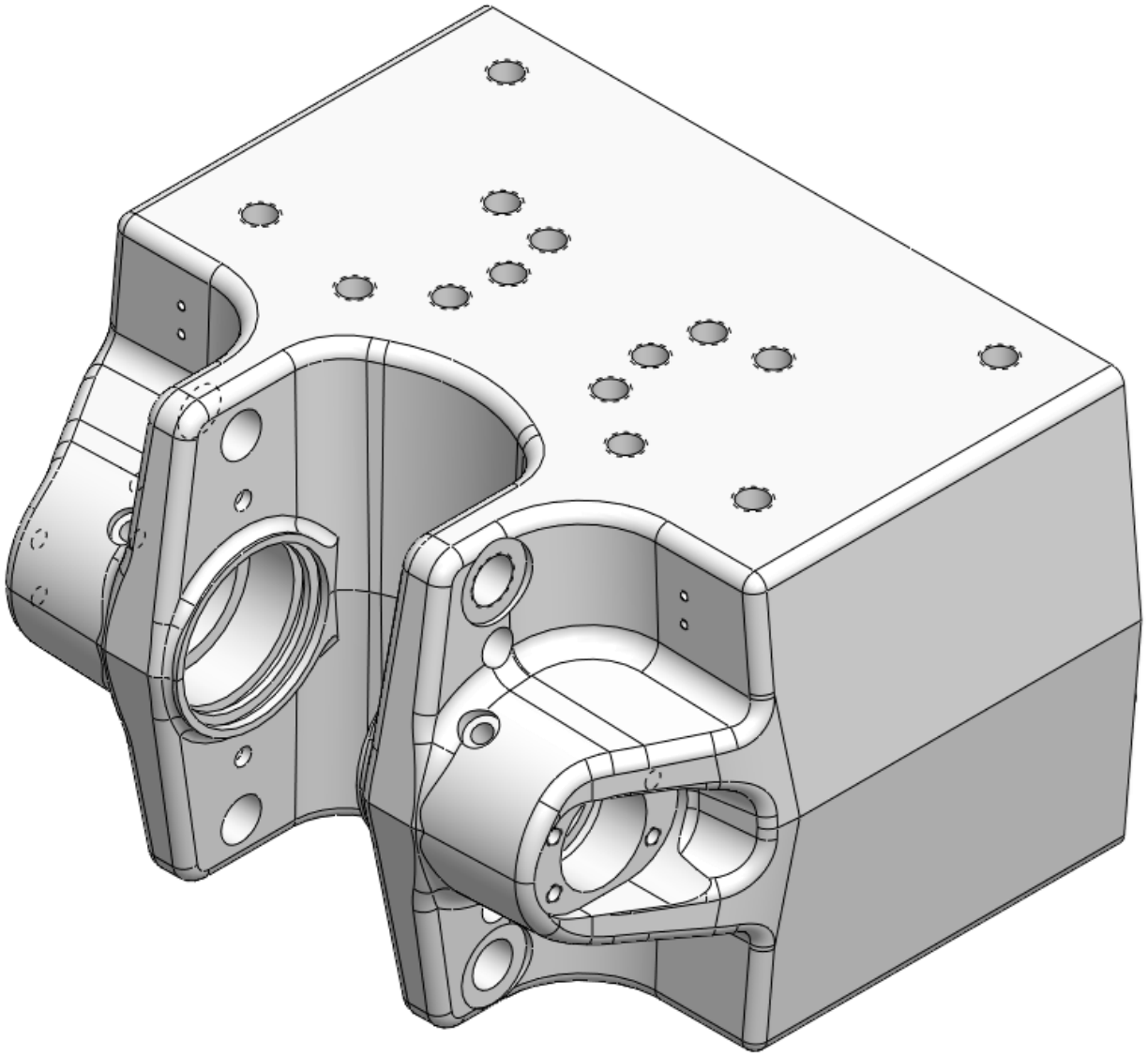
DOWNWARD FORCES





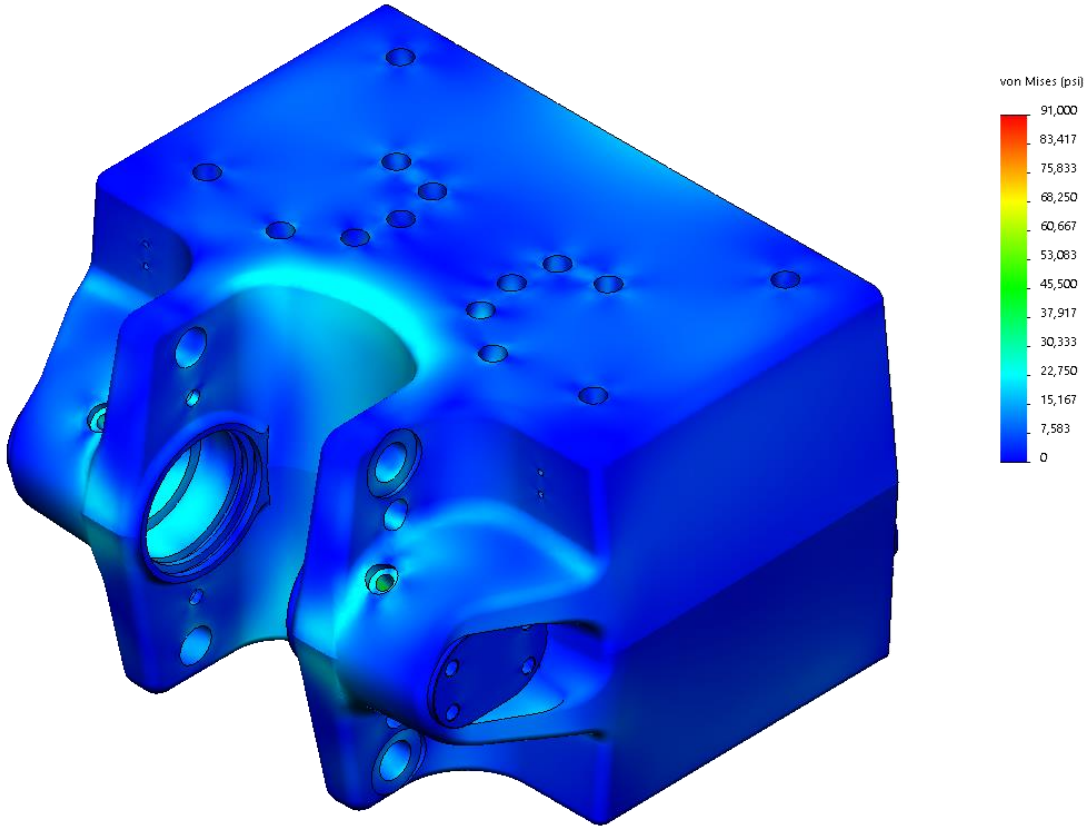
INITIAL MASS

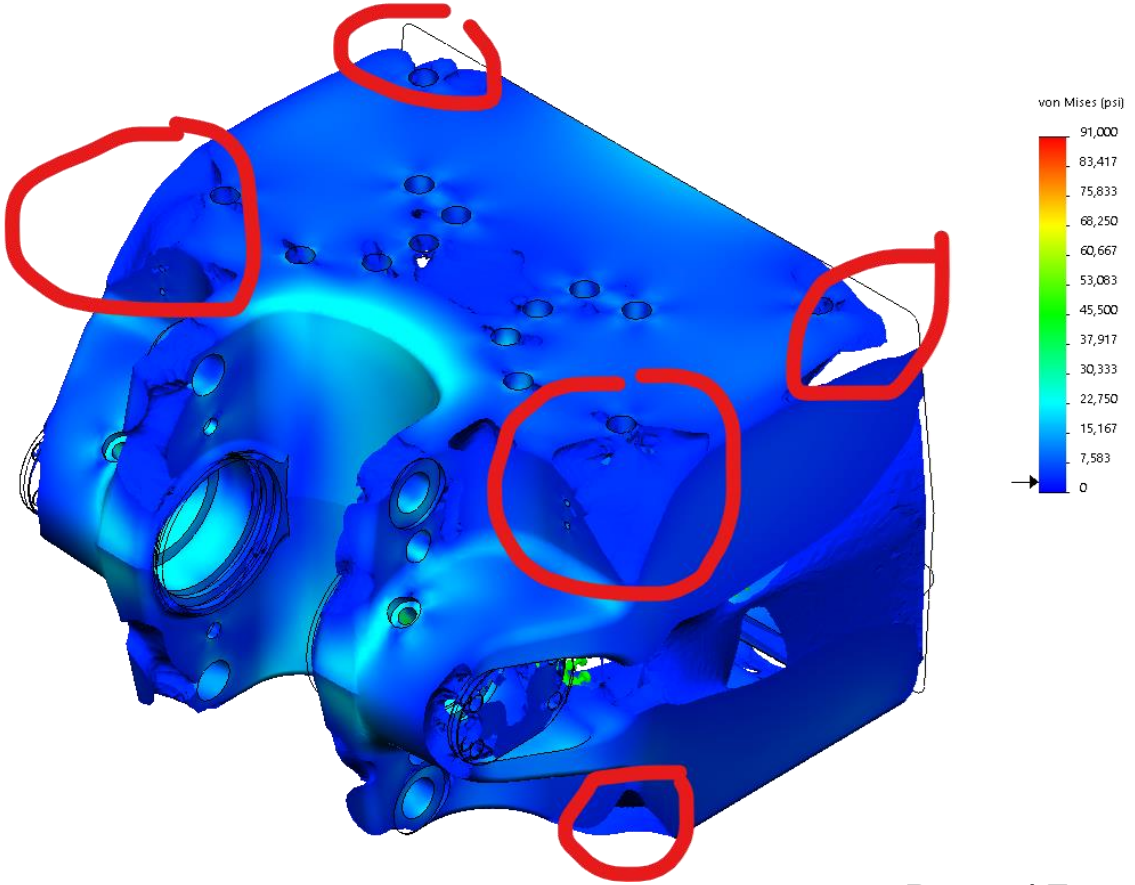
80.29lbs



Initial Observations

The initial observations pointed to removing material from the outboard corners.



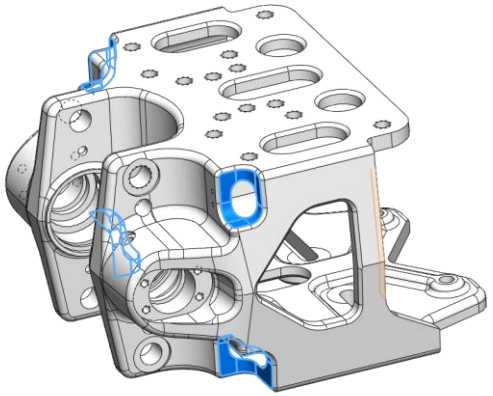


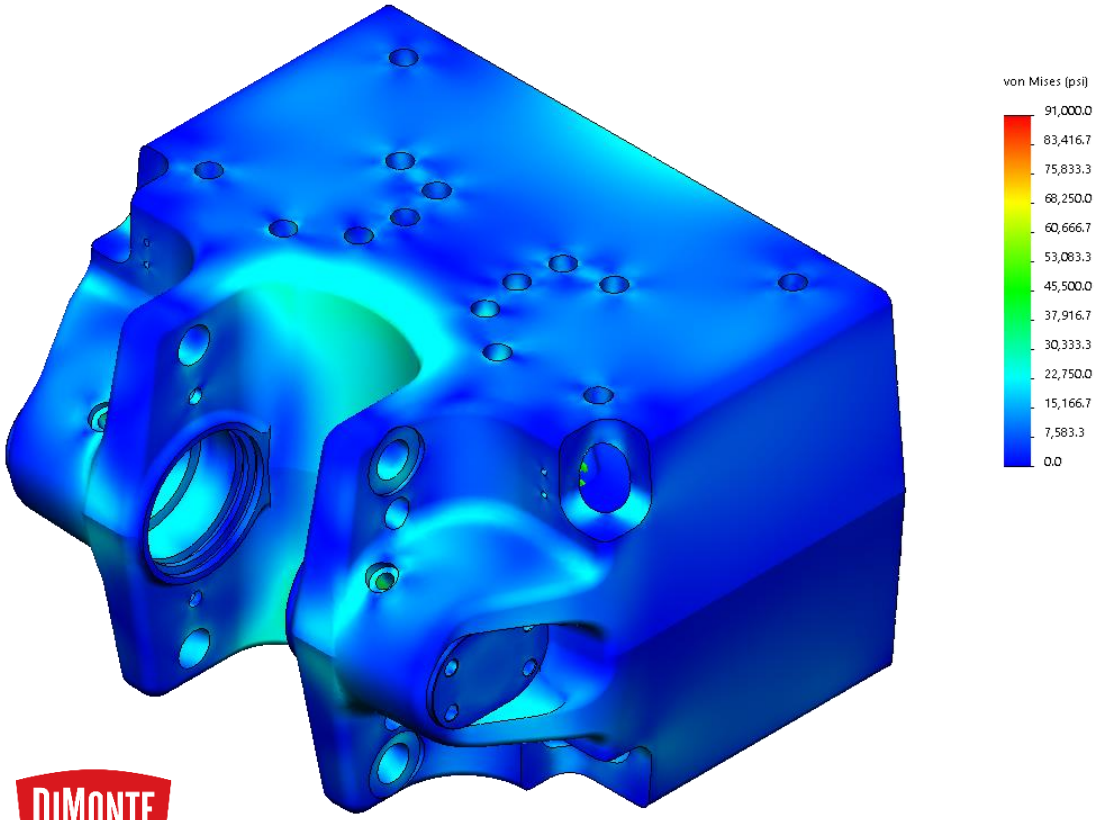
Mass Reduction

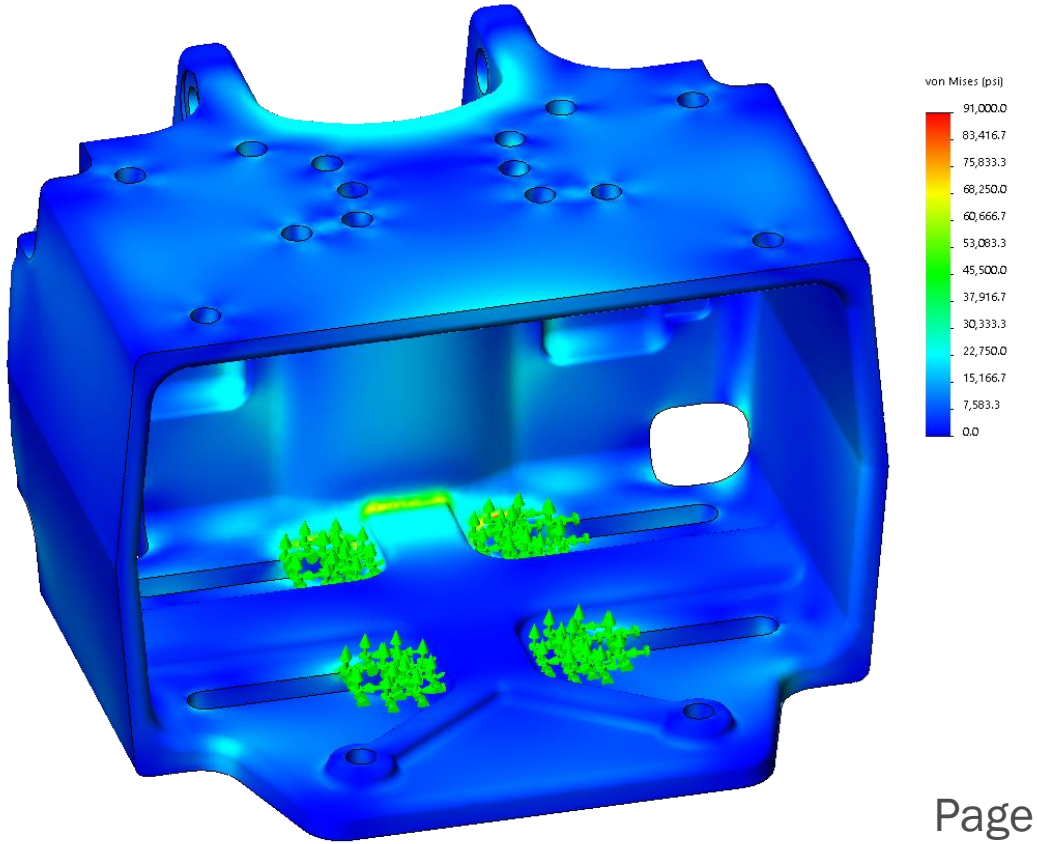
Mass reduction was made selectively removing material from key areas.
The following slides are the steps taken to reduce the mass.
Worst case results are in the DOWNWARD force scenarios, so the UPWARD results are only shown in the final iteration at the end.

Front Corner Cuts Stress Plots

DOWNWARD FORCE
77.6lbs
-2.69lbs

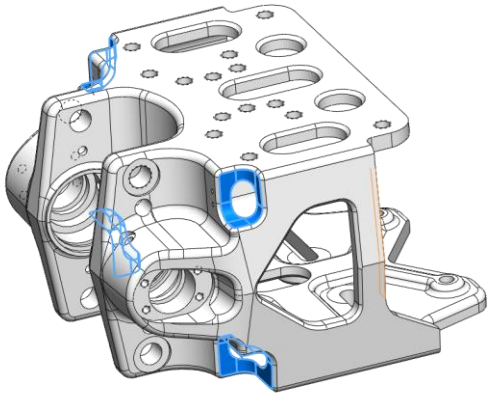


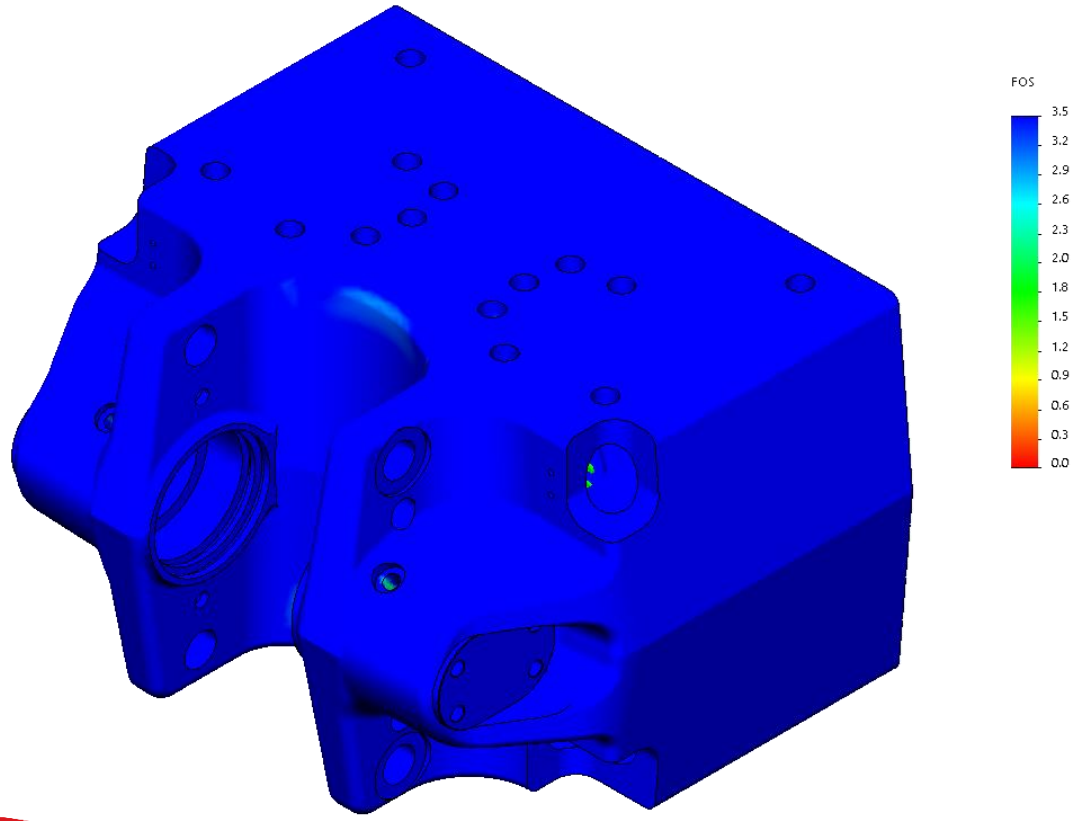


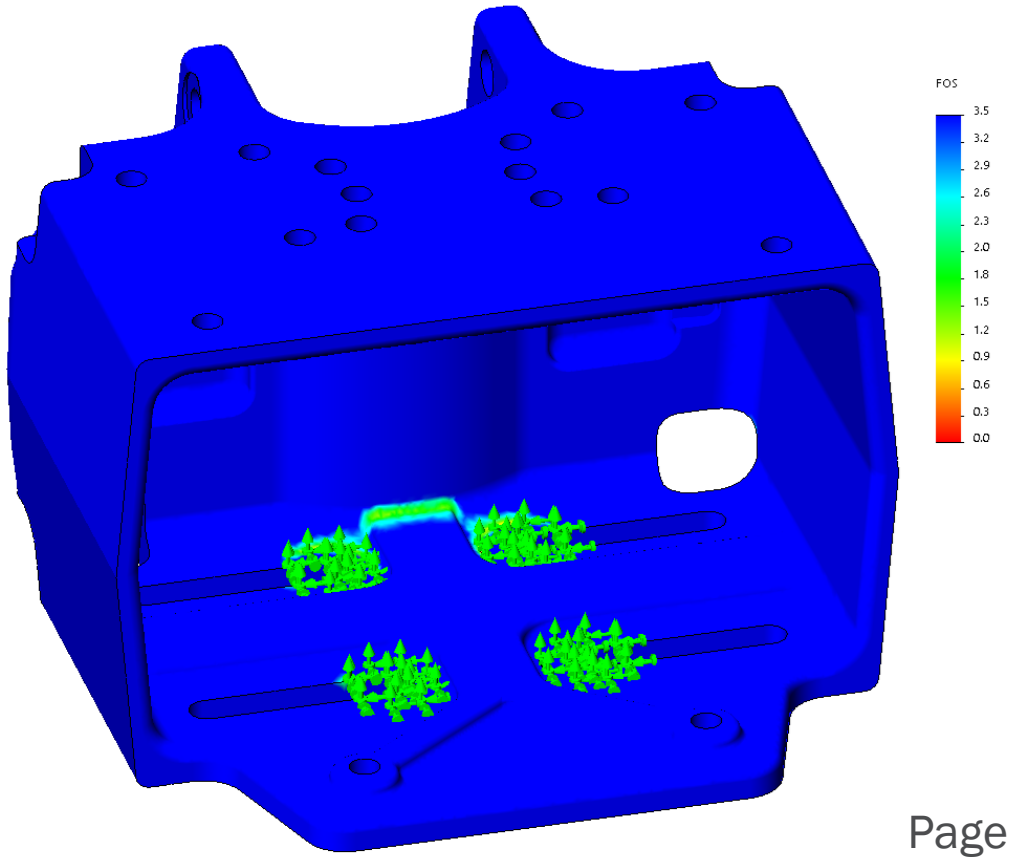


Front Corner Cuts FOS Plots

DOWNWARD FORCE
77.6lbs
-2.69lbs

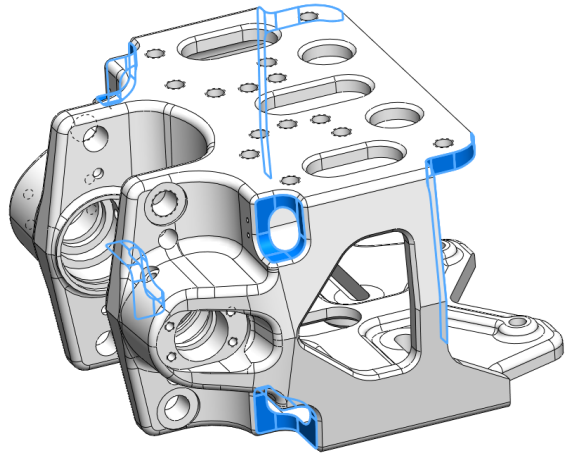


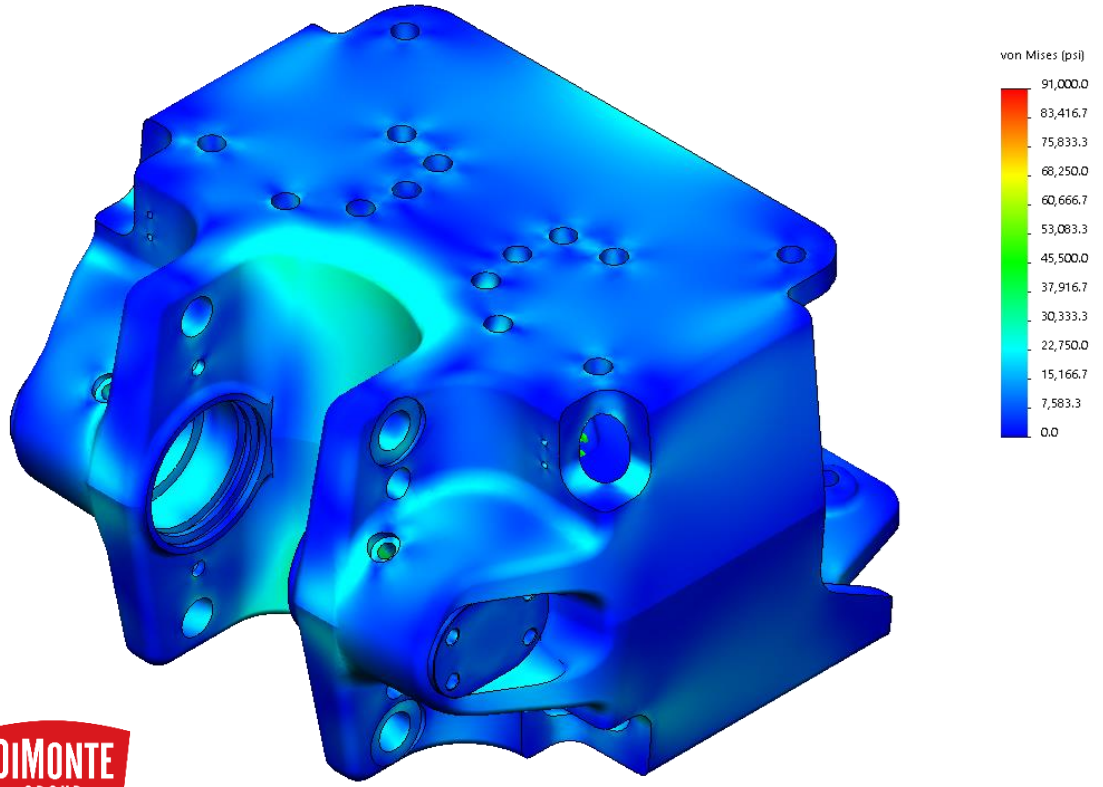


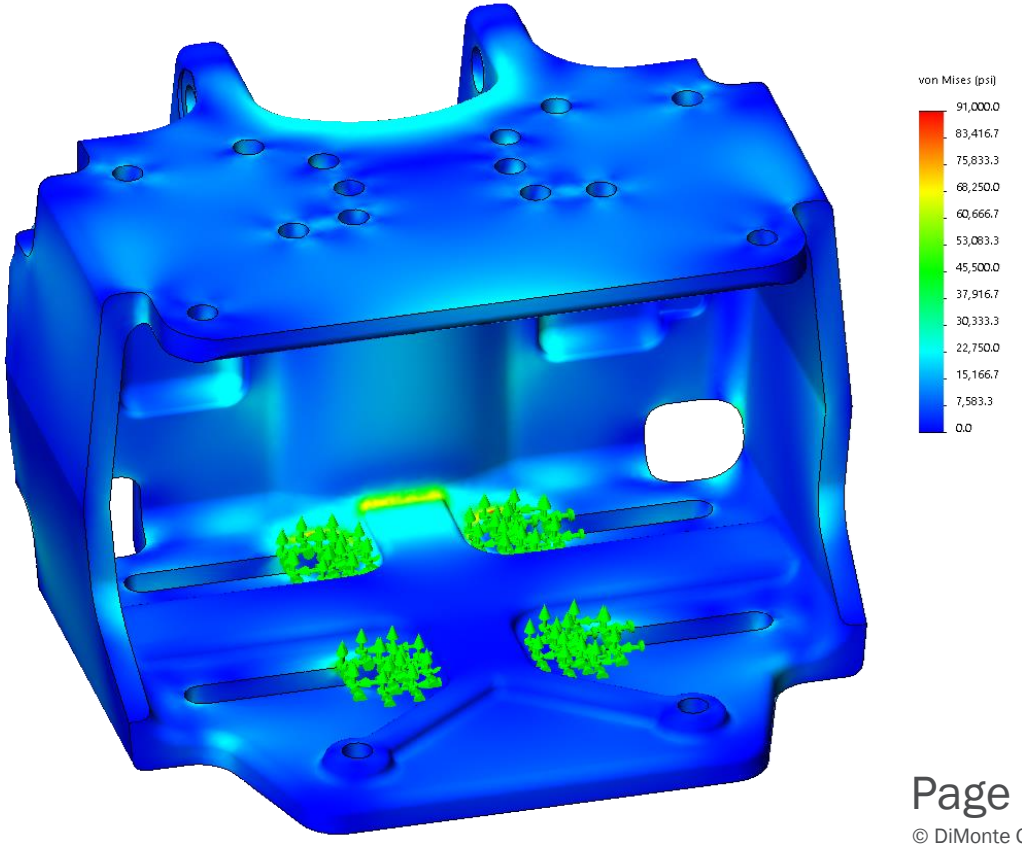


All Corner Cuts Stress Plots

DOWNWARD FORCE
74.17lbs
-6.12lbs

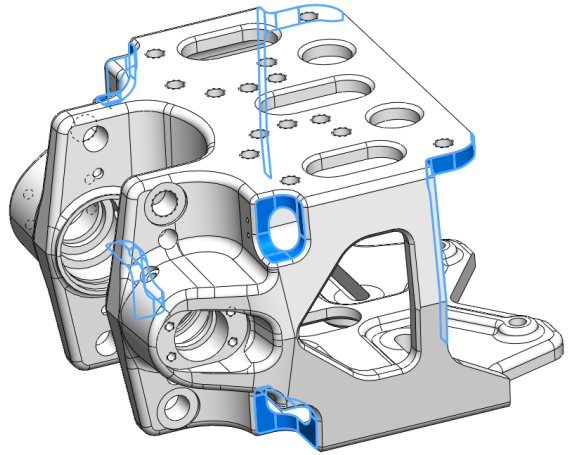


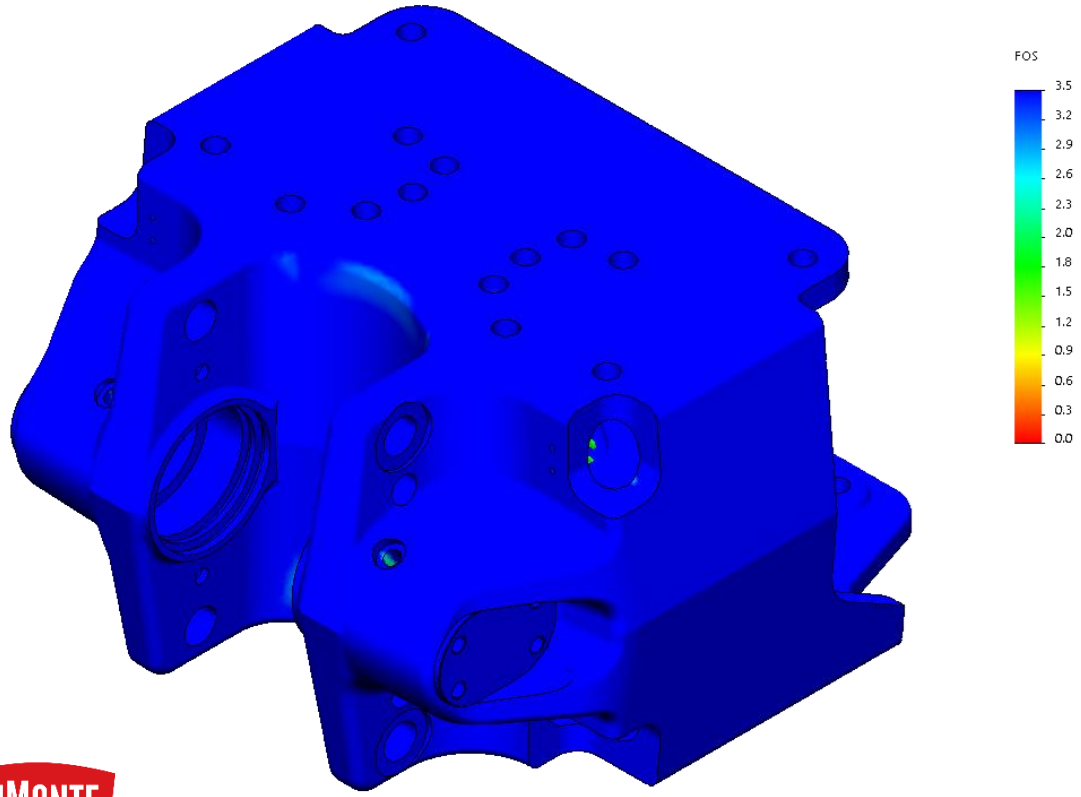


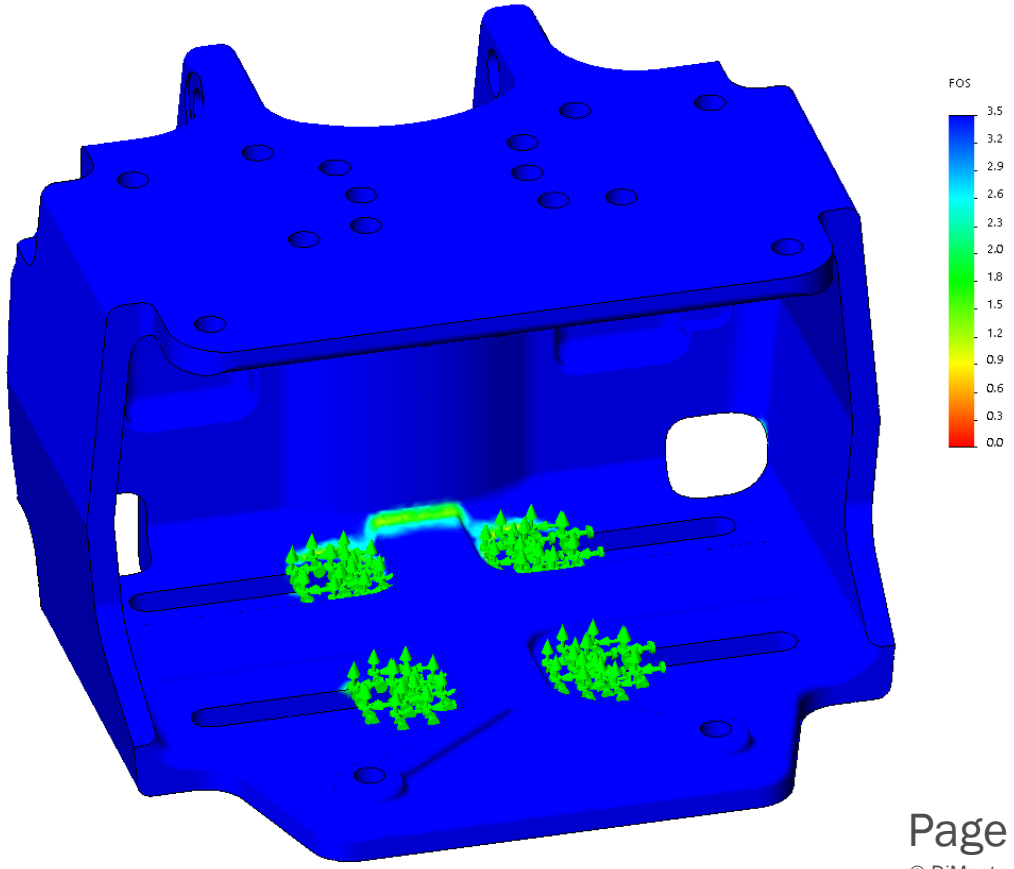


All Corner Cuts FOS Plots

DOWNWARD FORCE
74.17lbs
-6.12lbs

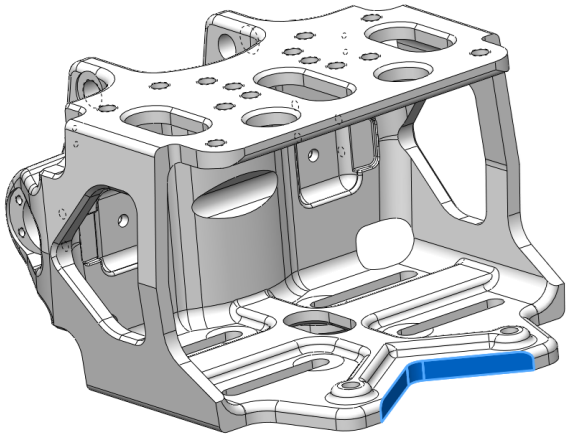


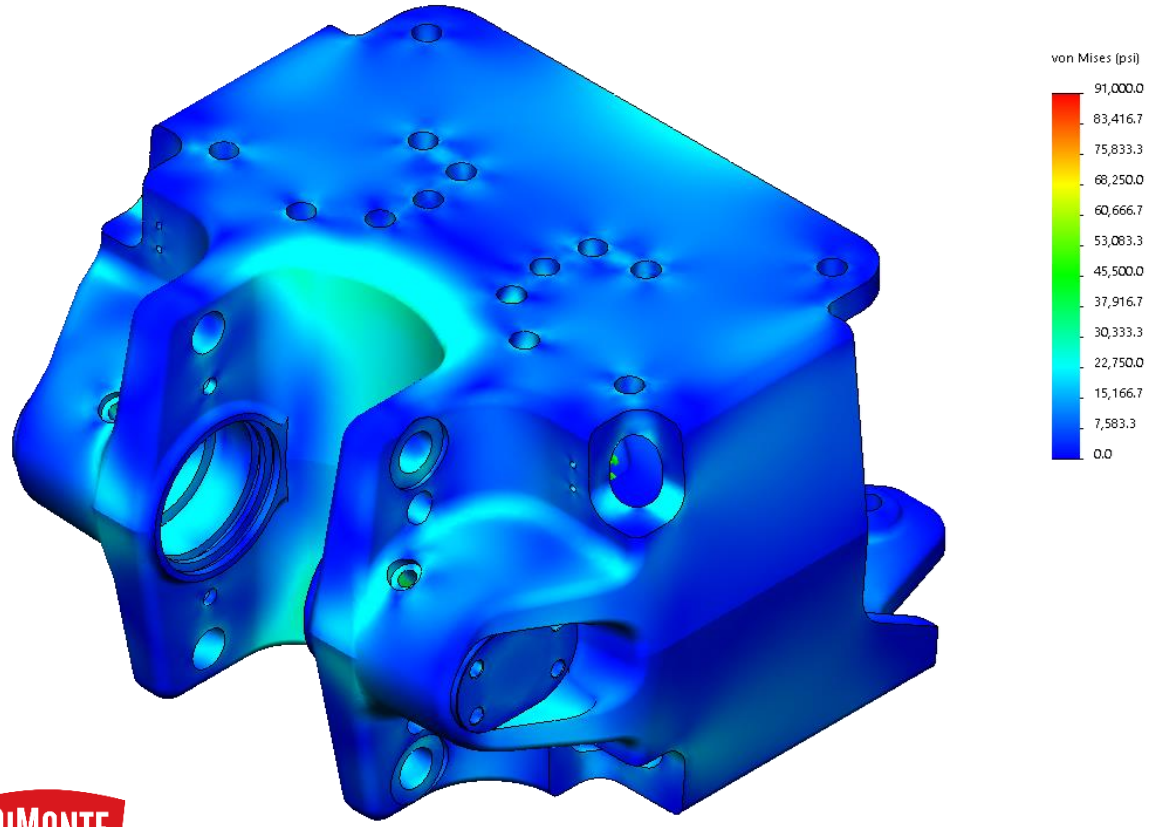


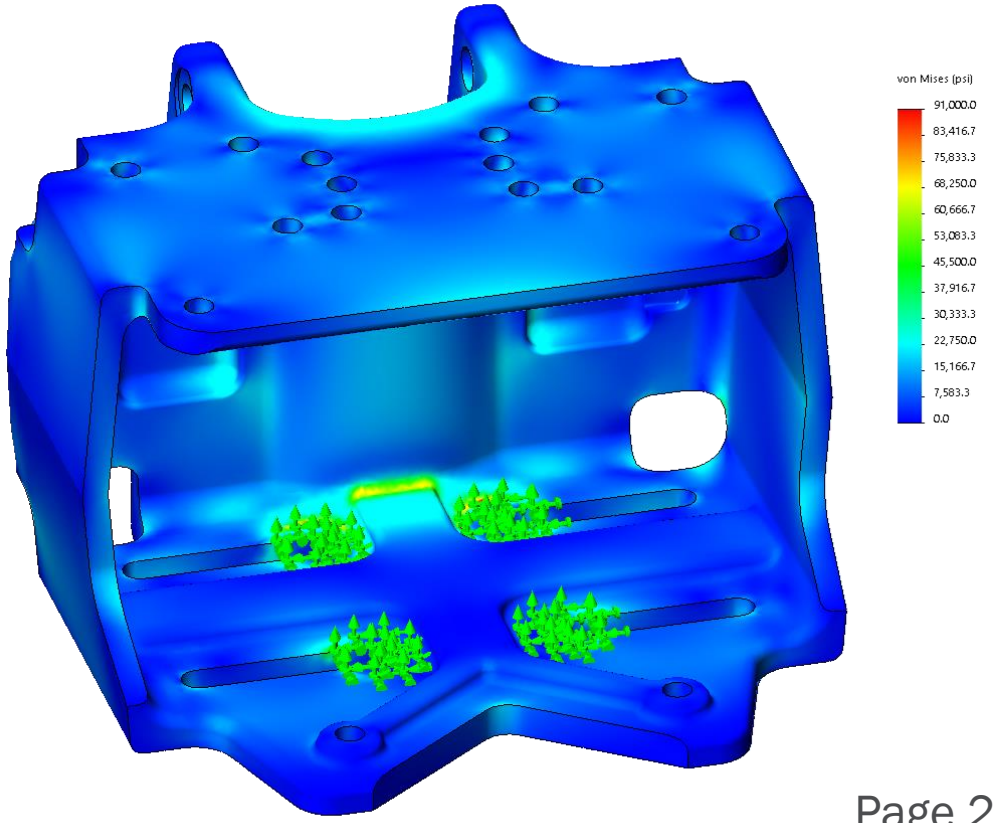


Rear Bottom Cut Stress Plots

DOWNWARD FORCE
73.23lbs
-7.06lbs

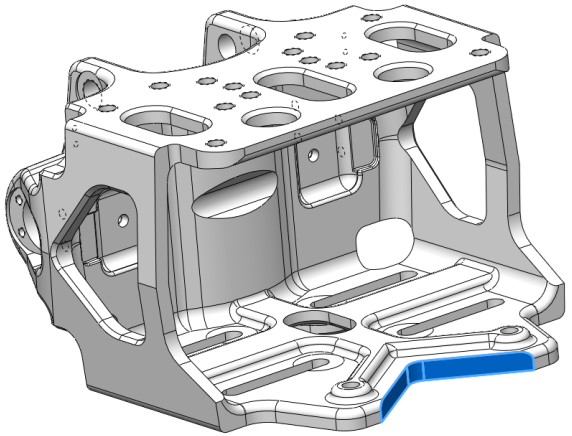


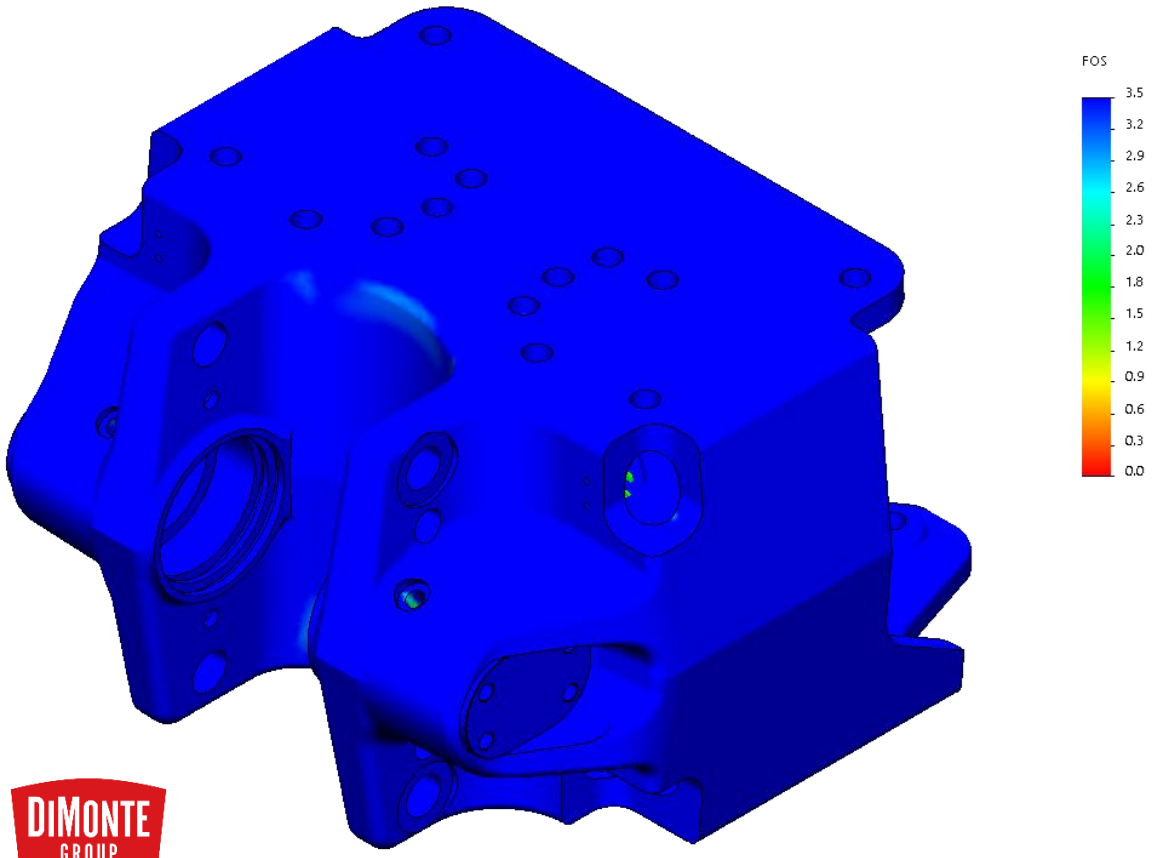


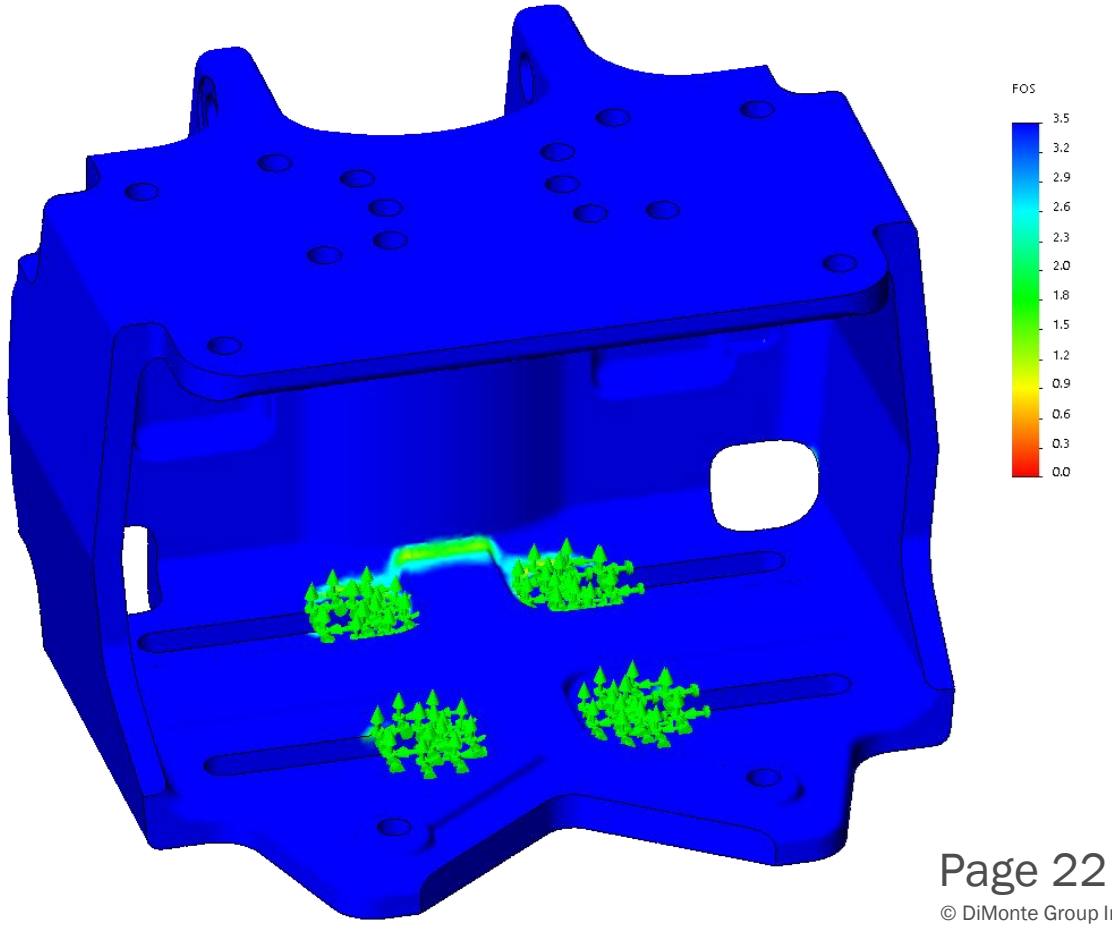


Rear Bottom Cut FOS Plots

DOWNWARD FORCE
73.23lbs
-7.06lbs

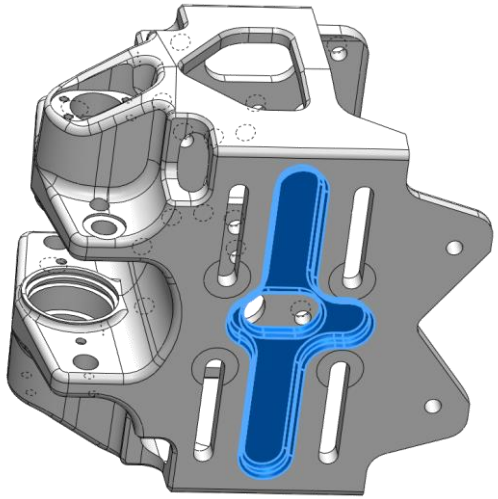


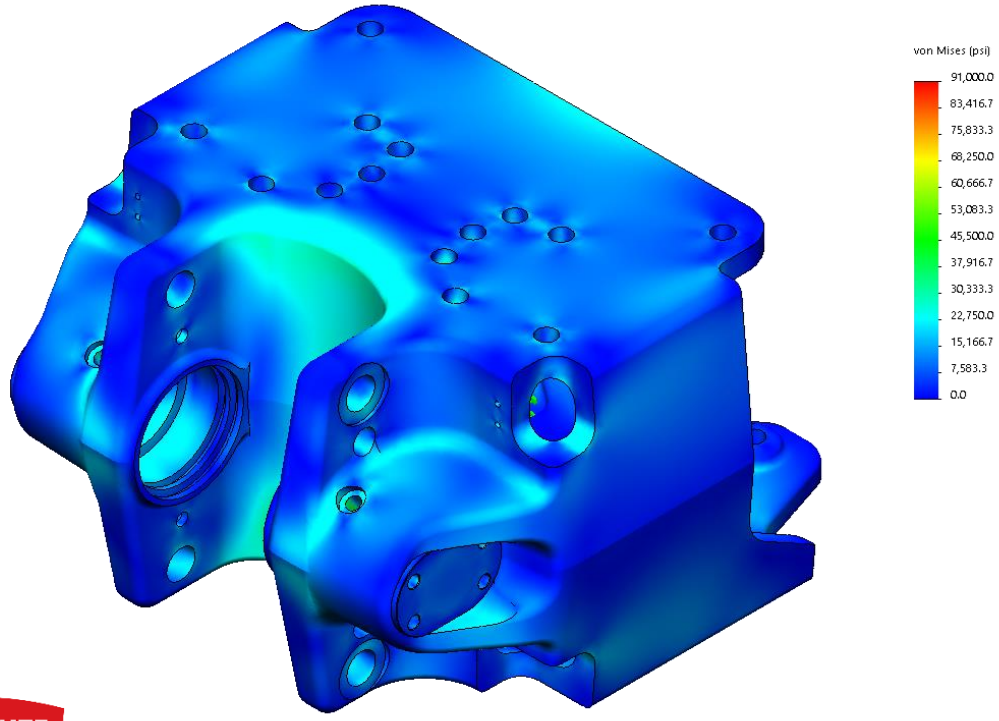


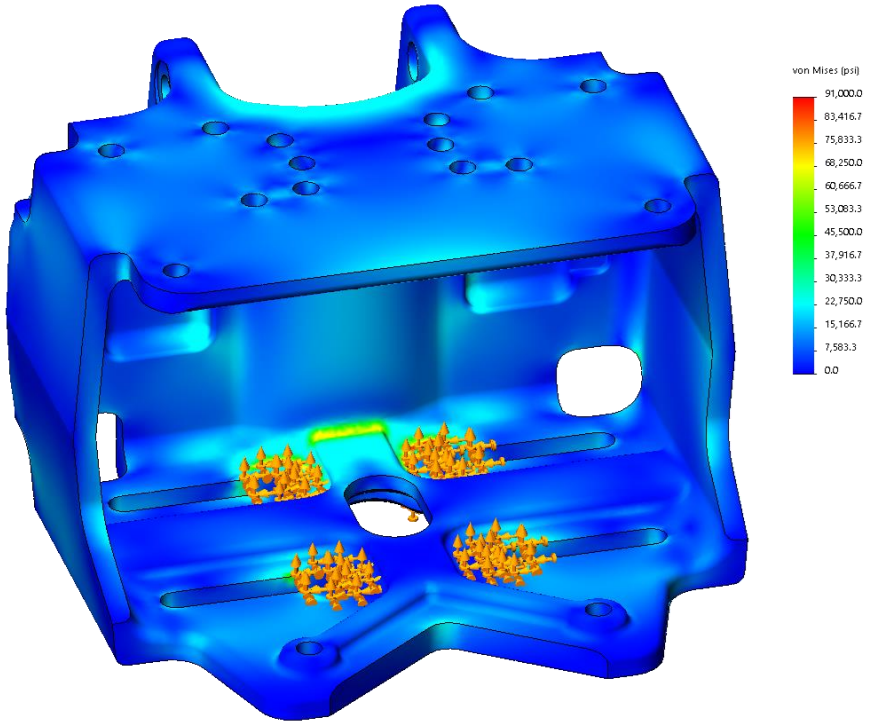


Bottom Cuts Stress Plots

DOWNWARD FORCE
70.01lbs
-10.28lbs

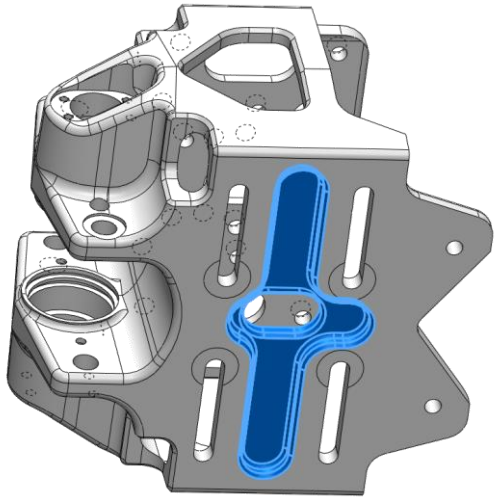


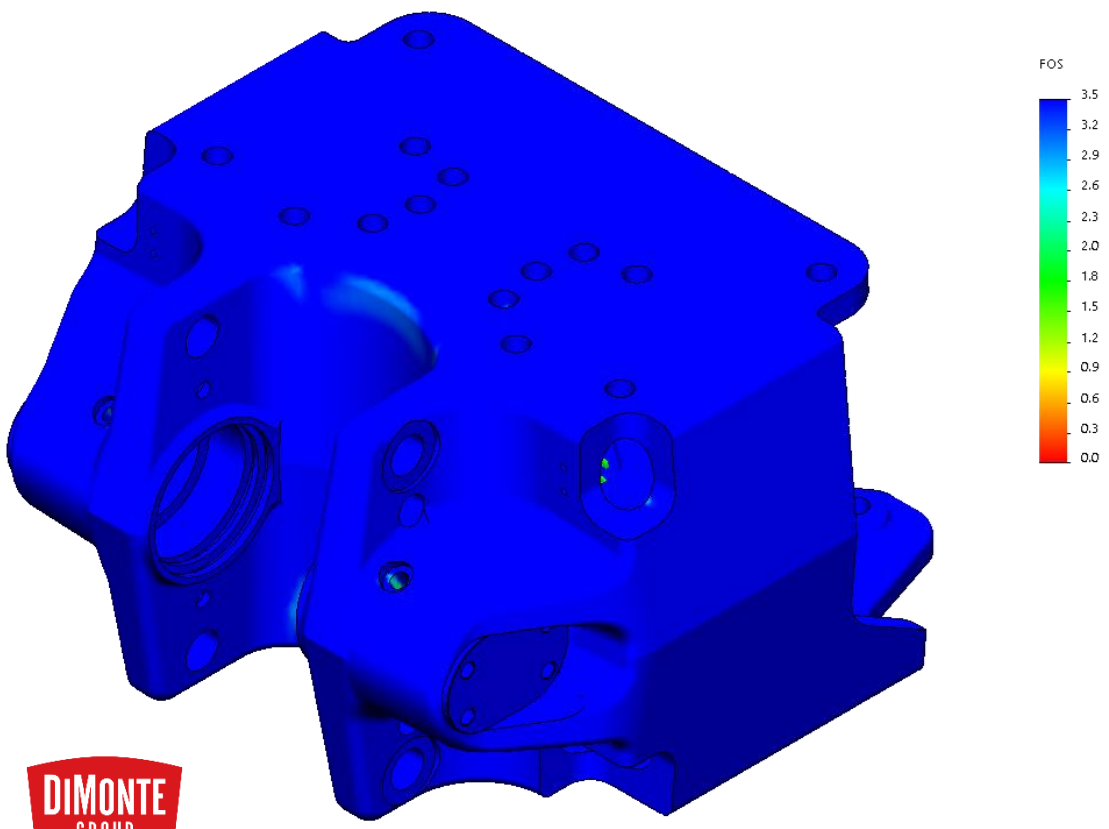


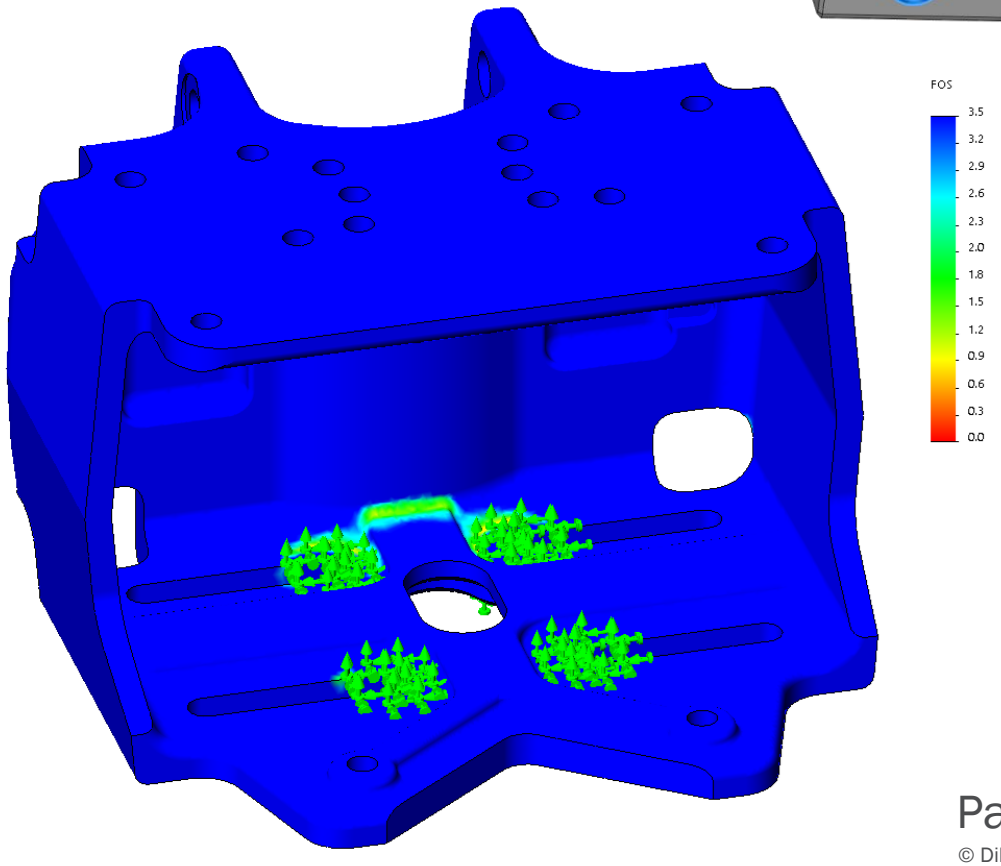


Bottom Cuts FOS Plots

DOWNWARD FORCE
70.01lbs
-10.28lbs

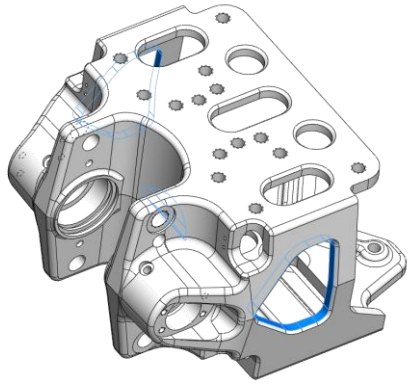


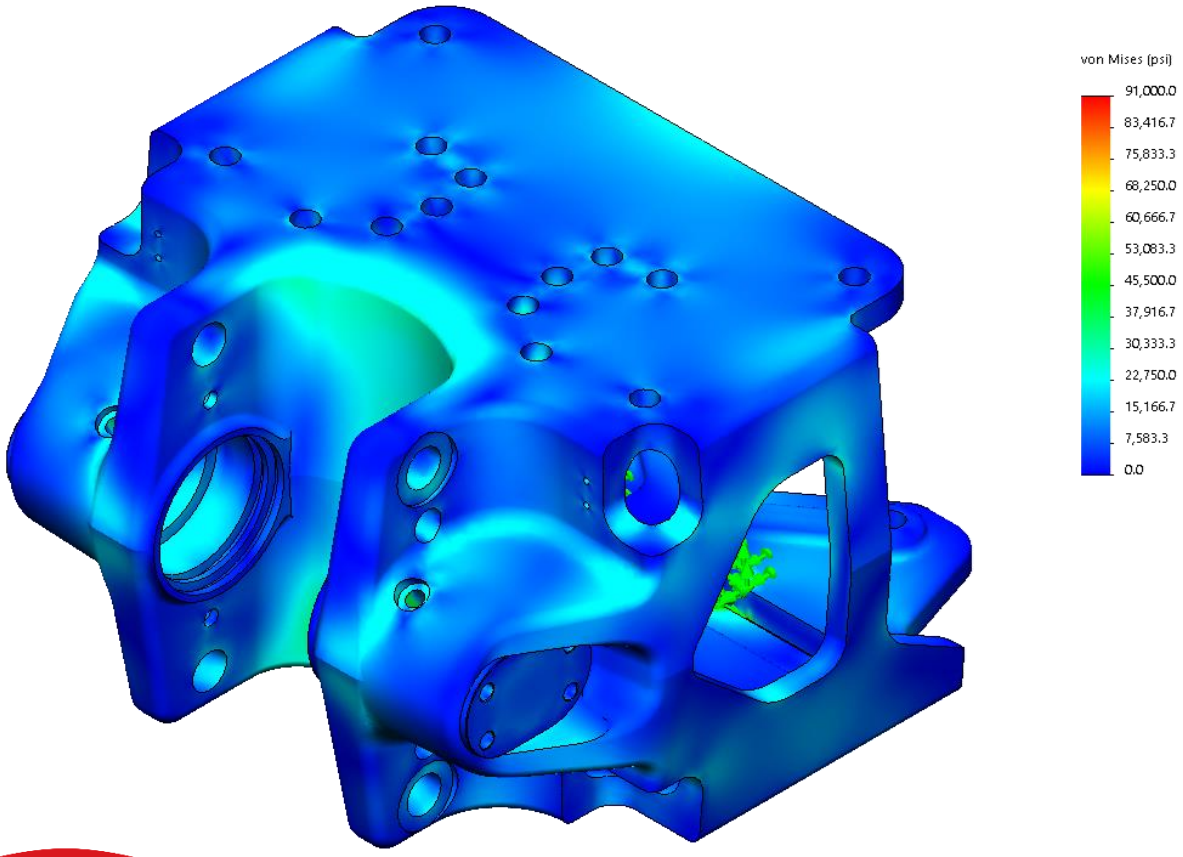


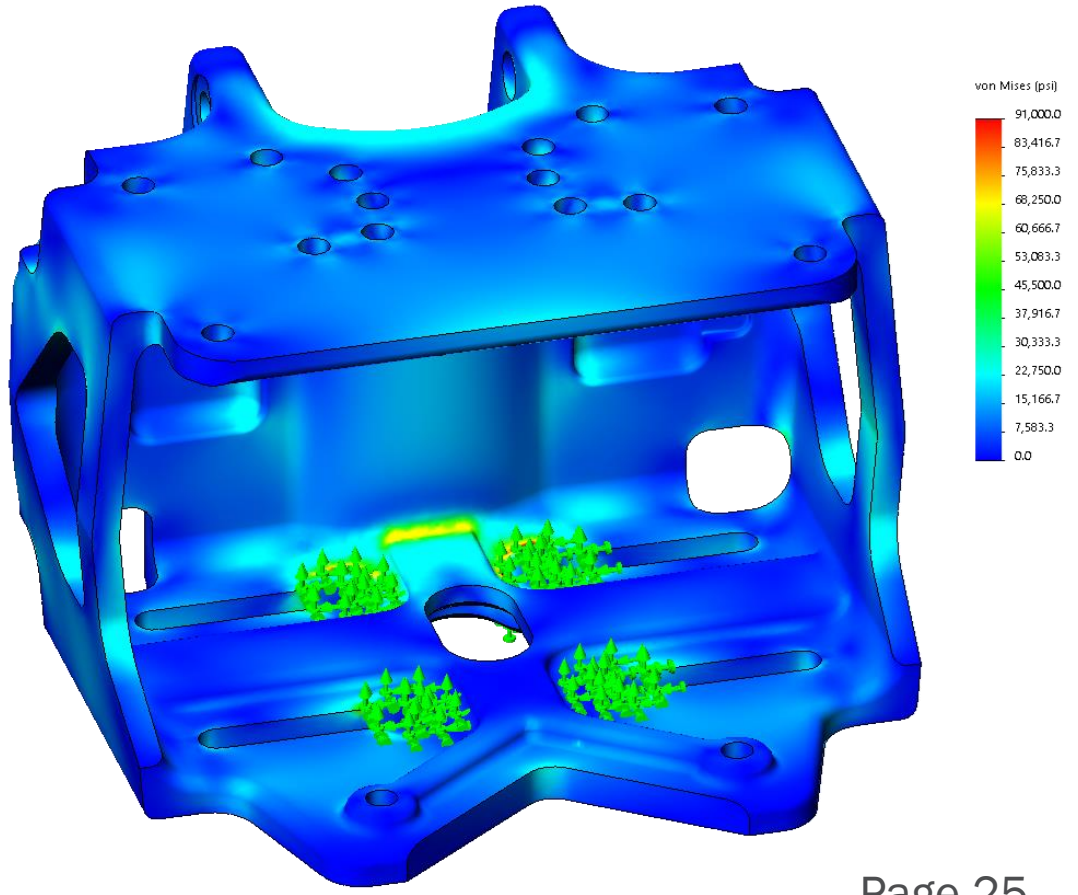


Side Cuts Stress Plots

DOWNWARD FORCE
66.60lbs
-13.69lbs

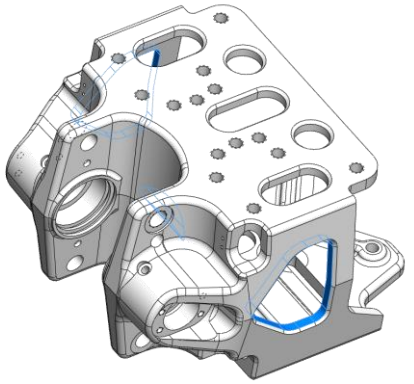


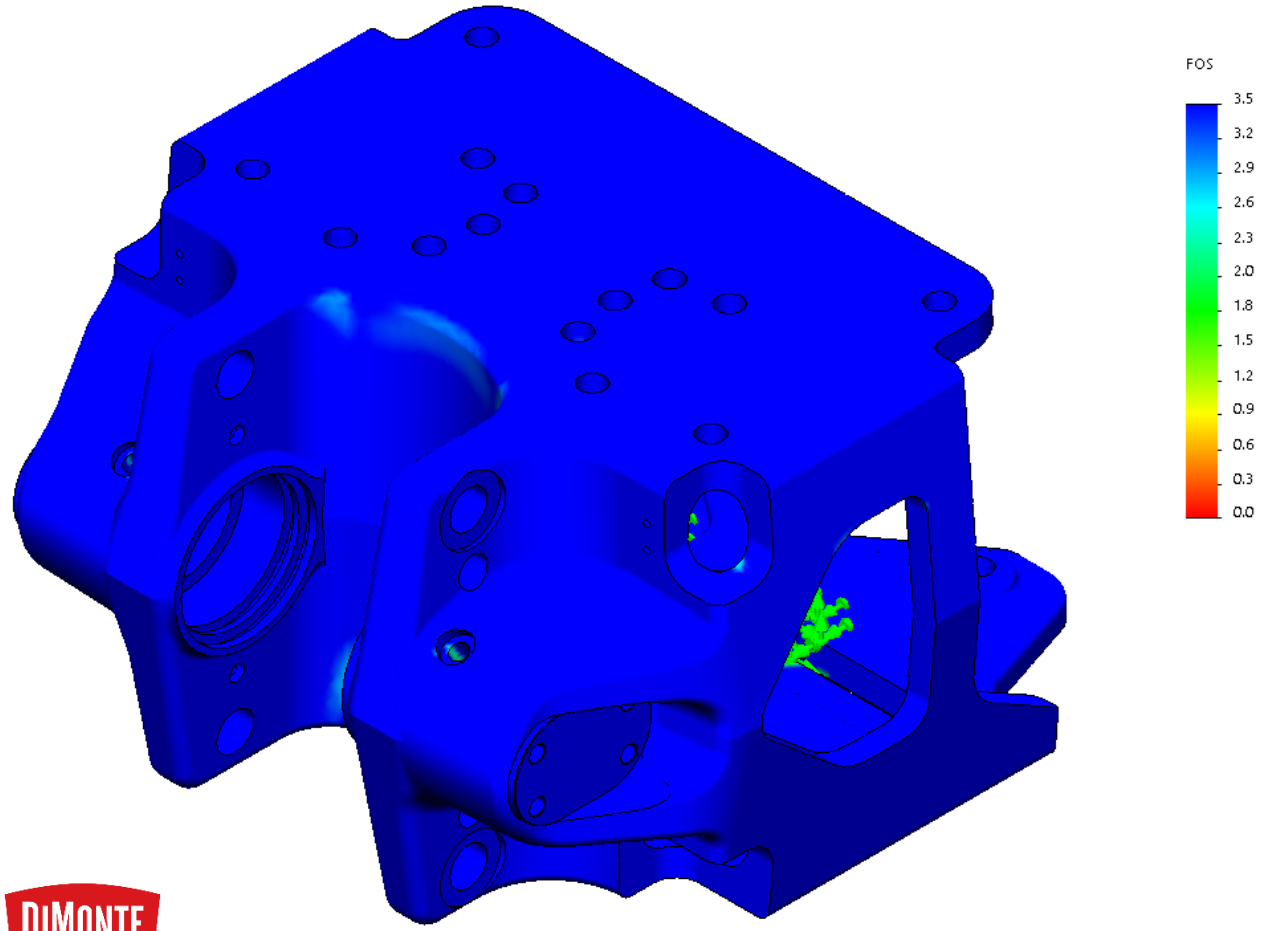


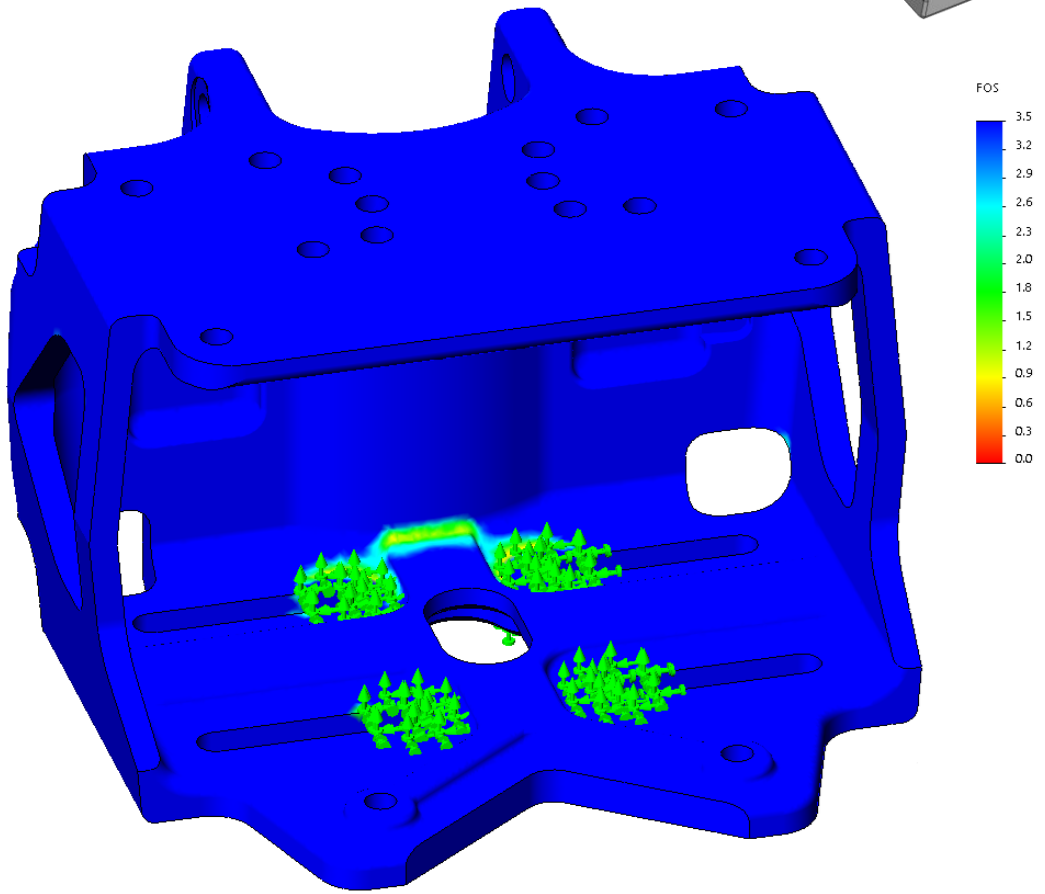


Side Cuts FOS Plots

DOWNWARD FORCE
66.60lbs
-13.69lbs

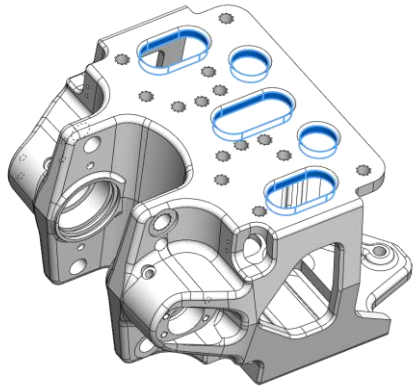


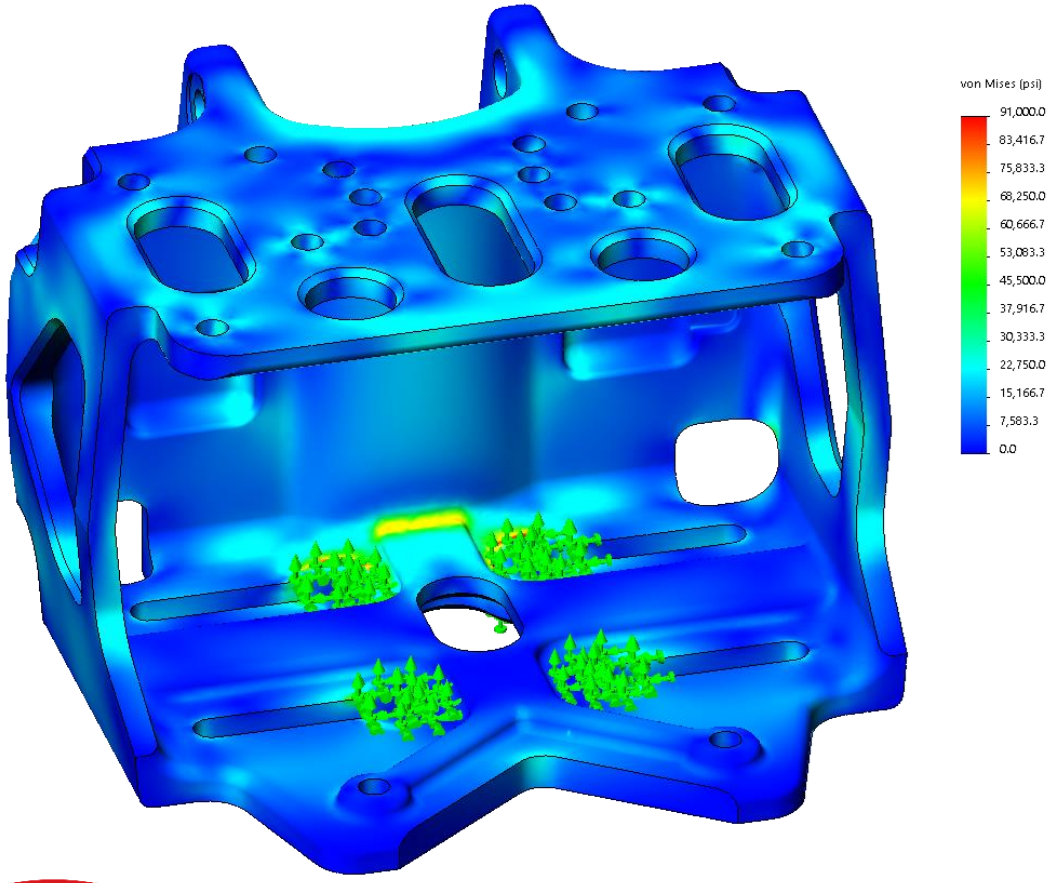


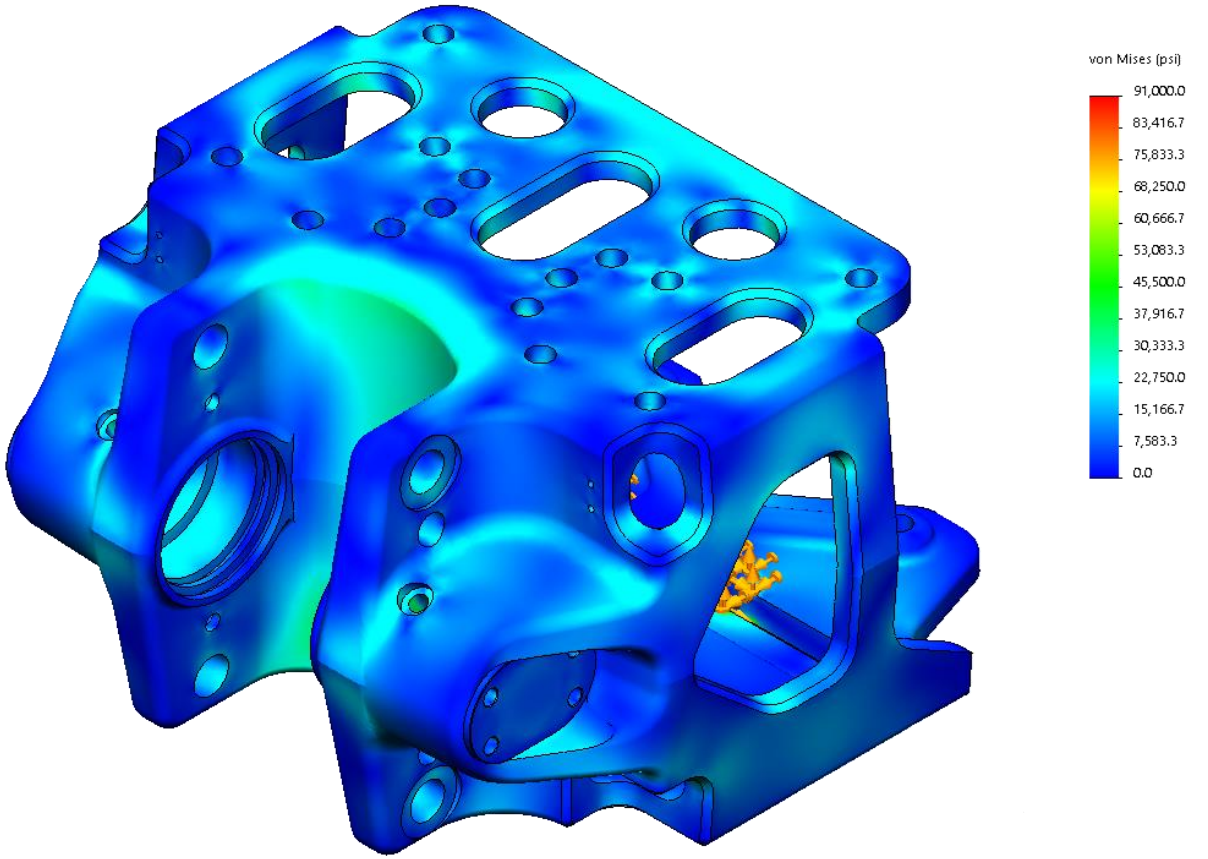


Top Cuts Stress Plots

DOWNWARD FORCE
64.27lbs
-16.02lbs

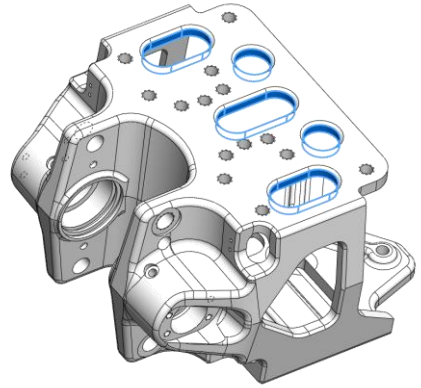


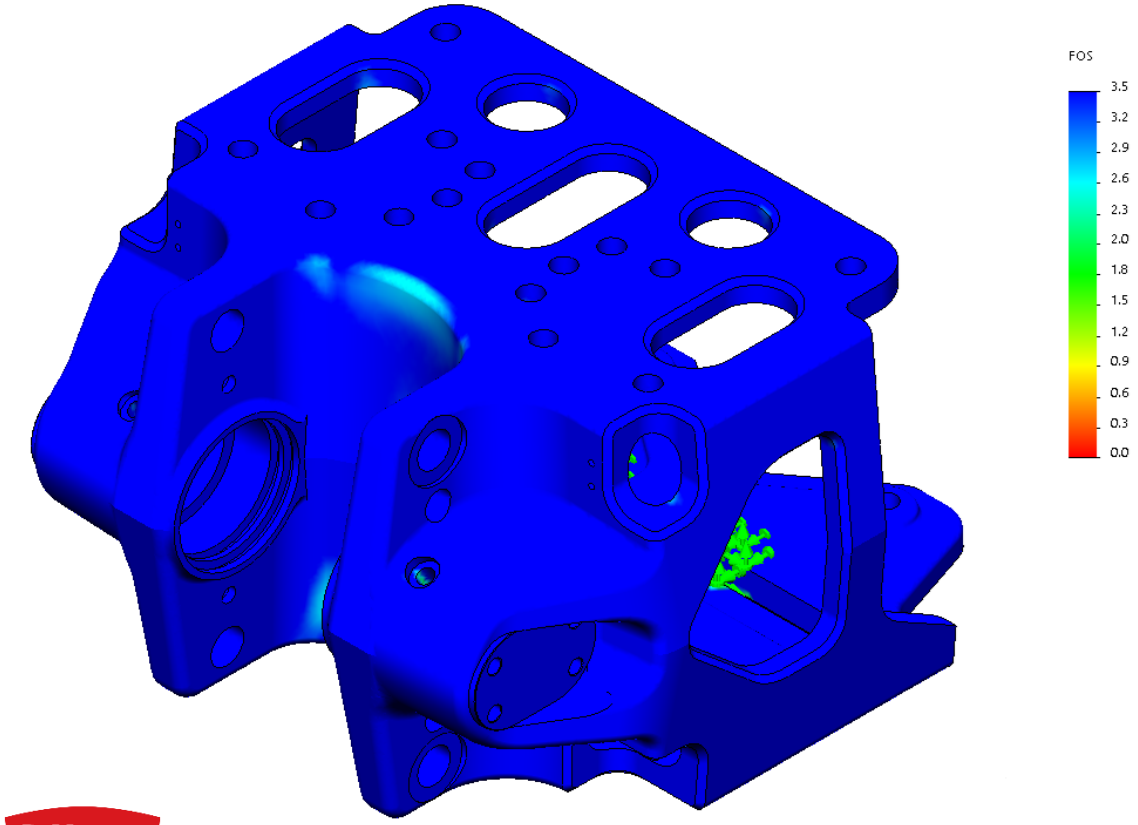


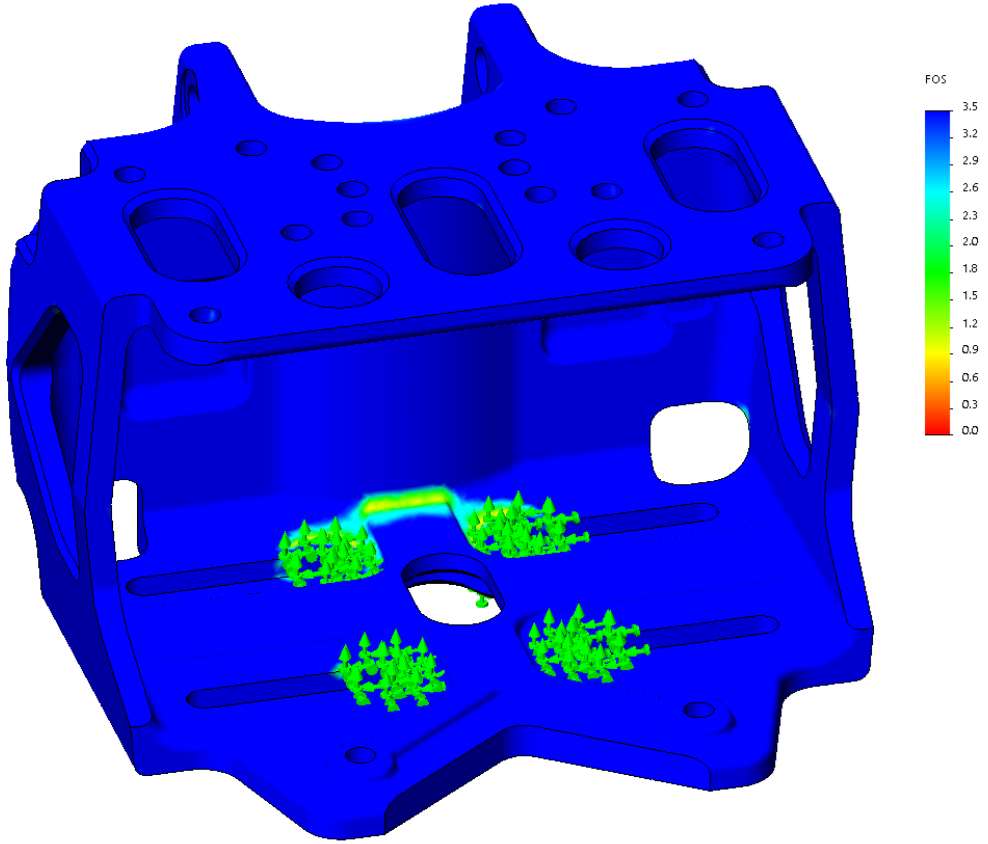


Top Cuts FOS Plots

DOWNWARD FORCE
64.27lbs
-16.02lbs

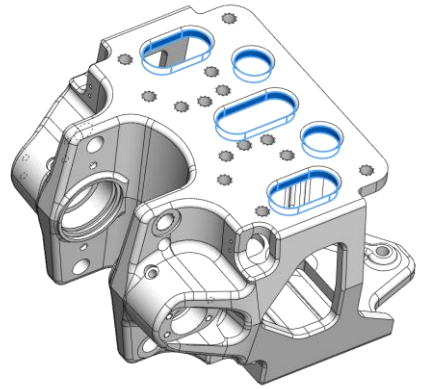


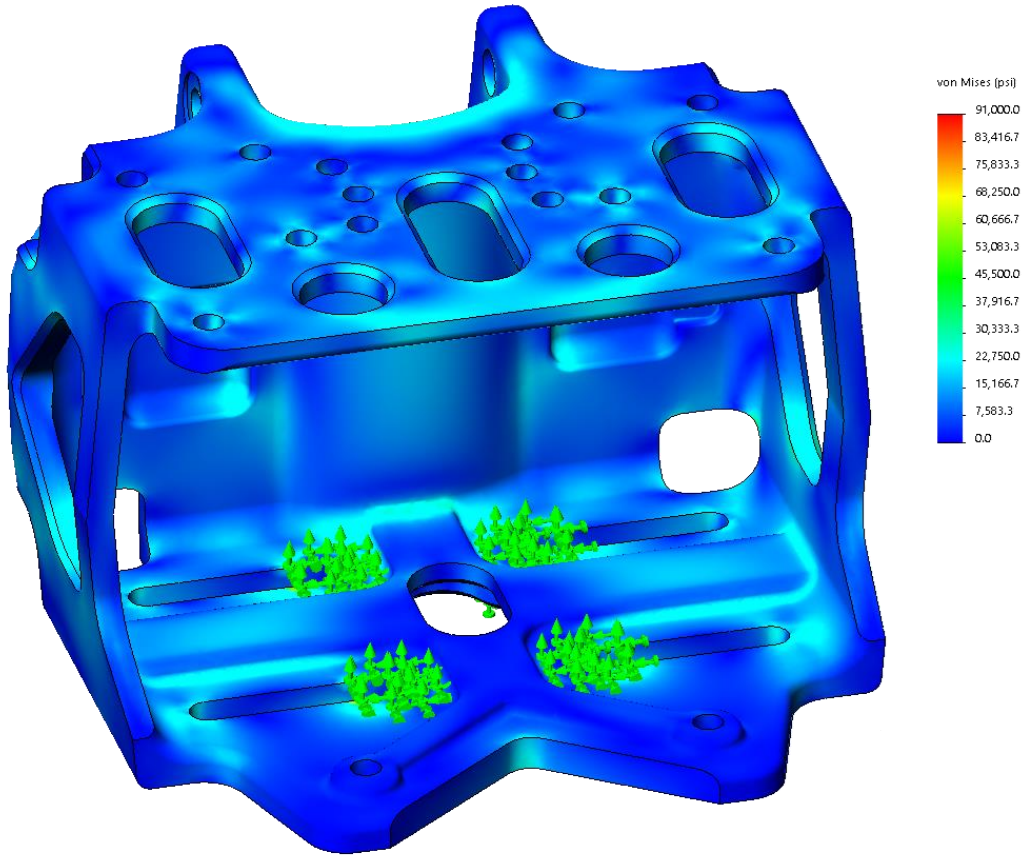


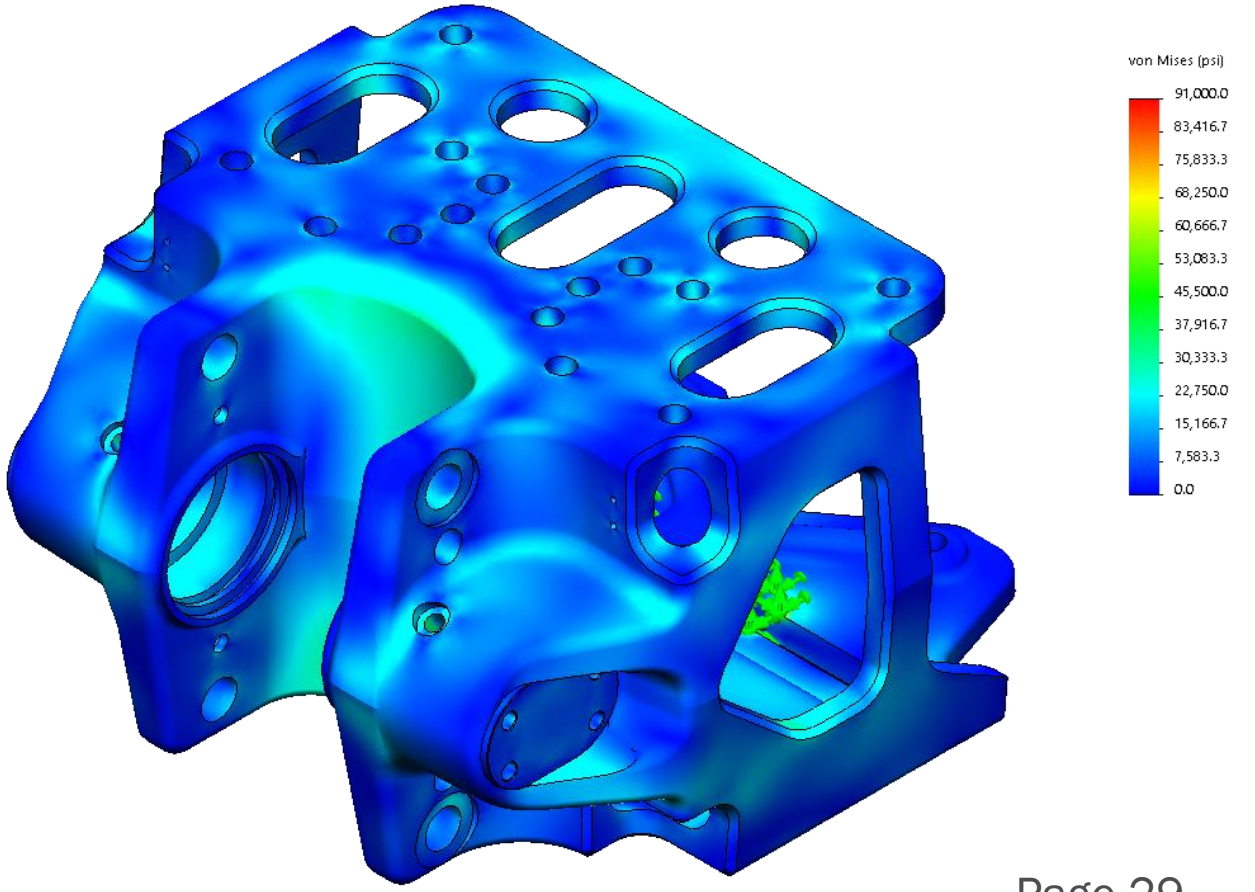


Top Cuts Stress Plots

UPWARD FORCE
64.27lbs
-16.02lbs







Top Cuts FOS Plots

UPWARD FORCE
64.27lbs
-16.02lbs