Editorial for the Radiation Measurements/Physics Open Virtual Special Issue Radiation dosimetry
current challenges and future directions

McKeever, Stephen W.S.; Bailiff, Ian; Bos, Adrie A.J.; Yukihara, Eduardo G.

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Editorial for the Radiation Measurements/Physics Open Virtual Special Issue *Radiation dosimetry: current challenges and future directions*

This Virtual Special Issue (VSI) on *Radiation dosimetry: current challenges and future directions* is a collaboration between the journals *Radiation Measurements* and *Physics Open*. The goal is to review the status of radiation dosimetry and provide guidance toward future research and applications. The editors hope that by publishing jointly between the two journals we will provide authors and researchers alike with a greater range of publication choices, through print and open access options.

In many respects, radiation dosimetry can be considered, at least from the outside, as a stable and settled field. Over the years methods of radiation detection and measurement have been devised that have been outstandingly successful at providing critical quantitative data for the purposes of radiation protection of individuals in many areas of radiation protection. However, as knowledge of the microscopic interaction of radiation with matter (biological matter in particular) has increased, so the need to both understand and measure the microscopic deposition of dose in greater detail has increased correspondingly. For example, the medical treatment of patients with more precise radiation probes and with different varieties of energetic charged particles has presented challenges in dosimetry which have not yet been fully met for the optimum treatment of patients. The physics of microdosimetry continues to present significant challenges.

Methods for measuring and imaging radiation dose deposition at the microscale are also required, especially for ion beams, leading to the quest for not just new methods but also new materials, including new luminescence materials and luminescence methods. New materials and methods are also required in several other radiation dosimetry applications. Among these is included the very difficult challenge of neutron dosimetry. Dosimeters in general rely upon ionization effects to detect and measure the absorbed radiation dose, and this presents an obvious immediate difficulty with the dosimetry of neutrons.

Most dosimetry is “retrospective” in the sense that the dose is evaluated after the radiation event has occurred. The dosimeters used in these situations are “passive” and are analyzed post-irradiation, but there are more and more applications in which real-time dosimetry is needed using “active” dosimeters. Here, the dose is indicated immediately as the radiation is being absorbed. The development of these devices, and how they can meet the requirements of the accreditation agencies in comparison with established passive dosimeters, is a modern application topic of high relevance. Another retrospective dosimetry topic of grave concern in modern times is how to measure absorbed dose to large numbers of the general population when conventional dosimeters were not prospectively in place before the irradiation event occurred. Examples include nuclear power plant accidents and the release of radioactive contamination to which large numbers of the general public may be exposed. A large current effort is underway to address how successful, or not, common-place materials may be in acting as surrogate passive dosimeters in these situations.

The eight papers in this VSI cover the range of dosimetry topics noted above. They are reflective of topics currently at the forefront of interest in both research and application in these varied fields of dosimetry. Agosteo (2022) addresses the challenges of devising microdosimeters to measure radiation quality in hadron fields at the cellular level during proton and carbon ion therapy. Vedelago et al. (2022) review the dosimetry of proton and light ion beams in ion therapy and discuss particularly the issues relating to the effects of magnetic fields on the detectors used.

Dosimetry methods which may not be so affected by magnetic fields include traditional methods of luminescence dosimetry including thermoluminesence (TL), optically stimulated luminescence (OSL) and radiophotoluminescence (RPL). Two papers address new materials for applications of TL and OSL (Yukihara et al., 2022) and of RPL (Yanagida et al., 2022) including highly ionizing, charged particle and neutron beam irradiation. Yukihara et al. call for a systematic, guided approach for the development of new TL and OSL materials using past experience to guide future efforts, while Yanagida et al. outline a potential exciting future for RPL by highlighting new RPL materials, as yet unexploited in dosimetry.

The ever-challenging issue of neutron dosimetry is discussed in two papers, by Bolzonella et al. (2022) and by Gómez-Ros et al. (2023). The former discuss the fundamentals and current best practices while the latter illustrate new directions using a wide variety of dosimetry techniques.

The state of the art in passive, active and hybrid personal dosimetry is reviewed by Vanhavere and Van Hoey (2022), who also examine the potential of computational dosimetry, artificial intelligence and machine learning to address some of the dosimetry challenges in the future.

Finally, the state of the art in retrospective dosimetry for radiation emergencies, including the challenges of dosimetry of a large population of potentially exposed people, are addressed in a thoughtful discussion by Fattibene et al. (2023). The paper provides an excellent guide to future research on this very difficult topic.

Although the list of topics covered in this VSI is not exhaustive, in the continually progressing field of radiation dosimetry, the editors hope that the papers included will provide researchers across the field with much useful information and will act as an illuminating guide to at least some of the exciting ways forward for future research in this forever challenging field.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Stephen W.S. McKeever[a], Ian Bailiff[b], Adrie A.J. Bos[c], Eduardo G. Yukihara[d,*]

[a] *Radiation Dosimetry Group, Department of Physics, Oklahoma State University, Stillwater, OK, USA*

[b] *Luminescence Research Laboratory, Department of Archaeology, Durham University, Durham, UK*

[c] *Department of Radiation and Technology, Faculty of Applied Sciences, Delft University of Technology, Delft, Netherlands*

[d] *Department of Radiation Safety and Security, Paul Scherrer Institute, Villigen, Switzerland*

[*] Corresponding author.
E-mail address: eduardo.yukihara@psi.ch (E.G. Yukihara).