European Innovation Council

Workshop on MedTech & MedDev with Member States representatives

On 22nd September 2022, Enric Claverol-Tinturé, EIC Programme Manager (PM) for Medical Technologies & Medical Devices hosted a workshop to present future EIC challenges to European Union Member States and Associated States. The online workshop was moderated by the Head of Unit Anne-Marie Sassen. Each part of the agenda was followed by an interactive part in which representatives gave their input and raised questions.

Claverol-Tinturé started his session by highlighting the importance of targeting funding to areas where Europe could retain or gain competitive advantage as well as ensuring appropriate focus on EU and global societal challenges. Following this, he explained the differences between Pathfinder, Transition and Accelerator and presented his challenges ideas for next year. The proposed challenges for 2023 include "Full scale Micro-Nano-Bio devices for medical and medical research applications", providing opportunities for previous *lab-on-chip projects* to make it to the market *(Transition),* and *Stop pandemic social distancing by smart aerosol/surface decontamination tech* (Accelerator). Topics for 2024 and beyond include *Defeating blindness by retina reprogramming* (Pathfinder) and *Low-field MRI for the developing world* (Accelerator).

Representatives pointed out the challenges posed by the new MDR (Medical Devices Regulation) for academia, SMEs and healthcare setting in terms of regulatory landscape. They suggested having a broad topic that is meant to help projects with the process of complying with MDR. A further recommendation to deal with the MDR was the provision of courses on regulatory issues by the EIC. In this regard, Sassen highlighted that EIC Programme Managers build portfolio of projects with common thematic approaches. This allows the EIC to identify common needs of funded projects as well as to provide targeted support, MDR being a good example.

Regarding feedback on the specific technological challenges presented, representatives highlighted the relevance of retina research, medical robotics and automation as well as circularity in the context of medical technologies. Claverol-Tinturé thanked participants for their contribution and noted that these will be taken into consideration for the Work Programme 2023.

Anne-Marie Sassen closed the session by informing participants that the slides will be made available in the upcoming weeks and reiterated that representatives are welcome to share their inputs by reaching out to EISMEA-D.02@ec.europa.eu

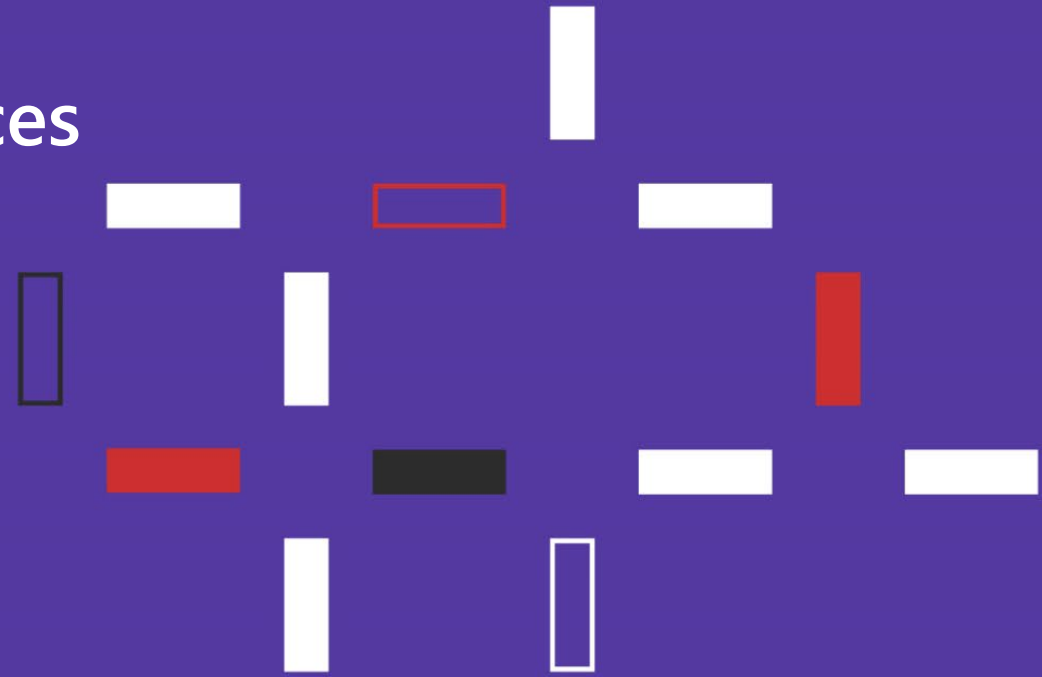
22 September 2022
Meeting with Member States

European Innovation Council

Backing visionary entrepreneurs

Medical Technologies and Medical Devices

***Enric Claverol-Tinturé**, EIC Programme Manager*



DISCLAIMER: The view expressed in this presentation is the sole responsibility of the Programme Manager and does not necessarily reflect the views of the European Commission

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An example of medtech supported by EIC:

Startup : Feops (*www.feops.com*)

Clinical Trial PREDICT-LAA : SUCCESSFUL!

Medtech topics

1. **Background** (5 min approx.)
   Why look for tech topics? Differences between Pathfinder and Accelerator
   Transition: bridge support from PF to Accel

2. **Discussion** on specific topics
   2.1 Neurotechnology (WP2021)
   2.2 Medtech Transition (WP2021)
   2.3 Health Continuum (WP2022)
   2.4 Transitioning Micro-Nano-Bio-Systems (WP2023)
   2.5 Aerosol and surface decontamination (WP2023)
   2.5 Defeating Blindness (2024-)
   2.6 Low-field MRI (2024-)
   2.7 Protein-sized medical devices (2024-)
   2.8 Robotic medical scientists(2024-)
   2.9 Quantum medical technologies (2024-)
   2.10 Micro/Nano bubbles (2024-)
   2.11 High-tech Psychiatrist (2024-)

3. **Closing** comments (5 min)

Medical Technologies and Medical Devices

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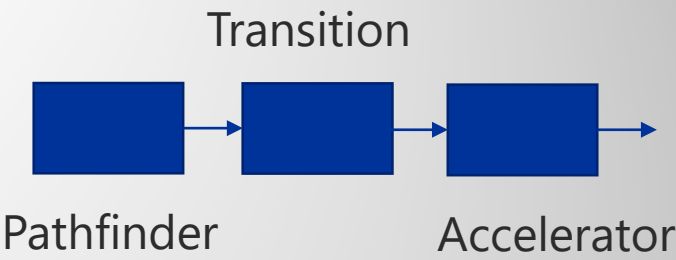
Background

Why look for tech topics?



- To create a pipeline of tech projects and companies with high probability of reaching market

- To ensure appropriate focus at EIC on important EU and global societal Challenges

- To contribute EIC with policy at Commission level (e.g. strategic autonomy)…

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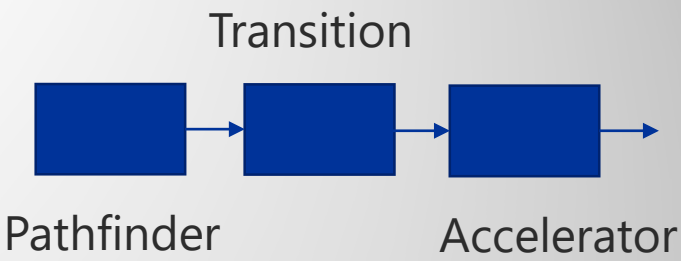
Pathfinder vs Accelerator topics



Pathfinder

Topic = area where an important problem needs a new tech solution.

Realizing this solution will bring societal change and market advantage.

We allow and encourage high-risk high-return technology developments.

But target a real user need (future product or service).

Creativity by technology inventors is welcome.
But fundamental research is more appropriate for ERC and other programmes.

Focus on an end tech product.

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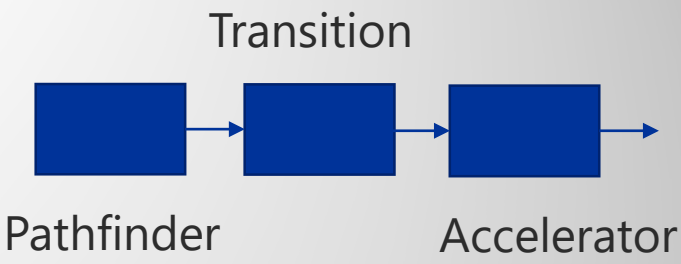
Pathfinder vs Accelerator topics

Accelerator



Topic = area where new tech solutions are ready to reach the market.

Focus on reaching the persons in need of the solution (market entry).

Focus on growing a Europe-based Global Leader.

We allow and encourage entrepreneurial risk taking.

Target a real user need ("short-term" product or service).

Limited research appropriate for Accelerator (given limited time-frame to enter market).

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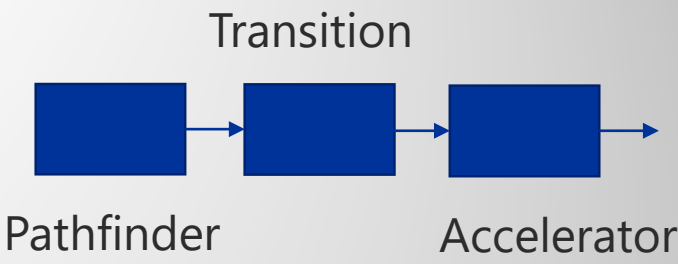
Transition



Capture the most “transitionable” results from PF

Bridge funding to increase readiness for investment

Topics = broad scope, cast a wide net to avoid missing opportunities

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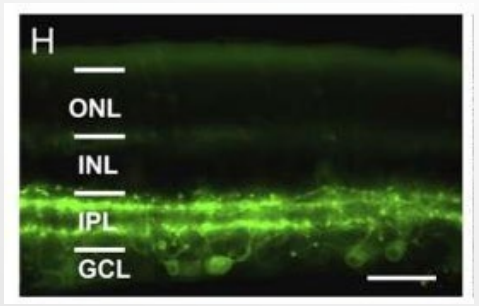
Pathfinder topic:

Cure the <u>electric</u> brain *with XXI century <u>electronics.</u>*

WP2021

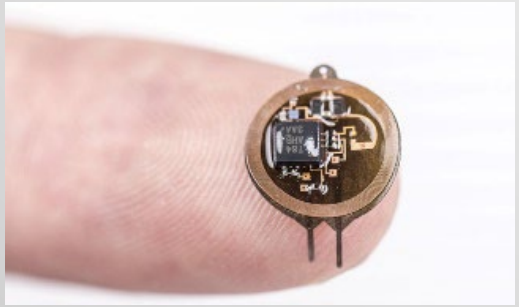


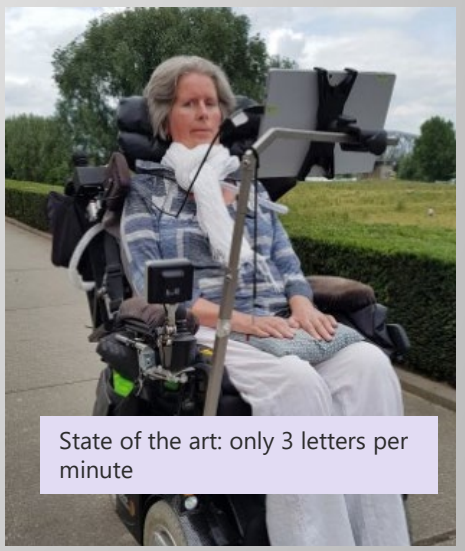
SCI *Locked-in Syndrome/ALS*

Parkinson's *Depression*

Brain Surgery

Epilepsy *Essential tremor*





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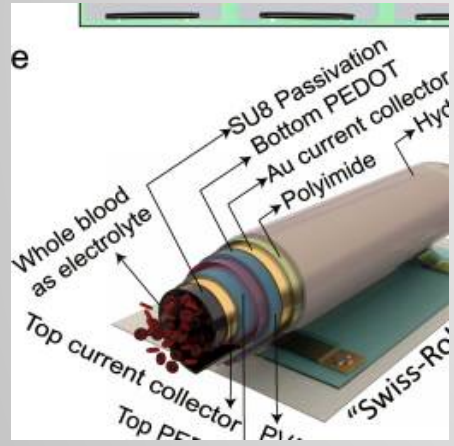
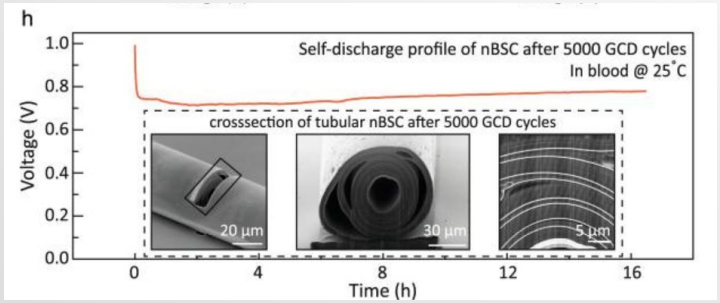
Pathfinder topic:

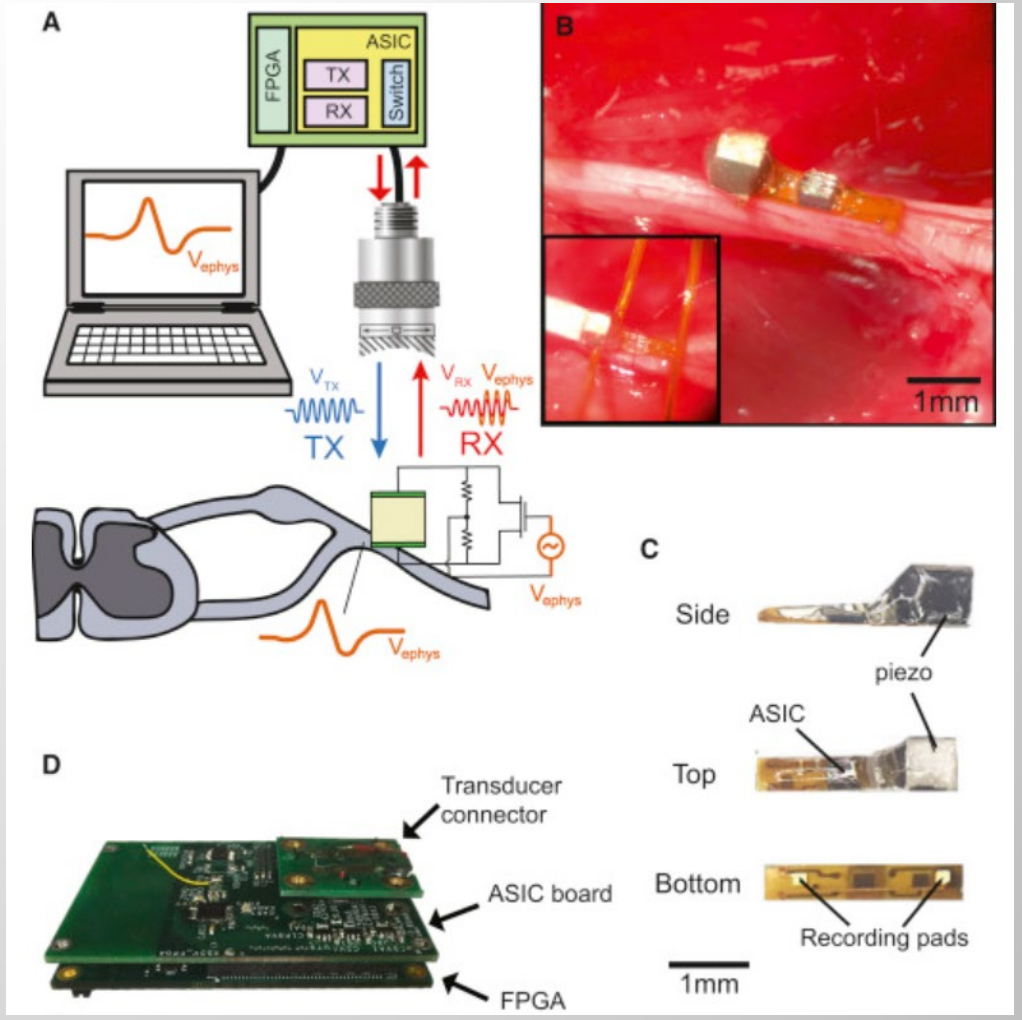
Cure the <u>electric</u> brain *with XXI century <u>electronics.</u>*

WP2021

Battery-less US-power smart-dust for nerve recordings







[Nat Commun.](#) 2021; 12: 4967

Biosupercapacitor (vol:1nL, 90nWh/mm^3)
Intra-vascular microsensors/microsystems
Blood pH sensor
Progress towards solving self-discharge problems

Seo etal. Neuron
Volume 91, Issue 3, 3 August 2016, Pages 529-539

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Transition topic:

Medtech opportunities for transition

WP2021

Note: wide scope to capture the best opportunities

Total funding €20M for medtech, 9 projects

Raman for AI-enabled cancer histopathology
Novel Hearing Aids,
Non-invasive optoaccoustic glucose sensing,
Handheld Ultrasound portable imaging,
…

III.2.1 EIC Transition Challenge – Medical Technology and Devices: from Lab to Patient

EU funded early stage Research on novel Medical Technologies and Devices is uncovering unique opportunities to benefit patients and support clinicians.

Yet transitioning from a proof-of-concept result to a level of technological maturity appropriate for clinical evaluation poses significant technical, financial, business and operational challenges to innovators in the field.

The early stage devices must often evolve substantially, being recast with electronics, software, materials, ICT system operating environments and processes compliant with the appropriate safety standards, e.g. IEC 60601, ISO 10993, etc. and suitable for future manufacturing with appropriate quality levels, etc. in line with ISO 13485.

Moreover, thorough safety and efficacy validation of Medical Technologies and Devices in a clinical setting is necessary to advance towards regulatory compliance, to fully gauge the potential of the technology jointly with clinicians and patients and to motivate private-sector involvement.

Medical Technology and Devices businesses are also facing long and capital intensive product development cycles, complex regulatory procedures, slow market uptake requiring the support of key opinion leaders and intensive follow-up with early adopters. As a result, in addition to a mature technology, a well thought-out and realistic exploitation path with emphasis on achieving market traction as proof of both clinical and market potential of the idea is needed.

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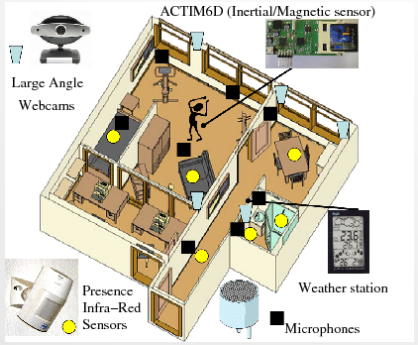
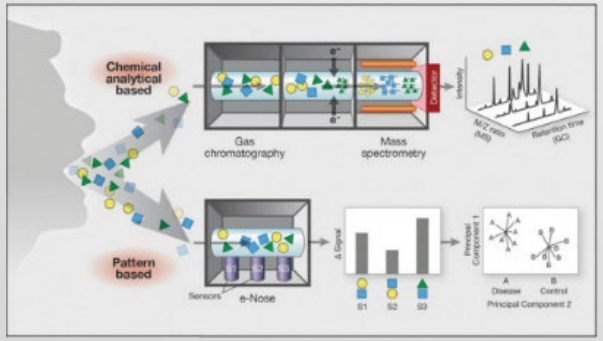
Pathfinder topic:

*From **episodic to continuous healthcare**: Unobtrusive monitoring for life-long health*

WP2022



*Teladoc (NYSE:TDOC) acquired Livongo in 2020 for **$18.5B***



Indicative budget

€28M

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Transition topic:

Full scale Micro-Nano-Bio devices for medical and medical research applications

WP2023

- European Commission has funded a large number of projects
- Transition to market remains challenging
- Example areas: R&D Life Science Tech, Clinical Tech (e.g. PoC), Pharma

High sensitivity pocket **COVID-19** PCR?

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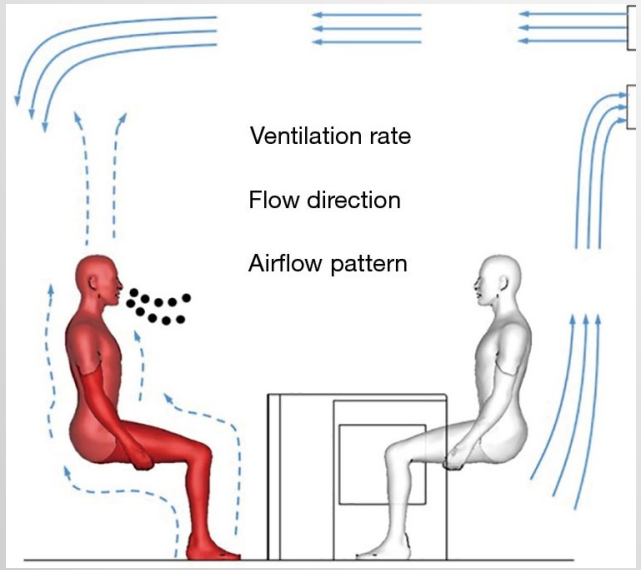
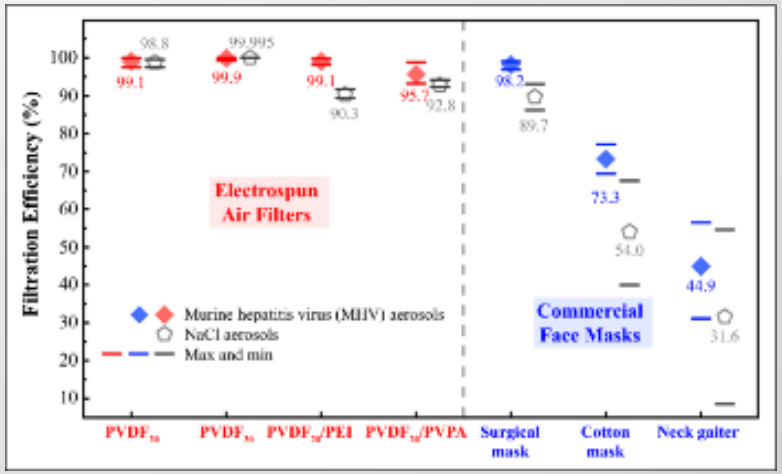
Accelerator Topic:

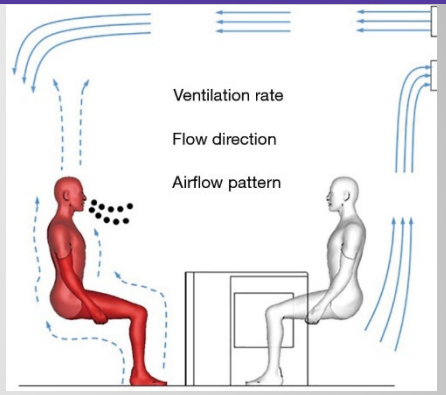
Aerosol and surface decontamination for pandemic management

WP2023





The Challenge



The management of infectious diseases propagated by aerosol suspensions of pathogens and/or by direct physical contact with surfaces populated by pathogens requires **social distancing**.

However social distancing can have a dramatic effect on economies, e.g. precluding air-travel, retail activities, office team work, etc. Moreover, insufficient social interaction is a major cause of depression and anxiety and underpins the observed peaks in mental disorder incidence linked to pandemic events.

This Challenge calls for proposals by SMEs developing technologies, backed by scientific evidence, for **normal social interaction, without social distancing, in the presence of air- or surface-borne pathogens**.

We call for novel **aerosol capture technologies for pathogen-free air**, e.g. for use in confined and poorly ventilated spaces, continuous air sampling and real-time pathogen detection and profiling systems, novel materials for next-generation face-masks and skin protection, solid surface rapid decontamination technologies, etc.

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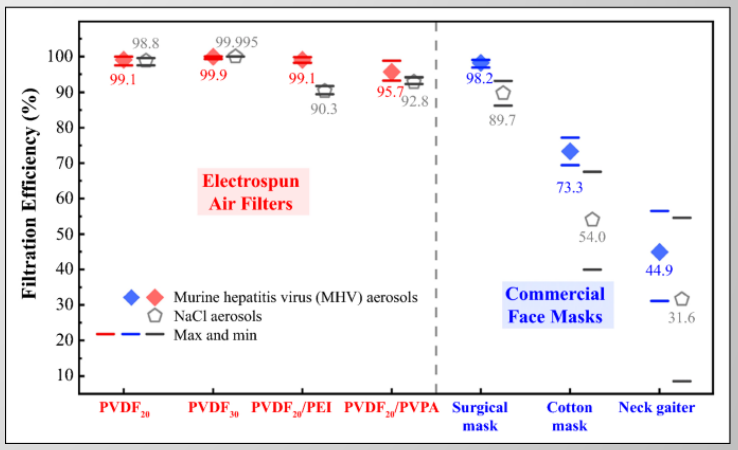
WP2023

Specific Objectives

- Novel high-efficiency aerosol capture and pathogen deactivation technologies
  - high-efficiency nanostructured membranes with tuneable functional properties
  - optimisation of electrostatic sampling and ioniser-enabled aerosol capture
  - intelligent systems for computer-controlled air circulation management
- Real-time pathogen identification technologies for integration with air renewal systems, surface testing devices, etc.
  - PCR/LAMP, CRISPR/Cas12a and immunoassay compact devices
  - novel nanomaterials with electrical, luminescent, catalytic properties
  - MEMS for high-sensitivity pathogen sensing

Méndez-Román, J. Electrospinning technology controls spread of COVID-19. *MRS Bulletin* **46,** 670 (2021)



Rationale

There is a **window of opportunity** due to:

- ongoing pandemic crisis
- novel technologies for pathogen capture and air filtering (e.g. nanostructured functionalised membranes)
- novel technologies for rapid pathogen profiling

Medical Technologies and Medical Devices

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WP2023

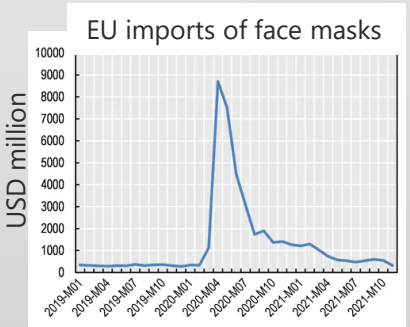
Synergy/ complementarity with other EU programmes

Preparedness (relevance for HERA) – support pandemic management and economy resilience
Technological sovereignty – provide EU with competitive advantage (civil and defence-related) in the case of air- or surface-borne pathogens or toxins, secure EU-produced supply of air-filtering products (e.g. masks)
Chip Act – support development of novel biosensors and their integration with existing IC technologies

Underpinning evidence

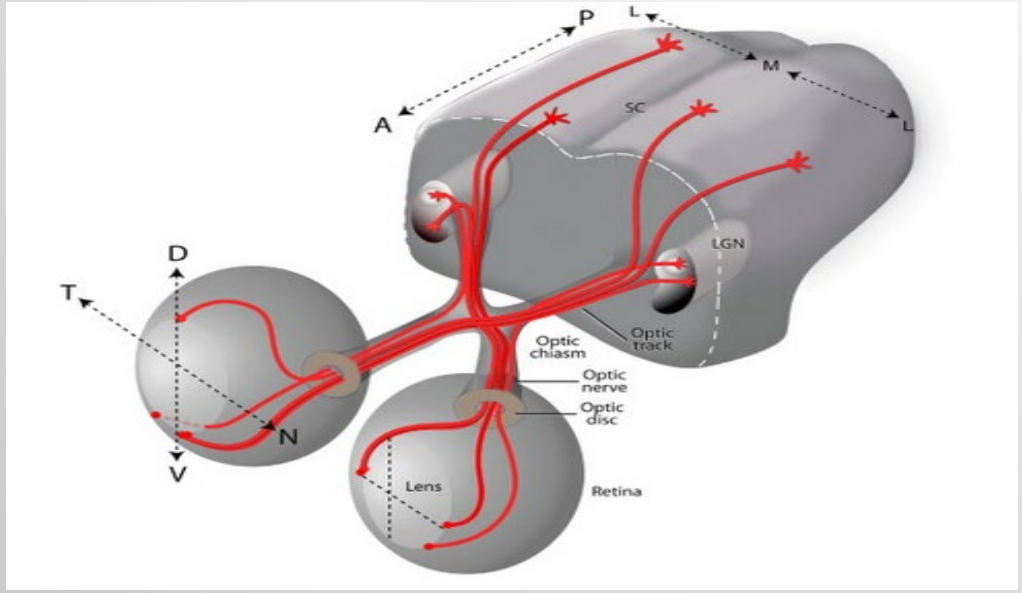
- **Recent developments in the field of nanomembranes**
  Mills, R., Vogler, R.J., Bernard, M. et al. Aerosol capture and coronavirus spike protein deactivation by enzyme functionalized antiviral membranes. Commun Mater 3, 34 (2022). https://doi.org/10.1038/s43246-022-00256-0
- **Recent developments in the field of rapid biosensing of pathogens**
  Ananthi V. and Arun A. Chapter 17 - Pathogen identification through surface marker recognition methods, Editor(s): Chaudhery Mustansar Hussain, Handbook of Microbial Nanotechnology, Academic Press, Pages 355-373 (2022)
- **Recent developments on electrostatic aerosol capture for pathogen identification**
  Ladhani L. et al. Electrostatic Sampling of Patient Breath for Pathogen Detection: A Pilot Study. Front. Mech. Eng., 18 June (2020)

- **Recent evidence** showing insufficient **EU capacity** to serve air-filtering needs in response to pandemic demand (e.g. see OECD data on EU face-mask **imports**)



Pathfinder Topic:

Defeating blindness *by retina reprogramming*



Medical Technologies and Medical Devices

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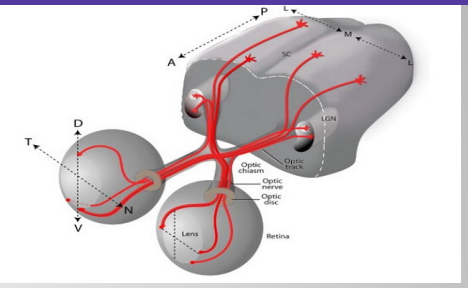
ideas for 2024 and beyond

The Challenge



(Erskine and Herrera, Dev. Biol 2007)

Blindness due to retinal damage, e.g. by age-related macular degeneration, remains mostly incurable.

Retinal transplantation is not viable because adult cells in the retina of a donor will not regrow axons (optic nerve) to connect to the appropriate target neurons in the brain of the receiving patient.

However, we now know that re-engineering/re-programming tissue is possible. A combination of reprograming factors (chemical, mechanical, genomic), when used in the correct time sequence, can trigger regrowth of axons and formation of synapses. **A donor's retina could be re-engineered/re-programmed** in-vitro prior to implantation.

But unfortunately progress in optimising the reprogramming process for clinical use has been slow, to a large extent due to the vast number of possible reprograming factors which leads to an **exponential number of required experiments to discover the optimal protocol**.

A novel family of robotic technologies could automate scientific reasoning and experiment execution to discover retinal re-engineering factor combinations in 5 years.

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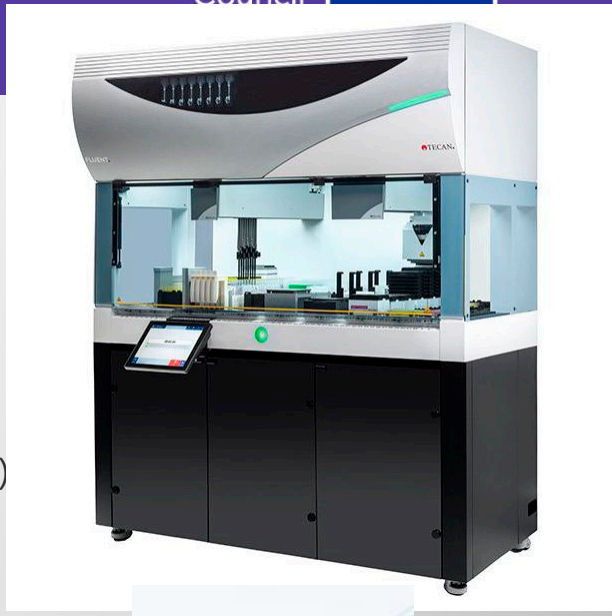
ideas for 2024 and beyond



Synergy/ complementarity with other EU programmes

Technological sovereignty– robotics, electronics, software (IT)

Chip Act – Integrated Circuits for machine learning, robotics, heterogeneous architectures (microfluidics, live cells, microsensors, microactuators)

Preparedness (relevance for HERA) – Automation for rapid discovery of neuron re-engineering treatments against **neuropathies** caused by infectious disease pathogens (e.g. Covid, Epstein-Barr, etc.)

Underpinning evidence

-Sinclair's lab has achieved recently partial reprogramming of retinas.
Lu Y. et al. Nature. 2020 Dec;588(7836):124-129

- May 2022! Recent success in keeping retinas from donors electrically activity (potentially viable for transplantation).
Revival of light signalling in the postmortem mouse and **human retina**.
Abbas F, Becker S, Jones BW, Mure LS, Panda S, Hanneken A, Vinberg F. Nature. **2022 May** 11

- Sony's **Hiroaki Kitano** (director for Sony's Computer Science lab and board member at Sony) discussed with the Programme Manager the robotisation/automation of medical/scientific discovery and the opportunities for the future of robotics.
Kitano, H. Nobel Turing Challenge: creating the engine for scientific discovery. *npj Syst Biol Appl* **7,** 29 (2021). https://doi.org/10.1038/s41540-021-00189-3

- **April 2022!!!** Full mapping of the temporal series of transcription factors in fly visual system. Konstantinides, N., Holguera, I., Rossi, A.M. et al. A **complete temporal transcription factor series in the fly visual system**. Nature 604, 316–322 (2022)

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ideas for 2024 and beyond

Specific Objectives

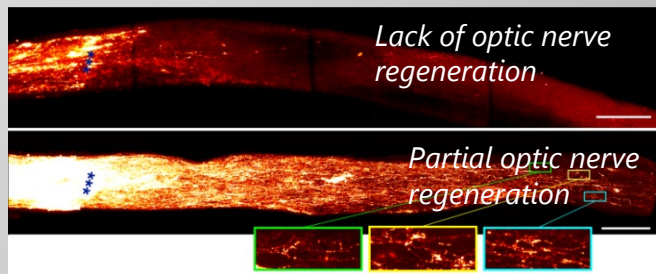
- **Overall end-goal**: autonomous robot architectures capable of rapid discovery of neuronal re-engineering protocols, enabling transplantation with appropriate cell reconnection

- Propose **competing technological solutions for**:

  - Multi-well neuron culture devices for in-vitro screening of neuronal re-programming protocols capable of inducing axon regeneration and synapse formation (e.g. microwell-compartamentilised patterned cultures of ganglional neurons and lateral-geniculate-nucleus)

  - Algorithms for automated experiment design towards optimising re-programming protocols (for maximisation of axon elongation and synapse number), e.g. genetic algorithms.

  - High-throughput robotised experiment execution units capable of large-scale screening of chemical, physical and genetic re-programming factors (target: 10^6 experiments/week)



Rationale

There is a **window of opportunity** due to:

1. recent achievements in retinal re-programming and 2. progress in medical robotics

Accelerator Topic:

Low-field MRI *for the developing world*

Medical Technologies and Medical Devices

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ideas for 2024 and beyond

The Challenge

Accelerator Topic:

MRI is used often in clinical settings. The quality of an MRI image is important for successful diagnosis, and quality has been traditionally achieved by increasing the strength of the static magnetic field. The cost (and size) of an MRI machine increases with field strength at about >1M euros per Tesla. Standard MRI machines offer >1T.

Yet refinement of the various components of MRI systems, including machine learning applied to image enhancement, has made it possible to achieve relatively high quality MRI images with low magnetic fields, also leading to novel portable and low-cost MRI machines.

The impact on European and developing country's healthcare of portable low-cost MRI would be high, enabling imaging in primary care, emergency care, rural settings, both in high and low-income countries.

Moreover, today's X-ray sources, lenses and imaging devices have evolved to achieved low-dosage high-quality images capable of 3D organ reconstruction. A new family of X-ray imaging technologies is available to achieve EU leadership in the imaging domain.

Accelerator Topic:

Specific Objectives

- **Portable low-cost low-field/low-dose** novel MRI/X-Ray imaging systems
- Enhance low-field MRI with metabolic (functional) imaging beyond classic anatomical imaging

Rationale

There is an opportunity window to commercialise portable MRI and X-ray imaging enabled by new developments in the components making up the systems and data processing.

The market is still captive, using classic imaging systems, for which high capex investment was carried out in the past.

Portable imaging can revolutionise Primary and Emergency care.

Accelerator Topic:
Synergy/ complementarity with other EU programmes

HERA – Novel portable MRI machines will render possible the deployment of point-of-care image-enabled management of infectious disease

Chip Act – Support development of electronics enabling deep-tech medical imaging

Cancer Mission – Support early diagnostic by wide access to imaging, including Primary Care

Underpinning evidence

The US company Hyperfine Inc IPOed on the Nasdaq stock exchange in 2021 to offer low-field MRI. Take-up has been slow but growing steadily.
There is generally good feedback from the clinical community.
The opportunity for European SMEs is still open.

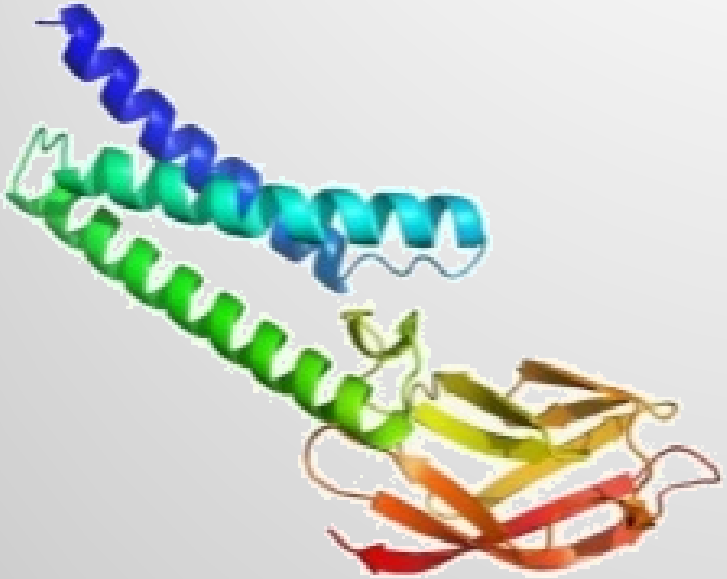
- Single-center prospective study evaluated feasibility of bedside MR neuroimaging in the intensive care settings for 50 critically-ill patients with COVID-19, stroke, hemorrhage, traumatic brain injury and tumors.
  Sheth KN, Mazurek MH, Yuen MM, et al. Assessment of Brain Injury Using Portable, Low-Field Magnetic Resonance Imaging at the Bedside of Critically Ill Patients. *JAMA Neurol.* 2021;78(1):41–47. doi:10.1001/jamaneurol.2020.3263

- Lévy S. Free-Breathing **Low-Field MRI of the Lungs** Detects Functional Alterations Associated With Persistent Symptoms After **COVID-19 Infection**. Invest. Radiol. (2022) May 27

Pathfinder Topic:

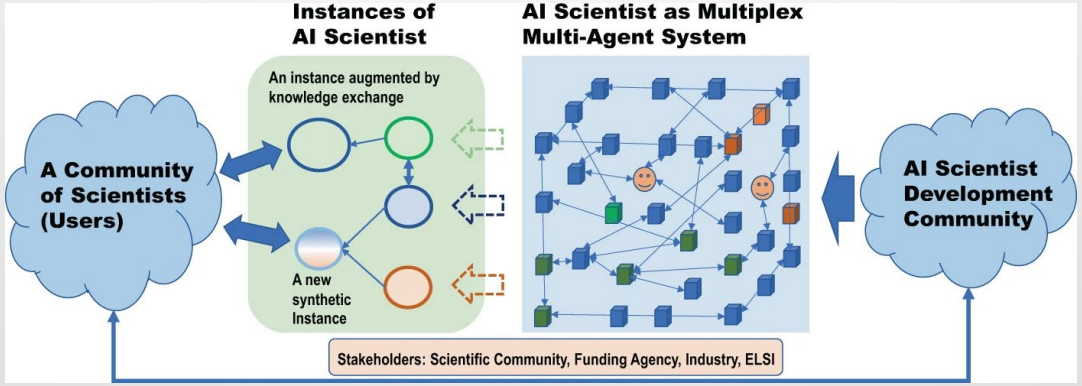
Designing Proteins as State Machines to act as new-generation medical devices.

e.g. Folding prediction (AlphaFold Google)



Pathfinder Topic:

The Robotic medical technologist. Funding therapies faster with robotics and AI.



Kitano, H. Nobel Turing Challenge: creating the engine for scientific discovery. *npj Syst Biol Appl* **7,** 29 (2021)

IF x THEN DO y

IF a THEN DO b

Pathfinder Topic:

Quantum physics and the future of medical technologies

1. **Scope** (S&T&I area)

Quantum physics has opened opportunities for disruptive novel technologies in areas such as computation, communications, cryptography, metrology, etc. However, quantic phenomena has not been applied yet to hard medical technology problems.

Phenomena such as photon entanglement hold potential for the development of new non-invasive imaging technologies capable of "seeing" and diagnosing live tissue or to sense and map (in time and space) processes such as electrical activity in the nervous system.

Using quantum physics-enabled technologies to monitor body processes is the scope of the Challenge.

Can we spot early cancer by scanning the patient to discover the first 1000 neoplasic mass of cells (occupying a tiny volume volume of 100 microns x 100 microns x 100 microns)?

2. Key **objective(s)** to be achieved and expected **impact(s)**

- Develop a novel non-invasive body imaging modality relying on quantum properties of matter and radiation. Deliver proof-of-concept device/instrument as main objective of the project.

Pathfinder Topic:

Quantum physics and the future of medical technologies

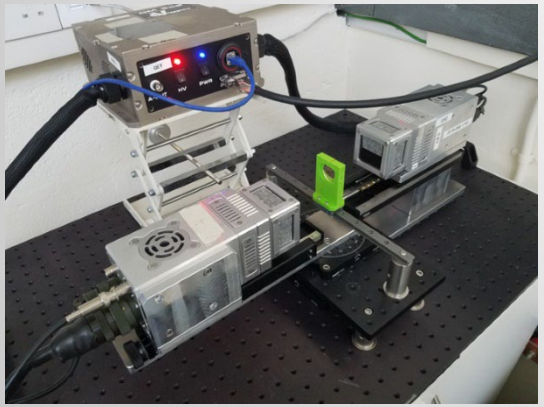
3. **Rationale** (Why this proposal? What opportunities/ gaps/ technology or innovation barriers? Why now?)

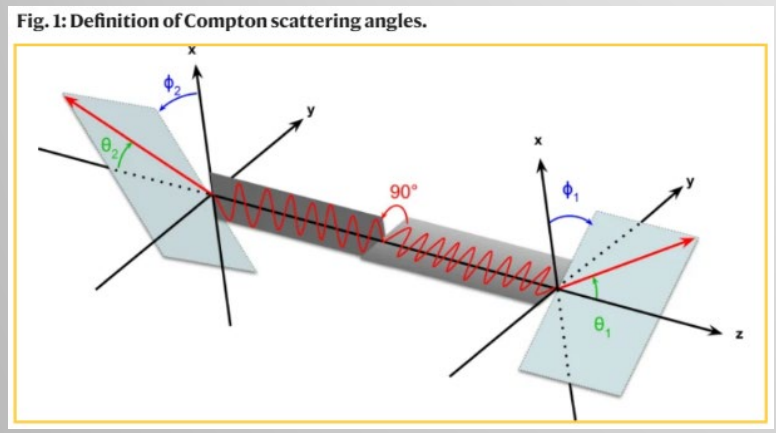
The imaging technologies used in today's hospitals such as ultrasound, MRI, (x-ray) CT scans, etc. do not exploit the opportunities of quantum physics.

Moreover, our current technologies have serious limitations. For example, their spatial resolution is far from single-cell in-vivo, i.e. it is not possible to measure the state of individual cells within the human body beyond a few hundred microns below the skin. Moreover, most of the information offered by imaging systems is anatomical. Yet diagnosis and treatment rely in detailed knowledge of the physiological processes (and electrical in the case of CNS) taking place in the diseased organ.

Achieving spatio-temporal resolution in deep tissue at the level of single cells, with sensitivity/contrast adequate to measure specific physiological events (as opposed to just anatomical features) is one of the greatest challenges in medical technology.

Quantum physics and the future of medical technologies





Nature Comms Paper
https://www.nature.com/articles/s41467-021-22907-5

Related news item:
https://www.york.ac.uk/physics/news/departmentalnews/2021/spooky-quantum-entanglement-pet-imaging/

Abstract

Positron Emission Tomography (PET) is a widely-used imaging modality for medical research and clinical diagnosis. Imaging of the radiotracer is obtained from the detected hit positions of the two positron annihilation photons in a detector array. The image is degraded by backgrounds from random coincidences and in-patient scatter events which require correction. In addition to the geometric information, the two annihilation photons are predicted to be produced in a quantum-entangled state, resulting in enhanced correlations between their subsequent interaction processes. To explore this, the predicted entanglement in linear polarisation for the two photons was incorporated into a simulation and tested by comparison with experimental data from a cadmium zinc telluride (CZT) PET demonstrator apparatus. Adapted apparati also enabled correlation measurements where one of the photons had undergone a prior scatter process. We show that the entangled simulation describes the measured correlations and, through simulation of a larger preclinical PET scanner, illustrate a simple method to quantify and remove the unwanted backgrounds in PET using the quantum entanglement information alone.

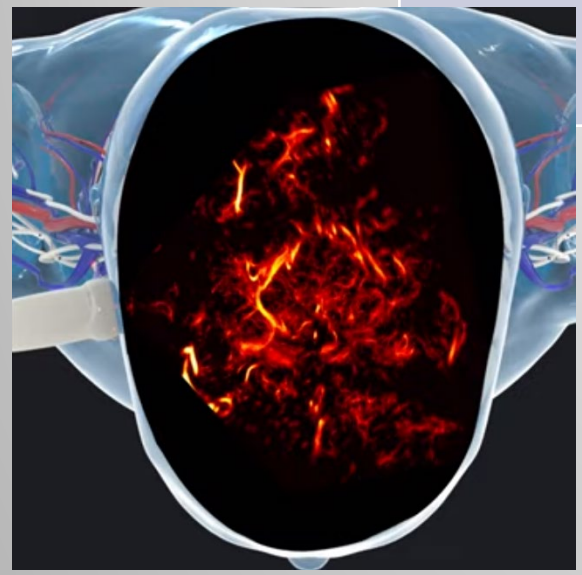
Medical Technologies and Medical Devices

E. Claverol-Tinturé

European Innovation Council

ideas for 2024 and beyond

New (2023) Technological Opportunity	ACCELERATOR Short-term challenge (5 YEARS)	PATHFINDER Long-term challenge (15 YEARS)
Interesting physics of **nanobubbles** has recently been discovered. **Microbubbles** in the blood stream are already used routinely to provide vascular contrast during **ultrasound imaging**. **Optoacustic** imaging (combining ultrasound and pulsed laser illumination) has recently demonstrated extremely high resolution in-vivo. **The opportunity: turn nano/microbubbles into sensors of physiological processes coupled to optoacustic imaging for ultra-high resolution.**	Challenge: Novel applications of ultrasound and optoacoustic imaging technologies with microvascular resolution levels	Challenge: Develop Novel Smart Microbubbles to sense physiological processes and act as Contrast Agents for deep body functional imaging

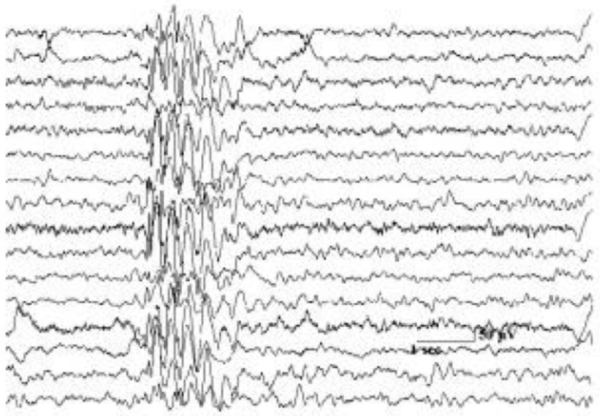


Ultrafast ultrasound maps tiny blood vessels deep in the human brain – Physics World

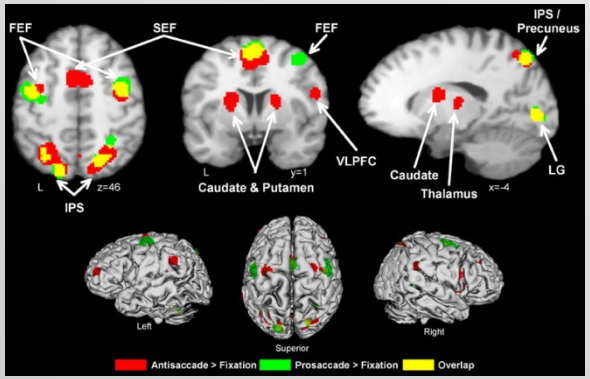
High-Tech Mental Health Practitioner

Problem: lack of quantitative/precision technologies for adequate diagnosis in psychiatry

EEG



fMRI / PET



Concluding notes

Workshops with Member States like this one will continue to foster co-creation

Dialog with DGs and other Agencies to strengthen coherent alignment with policy

Growing strategic intelligence efforts at EIC also providing input for future topics