



MetacMed Doctoral Network

Call for Applicants

This guide is to provide practical information to potential applicants on how to apply, together with a description of the assessment procedure.

For further and up-to-date information, visit www.metacmed.eu or contact us at info@metacmed.eu

MetacMed – Grant n° 101119738

HORIZON-MSCA-2022-Doctoral Network

Table of Contents

1	ABOUT MetacMed	3
1.1	ABOUT THE RESEARCH PROGRAMME	3
1.2	PARTICIPATING ORGANISATIONS.....	3
2	CALL FOR APPLICANTS	4
2.1	WHY APPLY?.....	4
2.2	BENEFITS AND SALARY	4
2.3	ESSENTIAL ELIGIBILITY CRITERIA	5
2.4	DC ROLES & RESPONSIBILITIES	5
3	DC PROJECTS	6
3.1	DC INTERNATIONAL & INTERSECTORAL SECONDMENTS.....	6
3.2	PROJECT DETAILS	6
	DC 1 – Metamaterial lenses for ultrasonic sub-wavelength imaging in water	6
	DC 2: Artificial Intelligence for discovering novel acoustic/mechanical metamaterials designs and properties	7
	DC 3: Noise reduction and energy harvesting from walking via metamaterials.....	8
	DC 4: Metamaterial-based devices for energy harvesting and metamaterial insoles	9
	DC 5: Metamaterial-enhanced ultrasonic GW monitoring for osseointegrated implants and fractured bone healing.....	10
	DC 6: Metamaterial adaptive filters for harmonic imaging in clinical applications	11
	DC 7: Filtering acoustic waves with multiphysics.....	12
	DC 8: Metamaterials and metasurfaces for improved ultrasonic clinical screening.....	13
	DC 9: Guiding and confining wave energy in 3D chiral metamaterials	14
	DC 10: Metamaterials for spinal implants.....	15
	DC 11: AI-aided topology optimization of phononic crystals.....	16
	DC 12: Additively-manufactured metamaterial with embedded FBG sensors for human joints monitoring and rehabilitation	17
4	APPLICATION PROCEDURE	18
5	SELECTION & EVALUATION CRITERIA	18
6	FURTHER INFORMATION	18
7	FUNDING	19

1 ABOUT MetacMed

MetacMed is a Marie Skłodowska-Curie Action (MSCA) Doctoral Network (DN) that will provide world-class interdisciplinary training to 12 Doctoral Candidates (DCs) in the area of “Acoustic and mechanical metamaterials for biomedical and energy harvesting applications” (MetacMed). It consists of a well-balanced consortium that spans four countries member of the European Union, plus Switzerland and the UK, and incorporates academic, research centers and SMEs, interdisciplinary and inter-sectoral aspects of DC skill development.

The starting date of the project is 1st of March 2024. Nevertheless, **Pre-applications are now invited for 12 DCs positions on the MetacMed DN**. Successful candidates will undertake 3-year PhD programmes, either offered at the recruiting institution, or by top-level universities.





Further details about the research programme, applicant eligibility criteria, DC projects and application procedure are provided in this document, with up-to-date information available on the [MetacMed website](#).

1.1 ABOUT THE RESEARCH PROGRAMME





MetacMed aims to link basic research on acoustic and mechanical metamaterials (MMs) to health and well-being issues. DCs will each consider ways in which human health can be improved using MMs, e.g. improvement in the resolution of biomedical ultrasound imaging for e.g. cancer diagnostics, the design of better spinal implants, monitoring of bone healing, and the use of insoles to aid human walking. Another area of interest is to develop MMs that can be used for energy harvesting, to better power e.g. medical devices, and reduce reliance on conventional power sources. These are all backed up by fundamental studies into the MMs themselves to provide the background to achieve these tasks. The balance of the network has thus been carefully considered in terms of basic science and applications, with input from industry in areas such as MMs fabrication and exploitation. Associated with the above is a strong set of training events and tailored secondment periods at both associated partners and beneficiaries.

1.2 PARTICIPATING ORGANISATIONS

Beneficiaries:

-  Università della Calabria, IT
-  Instytut Maszyn Przeplywowych Im Roberta Szwalskiego Polskiej Akademii Nauk - Imp Pan, PL
-  Università Degli Studi Di Messina, IT
-  Centre National De La Recherche Scientifique Cnrs, FR

Associated Partners recruiting via [SERI](#) and [UKRI](#):

-  The University Of Warwick, UK
-  University of Leeds, UK
-  OrthoSens SA, CH
-  Eidgenössische Materialprüfungs- und Forschungsanstalt (Empa), CH

Associated Partners:

-  Politecnico Di Bari, IT
-  Amazemet SP. Z O.O., PL
-  Ecole Polytechnique Federale De Lausanne, CH
-  Universite De Lille, FR
-  Skills4Science, ES

2 CALL FOR APPLICANTS

2.1 WHY APPLY?

DNs are financially supported by the European Commission (and from SERI and UKRI where applicable) because they provide excellent research, training and career aspects. The benefits of being a PhD student in a doctoral network include:

- You will get the chance to participate in specially developed courses (e.g. on specific techniques, academic soft skills, etc.);
- You can already at a very early stage start building your personal professional network due to the embedding of our PhD projects in an extended academic network, including the possibility to collaborate and being seconded at SMEs partners, and to collaborate with other DCs;
- You will be advised by excellent group leaders – they are all outstanding in their research and trainings.

2.2 BENEFITS AND SALARY

The MSCA-DN programme offers a highly competitive and attractive salary and working conditions. The successful candidates will receive a salary in accordance with the MSCA regulations for early stage researchers.

Exact salary will be confirmed upon offer and will be based on:

- Living Allowance of €3400/month to be paid in currency of country where based and with a correction factor to be applied per country.
- Mobility allowance of €600/month to be paid to all DCs recruited.
- Additionally, researchers may also qualify for a family allowance of €660/month depending on family situation.

Taxation and Social Contribution deductions based on National and Institutional regulations will apply and will be deducted from the gross payment highlighted above. In addition to their individual scientific projects, all fellows will benefit from further continuing education, which includes the opportunity to register for a PhD degree, scientific skills courses, transferable skills courses, active participation in workshops and conferences, and secondments to partner labs.

2.3 ESSENTIAL ELIGIBILITY CRITERIA

Applicants need to fully comply with four essential eligibility criteria:

Academic Qualification: The applicant has obtained a degree that formally entitles them to enrol for a doctorate in the host country. The degree should be in the area of Biomedical Engineering, Mechanical Engineering, Aeronautical/Aerospace Engineering, Material Science/Engineering or Physics (or related disciplines), Applied Mathematics, Electrical and electronic engineering, Mechatronics, computer science. Any other with any other related experience/education might contact us at info@metacmed.eu

Doctoral Candidates: In order to be recruited to the network as a doctoral candidate, applicants must not already be in possession of a doctoral degree at the date of the recruitment.

Conditions of international mobility of researchers: At the time of appointment by the host organization, researchers must not have resided or carried out their main activity (work, studies, etc.) in the country of their recruiting organization for more than 12 months in the 3 years immediately prior to their recruitment. Short stays, such as holidays, are not taken into account.

2.4 DC ROLES & RESPONSIBILITIES

All DCs recruited will be expected to carry out the following tasks

- To manage and carry out their research projects within 36 months
- To write a PhD dissertation within the requested time frame of the specific university where the DC pursues his/her PhD (duration of PhDs varies from a country to another);
- To participate in research and training activities within the MetacMed network;
- To write articles for scientific peer reviewed journals;
- To participate in meetings of the different MetacMed consortium bodies;
- To disseminate their research in the scientific community (international conferences) and non-scientific community, by outreach and public engagement;
- To liaise with the other research staff and students working in broad areas of relevance to the research project and partner institutions;
- To write progress reports and prepare results for publication and dissemination via journals, presentations and the web;
- To attend progress and management meetings as required and network with the other research groups;
- To work 100% of their time for the research activities specified in their Individual Research Project;
- You cannot take on any additional paid responsibilities to supplement your income as part of your duties;

3 DC PROJECTS

3.1 DC INTERNATIONAL & INTERSECTORAL SECONDMENTS

The MetacMed is a Doctoral Network, which promotes interaction and networking with several consortium-wide activities, including fostering secondment periods at both academics and SMEs level.






DCs will be recruited to either an academic institution, research center, or SMEs, and will complete secondments in either an academic and/or SMEs, which may be located in an international location (relative to the host institution).

3.2 PROJECT DETAILS

There are 12 PhD Fellowship positions available in the MetacMed Marie Skłodowska-Curie Actions Doctoral Network:

DC 1 – Metamaterial lenses for ultrasonic sub-wavelength imaging in water

Main objectives:

-  Design Metamaterial-based lenses and hyperlenses to be used in water at 2 MHz;
-  Develop FEM models to predict their behavior;
-  Use Additive Manufacturing to build prototype optimized structures using trapping-air within the polymer or using MMs based GRIN structures;
-  Embed piezo-electricity in the lenses to tune their working bandwidth in real time and/or steer the ultrasonic beam and act as filters;
-  Test these lenses both in trough transmission and pulse-echo mode and verify the intended lateral resolution;

Recruiting partner: Università della Calabria (UNICAL), Cosenza, Italy

PhD enrollment: PhD in Information and Communication Technologies (ICT), UNICAL, DIMES. Dept.

Secondment host: Amazemet (PL), University of Leeds (UK), The University of Warwick (UK)

Lead Supervisors: Prof. Marco Ricci, Dr. Stefano Laureti

For further details or queries about this project, please visit the [website](#).





To pre-apply for this position please follow the [pre-application procedure](#).



Funded by
the European Union

DC 2: Artificial Intelligence for discovering novel acoustic/mechanical metamaterials designs and properties

Main objectives:

-  Create an extended database of ultrasonic Metamaterials (MM)/Phononic crystals via FEM simulation simulating a range of different mechanical properties, which include random geometrical arrangement in 2D and 3D;
-  Use AI (Machine Learning- Deep Learning) techniques to boost the discovery of novel structures and optimized them, and benchmark against the current state-of-the-art;
-  Verify the suitability of the top-performing AI algorithms;
-  Understand the potential of MM for fine-tuning spinal auxetic MM devices' properties.

Recruiting partner: Università della Calabria (UNICAL), Cosenza, Italy

PhD enrollment: PhD in Information and Communication Technologies (ICT), UNICAL, DIMES. Dept.

Secondment host: CNRS (FR), University of Messina (IT), OrthoSens (CH)

Lead Supervisors: Dr. Stefano Laureti, Prof. Andrea Tagarelli

For further details or queries about this project, please visit the [website](#).





To pre-apply for this position please follow the [pre-application procedure](#).



**Funded by
the European Union**

DC 3: Noise reduction and energy harvesting from walking via metamaterials

Main objectives:

-  To perform extensive numerical simulations aimed at finding promising configurations for Metamaterials (MMs) capable of exhibiting wave control properties at multiple audible frequencies;
-  To evaluate the performance of the MMs via frequency response analyses and time-transient FEM computations;
-  To realise specimens via Additive Manufacturing at different scale levels;
-  To optimize the structural design on the base of the predicted dynamic behavior. Methods will include optimization algorithms, including genetic algorithms.

Recruiting partner: CNRS-IEMN, Villeneuve d'Ascq
Cedex, FR

PhD enrollment: PhD in Engineering Science, Université
de Lille, Lille, FR

Secondment host: Amazemet (PL), EMPA (CH)

Lead Supervisors: Dr. Marco Miniaci, Prof. Jerome Vasseur

For further details or queries about this project, please visit the [website](#).





To pre-apply for this position please follow the [pre-application procedure](#).



**Funded by
the European Union**

DC 4: Metamaterial-based devices for energy harvesting and metamaterial insoles

Main objectives:

-  Develop a hybrid semi-analytical (integrating Boundary/FEM and analytical models) to include the coupled piezoelectric wave equations;
-  Conversion of mechanical energy into electrical energy through the piezoelectric element: to model the equivalent electrical circuit satisfying the Bloch-Floquet condition with integrated electrical circuits;
-  Additive Manufacturing-realisation of an auxetic Metamaterials (MMs)-based insole with energy harvesting embedded device network;
-  Manufacture and measure the efficiency of the designed piezoelectric MM.

Recruiting partner: CNRS-IEMN, Villeneuve d'Ascq Cedex, FR

PhD enrollment: PhD in Engineering Science, Université de Lille, Lille, FR

Secondment host: EPFL (CH), University of Messina (IT), EMPA (CH)

Lead Supervisors: Dr. Marco Miniaci, Prof. Jerome Vasseur

For further details or queries about this project, please visit the [website](#).




To pre-apply for this position please follow the [pre-application procedure](#).



**Funded by
the European Union**

DC 5: Metamaterial-enhanced ultrasonic GW monitoring for osseointegrated implants and fractured bone healing

Main objectives:

-  Develop numerical tools for simulation of Guided Waves in bones and osseointegrated implants transmitted and registered by ultrasonic transducer;
-  Investigate methods for ultrasonic transducer enhancement by Metamaterials matching layer;
-  Perform feasibility studies of multi-mode QUS methods for fractured bone healing and osseointegrated implant monitoring.

Recruiting partner: Instytut Maszyn Przeplywowych im Roberta Szewalskiego Polskiej Akademii Nauk (IMP-PAN), Gdansk, Poland

PhD enrollment: IMP-PAN Tricity Doctoral School, Polish Academy of Sciences, PhD in Mechanical Engineering, Gdansk, Poland

Secondment host: CNRS (FR), Amazemet (PL), OrthoSens (CH)

Lead Supervisor: Prof. Wieslaw Ostachowicz

For further details or queries about this project, please visit the [website](#).

To pre-apply for this position please follow the [pre-application procedure](#).



**Funded by
the European Union**

DC 6: Metamaterial adaptive filters for harmonic imaging in clinical applications

Main objectives:

- 📦 Design and fabricate new Phononic Crystals(PCs)/Metamaterials (MMs) that can be used to block frequencies over a defined ultrasonic bandwidth in a water environment;
- 📦 Establish the efficiency of PCs at blocking a fundamental frequency f_0 but allow transmission of subharmonics ($f_0/2$), and ultra-harmonics ($3f_0/2$) that would arise from a scattered signal;
- 📦 Use them in an experimental measurements in a water tank using microbubble contrast agents;
- 📦 Investigate operation in phantoms for vascular structures containing microbubbles;
- 📦 Measure imaging resolutions that arise only from the contrast agents and not from surrounding areas using ultrasonic arrays.

Recruiting partner: University of Leeds, Leeds, UK

PhD enrollment: School of Electronic and Electrical Engineering, PhD in Electrical and Electronical Engineering, Leeds, UK

Secondment host: UNICAL (IT), Amazemet (PL)

Lead Supervisor: Prof. Steven Freear

For further details or queries about this project, please visit the [website](#).

To pre-apply for this position please follow the [pre-application procedure](#).



DC 7: Filtering acoustic waves with multiphysics

Main objectives:

- 🧩 Development of a self-consistent simulation tool able to predict and optimize the magnetoacoustic properties of Multiphysics Metamaterials (MMs). This tool will be able to describe the filtering process in the range of MHz, GHz and THz;
- 🧩 Development of an AI tool based on the data produced via the simulations;
- 🧩 Benchmark of the previous simulation and AI tools vs. FEM and ultrasonic clinical screening and further improvement of this application.

Recruiting partner: University of Messina, Italy

PhD enrollment: University of Messina, MIFT Dept., PhD in Bioengineering applied to Medical Sciences

Secondment host: University of Warwick (UK)

Lead Supervisor: Prof. Giovanni Finocchio

For further details or queries about this project, please visit the [website](#).







To pre-apply for this position please follow the [pre-application procedure](#).



**Funded by
the European Union**

DC 8: Metamaterials and metasurfaces for improved ultrasonic clinical screening

Main objectives:

-  Design holey metamaterials (MMs) structures for ultrasonic imaging at resolutions below the usual diffraction limit;
-  Develop FEM models to predict their behaviour, using AI methods to optimize the structure;
-  Use additive manufacturing to build prototype optimized structures;
-  Test these structures for effectiveness and determine their frequency range of operation;
-  Construct a phantom to simulate operation at the surface of the skin;
-  Demonstrate that both surface and subsurface features can be detected at subwavelength resolution.

Recruiting partner: University of Warwick, Coventry, UK

PhD enrollment: University of Warwick, School of Engineering, PhD in Engineering, Coventry, UK

Secondment host: UNICAL (IT)

Lead Supervisors: Prof. David Hutchins, Prof. Peter Thomas

For further details or queries about this project, please visit the [website](#).

To pre-apply for this position please follow the [pre-application procedure](#).



DC 9: Guiding and confining wave energy in 3D chiral metamaterials

Main objectives:

- 🧩 Dispersive properties of chiral periodic structures will be confirmed by FEM computations (time-harmonic or transient) of guided and confined waves at interfaces and inclusions;
- 🧩 Metamaterials design parameters determined based on manufacturing constraints and frequency range considered for energy harvesting, interfaces appropriately designed and physical model prepared for validation;
- 🧩 Advanced Multiphysics models including coupling materials (e.g. piezoelectric) ready;
- 🧩 Device concepts for energy harvesting.

Recruiting partner: Eidgenössische Materialprüfungs und Forschungsanstalt (EMPA), Dübendorf, Switzerland

PhD enrollment: ETH Zurich, Dept. D-MAVT, PhD in “Dr. Sc. Tech ETH Zurich”, Zurich, Switzerland

Secondment host: Amazemet (PL), CNRS (FR)

Lead Supervisors: Dr. Andrea Bergamini, Dr. Bart Van Damme

Academic Supervisor: Prof. Dr. Dennis Kochmann (ETH-Zurich)

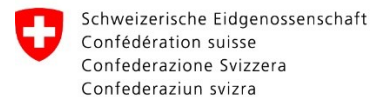
For further details or queries about this project, please visit the [website](#).

To pre-apply for this position please follow the [pre-application procedure](#).



ETH zürich

Project funded by







Swiss Confederation

Federal Department of Economic Affairs,
Education and Research EAER
**State Secretariat for Education,
Research and Innovation SERI**

DC 10: Metamaterials for spinal implants

Main objectives:

-  Create novel auxetic Metamaterials (MMs) designs via FEM simulation, exploring a range of different mechanical properties to mimic natural material properties of intervertebral disks;
-  Integrate promising MM designs into spinal implants accounting for manufacturing and medical regulatory constraints;
-  Produce and perform testing on specimen to validate the implant design;
-  Understand the potential of AI to fine-tuning spinal auxetic MM devices' properties.

Recruiting partner: OrthoSens SA, Corroux, Switzerland

PhD enrollment: EPFL, PhD in Electrical Engineering Lousanne, Switzerland

Secondment host: CNRS (FR), UNICAL (IT), IMP-PAN (PL)

Lead Supervisors: Mr. Gwenael Hennema


Academic Supervisor: Prof. Romain Fleury (EPFL)

For further details or queries about this project, please visit the [website](#).

To pre-apply for this position please follow the [pre-application procedure](#).



Project funded by




 Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Federal Department of Economic Affairs,
Education and Research EAER
**State Secretariat for Education,
Research and Innovation SERI**

DC 11: AI-aided topology optimization of phononic crystals

Main objectives:

-  Develop Deep Learning surrogate model for calculation of dispersion diagrams;
-  Consider hierarchy and fractal patterns in the unit cell of phononic crystal;
-  Propose topology optimization framework by utilizing soft computing methods such as particle swarm optimization and genetic algorithms.

Recruiting partner: Instytut Maszyn Przeplywowych im Roberta Szewalskiego Polskiej Akademii Nauk (IMP-PAN), Gdansk, Poland

PhD enrollment: IMP-PAN Tricity Doctoral School, Polish Academy of Sciences, PhD in Mechanical Engineering, Gdansk, Poland

Secondment host: CNRS (FR), University of Leeds (UK)

Lead Supervisors: Prof. Pawel Kudela

For further details or queries about this project, please visit the [website](#).




To pre-apply for this position please follow the [pre-application procedure](#).



**Funded by
the European Union**

DC 12: Additively-manufactured metamaterial with embedded FBG sensors for human joints monitoring and rehabilitation

Main objectives:

-  Design a novel auxetic Metamaterials (MMs) with embedded FBG sensors via FEM simulations, explore a range of the MMs limitations with reference to the best possible representation of the behaviour of tendons or ligaments in joints;
-  Selection of the most promising MM for manufacturing (with embedded FBG sensors);
-  Perform static and dynamic tests for a manufactured specimen to validate the proposed design.

Recruiting partner: Instytut Maszyn Przeplywowych im Roberta Szewalskiego Polskiej Akademii Nauk (IMP-PAN), Gdansk, Poland

PhD enrollment: IMP-PAN Tricity Doctoral School, Polish Academy of Sciences, PhD in Mechanical Engineering, Gdansk, Poland

Secondment host: UNICAL (IT), CNRS (FR)

Lead Supervisors: Prof. Katarzyna Majewska

For further details or queries about this project, please visit the [website](#).

To pre-apply for this position please follow the [pre-application procedure](#).



**Funded by
the European Union**

4 APPLICATION PROCEDURE

4.1 CONTENT AND SUBMISSION OF YOUR APPLICATION

To submit your **pre-application**, please fill in the requested data in the online webpage on the MetacMed website (link: [pre-application procedure](#))

Applications must be submitted via specific links, which will be available when these are officially opened.

5 SELECTION & EVALUATION CRITERIA

5.1 ELIGIBILITY CHECK

All applications will be checked according to the eligibility criteria. Only eligible applications will be processed to the next phase.

- The applicant is not in possession of a doctoral degree.
- The applicant complies with the mobility rule for the project(s) to apply for.

5.2 SELECTION PROCEDURE

Remaining candidates will be ranked by the principal supervisors of the DC according to the following criteria:

- Scientific/Academic background and merits to date
- Professional experience
- Motivation

Candidates who are ranked sufficiently highly for a DC position will be invited for online interviews with supervisors.

6 FURTHER INFORMATION

For further and up-to-date information, please visit the website, or contact us through the website www.metacmed.eu or at info@metacmed.eu

7 FUNDING



This project has received funding from the European Union's EU Framework Programme for Research and Innovation Europe Horizon (Grant Agreement No 101119738)