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# The Method of Light Dose Measurement During Phodinamic Therapy

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## Abstract

A new method of light dose monitoring during the photodynamic therapy of abdominal cavity organs was developed. To apply this method specially developed sensors were constructed. For these sensors the temporal and distance dependences of light doses were received and analyzed. It was shown that the light dose from the operating lamp is large enough in laser light field to be taken into account when planning photodynamic therapy.

**Keywords:** PDT, light doses, other source of light in PDT, photodynamic therapy.

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## 1. Introduction

In planning the photodynamic therapy (PDT) of the peritoneum, it is very important to make an informed choice of irradiation regimes and conduct its precise control throughout the procedure [1, 2]. Moreover, it is required to consider not only the target laser therapeutic radiation within the calculated light spot, but also additional radiation sources that can deform the resulting light dose received by the tissue at a work point. Monitoring of the light dose during PDT of various points of the irradiated area and its surroundings allows to achieve maximum selectivity of treatment.

Early, this topic was discussed in papers of L. Brancaleon and H. Moseley where they compared laser and non-laser light sources for PDT [3].

Serge Mordon, Vincent Manuory in those later works, researched the treatment effect of endoscope visualization light was considered, or rather the methods of lighting used [4, 5].

## 2. Materials and Methods

A new fiber-optic four-element sensor was created to rich the goal, which represents in four optical fibers connected by SMA connector from one end, and four white plastic ellipsoids (sensors), which recording radiation with a frontal projection area of $cm^2$as shown in Fig.2. Signal recording with sensors using fiber-optic spectrum analyzer LESA-01-BIOSPEC. The density of energy value in each measurement, which taking into account the coefficients, obtained as a result of preliminary calibration. The amount of light dose was calculated automatically during the monitoring process. For this purpose, a special software module was created.

According to the instructions, the optical fiber of the spectrometer must be positioned so that the optical fiber was perpendicular to the slit of the spectrometer so that radiation will fall on the matrix, as shown in Figure 1. In this case, the signals from the different fibers are added and after processing on the graph shows one peak, as shown in Figure 3.

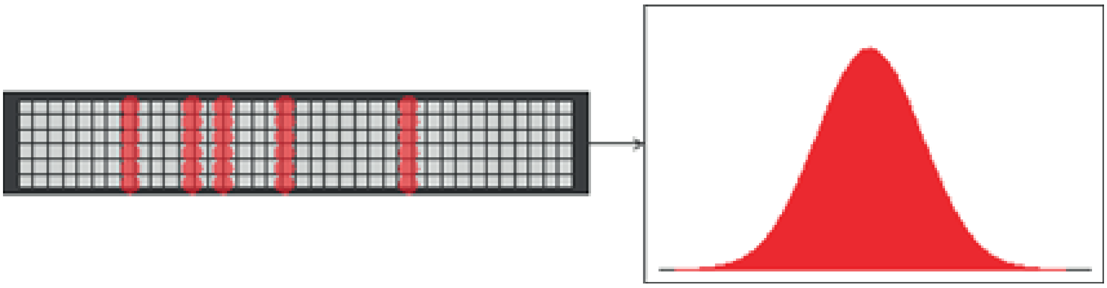

**Figure** 1: Irradiation on matrix and it spectrum in case of normal position of optical fiber.

In process of this work, the optical fiber was oriented parallel to the slit. In this case, the radiation falling on the matrix, and its graph on the spectrometer is many peaks, as shown in Figure 3.

The sensors were placed under a laser spot 4 cm in diameter with a homogeneous intensity. A laser unit for photodynamic therapy of LFT-630 / 675-01-BIOSPEC (668.9 nm) with a power of 1.04 W was used as a source of laser radiation. Schema of laboratory installation shows at the picture 4.

Also, LabMax-TO tuned to a wavelength of 668 nm was used to measure power.

In process of measurement, the same sensors for leveling the optical parameters of sensors.

The measurements are made in 5 stages, which parameters at the table 1 described.

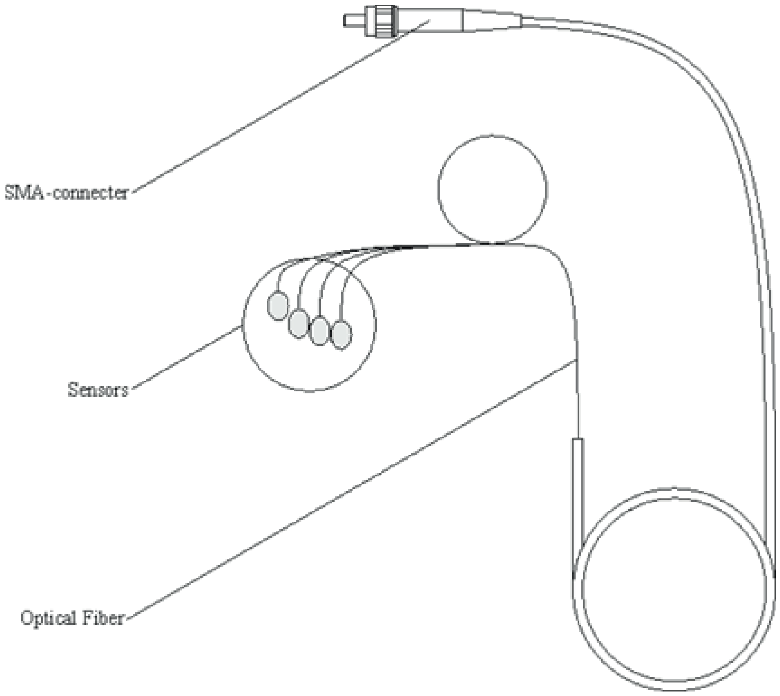


**Figure** 2: Scheme of experimental fiber-optic device.

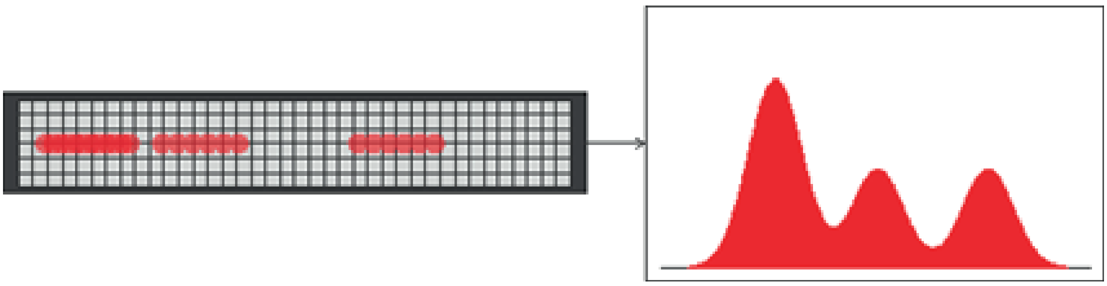

**Figure** 3: 'Irradiation on matrix and it spectrum in case of unnormal position of optical fiber'.

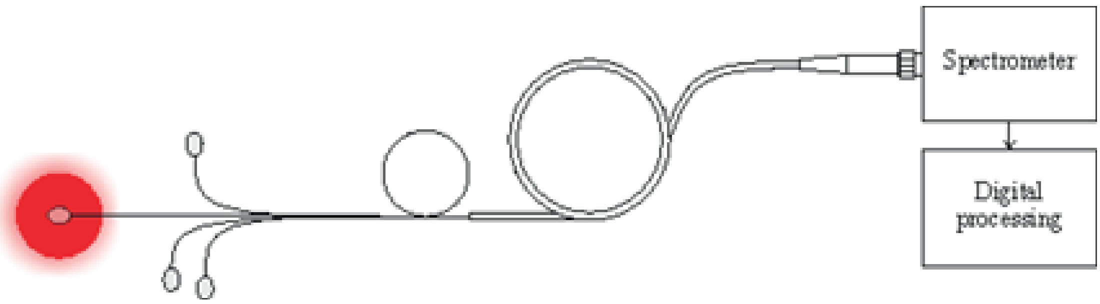


**Figure** 4: 'Scheme of laboratory installation'.

SMA-socket sensors were placed in the spectrometer so that the peaks in the spectrum from different optical fibers were located at the greatest distance from each other as in the picture 5.

In picture 5 shown case, when all sensors are irradiated at the same time. The received signal contains 4 peaks, each of which belongs to one sensor. Peaks number

Table 1: Stages of measurements.

| Stage | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Time | 00:01:00 | 00:01:00 | 00:01:00 | 00:02:00 |
| Distance from the center of laser spot, cm | 0.00 | 3.00 | 6.00 | 6.00 |

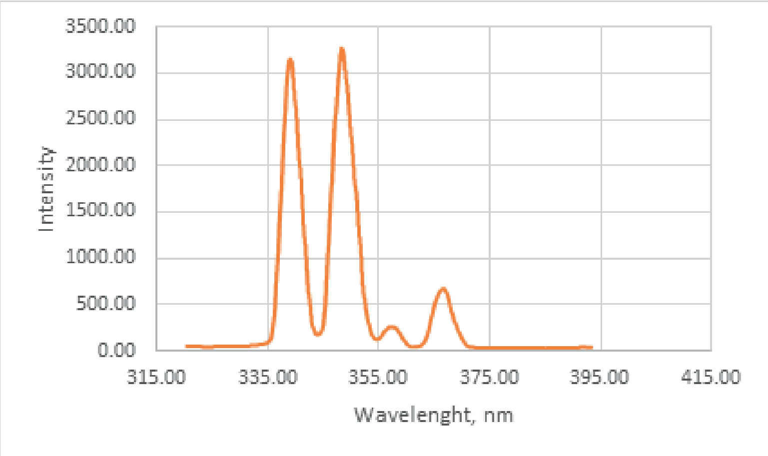


**Figure** 5: Spectrum signal of sensors.

3 and 4 (left to right), less than 1 and 2 in intensity, as their sensors had mechanical defects that distorted their optical parameters. Such distortions can be calibrated, to bring them to known units.

## 3. Results

The power density was calculated to calibrate the spectrometer. To do this, the output of the OF connected to the laser unit was measured power, which is 600 mW. At the same time, the area of the laser radiation spot is 12.57 $cm^2$, then according to calculations the power density is 47.73 $mW/cm^2$.

The measurements are made by using the same sensors. The results visualized in Figures 6 and 7.

As a result, it was shown that in the neighboring field of laser spot the light dose significantly affect the absorbed dose of laser irradiation during PDT. Moreover, Beer-Lambert law on distance and liner dependence on time is found.

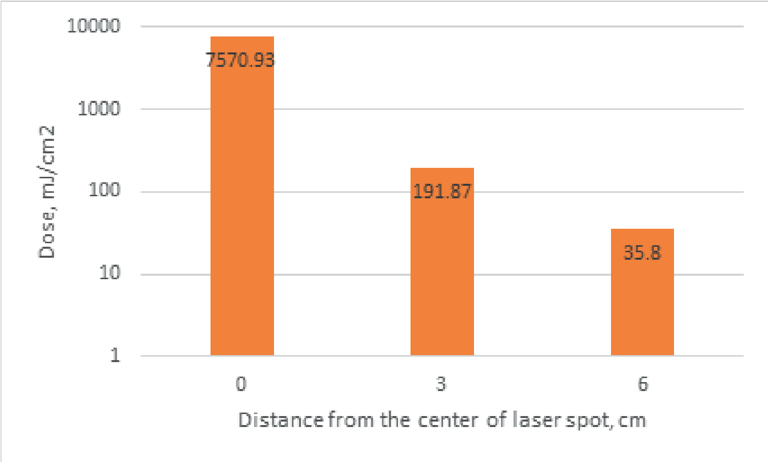


**Figure** 6: Depending Dose from Distance from the center of laser spot.

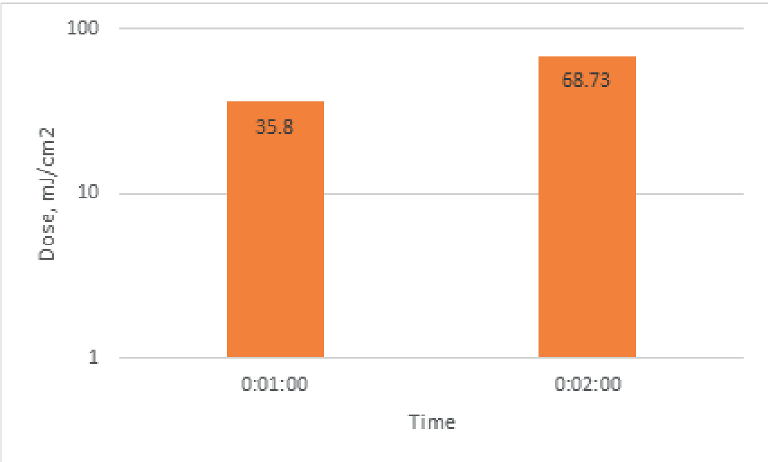


**Figure** 7: Depending Dose from Time.

## 4. Discussion

At the same time, during the resection stage of surgical intervention, the size of the light dose during irradiation of the operating field from the operating lamp is large enough to be taken into account when planning PDT.

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