

Curriculum vitae

Family name, First name: Mirabelli Riccardo

EDUCATION

- 2016-2020 Ph.D. in Accelerator Physics (XXXII cycle)
“Development of a new tracking device for characterisation and monitoring of ultra fast neutron beams”
Supervisor: Prof. V. Patera and Dr. M.Marafini
“Sapienza” - Dipartimento SBAI, Università di Roma. Rome, Italy
- 2014-2016 Master Degree in Physics
“Caratterizzazione di un prototipo di tracciatore per l’esperimento MONDO”
(Characterisation of a tracker prototype for the MONDO experiment) 110/110 cum laude Supervisor: Prof. R. Faccini and Dr. M.Marafini
“Sapienza” - Università di Roma, Rome, Italy ^[1]_[SEP]
- 2011-2014 Bachelor Degree in Physics
“Rivelatori per Scintigrafia (SPECT Detectors)” 110/110
Supervisor: Prof. R. Faccini and Dr. M.Marafini
“Sapienza” - Università di Roma, Rome, Italy ^[1]_[SEP]

CURRENT AND PREVIOUS POSITIONS^[1]_[SEP]

- Since 11/2019 Researcher Post-Doc in Physics
“Development of low energy radiation detectors for medical application”
“Sapienza” - Dipartimento di Fisica, Università di Roma, Rome, Italy

TEACHING ACTIVITIES

- 2019 - 2020 Course of Scientific Computation for foreign students ^[1]_[SEP]
“Sapienza” - Physics Department, Università di Roma, Rome, Italy
- 2018 – 2019 Assistant for the course of Physics I (Classical Mechanics and Thermodynamics) for Mechanical Engineer students held by Prof. A. Sarti. [40 hours] ^[1]_[SEP]
“Sapienza” - Dipartimento SBAI, Università di Roma, Rome, Italy
- 2017 – 2018 Assistant for the course of Physics II (Electromagnetism and Optics) for Space and Astronautical Engineer students held by Prof. M.Migliorati. [40 hours] ^[1]_[SEP]
“Sapienza” - Dipartimento SBAI, Università di Roma, Rome, Italy
- 2017 – 2018 Assistant for the course of Math OFA (Obblighi Formativi Aggiunti) for students with formative debts. [40 hours] ^[1]_[SEP]
“Sapienza” - Physics Department, Università di Roma, Rome, Italy

2014 – 2015 Assistant for the course Electronics Laboratory (Laboratorio di Segnali e Sistemi) for Physics students. [150 hours]^[L]_[SEP]
“Sapienza” - Physics Department, Università di Roma, Rome, Italy

2018 – CoSupervisor of 3 Bachelor Students of ^[L]_[SEP]
“Sapienza” - Physics Department, Università di Roma, Rome, Italy

RESEARCH PERFORMANCES

My research focuses on developments of new detectors and on application of particle physics detection techniques to different fields, in particular to the medical one. The Particle Therapy field offered me the opportunity to investigate different detection strategies and devices.

- o h index of 4 with ~30 publications in refereed international journals for a total of about 23 citations (database: <http://www.scopus.com>); o 4 publications in refereed international journals as first author/corresponding author; o 8 presentations at national and international conferences and workshops;

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MAJOR COLLABORATIONS

Since 2017 TIFPA - Trento Institute for Fundamental Physics and Application. ^[L]_[SEP]
Member of the SPARE project for the measurement and characterisation of active and passive shield for space radiation protection (C. La Tessa, F. Tommasino).

Since 2017 CNAO - Centro Nazionale di Adroterapia Oncologica, Pavia. ^[L]_[SEP]
Member of INSIDE project. ^[L]_[SEP]
Collaboration activities with carbon and proton beam facility (M. Pullia): characterisation of the low intensities beam setup.

Since 2016 FBK - Fondazione Bruno Kessler. ^[L]_[SEP]
Development of the SBAM electronic readout (L. Gasparini, M. Perenzoni) for the MONDO project: collaboration activities in the design phase, in the development of the acquisition software and in the electronic calibration test of the device. ^[L]_[SEP]

FUNDED PROJECTS

- as Principal Investigator:

2017 – 2018 Avvio alla ricerca (Young Researcher financing) - “Sapienza” - Università di Roma “Misura della risoluzione temporale del sistema ToF dell’ esperimento FOOT (FragmentatiOn On Target) basato su un calorimetro phoswich (Measurement of the ToF system resolution for the FOOT experiment based on a phoswitch calorimeter)”. Funding: 1000 euro. ^[L]_[SEP]

- as a Member:

2018 – 2019 Progetti Medi Sapienza - “Sapienza” - Università di Roma “SOLE: Secondary photons OnLine monitor Experiment”. Funding: 12 keuro.

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RESEARCH ACTIVITY^[L]_[SEP]

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I joined the ARPG group during my Master Thesis in Particle Physics and I decide to continue my work in the collaboration also for my Ph.D thesis.

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My main activity concerns the development of a tracking detector for fast and ultra-fast secondary neutrons [19, 20]: I collaborate on the construction of the MONDO prototype at SBAI department in close collaboration with the mechanical service. I participate to the data taking campaigns with electrons at Beam Test Facility of Laboratori Nazionali di Frascati [12] and with protons at the Trento Proton Therapy Centre experimental room [11,13]. In parallel, in collaboration with Fondazione Bruno Kessler (FBK), I work at the development of the electronic readout of the MONDO experiment, a new SPAD array sensor [12]. I am collaborating with the FBK engineers in the design phase, in the development of the acquisition software and in the electronic test of the device.

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Since 2017 I am also responsible of the implementation of the readout system in the FLUKA Monte Carlo simulation of the MONDO detector [3].

I am also the responsible of the Monte Carlo studies of the possible application of MONDO as an online monitor exploiting the detection of secondary prompt photons emitted in Particle Therapy treatments. This research has been supported by the "Sapienza" within the SOLE: Secondary photons OnLine monitor Experiment project (Progetto Medi Sapienza).

In the context of the SPARE project (SPAcE Radiation Shielding), aiming at the development of a new Quasi-Monoenergetic Neutron facility at INFN-LNL and at the characterisation on different shielding material for radio-protection in space, I am the responsible of the simulation studies of MONDO as beam monitor.

During my Ph.D I also carried out R&D activities for the development of new detectors and technologies.

In 2017 I have worked on the construction of an on-line tracker monitor for the CNAO therapy center and I participated to the calibration and commissioning of the device. The measurements campaign was aimed to characterise the low intensity carbon ion and proton beams that could be provided to the users of the new experimental room that will be completed at CNAO in the next few years.

Since 2018 I am involved in the TOPS (Time Of flight Plastic Scintillators) project, a collaboration with scientists of different backgrounds (chemists, solid state physicists, particle physicist, ecc.) for the realisation of new fast plastic scintillators. I am in charge of new scintillators time resolution measurements with different readout systems. I participate to the calibration data taking of the new plastic scintillator sample with m.i.p. particles, radioactive sources and with light ions (protons and carbon ion) beam at CNAO.

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Since 2016 I am a member of the FOOT collaboration, devoted to the Relative Biological Effectiveness (RBE) proton measurements for PT applications and radio-protection measurements for space applications. My work in the collaboration has been focused on the test of the time detector performances (Start Counter). I also gave an important contribution to the R&D work aimed to develop a phoswich detector made by the combination of fast plastic scintillator and BGO crystal [2].

Within the ARPG group I contributed also on a project in which radio-guided surgery can be performed by means of a novel probe exploiting the detection of β - radiation [1,4]. Moreover, using the knowledge acquired with MONDO, I participated to the development of the Dose Profiler detector [6,8] (INSIDE collaboration).

In all the different phases of my work, I have faced and overcame different hardware and software challenges: I built and tested the detectors needed for the secondary fragments production and primary beam measurements, performed the data analysis and published the results on peer-reviewed international journals. I also gain some experience in signal processing, both with commercial electronics (NIM/VME) and custom electronics thanks to the synergy work performed with FBK.

SCIENTIFIC OUTCOME

- Conferences and Seminars

- (I) 09/2019 105 Italian Physical Society Congress, L'Aquila, Italy, "MONDO tracker for secondary ultra-fast neutron characterization in Particle Therapy"
- (II) 09/2019 FATA2019: FAsT Timing Applications for nuclear physics and medical imaging workshop, Catania, Italy "TOPS Project: Development of New Fast Timing Plastic Scintillators".
- (III) 11/2018 IEEE Nuclear Science Symposium and Medical Imaging Conference, Sydney, Australia, "In-room performance evaluation of a novel charged particles monitor of light ions PT treatments".
- (IV) 06/2018 World Congress on Medical Physics and Biomedical Engineering, Prague, Czech Republic, "Particle Therapy secondary neutrons characterisation with the MONDO project".
- (V) 09/2017 103 Italian Physical Society Congress, Trento, Italy, "Study and design of a Drift Chamber for the FOOT experiment" & "MONDO neutron tracker characterisation by means of proton therapeutical beams and Monte Carlo simulation studies"
- (VI) 05/2017 8th Young Researchers Meeting, Cagliari, Italy, "MONDO: A tracker for the characterization of secondary fast and ultrafast neutrons emitted in Particle Therapy". Contribution on IOP Conf. Series: Journal of Physics: Conf. Series 956 (2018) 012013 doi: 10.1088/1742-6596/956/1/012013
- (VII) 09/2016 102 Italian Physical Society Congress, Padova, Italy, "MONDO: a neutron tracker for particle therapy secondary emission fluxes measurements." ^[1]_{SEP} Special mention for the best presentation in "Medical Physics and Biophysics session". Contribution on IL NUOVO CIMENTO 40 C (2017) 99 DOI 10.1393/ncc/i2017-17099-0

- Poster Presentations

- (VI) 07/2018 NDRA2018 - Summer School in Neutron Detectors, Riva del Garda (TN), Italy, "Secondary neutrons characterization in Particle Therapy with the MONDO tracker".
- (VII) 10/2017 SQUAD2017 - Advanced School on QUANTum Detectors, Trento, Italy, "The SBAM sensor for the MONDO experiment".

- Publications

- (1) Collamati, F. et al, Radioguided surgery with β – radiation in pancreatic Neuroendocrine Tumors: a feasibility study
- (2) Morganti, S. et al, Tumor-non-tumor discrimination by a β - detector for Radio Guided Surgery on ex-vivo neuroendocrine tumors samples
- (3) Gioscio, E. et al, Development of a novel neutron tracker for the characterisation of secondary neutrons emitted in Particle Therapy (Corresponding author)
- (4) Mattei, I. et al, Charged particles and neutron trackers: Applications to particle therapy
- (5) Collamati, F. et al, Characterisation of a β detector on positron emitters for medical applications
- (6) Manuzzato, E. et al, A 16×8 Digital-SiPM Array with Distributed Trigger Generator for Low SNR Particle Tracking
- (7) Traini, G. et al, Review and performance of the Dose Profiler, a particle therapy treatments online monitor
- (8) Rucinski, A. et al, Secondary radiation measurements for particle therapy applications: Charged secondaries produced by ^{16}O ion beams in a PMMA target at large angles (2019) Physica Medica, 64, pp. 45-53. DOI: 10.1016/j.ejmp.2019.06.001

- (9) Russomando A. et al, The β - radio-guided surgery: Method to estimate the minimum injectable activity from ex-vivo test (2019) *Physica Medica*, 58, pp. 114-120. DOI: 10.1016/j.ejmp.2019.02.004
- (10) Morrocchi M. et al, Development and characterization of a ΔE -TOF detector prototype for the FOOT experiment (2019) *Nuclear Instruments and Methods in Physics Research, Section A: Accelerators, Spectrometers, Detectors and Associated Equipment*, 916, pp. 116-124. DOI: 10.1016/j.nima.2018.09.086
- (11) Montesi M.C. et al, Ion charge separation with new generation of nuclear emulsion films (2019) *Open Physics*, 17 (1), pp. 233-240. DOI: 10.1515/phys-2019-0024
- (12) Giacometti V. et al, Characterisation of the MONDO detector response to neutrons by means of a FLUKA Monte Carlo simulation (2018) *Radiation Measurements*, 119, pp. 144-149. DOI: 10.1016/j.radmeas.2018.10.006
- (13) Collamati F. et al, Radioguided surgery with β radiation: a novel application with Ga68 (2018) *Scientific Reports*, 8 (1), art. no. 16171 . DOI: 10.1038/s41598-018-34626-x
- (14) Fischetti M. et al, Characterisation of the secondary-neutron production in particle therapy treatments with the MONDO tracking detector (2018) *Nuovo Cimento della Società Italiana di Fisica C*, 41 (6), art. no. 206, . DOI: 10.1393/ncc/i2018-18206-5 © ([Corresponding author](#))
- (15) De Simoni M. et al., In-room test results at CNAO of an innovative PT treatments online monitor (Dose Profiler) (2018) *Nuovo Cimento della Società Italiana di Fisica C*, 41 (6), art. no. 209, . DOI: 10.1393/ncc/i2018-18209-2
- (16) Valle S.M. et al, The FOOT (FragmentatiOn Of Target) experiment (2018) *Nuovo Cimento della Società Italiana di Fisica C*, 41 (5), art. no. 169. DOI: 10.1393/ncc/i2018-18169-5 (17)
Mattei I. et al, Scintillating fiber devices for particle therapy applications (2018) *IEEE Transactions on Nuclear Science*, 65 (8), art. no. 8370744, pp. 2054-2060. DOI: 10.1109/TNS.2018.2843179
- (18) Morganti S. et al, Position sensitive β -Detector based on p-terphenyl scintillator for medical applications (2018) *Journal of Instrumentation*, 13 (7), art. no. P07001. DOI: 10.1088/1748-0221/13/07/P07001
- (19) Solestizi L.A. et al, Use of a CMOS image sensor for beta-emitting radionuclide measurements (2018) *Journal of Instrumentation*, 13 (7), art. no. P07003. DOI: 10.1088/1748-0221/13/07/P07003
- (20) Traini G. et al, Preliminary test of the MONDO project secondary fast and ultrafast neutrons tracker response using protons and MIP particles (2018) *Journal of Instrumentation*, 13 (4), art. no. C04014. DOI: 10.1088/1748-0221/13/04/C04014
- (21) [Mirabelli R.](#) et al, The MONDO Detector Prototype Development and Test: Steps Toward an SPAD-CMOS-Based Integrated Readout (SBAM Sensor) (2018) *IEEE Transactions on Nuclear Science*, 65 (2), pp. 744-751. DOI: 10.1109/TNS.2017.2785768
- (22) [Mirabelli R.](#) et al, MONDO: A tracker for the characterization of secondary fast and ultrafast neutrons emitted in particle therapy (2018) *Journal of Physics: Conference Series*, 956 (1), art. no. 012013. DOI: 10.1088/1742-6596/956/1/012013
- (23) Mattei I. et al, Charged particles and neutron trackers: Applications to particle therapy (2018) *Nuclear Instruments and Methods in Physics Research, Section A: Accelerators, Spectrometers, Detectors and Associated Equipment*. In Press. DOI: 10.1016/j.nima.2018.09.064
- (24) Carlotti D. et al, Use of bremsstrahlung radiation to identify hidden weak β -Sources: Feasibility and possible use in radio-guided surgery (2017) *Journal of Instrumentation*, 12 (11), art. no. P11006. DOI: 10.1088/1748-0221/12/11/P11006
- (25) Mattei I. et al, Addendum: Measurement of charged particle yields from PMMA irradiated by a 220 MeV/u 12C beam, (2017) *Phys. Med. Biol.* 62 8483–8494. DOI:10.1088/1361-6560/aa8b35

- (26) Mancini-Terracciano C., Feasibility of beta-particle radioguided surgery for a variety of “nuclear medicine” radionuclides (2017) *Physica Medica*, 43, pp. 127-133. DOI: 10.1016/j.ejmp.2017.10.012
- (27) Gasparini L. et al, MONDO: A neutron tracker for particle therapy secondary emission measurements (2017) 2016 IEEE Nuclear Science Symposium, Medical Imaging Conference and Room-Temperature Semiconductor Detector Workshop, NSS/MIC/RTSD 2016, 2017January, art. no. 8069401, . DOI: 10.1109/NSSMIC.2016.8069401
- (28) Mirabelli, R. MONDO: A neutron tracker for particle therapy secondary emission fluxes measurements (2017) *IL NUOVO CIMENTO* 40C 99 DOI: 10.1393/ncc/i2017-17099-0
- (29) Marafini M., MONDO: A neutron tracker for particle therapy secondary emission characterisation (2017) *Physics in Medicine and Biology*, 62 (8), pp. 3299-3312. DOI: 10.1088/1361-6560/aa623a

ATTENDED SCHOOL

- Ph.D Schools

07/2018 NDRA2018 - Summer School in Neutron Detectors, Riva del Garda (TN), Italy
 10/2017 SQUAD2017 - Advanced School on QUAntum Detectors, Trento, Italy; 01-02/2017
 JUAS 2017 - ESI - Joint Universities Accelerator School, Archamps, France. Final
 examination: graduated (Top 8).

- Scientific courses

2014 GraSPA 2014 - Summer School in Particle and Astroparticle Physics, ^[L]_[SEP]
 Annecy-le-Vieux, France, LAPP scholarship for excellent student.
 07/2015 Re-writing Nuclear Physics textbooks: 30 years of radioactive ion beam physics, ^[L]_[SEP]
 Pisa, Italy, INFN scholarship for excellent students in Nuclear Physics.

OUTREACH

2018 - 2019 LAB2GO, Rome, Italy, ^[L]_[SEP]
 Internship for High School student (Alternanza scuola-lavoro) in Physics laboratories ^[L]_[SEP]
 Tutor for the student of "Ignazio Vian" High School [40 hours]

05/02/2019 Training Course Event for FameLab2019
 Museo Storico della Fisica e Centro Studi e Ricerche E.Fermi, Rome, Italy,

2014 - 2015 Scuola Sperimentale di Comunicazione della Scienza (Experimental School on
 Science Communication), asSaggi bookshop Rome, Italy [45 hours] ^[L]_[SEP]
 Course organised by asSaggi bookshop in collaboration with MaddMaths! and EPS.

Rome,
 11 Nov 2020

Riccardo Mirabelli