Faculty of Sciences of the University of Lisbon

LOLS - 2013

Laboratory of Optics, Lasers and Systems

In May 2009, **INETI** optics and laser capabilities - within the **Aerospace Laboratory (LAER)** and the **Optoelectronics Department (DOP)** - were transfered to the Faculty of Sciences of the University of Lisbon (**FCUL**) and organized in the **LOLS**, the Laboratory of Optics, Lasers and Systems

History should not be lost. Past R&D projects of LOLS researchers have therefore been considered as part of FCUL achievements

Space & Astrophysics

ESA – Gaia - FPASS

GAIA Focal Plane Assembly Static Simulator

Partners	EADS Astrium (F), Critical Software
Funding	ESA
Contracts	ESA → EADS Astrium → FCUL → Critical Software
Period	2006-2007

GAIA is an ESA astrometric mission. It will analyse the position of stars for 5 years and will generate the most complete stars catalogue generated so far with astrometric accuracy

FCUL simulated images at the focal plane of the instrument and the corresponding data streams (samples).

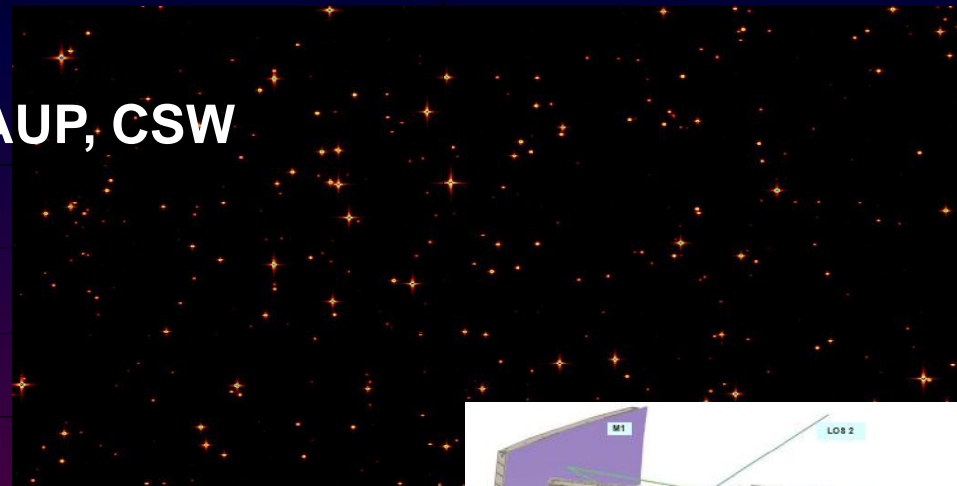**Gaia focal plane: 1x1.5 m, 106 CCDs, 900 000 pixels**
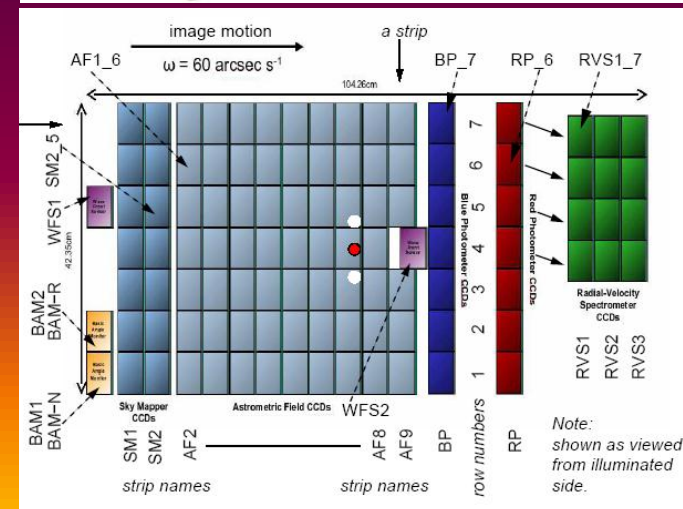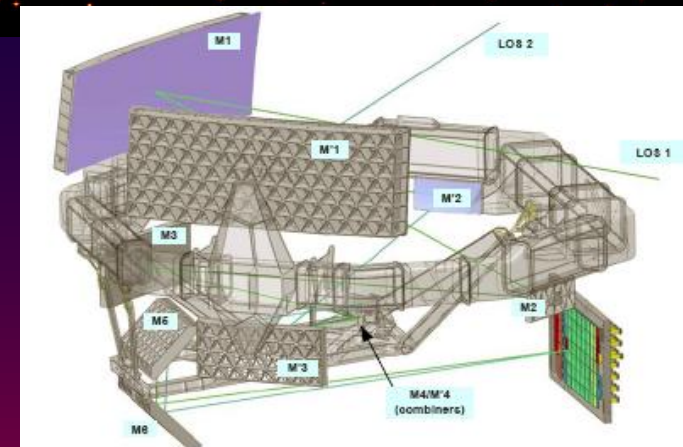
# ESA – Gaia - DPAC

## GAIA Data Processing Analysis Consortium

Partners	DPAC Consortium Po - FCUL, OAUC, OAUP, CSW
Funding	FCT / PDCTE
Contracts	FCT → FCUL
Period	2007-2009

GAIA is an ESA astrometric mission. European Science community is developing GAIA ground segment and operational data processing algorithms to retrieve astrometric data and build up the final catalogue

FCUL was in charge of:

- CU2 – Simulation / DU4 – Instrument Model
- WP – Spectral CCDs modelling
- DU4 Co-Management

2013
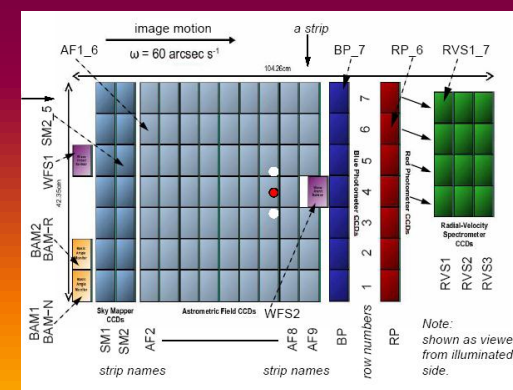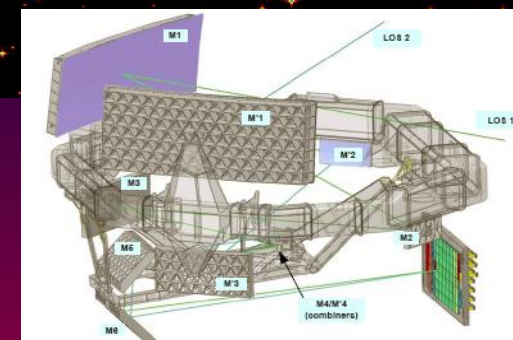
ESA - GAIA - OGSE

Optical Ground Support Equipment calibration and tests

Partners **LusoSpace**

Funding **ESA**

Contracts **Astrium SAS → LusoSpace → FCUL**

Period **2007-2008**

Radiometry tests and calibration of the OGSE developed by Lusospace for Astrium:

Low light level radiometry, attenuation characterization, temporal stability and radiance uniformity.

Courtesy LusoSpace 2008
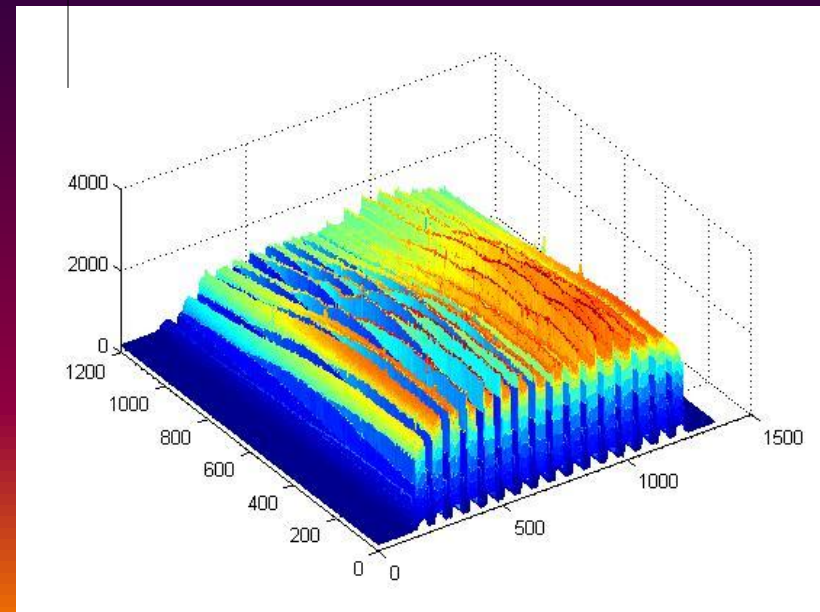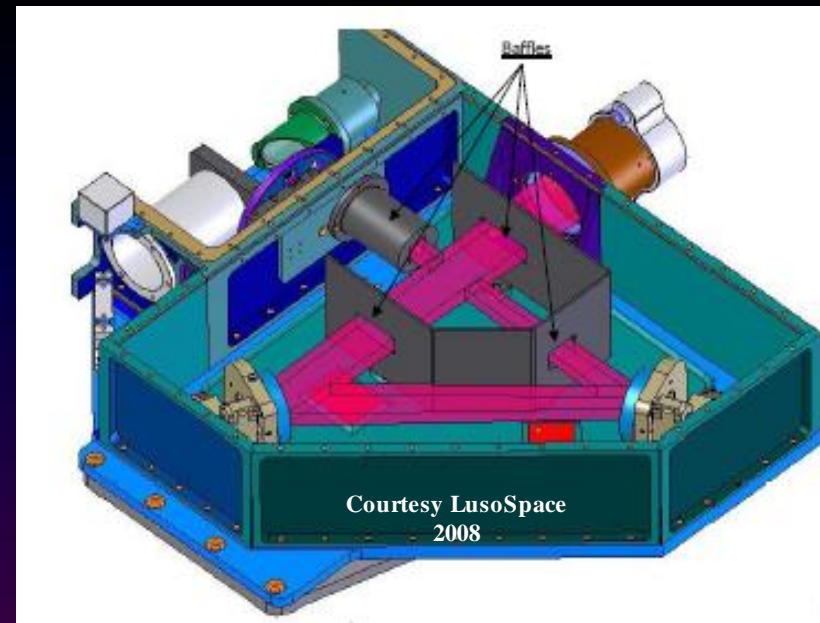
ESA – PLATO

PLAnetary Transits and Oscillations of stars

Partners   PLATO Consortium - LESLIA (Fr)
                 FCUL, CAUP

Funding

Contracts

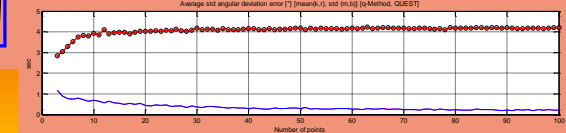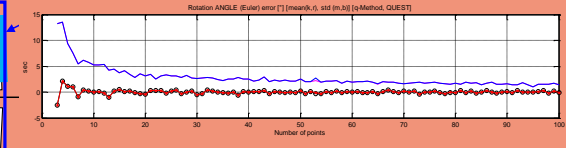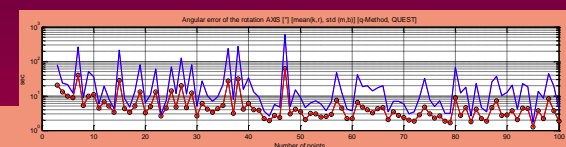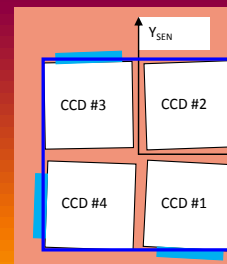**Period**   2010-2012

- Image Processing (15"/pix, pix/10):
  - Image calibration
  - Star centroids
  - Field recognition
- Attitude determination & time management
- Reference systems definition
- Optical Ground Segment Equipment (OGSE)
  - PLATO camera tests at room temperature
  - Star field simulator for PLATO cameras

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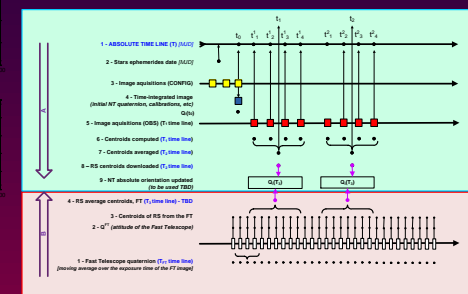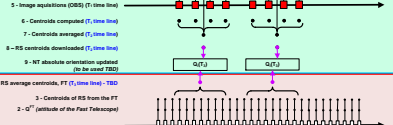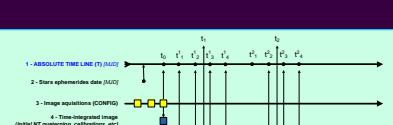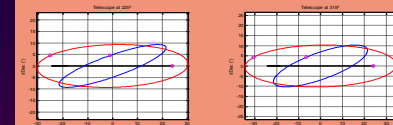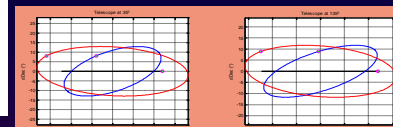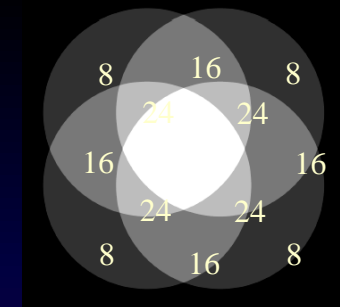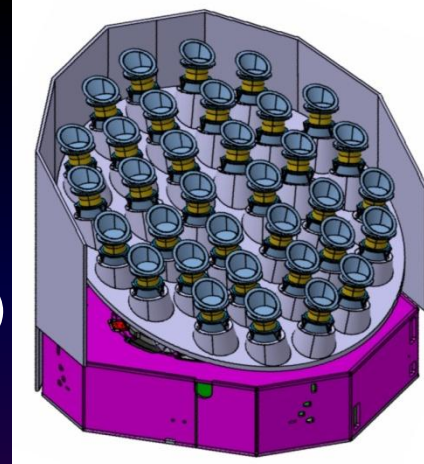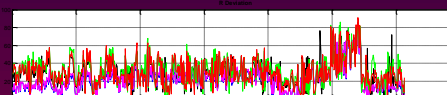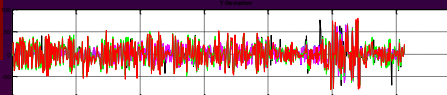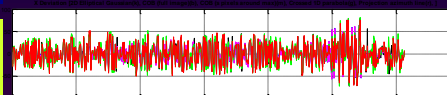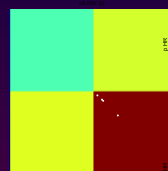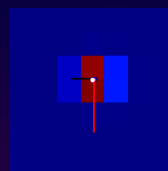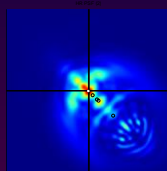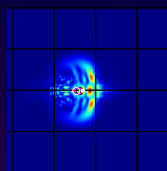
ESA - AutoNav

Autonomous on-board navigation for interplanetary missions

Partners	ESA, EADS Astrium (Fr), GMV (Sp), BDL
Funding	ESA
Contracts	ESA → Astrium SAS → FCUL
Period	2001-2004

Simulation of the navigation optical camera, to be included into the general system simulator; generation of images of star fields, planets and asteroids.

Image analysis of star fields, asteroids and planets in order to measure the attitude of spacecraft and contour / limb of asteroids / planets, enabling satellite autonomous relative navigation.

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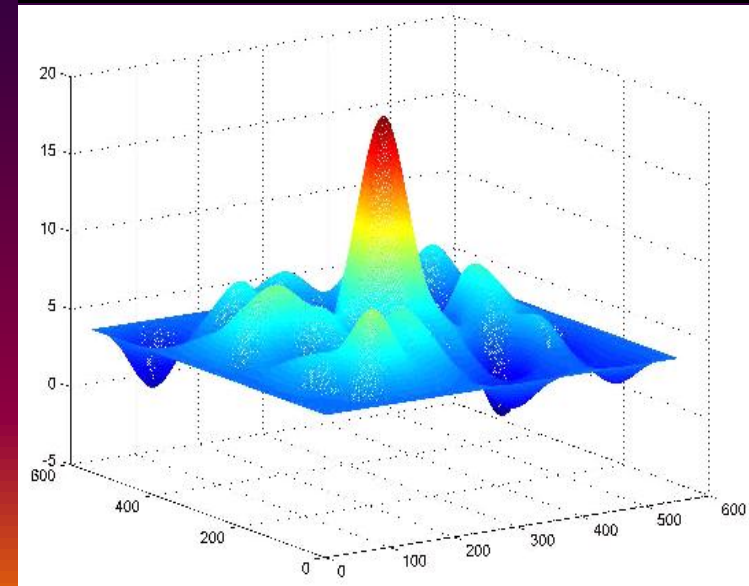
ESA - Planav

Image based navigation tool for Mars landing

Partners	ESA, Deimos Engª (P)
Funding	ESA (Task Force Portugal – ESA)
Contracts	ESA → Deimos Engª → FCUL
Period	2003-2004

Utilization of the geophysical cameras of Beagle in the opposite direction, to track Mars moons Phobos and Deimos, against a fixed background of bright stars.

Analysis of the visibility of stars and moons, to ensure that a Kalman filter receives an adequate number of observables, in order to reduce the positional error of Beagle 2 after landing

Beagle 2 as seen from Mars Express

Precise determination of Beagle 2 landing position in Mars

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Optics Lasers & Systems

FP7 - AEROFAST

AEROcapture for Future spAce tranSporTation

Partners	**Astrium (Fr), Deimos Engenharia, Corticeira Amorim (PT), Samtech (B), U. Rome, STIL (Bu), I. Lotnictwa (Pl), SRCPAS (Pl), ONERA (Fr), Kybertec (CZ)**
Funding	**FP7**
Contracts	**EADS Astrium ST→ FCUL**
Period	**2009-2012**

Solar system missions (e.g., Mars) encompassing return missions (humans and cargo) may rely on aerocapture to be mass effective, profitting from atmospheric drag to slow space vehicles.

FCUL addressed image-based optical navigation relying on images of planet limbs, stars and asteroids, to support GNC.

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ESA - NPAL

Navigation for planetary approach and landing

Partners	ESA, EADS Astrium (Fr), O. Galileo (It), U. Dundee, SSSL (Uk), Atmel (It)
Funding	ESA
Contracts	ESA → Astrium SAS → FCUL
Period	2001-2004
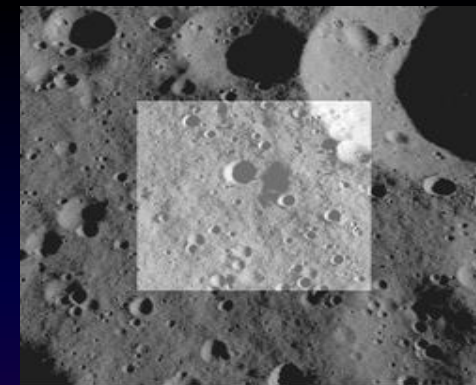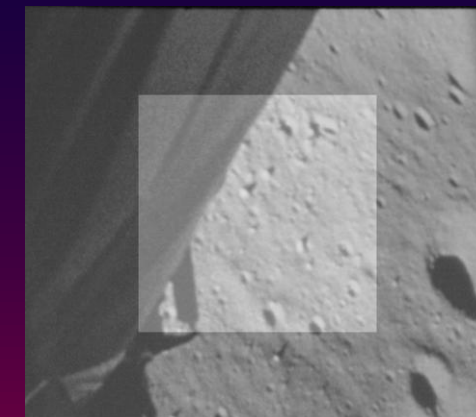
Image analysis of planetary surfaces (feature detection and tracking) in order to enable navigation relative to terrain landmarks (kinematics).

Modelling and testing image processing algorithms to be hardcoded in ASIC

Landing safely in Mercury

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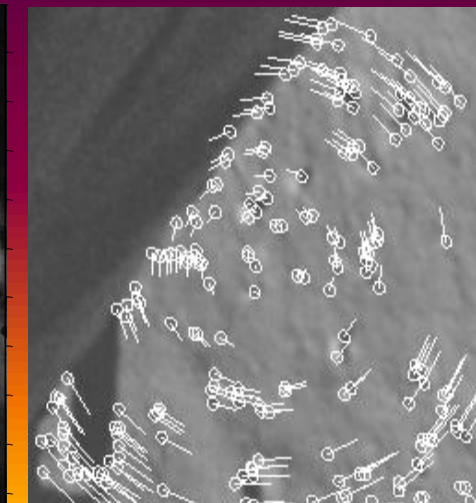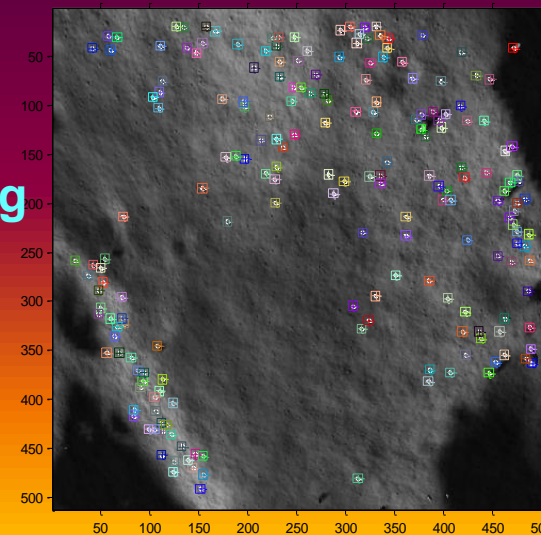
ESA - LiGNC
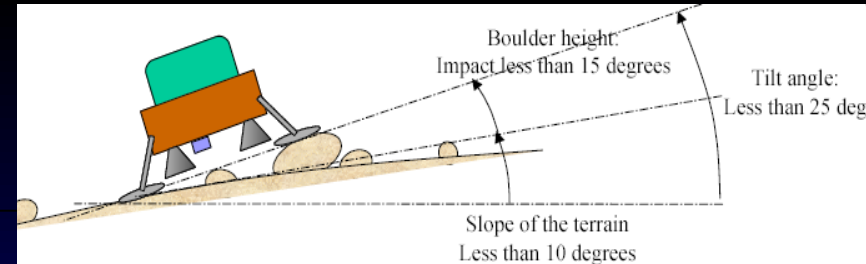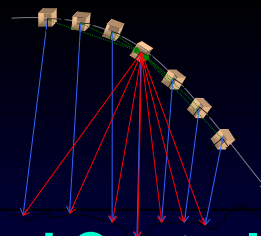
LIDAR Guidance, Navigation and Control

Partners	ESA, EADS Astrium (Fr), Deimos Er... Solscientia (P), U. Dundee (Uk)
Funding	ESA
Contracts	ESA → EADS Astrium → FCUL
Period	2001-2005
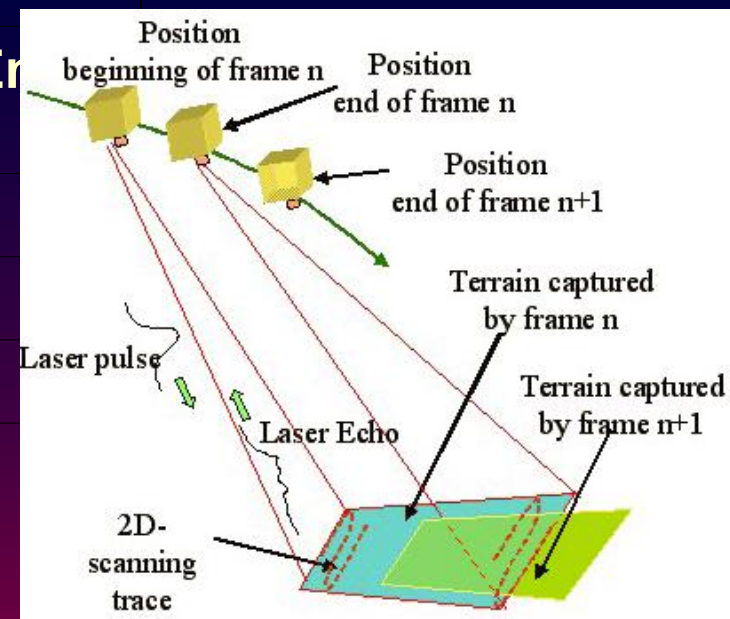
LIDAR data processing in order to:

➢ **generate topographic maps of the landing regions,**

➢ **build up landing hazard maps**

➢ **estimate dynamically navigation kinematical parameters.**
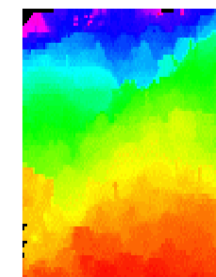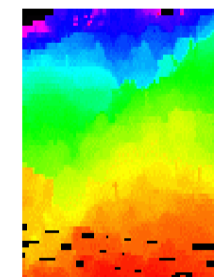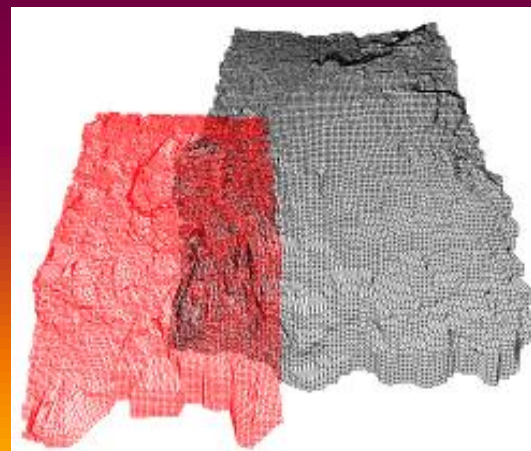
ESA – LAPS

LIDAR-based Autonomous Planetary landing System

Partners EADS Astrium SAS (Fr), ABSL Space Products (Uk), Vision-Box (Pt), U. Dundee (Uk)

Funding ESA

Contracts ESA → EADS Astrium → FCUL

Period 2008-2010

New Lidar developed for planetary topography

**Image processing (IP) consolidation & updating
LiGNC IP algorithms for LAPS needs**

Adaptation to new LIDAR outputs

**Real-time implementation and optimization
(with Vision-Box)**
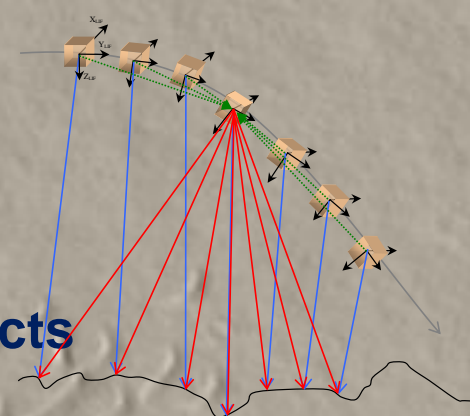
ESA - VBrNav

Vision-Based relative Navigation techniques framework

Partners	ESA, LusoSpace, Deimos Engª (P), Astrium SAS (F)
Funding	ESA (Task Force Portugal – ESA)
Contracts	ESA → Deimos Engª → FCUL
Period	2004-2006
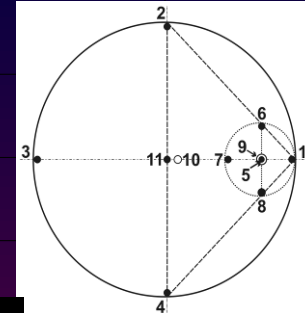
Development of landing hazard maps (in view of Mercury or Mars landing), based on optical images using *shape from shading* methods.

GNC (Guidance, Navigation & Control) for Rendezvous & Docking between autonomous spacecrafts in space (in view of *Mars Return Sample mission*)

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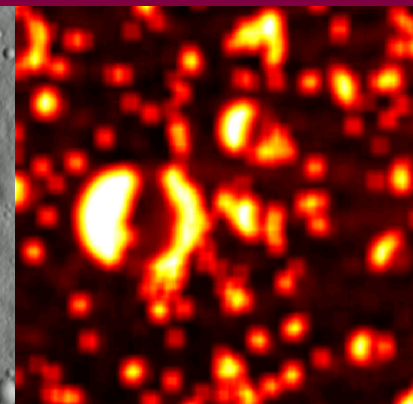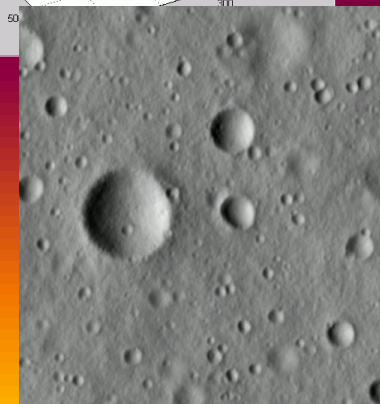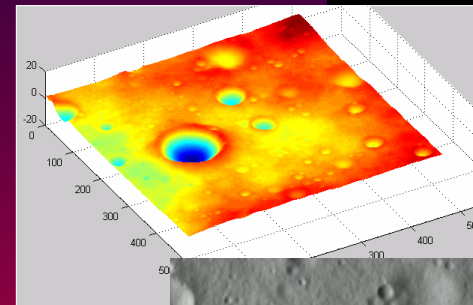
ESA – HASE

Hazard Avoidance System Experiment

Partners   Astrium SAS, Deimos Engenharia

Funding   ESA

Contracts   ESA → Astrium → Deimos → FCUL

Period   2008-2010

Autonomous landing in planetary surfaces is a key technology for solar system exploration. ESA has been supporting the development of several subsystems and will integrate them in a real time helicopter experiment landing on a planet-like terrestrial environment.

FCUL adressed hazard mapping, upgrading and consolidating image processing tasks to build up the hazard map, by estimating slopes, shadows and terrain roughness.
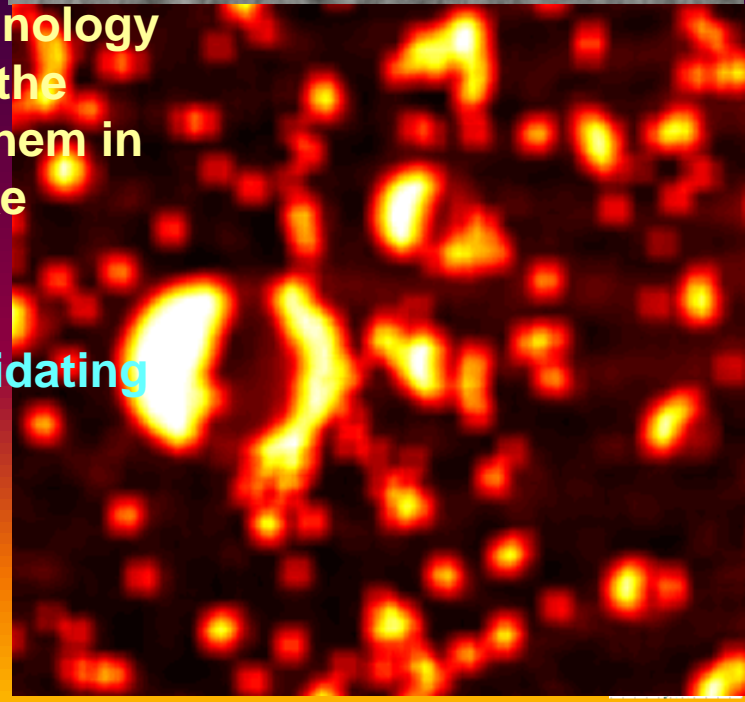
ESA – GNCO Maturation

Guidance for Non-Circular Orbits

Partners	**Deimos Engenharia**
Funding	**ESA (Task Force Portugal – ESA)**
Contracts	**Deimos Engenharia → FCUL**
Period	**2006-2011**

Modelling optical navigation sensors and image processing chain

Development of performance models

Tests & validation for Mars Return Sampler mission

Passive spherical, non-stabilized white canister

Laboratory simulator: closing the loop with GNC with RT HW in the loop

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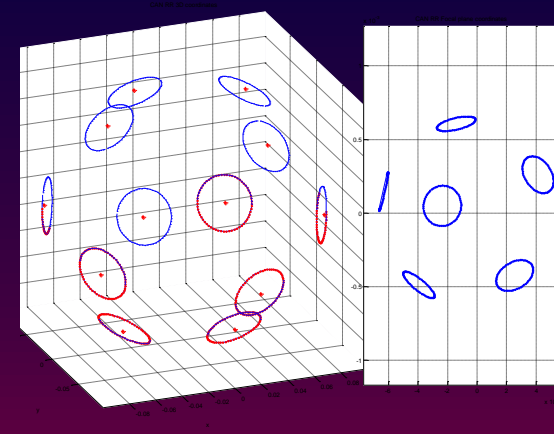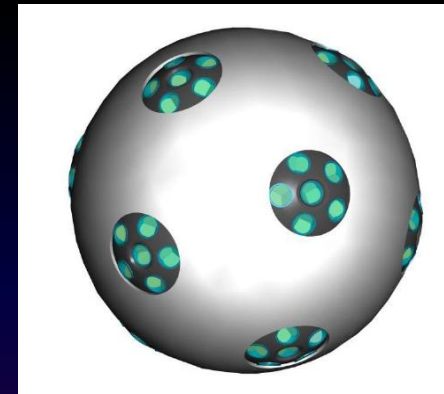
ESA – PROBA 3

Autonomous Rendezvous Experiment

Partners	**Sener, Deimos Engenharia**
Funding	**ESA**
Contracts	**ESA → Sener → Deimos → FCUL**
Period	**2009-2015**

Proba-3 is 1st world precision formation flying mission. Two satellites will fly together maintaining a fixed configuration as a 'large rigid structure' in space to prove formation flying technologies.
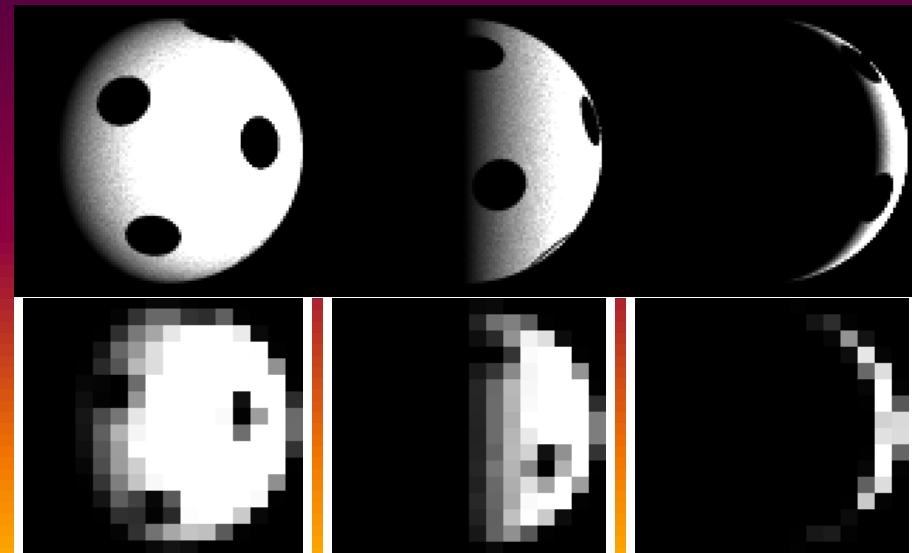
The satellites will form a 150-m long solar coronagraph to study the Sun's faint corona closer to the solar rim. Proba-3 will be a perfect instrument to measure the achievement of the precise positioning of the S/C's.

Implementation of a Rendezvous Experience, using technology previously developed by LOLS & Deimos in the ESA-VBrNav activity, with an active mire of light spots, image processing and GNC approach.

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EUMETSAT EPS - IASI L2

IASI (*Infrared Atmospheric Sounder Interferometer*) is one of payload of EPS / METOP, to determine:

➢ vertical profiles of temperature and water vapour;

➢ surface parameters (temperature, emissivity, …), clouds parameters (pressure, temperature at the top, cloud cover);

➢ vertical profiles of trace gases (O_3, CO, CH_4, N_2O, SO_2).

EUMETSAT Polar System - METOP / IASI Ground Segment Level 2

Partners	Alcatel Space (Fr), Skysoft, Critical Software, Edisoft
Funding	Skysoft
Contracts	EUMETSAT → Alcatel → Skysoft → FCUL
Period	2001-2003

➢ **Development of geometrical and radiometrical algorithms for IASI Level 2.**

➢ **Geometrical registration of the footprints of 5 instruments required for combined processing**

➢ **Unit testing to validate industrial implementation**

Sensors footprints

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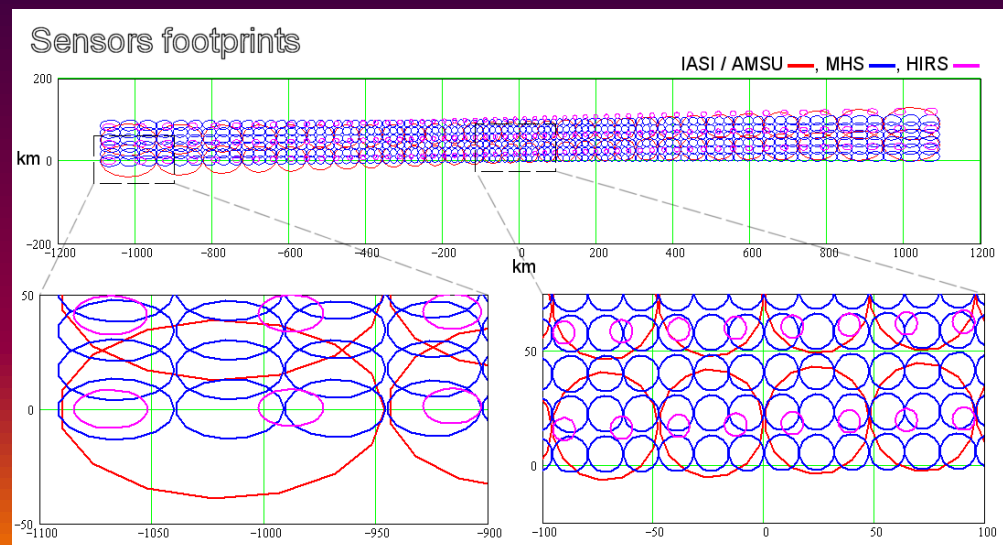
ESA - SMOS

Soil Moisture and Ocean Salinity

Partners	ESA, Deimos Engenharia, Critical Software (P)
Funding	ESA (Task Force Portugal – ESA)
Contracts	ESA → Deimos Engª → FCUL
Period	2003-2007

MIRAS instrument processor design (multiple aperture radiometer)

Development of algoritms to regularize the sampling of the Earth surface using suitable apodization functions (*adaptive striping*)

Error estimation models and tests of the industrial processor (Phase 2)

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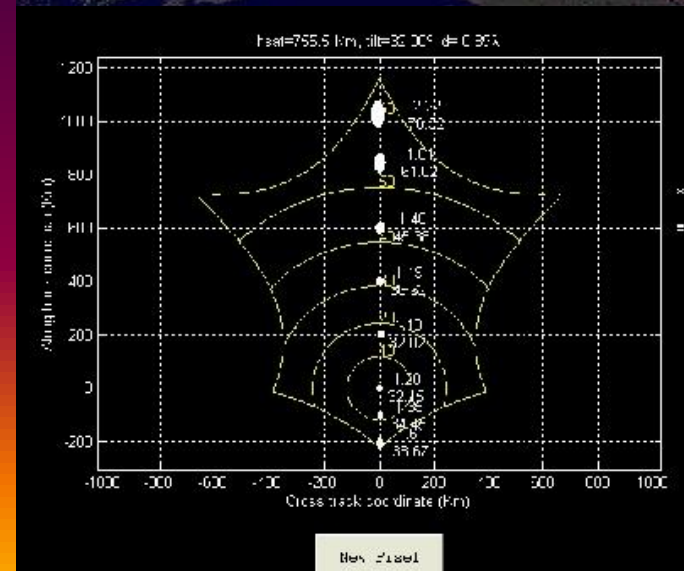
FCT / ESO - CAMCAO

Development of an IR camera for ESO VLT

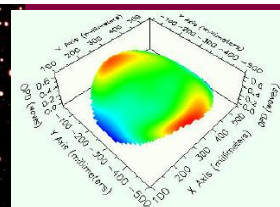| Partners	ESO, FCUL (SIM & LOLS), LIP (P)
Funding	FCT (ESO budget)
Contracts	FCT → FCUL
Period	2002-2005

Design, integration and tests of the optical subsystem of the IR CAMCAO, for ESO MCAO system

Adaptive optics to compensate the optical effects of atmospheric turbulence

Cryogenic tests (77 K): February 2005
Delivery to ESO: November 2006
First image: March 2007

System, 77K

1st image, March 2007

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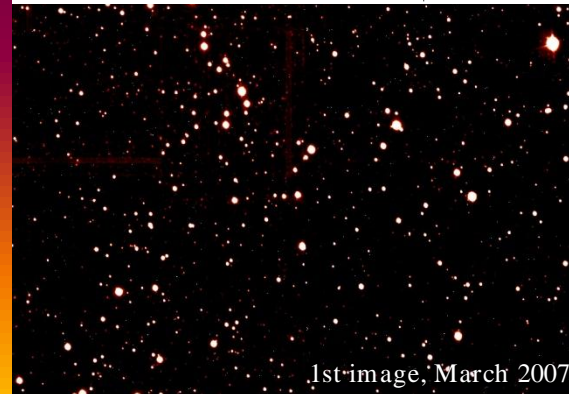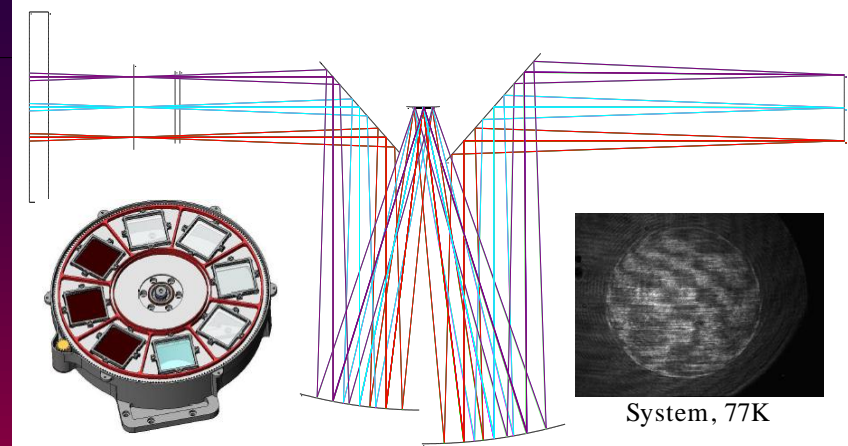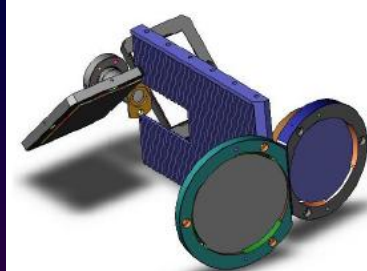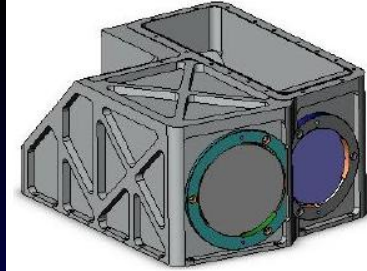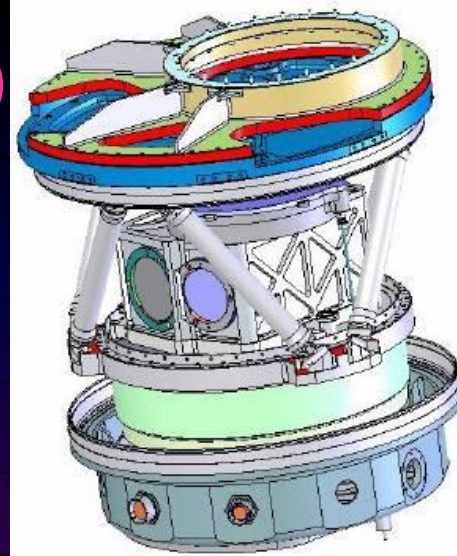
ESO - MOONS

Fiber-fed Multi-Object Optical and Near - infrared Spectrograph for the VLT (Phase A)

Partners	**UKATC, FCUL**
Funding	**ESO**
Contracts	**ESO → UKATC → FCUL**
Period	**2011-2013**

Study of the effect of the Atmospheric Dispersion and the need to use an Atmospheric Dispersion Compensator

Design of a Field Corrector for the VLT (VIS to near IR)

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2013

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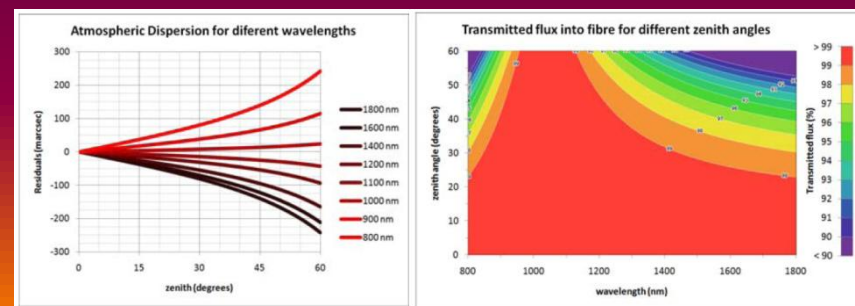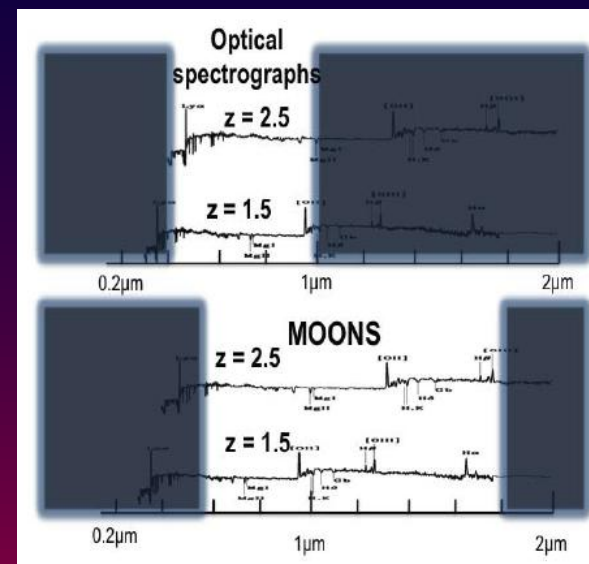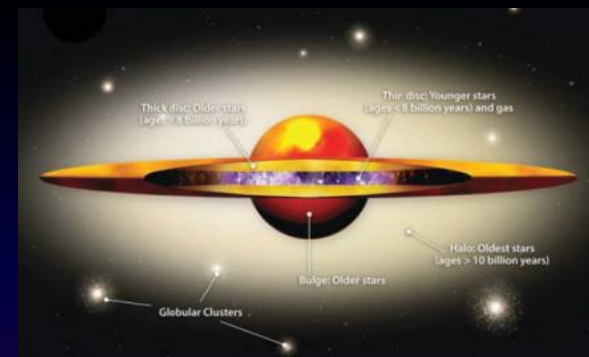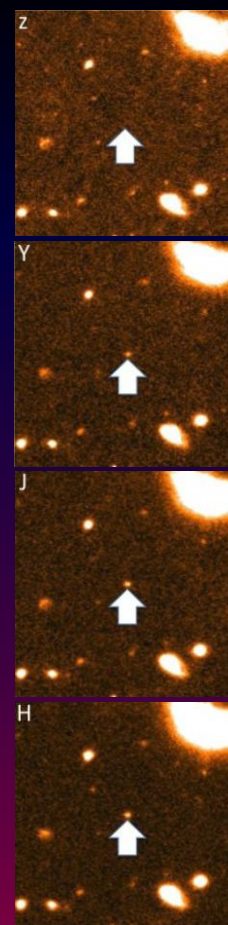
ESO - ESPRESSO

High Resolution Ultra Stable Spectrograph for the Incoherent Combined Focus of the VLT

Partners   **CAUP, FCUL (LOLS & SIM)**

Funding   **ESO + FCT**

Contracts   **ESO → U. Genève → FCUL**

Period   **2009-2010** (Phase A) **/ 2015** (Phase A'-E)

Light Injection Concept Study

- **Alternative Coudé Train concepts**
- **Trade-off analysis**
- **Coudé Train Optics, Mechanics and Control Electronics:**
  - **Design**
  - **Implementation**
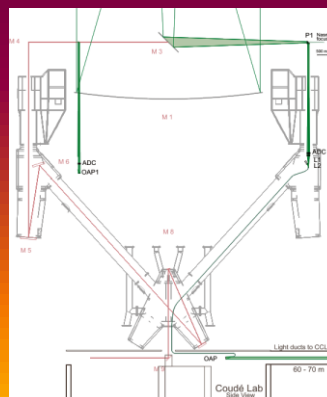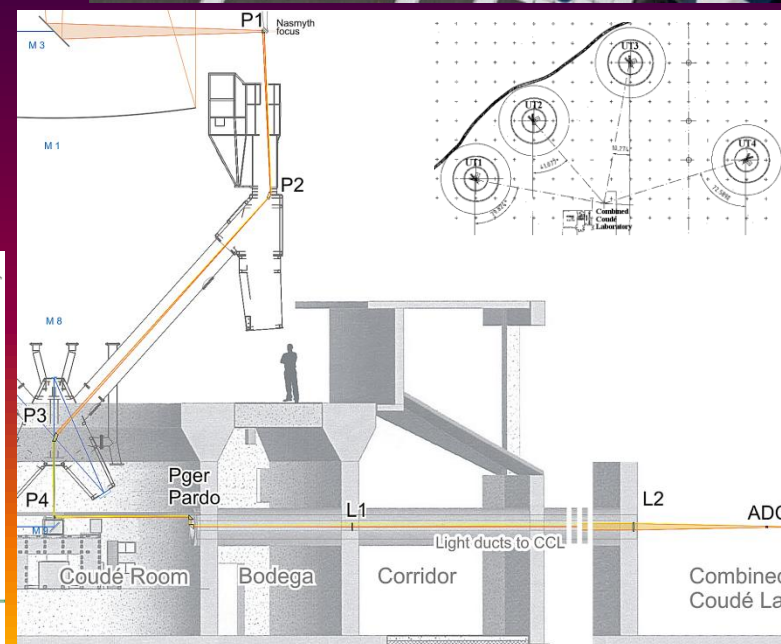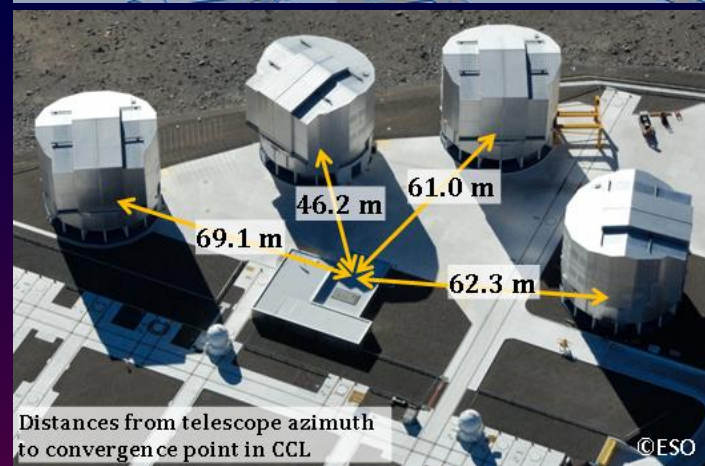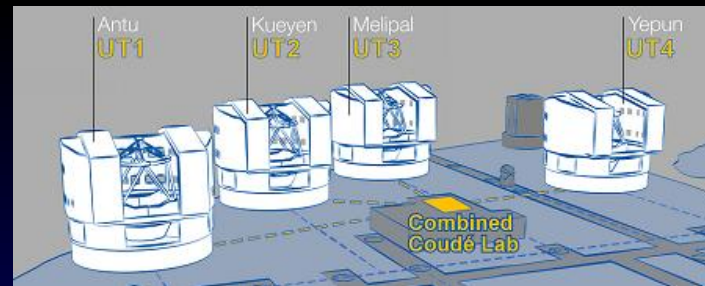
FCT / ESO - VSI

Very Large Telescope (VLT) Spectro Imager

Partners	FCUP
Funding	FCT
Contracts	FCT → FCUL
Period	2007-2009

Spectral callibration

Interferometric calibration

Beam injection into fibres
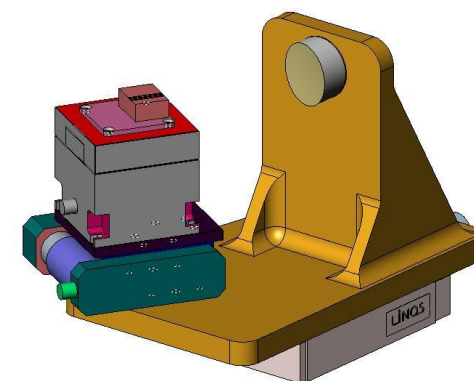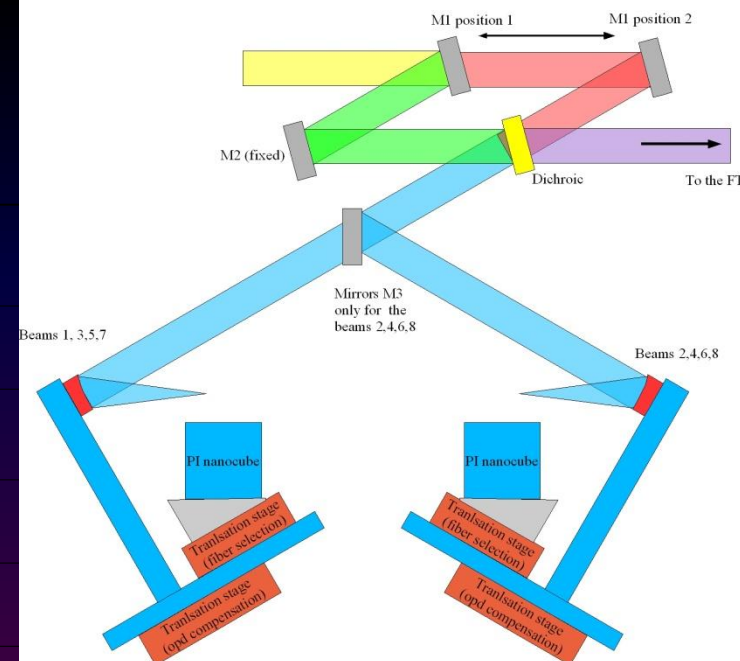
FCT – ODySSea

Dinâmica orbital de sistemas espaciais

Partners UBI (CCTA),UP(FC),CCRAS,INPE,ITA,KIAM

Funding FCT

Contracts FCT → UBI → FCUL

Period 2010-2013

Study space flight dynamics of a single spacecraft or a system of satellites and develop efficient methods of orbital and attitude control necessary for success of the respective missions.

Development of a specialized numerical simulator to implement accurate dynamics models and enhanced models of environment and disturbances.

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Optics Lasers & Systems
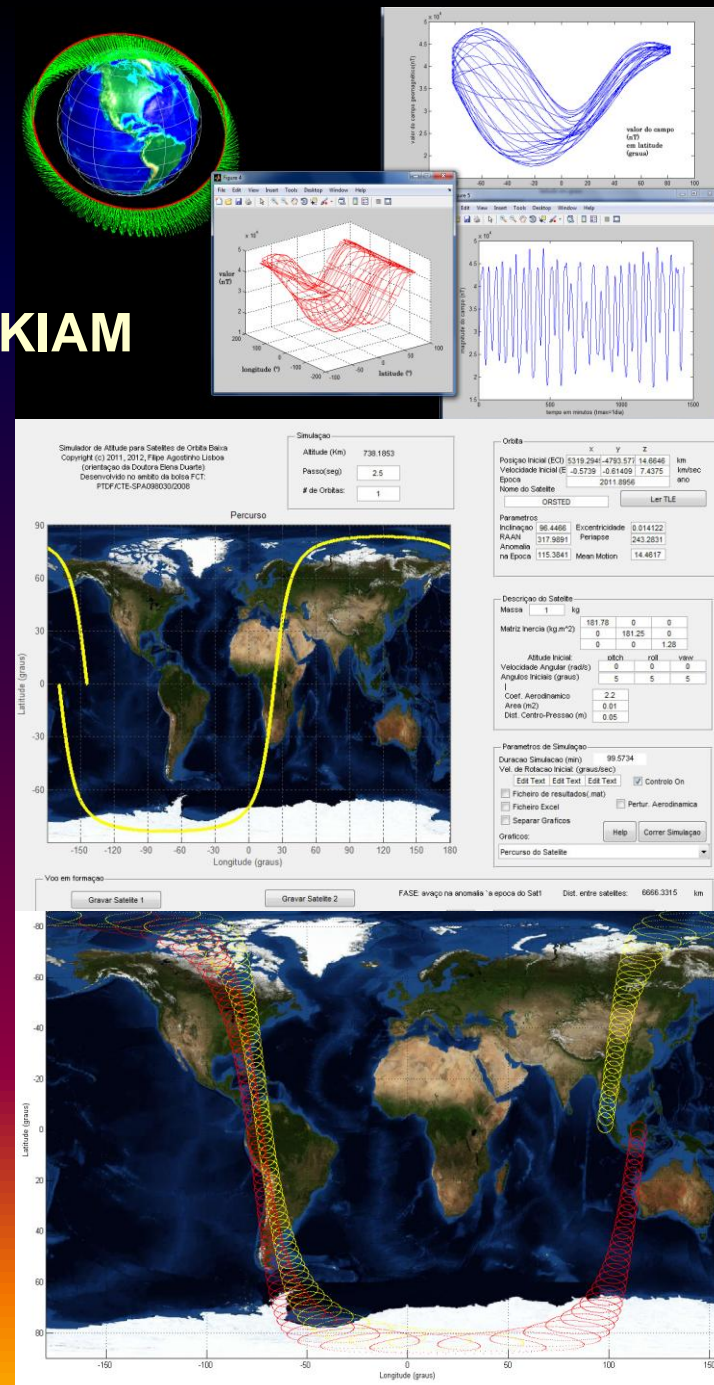
FP7 – ADAVES

Advanced Avionics Equipment Simulation

Partners	**EDISOFT**
Funding	**FP7/Clean Sky**
Contracts	**FP7 → Alenia Aeronautica → EDISOFT → FCUL**
Period	**2011-2013**

Development of a high fidelity and accurate GPS system simulation, capable of being seemly integrated in Green Regional Aircraft (GRA) flight simulator.

Development of SW models for a GPS Satellite Constelation and for onboard GPS receivers.

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ESA - CESI

Concurrent Engineering of Space Instrumentation

Partners	Critical Software (P)
Funding	ESA
Contracts	ESA → Critical → FCUL
Period	2008-2009

Design, implementation and integration of optical and microwave instrument simulation models to be included into ESA Concurrent Design Facility (CDF) Instrument Design Activity.

These models will support conceptual design at CDF but will also be designed in order to enhance future extensions to cope with later phases in the design cycle.

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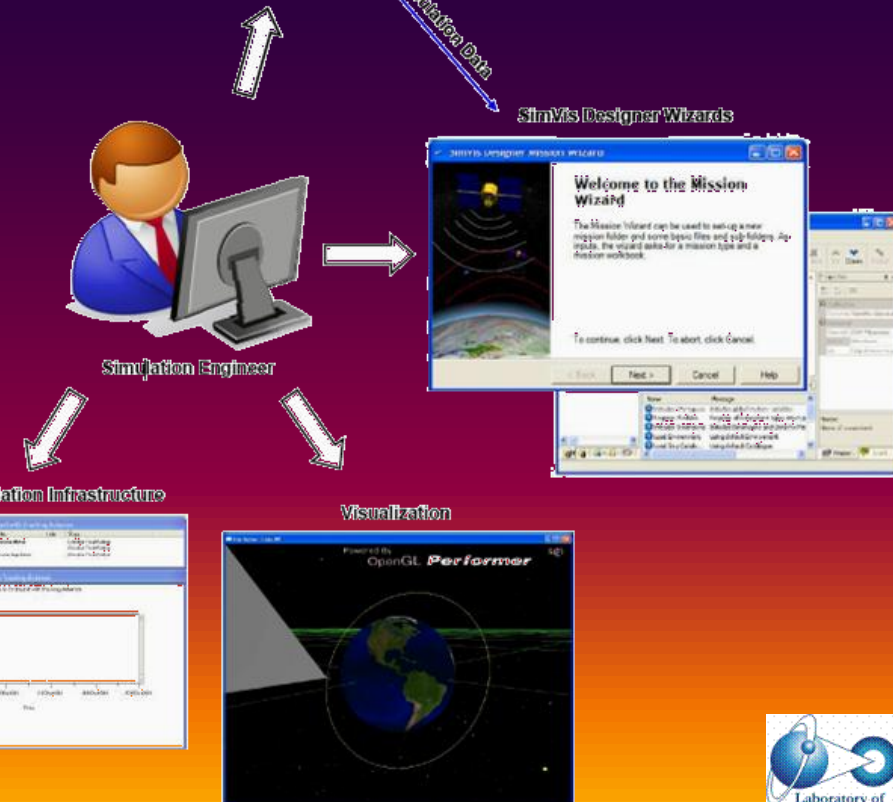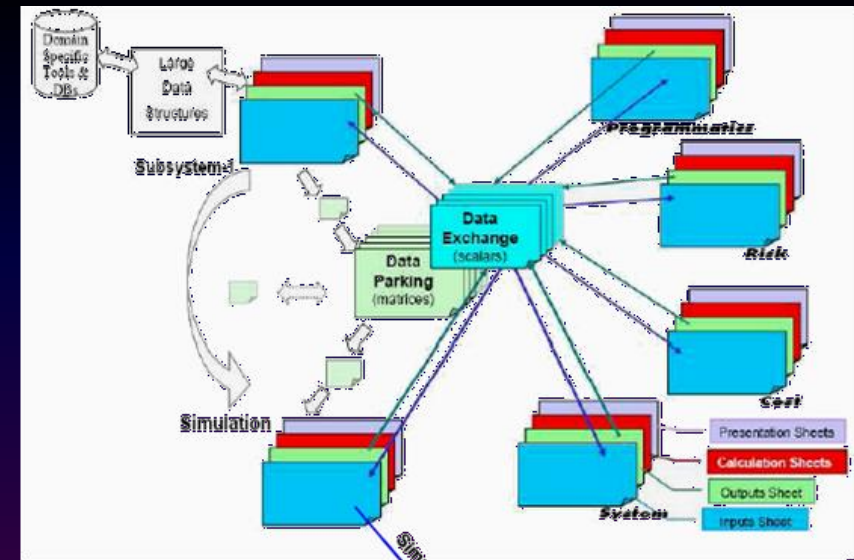
Earth Observation, Spatio-temporal phenomena & GIS

FCT – Flexible Spatial Structures

Dynamics and control of flexible spatial structures in X-SAR remote sensing

Partners	IST / IDMEC
Funding	FCT
Contracts	FCT → IDMEC → FCUL
Period	1999-2002

Generation of SAR images from amplitude and phase raw data:

- Propagation and dispersion of radar waves
- SAR image formation
- Generation of X-band SAR images
- Amplitude and phase corrections

Generation of X-SAR interferograms and analysis of their viability (time interval, spatial base)

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FCT – SAR Açores

SAR interferometry in Açores

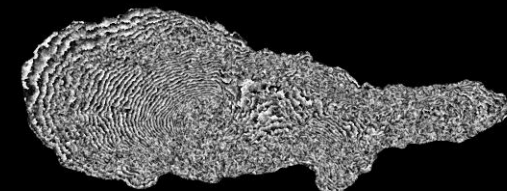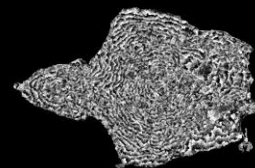| Partners	FCUL / Inst. Ciências da Terra e do Espaço, UP / Obs. Astronómico
Funding	FCT
Contracts	FCT → FCUL → FCUL
Period	2000-2003

SAR image processing for interferometric analysis and generation of digital terrain models.

Geo-registration of different images of the same scene using permanent retroreflectors.
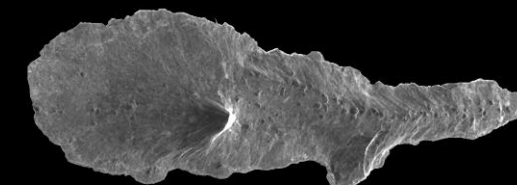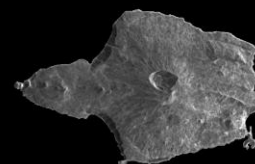
Reduction of atmospheric effects
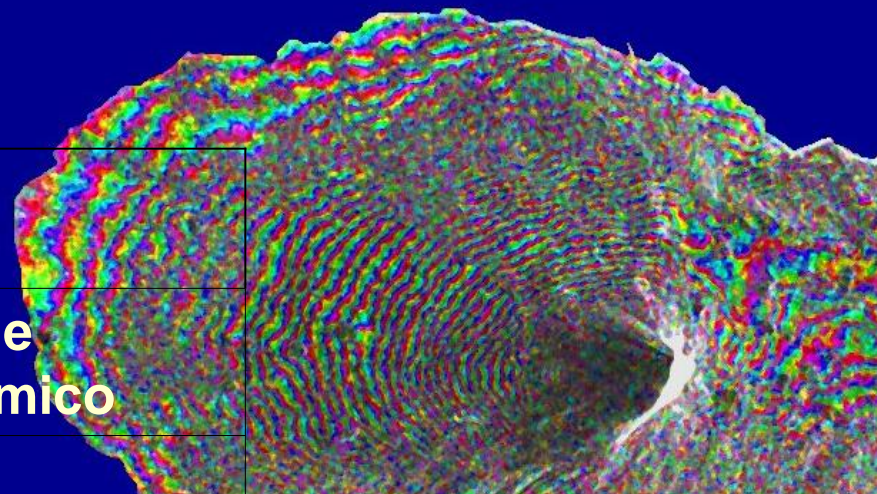
Phase image

Amplitude image

Final Interferogram
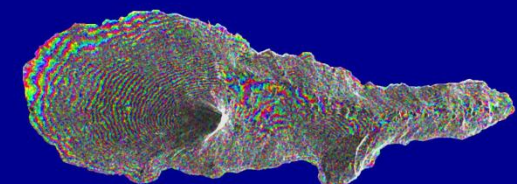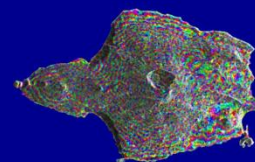
Açores - Pico and Faial islands

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FCT – Arbovírus

New arboviruses isolated in Portugal. Risk assessment and public health application.

Partners   **INSARJ, Robert Koch Institute (RKI), CESAM/UA**

Funding   **FCT**

Contracts   **FCT → INSA → FCUL**

Period   **2012-2015**

Study of the insect vectors and the circulating viral strains of flaviviruses and phleboviruses to achieve appropriate health surveillance programs, based on a ongoing mosquito national surveillance program (2008).

GIS modelling areas of high risk of occurrence for the vector species, relating its abundance and distribution to environmental and physiographic variables.

Densidade de mosquitos

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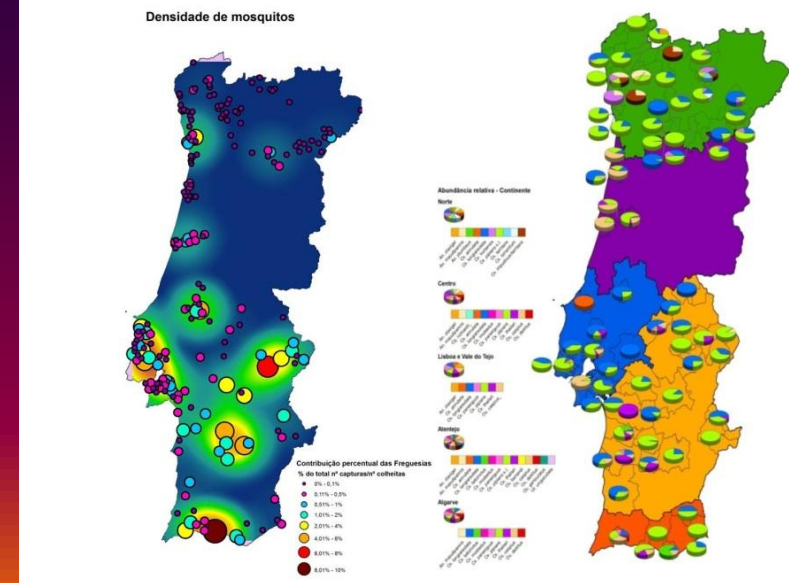
FP7 – NORSEWInD

Northern Seas Wind Index Database

Partners   OBS (UK), DTU (Denmark), GH (UK), ISET (Germany), KVT (Norway), RISOE (Denmark), UoS (UK), WKWK (Germany), SE (UK), DONG (Denmark), Nautilus (UK),Talisman (UK), BPAE (UK), StatoilHydro (Norway)

Funding   FP7

Contracts   OBS → FCUL

Period   2008-2012

Creation of offshore wind atlas for the Baltic, Irish and North Seas.

Improve the accuracy of short-term forecasting - critical for the integration of wind power into the grid.

Network of wind speed sensors

Ground-based remote sensing technologies, (SoDAR - Sound Detecting And Ranging & LiDAR – Light Detecting And Ranging)

Meteorological masts (offshore or near shore) combined with the horizontal resolution offered by SAR (Synthetic Aperture Radar) and scatterometer techniques.

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Laboratory of Optics Lasers & Systems

Optical Metrology

ESA - HPOM

High precision optical metrology (Darwin)

Partners	ESA, EADS Astrium (Fr + D), SIOS, TPD/TNO (Nl), EADS-CASA (Sp)
Funding	ESA
Contracts	ESA → Astrium SAS → FCUL
Period	2001-2005

DARWIN is based on an *InfraRed Space Interferometer* (MAT) to detect planets in non-solar planetary systems.

**Optical metrology (FSI, frequency sweeping interrferometry) for formation flying missions**

New concepts for compensation of metrological networks in space.

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2013
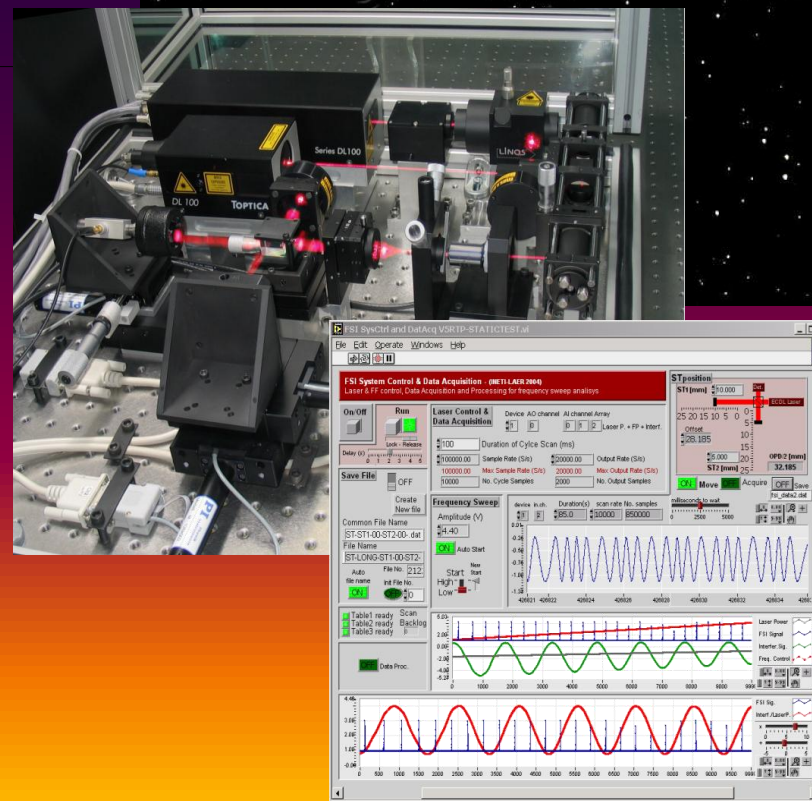
EUCLID RTP 9.9

High Resolution Optical Satellite Sensor (HROSS)
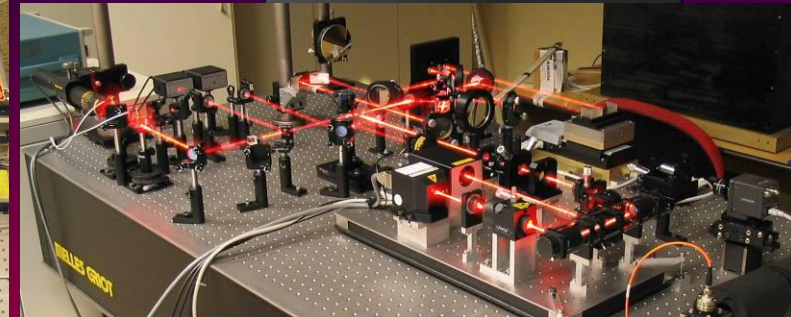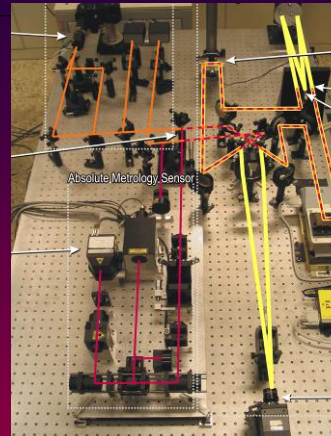
Partners	Alenia (It), CSL (B), mOmega (B), IST/ISR (P)
Funding	Ministery of Defence (PT)
Contracts	Alenia → FCUL → IST/ISR
Period	2002-2005
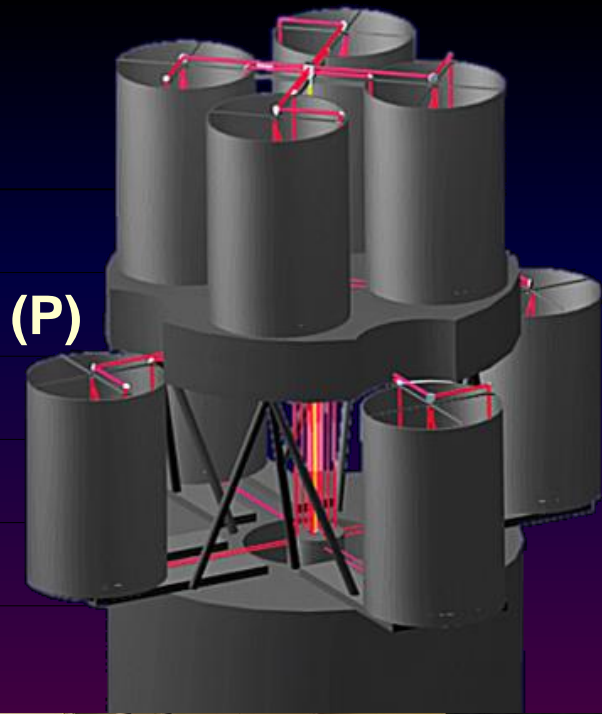
Earth observation with geostationary multiple aperture telescopes

Internal metrology systems

Generation and restoration of space variant images (variable PSF)

Blurred   Original   SVD

2013

ESA – FP-MET

Fabry-Perot metrology

Partners	ESA
Funding	ESA (Task Force Portugal – ESA)
Contracts	ESA → FCUL
Period	2007-2010

Frequency sweep range measurement of tunable lasers for *Frequency Sweep Interferometry* (FSI) metrology

Development of monolitical Fabry-Perot *étalons*

Candidate technology to be tested in PROBA 3
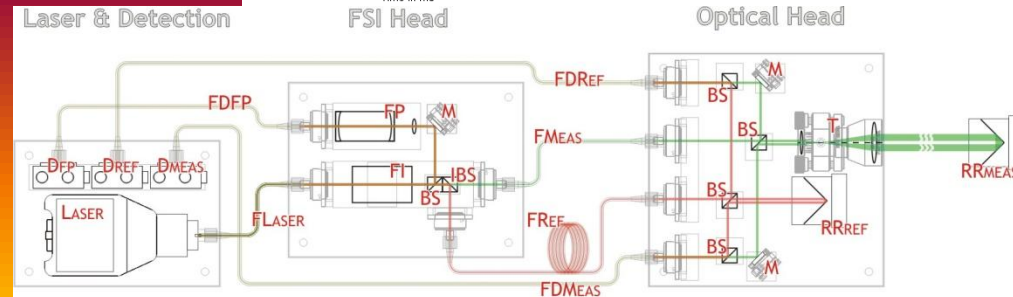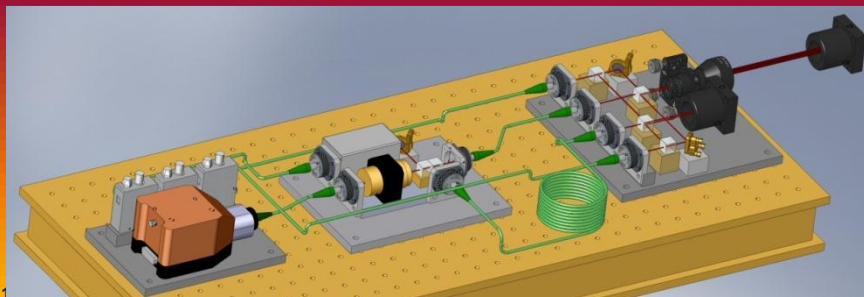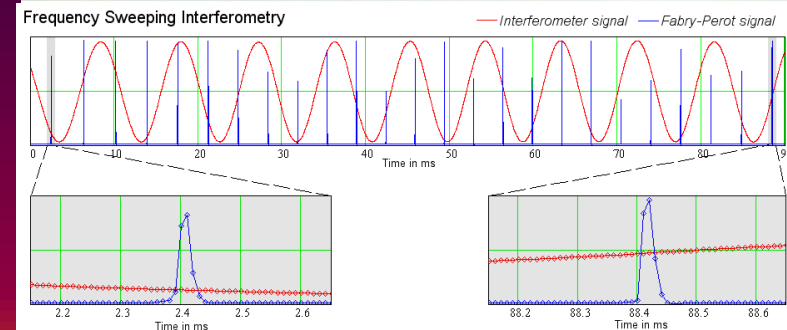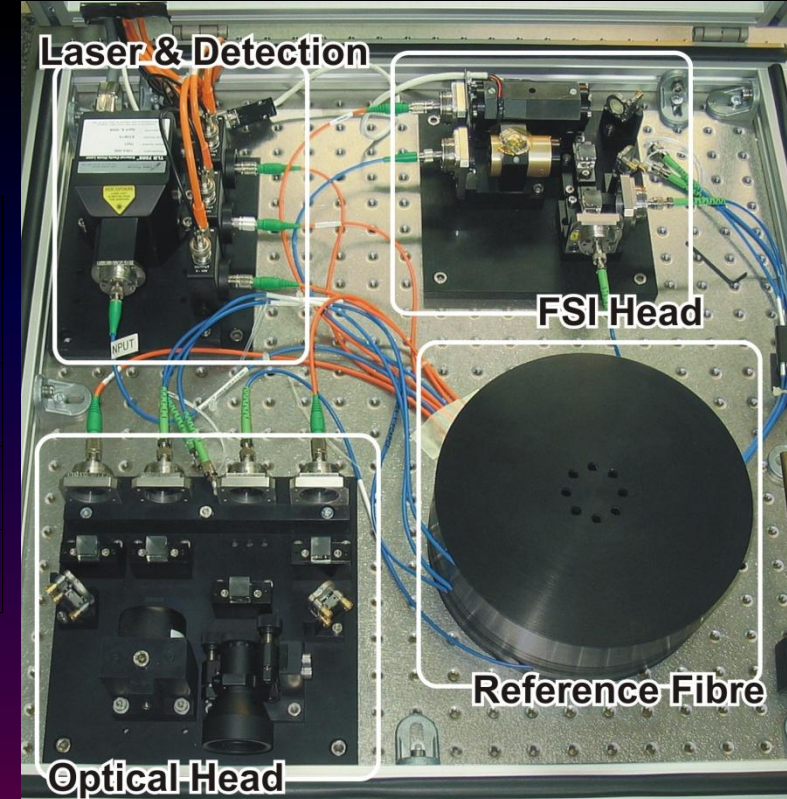
ESA - FEMTO
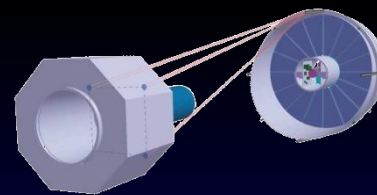
Absolute long distance measurement with (sub-)µm accuracy for formation flight applications

Partners   ESA, TPD/TNO (Nl), LCVU (Nl), ASTRIUM (D)

Funding   ESA

Contracts   ESA → TPD/TNO → FCUL

Period   2007-2008

Realisation and fundamental technological limitations of femto-seconds (fs) metrology

Assessment of maturity of technology

Applicability of fs-metrology to different space mission scenarios

Assessment of complexity and impact at system level

Baseline Metrology for XEUS

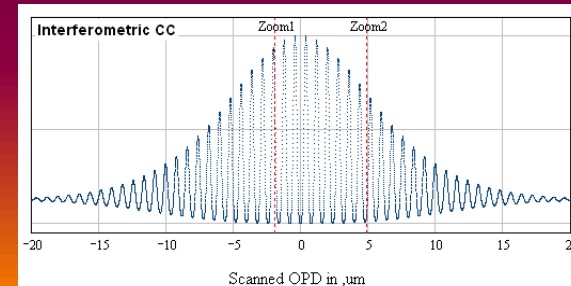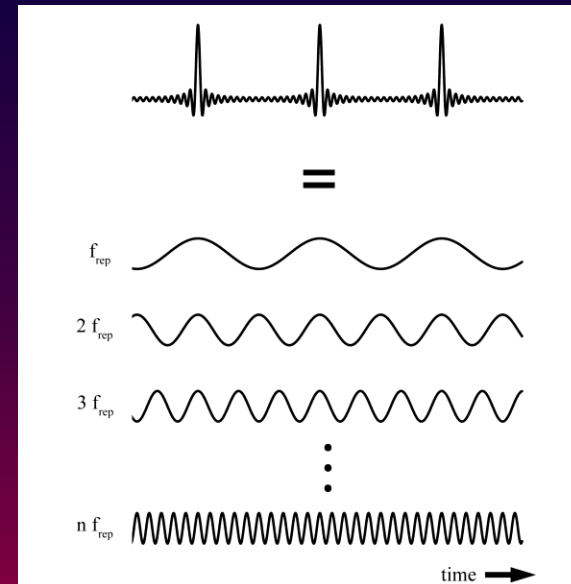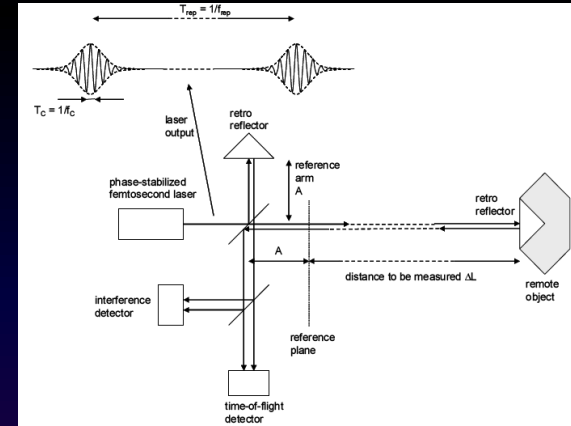◆ **XEUS** (**X-ray Evolving Universe Spectroscopy**): two **separate** spacecrafts flying in formation with a **focal length of 35 m**, without the use of a large deployable bench or a telescope tube system.

◆ XEUS Optical metrology must measure all **6 degrees of freedom** of DSC (Detector S/C) relative to MSC (Mirror S/C),

◆ The solution to measure 6 DOF is to use a **Trilateration** scheme to obtain the lateral displacements and angular orientation of the DSC wrt the MSC with an absolute **distance** metrology system.
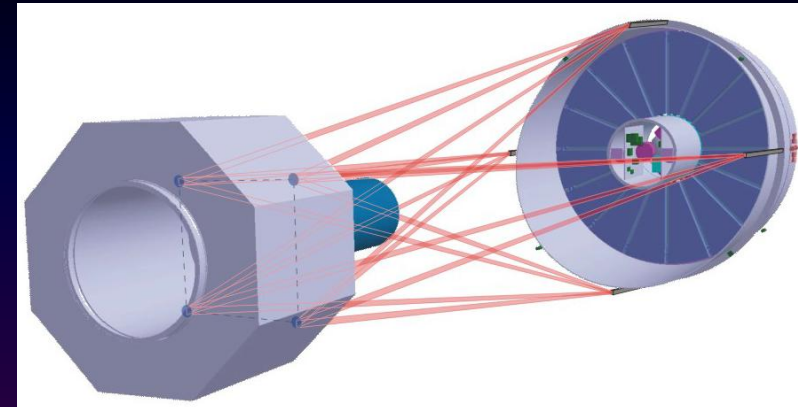
Parameter	Value and Range	Uncertainty (2σ) Required – Predicted
z (ISD)	35 m ± 1 m	300 μm – 10 μm
x & y	0 m ± 1 m	170 μm – 125 μm
pitch & yaw	0 degrees	10 arcsec – 1 arcsec
roll	0 degrees	>>10 arcsec – 10 arcsec
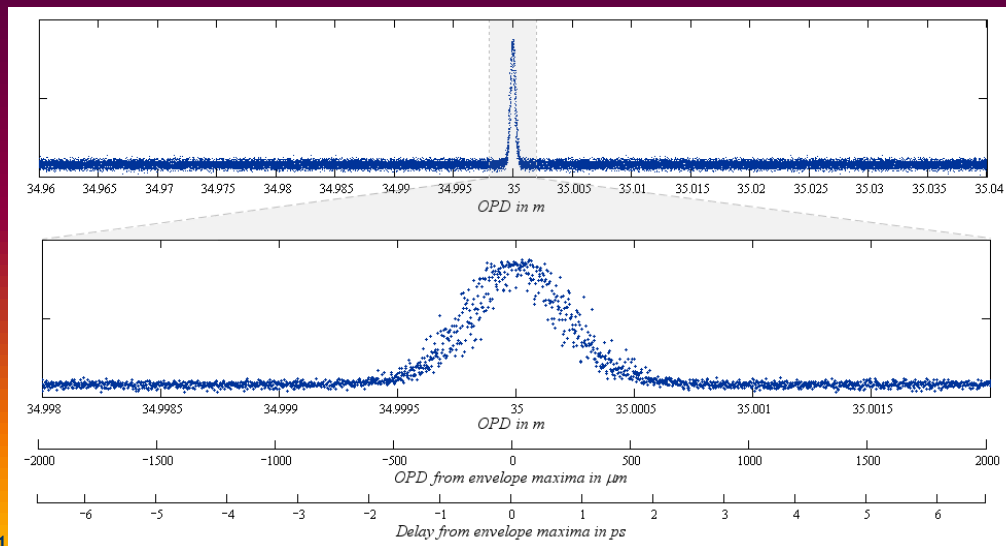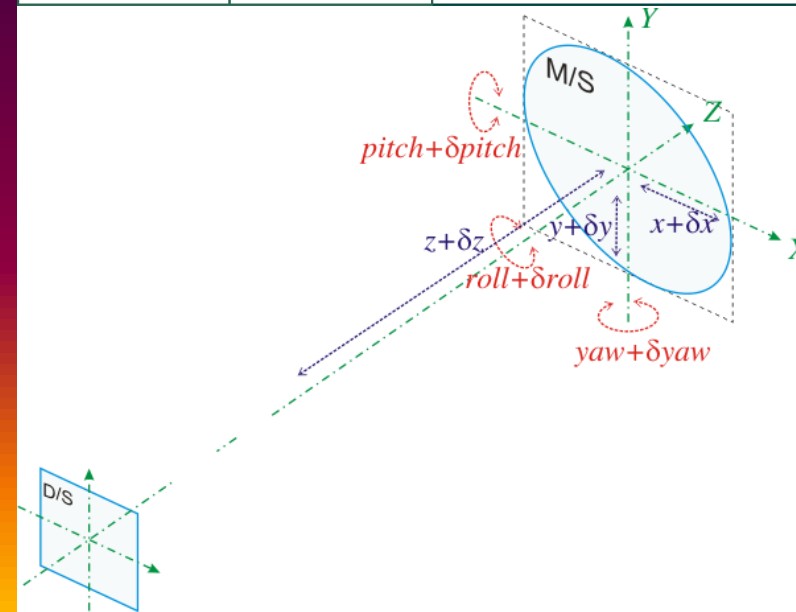
ESA – Mode Locked SC Lasers

Mode locked Semiconductor Lasers for Optical Precision Metrology

Partners   **Astrium (D), Reflekron (Fi)**

Funding   **ESA – ITI** (Industrial Triangular Initiative)

Contracts   **ESA → FCUL**

Period   **2008-2010**

Modelocked Laser diode accurate timing stabilization

Pulse Cross-correlation for time-of-flight distance measurement

Application to space and to Formation Flying missions metrology
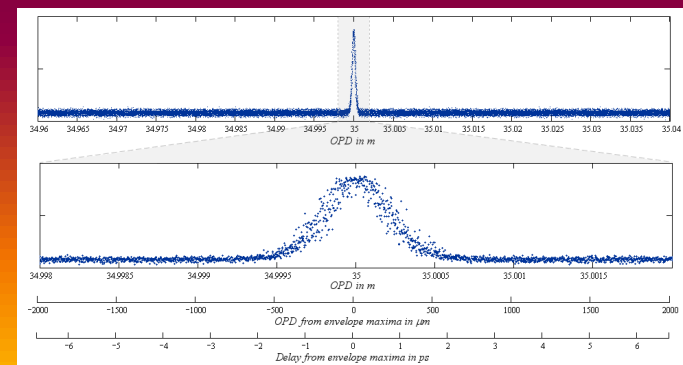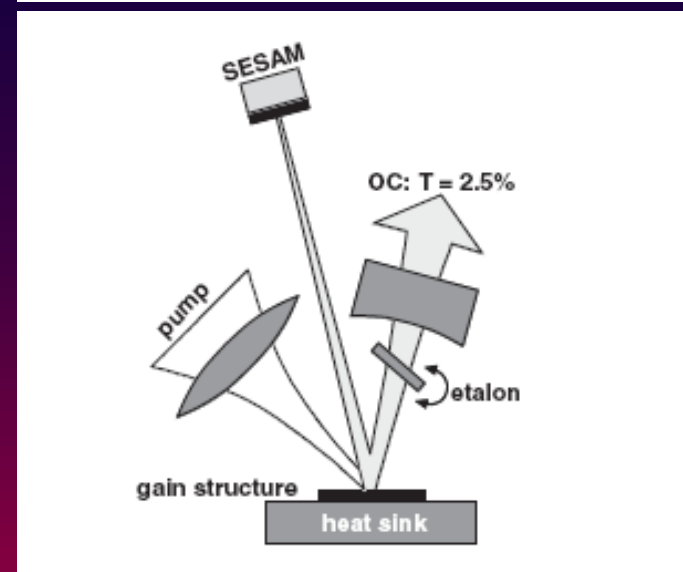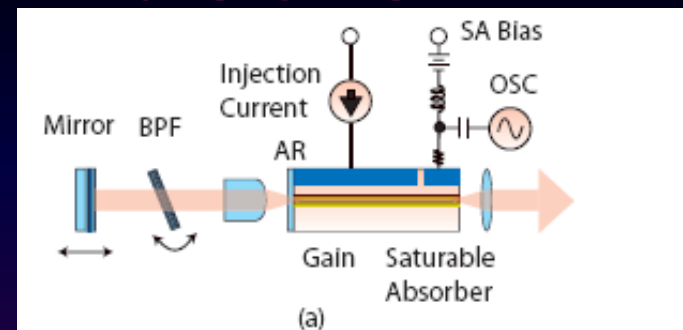
FCT – Accelerometry & Space Metrology

Medium and high frequency callibration of accelerometers

Partners	FCUL (INETI / LAER, IPQ/ LME)
Funding	FCT
Contracts	FCT → FCUL
Period	2003-2006

High frequency calibration of accelerometers (1-20 kHz). Traceability to SI.

Laser metroloy to measure distance between satellites in formation flying missions

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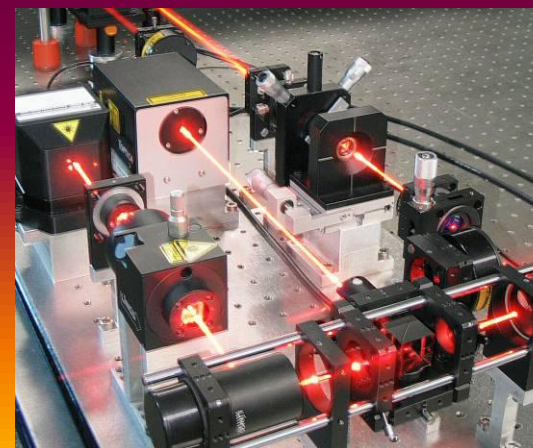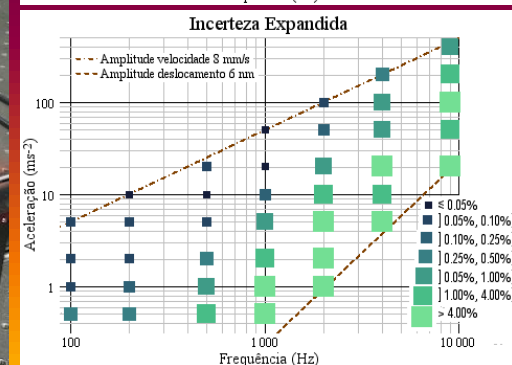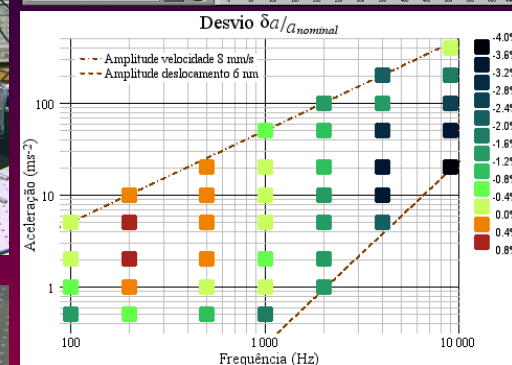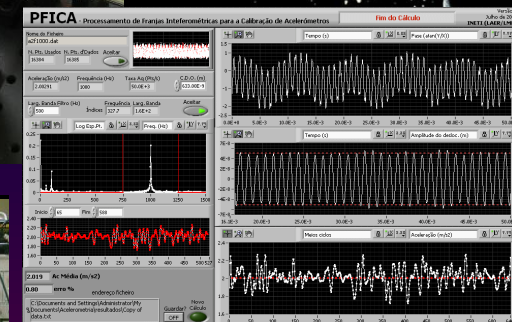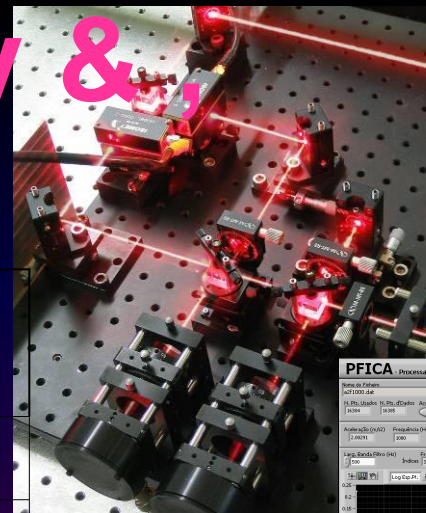
FCT – Angular Optical Metrology

High Accuracy Optical 2D Angular Metrology

Partners	**FCUL**
Funding	**FCT**
Contracts	**FCT → FCUL**
Period	**2010-2013**

Calibration of primary accelerometers
 Traceability to SI

Angular measurements for formation flying space missions
 nrad level

2013
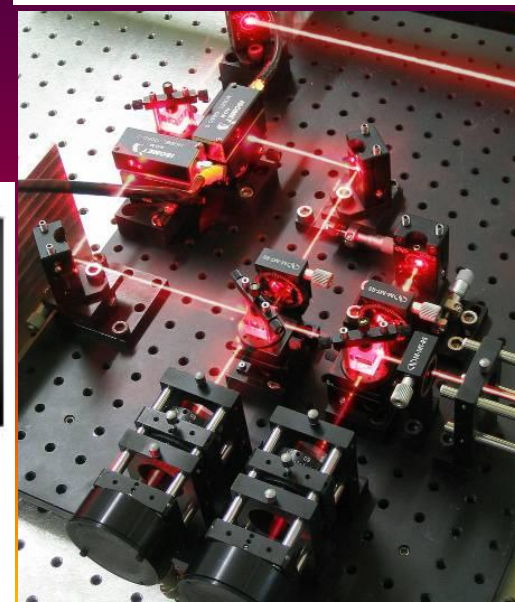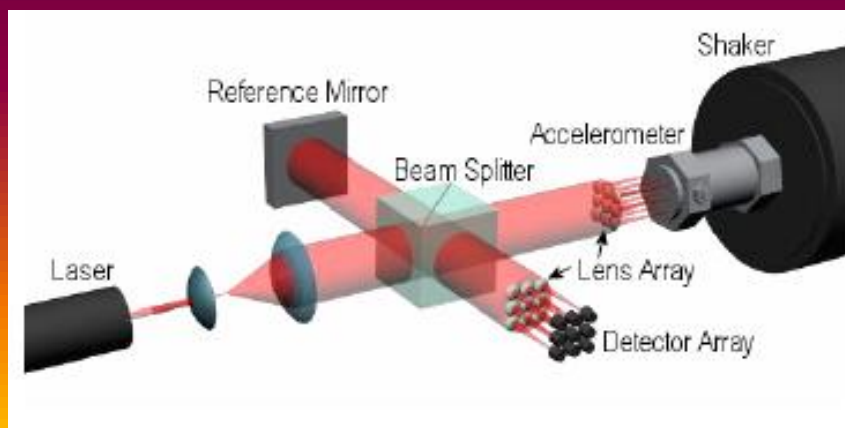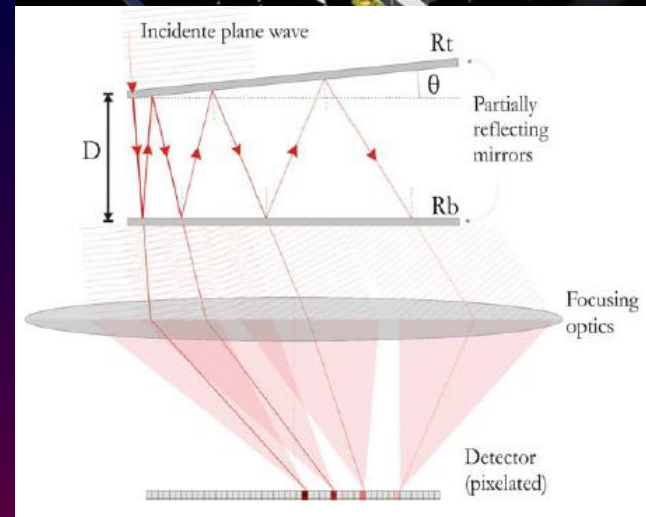
Solar Ponds

Bio-convection Modeling	
Partners	DER (INETI), IDMEC (IST)
Funding	FCT
Contracts	FCT → FCUL
Period	2006-2008

Diffusion processes take place in a solar pond when biological elements are introduced.

Specific Particle Image Velocimetry (PIV) system and other monitoring techniques

Simulation of Solar ponds dynamics and analysis in laboratorial conditions.

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Systems
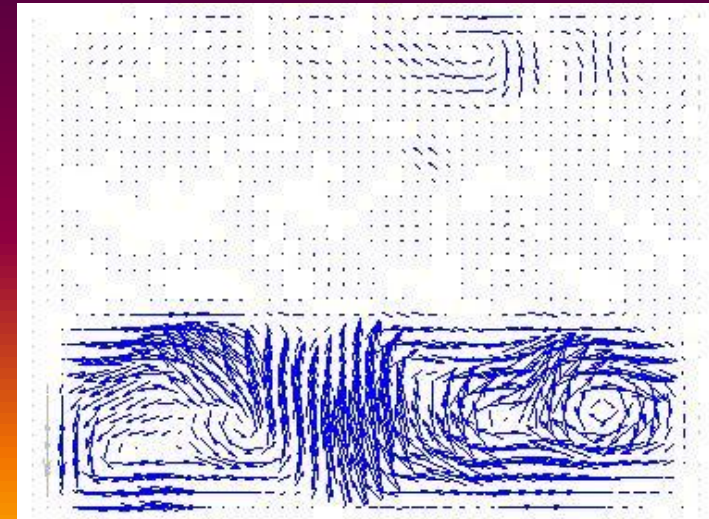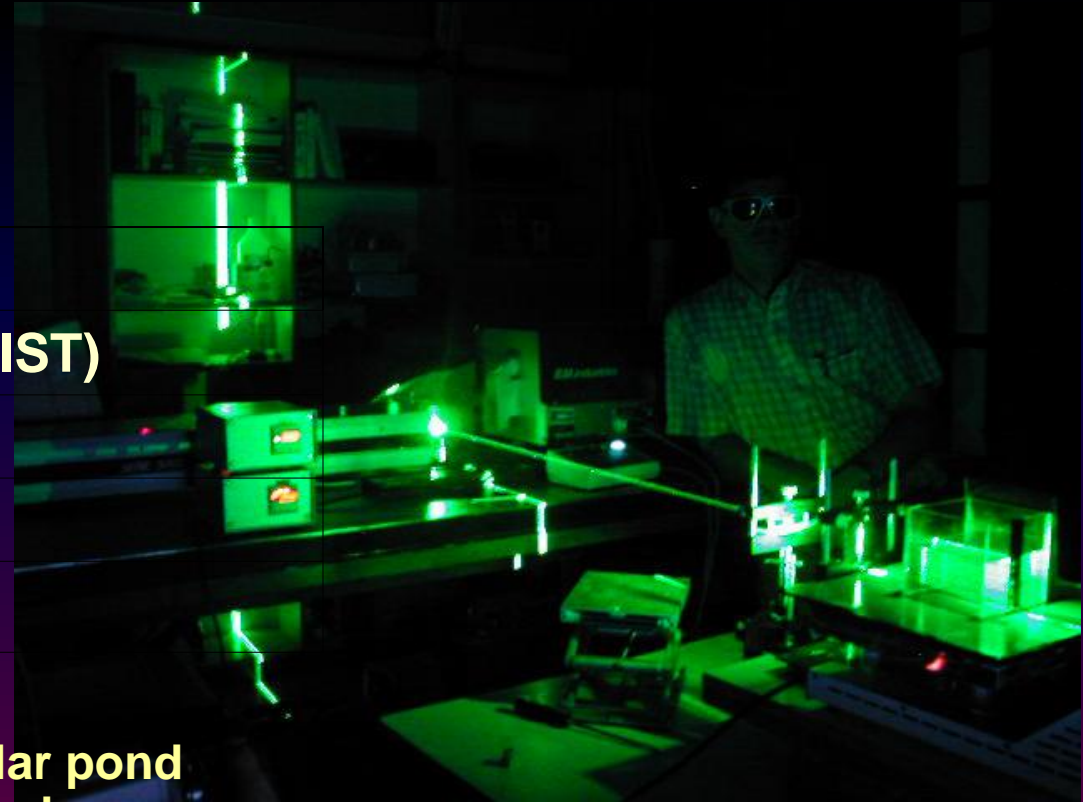
NANOTOX

Integrated evaluation of nanomaterials: Characterization and Assessment of Environmental Toxicity

Partners   LNEG, FCT-UNL, Hospital Curry Cabral

Funding   FCT

Contracts   FCT→ FCUL

Period   2010-2013

50 nm
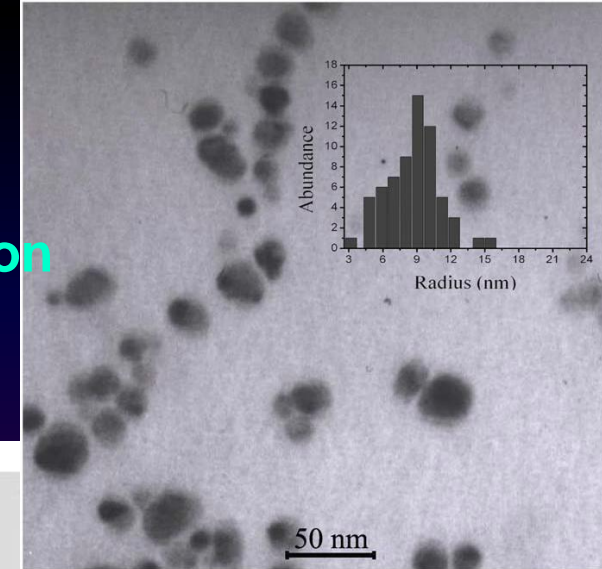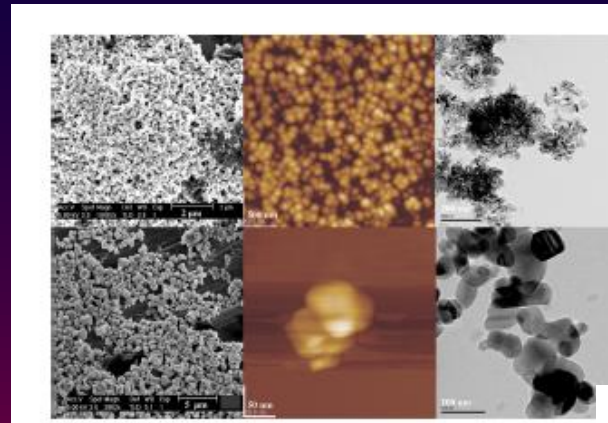
Nano particles (TiO, …) characterization

Particle and colloid chemistry and implications with ecotoxicology

Characterization of wet nanomaterials in aqueous or biological solutions

LIBD

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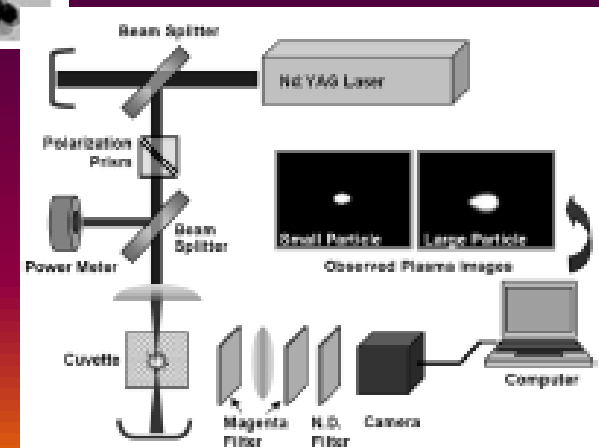
FCT - ALF

Analisador Laser de Fluidos / Laser Analyzer of Fluids

Partners	FCT-UNL
Funding	PRAXIS XXI
Contracts	FCT
Period	1997-2000

Development of a new optical process for characterization of fluids and suspended particles.

Design and implementation of a prototype that allows the use of the process *in situ*.

Diffusive tomography techniques

2013
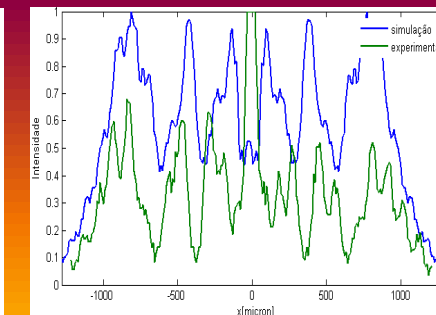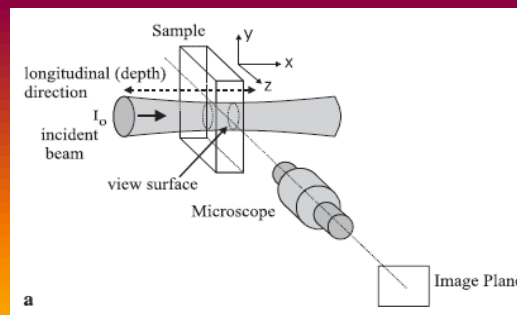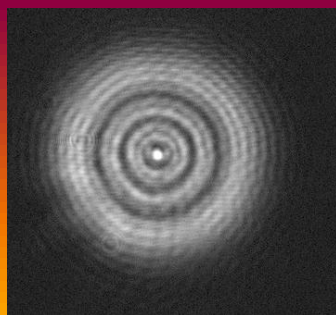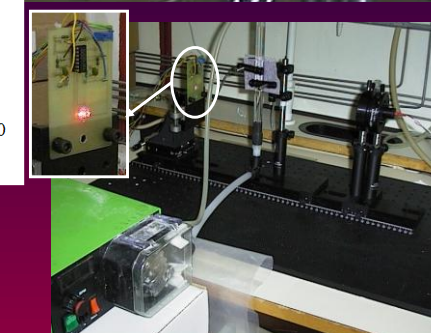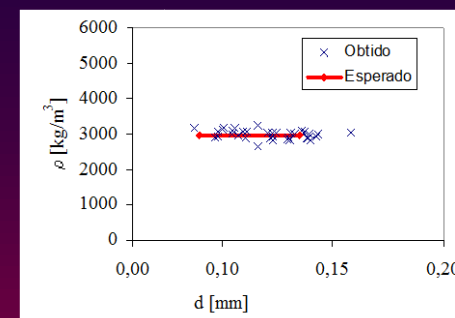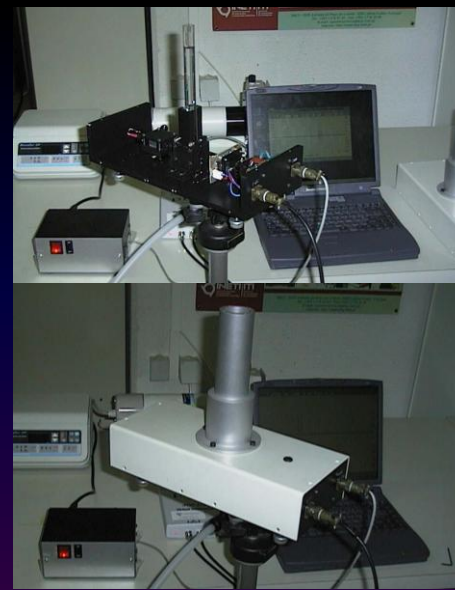
Long Period Gratings Engineering

Optimization and modeling LPG-based fiber sensors

Partners   INESC-Porto, FCUP

Funding

Contracts

Period   2007-2011

Modeling and production of long-period fiber gratings (LPG) by means of CO_2 laser radiation.

Development of encapsulation systems for specific environment sensing applications.

Transmission spectrum — Cladding — Source spectrum — Core — LPG
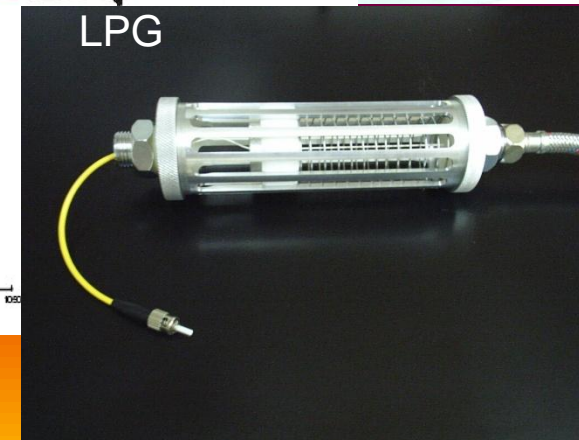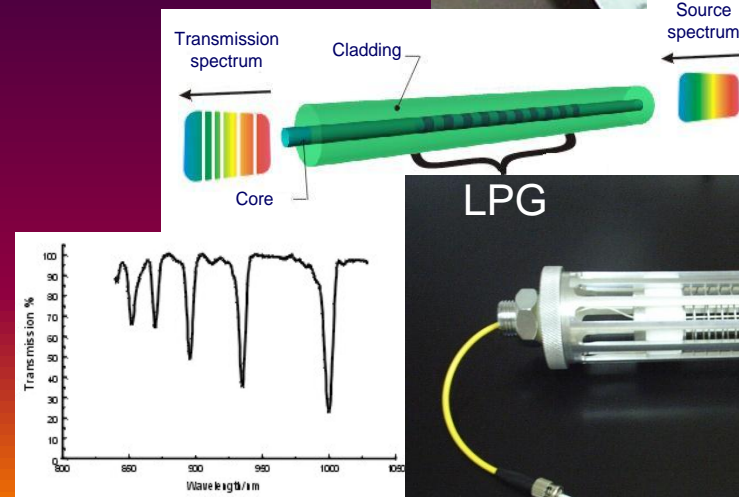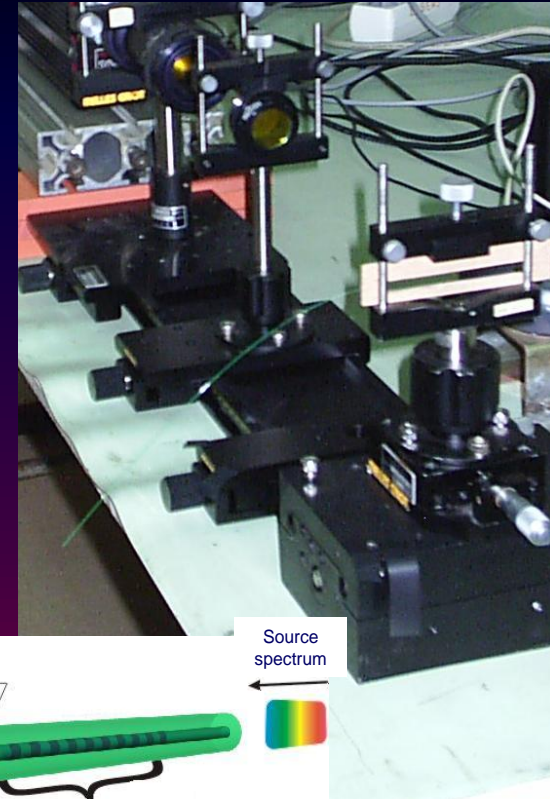
VIAPAV

Integrated optoelectronic system dedicated to analysis of pavement and road structures

Partners   **Estereofoto**

Funding   **IAPMEI- QREN**

Contrats   **Estereofoto → FCUL**

Period   **2007-2010**

Development of an integrated optoelectronic system for a vehicle mounted modular system for geo-referencing and collecting data on roads, pavements and other road structures:

GPS, IMU, imaging (1D), laser triangulation, laser scanning

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2013
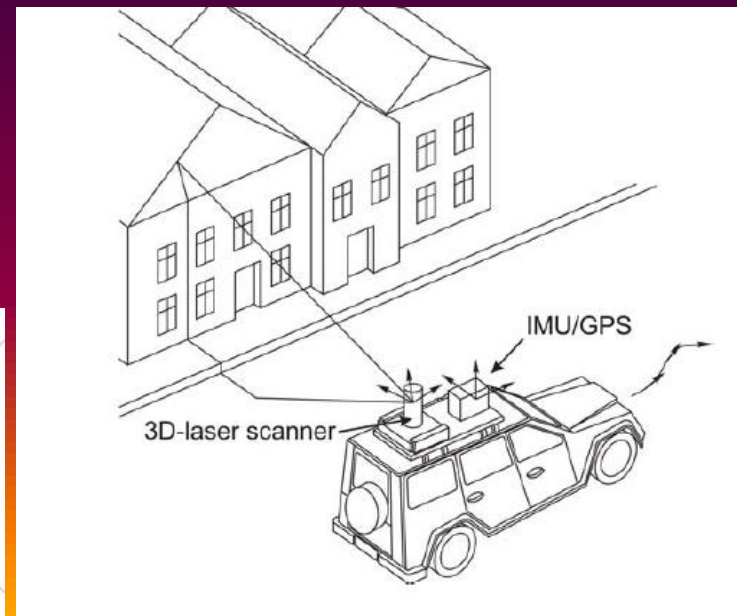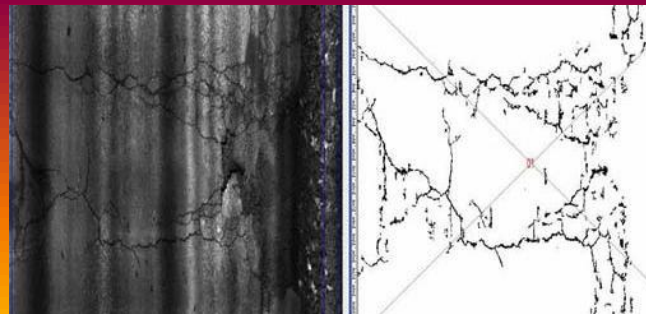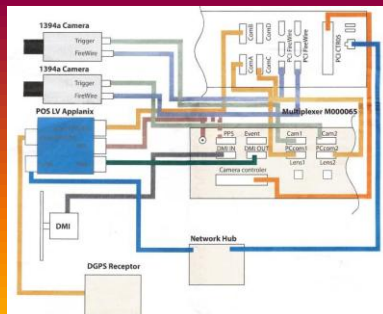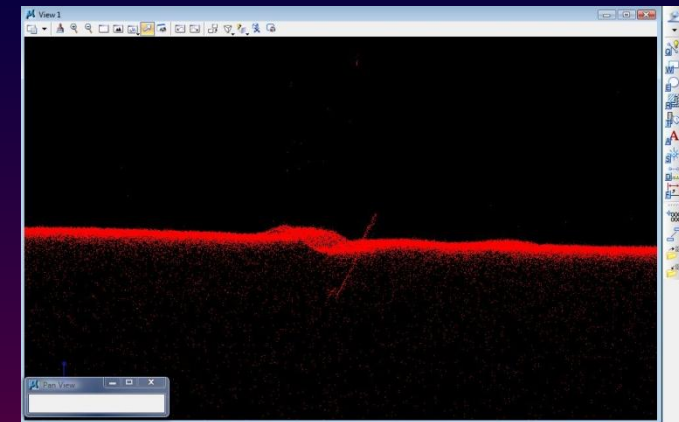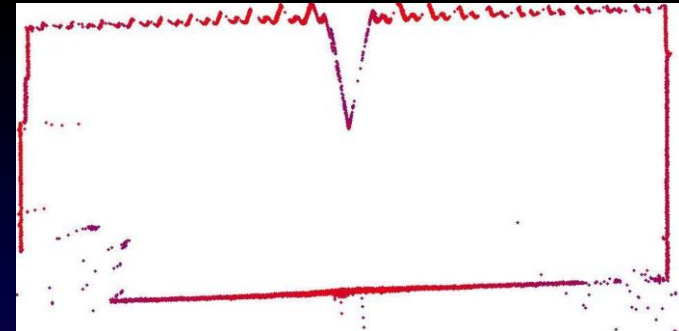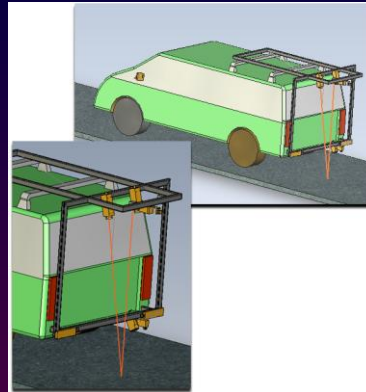
IDAUTO

Licence Plate Recognition

Partners	Fatrónica
Funding	Fatrónica
Contracts	PRIME → Fatrónica → FCUL
Period	2004-2008

Vision System for Automatic Licence Plate Recognition of Vehicles accessing restricted areas.

2013
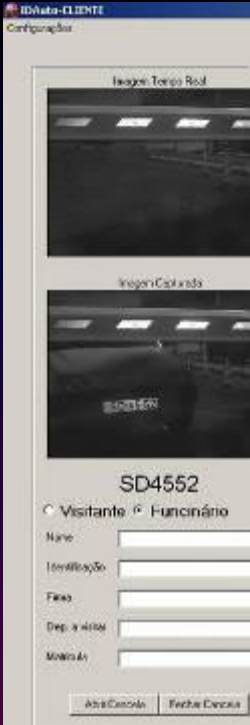
CAUTELA

Counting People in public areas

Partners	**NewVision**
Funding	**NewVision**
Contracts	**SIME IDT → NewVision → FCUL**
Period	**2006-2008**

Vision system for the evaluation of the number of people that crosses reference virtual lines, accessing commercial areas, allowing the estimation of the ratio between the number of accesses and the number of effective buyers, in a particular location.

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2013

Laboratory of
Optics Lasers &
Systems
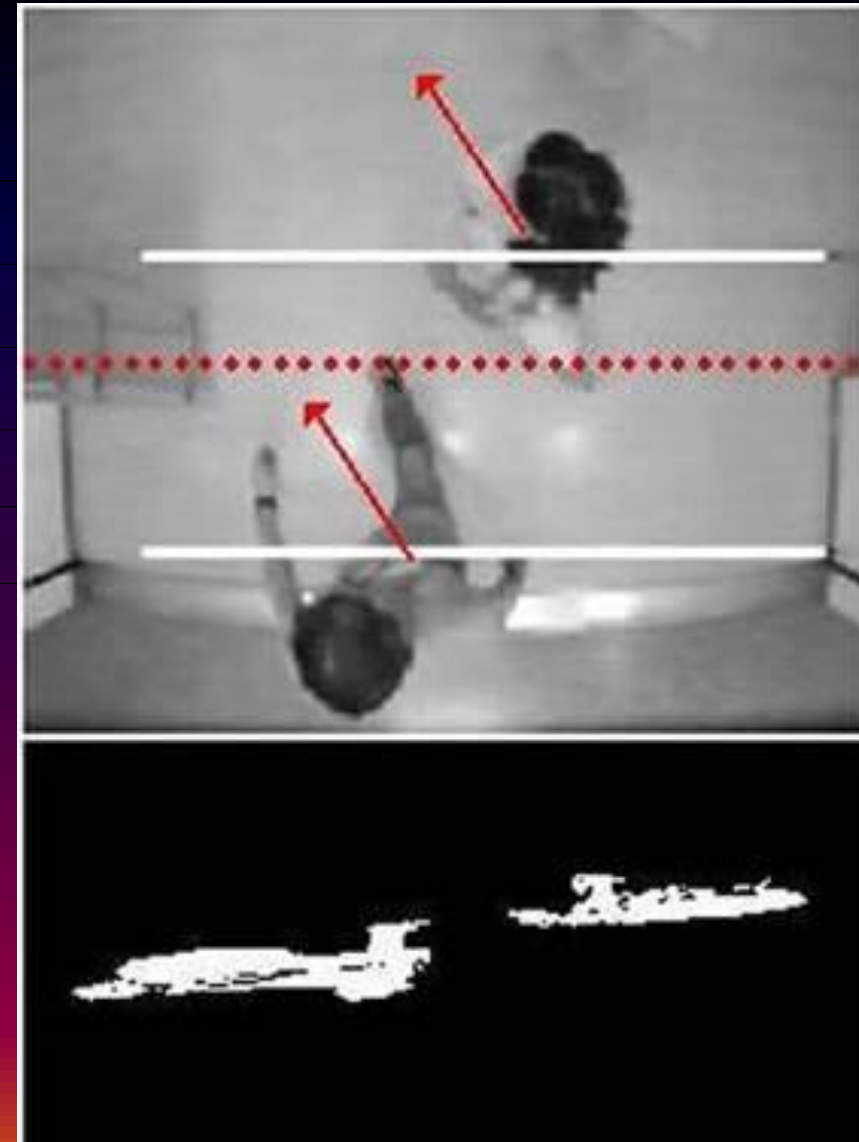
CEMICRO

Competence network on micro-manufacturing

Partners	CENTIMFE, CCG, CTCV, ESTG, FAMOLDE, IBER-OLEFF, ICEMS, INESC-Porto, IST Mastermatic, Nanologic, OPEN, PIEP, U.Minho
Funding	Prime POS-C
Contracts	AdI → FCUL
Period	2007-2011
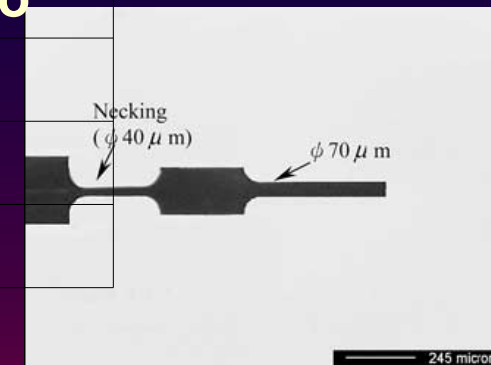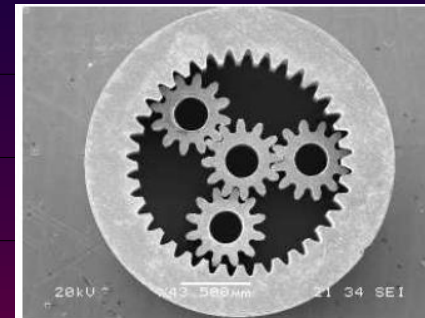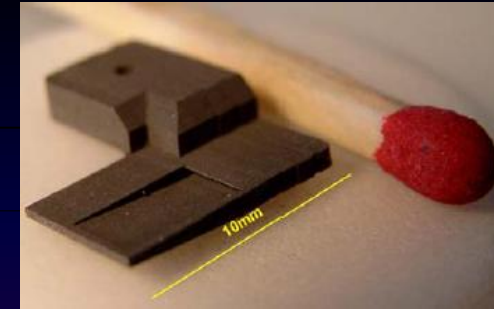
Competence network on micro-manufacturing to evaluate the state of the art of the technology, and mobilize partners into new chalenges in micro and nanotechnology.

Development of techniques for laser cleaning of micromoulds and micro-parts

3D metrology for quality control.

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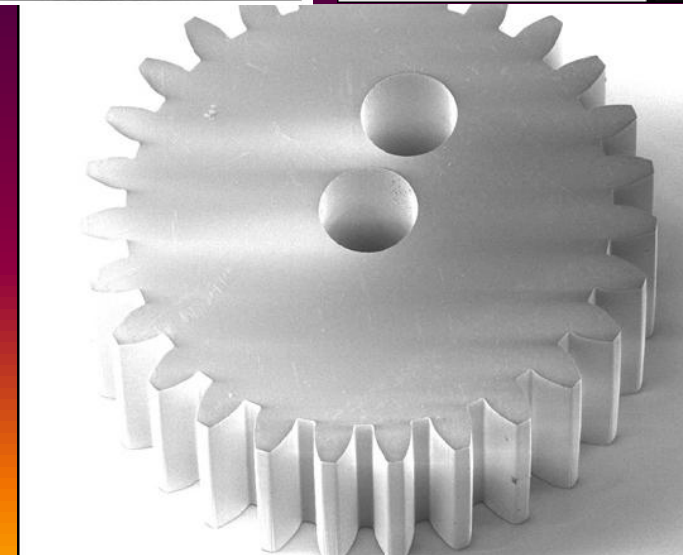
Security & Defence

NATO – SAFEPORT

An approach to port surveillance and protection

Partners   **EDISOFT, FEUP, U. Évora**

Funding   **NATO**

Contracts   **NATO – Po Navy → EDISOFT → FCUL**

Period   **2011-2014**

Development of a Decision Support System to:

➢ **Aid decision-makers in selecting assets for harbour and port protection in multiple scenarios**

➢ **Determine a set of configuration solutions that maximize the level of protection (threats detection) within a given area**

Development of models for electrooptical and infrared sensors to be used in simulation of the activities dealing with the detection of threats

2013
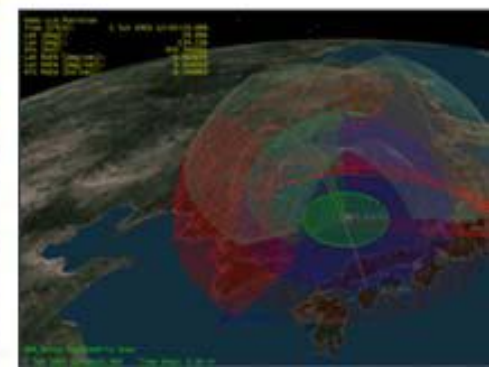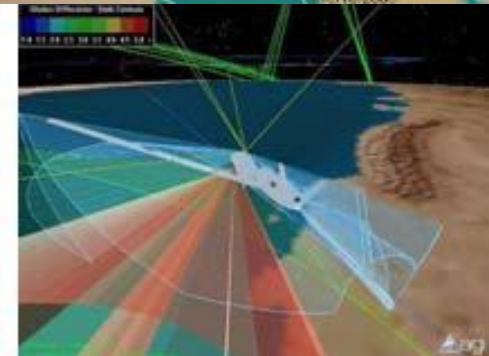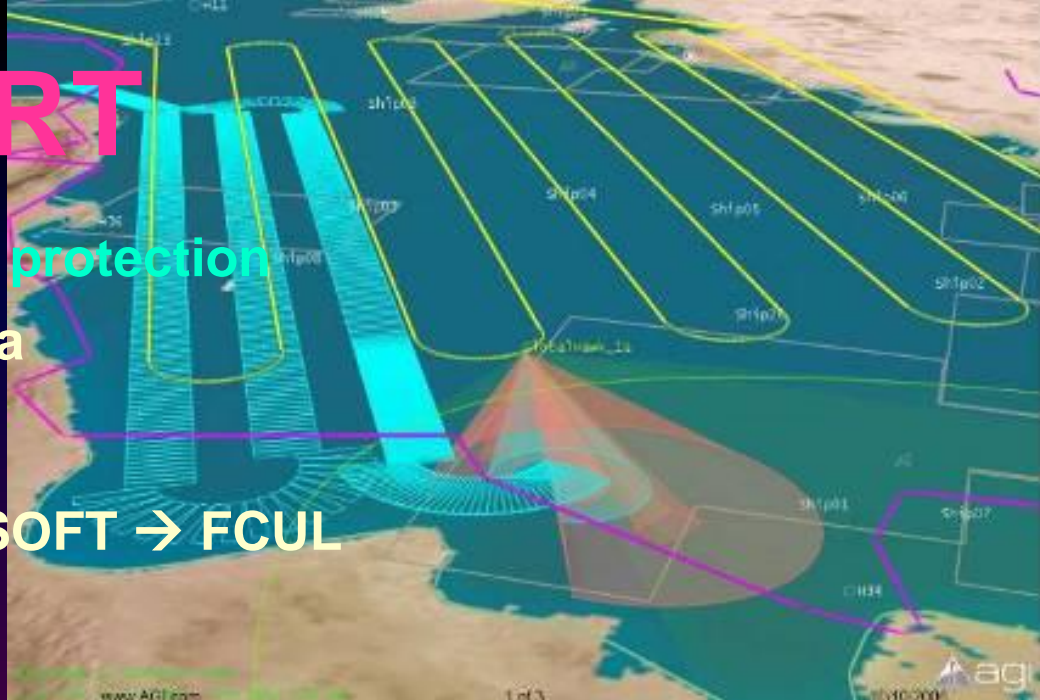
PAIESAT

Satellite IMINT program	
Partners	EME, EMFA, EMM
Funding	EMGFA
Contracts	EMGFA → SATCART
Period	1991-1993

Training in military satellite image computer assisted photo-interpretation – *IMINT – image* processing and GIS

Interpretation *dossiers*

WEU Satellite Centre (Torréjon) follow on and staffing by portuguese officials

Representation of MoD and Foreign Affairs in the WEU *Space Group*.

COP – Common Operating

Brings together intelligence and geography

GEO INTELLIGENCE: the exploitation and analysis of imagery and geospatial information to describe, assess, and visually depict physical features and geographically referenced activities on the Earth.

EU Space Center, *www.eusc.europa.eu*

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Optical Security

Diffractive Optics Variable Imaging Devices (DOVID)

Partners	INCM, AOT (UK)
Funding	INCM
Contracts	INCM → FCUL
Period	1996-2009

Diffractive optics - holography, interferometric litography, direct writing, CGH:
- Origination , ..., tests;
- Operational systems;
- Proprietary technologies

Paragon (MOEMS)

Hidden information

Quality control:
- Dimensional metrology,
- Raw materials assessment *(holographic foils)*

Consultancy to Police Forces *(LPC, SEF, SSI)*

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Laboratory of Optics Lasers & Systems

Optical Security - PARAGON

Diffractive Optics Variable Imaging Devices (DOVID)

Partners   OPSEC (UK), INCM

Funding

Contracts   OPSEC → FCUL

Period   2010-2012

Diffractive optics: holography, interferometric litography, direct writing, CGH:
- ➢ **Origination , ..., tests;**
- ➢ **Operational systems;**
- ➢ **Proprietary technologies**

Paragon (MOEMS)
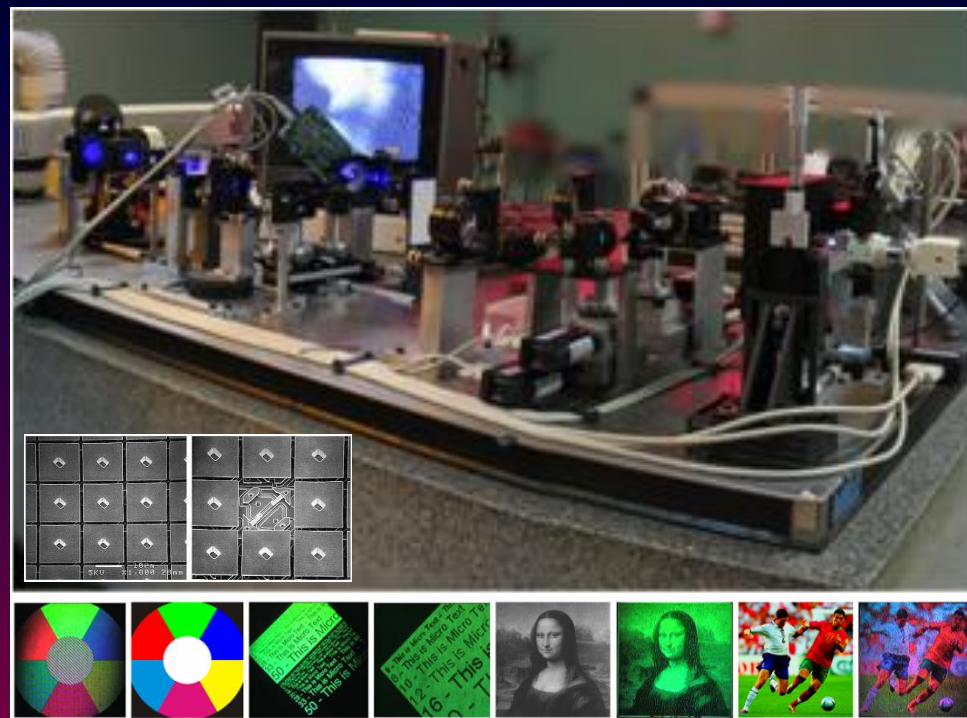
Documentos de soberania

Vision Box

Quiosque Biométrico

Partners	VisionBox, SEF
Funding	
Contracts	
Period	2005-2006

Landing safely in Mercury

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Optics Lasers & Systems
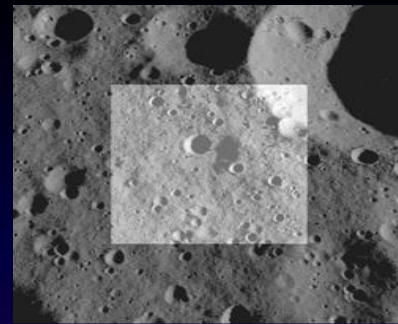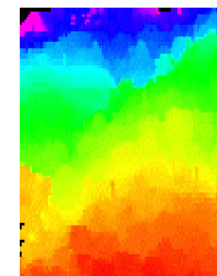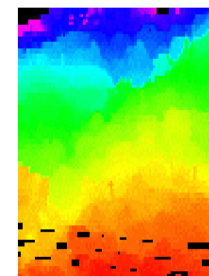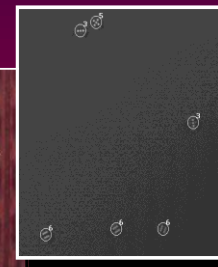
EDA - Unmanned Combat Aircraft Vehicles

UCAV's - Assessment of Technology Needs

Partners	**IT - Alenia Aeronautica, Galileu Avionica, MBDA, Oto Melara** **NL - ADSE, Stork-Fokker, NLR, TNO** **SP - EADS-Casa, Aries, Sener, Espelsa, ITP** **PT - Edisoft, IST/IST** **NO - Kongsberg**
Funding	**Ministery of Defence (PT)**
Contracts	**EDA → Alenia Aeronautica → FCUL**
Period	**2005-2008**

Assessment of technologies that need to be in place for UCAV's in operation beyond 2018, according to a definition of preliminary specifications, based on the description of different operational scenarios and missions that can be assigned UCAV's

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EDA – RTP 11.12 - WaSIF

WaSIF - Weapon System Simulation in Flight

Partners	EADS (D), OGMA (Po), AerMacchi (It), NLR, Fokker Space (NL) ,Tübitak, MRC (Tr)
Funding	EDA / WEAG
Contracts	WEAG → FCUL
Period	2000-2004

Flight Demonstration of Embedded Simulation for Training Purposes On-Board Fighter Aircraft. Development of:

➢ **Graphics software interface that simulates the radar and tactical displays in the aircraft's cockpit (pilot's primary interface with the WaSiF system).**

➢ **Mission preparation and debriefing SW for WaSiF ground station. The debriefing application provides the instructor and pilot with a post-simulation, 3D animated visualization of the mission, including the synchronized reconstruction of radar, tactical and head-up displays.**

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NetWaSiF

Networked Weapon System in Flight

Partners	EADS GmbH, DBD, D; INETI, ETI, Po; AerMacchi, Alenia, It; MRC, Tk
Funding	Ministery of Defence (PT) / Europa MoU
Contracts	EDA → BWB → EADS → FCUL
Period	2005-2008

Flight Demonstration of a Networked Embedded Simulation System for Training Purposes, On-Board Fighter Aircrafts in an air combat environment.

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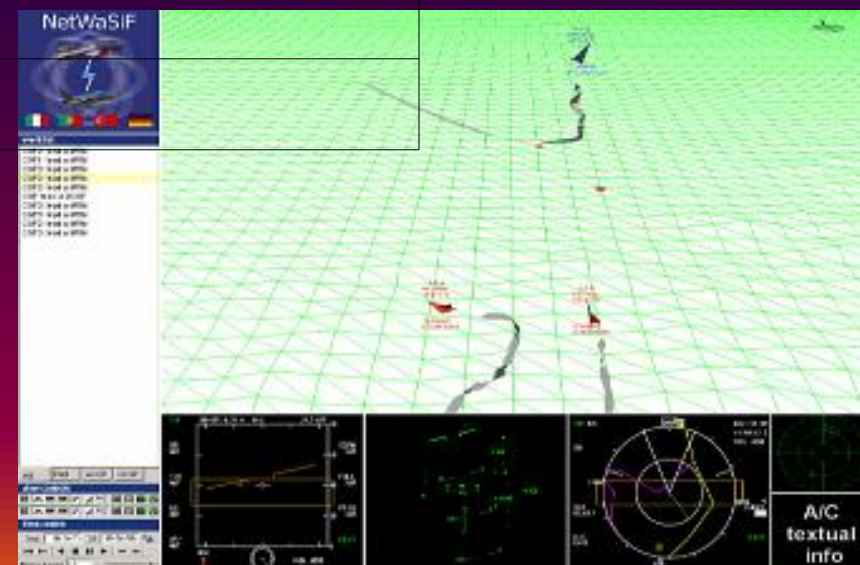
NIAG 107

Study on Directed Energy in the Defence Related Environment

Partners	**BAE Systems (UK), Alenia (IT), QInetiQ (UK), Thales (FR), FinMeccanica (IT), MBDA (IT), Rheinmetall (D), Galileo Avionica (IT), EADS (FR), IABG (D), LFK (D), Tubiak-Sage (TK), Raytheon (US), Indra (ES)**
Funding	**NATO**
Contracts	**NATO → FCUL**
Period	**2006-2007**

NATO Industrial Advisory Study Group for the analysis of the state of the art of Directed Energy systems in defence.

Develop and implement a process for assessing the military and civil utility of Directed Energy systems.

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2013
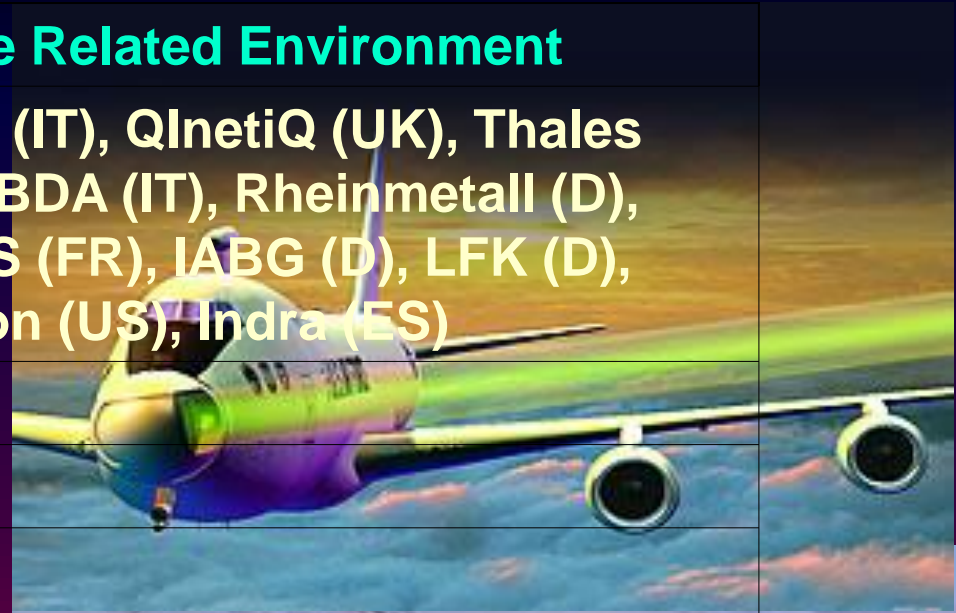
EDA – HELW

Air Defence High Energy Laser Weapon

Partners MBDA/LFK - Lenkflugkörpersysteme GmbH, DLR ITP (G), CILAS, ISL (Fr), M.U.T. (Pl)

Funding EDA (JIP 2)

Contracts EDA → MBDA/LFK → FCUL

Period 2008-2011

High power laser beam / target interaction with modeled RAM (rocket, artillery & mortars) targets containing explosives.

System modeling and simulation, addressing atmospheric propagation, adaptive optics, closed loop target fine tracking and design proposals for a high energy laser weapon against RAM.

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Optics Lasers & Systems

EDA – HELW

Hign Energy Laser Weapon

Partners   **MBDA/LFK, DLR (D), CILAS, ISL (Fr), MUT (Pl)**

Funding   **EDA (JIP 2): Force Protection, Collective Survivability**
Topic: "Defence options for airborne threats"

Contracts   **EDA → FCUL**

Period   **2008-2011**

Applied research on high power laser beam / target interaction with modelled RAM (targets containing explosives). Closed loop target fine tracking, and a design proposal for a high energy laser weapon against RAM.

LOLS activity:

➢ **Evaluation of results of propagation experiments**

➢ **Mathematical model of atmospheric optical propagation and correction of turbulence effects by adaptive optics**

➢ **Performance of simulations of beam propagation with Adaptive Optics**

➢ **Lay Out Of Laser Tracker**

Air Defence High Energy Laser Weapon

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Optics Lasers & Systems
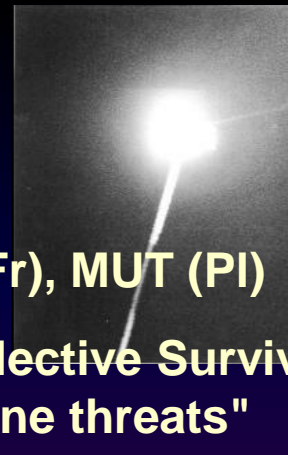
EDA – IRST

RTP 8.2 – IRST - Intelligent Sensors

Partners   OFFICINE GALILEO (IT), SOFRADIR, CEA/LETI/LIR, SAGEM (FR), TNO/FEL (NL), CRL/PILKINGTON, OPTRONICS (UK)

Funding   WEAG
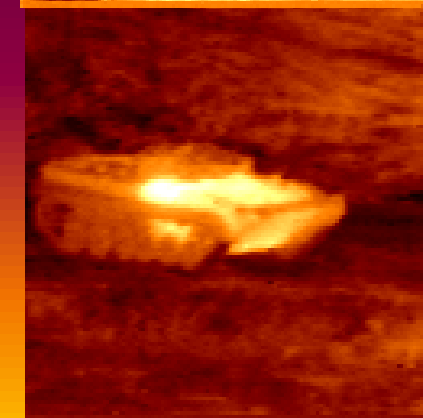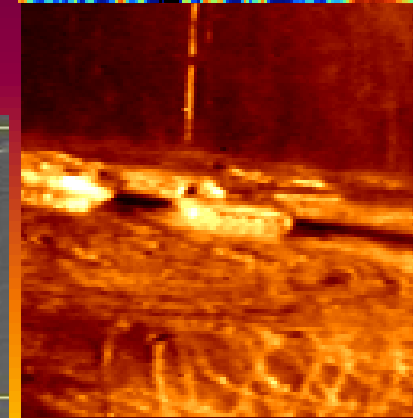
Contracts   WEAG → FCUL

Period   1995-2000

New technology and design concepts for future Infrared Search & Track Systems

Development of algorithms for detection and identification of targets in the spectral windows of 3-5µm and 10-12 µm

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2013
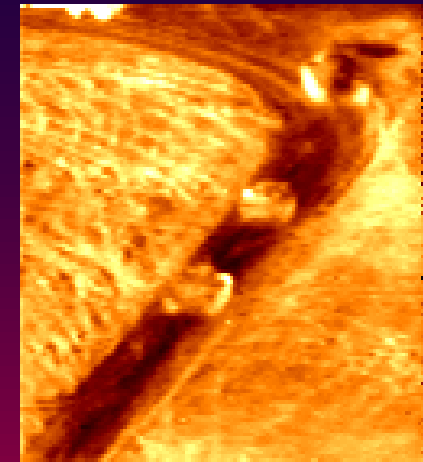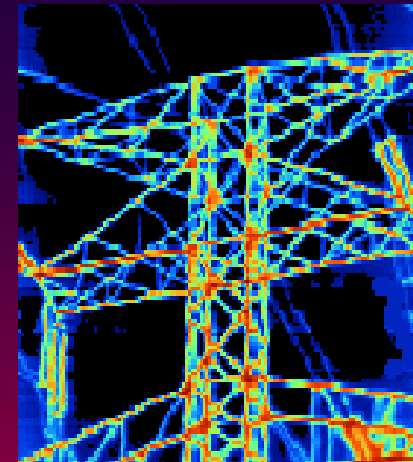
EUCLID RTP 8.05

Oracles - Optical Laser Radar

Partners	**Galileo Avionica (It), Havelsan, Aselsan (Tk)**
Funding	**Ministery of Defence (PT)**
Contracts	**Euclid → FCUL**
Period	**2001-2006**
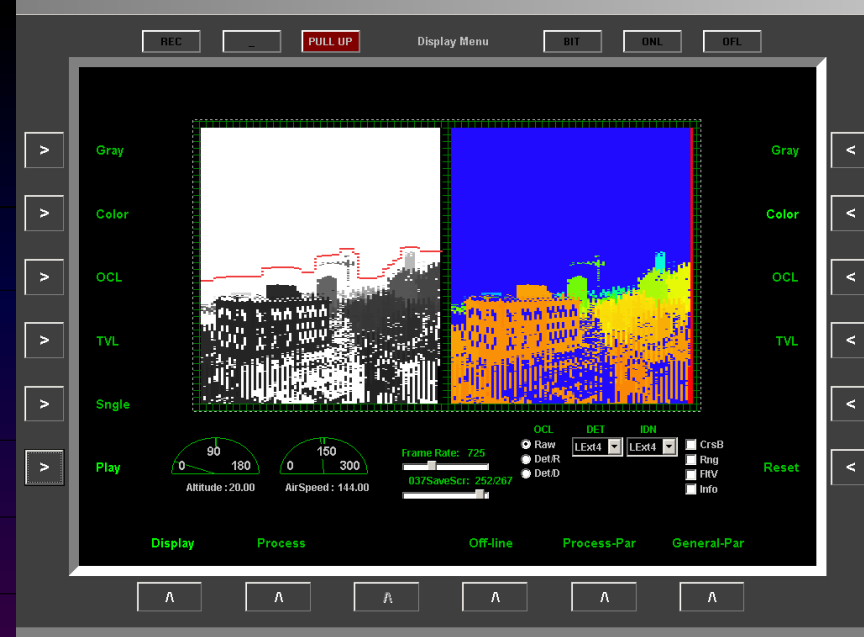
Development of a obstacle avoidance demonstrator for aircrafts.

Development of the receiver channel: optics, sensor and processing electronics.

Subsystems produced and tested in relevant operating conditions.

2013
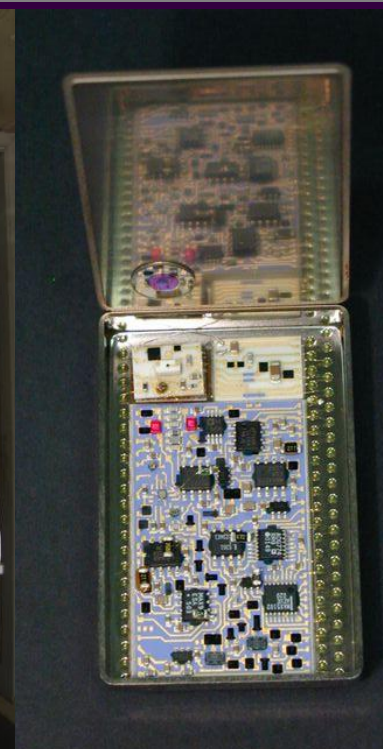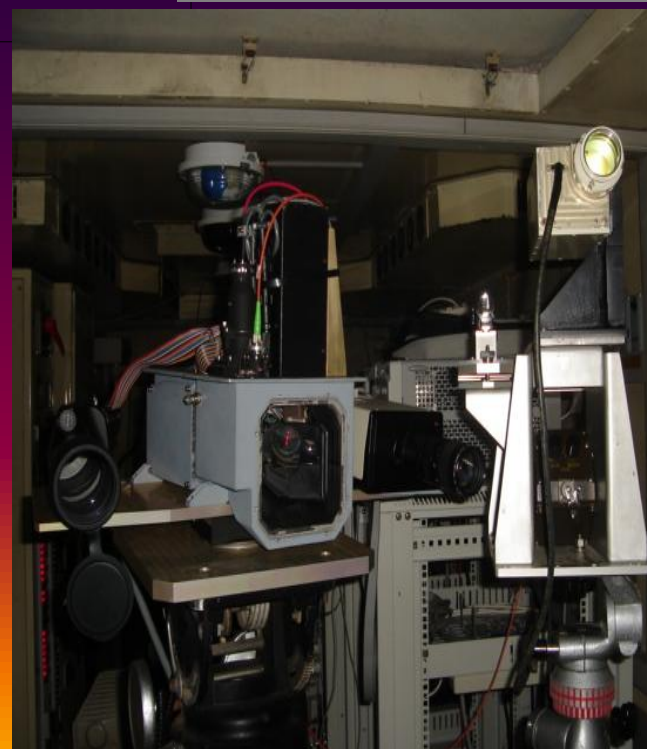
EUCLID RTP 9.1

Technological Concepts and Harmonization

Partners	**ONERA (F), DLR (D), NLR (NL), NDRE (No), INTA (E), MoD (B), ALENIA (It)**
Funding	**Ministry of Defence (PT)**
Contracts	**ONERA → FCUL**
Period	**1993-1996**

Algorithm development for in-orbit automatic identification of ground control pojnts (rotation and contrast invariance) to enable autonomous geo-registration and therefore reduce telemetry bandwith requirements.

Very high resolution image simulation, using 3D object modelling, and physical-based modelling of all relevant system components: orbit, illumination, atmosphere, diffusion, attitude stability, optical system, sensor and electronics.

Assessment of the detectability of objects of military interest under different physical conditions.

Formal cooperation between national space agencies / state laboratories in space

EUCLID RTP 9.6

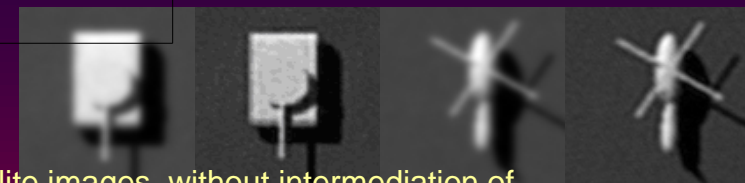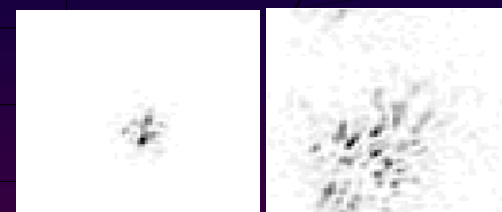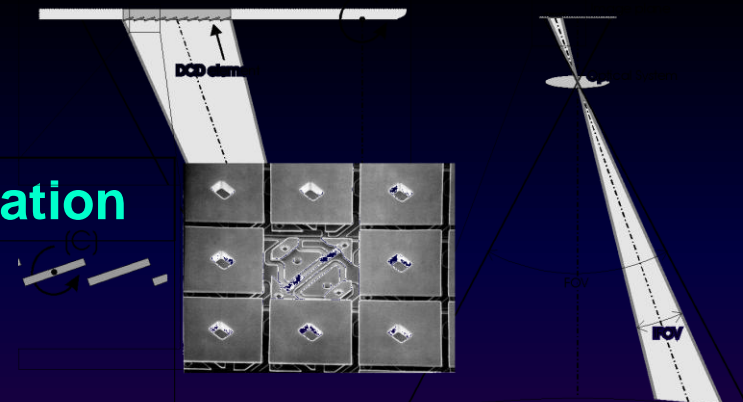## Earth Observation Technical Concepts & Coordination

| Partners	ONERA (F), DLR (D), NLR (NL), NDRE (No), INTA (E), MoD (B), ALENIA (I), DERA (UK)
Funding	Ministery of Defence (PT)
Contracts	ONERA → FCUL
Period	1998-2001

➢ **Decentralized satellite control** – Direct access of the user to satellite images, without intermediation of centralized ground control centers, profiting from current telecommunication systems constellations to reduce delivery delays.

➢ **Satellite Autonomous navigation** – Electric propulsion (continuous thrust) with very small specific impulse, for transfer between co-planar and quasi-circular orbits, using optimal control (Edelbaum analytical model)

➢ **Compensation of technological limits** – Satellite image restoration, to compensate optical system limitations and therefore reduce overspecification of the space segment for military observation

➢ **Effects of atmospheric turbulence in very high resolution images**

➢ **Fast steering of the optical axis of the onservation instrument** – New alternative optical components based on MOEMS DMD (Digital Micromirror Device – Texas Instruments) and CCDs, to steering the optical axis of observation instruments

EDA RTP 11.13

Realizing the potential of Networked Simulation in Europe

Partners   Alenia, Datamat (It), CAE, EADS (D), DMI, IFAD (DK), Fokker Space, NLR, TNO (NL), Indra, Sainsel (Sp), INESC, OGMA (Po), INTRACOM (Gr), KDA (No), MR (Tr), Pitch, SAAB (SW), Sogitec, TT&SA (Fr)

Funding   WEAG

Contracts   WEAG → FCUL

Period   2000-2004
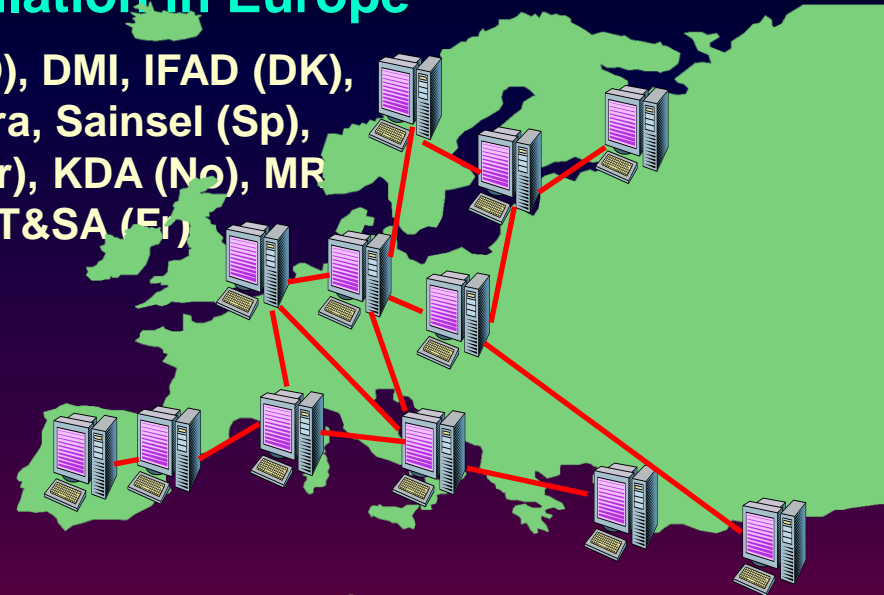
To overcome obstacles that prevent synthetic environments (SE's) being exploited in Europe by developing processes and an integrated set of prototype tools to reduce the cost and timescale of creating and utilizing SE's for training, mission rehearsal and simulation based acquisition.

Development of SW for a distributed, European repository, capable of storing classified data securely. The repository plays a central role as a means of storing simulation assets, and of linking together tools that are used in the SE development process.

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2013

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Lasers, sensors and systems

FCT – FLIT
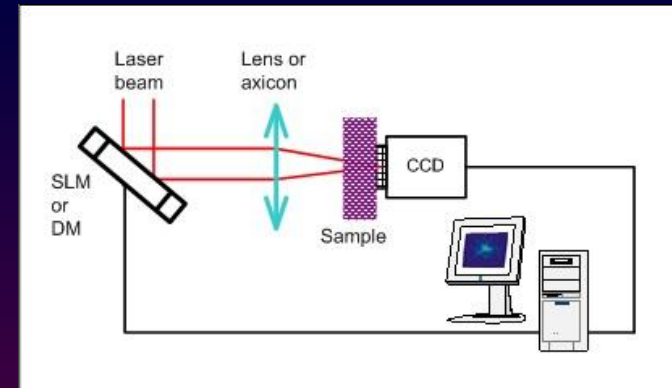
A novel approach for tumoral targeted phototherapy: Focusing LIght Through scattering

Partners   **FCT-UNL, COFAC (CBIOS), INL**

Funding   **FCT**

Contracts   **Pending**

Period   **2013-2015**

Phototherapy by thermal activation and destruction of cancer cells

Methodologies for concentrating light inside turbid biological media

Development of new multifunctional nanoparticles the phototherapeutic potential of which can be improved by in-depth sub-surface activation.

Optical methods to improve light concentration inside turbid media
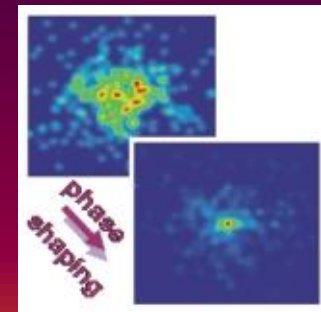
FCT – Plasmónica

Sensorização de elevado desempenho em fibra óptica de base plasmónica

Partners INESC-PORTO
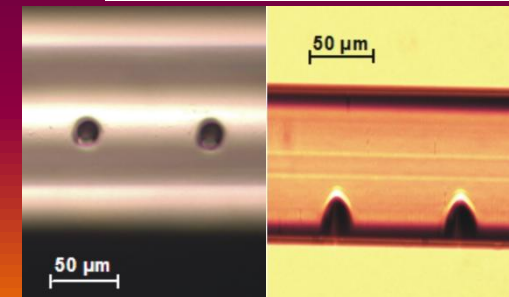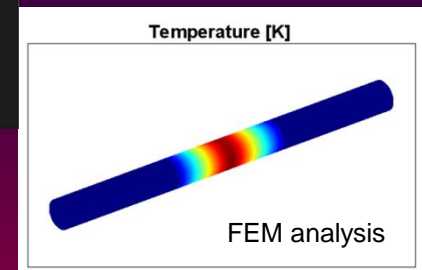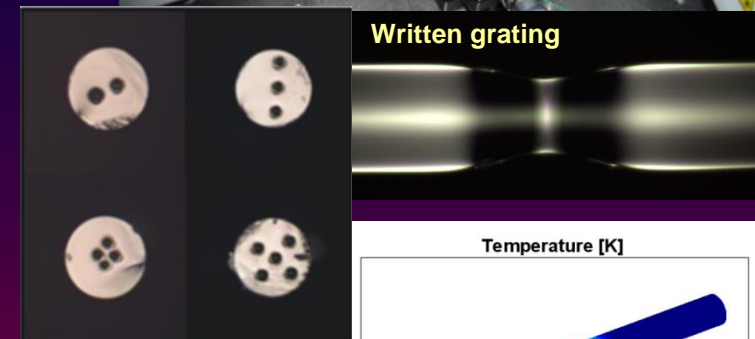
Funding FCT

Contracts FCT

Period 2012-2014

Design and development of high performance optical fibre systems for local and distributed sensing based on the phenomenon of Surface Plasmon Resonance (SPR).

Laser technology to implement SPR sensors.

New techniques for long period fiber gratings writing. Laser micropaterning

OSA · Mirror · Laser · Weight · Lens · Camera · Fiber · PCO · Pos. stage

Written grating

Temperature [K]

FEM analysis

50 μm

50 μm

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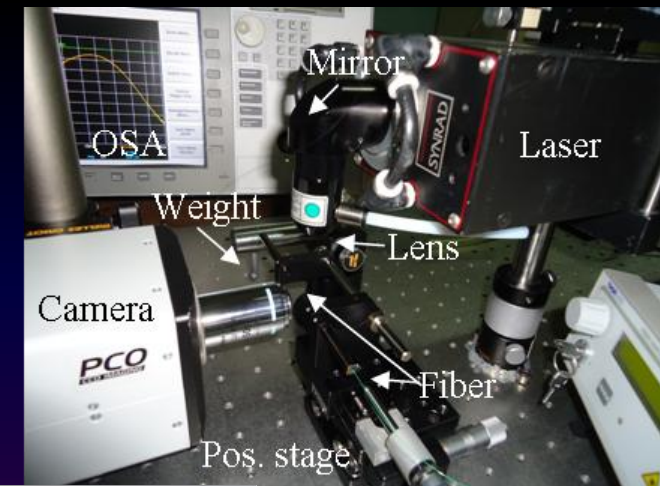
GAP – Glass Art

Glass Art and 2D and 3D Printing

Partners **FCT/UNL (Glass Center), FBA/UL**

Funding **FCT**

Contracts **FCT → FCUL**
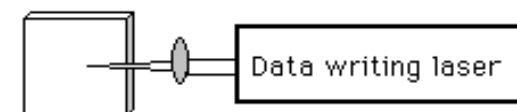
Period **2007-2010**

Understanding of scientific methods and artistic expression to balance the approach of working with vitreous materials.
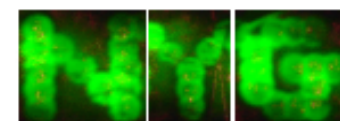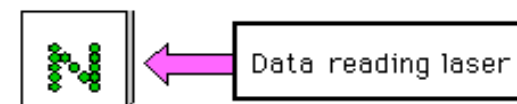
Printing luminescent images:

➢ **laser nucleation of silicon nanocrystals**

➢ **stimulation of luminescence in rare earth based glasses**

Image digitalisation by 3D scanning.

Data writing laser

Data writing
(Glass crystallization)

Data reading laser

Data reading (visible luminescence from the transparent crystallized regions can be seen)

JetStone

Laser Processing and machine vision of mosaics

Partners	CEI, SOLANCIS, REAL GRANITOS, CEVALOR, ALANDROMAR, PLÁCIDO SIMÕES, SOGÉNIUS GRAMAFAM, CTC.
Funding	PRIME
Contracts	PRIME → CEI
Period	2005-2008

Laser Processing of mosaics (ornamental polished surfaces of marbles and granites) to avoid slipping conditions by optimized patterns of small holes / drils.

Classification of individual marble and granite mosaics according to their colour, textures and defects, to improve mosaic selection for large cover large surfaces
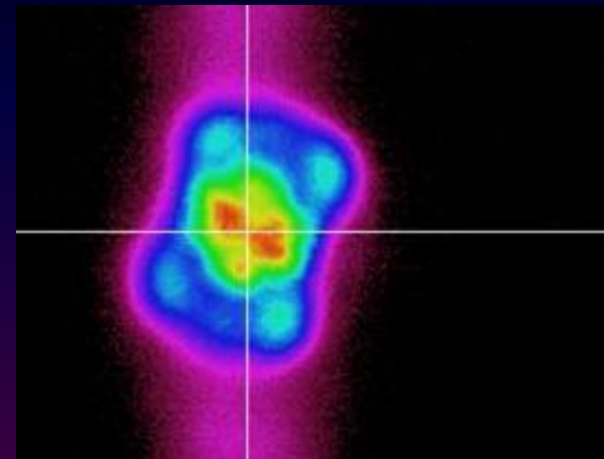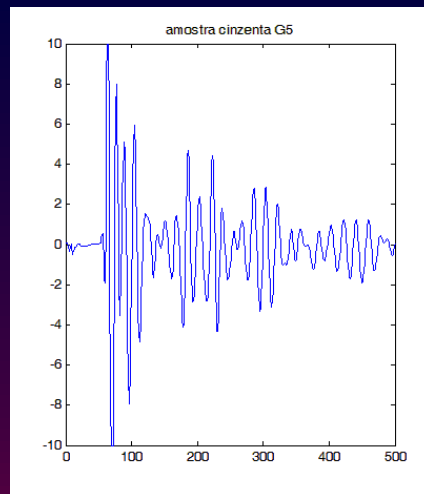

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2013

Lasers na Indústria de Moldes

Lasers for paint ablation in automotive applications

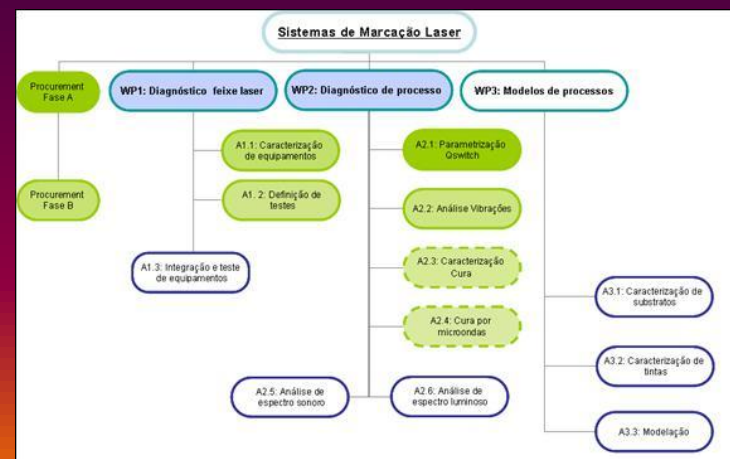|	
Partners	**IBER-OLEFF**
Funding	**IAPMEI - QREN**
Contracts	**Iber-Oleff → FCUL**
Period	**2009-2010**

R&D for system characterization in laser material processing.

Development of techniques for process diagnostics, monitoring and control

Research on new techniques for process characterization

NATO – Po-Laser Cutting

Laser Cutting

Partners	**IBE, FEUP**
Funding	**NATO-SFS**
Contracts	**NATO → FCUL**
Period	**1996-2000**

Develop a functional demonstrator for laser cutting and welding of plastic films at velocities as higher as 50 m/s.

System design and validation of specifications

Integrate and test a functional prototype

Optimization of operational procedures and evaluation

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2013

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