Curriculum vitae di Marco Selvi

Life

Name	Marco Selvi
Birth	August 4th, 1971 in Forlimpopoli (FC), Italy
Married with	Anna Natali, since May 10th, 1998
Children	Cecilia (1999), Samuele (2002), Lorenzo (2006).
Nationality	Italian
Languages	Italian (mother tongue), English (fluent in reading, speaking and writing)**.**

Education and Training

July 1990	End of secondary education: "Diploma di maturità scientifica" at Liceo Scientifico Statale ``Fulcieri" in Forlì (final score: 57/60).
1990-1996	Laurea degree course in Physics at University of Bologna, Italy. Degree thesis about "*Measurement of the muon flux with the LVD detector, at LNGS*", tutor prof. G. Sartorelli, final score 110/110.
1996-1997	Civil service in an institution who takes care of children with disabilities.
1997-1999	Employed as a webmaster and web-programmer by a private company in Rimini (Italy): development of web sites and databases for E-commerce.
1999-2002	Ph. Doctorate in Physics at University of Bologna. Thesis on "*Neutrino oscillation studies with a massive magnetized calorimeter*", tutor prof. M. Basile, concluded **March 15th, 2002**.
2002-2005	Post-doc fellow ("assegno di ricerca") at the Physics Department, University of Bologna.
2005-2009	Tenure-track researcher at INFN (National Institute for Nuclear Physics) with a 5-years grant, obtained with a national selection in November 2005; **first classified in Italy in the Astroparticle Physics sector.**
2009-now	Permanent researcher at INFN.

Scientific activities (in almost-chronological order):

(the papers cited in the CV refer to the number in the full list of my publication, attached)

LVD: since 1995 I have been involved in the LVD experiment in the Gran Sasso National Laboratory. It's a 1000 t liquid scintillation detector mainly dedicated to the study of neutrinos from gravitational core collapse and to cosmic muon physics.
- During the Degree Thesis I developed the code for the reconstruction of cosmic muons and the MonteCarlo simulation (in GEANT3) for the calculation of the detector acceptance. The results of this work where published in two papers in Physics Review D [44, 45]. I was involved in the transition of the data acquisition of the experiment from the old VMS-CAMAC system to a new Unix-VME one; in particular I took care of the web interface of the slow controls and monitors of the experiment [92].
- Since 2003 I worked on the MonteCarlo simulation of the interactions of supernova neutrinos and of the CNGS beam neutrinos [40].
- Since October 2003 I've been a member of the Editorial Board of the LVD experiment
- In 2004 I started the study of the muon-induced neutron flux in LVD. In 2005 we began the transition of the simulation code from GEANT3 to GEANT4, in order to take into account the production, propagation and detection of neutrons [48].
- In 2005 I was involved in an R&D study to dope the LVD scintillator with Gadolinium. Two counters were doped and we performed measurements of neutron capture efficiency with a ^{252}Cf source and of attenuation length with the construction of a dedicated 2m-long detector [29].
- In 2006 I studied the effect of neutrino oscillations on the supernova neutrino signal in LVD [35] and in 2007 we quantified the sensitivity of LVD to neutrino bursts from supernova core collapse in our Galaxy [31].
- In 2008 I studied the performances of LVD as an active shield and a muon veto to host a Dark Matter detector in its central part. The results showed that inside LVD it is possible to get a muon-induced neutron background level similar to the one in the deepest laboratory in the world, namely Sudbury in Canada [54]. This work was carried on together with the members of the XENON project, which we joined officially one year later.
- In 2009 I studied the seasonal modulation of cosmic muons, analysing 8 years of data acquisition. We observed a 2% annual modulation with maximum in July, due to the warming of the stratosphere during summer. Since this modulation is similar to the one observed by some experiments looking for Dark Matter signals, this work was very interesting also for the Dark Matter community [51].
- LVD was the first experiment to detect neutrinos from the CNGS beam in 2006 [37]; at the time I was responsible of the data acquisition and the synchronization with the CERN database. When in 2011 the OPERA experiment claimed a superluminal velocity for neutrinos, we started scrutinizing the result. Together with the OPERA collaboration we studied horizontal cosmic muons crossing both detectors and we discovered a systematic time shift in the OPERA clock, which was found to be responsible for the erroneous determination of time of flight [25]; I was the person in charge of the data analysis from the LVD side.
- In 2012 we upgraded the LVD clock to improve the absolute time performances; during the bunched beam run in May 2012 we independently measured the neutrino velocity, obtaining results compatible with the speed of light, with the best systematic and statistical uncertainty [23].
- LVD is so far the oldest observatory among those with sensitivity to a core collapse in the whole Galaxy. Therefore in 2015 we presented the best limit in the world about this search [8].

MONOLITH: I spent my Ph.D. (1999-2002) on a feasibility study of a new experiment for the measurement of neutrino oscillations of atmospheric neutrinos. The proposed detector was a massive (34 kt) magnetized calorimeter, made of iron plates interleaved with glass RPC detectors, to be installed at LNGS.
I actively participated in the "simulation" and "physics" working groups, studying the muon reconstruction and the determination of their momentum through the curvature in the magnetic field. I

applied this technique to various topics: atmospheric neutrinos, CNGS beam ν and also neutrinos generated at a "neutrino factory". We built a small-scale module of the detector and we tested the performances in a test beam at CERN [41]. The work culminated with the preparation of the proposal of the experiment in 2000 and its addendum in 2001 [110]. In the framework of the neutrino factory study I participated to a working group at CERN, leaded by prof. F. Dydak, and I contributed writing a CERN Yellow Report [109].

REACTOR NEUTRINOS: in 2003 I participated to an international working group dedicated to study neutrino oscillations through reactor neutrinos using two identical detector, near and far from the cores, in order to reduce the systematic uncertainties and improve the measurement of the θ_{13} mixing angle. The summary of the working group activities was published in a White Report [108].

CONCEPTUAL STUDIES ON FUTURE NEUTRINO BEAMS: I kept a small fraction of time to study neutrino oscillations in the framework of the "International Scoping Study of a future Neutrino Factory and Super-Beam facility", in particular in the optimization of a massive magnetized detector [30]. We also studied the performances of such a detector to measure neutrinos either atmospheric and from a high-energy beta-beam, in order to determine the neutrino hierarchy [34].

XENON PROJECT: in 2009 we joined the XENON project, aimed to directly detect Dark Matter particles through their interaction with the nuclei of the detector, a liquid xenon Time Projection Chamber with ultra low background. It is a staged project: the current detector, XENON100, in operation at LNGS is one of the most sensitive experiment for Dark Matter search in the world; with an active mass of 66 kg we obtained in 2011 and 2012 the best exclusion limit of 2×10^{-45} cm^2 at 50 GeV [20, 24, 27, 28] (with hundreds of citations), improved in 2013 by LUX, a detector using the same concept with a 3 times larger fiducial mass. The next phase of the project, XENON1T, with a 2 ton active mass and a reduced background, is currently under commissioning at LNGS.

- In XENON100 we are mainly focused to data analysis and detector calibration and maintenance. We developed the MC simulation to quantify the muon-induced neutron background [18] and we contributed to the analysis of the response of nuclear recoils in Xenon with an AmBe neutron source [19].
- We're currently taking care of the comparison between data and MC for the electron recoils, in order to study the response of LXe also for those signals.
- People from our group spent several months at the Columbia University (New York), the institution of the XENON spokesperson prof. Elena Aprile, to work on the development of a small liquid Xenon chamber to study electronic recoils and gained a valuable experience in operating LXe detectors; we're currently setting-up and operating a similar prototype to study the performances of light detectors (standard PMTs, multi-anode PMTs, SiPM, MPPCs) immersed in liquid xenon.
- In XENON1T I initially worked on the Monte Carlo simulation of the muon-induced neutron background. The study led to characterize the external shield of the detector, which is made of water, inserting XENON1T inside a 10m x 10m water tank, instrumented with PMTs to detect Cerenkov light produced by muons [49]. I also developed the MC simulation of the light propagation and collection in the Muon Veto, to define the number and position of PMTs and estimate the efficiency of the muon tagging [14].
- We are responsible for the installation and the operation of the Muon Veto, currently under commissioning at LNGS. During 2013 we tested all the 90 PMTs at LNGS, we installed them inside the water tank in Fall 2014, together with the reflective foil, and we are now testing their operation in the final setup.
- Since the end of 2011, I'm the Leader of the XENON1T Monte Carlo Working Group. The main task is to reproduce the performances of the detector through a detailed simulation using GEANT4 and to predict the background produced by the various sources: gammas and neutrons from material contamination, radioactivity of the intrinsic sources (^{85}Kr, ^{222}Rn and ^{136}Xe), ER and NR scattering due to solar neutrinos, gammas and neutrons from the environment, and muon-induced neutrons. This task

is crucial for the success of the whole project, since for rare event search it is mandatory to have a low background, with a reliable estimation. Indeed, many technical details in the detector design (Cryostat, TPC, PMT position) and on the allowed contamination of the materials have been determined on the basis of the studies performed with the Monte Carlo simulations that I lead.
We also developed the MC simulation of the light propagation and collection in the TPC, which allowed to improve the light yield of the experiment (crucial to detect low mass WIMPs) and to determine the performances in the position reconstruction of the interactions in the TPC, one of the key factors to remove the external backgrounds.
We also studied the sensitivity of the experiment with a Profile Likelihood approach, considering the various systematic uncertainties as nuisance parameters: in 2 ton year exposure we can reach less than 2 x 10^{-47} cm^2 for the WIMP-nucleon spin-independent cross section. In the paper "Physics reach of the XENON1T dark matter experiment" [1], recently published by JCAP, we summarized the whole work performed inside the MC WG; I'm the main author of that paper. The results have been presented by me at the UCLA Dark Matter conference in Feb 2016.
The second main goal of the MC Working Group, started in the last year, is to obtain an output of the MC simulation identical to the one coming from the detector digitized signals. In this direction we're building a waveform generator for both the prompt (S1) and delayed (S2) signals that will be validated against the XENON100 data and used in XENON1T with the same analysis chain as for the real data.
- Since 2013 I'm a member of the XENON Editorial Board;
- In the context of the DARWIN consortium, aimed at studying and developing a future multi-ton LXe detector, I worked mainly on the background estimation and on the sensitivity projections. The work has been published in [6].

Outreach:

EEE (Extreme Energy Events) is an outreach project, started in 2004, which aims to build and install cosmic ray detectors in secondary schools in Italy. The detector is a telescope made of three planes of Multigap Resistive Plate Chambers (time resolution: hundreds of ps), which allows the tracking of the crossing muons. My main responsibilities were the simulation of the detector (and of the network of telescopes) performances to the flux of cosmic muons and of extended air showers, and the construction of the MRPC planes assisting students and teachers of secondary school at CERN. In the Bologna area we installed telescopes in 5 schools and we are currently going on with the detector maintenance and assisting students in the data acquisition and analysis. In addition, we are involved in the dissemination of the basic concepts of particle and astroparticle physics with seminars in the schools or in other public contexts.
Some of the results of this outreach project are published in referred journals and presented to HEP conferences; see e.g. [2, 3, ...].

Funding ID

INFN directly funds the research of our group through the 'Commissione 2, Astroparticle Physics' panel.

- We manage about 300k euro per year for the construction of the muon veto of XENON1T, the ancillary systems at LNGS (water purification, service building, electrical plant, security) and the standard operations in XENON100.
- In 2011, 2013 and 2014 I've been the responsible person (RUP) for the tenders to procure the XENON1T muon veto PMTs (150 keuro), the xenon gas (140 keuro), and the PMT of the TPC (130 keuro).
- We are also funded with about 150 keuro per year to run and maintain the LVD neutrino telescope at LNGS.
- I manage the funds of the INFN Astroparticle Group in Bologna.

Roles & Responsibility

- Member of the Editorial Board of the LVD experiment [2003, present].
- Coordinator of the Monte Carlo Working Group of the XENON experiment [2011, present].
- Member of the Editorial Board of the XENON experiment [2013, present].
- Coordinator of the Astroparticle Group in Bologna (member of INFN Commissione 2) [2015, present].
- Referees for INFN of the NEWS experiment for directional Dark Matter search [2015, present].

Recent Presentations at National and International Conferences

- **UCLA Dark Matter 2016, February 2016, Los Angeles, USA,** *"Physics reach of the XENON1T dark matter experiment"*
- **SIF2014 (Congress of the Italian Physics Society), September 2014, Pisa, Italy,** *"The XENON dark matter project: status and prospects"* (invited talk).
- **WIN2013, Weak Interactions and Neutrinos, September 2013, Natal, Brazil,** *"Status and prospects of the XENON project: XENON100 and XENON1T"*
- **LRT2013, Low Radioactivity Techniques, April 2013, LNGS, Italy,** *"Monte Carlo modeling of background radiation"* (invited talk).
- **SIF2012 (Congress of the Italian Physics Society), September 2012, Napoli, Italy, "***Search for dark matter: from XENON100 to XENON1T, results and perspectives"* (invited talk).
- **Cosmogenic Activity and Background Workshop, April 2011, Berkeley (CA), USA,** *"Measurement of muon-induced neutron yield"* (invited talk) and *"Background estimation for XENON1T".*
- **IDM2010, International Workshop on Identification of Dark Matter, July 2010, Montpellier, France,** *"Study of the performances of the shield and muon veto of the XENON1T experiment".*
- **ICRC2009, 31st International Cosmic Ray Conference, July 2009, Lodz, Poland,** *"Analysis of the seasonal modulation of the cosmic muon flux in the LVD detector during 2001-2008".*
- **IDM2008, International Workshop on Identification of Dark Matter, August 2008, Stockholm, Sweden,** *"The LVD core facility: a study of LVD as a muon veto and active shielding for dark matter experiments"*

Submission of ERC grants

In 2007 I participated to the ERC Starting Grant selection with a project on "*Upgrade of the LVD detector with Gadolinium".*

In 2013 I participated to the ERC Consolidator Grant selection with a project called "*BoXe: Study of liquid Xenon properties for Dark Matter search".*

Activity as Referee

- **for Physics Journals:** I am referee for the international journals: Astroparticle Physics and JINST.
- **National and International Panels**: I am referee for the ANVUR (Agenzia Nazionale per la Valutazione del sistema Universitario e della Ricerca), REPRISE (Register of Expert Peer Reviewers for Italian Scientific Evaluation), Programma per Giovani Ricercatori "Rita Levi Montalcini", Scientific Evaluation Panel "Subatomic Physics, Sciences of the Universe, Structure and History of the Earth" of The French National Research Agency;
- **External referee for a PhD thesis** at the APC - Universite' Paris Diderot, September 2016

Teaching, tutoring and supervising

- Since 2001, up to now, I've been teaching as assistant professor in basic and advanced courses of the Science School of the University of Bologna:
  - "Physics" and "Statistics" at the "Biotechnology" Degree Course;
  - "Laboratory of Nuclear and Subnuclear Physics" and "Advanced Techniques for Particle Detection in Physics and Astrophysics" at the "Physics" Master Course;

  I took part to all the examinations.

- Since 2015 I am in charge of a course on Dark Matter Phenomenology for the PhD school at the Physics Department of the University of Bologna.

In 2004 I was co-supervisor of a Ph.D. Thesis about the neutron flux measurement with LVD.
In 2007, co-supervisor of a Degree Thesis about the MonteCarlo simulation of LVD with GEANT4.
In 2011, co-supervisor of a Ph.D. thesis about the neutron flux measurement with LVD and its interpretation with GEANT4.
In 2011, co-supervisor of two Diploma Thesis and one Master Thesis about the Muon Veto of XENON1T.
In 2012, co-supervisor of a Master Thesis about the light propagation inside the Muon Veto Water Cerenkov detector.
In 2013, co-supervisor of a Diploma Thesis about neutron interactions in liquid xenon.
In 2014, co-supervisor of a Ph.D. Thesis about the MC simulation of backgrounds in XENON1T.
In 2015, supervisor of a Master Thesis about the sensitivity of the XENON1T experiment.

Together with our group leader, prof. G. Sartorelli, I constantly follow and organize the work of younger people in our group (currently two post-docs, two PhD and two undergraduate student).

Organization of School and Workshop

- LIDINE2017, Light Detection In Noble Elements, SLAC, CA (USA), July 2017

Member of academic panels and selection committees

- Since 2010 I've member of the Master Thesis Committee of the Physics Department of the University of Bologna, as reviewer for Thesis in the Astroparticle sector.
- In 2011 I was member of the panel to select PhD students for the Physics Department of the University of Bologna.
- In 2014 I was deputy-member of the panel to select PhD students for the Physics Department of the University of Bologna.
- In 2015 I was member of the panel to select a post-doc fellow in Dark Matter search for the Physics Department of the University of Bologna.

Luogo e data
Bologna, 2 maggio 2016

Firma