Roots | MGF | Cell | EM/PF | Organism | Tools

Biophotonics

or

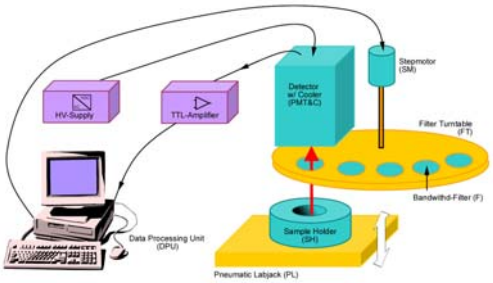
The Light of Life

"Improving the existing UwPE-Detector @ PLUS

Universität Salzburg

Contributed by
Pierre MADL

EDGE



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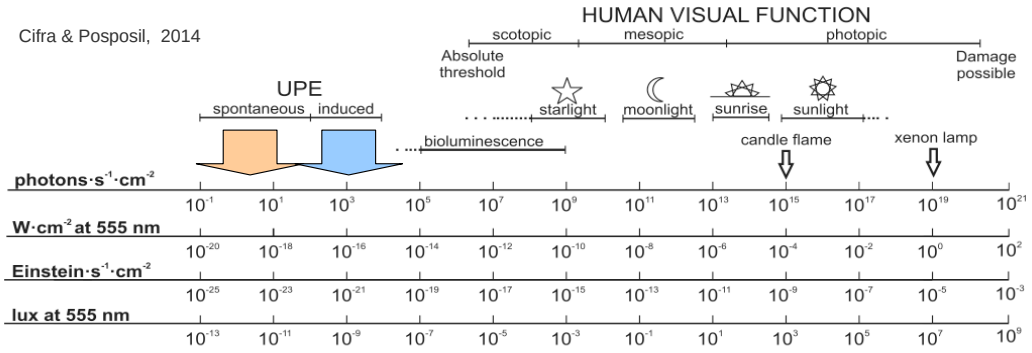
URL: biophysics.scb.ac.at/talk/CM-prototype.pdf

Development (1/3)

Originally termed “mitogenic radiation”,
today better known as **U**ltra-**w**eak **P**hoton **E**mission (UwPE, UPE) or Biophotons:



17-01-05 Madl 1

This review attempts to summarize molecular mechanisms, spectral and intensity properties, detection techniques and applications of ultra-weak photon emission. Ultra-weak photon emission is the chemiluminescence from biological systems where electronically excited species are formed during oxidative metabolic or oxidative stress processes. It is generally accepted that photons are emitted (1) at near UVA, visible, and near IR spectral ranges from 350 to 1300nm and (2) at the intensity of photon emission in the range of several units to several hundreds (oxidative metabolic process) and several hundreds to several thousands (oxidative stress process) photons $s^{-1}\cdot cm^{-2}$. Current development in detection using low-noise photomultiplier tubes and imaging using highly sensitive charge coupled device cameras allows temporal and spatial visualization of oxidative metabolic or oxidative stress processes, respectively. As the phenomenon of ultra-weak photon emission reflects oxidative metabolic or oxidative stress processes, it can be widely used as a non-invasive tool for monitoring of the physiological state of biological systems.

Image: Radiometric and photometric units comparing ultra-weak photon emission intensity with that of common light phenomena. First three axis (photon flux [photons $s^{-1}\cdot cm^{-2}$], radiant flux [$W\cdot cm^{-2}$], photon flux or irradiance in Einsteins ([mol of photons $s^{-1}\cdot cm^{-2}$) are radiometric units which are easily interconvertible from one to another. Conversion between radiometric units is as follows: number of photons $s^{-1}\cdot cm^{-2}$ = [$W\cdot cm^{-2}$] $h\cdot c\cdot \lambda$ = einstein. 6.022 1023 $s^{-1}\cdot cm^{-2}$. [$W\cdot cm^{-2}$] at 555 nm on the second axis does not mean that the radiation from given sources only at 555 nm is considered, but that we calculate number of photons from given radiant .ux as if every photon from the source in the visible region of the spectrum had the wavelength of 555 nm. Lux is a photometric unit, unit of illuminance, related to sensitivity of human eyes and varies strongly with wavelength. Only the visible spectrum contributes to illuminance. Under approximation that all incoming photons would have wavelength of 555 nm, one can use conversion number of $s^{-1}\cdot cm^{-2}$ = 2.45 1012 lux.

Note: threshold for human vision ~ $1\cdot E^6$ $s^{-1}\cdot cm^{-2}$ → bioluminescence is not normally visible → need special setups to be detected: dark rooms and photon counting devices.

Source: Cifra M, Pospsil P. (2014) Ultra-weak photon emission from biological samples: Definition, mechanisms, properties, detection and applications. J Photochem Photobiol B. Vol. XX pii: S1011-1344(14)00046-3. doi: 10.1016/j.jphotobiol.2014.02.009.

Development (2/3)

What is UwPE and **where** does it originate from and **why** does it matter?

Why:
i) involved in Bio-Communication (exchange of information, that does not primarily rely on energy),
i) is an intrinsic feature of all **Life-forms** across kingdoms (most Eubacteria Protists, Fungi, Plantae, Animalia)

Where:
i) originates from within cells (DNA, Microtubuli, Proteins, etc.),
i) during cellular metabolism
i) form spontaneously, but also during oxidative reactions (ROS)

What:
i) according to the Theory of
- Imperfection …. by-product of photo-biochemistry (QM)
- Coherence …. by-product of coherent delocalized EMF (QED)

i) few quanta per second and cm^2 (typ. 100 photons·sec^{-1}·cm^{-2})
i) within the UV-VIS-IR-range (<200-800nm @ 1.67 - 3.41 eV) thus with very low intensities (see previous slide)

Bischof & DelGiudice, 2013
Cifra & Bosposil, 2014

Why: The problem of bio-communication has been addressed in recent times within the frame of the molecular paradigm, which states that a living organism is an ensemble of appropriate molecules kept together solely by chemical forces, whose essential features are that they can be always reduced to pairwise interactions [1].

1) the existence of chemical codes remains unexplained since no reason is given why a molecule is able to encounter its molecular partner in the sequence underlying the given biological cycle just in the right place at the right time;

2) spreading of information about each molecular event to the other component molecules of the organism would require the emission of signals, such as chemical messengers or electromagnetic signals, whose formation would require energy. The huge ensemble of all the signals necessary to keep other parts of the organism informed about what is going on in one part …. would demand an immense consumption of energy.

There are two opposite "theories" about biophoton emission, i.e., the "imperfection theory" and the "coherence theory“[1] …. See later slides

Ultra-weak photon emission originates from the oxidative metabolic reaction in microbial, plant and animal cells. It is generally considered that electronically excited species formed during the oxidative metabolic processes are solely responsible for the ultra-weak photon emission. Spontaneous photon emission without any special dedicated high-intensity-luminescent enzymatic systems (e.g. luciferin/luciferase) is what distinguishes ultra-weak photon emission from ordinary bioluminescence. Photon emission without external stimulation by light is a feature that distinguishes ultra-weak photon emission from fluorescence and phosphorescence. Experimental evidence for other types of luminescence than chemiluminescence (for instance mechano-luminescence and electroluminescence in biological systems is very limited[2].

Source: [1] Bischof M, DelGiudice E (2013). Communication and the Emergence of Collective Behavior in Living Organisms: A Quantum Approach. Molecular Biology International, Vol. 2913, ID 987549: 1-19. doi:10.1155/2013/987549.

[2] Cifra M, Pospsil P (2014). Ultra-weak photon emission from biological samples: Definition, mechanisms, properties, detection and applications. J Photochem Photobiol B. Vol. XX pii: S1011-1344(14)00046-3. doi: 10.1016/j.jphotobiol.2014.02.009.

Development (3/3)

How could UwPE be harnessed?

Possible applications:

i) **Food quality** (examination & control)
i) **Pollution** (bio-indication of toxic load)
i) **Drugs** (efficiency & dosage …. dose-effect relation)
i) **Disease processes** (chronic pathologies, incl. cancer)
i) **Cell-metabolism** (development, growth, differentiation & senescence)
i) **Bio-communication** (investigating the flow of information by non-chemical means)

Popp, 1992

Despite their low intensities, biophotons have the advantage of a rather high signal/noise-ratio. In view of their correlations to many, if not all, biological functions they provide a most powerful, non-invasive tool for analyzing biological systems.

Irrespective of how one interprets the results, the very sensitive dependence of biophoton emission on almost all external and internal influences has already opened up many applications, e.g.:

•the examination and control of food quality,

•bioindication of pollutants and other environmental factors,

•research on the efficacy of drugs,

•diagnostic and therapeutic treatment of different kinds of illness, such as immune diseases and cancer.

A wide range of basic problems in the life sciences may be amenable to investigation by means of biophoton emission. These include molecular interactions, immunological and repair processes in aging, growth and differentiation, pattern formation in development, biocommunication and the nature of consciousness.

Source: Popp FA (1992). Preface: Introductory Remarks. In: Popp FA, Li KH, Gu Q (eds) Recent Advances in Biophoton Research and its Applications. World Scientific Publ., Singapore.

Concept of Existing Hardware

(Status Quo)

1D-PMT (1/5)

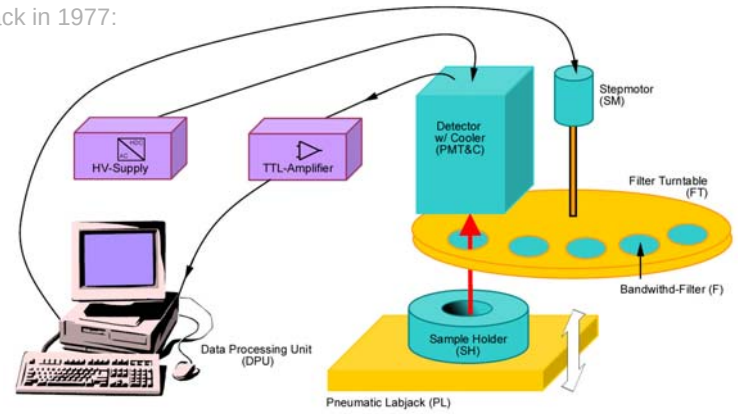
i) Schematics of 1st setup used back in 1977:

i) The existing equipment:

i) Schematics

Setup:
Block Diagram of a
state of the art system

Results:
i) Currently in the making



Madl, 2015

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Upon placing a biological specimen into the detector chamber, as conceptualized in Figure 2, two modes of operations are possible. The first concerns activation of the sample with a light source (delayed luminescence, DL-mode) prior to measurement, whereas the second operates without an external light source and aims to detect spontaneous emissions (SE-mode). Illumination in the DL-mode requires a focused light source with a spectral range covering UV, VIS and IR (e.g. xenon-lamp or high-yield polychromatic LEDs with a power rating in the order of 50-150 W). A suitable optic fiber cable routs the beam of light to the sample. The optical link, as shown in Figure 2, is recommended as this cuts off specific wavelengths; e.g. above 720 and below 310 nm. In addition, the light source can be used in full spectral mode (polychromatic DL-mode) or via a monochromator split into the desired narrow spectral window (monochromatic DL-mode). Illumination with monochromatic light provides additional information with regard to the most active spectral luminescence window. Each measuring cycle should start with an irradiating phase that lasts from 1 to several minutes. After excitation, the subsequent DL-emission are then recorded and evaluated in a time slot ranging from 0.7 to 60 seconds. For statistical purposes, every sample should be measured at least three times (Scholz et al., 1988).

Figure 2: Schematics of Ultra-weak Photon Emission Detector for spontaneous and delayed emission modes. **Amp**: signal amplifier; **Ctrl**: Control-signal-link; **DC**: dark chamber; **Dis**: signal discriminator; **DPU**: data processing unit, i.e. desktop computer; **ES**: electronic shutter; **FoC**: Fiber-optical cable link; **M:** mirror; **H**: temperature controller; **HV**: high voltage supply; **MC**: monochromator; **PMT**: photo-multiplier-tube; **PC**: Peltier-elements for cooling; **PS**: standard power supply; **SM**: step-motor; **Xe-LS**: wide spectral Xenon-light source.

Source: Madl P, (2015) Chapter 3 - Detection and Measurement of Photonic Emissions of Biogenic Origin. In: Fels D, Cifra M, Scholkmann F. Field of the Cells Volume 1. Research Signpost, Kerale (IND)

1D-PMT (2/5)

i) Schematics of 1st setup used back in 1977:

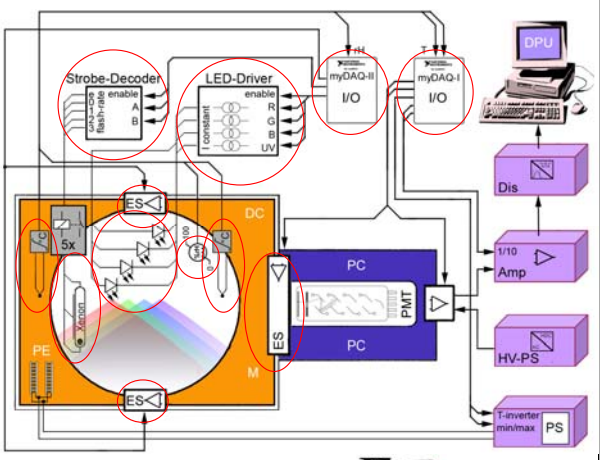
i) The existing equipment:

i) Schematics

Block-Diagram – the core unit consists of four major functional groups:

- cooled photon detector unit with signal processors
- T-adjustable dark-chamber
- Illumination sources - supplementary electronics (power supply & control unit for LED / strobelight)
- Bandwidth filter-wheel (not shown)

Madl, 2015



Schematics of Ultra-weak Photon Emission Detector for spontaneous and delayed emission modes:

- **Amp**: signal amplifier;
- **Ctrl**: Control-signal-link;
- **DC**: dark chamber;
- **Dis**: signal discriminator;
- **DPU**: data processing unit, i.e. desktop computer;
- **ES**: electronic shutter;
- **FoC**: Fiber-optical cable link;
- **HV**: high voltage power supply;
- **MC**: monochromator;
- **PMT**: photo-multiplier-tube;
- **PC**: Peltier-elements for cooling of PMT;
- **PE**: Peltier-elements for cooling sample;
- **PS**: dimmable LEDs power supply;
- **Xenon**: adjustable Stobelight;
- **DPU**: Data Processing Unit (Tennelec MSC-II Oxford) to count pulses and Control Unit to adjust stepmotor of turntable

Source: Madl P. (2015) Detection and Measurement of Photonic Emissions of Biogenic Origin. In: Ch.3, Fels D, Cifra M Scholkmann F (eds). Fields of the Cell, Research Signpost, Kerala (IND)

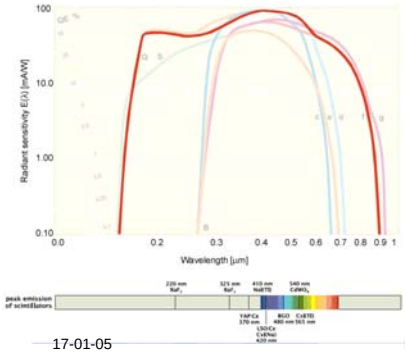
1D-PMT (3/5)

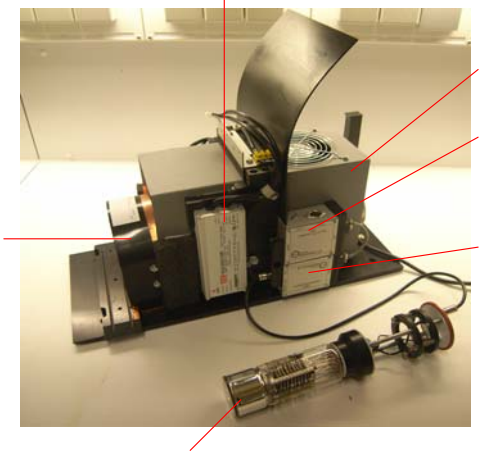
i) Schematics of 1st setup used back in 1977:

i) The existing equipment:

i) Schematics

…. Assy of core detection unit ….





ET, 2014

17-01-05 Madl

7

PMT: The PMT 98xx-series consists of 52 mm diameter end window photomultiplier, with S20 infra-red sensitive photocathode, and 11 high gain, high stability, SbCs dynodes of the long-established venetian blind design providing a low after-pulse rate. The employed PMT-window characteristics cover a band from 160 – 870 nm with a corresponding refractive index of 1.46 (see insert above).

Cooling Unit & Power Supply: To suppress dark-current formation and thereby increasing low level photon detection efficiency an air-cooled, 120W thermoelectric cooling unit is used. The unit operates with PE, thus offering the advantage of no moving parts (except for the fans). The photocathode is set 31.8 mm behind the front surface of the flange and behind an evacuated, double-walled quartz-glass window (with a lower cut-off window at 170 nm) allowing the unit to remain condensation-free. In order to facilitate easy operation, the unit is supplied with a mains driven power supply, including a temperature control unit, digital temperature read-out and interconnecting cables.

PMT-signal amplification: An amplifier-discriminator circuit combines a fast amplifier and a fixed-threshold discriminator with an overall sensitivity of approximately 1mV. With the gain of the photomultiplier optimised, photon counting with a high signal to noise ratio and stability can be achieved up to count rates of 100 MHz. In addition, the unit is fitted with an adjustable input threshold (in the range from -0.5 to -2.5 mV), yielding an additional advantage where setting a higher threshold is necessary to eliminate pickup from an electrically noisy environment.

Counter-Timer TTL-unit: is a high performance pulse counting instrument for use with a PC or Laptop via the USB 2.0 interface that is also used to cover its power ratings. It can be operated as a laboratory rate-meter is a a wide dynamic range photon counting system. A LabVIEW virtual instrument program option is included.

Source: http://www.et-enterprises.com/

1D-PMT (4/5)

i) Schematics of 1st setup used back in 1977:

i) The existing equipment:

i) Schematics

…. Assy of core detection unit ….

…. Assembled detector unit ….

Madl et al, 2015

Actual pre-prototype of the CM in operation: Working units of the pre-prototype CM – besides the Navetta (a flat-bed aerosol exposure device), itself a crucial component of RACES (real-time aerosol-based cell-culture exposure system – not described herein):

(1) data processing unit;

(2) High Voltage Power Supply;

(3) PE-Power Supply;

(4a) shutter control unit;

(4b) high speed electromechanical shutter;

(5) dark chamber compartment where Navetta should slide into;

(6) PMT-housing with detector and quartz window;

(7a) signal amplifier;

(7b) signal discriminator;

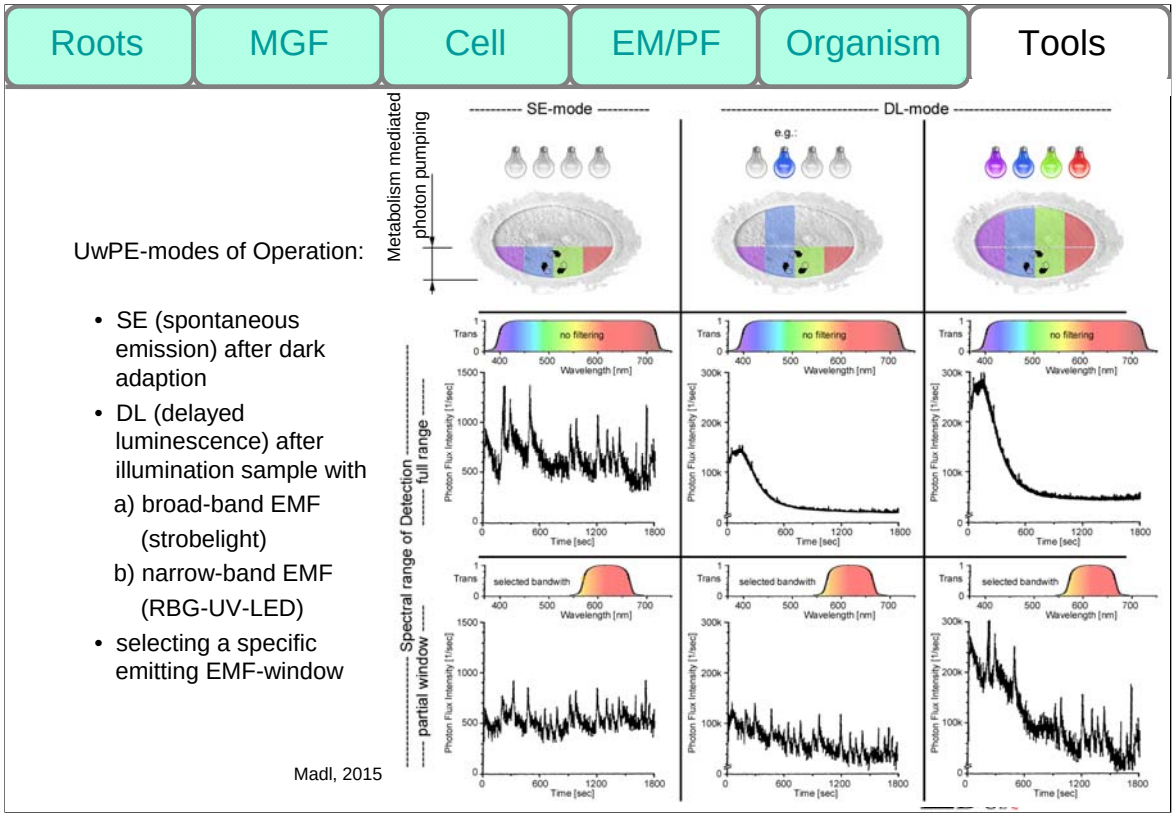
(7c) TTL signal converter;

(8) photon-proof aluminium lid cover;

(9) peripheral electronics controlled via a LabVIEW-based software solution for LED-cascade, strobe-light, T-&-rH-sensors, PE-unit (all elements within the dark chamber) and PMT-data interfaces to computer.

Source: Madl P, Lehner B, Sereni P (manuscript in preparation) Controlling detector components via LabVIEW for cell exposure studies. Proceedings for the VIP-Congress:

Virtual Instruments in practical use. VDE-Verlag, Munich, FRG



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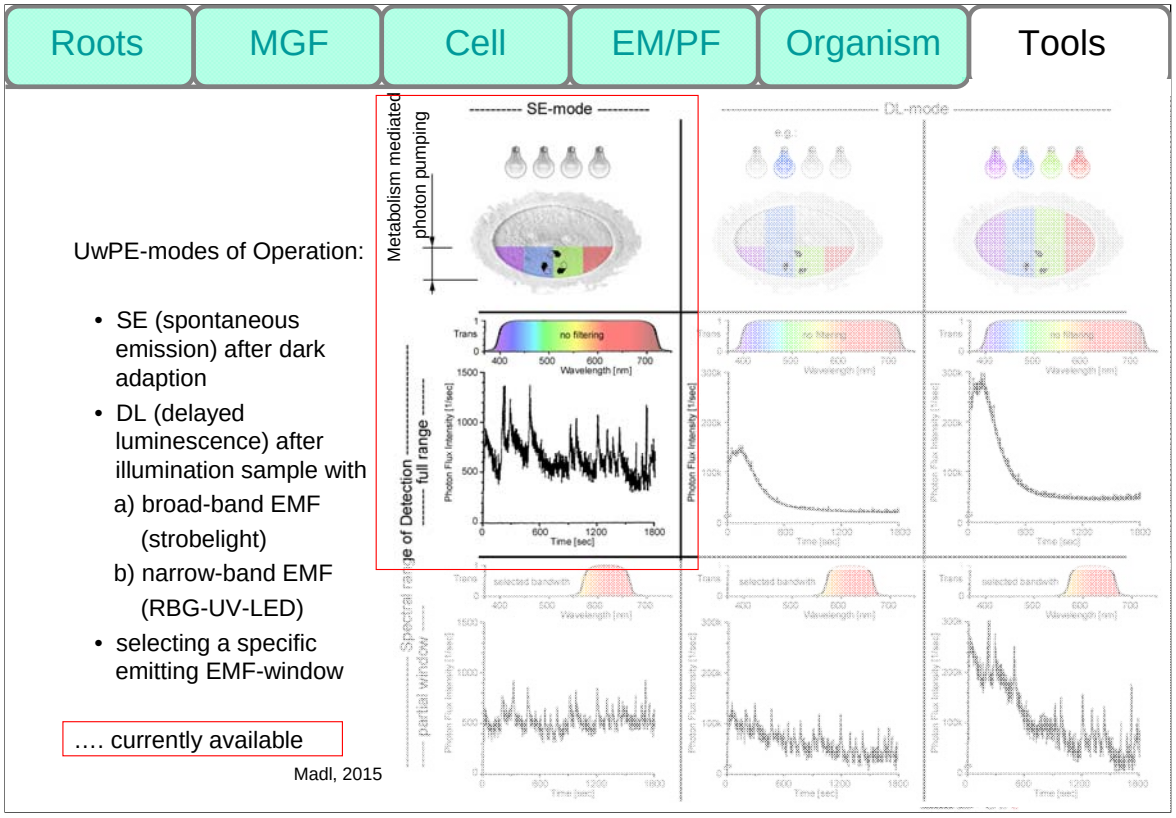
Source: Madl P. (2015) Detection and measurement of biogenic ultra-weak photon emission. In: Fels D, Cifra M, Scholkmann F (eds). Fields of the Cells. Research Signpost Press.



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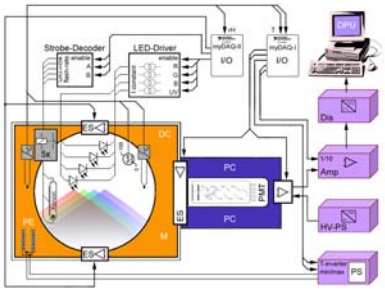
Source: Madl P. (2015) Detection and measurement of biogenic ultra-weak photon emission. In: Fels D, Cifra M, Scholkmann F (eds). Fields of the Cells. Research Signpost Press.

Upgrading Existing Hardware

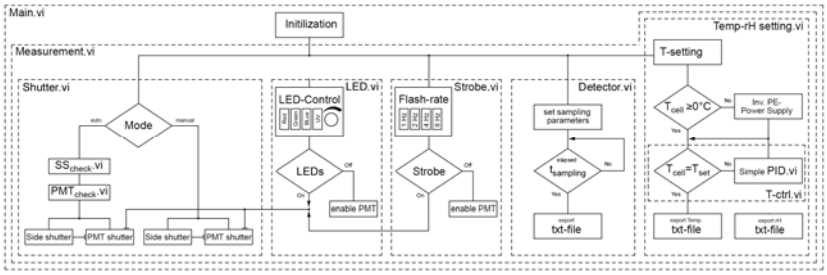
(Wishlist)

1D-PMT (1/9)



i) Interface: **myDAQ** to communicate w/ periphery

- rH-Sensor
- T-Sensors (PE & chamber)
- PWM for LED-cascade
- Flashrate of Strobelight
- PE-controler (heating/cooling)
- Shutter controller
- Filterwheel SW-plugin



Madl et al., 2016

The article describes a finalized “coherence monitor” which is able to detect ultra-weak electromagnetic emissions originating from biological samples in almost real-time. Due to specific hardware requirements, a tailor-made software-solution was developed, which controls a photo multiplier, temperature and relative humidity sensors, electro-mechanical shutters, and an illumination source consisting of four-color LEDs as well as a strobe-light. The software is designed to enable two fundamental but distinct modes of operation (spontaneous and induced) in order to characterize living samples. The whole software is written in LabVIEW 2013.

Image: block-diagram of the parallel processes occurring prior and during measurement of UwPE. The corresponding steering-, control-, and measurement-VIs are shown. These can be grouped into the categories Shutter, LED, Strobe, Detector and Temp-rH.

Source: Madl P, Lehner B, Meyer P, Sereni P (2016) Controlling detector components via LabVIEW for cell exposure studies. Jamal R, Heinze R (eds) Proceedings of the 21st VIP-Congress: Virtual Instruments in practical use. VDE-Verlag, Munich, FRG;

http://www.etz.de/6572-0-Steuerung+eines+Detektors+durch+LabVIEW+fuer+Zellexpositionsstudien.html#.WGvFyUIy0vg

1D-PMT (2/9)

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- T-Sensors (PE & chamber)
- PWM for LED-cascade
- Flashrate of Strobelight
- PE-controler (heating/cooling)
- Shutter controller
- Filterwheel SW-plugin

via
2 myDAQ
Interfaces

NI, 2015

17-01-05 Madl

myDAQ-I

Bus	EINGANG		AUSGANG	
	Analog	Digital	Analog	Digital
0	$T_{Interior}$ chamber		PE via I-Controller (dynamic 1-10V)	Peltier element (heating/cooling)
1	$T_{Interior}$ of PE		not used	Shutter-I (PMT)
2				Shutter-II (Aerosols)
3				Sensitivity (x1 / x10)
4				not used
5				not used
6				not used
7		status of chamber lid		

myDAQ-II

Bus	EINGANG		AUSGANG	
	Analog	Digital	Analog	Digital
0	$rH_{Interior}$ in chamber		not used	Strobe (enable)
1			not used	Strobe (rate)
2				Strobe (rate)
3				LED-PWM (enable)
4				LED_{red} (on/off)[b]
5				LED_{green} (on/off)[b]
6				LED_{blue} (on/off)[b]
7				LED_{UV} (on/off)[b]
0			+15 V	
1			-15 V	
2				+5 V

Communication with peripheral devices: In order to enable automazid measurement mode, the periphery needs to be controlled via a computer controlled interface. This is achieved via two myDAQ devices. These are low-cost portable data acquisition (DAQ) device that uses NI LabVIEW-based software instruments, allowing students to measure and analyze real-world signals. Combined with NI LabVIEW on the PC, one can analyze and process acquired signals and control simple processes anytime, anywhere. As more control options are required for the required peripheral elements, two myDaq devices are used which share the following tasks;

myDaq-I:

Analog-IN_0: measuring the temperature of the dark-chamber;

Analog-IN_1: measuring the temperature of Peltier-Element (PE);

Analog-OUT_0: voltage to tune the dimmable power supply of the PE in a range of 0-10VDC;

Digital-OUT_0: selective mode switch to operate PE in either heating (0) or cooling (1) mode;

Digital-OUT_1: enabling the PMT-shutter (1);

Digital-OUT_2: enabling the aerosol-(side)-shutters (1);

Digital-OUT_3: selecting the sensitivity of the PMT-amplifier (0 for x1 and 1 for x10);

myDaq-II:

Analog-IN_0: measuring the relative humidity of the dark chamber;

Digital-OUT_0: enable strobelight (1);

Digital-OUT_1&$_2$: multiplexed signal for the four strobe-frequencies (00, 01, 10, 11);

Digital-OUT_3: enable LED-cascade (1);

Digital-OUT_{4-7}: selectively selecting a single or multicolour illumination (4:R; 5:G; 6:B; 7:UV);

Source: USER GUIDE NI myDAQ - *www.ni.com/pdf/manuals/373060f.pdf*

1D-PMT (3/9)

i) Interface: **myDAQ** to communicate w/ periphery
i) **Upgrade I**: rH-Sensor Integration:
To do list:

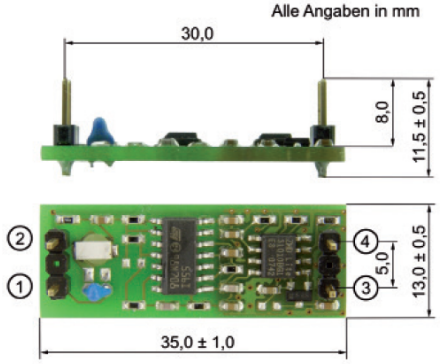
- Integration of analogue output of rH-sensor into a “sub.vi”
- plotting rH vs time

using:

- myDAQ interface
- rH-sensor **HYTE-ANA-1735**

B+B, 2015

Alle Angaben in mm



Stift	Signal	Funktion
1	NTC	Passiver Temperatursensor
2	GND	Masse
3	VCC	Betriebsspannung 4,75...5,25 V
4	RH	Spannungsausgang rel. Feuchte

The B+B **humidity module** combines a modern thin film sensor technology with flexible, digital signal processing of an ASIC. The high quality, capacitive humidity sensor guarantees highest measuring accuracy, drift stability, weather resistance as well as an outstanding long-term stability. Moreover, after long saturation phase, the measured value builds up very fast. Additionally, temperature can also be determined over the brought out NTC, which enables calculation of dew point or absolute humidity.

Source: Calibrated humidity module HYTE-ANA-1735 - *https://www.conrad.at/de/analoges-feuchtemodul-hyte-ana-1735-bb-thermo-technik-hyte-ana-1735-0-100-40-100-c-180835.html*

1D-PMT (4/9)

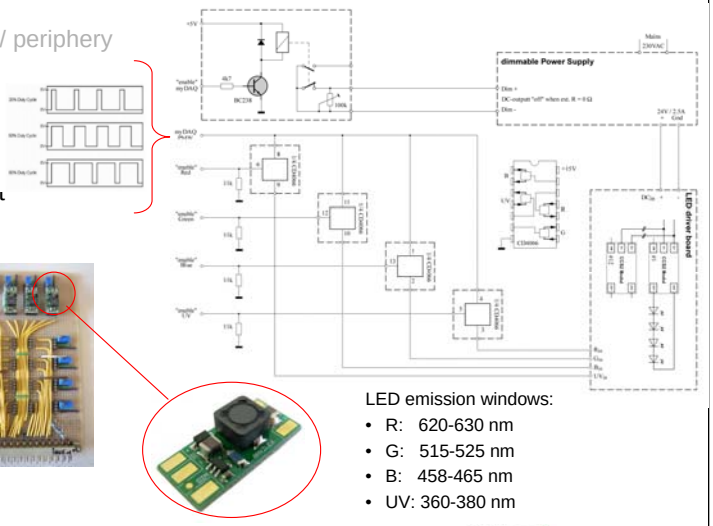
i) Interface: **myDAQ** to communicate w/ periphery
i) **Upgrade I**: rH-Sensor Integration
i) **Upgrade II**: LED using PWM :
To do list:

- Integration of PWM-vi into a "sub.v
- illumination control from 0-max ligh
- Both white (RBG-UV) & selected color (specific wavelength)

using:

- myDAQ interface
- PWM.vi
- HW-driver (**P011.36-350**)

Madl, 2015



LED emission windows:

- R: 620-630 nm
- G: 515-525 nm
- B: 458-465 nm
- UV: 360-380 nm

17-03-17 Madl 15

Narrowband-light source for DL-Mode: The constant current module (CIQ-Modul) CCS2-350 is able to supply single or multiple LEDs in series (here 4x 1W LEDs) with a constant current up to 350mA. The module is reliable, small in size and is fitted with input as well as output filters to enable trouble-free operation at low remnant noise levels. The high efficiency reduces heat losses and assures operation without additional heat sinks. In order to dim the attached LED-cascades, it is necessary to use the DIM-input-pin. The signal applied to achieve dimming consists of a Pulse width modulated (PWM) signal. PWM is a technique in which a series of digital pulses is used to control an analog circuit. The length and frequency of these pulses determines the total power delivered to the circuit. PWM signals are most commonly used to control DC motors to adjusting the brightness of an LED. The power supply for the LED-cascade consists of a standard 120W HLG-120H-54B constant current energy block. Switching of R/G/B/UV LED-cascades in single or multiple mode is done using a CD4066 analogue switch that is controlled via the myDAQ digital outputs 4-7 (add circuit diagram into presentation).

Source: Pulse Width Modulation (PWM) Using NI-DAQmx and LabVIEW
http://www.ni.com/tutorial/2991/en/
Dimmbable high-power constant-current source for LED-cascades -
http://shop.anvilex.de/index.php?route=product/product&product_id=177
MeanWell Constant Current Power supply - http://www.meanwell.com/product/led/LED.html
A6-RGB-3 High Power LED, 3x1W (620/515/460 nm)
www.**roithner**-laser.com/datasheets/**led**_multi/hexagonal/h6-**rgb**-3.pdf
APG2C1-365-R4 High Power LED, 1W (365 nm)
http://www.roithner-laser.com/led_highsingle_emitter.html

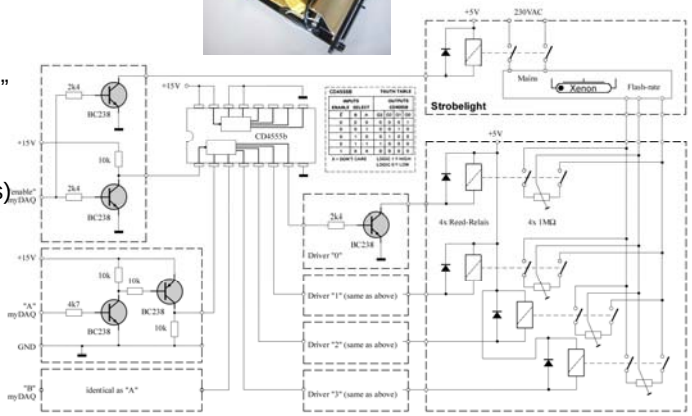
1D-PMT (5/9)

i) Interface: **myDAQ** to communicate w/ periphery
i) **Upgrade I**: rH-Sensor Integration
i) **Upgrade II**: LED using PWM
i) **Upgrade III**: Strobelight
To do list:

- Integration of CD455B into a “sub.vi”
- Output routed to reed-relays (galvanic separation required!)
- 4 different strobe-rates (1, 2, 4, 8 f/s)

using:

- myDAQ interface
- 2 bit De-multiplexer to address prefixed trimmers (via reed relays)
- Strobe (**Strobelight**) Madl, 2015



17-01-05 Madl 16

Broadband-light source for DL-Mode: The strobelight generates lighting effects with a repetition frequency between 1 to 10 flashes/secs. It operates at 230 V/50 Hz AC, utilises a HV-xenon-flash tube with a max. power rating of 5W. In order to adjust the repetition frequency, this device has been upgraded with additional electronics that utilize a demultiplexing circuit (CD4555b) in such a way that according to the multiplexed 2-bit input signal 4 different frequencies can be chosen from. Each of the individual frequencies needs to be pre-set using cermet-trimmers. In order to assure galvanic separation between the IC and the HV-section of the strobe-light, each of the 4 output-channels are activated via TUNs with attached reed-relays. Similarly, “enabling” of the strobe-light is likewise done using a TUN-operated reed-relay.

Source: - Renkforce TM-SL-M1 Strobelight - *https://www.conrad.at/de/stroboskop-renkforce-weiss-1337780.html*

1D-PMT (6/9)

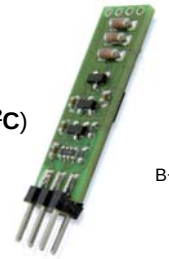
i) Interface: **myDAQ** to communicate w/ periphery
i) **Upgrade I**: rH-Sensor Integration
i) **Upgrade II**: LED using PWM
i) **Upgrade III**: Strobelight
i) **Upgrade IV**: T-sensors

To do list:

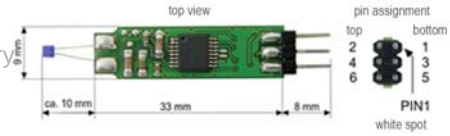
- Integration of the two sensors into 2 “sub.vi’s”
- plotting T vs time (dark-chamber & PE)

using:

- myDAQ interface
- HW-driver (**TEMOD-I²C**)

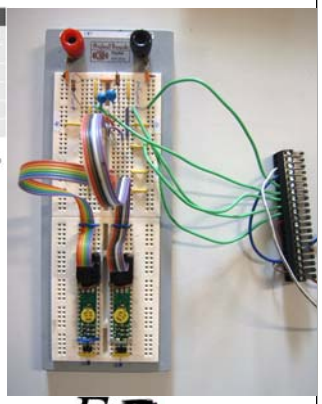


B+B, 2016 & Heraeus, 2015



6-pole pin strip		
1	VDD	Supply Voltage +6 ... 24 V DC
2	GND	Ground
3	SDA	Serial Data I²C
4	SCL	Serial Clock I²C
5	V_TEMP	Temperature Voltage Output
6	GND	Ground

Pin 1 of the pin strip is marked with a white spot.
The standard calibration of Temperature signals V_TEMP (PIN6) is 0 ... 5 V.



Temperature module: Both the temperature of the chamber as well as that of the PE is monitored using a fully integrated semiconductor sensors with a temperature range of approx. –50 to +150 °C. As sensor, a high quality platinum resistance is used (Pt1000 class B with 1kΩ at 0 °C). The ASIC as subsystem with flexible signal processing performs the job of capturing, linearization and calibration of the sensor raw value till delivering of refined and processed output signal, which is made available as binary value over the I2C-Bus or alternatively as voltage signal 0 to 5 VDC.

Source: TEMOD-I2C-R1 - https://www.conrad.at/de/temperatursensor-modul-bb-thermo-technik-temod-i2c-r1-32-bis-96-c-502001.html

1D-PMT (7/9)

i) Interface: **myDAQ** to communicate w/ periphery
i) **Upgrade I**: rH-Sensor Integration
i) **Upgrade II**: LED using PWM
i) **Upgrade III**: Strobelight
i) **Upgrade IV**: T-sensors
i) **Upgrade V**: PE-controller

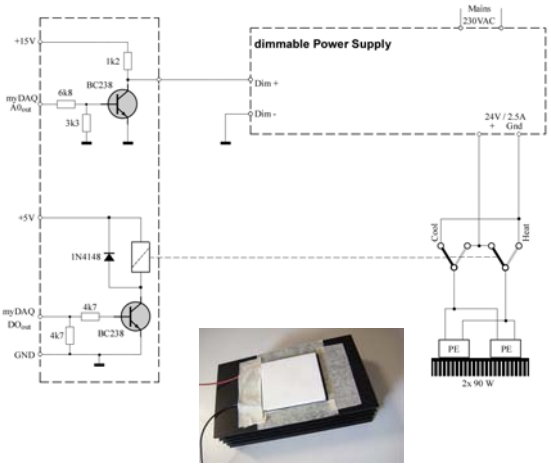
To do list:

- Integration of controller into "sub.vi"
- modes of operation: cooling / heating (Temp. via SW-controlled set values)

using:

- myDAQ interface
- HW-inverter board
- 100W Peltier Element

Madl, 2015



Voltage supply inversion for the PE to operate it either in cooling or heating mode. Using a simple TUN-operated relay switch it is possible to invert the voltage applied to the PE in such a way as to switch from heating to cooling and reverse. In combination with the analoge output (0: PE-dimming voltage) and the analogue input (1: T-sensor of PE) of the myDAQ-I data interface a selected temperature can be accurately achieved by an V-tuned signal output that operates the dimmable power supply of the PE. As with the LED-cascades, the PEs are operated via a dimmable 120W HLG-120H-54B constant current energy block.

Source: TEMOD-I2C-R1 - https://www.conrad.at/de/temperatursensor-modul-bb-thermo-technik-temod-i2c-r1-32-bis-96-c-502001.html

MeanWell Constant Current Power supply - http://www.meanwell.com/product/led/LED.html

1D-PMT (8/9)

i) Interface: **myDAQ** to communicate w/ periphery
i) **Upgrade I**: rH-Sensor Integration
i) **Upgrade II**: LED using PWM
i) **Upgrade III**: Strobelight
i) **Upgrade IV**: T-sensors
i) **Upgrade V**: PE-controller
i) **Upgrade V**: Shutter-controller

To do list:

- Integration of controller into "sub.vi"
- Closing shutter of PMT when LED, strobe is on or door is open
- opening side-shutters (aerosol)

using:

- myDAQ interface
- GVI-shutter controller
- Dark-chamber-microswitch

Melles-Griot, 2015

Shutter operation for both the PMT and the aerosol-side openings utilize a standard Melles Griot shutter-controller unit. These GVI solenoid drive, spring return shutters offer high performance in a range of operating conditions. The shutter for the PMT has an aperture of 64 mm while that for the aerosol side inlets measure 25 mm in aperture. Both operate at 12 volts. Shutters are normally closed. The shutters are operated via the standard Melles-Griot 12-volt IES controller is fitted with built-in control functions (including eight pre-set shutter speeds) as well as a remotely operated trigger port. Power to the shutter-controller unit is provided by a12 V unit designed for use with IPS Electronic Shutter Controllers. The minimally required triggering time to activate the shutter should be >20 ms @ 12 V, whereas the holding voltage can drop to 6V. The maximum duty cycles possible with these shutters are 45 ms (approx. 22.2 Hz); significantly higher rates may damage the solenoid as it may overheat.

Source: Shutters & controllers

http://marketplace.idexop.com/store/ies-shutters

http://marketplace.idexop.com/store/ips-electronic-shutter-controllers

http://marketplace.idexop.com/store/IdexCustom/PartDetails?pvId=35863

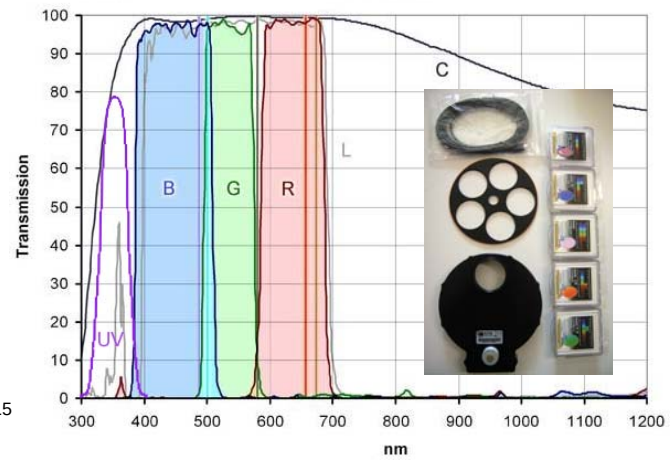
1D-PMT (9/9)

i) Interface: **myDAQ** to communicate w/ periphery
i) **Upgrade I**: rH-Sensor Integration
i) **Upgrade II**: LED using PWM
i) **Upgrade III**: Strobelight
i) **Upgrade IV**: T-sensors
i) **Upgrade V**: PE-controller
i) **Upgrade V**: Shutter-controller
i) **Upgrade VI**: Bandwidth-Filterwheel

To do list:

- Integration of controller into "sub.vi" using:
- myDAQ interface
- "exe-file" available from supplier

Atik, 2015 & Baader 2015



Filter-wheel to select specific wavelength-windows: in order to filter the emission spectra originating from the sample, an USB-controlled Atik-EFW2-50 filter-wheel is used. This is a motorized filter wheel that can house multiple filters. Given the aperture of the PMT, the maximum filter disk option available of 5×50.4mm (AtkFw5x50) was chosen. A standard 12VDC 0.3A power supply unit is used to operate the device. The current application is fitted with a standard BADER-high quality 50,4mm L/R/G/B filter-set (BA2458291) as well as a Baader 2" U-Filter ZWL 350 nm UV-filter (BA2458482).

Source: Filter-Wheel and filters –

http://www.teleskop-express.de/shop/product_info.php/info/p4370_ATIK-2--mot--filter-wheel---USB---for-5x-50mm-unmounted-filter.html

http://www.teleskop-express.de/shop/product_info.php/info/p4360_Baader-50-4-mm-LRGB-CCD-Filter-set-w-o-cell---Interference-filter.html

http://www.teleskop-express.de/shop/product_info.php/info/p513_Baader-UV-Filter-2--for-Venus-photography.html

Conclusion

- BP-measuring technique is extremely **sensitive and non-invasive**;
- provides a **new understanding** of living systems and their complexity;
- enables in-vitro as well as **in-vivo study of living systems**;
- BP is an integrative, physically based approach, that has the potential of giving significant impulses to the interdisciplinary **life-sciences**.

BP helps to understand how living (dynamic) systems as multimode storage structures **communicate** (**inter-, intra- and transcellular**); regulatory processes regard:

- the spatially inhomogeneous **energy-distribution structures biological matter**;
- the flow of information affecting **organization of biological matter**;
- biological matter changes the **spatial distribution of energy**;
- feedback loop yielding a **self-organizing** (autopoietic) control of regulation processes;
- reg.-processes enabling **growth in stability**, leading to **increased functional complexity**;

Said all that, shouldn't we get the fibroblast-experiment up and running?

Danke für Eure Aufmerksamkeit - Thanks for your attention

Conclusion: Univ. - Prof. DDr. Herbert Klima: Without light, there would be no life at all. The sun sends its rays over not only energy but also sends itself in the colors of coherence (healing power). Plants not only receive and store sunlight, but also the utilize the corresponding colors. Everyone turns towards light: the skin, eyes and especially on the places where the blood vessels joined at the surface - in the knee bends or joints.

All living things need and emit BP-light. The healthier and more balanced organism, the better (coherent) the radiation. A lucky man literally *radiates*. And that can be precisely measured. In medicine, light and color have their fixed place. For example laser light, is used for surgery or therapy. The good old red light bulb is still used to boost one's immune system in flu-like infections - its light promotes a healing process. Interestingly, the organism actually lights up "red" when a immune reaction is set in motion. While leukocytes fight pathogens, they radiate red light. That can show well in the laboratory. This stimulated the cells and accelerated cell division.

• Coherence is the capability of each unit to interact will al the other parts that constitute a living system. It is possible to show an extraordinary high degree of coherence of BP. It follows that this universal phenomenon of biological systems is responsible for the information transfer within and between cells. This responsive patterns is crucial for intra- and extracellular communications, including the regulation of the metabolic activities of cells as well as of growth and differentiation and even of evolutionary development as well as for self-organization.

• Self-Organisation: Self-organization is a process where the organization (constraint, redundancy) of a system spontaneously increases, i.e. without this increase being controlled by the environment or an encompassing or otherwise external system.

i) Not only cellular compounds and population of species but also growth, embryogenesis, morphogenisis, biological rhythms, metamorphosis, differentiation of tissues, as well as communication and social forms, patterns and behaviors of individuals and populations are organized and regulated by coherent photons.

ii) Biophotons are a neglected aspect of biophysical reality that may be useful in

• investigating subluxation related phenomena;

• explaining a part of intercellular communication;

• explaining local and at distance selective inhibition or stimulation of neural circuits.

The major impediment to be surmounted is a technical methodology of recording consistent data.

Source: *Marius R.V. Hossu, Ronald L. Rupert; 2003.* The Significance of Biophotons; Parker College Research Institute, Dallas - USA