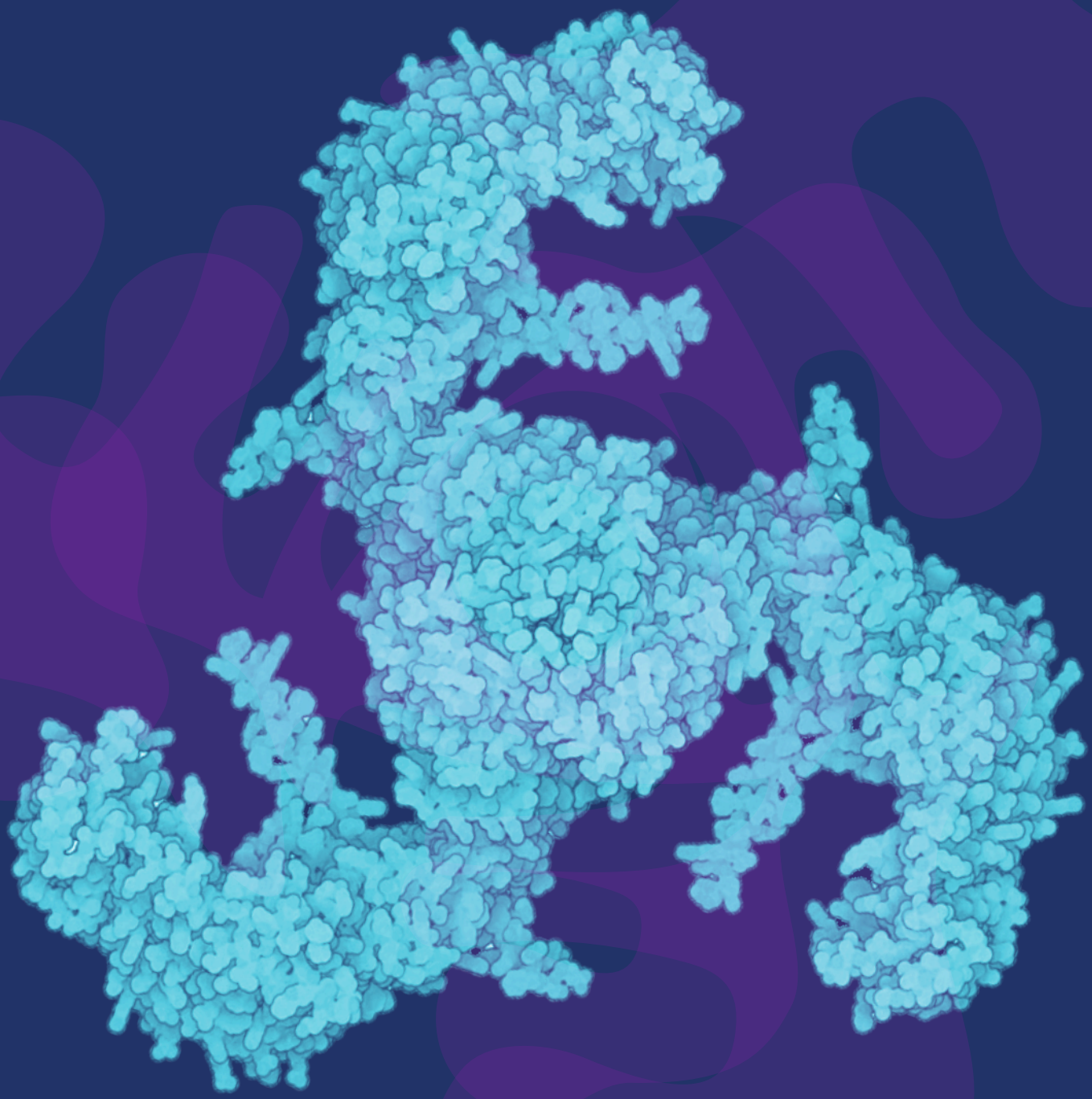
Picture: Piezo1 mechanoreceptor by David S. Goodsell, RCSB PDB.



PIEZ 4SPINE NEWSLETTER

№2

SECOND PIEZO4SPINE NEWSLETTER

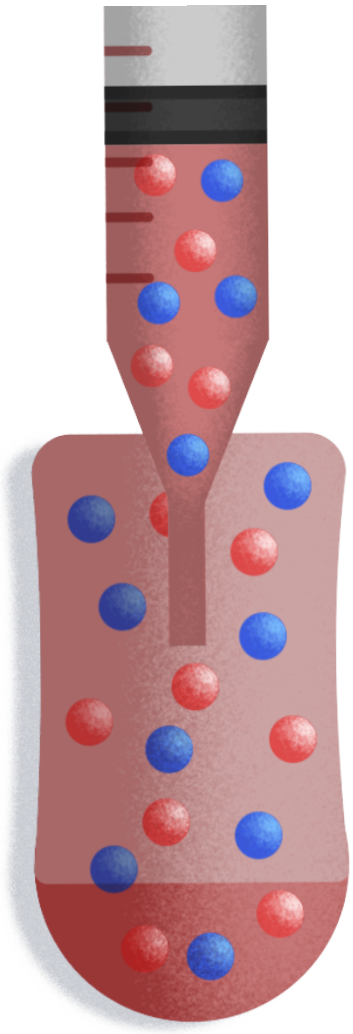
Welcome to the second edition of the Piezo4Spine Newsletter. As we begin 2025, we are excited to reflect on the remarkable progress of Piezo4Spine, our HORIZON EUROPE EIC Pathfinder Project. This groundbreaking research continues to advance spinal cord injury therapy through innovative materials and technologies, thanks to the dedication of our consortium.

A highlight of 2024 was our third in-person meeting in Coimbra, Portugal, hosted by our partner the University of Coimbra. This productive gathering showcased significant scientific achievements and set the stage for future progress. Participants also enjoyed a tour of the historic university, including the breathtaking Joanina Library and the Grand Hall, offering inspiration from its rich academic heritage.

The past year has also seen impactful research publications and innovative breakthroughs, complemented by active outreach through scientific conferences and public events. We invite you to explore this edition of our newsletter to learn more about our progress in the project.

YOURS SINCERELY,
THE PIEZO4SPINE TEAM

OUR RADICAL VISION



THERAMESH

THE GLOBAL CHALLENGE OF SPINAL CORD INJURIES

Annually, between 250,000 and 500,000 people worldwide suffer from spinal cord injuries (SCIs), predominantly due to preventable causes like road accidents, falls, and violence. These injuries severely disrupt neural circuits, impairing connectivity between the brain and the rest of the body. The complex nature of these injuries, influenced by factors such as injury severity and location, has so far limited treatment options to merely symptomatic relief [1].

OUR AIM: REVOLUTIONIZING SCI RESEARCH

Piezo4Spine is dedicated to developing a novel multifactorial therapy for SCI, focusing on two pivotal aspects of neural repair: mechanotransduction and inhibitory scarring. Our approach is designed to more effectively tackle the complexities of SCIs, offering new possibilities for therapies and functional recovery.

OUR CUTTING-EDGE-TECHNOLOGY

Leveraging advancements in Nanotechnology, Molecular Biology, Tissue Engineering and Neuroelectronics, Piezo4Spine is developing a bioprinted 3D mesh, the '3D-theramesh', infused with nanocarriers. These carriers are engineered to deliver gene therapeutic agents to injury sites via wireless powering.

OUR IMPACT

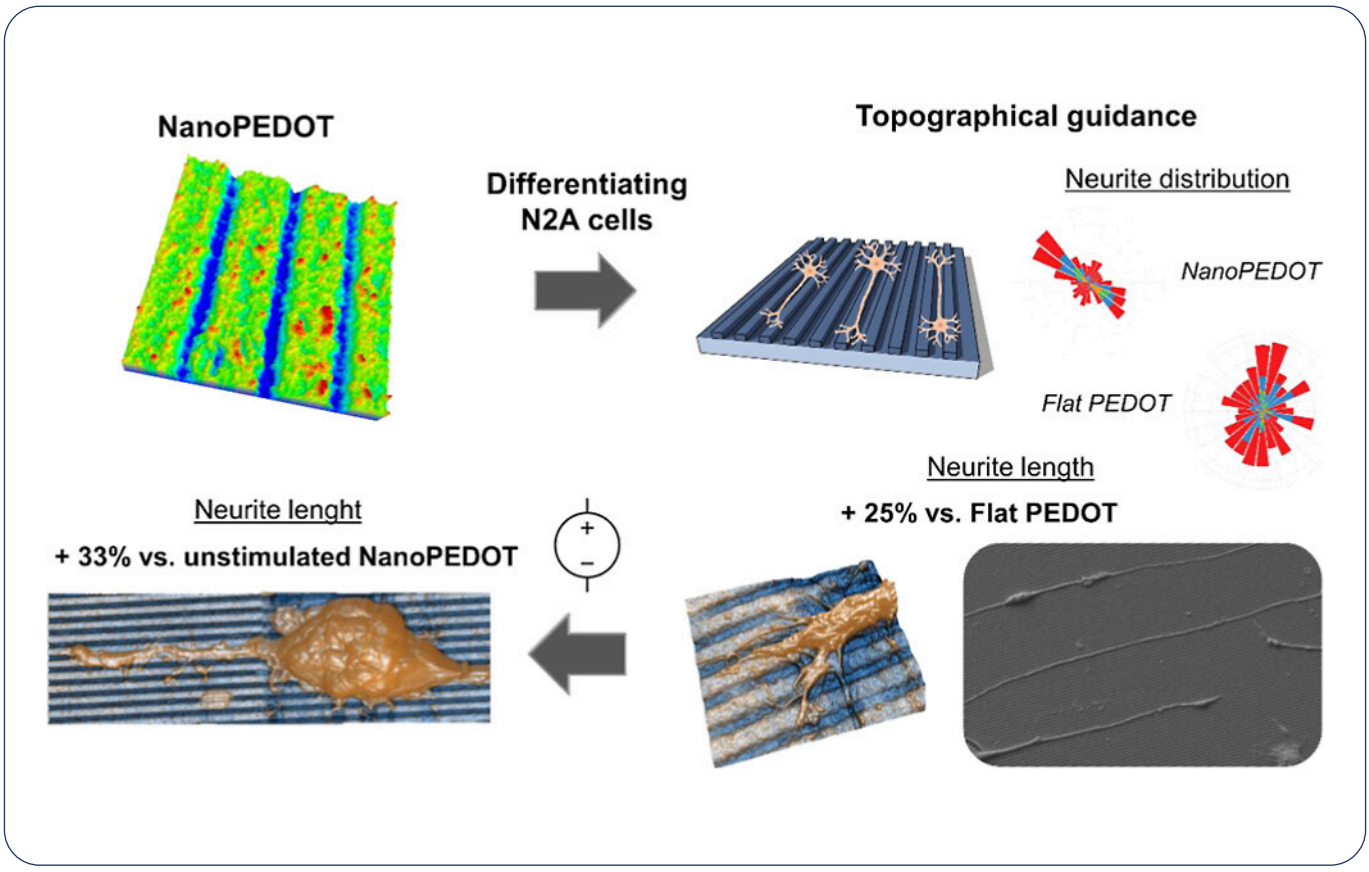
Our interdisciplinary consortium aims to transcend the limitations of current technologies by addressing multiple cellular targets involved in neural regeneration. This includes a balanced combination of therapeutic interventions focusing on mechanotransduction and inhibitory scarring, which has the potential to significantly enhance functional recovery after SCI and pave the way for novel treatments in various other neural and non-neural pathologies.
Discover more about our project's aims and groundbreaking approach by watching our informative video on YouTube and on www.piezo4spine.eu.

[1] https://www.who.int/news-room/fact-sheets/detail/spinal-cord-injury

SCIENTIFIC ACHIEVEMENTS

ENHANCING NEURONAL DEVELOPMENT WITH NANOSTRUCTURED CONDUCTIVE MATERIALS

In the December 2023 issue of *ACS Applied Materials & Interfaces*, researchers from our partner, the Italian Institute of Technology (IIT), published a study on how the synergy between nanotopography and electrical conductivity enhances neuronal development. Using conductive materials with nanoscale grooves, the team demonstrated improved neural cell adhesion, proliferation, and neurite outgrowth. Notably, these substrates promoted directional neurite growth along the grooves and increased neurite length by 30% under low electrical stimulation. These findings highlight the potential of multifunctional materials in neural tissue engineering and regenerative medicine.



FOLLOW THE LINK TO FULL PUBLICATION
https://doi.org/10.1021/acsami.3c15278

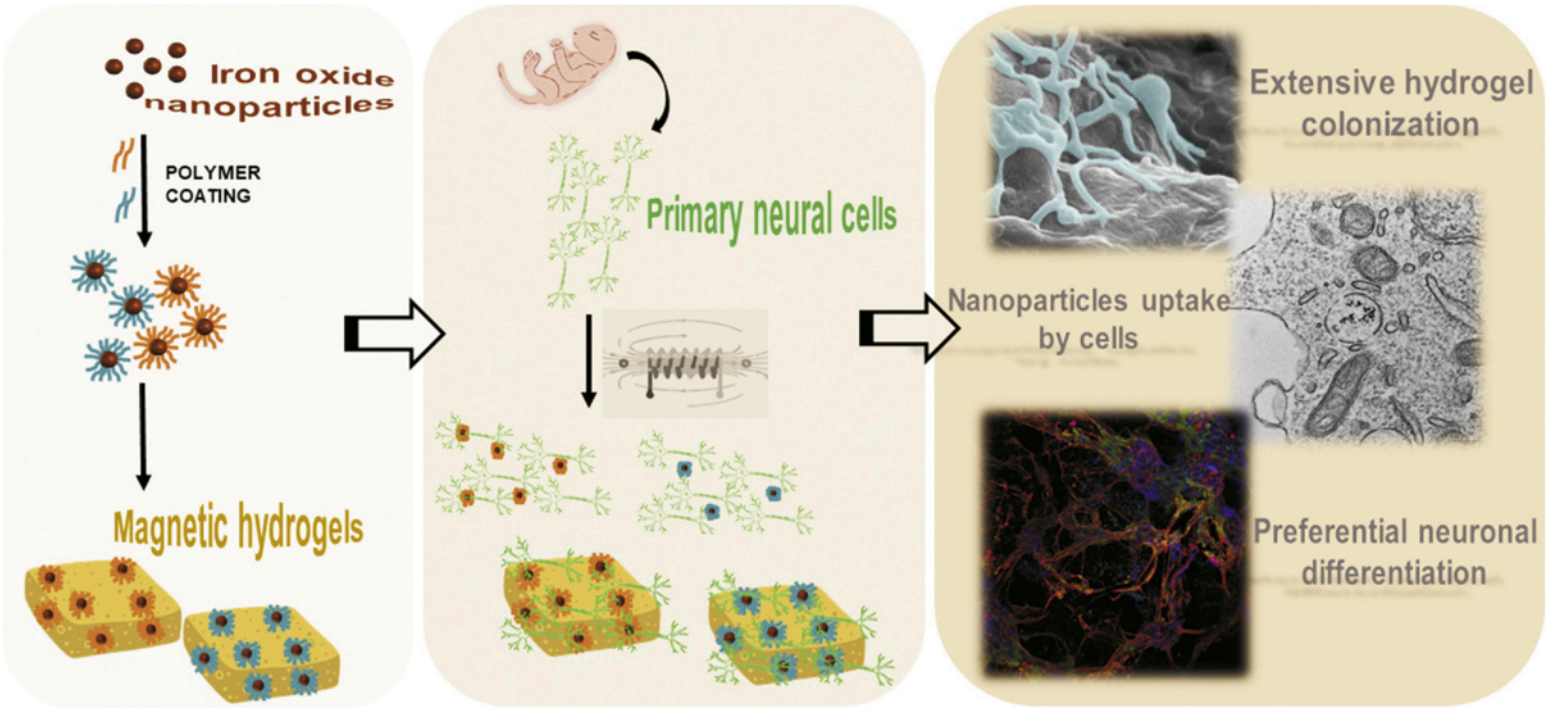
SCIENTIFIC ACHIEVEMENTS

UNDERSTANDING NEURAL CELL RESPONSES TO MAGNETIC NANOPARTICLES

In April 2023, the MaMBIO Group of CSIC published a study in *ACS Applied Materials and Interfaces* showing how small variations in iron oxide nanoparticles (IONPs) properties affect neural cells. Their findings highlighted the potential of IONPs to target specific cellular processes, paving the way for further research.

Continuing this work, the IONPs integrated into hydrogels was explored in a 2024 study. In March, our partners from ICMM-CSIC, the MaMBIO and Force Tool Groups, published a paper in *Acta Biomaterialia* focusing on hybrid 3D matrices. These matrices integrate natural polymers, forming soft and flexible 3D networks that mimic the extracellular matrix of natural tissues, with IONPs responsive to magnetic fields. Polymer-coated IONPs preserved primary neural cell viability and neural differentiation, even boosting neuronal interconnectivity. When integrated into a 3D mesh, magnetic hydrogels supported the formation of highly interconnected and differentiated neuronal networks. Under magnetic stimulation, neuronal differentiation was affected only at the highest dose of IONPs, with chitosan-coated IONPs demonstrating superior performance.

The research underscores the potential of IONPs and magnetic hydrogels in neural therapies, where precise modulation of cellular environments can aid regeneration and repair processes. These findings are of high value for the development of the 3D-theramesh in the framework of the Piezo4Spine project.



FOLLOW THE LINK TO FULL 2024 PUBLICATION
https://doi.org/10.1016/j.actbio.2024.01.030

FOLLOW THE LINK TO FULL 2023 PUBLICATION
https://doi.org/10.1021/acsami.3c02729

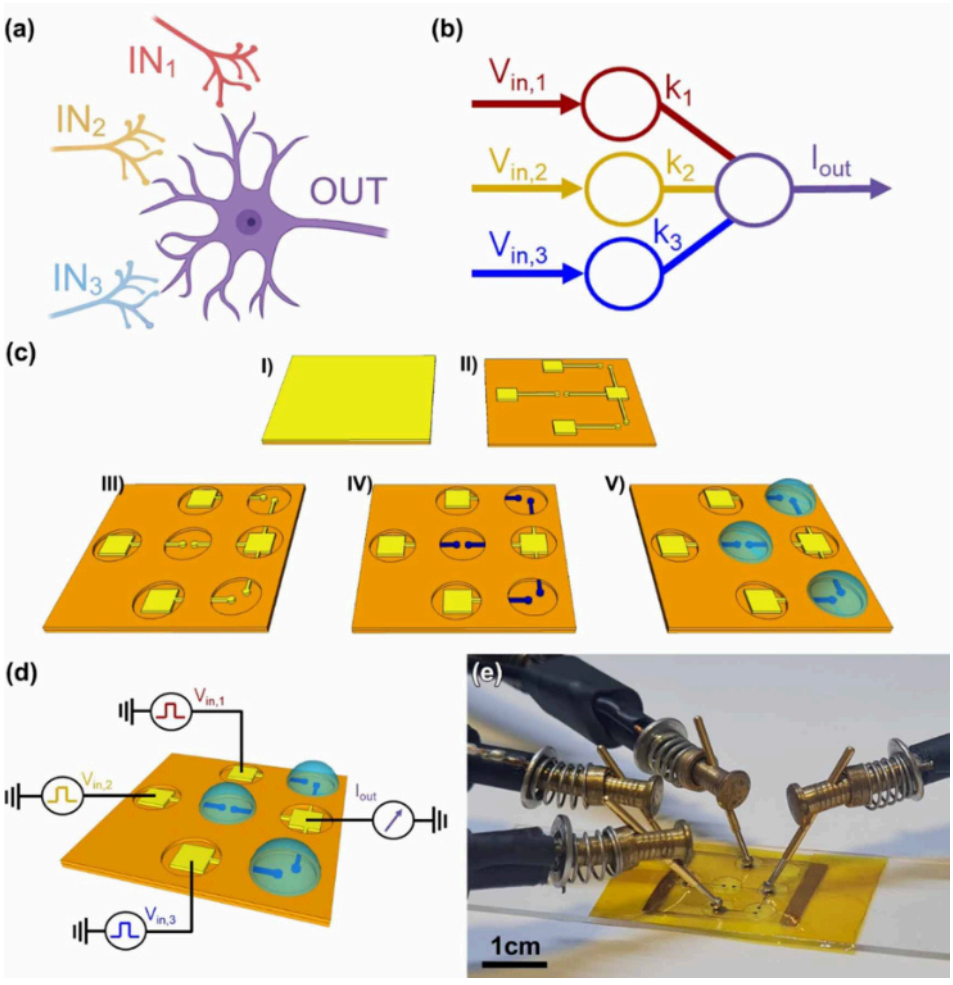
SCIENTIFIC ACHIEVEMENTS

NEUROMORPHIC INNOVATIONS FOR NEURAL REGENERATION

In the April 2024 issue of *Neuromorphic Computing and Engineering*, researchers from our partner, the Italian Institute of Technology (IIT), introduced an organic neuromorphic device designed to mimic neuronal activity for advanced pattern recognition. This device acts as an artificial soma, integrating inputs from pre-synaptic neurons and delivering an output signal based on dendritic processing.

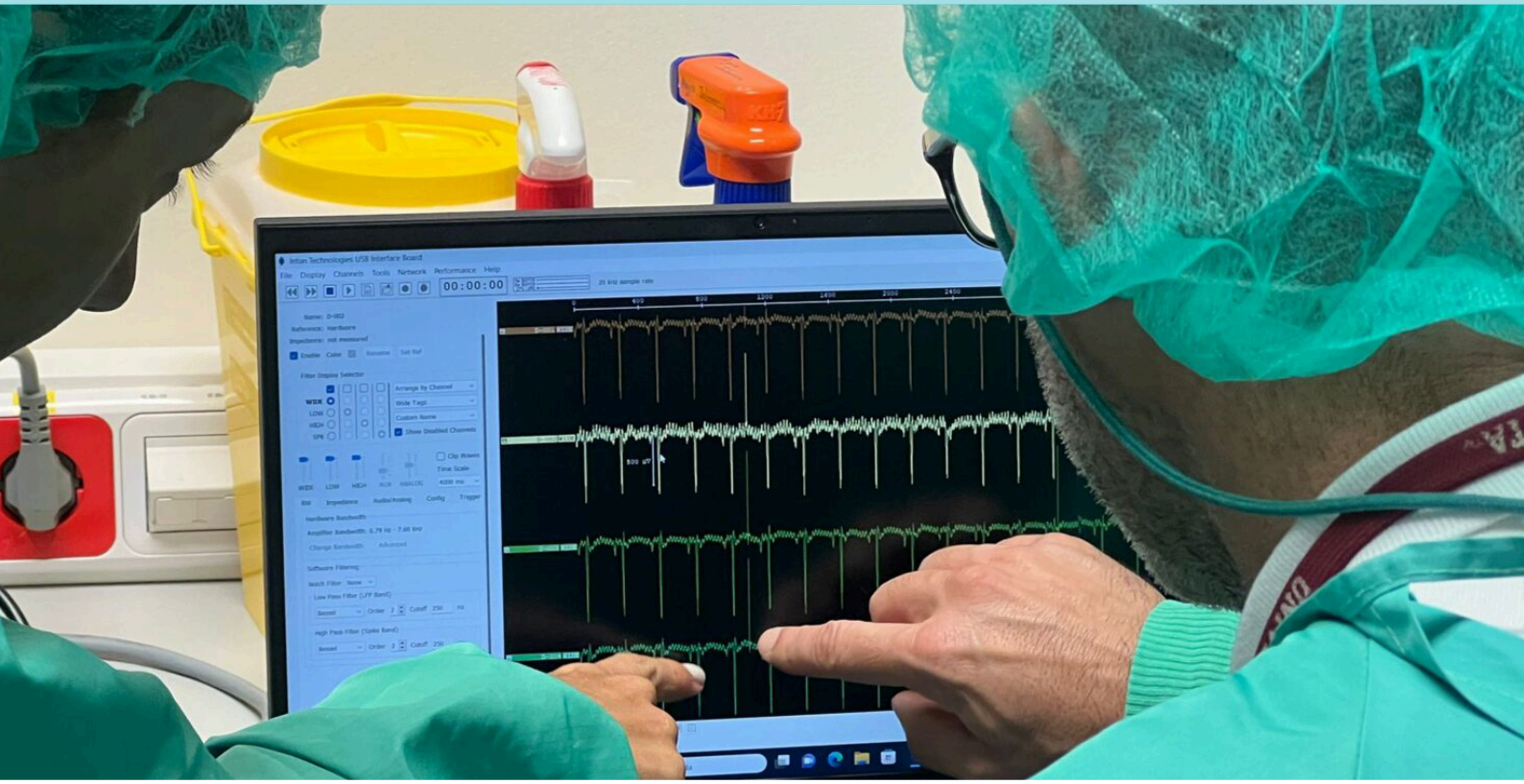
Key experiments demonstrated the device's ability to classify spatio-temporal patterns, such as speech recognition tasks, using minimal energy while maintaining high accuracy. Its functionality is influenced by environmental factors, including ionic strength, allowing for tunable performance. The study highlights how neuromorphic electronics can interface seamlessly with biological systems, offering a new dimension in neural repair and monitoring.

This innovation aligns with Piezo4Spine's mission to combine advanced materials and technologies to support spinal cord regeneration. By enabling real-time interaction and feedback within neural networks, neuromorphic devices could significantly enhance therapeutic strategies.



READ FULL PUBLICATION HERE:
https://iopscience.iop.org/article/10.1088/2634-4386/ad3a96

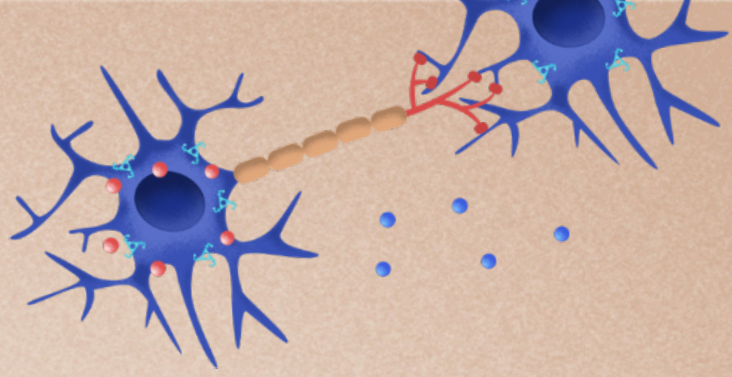
SCIENTIFIC ACHIEVEMENTS



IIT MEMBERS VISITED SESCAM FOR ELECTRODE IMPLANTATION TESTS

In June and December 2024, members of the Italian Institute of Technology (IIT), Ana and Federica, visited SESCAM facilities in Toledo to conduct the first tests of electrode implantation in our animal model. This marked a significant milestone in our ongoing project aimed at advancing neural regeneration research.The experiments carried out were highly complex, involving intricate procedures to implant electrodes in the animal model. Despite the challenges, the team successfully gathered valuable data and insights that will guide the next steps of our research.

PIEZO4SPINE AT CONFERENCES



ASPAYM ANNUAL MEETING, MAY/JUNE 2024

Elisa López-Dolado from SESCAM and our project coordinator **María Concepción Serrano** from ICMM-CSIC, participated in the annual meeting of ASPAYM (Association of Patients with Spinal Cord Injury and Other Disabilities). During the meeting, which targeted paraplegic patients, Elisa and Conchi shared our innovative approach to develop new treatments for SCI. The audience had the opportunity to learn about our pioneering work in this field: cutting-edge technologies in nanotechnology, molecular biology, and tissue engineering.

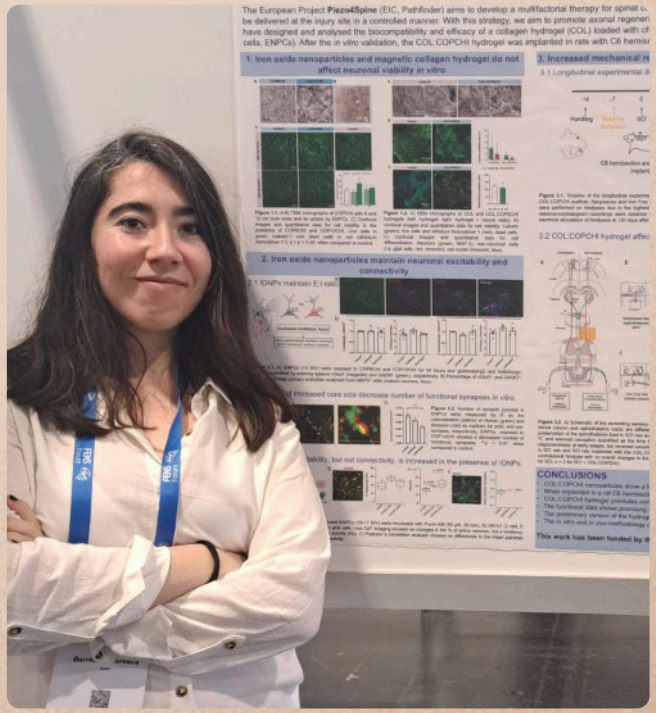
FEDERATION OF EUROPEAN NEURO-SCIENCE SOCIETIES

FEMS FORUM 2024 IN VIENNA

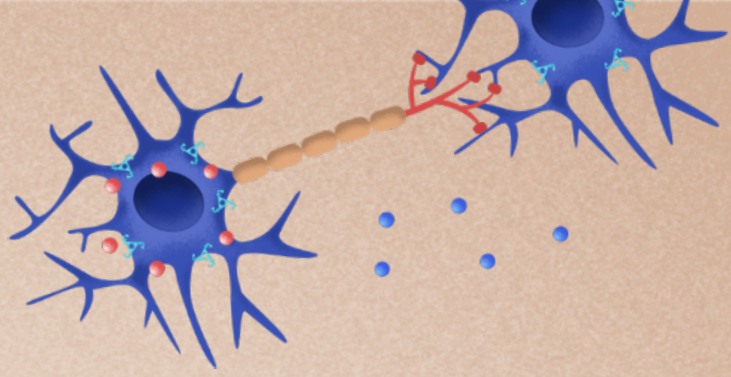
Veronica Barranco and **Juliana M. Rosa** from SESCAM showcased our findings through an impactful poster presentation with the title:

"Analysis of neural connectivity and functional recovery of rats with spinal cord injury implanted with magnetic collagen hydrogels"

The FENS Forum 2024 is the Europe's largest neuro-science congress, bringing together researchers from all areas of neuroscience. The forum covers topics from basic to translational research and features plenary and special lectures, scientific symposia, technical workshops, special interest events, career development opportunities, and networking sessions.



PIEZO4SPINE AT CONFERENCES



CONFERENCE OF CLINICAL APPLICATIONS OF MAGNETIC

CARRIERS 2024 IN BARCELONA

Members of the MaMBIO group (ICMM – CSIC) participated in the Conference of Clinical Applications of Magnetic Carriers in Barcelona. Our project coordinator, **María Concepción Serrano,** delivered an insightful oral presentation titled "Exploring Magnetic Collagen Hydrogels for Neural Regeneration in Hemisected Rats", showcasing the latest results from her team and Elisa López-Dolado's lab (SESCAM) as part of the Piezo4Spine project. Additionally, **Sabino Veintemillas-Verdaguer** presented a highly informative poster on magnetic separation of cells, capturing the attention and interest of attendees.

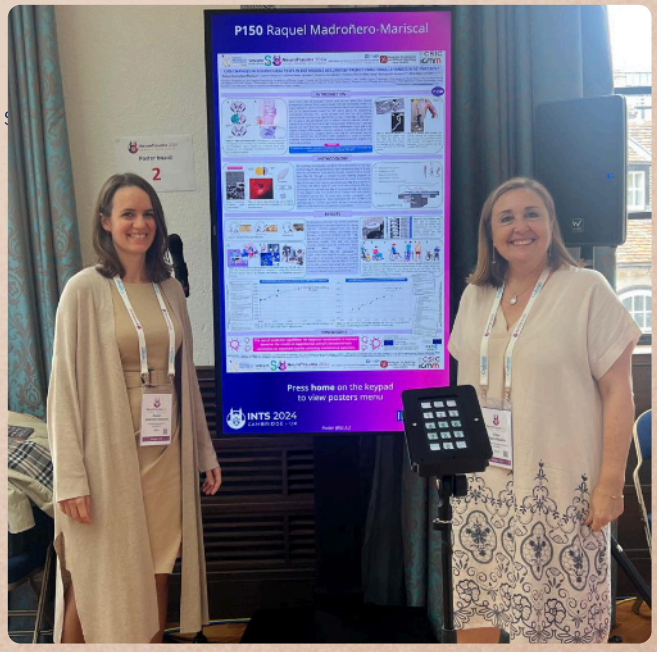
NEUROTRAUMA

2024 IN CAMBRIDGE

Elisa López-Dolado and **Raquel Madroñero** from SESCAM participated at the NeuroTrauma 2024 Conference held in Cambridge, United Kingdom. They presented a poster featuring data from both SESCAM and CSIC, showcasing our team's latest contributions to spinal injury research. The poster dealt with the question

"Can Changes in Behavioural Tests in Rat Models Accurately Predict Functional Changes in SCI Patients?"

The NeuroTrauma Conference is a renowned platform for cutting-edge research covering basic, translational, and clinical aspects of research into brain and spinal cord injuries and bringing together leading experts from around the globe.



PIEZO4SPINE AT CONFERENCES

SPANISH CONFERENCE OF BIO-MEDICAL APPLICATIONS

OF NANOMATERIALS (SBAN 2024)

Several members of the Piezo4Spine project participated in the Spanish Conference of Biomedical Applications of Nanomaterials (SBAN), held at the ICMM-CSIC in Madrid. This event brought together Spanish experts to discuss the latest advances in nanomaterials for biomedical applications.

Our team member, **Esther Benayas**, gave an engaging oral presentation highlighting the innovative research being conducted within the Piezo4Spine project. **Andrea Ferraras** presented a poster showcasing the "Design of Immuno-Active Nanocarriers for Neural Repair", which contained recent results in the development of nanomedicines for the development of the theramesh.

We are also proud to share that **Puerto Morales**, a member of the MaMBIO team, was one of the organizers of this important event, further underlining our team's dedication to advancing biomedical science.

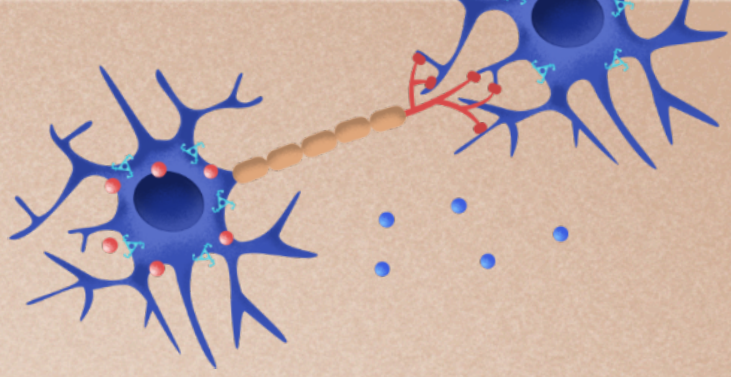
SYMPOSIUM AT THE ANNUAL MEETING

OF THE SPANISH SOCIETY OF PARAPLEGIA

We are excited to share that **Elisa López-Dolado, Juliana M. Rosa**, both from SESCAM, and our project coordinator María Concepción Serrano, from CSIC, participated in a dedicated symposium at the Annual Meeting of the Spanish Society of Paraplegia in Toledo. This year's event was particularly special, coinciding with the 50th anniversary of the Hospital Nacional de Parapléjicos—a milestone in the field of spinal cord rehabilitation.

The symposium highlighted the latest developments and goals of the Piezo4Spine project, fostering valuable discussions with leading experts. The broader conference program featured plenary sessions, breakouts, and poster presentations, covering a range of topics from rehabilitation advances and medical practice with SCI patients to novel therapeutic approaches.

PIEZO4SPINE AT CONFERENCES



EUROPEAN SUMMIT OF INDUSTRIAL BIOTECHNOLOGY

ESIB 2024 IN GRAZ

We are excited to share that **Elisa López-Dolado, Juliana M. Rosa**, both from SESCAM, and our project coordinator **María Concepción Serrano,** from CSIC, participated in a dedicated symposium at the Annual Meeting of the Spanish Society of Paraplegia in Toledo. This year's event was particularly special, coinciding with the 50th anniversary of the Hospital Nacional de Parapléjicos - a milestone in the field of spinal cord rehabilitation.The Piezo4Spine Workshop "3D Printing Innovations" at ESIB in Graz was a tremendous success! We extend our heartfelt thanks to our expert speakers, **Peter Satzer, Karin Stana Kleinschek**, both from acib and **Andreas Blaeser** from Black Drop, for their captivating presentations. Their talks on medical applications of bioprinting and the use of 3D printing to create sustainable consumables for life science labs sparked engaging discussions and inspired our audience. A special shoutout to **Duarte Moura** and **Amita Shinde**, both from Black Drop, for their hands-on demonstrations, which provided practical insights into cutting-edge 3D printing technology. We are grateful for their effort in bringing and showcasing the cutting-edge equipment. Their commitment did not stop there – thank you for running the Piezo4Spine and Black Drop exhibition booth for the entire three days of ESIB.

SFNANO 2024 CONFERENCE

TOULOUSE, FRANCE

Our project coordinator, **María Concepción Serrano**, delivered an invited talk at the SFNano 2024 Conference in Toulouse, France.
The SFNano 2024 Conference, organized by the French Society for Nanomedicine, is a premier event that brings together experts in nanomedicine to discuss the latest scientific and clinical developments in the field. This year's conference featured five sessions covering cutting-edge topics, including new approaches for nanomedicine in cancer, imaging, diagnostics, theranostics, infectious and immune diseases, central nervous system disorders, cardiovascular conditions, vaccination, nucleic acids, translational studies from scale-up to clinical applications, and (nano)materials chemistry involving polymers, lipids, gels, and peptides. The SFNano Conference provided an ideal platform to showcase how Piezo4Spine's innovative strategies align with the broader goals of nanomedicine in addressing complex medical challenges.

PIEZO4SPINE GOES *PUBLIC*

EUROPE DAY IN MADRID SPAIN

IN MADRID, SPAIN

On May 9th, 2024, **Esther Benayas** (PhD Student) and **María Concepción Serrano**, both from the ICMM – CSIC, presented our project to high school students. This date holds special significance as it celebrates the anniversary of the "Schumann Declaration" of 1950, when French Minister **Robert Schumann** set forth the idea of the European Coal and Steel Community.
This visionary concept laid the foundation for what would evolve into the modern European Union, a proof to the power of collaborative effort and unity, also from a scientific perspective.

LONG NIGHT OF RESEARCH

IN GRAZ, AUSTRIA

Recap from the Long Night of Research in Graz (May 24th): Our Austrian partner, acib GmbH, presented our project and the research behind the process of developing a novel spinal cord injury therapy - thanks to the tinkering skills of our partners at ICMM-CSIC, who kindly provided the equipment to visually demonstrate the research and science. The event was a huge success and captivated many visitors.
Thanks to everyone who showed interest! And thanks to **Christiane Luley** and **Katharina Schwaiger** from acib for running the booth!

EUROPEAN RESEARCHERS' NIGHTS

IN COIMBRA, MADRID, GRAZ AND MODENA

On Friday, September 27th, Piezo4Spine participated in the European Researchers' Night in Coimbra (Portugal), Madrid (Spain), Graz (Austria), and Modena (Italy).

Our interactive and informative stations, e.g. the Spinal Cord Maze, organized by our partners from the University of Coimbra, ICMM-CSIC, acib and IIT, attracted significant interest from visitors. It was a fantastic opportunity to engage with the public and showcase our groundbreaking research in spinal cord therapy.

AWARDS

We are thrilled to spotlight two scientific and business achievements within our Piezo4Spine consortium:

Kudos to our team at the University of Coimbra – **Susana Simões, Lino Ferreira,** and **Filipe Rodrigues** – for winning the 1st place in the Innovation category at the ARRISCA C 2024 business ideas competition! Their ground-breaking project, mFIBRO, focuses on using mRNA technology to restore the function of organs that cannot regenerate. This innovative approach holds immense potential for advancing regenerative medicine and showcases the team's commitment to pioneering cutting-edge solutions.

Big Congratulations to **Julia Martínez Ramírez!** We are delighted to share that Julia, a PhD student at the ICMM-CSIC, was awarded the prize for the best oral presentation in the "Materials for Health and Digital Information" section at YOUMAT2024 (2nd Seminar for Young Materials Researchers).

Her insightful talk on "Magnetic hydrogels that support neural cell culture development" garnered well-deserved recognition.

We heartily congratulate
on these outstanding achievements!

PIEZO4SPINE NEWSLETTER
EDITORIAL TEAM

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MORE INFO & NEWS

www.piezo4spine.eu

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