Understanding and Communicating the Effects of RFI on Astronomy Data

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**INTRODUCTION:**

Arecibo Observatory (AO), a radio telescope located in Puerto Rico, conducts experiments probing at our deepest understanding of the universe. These experiments examine signals in the L-Band frequencies such as pulsar pulses and hydrogen ion (HI) transitions, which can provide insight into special and general relativity applications. However, man-made radio frequency interference (RFI) can adversely affect these signals and causes, otherwise useful results to be lost.

**MAIN GOAL:**

This study strives to make AO visitors aware of man-made RFI and its highly detrimental impact on the experiments performed by scientists.

- Understand the main RFI sources around AO and identify impacted experiments.
- Develop an user friendly installation to display typical man-made RFI and its negative effects on astronomical signals.

**BACKGROUND:**

Man-made RFI is comprised of a superposition of some combination of Long Narrow Band Oscillations and Impulse-like Bursts [1]. Some examples in the L-Band include:

- Global Positioning System (GPS) [174.42 | 1227.6 | 1381.05 | 1379.91 | 1176.45 MHz]
  - L1 and L2 bands most active.
  - Affects both pulsar and HI experiments.
  - AO sets up observation schedules to avoid GPS L2.
- Cellular (3G/4G/LTE) [700 - 900 | 1700 - 2300 MHz]
  - Frequencies vary by cell-phone provider (e.g. AT&T)
  - Affects ~1.7 GHz pulsar experiments.
  - Without Airplane mode enabled, cell phones constantly emit RFI.
- Local Active Radar (See map) [1210 - 1360 MHz]
  - Appear as pulses at their carrier frequency due to the rotation period of the dish (~12 sec).
  - Affect both pulsar and HI experiments.

**DESIGN & IMPLEMENTATION:**

**FRONT END**

A PCB shield with attached buttons provides an interface for visitors to interact with the installation. Information and data is displayed on a monitor.

**BACK END**

An Arduino handles user input through and communicates to the CPU through a serial connection. The CPU runs C++ code using openFrameworks (OFW) extended libraries. It uses previous generated synthetic data and shows various plots to convey information about RFI and its effects.

**CONCLUSION & FUTURE PLANS:**

This study allowed us to understand the main RFI sources affecting AO. An installation to show these problems has been successfully implemented.

Future work will focus on adding an antenna to the Arduino that can detect cellular data activity and provide confirmation when a visitor disables their phone. The OFW code used for this installation can be improved both in robustness and user experience. The displays can be tuned to best relay information to visitors and implore them to disable their device.

**REFERENCES**