28 de abril de 2021

INDUSTRIALES RESEARCH MEETING 21

Catálogo de la Exposición

IRM

IV Industriales Research Meeting

Escuela Técnica Superior de Ingenieros Industriales

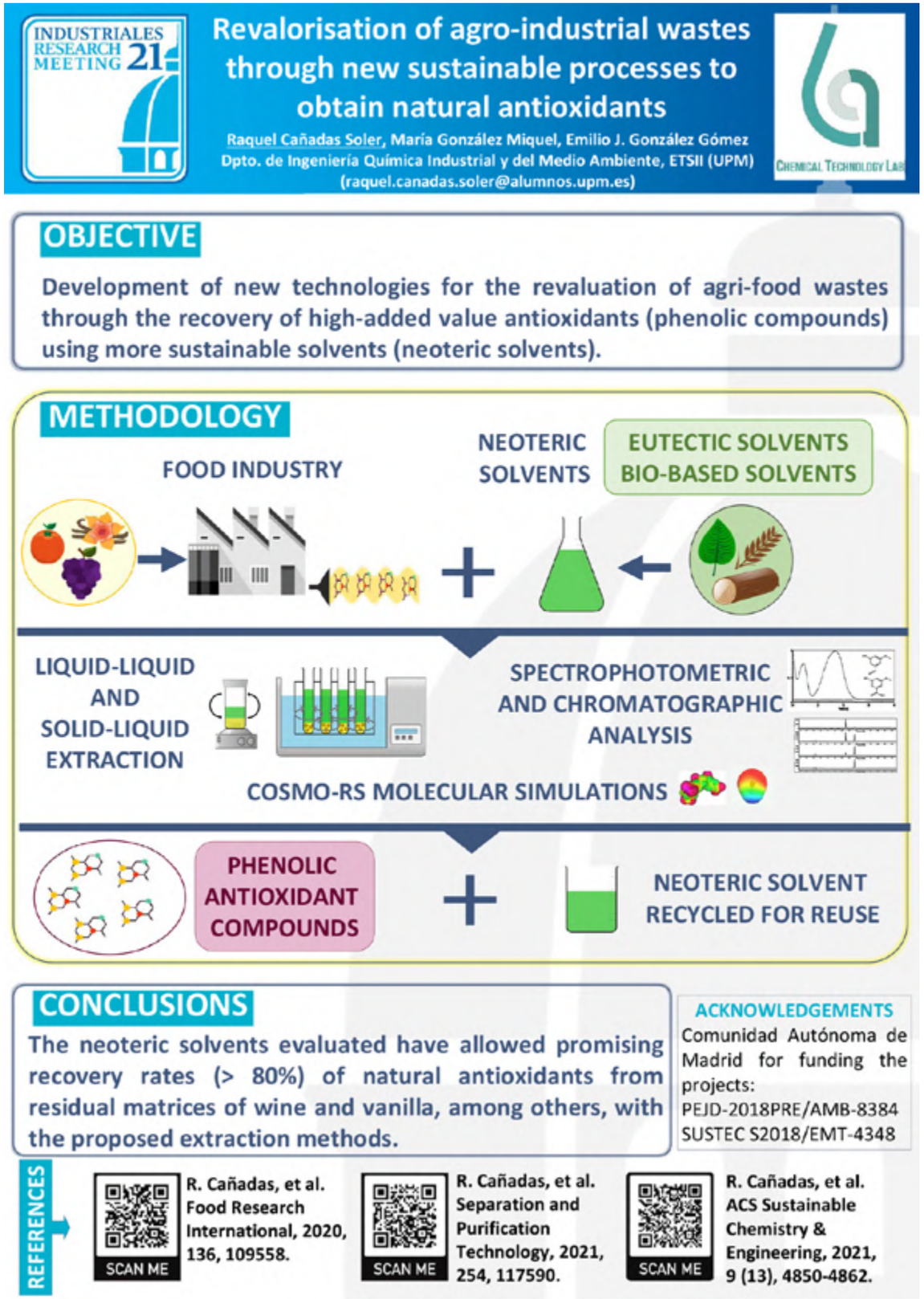
Listado de los pósteres presentados.

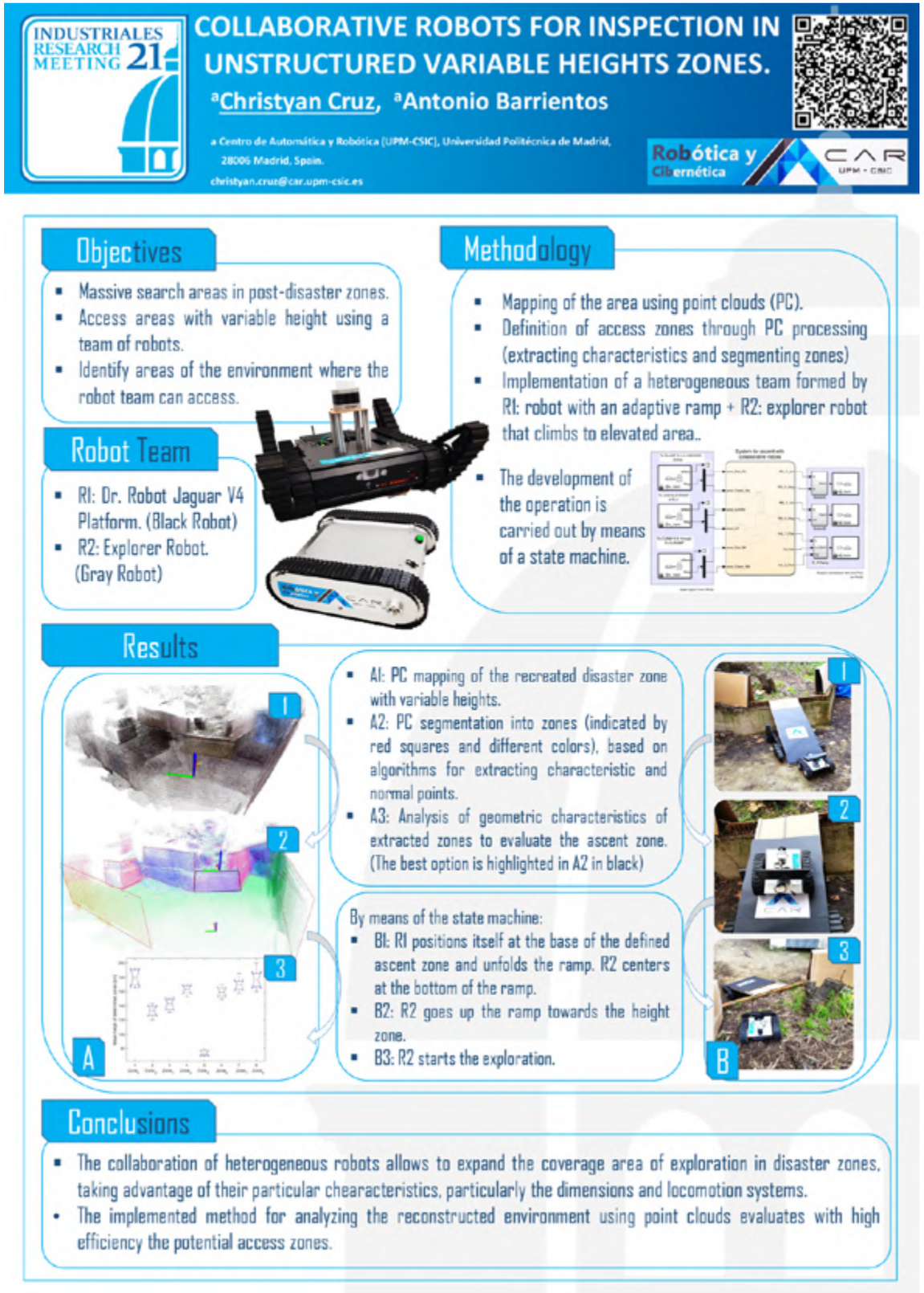
Dispuestos siguiendo orden alfabético por apellidos de los autores dentro de cada Área de trabajo.

Pulsando sobre cada uno de los pósters se abrirá una ventana del navegador con dicho póster en alta resolución.

Raquel Cañadas Soler

REVALORISATION OF AGRO-INDUSTRIAL WATES THROUGH NEW SUSTAINE PROCESSES TO OBTAIN NATURAL ANTIOXIDANTS





Christyan Cruz Ulloa

COLABORATIVE ROBOTS FOR INSPECTION IN UNSTRUCTURED VARIABLE HEIGHTS ZONES

David Hidalgo Carvajal

3D-PRINTING WASTE? NOT ANYMORE!

Alberto Mínguez Martínez

DESIGN OF INDUSTRIAL STANDARDS FOR THE CALIBRATION OF OPTICAL MICROSCOPES

INDUSTRIALES RESEARCH MEETING 21

DESIGN OF INDUSTRIAL STANDARDS FOR THE CALIBRATION OF OPTICAL MICROSCOPES

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LMM ETSII - UPM

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Abstract

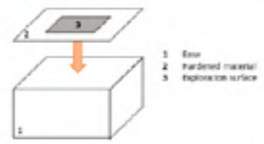
One of the most important fields of study in material science is surface characterization. This topic is currently a field of growing interest as many functional properties depend on the surface texture. After a short a review of different methods for surface topography characterization and the determination of the traceability problems that arise in this type of measurements, four different designs of material standards are proposed. They can be used to calibrate the most common optical measuring instruments used for these tasks, such as measuring microscopes, metallurgical microscopes, confocal microscopes, focus variation microscopes, etc.

It is considered that the use of this type of standards (or others like them) could provide a step forward in assuring metrological traceability for different metrological characteristics that enables a more precise measurement of surface features with optical measuring instruments.

In addition, it is expected that this work could lay the groundwork for the development of custom standards with specialized features tuned to gain a better metrological control when measuring specific geometrical surface properties.

Commercial Surface Standards

The **commercial surface standards** usually consist of:



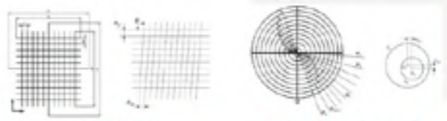
The **typical materials** used for the manufacturing of these standards are hardened stainless steel, nickel, copper, silicon, chromium, platinum, iridium, nickel-boron, tungsten, niobium, silicon dioxide, hard aluminum alloys, mica, colloidal gold, glass, borosilicate glass, lapped silicon, quartz, plastics,…

To mark the profile over the exploration surface, it is used one of the following **manufacturing processes**:

- *Pressure method*: using a negative with the desired shape and pressing it over the heated surface
- *Grinding method*: using a negative with the desired shape and grinding the surface until reach the expected roughness.
- *New technologies*: including additive manufacturing (AM) processes such as focus ion beam or direct laser writing.

Proposed designs

Considering the different types of roughness and surface texture standards that it is possible to find at suppliers and normative (ISO 5436-1, ISO 25178-701), four designs have been proposed:



The grid — The dartboard

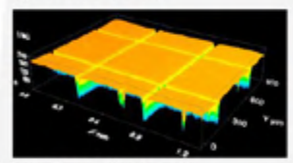
The star — The spiral

For each design, the characteristics of the model, the main sources of error, the different calibration strategies and some applications are included.

Proof of concept

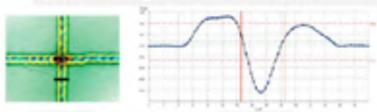
As an example of the manufacturing process, a pattern consisting of four perpendicular lines two by two and separated by 50 μm, has been produced. The characteristics are:

- It is made over a polished monocrystalline silicon wafer glued to a microscope slide.
- Lines are engraved using a laser with expected dimensions 6 μm width and >0,04 μm depth (as a stage micrometer).



The obtained dimensions are:

- The separation between the slopes is 5,97 μm.
- The depth of the groove is 1,03 μm.



Thanks to its dimensions can be calibrated with low uncertainty using traditional measuring instruments (stylus instrument).

Julen Molinuevo

SEMI-EMPIRICAL PREDICTION OF POLYMERIC SURFACE WETTABILITY MODIFICATIONS WITH LASER TECHNOLOGY

Semi-empirical prediction of polymeric surface wettability modifications with laser technology

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[b]Centro Láser de la UPM

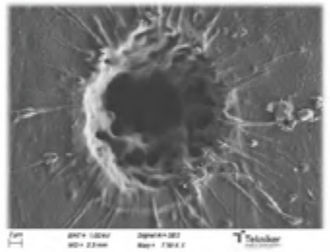
ABSTRACT

The modification of wettability of certain polymers is yet a difficult concept to understand. Experimental setup and contact angle (CA) obtention need a huge amount of time that can be saved with predictive models. This work provide a semi-empirical analysis and prediction of the CA modification of polypropylene with laser patterning, validated by simulations with COMSOL Multiphysics.

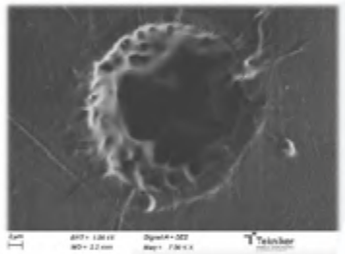
Chapter 1: Laser parameter optimization and patterning

Laser-material interaction: optimization

Pulse emitting modes: Single pulse vs Pulse trains



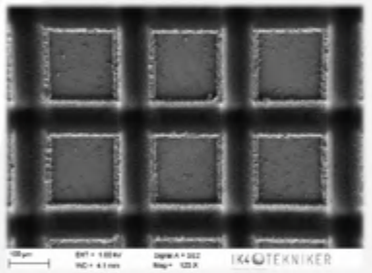
- **Single pulses** emitted 3 times
  - Pulse energy: 33µJ
  - Worse quality. Slower



- **3-Pulse train** emitted once
  - Pulse energy: 33µJ
  - Better quality. Faster

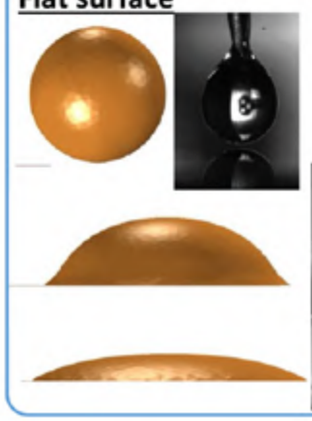
Laser patterning

- Texture definition
- Pattern dimension
- Texture fabrication with chosen parameters



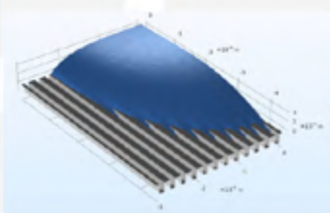
Chapter 2: Contact angle prediction and liquid droplet simulation

Flat surface

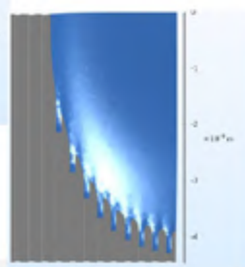


30 minutes simulation

Textured surface



Over 10 hours of simulation



Belén María Moreno Cabezali

APPLICATION OF A FUZZY-LOGIC BASED MODEL FOR RISK ASSESSMENT IN ADDITIVE MANUFACTURING R&D PROJECTS

APPLICATION OF A FUZZY-LOGIC BASED MODEL FOR RISK ASSESSMENT IN ADDITIVE MANUFACTURING R&D PROJECTS

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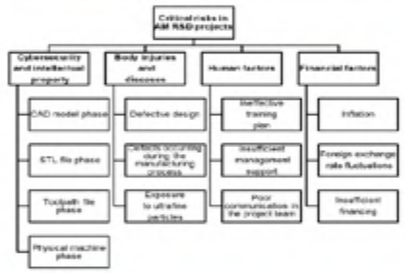
[a]E.T.S. Ingenieros Industriales, Universidad Politécnica de Madrid, C/José Gutiérrez Abascal 2., 28006 Madrid, Spain.
*Corresponding author: belen.moreno.cabezali@alumnos.upm.es.

ABSTRACT

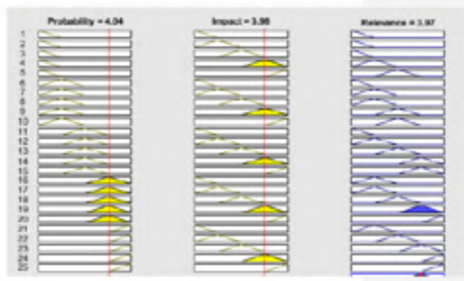
Additive Manufacturing (AM) is a process that consists of creating a three-dimensional object by incorporating layers of a material such as metal or polymer. Over the last few years, the use of AM techniques has been extended to multiple sectors such as aviation and aerospace, medical, construction, automotive and dental.
This research studies risks associated with AM R&D Project Management. A significant set of risks with a potential negative impact on project objectives in terms of scope, schedule, cost and quality are identified through an extensive literature review. These risks are assessed through a survey answered by ninety academics and professionals with noteworthy sector expertise. This process is made by the measurement of two parameters: likelihood of occurrence and impact on project objectives. According to the responses of the experts, the level of relevance of each risk is calculated, innovatively, through a fuzzy logic-based model, specifically developed for this study, implemented in MATLAB Fuzzy Logic Toolbox. Finally, the results are analyzed to rank them from the most critical to the least critical regarding the level of relevance that each risk has in AM R&D Project Management.

I. Risk identification



II. Structure of the developed fuzzy logic-based model

III. Fuzzy inference process



IV. Results

Risk	Likelihood	Impact	Relevance	Ranking
Defects occurring during the manufacturing process	4.04	3.98	3.97	1
Defective design	3.41	3.81	3.74	2
Poor communication in the project team	3.31	3.75	3.70	3
Insufficient financing	3.39	3.74	3.68	4
Ineffective training plan	3.31	3.65	3.62	5
Insufficient management support	3.29	3.63	3.61	6
Exposure to ultrafine particles	3.23	3.17	3.22	7
Cybersecurity and intellectual property risk in CAD model phase	2.78	2.82	2.74	8
Cybersecurity and intellectual property risk in STL file phase	2.67	2.69	2.64	9
Cybersecurity and intellectual property risk in toolpath file phase	2.44	2.64	2.45	10
Inflation	2.55	2.37	2.42	11
Foreign exchange rate fluctuations	2.77	2.35	2.39	12
Cybersecurity and intellectual property risk in physical machine phase	2.54	2.67	2.37	13

V. Conclusions

The results of this study show that the risks "Defects occurring during the manufacturing process", "Defective design", "Poor communication in the project team" and "Insufficient financing" are determined as the most critical in AM R&D Project Management. The proposed model is presented as a powerful new tool for organizations and academics, to prioritize the risks that are more critical to develop appropriate response strategies to achieve the success of their projects.

References

Moreno-Cabezali, B. M., & Fernandez-Crehuet, J. M. (2020). Application of a fuzzy-logic based model for risk assessment in additive manufacturing R&D projects. *Computers & Industrial Engineering*, *145*, 106529.

Juan José Moreno Labella

CAVITATION EFFECTS IN BLISTER-ASSISTED LASER-INDUCED FORWARD TRANSFER OF FLUIDS

Cavitation effects in blister-assisted laser-induced forward transfer of fluids

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Abstract

In Blister Assisted - Laser-Induced Forward Transfer (BA-LIFT), a blister is generated in an intermediate layer to push away the fluid only by mechanical dynamics. Some observed effects are not explained, but given its analogy with direct LIFT processes, a hypothesis is proposed: the velocity field generated by the blister generates a cavitation bubble in the interface between the polyimide layer and the fluid.

A model has been proposed to study the first stages of transference and the secondary effects that take place at intermediate times. Simulations and experimental images taken by shadowgraphy for water-glycerol mixtures are compared. The inclusion of only the effects of a cavitation bubble –in the form of a second push– is enough to replicate these secondary effects observed in BA-LIFT in both time and shape.

Laser-Induced Forward Transfer (LIFT)

- Blister Assisted LIFT (BA-LIFT) with an intermediate layer
- Deposition of small volumes of material (even pl)
- Capability of printing user-defined high-resolution patterns
- Like droplet-on-demand (DOD), without nozzle clogging
- Wide variety of fluids with any viscosity

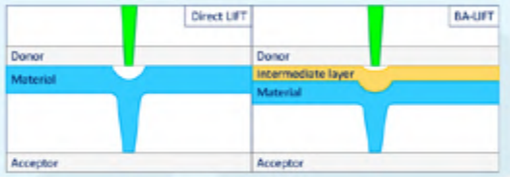
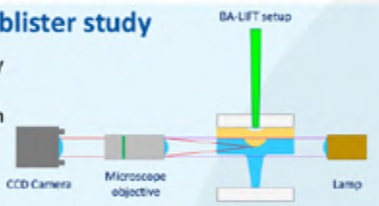
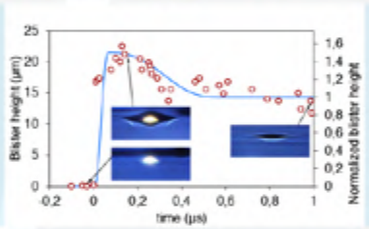


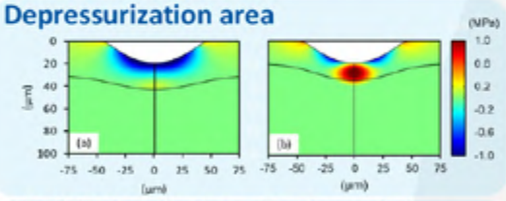
Image acquisition and blister study

- Time-resolved shadowgraphy
- Side-view images of blister expansion and fluid evolution
- Plasma-discharge ns-flash stroboscopic lamp





Depressurization area



BA-LIFT simulation – Basic model

- Two-Phase Flow, Phase Field interface
- Moving wall
  - Its velocity is set through experimental data
  - Moving Mesh node
- Navier-Stokes equations:

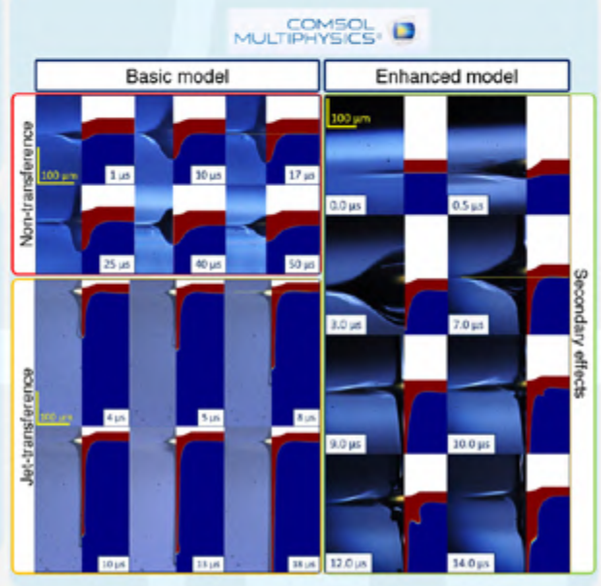
$$\rho\frac{\partial \mathbf{u}}{\partial t} + \rho(\mathbf{u}\cdot\nabla)\mathbf{u} = \nabla\cdot\left[-p\mathbf{I} + \mu\left(\nabla\mathbf{u} + \nabla\mathbf{u}^{T}\right)\right] + \mathbf{F}_{st}$$

$$\nabla\cdot\mathbf{u} = 0$$

- Phase Field equations:

$$\frac{d\phi}{dt} + \mathbf{u}\cdot\nabla\phi = \nabla\cdot\frac{\gamma\lambda}{\varepsilon^2}\nabla\psi$$

$$\psi = -\nabla\cdot\varepsilon^2\nabla\phi + (\phi^2 - 1)\phi + \left(\frac{\varepsilon^2}{\lambda}\right)\frac{\partial f_{ext}}{\partial\phi}$$



Acknowledgements

Partial financial support for this work has been provided by the Spanish Ministry of Science and Innovation under the projects: SIMLASPV-MET (ENE2014-58454), CHENOC (ENE2016-78933-C4-4-R), ADITIMAT-CM (S2018/NMT-4411) and BIOPIELTEC-CM (P2018/BAA4480)

Sergio Quintero Moreno

P-NOSES FOR CHEMICAL DETECTION

INDUSTRIALES RESEARCH MEETING 21

P-noses for chemical detection

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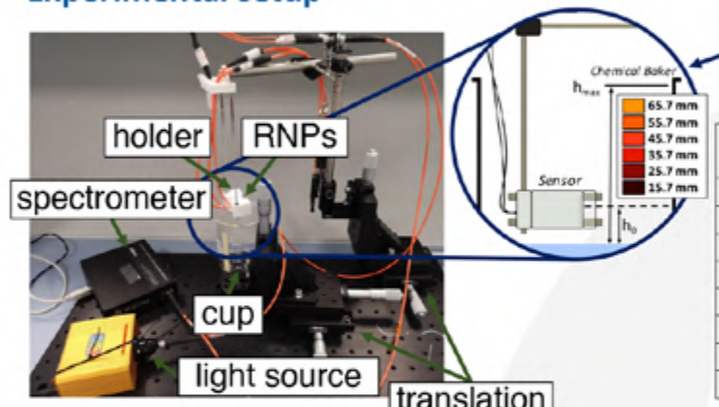
CTB

What is a photonic nose ?

P-noses are a particular type of electronic noses that used photonic transducers to detect and determine the presence of volatile components dissolved in the air.

In this work it is implemented a p-nose using optical transducers based on resonant nanopillars arrays.

Experimental setup

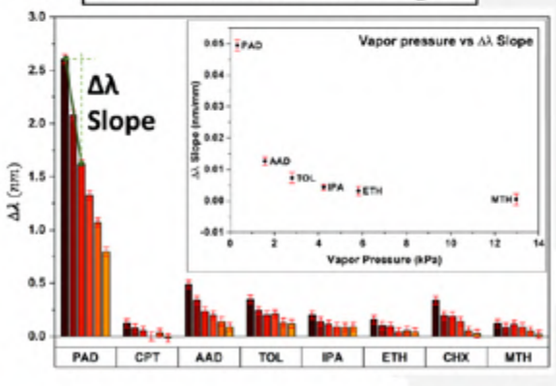


The sensor is placed at different distances to the volatile liquid samples

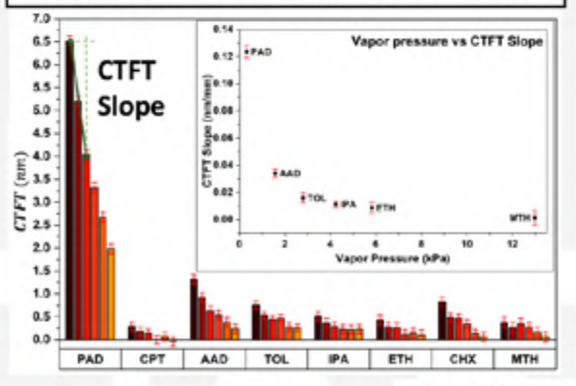
VOC SAMPLE	SHORTCUT	REFRACTIVE INDEX	VAPOR PRESSURE (kPa)
Methanol (99.8%)	MTH	1.329	12.98
Ethanol (99.8%)	ETH	1.361	5.82
Acetic Acid (100%)	AAD	1.372	1.58
Isopropanol (99.5%)	IPA	1.380	4.24
Propionic Acid (99.5%)	PAD	1.387	0.52
Cyclohexane (99.5%)	CHX	1.427	2.8
Cyclopentanone (99%)	CPT	1.435	3.15
Toluene (99.5%)	TOL	1.496	2.8

Results

shift of the transducer signal



simulated condensed thin film onto RNPS



- The sensor signal is proportional to the vapor concentration
- The sensor signal is inversely proportional to the vapor pressure
- The RNPs can be implemented in e-noses for vapor identification

Original Paper

Sofía Sánchez Mateo

COGNITIVE LOAD INFLUENCE OF DRIVING HMIs

Cognitive load influence of driving HMIs

[a]Sofia Sanchez-Mateo, [b]Guillermo De la Puente,
[b]Alejandra Martín, [a]Samuel de la Fuente, [a]Felipe Jiménez
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ABSTRACT

The human machine interface (HMI) design in advanced driver assistance systems (ADAS) is a fundamental part of their operation that is not always correctly evaluated, as it can be distracting for the driver. This study aims to correlate the cognitive load of several drivers in front of two Google Maps application interfaces with data obtained from the eye-tracking system (Fig. 1) and the acceptance, usability and mental effort surveys.

COGNITIVE LOAD IN REAL DRIVING

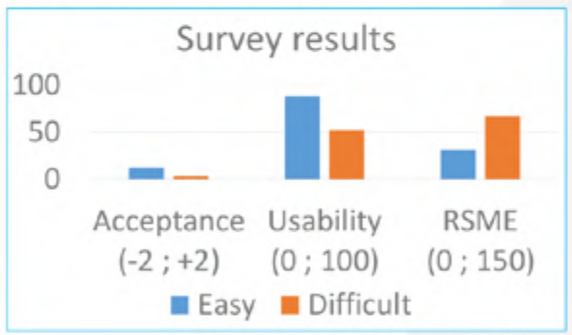
The proposed test consisted of a real driving route (Fig. 2) with the two possible configurations of Google Maps, own orientation (Fig. 3) and north orientation (Fig. 4). Both interfaces were displayed during each half of the route in a counterbalanced way.

Figure 1

Figure 2

Figure 3

Figure 4



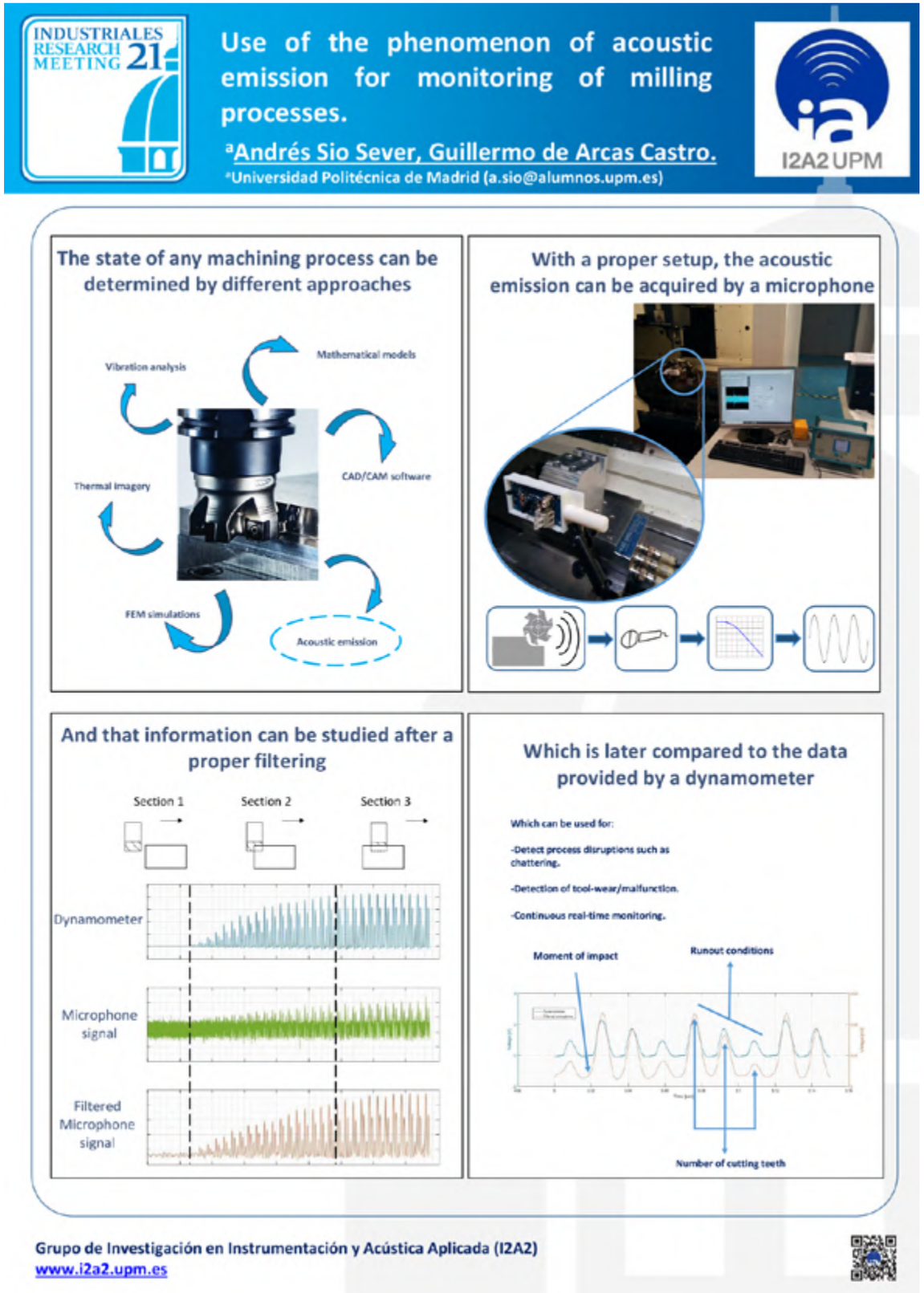
	MEDIAN VALUES	
Number of fixations	Easy	95.5
	Difficult	160.66
Pupil diameter left (mm)	Easy	2.48
	Difficult	2.52
Pupil diameter right (mm)	Easy	2.44
	Difficult	2.48

RESULTS

Subjects chose which one they considered easier to follow and which one not. A large number of fixations combined with a high pupil diameter show distraction and difficulty looking for information in the interface. The more difficult interface also shows worse results in acceptability and usability, and more mental effort. Both results support the hypothesis put forward in this study.

Andrés Sio Sever

USE OF THE PHENOMENON OF ACOUSTIC EMISSION FOR MONITORING OF MILLING PROCESSES



Wsewolod Warzanskyj Prieto

ANALYSIS OF THE THERMAL STABILITY OF RESIDUAL STRESSES INDUCED IN Ti6AI4V BY HIGH DENSITY LSP TREATMENTS

INDUSTRIALES RESEARCH MEETING 21

ANALYSIS OF THE THERMAL STABILITY OF RESIDUAL STRESSES INDUCED IN Ti6Al4V BY HIGH DENSITY LSP TREATMENTS

[a]W. Warzanskyj, [a]I. Angulo, [a]F. Cordovilla, [a]M. Díaz, [a]J. A. Porro, [a]A. García-Beltrán, [a]J. L. Ocaña

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GRIAL-UPM

ABSTRACT

Study of the residual stresses in Ti6Al4V alloy subject to Laser Shock Processing (LSP) and thermally treated at a typical alloy working temperature. Residual stresses have been obtained by the hole-drilling method, neutron diffraction and x-ray diffraction. A comparison between the three experimental results is presented, showing a good degree of agreement.

I. PROBLEM DEFINITION

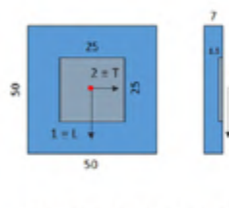


Fig. 1. Treated specimens.

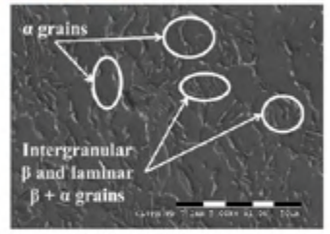


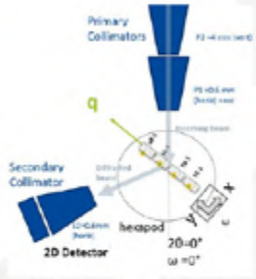
Fig. 2. SEM samples micrography.

Sample	Thermal treatment (pre LSP)	LSP EOD (cm^{-2})	Annealing (post LSP)	*PD
TB	710°C / 2h	5000	No	T
LB				L
TC			595°C / 1h	T
LC				L

*PD ≡ LSP Direction; T ≡ Transverse direction; L ≡ Rolling direction.

Table I. Samples treatment description.

II. NEUTRON DIFFRACTION



L direc.:$\{1\ 0\ 1\}_\beta$
T direc.: $\{1\ 2\ 1\}_\beta$
$\lambda = 1.704$ Å
Measurements from 500 µm from the surface
$\sigma_{ij} = C_{ijkl}\,\varepsilon_{kl}$ [1]

Fig. 3. Experimental setup.

III. X-RAY DIFFRACTION

Cu-K_α, $\{2\ 1\ 3\}_\alpha$,
electro-polishing, $\sin^2\psi$ method [2],
measurements till 500 µm from the surface

IV. IN-DEPTH RESIDUAL STRESSES FIELDS

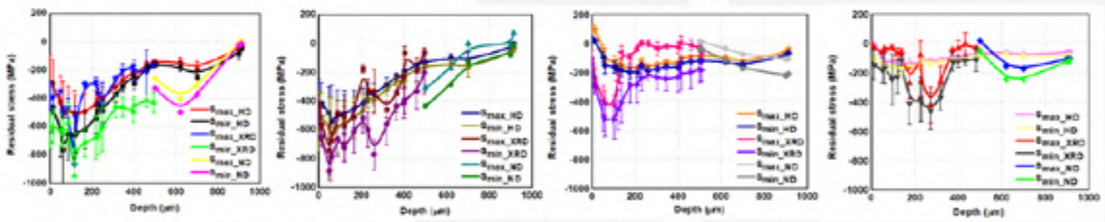


Fig. 4. Residual stresses measurements. From left to right: LB, TB, LC and TC.

CONCLUSIONS

- LSP can induce in-depth compressive residual stresses up to 1 mm from the surface in the Ti6Al4V alloy.
- Peak stresses are around 800 MPa in the un-thermally treated samples and are located at a depth lower than 200 µm from the surface.
- Stresses remain to a certain level at a typical alloy working temperature.
- The different measurements are reasonably consistent.

ACKNOLEDGEMENTS

Work partly supported by MINECO (Spain; Project MAT2015-63974-C4-2-R). Neutron diffraction measurements were performed at Institute Laue-Langevin (ILL) through grant 81436 (2019-2020).

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Rocío Candorcio Simón

FLUORESCENCE ENHANCED BA-LIFT FOR BIOMEDICAL APPLICATIONS

Fluorescence enhanced BA-LIFT for biomedical applications

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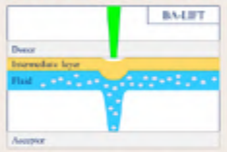
Abstract

Blister Assisted - Laser-Induced Forward Transfer (BA-LIFT), is a disruptive technique in the bioprinting field. Single cell resolution is achieved, which allows an exhaustive analysis of biological samples, improving the data obtained towards personalized treatments.

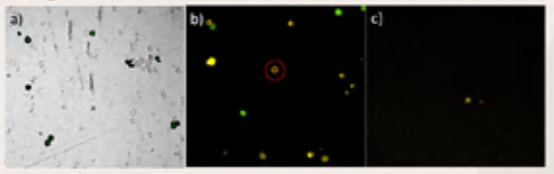
BA-LIFT technology assures the integrity of cells during the whole transference process. Not only a high viability is obtained, but also its proliferation capability is preserved. Also, the metabolic activity was tested in natural killer (NK) cell line with a bi-cistronic expression of eGFP and IFN-γ, though PMA-ionomycin activation. Finally, primary cells (HSPC´s) and its differentiation properties were assessed. These results confirm the efficiency of BA-LIFT for biological samples.

Blister Assisted Laser-Induced Forward Transfer (BA-LIFT)

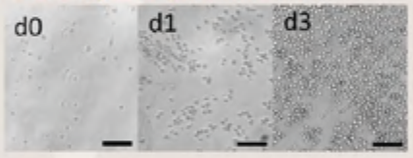


- High resolution bioprinting technology.
- Single cell.
- Radiation and thermal protection of the biomaterial.
- Drop on demand.
- High viability (up to 98%).

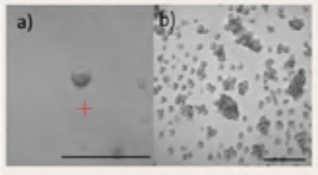
Single cell isolation



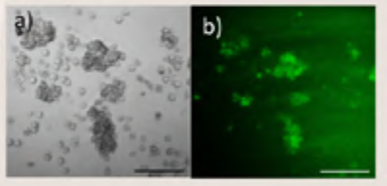
Cell viability and proliferation



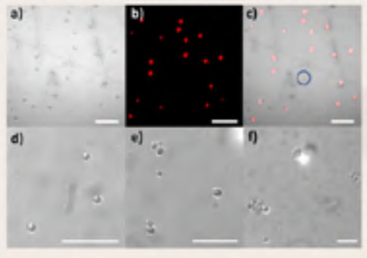
Functionality assay: NK cell line transfer and activation



- Cell aggregation.
- NK cell line with a bi-cistronic expression of eGFP and IFN-γ.
- 6 h incubation on stimulation media (50 ng PMA and 1 µg ionomycin).



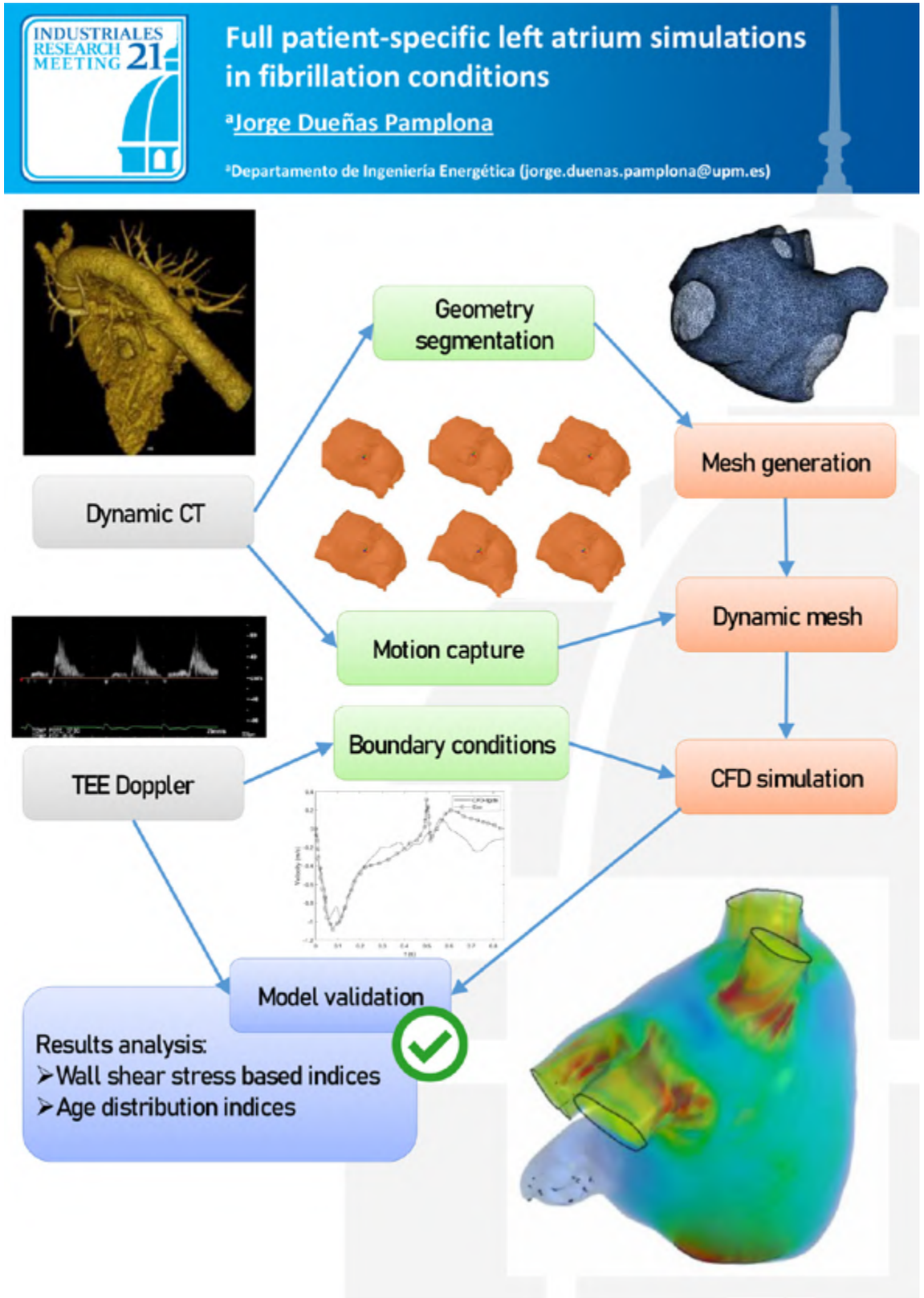
Differentiation assay: HSPC´s colony units formation (CFU)



- Differentiation capacity of primary cells.
- Mouse bone marrow cells from C57BL6 mice.
- Biotin conjugated antibody cocktail consisting in anti-CD3, anti-CD4,anti-CD8, anti-CD19, anti-CD220, anti-NKp46, anti-CD11b and anti-CD11c. Cells were then incubated with streptavidin-PE in order to label Lin+ cells as red cells.
- Lin− cells were BA-LIFT-transferred onto a culture dish with 1.27% methylcellulose and placed in a 37 °C and 5% CO_2 incubator.

Acknowledgements

Partial financial support for this work has been provided by the Spanish Ministry of Science and Innovation under the project: BIOPIELTEC-CM (P2018/BAA4480)



Jorge Dueñas Pamplona

FULL PATIENT-SPECIFIC LEFT ATRIUM SIMULATIONS IN FIBRILATION CONDITIONS

Roberto García Baonza

DESIGN OF WIDE RANGE NEUTRON AREA MONITORS AND BONNER SPHERES FOR PROTONTHERAPY FACILITIES

Design of wide range neutron area monitors and Bonner spheres for protontherapy facilities

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ABSTRACT

The two first protontherapy facilities in Spain started to operate 2020, and both centers are located in Madrid. Thus, from the Department of Energy Engineering of the ETSII-UPM different devices for neutron monitoring and spectrometry have been analyzed, characterized, designed and constructed for their application in these centers.

I. INTRODUCTION

The stray neutron radiation is the main concern about radiological protection in protontherapy facilities and must be monitored with reliable devices. This poster presents the main considerations for the characterization and design of wide range neutron area monitors.

II. MATERIALS & METHODS

Neutron detection is mainly based on the detection of thermal neutrons by activation of materials, generation of defects, or generation of charged particles.

MCNP and PHITS are the simulation codes employed by the UPM to characterize the response function (Figure 1 [1]) of wide range neutron area monitors and Bonner spheres, which are composed of a detector, a moderator material and a spallation layer (Figure 2).

III. RESULTS

The correctness of the simulation models is checked by benchmarking computational and experimental results at the UPM irradiation bench [2] (Figure 3). An example of these benchmarking activities can be observed in Figure 4.

Nowadays, the authors are carrying out the final tests of two novel devices.

IV. CONCLUSIONS

The extended-range Bonner spheres designed and constructed by the authors are nowadays being tested, performing experimental tests at the UPM irradiation bench (Figure 3).

On the other hand, the authors are also doing the final steps to calibrate a novel wide range neutron area monitor, which is expected to be ready in the first semester of 2022.

Figure 2. Configuration of an extended-range Bonner sphere.

Figure 3. Test of a LUPIN-II monitor at the UPM irradiation bench.

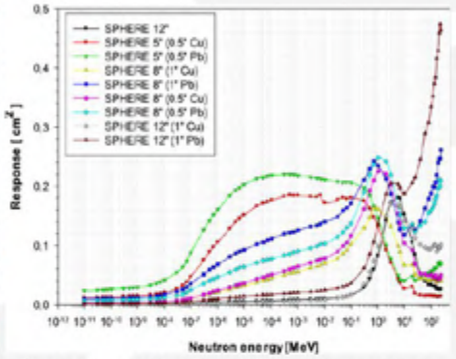

Figure 1. Response functions of different Bonner spheres.

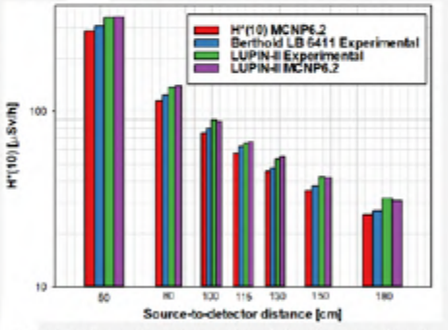

Figure 4. Comparison of experimental and computational results at the UPM neutronics hall.

COLLABORATIONS

Ciemat
Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas

Universidad de Sevilla

CNA
Centro Nacional de Aceleradores

V. REFERENCES

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Gonzalo García Fernández

CONTRIBUTIONS TO COMMISSIONING AND OPERATIONAL RADIATION PROTECTION IN PROTON THERAPY CENTERS

Contributions to commissioning and operational radiation protection in proton therapy centers

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Abstract

Proton therapy is an external radiotherapy using proton beams to treat some tumours with outstanding benefits. This research project is focused on the development of methodologies to analyze the stray neutron radiation yielded in proton centers, to assess the radiation protection for medical staff and public. The project has been developed since 2018, at the same time as the advent of proton centers to Spain, under an Industrial Doctorate agreement between UPM and Bioterra, SL.

Cancer treatment with proton therapy (PT)

Cancer is the second leading cause of death worldwide, with an estimated 9.6 million deaths in 2018. Therefore, improved treatments have a positive impact on many people[1].

Proton therapy is an external radiotherapy using accelerated proton beams, with energies between 70 and 230 MeV, achieving relevant clinical advantages in some cancer treatments, due to energy transfer plot (Figure 1 down).

Pencil beam scanning (PBS) is the usual way of delivery protons in tumours (Figure 1 up), however, other modes are currently under research, as PMAT, proton monoenergetic arc therapy [2].

Compact Proton Therapy Centers (CPTC), as those coming to Spain (Table 1), are made of the accelerator and one or two treatment rooms, comprising latest technical advances with the goal of reducing footprints and costs (Figure 2).

Radiation protection in proton centers (PTC)

Interactions of high energy protons with elements of the facility yield a large amount of stray radiation, mainly neutrons and gamma rays.

The aim of this project has been to develop the operational radiation protection in proton therapy centers, starting with the shielding design and selecting the radiation detection devices for wide range energy neutrons.

The final purpose was the assessment and verification of the compliance of international limits of dose for both, professionals and general public.

Vendor	Model	Accelerator	Number of rooms	Footprint Aprox. (m²)	Start date
IBA	ProteusOne®	Synchrocyclotron	1	400 m²	December 2019
Hitachi	Expandable One Gantry System	Synchrotron	1 + (1 room)	800 m²	April 2020

Table 1: Main features of Compact Proton Therapy Centers (CPTC) working in Spain

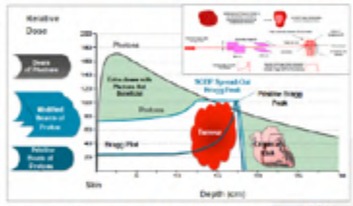

Figure 1: Dose delivery with photons and protons (PBS)

Figure 2: Footprint of CPTC with synchrocyclotron

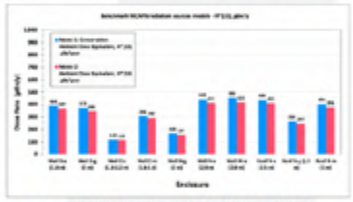

Figure 3: Ambient dose outside shielding of CPTC

Figure 4: Experimental setup of arc therapy tests at RPTC

Main activities and results

The main activities carried out and results achieved in the project are the following:

- Defining and modelling geometry, equipment and radiation sources of CPTC, with Monte Carlo codes (MCNP6).
- Study and measurements (in the Laboratory of Neutronic Measurements at LMN-ETSII-UPM) with extended detectors and spectrometry devices [3].
- Shielding verification and neutron dosimetry in CPTC (Figure 3) [4].
- Benchmarking of stray neutron fields yielded by main medical proton accelerators types (synchrocyclotrons and synchrotrons), used in CPTC.
- Experimental measurements at the Roberts Proton Therapy Center (RPTC), of University of Pennsylvania, comparing neutron fields yielded with different proton delivery techniques (Figure 4).
- Design and proposal of operational radiation protection measures in commissioning of CPTC.

Conclusions

The operational radiation protection in proton therapy centers has been carried out. The activities developed were collected in scientific papers (8), oral presentations (36), at least one master work, and one doctoral thesis (in progress). The project include contributions of researchers from five institutions in four countries.

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Acknowledgments and funding

This work has been developed under the Industrial Doctorate Program IND2017/AMB-7797 funded by Madrid Government (CM).

Some training courses and conference attendances have been funded by the Federico Goded Chair of Nuclear Safety Council (CSN).

Sonia Guerra Rodríguez

ADVANCED TREATMENTS FOR WASTEWATER REGENERATION

ADVANCED TREATMENTS FOR WASTEWATER REGENERATION

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ETSI INDUSTRIALES, UNIVERSIDAD POLITÉCNICA DE MADRID
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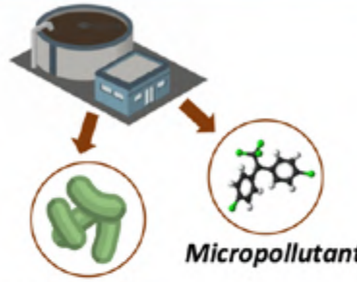
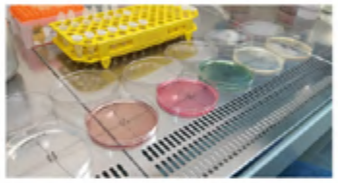


INTRODUCTION

Did you know that the effluent of a wastewater treatment plant can contain significant concentrations of micropollutants and pathogenic microorganisms?

Advanced oxidation processes based on sulfate radicals, like those based on hydroxyl radicals, are capable of degrading organic molecules while inactivating microorganisms, allowing a safer reuse of treated water.

INACTIVATION OF MICROORGANISMS



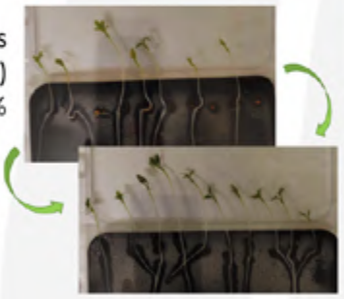
Different oxidants have been successfully assessed on the inactivation of *Enterococcus sp.* Moreover, the effect of the composition of the matrix has also been studied.

PILOT SCALE TREATMENTS

MICROPOLLUTANTS REMOVAL AND TOXICITY REDUCTION

The removal of 20 contaminants (pesticides and pharmaceuticals) was studied, with an average 80% of degradation achieved.

A significant reduction on the phytotoxicity was observed after the treatments.



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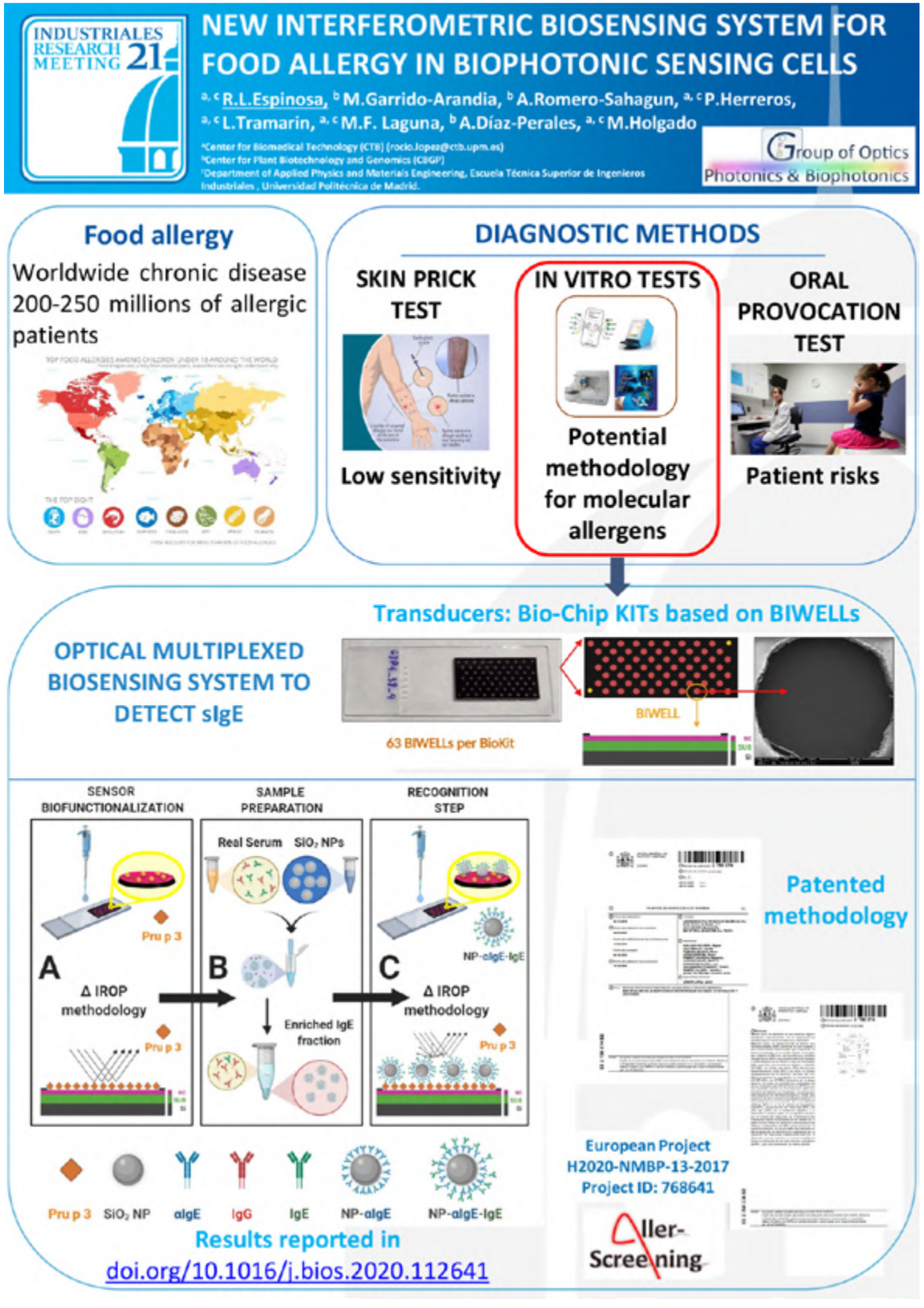
Guerra-Rodríguez el al., (2018) Assessment of Sulfate Radical-Based Advanced Oxidation Processes for Water and Wastewater Treatment: A Review. *Water (Switzerland)* 10 (12), 1828

Guerra-Rodríguez el al., (2020) Towards the implementation of circular economy in the wastewater sector: Challenges and opportunities. *Water (Switzerland)* 12 (5), 1431

Guerra-Rodríguez el al., (2021) UV-A activation of peroxymonosulfate for the removal of micropollutantsfrom secondary treated wastewater, *Sci. Total Environ.* 770, 145299

Guerra-Rodríguez el al., (2020) Photocatalytic activation of sulfite using Fe(II) and Fe(III) for *Enterococcus* sp. Inactivation in urban wastewater *Chem. Eng. J.* 408, 127326



Rocío López Espinosa

NEW INTERFEROMETRIC BIOSENSING SYSTEM FOR FOOD ALLERGY IN BIOPHOTONIC SENSING CELLS

Daniel Nagem Bouzon

FORECASTING COVID-19 OUTBREAK

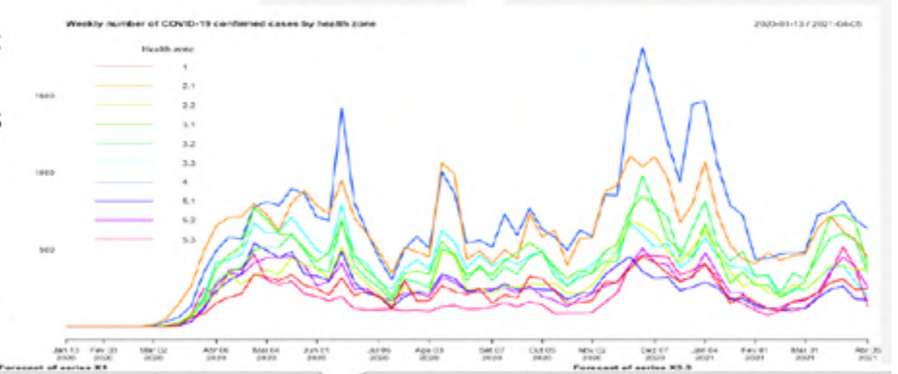
Forecasting COVID-19 outbreak: a multivariate time-series approach

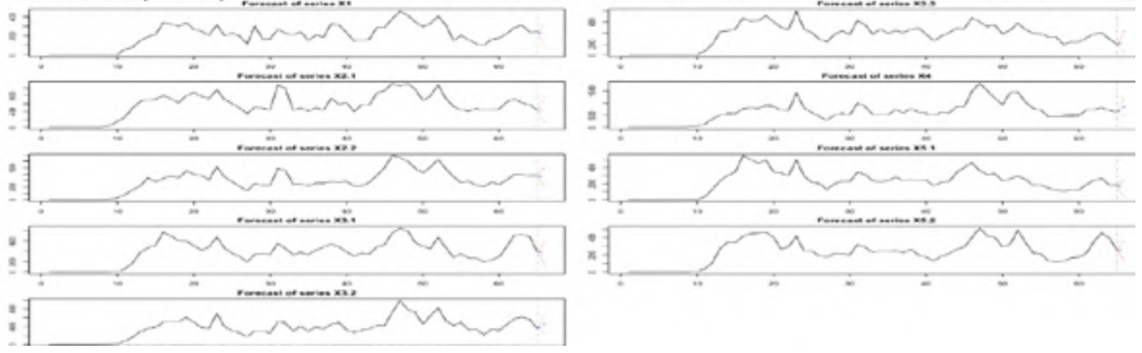
- COVID-19 is not the first infectious disease outbreak (DO) and will not be the last.
- **Research Question**: Which forecast/predict approaches/methods are currently used to support decision makers faced by disease outbreaks?

AU	YR	MLM	CLM	COM	Uni	Mul	Exog	Pred range	Pred object	DO
A	2020	X	X			X		7 days	# cases	COVID-19
B	2017			X	X		X	2 weeks	# deaths	Zika virus
C	2018	X		X	X			1 month	# hospital beds	Ebola
...	...	...	...	...	...	...	...	...	...	...

Most common approaches found:

- Machine learning models (MLM)
- Classical time-series models (CLM)
- Compartmental Models (COM)





Luis Sigcha Guachamin

MOTOR SYMPTOMS MONITORING IN PARKINSON´S DISEASE USING WEARABLE DEVICES

Motor symptoms monitoring in Parkinson's disease using wearable devices

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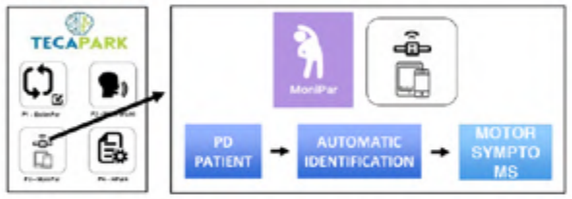
[b] ALGORITMI Research Center, School of Engineering, University of Minho

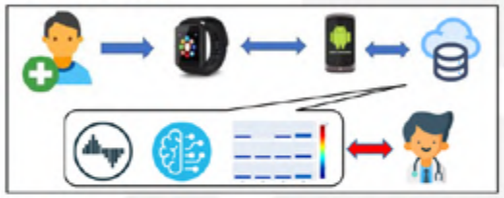
Abstract

The project analyses the use of wearable technology and artificial intelligence to objectively identify the motor-symptoms and physical events associated with Parkinson's Disease (PD), such as tremor, bradykinesia (slowness of movement) or freezing of gait. The main objective is to improve the quality of life of PD patients by using inclusive technologies that promote continuous and objective monitoring.

The project



Methodology



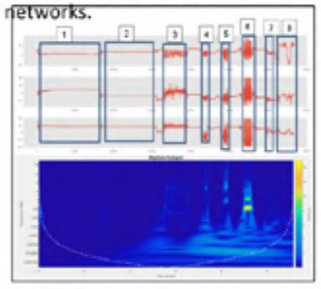
Methodology validation

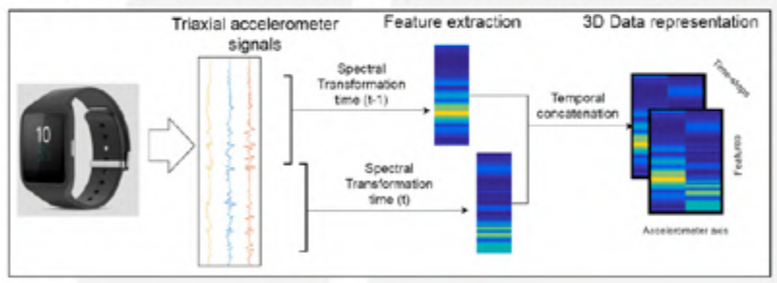
A mobile and smartwatch application has been developed to guide the patient in performing a set of exercises proposed in the UPDRS scale. The data collection methodology was validated by the MIT AGE LAB and the Madrid Parkinson Association.

Experimentation

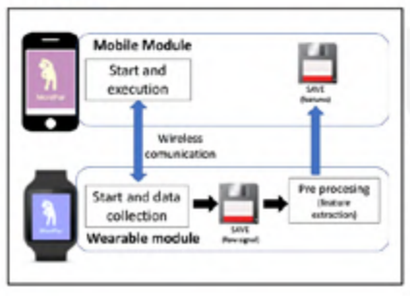
The experimentation was carried out in Parkinson's associations in the cross-border area between Portugal and Spain.

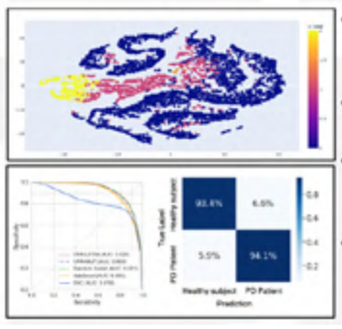
The movement data is processed with time-frequency data representations and is analyzed through deep neural-networks.





Results





- A PD motor-state analysis system based in consumer smartwatches and a mobile application (m-Health).
- A multitask PD tremor detection and assessment system (AUC 0.936).
- A State-Of-The-Art freezing of gait detection algorithm, based in a deep sequential network (AUC 0.923).
- An early PD detection algorithm based on movement analysis (AUC 0.983).

Andrés R. Tejedor

PHYSICS OF POLYMERS IN COMPLEX ENVIRONMENTS

Physics of polymers in complex environments

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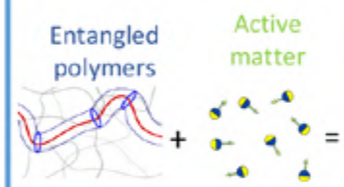
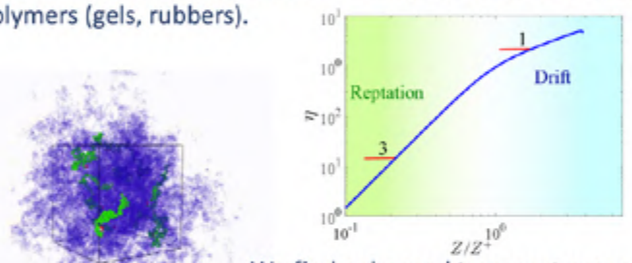
INTRODUCTION

Polymers are present in our lives in many ways, from biological (DNA, proteins,...) to industrial processes (plastics, gels,...). Here, we cover different problems of polymers in complex environments, from theoretical models (Active entangled polymers and semiflexible polymers) to more specific problems (Phase separation or proteins).

ACTIVE ENTANGLED POLYMERS

By means of **analytical calculations and simulations**, we explore the impact of an activity in the physical properties of entangled polymers (gels, rubbers).





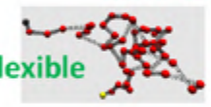
We find enhanced transport properties!

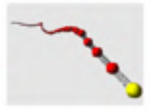
A.R. Tejedor, *et al.* **Soft Matter** (2020)
A.R. Tejedor, *et al.* **Macromolecules** (2019)

Applications: design of superfluid materials

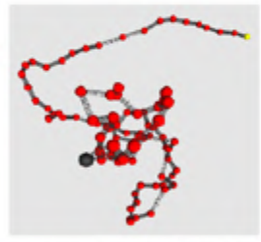
SEMIFLEXIBLE POLYMERS

We solve analytically a discrete model for **gaussian semiflexible polymers**. The results are verified with simulation.





We also explore the general case where the stiffness is not constant along the chain. Particularly, we study **the whip-like polymer.**

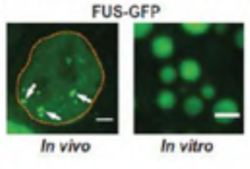


A.R. Tejedor, *et al.* **Polymers** *in preparation* (2021)

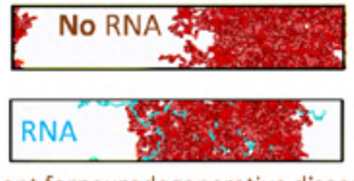
Applications: biomolecules are commonly semiflexible

PHASE SEPARATION OF PROTEINS

Experimental evidences demonstrate the role of solid-like condensates of proteins in the emergence of **neurodegenerative diseases** (Alzheimer, ALS, ...). However, RNA can somehow modulate this phenomenon.



By means of simulations, we **characterize the protein droplets** in absence and in presence of RNA



Applications: medical treatment forneurodegenerative diseases

A.R. Tejedor, *et al.* **ACS Central Science** *under review* (2021)

Javier Cano Nogueras

RELOJ DE SOL

INDUSTRIALES RESEARCH MEETING 21

RELOJ DE SOL

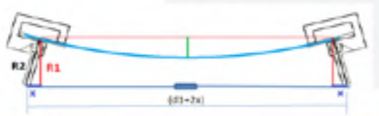
JAVIER CANO NOGUERAS, JAVIER MUÑOZ ANTÓN, JOSE Mª MARTÍNEZ-VAL.
UNIVERSIDAD POLITÉCNICA DE MADRID, ETSI Industriales (javier.cano.nogueras@alumnos.upm.es)

GIT

F²I² FUNDACIÓN PARA EL FOMENTO DE LA INNOVACIÓN INDUSTRIAL

ABSTRACT

"Reloj de Sol": New configuration solar radiation concentrator
Using simple and cheap flat mirrors.
Circular cylindrical mirrors obtained by applying an inexpensive and simple folding technique through a patent from the GIT research group.
Mirror fixed on a platform that rotates horizontally



A SMALL SCALE PROTOTYPE

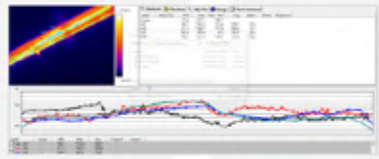
- 40 m² of mirrors
- Two 4-meter PTC receivers
- Receiver at 4.5 m
- 8 m diameter platform
- Temperature over 300 ºC

Description	Value
Thermal power	30 kW
Base diameter	8 m
Aperture area	20.25 m²
Receiver diameter	140 mm
Working fluid	Air
Working pressure	Atmospheric pressure
Working temperatures	Up to 325ºC
Receiver absorptivity/emissivity	80

RESULTS

Working images from platform

Bottom view of concentrated sunlight over receiver



Thermal Camera sample

Thermocouple datalogging sample

CONCLUSION AND FUTURE WORK

- Very simple structure
- Solar Concentration Capability and Platform Operation validation
- cost per installed watt significantly lower than a conventional solar thermal plant.

REFERENCES

GIT → "Futuro Solar" With OHL (2015)
3rd prize UPM 2T Innovatech Challenge 2016
2nd prize of UPM 2T Innovatech Challenge 2018

PATENT

•Granted: ES1138715U, ES2537607, ES1138715U, ES2596294 and ES2578804.

Leo Casasola-Aignesberger

E.V. CONTRIUBTION TO FREQUENCY CONTROL IN HIGH WIND POWER SCENARIOS

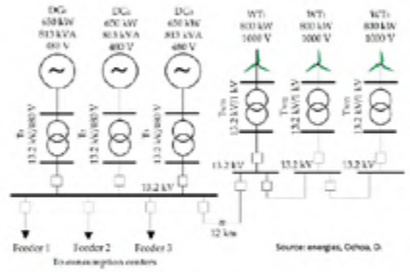
E.V. CONTRIBUTION TO FREQUENCY CONTROL IN HIGH WIND POWER SCENARIOS

[a]Leo Casasola-Aignesberger, [a]Sergio Martínez
[a]Escuela Técnica Superior de Ingenieros Industriales,
Universidad Politécnica de Madrid (leo.casasola@upm.es)

GELEO research group

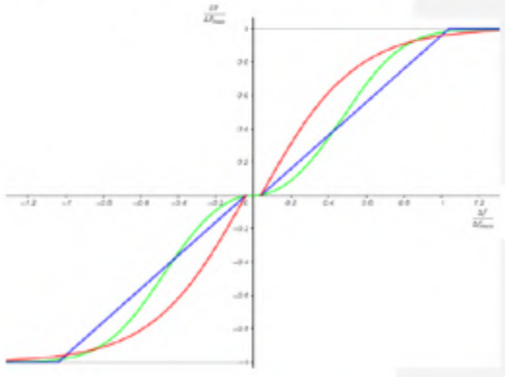
PROBLEM STATEMENT

Variations in wind speed over short periods of time cause deviations in wind power generation which lead to oscillations in the system frequency.



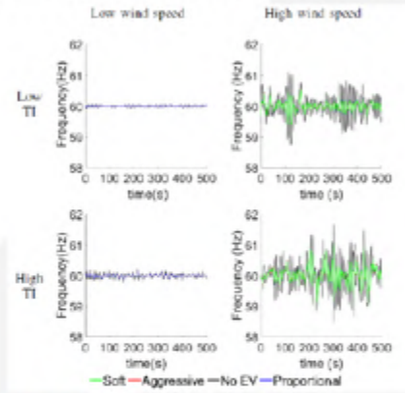
PROPOSAL

Electric vehicles that are actively charging at a given moment, can participate in frequency regulation by adapting their demanded power according to some strategy. Three different strategies are implemented:



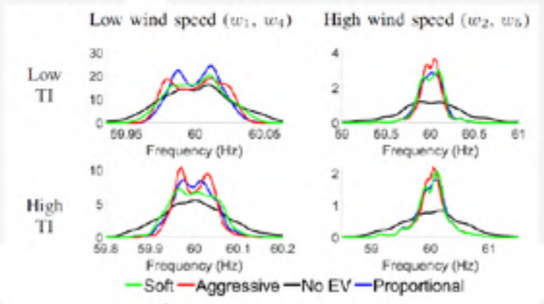
RESULTS

Simulations show that the participation, even of a small fraction of the total demand, can lead to a significant improvement in frequency stability.



EVALUATION

The performance is measured as the fraction of the time the frequency stays within acceptable bounds.

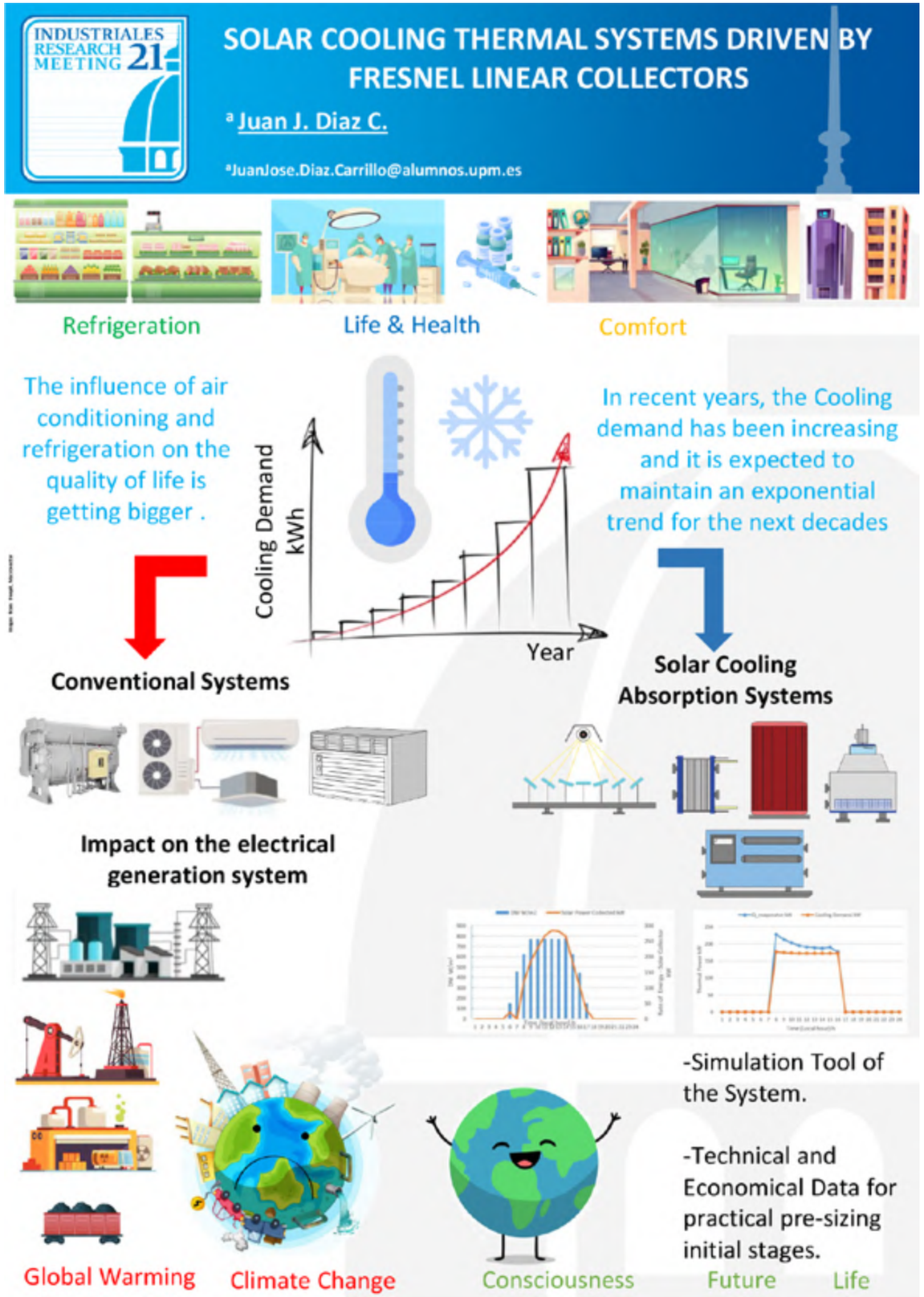


	w_1	w_2	w_4	w_5
No control	1	0.3462	0.9480	0.2329
Proportional	1	0.7272	0.9983	0.4729
Aggressive	1	0.8030	0.9999	0.5325
Soft	1	0.7557	0.9995	0.4967

L. Casasola-Aignesberger and S. Martinez, "Electric vehicle recharge strategies for frequency control in electrical power systems with high wind power generation." in 2020 IEEE International Conference on Environment and Electrical Engineering and 2020 IEEE Industrial and Commercial Power Systems Europe (EEEIC /I CPS Europe) pp. 1-5, June 2020

Juan José Díaz Carrillo

SOLAR COOLING THERMAL SYSTEMS DRIVEN BY FRESNEL LINEAR COLLECTORS



Carlos Ramos Romero

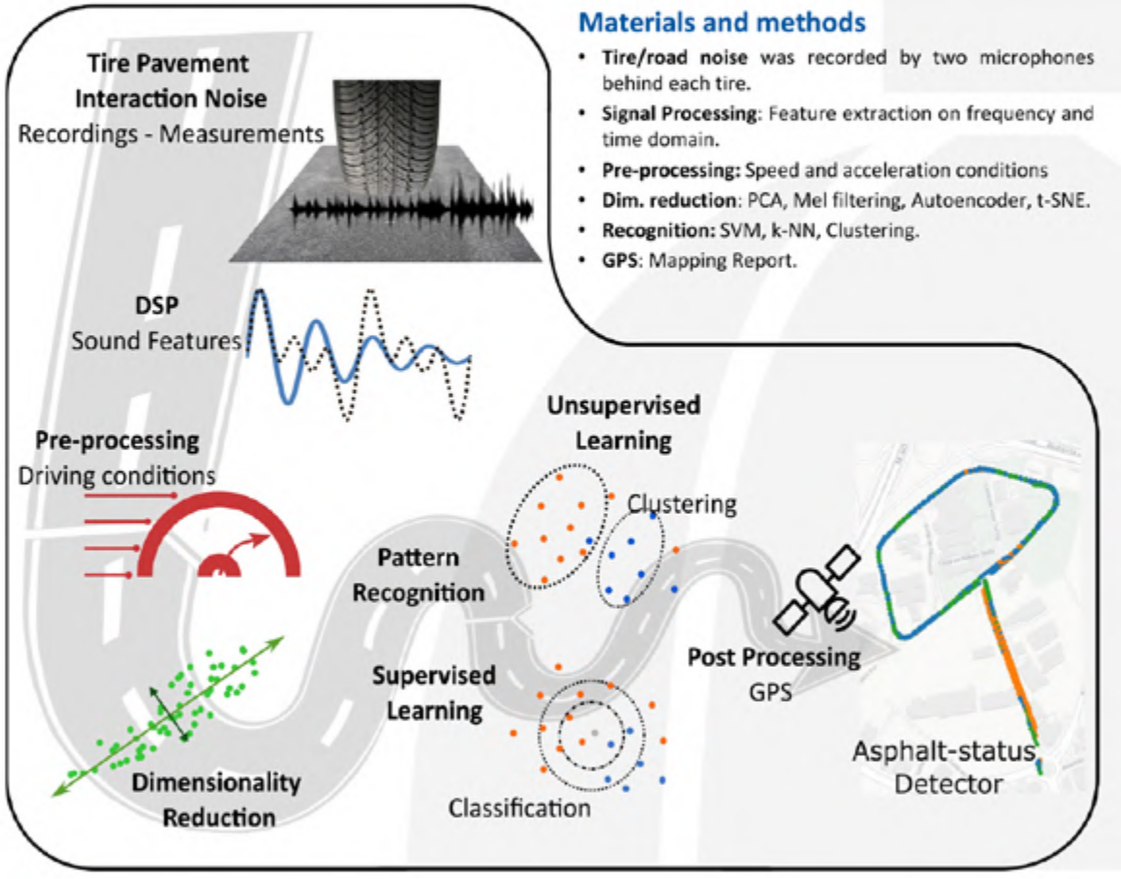
IDENTIFICATION OF THE ASPHALT SURFACE STATE THROUGH THE ACOUSTIC SIGNAL

Identification of the asphalt surface state through the acoustic signal.

[a]C. Ramos-Romero., [a]C. Asensio.
[a] Instrumentation and Applied Acoustics Research Group (I2A2).
c.ramosr@alumnos.upm.es

Abstract

A novel non-intrusive approach to detecting the homogeneity and deterioration signals over asphalt surfaces is presented. With a pair of microphones mounted near the wheels any vehicle becomes an asphalt condition inspector. It is possible to categorize the road surface into impairment or ageing levels by combining both audio signal processing and automatic classification algorithms.



Materials and methods

- **Tire/road noise** was recorded by two microphones behind each tire.
- **Signal Processing**: Feature extraction on frequency and time domain.
- **Pre-processing:** Speed and acceleration conditions
- **Dim. reduction**: PCA, Mel filtering, Autoencoder, t-SNE.
- **Recognition:** SVM, k-NN, Clustering.
- **GPS**: Mapping Report.

Results

- The tire-pavement interaction noise contains information. It includes data related to the road surface condition.
- The information retrieval was made by signal power spectrum into linear and logarithmic bands.
- Frequency bands below 2500 Hz have been found to identify change in asphalt aging.
- The bands obtained form the characteristics. It allows us to separate classes with an accuracy of more than 95% on supervised learning applications.
- The unsupervised algorithms allows to identify the asphalt-condition homogeneity over a selected road trip.
- The classification could be improved through smoothing data by post geo-processing.

José Miguel Riquelme Domínguez

ANCILLARY SERVICES IN STORAGELESS GRID-CONNECTED PV SYSTEMS

ANCILLARY SERVICES IN STORAGELESS GRID-CONNECTED PV SYSTEMS

[a]J. M. Riquelme-Dominguez, [a]Sergio Martinez
[a]Escuela Técnica Superior de Ingenieros Industriales,
Universidad Politécnica de Madrid (jm.riquelme@upm.es)

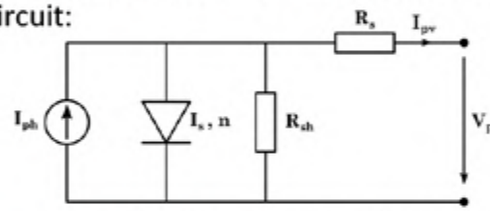
GELEO research group

I. Abstract

As the penetration of photovoltaic (PV) energy increases in power systems, TSOs have started to request their participation in the provision of ancillary services, in order to maintain adequate conditions of guarantee and quality in the supply of electricity. This work is focused in the provision of these services in storageless grid-connected PV systems.

II. Single-diode PV model

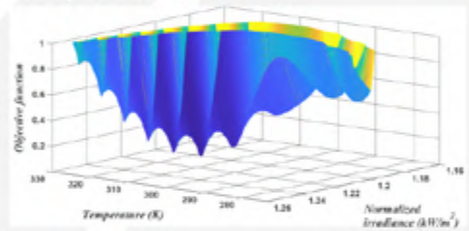
The PV system under study in this work is based on the single-diode model and represented by its electrical equivalent circuit:



$$I_{pv} = I_{ph} - I_s\left[exp\left(\frac{V_{pv} + I_{pv}R_s}{\frac{n\,k\,T}{q}}\right) - 1\right] - \frac{V_{pv} + I_{pv}R_s}{R_{sh}}$$

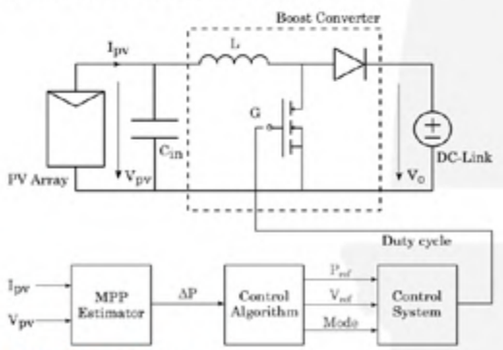
III. Maximum Power Point Estimator

The proposed control strategies require information about the Maximum Power Point in real-time in order to know the available power reserve. This can be achieved by the application of nonlinear least squares algorithms.



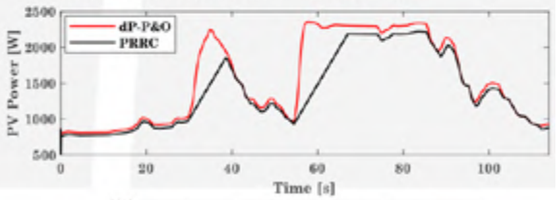
IV. Control system

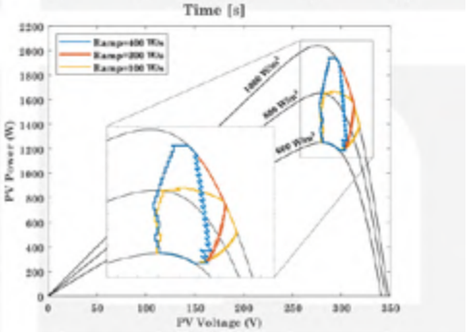
The operating point of the PV system is adjusted by controlling the duty cycle of the DC-DC boost converter.



V. Results

The proposed strategies perform appropriately even in real-fiel highly variable irradiance conditions.





VI. Publications

J. M. Riquelme-Dominguez and S. Martinez, "Comparison of Different Photovoltaic Perturb and Observe Algorithms for Drift Avoidance in Fluctuating Irradiance Conditions," in Proceedings EEEIC 2020, Madrid, Spain, pp. 1-5, 2020.
Riquelme-Dominguez, J.M.; Martinez, S. A Photovoltaic Power Curtai lment Method for Operation on Both Sides of the Power -Voltage Curve. Energies, 13, 3906, 2020.

Pablo Rodríguez Pajarón

IMPACT OF ELECTRIC VEHICLE CHARGING IN POWER QUALITY AT FUTURE DISTRIBUTION NETWORKS

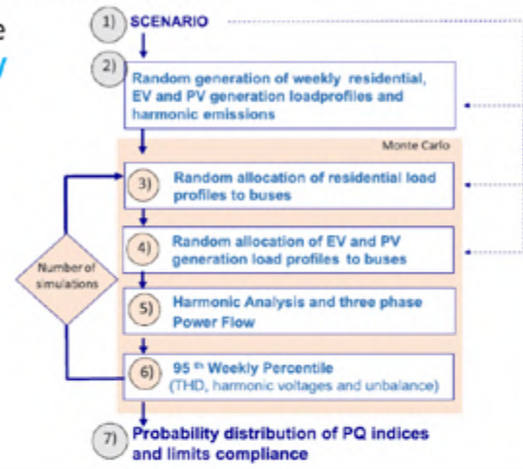
Impact of Electric Vehicle Charging in Power Quality at Future Distribution Networks

[a]Pablo Rodríguez-Pajarón, [a]Araceli Hernández

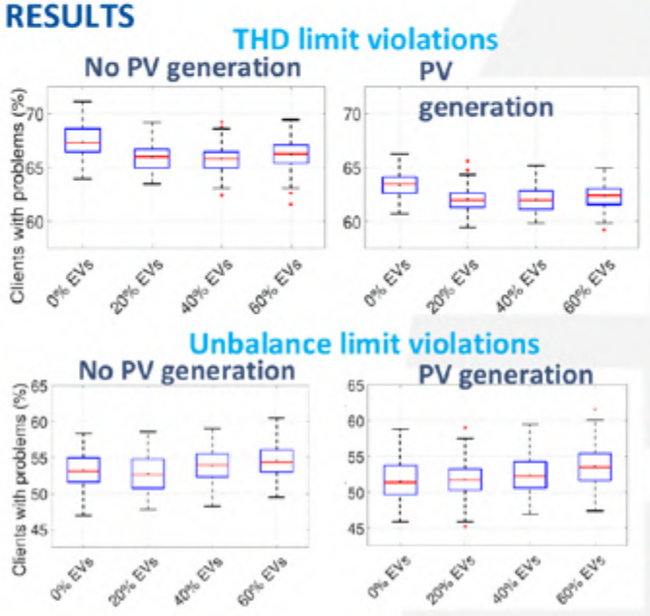
[a]Escuela Técnica Superior de Ingenieros Industriales – Universidad Politécnica de Madrid (pablo.rpajaron@upm.es)

OBJECTIVES

1. Assess **Power Quality** in residential networks with EVs.
2. Obtain representative results of future distribution networks, including **PV generation**.
3. Compare to standards.



RESULTS



CONCLUSIONS

1. **PV generation improves quality of power** of residential network.
2. **EV** can help to **reduce harmonic distortion**, due to cancellation of 3rd harmonic currents.
3. **EV carparks** should be placed close to the **substation**.
4. **Smart charging** strategies reduce unbalance in the network.

Pablo Rodríguez-Pajarón, Araceli Hernández, Jovica V. Milanović, Probabilistic assessment of the impact of electric vehicles and nonlinear loads on power quality in residential networks, International Journal of Electrical Power & Energy Systems, Volume 129, 2021, 106807, ISSN 0142-0615,

Fredy Rosero

THE EFFECTS OF TRAFFIC CONGESTION ON EMISSIONS FROM URBAN BUSES

THE EFFECTS OF TRAFFIC CONGESTION ON EMISSIONS FROM URBAN BUSES

[a,b] Rosero F., [c] Fonseca N., and [a] J.M. López
[a] University Institute for Automobile Research (INSIA), Universidad Politécnica de Madrid, (fa.rosero@alumnos.upm.es)
[b] Faculty of Applied Sciences, Universidad Técnica del Norte - Ecuador
[c] Department of Energy and Fuels

INTRODUCTION

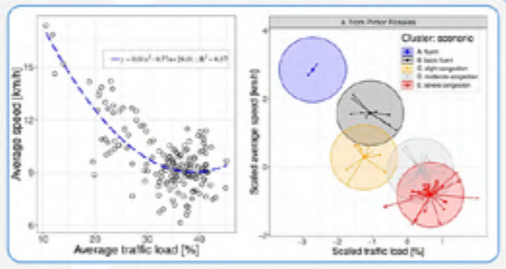
- The main objective was to estimate the effects of traffic congestion at the route level on emissions from diesel and compressed natural gas (CNG) urban buses in a representative bus route in Madrid (Route 74).

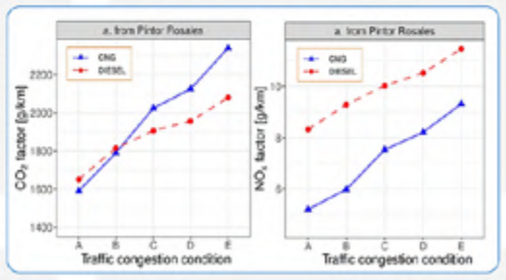
METHODOLOGY

- A complex process was conducted to integrate real-world emissions, naturalistic trips, and traffic information.
- The VSP approach was used for modelling second-by- second bus emissions.

RESULTS

- The average speed was the congestion indicator based on vehicle dynamics that showed the highest correlation with the stationary road traffic load. With the K-means clustering method, five traffic scenarios were defined for this study.
- From the free-flow to severe congestion scenarios, the CO_2 emissions for the Euro V diesel and Euro VI CNG buses increase by 31% and 53%, respectively; furthermore, the NO_x emissions for the diesel bus increase by 43%, whereas those for the CNG bus increase sharply, by 85%.

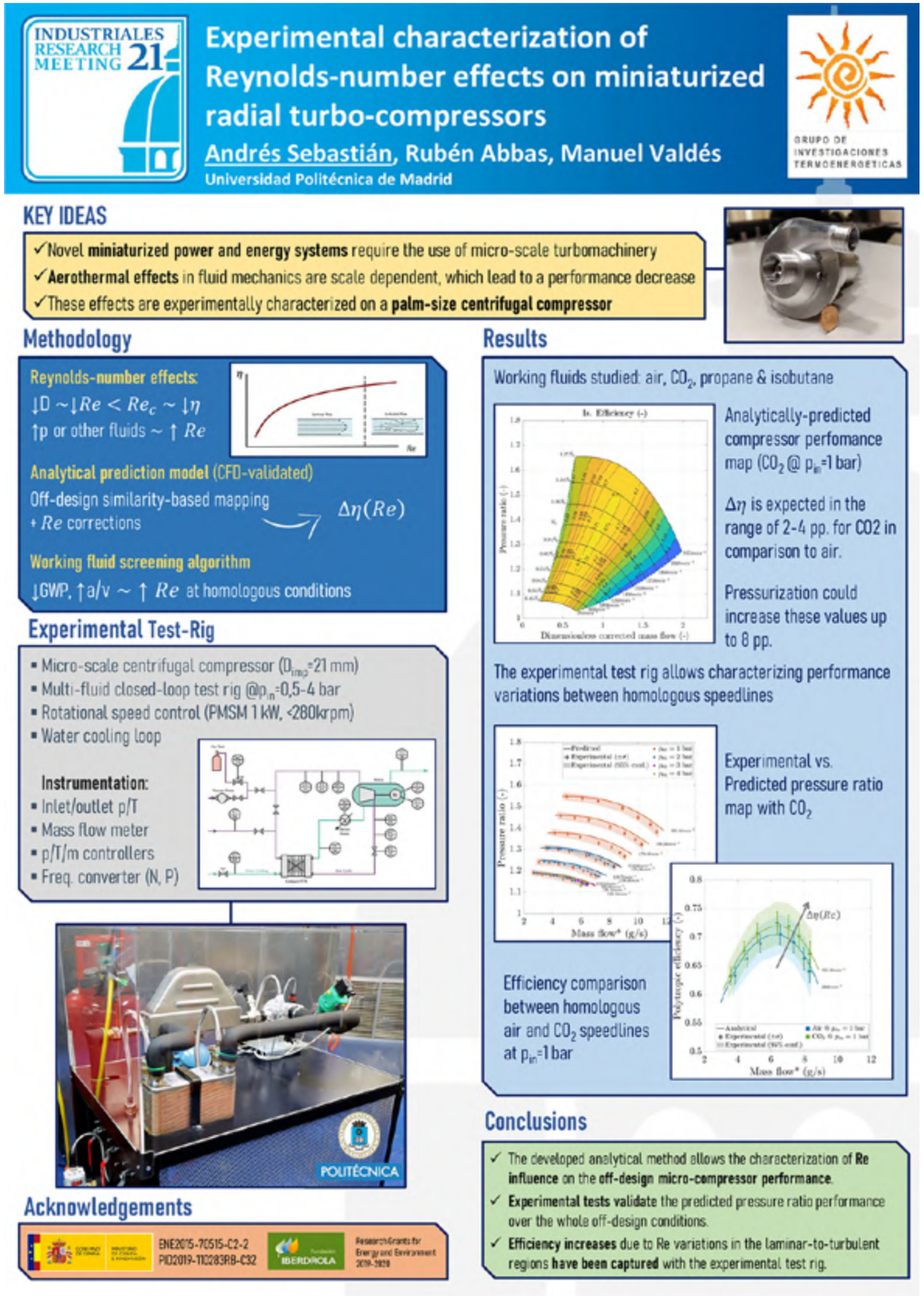




CONCLUSIONS

- This study, based on extensive real-world data, demonstrate that the congestion has a significant effect on travel times, as well as on the operating modes and levels of emissions of urban buses.

Acknowledgment
- This work was derived from the CICLOPE Research Project.TRA2015-68803-R (MINECO/FEDER).



Andrés Sebastián Herrera

EXPERIMENTAL CHARACTERIZATION OF REYNOLDS-NUMBER EFFECTS ON MINIATURIZED RADIAL TURBO-COMPRESSORS

Escuela Técnica Superior de Ingenieros Industriales

IV Industriales Research Meeting

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