**Pietro Antonioli**
**Curriculum Vitae**

Born in Turin (Italy) 1/9/1966

Senior Researcher at INFN, sezione di Bologna, with qualification as Full Professor (Abilitazione Scientifica Nazionale) for sector Experimental Physics of the Fundamental Interactions (A2/01) taken in 2013. Co-author of 501 publications (article on international journals), wih h-index: 77 (Web of Science), h_HEP index 101 (INSPIRE). Teaching activity at Bologna University.

**Current responsibilities:**

- ALICE Bologna group leader, coordinating the analyses carried out in Bologna and the operations of the TOF detector (managing 200 KEU/year budget, ALICE Bologna group has currently 24 persons with 17.8 FTE). Leading the group since 2012.
- ALICE TOF DAQ and TDC Electronics coordinator (since 2001)
- ALICE Collaboration, Collaboration Board, member (since 2012)
- ALICE TOF Upgrade Project Leader (managing total 500 KEU budget)
- co-chair of ALICE Conference Committee: responsibility over speakers' assignments and review/approval of all presentations at International Conferences (since 2017). This position includes ex-officio membership of Physics Board and Management Board
- INFN representative in Comitato di Indirizzo Scientifico of ASTER, the Consortium promoted by Regione Emilia Romagna for Innovation and Technology Transfer (since 2015)

**Career (including awards and selected past responsibilities)**

- 1985 Bachelor Degree (high school): Maturità Classica, Liceo M. D'Azeglio, Turin (59/60)
- 1990 Master Degree in Physics, Turin University, dissertation on "Detection of neutrino from stellar collapse via neutral current interactions on $^{12}C$ in liquid scintillator experiment" (110/110 cum laude and honor mention)
- 1992 winner of the Special Award by Italian Physics Society for Physics for young graduates
- 1994 Ph.D. in Physics, Turin University, dissertation on "First results on the study of e.m. and hadronic components inside EAS cores"
- 1994-1995, post-doc position at INFN, sezione di Torino
- 1995-2008 INFN, Sezione di Bologna, researcher
- 2006-2009, INFN Scientific Committee III ("Nuclear Physics"), member
- 2008-current, INFN, Sezione di Bologna, senior researcher
- 2010-2014 ALICE Collaboration, Particle Identification coordinator

**Scientific activity**

Neutrino and high energy physics are my main fields of research. For the latter I had the opportunity to work both at cosmic ray experiments and at accelerators, for the former in underground laboratories. My activity is roughly divided in three main periods.

1) (**1989-1994)** During my degree, Ph.D. and a post-doc grant at Turin University I worked in the LSD (Mont Blanc), LVD and EAS-TOP (Gran Sasso Laboratories) experiments. Main analyses achievements included:

- best limit on the stationary flux of relic $\nu_\mu$ and $\nu_\tau$ neutrinos from stellar collapses using data of the LSD Mont Blanc detector;
- measurement of the muon intensity-depth underground and study of the muon energy losses with the LVD detector in correlated events with the EAS-TOP experiment;

- successful calibration and operation of the quasi-proportional chambers of the EAS-TOP calorimeter to measure with high granularity the electromagnetic component of the EAS shower. This seminal work during my PhD thesis brought then to the measurement of the jet production cross section in proton-ion collisions at large pseudorapidities derived from EAS data;
- calibration, monitoring and data analysis of both LVD and EAS-TOP experiments, gaining experience on data acquisition and electronics, as well as scintillator and gaseous detectors

2) **(1995-2000)** As staff at INFN Bologna, I maintained during these years a prevailing interest for neutrino physics but I gradually moved to high energy physics, joining the ZEUS Collaboration at HERA. This was a great opportunity to learn experimental methodologies at accelerators. The uniqueness of the HERA machine allowed to probe the proton's structure to thoroughly test QCD predictions. Working with the ZEUS experiment, I contributed to outstanding physics results such as the extraction of the $F_2$ parton distribution function measured over a large kinematic region. Main analyses achievements included:
- study of the distortion of the detected neutrino signal at Earth from stellar collapses due to neutrino oscillations;
- work with professor T. Ypsilantis on a proposed water Cerenkov detector with focusing mirrors (AQUA-RICH) and with the Monolith Collaboration proposing a magnetized tracking calorimeter for new neutrino experiments;
- development of a fully 3D Monte Carlo simulation code for muon propagation in the rock;
- the study of the photoproduction of $\Upsilon$ and J/$\psi$ quarkonium states via the channel $\gamma$ p --> $\mu^+$ $\mu^-$ p, using the Forward Muon detector.

Experimentally, besides providing support for data taking and data quality assurance in LVD and ZEUS, I used the know-how gained at ZEUS on VME bus to upgrade the Data Acquisition system at LVD with full responsibility of the project.

3**) (2001-current)** I then joined the ALICE Collaboration, the LHC experiment focusing on the hot QCD matter generated in nuclear collisions at collider energies. The Bologna group is responsible for the time-of-flight TOF detector. Based on Multi-Gap Resistive Plate Chambers, the TOF covers the pseudorapidity interval [−0.9, +0.9] and the full azimuthal angle, for a total active area of 141$m^2$. The TOF is responsible to provide Particle Identification (PID) in the region of intermediate momenta (0.5 – 5.0 GeV/c) for charged hadrons (pions, kaons and protons).

During last 17 years my engagement with ALICE moved naturally from a very intense experimental effort during the R&D and construction phase, to the optimization of the detector and to the engagement with major physics analysis, reaching since some years managerial responsibilities in the Collaboration.

The TOF detector had the challenge to maintain the excellent MRPC time resolution on a large scale and area detector (152K TDC channels over 140 $m^2$). I contributed to this effort:
- optimizing MRPC design, including several test beam campaigns, operations of small lab facility with cosmic rays (both in Bologna and CERN) and measurements at irradiation facilities;
- leading the realization of the TDC cards (based on the HPTDC chips). This included evaluation of HPTDC performance and calibration procedures, conduct tests at irradiation facilities for critical electronic components, develop solutions for clock distribution (keeping the jitter below 15 ps) and maintain relationship with key commercial partners.
- design and realization of the DAQ system for the TOF. The choices made in terms of multi-buffering proved solid and far-reaching: for the planned upgrade during LS3 it will be necessary only to upgrade one readout card to operate the detector in continuous mode.

In ALICE I then took the co-responsibility of the coordination of the Particle Identification among the different detectors (ITS, TPC, TOF, EMCAL, TRD and HMPID) in the central barrel when the data taking just started. This led to the development of a common framework for PID data analysis in ALICE, allowing end

users to easily manipulate the complexity of the different detectors. A big effort was the combination of the different detector signals, using a Bayesian approach. I was appointed as the lead author by the Collaboration for a paper (published in 2016) summarizing the results achieved during LHC Run-1 and the validation done for the Bayesian approach.

The Bologna group I'm now coordinating since 2012 contributed to critical analyses for the mainstream ALICE physics, devoted to the study of strongly interacting matter under extreme conditions reached during relativistic heavy-ion collisions:

- identified hadron spectra;
- the study of strange hadronic resonances, such a K*(890) and $\phi$ meson, to study the dynamic evolution of the QGP and the study of strangeness as a function of multiplicity in different collision systems (the latter published on Nature Physics in 2017);
- the elliptic flow of identified hadrons;
- entirely within Bologna group, during 2013-2015, we performed a precision measurement of the mass differences between nuclei and their anti-matter counterparts using ALICE data. The new result on CPT invariance in the light-nuclei sector for d and $^3$He improves on existing measurements by a factor of 10-100. It was published in Nature Physics and I was one of the members of the Paper Committee.
- the study of heavy-flavour production via identified hadron decays of charmed mesons (D0 -> K-pi+) and baryons (Lc -> K0s p). For the latter analysis, recently (February 2018) accepted for publication on JHEP, we introduced for the first time Multivariate Analysis in ALICE to identify a rare signal from a large combinatorial background. I played here a direct role, coordinating the analysis and chairing the Paper Committee appointed by the ALICE Collaboration

Other analyses and papers where I have been directly involved include:

- analysis of the TOF detector performance: the paper published in 2013 showed an overall 80 ps time resolution was achieved;
- the major ALICE performance paper published in International Journal of Modern Physics A (I authored the PID section)

**International Conferences: talks and conference organization**

I regularly reported at international conferences. The number of invited talks has increased during recent years, including the responsibility to give multi-experiment talks on behalf of the LHC Collaborations at major high energy physics conferences or overview talks for the whole ALICE program:

- "Double Parton Scattering, Multi-Parton interactions and Underlying Event and identified hadrons" (LHCP 2014, New York, June 2014)
- "Heavy flavour production in pA and AA" (LHCP 2015, Saint Petersburg, September 2015)
- "The ALICE upgrade programme", (LHCP 2016, Lund, June 2016)
- "Review of ALICE results", (ICPPA-2017, Moscow, October 2017)

I organized workshop and conferences (such as XXIV International Symposium on Multiparticle Dynamics, Bologna, 2014). In particular I co-organized in 2015 a workshop in Bologna about "The physics of heavy ions at LHC" (https://agenda.infn.it/conferenceDisplay.py?confId=9453) and I'm currently co-chairing the Sixth International Conference on Large Hadron Physics, that will be held in Bologna in June 2018 (http://lhcp2018.bo.infn.it).

**Tutoring and teaching activity at Bologna University**

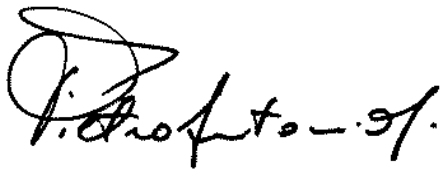
I regularly trained young researchers co-supervising Master Degree and Ph.D. thesis at Bologna University. I'm currently teaching in the course "Metodologie sperimentali in Fisica e Astrofisica delle Particelle" (http://www.scienze.unibo.it/it/corsi/insegnamenti/insegnamento/2017/330153). In the past I taught in the course of sub-nuclear physics.

**Expertise**

As per activities stated in my CV I matured expertise and in-depth knowledge in the following sectors as of December 2017:

- Relativistic heavy-ion collisions and the study of the QGP plasma
- Heavy flavours physics
- Neutrino and cosmic-ray physics (not in recent years, though)
- Data Acquisition techniques including high-speed data transmission, development of custom electronic cards
- Methodologies to test and qualify electronic components for radiation tolerance
- Particle detectors, in particular Multigap Resistive Plate Chambers with state-of-the-art performance in terms of timing
- Digital electronics, with particular reference about Time-to-Digital Converters

The experience with ASTER, the High Technology network developed as consortium between institutions (Regione Emilia Romagna), Universities and Research Institutions (INFN, CNR, ENEA) and the private sector gave me additional access to companies potentially partners of research activities.



Bologna, 22 February 2018

# CURRICULUM VITAE

## Silvia Arcelli

Silvia Arcelli was born in Bologna on May 1st, 1967. The subject of her research activity is high energy subnuclear physics. She has been a member of the OPAL collaboration at LEP and of the CMS experiment at the LHC. She is presently a member of the ALICE collaboration, the experiment dedicated to the study of ultrarelativistic heavy ion collisions at the LHC. She is currently participating also in the DarkSide project at LNGS, to search for dark matter with a large liquid Argon detector under construction.
She is co-author of more than 550 scientific publications, and presented her research activity at several national and international conferences and workshops, often as invited talks (h-index (SPIRES)=100, h-index (WOS)=69).
Career:
-1990: Laurea degree in Physics at the Bologna University, magna cum laude.
-1991: INFN fellowship for Graduate Students.
-1995: P.h.d. in Physics defending the thesis: ``Misura di precisione della Luminosita' e determinazione dei Parametri Elettrodeboli della Z0 con il rivelatore OPAL al LEP".
-1997: Award of the Italian Physics Society for young researchers in Physics.
-1996-1997: Two-year Post-Doc fellowship at the Bologna University
-1998-2000: Research Associate at the High Energy Physics Department of the Maryland University, USA.
-2000-2004: Research Associate at the Physics Department of the Bologna University.
-2004-2005: "Senior Grant" at the Museo Storico della Fisica e Centro Studi e Ricerche E.Fermi.
-2005-2014: Assistant Professor (Experimental Physics , FIS/01) , Department of Physics and Astronomy, Bologna University,Italy.
-2014-Now: Associate Professor (Experimental Physics , FIS/01), Department of Physics and Astronomy, Bologna University, Italy .
-2017-Now: Coordinator of the PhD programme in Physics , Department of Physics and Astronomy, Bologna University, Italy .

**Scientific Activity:**
1) From 1991 to 2003 she has been a member of the OPAL (Omni Purpose Apparatus for LEP) experiment at LEP , studying electron-positron collisions near the Z0 vector boson resonance(LEP1) and above the WW pair production threshold (LEP2) up to 209 GeV center-of-mass energy. Major results of the experiment have been very accurate measurements of several parameters of the Standard Model (both in the electroweak and in the strong sector) , limits on the production of new phenomena beyond the Standard Model, and a throuroug study of the properties of heavy quarks b and c. Her scientific activity covered both more technical aspects, connected to the operation, calibration and monitoring of the OPAL luminometers (Forward Detector FD and SiW Luminometer) and of the OPAL Hadron Calorimeter (HCAL), and several physics analyses spanning from electroweak measurements , heavy quark production and search of particles beyond the Standard Model.
Selected Contributions to Physics Analysis as a main author in OPAL:
• Precision Measurement of the Luminosity with The SiW luminomer (<0.1% experimental accuracy, mandatory for a precise determination of the Z0 invisible width);

• Determination of the electroweak parameters of the Z0 at LEP1, through the Lineshape Analysis;
• Two-fermion production e+e- -->f f(bar) at LEP2;
• Measurement of Rb and Ab(FB) at LEP2, using b-tagging techniques based on the OPAL microvertex;
• Isolated photons with missing energy at LEP2, for the determination of the number of light neutrinos, and searches for new physics decaying into invisible states.
• Anomalous Triple Gauge Couplings Z-Z-photon, Z-photon-photon a LEP2.

Responsabilities in OPAL:
• Responsible of the Monte Carlo simulation for the luminosity measurement with the OPAL SiW luminometer;
• Responsible of the luminosity measurement in the LEP2 phase;
• Responsible of the OPAL Hadron Calorimeter (operation, monitoring, calibration,data quality, simulation) ;
• "On Call" expert during data taking for the OPAL Forward Detectors (FD, SiW Luminometer) and for the OPAL hadron calorimeter;
• Shift leader ("e+e- expert") during data taking.

Responsabilities in the LEP general Working Groups :
• OPAL representative for the neutrino-antineutrino photon (photon) channel
within the Monte Carlo Workshop for precision calculations at LEP2;
• Member of the LEP Electroweak Working Group for the combination of the electroweak measurements at LEP ;
• Member of the LEPS Susy Working group for the combinations of the results of the photon (photon)+missing transverse energy channels.

2) From 2000 to 2003, she has been a member of the CMS (Compact Muon Solenoid) experiment at the Large Hadron Collider (LHC). As a Research Associate of the Hgh Energy group of the Maryland University, she contributed to the design and the optimizaton of the CMS hadron calorimeter Level 1/2 Triggers. From 2001 to 2003, she worked as a research associate of the INFN Bologna group responsible for the construction of the Drift Tubes (DT) chamber of the CMS muon system. During this period, she took part to the construction and testing of the muon DT chambers both in Bologna and at LNL, and was responsible of the Monte Carlo simulation for the Muon Barrel detector group in CMS. She contributed to the design and the optimization of the level 1/2/3 Trigger Selections for the CMS muon system, and to several preparation studies for future physics analyses.
Selected Contributions to Preparation Studies and Physics Analysis as a main author in CMS:
• Optimization of the Lv1 Trigger selections of the CMS hadron Calorimeter
• Optimization of the Triggers algorythms (Lv1/2/3) for the CMS muon system
• Preparation Study for the detection of the MSSM Higgs in the H/A->mu+mu- channel.

Responsabilities in CMS:
• Coordinator of the pre-production and testing of the cathodes co of the CMS Muon Barrel Drift Tubes , INFN-Bologna; Construction and testing of DT chambers in the INFN Legnaro National Laboratory
• Responsible of the Monte Carlo production for the CMS muon system reconstruction and simulation group (Muon PRS, Physics Reconstruction and Selection).

3) In 2004 she started her scientific activity in the ALICE (A Large Ion Collider Experiment) collaboration, dedicated to the study of ultrarelativistic heavy ion collisions at the LHC, as a member of the INFN/University Bologna group for the time-of-flight (TOF) detector. Based on Multi-Gap Resistive Plate Chambers (MRPC), the Time of Flight system covers the pseudorapidity interval [−0.9, +0.9] and the full azimuthal angle, and provides Particle Identification (PID) in the region of intermediate momenta (0.5 - 4.0

GeV/c) for charged hadrons (pions, kaons and protons).
She has been responsible of the simulation and the reconstruction software, having a leading role in the their design and development. She has also been one of the major contributors to the development and optimization of the TOF Particle Identification algorithms, exploiting a Bayesian approach. She designed the major part of the software for the calibration, alignment and Data Quality Monitoring of the TOF using physics events during data taking. Se also has developed, coordinating a group of 4 researchers, a framework for the calculation of acceptance and efficiency corrections (Correction Framework) currently used within the ALICE collaboration.
Her physics analysis activity focusses on the study of the properties of identified charged hadrons in the central pseudorapidity region and on the production of hadronic resonances in Pb-Pb, p-p e p-Pb collisions. She has been heavily involved in the precision measurement of the mass differences between light nuclei and anti-nuclei. The result, published in Nature Physics, improves the constraints on CPT invariancein the light-nuclei sector by a factor of 10-100.
Selected Contributions to Physics Analyses in ALICE:
• Identified hadrons transverse momentum spectra in proton-proton and Pb-Pb collisions;
• Production of phi/K* resonances in p-p, Pb-p and Pb-Pb collisions.
• Anisotropic flow (v2,v3) of identified hadrons Pb-Pb collisions.
• Production of light (anti-)nuclei in Pb-Pb collisions and precision measurement of their masses.

Responsabilities in ALICE:
• Member of the ALICE Computing Board;
• Responsible of the development and optimization of the simulation,reconstruction and identification software for the ALICE Time of Flight System TOF .
• Responsible for the TOF detector within the Working Group for the preparation of the ALICE Physics Performance Report (PPR) ;
• Responsible of the design and development of the software for the determination of acceptance and efficiency corrections to physics analyses (ALICE Correction Framework)

**Other Activities :**
-She is regularly serving as a referee for the following journals: The European Physical Journal C (EPJC), The European Physical Journal-Plus (EPJ-Plus), The Journal of Instrumentation (JINST);
-Supervision of young researcher s for Bachelor (6) and Master Degree(8) and PhD (2) Thesis in Physics;

**Curriculum Vitae of Francesco Noferini**

## PERSONAL INFORMATION

Noferini, Francesco:
ORCID: orcid.org/0000-0002-6704-0256
Date of Birth: 19th September 1978
Nationality: Italian
URL for web site: www.bo.infn.it/~noferini

- EDUCATION

2012 National Academic Qualification, eligibility as Associate Professor
Sector: 02/A1 - EXPERIMENTAL PHYSICS OF FUNDAMENTAL INTERACTIONS
2007 PhD
Physics Department, Bologna University, Italy
Supervisor: prof. Luisa Cifarelli
2003 Master
Physics Department, Bologna University, Italy

- CURRENT POSITION

2017 Staff researcher, INFN (Bologna)
INFN sez. Bologna at Physics Department of Bologna University

- PREVIOUS POSITION

2015-2016 INFN Researcher at CNAF (INFN computing centre), Bologna (Italy)
2010-2015 E. Fermi centre research Grant, Rome (Italy)
2008-2010 INFN research Grant at CNAF (INFN computing centre), Bologna (Italy)
2007-2008 E. Fermi centre research Grant, Rome (Italy)

- FELLOWSHIP AND AWARDS

2007-2017 Scientific association with CERN (Geneve)
2014: "F. Rimondi" award (poster session) at the 44th International Symposium on Multiparticle Dynamics.
2007: G. Puppi - WFS Award for New Talents 2007 - For his original study of two particle correlations from RHIC to LHC.
2006: International School of Subnuclear Physics 2006, 44th Course - Talk awarded as "Valuable Work in Experimental Physics".

- ISTITUTIONAL RESPONSIBILITY

2014-2016: Co-convener particle identification group in ALICE (PAG-PP-PID)
2014-2017: Responsible for EEE computing at CNAF, Bologna
2008-2017: Responsible for ALICE resources at the Italian Tier-1

- COMMISSIONS OF TRUST

2013-2017: Reviewer for European Physical Journal

- SELECTED INVITED SEMINARS

2015: CERN seminar on Precision measurement of the mass difference between light nuclei and anti-nuclei with ALICE at the LHC
2010: Particle production at LHC with the ALICE experiment, Gangnung University, South Corea.
2010: The Italian Tier1: CNAF status report and experience within the ALICE experiment, KISTI Tier-2, Daejon, South Corea

- SELECTED CONFERENCE PRESENTATION

2015: The ALICE PID performance in Run-1 and perspectives in view of Run-2, 3rd Course LHCp: Large Hadron Collider Physics, St. Petersburg
2015: The computing and data infrastructure to interconnect EEE stations, 13th Pisa Meeting on advanced detectors: Frontier detectors for frontier physics, La Biodola, Italy
2014: Elliptic flow of identified particles measured by ALICE at the LHC, 44th Internetional Symposium on Multiparticle Dynamics, Bologna
2012: Anisotropic flow of identified particles in Pb-Pb collisions at 2.76 TeV measured with ALICE at the LHC, Quark Matter 2012, Washington
2011: Anisotropic flow of identified particles measured with the ALICE detector in the first year of heavy-ion, Strangeness in Quark Matter, Cracow
2010: Momentum spectra of identified particles in pp collisions with the ALICE detector, Rencontres de Moriond QCD and High Energy Interactions
2009: A Comparison of Data-Access Platforms for BaBar and ALICE analysis Computing Model at the Italian Tier1, CHEP 2009, Praga

- TEACHING ACTIVITY

2016-2017 lecturer on contract – “Data Acquisition Laboratory”, Bologna University, Italy

- BIBLIOGRAPHY (Web Of Knowledge)

188 Publications

# F. Noferini activity

I have been working in high-energy physics since 2004 when I joined the INFN TOF ALICE group in Bologna during my PhD.

## *ALICE* ACTIVITY

### Physics

Before of the start of the LHC Hera (in 2009) I worked in the construction of the ALICE Time of Flight (TOF) and in the software development for the reconstruction of the TOF data. In particular, I shared the responsibility, since 2010, in the management/development of the TOF software data structure, data reconstruction and simulation. In November 2009 I started to work on the identification of pions, kaons and proton via the time-of-flight measurement. I obtained the **first results of the ALICE collaboration for this observable that I presented in Moriond at the beginning of 2010** (Momentum spectra of identified particles in pp collisions with the ALICE detector, Rencontres de Moriond QCD and High Energy Interactions).
In order to reach the desired performance (TOF resolution of 80 ps) I worked on a procedure to provide the **initial start time of the collision based on a combinatorial algorithm on all the track reached the TOF** (the TOF is then able to provide also the start by itself, not only the time arrival).
I continued to be strongly involved in the Particle Identification (PID) in ALICE to improve the PID capability using statistical Bayesian approaches becoming one of the most expert in ALICE in the PID: I'm co-convener of the Particle Identification group (PWG-PP-PID) from 2014 and I presented the first results on Bayesian PID at LHCP15 in St. Petersburg.

In 2010 with the first PbPb collisions provided by LHC, I started an **activity in the correlation analysis group to perform measurements needed to characterize the matter produced in such collisions in terms of collective effects**. My main role in the group was in the characterization of collective phenomena using identified particles. My work on the elliptic flow of identified particles in PbPb collisions was also awarded as "F. Rimondi" award (poster session) at the 44th International Symposium on Multiparticle Dynamics.

### Computing

In 2008 I became **responsible for ALICE activities at the Italian INFN Tier-1** (CNAF). In particular, I followed the management of the ALICE services for computing and storage and their interaction with the framework used in ALICE (AliEn). The amount of resources managed corresponds, in 2017, to thousands of cores dedicated to ALICE, several PBs for disk and data preservation tapes and a connection with an access rate to data up to 6 GB/s [1,2].

[1] A Comparison of Data-Access Platforms for BaBar and ALICE analysis Computing Model at the Italian Tier1, CHEP 2009, J. Phys. Conf. Ser. 219 072003 (2010).
[2] Xrootd data access for LHC experiments at the INFN-CNAF Tier-1, J.Phys.Conf.Ser. 513 (2014) 042023.

**My roles in ALICE favoured the achievement of a big experience in using big data both from the point of view of data analysis and data management at a computing centre**.

## *EEE PROJECT* ACTIVITY

In 2014 I joined also the EEE Project collaboration during its upgrade phase to a coordinate acquisition system at CNAF.

**Physics and Outreach**

I'm involved in the physics program of EEE Project **searching for coincidences in cluster** of telescopes at a distances < 2 Km accessible in several EEE sites with the role of coordinator of the analysis and the paper preparation. Coincidences of secondary cosmic rays at large distances allows to select primary rays of very high energies (> 10^16 eV) [3].

**Computing**

I'm also **coordinating the EEE data management at CNAF in Bologna** where the data of all the 50 telescopes are collected. Starting from 2014 the data are collected at CNAF and reconstructed to allow the monitor of the data quality in quasi-real time. The architecture of the data management system [4] was developed to account for the specific requests of the experiment. I worked in the optimization of the reconstruction software and in particular in managing the information of multi-tracks events. The new software I developed is in production from the end of the Run-2 (June 2016). The new software allows to perform also the measurement of the efficiency of the chambers without the need of external detectors. This is realized using the feature of the trigger card to provide a signal excluding one of the chambers from the trigger. This technique allowed at the end of Run-2 to **perform *remotely* an efficiency scan on all the telescopes** even if the detectors are placed in the schools.

[3] Towards the installation and use of an extended array for cosmic ray detection: The EEE Project", Nucl. Phys. Proc. Suppl. (2009) 190:38.
[4] The computing and data infrastructure to interconnect EEE stations", F. Noferini, Nucl. Inst. & Meth. A (2015), doi:10.1016/j.nima.2015.10.069.

**The experience I achieved in the EEE collaboration in the last two years convinced me that the idea behind the LDCORE proposal is sustainable and innovative.**

**OUTREACH AND TEACHING ACTIVITY**

Since the telescopes of the EEE Project are hosted in Italian high schools, **I'm also involved in an important outreach activity**. I periodically present to the students the physics of cosmic rays through the analysis of data collected by their telescope (muon decays, rate vs pressure, …). Moreover, also joined in the past years speed date activities at the European night of researcher initiatives.

As INFN researcher, I don't have any teaching obligation, however I am **engaged in teaching activity in Bologna University** since the end of my PhD giving seminaries and lectures addressed to the student for Modern Physics (first level degree) and Subnuclear Physics (second level degree) courses. I followed students as thesis advisor (three first level degree theses and four second level degree theses) and I am in several examination boards.

In 2016-2017, I am holder of a teaching module: "Laboratorio di acquisizione ed elaborazione dati - 3 modulo 3" (data acquisition laboratory).