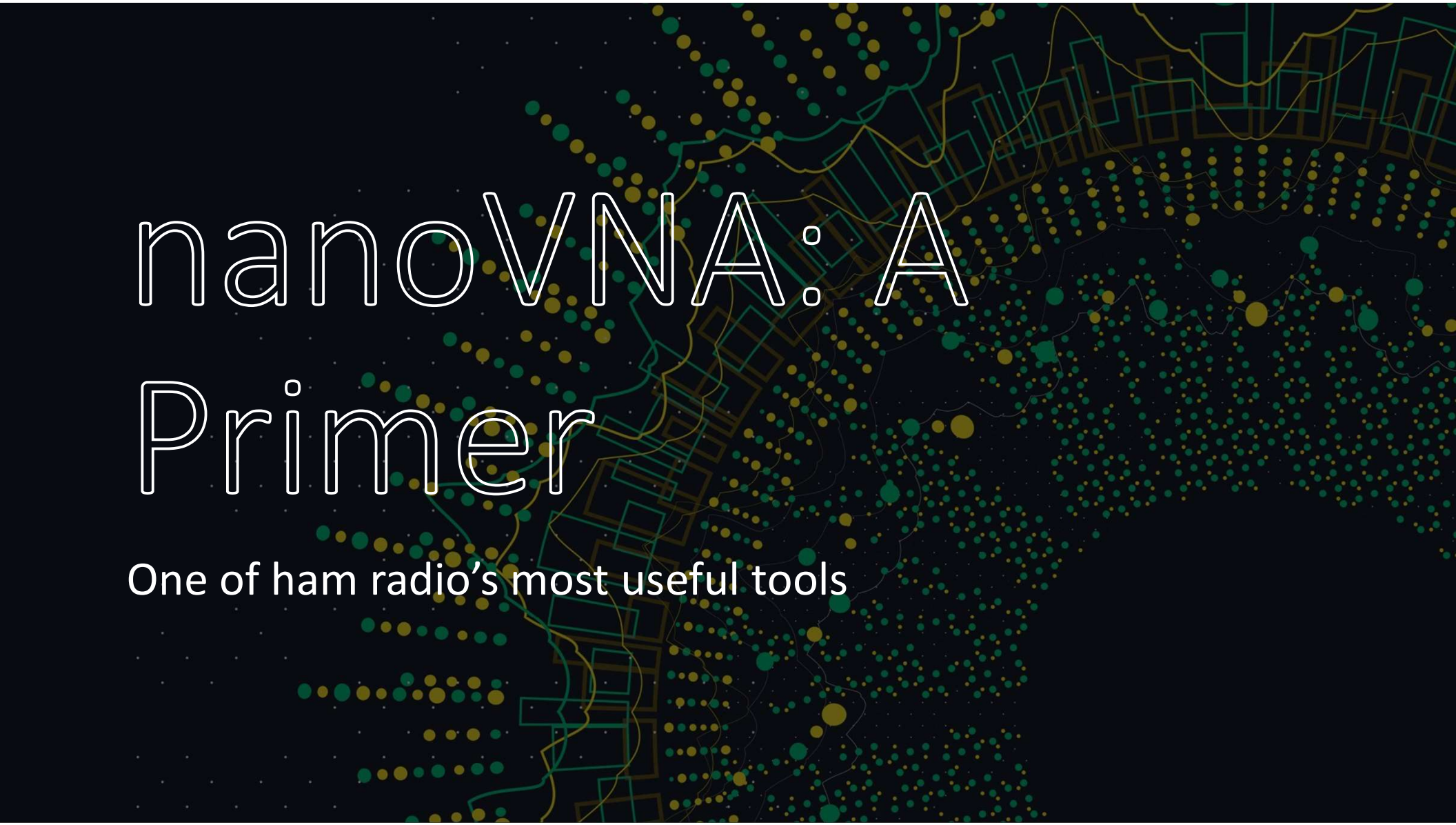
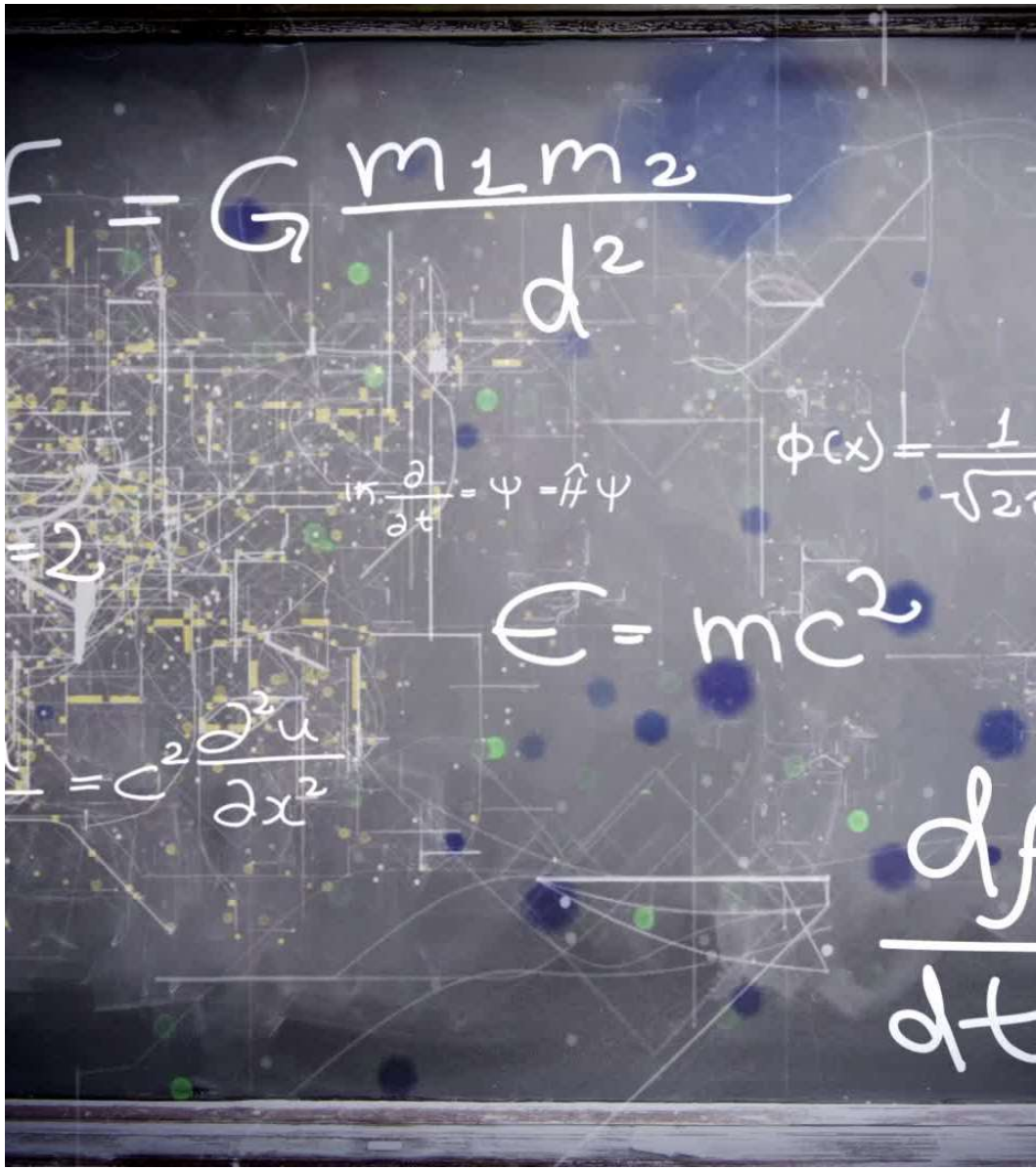

nanoVNA: A
Primer
One of ham radio’s most useful tools

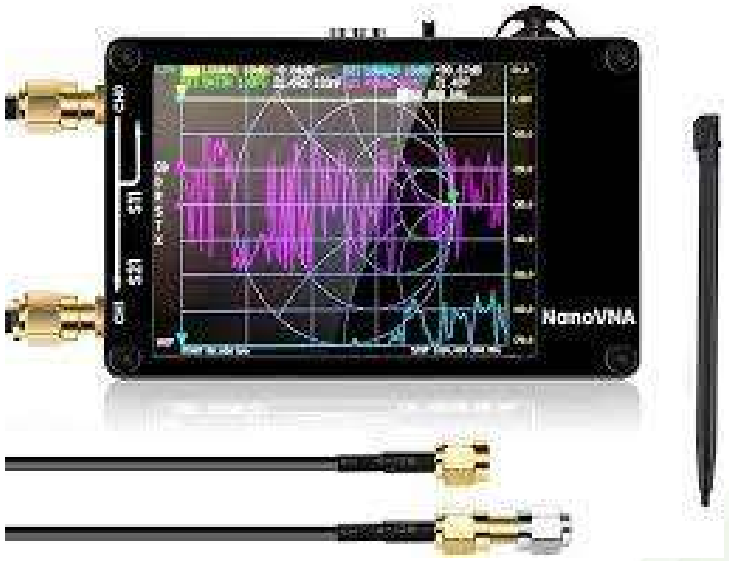
What is the nanoVNA?

- It is a small, inexpensive VNA (Vector Network Analyzer)
- In an electronic network (circuit), it can be used to measure:
  - Impedance
  - Reflection coefficient
  - Transmission coefficient
- In ham radio, we use it for:
  - Testing antennas (SWR)
  - Tuning filters
  - Measuring cable loss



Procuring a nanoVNA

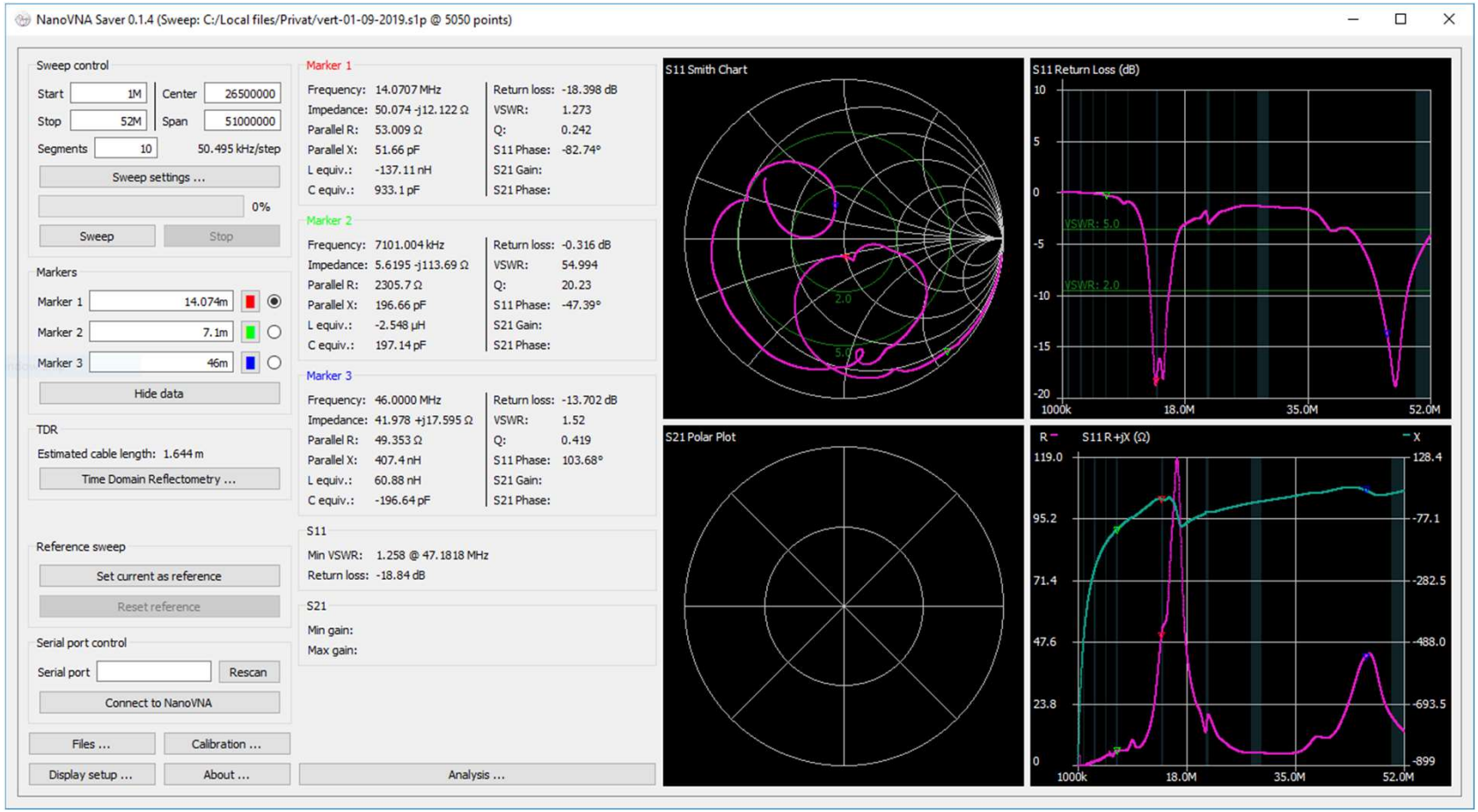
- They typically cost $60 and are available from:
  - Gigaparts
  - R&L Electronics
  - Amazon (AURSINC store only – beware of clones!)
  - https://nanovna.com/?page_id=121
- The kit includes:
  - nanoVNA (obviously)
  - 3 calibration connectors (open, short, and 50 Ohm)
  - Stylus
  - Short connection cables (USB A to C, small coax SMA cables)



Using your nanoVNA

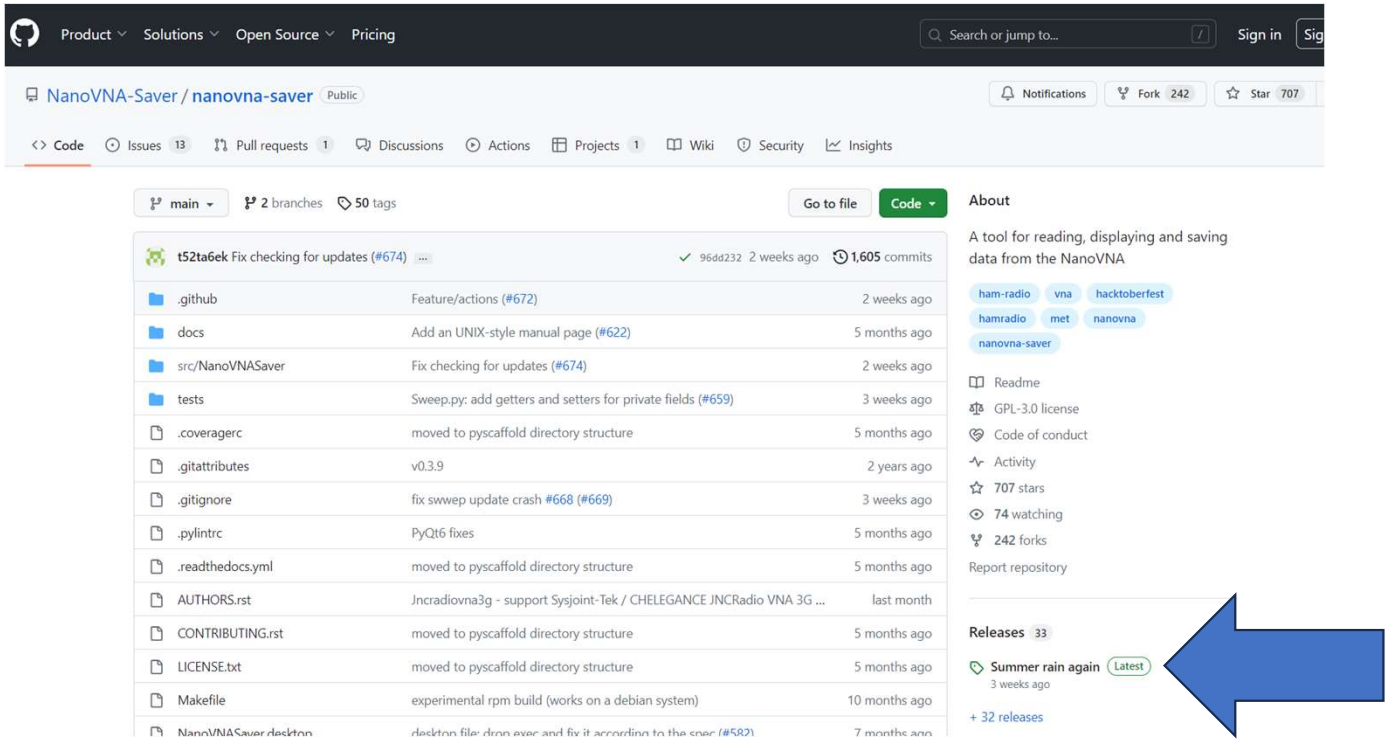
- The nanoVNA has a touchscreen along with a stylus
- While this may be fine for quick, in-the-field antenna sweeps for youngish eyes, the screen can be hard to see in direct sunlight or if you have large digits
- I highly recommend a piece of software called nanoVNA Saver
  - Allows you to use/control your nanoVNA from your PC
  - Larger screen, can save plots, easier-to-use controls!
  - Simply plug your nanoVNA's USB cable into it and your computer and go!
  - https://github.com/NanoVNA-Saver/nanovna-saver
- Practically everyone logs on a computer (even in the field!)

nanoVNA Saver



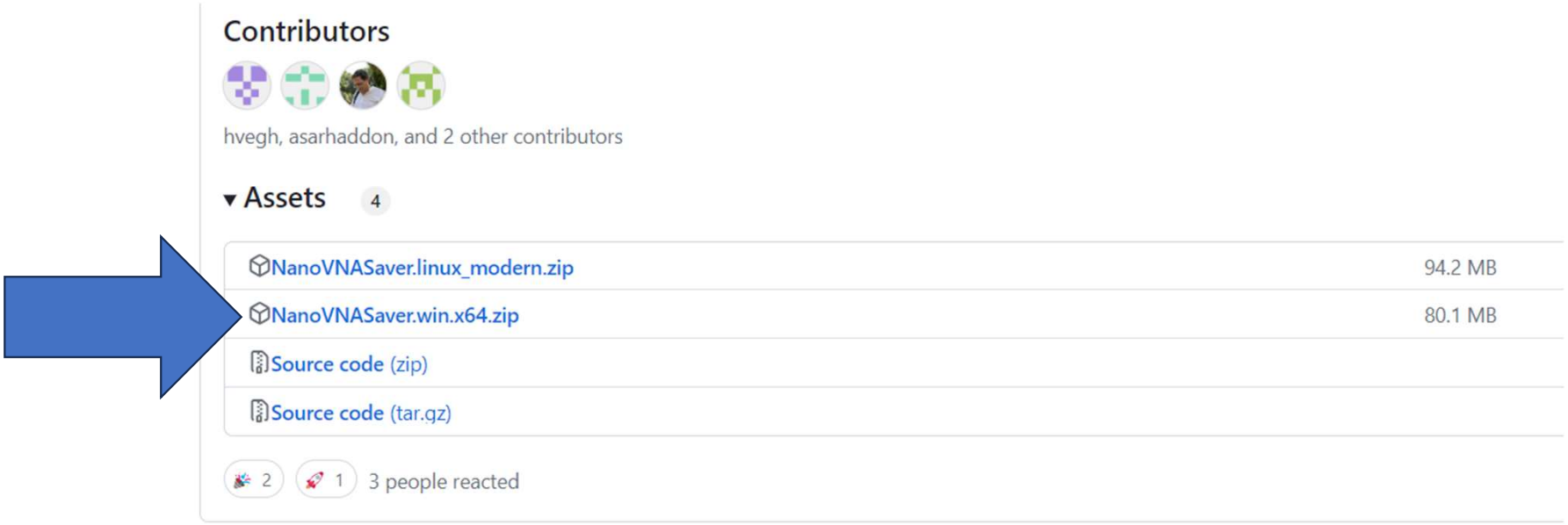
Downloading nanoVNA Saver

- On the GitHub page, there is a link on the right-hand side called “Latest”



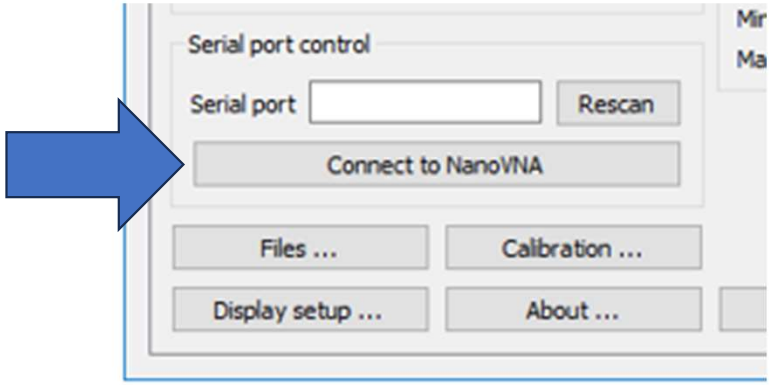
Downloading nanoVNA Saver

- Click the “Latest” link and then click either Windows or Linux



Using nanoVNA Saver

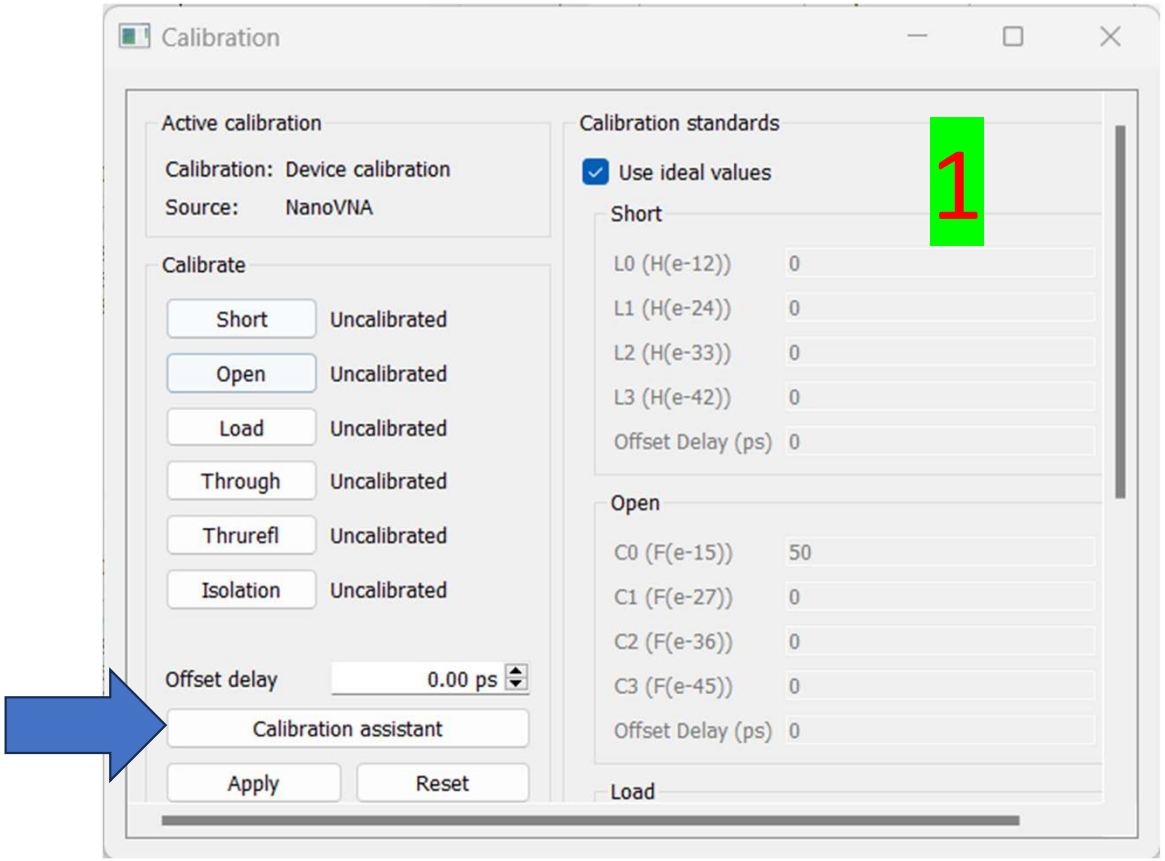
- Inside the zip file is a self-contained executable – just double-click the .exe file and it starts up nanoVNA Saver
- In the lower left-hand corner, click Connect and choose the COM port that corresponds to your nanoVNA (connecting to computer with USB cable enumerates the nanoVNA as a COM port to the computer)

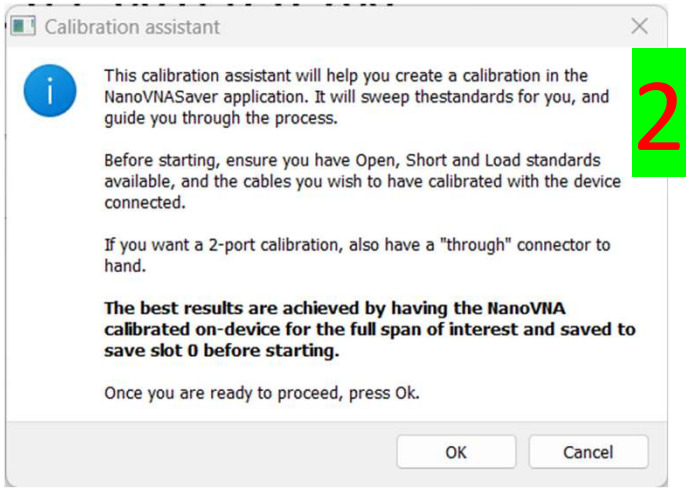


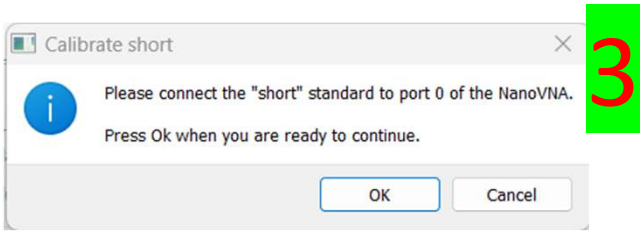
Calibrating your nanoVNA

- The first time you use your nanoVNA, you ***must*** calibrate it
- Before calibration, set your start frequency to be the lowest you intend to measure (say, 3.5MHz for 80m) and the stop frequency to be the highest frequency you intend to measure (say, 30MHz for 10m)
- Once you have calibrated the nanoVNA, you don't need to recalibrate unless the ambient temperature where you are using the nanoVNA changes
  - Moving from indoor to outdoor
  - Vice-versa
- Calibration will use each of the three calibration connectors
- On nanoVNA Saver, just click Calibration and the Calibration window will open

Calibration window







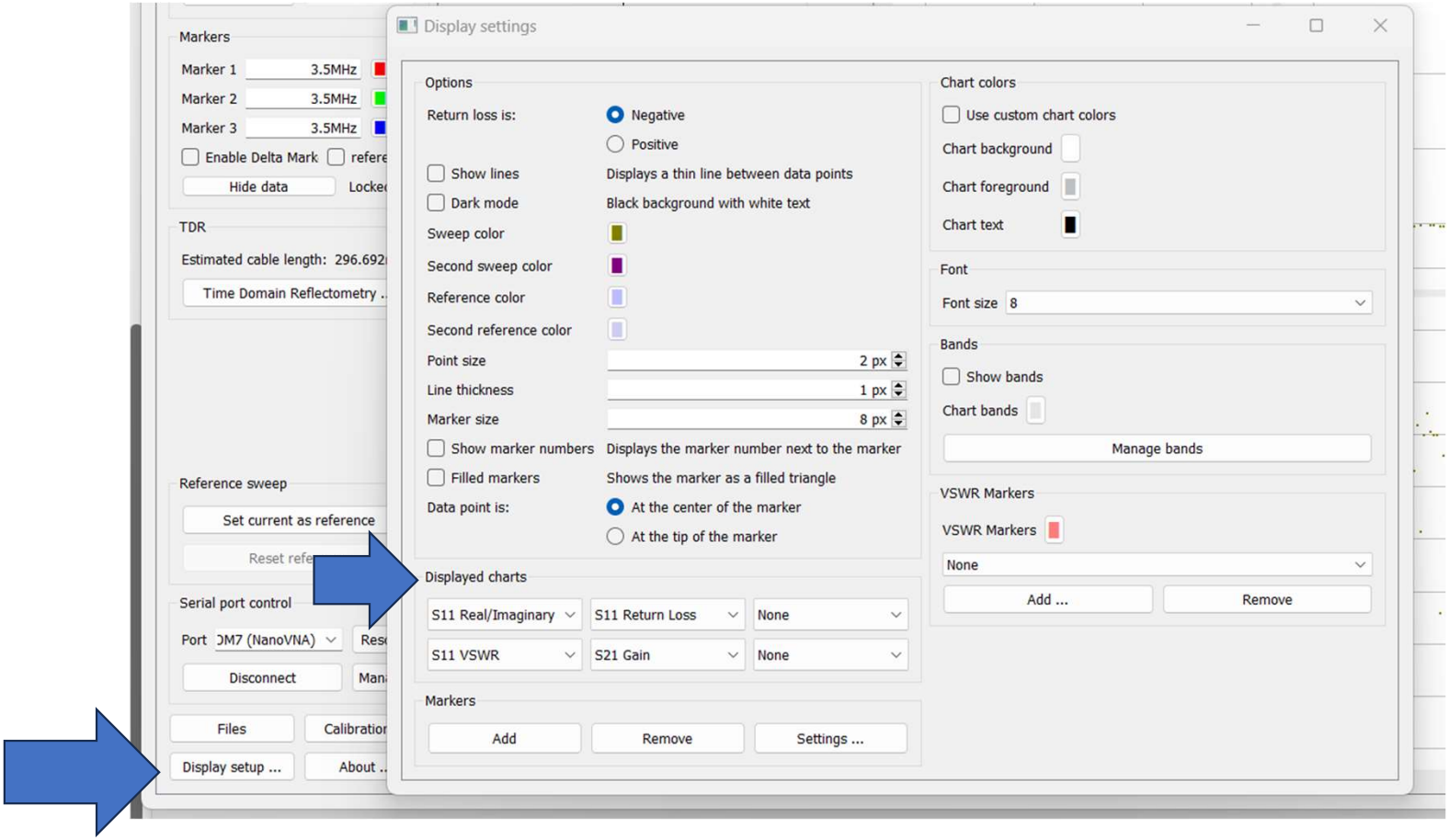
Just follow the calibration wizard

- You will connect the calibration connectors to Port 0 (which is also called CH0 or S11 on the nanoVNA)
- You start with the short (as in 0 Ohm impedance) connector
- You will then proceed to the open (infinite impedance) connector, then load (50 Ohm impedance).
- You can then click Apply to finish the one-port calibration

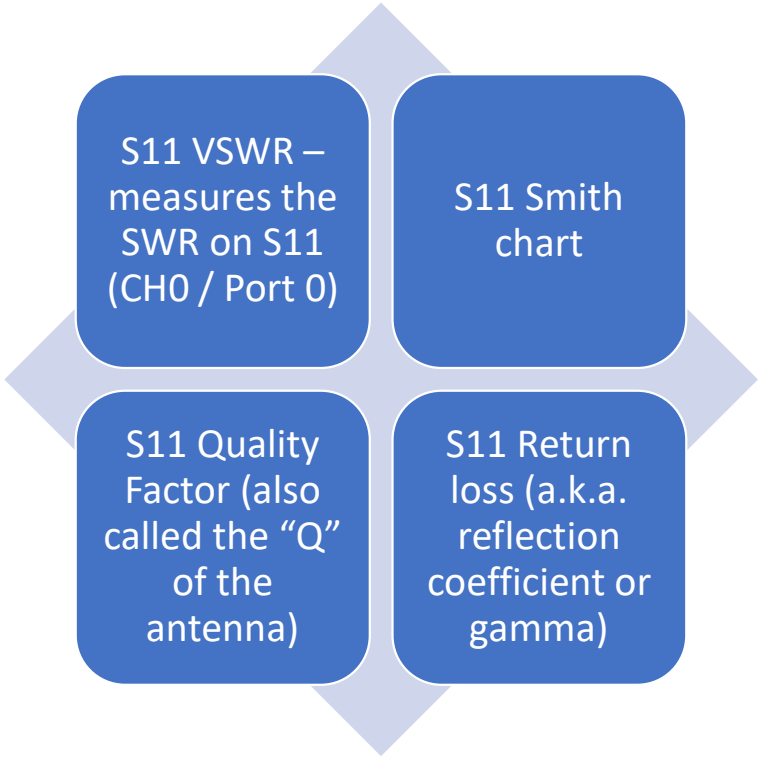
Calibration

- You can save the calibration data to your computer on the Calibration window if you want
  - However, the calibration data is already saved on the nanoVNA
  - If you frequently move between outside and inside, it might be convenient to have calibration files for each climate saved on your PC
- You can now close the Calibration window to return to nanoVNA Saver

Changing your display settings in nanoVNA Saver

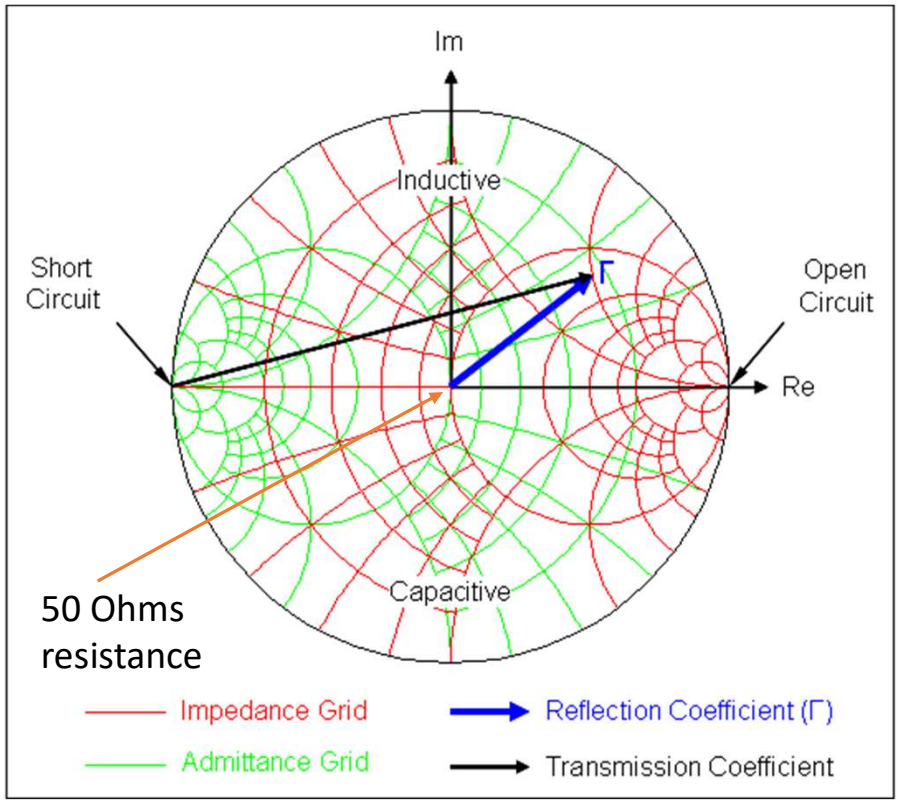


Commonly-used plots in nanoVNA Saver



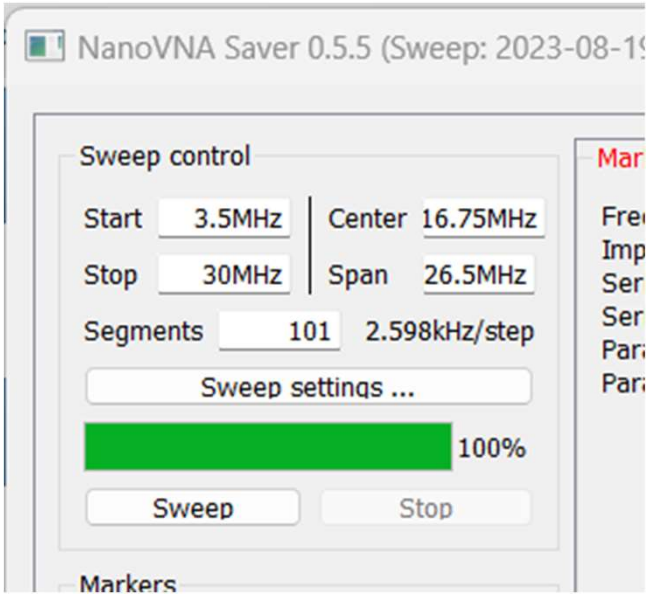
Reading a Smith chart

- The center of a Smith chart is 50 Ohms resistance (no reactance)
- Note that the three calibration plugs are on the “x axis” of the Smith chart
- The red arcs are constant impedance
  - Impedance is resistance plus reactance
  - As you leave the “x axis” of no reactance (all resistance), the resistance goes down and the reactance goes up to make constant impedance
- A tuner applies an opposite load to the antenna to make the radio think it’s always at the origin of the Smith chart
- Wide arcs when sweeping a single band indicate a high Q antenna



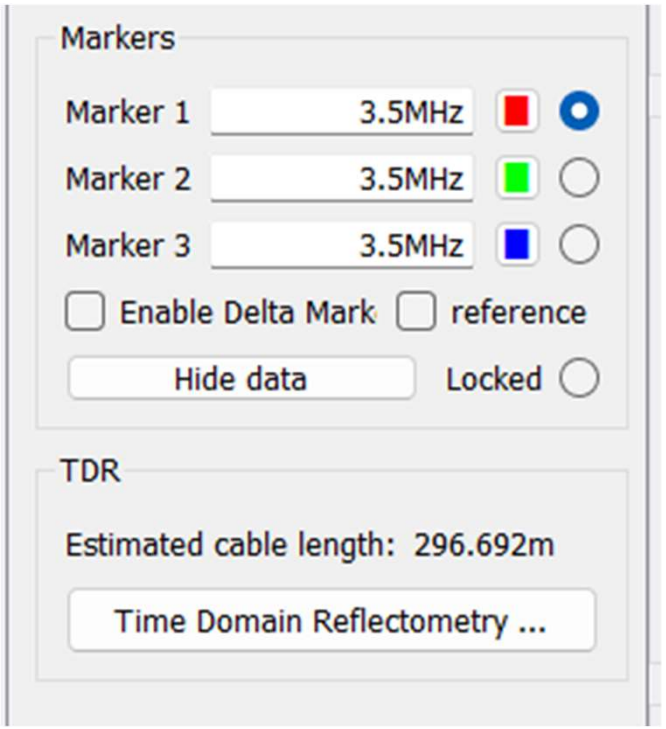
Sweep settings

- Set your start and stop frequencies
  - Center and Span are calculated auto-magically
  - You can do all-band (3.5-30MHz) or single band, e.g. 20m (14-14.35MHz)
- Set your number of test points (segments)
  - ~100 is good, takes about 2 minutes to sweep
  - More points gives you more accuracy but takes more time (linear)
- If you click Sweep settings, you can make it run once or continuously
- Press Sweep to begin the sweep



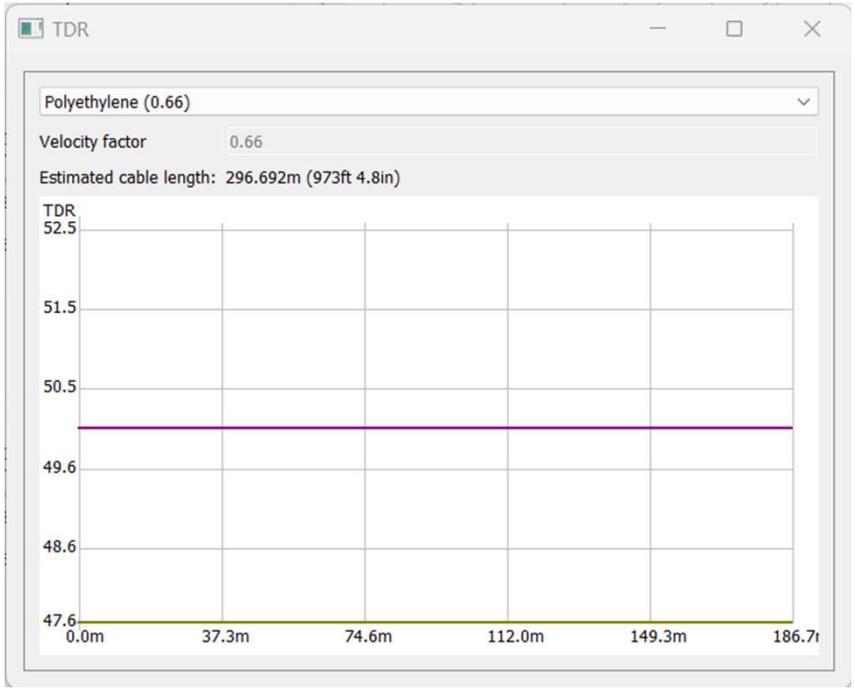
Markers

- There are three markers that you can use to mark certain frequencies on all the plots
- This helps you to identify specific frequencies of interest to see their VSWR, Q, Reflection loss, and point on the Smith chart
- You can either enter the frequency, or click a point on one of the plots



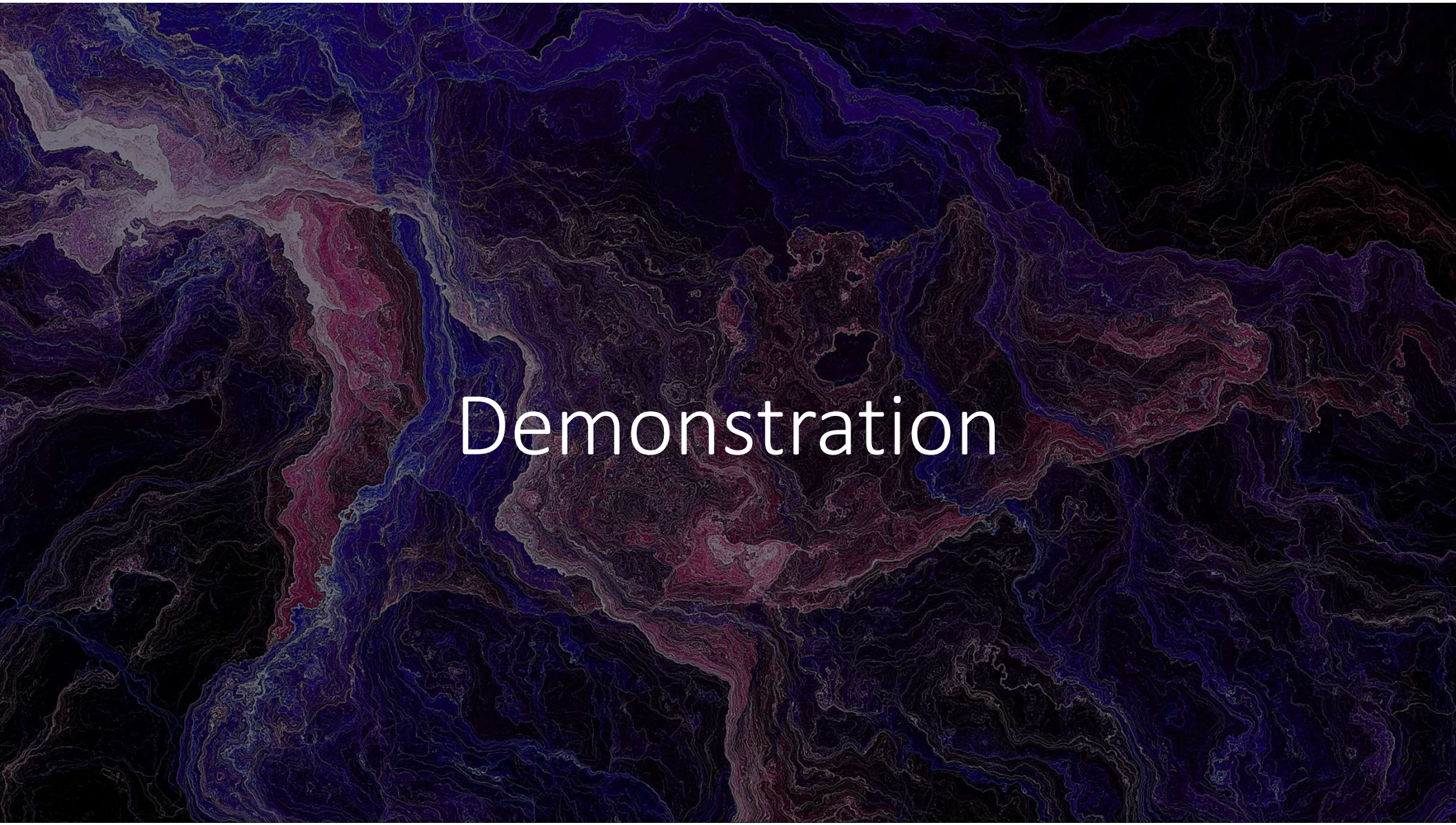
Time Domain Reflectometry

- TDR is used to measure the length of coax
- You must know the velocity factor of your coax
  - There are a list of various coax types in a drop-down list
  - You can create your own custom velocity factor



Accuracy

- Is it as accurate as, say, a Rohde & Schwarz VNA?
  - No, but it's close enough for ham work
  - It's also 3 orders of magnitude cheaper
- Testing my fully-extended vertical on 40m
  - nanoVNA indicated SWR was 2.93 pretty much across the 40m band
  - However, my 991A wouldn't tune it as it saw it as above 3
  - 30m was indicated to be about 2.5 and would tune with 991A
  - 20m and up were indicated to be sub-2:1 SWR
  - Probably off around 3%-5%
  - Close enough to find resonant lengths of the vertical for various bands
- TDR is not very accurate, sadly


Demonstration