



PhD in INGEGNERIA DELL'INFORMAZIONE / INFORMATION TECHNOLOGY - 38th cycle

Research Area n. 2 - Electronics

PNRR_351_DOTT_RICERCA Research Field: **STUDY OF DETECTION SYSTEMS FOR DOSE MONITORING IN HADRONTHERAPY**

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

The aim of the research is to develop detection techniques to be applied to dose monitoring in Particle Therapy (PT), in particular with irradiation with Carbon ions, and in Boron Neutron Capture Therapy (BNCT), to be applied in radiotherapy centers, such as the CNAO in Pavia and other centers in the world. The studies will concern the simulation of the detection system with respect to clinical radiation fields and the experimental development of detectors and electronics for the measurement of gamma rays, with particular reference to the PGI (Prompt Gamma Imaging) technique, to be applied to PT, and to measurement of gamma rays emitted in the neutron capture from B-10, to be applied to the BNCT. This is a very topical issue, given that the precision in current particle radiotherapy techniques strictly depends on the monitoring of the dose actually deposited in the patient and to date these techniques are not yet used.

The activity will be organized according to the following objectives:

- Montecarlo (MC) simulation of beams inside the target and determination of PG profiles and secondary radiation emission.
- Design and simulation of the detection system
- Development of components, readout electronics and



	<p>realization of the detector</p> <ul style="list-style-type: none"> - Characterization of the detector in beam tests at PT facilities, also in clinical trials
<p>Methods and techniques that will be developed and used to carry out the research</p>	<p>In proposed research, first studies will be carried out using simulators (eg. Fluka) of representative models of clinical irradiation, in order to extract the spatial distribution and intensity of the gamma ray fluxes that will be used for the monitoring techniques (PGI and range from B-10 in the BNCT). These simulations will allow to define and optimize the detector configuration to be developed. Then the overall detector will be designed and simulated to cope with the specifications resulting from the previous simulation activities. The specific components and subsystems, e.g. scintillators, photodetectors, readout ASICs will be procured or developed specifically for the instruments. A specific data acquisition system (DAQ), including firmware and software, will be developed. Finally, the experimental prototypes optimized according to the results of previous studies will be tested in hadrotherapy centers, either in Italy, e.g. CNAO (Pavia) and in other centers abroad (e.g. IFJ-PAN in Krakow, Poland and medical centers in Japan).</p>
<p>Educational objectives</p>	<p>To learn: 1) techniques for dose monitoring in hadrontherapy 2) scientific research methods in development of gamma-ray detectors and related electronics 3) team working and scientific dissemination skills.</p>
<p>Job opportunities</p>	<p>Positions opportunities in: 1) medical imaging instrumentation Companies; 2) Radiotherapy Centers; 3) Universities and Research Centers.</p>
<p>Composition of the research group</p>	<p>1 Full Professors 1 Associated Professors 1 Assistant Professors 10 PhD Students</p>
<p>Name of the research directors</p>	<p>Carlo Fiorini</p>

Contacts

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<https://www.deib.polimi.it/eng/research-lines/details/134>
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)	CNAO (Centro Nazionale di Adroterapia Oncologica)
By number of months at the company	3
Institution or company where the candidate will spend the period abroad (name and brief description)	ANSTO (Australia's Nuclear Science and Technology Organisation), Australia
By number of months abroad	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
ATTINENZA ALLA TEMATICA PRESCELTA

L'attività di dottorato qui proposta risulta coerente a tematiche previste dal PNRR, in particolare con la Missione 6 (Salute), tematica M6C2.2 (Formazione, Ricerca Scientifica e Trasferimento Tecnologico) e Investimento 2.1 (Valorizzazione e potenziamento della ricerca biomedica del SSN). Più specificamente la ricerca proposta risulta coerente con l'obiettivo "finanziamento di progetti Proof of Concept (PoC) volti a ridurre il gap fra i risultati del settore della ricerca scientifica e quello dell'applicazione per scopi industriali, attraverso la predisposizione di prototipi per la commercializzazione e la mitigazione dei rischi potenziali - derivanti da eventuali brevetti, licenze o barriere all'entrata - che potrebbero scoraggiare gli investitori di mercato".

IMPRESA, CENTRO DI RICERCA, PUBBLICA AMMINISTRAZIONE (PER PA E PC) PRESSO CUI SI SVOLGERÀ L'ATTIVITÀ ESTERNA

Sebbene per la proposta PNRR non risulti obbligatorio, si prevede un periodo di almeno 3 mesi (eventualmente aumentabili a 6, se previsto dal bando) presso:

- CNAO (Centro Nazionale di Adroterapia Oncologica)
- Radioterapia
- <https://fondazionecnao.it/>
- numero di mesi previsti: 3
- Test di strumentazione per la misura di dose in sessioni di radioterapia



- E' già attiva una collaborazione (Accordo Attuativo) nell'ambito della Convenzione Politecnico-CNAO

ENTE, UNIVERSITÀ, AZIENDA, CENTRO DI RICERCA PRESSO CUI SI SVOLGERÀ IL PERIODO DI STUDIO E RICERCA ALL'ESTERO

- ANSTO (Australia's Nuclear Science and Technology Organisation), Australia
- Istituto di ricerca nell'ambito delle applicazioni delle radiazioni
- <https://www.ansto.gov.au/>
- numero di mesi previsti: 6
- Sviluppo congiunto e sperimentazione di strumenti per la misura di dose in radioterapia
- E' attualmente in corso, sebbene non ancora formalizzata, una collaborazione di ricerca sul tema che ha già dato luogo a pubblicazioni (Chacon, A., et al. Detection and discrimination of neutron capture events for NCEPT dose quantification. Sci Rep 12, 5863 (2022))

EDUCATIONAL ACTIVITIES (purchase of study books and material, including computers, funding for participation in courses, summer schools, workshops and conferences): financial aid per PhD student

5.707,13 Euro per student

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