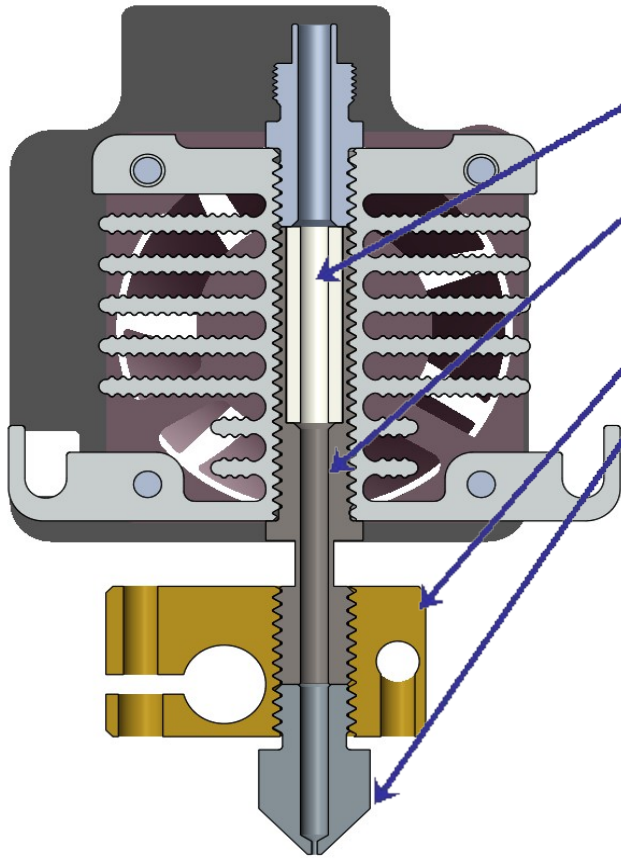

Why does the J1 Hotend clog?

Design of original J1 hotend



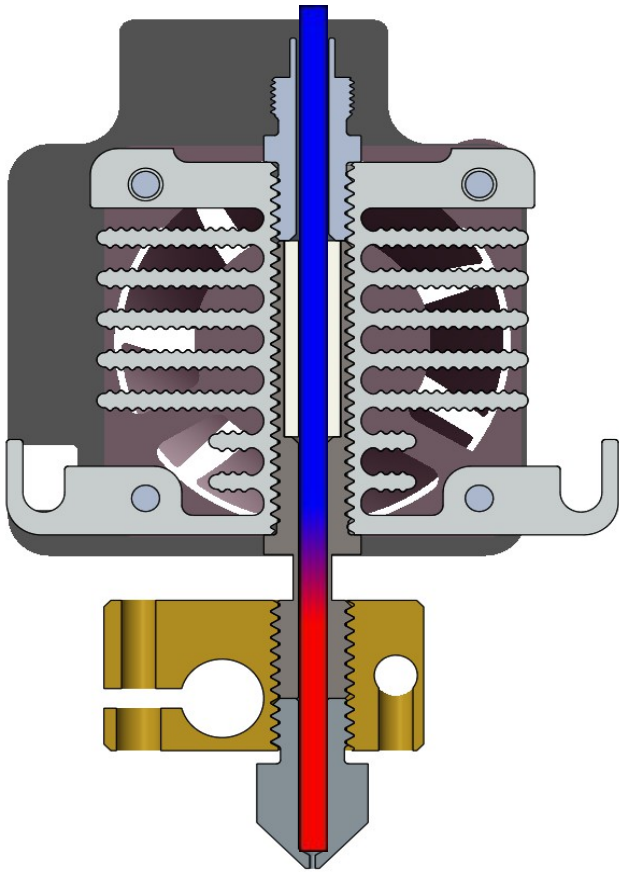
- PTFE bowden, ca, 20 mm long
- titanium heat break
- MK8 nozzle in a 1:1 (but made from brass) clone of the E3D V6 heater block

For some reason, this hotend has a rather large tendency to clog, especially (but not completely limited to) when frequent retracts happen. Cold pulls indicate the clog to be inside the heat block.

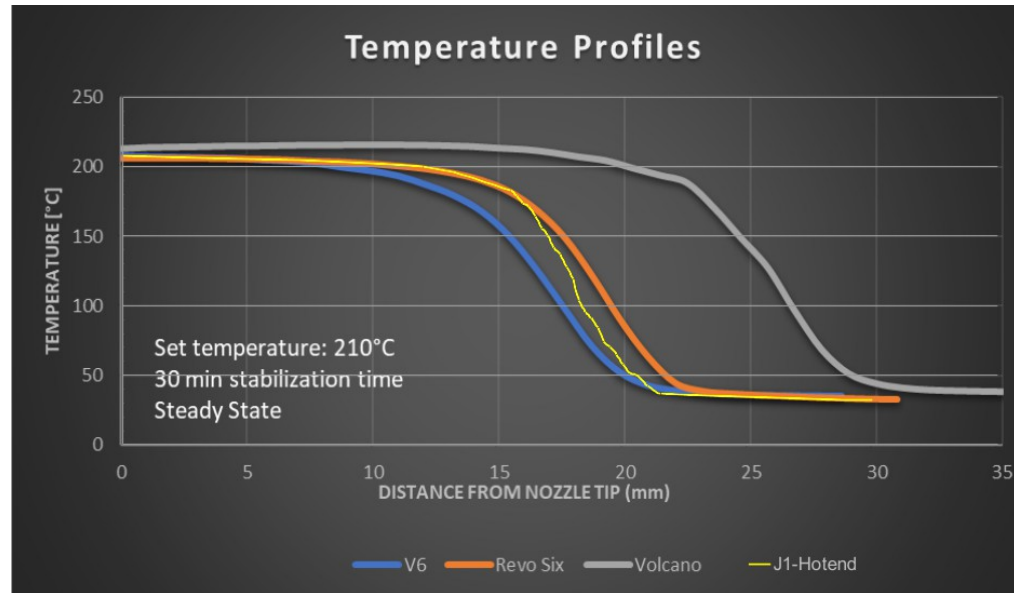
If you want to try your own solution, this assembly of the J1 hotend can be downloaded here:

<https://www.myminifactory.com/object/3d-print-3d-model-of-snapmaker-j1-hotend-module-282895>

original hotend - static thermal distribution



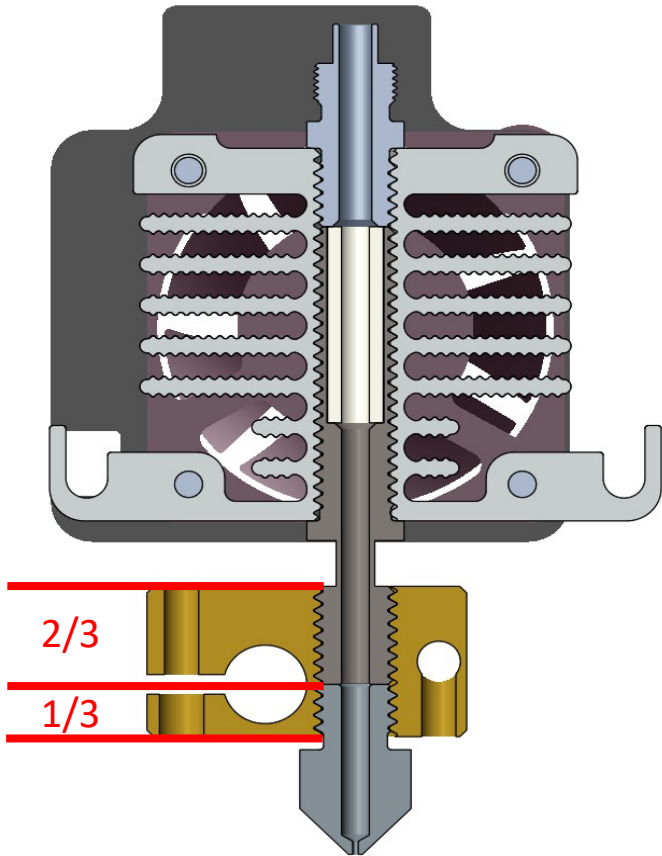
- static state: filament heated up over length of heat block.



Temperature measured inside of filament channel with Comark BS4937 Cu/Cu-Ni thermocouple
source of reference values: <https://www.cnckitchen.com/blog/e3d-rapidchange-revo-review>

→ cooling looks fine, focus on the lower end of the hotend!

Original J1 hotend vs. E3D V6



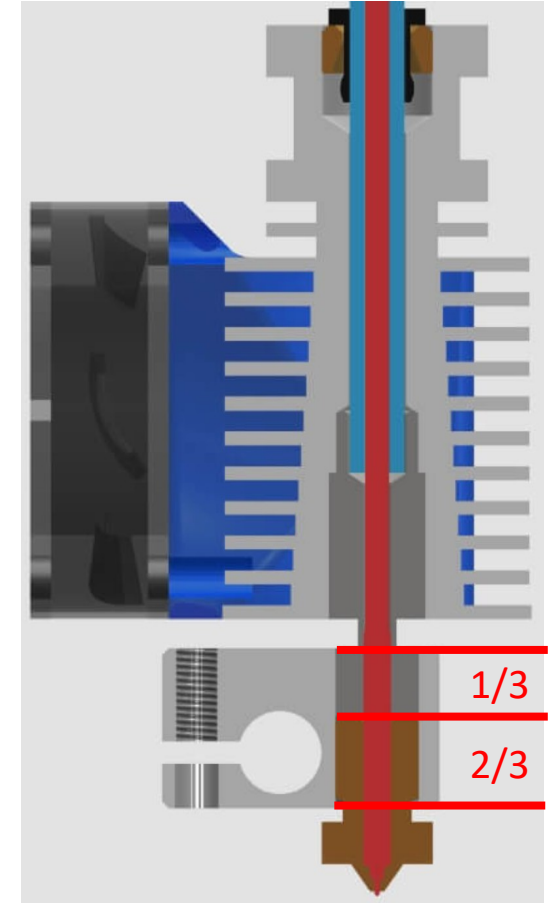
Two major differences in the heat block when compared to E3D V6:

1. The heat block is made of brass instead aluminium
2. just 1/3 of the thread is used by the nozzle, the rest is covered by the Titanium heatbreak.

Thermal conductivity:

- brass: ca. 81..105 W/(m·K)
- copper: ca. 380 W/(m·K)
- but: titanium ca. 16 W/(m·K)

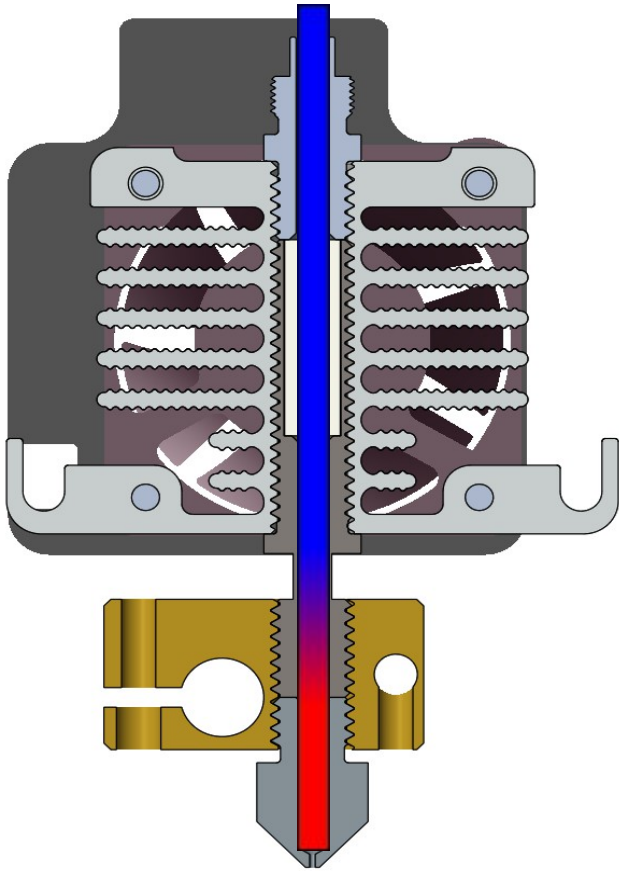
→ ca. 2/3 of the contact surface may not transfer enough heat when printing!



E3D V6 inside. Source:

<https://reprap.org/forum/read.php?1,887134>

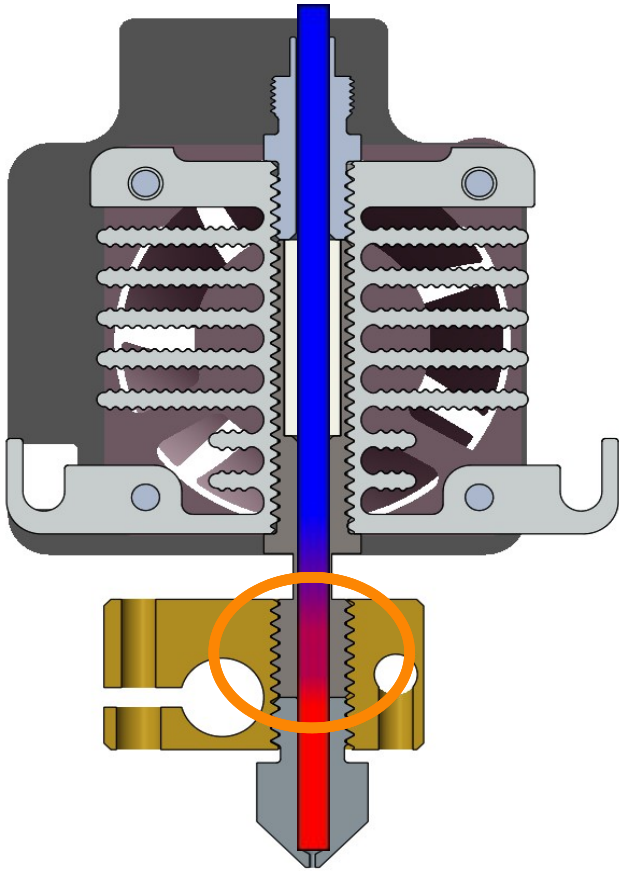
original hotend - thermal distr. while printing



When printing (i.e cold filament is constantly pulls heat from the hotend), this will cause the following effect:

- melted area creeps down in heat block because the lower titanium thread of the heat block cannot transfer enough heat.
- when the filament is moved only in one direction and in a rather steady manner, this is not much of a problem, the melting zone will just be shorter...

original hotend - thermal distribution

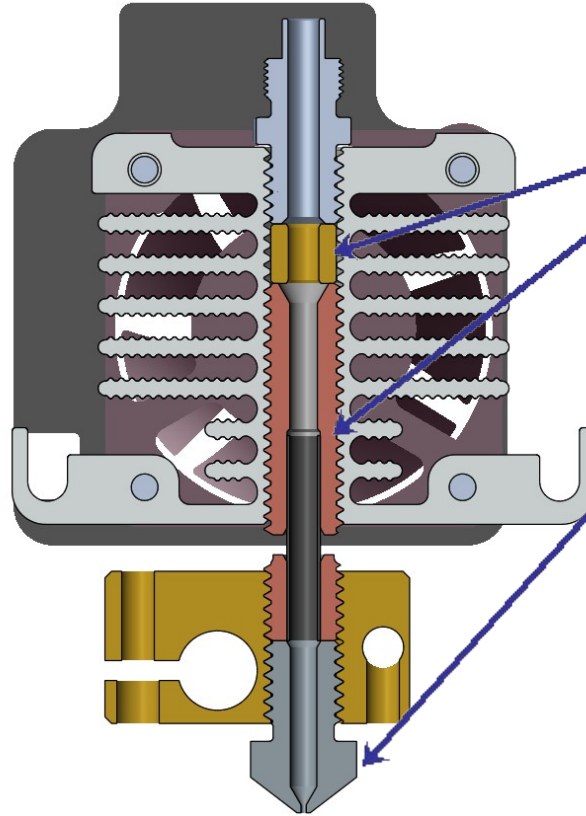
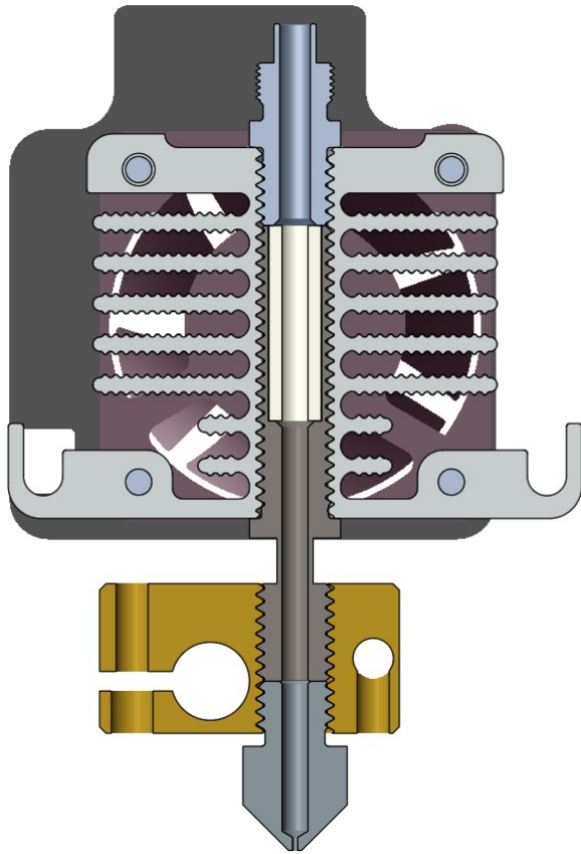


- ... but in some cases, e.g. when frequent retracts occur (other cases may exist as well), a longer area where the filament is soft but still solid forms due to the missing protrusion. Depending on the filament, this softened area may be compressed by the extruder instead of pushing out the filament through the nozzle.
- additionally, titanium walls in the affected area have a high friction coefficient
 - the softened filament forms a clog,
 - the printer pauses
 - enough heat will come through the titanium thread to make the clog disappear by simply waiting in many cases.

So far, it's just a theory...

Updated Hotend and real tests

Improving the design with using available parts

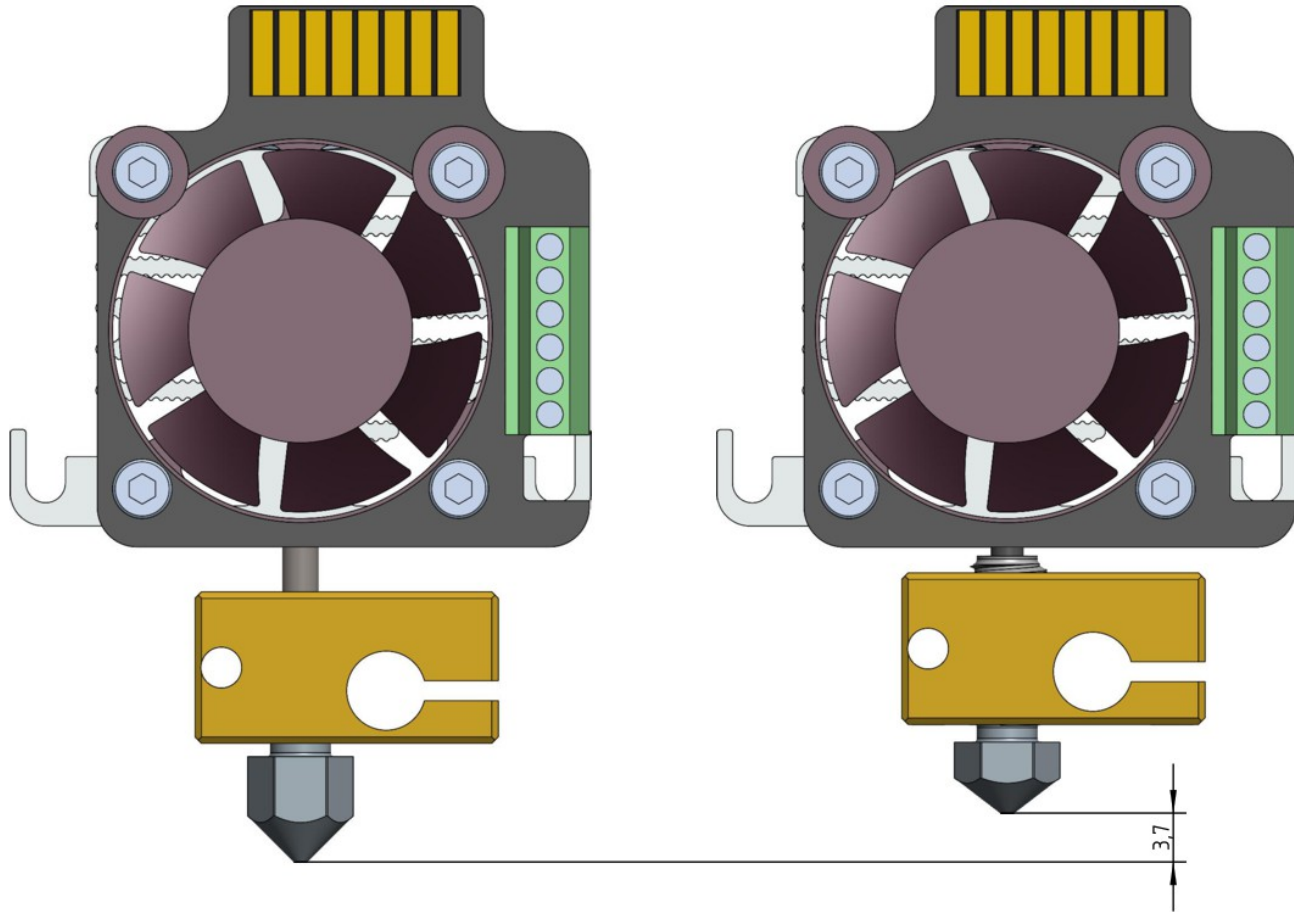


Back to a V6 design:

- Copperhead MK8 heatbreak and distance ring replace J1 heatbreak
- Bondtech* V6 nozzle instead of MK8

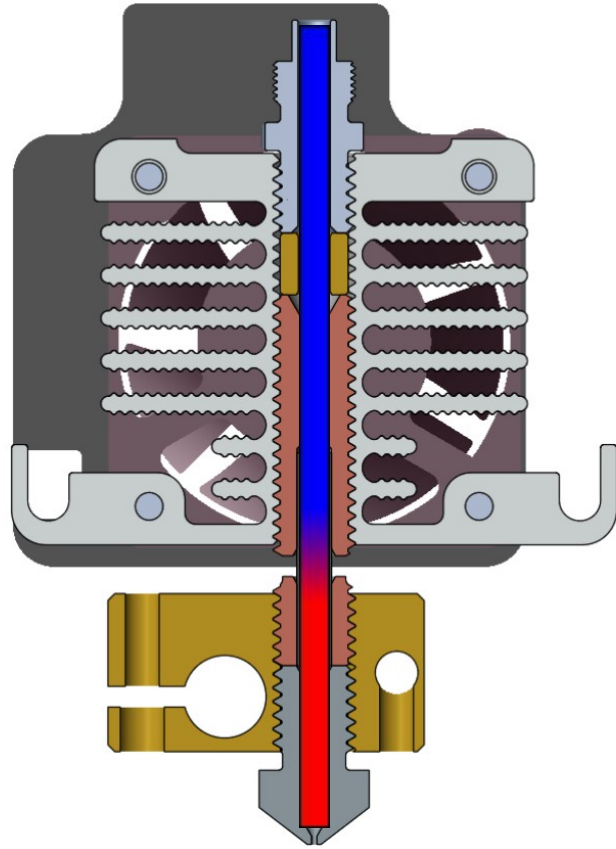
(* why Bondtech? Their V6 nozzle features a fully conical tip which is needed for XY calibration, and it is 0.5 mm longer than the original.)

Original vs. improved



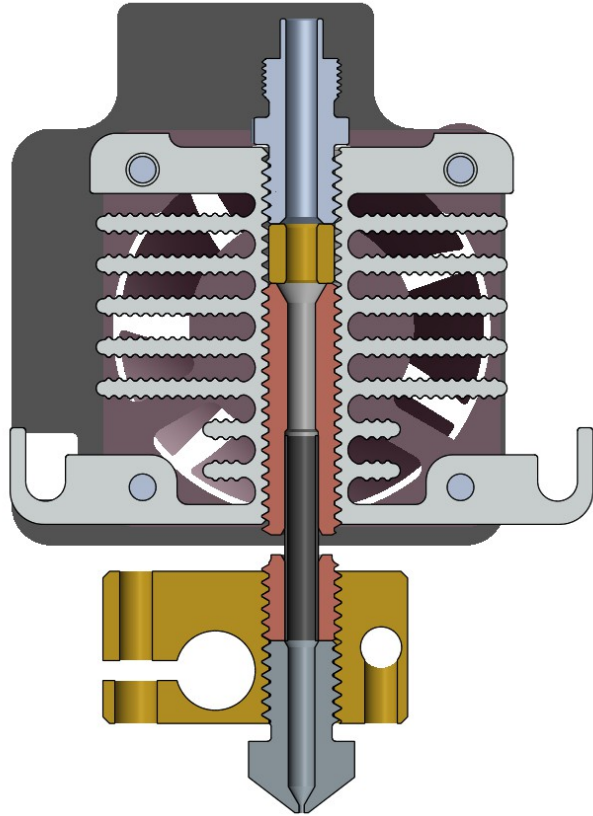
- hotend is 3.7 mm shorter than original one (measured from fixation screw height - the upper adapter screw is about 0.2 mm higher on the new variant → difference from the top: 3.5 mm)

thermal distribution - improved hotend



- much better thermal conductivity
 - significantly reduced friction (stainless steel tube combined with tungsten disulfide plating inside tube)
- melting zone more stable in all function cases
- if a clog begins to form nevertheless (still a metal hotend), it can be pushed back into the melting zone easier

Verification



1. Use PLA filament which is known to be critical with full metal hotends, such as
 - DasFilament PLA (ideally one of the variants with metallic particles)
 - e-Sun e-twinkling PLA, PLA Plus shiny silk, improved matte PLA, PLA+
 - Sunlu PLA Plus Shiny Silk, Marble PLA, PLA Stone Color
 - Extruder PLA NX2 Matt,
 - Xingtongzhilian Silk PLA

Note: Snapmaker PLA filament is not suitable for tests, very tolerant!
2. test gcode for retraction issues: XY belt calibrator delivered with firmware version 2.2.24. Uses numerous 2mm retracts with very short extrusions in between → reliable clogs seem guaranteed after about 8...10mm print height. Allowed in-print changes: ONLY change temperature after the first layer to the filament value.
3. test gcode for speed issues: 120x120 mm wall test part from i3sven
Allowed in-print changes: change temperature after the first layer to the filament value, for very high speeds ca. 10°C above noted max. temp suggested.
4. print further parts that already failed with clogs. Reuse the SAME gcode!

Verification - results

Two J1 printers that had issues before have so far been fitted with the improved hotend design (both with 0.4 mm nozzles):

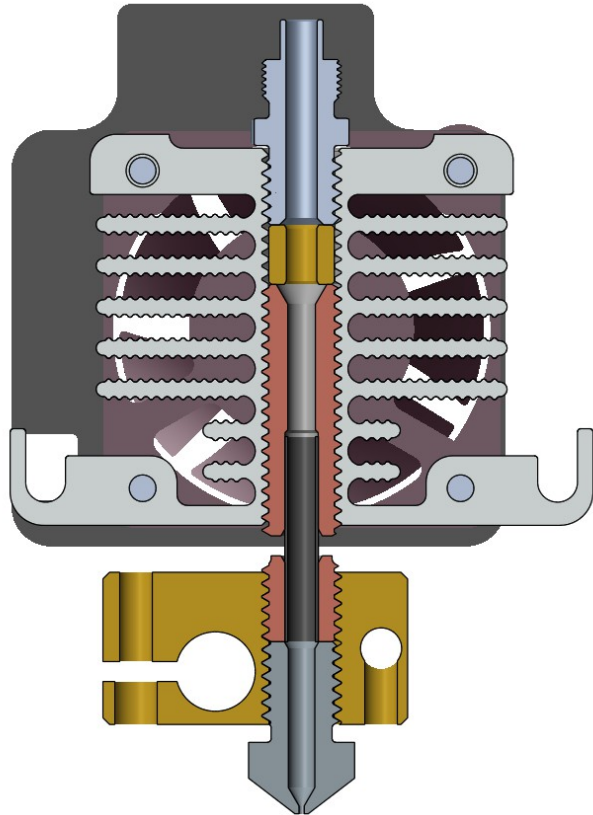
Test criterion: OK = print is finished without clogs. Otherwise NOK

	original hotend			improved hotend		
	XY belt calibrator	speed test code	further parts tested	XY belt calibrator	speed test code	further parts
i3sven	1x NOK	1x NOK	1x NOK (Benchy)	1x OK	1x OK @350 mm, 0,2mm layer height	1x OK
Mechanikus	7x NOK	-	1x NOK (own design)	2x OK	1x OK @250 mm, 0,15mm layer height	1x OK

Tests - overview - state 2023-03-22

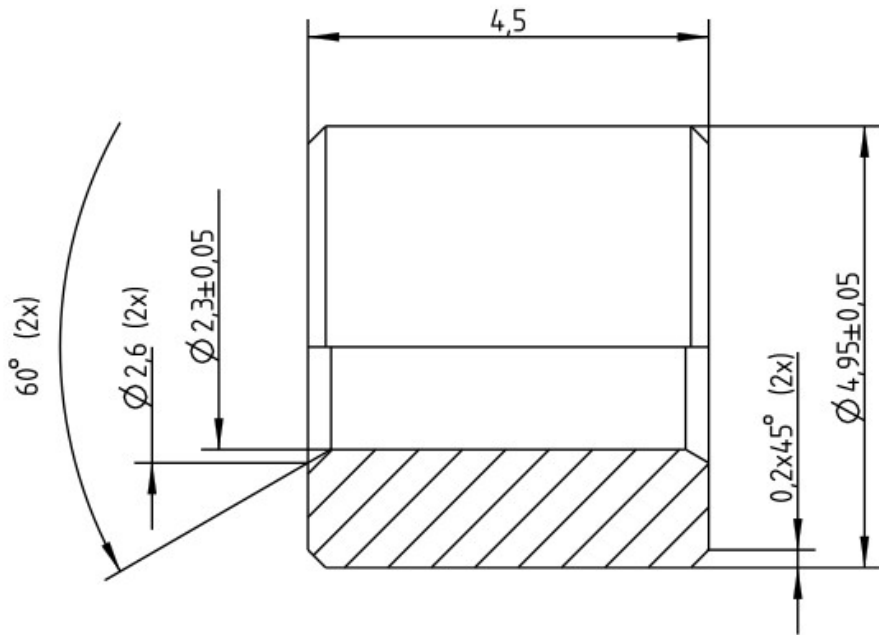
Tests are ongoing.

Assembly



- screw in upper adapter screw into heat sink completely
- loosen upper adapter screw 1/4 turn
- apply thermal grease to upper portion of heat break
- insert distance roll and screw in heat break.
- tighten assembly by tightening upper adapter screw.
- screw nozzle onto heat block
- loosen nozzle about 0,5...1 turn
- screw heat block onto heat break until it touches the nozzle
- align heat block with heat sink.
- Hold heat block with tool. DO NOT grip heat sink instead, no torque shall be applied to heat break! Then tighten heat block by tightening nozzle with 1.5 Nm

Where do I get that distance roll?



the distance roll must keep its shape under constant load, and it must be centered by the heat sink!

- ideally: lathe/get lathed from brass or aluminium (tensile strength 400..500 N/mm² recommended)
- Amazon sells a D5/D2-brass pipe, at least in Germany. drill open a bit, add the chamfers and lightly sand the outside to make it fit*
- press a distance roll for M2 screws with outer dia. = 4 mm into a 5x0,5 mm brass pipe piece and sand it to final dimensions
- **Plastic of any kind seems not really up to the task.**

**: many thanks at alfrank from the Drucktipps3D forum for the hint!*

3.7mm shorter...which printer changes are needed?

The updated printers were able to cope with this with just small changes:

- depending on the print head case tolerances, ca. 1 mm needs to be sanded off from the lower edge of the print head case (print head must not touch print bed during XY calibration procedure)
- The same applies to the cooling nozzle (or take the chance to print a better one)
- XY calibration still seems to have a small bug at the moment: it looks as if a wrong diameter value is used for X calibration of the right hand nozzle. The relatively blunt cone of the V6 nozzles causes this to have huge effects on accuracy.
→ be VERY precise with Z calibration, then XY calibration should fit automatically!