

# S-Stack – Flow Battery test stack

## Overview & assembly manual

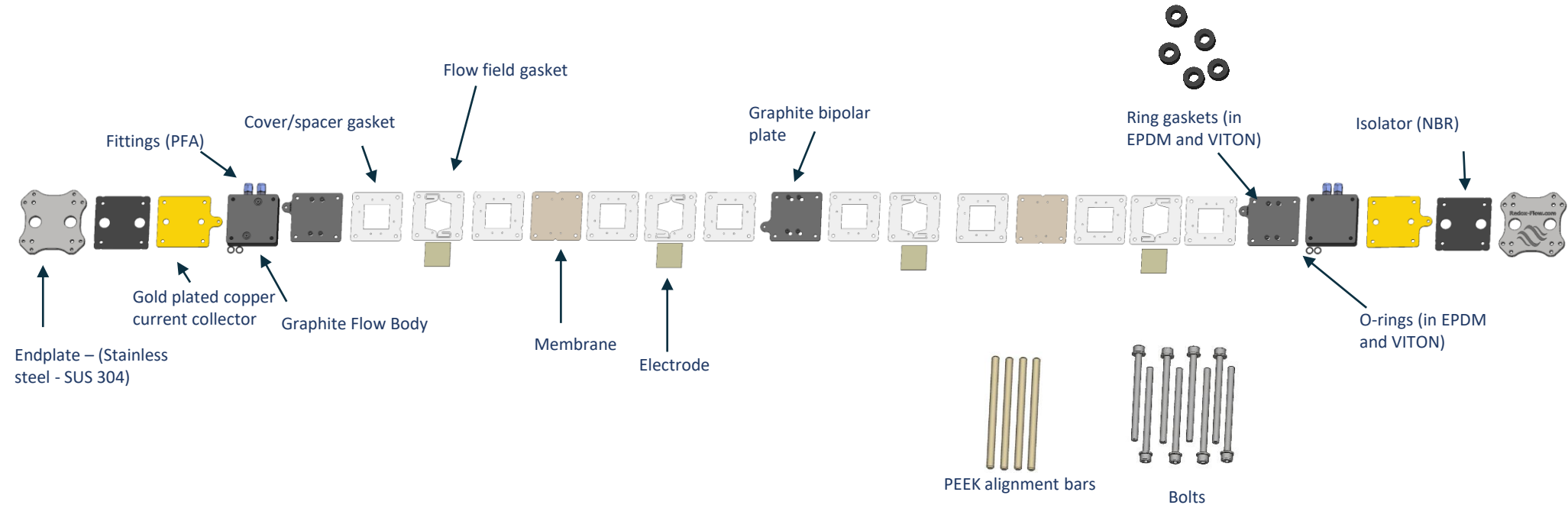


Version date	January 27 - 2025
Manual version	2.0 - visit <a href="http://www.redox-flow.com">www.redox-flow.com</a> for updated versions and spare parts
Notes	This cell is intended for research purposes only and can be used for many different purposes. There is no guarantee on performance, corrosion or lifetime on this items See <a href="https://redox-flow.com/termsandconditions/">https://redox-flow.com/termsandconditions/</a> for more information.

# Overview of variants & components included in the cell package

## General notes

- All gaskets are ordered separately - can be delivered in PTFE, EPDM and VITON
- Color of gaskets vary. PTFE is white, while VITON and EPDM are black. In this manual gaskets are depicted as white only, however, it represents all gasket materials (PTFE, VITON and EPDM)
- Membranes and electrodes are not included in the cell package – can be ordered separately

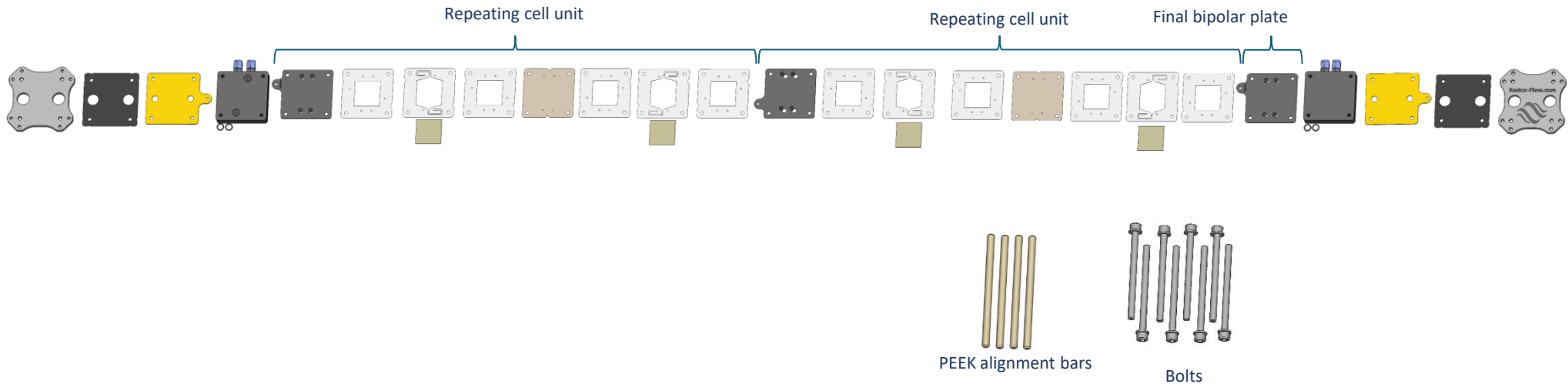


visit [www.redox-flow.com](http://www.redox-flow.com) for updated information and spare parts

# Assembly

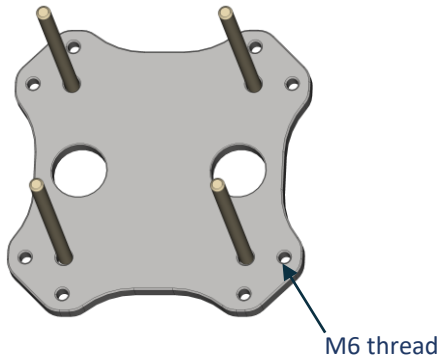
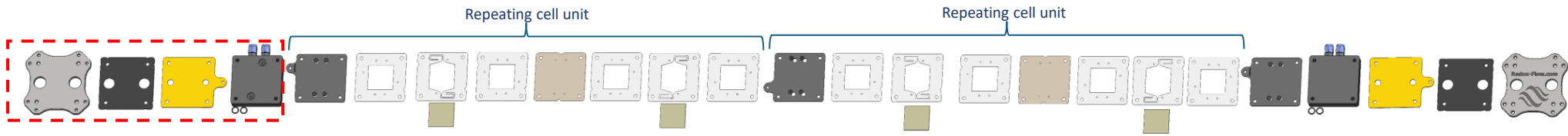
- Image below shows the overall assembly of the stack
- Assembly goes from left to right with the components turned and rotated as shown in the image.
- Following pages shows a detailed description

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



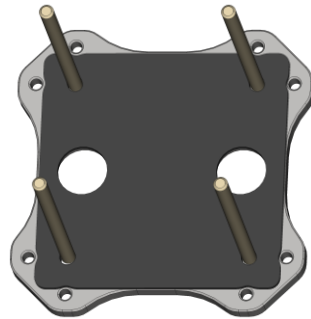
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# Assembly – initial assembly

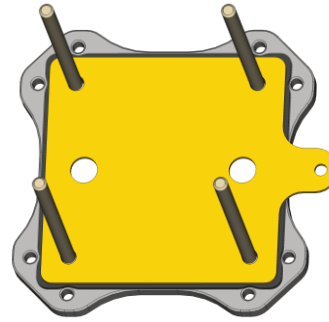


1. Threaded endplate is placed with logo downwards

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

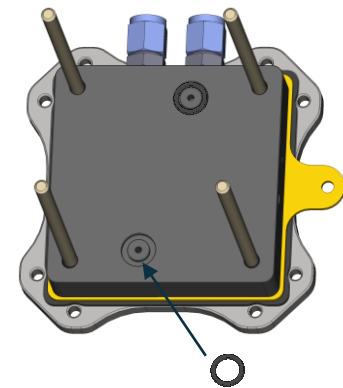


3. Isolator is placed on endplate



4. Current collector is placed on isolator

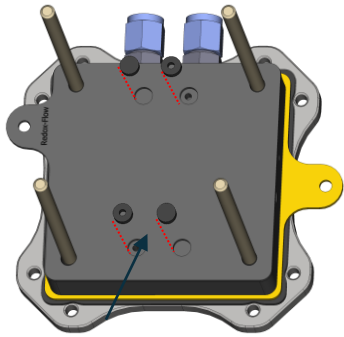
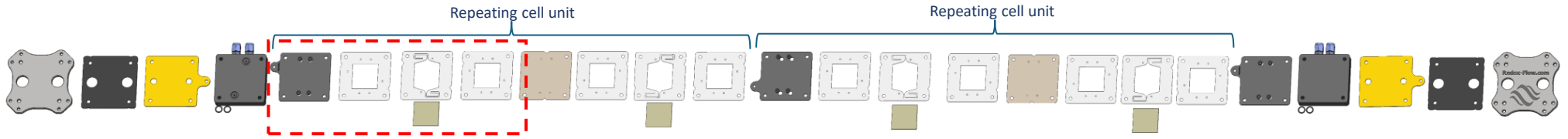
NOTE: The tap of the current collector can be placed either to the right side (as shown) or to the left



5. Graphite flow body is placed on isolator

6. O-rings are mounted in the graphite flow body

# Assembly – Repeating cells



2a 2b

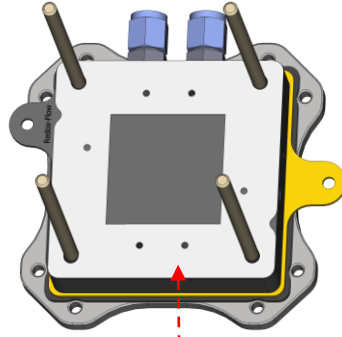
1. Bipolar plate is placed on graphite flow body

NOTE: The top of the current collector can be placed either to the left side (as shown) or to the right. It can also be turned towards the bottom

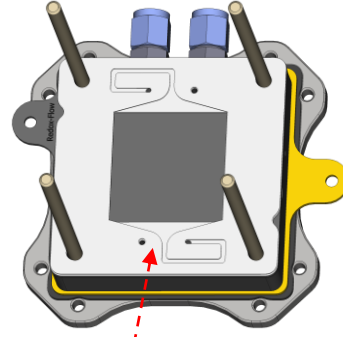
2a. In first and last bipolar plate in the stack *Ring gaskets* with holes and without holes are mounted in bipolar plate. *Ring gasket* with holes must be placed in the holes for the inlet/outlet of graphite flow body.

NOTE: Ring gaskets without holes are used for blocking the manifold

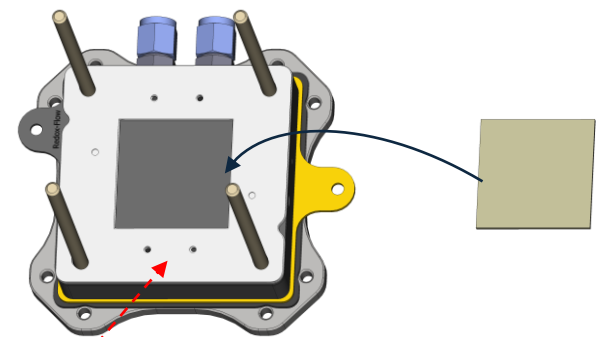
2b. For all bipolar plates (except start and end) in the stack only *Ring gaskets* with holes are used.



3. Cover gaskets is mounted



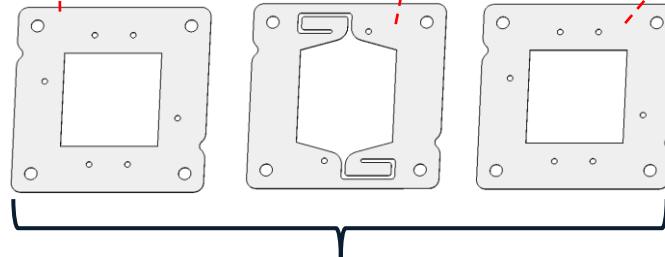
4. Flow field gasket is mounted



5. Cover gaskets is mounted

6. Electrode is placed inside the gaskets

## IMPORTANT NOTES

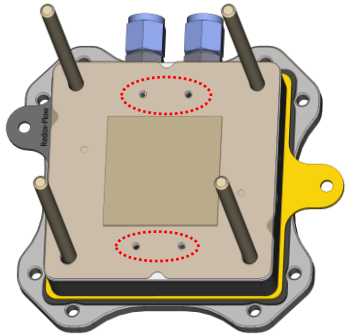
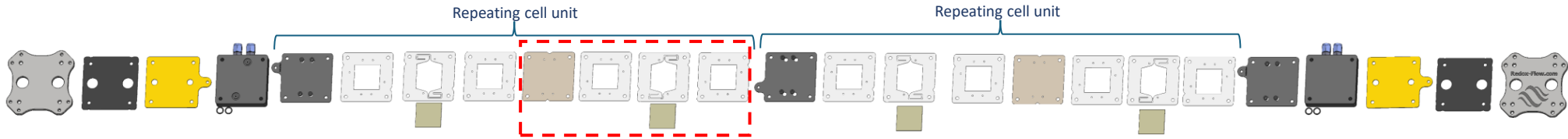


A. The final compressed thickness of the electrode is determined by the sum of the thicknesses of all stacked gaskets. Depending on the electrode varying compression is needed to ensure good electrical contact to the current collector

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

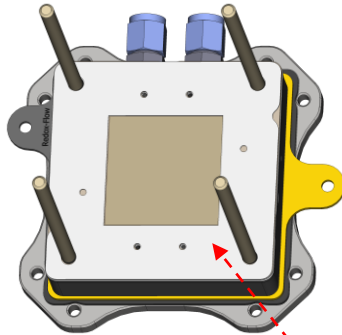
C. It is recommended to have the *flow field gasket* with a thickness of 1.5 mm to 2.0 mm. This is to minimize shunt currents.  
NOTE: If *flow field gasket* with a thickness of 1.0 mm or lower is used, this can lead to significant hydraulic resistance.

# Assembly – Repeating cells

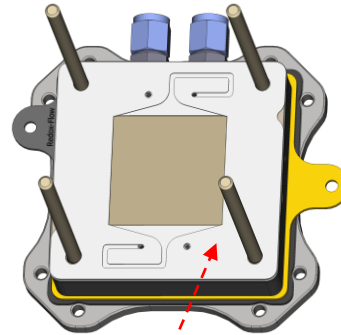


**1a.** Membrane that covers full area is mounted. Holes with a diameter of 3-4 mm must be made in the membrane before mounting (indicated by red circles). It is important that the holes overlap with the holes in the gasket behind it.

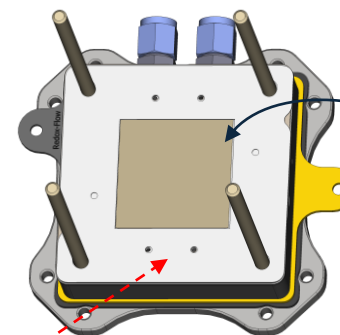
**1b.** Smaller membranes that are not covering the whole area can also be used. It is recommended that the membrane has at least an area of 55 mm x 55 mm. .



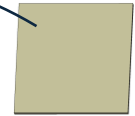
**3.** Cover gaskets is mounted



**4.** Flow field gasket is mounted



**5.** Cover gaskets is mounted

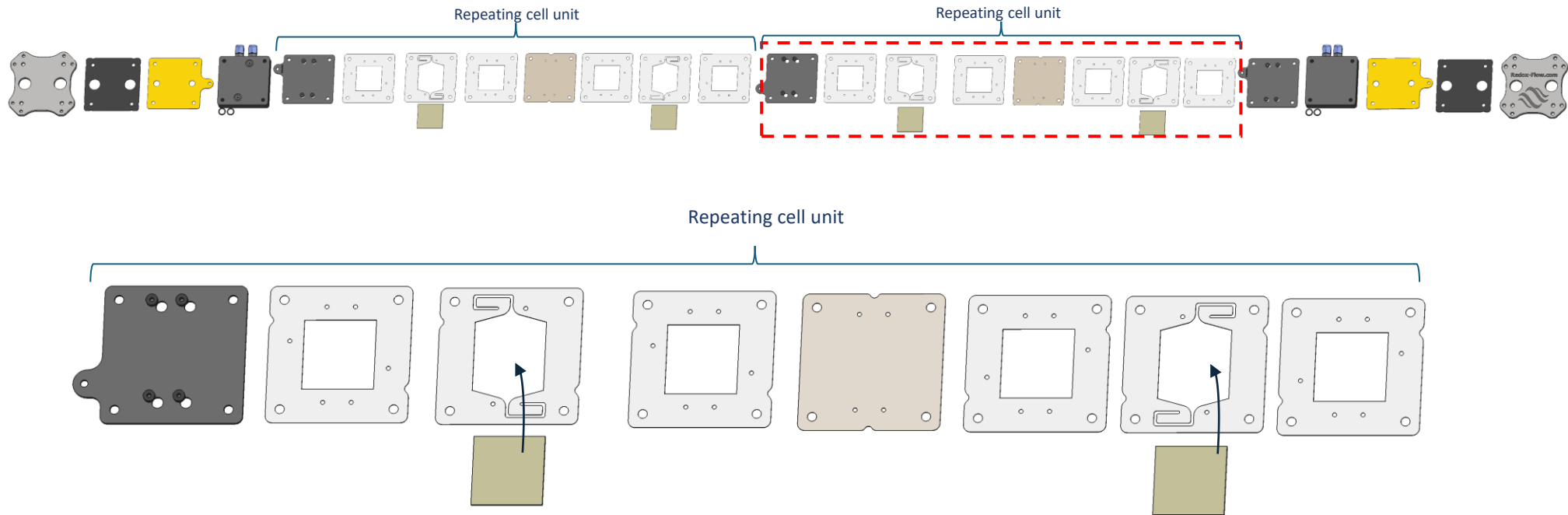


**6.** Electrode is placed inside the gaskets

## IMPORTANT NOTES

**A.** The final compressed thickness of the electrode is determined by the sum of the thicknesses of all stacked gaskets (as shown on previous page).

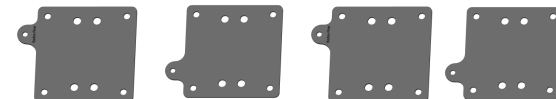
# Assembly – Repeating cells



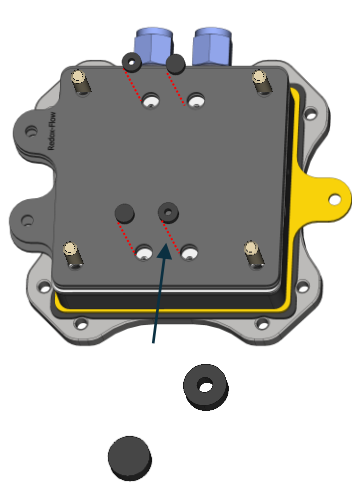
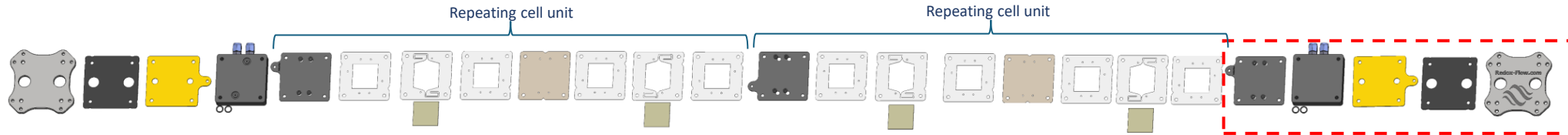
## SUBSEQUENT CELLS IN THE STACK

**A.** All subsequent cells in the stack follow the scheme outlined above and described in detail in the previous two pages of the manual.

**B.** The bipolar plates can be mounted in different ways. Only requirement is that the four holes are at the top and bottom. It is recommended to alternate the position of the tab from top to bottom between cells (see the image at right)

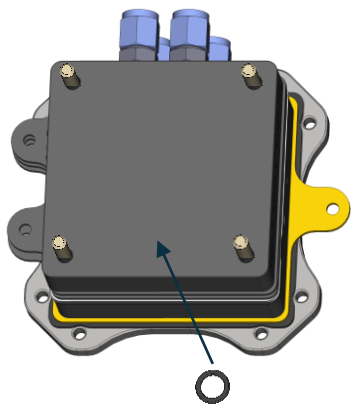


# Assembly – Final assembly



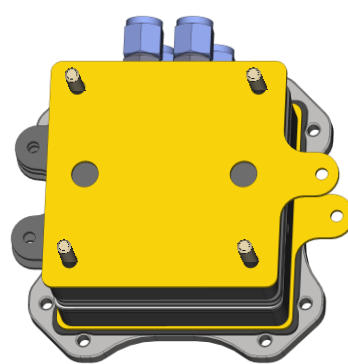
1. Last bipolar plate is mounted on the cell

2. *Ring gaskets* with holes and without holes are mounted in bipolar plate. *Ring gasket* with holes must be placed in the holes for the inlet/outlet of graphite flow body. only *Ring gaskets* with holes are used.

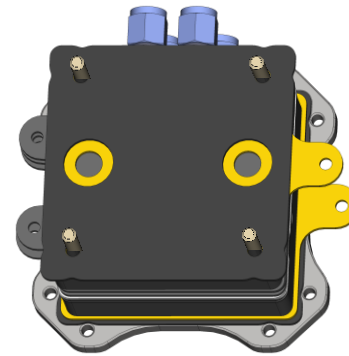


3. O-rings are mounted in graphite flow body (opposite side)

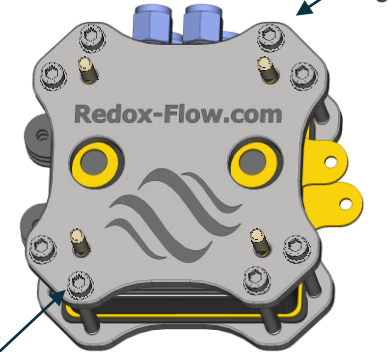
4. Graphite flow body is mounted



5. Current collector is placed on graphite flow body



6. Isolator is mounted



Hole for bolts in endplate is without a thread

7. Unthreaded endplate is placed with logo downwards

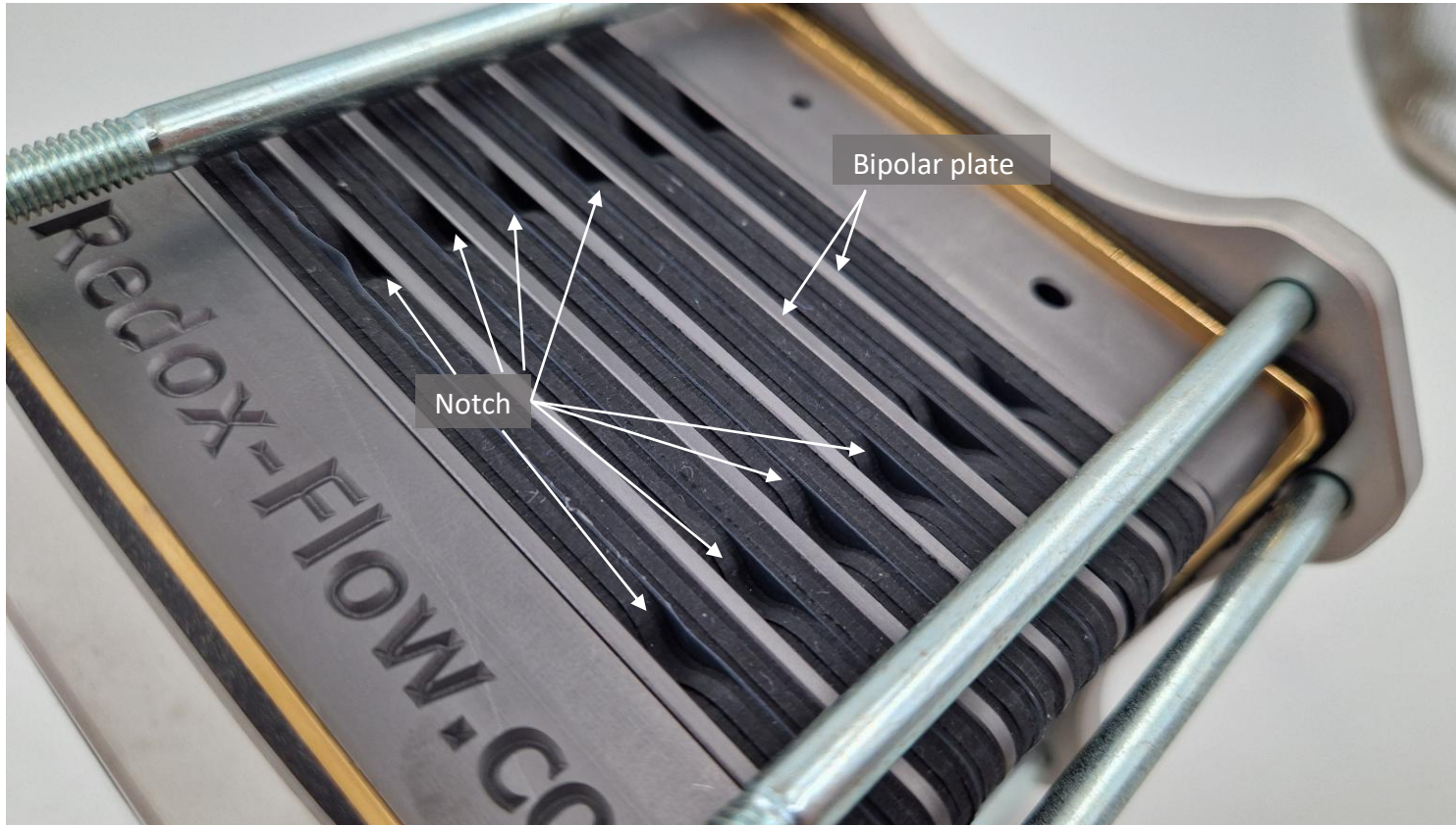
8. All eight bolts are placed in the outmost holes in the endplate  
NOTE: Use bolts with correct length  
NOTE: Keep alignment bars in the cell – they are taken out during the tightening of the cell

**CELL IS NOW ASSEMBLED AND READY FOR TIGHTENING**

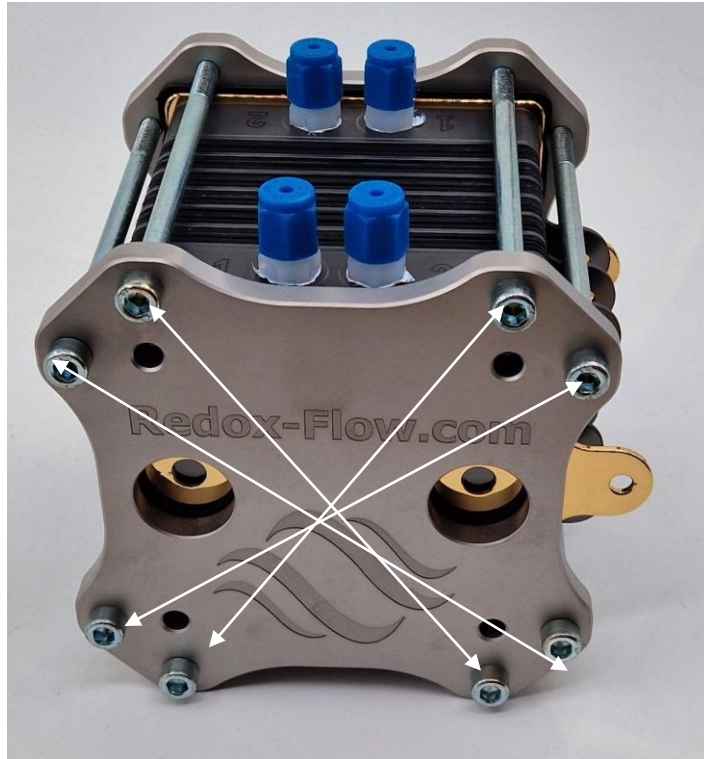


## Assembly – Final assembly

The integrity of gasket assembly can be inspected on the stack from the outside. The notches in the gaskets between each half cell must alternate as shown below



# Assembly – Final assembly

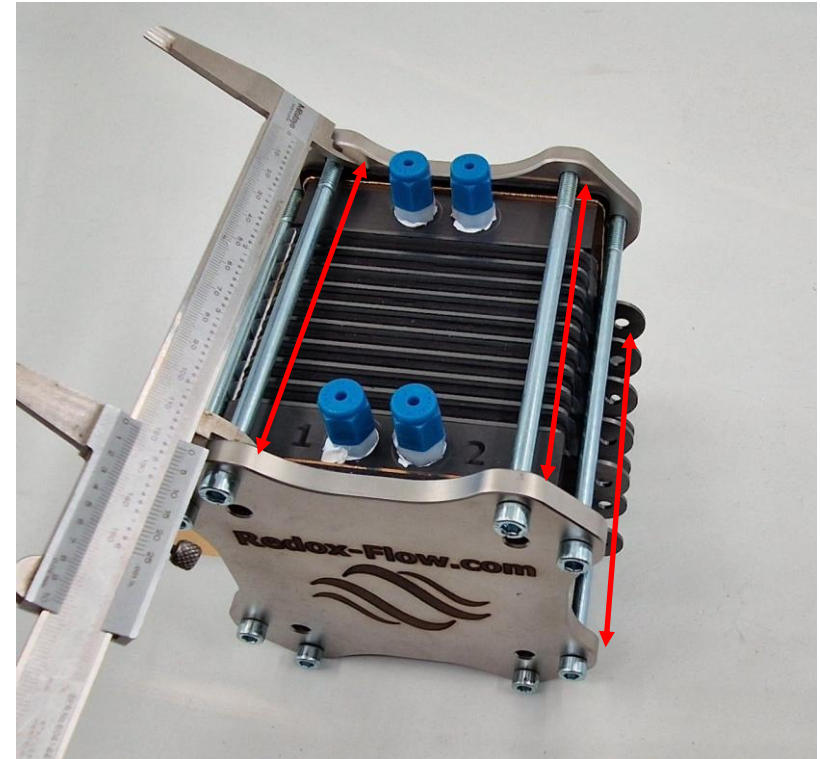


## STEP 1

- Hex bolts are cross tightened up to 6 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

## IMPORTANT NOTES

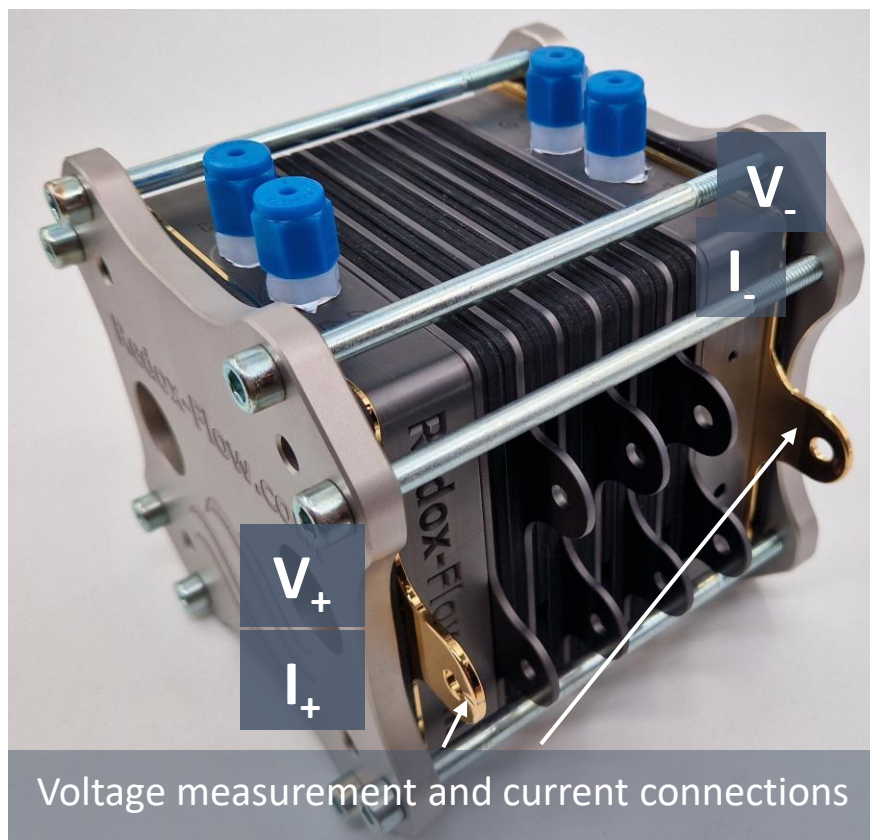
- Measurement with caliber is paramount for a tight sealing – It is not a high torque that seals the cell, it is a correct alignment of the flow bodies



## 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.

# Application notes – Electrical 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 other recognized solutions for making proper electrical connections

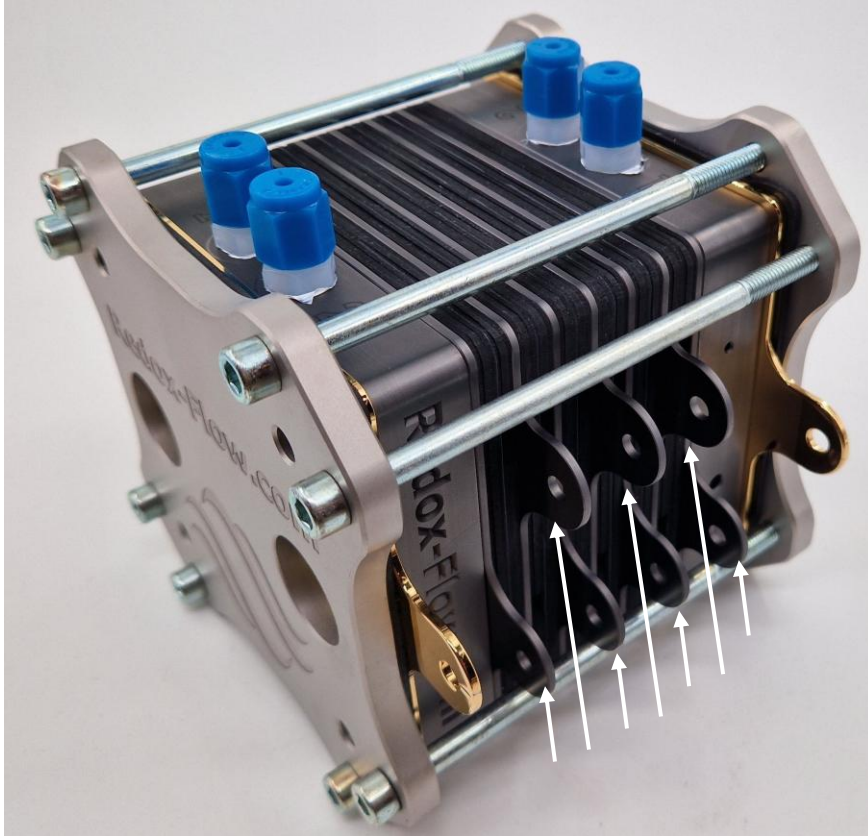
NOTE: Poorly connected current wires will lead to significant contact resistance between the wire and current collectors. For high current operation (e.g.  $> 1\text{ A}$ ) the contact resistance (even small ones) can lead to significant heating in the contact points.

- 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

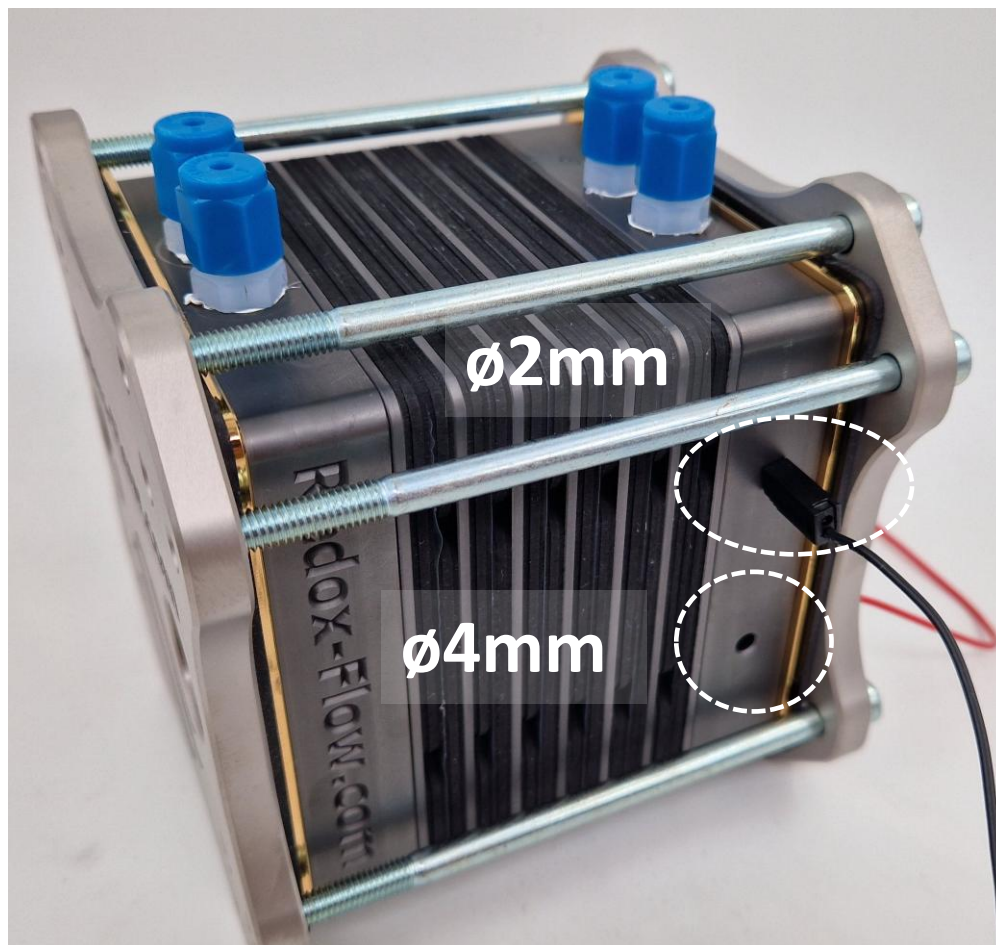
NOTE: As an alternative to measuring stack voltage on the current collectors, it can also be done on the graphite flow bodies or the start/end graphite bipolar plates (see following pages in the manual)

# Application notes – Electrical connections



- Stack voltage can be measured on the start and end graphite bipolar plates
- Individual cell voltages can be measured on each of the graphite bipolar plates

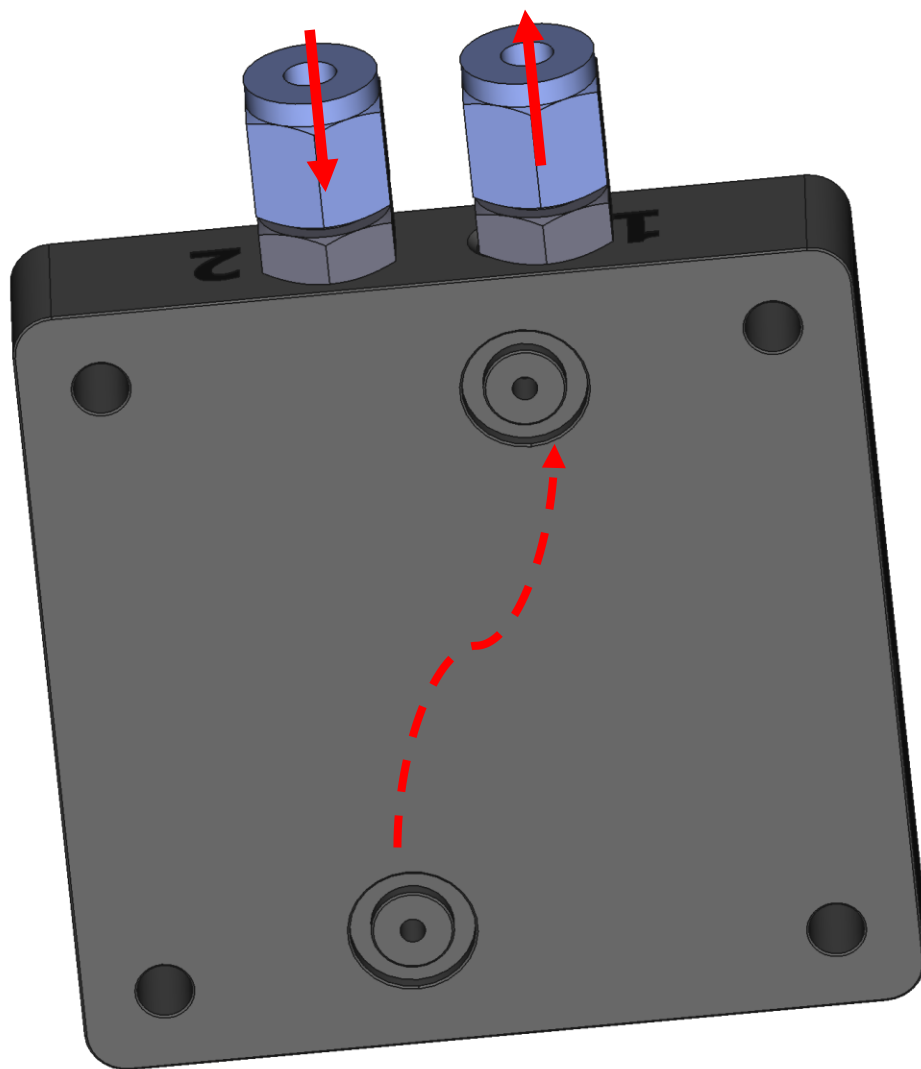
# Application notes – Temperature sensors & voltage measurements



## NOTES

- In each of the graphite flow bodies there are  $\varnothing 2\text{mm}$  and  $\varnothing 4\text{mm}$  holes that can be used for both banana plugs and temperature sensors

## Application notes – Hydraulic connections



- 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. The makes removal of bubbles easier.