One of the still open issues in the Elementary Particle physics is the Flavor problem and the CP violation origin with its implications, analogies and differences in the quark and lepton sector.
I dedicated my research to this topic through the precision measurements in the high statistics Heavy Flavor experiments (E687/E831 @FNAL) and through the observation of solar neutrinos in the CTF/Borexino experiments @LNGS.
The phenomenological picture developed in the years, thanks to the numerous and complementary measurements, had led the community to formulate Beyond the Standard Model scenarios, that still await for experimental tests.
My involvement in the CMS experiment represents the natural continuation of my research with the aim to personally contribute to the ambitious foreseen program, from the Higgs detection to the search for New Physics.

Since the beginning of my scientific activity, I have dedicated my research to the Heavy Flavor Physics. I was firstly involved in the E687 experiment and, later, in its upgrade E831/FOCUS; they are photo-production experiments of heavy quark at FNAL, whose main goal is the systematic study at high statistics of the charm quark.
My collaboration with E687 started in the final construction phase; this allowed me to diversify my contribution according to the development of the experiment itself, from the apparatus construction to the data analysis.
Indeed, I worked in the design and building of the tagging system for the measurement of momentum of the primary beam: a data pipelining system was realized for the first time for the readout system at the machine RF of 53 Mhz.
I also contributed to the assembly and calibration of the micro-vertex detector, followed all the DAQ and data analysis phases, to eventually focused to the amplitude analysis techniques on the Dalitz plot.
Analogously, for the experiment upgrade, FOCUS, I was involved in the design and building of the tile hadron calorimeter (scintillator and fibers) , being responsible for the R&D phase, necessary because of the novel technology, and following all the data processing proposing both new measurements, such as CP violation over the Dalitz plot, and new formal approaches for the amplitude analyses.
I underlined the limits of the formalisms traditionally applied: the single Breit-Wigner approximation is non adequate for the treatment of scalar, broad , overlapping resonances populating the Dalitz plot, mainly in pipi and Kpi requiring a more rigorous formalism preserving the unitary constraint. The K-matrix approach, based on the scattering matrix general principles, represents a more proper analysis tool. The proposal of applying it, for the first time, in the charm sector, has placed me and the students I coordinated, in a primary role in the international debate between experimentalist and theoreticians.
The problems identified for charm will manifest in the interpretation of the beauty decay dynamics.; the pioneering FOCUS approach has been then applied by the beauty-factories for their analyses.

I have frequently taken part in the review internal committees for analysis approvals.
I am Physics Review D and Physics Letter referee and member of the CSN1, the National INFN Committee for particle physics funding.
Even in CMS, the experiment I am currently involved in, I lead an activity related to the Heavy Flavor, in particular concerning the Bc study. This meson, formed by two unlike heavy quark,

represents a unique laboratory to study the heavy quark dynamics, enriches the phenomenological picture and test its consistency.

The decay channels via J/Psi(mu+mu-) are competitive in CMS thanks to the excellent muon identification, dedicated triggers and high standard performances of the tracking systems. The ongoing analysis concerns the Bc-> J/Psi pi and Bc->J/Psi 3 pi channels, and the lifetime measurement. The J/Psi 3 pi final state has been for the first time detected in LHCb and CMS.

In my scientific carrier I have dedicated part of my time to the neutrino physics as well, in the Borexino experiment where the Milan group has been leader.
My involvement in the experiment coincided with the first phase of the CTF (Counting Test Facility) data taking, a small scale prototype built to demonstrate the full scale experiment feasibility.

My high-energy physics background allowed me to bring a contribution complementary to that of the major part of the collaboration, coming from low energy nuclear physics.
In particular the knowledge acquired in the data analysis techniques of E687/E831 made me suggest and realize a spectral shape analysis for the energy and spatial distributions, able to discriminate internal and external events and gauge the residual contamination in the active volume of the detector.
The matured experience in this analysis made me propose a calibration plan for Borexino, defining the strategy and coordinating the hardware system project along with the Virginia Tech Group.
The calibration systems, funded by the INFN under my responsibility, have met the design parameter and performances. The Borexino experiment published the first direct measurements of low energy solar neutrinos.

My research is now also covering the high pT physics in the CMS experiment at CERN. Although my involvement in the LHC projects was dictated by the BTeV experiment cancellation at FNAL, I found immediately exciting to work in an experiment with discovery potential.
My interest has been aimed at the Higgs physics, central topic in the current scenario of the elementary particles in the context, on the one han , of the Standard Model test, and on the other hand of the links with the flavor problem, the hierarchy and, consequently , of the new physics.
In CMS the study covers both the Standard Model and its extensions.
I coordinate in Milan the analysis of the di-τ final state.
The $H \rightarrow \tau\tau$ channel, thanks to the nice balance between high Branching Ratio (~ 10% for mH between 110 GeV and 130 GeV, second to $H \rightarrow b\bar{b}$ only) and relatively low background contamination, is well suited to perform a complete study of the Higgs production mechanism with the data collected by CMS.
The importance of the di-τ channel does not exhaust in the context of the SM Higgs search: in fact, in many Beyond Standard Model scenarios, and in particular in its Super Symmetric extension, the decays into τ's are favored, making this channel one of the most sensitive for New Physics searches.
My contribution started with the analysis of the $Z \rightarrow \tau\tau$ channel, which is a benchmark at LHC: on the one hand, the measurement of its cross-sections is a test for the Standard Model at the TeV scale, on the other, its events constitute the main irreducible background in the search for the Higgs boson decaying into τ-pairs.

The analysis strategy and the tools developed by the group for the Z → ττ study have been instrumental for the H → ττ investigation. The Milan group became active in the CMS H → ττ Working Group where we have contributed to the data analysis, playing a primary role first in Higgs-> 2 tau-> e +mu+X channel and later in the development of the fully hadronic di-tau final state analysis.

The group has contributed to the Higgs discovery paper.

Indeed, the search for a Higgs boson at the LHC has recently entered a new and exciting phase. It is worth recalling that a resonance consistent with the SM Higgs boson and of mass about 125 GeV has recently been observed with a significance of approximately 5σ by both the CMS and ATLAS experiments. The excess is driven by the H → ZZ and H → γγ decay modes. While the data are still insufficient to exclude the presence of the SM Higgs boson decaying to tau pairs, no excess has been observed in any H → ττ searches. It is therefore critical to measure the contribution in the ττ decay to determine whether or not the new resonance is consistent with the SM.

In addition, as mentioned above, the di-tau final state would be particularly interesting for beyond the Standard Model Higgs investigation; in the Minimal Supersymmetric Standard Model (MSSM) the τ coupling to the neutral CP-odd Higgs is enhanced by a factor tanβ with respect to the SM.

Teaching experience:
Tutor of many Ph.D Students (in all the three experiments) and Relator of many Master Thesis (in all the three experiments).
Professor of Particle Physics at the Milan University.
Lecturer of Specialized Courses for Post-Graduated Students
Collaborator with local high level schools to promote Particle Physics among the young students.

Collaborator of various INFN exhibitions for physics divulgation (Fiera di Milano, Quark2000).