

Operating Green Bank Observatory's 20 Meter Telescope with Ham Radio Students



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Introduction

NRAO's Exploring the Electromagnetic Spectrum - Ham Radio Project

This project is a comprehensive two-semester program organized by the National Radio Astronomy Observatory (NRAO), aimed at fostering diversity within the realm of amateur radio. This program engages two cohorts of young adults, totaling thirty participants, as they strive to attain their technician's and/or general class licenses. To successfully navigate the program, participants leverage an online platform for lessons, actively participate in weekly Zoom classes, benefit from presentations delivered by guest speakers and have opportunities for in-person trips such as to GBO and HamSci Workshops. Beyond the acquisition of technical skills, students also cultivate enduring connections with both their peers and mentors. Please see poster "Student Reflections of NRAO's Exploring the Electromagnetic Spectrum - Ham Radio Program" for further details.

GBO Site Visit & Beyond

As part of the 40-week Exploring the Electromagnetic Spectrum - Ham Radio program with the National Radio Astronomy Observatory, students had the opportunity to visit Green Bank Observatory (GBO) to apply their technical knowledge from the first semester and gain hands-on experience with activities related to the radio spectrum. Students were trained and used Skynet's GBO 20-meter radio telescope in Green Bank, West Virginia while at GBO and continued to observe remotely after the trip to understand operational parameters by conducting a comparative analysis of known pulsars.



Skynet Robotic Telescope Network

Funded primarily by the NSF since 2004, Skynet is an online network of robotic telescopes and telescope control software used for astronomy education and research projects. It allows students, educators, researchers, and hobbyists to remotely access large professional telescopes without having to travel. The Skynet Robotic Telescope Network spans four continents with around 20 telescopes. Over 40,000 students globally have accessed Skynet's research-grade equipment.

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References: "20m." Green Bank Observatory, 14 Feb. 2022, greenbankobservatory.org/about/telescopes/20m.; International Astronomical Union | IAU. www.iau.org/news/pressreleases/detail/iau1514.; https://public.nrao.edu/gallery/us-naval-observatory-at-green-bank/; Skynet: Home. skynet.unc.edu.

Observing Pulsars with the 20m

GBO's 20m Telescope

GBO's 20m radio telescope arrived at the observatory in Green Bank, West Virginia in 1995 and was originally funded by the US Naval Observatory. Though the USNO no longer uses the telescope, it continues to be used for education and research and is the only radio telescope in the Skynet system. It receives from 1.3-1.8 GHz and 8-10GHz at the prime focus.

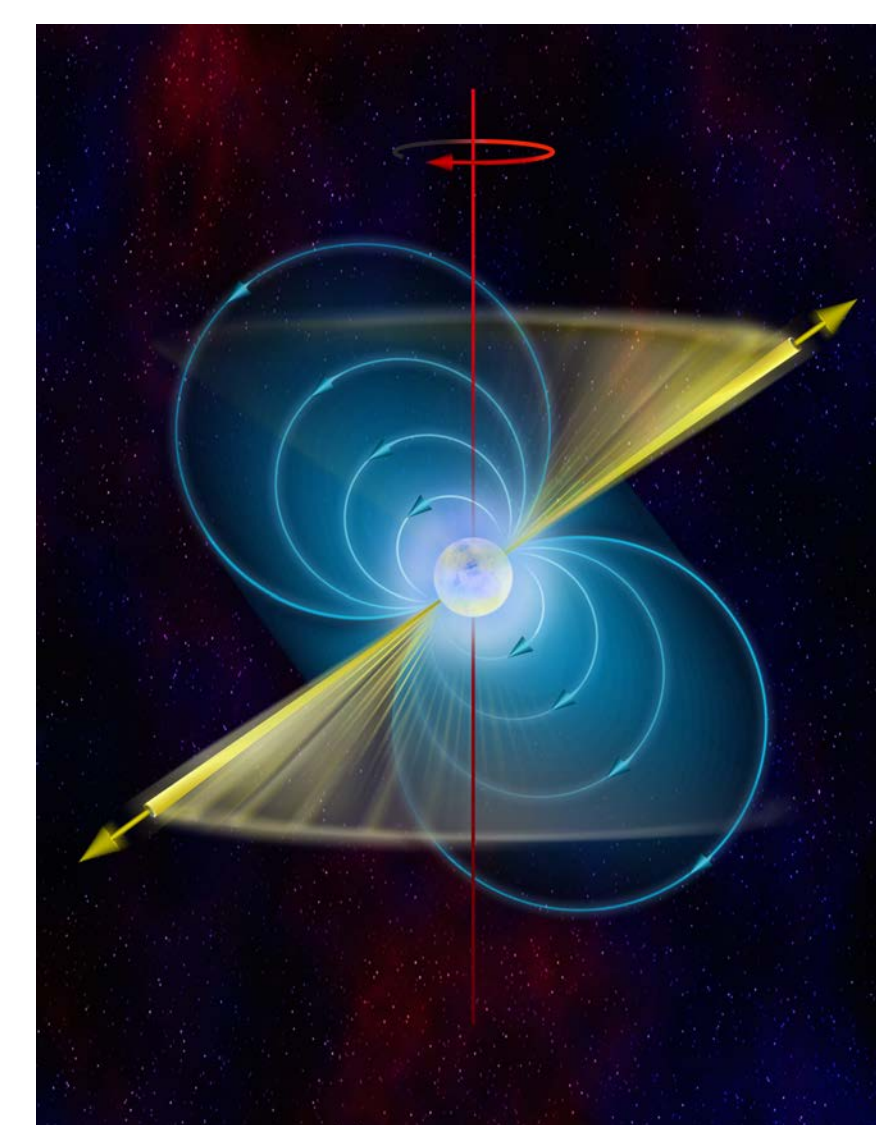


Credit: NRAO/AUI/NSF

Pulsars Observed

A pulsar is a rapidly rotating neutron star with strong magnetic fields that funnel beams of electromagnetic radiation out along two magnetic poles at regular intervals ranging from milliseconds to seconds.

PSR B1919+21 "Little Green Man" First pulsar ever discovered	PSR B0531+21 "Crab Pulsar" Bright pulsar in Crab Nebula
PSR B1937+21 First discovered pulsar with a millisecond period	PSR B1257+12 "Lich" Pulsar with transiting exoplanet



Credit: B. Saxton, NRAO/AUI/NSF

GOAL: to gain intuition about the impact of parameter values on our data

Parameters Kept Constant per Pulsar

- **Right Ascension and Declination:** The coordinates of the pulsar; where the telescope is aiming (different for each pulsar)
- **Minimum Sun Separation and Target Elevation:** The distance the pulsar must be from the sun and the horizon for the telescope to observe it (10° sun separation, 20° target elevation)
- **Receiver Data Acquisition Mode:** The resolution of the observation (low resolution mode)
- **Pulsar Mode:** Specific mode for observing pulsars
- **Path Type:** Different ways the telescope can observe the target (track mode: follows the target across the sky)
- **Repeat:** the amount of times the observation is repeated (zero)

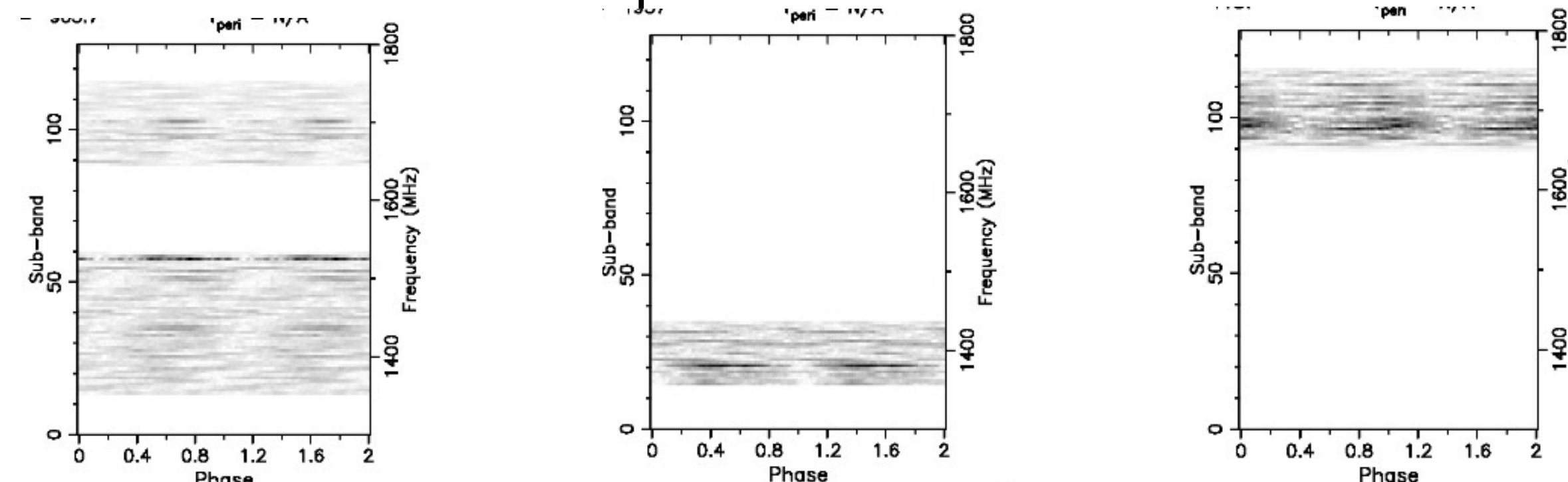
Observation Results

Parameter Varied: Filter

Changing the filter to smaller frequency ranges typically generated a less uniform pulse. This is expected, as much of the bandwidth has been removed with the smaller ranges.

Phase Graphs for PSR B1937+21

Pulsar has period of 0.0016s



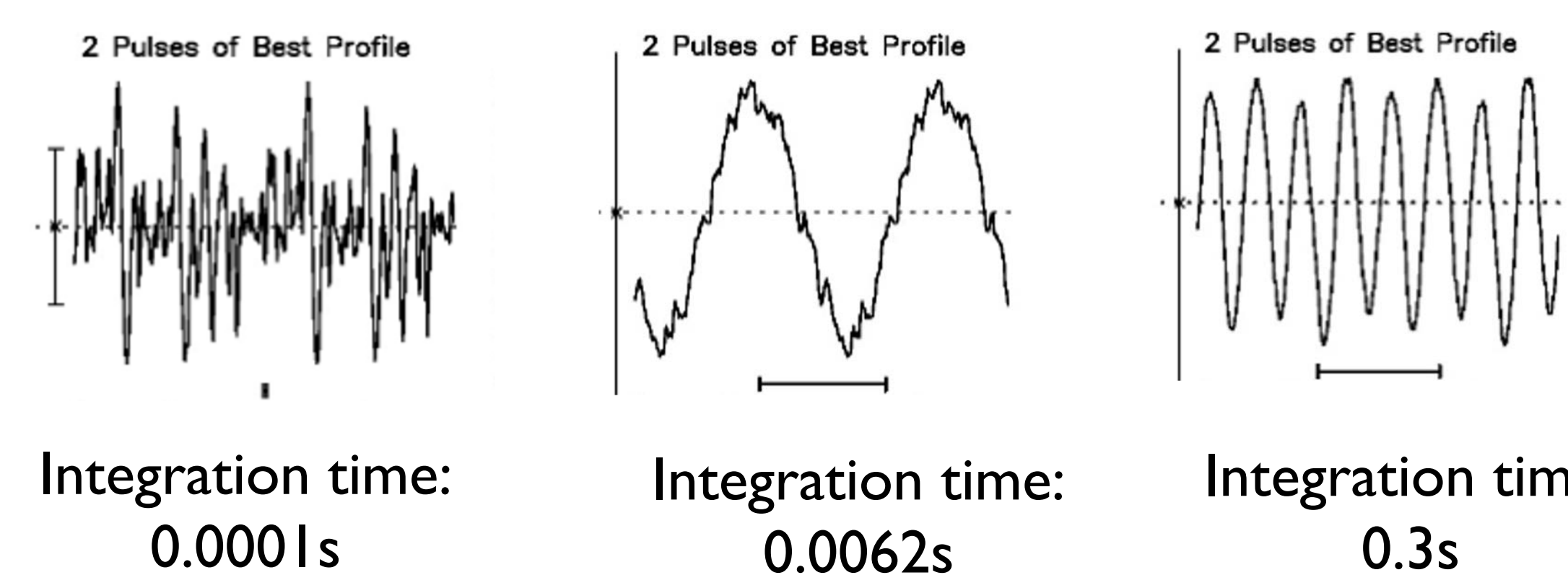
Filter: All (1345-1750 MHz) Filter: HI (1355-1435 MHz) Filter: OH2 (1650-1750 MHz)

Parameter Varied: Integration Time

In general, integration time is the amount of time used to divide the total observing time into data that will be "stacked" to create our final image. An integration time much longer than the pulsar's period generally resulted in seeing more pulses, while an integration time much shorter than the pulsar's period could result in not seeing a pulse at all and only getting noise.

Pulse Profiles for PSR B1257+12

Pulsar has period of 0.0062s

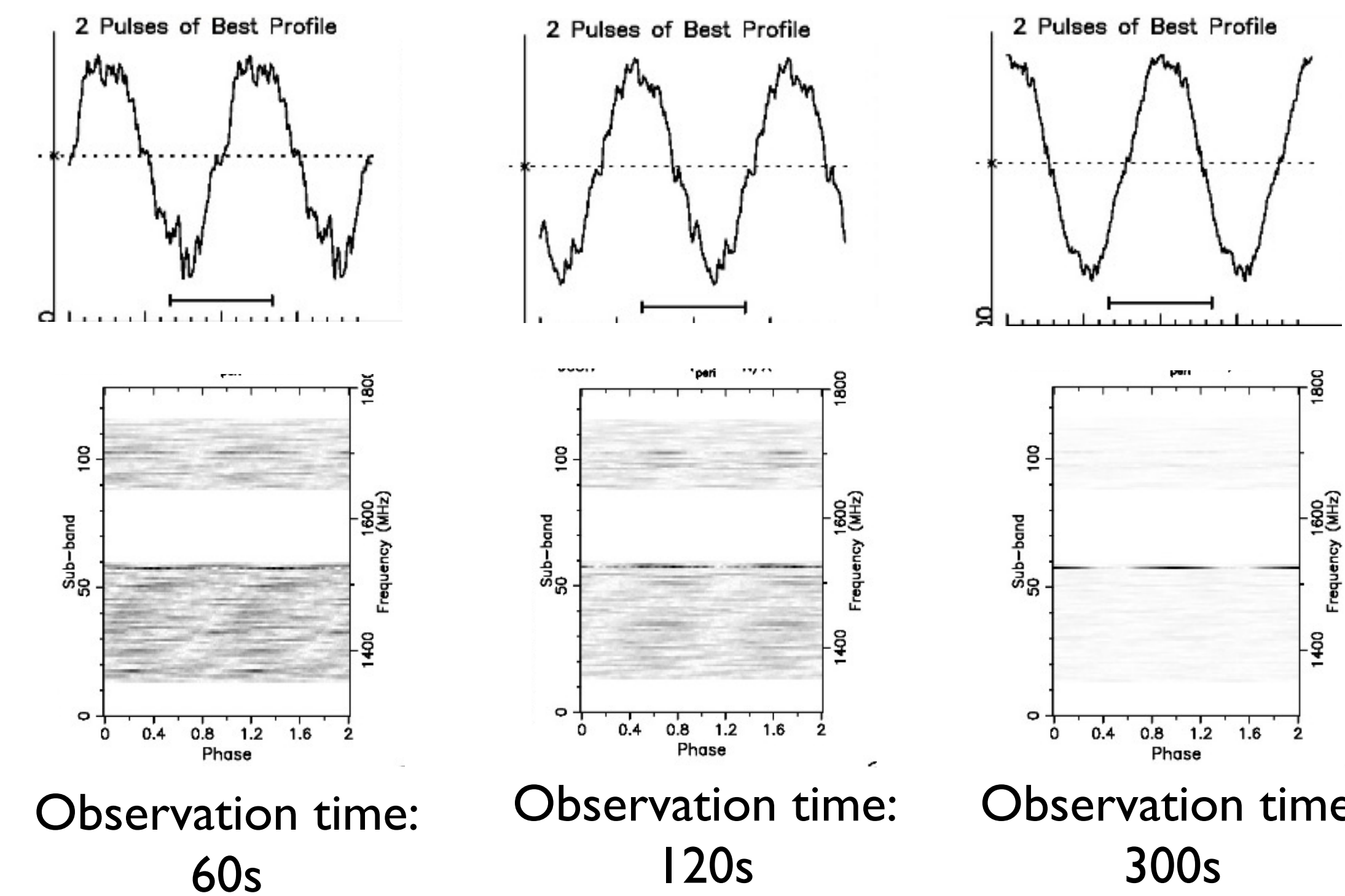


Parameter Varied: Observation Time

Longer observation times seemed to result in less noise than shorter observations. Generally, the number of pulses observed with different observation time stayed the same, but with longer observation time, the pulses were clearer.

Phase Graphs for PSR B1257+12

Pulsar has period of 0.0062s



Summary

By the end of the program, students that have participated fully have gained: Technician class license, General class license, EMS knowledge, On-air experience, Hands-on building experience, GBO visit, HamSci Workshop exp.

➤ The parameter with the greatest impact on our pulsar data was integration time.

Mia B. - "I have loved...getting the chance to learn and use some technical skills like circuit building and Skynet's telescope operation that I haven't gotten to learn or use much in my life"

"When I first started HAM Radio I was unaware of the wide range of areas of applications. Since being apart I have thoroughly enjoyed applying ham radio concepts to my everyday life." – Alia W.

Xander W-S. - "I ended up getting rather immersed in the world of Ham Radio and I got a great refresher of the basics of the electromagnetic spectrum from a perspective that I had never considered before."