

# Measuring fluorescence by means of smart phones with the new Citclops-application

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## MOTIVATION

Chlorophyll *a* (Chl *a*) fluorescence is a proxy for algal biomass. This is one of a number of key parameters to indicate different processes of societal concern. It is commonly measured within monitoring programmes and scientific research. By utilizing smart phones, citizens are enabled to actively participate in measurements of water quality. The potential of the FP7 EU-project Citclops ([www.citclops.eu](http://www.citclops.eu)) initiative is an almost synoptically and spacious data set of coastal seas based on citizen science.

**Citclops: Citizens' observatory for Coast and Ocean Optical Monitoring:**

- ❖ Developing algorithms and applications for smart phones
- ❖ Constructing a new devices: Method and sensor geometry for the use of internal and external smart phone elements
- Easy to use, small and affordable sensors for their respective field of use.
- Provide low-cost Chl *a* fluorescence sensors to allow citizen's involvement in measurements

## DESIGN and DEVELOPMENT

### Holder System for smart phone adapter including the electronics based on 3-dimensional (3D) prints

Computer Aided Design (CAD) – drawing (fig. 1)

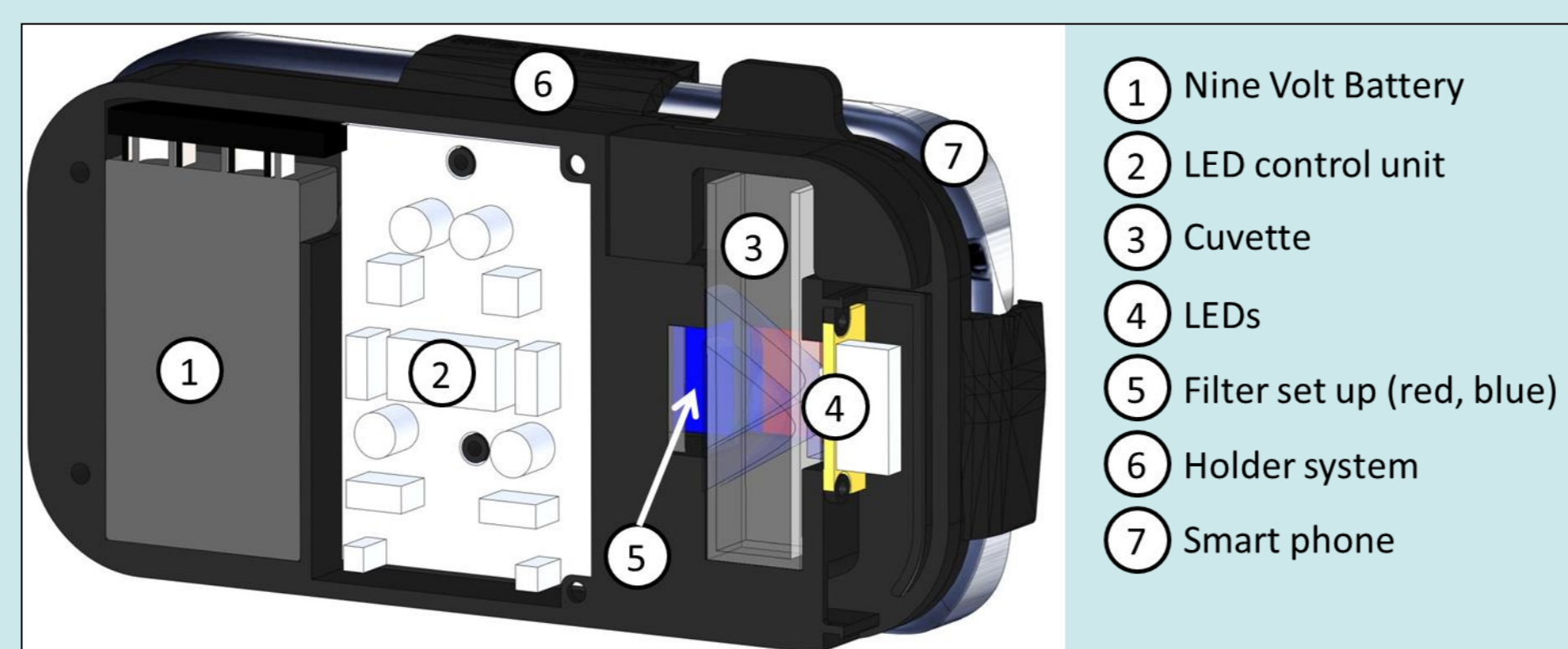


Fig. 1: CAD-drawing for the holder system

3D – print as prototype (fig. 2)

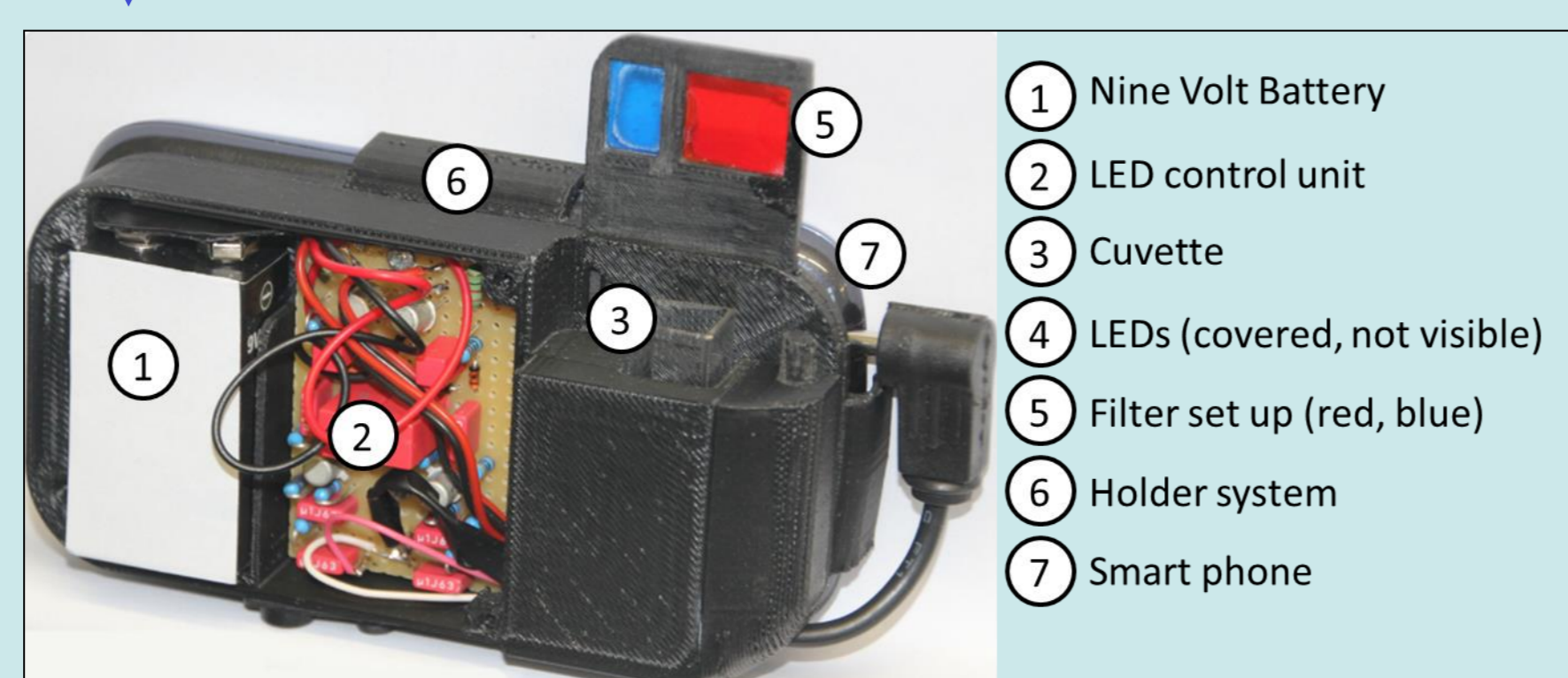


Fig. 2: 3D-printed holder system for measurements

### Proof of principles

- ❖ Excitation: external and internal smart phone light emitting diode (LED) (fig. 3)
- ❖ Detection: red-blue-green (RGB) images by means of internal smart phone camera

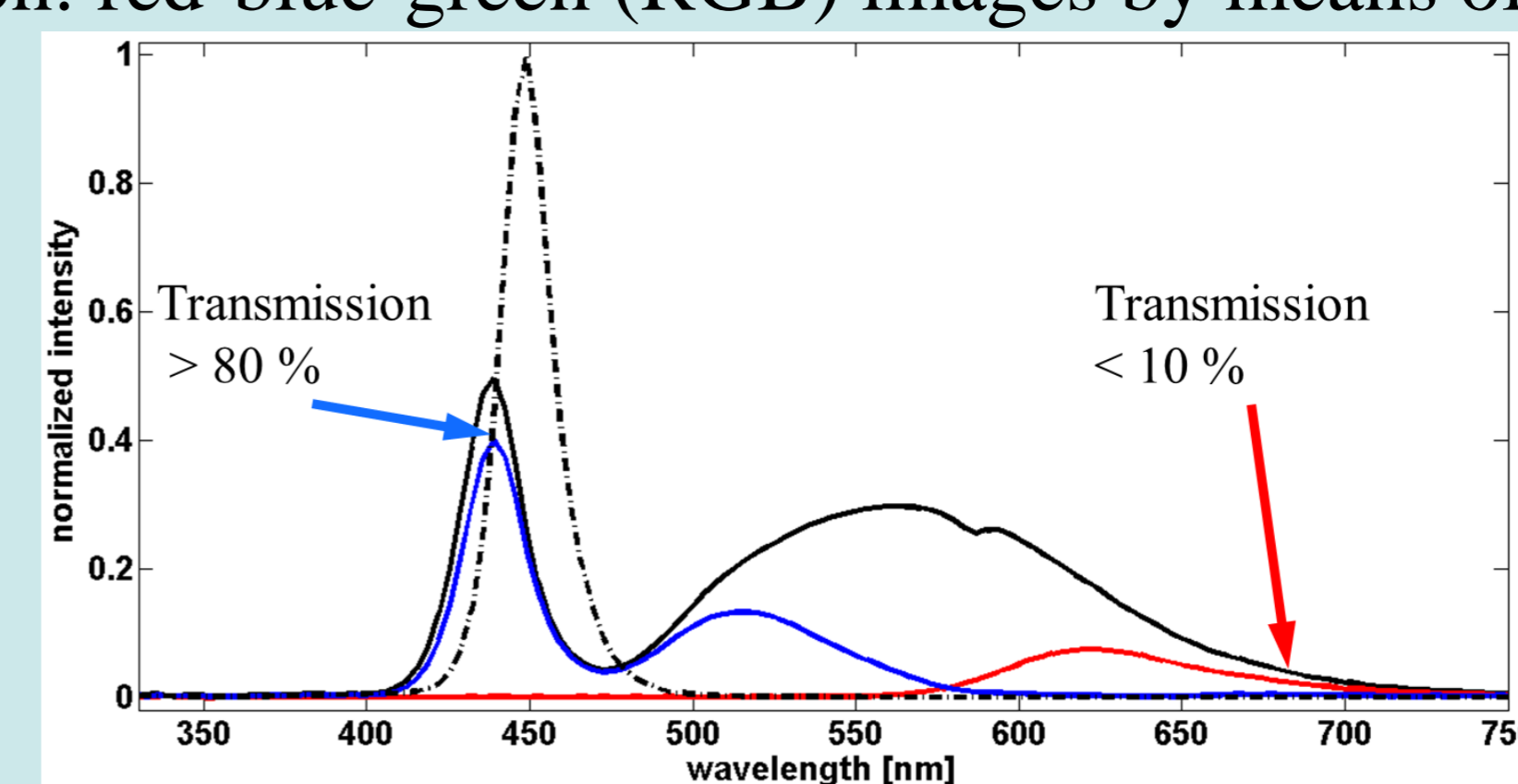


Fig. 3: Normalized spectra of smart phone LED (black), restricted by blue filter (blue), and red filter (red) compared to brighter external blue LED (black dashed)

Measurements (fig. 4 a – c):



Fig. 4: Measurements with the (a) set up for proof of principles, (b) prototype and smart phone application, (c) control measurements

### Conversion of resulting RGB image to Chl *a* concentration

- ❖ Algorithm relates Chl *a* concentration to the intensity of the red channel (fig. 5) based on RGB images (fig. 6) with fit of  $R^2 = 0.981$

Fig. 5: Intensity versus concentration (circles) with logarithmic fit (green line).

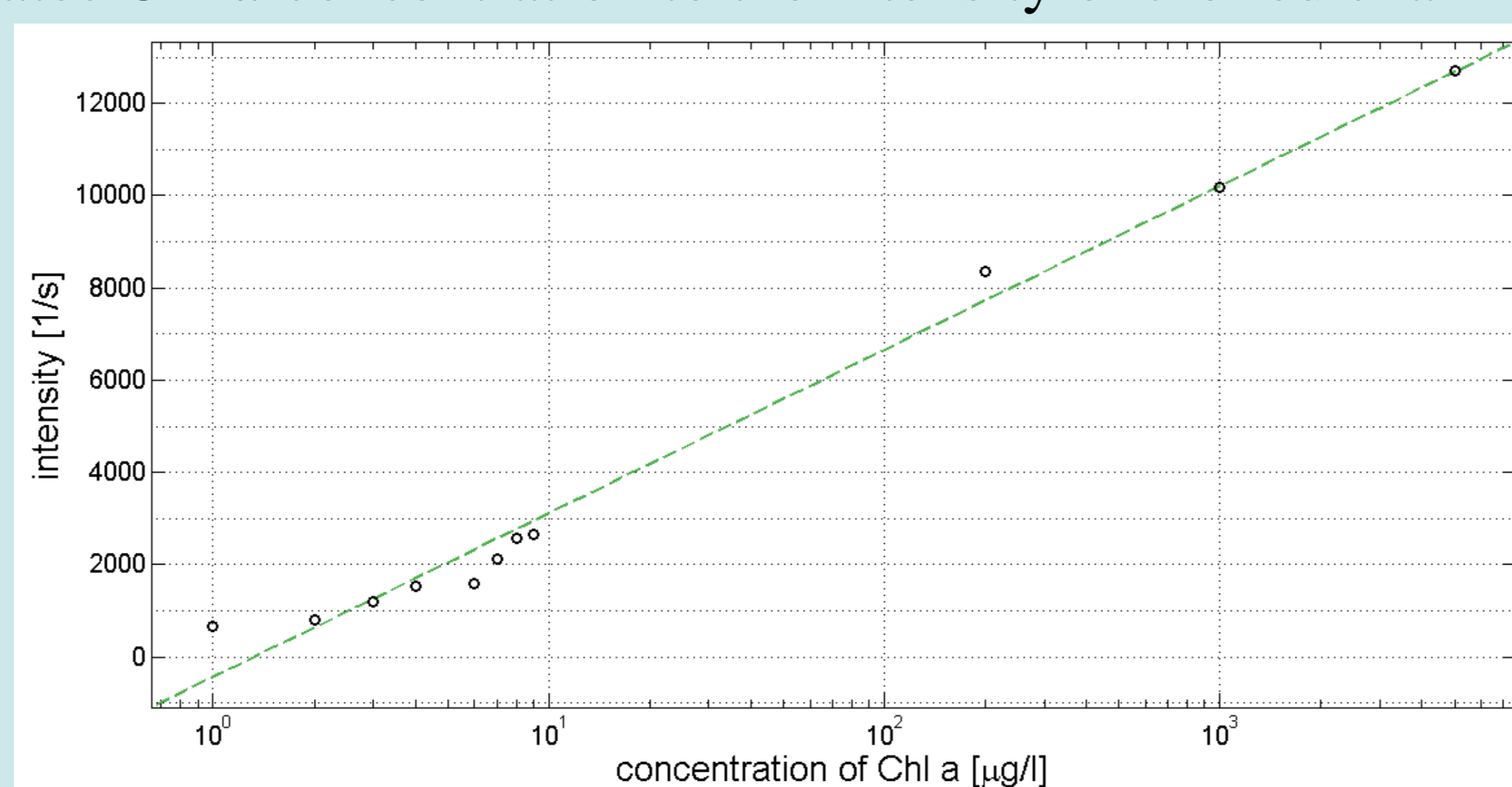


Fig. 6: Examples of selected squares of RGB images for the given Chl *a* concentration.

## DISCUSSION and OUTLOOK

- ❖ Transfer of Chl *a* fluorescence measurements to smart phones was successfully accomplished with a 3D-printed adapter and new algorithm.
- ❖ New affordable tool for fluorescence measurements with smart phones was developed.
- ❖ Refinement of sensors with laboratory (algal) and field measurements.
- ❖ Transfer to other smart phone types: open source CAD-drawings and construction plans for 3D-prints.
- ❖ Promising results to use smart phones as sensor system to measure fluorescence.
- Use the potential of environmental observations by citizens for an almost synoptically and spacious data set of coastal seas.

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For more information see: [www.citclops.eu](http://www.citclops.eu)  
Citizen's observatory for coast and ocean optical monitoring