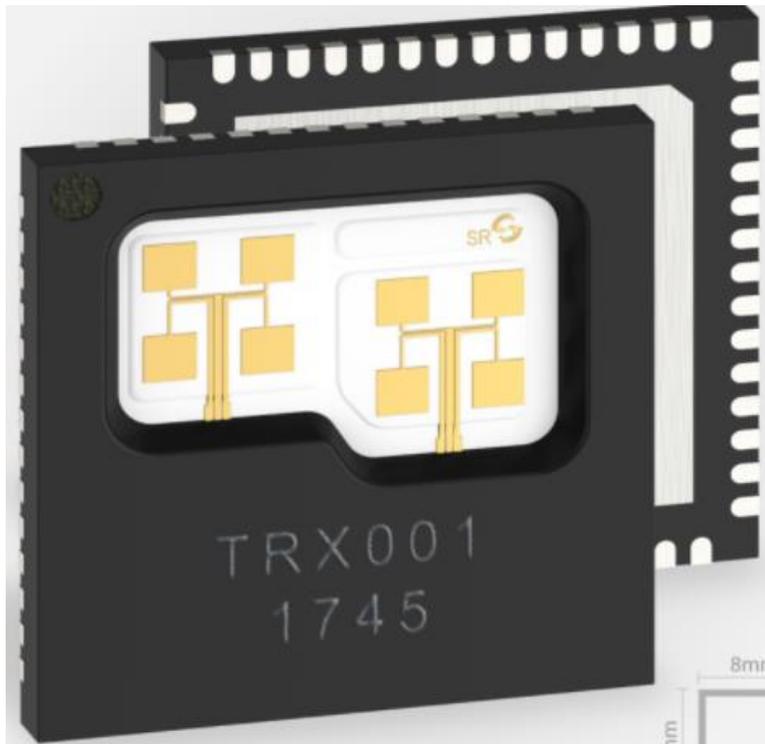


# 122 GHz Experiments and Construction

Doug Millar K6JEY

Tony Long KC6QHP



## It Started in Australia

---

- ▶ After years of difficult to get or expensive parts and no one to talk to-
- ▶ VK3CV Tim Tuck, develops a board based on a Silicon Radar chip for 122GHz that promises simple operation on 122GHz.
- ▶ Antenna was the problem. They developed a combiner that made a single horn or chaparral feed possible and that made the project possible.
- ▶ All that is left is to do DC wiring and drill holes.
- ▶ Meanwhile a group in the Bay Area has been working on a similar project- but that is a different story.
- ▶ The Silicon Radar chip is good for 0.5mw output and 10db NF.



# The Board Block Diagram

All you need is-

**Jacks for**

microphone

DC input

144mhz output

**Switches for-**

Mode

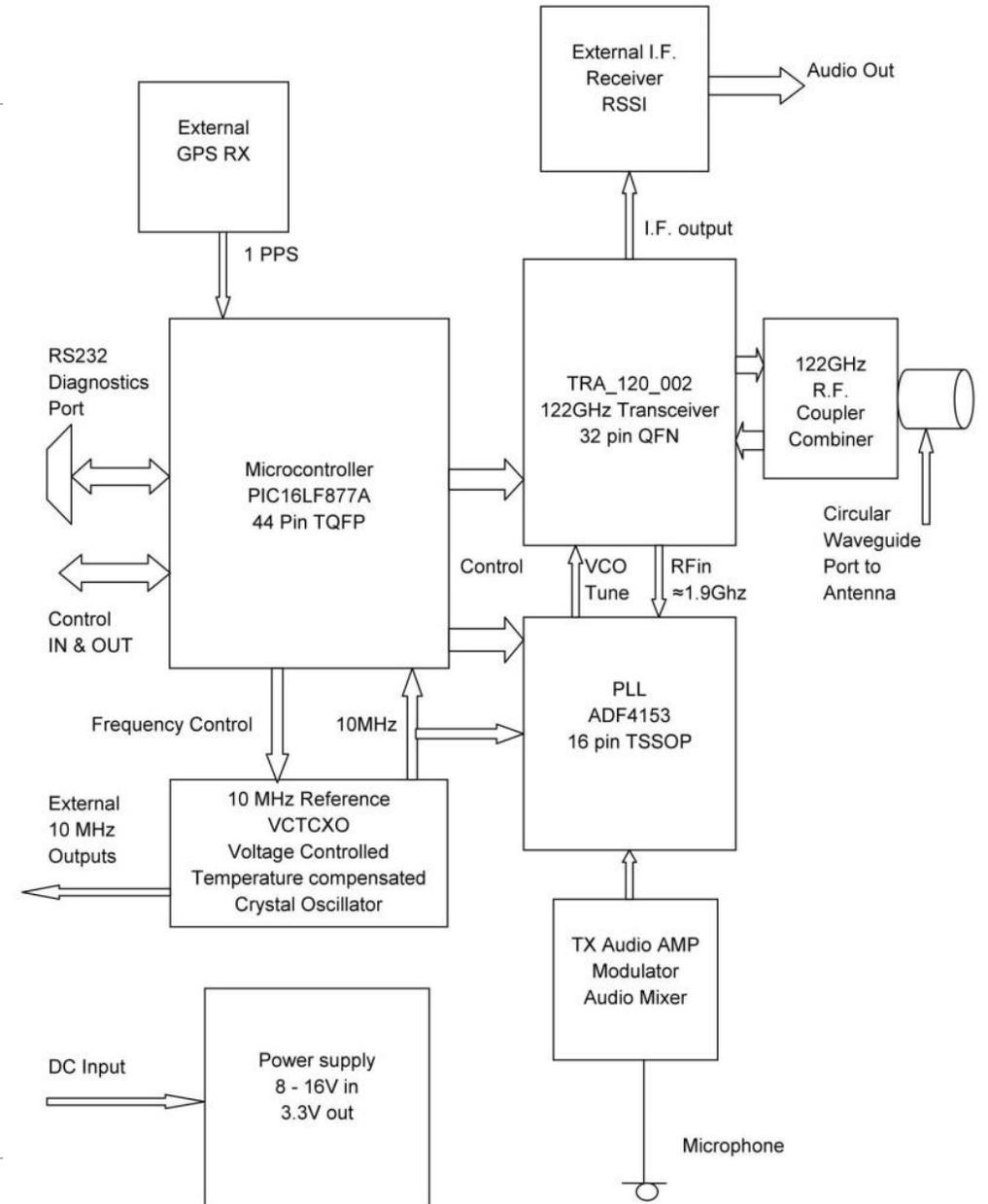
Off/on

TX/PTT

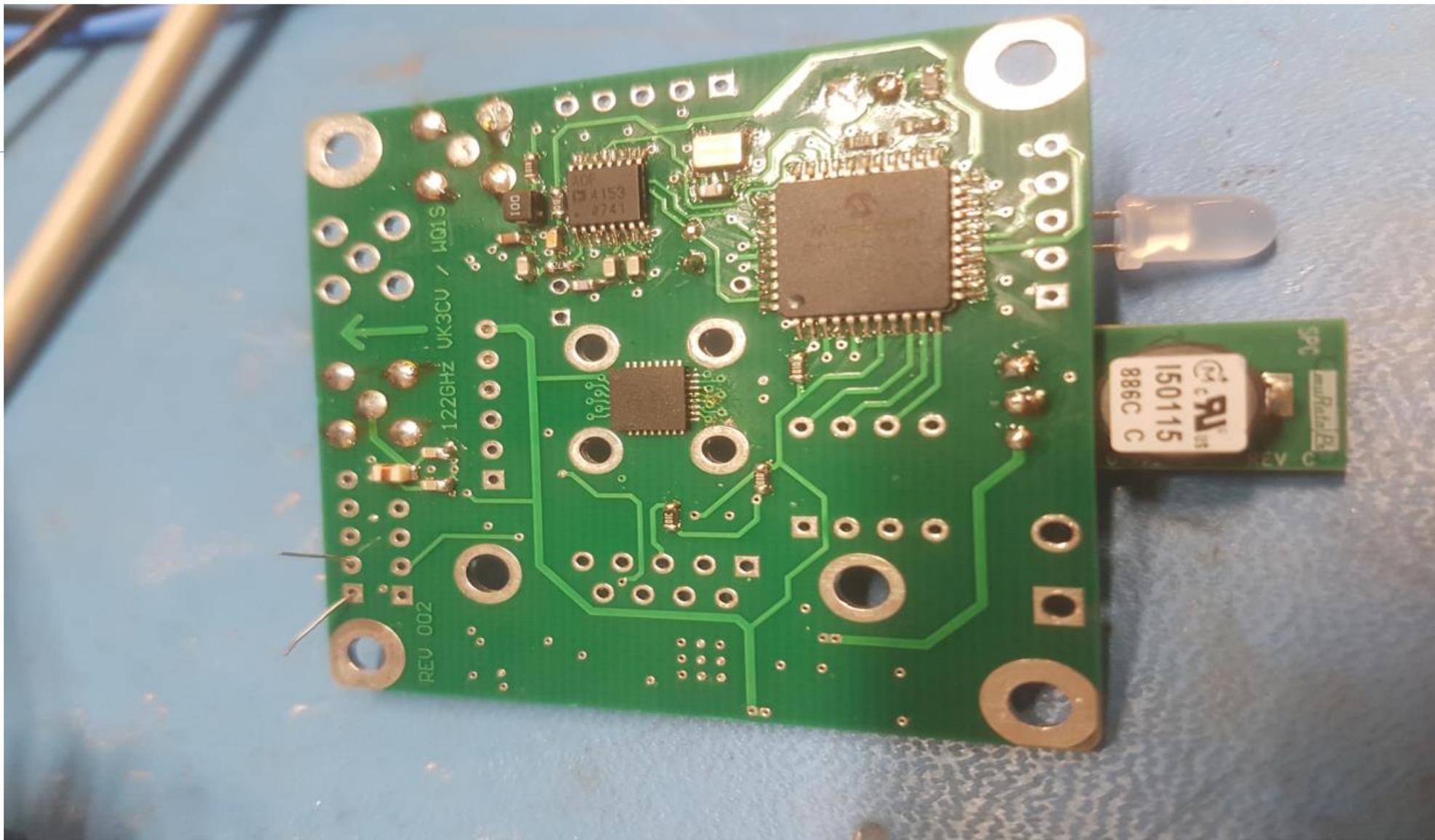
**Indicator lights**

GPS is not needed.

**(Disable the ptt on the HT)**



# The Board First Run



# Feeds-

---

- ▶ Horn with combiner
- ▶ Chaparral feed with combiner
- ▶ WR8 adapter with combiner



# Levels of Complexity

---

- ▶ **Basic Level-**
- ▶ Start simple and build more as you get better.
- ▶ Full Duplex,
- ▶ IF radio is an FM receiver on 2 meters (Baofeng works fine)
- ▶ Horn antenna for 20db gain.
  - ▶ Easy to use, pointing and tuning are easy
  - ▶ More than 3 miles is difficult



# Intermediate Level-

---

- ▶ Horn plus lens antenna, 10db more gain.
- ▶ Use an OCXO for CW, and multimode 2m receiver. (I use an Alinco
  - ▶ DJ XII wideband receiver.)
- ▶ Pointing needs a riflescope to help. Pointing begins to be challenging.
- ▶ Stability and frequency accuracy good for CW.
- ▶ Think 2ft dish on 10GHz.
- ▶ Start to see variable effects of propagation.



## Advanced level-

---

- ▶ Dish antenna-
  - ▶ 10db better than lens.
  - ▶ Pointing becomes more challenging
  - ▶ More problems with propagation vs distance.



# Future Improvements

---

- ▶ The Third run of boards will be dual frequency 122/134GHz. Date?
- ▶ Many people doubled their order for the second run, so boards are available.
- ▶ The instructions to make the radio are pretty complete
- ▶ But make sure you can solder well around surface mount components.
- ▶ A series of building sessions at a club lab might be a good idea.
- ▶ Who would have ever thought the hot tip in ham radio would be 122GHz?



# 122 GHz is the Hot Homebrew Band

---

- ▶ Once you have the board, some switches and plugs, the rest is up to you and your needs and creativity



# Crude Beginnings

---

Basically a good idea. But-

What didn't work-

- GPS not necessary

- Zero power finder not enough

- Switches on the front moved to Back.

- New main board with better mic circuit. (Huge improvement)

- Using a Linhof tripod.



# More Rigs

---

## **N6NB's version.**

Internal microphone  
Headset.

Baofeng HT.

Felt like a Gunn diode  
rig.

No tripod

But it worked!

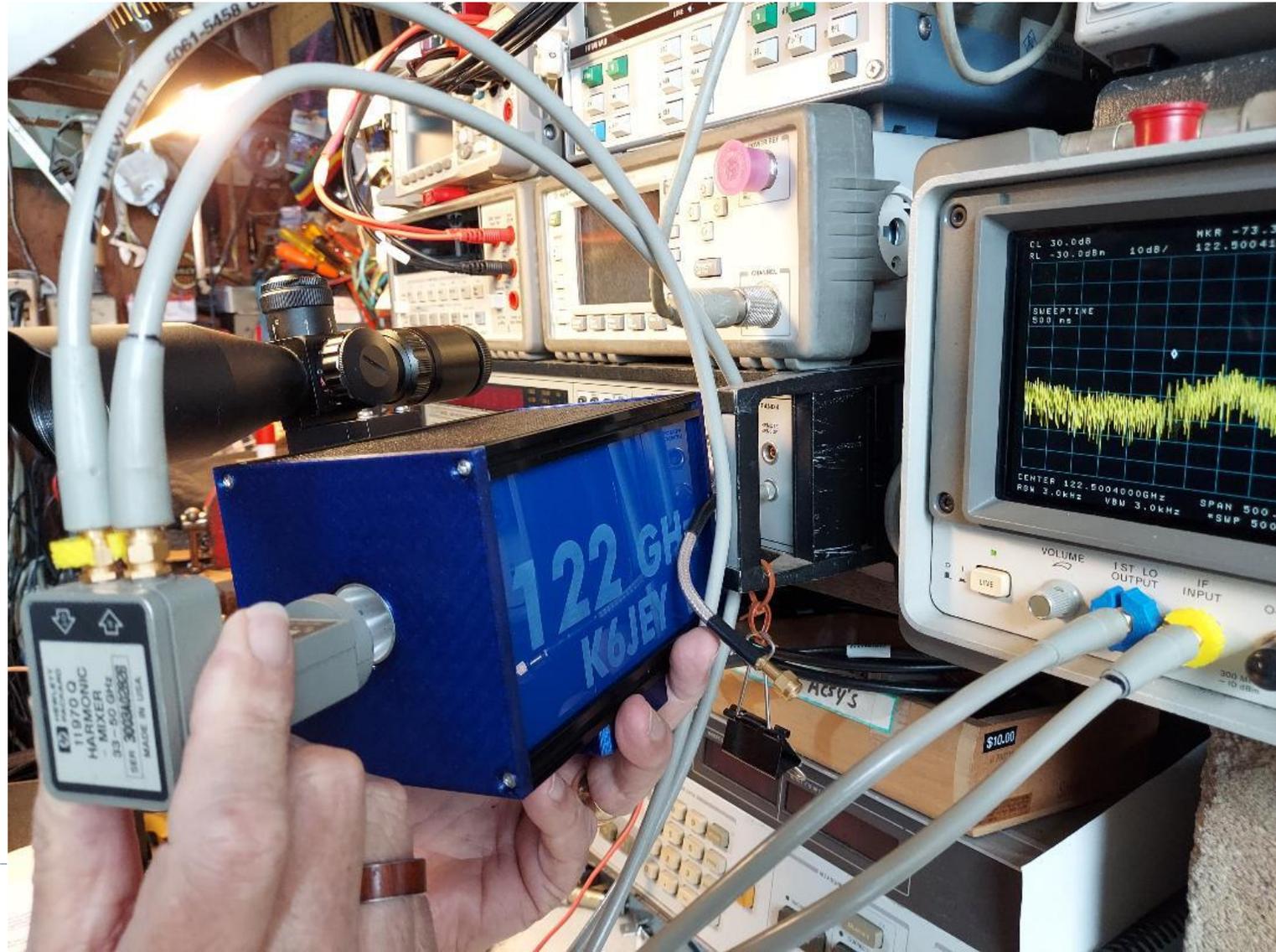
2.5 miles with good  
Signals!



# Optimized version

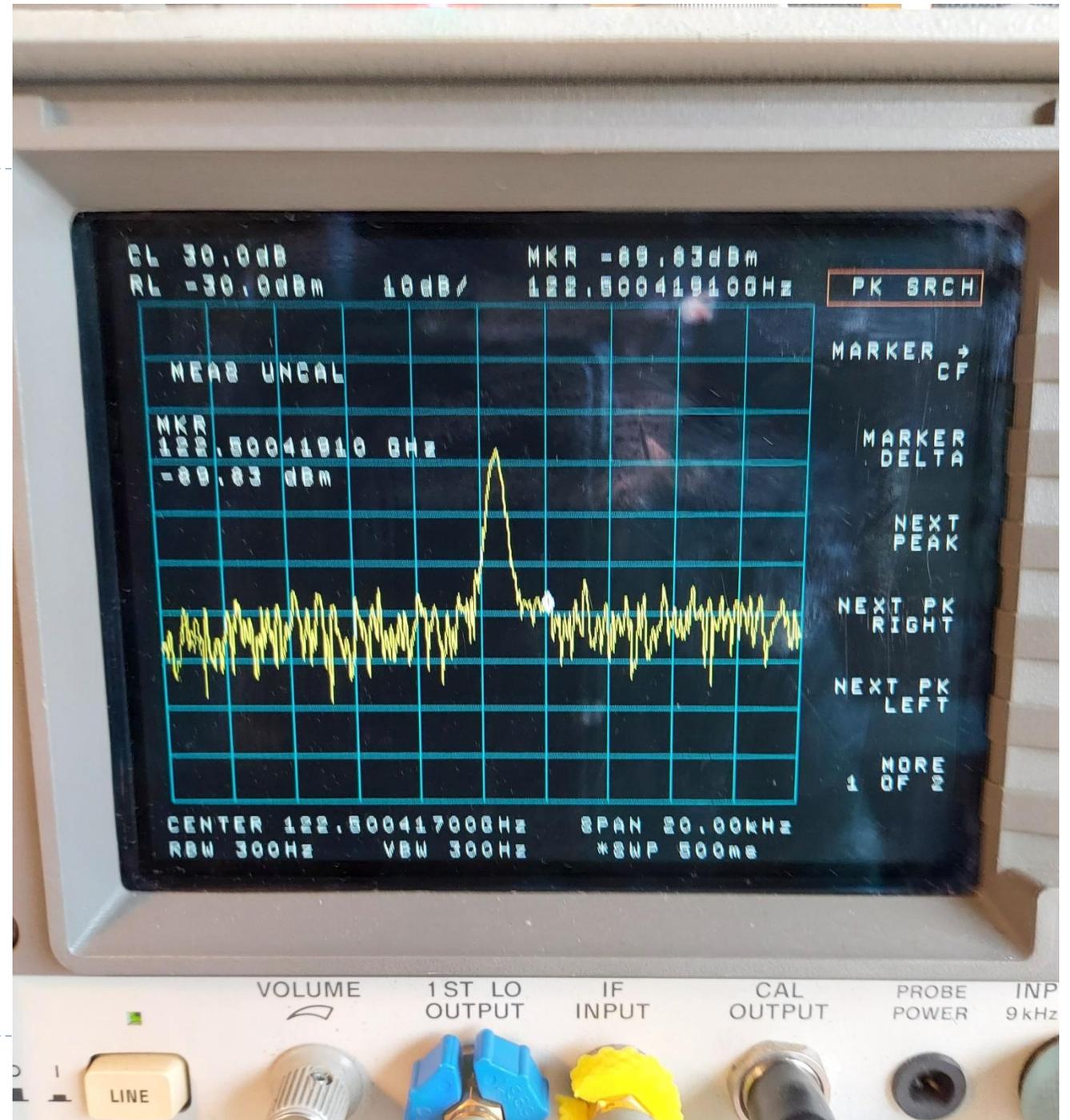
## Testing-

- With hp11970Q mixer in front of the horn
- Second run board
- Custom box
- Flush mount horn
- Scope well mounted.
- *Cool looking.*



# Better Analyzer Picture

- ▶ HP8563AC tuned to
- ▶ 122,500.417000MHz
- ▶ GPS locked.
- ▶ Phase noise is better than the
  - ▶ Picture.
- 1. Using a 50GHz mixer
- 2. HP8563A's are about \$1500



# Helen with Tony's first run- Optimized basic radio

Solid Linhof tripod

Baofeng UV6r HT

Rifle scope

External Mic

Bienno battery on  
the ground

Horn just peeks out of the box

Easily does 4 miles.

**PTT modified so the HT will  
never transmit.**



**Next-**

---

**Intermediate Level Details  
- With Tony Long**



# An Improved 122 Ghz Radio Chassis

Things I like in microwave radio chassis:

- Modular design
- Clean wiring
- Flexible mounting options
- Durable
- Field serviceable

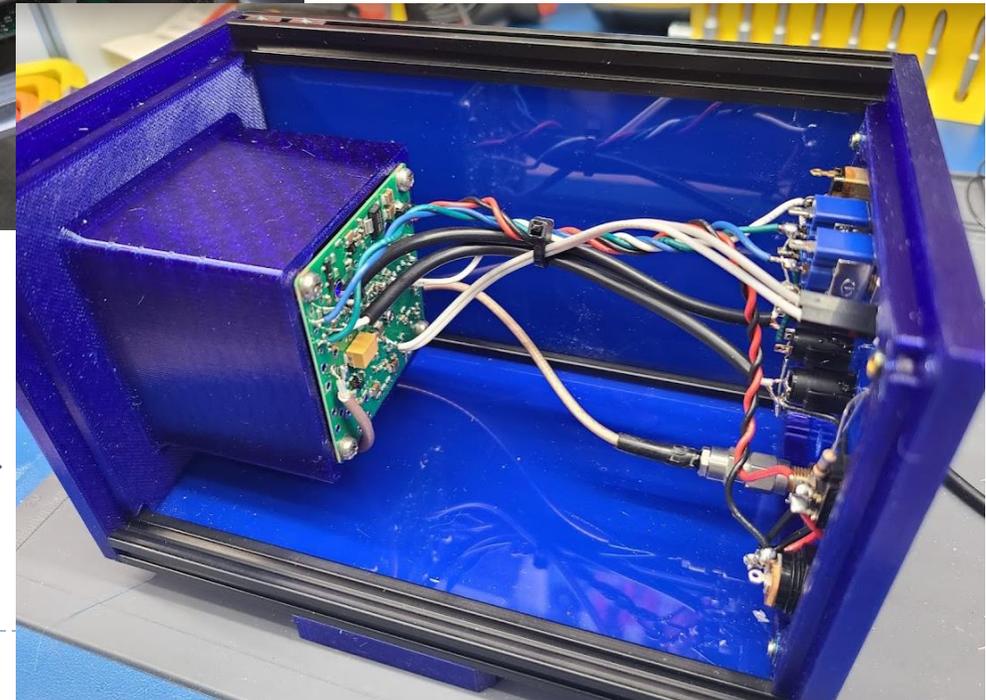
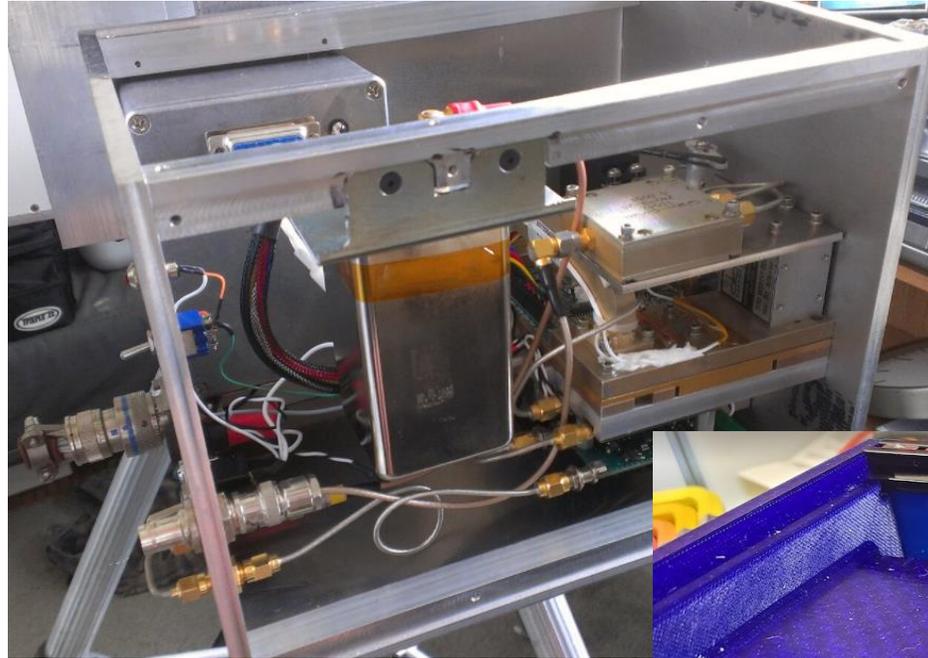
Ten Years ago my radios:

- Had lots of machined aluminum
- Took months to build

Since then, 3D printing, laser engraving, and better parts have become more readily available.

Now my radios feature:

- Aluminum structural extrusions
- Lots of custom 3D printed pieces
- Take days to build
- Can share the designs with others



# Pros and Cons of Plastic

---

- ▶ Untreated plastic offers no shielding
- ▶ Plastic is light!
- ▶ Break something? Print a new one for pennies and zero labor time.
- ▶ Some plastics don't hold tolerances well over time
- ▶ Consumer 3D printing still not good enough for high performance waveguide > 5 GHz or so, plating still not widespread.
- ▶ CAD – steep learning curve, none of it is very good software, most of it is very expensive, especially anything decent.
- ▶ Laser cutting/engraving is simply incredible for front panels
- ▶ 3D printers are cheaper than a milling machine and constantly improving.



# Front Panel Example

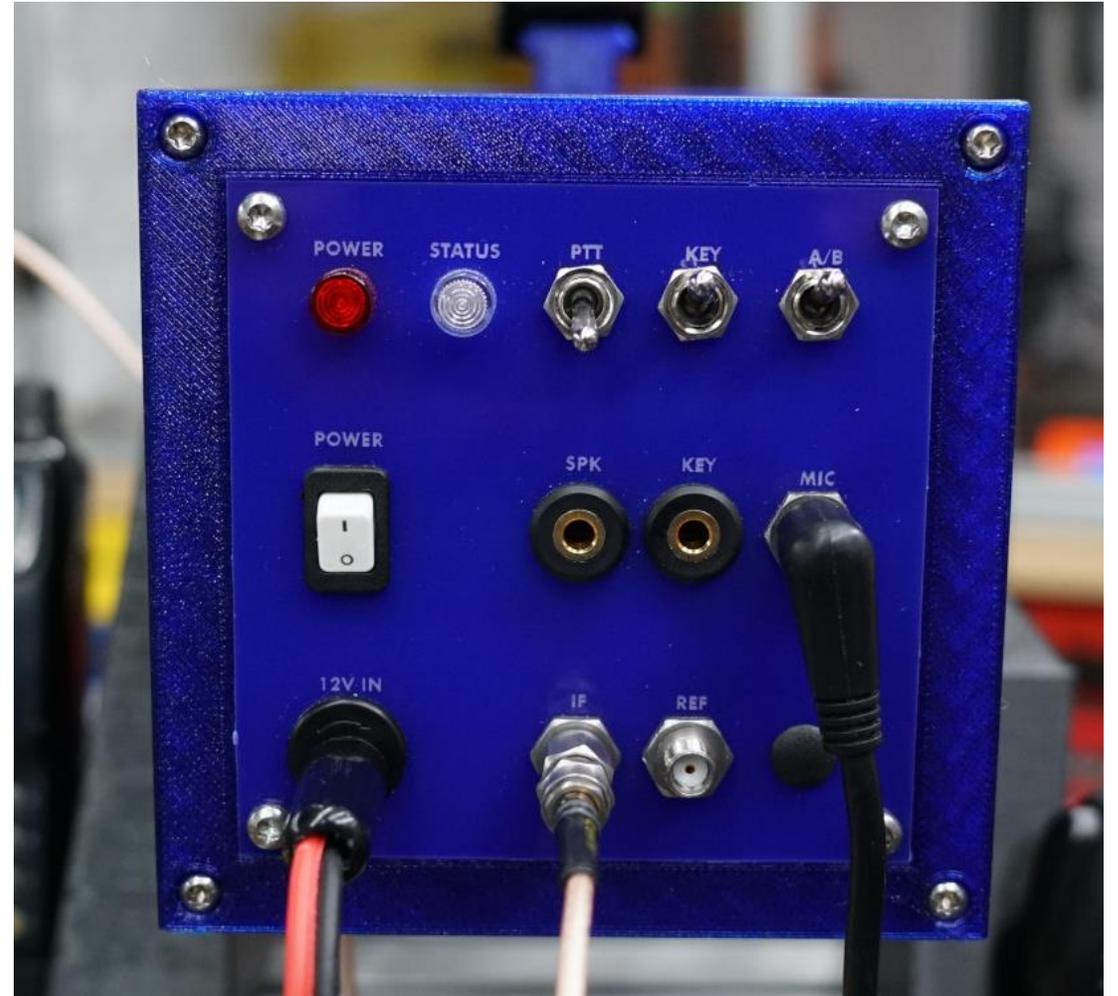
---

This front panel took ~20 minutes to design, 5 minutes to fabricate.

Labels are laser engraved, holes are laser cut, all in the same machine, in one job.

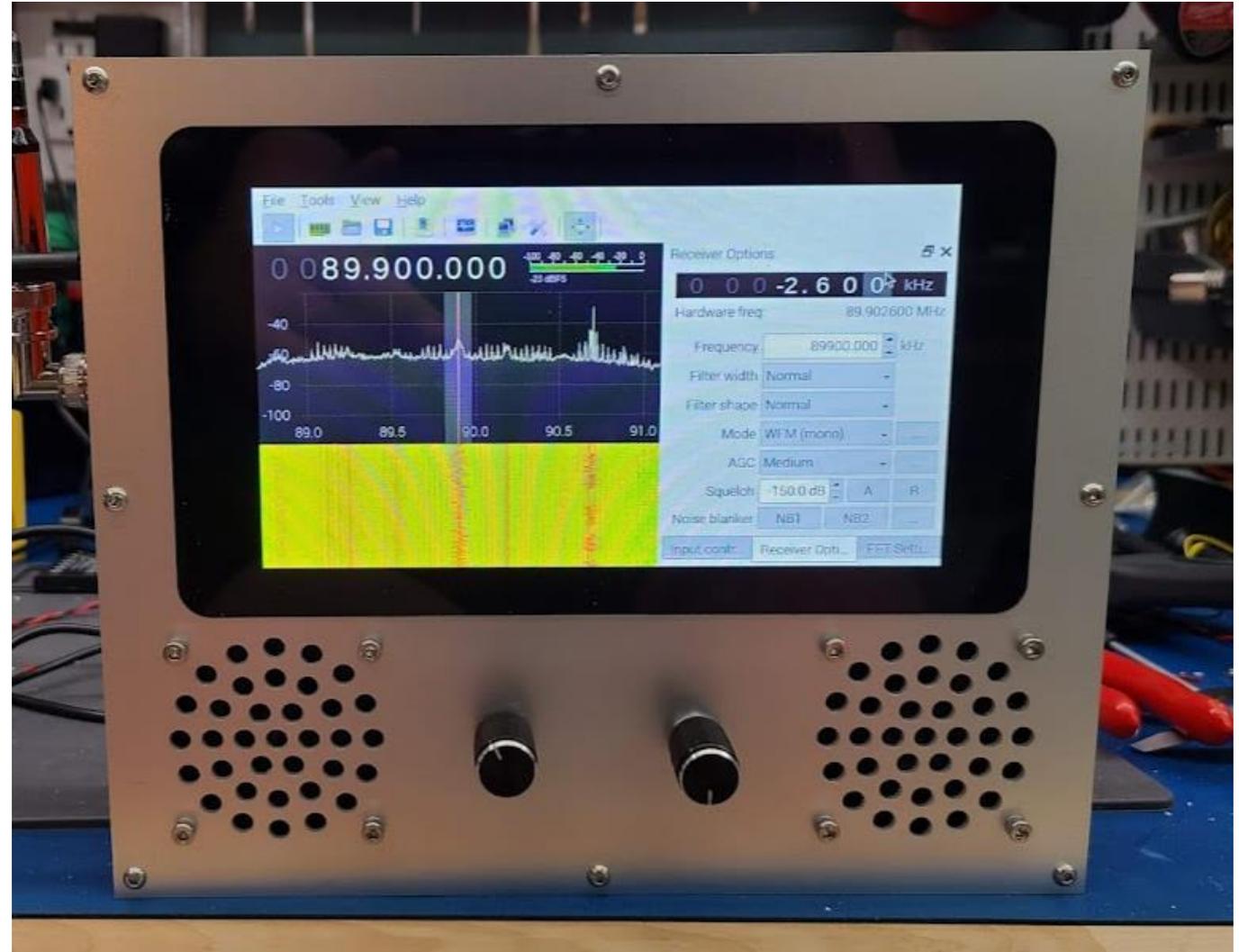
Sadly a decent consumer laser is ~\$5,000+

You can order laser cut pieces online...



# Metal panels

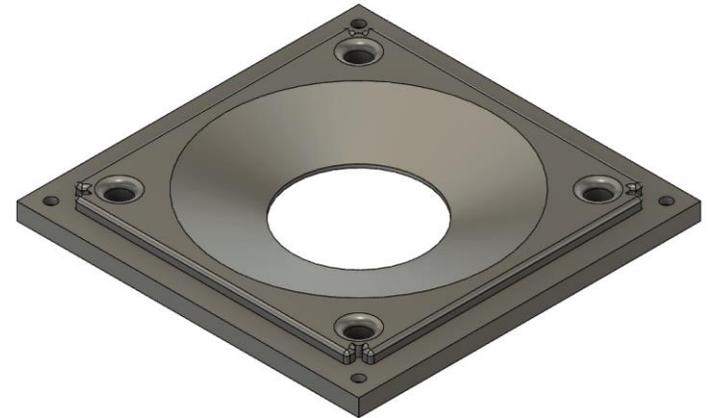
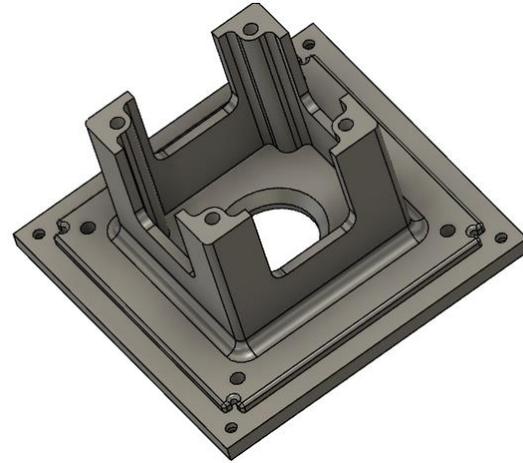
- ▶ This panel is made from 6061 Aluminum
- ▶ This front panel was cut on a waterjet.
- ▶ Can also cut carbon fiber, or basically anything.
- ▶ Cheapest machine is ~\$25k
- ▶ But you can get this service online too!



# I use Fusion 360

---

- ▶ Free for personal use
- ▶ Some annoying limitations (cannot export 2D geometry unless you pay)
- ▶ Has CAM



# 3D Printing at KC6QHP

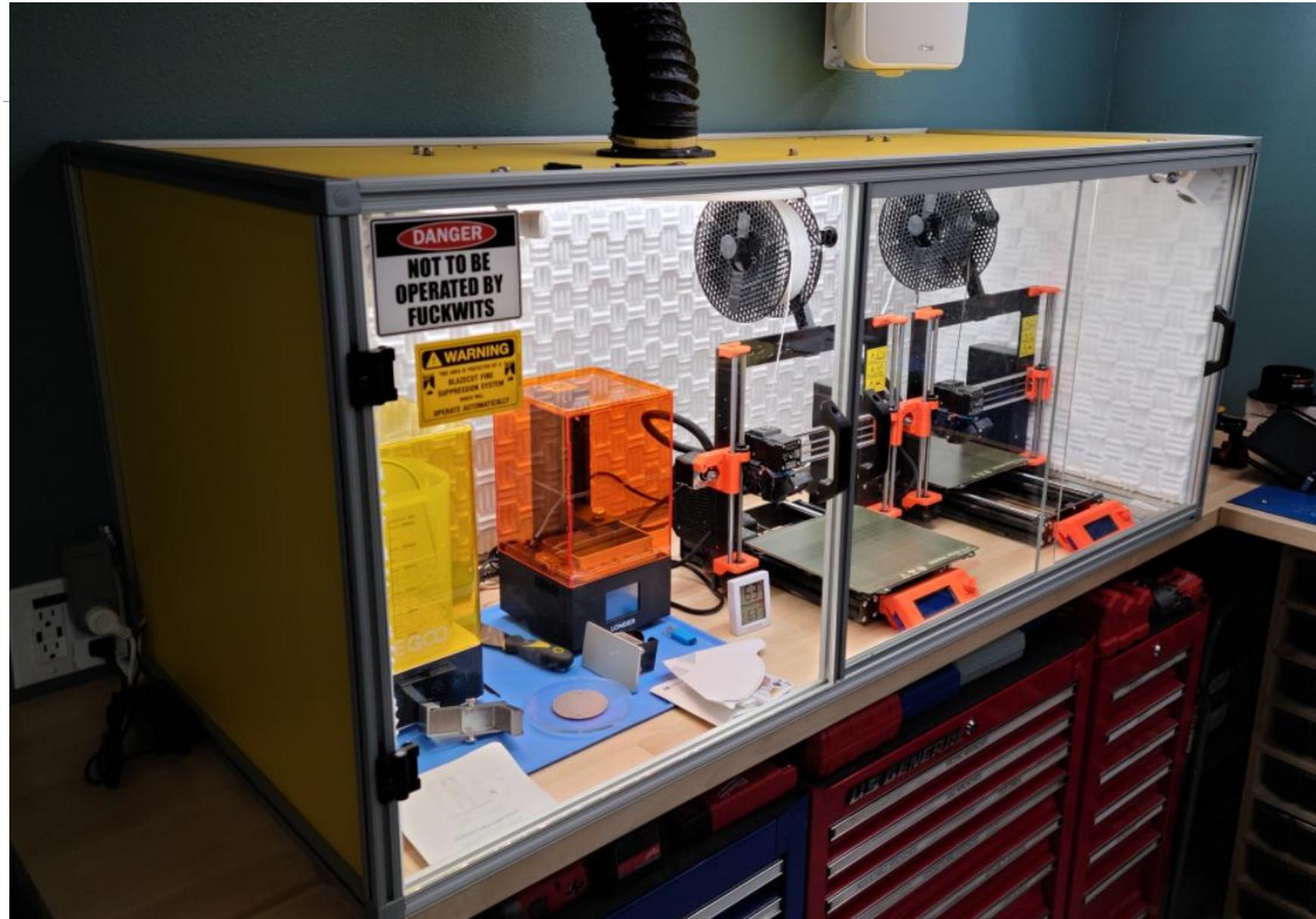
- 2x Prusa i3 Mk3s+ FDM printers
- 1x Longer Orange 10 resin printer
- Acoustically insulated, fire resistant enclosure with fume extraction and automatic fire suppression



Safe-T-Sensor: Cooking  
Fire Solution for  
Microwave Ovens

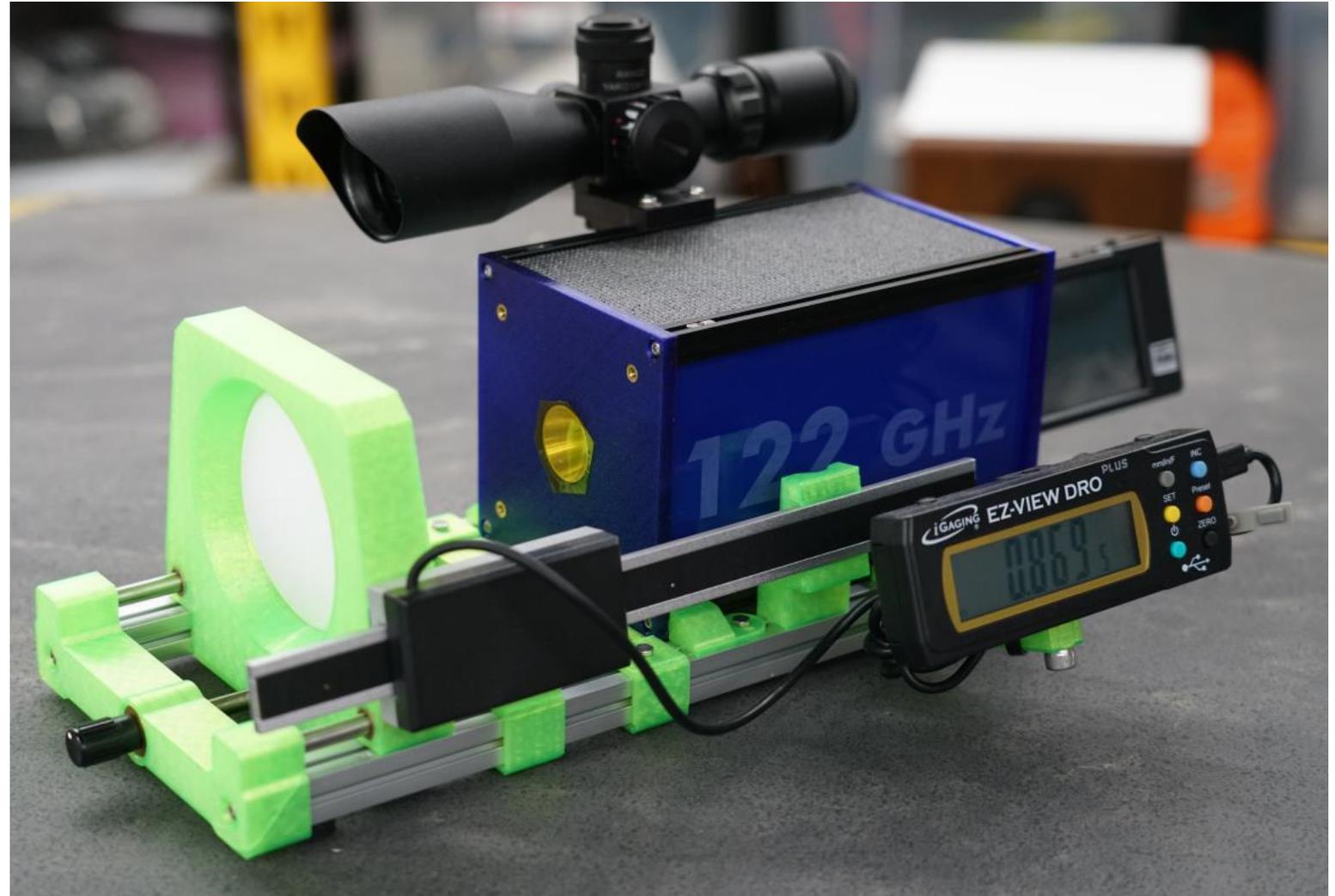


Blaze Cut automatic fire  
extinguisher



# Antenna calibration fixture

- ▶ Makerbeam aluminum extrusion used again, this time the XL size (15mmx15mm)
- ▶ Threaded adjuster allows 1 inch of travel



# Completed Radio on 3D Printed Gimbal

- ▶ Lens can be removed if desired.
- ▶ Still finishing the worm gear drive for elevation adjustment
- ▶ Azimuth adjustment is an inexpensive but very smooth pan head (and has printed graduations).



# Demo Time

---

- ▶ Show off the live demo from the back yard/ garage at KC6QHP QTH

