



Newsletter

Issue 1 – February 2024

Introducing the world of mechanical impedance
and multi-physics technologies



Funded by the European Union

Views and opinions expressed are however those of the author(s) only
and do not necessarily reflect those of the European Union or European Research Executive Agency.
Neither the European Union nor the granting authority can be held responsible for them.

MELCHIOR in a nutshell

MELCHIOR is an EU-funded Horizon Europe Innovation Action project, with a total duration from September 2022 until August 2025. The project aims to improve substantially a novel technology for fast detection of drugs, explosives, weapons and illicit goods concealed on individuals and in critical cavities of the human body, based on infrasound mechanical impedance interrogation, optionally complemented with other harmless and non-contact technologies.

Infrasound computer aided modelling and improved Artificial Intelligence, combined with new infrasound generators and sensors will enable enhancements in reliability and sensitivity. Integration will be explored with other non-contact technologies like low-cost millimeter waves and Terahertz

point echo sensors, both with no image formation. Compatibility and complementary combination of specific bioaerosols and chemical vapour detection novel technologies will also be studied and tested. Slight variations of the prototypes will be demonstrated in multiple locations, covering operational environments of customs and border authorities in the EU external air, land and sea border crossing points, and security controls in sports arenas and prison facilities.

MELCHIOR will increase the safety of the security and border staff since it provides the opportunity to avoid the physical interaction with inspected individuals. At the same time, the comfort of travelers and sports fans will improve, while no undressing or physical contact is required.

In the spotlight: MELCHIOR Coordinator Professor Jose Luis Pérez Díaz



Coordinator Professor Jose Luis Pérez Díaz

Dr. Jose Luis Pérez Díaz is a Professor in Mechanical Engineering at the University of Alcalá, Spain, and Coordinator of MELCHIOR. The customs innovation boosting network PEN-CP (www.pen-cp.net) recently interviewed him for the podcast known as "Pencast", and in this newsletter is presented a summary of Part 1 of the interview. The Pencast interview Part 1 can be listened to both on Spotify and on YouTube (links shared below).

The University of Alcalà was founded in 1498 by Cardinal Cisneros. Ten years ago, the University introduced its first mechanical engineering faculty. During the last three years, work has been carried out in different security projects, related to space, nanotechnologies, and decontamination, with the most recent addition of the MESMERISE project.

Dr. Jose Luis Pérez Díaz who is a physicist and also a mechanical engineer, mentioned that is worthy and fruitful trying to engage and to involve with multiple sectors, for instance from the Health and Medicine faculty, or from the Biology faculty. Interdisciplinary work and bringing different fields together in creative ways is not just a central part of the 'regular University work', but it is also focal on what needs to be implemented in EU-funded projects, including MELCHIOR. This could be mentioned as the most interesting aspect of the project, as all kinds of partners from different countries and from different disciplines are invited to work together. When you combine them all together, the result can be really innovative and productive.

Being the coordinator of a project such as MELCHIOR, can be seen as an orchestra conductor. Sometimes one needs just to ensure that everything is on schedule. Still, most of the time, the coordinator has to translate the language of one group of people into the other: defining how the needs of end-users have to be transformed into instructions for engineers. Or vice versa: what is actually feasible, and can be implemented. And to synchronise that isn't easy, since sometimes there are issues such as the procurement of a particular component. Moreover, it is important that all ethics requirements are fulfilled and all relevant authorisations are obtained. Just like an orchestra: one has to keep everyone in coordination.

MELCHIOR partners such as the Technical University of Munich from Germany, and the University of Galati from Romania, are both top experts in acoustics and in sound scattering. Furthermore, there are experts in acoustic sensors, in creating prototypes from scratch, in millimetre waves, in artificial intelligence and in anti-blast construction and devices. INTA, the National Institute of Aerospace Technology, acts as the research centre from the Ministry of Defence in Spain, where they have the facilities to test this anti-blast capability. Last but not

least, the MELCHIOR governmental end-users – from Spain, Greece, Romania and Finland – not only are going to test the devices, but they will also provide their needs and points of view. All in all, there are a lot of different abilities, capacities and backgrounds that are quite fruitful when they all work together as a team.

While MELCHIOR's purpose is to develop and test multiple detection technologies, the simplistic idea is to avoid the physical touch. During the body search, both the officer and the inspected person may feel uncomfortable. Thus, the idea in MELCHIOR is to avoid or to minimise the number of cases in which physical touch is needed. Differentiation regarding material stiffness, mechanical properties, or in simple terms, something 'appearing as soft versus hard' is done with sound: with vibrations, with waves that propagate and are scattered by the human body. And from the reflection of scattered waves, one gets the information to distinguish the same kind of information when patting down, making this a sort of 'non-contact patting down' scheme. This will be complemented or improved with the use of millimetre wave at particular sites or critical positions.

The human body sounds different if there are irregular items on/in it. It's like a bell: if you attach something to a bell, it doesn't sound the same way and neither does the human body. One will know if there is something heavy and metallic or something like powder. But if it's like powder, you will not be able to distinguish if that powder is flour or cocaine – of course, not many people conceal flour under their clothes. While the exact position of an anomaly cannot be automatically located, the region where it may be can, for example the legs or trunk or arms. It should be underlined that MELCHIOR technology is not scanning, thus it respects the privacy of the person – not only because the person is not touched, but also because no explicit image of the person is created.

Stay tuned for Part 2 of this interview.

You may listen to the PEN-CP Podcast interview (part 1 of 2) with the Coordinator of MELCHIOR Professor Jose Luis Pérez Díaz here:



MELCHIOR participation at RISE-SD 2023

This article features Mike Ellis, from partner organization CBRA, summarising the highlights of the MELCHIOR participation at the RISE-SD 2023 event - “EU Research and Innovation show in the field of Civil Protection & Defense”, held in Rhodes, Greece, end of May 2023. MELCHIOR had its own stand at the event exhibition area, where visitors were briefed about the project, including its objectives, innovations and ambitions. Mike Ellis also delivered a thorough presentation as part of a panel session chaired by SIMAVI and the Hellenic Police.

Mike Ellis comes with over 40 years of experience in the fight against crime from both the public and private sector. He has an extensive operational police experience working at Scotland Yard and later as Assistant Director of Police Services at INTERPOL, where he was the Head of the INTERPOL Trafficking in Illicit Goods and Counterfeits -program. He has been engaged in Global illicit trade enforcement, investigations, capacity building and training efforts for four decades; and now he represents the Cross-border Research Association, CBRA, as their senior expert in illicit trade and law enforcement coordination. His role in MELCHIOR is to help reach representatives from law enforcement, and governmental and private sector security communities to promote the relevance and capabilities of this innovative and developing technology.



MELCHIOR participation at RISE-SD 2023

The RISE-SD 2023 event offered opportunities to learn about other organisations and projects, some of which relate to MELCHIOR for defining potential synergies, for example how the technology could be integrated into protection systems for large gatherings at religious sites. Furthermore, experts joining the event shared their views on current terror threat levels, including how attacks on Western cities and elsewhere have remained a constant threat. Such attacks may come from improvised explosive devices or suicide bombers, which again is relevant in the context of MELCHIOR project where technology aims to enhance detection of hidden explosives in and on individuals. All in all, the RISE-SD 2023 event was rich in interesting and diverse presentations, describing also the EU approaches to counter emerging threats and the various responses under consideration.

As quoted by Mike Ellis, “what was made clear was how we live in challenging times and how it is so important to increase Governments capabilities and efficiencies to protect the citizens. The future security of societies and protection of public spaces by using counter terrorism solutions is critical, as the next generation threats we encounter will be very much interconnected. So, while there was no single most memorable moment that stands out, the importance of meeting so many subject matter experts sharing new innovative ideas was most interesting, for example how AI supported platforms can help to detect airborne bio threats, or emerging threats coming from drone attacks, cybercrime, or the misuse of AI”.



Mr. Ellis, CBRA, delivering his speech at RISE-SD 2023

The MELCHIOR Consortium congratulates the RISE-SD 2023 organisers on the highly successful event, hoping to join again during the coming years.

Introduction of the MELCHIOR Consortium

The MELCHIOR Consortium consists of 15 partner organizations from 9 European countries. The MELCHIOR Newsletter plans to introduce all partners in Issues 1 to 5. This Issue 1 covers technology partner San Jorge Tecnológicas (SJT), University and research partner Technical University of Munich (TUM), and governmental end-user partner Ministry of the Interior of Finland (FIMOI).



San Jorge Tecnológicas, Spain (SJT) is a small- and medium sized enterprise (SME) focused on mechatronics and advanced research on science and engineering - especially for space and security. Core skills of SJT consist of high-tech manufacturing and prototyping, robotics, artificial intelligence and complex modelling are some of their core skills. SJT participated in H2020 MESMERISE project, led by the University of Alcalá (UAH), developing the so-called Z-MESMERISE technology. As a result, SJT and UAH are patent co-owners of a non-invasive, non-contact technology for the detection of hidden goods on the body behind clothing using infrasound, which is the main basis for the development of the MELCHIOR project.

Mr. Juan Sánchez García Casarrubios, the Founding Partner and Technical Director of SJT, is one of the key technology specialists in MELCHIOR. He is an industrial engineer with a double master's degree in Entrepreneurship and Fire Safety Engineering. He has authored more than 20 scientific publications and patented 8 inventions, five of which are currently in operational use.

Furthermore, the Spanish National Police has awarded him the medal of civil merit with white badge. This is what Juan responded to our question about 'the biggest rewards and major challenges concerning your innovation and research and development during full MELCHIOR-project':

"Detecting hidden goods on people, and in particular in crowds such as those found on public transport or at cultural and sporting events, tends to be complex, intrusive and time-consuming, largely due to the huge volume to be inspected in a short period of time. Developing a rapid contactless detection

technology that allows fast flows is a major challenge that the MELCHIOR project seeks to solve, this way increasing the society's security without undermining yet prioritising the privacy of individuals". Approaching the mid-term of the project, SJT sees the evolution of the project as expected with considerable progress in the design of the test prototypes. Work continues on the detection algorithms by improving their efficiency and sensitivity.



The group at the Chair of Vibroacoustics of Vehicles and Machines at the Technical University of Munich, Germany (TUM) conducts widespread research on technical acoustics and on vibroacoustics. Its mission is to enhance the physical understanding of the emergence and distribution of airborne and structure-borne sound in order to deduce methods of manipulation and reduction.

Ever since its establishment in 2015, Prof. Dr.-Ing. Steffen Marburg has directed all teaching and research activities to involve physical principles of vibroacoustics, numerical simulations, and experimental investigations. With a solid background in vibroacoustic modelling, simulation and identification, his team has become part of a leading international network making many substantial scientific contributions in this field. At TUM, the chair is responsible for teaching basic parts of engineering mechanics, namely engineering dynamics as well as advanced courses on vibroacoustics, computational and experimental acoustics, application of data-based methods in vibroacoustics etc. As a volunteer, Steffen is a Co-Editor-in-Chief of the Journal of Theoretical and Computational Acoustics, which is a high-quality niche journal in the field.

Furthermore, he is an Associate Editor of the Journal of the Acoustical Society of America which is the leading journal in Acoustics, as well as an Editor of Mechanical Systems and Signal Processing being one of the leading journals in mechanical engineering. His chair's research covers theoretical and applied fields, often focused on both, new methodological developments and quite diverse applications. Among the latter, there are examples of vehicle acoustics, aircrafts, ships, hand-held electric machines, acoustic design for German Air Traffic Control, etc. The chair is closely collaborating with numerous companies such as BMW, Mercedes Benz, Bosch, Hyundai and others.

When asking Steffen about 'the biggest rewards and major challenges concerning your innovation and research and development

during MELCHIOR', he replied the following:

"With respect to acoustics, this is an extremely challenging project. It is the idea of the project to use low frequency sound (10-100Hz) to identify small hidden objects in the body of a human. In this frequency range, the sound's wavelength measures several metres, i.e. more than 3m at 100Hz and more than 30m at 10Hz. As the resolution for identification depends very much on the wavelength - usually, we assume that we can identify obstacles of the size of the wavelength but not much below - we need to compensate for this shortcoming by high accuracy in our theoretical model and the measurements. Furthermore, a literature search on acoustic scattering of a human body in the frequency range above 10Hz has not returned any entry, even over the entire audible frequency range of up to 20kHz. This means, the entire work on this part of the project can be understood as fundamental research in the field and the outcome is hardly predictable. Consequently, the relevant work package will be both a boon and a bane since stepping on new scientific ground is certainly tempting, but it is impossible to promise the 100% successful completion - of course, the best efforts are made to achieve the ambitious goals in the project".

So far, TUM has developed a fully parametric vibroacoustic simulation model of the human body, consisting of skeleton and tissue while considering full fluid-structure interaction between the structural vibration of the human body and the acoustic fluid around. Back in July 2023, together with MELCHIOR partners University of Alcalá (UAH) and San Jorge Tecnológicas (SJT), some experiments were carried out using MICROFLOWN devices in the anechoic chamber of colleagues at the Technical University of Denmark. In these experiments, the acoustic pressure around a sound scattering person in the near field and the far field were measured. Furthermore, measurements were carried out to determine the boundary impedance of the human skin. Overall and even with lots of manual efforts, the progress is slow but continuous, confirming the expected challenges.



Ministry of the Interior Finland

The Ministry of the Interior of Finland is responsible for internal security and migration and forms part of the Government. The Ministry's key tasks include law drafting as well as strategic planning and steering within its branch of government.

The National Police Board, the Finnish Border Guard, the Finnish Immigration Service, the Emergency Response Centre Agency, the Emergency Services Academy Finland, the Crisis Management Centre Finland, and the Finnish Security and Intelligence Service operate under the Ministry of the Interior.

The Ministry of the Interior employs research and development staff and officials responsible for oversight of legality in the Ministry's branch of government.

The Ministry's three key duties are:

- Preparing legislation concerning the police, rescue services, emergency response centre operations, border control, maritime search and rescue, and migration,
- Managing the performance of agencies and institutions in the Ministry's branch of government, and
- Dealing with international and EU affairs that fall within its remit

The Ministry's vision is a safe and secure society in all situations.

Antti Puhakka, Chief Specialist at the Ministry of the Interior, is responsible for the real estate and facilities management for the Finnish internal security agencies such as Police, Border Guard, Intelligence Service and Immigration. He has been working in different government agencies and ministries for over a decade. Antti shares the responsibility over the MELCHIOR project with his colleague Dr. Jarmo Puustinen, who has a dual role between FIMOI and the Police. Jarmo actually got first in contact with the MELCHIOR Coordinator about the project proposal via ENLETS, the European Network of Law Enforcement Technology

Services (<https://enlets.eu>). Antti and Jarmo can clearly see the operative applications of MELCHIOR and other on-going research projects, while of course realising that EU R&D projects form only a small part of their overall duties and tasks. Ultimately, the main objective in the project for the FIMOI-team is to find the practical use and bring the end-user needs into the attention of the research teams as well as keep the Finnish pilot venue, Nokia Arena in Tampere, informed of the developments.

When asked about 'the biggest rewards and major challenges concerning your innovation and research and development during full MELCHIOR-project', Antti replied as follows: "The Finnish pilot venue in MELCHIOR, Nokia Arena in Tampere, is one of the most modern multi-purpose arenas in the world, known for frequent use of advanced technologies to secure mass events. Nokia, the arena's main sponsor, has a well-known history in R&D, also visible at the Arena today.

The challenges related to the MELCHIOR project concern people flow management, risks being different depending on the type of events and the profile of the audiences. It is important to have continuous flow when people are getting into the arena, and the security checks should not hold a significant role in the visitor and end-user experience. The key goal is to have as quick checks as possible calls for continuous adjustments on the risk levels and accepted risks".

Lastly, from FIMOI perspective, the project has been managed in a professional manner and everything has progressed smoothly so far. Solutions and options have been well prepared for the conversation at the Consortium meetings.



Newsletter

Issue 1 – February 2024

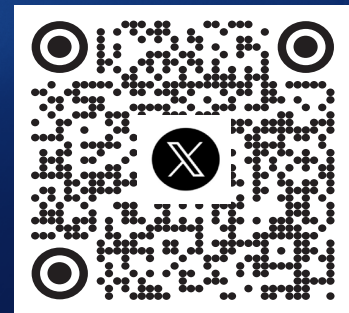
Introducing the world of mechanical impedance
and multi-physics technologies

The official newsletter of the MELCHIOR Horizon Europe project
is available at <https://melchior-project.eu>

Editorial team

Cross-border Research Association, Switzerland
Center for Security Studies, Greece
University of Alcalá, Spain

MELCHIOR Online Presence



Contact

melchior-newsletter@cross-border.org



Funded by the European Union

Views and opinions expressed are however those of the author(s) only
and do not necessarily reflect those of the European Union or European Research Executive Agency.
Neither the European Union nor the granting authority can be held responsible for them.