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The bioscope: two replications

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***Abstract*—Bioscope is a sensor that, according to developers, is able to perceive a physiological state of biological (living) organisms. The sensor is based on measuring the intensity of light scattered from a glass coated with a thin opaque material. In this paper we describe two replications of this sensor, performed in 2012-2015 by two independent laboratories in Russia and Germany. Measurements are curried out with biological objects and different rotational, entropic, fiber-optic and hydrodynamic devices. Additional high resolution sensors of temperature and humidity are utilized in over a hundred of measurements. The obtained results do not allow making unambiguous conclusions and require revising the design of reflection-scattering elements. Some measurements can be considered as abnormal in terms of temperature and hygrometric dependencies, which indicate a necessity of further research with this device.**

I. Introduction

The development of sensors perceiving weak and ultraweak signals of non-electromagnetic and non-thermal nature from biological and technological objects represents the priority area of unconventional research. Such state-of-the-art sensors are based on electrical double layers [1], spatial polarization of water dipoles [2], accurate pH and dpH measurements of organic and inorganic liquids [3], [4], conductivity of plant tissues [5], some processes in solid-body sensors [6].

The bioscope has attracted our attention due to a number of unique characteristics such as a fast reaction, the ability to measure biological and entropic processes. Large number of conducted experiments, long-term (more than 8 years) tests, and existence of several modifications represent a strong side of sensor development. These works have been published in various international papers, e.g. [7], [8], which pointed out that the bioscope is potentially capable of detecting cancer. Commercial version of this device is available. The doctoral thesis (doctor of science) in this research area was defended in 2008 in the Academy of Sciences of the Republic of Armenia [9].

Two independent laboratories – the Igor Volkov laboratory (further IVL) in Russia and the laboratory of advanced sensors (further LAS) at the research center of robotics and environmental science in Germany – attempted two replications of this sensor. Both laboratories have already performed similar works, such as a replication of methods and instruments of A.V.Bobrov [10], [11], S.N.Maslobrod [12], Yu.P.Kravchenko [13], V.T.Shkatov and others. Thus, the laboratories have the necessary equipment and experience of performing replication works. The tested technologies and devices in these laboratories received both positive and in some cases negative reviews. Moreover, LAS is testing and certificating unconventional instruments and methods, see. e.g. [2], and participates in many international projects, including academic projects funded by European Commission, as a testing laboratory and sensor manufacturer[1].

Preparing to replication, IVL and LAS contacted the developer of bioscope (further the developer), examined numerous publications, analyzed critical comments from previous replications of this device. The developer gave advices regarding elements and constructions of the sensor. Several versions were made, which differed from each other by the material of membrane and parameters of light sources/receivers. Experiments were carried out in 2012-2015 at IVL, and from September 2014 to March 2015 at LAS. Initial methodology of the developer has been adapted as a replication methodology. Additionally, LAS performed accurate measurements of temperature and humidity near the sensor.

These two replications include over a hundred of primary and secondary experiments. Based on recommendations of developer, authors manufactured rotational, entropic, hydrodynamic and fiber-optic test devices. They should impact the bioscope. Online experiments in real time were conducted with IVL, LAS and the developer. In general, experiments with the LED version of bioscope and the paper membrane fully confirmed initial results of the developer in regard to biological objects. The bioscope responded to presence and quality of biological objects (e.g. fresh and stale bread). However, the humidity and temperature sensors indicated that the reaction can be caused by moisture of biological objects. Further targeted experiments have shown that the hygroscopicity of paper membrane is responsible for bioscope reaction. When excluding the moisture variation, e.g. by isolating biological objects with multilayer film, the bioscope did not react anymore. As assumed, the curvature of reflecting surface

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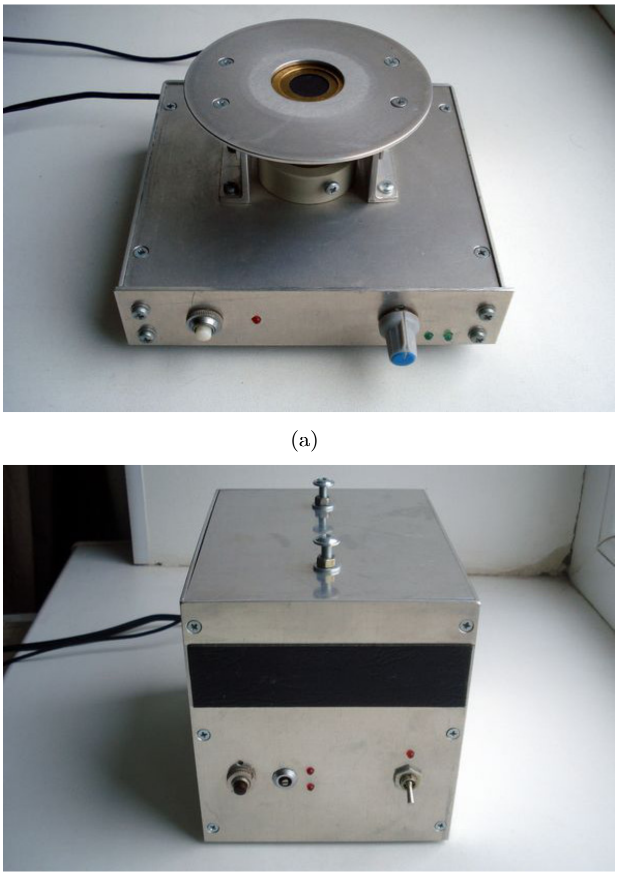
impacts the light flux between emitter and receiver. Even small changes of relative humidity and temperature from arbitrary non-biological objects, such as a wet rag, caused a reaction of bioscope. Although the developer conducted qualitative experiments to remove the moisture factor, for example, by measuring in water and in vacuum, accurate measurements of moisture have not been conducted. After IVL and LAS reported their results, the developer conducted own experiments with household (low resolution) sensors of humidity. These humidity measurement from 2014-2015 are included in the paper [14]. The influence of moisture, as a possible factor for bioscope reaction, was already pointed out by another replication in 2010 [15].



(a)

(b)

Fig. 1. **(a)** The prototype of bioscope with non-coherent light; **(b)** The prototype of bioscope with coherent light.

Experiments with non-biological objects have shown that replacing the paper membrane by a metal or thin film cancels the bioscope reaction provided the temperature remains constant. In general, these experiments have demonstrated the need to revise the sensor design and to remove the membrane. IVL and LAS failed to replicate a response on fiber-optic and hydrodynamic test devices.

Despite the overall negative result of both replications, several obtained data cannot be explained only by a hygroscopicity of paper membrane. For example, the system 'phytosensor-bioscope' demonstrated responses unrelated to humidity/temperature changes. Also, the experiments with coherent light are not replicated in this paper. IVL and LAS proposed to publish the initial and replication works jointly. In this way a reader can obtain a better impression about experiments with bioscope for further replications. LAS, for its part, plans to continue experimenting with a non-membrane bioscope.

This paper has the following structure. Section II is dedicated to replication in the Igor Volkov laboratory, Section III – in the laboratory of advanced sensors. Section IV generalizes both attempts and concludes main results.

II. Replication in Igor Volkov laboratory

A. Overview of experiments with paper membrane

After the 3rd conference on information interaction (2012) the laboratory has contacted R.Sarkisyan regarding his photometric device 'bioscope'. In autumn of the same year, with assistance of the developer, the first equivalent device with non-coherent light (LED) was developed, and shortly after – the version with coherent light (with semiconductor laser), see Fig.1. We conducted a series of experiments to understand the demonstrated phenomena.

The first device contains a small sample stage to fix test objects. The second device features special chamber to protect samples against external influences. This chamber provides also the capability for long-term monitoring of various test objects. Each device contains a circuitry for auto-selecting the 'zero-signal', the analog output of measured voltage, which after digitization was stored on PC.

The first experiments have shown that the device sensitivity and a phase of responded signal are strongly influenced by orientation of membrane (a black paper). It means that each bioscope needed own presetting with respect to the light source. It was concluded that the paper is an anisotropic material in this application. In general, the main effects, described by the developer, are fully confirmed. The device clearly responded to biological objects and did not respond to non-biological objects, provided their temperature is equal to the room temperature. The experience with 'biologization' of organic substances, such as paper, wood, cookies, wax, soap are also confirmed. Metals, glass, wax, various plastics do not have this property.

The only one exception was the water, and here the main problem arose. The best material for membrane in terms of device sensitivity is a black paper. As well-known, the paper is a hygroscopic material and an ambient humidity significantly affects its properties. Thus, the resulting output signal is the sum of parasitic factors (humidity, temperature, IR) and a useful signal from biological objects. It is impossible to estimate impact of different factors without additional sensors. From skeptical viewpoint, all bioscope effects regarding biological objects can be explained by humidity factors impacting the paper membrane. For examples, the paper membrane can undergo mechanical micro-deformations or change the surface reflectivity (albedo). The 'biologization' effect can also be explained by micro-vapor from human hand, which remains on object surface and then after some time (about 10-15 minutes) aligns to the humidity level of surrounding air. Such a micro atmosphere with water vapor is around any biological object. It can be even visualized e.g. by keeping a hand close a cold glass. However, the developer accounts the bioscope reaction to 'energetic component of the water' at the quantum level and not to physical hygroscopic effects. To separate a useful signal from humidity artifacts, IVL covered the bioscope by a thin rubber to insulate the sensor from environment. As a result, the sensitivity decreased but the bioscope continued to work. External noise, e.g. from indoor air inhomogeneities, was thereby significantly decreased (as turned out in LAS experiments, a thin rubber do not completely isolates the sensor from humidity but only weakens it).

Figure 2 shows an example of water 'biologization' by human hands and the impact of heated objects on bioscope. At first glance, the results of 'biologization' can be explained by the presence of residues evaporation condensate on glass container, especially if the water has a lower temperature than a body. However, this experiment was not always successful, even if a glass with water was placed on a wooden plank.

We also performed experiments with 'biologization' of beeswax. Despite the wax was placed in a plastic bag, different results of 'biologized' and control experiments were well visible. Moreover, in one of experiments the wax was cut with a knife after 'biologization'. Even in this case, the bioscope demonstrated different results in control and experiential measurements.

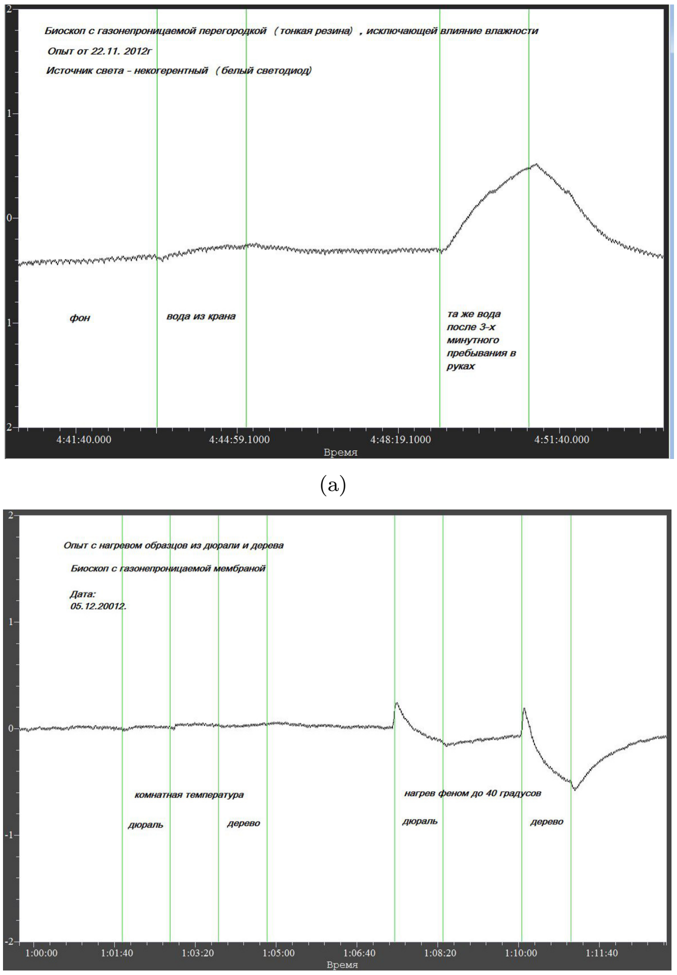
B. *Bioscope with coherent light*

This version of bioscope is essentially more sensitive than the LED version. A person entering the room can be registered on the distance of a few meters. It seems incredible that a human activity at the distance of 5-6 meters and within a few minutes is able to change temperature/humidity. However, according to experiments of S.Kernbach with temperature and humidity sensors, it is possible. A typical measurement of a biological object (a lemon fruit) by the laser bioscope is shown in Figure 3.

C. *Conclusion to this section*

Based on performed experiments a number of issues remains not entirely clear, for example, the occurrence of oscillations. We can roughly say that the output signal represents a 'beating' of the light rays reflected from the glass plate and from the scattering surface of membrane. However, such oscillations can be obtained using only the glass plate without membrane...

The developer, in my opinion, has a serious argument that is empirically verifiable. Even the earliest experiments with the LED version of bioscope demonstrated an unpleasant phenomenon – a long transition process (about 20 minutes) when turning on the device. Firstly, a drift of the light source during heating can explain this effect, but the stabilized LED current did not change the situation. Secondly, a photodetector and amplifier can be in charge of a long transition process. However, the temporal initial instability of photodetector and amplifier are only tens of seconds. The laser version of the bioscope can undergo the relaxation time up to several hours!



(a)

(b)

Fig. 2. **(a)** Experiment with 'biologization' of water (in a glass container) by human hands; **(b)** Impact of heated objects on bioscope.

The reason for such a long transition process is the membrane of bioscope. When only slightly moving or rotating the membrane, a long process of relaxation appears again. As turned out, switching the light inside the bioscope also changes the state of membrane and starts exponentially decaying process of 'adaptation'. Thus, any change of the system 'light source – membrane' leads to unstable dynamics of output signal. The greater is the change, the correspondingly longer is a relaxation time. These are preliminary findings. For further research the paper membrane should be removed in order make the device independent of temperature and humidity.

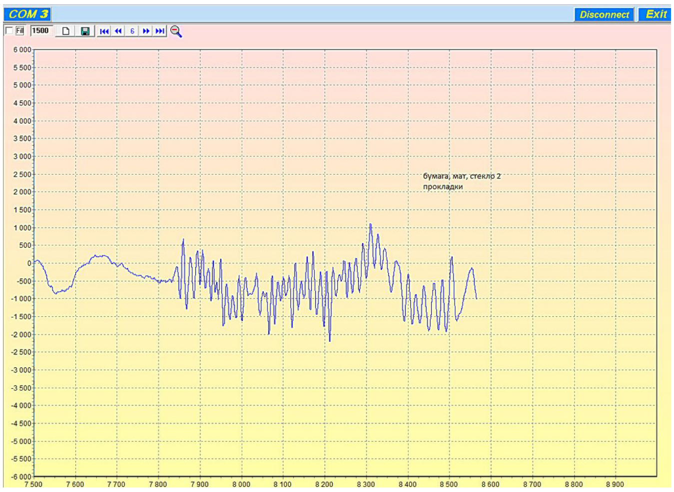


Fig. 3. Measurement of a biological object (a lemon fruit) by the laser bioscope.

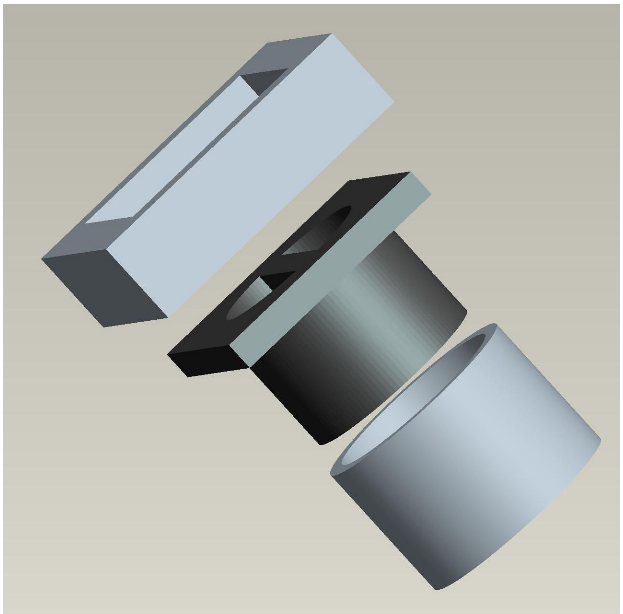


Fig. 4. 3D model of the LAS replication, all elements are printed on 3D printer from a black PLA polymer.

III. Replication in the laboratory of advanced sensors

A. Structure of the sensor

Since both the original bioscope and the IVL replication used the visible part of light spectrum (400-760nm), the LAS decided to test the IR versions (940nm) of LED and phototransistor. Separating the spectra of 'working light' and ambient light represents a standard solution in robotics and automation systems [16], [17], [18]. This makes the device insensitive to normal (no sun) light and removes doubts in influencing the ambient light on the sensor. Since phototransistors are more sensitive than photodiodes, this solution increases sensitivity of the sensor. The difference in 180nm from the 'red spectrum' is expected to introduce additional effects, but this should not essentially change the functionality of device.

The bioscope consists of three elements, see Figure 4. IR LED TSAL6100 and IR phototransistor TEFT4300 are fixed in the lower part, the middle part serves as an optical isolator and a light chamber, the upper part contains glass elements and a paper membrane. All parts are inserted into each other, the upper and middle parts are fixed with screws and thus secure the membrane. This design was printed on 3D printer from a black PLA plastic with 5mm thickness and the filling level of 90%. Such a construction provides mechanical stability and high optical isolation. Stationary measuring system with VISA interface was used as the first version of electronics, later the sensor was connected to the MU2.0 system, see [3].

Various materials for reflecting-scattering elements have been tested – 2mm glass, plexiglass of 2mm, 4mm and 8mm, and several kinds of black paper (the developer used a black paper from packaging of photomaterials). The best results are shown with 4mm plexiglass and slightly polymerized black paper. The current through the LED was set at 20mA, the phototransistor responded by 30-100mV. Fully illuminated phototransistor created about 3.3V, i.e. the working range of light-reflecting elements corresponds to 0.9% - 3.0% of a full illumination.

B. First experiments

A series of experiments has been performed to test the sensor functionality. Figure 6 shows one of the first calibration experiments with fresh bread as the test object. It was noted that the LED and phototransistor currents should be stabilized. Otherwise self-heating and a variation of ambient temperature impact the current and change optical-electric properties of the sensor. High initial drift is caused by these processes and can be reduced by using appropriate circuitry.

Figures 5 and 7 demonstrate several long-term measurements with people inside a room and with test objects. The sensor reacts in a similar way – a first surge followed by a gradual relaxation to a stationary state.

An interesting experiment is shown in Figure 8. Two pieces of one- and seven-days-old bread were used as test objects. Both objects are wrapped in thin plastic film used for sealing food and then placed on the bioscope. In both cases, the sensor responded according to a state of test objects. In general, these experiments demonstrated a full functionality of bioscope as declared by the developer.

C. Experiments with humidity and temperature sensors

Experiments shown in the previous section indicated a significant response of bioscope on biological objects (bread, hand) and a much weaker response on metal and other (inorganic) objects. However, the following observation attracted our attention. The same bread wrapped in a plastic film and without the film evoked different reactions of the sensor. The difference can be of 10 or more times.

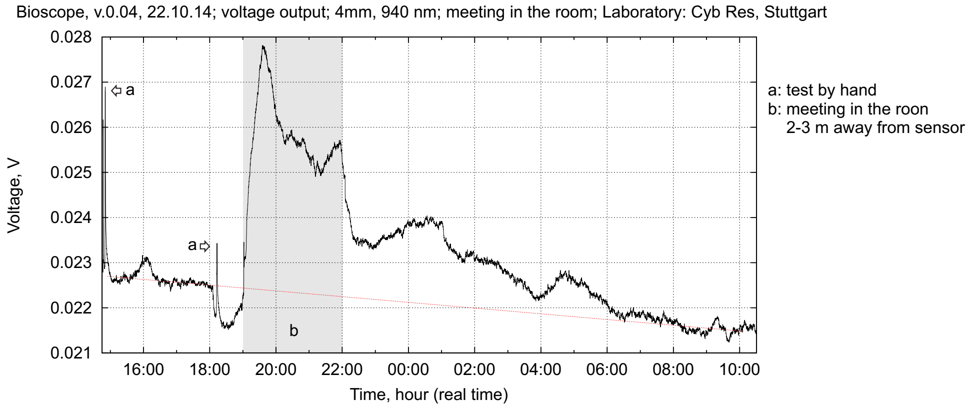
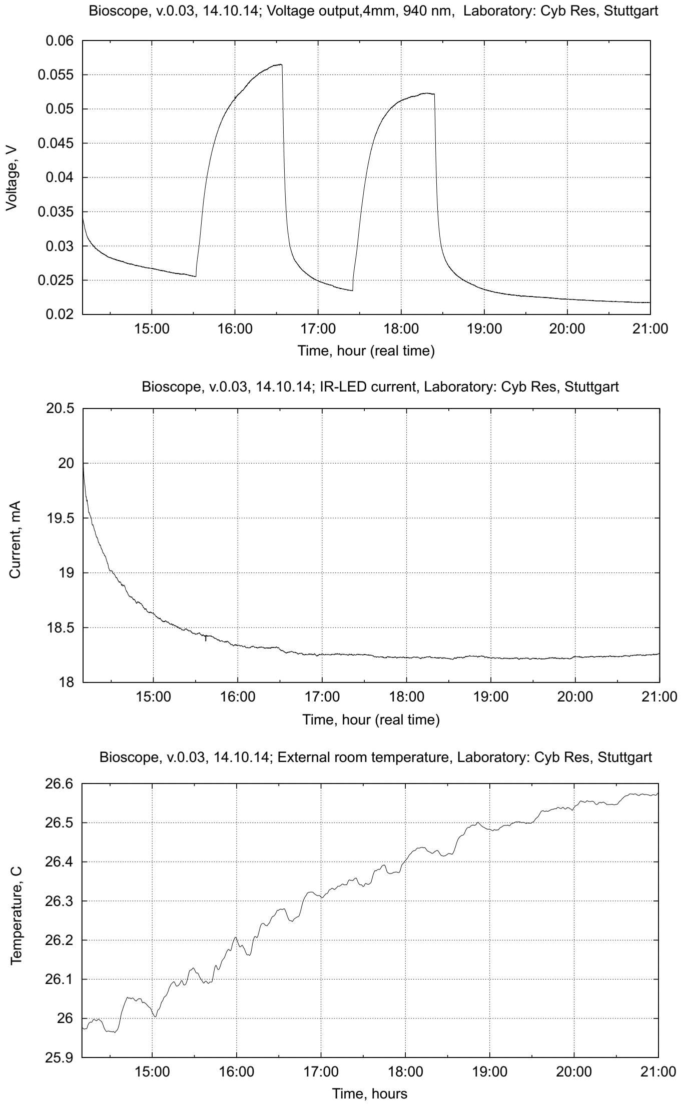

Bioscope, v.0.04, 22.10.14; voltage output; 4mm, 940 nm; meeting in the room; Laboratory: Cyb Res, Stuttgart

Fig. 5. The experiment 141014 during 18 hours, a meeting at 19.00-22.00 took place in this room. The bioscope demonstrated reaction on the test impact from a hand and a response to presence of human in the room.


Bioscope, v.0.03, 14.10.14; Voltage output,4mm, 940 nm, Laboratory: Cyb Res, Stuttgart

Bioscope, v.0.03, 14.10.14; IR-LED current, Laboratory: Cyb Res, Stuttgart

Bioscope, v.0.03, 14.10.14; External room temperature, Laboratory: Cyb Res, Stuttgart

Fig. 6. The experiment 141014. The voltage on phototransistor, the LED current and temperature are recorded. Fresh bread was used as a test object, peaks on the graph correspond to placement of the test object on bioscope.

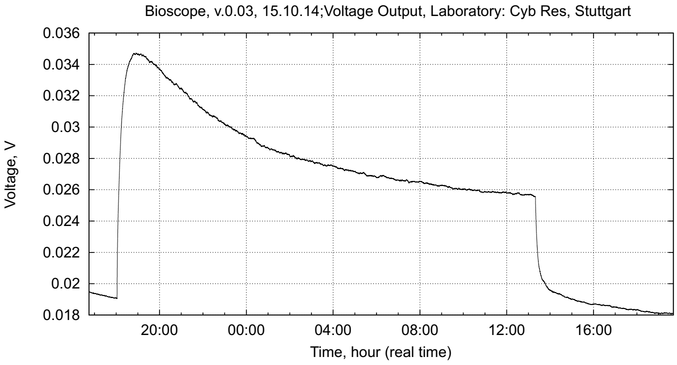

Bioscope, v.0.03, 15.10.14;Voltage Output, Laboratory: Cyb Res, Stuttgart

Fig. 7. The experiment 141014 during 24 hours. Sensor response corresponds to placement of the test object (fresh bread) on bioscope.

A suspicion appeared that the sensor reaction is affected by another factor – humidity of test objects.

To test this hypothesis the bioscope was connected to the measuring system MU2.0 c 20-24 bit ADC and ultra-low noise (<1 mV). The temperature LM35CZ and humidity HIH-5030-001 sensors are used. Both sensors operate in the relative measurement mode, where data are compared before/after and during the experiment. This mode, in conjunction with 20-24 bit ADC and low noise, enables a high-resolution measurements, typically a few hundredths of °C/%rh. For absolute measurements the following parameters are important: for HIH-5030-001 – repeatability 0.5%rh and a reaction time of 5 seconds; for LM35CZ – the resolution 10±0.1mV/C and a typical nonlinearity of 0.15°C. Both sensors are mounted on the front panel near the membrane, see Figure 9.

Humidity sensor readings are converted as follows[2]:

$$V_{OUT} = (V_{SUPPLY})(0.00636(RH) + 0.1515), \qquad (1)$$

where RH – the relative humidity, V_{OUT} – the output voltage of sensor, V_{SUPPLY} – the supply voltage. This relation is valid for the temperature of 25°C. For an

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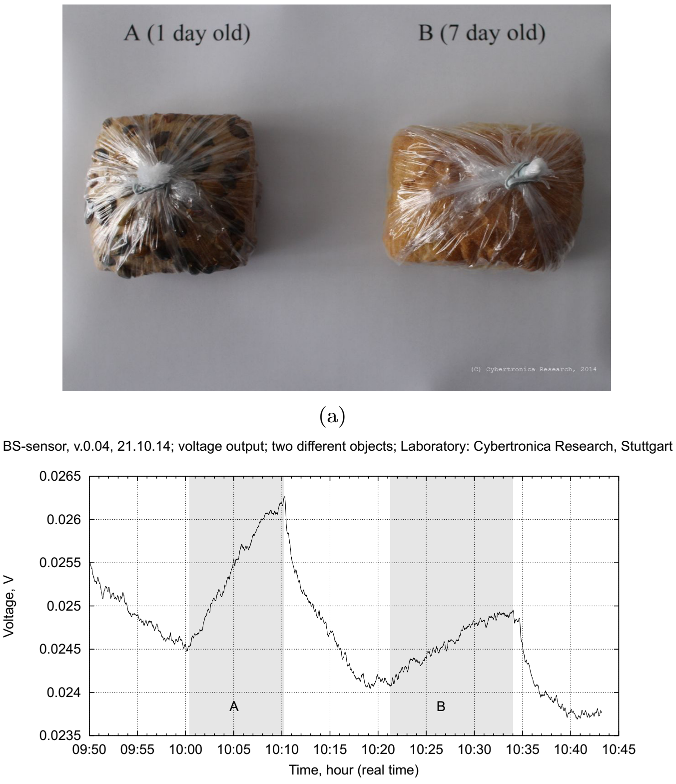
[2] Honeywell. HIH-5030/5031 Series. Low voltage humidity sensors.



(a)

(b)

Fig. 8. The experiment 211014. One- and seven days old breads were used as test objects. Both test objects were covered by a thin polyethylene film used for sealing food to keep it fresh. Responses 'A' and 'B' in Figure **(b)** correspond to the objects 'A' and 'B' in Figure **(a)**.

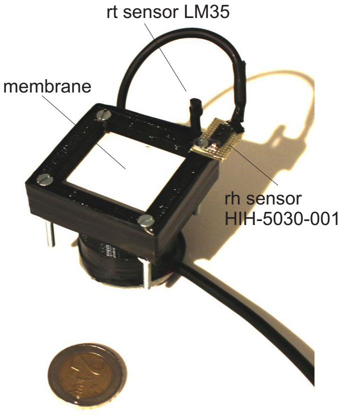
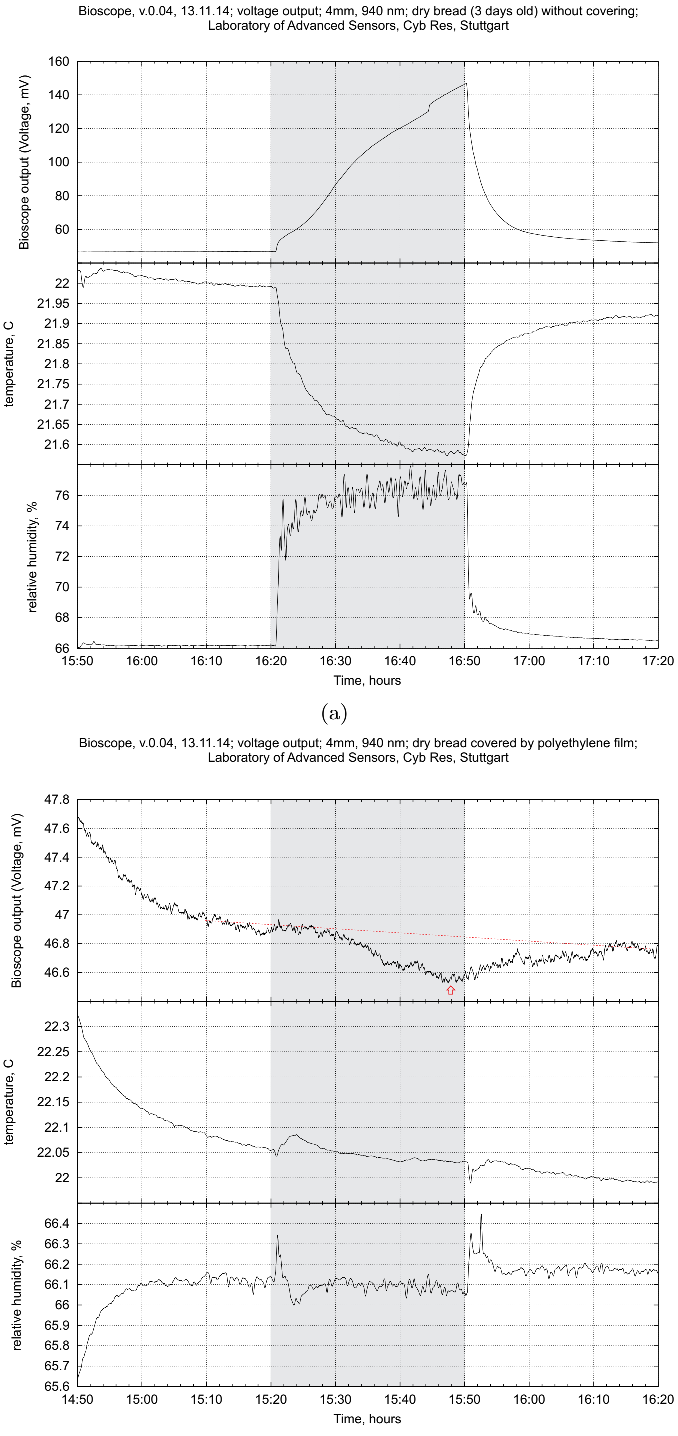


Fig. 9. Image of the bioscope with the temperature LM35CZ and humidity HIH-5030-001 sensors, 2 euro coin shows the scale.

arbitrary temperature a correction should be calculated

$$True - RH = (RH)/(1.0546 - 0.00216T), \tag{2}$$

where T – the temperature in Celsius (C), $True{-}RH$ – the true value of humidity. For example, the correction value for $T = 20°C$ and $RH = 60\%$ is $True - RH = 59.323709$, i.e. $\Delta t = 5°C$ corresponds to $\Delta RH = 0.67629$. It can be roughly estimated that the change of 0.1 ° corresponds to



(a)

(b)

Fig. 10. The experiment B131114A. Bioscope reaction and data from temperature/humidity sensors on **(a)** – a bread without polyethylene film; **(b)** – a bread wrapped in thin plastic film. Essential reaction of bioscope is observed at rising humidity, when a humidity remains without changes (with the same test object), the bioscope follows previous dynamics (relaxing after removing experimenter's hand).

$\sim 0.01RH$. It is necessary to emphasize that decreasing temperature corrects humidity downward, while decreasing the air temperature increases its moisture. All graphs show the value of $True - RH$.

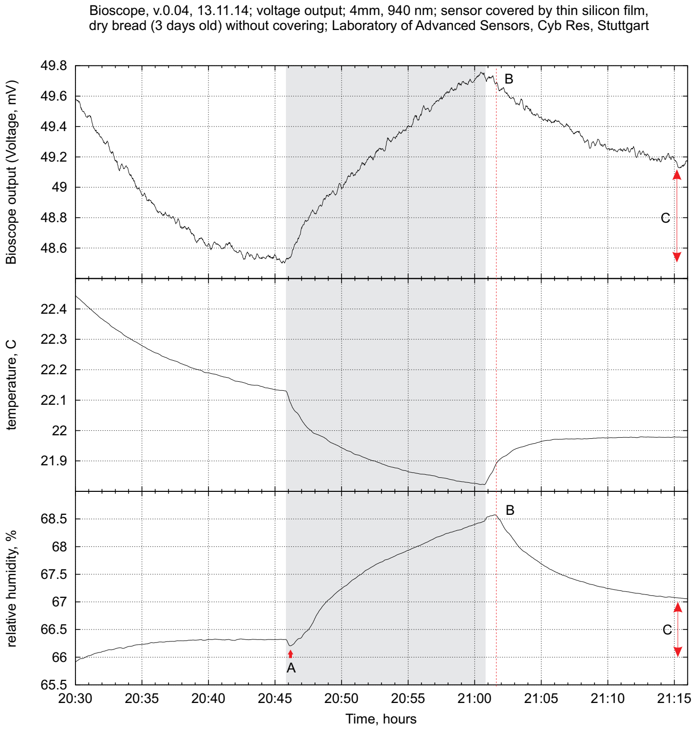
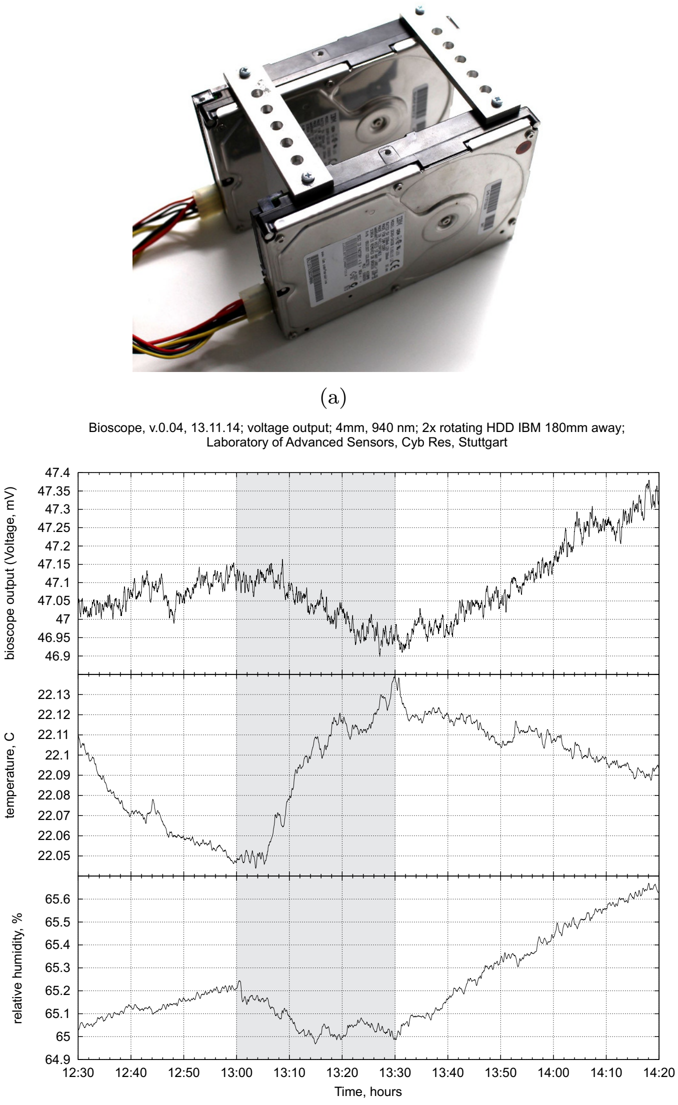


Fig. 11. The experiment B131114B. Bioscope is wrapped in a thin silicon film. The same test object as in the experiment B131114A is used. Building a micro-atmosphere under the film is visible with slow change of humidity and bioscope data after the object is removed.

The first experiments repeated measurements of bread without and with the film. At this time, a careful attention was paid to the isolation by several layers of film and balancing the temperature of object and sensor. As shown in Figure 10(a), as soon as the bread was placed on the sensor, the moisture significantly jumps on 8% -10% with a gradual change of temperature. When a brad is insulated by multiple film layers, the humidity sensor responds only to the experimenter's hand at begin and end of the experiment (about 0.2%rh). There is also no bioscope reaction, it continues to follow the previous trend.

After discussing results of this experiment, LAS was asked to wrap the bioscope with a thin silicon film. The test object should remain uncovered. Figure 11 shows the results of this experiment. Test object and its moisture level corresponds to the object from the experiment B131114A, see Figure 10(a). In this case, we observed the penetration of moisture at the level of 1% -2% through the film and the change of temperature on 0.2°C. The film-coated bioscope forms the inner atmosphere, it is well visible by a slow change of humidity and voltage after the experiment. This post-reaction (after the object has been removed) differs from previous experiments and indicates the moisture as an additional factor impacting the bioscope.


(a)

(b)

Fig. 12. The experiment B131114S, the impact of two HDD IBM Ultrastar (each disk has 3 rotating plates with 5400 rpm) on dynamics of bioscope. The distance between the sensors and the first HDD is about 180mm.

D. Experiments with rotating objects, dissolving salts and influencing by light

After the experimental results with humidity from biological objects were discussed with IVL, LAS and the developer, it was proposed to test the effects of rotational, entropic and light factors that were also detected in initial experiments. The idea was that the moisture from biological objects will be removed in these experiments and it will enable revealing an unknown impacting factor in the 'pure' form.

Figure 12 shows an experiment with two HDD IBM Ultrastar (each HDD has 3 rotating plates with 5400 rpm). The distance between the bioscope and the first disk was about 180mm. HDD were turned on/off remotely. Exposure time was 30 minutes, during this time the temperature rose to 0.07°C, and the humidity dropped to 0.1%rh. The voltage on bioscope was also decreased by 0.15mV. In this experiment we can estimate the impact of temperature compensation on the humidity sensor for small signals. Remember that the sign of correction corresponds to the sign of temperature change, e.g. for $< 25°C$ and 0.1°C the correction is about $\sim 0.01RH$. However, in this experiment we observed antiphase changes of temperature and humidity with much larger amplitude. In other words, even at small signals the possible inaccuracy of temperature compensation is not significant for measurements.

In the experiment B131114D, see Figure 13, a 100ml glass container was filled with 50ml bottle water at room temperature. This container was inserted into a long hermetically sealed plastic bag. One corner of the bag had a NaCl salt. Comparing the graphs, we observe the bioscope reaction of 0.3-0.4mV on a change of 0.6-0.7% humidity when dissolving NaCl salt, i.e. in this case the dynamics of voltage corresponds to the dynamics of humidity. Note, there is no reaction when stirring the NaCl solution (between the regions B and C in Figure 13). However, this reaction was expected according to a change of humidity and temperature, and its absence might indicate the influence of other factors.

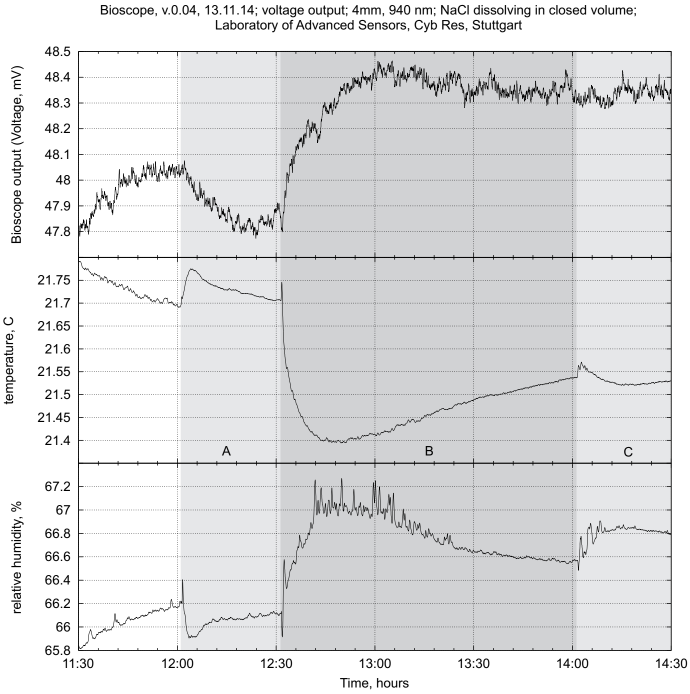


Fig. 13. The experiment B131114D. Dissolving NaCl salt at 50ml water in hermetically sealed glass container. **Region A:** container is placed on the sensor; **Region B:** salt is inserted in the water, about 75ml of solution is obtained; **Region C:** a long metal needle is inserted in the bag, the solution is stirred. There is no reaction between B and C.

The experiments B131114E and B181114A evaluated the impact of bright light on the bioscope. Following recommendations of the developer, a plexiglass was removed from the sensor, only a paper membrane remained. Sensor responded to biological objects (even more intense reaction was observed). In this configuration the sensor also provided much higher signal level. In the experiment B131114E a metal sheet of the size 500x250x0.5mm was tightly pressed against the sensor, the distance to the membrane was about 6-8 mm. The LED generator with 168 LEDs (LEDs are separated into 8 sectors: 2x yellow, 2x blue, 2x green and 2x blue LEDs) was used. This generator also produces a 'high penetrating emission' at a small level, see [12], [19]. The distance between the generator and bioscope was about 50cm. The generator is programmed to switch on/off every 5 minutes. The bioscope reaction is shown in Figure 14. It is well visible that there is no reaction without changing humidity. We also did not observe any fluctuations in the data of humidity sensor, i.e. it does not respond to light and to 'high penetrating emission' from the generator.

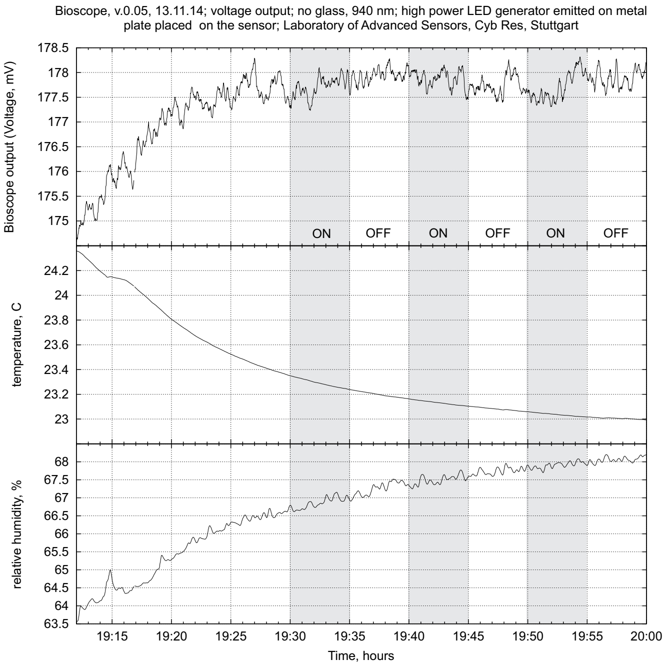


Fig. 14. The experiment B131114. Bioscope is covered by a metal plate 500x250x0.5 mm., shown is the reaction on 400-760nm light.

In the experiment B181114A the bioscope had only a paper membrane, i.e. without glass and a metal plate. Figure 15 shows the response of the sensor:

regions a, b, a – the LED Emitter (without IR spectrum) is switched on/off, distance 0.5 meters, there are no changes in temperature/humidity. The voltage on the phototransistor also does not change.

regions with a, d – switching on/off the overhead lights with filament bulbs. They contain the IR spectrum, the distance is about 2 meters. There is an abrupt change in voltage measurements, i.e. the phototransistor responds to the light passing through the membrane.

region e – sheet of paper (made from the same papers as a bioscope membrane) is placed on the bioscope. The paper sheet is about 4x-5x larger than the bioscope and completely covers it (including *t* and *rh* sensors). The phototransistor voltage does not change. Also to note that in this case we do not observe the reaction in the region **e**, although such a reaction should be according to the data of humidity and temperature sensors.

E. *Experiments with orientation of the glass*

During experiments, it was suggested that a rotation of glass and paper can cause some polarization effects, and as a consequence to increase or decrease the signal. In the experiments B181114B and B191114A-C, see Figure 16, this version has been tested, where a human hand represented the test object. The glass was rotated on 180° in horizontal and vertical axes. In all experiments no qualitative differences were found. It needs to pay attention to the humidity data and bioscope reaction in Figure 16(d) – this confirms the hypotheses that a hygroscopic properties of paper represent a main factor of the bioscope reaction.

F. *Using micro-structured thin film*

After the use of paper has been questioned because of its high water absorption, it was decided to use the micro-structured thin film (in the manner of paper) and to explore appearing effects. Black paper was removed. The outer surface of plexiglas was treated by fine abrasive material and coated with a several layers of a black matt (non-glossy) lacquer. The glass under the lacquer was exactly the same as in previous experiments. The impact was exerted by a hand, by heated aluminum to 30 °C and 45 °C and by a fresh bread. The results of this experiment are shown in Figure 17. Bioscope output varies strongly proportional to the temperature, a humidity change has no influence. Bioscope shows no reaction on the bread.

G. *Using fiber-option and hydrodynamics devices*

Previous experiments have demonstrated a clear impact of humidity and temperature on bioscope output data. When discussing these results, the developer proposed to make another series of replication experiments with such devices that do not alter the humidity and ambient temperature. For these experiments hydrodynamic and fiber optic devices were proposed.

The hydrodynamic device represents a closed system, where a water is pumped through a hose, spirally wound on a cylindrical shell. The shell diameter is 150mm, the hose length – 30 meters, the amount of pumped water is about 900 l/h by using a brushless motor. Fibre optic generator is a coil with 50 meters of multimode 62.5/125 fiber wound around the cylindrical shell with a diameter of 125mm, connected to the VCSEL laser HFBR-1 712TZ 850nm (without modulation, the laser class I), manufactured by Avago. These devices are used in online, real time experiments as shown in Figure 18. For example, in these online experiments the functionality of bioscope

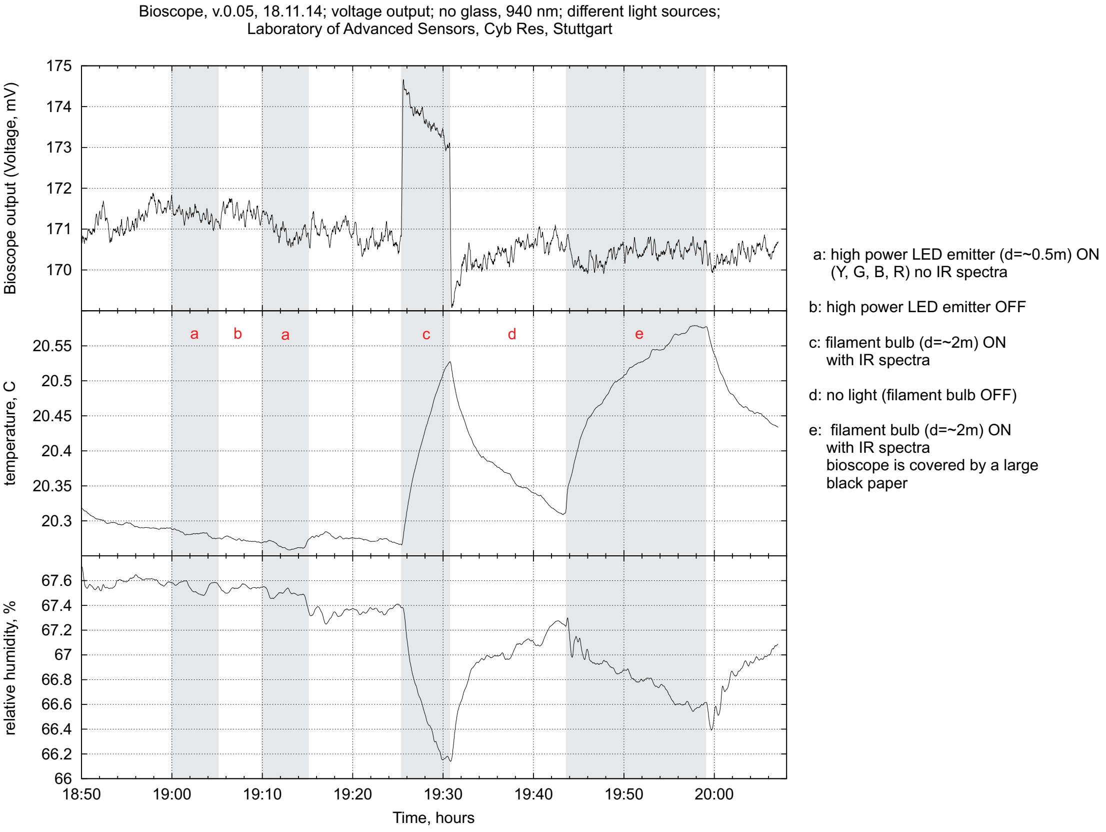
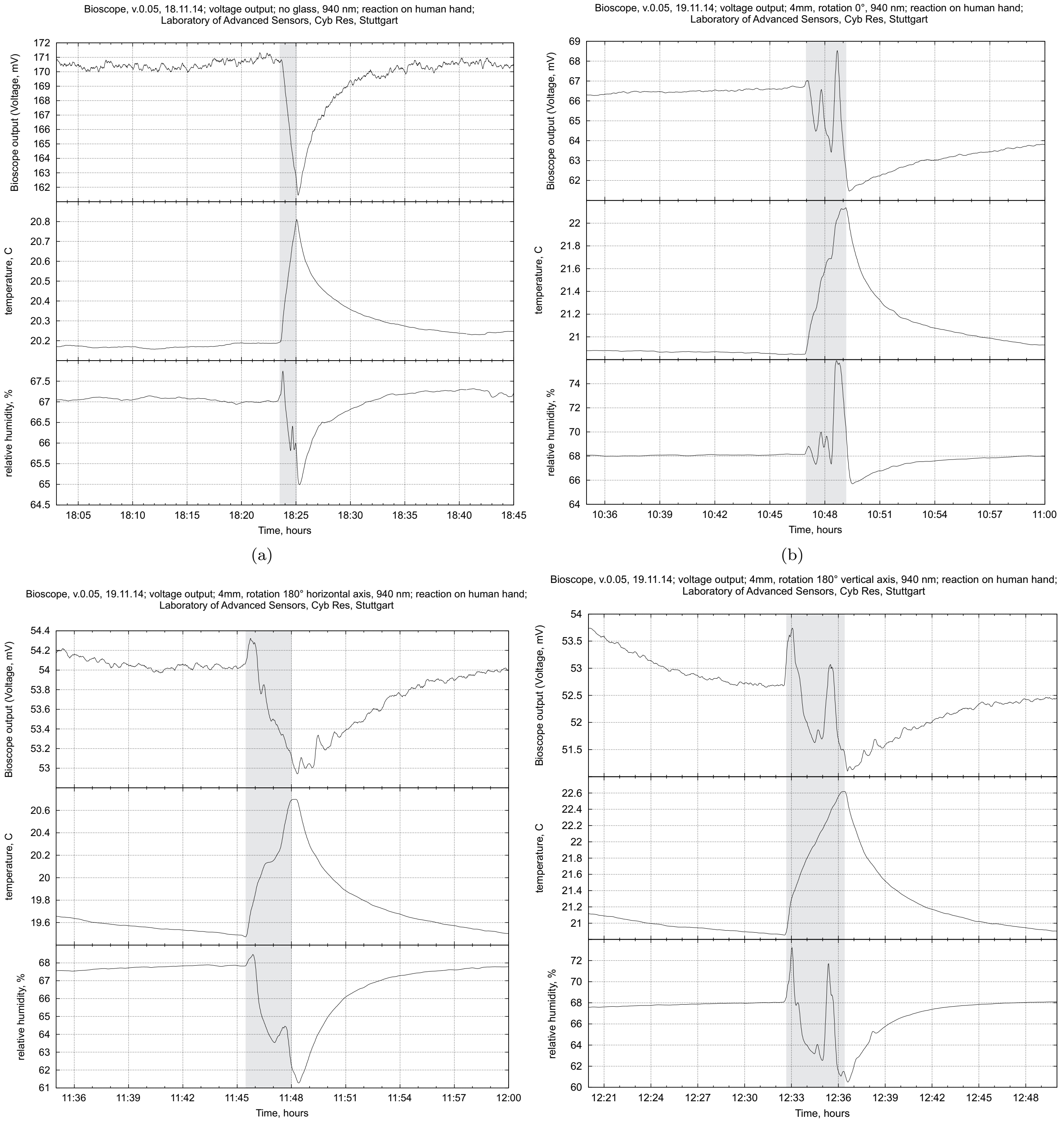


Fig. 15. The experiment B181114A. Biscope reaction on LED light and filament bulb without metal plate.



(a)

(b)

(c)

(d)

Fig. 16. Experiments with rotation of glass; **(a)** the experiment B181114B – the reaction on a human hand, the bioscope is without glass; **(b)** the experiment B191114A – the reaction on a human hand, the bioscope with a glass rotated on 0°; **(c)** the experiment B191114B – the reaction on a human hand, the bioscope with a glass rotated 180° horizontally; **(d)** the experiment B191114C – the reaction on a human hand, the bioscope with a glass rotated on 180° vertically.

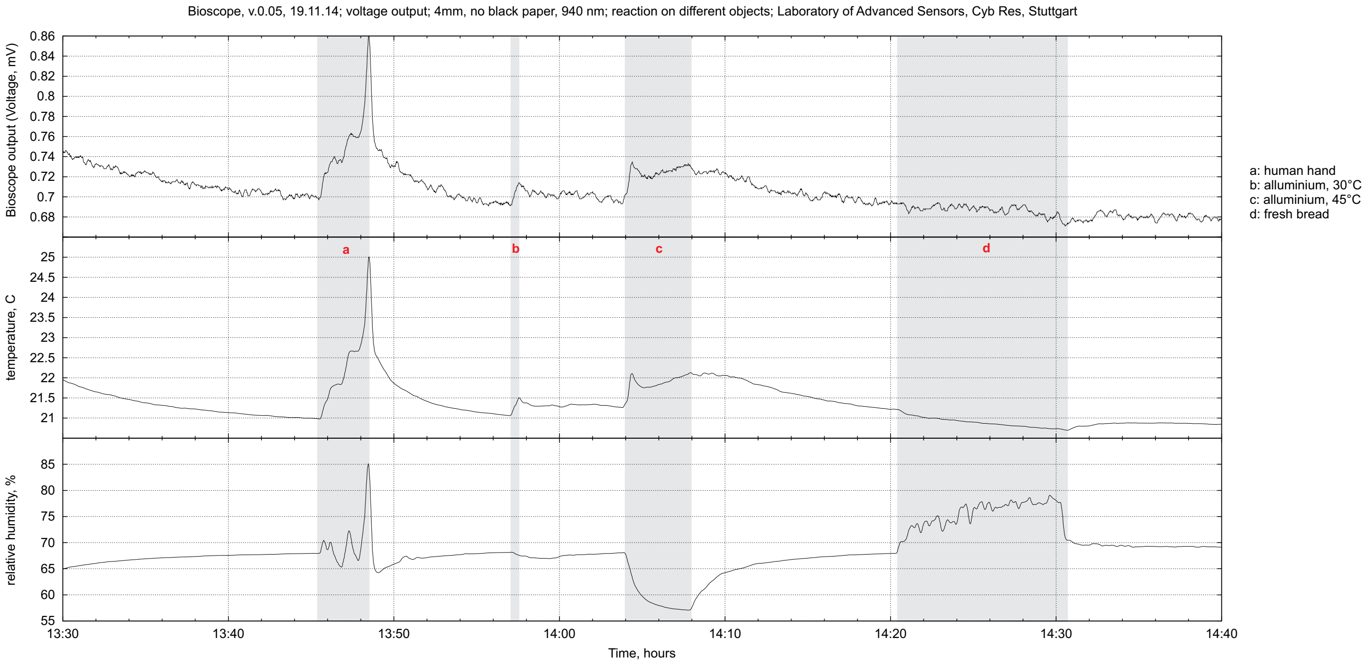


Fig. 17. The experiment B191114D. Using micro-structured thin film as a bioscope membrane. Voltage dynamics repeats very closely the temperature dynamics. There is no reaction on fresh bread.

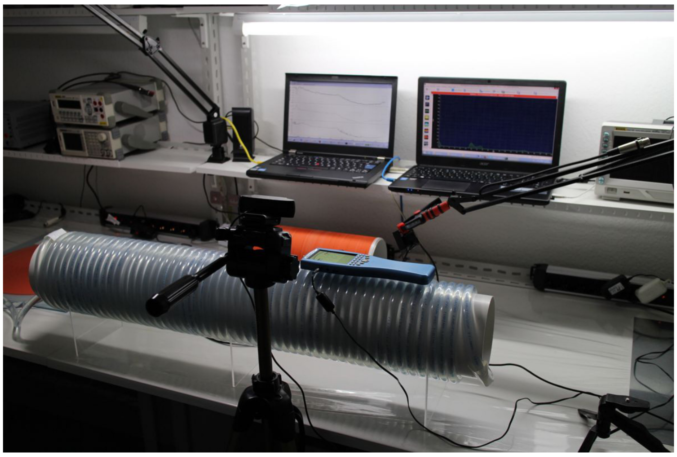


Fig. 18. Online experiments (via Skype) with hydrodynamic and fiber-optic devices (web camera is mounted in front of devices) in one of the LAS laboratories. IVL, LAS and the developer observed and discussed experiments and their results, gave advices to experiments and measurements.

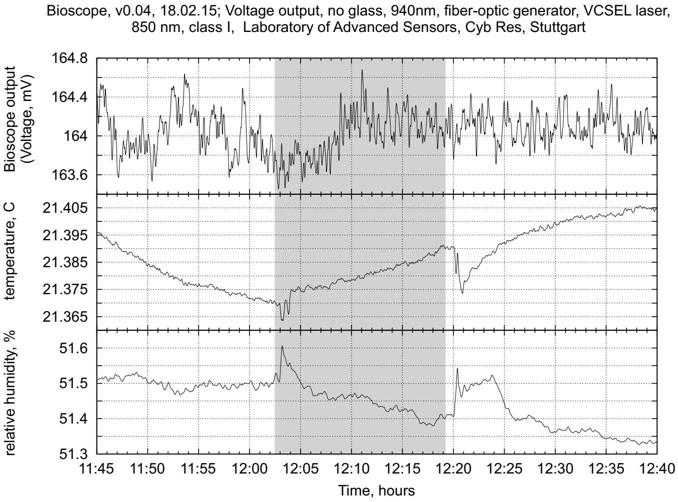


Fig. 19. The experiment with the fiber optic coil. When turning on/off the device a small temperature jumps are visible (assistant came into the room with the sensor). There is no bioscope reaction on the fiber optic device.

was demonstrated by a reaction on the biological object (hands), as well as a lack of response to the cylindrical fiber optic device. An example of such an experiment is shown in Figure 19.

When these experiments were demonstrated the developer, an objection against the fiber optic device was raised. The argument was that such a generator may be too weak to influence the bioscope.

Single-layer wound cylindrical fiber optic coils have been used in similar experiments [19], but in general no test procedure for such devices is available. Therefore, following the approach developed V.P.Kaznacheev [20], the biosensors – flowers *primula acaulis* – have been used for assessing the impact of fiber optic devices. During the replication a statistically significant number of tests with these biosensors was not carried out (since it is beyond the scope of replication experiments), but they allowed roughly estimating the presence/absence of any effect from the device. Figure 20 shows an example of experiments, where one of the flowers was inhibited by the fiber optic device (the bioscope was placed also on this side of device).

Since experiments with biosensors were not finished during the bioscope tests, a new fiber-optic generator was

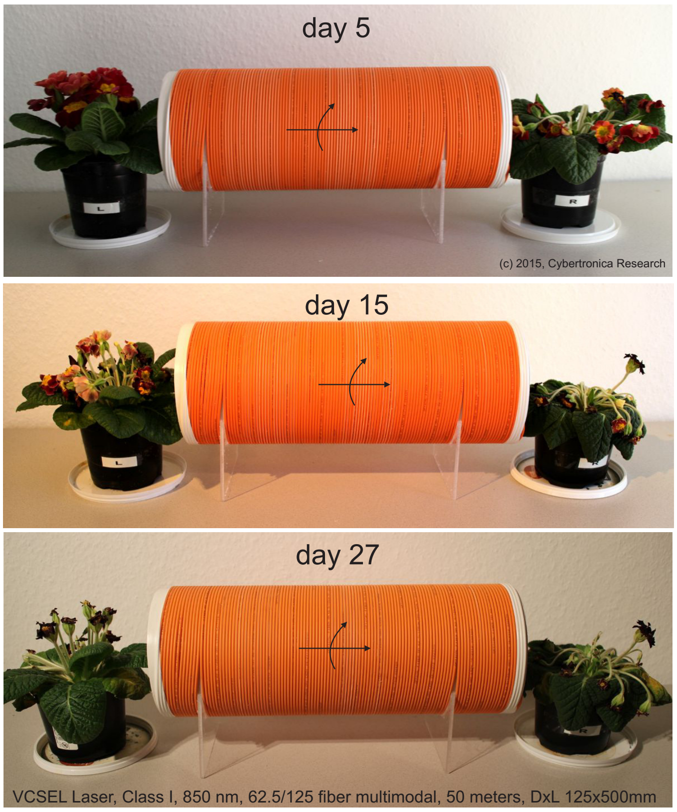


Fig. 20. The experiment with fiber optic device and flowers *primula acaulis*, an inhibition of one flower is observed (tests are not finished at the moment of this publication).

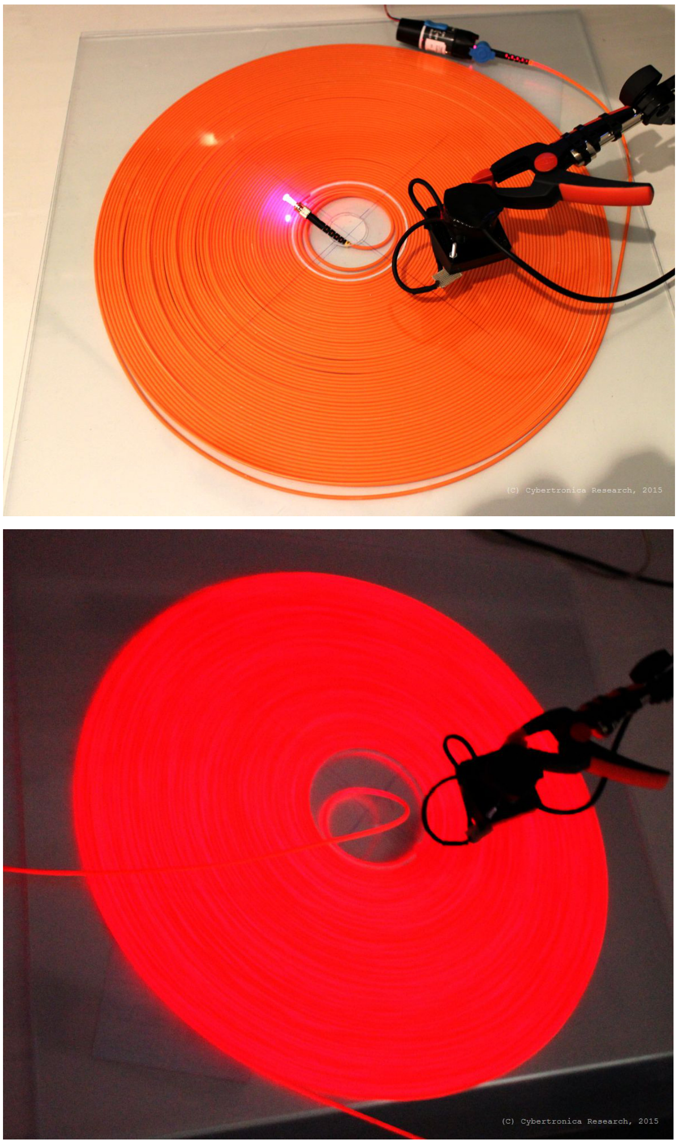


Fig. 21. **(a)** Flat fiber optic device, 50 meters of 62.5/125 fiber winded in a single layer. Semiconductor laser 650 nm, 10mW was used (this laser also used to test fiber optic systems). Distance between the coil and the bioscope is about 2-3cm.; **(b)** glowing of fiber optic coil in darkness.

assembled for further experiments. It consists of a flat fiber coil with 50 meters of 62.5/125 fiber wound in one layer. It was expected that the effects near the coil surface will be more intense. The semiconductor laser 650 nm, 10mW was used as a source of emission. Because the laser is developed to test optical fiber systems, it is possible to control a quality of the fiber visually, see Fig. 21. The exposure time was also increased to 60 minutes. Figure 22 shows data from bioscope, temperature and humidity sensors. To analyze the trend of bioscope data, the temperature trend was compared with the voltage trend. The voltage trend did not demonstrate any anomaly dynamics. At the end of experiment the bioscope was tested by a human hand. It is clearly visible that its dynamics follows changes in humidity.

All these experiment are repeated 5 times with the first and second setups. Thus, two different fiber optic devices with different lasers and different exposure times showed no bioscope reaction in any of repeating experiments.

Experiments with the hydrodynamic device showed an interesting effect. Firstly, by analysing the literature, we assumed a biologically active effect of such devices on organisms. Similarly to fiber optic devices, to assess the impact of this generator, two flowers *primula acaulis* were installed on both sides, see Figure 23. We recorded the dynamics of changes of these plants. On the 20th day of the experiment, both flowers died, see Figure 24. Plants placed in the same laboratory but away from the hydrodynamic device had a normal development. Also, the flowers close to the fiber optic device are in much better condition at the 20th day of experiment, especially the left flower.

We measured spectra of alternating electric and magnetic fields near the wound hose in the range from 20Hz to 1MHz by 'Spectran-NF5010'. As turned out, the device generates an electromagnetic emission in a frequency range up to 300kHz, the frequency of the first harmonic is about 16kHz, the intensity of electric magnetic fields up to 400V/m and 6nT (150-200V/m and 3-3.5nT near flowers), see Figure 25.

The motor was placed at the distance of 2 meters from the coil, we conducted numerous measurements of field intensity on the motors and in different locations

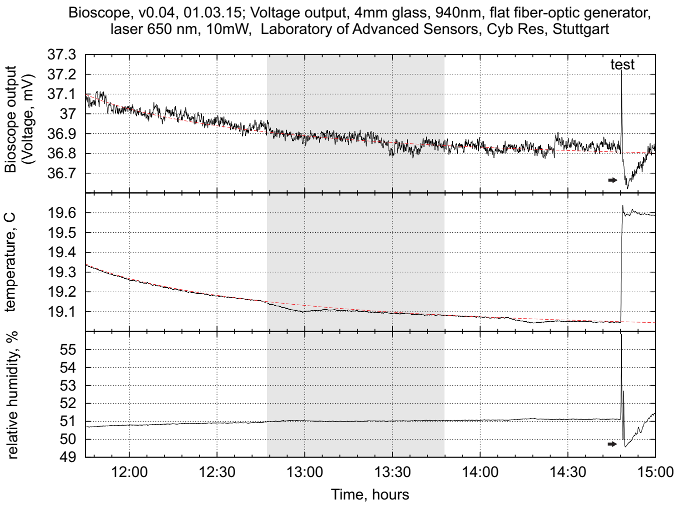


Fig. 22. The experiment with a flat fiber optic coil, exposure time 60 minutes, bioscope with paper membrane and 4mm plexiglass. The voltage trend is compared with the temperature trend – there are no anomalies of voltage trend. At the end of experiment the bioscope was tested by a human hand – its dynamics follows changes in humidity.

Fig. 23. The experiment 1H with the hydrodynamic generator and biosensors – flowers *primula acaulis*, the pumped water volume is about 900 l/h. Watering was carried out every 1.5-2 days (otherwise plants dry out) by the 'wet-floor' approach equally for L and R flowers.

of hoses and reels. Based on these measurements, we cannot attribute the appearance of fields to the device or motor directly. It has been suggested that the flow of moving water (distilled water with various additives) in the dielectric hose produces the fields. Experts in the field of plant physiology were contacted, who confirmed our assumption that the generated electric and magnetic fields (comparable with natural Earth fields) cannot act as the main factor in death of flowers.

Bioscope showed a reaction on the hydrodynamic device only when the light was blocked, or the LED was turned off, see Figure 26. In this case the output signal remains on a minimal level and the interference with EM-distortion generated by hydrodynamic device becomes visible. When turning on the LED, the useful signal on phototransistor did not demonstrated a reaction within 30 minutes after powering on/off the hydrodynamic device. These tests were also repeated 5 times.

H. Conclusion for this section

As well-known a paper has a high hygroscopicity, its structural, mechanical and surface properties depend on moisture [21], [22]. Moreover, a paper accumulates moisture nonlinearly. Surface deformation depends on difference and dynamics of moisture between both sides. This issue is essential for the bioscope. Additionally, a large number of temperature-dependent processes occurs in thin films [23], [24] and surfaces of solid bodies [25] associated with thermal emission and reflection. The bioscope operates at tenths of phototransistor voltage range, i.e. it is sensitive to possible variations of these 'secondary' factors. We were surprised that the developer did not perform until 2014 more or less accurate quantitative measurements of humidity and temperature with precision sensors (in the manner we carried out), and prepared only qualitative experiments with these factors [7], [8].

Before to draw any conclusions, we would like to discuss one experiment. In this attempts an impact of 'high penetrating emission' on the phytosensor *cactaceae* (tissue conductivity, 1Mhz) was measured, see Figure 27. Bioscope was directed to the phytosensor. We observed almost simultaneous reaction of the phytosensor and bioscope,

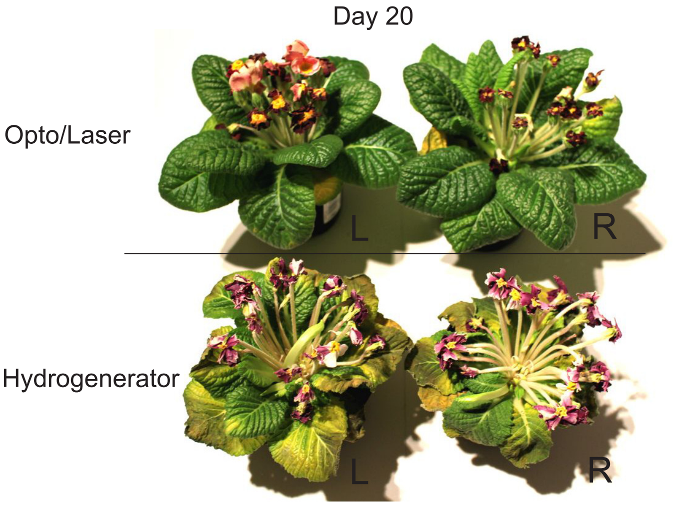


Fig. 24. The 20th day of the experiment 1H, flowers from hydrodynamic and fiber optic generators (staying in the same laboratory) are compared.

see the point X in Figure 27. Data from temperature and humidity sensors do not provide a reason for the bioscope reaction, but such a reaction is measured.

Generalizing these experiments, we refer to temperature and hygroscopic effects of a paper membrane and glass as the main factor of bioscope reaction. Reducing the humidity, the output voltage decreases and vice versa, increasing the humidity increases the output voltage. This is a nonlinear effect, which depends on the dynamics of temperature. For small changes we can expect $0.1-0.2$%rh at $0.1-0.2$mV – this is defined only for our design and cannot be transferred to other designs.

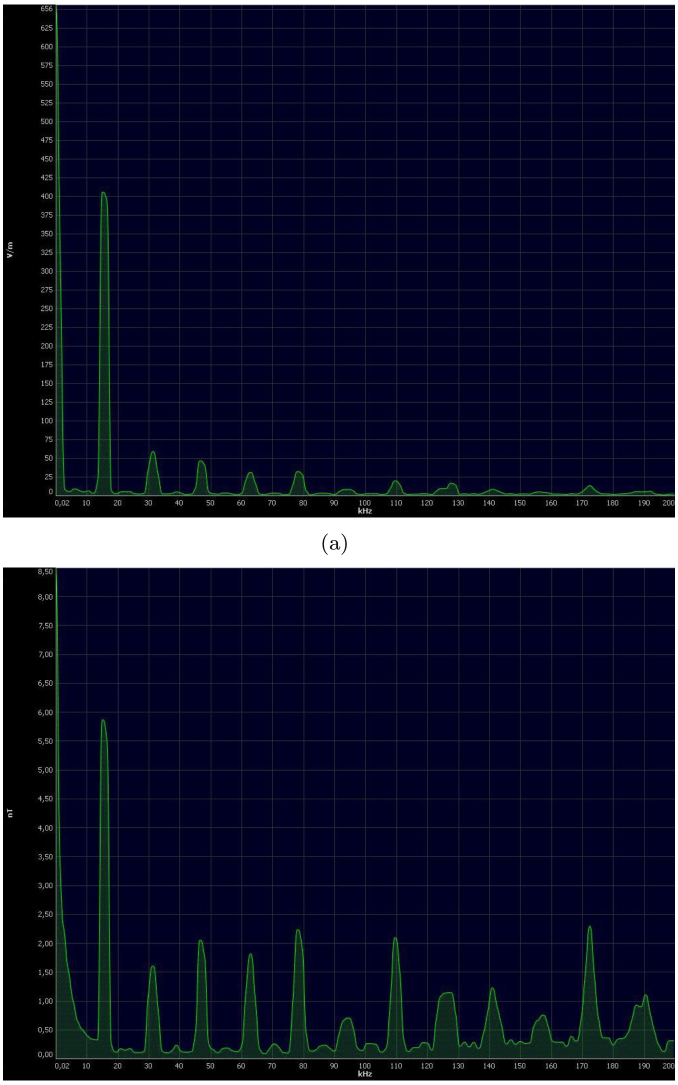
However, some experiments shown in Figure 13, 15, 27 demonstrated changes of bioscope output that do not correlate with changes of humidity or temperature. We can assume here an influence of other factors, as pointed out by the developer. Unfortunately, replacing the paper membrane by thin film or metal fully distorted the sensor functionality. It is necessary to investigate non-membrane types of bioscope.

IV. General conclusion

Conclusions on the replication of each laboratory have already been shown in sections II-C and III-H. Here we generalize them.

1. First, IVL and LAS confirmed results of measurements performed by the developer in regard to biological objects. Varying the design of this sensor, e.g. using the IR light, does not change fundamentally the dynamics of signals and demonstrate similar responses to similar impacts.

2. Secondly, the choice of paper membrane for bioscope is questioned. The experiments showed that the observed effects refer to the influence of humidity and temperature on paper membrane, and not to declared unconventional factors. The experiments start with an 'inanimate' wet rag and ends up with complex temperature-compensated measurements. These attempts were repeated more than 30 times, with a large number of preliminary and calibrating measurements (in total over 100 experiments). Replication is carried out only with the LED version. However, since the paper membrane is also used in a laser version, some observed effects are expected to be associated with humidity in this version of bioscope as well.



(a)

(b)

Fig. 25. Spectra of alternating electric and magnetic fields near the winding hose in the hydrodynamic device.

3. Third, replacing the paper membrane on metal or thin film in both laboratories removed the humidity impact. However, the bioscope did not respond any longer on biological objects. When exposed to light, the bioscope with these membranes demonstrated a response only to temperature changes. With a constant temperature, the bioscope showed no response to any impact. Since we are not specialists in the area of thin films/solid bodies, we cannot say whether these are unconventional or conventional physical effects.

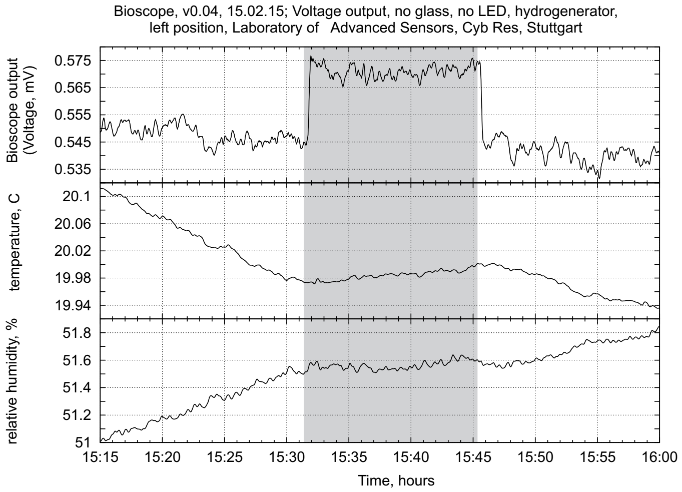


Fig. 26. The experiment with hydrodynamic device, the light flow in bioscope is blocked, the output voltage of 0.5mV is a noise. Step-like response on powering the hydrodynamic device is related to EM-distortion. When LED is on, there is no reaction (a regular output signal overtakes the noise).

4. IVL and LAS cannot confirm the bioscope reaction on fiber optic and hydrodynamic devices. These experiments were repeated 5 times for each device, all attempts are negative.

5. Authors and the developer discussed about an unconventional impact factor that might be associated with the humidity. We cannot deny the fact that dpH/EDL devices sense changed physical properties of water exposed to a 'high penetrating emission'. However, the authors inclined to think that in this case the 'Occam's razor' should be applied with a simpler explanation, especially in regard to the 'biologization' effect.

6. Both laboratories agreed that a non-membrane version is the most promising type of bioscope, on which further tests should be concentrated.

7. As a side effect of these replications we note an interesting preliminary assessment of fiber-optic and hydrodynamic devices. It needs to develop a methodology for more systematic tests.

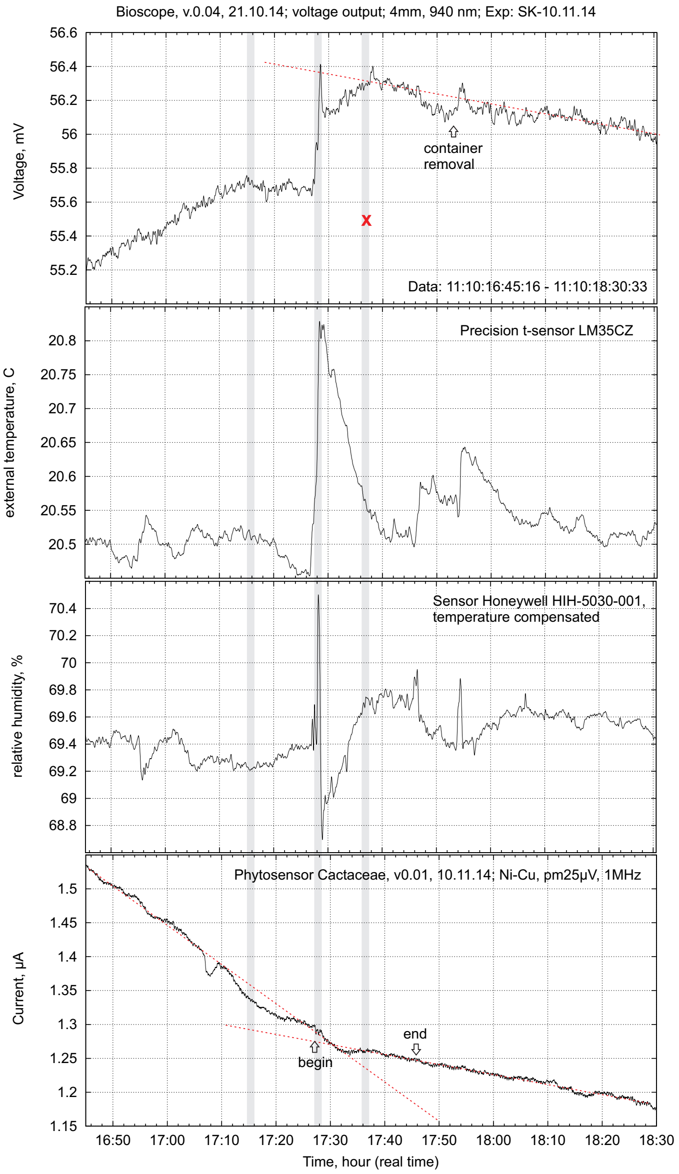


Fig. 27. The experiment SK101114. The reaction of bioscope and phytosensor (with temperature and humidity data) on a 'high penetrating emission'.

V. Acknowledgment

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