

# Spacer Tooling

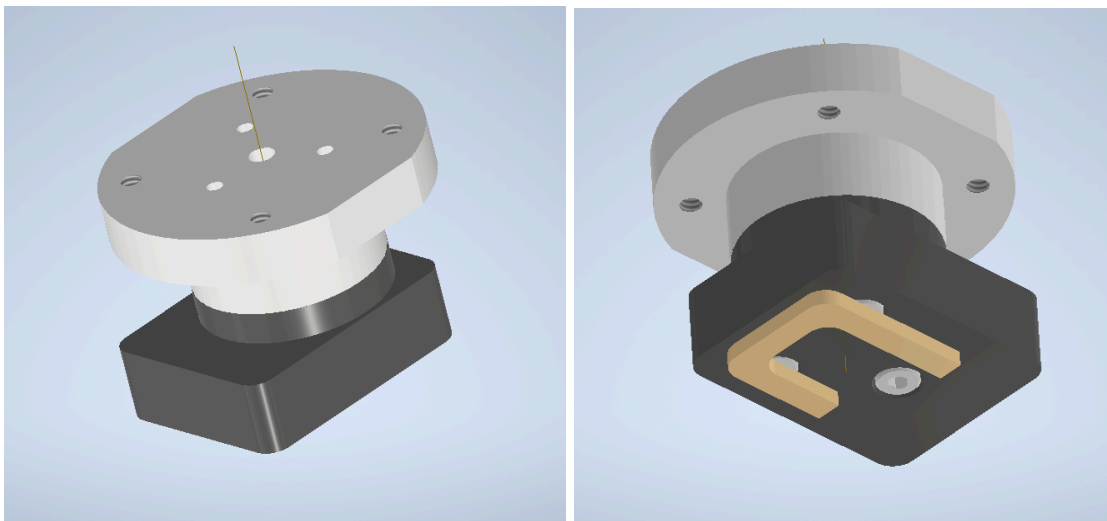
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## Assembly of the Spacer Sucker Tool

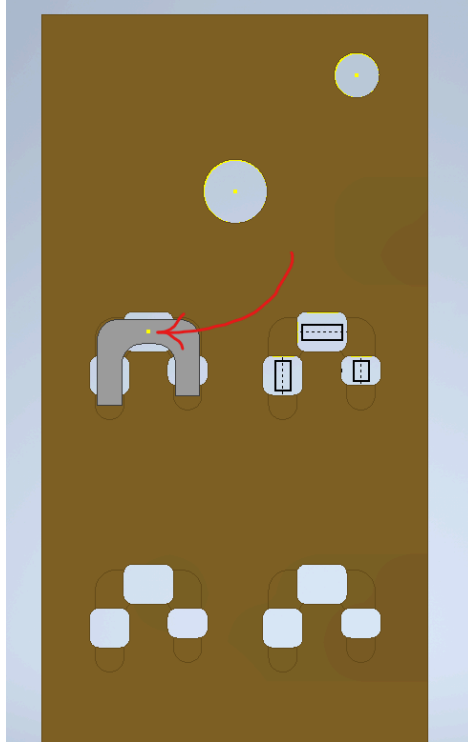
Attach the aluminum part of the spacer sucker tool to the vacuum bellows part. For historical reasons, the holes in the aluminum piece are for 3-48 machine screws, while the threaded holes that attach the black Delrin piece are M2x0.4. It may be necessary to enlarge the holes in the flange on the vacuum bellows to allow the use of the 3-48 screws. The assembly should be oriented so that the “foot” is pointing towards the front of the gantry when the tool is placed in the tool rack.

There are (at least) two types of black Delrin pieces - one for the small 1x2 spacers and the other is for the larger 2x2 spacers. You can switch between them by removing the three M2 socket cap screws and exchanging the black Delrin piece. The only difference is the positions of the vacuum holes, so if you are having difficulty pickup up a spacer, check that you are using the correct Delrin piece.



## Measurement of the SSCO Vector

The Spacer Sucker Camera Offset (SSCO) vector is the displacement between the focal point of the camera and the middle vacuum hole on the black Delrin spacer sucker. It can be measured by placing a spacer in the brass tray on the HDI launch pad and using the Aerotech Motion Composer software to focus on the edges of the spacer to calculate the coordinates of pickup point as shown in the figure below:



You can measure the x-coordinate of the yellow dot by averaging the x-coordinates of the left and right edges of the spacer, and the y-coordinate can be determined by averaging the coordinates of the top and bottom edges. The z-coordinate of the yellow dot should be at the focal point of the camera. We can refer to the coordinates of the yellow dot as  $\vec{x}_s$ . The script named Calibrate\_SSCO collects the coordinates used to calculate the coordinates of as  $\vec{x}_s$  although it refers to the 2x2 spacers and most likely needs to be modified to point the gantry to the right nominal coordinates. In any case, the SSCO is the same for 1x2 and 2x2 spacers.

Next, load the spacer sucker tool and position it using Motion Composer so that it is centered (by eye) on the spacer and just makes sufficient contact to pick it up when the vacuum is enabled. When in such a position, the coordinates can be referred to as  $\vec{x}_c$ .

The SSCO vector is just defined as  $\vec{x}_{SSCO} = \vec{x}_c - \vec{x}_s$ . At Purdue we have measured  $\vec{x}_{SSCO} = \{0.836799, 103.495743, -3.992\}$  mm for the small spacer. It should be the same for the 2x2 spacer since the Delrin pieces should have the same dimensions, but it is worth checking.

## Modification of Scripts

The script for installing the small 1x2 spacer is called 'spacer\_1x2\_sensor.gscript' which requires some site-specific modifications. In particular, check the following variables and definitions:

```
COPY $bolt_hole_origin {-83.365090,625.414110,92.520000}
COPY $top_pin_1x2_hdi_launch {170.018828,516.864208,64.280000}
COPY $bottom_pin_1x2_hdi_launch {170.115321,581.965337,64.104000}
COPY $theta_1x2_hdi_launch -0.087826
#
# These are for the 1x2 chucks
#
COPY $top_pin_chuck_0 {70.196240,516.672126,61.451700}
COPY $top_pin_chuck_1 {70.862935,364.169864,61.231700}
COPY $top_pin_chuck_2 {120.322618,364.555026,60.394200}
COPY $top_pin_chuck_3 {170.397701,364.147901,60.901700}
COPY $top_pin_chuck_4 {219.931859,364.834770,60.831700}
COPY $focus_1x2_hdi_launch 73.470000
COPY $focus_1x2_chip_launch 73.470000
COPY $focus_1x2_chuck_0 67.120000
COPY $focus_1x2_chuck_1 67.074999
COPY $focus_1x2_chuck_2 67.090000
COPY $focus_1x2_chuck_3 67.085000
COPY $focus_1x2_chuck_4 67.100000
#
# This is for the small 1x2 spacer sucker tool, measured October 14, 2025
#
COPY $small_ssco {0.836799,103.495743,-3.992}
```

Most of these should be copied directly from the 1x2 module assembly scripts. All other coordinates used in the assembly script are defined relative to the top-pin locations and should not need any modification.

The name of the middle tool rack position and the name of the spacer sucker tool are defined as

```
MOVENAME tool_rack_pos_1_out 100
LOADTOOL cua_picker_tool
```

You can rename these at your convenience.