Miniscope for fluorescence imaging based on a mobile phone

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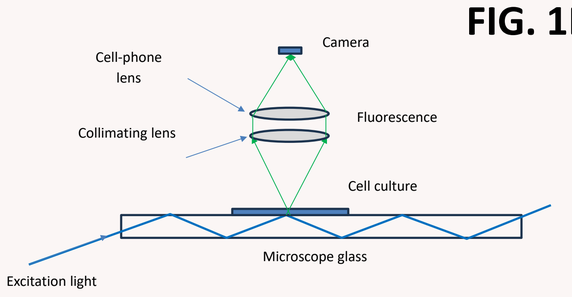
INTRODUCTION · Our project goal was to design a medical device for in vitro diagnostics with a flow-through system that can capture video images of signaling from intracellular fluorescence probes. We have managed to design a prototype of **lab-on-a-chip (NIMOCHIP™)** and the remaining task was to solve the optics-on-chip design.

MATERIALS & METHODS · We chose to use the **mobile phone camera** system as the core of a miniscope system (HUWEI P smart Z, 16 Mpix, 4608x3456 pixel; Fig. 1A). An additional cellphone lens (manufactured by Largan, model 70018A1, with NA 0.34) was placed in front of a cell phone camera (Fig. 1). As a result, we had a unit magnification optical system with **resolution of the order of 1 μm**. For the first tests we decided to use a standard glass plate sample of mounted fixed **primary astrocytes from rat brain** fluorescently immunostanied (Alexa 488) for GFAP.

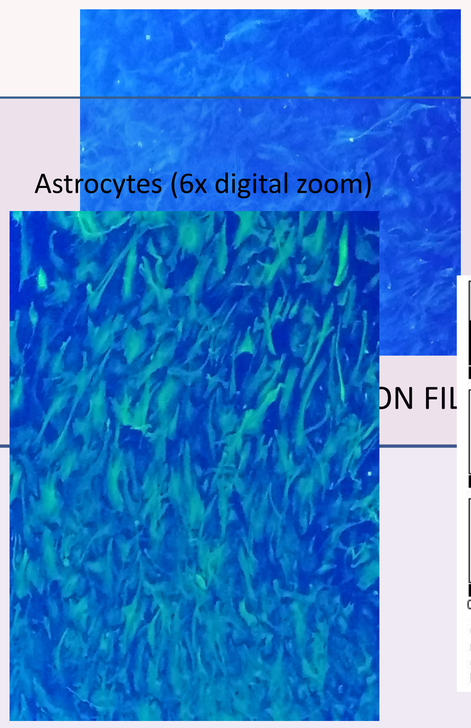
HUAWEI P smart Z, phone camera with 16 megapixels (4608x3456 pixel) ~ 1.12 μm

FIG. 1A

FIG. 1B



- high-power, white LED emission
- filtered by a band-pass (excitation) filter. -
- Excitation in a wave-guide mode, light edge-on, through the microscope glass



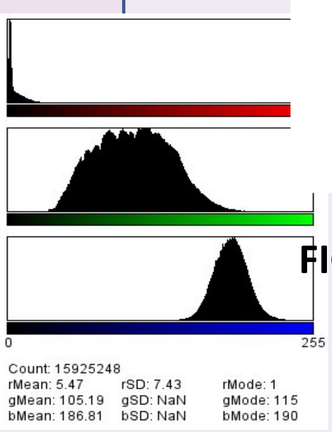


FIG. 3

RESULTS

The whole device is designed to be slightly larger than the cell-phone and easy to 3D print (Fig. 2). The cell-phone can be mechanically locked with spring-loaded adjustment screws for easy focusing. We used Blue light excitation of the sample by using a high-power, white LED with a band-pass excitation filter. Excitation of the cell sample was performed in a wave-guide mode, by light sent **edge-on, through the microscope glass** (thus, excitation light is efficiently transmitted to the sample without going into the collecting optics). The fluorescence of the sample is efficiently collected after passing an emission filter (ultra-thin filter **OD2**, manufactured by Everix, with cut-on wavelength of 500 nm) detected on the camera. Fluorescence was clearly seen, revealing the overall shape of individual cells of the sample (see Figs 3-5).

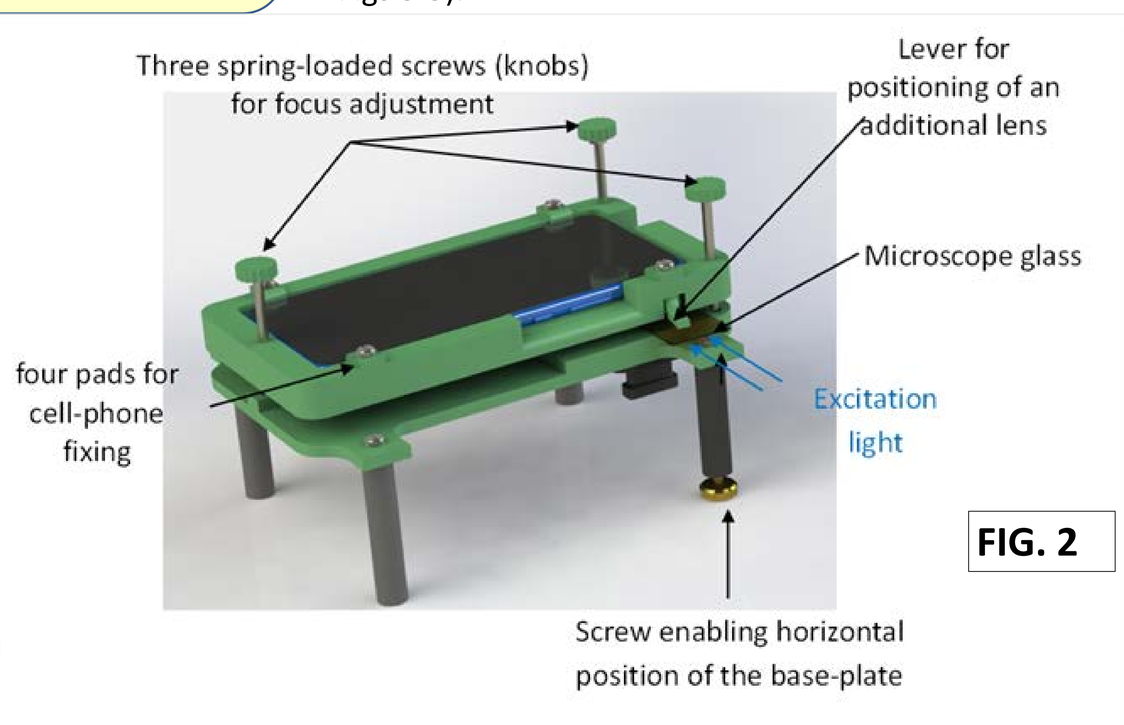


FIG. 2

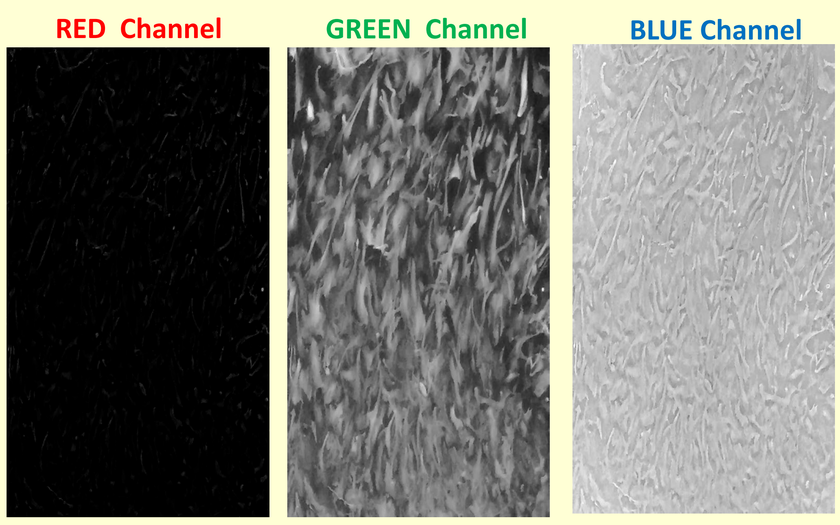


FIG. 4 Miniscope test of different channels

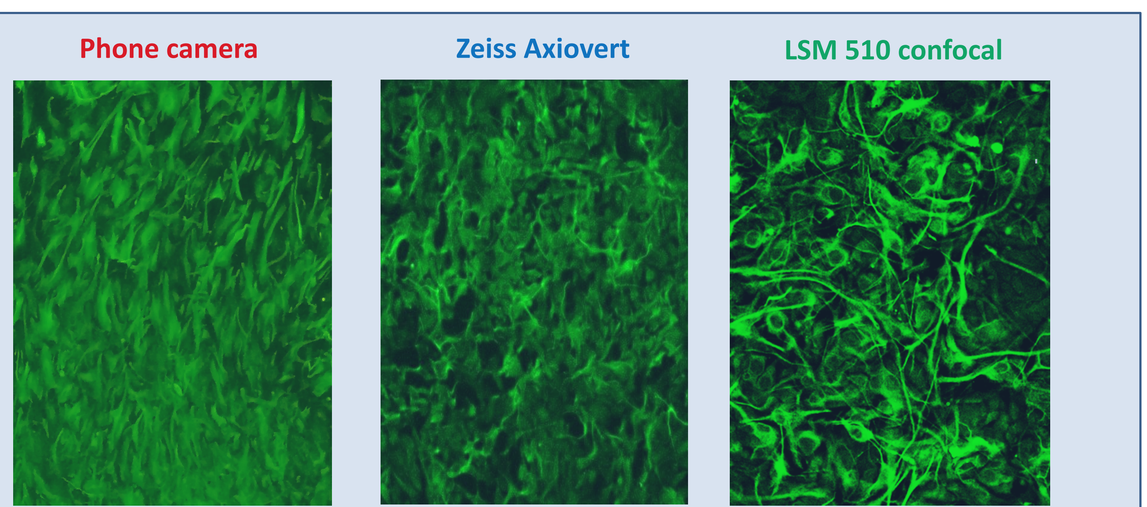


FIG. 5 IMAGE COMPARISONS

Astrocytes in culture (PFA fixed; GFAP Alexa 488 staining)

CONCLUSION

The testing results obtained with this **prototype device** offer the opportunity for further development towards an **optics-on-a-chip solution**. This will need an adaptation of sample positioning that can fit a lab-on-a-chip flow chamber for **time-resolved video imaging**.

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