POLITECNICO DI MILANO

PhD in SCIENZE E TECNOLOGIE ENERGETICHE E NUCLEARI / ENERGY AND NUCLEAR SCIENCE AND TECHNOLOGY - 39th cycle

PNRR 118 PC Research Field: DEVELOPMENT OF LASER-DRIVEN RADIATION SOURCES AND THEIR APPLICATION TO THE PRESERVATION OF CULTURAL HERITAGE

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0 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	Radiation sources play an important role in the preservation of cultural heritage, particularly for non-destructive analysis of the internal structure and composition of artworks and artifacts. Different types of radiation, such as protons, neutrons, X-rays, and gamma rays, interact with matter in different ways and can provide complementary information about the composition, structure, and properties of materials. Typically, each type of radiation requires a dedicated source; conventional sources such as particle accelerators can be expensive, difficult to transport, and may have radioprotection issues. To address these limitations, there is a growing interest in developing flexible and compact sources that can produce multiple types of radiation, enabling researchers and conservators to tailor the radiation field to the specific needs of the material being studied. One potential solution is the use of laser-driven particle accelerators, which have the potential to produce a wide range of radiation types, including protons, neutrons, and gamma rays, in a compact and flexible manner. The aim of this research is to assess the potential of laser-driven radiation sources for the conservation of cultural heritage. Specific emphasis is put on the development of advanced acceleration schemes (e.g. exploiting double-layer targets), that can enhance the

	acceleration performance with reduced requirements on the laser driver.
Methods and techniques that will be developed and used to carry out the research	The research will chiefly exploit theoretical and numerical tools and foresees continuous interactions with the relevant experimental activities in the research group. Particle-In-Cell simulations (PIC) will be used to model the laser-target interaction and the subsequent acceleration of particles. This can help to optimize the laser parameters and the target design to achieve the desired radiation properties. Monte Carlo (MC) simulations will be used to model the propagation of the generated radiation through the object being analyzed and to predict the resulting image or spectrum. This can help to optimize the detector design and to evaluate the feasibility of the proposed system for specific applications. Also, MC simulations will be employed for the design of converters the enable the generation of secondary particles (e.g. neutrons and gamma) starting from primary accelerated particles (namely electrons and protons). A combination of PIC and MC simulations can provide a comprehensive analysis of the laser-driven radiation source for non-destructive analysis of cultural heritage objects. In addition, a collaboration with “Istituto di Scienze del Patrimonio Culturale” of CNR would be essential to ensure that the proposed systems meet the specific requirements of the field. The expertise of conservationists can also provide valuable input into the development of the simulation models and the interpretation of the results.
Educational objectives	Education of professionals figures for the world of research and high technology industry, with a special focus on advanced topics in physics, nuclear science and technology, and high performance computing. The PhD graduate will be able to manage interdisciplinary issues, perform and interpret complex experiments and produce

	new equipment.
Job opportunities	Private and public R&D. Highly qualified positions in a wide range of companies and research istitutions working on high-tech topics such as material characterization, ion beam analysis and implantation, preservation of cultural heritage The present research will be performed in collaboration with national and international partners.
Composition of the research group	3 Full Professors 4 Associated Professors 2 Assistant Professors 11 PhD Students
Name of the research directors	Matteo Passoni

Contacts
Matteo Passoni Phone: 02/23993267 Email matteo.passoni@polimi.it

Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad	
Amount monthly	700.0 €
By number of months	6

National Operational Program for Research and Innovation	
Company where the candidate will attend the stage (name and brief description)	Istituto di Scienze del Patrimonio Culturale - Consiglio Nazionale delle Ricerche
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	to be defined
By number of months abroad	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
Educational activities:

Financial aid per PhD student is available for purchase of study books and material, funding for participation in courses, summer schools, workshops and conferences, instrumentation and computer, etc. This amount is equal to 10% of the annual gross amount, for 3 years.

Teaching assistantship:
Availability of funding in recognition of supporting teaching activities by the PhD student. There are various forms of financial aid for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.

Computer availability: individual use.
Desk availability: individual use.