Multi-Static HF Radar System in Peru.

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Introduction

A small network of HF Beacon transmitter and receivers has been deployed in Peru for specifying the F region ionosphere in the sector. The effort is motivated by ionospheric disturbances associated with Equatorial Spread F (ESF) and specifically disturbances arising under inauspicious conditions for ESF.
The beacons operate at dual frequency (2.72 and 3.64 MHz). Using the information collected at the different stations, and applying a refraction tomography technique, we can invert a 3D plasma density distribution of the bottom part of the ionosphere in the central part of Peru, measurements that are important to understand the origin and evolution of the plasma irregularities. Other observable are power, Doppler shift, and polarization.

Hardware

The hardware for the beacon transmitters and receivers is based on integrated software defined transceivers. The transceivers combine two 100MS/s, 14-bit ADCs and a 400 MS/s, 16-bit DAC in a single, compact package. They utilize GPS-disciplined oscillators for absolute time synchronization. Throughput is as high as 25 MSPS of complex baseband signal.

A) Transmitting Hardware

A beacon transmitter station consists of two transceivers connected to separate inverted V dipole antennas through amplifier chains producing approximately 4 W of continuos wave power each. The transmitting antennas are parallel to one another and aligned north-west to south-east. We use two transmitters to generate two HF frequencies at 2.72 and 3.64 Mhz.
The transmitted waveform is a unique pseudo random binary phase(PRN) code with a baud length of 10us. and a repetition time of 100 ms. The code is transmitted continuously and affords comprension ratios up to a factor of 10,000

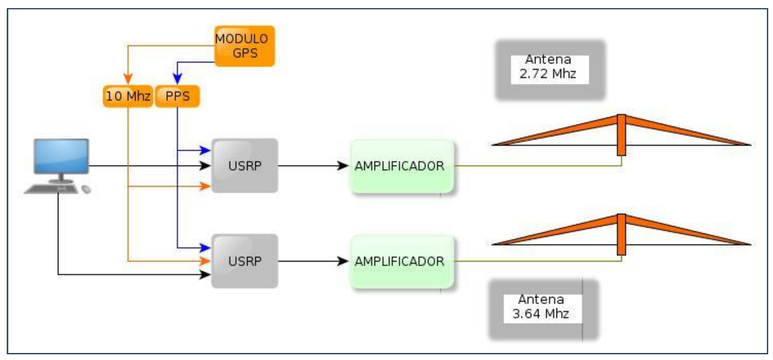

Fig. 1. Transmitter System Block Diagram

The Block diagram, shows the components of the station transmitter. Band pass filters are included in the Pre-amplifier stage. The software-defined radio generates the analog signals for transmission.

B) Receiving Hardware

For the receiving stations, a single transceiver capable of receiving two frequencies is conected to a pair of short, wideban dipole antennas through chains of low-noise amplifiers. The receiving antennas are aligned nowthwest to southeast.
Reception is perfomed continuously at a rate of 1 MS/s. Decimation reduces the effective sample rate to 100 kS/s, giving a range resolution of 1.5 km. Estimates of the sample voltages in each range gate are formed every 100 ms.

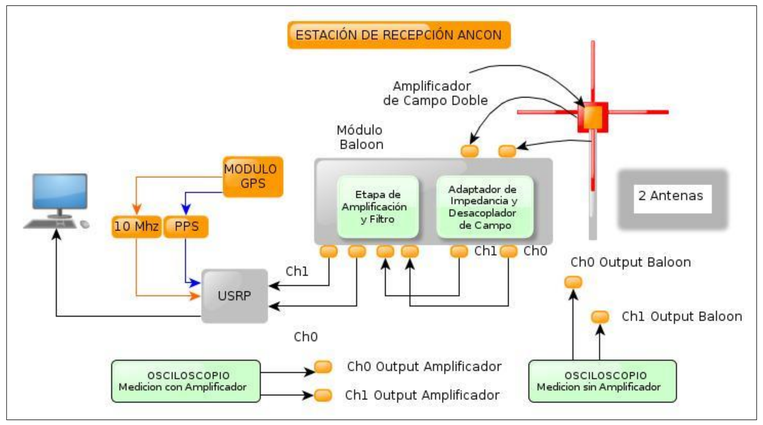

Fig. 2. Receiver System Block Diagram

The Block diagram, shows the components of the station receiver. Band pass filters are included in the Preamplifier stage. The software-defined radio digitize the analog signals in order to be processed.

Location

Currently, one transmitting station in Ancon (11°46’37”S, 77°09’1”W, 51masl), one receiving station at Jicamarca with dual receivers (11°57’5.8”S, 76°52’27”W, 510 masl), and one receiving station in Huancayo (12°02’30”S, 75°16 19’15”W, 3315 masl), Peru. The extra receiver at Jicamarca uses antennas aligned northeast to south-west, i.e., orthogonal to the other antennas. This makes it possible to measure the bearing and polarization of the incoming signal.

Fig. 3.Distance between station Tx and Rx

Results

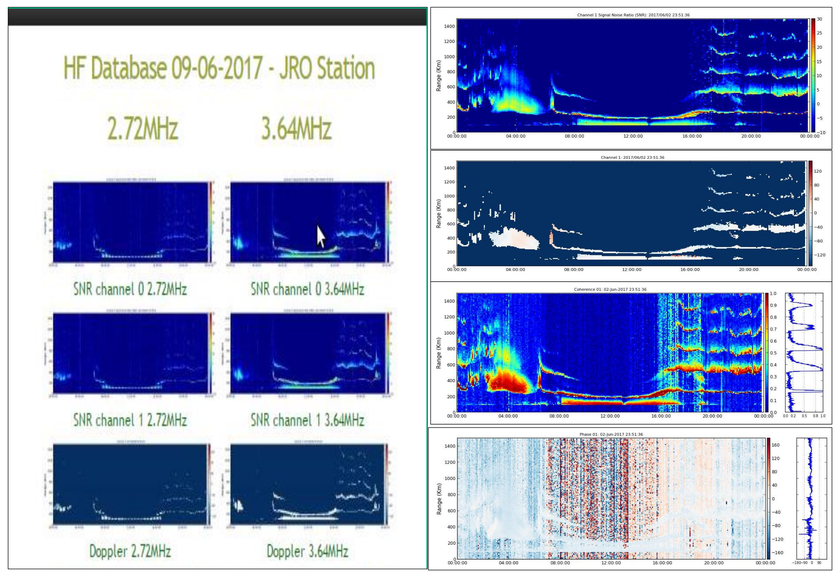

Fig. 4. Database

The primary results are focus on show the graphics of SNR Ch0, SNR Ch1, Doppler, coherence, and phase. The database is a group of image organized by the place of installation , polarization, year, month and day.
Actually, We have two station at Jicamarca Radio Observatory and Huancayo Observatory both with two polarization.
(*http://jro-app.igp.gob.pe/hfdatabase/webhf/web_signalchain/rawdata_test_new/#*).

Future Work

First, the number of station can be increased. For any given number of stations, the number of links is maximized when the stations are equally divided between transmitters and receivers and grows as the square of the number of stations. The number of links is doubled again if every station can transmit and receive simultaneously. This mode should be possible given the low transmit power levels and the high dynamic range of the digital receivers.
For this year we are planning to have :
2 Transmitting Station(Ancón Observatory, Huancayo Observatory)
4 Receiving Station(JRO, Huancayo Observatory, Ica)

Acknowledgments

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References

[1]A multistatic HF beacon network for ionospheric specification in the Peruvian sector.