Covmatic

Guide: setting up Covmatic – Part 1

Hardware

This guide will show you the custom parts that we designed to simplify and accelerate the robotic testing process. For each part, you will find:

- Picture of the physical prototype, and of its corresponding 3D model.
- Description of the function.
- Description of the manufacturing process.
- List of required material.

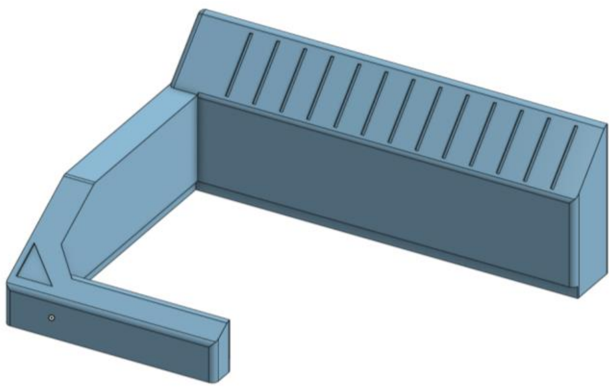
Index:

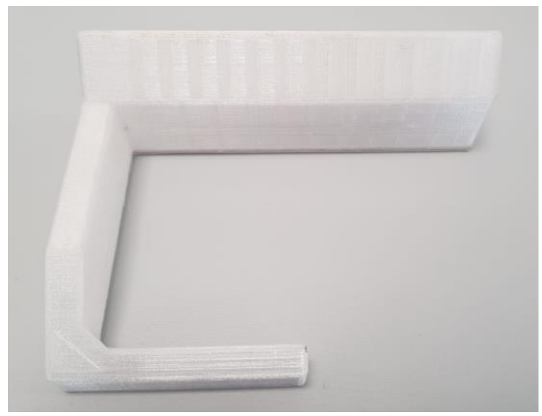
1. **3D printed parts**.. page 2
   1.1. 12-position microplate filling part
   1.2. Drilling guide for the deck of the Opentrons robot
   1.3. Mask for 96-well aluminum block
   1.4. Mask for 24-well aluminum block
   1.5. Indicator arrow for Rack 1
2. **Laser cut parts**.. page 6
   2.1. Top weight
   2.2. Six-position rack top
   2.3. 96-position tube rack
3. **Standard mechanical parts**.. page 10
   3.1. Pins for setting rack orientation
   3.2. Pins for setting 96-well plate orientation

1. 3D printed parts

All the 3D printed components have been created using a **Prusa i3 mk2** 3D printer, with 0.4mm nozzle and t-glase PETT-1.75mm/2.85mm-450g-clear which is an FDA-listed material.

1.1 12-position microplate filling guide

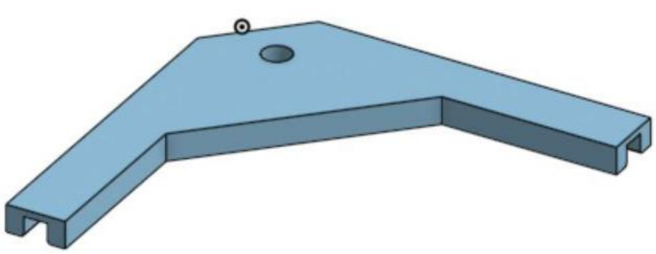


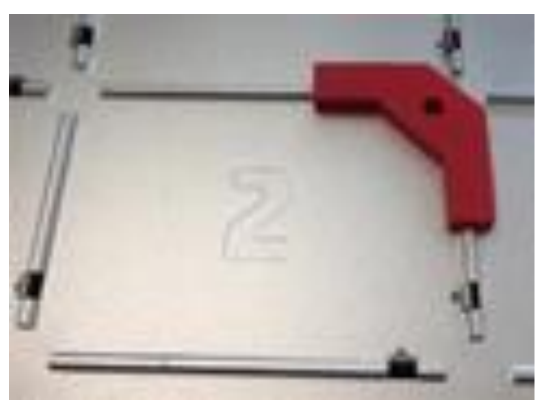


This device is basically a "filling mask". It's used outside the robot in order to prepare the 12 deep-well plate with all the different reagents. The empty deep-well plate is inserted from right and the bottom left corner has the same chamfer of the plate in order to avoid possible misalignments. If correctly positioned, the vertical bars should align with the cavities of the plate. Sticky labels may be placed above the bars to facilitate the identification of the position of the reagents.

3D Model : click here

1.2 Drilling guide for the deck of the Opentrons robot

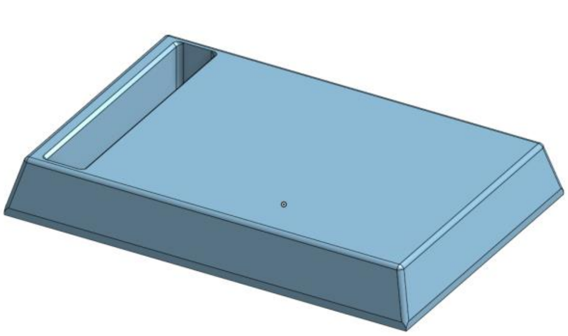


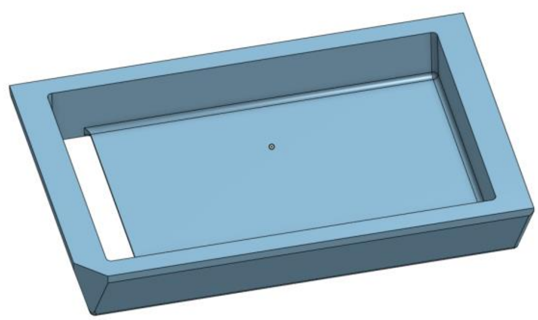


We use these devices to precisely drill the base plate (deck) of the Opentrons robots. Inside this plastic mask, we insert bushings to guide the drill bit. After this process, we create a thread in the base plate of the Opentrons robot. This allows us to screw a threaded pin into the base plate of the Opentrons robot. The pin works as a jig to ensure that the 96-well microplates or the racks are correctly positioned (in the right orientation) onto the base plate of the Opentrons robot.

See also Section 3.1 and Section 3.2 for a description of the pins. Due to the asymmetry (there is a chamfer at one corner) of the 96-well microplates that contain the samples (Section 3.2), if we position a pin at the corner in which the microplate does not have a chamfer, the pin will make it impossible to place the microplate in the wrong orientation. In this case, we use drilling guide B. Only 1 pin per microplate is needed to ensure that the plate cannot be positioned in the wrong orientation. The same for racks (Section 3.1), in this case drilling guide A is applied, moreover, in order to create mechanical features to make the rack asymmetric, we drilled the rack frames at the bottom to let the pins go through.
3D Model of Drilling guide A : click here
3D Model of Drilling guide B : click here

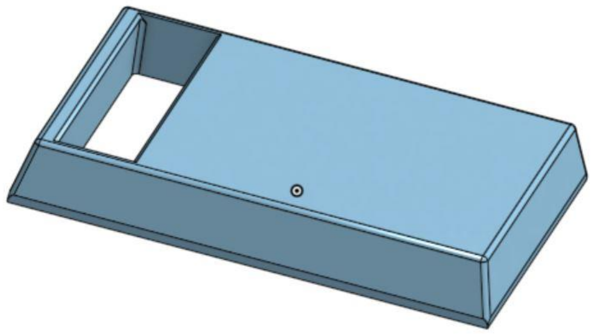
1.3 Mask for 96-well aluminum block

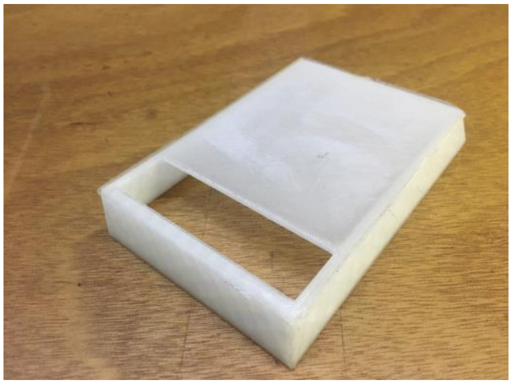




This mask is a replacement for the black plastic mask which Opentrons uses above the aluminum block. The original purpose is to avoid heat exchange and keep the plate cold for as long as possible. Since many holes are not used (in fact only the first row is filled), we improved the original piece by covering all the unused holes, so that we can avoid wrong positioning and keep the plate cold for a longer time.

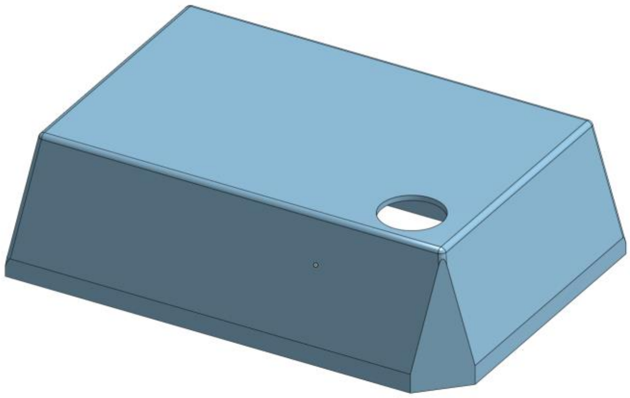
This piece is needed in Stations A, one separate part for each robot. As for Station C, two columns of the 96 aluminum block are used instead of one which causes the modification of the cover .





3D Model of mask in Station A: click here
3D Model of mask in Station C: click here

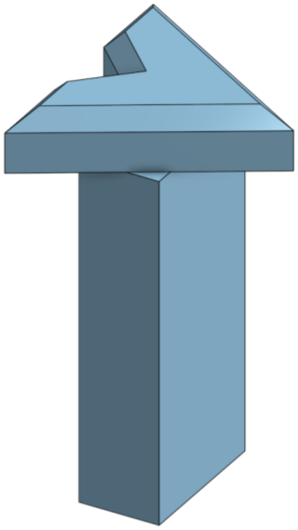
1.4 Mask for 24 aluminum block



This mask prevents wrong positioning of the tube in station C. Moreover, it avoids the plate to heat up since it covers the aluminum block almost entirely. Notice that we have a chamfer to define the right orientation.

We need 1 of this for each machine in station C.
3D Model: click here

1.5 Indicator arrow for Rack 1

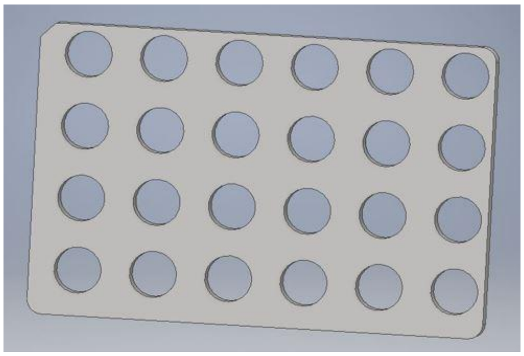


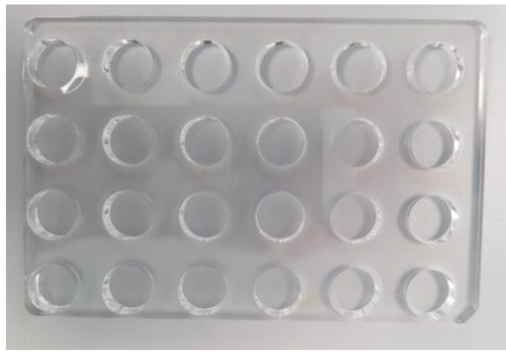
This very small arrow is inserted into the laser cutter plexiglass racks. We use it in order to remember the operator that A1 of the 1st rack is a fake sample (always negative). It's the only component which should be printed with a different color with respect to the t-glase (which is white).
3D Model : click here

2. Laser cut parts

The laser cut parts have been realized using the **Plotter Laser Co2 900x600mm machine**.
The base material for the laser cut parts are transparent acrylic (aka plexiglass) plates. The required pate thickness is specified in the description of each part.

2.1 Top weight

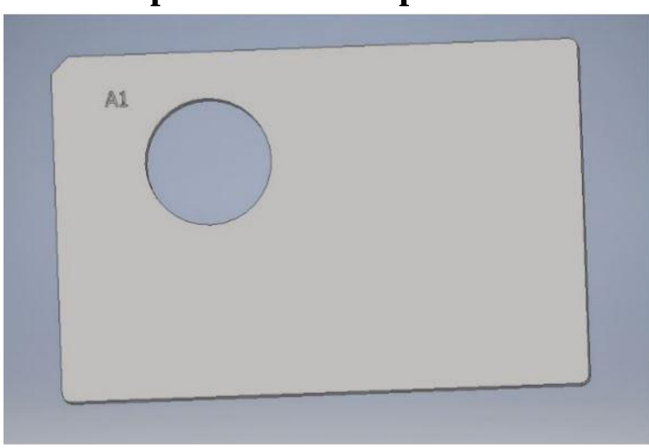




The top weight part is designed to avoid the pipette tip being stuck (due to the vacuum created in between) inside 10mm tubes by adding weight from the top of tubes. The dimension of the holes is smaller than the one of upper edge of the tubes which ensures the area to apply force caused by weight , in the meanwhile it is also big enough to let the operators place top-weight part easily above the rack top.

Required acrylic (plexiglass) plate thickness: 5mm.
3D Model: click [here]

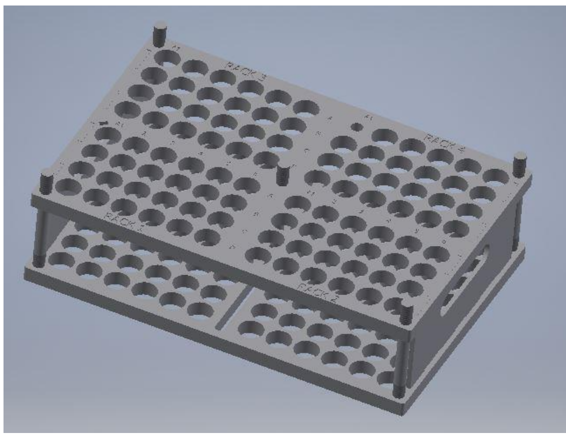
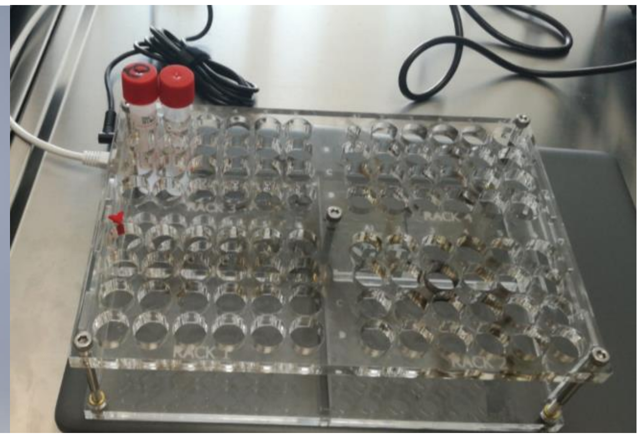
2.2 Six-position rack top



The six-position rack top is designed for specific application due to the working process. Only one hole exists on the top rack (due to the reason that only A1 position hole will be used in this station) to avoid wrong placement.

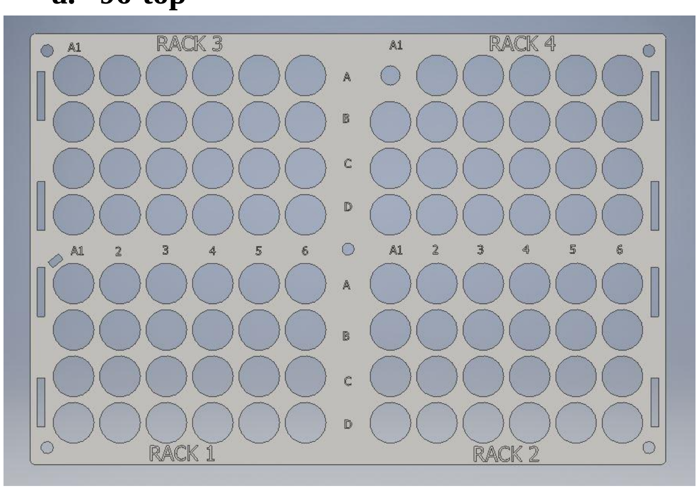
Required acrylic (plexiglass) plate thickness: 10mm.
3D Model: click here

2.3 96-position tube rack

According to the protocol of Station A , there are 4 (rack 1,2,3,4) 24-position racks which are placed adjacently ,moreover, rack 1 has different concept in the tube at position A1, rack 4 doesn't contain tube at position A1 but the pipette tip has to go through the hole. In order to avoid the confusion among 4 racks while placing, we designed a big 96-position tube rack which merges the function of these four small racks. The whole part is combined by single parts: 96-top ,96-bottom,96-side, long screws, spacers, thread inserts.

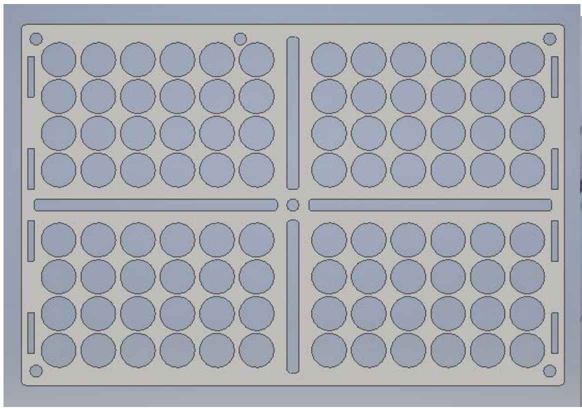
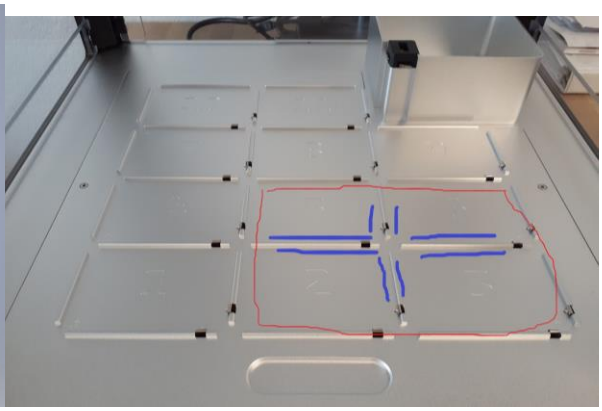
a. 96-top



The picture above is the 96-top. The small rectangular hole near A1 position hole in RACK 1 is for inserting the indicator arrow (see Section 1.5) in order to remind operators the difference. As for RACK 4, the A1 position hole is smaller than the standard holes to avoid operators placing tubes inside and in the meanwhile it can allow the pipette tip to go through without breaking down the whole process. The holes which are designed for assembly are placed properly as well.

Required acrylic (plexiglass) plate thickness: 10mm.
3D Model: click here

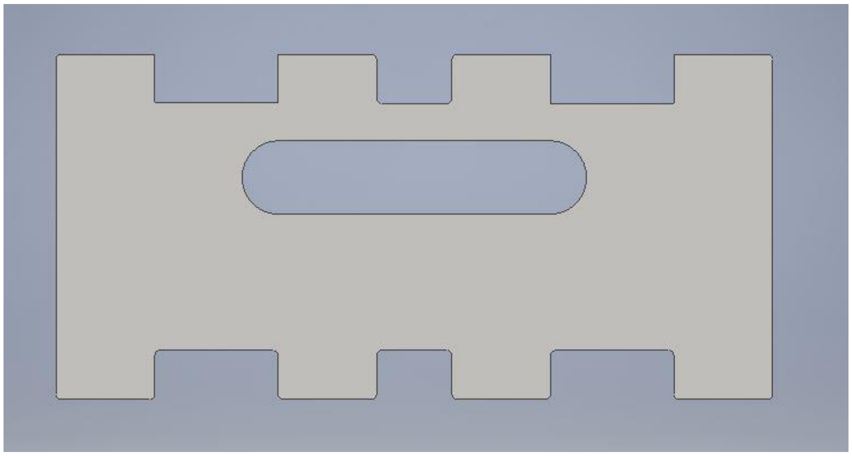
b. 96-bottom

As for the bottom part, the holes remain the same position as the top part, however, since the slots on the Opentrons robot deck are built by four metal bars ,while designing the big rack bottom part, we left the space for the bars between slots so that the big rack can be placed properly on the deck. Besides, in order to set the right orientation while placing the rack, we also leave a hole on the right side in RACK 3(top left rack) which matched with the pins that we insert on the base plate(deck) ,as Section 3.1,but instead of putting four pins in total (one pin per slot) , we only need one pin (at the slot where RACK 3 locates) for big 96 rack.

Required acrylic (plexiglass) plate thickness: 10mm.
3D Model: click here

c. 96-side



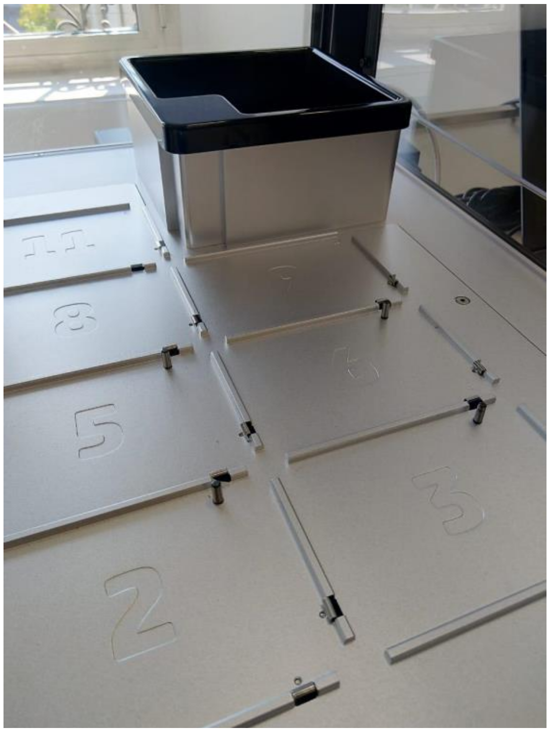
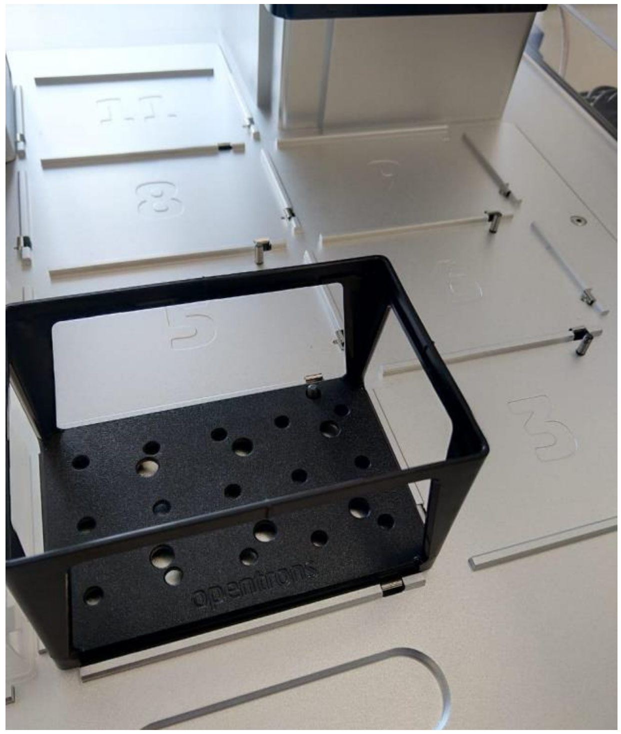
To make the rack more stable, we add two side-parts which allow operators to carry and move the rack easily by putting fingers inside the big hole in the middle.
For the last part which is the supporting rods to assemble top-part and bottom-part, we use the standard mechanical long screws. Due to the fact that it is difficult to add thread on bottom part (plexiglass), we use another standard mechanical part: thread inserts. By pressing or thermal inserting, we are able to place them inside the bottom part. Then combined with spacers (along with the long screws), the rack is more robust.

Required acrylic (plexiglass) plate thickness: 3mm.
3D Model: click here

long screws:KKT-HCSNNSZC5-70 Product link : click here
spacers:CU-560PH Product link : click here
thread inserts:HCL-M5-9.5-BR Product link: click here
(see also the Bill of Materials)

3. Standard mechanical parts

3.1 Pins for setting rack orientation (25mm)

First, we drilled holes in the deck of the Opentrons robot with the help of the drilling guides (see Section 1.2). Then we tapped the holes, created the internal threads to screw the pins (i.e. stainless steel bars with an external thread) onto the deck of the Opentrons robot. By adding simple holes on the base of the racks, we created asymmetric features that help operators place the rack in the correct orientation.

Product link for pins TPOSH-S45C-D4-25: click here (see also the Bill of Materials).

3.2 Pins for setting 96 well deep microplate orientation (50 mm)

Since the 96 well deep microplate has a chamfer at one corner and the empty space under the top surface at each corner can be used for inserting pins, the standard mechanical part that we decide to use is 50mm-long threaded pin. The corner which has the chamfer has smaller space (lower inner height to insert pin) than the other corners, thus the pin we choose is higher than chamfer surface but lower than top surface. In this way, we are able to avoid wrong placement.

Product link for pins TPOSH-S45C-D4-50: click here (see also the Bill of Materials).