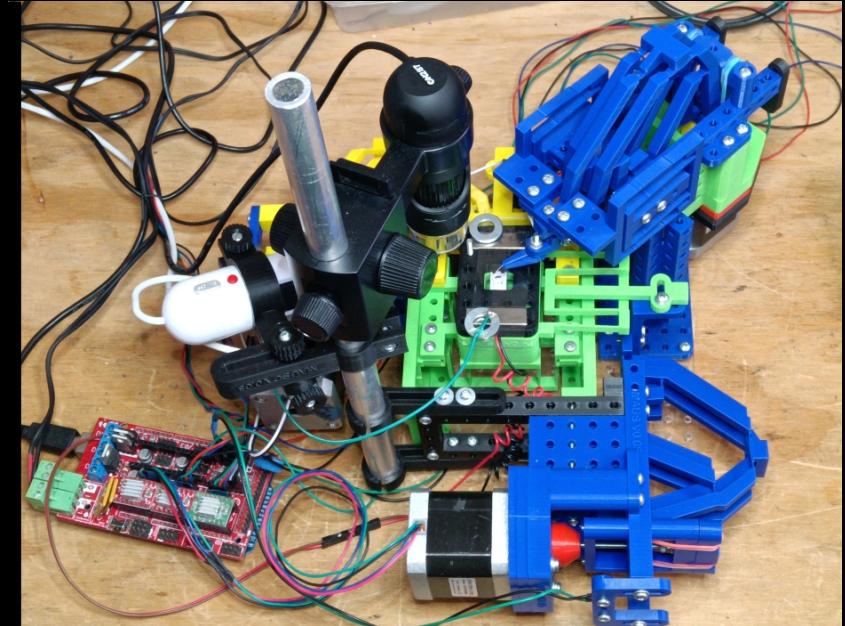


RepRapMicron

The Next Small Thing In 3D Printing



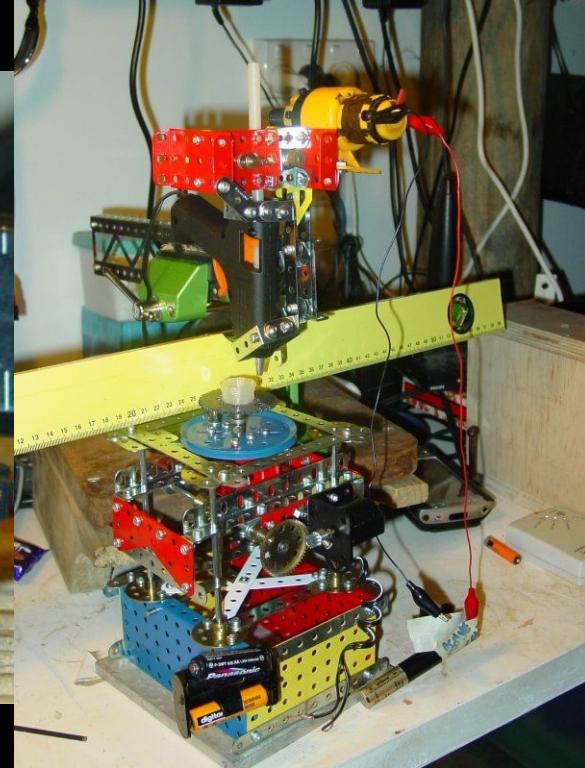
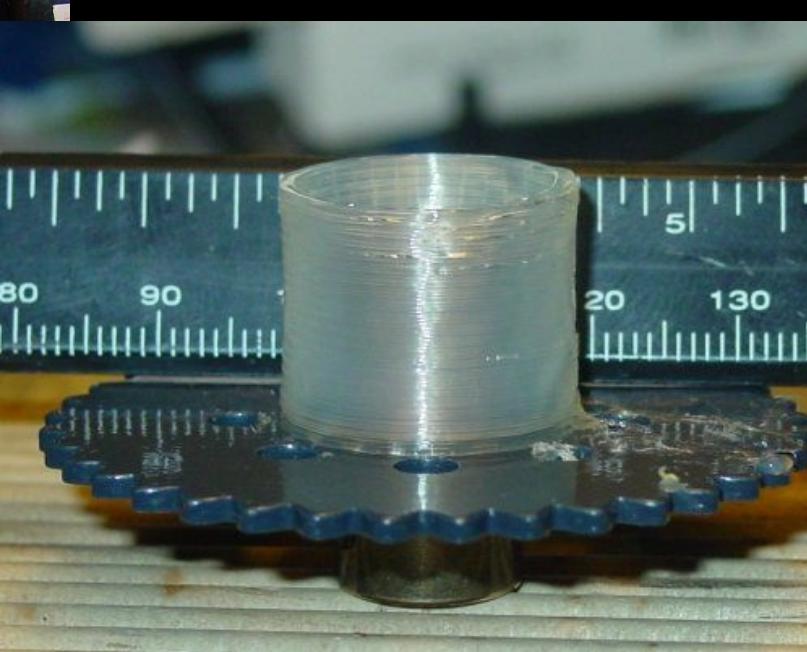
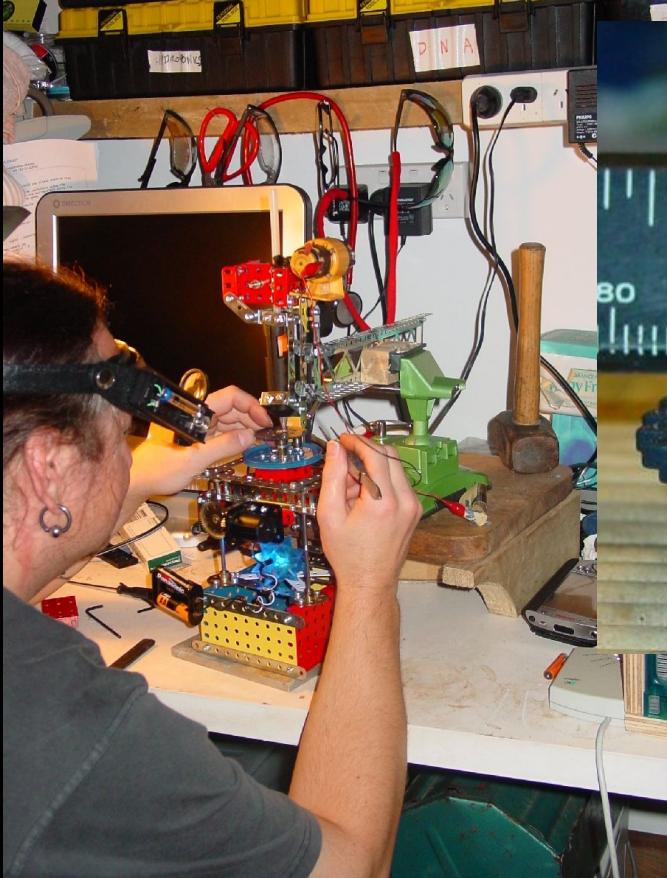
A Little Open Source Project
By Vik Olliver
vik@diamondage.co.nz



<http://blog.reprap.org>



In The Beginning...



https://www.researchgate.net/publication/398027280_Construction_of_Rapid_Prototyping_Testbeds_Using_Meccano

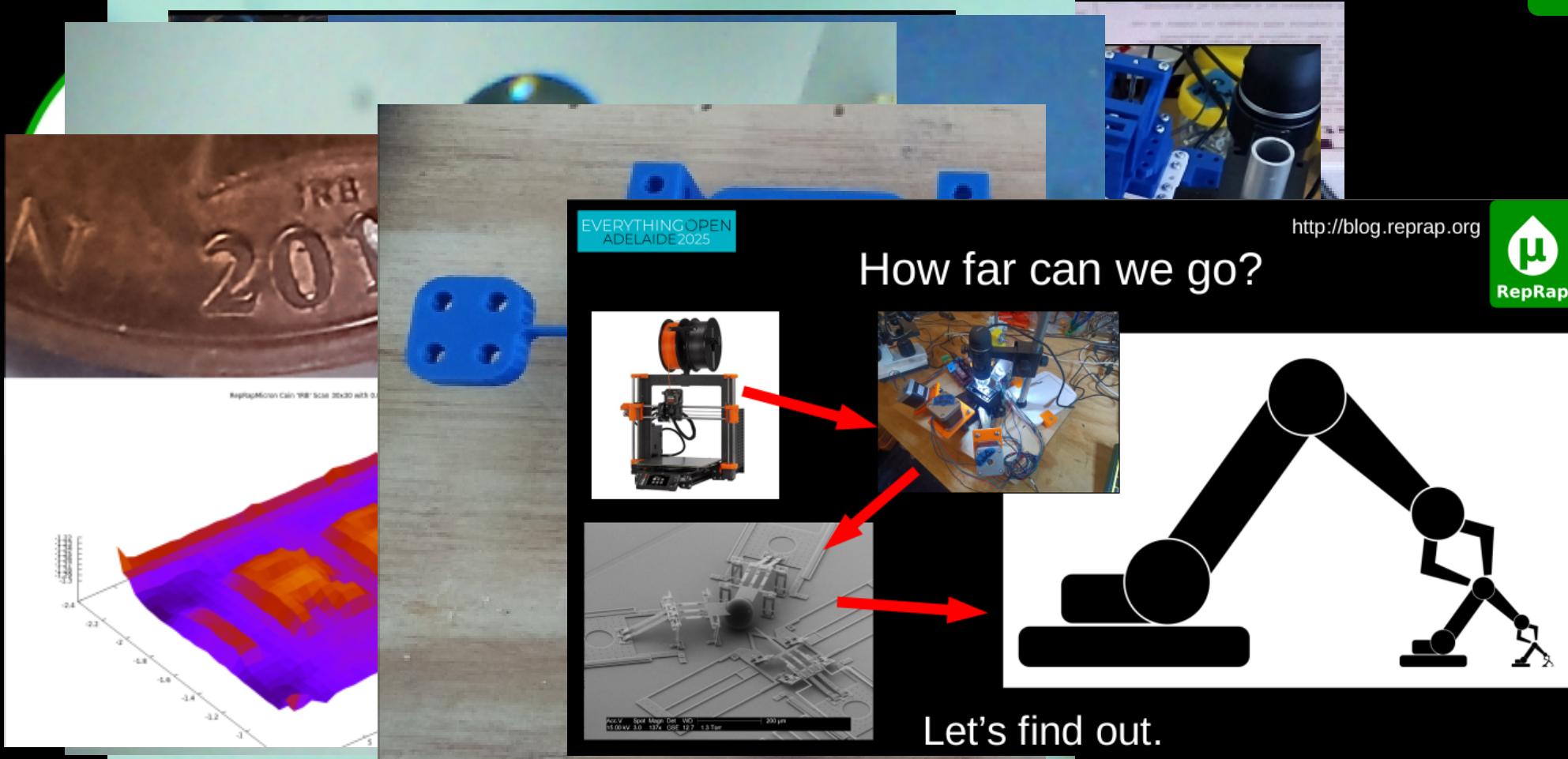
Anthony Demonstrates Microns



Small black ant next to a 1mm long logo.

Logo is 100 pixels wide, pixel spacing 10 microns.

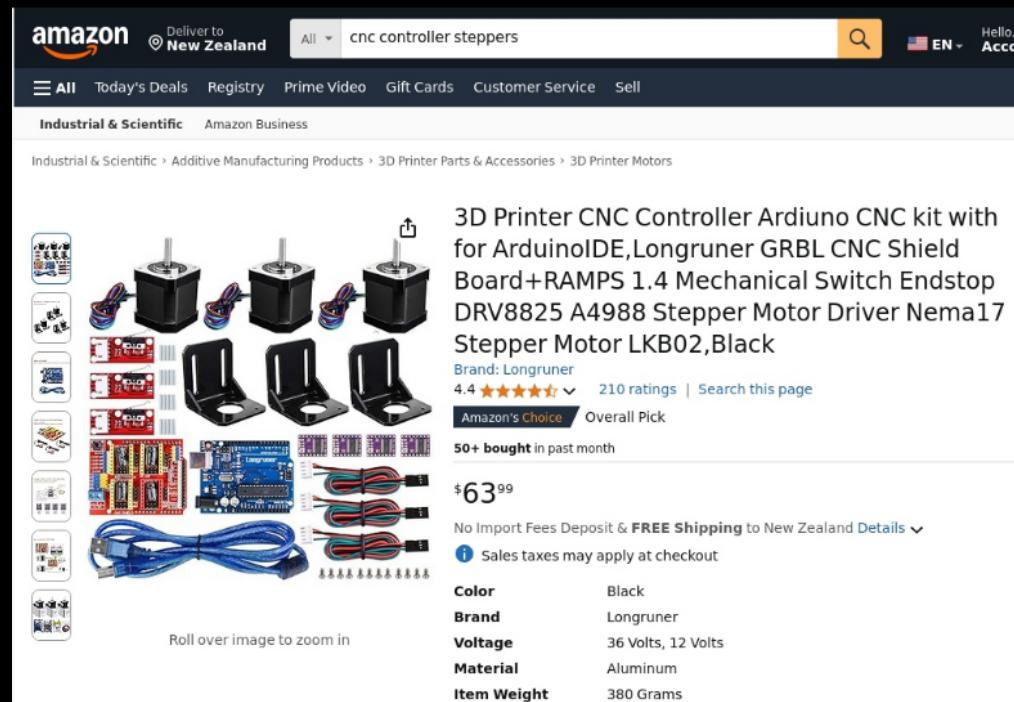
Quick Recap



The collage includes:

- A close-up of a 20 cent Australian coin.
- A blue 3D-printed three-prong power plug.
- A 3D surface plot of a printed part.
- A 3D rendering of a RepRap Micro Cain 3D printer.
- A photograph of a complex 3D-printed mechanical assembly on a workbench.
- A grayscale SEM image of a printed part.
- A black silhouette of a multi-link robotic arm.
- A white text overlay: "How far can we go?"
- A white text overlay: "Let's find out."
- The URL <http://blog.reprap.org>
- The RepRap logo.

What I Got Right

A screenshot of an Amazon product page for a "3D Printer CNC Controller Arduino CNC kit". The page shows a photograph of the kit components, which include an Arduino Uno-like board, several Nema 17 stepper motors with black mounting brackets, and various connecting wires. The main text on the page describes the kit as including an Arduino CNC shield, RAMPS 1.4, mechanical switch endstops, and DRV8825 stepper motor drivers. It is labeled as a "Longruner" brand item, an "Amazon's Choice" and "Overall Pick", and has a price of \$63.99. A note indicates "No Import Fees Deposit & FREE Shipping to New Zealand".

3D Printer CNC Controller Arduino CNC kit with
for Arduino IDE, Longrunner GRBL CNC Shield
Board + RAMPS 1.4 Mechanical Switch Endstop
DRV8825 A4988 Stepper Motor Driver Nema17
Stepper Motor LKB02, Black

Brand: Longrunner

4.4 ★★★★☆ 210 ratings | Search this page

Amazon's Choice Overall Pick

50+ bought in past month

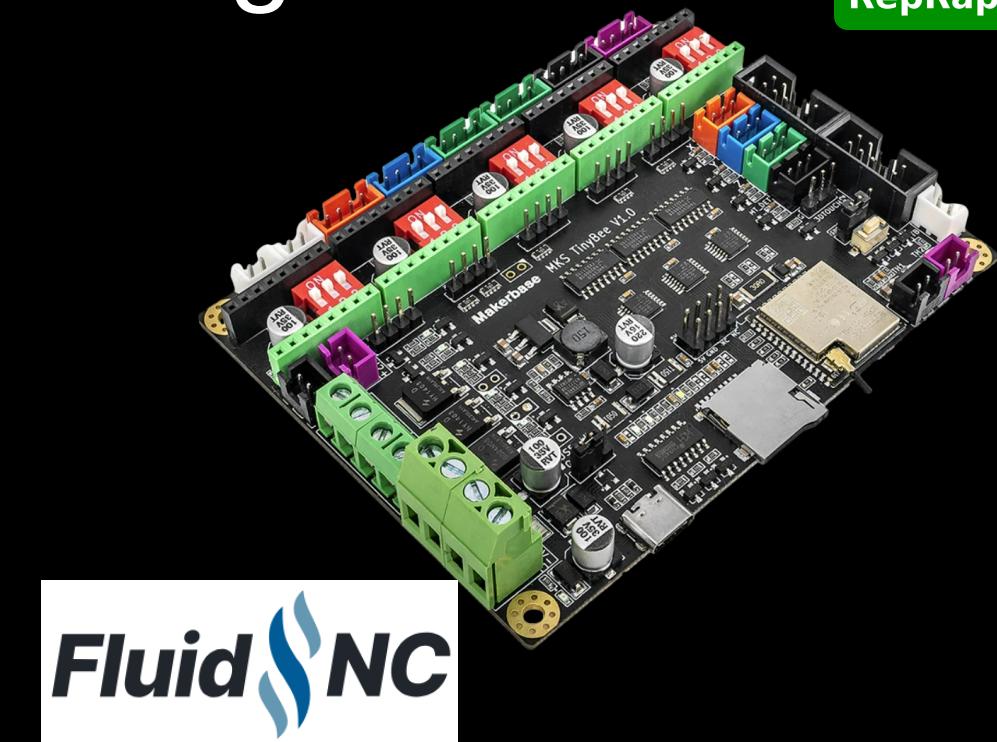
\$63.99

No Import Fees Deposit & **FREE Shipping** to New Zealand Details

Sales taxes may apply at checkout

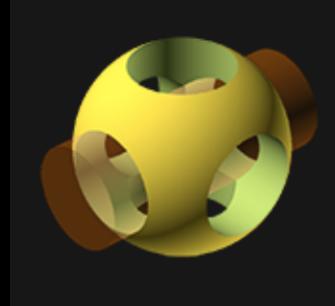
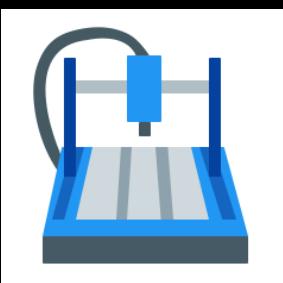
Color	Black
Brand	Longrunner
Voltage	36 Volts, 12 Volts
Material	Aluminum
Item Weight	380 Grams

A \$65 Arduino Clone CNC



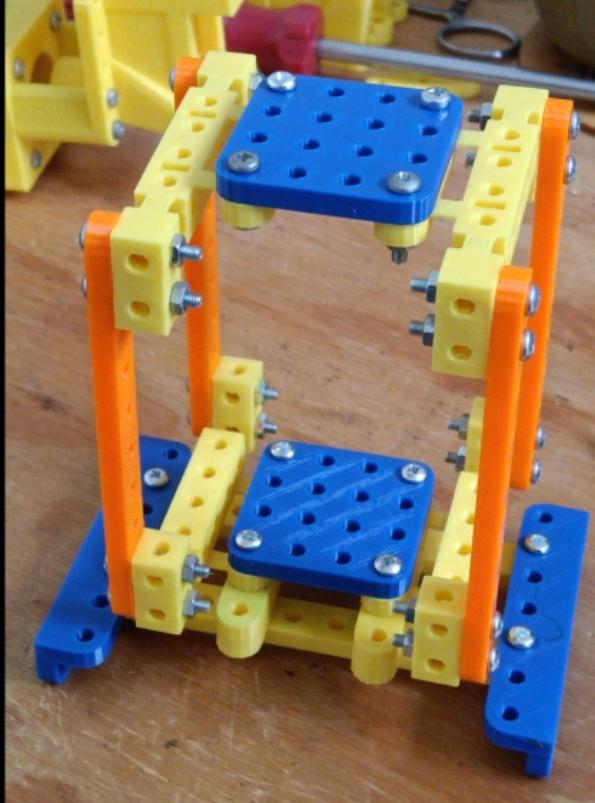
Or your choice of Open hardware

Open Source Toolchain

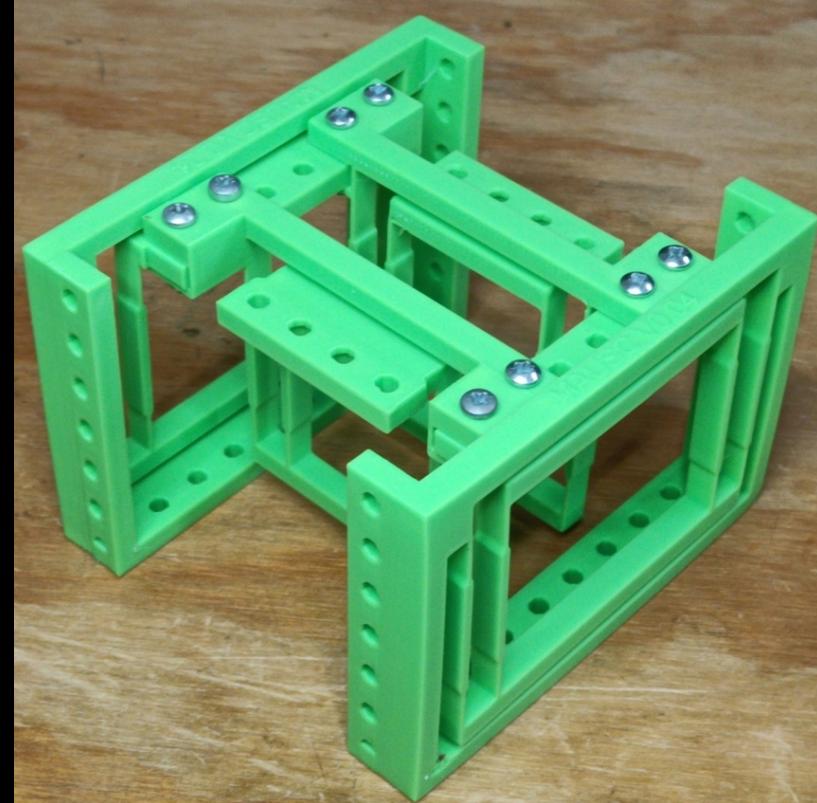


- RepRap
- GRBL
- CNCjs
- OpenSCAD
- PrusaSlicer
- mpv

Old And Busted ... New Hotness

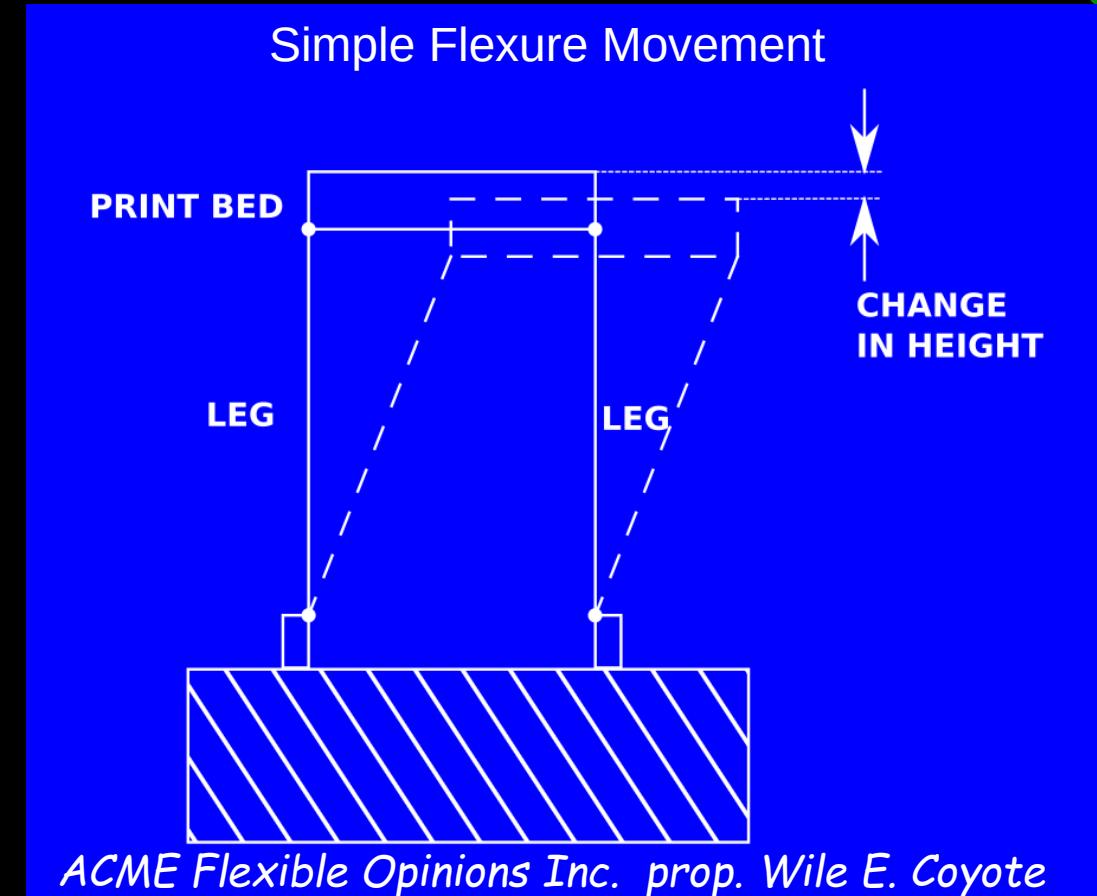
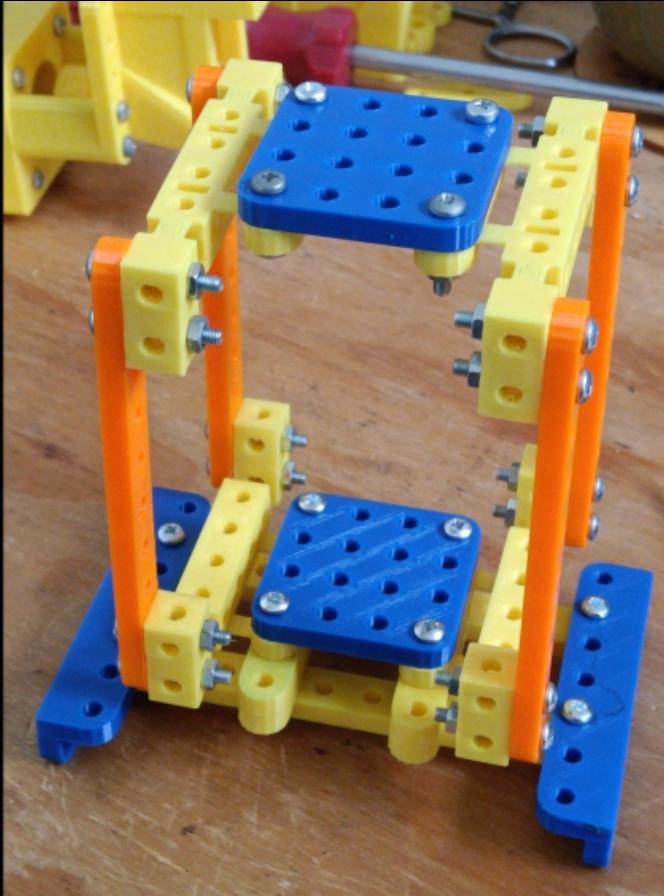


V0.01 XY Table



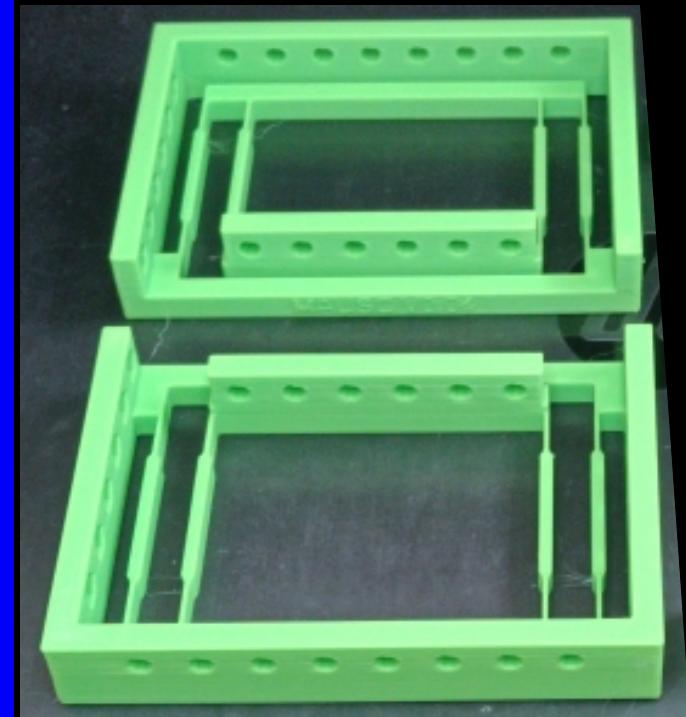
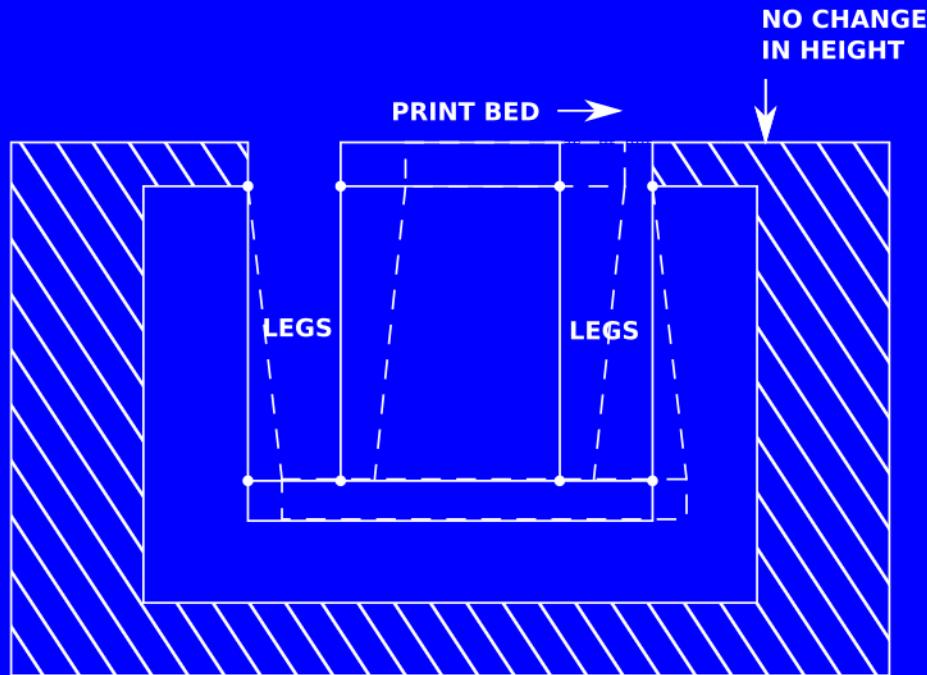
V0.05 XY Table

Simple Flexures Bad



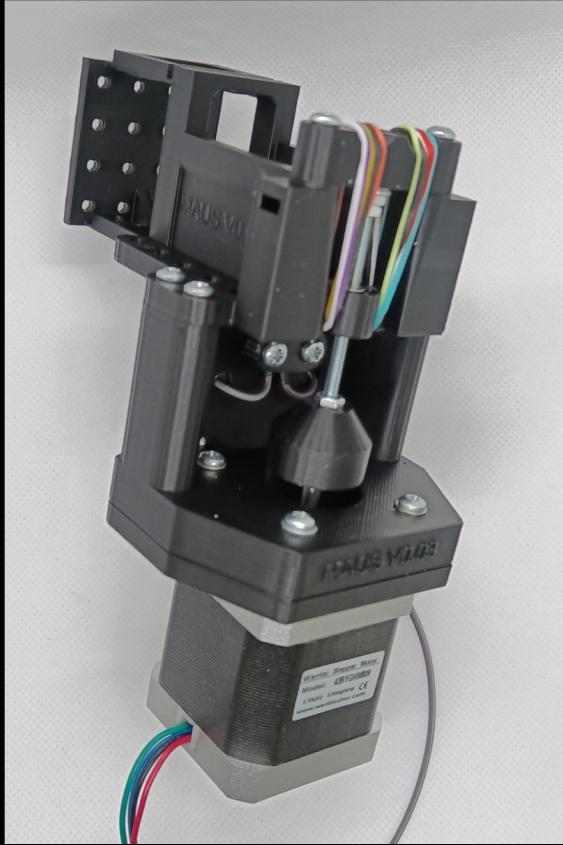
Being Complementary Instead

Complementary Flexure Movement

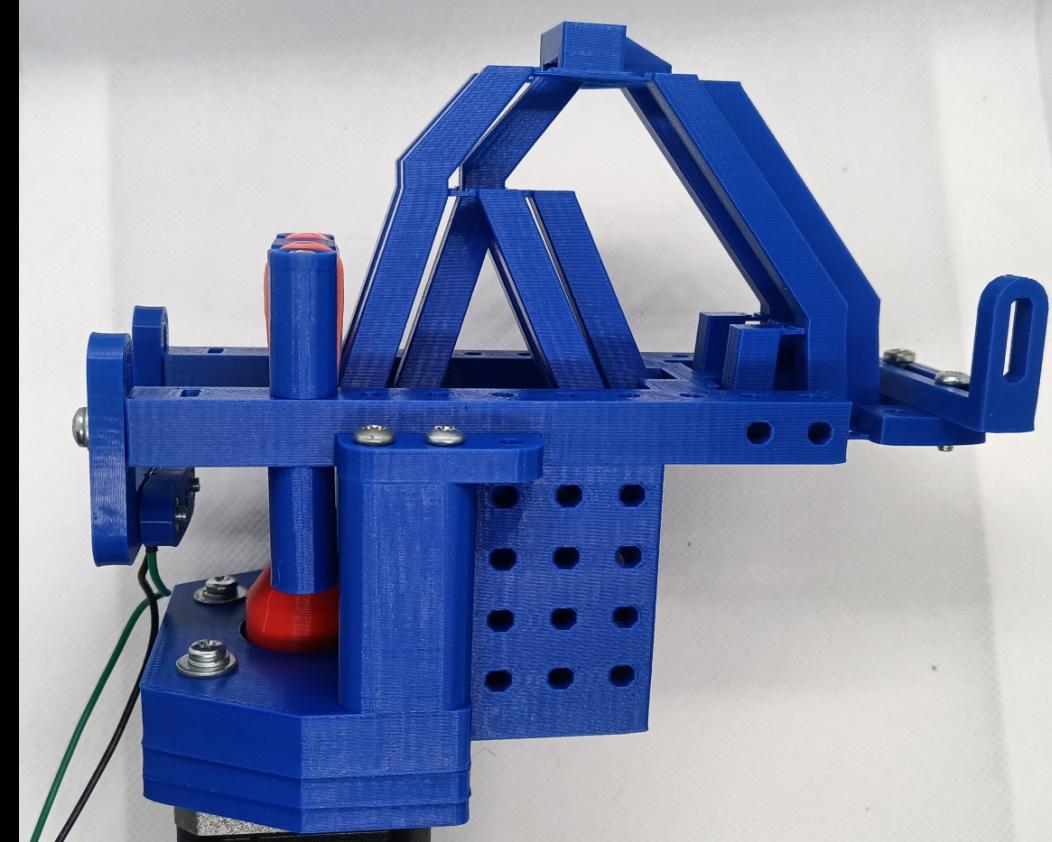


ACME Flexible Opinions Inc. prop. Wile E. Coyote

Sharpen Your Axes

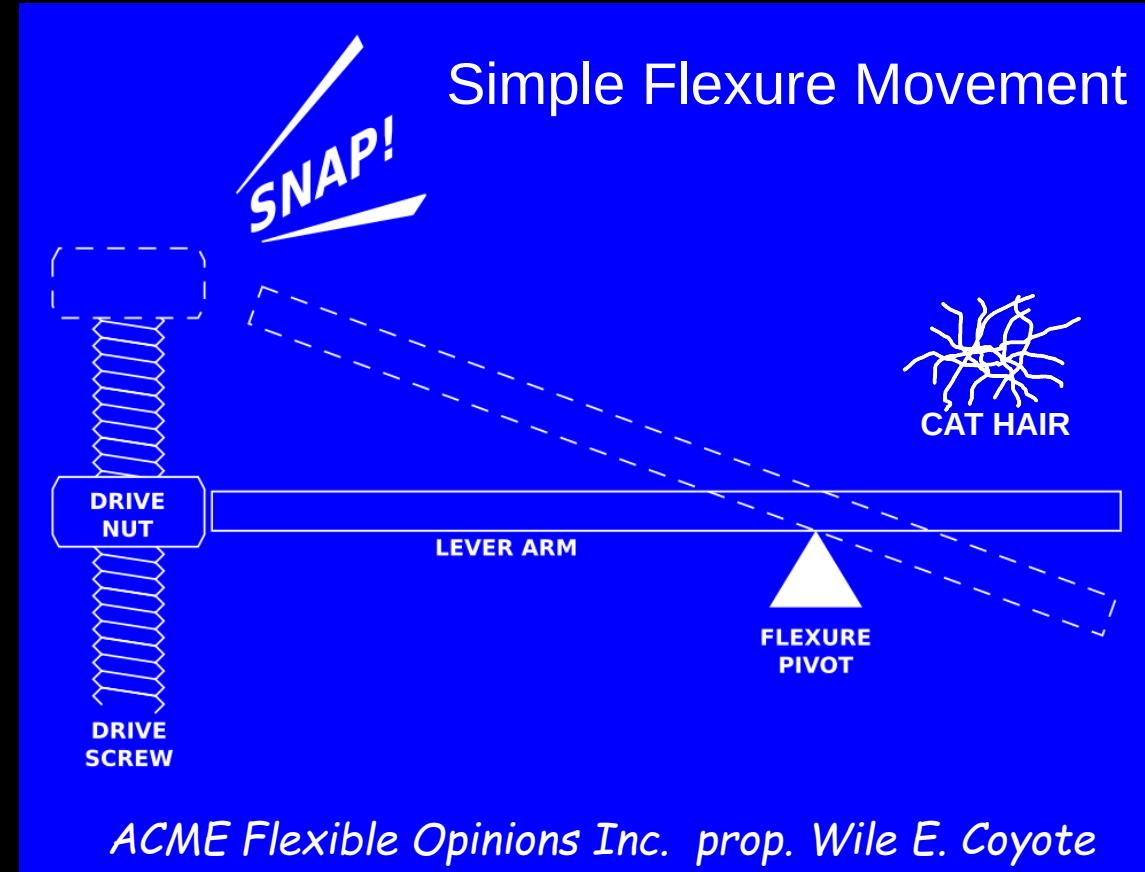
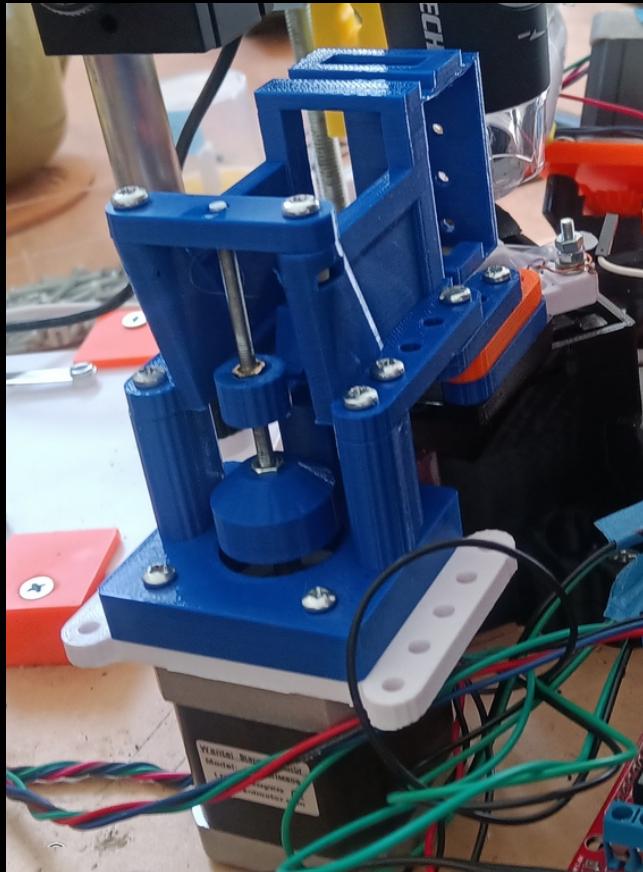


V0.01 Axis Driver

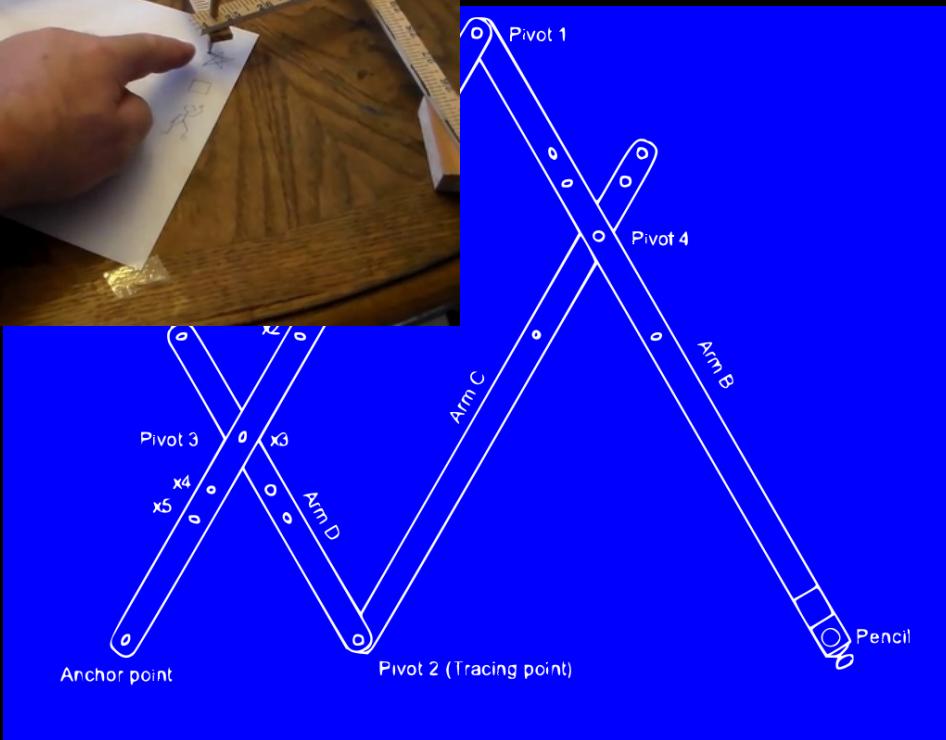
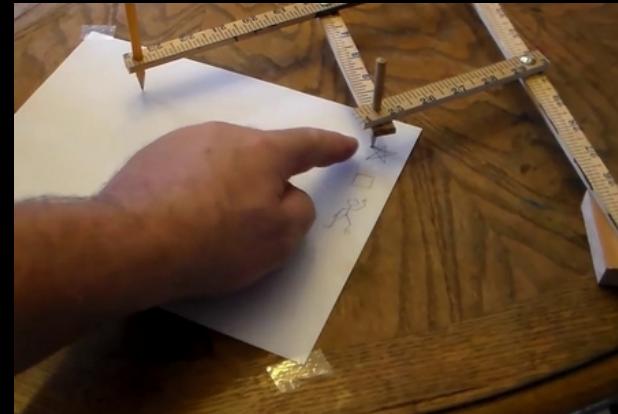


V0.05 Axis Driver

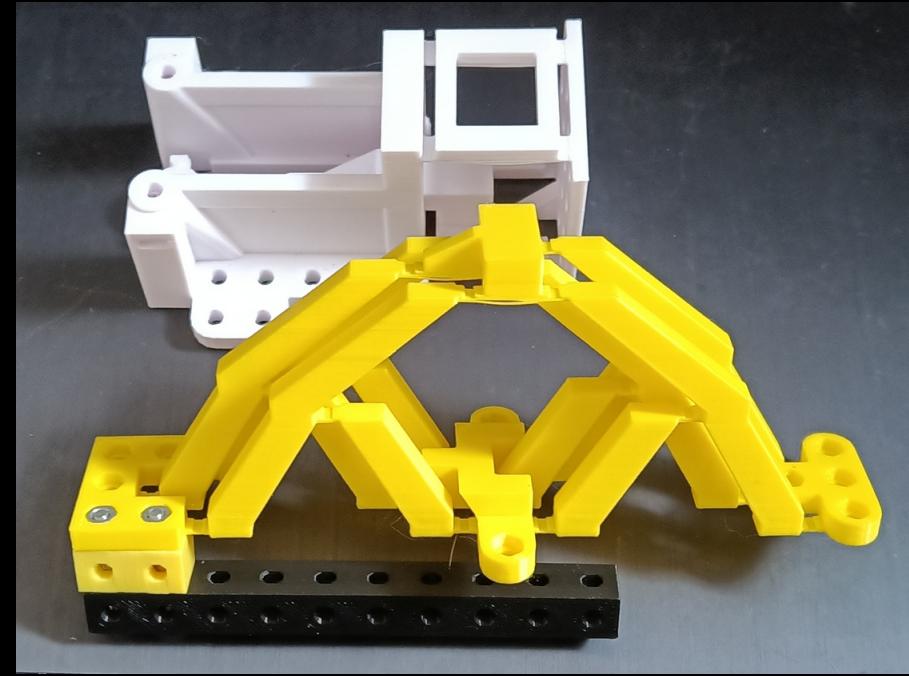
Simple Flexures ...



The Triple Pantograph

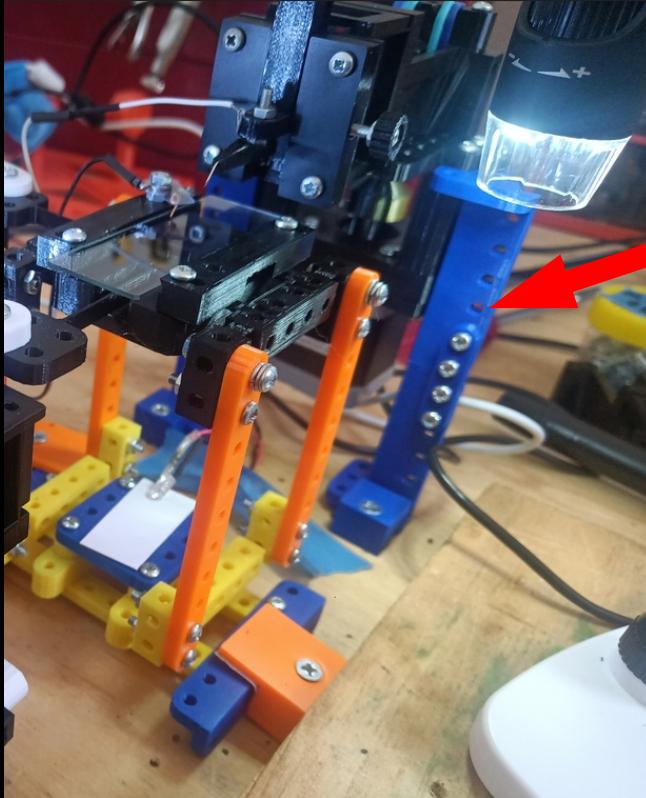


<https://www.peter.com.au/articles/pantograph.html>

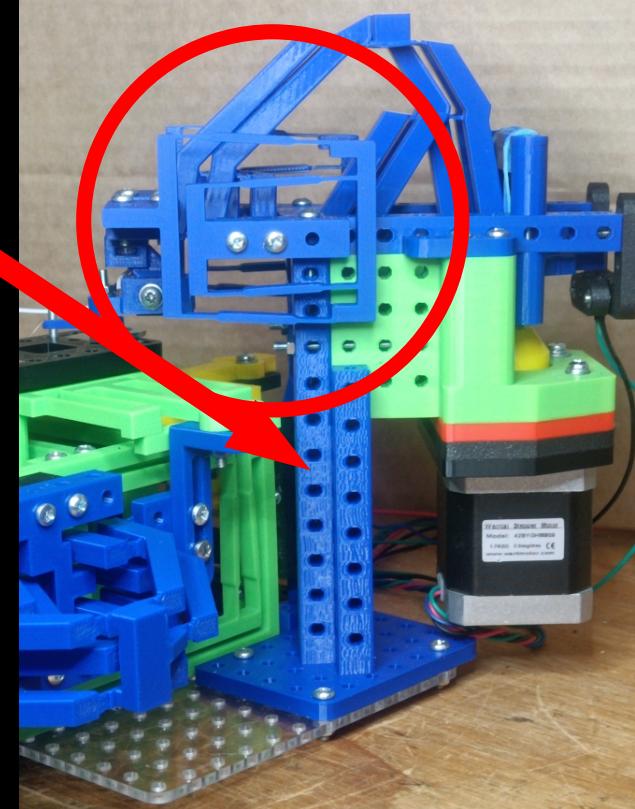


V0.01 (white) and development
V0.05 Pantograph Driver (yellow)

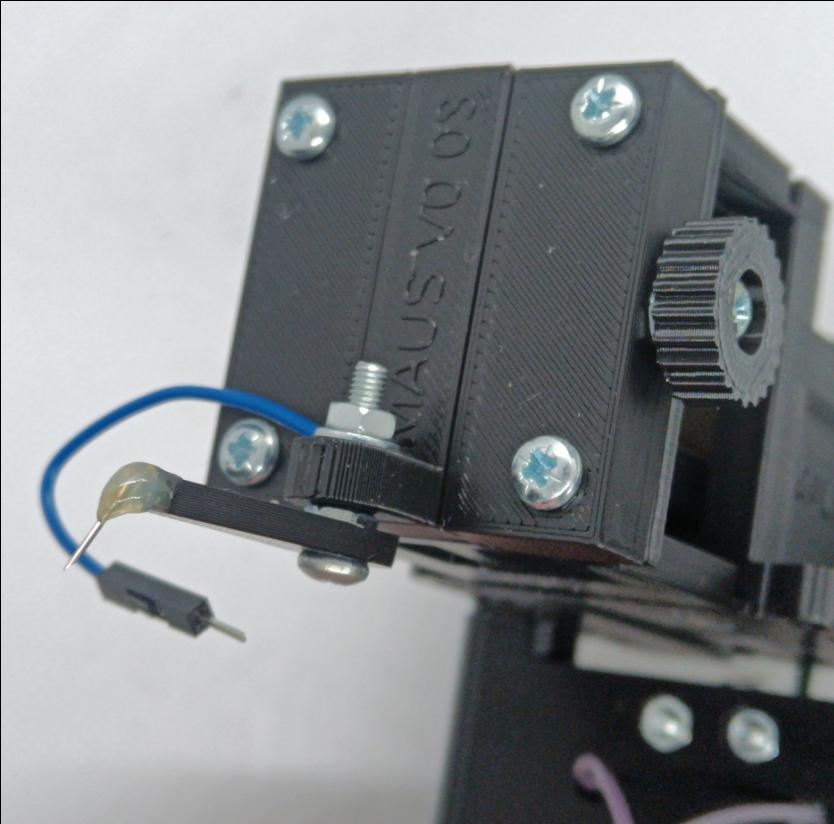
Z's Dead, Baby.



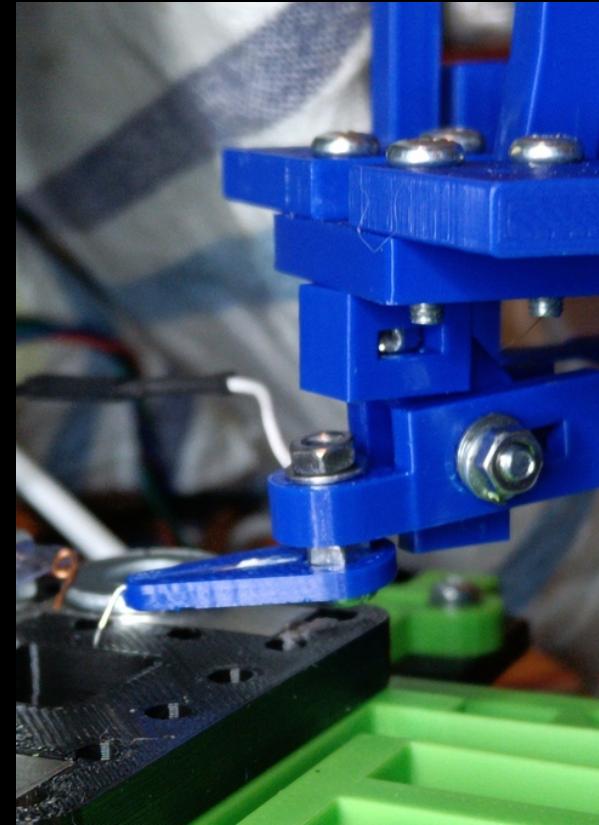
Z Tower



The Head



Early Head, 2 degrees of freedom



V0.05, 6 degrees of freedom

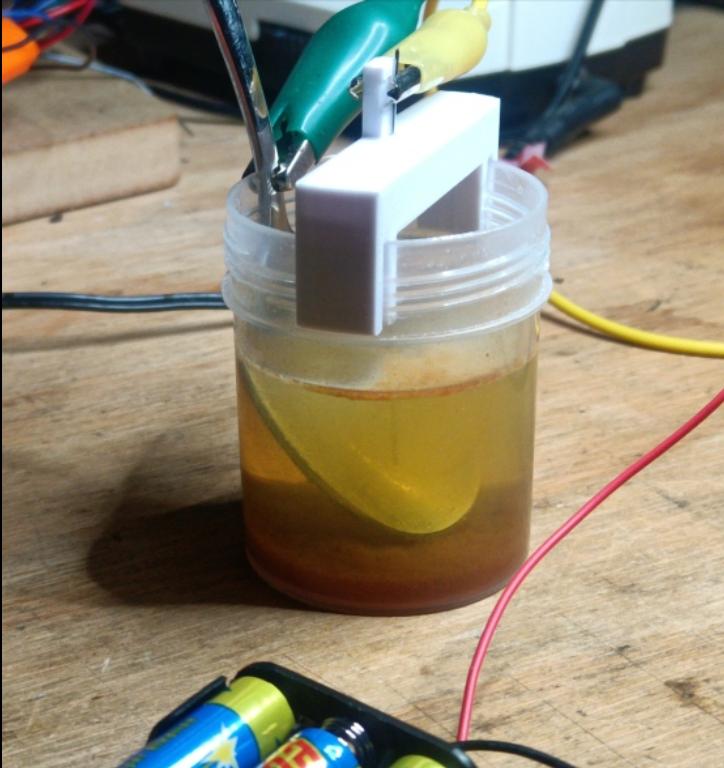
Prepare The Probe

0.5mm Diameter hypodermic needle

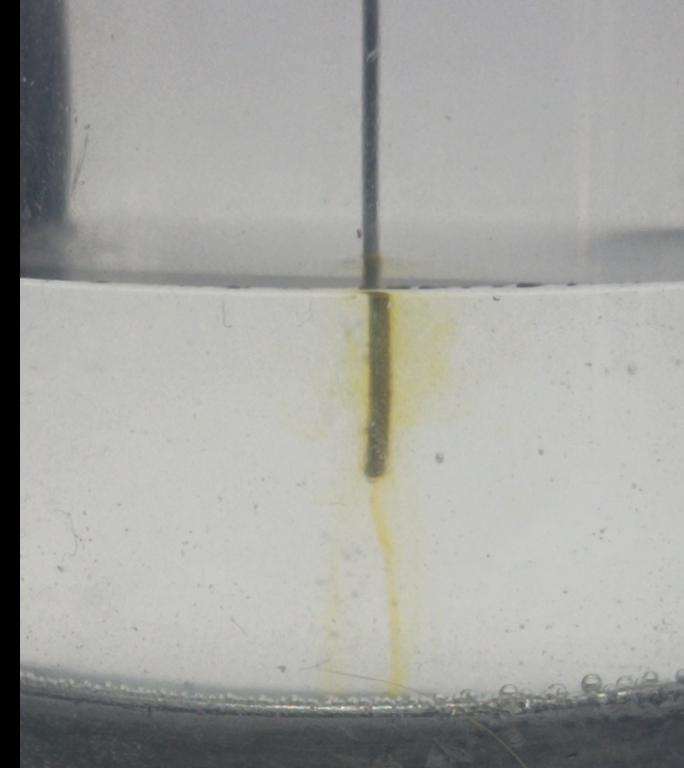


“Medium Fine”
etched probe tip

Tiny Pokey Pointy Things

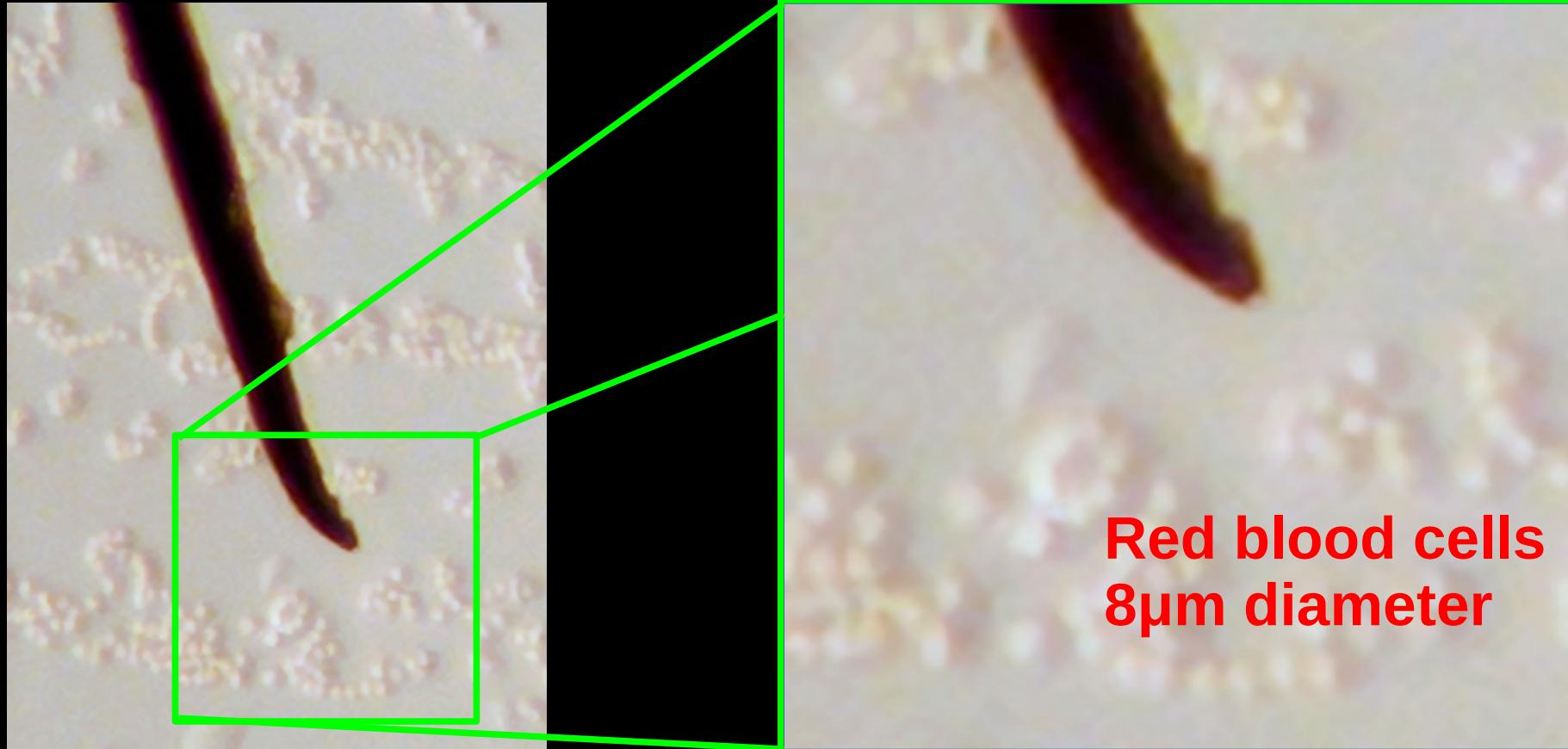


Saltwater/spoon
electro-etching



0.3mm Wire during etch

There Was Blood



Hello World

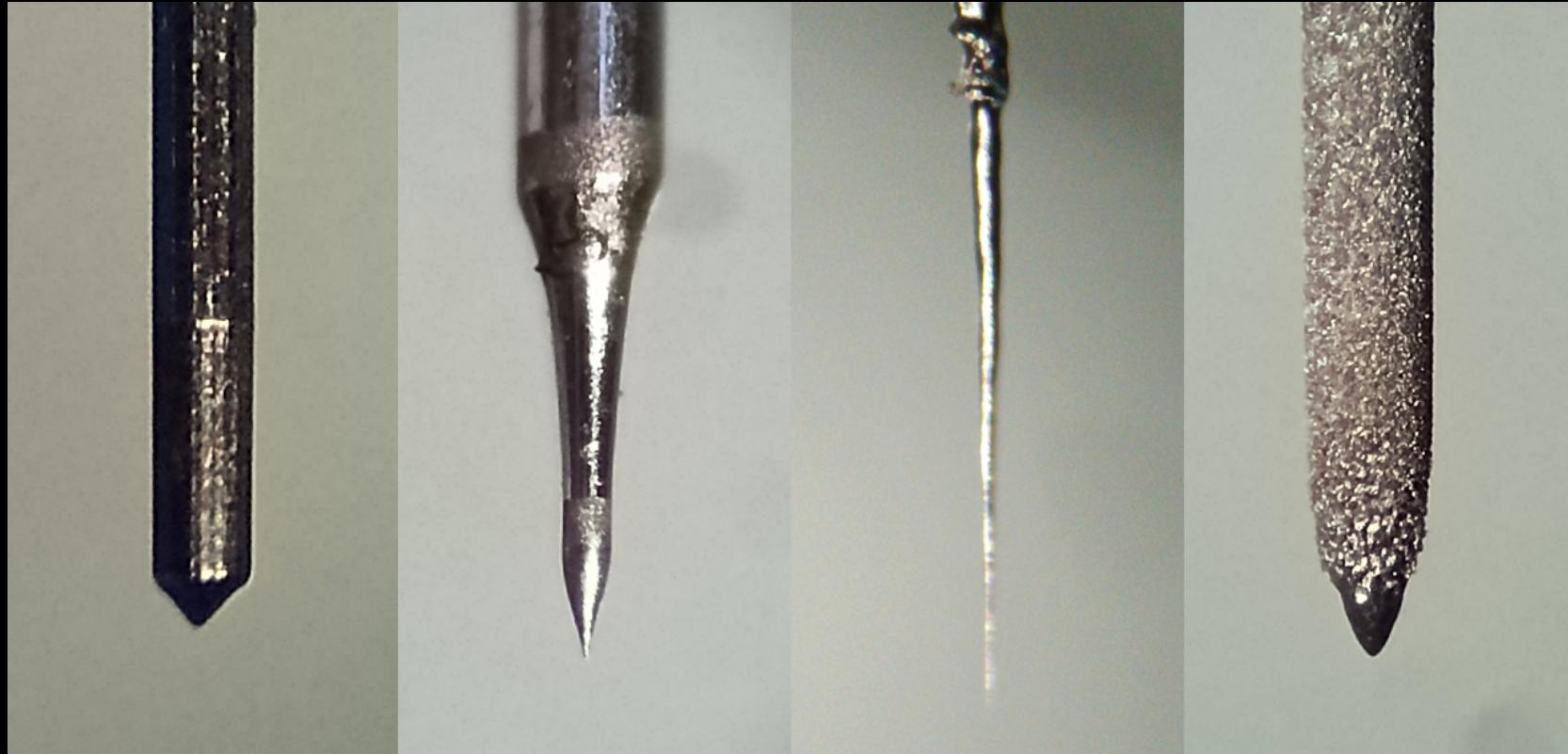


^ Familiar logo showing increase in resolution

< Early 1mm “Hello World”

Probe Etching Dynamics

Immersion ↓



Shallow

5mm

10mm

15mm



SEEMS LEGIT



Probe 9



Rough shaft

Waist

Ogival tip

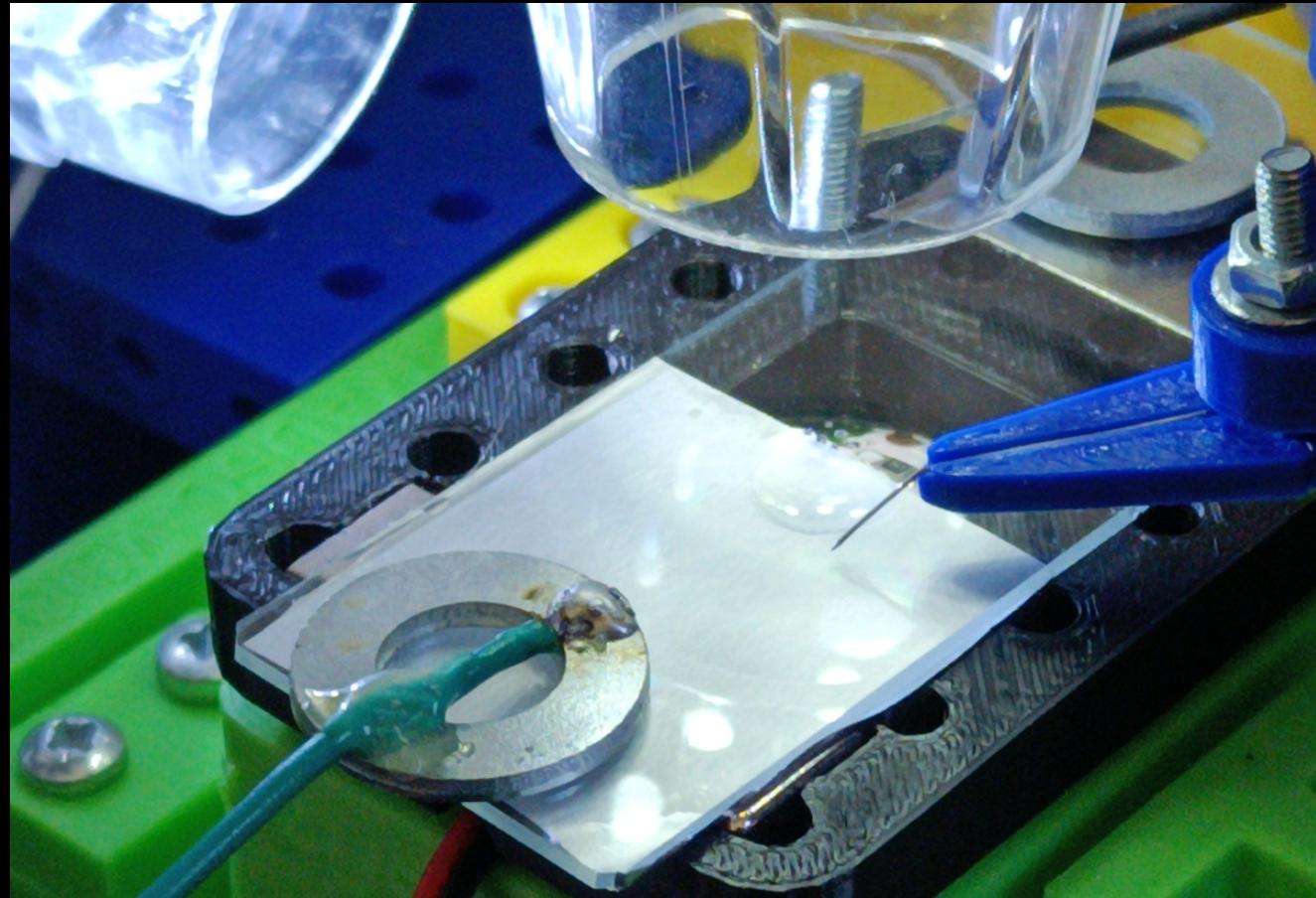
A Bit Of A Kinky Probe



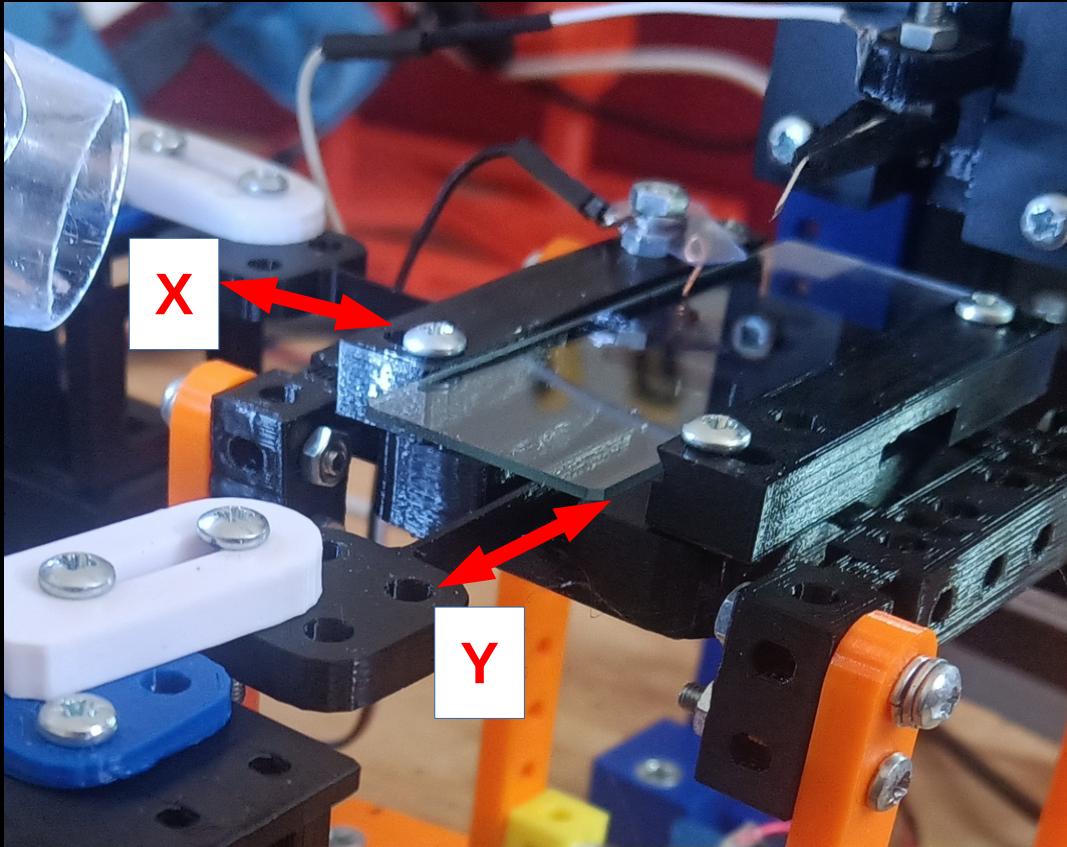
Probe tip is bent
for perpendicular
contact.

Excess solid
resin can be
dissolved in
acetone...

My Attempt Was Foiled

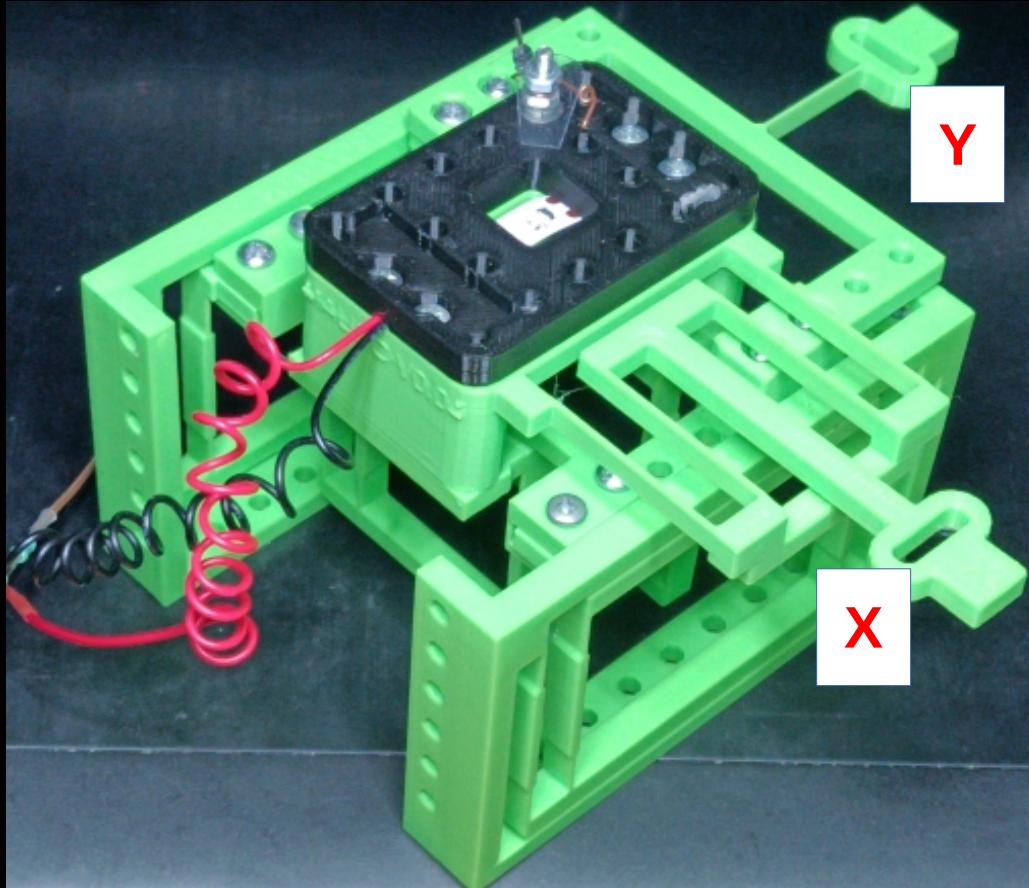


Setting The Stage V0.01



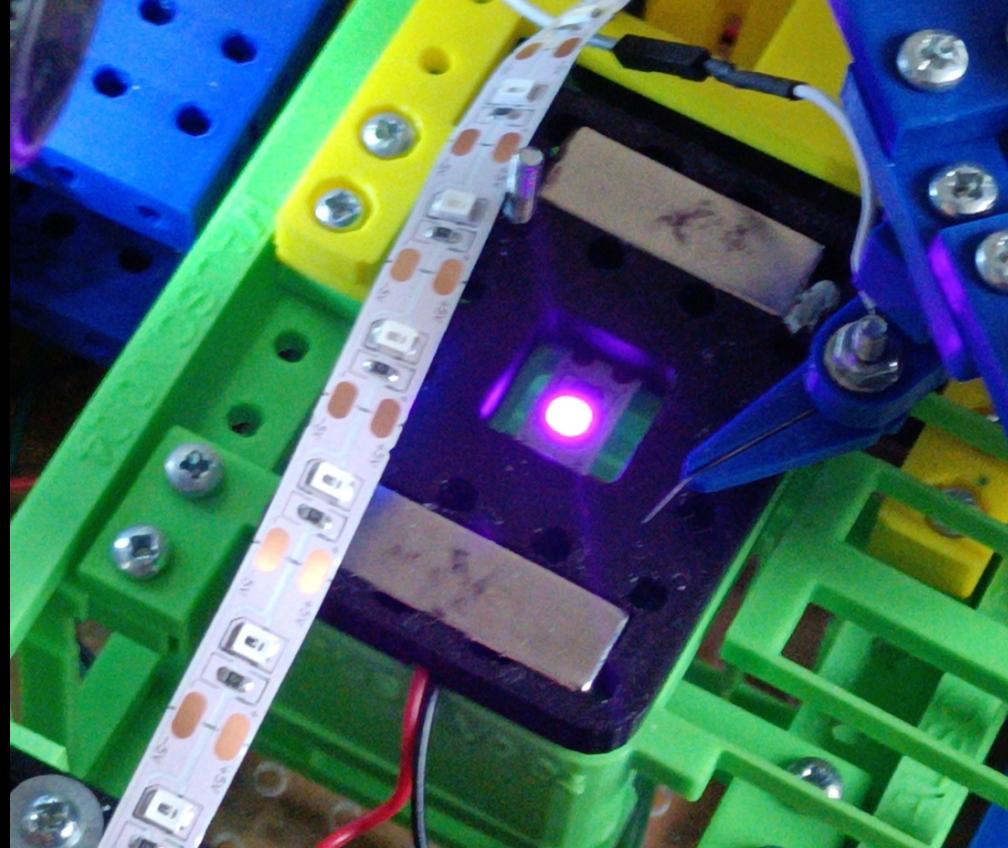
V0.01 Stage with
fiddly screws and
bendy X & Y
linkages

Setting The Stage V0.05

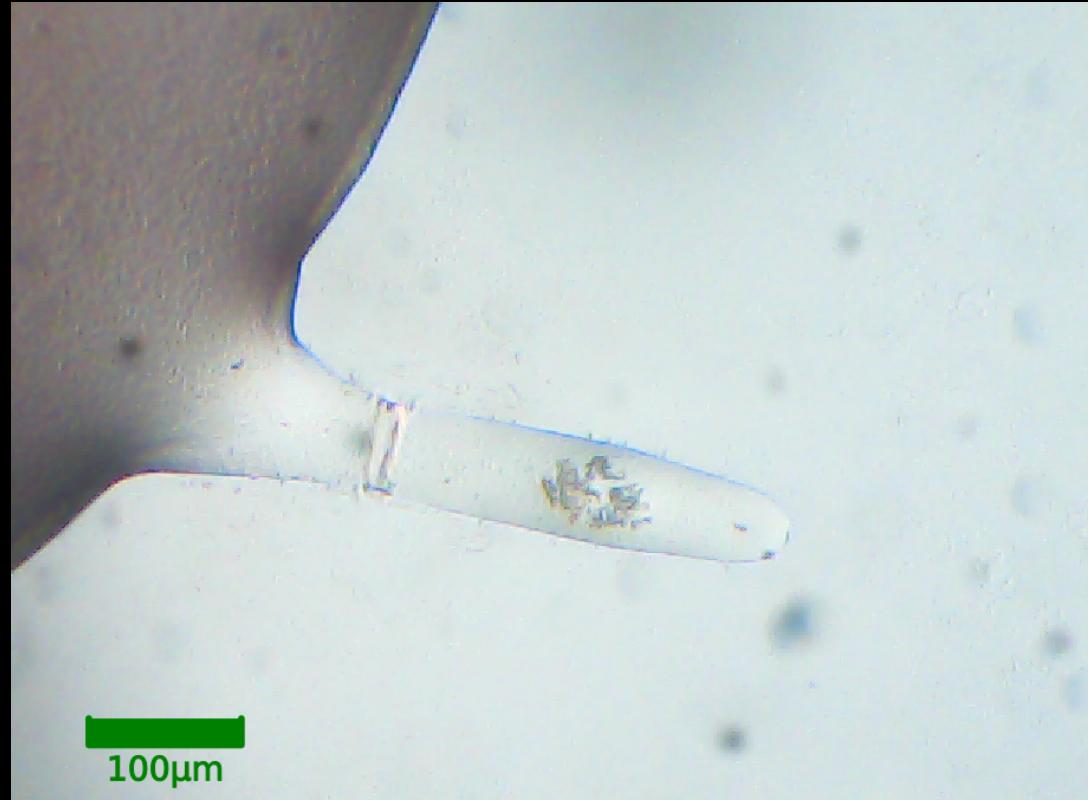


V0.05 Stage and
cunning flexure XY
linkages

Let There Be Light

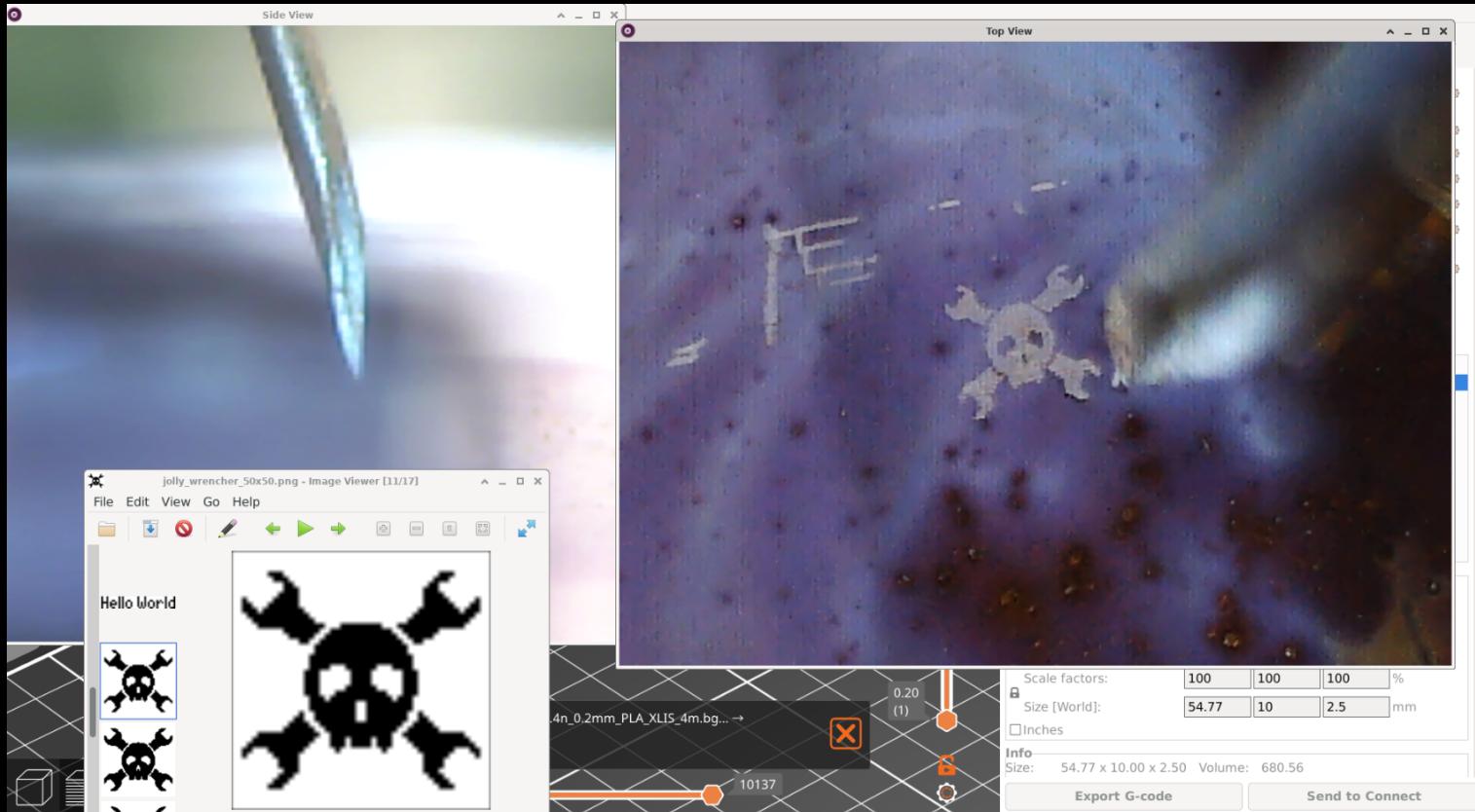


Coming Unstuck With Resin



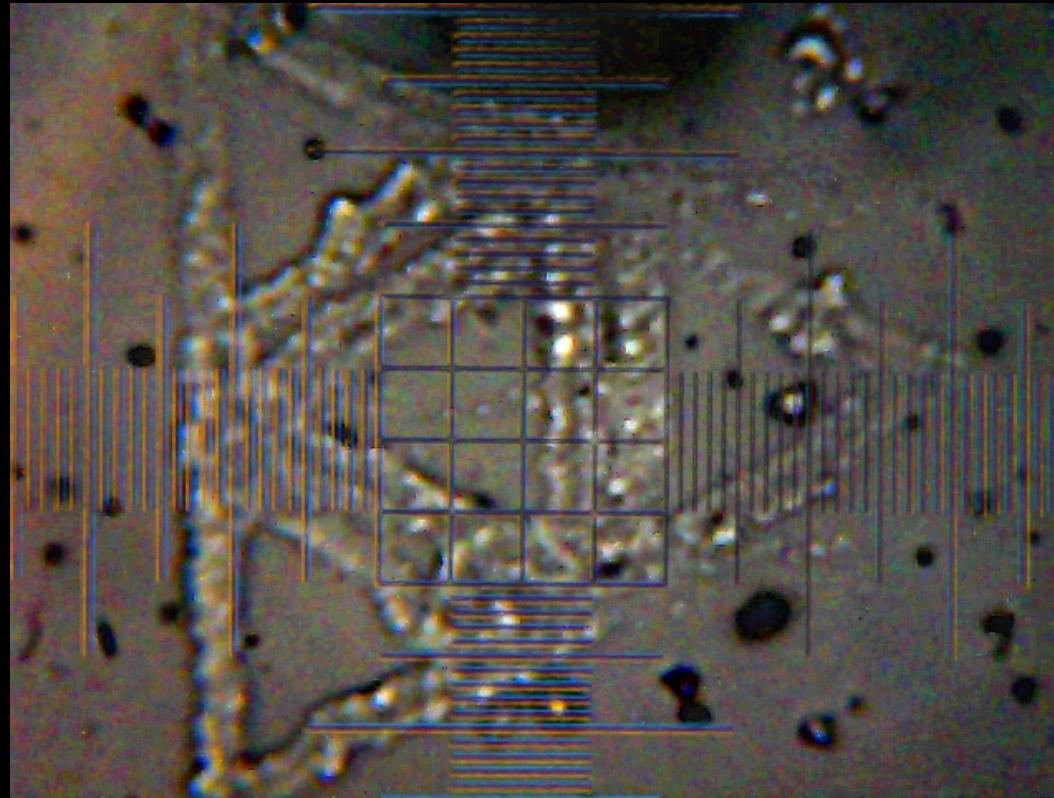
First attempt at dragging out 3D printer resin

Pointillism



Plotting a 0.5mm object as dots, feat. hackaday.io

You're Cured! Or not.



Triforce in eSun resin, 50µm grid



Josef Průša μRepRap Vik

Improvised Shielding Gas



- Sandwich box holds sample
- Blue tape holds sample still
- UV LED shines down on it
- Hole in lid allows introduction of CO₂ from the family SodaStream

Nailed It

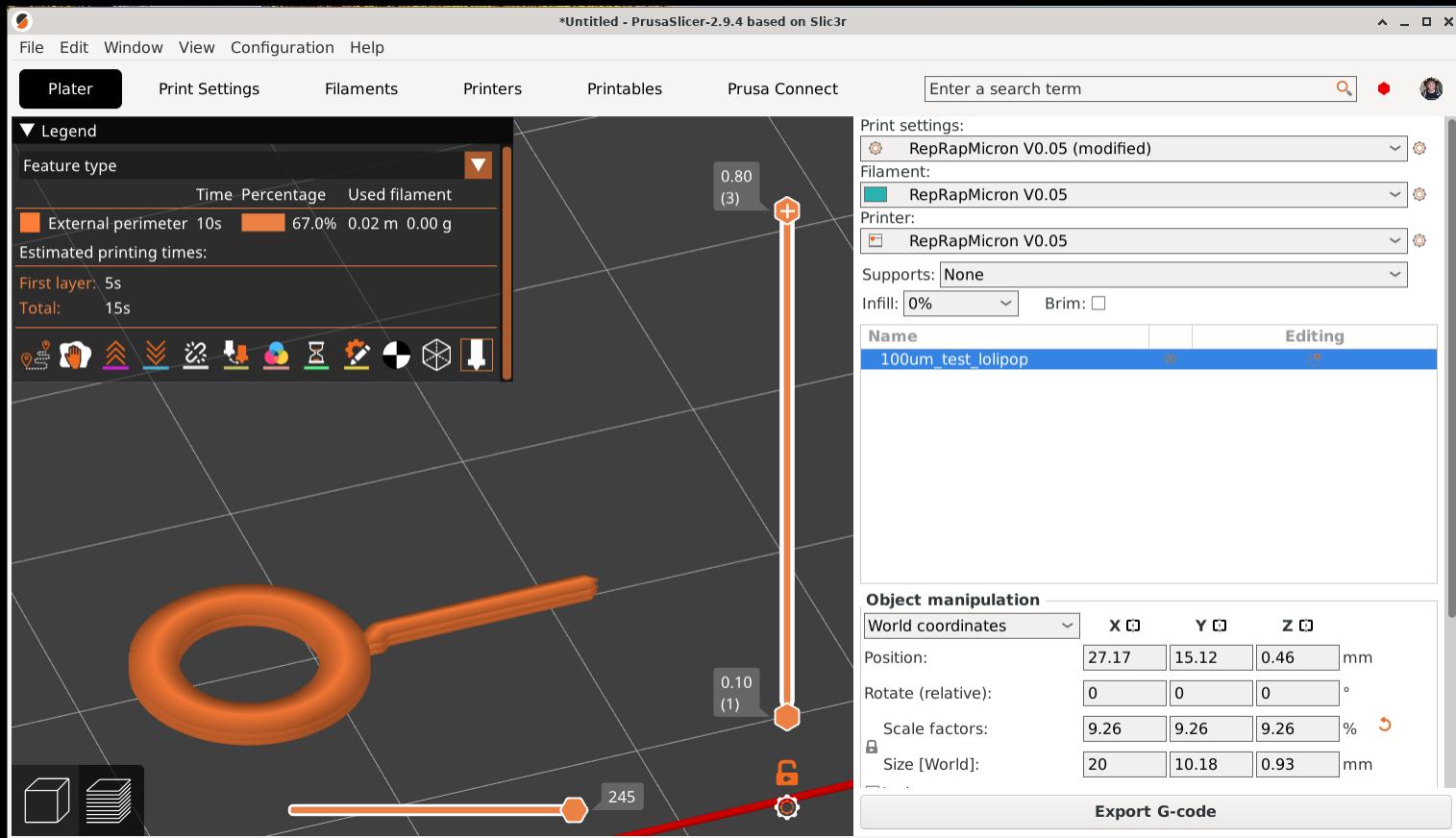


Printing supplies
from Kmart

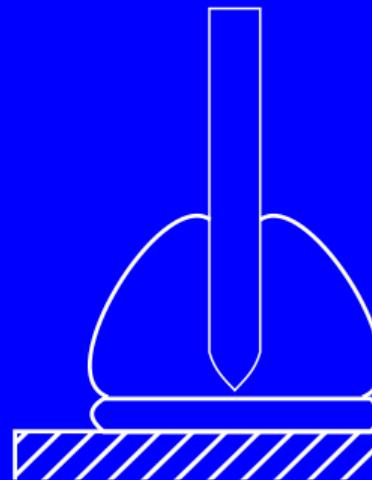


200µm diameter loop in nail resin

Thinly Sliced



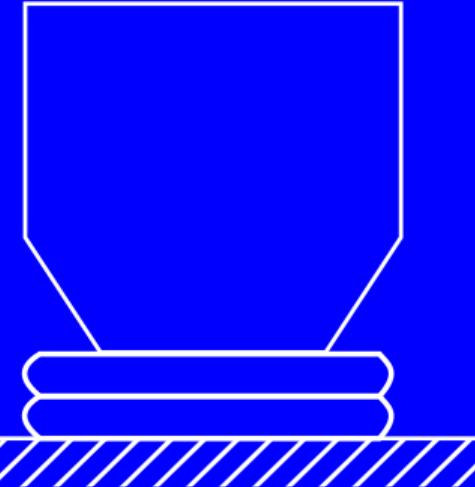
Other Material Issues



μRepRap Probe



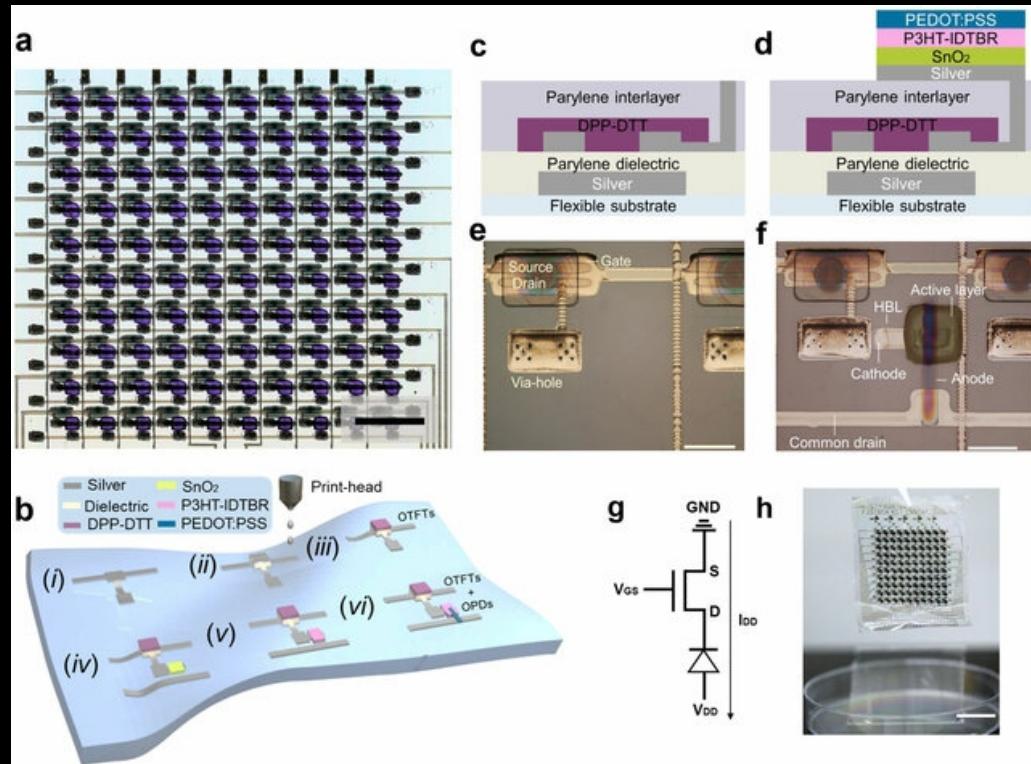
Cat Hair



FFF Print Head

ACME Flexible Opinions Inc. prop. Wile E. Coyote

Not-Silicon Microchips



Luis Arturo Ruiz-Preciado et al.
DOI: 10.1038/s41528-023-00242-7
CC BY 4.0

- 10 x 10 photodiodes
- 50mm square array
- Organic photodiodes and driver transistors

Poly(N-alkyl diketopyrrolopyrrole dithienylthieno-[3,2-b]thiophene) !??!

Bogan Cocktail



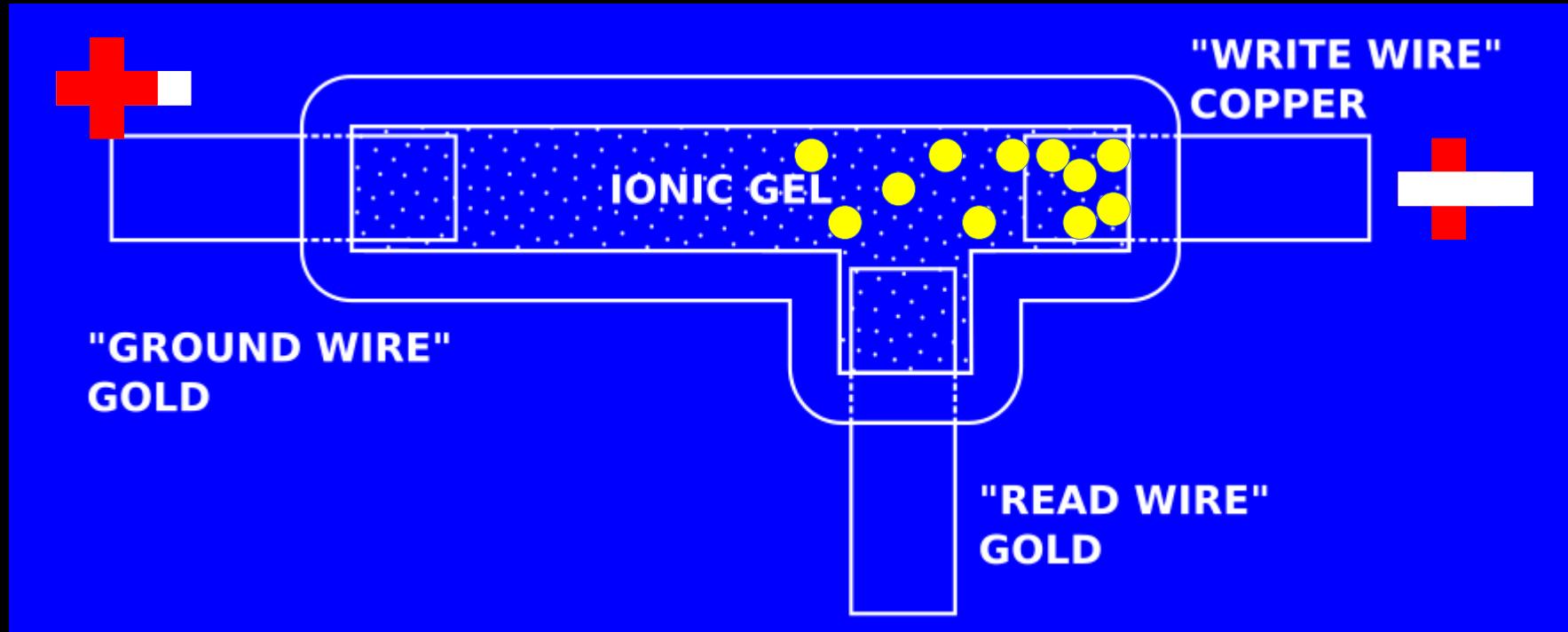
Ref:

“Calcium chloride-based systems for metal electrodeposition”

Jennifer M. Hartley et al.

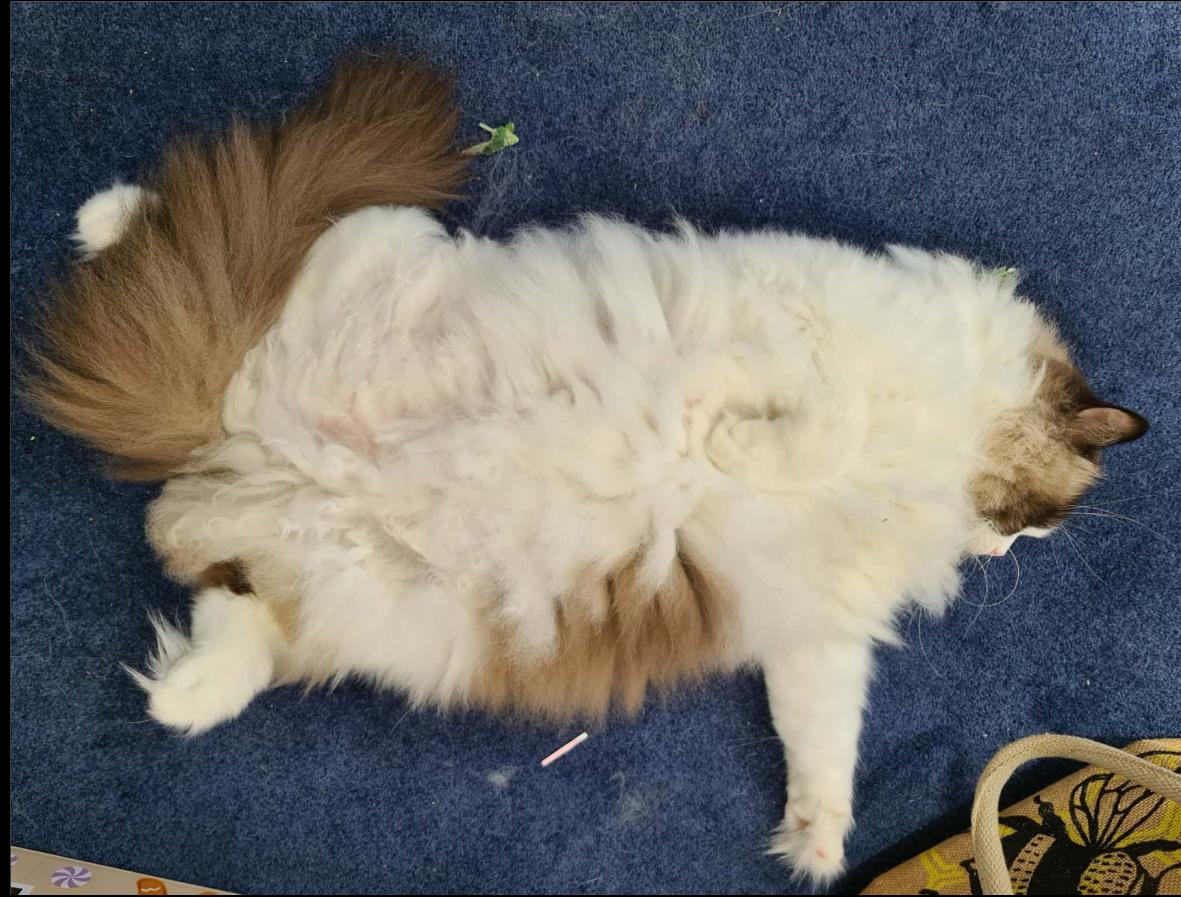
[https://doi.org/10.1016/
j.electacta.2021.139560](https://doi.org/10.1016/j.electacta.2021.139560)

Electrochemical Memory

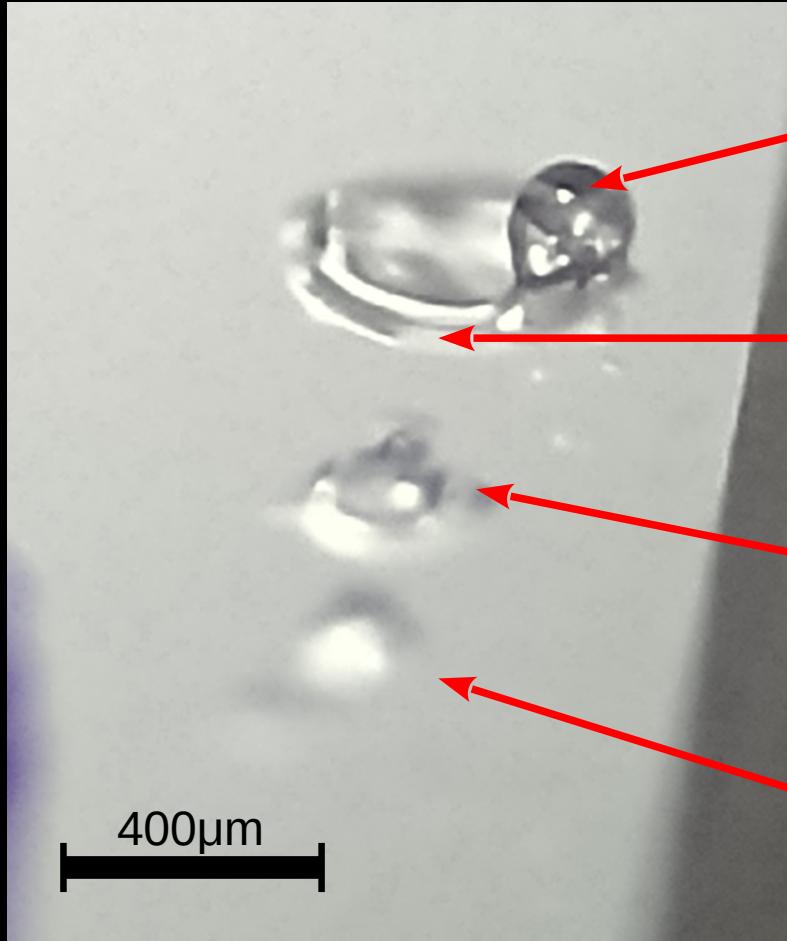


"WRITE WIRE" migrates copper ions into or out of $\text{CaCl}_2/\text{urea}$ Ionic Gel changing its conductivity.

One Memory Cell...



Finally, Layers



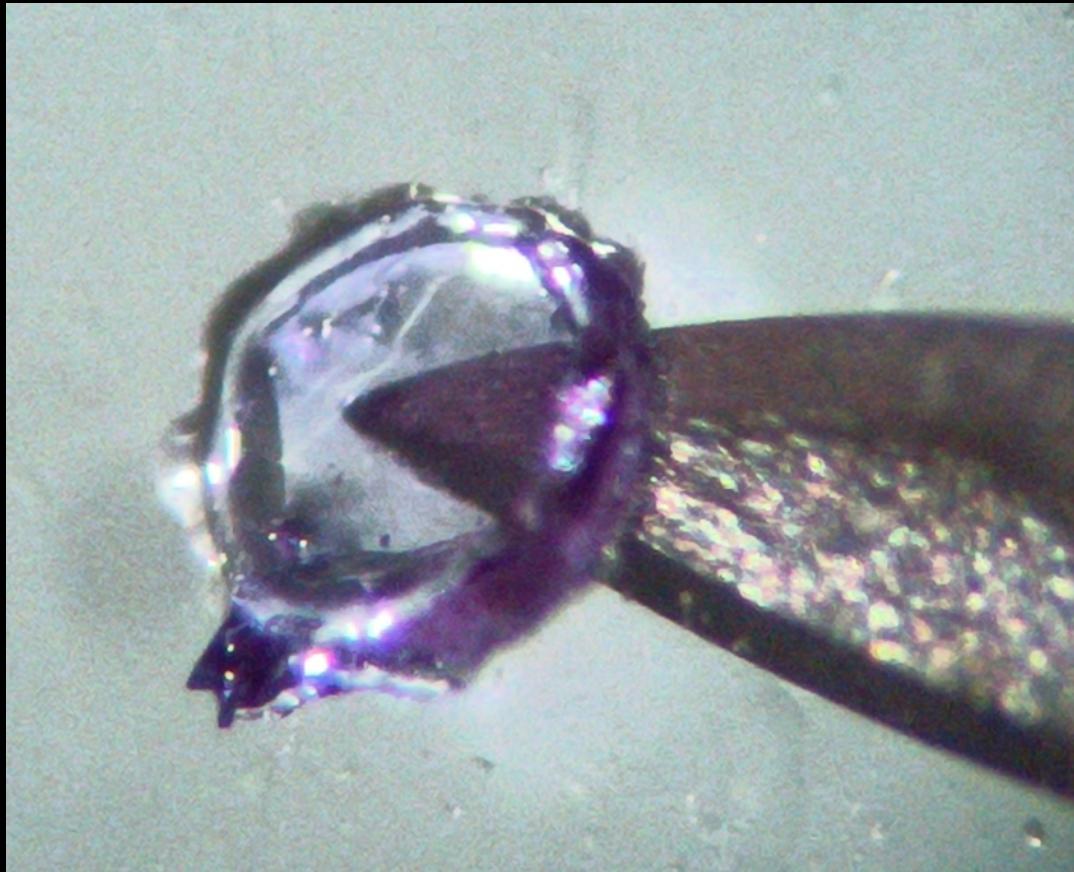
Ugly blob of fail

10 layer circle

3 layer circle

Aborted first print

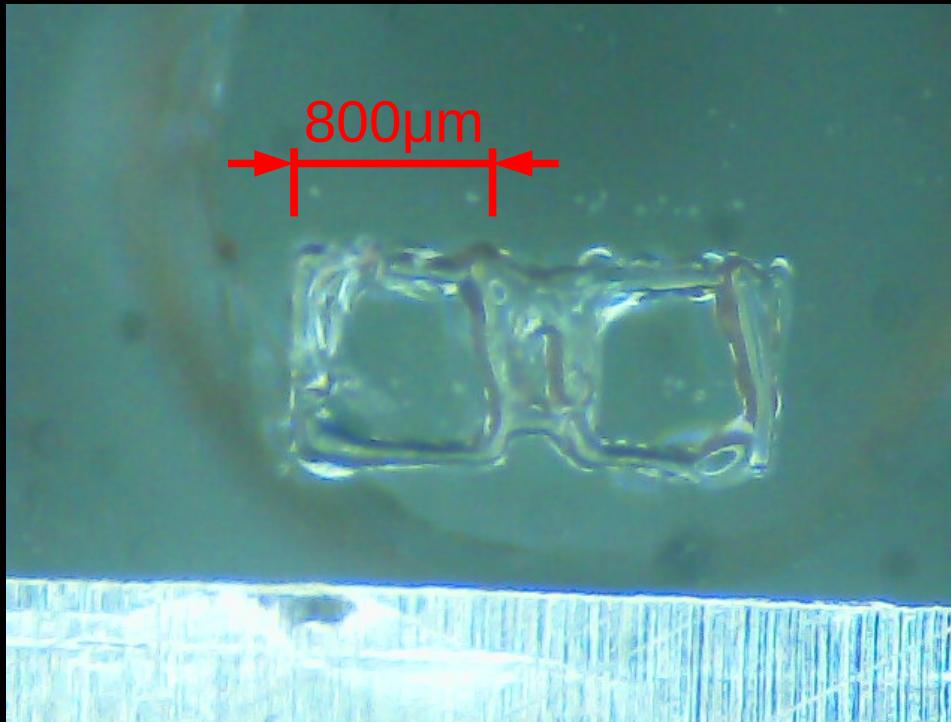
Solid Enough To Move!



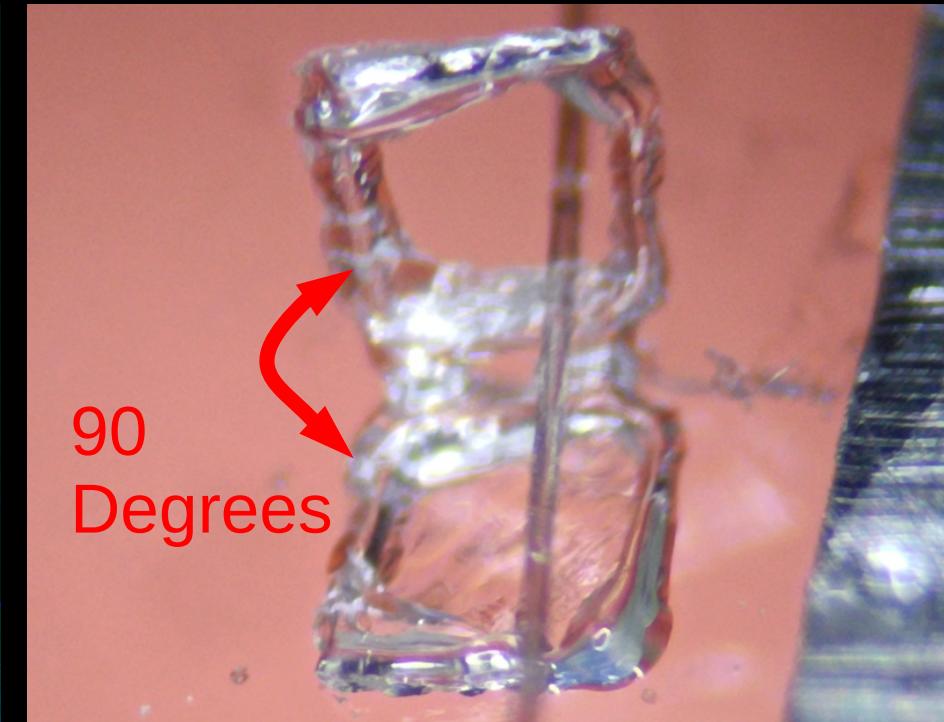
- 400 μm diameter
- 12 μm thick base
- Approx 50 μm walls
- ~40 μm tall

Object in background
is 0.5mm hypodermic
needle tip

Origami



Hinged squares



^ Hair

Surely We Have This Already?



(Image credit: Tom's Hardware)

“Resolution” given is creative marketing.

Can't replicate.

Doesn't scale to below light wavelength.

Still fun to play with...

Being Manipulative



Example:

Kleindiek MM3A-LS

- 20–40 µm span
- 20 nm resolution
- Starts US\$17,000

Credit: <https://www.kleindiek.com>

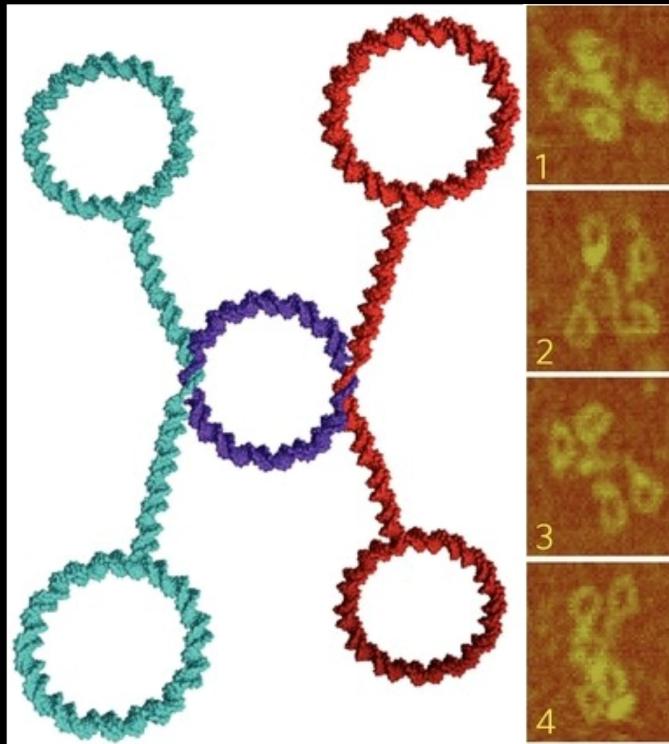
Bootstrapping



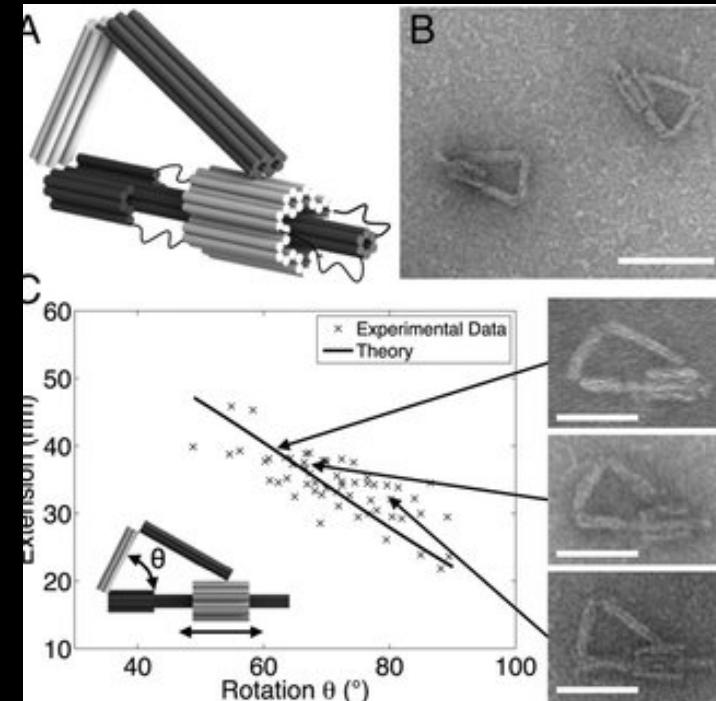
The Amazing Richard Feynman

- Research micron techniques
- Make micron fabricator
- Make micron tools
- Develop desirable bits
- Research sub-micron techniques
- Rinse and repeat

Smart Molecules

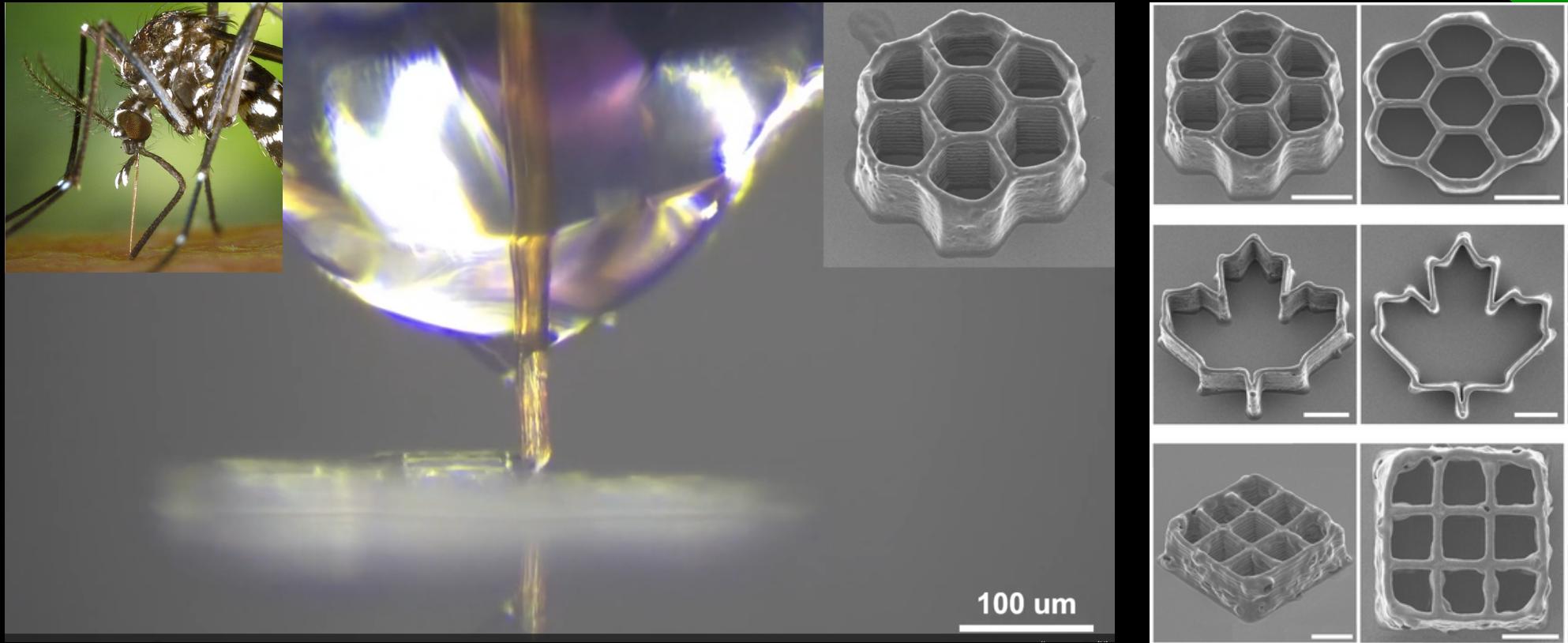


D. Ackermann et al. A double-stranded DNA rotaxane. *Nature Nanotechnology* 5, 436–442 (2010)



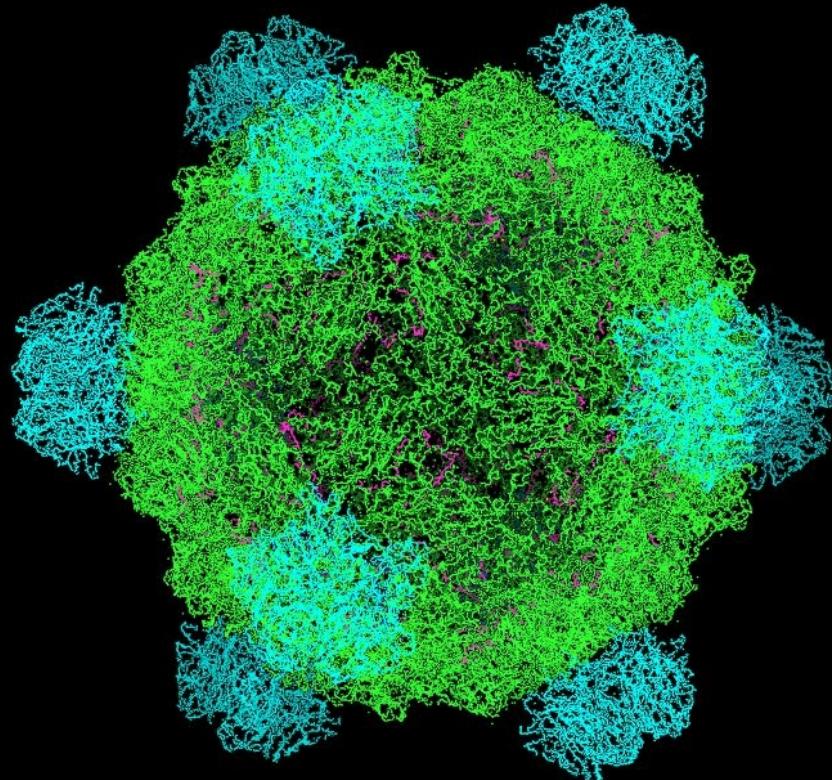
A.E. Marras et al. "Programmable motion of DNA origami mechanisms." *Proc. Natl. Acad. Sci. U.S.A.* 112 (3): 713-718 (2015).

Stealing From Nature



“3D necroprinting” Justin Puma et al. DOI: 10.1126/sciadv.adw9953

Nanotech Replicator



ϕ X174 bacteriophage

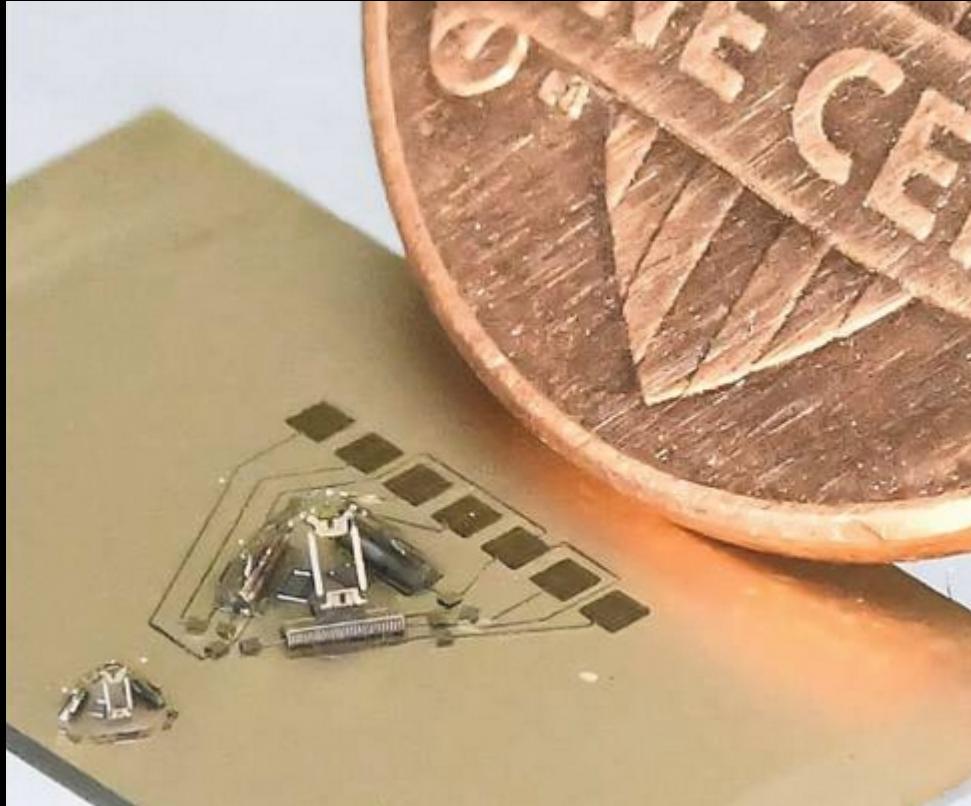
Assembled *in vitro* 2003

5,386 nucleotides

32 nm diameter

Infects *E. Coli*

Who Else Is Doing This?



CMU “microDelta”

- 3-Axis Delta robot
- 1.4mm and 0.7mm versions
- 1 micron accuracy
- Operates at 1,000Hz
- 3D Printed chassis

Steven Man, Sukjun Kim, Sarah Bergbreiter CMU

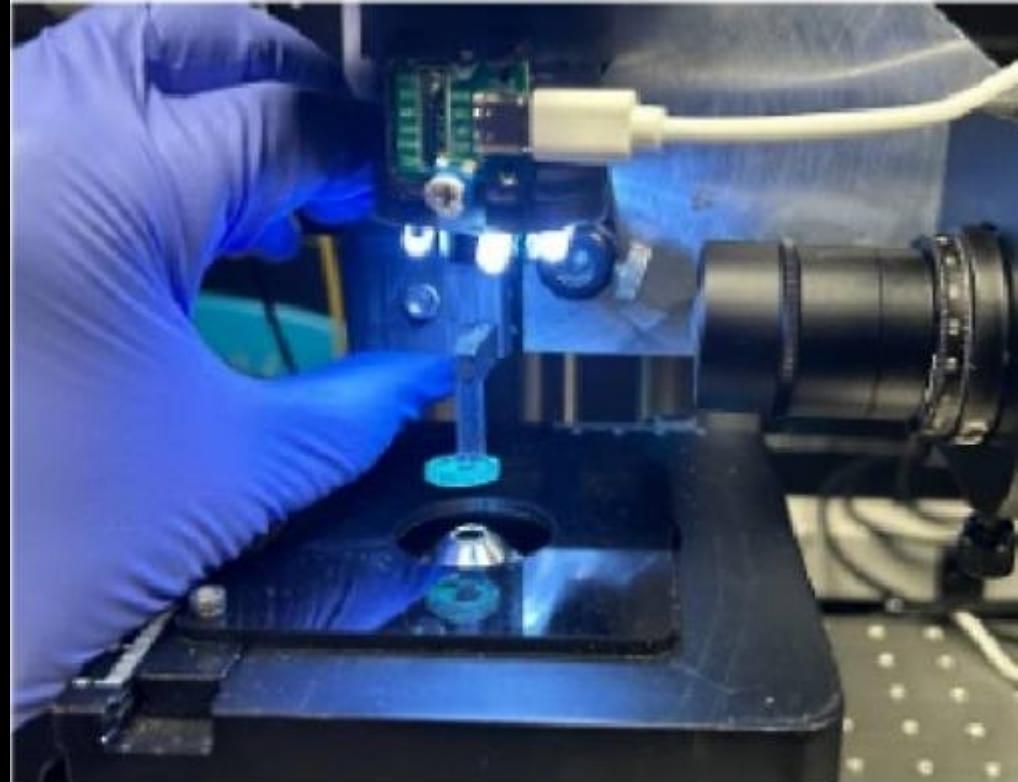
Diffraction Limited



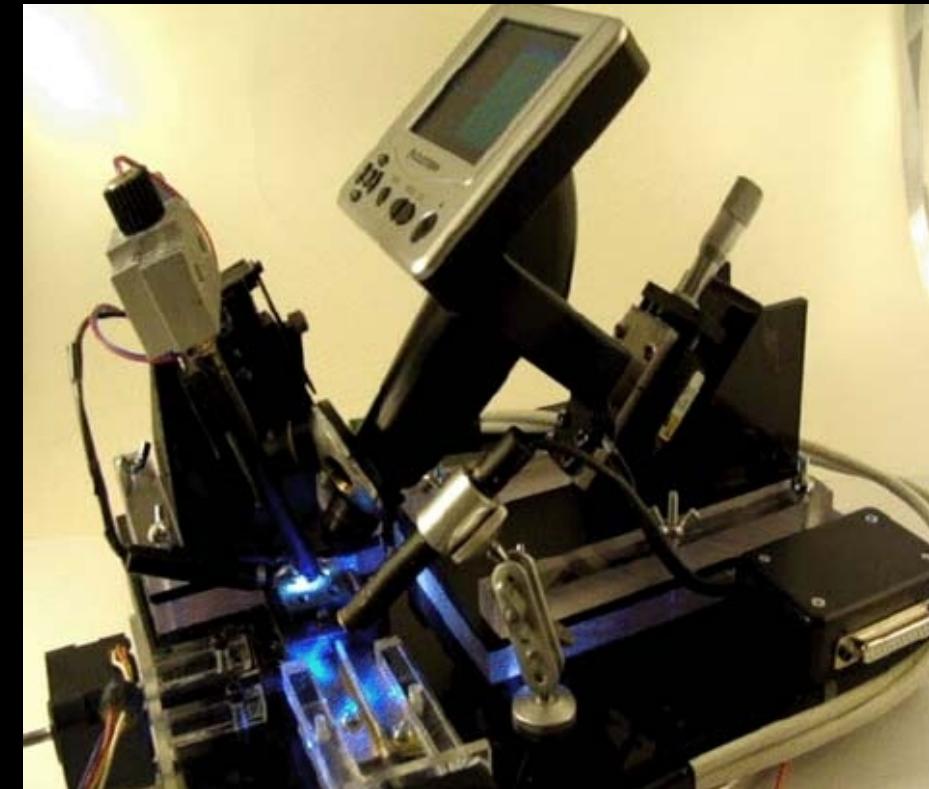
- Another Delta design
- 50 **nanometre** resolution
- Fully Open Source
- (Mostly) 3D Printed bits
- 23mm Range of motion
- Pretty quick!

<https://github.com/0x23/MicroManipulatorStepper>

Many Others



An open-source combined atomic force microscope PMID: 39386786



Low Cost UV Laser Direct Write Photolithography Abstr. MA2012-02 3990

The End Of A Small Beginning



Thank you, Canberra!

The RepRap Project
<https://reprap.org>

RepRapMicron
[https://github.com/VikOlliver/
RepRapMicron](https://github.com/VikOlliver/RepRapMicron)

Vik Olliver
vik@diamondage.co.nz
@vik@mastodon.nzoss.nz