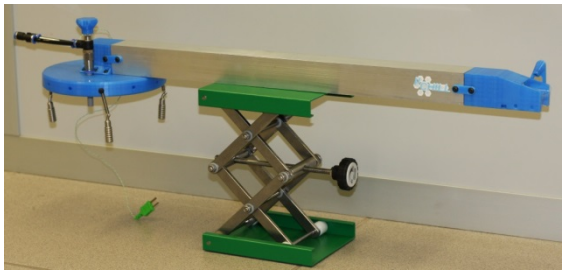
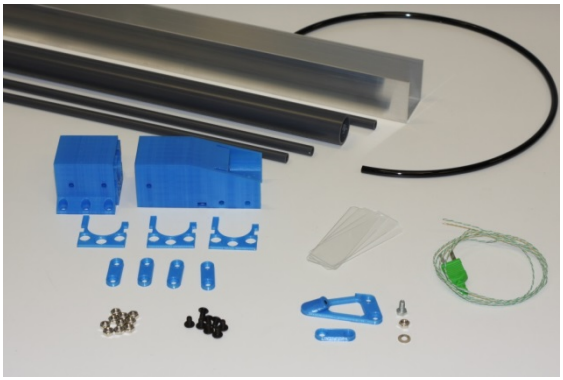
µCHILL Assembly



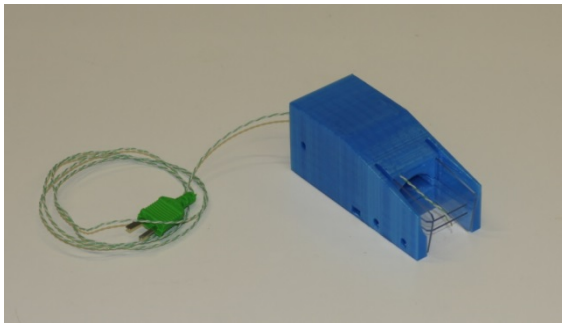


Introduction

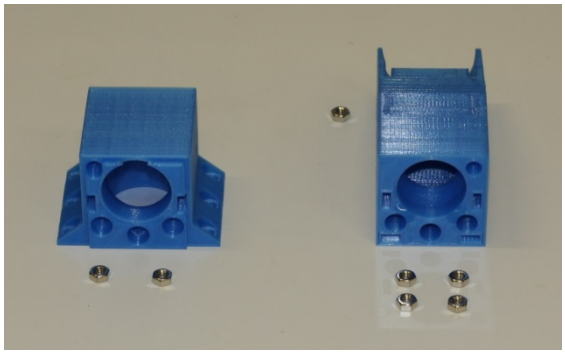
The image on the left shows the µCHILL variant described in this assembly manual (configuration C in paper), acting as a guideline for other possible setups. *It is absolutely recommended to read the whole assembly manual before starting.* You will need the following parts and tools to reproduce the setup *exactly* (many steps are optional, parts needed only for sample holder or Dewar lid are marked with *):

- 3D printed parts as shown (PLA or PETG)
- Standard issue microscopy slides (75.5 x 25.4 x 1.0 mm, beveled corners recommended)
- 40x40x2 aluminum U profile
- 25 mm OD PVC pipe
- 8 mm OD PVC pipe
- 6 mm OD PU hose
- PU construction foam
- Thermocouple with wire, 2 mm diameter
- M4 hex nuts
- M4x6 socket head button screws
- 3 mm diameter sealing strip or similar*
- IQS needle valve with 6 mm and 8 mm push-fit connectors*
- IQS Y splitter (6 mm to 2x 6 mm push-fit)*
- IQS adapter (8 mm tube to 6 mm push-fit)*
- M4x20 socket head button screws*
- M4 washer (1x)*
- M4x8 hex head cap screw (1x)*
- Cylindrical magnet (e.g. 3.5x7mm)*

Tools:
- Painters tape or electrical tape
- 3mm allen key
- Fine-toothed hacksaw (for U profile and pipes)
- Cutter or hobby knife
- Small pliers
- Flat-head screwdriver
- 5mm drill and drillpress or portable electric drill
- fine-point permanent marker

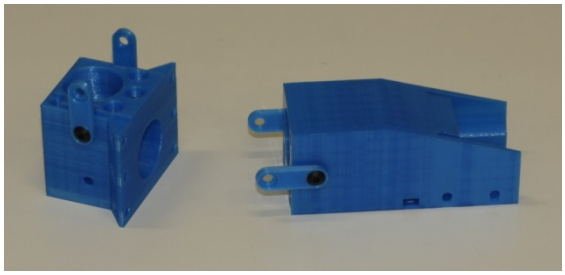


Begin by cleaning all parts carefully with a knife, making sure there are no filament strings or blobs left. All inner surfaces should be smooth. Test fit of all tubing (25, 8 and 6mm) and if necessary deburr all inlets on the back side carefully until the pipes slide in without too much force. Test fit of thermocouple and microscopy slides as shown in image. Slides should friction-fit, with no or minimal force. *Do not omit this step, it will be much more difficult later.*

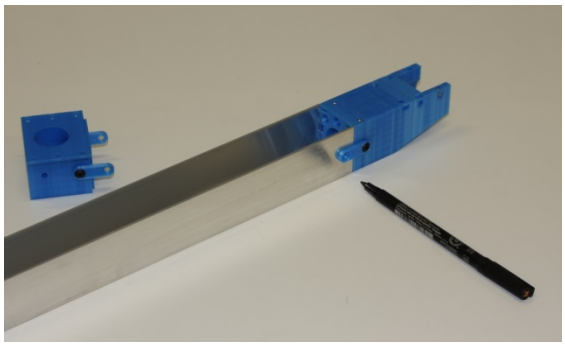


Step 1

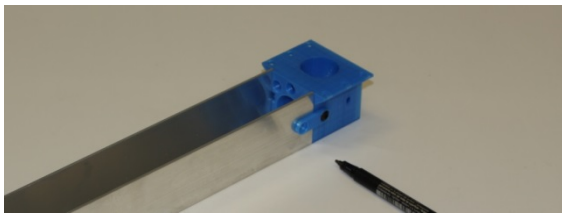
Remove glass and thermocouple. Slot M4 hex nuts into the coldhead and end piece as shown. If more accessories should be added later, it is advisable to add hex nuts to all unused slots, because some will be inaccessible later. If necessary, use flat head screwdriver to push the nuts in.

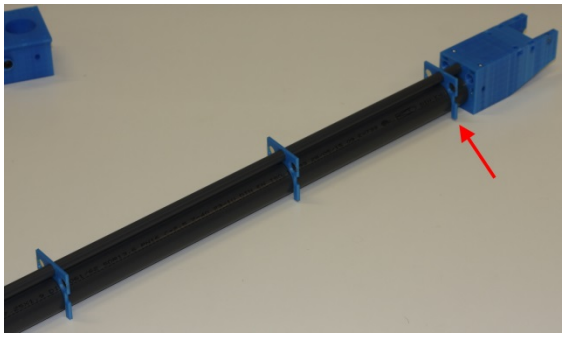


Attach 4x straight brackets with M4x6 screws as shown. *Be careful not to overtighten.*



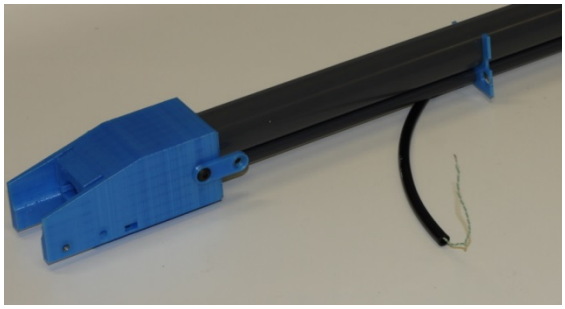
Cut aluminum profile to desired length, push both plastic parts over the ends as shown and mark position of drill holes with permanent marker. Remove profile and drill all four holes using a 5 mm drill.



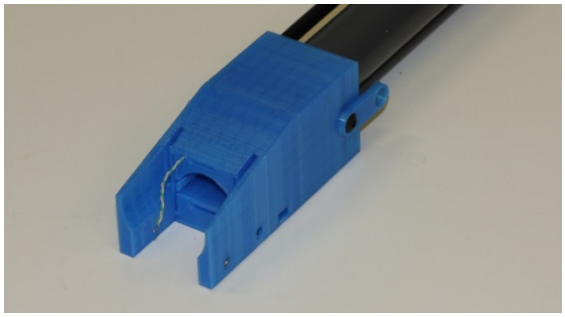


Step 2

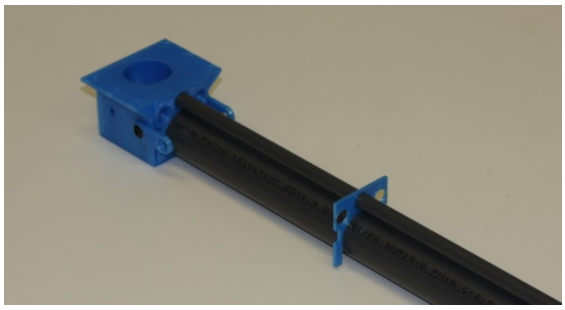
Cut 25 mm (length of aluminum profile + 20 mm) and 8 mm PVC (length of aluminum profile + 10 mm) to size and push-fit to coldhead. Slide 3 spacers over the tubes in the shown orientation. The spacer indicated by a red arrow must be pushed flat against the coldhead. If extra stabilizers are needed (one or two 8 mm rods or pipes, not shown), they should be inserted now.



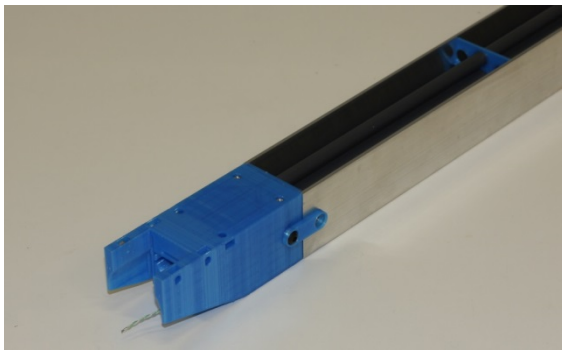
Cut the 6 mm PU hose (or PVC pipe) to size, leave some excess (e.g. length of aluminum profile + 100 mm). *Push the thermistor guide tube all the way through the end piece, match the lengths and cut off any excess at the back end of the end piece (not shown).* Push thermistor wire through the guide tube.



Thread thermistor wire through the coldhead, leaving some slack. Push-fit the thermistor guide tube into coldhead opening.



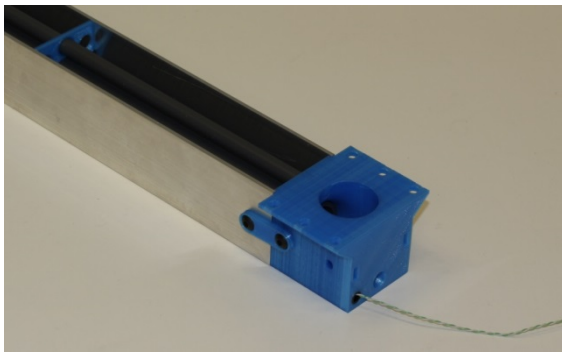
Push end piece over all pipes. The wire should protrude from the end piece (not shown). Make sure the front spacer is pushed firmly against the coldhead and the other two spacers are positioned fairly evenly.



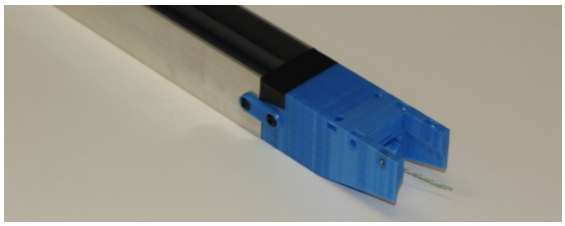
Step 3

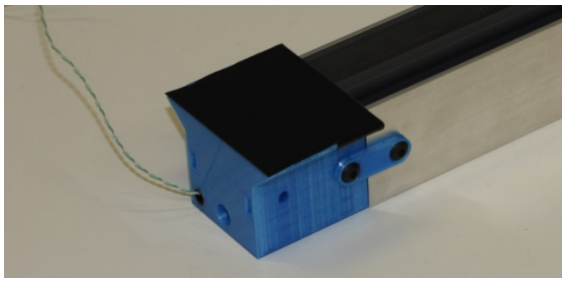
Note: Skip this step if you would like to use insulation different from PU foam.

Slide the aluminum profile over the assembly as shown. Connect everything using M4x6 screws and M4 hex nuts, using small pliers to hold down the nuts on the inside of the profile. *Do not overtighten.*



When finished, test the thermistor. Also test if air flow through 8 mm pipes is unobstructed. Do not omit this step, it will be impossible to replace 8 mm tubes after adding the foam, and replacing the thermistor will be more difficult.

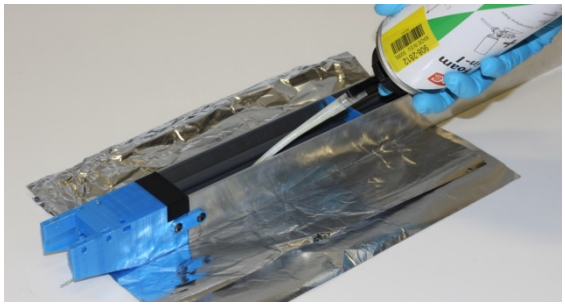




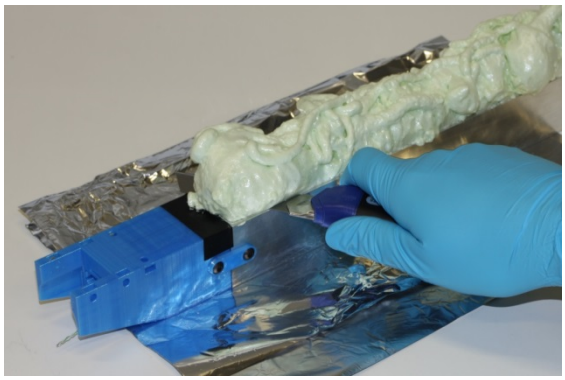
Step 4

Note: See below for instructions regarding alternate insulation not using PU foam.

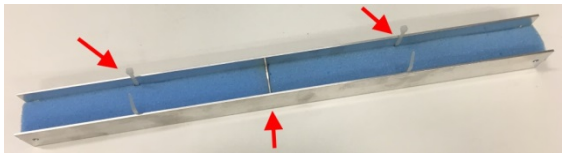
Tape off the coldhead and end piece with painters tape or electrical tape as shown to prevent clogging with PU foam.



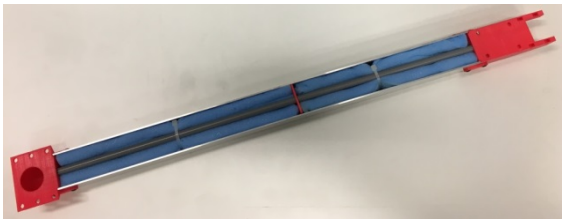
Using a mat and gloves, carefully fill U profile with construction foam. Let the foam extend into all cavities, and make sure there are no bubbles. Let foam set according to instructions (or overnight).



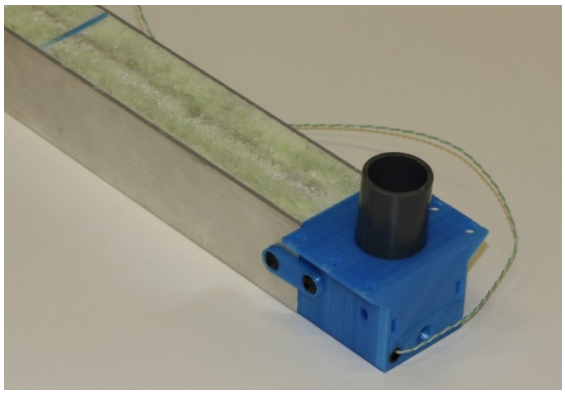
Test if foam is solid, then cut off any excess along the aluminum edge. Remove tape.



Alternate instructions for rubber foam sheets: Start off by placing a layer in U profile as shown. Insert one cable tie per segment and leave groove(s) for spacer(s) (middle arrow).

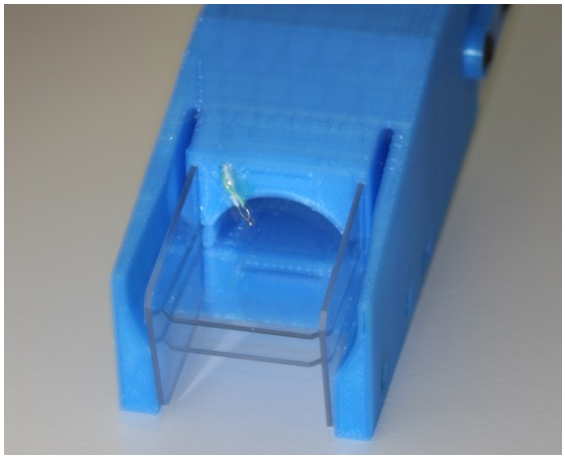


Place tubing assembly into U profile and use cable ties to fix foam sheets to tubes. Connect everything using M4x6 screws and M4 hex nuts as shown in step 3. Stuff foam sheet cuttings into all gaps in insulation. This type of insulation delivered the same performance as PU foam in all tests.



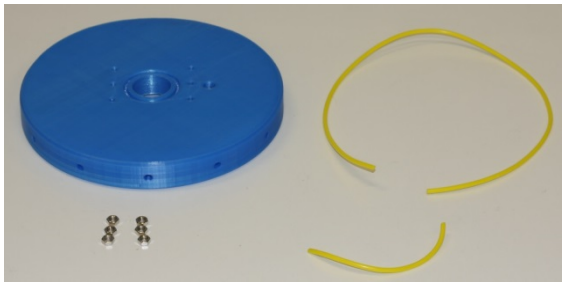
Step 5

Cut off a short piece of 25 mm OD PVC pipe (50-60 mm) and press into end piece inlet.



Adjust position of thermocouple on the coldhead so it sits in the cold gas outlet. Fix with glue if necessary. Install glass slides.

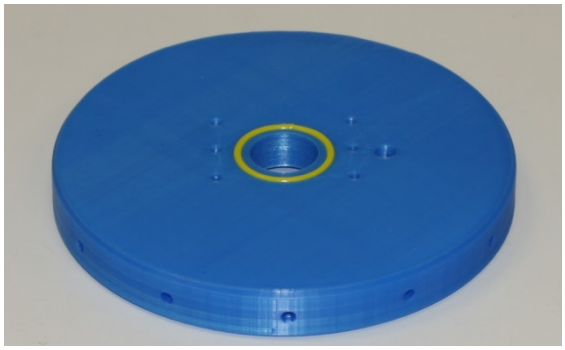
This concludes the assembly of the main µCHILL component.



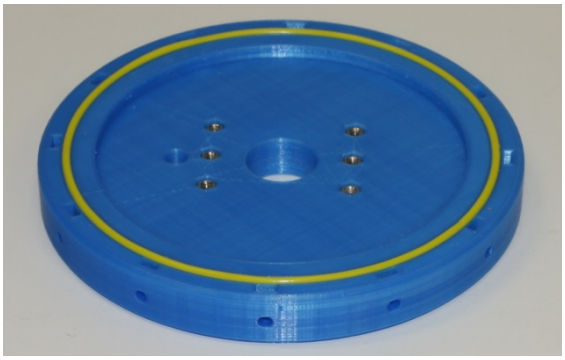
Dewar Lid (optional)

Note: The lid can take long to print and might be easier to build using traditional manufacturing techniques. Instructions are only provided for completeness.

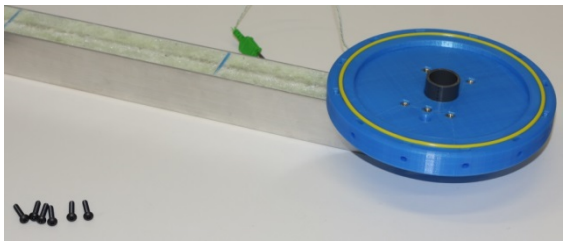
First test fit with pieces of 8 mm and 25 mm OD PVC pipe.



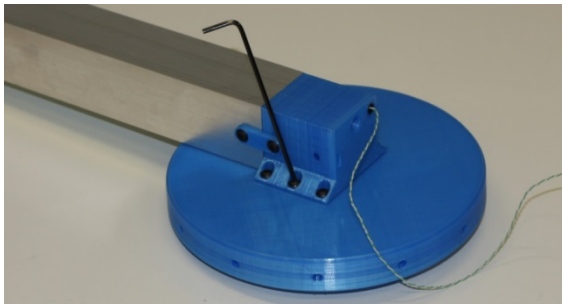
Begin by cutting a section of 3 mm sealing strip (in the picture 3 mm flexible TPU 3D printing filament was used). Insert into top groove.



Repeat on underside. Press M4 hex nuts into nutcatches.

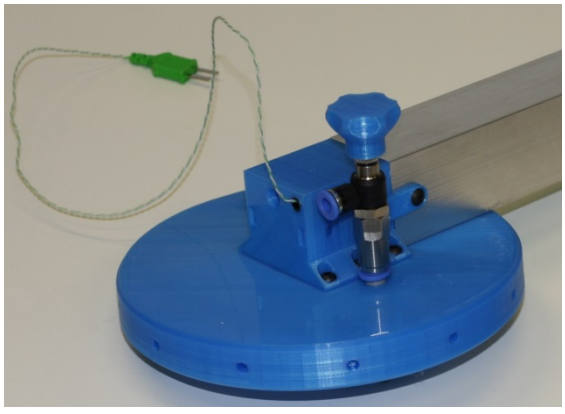


Place lid on end piece as shown. Note that the Dewar lid is not symmetrical, in the correct orientation the sealing strip on the top side is completely covered by the end piece (see next picture).



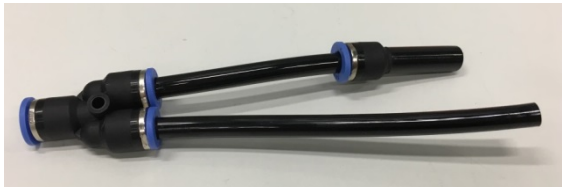
Affix Dewar lid to end piece with M4x20 screws. *Do not overtighten.*

Prepare IQS needle valve: Press on knob, cut a short piece of 8 mm PVC pipe (50 -60 mm) and push into connector.

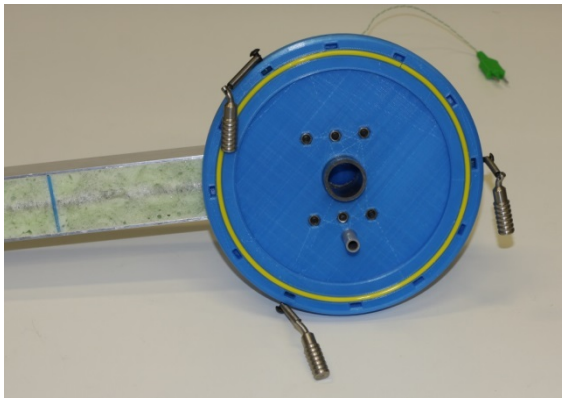


Push needle valve assembly into 8 mm hole.

Note: Alternate components are provided with the print files, e.g. a printed 8 mm tube to hose barb adapter could be used instead of PVC pipe to interface with other types of valve connected with standard laboratory tubing. The same adapter could be used for the shroud gas inlet.

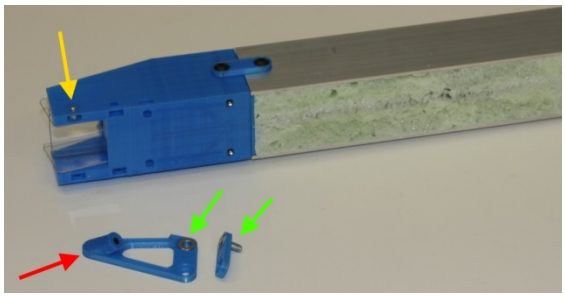


Prepare two pieces of 6 mm PU hose, IQS Y splitter and IQS 8 mm tube adapter as shown on the left. Press IQS tube adapter into shroud gas inlet on µCHILL end piece. Press free end of PU hose into IQS push-fit connector on needle valve.



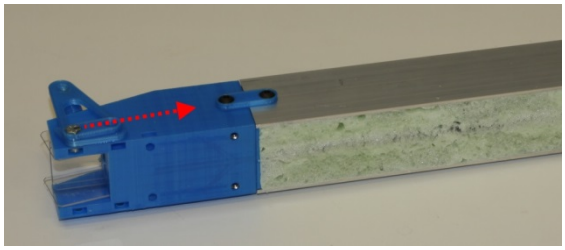
Push M4 hex nuts into slots on Dewar lid and use M4x20 screws to attach arbitrary fasteners. These serve to lock the lid to the Dewar. The image shows a simple system of springs and hooks, which can slide into catches supported by a metal strip around the Dewar body.
Depending on the setup, an additional flat ring seal cut from rubbery sheet material might be necessary.

This concludes the assembly of the Dewar lid.

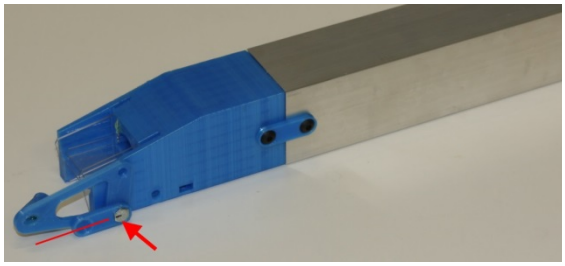


Magnetic Pin Holder (optional)

Note: Parts can be printed in a mirrored version for left-handed use.
Push magnet into socket on back side of holder (red arrow), followed by a drop of glue if necessary. Verify hex nut is installed in socket on coldhead (yellow arrow). Place M4x8 hex cap screw into lever and M4 washer into holder (green arrows).

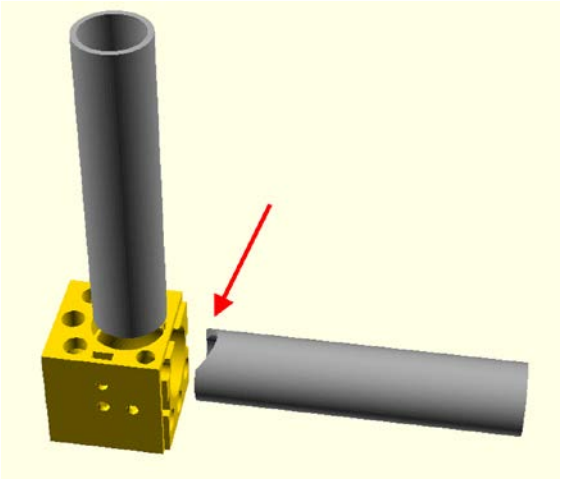


Put all parts together as shown and use lever to fix holder into the upright orientation. The lever should point backwards when the holder is fixed. If this is not the case, mark the side of the screw facing backwards with permanent marker. Then remove lever again, reorient screw in lever so the mark points towards the grip and reassemble.



The image on the left shows the mark on the screw and its orientation (holder oriented forward and loose). Note that the magnetic pin can be left on the holder and the crystal will neither touch the glass nor leave the cold zone in both orientations. You can now switch between both positions with a 180° rotation of the lever.

This concludes the assembly of the magnetic pin holder.



Notes on Variants with Corner Pieces

Whenever using the part from file corner_up.stl, the horizontal tube has to be indented because there is not enough clearance (red arrow). With PVC pipes this can easily be achieved with a sharp cutter and/or a file. Ensure good match before assembly. Alternatively, an indented pipe of appropriate length can be rendered using muCHILL_parametric.scad (part name: cropped_pipe) and printed.

Do not forget that the thermistor guide tube, if used, must be fed through all used connectors before inserting the wire and proceeding with the assembly (see Step 2).

When using PU foam for insulation, it is advisable to fill each segment separately and let it set completely before proceeding.