Bundesamt für Kartographie und Geodäsie

I A R
CCT La Plata
CONICET

Instituto Argentino de Radioastronomia

Radio Frequency Interference Observations at IAR La Plata

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21st EVGA Meeting, Espoo – Finland, March 5-8, 2013

Outline

- Motivation
- Equipments
- Measurements
- Results
- Conclusions

Motivation

Transportable Integrated Geodetic Observatory
Concepción - Chile

TIGO project evolution

- since 2001:
  - TIGO is a bilateral project between Germany and Chile
- since 2010:
  - Chilean government is not responding to financial problems of their project partners (hit by earthquake and student protests)
- since 2012:
  - BKG has lost its main partner UdeC
  - BKG took over some of the Chilean cost share in order to continue data provision to the International Services
  - BKG is looking for new project partner

Site finding

- For orbit determinations by SLR southern latitudes are important.
- Chile or Argentina?
- German Embassy made contact to Argentina
- BKG is negotiating collaboration with Argentinean science council Conicet
- Conicet owns Instituto Argentino de Radioastronomía (IAR) in La Plata
- Verification of the electro-magnetic situation at the IAR mandatory due to closeness of urban region Buenos Aires and La Plata

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Location of IAR close to Buenos Aires and La Plata

image: NASA-GSFC GES DISC

Flux Density of electro-magnetic spectrum

$$S_{dB} = P_{SA.dBm} - 10\log_{10}(B_S) - G_{R.dB} + k_{A.dB} - 35.77 \quad [dBWm^{-2}Hz^{-1}]$$

$$k_{A.dB} = 20\log_{10}(f_{MHz}) - G_{dBi} - 29.79$$

where:

$P_{SA.dBm}$ = power in [dBm] read at spectrum analyzer = measurement

B_S = signal bandwidth (resolution bandwidth) = 30 kHz

$G_{R.dB}$ = receiver system gain = median value from calibration measurement

$k_{A.dB}$ = antenna factor = computed

f_{MHz} = antenna frequency = 2000...14000 MHz

G_{dBi} = antenna isotropic gain = ~7 dBi (data sheet)

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Wettzell RFI Measurement System

overall gain: 70dB at 2 GHz
incl. ~7dbi antenna directivity

positioning manually

Rohde&Schwarz-Antenna HL024A1

- frequency range: 1-18 GHz,
- input signal: horizontal + vertical polarization

Antenna box

- 1 LNA for each polarization, 3 postA
- relais for noise cal injection
- noise cal diode NC346B

Receiver Box

- power combiner for both polarizations
- amplifier

Rohde&Schwarz Spectrum Analyzer FSL18

Data logging: Notebook PC

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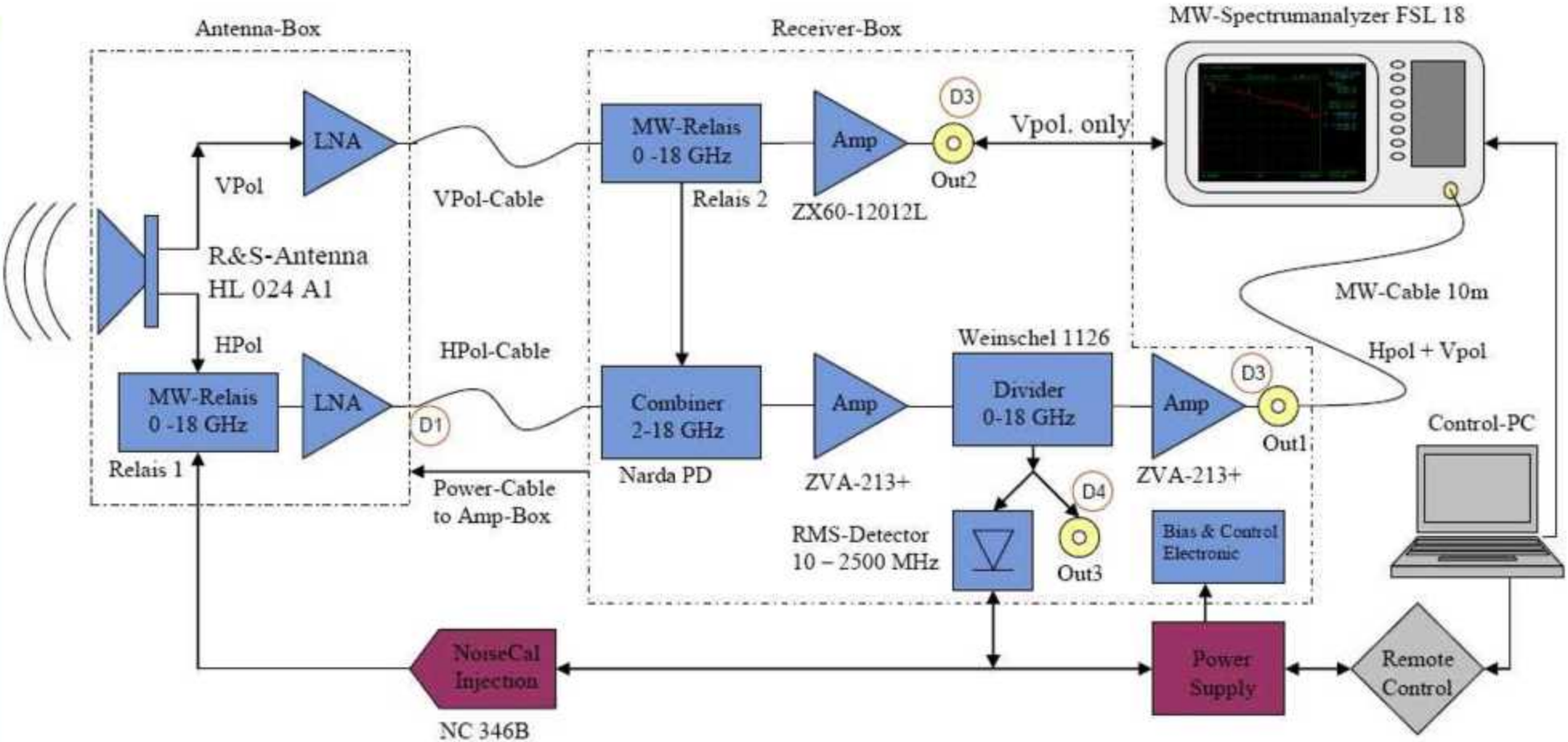
Wettzell RFI Measurement System
Block Diagram



Design: Gerhard Kronschnabl, BKG

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La Plata RFI Measurement System

developed for SKA site finding in Argentina
in 2005, reconditioned in 2012

overall gain: 75dB at 2 GHz
incl. ~8dbi at 2 GHz antenna directivity

positioning automatized

Dual ridge horn antenna, Emco 3115

- frequency range: 1 - 18 GHz
- polarization change mechanically
- 359° spatial coverage 5° resolution

Antenna box

- 3 LNA from Miteq, 2 - 8 GHz (!)
- relais for 50 ohm reference load used for Cal

HP9583E Spectrum Analyzer

- Tsys: 400-700°K, due to high display average noise level of spectrum analyzer

Data logging: PC with custom software

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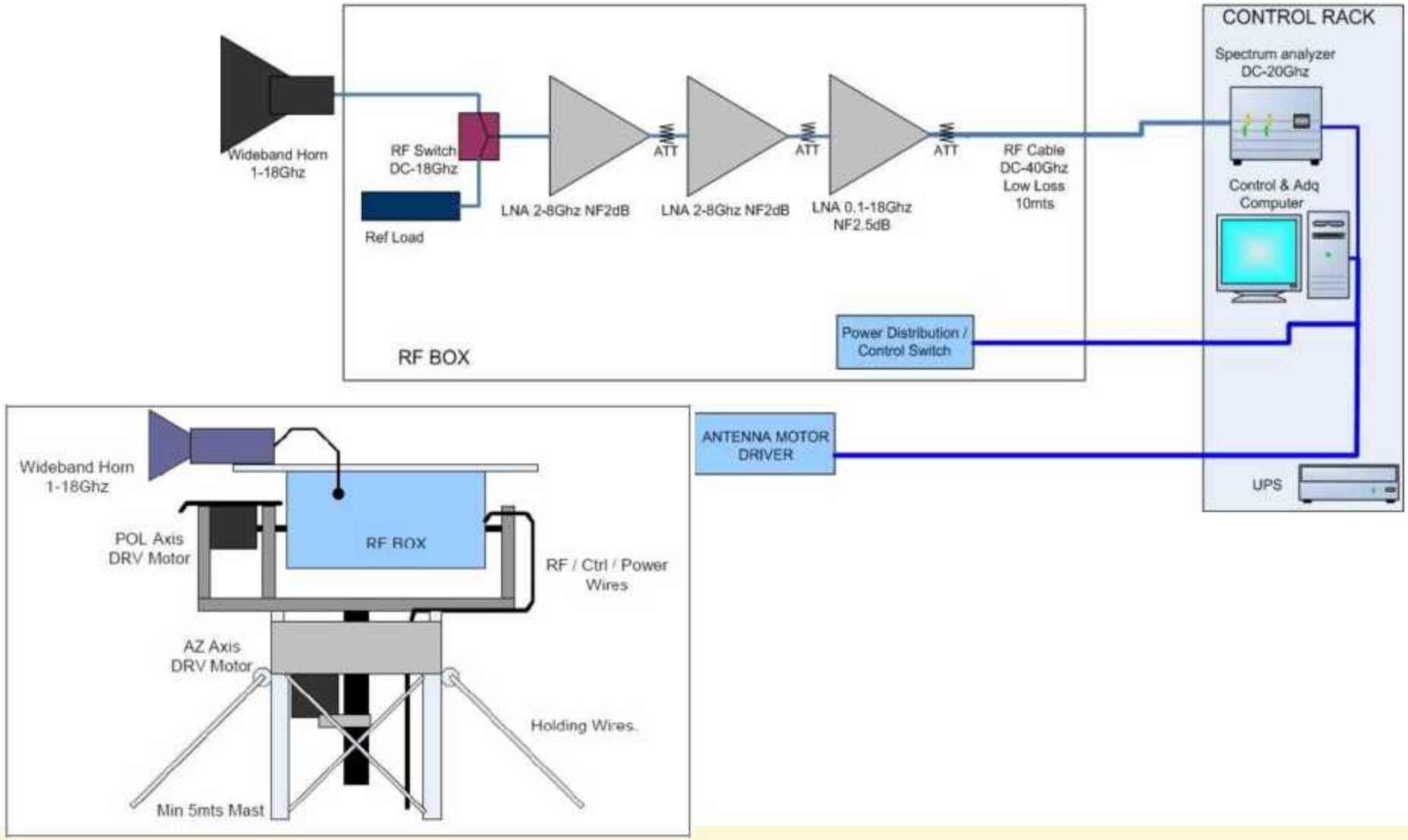
IAR RFI Measurement System
Block Diagram



Design: IAR

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Location of RFI monitoring at IAR

North

South

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Wettzell RFI measurement system mounted on La Plata motorized pedestal

combination of RFI-monitoring systems
BKG Wettzell and IAR La Plata
14.09.-14.10.2012

Measurement

- 30kHz resolution bandwidth
- 2-14 GHz range divided in 1GHz bands
- each 1GHz band requires 2.5s sweeptime (12 bands = 30s)
- 8 directions (N, NE, E, SE, S, SW, W, NW) + 1 Cal. = 15min

=> 96 azimuth scans/day

=> 768 images/day

After 30 days of measurement (14.09.-14.10.2012):

=> 21776 images of the spectrum analyzer recorded

most dense RFI data set known to the IVS

1 image = 9600 amplitude data points spaced by 1.25 MHz. => 209 million data points.

Flux Density of electro-magnetic spectrum

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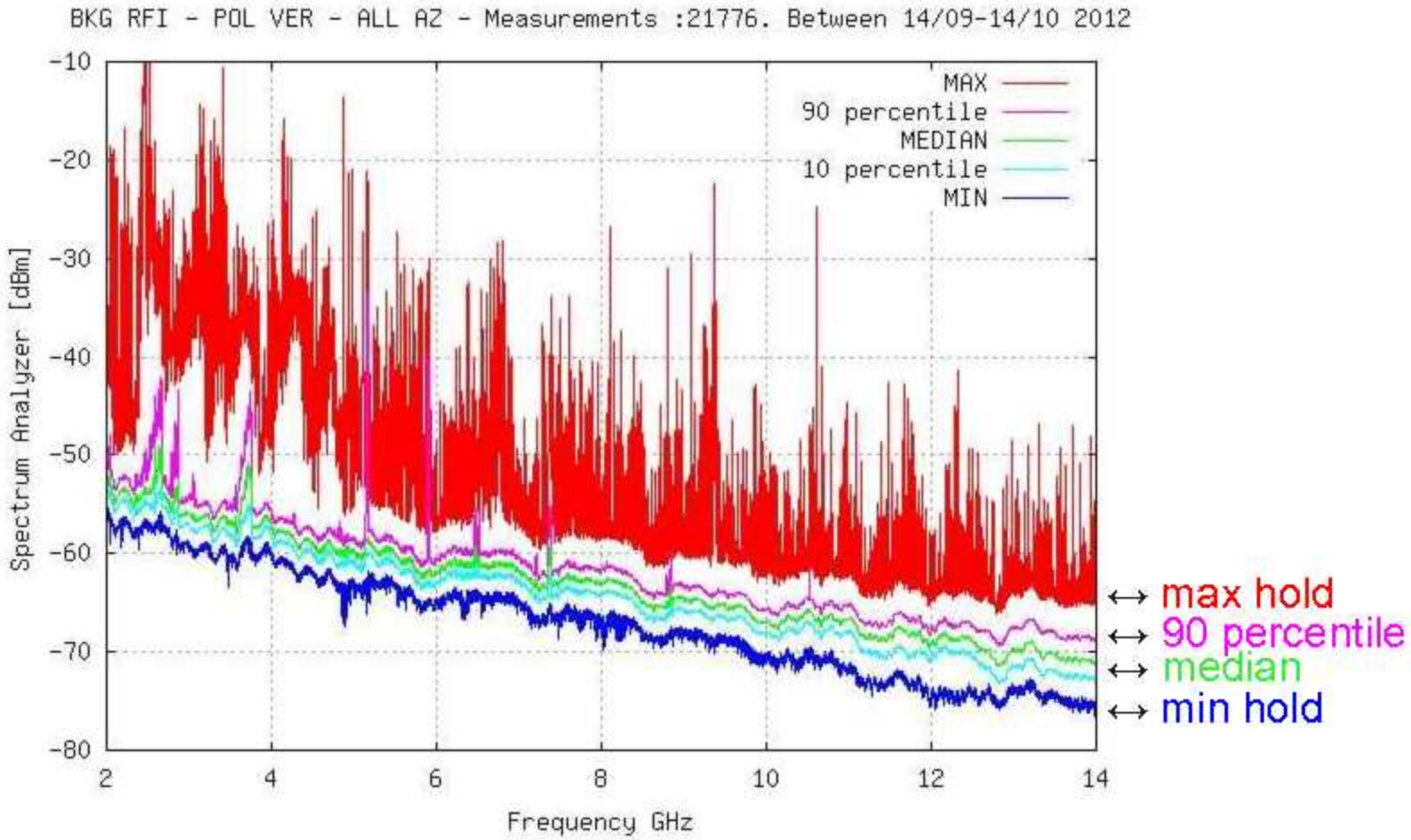
Power at Spectrum Analyzer [dBm] vs. Frequency [GHz]

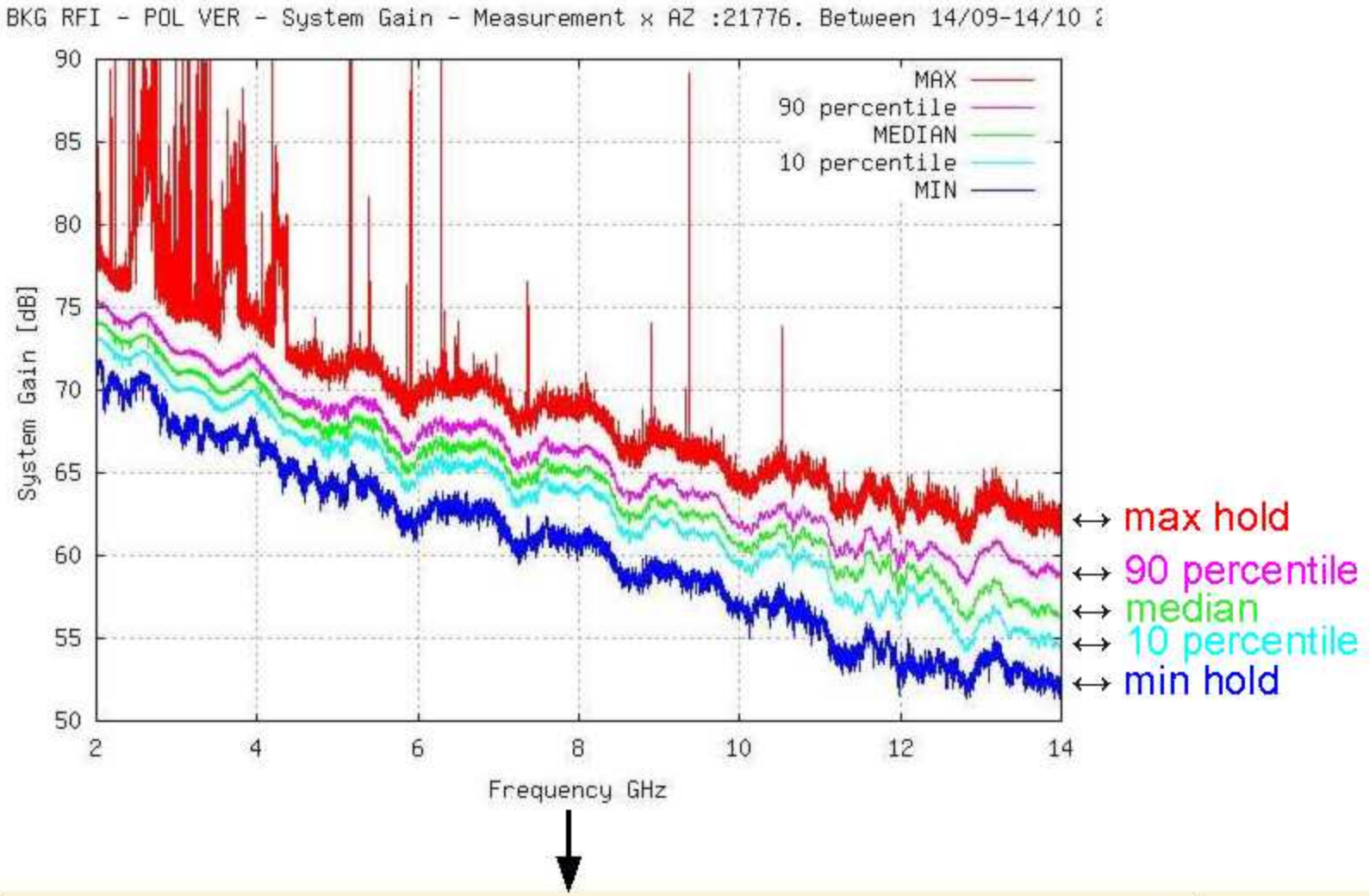
21776 measurements



$$S_{dB} = P_{SA.dBm} - 10\log_{10}(B_S) - G_{R.dB} + k_{A.dB} - 35.77 \ [dBWm^{-2}Hz^{-1}]$$

System Gain [dB] vs. Frequency [GHz]

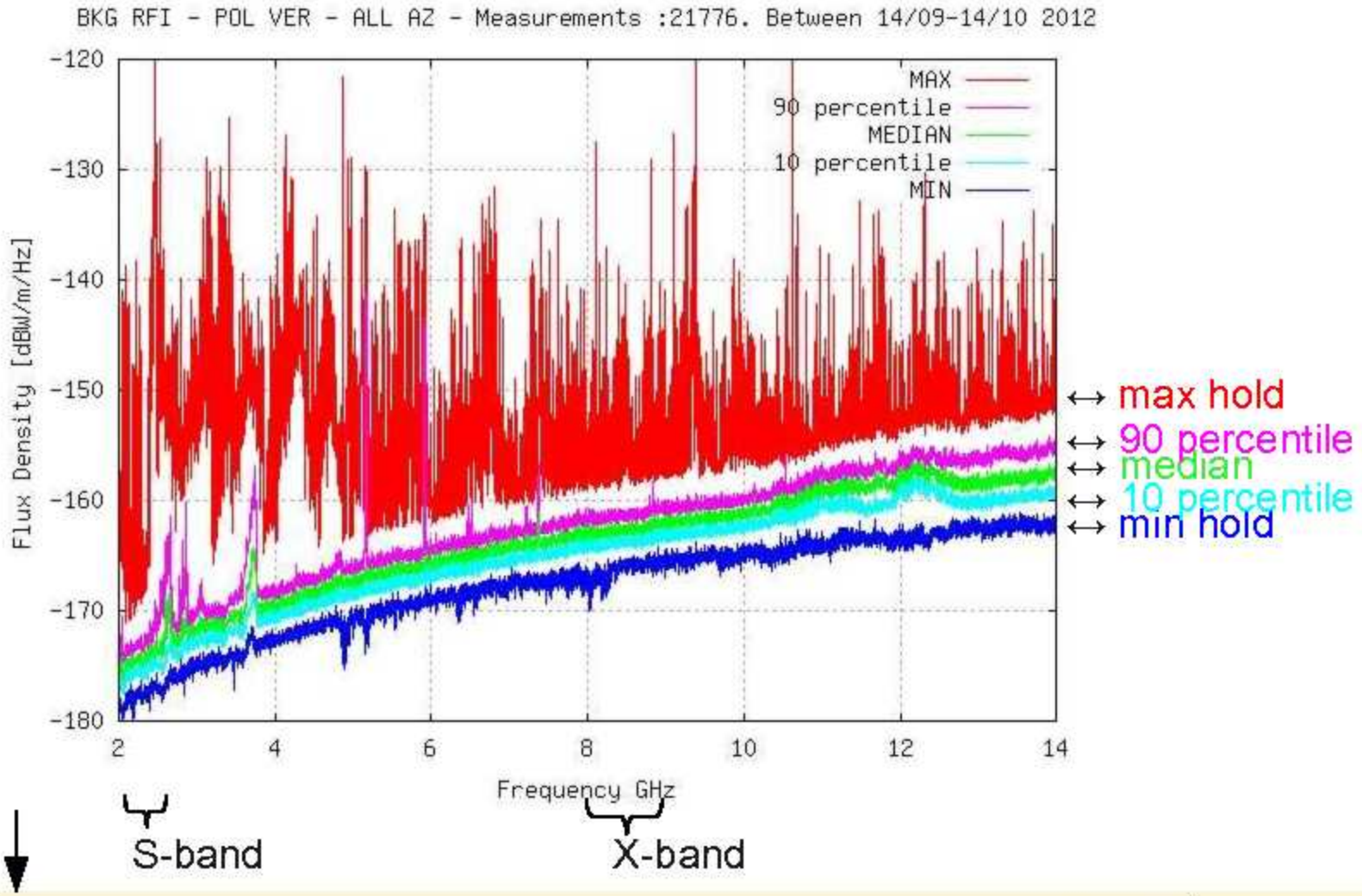
21776 measurements



$$S_{dB} = P_{SA.dBm} - 10\log_{10}(B_S) - G_{R.dB} + k_{A.dB} - 35.77 \ [dBWm^{-2}Hz^{-1}]$$

Flux Density [dBW/m²/Hz] vs. Frequency [GHz]

all directions: 21776 measurements



$$S_{dB} = P_{SA.dBm} - 10\log_{10}(B_S) - G_{R.dB} + k_{A.dB} - 35.77 \ [dBWm^{-2}Hz^{-1}]$$

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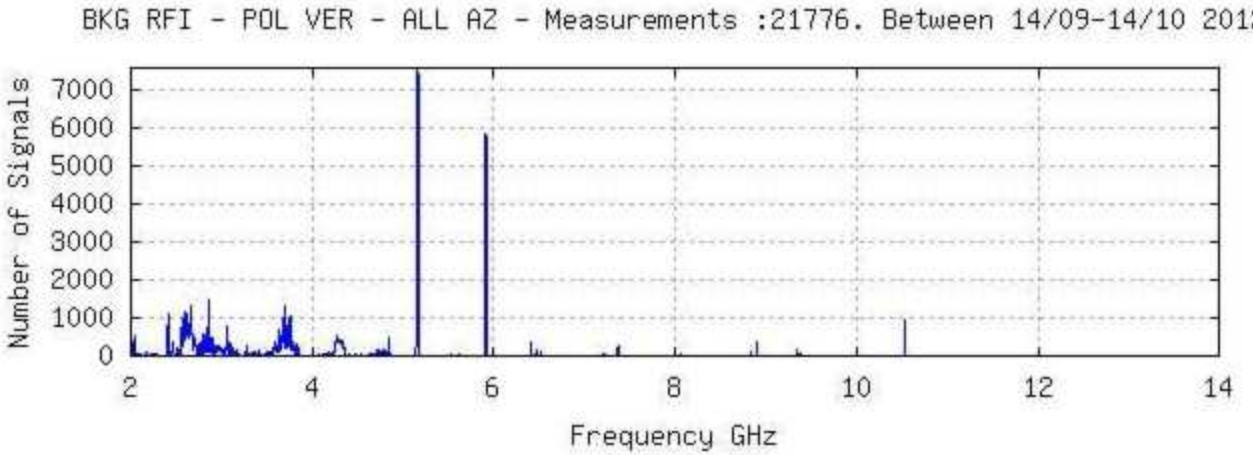
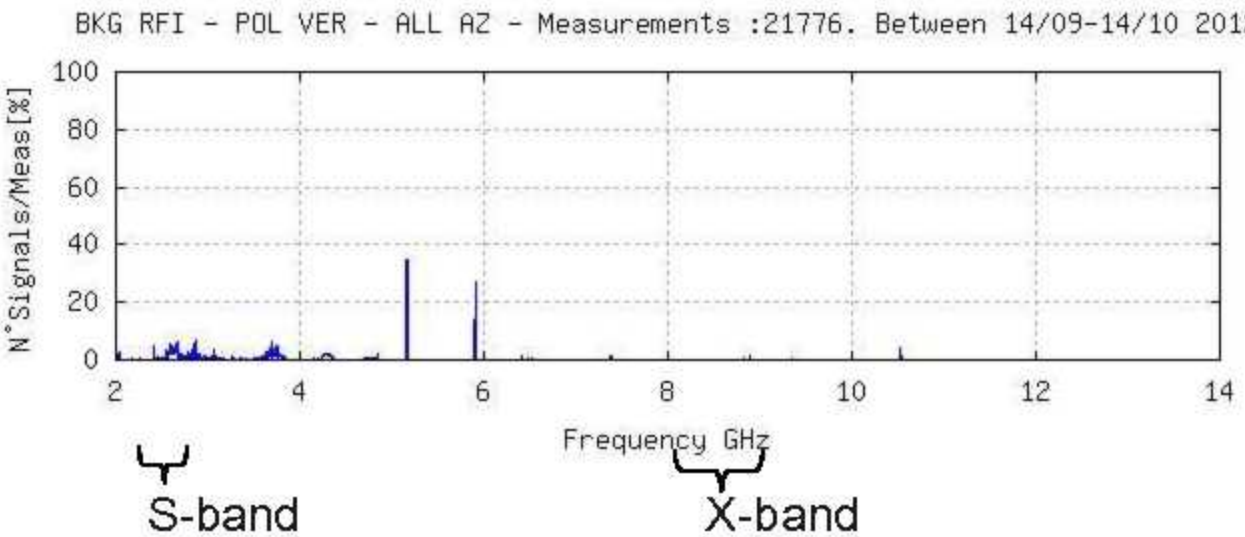
RFI detections (+6dB > median) vs. Frequency [GHz]

all directions: 21776 measurements

absolute number



percentage of total number



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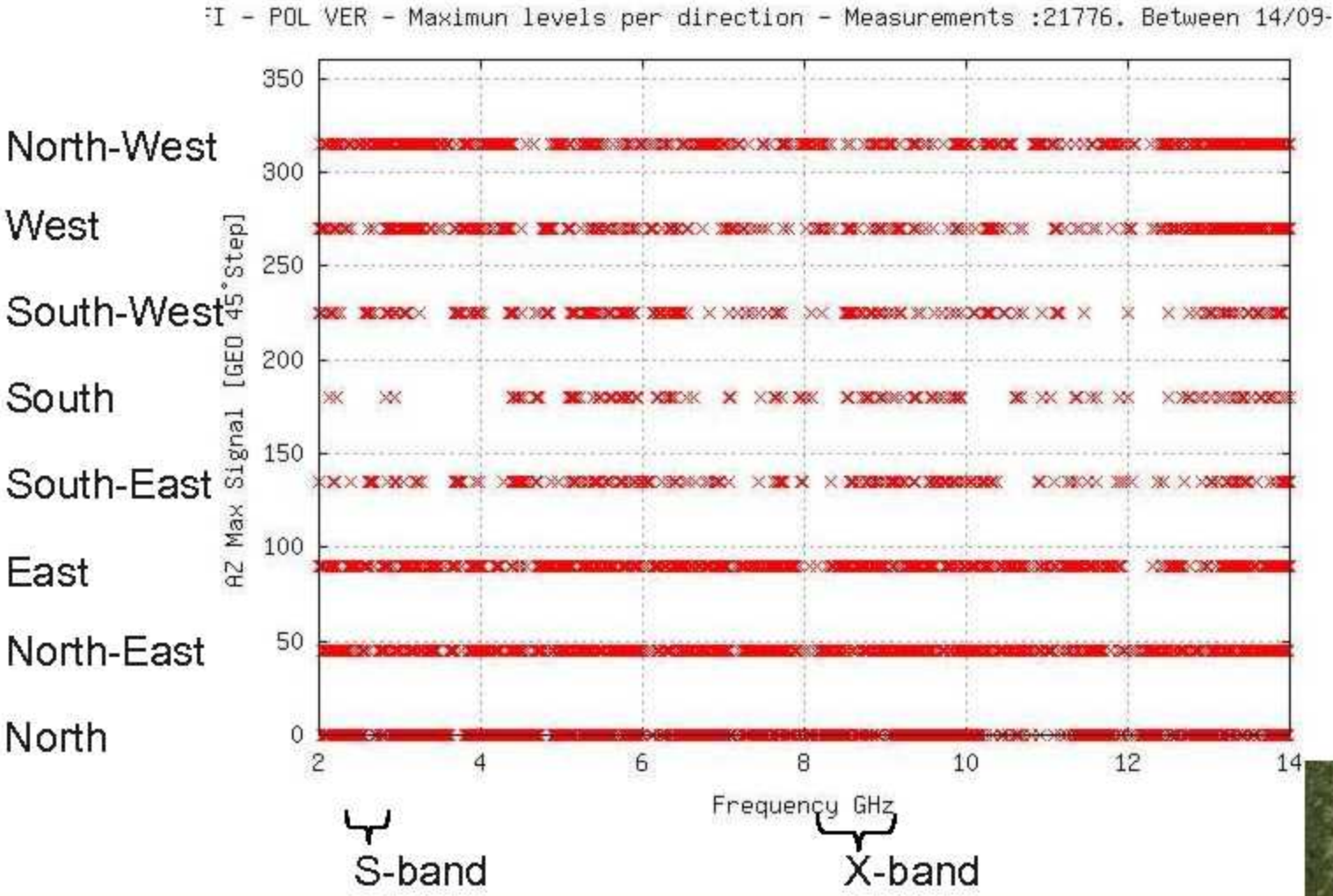
RFI detection (+6dB > median) directions vs. Frequency [GHz]

all directions: 21776 measurements



Buenos Aires

rural area

La Plata

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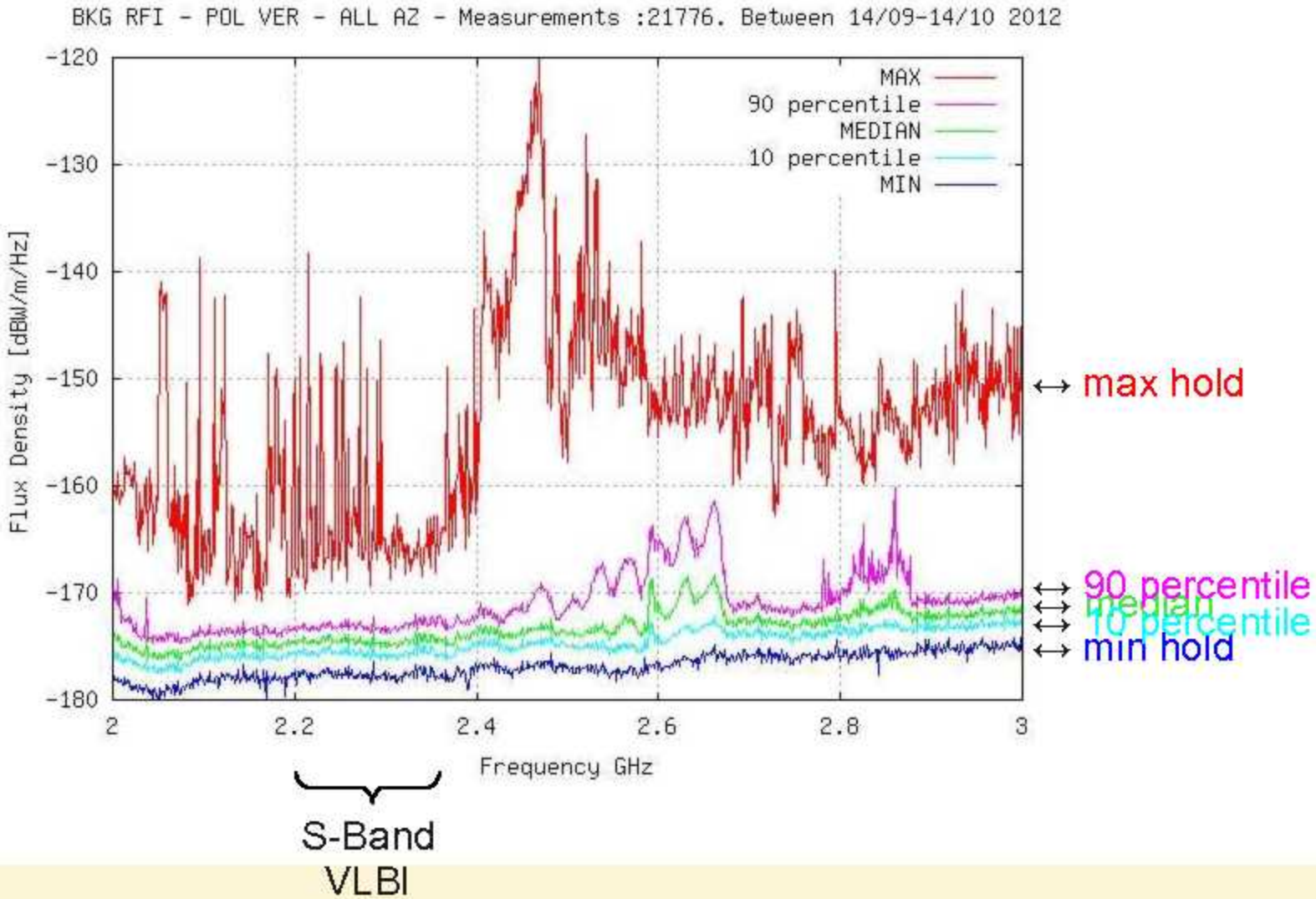
S-Band - Flux Density [dBW/m²/Hz] vs. Frequency [GHz]

all directions: 21776 measurements



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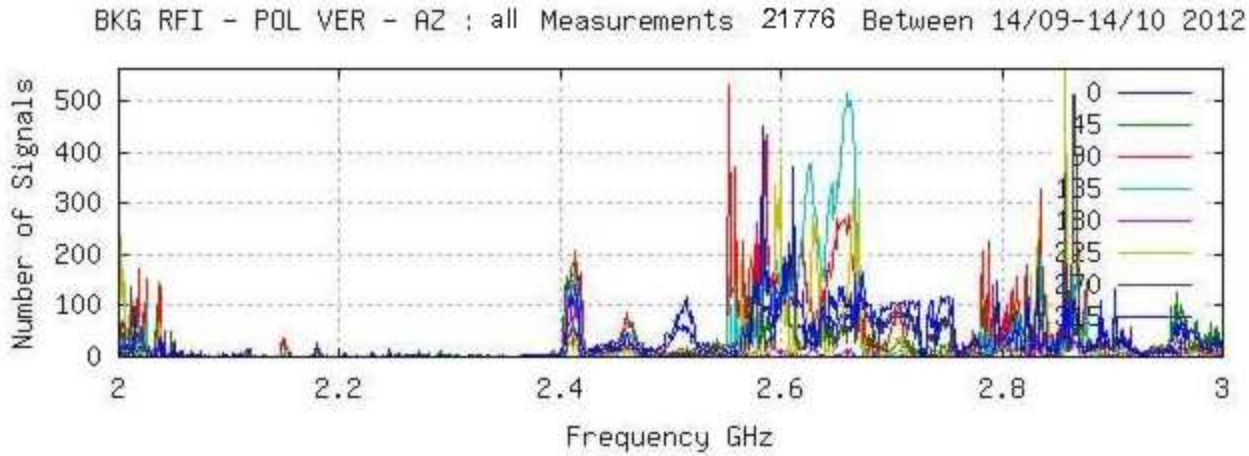
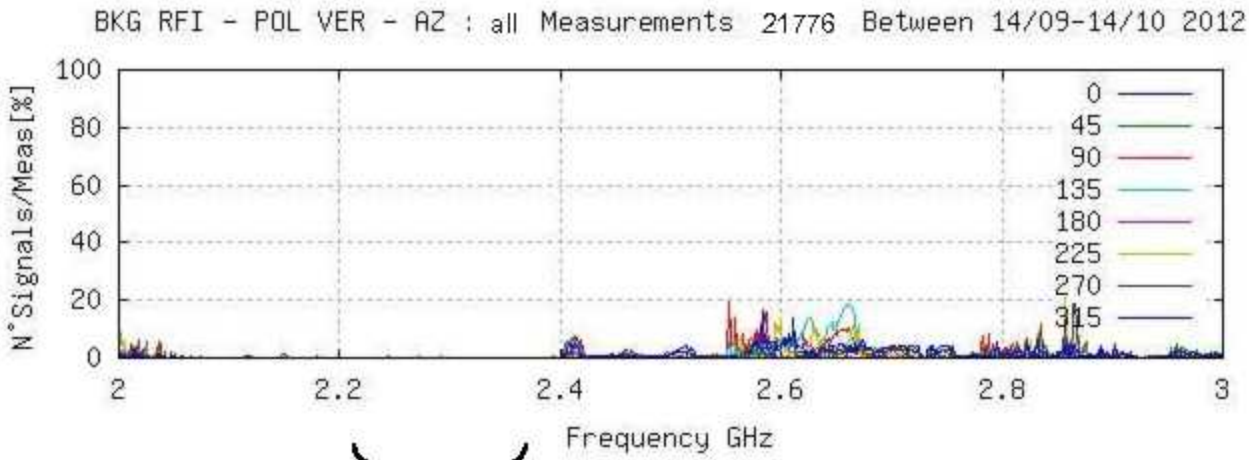
S-Band - RFI detections (+6dB > median) vs. Frequency [GHz]

8 directions: 21776 measurements





color coded directions

S-Band
VLBI

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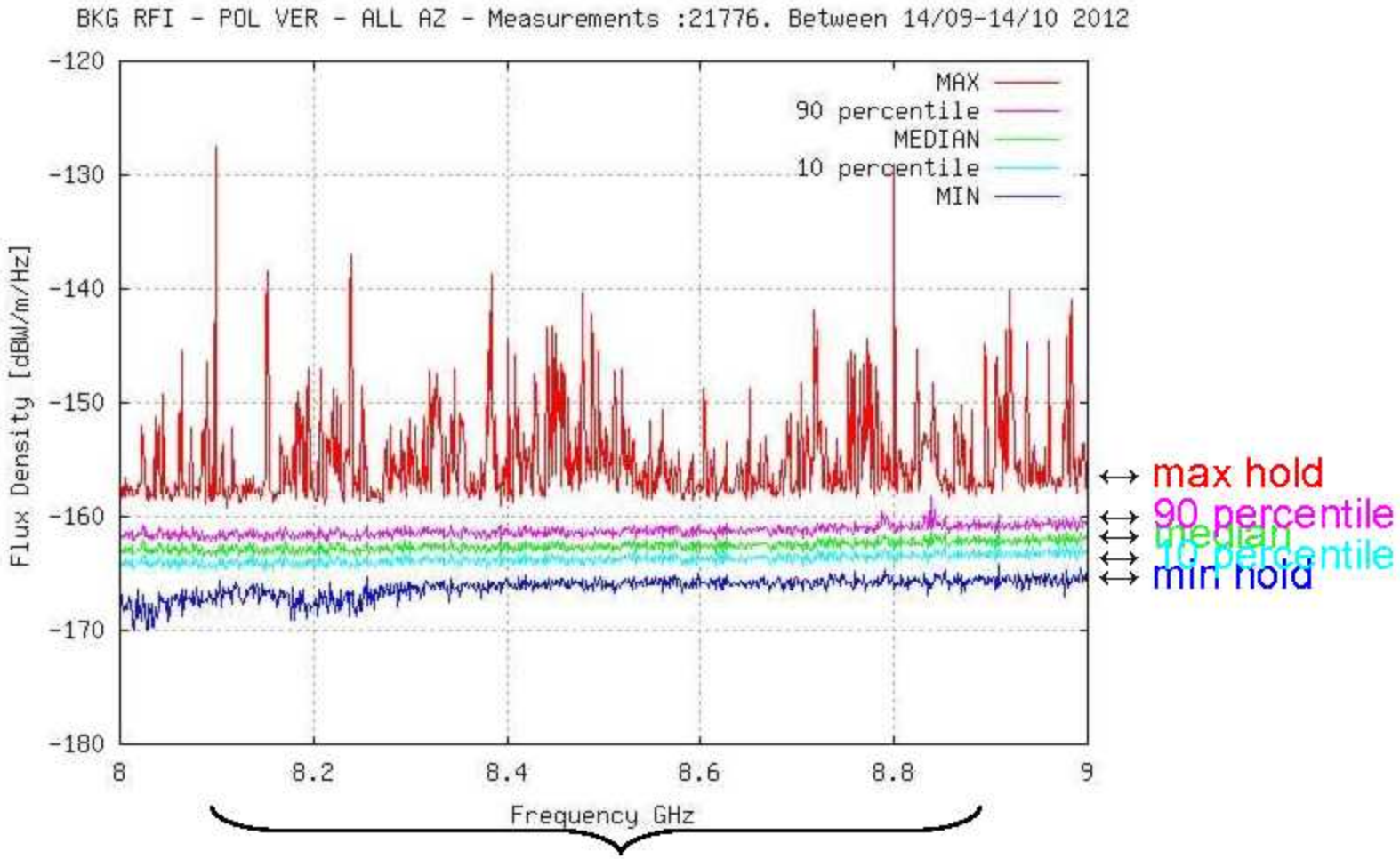
X-Band - Flux Density [dBW/m²/Hz] vs. Frequency [GHz]

all directions: 21776 measurements



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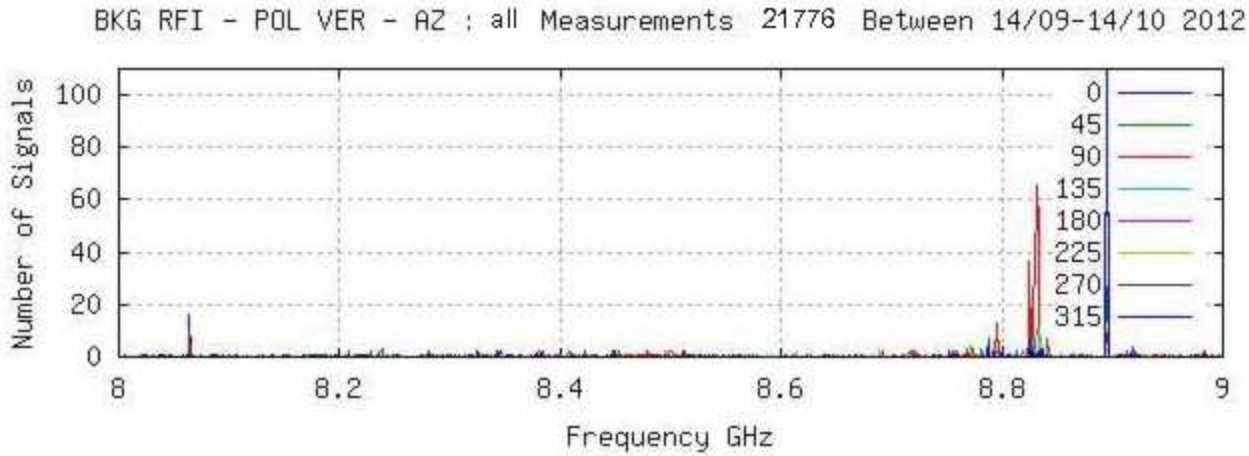
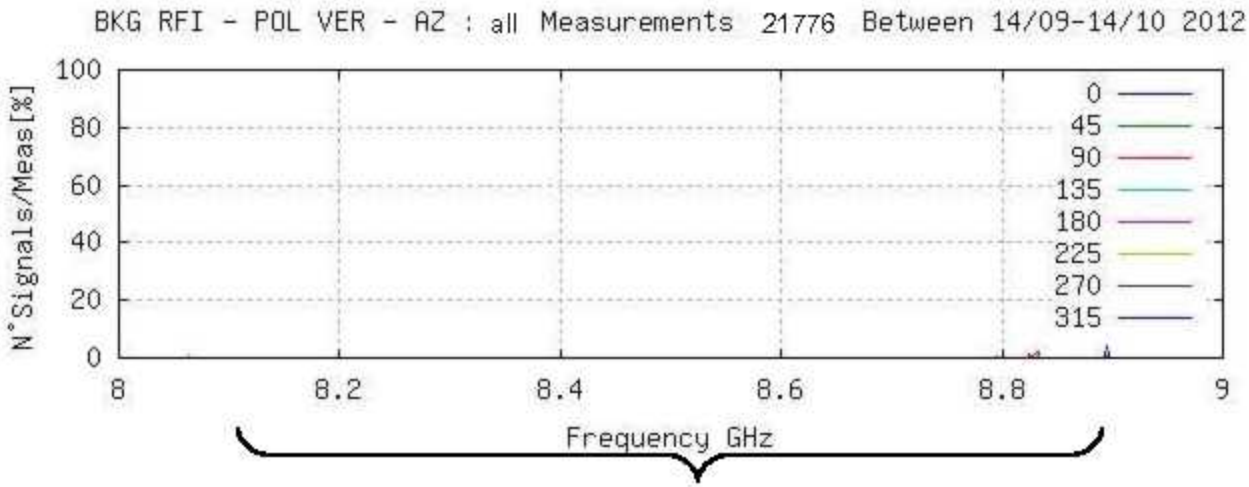
X-Band - RFI detections (+6dB > median) vs. Frequency [GHz]

8 directions: 21776 measurements





color coded directions

X-Band
VLBI

Conclusions

- The Wettzell RFI-measurement system was used for one month continuously in an automatized RFI-monitoring campaign in La Plata, Argentina.
- 21776 radiation images in the spectrum from 2.0-14.0 GHz were taken and processed.
- RFI-signals had been detected, i.e. 2.4-2.9 GHz.
- Most RFI signals appear sporadically and are absent most of the time as shown by the 90 percentile.
- Permanent RFI is mostly generated locally.
- **S-Band and X-Band used by geodetic VLBI are almost free of RFI** and hence IAR is a suitable site for a future IVS-network station.
- RFI-monitoring should become a permanent task in order to protect observatories against new transmitters.

Full report available under:
http://www.iar.unlp.edu.ar/biblio/cgi-bin/opacmarc/wxis?IsisScript=opac/xis/opac.xis&task=BIB-RECORD&db=infor&curr=3&total=7&cid=/tmp/files70lkK

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Possible future site for TIGO
100m behind the 30m radio telescope