Curriculum vitae et studiorum

Paolo Ciambrone

Laboratori Nazionali di Frascati - INFN
Via E. Fermi 40, 00044 Frascati (Rome)
Phone: +39 06 94032736
e-mail: Paolo.Ciambrone@lnf.infn.it

Ha conseguito nel 1994 la Laurea in Ingegneria Elettronica, indirizzo Microelettronica, con il voto di 110/110 e lode, presso l'Università degli Studi di Pisa. Nello stesso anno riceve un incarico di consulenza presso il "Dipartimento di Ingegneria dell'Informazione: Elettronica, Informatica, Telecomunicazioni" dell'Università degli Studi di Pisa e supera l'esame di abilitazione alla professione di Ingegnere. Nel 1995 vince, come primo classificato, una delle due borse di studio in Microelettronica messa a concorso dal CNR, "Centro di studio per metodi e dispositivi per radiotrasmissioni" di Pisa. A Giugno dello stesso anno inizia la sua collaborazione con l'Istituto Nazionale di Fisica Nucleare in qualità di borsista. Dal 1998 è dipendente dei Laboratori Nazionali di Frascati dell'INFN con il profilo di tecnologo. Dal 2006 è responsabile del Servizio Elettronica e Automazione dei Laboratori Nazionali di Frascati. Nel 2007 diventa responsabile dell'elettronica dell'esperimento KLOE2. Dal 2009 è primo tecnologo presso i Laboratori Nazionali di Frascati. Dal 2010 è il coordinatore dell'elettronica per l'upgrade del rivelatore di muoni dell'esperimento LHCb al CERN.

Attività scientifica

Ha iniziato la sua attività nel 1995 con l'esperimento KLOE, collaborando alla progettazione e allo sviluppo dell'intera catena elettronica di *readout* (*front-end*, condizionamento e acquisizione) del calorimetro elettromagnetico, con la responsabilità diretta dello sviluppo del sistema per la misura dei tempi. Ha successivamente collaborato allo sviluppo dei sistemi elettronici di *trigger* e di *slow control*. Ha, infine, partecipato alla fase di installazione e *commissioning* dell'apparato e ha curato la *maintenance* dell'elettronica durante tutto il periodo di presa dati dell'esperimento.

Nel 2001 ha iniziato la sua collaborazione con l'esperimento LHCb seguendo lo sviluppo delle *Multi Wire Proportional Chamber* che equipaggiano le 5 stazioni del rivelatore di μ e partecipando alla progettazione del sistema di alimentazione e di *grounding* del rivelatore stesso. Successivamente ha collaborato alla definizione dell'elettronica di *readout* ed è stato responsabile dello sviluppo dell'elettronica di acquisizione *off-detector*. Ha inoltre seguito e coordinato l'installazione e il *commissioning* di tale elettronica al CERN.

Nel corso del 2006 ha aderito alla collaborazione KLOE2 come responsabile dell'elettronica dell'esperimento. Ha partecipato alla fase di sviluppo del rivelatore di vertice e alla progettazione dell'elettronica di *front-end* dei nuovi rivelatori e ha disegnato l'architettura del nuovo sistema di *readout*.

Dal 2006 è responsabile del Servizio Elettronica e Automazione dei Laboratori Nazionali di Frascati e coordina l'attività delle 11 persone che lo compongono per dare supporto ai diversi gruppi sperimentali nello sviluppo, progettazione e produzione di sistemi elettronici di *front-end*, *readout*, alimentazione e controllo.

Dal 2010, nell'ambito dell'upgrade di LHCb, è il responsabile dell'elettronica del rivelatore di muoni. Ha coordinato le attività per la definizione della nuova architettura di *readout* di tipo *trigger-less* e ha curato la progettazione dell'elettronica di acquisizione *off-detector* di tipo *radiation tolerant*. È inoltre il *work package leader* del *MUON readout and control electronics* per l'installazione dell'upgrade di LHCb.

Nel corso degli anni ha dato supporto a vari esperimenti (Atlas, BESIII, Opera, PADME, PMu2e, PSuperB, RDH, SHiP, TPS) per le fasi di R&D, per studi di fattibilità, per lo sviluppo di schede di test e prototipi, per la realizzazione di sistemi per la produzione e per la progettazione di schede elettroniche per gli apparati.

Dal 2001 al 2013 ha svolto attività didattica presso l'Università degli Studi di Roma "La Sapienza" collaborando al corso di *Esperimentazioni di Fisica III* e al corso di *Laboratorio di Elettromagnetismo e Circuiti* della Facoltà di Scienze Matematiche, Fisiche e Naturali.

Ha svolto attività come tutor nei programmi di divulgazione scientifica dei Laboratori Nazionali di Frascati e attualmente coordina le attività che il Servizio Elettronica e Automazione svolge in questo ambito.

Curriculum vitae

PERSONAL INFORMATION

Family name, First name: Marafini Michela

Fiscal code: MRFMHL82H52H501A

Researcher unique identifier: ReserchерID: C-7439-2014

Date of birth: 12/06/1982

Nationality: Italian

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**

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

FUNDED PROJECTS *as Principal Investigator*

2015 – 2018 *"A fast neutron-tracking device tailored for hadrontherapy dose monitoring applications"*, Id: RBSI140VL4 – Funding: 539 keuro. 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.

ASN National Scientific Qualification

ABILITAZIONE SCIENTIFICA NAZIONALE — FASCIA: II
10/04/2018 - 10/04/2024 — ACADEMIC RECRUITMENT FIELD: 02/D1
ACADEMY DISCIPLE: FIS/07

ABILITAZIONE SCIENTIFICA NAZIONALE — FASCIA: II
05/10/2018 - 05/10/2024 — ACADEMIC RECRUITMENT FIELD: 02/A1
ACADEMY DISCIPLE: FIS/04

TEACHING ACTIVITIES

2017 - 2019 ***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

2008 – ***Supervised***: 2 Post-Doc (employed with my project funds), 1 Ph.D., 9 Master Students and 8 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

2015 – Reviewer of 4 international scientific journals:
Physics in Medicine and Biology – Measurement Science and Technology – Journal of Physics Communications - Nuclear Instruments and Methods in Physics A.

RESEARCH PERFORMANCES

My research focuses on research and development of new detectors and on application of particle physics detection technique to different applications, in particular to the medical one. The Particle Therapy field offered me the opportunity to investigate different new detectors (most of all tracking detectors!) with growing independency in leading projects and activities.

- h index of 13 with more than 70 publications in refereed international journals for a total of more than 230 citations (excluding self citations of all authors, database: http://www.scopus.com);
- 15 publications in refereed international journals as first, last or corresponding author;
- 1 Granted patent request for medical application: *"Intraoperative detection of tumour residues using beta- radiation and corresponding probes"* WO 2014118815 A2;
- More than 15 presentations and seminars at international conferences and workshops;

MAJOR COLLABORATIONS

Since 2016 ***APSS*** - *Trento Proton Therapy Center*. Collaboration activities with the proton beam facility (M.Durante, F.Tommasino): setup of the experimental room data acquisition system and beam monitoring;

Since 2015 ***CERN***. Collaboration with RD51 group (F.Sauli, L.Ropelewski) in studies and developments of next generation *Multi Purpose Gas Detector (MPGS)* with optical readout;

Since 2013 ***CNAO*** - *Centro Nazionale di Adroterapia Oncologica, Pavia.* Member of the treatment quality assurance task force dedicated to the INSIDE project integration and *DoseProfiler* detector installation in the treatment room.

2013-2015 ***HIT*** - *Heidelberg Ion-Beam Therapy Center.* Measurements planning, experimental setup installation and commissioning, data taking and analysis of the *NCS@HIT*

experiment with proton, ^{12}C, ^{4}He, and ^{16}O beams of energies of interest for PT applications (FP7 ULICE).

2012-2015 ***GSI*** *Helmholtzzentrum fur Schwerionenforschung of Darmstadt.* Collaboration with the biophysics group (M. Durante, C. La Tessa) for the installation, commissioning, data taking and analysis of an experiment performed using ^{12}C beams of therapeutic energy.

2008-2011 ***TUM*** - *Technical University of Munich*. Design and feasibility studies of next generation large-scale liquid target neutrino experiments (F. von Feilitzsch, M. Wurm). Development of a novel photo-sensors detector and its readout;

2008-2011 ***LAGUNA*** - *Large Apparatus for Grand Unification and Neutrino Astrophysics.* International collaboration of institutions and industrial partners addressing the feasibility of a new European research infrastructure hosting deep underground neutrino detectors. I contributed to this FP7 Design Studies (A. Rubbia) with a work focused on a Water Cherenkov based underground detector.

2008-2011 ***EUROnu*** - *High Intensity Neutrino Oscillation Facility* part of the Europe FP7 Design Study. I worked in the WP in charge of the detector performances evaluation studying large Water Cherenkov experiment detection capability as a function of to the proposed neutrino facilities characteristics (ex. energy, intensity, position).

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. I finally gained my independency in leading projects, coordinating teams and finalising R&D studies with an always-growing responsibility.

Ph.D in Neutrino Physics. I started my Ph.D. research work focusing on the neutrino oscillation investigations and the related innovative R&D projects. I worked on the MEMPHYS megaton water Cherenkov in the framework of the LAGUNA and the EUROnu European projects. In particular, I studied possible large-scale next generation detectors for theta13 and mass hierarchy neutrino measurements. I presented MEMPHYS in international conferences [i,l]. I have also built **the MEMPHYS prototype**, Memphyno, which was **needed to implement the new developed electronic readout system** (PARISROC, LAL-ORSAY). Memphyno, a 7-tons water Cherenkov tank, has been entirely built at the APC laboratory (Paris 7): with the support of the technical divisions **I have developed its design, mechanical assembly and readout system**. I designed and built a 3D tracking hodoscope with segmented plastic scintillators and WLF fibres readout by MAROC boards that was placed on Memphyno for testing the PARISROC innovative readout electronics in water. I followed the project from the start up to its realization: Memphyno is currently used to test the electronics and the photo-detectors in the LAGUNA collaboration [17-20]. During the realization of the prototype I was the responsible of the associated budget.

Physics applied to Particle Therapy. In 2011 I decided to continue my activity on particle detection and development of photo-sensor devices in a different context: Particle Therapy (PT). I joined the ARPG group at Sapienza Università di Roma to work on a project funded by Italian research centres. The main goal of my research activity was to exploit the secondary particles detection in a device capable of monitoring the dose delivered to patients during PT treatments: the Dose Profiler (DP) [2], a range monitor detector developed within the INSIDE framework. I have worked to the construction of the on-line tracker that will start his monitoring operation at CNAO at the end of 2017. I reviewed the DP status, on behalf of the INSIDE collaboration [6], at [g].

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 built and tested the detectors needed for the secondary fragments production measurements, performed the data analysis and published the

results on peer-reviewed international journals [1-3,5]. Since 2013 I have focused my activity on the DP, testing different layouts using scintillation fibres of various sizes and performing the related first efficiency calculations. I took part to **several data taking campaigns with proton and carbon-ion beams in different particle therapy centres**. During the HIT data taking (ULICE programme) I personally took care of the experimental setup planning and construction. The performed study of the different secondary particle emissions has been presented in several international conferences [d]. Since 2014 I am responsible of the forward fragmentation analysis [4].
In 2016 I joined the effort of building a new collaboration, FOOT, devoted to the Relative Biological Effectiveness (RBE) proton measurements for PT applications. I am currently in charge of the FOOT calorimeter Monte Carlo simulation studies team making available the experience I gained in handling neutrons and crystals detectors. In the FOOT collaboration I also gave an important contribution to the development of a phoswich detector made by the combination of fast plastic scintillator and BGO crystal.

New Detector developments: Towards high-risk-high-gain projects. 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 [12]) the Cherenkov light emitted by TeO_2 crystals (for $0\nu2\beta$-decay). I was also interested in p-terphenil (organic plastic scintillator): I measured and published [13] its transparency and attenuation length, opening to the ARPG group the opportunity to design an innovative probe for radio-guided surgery [14], for which an international patent is now pending.

Since 2014 I have started **a 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 [9-11], in December 2014 was funded by the INFN. In spring 2015, an upgraded version of the MONDO project got a larger funding by the Italian Ministry of Research. Since 2015 I am the coordinator of the project and I presented it in international conferences [a,b,c]. 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 sensor in collaboration with CF (who is hosting the SIR project) that shares now its 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. The results have been presented in international conferences [a,d] and are under press in referred international journals.

In 2015 I started to work on the **development of an optical readout for triple-GEM detectors** (ORANGE). **I demonstrated, for the first time, the feasibility of such detectors** [15,16]. In the last two years, triple-GEM detectors readout with commercial camera and lens has been successfully built. The results have been presented to the RD51 collaboration (CERN) [f] and put the basis for a joined effort in the development of next generation gaseous detectors. The promising performances obtained within ORANGE tracking detector, resulted in a proposal for an optimised detector, LEMON, currently exploited and considered for several different applications from the medical field up to the dark matter search (CYGNUS experiment).

In 2018 I start collaborating with a new working group (join effort between the chemistry, engineering and physics department of SBAI) dedicated to the **development of innovative plastic scintillators**. I personally coordinate the laboratory tests and the characterisation of the new materials with different sources of radiation. The final aim of the new scintillators development is the realisation of fast timing detectors. Moreover, future investigations would define the potentiality of pulse shape discrimination between neutrons and photons with new materials. With the results obtained so far on the new plastic scintillator sample a patent request procedure has been started.

- **Scientific products**

- Publications - This selection of **5 publications** highlights my personal contributions on particle therapy application. A larger selection of 40 publications is reported in the document “list of publication” as request for this application.

1. C. Agodi, et al. (MM corr. author) *"Precise measurement of prompt photon emission from 80 MeV/u carbon ion beam irradiation"* JINST 7 3 (2012) P03001 doi: 10.1088/1748-0221/7/03/P03001
2. M. Marafini et al. *"Secondary radiation measurements for particle therapy applications: nuclear fragmentation produced by 4He ion beams in a PMMA target"* PMB 62 (2016) 4 1291 doi: 10.1088/1361-6560/aa5307
3. S.Muraro et al. ``*Monitoring of hadrontherapy treatments by means of charged particle detection*" Review Article Front. Oncol. (2016) doi: 10.3389/fonc.2016.00177
4. R.Mirabelli et al. (MM corr. author) "The MONDO detector prototype development and test: steps towards a SPAD-CMOS based integrated readout (SBAM sensor)" TNS (2017) ISSN 1558-1578 doi: 10.1109/TNS.2017.2785768
5. M. Marafini et al. *"MONDO: a neutron tracker for Particle Therapy secondary emission characterization"* PMB 62 (2017) 32993312 doi: 10.1088/1361-6560/aa623a

- Granted patent request - WO Patent App. PCT (Patent Cooperation Treaty), PCT/IT2014/000025, for a *"Intraoperative detection of tumour residues using beta- radiation and corresponding probes"* WO 2014118815 A2 - http://www.google.com/patents/WO2014118815A2?cl=en

- **Conferences and Seminars**

Selection of the most important attended conferences and invited seminars were I presented the results obtained in the medical physics application field and in neutrino physics (Ph.D work) in the last 10 years.

(a) 6/2018 NRM: 15th Varenna Conference on Nuclear Reaction Mechanisms - Varenna, Italy. *"The FOOT Experiment"*.
(b) 11/2017 PRESS: PRoton thErapy research SeminarS – Krakow, Poland. *"Secondary neutrons in particle therapy: the Mondo project"* Invited talk.
(c) 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"*.
(d) 4/2016 Seminar: Colloqui di Fisica, Università Roma Tre, Italy. *"The particle therapy and the role of secondary neutrons: the MONDO project"* Invited talk.
(e) 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.
(f) 5/2015 SRHITS: Space Radiation and Heavy Ions in Therapy Symposium - Osaka, Japan. *"The MONDO Project"*.
(g) 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.
(h) 9/2014 SPET: II Symposium on Positron Emission Tomography - Krakow, Poland. *"The INSIDE project: Innovative solutions for in-beam dosimetry in hadrontherapy"*. Invited talk. Contribution on Acta Physica Polonica A 127 5 (2015) 1465 – 1467 DOI: 10.12693/APhysPolA.127.1465 (cit 16)
(i) 2/2014 Seminar: Novel particle physics applications - Sapienza Università Roma, Italy. *"New online methods to monitor dose profiling in particle therapy treatments"*.
(j) 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)
(k) 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,
26.02.2019 **Michela Marafini**