Tommaso Tabarelli de Fatis 1964, March 7th – Trento, Italy

Curriculum and research activities 2021, June – Milano, Italy

Full professor in experimental physics at Milano Bicocca (since 2016) and former associate professor (2006-16), I was senior researcher (2002-06), researcher (1996-02), and post-doc fellow (1993-95) at the *Istituto Nazionale di Fisica Nucleare*, after the Ph.D. in Physics (1990-92, supervisor prof. A. Pullia) and the B.Sc. in Physics (1988, supervisor prof. E. Fiorini) at the *Università di Milano*. In 1988-89, I served as Artillery Lieutenant at the Artillery School in Bracciano (Roma).

I am co-author of over 1000 peer-reviewed papers in particle physics spanning design, operation, and data analysis in experiments at the LHC and LEP colliders, neutrino physics, fixed target experiments, and detector R&D studies. The vast majority of these papers are the result of my participation in the CMS and DELPHI collaborations. They include renowned works like the observation of the Higgs boson (2012), the precision measurement of the Higgs boson mass and couplings at the LHC (2015-2020), the precision determination of the Z and W bosons mass and couplings at LEP (1990-2000). Papers in neutrino physics, fixed target experiments, and R&D studies are the results of small collaborations or, in a few but notable cases, single-author papers. Well-known papers include studies of neutrino beams (2001), of mass-hierarchy effects in atmospheric neutrino oscillations (2002), and the proposal of a novel method for background rejection in double-beta decay searches (2010).

Since 2003, I am actively involved in the CMS experiment at the LHC proton-proton collider (CERN), where I took part in the construction and commissioning of the electromagnetic calorimeter (ECAL), with the specific responsibility for the energy calibration. At the startup of LHC operation, I coordinated the ECAL Performance Group (2009-10), in charge of the detector operation and of the trigger, reconstruction, identification, and energy calibration of the electromagnetic showers from photons and electrons. For the next two years (2011-12), I was appointed ECAL project leader by prof. G. Tonelli (CMS spokesperson) and I coordinated the activity of about 250 physicists from 14 countries[§]. In that role, I led ECAL to achieve its design performance and contributed significantly to the scientific success of CMS, culminated in the observation of the Higgs boson through its decays into two photons and four leptons. In the following years, I contributed to the characterization of the Higgs boson, with leading work in the precision measurement of its mass (2013-14), and with the study of different Higgs boson production and decay modes, including the associated production with top/anti-top pairs and of Higgs boson pairs (2015-21). In addition, I contributed to searches for new phenomena, including massive gauge bosons, high-mass scalar resonances. I have supervised 7 Ph.D., 14 Master, and many bachelor students. From 2014 to 2017, I served as member of the CMS Higgs boson publication committee.

In 2014-17, I acted as coordinator of the Italian contribution to the CMS ECAL (Milano-Bicocca, Roma La Sapienza, Torino, and Trieste). In this role, I participated in the design of the ECAL upgrade for the high-luminosity phase of the LHC (HL-LHC), planned to begin in 2027, and help define the responsibility and commitment of the Italian team. In parallel, I led the R&D and the proposal of a novel detector to provide precise time information for charged tracks crossing it. This information will enable the 4D reconstruction of collision events at the HL-LHC and will boost the performance of the CMS experiment in presence of multiple collisions per beam crossing, with significant benefits in the precision characterization of the Higgs boson, in Heavy Flavour physics, and in the search of long-lived particles postulated in several particle models. In 2017, I resigned from Italian ECAL coordinator to be appointed project manager of the MIP Timing Detector (MTD) by Dr. J. Butler (CMS spokesperson). I led the collaboration through the project approval by the CERN LHC Committee (2019) and I am currently leading the international effort[**] for the construction and integration of this detector into the CMS experiment.

Before CMS, from 1991 to the end of LEP operation, I have been a member of the DELPHI experiment at the LEP electron-positron collider (CERN). In DELPHI, I developed and successfully implemented the procedure for calibration and monitoring of the analog response of the barrel electromagnetic

[§] ECAL: Armenia, Croatia, Cyprus, France, Greece, India, Italy, Portugal, Russia, Serbia, Switzerland, Taiwan, UK, USA.
[**] MTD: China, Finland, France, Korea, Hungary, Italy, Latvia, Portugal, Spain, Switzerland, USA.

calorimeter (HPC). This method ensured complete control of the unexpected HPC aging, linearity of response, and optimal performance throughout the LEP program, solving one of the most critical challenges encountered by the DELPHI experiment after construction. In this context, I was responsible for the HPC test facility at the West Area of the SPS at CERN (1992-95), where we achieved full understanding of the detector aging. During LEP-I with the beam energy at the Z boson resonance (1990-95), I contributed to the electron reconstruction, calibration and identification, to the b-tagging through its semi-leptonic decays, and to the precision characterization of the Z boson, with measurements of its decay into b quarks. During LEP-II (1996-2000), I participated in the precision measurement of the W boson mass, with studies of W decays with electrons in the final state. As a member of the DELPHI Editorial Committee (1999-2001), I reviewed several DELPHI publications on SUSY particles and Higgs boson searches, and electroweak precision tests.

My contributions in the field of neutrino physics are mainly the result of several scientific initiatives aimed at the understanding of neutrino oscillations. In 1995-99, I provided leading contributions to the design of the NA56/SPY fixed target experiment at CERN (spokesperson S. Ragazzi), aimed to consolidate the experimental input to the calculation of neutrino beams. I coordinated the data analysis and – with three colleagues – I developed a well-known fast-simulation code for the calculation of the neutrino fluxes (BMPT, after the initials of the authors). These studies helped optimize the neutrino beams CNGS from CERN to the INFN LNGS laboratories and NuMi at FNAL, which both contributed to consolidate the observation of atmospheric neutrino oscillations. From 1998 to 2001, I contributed with leading roles to the proposal of a massive magnetized-iron detector for the precision measurement of atmospheric neutrino oscillations (MONOLITH, spokesperson S. Ragazzi). Within the proto-collaboration, I coordinated the simulation studies and the optimization of the detector design. If approved, MONOLITH would have established the neutrino mass hierarchy, exploiting the Earth-induced asymmetry in neutrino and anti-neutrino oscillations with a method discussed in known paper of mine (2002). As someone commented, that paper was ahead of its time. The size of subdominant oscillation components (technically the size of $\sin^2\theta_{13}$) was uncertain at the time of the proposal. The project was rejected. Twenty years later, the neutrino mass hierarchy remains undetermined.

In my youth (1987-88 and 1990), I participated in an experimental search for the neutrino-less double-beta decay of the isotope Xe-136 with a high-pressure multiwire proportional chamber (spokesperson E. Fiorini). This process provides a unique probe of the neutrino mass and charge conjugation properties. With a beginner's naivety, I identified a gas-purification deficiency, which prompted a refurbishment of the apparatus and the monitoring and calibration procedure. After these upgrades, the experiment achieved the best sensitivity for this isotope at that time. Later, with the growing evidence for non-vanishing neutrino masses from oscillation experiments, the physics case for double-beta decay searches moved from being a curiosity to one of the leading concepts for probing neutrino properties. In this context, I proposed to exploit the Cherenkov emission from beta rays to provide a positive tag of double-beta decays and suppress the dominant background from alpha decays in the TeO_2 bolometers (2010). My paper spurred a lively R&D activity for next-generation double-beta decay experiments of several research teams, which confirmed the viability of the proposal with direct measurements.

Although I have participated in the organization of conferences, in scientific committees, and helped as a reviewer on several occasions, my main contribution to the research has been frontline work.

My teaching experience spans Laboratory Courses on Nuclear and Particle Physics (2005-09), Electromagnetism and Optics (2010-12), courses in General Physics on Mechanics, Thermodynamics and Special Relativity (2013-17), and Electromagnetism and Optics (2018-21), in instrumentation for Particle Physics (2019-21) at the University of Milano Bicocca, as well as in Medical Physics, at the University of Milano San Raffaele (2006-21). I have also been deputy coordinator of the Ph.D. School in Physics at Milano Bicocca (2014-18) and participated in several organization committees of the Physics Department.