Prototype Tooling Review

SCIPP

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Constraints

Each module assembly site will build ~12,000 modules in ~2.5 years.

Production Rate	30 modules per day assembled, wirebonded, and tested.
Working Space	Araldite 2011 has a long cure time and 2 separate gluing operations are done, one for the chips and one for the hybrid.
Storage Space	At any given time, we should expect to have at least 200 modules in process.

Assembly Precision

No specifications yet for assembly precision. These tools are designed for creating prototype modules within these tolerances:

Chip position

- X-Y position +/-10 um to each other and +/-100 um or better to the centerline of the extrusion
- Height -> for now will be set by adjustable feet until final stackup and glue heights are determined

Hybrid Position

- X-Y position depends on the precision of PCB cutting, generally ~50 um, and accuracy of locating pins, +/-100 um or better to the centerline of the extrusion
- Height -> for now will be set by adjustable feet until final stackup and glue heights are determined

Extrusion

X-Y position depends on the accuracy of the extrusion and:

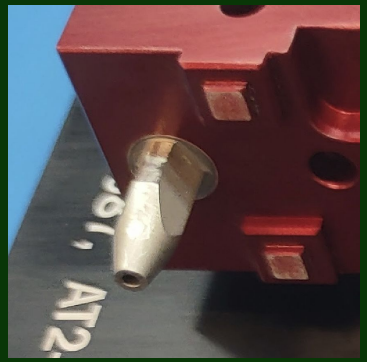
- X position depends on accuracy of locating pin, +/-50 um or better to the edge of the extrusion
- Y position depends on the operator to position reference face correctly in the gluing jig before engaging vacuum, variable by +/-250um
- Rotation of +/- 250um down the length is also possible

Special Materials

Metapor Aluminum

Metapor aluminum is porous to let vacuum through. These sheets must be milled to expose the pores; average pore diameter is 0.0006” with a total porosity of 15%. Available from McMaster-Carr and others.

Misumi Pins



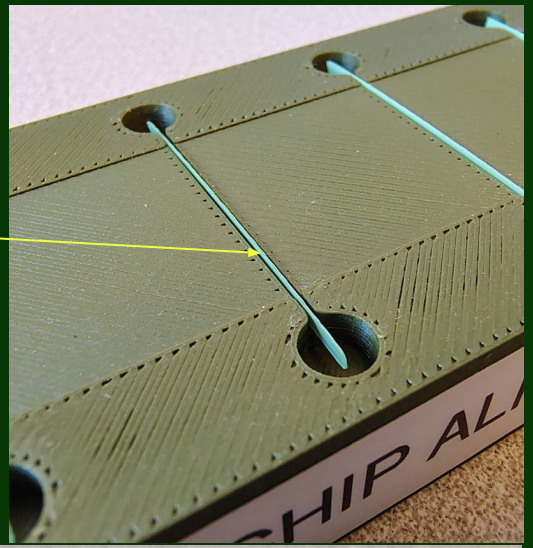
High precision hardened steel or stainless steel locating pins in both round and diamond head configurations, with matching bushings. Mounting features are machined into the shank, with options for press-fit, threaded, or tapped. Website

Chip Alignment Tray

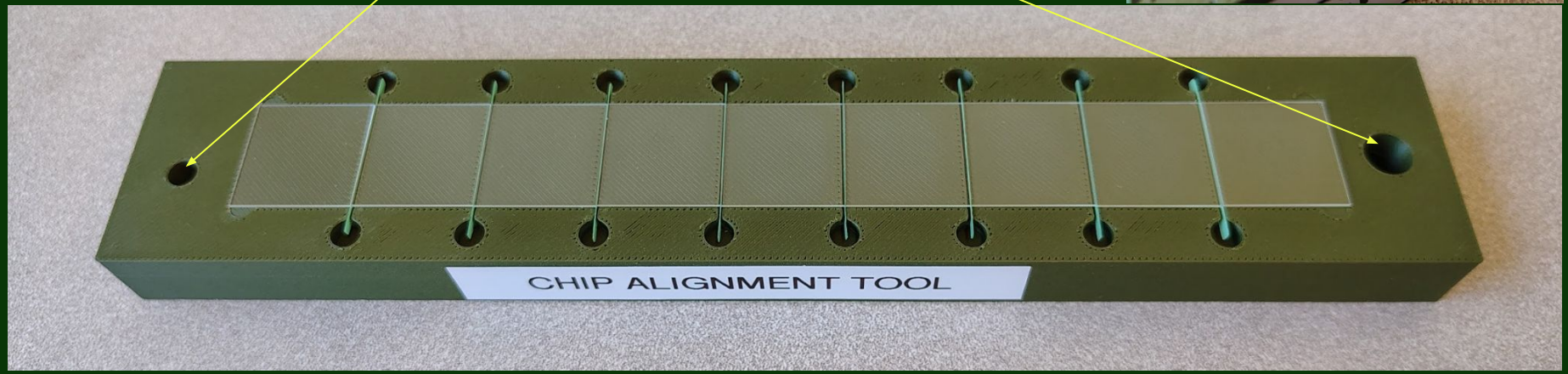
The alignment plate needs to align chips with only 100 um separation before picking them up all at once to place onto the aluminum extrusion.

Chips are NOT held with vacuum in tray.

80-90 um thick material to separate chips in tray; preferably below the level of the top of the chips, so will have to be max 1.5mm tall; Glued in place??? Need to be easy to replace when they get bent so maybe loose



Bushings for Misumi locating pins

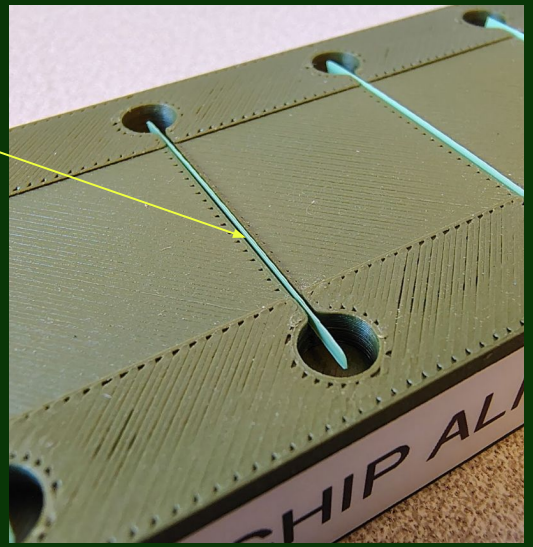


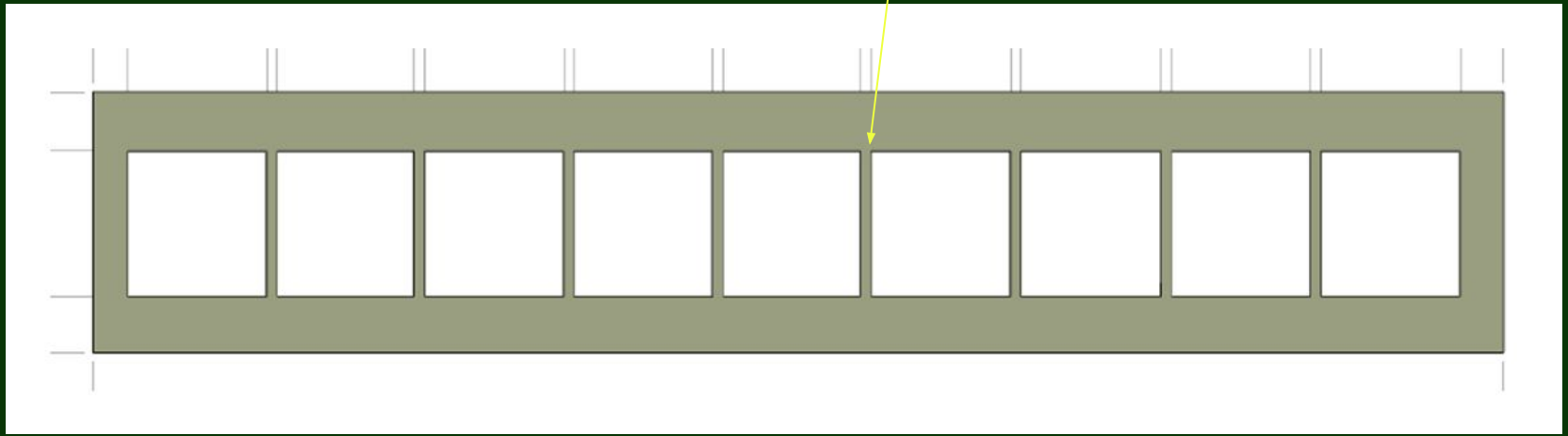
Chip Alignment Options

Easiest assembly solution would be to decrease the width of the chips from 20mm to ~19.5mm, so that the gap between chips can be at ~1mm.
This will have no impact on the physics, but will significantly simplify the assembly process.

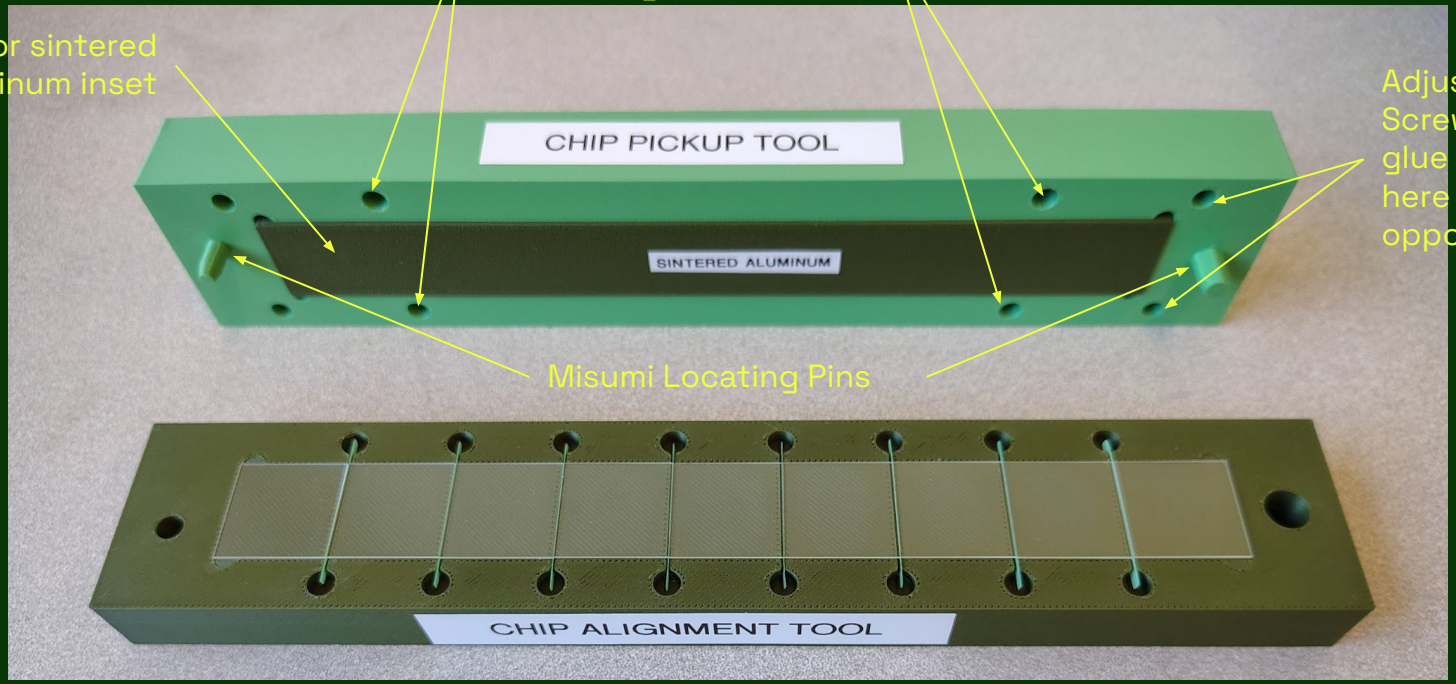
Depth of slots is limited by the width of the slot. A slot 1mm wide could be milled 3mm deep, which will make the shim material more stiff and durable.

Or a stencil could be laser cut with 0.8mm bars across (wiggle room) to separate the chips in the alignment tray before being picked up all at once with the pickup tool.





Chip Pickup Tool



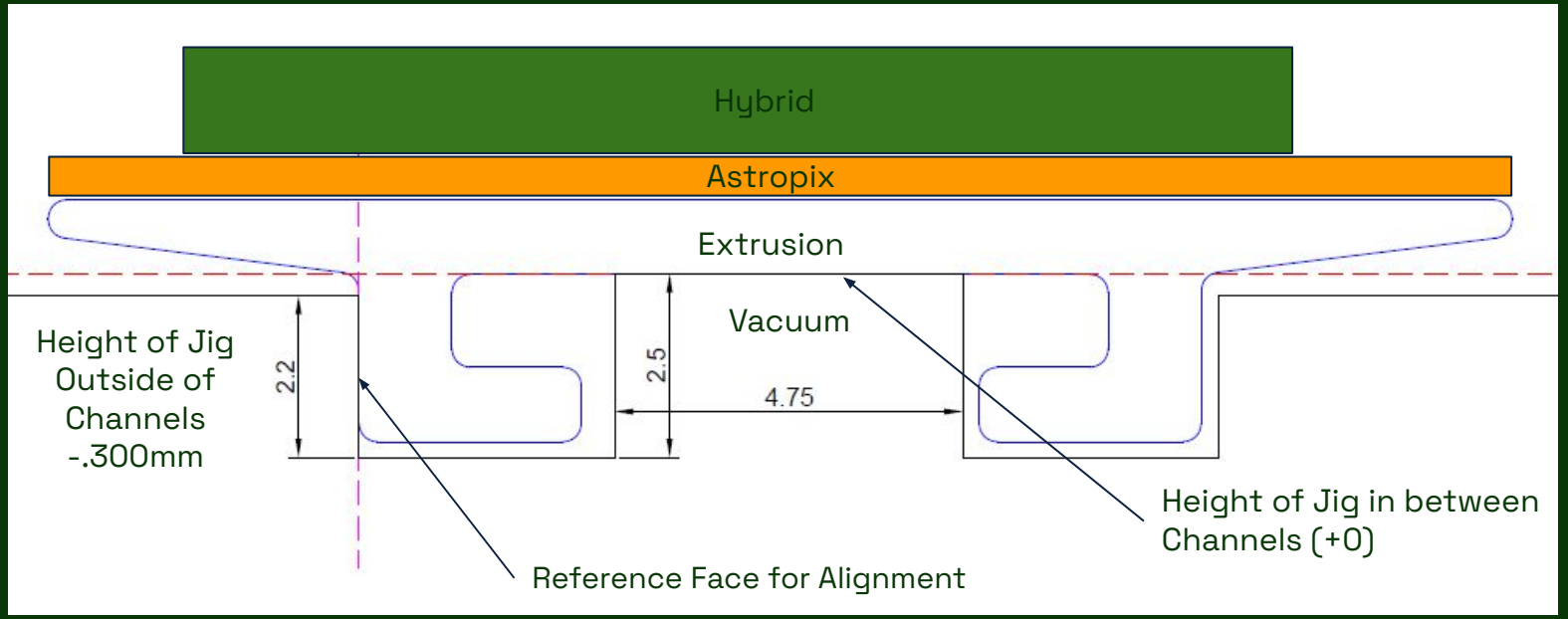
4 adjustable screws at the ends will set the height of the chips above the extrusion. Vacuum port on end of tool will help with routing of hoses and stacking. 4 additional holes (large tolerance!) in the pickup tool will be used to screw it into the gluing jig while the glue cures.

Chip/Hybrid Gluing Jig

First Gluing Step: Attach chips to aluminum extrusion
Second Gluing Step: Attach hybrid to chips

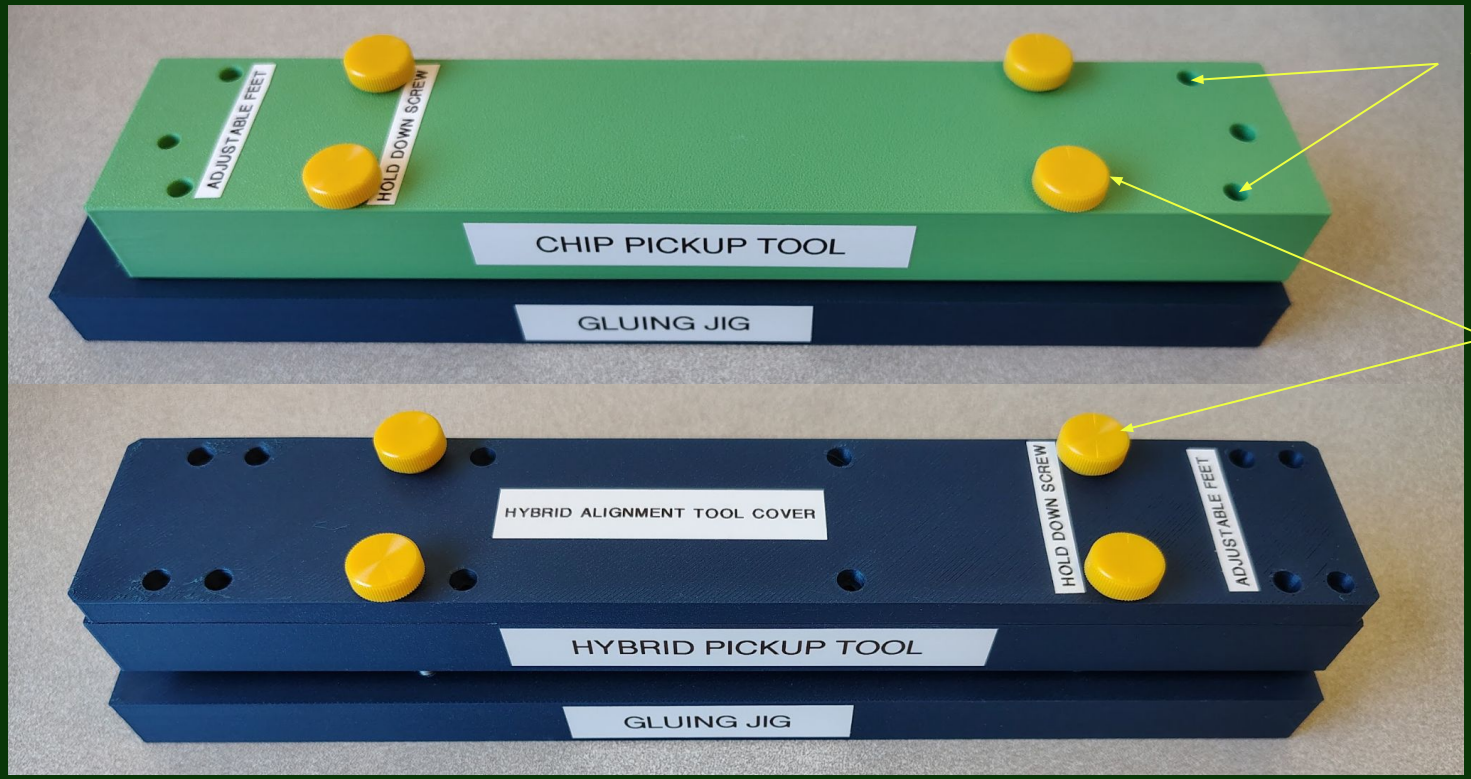
This is a single-module gluing plate, with grooves cut to fit the extrusions. Alignment bushings are located such that plates can be used for both chip gluing and hybrid gluing.

Chip/Hybrid Gluing Plate - side view



Aluminum extrusions are positioned onto plate and the vacuum is engaged. *Verifying that the alignment and vacuum are sufficient for assembly (and bonding) will require samples of the final extrusion profile.* The chips are aligned in the chip tray and picked up. The locating pins on the pickup tool engage with the bushings in the gluing plate. Adjustable screws set the height of the chips above the extrusion. The pickup tools are screwed down into the gluing plate to keep them in place while the glue is curing (otherwise the vacuum hoses could make the tools tilt).

Chip/Hybrid Gluing Plate

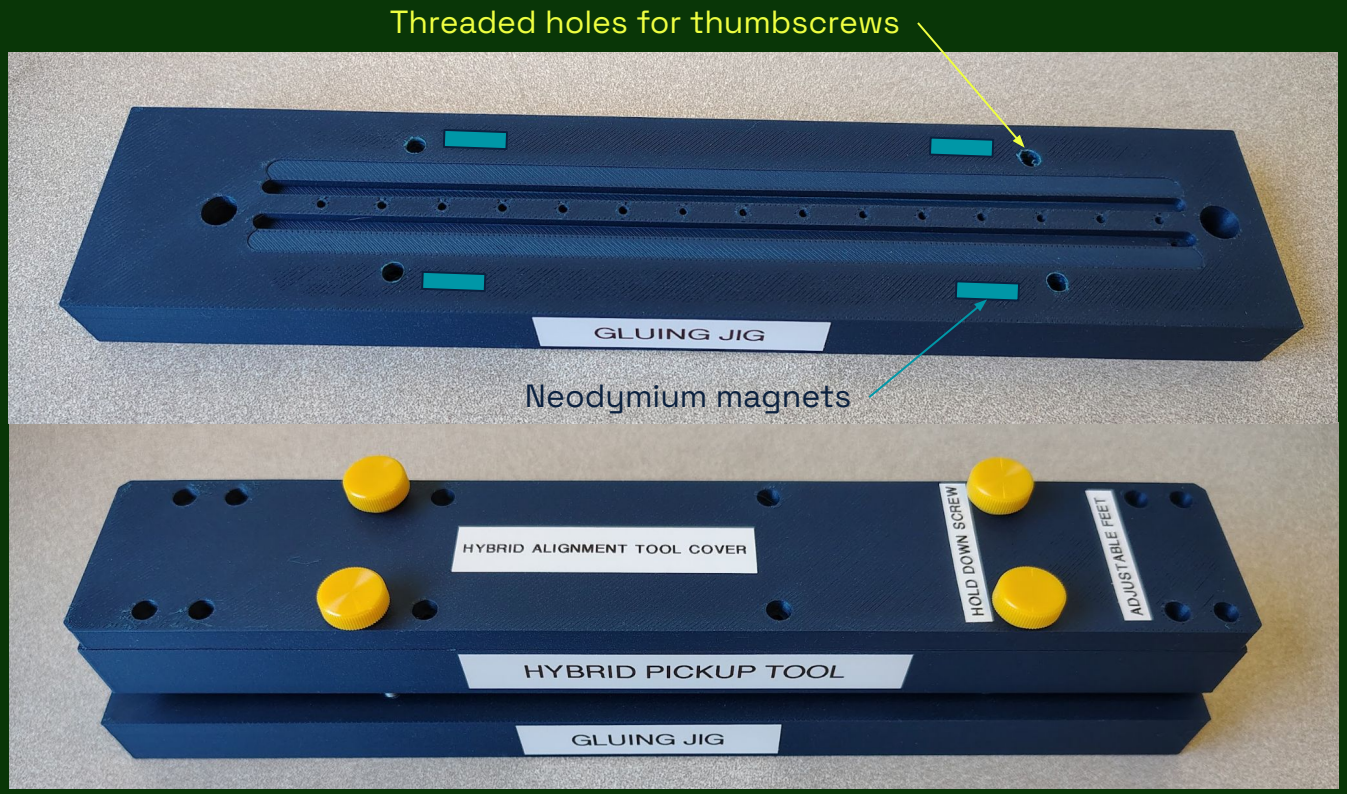


Adjustable height feet to set glue gap on module

Thumbscrews

Thumbscrews can be used to clamp pickup tools to gluing jig while glue cures. For now (until the module stackup is finalized) adjustable height screws on both sides of the Misumi pins can be used to set the height of the pickup tools above the gluing jig to control the glue gap thickness.

Chip/Hybrid Gluing Plate

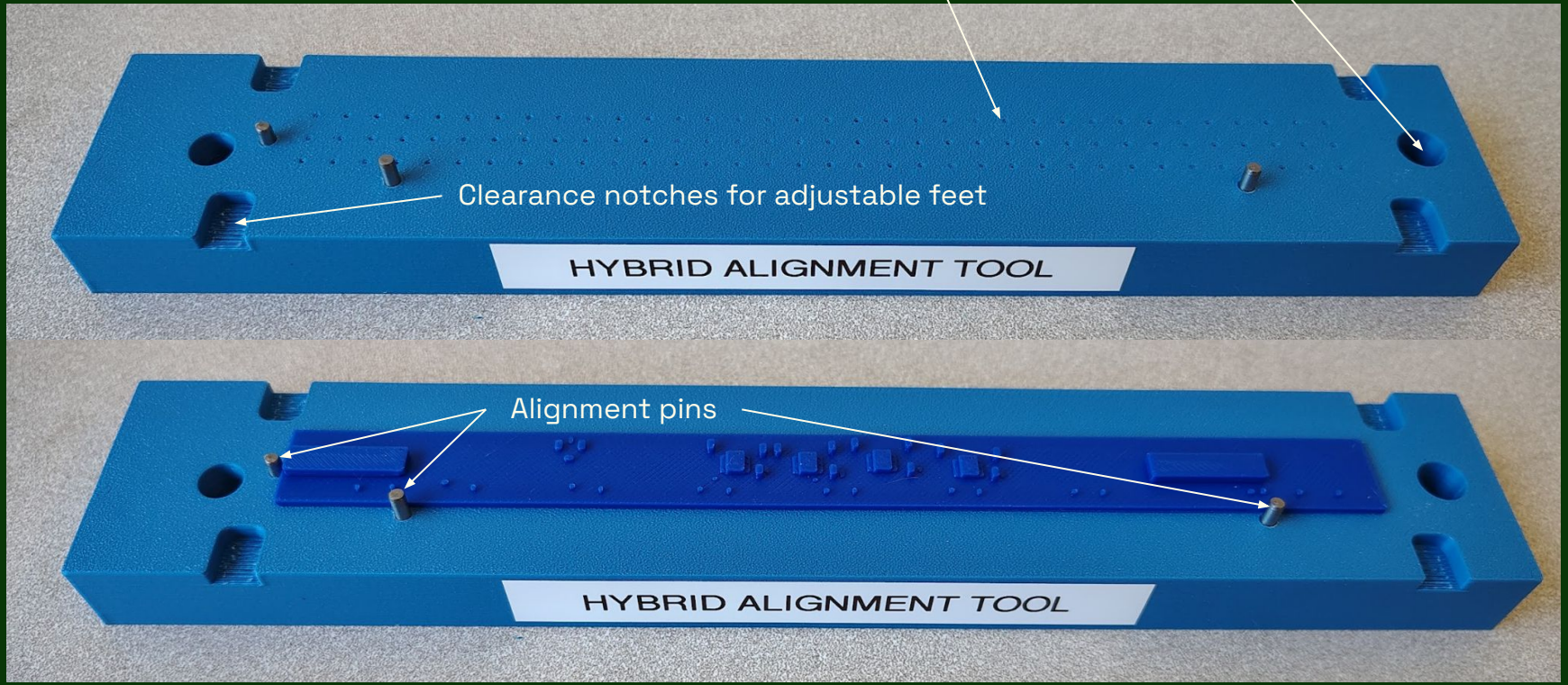


The pickup tools must be fixed to the gluing jig while the glue cures or the vacuum hoses could make them tip.

Using thumbscrews ~1000 times will strip the threads in the holes if the threads are just cut into the aluminum jig. So it would be better to enlarge these holes to fit stainless steel threaded bushings, which can be replaced as they wear out.

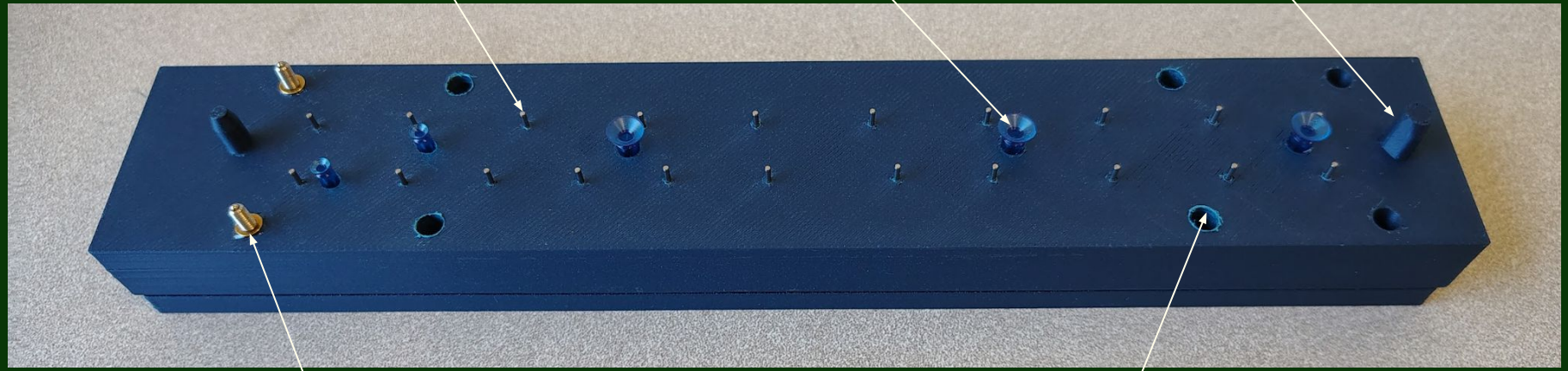
Or clamping the gluing jig and the pickup tools together could be done with neodymium magnets, fixed onto the jigs with enough air gap to release without excessive force.

Hybrid Alignment Tool



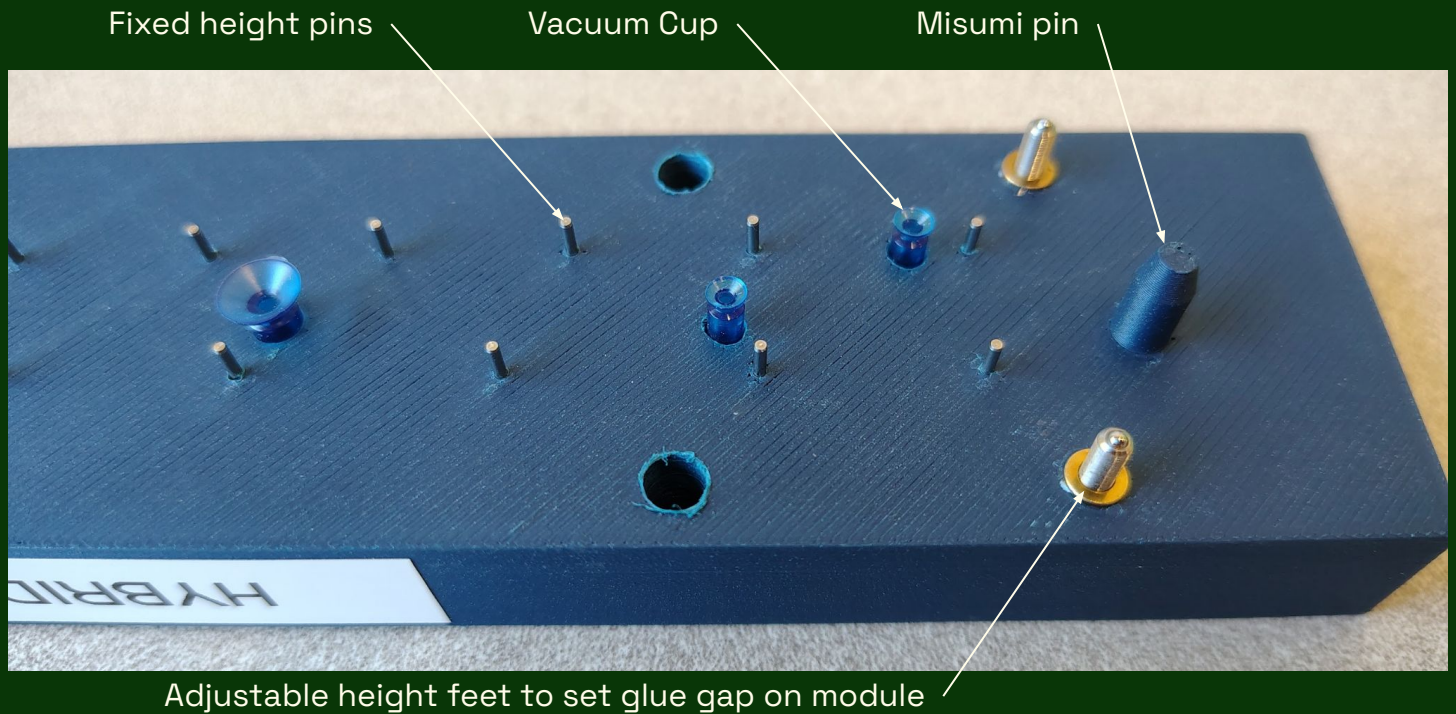
The Hybrid Alignment Tool is used to position the hybrid relative to the Misumi pins, before being picked up by the Hybrid Pickup Tool and then placed on the module in the gluing jig.

Hybrid Pickup Tool



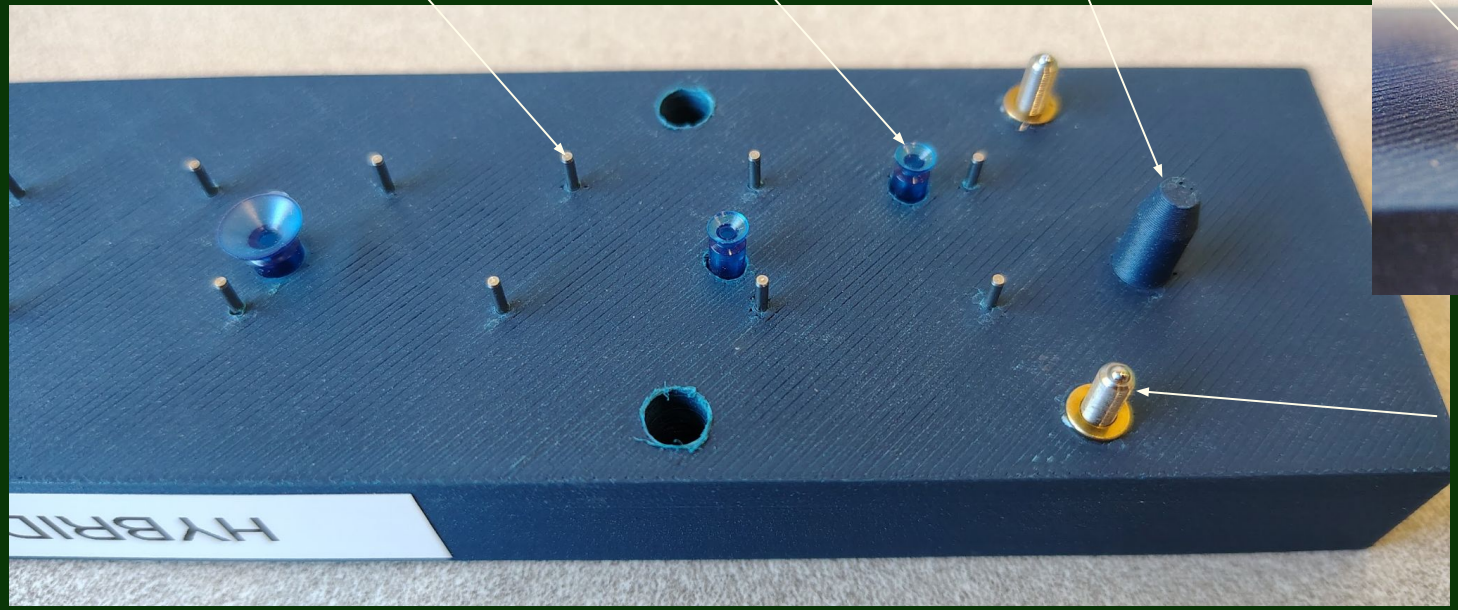
The hybrid pickup tool uses vacuum cups and small fixed-height pins to pick up the hybrid, keep it flat, and place it on the gluing plate.

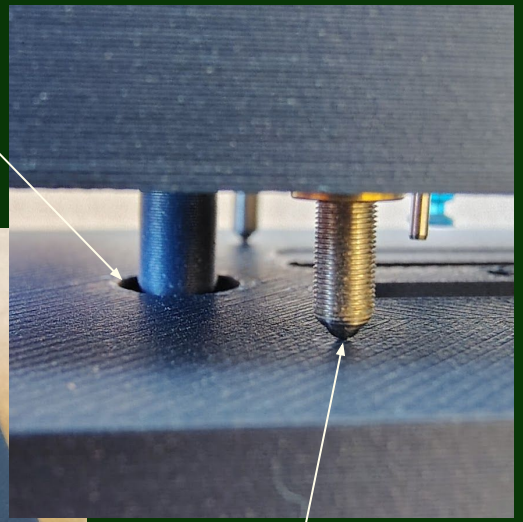
Hybrid Pickup Tool



Two smaller vacuum cups are used to fit around the connector. Three larger vacuum cups fit down the length. Fixed height pins make contact in between chip bonding pads and SMDs.

Hybrid Pickup Tool





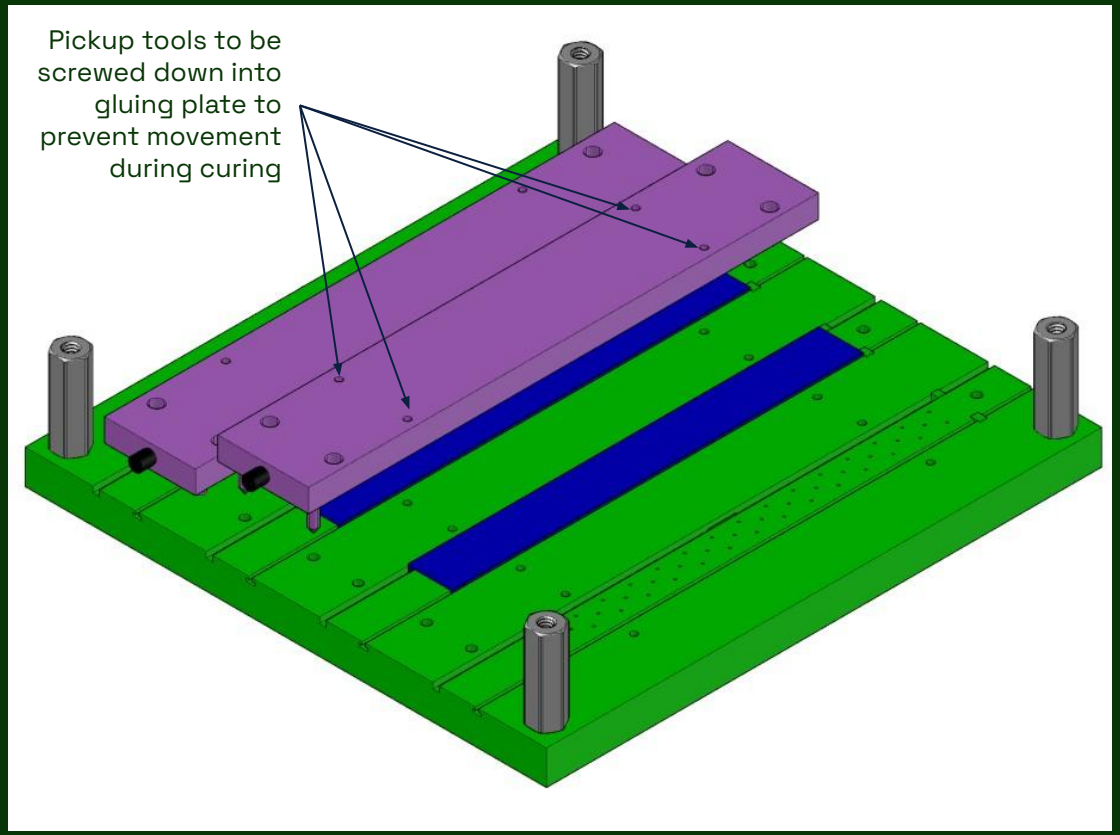
Adjustable height feet on both sides of Misumi pins will set the glue gap on modules for prototyping. Clearance notches for the adjustable feet are included on chip and hybrid alignment jigs. Eventually the adjustable feet can be replaced with fixed-height pins.
Misumi pins need to be longer than what is shown here to engage earlier.

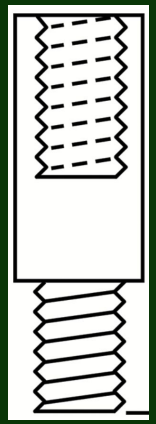
Hybrid Pickup Tool

Pins and vacuum cups extend into the tool's vacuum cavity, allowing for height adjustments. To set the pins, a representative PCB is placed on a very flat surface, the pins are pressed onto it, and secured with superglue. Sealant is applied around the vacuum cavity between the tool and cover, which is held in place by eight countersunk screws.

Stacking Chip/Hybrid Gluing Plate

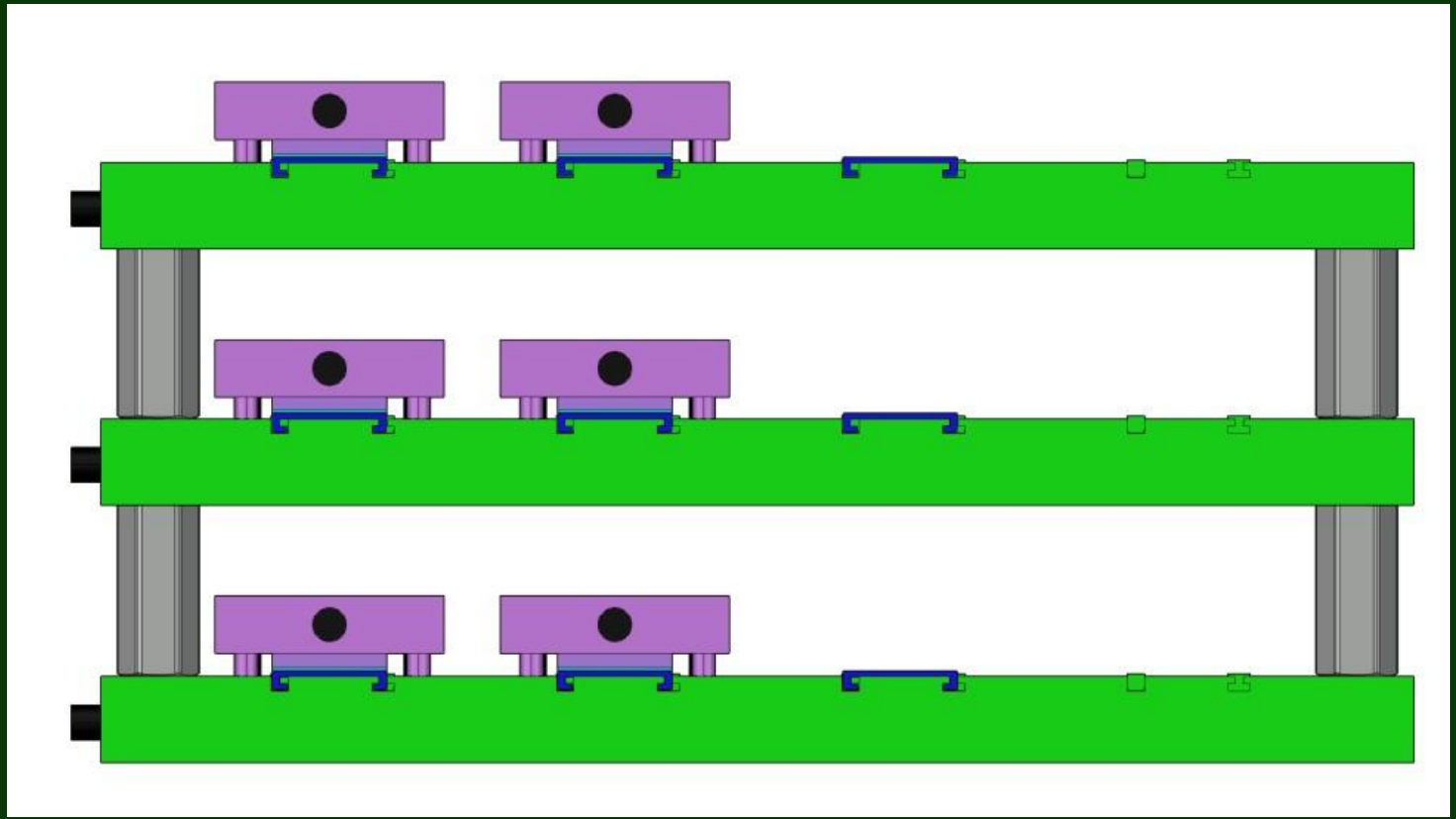
For prototyping, only single gluing jigs will be used, but for production, multiple gluing positions can be machined into a larger gluing plate, similar to this.





4 large hex standoffs (off-the-shelf) are screwed into the corners of the plate after the pickup tools are secured

Stacking Chip/Hybrid Gluing Plate

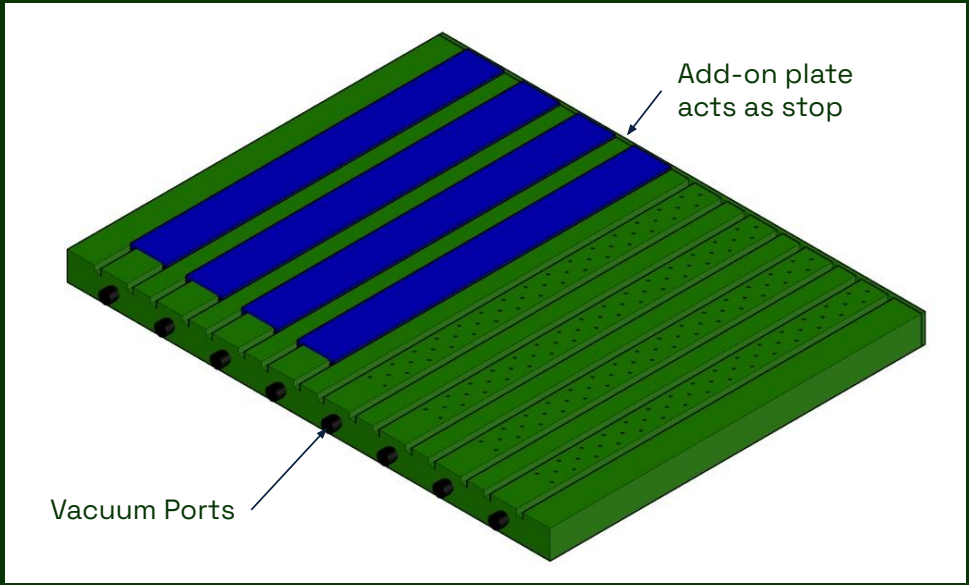


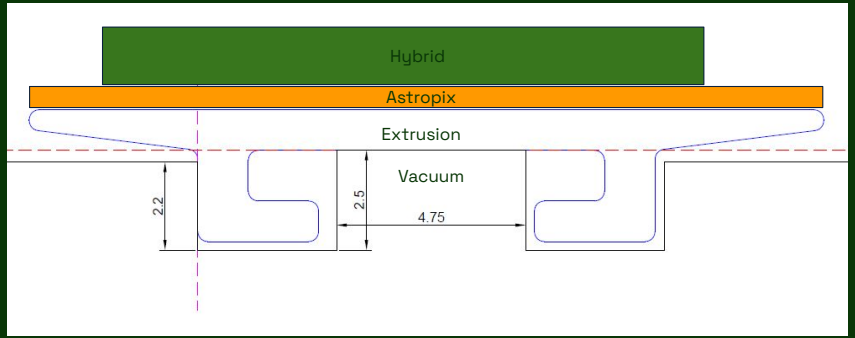
A recess in the bottom of the gluing plate allows the standoffs to be connected to the standoffs below so that multiple plates can be stacked for curing.

Bonding Jig

For prototyping, module bonding can be done on the single gluing jig (so gluing and bonding cannot be done in the same day, but the rates are low so this is not a problem).

For production, a larger bonding plate can be fabricated. Eight modules will fit within the working space of the bondhead.





Corrections to be Made

Chip Alignment Tray

- Chip separation is still an issue to be resolved. The best solution is to reduce the width of the chips to allow for a bigger gap between the chips, which is much cheaper to fabricate and much faster to build.

Chip Pickup Tool

- Longer Misumi pins to engage earlier in placement process
- Add grooves or pockets for magnets

Hybrid Alignment Tool

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Hybrid Pickup Tool

- Longer Misumi pins to engage earlier in placement process
- Add grooves or pockets for magnets
- If PCB is stiff enough not to bend under vacuum, many of the fixed height pins can be eliminated

Gluing Jig

- Add threaded bushing for thumbscrews
- Add grooves or pockets for magnets

Bonding Jig

- For prototyping, the gluing jig can be used for wirebonding
- For production, a gluing jig that will hold 8 modules at the same time needs to be designed

Thank You