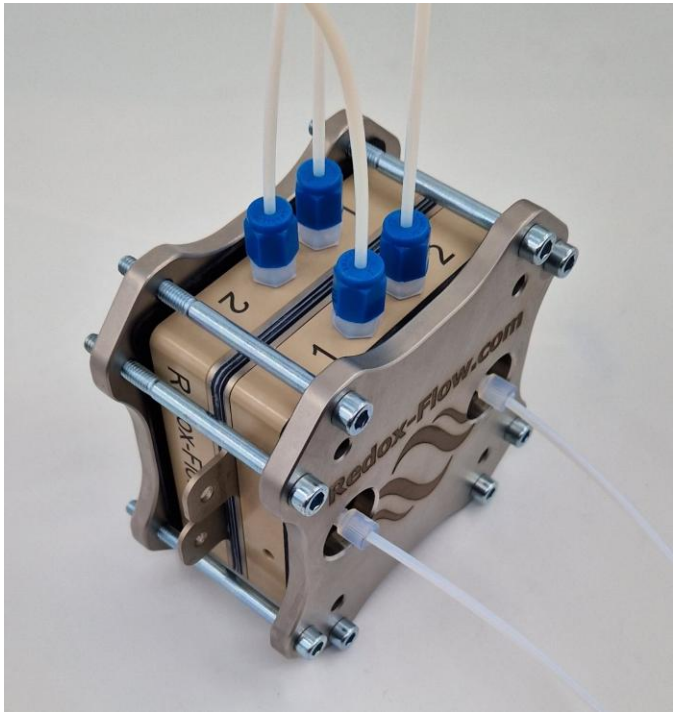
Overview & assembly manual



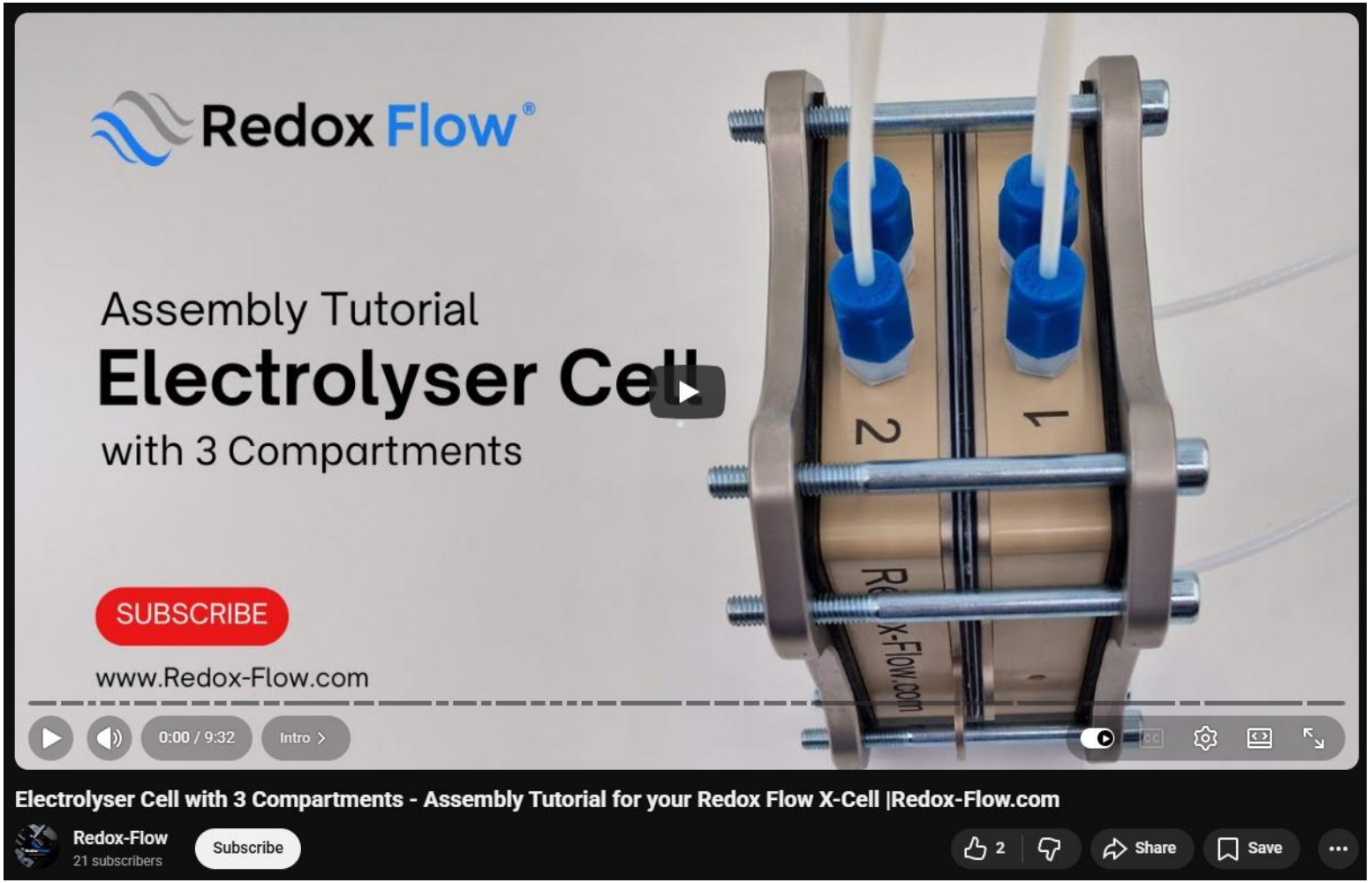
X-Cell – Electrochemical test cell

X-cell with 3 compartments

Version date	March 12 – 2026
Manual version	2.3 - visit www.redox-flow.com for updated versions and spare parts
Notes	This equipment is intended for research purposes only and can be applied for different purposes. There is no guarantee on performance, corrosion or lifetime of the equipment. See https://redox-flow.com/termsandconditions/ for more information.

Assembly Tutorial Video

https://youtu.be/8gE3EPbNT-E?si=_oLzirf1AGXmFPFe

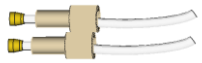


Overview of variants & components included in the cell package

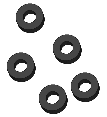
General notes

- All gaskets are ordered separately – are available in PTFE, EPDM and VITON

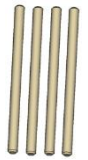
  NOTE: Gaskets are here generally depicted as white (PTFE), however, VITON and EPDM are black.
- Cells are delivered with ring-gaskets and o-rings in both EPDM and VITON
- Current collectors comes in standard materials (see www.redox-flow.com for materials).
- Membranes and electrodes are not included in the cell package – can be ordered separately



Flat bottom flangeless fittings and blinds (1/4-28 UNF)



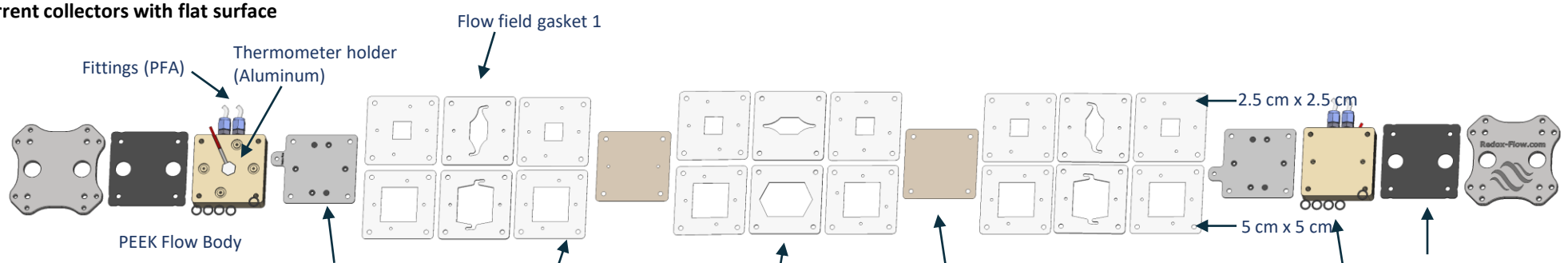
Ring gaskets (in EPDM and VITON)



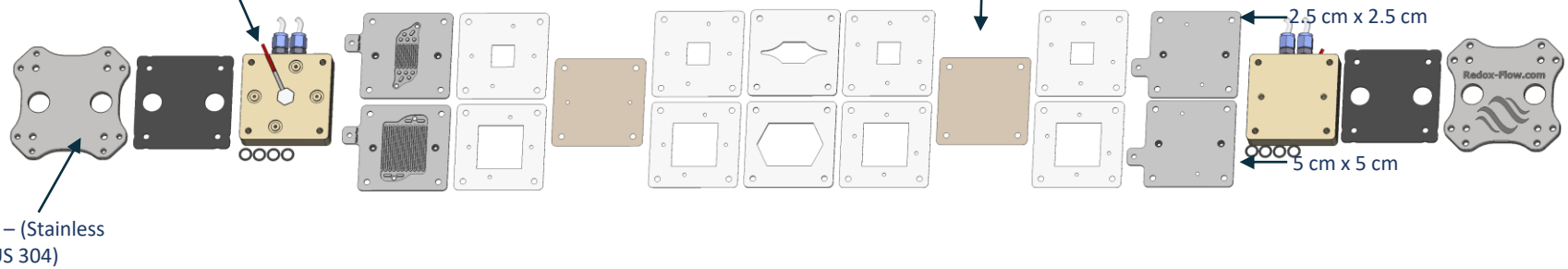
PEEK alignment bars

Bolts

Current collectors with flat surface

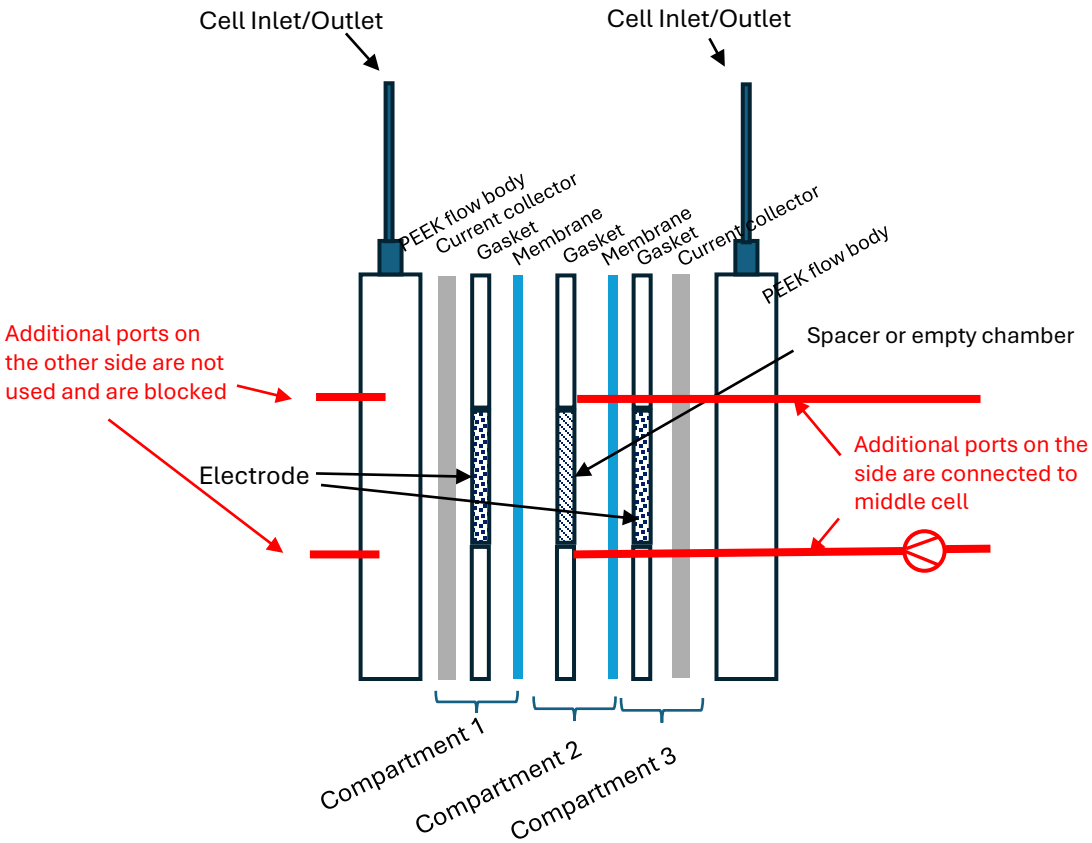


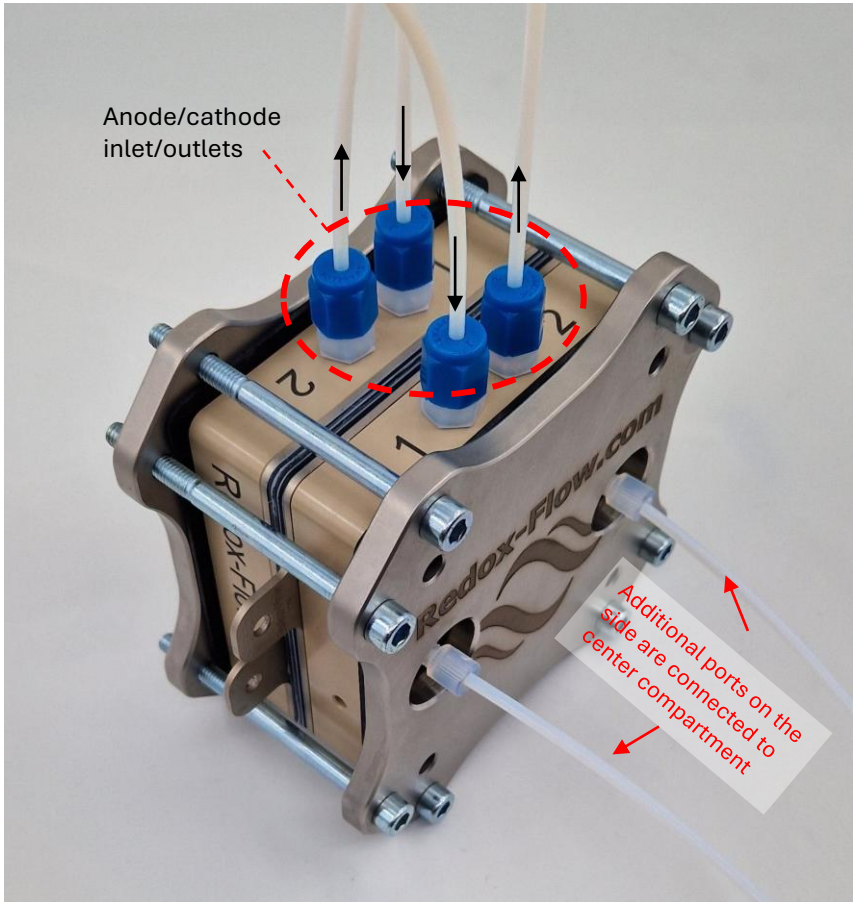
Current collectors with flow field



Working principles

This cell is a variant of the X-cell, the main difference being additional ports that allows a third middle chamber in between the anode/cathode chambers. The middle chamber is separated by membranes on each side. The left figure below is a schematic overview of the working principle, while the right photo show the cell with the inlet/outlets. The additional ports on the back of the cells are not used and are blocked.
All chambers/half cells have variable thicknesses and are determined by the gaskets used.



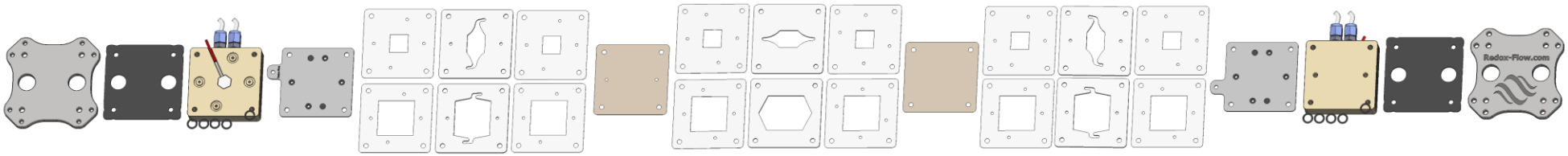


Assembly

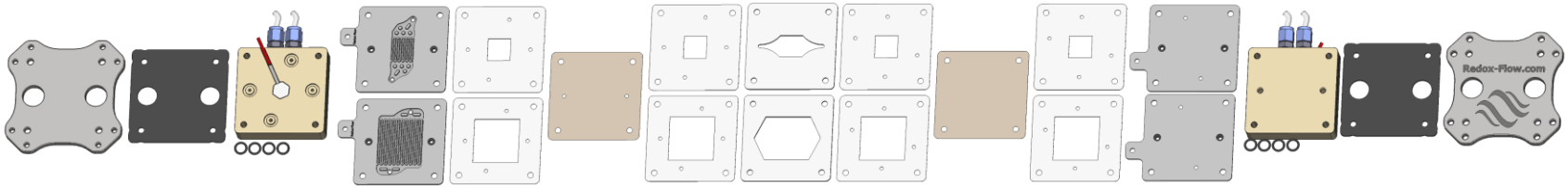
- Image below shows the overall assembly of the cell for both 2.5cm x 2.5cm and 5cm x 5cm active area.
- Assembly goes from left to right with the components turned and rotated as shown in the image.
- Following pages shows a detailed description

NOTE: The order of assembly does not strictly need to follow this manual. Depending on use and experience, assembly can deviate from this manual.

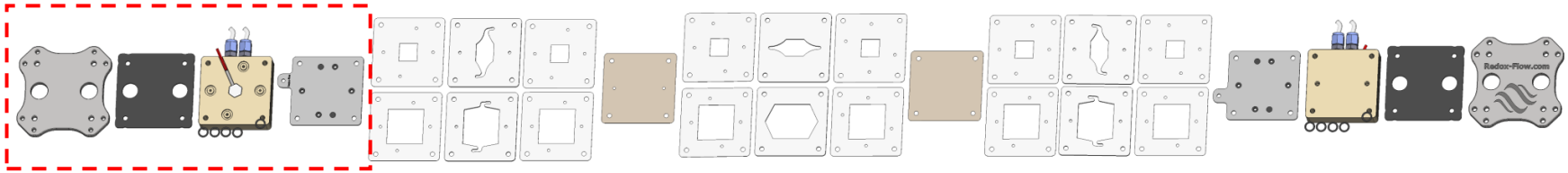
Current collectors with flat surface

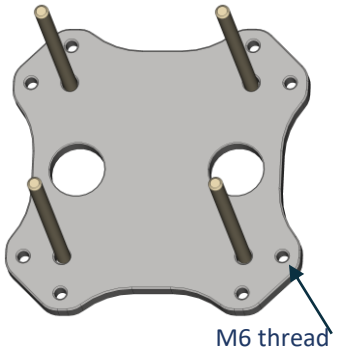


Current collectors with flow field



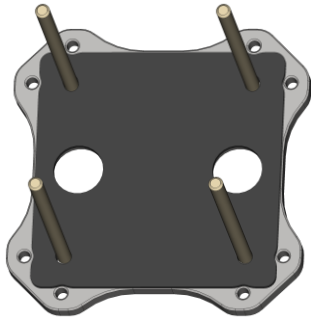
Assembly - Current collectors with flat surface



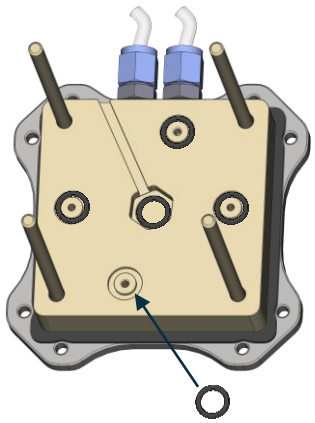


1. Threaded endplate is placed with logo downwards

2. All four alignment bars are placed in the holes in the endplate

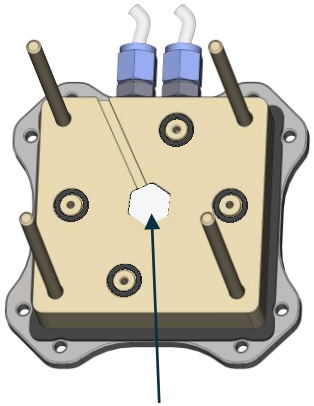


3. Isolator is placed on endplate



4. PEEK flow body is placed on isolator

5. All five O-rings are mounted in the PEEK flow body



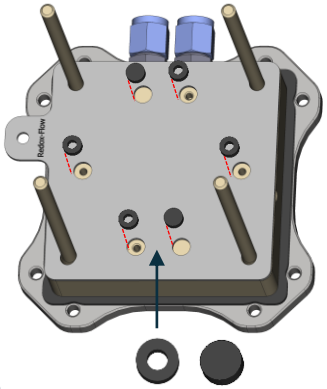
6. Alu thermometer holder is placed in the center hole

NOTE: The holder comes with three holes with different diameter.

-Choose the hole that fits your thermometer best

-Make sure the hole points toward the groove in the PEEK plate

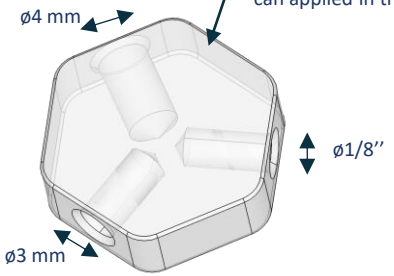
-To ensure good thermal contact a little grease can applied in the hole.



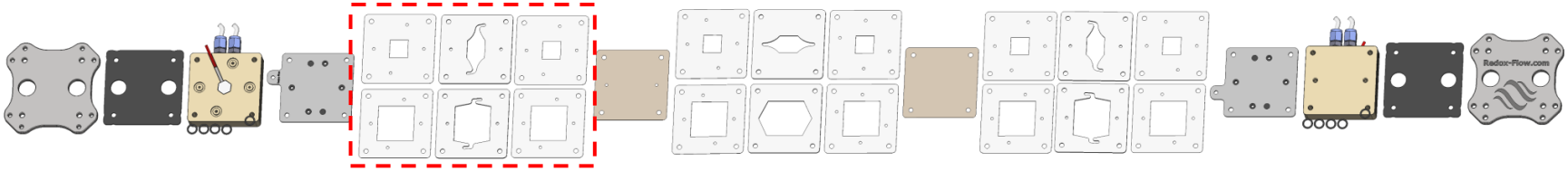
7. Current collector is placed on PEEK flow body

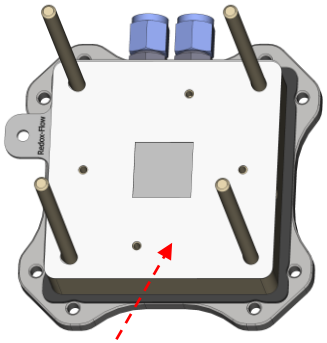
8. *Ring gaskets* with and without holes are mounted in current collector

NOTE: If port is unused, it can be blocked with ring gaskets without holes

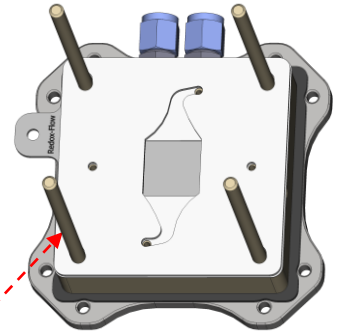


Assembly - Current collectors with flat surface

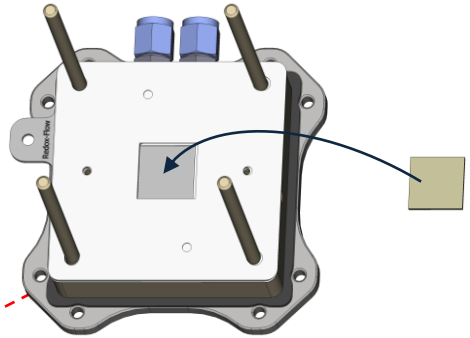




1. *Cover/spacer gaskets* is placed on current collector



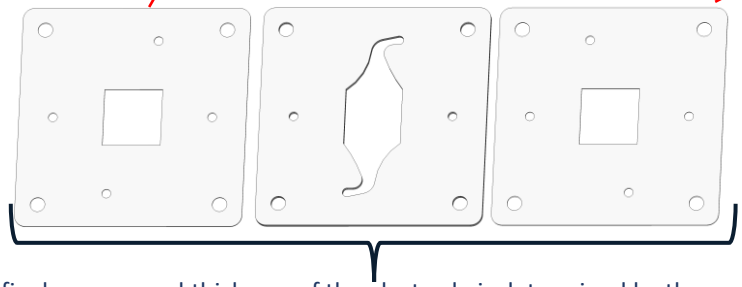
2. *Flow field gasket 1* is placed on cover/spacer gasket isolator



3. *Cover/spacer gaskets* is placed on current collector isolator

4. Place electrode inside the gaskets

IMPORTANT NOTES

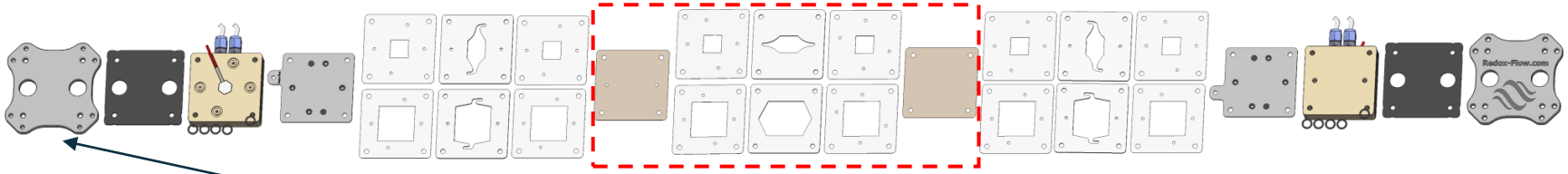


A. The final compressed thickness of the electrode is determined by the sum of the thicknesses of all stacked gaskets. Depending on the electrode varying compression is needed to ensure good electrical contact to the current collector

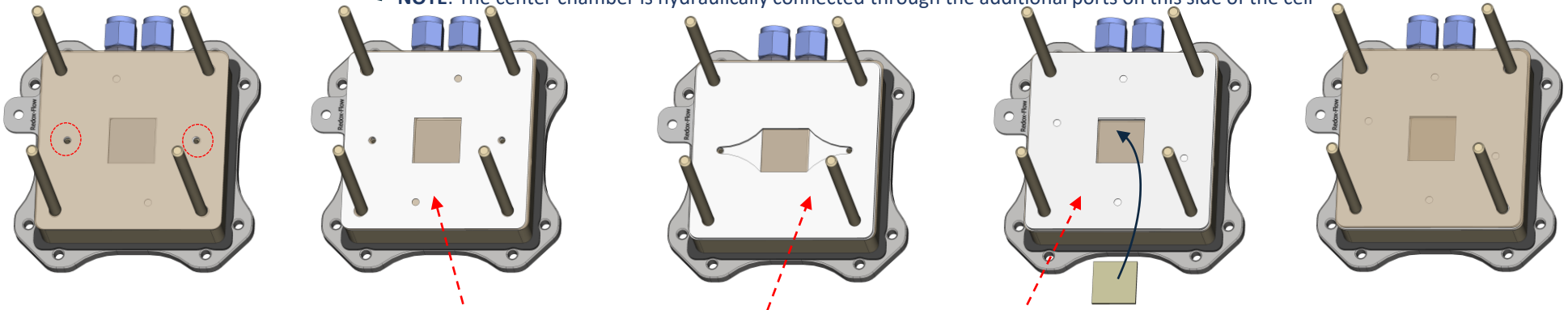
B. Several gaskets of all three types can be stacked on top of each of to fine-tune final compressed electrode thickness

C. It is recommended to have the *flow field gasket* as thick as possible and the two *cover/spacer gaskets* as thin as possible - This is to ensure that the hydraulic channels that connects to the reference electrode(s) are as large as possible.

Assembly - Current collectors with flat surface



NOTE: The center chamber is hydraulically connected through the additional ports on this side of the cell



1. Pierce a small hole ø3-4 mm in the membrane (indicated by red circles). The hole must be exactly on top of the hole in the previous gasket.
NOTE: A membrane (if thin and dense) with area larger than appr. 60 mm x 60 mm can be used as an alternative.
NOTE: All vertical holes in membrane and previous gaskets forms a manifold that cnonn

2. Membrane is mounted

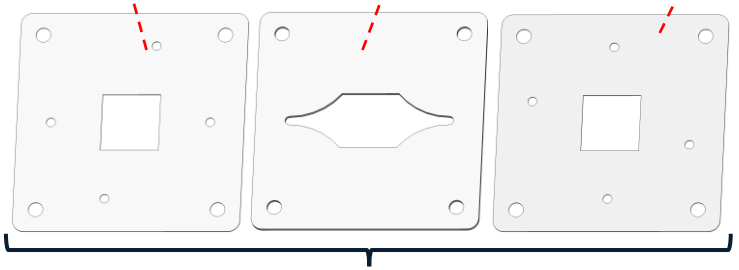
3. *Cover/spacer gasket* is mounted

4. *Flow field gasket 2* is placed on cover/spacer gasket isolator

5. *Cover/spacer gasket* is placed on current collector isolator

6. Optional electrode, spacer or similar is placed in gaskets

7. Membrane is mounted
NOTE: No holes are needed in the membrane



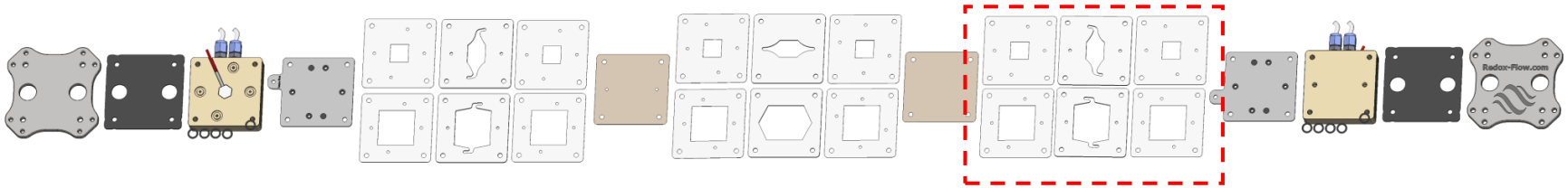
IMPORTANT NOTES

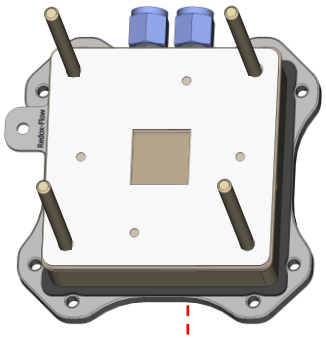
A. The final compressed thickness of the electrode or spacer is determined by the sum of the thicknesses of all stacked gaskets. For rigid spacers it is recommended to have a thickness that matches the total gasket thickness within 0.1 mm

B. Several gaskets of all three types can be stacked on top of each of to fine-tune final compressed electrode thickness

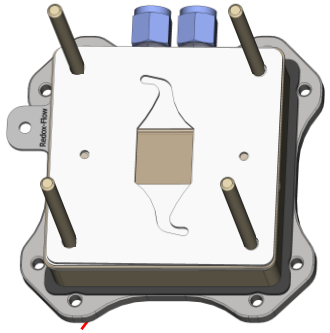
C. It is recommended to have the *flow field gasket* as thick as possible and the two *cover/spacer gaskets* as thin as possible - This is to ensure that the hydraulic channels that connects to the reference electrode(s) are as large as possible.

Assembly - Current collectors with flat surface

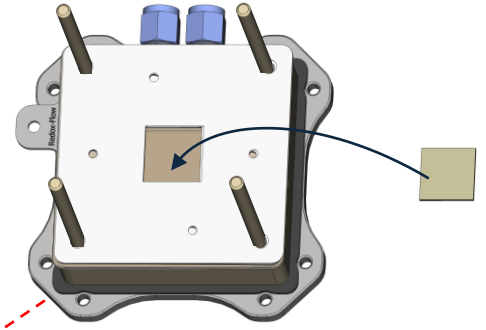




1. *Cover/spacer gaskets* is placed on membrane



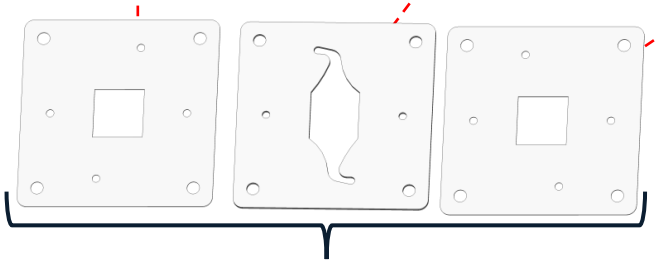
2. *Flow field gasket 1* is placed on cover/spacer gasket isolator



3. *Cover/spacer gaskets* is placed on *Flow field gasket*

4. Place electrode inside the gaskets

IMPORTANT NOTES

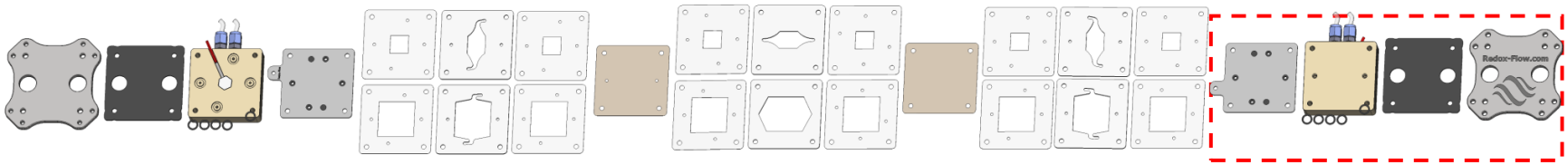


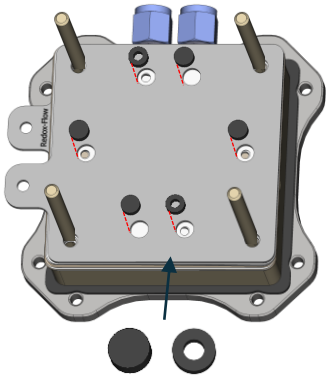
A. The final compressed thickness of the electrode is determined by the sum of the thicknesses of all stacked gaskets. Depending on the electrode varying compression is needed to ensure good electrical contact to the current collector

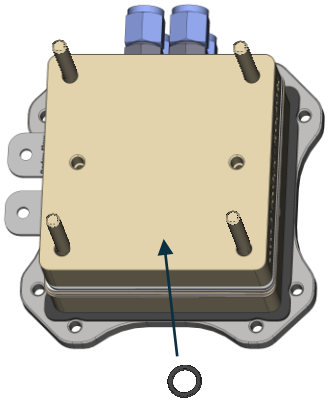
B. Several gaskets of all three types can be stacked on top of each of to fine-tune final compressed electrode thickness

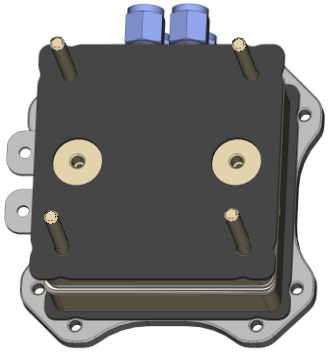
C. It is recommended to have the *flow field gasket* as thick as possible and the two *cover/spacer gaskets* as thin as possible - This is to ensure that the hydraulic channels that connects to the reference electrode(s) are as large as possible.

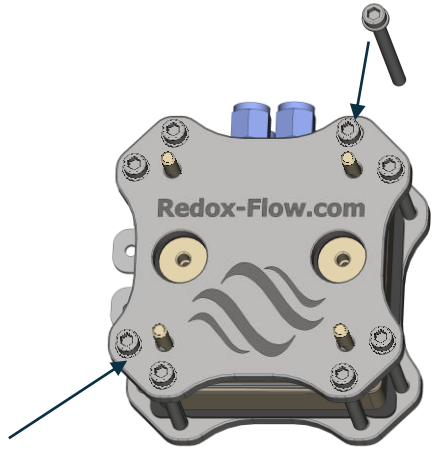
Assembly - Current collectors with flat surface











Hole for bolts in endplate is without a thread

1. Current collector is placed on last *Cover/spacer gaskets*
NOTE: the flow field in the current collector must face downwards

2. Ring gaskets are mounted in current collector
NOTE: On this side the additional ports are unused and are blocked with ring gaskets without holes

3. All four/five O-rings are mounted in the PEEK flow body (opposite side)
NOTE: If a thermometer is also used on this side, the thermometer holder should also be mounted.

4. PEEK flow body is placed on current collector

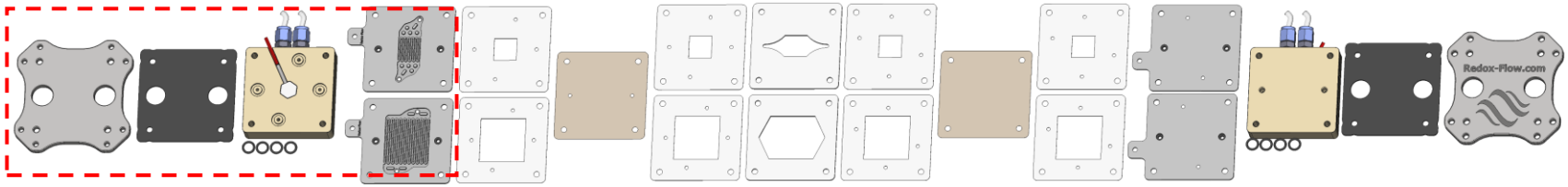
5. Isolator is placed on PEEK flow body

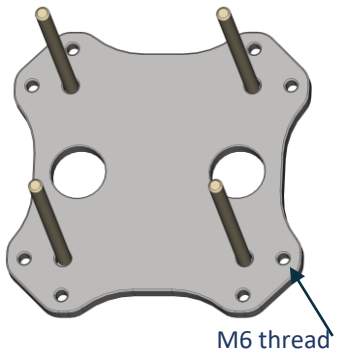
6. Unthreaded endplate is placed with logo downwards

7. All eight bolts are placed in the outmost holes in the endplate
NOTE: Use bolts with correct length
NOTE: Keep alignment bars in the cell – they are taken out during the tightening of the cell

CELL IS NOW ASSEMBLED AND READY FOR TIGTHENING

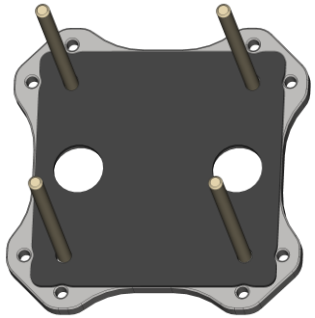
Assembly - Current collectors with flow field



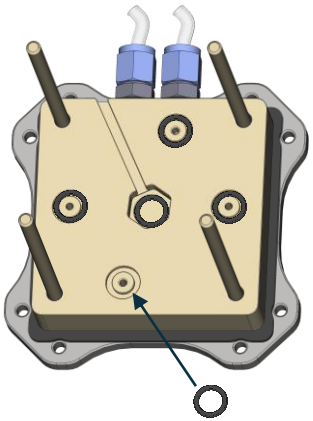


1. Threaded endplate is placed with logo downwards

2. All four alignment bars are placed in the holes in the endplate

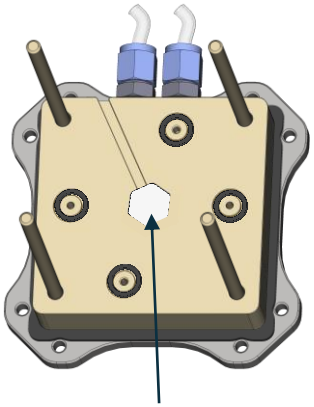


3. Isolator is placed on endplate



4. PEEK flow body is placed on isolator

5. All five O-rings are mounted in the PEEK flow body



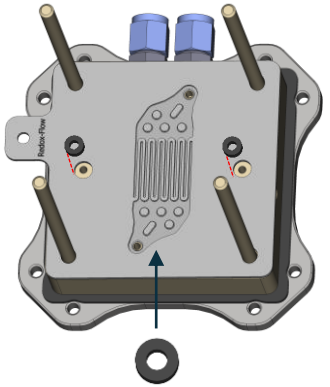
6. Alu thermometer holder is placed in the center hole

NOTE: The holder comes with three holes with different diameter.

-Choose the hole that fits your thermometer best

-Make sure the hole points toward the groove in the PEEK plate

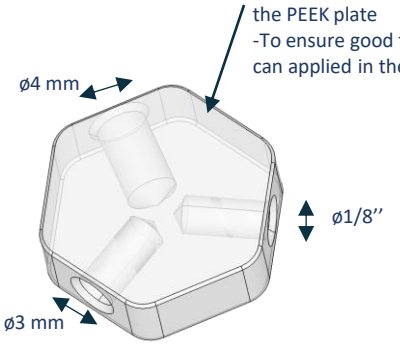
-To ensure good thermal contact a little grease can applied in the hole.



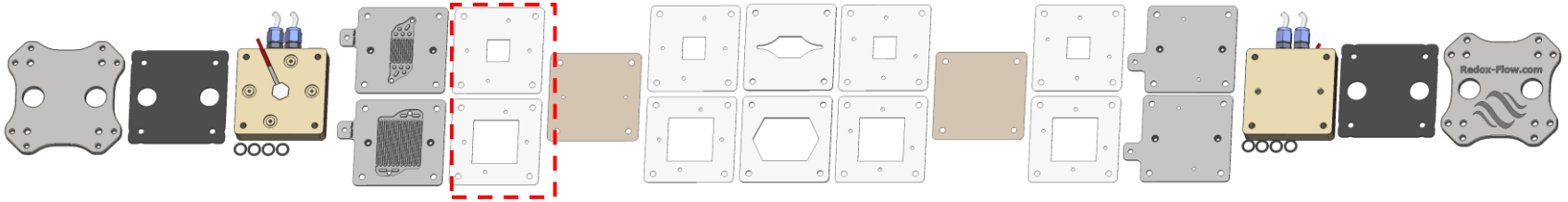
7. Current collector is placed on PEEK flow body

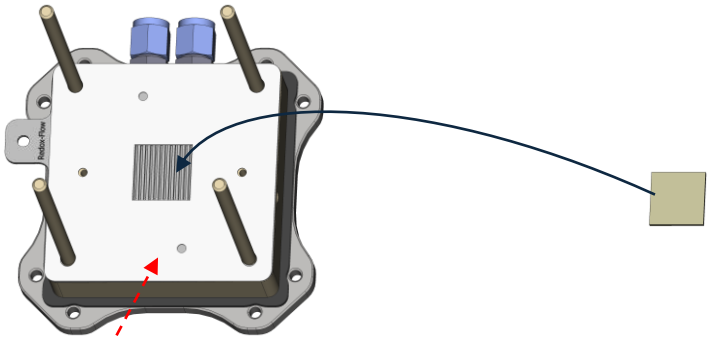
8. *Ring gaskets* with and without holes are mounted in current collector

NOTE: If port is unused, it can be blocked with ring gaskets without holes



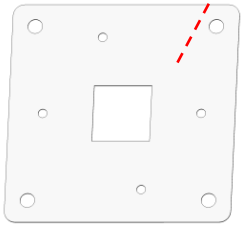
Assembly - Current collectors with flow field





1. *Cover/spacer gaskets* is placed on current collector

2. Place electrode inside the gaskets



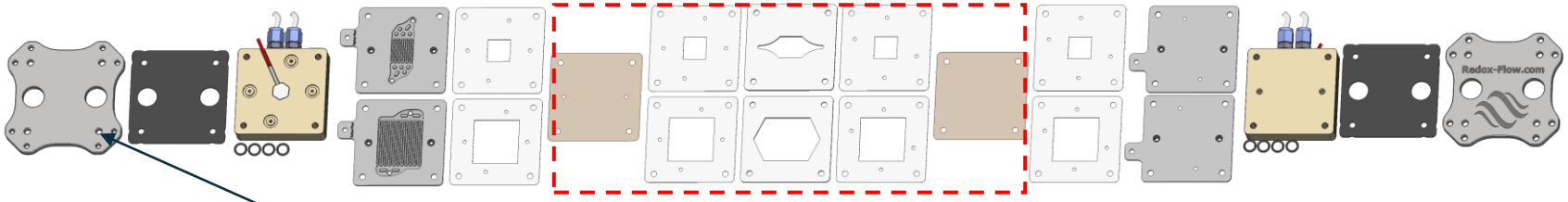
IMPORTANT NOTES

A. The final compressed thickness of the electrode is determined by the sum of the thicknesses of all stacked gaskets. Depending on the electrode varying compression is needed to ensure good electrical contact to the current collector

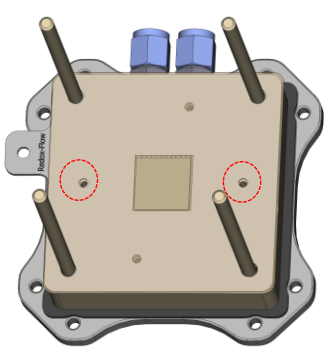
B. Several gaskets can be stacked on top of each of to fine-tune final compressed electrode thickness

C. It is recommended to have the *flow field gasket* as thick as possible and the two *cover/spacer gaskets* as thin as possible - This is to ensure that the hydraulic channels that connects to the reference electrode(s) are as large as possible.

Assembly - Current collectors with flow field

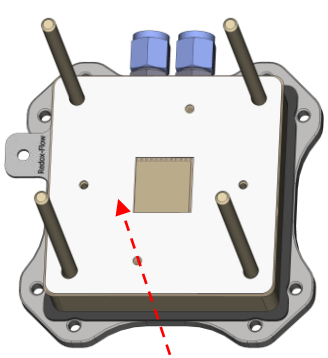


NOTE: The center chamber is hydraulically connected through the additional ports on this side of the cell

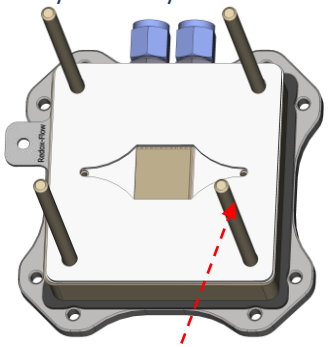


1. Pierce a small hole ø3-4 mm in the membrane (indicated by red circles). The hole must be exactly on top of the hole in the previous gasket.
NOTE: A membrane (if thin and dense) with area larger than appr. 60 mm x 60 mm can be used as an alternative.
NOTE: All vertical holes in membrane and previous gaskets forms a manifold that cnonn

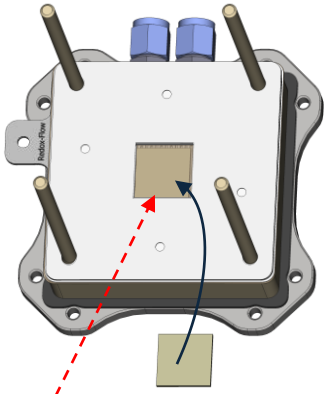
2. Membrane is mounted



3. *Cover/spacer gasket* is mounted

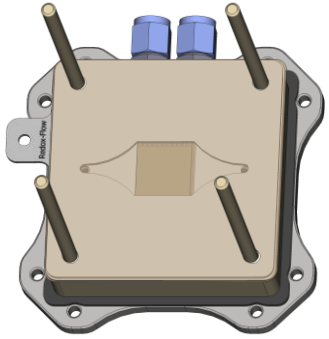


4. *Flow field gasket 2* is placed on cover/spacer gasket

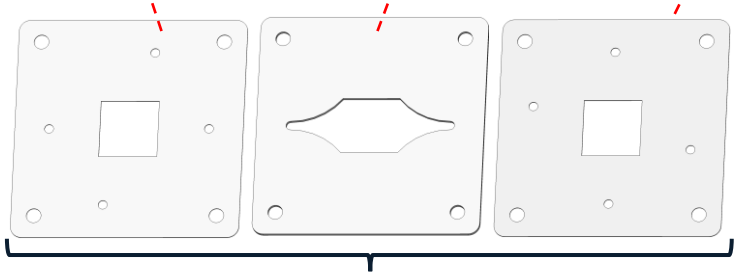


5. *Cover/spacer gasket* is placed on flow field gasket

6. Optional electrode, spacer or similar is placed in gaskets



7. Membrane is mounted
NOTE: No holes are needed in the membrane



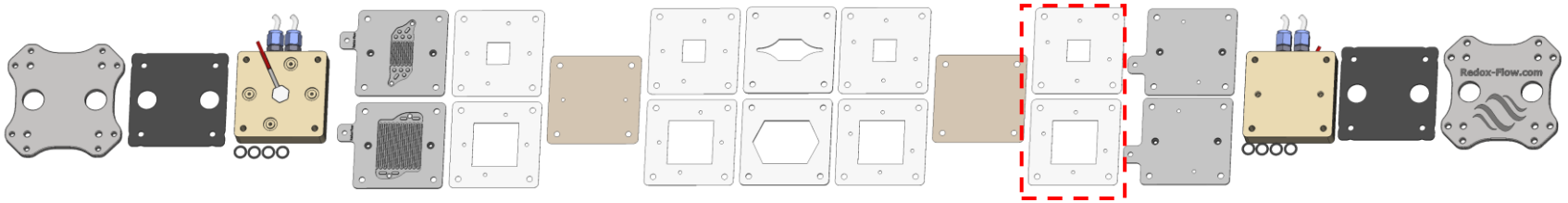
IMPORTANT NOTES

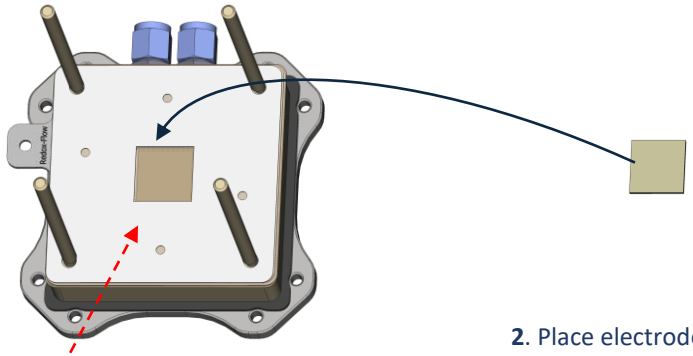
A. The final compressed thickness of the electrode or spacer is determined by the sum of the thicknesses of all stacked gaskets. For rigid spacers it is recommended to have a thickness that matches the total gasket thickness within 0.1 mm

B. Several gaskets of all three types can be stacked on top of each of to fine-tune final compressed electrode thickness

C. It is recommended to have the *flow field gasket* as thick as possible and the two *cover/spacer gaskets* as thin as possible - This is to ensure that the hydraulic channels that connects to the reference electrode(s) are as large as possible.

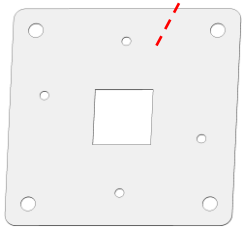
Assembly - Current collectors with flow field





1. *Cover/spacer gaskets* is placed on membrane.

2. Place electrode inside the gaskets



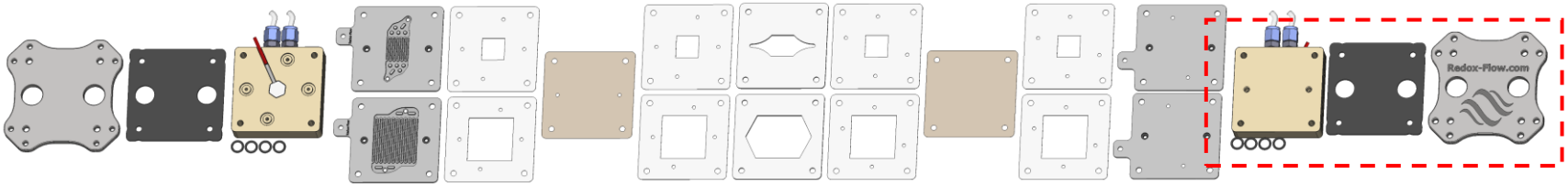
IMPORTANT NOTES

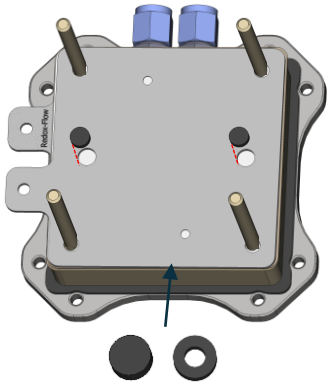
A. The final compressed thickness of the electrode is determined by the sum of the thicknesses of all stacked gaskets. Depending on the electrode varying compression is needed to ensure good electrical contact to the current collector.

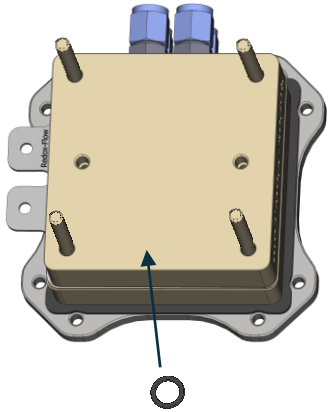
B. Several gaskets can be stacked on top of each of to fine-tune final compressed electrode thickness.

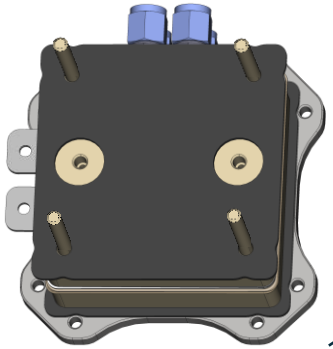
C. It is recommended to have the *flow field gasket* as thick as possible and the two *cover/spacer gaskets* as thin as possible - This is to ensure that the hydraulic channels that connects to the reference electrode(s) are as large as possible.

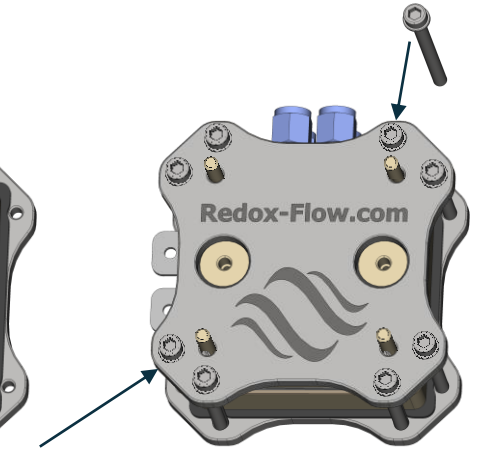
Assembly - Current collectors with flow field











Hole for bolts in endplate is without a thread

1. Current collector is placed on last *Cover/spacer gaskets*
NOTE: the flow field in the current collector must face downwards

2. Ring gaskets are mounted in current collector
NOTE: On this side the additional ports are unused and are blocked with ring gaskets without holes

3. All four/five O-rings are mounted in the PEEK flow body (opposite side)
NOTE: If a thermometer is also used on this side, the thermometer holder should also be mounted.

4. PEEK flow body is placed on current collector

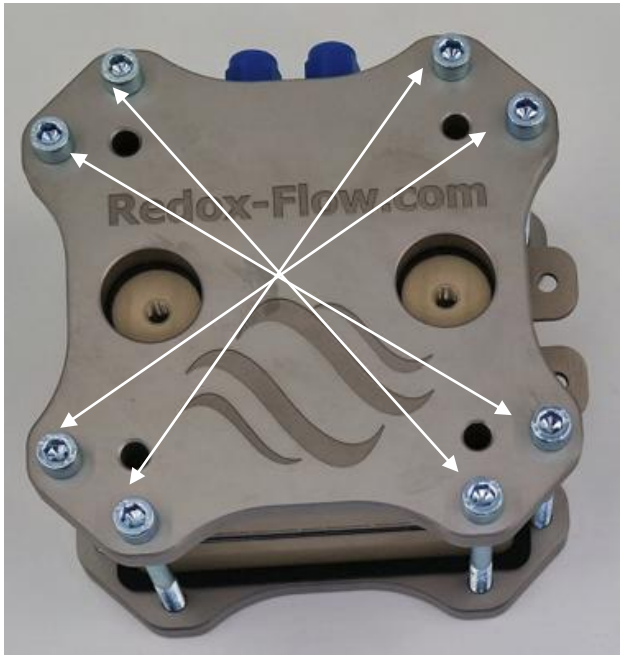
5. Isolator is placed on PEEK flow body

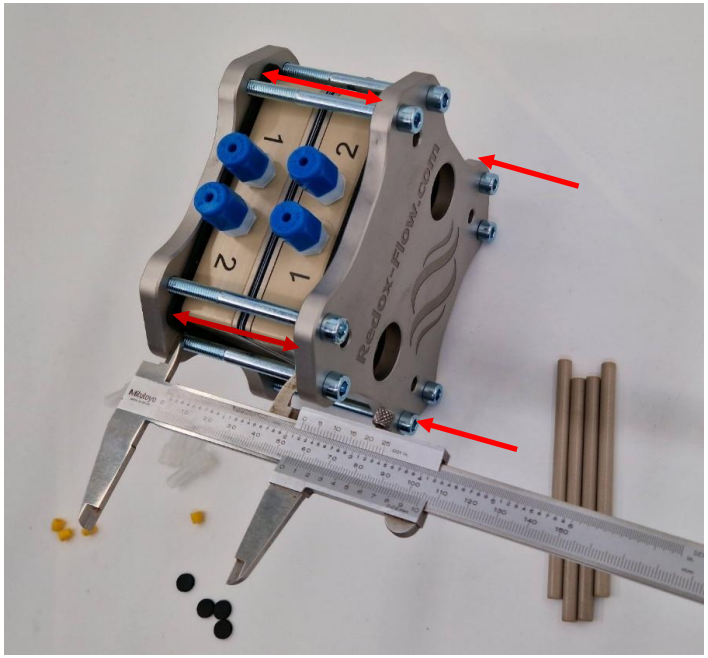
6. Unthreaded endplate is placed with logo upwards

7. All eight bolts are placed in the outmost holes in the endplate
NOTE: Use bolts with correct length
NOTE: Keep alignment bars in the cell – they are taken out during the tightening of the cell

CELL IS NOW ASSEMBLED AND READY FOR TIGTHENING

Assembly – Final assembly





STEP 1

- Hex bolts are cross tightened up to 9 Nm.
- Alignment bars are removed before cell is completely tightened - if left in the cell, there is a (small) risk of leaks inside channels for the alignment bars

STEP 2

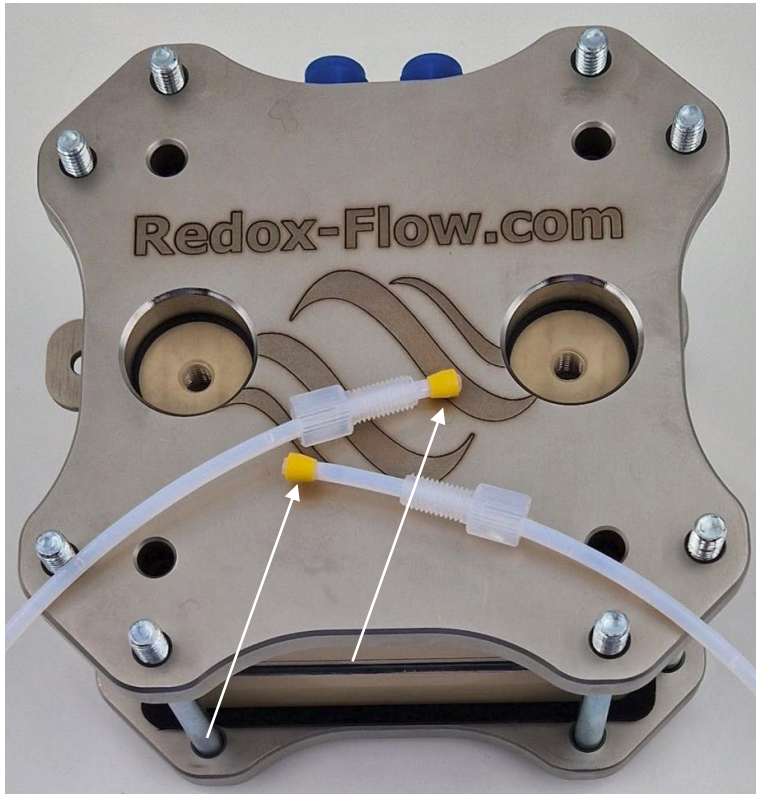
- Quality of the cross tightened is checked by measuring the distance between the endplates at all four corners with a caliber
- The distance should not vary more than 0.1-0.2mm
- NOTE: Step 1 and 2 can be performed iteratively.

IMPORTANT NOTES

- Measurement with caliber is paramount for a tight sealing – It is not a high torque that seals the cell, it is a correct alignment of the flow bodies. Up to 9 Nm max. Recommended to experiment 5-8 Nm, seeing what is the best fit.

Application notes – Unused ports

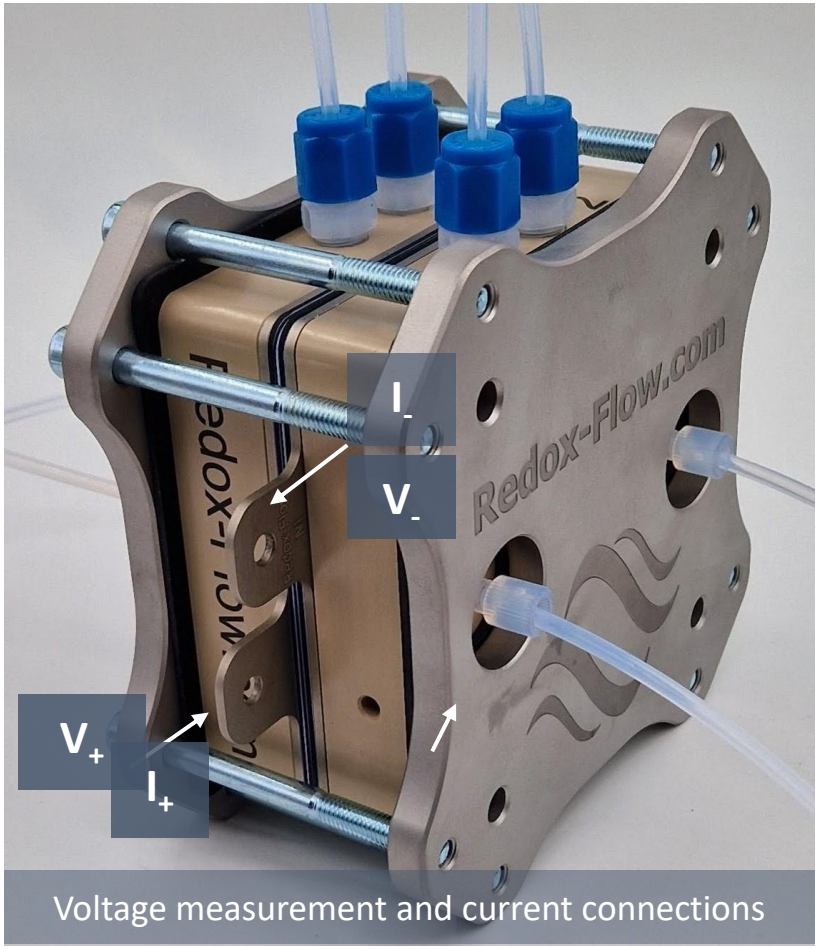
If assembled as described in the current manual, the ports on the front side are not used can be sealed by the blind fittings (and ring gaskets without holes – see assembly)



A. Ferrules are mounted on the tube
NOTE: The flat part of the yellow ferrule has to be pointed toward the cell

B. Tube fittings are mounted in cell
NOTE: Only use finger tightening (no tools)

Application notes – Electrical connections



Voltage measurement and current connections

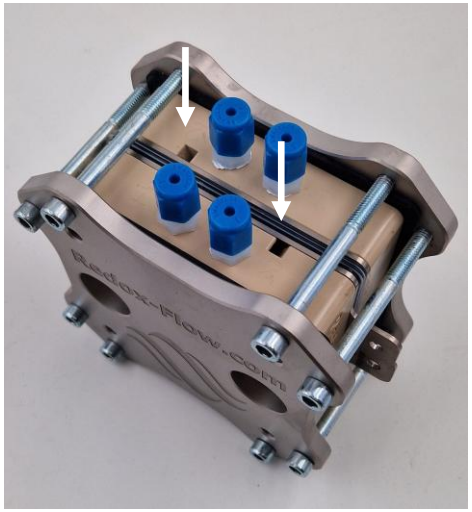
IMPORTANT - It is paramount for safety and reproducible data that the wires for

- Electrical current (I_+ and I_-) are well connected on the current collectors e.g. with cable lugs, bolts or other recognized solutions for making proper electrical connections

NOTE: Poorly connected current wires will lead to significant contact resistance between the wire and current collectors. For high current operation (e.g. > 1 A) the contact resistance (even small ones) can lead to significant heating in the contact points.

- Voltage measurements (V_+ and V_-) are mounted on the current collectors to ensure a proper 4-wire configuration

NOTE: As the wires for voltage measurement does not carry any electrical current, there are no strict requirements for the quality of the connection and can e.g. be connected with crocodiles or similar

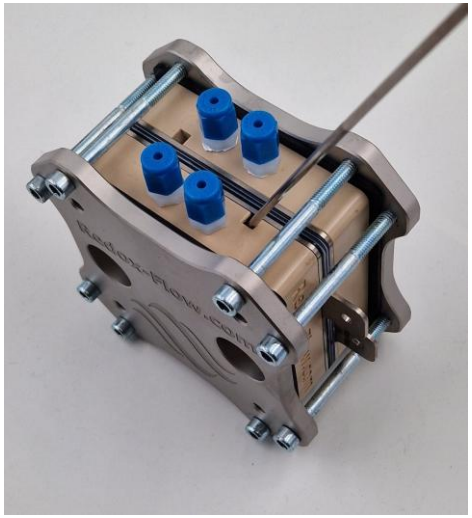


Holes for thermometers

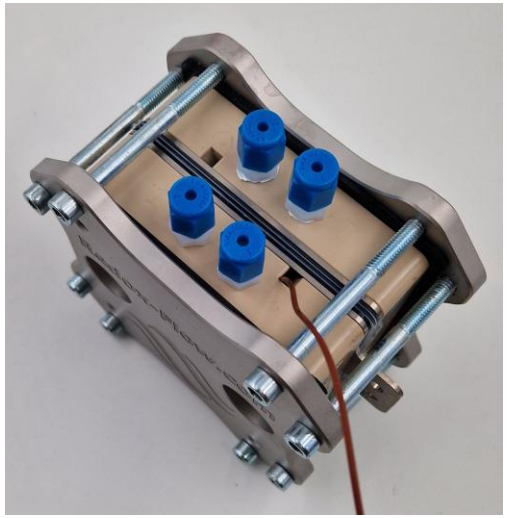
Temperature sensor

- In each of the PEEK flow bodies there are holes with direct access to the aluminum thermometer holder. The distance from the PEEK surface to the bottom of the thermometer holder is approximately 55 mm
- The aluminum holder is pressed up against the metal current collector. This ensures very good thermal contact whereby
    - The temperature can be measured fast (very short time delay on temperature changes)
    - The temperature can be measured very precise
- To increase the thermal contact a little grease can be applied to the head of the thermometer or inside the hole of the thermometer holder

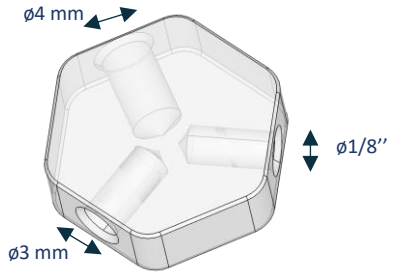
VERY IMPORTANT: The thermometer holder is in direct metallic contact with the bipolar plate and will for this reason have the same applied electrical potential as the bipolar plate. **Here is it extremely important that the electrical circuit of the thermometer is electrically isolated from the metal parts**. This is the case for most thermometers with housings (even metallic ones) but can be tested by measuring the electrical resistance with a multimeter between thermometer housing and thermometer measurement wires. However, this is not the case for bare/unprotected thermometer, these can be isolated with tape, shrinking tube or similar.



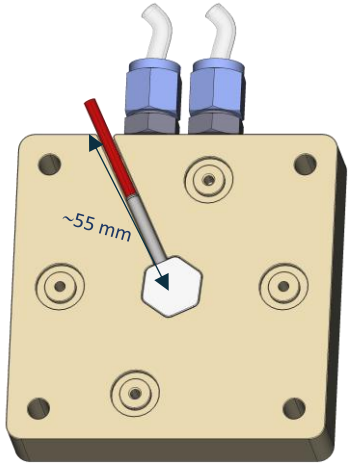
Mounting with rigid thermometer



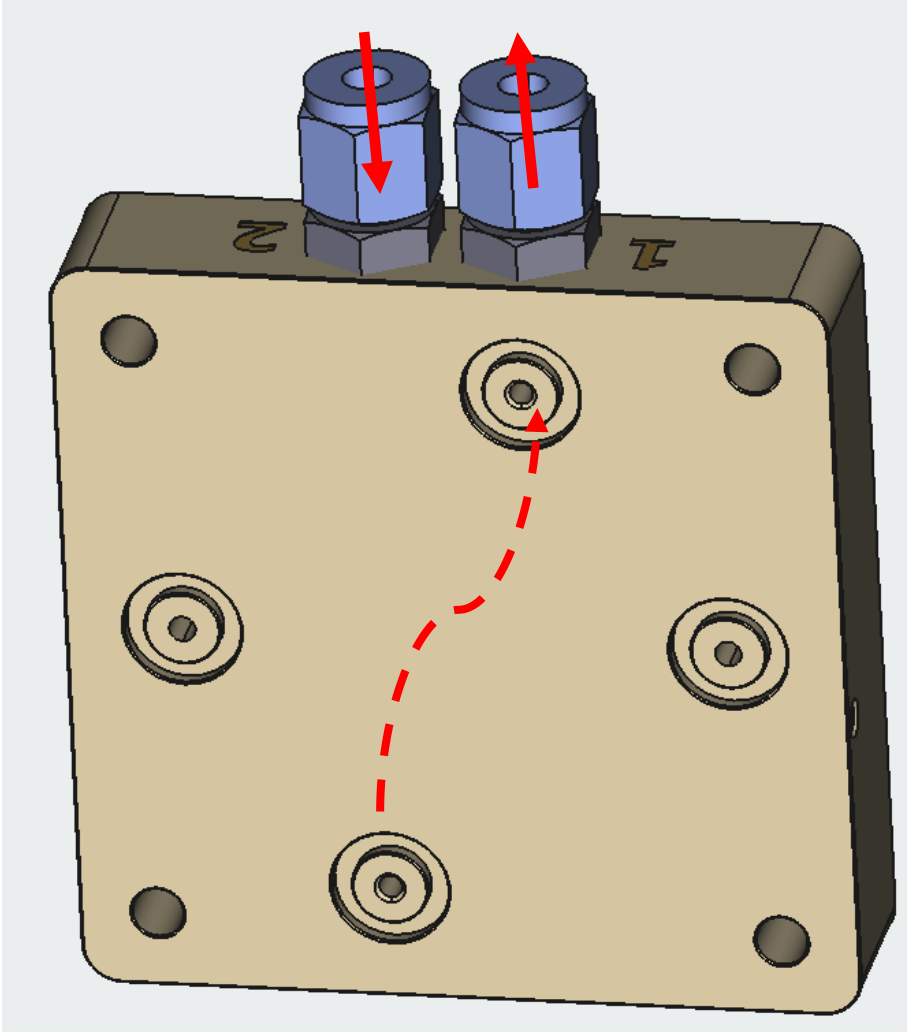
Mounting with wire thermometer



Thermometer holder



Thermometer, holder & PEEK block (metal current collector is mounted on top)



For normal operation it is recommended to use **port 1** as outlet of for the liquid and **port 2** as the inlet for the liquid

NOTE: With this configuration the liquid enters at the bottom and exits at the top. This makes removal of bubbles easier.