

# Hardware and Software Development of Antenna Characteristics Demonstration Module



Trevor Wolf, Kobe Prior, and Atef Elsherbeni  
tjwolf@mines.edu, kdprior@mines.edu, aelsherb@mines.edu  
Electrical Engineering Department  
Colorado School of Mines, Golden, CO 80401, USA

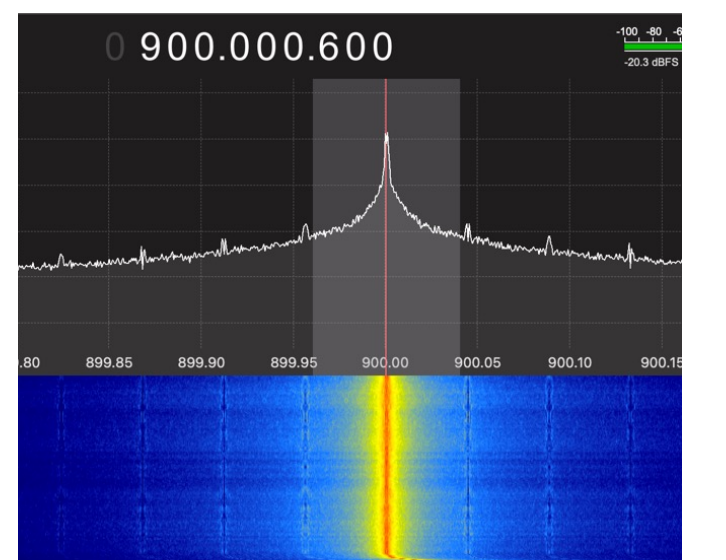
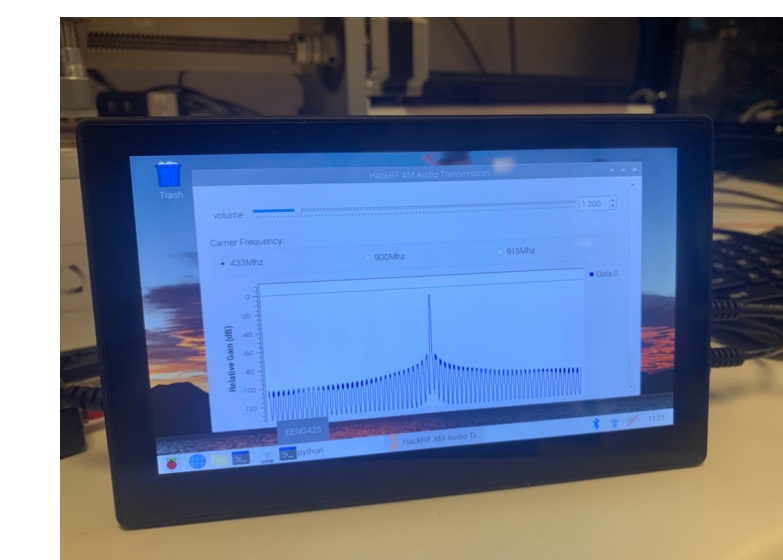


## Introduction

- The relative positioning of a pair of transmitting and receiving antennas has a significant effect on the received signal strength.
- Antenna position, orientation, and polarization affect the strength of the received signal.
- There is a reduction in power density of an electromagnetic wave as it propagates through space.
- The way these factors change the signal strength can be challenging for students to understand and to visualize from mathematical equations and static illustrations alone.
- This project aims to create an interactive demonstration that shows these effects in real time with easily manipulatable antennas and intuitive graphical interface.

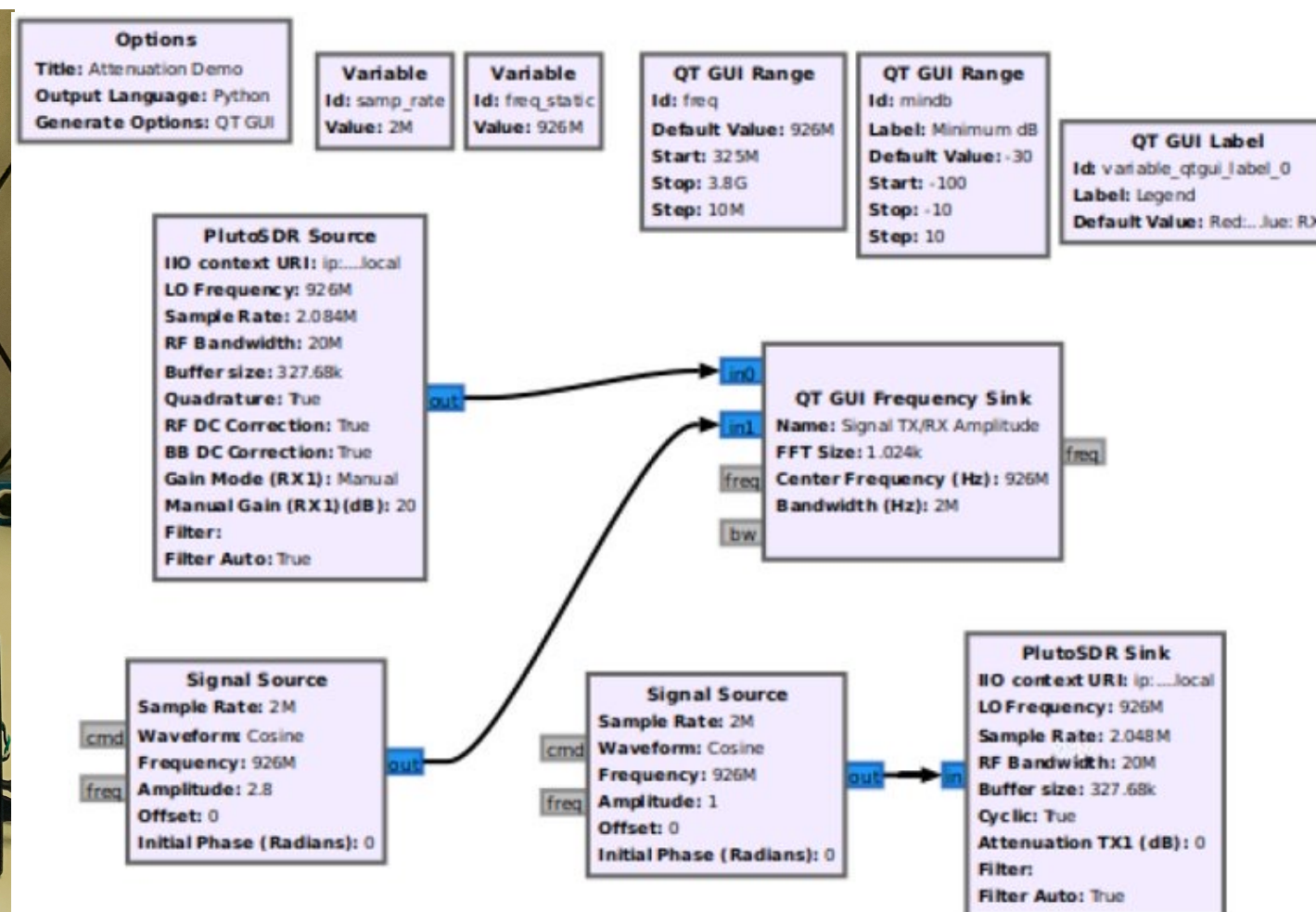
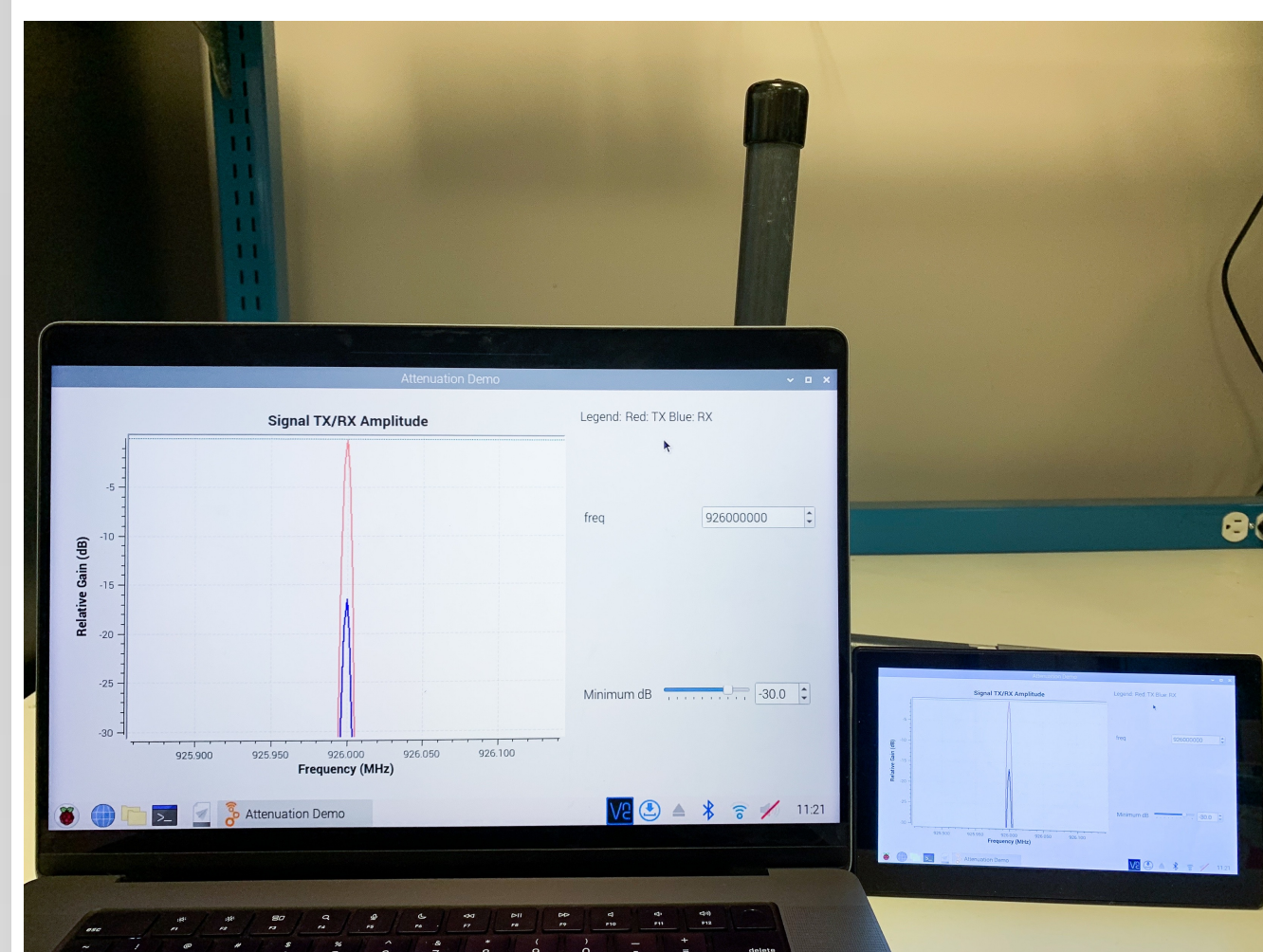
## Hardware Development

- The final developed module consists of:
  - ADALM-Pluto SDR (Transmits and receives signal)
  - Raspberry pi 4
  - All in one touch screen display
  - 20,000 mAh battery pack
  - 3D printed stand
- First Iteration:
  - A HackRF SDR transmits AM audio and an RTL-SDR receives the signal
  - During the first demonstration it was difficult to identify the received signal gain because the amplitude of the transmitted audio signals varied with time



## Software Development

- A virtual network computer (VNC) connection is used to allow for larger display for class demonstrations [4]. (pictured left)
- The Software driving the ADALM-Pluto SDR is GNU Radio (flowgraph pictured right)
  - The program transmits a tone at a user-defined frequency.
  - That signal is then received by the receiving antenna and the relative signal strength can be seen based on polarization, position, orientation, and frequency.



## Conclusion and Future Work

- This second iteration is a proof-of-concept hardware unit, minimizing software setup
- Immediate next steps for this project are to attempt to adapt the software setup to make it compatible with Windows and Mac operating systems.
- Future version would not need remote desktop software to access the Raspberry Pi and would run on the teaching laptop directly.
- This would eliminate the need for the Pi and battery, slimming the unit down to just the SDR and the pair of antennas.

## Acknowledgements

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## References

- [1] GNU Radio Wiki Editors, "Simulation example: AM transmitter and receiver - GNU Radio," GNU Radio. [https://wiki.gnuradio.org/index.php?title=Simulation example: AM transmitter and receiver](https://wiki.gnuradio.org/index.php?title=Simulation%20example%3A%20AM%20transmitter%20and%20receiver) (accessed Oct. 4, 2022).
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- [3] S. Katz, "Using GNU Radio Companion: Tutorial 3. Receiving AM Signals," publisher: California State University, Northridge. [Online]. Available: [http://www.csun.edu/~skatz/katzpage/sdr project/sdr/grc tutorial3.pdf](http://www.csun.edu/~skatz/katzpage/sdr%20project/sdr/grc%20tutorial3.pdf)
- [4] Gus, "Raspberry Pi Screen Sharing with TightVnc," PiMyLifeUp. <https://pimylifeup.com/raspberry-pi-screen-sharing/> (accessed Feb. 3, 2023).