

Gaia Franciosini

EDUCATION

[2019 – Current] **PhD in Accelerator physics**

La Sapienza, University of Rome.

Thesis title: Development of a Treatment Control System for IOeRT FLASH beam

Thesis Advisor: Vincenzo Patera, Co-Advisor: Angelo Schiavi

[2017 – 2019] **Master's degree in Particle and Astroparticle Physics**

La Sapienza, University of Rome

110 with honors/110

Thesis title: Time of flight measurements at the FOOT experiment: detector characterization and preliminary results

Thesis Advisor: Riccardo Faccini, Co-Advisor: Alessio Sarti

[2014 – 2017] **Bachelor's degree in Physics**

La Sapienza, University of Rome

109/110

Thesis title: Comparison between conventional radiotherapy and hadrontherapy

Thesis Advisor : Riccardo Faccini

TEACHING ACTIVITY

[Sep 2022 – Current] **Tutor**

Course of Physics II (Electromagnetism and Optics), 9 CFU, held by professor Vincenzo Patera [40h]

Department of Biomedical Engineering, La Sapienza, University of Rome

Competition notice n. 428/2022

Link: https://web.uniroma1.it/trasparenza/bando/192549_rep-428/2022

[Mar 2022 – Jul 2022] **Tutor**

Course of Physics I (Classical Mechanics and Thermodynamics), 9 CFU, held by professor Angelo Schiavi [40h]

Department of Chemical Engineering, La Sapienza, University of Rome

Competition notice n. 439/2021

Link: https://web.uniroma1.it/trasparenza/dettaglio_bando_albo/180556

[Nov 2021 – Jan 2022] **Teaching Assistant**

Course of Physics II (Electromagnetism and Optics), 9 CFU, held by professor Vincenzo Patera [20h]

Department of Biomedical Engineering, La Sapienza, University of Rome

[Feb 2022 – Jul 2022] **Teaching Assistant**

Course of Radiation Physics, 9 CFU, held by professors Vincenzo Patera and Alessio Sarti [20h]

Department of Biomedical Engineering, La Sapienza, University of Rome

[Feb 2021 – Jul 2021] **Tutor**

Course of Physics I (Classical Mechanics and Thermodynamics), 9 CFU ,held by professor Angelo Schiavi [40h]

Department of Chemical Engineering, La Sapienza, University of Rome

Competition notice n. 401/2020

Link: https://web.uniroma1.it/trasparenza/dettaglio_bando_albo/168127

[Sep 2020 – Dec 2020] **Tutor**

Course of C/C++/python language, 6 CFU, held by professor Nicoletta Gnan [40h]

Department of Physics, La Sapienza, University of Rome

Link: https://web.uniroma1.it/trasparenza/bando/167728_6-2020

[Feb 2020 – Jul 2020] **Tutor**

Course of Physics (Classical Mechanics, Thermodynamics and Electromagnetism), 12 CFU, held by professor Massimo Germano and Alessandro Belardini [30h]

Department of Ingegneria Informatica, Automatica e Gestionale, La Sapienza, University of Rome

Competition notice n. 18/2019

Link: https://web.uniroma1.it/trasparenza/dettaglio_bando/148021

[Feb 2020 – Jul 2020] **Tutor**

Course of Physics (Classical Mechanics, Thermodynamics and Electromagnetism), 12 CFU, held by professor Michele Ortolani [30h]

Department of Ingegneria Informatica, Automatica e Gestionale, La Sapienza, University of Rome

Competition notice n. 18/2019

Link: https://web.uniroma1.it/trasparenza/dettaglio_bando/148021

SUPERVISION OF STUDENTS

[Apr 2022 – Sep 2022] **Co-supervisor of a master student**

Title thesis: Sviluppo del sistema di pianificazione del trattamento per IORT con elettroni: il caso del tumore al seno.

Supervisor: Prof. Alessio Sarti, student: Veronica De Liso.

Department of Scienze di Base e Applicate per l'Ingegneria (SBAI), La Sapienza, University of Rome

[Sep 2021 – Apr 2022] **Co-supervisor of a master student**

Title thesis: Un innovativo sistema di pianificazione del trattamento IORT: il caso del tumore al seno.

Supervisor: Prof. Alessio Sarti, student: Arianna Cerqua.

Department of Scienze di Base e Applicate per l'Ingegneria (SBAI), La Sapienza, University of Rome

[Nov 2020 – Jul 2021] **Co-supervisor of a master student**

Title thesis: Radioterapia FLASH con elettroni di alta energia: il caso del tumore alla prostata.

Supervisor: Prof. Alessio Sarti, student: Damiana Rubeca

Department of Scienze di Base e Applicate per l'Ingegneria (SBAI), La Sapienza, University of Rome

[Nov 2020 – May 2021] **Co-supervisor of a master student**

Title thesis: Sviluppo di un tool per il calcolo Monte Carlo di dose nell'ambito della terapia IORT.

Supervisor: Prof. Vincenzo Patera, student: Michela Palma

Department of Scienze di Base e Applicate per l'Ingegneria (SBAI), La Sapienza, University of Rome

ATTENDED CONFERENCES

[Sep 2022] **Development of a IORT Treatment Planning System using a GPU-based fast Monte Carlo**

Plenary talk

47th Annual Meeting of the European Radiation Research Society (ERRS 2022)

21th-24th September 2022, Catania, Italy.

[Aug 2022] **A feasibility study of IORT Treatment Planning system using a GPU based fast Monte Carlo**

Parallel talk

4th European Congress of Medical Physics
17th-20th August 2022, Dublin, Ireland.

[Apr 2022] **A feasibility study of IORT-FLASH using a GPU-based fast Monte Carlo (FRED)**

Plenary talk

International Conference on Monte Carlo Techniques for Medical Applications

11th-13th April 2022, Antwerp, Belgium.

[Sep 2021]

Inter-fractional monitoring in Particle Therapy treatments with ^{12}C ions exploiting the detection of charged secondary particles

Parallel talk

ANPC Applied Nuclear Physics Conference

12th-17th September 2021, Prague, Czech Republic.

[Dec 2021]

A feasibility study of deep seated tumor treatments combining FLASH effect and Very High Energy Electron beams

Poster Presentation

FRPT Flash Radiotherapy & Particle Therapy Conference

1th-3th December 2021, Virtual Conference.

[Jun 2021] **Prostate cancer FLASH therapy treatments with electrons of high energy: a feasibility study**

Parallel talk

PTCOG 59 Annual Conference of the Particle Therapy Co-operative Group (ONLINE)

4th-7th June 2021, Rome, Italy.

[Jun 2021] **Measurements of ^{16}O fragmentation cross sections on C target with the FOOT apparatus**

Poster Presentation

PTCOG 59 Annual Conference of the Particle Therapy Co-operative Group (ONLINE)

4th-7th June 2021, Rome, Italy.

[Nov 2020] **Monte Carlo Simulation of an electron beam generated by a mobile iort accelerator**

Poster Presentation

SIRR 2020, XIX Congresso Nazionale (ONLINE)

10th-12th November 2020, Rome, Italy.

[Jun 2019] **FOOT experiment (FragmentatiOn Of Target)**

Poster Presentation

10th Young Researcher Meeting

18th-21st June 2019, Rome, Italy.

SEMINARS

[9 Jun 2022] **Development of a Treatment Control System for IORT-FLASH beam,**

XIX Seminar on Software for Nuclear, Subnuclear and Applied Physics, Alghero, Italy

[13 May 2022] **Radiotherapy techniques for cancer treatment**

Department of Scienze di Base e Applicate per l'Ingegneria (SBAI), La Sapienza, University of Rome.

[9 May 2022] **Nuclear Medicine: PET&SPECT**

Department of Scienze di Base e Applicate per l'Ingegneria (SBAI), La Sapienza, University of Rome.

PH.D. AND TRAINING SCHOOL

[4 Sep 2022 – 19 Sep 2022] **GSI-ESA-FAIR Space Radiation School 2022**

The school trains students in basic heavy ion biophysics for both terrestrial and space applications. It provides lectures from experts and practical training

Darmstadt, Germany

Link: https://www.gsi.de/work/forschung/biophysik/esa_summer_school

[5 Jun 2022 – 10 Jun 2022] **XIX Seminar on Software for Nuclear, Subnuclear and Applied Physics**

The school hosted a cycle of seminars on particle detectors, a course on machine learning fundamentals and application in physics and a course on GEANT4 and Python programming language.

Alghero, Italy

Link: <https://agenda.infn.it/event/28830/>

[15 May 2022 – 20 May 2022] **INFN, School of Statistics 2022**

The school provided an overview of statistical methods and tools used in particle, astro-particle and nuclear physics.

Paestum, Italy

Link: <https://agenda.infn.it/event/28039/>

[13 Jan 2020 – 14 Feb 2020] **JUAS, Joint Universities Accelerator School**

Taught by leading European particle accelerators specialists, JUAS delivers a regularly updated, academically accredited training program in partnership with CERN and a cluster of 16 European universities. At the end of the school participants have to undergo an exam to verify the acquired competences. I passed it with 15.10/20

Archamps, France

Link: <https://www.esi-archamps.eu/Thematic-Schools/Discover-JUAS/JUAS-2020>

AWARDS AND SCHOLARSHIPS

[Apr 2022] **Best young investigator talk**

International Conference on Monte Carlo Techniques for Medical Application

Oral presentation: A feasibility study of IORT-Flash using a GPU-based fast Monte Carlo (FRED)

[Nov 2020] **Best Poster Presentation**

SIRR 2020, XIX Congresso Nazionale (ONLINE)

Poster Presentation: Monte Carlo Simulation of an electron beam generated by a mobile IORT accelerator

[Oct 2020] **Excellent student of the 2018/2019 academic year at La Sapienza**

VIII edition of the graduate's day, La Sapienza, University of Rome

Link: <https://www.uniroma1.it/it/content/giornata-del-laureato-23-ottobre-2020>

[Nov 2018]

INFN competition for undergraduate students for scientific activities at LNF aimed to the master's degree

I decided to present my application for admission in the field of nuclear physics with the FOOT (FragmentatiOn Of Target) experiment

Istituto Nazionale di Fisica Nucleare, Sezione dei Laboratori Nazionali di Frascati (LNF)

Competition notice n. 19871 (2018)

Funding: 2000 €

Link: <https://w3.inf.infn.it/borse-studio-laureandi/>

GRANTS

[Sep 2022] **Grant for 47th Annual Meeting of the European Radiation Research Society-ERRS**

21th-24th Sept, Catania, Italy

[Jun 2022] **Grant for the XIX Seminar on Software for Nuclear, Subnuclear and Applied Physics**

5th-10th Jun, Alghero, Italy

INFN, University of Sassari and SNAKE (Sharing Software Knowledge)

FOUNDED PROJECT AS PRINCIPAL INVESTIGATOR

[2022] **Avvio alla ricerca (Young researcher financing)**

Project: Treatment Planning optimization for breast cancer IOeRT-FLASH treatments Sapienza, University of Rome

Founding: 2000 €

[2021] **Avvio alla ricerca (Young researcher financing)**

Project: Development of a Treatment Control System for IORT FLASH beam Sapienza, University of Rome

Founding: 1000 €

FOUNDED PROJECT AS A MEMBER

[2022] **"FRIDA"-Flash Radiotherapy with high Dose-rate particle beams**

Call INFN CSN5

Founding: 225 k€

PI: Alessio Sarti

[2020] **"FlashDC" - Flash Dose Counting**

Domanda n. PROT. A0375-2020- 36748.

Avviso Pubblico "Gruppi di ricerca 2020"-POR FESR Lazio 2014-2020

POR FESR Lazio 2020-2022

Founding: 149 k€

OUTREACH

[Dec 2021 – May 2022] **Tutor for LAB2GO**

High school laboratory tutor (Arduino project)

Istituto Nazionale di Fisica Nucleare (INFN) and Physics Department of Sapienza University of Rome.
<https://lab2go.roma1.infn.it/doku.php>

Competition notice: 221/2021 [40h]

Link: https://lab2go.roma1.infn.it/doku.php\\href{https://web.uniroma1.it/trasparenza/dettaglio_bando/181320

RESEARCH PERFORMANCES, EXPLOITATION AND DISSEMINATION

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My research activity is focused on the development of new detectors and software tools mainly related to particle physics applied to the medical field.

The scientific outcome of my research is explicated in several publications on refereed journals and presentation at conferences and seminars.

From 2019:

- h index of 5 with 24 publications in refereed international journals (<http://www.scopus.com>);

- 5 oral presentations at international conferences.
- 3 seminars at La Sapienza, University of Rome and at international workshop

My professional training is due to the exploitation of several possible paths:

- Collaboration with the S.I.T. Sordina IORT Technologies for the development of a Treatment Planning System dedicated to Intra Operative Radio Therapy with electrons (IOeRT) treatments.
- Collaboration with Institute Curie (Paris, France) for the characterization of ultra-high dose rate electron beams with the ElectronFlash linac
- Participation to projects with dedicated call-funding opportunities, such as "FlashDC" and "FRIDA".
- Member of the "FOOT" international collaboration of INFN.

My public communication and dissemination activity is mainly focused to La Sapienza, University of Rome. In particular I was a member of the organization committee of:

- From conventional dose-rate to FLASH radiotherapy, Lecito magistralis by Vincent Favaudon, Institute Curie. La Sapienza, University of Rome, October 25, 2022.

SELECTION OF 10 PUBLICATIONS HIGHLIGHTING MY PERSONAL CONTRIBUTIONS

M. Fischetti et al, Inter-fractional monitoring of 12C ions treatments: results from a clinical trial at the CNAO facility

Scientific Reports, 10(1) DOI:10.1038/s41598-020-77843-z (2020).

M. Toppi et al, The MONDO Tracker: Characterisation and Study of Secondary Ultrafast Neutrons Production in Carbon Ion Radiotherapy

Frontiers in Physics, 8 DOI:10.3389/fphy.2020.567990 (2020).

G. Battistoni E. et al, Measuring the Impact of Nuclear Interaction in Particle Therapy and in Radio Protection in Space: the FOOT Experiment

Frontiers in Physics, 8. DOI:10.3389/fphy.2020.568242 (2021)

M. Toppi et al, PAPRICA: The pair production imaging Chamber—Proof of principle

Frontiers in Physics, 9. DOI:10.3389/fphy.2021.568139 (2021)

L. Faillace et al., Compact S-band Linear Accelerator System for FLASH Radiotherapy

Physical Review Accelerators and Beams (2021). DOI: 10.1103/PhysRevAccelBeams.24.050102

M. Toppi et al., Monitoring Carbon Ion Beams Transverse Position Detecting Charged Secondary Fragments: Results From Patient Treatment Performed at CNAO

Frontiers in Oncology, 2021, 11, 601784 DOI: 10.3389/fonc.2021.601784

Sarti A. et al., Deep Seated Tumour Treatments With Electrons of High Energy Delivered at FLASH Rates: The Example of Prostate Cancer

Frontiers in Oncology, 2021, 11, 777852. DOI: 10.3389/fonc.2021.777852.

A. Rahman et al., FLASH radiotherapy treatment planning and models for electron beams.

Radiotherapy and Oncology, 2022, 12, 929949. DOI: 10.1016/j.radonc.2022.08.009.

M. De Simoni et al., A Data-Driven Fragmentation Model for Carbon Therapy GPU-Accelerated Monte-Carlo Dose Recalculation

Frontiers in Oncology, 2022, 12, 2234-943X. DOI: 10.3389/fonc.2022.780784

G. Franciosini et al., GPU-accelerated Monte Carlo simulation of electron and photon interactions for radiotherapy applications

Physics in Medicine & Biology. 2022 DOI 10.1088/1361-6560/aca1f2

WORKING

[2016 – 2017] **Collaboration scholarship for student**

Department of Physics, La Sapienza University of Rome.

[2017 – 2018] **Collaboration scholarship for student**

Department of Scienze di Base e Applicate per l'Ingegneria (SBAI), La Sapienza, University of Rome.

TRACK RECORD

[2018 – 2019] **Gamma traker**

During my Master's degree I had the opportunity to work with Professor R. Pani in the nuclear imaging context for an extra-curriculum project. The precise detection of radioactivity, its secure containment and the efficient disposal of all radioactive waste is an ever-increasing concern for the nuclear industry, especially when considering decommissioning or the need for major works at nuclear power plants. In this framework, I developed a compact and handy gamma tracker prototype, dedicated to the detection of radioactive sources. It consists of thin scintillator detectors coupled with a position sensitive matrix of SiPM. I personally take care of the characterization with a spectrometer of the prototype detecting elements and irradiating the crystals with collimated ^{133}Ba and ^{57}Co source. Finally I explored the properties of the whole detecting system.

[2019] **FOOT (FragmentatiOn Of Target)**

For my Master degree thesis I joined the Applied Radiation Physics Group (ARPG) which involves members of INFN, Sapienza, University of Rome (Physics and SBAI Departments), and the Centro Ricerche Enrico Fermi (CREF). In particular, my activity was carried out within the FOOT (FragmentatiOn Of Target) collaboration. The FOOT experiment has been conceived to measure nuclear cross sections at the energy of interest for particle therapy applications and radio-protection in space. My thesis work was focused on the analysis of the data collected in two test beam at Centro Nazionale di Adroterapia Oncologica - CNAO - (Pavia, Italy) and at GSI (Darmstadt, Germany). In particular, I developed the algorithm for the Time Of Flight (TOF) evaluation, optimizing the performance of the TOF start detector. The aforementioned algorithms are now implemented into the software developed for the FOOT experiment as standard reconstruction code of the experiment.

[2019 – Current] **FRED and IOeRT TPS**

During my Ph.D I decided to continue my research activity in the ARPGroup focusing my contribution to the development of a fast, GPU-accelerated, dose engine based on Monte Carlo simulation, called FRED (Fast paRticle thErapy Dose evaluator). FRED has been developed to allow a fast optimization of Treatment Planning System (TPS) in Particle Therapy while keeping the dose release accuracy typical of an MC tool. Thanks to the GPU parallel programming ability, FRED is able to reduce the simulation time by a factor 1000 compared to the standard MC tool.

For the exceptional speed of the protons and recently also of the carbon ions tracking algorithms implemented in FRED and for the excellent results achieved in terms of dose accuracy, we decided to extend the use of this MC-on-GPU-based software, which today is already used at several clinical and research centers in Europe for protons, to other radiotherapy techniques where the time factor is crucial, such as the Intra-Operative Radio Therapy with electrons (IOeRT) whose potential is strongly limited by the unavailability of a dedicated TPS.

During my Ph.D. I implemented the electromagnetic interaction models present in literature for electrons, positrons and gamma in the FRED software, balancing the speed of calculation with the accuracy of implemented physical models. The FRED output has been benchmarked against the main general purpose full MC as FLUKA and GEANT4 in the medical context. Finally, I worked on its first clinical application as a tool for IOeRT treatment planning and optimization.

Collaborating with the S.I.T. Sordina IORT Technologies S.p.A. company (Aprilia, Italy), which is now exploiting a new 3D real-time ultrasound imaging acquisition, I worked on the development of the first ever complete TPS dedicated to IOERT treatments in conventional and FLASH regime based on FRED.

[2019 – Current] **FLASH effect and VHEE radiotherapy**

From 2021 I started to work in the field of the future Very High Energy Electrons (VHEE) (> 50 MeV) therapy. VHEE beams have been explored in the past for the treatment of deep seated tumours, to exploit their characteristic dose release that allows a better sparing of Organ at Risk (OARs) placed along the beam direction after the tumor with respect to conventional radiotherapy. Up to now the availability of VHEE in clinical centres has been hampered by the size, complexity, and high cost of the beam production and delivery system that has to be implemented. However, recent developments in the field of electrons acceleration and delivery are about to overcome such limitations, increasing the interest on the therapeutic potential of VHEE irradiations. This interest is today even more increased due to the FLASH effect discovery. In order to investigate the potential of VHEE based radiotherapy, an electron TPS is needed. I thus joined a Sapienza and INFN interdisciplinary team to investigate the efficiency achievable in VHEE treatments to treat deep-seated tumors. I shared the expertise on Monte Carlo simulation for clinical applications gained from the FRED experience for the development of a TPS dedicated to VHEE beam delivering in conventional and FLASH regime. I investigated the VHEE therapy potential in the cases of prostate, head&neck and pancreatic tumor. Using an accelerator with the characteristics of the machine being developed and built at La Sapienza University by the aforementioned collaboration, the obtained first results demonstrate that VHEE radiotherapy could represent a valid alternative to standard radiotherapy allowing a better sparing of the healthy tissues surrounding the tumour even without considering the FLASH effect.

In addition to that, I am a member of the FRIDA INFN project, which is a larger community that collects the effort of the INFN researchers on the FLASH innovation. In this context I worked on the characterization of ultra-high dose rate electron beams with the ElectronFlash Linac, which is installed at Institute Curie (Orsay-France) and it is entirely dedicated to FLASH irradiation for radiobiological and preclinical studies. In particular I worked on the dosimetric characterization of the machine.

A non negligible effort of my research activity inside the FRIDA collaboration is today focused on the development of a beam monitor dedicated to next generation beams at FLASH intensities based on the air fluorescence.

[2019 – Current] **Range Monitoring**

During my PhD activity I also participated in the development of two innovative particle tracker for range monitoring purpose during PT treatments: the MONDO (MONitor for Neutron Dose in hadrOntherapy) neutron tracker and the Dose Profiler, a charged particle tracker detector capable of monitoring online PT treatments in combination with a PET device to be operated within the INSIDE (Innovative Solution for monitoring inHadrontherapy) project.