POLITECNICO DI MILANO

PhD in SCIENZE E TECNOLOGIE ENERGETICHE E NUCLEARI / ENERGY AND NUCLEAR SCIENCE AND TECHNOLOGY - 41st cycle

THEMATIC Research Field: ADVANCEMENT OF COMPUTATIONAL DOSIMETRY FOR COMPLEX RADIATION FIELDS

Monthly net income of PhDscholarship (max 36 months)
1900.0 In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	Personal dosimetry is a fundamental component of radiation protection for radiation workers. Currently, most radiation workers are required to wear one or multiple personal dosimeters to monitor their radiation exposure. However, personal dosimeters have several limitations: • They measure only operational quantities ($H_p(10)$, $H_p(3)$, or $H_p(0.07)$) at the dosimeter's location, rather than the protection quantities effective dose or organ equivalent dose • Workers may forget to wear their dosimeters or wear them incorrectly • Dosimeters provide only point measurements and do not account for variations in radiation exposure across the body or differences in individual body characteristics. • Measurement uncertainties can be significant with passive and active dosimeters. A factor of 2 is accepted for low doses, but for complex fields involving for instance neutrons, high energies or pulsed radiation the uncertainty can be much larger. For neutrons for example, there is simply no good dosimeter available. All existing neutron dosimeters need to work with local energy correction factors. Complex radiation fields with neutrons, high energies and

	pulsed radiation would greatly benefit from the introduction of online dosimetry, because especially in such radiation fields personal dosimeters don't perform well. However, despite substantial previous research and technological developments, online dosimetry is not yet ready for replacing personal dosimeters for official dosimetry in such fields. The research hypothesis is that it is possible in this project to move towards a technology that can replace and improve the current official legal dosimetry system. The key technological developments that are needed were identified and will be tackled one by one. Within this project, an approach using predetermined dose rate maps based on measurements will be used. Such an approach is feasible to develop within the timeframe of the project, will be significantly more precise than the current dosimetry based on personal dosimeters, can be easily setup at different workplaces and will limit the required computational power. Furthermore, the project involves SCK CEN with strong expertise in online dosimetry, Polimi with strong expertise in dosimetry in complex radiation fields and the industrial partner ELSE Nuclear to guarantee obtaining the required technology readiness level. In this way the project will result in the development of a fully functional and user-friendly online dosimetry tool that can be accepted as official legal dosimetry system with a better precision than the current dosimetry systems.
Methods and techniques that will be developed and used to carry out the research	Online dosimetry is an emerging technique that addresses these challenges by integrating camera-based worker tracking, radiation field characterization, workplace geometry, and Monte Carlo radiation transport simulations or simplified dose calculations. This approach has the potential to overcome the limitations of personal dosimeters. The feasibility of online dosimetry as an alternative to conventional dosimeters was demonstrated in the PODIUM HORIZON 2020 project, particularly for neutron workplace fields and interventional radiology. Further research at SCK CEN has elaborated and extended the technology for application in neutron workplace fields, interventional radiology, nuclear decommissioning, nuclear medicine, and space radiation

	environments. Especially for complex radiation fields (like in nuclear reactors, high energy facilities, high energy laser facilities, fusion facilities, …) online dosimetry would have undeniable advantages compared to physical dosimetry. However, there is still further research and development needed before online dosimetry can be used as an official dosimetry method.
Educational objectives	The goal of this project is to advance online dosimetry for complex radiation fields involving neutrons, high-energies, and pulsed radiation from Technology Readiness Level (TRL) 5 to TRL 8 and prepare the technology for use as official dosimetry system. The following objectives will be tackled in the PhD project: • Improve the dose rate mapping by combining spectroscopic and directional measurements with state-of-the-art radiation monitors in an innovative way to obtain dose rate maps in terms of $H_p(10)$, effective dose or organ equivalent doses. • Enhance staff tracking and identification by development of novel algorithms to make sure that the calculated doses can be attributed undoubtedly to the correct person, and that appropriate interpolation is done for moments when the tracking is failing. • Implement robust quality control measures and linking with fixed environmental radiation monitors to guarantee system reliability and traceability of the calculated doses to primary standards. • Integrate all developed technology in a fully functional user-friendly system, taking into account customer feedback. The Educational objective is to develope interdiscilinary skills merging motion recognition thecniques with Monte Carlo simulations and dose assessement procedures.
Job opportunities	The student will have the opportunity to collaborate with academy, research centers and private industry. That opens job opportunities in the three areas in the field of advanced radiation dosimetry techniques

Composition of the research group	0 Full Professors 1 Associated Professors 0 Assistant Professors 0 PhD Students
Name of the research directors	Marco Caresana

Contacts
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Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents	--

Scholarship Increase for a period abroad	
Amount monthly	442.0 €
By number of months	18

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
The student will spend at least 18 non consecutive months at SCK-CEN in the frame of the Project ACCREDITED (ADVANCEMENT OF COMPUTATIONAL DOSIMETRY FOR COMPLEX RADIATION FIELDS) co-funded by the european project PIANOFORTE The student will be involved in the EURADOS (www.eurados.org) platform, participating to the eurados initiatives (young researcher events, grant and awards opportunities, courses organized by the platform)