

DIY turnstile bali v1 antenna + outdoor LNA case

(working good for LEO satellites 369 Mhz - 445 Mhz)
by bali

this document contain how to make turnstile bali v1 antenna, that is designed only for receive (rx) , specialized for rx (telemetry, image, sound) from 70 cm LEO satellites.

basically this antenna is just **two dipole antenna** combined into one single antenna. between first and second dipole are connected by phasing cable.

because only for rx, no need to add matching cable 50 ohm and tune for good SWR. this things make antenna creation and tune up more simply.

why i choose 75 ohm cable, because it low loss, only need for rx, the price is affordable, easy to find at local store, and in general rtl-sdr devices are 75 ohm.

material:

1. pvc manifold 1¼ to ¾ inch = 1
2. pvc pipe ¾ inch 80 cm = 1
3. belden RG6 75 ohm 1 metre as antenna feeder
4. belden RG6 75 ohm 16.245 cm as phasing cable
5. copper rod Ø 35 mm @11 cm x 4
6. copper tube Ø 65 mm @11.1 cm x 4
7. aluminium tube Ø 85 mm @20 cm x 4

for outdoor lna case (optional):

1. pvc tube 1½ inch x 20 cm = 1
2. pvc pipe cap 1½ inch = 1

Diameter is calculated based on the outer diameter. If you cannot find the right size, it can be replaced with material that is close/similar. **The most important thing is during the resonance measurement later.**

tools:

1. crimping tool (better) or pliers
2. nano vna (optional)

i create this antenna based on this calculation:

target center freq (common for amateur satellite)
= between 436 - 438 mhz ~ **437 mhz**

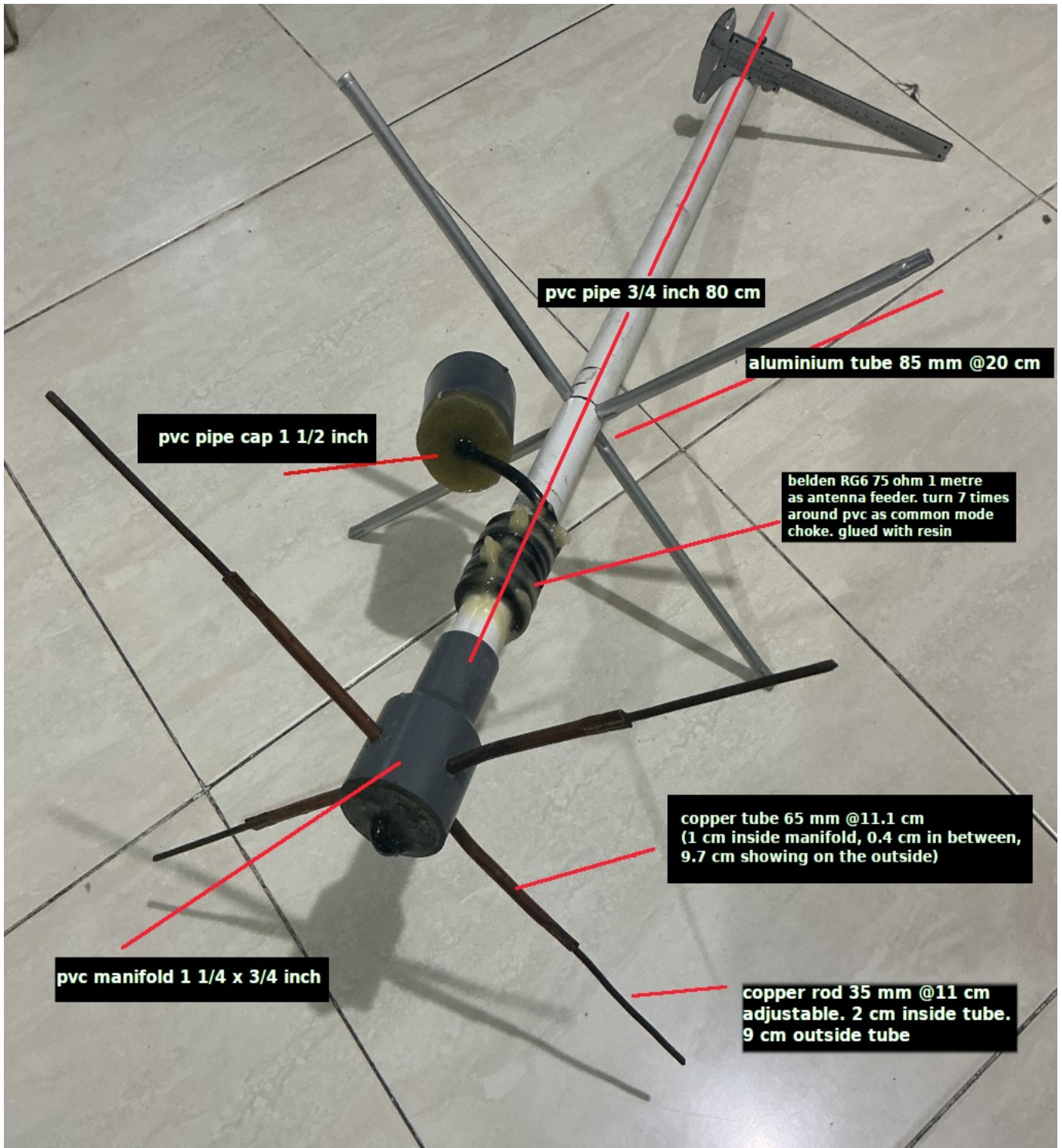
$\lambda = 300 / 437 = 68.65 \text{ cm}$

length for each element = $1/4 \times \lambda = 1/4 \times 68.65 \text{ cm} = 17.1625 \text{ cm}$

velocity factor (vf) of copper = 95%

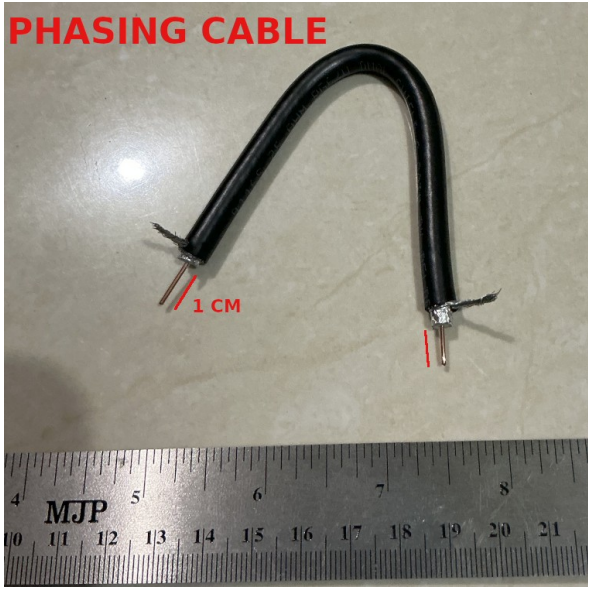
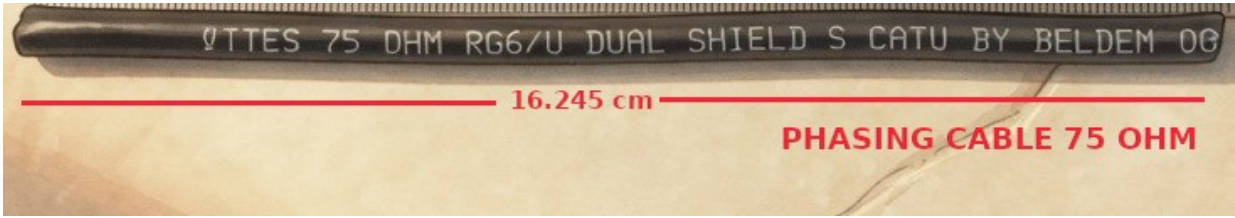
real length of each element = $\text{vf} \times \text{length} = 95\% \times 17.1625 = 16.30 \text{ cm}$

We use this number as the bare minimum for each element (tube + rod). **It should be no less than 16.30 cm!!**

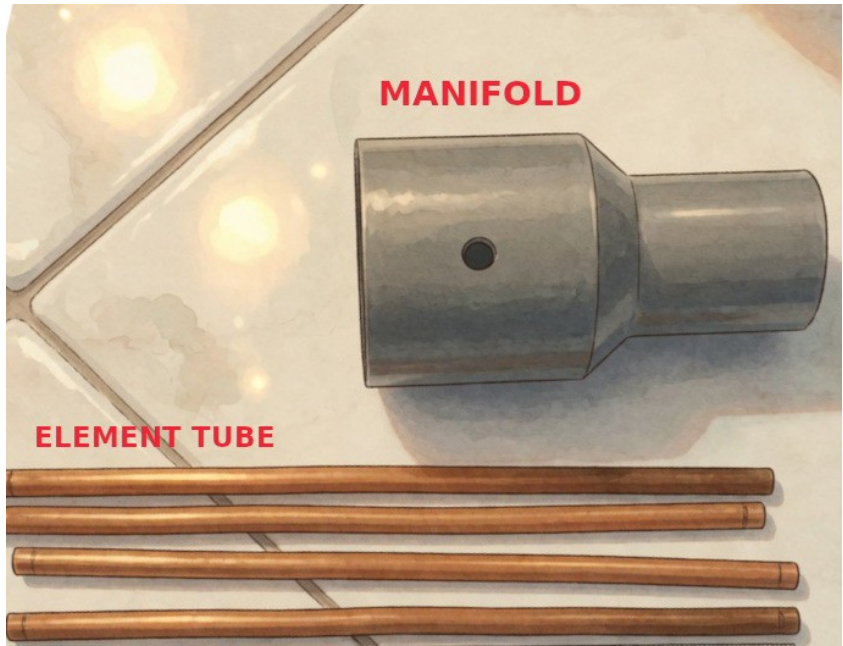


belden RG6 75 ohm, from datasheet have $v_f = 83\%$
 so for **phasing cable** 75 ohm, it should be $= 83\% \times 1/4 \lambda = 83\% \times 17.1625 =$
14.245 cm

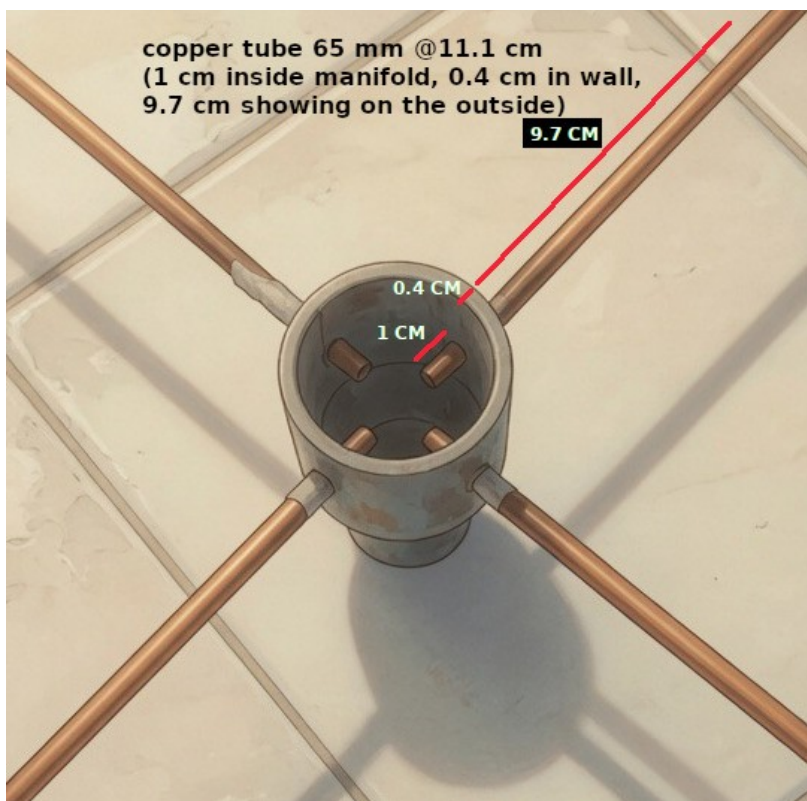
for phasing cable, we add additional length 1 cm for both side, so total become 16.245 cm. why? because we need 1 cm for each side, that will connected and put inside copper tube (look at image) (we press it with plier).



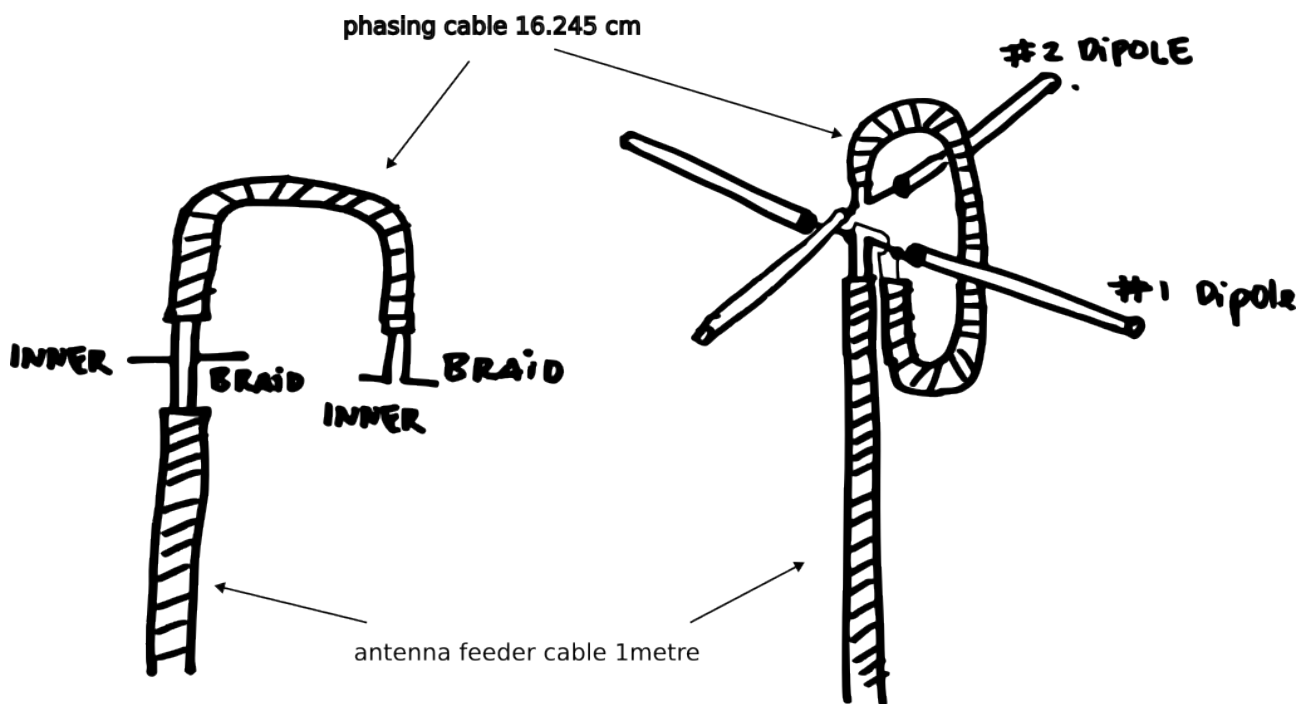
Use drill to make 4 hole on each side of manifold, or use hot element tube that burned above stove, and push into pvc manifold.



put the copper rod inside copper tube around **2 cm**. and press using crimping tool / pliers. **don't press too hard at first**, so that later it will be easy to adjust back and forth.



phasing cable diagram:



don't forget to make **common mode choke**, just bending and turn around 7 times. (look at image). use cable ties to tie it up.

to make it weather resistant, i pour resin into manifold (cable junction / driver). i also put the resin on cable hole at lna outdoor case and choke. btw i recommend too to make additional choke. so between lna and sdr you can add second choke

LNA <--> choke coax (7-8 turn) <--> length coax cable into home <--> rtl-sdr

fine tune antenna:

if you have **nano vna**, just connect it to your antenna. don't forget to calibrate it first. set start for example 362 Mhz and end 512 Mhz.

turn on **S11 Z phase 90°**:

from menu:

- display > trace > trace 1
- back
- format s11 (refl) > more > more > Z Phase
- back
- Measure > Resonance (S11), Measure R1 = 75 ohm

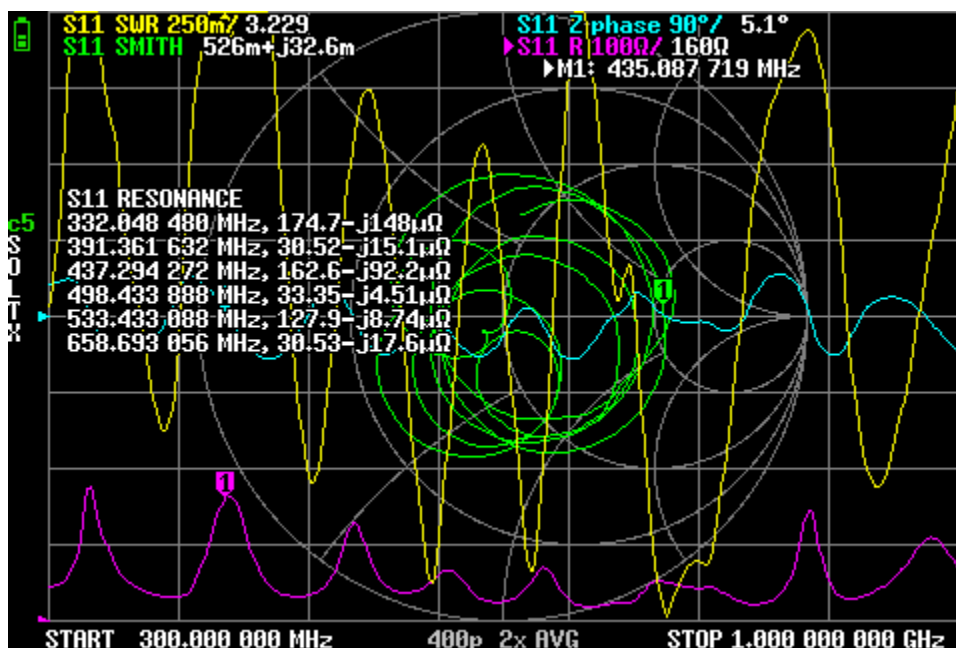
now this is the SECRET!!!

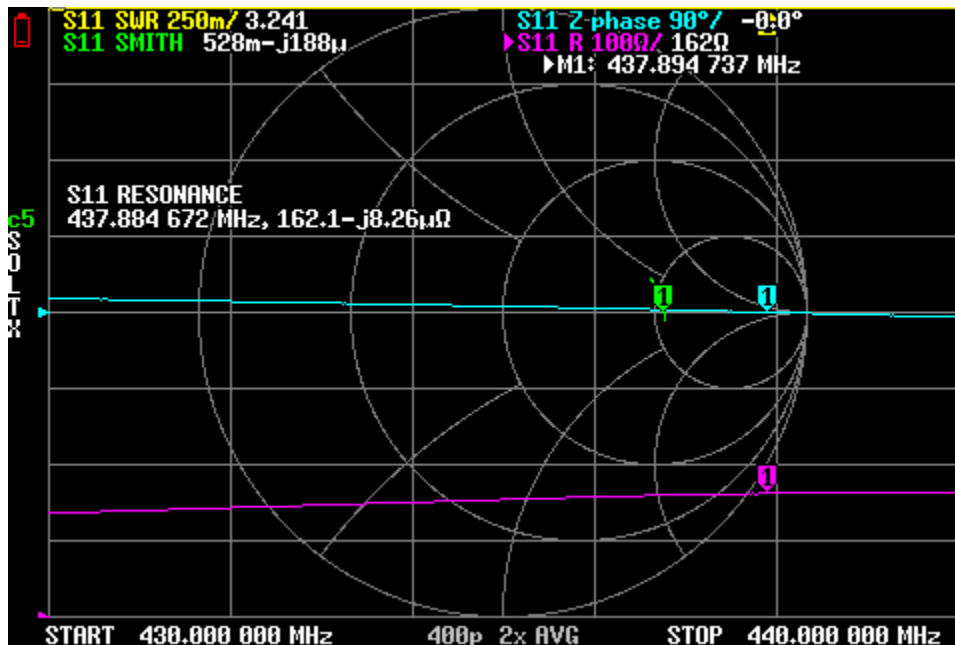
see at **S11 resonance**, and **S11 Z phase 90°**

the **closer Z phase gets to 0**, the more resonant your antenna becomes.

at S11 Resonance measure you see the freq your antenna resonance. now back and forth the rod for each element, little by little. until you got the resonance frequency you want.

if you see S11 SWR is more than 2, just ignore this. **the resonance is more importance than swr for rx.**



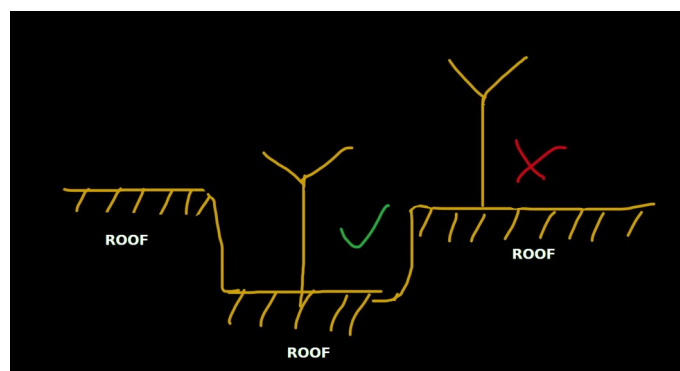


test antenna on outdoor

now put your antenna outdoor. if you have LNA, put it inside Ina tube case. and connect 75 ohm coax cable to your SDR. i use **sdr++ software**.

set the SDR gain into max, for rtl-sdr is set to 49.6 (why I set to maximum or big gain? I just want to trigger so that all the noise appears in the waterfall!)

your antenna location is crucial. The best satellite signal is when at high elevation. if you stay at area with high noise with crowded terrestrial signal (like at town), try put your antenna in a place that protected from terrestrial (horizon) transmission. (look at picture).

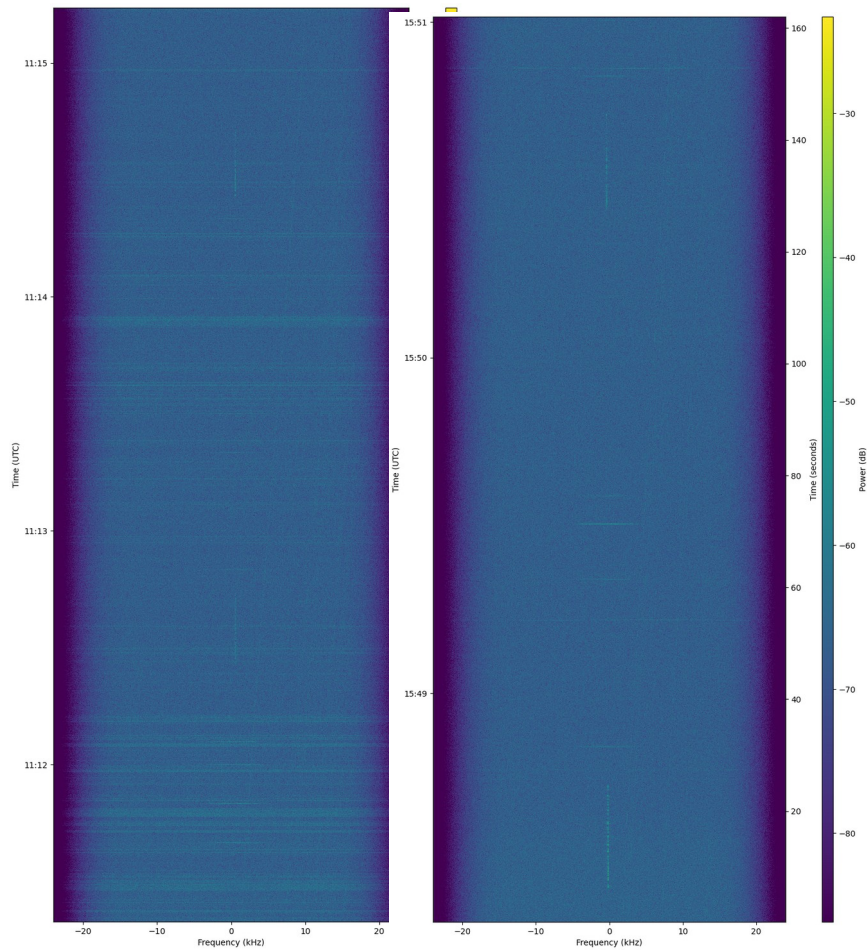


Ok, now back to your sdr software, set your target freq. i set to **437 mhz as center**

if you see the signal is good, and waterfall noise floor is stabil not up and down (wooble) , you are lucky!

but if you see the noise floor of waterfall is wooble, up and down it mean there is noise. the first you should do is try move your antenna position. Try moving a few steps. if noise still hard, try gradually lowering the antenna height. you will see in waterfall. try also rotate your antenna. try this until no wobble noise at waterfall.

Left = with noise, wooble line | right = clean, without noise, no wooble



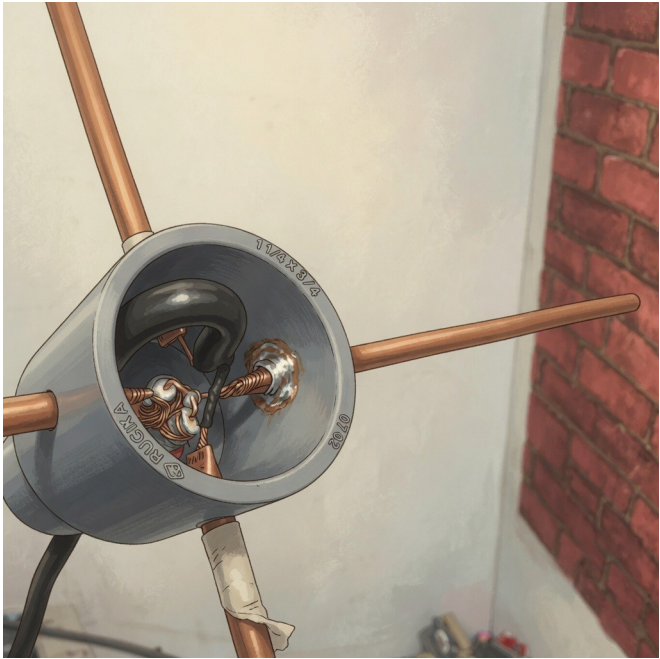
congratz, now just connect your antenna to your ground station, and make some obs.

if you like this antenna , please share it. Or if you have any questions or suggestions, please feel free to reach me out. just join satnogs forum, and pm me there
<https://community.libre.space/u/bali>

73!

bali

I pour resin there, and leave 24 hours until dry



Antenna feeder (RG6-SMA adapter) with builtin LNA Outdoor Tube Case

