

COST Action BM1309:
European network for innovative uses of
electromagnetic fields (EMFs)
in biomedical applications
EMF-MED

Proposer:
Prof. dr. Antonio Šarolić
FESB, University of Split
CROATIA

Aim:

To build an interdisciplinary European network for innovative uses of electromagnetic fields (EMFs) in biomedical applications

Initial network (current state):

- ~80 experts, representing an overall number of at least ~230 participants
- Dispersed in 26 countries: 25 COST countries spanning all across Europe, plus USA
- Connected through the preparation of this proposal – a new network

Presentation outline:

- Introduction and history of the proposal
- Objectives and working programme
- Networking

Idea

- Human body → an electrical object
- Numerous possibilities of interactions
- **Why not** use them for the benefit of health...

...systematically?

Background

- Previous research initiatives: harmful short-term effects of high-level EMFs
- **Beneficial** biological effects → **health-promoting** uses and applications
- Based on both high-level and low-level EMFs

Exciting possibilities

- EMF-based cancer treatment
- EMF exposure/stimulation of excitable and nonexcitable tissues
- Interaction mechanisms still not understood (!)

Needs

- Existing applications → improvement and optimisation

- Long-term biological effects:

Directive 2013/35/EU of the European Parliament and of the Council of 26 June 2013 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields), OJ L 179, 29/06/2013, p. 1-21 ("EMF Directive").

Initiative

- All pre-conditions now getting adequate for systematic approach → COST Action EMF-MED
- Beneficial effects → great potential for research and innovation

History of the proposal

- This shift of focus was proposed by the Action proposer, to a multidisciplinary group of EMF researchers at the last BM0704 MC meeting in Lisbon April 2012.
- Proposal promptly supported by a group of researchers who have already started to study the beneficial effects of EMFs in biomedical applications.

History of the proposal

- Workshop was organized in May 2012 in Zurich, to review both the state of the art, and the potentials.
- The workshop yielded a consensus on the Action aims and objectives, research topics, keywords, Action title.

History of the proposal

- Shortly after the workshop, the first draft of the preliminary proposal was produced and circulated via the mailing list of interested researchers, with request for comments.
- Based on the received responses, the next version was assembled and circulated to the continuously updated list of participants.

History of the proposal

- This procedure was repeated several times, first with the preliminary, then with the full proposal.
- The process has been fully transparent in all phases, ensuring that all opinions are included, and that the final material represents a consensus. .

History of the proposal

- The proposal was applied to the 2nd Call in 2012.
- The preliminary proposal passed.
- The full proposal was evaluated just below the threshold, not reaching the final stage of evaluation (DC hearing).

History of the proposal

- The proposal was then improved according to received comments, and reapplied to the 1st Call in 2013.
- After passing the Preliminary Proposal stage (ca. 20 out of 100 apps), and the Full Proposal stage (ca. 10 out of 20 apps.), the proposal was presented to the BMBS DC in September 2013 at the "DC hearing", by the proposer.

History of the proposal

- Out of 10 presented proposals, only 4 have been approved, yielding the final success ratio of 4%.
- The Action was approved as Action BM1309 by the decision of CSO in november 2013.

COST EMF-MED –

a new course in biomedical EMF research!

COST EMF-MED Objectives

- 1) Build the capacity for scientific networking and research on the topic of innovative and beneficial uses of EMFs in biomedical applications within Europe, increasing the number of highly trained and qualified researchers, pooling the relevant knowledge and research facilities, and establishing collaborations that will result in new research initiatives
- 2) Achieve a better understanding of EMF interactions with the human body at the molecular, cellular, tissue and system level, and the resulting health impacts

COST EMF-MED Objectives

- 3) Provide a sound scientific basis for better understanding of the existing and the introduction and development of innovative applications of EMFs in medicine
- 4) Develop appropriate computational and measurement tools for EMF dosimetry as well as optimal exposure and application setups

COST EMF-MED Objectives

- 5) Enable Early-Stage Researchers (ESRs) to gain knowledge and training in this promising field, and maintain the gender balance

- 6) Promote and/or establish new links with industrial partners, by converging academic and industrial research – resulting in possible new commercial applications, increasing the number of academic partners collaborating with industrial partners

COST EMF-MED Objectives

- 7) Provide inputs and recommendations for Health Technology Assessment (HTA) for commercial applications and for adequate policies, evaluation, monitoring and vigilance systems

- 8) Strengthen the position of EU in this field with respect to the rest of the world

Quantitative indicators

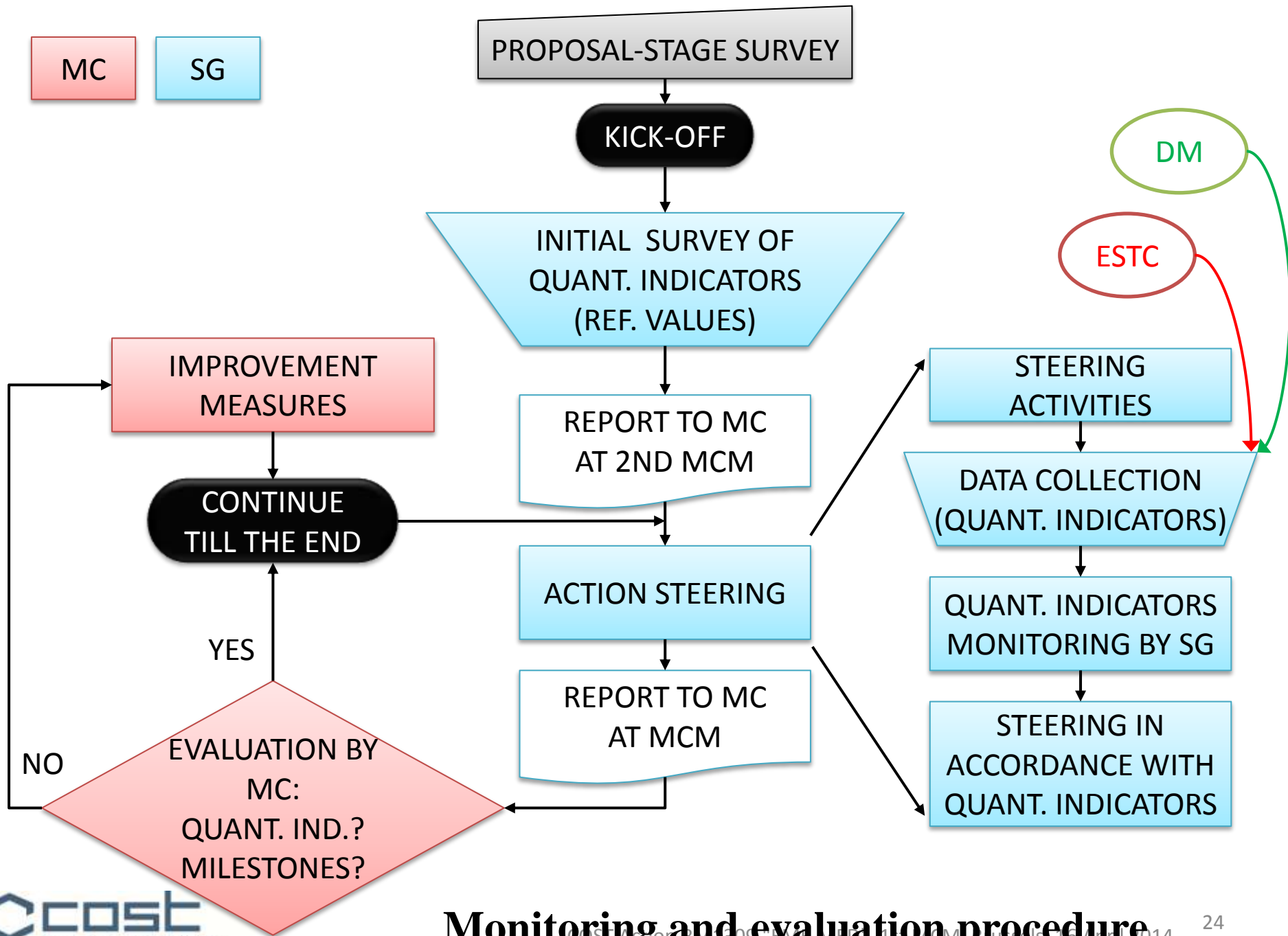
- active participants from COST countries
- active participants from non-COST countries
- Early Stage Researchers (ESRs) involved
- number of men and women involved
- companies involved or interested in the Action (especially innovative small and medium enterprises – SMEs)
- organized networking events (meetings, workshops etc.)

Quantitative indicators

- completed Short Term Scientific Missions (STSMs)
- Training School attendees
- studies undertaken by the participants, and specifically, undertaken in collaboration of different participating groups
- scientific publications authored during the course of the Action, and specifically, co-authored in collaboration of different participating groups
- reports and publications disseminated by the Action

Quantitative indicators

- researchers visiting other research groups and laboratories
- theses (especially PhDs) achieved on the Action topics
- subsequent initiatives for collaborative research
- contacts and queries received from outside of the Action, and specifically, from outside of Europe



Monitoring and evaluation procedure

Milestones

- Month 1: 1st MC meeting, management and organizational structure established.
- Month 3: Website set up.
- Month 12: Accomplishing yearly meeting activities given in the Timetable (section F) followed by the increase of quantitative indicators described in section C.2 with respect to their initial values (successful completion of year 1).

Milestones

- Month 24, Month 36: Accomplishing yearly meeting activities given in the Timetable (section F) followed by the increase of quantitative indicators described in section C.2 with respect to each previous year (successful completion of years 2 and 3).

Milestones

- Month 48: Accomplishing yearly meeting activities given in the Timetable (section F) followed by the increase of quantitative indicators described in section C.2 with respect to year 3, and publishing the final publication - an edited book or report summarizing Action achievements and accumulated knowledge on beneficial uses of EMFs in biomedical applications (successful completion of the Action).

Networking to achieve objectives

- Forming a European network of research groups (joined by key experts from non-member countries) working on relevant topics
- Concerting the activities of individual research groups, while tasking and focusing their research according to the Action objectives
- Structuring the Action activities into working groups devoted to interdisciplinary approaches to major topics and applications

Networking to achieve objectives

- Jointly analyzing the research results and strategically guiding further research through Management Committee (MC) and Working Group (WG) meetings, workshops, and other types of conferencing
- Fostering the formation of new European and other research initiatives and new research groups, to study relevant topics that are highly prospective, yet currently insufficiently addressed in the EU with respect to the rest of the world

Networking to achieve objectives

- Fostering the involvement and training of Early Stage Researchers (ESRs) to ensure a sound basis for further research in these important topics
- Fostering the cooperation that will lead to joint participation in European and other international research initiatives
- Disseminating information, involving SMEs and all other relevant stakeholders in the activities, either as participants, or as target audience for the dissemination of results.

Impact

- Improved, optimized, safer, more efficient and less invasive cost-effective therapeutic and diagnostic applications
- Boost to the current healthcare systems, associated technologies and SMEs
- Breakthrough discoveries and innovations

Impact

- Research and innovation capacities → subsequent targeted R&D projects
- Better understanding of the long-term biological effects – in line with "EMF Directive"

Target groups/end users

- researchers, engineers, and other experts in R&D sector of EMF-based biomedical technologies;
- Early-Stage Researchers and students (especially PhD students) in the related fields;
- health care institutions and medical practitioners, who apply the EMF-based medical devices in clinical settings;

Target groups/end users

- industry, especially small and medium enterprises (SMEs) in the field of biomedical technology, both new start-ups and established enterprises, aiming to improve their products
- government and administration bodies during legislative procedures, policy making or when making strategic decisions regarding EMF-related applications and issues

Target groups/end users

- international organizations, bodies, agencies, societies, and other policy makers in need of scientific knowledge, or when considering scientific facts in the related fields
- standardization bodies and technical committees when preparing relevant technical standards

Target groups/end users

- ultimately and most important: the general public, receiving better health care based on innovative, efficient and less invasive EMF-based biomedical technologies

Initial state of the network (Full Proposal)

Out of 77 listed experts, there are (at least):

- 15 researchers conducting or connected to the clinical hospital research or practice;
- 14 members of government and administration bodies (mainly national);
- 27 members of various international organizations, bodies, agencies, societies, and other policy makers (e.g. ICNIRP, EBEA, BEMS, IEEE, WHO, and many other field-specific associations), some of them serving as chairpersons or officers, i.e. at decision making levels;

Initial state of the network (Full Proposal)

- 18 members of various standardization bodies and technical committees (at national, European, and international level), some of them serving as chairpersons or officers, i.e. at decision making levels;
- 9 participants representing or connected to industry partners (SMEs) in the field of biomedical applications.

The numbers are indicative - overall number of participants throughout the participating groups is much larger than 77.

Scientific focus - Topic 1: EMF-based cancer interactions, treatment and related applications

Low-level EMF cancer treatment:

- Local or whole-body treatment with low-level EMFs having accurate and precise characteristics
- Interactions at non-thermal level

Topic 1: EMF-based cancer interactions, treatment and related applications

Low-level EMF cancer treatment:

- Emerging methodology
- Breakthrough potential
- Explanation still lacking (!)

Topic 1: EMF-based cancer interactions, treatment and related applications

High-level EMF cancer treatment:

- Using high-level EM energy to overheat the tumour
- Difficult to target the tumour tissue without damaging the surrounding tissue

Topic 1: EMF-based cancer interactions, treatment and related applications

High-level EMF cancer treatment:

- Could be improved and optimized by:
 - personalised treatment planning
 - novel types of antennas and applicators
 - using magnetic nanoparticles

Topic 1: EMF-based cancer interactions, treatment and related applications

EMF-based cancer diagnosis:

- "tumour-specific frequency signature"
- impedance tomography and radar-like applications
- use of functionalized nanoparticles (e.g. magnetic)
- complementing current methods, improve diagnosis accuracy.

Scientific focus - Topic 2: EMF-based non-cancer interactions and applications

EMF stimulation/exposure of excitable and non-excitable tissues

- surface, subcutaneous, implanted electrodes (electric field)
- contactless application (magnetic field)

Topic 2: EMF-based non-cancer interactions and applications

- Excitable tissues:
 - inducing, suppressing, or synchronizing spiking and signal propagation across neurons
 - treating neurological, neurodegenerative and psychiatric disorders and conditions

Topic 2: EMF-based non-cancer interactions and applications

- Non-excitabile tissues:
 - affecting cell differentiation and proliferation
 - e.g. tissue healing, growth, or regeneration; fractures and non-union consolidation

Topic 2: EMF-based non-cancer interactions and applications

- Excitable and non-excitable tissues:
 - need for better understanding of mechanisms between stimuli, target tissues, and targeted diseases or effects
 - need to improve targeting and optimize the stimulus

Topic 2: EMF-based non-cancer interactions and applications

- Topic 2 also includes other biomedical procedures, applications, and technologies, that are:
 - essentially and functionally based on EMFs
 - benefiting from sharing or reusing the same research methods and tools

Scientific focus - Topic 3: EMF dosimetry – *in silico* tools and measurements

- Understanding and control of physical, technical, and tissue parameters
- Achieving and maintaining repeatability of experiments and procedures (needed in Topics 1 and 2)
- Relying on computational simulations ("*in silico*" tools) and measurements

Topic 3: EMF dosimetry - *in silico* tools and measurements

- The tools to be developed or improved include:
 - simulation tools (multi-physics, multi-scale)
 - anatomical models (functionalized, integrated, multi-level)
 - dosimetric measurement equipment and methods
 - exposure/application equipment and methods (for tight control over relevant parameters)

Working groups:

- WG1 – Cancer EMF interactions and applications
- WG2 – Non-cancer EMF interactions and applications
- WG3 – EMF dosimetry - in silico tools & measurements

Working modules

- Working modules specified by WGs and MC
- Achieve and maintain focus and efficiency
- Candidates for topics of subsequent workshops

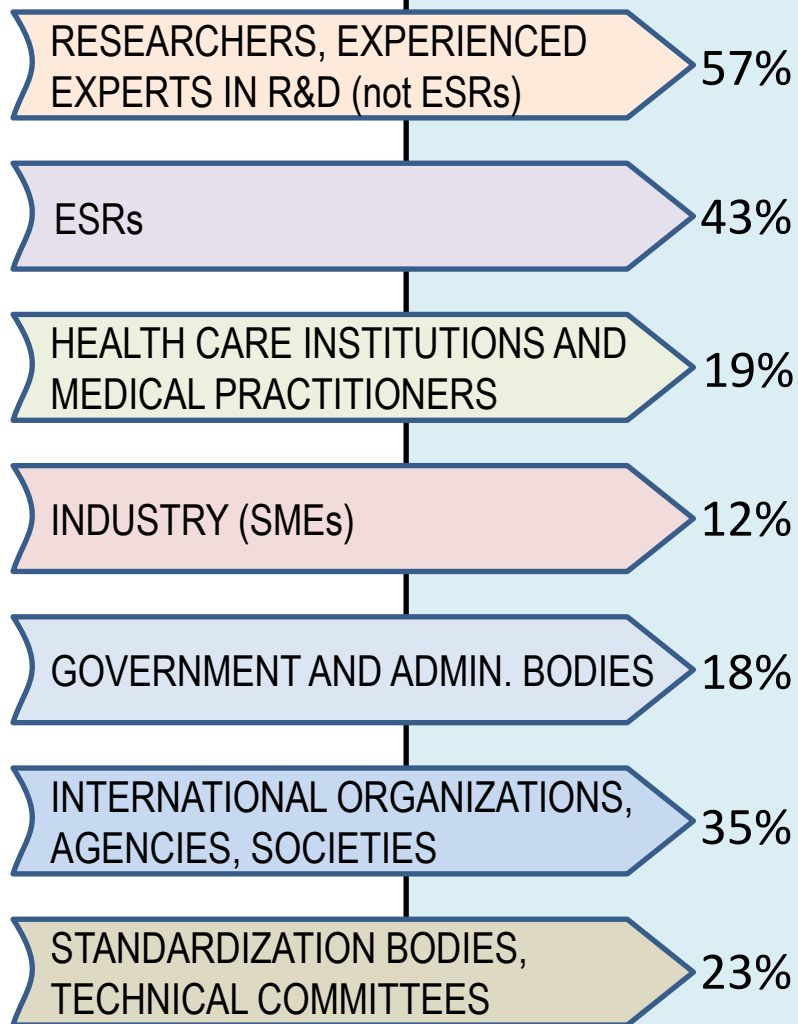
Working modules

- Cancer treatment with amplitude modulated EMFs
 - Optimization of high-level EMF cancer treatment
 - Tissue healing using low frequency EMFs
 - Optimization of techniques for neural tissue stimulation
 - Functionalized computational anatomical models for personalized EMF treatment
- etc.

Research methodology

- The research should be interdisciplinary, application oriented and result oriented.
- Multidisciplinarity - each discipline does its own part of the work, not necessarily knowing what other disciplines do for their part of the work. ☹️
- Interdisciplinarity - the synergy of disciplines working together at the same time on the same problem, deeply involved in each other's work. 😊

STAKEHOLDERS/ END USERS:



PARTICIPANTS (228)

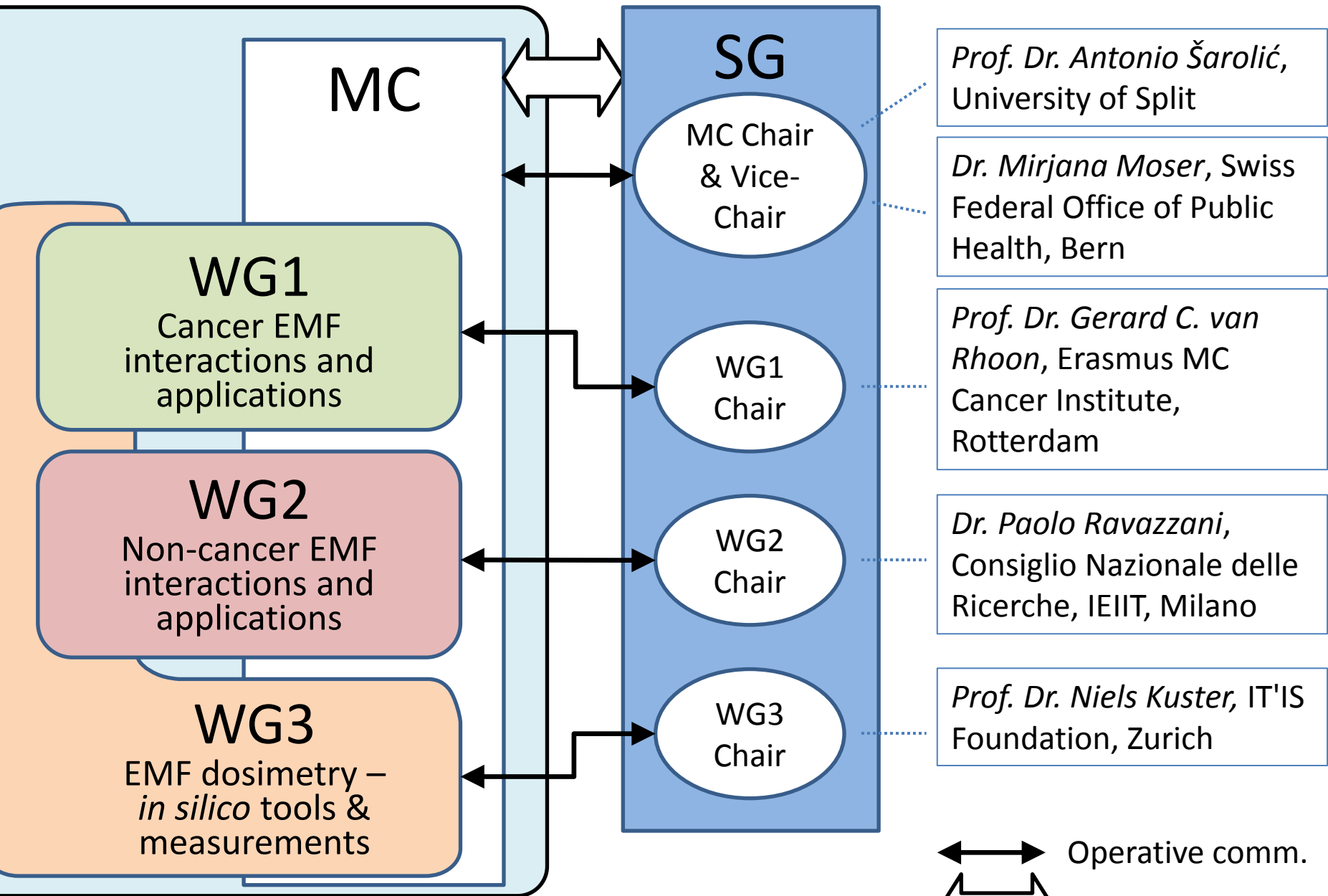
MC
(44)

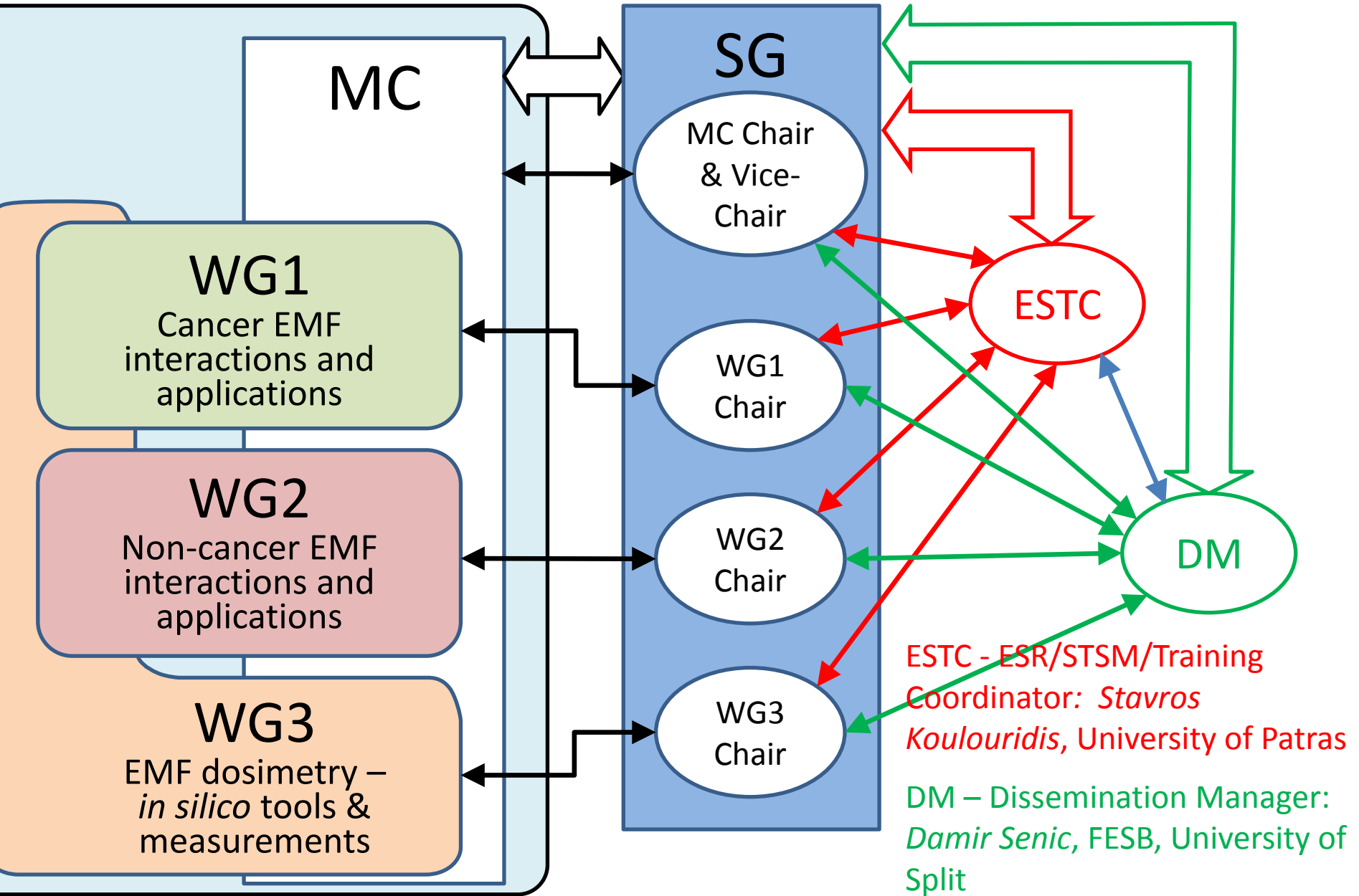
WG1
Cancer EMF interactions and applications

WG2
Non-cancer EMF interactions and applications

WG3
EMF dosimetry – *in silico* tools & measurements

Organizational structure



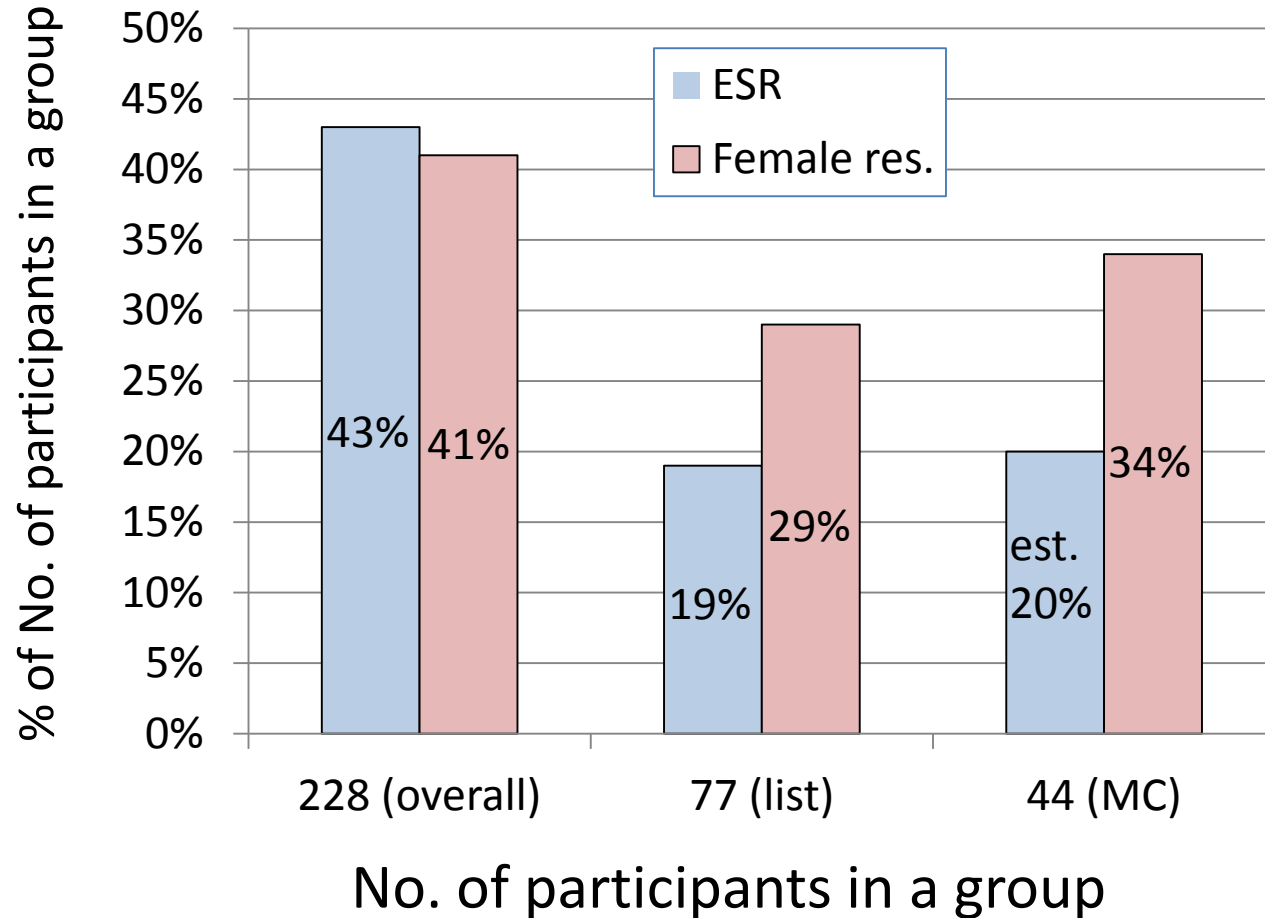


ESTC - ESR/STSM/Training Coordinator: *Stavros Koulouridis, University of Patras*

DM – Dissemination Manager: *Damir Senic, FESB, University of Split*

Organizational structure

ESR and gender balance



ESRs

- "The Action will be committed to considerably involve Early-Stage Researchers. This item will also be placed as a standard item on all MC agendas."
- One of the objectives of the Action is to enable early stage researchers (ESRs) to gain knowledge and training in the field of EMF-based biomedical applications.

ESRs

- ESRs are regarded as one of the target groups/end users of the Action
- Monitored and evaluated using Quantitative Indicators, i.e. number of: ESRs involved; completed STSMs; Training School ESR attendees; theses (especially PhDs) achieved on the Action topics.

ESRs

- ESRs trained to become interdisciplinary personalities, i.e. to gain additional expertise in complementary disciplines.
- ESRs will have priority when approving STSM and Training School grants, and they will be encouraged to apply for the COST Conference Grants.

ESRs

- Dedicated person to coordinate ESRs and the associated training and STSM activities:
ESR/STSM/Training Coordinator (ESTC).

Gender balance

- "This COST Action will respect an appropriate gender balance in all its activities and the Management Committee will place this as a standard item on all its MC agendas."
- Interdisciplinary Action composed of life sciences mixed with engineering - could yield an appropriate overall gender balance in the Action?

Gender balance

- The Action will foster cross-discipline involvement of the less-represented gender, using STSMs and Training Schools as appropriate mechanisms.
- This will be managed by the SG with the help of ESTC.

Timetable (planned)

Activity	Year 1	Year 2	Year 3	Year 4
Kick-off meeting	x			
Website set up	x			
MC Meetings	x x	x x	x x	x x
WG Meetings	x x	x x	x x	x x
Workshops		x	x	x
Training Schools		x	x	x
STSMs	> 4 per year	> 4 per year	> 4 per year	> 4 per year
Newsletter	monthly	monthly	monthly	monthly
Reports and evaluation		x	x	x
Final publication				x

*Final publication - an edited book or report summarizing Action achievements and accumulated knowledge on beneficial uses of EMFs in biomedical applications

**COST EMF-MED –
a new course in biomedical EMF research!**

Thank you for your attention!