

Digital fabrication of electronic circuit prototypes: a field report

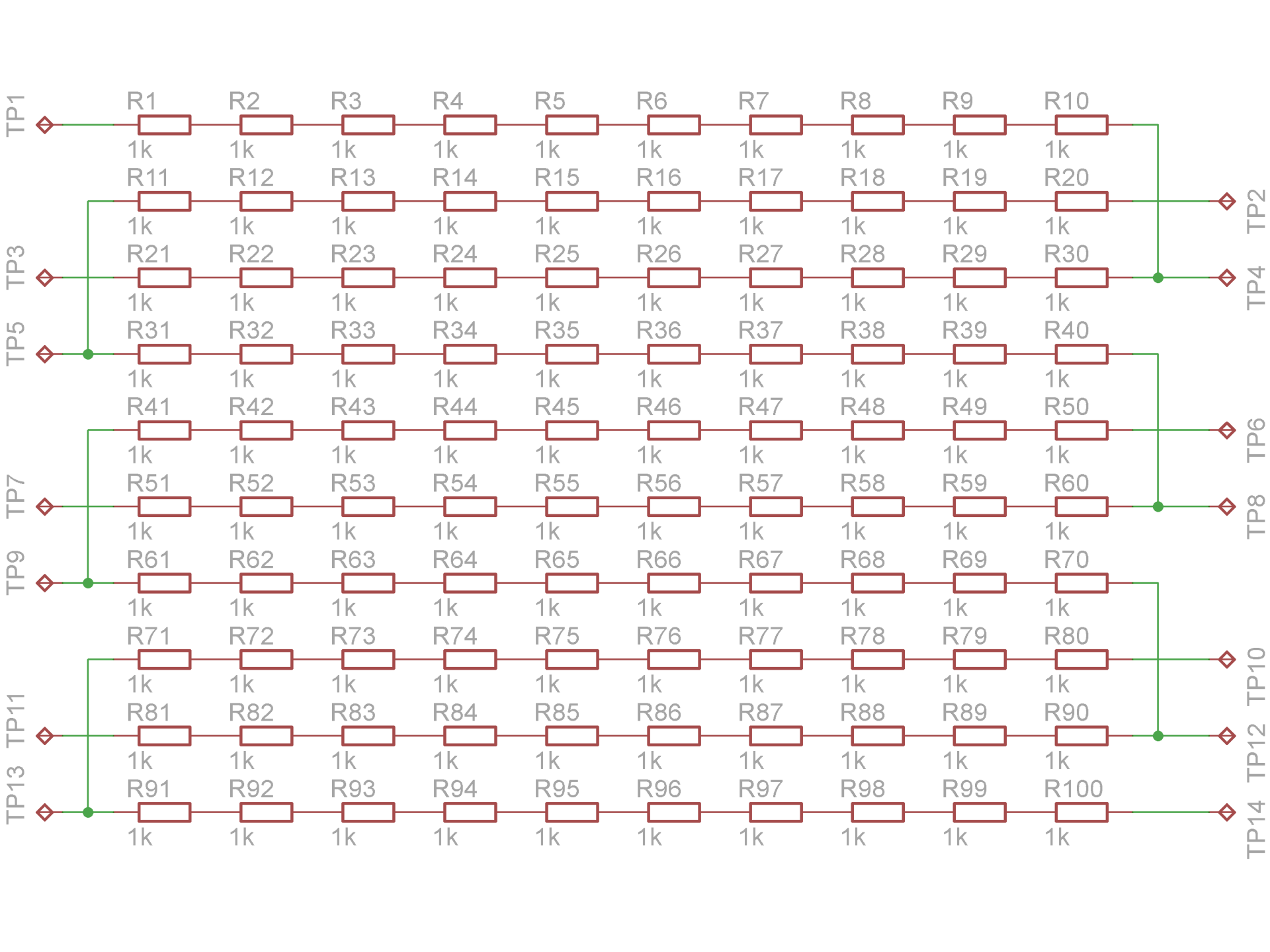
Johannes Taelman

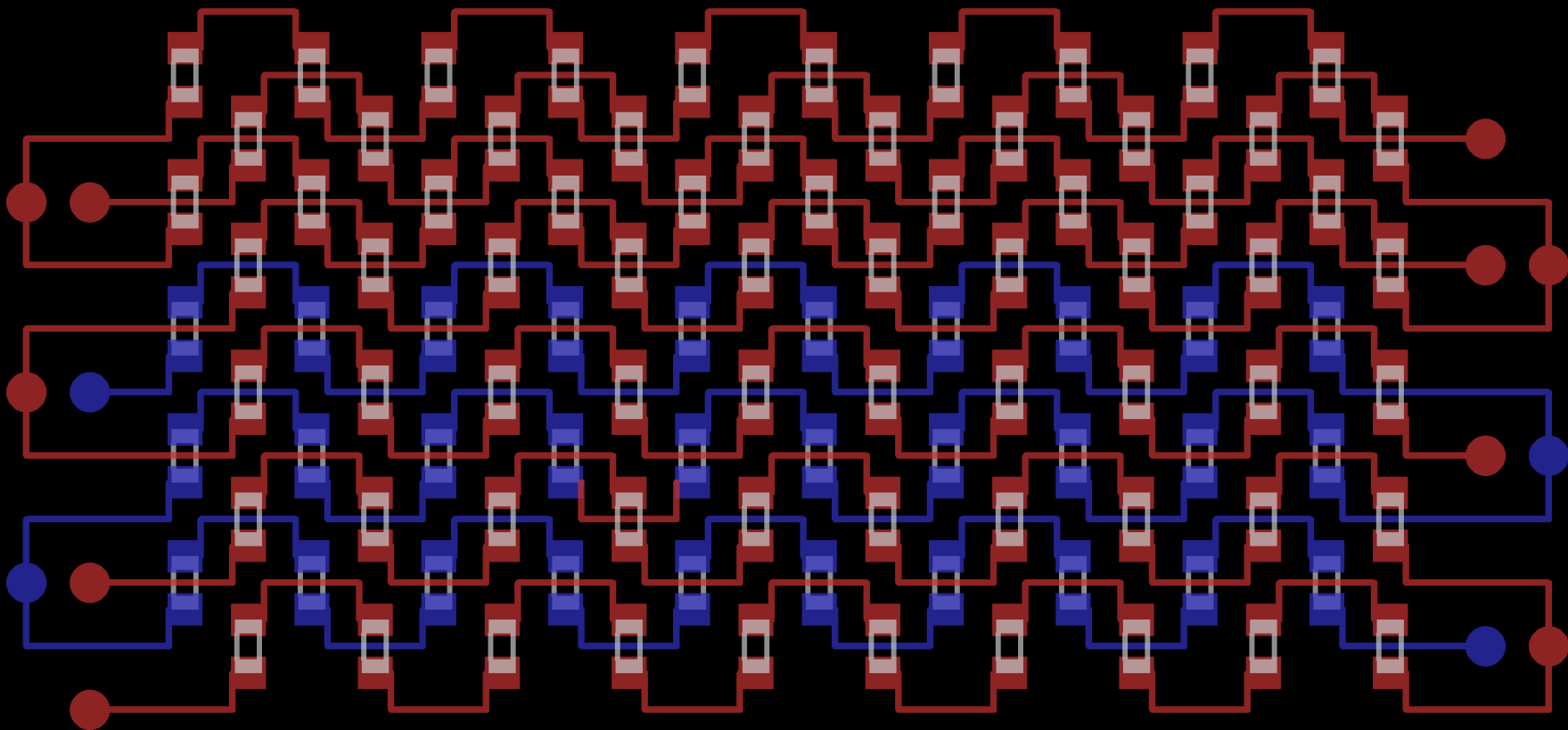


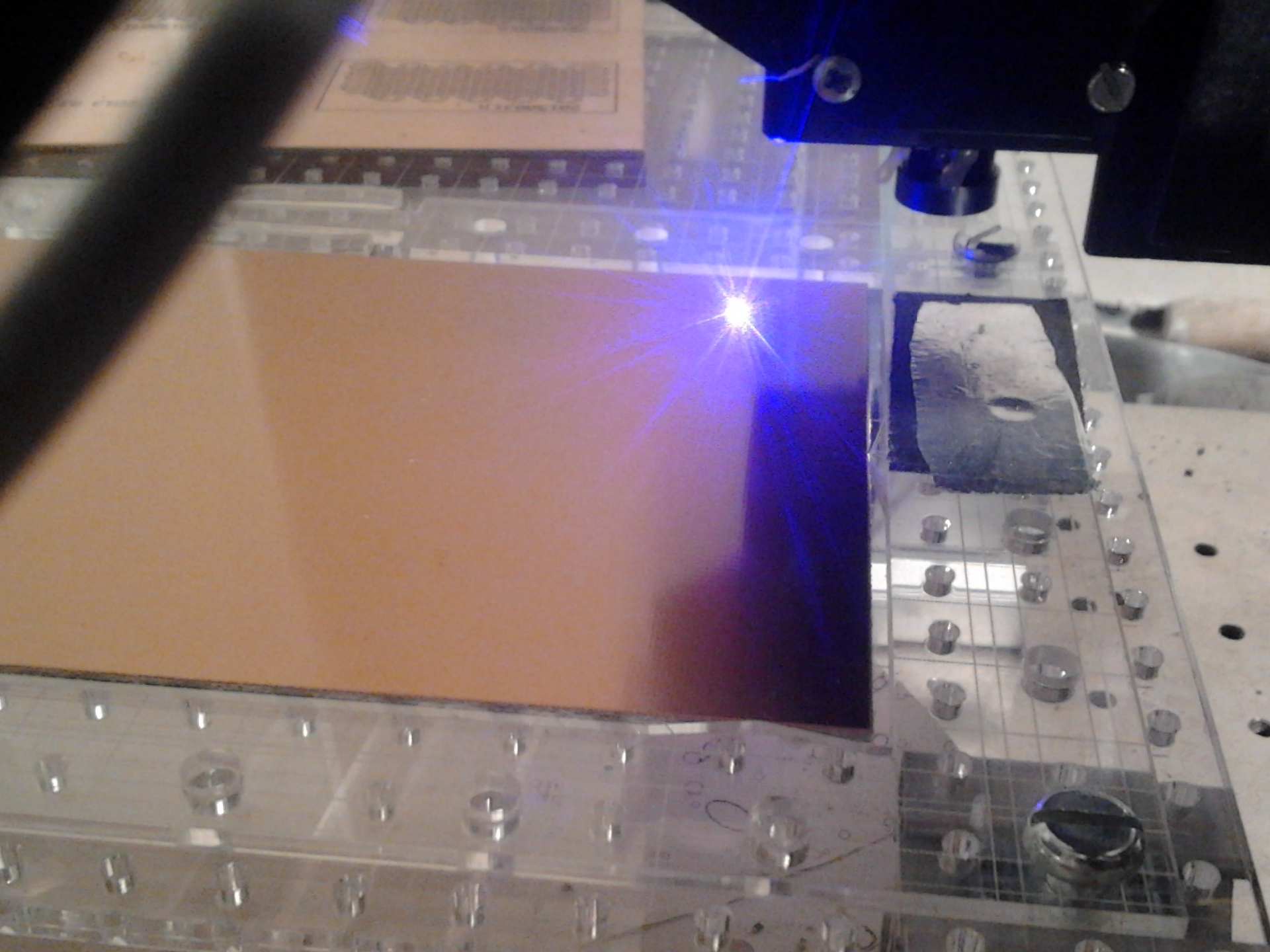
Goal

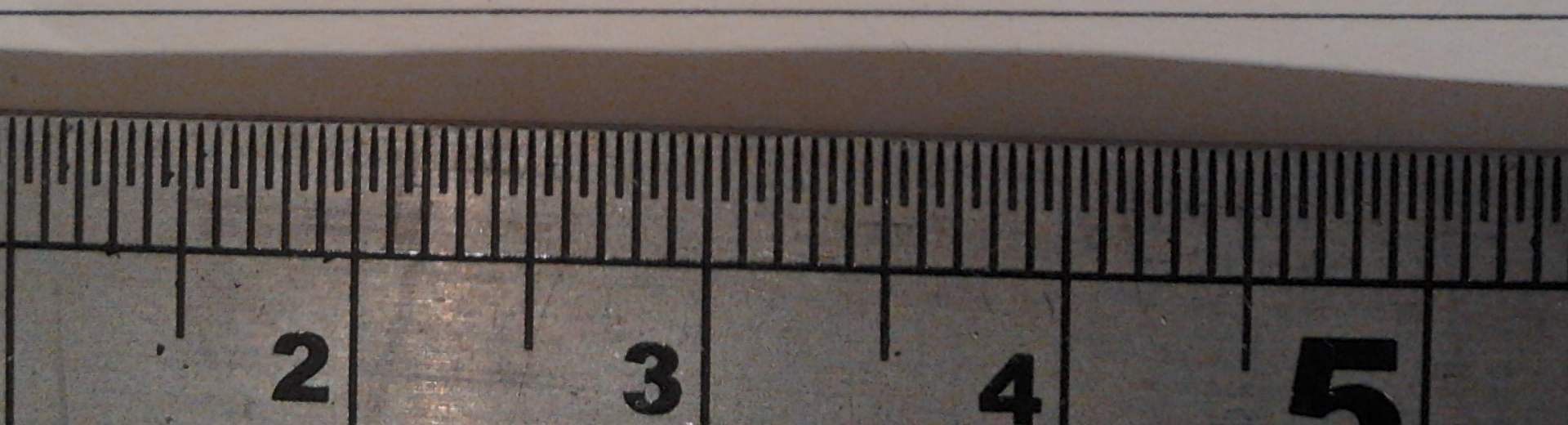
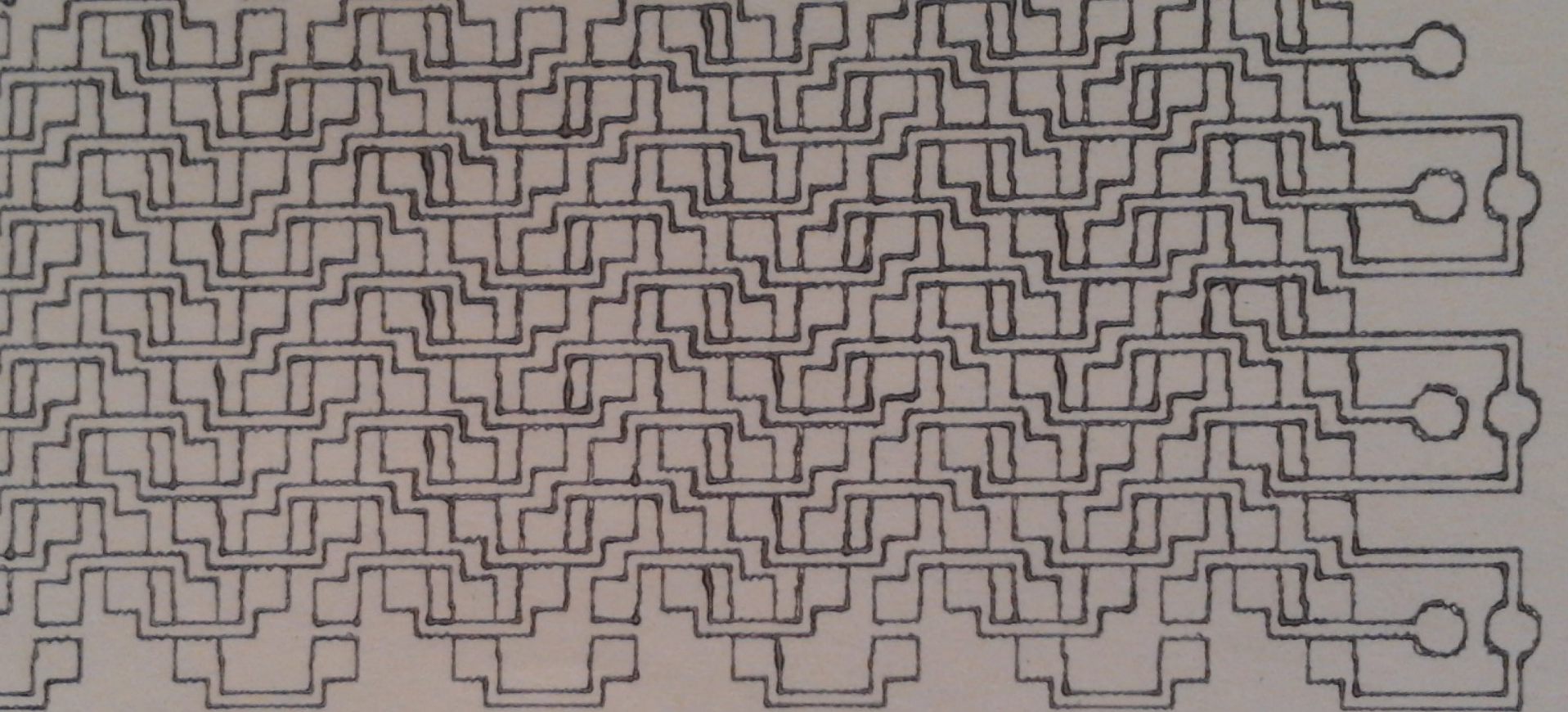
- Low-cost home fabrication of dense electronics prototypes
- Reduce design-prototype-test iteration cycle time

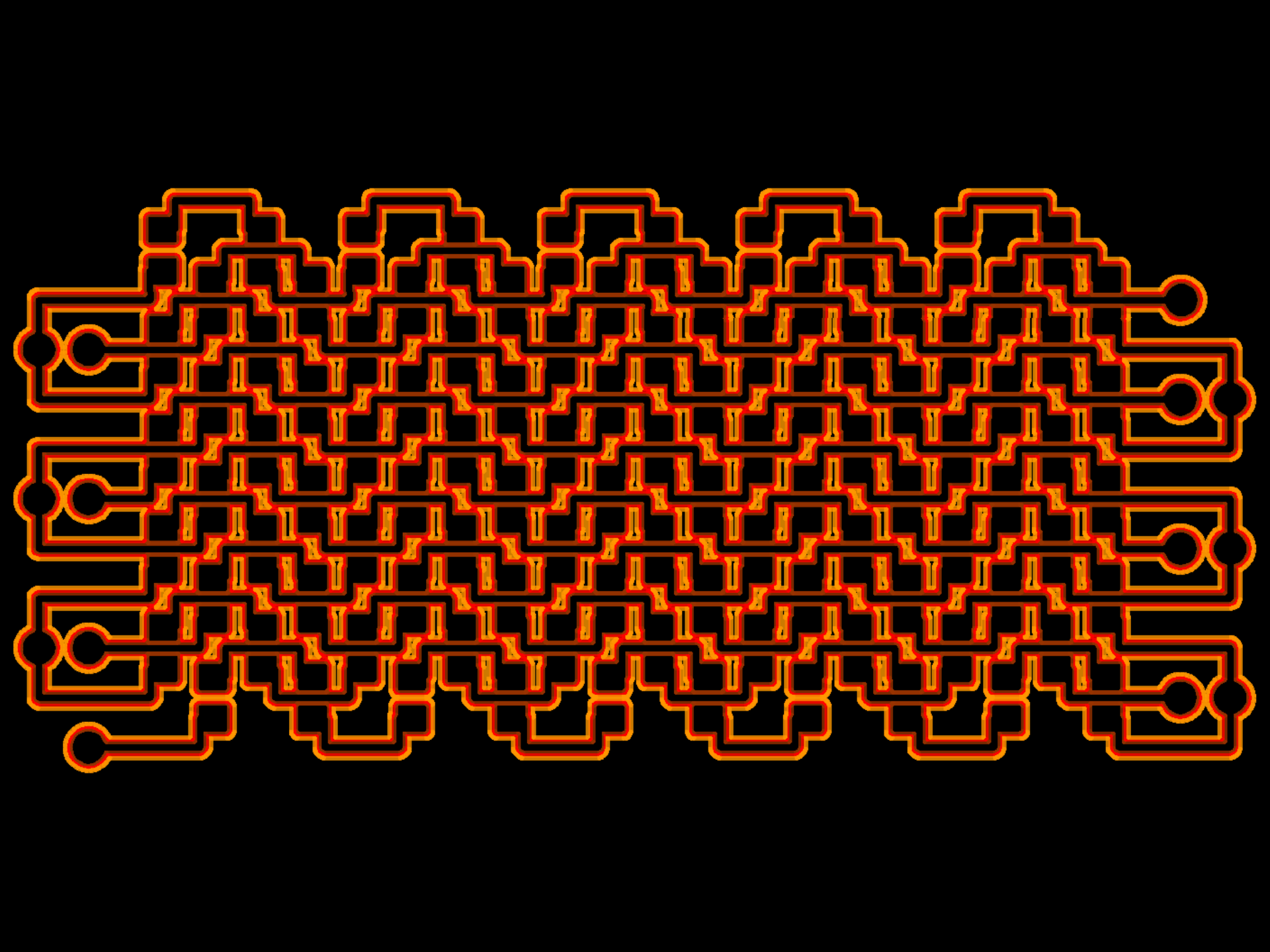
(NOT: series production assembly line)

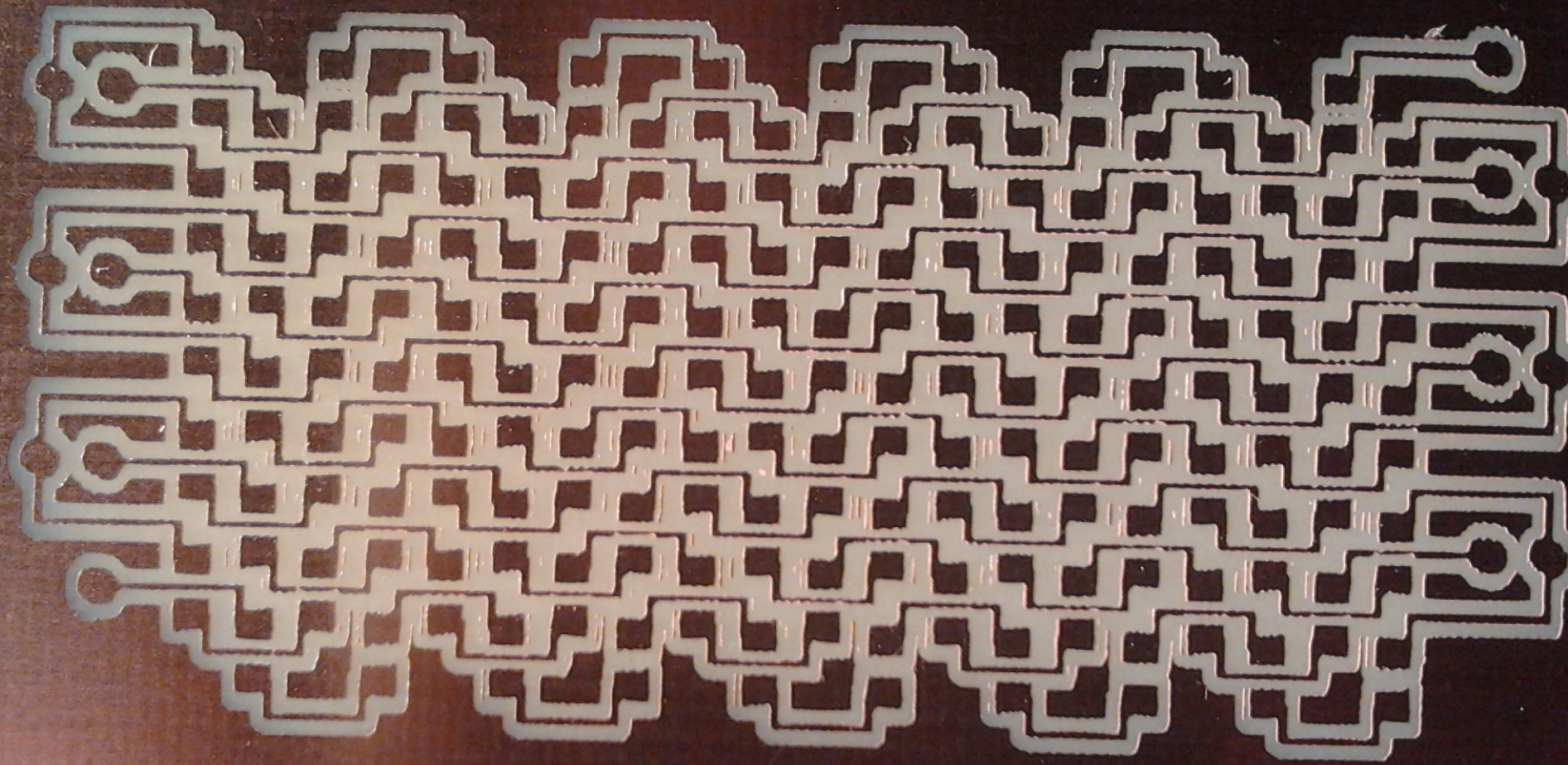


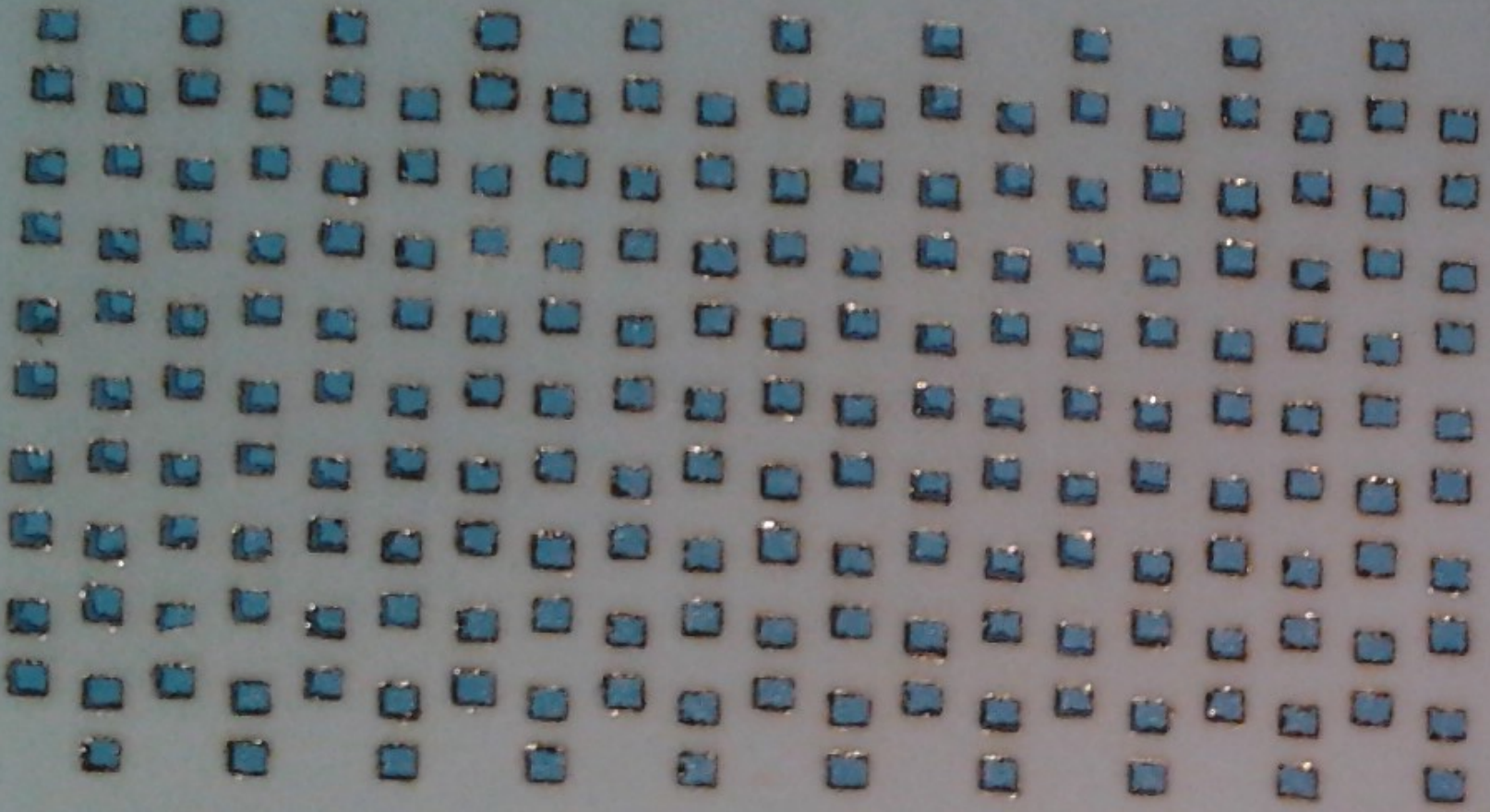


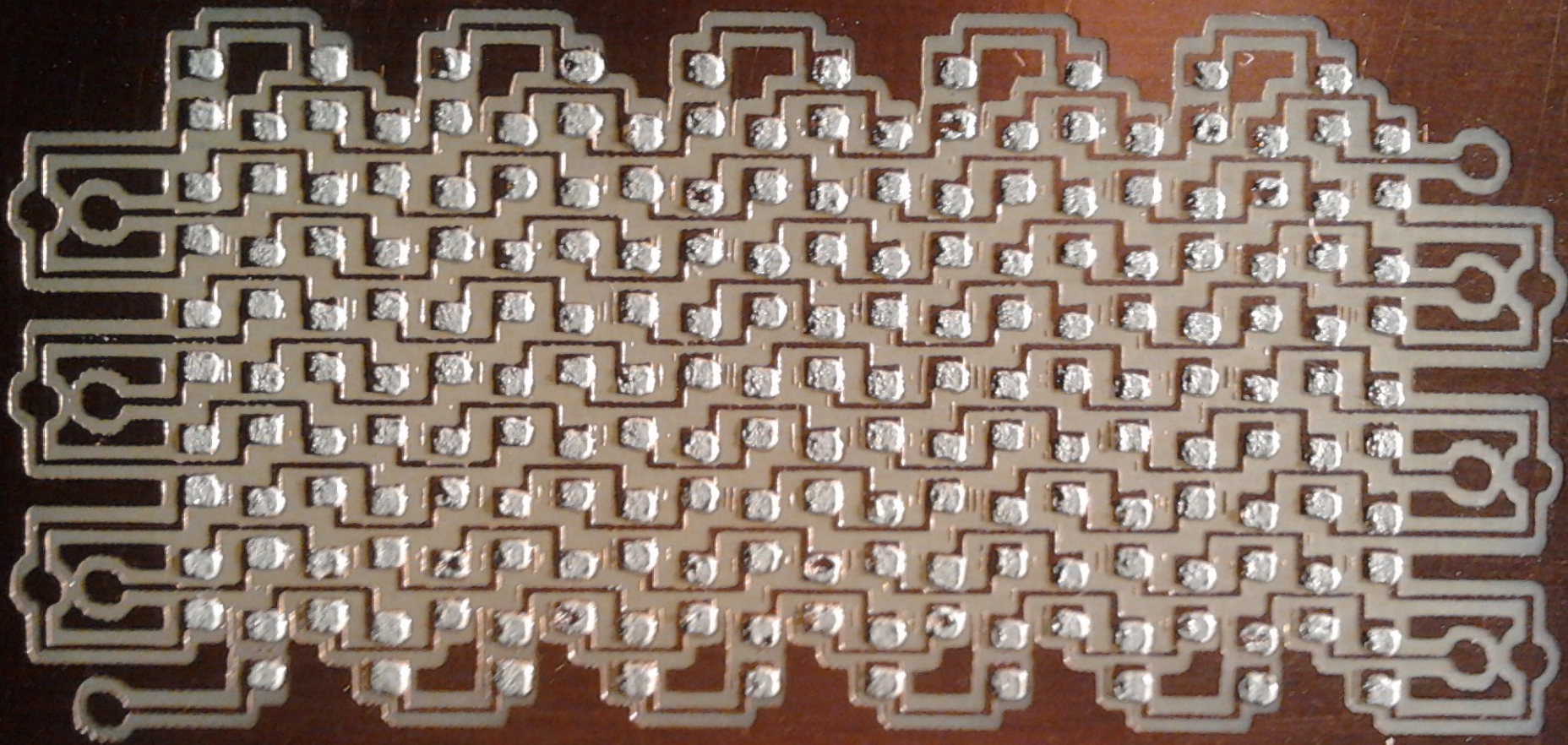


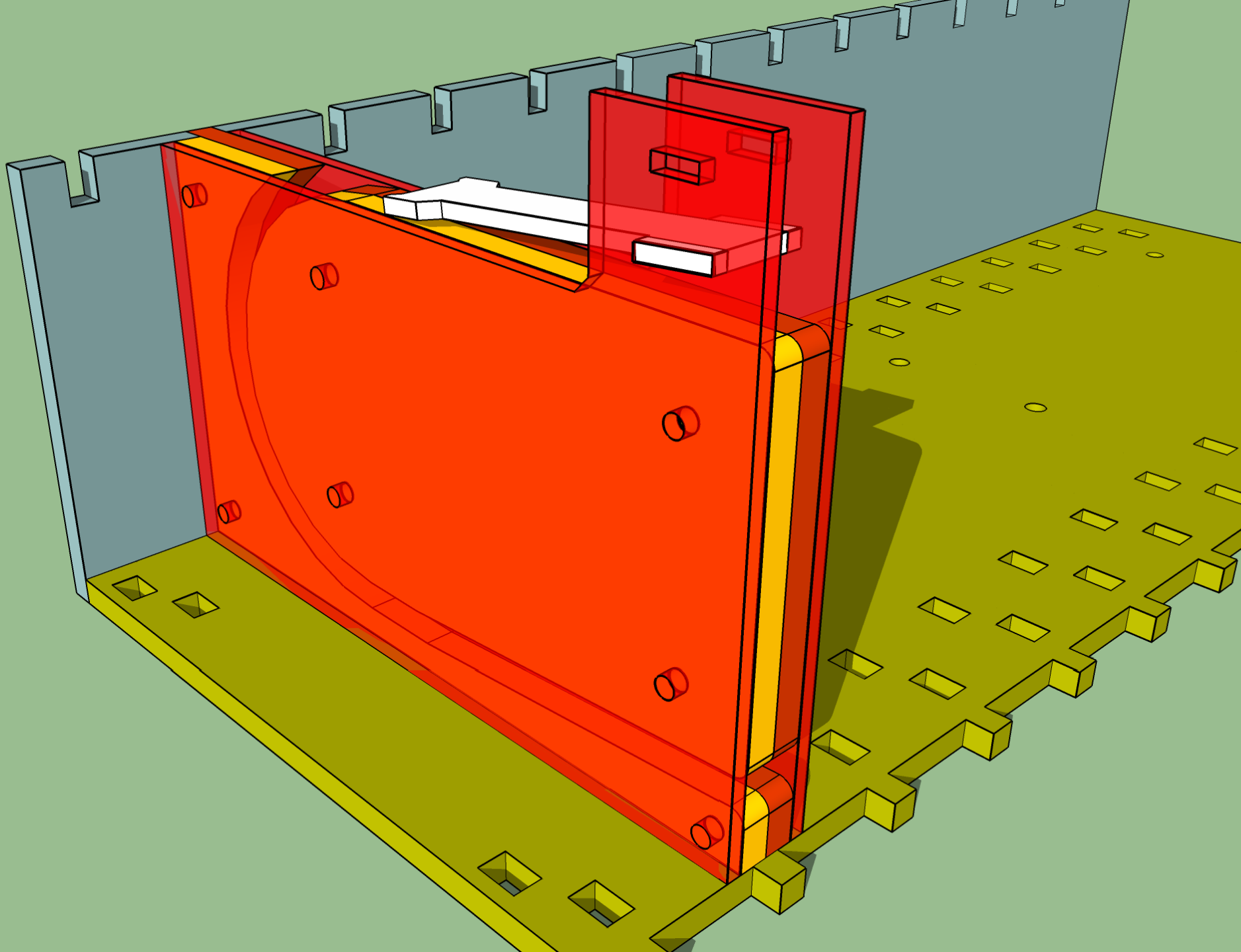


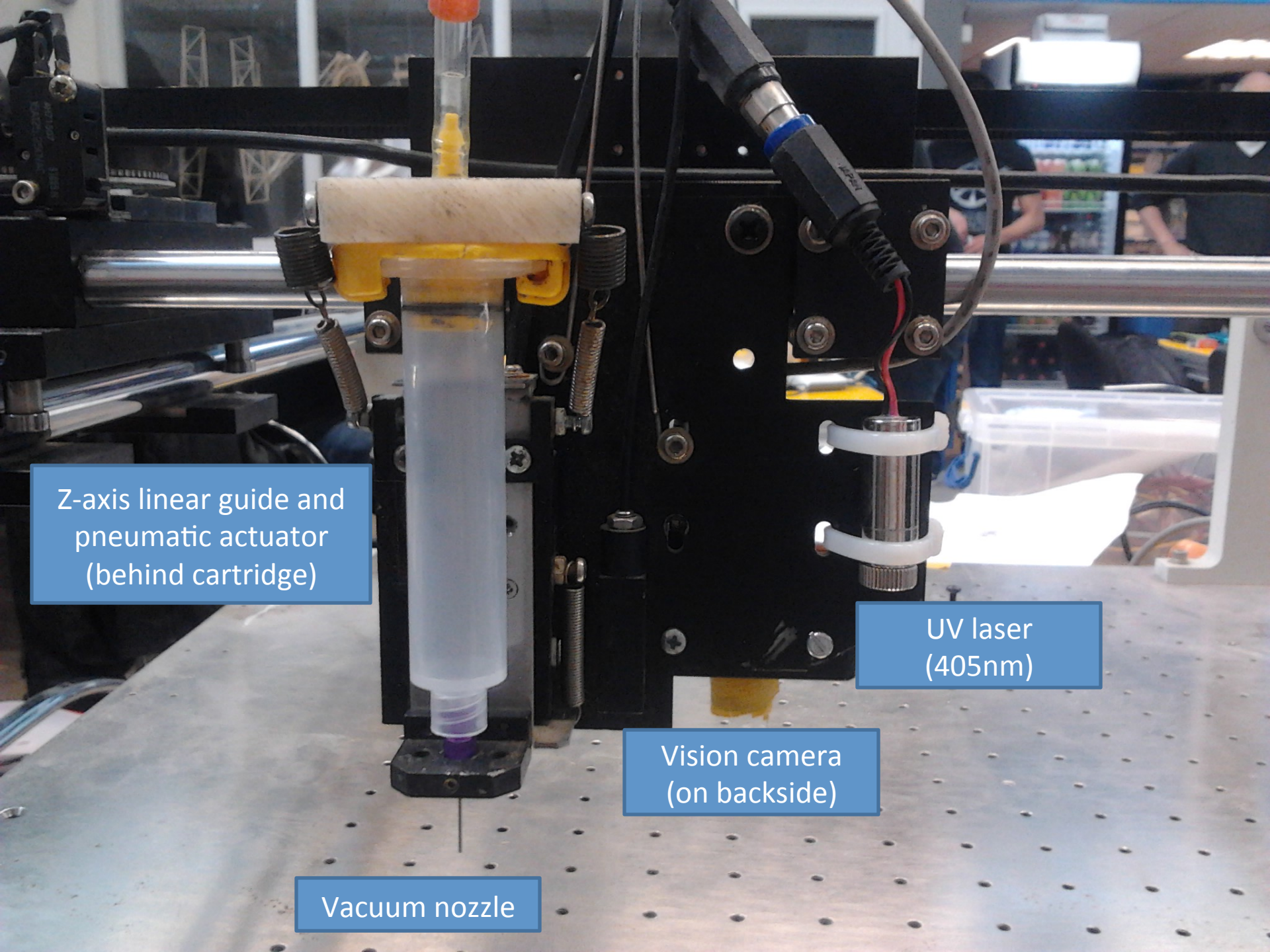










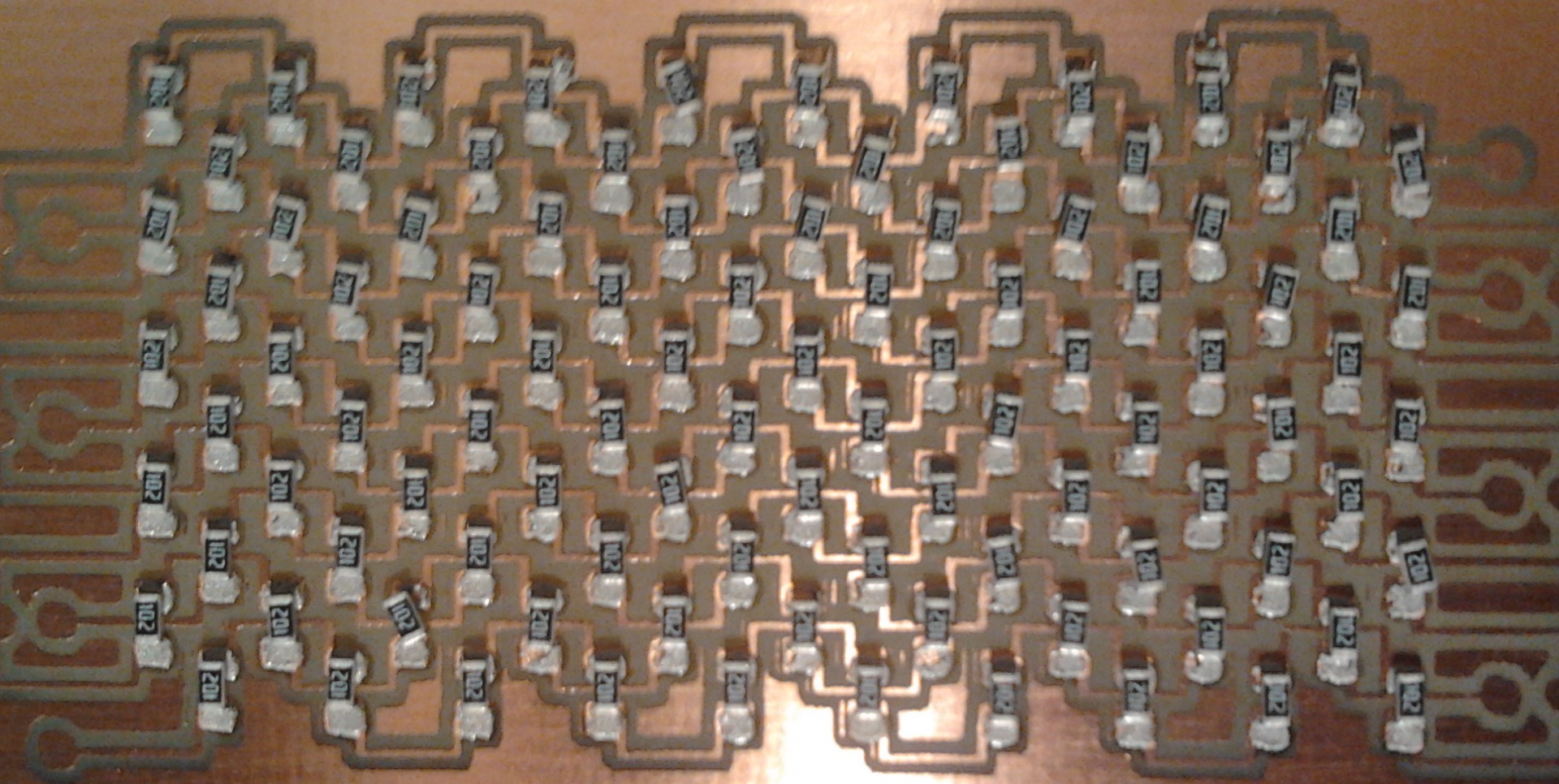


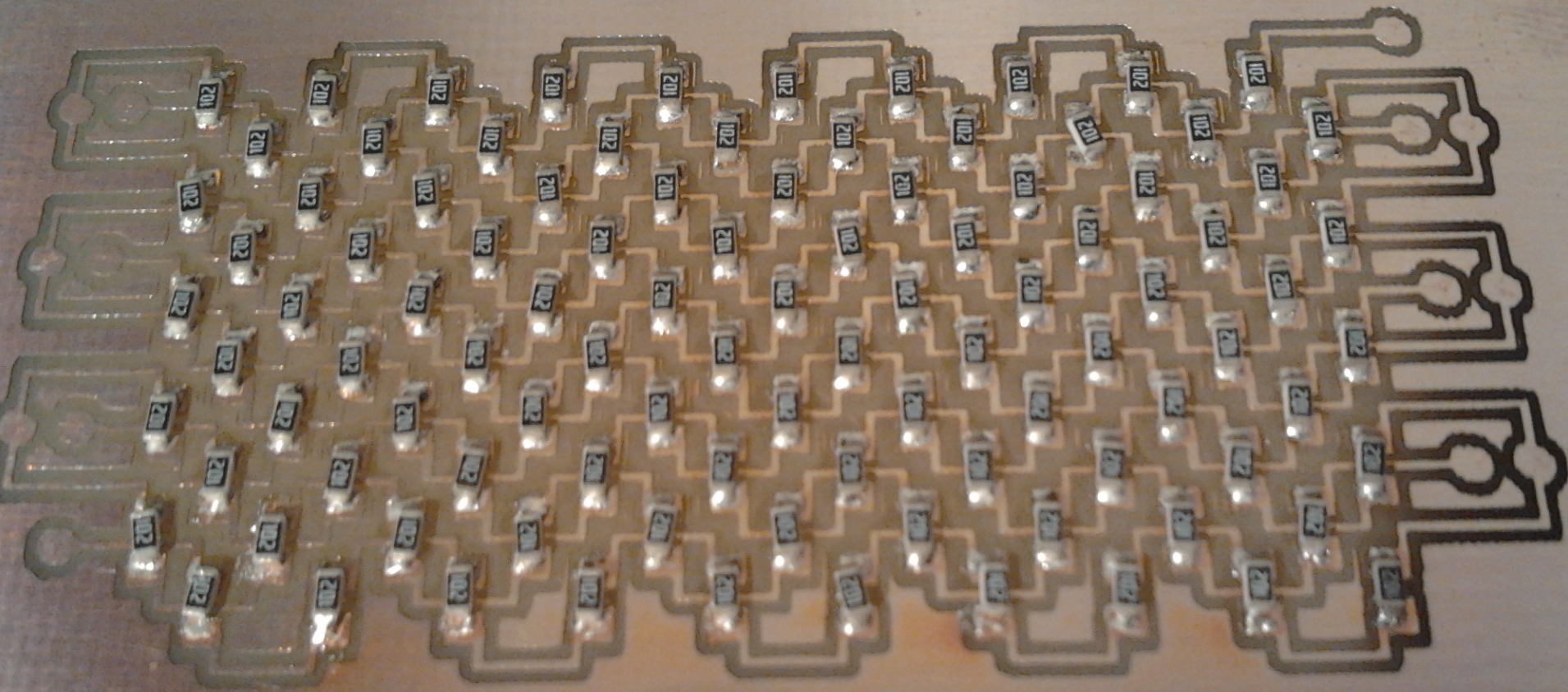
Z-axis linear guide and
pneumatic actuator
(behind cartridge)

UV laser
(405nm)

Vision camera
(on backside)

Vacuum nozzle





HOW LONG CAN YOU WORK ON MAKING A ROUTINE TASK MORE EFFICIENT BEFORE YOU'RE SPENDING MORE TIME THAN YOU SAVE?
(ACROSS FIVE YEARS)

		HOW OFTEN YOU DO THE TASK					
		50/DAY	5/DAY	DAILY	WEEKLY	MONTHLY	YEARLY
HOW MUCH TIME YOU SHAVE OFF	1 SECOND	1 DAY	2 HOURS	30 MINUTES	4 MINUTES	1 MINUTE	5 SECONDS
	5 SECONDS	5 DAYS	12 HOURS	2 HOURS	21 MINUTES	5 MINUTES	25 SECONDS
	30 SECONDS	4 WEEKS	3 DAYS	12 HOURS	2 HOURS	30 MINUTES	2 MINUTES
	1 MINUTE	8 WEEKS	6 DAYS	1 DAY	4 HOURS	1 HOUR	5 MINUTES
	5 MINUTES	9 MONTHS	4 WEEKS	6 DAYS	21 HOURS	5 HOURS	25 MINUTES
	30 MINUTES		6 MONTHS	5 WEEKS	5 DAYS	1 DAY	2 HOURS
	1 HOUR		10 MONTHS	2 MONTHS	10 DAYS	2 DAYS	5 HOURS
	6 HOURS				2 MONTHS	2 WEEKS	1 DAY
1 DAY					8 WEEKS	5 DAYS	

From: <http://xkcd.com/1205/>

Workflow

- Laser expose (10 min)
- Lasercut stencil (60 min)
 - Develop
 - Etch
 - Dissolve photoresist
 - Stencil solderpaste
- Pick and Place (30 min)
 - Reflow oven
 - Test!

Software

- OpenPNP by Jason Von Nieda
- Smoothieware
- Pronterface
- pcb-gcode.ulp script for Eagle
- stencil_gcode.ulp script for Eagle

Conclusion

With affordable tools:

- PCB's can be prototyped meeting 8 mil (0.2mm) design rules, and populated with 0603 components..
- A track can run below a 0603 component on a board without soldermask, reducing the number of via's.

Future work

- Part rotation
- Computer vision
- Cover tape spooler
- Solder mask (UV cured contours)
- Nozzle toolchanger