

CURRICULUM VITAE

Dr. Ing. Valerio PETTINACCI

Formazione ed attività professionale

- **Maturità Scientifica** conseguita con votazione 100/100 durante A.S. 2001/2002;
- Laureato presso la Facoltà di Ingegneria dell'Università degli Studi di Perugia, nel Corso di **Laurea in Ingegneria dei Materiali** con votazione 110/110 e lode durante l'A.A. 2004/2005;
- Laureato presso la Facoltà di Ingegneria dell'Università degli Studi di Perugia, nel Corso di **Laurea Specialistica in Ingegneria dei Materiali**, con la votazione di 110/110 e Lode durante l'A.A. 2006/2007;
- **15/10/2007 – 30/09/2008**: assunto come *Techn. Fachspezialist/in II – 3041* presso l'ETH Zurich, all'interno del gruppo del **Prof. André Rubbia**, con sede di lavoro Laboratorio CERN (Meyrin, Svizzera);
- **01/10/2008 – 30/04/2009**: CERN associate per progettazione meccanica apparati sperimentali;
- **01/05/2009 – 30/04/2011**: titolare di **Assegno di Ricerca** per la collaborazione ad attività di ricerca presso il Dipartimento di Fisica dell'Università "Sapienza" di Roma, con compiti di progettazione meccanica per linea di assemblaggio rivelatore esperimento CUORE;
- **01/05/2011 – 29/02/2012**: **Project Engineer** presso il *Department of Physics and Astronomy* della *University of South Carolina (USA)*, con compiti di progettazione ed installazione sistemi meccanici semi-automatici per completamento linea di assemblaggio esperimento CUORE;
- **01/03/2012 – 31/12/2013**: titolare di **Assegno di Ricerca** per la collaborazione ad attività di ricerca presso l'INFN Sezione di Roma, con compiti di progettazione meccanica, verifiche strutturali, gestione ed installazione di assemblaggi meccanici per esperimenti CUORE, CMS, SuperB, ELI-NP;
- **01/01/2014 – 31/12/2014**: assunto come **Tecnologo III livello a Tempo Determinato** – presso l'INFN Roma su progetto ELI-NP con compiti di progettazione meccanica e verifica termo-strutturale agli elementi finiti delle strutture acceleranti, nonché per la gestione dell'integrazione CAD (2D e 3D) della macchina in costruzione;

- **15/01/2015 – 31/12/2019:** assunto come **Tecnologo III livello a Tempo Indeterminato** presso INFN Roma, in qualità di vincitore del “Concorso per titoli ed esami ad un posto per il profilo professionale di Tecnologo di III livello professionale” (Bando 16295/2014). Operativo, con compiti di:
 - Responsabilità per progettazione meccanica, realizzazione, integrazione di sistemi meccanici complessi all’interno degli esperimenti della Sezione di Roma;
 - Rappresentante del personale tecnologo della sezione di Roma;
 - Coordinatore dello sviluppo di nuove tecnologie in area meccanica per la sezione di Roma per:
 - monitoraggio di nuovi software di progettazione e tecniche di produzione/lavorazione meccanica;
 - partecipazione a bandi competitivi e programmi di finanziamento in collaborazione con altre entità pubbliche e private;
 - formazione del personale ed interfaccia con altri istituti di istruzione per eventuali collaborazioni.

- **01/01/2020 – in corso:** selezionato come **Primo Tecnologo** a seguito della delibera del CD n. 16452 del 28 ottobre 2022, con decorrenza retroattiva a far data dal 1° gennaio 2020. Nominato Responsabile del Servizio Progettazione Meccanica della Sezione di Roma con Lettera di incarico del Direttore Dr. Aleandro Nisati dal 01/12/2021.

Attività scientifica e tecnologica

ESPERIMENTO AMS-02 (Lavoro di tesi triennale). Progetto preliminare interfaccia meccanica per test a vibrazione sottosistema L-ToF esperimento AMS-02, installato su Stazione Spaziale Internazionale (ISS).

Presso l’ETH Zurich – IPP (c/o Lab. CERN, Ginevra):

- **ESPERIMENTO T2K.** Analisi sismica magneti ND280 per esperimento T2K al fine di garantirne installazione presso J-Parc Tokai (Giappone);
- Progettazione meccanica ed installazione componentistica per esperimento ArDM (ETHZ, CERN);

- Progettazione preliminare (*conceptual design*) con verifiche strutturali per parti del progetto GLACIER (ETHZ).

Presso INFN Roma:

- **ESPERIMENTO CUORE.** Progettazione, realizzazione, installazione, collaudo e messa in opera della linea di assemblaggio moduli del rivelatore dell'esperimento CUORE, installato presso LNGS. Progettazione 3D e verifiche strutturali del sistema meccanico *Detector Installation Tooling (DIT)* dell'esperimento CUORE necessario per installazione ed integrazione delle torri dell'esperimento CUORE all'interno del criostato (in collaborazione con team LNF).
- **ESPERIMENTO CMS.** Progettazione del supporto meccanico per connettore *Multibox* necessario durante procedure calibrazione super-moduli esperimento CMS (CERN). Project Engineer dell'INFN Roma per l'upgrade della macchina di movimentazione dei supermoduli del calorimetro elettromagnetico ECAL e per la realizzazione di un secondo esemplare della stessa. Macchinario da 20 tonnellate certificato CE consegnato e collaudato con successo presso il laboratorio CERN di Ginevra nel febbraio 2024.
- **PROGETTO GBS, ELI-NP.** Integrazione e gestione layout CAD 3D e 2D modelli e disegni per macchina GAMMA BEAM SYSTEM (Work Package Leader per WP11a) relativamente al progetto ELI-NP (Bucarest, Romania). Collaborazione con Divisione Acceleratori LNF per sviluppo e progettazione sistemi di raffreddamento strutture acceleranti in banda S e banda C relativamente al progetto ELI-NP. Collaborazione con LNF per verifica agli elementi finiti schermi OTR per stazioni diagnostica.
- **ESPERIMENTO CUPID-0.** Progettazione di interfacce, della strumentazione per assemblaggio e della camera di storage per rivelatore esperimento CUPID installato ed attualmente rimosso per conclusa presa dati presso i Laboratori Nazionali del Gran Sasso.
- **ESPERIMENTO CUPID:** responsabile del Work Package 1.03.05 della concezione, progettazione, installazione e collaudo delle stazioni di assemblaggio meccanico dei moduli del rivelatore per l'esperimento *full scale*, la cui installazione è prevista presso i Laboratori Nazionali del Gran Sasso, e dell'integrazione dell'intera linea di assemblaggio presso la clean room indicata dalla Divisione Tecnica LNGS.
- **ESPERIMENTO SABRE.** Progettazione sistema di movimentazione dei cristalli (*CIS – Crystal Insertion System*) per esperimento SABRE Proof of Principle installato e poi concluso presso i Laboratori Nazionali

del Gran Sasso. Co-responsabile – con ruolo di supervisione – della progettazione del sistema CIS per la collaborazione SABRE SOUTH (Memorandum of Understanding stipulato tra INFN Roma ed Università di Melbourne), il cui setup full scale sarà installato presso Stawell (Australia).

- **PROGETTO DI RICERCA COLLABORATIVA ITALIA-CINA (Finanziamento Ministero Affari Esteri).** Progettazione, installazione e collaudo camera per misura di *Light yield* cristalli, denominata **BlackBox**, da installare presso SICCAS (Shanghai, Cina) nell’ambito del progetto progetto “*Produzione di cristalli NaI(Tl) ultra radio-puri per la ricerca della materia oscura*” (collaborazione INFN – SICCAS, *Shanghai Institute of Ceramics Chinese Academy of Sciences*), cofinanziato dal Ministero degli Affari Esteri e della Cooperazione Internazionale.
- **ESPERIMENTO MEG.** Progettazione, integrazione ed installazione del sistema meccanico di supporto ed interfaccia per strumentazione di misura ottica del bersaglio esperimento MEG, installato ed operativo su linea sperimentale ciclotrone del Laboratorio “*Paul Scherrer Institute*” (*Villigen, Svizzera*). Responsabilità analisi termo-meccanica e progettazione supporto per la definizione dell’apparato sperimentale di ricerca *dell’X-boson*: sistema realizzato ed utilizzato con successo. Responsabile della progettazione dell’upgrade del medesimo supporto per raggiungere potenze di fascio incidenti superiori (fino a 30W).
- **POLO DIFFUSO HAMMER (Hub for Additive Manufacturing Materials Engineering and Research).** Cofondatore del polo di ricerca diffuso tra INFN Roma ed LNGS per lo studio e la sperimentazione della produzione additiva sia metalliche che plastica. Applicazione delle competenze sviluppate per produzione di telai in rame puro stampati 3D per l’esperimento **BullKid**. Rilasciato brevetto nazionale e richiesta di estensione internazionale inoltrata per la seguente invenzione:

METODO DI PRODUZIONE DI UNA MISCELA DI RAME PURO E NANOTUBI DI CARBONIO E DI MANIFATTURA ADDITIVA DI UN MATERIALE NANOCOMPOSITO A MATRICE METALLICA DI RAME PURO RINFORZATO CON NANOTUBI DI CARBONIO PER MEZZO DI DETTA MISCELA

Data di priorità : 20/05/2022

Titolari

Sapienza 50%, INFN 50%

Inventori

Rago Ilaria Carmela, Cavoto Gianluca, **Pettinacci Valerio**, Cortis Daniele, Pandolfi Francesco

<https://www.uniroma1.it/it/brevetto/102022000010511>

- **PROGETTO LATINO (Laboratory in Advanced Technologies for INNOVation)**. Responsabile congiunto del Laboratorio di Integrazione per progetto finanziato ad INFN in ambito Call POR-FESR dalla Regione Lazio.
- **PROGETTO SQMS (Superconducting Quantum Materials and Systems Center)**. Collaborazione con *Fermilab* (Chicago, USA) e Membro del gruppo INFN Roma con compiti di progettazione meccanica di apparati sperimentali criogenici.

A seguito degli studi eseguiti nel campo della manifattura additiva, invitato come **relatore presso i seguenti workshop**:

- **“Primo Workshop Nazionale su: Additive Manufacturing per lo Spazio - Stato dell'arte, Sviluppi e Prospettive”** (*Agenzia Spaziale Italiana, Roma, 20-22 luglio 2016*);
- **“METHODS Workshop BeamIT”** (*BeamIT, Fornovo di Taro – PR, 08 giugno 2017*).

A seguito dei lavori di analisi agli elementi finiti in Ansys, svolti e pubblicati, nell'ambito del progetto ELI-NP (in collaborazione), i relativi **poster** sono stati esposti alle seguenti conferenze (solo i primi due personalmente):

- **IPAC14** (15-20 giugno 2014, Dresda, Germania) per il lavoro *“Thermal-Mechanical Analysis of the RF structures for the ELI-NP proposal”*;
- **IBIC16** (11-15 settembre 2016, Barcellona, Spagna), per il lavoro *“Thermal Simulations For Optical Transition Radiation Screen For Eli Np Compton Gamma Source”*;
- **IPAC17** (14-19 maggio 2017, Copenaghen, Danimarca) per il lavoro *“Thermal Issues For The Optical Transition Radiation Screen For The Eli-Np Compton Gamma Source”*.
- **IPAC21** (Campinas, Brazil, May 2021) per il lavoro *“The CMS ECAL Enfourneur: A Gigantic Machine with a Soft Touch”*, pp. 986-988. doi:10.18429/JACoW-IPAC2021-MOPAB320

A seguito di un lavoro di modellazione, simulazione ed analisi agli elementi finiti svolto nell'ambito del progetto ELI-NP, vincitore del **premio**:

- **ANSYS Best Paper Award – Categoria Research**, per il paper *“Thermal Analysis of a Radiofrequency Gun”* (Ansys Users Meeting 2013 - Salsomaggiore Terme, 20/06/2013). Relatore alla conferenza per presentazione lavoro.

Per il lavoro come Project Engineer nelle attività elencate su CMS vincitore del premio:

- **CMS 2020 AWARD**

Publicato articolo su rivista “**Il Nuovo Saggiatore**”, **VOL. 38, ANNO 2022, NO. 5-6**, dal titolo:

- “Mechanics in experimental research: drivers for the processes of the future”, *Valerio Pettinacci, INFN Roma*. <https://www.ilnuovosaggiatore.sif.it/issue/69>

Tra le altre attività seguite si possono citare quella di: coordinatore programma di Alternanza Scuola Lavoro nel 2018 con ITIS G. Galilei (Roma), coordinatore di n.2 Assegni di Ricerca tecnologici presso INFN Roma, coordinatore di n.2 stagisti presso CERN (Ginevra) nell’ambito dell’esperimento CMS. Inoltre si può citare la collaborazione alla redazione del progetto MAD (la Metamorfosi Additiva del Design) e responsabile per task INFN Roma, finanziato all’INFN (leader del partenariato applicante) in ambito del programma ministeriale PON.

Autore di più di 100 paper di carattere tecnico e scientifico, pubblicati su riviste internazionali o presentati presso conferenze e workshop (<https://inspirehep.net/authors/1078798>).

Curriculum vitae

PERSONAL INFORMATION

Family name, First name: Marafini Michela

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 – 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 high 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-physics 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 DISCIPLINE: FIS/07
- ▶ 23/05/2023 - 23/05/2034 ACADEMIC RECRUITMENT FIELD, SECONDA FASCIA: 02/A1
ACADEMY DISCIPLINE: FIS/02
- ▶ 05/10/2018 - 05/10/2024 ACADEMIC RECRUITMENT FIELD, SECONDA FASCIA: 02/A1
ACADEMY DISCIPLINE: 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*
 - ▶ conducted at NET Scienza Insieme 2023, *Notte dei Ricercatori Roma* (<https://www.scienzainsieme.it/il-memory-delle-particelle/>)
 - ▶ conducted 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, ix). 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 (and publish) the Cherenkov light emitted by TeO_2 crystals (for $0\nu 2\beta$ -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 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. 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 joint 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).

- **Scientific products: 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

- **Conferences and Seminars: 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: PProton 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

Alessandro Curcio, Ph.D.



Academic Parameters

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- ASN**  Associate Professor in Experimental Physics of Fundamental Interactions (**02/A1**)
-  Associate Professor in Experimental Physics of Matter (**02/B1**)

Appointments

- 31/08/2024–  **Tenure Track Researcher** at the Department of Basic and Applied Sciences for the Engineering at **University of Rome La Sapienza**.

- 01/03/2023 – 31/08/2024  **Staff Scientist** at National Laboratories of Frascati (**LNF**) of the Italian Institute for Nuclear Physics (**INFN**), Frascati (Italy).

- 15/02/2021 – 28/02/2023  **Senior Scientist** at Laser Accelerator Centre **CLPU** of the **University of Salamanca** (Spain).

- 01/09/2020 – 31/01/2021  **Leader of the Beam Operation and Beam Diagnostics Sections** at **SOLARIS** (Polish National Synchrotron Radiation Centre), **Jagellonian University of Krakow** (Poland).

- 07/01/2020 – 31/08/2021  **Staff Scientist** at **SOLARIS** (National Synchrotron Radiation Centre), **Jagellonian University of Krakow** (Poland).

- 01/01/2020 – 01/01/2021  **Visiting Scientist** at **CERN** (European Organization for Nuclear Research), Geneva (Switzerland).

- 01/11/2017 – 31/12/2019  **Senior Research Fellow** at **CERN** (European Organization for Nuclear Research), Geneva (Switzerland).

- 01/11/2014 – 31/10/2017  Ph.D. student in Accelerator Physics (**University of Rome La Sapienza**).