MAY 06, 2020
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BIOSENSORS FOR PANDEMICS

NANO-ILLUMINATION MICROSCOPY AS A FAST-LOW-COST CHIP-SIZED TECHNIQUE TO FACE PANDEMICS

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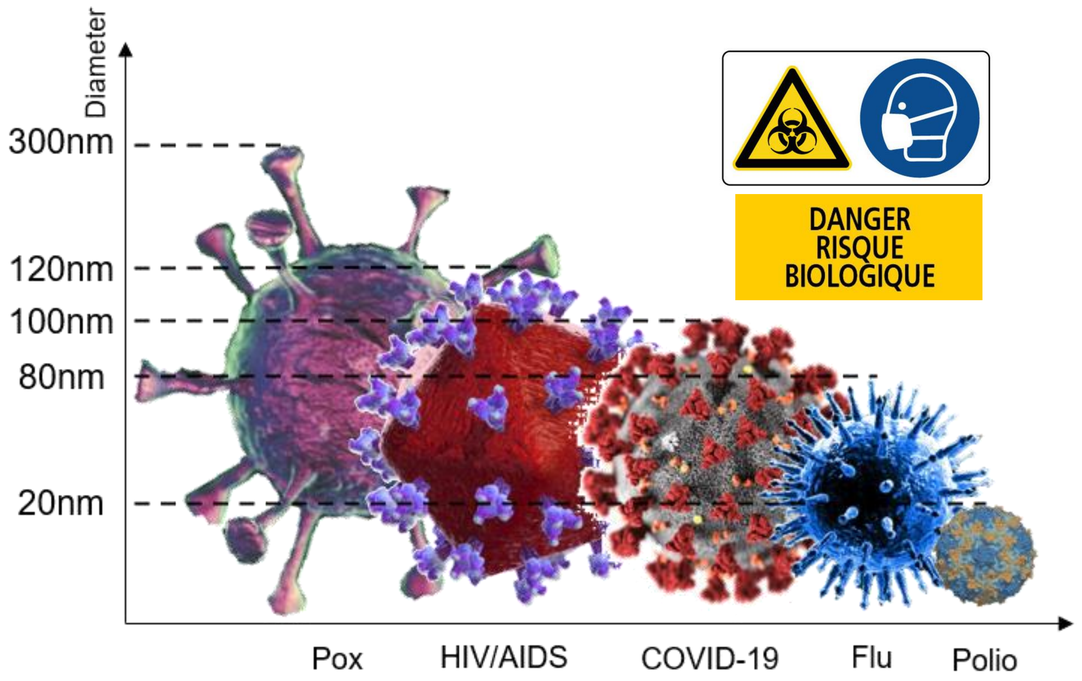
Motivation

Over the past few decades, virologists, epidemiologists and other health sectors have issued alerts about new viruses that could lead to **global pandemics**. The need for rapid and effective methods to diagnose viruses is of paramount importance to prevent its massive spread among the population. Most **viruses** vary in size from **20 nm to 250-400 nm**, but only the largest ones (700 nm-1 µm) can be seen with a traditional optical microscope. Although some optical super-resolution techniques achieve a resolution of tens of nm, these are **complex** and require **expensive** setups. Thus, the European FET-open project **ChipScope** goal is to build a microscope **overcoming the limits of diffraction** by simple methods on a chip size.



Examples of well known pandemics viruses ordered by diameter.

Experiment

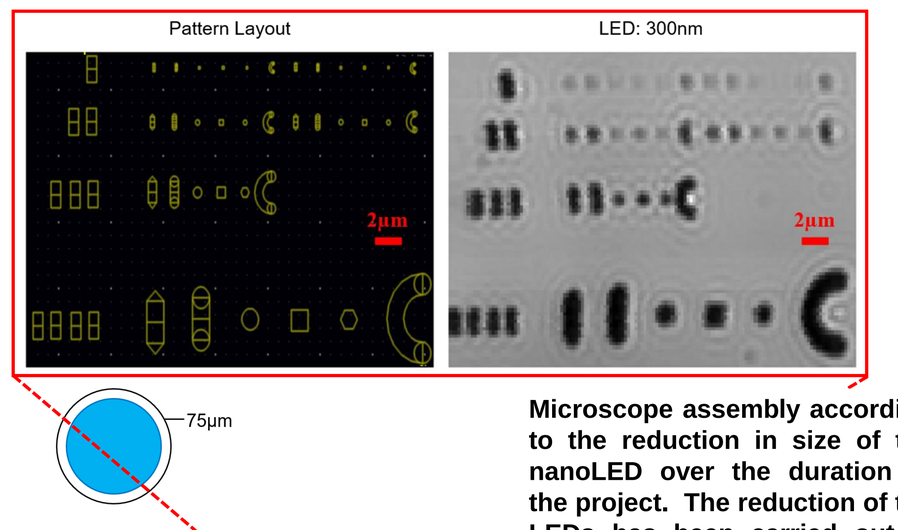
Lens less microscopy is a **low-cost** alternative to previous super resolution microscopes, but its resolution is limited by the pixels size on the camera. To overcome this limitation, a **new super resolution microscope** based on nano-illumination microscopy (**NIM**) [1], [2] is being developed with :

· 2-D array of 8x8 InGaN/GaN LEDs emitting at 465nm of 5µm size and pitch.

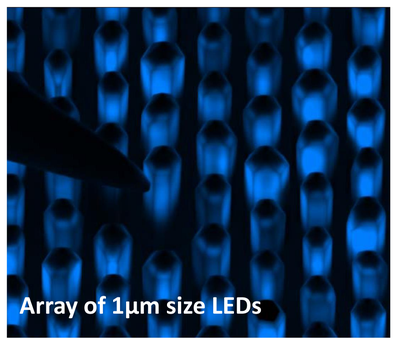
· **Shadows** are observed on a CMOS sensor in **near field**.

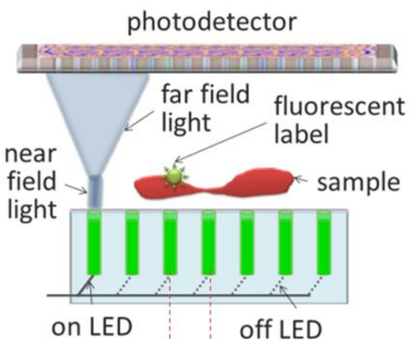
· 1 single photodetector, i.e. **CMOS Sensor**.

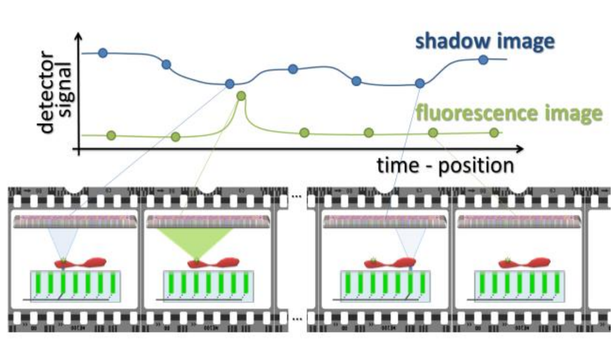
· NIM is also used to excite fluorophores



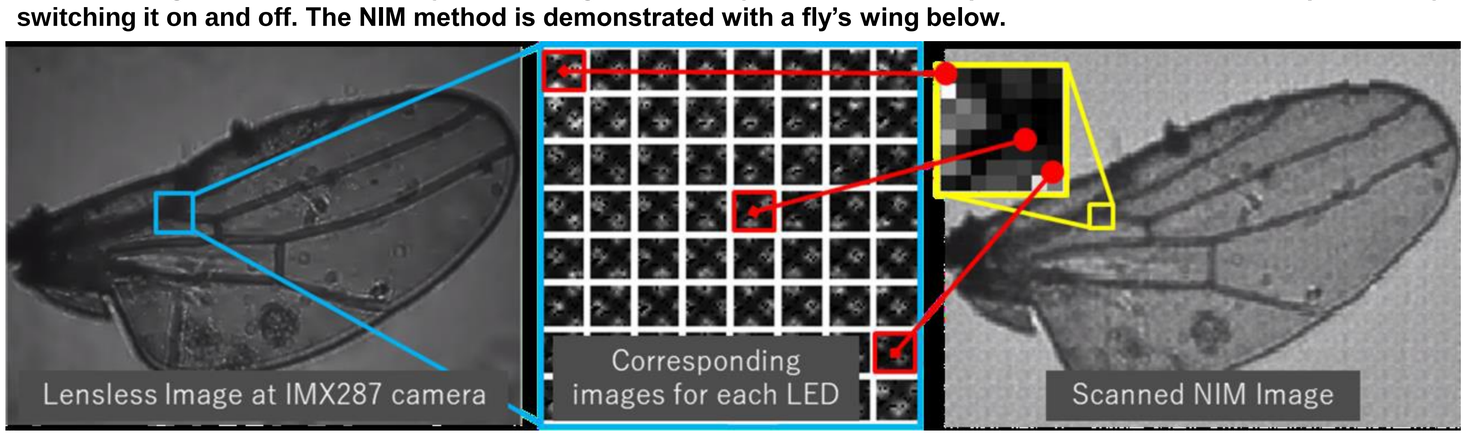
Microscope assembly according to the reduction in size of the nanoLED over the duration of the project. The reduction of the LEDs has been carried out in two different ways in parallel: the first by optical reduction (orange) and the second by continuing with the reduction integrated on-chip (green). It is currently 300nm [3].







The NIM image is reconstructed by associating the intensity measured at the photodetector to each LED position by switching it on and off. The NIM method is demonstrated with a fly's wing below.



Conclusions

As no lenses or expensive setups are involved the microscope is affordable by anyone. Several **prototypes** that integrate both the sensor and the LED array with the sample are being developed to reduce the setup, so it can be produced on a **chip** size, available to be plugged in **mobile phones**.

Acknowledgements:

This work has been partially supported by the European Union's Horizon 2020 research and innovation programme under grant agreement No 737089 - ChipScope Project and by the Catalan government though the project InnotecRD18-1-0016 of ACCIÓ.

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[3] H.S. Wasisto, J.D. Prades, J. Gülink, A. Waag, "Beyond solid-state lighting: Miniaturization, hybrid integration, and applications of GaN nano- and micro-LEDs", Appl. Phys. Rev. 6, 041315 (2019).

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