MIT Haystack Observatory -Program Research

USRP implementation of multi static meteor radar transmit and receive applications

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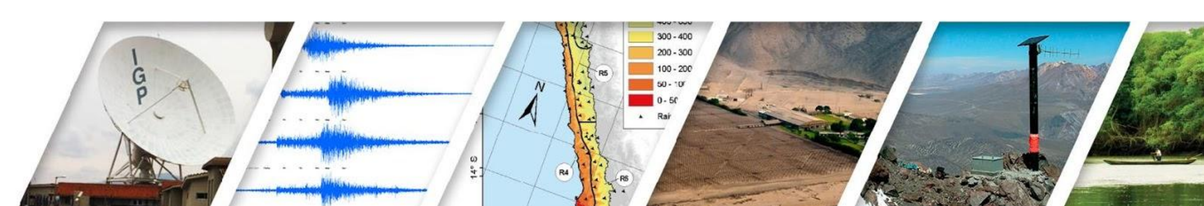
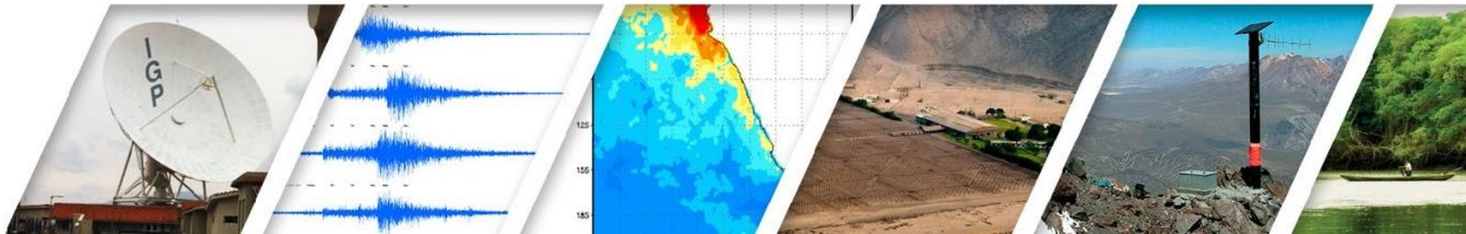
July 22 2019



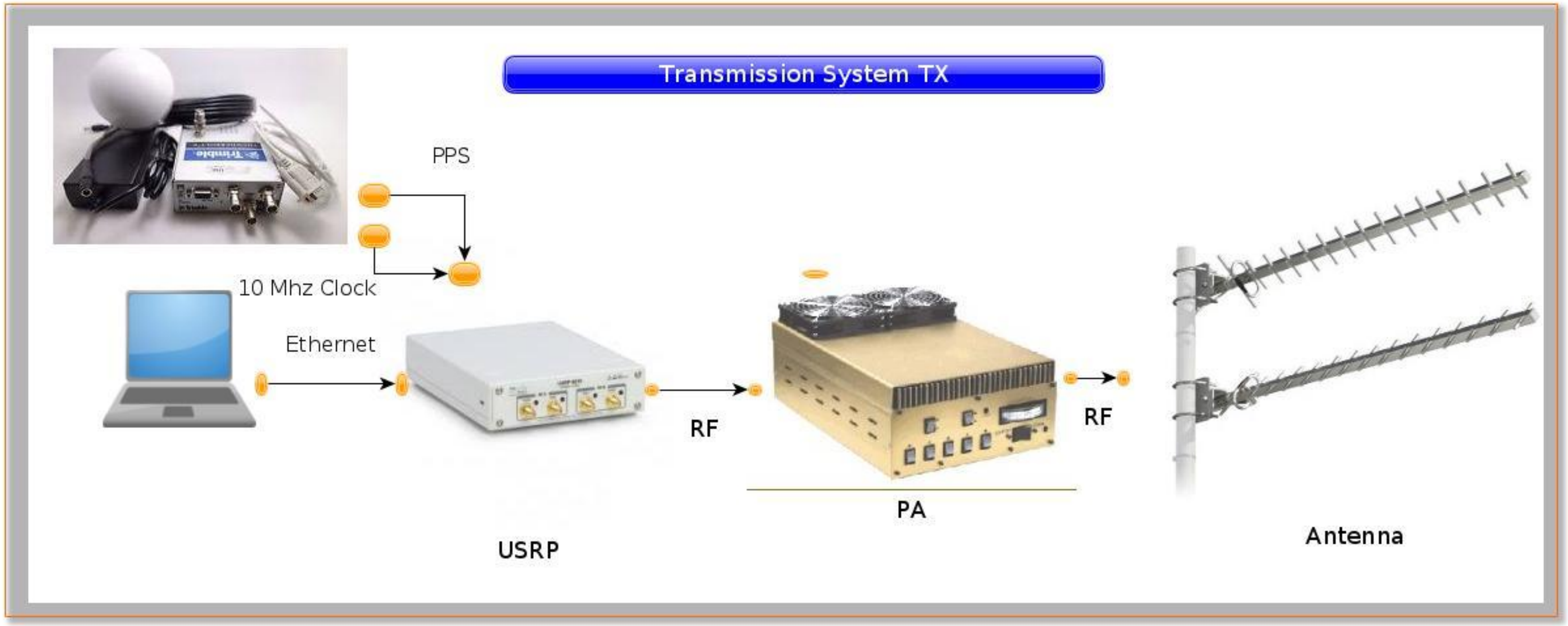
OUTLINE

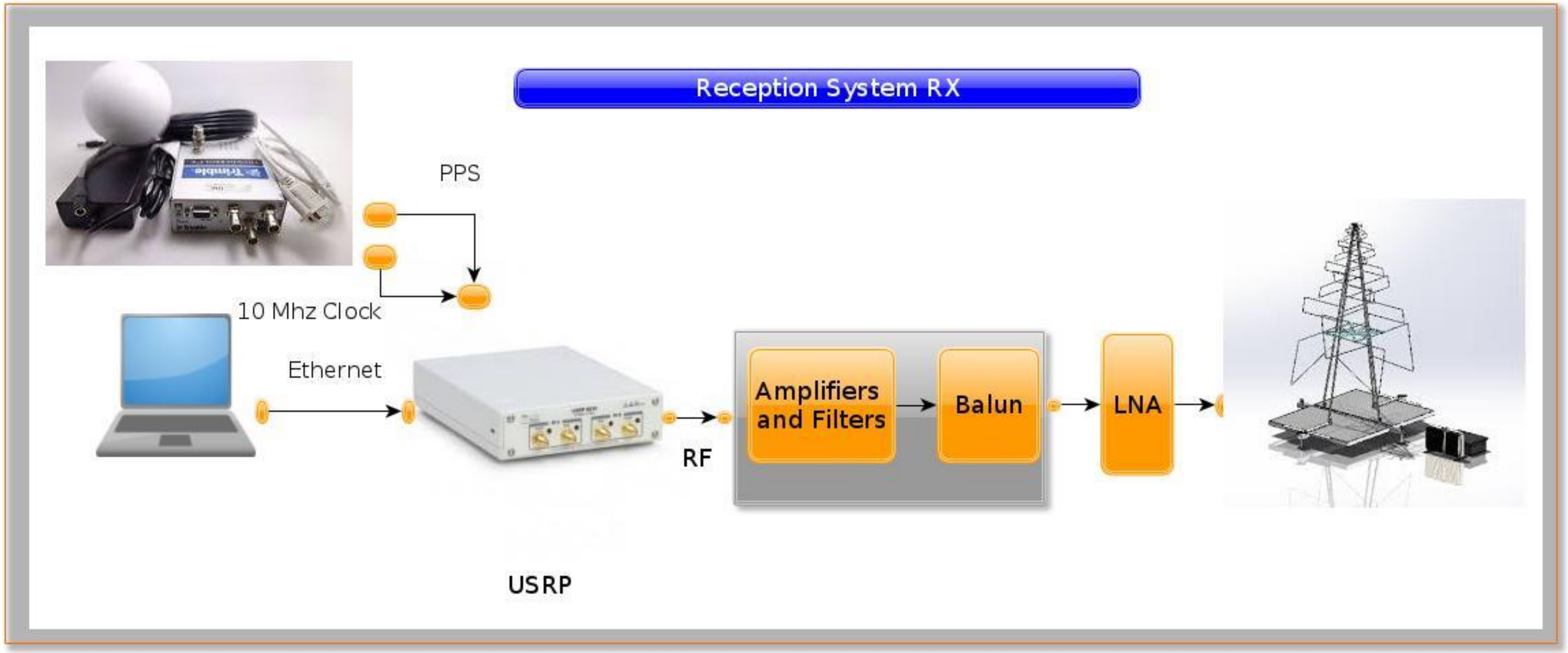
- Implementation of Multistatic Radar for Meteor Detection
- Documentation.
- Starting
- Hardware and Software available.
- Acquisition
- Transmission
- Analyze



Implementation of Multistatic RadarMeteor Detection

- MIMO
- MISO
- **SIMO**
- SISO





Starting

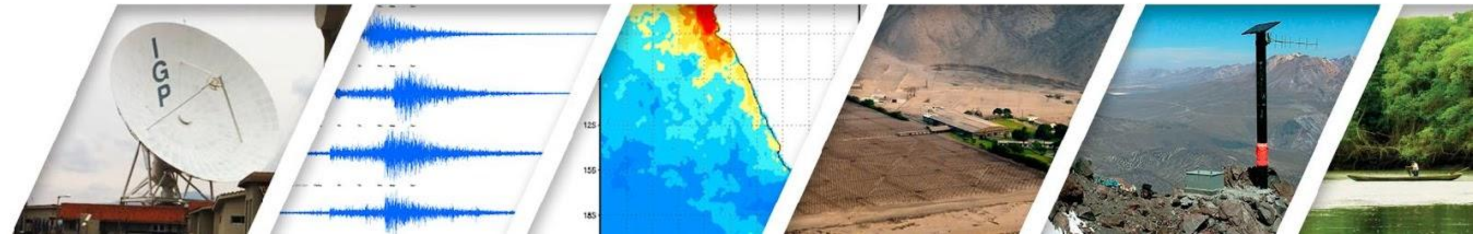
- Coded continuous wave meteor radar
  Juha Vierinen 1 , Jorge L. Chau 2 , Nico Pfeffer 2 , Matthias Clahsen 2 , and Gunter Stober 2
  1 MIT Haystack Observatory, Route 40 Westford, 01469 MA, USA
  2 IAP,Kühlungsborn, Germany

- Novel specular meteor radar systems using coherent MIMO techniques to study the mesosphere and lower thermosphere
  Jorge Luis Chau 1 , Juan Miguel Urco 1 , Juha Pekka Vierinen 2 , Ryan Andrew Volz 3 , Matthias Clahsen 1 , Nico Pfeffer 1 , and Jörg Trautner 1
  1 Leibniz Institute of Atmospheric Physics at the University of Rostock,Germany
  2 UiT Arctic University of Norway, Norway
  3 MIT Haystack Observatory, USA

- Radio Array of Portable Interferometric Detectors(RAPID) : Design and Applications
  Frank D. Lind, Colin J. Lonsdale, Ryan Volz, Anthea Coster, Chris Eckert, Russ McWhirter, Jim Marchese, Robert Schaefer, William Rideout, Reggie Wilcox
  Haystack Observatory- Massachusetts Institute of Technology

- Digital RF 2.0
  Juha Vierinen, William Rideout, Frank Lind, Robert Schaefer

- A multistatic HF beacon network for ionospheric specification in the Peruvian sector
  D. L. Hysell M. A. Milla J. Vierinen



Starting

- Hardware available:
  - USR N310
  - URSP N200 + BASIC RX
  - USRP N200 + UBXN40

- Software available
  - Gnuradio
  - Uhd
  - Digital_rf
    - https://github.com/MITHaystack/digital_rf
    - Programs: thor.py , tx.py , prc_analyce.py, drf_plot.py and create_waveform.py

ACQUISITION

THOR.py

gnuradio-config-info -v
3.7.13.4

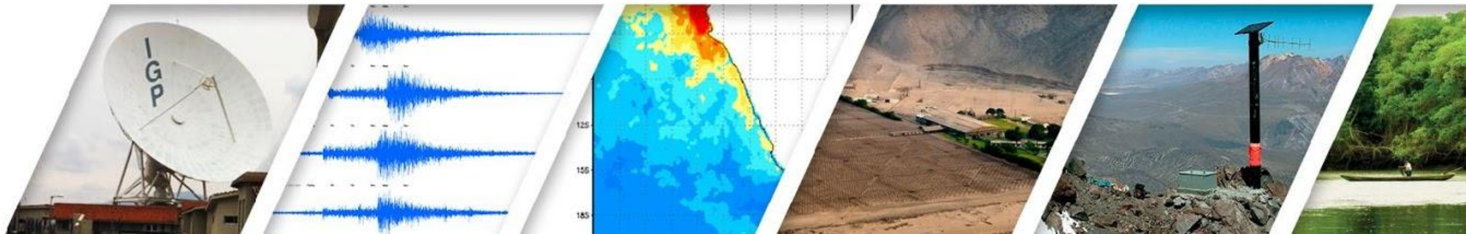
uhd_config_info --v
UHD
3.14.0.HEAD-0-g6875d061

Sistema Operativo
LSB Version: core-9.20170808ubuntu1-noarch:security-9.20170808ubuntu1-noarch
Distributor ID: Ubuntu
Description: Ubuntu 16.04 LTS
Release: 16.04
Codename: xenial

Ubicacion:
/home/alex/HaystackOP/

-m 192.168.10.2 -d "A:0" -c ch1 -y "TX/RX" -f 20e6 -F 10e3 -g 20 -b 0 -r 1e6 /data/test

ARGUMENTOS DE ENTRADA		ESCRITURA EN METADATA
-m	MBOARD	sequence_num
-d	subdev	num_subchannels
-c	CH	sample_rate_numerator
-f	Frequency	samples_rate_denominator
-F	OFFSET	init_utc_timestamp
-g	Gain	computer_time
-b	Bandwidth	
-r	rate	
DIR	Path	



TRANSMISION

tx.py

gnuradio-config-info -v
3.7.11

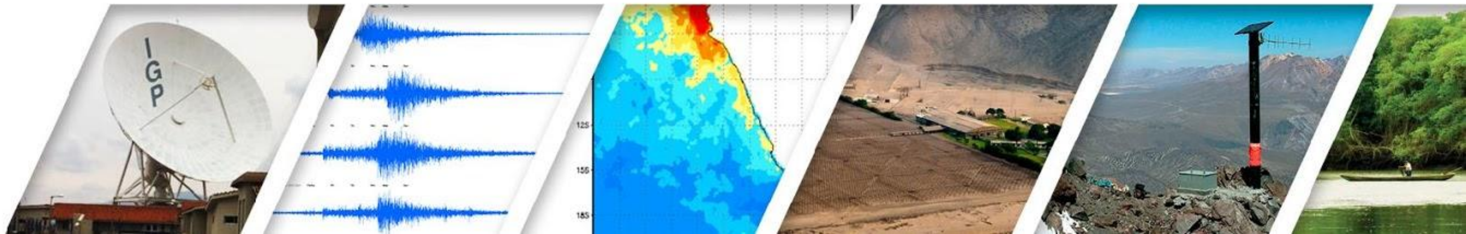
uhd_config_info --v
UHD
3.14.0.0-269-g11bbc3c0

Sistema Operativo
LSB Version: core-9.20170808ubuntu1-noarch:security-9.20170808ubuntu1-noarch
Distributor ID: Ubuntu
Description: Ubuntu 18.04.1 LTS
Release: 18.04
Codename: bionic

Ubicacion:
/home/soporte/GNURADIO_TX/uhd/host/examples/python/

python tx.py -m 172.16.5.189 -r 1e6 -f 25.0e6 -d "A:0" -y "TX/RX" -G 1 -g 33 -b 40e6 -l 1 --starttime 2019-07-10T13:05:00Z --duration 240 --sync_source "external" /home/alex//sounder/waveforms/code-l10000-b10-000000.bin

ARGUMENTOS DE ENTRADA	
-m	
-f	freq
-r	rate
-d	subdev
-c	channels
-g	gain
--sync	external
-l	duration
-File	File



ANALYZE

prc_analyze.py

- create_pseudo_random_code(clen=10000, seed=0)
- periodic_convolution_matrix(envelope, rmin=0, rmax=100)
- create_estimation_matrix

Nranges Number of code(code, rmin=0, rmax=1000, cache=True):

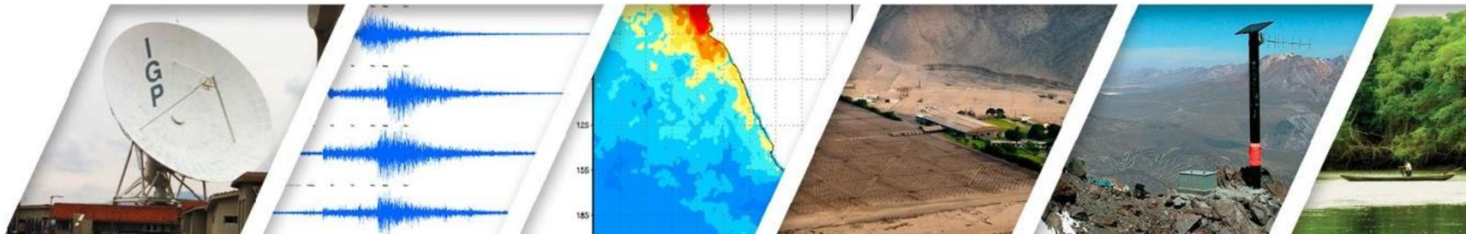
res= (1000,10000)* z

Z= Data of our hdf5 file. (10000)

We get **res(100,1000), and finally ---> After fft----> SPEC**

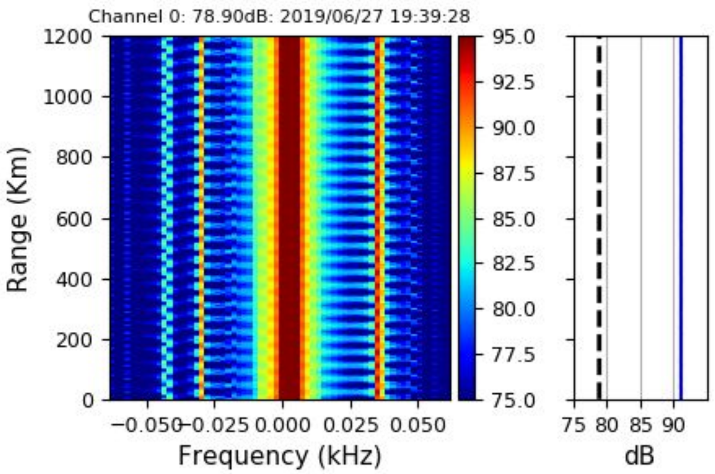
100 profiles

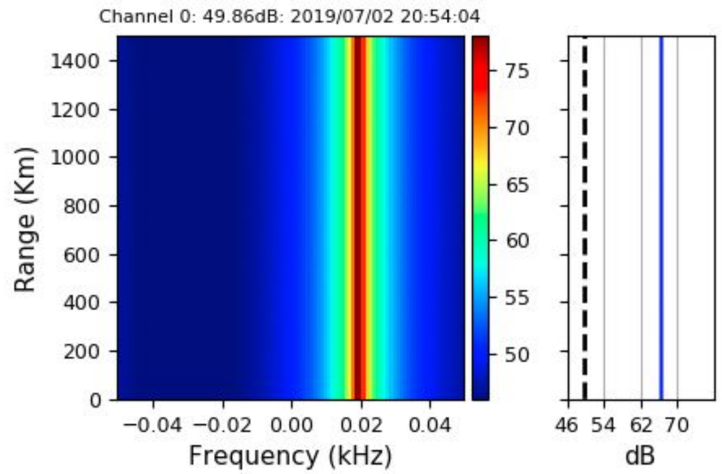
10000 Nranges

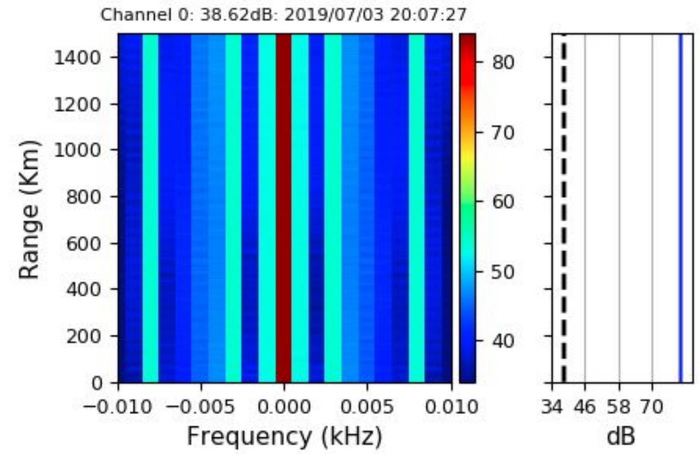


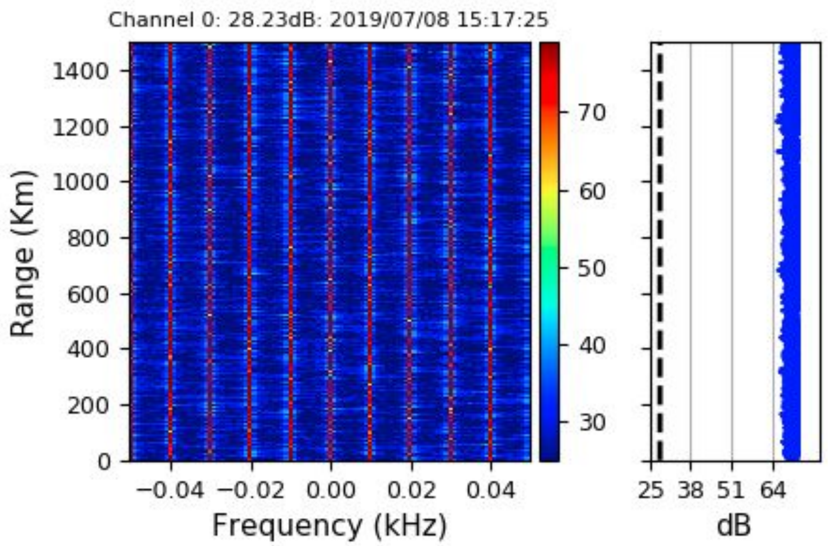
PROCESAMIENTO

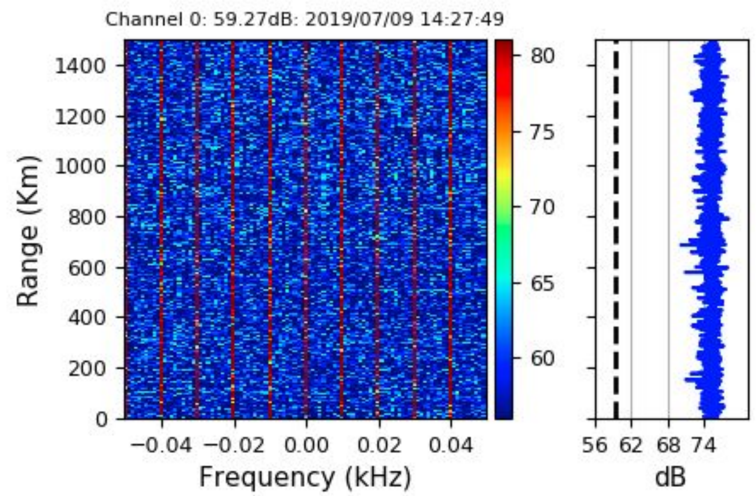
PRC_ANALYZE.py

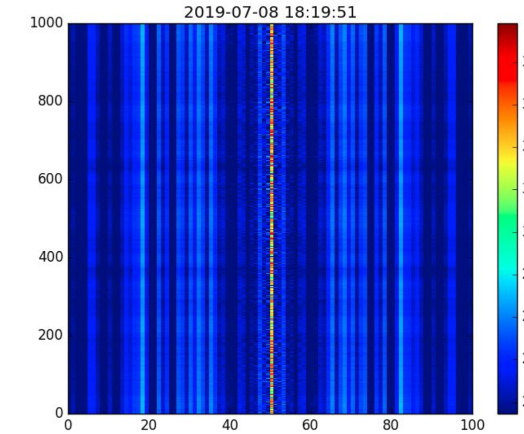


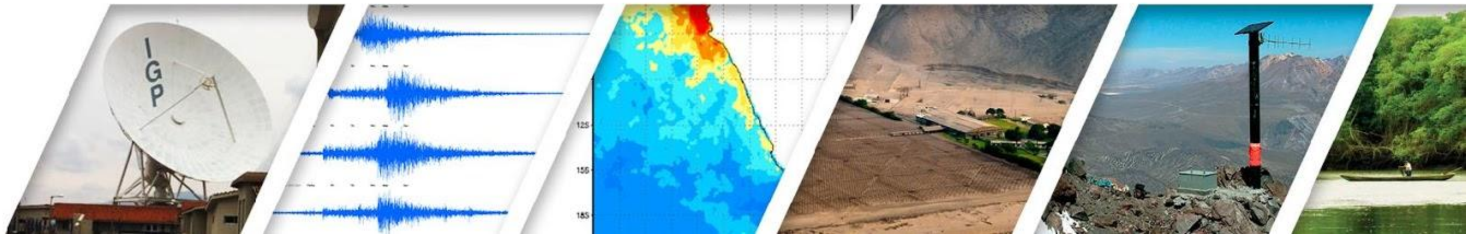




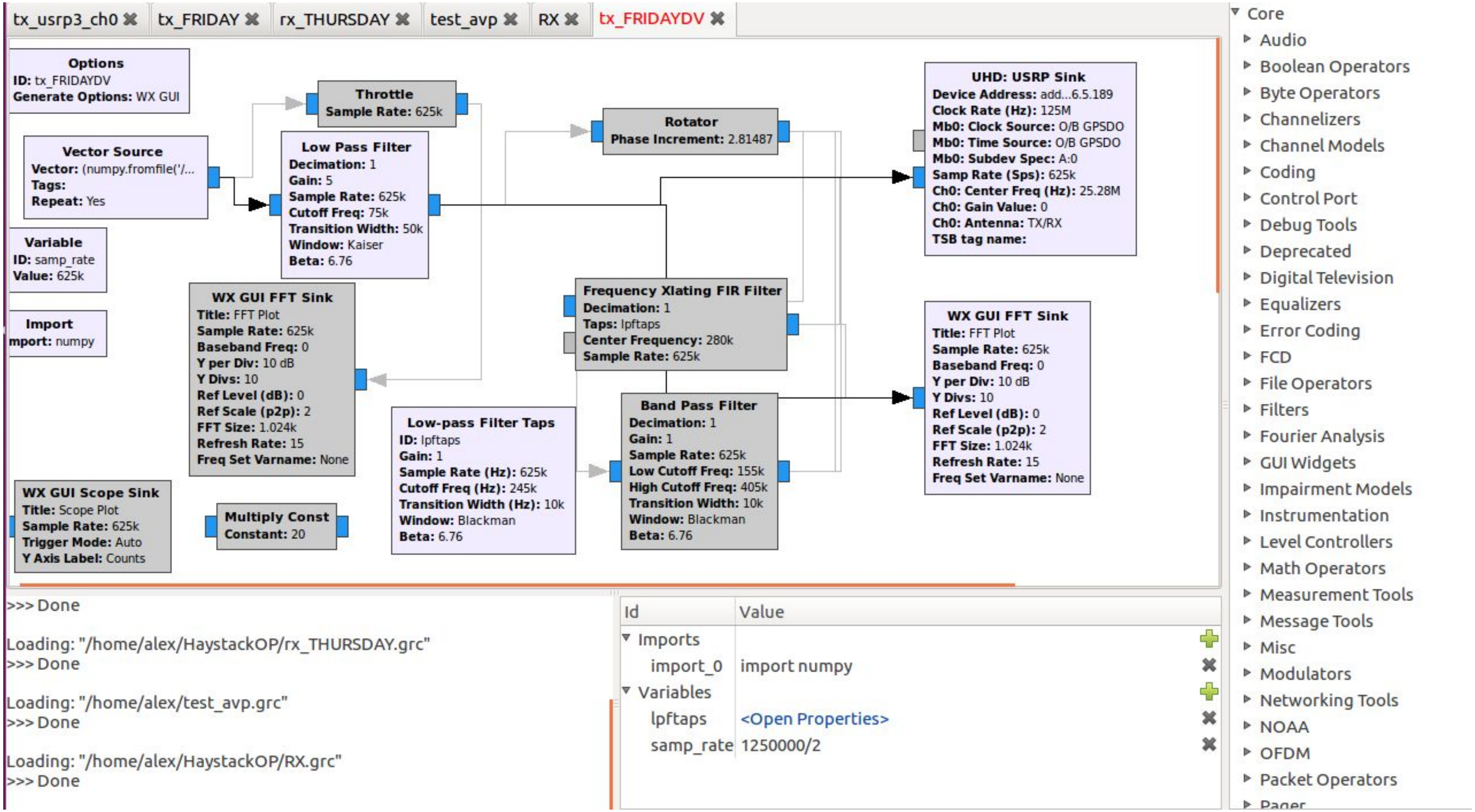


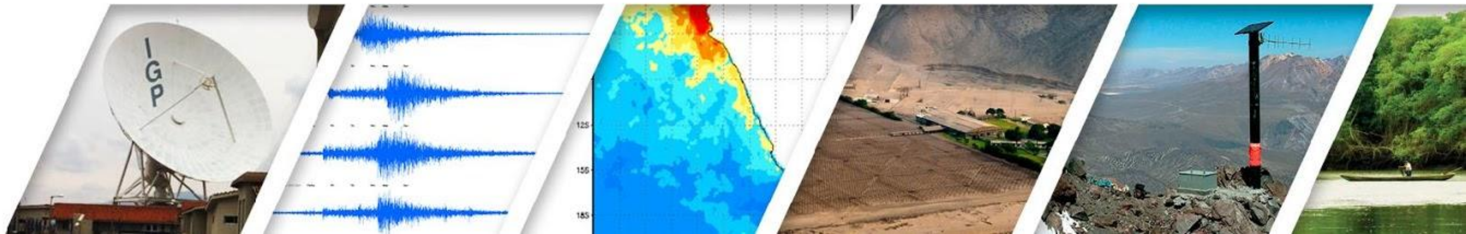






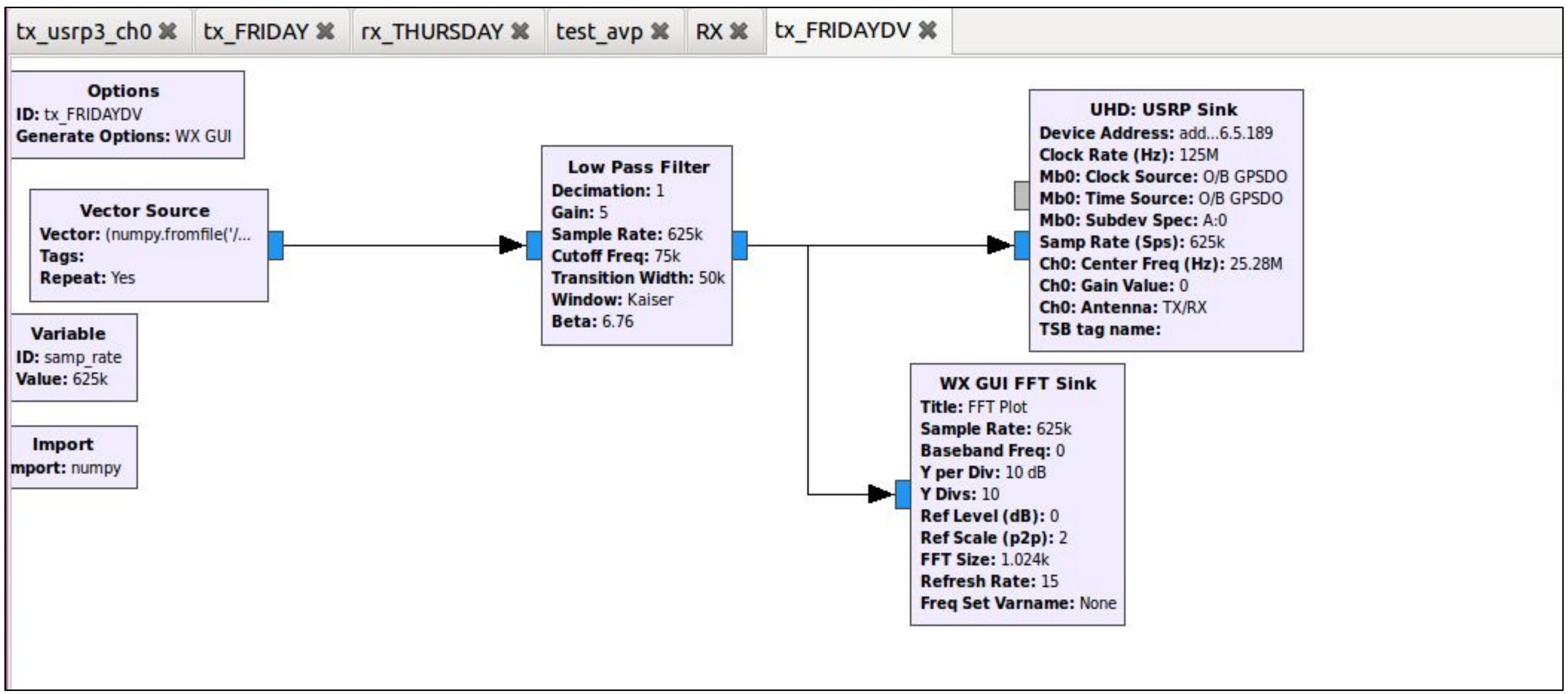
GNURADIO-COMPANION



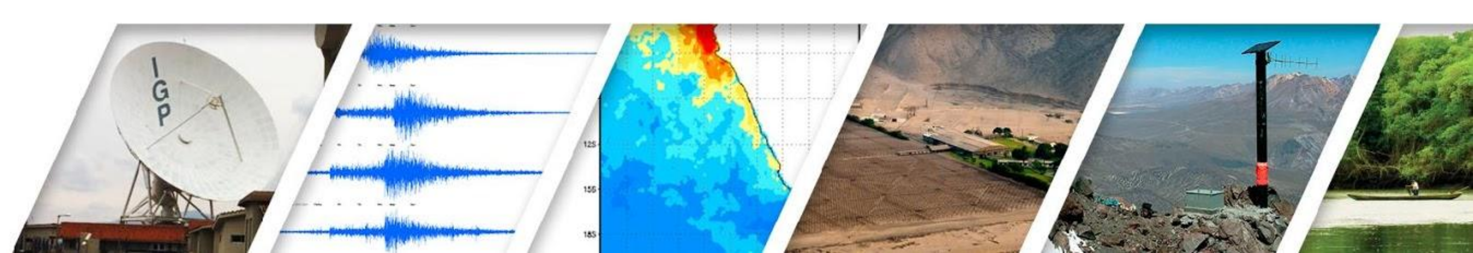


EXPERIMENT-METEOR CAMPAIGN

Rx: Thor.py
Tx: Gnuradio companion
Processing: prc_analy

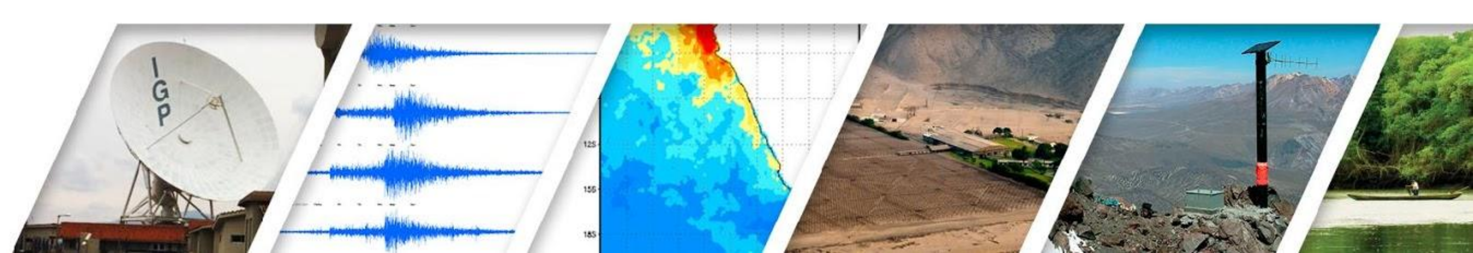


Tx_Program-GNURADIO- COMPANION

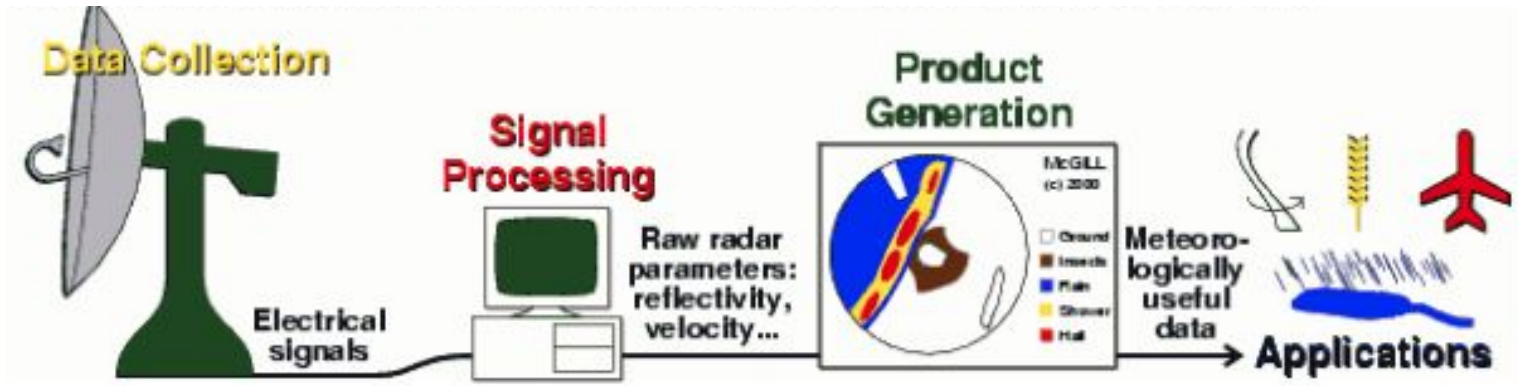


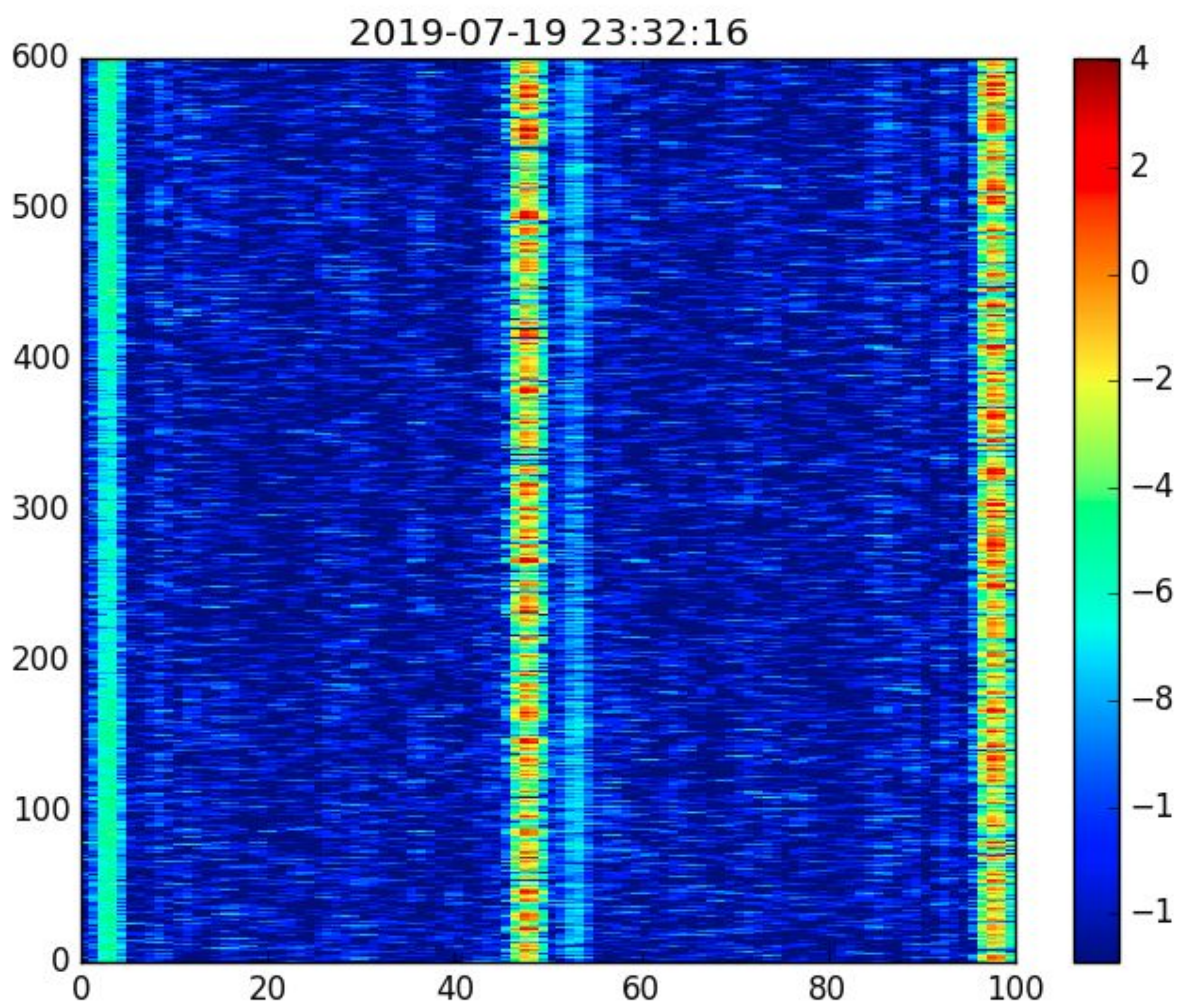
PARAMETER OF EXPERIMENT

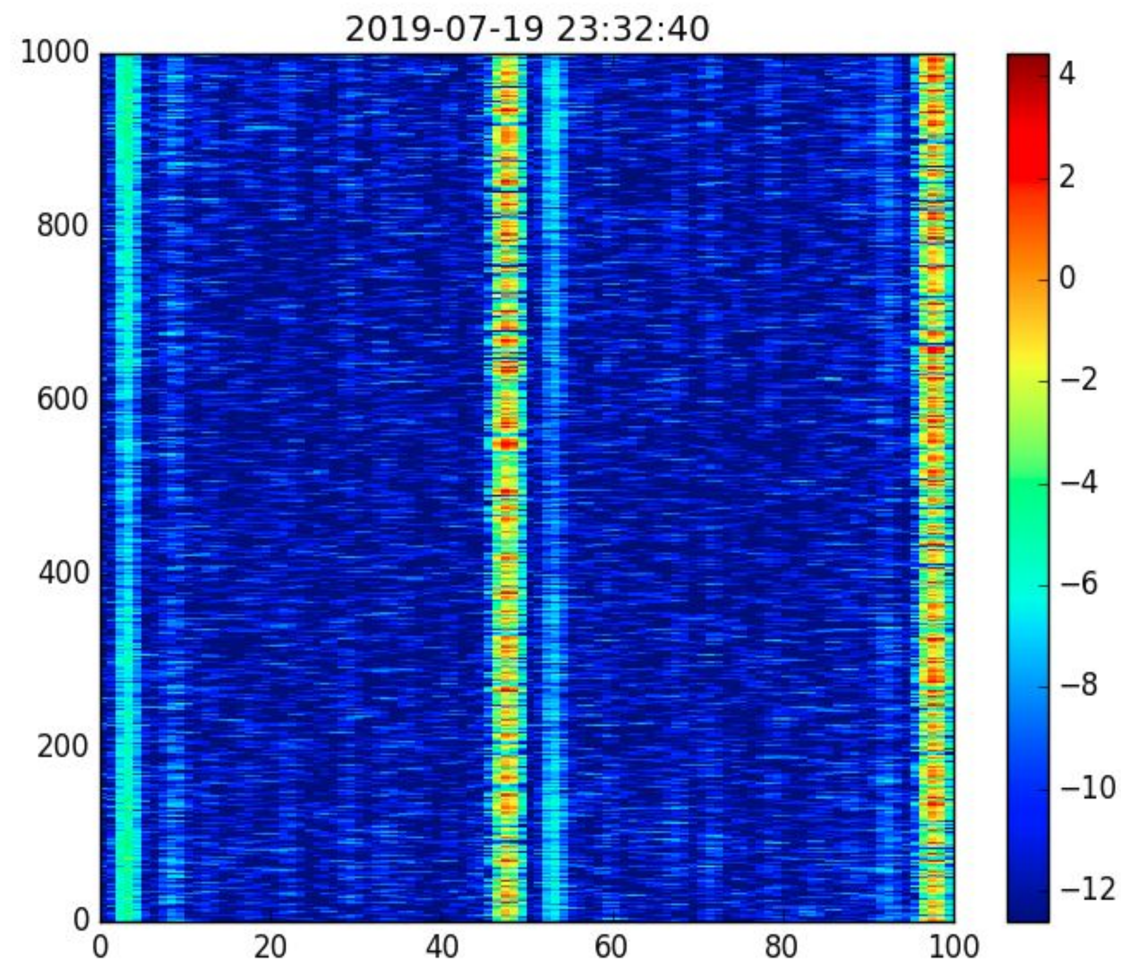
Parameter	SIMO -CW
Frequency	25.280 MHz (11.859 meters / 38.9074803 feet)
Transmitter	250 kHz (out of 500 kHz licensed band), target ERP is 1W with antenna. 1 Transmitter
Pulse Type	Coded CW
Code length	10000 (Oversample by a factor of 5)
Code Type	Pseudorandom
Rx	Digital RF target recording bandwidth is 250 kHz. For N310, sample at 25.0 MHz with 1.25 MHz of bandwidth, use thor to offset tune 25.280 MHz and produce 250 kHz output as sc16 integer data
Receiver	a. Haystack Array Pad site with LWA-R antenna, MIT LWA-R LNA, and N310 radio (dual polarization) b. Haystack Office Lab site with LWA-R antenna and N310 radio (dual polarization) c. Lind LWA-R site (N200 radio, 30 MHz LPF, dual polarization)

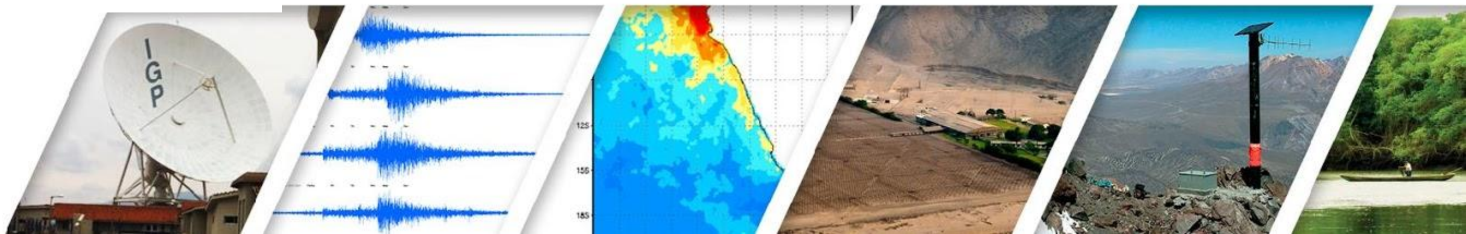


PROCESSING


Data Collection
Electrical signals
Signal Processing
Raw radar parameters: reflectivity, velocity...
Product Generation
McGILL
Meteoro-logically useful data
Applications

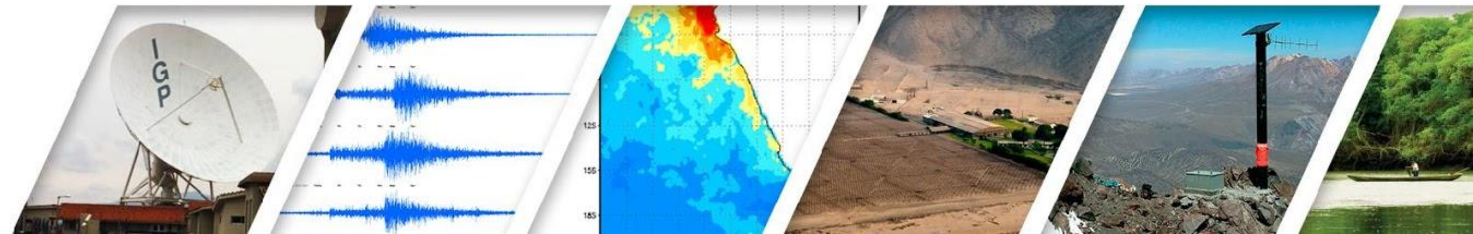

2019-07-19 23:32:16
600
500
400
300
200
100
0
0
20
40
60
80
100
4
2
0
−2
−4
−6
−8
−1
−1


2019-07-19 23:32:40
1000
800
600
400
200
0
0
20
40
60
80
100
4
2
0
−2
−4
−6
−8
−10
−12

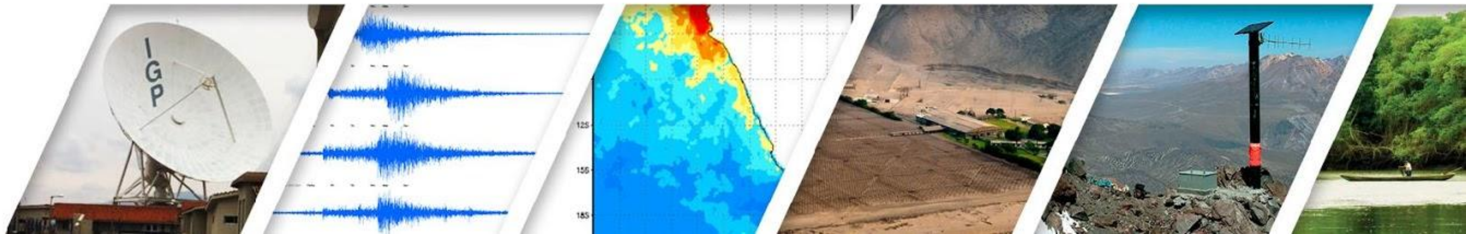


CONCLUSIONS AND RECOMMENDATION

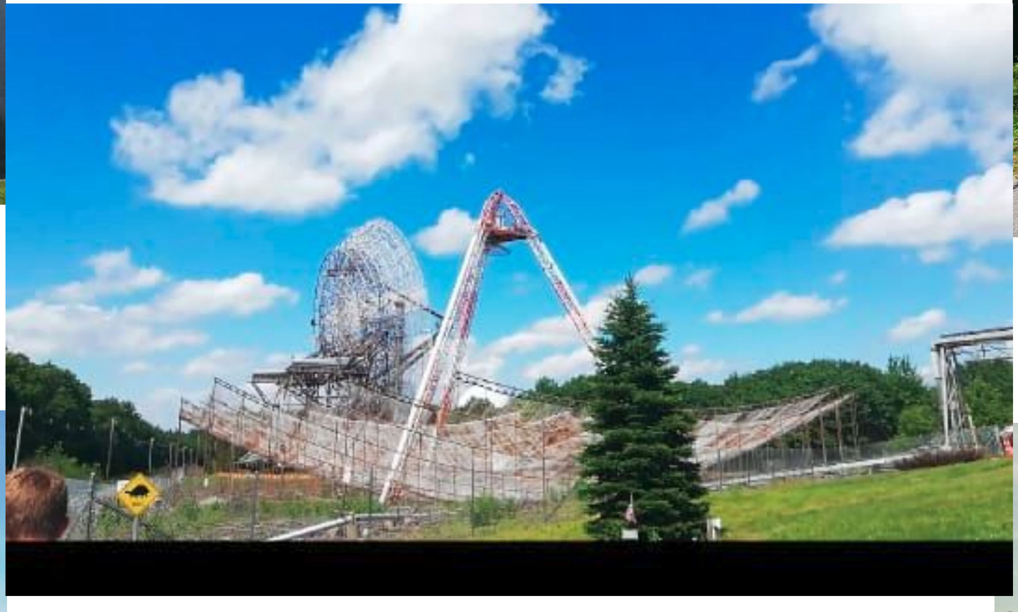
- Successfully run a Meteor Campaign with all instrument available.
- SDR and GNURADIO in general are a powerfull tool to rapid prototyping and implementation.
- Test in laboratory with the 25.280 Mhz and repeat the experiment with more Power.
- Lear more about code continuous wave meteor radar.
- Design a program to acelerate and setup the configuration in USRP N310.
- Design a Web Application for Monitoring SDR in general.

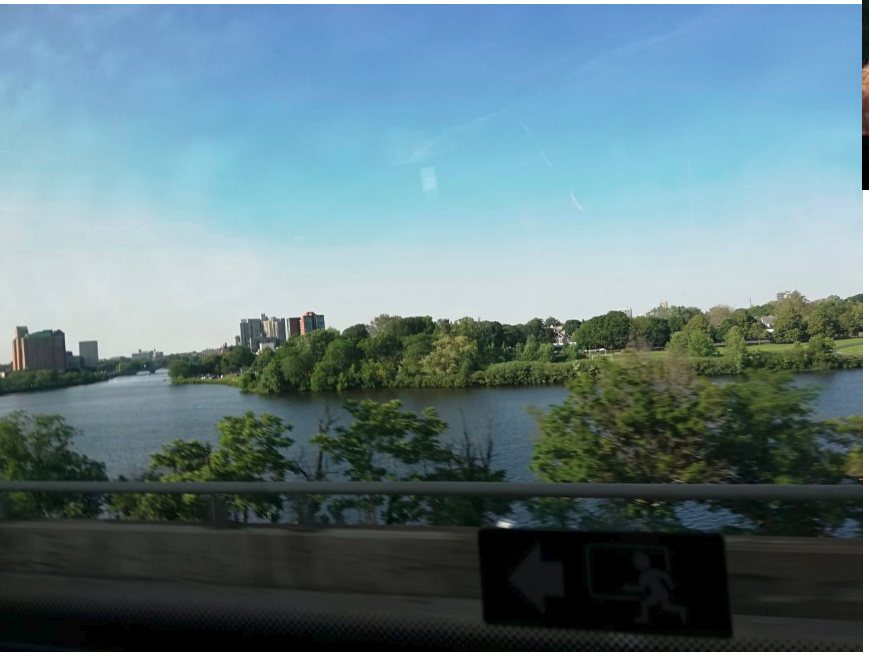


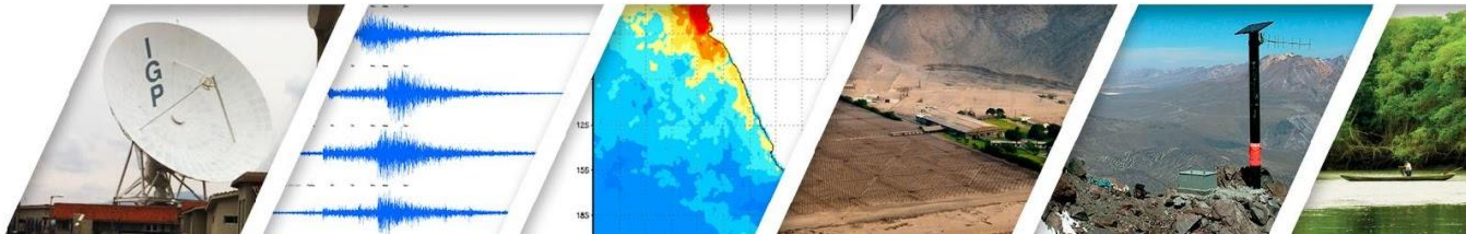
Happyness



WONDERFUL INFRASTRUCTURE







Thank you!

Ciencia para protegernos, ciencia para avanzar.

www.igp.gob.pe