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Radio Communications Research Group
Grupo de Radiocomunicación (GRC)



ETSIS Telecomunicación

RADIO COMMUNICATIONS GROUP (GRC)

Director: **Full Prof. Cesar Briso**

TECHNICAL UNIVERSITY OF MADRID

ETSIS Telecomunicacion

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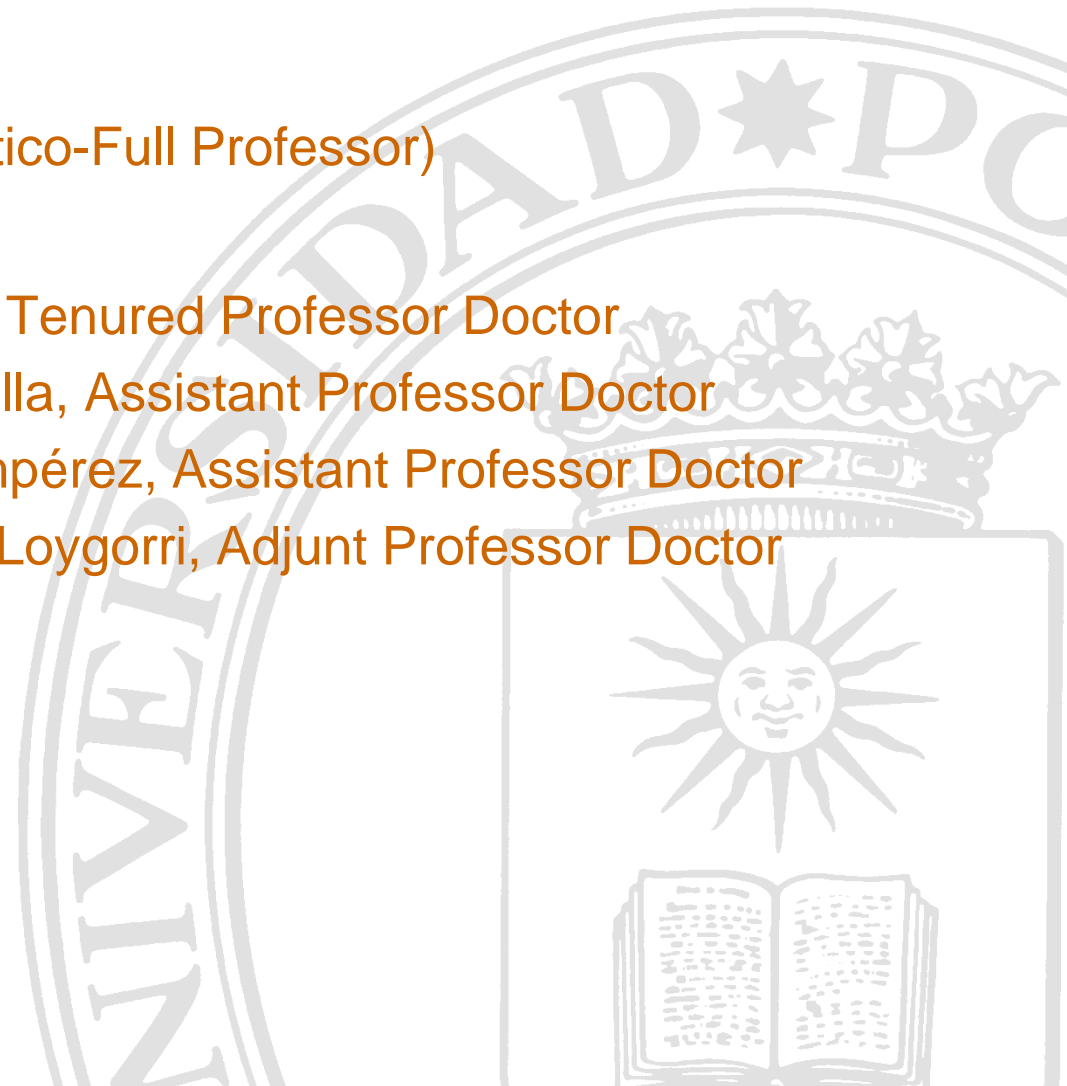
Madrid 2022





MEMBERS OF THE GROUP

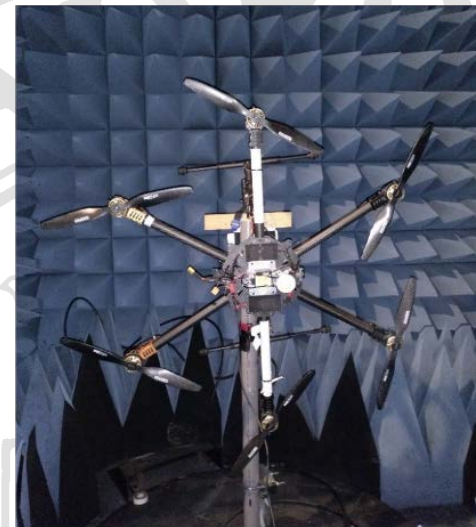
- **Coordinator:**
Prof. Cesar Briso (Catedrático-Full Professor)
- **Members (PhD)**
Prof. Antonio Pérez Yuste, Tenured Professor Doctor
Prof. Yolanda Blanco Archilla, Assistant Professor Doctor
Prof. Alejandro García Lampérez, Assistant Professor Doctor
Prof. Juan Moreno García-Loygorri, Adjunt Professor Doctor
- **Members (non PhD)**
8 Undergraduate
5 Master
4 PhD candidates





EQUIPMENTS

- 2 Anechoic chamber (4x6x3m), EMC and antennas
- 3 VNAs : 4/6/ 20Ghz,
- 3 Spectrum analyzer 6/26/43 GHz
- 1 Digital oscilloscope (6 Ghz)
- 3 Signal Generator, 3/6/ 10 Ghz
- 7 SDR USRP 2910
- 6 Permanent Researchers place



Auxiliary equipment: mechanical/electrical tools, prototype laboratory.

Software: Matlab, PCB desing, AWR MW, CST, FEKO antennas, propagation proprietary software.



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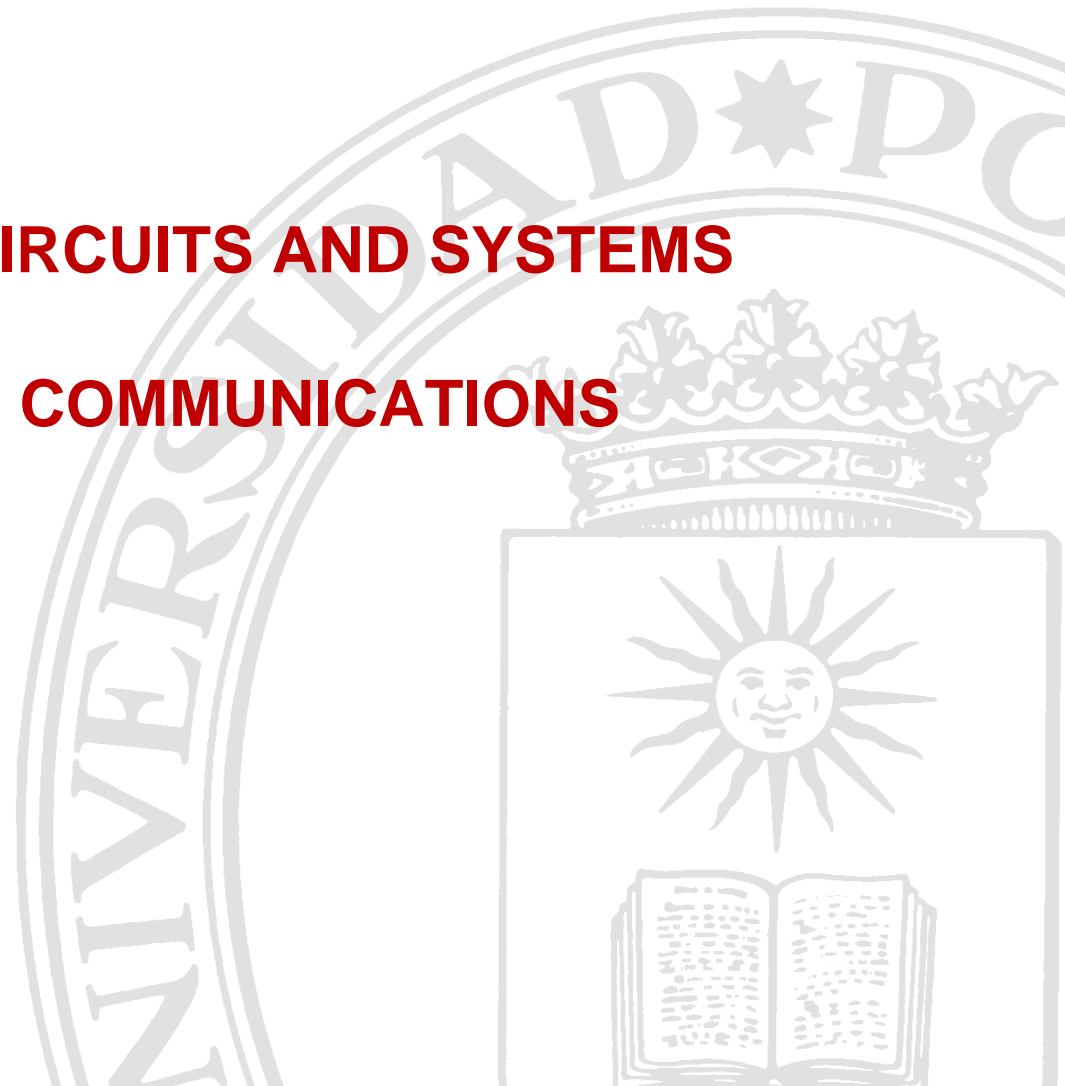
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ETSIS Telecomunicación

RESEARCH LINES

- **Communications CIRCUITS AND SYSTEMS**
- **MISSION CRITICAL COMMUNICATIONS**





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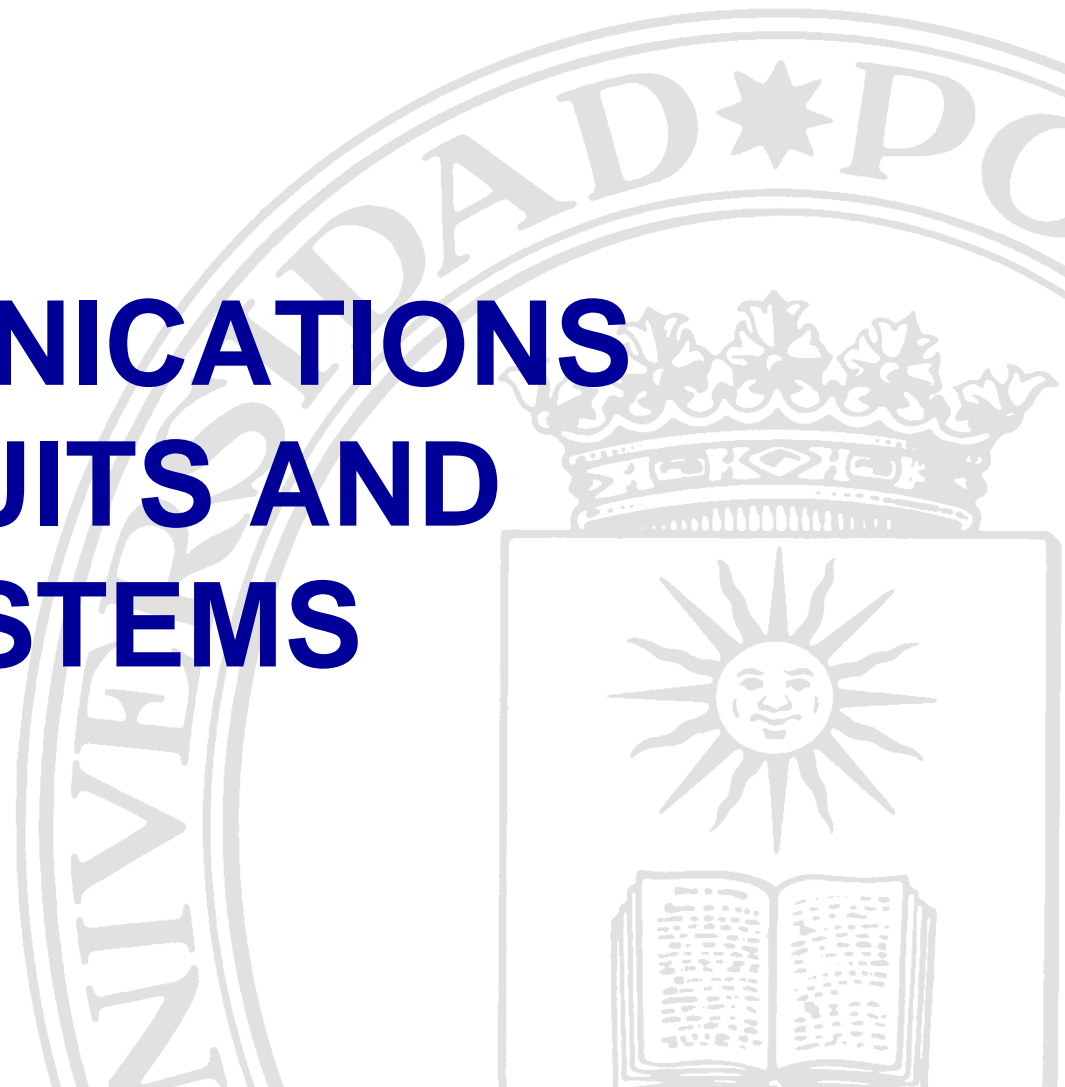
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ETSI Telecomunicación

COMMUNICATIONS CIRCUITS AND SYSTEMS





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RESEARCH PROJECTS. COMMUNICATIONS CIRCUITS

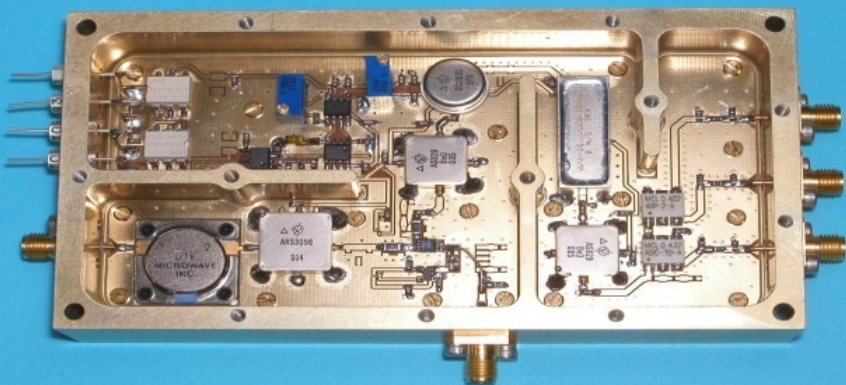
RF advanced circuits.

Receiver Module. (ESA) ground station

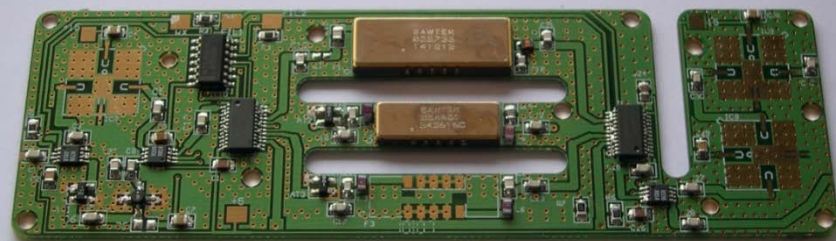
Proyecto: International Space Station

Precision L band receiver with high thermal stability

L band Downconverter module



IF SAW Switching bank filter

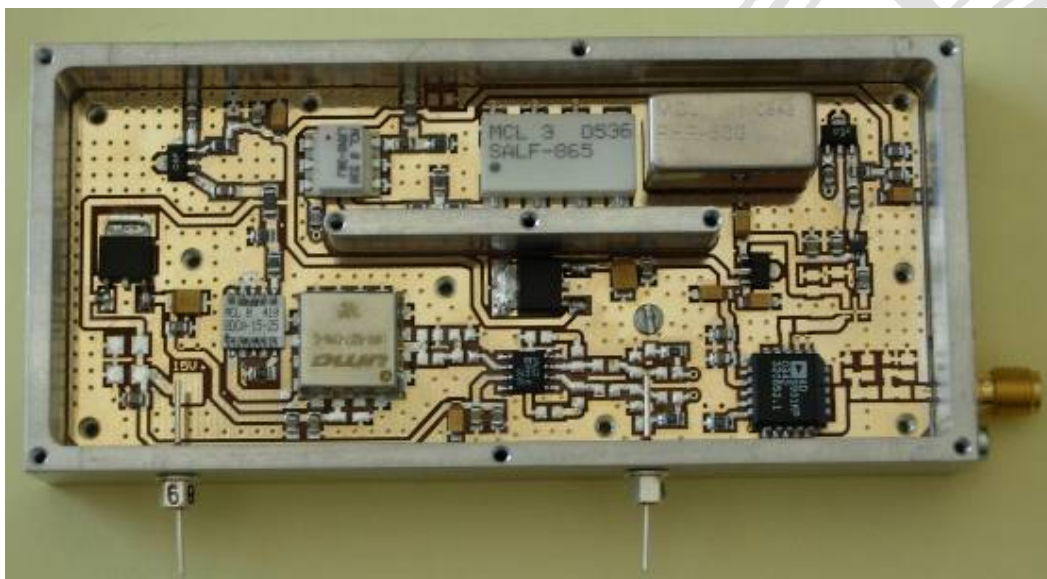




RESEARCH PROJECTS. COMMUNICATIONS CIRCUITS

Project: DOPLER RADAR Radar Calibration Systems
Spanish Ministry of Army

Frequency Synthesizer: Fractional PLL with fast switching and continuous phase control

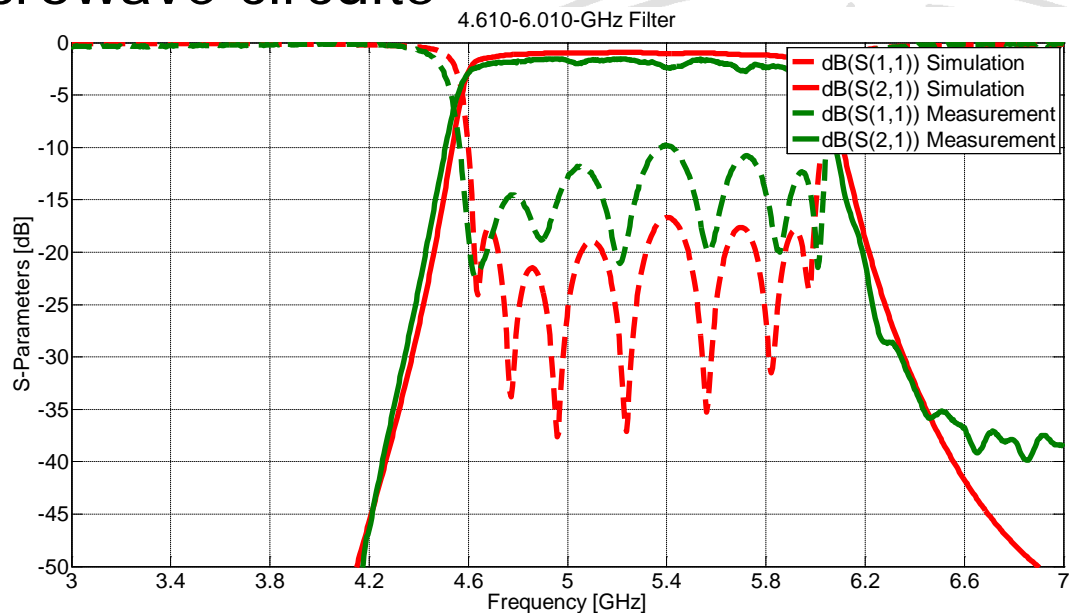


Application: Doppler radar emulation system based on DDS

RESEARCH PROJECTS. COMMUNICATIONS CIRCUITS



Microwave circuits



Specifications	4.610-6.010 GHz	
Design	AWR	REAL
Center frequency	5.395 GHz	5.285 GHz
3.0 dB Bandwidth	1433 MHz	1380 MHz
Insertion loss	< 1.5 dB	< 2.5 dB
Stopband Attenuation (@30 dB)	4.368 GHz	4.34 GHz
	6.361 GHz	6.345 GHz
Return loss	> 16.5 dB	> 9.5 dB

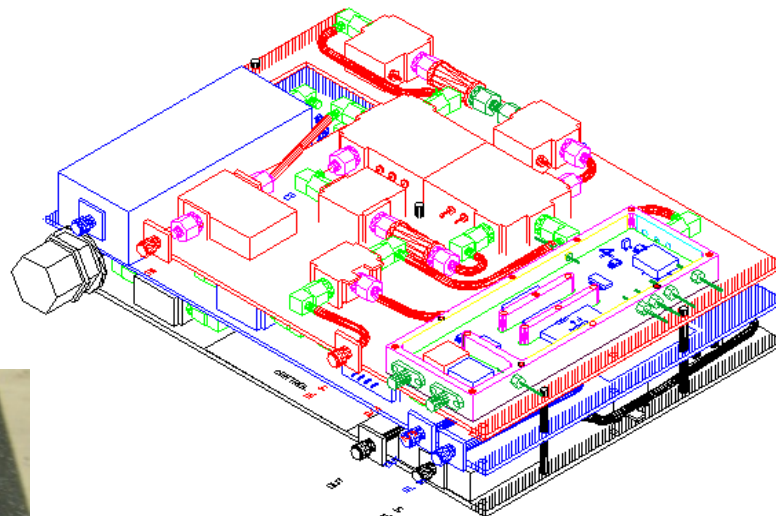
Dual band channel sounder .



RESEARCH PROJECTS. COMMUNICATIONS SYSTEMS

RADIO SOFTWARE TRANSCEIVER. **INDRA/Ministry of Army**

- Complete radio transceiver from: 40MHz to 2000MHz
- Development of the system:
- Receiver, filters and PLL
- Construction and measurements





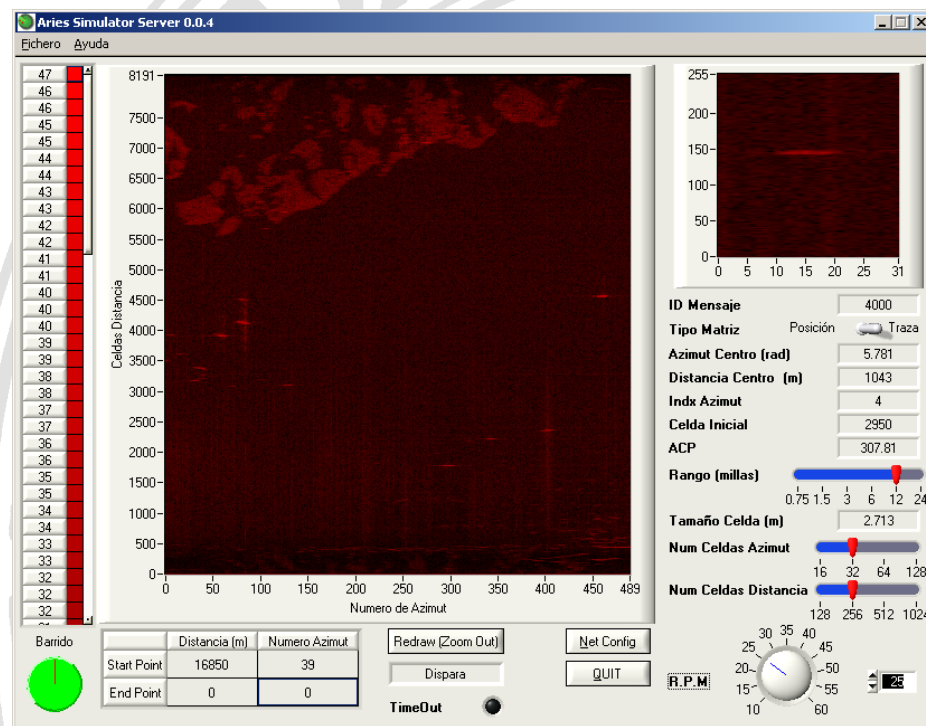
RESEARCH PROJECTS. COMMUNICATIONS CIRCUITS

Radar Signal processing based on FPGA Minister of Defense. Radar ARIES

- Radar processing unit: FPGA
- Radar control software
- Test and measurements



Control software

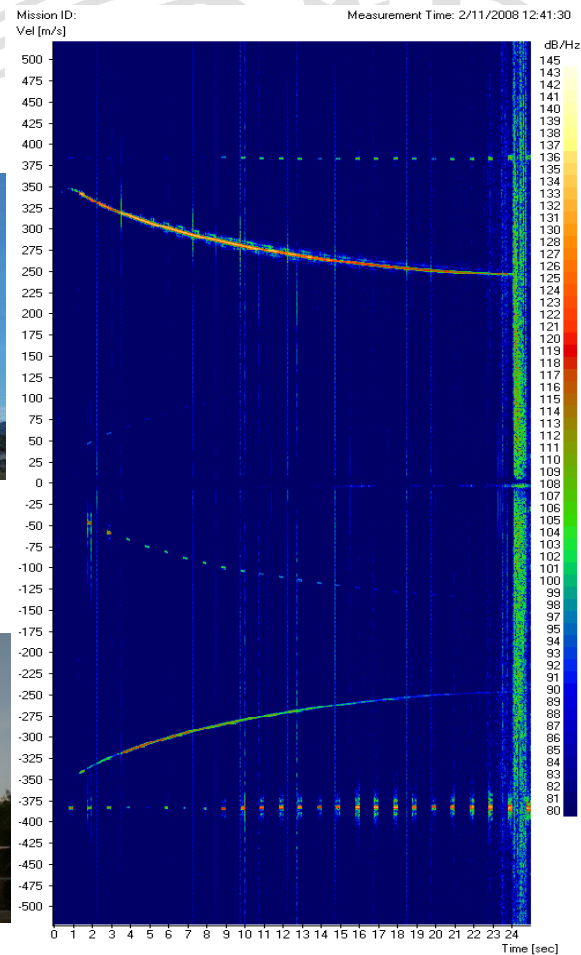




RESEARCH PROJECTS. COMMUNICATIONS SYSTEMS

Radar Calibration System Minister of Defense.

- Complete design and simulation of the system(C- Band)
- Radar control software
- Test and measurements

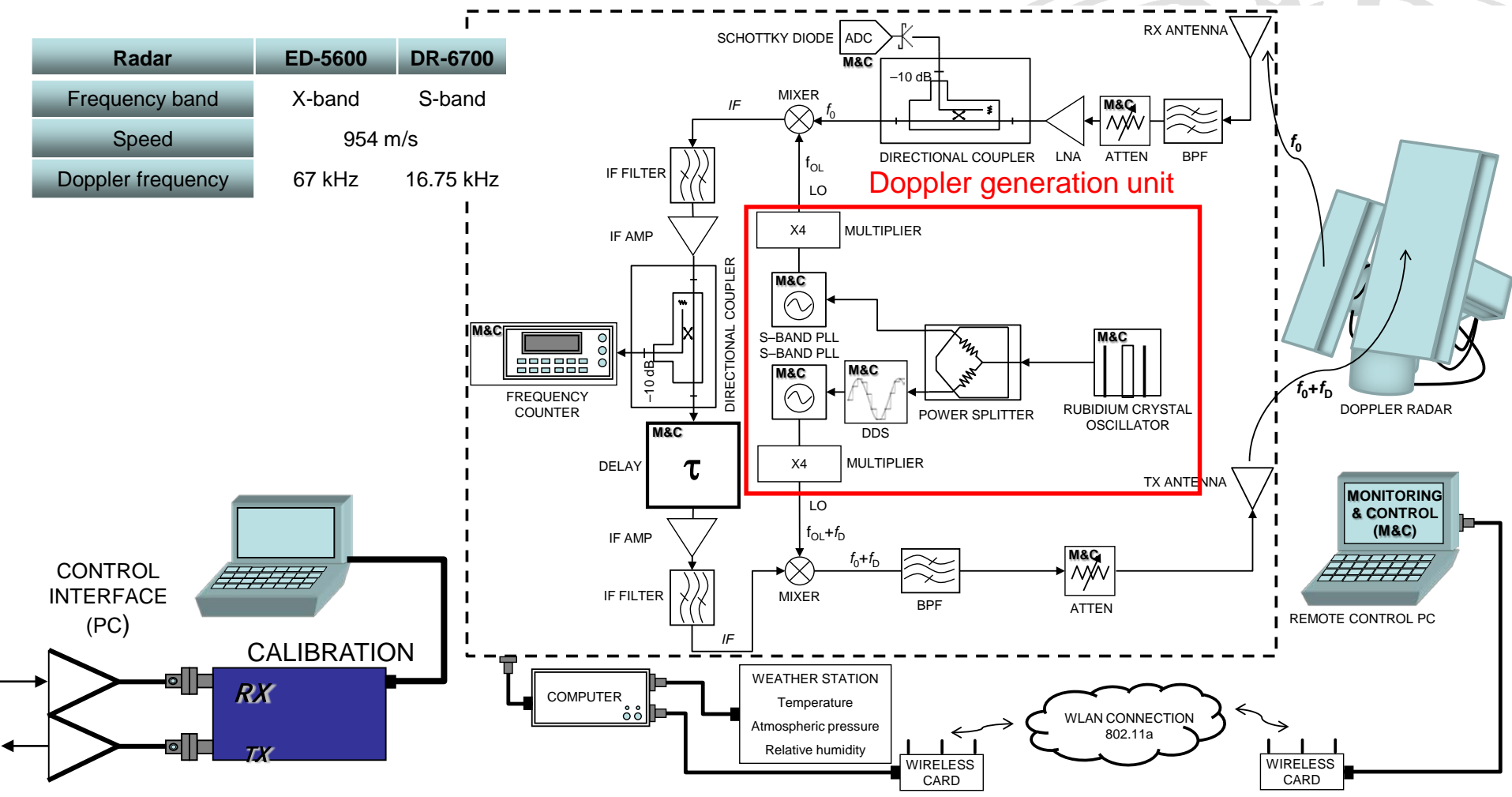




RESEARCH PROJECTS. COMMUNICATIONS SYSTEMS

Radar Calibration System

Radar	ED-5600	DR-6700
Frequency band	X-band	S-band
Speed	954 m/s	
Doppler frequency	67 kHz	16.75 kHz

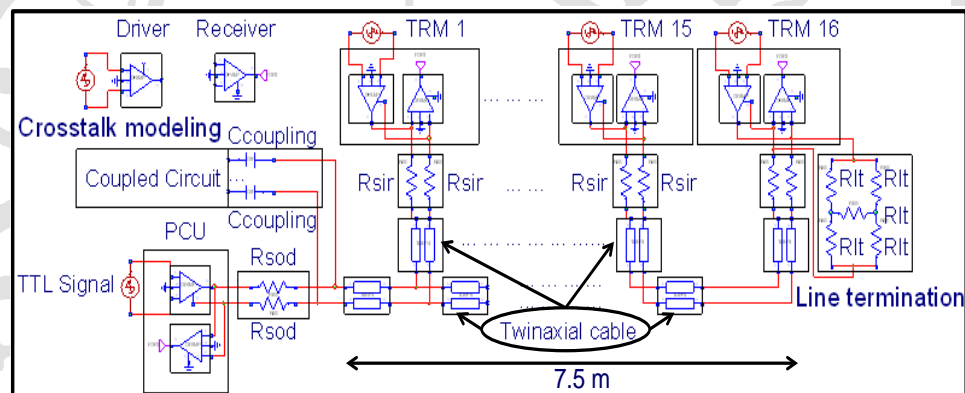
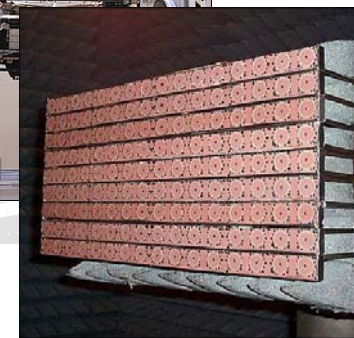
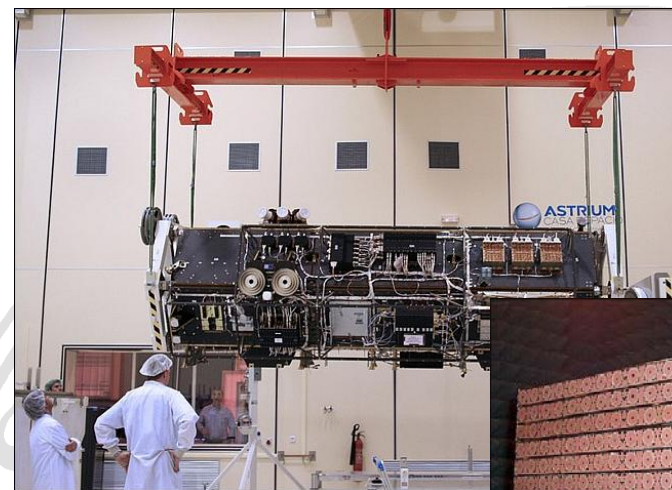
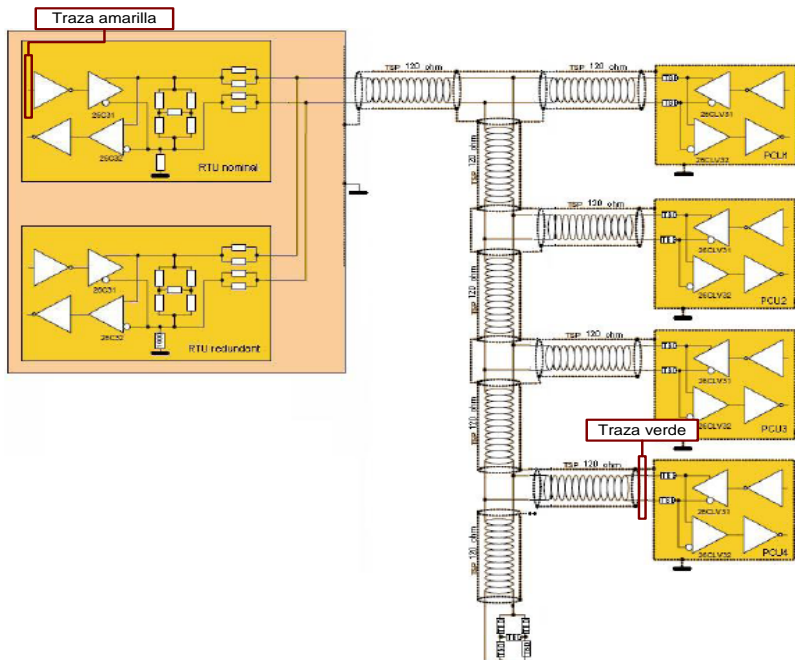


RESEARCH PROJECTS. COMMUNICATIONS SYSTEMS

SEOSAR/PAZ SATELLITE.

Ministre of Army

- SAR RADAR
- Modelling of the distribution network
- Test and measurements



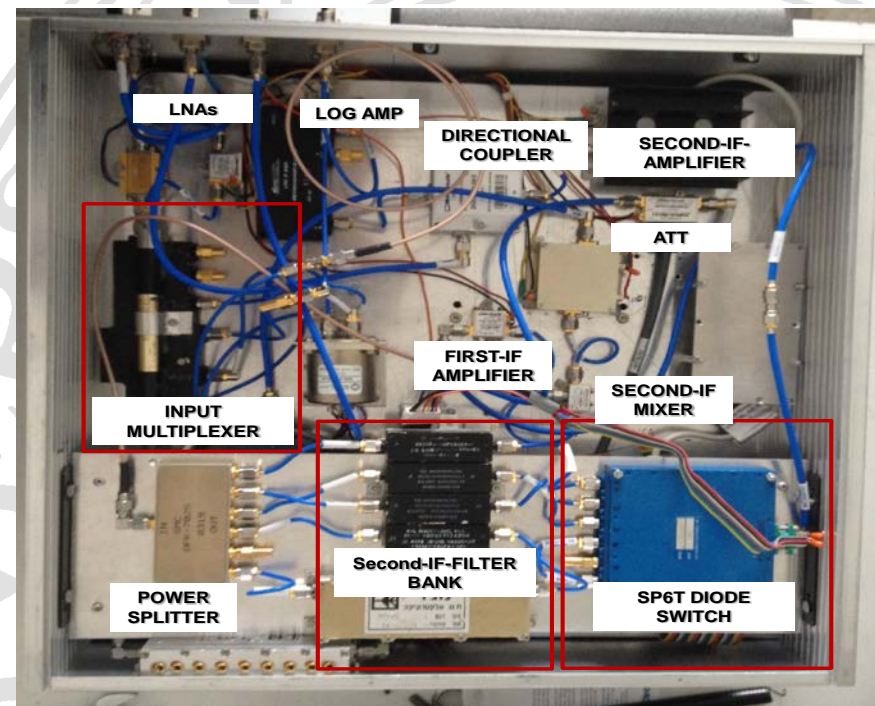
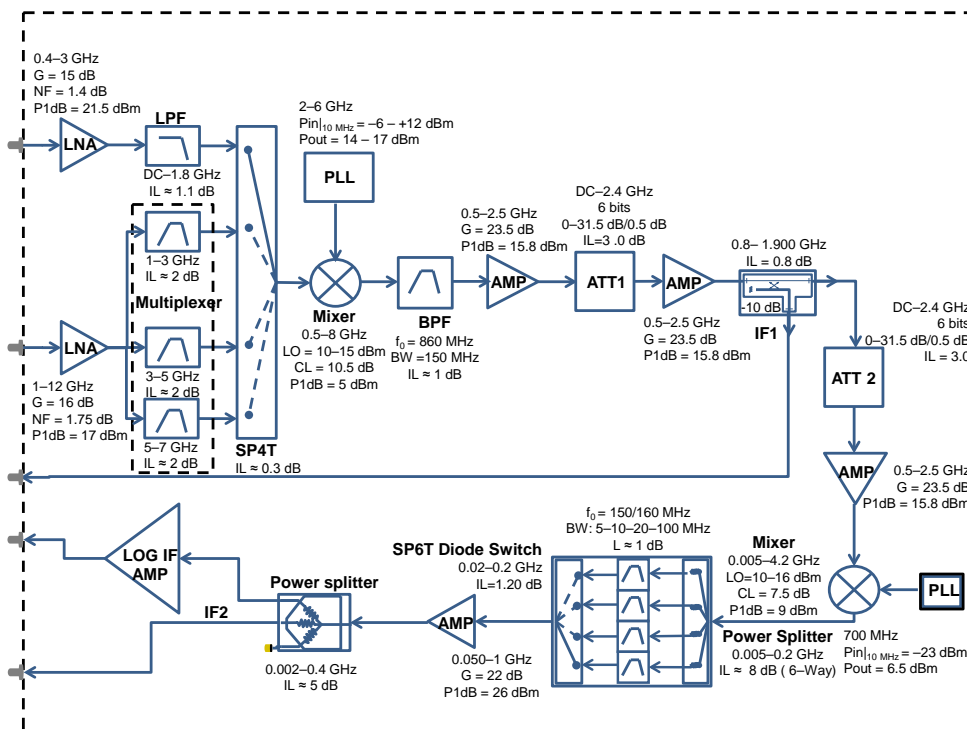


RESEARCH PROJECTS. COMMUNICATIONS SYSTEMS

ULTRA WIDE BAND CHANNEL SOUNDER

PROJECT: Ministry of Science

- RX front end :0.01-7 GHz, BW=5-100MHz
- Wide band logarithmic detector



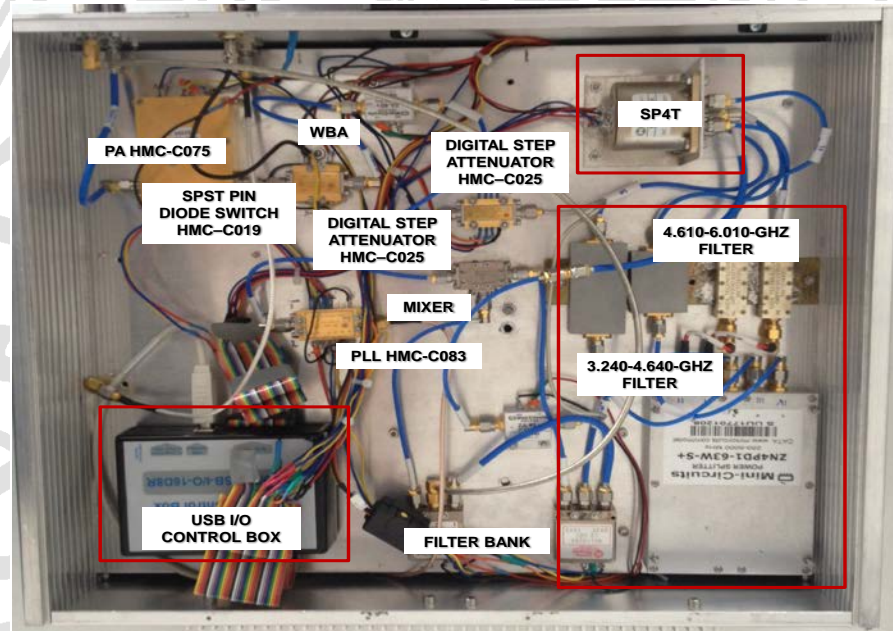
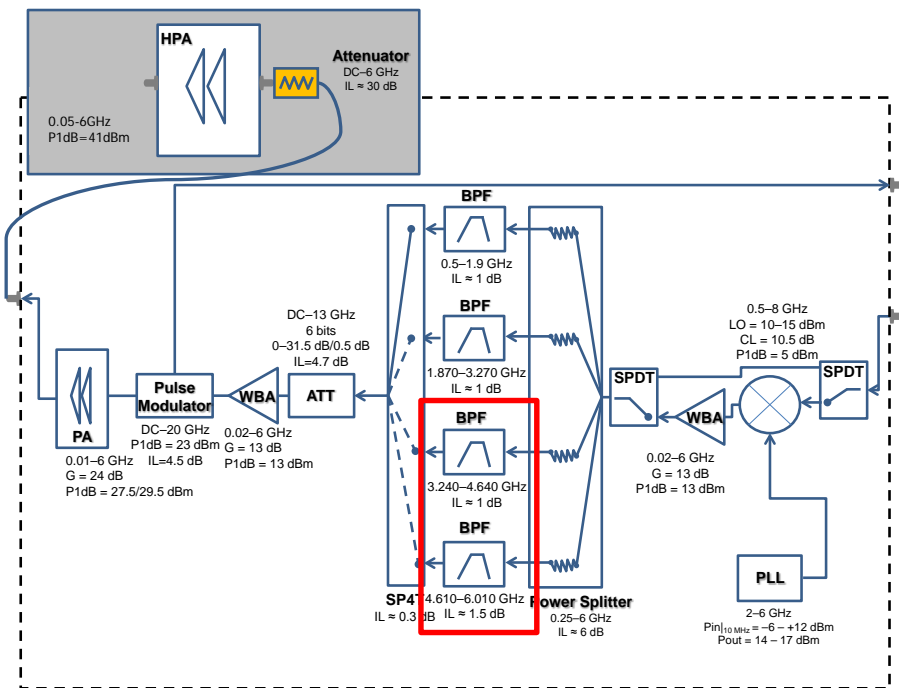


RESEARCH PROJECTS. COMMUNICATIONS SYSTEMS

ULTRA WIDE BAND CHANNEL SOUNDER

PROJECT: Ministry of Science

- TX front end :
 - 0.01-6 GHz, 41 dBm, 1ns Pulse modulated





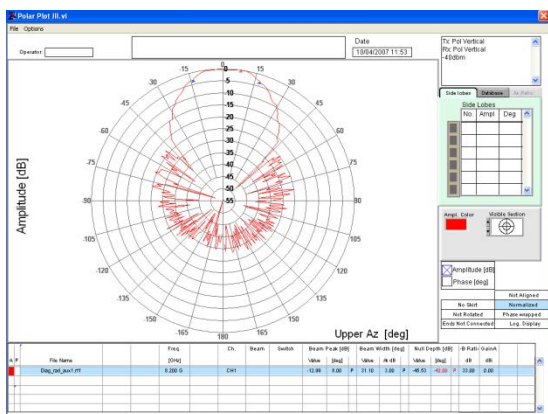
RESEARCH PROJECTS. COMMUNICATIONS SYSTEMS

ANTENNA TEST AND MEASUREMENTS SYSTEM .

Ministry of Telecommunications, (Dirección General Telecomunicaciones)

Analysis of the test facility

- Minimal conditions
- Measurements errors
- Measurement software.





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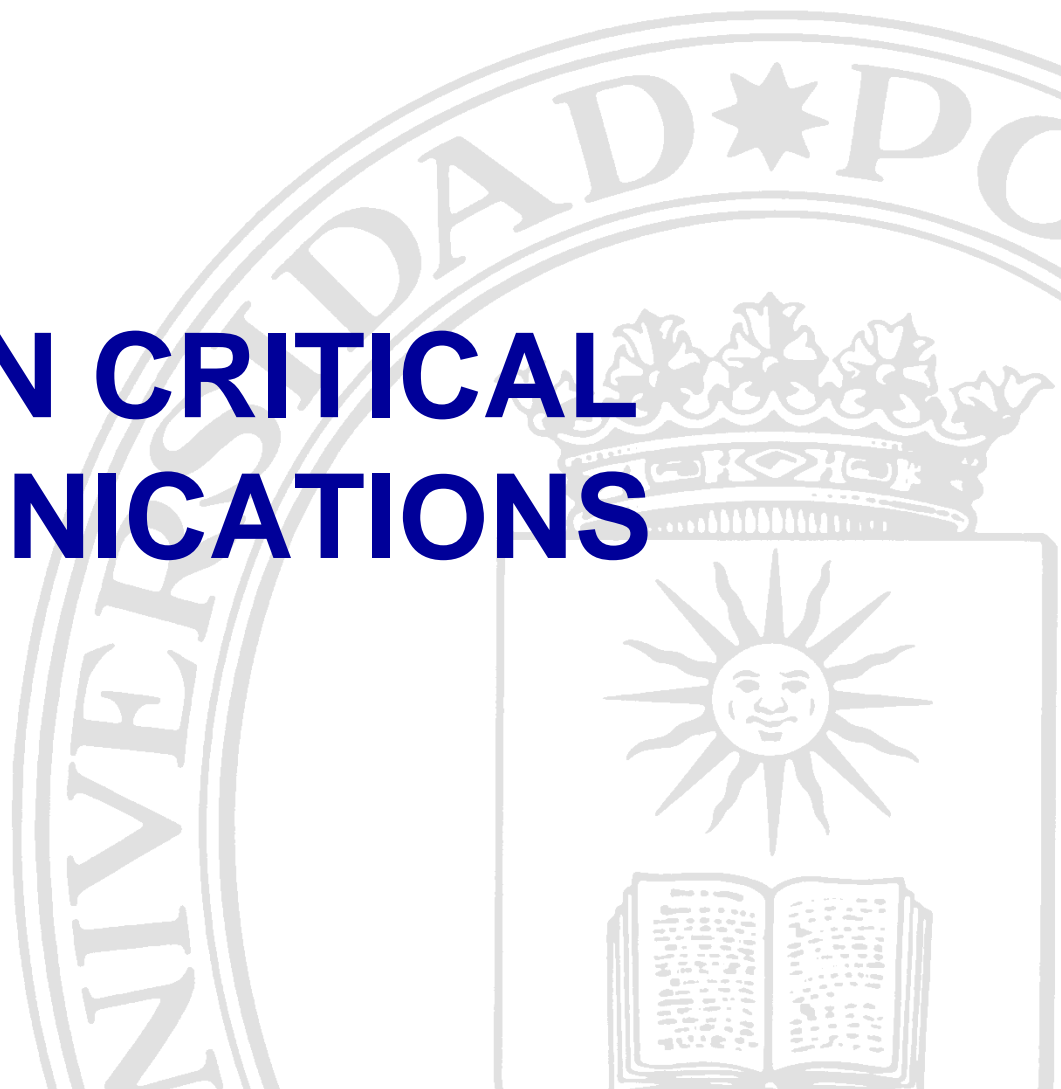
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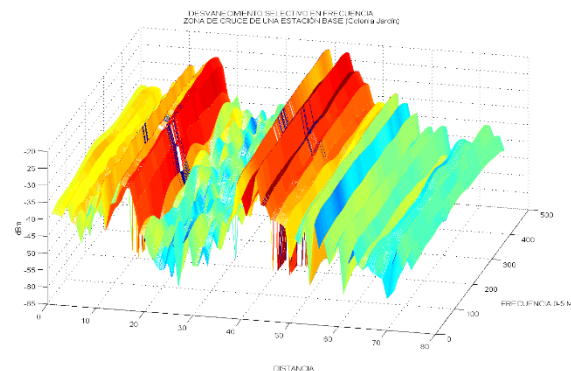
Mission critical communications Railway

Radio propagation measurements : Project: Metro de Madrid/Invensys sistema CBTC

TRANSMITTERS : Proprietary



Broadband Measurements



ADIF Línea AVE Madrid-Barcelona



Fig. 1. Tunnel and train used in measurements.

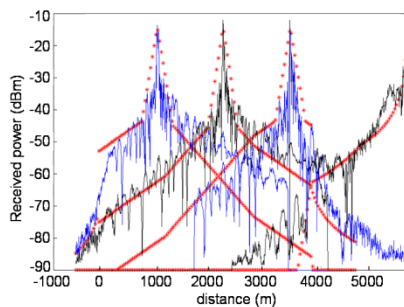
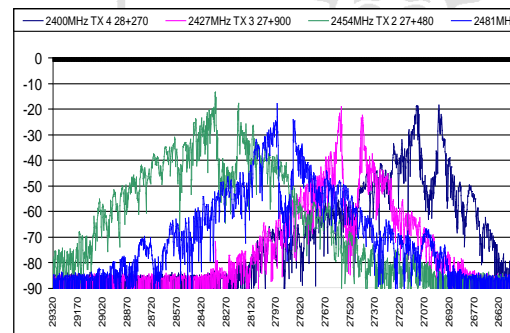


Fig. 12. Comparison of measurements and modelling. Multifrequency transmitters.





Mission critical communications

Research on wideband Communications at high Mobile speed

- Wide band radio test and evaluation in house.
- Proprietary Channel Emulation System for emulation of Communications up to 500Km/h
- Proprietary Channel modelling System

Wide band radios
2.4Ghz , 20Mbps

Propagation
emulator



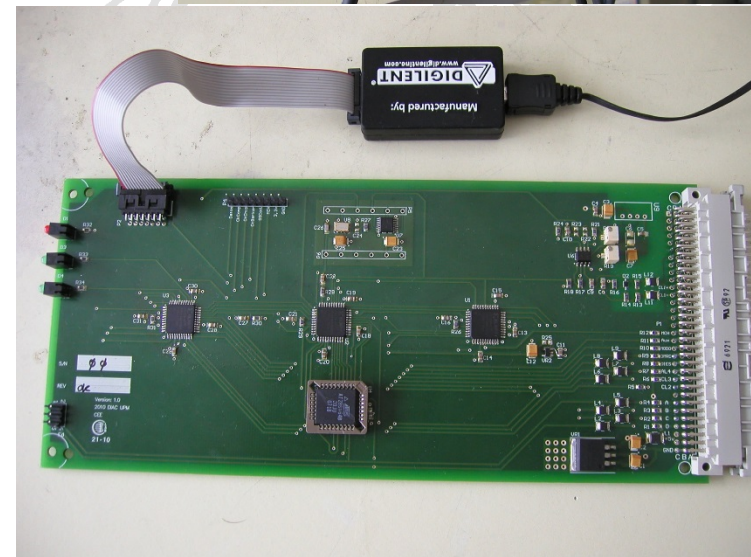
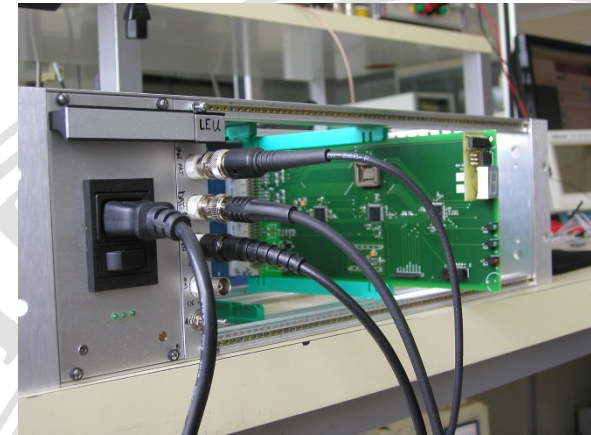
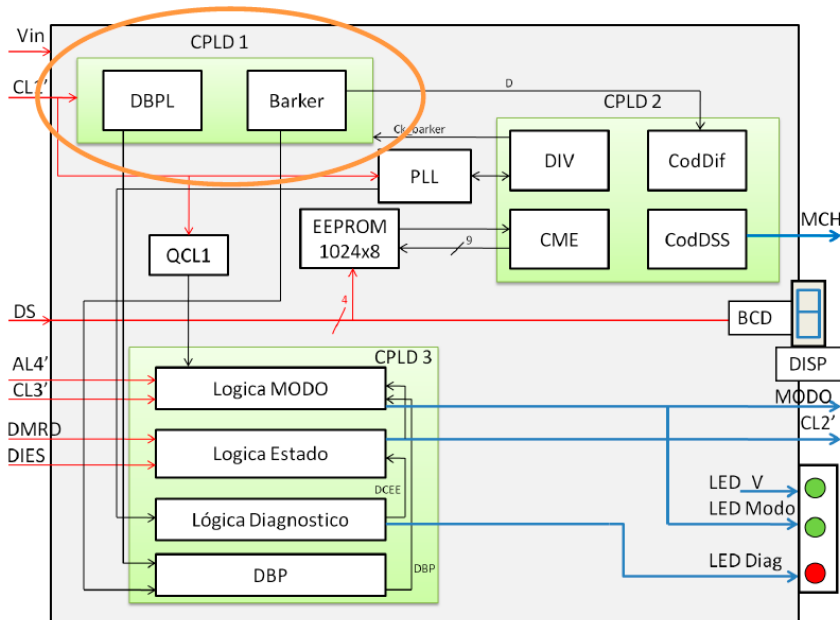


ETSIS Telecomunicación Mission critical communications CDMA MODEM

Euroloop Modem development: TRL-7.

Project: ADIF

- CDMA modulation
- SIL 4 desing
- Full desing: PCM, FPGA, soft



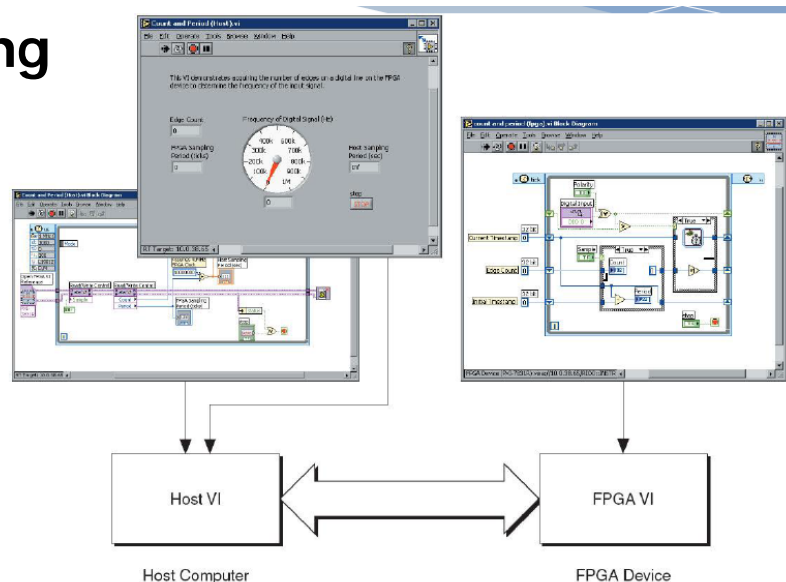
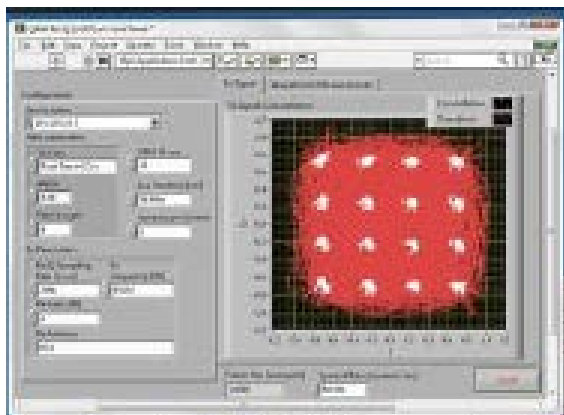


Mission critical communications Radio Software

Radio Signal detection and decoding

CNI: Ministry of army

- Digital Waveform detection
- Wideband Software Design Radio
- Data Demodulation
- Wide band 400-2500 MHz
- LabView and National USRP



Transceptor RF Front Ends

- Rangos de Frecuencia:
 - 50 - 2200 MHz (NI-2940R)
 - 400 - 4400 MHz (NI-2942R)
 - 2.4 GHz & 5.5 GHz (NI-2941R)

Procesamiento y síntesis de Señales

- NI LabVIEW FPGA para integrar código específico en RT



RIO - Reconfigurable I/O

- Puertos digitales I/O personalizables

- 1/10 Gigabit Ethernet a PC
- Plug-and-play
- Conexión IQ banda base hasta 120 MS/s

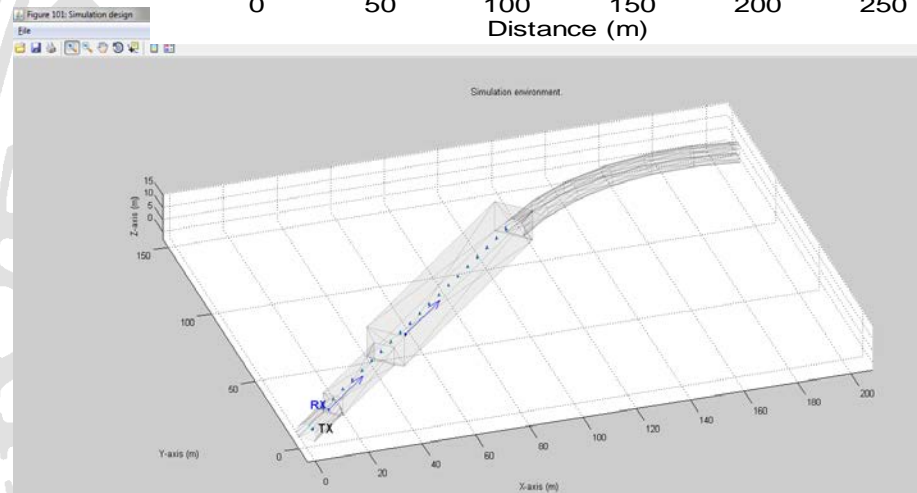
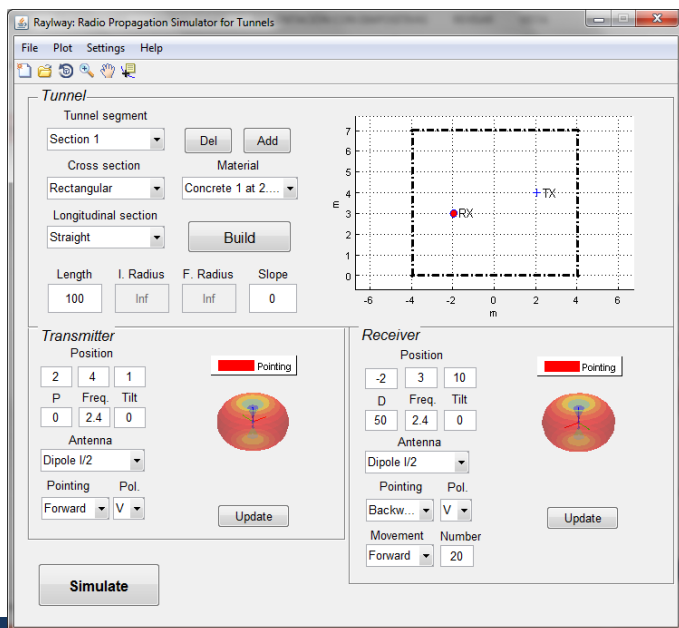
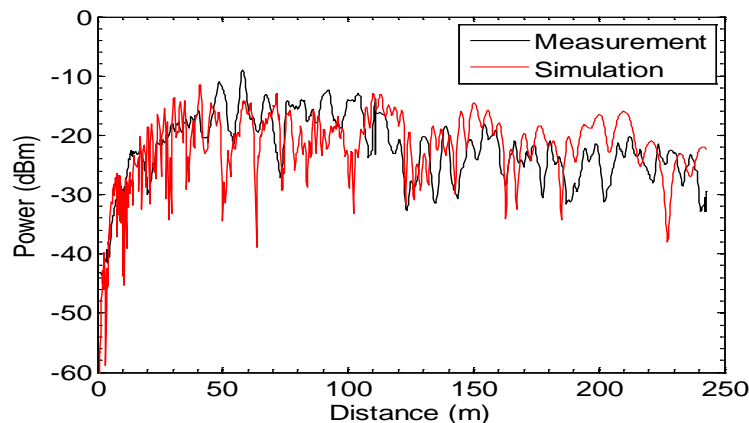


Mission critical communications Propagation Railway (HITACHI)

Radio Propagation Simulator: RAPS

MATHLAB

- Tunnels propagation simulation
- Ray tracing simulator
- Validated with measurements



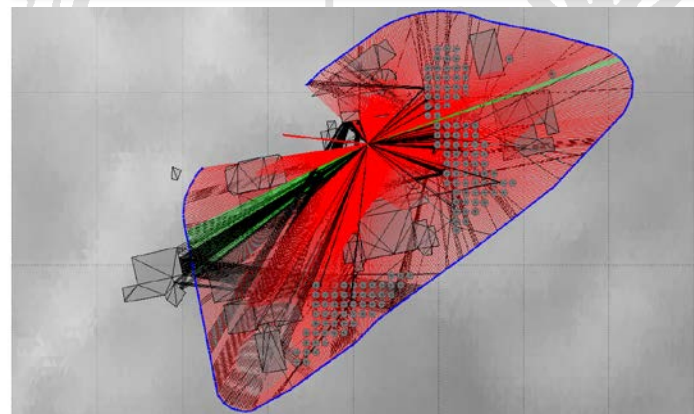
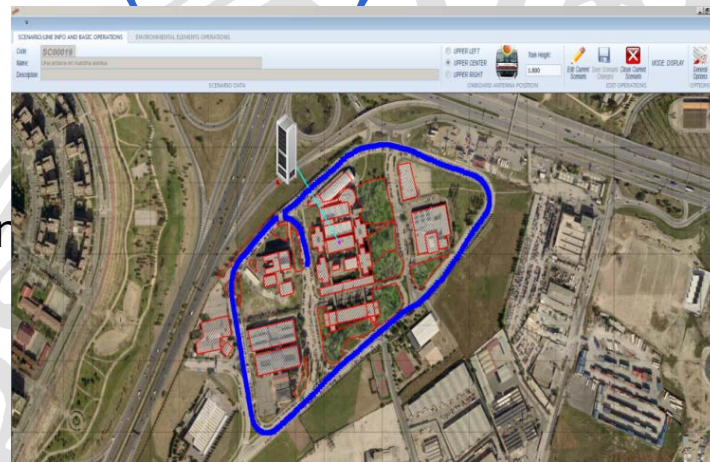


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Mission critical communications Railway (2011-2015)

Radio Propagation Simulator: RAPS International Research Project (Hitachi)

- Free space and tunnels propagation
- Specially designed for open areas
- Design and simulation of the environment
- Test and measurements
- Use of 3D cartography
- High accuracy (<5% error)





Mission critical communications Railway (2011-2015)

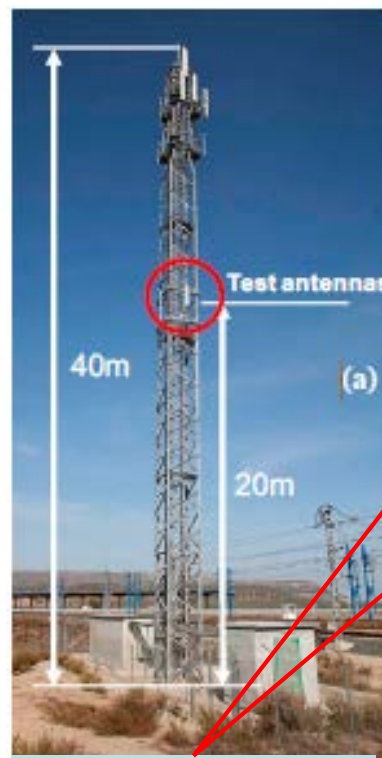
Ministry of Science

Broadband Propagation Measurements At high speed (300Km/h)

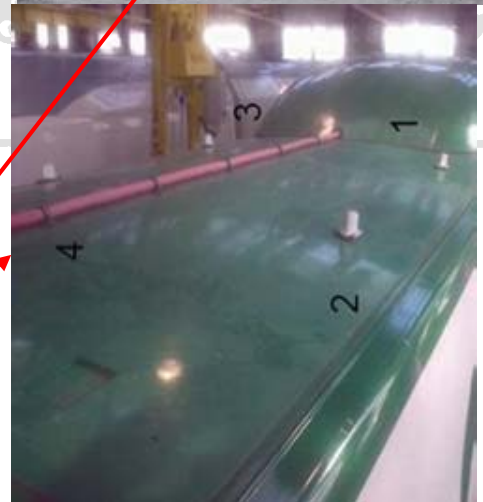
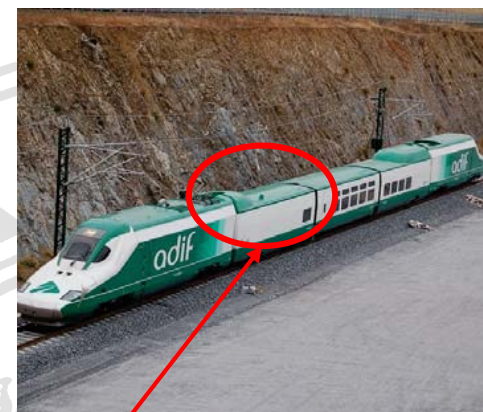
Participant: Nokia, AT4Wireless, ADIF,
UPM,UAC, UM

Experimental setup

Carrier frequency	2600 MHz (LTE Band)
Bandwidth	10 MHz (9 MHz occupied)
Nº of carriers	1024 (600 used)
Speed of the train	300 km/h



Outdoor





COMUNICACIONES T2T . Shif2Rail

Equipos de medidas

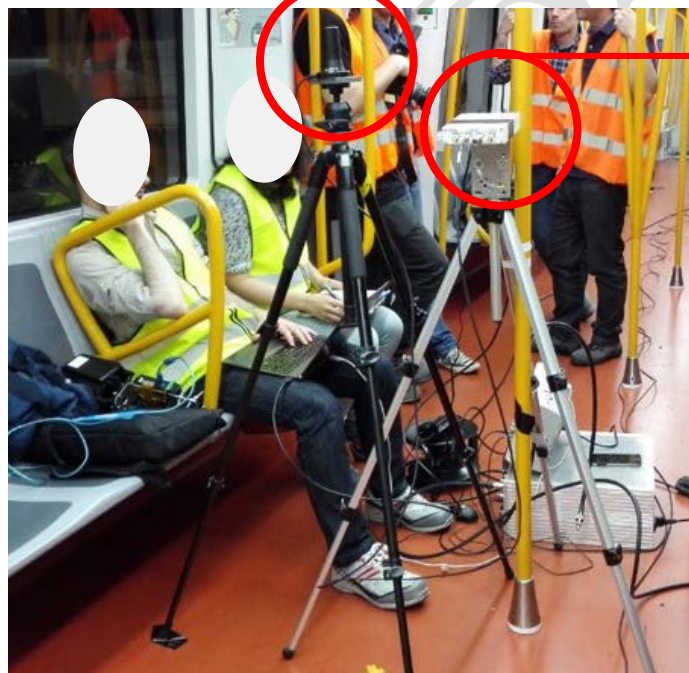
- Banda ancha: Sonda de canal, 100MHz ancho de banda
- Banda estrecha: equipo radio software USRP

Modelado

- Pérdidas del camino
- Distribuciones estadísticas de los desvanecimientos rápidos
- Modelo de banda ancha:
 - Perfil de retardo de potencia
 - Estadísticos

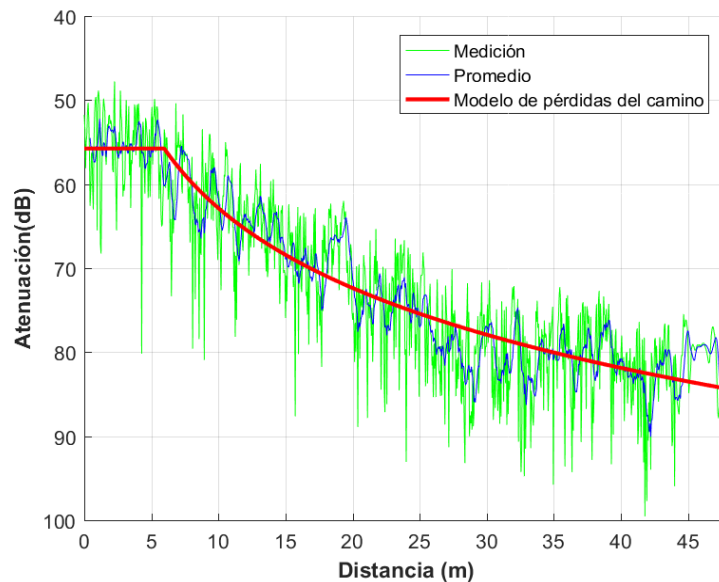
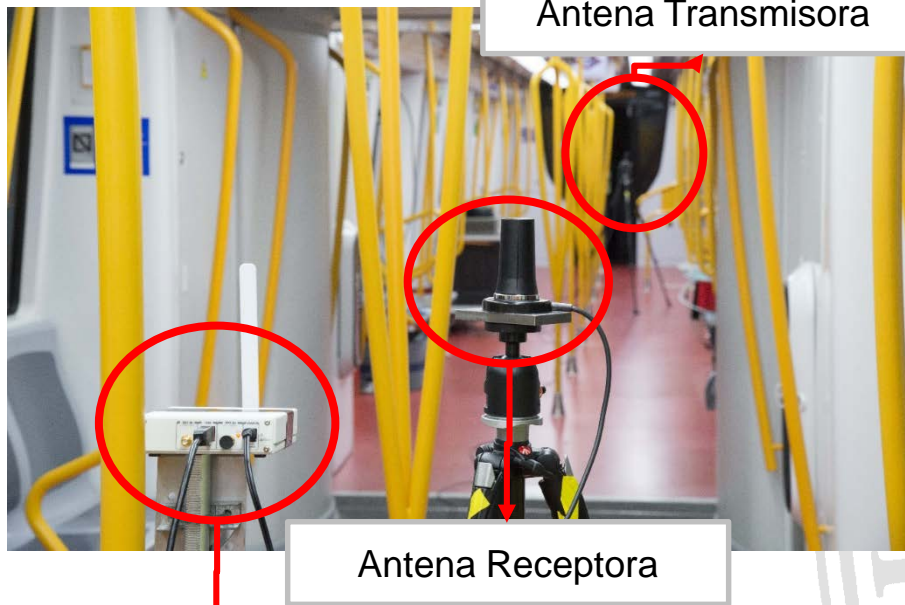
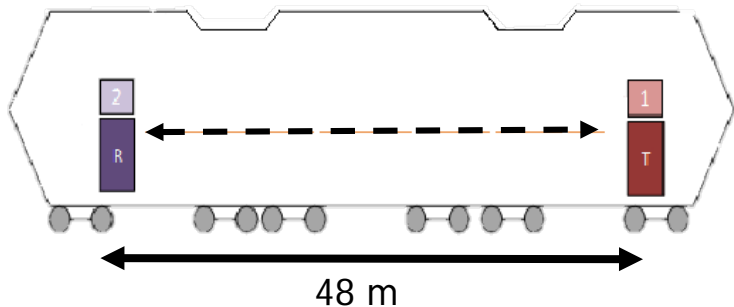
Monopolo de banda ancha

Receptor USRP



Receptor Sonda de Canal

PROPAGACIÓN INTERIOR TRENES (TCMS). Shift2Rail



- Modelo dos pendientes

$$A(dB) = \begin{cases} 55,8 & \text{si } d < 6 \\ 31,6 \cdot \log(d(m)) + 31,2 & \text{si } d \geq 6 \end{cases}$$

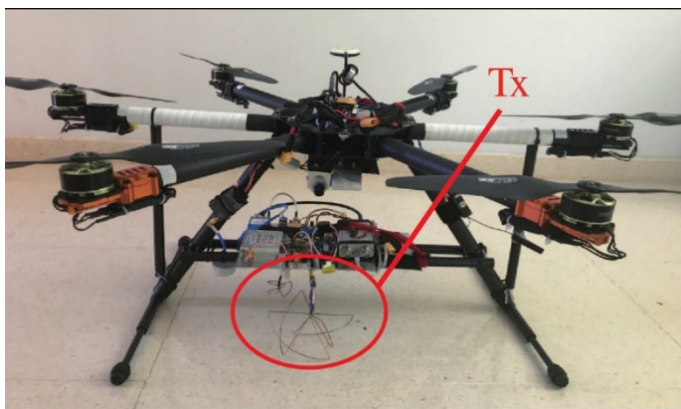
- Fuerte efecto de las componentes de multirayecto

Distribución estadística	Rice
Desviación típica	0,5413
K (dB)	1,5538

RESEARCH PROJECTS: UAV

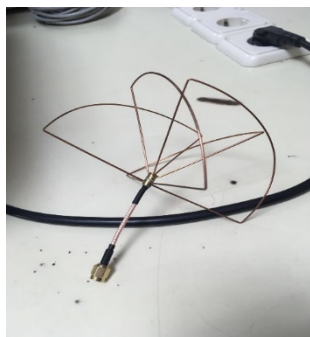
Wide band Propagation channel modeling and Communications testing for UAVs

Spanish Agency of Aerial Security, Ministry of transport



UAV

The UAV was an hexacopter of 3 kg weight, able to carry a 2 kg payload and 20 minutes flying time.



Tx



Rx

Configuration

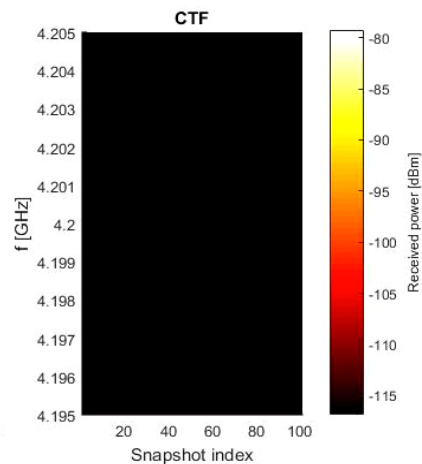
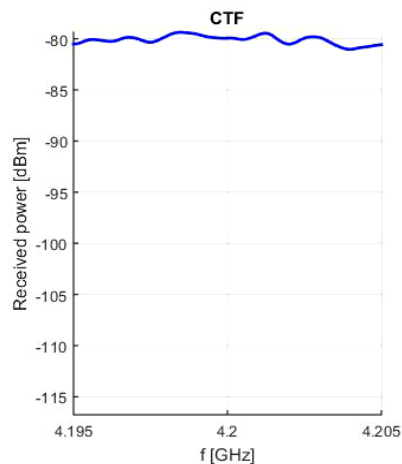
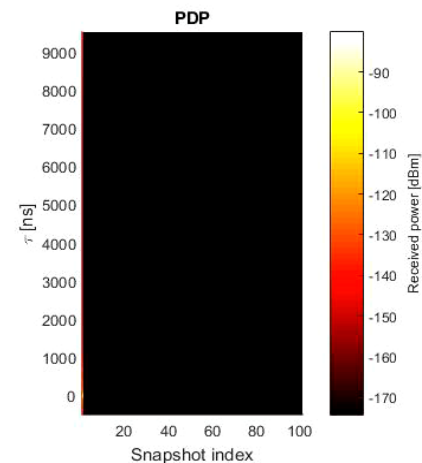
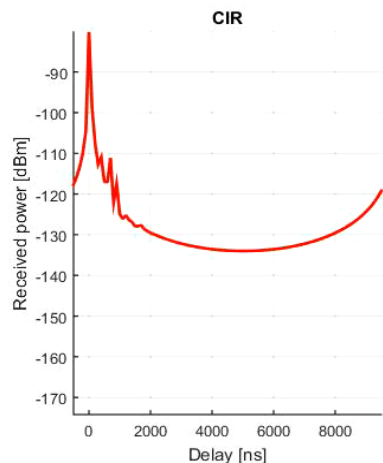
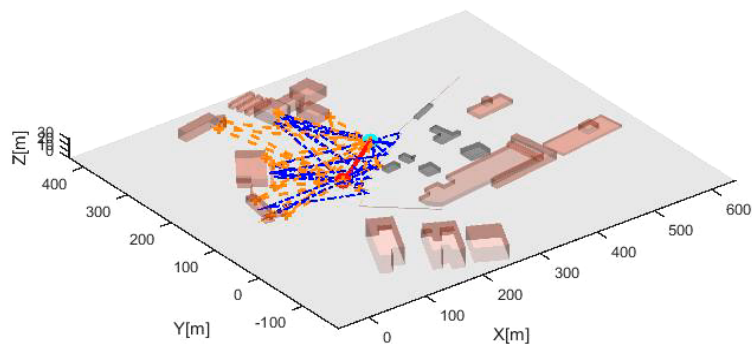
Carrier frequency	L band	C band
	1.2 GHz	4.2 GHz
Transmitting power	30 dBm (maximum)	
Tx	Cloverleaf antenna, circular polarization	
	1.2 dBi gain	1.5 dBi gain
Rx	MGRM-WHF, vertical polarization with omnidirectional horizontal radiation pattern	
	5 dB gain and 45°-50° 3 dB elevation beam width.	



Wide band Propagation channel modeling for UAVs

Spanish Agency of Aerial Security,
Ministry of transport

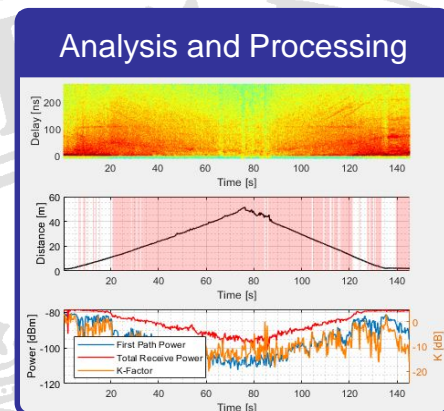
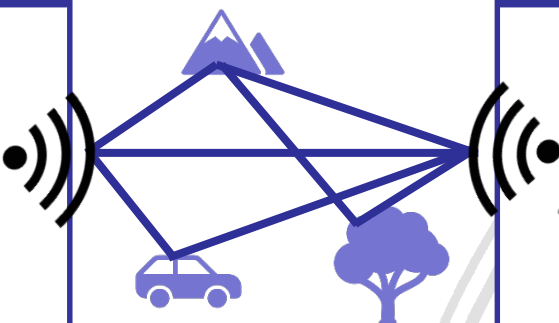
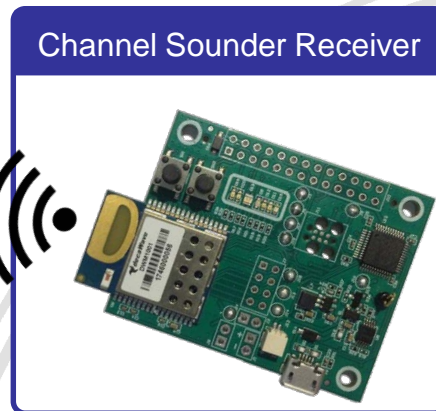
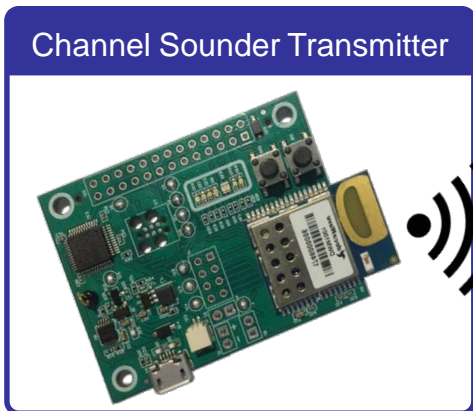
PROPAGATION SIMULATION UAVS





RESEARCH PROJECTS: (2021)

Portable UWB RADAR , UAVs. 500 MHz Bandwidth, 3-6GHz



Light weight

Flexible to config.

Easy to handle.

Trains

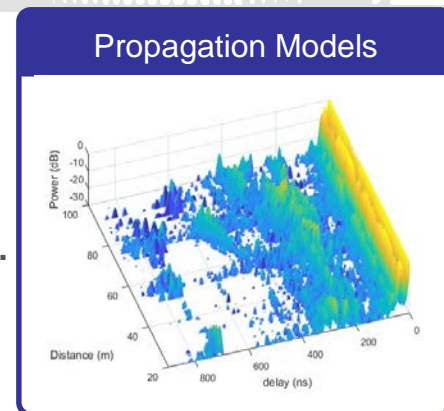
UAV

Indoor

No Sync. Need

1ns Resolution

30dB Dyn. Rang.



Used to model and extract useful channel parameters to perform on-lab channel emulations that optimized and enhances communication systems for complex environments.



RESEARCH RESULTS: 2012-2022

National and International Research Projects	10
Industrial research projects	30
PhD thesis	10
Research Paper on International Journals SCI	90
International congress	80
Books Chapters	4
Patents	4
Software Registration	6



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