



University of Idaho

College of Engineering

NEED 4 SPEED

**Andy Hoang, Braden
Connolly, Nasser Aldawsari,
Nathan Miller**

Objective

To supercharge a KTM 525 SX motorcycle engine with a M24 Eaton Supercharger and redesign it to package inside a snowmobile chassis.

To create a new engine for the Clean Snowmobile Team with greater power, better efficiency, and weight reduction.



Supercharged Engine For Sustained Powertrain

- Over the last 16 years, the CSC Team is known for its pioneering work on lightweight, efficient, and cleaning running snowmobile innovations.
- Won many accolades in the annual SAE international competition.
- Need 4 Speed will be modifying a KTM 525 SX engine with a supercharger and intercooler that will fit in a snowmobile.
- Mathematical model for engine performance, full size prototype, bill of materials, and manufacturing plan.

Expectations

- Design a virtual and physical proof of concept for engine package in snowmobile chassis
- Identify engine performance with supercharger and snow to air intercooler
- Modify layout of supercharged engine for snowmobile packaging
- Remove existing transmission to interface with CVT
- Electric start
- Achieve 80 hp with same engine displacement
- Create metrology for new engine design and chassis
- Write a bill of materials and budget for functional prototype
- Implement a manufacturing plan for functional prototype



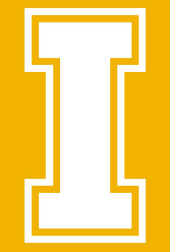
Stock KTM vs Supercharged Engine Specs

KTM 525 SX Engine		
	Stock Engine	With Eaton Supercharger
Horsepower	55 Hp	85 Hp
Compression Ratio	11.5:1	8:1
Displacement	538.5 ccm	538.5 ccm
Boost Pressure	0 PSI	10 PSI
Weight	60 lbs	70 lbs

"A 4-stroke, 1-cylinder IC engine modeled with the Otto Cycle,"

```

a$ = 'air_ha'
rpm = 7500[rev/min]
P[1] = 14.7[psia]
T[1] = 50[F] "Inlet Temp"
Vol_1 = 32.574[in^3]*convert(in^3,ft^3)
P[3] = 700[psia]
CR = 11.5
N_r = 2[rev] "4-stroke engine"
    
```



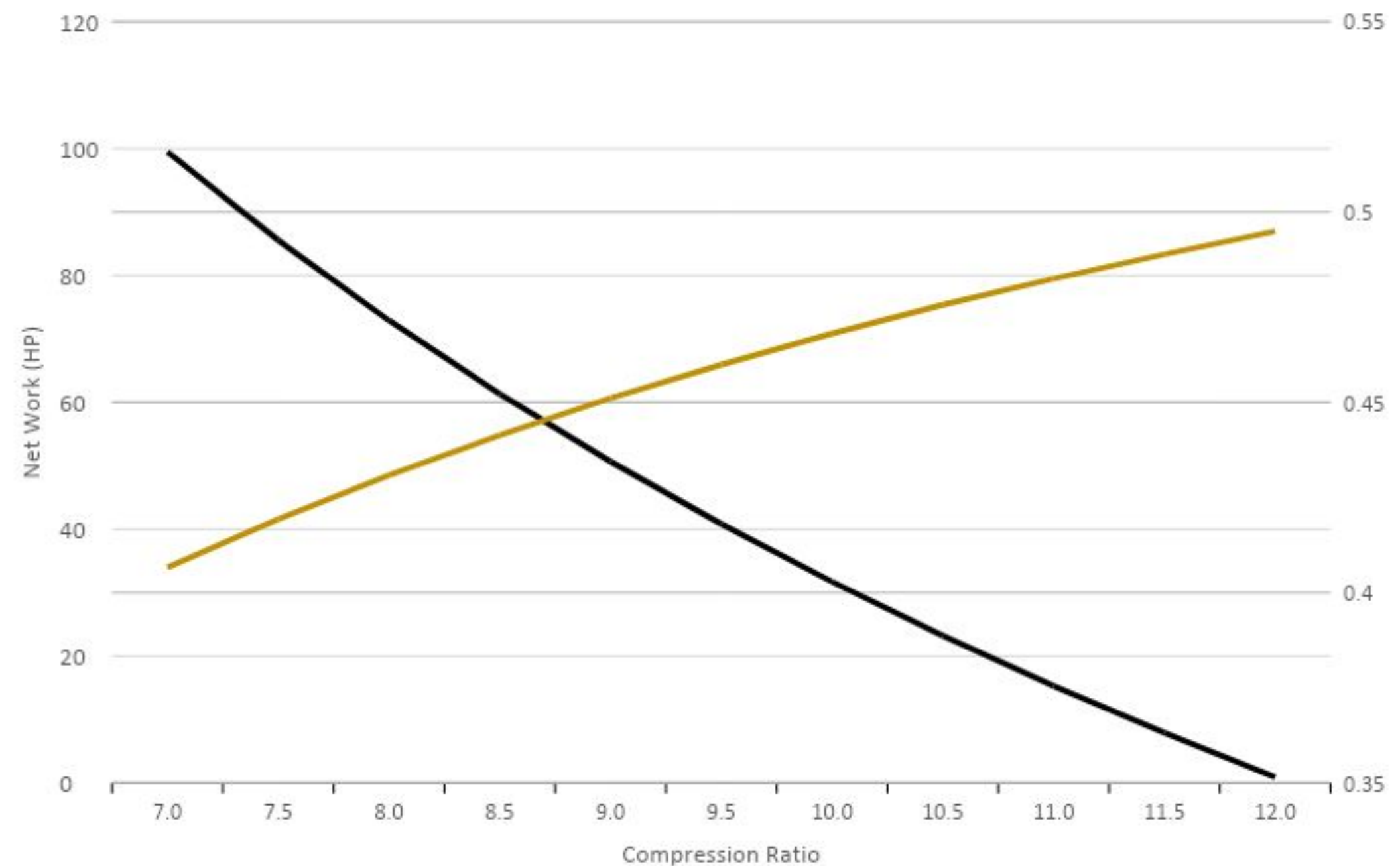
Math Modeling

Sort	T _i [F]	P _i [psia]	v _i [ft ³ /lbm]	u _i [Btu/lbm]	s _i [Btu/lbm-F]
[1]	80	14.7	13.6	92.01	1.639
[2]	928.8	439.8	1.182	244.2	1.639
[3]	1745	700	1.182	410.5	1.733
[4]	466.4	25.25	13.6	159.3	1.733

$\dot{W}_{net} = 48.57$ [hp] (a) Power developed by the engine
 $\eta_{th} = 0.5956$ (b) Thermal Efficiency of the engine
 $mep = 43.12$ [psia] (c) mean effective pressure of the engine

	Stock Specs	Modified (100% Cooling)	Modified (Real)		Vol_1 (in ³)	W_dot_Net (hp)	Thermal Efficiency (%)
C.R	11.5	8	8	C.R			
Pressure Psia	14.7	14.7	24.7		7	38.02	99.46
Temp F	50	50	79.495		7.5	37.6	85.54
W_dot_Net (hp)	70.18	141.7	72.9		8	37.24	72.89
Thermal Efficiency (%)	59.36%	51.53%	43.09%		8.5	36.93	61.32
					9	36.66	50.66
					9.5	36.42	40.83
					10	36.21	31.72
					10.5	36.02	23.24
					11	35.85	15.33
					11.5	35.69	7.92
					12	35.55	0.96

KTM 540cc with Eaton M24 Supercharger



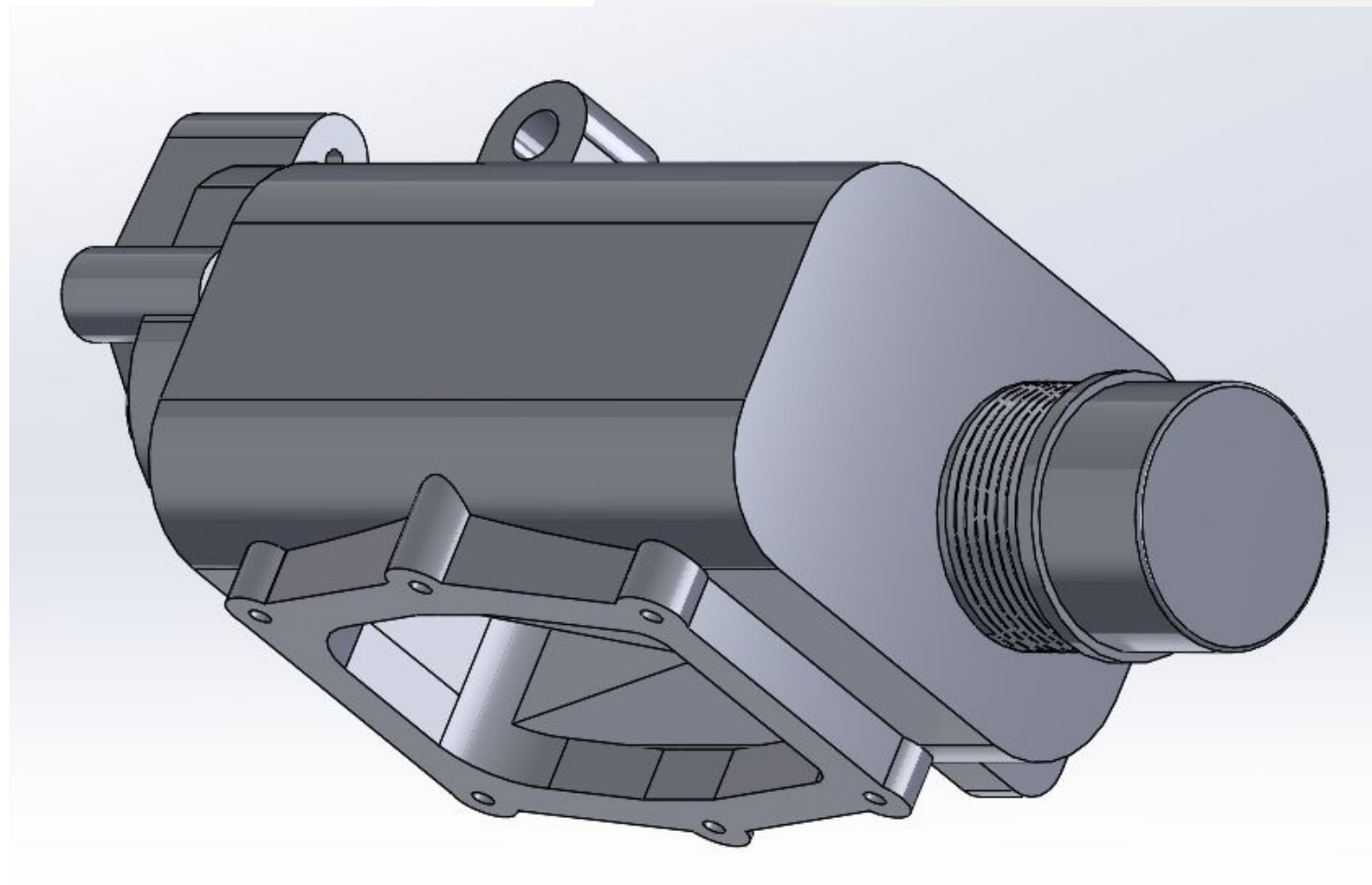
Calculations assume the following initial conditions:

Inlet Temp: 79.495 F
 RPM: 7200
 Boost: 10 Psia

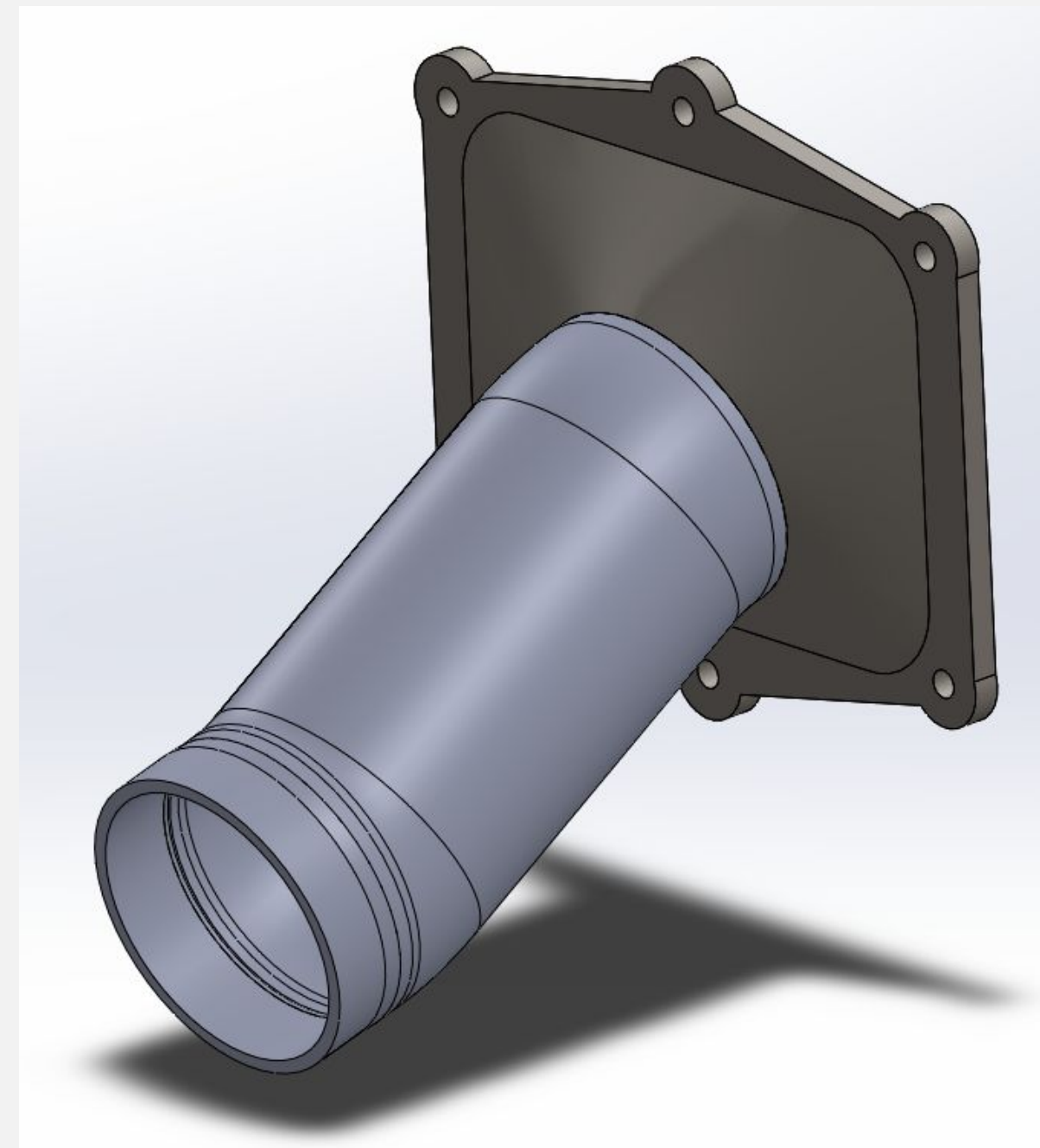
Input parameters for supercharged model:

- Inlet temp based on compression and intercooling
- Inlet pressure of 10 psi
- Combustion pressure due to thermodynamic and stoichiometric properties
- Compression ratio reduced to 8:1

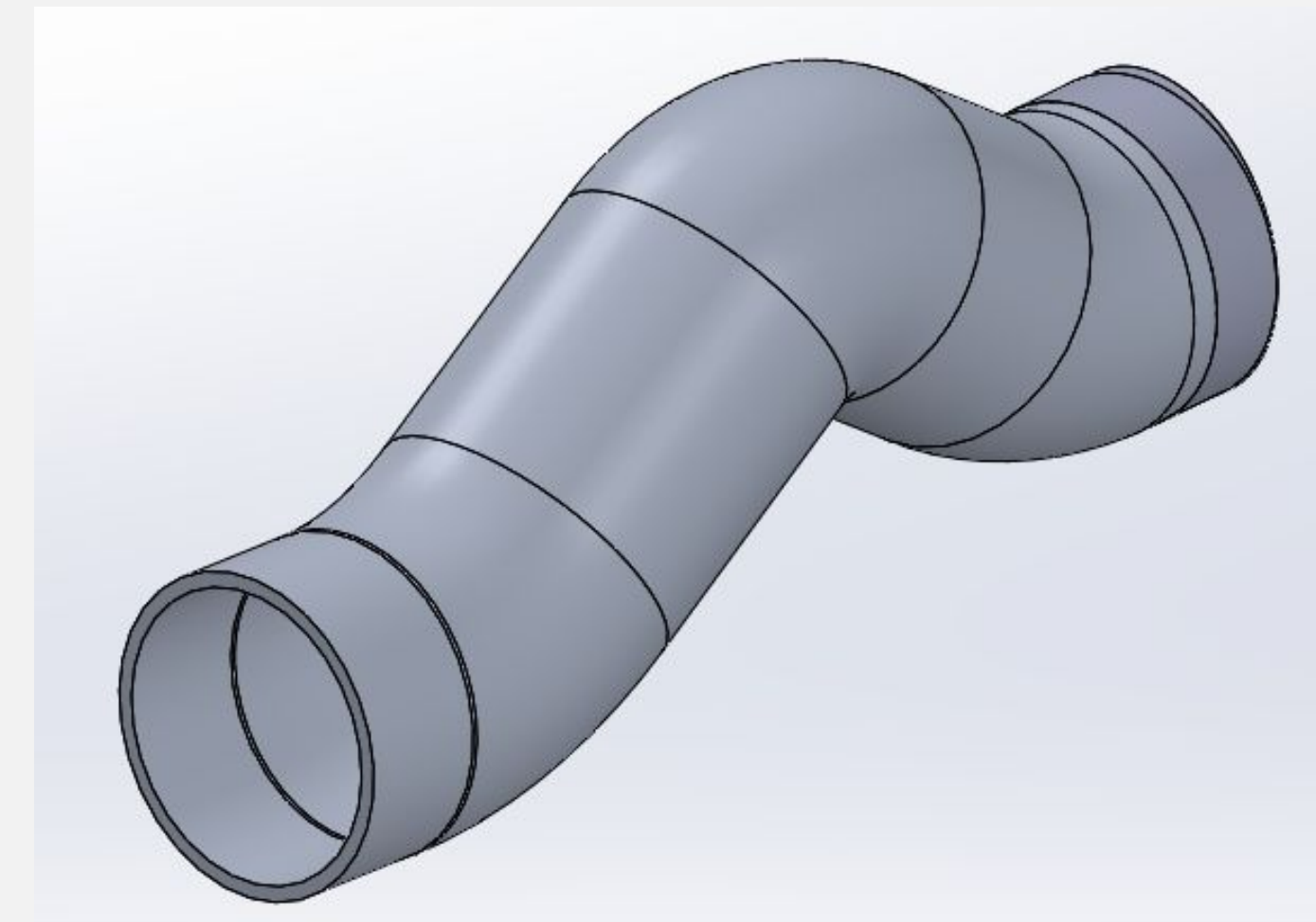
Supercharger and Plenum



Eaton M24
Supercharger

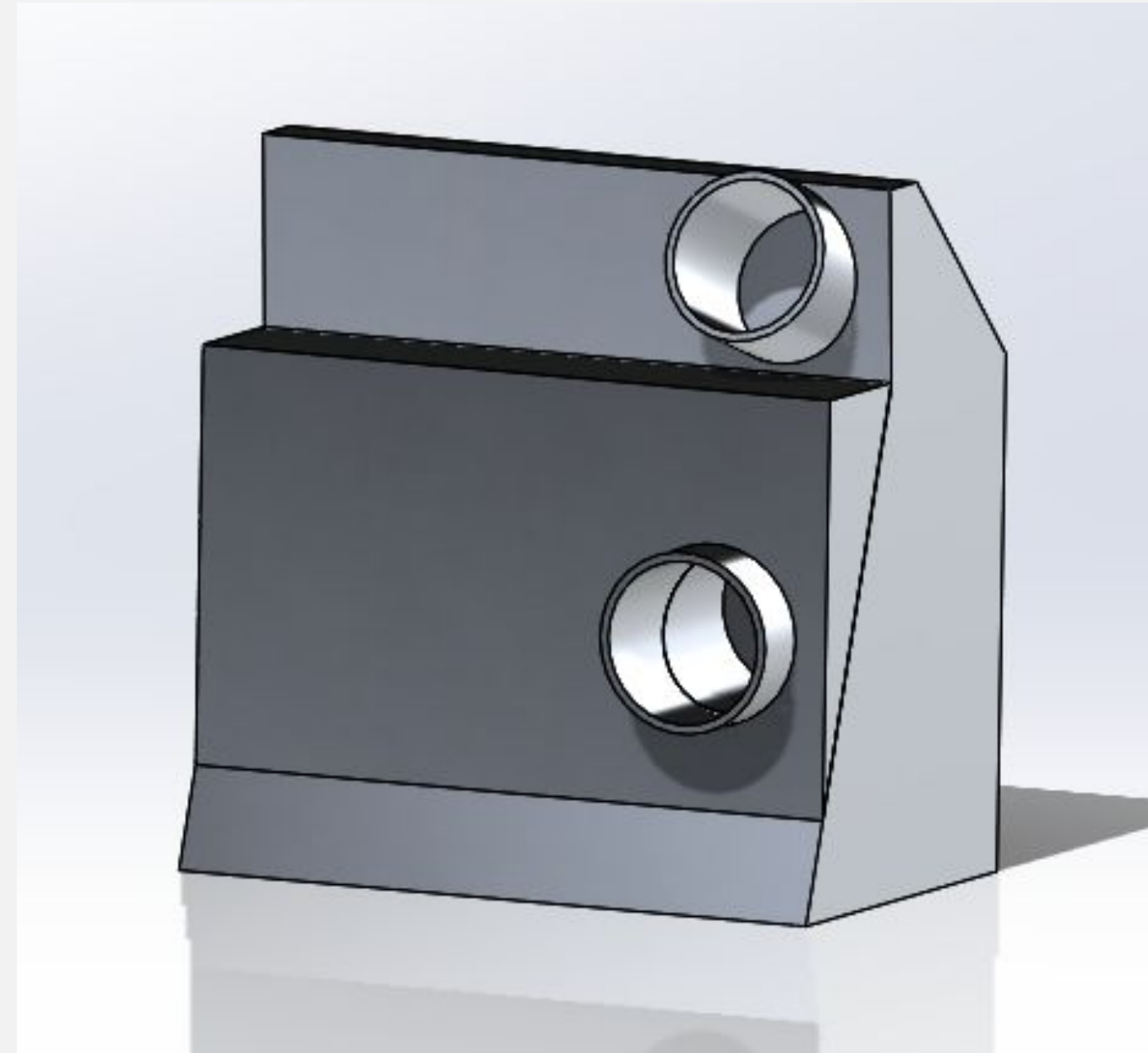
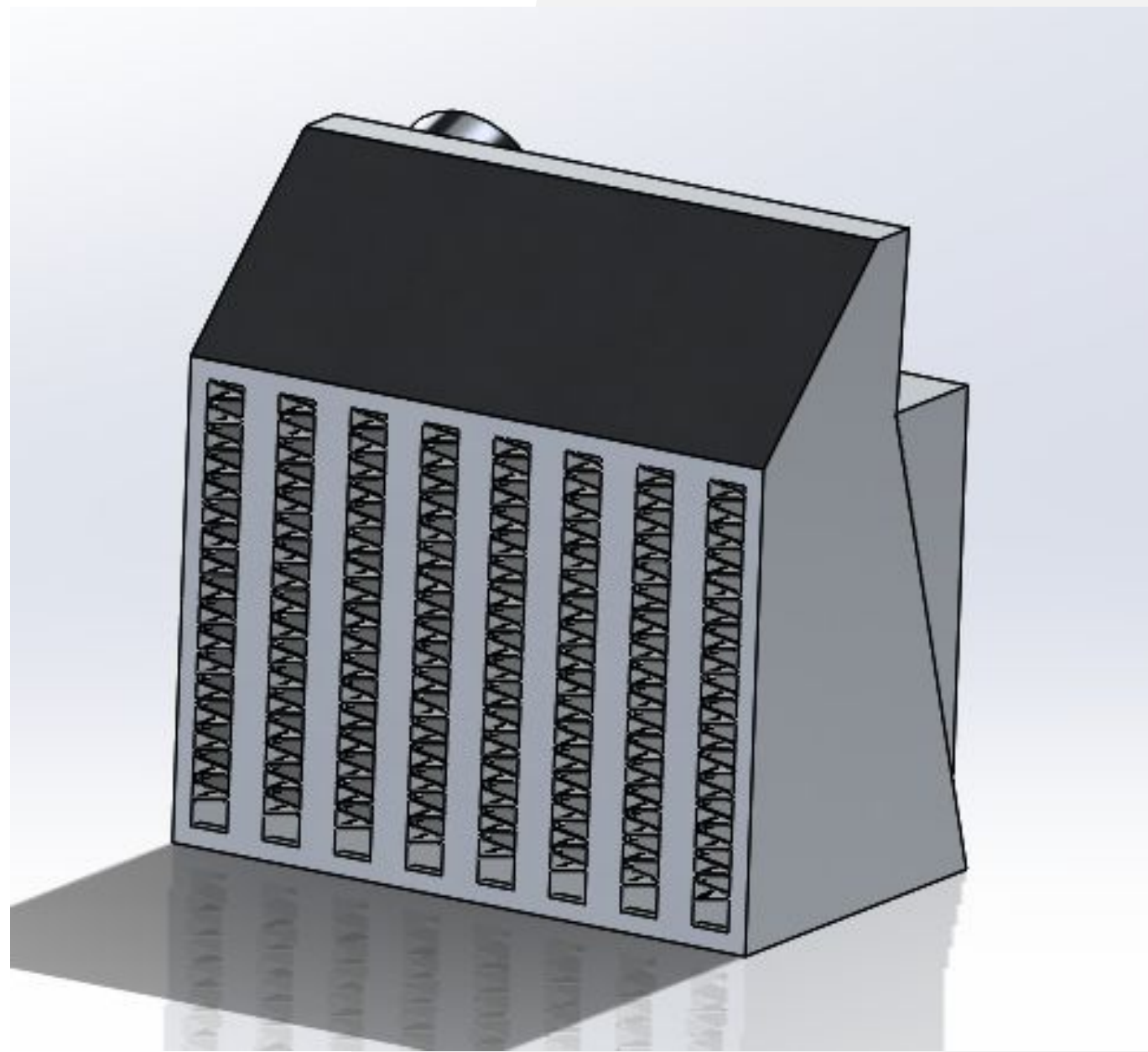


Top Plenum



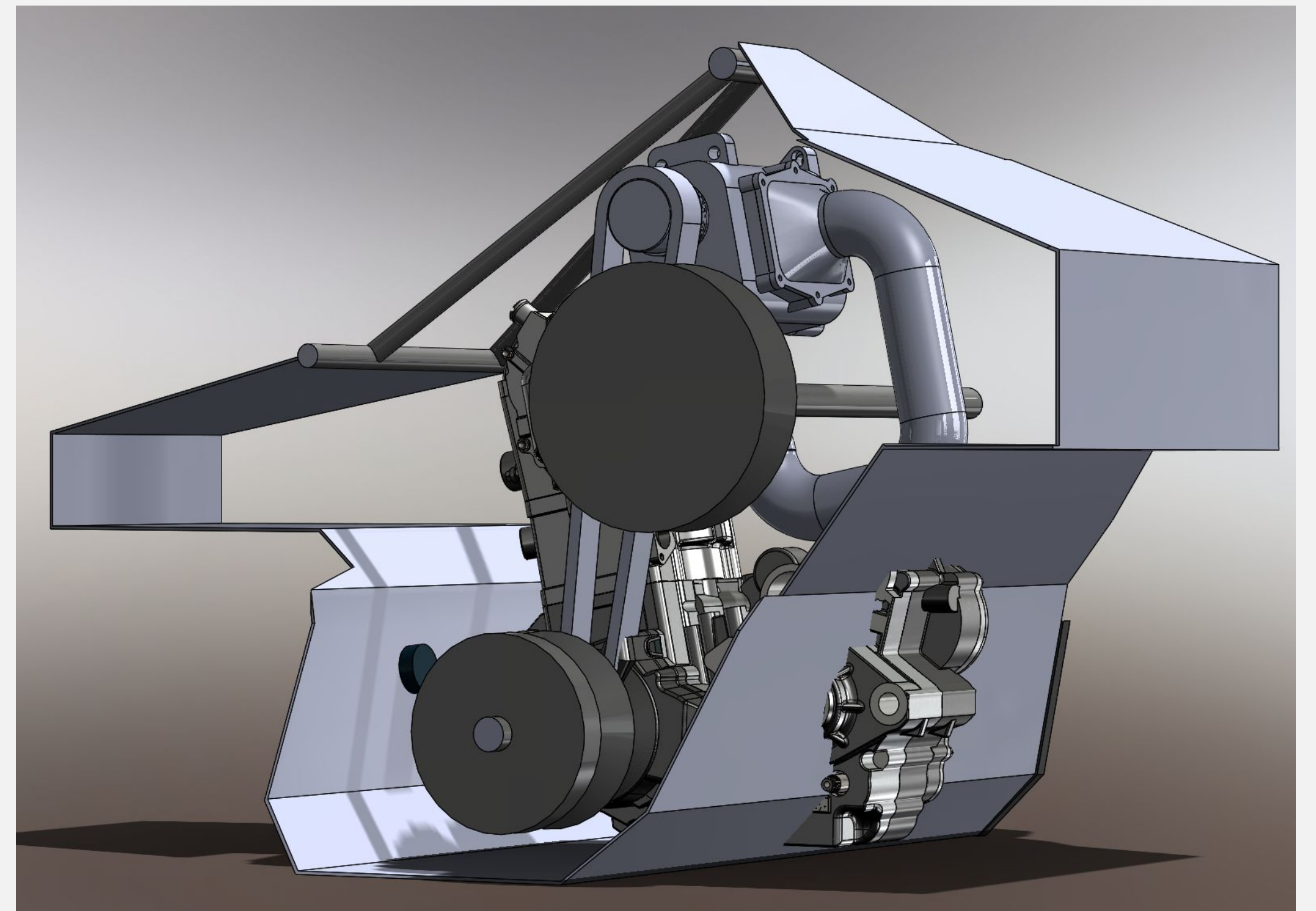
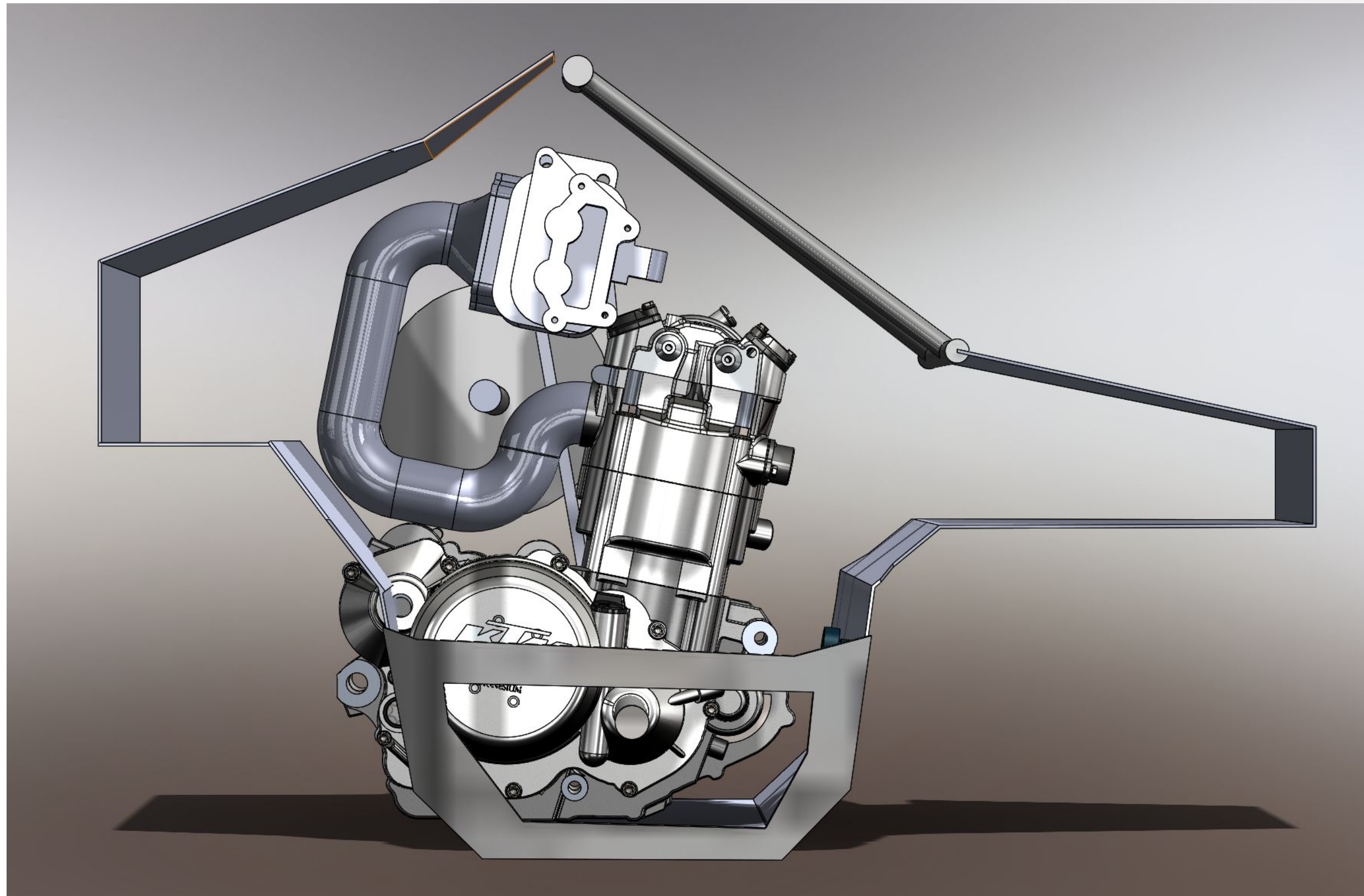
Bottom Plenum

Snow-to-Air Intercooler

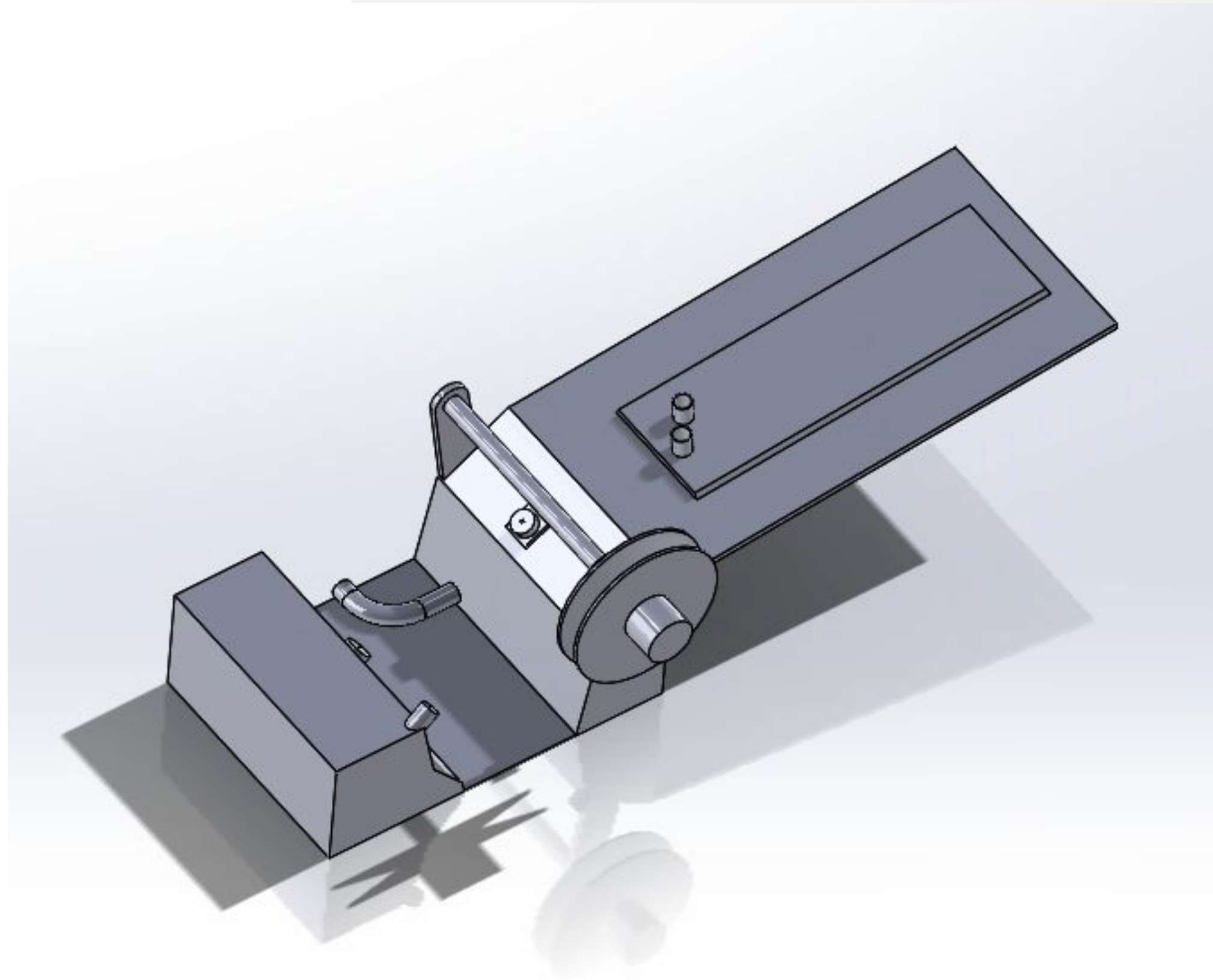


- 8 in. x 5 in. x 8.5 in.

Supercharged Stock Engine in Chassis

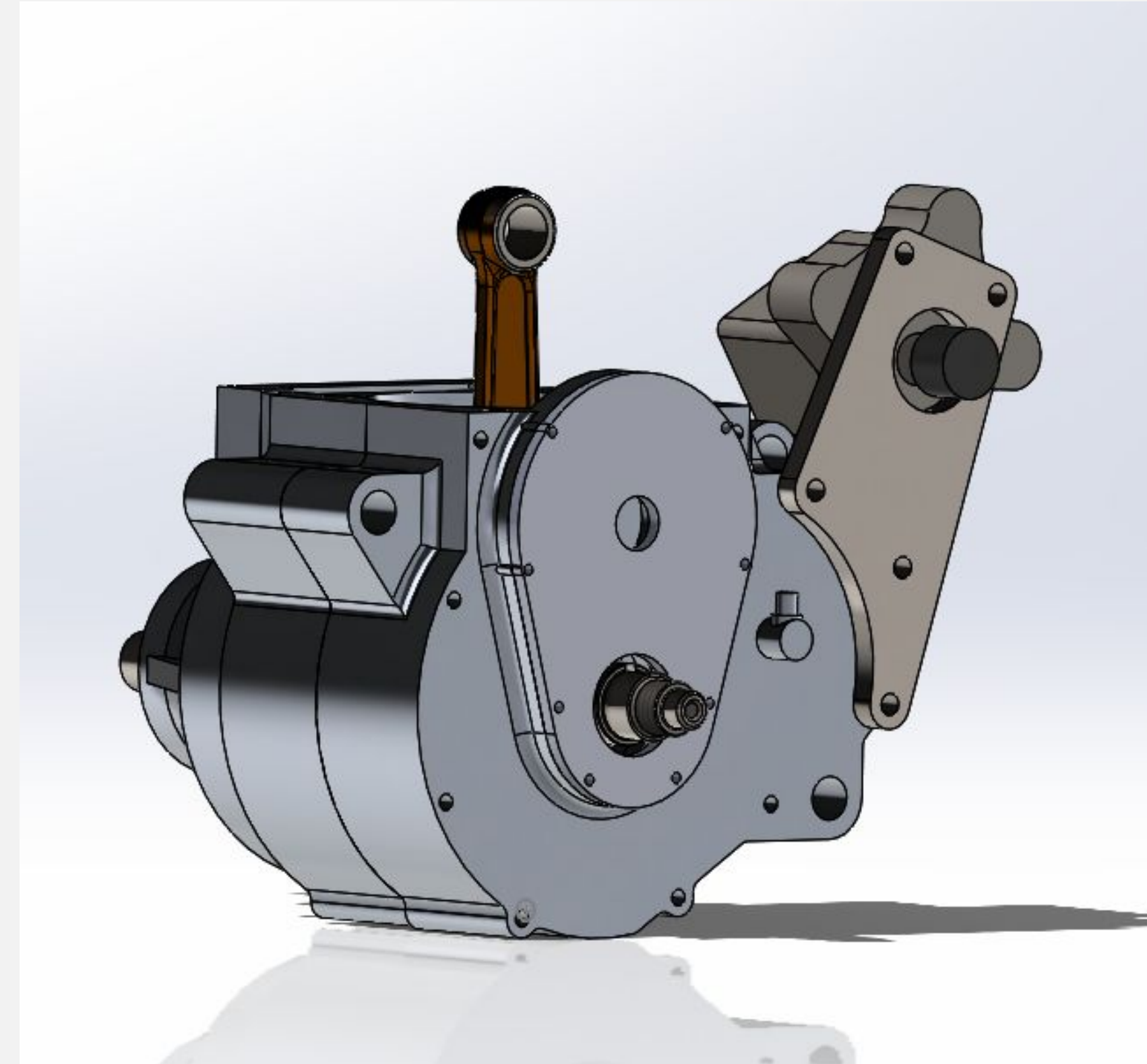
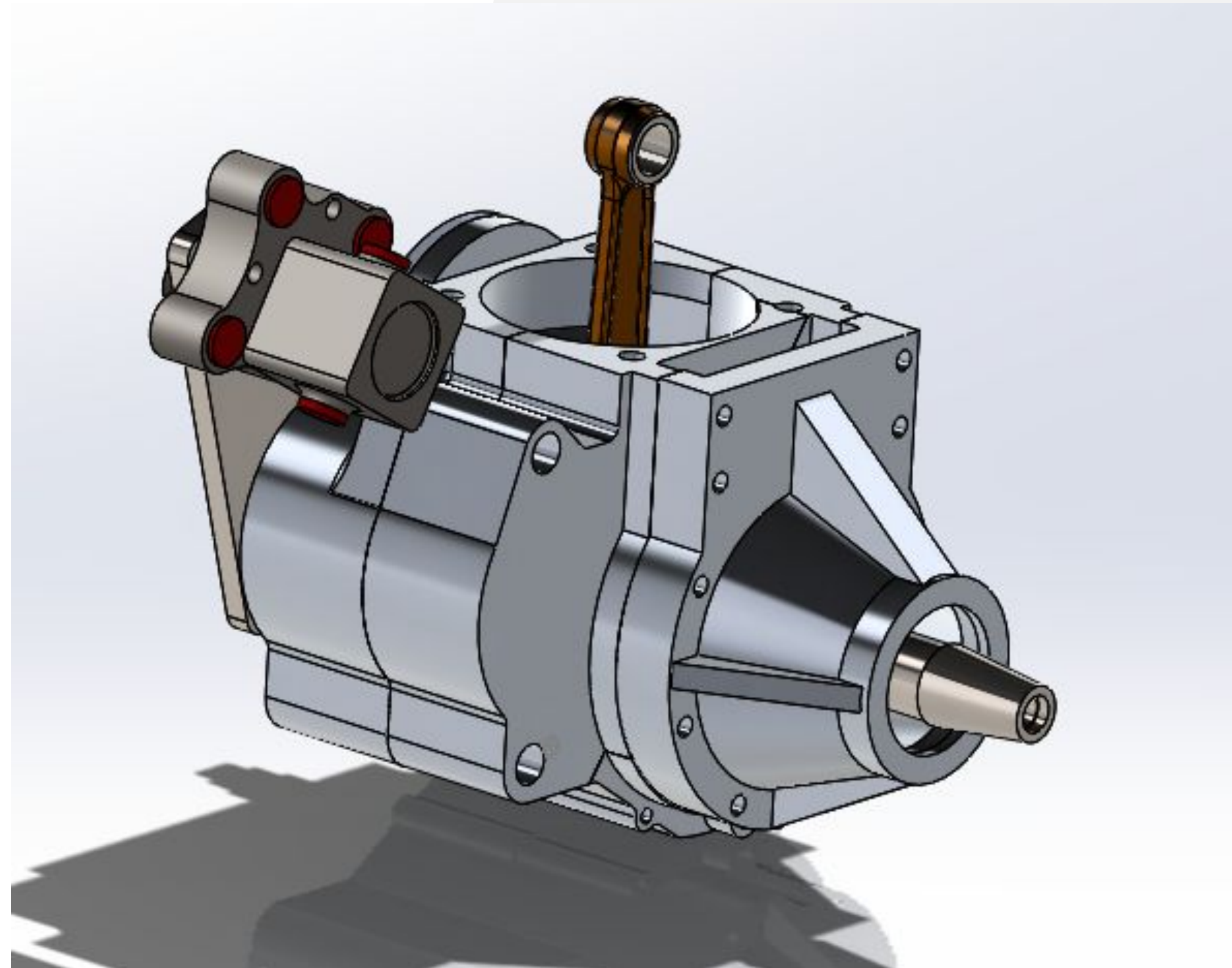


Snowmobile Chassis



- 16.5 in. x 13 in. x 22 in. - space available for new engine
- CVT - continuously variable transmission

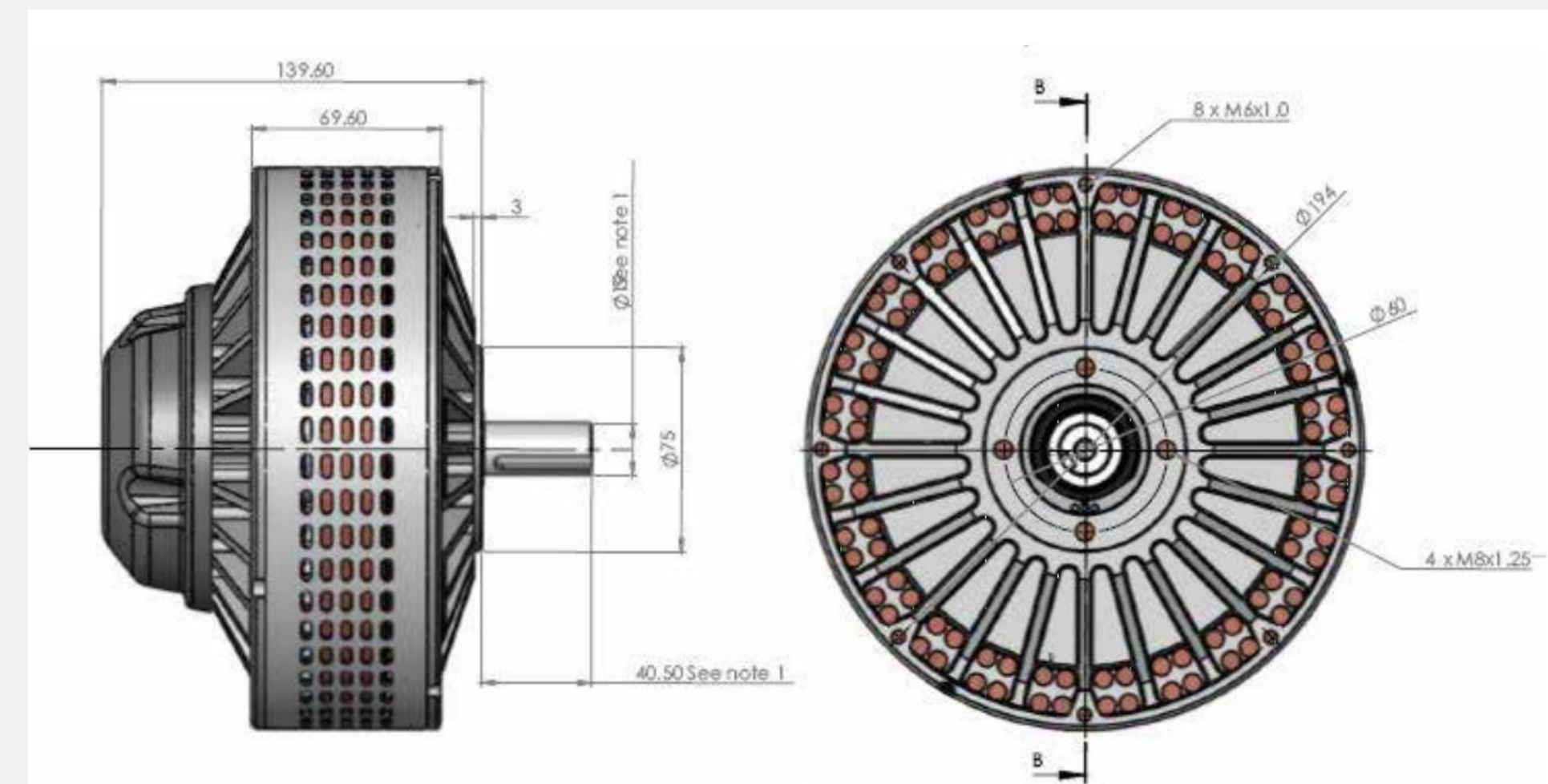
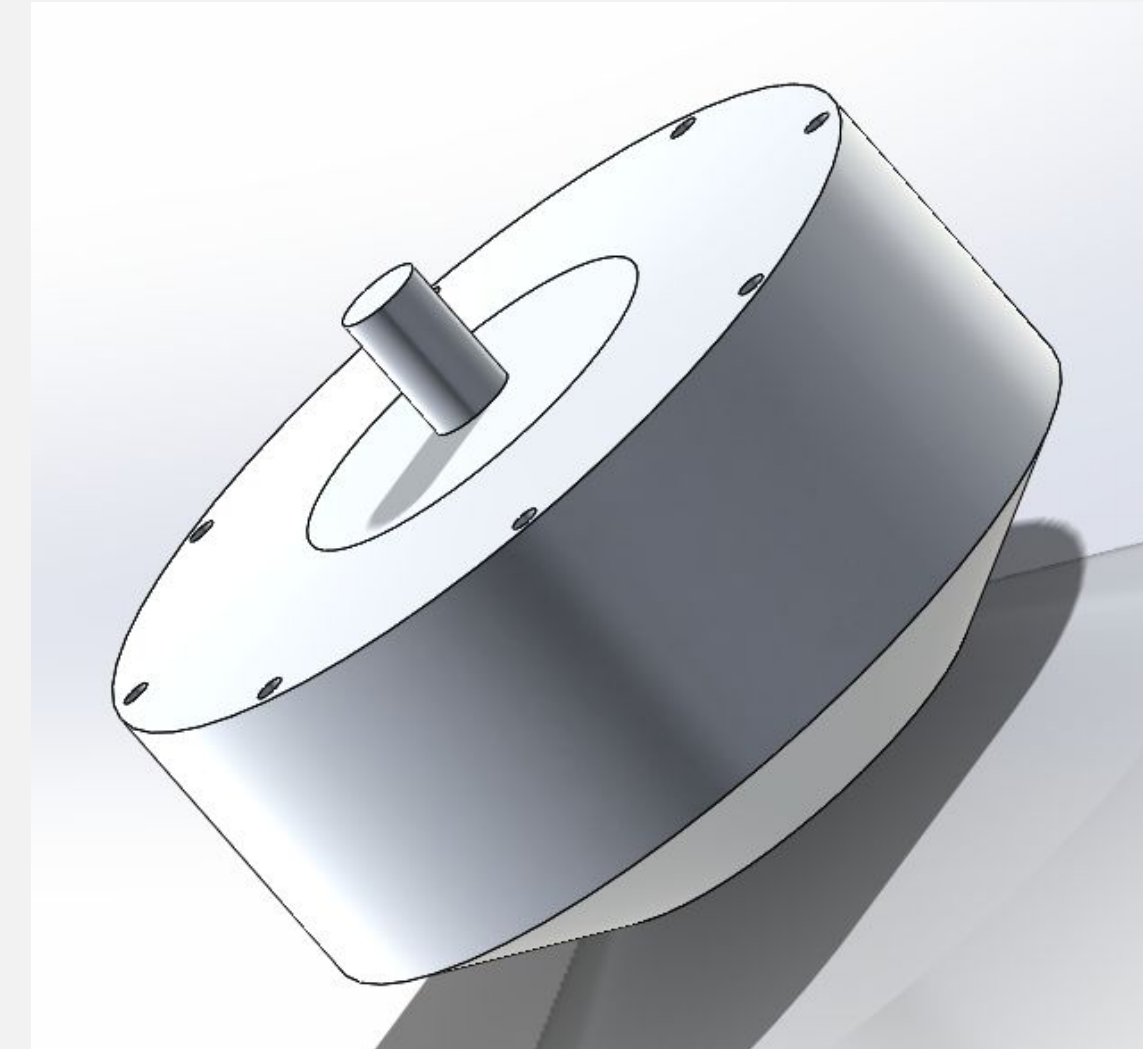
Crankcase Design



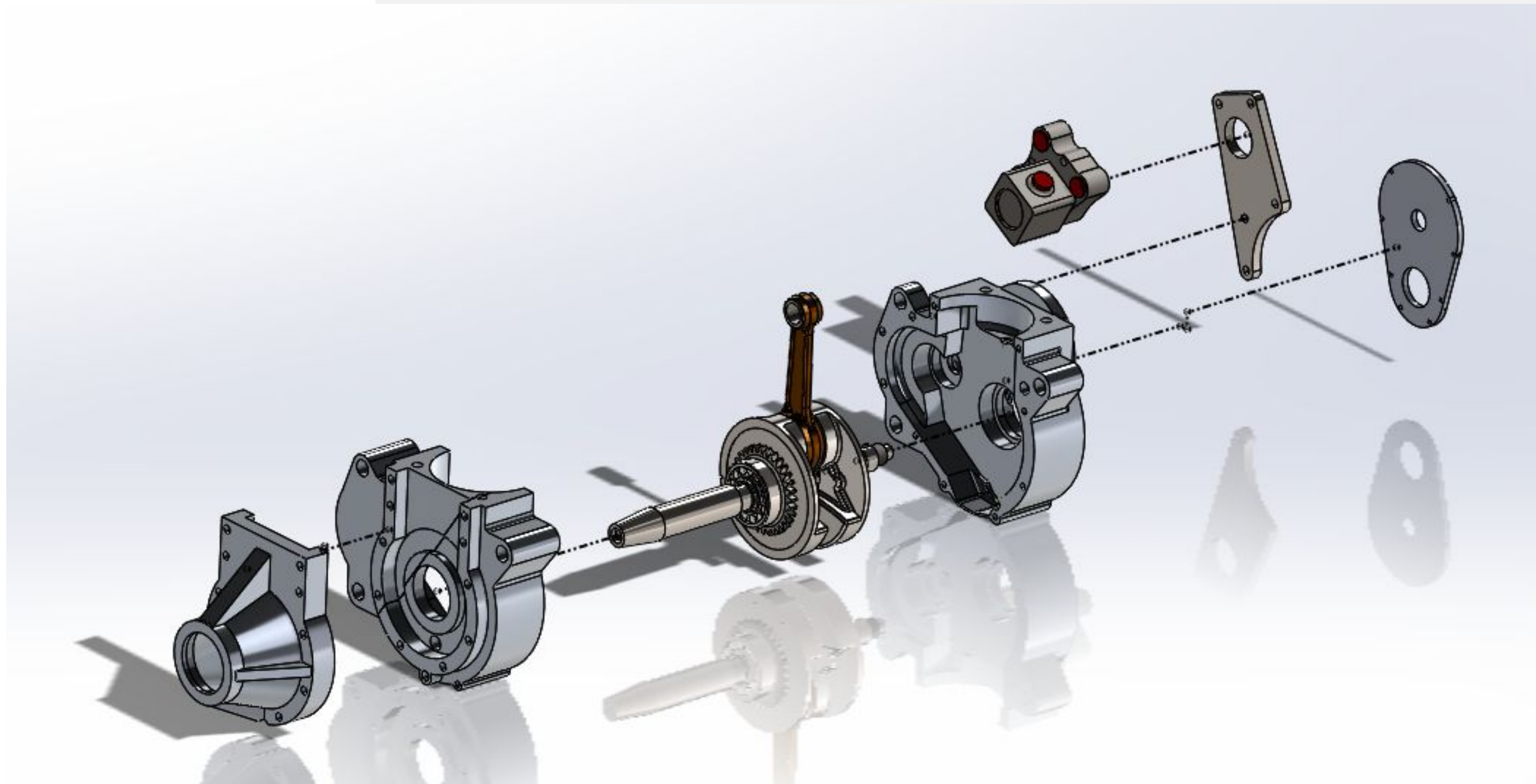
- External dry sump oil pump - Titan Oil Pump
- One oil filter attached to external oil reservoir
- Remove stock transmission components
- Include starter/generator

Electric Starter

- LEM-200
- 48 Volts
- Rated Speed - 3888 Rpm
- Rated Torque -28 Nm
- Generate more power
- Used in hybrid formula car



Exploded Crankcase Design



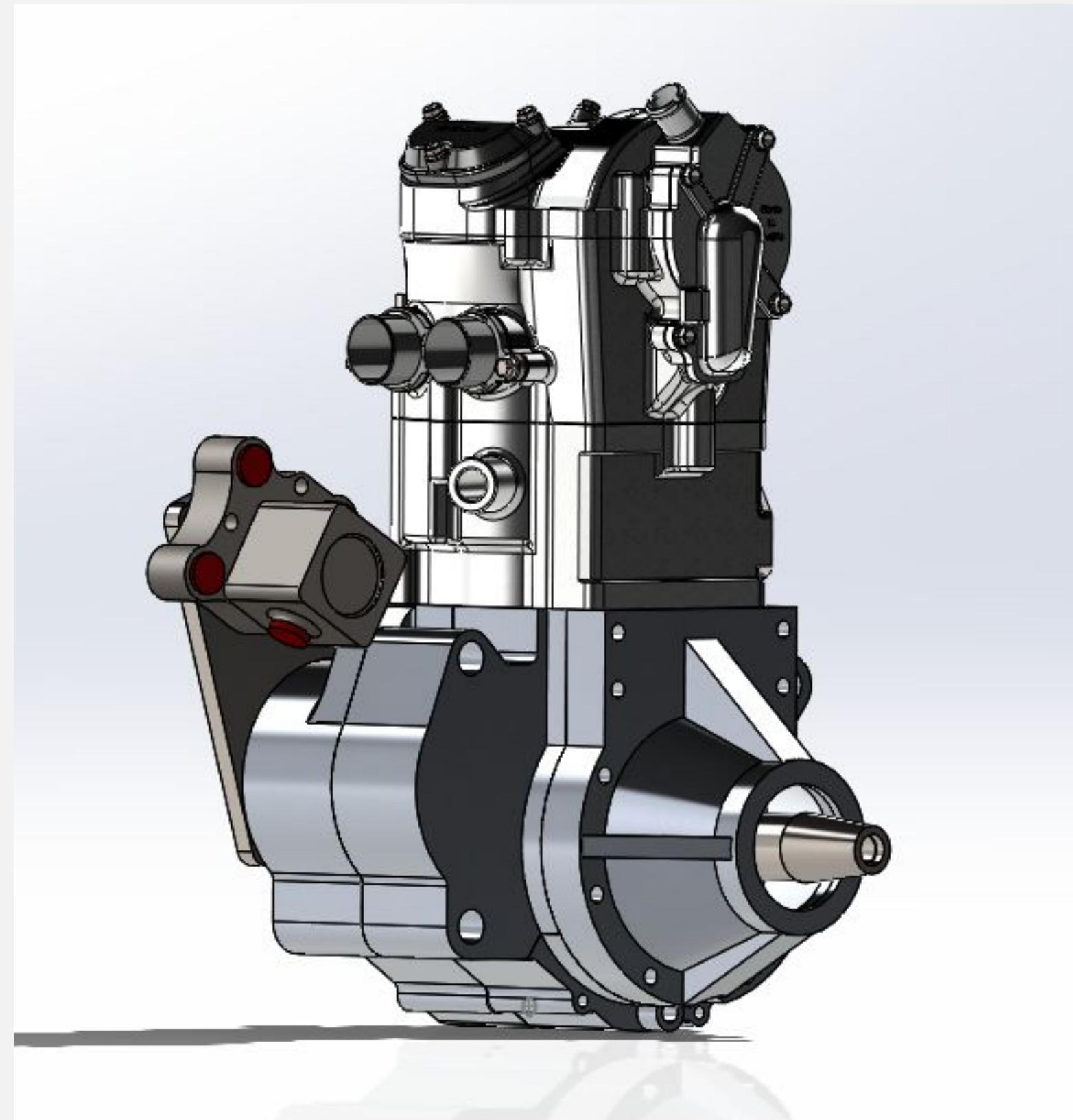
Right Hand Side:

- Oil Pump
- Supercharger Belt
- Starter/Generator/Hybrid Electric Motor
- Gear Reduction for Starter

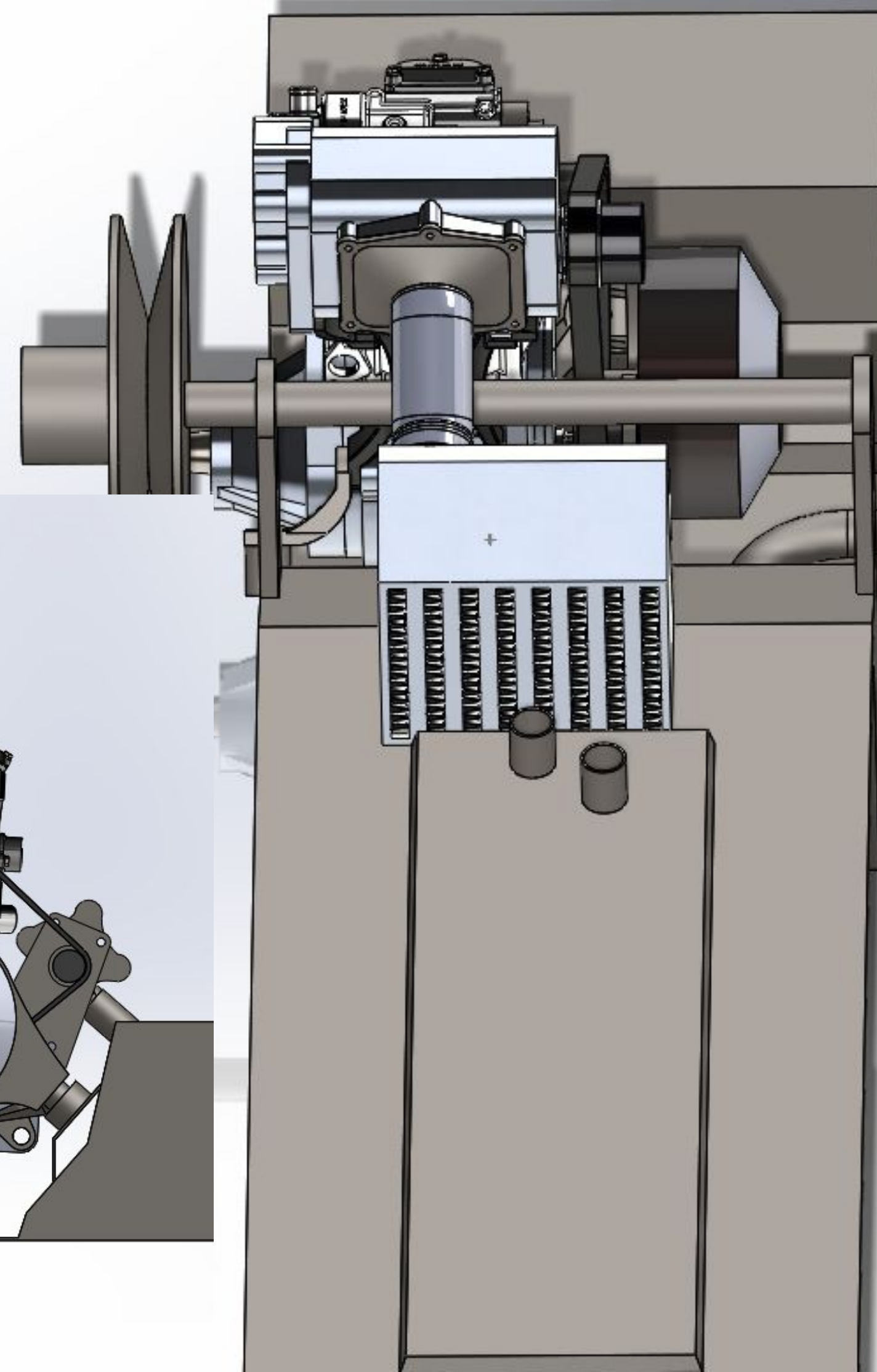
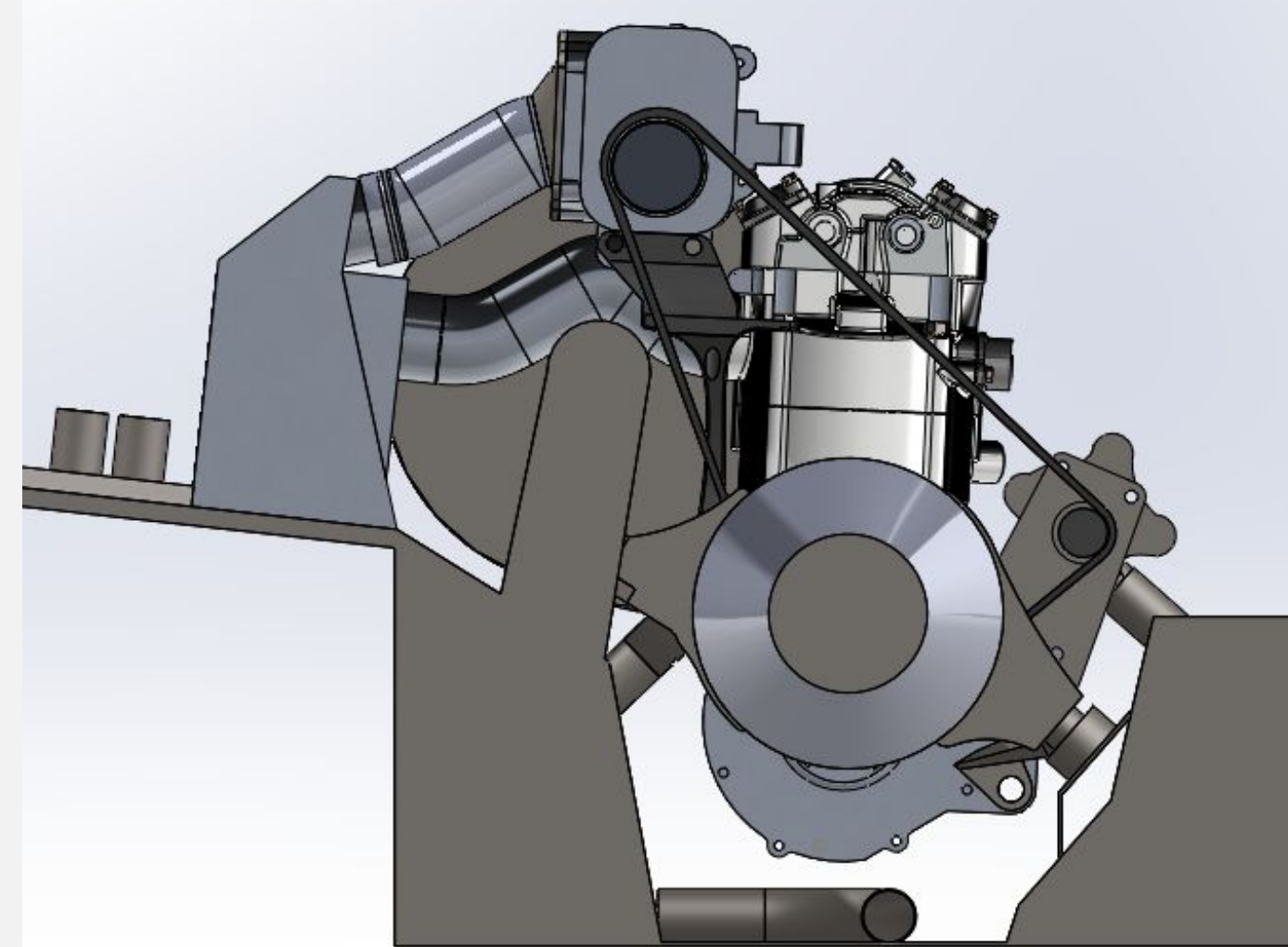
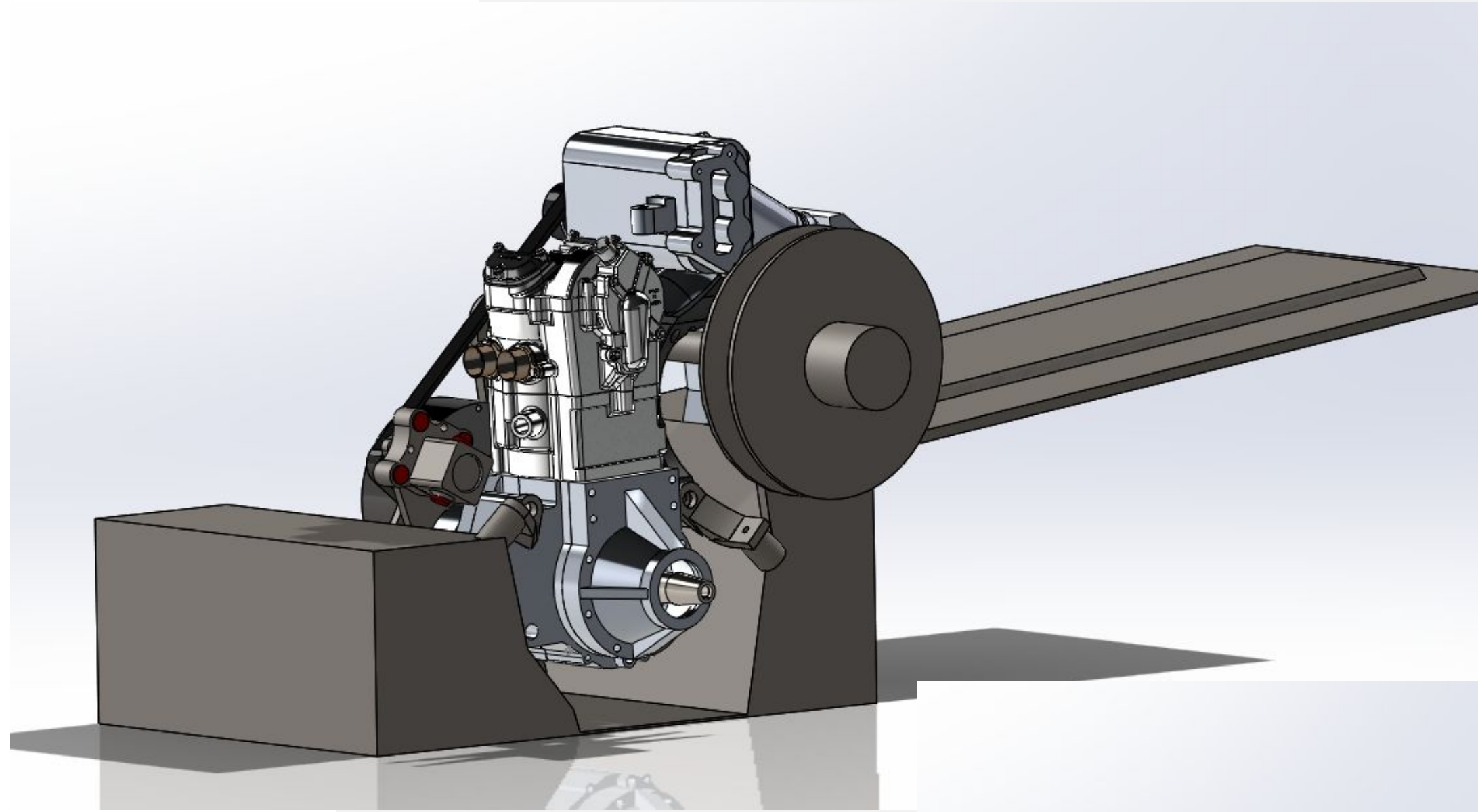
Left Hand Side:

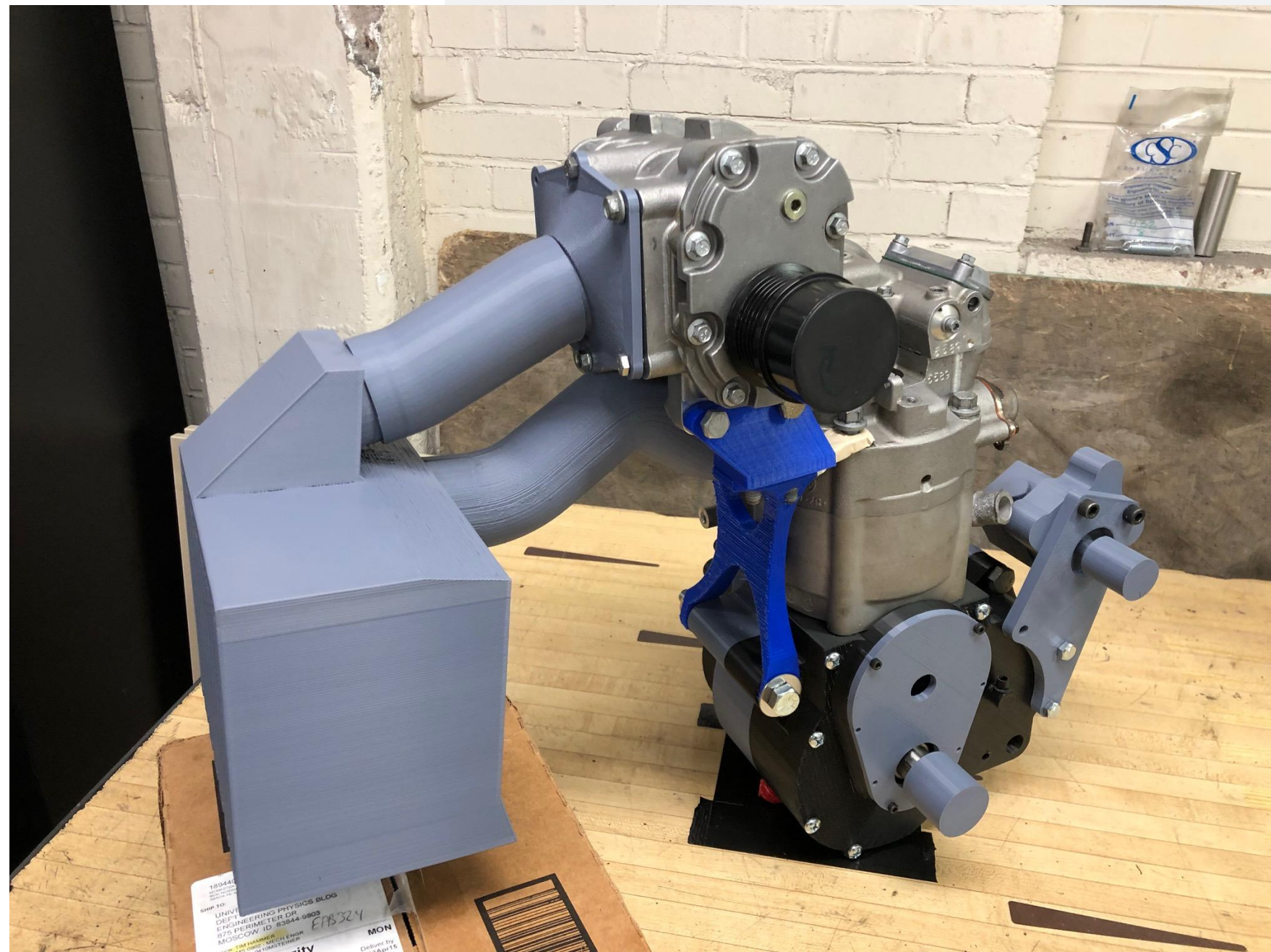
- Dry Sump Oil Pickup
- Timing Gear and Chain
- Clutch Extension Shaft
- Clutch Bearing and Bracket

Stock Head and New Crankcase



Prototype Packaging Concept







Future Development Work

- Machine/Fabricate Parts
- Fuel Injection System
- ECU and Electrical System
- Supercharger Bypass Valve
- Air Intake and oiling system