Photonics21 workshop session – Defining photonics call topics towards Horizon Europe

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Overview – Workshop Agenda

First part (~15 minutes)

- Introduction and aim of the workshop

Second part (~3 hours 15 minutes)

- Workshop discussion with all participants on potential photonics research and innovation topics for the first calls (2021-2022) of the new Horizon Europe work programme on the basis of the new photonics roadmap

Lunch Break

- Continuation of the workshop discussion

Third part (~30 minutes)

- Presentation of the main workshop results in the plenary session after the coffee break

Introduction and Aim of the Workshop

Todays Photonics21 workshop

- will kick-off the photonics strategy process to discuss about and define the photonics research and innovation as well as CSA priorities for the first calls of the Horizon Europe work programme
- should be an interactive workshop which provides room for discussion with all workshop participants on the future photonics research and innovation challenges

As basis for this discussion the new European photonics roadmap and respective thematic chapter should serve as a background document.

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Pillars of Horizon Europe

Pillar 1 Open Science	**Pillar 2** Global Challenges and Industrial Competiveness	**Pillar 3** Open Innovation
European Research Council	Clusters • Health • Inclusive and Secure Society • Digital and Industry • Climate, Energy and Mobility • Food and natural resources	European Innovation Council
Marie Skłodowska-Curie Actions		European Innovation Ecosystems
Infrastructures	Joint Research Centre	European Institute of Innovation and Technology

TRL1 | TRL2 | TRL3 | TRL4 | TRL5 | TRL6 | TRL7 | TRL8 | TRL9

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Photonics Vision Paper for Horizon Europe: “Europe’s Age of Light”

Derived from our Mega-Markets Approach: How Photonics will power Growth and Innovation – 8 Expert Meetings defined our Missions for 2030

- **Instant diagnosis of major diseases**
  fast, precise and cost effective healthcare, advanced diagnostics, pervasive monitoring and innovative e-health applications
- **Quality food from farm to fork**
  push back food-borne illness and reduce environmental footprint
- **Accident and congestion-free road transport**
  Multimodal transport, automated, connected and electric to maximize safety, efficiency and comfort
- **A truly circular economy**
  end to depletion by managing material streams and reducing energy consumption & creating efficient industrial processes
- **A million new jobs**
  revolutionize industrial production and working environments with a fully digital value chain from supplier to customer
- **10% higher productivity**
  digital connectivity will create entirely quality of urban life
- **Zero downtime in a terabit economy**
  making digital society work and safeguard trust, comfort and privacy by performance, resilience and security in data services
- **Photonics as a flagship science for innovation**
  acting as a pillar and driver of the knowledge society playing an instrumental role in creation and dissemination of knowledge

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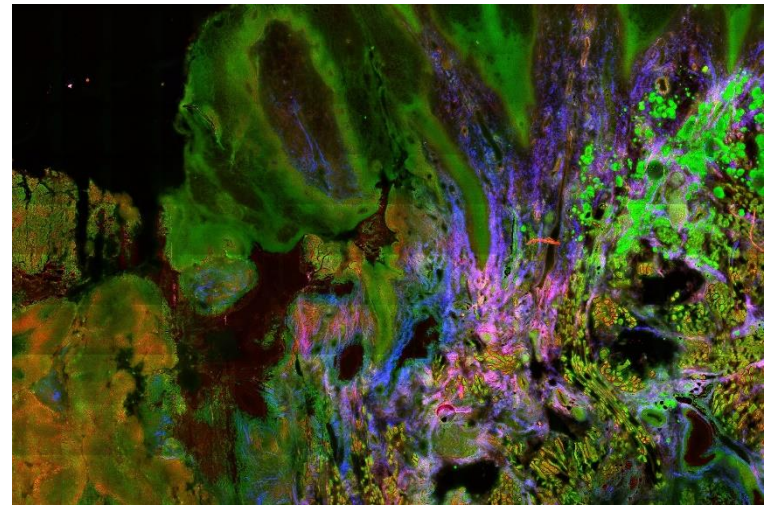
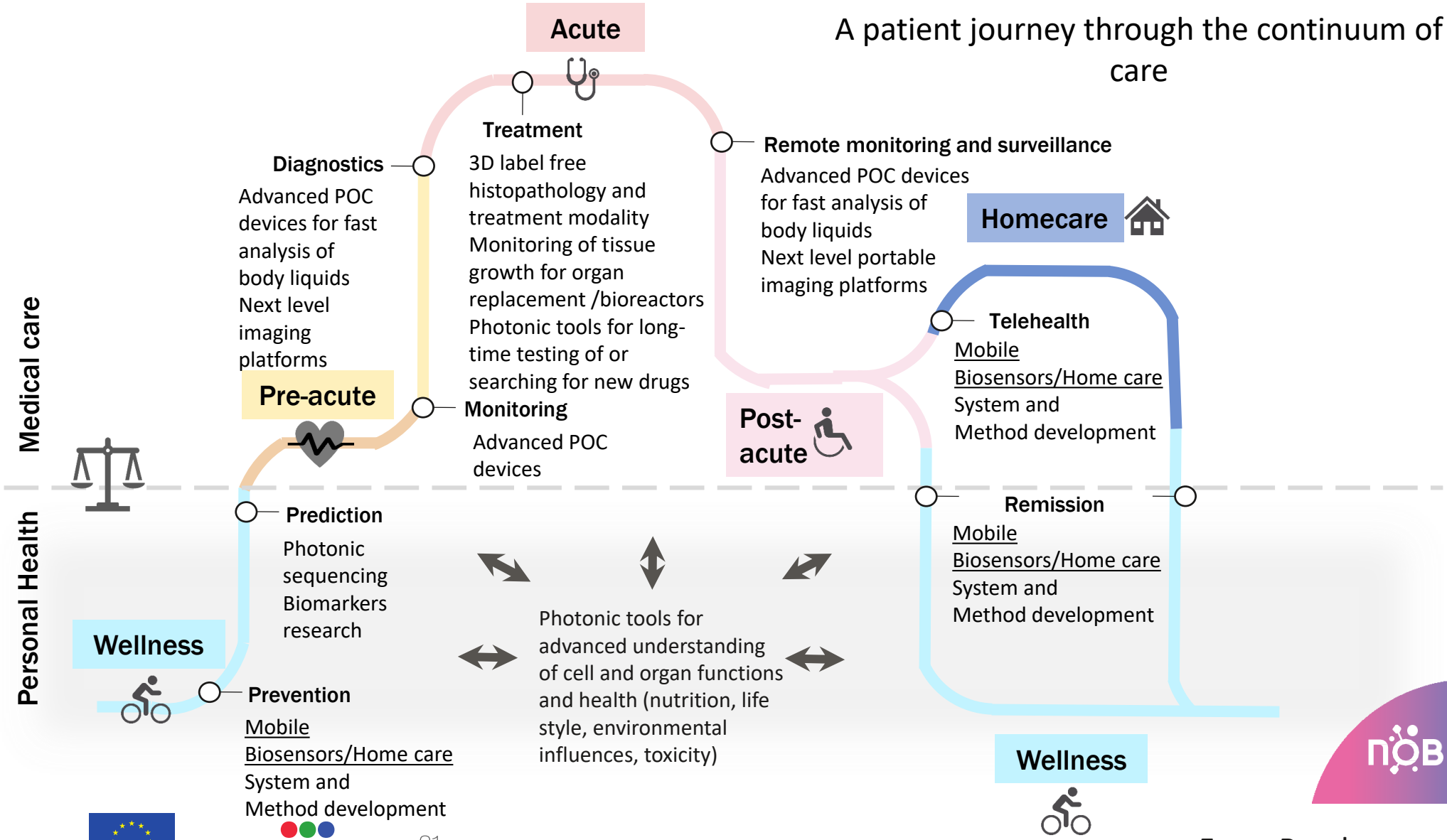
Main socio-economic challenge(s): instant diagnosis of major diseases

Basic ideas of the WG3 Horizon Europe Roadmap

- Concrete
- Challenging
- Continuum of Care - oriented



Main socio-economic challenge(s): instant diagnosis of major diseases



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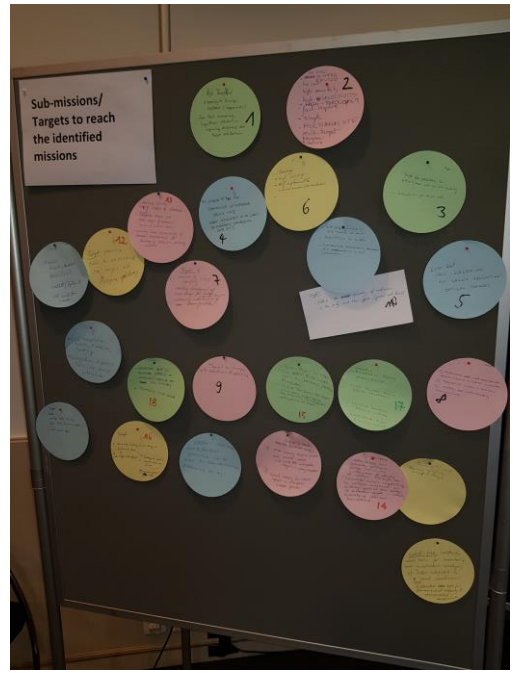
NOBEL

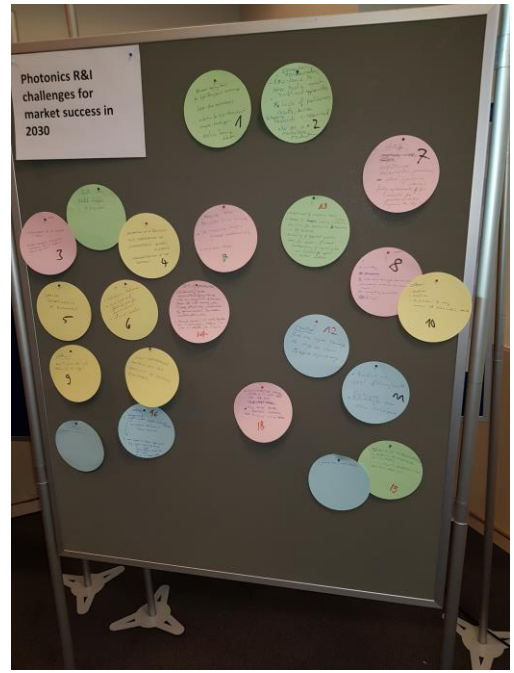
From Roadmap project of ETP Nanomedicine

Kickoff for strategic roadmap process on annual meeting 2018

Focussed on „Instant diagnosis of major diseases”

- „Sub-missions and targets“
- Detailing Sub-missions and challenges for market success
- Results were taken over into the first draft of the roadmap document chapter of WG 3





Discussion on the photonics research and innovation topics for the first calls (2021-2022) of the new Horizon Europe work programme

All workshop participants

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Workshop discussion – main question and steps

Proposal for Research or Innovation topics in Horizon Europe Work Programme 2021-2022

We will now proceed in **3 steps**:

Step 1.) Review our identified research and innovation targets based on the new European photonics roadmap **(Today!)**

Step 2.) Break down our research and innovation objectives in operable call topics and define which products/technologies/application development is needed to achieve the target **(Today!)**

Step 3.) Further describe the area and the research and innovation topic where Horizon Europe funding is requested according to the template **(Only partly today/complete the draft that will be sent around later on)**

Step 1: Review our identified research and innovation targets based on the new European photonics roadmap

From the roadmap:

Mobile photonics devices and advanced biosensors for instant point-of-care (-use) detection/diagnostics and treatment that measure the patient's medical condition and wellness, transportable photonic devices for monitoring environmental parameters, e.g.

- blood sugar for diabetes
- vital sign monitoring such as pulse, blood pressure, blood oxygenation
- evaluating the quantity of new specific and local biomarkers,
- controlling the pharmacokinetics of pharmaceuticals and the progression of pathologies
- pathogen identification
- support doctors on visits to enable fast medication

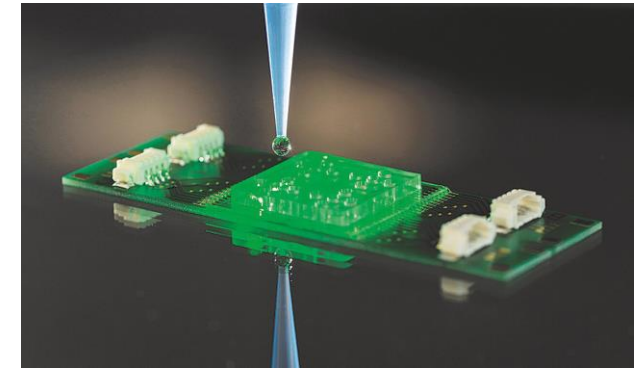
Step 1: Review our identified research and innovation targets based on the new European photonics roadmap

	2021-22
Overview Technology Challenges	**Mobile Biosensors**
Critical milestones to move from Science to Market	Biocompatible materials need to be found/investigated. Further convergence and integration of photonics, electronics and microfluidics: - Miniaturization of optical components to enable smaller on-chip solutions (in-body devices with volume < $1cm^3$) - Low cost miniaturized broadband sources and detectors - Demonstration of higher effectiveness with respect to state of the art, reliability and specificity in in-vivo conditions
Photonics Research (R) & Innovation (I) Challenges	Improve optical contact for on-body/in-body biosensors (R) Biomarkers research (R) Develop mobile biosensors to the next level (body liquids, but also portable image systems) (R & I)
Joint actions required with other disciplines	ETP: EuMaT for biocompatible materials ETP 4 HPC for the development of data handling and evaluation ETP Nanomedicine (biomarkers)

Step 2: Break down our research and innovation objectives in operable call topics and define which products/technologies/application development is needed to achieve the target

Operable call topics

Think of 1 potential research priority, write it on a notepad, pin it to the poster wall and explain it.



Examples:

- Homecare or wearable lab-on-a-chip device for daily liquid biopsy to allow the early detection of diseases related to age or lifestyle or for the prediction of drastic events.

- Mobile photonics device for pathogen identification and potential antibiotics resistance for homecare or for doctor's practices to enable fast medication.

After we have all suggestions, we deflate the number of suggestions down to 2 by combining and voting.

Prevention, photonics only technique for non-invasive detection photoacoustic, diffuse optics, Raman/vibrational spectroscopy, home care (not necessarily wearable / part of it wearable), taking more physical parameters at the same time, correlation with other parameters, AI-based

Portable sensor NIR/MIR biomarker (today in-vitro -> in-vivo), absorption or reflection mode (labelfree). MIRHAP… probably not cheap enough, interpretation of the spectra… pretreatment of spectra, put it on the cloud via mobile phone, deep learning approach

Understanding of the usability of the device, calls need to add baseline data (also personal baseline), call maybe not big enough to get enough data (at least for evidence). Obtainment of accurate information is generally necessary.

Think of the hardware behind, do we need new detectors, sources etc. Where to measure, skin, eye as portal to the disease information. What is the technology to look deeper into the body e.g. mitochondria metabolism.

Photonic Instruments are scalable. What about the cost, do we need cheaper devices. Cost is very important if you go to the doctor's office and to homecare and wearables.

There are many non-invasive ways, you need a general view of the metabolism: Diagnostics 4.0 (which technology: depends on the patient and his state); we can extract a lot of data, who is going to decide if the data are significant. How are these sensors connected with some center we have to put something in the proposal about how the data is evaluated and where. This is not a photonics topic?! How to adapt the sensor the device to track the biomarker. We need a large cohort of patients to get reliable data.

NIR infrared better for through skin detection. MIR better for breath analysis. Touching breath analysis… is it acceptable to make a urine analysis every day. Should not be a burden and no need to remember to do this in particular if you are feeling healthy. This is different in the doctor's office or if you are already sick (a patient is willing to collect sample). Hierarchil system, going from breath analysis to more invasive things if there is an alarm.

Slow metabolism (mostly women problem). Hard to diagnose this disease (probably change in odor linked to it). SPR, whisper gallery modes devices, to track the sources.

Interim position between wearable and go to the doctors. Diabetes from the eye, early stage diseases. Professional but not medical place and your optometrist can measure.

So far only home care devices but no wearables. Underlying technology, could be infrared spectroscopy. We need miniaturized devices, could be UV-Vis, SPR, Raman etc. Capture molecules.

Easy to be used, accepted by the people, cheap, either at home or in the doctor's office

Could also be used at the hospital.

Devices based on iphones, treatment with PDT, could we do this in developing countries. Difficult to measure singlet oxygen. Big challenge is ageing society. Age-related diagnostic methods -> fiber technology; chronic diseases. Younger people vs. older people may have different needs concerning sampling technology.

Ageing society + inflammation (wounds; infection), detection of progress of healing of the wound, wearable (continuously, treatment monitoring) or once per day, technique: imaging, cofactors which could be monitored. Would it be something to buy/rent (business model). Operated by a nurse and not by the person her-/himself. How to measure inflammation? By certain biomarkers. What would then be the sample? “Wound liquids”.

Strength of photonics can be adapted prevention, diagnosis etc. Cheap instruments, more complex. In many cases we still need to find out which biomarkers are linked to which disease and, in particular, which parameter accessible by photonics are linked to the biomarkers. For this we need close collaboration with the medical fields. What kind of information can you get out of e.g. breath. Either it is known beforehand which kind of biomarker(s).

Way to monitor if the patient takes her/his medication like in cancer, depression etc.: Measure noninvasively the concentration of a drug in a body liquid to that end (at the doctor's office) in order to find out if she or he takes the prescribed dose. Probably to do this you need genomic information.

Control if the device is used in the right way. Robust. Self-test to control if the device is properly working. Scientist should think of the requirements right from the start.

Would it be better to come up with a platform technology -> open platform where you can dock on different technologies. Standardized platform… “One device to test them all…” Plug-ins to measure the different parameters. Same interface… housing could be different. “Reminds of Europe’s structure”, but are we at a stage too early for this? Must technology mature first? EPOSS has started an initiative to standardize the interface between the building blocks. Good from technology point of view, but what about data security. Idea could be data combination of an anonymous level…

One level is to build the building blocks. Once we have those we can start to integrate them. Can we get something like this approved?

What is the difference between having 5 different machines vs. a platform with 5 different plugins? Measure more things at the same time from one sample?!

Step 3: Further describe the area where Horizon Europe funding is requested according to the template

1. Area to be adressed

- Application domain: Health
- Targeted application: Mobile Biosensors

2. Position of Europe in the application/research/industry domain & evolution from now to 2022 ff

What is the challenge (in Europe) in the respective area today?

3. What needs to be done?

Necessary steps to overcome the problem described, including the type of activity (research, innovation, other)

4. When and why should the call be launched and how much funding is needed?

In which year should the respective area be called: as part of WP 2021 or WP 2022?

Step 3: Further describe the area where Horizon Europe funding is requested according to the template

2. Position of Europe in the application/research/industry domain & evolution from now to 2022 ff

What is the challenge (in Europe) in the respective area today?
We start from a position of strength, but it is necessary to have usability studies, but also miniaturization, make it cheaper; Only big players might be able to provide such instruments, very difficult for SME. High costs to take the instruments to market. Example: Apple watch, regulations etc. The cost of the devices is the challenge. You need to have access to many people.

3. What needs to be done?

Necessary steps to overcome the problem described, including the type of activity (research, innovation, other)
Innovation hub to help with design and proof of concept. Access to patients has to be organized on a European level (preclinical and clinical studies). Coordination of actions/projects, can be individual projects, but needs some coherence. Standardization needs to be further promoted. Reimbursement would have to be somehow coordinated. Data security must be ensured.