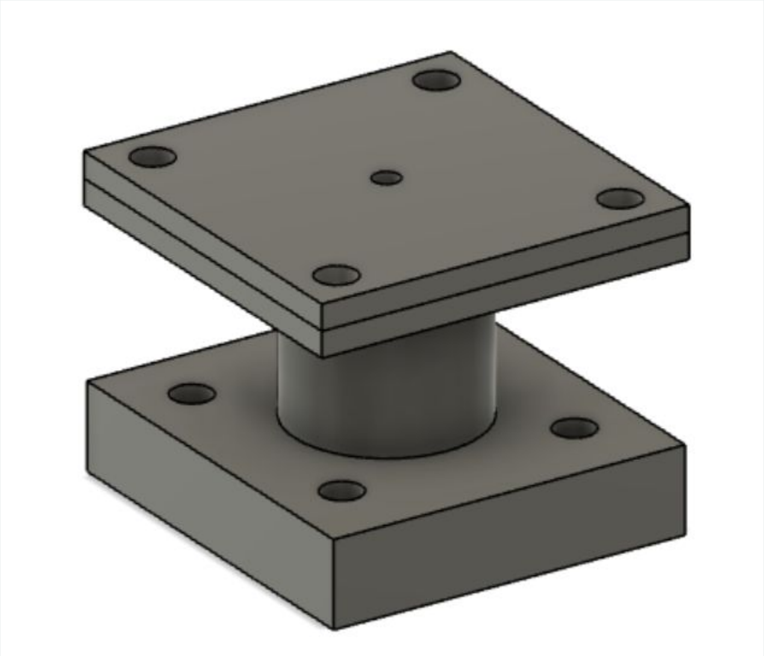
RETHi Updates (Compiled)

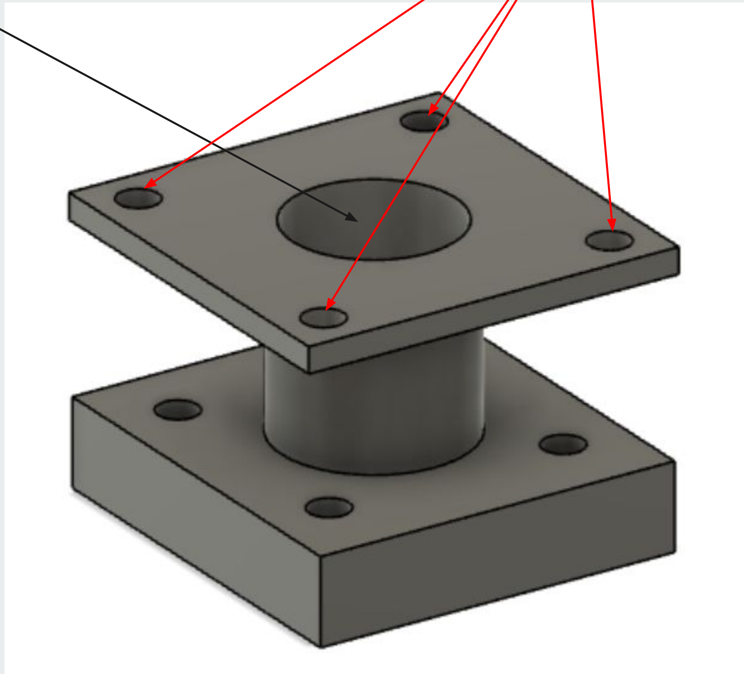
Please see slides 21-29 for detailed explanations of the mechanics of the design.

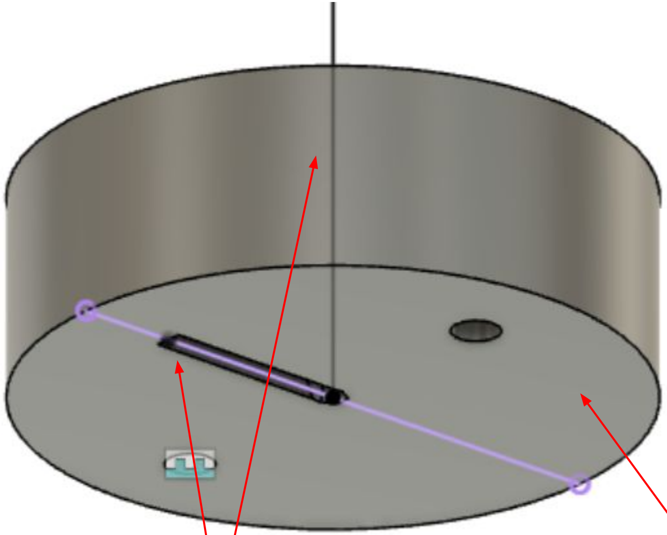
Revision 1 Updates

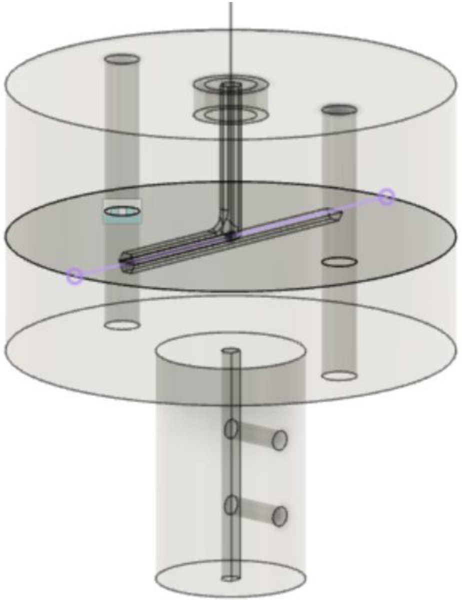
Lid removed to allow motor to be placed inside

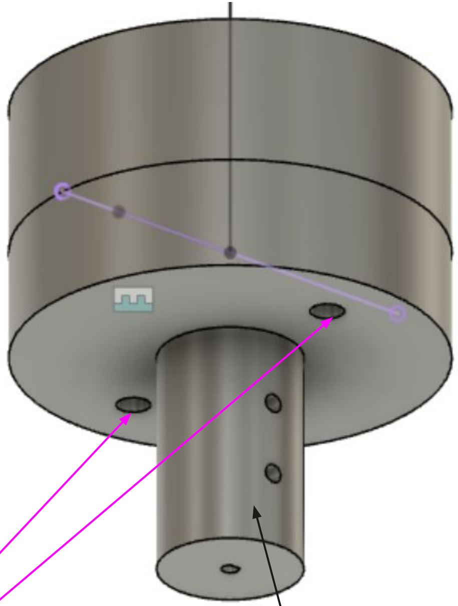
4 holes to screw lid to base compartment











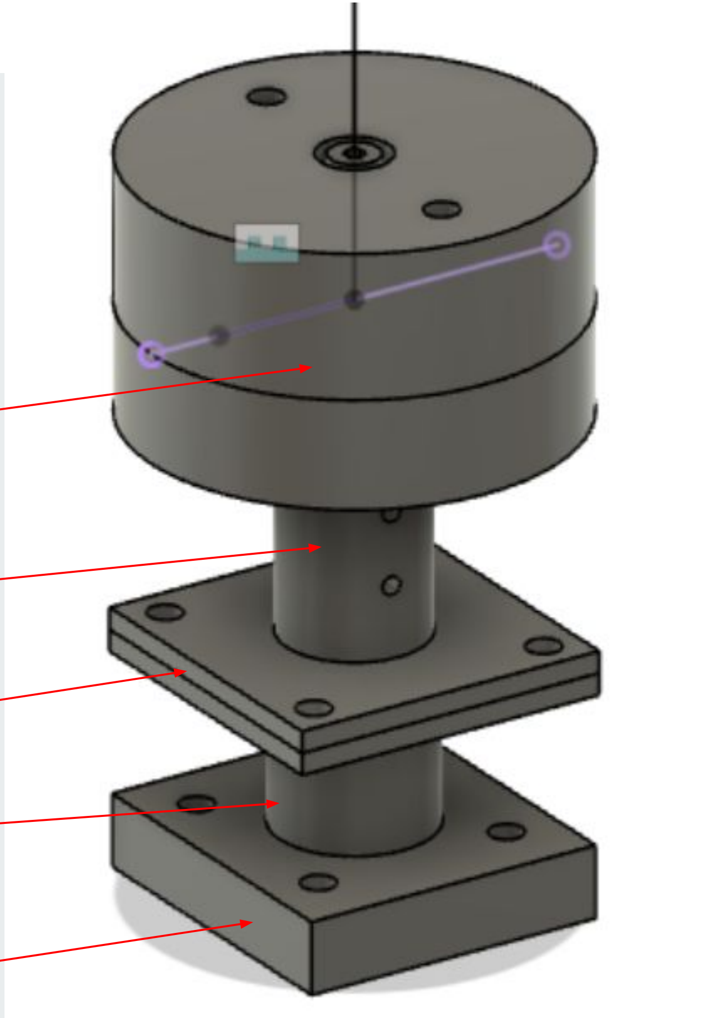
Black and purple lines model where the allen wrench will sit.

Upper half/cap to keep the allen wrench from coming out. 2 screws keep the cap on.

Set screws; when motor spins, this part will do so too.

This is the only part that will actually rotate

Assembly so far



Allen wrench housing

Rigid shaft coupling

Motor cap

Motor housing

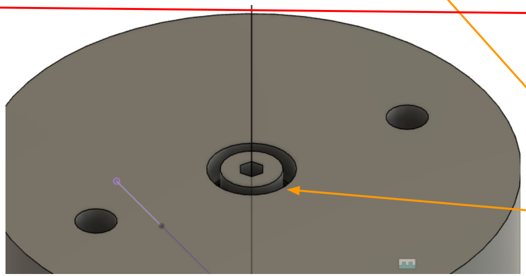
Base plate. 4 holes are aligned to screw into Juncheng's existing design

Vacuum Chamber

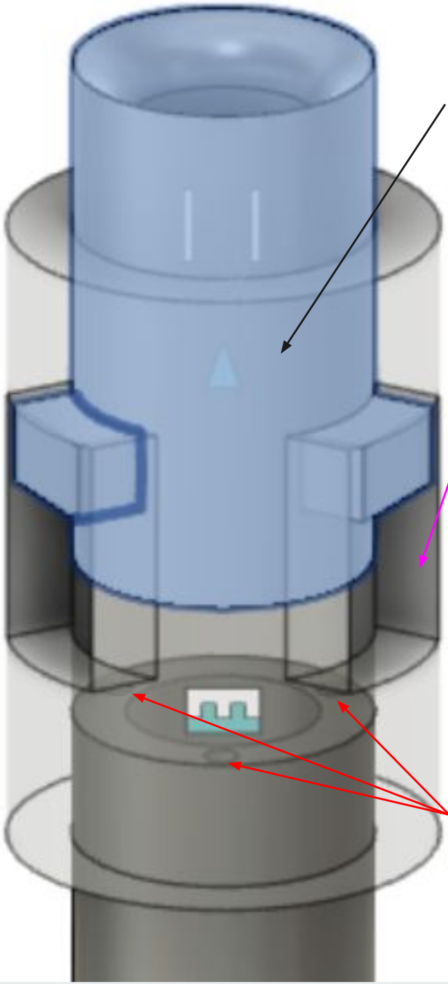
The inside of this chamber will become a vacuum.

A sealed bearing will be used to allow an airtight seal while allowing for rotational motion. The psi values seen by this part are low enough such that imperfections in the bearings will not compromise the functionality of the vacuum.

Vacuum hose will be connected at this hole. Therefore, this part cannot rotate to prevent the hose from getting spun around and tangled. This is why this part is not rigidly attached to the part shown on the previous slide. The vacuum chamber will instead sit on a rotating joint so the part underneath it is free to spin but the vacuum chamber itself will not.



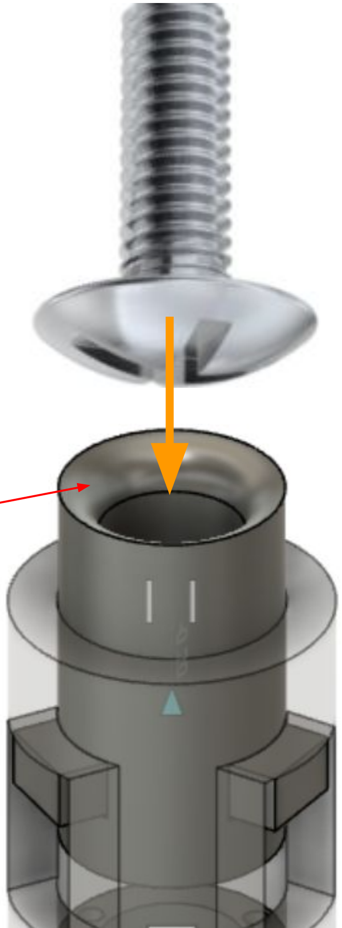
Top of vacuum chamber - spring loaded mouth



Highlighted portion can slide vertically along the tracks.

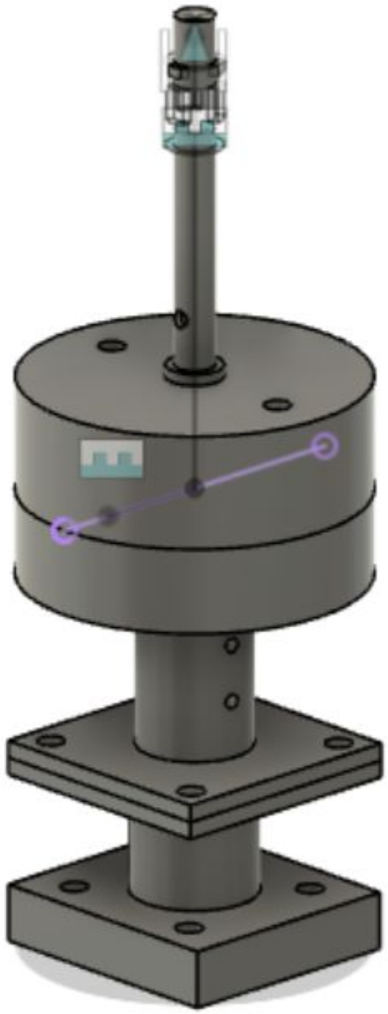
PTFE Thread seal tape can be wrapped around to create an airtight seal around the tracks.

Small springs will be fixed into the holes to make the highlighted portion spring loaded.



Fillet at the mouth so that any sized screw can sit into it and make an airtight seal. The fillet will "hug" the head of the screw

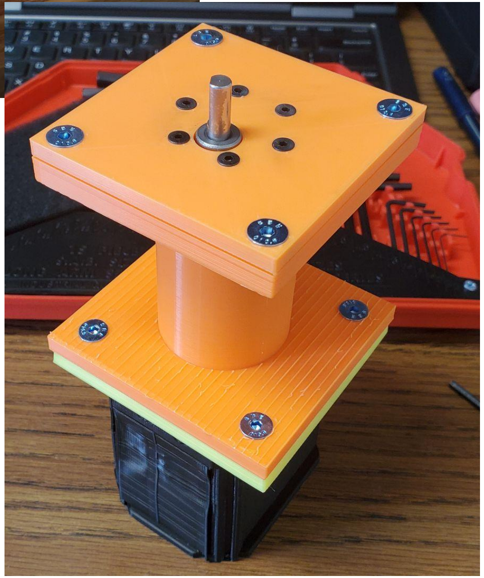
Assembly so far



Revision 2 Updates

Final Iteration of Motor Casing

1. All screws fit perfectly and flush
2. Brass fittings are permanently fixed and tight to avoid unwanted rotation
    a. PLA was heated with a hairdryer (to soften the plastic) and fittings were hammered inside
3. Motor casing is properly sized and fits well (not too loose or tight)
4. All critical dimensions are perfected.
5. Part attaches to Juncheng’s existing design

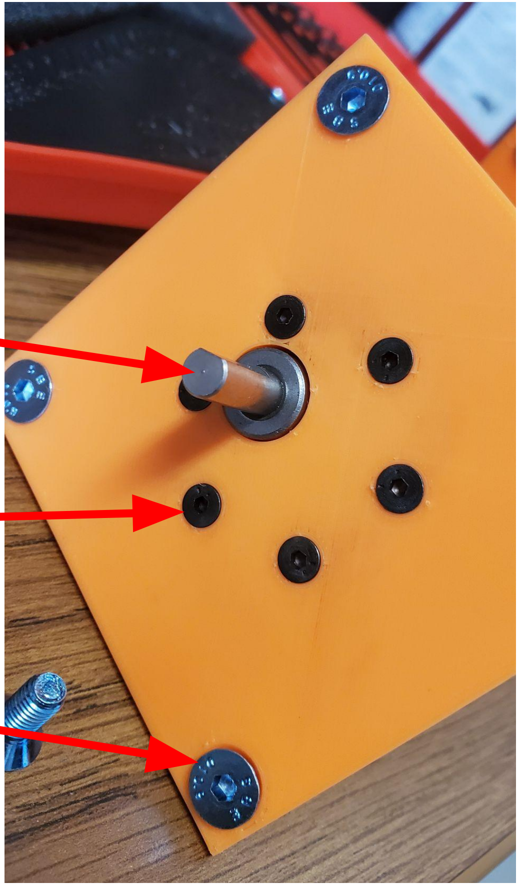


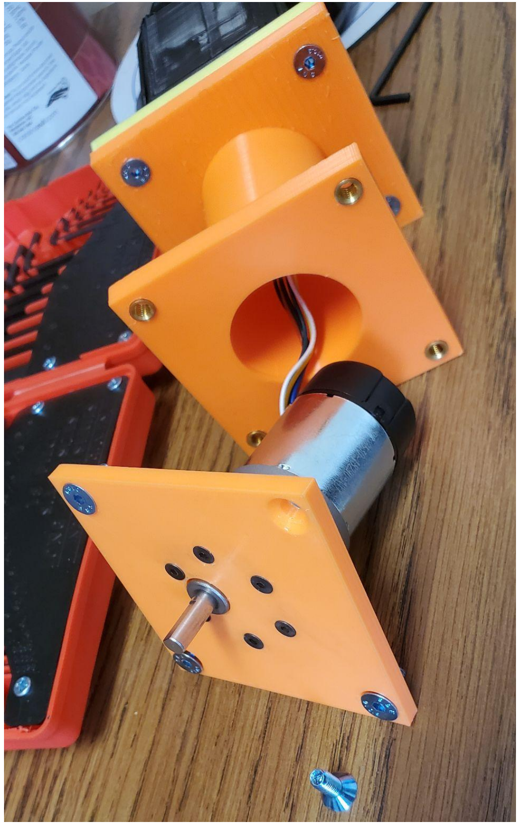
Top Cap

Motor shaft protrusion is maximized so that screwdriver housing can securely fit on the shaft.

6 M3 screws perfectly fit into the motor (depth and radius) to constrain the motor from rotating.

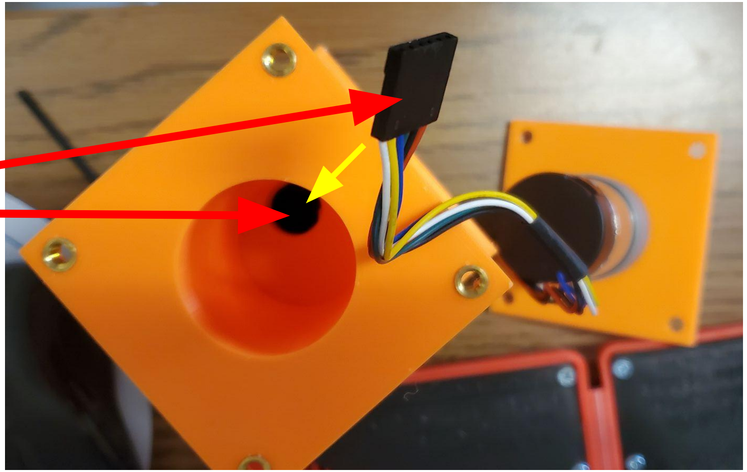
4 M5 screws connect cap to the remainder of the casing





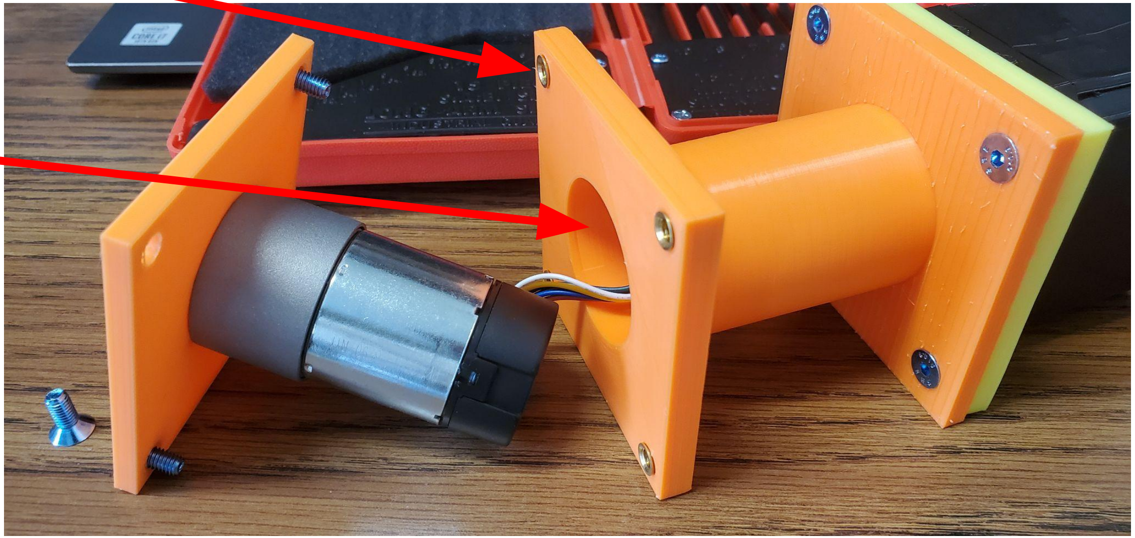
Motor Housing

Hole perfectly accepts motor wires



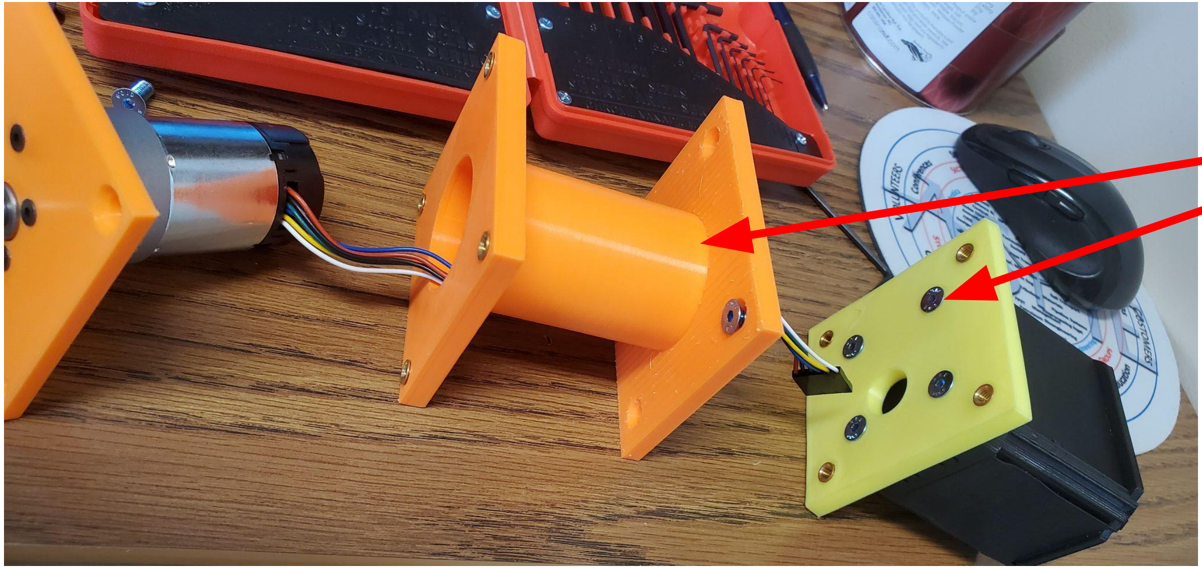
Brass fittings are press fitted onto the part to avoid threading/tapping holes

Motor casing snugly fits motor. Mild pressure is required to remove the motor



Connector

The pre-existing holes in Juncheng's design are too close to critical dimensions on my design. Since neither design can be changed, an additional connector part was added to affix to both parts and serve as an intermediary.



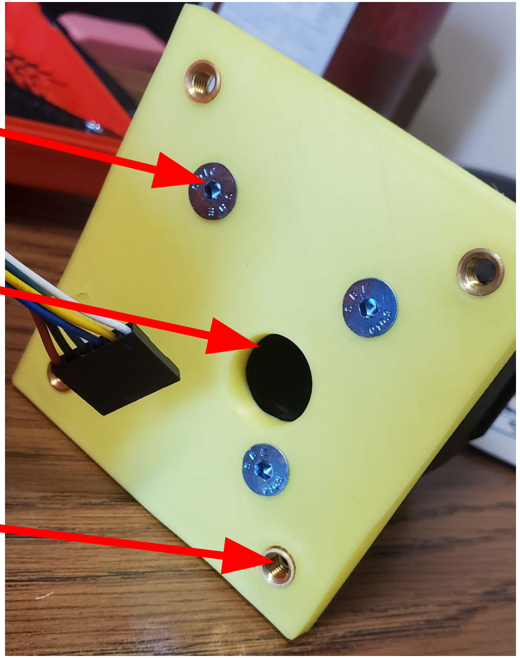
These M5 screws are too close to the cylinder dimensions and will interfere with the motor. Thus, the motor casing and Juncheng's parts could not be directly connected. An intermediary was needed (yellow part)

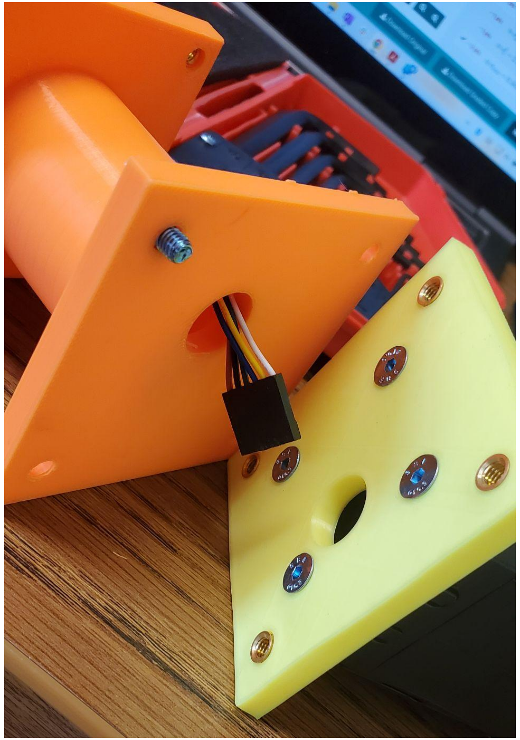
Connector, cont.

M5 screws and brass fittings (not shown) to connect to Juncheng's part.

Wire hole

Brass fittings to accept the M5 screws from the motor casing part.





Revision 3 Updates

Parts to Manufacture

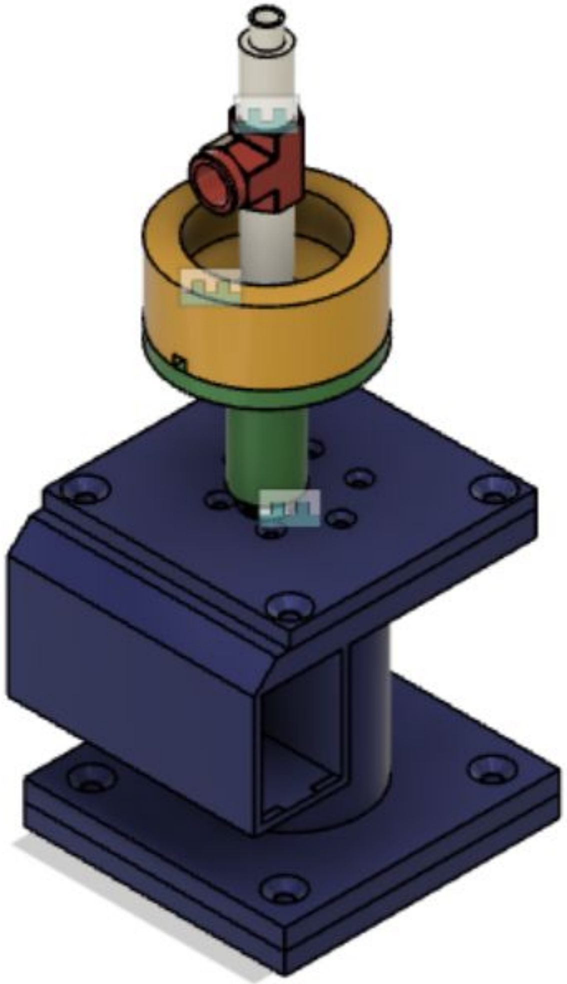
Items in blue are non-critical and are to be 3D printed to minimize weight.

Items in red are purchased parts.

Items in white are for the vacuum chamber and have been machined at BIDC with the lathe. Some geometry has yet to be machined as it requires the CNC mill.

Items in green connect directly with the motor shaft and have been machined on the lathe. Some geometry is left to be machined as it requires the CNC mill.

Items in yellow have not yet been machined as it required the CNC mill.



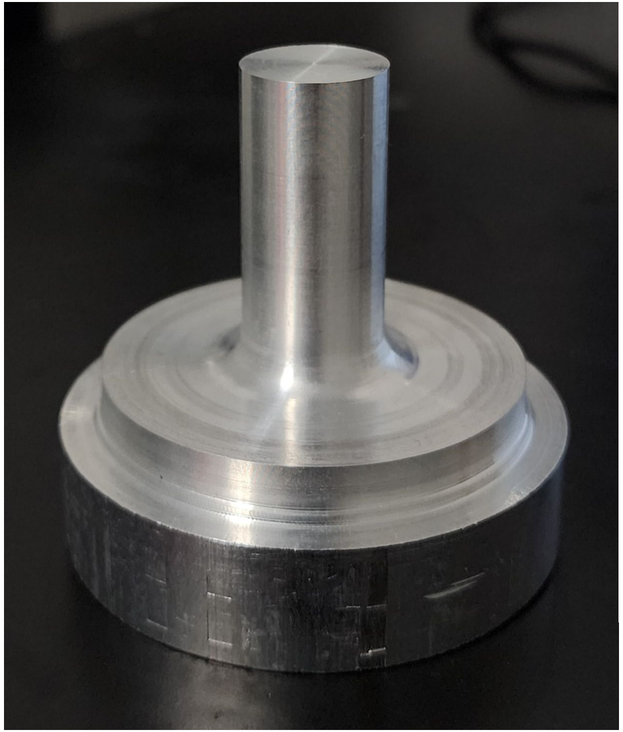
Mount Cap (green) - Aluminum

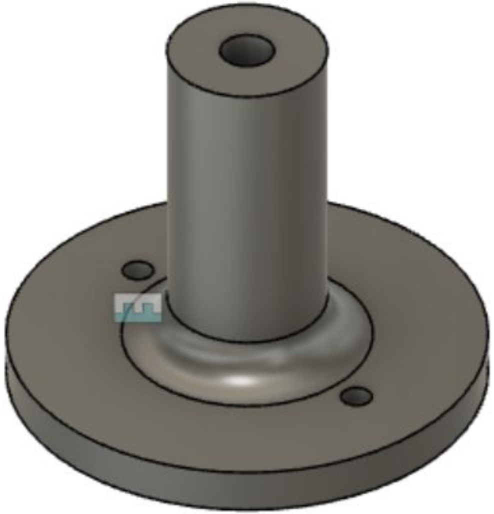
Basic geometry has been created on the lathe.

Holes are to be made on the CNC mill.

The base of the part has been kept to provide surface area for the CNC's chuck to grab onto when milling.

The base can then be removed on the CNC or lathe afterwards.



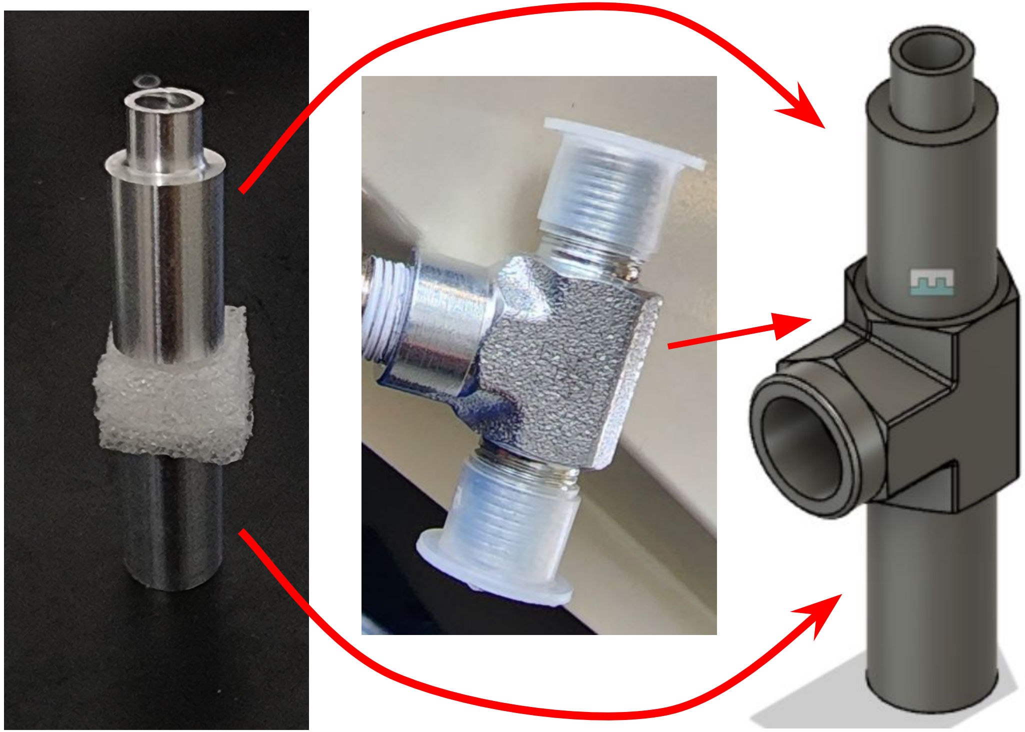


Vacuum Chamber (white) & Tee (red) - Aluminum

Consists of upper and lower chambers w.r.t the purchased tee.

Upper chamber has a smaller diameter at the top to allow for the spring-like rubber material to wrap around

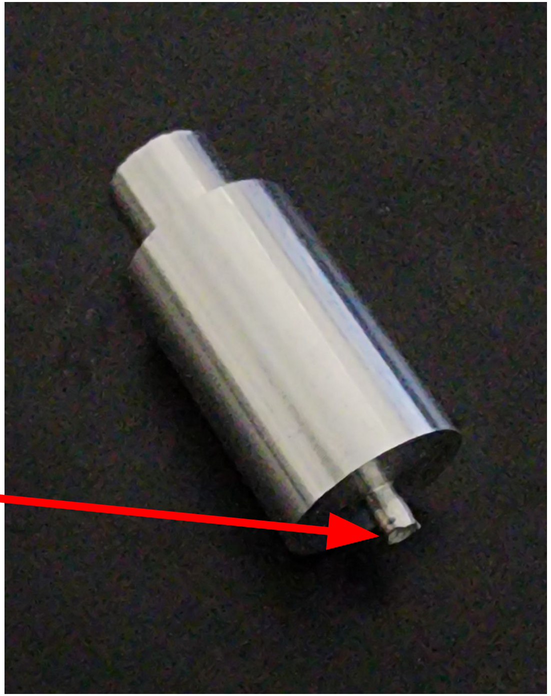
Lower chamber has a critical OD to maintain a press-fit with the ID of the bearing. Fit must be airtight.



Vacuum Upper Chamber

A through hole (to fit the tee) is left to be drilled on the bottom side. This is to be done on the CNC mill.

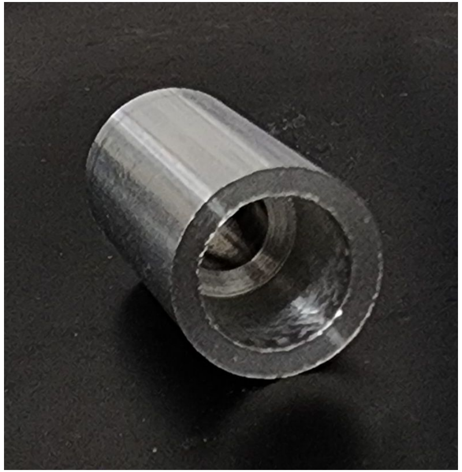
The small knob at the bottom is a result of the parting tool on the lathe. It will disappear after the through hole is made.



Vacuum Lower Chamber

The tested fit of the 3D printed model to the bearing ID was not a good representation of the machined part to the bearing. In addition to a poor finishing tool being used on the lathe, the lower chamber experiences a clearance fit with the bearing as opposed to a transition/press fit.

It will be remade on the lathe or mill. Due to the nature of the design, the upper chamber need **not** be remade as a result.

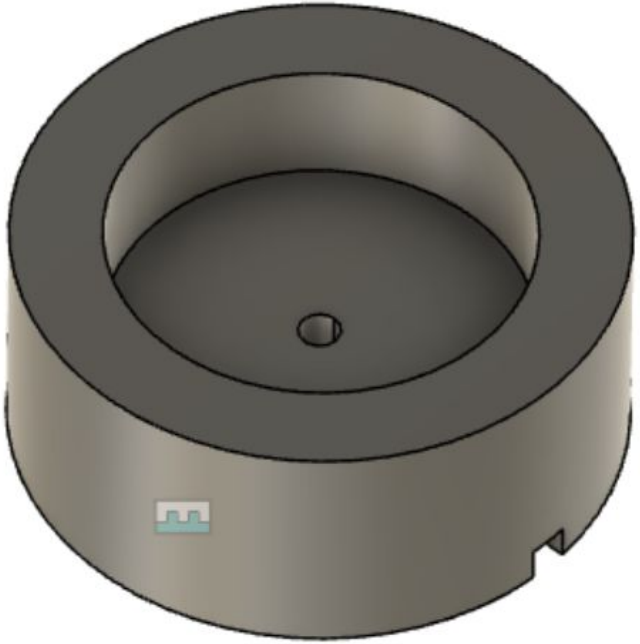


Mount Cap Intermediary (yellow) - Aluminum

This is the only part that has not yet been machined yet as it requires the CNC mill.

Available aluminum stock compatible with this geometry is ubiquitous.

Geometry has been slightly modified to improve manufacturability without affecting intended functionality.



Overall Design

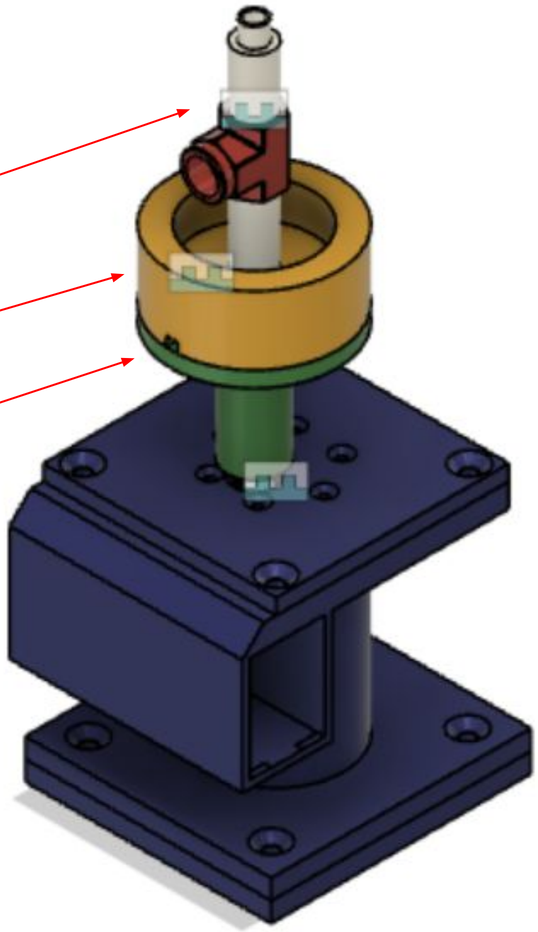
General Assembly

Vacuum Chamber (white + red)

Bearing Mount (yellow)

Shaft Connector (green)

Motor Housing (blue)

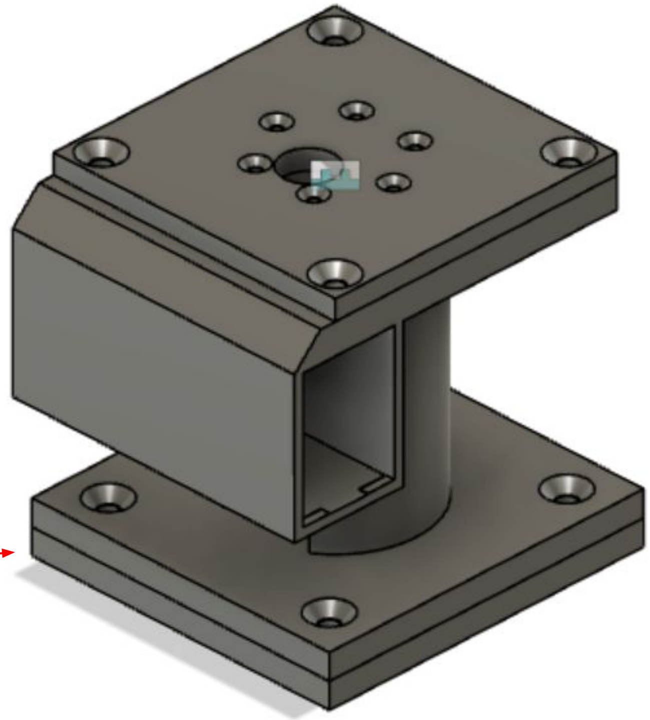


Motor Housing (blue)

Can be 3d printed to reduce weight - no critical tolerances are seen in this design that would warrant aluminum manufacturing.

Casing for driver. Areas were kept open to allow for port access and wires.

Intermediary plate - holes in Juncheng's part are too close to the inner cylinder (critical dimension). Since neither design can be changed, an intermediary was introduced to allow the two parts to connect. Countersinks are used to ensure that screws lay flush.



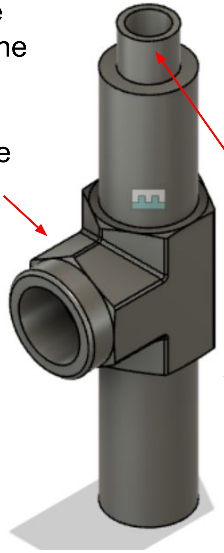
Vacuum Chamber (white + red)

Design 1

Design 2

Design 3 (most recent)

A tee fitting was purchased to be integrated into the design to avoid welding and to simplify in-house manufacturing

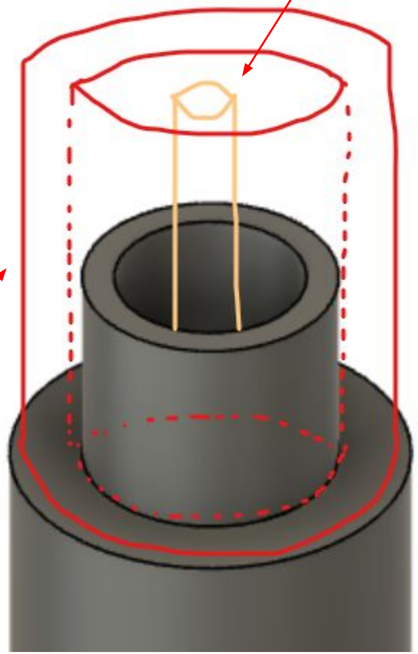


A rubber material will be placed here to simulate a spring (calculations on the next slide)

Validating material selection

As opposed to a complex spring-loaded system, 30A neoprene rubber was chosen instead to wrap around the tip of the vacuum chamber and serve as a spring. The protruding rubber will make contact with the screw head.

92.8psi was found to be within the viable pressure range.



Area: $\pi(0.2)^2 - \pi(0.15)^2$

↳ 0.054978 in^2

↳ $3.547\text{E-}5 \text{ m}^2$

Tensile Ultimate: 900 psi

Force: 49.48 lb

↳ 220.09 N

$E = e^{(30 \cdot 0.0235 - 0.6403)}$

↳ $1.0668 \rightarrow [0.948, 1.1998]$

Thickness $= 0.2 - 0.15 = 0.05$ in

max length:

$[0.05 \times 2$

$\varepsilon_y = 0.15/0.25 = 0.6$

$\sigma = 1.0668\,(0.6) = 0.64008$ MPa

↳ 92.8357 psi

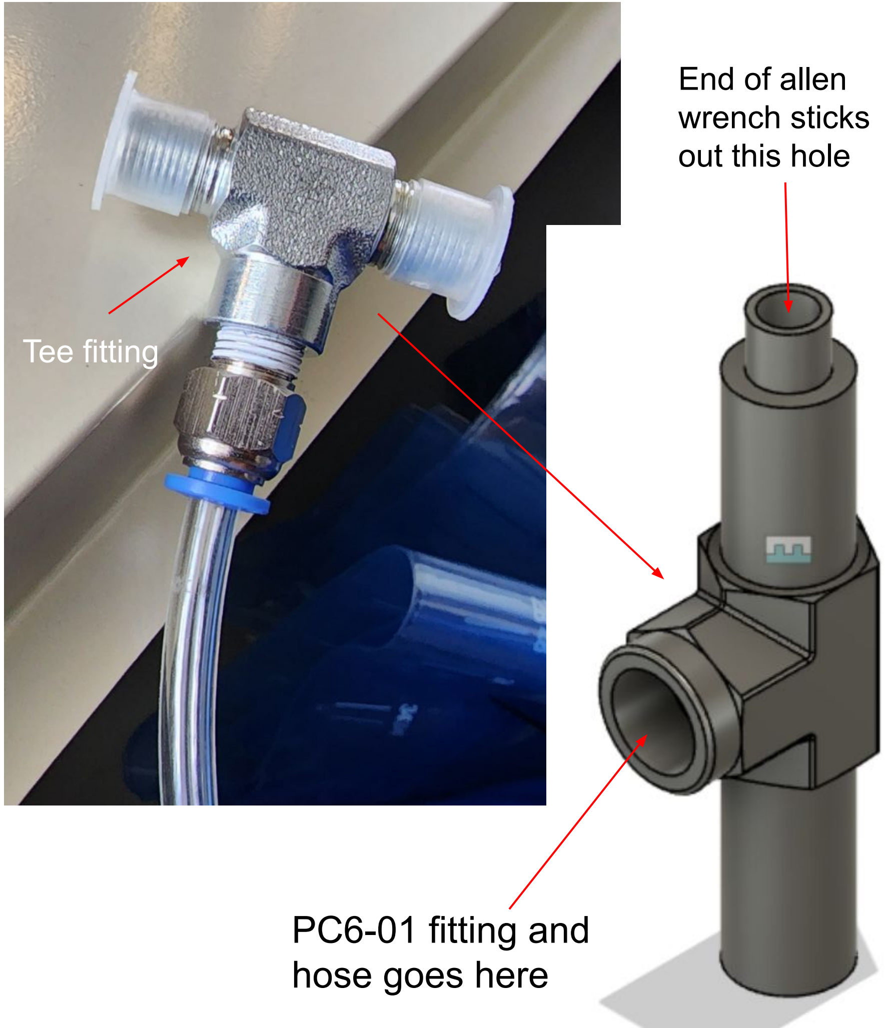
Can't estimate with uniaxial loading thru Poisson's ratio as shear modulus is unknown

Vacuum Chamber

Tee fitting (red) successfully connects to a PC6-01 hose fitting and hose. This fitting allows the hose to create a vacuum within the chamber.

Note, this chamber **does not spin** to prevent the hose from tangling up. The allen wrench that is within this chamber (without contact) **DOES** spin.

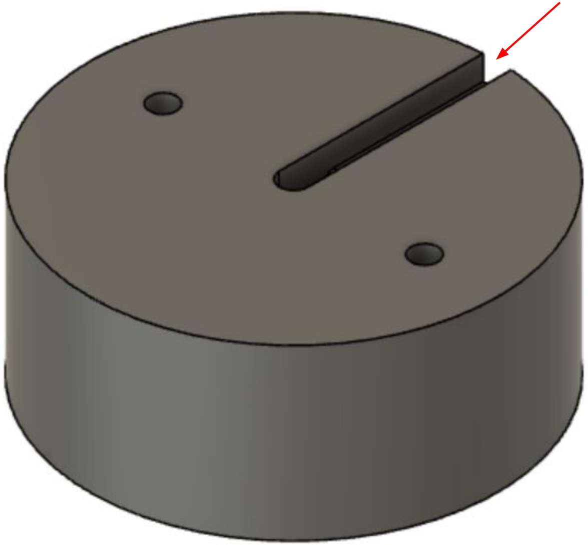
The motor spins the allen wrench **within** the vacuum chamber but not the chamber itself. When the allen wrench makes contact with the screw head, the rubber is compressed, and a vacuum seal is established.



Bearing Mount (yellow)

Bottom side

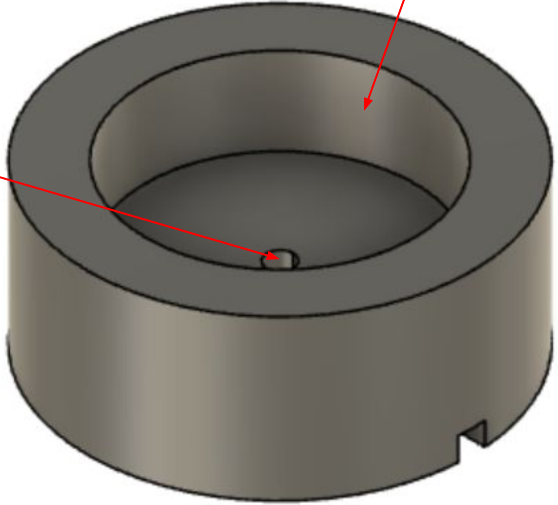
Short arm of Allen wrench seats here. The bearing mount rotates and thus turns the allen wrench



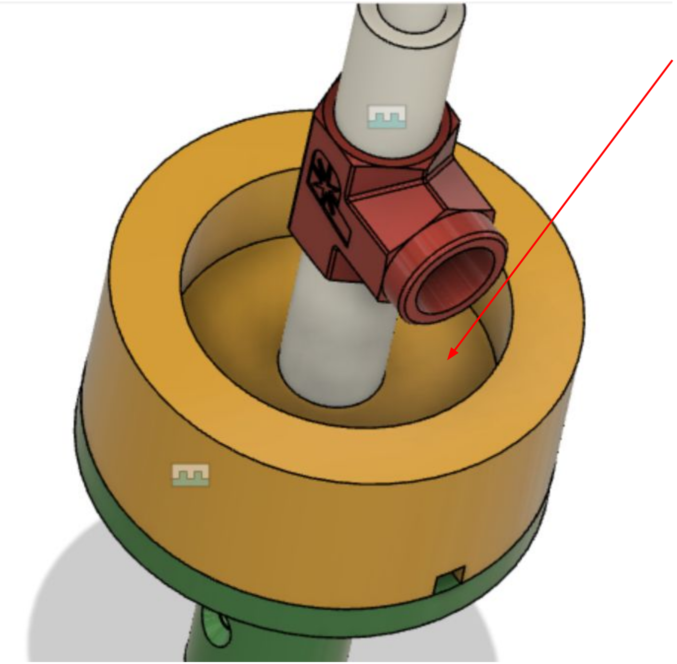
Long arm of Allen key comes out this hole and goes into the vacuum chamber (passing through the bearing)

Press fit to the OD of a sealed 6301 ball bearing (higher rotational speeds than rollers).

Top side



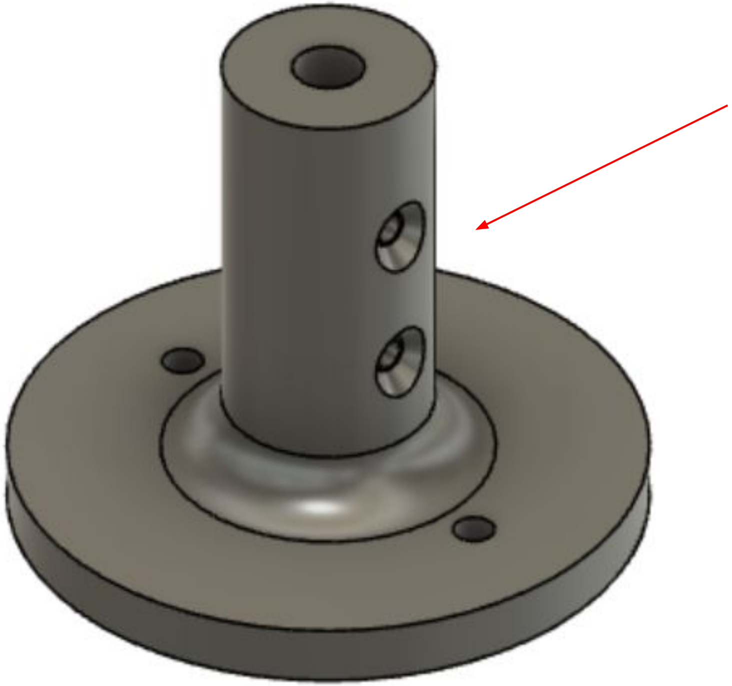
Vacuum chamber + bearing mount



Bearing seats in this cavity. OD of bearing press fits to the bearing mount and the ID of the bearing is press fit to the OD of the vacuum chamber (white)

Thus, the bearing carries the rotational load while maintaining an airtight seal. The allen key rotates within the vacuum chamber

Shaft Connector (green)



Holes to allow set screws to constrain the shaft within the hole. The fit is intended to be a transition fit.