

Science Days

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2026

3rd edition

 **Lisbon**

 **October**



Book of Abstracts

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NInTec Science Days (22-23 October 2026)

Foreword

NInTec is pleased to present the 3rd edition of NInTec Science Days, an interdisciplinary event dedicated to showcasing research excellence across the broad scientific ecosystem of Instituto Superior Técnico.

Building on the success of the previous editions, NInTec Science Days 2026 provides a unique forum for researchers, students and research professionals to share knowledge, exchange ideas and present some of the latest scientific and technological developments taking place within the Técnico community. The event promotes cross-fertilization between different scientific disciplines while fostering dialogue between academia, industry, public institutions and society. As in previous editions, participation of PhD students, early-career researchers and Técnico alumni pursuing research careers in academia, industry, SMEs and other organizations is strongly encouraged.

The scientific programme features oral and short oral presentations covering the major research areas represented at Técnico, including Exact Sciences, Natural Sciences, Engineering and Technology, Medical and Health Sciences, and Interdisciplinary Research.

In addition to the scientific programme, NInTec Science Days 2026 addresses current challenges affecting research careers and research policy in Europe. As Instituto Superior Técnico is currently implementing the Human Resources Strategy for Researchers (HRS4R) and simultaneously coordinates the SECURE2 project, funded under the Horizon Europe WIDERA programme, this year's policy session focuses on one of the most relevant topics for the European Research Area: "Challenges in the Implementation of the European Charter for Researchers". A round table brings together distinguished representatives from European and national research policy, institutional leadership and the research community to discuss the practical implementation of the European Charter for Researchers.

The debate explores topics including:

- translating European research policy into institutional practice;
- improving researchers' working conditions and career development;
- promoting attractive, fair and inclusive research careers;
- institutional experiences with HRS4R implementation;
- future developments within the European Research Area, including the forthcoming ERA Act.

The session aims to stimulate an open discussion between policymakers, institutional representatives and researchers on how to strengthen research careers and contribute to a more competitive, inclusive and sustainable European research ecosystem.

As in previous editions, NInTec Science Days 2026 also distinguishes outstanding scientific contributions through the Best Student Contribution Award, recognizing exceptional work presented by MSc and PhD students.

NInTec acknowledges the support of [Instituto Superior Técnico](#) and [Impersol](#).

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Scientific Programme

Oral presentations: 15 min + 5 min discussion. Short orals: 10 min + 2 min discussion.

Thursday, October 22

10:00 – 10:30	Registration & Welcome Coffee
10:30 – 10:40	Opening Session – Nuno Cruz
10:40 – 12:00	First Session – Chair: Pedro Paulo
10:40	Joana Santos – <i>Exploring the PLCγ1-SHP2 Interaction as a Therapeutic Target in Cetuximab-Resistant Colorectal Cancer</i>
11:00	Mafalda Nunes – <i>The Nervous Heart: Unravelling Neuro-Cardiac Dysfunction in Rett Syndrome</i>
11:20	Nuno Graça – <i>Vibrio natriegens as a novel host for RNA therapeutics</i>
11:40	Sebastião Santos Pereira – <i>Biomanufacturing of DNA-Origami Nanostructures Towards Image-guided Drug Delivery</i>
12:00 – 14:00	Lunch Break
14:00 – 15:40	Second Session – Chair: Victoria Corregidor
14:00	Sara Gonçalves – <i>Chromosomal Aberration Assay for Rapid Screening in Emergency Exposure: IST Insights from the RESILIENCE Project</i>
14:20	Diogo Dias – <i>Fighting Cancer with Synthetic Antibodies</i>
14:40	Amin Gharghi – <i>Thermal Comfort as a Design Variable for Climate-Neutral Cities</i>
15:00	Maria Eugénia Vozzone Naudin – <i>Elemental characterization of metal artefacts using p-XRF and μ-PIXE</i>
15:20	Janice Lopes – <i>Gamma Irradiation as a Tool for Unlocking the Bioactive Potential of Grape Pomace</i>
15:40 – 16:10	Coffee Break
16:10 – 17:50	Third Session – Chair: Nuno Cruz
16:10	Bárbara Baptista – <i>Data Visualization Tools for Nuclear Fusion Experiments: ITER Interactive MDSplus MINT Interface</i>
16:30	Daosheng Ning – <i>When Waves Meet Structures: Modelling Approaches for Safer Marine Systems</i>
16:50	Mariana Ribeiro – <i>Seeing the invisible: how diagnostics let us describe and control plasmas</i>
17:10	Bruno Miroto – <i>Data Visualization Tools for Nuclear Fusion Experiments: An MDSplus Interface for Grafana</i>
17:30	Andre Ohara – <i>From the Inner Ear to the Origin of Warm-Bloodedness: a Multi-Omics View of Endolymph (ENDOMICS)</i>

Friday, October 23

09:30 – 10:45	Fourth Session – Short Orals – Chair: Pedro Santos
09:30	Maria Morgado – <i>The Role of RNA in the Formation of Tau Biomolecular Condensates</i>
09:42	Rúben Matias – <i>TIA1 and Tau: From Protein Production to Biomolecular Condensation</i>
09:54	Maria Jeremias – <i>The use of deep eutectic solvents in the pre-treatment of environmental samples for the voltammetric analysis of Pd</i>
10:06	Tiago Jesus – <i>Towards autonomous experiments at the nuclear microprobe</i>
10:18	André Pereira – <i>Development of functionally graded materials for nuclear fusion reactors</i>
10:30	Antonio Silva – <i>Compact, Reconfigurable Millimeter-Wave Back-End for Next-Generation Fusion Reactors</i>
10:45 – 11:20	Coffee Break
11:20 – 12:20	Fifth Session – Chair: Nuno Cruz
11:20	Salomé Rosa – <i>Spectroscopy4All: Low-Cost Multifunctional Modular Spectrometer Applied to Monitor the Activity of PSA</i>
11:40	Amin Gharghi – <i>Interfacial Forces in Three-Phase Systems</i>
12:00	Tiago Silva – <i>Development of a Microwave Plasma Reactor Facility for Gas Conversion at IST</i>
12:20 – 14:30	Lunch Break
15:00 – 17:00	Round Table – “Challenges in the Implementation of the European Charter for Researchers”
17: 00 – 17:10	NInTec Science Days 2026 – Student Award Winner Announcement
17: 10 – 17:20	Closing Session with Prof. Rogério Colaço – Presidente do Técnico

October 22

Oral Sessions

Exploring the PLC γ 1-SHP2 Interaction as a Therapeutic Target in Cetuximab-Resistant Colorectal Cancer

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Colorectal cancer (CRC) is the second leading cause of cancer-related death worldwide. Although cetuximab (Ctx), an Epidermal Growth Factor Receptor (EGFR)-targeted therapy, is used in metastatic CRC (mCRC)¹, resistance frequently occurs². Recently, we demonstrated that tumors with high levels of EGFR effector phospholipase c gamma 1 (PLC γ 1) are intrinsically resistant to Ctx, while inhibition of downstream SH2-containing protein tyrosine phosphatase 2 (SHP2) can sensitize Ctx-resistant cells³. Thus, we investigated the PLC γ 1-SHP2 interaction and explored its therapeutic potential in Ctx-resistant CRC. Given the association of PLC γ 1 with Ctx resistance and its direct interaction with SHP2, we explored SHP2 inhibition as a strategy to overcome this resistance. Towards this goal and within a theranostic approach, we developed EGFR/SHP2-targeted antibody drug conjugates (ADCs) combining: i) an anti-EGFR antibody (Ctx) to confer specificity and therapeutic effect; ii) a SHP2-inhibitor (SHP099); iii) a DOTA chelator for the complexation of an imaging radionuclide (⁶⁷Ga); iv) a non-cleavable (ADC-1) or cleavable (ADC-2) linker (Fig. 1).

As a first step, using purified proteins in pull-down assays, we confirmed that there is a PLC γ 1-SHP2 direct binding. Subsequent in silico studies identified V592, M681 and Y754, within the PLC γ 1 cSH2-nSH2 domains, as important residues for this interaction. Binding of PLC γ 1 to SHP2 was found to be strongly promoted by SHP2 phosphorylation. Moreover, further studies with the SHP2 E76K mutant, adopting an open conformation, showed that binding occurs independently of phosphorylation. This finding supports SHP2 conformational opening, rather than phosphotyrosines recognition, as the main determinant for PLC γ 1 binding. The ADCs carrying Ctx and SHP099 were synthesized via maleimide chemistry, with high drug-to-antibody ratios (3.1-3.5). Western blot analysis of resistant cells expressing high levels of PLC γ 1 (Caco-2) demonstrated a higher inhibition of EGFR and phosphorylated ERK by ADC-1 than Ctx alone. Consistently, ADC-1 presented enhanced cytotoxic activity in the same cell line. Importantly, ADC-2 induced the highest decrease in cell survival, ca. 20% lower than that induced by Ctx. The corresponding radiolabeled conjugates, [⁶⁷Ga]Ga-ADC-1, [⁶⁷Ga]Ga-ADC-2 and [⁶⁷Ga]Ga-Ctx, were obtained with radiochemical purity (RCP) above 95%, remaining stable in PBS and DMEM up to 48 h (RCP>90%). All radioconjugates present high cellular uptake (30%) in Caco-2 cells, with the majority of cell-associated activity corresponding to internalized radioconjugate. ⁶⁷Ga-labeled ADCs and Ctx showed similar binding affinities towards EGFR, in the nanomolar range. Blocking of EGFR with Ctx decreased cellular uptake by around 80%, further confirming that it is receptor-mediated.

In summary, our results identify PLC γ 1 residues involved in direct SHP2 binding and indicate that this interaction is mainly regulated by the conformational state of SHP2. Also, EGFR/SHP2-targeted ADCs were successfully developed and radiolabeled, showing enhanced cytotoxicity and specific uptake in CRC cells. These findings support their potential as theranostic agents for overcoming Ctx resistance in CRC.

Keywords: colorectal cancer, drug resistance, antibody-drug conjugates.

Acknowledgments: This work was supported by Fundação para a Ciência e Tecnologia, Portugal, under ProtoTera Association's agreement (PhD grant PRT/BD/154612/2023).

References

1. El Guerrab, Abderrahim, et al., *Oncotarget* 7.45 (2016):73618.
2. Zhao, Ben, et al., *Oncotarget* 8.3 (2017):3980.
3. Cruz-Duarte, Raquel, et al., *Clinical Cancer Research* 28.6 (2022):1203-1216.

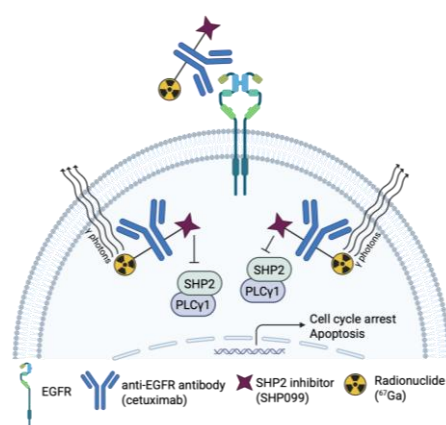
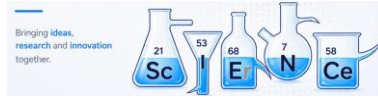


Fig. 1. Schematic representation of the proposed strategy.



The Nervous Heart: Unravelling Neuro-Cardiac Dysfunction in Rett Syndrome

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Rett syndrome (RTT) is a severe neurodevelopmental disorder affecting brain development and function, mostly caused by mutations in the X-linked gene MECP2¹. Beyond its neurological features, RTT patients often develop life-threatening complications such as breathing abnormalities, QT prolongation and sudden death². Whether these cardiac problems originate in the heart itself, in the autonomic nerves that control it, or in their interaction remains unknown, and current models cannot distinguish between these possibilities.

To address this, we are building three-dimensional innervated heart models from hiPSC lines carrying different MECP2 mutations, starting with the R255X line and its isogenic control (IC), starting with each component separately. First, we established a protocol for self-organising cardioids³ and discovered that RTT cardioids were significantly larger than IC cardioids and showed increased proliferation. Rather than losing cardiac identity, they expressed key cardiac transcription factors (HAND1, HAND2, GATA4, ISL1, TBX5) with altered timing over 15 days. This suggests that MeCP2 loss delays early heart development instead of blocking it.

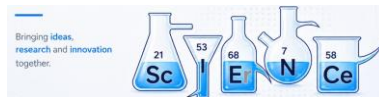
Since the heart is dually innervated, we then generated sympathetic (SN) and parasympathetic (PSN) neurons through a neural crest intermediate⁴. In both genotypes, neural crest cells expressed SOX10 and AP2 α at day 10 and gave rise to TH⁺ SNs and ChAT⁺/VACht⁺ PSNs. During differentiation, SOX10 intensity kept rising while the percentage of SOX10⁺ cells stayed stable, suggesting ongoing progenitor maturation. Importantly, only spheroids with more than 85% S100⁺ Schwann cell precursors produced ChAT⁺/VACht⁺ neurons, pointing to S100 as an early marker of parasympathetic competence. On multielectrode arrays, SNs cultured for 51–57 days showed electrical activity, extensive axonal outgrowth and network formation, confirming that they are functional and ready to be paired with cardiac tissue.

Reproducibility is now our main challenge. The quantitative checkpoints defined here will guide the selection of differentiations before comparing mutant and IC neurons and combining them with cardioids. These innervated models will let us ask whether RTT arrhythmias are mainly cardiac, neuronal or emerge from their interaction, and will provide a platform for testing therapies. These challenges open opportunities for interdisciplinary collaboration, particularly in multielectrode data analysis and co-culture platform design.

Keywords: Rett syndrome; hiPSC-derived cardioids; autonomic neurons.

References

1. Gomes AR et al., Int J Mol Sci. 2021;22:3751.
2. Guideri F et al., J Child Neurol. 2001;16:370–3.
3. Branco MA et al., Methods Mol Biol. 2022;2454:127–43.
4. Wu HF et al., Cell Stem Cell. 2024;31:734–53.



***Vibrio natriegens* as a novel host for RNA therapeutics**

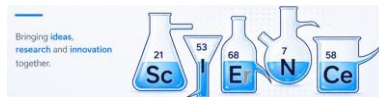
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Vibrio natriegens, discovered in 1958, is a marine Gram-negative bacterium with the fastest growth rate known to date among living organisms. This fact and its metabolic versatility make *V. natriegens* as a potential new microbial chassis for biotechnology applications like plasmid DNA (pDNA) production or recombinant proteins expression. The safety of this bacterium has already been proven, and it is classified as a biosafety level 1 organism. Taken together, these factors position *V. natriegens* as a promising candidate for cell host in various biotechnology fields. However, despite having been discovered in the 50's, there is a huge knowledge gap about this bacterium, especially in terms of pDNA production yields that can be achieved. In recent years, pDNA market has grown exponentially principally due to their applications in DNA vaccines or in gene therapies. So, the production capacity should be able to keep pace with demand. With this, the aim of this work was to access the capabilities of *V. natriegens* to produce pDNA intended for mRNA and siRNA production and compare it with *Escherichia coli* to evaluate whether its rapid growth can be leveraged to improve pDNA production efficiency. The results shown that it is possible to take advantage of the rapid growth of *V. natriegens* to the production of higher amounts of pDNA in less period of time. It was also possible to confirm that the pDNA produced by *V. natriegens* was as functional as the one produced by *E. coli*.

Keywords: *Vibrio natriegens*; pDNA production; RNA therapeutics; microbial chassis.



Biomanufacturing of DNA-Origami Nanostructures Towards Image-guided Drug Delivery

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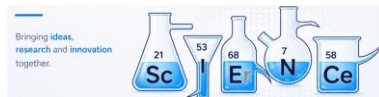
DNA origami is an emerging nanotechnology that enables the construction of precisely designed nanostructures through the self-assembly of DNA. Its programmability offers opportunities across nanofabrication, bioimaging, drug delivery, and biomedicine. However, translating DNA-origami technologies from laboratory-scale demonstrations toward biomedical applications requires scalable and robust manufacturing processes. A key challenge is the purification of the long single-stranded DNA (ssDNA) scaffold required for nanostructure assembly. Current approaches, including agarose gel extraction and ethanol precipitation, are labor-intensive, inefficient, and difficult to scale.

This work explores novel and scalable purification strategies for ssDNA scaffolds using tangential flow filtration (TFF) and steric exclusion chromatography (SXC). Both approaches were evaluated in terms of scaffold recovery, product quality, and removal of process-related impurities. TFF enables size-based separation through membrane filtration, while SXC exploits steric exclusion effects between polyethylene glycol (PEG) and large DNA molecules to provide an alternative chromatographic purification strategy.

TFF achieved up to >97% scaffold recovery and 96% protein removal, demonstrating efficient recovery and impurity clearance. However, high shear stress can affect scaffold integrity, highlighting an important process trade-off between purification performance and preservation of the DNA scaffold. SXC showed lower recovery but improved upon the conventional purification approach and produced scaffold DNA suitable for downstream DNA-origami assembly.

The purified scaffold was successfully assembled into a DNA-origami nanostructure, confirmed by agarose gel electrophoresis and electron microscopy. This work connects bioprocess engineering, nanotechnology and biomedicine, providing a foundation for ongoing work toward functionalization with bioimaging, therapeutic, and targeting agents for prostate cancer applications, followed by evaluation in relevant cell models. More broadly, it addresses the challenge of developing scalable manufacturing strategies that preserve the structural quality required for the future biomedical application of DNA nanostructures.

Keywords: DNA-origami, Biotechnological Production, Nanotechnology, Drug Delivery, Bioimaging.



Chromosomal Aberration Assay for Rapid Screening in Emergency Exposure: IST Insights from the RESILIENCE Project

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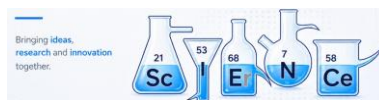
The RESILIENCE-R-2023 project is currently establishing a European collaborative ecosystem designed to overcome the growing threat posed by chemical, biological, radiological, and nuclear (CBRN) agents. In a world characterized by increasing geopolitical tensions, the development of effective response strategies has become more crucial than ever. This study contributes to this mission by supporting medical diagnosis and clinical decision-making during radiological emergencies. One of its main focuses is the triage of individuals, distinguishing those who have not been exposed to ionizing radiation from those who develop mild or severe forms of acute radiation syndrome (ARS). Radiotherapy patients were studied to mimic different ARS severity degrees. Based on this approach, the dicentric chromosome aberration (DCA) assay was used to assess the radiation-induced damage in peripheral blood lymphocytes. Based on the number of dicentric chromosomes identified, it is possible to estimate the exposure dose using specific calibration curves and the “Biodose Tools” programme. This method is widely recognized as a Biodosimetry tool and provides reliable estimation of radiation exposure.

Blood samples from breast and prostate cancer patients, representing mild ARS conditions, and from leukemia patients, representing high ARS conditions, were analyzed using an optimized protocol. Samples from breast and prostate cancer patients were collected before, during and after radiotherapy, whereas samples from leukemia patients were collected only after treatment. The samples were preserved in liquid nitrogen, defrosted in a water bath and cultured in supplemented RPMI medium. Colcemid was added after 24 hours, and the assay was completed at 48 hours. The slides were stained with Giemsa and analyzed using an optical microscope. Whenever possible, a total of 250 metaphases containing 46 centromeres were scored for each sampling time.

For leukemia patients, an absence of scorable metaphases was observed, possibly due to lymphocytopenia. In prostate cancer patients, the number of metaphases was particularly low in several samples, whereas in breast cancer patients it was possible to score 250 metaphases at each sampling time. Both groups showed a progressive increase in the number of dicentrics throughout the course of treatment. These findings suggest that the DCA assay can be used as a screening tool to distinguish exposed from non-exposed individuals in radiological emergencies, as long as a sufficient number of scorable metaphases are available. Further research, with more samples, is required to strengthen the reliability of triage.

Keywords: Radiological and nuclear emergency, Screening, Dicentric chromosome.

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Fighting Cancer with Synthetic Antibodies

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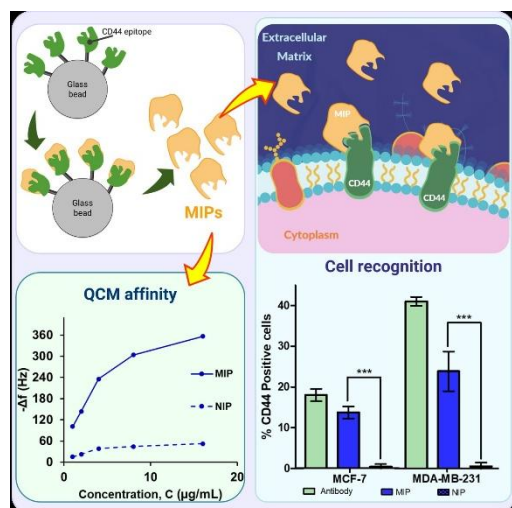
Cancer remains one of the leading causes of death worldwide, and the selective recognition of tumor cells is a critical challenge in both diagnosis and therapy. Current treatments such as chemotherapy and radiotherapy lack precision on this recognition, causing severe side effects that compromise patient quality of life. Developing platforms that selectively recognize cancer cells and deliver a therapeutic response only where needed is a major goal of modern nanomedicine. Molecularly imprinted polymers (MIPs) offer a compelling solution to this challenge. MIPs are synthetic receptors engineered to recognize specific molecular targets with affinity and selectivity comparable to antibodies, while offering superior chemical stability, lower production cost, and higher scalability. Unlike biological antibodies, MIPs can be tailored to bind virtually to any target molecule while withstanding harsh conditions, making them attractive candidates for diagnostic and therapeutic applications.

In this work, MIP nanoparticles were designed to recognize the extracellular domain of CD44, a protein overexpressed on the surface of breast cancer cells and associated with tumor aggressiveness, metastasis, and resistance to therapy. Using a solid-phase imprinting strategy against a rationally selected peptide epitope of CD44, two formulations were developed and characterized in detail. Binding affinity was assessed by quartz crystal microbalance, revealing sub-picomolar dissociation constants ($K_d \sim 0.83$ pM), among the highest associations reported for synthetic receptors of this type. Selective recognition of CD44-expressing MCF-7 and MDA-MB-231 breast cancer cells was then confirmed by fluorescence microscopy and flow cytometry, with performance comparable to a commercial monoclonal antibody under equivalent conditions.

These results establish CD44-targeting MIP nanoparticles as robust affinity tools for cancer cell detection, with applicability in diagnostic imaging and targeted drug delivery platforms. As a future application, these MIP nanoparticles are being explored as targeting agents in a multifunctional theragnostic platform, in which their conjugation to ultrasound-responsive piezoelectric particles may enable simultaneous selective cell recognition and bioelectrical disruption of tumor cells. This challenge sits at the interface of materials science, polymer chemistry, bioengineering, and cancer biology.

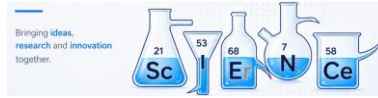
Keywords: molecular imprinted polymer; cancer biomarker; CD44; biosensing; detection.

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<https://doi.org/10.54499/2024.02049.BD>,
<https://doi.org/10.54499/SFRH/BD/145057/2019>,
<https://doi.org/10.54499/2023.13896.PEX>,
<https://doi.org/10.54499/UID/04565/2025>,
<https://doi.org/10.54499/UID/PRR/04565/2025>,
<https://doi.org/10.54499/LA/P/0140/2020>

Keywords: molecular imprinted polymer; cancer biomarker; CD44; biosensing; detection



Thermal Comfort as a Design Variable for Climate-Neutral Cities

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Buildings account for roughly 40% of energy use in the European Union, and most of that energy is spent on one service: keeping people thermally comfortable. Yet comfort itself, the real objective, is rarely treated as a design variable. In practice, most spaces are conditioned in the same way: the whole volume is held at a fixed temperature setpoint, regardless of what people are actually doing there. This uniform approach wastes a large amount of energy. Thermal comfort is not the same for every activity. A person exercising in a gym produces several times more metabolic heat than a person sitting at a desk, so what feels comfortable to one is uncomfortable to the other. In a gym, higher air velocity can remove heat from the body effectively, often with little need to cool the air itself. At a desk, on the other hand, people are more sensitive to draughts, and a stable temperature matters more. In many uses there is no need to control the temperature of the entire space at all: local control at the workstation, through a desk fan, a heated chair or a radiant panel, can deliver comfort to the occupant directly, while the rest of the room is allowed to float within a wider range. Knowing how comfort is formed for each type of occupant and activity is therefore the key to saving energy without sacrificing well-being.

Climate adds another layer. Many European cities, Lisbon among them, are humid, yet humidity is often a secondary parameter in thermal comfort assessment and in the control of building systems, which mostly react to air temperature alone. High humidity reduces the body's ability to lose heat by sweating in summer and can increase the sensation of cold in winter. Ignoring it leads both to discomfort and to unnecessary heating or cooling. The talk is built around open questions rather than final results: How can comfort requirements be defined per activity and translated into control strategies that target air velocity, temperature or humidity, according to need? Where is local control enough, and where is whole-space conditioning really necessary? How much energy could a city save if its buildings were conditioned according to how comfort is actually formed? I hope to start a dialogue with architects, civil and mechanical engineers, health scientists and data scientists at Técnico interested in shaping a joint, interdisciplinary research line.

Keywords: Thermal comfort; Local climate control; Humidity; Building energy demand; Climate-neutral cities.

Elemental characterization of metal artefacts using p-XRF and μ -PIXE

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The present study uses two non-destructive techniques to study the major and minor elements of two metal artefacts, a chisel and a spear head, found in the archaeological site of Penedo do Lexim (Mafra), shown in Figure 1. Preliminary analysis was performed by portable x-ray fluorescence (p-XRF) followed by the elemental quantitative determination by proton induced x-ray emission (μ -PIXE). Both analysis were performed on small clean and polished areas of the samples.

The p-XRF results revealed the chisel and the spear head to be made of a bronze alloy, with Cu and Sn as major elements. As, Fe, Ni, Zn, and Pb are present as minor elements in the chisel, while in the spear head, only Pb could not be detected.

These observations were further explored by μ -PIXE analysis, as it showed that the chisel had a Cu content of 82 wt% and 15wt% of Sn. The composition of the minor elements identified were: Fe 0.05 wt%, Zn 0.09 wt% and As 0.12 wt%. The analysis of the spear head was done in two distinct areas, that exhibited similar Sn contents, while the Cu and minor elements concentration showed some variability between the analysed areas. At the edge of the artefact the Cu content was 74 wt%, and Ni and Zn were also identified. In contrast, the central area Ni and Zn could not be detected and the Cu content was higher (79 wt%). The content composition of the identified minor elements identified was: Fe varying between 0.03 wt% and 1.62 wt%, Ni 0.73 wt%, Zn 0.67 wt% and As 0.05 wt%.

Another difference found between techniques was the higher sensitivity of μ -PIXE analysis that allowed the identification of S in both artefacts, and Co in the spear head, which can help identifying the source of the raw material used. Cl and Ti were also identified in both samples, likely associated with incomplete removal of corrosion products of the buried artefact and residues from the polishing compounds used during the sample cleaning.

In conclusion, the two artefacts were identified as bronze objects composed of a copper-tin alloy with variable minor elements composition, providing insights into the metallurgical process and raw materials provenance.

The present study confirms p-XRF to be an useful technique for rapid preliminary compositional assessment, while the higher sensitivity of μ -PIXE provides a detailed elemental characterization, preventing additional damage to the artefacts.

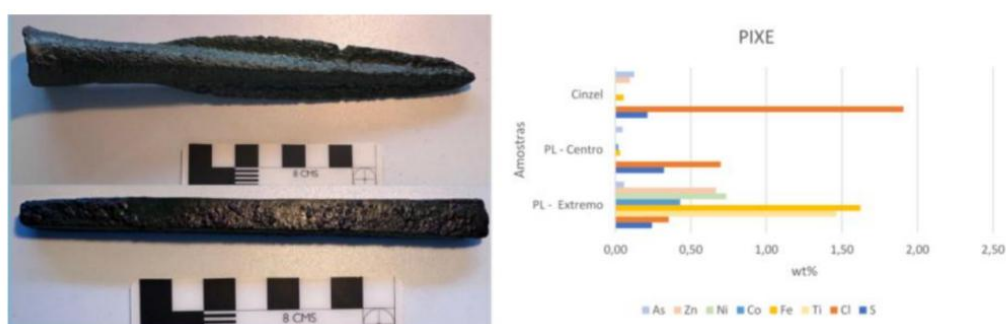
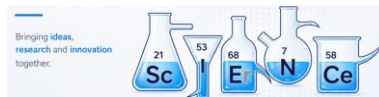


Figure 1: Spear head (top) and chisel (bottom) analysed by PIXE to determine minor elements composition

Keywords: Archaeometallurgy; p-XRF; μ -PIXE; Bronze artefacts; Major and minor elements.

Acknowledgments: MEVozzone-Naudin gratefully acknowledges the support of the DECN summer internship program. Authors also thank archaeologists Dr. Ana Catarina Sousa and Marta Miranda for providing the artefacts. SSGomes acknowledges the junior Researcher contract from Fundação para a Ciência e a Tecnologia, I.P. (2021.03181.CEECIND-CP1651-CT0021). This work has been supported by the C2TN project UID/04349/2025.



Gamma Irradiation as a Tool for Unlocking the Bioactive Potential of Grape Pomace

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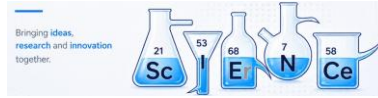
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Grape pomace, a major by-product of winemaking, is an abundant source of phenolic compounds and other bioactive constituents with antioxidant, antidiabetic and antimicrobial properties. However, their recovery remains challenging, prompting the exploration of gamma irradiation as a pre-treatment strategy to enhance extraction efficiency and potentially modulate biological activity. Accordingly, the effect of different gamma irradiation doses (5, 15 and 37 kGy), on phenolic compound recovery (TPC and TFC), antioxidant activity (FRAP and DPPH), antidiabetic potential (α -amylase and α -glucosidase inhibition), and antimicrobial activity against several bacteria, yeasts and filamentous fungi were evaluated in grape pomace extracts. Gamma irradiation enhanced the recovery of phenolic compounds, with TPC and TFC reaching their highest values at 37 kGy. Compared with the non-irradiated control, the 37 kGy treatment increased TPC and TFC as well as the antioxidant activity of the grape pomace extracts. Similarly, the 37 kGy treatment showed the strongest α -amylase inhibitory activity, whereas α -glucosidase inhibition was maximized at 15 kGy. Antimicrobial activity revealed a microorganism-specific response to irradiation treatment. *Bacillus cereus* and *Staphylococcus aureus* seemed to be the most susceptible microorganisms to grape pomace extracts, displaying the lowest MIC values among the tested microorganisms (12.5 and 25 mg/mL, respectively). Overall, gamma irradiation enhanced phenolic compound recovery and the bioactive properties of grape pomace extracts, highlighting its potential as a sustainable tool for winemaking by-product valorization.

Keywords: gamma radiation, grape pomace, phenolic compounds, bioactive properties, sustainable valorization.

Acknowledgments: The authors acknowledge the Foundation for Science and Technology (FCT, Portugal) for financial support through national funds (FCT/MCTES) to C²TN (UID/04349/2025; doi: 10.54499/UID/04349/2025) and Janice Lopes (UI/BD/154696/2023; doi: 10.54499/UI/BD/154696/2023). The authors also thank Sociedade Agrícola de Pias (Serpa, Alentejo, Portugal) for kindly providing the grape pomace samples.



Data Visualization Tools for Nuclear Fusion Experiments: ITER Interactive MDSplus MINT Interface

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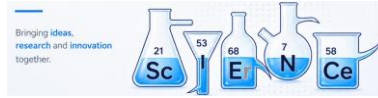
Nuclear fusion experiments generate large volumes of data that need to be accessed quickly to support decisions during operation. At the Neutral Beam Test Facility (NBTF), these data are stored in MDSplus, but analyzing them interactively is not straightforward. Operators work with legacy visualization tools that offer little real-time capability. Conversely, ITER employs an in house developed modern data visualization environment: Make Informative and Nice Trends (MINT). However its strict reliance on HDF5 databases requires data conversions from the NBTF's native MDSplus servers. Consequently, this scenario hinders not only the efficiency of local monitoring by NBTF operators, but also restricts the remote collaboration of ITER scientists.

This contribution presents the work to remove that bottleneck by developing a direct, Python-based connection to MDSplus. This allows MINT to be deployed natively within the NBTF systems, reading and displaying data without any prior conversion. The resulting middleware handles both static and continuous data retrieval, and includes a Shot Hopping mechanism that automatically follows the transition from one experimental pulse to the next, keeping the visualization active without any manual input from the user.

A PostgreSQL database was added alongside MDSplus to translate hardware timestamps into a common UTC reference, which was necessary to correctly align and compare data across pulses. The system was tested through a series of functional and performance evaluations, combining representative experimental scenarios with simulated real-time acquisition. Across all tested configurations, the combined time to query the database, fetch the data from MDSplus, and process it before rendering averaged between 5 and 33 ms, confirming that the new access layer does not introduce any meaningful delay to the visualization.

Altogether, this work equips the NBTF with a modern, MDSplus-native alternative to its previous visualization options, helping standardize how experimental data is analyzed and paving the way for a more unified working methodology with ITER.

Keywords: Nuclear fusion, Real-time monitoring, Data visualization, ITER MINT, MDSplus.



When Waves Meet Structures: Modelling Approaches for Safer Marine Systems

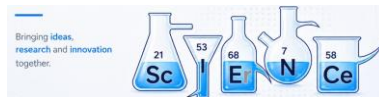
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Ships transporting goods, floating platforms supporting offshore activities, and devices harvesting renewable energy all face the forces of the ocean. Predicting how these systems move, bend and withstand waves is essential for protecting lives and infrastructure, while improving the performance of offshore renewable energy technologies. This research develops an open-source simulation framework with four complementary modelling approaches for different marine engineering applications. The first captures the motion of floating systems, such as floating solar panels and wave energy devices, together with the mooring lines that hold them in position. The second uses a high-accuracy approach based on isogeometric analysis (IGA) to model complex shapes and large deformations of flexible structures. The third employs the finite element method (FEM) to resolve local deformation and stress in structural components. The fourth uses multibody dynamics (MBD) to represent ships as interconnected flexible sections, enabling efficient analysis of vessel motion and overall bending. This shared framework allows the level of detail to be tailored to each application, balancing prediction accuracy with computational efficiency. The developed models are assessed against experimental measurements and established benchmark cases covering selected wave interactions, water impacts and floating systems. This doctoral research brings together marine engineering, structural mechanics and scientific computing. It aims to support reliable safety assessments for maritime transport and offshore structures, while guiding improvements in the performance of floating renewable energy systems. These applications contribute to protecting lives and assets at sea and supporting the transition to low-carbon energy.

Keywords: Fluid-structure interaction; Open-source simulation; Marine structural safety; Floating renewable energy; Multisolver framework.



Seeing the invisible: how diagnostics let us describe and control plasmas

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Low-temperature plasmas are partially ionized gases made of electrons, ions, and highly reactive atoms and molecules. Their electrons are highly energetic while the gas itself stays close to room temperature. This allows them to drive chemical reactions that would otherwise require extreme heat or energy-intensive conditions, and makes them well suited to integration into industrial processes. As a result, they quietly underpin much of modern technology. They are used to etch the nanoscale circuits present in every computer and phone, to modify material surfaces, to treat wounds in plasma medicine and to convert greenhouse gases into useful chemicals. In each case, what the plasma achieves depends largely on the reactive species it produces, and on how much of each is present.

The challenge is that directly probing a plasma tends to disturb it and alter the very properties we want to measure. Plasma diagnostics are therefore our way of describing it from the outside. By analysing the light a plasma emits, or the light of a laser it absorbs, we can infer properties such as which species are present, in what amounts, and how energetic the electrons driving the chemistry are. A reliable diagnostic turns a plasma from a black box into a controllable tool, which is why diagnostics are central to plasma applications.

This work aims to make plasma diagnostics more accurate, using CF_4 plasmas, widely employed in semiconductor etching, as a case study. We focus on actinometry, a popular, widespread and cheap diagnostic that estimates the number of reactive species in the plasma from its emission of light. It relies on assumptions about the plasma, in particular about how the energy is distributed among its electrons. Since the density of reactive species strongly influences processes such as etching rates, the reliability of these assumptions matters directly for industrial applications.

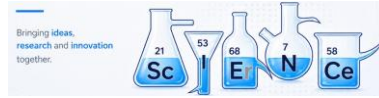
To test them, we combined experiment with modelling through an international collaboration. The modelling builds on simulation tools developed at the Instituto de Plasmas e Fusão Nuclear (IPFN) at Técnico, while the experiments were carried out at the Centre for Low-Temperature Plasma Sciences at Nagoya University in Japan. We used these tools to describe the electron kinetics of the plasma, namely how its electrons gain and lose energy through collisions, and built a framework that links these calculations to the experimental measurements, so that the assumptions are no longer imposed but calculated. To validate the strategy, we compared our results with independent laser-based measurements, a technique that does not depend on the assumptions under test.

The framework converged to a self-consistent description of the plasma, from which we obtained the densities of key reactive species such as fluorine, hydrogen and oxygen atoms. Where laser-based measurements were available, for hydrogen and oxygen, they agreed well with our results. Comparing the new approach with the conventional one also showed only small differences, suggesting that under our conditions the traditional assumption is a reasonable approximation, a finding that could only be established by testing it.

More broadly, this work shows how we can combine measurement and modelling so that each refines the other, a strategy that applies wherever hidden quantities must be inferred from indirect signals.

Keywords: plasma diagnostics; low-temperature plasmas; actinometry; CF_4 plasmas; electron kinetics.

Acknowledgments: This work was supported by the Japan Science and Technology Agency (JST)'s ASPIRE Project JPMJAP2321. This work was also supported by the FCT - Fundação para a Ciência e Tecnologia, I.P., under projects UID/50010/2025 (<https://doi.org/10.54499/UID/50010/2025>), UID/PRR/50010/2025 (<https://doi.org/10.54499/UID/PRR/50010/2025>), UID/PRR2/50010/2025 (<https://doi.org/10.54499/UID/PRR2/50010/2025>), LA/P/0061/2020 (<https://doi.org/10.54499/LA/P/0061/2020>).



Data Visualization Tools for Nuclear Fusion Experiments: An MDSplus Interface for Grafana

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Nuclear fusion, often described as the future of clean energy, relies on massive and complex experiments to replicate the power of the sun. The SPIDER experiment in Padova, Italy, is a critical testbed for ITER (the world's largest fusion project) and is designed to test particle beams for up to one hour. Unlike previous short experiments, a single SPIDER pulse generates approximately 130 GB of data, spanning high-speed physics measurements to slow engineering checks such as temperature and vacuum pressure.

The challenge this project addresses is not just storing this data, but visualizing it effectively. Currently, scientists face a “technological gap”. To analyse historical data, they must use ageing desktop software (jScope) that requires complex VPN connections, loads slowly, and often freezes when handling large files. While modern web dashboards like Grafana are used for real-time monitoring, they currently rely on a temporary “cache” that shows only the last hour of data, leaving the vast archives of historical experiments inaccessible on the web.

The proposed solution to bridge this gap is a custom “Native Plugin” that connects Grafana directly to the fusion database (MDSplus). Using a high-performance programming language (Go) and a smart mathematical algorithm called LTTB, this tool compresses massive signals so they can be viewed instantly in a web browser without losing critical details, such as dangerous voltage spikes. This innovation eliminates the need for data duplication and enables researchers worldwide to collaborate and analyse years of experimental history securely and efficiently, without installing special software on their computers.

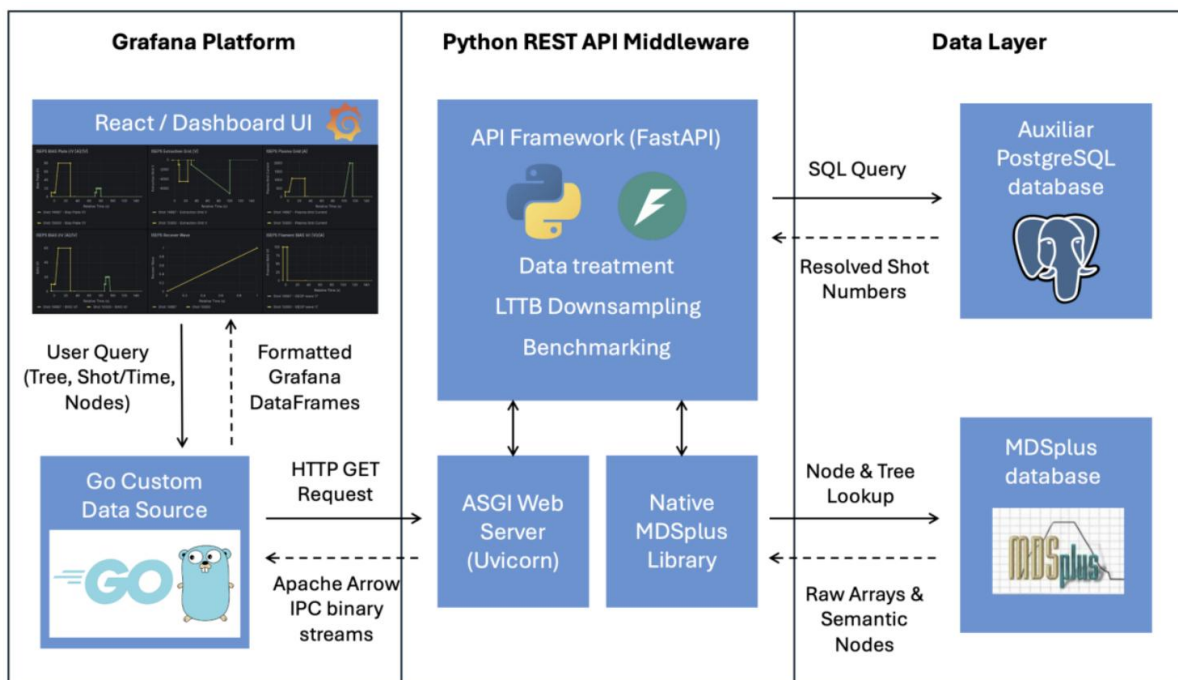
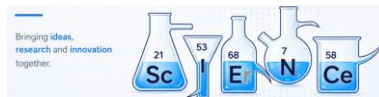


Figure 1: Block diagram of the proposed three-tier system architecture.

Keywords: Nuclear fusion; Real-time Monitoring; Data visualization; Grafana; MDSplus.



From the Inner Ear to the Origin of Warm-Bloodedness: a Multi-Omics View of Endolymph (ENDOMICS)

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How did birds and mammals become warm-blooded? Endothermy, the ability to keep a high and stable body temperature, reshaped vertebrate evolution, yet its origin remains an open question in palaeobiology because body temperature does not fossilise. An unexpected answer may lie in the inner ear. The semicircular canals that sense head rotation are filled with endolymph, a fluid whose viscosity falls as body temperature rises. Mammals compensated by changing canal geometry, a signature that can be read in fossils. Birds appear to have also changed the chemistry of the fluid: the pigeon, the only bird measured so far, has the most viscous endolymph of any tetrapod despite its high body temperature. Which molecules cause this is unknown, since endolymph has been studied almost only for its ions and in the context of human disease.

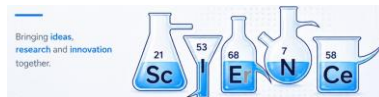
ENDOMICS, a Marie Skłodowska-Curie Postdoctoral Fellowship at CERENA and iBB (Técnico), addresses this question by bringing together palaeontology, fluid biophysics, analytical chemistry and data science. Endolymph is being collected from birds, mammals, lizards, turtles and amphibians, spanning both endothermic and ectothermic vertebrates. Its ions, metabolites and proteins will be mapped by mass spectrometry (ICP-MS, LC-MS and tandem MS) and integrated by Multi-Omics Factor Analysis, a machine-learning framework. The resulting molecular profiles will then be related to viscosity measured with microfluidic devices, to identify the molecules that set this property in each lineage.

The project is expected to deliver the first molecular maps of endolymph across tetrapods and to identify the molecules and pathways that set its viscosity, giving palaeontologists a new marker to date the emergence of endothermy in birds and their dinosaur ancestors. The same knowledge opens the way to a synthetic endolymph for testing drug delivery to the inner ear in conditions such as Ménière's disease. We will present the rationale and design of the project and invite discussion on challenges it shares with other fields: omics on very small sample volumes, integration of heterogeneous datasets, and linking molecular composition to the physical properties of a fluid.

Keywords: endothermy; endolymph; multi-omics; mass spectrometry; evolution.

October 23

Short Oral Session



The Role of RNA in the Formation of Tau Biomolecular Condensates

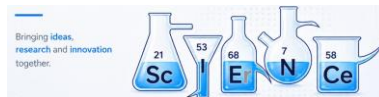
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Biomolecular condensates are formed through the de-mixing of biomolecules into liquid-like droplets via a biophysical process known as liquid–liquid phase separation (LLPS). Although LLPS is a vital physiological process, its dysregulation is increasingly implicated in neurodegenerative diseases. In tauopathies such as Alzheimer's disease, aberrant LLPS has been considered a critical early intermediate of pathological protein aggregation. As an intrinsically disordered protein (IDP), Tau undergoes LLPS primarily by electrostatic interactions through both homotypic self-coacervation and heterotypic complex coacervation with polyanionic partners such as RNA. While Tau–RNA coacervation promotes condensation, how RNA sequence, length, and structure regulate this process remains controversial, and the early binding dynamics between monomeric Tau and distinct RNA species prior to droplet formation remain poorly understood. This project aims to elucidate the initial molecular mechanisms governing heterotypic Tau–RNA phase separation. Using Fluorescence Correlation Spectroscopy (FCS), we probe the early binding events between monomeric Tau and different RNA substrates, comparing homopolymeric polyA with total RNA extracted from HEK293T cells. Additionally, droplet formation assays systematically evaluate how protein concentration modulate condensation by confocal microscopy. By characterizing these early electrostatic interactions, this work aims to provide biophysical insights into the molecular triggers of Tau phase separation.

Keywords: Liquid–liquid phase separation, Condensates, Tau, RNA, Fluorescence microscopy.



TIA1 and Tau: From Protein Production to Biomolecular Condensation

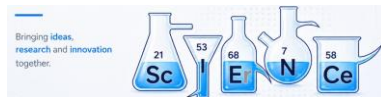
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Alzheimer's disease and related tauopathies are characterized by the abnormal aggregation of the microtubule-associated protein Tau. However, the early molecular events driving the transition from soluble Tau to toxic aggregates remain poorly understood. Recent evidence suggests that Tau, an intrinsically disordered protein, can undergo liquid-liquid phase separation (LLPS) under conditions of molecular crowding, RNA and RNA-binding protein (RBP) interactions, or an altered ionic milieu. This may precede pathological aggregation. Among these RBPs, T-cell intracellular antigen 1 (TIA1) has been highlighted as a key binding partner that enhances Tau condensation and promotes the toxic Tau oligomer formation, while its reduction mitigates Tau-mediated toxicity in experimental models. Building on the hypothesis that TIA1 modulates Tau LLPS, this work focuses on optimizing the recombinant expression and purification of TIA1 in *E. coli* BL21(DE3). In parallel, we use confocal microscopy to investigate Tau homotypic LLPS, induced by PEG and modulated by salt concentration. Together, these approaches aim to establish an experimental framework for future mechanistic studies on Tau–TIA1 phase separation and its contribution to the early stages of tauopathy pathogenesis.

Keywords: Tau protein, liquid-liquid phase separation, T-cell intracellular antigen 1, tauopathies, RNA-binding proteins.



The use of deep eutectic solvents in the pre-treatment of environmental samples for the voltammetric analysis of Pd

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Palladium (Pd) is part of the technology-critical elements, so its use has increased exponentially, which is raising environmental concern. Its concentration can depend on the matrix studied, in aquatic media it can range from 0.04 ng/L [1] to 3.2 µg/L [2], with higher concentrations found in wastewaters. In road dusts and roadside soils, the concentrations can be higher (e.g. 58 µg/g [3]). One of the methods used for the quantification of Pd in environmental samples is voltammetry, but nickel (Ni) is one of the main interferences due to both complexing with dimethylglyoxime (DMG) [4, 5]. Using Deep Eutectic Solvents (DES) in the pre-treatment of samples, allows us to extract only Pd, separating Ni and eliminating its interference. Additionally, Pd can also be pre-concentrated in a small amount of DES, which can help overcome the high limits of detection.

In this work, the optimization of two DES and four parameters (volume of DES, contact time, centrifugation time and acid digestion time) were tested for pre-treating samples. After this process, the parameters were chosen and the pre-treatment was applied to a reference material, both Pd and Ni were quantified, with a recovery of 98% for Pd and 1% for Ni. During the analysis, it was used square wave voltammetry (SWV) with the second derivative signal transformation to improve the sensitivity of the determination overcoming the issues caused by the presence of Ni in solution.

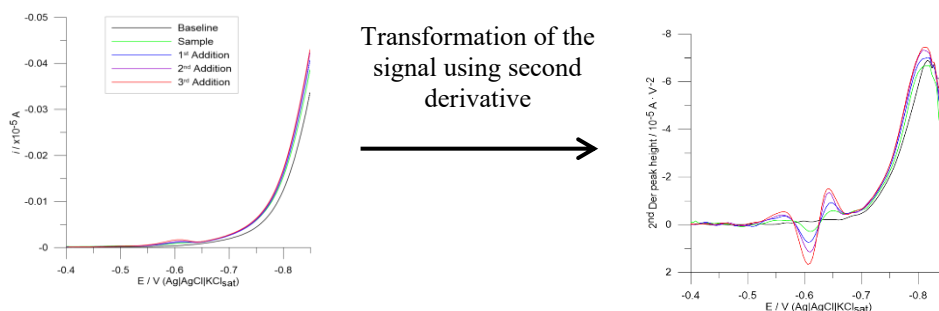


Figure 1 - Signal transformation using second derivative

Keywords: Green Chemistry, Technology-critical Elements, Method Optimization, Second Derivative Signal Transformation.

Acknowledgments: The Portuguese Science Foundation (Fundação para a Ciência e a Tecnologia, FCT) is acknowledged for funding MJ PhD grant (2025.03477.BDANA), CM contract under the Individual Call to Scientific Employment Stimulus - 6th Edition (2023.09489.CEECIND), Centro de Química Estrutural through projects UID/00100/2025 (<https://doi.org/10.54499/UID/00100/2025>), UID/PRR/00100/2025 (<https://doi.org/10.54499/UID/PRR/00100/2025>), and the Associate Laboratory Institute of Molecular Sciences through project LA/P/0056/2020 (<https://doi.org/10.54499/LA/P/0056/2020>). The authors also acknowledge the EU COST Action TD1407–NOTICE (<https://www.costnotice.net/>).

References

- [1] Mashio, A.; Ichimura, A.; Yamagishi, H.; Wong, K.; Obata, H.; Hasegawa, H. (2022). Determination of the sub-picomolar concentration of dissolved palladium in open ocean seawater. *Marine Chemistry* 243, 104-124.
- [2] Zereini, F and Wiseman, C. (2015) *Platinum Metals in the Environment XXII*: 492.
- [3] Figueiredo, A. M. G., Enzweiler, J., Morcelli Claudia, P. R., & Sarkis, J. (n.d.). ICP-MS and The Co-Precipitation after Nickel Sulphide Fire-Assay Collection for Pd Determination in Roadside Soils. In *Palladium Emissions in the Environment* (pp.163–172).
- [4] Pihlar, B, Valenta, P and Nürnberg, H. W. (1986) Electrochemical reduction of Ni (II) on the hanging mercury drop electrode in the presence of dimethylglyoxime. *J. Electroanal. Chem.* 214, (1-2) 157-177.
- [5] Wang, J and Varughese, K (1987) Determination of traces of palladium by adsorptive stripping voltammetry of the dimethylglyoxime complex. *Chimica Acta* 199, 185-189.

Towards autonomous experiments at the nuclear microprobe

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A nuclear microprobe is an analytical instrument that uses a focused beam of MeV light ions to obtain elemental and structural information from materials. At the CTN-IST nuclear microprobe facility, the ion beam is raster-scanned across the sample surface, generating various spectra, including PIXE (Proton-Induced X-ray Emission) and RBS (Rutherford Backscattering Spectrometry) spectra. From selected regions of interest (ROIs) within the spectra, 256×256 pixel elemental maps can be produced (figure 1), allowing the identification of compositional inhomogeneities and defects that may affect the properties of the material under study.

Currently, identifying these areas within the maps associated with inhomogeneities is performed manually by the researcher through visual inspection. This process is time-consuming, operator-dependent, and particularly challenging when dealing with multiple maps or subtle compositional variations are involved. The aim of this work is to develop a novel procedure towards autonomous experiments by automatically detecting these regions in microprobe maps. For this purpose, the maps are treated as images and analysed using a U-Net convolutional neural network architecture.

Results show that the U-Net architecture provides a highly effective solution, successfully automating the accurate detection of inhomogeneous regions. Furthermore, these regions can be translated into a binary mask that can be used by the OMDAQ software (which controls the ion beam). This is a more direct integration path than the traditional manual method (mouse-drawn polygon method). The proposed approach seeks to reduce user intervention and significantly enhance the efficiency of microprobe data analysis.

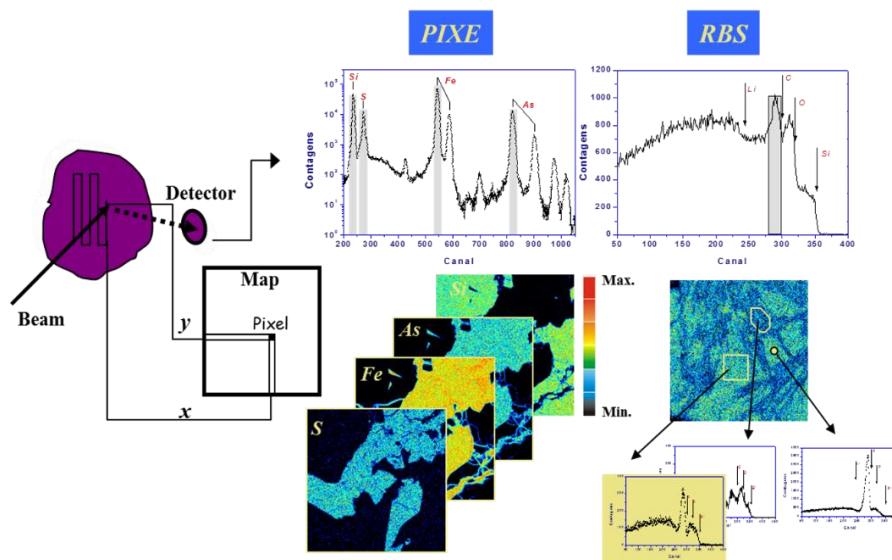


Fig 1: A schematic overview of a standard experimental workflow employed in a nuclear microprobe analysis.
Source: L.C. Alves.

Keywords: Nuclear microprobe, autonomous experiments, convolutional neural network, U-net.

Development of functionally graded materials for nuclear fusion reactors

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Nuclear fusion is a promising source of clean energy. With the International Thermonuclear Experimental Reactor (ITER) leading efforts to develop tokamak type reactors. Its divertor uses tungsten as plasma-facing material and CuCrZr alloy as heat sink. However, the mismatch in their operating temperatures requires a thermal barrier interlayer. Furthermore, the mismatch between the coefficient of thermal expansion (CTE) of W and CuCrZr generates thermal stresses at the interface during operation, which can also be mitigated by adding an interlayer with intermediate CTE. This research focuses on the development and characterization of a functionally graded material based on CrFeTaV high-entropy alloys to bridge the gap between W and CuCrZr. $(\text{CrFeTaV})_{1-x}\text{W}_x$ alloys will be produced by mechanical alloying and spark plasma sintering. Their microstructures will be analysed by scanning and transmission electron microscopy coupled with energy dispersive spectroscopy, and X-ray diffraction. The thermal diffusivity and coefficient of thermal expansion will be measured, by thermal flash and dilatometry, respectively. The mechanical properties will be determined through tensile, compressive and creep tests up to 1000°C. Finally, a W/FGM/CuCrZr monoblock-type mock-up will be produced and tested under cyclic thermal loads.

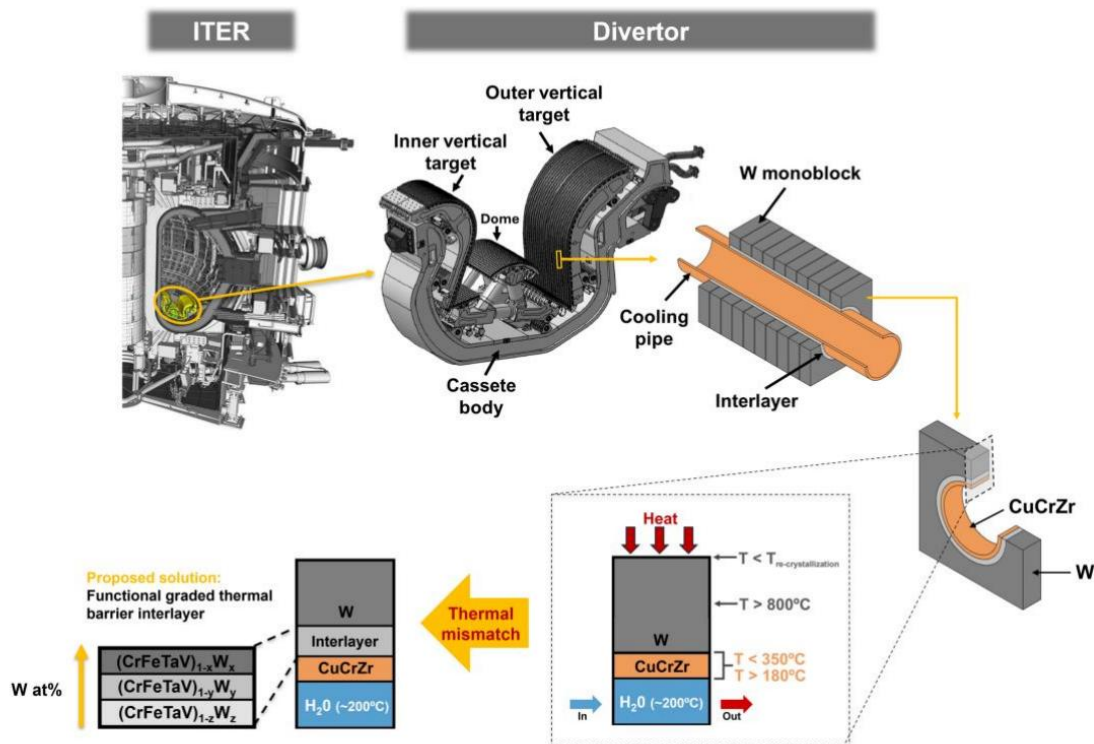
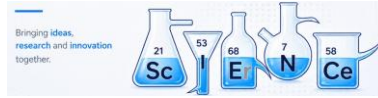


Figure 1: Schematic cross section of ITER tokamak (top left); scheme of ITER divertor cassette (top middle) and plasma facing unit composed of W monoblocks connected by a CuCrZr cooling pipe (top right), and the refractory high-entropy alloy based functionally graded material as proposed solution (bottom).

Keywords: High-entropy alloy; Functionally graded materials; Nuclear fusion; Interlayer; Spark Plasma Sintering.



Compact, Reconfigurable Millimeter-Wave Back-End for Next-Generation Fusion Reactors

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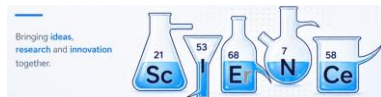
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Plasma diagnostics in next-generation fusion reactors such as the Next Power Plant must operate with very restricted access to the vessel and under severe environmental conditions. Millimeter-wave reflectometry is a robust option for measuring the electron density; however, providing the plasma coverage required for position and shape control calls for a large number of probing channels, each with a wide frequency bandwidth and a compact back-end. We report on a redesigned compact, fast frequency-sweeping millimeter-wave back-end that overcomes the limitations of an earlier prototype. The system is built around commercially available Monolithic Microwave Integrated Circuits (MMICs) operating over a base band of 10–20 GHz, which external frequency multipliers extend to ultra-wideband coverage of up to 160 GHz for detailed plasma characterization. Component obsolescence motivated a complete redesign of the printed circuit board, which was used to introduce three main improvements: (1) a programmable function generator to sweep the voltage-tuned oscillator (VTO), giving greater control and flexibility; (2) a new frequency-translation low phase noise sources; and (3) a new programmable phase-locked loop (PLL) that generates the in-phase/quadrature (I/Q) reference signal with high precision. We describe the design of the new back-end and present the results of its performance evaluation. This work has been carried out under the EUROfusion Enabling Research Project ENR-TEC.01.IST.

Keywords: Microwave reflectometry; MMIC; Plasma diagnostics.

October 23

Oral Session



Spectroscopy4All: Low-Cost Multifunctional Modular Spectrometer Applied to Monitor the Activity of PSA

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Low-cost, accessible, and adaptable optical platforms are increasingly relevant for spectroscopic and biosensing applications. In this work, a Multirole 3D-Printed Modular Spectrometer (MPMS) is explored as a compact and versatile optical readout platform. The MPMS is based on a simplified spectrometric architecture that supports different operating modes, including UV-Vis, fluorescence, Raman, flame emission, and glow discharge, highlighting its versatility for both educational and analytical applications. Its additive manufacturing-based design enables rapid fabrication, easy replication, and straightforward modification, making it adaptable to different optical configurations and experimental needs [1].

As a proof-of-use case study, the MPMS is applied to the development of a Prostate-Specific Antigen (PSA)-responsive plasmonic biosensor. The sensing strategy uses gold nanostructures as optical transducers, exploring different geometries to assess how nanoparticle morphology affects plasmonic response, surface functionalization, and colloidal stability. A rationally designed PSA-responsive peptide, supported by AlphaFold-based structural assessment, is investigated as the recognition element. PSA-mediated cleavage of the peptide sequence is expected to alter the surface protection and colloidal behaviour of the nanohybrid, leading to detectable spectral changes such as peak shifts, intensity variations, and band broadening [2].

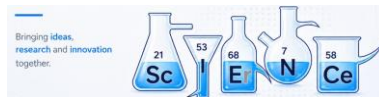
Beyond demonstrating a biosensing application, this work addresses practical challenges in plasmonic sensor development, including peptide immobilization, nanoparticle stability, and reproducible optical response. MPMS measurements will be benchmarked against commercial spectroscopic instrumentation to evaluate spectral agreement and analytical suitability. Overall, this work aims to showcase the MPMS as a low-cost, modular, and adaptable platform for accessible optical sensing.

Keywords: MPMS; 3D printing; spectroscopy; gold nanostructures; protease-responsive biosensing.

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References

- [1] H. Ren, J. Zhang, L. Peng, H. Li, and Z. Su, "Multirole 3D-Printed Modular Spectrometer for Various Teaching Spectral Experiments in the Classroom and at Home," *J. Chem. Educ.*, vol. 100, no. 11, pp. 4307–4317, Nov. 2023, doi: 10.1021/acs.jchemed.3c00406.
- [2] J. H. Choi, H. S. Kim, J. W. Choi, J. W. Hong, Y. K. Kim, and B. K. Oh, "A novel Au-nanoparticle biosensor for the rapid and simple detection of PSA using a sequence-specific peptide cleavage reaction," *Biosens. Bioelectron.*, vol. 49, pp. 415–419, 2013, doi: 10.1016/j.bios.2013.05.042.



Interfacial Forces in Three-Phase Systems

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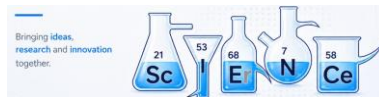
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Green hydrogen is expected to play a key role in decarbonising industry and transport, and both water electrolysis and photoelectrochemical (PEC) water splitting produce it in the same way: gas is born as bubbles on a solid electrode immersed in a liquid. These bubbles are far from passive by-products. While attached, they block the active surface, add ohmic resistance, hinder mass transfer and, in PEC devices, scatter the incoming light. Their cost grows precisely where we want to operate, at high production rates. Remarkably, the same three-phase problem appears in boiling heat transfer, CO₂ electroreduction and microfluidics, often studied by communities that rarely talk to each other. This research starts from a simple shift in viewpoint. Instead of describing bubbles stage by stage (nucleation, growth, coalescence, detachment), it treats every bubble as the visible outcome of a landscape of interfacial forces: surface tension, adhesion, contact line pinning, buoyancy, drag, Marangoni and electric forces, which compete and cooperate over the bubble lifetime. As a first step, all of the forces acting across gas-evolving electrochemical systems were surveyed and brought together into one force-based picture. Once this force balance is understood, it can be engineered, so that bubbles leave the surface when and where we want.

The long-term goal is a PEC device with higher efficiency, built on this understanding. Unlike most current approaches, the device is intended to work without active inputs such as pumps, stirring or external fields. Instead, it relies only on passive forces, such as capillarity and wettability, to supply the electrolyte and to remove the bubbles. Nature offers many examples of such passive designs, from water transport in plants to surfaces that shed gas or liquid by their structure alone, and these serve as inspiration for shaping a better force landscape. A series of focused experiments, each isolating one window of this landscape with high-speed imaging, microscopy and 3D-printed test geometries, will build the path from understanding to device.

In this talk I would like to share the questions that drive this work, more than finished answers: Can a single force-based language describe gas evolution across electrochemistry, heat transfer and microfluidics? Which forces dominate at which length scale, and which can be tuned by passive means alone? What can nature teach us about moving gas and liquid without spending energy? I am particularly interested in feedback and collaboration with colleagues working on modelling and CFD, surface chemistry, materials, optics, biology and nature-inspired design.

Keywords: Interfacial forces; Bubble dynamics; Photoelectrochemical hydrogen; Passive devices; Bioinspired design.



Development of a Microwave Plasma Reactor Facility for Gas Conversion at IST

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Gas conversion processes are relevant to a broad range of applications, including chemical processing, energy-related technologies and environmental applications. The efficient activation and conversion of stable gas molecules remains a significant scientific and technological challenge. Microwave (MW) discharges provide a versatile approach for coupling energy to gases and generating non-equilibrium plasma conditions that can promote chemical reactions under conditions that differ from conventional thermal processes.

A new experimental facility is being established at Instituto Superior Técnico (IST) for the investigation of microwave-assisted gas conversion. The facility combines a dedicated MW reactor with controlled gas handling and power delivery, together with complementary advanced plasma and gas-phase diagnostics. The reactor is designed to provide controlled and reproducible operation over a range of pressures, gas compositions and flow conditions, enabling systematic studies of the interaction between MW power coupling, plasma properties, gas-phase chemistry and conversion performance.

The research programme supported by the facility is currently promoted by the development of technologies for *in-situ* resource utilization (ISRU) on Mars [1]. Ongoing activities at IST are investigating approaches for the utilization of locally available resources, including the conversion of the CO₂-rich Martian atmosphere for oxygen production (see Figure 1). Within this context, CO₂ conversion represents an important research direction for the facility, while its broader scope allows the investigation of other gas-phase processes, including nitrogen fixation and other plasma-assisted conversion reactions. This flexibility is intended to provide a common experimental platform for studying different gas conversion processes relevant to both space and terrestrial applications.



Figure 1 - Microwave discharge ignited at approximately 5 mbar, simulating the atmospheric pressure of Mars.

This contribution will present the current status of the facility, including the reactor development, experimental capabilities and diagnostic systems currently available or under development. The ongoing research activities and the range of gas conversion processes that can be investigated will be discussed, with particular emphasis on CO₂ conversion and its relevance to ISRU. The presentation will also highlight the experimental capabilities and research opportunities currently available to students and researchers at IST, including potential projects in plasma physics, microwave technology, reactor engineering, plasma and gas diagnostics, and gas conversion.

Keywords: MW plasma; gas conversion; CO₂ conversion; plasma diagnostics; in-situ resource utilization

[1] <https://www.ipfn.tecnico.ulisboa.pt/news-and-events/news/563138931982712>

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Round Table

Friday, October 23rd · 15h – 17h

NInTec Science Days 2026 addresses science policy issues in parallel with the main scientific programme.

This third edition focuses on the topic:

“Challenges in the Implementation of the European Charter for Researchers”

The event promotes a round table on this topic, including a panel of invited speakers and the participation of the audience.

Speakers

<i>Moderator</i>	Pedro Paulo , President of NInTec
<i>Invited</i>	Maria Mecenero , Policy Officer at the European Commission, DG Research and Innovation – Research Careers
<i>Invited</i>	Cecilia Rodrigues , Vice-Rector for Research and Innovation at Universidade de Lisboa
<i>Invited</i>	Carolina Varela , Policy Officer at the International Consortium of Research Staff Associations (ICoRSA)
<i>Invited</i>	Bruno Pereira , President of ANICT, National Research Staff Association