PROCEEDINGS OF SCIENCE

The Argentine Institute of Radio Astronomy and its Observatory: Present and Future

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The Argentine Institute of Radio Astronomy (IAR) has been a cornerstone of Argentine radio astronomy since its inception in 1962. Located in the Province of Buenos Aires and supported by CONICET (Consejo Nacional de Investigaciones Científicas y Técnicas), CICPBA (Comisión de Investigaciones Científicas), and the National University of La Plata, the IAR is home to two 30-meter radio telescopes. These telescopes are now focused on studying cosmic phenomena such as pulsars, transient objects, and blazars. Beyond astronomy, the IAR contributes to interdisciplinary projects, including satellite and industrial applications.

The IAR has also been instrumental in managing and mitigating radio frequency interference (RFI), working with Argentine regulators to protect frequency bands for scientific research. The Institute's efforts include RFI measurement campaigns to identify and mitigate sources of interference. Internationally, the IAR participates in the development of filtering methods and monitoring protocols to ensure data integrity, supporting projects such as the Pulsar Monitoring Array (PuMA) and Fast Radio Burst (FRB) monitoring.

Recent technological advances, including RFoF systems and CASPER-based back-end processors, enable the IAR to handle larger bandwidths and maintain data quality in an increasingly noisy RF environment.

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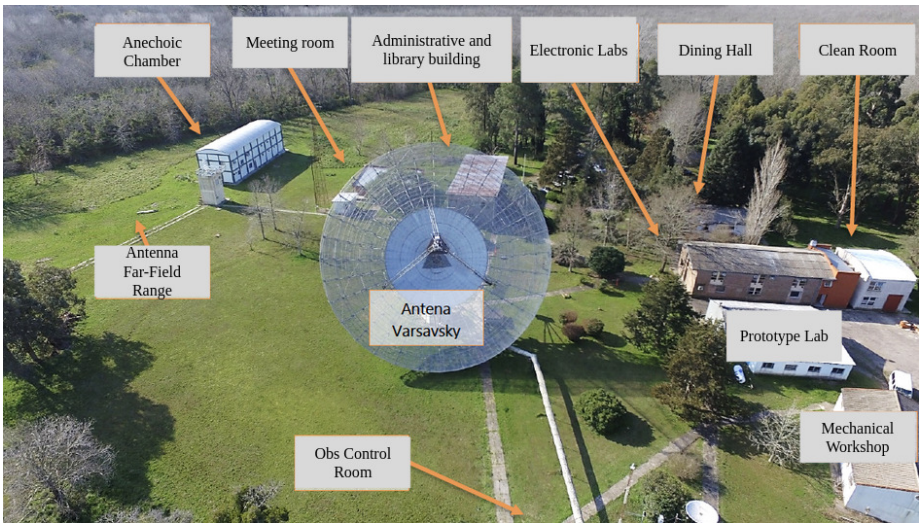

Figure 1: IAR facilities Overview.

1. Introduction

The Argentine Institute of Radio Astronomy (IAR) was founded in 1962. Located in the Province of Buenos Aires, it operates under the auspices of CONICET, CICPBA and the National University of La Plata. With its technological facilities and innovative research, the IAR plays a central role in the development of radio astronomy and contributes significantly to astronomical research in Argentina 1.

Since the 1990s, the IAR has been instrumental in managing and mitigating radio frequency interference (RFI). Its collaboration with Argentina's communications authorities, including CNC, AFTIC, and now ENACOM, has supported frequency regulation for scientific use, protecting radio astronomy observations. This partnership has enabled several RFI measurement campaigns, notably with the Argentine-German Geodetic Observatory (AGGO), to identify RFI sources affecting geodetic and astronomical data.

Recent advances in RFI management at the IAR include the implementation of RFoF systems to reduce noise and interference in signal transmission, as well as the deployment of new back-end systems, such as CASPER cards[1], which have enabled more efficient data handling with bandwidths up to 400 MHz. These technologies ensure that the Institute can continue its radio astronomy research despite the challenges of the modern RF environment.

As radio astronomy continues to evolve, the IAR remains committed to advancing its technological capabilities and strengthening its efforts in RFI management. Future projects include a Multi-Purpose Interferometric Array (MIA project) that will enhance the IAR's ability to study non-thermal radiation and transient radio sources. This array will consist of several 5-meter antennas operating in the 1-2 GHz range and will further benefit from the Institute's experience in RFI mitigation.

The IAR is also home to several specialized research groups, including the Relativistic Astrophysics and Radio Astronomy Group (Garra), the X-ray Astrophysics Group (Garx), and the Pulsar Monitoring in Argentina Group (PuMA).

2. Technical Infrastructure and Scientific Contributions

2.1 Radio Telescopes

The IAR's two 30-meter radio telescopes, named for Dr. Carlos Varsavsky and Dr. Carlos Bajaja, are the Institute's primary instruments. Fully upgraded for advanced research on transient objects, each telescope features ambient temperature LNAs operating below 85 K and supports dual polarization in L-band for high-sensitivity observations from 1.2 to 1.6 GHz, essential for studying the 21 cm hydrogen line.

The observatory, which can be operated with an automated observing scheduler for remote operation, enables autonomous 24-hour data collection over a north-south range of -90 to -9 degrees. It collects up to 2.2 terabytes of data daily, with local storage for immediate processing and long-term storage at Rochester Institute of Technology for pulsar timing studies.[3].

The observatory also supports research on pulsars, magnetars, fast radio bursts (FRBs), and blazars, providing data that refine models of pulsar emissions and transient behavior.

2.2 PathFinder - Multipurpose Interferometric Array (P-MIA)

The PathFinder Multipurpose Interferometric Array (P-MIA) represents the next step in IAR's instrument development. Designed as a modular low-frequency interferometer, PathFinder consists of three 5-meter antennas arranged in a 141-meter baseline, providing an angular resolution of approximately 0.2 degrees. Operating between 1 and 2 GHz with a receiver temperature of 45 Kelvin, the primary purpose of the PathFinder is to serve as a teaching tool for engineering and science education, providing hands-on experience in interferometry and radio astronomy technology.

A key feature of the PathFinder is its use of analog radio frequency (RF) signal transmission over fiber optics, followed by central correlation. This design allows data acquisition over a wide bandwidth from 250 MHz to 1000 MHz. The PathFinder array is currently in the integration phase, but is envisioned as the basis for a larger instrument, the MIA 16/32, which could be deployed in remote areas of Argentina for large-scale interferometric studies of the non-thermal universe[4].

3. Radio Frequency Interference (RFI) Management and Mitigation

3.1 Early Challenges and Strategies

The growth of telecommunications infrastructure in Argentina has posed significant challenges to radio astronomy observations, particularly at the IAR. Beginning in the 1990s, the Institute experienced increasing levels of radio interference, particularly from local FM radio stations and radar systems at the nearby Ezeiza airport. These early sources of interference were problematic because they fell within the frequency range of the radio telescopes' intermediate frequency (IF) signal chain, pand, at 1419 MHz.

In response, IAR engineers developed a series of filters to block specific RFI sources, including bandpass and notch filters tuned to avoid interference at both the RF and IF levels. These efforts were largely successful in mitigating the most egregious sources of RFI, although the increasing complexity of the radio environment required further innovation.

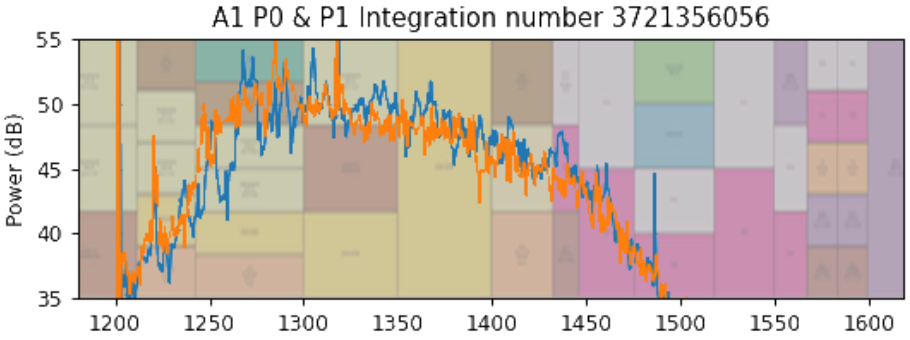

Figure 2: Example of spectrum measurement next to spectrum allocation chart to identify sources of interference to observing data.

3.2 RFI Monitoring Campaigns

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In addition to real-time mitigation, IAR researchers have implemented post-processing software for RFI removal, including the PRESTO[6] and RFIClean[7] packages, which are particularly useful for pulsar observations. In the future, the IAR plans to create a comprehensive RFI database to store data on the presence and characteristics of RFI over time 2. With the integration of RFSoC boards for real-time spectrum analysis, this database will be analyzed using machine learning algorithms to identify patterns and improve future mitigation strategies.

4. Conclusions

The Argentine Institute of Radio Astronomy has established itself as a key institution in Argentine radio astronomy. With upgraded telescopes, innovative RFI mitigation strategies, and forward-looking projects such as the MIA instrument, the Institute continues to advance scientific discovery. With its commitment to RFI management to protect the quality of astronomical observations, the forthcoming integration of machine learning techniques, and the development of new instruments, the IAR is well positioned to contribute significantly to the next generation of radio astronomy research in Argentina.

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