

# IT - Instituto de Telecomunicações

José Neves

Aveiro, 21 de Outubro de 2011

INSTITUIÇÕES ASSOCIADAS:



INSTITUTO  
SUPERIOR  
TÉCNICO



Faculdade de Ciências  
e Tecnologia da  
Universidade de Coimbra



universidade  
de aveiro



Inovação



instituto de  
telecomunicações

*creating and sharing knowledge for telecommunications*

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# Estatuto e instituições associadas

## ➔ Associação Privada

Instituto Superior Técnico (IST)

Universidade de Aveiro (UA)

Faculdade de Ciências e Tecnologia da Universidade de Coimbra (UC)

Portugal Telecom Inovação

Nokia Siemens Networks (NSN)

Universidade da Beira Interior (UBI)

Instituto Superior de Ciências do Trabalho e da Empresa (ISCTE)

Universidade do Porto (UP)

➔ Sem fins lucrativos

➔ Utilidade Pública

➔ **Laboratório Associado**

**Missão**

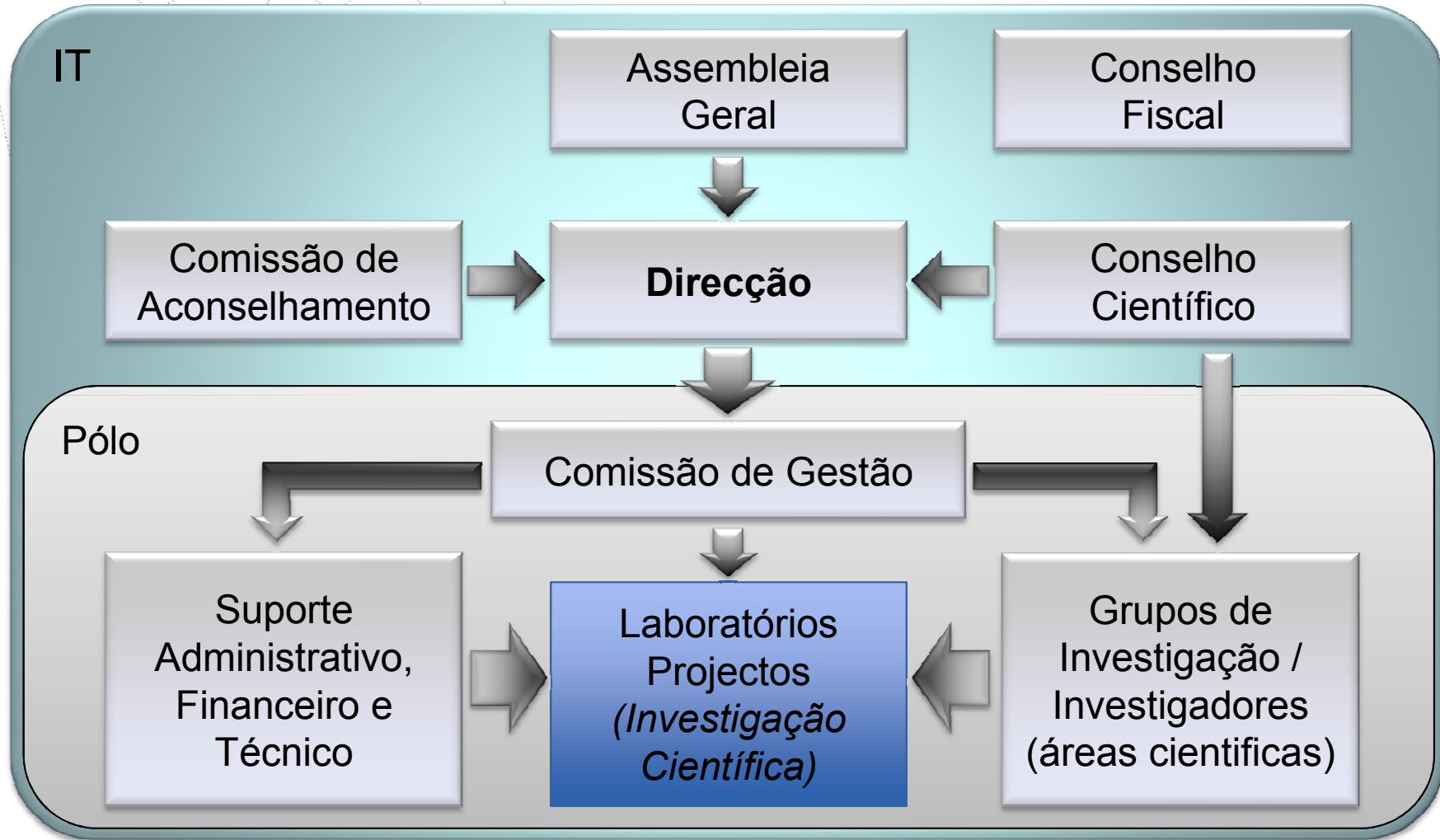
Criar e disseminar conhecimento científico e  
promover formação avançada no sector das  
telecomunicações

## Pólos do IT e outras parcerias

Instituto Politécnico de Leiria (IPL-ESTG)  
Instituto Superior de Ciências do Trabalho  
e da Empresa (ISCTE)  
Instituto Politécnico de Coimbra (ISEC)  
Instituto Politécnico de Lisboa (ISEL)  
Instituto Politécnico de Setúbal (EST)  
Instituto Politécnico de Tomar (ESTT)  
Universidade do Porto (UP)



# Organização



## Gestão e Contabilidade

➔ O IT-Aveiro é responsável pela Gestão Financeira e Contabilidade do IT, promovendo a consolidação contabilística

➔ Contabilidade Geral e Analítica

➔ Auditoria Financeira Externa

Organização científica

**Networks & Multimedia**

**Radio  
Comm**

**Optical  
Comm**

**Enabling Technologies**

**Basic Sciences**

# Organização por áreas temáticas

## Redes e Multimédia

- Arquitectura e protocolos
- Segurança e informação quântica
- Engenharia de tráfego
- Operações, gestão e planeamento de redes
- Aplicações e serviços de rede
- Processamento, análise e codificação de informação sonora e visual
- Reconhecimento de padrões e escuta automática

## Comunicações Móveis

- Análise e desenho de antenas
- Circuitos e equipamentos sem fios
- Ondas e propagação
- Sistemas de transmissão e recepção
- Redes de rádio

## Comunicações ópticas

- Componentes e subsistemas ópticos
- Sistemas de comunicações ópticas
- Redes ópticas

## Ciência Básicas e Tecnologias de Suporte

- Tecnologia e materiais
- Circuitos e sistemas integrados
- Radioastronomia
- Instrumentos e medidas
- Electrónica e sistemas de alimentação
- Matemática aplicada
- Lógica e computação



# Recursos Humanos

	2006	2007	2008	2009	2010
N.º docentes	31	32	37	40	44
Nº investigadores (a tempo inteiro) não docentes	86	120	126	136	150
Nº total de estudantes de pós-doutoramento	3	7	9	10	13
Nº total estudantes de doutoramento	28	24	25	49	52
Nº total de estudantes de mestrado	21	38	53	62	45
Nº técnicos de investigação/ prestação de serviços afectos à UI	3	4	6	6	8
Nº técnicos administrativos afectos à UI	6	6	7	7	8

# Produção científica

	2006	2007	2008	2009	2010
Revistas internacionais e livros/capítulos	46	52	59	55	57
Conferencias	75	105	123	130	130
Nº de patentes submetidas	9	6	9	11	15

# Contratação externa

	2006	2007	2008	2009	2010
Volume de contratação externa Financiamento Plurianual	112.000,00 €	144.000,00 €	166.500,00 €	220.000,00 €	292.000,00 €
Volume de contratação externa Projectos Nacionais	1.207.490,20 €	982.810,66 €	1.285.995,66 €	1.077.817,70 €	903.945,14 €
Volume de contratação externa Projectos Europeus	1.603.334,77 €	1.226.715,90 €	2.171.810,73 €	921.007,59 €	1.144.525,13 €
Volume de contratação externa Contratos / Prestação de Serviços	739.408,74 €	853.246,10 €	617.420,64 €	898.996,70 €	637.485,50 €
Volume de contratação externa Bolsas			80.049,88 €	54.369,32 €	24.078,83 €
Volume de contratação externa Universidade de Aveiro	182.064,24 €	475.085,51 €	760.449,90 €	446.411,04 €	1.432.964,79 €
<b>Total</b>	<b>3.844.297,95 €</b>	<b>3.681.858,17 €</b>	<b>5.082.226,81 €</b>	<b>3.618.602,35 €</b>	<b>4.434.999,39 €</b>

# Participation in FP7 (Future Networks)

<i>Top Participants in Terms of Project Participation</i>	<i>Top Participants in Terms of Budget</i>
• Alcatel-Lucent	• Ericsson
• Nokia-Siemens	• Alcatel-Lucent
• Ericsson	• France Telecom
• Telefonica	• Commissariat à l'Energie Atomique (CEA)
• Fraunhofer Institute	• Nokia-Siemens
• France Telecom	• Fraunhofer Institute
• Universitat Politecnica de Catalunya	• Thales
• Instituto de Telecomunicacoes	• Telefonica
• Commissariat à l'Energie Atomique (CEA)	• Instituto de Telecomunicacoes
• Groupe des Ecoles des Telecommunications (GET)	• Motorola
• Motorola	• NEC
• Interdisciplinair Instituut voor Breedband Technologie (IBBT)	• Interdisciplinair Instituut voor Breedband Technologie (IBBT)



**Novas interações com a indústria**

# Telesal

**Centro de excelência em  
telecomunicações**

Parceiros:

- Universidade de Aveiro
- Nokia Siemens Networks
- PT Inovação
- InovaRia
- IT

Aveiro, 21 de Outubro de 2011



**Novas interações com a indústria**

**TICE.PT**

**Pólo de competitividade e tecnologia**

Objectivo:

- Colocar Portugal entre os 10 primeiros países da UE no que se refere ao peso das TICE:
  - no PIB;
  - no emprego;
  - no investimento em I&D;
  - no volume total de exportações.

## Novas interações com a indústria

# TICE.PT

- 42 entidades entre empresas de alto valor tecnológico e instituições do SCTN agrupadas em torno da UA e do IT.
- Envolver e mobilizar os principais actores das TICE nos processos de:
  - Inovação I&DT;
  - Transferência do conhecimento;
  - Formação avançada;
  - Desenvolvimento;
  - Produção e comercialização de produtos e serviços;
  - Marketing e internacionalização.

## Realizações

- ➔ Equipa competente, devotada e motivada.
- ➔ Numero elevado de estudantes finalistas. Em 2009/10 o IT foi a instituição de acolhimento de 72 estudantes finalistas para a realização de dissertações de mestrado.
- ➔ Número elevado de candidatos aos programas doutorais na área das Telecomunicações (MAP-Tele e Engenharia Electrotécnica) com significativo número de alunos estrangeiros.



## Realizações

- ➔ Forte capacidade de captação de financiamento externo junto da FCT, da UE, da ADI e do mundo empresarial. Segundo dados oficiais da Comissão Europeia, na tabela dos principais participantes no FP7 (Future Networks) o IT encontra-se entre os 10 maiores beneficiários, quer a nível de número de projectos quer a nível de financiamento concedido.

## Realizações

- ➔ Possuímos uma forte ligação com a indústria, nomeadamente através das nossas associadas PT-Inovação e Nokia Siemens Networks. Achamos importante fortalecer e expandir este tipo de relacionamentos.



## Realizações

➔ Os investigadores do IT estão cada vez mais conscientes da necessidade de proteger a propriedade intelectual. Isto reflecte-se no aumento do número de patentes desde 2005. No futuro é necessário que este esforço seja complementado com a capacidade de capitalização do IPR (Intellectual Property Rights). Empreendedorismo está a começar e deve ser incentivado e apoiado activamente.



## Realizações

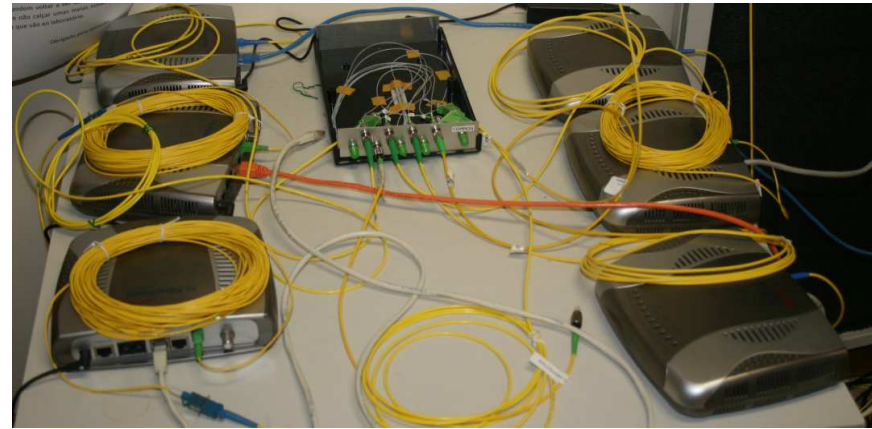
- ➔ Os estudantes de doutoramento são o cerne das actividades de investigação do IT. Para permanecer competitivo, o IT deverá ser capaz de atrair mais e melhores estudantes de doutoramento.
- ➔ O IT já alcançou excelência a nível nacional e internacional em algumas áreas. É necessário estender a excelência a outras áreas das telecomunicações.

## Realizações

➔ Com a experiência ganha com as actividades do TELESAL - Rede de Excelência em Telecomunicações - o IT-Aveiro deverá continuar e mesmo reforçar a cooperação com as empresas no âmbito do Pólo de Competitividade TICE.PT, nomeadamente deverá encorajar as interacções com as PME's nacionais com o objectivo de as envolver em consórcios nacionais e internacionais.

## GPON in a BOX

The main objective is to develop new components for the next generation of optical networks. These components, to be manufactured by the Portuguese industry, should provide complete off-the-shelf solutions to interconnect residences and business centers throughout optical fibers, allowing the subscription of services such as digital and analog TV, internet and voice. The characteristics for the developed solutions, in comparison with commercial ones are the low implementation cost and energetic consume, flexibility in terms of network design and interoperability with other brands equipments.



### Research team

Paulo André<sup>1,2</sup>, Armando Nolasco Pinto<sup>1,3</sup>, António Teixeira<sup>1,3</sup>, Mário Lima<sup>1,3</sup>, Rogério Nogueira<sup>1,2</sup>, João Lemos Pinto<sup>1,2</sup>, Ali Shahpari<sup>1</sup>, Telmo David Pelicano de Almeida<sup>1,2</sup>, Gabriel Gonçalves<sup>1</sup>, Fernando Jorge Lopes Parente<sup>1</sup>, Andreia Juliana Alves<sup>1</sup>, Irina Paula Mendes dos Santos Carvalho<sup>1</sup>, Paulo Miguel Alves Monteiro<sup>1</sup> José Pedro De Sousa Girão<sup>1,3</sup> e João Pedro Morais Davim<sup>1</sup>

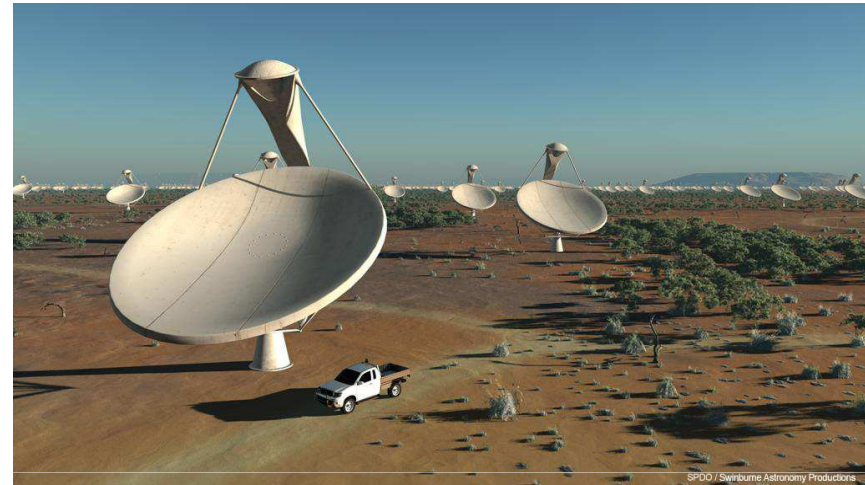
1 - Instituto de Telecomunicações

2 - Departamento de Física da Universidade de Aveiro

3 - Departamento de Electrónica Telecomunicações e Informática da Universidade de Aveiro

## SKA : The Square Kilometer Array

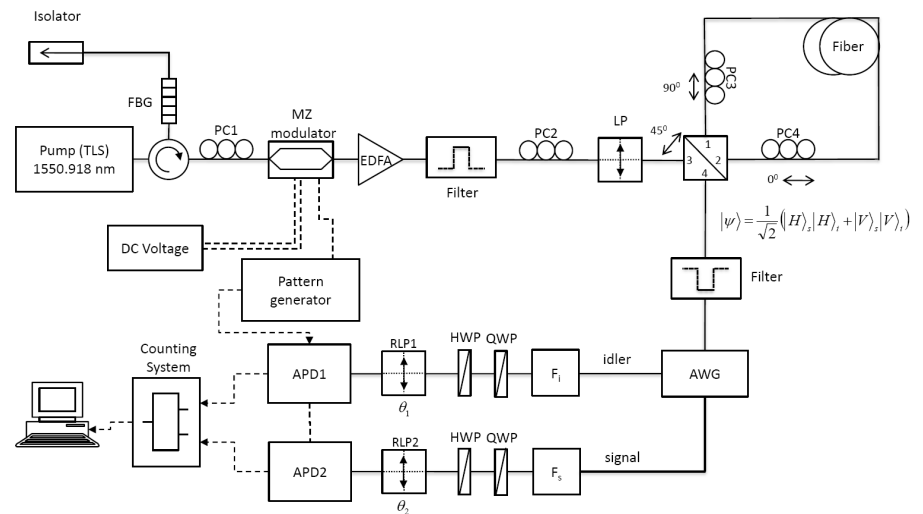
The SKA project is a global project with the participation of 17 countries and 55 institutions around the world (Europe, USA, China, Australia, South Africa, Russia, India, South Korea, Japan, Brasil) whose Phase 1 of construction shall start by 2015. As a top project from the ESFRI roadmap, it aims the construction and installation in the South Hemisphere (either in Australia or South Africa) of a giant radiotelescope that will represent the future of radio astronomy, probing an ample radio wavelength bandwidth from decametric waves up to microwaves.



- > **Research team**
- > Domingos Barbosa
- > Miguel Bergano
- > Claudia Camacho
- > Paulo André
- > Rogério Nogueira
- > Paulo Monteiro
- > Rui Aguiar

# Quantum Cryptography

We have been engineering secure fiber-optic communication systems based on quantum cryptography. Instead of being based on unproven lack of computational power, like traditional cryptographic protocols, quantum cryptographic protocols relies on fundamental laws of nature to guarantee that any attempt to hack into a communication system cannot go undetected.

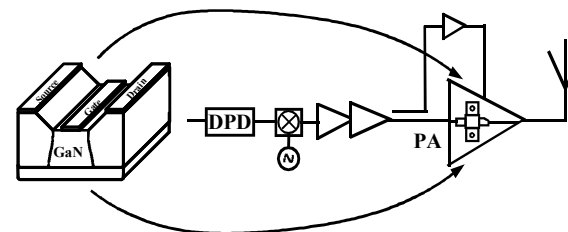


- > **Research team**
- > Armando Nolasco Pinto
- > Nuno Alexandre Silva
- > Nelson de Jesus Muga
- > Álvaro Almeida
- > Steven Ramos Carneiro
- > Luís Martins
- > Gil Fernandes
- > Manfred Niehus
- > Paulo André
- > Rogério Nunes Nogueira
- > João Lemos Pinto



## Power Amplifiers: From Semiconductors to Linearised Wireless Systems

WiSeLPAS – Power Amplifiers: From Semiconductors to Linearised Wireless Systems is a eighteen months project within the EC Network of Excellence TARGET – Top Amplifier Research Group in a European Team. It is devoted to fill in all the gaps between the most basic phase of semiconductor growth up to the design of complete wireless transmitter systems. Therefore, it addresses material and device characterization, power amplifier design, and system level integration.

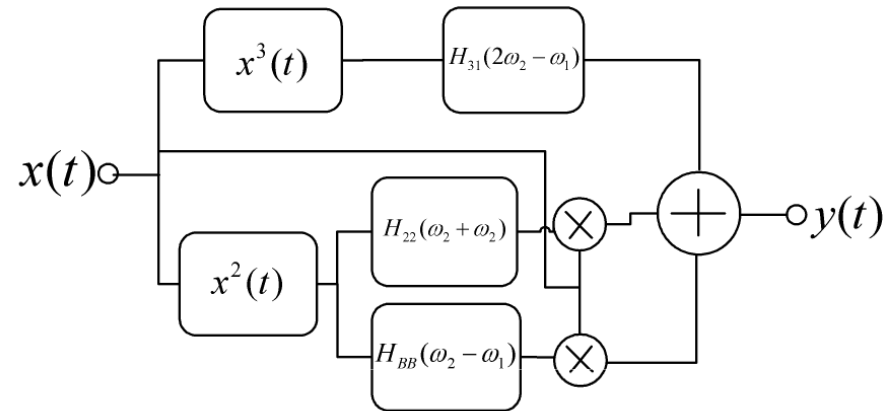


- > **Research team**
- > José Carlos Pedro
- > Pedro Miguel Lavrador
- > Pedro Miguel Cabral
- > Telmo Reis Cunha

TARGET EC Project No 507893

## Compensation of Long Term Memory Effects in Power Amplifier Intermodulation Distortion

The main objective of this project is to propose new design techniques for power amplifiers (PA) in order to transform a dynamic PA into a memoryless one, mainly by eliminating thermal and/or trapping low frequency behaviors.

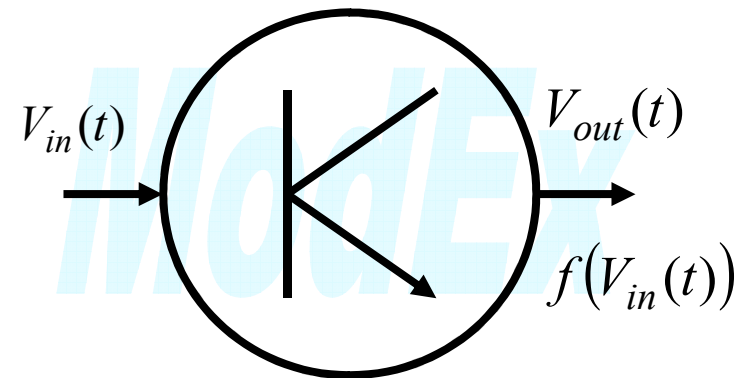


### Research team

- > Nuno Borges Carvalho
- > João Paulo Martins
- > José Carlos Pedro
- > Rui Estanqueiro Santos

## ModEx – Behavioral Model Extractor

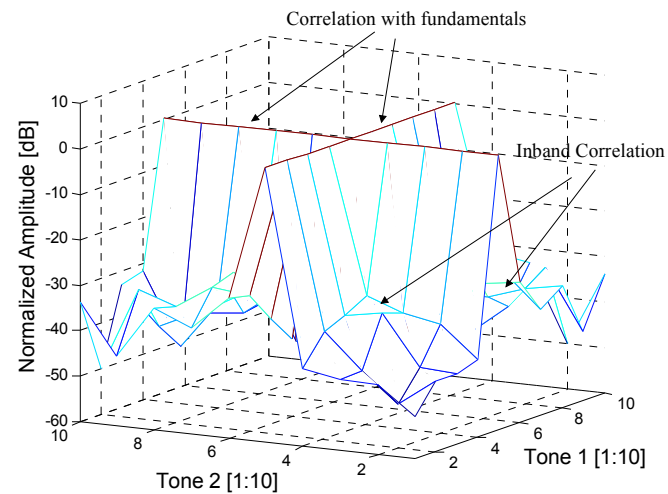
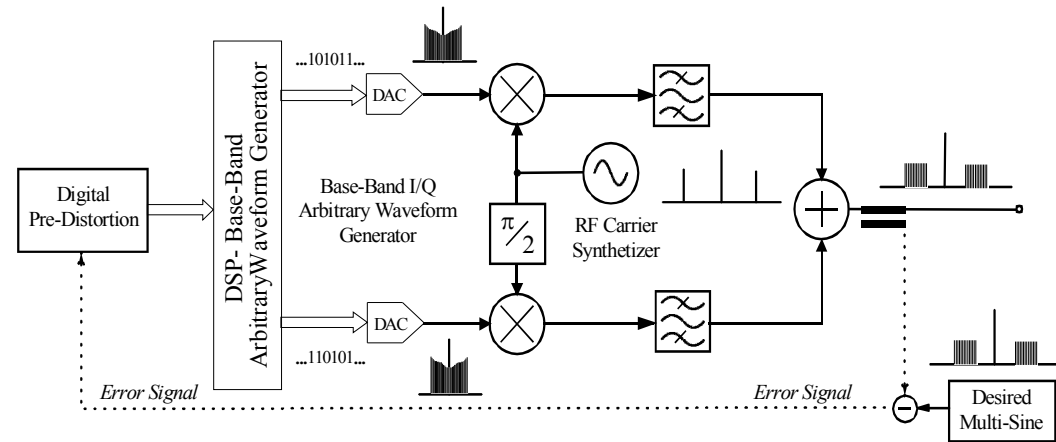
ModEx was a two year project dedicated to the design of mathematical models that simulate the input-output behavior of a power amplifier (PA), one of the most important components of a telecommunications hardware transmission chain. The PA is a nonlinear system with memory, and accurate modeling of its behavior is highly important for simulation purposes (at the design stage of telecommunication equipments) and also for industrial property guaranteeing.



- > **Research team**
- > Telmo Reis Cunha
- > José Carlos Pedro
- > Hugo Miguel Teixeira

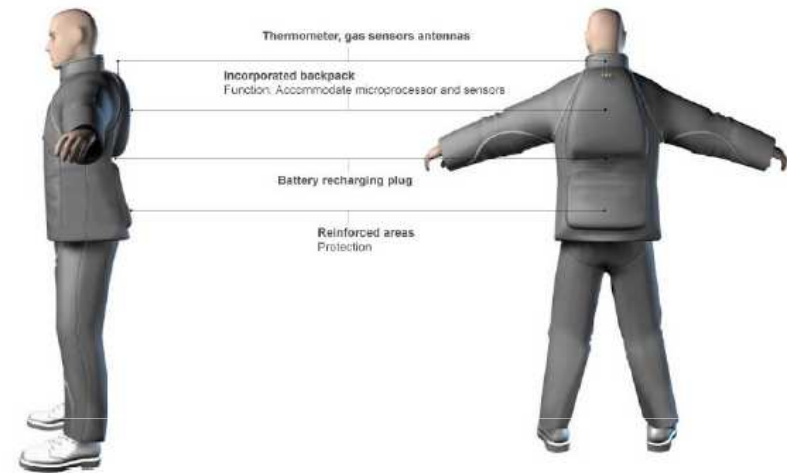
# Multi-Sine Laboratory Generator

This project had the goal to create the concept, to design and implement an instrument capable of generating correctly the proposed modulated complex signal, designed in a computer machine, and being downloaded to an arbitrary waveform generator.



## I-Garment - Integrated System for Management of Civil Protection Units

I-GARMENT developed full-bodied smart garments equipped with sensors to monitor position, vital signals (temperature and heart beat) of the agents. This information is sent via a wireless link to Civil Protection Officers in the HQ, processed and returned to the field officers equipped with PDAs and/or TabletPCs.



### IT Research team

- > Nuno Borges Carvalho
- > Pedro Claro
- > Mário Rui Santos



## LOPES

All art galleries, museums and other public buildings such as cathedrals need some way to tell the visitor what they are looking at. Project LOPES was implemented and installed in the Fábrica - Center of Alive Science of Aveiro. LOPES is the concept of virtual museum that provides visitors, in an automatic way, dedicated information about the art pieces that they are seeing at that moment.

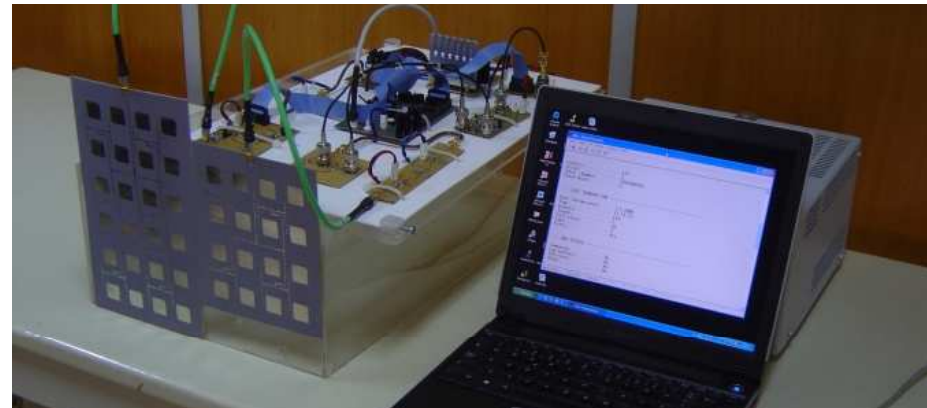
# LOPES

### Research team

- > Nuno Borges Carvalho
- > João Nuno Matos
- > Arnaldo Monteiro
- > Pedro Cruz

## The VIAVE project

The Viave project aims the design and development of Dedicated Short Range Communications (DSRC) equipment for Road Transport and Traffic Telematics (RTTT).

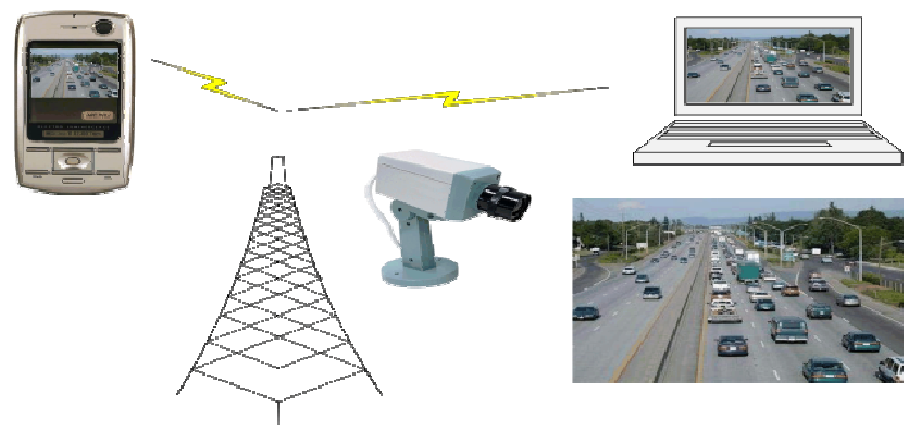


### Research team

- > João Nuno Matos
- > Nuno Borges de Carvalho
- > Ricardo Abreu
- > Luis Domingos

## Digital Video Recorder

Project DVR addressed the research and development of an efficient multi-mode video H.264 encoder. Besides, a spatial multi-resolution transcoder was developed in order to serve different terminal types through heterogeneous networks, as well as a video server. The main intended application is video-surveillance in the motorways. The system indexes the video with metadata, such as automatically detected vehicular speeds.



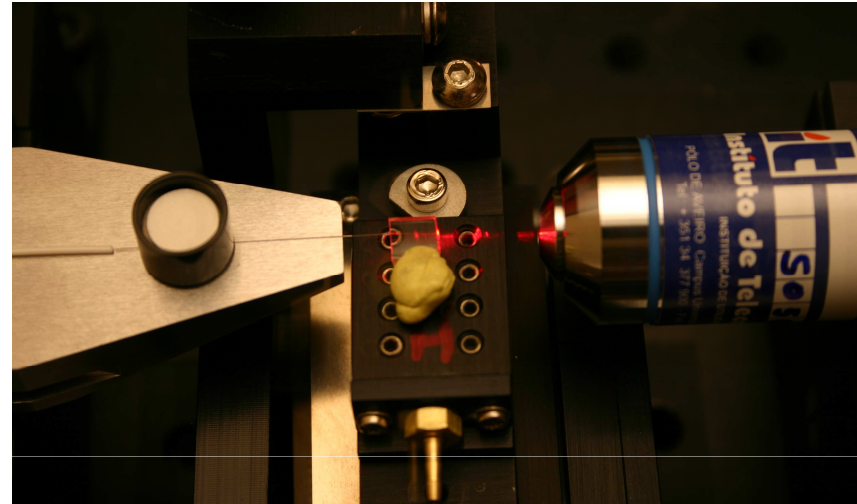
### Research team

- > Antonio Navarro
- > Paulo Mão-Cheia
- > Henrique Teixeira de Sousa
- > Rui Silva
- > Antonio Silva



## OreO - Organic/Inorganic hybrids for Integrated Optics

- This project aims at investigating sol-gel derived organic/inorganic hybrids as material substrate for production of integrated optics architectures.
- The fabrication of planar waveguides, with the proposed materials, allowed the implementation of enabling solutions for future high bit rate optical networks.



- > **Research team**
- > Paulo André
- > Rogério Nogueira
- > António Teixeira
- > Paulo Monteiro
- > Maria Rute Ferreira (CICECO)
- > Paulo Marques (INESC/Porto)
- > Verónica Bermudez (UTAD)

## All-optical Routing

All-optical packet switching based on all-optical processing is targeted and will assure the future generation of transparent high data rate optical networks. Within this objective, a subsystem which can be the base for this scenario has been designed and tested, showing the potential of this technique.

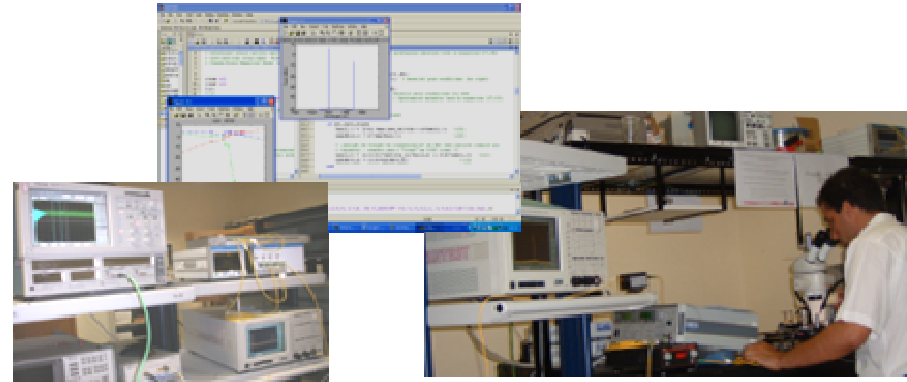


### Research team

- > António Teixeira
- > Tiago Silveira
- > Rogério Nogueira
- > Paulo André
- > Mário Lima
- > Leandro Oliveira
- > Pedro Teixeira
- > Ferreira da Rocha
- > Paulo Monteiro

## All optical gates and logical devices

The idea of all-optical signal processing has been following researchers for long time. Several are the solutions popping up nowadays resulting from the increased development of the components and techniques in optics. It is the aim of the team to develop fully functional subsystems (gates, latches and Flip-flops) recurring to low cost approaches, off-the-shelf devices, the existing know how and fiber bragg grating design facilities and techniques.



### Research team

- > António Teixeira
- > Sergio L. Stevan Jr.
- > Tiago Silveira
- > Paulo André
- > Rogério Nogueira

# All-Optical Processing With Passive Devices in Optical Communication Systems

The intrinsic optical bandwidth of the optical fibers has allowed the transmission of data at Tbit/s rates. In these systems, in addition to transmission and amplification, it is often necessary to do all-optical processing to the signal. This is due to the inherent advantages of the optical processing, relatively to the optic-electric-optic processing, like the higher flexibility to operate at different bit rates and modulation formats and also the higher bandwidth.



## Research team

- > Rogério Nogueira
- > Paulo Monteiro
- > António Teixeira
- > Paulo André
- > Miguel Drummond

## Raman Amplification

Raman amplification is a wide and actual research topic in the field of optical communications. Theoretical and experimental activities are focused on the main relevant issues related with Raman effect, such as pump allocation, wide band amplification, incoherent pumping, transients effects, multiple low power pumping, catastrophic fuse effect and Rayleigh backscattering.



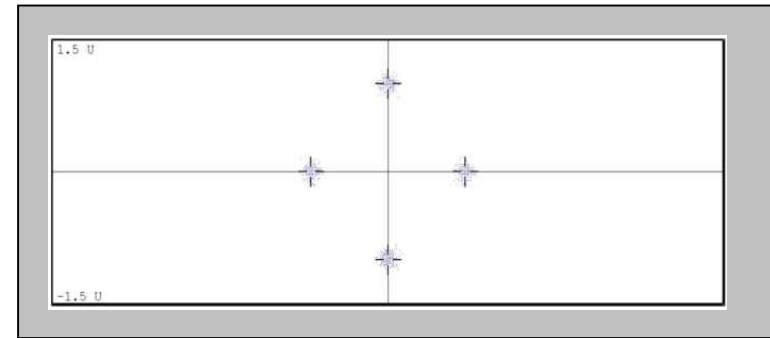
### Research team

- > Paulo André
- > Armando Nolasco Pinto
- > António Teixeira

Partners: Siemens Nokia Networks, PT Inov

## 3G Over Fiber With Low Cost Components

3G Radio Distribution over Passive Transparent Optical Networks can be seen as a promising technique to overcome many of the RF spectrum limitations and also its distribution. However, this can only be a reality if it is proven to be robust and possible to implement in a cost effective way. The work performed explored direct modulation of low cost lasers as well as amplification with low cost amplifiers.

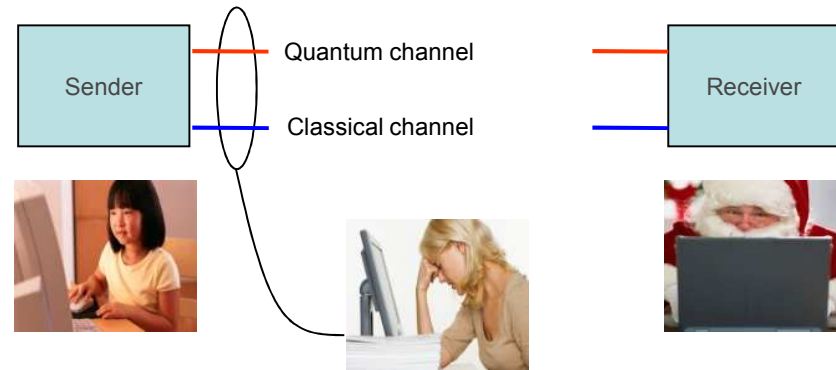


### Research team

- > António Luis Jesus Teixeira
- > Mário José Neves de Lima
- > Rogério Nogueira

# Quantum Cryptography Over Optical Fibres

We have been working toward the engineering of a quantum cryptographic system over optical fibers. We succeeded in generating and detecting pulses with less than one photon per pulse on average. We have also been able to manipulate the photon quantum states and to generate and detect entangled photon-pairs. We are using the four-wave mixing effect in optical fibers to generate the photon-pairs and avalanche photo-detectors operating in the Geiger mode for the detection.



## Research team

- > Armando Nolasco Pinto
- > Paulo André
- > José Ferreira da Rocha
- > João Lemos Pinto
- > Nuno Silva
- > Paulo Antunes
- > Nelson Muga
- > Meire Fugihara

# Fiber Based Sensors for Structure Health Monitoring and Intelligent Materials

Nowadays, our technology driven society is demanding for more and better products with “intelligent” capabilities. Smart materials and structures are one of the key technologies of the future, since they can impart information about the surrounding environment to an observer or monitoring device. Advances in smart materials and technologies are impacting disciplines across the scientific and technological landscape.



## Research team

- > Rogério Nogueira
- > João Lemos
- > Paulo André
- > Hugo Lima
- > Ilda Abe
- > Pinto Lucia Bilro
- > Nélia Alberto

Funding: Weber cimenfix, Just Bit, Citeve, Aenor



## DAIDALOS

Daidalos II deals with rapid technological and societal changes with proliferating technologies and services that have resulted in complex and confusing communications environments for users and network operators. The goal is a seamless, pervasive access to content and services via heterogeneous networks that supports user preferences and context.

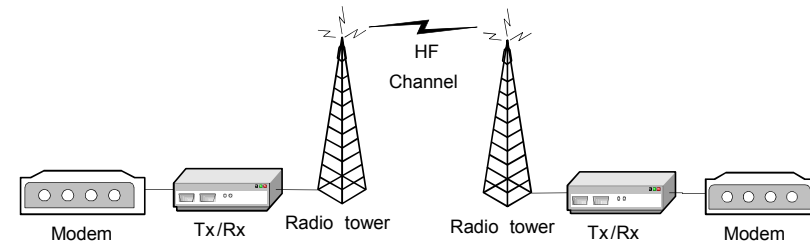


### Research team

- > Rui L Aguiar
- > Susana Sargento
- > Diogo Gomes
- > Alfredo Matos
- > Vitor Jesus
- > Nuno Ferreira

## TCP/IP Communications over HF

HF transmission systems can achieve huge distances without satellite support. However, their low bit rates and high transmission delays make their use for TCP/IP communications a challenging task. Traditionally used by military forces for voice and text based short message communications, the aim is to implement TCP/IP over HF military transmission systems (using the STANAG 4539 and STANAG 5066) optimizing the system to support email and web browsing.

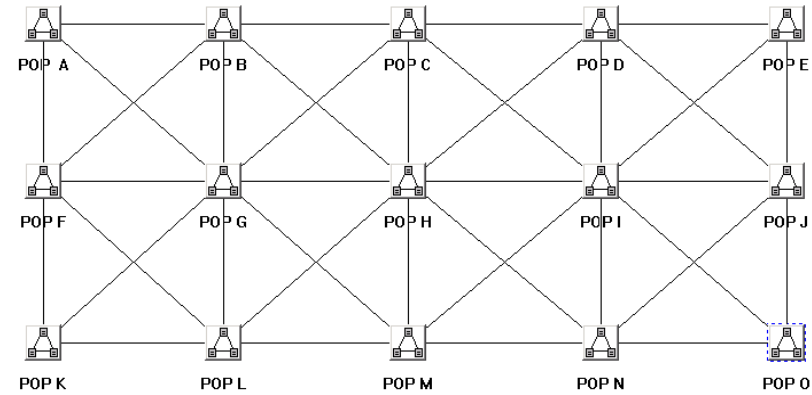


### Research team

- > Amaro de Sousa
- > António Amaral
- > José Lino Teixeira
- > Teixeira de Sousa

# Design and Traffic Engineering of Telecommunication Networks

Given a set of service demands and constraints (bandwidth, delay, survivability, etc...), an operator must determine, first, the most cost effective network design solution to support all demands and, then, the routing configuration that optimizes network performance (known as traffic engineering). Both tasks require optimization methods, which are far from trivial, and tools that enable the operator to minimize its costs (both investment and operational costs) and to take the most out of its network infrastructure with a positive impact on the operator revenue.

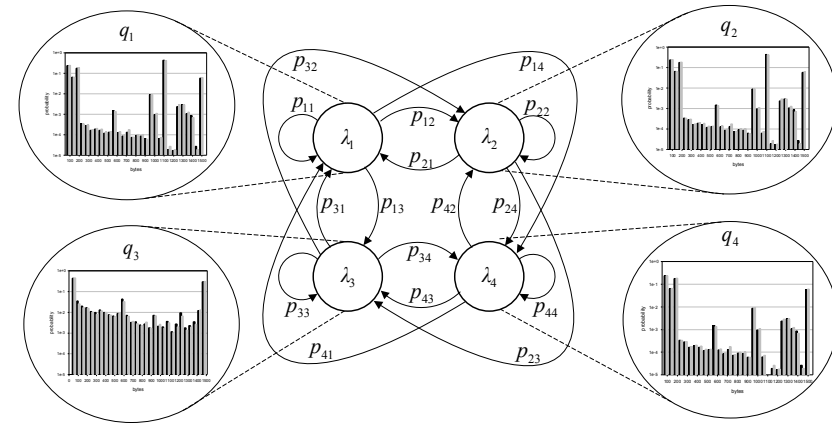


## Research team

- > Amaro de Sousa
- > Rui Valadas
- > Carlos Lopes
- > Gil Soares
- > Dorabella Santos
- > Pedro Moreira
- > André Santos

## Markovian and L-Systems Based Traffic Models

Traffic modeling must provide suitable approximations to the scale invariance phenomena discovered in the Internet (e.g. self-similarity and LRD). Time scales are an important ingredient for traffic modeling because of the scale invariance phenomena and the fact that traffic is generated and controlled by mechanisms operating on several time scales. When selecting a traffic model (i) the model structure and the parameter inference procedure must be jointly considered; (ii) the model structure can explicitly account for time-scales; (iii) the parameter inference procedure needs to be fast and accurate; (iv) for IP traffic, the model needs to consider both the packet arrival and packet size processes.

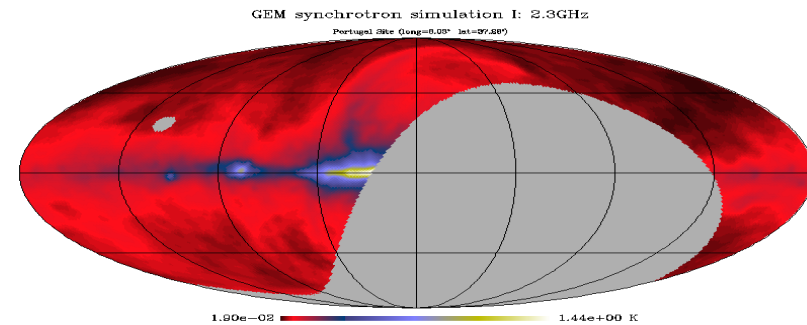


### Research team

Rui Valadas; Paulo Salvador; António Nogueira

## Cartography of the sky emission: the Galactic Emission Mapping Project

In the context of the international GEM - Galactic Emission Mapping collaboration, a sky survey at 5GHz is in preparation aiming at the characterization of the galactic foreground to the Cosmic Microwave Background Radiation (CMBR). For the North sky survey, a radiotelescope in central Portugal is being setup using a custom low noise receiver. This aims at the production of sky emission templates to be used by the next generation of microwave space probes.

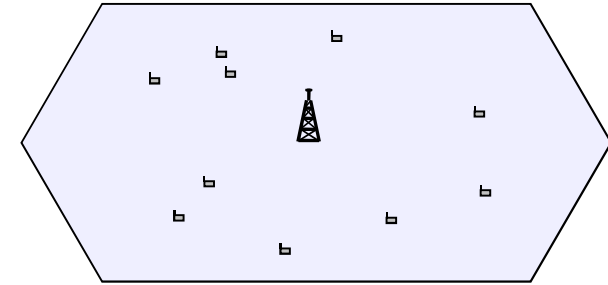


### Research team

- > Domingos Barbosa
- > Dinis Magalhães dos Santos
- > Luis Cupido
- > Rui Fonseca
- > George Smoot

# Signal Processing Techniques for B3G and 4G Systems

Research activities focus on multiple access schemes, advanced physical layer algorithms to enhance the capacity of 3G systems and contribute to the definition of efficient processing algorithms and techniques for the broadband component of 4G systems. For the latter topic, we are currently focusing on OFDM based techniques (coded and uncoded), since it is recognized that it will be one of the most likely candidates as the multiple access scheme of such systems



## Research team

- > Atílio Gameiro
- > Adão Silva
- > Paulo Marques
- > Carlos Ribeiro
- > Luís Gonçalves
- > Sara Teodoro
- > Joaquim Bastos
- > Daniel Castanheira

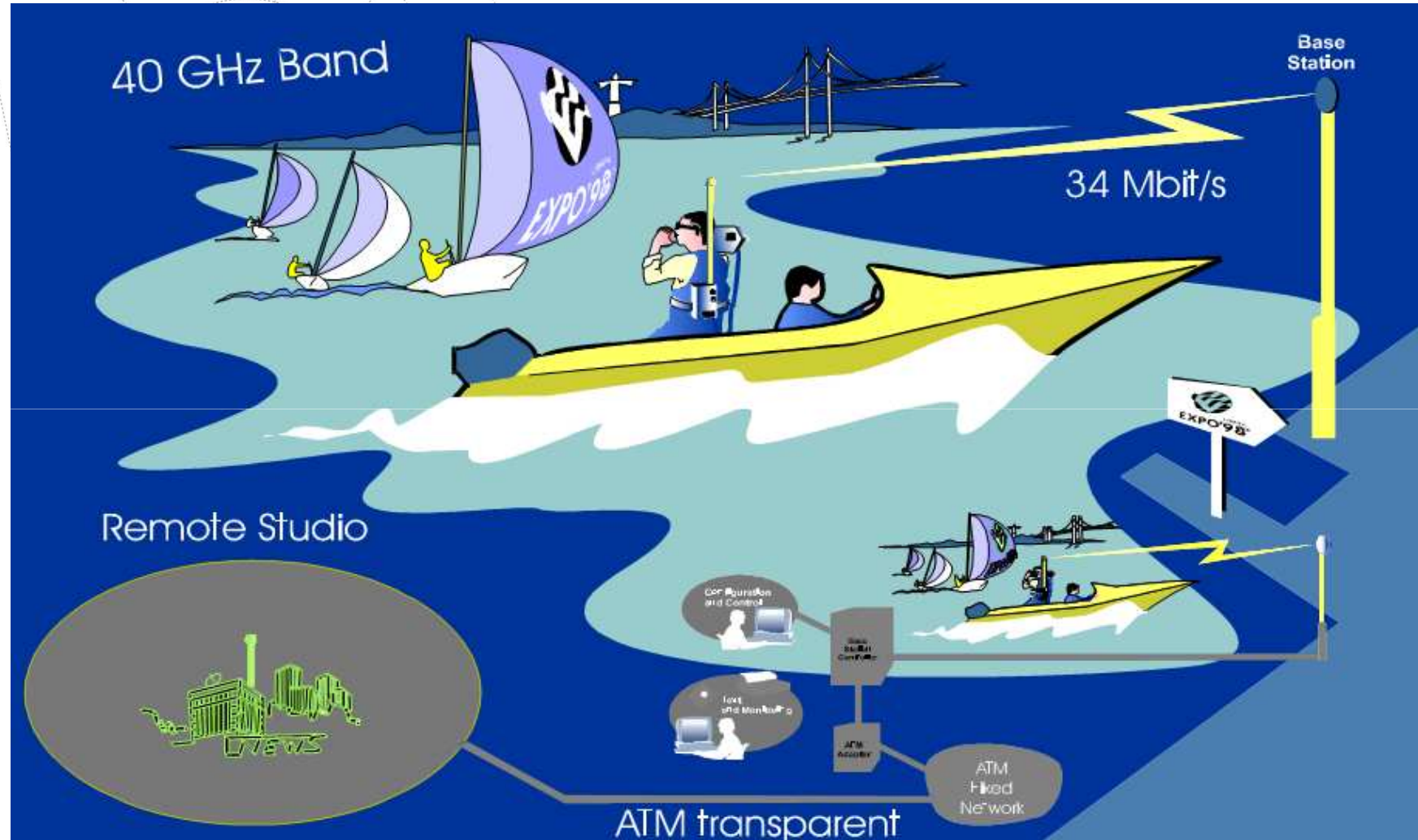
**Space-Time Beamforming and Pre-Equalization for DS-CDMA and MC-CDMA Systems**

**Multi-User Detection for CDMA Systems**

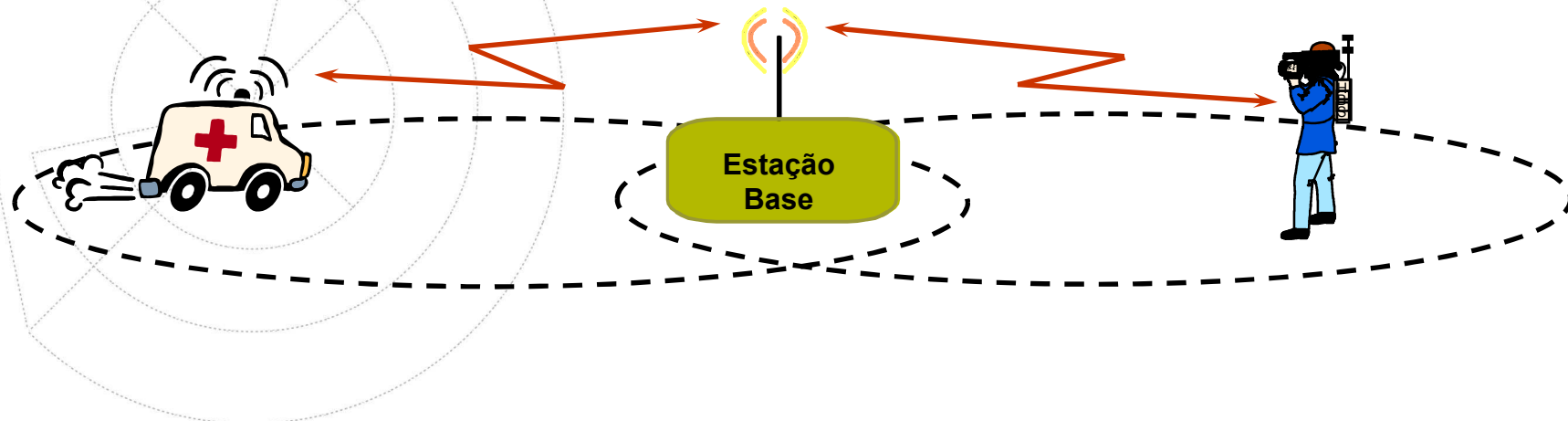
**Channel Estimation Algorithms for SISO and MIMO Channels**

**Cooperative Diversity**

## MBS - A Caminho da 4G



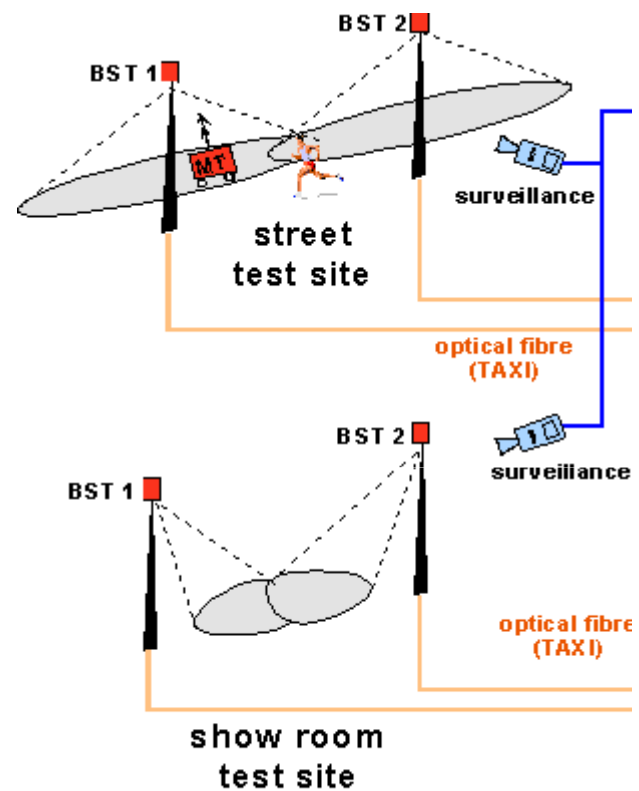
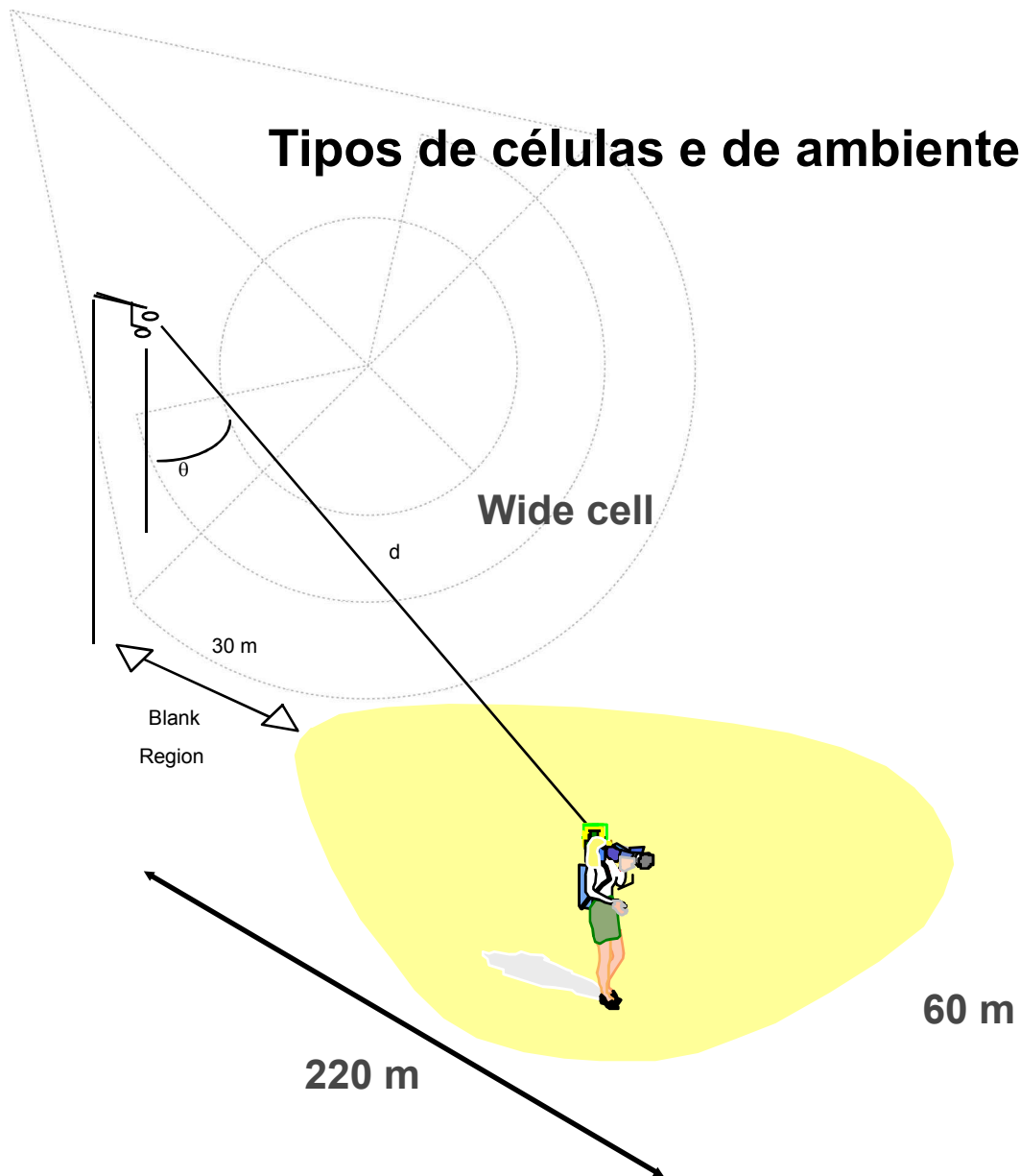
## Demonstrador SAMBA - Funcionalidades



- Interligação com a rede fixa de banda larga
- Ligação entre dois terminais móveis em diferentes células
- *Handover* quando uma estação móvel se desloca de uma célula para outra
- Partilha do mesmo canal de acesso quando dois móveis estão na mesma célula
- Localização do terminal móvel quando uma chamada é originada na rede fixa



# Tipos de células e de ambientes

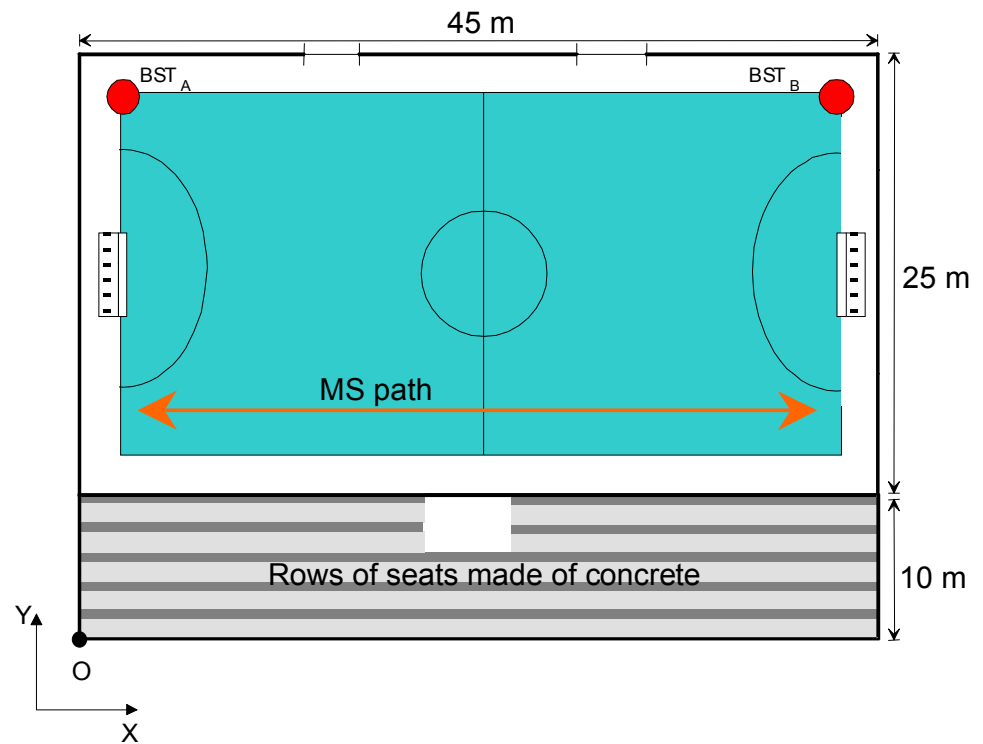


Estação base

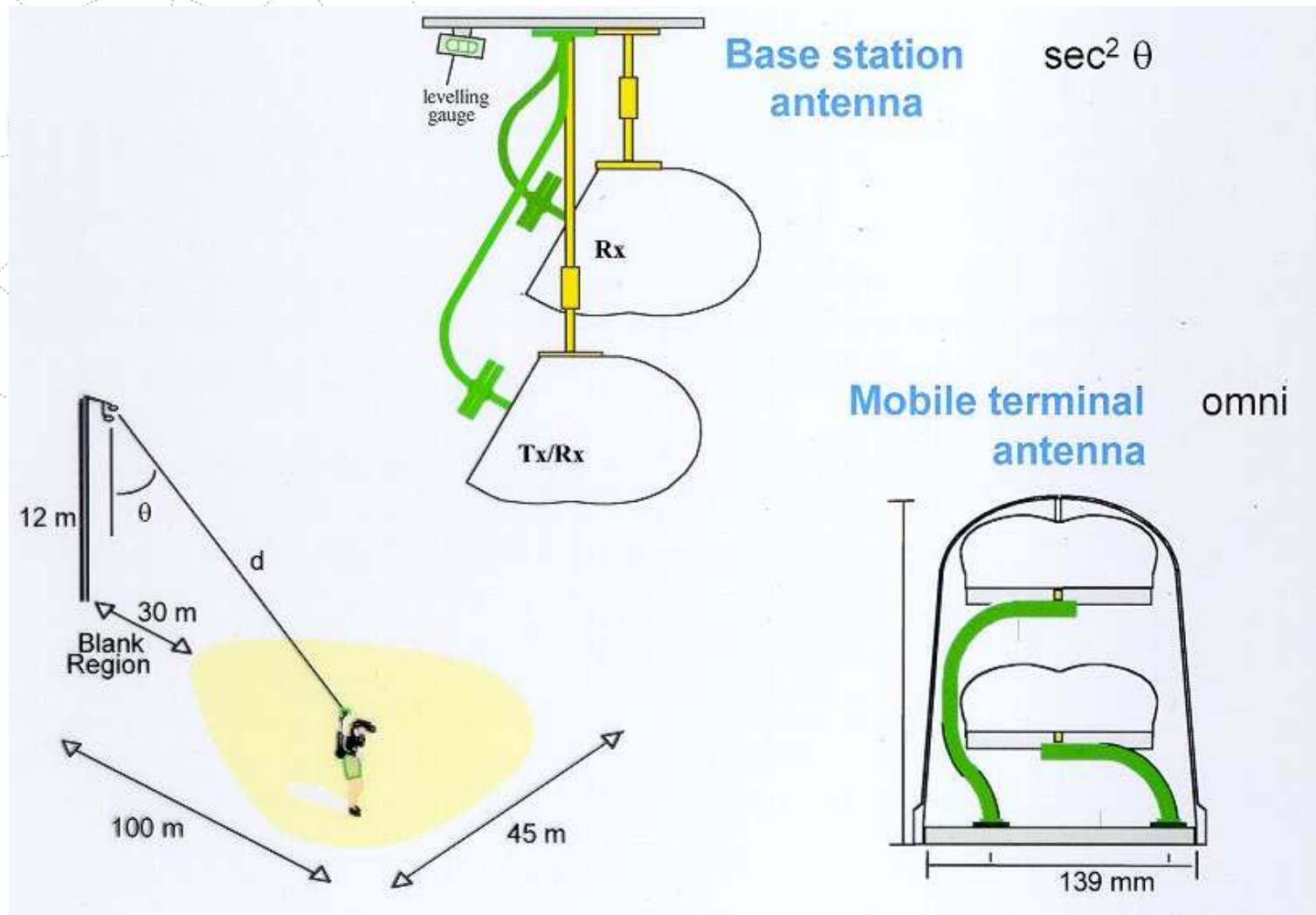


Aveiro, 21 de Outubro de 2011

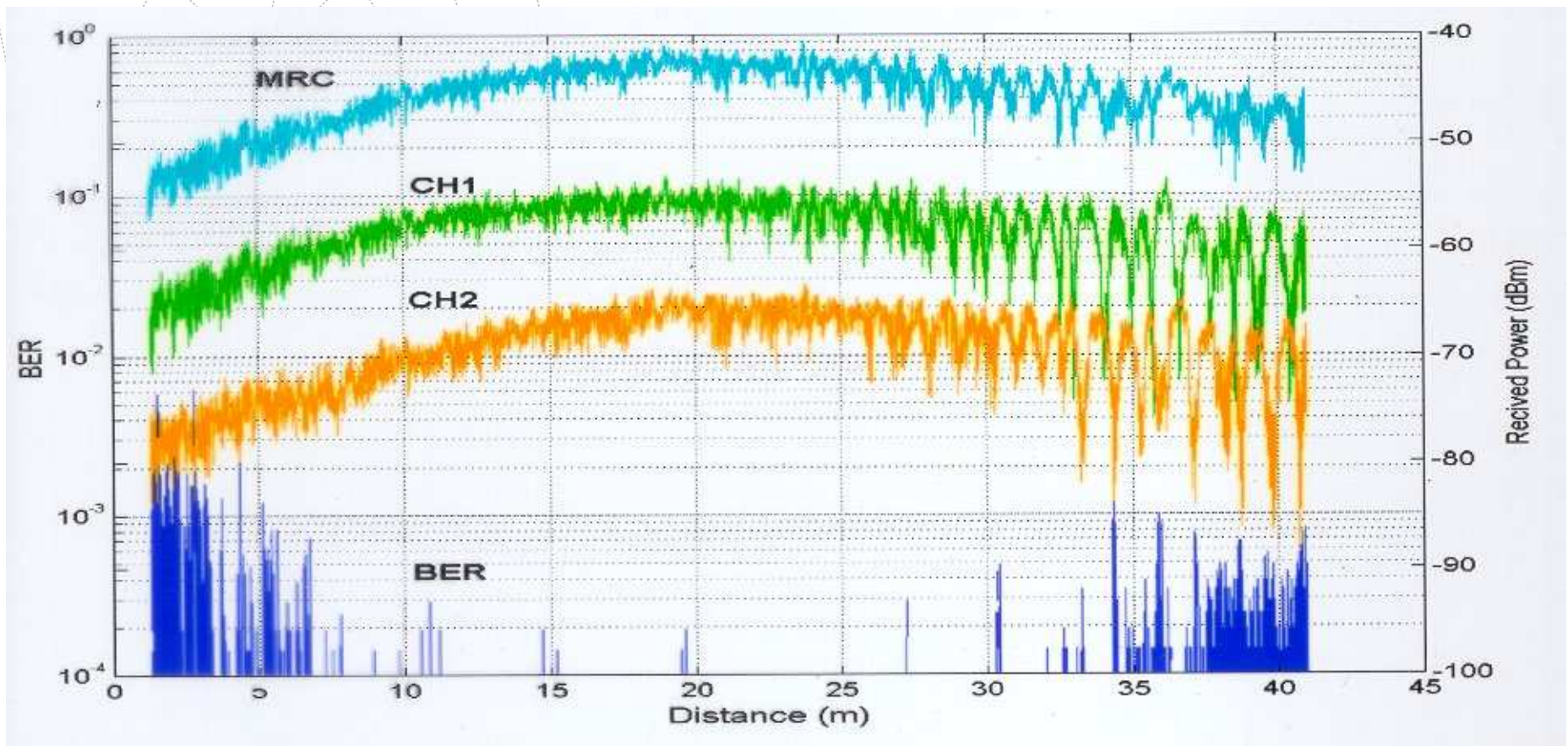
## Cenários – Rua Nova e Pavilhão da UA



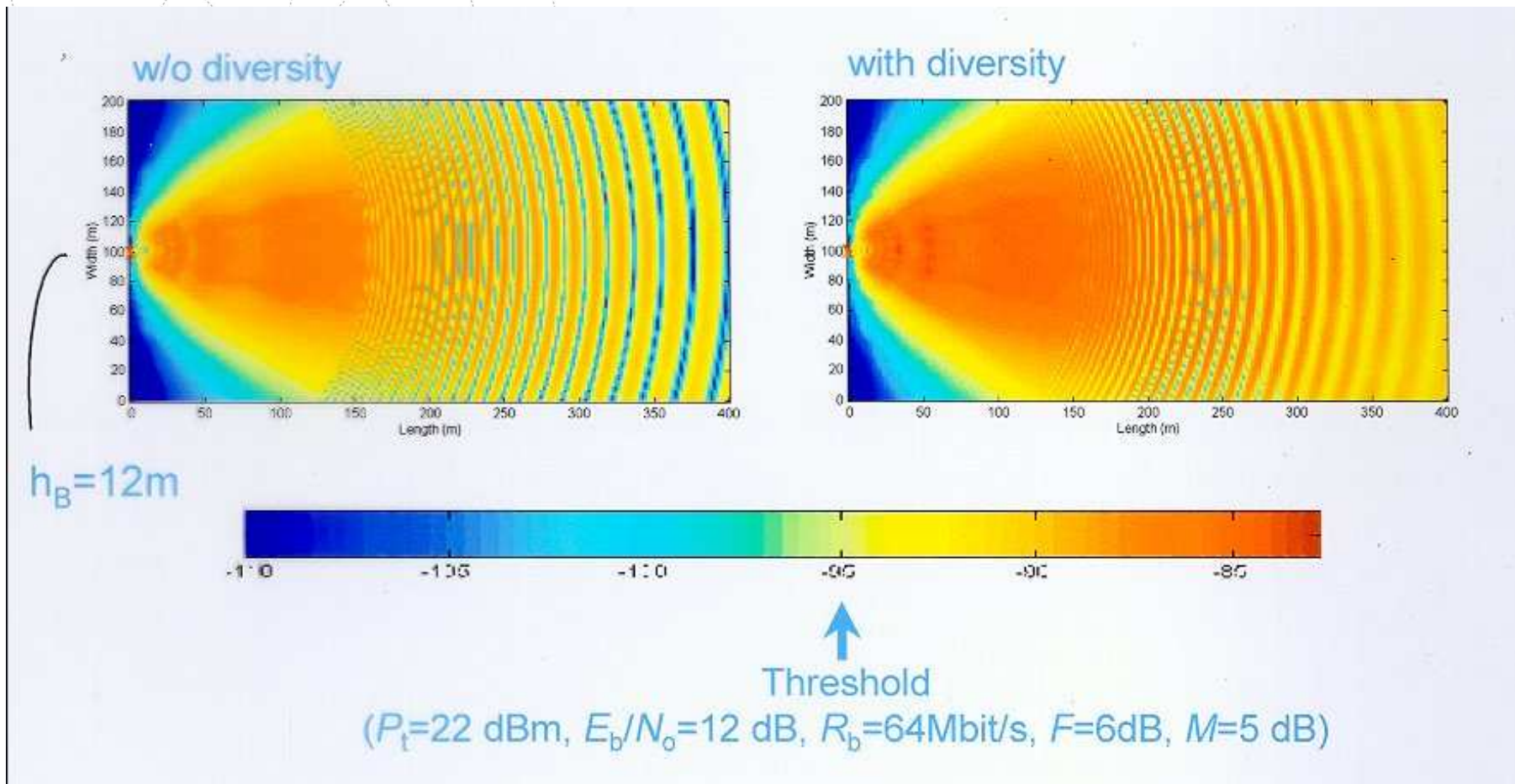
# MBS - A Caminho da 4G



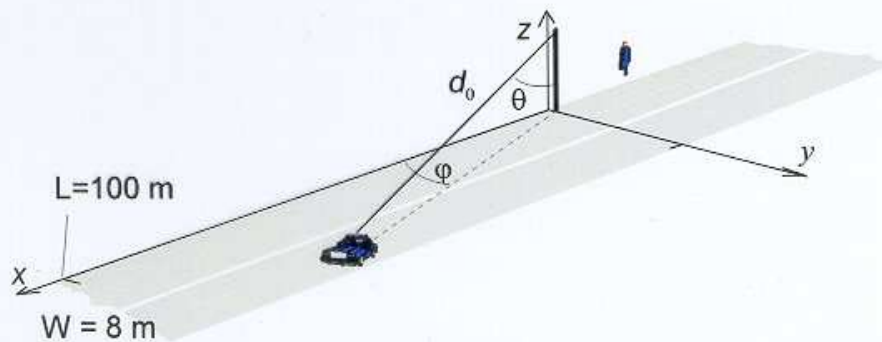
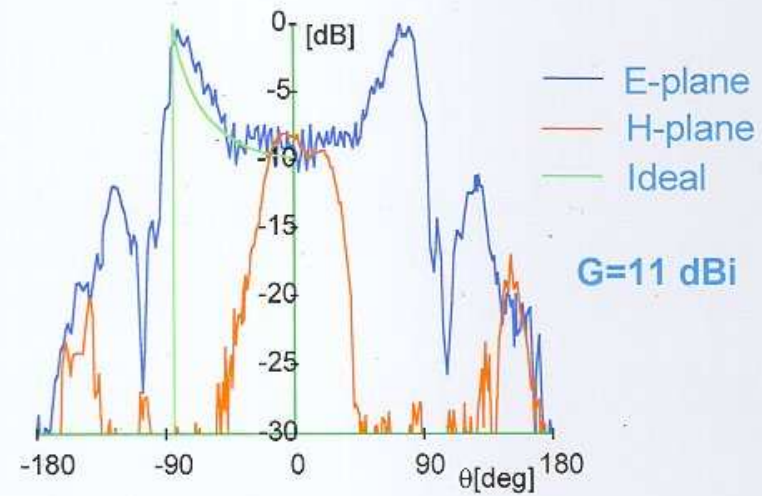
## Potência recebida e BER



# Potência recebida normalizada



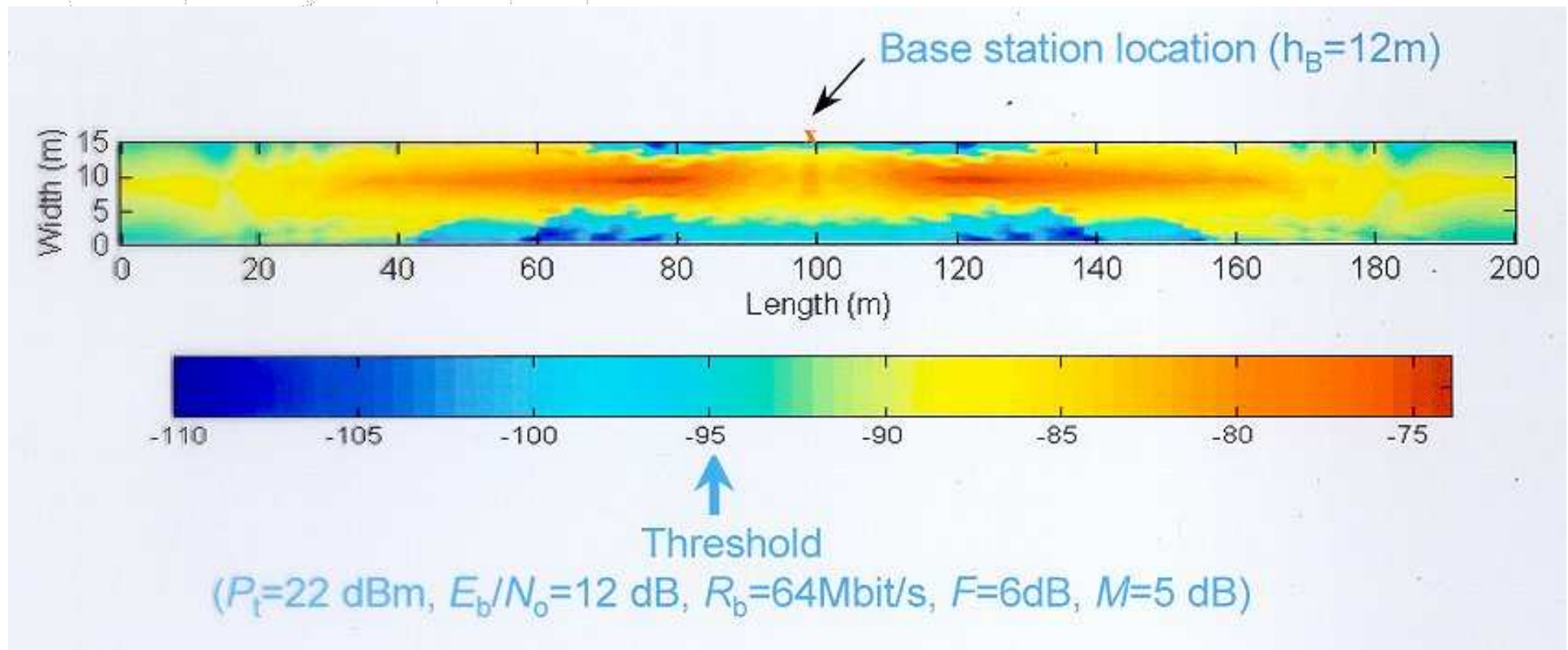
# Célula alongada



Base station  $\sec \theta$

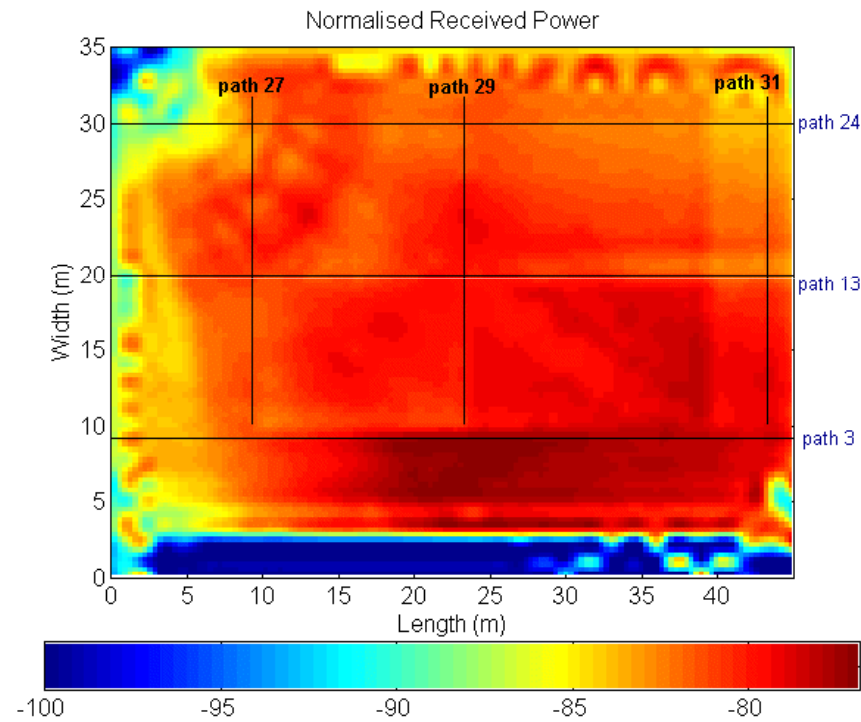
Mobile Terminal  $\sec \theta$

## Potência recebida normalizada

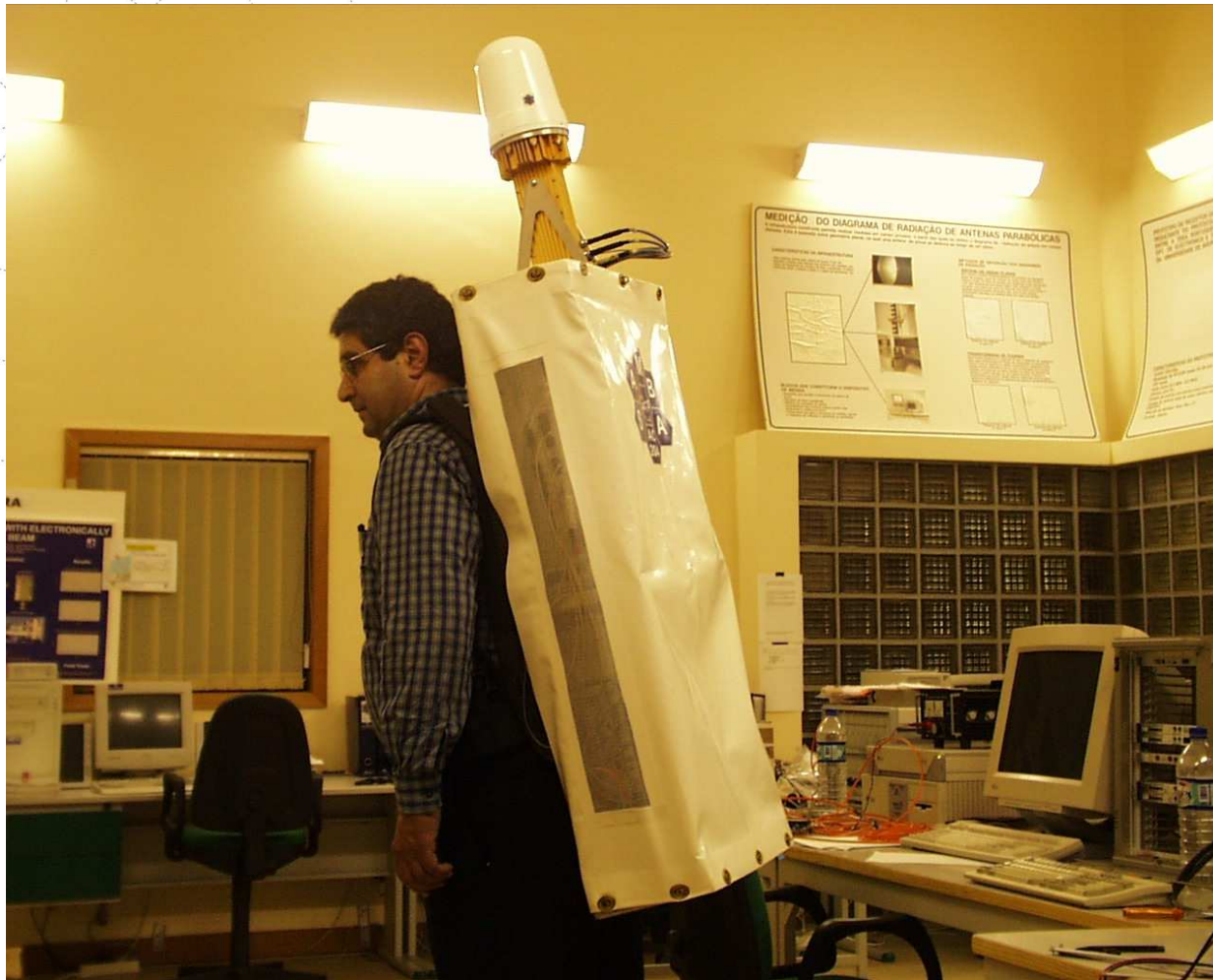




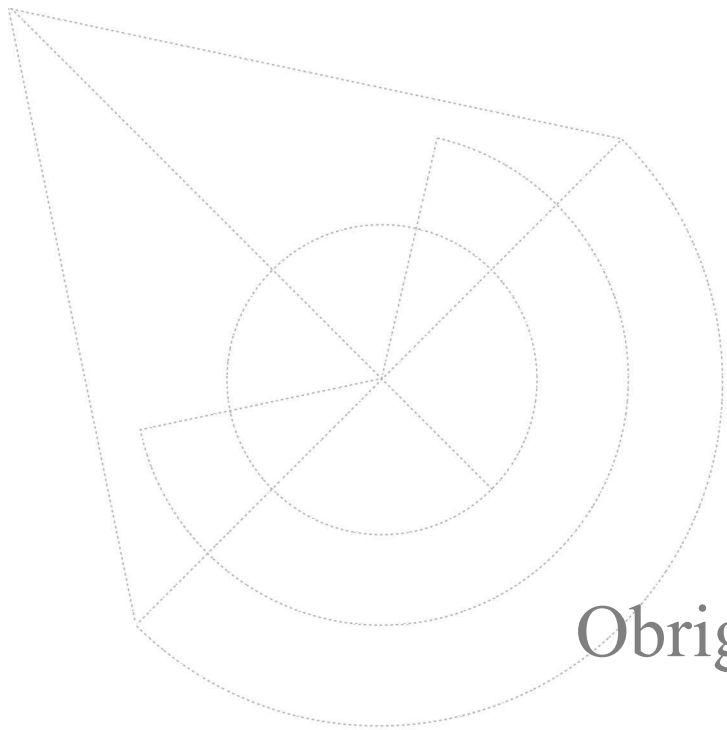
# Medições no Pavilhão da UA



## Protótipo de móvel MBS



Aveiro, 21 de Outubro de 2011



Obrigado pela vossa atenção