Massimo Caccia
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1 Personal data

- Name: **Massimo**
- Surname: **Caccia**
- Born in **Novara** on **June 14^{th}, 1961**
- Fiscal code: **CCCMSM61H14F952X**
- Private address: **Via Macedonio Melloni, 40 - 20129 MILANO, Italy**
- Marital status: **married**, father of three (24, 22 and 20 years old)
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2 Academic Cursus Honorum

- **1985:** Laurea Degree in Physics, cum laude, at Universitá degli Studi di Milano

- **1986:** fellow of the *Angelo della Riccia Foundation* at the European Centre for Nuclear Research (CERN, Geneva, Switzerland) for 12 months

- **1987-1989:** graduate Student in Physics at Universitá degli Studi di Milano. The Ph.D. degree was awarded in 1990 after a defence at national level

- **1990:** post-doctoral Fellow of the Italian National Institute of Nuclear Physics (I.N.F.N.)

- **1990:** CERN Fellow in the Experimental Physics Division (2 year contract)

- **1991, December:** Appointed, after a public selection procedure, Research Officer with a permanent position at the Physics Dept. of Universitá degli Studi di Milano

- **1999:** after a public selection procedure at national level, M.C. is one of the candidates qualified for an Associate professorship in Experimental Physics. In November 1999, M.C. is appointed by Universitá degli Studi dell'Insubria, Faculty of Science.

- **2004:** director of the Dept. of Physics and Mathematics, Universitá degli Studi dell'Insubria, with a three year mandate

- **2010, September:** habilitation as Full Professor of Experimental Physics

- **2011, November:** appointment as Full Professor at Universitá degli Studi dell'Insubria, Faculty of Science

3 Main Research activities

M. Caccia's research activity is focused on the use of solid state detectors of ionizing particles and photons for High Energy Physics experiments, instruments and methods in Medicine, Radioprotection, Homeland and Cyber Security, High level Education. He contributed to the development of high granularity position sensitive sensors based on the direct detection of ionization in a Silicon substrate (microstrip and pixel detectors). Since 2006, the focus of his activity is related to Silicon Photomultipliers (SiPM), state-of-the-art sensors of light with single photon sensitivity and photon number resolving capability.

M.C. was member of the CERN based DELPHI collaboration at the Large Electron-Positron collider (1985-2000), where he served as project leader of the Very Forward Tracking Detector in 1997-1998. He also participated in the early development of the pixel detector for the ATLAS experiment at the CERN Large Hadron Collider.

Since 2001, his prevailing interest is in applied physics projects based on the technology developed for Particle Physics experiments:

- **2001-2004: Principle Investigator and coordinator of the SUCIMA project (Silicon Ultra fast Cameras for electron and gamma sources In Medical Applications, project id G1RD-CT-2001-00561), approved by the European Commission (EC) within the Fifth Framework Program. The proposal involved 10 partners, had a total budget of 3.5 million EUR and a financial contribution by the EC of 2.8 million EUR.** The project was focused on the development of novel imaging techniques for radioactive sources used in intravascular brachytherapy and for the quality control (QC) of beams at hadron therapy facilities. The development was based on custom designed pixel detectors in CMOS and SOI technology targeted to the design, construction and commissioning of a high granularity dosimeter and a particle beam real-time monitor. In terms of detectors, the consortium pioneered the pixel technology based on high resistivity Silicon-on-insulator wafers. Moreover, it developed the MIMOTERA, a CMOS monolithic active pixel sensor yet today with unique characteristics. The detector, back illuminated after an extreme thinning down to the epitaxial layer, is characterized by a modest granularity (153-micron pitch, for a total number of 10 000 pixels in the sensor) and by a patented architecture implementing a dead timeless operational scheme, with a frame rate up to 10 kHz and a full well capacity corresponding to a deposited energy of 30 MeV/pixel. The MIMOTERA, originally designed for QC at the hadron therapy machines, was exploited in a number of applications, reported in the following. **The project was classified as excellent by an ex-post evaluation performed for the EC by independent experts.**

- **2006-2008: Principal Investigator and coordinator of the RAPSODI project (Radiation Protection with Silicon Optoelectronics Devices), approved by the EC within the Sixth Framework Program (project id 32993, FP6-SME-COOP). The proposal involved 7 partners, had a total budget of 2.2 million EUR and a financial contribution by the EC of 1.5 million EUR.** The project was targeted to collaborative research

for the benefit of Small and Medium Enterprises and addressed the development of SiPM sensors, by the time in their infancy. The sensor activities within the collaboration were lead by SENSL, today one of the major player, and was aiming to the development of an end-user driven design & production process which could end-up with customized optimal sensors. The goal was pursued addressing the specific and complementary features required to integrate SiPM into novel instruments, namely: a device for real-time dosimetry in mammography (with PTW-Freiburg, D); a novel instrument for the measurement of indoor Radon concentration (with JP-SMM, Prague, CZ); a hand-held, battery operated pager compliant with the ISO standards concerning the illicit trafficking of radioactive material (FORIMTECH, Geneva, CH). By the end of the project, the objectives were fully met. **RAPSODI was also classified as excellent by an ex-post evaluation. It is worth mentioning that the know-how by the 3 research partners was licensed to CAEN s.p.a. and lead to the development of a flexible SiPM kit currently on the market. As a consequence, CAEN and Uni. Insubria established a Joint Development Center, still active by the time of writing.**

- **2009-2011: Principal Investigator and coordinator of the CLAVIUS project, approved within the EC-INTERREG program of cross border cooperation between Italy and Switzerland (INTERREG IT-CH). The proposal involved 5 partners, had a total budget of 384 kEUR and a financial contribution of 171 kEUR.** The workplan was based on the use of the MIMOTERA, resulting by the SUCIMA project. The goal of the activity was to qualify the MIMOTERA as a beam monitor of accelerated particle beams and to perform a measurement of the sun diameter relying on the drift-scan method and profiting from the high frame rate of the detector. The detector was commissioned for direct imaging and optimisation of ion beams extracted by a tandem accelerator used for material science and irradiation of living cells (in collaboration with the Laboratoire d'Analyses par Reactions Nucleaires (LARN), Namur, Belgium). The sensor was also used as a beam profilometer at the CERN-AD antiproton machine, in collaboration with the ACE-AD4 collaboration (2010-2014) studying the possibility to improve cancer hadron therapy by using anti-protons. Beam profilometry by direct impact was also performed at the Heidelberg Ion Therapy center, demonstrating an excellent linearity of the response over the full range of intensities and beam energies. Measurements of the sun diameter were performed at the IRSOL solar observatory (Istituto Ricerche Solari di Locarno, CH), following the development of a dedicated data acquisition system in collaboration with SUPSI (Scuola Universitaria Professionale della Svizzera Italiana). The results report a relative intrinsic precision at the 10^{-5} level, to be compared to atmospheric variations larger by 2 orders of magnitude, possibly the most precise measurement ever performed for a ground based experiment.

- **2011-2014: Principal Investigator and coordinator of RADICAL (RADon: Integrating Capabilities of Associated Labs), an EC-INTERREG IT-CH proposal. The proposal involved 4 partners, had a total budget of 771 kEUR and a financial contribution of 289 kEUR.** The project addressed the development of instruments and methods for monitoring the indoor

radon concentration. More specifically, it targeted:

- the development of an auxiliary module for the wireless GPRS transmission to a web server of radon concentration values and environmental parameters;

- the study of protocols for monitoring and control of the radon concentration in buildings with public access and complex architecture (schools, hospitals, bank agencies), using a network of instruments;

- the development of on-field methods for the measurement of the equilibrium factor between radon and its progeny, essential for dosimetric studies.

The project was successfully completed

- **2012-2014: partner of the FP7 project identified as MODES-SNM (project id 284842, FP7-SECURITY), lead by Universitá di Padova. The proposal involved 8 partners, had a total budget of 3.2 million EUR and a financial contribution by the EC of 2.4 million EUR.** The project addressed the development of a novel fast neutron detector for homeland security at seaports and airports, based on the scintillation by 4He gas in a high pressure tube. The team lead by M.C. was in charge of the integration of SiPM arrays in a re-designed, optimized detector. The collaboration successfully concluded the project engineering a full scale prototype that was qualified by external, independent experts and authorities at the Rotterdam and Dublin seaport, at Heathrow airport and at the Basel custom. The main partner company (ARKTIS detectors, located in Zuerich, Switzerland) engineered the prototype, currently on the market. The know-how in security applications generated within the project lead the team to new contracts with agencies and companies in the field.

- **2015-today**: partner of University of Aveiro (Pt) and CAEN s.p.a. in a project targeting the development of a novel Positron Emission Tomography System for pre-clinical studies. A 2D prototype for high level education has been designed, qualified, optimized and engineered and it is currently being commissioned.

- **2106-today**: leading partner of a collaboration with AWE, the U.K. Atomic Weapons Establishment, focused on the characterization of a new class of neutron sensitive plastic and inorganic scintillator, neutron sensitive and with gamma-neutron discrimination. The collaboration involves as well KROMEK, a British based company active in the field of protection against nuclear threats.

- **2016**: Principal investigator of an exploratory project on radio-guided surgery based on the detection of positrons emitted by a 18F source, in partnership with Light Point Medical and UNITIVE design, two U.K. based companies.

- **2016-today**: Principal investigator of the design, construction, commissioning and qualification of a calorimetric module based on the detection of scintillation and Cherenkov fibers embedded in a copper converter. The prototype module, based on the use of a 64 channel SiPM array, was commissioned on beam in July 2016. An upgraded module has been constructed and qualified on a beam test in July 2017.

- **2019-2020: Principal investigator of the proposal identified as Random Power, approved within the ATTRACT project, funded by the European Commission**. The ATTRACT project (https://attract-eu.com), led by CERN, published a competitive call for the selection of 170 breakthrough ideas springing off the Particle Physics community. 1211 proposals were submitted and RANDOM POWER has been selected. The project targets the development of a Quantum True Random Number Generator, based on the analysis of the time series of self-amplified endogenous pulses in a dedicated Silicon Device. Random Power received a grant of 100 000 EUR for a one-year-long activity. The principle at the base of Random Power is protected by an international patent application, entering the national phases (China included) by the time of writing. Random Power is being established as a company, officially recognised as spin-off of Uni. dell'Insubria.

- **2019-today: partner of ORIGIN (http://origin2020.eu) an European Commission project approved within the HORIZON 2020 framework program. The proposal involves 8 partner, received funding for 4.8 Million EUR for three year activities and scored and exceptional evaluation of 15/15 marks.** The project, lead by University of Limerick (IL), is targeting the development of a fibre based real-time dosimeter for oncological brachytherapy. M. Caccia is in charge of the work-package on the development of the sensing and data acquisition systems.

M. Caccia continues on the track of basic research as a member of the AEGIS collaboration at CERN and being active in the International Linear Collider (ILC) community. As far as AEGIS is concerned, in 2015 the team lead by M.C. successfully commissioned a monitor for the slow antiproton beam at the entrance of the experiment, yet based on the MIMOTERA thinned down to a total thickness of $50\mu m$ and operated at cryogenic temperature in high vacuum.

Concerning the ILC, M.C. lead an R&D project supported by the Italian National Institute of Nuclear Physics oriented to pixel based vertex reconstruction and SiPM based calorimetry (2006-2010).

Since 2016, M.C. is also part of the international collaboration involved in the design study of the next generation electron-positron circular collider in China (CepC).

4 Management, coordination, evaluation & peer reviewing, Technology Transfer activities

Beside the leadership of Research collaborations and project management, Massimo Caccia was serving as director of the Department of Physics and Mathematics for three years (2004-2007). Since its establishment (2005) and till June 2013, M.C. has been directing the unit at Uni. Insubria identified as SISRIT (*SIstema di Supporto alla Ricerca, Innovazione e Trasferimento tecnologico*), in charge of supporting the Research personnel in Technology Transfer activities and submission of proposals to the EC.

As a consequence of the performed activities related to exploitation projects and collaborative projects with industries, since May 2007 till October 2012, M.C. was serving as Italian representative in the Technology Transfer Task Force (T^3F), following a nomination by the I.N.F.N. President and the appointment by the CERN Council. The T^3F had the main charge to analyze the Knowledge Exchange & Technology Transfer process within the High Energy Physics community and propose actions to improve its efficiency and efficacy at CERN and in the member states.

Since October 2010 with a three year appointment M.C. has been member of the National Committee for Technology Transfer at I.N.F.N.

Since 2004 until 2008, M.C. was member of the International Advisory Committe of the international VERTEX yearly workshop. Since 2009, he is member of the International Advisory Committee for the Front-End Electronics international workshop.

Since 2006, M.C. is serving as Program Reviewer for the IEEE Nuclear Science Symposium and Medical Imaging Conference; in 2008, he was topic convener for the *New Solid State Detectors* session, together with G. Deptuch (now at FERMILAB). In 2019, he served as Topic Convener for the session on *Photodetectors* .

M.C. has been reviewing papers for Nuclear Instruments and Methods, the Journal of Instrumentation and the IEEE Transaction in Nuclear Science. Occasionally, he reviewed papers for the Journal of Micromechanics and Microengineering and the Chinese Optics Letters. In 2006 and 2007 he served as project evaluator for the French *Agence Nationale de la Recherche* while in 2006 he acted as external reviewer for the *Development Plan of the Research Activities* at Uni. Siena. Recently, he was reviewing research proposals for Uni. Padova and Uni. Catania. In 2017, he was appointed by the Polish National Research Agency as member of the evaluation board for the assignment of the POLONNEZ, MAESTRO and SONATA grants, a mandate still active today.

In January 2021, M. Caccia started a three year long assignment as Editor-In-Chief for the European Physics Journal, Techniques and Instrumentation, Novel detector concepts, technologies and interdisciplinary applications.

Since 2013 and until February 2019, Massimo Caccia served as coordinator of the Graduate School in Physics and Astrophysics at Uni. Insubria.

5 Teaching activity

Since his appointment as Full Professor, Massimo Caccia is in charge of the following courses for Physics students:

- Statistics and Probability (year 1)
- Physics Lab (year 1)
- High Energy Physics (year 4 or 5)
- Semiconductor particle detector laboratory (year 4 or 5)

Moreover, during the academic year 2012/2013, M.C. was in charge of the course on *General Physics* for students at the School of Engineering (year 1).

Massimo Caccia has been tutor and person in charge of more than 20 thesis at diploma and master level and internal reviewer for 6 thesis in Environmental and Medical Physics, with activities developed in Medical Physics units hosted by hospitals or at the Environmental Protection Agency. Moreover, he has been supervising (Directeur de thése) 7 Ph.D. students and co-supervising 1 graduate student enrolled within the Ph.D. program in Milano.

Since 2019, M. Caccia is part of the team involved in a design study on the implementation of a master course in Data Science at Universitá dell'Insubria.

6 Publications, conference presentations and seminars

Massimo Caccia is author or co-author of more than 415 articles published in peer reviewed journals and conference proceedings. According to the SPIRES data base (http://www-spires.fnal.gov/) his papers have a total number of citations (excluding self-citations) = 21 589 and a h-factor = 65. According to the Web of Science, numbers are adjusted to 390 papers, 22313 citations, h-factor = 51.The majority of the papers can be associated to the activity within the CERN based large collaborations. Throughout his career, M.C. presented the results of his activity in about 120 conferences and seminars.

Milano, February 2021

Massimo Caccia