DESIGN OF OPTICAL IMAGING SYSTEM FOR POLYMER GEL DOSIMETRY

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Motivation

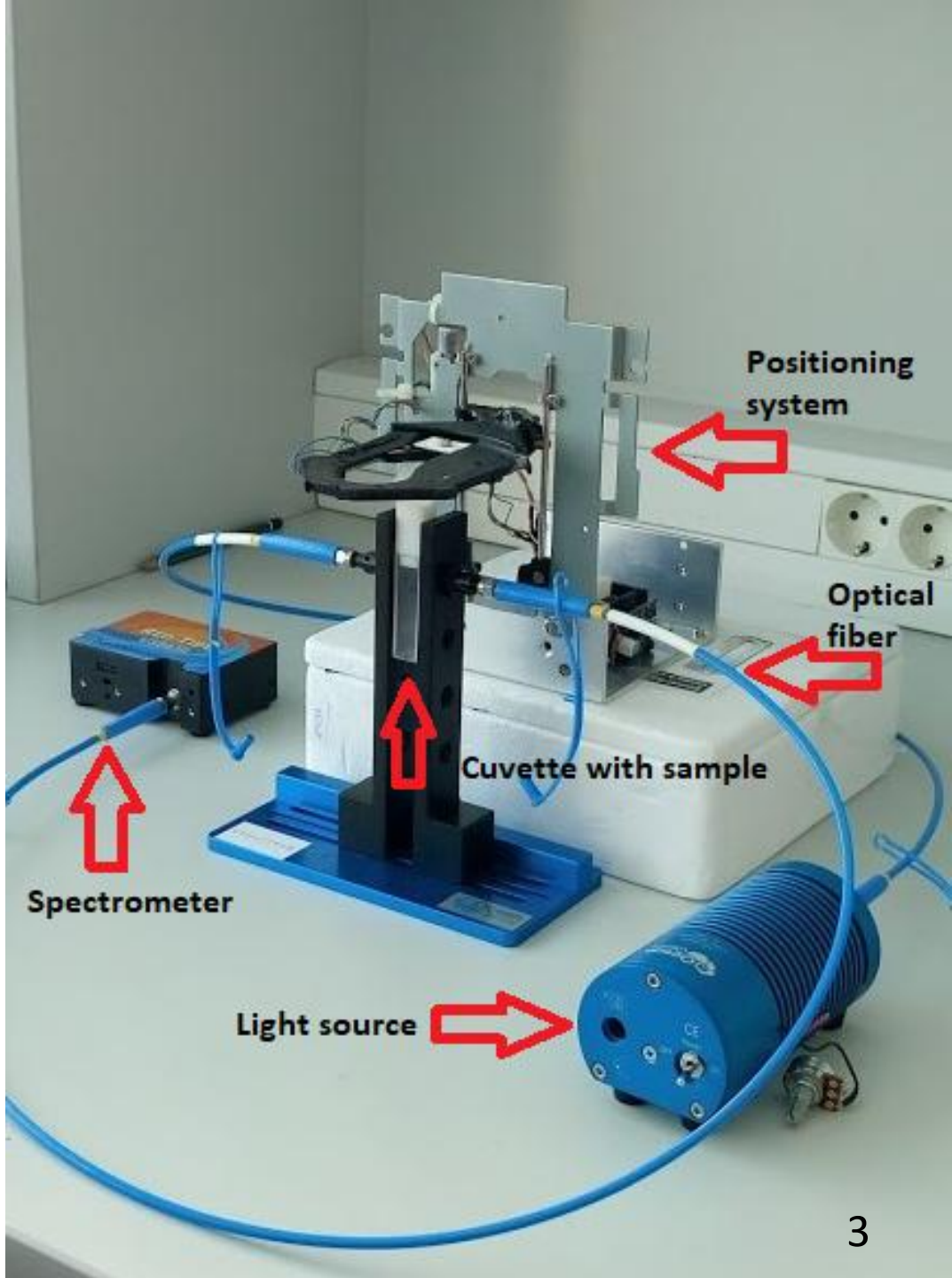
Polymer gel dosimetry has substantial advantages:

- allows the acquisition of dose distribution in three dimensions,
- boasts relatively good spatial accuracy,
- gels are tissue equivalent.

However, commonly-used gel imaging techniques, such as MRI and CT, are expensive and complicated.

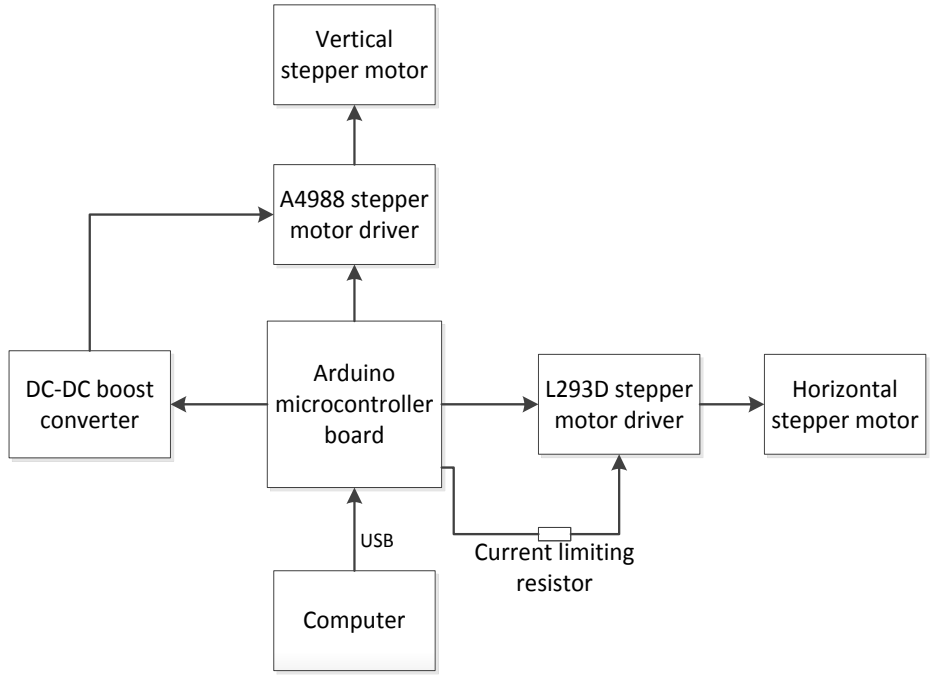
Optical imaging

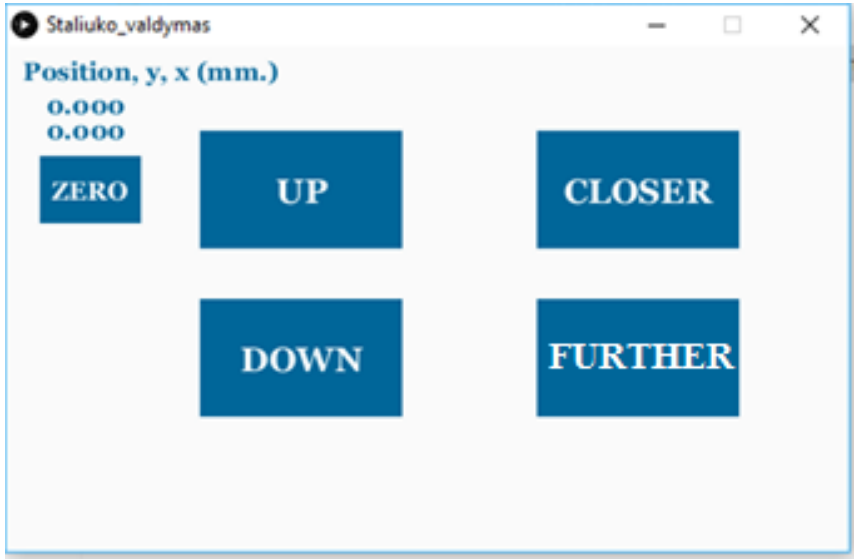
- Optical imaging allows to achieve results comparable with MRI though implementation of the system is less sophisticated.
- Created optical imaging system consists of Ocean Optics USB650 spectrometer, cuvette positioning system and a specialized in-house developed control software.

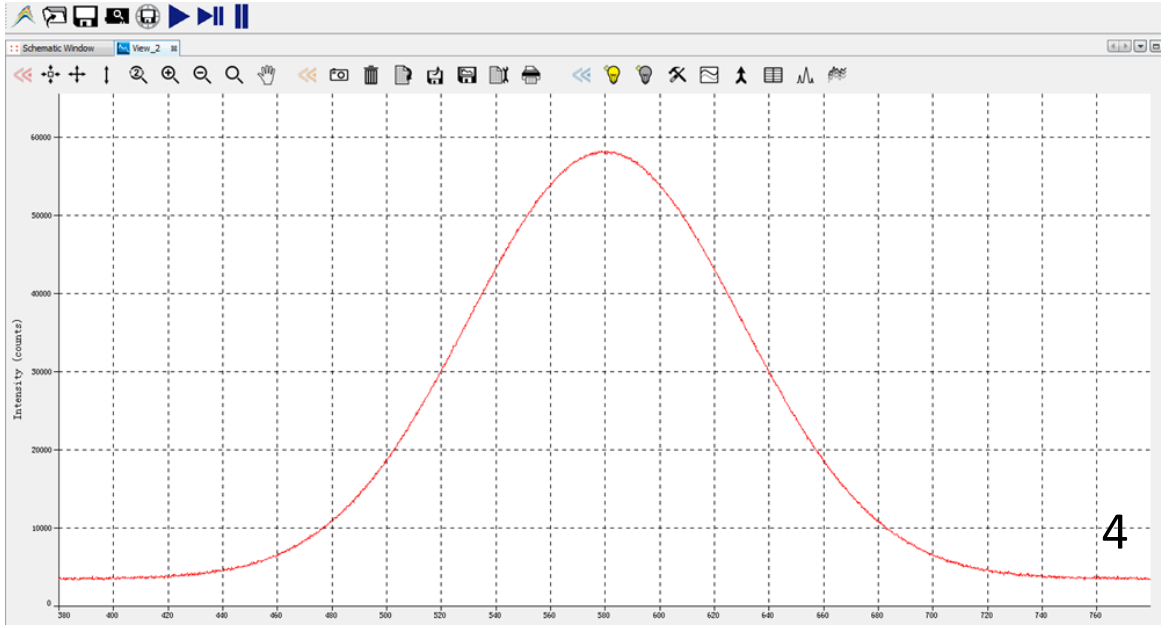


Positioning system

- To achieve dose mapping capabilities a specialized sample positioning system was developed.
- Measured step size in a vertical direction is 0.15 mm. Step size in horizontal direction – 0.125 mm.
- A specialized firmware for the microcontroller was developed along side the PC control software for manipulating the sample and data acquisition from the spectrometer.







Materials and Methods (1)

Pilot experiments with designed optical imaging system were made using MAGAT polymer gel. Constituent parts of the MAGAT gel:

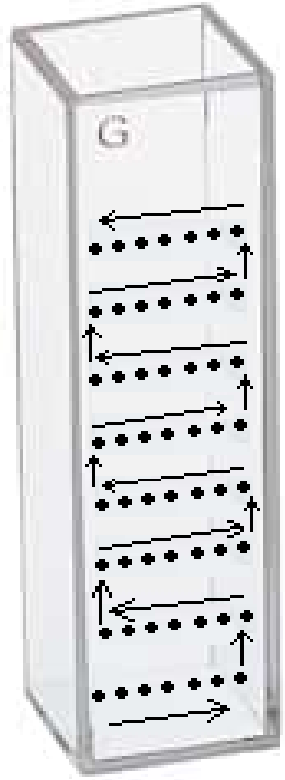
- distilled water
- gelatin
- methacrylic acid (MAA)
- tetrakis (hydroxymethyl) phosphonium chloride (THCP)

Materials and Methods (2)

Fabricated MAGAT polymer gel was poured into cuvettes.

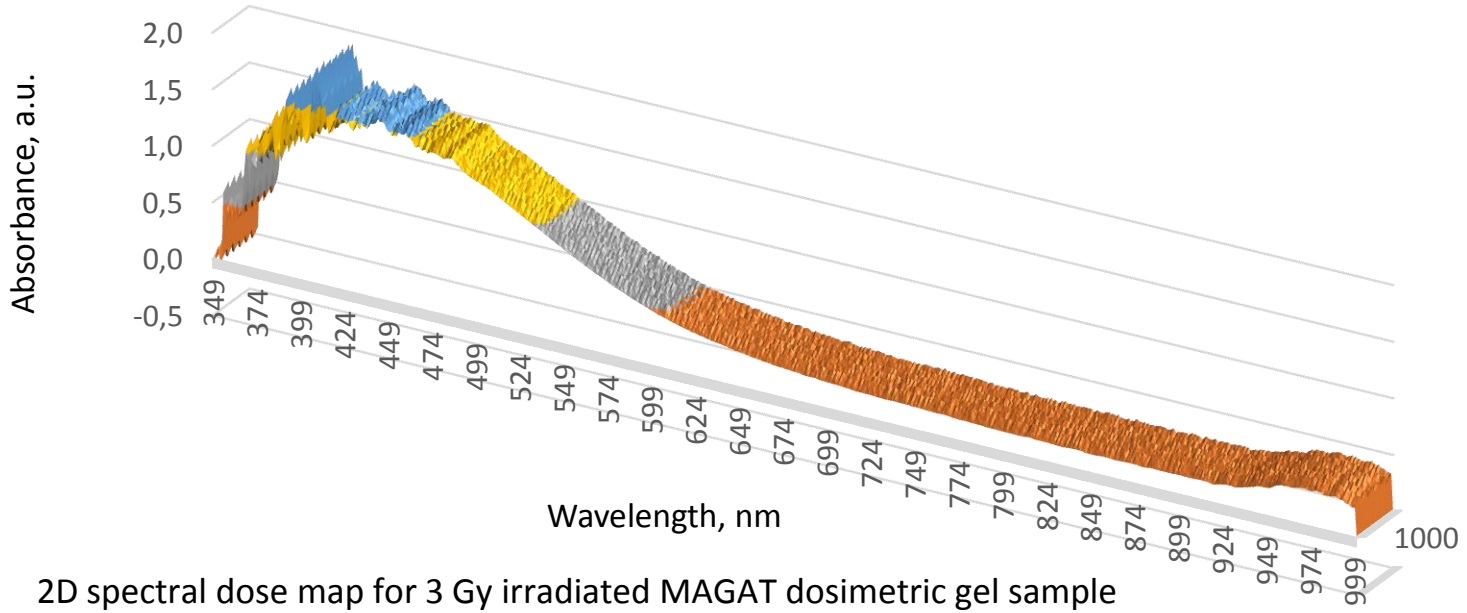
6 MeV photons were used for irradiation of the samples in the dose range of 1 Gy to 7 Gy, with 1 Gy step.

Irradiated gels were scanned using developed optical imaging system three days after irradiation in 56 equally distributed measurement points.



Results (1)

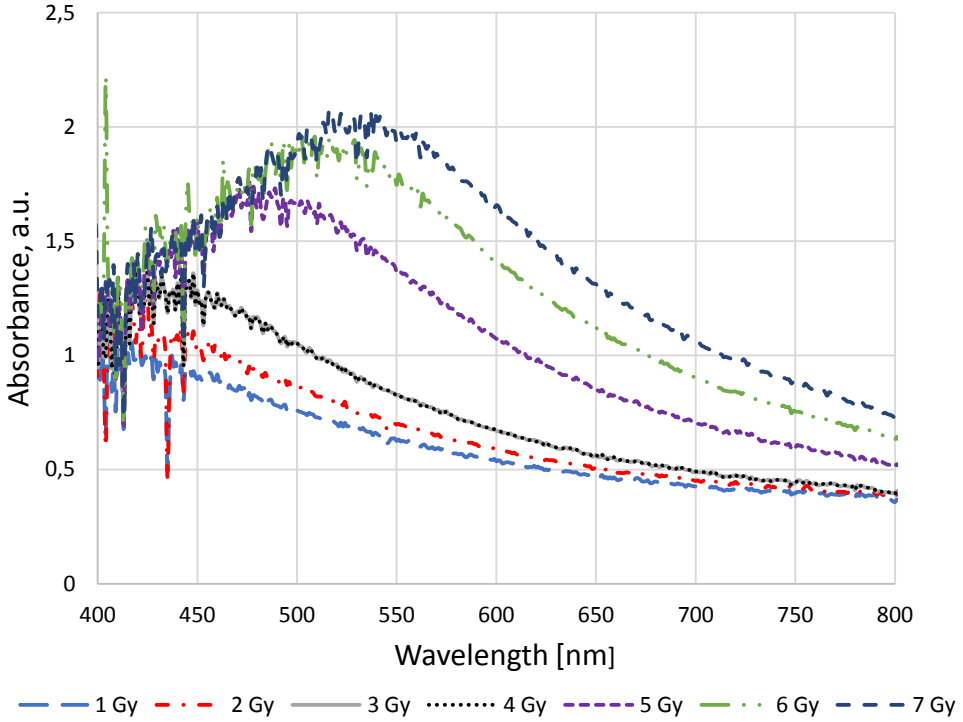
- Using acquired data it is possible to perform dose mapping of the samples in 2D.
- Obtained dose maps for different irradiation doses were consistent. Calculated highest deviation form the average was no more than 3% when samples were irradiated with uniform radiation field.

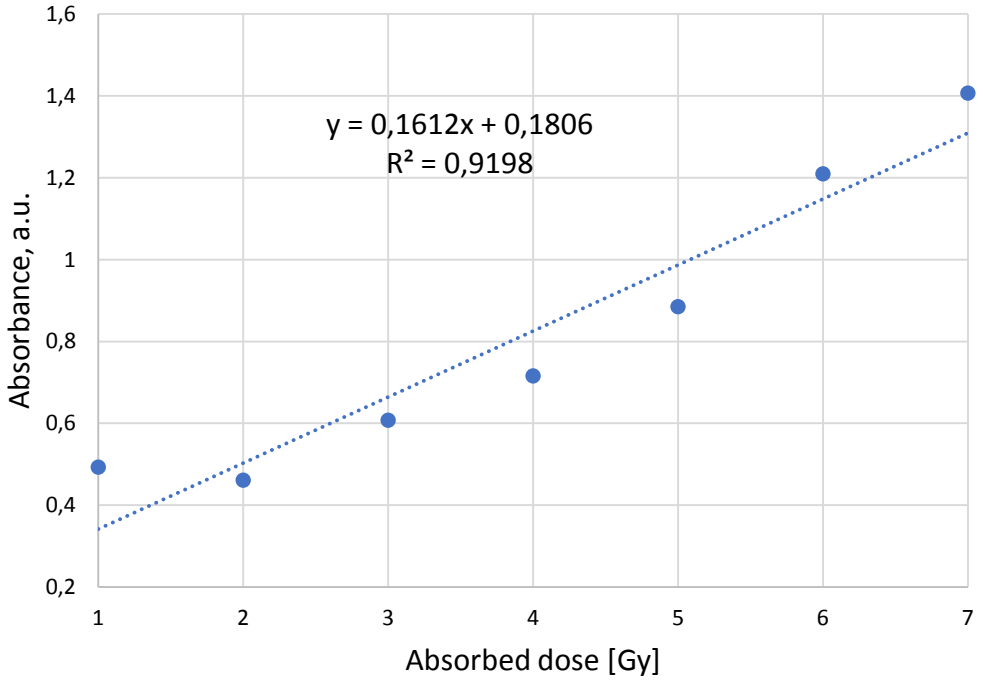


2D spectral dose map for 3 Gy irradiated MAGAT dosimetric gel sample

Results (2)

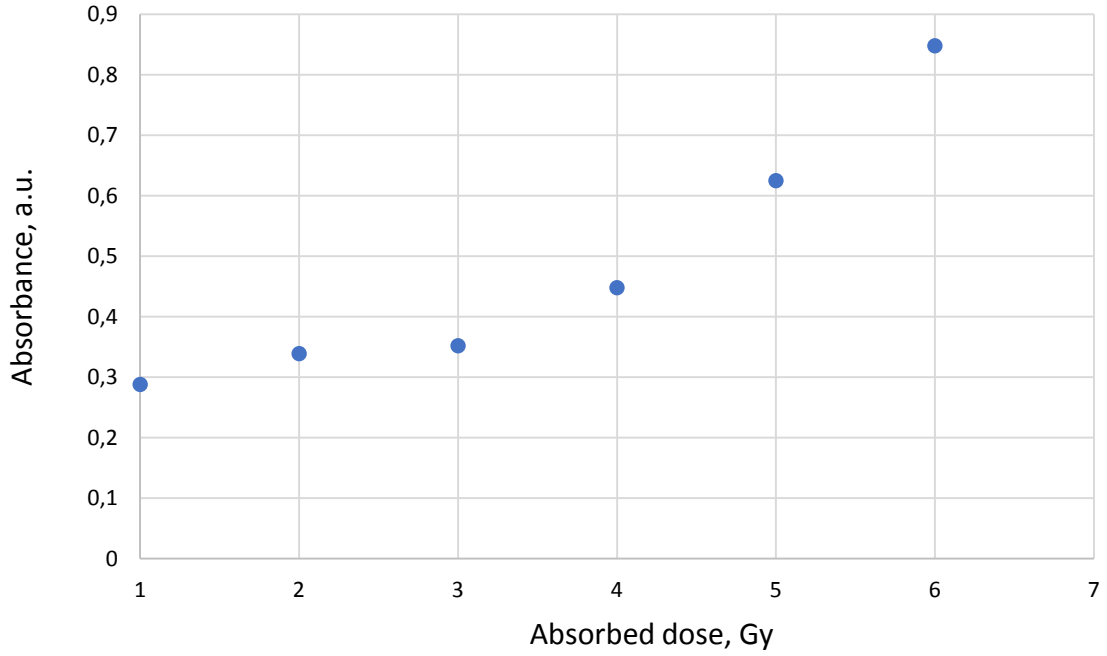
- Average spectral data for different irradiation doses was acquired.
- Using this data, optimal readout wavelength for the specific MAGAT dosimetric gel formulation was determined to be **582 nm**
- At this wavelength dose – absorbance calibration curve was obtained.





Results (3)

- To compare these results with a measurement from a single point on a sample (classical method), another set of measurements were performed with Ocean Optics USB 2000+ spectrometer.
- Determined optimal wavelength – 660 nm. Results differ from previous results mainly due to high impact of possible measurement uncertainty in single point measurements.



Conclusions

- Developed optical imaging system for polymer gel dosimetry has great potential to acquire accurate dose distribution data. With designed system acquired scanning point resolution in vertical direction is 0.15 mm, in horizontal direction – 0.125 mm.
- Comparing obtained data with another readout method showed that dose mapping capabilities are promising, although improvements are needed for data acquisition and processing algorithms used. Also, more detailed comparison with other readout methods should be implemented.

References

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