

Article

Radio Frequency Interference Measurements to Determine the New Frequency Sub-Bands of the Coaxial L-P Cryogenic Receiver of the Sardinia Radio Telescope

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Abstract: Radio frequency interference (RFI) represents all unwanted signals detected by radio receivers of a telescope. Unfortunately, the presence of RFI is significantly increasing with the technological development of wireless systems around the world. For this reason, RFI measurement campaigns are periodically necessary to map the RFI scenario around a telescope. The Sardinia Radio Telescope (SRT) is an Italian instrument that was designed to operate in a wide frequency band between 300 MHz and 116 GHz. One of the receivers of the telescope is a coaxial cryogenic receiver that covered a portion of the P and L bands (i.e., 305–410 MHz and 1300–1800 MHz) in its original version. Although the receiver was used for years to observe bright sources with sufficient results, its sub-bands can be redesigned considering the most recently evolved RFI scenario. In this paper, the results of a RFI measurement campaign are reported and discussed. On the basis of these results, the new sub-bands of the L-P receiver, together with the design of the new microwave filter selector block of the SRT receiver, are presented. In this way, SRT will cover up to 120 MHz and 460 MHz of -3 dB bandwidth at the P-band (290–410 MHz) and L-band (1320–1780 MHz), respectively. The bands of these filters are selected to reject the main RFI with high levels of amplitude and optimize the estimated antenna temperature and sensitivity of the receiver during the research activities, such as pulsar observations, very long baseline interferometer applications and spectroscopy science.

Keywords: radio telescope; radio frequency interference (RFI); cryogenic radio receivers; ultra-high frequency (UHF); L-band; P-band



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1. Introduction

Radio frequency interference (RFI) consists of unwanted human-made signals detected by a receiver (i.e., radio telescope), such as self-produced spurious signals and harmonics from lower frequency bands, and spread-spectrum signals generated by devices installed in the surrounding area or on space-to-ground transmissions [1]. Currently, the presence of RFI is increasing because of the extensive abuse of wireless technologies around the world [2]. Although the International Telecommunication Union (ITU) assigned several specific frequency bands to the radio astronomy service (RAS) [3], the radio receivers for telescopes are designed and developed with the widest bandwidth as much as possible. In this manner, astronomers can analyze a larger amount of data at several frequencies with respect to the narrow bands dedicated to the RAS. In the receiver design stage, or more generally in a radio telescope development, a trade-off needs to be found in order to have a wide bandwidth with the least number of unwanted signals [4–7].

The unavoidable presence of RFI in the telescope frequency bands increases the estimated antenna temperature, leading to a degradation in the sensitivity of the system. Consequently, the monitoring and mitigation of RFI represents one of the most important aspects to consider for the optimal functioning of a radio telescope. With regards to the monitoring operations, dedicated measurement campaigns are periodically necessary [7–9].

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Table of Contents Radio Frequency Interference Publication No 34 Of The Radio Amateurs Library

1. Understanding the eBook Radio Frequency Interference Publication No 34 Of The Radio Amateurs Library
 - The Rise of Digital Reading Radio Frequency Interference Publication No 34 Of The Radio Amateurs Library
 - Advantages of eBooks Over Traditional Books
2. Identifying Radio Frequency Interference Publication No 34 Of The Radio Amateurs Library
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Radio Frequency Interference Publication No 34 Of The Radio Amateurs Library
 - User-Friendly Interface
4. Exploring eBook Recommendations from Radio Frequency Interference Publication No 34 Of The Radio Amateurs Library
 - Personalized Recommendations

Radio Frequency Interference Publication No 34 Of The Radio Amateurs Library

- Radio Frequency Interference Publication No 34 Of The Radio Amateurs Library User Reviews and Ratings
- Radio Frequency Interference Publication No 34 Of The Radio Amateurs Library and Bestseller Lists
- 5. Accessing Radio Frequency Interference Publication No 34 Of The Radio Amateurs Library Free and Paid eBooks
 - Radio Frequency Interference Publication No 34 Of The Radio Amateurs Library Public Domain eBooks
 - Radio Frequency Interference Publication No 34 Of The Radio Amateurs Library eBook Subscription Services
 - Radio Frequency Interference Publication No 34 Of The Radio Amateurs Library Budget-Friendly Options
- 6. Navigating Radio Frequency Interference Publication No 34 Of The Radio Amateurs Library eBook Formats
 - ePub, PDF, MOBI, and More
 - Radio Frequency Interference Publication No 34 Of The Radio Amateurs Library Compatibility with Devices
 - Radio Frequency Interference Publication No 34 Of The Radio Amateurs Library Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Radio Frequency Interference Publication No 34 Of The Radio Amateurs Library
 - Highlighting and Note-Taking Radio Frequency Interference Publication No 34 Of The Radio Amateurs Library
 - Interactive Elements Radio Frequency Interference Publication No 34 Of The Radio Amateurs Library
- 8. Staying Engaged with Radio Frequency Interference Publication No 34 Of The Radio Amateurs Library
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Radio Frequency Interference Publication No 34 Of The Radio Amateurs Library
- 9. Balancing eBooks and Physical Books Radio Frequency Interference Publication No 34 Of The Radio Amateurs Library
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Radio Frequency Interference Publication No 34 Of The Radio Amateurs Library
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Radio Frequency Interference Publication No 34 Of The Radio Amateurs Library
 - Setting Reading Goals Radio Frequency Interference Publication No 34 Of The Radio Amateurs Library

- Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Radio Frequency Interference Publication No 34 Of The Radio Amateurs Library
 - Fact-Checking eBook Content of Radio Frequency Interference Publication No 34 Of The Radio Amateurs Library
 - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
- 14. Embracing eBook Trends
 - Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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