12 PhD positions in the Europe Horizon Marie Skłodowska-Curie Project

Applications are invited for **12 PhD positions** (“Doctoral Researchers”) to be funded by the Marie-Skłodowska-Curie Doctoral Network “**PARASOL – European Doctoral Network for Safe and Sustainable ElectroMagnetic Shielding Solutions for Mobility**” The consortium groups 6 hiring Universities: TU Eindhoven (NL), University of Twente (NL), KU Leuven (BE), Tomáš Baťa University (CZ), University of York (UK) and Universitat Politècnica de Catalunya (ES). Together, these universities have a proven track record in the management of Electromagnetic Interference (EMI), Material Engineering, Sustainability Management, and System-Safety Engineering, and are the leaders in their field in Europe. 16 Industrial Partners are completing the Doctoral Network, and representing the complete life cycle of (future) shielding solutions dedicated to Mobility: starting with development of Innovative Material (DSM, Dycomet), design and packaging of Integrated Chips and Power Switches (NXP, CITC, Dynex), Interconnects and Cables design (Ferristorm, Radiotechnika, Schlegel) and, to ensure completeness of the traning program, all means of transport with cars (Jaguar-Land-Rover, Ford, Lotus), trains (Siemens), planes (NLR, Evektor) and ships (Thales).

Each of the 12 DRs will be trained to work in multi-disciplinary and multi-cultural teams, with a new mindset tuned towards the inclusion of the Safe and Sustainable-by-Design (SSbD) framework - a holistic approach that integrates the safety, circularity, energy efficiency and functionality of materials, products, and processes throughout their lifecycle – into the design of innovative shielding solutions for mobility**.** For this inclusion to occur, each DR will develop through their research the missing dedicated materials, tools and techniques, and apply them to a representative set of shielding solutions under development. This hands-on training is supplemented with several scientific professional courses and an immersive training where the DRs can fine-tune their skills for the Jobs of tomorrow, while addressing the societal challenges of the PARASOL program.

Key dates:

- **Beginning of June 2022: Launch of 12 DR Positions**
- **30 September 2022: Deadline for on-line application**
- **15 October 2022: Circulation list “PARASOL pre-selected candidates”**
- **Beginning November 2022: PARASOL Recruitment Event**
- **Mid-November 2022: Circulation list “recruited PARASOL DRs”**
- **1 March 2023: Targeted starting date for DR contracts**

Key background info

EU FUNDING

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Europe Horizon under Grant Agreement No. 101072881 and UKRI (Public Body for Innovation and Research in UK, for position DR5 and DR9).

Number of positions available
12 PhD Positions

Research Fields
Electrical/Electronic Engineering – Materials Engineering – Safety Engineering – System Engineering – Sustainability Management.

Keywords
Electromagnetic Interference – Electromagnetic Compatibility – Shielding Materials - Medical Equipment – Risk Analysis – Risk Reduction – Safety Assurance

Career Stage
Doctorate Researcher (DR) i.e., not already in possession of a doctoral degree at the date of the recruitment.

Benefits and salary
The successful candidates will receive an attractive salary in accordance with the MSCA regulations for Doctoral Researchers. The exact (net) salary will be confirmed upon appointment and is dependent on local tax regulations and on the country correction factor (to allow for the difference in cost of living in different EU Member States). The salary includes a living allowance, a mobility allowance, and a family allowance (if applicable). The guaranteed PhD funding is for 36 months (i.e., EC funding, additional funding is possible, depending on the local Supervisor, and in accordance with the regular PhD time in the country of origin). Position DR5 and DR9

are exceptions to these conditions and will be directly funded by UKRI (Public Body for Innovation and Research in UK).

In addition to their individual scientific projects, all fellows will benefit from further continuing education, which includes internships and secondments, a variety of training modules as well as transferable skills for the Jobs of Tomorrow acquired through a unique immersive learning.

Recruitment Procedure (see Appendix 1 for full description)

All applications proceed first through the on-line recruitment portal on the www.parasol-project.eu website. Candidates apply electronically for one to maximum three positions and indicate their preference. Candidates provide all requested information including a detailed CV (Europass format[1] obligatory), a motivation letter and transcripts of bachelor and master's degree[2]. During the registration, applicants will need to prove that they are eligible (cf. DR definition, mobility criteria, and English language proficiency). The deadline for the on-line registration is **30 Sept. 2022**. The PARASOL Recruitment Committee selects between 24and maximum 30 candidates for the Recruitment Event which will take place in Eindhoven (The Netherlands) (**Beginning November 2022**). The selected candidates provide a 20-minute presentation and are interviewed by the Recruitment Committee. Candidates will be given a domain-relevant peer-reviewed paper (prior to the recruitment event) by their prioritized Supervisor(s) and will be asked questions about this paper during the interview to check if the candidate has the right background/profile for the DR position. Prior to the recruitment event, skype interviews between the Supervisor(s) and the candidates are recommended, along with on-line personality tests. In order to facilitate their travel, selected candidates (from outside The Netherlands) receive a fixed, lump sum of 250 euro (paid by the prioritized Supervisor). If local circumstances in the country of residence of a candidate or supervisor do not allow for travels (e.g due to COVID-19 restrictions), a good quality digital connection will need to be organised. The final decision on who to recruit is communicated shortly after the Recruitment Event (estimated **Mid November 2022**). The selected DRs are to start their research as quickly as possible (targeted date: **1 March 2023**).

Applicants need to fully respect the following eligibility and mobility criteria (to demonstrated in the Europass CV):

- Supported researchers must be doctoral candidates, i.e. not already in possession[3] of a doctoral degree at the date of the recruitment.
- Recruited researchers can be of any nationality and must comply with the following mobility rule: they must not have resided or carried out their main activity (work, studies, etc.) in the country of the recruiting beneficiary for more than 12 months in the 36 months immediately before their recruitment date. For 'International European Research Organisations' (IERO), 'international organisations', or entities created under Union law, the researchers must not have spent more than 12 months in the 36 months immediately before their recruitment in the same appointing organisation. Compulsory national service, short stays such as holidays and time spent by the researcher as part of a procedure for obtaining refugee status under the Geneva Convention[4] are not considered.

The 12 available PhD positions
(See Figure 2 for interactions between DRs/WPs)

DR1: Sustainable polymer-based electromagnetic shields using functional coatings
Host: KUL (Be)
Main supervisor: Prof.dr.ir. Ruth Cardinaels (ruth.cardinaels@kuleuven.be)
Co-supervisors/mentors: Prof.dr.ir. Christian Clasen (KU Leuven, BE), Dr.ir. Rob Janssen (DSM, NL)
Duration: 36 months
Required profile: Materials Engineering, Chemical Engineering, Mechanical Engineering, Applied Physics, Electrical Engineering
Desirable skills/interests: Materials science, coating and spraying, suspensions, soft matter, rheology, polymers, electromagnetism, experimental research, problem solving.
Objectives: This DR postion is about investigating the potential of cold spraying for the generation of EM shielding coatings on polymers. Spray formulations will be developed that optimally balance superior electromagnetic shielding performance with durability during mechanical and thermal loading, good scratch resistance and adhesion as well as enable a sustainable end-of-use option. Thereby, apart from more traditional metallic coating formulations also coatings including magnetic nanoparticles or doped with self-healing polymers will be investigated as well as polymer surface pre-treatments to optimize adhesion and to facilitate matrix-coating separation after end-use.

DR2: Novel in-situ material characterization method applied to carbon-fibre-filled plastic
Host: TUe (NL)
Main supervisor: Dr. Ir. Anne Roc'h (a.roch@tue.nl)
Co-supervisors/mentors: Prof.dr.ir. John Dawson (UoY, UK), Dr.ir. Rob Janssen (DSM, NL)
Duration: 36 months
Required profile: Electronic Engineering, Material Engineering
Desirable skills/interests: Electromagnetism, Electromagnetic Compatibility, Metrology, Material Engineering
Objectives: This DR position is about developing neat methods for material characterization, covering a large frequency band (100MHz-10GHz), to measure the complete constituent without modifying the material under test. While broad-band methods for material characterization at frequencies are relatively well established for dielectric materials, convenient methods for characterization of magnetic materials are much rarer and often cumbersome. This novel (in-situ) material characterization method applied to a set carbon-fibre-filled plastic produced with specialists from DSM. To overcome the intrinsic connection limitations in such fibre composites, synergistic filler combinations will be exploited (e.g., with carbon fillers).

DR3: Enable in-situ low frequency (LF) testing
Host: KU Leuven (BE)
Main supervisor: Dr. ir. Tim Claeys (tim.claeys@kuleuven.be)

[1] https://europass.cedefop.europa.eu/documents/curriculum-vitae
[2] Master students who will graduate in the next coming months are welcome to apply. In that case, please provide an overview of the transcripts that are already available.
[3] Researchers who have successfully defended their doctoral thesis but who have not yet formally been awarded the doctoral degree will not be considered eligible.
[4] 1951 Refugee Convention and the 1967 Protocol.

Co-supervisors/mentors: Prof. dr. ir. Davy Pissoort (KU Leuven - BE), ir. Hans Schipper (Thales, NL)
Duration: 36 months
Required profile: Electrical/Electronic Engineering, Antenna Engineering, Microwave Engineering, Physics
Desirable skills/interests: Electromagnetism, antenna measurements, electromagnetic modelling, low-frequency measurements
Objectives: In this task, the DR will, starting from the characterization method described in IEEE 299, develop, and compare several SE characterization methods to characterize the shielding properties of materials at very-low-frequencies. A sound theoretical background will allow to give the right interpretation to the obtained SE values for use of the material in practice. Low-frequency electromagnetic disturbances are very hard to confine by shielding and proper characterization methods are lacking. Especially in that frequency range, shielding effectiveness values heavily depend on the specific source, the source orientation, the distance between source and shield, etc.

DR4: Active Shielding design for capacitive touch-based control applications
Host: TBU (CZ)
Main supervisor: Dr. ir. Stanislav Kovar (skovar@utb.cz)
Co-supervisors/mentors: Prof.dr.ir. John Dawson (UoY, UK), Ing. Michael Galda (NXP, CZ)
Duration: 36 months
Required profile: Electrical / Electronics / Mechanical / Antenna / Microwave Engineering, Physics or related
Desirable skills/interests: Electromagnetic Compatibility, Computational Electromagnetics, Printed Circuit Board Design, Programming, Measurement Technology
Objectives: This DR will develop an active shield method to increase the robustness and immunity of PCB with safety-critical applications such as capacitive touch-based control applications are increasingly used on-board and are especially sensitive to harsh EM fields and other parasitic environmental effects like temperature drifts and humidity. The sensitive frequencies of the device and the possibilities of eliminating these weaknesses will be investigated. Design solutions and their trade-off in term of performances vs SSbD approach will be documented. Selected designs will be verified using simulation tools (CST Studio Suite) and resulting prototypes will be manufactured and tested within the EMC laboratories (semi-anechoic chamber and reverberating chamber).

DR5: Time-domain shielding for on-board power-electronic
Host: UoY (UK)
Main supervisor: Dr.ir Yihua Hu (yihua.hu@york.ac.uk)
Co-supervisors/mentors: Prof.dr.ir. Milan Adámek (TBU, CZ), Ing. Wesley Koh (Siemens, UK)
Duration: 36 months
Required profile: Electrical Engineering
Desirable skills/interests: Power electronics and motor drives, EMC/EMI, hardware design, Analysis software (MATLAB/Simulink, ANSYS, CST) Electromagnetism, Electromagnetic Compatibility. Lab measurement and data processing (Matlab, Python etc.)
Objectives: This DR aims to further the understanding of on-board shielding for power electronic and provide tools to allow engineers to optimize this shielding. An innovative strategy to shield on-board EMI generated by power-electronic equipment will be explored. It consists in a holistic shielding technique including both software and hardware. This will enable a trade-off between waveform control (complexity and efficiency) and shielding techniques (mass and cost) in the overall on-board design. This trade-off will be assessed with respect to the SSbD approach.

DR6: Integrated Circuit (IC) and Printed Circuit Board (PCB) Shielding
Host: KU Leuven (BE)
Main supervisor: Dr. ir. Tim Claeys (tim.claeys@kuleuven.be)
Co-supervisors/mentors: Prof. dr. ir. Davy Pissoort (KU Leuven - BE), Dr.ir. Rick Jansen (NXP, NL)
Duration: 36 months
Required profile: Electrical/Electronic Engineering, Microwave Engineering
Desirable skills/interests: Electromagnetism, antenna, measurements, electromagnetic modelling, printed circuit board design, high-frequency design, high-frequency measurements
Objectives: This DR will develop a characterization method to measure the absorption of multiple material under different EM conditions. The measurement results of these materials will directly lead to a very specific guidelines on how and when to apply these materials within the framework of the SSbD approach. Containing the EM emissions within a confined space is mostly achieved by implementing shielding materials like board level shields, gaskets, etc. Despite their efficiency, some downsides exist (e.g., heat conduction, space, etc.) by implementing these materials. Another solution is to employ specific absorbers on the radiating parts directly to decrease their emissions. There are however not many easy-to-use characterization methods to measure the shielding capabilities of absorbers. Also, the absorption of those materials would depend on the type of EM source.

DR7: Interconnects characterization
Host: UT (NL)
Main supervisor: Dr. ir. Robert Vogt (r.a.vogtardatjew@utwente.nl)
Co-supervisors/mentors: Prof. F. Leferink (UT, NL), Wit Tyranowicz (Radiotechnika, PL)
Duration: 36 months
Required profile: Electrical Engineering, System Engineering
Desirable skills/interests: Statistics, Computational Electromagnetics, Measurement Technology, Electromagnetic Interference
Objectives: This DR will investigate the shielding effectiveness of real complex 3D structures like boxes, enclosures, and (parts of) cars, planes or ships. The currently used, simplified techniques are based on flat-panel structures, while the most critical aspect of SE is the interconnection of those panels, especially for composite materials. Even the most high-tech industries are forced to manufacture and test several prototypes, because the actual performance of interconnection techniques is unpredictable. A major factor is also the lack of interaction between material engineers, mechanical engineers, and electromagnetic engineers. The SE of a complex structure is only as good as its weakest point, therefore it needs to be characterized to expose the bottlenecks and adapt its design to balance and optimize the performance overall. This DR focuses on the characterization of various interconnect types that will serve as a tool for estimating and optimizing the SE following the steps: modelling, validation, correction, and conversion to parameters usable by industry depending on the application ranging from small full-metal, composite, and embedded plastic structures, interfaces, feedthroughs, to complete ships, rooms, or buildings, including monitoring the effects of breaching, corrosion, and deterioration over time.

DR8: Screening Effectiveness (SE) of Cables
Main supervisor: Dr. Ir. Anne Roc'h (a.roch@tue.nl)

Co-supervisors/mentors: Prof.dr.ir. Guus Pemen (TUe, NL), Dr. Ayhan Gunsaya (Ford GB, UK)
Duration: 36 months
Required profile: Electronic Engineering, Metrology
Desirable skills/interests: Electromagnetism, Electromagnetic Compatibility, Reverberation Chamber, Ferromagnetic Material, Statistics
Objectives: Cables are at the heart of the revolution occurring in our electronic and electric systems for mobility. They are the key propagator of EMI: they catch, radiate, and amplify noise. Parasitic EM noise propagates in a cable as a current, or around it as EM waves. This DR will develop an accurate measurement procedure to measure the energy exchange through the shield of a cable. The Reverberating Chamber (RC) is the most accurate means to measure radiation efficiencies because it allows isotropic device measurements. There is no need for device alignment or three-dimensional scans, as there would be in an anechoic chamber.

DR9: Statistical Shielding Metrics for Enclosures
Host: UoY (UK)
Main supervisor: Dr.ir. Simon Bale (simon.bale@york.ac.uk)
Co-supervisors/mentors: Prof.dr.ir. Guus Pemen (TUe, NL), Dr. Zdeněk Řezníček (EVE, CZ)
Duration: 36 months
Required profile: Electronic Engineering, Physics
Desirable skills/interests: Electromagnetics, Computational Modelling, RF and Electromagnetics Measurement and Analysis.
Objectives: This DR will develop more accurate shielding metrics, modelling and measurement techniques that will allow the real-world shielding effectiveness of enclosures with contents to be quantified. This will allow engineers to better predict the risk of EMC failures and optimise the shielding design of their equipment resulting in a reduced design overhead and therefore lower costs. Our previous work has shown that the shielding effectiveness (SE) of an enclosure is not an intrinsic property of the enclosure itself. It depends on the absorption cross-section (ACS) of the enclosure contents as well as the transmission cross-section (TCS) of the enclosure apertures. In this work we aim to measure the TCS of an enclosure and the ACS of its contents in a statistical sense so that the SE of an enclosure can be statistically quantified. You will have the opportunity to work with EVEKTOR and apply the techniques developed in this work to aircraft structures.

DR10: Trade-off SE solutions for enclosures
Host: UT (NL)
Main supervisor: Dr. ir. Robert Vogt (r.a.vogtardatjew@utwente.nl)
Co-supervisors/mentors: Prof. F. Leferink (UT, NL), Dr. Andrzej Vogt (FERRISTORM)
Duration: 36 months
Required profile: Electrical Engineering, System Engineering
Desirable skills/interests:
Statistics, Computational Electromagnetics, RF Measurements, Electromagnetic Interference, Mechanical Engineering
Objectives: This DR addresses the fundamental concept of shielding achieved by reflection and/or absorption. The corresponding trade-offs regard the material properties, design, and implementation, as well as performance evaluation methods, also in their designated applications, with a strong focus on reverberant enclosures such as airplanes and cars. These reverberant enclosures can generate hot sports of (much) higher field strength rendering reflective SE measures much less effective than absorption. However, the currently available absorbing materials have disputable stable performance, and the materials are used in a trial-and-error process, based on measurement techniques which have been developed, but not (yet) standardised. The DR will focus on the selection of materials (e.g., carbon-fibre filled plastics, ferrite, sprayed-cold composite, or metal, also as a frequency selective surface (FSS)), trade-offs (considering e.g., weight, volume, shape, frequency range and selectivity), implementation type (e.g., coating, paint, gasket/rivet/screw, FSS mesh), design fit and integration in the designated application, as well as cost/performance trade-offs. Although this task looks interesting for material research, it is focused on electromagnetics in the microwave range 1-100 GHz.

DR11: Embedded shielding solutions using innovative layer-by-layer approaches
Host: KUL (Be)
Main supervisor: Prof.dr.ir. Ruth Cardinaels (ruth.cardinaels@kuleuven.be)
Co-supervisors/mentors: dr.ir. Anne Roc'h (TUe, NL), Dr. Ir Francesca Chiappini (CITC, NL)
Duration: 36 months
Required profile: Materials Engineering, Chemical Engineering, Mechanical Engineering, Applied Physics, Electrical Engineering, Microwave Engineering
Desirable skills/interests: Materials science, 3D printing, suspensions, soft matter, rheology, polymers, experimental research, electromagnetism, problem solving.
Objectives: This DR will develop a layer-by-approach for the generation of embedded and local 3D embedded shielding solutions for Integrated Chips using the printability properties exhibited by some electromagnetic shielding polymer formulations. This technique has not yet been exploited to incorporate embedded shielding solutions that provide local shielding within larger structures. Novel material formulations and modified 3D printing methods will allow to achieve the required trade-off between shielding efficiency and processibility while maintaining sufficient resolution. Electromagnetic propagation modelling will be used to design demonstrator materials with local shielding capability.

DR12: Time-domain Electromagnetic shieling measurement methodologies for novel materials
Host: UPC (ES)
Main supervisor: Dr. Marco A. Azpúrua (marco.azpurua@upc.edu)
Co-supervisors/mentors: Dr. Marc Pous (UPC, ES), Prof.dr.ir Frank Leferink (Thales, NL)
Duration: 36 months
Required profile: Telecommunications/Electronic Engineering, Physics, Metrology
Desirable skills/interests: Electromagnetic modelling and simulation, Experience in conducting measurements, Design of Experiments (DOE), Estimation of the measurement uncertainty, Computer Assisted Design (CAD), 3D printing
Objectives: This DR will take up the challenge of investigating time-domain techniques intended to simultaneously assess the electric and magnetic field shielding effectiveness. The methodologies will be applied to novel materials like composite or 3D printed structures. The possibility of obtaining equivalent, yet simplified, EM simulation models for heterogeneous materials will be evaluated and validated both numerically and experimentally. The measurement setup will be modelled and analysed to calculate the measurement uncertainty. Efforts will be made to minimize experimental error

PARASOL is a Doctoral Network at the intersection of electromagnetic compatibility (EMC), materials engineering, system-safety engineering, and sustainability management. The project centres on the Safe and Sustainable-by-Design (SSbD) approach as applied to vehicles. The project will investigate electromagnetic (EM) shielding solutions, which are performance-defining technologies in terms of EM safety, weight, volume, mechanical strength, and the cost of a vehicle.

PARASOL's science case is based on the integration and optimisation of every Key Performance Indicator (KPI) in the SSbD approach. This requires thinking in terms of a trade-off across a new mix of disciplines, to develop innovative solutions accordingly, and to consider all the far-reaching societal and technical consequences of the design choice. Up to now, even most high-tech industries are forced to manufacture several prototypes and perform tests, because the actual performance of shielding in the final vehicles is unknown. A characterisation strategy embedded in the SSbD approach is urgently needed.

PARASOL is the first training network dedicated to the inclusion of the SSbD approach in the design of electronic equipment. It answers the recently highlighted, pressing need for trained specialists in the field.

PARASOL involves 6 Hiring Universities and 16 industrial Associated Partners, across the complete lifecycle of design solutions, from 6 countries. A pan-European approach in a multi-sectoral context is guaranteed (universities, an established start-up, SMEs, and major industries), while representing all types of vehicles (land, air, marine).

PARASOL will train a new generation of scientific professionals who can transition between disciplines and take up leading positions in the field of electronics, safety, and sustainability, while thinking differently in terms of design solutions. These professionals can support Europe's ambition to play a major role in the safety-critical market for vehicles.

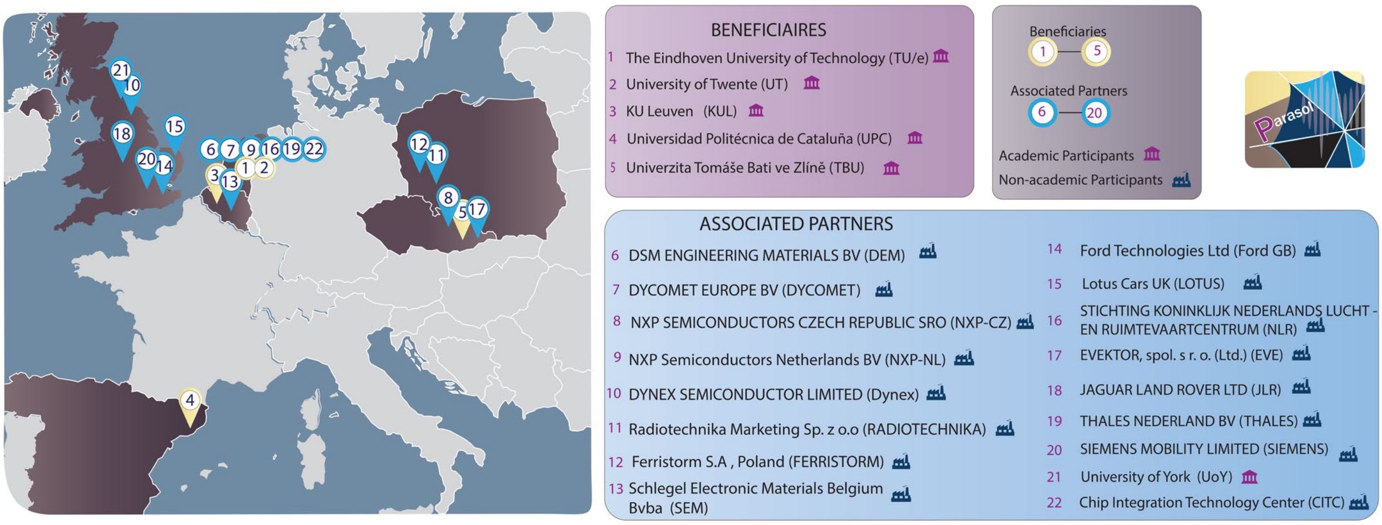

Figure 1: PARASOL Consortium

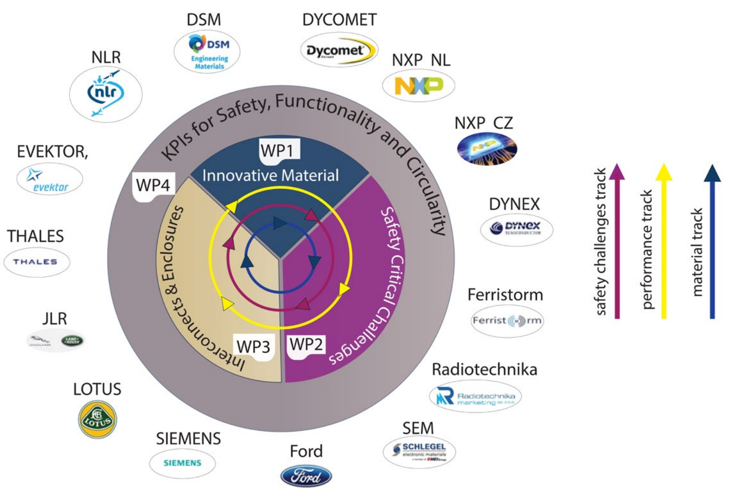

Figure 2: PARASOL WPs and DRs

The Work Packages (WPs) of the PARASOL network are consistent with the lifecycle of shielding solutions for mobility market. The Doctoral Researchers (DRs) will be trained to work in multi-disciplinary and multi-cultural teams, with a new mindset tuned towards defining and including the holistic SSbD approach across the lifecycle of innovative shielding solutions, from a material's conception to its embedding into on-board enclosures and shielding solutions. For this to occur, each DR will build the missing connections and missing KPIs across the stakeholders and lifecycle steps of the shielding products. They will develop innovative and dedicated tools and techniques and apply them to a set of representative shielding products on-board a train, a plane, a ship, and a car. This hands-on training is supplemented with several professional scientific courses and an immersive training course where the DRs can fine-tune their skills for the Jobs of tomorrow[5], while addressing the societal challenges (SCs) of the PARASOL programme.
The solid diversity of industrial cases, covering most of the relevant forms of transport in Europe, at different stages of their lifecycle, will ensure that the network runs smoothly, while strengthening the interactions and the exchange of academic and non-academic resources. From the market perspective, PARASOL covers all 4 key transport systems with rail, shipping, automotive, and aerospace stakeholders.

The consortium is formed by 6 universities, TU/e (NL), UT (NL), KU Leuven (BE), UoY (UK), UPC (ES) and TBU (CZ). Together, these universities have a proven track record in the management of EMI, material engineering, system-safety engineering, and risk management, and are the leaders in their field in Europe. Existing knowledge in sustainability management will be reinforced by connecting the industrial network of PARASOL's 16 industrial stakeholders across the complete lifecycle of shielding-design solutions.

A total of 12 individuals DR projects have been defined, which contribute to the WPs. Through their project definition and their common secondments, each DR will have a mix of requirements, design, and system-level verifications. While each DR project has been defined as a stand-alone contribution, several collaboration points have been planned to bring complementary results together and give extra value-added to the project. The inter-relation between each DR project and their corresponding core WPs are described below.

WP1: Innovative shielding-material development, characterization, and assessment

WP1 addresses the development and assessment of innovative shielding materials through their complete lifecycle in line with the SSbD approach. Apart from EM shielding, these materials traditionally protect electronic devices from corrosion and oxidation. Metal is typically the best option for EMC shielding, but it is sometimes not preferred due to its high density, high cost, and susceptibility to environmental degradation. Polymeric materials are lighter and cheaper to manufacture, they can sustain much larger deformations without permanent damage, but they also lack inherent EMC shielding capabilities – and this is where PARASOL will act.

WP1 combines the SSbD approach to the innovation of adding EM-absorbing and reflective properties to polymeric materials. **DRs 1 and 2** will develop two different types of innovative shielding materials. Along with their holistic characterization, end-of-life recycling, safety for humans and our environments as well as reusability performances will be considered. **DR3** will extend the EM characterization to the missing and challenging low-frequency band where critical new EMI is occurring due to on-board electrical power conversion.

DR1 will develop *new sustainable coatings for EM shielding with plastics*. The latest advances have shown that cold-spray technology is feasible for coating polymers as well as being sustainable for the environment: low energy consumption and thus CO_2 footprint, longer product lifetimes, efficient use of raw (and recycled) materials. Moreover, coatings offer an easier component separation than filled plastics. DR1 will have access to the cold-spray facilities of DYCOMET and the characterization laboratories at DEM to investigate mechanical and thermal strength, aging or resistance to scratching (to name just a few examples). EM performance will be optimized by introducing functional nanoparticles in the cold-spray formulation. DR1 will test the developed technique on a real-life plane enclosure at NLR. **DR2** will take up the challenge of *developing the first in-situ EM characterization probe*. It aims at investigating the final performance of an installed, on-board material, measure the deviation in the production process and the impact of long-term environmental effects. This new probe will be tested on a set carbon-fibre-filled plastics that she/he will produce together with specialists from DEM. To overcome the intrinsic connection limitations in such fibre composites, synergistic filler combinations will be exploited (e.g., with carbon fillers provided by the industrial Cabot). Guidelines for the optimization of the reflective and absorbing properties of carbon-fibre filled plastics (over their lifecycle) are lacking. **DR3** will complement the *characterization of innovative shielding materials in the low-frequency range*, where electromagnetic disturbances are very hard to confine by shielding, and proper characterization methods are lacking. In this frequency range, shielding-effectiveness (SE) values depend heavily on the specific source, the source orientation, the distance between source and the shield, etc. **DR12** will investigate innovative time-domain characterization technique, and **DR11** will develop 3D embedded shielding solutions using layer-by-layer approaches. **DR11** will develop 3D embedded shielding solutions using layer-by-layer approaches. It has already been realized that some electromagnetic shielding polymer formulations exhibit printability. However, this technique has not yet been exploited to incorporate embedded shielding solutions that provide local shielding within larger structures. Novel material formulations and modified 3D printing methods (CTIC) will allow to achieve the required trade-off between shielding efficiency and processibility while maintaining sufficient resolution. Electromagnetic propagation modelling will be used to design demonstrator materials with local shielding capability at TU/e. **DR12** will take up the challenge of investigating (in-situ) time-domain techniques

5 Report World Economic Forum, Report on "Future of Jobs 2020", p36, https://www3.weforum.org/docs/WEF_Future_of_Jobs_2020.pdf

which would enable a simultaneous link to be made between Electric and Magnetic field. S/he will validate these techniques on Board Ships (THALES) and with Innovative Shielding Material developed at TU/e.
DRs1, 2, 3 and **11 and 12** are the first contributors to the "***Material track***", where data, measurements and samples are shared between all the DRs of PARASOL to ensure a continuity of the work through the WPs. **DR1** will characterize her/his coated samples together with **DR5** (investigating the shielding of integrated circuits) at DEM. **DR2** will join **DR9** to measure the in-situ performance of carbon-fiber filled materials in plane structures at EVE. And **DR3** and **DR10** at UoY will together extend the scope of the low-frequency testing into enclosures. **DR3** will also visit THALES with **DR7 and DR12** to analyse the impacts of interconnects on-board ships at low frequencies. **DR11** and **DR12** will simulate the EM properties of Innovative packaging solution at TU/e.

WP2: Design and performances assessment of innovative EMI shielding solutions for safety-critical mobility, in-line with the SSbD approach.

WP2 addresses the specific safety-critical challenges of shielding EMI in future mobility. With the increasing use of higher frequencies in electronic components with ever-smaller footprints, it becomes more difficult to confine EM emissions. This is especially true for systems that comprise very different types of circuits that are close to each other, like in autonomous vehicles implementing high-power frequency drives and very-high-frequency radars. The DRs of WP2 will develop innovative shielding technologies at a different scale of the electronic system: integrated-circuit (IC) level (**DR4**), printed-circuit-board (PCB) level (**DR6**) and enclosure level (**DR5**).

Capacitive touch-based control applications for instance are especially sensitive to harsh EM fields and other parasitic environmental effects like temperature drifts and humidity. **DR4** will develop *an active shield method* to increase the robustness and immunity of these safety-critical applications. The developed shield will be tested at UoY. **DR5** will develop and measure *time-domain shielding methods* applicable to an on-board scenario in enclosures. **DR5** will analyse typical shielding scenarios to understand the trade-off between traditional shielding (frequency domain) and waveform control in the time domain. This trade-off will be considered on-board for a series of existing train-based systems at Siemens. **DR6** will design a *Printed-Circuit-Board-Level Shield* and determine its effectiveness using several measurement set-ups. The shielding of IC packages (for automotive applications) with innovative coated material (manufactured by **DR1**) will be modelled and tested with NXP-NL.

DRs 4, 5 and **6** will use and complete the data and samples available in the "***Material track***". They will also directly contribute to the "***Safety challenge track***" where scenarios, design solutions, simulations and results are shared with all the DRs of PARASOL. The DRs of WP2 are also invited to relate to on-going research within the MSCA ITNs [PETER, PARASOL, SAS, AutoBARGE] (all coordinated by the consortium) focusing on EMI risks and EM safety-critical challenges. Within PARASOL, **DR 4 and 5** will visit together NXP-CZ to investigate possibilities to combine active and waveform-shielding technologies. **DR 6** and **DR 1** will visit together DEM to characterize coated plastic material ("***Material track***").

WP3: Characterization and trade-off for enclosures and interconnects

The DRs of WP3 will assess the coherence of the complete and final on-board shielding solutions. There is an explosion in the availability and variety of innovative EM shielding-design solutions acting on both the structural design and the materials. The structural design should minimise the discontinuity and ensure a proper bonding of enclosures at every seam to ensure a homogeneous conductive surface.

New materials (WP1) and innovative shielding solutions (WP2) are combined with bonding techniques such as welding or gaskets. Sometimes even absorbers are added to the cavity enclosures to enhance the performance. **DR7** will characterise *the (im)proper application of interconnects and the effect of the SE of the whole 3D structure.* **DR7** will work with samples from SEM and visit Radiotechnika' s facilities to assess the effect of climatic and mechanical changes on performance. **DR8** will develop new metrology test-benches to *measure shielding effectiveness in terms of actual energy exchange using a cable and its connector*. The technique will be used to optimise the shielding of high-voltage cables at Ford GB. Samples of cables are completed by FERRISTORM (with innovative absorbing coating). **DR 9** and **DR 10** will both focus on the final enclosure of the vehicle. **DR 9** will develop, model, and test *Statistical Transmission and Absorption Metrics techniques* that allow a risk quantification of the real-world shielding effectiveness. **DR 9** will merge this metric (in the laboratories of UT) with the *trade-off* of **DR 10** *between reflection and absorption in real-life enclosures*. DR 10 will complete this trade-off by optimising cable placements with FERRISTORM.

DRs 7, 8, 9 and 10 will share their results within the "***Performance Track***" and will use priority data from the "***Material track***" and the "***Safety challenge track***" to ensure continuity in the evaluation of the performance of innovations initiated in WP1 and WP2, over the complete life cycle. **DR 10, 7 and 1** (WP1) will visit together JLR, Siemens and Lotus, where they will be given access to (plane, train and car) real-life enclosures to optimise performance by merging their respective findings in terms of innovative materials, interconnects, and overall trade-off. **DR 9** and **2** will visit EVE to combine a risk evaluation at the enclosure level with innovative material properties. **DR 7 and 3** will extend the characterisation of interconnects in the low-frequency range on board ships at THALES.

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Advertisement Process: The search for appropriate candidates is initially based on normal recruitment strategies (e.g., publication on ec.europa.eu/euraxess, etc.; personal contacts of the network partners). All the recruitment is in line with the European Charter for Researchers, providing the overarching framework for the roles, responsibilities of both the researchers and employers. The Code of Conduct for the Recruitment of Researchers functions as a set of principles and ensures that the selection procedures are transparent and fair. The recruitment strategy for PARASOL will fully comply with the Code of Conduct's definition of merit. For example, merit is not just measured on researchers' grades, but on a range of evaluation criteria, such as teamwork, interdisciplinary knowledge, soft-skills and awareness of the policy and economic impact of science. The Recruitment Committee (RC) has members of each gender and considers the promotion of equal opportunities and gender balance as part of the recruitment strategy. A special focus will be made to attract female DRs from EU's new Member States.

Selection Process: The pre and final selection will be made in a collective progress, led by the Recruitment Committee (RC), which consists of all the people who will be involved in the supervision process. Every member of the RC will receive 4 hours of training on recruitment procedures and will be made aware of factors like unconscious gender bias. The candidates can apply for a maximum of three projects and list their order of preference. The 30 most suitable candidate DRs are invited to a Recruitment Workshop (Eindhoven, the Netherlands). Each candidate gives a presentation and is interviewed. The committee selects the DRs (1) based on their scientific background and potential, (2) based on the expected benefit of the scientific exchange between the trainees' home countries and institutions and the hosts, and (3) in accordance with gender equality and minority rights. The candidates are ranked, and a collective decision is made, considering the order of preference. In this way a complementary team of DRs can be assembled. All non-selected candidates will receive a letter explaining the reasons why they were not selected (in line with the Code of Conduct). The DRs are employed on fixed-term contracts and are registered as staff candidates for their PhD degrees. Therefore, they are entitled to pension contributions, paid holidays, and other employment benefits, as governed by the universities, non-academic partners, and industrial companies.

In case not all 12 DRs can be recruited during the collective Recruitment Event, the recruitment procedure is "decentralized", meaning that the involved supervisors continue the search for good candidates. The RC is kept always informed when new eligible candidates appear. The RC makes an official complaint in case the Code of Conduct for the Recruitment of Researchers is breached. The involved supervisor is then expected to find another candidate. Recruitment problems are also, if still needed, discussed during the first PARASOL Network Wide Events (M6, M12) to deliver specific action plans to target specific networks relevant for the vacant DR positions.

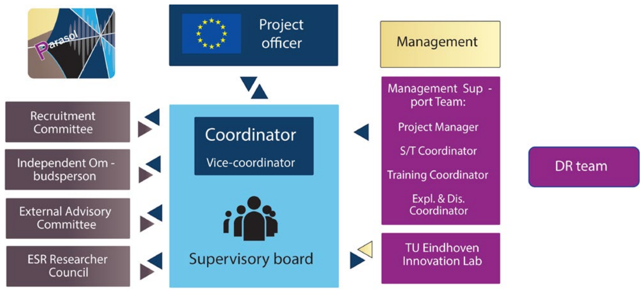

Figure 3: PARASOL Project Management Structure

Recruitment Committee = This committee involves the General Coordinator, the Vice-Coordinator and at least one representative per hiring University. Its goal is to oversee the recruitment of the 12 DRs during the collective recruitment event.