PHOREVER

Photonic integrated OCT-enhanced flow cytometry
for cancer and cardiovascular diagnostics enabled
by Extracellular vesicles discrimination

Project Launch

The implementation of the PHOREVER project was officially inaugurated with the kick-off meeting that took place on the 18th and 19th of January 2023. The eight (8) members of the consortium participated in a two-day productive hybrid meeting which was held at the premises of Institute of Communications & Computer Systems (ICCS) in Athens. During the hybrid event, PHOREVER's workplan was analyzed in depth, the role of each partner in the project's deployment was specified detail, and the next actions towards the achievement of project's objectives were defined.

Modern medicine is continuously working to create methods and tools that can illuminate the causes of our two biggest health problems today, cardiovascular disease (CVD) and cancer. High-end imaging techniques like sonography, computed tomography (CT), magnetic resonance imaging (MRI), and positron emission tomography (PET) are still the primary non-invasive methods for diagnosing these illnesses, however they are prohibitively time-consuming, costly, and risky to use for routine monitoring.

Additionally, as imaging tools, these modalities can successfully detect the diseases' symptoms, such as the presence of solid tumors or blood clots, but they are unable to accurately shed light on the molecular mechanisms underlying the diseases' progression, recurrence, or resistance to medical treatment. In fact, it is thought that most, if not all, of the knowledge needed to comprehend these systems is contained in the circulating cells, vesicles, and chemicals present in human blood. Therefore, we require powerful imaging technologies that enable us to switch from the macroscopic to the microscopic level in order to detect and measure this blood content. Extracellular Vesicles (EVs), in particular, are membrane-enclosed vesicles that cells release. EVs are essential for both cell-to-cell communication and the process of eliminating waste from the cell. When used as circulating markers, EVs can reveal important information about the physiological and pathological state of the cell that produced them, and as a result, about the presence and stage of disease. Thus, the possibility to identify EVs in blood samples has been emphasized as one of the most revolutionary and potentially important tasks in modern medicine. Since the bulk of EVs are between 50 and 200 nm in size, this possibility still poses a big challenge.

Using this scientific and technological background, PHOREVER will create a unique multi-sensing platform that will enable the detection of EVs with size down to 80 nm, detection of EVs with disease-specific proteins (biomarkers) as cargo on their membrane surface, and calculation of the corresponding EV concentrations in human blood samples. This disruptive detection performance will employ three distinct sensory modalities:

In this project, flow cytometry (FCM) is the primary sensing modality for the detection and size classification of particles in blood. Optical coherence tomography (OCT) is used as a secondary sensing modality for the micro-imaging of the sensing area and the application of a coherent gate for drastic noise reduction in the FCM measurements. Fluorescence sensing is a third modality for the detection of the target biomarkers on the surface of the EVs after a proper stain process with fluorescent dye.

Funded by
the European Union

PHOREVER will demonstrate its potential via the development of:

1) a TriPleX® based photonic integrated circuit for fluorescence and flow-cytometry (FCM), which may be used as a dual sensing instrument to identify EVs in blood samples and identify biomarkers on their surface,

2) a TriPleX® based photonic integrated circuit with an on-chip dual-channel swept-source optical coherence tomography (SS-OCT) unit as a coherent gate for processing the FCM measurement data,

3) a microfluidic device for the disposable portion of the multi-sensing PHOREVER platform that handles pre-analytical and analytical handling of blood samples, and

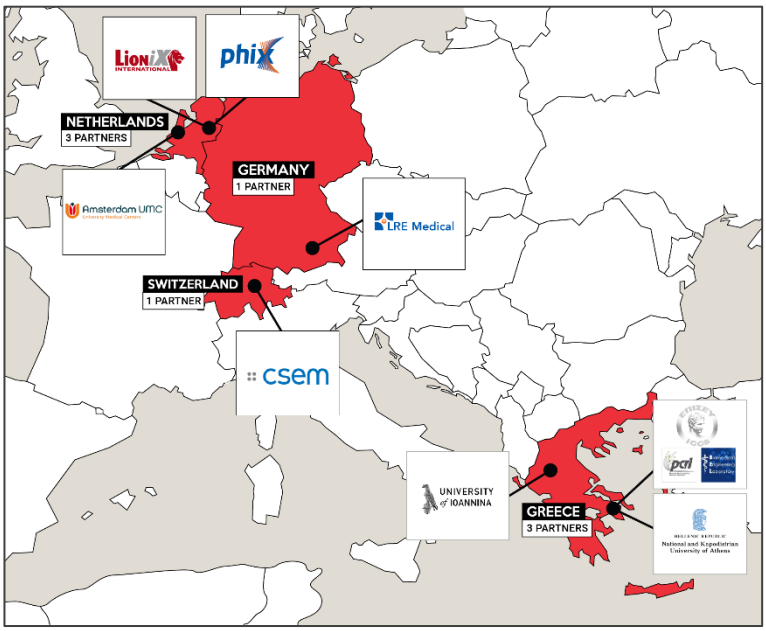
4) the creation of an extensive data analysis tool supported by AI algorithms for application in stroke and pancreatic cancer cases.

A roadmap for offering PHOREVER technology as commercial services will be prepared.

Project facts

Topic: Advanced multi-sensing systems (Photonics Partnership) (RIA)
HORIZON-CL4-2022-DIGITAL-EMERGING-01-03
Project no: 101093171
Start date: 1 January 2023
Duration: 42 Months
EU contribution: € 4,973,882.50
Beneficiaries: 8 Partners from 4 countries

PHOREVER project comprises eight (8) partners from four (4) European countries among which:



2 **Large companies**: LRE Medical (LRE) - DE, and LioniX International BV (LXI) - NL

1 **World renowned research and technology organizations**: Centre Suisse d'Electronique et de Microtechnique (CSEM) SA[1] - CH

1 SMEs: PHIX Photonics Assembly (PHIX) - NL

4 Academic organizations: National and Kapodistrian University of Athens (NKUA) - EL, University of Ioannina (UOI) - EL, Amsterdam University Medical Centers (AMC) - NL and the Institute of Communications & Computer Systems (ICCS) - EL that coordinates the action.

For more info, visit PHOREVER website https://horizon-de-phorever.eu/

[1] Funded by SERI