Optimized miniature bio and chemical sensing system

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About PhotonicSys Ltd

- Established in 2014 by Professor Ibrahim Abdulhalim following many years of research in the field of optical devices and imaging methodologies as well as wide industrial experience. See link:

http://aizena.wix.com/abdulhalim-group
http://scholar.google.com.sg/citations?user=ZtpoAh8AAAAJ&hl=en&oi=ao

- Company 1st product is a miniature surface plasmon resonance sensor and associated substrates for detecting small and large bioentities.

- Current status: 1st product is launched and looking for strategic partners.

- Intellectual Property:
  - I. Abdulhalim, "Optical Sensor Based on Multilayered Plasmonic Structure Comprising Nanoporous Metallic Layer"
    International Patent Application No. PCT/IL2014/050522.
  - I. Abdulhalim, "Tunable Device and Optical Sensor and Methods for Using the Same"
    Patent Pending 62090044.

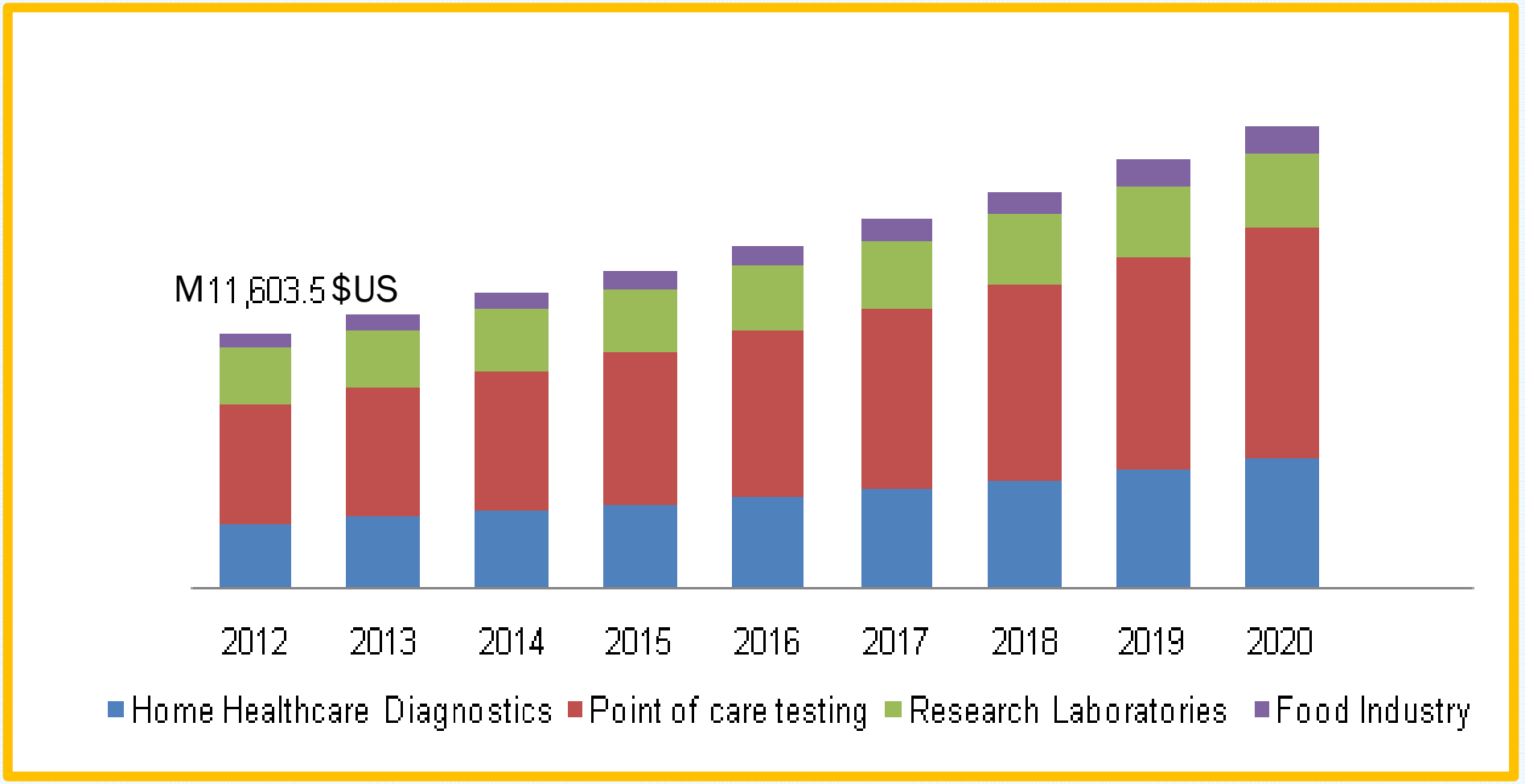
Technology Principles and Advantages:

- Compact Design that uses single or multiple wavelengths and camera.
- Precise detection algorithm to locate the SPR position.
- Referenced measurement.
- Two or more channels.
- Unique plasmonic substrates that enable short and long penetration depths ⟹ Hence can be used for small entities (molecules, viruses, proteins) and large bioentities (cells, bacteria).
- Being miniature, it can be combined with other inspection equipment such as a microscope or spectrometer.

The System is Based on Technological Innovations Described in the Following Publications:

- **I. Abdulhalim**, M. Zourob, A. Lakhtakia, Surface plasmon resonance sensors-a mini review, *Invited* review to a special issue on the topic: Electromagnetic Surface Waves, J. Electromagnetism 28:3, 213-242 (2008).
- **I. Abdulhalim**, Surface plasmon TE and TM waves at anisotropic film-metal interface, J. Opt. A: Pure Appl. Opt. 11, 015002 (2009).
- Amit Lahav, Mark Auslender and **I. Abdulhalim**, Sensitivity enhancement of guided wave surface plasmon resonance sensors, Opt.Lett. 33, 2539-2541 (2008).
- **I. Abdulhalim**, Optimized guided mode resonant structure as thermooptic sensor and liquid crystal tunable filter, Chinese Optics Letters, 7 (8), 667, (2009).
- Atef Shalabney and **I. Abdulhalim**, Sensitivity enhancement methods for surface plasmon sensors, Lasers and Photonics Reviews, 5, 571-606 (2011).
- Olga Krasnykov, Mark Auslander and **I. Abdulhalim**, Optimizing the guided mode resonance structure for optical sensing in water, Physics Express 1(3), 183-190 (2011).
- Atef Shalabney, C. Khare, B. Rauschenbach, and **I. Abdulhalim**, Sensitivity of surface plasmon resonance sensors based on metallic columnar thin films in the spectral and angular interrogations, Sensors and Actuators B: Chemical, 159, 201-212 (2011).
- Atef Shalabney and **I. Abdulhalim**, Figure of merit enhancement of surface plasmon resonance sensors in the spectral interrogation, Optics Letters 37, 1175 (2012).
- Sabine Szunerits, Atef Shalabney, Rabah Boukherroub and **I. Abdulhalim**, Dielectric coated plasmonic interfaces: their interest for sensitive sensing of analyte-ligand interactions, Invited review article, Anal.Chem. 31, 15-28 (2012).
- **I. Abdulhalim**, Plasmonic Sensing using Metallic Nano-Sculptured Thin Films, *Invited review article*, Small 10, 3499-3514 (2014).
- Sivan Issacs and **I. Abdulhalim**, Long range surface plasmon resonance with ultrahigh penetration depth for self-referenced sensing and ultralow detection limit using diverging beam approach, Appl.Phys.Lett. 106, 193701 (2015).

We are Targeting the Global Biosensors Market



http://www.grandviewresearch.com/industry-analysis/biosensors-market

Solutions Addressed by the Technology/Company

- **Miniaturization:** the sensor is compact, portable, in its present version can be combined with other instruments for example to be used under the microscope for combining surface plasmon resonance (SPR) measurement with optical imaging (fluorescence (SEF), Raman (SERS), brightfield, dark field, phase contrast, etc.)

- **Cost Effective:** price varies depending on the version required but the end mass-produced price for standard version is under US$5k.

- **Suitability for cells detection:** using an innovative plasmonic structure, the penetration depth is increased to few microns inside the analyte solution using wavelengths in the visible and near infrared range. This allows cells detection such as bacteria.

- **Tunability of penetration depth:** in a customized version the penetration depth can be tuned so that small and large bioentities can be detected in the same device.

- **Stability:** due to the self-referenced design, the measurement is stable against drifts, temperature fluctuations and misalignments.

Current Products

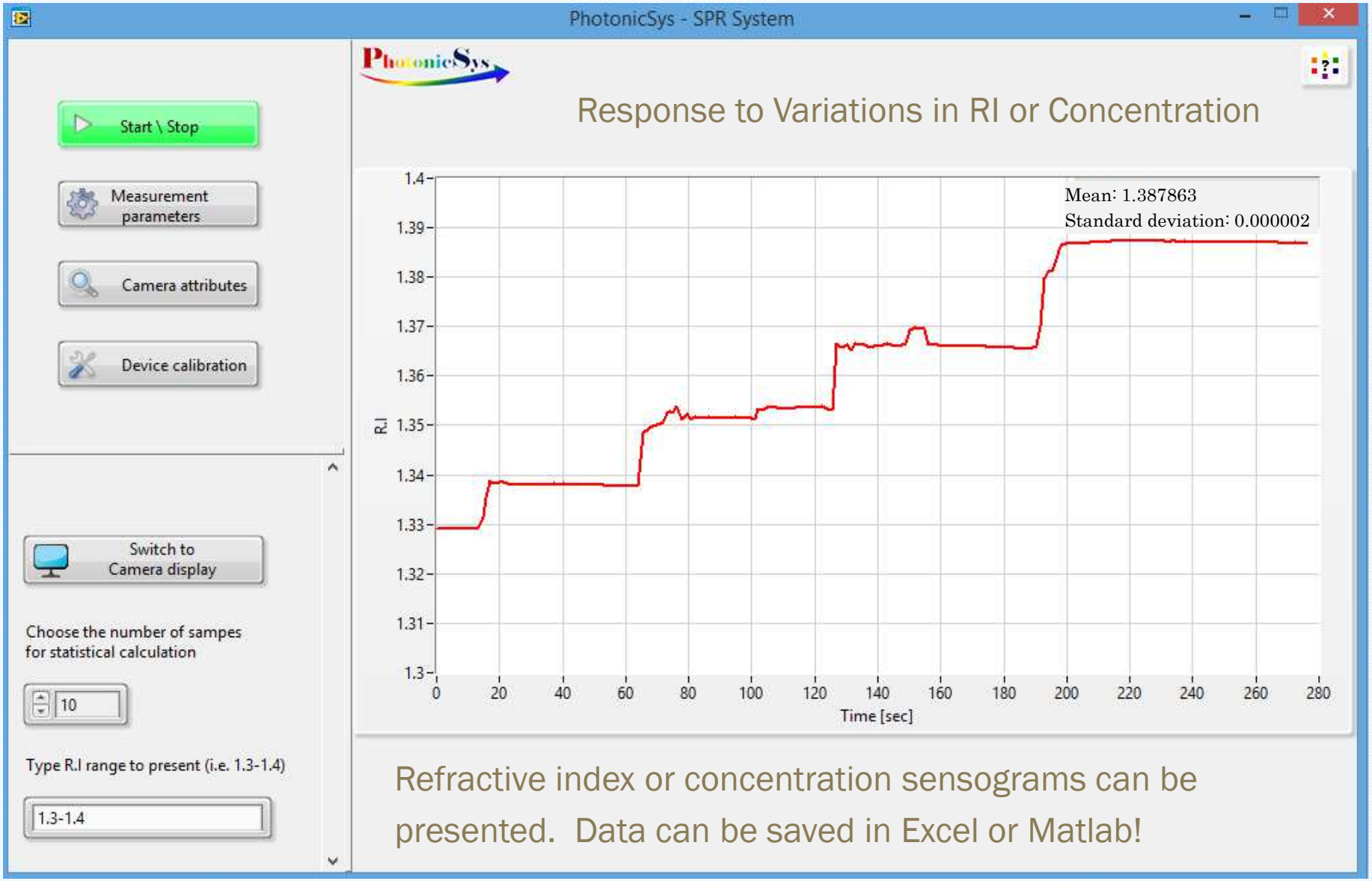
Presently the company is concentrating on three main products:

- **Compact SPR System:** the sensor device is compact, portable, in its present version can be combined with other instruments for example to be used under the microscope for combining surface plasmon resonance (SPR) measurement with optical imaging (fluorescence (SEF), Raman (SERS), brightfield, dark field, phase contrast, etc.)

- **SPR substrates:** designed as substrates to be used with our system. Variety of substrates are available such as for cells detection, small bioentities and regular substrate with basic functionalization layer on top of the metal.

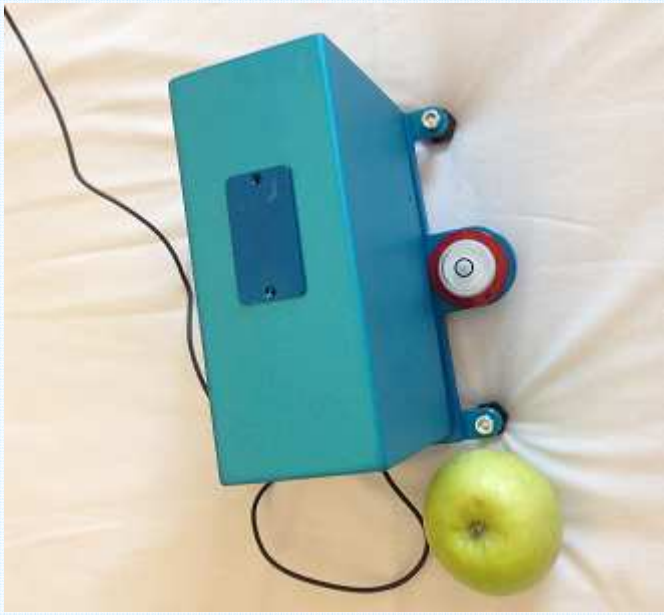
- **Surface enhanced spectroscopy substrates:** substrates that enhance the fluorescence, Raman scattering, both to be used alone or combined with the SPR sensing measurement.

Software GUI - User Friendly Interface



Refractive index or concentration sensograms can be presented. Data can be saved in Excel or Matlab!

Current Status



- Seed government funding received
- First functioning prototype is built
- Fully integrated coded software
- SPR substrates are developed
- Working on the next beta system to be installed in several sites worldwide.

Preliminary Specs

Parameter	Present	Expected Beta Performance
Size	4.5″x4.5″x8.5″	3″x3″x8.5″ or smaller
Detection limit (RIU)	10^{-5}	$<10^{-7}$
Speed	16msec	16msec
Refractive index range	1.3-1.4	1.3-1.5 and can be customized
Reference and calibration	Yes	Yes
Portability	Yes	Yes
Operation	PC or laptop	PC or laptop and smartphone option will be developed
Substrates	Available upon request	Available upon request
Penetration depth	200nm	Variable from 200nm to few microns
Bioentities size	< 300nm	Small and large up to cells size (few μm)
Can be combined with microscope	Yes	Yes
Combined with fluorescence excitation	No	Available upon request

Near Future Plans

- Looking for partners both in the academy and the industry for acting as beta sites.
- Continuous improvement of the system following feedback from the beta sites.
- Continuous R&D work for a more compact versions integrated with optical microscopy.
- Marketing at the local and global scales.
- Small investment will be considered.