"System for highly reliable, cost effective, early detection and accurate localization of incipient forest fires"

The Problem

The global problem of fire is self-evident with thousands of deaths and injuries and €billions in loss and damage resulting from fires every year. Within the last decade Europe has experienced several wildfire episodes that have resulted in severe environmental damages, high economic losses and considerable humanitarian problems.

Summary statistics capture the scale of the problem:

- The cost of fires is estimated by the Geneva Association World Fire Statistics October 2011 to be 1% of the GDP of most developed countries. This translates into $25 billion in losses for France, $33 billion for Germany, $145 billion for the US, etc. Stating the obvious, these are staggering sums.
- The same report indicates that in Europe in 2007, 3,265 lives were lost to fire.
- With regard to forest fires:
  - On average, about 50,000 fires burn a surface of 500,000 ha every year in Europe.
  - In Europe in 2010, 2,740 km^2 of forest and agricultural terrain was destroyed not including Russia where 23,000 km^2 of forest was destroyed by fire with 62 deaths.
  - In addition to the direct loss and damage caused by forest fires, there are serious side effects to include soil erosion, floods and landslides resulting in >€25 billion in European losses per annum.
  - Forest fires comprise 20% of global CO2 emissions.
  - The number of forest fires is continually increasing due to human factors such as smokers, campers, picnickers and tourists and due to environmental factors, in particular, drought and global warming.
  - According to a prognosis by the United Nations Food and Agriculture Organisation forest fires, including fire clearing in tropical rain forests will halve the world's forest stand by the year 2030, a truly frightening statistic.
  - Despite of the use of high-technology solutions such as satellite monitoring or active laser-based systems, the situation has not significantly improved in the last 25 years mainly due to the absence of a solution with a sufficient degree of reliability and low manufacturing, operational and installation costs that can justify adoption by Forest Management Authorities.

- With regard to industrial fires:
  - In the UK in 2008 there were 27,500 fires in non-domestic buildings, 21 deaths, 1200 injured, > £1.1 billion in losses.
  - At least 50% of companies which suffer major industrial fires never recover.

FORFIRE strategy

The major axis of the FORFIRE strategy is that the largest, most readily available and cost effective reduction in global fire loss and damage can be achieved by the combination of super-early stage fire detection followed by very rapid deployment of fire suppression techniques. Essentially, the strategy focuses on the prevention of the spreading of fire so that the degree of suppression required becomes small and low cost.

The prerequisite to such an approach, however, is the existence and deployment of very early stage fire detection. Early detection is crucial for minimising the extent of the fire before fire fighting assets and resources can be delivered to the fire location and suppression can be applied. The European Forest Fire Information System (EFFIS) 2006 Report concluded that efficiency in extinguishing forest fires decreases exponentially with time and that the time from ignition to suppression should be less than 15 minutes for effective prevention.

It is the FORFIRE thesis that the above considerations motivate a global market demand for a very rapid, highly reliable, continuous, remote and cost effective fire detection and location system able to report incipient fires for optimal fire fighting deployment and early stage application of fire suppression.

FORFIRE product

The FORFIRE product is an outdoors fire detection system using an innovative solar blind camera only sensible to VUV part of the spectrum, based on the technology of photosensitive gas ionizing and solid-state detectors with appropriated filters. This product is designed to detect the presence of fire in the outdoor forest environment and to supply its location in the forest terrain.

FORFIRE detector

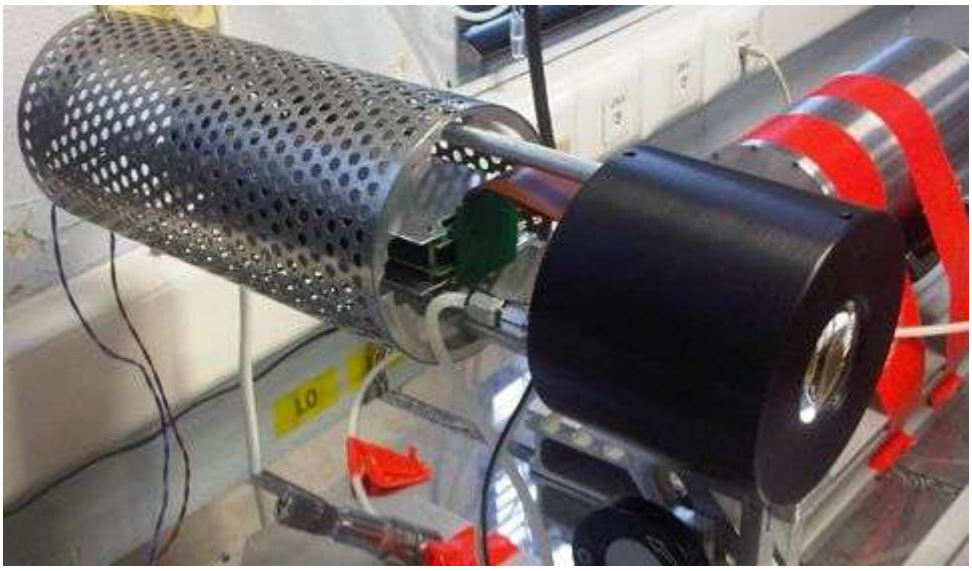
A complete prototype with a granularity optimized to the required spatial resolution, exploiting the potential of photosensitive gas detectors to spatially reconstruct sparks or generally UV sources and superpose the VUV image of the image of a standard visual flame detector, has been designed, developed and constructed with a VUV transparent focal optical system and a bi-dimensional readout matrix achieving an amplification gain over 10^7, allowing the fire surveillance of large areas, e.g. forests, oil wells, etc.

The two dimensional prototype of this gaseous detector combines large area imaging capability, high sensitivity, sufficient gas gains to detect single photoelectrons, intrinsic "solarblindness" and excellent timing characteristics (<1μs). An integrated visual flame imaging detector allows to combine the advantages of both types of VUV and visual flame detectors. The superposition of the UV and visual images provides a key tool to handle local false alarms from conventional energy sources by masking them and the achieved strong solar blindness the reduction to negligible level of global false alarms, eliminating thus the main disadvantage of UV flame detectors.

Final prototype of FORFIRE detector with localization software

Description of the work performed and main results

The design for cost effective mass production of detectors has been performed by selecting the best material for industrial manufacturing of the ultraviolet sensitive photocathode achieving high quantum efficiency (QE). The industrial prototype of the photodetector implemented has allowed to dramatically increase the knowledge on industrial manufacturing processes involved in combination with two dimensional gas ionisation photosensitive charged particle detectors. Various detector parts and the specifications of the processes to enable transformation of the Micromegas detector from laboratory prototype to an industrial sensor have been fully analysed and described.



Latest version of the FORFIRE detector in testing mode

The photodetector has been manufactured with a special optics system with high transmission and low reflectivity. The design of this special filter and the testing of lens integrated with the photodetector against specifications have been successfully completed.

The system is coupled with a special electronics readout system and a reliable pattern localization algorithm for early fire detection. The remote receiver module receives the information of a fire alarm event that consists on an image taken with the CCD camera which is superposed with a highlight of the fire detection location which has been read from the VUV detector. Additionally, some more information can be sent if required or convenient (camera GPS location, time, number of observation unit, etc).

Potential impact and use

The capability of the FORFIRE sensor to detect single photoelectrons escaping from the photocathode surface renders the sensitivity of this detector superior by more than 4 orders of magnitudes as compared to the requirements imposed by the European norm EN54-10, rendering thus this detector unique and without direct competition. This extreme sensitivity in the vicinity of 200 nm light allows a single detector to survey a large area measured up to more than 1 km, in agreement with the the proposal's estimation using theoretical values.

The excellence of the choice to use photosensitive MPGDs as ultraviolet sensors can be supported by the report to the NASA “Astro2010” Committee stating:

- *«MPGDs have a wide range of desirable attributes for flight detectors – high reliability, low power and weight, operation at room temperature, immunity to the radiation environment of space, solar blindness, high temporal resolution, and non-planar (curved) format options. For these reasons, they are likely to remain an attractive choice for future space missions requiring UV detectors».*

- ♣ *«Developmental work is needed in many areas beyond quantum efficiency and format extension. These include: the fidelity of MCP amplification, readout performance, electronics development, and noise suppression».*

- ♣ *«To date, solid-state arrays have not been featured prominently as UV flight detectors partially due to the fact that many solid-state arrays are not solar blind or because they do not offer photon-counting ability».*

Moreover, big industrial concerns, as HAMATSU in Japan, are working in the development of the FORFIRE technology.

The overall European **Fire Detection market** has been valued 1.89 billion Euro in 2011. The potential global target market for the FORFIRE fire detector products can be estimated at €500 – 750 million if they were on the market now in 2011 with CAGR = 5.5%. By market launch in 2013, the potential market for FORFIRE will exceed €800 million p.a.

It is critical to note that Intellectual Property (IP) protection of the above technology has been achieved through patents and patent applications by CEA and HERON. Micromegas and AGET patents owned by CEA have been exclusively licensed for commercial products related to application of fire prevention and HERON has taken out its own patent applications in respect of applications of the technology.

Consortium members

Partner	Short name	Country
IRISH PRECISION OPTICS	IPO	Ireland
HERON TECHNOLOGIES SAS	HERON	France
OPTOELECTRONICA	OPTOEL	Romania
PINDIATEC	PINDIATEC	Spain
FOREST RESEARCH INSTITUT	FRI	Poland
COMMISSARIAT A L'ENERGIE ATOMIQUE	CEA	France
TECNOLOGIAS AVANZADAS INSPIRALIA S.L.	ITAV	Spain
UNIVERSITY OF ATHENS	UOA	Greece

Contact details

Tony Herbert (Finance and Operations Director)

LIGHTWAVE OPTICS LTD trading as IRISH PRECISION OPTICS
22 Summerhill North,
Cork, IRELAND
Tel: +353 86 244 4412/+353 86 1951682

Email: therbert@irishprecisionoptics.com
Project website address: http://www.forfire.eu/