

Investigations of 3D-printed and commercial plastic scintillators for dosimetry applications

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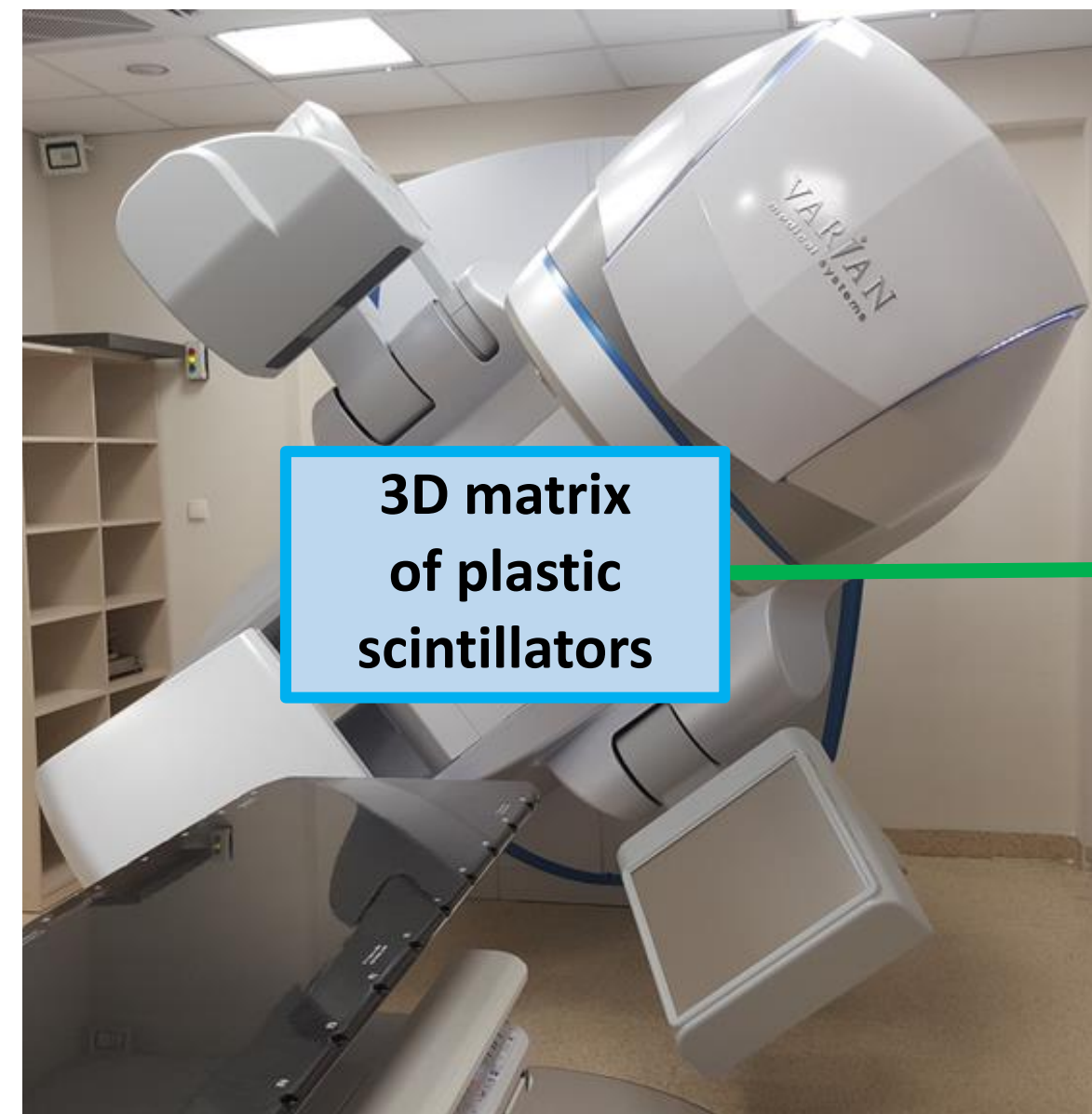
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Antoni Rucinski, 1.08.2023, LLU Workshop

Motivation

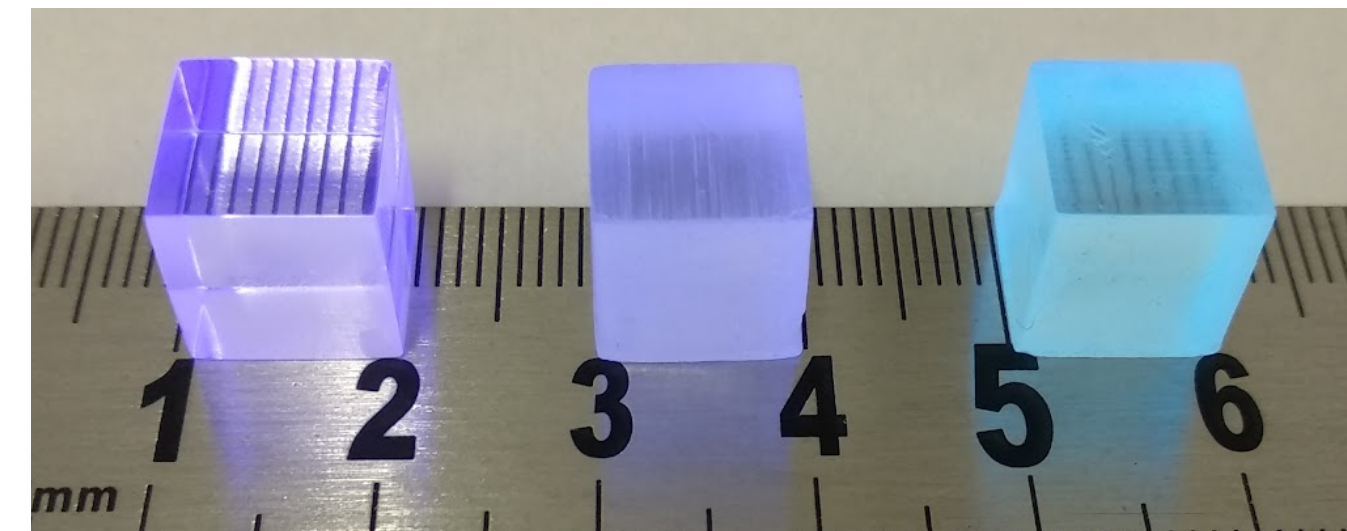
Develop 3D plastic scintillation detector for patient specific TP verification for dynamic IMRT radiotherapy

- Investigate two types of plastic scintillators: cell casted and 3D-printed
 - Light output of scintillators
 - Wrapping and polishing methods
 - Connection of scintillators and optic fibers
 - Radiation hardness

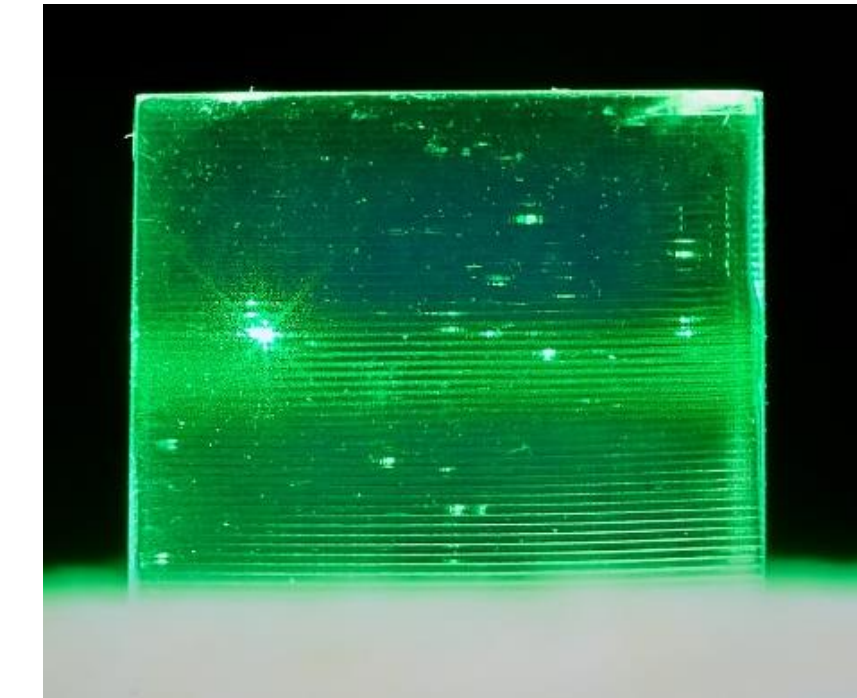


Plastic optical fibers

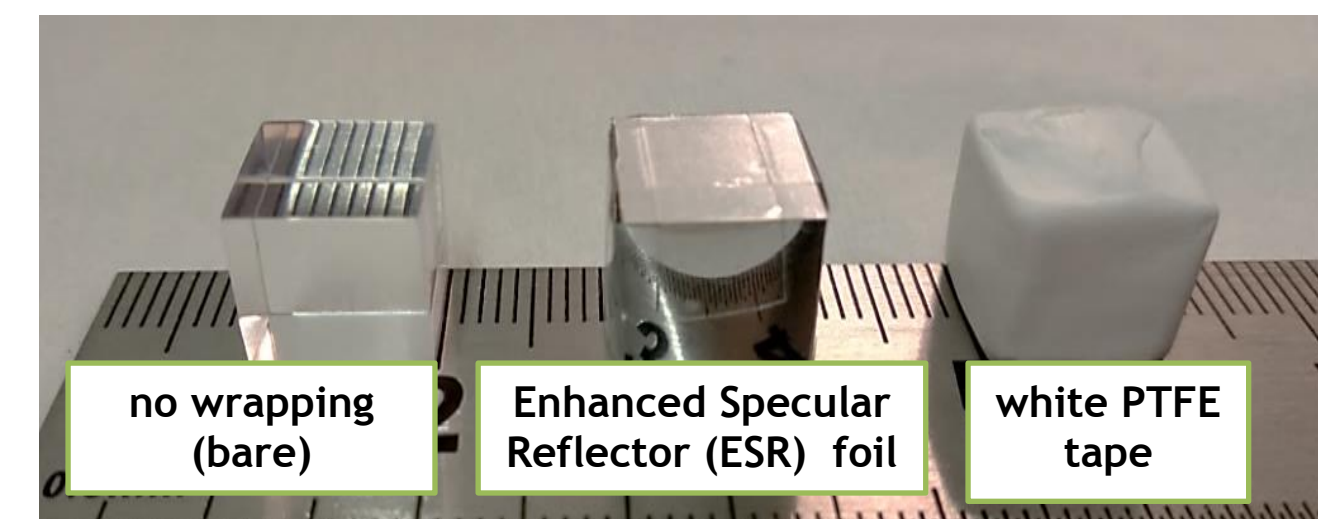
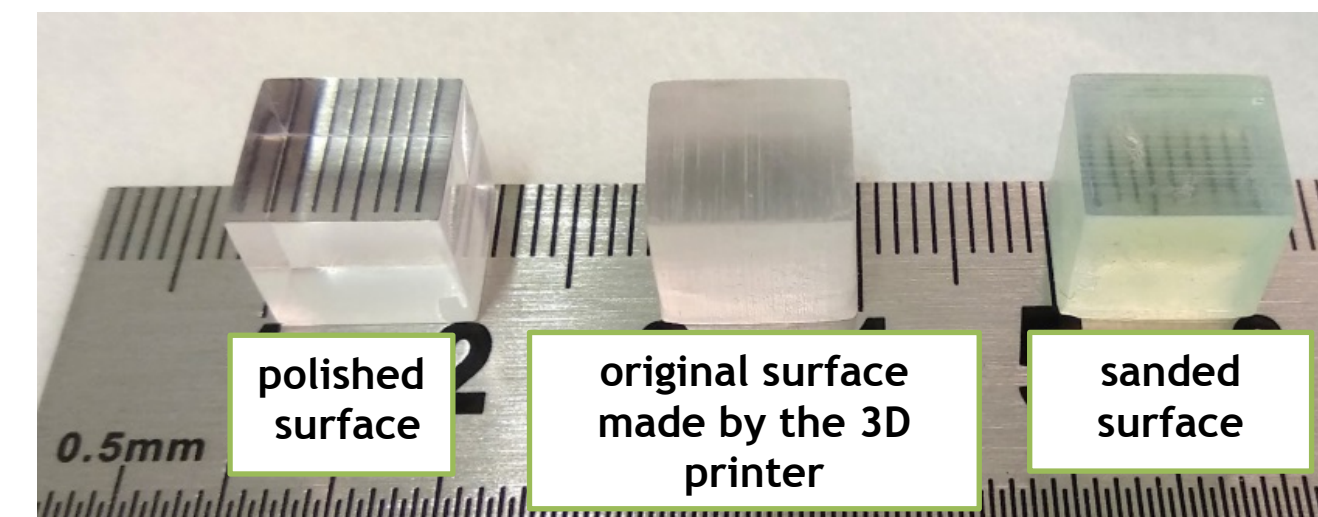
Light detectors and electronics



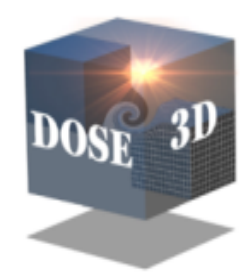
Cell casted and 3D-printed scintillators 1x1x1cm² cubes



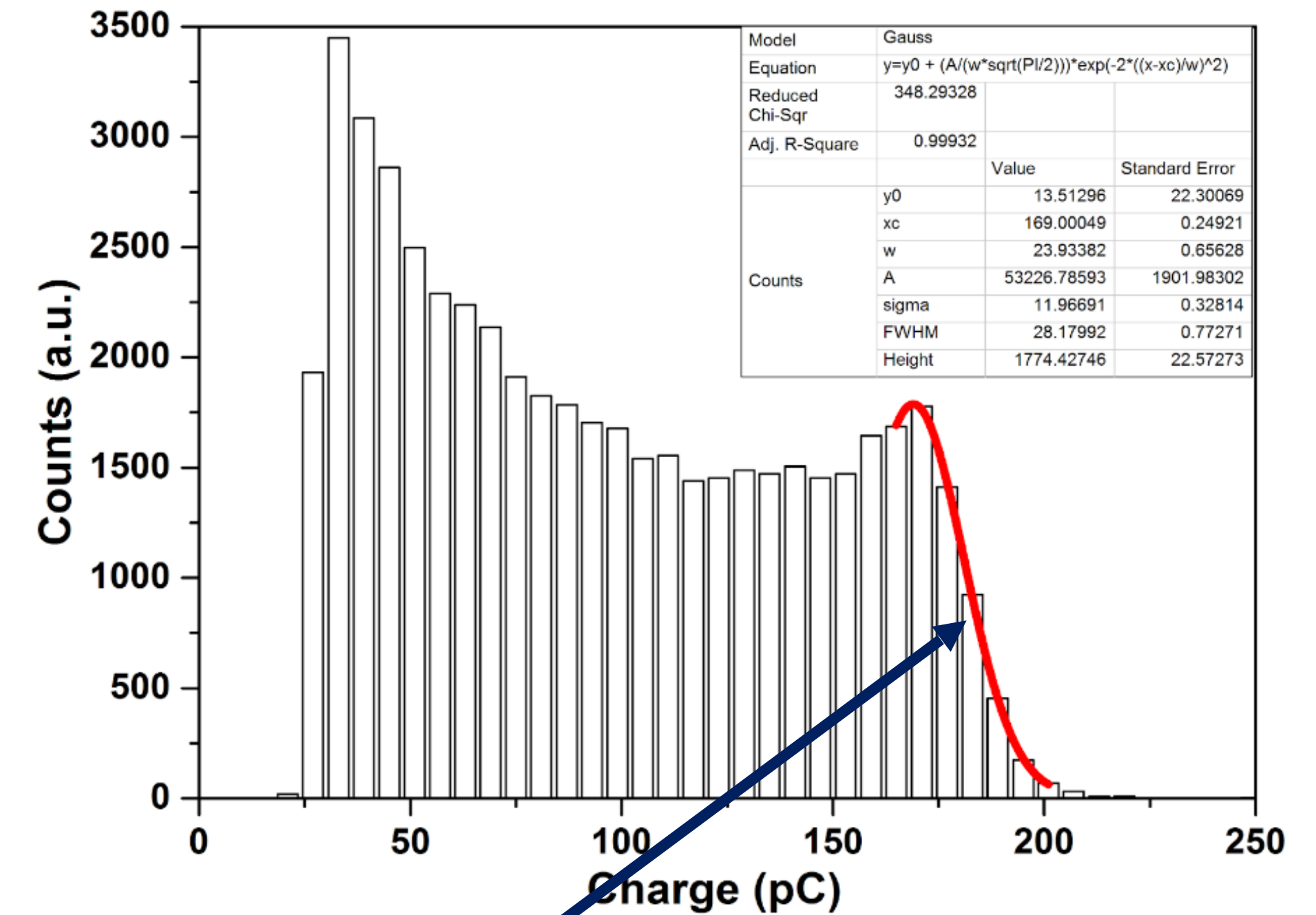
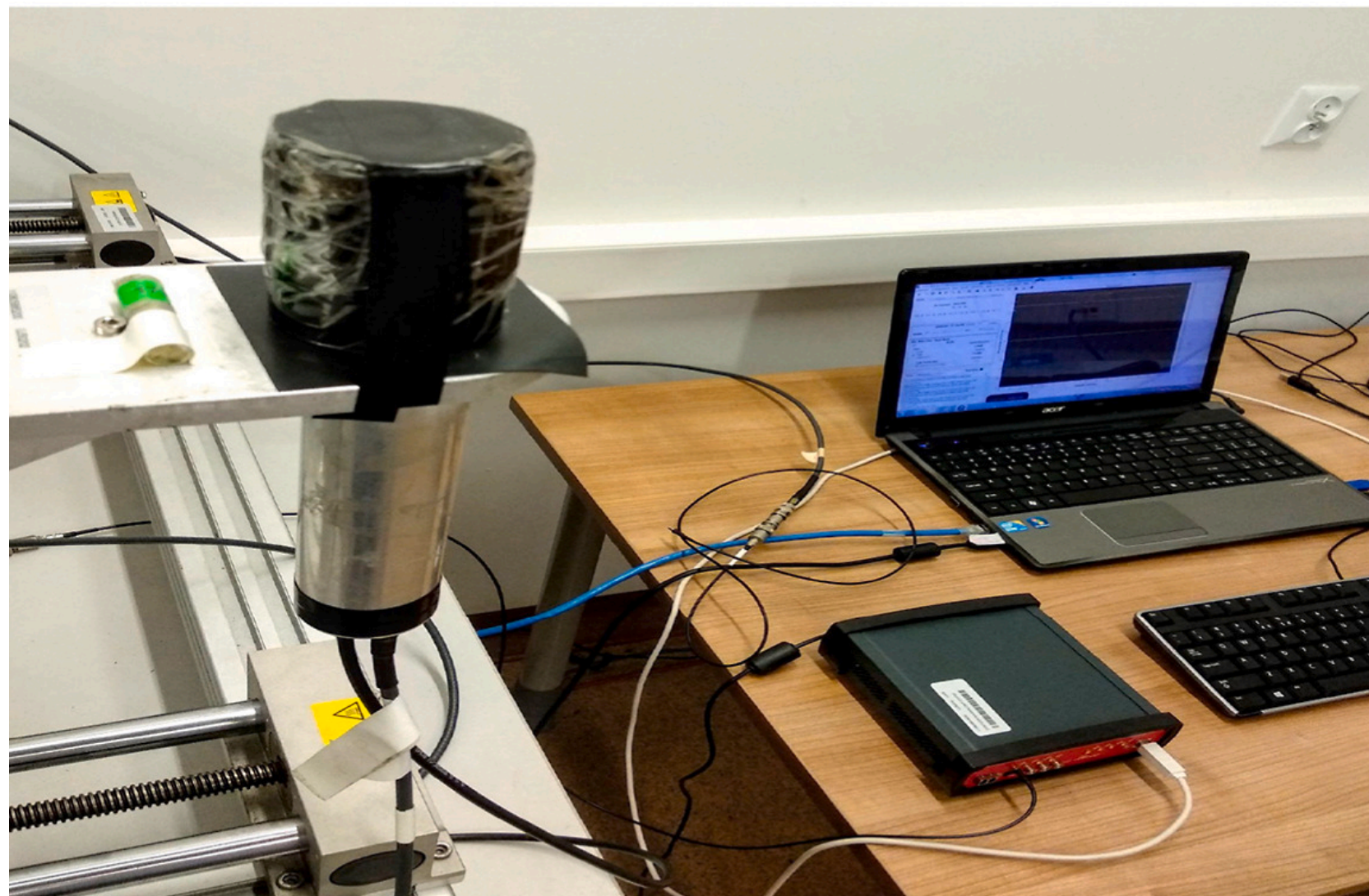
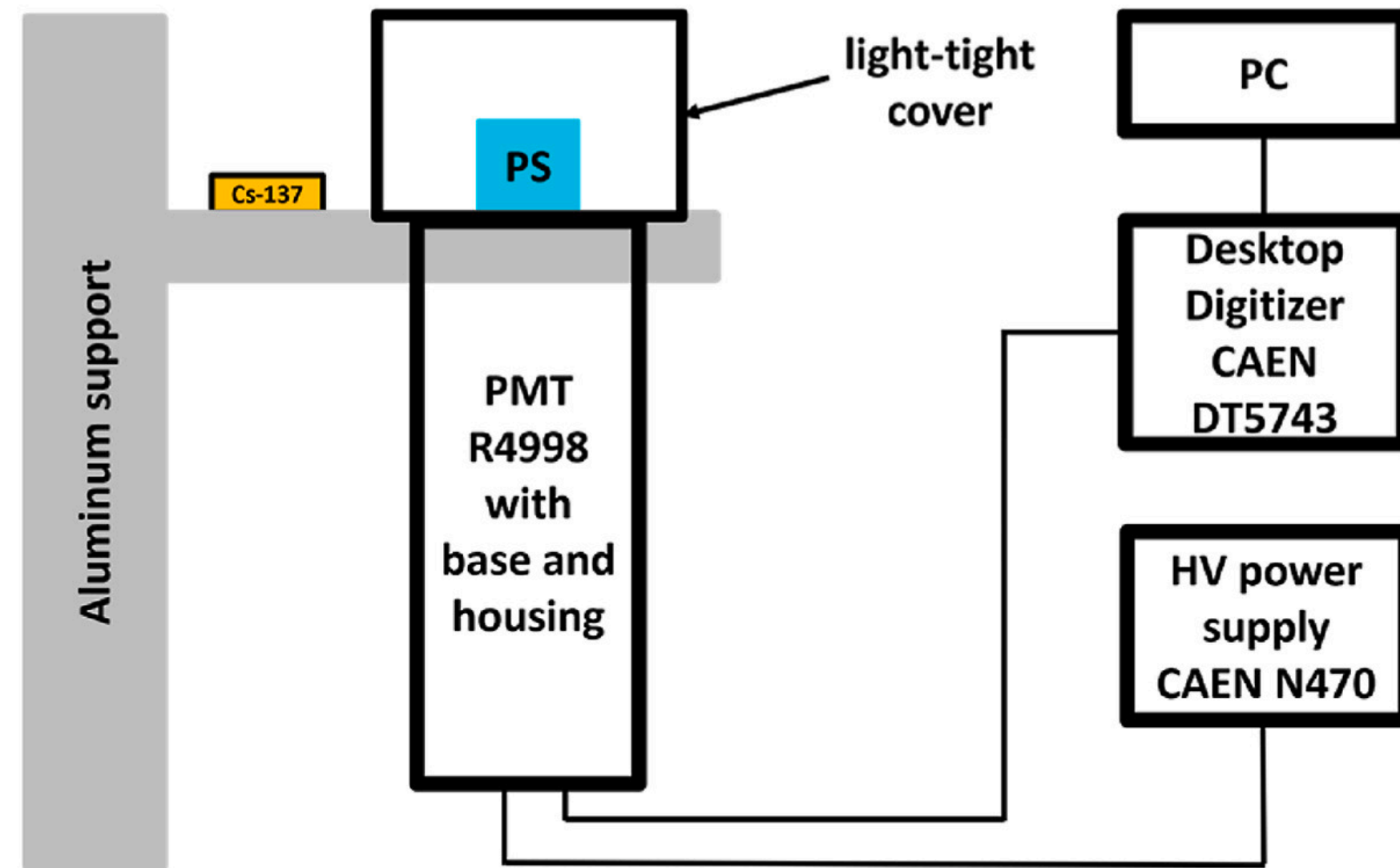
RAYMETRICS
AI-ASSISTED RADIATION INSTRUMENTS
<https://raymetrics.co.kr/>



<https://www.pib-nio.pl/zapraszamy-na-wirtualny-spacer-po-zakladzie-radioterapii-coi/>



Experimental setup for scintillator testing



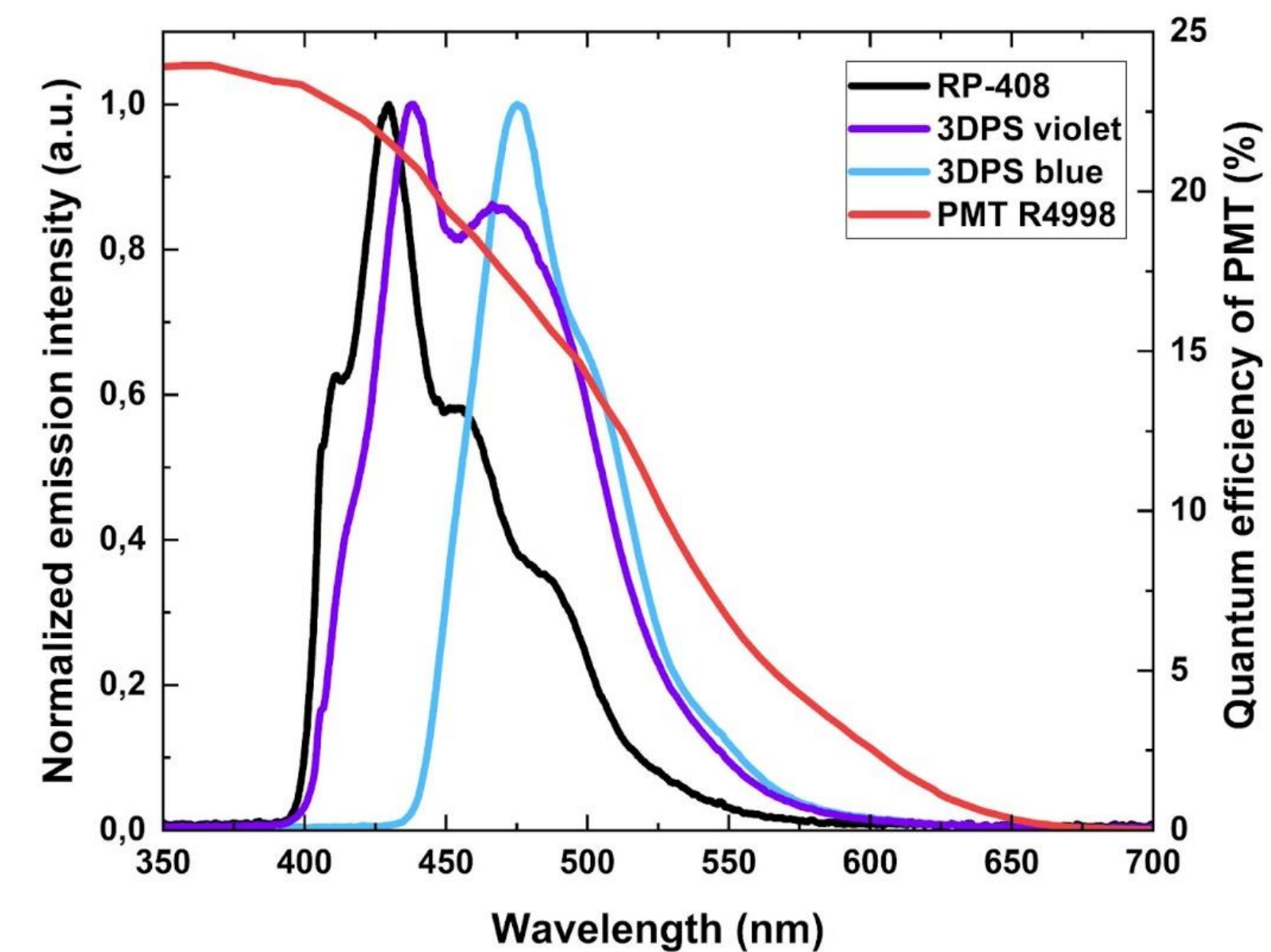
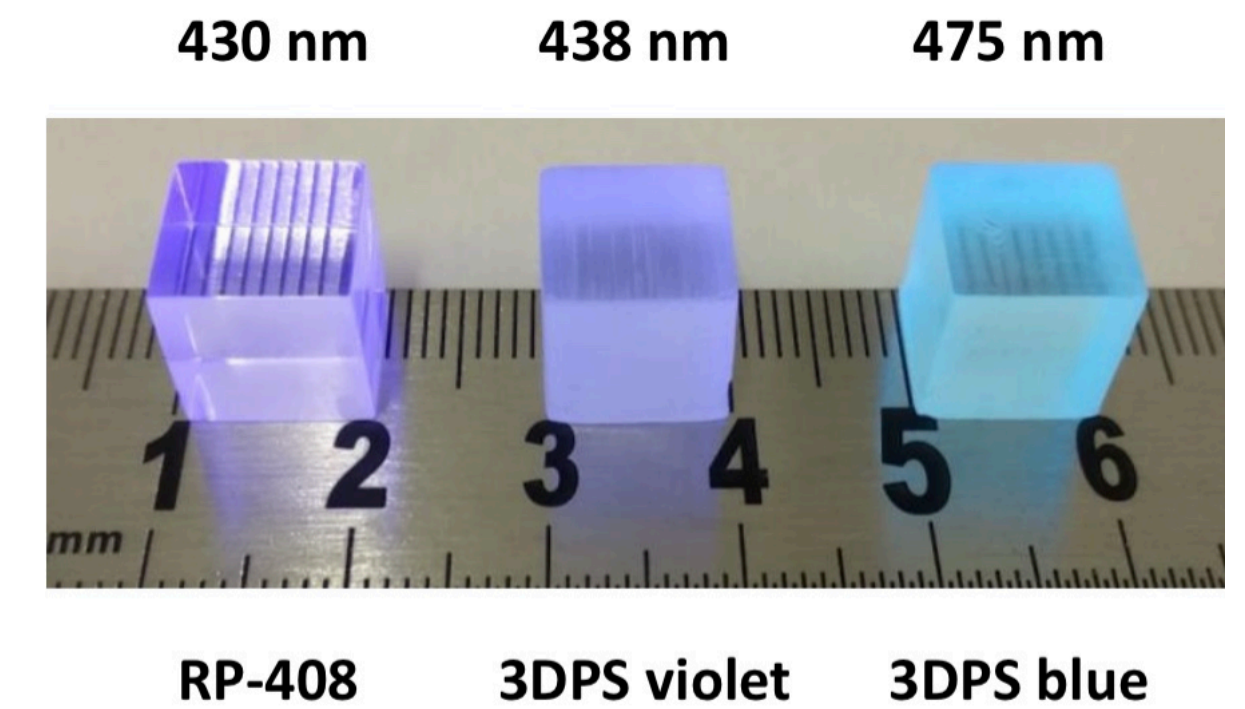
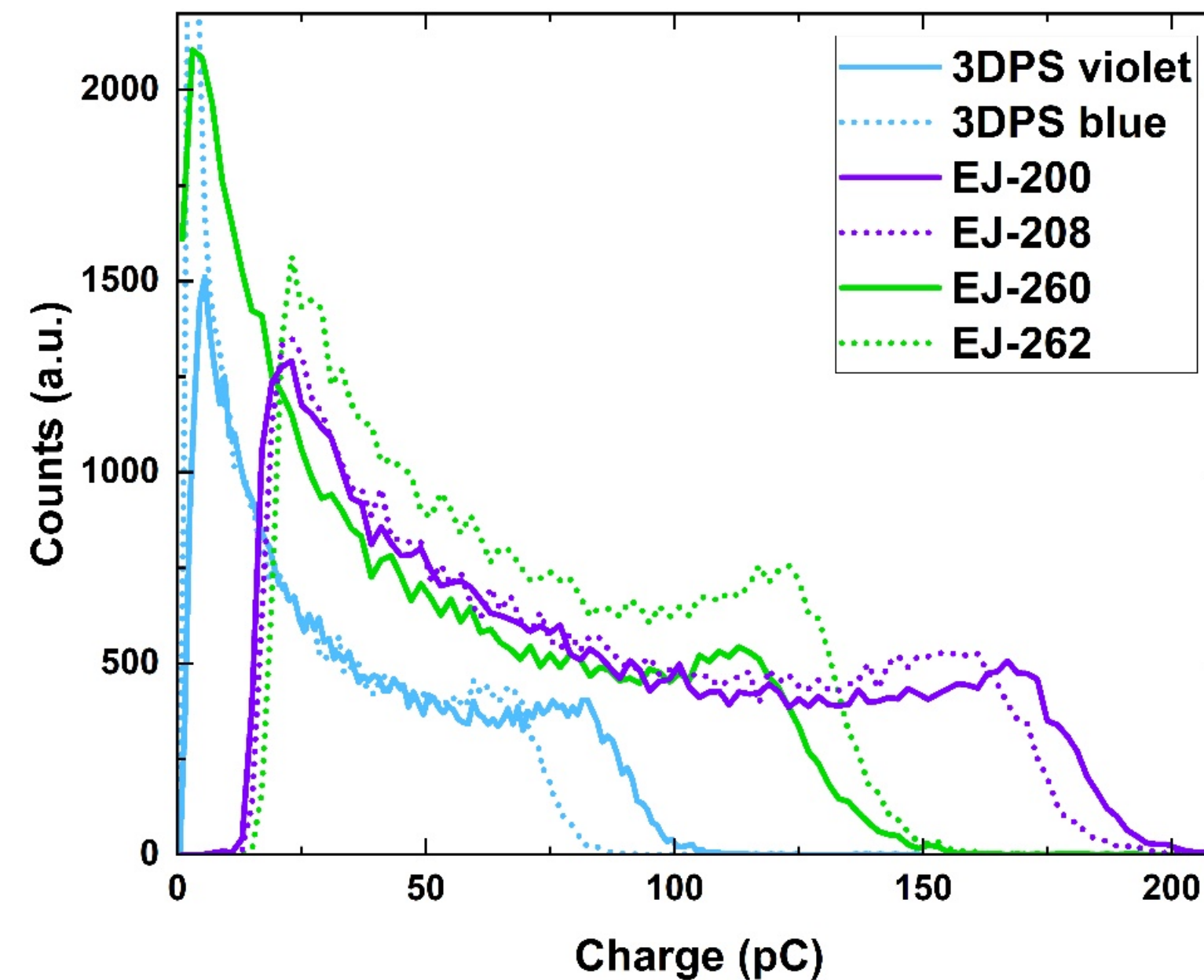
$$LO = \frac{CE_{sam}}{CE_{ref}} \times 10000 \text{ photons/MeV}$$

CE_{sam} – middle of Compton edge for sample

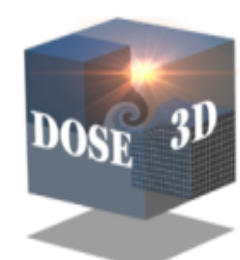
CE_{ref} – middle of Compton edge for reference scintillator RP-408

Light output measurements

Sample	Wavelength of maximum emission (nm)	Light output (photons/MeV)
3D-printed plastic scintillators		
3DPS violet	438	$4\,931 \pm 15$
3DPS blue	475	$4\,050 \pm 24$
Cell casted plastic scintillators		
EJ-200	426	$10\,000 \pm 73$
EJ-208	436	$9\,426 \pm 62$
EJ-262	489	$7\,322 \pm 28$
EJ-260	494	$6\,975 \pm 19$



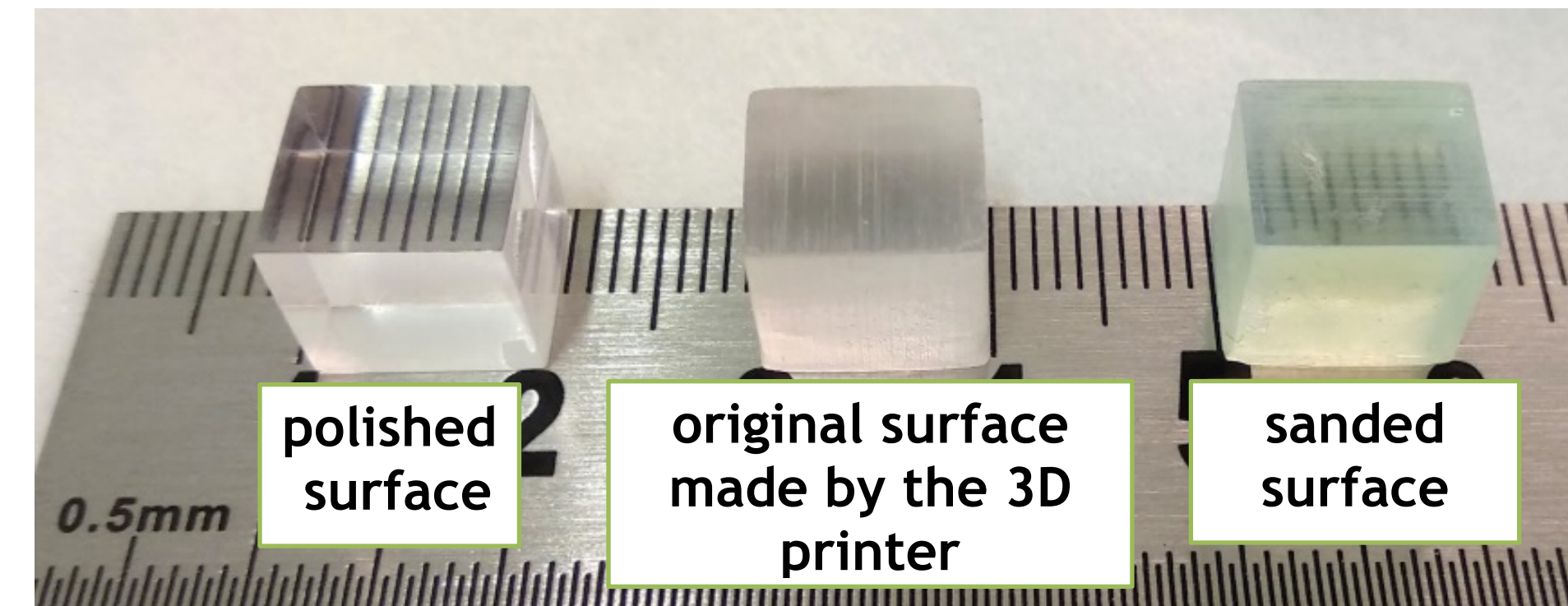
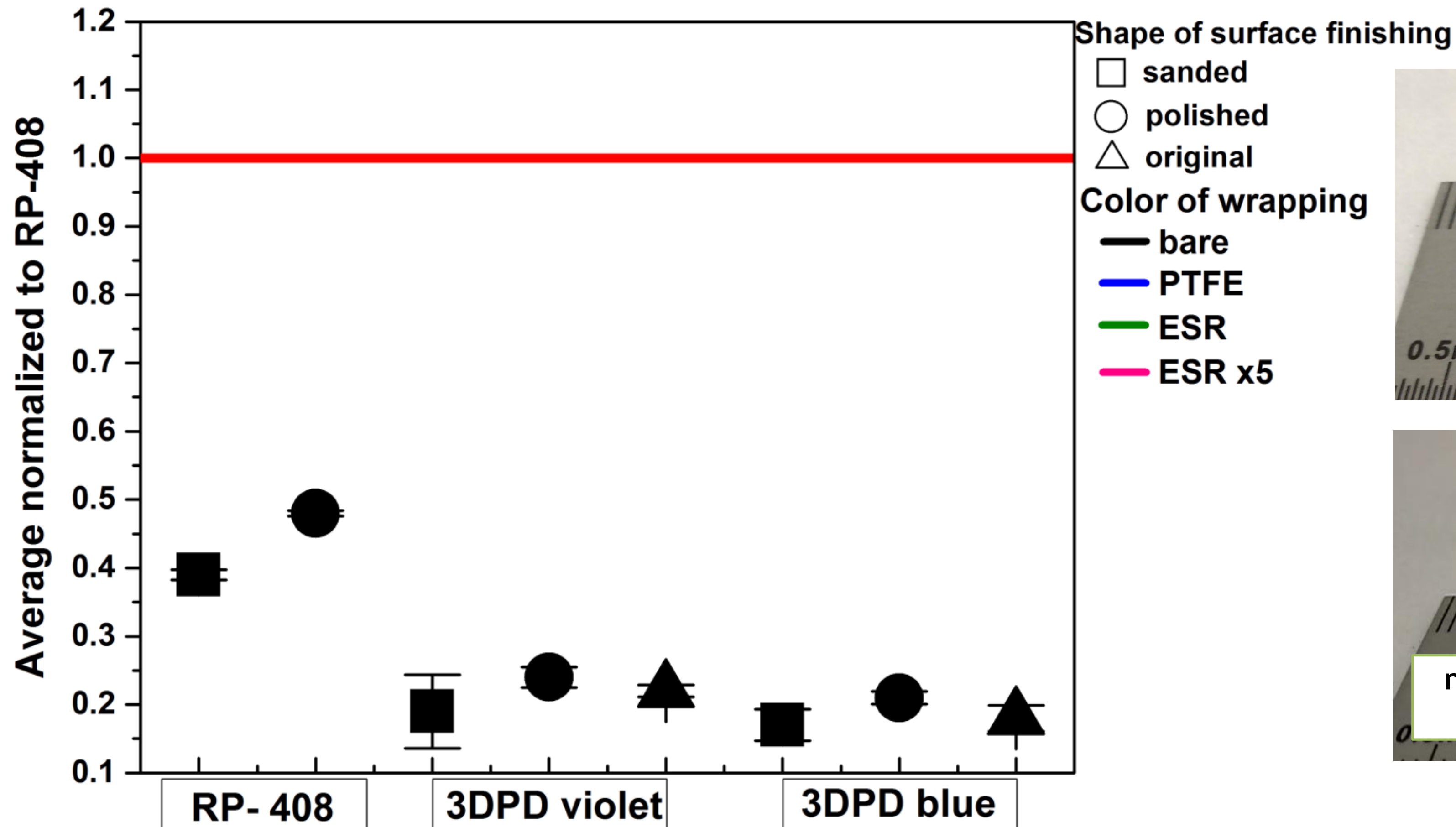
Ł. Kapton et al., Investigation of the light output of 3D-printed plastic scintillators for dosimetry applications, *Rad. Meas.* (2022) 158:106864



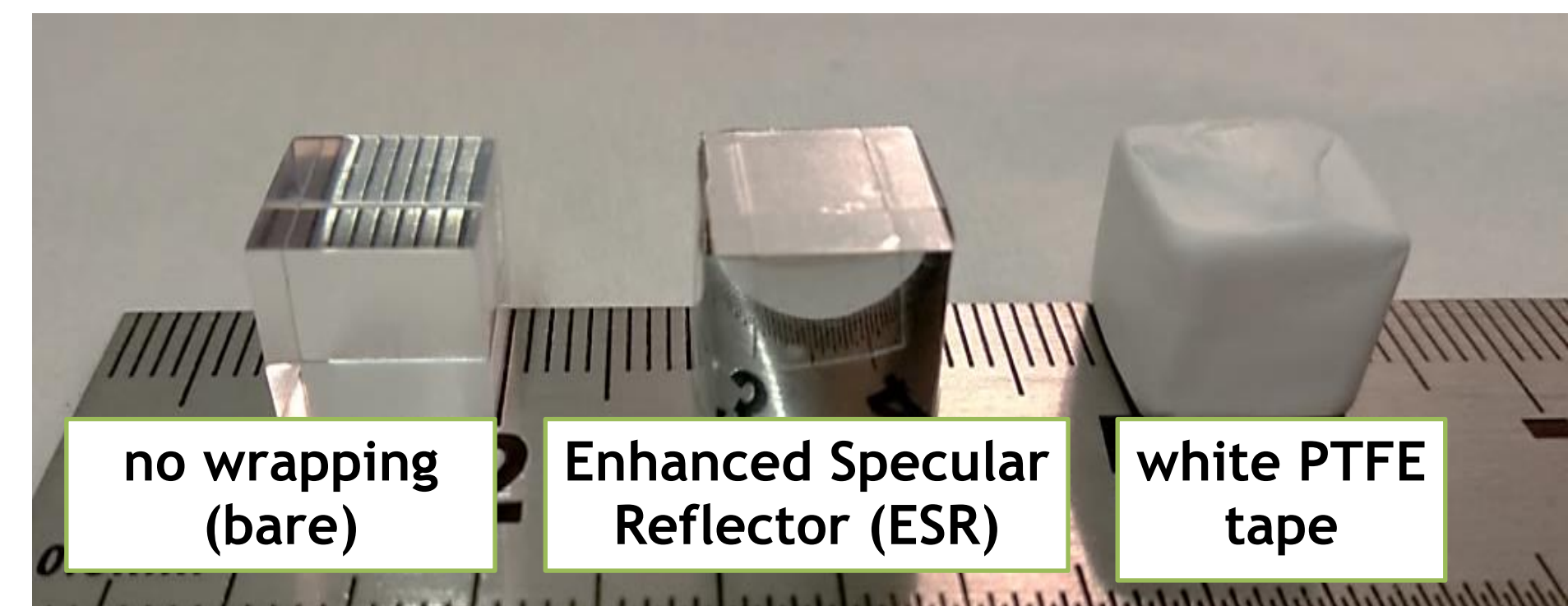
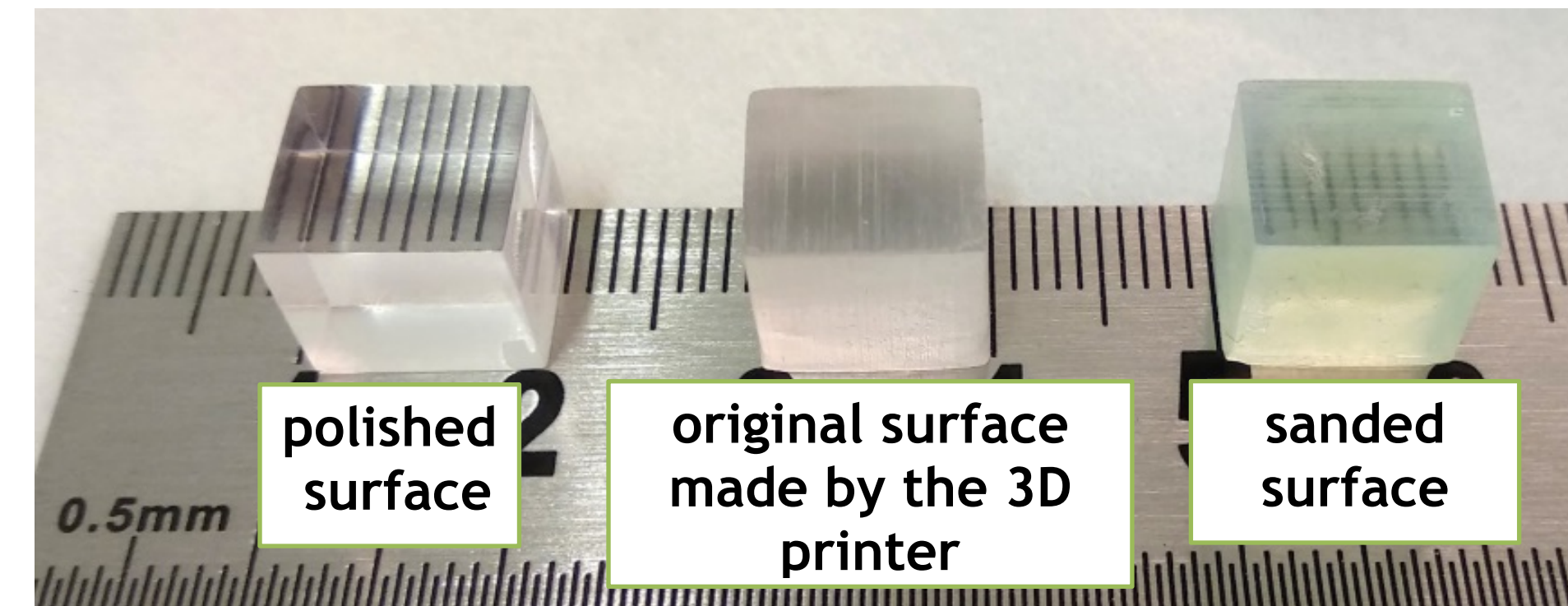
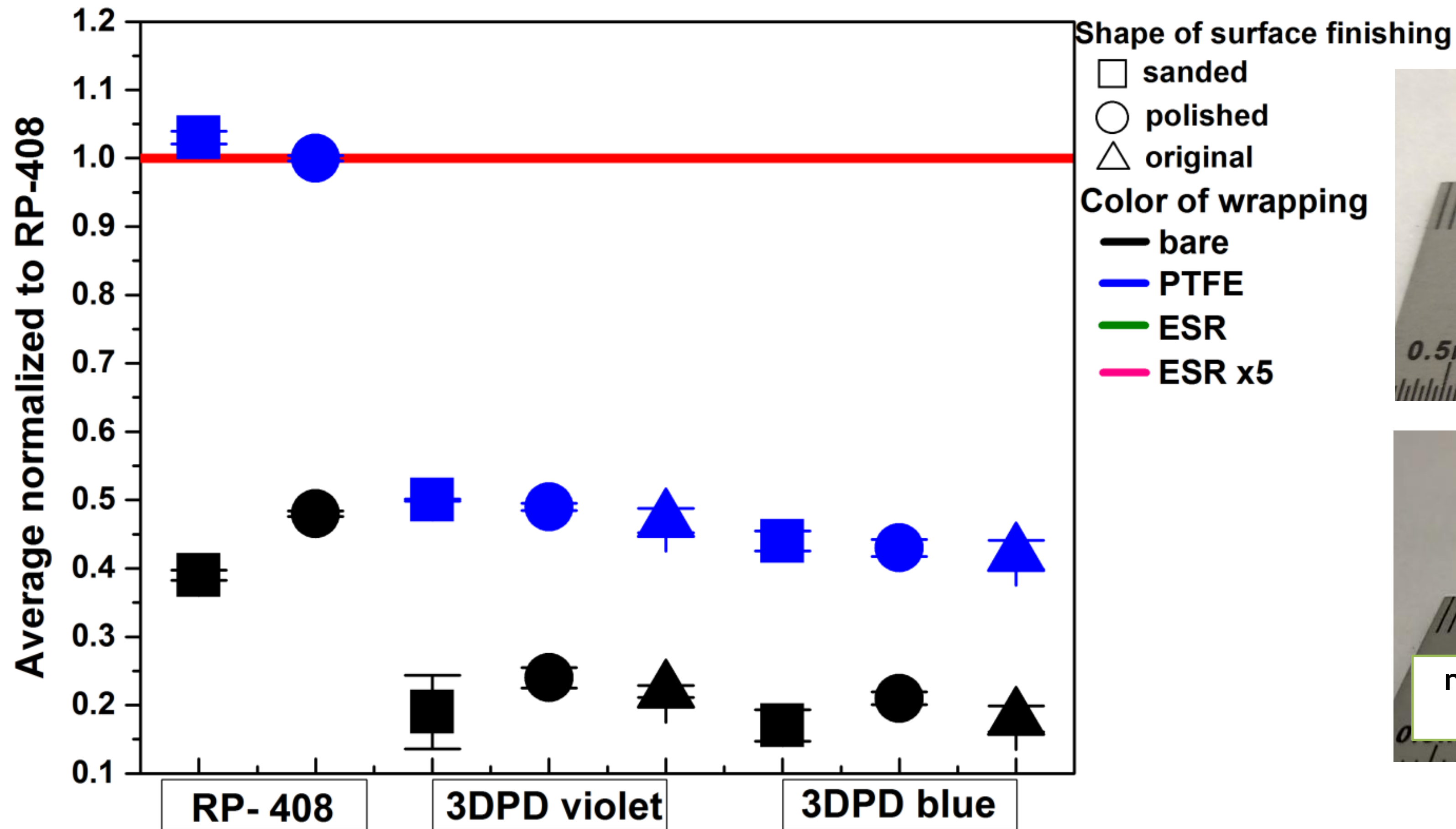
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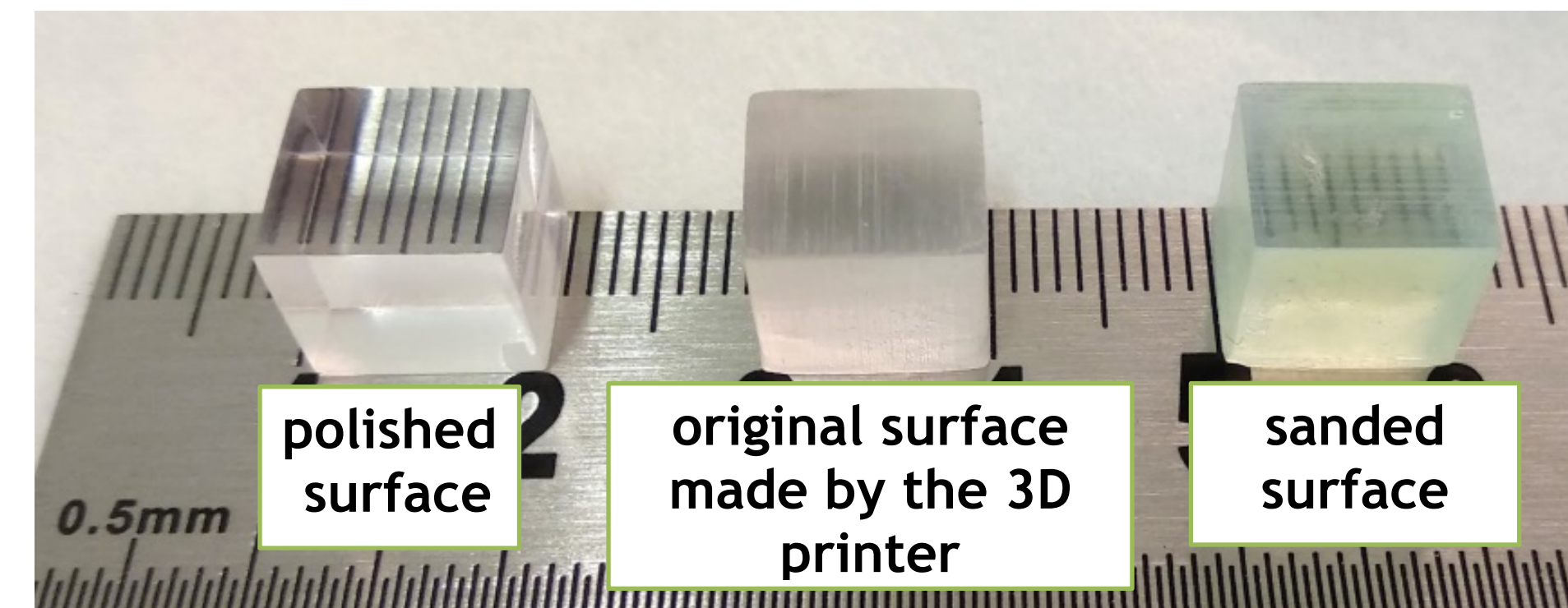
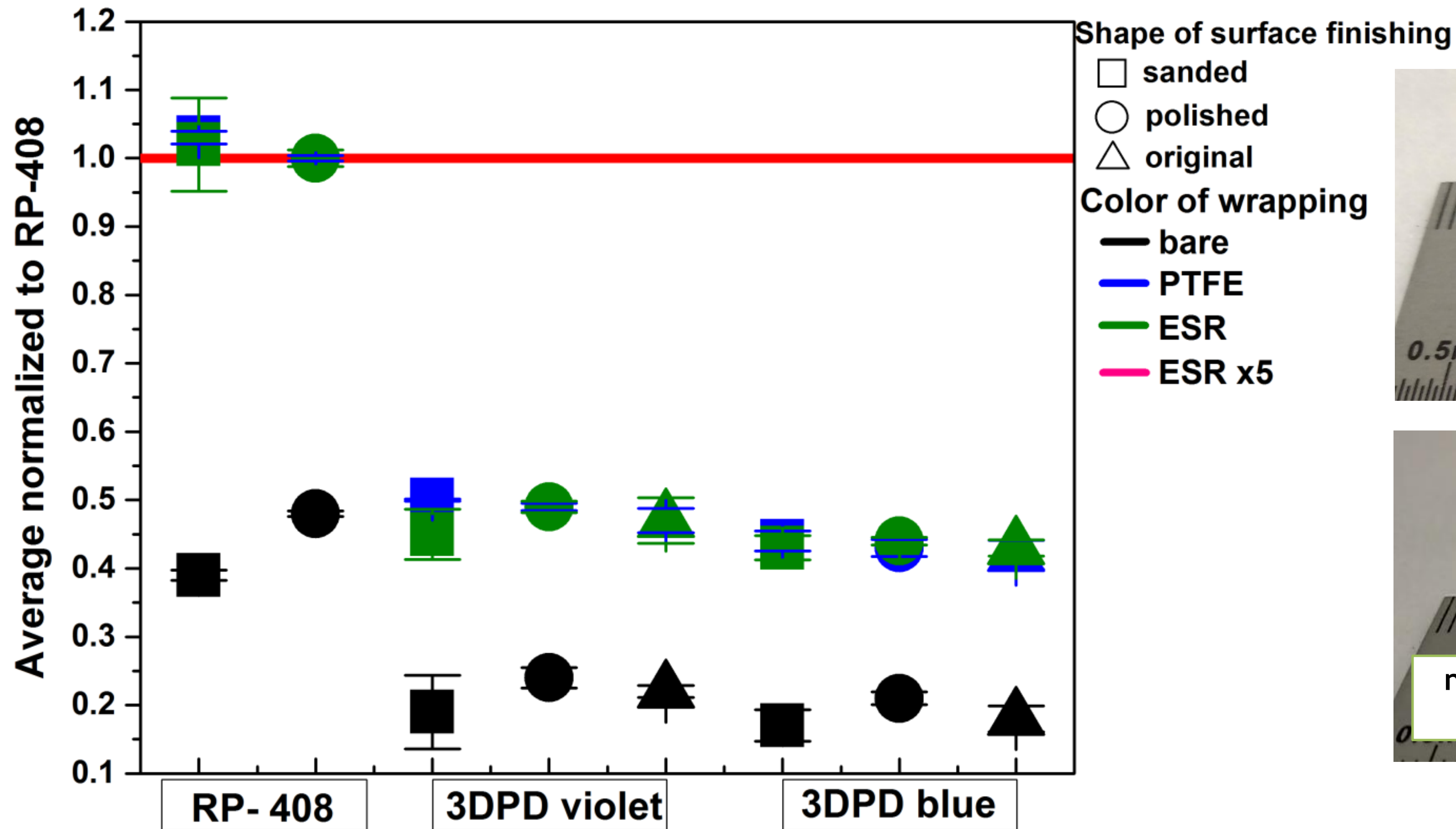
Scintillator surface finishing & wrapping



Scintillator surface finishing & wrapping

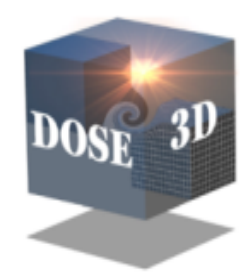
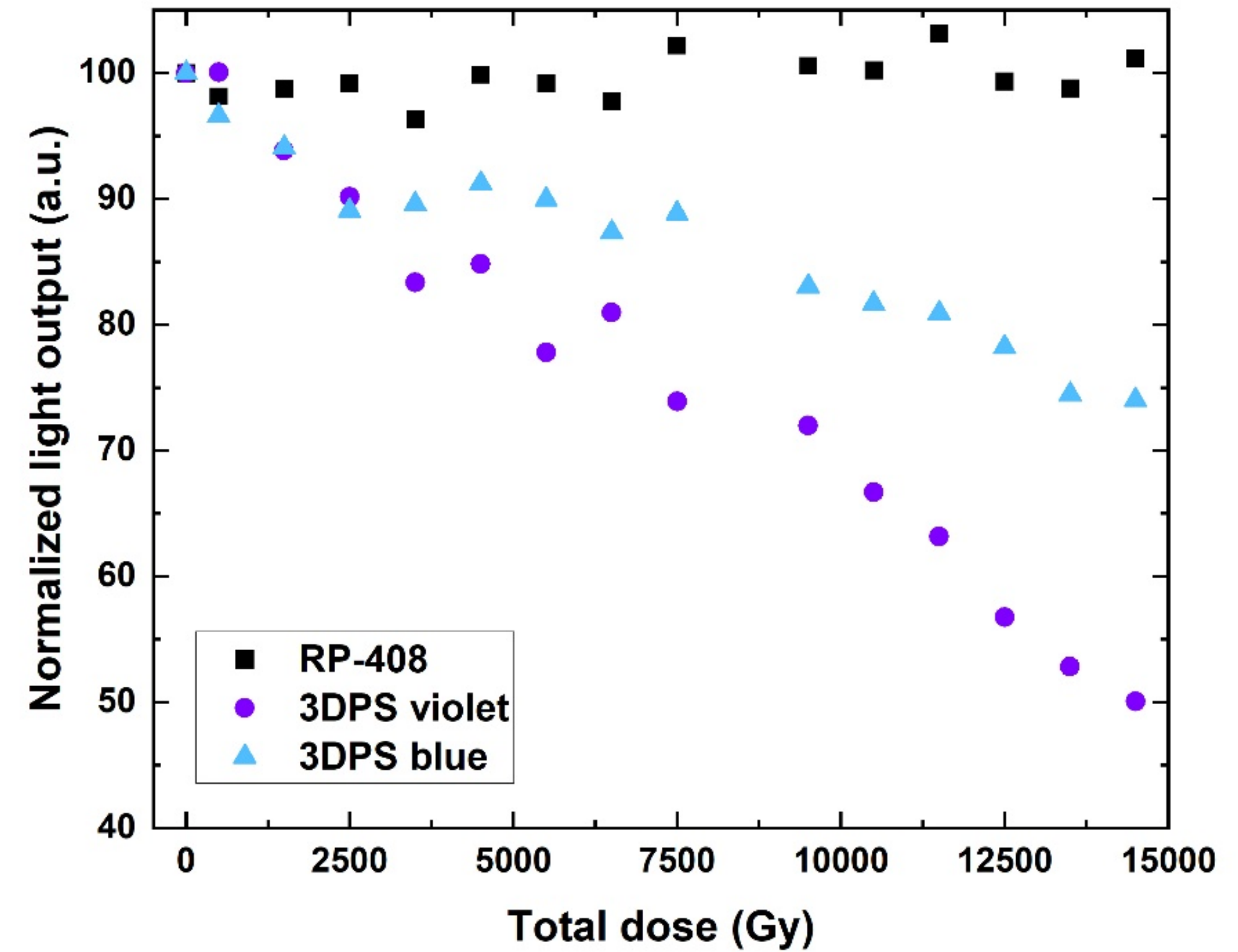
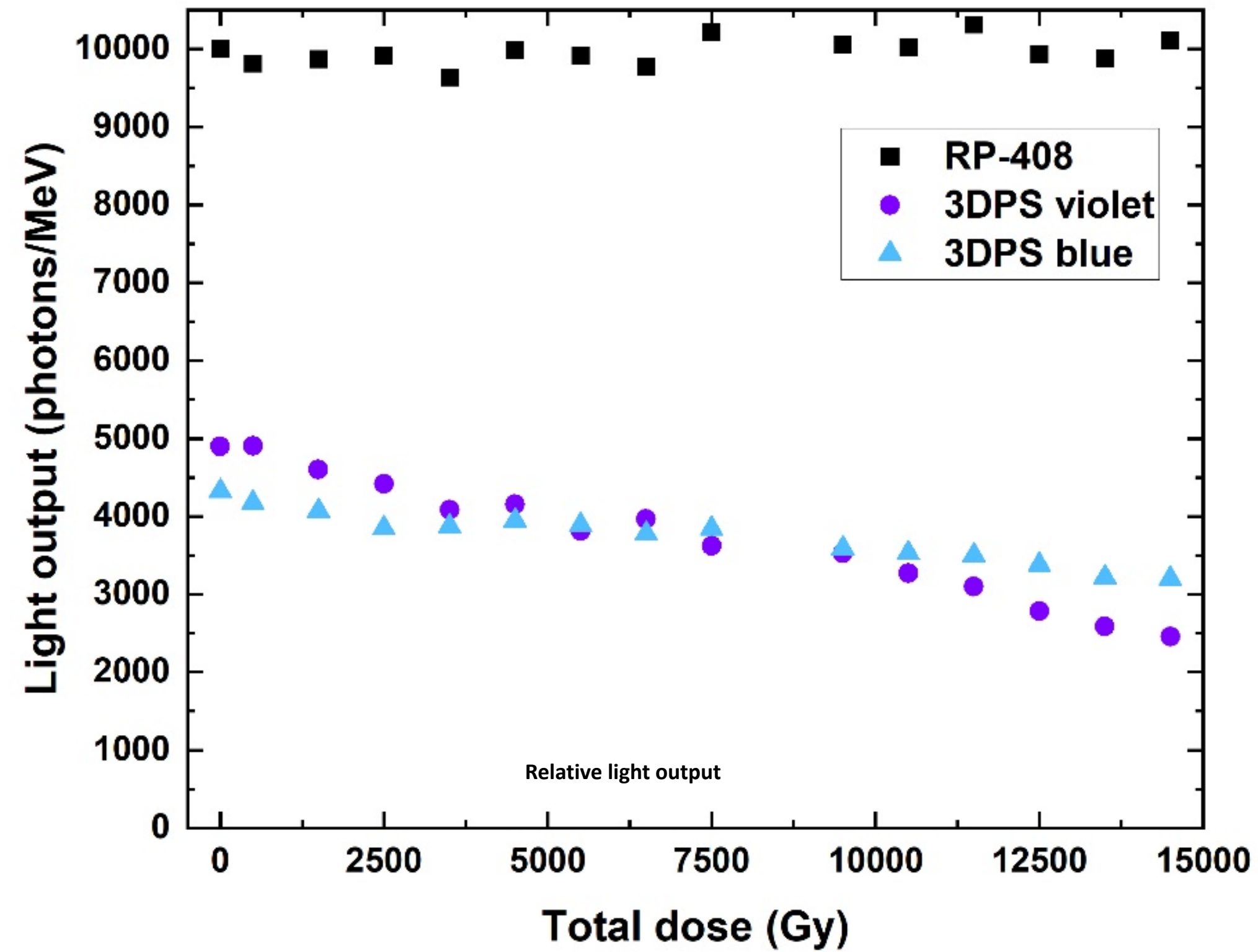


Scintillator surface finishing & wrapping



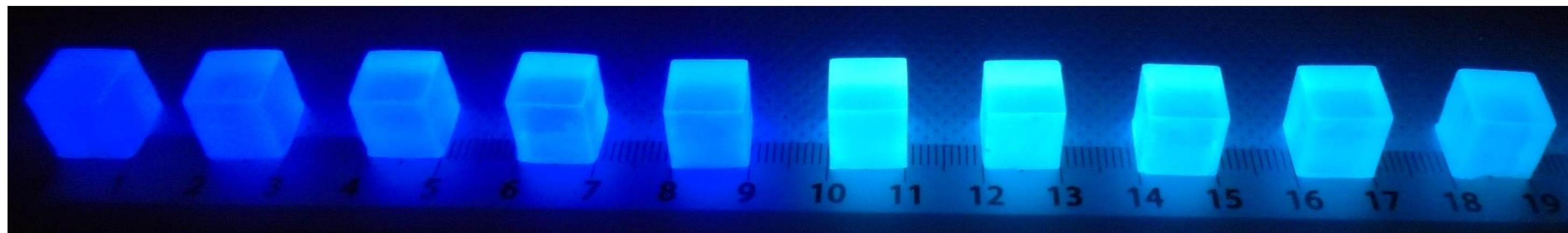
Radiation hardness

- Irradiations:
- Varian Clinac
 - 6 MeV X-Rays
 - 1000 Gy intervals



Summary

- Dose-3D project aims at development of an active 3D detector for patient QA
 - >1000 3D-printed scintillator cubes/channels (each cube <math><1\text{cm}^3</math>)
 - 3D-printed scintillators are characterized by
 - 50% reduced light output
 - Increased radiation hardness
- Experiments with photons are ongoing
- Experiments with protons are planned to test quenching



Dose-3D research teams

- Polish National Centre for Research and Development through grant LIDER/17/0046/L-7/15/NCBR/2016.
- The research group from the Department of Nuclear Engineering, Hanyang University in South Korea for manufacturing 3D-printed scintillator cubes



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Z. Tabor



B. Rachwał



T. Szumlak



B. Mindur



T. Fiutowski



S. Koperny



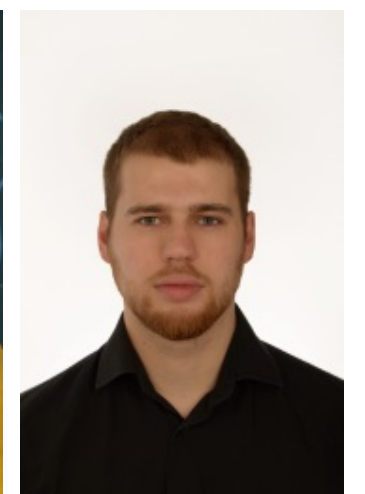
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D. Kulig



Ł. Kapton



G. Moskal



M. Baran



K. Jeleń



W. Górską

and

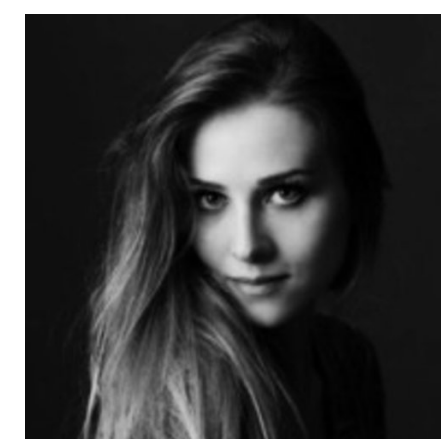
J. Hajduga



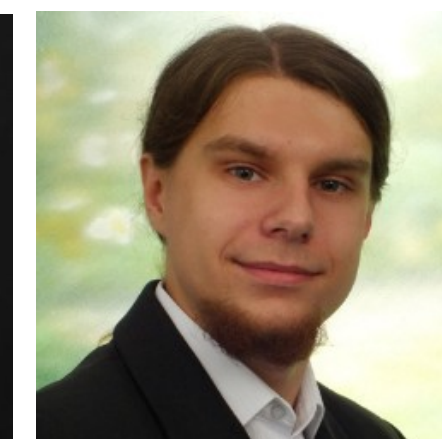
P. Wiącek



P. Jurgielewicz

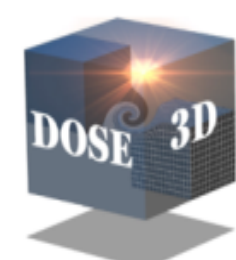


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