Infortuni sul Lavoro (INAIL). In the latest editions, in particular, both the regulatory updates introduced by the Ministerial Decree of January 14, 2021 and the innovations proposed by technical documents issued at the national and international level related to patient and operator safety had been explored. Particular attention is devoted to illustrating, both with frontal reports and with practical exercises and small groups role-playing aspects related to the site design and to the preparation of the technical reports within the competence of the ER. In all the editions, a practical small group learning session, dedicated to the simulation of inspections that are normally held by supervisory bodies at the RM SITE is proposed.
Participants come from all Italian regions; in 18 editions the course has benefited from the contribution of about 70 teachers and the participation of about 750 medical physicists.
Participation to AIFM courses, other than increasing competences, represent the opportunity to become a part of the AIFM community so broadening the network of physicists involved in Magnetic Resonance quality and safety.

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Nuovi ambiti - multidisciplinare

Abstract PO.01.156

Optimization of gold nanorods for theragnostic applications: a possible nuclear medicine tool for cancer treatment

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Gold nanorods (GNRs) have emerged as promising nanomaterials in theragnostic, thanks to their unique optical and physicochemical properties make them ideal candidates for biomedical applications, particularly in drug delivery and imaging (Jahangiri-Manesh, 2022). Therapeutic and diagnostic agents can be absorbed onto, attached to the surface of, or encapsulated within the carrier and, thanks to the enhanced permeability and retention effect, which arises from the abnormal vascular structure of solid tumours, they can be accumulated within the tumour tissue (Panwar, 2024). In addition, GNRs can emit Auger electrons, a phenomenon that can be stimulated by external factors. For instance, the presence of a radiopharmaceutical attached to the nanorod can induce Auger electron emission during its decay, enhancing localized energy deposition and potential therapeutic effects. GNRs can therefore offer an important contribution to the field of nuclear medicine, enabling the transport of radiopharmaceuticals for diagnosis, treatment and follow-up of diseases, including tumors. The study is a first step to investigate the use of GNRs for radiopharmaceutical delivery in glioblastoma cells, in the framework of the INFN SEGNAR project.
This work focused on the synthesis and characterization of GRNs with a seed-mediate growth method, using a cationic surfactant as capping agent. Moreover, the in vitro evaluation of cytotoxicity in human glioblastoma (GBM) T98G cells induced by different GNRs configurations, without and with irradiation (gamma rays, Cs-137), together with the assessment of GNR suspension stability has been performed by using MTS assay and high resolution 1H Magnetic Resonance Spectroscopy (MRS).
The preliminary results obtained by MRS and MTS suggest a possible synergistic effect of the two treatments GNRs + irradiation. However, the effectiveness of the penetration of the particles inside cells needs to be assessed. For this purpose, fluorescence and TEM microscope analyses are underway.
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Nuovi ambiti - multidisciplinare

Abstract PO.01.167

High-resolution bioluminescence microscopy of 3D tumor spheroids

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Bioluminescence imaging (BLI) is popular for its noninvasive nature, and it's already used for in vivo and in vitro studies in 2D cultures. This study aims to adapt BLI for high-resolution microscopy of 3D tumor models, enabling detailed analysis of cells behavior and new insights in tumor progression.
A light-tight box was equipped with an EMCCD camera cooled to $-80\,^{\circ}$C, coupled with a 10x microscope objective. A positioning system allowed precise focusing on microscope slides. U87mg luc + glioma cell spheroids were cultured in ultra-low attachment plates, obtaining uniform spheroids both in shape and size. Two days after seeding, spheroids were treated with 5, 15, or 25 Gy X-ray radiotherapy, keeping a fourth group as control. On days 4, 8, and 12 post-treatment, BLI microscopy was performed on individual spheroids, acquiring twenty consecutive frames with exposure of 10 s each.
The dimensions of the 15 Gy and 25 Gy spheroids remained stable ($\sim 0.25\ mm^2$), while gradual growth was observed in the 5 Gy spheroids (0.28 to $0.40\ mm^2$ from day 4 to day 12) and faster growth in the controls (0.35 to $0.70\ mm^2$). As spheroid dimensions increased, a corresponding rise in BLI signal was observed. Interestingly, time-lapse imaging revealed dynamic changes in the fine structure of the spheroid, characterized by sudden increases in BLI signal intensity at specific spot regions, followed by a gradual decline over varying time intervals.
Although further upgrades to the instrument and refinements to the technique are needed, this study highlights the potential of BLI microscopy as a non-invasive tool for high-resolution imaging of 3D tumor models. Future efforts will focus on developing computational methods for the quantitative analysis of spheroid signal dynamics and exploring the underlying mechanisms driving these dynamics.

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Nuovi ambiti - multidisciplinare

Abstract PO.01.172

Getting the most from data: how to organize heterogeneous data for effective AI analysis to investigate Flash and Minibeam radiotherapy techniques

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The result of the observed FLASH and Minibeam effects is obtaining tumor efficacy similar to that of conventional radiotherapy while significantly reducing radiation-induced toxicity on normal tissues. The incomplete understanding of the underlying mechanisms, combined with the lack of comprehensive knowledge regarding the quantitative dependence of beam and irradiated tissue parameters on the extent of these effects, hinders their clinical translation. Therefore, further multidisciplinary studies, including beam dosimetric characterization, in vitro and in vivo radiobiology, simulation and data modeling analysis, are essential for effectively translating these promising techniques into clinical practice.
In the PNRR-THE and INFN-MIRO projects, experiments on beam delivery, dosimetry, radiobiology, and modeling are being conducted, generating diverse data types (such as microscopy images, tabular, textual and raw data) and various parameters, making the study of radiobiological mechanisms a complex multivariate problem. While multiscale models have been developed to describe radiobiological responses, they require parameter optimization, which can be addressed with Machine Learning (ML) using experimental and simulation data. Artificial Intelligence techniques like clustering and neural networks can further identify patterns and hidden associations, with the added benefit of explainability methods to analyze the influence of beam and biological parameters on the radiobiological effects.
To facilitate this multivariate analysis, the collected data of different origins and typologies need to be interconnected and adequately organized. We realized a modular database platform to store, manage, share and analyze the data collected within the two projects. The final aim is to have super-users that can access these data to perform correlation analysis through ML, simulations and data modeling techniques to comprehend the radiobiological mechanism.
This centralized AI-based IT platform can play a crucial role in enhancing both the efficiency and speed of traditional preclinical studies and also improving data standardization and interoperability among various research institutions, undoubtedly accelerating clinical translation.

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Nuovi ambiti - multidisciplinare

Abstract PO.01.183

Explainable AI identifies key gait metrics for neurodegenerative disease diagnosis

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Gait analysis is an established tool for assisting the diagnosis of neurological disease and has a growing importance for rehabilitation. It provides measurements of the human gait, including kinematic and kinetic data, going towards the need for quantitative data for rehabilitation and diagnosis. Traditionally, this kind of analysis relies on expert observation, which makes it prone to variability. Recently, machine learning paved the way for new analysis approaches for medical data, with gait analysis being no exception. Additionally, with the use of explainability methods, the models increase their transparency and provide insights on the most relevant gait parameters used for disease identification.
This study analyzes a public dataset of gait spatiotemporal and cinematic parameters of subjects affected by three neurodegenerative diseases together with healthy controls using Random Forest, eXtreme Gradient Boosting (XGBoost), and multilayer perceptron classifiers. We also employed different explainability methods, such as permutation importance and SHapley Additive exPlanations (SHAP), to ensure a model-independent estimation of the importance of the gait parameters in the classification of the diseases.
The models have different classification performances, with an average accuracy of 65 % in the case of multiclass classification and 80 % for binary (controls vs. specific disease) classification. Moreover, the importance of the gait parameters is dependent from the disorder studied. Additionally, the explainability results are consistent across different explainability methods and classifiers.
We investigated the importance of the gait parameters in the context of classification, showing the consistency of the results obtained using different classifiers and explainability methods. Moreover, most of the gait parameters identified as relevant for classification have also been identified by expert observation as correlates of the observed disease. This is a promising result for future insights into machine learning applications for gait analysis.

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Nuovi ambiti - multidisciplinare

Abstract PO.01.187

Integrating delta radiomics in tomotherapy workflow: robustness, stability and repeatability analysis of ClearRT derived radiomics features

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Delta radiomics offers a powerful tool for monitoring treatment response by detecting sequential changes in tumor characteristics over time. This study evaluates the stability, repeatability, and robustness of delta radiomic features extracted from ClearRT-kVCT fan-beam images acquired on the Radixact linac (Accuray), to assess their potential clinical applicability.
An abdominal anthropomorphic phantom was scanned daily using kVCT over 12 fractions, with two different acquisition protocols: Fine and Normal mode. The images were co-registered and segmented to extract radiomic features (RFs) from three regions of interest (ROI) of varying dimensions, located into liver, spine, and a tumor-like structure, with radius of 1 cm, 0.7 cm and 0.4 cm, respectively. Delta RFs were calculated as the ratio of features from fractions 2–12 to fraction 1. Feature robustness was assessed using the intraclass correlation coefficient (ICC) varying acquisition protocols. Temporal stability and repeatability were evaluated using the coefficient of variation (CV) and coefficient of repeatability (CR). CR values below 10 % of the mean feature value were considered indicative of good repeatability.
ICC analysis indicated that acquisition protocols significantly impact feature robustness, highlighting the importance of data harmonization. Stability analysis showed that 63 % of liver and spine features have CV $<$ 10 %, whereas only 40 % of tumor features remained within this