Scalable, point-of-care and label free microarray platform for rapid detection of Sepsis

The overall objective of the RAIS project is to develop a new, point-of-care, label-free microarray platform based on a proprietary interferometric lens-less microscopy design and validate it for quantifying levels of specific Sepsis biomarkers within 30 minutes.

Background / Motivation

Sepsis is a potentially fatal whole-body inflammatory reaction caused by severe infection, with a mortality rate of 35%, and is one of the 10 leading causes of death worldwide, responsible for ~20,000 deaths per day. Each hour of delayed treatment increases the mortality of patients by eight percent. The rapid detection of Sepsis is thus critical and RAIS proposes a disruptive microarray technology, similar to a miniature, large field of view differential interference contrast (DIC) microscope, to achieve it.

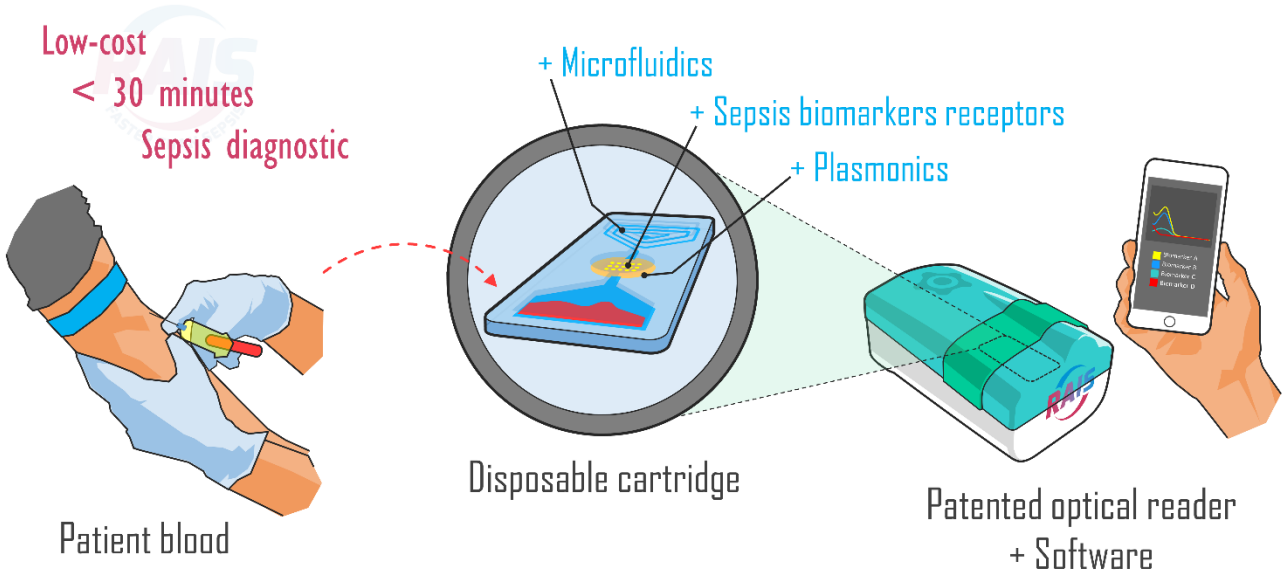
Microarrays are a powerful set of technologies which are widely used for the detection of pathogenic micro-organisms, proteins and Deoxyribonucleic acid (DNA) sequencing, among others. The advantages of microarrays are their small size, low cost, scalability and label-free detection method.

Objectives

The specific objectives include the development of:

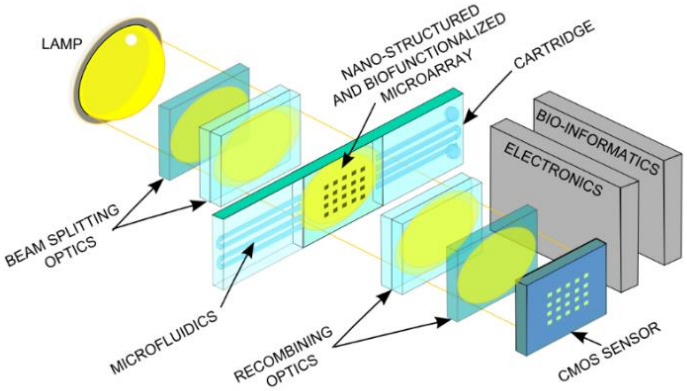
- An optical microarray reader based on a novel design combining interferometric lens-free microscopy and CCD or CMOS image sensing and analysis, for high-throughput, label-free, rapid and sensitive detection of nucleic acids, proteins and pathogenic microorganisms.
- A microarray plate with a novel nano-structured surface geometry to increase the optical detection sensitivity and covered by specific receptors to capture the biomarkers.
- A disposable microfluidic cartridge capable of detecting Sepsis biomarkers using a few microliters of blood or serum.
- Integration of the microarray reader, cartridge and analytical software in a portable (point-of-care) size instrument.

RAIS also aims to evaluate the technology both in the laboratory and in a diagnostic clinical setting.



Technology Description

RAIS will make use of low cost lens-free microscopy (LFM) based on CCD or CMOS image sensing and scalable nano-structuring techniques (see figure below). The proposed microarray platform, similar to a DIC microscope but with at least two orders of magnitude larger field of view and much smaller in size (about the size of a mobile phone), is very suitable for point-of care applications.



Each detection spot of the microarray is composed of two optical beams: a first one that crosses a region where the captured biomarkers are located, and a second one crossing only the transparent substrate, which functions as a reference beam. These two beams are generated from a single beam incident light source by using a Savart plate, which is a birefringence element that creates a shear (reference) beam with orthogonal polarization parallel but displaced with respect to the original beam. These two beams are then recombined using another Savart plate and detected by the image sensor after passing through a polarizer, which transforms the optical path difference experienced by the two beams into an intensity modulation processed by software for further analysis.

Expected Results & Impacts

RAIS will have a significant impact on European industry, making it more competitive in the point-of-care medical market for detection of Sepsis and other infectious diseases, as well as microarrays for DNA sequencing and proteins.

The low cost point-of-care RAIS microarray will permit clinicians to identify sepsis early and therefore start patients on the right treatment much more quickly, potentially reducing the mortality rate by as much as 70-80%. It has been estimated that the cost savings to the healthcare system of fast and effective Sepsis detection could be several tens of billion euros per year from reduced hospital stays, reduced use of unnecessary drugs and associated insurance bills.

However, it could also be extended to perform other types of disease screening or multiple simultaneous diagnoses, especially those requiring to rapidly screen a large number of biochemical targets (more than 1 million) on a single microarray.

Regular updates of project results will be published through conferences, journal publications and the RAIS website.

At A Glance

Project co-ordinator:
Institute of Photonic Sciences (ICFO), Spain

Contact person:
Prof Valerio Pruneri
Tel. + 34 93 553 4052
E-mail: valerio.pruneri@icfo.eu

Timetable: from 01/2015 to 12/2017

EC funding: € 2,988,572

Instrument: Horizon 2020 Project

Grant Agreement No.: 644956

Project Website:
www.rais-project.eu

Twitter:
@RAIS_Project

Project Partners

The Institute of Photonic Sciences (ICFO) - Spain

École Polytechnique Fédérale De Lausanne (EPFL) – Switzerland

Agencia Estatal Consejo Superior de Investigaciones Científicas (CSIC) – Spain

microTEC Gesellschaft für Mikrotechnologie mbH (microTEC) – Germany

Trinean NV – Belgium

Institut Català De La Salut – Hospital Universitari Vall D'Hebron (ICS-HUVH) – Spain

B R A H M S GmbH (part of Thermo Fisher Scientific) – Germany

iXscient Ltd – UK

DIESSE Diagnostica Senese S.p.A. – Italy