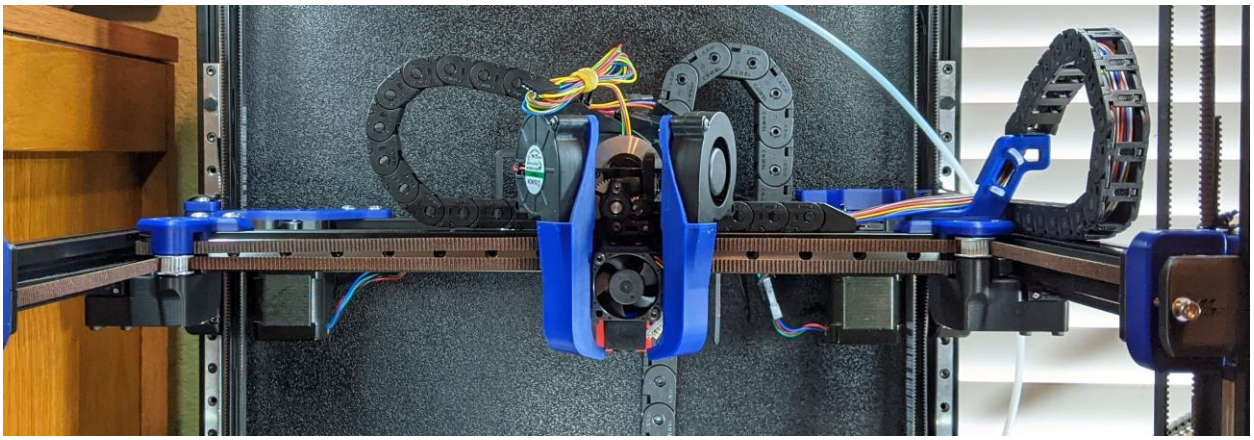
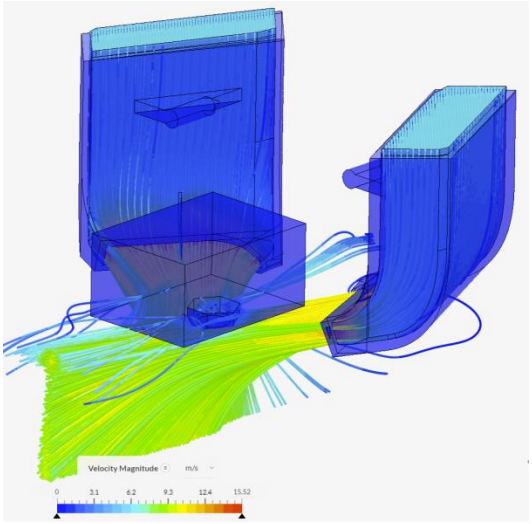
Mantis (Dual 5015 Toolhead) by Long



Features:



- Now compatible with single MGN9 and MGN12 X-Rail.
- Dragon Hotend only right now although mods are floating around for others
- Dual 5015
    - Left to Right airflow balance is no longer an issue
    - Single piece ducts without splitting and fewer bends = less duct losses
    - Total airflow is ~3x more than Longsfang using the same fans.
- Lighter
    - This entire tool head weighs ~290g including the carriage
    - Spec AB is ~470g. Spec AB with gailieo is ~375g.
    - Using single MGN9 removes an additional ~120g from the Y axis.
- Stiffer
    - Single piece carriage and hotend mounts are stiffer than spec.
- Detachable Bed Probe (magprobe)
    - Decreases weight and allows shrinkage of the carriage.
    - Direct probing of the bed surface. Allows usage of any bed surface.
- More balanced weight
    - Hotend is moved closer the rail +y, and upwards +z
    - Gain in Y and Z travel (~5mm each)
- Decreased length from extruder to hotend
    - Bowden from mini-sherpa to Dragon is only 19mm
- X-endstop relocated to carriage. Easy to transition to umbilical if desired.
    - Y-endstop can still be from the spec endstop pod on the right xy-joint.
- Area around heat block is very open. Ducts give wide berth to block. Duct shouldn't have any issues with melting.
    - Josh Murrah has been printing ABS at 300c without duct melt.

Cons:

- With spec front idlers, you will lose space at the front corners of the bed ~10mm in X at each idler.
- There are now alternative idlers that allow use of Mantis without any loss of build area
    - Phalanx - https://github.com/selliott79/Other-V2-Idlers
    - Rama - https://github.com/Ramalama2/Voron-2-Mods/tree/main/Front_Idlers
- Some parts like the ducts and hotend mount are a bit tricky to print.
- Thumb screw for the mini-sherpa will not fit. Use a buttonhead to save space.
    - I bought 6mm diameter x 0.9mm coil diameter x 10mm length springs for extra clearance.
        - (Replaces stock 6mm x 1mm x 12mm spring)
        - Depending on how much you tighten your screw, the 12mm one will work.

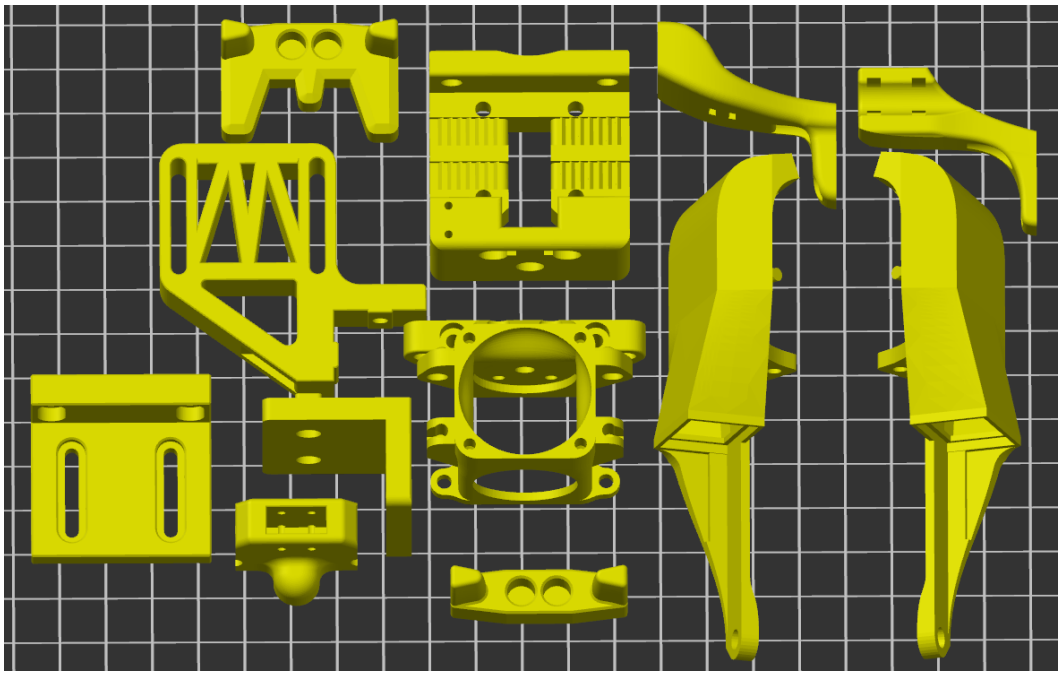
BOM:

- **Fasteners**
  - m2 x 10 (or m2 x 12) self tapping screws
    - This is a standard Voron part used to attach the Omron microswitches
  - m3x5x4 heatsets – Standard voron heatsets
  - m3x20 SHCS x2 (upper screws to attach hotend mount to carriage)
  - Assorted BHCS (all other screws can be button head to save weight)
- **Other**
  - Magnets
    - (11) m6x3 magnets
    - larger diameter magnet stack (used if soldering directly to the m6x3 magnets) so that magnetic field loss is minimized during soldering)
  - MGN9 Carriage
    - (2) Makerbeam XL m3 T-nuts
      - https://www.amazon.com/gp/product/B06XHQHD4H
    - Alternatively use m3 Openbuild T-nuts
      - https://www.aliexpress.com/item/4000886303032.html
      - These will need to be ground down so they're around 5.5-6mm wide
    - m3x10mm screws will make threading the belts easier but aren't required.
  - Microswitch
    - D2F-5 is recommend by Annex
    - I've had better luck with cheap KW10 microswitches from Aliexpress
      - https://www.aliexpress.com/item/32829746929.html
    - I tested at least 3-4 of the D2F-5L (with lever ripped off) microswitches, which were genuine bought from Digikey or Mouser. While using these I would often see random probings which would sound different and give results that were not precise. Since switching to the KW10 switches, my bed probing has been much more precise. Maybe I got a bad batch if D2F-5? Who knows….
- **Fans**
  - 5015 fans x2
    - Sunon MF50151VX-B00U-A99 (12v)
      - Sunon: https://www.digikey.com/short/zrwpw9
      - Note, make sure it is MF5015V ***X**** the X is important
    - Delta BFB0524HH (24v)
      - Delta: https://www.digikey.com/short/z4b1vtpj
    - Delta slightly better than Sunon >> GDSTime >> Winsinn
  - 3010 Hotend Fan
    - I'm using Sunon 3010v1 (12v)
      - https://www.digikey.com/short/t5dpqw4w
    - I think the Sunon 3010v2 (12v) will probably work but haven't tested yet. This fan will be decently quieter than the 3010V1.
      - https://www.mouser.com/ProductDetail/Sunon/MF30101V2-1000U-A99?qs=EU6FO9ffTwfZ4Kz3LWY0zg%3D%3D

References, Acknowledgements:

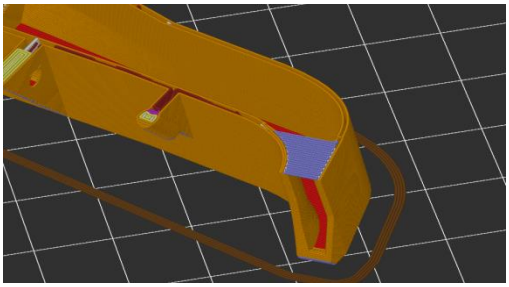
- **Mini-Sherpa**
  - See the Annex guide for its instructions and BOM.
  - https://github.com/Annex-Engineering/Sherpa_Mini-Extruder
  - https://www.youtube.com/watch?v=3WogD5IUwAM
- **Mag Probe**
  - My version is highly inspired by the Annex Mag Probe. ***Credit to ANNEX for their awesome work here***. The mag probe and being able to remove the bulk of the Omron probe is a major factor in what made this tool head possible. Please see their mag probe repository for the original.
  - https://github.com/Annex-Engineering/Quickdraw_Probe
- **Ark's MGN12H Mod**
  - There may be several mgn12 mods floating around. This is one of them:
  - https://github.com/VoronDesign/VoronUsers/tree/master/printer_mods/arkeet/mgn12
- **JoshMurrah**
  - Just wanted to note him here as he has been extremely helpful in some insane stress testing. His speed benchies have been fun as hell to watch and a motivation for me to keep improving. His testing has resulted in a lot of improvements to this toolhead.
- **JosAr**
  - Thank you to JosAr for his work on creating a gantry mounted magprobe dock.
- **Phalanx**
  - For his "Other V2 Idlers" - https://github.com/selliott79/Other-V2-Idlers
- **Rama**
  - For his version of narrow idlers. https://github.com/Ramalama2/Voron-2-Mods/tree/main/Front_Idlers
- **Henrikssn and BobArctor**
  - Helping with early testing of the MGN9 carriage.

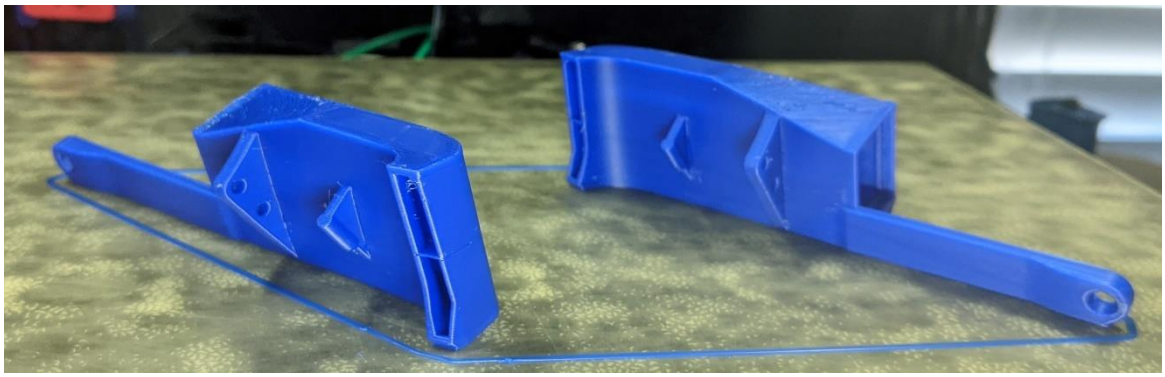
Print Orientation:



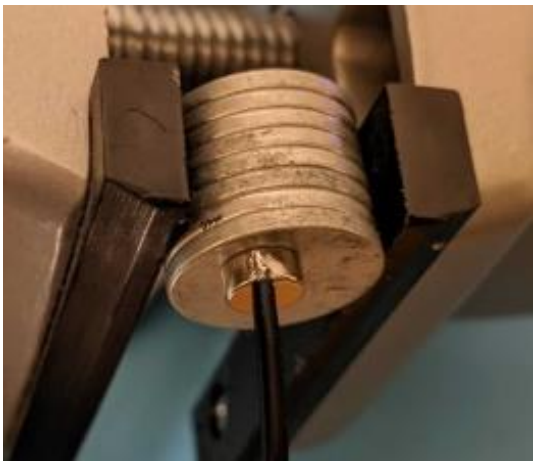
Slicer Tips:

- **Perimeters/Shells**
  - 3-4 Perimeters and low infill is adequate.
  - Josh Murrah is using 3perim/40% on his toolhead used in speedruns.
  - I've been using 4 perimeters/15%
- **Ducts**
  - Check that this outlet divider is sliced in a sane way.
  - In superslicer, I find the "keep only bridges" option under "Perimeters & Shell" works well for the ducts
  - The ducts have some tough overhangs, so orient the part so the over hangs print the best for you. Prioritize good quality for the outlet. The 5015 mount surface will generally be rough, but that's ok.



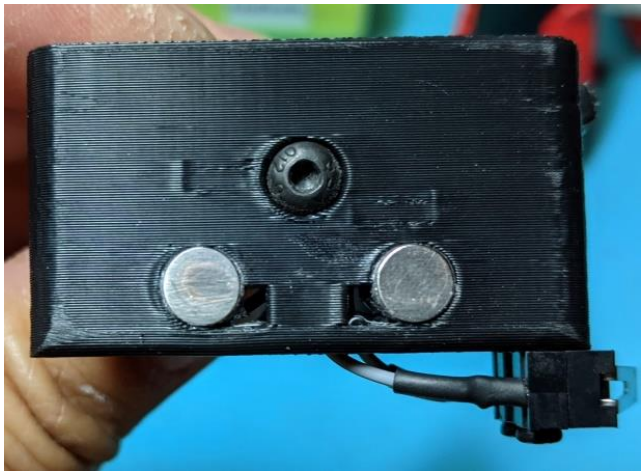


Carriage Assembly:



Magnets:

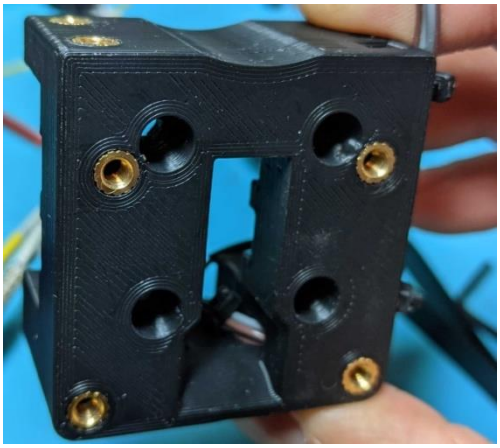
- **Solder Method**
  - Sand the side of 2 m6x3 magnets. Place a magnet on a bigger stack of magnets then solder a piece of wire to the side as shown.
  - If you don't have the magnet on the bigger stack, your magnet will lose some of its magnetic strength. I haven't tested, but I think it's probably ok because of the double stack with an unsoldered magnet.
  - **Put superglue into the magnet holes.**
  - Place the second magnet on top of the soldered magnet, and then press the two magnets into the hole so the unsoldered magnet is out. The magnets should be "proud" of the carriage.
  - I use a flat surface to press the magnets in and then lap them so they mate well with the mag probe.

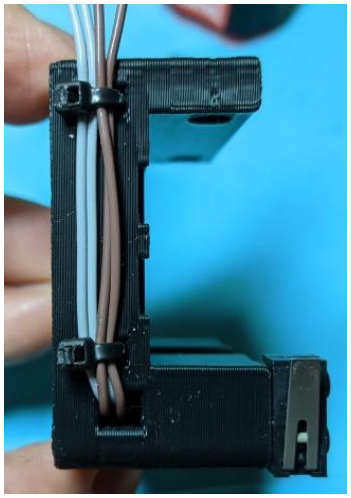


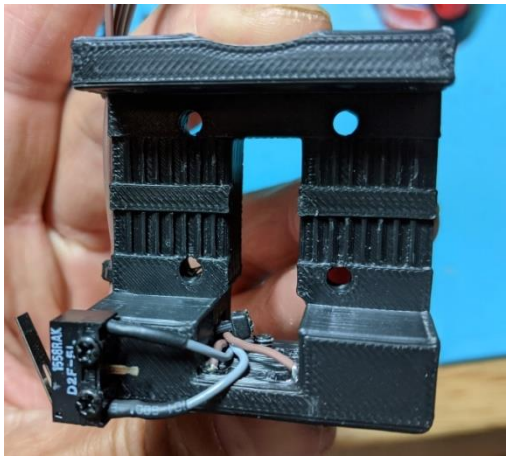
- **Wire Pinch**
  - Josh Murrah was able to attach his magnets by fanning out the wire then compressing the wire between the carriage and magnet and gluing in place. This method appears to be working fine for him.
- **Misc Notes**
  - Adjust the tilt of your magprobe by screwing in and out the m3x6 button head screw on the bottom of the carriage
  - Do not forget to put superglue into the holes in the carriage prior to putting in the magnets.
  - Hole on left side of carriage is for ADXL mounting. (Thanks @Koonweee)

Heatsets:

- As shown on front and top. There will be an extra hole on top/right. This extra hole is currently unused.

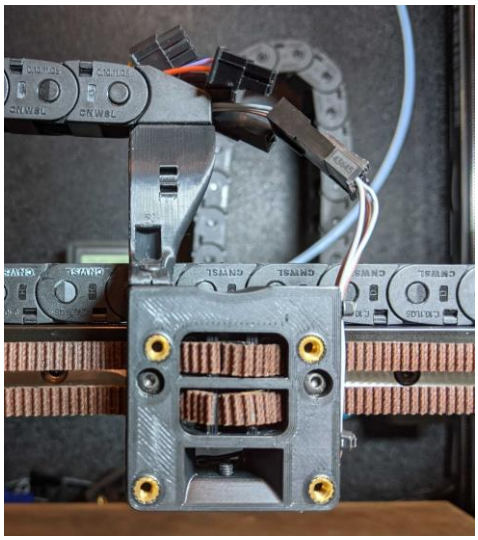


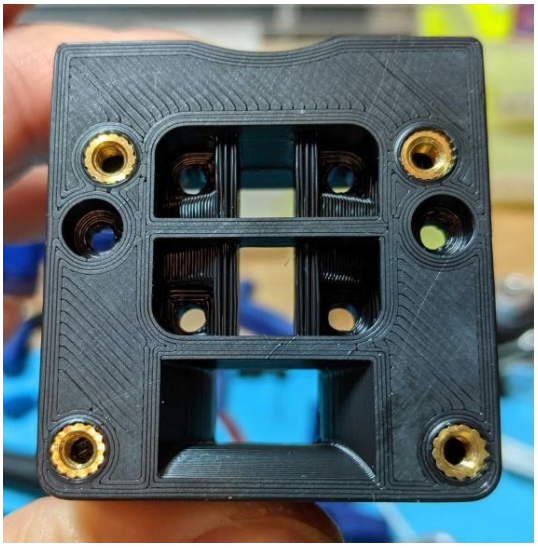


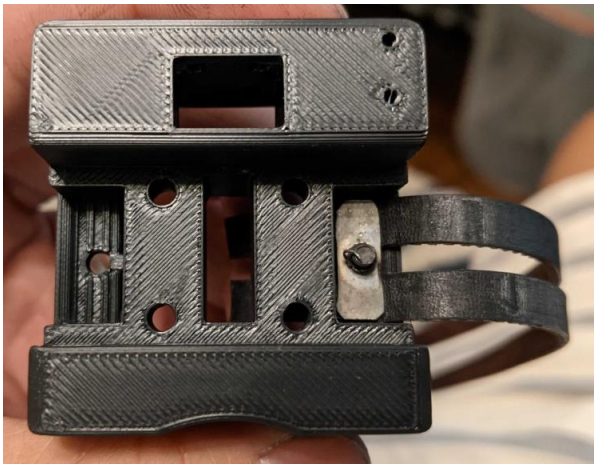


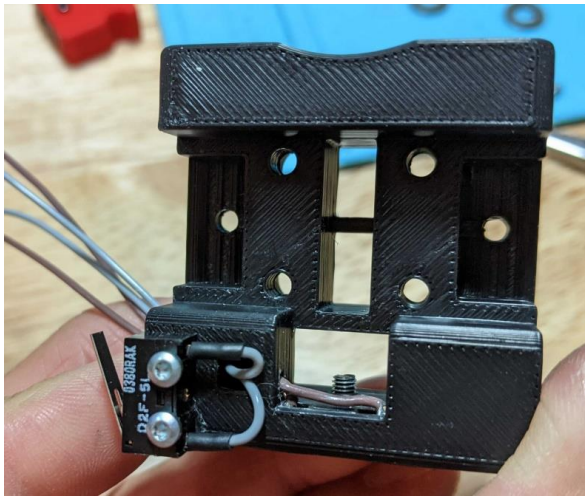
MGN9 Carriage Notes:

- **Notes**
  - Mounting Mantis with a single MGN9 carriage is possible. I am currently testing this with a Robotdigg 440 SUS MGN9 rail. So far, I am not noticing any loss in quality after switching from MGN12 using the same slicer profile. However, your results may vary depending on the quality of your linear rail.
  - MGN12 is 278g. MGN9 is 157g, which will help during Y-axis moves.
  - Is it better than mgn12? I haven't tested long enough to know. I will eventually ramp speeds and see.
- **Printing and Assembly**
  - The MGN9 carriage is tricky to get to print perfectly due to some steep overhangs. However, if these overhangs do not come out well, it should not affect the functionality of the part. The overhangs are part of the belt path, so as long as the belt goes through from the back to the front, you'll be ok.
  - The belts are clamped using makerbeam T-nuts (see the V0.1 BOM for these)
    - You can use up to m3x8mm or m3x10mm SHCS or BHCS with the T-nuts.
    - m3x10mm nuts will make threading the belts easier.
    - I used openbuild T-nuts (because I had them around) and dremeled them narrower
  - m3x8mm bolts to attach carriage to MGN9.
  - Make sure the carriage is straight while tightening. If your carriage is tilted, using Auto-Z calibration will give inconsistent results. If you need to adjust the tilt, note that you can loosen the carriage bolts without loosening the belts ☺

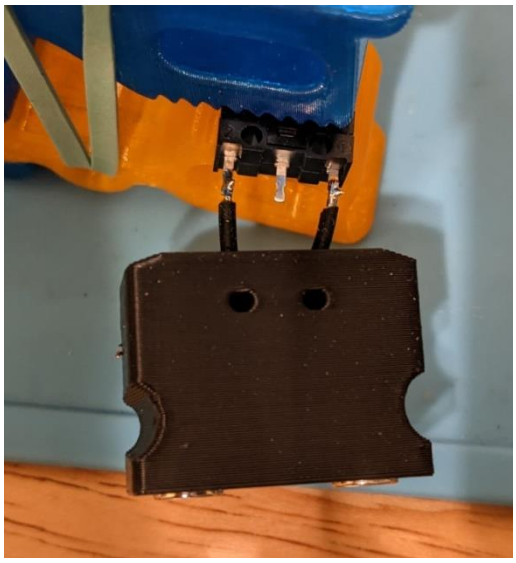




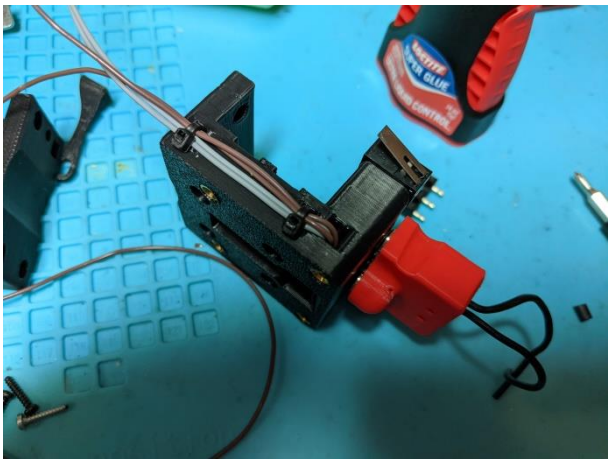


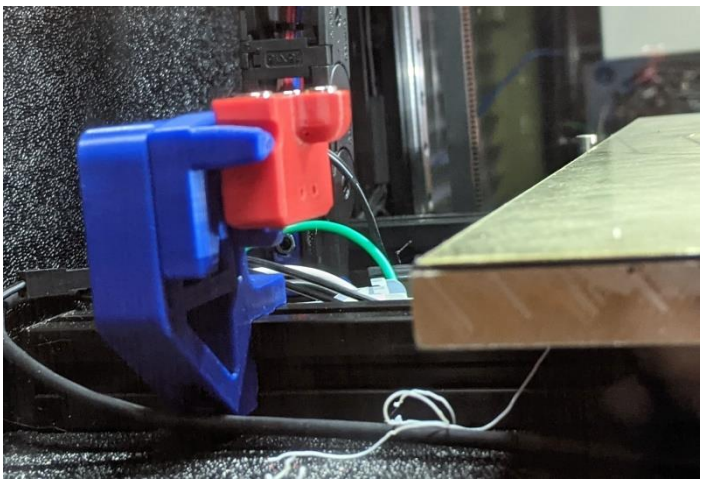


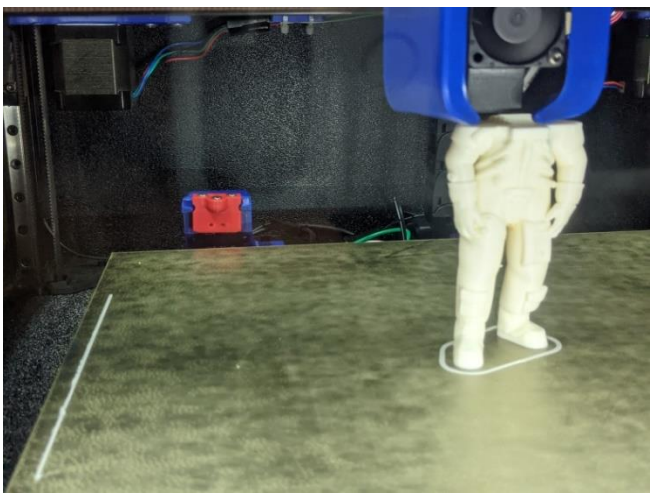
Mag Probe Assembly:



- Solder a short length of flexible wire to two m6x3 magnets then press the magnets into the holes.
- Alternatively, fan out the wire and press/glue in the magnets.
- When pressing in the magnets, I used a clamp and a flat surface to try to get the magnets flat.
- Screw in two of the m2x10 or m2x12 self-tapping screws (silver ones on the red pictured magprobe below) prior to soldering the microswitch in. Take care not to damage the wires.
- Solder the other ends of the wires to the **outer prongs (NC)** of the microswitch. Note the image with the black magprobe is an older version.
- Press in the microswitch now and screw in two more m2x10 or m2x12 to secure the microswitch. If there is any play in the microswitch, use some superglue to remove the play.
- Test fit the magprobe to the carriage and adjust the level of the probe using the m3x6 button head on the bottom of the carriage.
- Insert magnets into dock arms and secure to bed extrusion or gantry extrusion.
    - Most of my testing has been on the bed mounted dock, but the gantry mounted docks seem to be very popular and work well (prob even better than the bed mounted one).
- You don't have to remove your bat85 diode when wiring in the wires to the magnets on the carriage, just omit the 24v.
- Video of docking and undocking. Build your own macros or see annex engineering or klicky for their macros.
    - https://youtu.be/hdD8uaDW-pA







Magprobe Config:

- This can be a bit daunting…You can do it though!
- I highly recommend you print extra dock arms while you are figuring this out—especially if you are doing bed extrusion mounted.
- The general movements for docking and undocking are in Macros_and_Config.txt
    - Note this is for my bed mounted magprobe dock.
    - Don't forget to home y before x in homing_override.

```
#   Get Probe
[gcode_macro Get_Probe]
gcode:
    G0 X46.3 Y305 Z20 F12000        #Spot above where the carriage magnets line up with the magprobe magnets
                                    #   (with magprobe in the dock)
    G0 X46.3 Y305 Z2 F3600          #move -Z where all the magnets pairs first fully grab onto each other
    G0 X46.3 Y290 Z2 F1800          #Move -Y so the probe is fully clear of the the arms of the dock
    G0 X46.3 Y290 Z20 F3600         #move +Z so any move from here clears the buildplate.

#   Dock Probe
[gcode_macro Dock_Probe]
gcode:
    G0 X46.3 Y290 z10 F12000        #Above +Z and forward -Y of where magprobe side cutouts line up with dock arms
                                    #   (allows build plate clearance for next downward move to line up magprobe to arms)
    G0 X46.3 Y290 Z2 F3600          #Location where the side cutouts of the magprobe line up with the front of dock arms
    G0 X46.3 Y305 Z2 F3600          #move the magprobe +Y into the dock, engaging the arms
    G0 X80 Y305 Z10 F1800           #move +X and +Z to disengage the magprobe from the carriage
    G0 X80 Y290 Z20 F3600           #Move +Z and -Y to a safe spot where further moves won't collide with dock
```

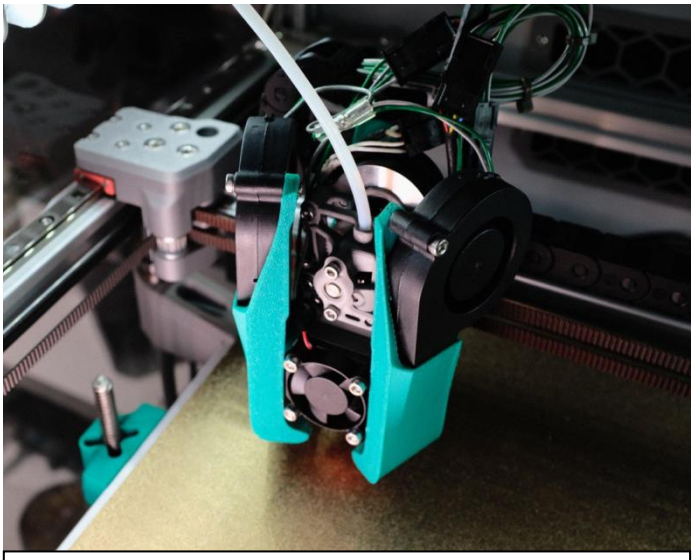
- **For smart macros**
    - See the annex repo for their magprobe at:
        - https://github.com/Annex-Engineering/Annex-Engineering_Other_Printer_Mods/tree/master/All_Printers/Microswitch_Probe
    - Or the Klicky probe repo at:
        - https://github.com/jlas1/Klicky-Probe

Notes for building on a Voron 1.8:

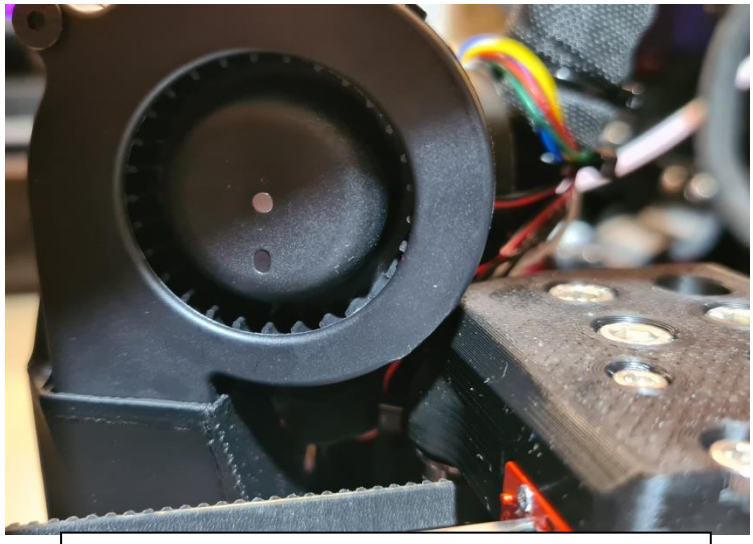
- You will need to cut the rearward “ears” off the 5015 fans for clearance.
- OscarGM was able to get the standard length ducts (found in the 2.4 folder to clear. It looked tight, but it did clear.
- The ducts in the 1.8 folder have 2mm extra clearance, and should clear with most fans.

Acknowledgements:

- Just wanted to thank GarretWP, OscarGM, and Koonweee for being the brave souls who worked to get compatibility with 1.8. It wouldn’t have happened without their feedback.



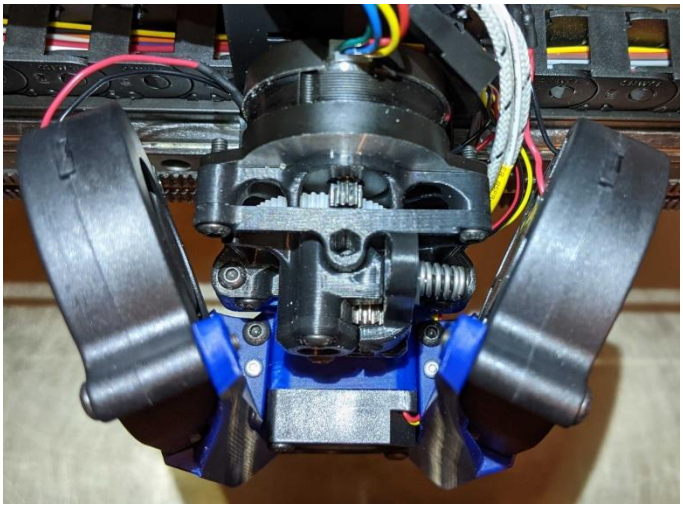
Koonweee’s Voron 1.8 using 2mm extended ducts

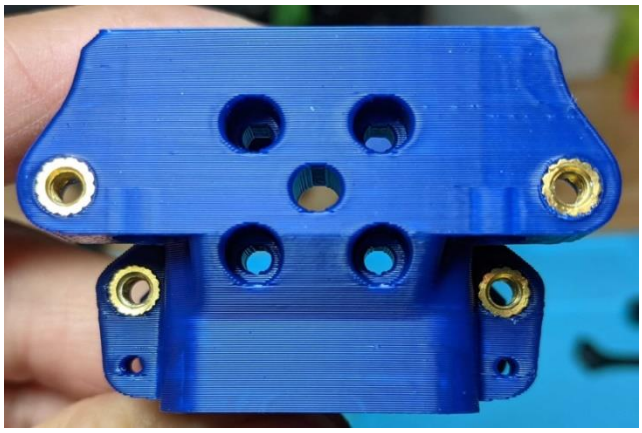


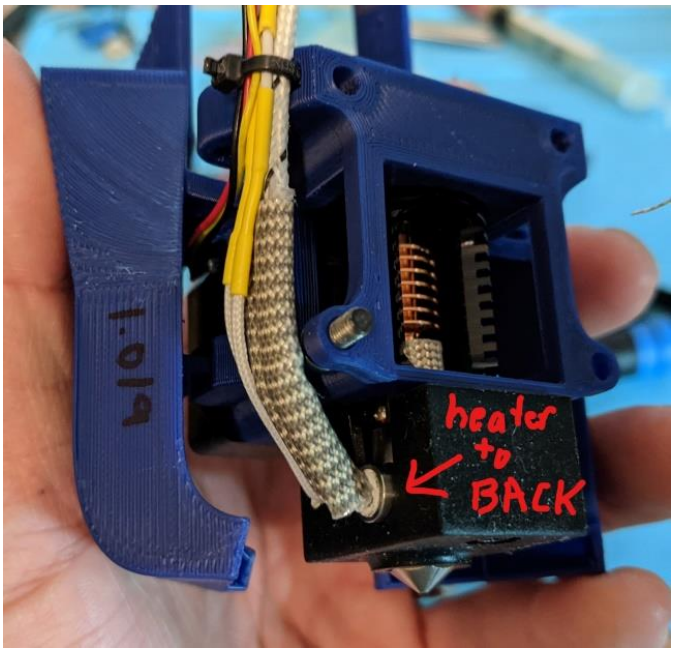
OscarGM’s Voron 1.8 with standard length ducts (found in the 2.4 folder)

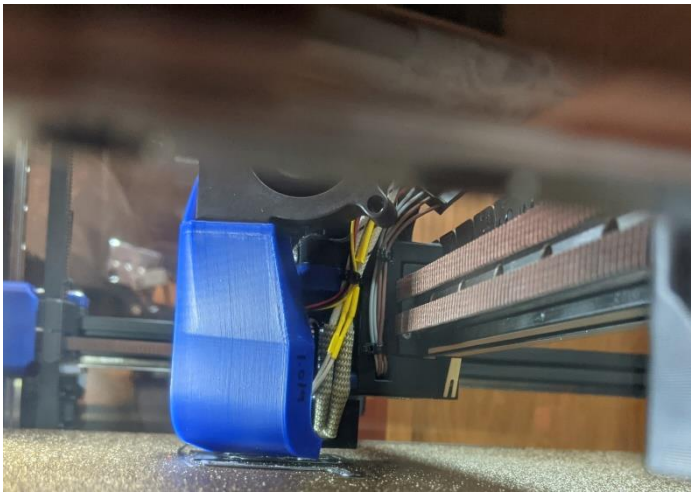
Final Assembly:

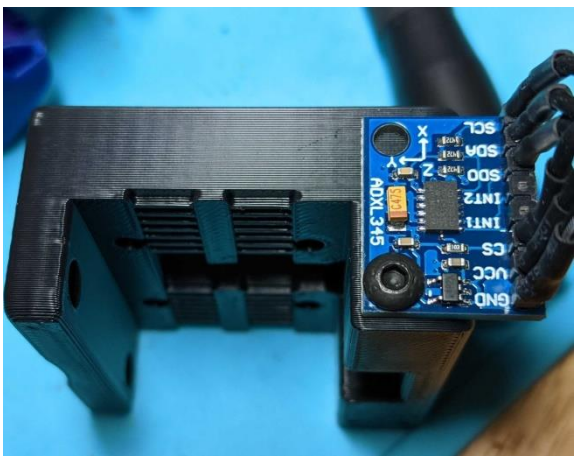
- Use button heads for everything if possible.
- ****note the heater cartridge location****
- ADXL can be mounted two ways as shown.











Firmware Settings:

- With my Sunon 5015s I have been able to pwm down to 7% using these settings
  kick_start_time: 0.5
  off_below: 0.05
  cycle_time: 0.008
- I'm using https://github.com/ctso/klipper/commit/75beccd22a70b49b50ae20391b5c0054113eb7b7 to ignore the first probe (helps with the slight amount of backlash in Z-drives with a Voron 2.4).
- This is what I'm using for my probe settings in firmware.

```
[probe]
#  Mag Probe
x_offset: -1.95          #This will be +1 or -1 depending on which way the nub on your magprobe microswitch is oriented.
y_offset: 32.95
z_offset: 2.4

speed: 5
samples: 3
sample_retract_dist: 1.5
samples_tolerance: 0.006
samples_tolerance_retries: 5
drop_first_result: true  #only used if you're using the ignore first probe.
```

- Homing override to home y before x.

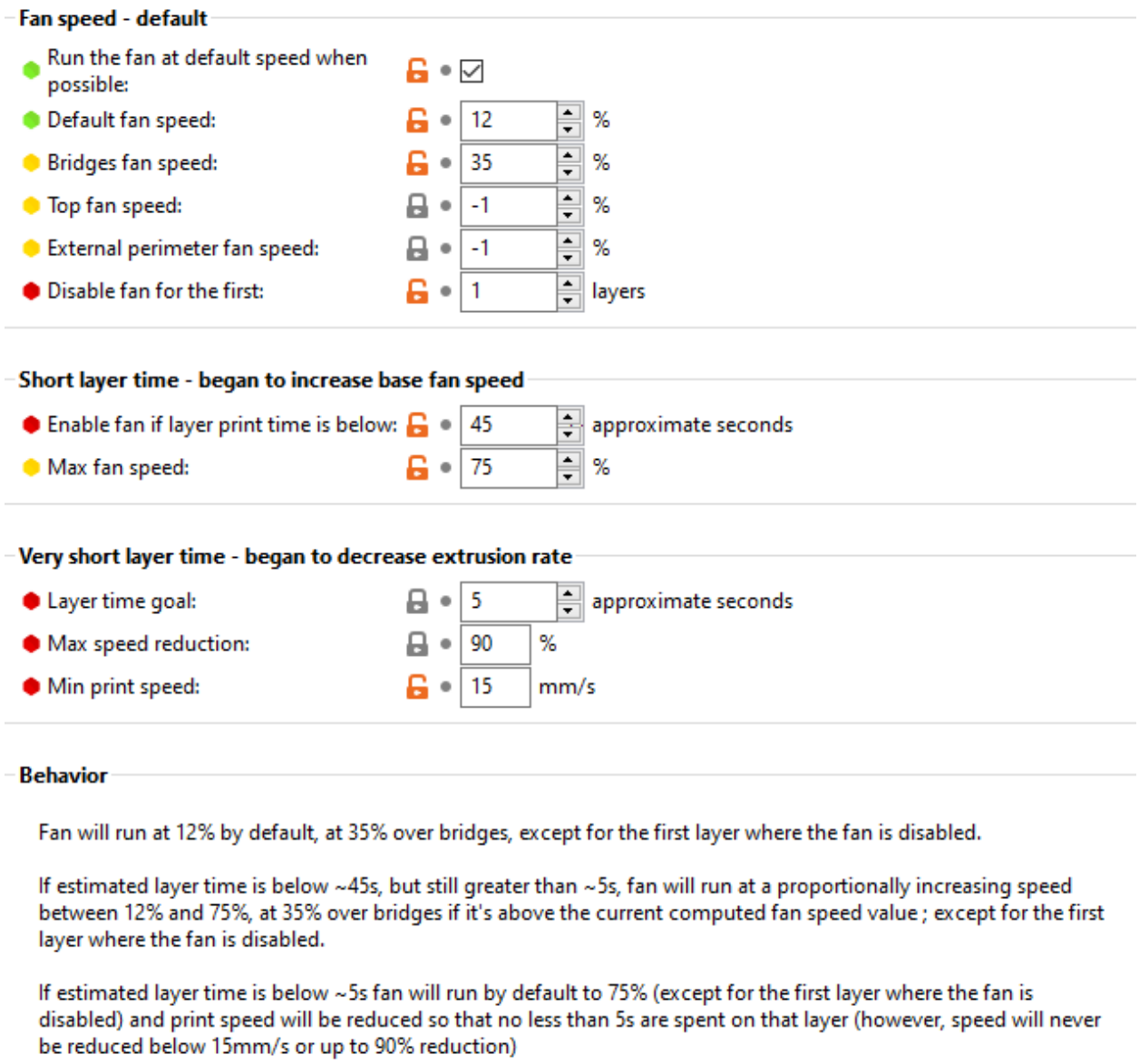
```
[homing_override]
axes: z
set_position_z: 0
gcode:
  G90
  G0 Z5 F600                    # move up a little for clearance
  G28 Y
  G28 X

  G0 X200 Y305 F3600            # home on z pin at this location (update your own)
  G28 Z

  G0 Z10 F1800                  # move up a little for clearance
  G0 X150 Y150 Z30 F3600        # Go to middle of bed
```

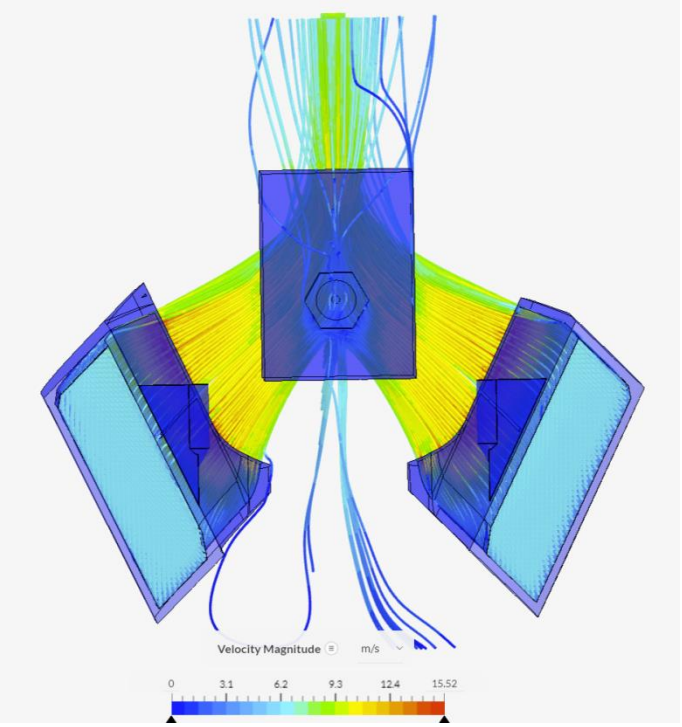
Slicer settings:

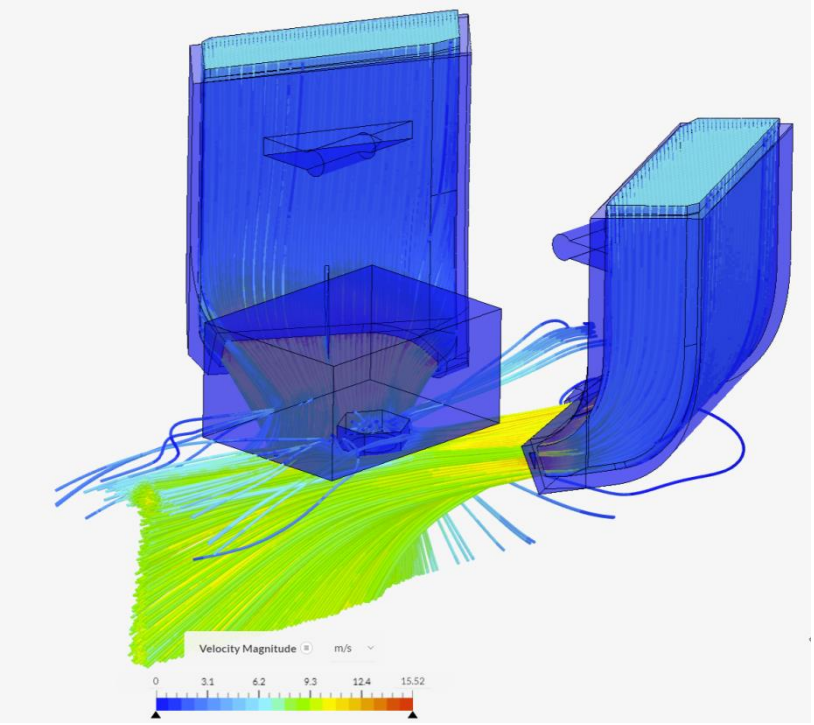
- This is currently what I've been using for ABS as far as cooling with my Sunon 5015s. Not sure where I'll end up here, but it's a starting point.
- Don't be afraid to pump the fan up with ABS, especially for overhangs and short layer times. The higher fan percent will increase your chamber temps and offset the higher fan usage. I often see 55c+ chamber temps in my uninsulated Voron 300. If I'm printing a single ABS part with short layer times I'll often use 50%+ fan for the whole part. I haven't had issues with layer splitting when I do this.

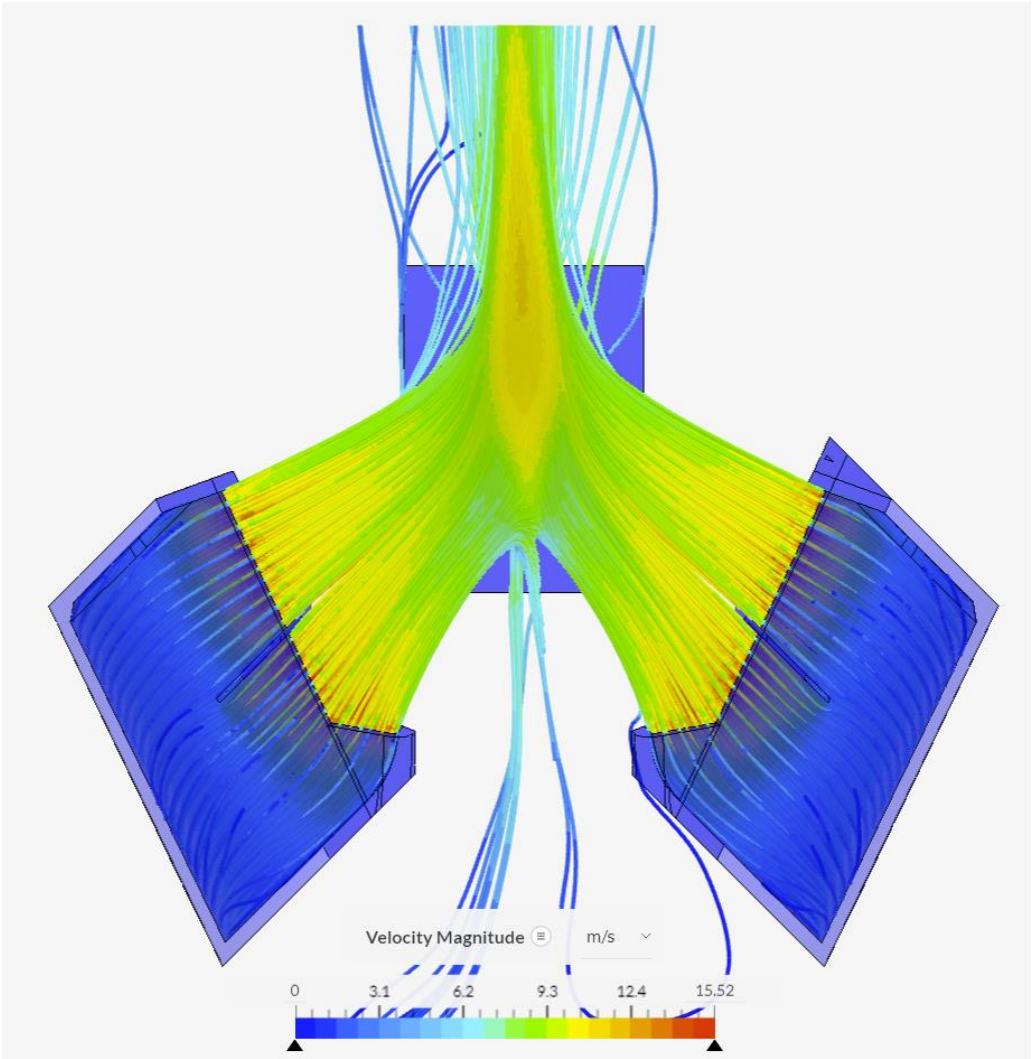


CFDs:

- Tons of CFD work was done for this toolhead.







Changelog:

version	notes
1.016	move duct forward 4mm. Chamfer front upper lip 1mm down 7 mm back
1.017	Move duct back to 1mm forward of nozzle. Front duct angle to 15 degrees. Front duct height to 5.5. increase duct clearance to 2 from 1.25. Change lip to 2/2mm.
1.018	Move duct forward to clear. Change angles a little. This has very high velocity!
1.019	change upper duct mount to use plastite. Thicken lower duct wall by 0.2mm to 0.8mm
1.020	incrase duct height by .2mm, decrease outlet height to 5.4 from 5.9
1.022	Shorten length of duct by 5mm (from 30 to 25mm)
1.023	move duct forward by 6mm (from 1.022)
1.024	from 1.019, change duct angle from 45 degrees to 50 degrees. 25mm nozzle length
1.025	From 1.019 narrow outlet by 1mm. Raise front and back by 0.5mm
1.026	from 1.025 lower front back by 0.5mm. Raise back by 0.3
1.027	incrase duct height to 5.4mm. Raise back by 0.3mm to 3.4mm
1.028	From 1.027. change front lip so that it is a little bigger. Also it angles down slightly.
1.029	from 1.028. increase forward aspect of lip from 2mm to 4mm
1.030	adjust lip some and rear angle
1.031	increase duct height by 0.25mm. Chamfer the front lip. Adjust front lip a little.
1.031.1	Raise back duct by 0.25mm
1.031.1	Heatset Duct Mount - Swap rear duct mount to heatset/m3x6
1.032	Make a cut of rear outlet at 20 degrees prior to shelling to focus rear part of flow.
1.033	change nozzle angle of back to 8degrees from 6. Not sure if this is better than 1.031.1 yet
1.033.2	upper duct mount arm is now 4mm thick and the space around the m3 hole on the upper mount is a little thicker
1.034	Skipped due to cad problem
1.035	move duct forward 2mm
1.036	Moved Duct back 2mm and a few fixes for things
1.037	modify upper arm duct mount to be much stronger. Uses new divot/cup instead of second screw.
1.037a	Chain_anchor v3.2 - ziptie holes on front moved upwards, added rear ziptie holes. Hole added to carriage v1.037 on left side to mount ADXL. Magprobe_dock_arms_v1.5 are longer, have a tighter fit.
	Added new 1.037 ducts with a 1.5mm lowered 5015 Mount (2mm clearance now from 3.5). These are the same ducts and will perform basically the same. Just have a slightly shorter appearance.
MGN9 v1.0	First release of single mgn9 carriage for mantis. Belt spacing is best with dual f695 bearings in the xy joints.