EUROPEAN CURRICULUM VITAE FORMAT

PERSONAL INFORMATION

Name	**PROF. ANDREA MOSTACCI**

GENERAL RESEARCH INTERESTS

Physics and Technology of Particle Accelerators, Application of THz radiation, Applied Electromagnetics, Microwave Measurement, RF design

BIBLIOMETRIC SUMMARY DATA

• Total international publications	416, source scholar.google.com
• Total citations	4640, source scopus.com
• Total cited paper	265, source scopus.com
• H-index	35, source scopus.com

EDUCATION AND TRAINING

• Dates (1997-2001)	
• Name and type of organization providing education and training	Sapienza, University of Rome
• Principal subjects/occupational skills covered	Beam physics, Particle Accelerator technology, Microwave Measurements
• Title of qualification awarded	PhD in Applied Electromagnetism and Electro-Physical Science
• Dates (1991-1997)	
• Name and type of organization providing education and training	Sapienza, University of Rome
• Principal subjects/occupational skills covered	Modern Electronic Engineering, Applied Electromagnetics
• Title of qualification awarded	Master Degree in Electronic Engineering

PRINCIPAL POSITIONS

• Dates (2018 – today)	
• Name and address of employer	Sapienza, University of Rome (Italy)
• Type of business or sector	02/A1 – Fis01
• Occupation or position held	Associate Professor
• Main activities and responsibilities	Design of RF devices, Medical accelerators, Plasma based accelerators

• Dates (2006 – 2018)	
• Name and address of employer	Sapienza, University of Rome (Italy)
• Type of business or sector	02/A1 – Fis01
• Occupation or position held	Assistant Professor
• Main activities and responsibilities	THz radiation Sources, Physics of High brightness beam, Beam commissioning
• Dates (2002 – 2006)	
• Name and address of employer	Sapienza, University of Rome (Italy)
• Type of business or sector	02/A1 – Fis01
• Occupation or position held	Researcher
• Main activities and responsibilities	Medical applications, Hadroterapy, Post-acceleration of Plasma generated protons
• Dates (2001 – 2002)	
• Name and address of employer	CERN, European Organization for Nuclear Research (Genève, Switzerland)
• Type of business or sector	
• Occupation or position held	Research Fellowship
• Main activities and responsibilities	Microwave measurements
• Dates (1999 – 2001)	
• Name and address of employer	CERN, European Organization for Nuclear Research (Genève, Switzerland)
• Type of business or sector	
• Occupation or position held	Doctoral Student
• Main activities and responsibilities	Beam wall interaction in the LHC liner
• Dates (1997 – 1998)	
• Name and address of employer	CERN, European Organization for Nuclear Research (Genève, Switzerland)
• Type of business or sector	
• Occupation or position held	Technical Student
• Main activities and responsibilities	Beam coupling impedance of LHC beam screen pumping slots

ADDITIONAL POSITIONS

• Dates (2021 – today)	
• Name and address of employer	Sapienza, University of Rome (Italy)
• Type of business or sector	
• Occupation or position held	Member of the Professor Board of Mechanical Engineering
• Main activities and responsibilities	Professor of General Physics
• Dates (2016 – today)	
• Name and address of employer	Sapienza, University of Rome (Italy)
• Type of business or sector	
• Occupation or position held	Member of the Professor Board of PhD Course in Engineering and Applied Science for Energy and Industry
• Main activities and responsibilities	
• Dates (2011 – today)	
• Name and address of employer	Sapienza, University of Rome (Italy)
• Type of business or sector	
• Occupation or position held	Member of the Professor Board of Electronic Engineering
• Main activities and responsibilities	Professor of Microwave measurement laboratory and Accelerator Physics
• Dates (2008 – today)	
• Name and address of employer	INFN, Istituto Nazionale di Fisica Nucleare
• Type of business or sector	
• Occupation or position held	Research appointment renewed yearly on particle accelerators activities
• Main activities and responsibilities	R&D of novel particle accelerators, THz radiation sources and manipulation

• Dates (2016 – 2021)
• Name and address of employer — Sapienza, University of Rome (Italy)
• Type of business or sector
• Occupation or position held — Member of the Professor Board of Electrical Engineering
• Main activities and responsibilities — Professor of General Physics

VISITING POSITIONS

• Dates (2019 – today)
• Name and address of employer — CERN, European Organization for Nuclear Research (Genève, Switzerland)
• Type of business or sector
• Occupation or position held — Cooperation Associate (COAS)
• Main activities and responsibilities — Coupling impedance measurements, Accelerator devices optimization

• Dates (2002 – 2014) — Various, non-continuative appointments of about 1 month of duration
• Name and address of employer — CERN, European Organization for Nuclear Research (Genève, Switzerland)
• Type of business or sector
• Occupation or position held — Visiting Scientist
• Main activities and responsibilities — Coupling Impedance measurements on LHC device

TEACHING

• Current

General Physics II (Electromagnetics) for BD in Mechanical Engineering (2021 – today)
Multidisciplinary Laboratory of Electronics – RF measurement module for MD in Electronic Engineering (2014 - today)
Accelerator Physics and Relativistic Electrodynamics for MD in Electronic Engineering (2017 – today)
Course on RF Engineering at the “Science and technology of Particle accelerators” at the Joint Universities Accelerator School (JUAS) of the European Scientific Institute (2017-today)

• Past

General Physics I (Mechanics and thermodynamics) and General Physics II (Electromagnetics) for BD in Transportation Engineering (2002)
General Physics II (Electromagnetics) for BD in Environmental Engineering (2003)
Laboratory of Experimental physics for BD of Aerospace Engineering (2004 – 2009)
High Frequency measurement laboratory for MD in Electronic Engineering (2011 - 2013)

GRANTS & PROJECTS

• Dates (2022 – today) — INFN – Fifth National Research Committee
• Name of the project — FLASH radiotherapy with high dose rate particle beams
• Description — Responsible of Work-package
• Total grant — 120k€

• Dates (2019 – today) — INFN – Fifth National Research Committee
• Name of the project — Free electron laser (FEL) radiation from plasma accelerated (PWFA) electron beams
• Description — Responsible of Unit
• Total grant — 40k€

• Dates (2018) — Sapienza, Research Project
• Name of the project — Beam energy measurement in advanced linear particle accelerators for electrons
• Description — PI
• Total grant — 13k€

• Dates (2017) — Sapienza, Research Project
• Name of the project — Advanced beam position monitors for the Compton Gamma Source of the Extreme Light Infrastructure

• Description | PI
• Total grant | 38k€

• Dates (2014 – 2016) | INFN – Fifth National Research Committee
• Name of the project | Plasma based acceleration at SPARC-LAB
• Description | Responsible of Unit
• Total grant | 40k€

• Dates (2013 – 2016) | INFN – Fifth National Research Committee
• Name of the project | European FEL Design Study (EuroFEL project)
• Description | Responsible of Unit
• Total grant | 300k€

• Dates (2012 – 2015) | RBFR12NK5K_002 - FIRB-Futuro in Ricerca 2012
• Name of the project | Generation of high brightness electron beams from plasma-based accelerators
• Description | Responsible of Unit
• Total grant | 180k€

SELECTED PUBLICATIONS AND RESEARCH REPORTS

(out of more than **260** journal publications)

- R. Pompili et al., "Energy spread minimization in a beam-driven plasma wakefield accelerator", Nature Physics 2021
  DOI: 10.1038/s41567-020-01116-9
- D.B. Durham, et al., "Plasmonic lenses for tunable ultrafast electron emitters at the nanoscale", Physical Review Applied 2019
  DOI: 10.1103/PhysRevApplied.12.054057
- V. Shpakov, et al., "Longitudinal phase-space manipulation with beam-driven plasma wakefields. Physical Review Letters 2019
  DOI: 10.1103/PhysRevLett.122.114801
- R. Pompili, et al, "Focusing of high-brightness electron beams with active-plasma lenses" Physical Review Letters 2018.
  DOI: 10.1103/PhysRevLett.121.174801
- N. Biancacci, et al, "Impedance simulations and measurements on the LHC collimators with embedded beam position monitors". Physical Review. Accelerators and Beams 2017
  DOI: 10.1103/PhysRevAccelBeams.20.011003
- F. Giorgianni et al., "Strong nonlinear terahertz response induced by Dirac surface states in Bi2Se3 topological insulator", Nature Communications 2016
  DOI:10.1038/ncomms11421
- A. Petralia, et al. "Two-Color Radiation Generated in a Seeded Free-Electron Laser with Two Electron Beams" Physical Review Letters 2015.
  DOI: 10.1103/PhysRevLett.115.014801
- M. Ferrario et al., "Experimental demonstration of emittance compensation with velocity bunching", Physical Review Letters 2010
  DOI: 10.1103/PhysRevLett.104.054801
- A. Mostacci, et al, "Beam emittance evolution measurements in a rf photoinjector", Physical Review Special Topics. Accelerators and Beams 2008
  DOI: 10.1103/physrevstab.11.032801
- A. Mostacci, et al, "Analysis methodology of movable emittance-meter measurements for low energy electron beams", Review of Scientific Instruments 2008,
  DOI: 10.1063/1.2835715
- A. Mostacci, "Image currents in azimuthally inhomogeneous metallic beam pipes". Physical Review Special Topics. Accelerators And Beams, 2005.
  DOI: 10.1103/PhysRevSTAB.8.084402

- DISPOSITIVO PER IL TRATTAMENTO RADIOTERAPICO DI MALATI ONCOLOGICI, Italian patent for an electron linear accelerator for ultra-high dose rate cancer treatment based on Flash Radiation Therapy, 2019.

PERSONAL SKILLS AND COMPETENCES

Acquired in the course of life and career but not necessarily covered by formal certificates and diplomas.

MOTHER TONGUE — **ITALIAN**

OTHER LANGUAGES

ENGLISH

• Reading skills	excellent
• Writing skills	excellent
• Verbal skills	excellent

FRENCH

• Reading skills	basic
• Writing skills	basic
• Verbal skills	basic

ORGANIZATIONAL SKILLS AND COMPETENCES

Coordination and administration of people, projects and budgets; at work, in voluntary work.

Coordination of the activity in the Accelerator Laboratory at the SBAI Department of Sapienza University of Rome (2002-today)

Coordination of Work Package on “Membership extension strategies” (WP6) of the project “Compact European Plasma Accelerator with superior beam quality – Preparatory Phase” (EUPRAXIA-PP); Horizon Europe Grant Agreement N. 101079773. Member of the Collaboration Board and Sapienza representative. (2022-today)

Steering Committee of the project “Compact European Plasma Accelerator with superior beam quality – Doctoral Network” (EUPRAXIA-DN); Horizon Europe Grant Agreement N. 101073480. Member of the Collaboration Board and Sapienza representative (2022-today)

Coordination of Work Package on “Accelerator prototyping and experiments at Test facilities” (WP12) of the project “Compact European Plasma Accelerator with superior beam quality” (EUPRAXIA); Horizon 2020 grant agreement No 653782. Member of the Collaboration Board and Sapienza representative. (2015-2020).

Coordination of diagnostics group for the linear accelerator of the Compton Gamma Source being built in the Extreme Light Infrastructure for Nuclear Physics (ELI-NP), Magruele (Romania) (2015-2018)

Coordination of the Work Package "Accelerators: Novel compact particle sources" (WP6) of the project “Cluster of Research Infrastructures for Synergies in Physics” (CRISP) in the framework of FP7- INFRASTRUCTURES-2011-1 (2012-2014)

Coordination of the data analysis of all the experiments executed on the SPARC photo injector at the LNF-INFN (2006-2013)

ADDITIONAL INFORMATION

References

Prof. Luigi Palumbo, Prof. Mauro Migliorati, Sapienza, University of Rome
Fritz Caspers, I. Papaphilipou, CERN, Geneve

According to law 679/2016 of the Regulation of the European Parliament of 27th April 2016,
I hereby express my consent to process and use my data provided in this CV.

Rome, 13.09.2023
Andrea Mostacci
Signature

Research Activity highlights

Keywords	Brief Description
Circular accelerators, Coupling impedance,	The electromagnetic interaction between the beam in a particle accelerator and its surrounding (beam pipe) in a circular accelerator is studied with the coupling impedance. Such interaction can lead to energy losses (longitudinal impedance) or transverse instability (transverse impedance). Applying Electromagnetic theory, A. Mostacci studied several potential impedance sources relevant for modern particle accelerators.
LHC liner	The beam pipe foreseen for the Large Hadron Collider (LHC) is rather unconventional. To shield the magnets cold bore from the synchrotron radiation emitted by 7 TeV protons, a beam screen (the so called "liner") has been introduced practically along all the machine. The design of the liner is a compromise among the beam stability issues, the vacuum requirements, the heat load on the cold bore, the electron cloud effects and the realization constraints. Three main potential sources of beam energy losses in the actual LHC liner are important, namely the interaction with the pumping holes, the (saw tooth) surface corrugation and the effect of an azimuthally inhomogeneous metallic beam pipe.
LHC liner Pumping holes	The pumping slots in the beam screen couple the inside of the beam pipe with the external coaxial region, leading to RF power flow with possibly power dissipation on the cold bore. Interference effects between the slots have been studied in details and analytical estimates for the power dissipated in the cold bore as a function of the slot dimensions (hole width and wall thickness) has been given. For the actual slots dimensions, the losses were still within the safe limits. Such studies are being revisited in the context the the Future Circular Collider (FCC) studies where the availability of analytical formulae can simplify the design phase.
LHC liner Surface roughness	The artificial roughness (saw tooth corrugation) of the surface foreseen in the final design of the LHC beam pipe allows the propagation of surface waves synchronous with the beam and thus potentially dangerous for its stability. Using a field matching technique and assuming a periodically rough surface, the frequency of such waves is found to be very high (out of the relevant bunch spectrum): it scales with the inverse of the square root of the depth of the corrugation, that is in the range of microns. The potential dangers have been investigated for the nominal LHC bunch intensity.
LHC liner azimuthally inhomogeneous metallic beam pipe	Based on the Green's function approach, the field excited by a beam traveling in a pipe whose resistivity varies with the azimuth (but is constant in the z-axis direction) can be found (semi)analytically for an ultra-relativistic beam by using some approximated boundary conditions (for conductors). Even at relatively low frequencies (in the MHz range) it was found that the image currents do not avoid the low conductivity region (as you would expect in the limit of static solutions), thus implying potentially high power losses due to the longitudinal welding in the LHC beam screen. Infact, the inner part of the beam screen is covered with a layer of copper (very good conductor) but the weldings have approximately the resistivity of stainless steel (bad conductor) which gives a big contribution to the losses. Numerical studies using the conventional electromagnetic CAD code confirmed such a conclusion. A prototype has been designed and built to experimentally verify the azimuthal distribution of the image currents, through very accurate Q-factor measurements in a coaxial resonator. The measured data confirmed the theoretical predictions.
Impedance studies	The theoretical environment built to study the LHC liner impedance issues has been subsequently applied to similar problem to give estimations of the impedance contribution in more complicated devices in order to explain unexpected phenomena (e.g. heat load) suffered by the beam, particularly relevant in cryogenic machines.
RF devices, bead pull measurement,	In the “Accelerators” laboratory at the SBAI department, A. Mostacci designed, built and maintained a test bench to measure electromagnetic field inside closed RF

	structures (so called "bead-pull" method). Several devices installed in SPARC, the high brightness LINear Accelerator (linac) of Laboratori Nazionali di Frascati (LNF), have been tested in the laboratory. Those measurements were calibrated to measure not only the field shape, but also the accelerating efficiency of the structure. Typical RF devices measured are deflector, electron gun and accelerating sections in the 3 to 12 GHz frequency range. The tuning procedure for 6GHz accelerating structures built at LNF have been defined and applied for the first time in the previously discussed test bench. The laboratory is equipped also with codes for electromagnetic CAD used both for designing novel devices and for validating measurements on prototypes. A. Mostacci studied also on the bead-pull measurement theory for non-conventional RF structures.
Coupling impedance, bench measurements, coaxial wire method	Bench measurements nowadays represent an important tool to estimate the coupling impedance of any particle accelerator device. The well-known technique based on the coaxial wire method allows to excite in the device under test a field like the one generated by an ultra-relativistic point charge. The field of a relativistic point charge in the free space (or in a perfectly conducting beam pipe) is a Transverse Electric Magnetic (TEM) wave, namely it has only components transverse to the propagation direction. The amplitude scales inversely with the distance from the propagation axis and phase velocity is equal to the speed of light. The fundamental mode of a coaxial wave guide is a TEM wave as well, with the same amplitude dependence and the same propagation constant. Therefore, the excitation due to a relativistic beam in a given Device Under Test (DUT) can be "simulated" by exciting a TEM field by means of a conductor placed along the axis of the structure. With the coaxial wire method, A. Mostacci measured the coupling impedance of many particle accelerator devices of interest of CERN machines such as LHC and its injectors. A. Mostacci also performed beam experiments at CERN to compare bench measurement with direct beam measurement on the same devices. The coaxial line approach has also been used to bench measured the effect of coating in the secondary emission yield, relevant for LHC electron cloud issues. More recently the new generation of LHC collimators has been bench measured in order to estimate the coupling impedance and look for possible trapped modes in the moving jaws.
SPARC, machine measurements Physics of high brightness beam	Since 2006, A. Mostacci joined SPARC commissioning and operation. SPARC is a high brightness linear accelerator initially conceived to drive proof-of-principle experiments in the generation of radiation with Free Electron Laser (FEL). Nowadays the SPARC accelerator has been upgraded to SPARC_LAB with the installation of multi TW class lasers, allowing world-class, ground breaking experiments in accelerator and plasma physics as well as interdisciplinary research. Following the time line of the SPARC_LAB upgrades, the activity can be roughly divided in research on physics of high brightness electron beams, on FEL innovative schemes, on the generation of THz radiation, on novel plasma-based particle acceleration techniques and on Compton effect based radiation sources. Concerning the physics of high brightness electron beam, SPARC measured for the first time the emittance oscillation of beams generated by RF photocathodes, assessing the working point used world-wide in all the FELs based on RF guns. Such result has been possible due to a carefully conducted experiments and data analysis. In order to longitudinally compress the electron beam (to increase the bunch current), SPARC introduced and demonstrated the low energy compression (namely "velocity bunching") properly tuning low energy focusing solenoids, for the first time used there. Such velocity bunched beam exhibit non-negligible energy spread that must be considered in beam measurements or exploited in to produce radiation with non-conventional FEL configurations. SPARC high brightness beams are also used to propose and demonstrate novel concepts in beam diagnostics or medical applications in electron-based radiotherapy.

Free Electron Laser	SPARC contributed to develop and test innovative ideas on Free Electron Laser schemes which have been afterword applied in bigger FEL facilities; such results have possible also to extensive benchmarking of code against experiments and innovative diagnostics. For instance, SPARC introduced the undulator tapering to compensate energy spread or demonstrated the generation of a super radiant pulse in the long radiator of a single stage cascaded FEL, by seeding the modulator with an external laser. Seeded FELs can operate either in the amplifier "direct seeding" scheme, or in the high gain harmonic generation configuration, where the seed in a first undulator (modulator) is used to induce an energy-density modulation in the electron beam longitudinal phase space. This bunched beam then emits a higher order harmonic in a following undulator (radiator). This scheme can be repeated in a multiple stage cascade of modulators and radiators, extending the operation wavelength toward a range where seed sources are not available. The versatility of the SPARC linac allowed also to send a train of bunches in the FEL undulator, resulting in a two colour FEL radiation time modulated FEL radiation and seeded two colours radiation. Also, this scheme was pioneered at SPARC and it is now used in several other laboratories for pump-probe FEL experiments.
THz radiation	The generation of THz radiation at SPARC relies on the usage of sub-ps high brightness electron bunches when a broadband radiation is needed, while longitudinally modulated electron beams allow for tunable narrow-band radiation. The generation is quite efficient since the velocity bunching imposes a longitudinal phase space distortion, leading to asymmetric current profiles with sharp rising charge distribution at the bunch head; therefore, high frequency (THz) radiation can be emitted if the bunch goes across a radiator (coherent transition radiation). The resulting THz radiation is more intense than other sources and it has been used for advanced material studies.
Laser-plasma accelerators, CRISP project, FIRB project, Eupraxia project	Plasma-based accelerators represent the new frontier for the acceleration of high quality, i.e. high brightness, electron beams because of their capability to sustain extremely large accelerating gradients. In conventional Radio-Frequency (RF) linear accelerators, accelerating gradients are currently limited to ~100 MV/m, mainly due to breakdown occurring on the metallic walls of the devices. Ionized plasmas, however, can sustain electron plasma waves with electric fields three orders of magnitude higher than those achievable with actual RF technologies. Moreover, the accelerating field strength is tunable by adjusting the plasma density. Even though the principle of plasma-based acceleration has been proven by several groups, the so accelerated beams still suffer from large angular divergence, large energy spread, poor reproducibility, which prevent their use as an alternative to conventional RF accelerators which typically provide stable and high quality electron beams. A possible solution is to use innovative transport lines based on conventional technology, such quadrupole or solenoid based transport lines arranged in a clever way. Another approach towards plasma-accelerated high-brightness electron beams relies on the use of the plasma only as the active media, injecting electrons into a pre-formed plasma channel. A first scheme consists in injecting a witness electron bunch in a plasma where the plasma wave is excited by a high-power laser pulse, i.e. external injection in a Laser Wake Field Accelerator (LWFA). The second scheme relies on the induction of coherent plasma oscillations with multiple electron bunches, that is a resonant Plasma Wake Field Accelerator (PWFA). Such idea relies on using a comb beam, i.e. a train of equidistant bunches, to increase the accelerating gradient. A scheme to produce comb-like beams was conceived at Laboratori Nazionali di Frascati and successfully tested at SPARC for the first time. The additional benefit of resonant PWFA relies on the use of lower charge bunches in the train with respect to traditional PWFA, with the advantage of a better control of acceleration and transport. The proof of principle experiments of resonant wake field acceleration triggered improvements in the plasma generation schemes, in active plasma lens for symmetric beam focusing, in the SPARC synchronisation, in standard bunch measurement as

	well as in non-intercepting beam diagnostics; also, the betatron radiation emitted by electron moving in the plamsa channel can be used. Efforts are ongoing also in measurement the plasma channel properties with spectroscopic and opto-acoustic methods. Moreover, to support the plasma source commissioning, simplified (but accurate) models are necessary to properly choose the machine working point. Those models, before being used, must be assessed against accurate Particle In Cell simulation.
Compton Sources ELI-NP	High brightness linacs are used also in Gamma ray source based on Compton back scattering between electron and counter-propagating laser pulses. A possible design has been proposed investigating the bam dynamics as well as the issues due to the necessity of multi-bunch operation to increase the luminosity. A single bunch, proof of principle experiment has been done at SPARC_LAB. Even if in a smaller sized design, the Gamma Beam Source is being built in Romania under the ELI-NP project supported by EU. One of the most relevant issues is the need of multi-bunch, high charge beams affecting the design and the operation of accelerating structures and diagnostics.
Medical applications FLASH electron accelerators	Radiation Therapy is currently the most utilized technique for the treatment of tumours by means of high-energy beams, either particles (such as electrons, protons and neutrons) or X/gamma rays, depending on the type, size and depth of the cancer mass. Radiation therapy has in general fulfilled the main requirement of targeting thus damaging the malignant cells and sparing the healthy tissues as best as possible. Recently, it has been experimentally demonstrated that ultra-high dose bursts of electrons and X-ray beams augment the differential response between healthy and tumour tissues. This beneficial response is referred to as the FLASH effect. A compact S-band linear accelerator (named ElectronFlash) for FLASH radiotherapy has been conceived, design and realised in collaboration with S.I.T. ElectronFlash is fabricated and tuned by following low-cost procedures appropriate for industries and it is mounted on a remote-controlled and light-weight robot system that is perfectly suitable for even small operating rooms. The work done includes RF and beam dynamics design of ElectronFlash as well as the commissioning and high-power RF tests. The results of the dosimetry measurements for the specific application of intra-operative electron radio-therapy (IOeRT) are extremely encouraging. ElectronFlash has been specifically designed dedicated to ultra-high dose rate experiments in order to consolidate the promising radiobiological results given by the FLASH effect; ElectronFlash is now installed in Institut Curie (in Paris). Currently, A. Mostacci and his team are facing the next step in this research, i.e. the design of high-gradient RF cavities (e.g. C-band) to provide very High Energy Electrons (VHEE) suitable for FLASH radiotherapy.
Medical applications Hadroterapy, post-acceleration	Hadroterapy protons are typically produced with Radio Frequency quadrupoles and then delivered to the patient with circular accelerators (even if recently hospital proton linacs are under construction). Few tens of MeV protons can also be produced with high energy laser pulse hitting a target; such scheme has interesting feature in terms of beam properties, versatility and compactness. In order to improve the beam properties up to medical requirements proposed a post acceleration scheme based on modified hospital proton linac cavities.
Montecarlo, FLUKA	A. Mostacci has been involved in the design of particle detectors for biomedicine, joining the research on Treatment Planning Systems (TPS) for tumour hadroterapy with carbon ions using Monte Carlo techniques (FLUKA code); he was involved in the FLUKA collaboration on the optics module in order to calibrate the simulations against measurements on Compton chamber for Single Photon Emission Computed Tomography.

Curriculum vitae

PERSONAL INFORMATION

Family name, First name: Marafini Michela
Researcher unique identifier: ResercherID: C-7439-2014
Nationality: Italian

CURRENT AND PREVIOUS POSITIONS

31/12/2018 - Researcher
Museo Storico della Fisica e Centro Studi e Ricerche Enrico Fermi, Rome, Italy
Sapienza Università di Roma, Italy – Scienze di Base e Applicate per l'Ingegneria

2/2016-9/2018 Researcher (RTD)
Museo Storico della Fisica e Centro Studi e Ricerche Enrico Fermi, Rome, Italy
Sapienza Università di Roma, Italy – Scienze di Base e Applicate per l'Ingegneria

7/2015-1/2016 Researcher Grant
Istituto Nazionale Fisica Nucleare (INFN), Rome division, Italy

8/2013-6/2015 Researcher Post-Doc
Museo Storico della Fisica e Centro Studi e Ricerche Enrico Fermi, Rome, Italy
Sapienza Università di Roma, Italy Italy – SBAI Department

5/2011-4/2013 Researcher Grant
Museo Storico della Fisica e Centro Studi e Ricerche Enrico Fermi, Rome, Italy
Sapienza Università di Roma, Italy – Physics Department

EDUCATION

2008-2011 ***Ph.D.*** in Physics *"Physics studies and R&D towards the MEMPHYS experiment: a water Cherenkov Detector in Europe"* (*Mention très honorable*)
Supervisor: Prof. T. Patzak
Université Paris 7 - Laboratoire Astro Particules et Cosmologie (APC), Paris, France

2004-2007 ***Master Degree*** in Physics *"A water Cherenkov prototype for neutrino detection: light collection simulation studies and efficiency measurements" (110/110 cum laude)*
Supervisor: Prof. F.Ceradini and Prof. T.Patzak
Università Roma Tre, Roma, Italy – Master **Stage at APC** - Université Paris 7

2001-2004 ***Bachelor Degree*** in Physics *"The MDT detector for the ATLAS experiment at CERN: final certification procedure" (Full mark)* Supervisor: Prof. A. Tonazzo
Università Roma Tre, Roma, Italy – Bachelor **Stage at CERN**

FUNDED PROJECTS *as Principal Investigator*

2023 – 2025 *"reSPECT: Towards a new family of nuclear imaging gamma detectors"* – Funding: 304 keuro. PRIN: PROGETTI DI RICERCA DI RILEVANTE INTERESSE NAZIONALE – Bando Prin 2022 - Decreto Direttoriale n. 104 del 02-02-2022 - Prot. 2022Z72Y3K. The aim of the project is to realise a next generation SPECT for diagnosis imaging.

2020 – 2022 *"FlashDC"* – Funding: 149 keuro. Domanda n. PROT. A0375-2020- 36748. Avviso Pubblico "Gruppi di ricerca 2020" - POR FESR Lazio 2014-2020.

2015 – 2018 *“A fast neutron-tracking device tailored for hadrontherapy dose monitoring applications”*– Funding: 539 keuro. Id: RBSI140VL4. Italian Ministry of Education, University and Research (MIUR) with SIR Program (Scientific Independence of young Researchers): competitive funding (success rate of 2%) of research projects with high scientific quality developed by independent research teams, under the scientific coordination of a Principal Investigator at the start of his research activity.

2015 – 2017 *“MONDO (Monitor for Neutron Dose in hadrOntherapy)”* – Funding: 132 keuro. INFN Young Researcher Grant award funding research projects to foster excellence among researchers working in the research and technological developments.

FUNDED PROJECTS *as a member*

2024 – 2026 *“MULTIPASS: MULTIPle trAcker for Secondary particleS monitoring”* – Funding: 225 keuro. PRIN PNRR 2022: PROGETTI DI RICERCA DI RILEVANTE INTERESSE NAZIONALE Prot. P2022FZAC3 –. The aim of the project is to realise a tracker for the detection of secondary radiation of different types, charged and neutral, for the beam monitoring in particle therapy. PI: Ilaria Mattei (INFN)

2022 – *“FRIDA”* – Call CSNG5 INFN. Flash radiotherapy with hight dose-rate. I participate in WP2 in the beam monitor development. Funding 2022: 225 keuro. PI: Alessio Sarti (Dipartimento SBAI, Sapienza)

2020 – 2022 *“3DIT”* – Bando di Ateneo Progetti Medi 2021. 3D Printed Plastic Scintillator. I am one of the main actors in this multidisciplinary chemistry-physic development. Funding 10 keuro. PI: Leonardo Mattiello (Dipartimento SBAI, Sapienza)

2018 – 2021 *“SPARE (Space Radiation Shielding)”* -. Premiale 2016. Irradiation facilities in INFN laboratories (TIFPA and LNL) for space radiation applications. I have been part of WP400 *“Detectors”*. Funding 1.432 Meuro. PI: Marco Durante (TIFPA, GSI)

2013 – 2016 *“INSIDE” - MIUR PRIN 2011.* Development of monitoring for charged particles. I have been part of WP5 “*Dose Monitoring for Hadrontherapy"* and WP6 *“Nuclear Fragmentation Studies for Hadrotherapy”*. Funding: 977.9 keuro. PI: Alberto Del Guerra (Università di Pisa).

ASN National Scientific Qualification

ABILITAZIONE SCIENTIFICA NAZIONALE FASCIA: II

- 29/09/2023 - 29/09/2034 ACADEMIC RECRUITMENT FIELD, PRIMA FASCIA: 02/D1
  ACADEMY DISCIPLE: FIS/07
- 23/05/2023 - 23/05/2034 ACADEMIC RECRUITMENT FIELD, SECONDA FASCIA: 02/A1
  ACADEMY DISCIPLE: FIS/02
- 05/10/2018 - 05/10/2024 ACADEMIC RECRUITMENT FIELD, SECONDA FASCIA: 02/A1
  ACADEMY DISCIPLE: FIS/04

TEACHING ACTIVITIES

2017 - 2022 ***Assistant*** for the course of *Physics Laboratory II* held by Prof. G.Cavoto.
Università di Roma, Italy - Physics Department

2016 - 2017 ***Assistant*** for the course of *Nuclear and Sub-nuclear laboratory* held by Prof. S.Veneziano. Università di Roma, Italy - Physics Department

2004 – 2005 ***Assistant*** for the course of *Classical Mechanics and Thermodynamics* held by Prof. F. De Notaristefani. Università Roma Tre - Faculty of Science

SUPERVISION OF STUDENTS AND POSTDOCTORAL FELLOWS

- 4 Post-Doc (employed with my projects funds)
- 2 Ph.D.
- > 15 Master and >15 Bachelor Students

from different universities: Sapienza Università di Roma, Italy - Physics and Engineering Departments and Université Paris 7 - Physics Department - Laboratoire APC, Paris, France

COMMISSIONS OF TRUST

- Member of ***PhD Commission*** - Juri de Thèse: 1 PhD (ITM Atlantique et Ecole Doctorale 3M) commission for the PhD in Physique Subatomique et Instrumentation Nucléaire.;
- Member of **Commissions**:
  - 6 LNF (Laboratori Nazionali di Frascati, INFN) call for applications for *"Collaboratore Tecnico e Collaboratore Amministrativo a tempo Determinato/Indeterminato degli enti di ricerca"*.
  - 5 CREF call for applications for research fellowship
- International scientific journals activities:
  - **Associate Editor** of: Frontiers in Physics - Medical Physics and Imaging
  - **Reviewer** of: Scientific Reports - Physics in Medicine and Biology – Measurement Science and Technology – Journal of Physics Communications - Nuclear Instruments and Methods in Physics A - Frontiers in Oncology.
- National **Scientific Responsibilities:**
  - From 2021 Local Responsible for the INFN FOOT (Member of the IB)
  - From 2020 Responsible of all Radio-hAdron Therapy (RAT) at CREF
  - 2015-2016 National Responsible for the INFN MONDO
- 2019 Early Career Investigator (ECI) Membership of Radiation Research Society.

RESEARCH PERFORMANCES, EXPLOITATION AND DISSEMINATION

My research focuses on research and development of innovative detectors and to the application of particle physics detection technique to different fields, in particular to the medical one. The scientific outcome of my research is explicated in several publications on referred journals and presentations at conferences and seminars.

- h index of 20, with more than 130 publications in refereed international journals for a total of more than 1200 citations (database: http://www.scopus.com);
- 19 publications in refereed international journals as first, last or corresponding author;
- More than 15 presentations and seminars at international conferences and workshops;

The technology transfer is of large importance in applied physics. I devote a huge effort to make TT of our research possible through the exploitation of different possible paths.

- 2 Granted patents:
  - 2021 P3080IT00, request accepted. Development of a new class of plastic scintillators for the realisation of fast timing detectors. Shared ownership between SBAI and CREF.
  - 2014 PCT/IT2014/00002: *"Intraoperative detection of tumour residues using beta- radiation and corresponding probes"* WO 2014118815 A2. Shared ownership between INFN, SBAI and CREF.
- Realisation of an international consortium of companies and research organisations as the *scientific and technical coordinator* for the reSPECT project (6 partners: Fondazione

Bruno Kessler Italy, Museo Storico della Fisica e Centro Studi e Ricerche E.Fermi Italy, Università degli Studi di Roma La Sapienza Italy, Synective Labs Aktiebolag Sweden, Univeritair Medisch Centrum Utrecht Netherlands, Molecubes NV Belgium);

- Collaboration with the SIT- Sordina IORT Technologies for a TPS IORT development
- Participation to projects with dedicated call-funding opportunities:
  - POR Regione Lazio 2020 dedicated to the technology transfer to companies (funding obtained)
  - HORIZON-EIC-2022-PATHFINDEROPEN-01 and HORIZON-EIC-2021-PATHFINDEROPEN-01 (excellent evaluations, 4.15/5, not selected because of the budgetary resources available for the call)
  - H2020-FETOPEN-2018-2019-2020-01 (excellent evaluation, 4.20/5, not selected because of the budgetary resources available for the call)

My large public communication and dissemination activity is mainly focused to the Enrico Fermi Museum and the organisation of events at CREF (Museo Storico della Fisica e Centro Studi e Ricerche E.Fermi).

- Creation of an activity for kids *Memory delle Particelle*
  - conduced at NET Scienza Insieme 2023, *Notte dei Ricercatori Roma* (https://www.scienzainsieme.it/il-memory-delle-particelle/)
  - conduced at *Festival della Scienza* Genova 2023 (https://www.festivalscienza.it/programma-2023/il-memory-delle-particelle)
- Organisation and participation of:
  - scientific aperitif event - *aperitivo scientifico* (NET Scienza Insieme, 6/2021)
  - event of *Talenti per la Scienza* (NET Scienza Insieme, *7/2021)* at parco Talenti
  - open projection of the movies: *Una cattedra per Laura Bassi, Bruno Pontecorvo, La particella Fantasma* (9/2021)
  - open access of the center for the *Notte dei Ricercatori 2021 (9/2021)*
- Guides to of the museum *"L'Eredità scientifica di Enrico Fermi"*, to about 300 visitors and students (2019 - 2023);
- Organisation of the inauguration event of CREF infrastructure (10/2019);

TRACK RECORD

My research career has taken place along a path closely related to the application of particle physics techniques to the development of novel detectors and their various applications either to fundamental or applied research topics. I grew my experience in an international R&D environment, facing both hardware and software challenges. I have steadily increased my skills profiting from the participation to the work of different experimental groups, across different countries in an international environment, whose main activities were focused in different fields. The Particle Therapy field offered me the opportunity to investigate different new detectors with growing responsibilities. I finally gained my independency in leading projects, coordinating teams and finalising R&D studies with an always-growing responsibility.

I started my Ph.D. research work focusing on the neutrino oscillation investigations and the related innovative R&D projects. I worked on the large-scale next generation detectors neutrino measurements in the framework of the LAGUNA and the EUROnu European projects [10]. I presented MEMPHYS [9], megaton water Cherenkov, in international conferences (xiii, ixx). I developed, design, mechanical assembled and instrumented with a readout system the MEMPHYS prototype, which was needed to implement a new electronic readout based on PARISROC system (LAL-ORSAY). During the realisation of the prototype I was the responsible of the associated budget. The R&D experience has given me the opportunity to explore many aspects of particle detection.

In 2011 I decided to continue this activity on development of photo-sensor devices in a different context: the Particle Therapy (PT). I joined the ARPGroup at Sapienza Università di Roma. At the time the activities were focused on the characterisation of the secondary particles produced in PT treatments and to their exploitation in the monitoring of the dose delivered to patients during oncological treatments. Within the ARPG group **I have directly contributed to the study of the secondary particles emission, aiming to a precise measurement of rates, energy and spatial distributions, for charged particles and photons** (prompt and PET-gamma). In all the different phases of my work, I have faced and overcame different hardware and software challenges: I assembled and tested the detectors needed for the secondary fragments production measurements, performed the data analysis and published the results on peer-reviewed international journals.

Since 2013 I have focused my activity on the construction of an on-line tracker, the Dose Profiler (DP), within the INSIDE framework. I characterised different layouts using scintillation fibres of various sizes and performing the related first efficiency evaluations.

From 2012, with the ARPGroup I took part to **many data taking campaigns with proton, carbon, helium and oxygen ion beams in different particle therapy centres** (HIT, GSI, CNAO, APSS). I personally took care the several experimental setups planning and construction. I contribute to the data analysis of the several performed study and I presented and published the results in several international conferences (viii) and papers [2,5].

The DP continued with MonteCarlo and data taking studies and in 2017 it started a clinical trial on monitoring operation at CNAO. I reviewed and presented the DP status, on behalf of the INSIDE collaboration (xi) and the first results of inter fractional monitoring has been published [4].

My interest in the development of new detectors led me to work with different crystals and scintillating materials. In 2011-2012, I decided to join a small group of researchers in the experimental effort of studying (ad publish) the Cherenkov light emitted by TeO_2 crystals (for $0\nu2\beta$-decay). I was also involved in p-terphenil characterisation (organic plastic scintillator): I measured and published its transparency and attenuation length, opening to the ARPG group the opportunity to design an innovative probe for radio-guided surgery [7], for which an international patent is now pending.

Since 2014 I started **my own new research effort devoted to the study of the experimentally most challenging PT secondary radiation type: neutrons**. Neutrons produced in PT treatments are poorly known, therefore I proposed a neutron-tracking detector to be used in PT centres to characterise their production. The related project, MONDO, in December 2014 was funded by the INFN and in spring 2015 (upgraded version) I received a larger funding by the Italian Ministry of Research (SIR2014). Since 2015 I am the coordinator of the project. The research work performed within the MONDO project led to **the implementation of a new SPAD array sensor**. Fondazione Bruno Kessler (FBK) has developed the SBAM sensor in collaboration with CREF that shares now it intellectual property. In March 2016 I started the construction of a MONDO prototype at SBAI department in close collaboration with the mechanical service. I organised data taking campaigns at the electron Beam Test Facility of Laboratori Nazionali di Frascati and at the protons experimental room of the Trento Proton Therapy Centre. In 2019 the first SBAM chips have been produced and tested at SBAI and FBK. The evaluation of the expected MONDO performances (via FLUKA MC Simulation) and the results obtained with the prototype irradiation with different readout systems have been presented in international conferences (iii,vi,viii, x) and have been published in referred international journals [1].

During the optimisation of the MONDO detector layout I start working on the **development of an optical readout for triple-GEM detectors** (ORANGE). **I demonstrated, for the first time, the feasibility of such detectors**. In less than two years a triple-GEM detectors readout with commercial camera and lens has been successfully built. The results have been presented to the RD51 collaboration (CERN) (xi) and put the basis for a joined effort in the development of next generation gaseous detectors. The promising performances obtained within ORANGE tracking detector [8], resulted in a proposal for optimised detectors (ex. LEMON) currently exploited and considered for several different applications from the medical field up to the dark matter search. Up to now the optical GEM technology is exploited by the CYGNO experiment, funded by INFN, dedicated to the **dark matter detection** at LNGS.

From 2016 I joined the effort of building the FOOT collaboration, an experiment devoted to the **proton Relative Biological Effectiveness (RBE)** evaluation for PT applications. I worked in the development of the calorimeter and the start detectors making available the experience I gained in handling inorganic crystals for calorimetric purpose and organic scintillators for time detectors developments. In the FOOT collaboration I gave an important contribution to the R&D of a phoswich detector made by the combination of fast plastic scintillator and BGO crystal. I presented the status of the FOOT on behalf of the collaboration at (iv) and (v) international conferences.

During the FOOT data taking with oxygen ion in spring 2019 at GSI I coordinated the installation of the beam monitor detectors allowing the emulsion setup to be fully online controlled during the irradiation. In winter 2020 I have been the **run coordinator of the carbon ion data taking at GSI** with the electronic FOOT setup. From summer 2021 I am the FOOT local responsible at INFN Rome1 and I am the member of the FOOT Internal Board.

In 2019 I had the chance to put in use the know-how I gained on tracking detectors in the Particle Therapy field supporting a young national grant (PAPRICA, PAir PRoduction Imaging ChAmber), devoted to the **detection of prompt photons** emitted in PT treatments, to monitor the range of the beam in the patient. The detector expected performances have been studied through a MC FLUKA simulation and have been published in [3].

In 2018 I start cooperating in a join effort between chemistry, engineering and physics researchers at SBAI. We decided to **investigate and develop a new family of fluorens for plastic scintillators developments.** I selected the most promising attempts in order to optimise fast plastic scintillators (Time Of flight Plastic scintillators, TOPs). I personally coordinate the laboratory tests and the characterisation of the new materials with different sources of radiation. Form 2019 I characterised the new TOPs scintillators with proton beam (at CNAO) and carbon ion (at GSI) at different energy and with m.i.p. at SBAI. I also provide the analysis of the collected data and the promising results [6] has been accepted for contribution in several international conferences. A paper is in preparation. With the results obtained so far a patent request has been submitted in December 2021. In this framework, I am coordinating a feasibility study dedicated to the development of a plastic scintillator dissolved in the 3D printer resins. The *veroclear* material (https://www.stratasys.com/materials/search/veroclear) is highly transparent and we demonstrate the possibility of dissolved the TOPs scintillator in this solvent. The study has been supported by the 3DIT university funding (**3D Printed Plastic Scintillator**: SBAI, INFN Roma1 and CREF collaboration).

From 2019 I start investigating the possibility of integrate the increasing chemistry skills in our activities. Together with the same chemistry, engineering and physics team of researchers I elaborate the reSPECT idea: a new family of gamma imaging detectors based on organic scintillators combined with 3D printed collimators, allowing for a significant cost reduction while achieving a beyond state-of-the-art resolution and count-rate capability. The reSPECT active material is an **enriched hi-Z organic scintillator** [6] that allows for a detector integration in MRI systems, leading to a 10 time better signal to noise ratio. The key aspect is the possibility to detect via photoelectric effect the few hundred of keV photons in a doped organic scintillator. Up to now an international consortium has been constituted and the test on the sample of enriched Hi-Z organic scintillator is under going under my supervision at SBAI.

In the last two years the radiotherapy community has been pleasantly shocked by the more and more scientifically trustable evidences of the so called Flash effect. Within the ARPGroup I propose a **beam monitor dedicated to next generation beams at Flash intensities** based on the **air fluorescence**. In 2020 I ask and obtained a regional funding to support the investigation in this topic (FlashDC project) and up to now two prototypes of beam monitors for electron flash beam have been constructed and tested at the SIT electron machines (i). The FlashDC project is now (from November 2021) part of a larger community (FRIDA) that collects the effort of the INFN researchers on the Flash innovation.

Beside the Flash effect the SIT company asked for a tool capable of dose computation for an IOeRT mobile electron linear accelerator. Therefore, since 2020 I cooperate to the development with a GPU-based fast Monte Carlo of a fast MC tool tuned for IOeRT application (ii).

- **<u>Scientific products:</u> selection of 10 publications highlighting my personal contributions**

1. M. Marafini et al. *Mondo: A neutron tracker for particle therapy secondary emission characterisation*. doi: 10.1088/1361-6560/aa623a
2. M. Marafini et al. *Secondary radiation measurements for particle therapy applications: Nuclear fragmentation produced by 4he ion beams in a pmma target*. doi: 10.1088/1361-6560/aa5307
3. M. Toppi et al. *Paprica: The pair production imaging chamber- proof of principle*. doi: 10.3389/fphy.2021.568139
4. M. Fischetti et al. *Inter-fractional monitoring of 12C ions treatments: results from a clinical trial at the cnao facility*. doi: 10.1038/s41598-020-77843-z
5. L. Piersanti et al. *Measurement of charged particle yields from pmma irradiated by a 220 Mev/u 12C beam.* doi: 10.1088/0031-9155/ 59/7/1857
6. R. Mirabelli et al. *Tops project: Development of new fast timing plastic scintillators.* doi: 10.1393/ncc/i2020-20017-4. and D.Rocco et al. *TOPS fast timing plastic scintillators: Time and light output performances* doi:10.1016/j.nima.2023.168277
7. E.S. Camillocci et al. *A novel radio-guided surgery technique exploiting beta- decays.* doi: 10.1038/srep04401
8. M. Marafini et al. *High granularity tracker based on a triple-gem optically read by a cmos-based camera*. doi: 10.1088/1748-0221/10/12/P12010
9. L. Agostino et al. *Study of the performance of a large scale water- cherenkov detector (Memphys)* doi: 10.1088/1475-7516/2013/01/024
10. M. Wurm et al. *The next-generation liquid- scintillator neutrino observatory Lena.* doi: 10.1016/j. astropartphys.2012.02.011

- **<u>Conferences and Seminars:</u> Selection of my most important contributions in conferences**

i) 03/2023 Geneva: Spring Seminar - Université de Genève 2023 "*News from Radio and Particle Therapy against tumours: the flash effect and the potential of the almost empty (or full?!)"*. Invited Seminar.

ii) 11/2022 FRPT: Flash Radiotherapy and Particle Therapy Conference. *"An online beam monitor for flash radiotherapy: the FlashDC project"*. E-Poster Presentation.

iii) 09/2022 SIF: 107 Congresso Nazionale Società Italiana di Fisica - online. *"Dose computation with a GPU-based fast Monte Carlo for an IOeRT mobile electron linear accelerator"*. Invited talk.

iv) 6/2019: PTCOG58 Manchester, UK. "*Characterisation of the secondary neutron production with the MONDO project: an innovative tracker of ultra-fast neutrons optimised for Particle Therapy applications"*. Poster Contribution.

v) 11/2019 RRS: 65th Annual Radiation Research Society Meeting - San Diego, USA. *"Measuring the impact of Nuclear Interaction in Particle Therapy and in Radio Protection in Space: the FOOT Experiment"*. Invited talk.

vi) 6/2018 NRM: 15th Varenna Conference on Nuclear Reaction Mechanisms - Varenna, Italy. *"The FOOT Experiment"*.

vii) 11/2017 PRESS: PRoton thErapy research SeminarS – Krakow, Poland. *"Secondary neutrons in particle therapy: the Mondo project"* Invited talk.

viii) 6/2017 MLZ: Neutrons for Health - Bad Reichenhall, Germany. *"Characterisation of the secondary fast and ultrafast neutrons emitted in Particle Therapy with the MONDO experiment"*.

ix) 4/2016 Seminar: Colloqui di Fisica, Università Roma Tre, Italy. *"The particle therapy and the role of secondary neutrons: the MONDO project"*. Invited talk.

x) 6/2015 RAD: Montenegro. *"Measurement of charged particle yields from therapeutic beams in view of the design of an innovative hadrontherapy dose monitor"*. Contribution on RAD 2015 Proceeding.

xi) 5/2015 SRHITS: Space Radiation and Heavy Ions in Therapy Symposium - Osaka, Japan. *"The MONDO Project"*.

xii) 3/2015 RD51: Second Special Workshop on Neutron Detection with MPGDs - CERN. *"MONDO: A neutron tracker for particle therapy secondary emission fluxes measurements"*. Invited talk.

xiii) 9/2014 SPET: II Symposium on Positron Emission Tomography - Krakow, Poland. *"The INSIDE project: Innovative solutions for in-beam dosimetry in hadrontherapy"*. Invited talk.

xiv) 1/2010 EC: Epiphany Conference - Krakow, Poland *"Physics with the MEMPHYS Detector"*. Contribution on Acta Physica Polonica B 41(7), pp. 1733-1748 (cit 2)

xv) 10/2009 NNN09: Workshop on Next Generation Nucleon decay and Neutrino Detectors - Estes Park, Colorado (USA). *"Water Cherenkov R&D in Europe"*. Invited talk.

Rome,
17.01.2024 **Michela Marafini**

Davide Badoni - Curriculum vitae

DATI ANAGRAFICI – Posizione lavorativa e riferimenti di contatto

Dal 5 Dicembre 2018 – Tecnologo III livello - I.N.F.N., Sezione Roma Tor Vergata
1989 – 4 Dicembre 2018: CTER INFN – Sezione Roma Tor Vergata.
Maggio 1985–1989: tecnico INFN – LNF.

ISTRUZIONE E FORMAZIONE

Maggio 2005: Laurea magistrale in Fisica**.** Università di Roma Tor Vergata, Roma: Titolo della tesi: "Progetto e realizzazione in VLSI analogico di sinapsi e neurone impulsato per un chip neuromorfo".
Periodo di studi universitari: da A.A: 1996/1997 (immatricolazione) ad A.A: 2003/2004.
Luglio 1979: Diploma di maturità da "I.T.I.S. Enrico Fermi di Frascati" in Frascati (Roma).

ATTIVITÀ DI RICERCA

La mia attività di ricerca tecnologica negli ultimi 15 anni si è concentrata nello sviluppo e nell'applicazione di nuove tecnologie e tecniche per la rivelazione, articolandosi in canali distinti: sviluppo di ASIC per front-end di sensori e sviluppo di elettronica a basso rumore con relativa implementazione in apparati spaziali con relativa gestione dei progetti.
Nel periodo dal 2011 fino al presente, la mia attività si è concentrata nella gestione e realizzazione di apparati per applicazioni spaziali, seguendo e coordinando le attività in tutte le loro fasi: a partire dallo studio di fattibilità, sino al progetto, sviluppo e test di qualifica ed accettazione degli strumenti, sia a livello di singola board che a livello di sistema elettronico completo ed integrato. In particolare, nell'ambito delle due missioni satellitari Italo-Cinesi, CSES-Limadou (lancio 2 febbraio 2018) e CSES-02-Limadou-02 (completata, lancio previsto per il 2024), sono stato responsabile di sviluppo e caratterizzazione del rivelatore Electric Field Detector (EFD-01) per il primo satellite e di progettazione, realizzazione, integrazione dell'elettronica e test del rivelatore EFD-02 per il secondo satellite. In tale contesto mi sono occupato sia 1) dello studio e sviluppo dell'elettronica dello strumento, con particolare riguardo alle sezioni analogiche che 2) della gestione e coordinamento del team e delle attività di cooperazione tra team cinese ed italiano, sia nella fase progettuale/costruttiva, che in quella di analisi dei risultati dei test a terra.
In parallelo, dal 2020 ad oggi la mia attività è di sviluppo di rivelatori All-In-One (detector, elettronica, DAQ) per la rivelazione di particelle e la misura di flussi di bioluminescenza, occupandomi degli sviluppi dell'elettronica e dei test e coordinando l'attività del gruppo della Sezione di Tor Vergata come responsabile locale di sigle SLICE e MICRO di Commissione Scientifica Nazionale V INFN.
Nel 2017-2019 ho partecipato all'esperimento SPE (Silicon Photonics Experiment), che permette di utilizzare dispositivi fotonici integrati nello stesso microchip con dispositivi standard Bi-CMOS (transistor bipolari e mosfet complementari). Ho contribuito al disegno preliminare del layout del primo prototipo di dispositivi fotonici: Mach-Zehnder (MZI).
Dal 2006 al 2010 nell'ambito degli esperimenti SI-RAD, ALTCRISS (Commissione Scientifica Nazionale V INFN) e KLOE (Commissione Scientifica Nazionale II INFN) ho partecipato e contribuito ad attività di studio, misura e caratterizzazione di sensori Silicon Photo Multiplier (SiPM). In quest'ambito ho sviluppato modelli di sensore per l'utilizzo in ambiente di simulazione analogica per progetto in VLSI analogico/misto_digitale e progettato/realizzato chip comprensivi di front-end per SiPM, condizionamento segnale e discriminazione veloce.
Dal 2005 al 2009, nel contesto di attività tecnologica interdisciplinare, partecipando agli esperimenti Haptic e Stiper finanziati dalla Commissione Scientifica Nazionale 5 dell'INFN, mi sono occupato dello studio, definizione, progetto ed implementazione di circuiti elettronici di neurone e sinapsi di

reti neuronali, partendo dai modelli matematici fino al layout e realizzazione dei chip in VLSI, prevalentemente con tecnologia standard a mosfet in regime di sottosoglia. Ho contribuito inoltre alla definizione e realizzazione delle relative piattaforme di test.

RESPONSABILITÀ ESPERIMENTI e WP

1. *Responsabile locale di esperimento*
   2019 - 2020 Esperimento SLICE RM2 (CSN5)
   2021 - 2022 Esperimento MICRO RM (CSN5)
   2023 Esperimento LITE_SLPD (CSN5)

2. *Responsabile di work packages*
   a) Incarico: **Responsabile del WP 1B22B intitolato: "EFD-02 Analog Electronics Design & MAIT"** dell'Accordo Attuativo ASI-INFN n. 2019-22-HH.0 dell'accordo quadro ASI - INFN n. 2016-4-Q.0 codice unico di progetto (CUP) F14E19000100005 per "Progetto Limadou-2 fase B2/C/D/E1**"**. Data Inizio: 16 dicembre 2019 - Data Fine: inizialmente prevista per 15 dicembre 2022, attualmente in corso per proroga.
   b) Incarico: **Responsabile del WP 3000_UTV intitolato: "EFD-02 Electrical Model"** dell'Accordo Attuativo n. 2018-7-HH.0 dell'accordo quadro n. 2016-28-H.0 codice unico di progetto (CUP) F81I16000040005 per il "Progetto Limadou-2 fase B1" tra ASI e Università di Tor Vergata, Dipartimento di Fisica. Data Inizio: 26/04/2018 - Data Fine: 06/1/2020
   c) **Responsabile del WP 11000 intitolato:** "**EFD SENSOR, MECHANICAL DESIGN AND MAIT**" dell'Accordo Attuativo n. 2014-012-R.0 ASI-INFN "Progetto Premiale Limadou fase B/C/D1" Data Inizio: 16 maggio 2014 - Data Fine: 16 luglio 2018

RESPONSABILITÀ DI SERVIZIO – ORGANIZZAZIONI EVENTI

1. *Responsabile **Servizio elettronico*** della sezione INFN di Roma Tor Vergata dal 1° gennaio 2020 ed attualmente.
2. *Incarichi **RUP*** (Responsabile Unico del Procedimento) per acquisizioni di materiali, servizi e lavori progressivamente per diversi gruppi di ricerca relativamente alle CSN1, CSN2, CSN3 e CSN5 tra il 2011 ed attualmente.
3. *Organizzazione **seminario nazionale***: Europractice National Seminar in Italy - 27-September-2018 - INFN Roma1. Co-organizzato con i responsabili europei del consorzio Europractice.

ATTIVITÀ DIDATTICA

Corsi Universitari

a) "Microelettronica" dal 2010 ed attualmente (A.A 2023/2024) - <u>Titolare corso</u> per la Laurea magistrale in Fisica. Facoltà di Scienze Matematiche Fisiche e Naturali, Università di Roma "Tor Vergata".

b) "Laboratorio 3" A.A. 2022/2023 – Codocenza per la laurea triennale in Fisica. Facoltà di Scienze Matematiche Fisiche e Naturali, Università di Roma "Tor Vergata".

c) "Elettronica 1" A.A 2021/2022 - A.A 2020/2021- A.A. 2019/2020. Codocenza corso per la Laurea Magistrale in Fisica. Facoltà di Scienze Matematiche Fisiche e Naturali, Università di Roma "Tor Vergata".

d) "Laboratorio di Elettronica digitale" A.A. 2010/2011. <u>Titolare modulo</u> per il corso Universitario di Perfezionamento "Automazione e comfort degli edifici residenziali e terziari". Facoltà di Scienze Matematiche Fisiche e Naturali, Università di Roma "Tor Vergata".

e) *"Elettronica Fisica 1"* A.A. 2008/2009 - A.A. 2009/2010. Titolare corso per la Laurea in Scienze dei Media e delle Comunicazioni. Facoltà di Scienze Matematiche Fisiche e Naturali, Università di Roma "Tor Vergata".
f) *"Cibernetica Applicata"* A.A. 2007/2008. Titolare corso per la Laurea Specialistica in Fisica. Facoltà di Scienze Matematiche Fisiche e Naturali, Università di Roma "Tor Vergata.
g) "*Complementi di Elettrotecnica*" A.A 2006/2007 - A.A 2007/2008. Titolare modulo per il corso del MASTER Universitario di primo livello: "Automazione e comfort degli edifici residenziali e terziari". Facoltà di Scienze Matematiche Fisiche e Naturali, Università di Roma "Tor Vergata.

Relatore di tesi universitarie

a) Anno Accademico 2018/2019 - Co-relatore - "*Il trigger calorimetrico dell'esperimento NA62 al CERN"*, C. Marin, Laurea triennale in Fisica, Università degli Studi di Roma Tor Vergata.
b) Anno Accademico 2016/2017 Co-relatore - "*Studio di un interferometro di Mach-Zehnder su silicio per applicazioni di trasmissione a larga banda'*, F. Monnati, Laurea triennale in Fisica, Università degli Studi di Roma Tor Vergata.
c) Anno Accademico 2012/2013 Co-relatore - "*Modelli neuronali: progettazione hardware neuromorfa VLSI e simulazione computazionale"*, A. Caltabiano, Laurea in Fisica, Università degli Studi di Roma Tor Vergata.
d) Anno Accademico 2008/2009 Co-relatore – "*Progetto e realizzazione di un front-end VLSI per rivelatori SiPM"*, D. Brunati, Laurea in Ingegneria Elettronica, Università degli Studi di Roma Tor Vergata.
e) Anno Accademico 2008/2009 Co-relatore – "*Calibrazione e gestione di schede audio integrate per misure acustiche"*, G. Fattori, Laurea in Scienza dei Media e della Comunicazione, Università degli Studi di Roma Tor Vergata.
f) Anno Accademico 2006/2007 Relatore - "P*rogetto e realizzazione di un front-end VLSI per rivelatori SiPM"*, V. Capuano, Laurea in Fisica (vecchio ordinamento), Università degli Studi di Roma Tor Vergata.

Docenze di altri corsi

"Strumentazione virtuale e bus di campo" Anno scolastico 2007/2008. Titolare del modulo per il corso IFTS (Istruzione Formazione Tecnica Superiore) "Tecnico superiore per la progettazione dei sistemi di controllo ed automazione" presso l'ITIS Enrico Fermi di Frascati.

In fede, Roma, 23/01/2024

Davide Badoni