

Quad cooling unit V0.5 assembly

List of required components

Item	Type	Amount	Source
Cooling stack clamping screws	M6x35 RENY	2	https://us.misumi-ec.com/vona2/detail/221000237816/?HissuCode=SPA-M6X40-C-VA
Cooling stack disc springs	DIN 2093 $D_e=18\text{mm}$, $D_i = 6.2\text{mm}$, $t=0.6\text{mm}$ (400N at 75% deflection)	6	Available from many distributors, e.g: https://catalog.lesjoforsab.com/ds-18x6-2x0-6
3mm OD tubing	Festo PUN-H-3X0,5-NT	~1m	https://uk.rs-online.com/web/p/air-hose/1262774/
TIM sheet	Panasonic EYG-S	32cm ²	https://www.digikey.com/product-detail/en/panasonic-electronic-components/EYG-S1818ZLX2/P122036-ND/6575966
Peltier module 1	Laird 108161050003	1	https://www.digikey.com/products/en?keywords=108161050003
Peltier module 2	Laird 387004685	1	https://no.mouser.com/ProductDetail/Laird-Thermal-Systems/387004685?qs=%2Fha2pyFadui0Mu6K9PzJu%2FuKkU0oHM%2F5ecGTNpPgSHZkvhEeRcaLwg%3D%3D
~8mm ID / ~11.5mm OD tubing	Any flexible tubing, e.g. Saint Gobain ACF00022-C	Enough to reach your circulating chiller	https://uk.rs-online.com/web/p/flexible-tubes/3139549/?sra=pstk
Temperature sensors	Any small sensor which fits your readout system/peltier control system	2	
Internal insulation screws	Nylon M3x35	2	
Internal insulation screws	Nylon M3x25	2	
Internal insulation washers	M4	4	
Bottom insulation screws	M6x25	4	
Bottom insulation washers	M6	4	

Alternative peltier combinations

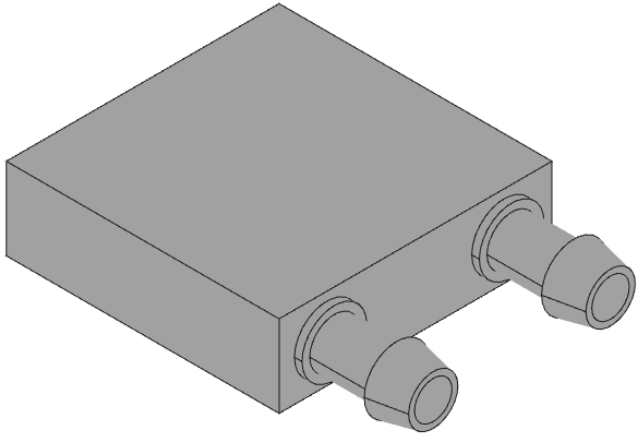
Use this table to select an alternative combination of peltiers if you cannot purchase the recommended combination from the table on the previous page.

	Peltier 1	Peltier 2	Module powered ($P_{mod} = 10W$)			Module unpowered ($P_{mod} = 0W$)			Electrical arrangement	
			T_{min} [C]	P @ T_{min} [W]	P @ -40C [W]	T_{min} [C]	P @ T_{min} [W]	P @ -60C [W]		
	56890-503	430848-502	-37	Unknown	Unknown	-60	Unknown	Unknown	Series	Peltier 2 is "normal"
	56890-503	7945001-601	-37	Unknown	Unknown	-60	Unknown	Unknown	Series	
	56890-503	430875-503	-40	Unknown	Unknown	-63	Unknown	Unknown	Series	
	56890-503	430874-503	-40	Unknown	Unknown	-61	Unknown	Unknown	Series	
	7945002-601	387004685	-46	98	Unknown	-65	109	Unknown	Parallel	Peltier 2 is UltraTEC
Recommended →	430848-504	387004685	-48	102	54	-67	97	49	Parallel	
	108161050003	387004685	-48	88	41	-65	89	51	Parallel	
	7950003-601	387004685	-47	92	48	-64	92	48	Parallel	
Not recommended, only for comparison →	56890-503	387004679	-42	Unknown	Unknown	-63	Unknown	Unknown	Series	
	CUI devices CP854705-2		-40	~100		-55	~100			

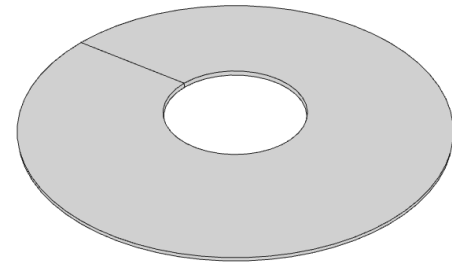
The table above shows real experimental results from tests performed with various peltier element combinations in the cooling unit.

For each combination you can see the minimum temperature reached on the vacuum chuck with the module powered and unpowered. For some combinations the total power consumption is also given at the minimum temperature and at a fixed vacuum chuck temperature setpoint.

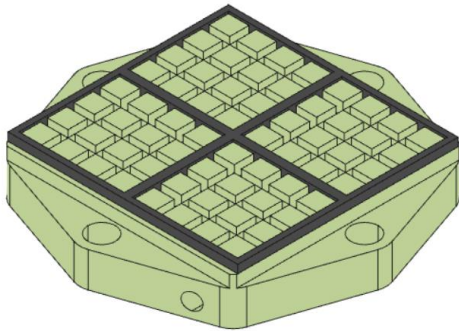
Illustrations



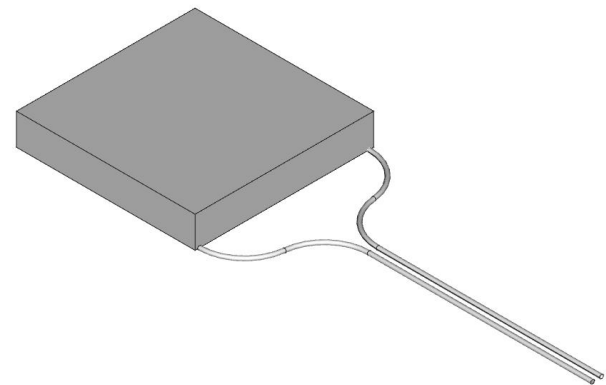
Coldplate



Disc spring

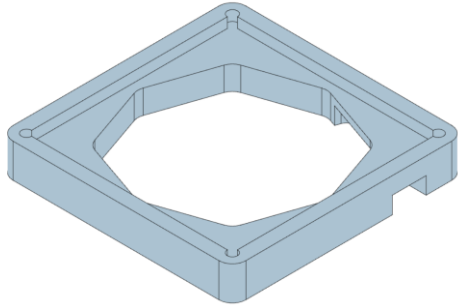


Vacuum chuck

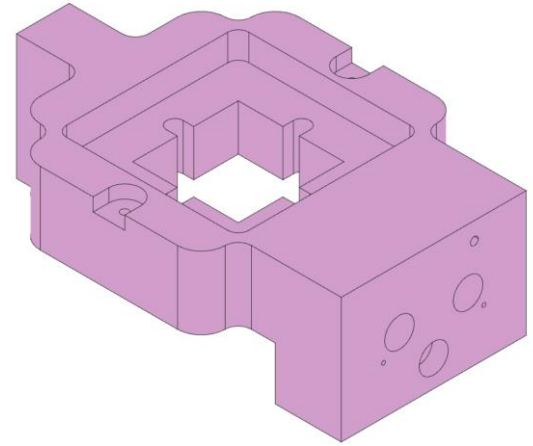


Peltier device

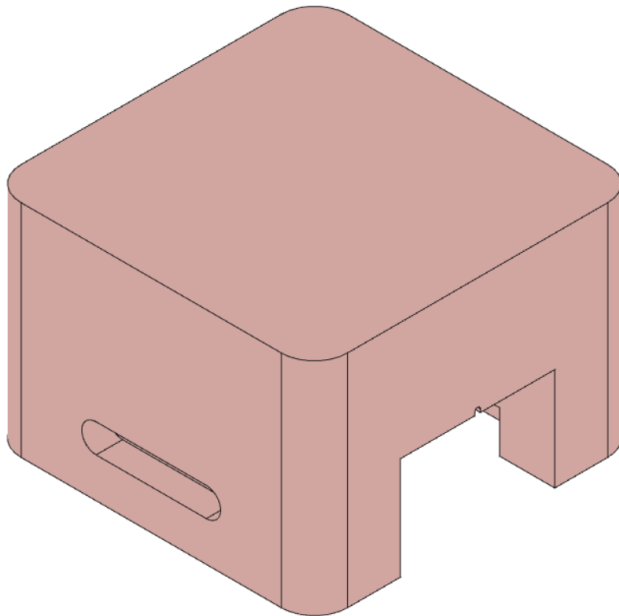
Illustrations



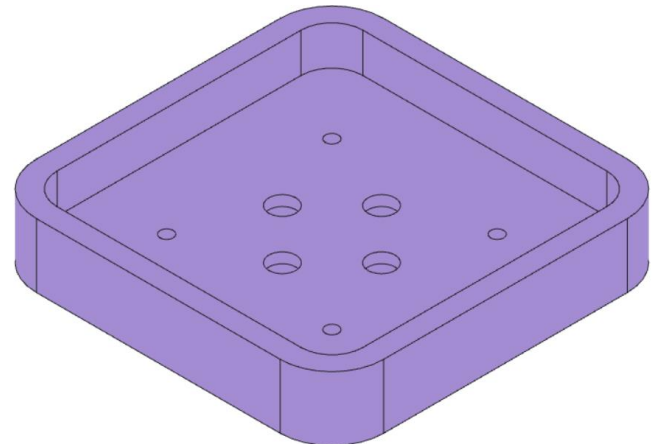
Insert insulation



Internal insulation



Lid

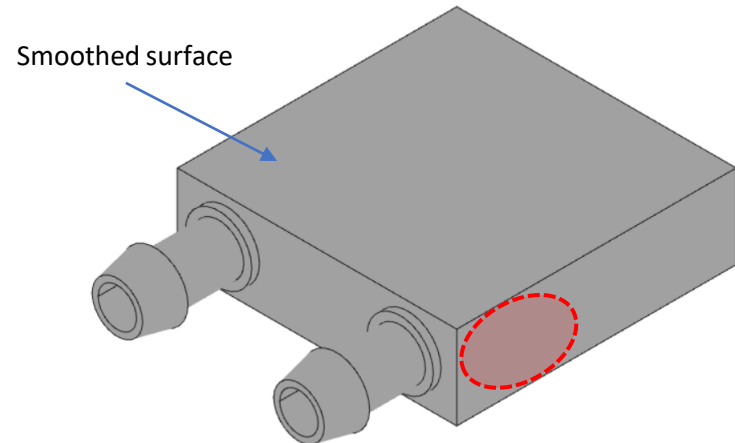
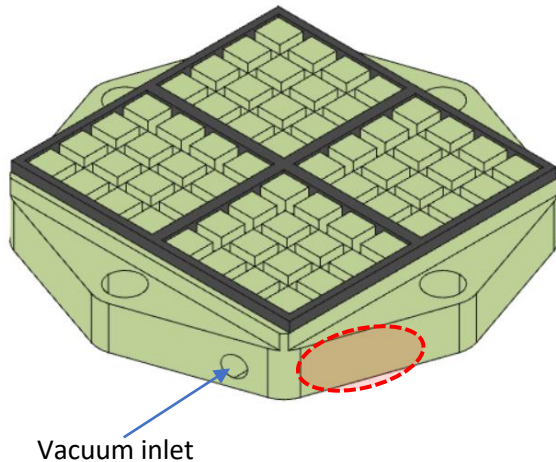


Base insulation

Step 1a: Attaching sensors

Glue the peltier controller temperature sensors to the coldplate and the vacuum chuck. Either use heat-conductive glue or attach it with thermal compound and pot it with epoxy.

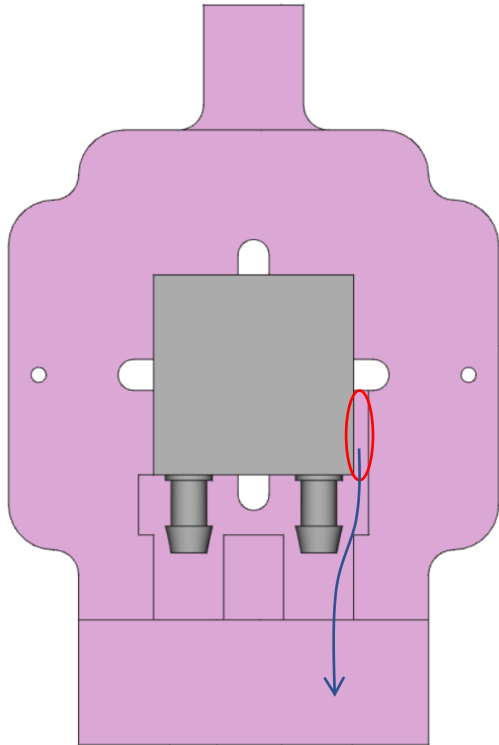
The sensors must be placed at the locations marked here in red:



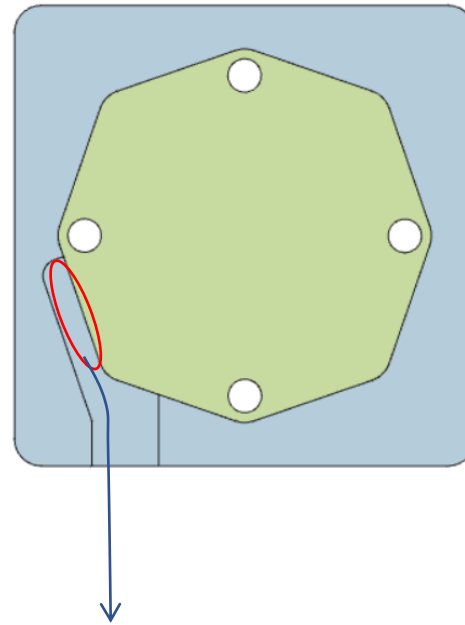
The next page shows why the location matters.

Step 1b: Attaching sensors

There are slots in the foam parts where sensors are meant to fit. Glue the sensors to the coldplate and vacuum chuck so that they will fit in these slots. The sensor wires follow the arrows.



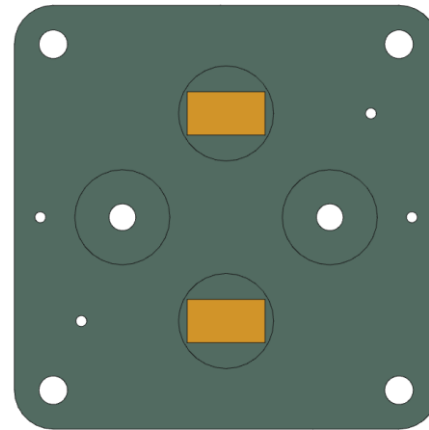
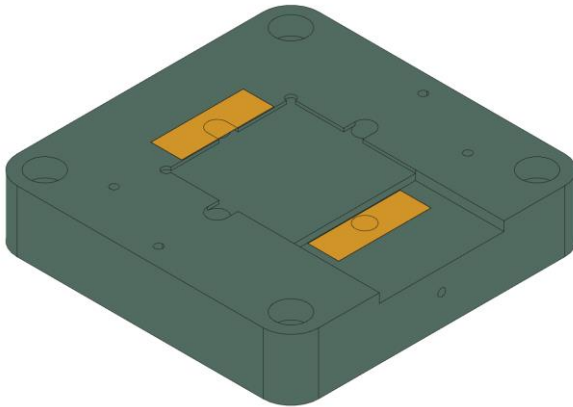
Coldplate temperature sensor location



Vacuum chuck temperature sensor location

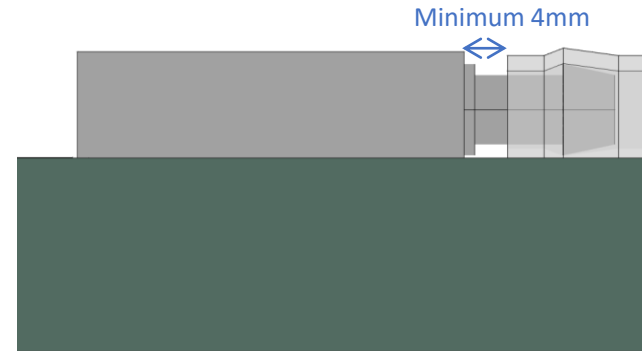
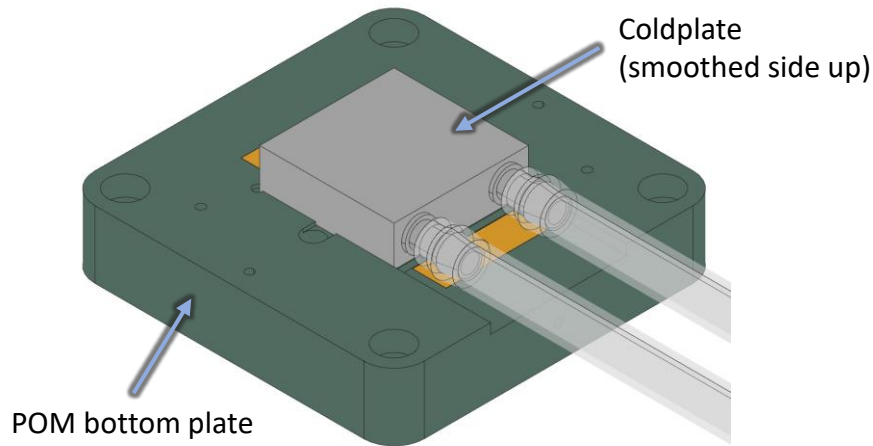
Step 2: Cover the unused holes

This assembly manual assumes you are using a 40x44mm Laird UltraTec as the bottom peltier device. If you are using a standard 40x40mm device instead, please see the appendix.



Begin by taping over the front and bottom cooling stack mounting holes. These holes are not to be used and must be covered up to reduce purge gas leaking.

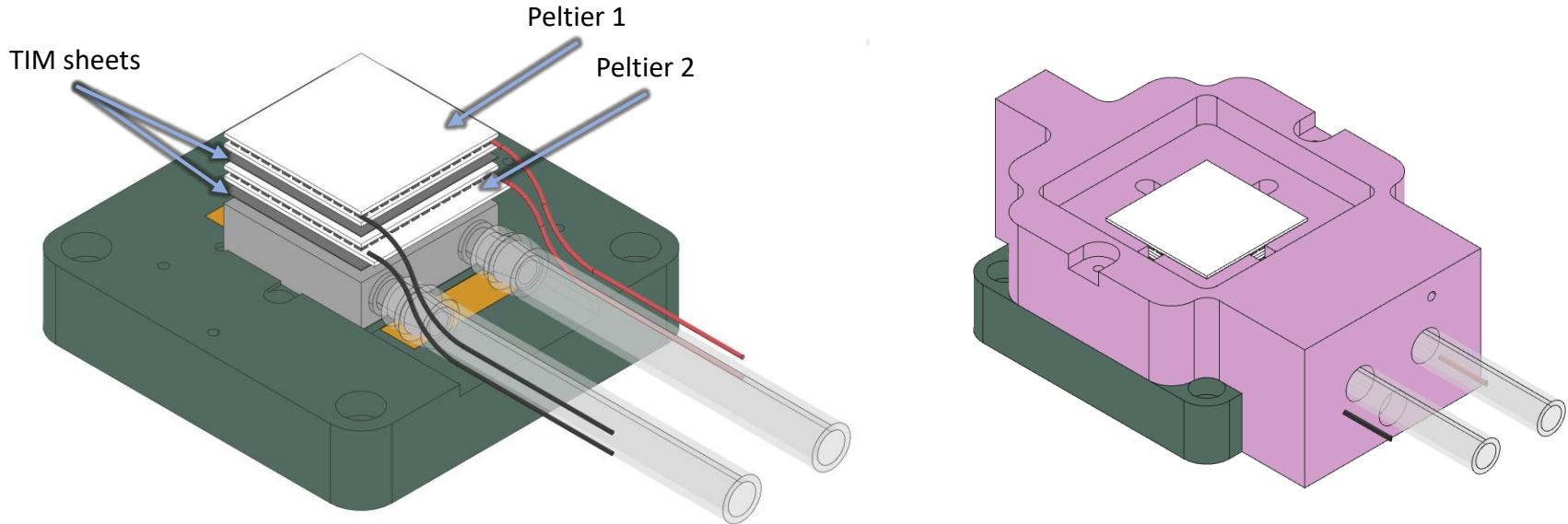
Step 3a: Assemble the cooling stack (1/3)



Attach the flexible coolant tubes to the coldplate. You should tighten the coldplate-tube joint with a zip-tie or similar to prevent coolant leaks. Using grease will further improve the leak tightness.

It is important to ensure that there is at least 4mm of free space from the edge of the coldplate to the tube, since the bottom peltier device will extend 4mm out from the edge of the coldplate.

Step 3b: Assemble the cooling stack (2/3)



This is the trickiest part of the assembly, two persons are recommended.
First double check that the smooth side of the coldplate is pointing up, i.e. in contact with the Peltier.

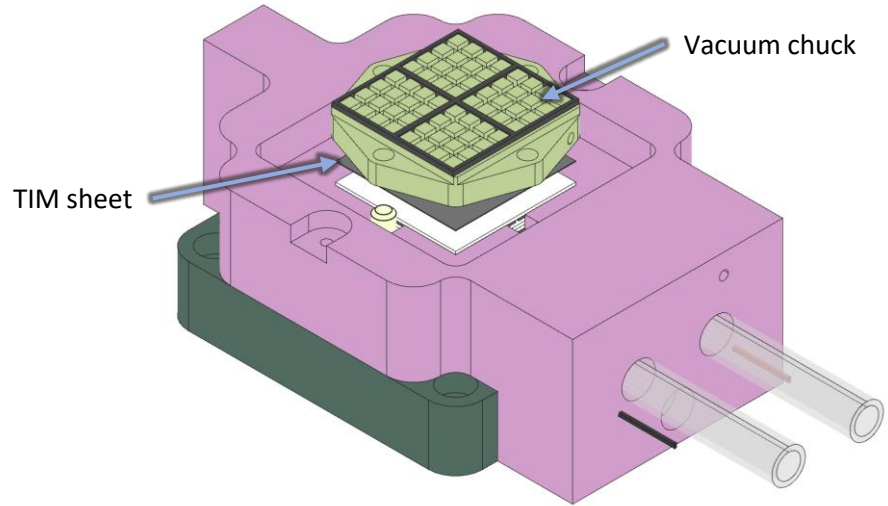
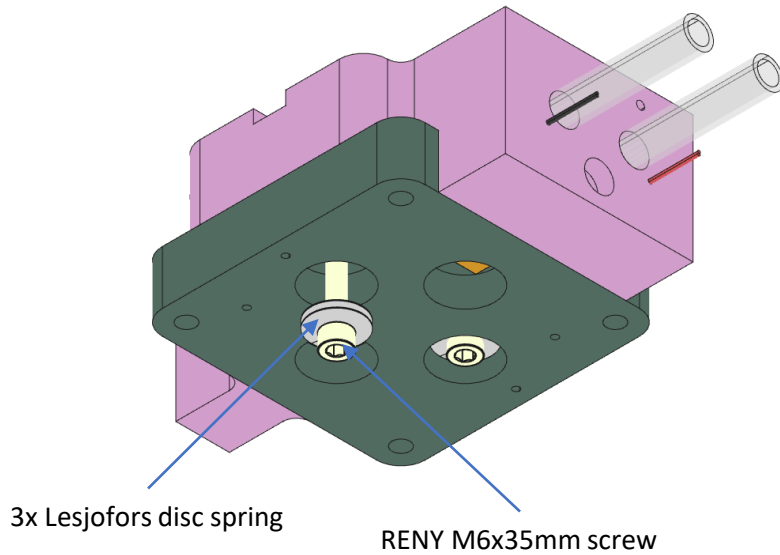
You will stack the TIM sheets and Peltier elements in the following order:

1. TIM sheet
2. Peltier 2, hot side in contact with coldplate
3. TIM sheet
4. Peltier 1, hot side in contact with Peltier 2

Ensure that the TIM sheets and the Peltier elements are aligned.

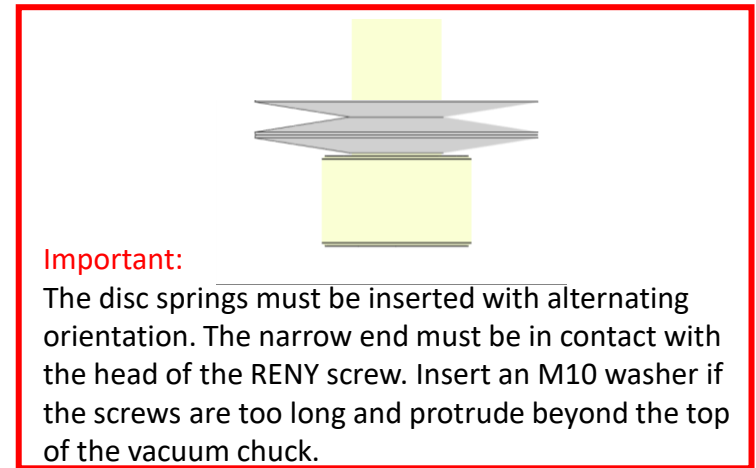
The coolant tubes and the peltier cables are routed through the front of the Internal insulation. You will have to make cuts in the Internal insulation near the Peltier elements to route the cables from Peltier element 1.

Step 3c: Assemble the cooling stack (3/3)



Insert 3 Lesjofors 4273 disc springs (alternating orientation, beginning with the wide end towards the bottom plate) in the two non-blocked mounting holes in the bottom plate. Insert a RENEY M6x35 screw in each hole.

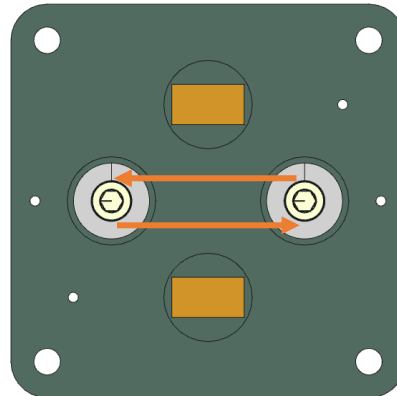
Place the vacuum chuck on top of the peltier device with a 40mm x 40mm TIM sheet between. The vacuum hole must point towards the front. Screw the RENEY screws in gently, do not tighten.



Step 4: Tighten the clamping screws

Flip the cooling unit upside down on a clean surface so the vacuum chuck do not become dirty or damaged. Apply some weight (1-10 kg) to the base plate with your hand to compress the cooling stack. While it is compressed, rotate the RENY screws with your fingers until you feel the slightest friction. This is in order to align the screws with each other which in turn results in even pressure on the cooling stack when they are tightened.

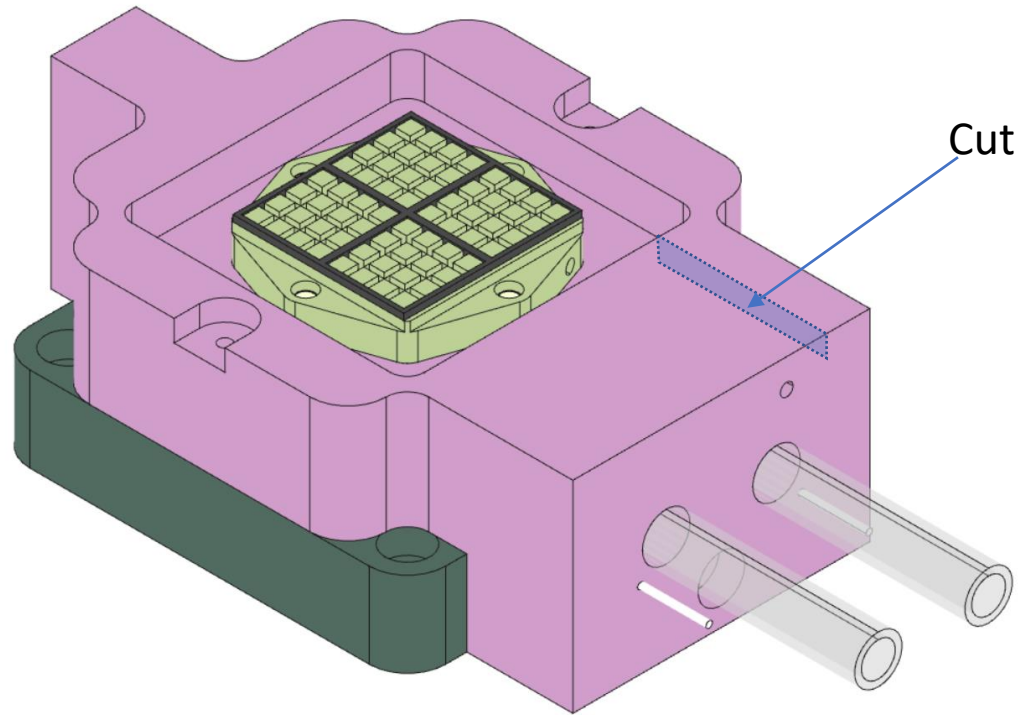
Tighten the clamping screws by making quarter turns, alternatingly, on each screw in this pattern:



Keep making quarter turns until the force applied to the cooling stack is between 500N to 1000N. When using a stack of 3 Lesjofors 4273 disc springs this means a total of 6 quarter turns to each screw.

Warning: Applying excessive force, or worse, uneven force, can easily break the peltier elements.

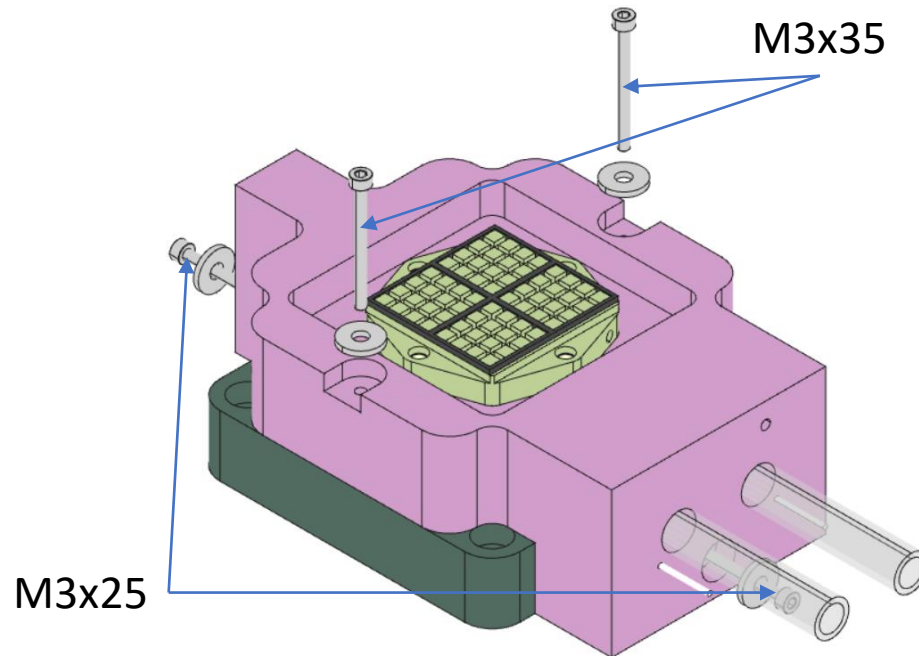
Step 5: Assemble the cooling stack (3/3)



Make a cut with a sharp knife as indicated.

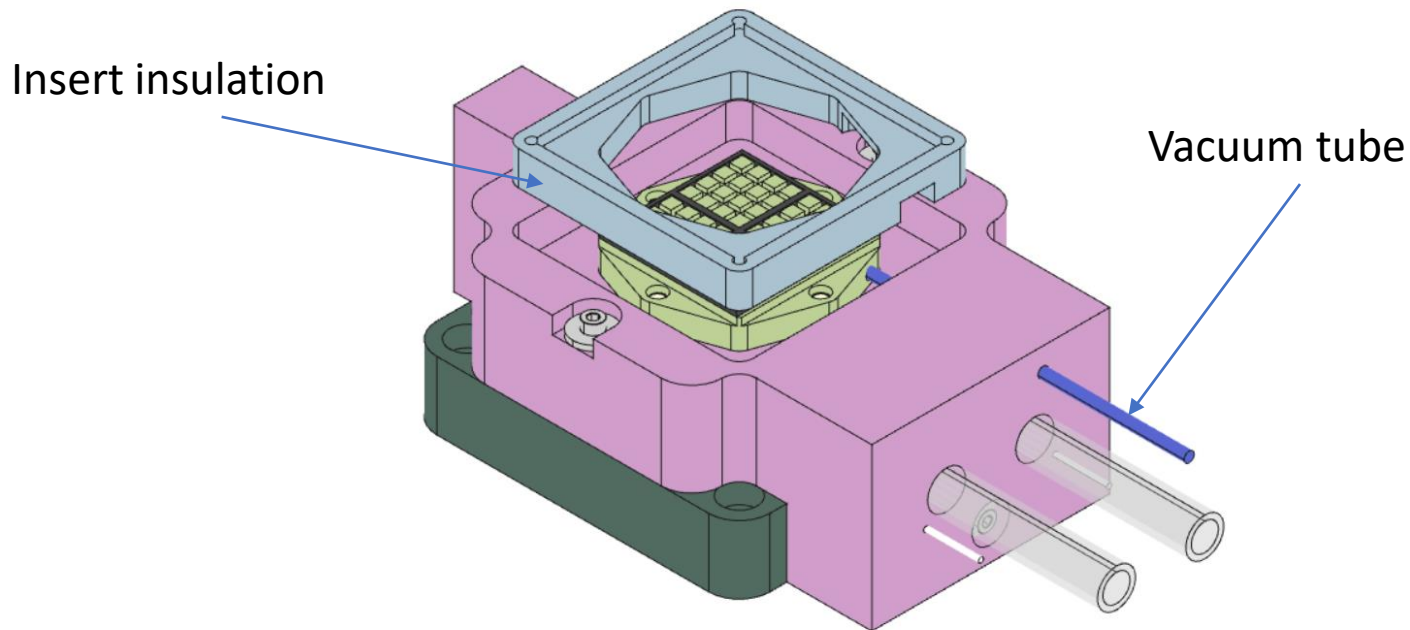
Route the vacuum chuck temperature sensor wires out of the cooling unit by placing them in the cut.

Step 6: Mount the internal insulation



Screw in the four M3 nylon mounting screws. Use washers. Do not tighten excessively.

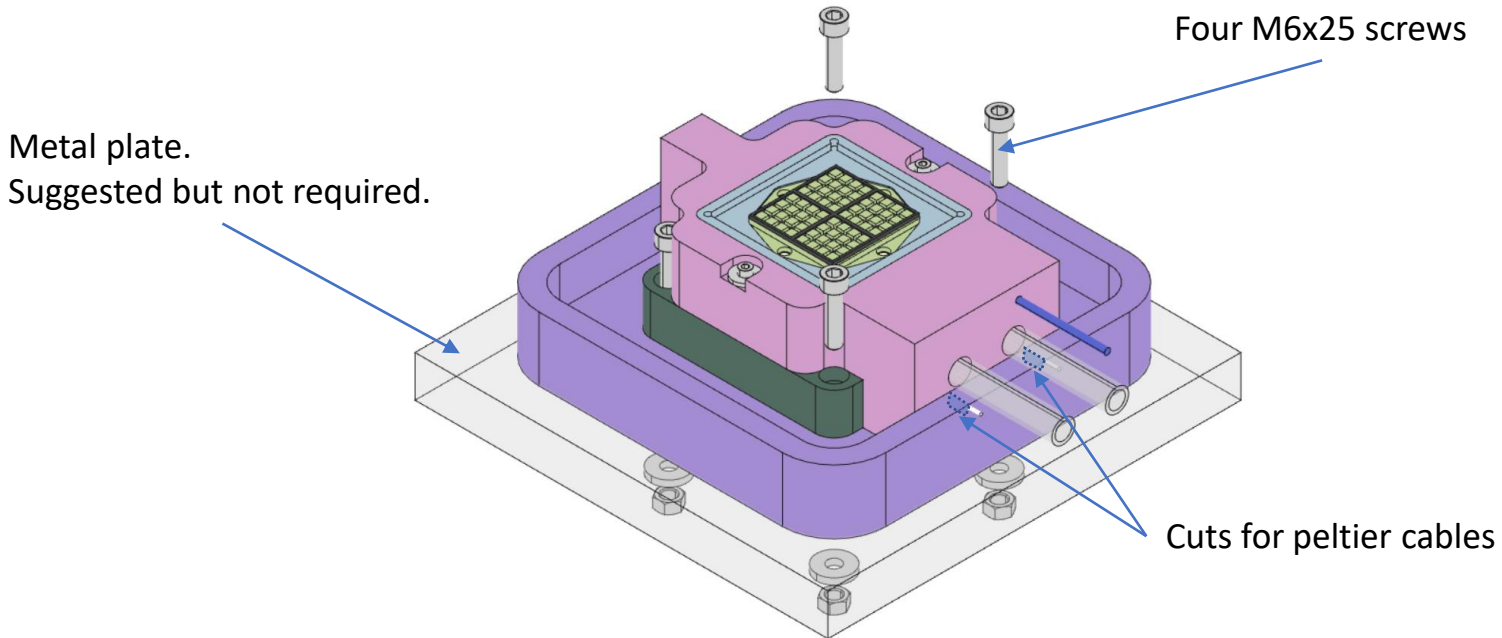
Step 7: Add insert insulation and vacuum tube



Add the insert insulation.

Guide the 3mm OD vacuum tube through the designated hole and attach it to the vacuum chuck. A bit of grease can improve the seal if you experience leaks.

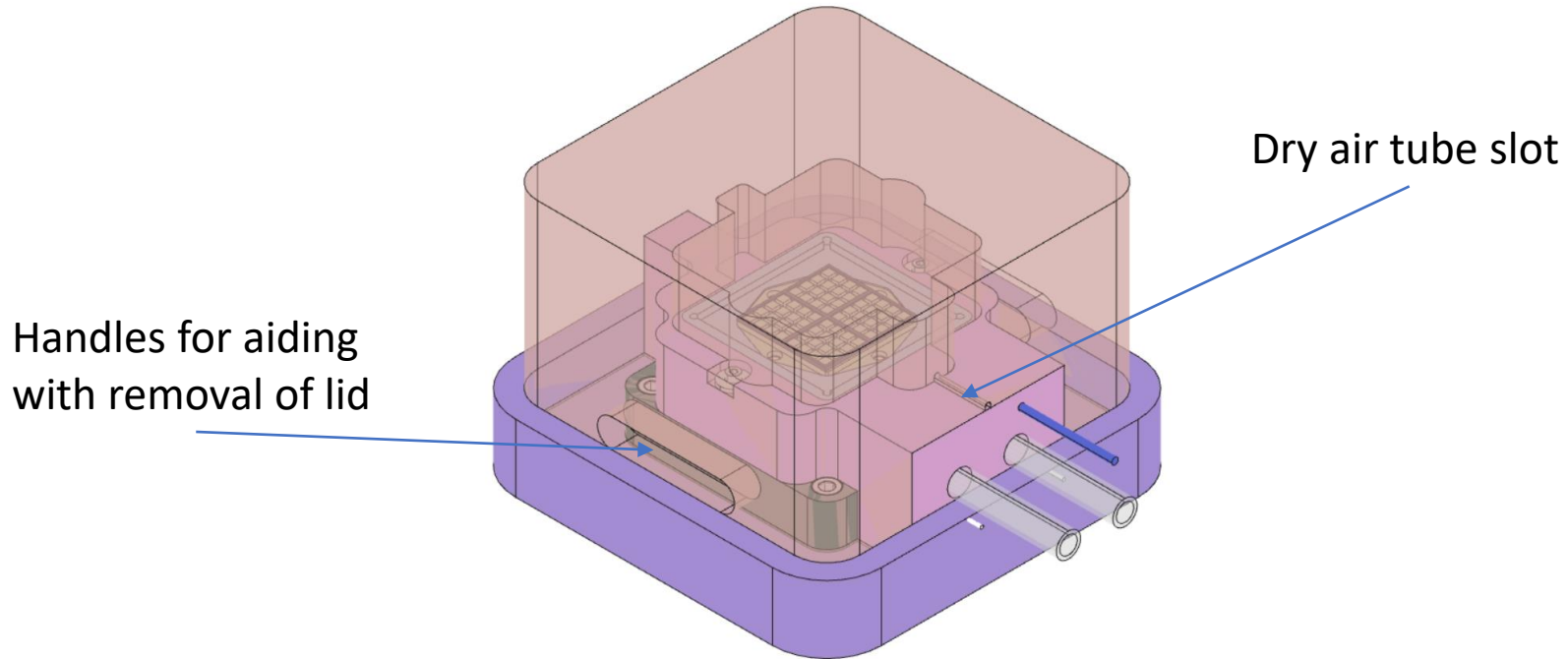
Step 8: Mount the base insulation



Attach the base insulation to the bottom plate using four M6x25 screws. With a sharp knife, make cuts as indicated for the peltier element cables.

Suggestion: Mount the cooling unit to a large metal plate or something else that is immovable. The reason is that the lid of the cooling unit attaches tightly and can be difficult to remove.

Step 9: Add the lid



The lid slides on top of the cooling unit. It has been designed to fit tightly. Flat flex cables (data/power/others) from the interior is routed through the interface between the lid and the internal insulation.

Step 10: Solder the Peltier cables together

The Peltier elements recommended in this guide (see the table in the beginning) are meant to be soldered in parallel (red to red and black to black).

Depending on your selection of peltier elements, you either have to solder them in series or in parallel.

Appendix

Using standard sized peltier elements

If you will be assembling a cooling unit with a standard-sized peltier element (40x40mm), and not the Laird UltraTec (40x44mm) or any other peltier elements that are longer than 40mm, the assembly instructions for Step 2, Step 3, and Step 4 are slightly different.

Step 2 : Skip entirely.

Step 3a : There is no limit on how close the tubes can be to the coldplate.

Step 3b : Assemble as illustrated.

Step 3c : Use all four screws. Use 5 alternating disc springs per screw instead of 3.

Step 4 : Each screw must be turned $3 \frac{1}{2}$ quarter turns in the following pattern:

