MICHELA PREST

Como, October 4, 2015

CURRICULUM VITAE

Born in Udine (Italy) on the 4th of September 1968

29/03/1993 Degree in Physics at the University of Trieste (Italy) with full marks (110/110 cum laude) presenting a thesis entitled "Lambda-Lepton correlations in DELPHI: a new method to measure the oscillations of B_0 mesons" (in italian), tutor Prof. P. Poropat, co-tutor Dr. C. Petridou

21/07/1997 PhD in Physics (Trieste) presenting a thesis entitled "SYRMEP: at the frontiers of digital mammography" (in italian), tutor Prof. E. Castelli, referee Prof. P. F. Manfredi (University of Pavia)

02/1997 5th in ranking in the selection for 13 post-doctoral fellowships for experimental physicists; the selection was organized by the National Institute for Nuclear Physics (INFN). The fellowship lasted from 03/06/1997 to 02/06/1999

2000-2007 Project leader of the silicon-tungsten tracker of the AGILE satellite

2000-2007 Responsible of the calibration photon tagged beams of the prototypes and the flight model of the AGILE satellite at the CERN extracted beamlines and at the BeamTest Facility of the INFN LNF laboratories

2000-2007 AGILE Instrument Scientist and member of the ASB (AGILE Science Board), that is the board responsible of the definition of the scientific requirements of the project and of the validation of the technical choices

1/11/1999-30/12/2002 Research fellowship and temporary appointment as an INFN researcher (article 36/23 (D.P.R. 70/75-171/91)) for the AGILE project

31/12/2002-30/09/2014 Researcher at the Department of Physics and Mathematics (since 2012 Department of Science and High Technology) of the Insubria University (Como, Italy)

since 01/10/2014 Associate Professor at the Department of Science and High Technology of the Insubria University (Como, Italy)

2001-2008 Local responsible for AGILE at the Trieste and then Milano and Milano Bicocca INFN Sections

2005-2007 Responsible of the Como Unit for the PRIN (Projects of high national relevance financed by the University and Research Ministry) 2005 project entitled “Real time dosimetry of photon and neutron beams for radiotherapy and BNCT (Boron Neutron Capture Therapy) with clinical Linacs”

2008-2009 Local reponsible in INFN-MiB for the NTA-HCCC project on collimation with bent silicon crystals

2009 INFN national responsible and deputy spokesperson for the UA9 experiment on crystal collimation on the SPS circular beam

2008 - 2012 Member of the Insubria University Administrative Council

since 2008 Representative of the Insubria University in the national scientific network entitled “Study of tumour therapies based on neutron irradiation”

2010-2012 Responsible of the outreach activities for the faculty (then Department); in 2011-2012 convener and tutor of the Science group for the Ufficio Scolastico Regionale to prepare the advisors of high school teachers in the framework of the new teaching guidelines

2010-2012 Local responsible for the FIBER-SPAD project (led by CNR-IMM Bologna) of the Italian Space Agency for the industrial competitiveness in the space field (ASI call DC-PRZ-2007-001)

since 2011 Local responsible in INFN-MiB for the TWICE (on silicon photomultiplier development) and COHERENT (on crystal collimation) projects

2012-2013 Responsible of the fanout design and production for the SuperB vertex detector and local responsible in INFN-MiB

2012 The 2012 Rossi Prize has been awarded by the American Astronomical Society to astrophysicist Marco Tavani and the AGILE team for the discovery of gamma-ray flares from the Crab Nebula. Long thought to be a steady source of energy - from optical to gamma rays - this finding has changed the understanding of this very important cosmic object.

2012 Project selected for the financial support in the framework of the Transnational Access for the EU project AIDA GA no. 262025 to use the testbeams at CERN (60 user-days for a total of 9 visits). The project deals with the study of the performance of several SiPM readout crystal calorimeters on high and low energy beams

since 11/2012 Member of the Academic Senate

since 02/2013 Delegate of the Dean for the outreach

2013 member of the founding committee of Scuola di Como, the inter-universities college of Como supported by the local institutions; member of the selection committee for the first year of the School

since 12/2013 representative of the Insubria University in the administrative board of Scuola di Como; member of the selection committee

since 2014 Local responsible in INFN-MiB of the ICERAD (on crystal collimation) and the SQUOP (on the development of Silicon PhotoMultipliers for quantum optics) projects

since 03/2014 representative of the Insubria University in the welfare technical committee of the Fondazione Provinciale della Comunità Comasca (working on possible activities to limit the number of school early leavers)

since 07/2014 representative of the Insubria University in the University-Industry committee of Unindustria-Como

since 2015 Local responsible in INFN-MiB of the CHANEL (on crystal collimation and radiation production) project

since 07/2015 Member of the Admistration Council of Fondazione Provinciale della Comunità Comasca

ABILITAZIONE SCIENTIFICA NAZIONALE

Winner of the “abilitazione” for associate professor (seconda fascia) and full professor (prima fascia) in the 02/A1 sector (experimental physics of fundamental interactions) on the 23rd of January 2014.

PARTICIPATION TO CONGRESSES

9/1993 Annual SIF (Italian Physics Society) congress (Udine, Italy) with an oral presentation: "Production of Λ and $\Lambda\bar{\Lambda}$ correlations in the hadronic decays of the Z^0" (Nuclear and Subnuclear Physics Session)

13/1/1994 CMS ECAL Workshop (Annecy, France) with an oral presentation on the DELPHI STIC detector

22/5/1994 6th Pisa Meeting on advanced detectors: Frontier Detectors for Frontier Physics (Elba, Italy) with an oral presentation: "A silicon pad shower maximum detector for a Shashlik calorimeter"

9/1994 Annual SIF congress (Lecce, Italy) with an oral presentation: "Development of silicon detectors for soft X rays" (Electronics and Physics Application Session)

7/5/1995 7th European Symposium on Semiconductor Detectors, New Developments In Radiation Detectors (Schloss Elmau, Germany) with a poster: " New Technology for shower maximum silicon detectors for shashlik calorimeters"

18/9/1995 9th International Workshop on Room Temperature Semiconductor X and γ-Ray Detectors, Associated Electronics and Applications (Grenoble, France) with an oral presentation: "A pixel-like matrix for digital mammography"

9/9/1996 4th International Conference on Position-Sensitive Detectors (Manchester, UK) with an oral presentation: "SYRMEP: an Innovative Detection System for Soft X-Rays"

29/5/1997 7th Pisa Meeting on advanced detectors: Frontier Detectors for Frontier Physics (Elba, Italy) with an oral presentation: "At the frontiers of digital mammography: SYRMEP"

23/9/1997 IEEE RT97 (Beaune, France) with a review talk: "Real time in frontier detectors for medical physics"

12/11/1998 IEEE Nuclear Science Symposium (Toronto, Canada) with an oral presentation: "Data Acquisition, Processing and Control for the SYRMEP/FRONTRAD Experiment"

13/03/2000 International workshop "Gamma-ray astrophysics with AGILE" (Milan, Italy) with an invited talk: "The AGILE silicon tracker".

15/5/2000 4th International Meeting On Front End Electronics For Tracking Detectors At Future High Luminosity Colliders (Perugia, Italy) with an invited talk: "The AGILE silicon tracker: a challenging γ-ray instrument for space".

29/5/2000 8th Pisa Meeting on advanced detectors: Frontier Detectors for Frontier Physics (Elba, Italy) with an oral presentation and a poster: "FROST: a low-noise high-rate photon counting ASIC for X-Ray Applications" (oral); "The future of Gamma ray detectors for space: the AGILE silicon tracker" (poster)

15/03/2001 National workshop “Science with AGILE” (Milan, Italy) with an invited talk: “AGILE: the silicon tungsten tracker”

4/06/2001 12th IEEE-NPSS Real Time Conference 2001 (Valencia, Spain) with an oral presentation: “ The trigger and data acquisition system of the AGILE gamma-ray satellite”

23/09/2001 10th International Workshop on Vertex detectors, VERTEX 2001 (Brunnen, Switzerland) with an invited talk: “The AGILE silicon tracker: an innovative γ-ray instrument for space”

13/9/2004 13th International Workshop on Vertex detectors, VERTEX 2004 (Menaggio, Italy) with an invited talk: “Silicon in space: a universal detector for photons and charged particles”.

10/10/2004 5th International Conference on Radiation Effects on Semiconductor Materials Detectors and Devices (Florence, Italy) with an invited talk: “A long and successful story: the applications of silicon detectors in space”

07/04/2005 Workshop on the “Treatment of bone metastases: comparing opinions” (Como, Italy) with an invited talk: “Physical characteristics and production systems of radio-isotopes for the radiometabolic therapy”

17/12/2008 Seminar at the University of Geneva: “Bent crystals: a long story and its new frontiers”

29/09/2009 Annual SIF congress (Bari, Italy) with an invited talk: “UA9 and bent crystals: towards the frontiers of collimation” (Nuclear and Subnuclear Physics Session)

CONFERENCE ORGANIZATION and REVIEWER ACTIVITY

2004 Member of the local organizing committee of the 13th International Workshop on Vertex detectors (VERTEX 2004)

2004 Topic convener of the ”Astrophysics and Space Instrumentation” session at the 2004 IEEE NSS Conference (Rome, 16-22/10/2004)

since 2004 Member of the IEEE

since 2004 Reviewer for the Nuclear Science Symposium, Medical Imaging Conference

since 2007 Reviewer of Nuclear Instruments and Methods in Physics Research A

THESES TUTORSHIP

Cotutor of:

05/1996 D. Pontoni - master thesis: "Microstrip silicon detectors and associated VLSI electronics in the SYRMEP project" (in italian, tutor Prof. E. Castelli, University of Trieste)

11/2000 G. Fedel - master thesis: "The AGILE silicon-tungsten tracker: an innovative instrument for gamma astrophysics" (in italian, tutor Prof. G. Barbiellini, University of Trieste)

12/2001 G. Bordignon - master thesis: "Detection of gamma rays with the AGILE silicon tracker" (in italian, tutor Prof. G. Barbiellini, University of Trieste)

09/2003 B. Nadalut - master thesis: "Characterization of the frontend electronics of the AGILE silicon-tungsten tracker" (in italian, tutor Prof. G. Barbiellini, University of Trieste)

10/2003 M. Amati - master thesis: "Analysis of microstrip silicon detectors performance with a high particle flux" (in italian, tutor Prof. M. Caccia, Insubria University)

02/2005 F. Boffelli - master thesis: "The calibration of the AGILE satellite: study and commissioning of a tagged photon beam" (in italian, tutor Prof. G. Bignami, University of Pavia)

2005 C. Salvioni - thesis: "Background active discrimination in bolometric experiments for the search of double beta decay" (in italian, tutor prof. A. Giuliani, Insubria University)

2007 E. Caibucatti - thesis: "Gamma astronomy in the TeV range" (in italian, tutor prof. A. Treves, Insubria University)

2009 L. Negrini - bachelor thesis: "Profilometry of ionizing beams" (in italian, tutor prof. M. Caccia, Insubria University)

2012 L. Negrini - master thesis: "Mimotera: a silicon pixel detector for beam profilometry" (tutor prof. M. Caccia, Insubria University)

Internal tutor of:

2007 S. Sala - master thesis: "Application of personalized dosimetric parameters and definition of a procedure to determine the treatment volumes in SPECT images in the therapy with iodine for hyperthyroidism" (in italian, external tutor Dr. M. Cacciatori, Ospedale S. Anna, Como)

2011 F. Carinci - master thesis: "Characterization of phase-based methods for $B_1{}^+$ mapping at 3.0 T and 7.0 T MRI" (external tutor Dr. D. Santoro, Max Delbrueck Center for Molecular Medicine, Berlin)

2012 L. Caverzasio - bachelor thesis: "Occupation dosimetry of a PET unit" (in italian, external tutor Dr. A. Ostinelli, Ospedale S. Anna, Como)

2013 G. A. Stanizzi - master thesis: “Pediatric TC: considerations on the image quality and radioprotection evaluations” (in italian, external tutor Dr. G. Frigerio, Ospedale S. Anna, Como)

Tutor of:

01/2005 V. Conti - bachelor thesis: “Characterization of an electron radiotherapy beam with scintillator and solid state detectors” (in italian, Insubria University)

10/2005 V. Mascagna - bachelor thesis: “New techniques for the real time mapping of the diffused radiation of a radiotherapy accelerator” (in italian, Insubria University)

12/2005 C. Perboni - bachelor thesis: “Neutron activation studies with a clinical accelerator” (in italian, Insubria University)

12/2005 G. Montù - bachelor thesis: “Characterization of a fiber detector performances” (in italian, Insubria University)

12/2005 S. Hasan - bachelor thesis: “Simulation and commissioning of a tagged photon beam at the Frascati BTF” (in italian, Insubria University)

01/2006 A. Berra - bachelor thesis:“MICRO: a mini-observatory for cosmic rays” (in italian, Insubria University)

07/2006 G. Bartesaghi - master thesis: “Real time detectors for radiotherapic beams” (Insubria University)

10/2006 S. Taroni - master thesis: “The CMS Forward Pixel detector: the prototype characterization” (co-tutor D. Pedrini (INFN MiB), Insubria University)

10/2006 V. Conti - master thesis: “Neutrons from radiotherapy accelerators: production and detection” (Insubria University)

07/2007 C. Perboni - master thesis: “A 2D dosimeter for neutron beams from clinical accelerators” (Insubria University)

10/2007 V. Mascagna - master thesis: “Design and performance of FAST, a tracker for antiproton physics” (Insubria University)

10/2007 S. Hasan - master thesis: “Bent silicon crystals for the LHC collimation: studies with an ultrarelativistic proton beam‘” (Insubria University)

01/2008 A. Mattera - bachelor thesis: “Imaging with neutrons from hospital Linacs” (in italian, Insubria University)

01/2008 D. Lietti - bachelor thesis: “A scintillating fiber tracker for monitoring and tracking of high intensity beams” (in italian, Insubria University)

03/2008 A. Berra - master thesis: "Search for B^0 meson decays to $K_1^+(1270)\pi^-$ and $K_1^+(1400)\pi^-$ with the BABAR experiment" (co-tutor Prof. F. Palombo (University of Milan), Insubria University)

07/2008 S. Scazzi - master thesis: "Imaging possibilities with neutrons from radiotherapic Linacs" (Insubria University)

10/2008 D. Bolognini - master thesis: "Study of channeling phenomena in bent crystals: the new frontiers" (Insubria University)

2008 L. Gabaglio - bachelor thesis: "Characterization of the readout chain of a silicon detector" (in italian, Insubria University)

12/2009 L. Stoppani - bachelor thesis: "The scintillating bar tracker of the ASACUSA (CUSP-TRAP) experiment" (in italian, Insubria University)

02/2010 F. Scarpino - bachelor thesis: "Test of a shashlik calorimeter readout by a multianode photomultiplier" (in italian, Insubria University)

10/2010 D. Lietti - master thesis: "The Electron Muon Ranger for the MICE experiment" (Insubria University)

10/2010 A. Mattera - master thesis: "A hospital-based real time imaging system for the study of BNCT carriers" (Insubria University)

12/2010 S. Rabaioli - bachelor thesis: "A fast neutron irradiation station for the SINQ target" (co-tutor Dr. L. Zanini (PSI), Insubria University)

12/2010 A. Aiani - master thesis: "Hospital neutrons for BNCT: simulation tools and experimental results" (Insubria University)

05/2011 S.Zanoletti - master thesis: "The characterization of the ASACUSA cusp-trap tracker" (Insubria University)

02/2012 D. Guffanti - bachelor thesis: "Channeling phenomena in bent silicon crystals" (in italian, Insubria University)

07/2012 L. Stoppani - master thesis: "Silicon PhotoMultipliers for Totally Active Scintillating Detectors" (Insubria University)

10/2012 S. Bonfanti - master thesis: "The high resolution silicon telescope of the INSULAB group" (Insubria University)

02/2013 F. Scarpino - master thesis: "Large area Silicon PhotoMultipliers for the readout of inorganic scintillators" (in italian, Insubria University)

02/2013 C. Marcon - bachelor thesis: "Measurements of Cherenkov light in lead tungstate crystals" (in italian, Insubria University)

03/2013 E. M. Donegani - master thesis: "A time of flight spectrometer for clinical neutron beams" (Insubria University)

03/2013 M. Duchini - master thesis: “A dysprosium neutron dosimeter for radiotherapy linear accelerators” (Insubria University)

03/2013 D. Quadrelli - bachelor thesis: “Cosmic ray observations with a microstrip silicon tracker” (in italian, Insubria University)

05/2013 M. Signoriello - bachelor thesis: “Comparative study of scintillating bars readout by Silicon PhotoMultipliers” (in italian, Insubria University)

07/2013 S. Cotta - bachelor thesis: “Characterization of a $PbWO_4$ crystal calorimeter readout by Silicon PhotoMultipliers” (in italian, Insubria University)

03/2014 M. Maspero - master thesis: “Integrated DAQ system for a scintillating fiber neutron dosimeter” (Insubria University)

03/2014 S. Rabaioli - master thesis: “Cosmic rays, a tool for didactics in physics” (Insubria University)

03/2014 C. Magatti - bachelor thesis: “Test of a boron doped fiber detector for hospital neutron beams” (in italian, Insubria University)

At the moment following 1 master thesis in particle physics and detectors and 2 master thesis in medical physics.

PhD theses:

12/2007 Co-tutor of Dr. A. Mozzanica: “FAST: a scintillating tracker for antiproton cross section measurements” (tutor Prof. I. Iori, University of Milan)

05/2011 Tutor of Dr. S. Hasan: “Experimental techniques for deflection and radiation studies with bent crystals“

02/2012 Tutor of Dr. D. Bolognini: “The MICE Electron Muon Ranger: a fundamental step towards a neutrino factory”

06/2012 Tutor of Dr. A. Berra: “Silicon PhotoMultipliers in high energy and space applications“

At present tutoring 3 PhD theses in medical physics, particle physics and didactics in physics.

TEACHING ACTIVITIES

All the courses are held for Physics students.

- since 2002/03 till now: Laboratory of Physics III
- in 2003/04: Laboratory of Physics II
- from 2006/07 to 2010/11: Laboratory of Physics IV
- in 2004/05, 2005/06, 2006/07, 2007/08, 2009/10, 2011/12, 2013/14: Analog Electronics
- in 2004/05, 2005/06, 2006/07, 2007/08, 2008/09, 2010/11, 2012/13: Physics of Detectors

In the following, the topics of each course are described.

Course topics:

- **Laboratory II:** geometric and wave optics (from lens to Michelson experiment); fundamental physical constants (light speed, electron charge/mass ratio); development of a Montecarlo simulation to solve easy problems (circle area, random walk, etc)
- **Laboratory III:** analog electronics basic principles (from filters to diodes, from transistors to opamps); assembly and data taking of modern physics experiments (Planck constant measurement, Franck-Hertz experiment, Hall effect measurement)
- **Laboratory IV:** nuclear physics experiments from basic ones (Geiger counter, scintillators, alpha spectroscopy) to complex ones (muon lifetime, nuclear lifetimes, XRF); assembly of a complete detection system (tracking+calorimetry) and data taking at a particle accelerator
- **Analog Electronics:** bases of analog electronics for experimental physics; circuit behaviour with the Laplace transform; filters, diodes, transistors (bipolar, FET); opamps, comparators, oscillators; noise problems and assembly of a complete electronics chain (from preamp to ADC); lab sessions on all the items and simulation of the circuits with Spice
- **Physics of Detectors:** nuclear and subnuclear physics measurements (momentum, energy, time of flight, particle ID, radiation matter interaction); detailed analysis of all detector types with their pros and cons; data acquisition, trigger and data analysis

OUTREACH/EDUCATION ACTIVITIES

since 2005 member of the PLS (Piano Lauree Scientifiche) group for physics: activities with high schools (laboratory sessions at the university or in the school itself; lessons and seminars), summer stages on particle physics (2 weeks in june, with a number of students ranging from 5 to 10), courses for teachers on classical and modern physics, courses for teachers from all school levels on laboratory-based and competence-based didactics

since 2012 participating to the MIUR program for high schools "Alternanza Scuola-Lavoro"; students are asked to perform a working experience during their school period for a total of 50-70 hours (depending on their age). 5 groups of students in 3 years have been hosted by my laboratory

2005 member of the organizing committee of the physics exhibition "La fisica attorno a noi: come 100 anni di scoperte hanno cambiato la vita quotidiana" (Physics around us: how 100 years of discoveries have changed our daily life); the exhibition was organized for the world year of physics on an area of 600 m^2 and was visited by more than 10000 visitors in the period 15/12/2005-15/01/2006.

2013 responsible of the organizing committee in Como for the Researcher's night 2013

2014 responsible of the organizing committee in Como for the Researcher's night 2014

2015 responsible of the organizing committee in Como for the Researcher's night 2015

since 2012 organization of scientific experiments in primary schools. The activity is part of the research in didactics of physics and is organized in laboratory based lessons of 2 hours with a maximum of three lessons per class. In the 2013/2014 school year, 50 lessons have been held with topics ranging from sound to light, from electricity to matter transformations. The title of the laboratory is "La nuvola in una bottiglia" (a cloud in a bottle)

since 2010 courses for teachers of all the school levels.

RESEARCH ACTIVITY

My scientific activity has focused on several items:

- design, construction and test of silicon detectors and their frontend and readout electronics
- design, construction and test of detection systems based on silicon detectors and scintillators, for High Energy Physics, Medical Physics and Space Physics
- development of software and data acquisition systems
- data analysis

Activity before becoming a researcher in Como

During my thesis, I have worked on analysis items in the ***DELPHI collaboration***, in particular on the measurement of the oscillation parameter of the B_d^0 and B_s^0 mesons. I developed a different method with respect to the normally used ones (the one based on the di-leptons and the one using the reconstruction of the jet charge) whose basis was the identification in opposite jets of Λ^0-lepton pairs with high p and p_T deriving from the decay of a b and a $\overline{b}$ quark. The work contributed to [11].

The year after the degree, I was responsible of the installation and commissioning of the silicon detectors in the DELPHI small angle luminosity monitor, the ***STIC*** (Small angle TIle Calorimeter, [160]-[166]), an electromagnetic calorimeter made of scintillator and lead, readout by Wave Length Shifter fibers. To reduce the error on the determination of the shower axis and to increase the e/π separation, two layers of curved silicon strip detectors were introduced; the detectors have been tested and assembled under my supervision at the INFN of Trieste and then commissioned in the DELPHI experiment, in the period 1993-1996.

Starting from my PhD years, I have worked for the ***SYRMEP experiment*** ([65]-[84]), in particular on the hardware and software of the detector and electronics [69, 76, 78, 81]. SYRMEP (SYnchrotron Radiation for MEdical Physics) is an experiment developed in the new optics of digital radiology in general and digital mammography in particular; digital radiology means the development of completely digital devices that enable the separate optimization of acquisition, display and storage of the image. The goal of these systems consists in overcoming the intrinsic limits of the standard mammography examination (film + X-ray tube): high doses to the patients, loss of contrast due to the scattered radiation, low efficiency in detecting the incident photons. SYRMEP has acted on all the elements of the mammographic examination: on the source substituting the standard tube with a monochromatic and laminar synchrotron beam and on the detector substituting the film with a completely digital detector based on the silicon strip detectors used in Particle Physics. In SYRMEP, I have been responsible of the silicon detector, its VLSI electronics (developed by LEPSI, Strasbourg [168]), the DAQ and Slow Controls and the commissioning on the synchrotron beam. Among the main results, contrasts below 1% have been reached (to compare with the 2.5% of the standard systems)

with a dose between 5 and 10 times lower.
From 1997 to 2000, in the ***FRONTRAD*** (FRONTier RADiography) collaboration , SYRMEP natural evolution, I have been responsible of the design of the new frontend ASIC of the experiment [85, 86] and of the new silicon detector, in order to obtain a mammographic image in less than 10 sec. Nowadays, the SYRMEP beamline has become a facility for patients.

In the same period, I have also been responsible of the design, production and test of the fanout circuits [169] for the ***BaBar*** vertex detector [172, 173], that is the flexible circuits connecting the silicon strips to the ASICs channels. More than 500 fanouts were produced for the whole tracker before 1998.

Since 1998, I am a member of the ***AGILE*** collaboration ([87]-[119]), with the responsibility of the silicon-tungsten tracker of the satellite (from the design to the assembly and the commissioning) and of all the calibration facilities, both for the prototypes and the final satellite [93, 94, 97, 110]. Moreover, I have defined the guidelines for the trigger and data acquisition of the whole satellite. AGILE, the first Small Scientific Mission financed by ASI (the Italian Space Agency), is a satellite for the observation of gamma rays in the energy range 30 MeV-50 GeV; it is light (around 100 kg) and it has a wide field of view (around 1/4 of the sky). The instrument consists of a silicon-tungsten tracker, a CsI(Tl) mini-calorimeter, a coded mask silicon detector for X rays in the range 15-40 keV and a plastic scintillator anticoincidence system.
The tracker is organized in 12 $x-y$ planes with 16 silicon detectors per side, covering an area of 38×38 cm^2. Each tile is 9.5×9.5 cm^2 and 410 μm thick with 768 121 μm strips AC coupled to the electronics. The readout pitch is 242 μm (one floating strip) in order to reduce the number of electronics channels and the overall power consumption while maintaining an optimal space resolution. Four detectors are bonded together to form a ladder and each plane side is formed by 4 ladders; each ladder is readout by 3 TAA1 low power low noise ASICs with self triggering capabilities. The total number of readout channels is around 37k. The 12 planes are organized in 13 carbon fiber+Al honeycomb trays with the first 10 trays equipped with a 0.07 X_0 tungsten layer for the gamma ray conversion.
To test both the tracker and the other sub-systems, I have developed a tagged photon beamline (based on the production of photons via bremsstrahlung of an electron beam) first at the CERN PS and then at the BeamTest Facility at the INFN LNF labs where the satellite has been calibrated in November 2005. AGILE has been launched on the 23rd of April 2007 from India and is still taking data.

Activity since becoming a researcher in Como

From 2003 to 2006, I have collaborated to the research of the ***SUCIMA collaboration*** (Silicon Ultra Fast Cameras for Electron and Gamma Sources in Medical Applications, [120]-[124]) at the Insubria University, a project approved in the 5th framework of the European Community (E.C. Contract N. G1RD-CT-2001-00561); I have been involved in the development, the integration and the data acquisition of a strip silicon detector readout by charge integrating ASICs. The goal of the project was the development of an advanced imaging system for extended radioactive sources used in the medical field. Two were the

foreseen applications: the intravascular brachytherapy and the real-time monitoring of proton and light ion beams for hadrotherapy treatment. The novel dosimeter is a pixel detector with the electronics integrated on the detector surface (CMOS imager); in the prototyping phase, dedicated tests have been performed on brachytherapy sources with the silicon strip detector designed by myself for the AGILE project.

Since 2005, I am responsible of a group working on several scientific lines: particle physics (in the ASACUSA, MICE, H8RD22, UA9, COHERENT and ICERAD collaborations), medical physics and detector development.

Particle Physics

Since 2005, I am collaborating with the ***ASACUSA*** experiment at the CERN Antiproton Decelerator in the group of Prof. L. Venturelli (Brescia University and INFN Pavia) for two different goals: the measurement of the annihilation cross section of low energy antiprotons (ASACUSA) and the development of a dedicated antiproton trap for the study of anti-hydrogen (ASACUSA CUSP TRAP). As far as the cross section is concerned, I have suggested the use of a scintillating fiber tracker (FAST [179, 180, 182, 226]) readout by multianode photomultipliers. The tracker consists of two shells, each one with 3 layers of 1 mm diameter fibers, one parallel to the axis and the other two at $\pm 20^{\circ}$ to obtain a point in space. I have been responsible of the whole electronics which is based on the VA64TAP+LS64 ASICs (Gamma Medica- IDEAS): the VA64TAP amplifies, shapes and discriminates the PMT signals, allowing (if needed) a multiplexed analog readout; the 64 discriminated signals are level shifted by the LS64 to be fed to a FPGA that samples them with a 640 MHz clock. The readout electronics is based on a VME system with custom developed Input/Output boards to store the sampled data coming from the frontend. This timing info (that needs a resolution of at maximum 3 ns) allows the association of the hits to tracks to reconstruct the position of the annihilation vertex. The AD cycle foresees a beam emission every 110 s in 6 bunches of 40 ns spaced of 1 s, which sets the constraints of the system. Each bunch contains around 10^5 antiprotons for a total of about 10 annihilation vertices per bunch. The tracker has been taking data since 2006 [188, 190, 191, 233, 234].
In 2008, I have been responsible of the upgrade of the ASACUSA electronics for a scintillating bar detector for the ASACUSA CUSP TRAP (MUSASHI) group, who is developing a dedicated trap (the name cusp derives from the shape of the magnetic field) to increase the number of trapped antiprotons that would produce anti-hydrogen once combined with positrons. The bar tracker is needed to reconstruct the annihilation position of the antiprotons in the trap while varying the trap parameters. In 2008, the electronics was affected by a high level of electromagnetic noise; for this reason the board design has been changed inserting the socket of the PMT in the board itself (without any cable connection) and digitizing the data (in this case, the analog info is used) on the board itself to reduce the connections to the VME and to increase the data acquisition rate. In 2009, the detector has proven fully operational [228].

In the period 2006-2009, I have been part of the CERN ***H8RD22*** collaboration for the study of the channeling of high energy particles in bent silicon crystals in order to exploit them for the reduction of the beam halo in the LHC collider ([132]-[142, 144, 147, 152]).

The presently used collimation systems are multi-stage systems consisting of a primary (amorphous) collimator which scatters the halo over the whole solid angle, followed by a secondary and tertiary collimator. These collimators (whose surfaces have strict mechanical requirements) have to be put as near as possible to the beam core thus increasing the impedance and reducing luminosity. Bent crystals are able to deviate particles in a given direction, thus allowing to position the secondary collimator farther from the beam core reducing the impedance. Since 2006, I have been responsible of the tracking system (based on double side silicon microstrip detectors) and of the DAQ system/online analysis for the tests on the SPS H8 beamline with 400 GeV/c protons. I have been the coordinator of the Como group as far as the analysis is concerned; our first work has demonstrated for the first time that collimation can be performed not only using bent crystals in channeling mode (and thus with a limited acceptance as far as the particle incident angles) but also in volume reflection mode (with an efficiency close to 100%) [133]. In 2007, I have organized the data taking also with negative particles (180 GeV/c) [140, 141] and for the study of the radiation emission in channeling/VR conditions [138].

Given these results, in 2008 it has been proposed to the CERN Research Board (who approved the proposal with the name ***UA9*** [137]) to test the bent crystal collimation capabilities on a circular beam such as the SPS one. I have been the deputy spokesperson up to the end of 2009 and the responsible of the tracking system for the reconstruction of the deviated particles. The UA9 experiment is located in the LSS5 straight section of the SPS and consists of 3 stations: the vacuum tank with the goniometers for the insertion of the crystals in the beam halo and their alignment; a first detecting station with a roman pot with silicon strip detectors; a second detecting station with a second roman pot (in order to "track" particles to reconstruct the phase space) and the secondary tungsten collimator. The tracking system was based on double side silicon strip detectors readout by self-triggering ASICs, inserted in the secondary vacuum of the SPS machine in dedicated roman pots. The silicon signals are digitized locally and then transmitted to ground through optical fibers (GOH system). In the first prototype commissioned in the first half of 2009 [143], the transmission was based on standard cables; dedicated repeaters were located in the UA1 cavern to repeat the signals half way through between the tunnel and the ground, where the VME crate and the DAQ controller were positioned. The power supplies for the silicon system were located in the same cavern and controlled through the Slow Controls via a GPIB-Ethernet connection. The Slow Controls allowed the switching of the supplies, their automatic shutdown in case of latch-up and the monitoring of all the detector parameters (temperature, pressure, main voltages of the ASICs). The prototype has measured the channeling and volume reflection effects [229] but has been damaged (probably due to radiation, even if extensive radiation tests were performed on the whole system before the installation); in the first data takings, the number of particles on the detector resulted too high (a few hundreds in 5 ns) not allowing the use of a single particle detector. For this reason the detector has been taken out from the pot and substituted with an integration detector.

My group has thus decided to stop the activity on UA9 to continue the activity on the physics of crystals (INFN ***COHERENT*** experiment) and on the study of the radiation emission in channeling and volume reflection conditions (a project that has been selected also by the Italian-Russian Einstein Consortium in the 2008 call). This last item is particularly interesting since the emitted spectrum energy range depends on the crystal and is anyway higher both in

the average energy value and in intensity with respect to the bremsstrahlung one [148]-[151], [153]-[157].
Since 2013, my group is part of the ***ICERAD*** (Interaction in Crystals for Emission of RADiation) which intends to study the behaviour of crystals with low energy ($<$1 GeV) electrons, which is an unexplored field. The study of the crystal performance with low energy electrons in terms of deflection and radiation emission will allow to increase the knowledge in matter physics and to bring the technology to the limit for the production of thin enough crystals, defining new possibilities in the field of collimation and extraction for the large number of facilities with electron beams in this energy range and allowing to study the possibility of producing intense gamma sources with an energy larger than 1 MeV. The project foresees several data taking sessions at the MAMI accelerator at Mainz with continuos electron beams with a maximum energy of 1.5 GeV. In the framework of the ICERAD project, the Como group has the complete responsibility of the detection system for the reconstruction of the trajectory of each single particle, either in terms of the integrated profile of the beam in the x and y directions (as in the MAMI case) or reconstructing the tracks (as in the CERN secondary beams). In 2013, the group has performed the first world measurement of planar channeling and volume reflection with 855 MeV electrons [158] with a bent silicon crystal (with a thickness of 30.5 μm in the beam direction and an area of 30x20 mm^2). Radiation emission measurements have been performed with the same crystal in volume reflection. Future tests will involve germanium quasi-mosaic crystals and silicon and germanium membranes, where the mirror effect (crystals whose length is half of the oscillation period of the channeled particle lead to a defletion angle which is twice the critical angle) will be verified.

In the 2008-2012 period, I have collaborated with the ***MICE*** experiment for the construction of the Electron Muon Ranger detector for the experimental apparatus at RAL; MICE is testing the feasibility of a neutrino factory based on the ionization cooling of a muon beam. EMR consists of 50 layers of 59 1.1m scintillating triangular bars each readout by WLS fibers and multianode PMTs. It is in practice a tracker-calorimeter whose goal is the indentification of the electrons produced by the muon decay to allow the measurement of the emittance of the beam with the required precision (0.1%). In collaboration with INFN-Trieste, we have developed and tested a prototype of EMR consisting of 4 x-y layers with 19 cm long square bars (with a section of 1.5$\times$1.9 cm^2) readout by 64 anodes PMTs whose signals are readout by dedicated ASICs (the same of the ASACUSA tracker) [183, 227]. The prototype has been tested with cosmic rays and on the CERN PS lines. I have coordinated the development of the frontend electronics (based on a different ASIC, the MAROC) and the organization of the test systems both in the lab and on the CERN beams.

Medical Physics

Since 2005, I am collaborating with the Medical Physics unit of the S. Anna Hospital in Como and in particular with the Radiotherapy section. The collaboration concerns two different activities:

- in 2005, I have been responsible of the Como Unit for the PRIN05 project on the development of real time dosimeters for electrons, photons and neutrons [125, 128] from radiotherapic linacs. The project was based on the development and test of a multichannel

real time dosimeter based on scintillating fibers readout by multianode photomultipliers. The prototype tests have been successfully completed and the portable readout electronics is being developed in order to make the prototype usable in a radiotherapic unit. The comparison with the standard systems resulted in an agreement better than 2%.

- my group is part of the INFN ***PhoNeS*** (PhotoNeutron Source) [126] project for the development of a radiotherapy linac neutron source to offer the possibility of using BNCT (Boron Neutron Capture Therapy) in a hospital environment. There are several tumours that in the last 20 years have not witnessed an improvement in the survival after 5 years from the diagnosis either in incremental or absolute terms: extended tumours (stomach, liver, lung), radioresistant tumours (melanoma), tumours located in or near vital organs (brain). BNCT could represent a hope for these tumours; it is a binary technique: the patient is administered a carrier with a ^{10}B compound and then is irradiated with a thermal/epithermal ($<$10 keV) neutron beam. The neutron capture reaction in the boron atom (^{10}B(n,α)^{7}Li) produces high LET particles that stop in the cell causing its apoptosis. In practice, BNCT would combine the targeting principle of chemotherapy with the localization capability of radiotherapy. It has been proposed in 1936 by the biophysicist G. L. Locher and is being performed (with ups and downs in its story) in USA, Japan, Argentina, Sweden, Finland with phase I (toxicity) and phase II (efficacy) trials; no phase III (randomized test wrt other techniques) trial has been approved up to now. The development of BNCT in fact is blocked by two facts: the necessity of a nuclear reactor to produce the neutron beam (with an intensity $>5{\cdot}10^{8}$n cm^{-2} s^{-1}) and the lack of specificity of the boron carriers with respect to the tumour cells.
  PhoNeS is acting on both these aspects. Neutrons in fact can be produced by Giant Dipole Resonance by the clinical high energy ($>$10 MeV) photon beams. PhoNeS has simulated, manufactured and tested a converter+moderator system to increase the fraction of slow neutrons needed for BNCT at the same time reducing the gamma dose to the patient. My group has qualified the beam in terms of intensity (with the activation of Al samples measuring the spectrum with a 5$\times$5 CsI(Tl) matrix) and of energy (with a time of flight method based on boron doped scintillators and scintillating fibers [127, 129]). The intensity is still a factor 10 less than what needed by BNCT but enough to perform in hospital tests on the carrier and on possible applications.
  For this reason, we have developed an imaging system to measure the boron content in biological samples (urine, tissues, blood) and produce kinetic curves (that is the boron content as a function of the time from the administration to the patient) [225, 130]. The system performs a real time neutron autoradiography and is based on a non depleted silicon microstrip detector able to detect the alpha particles and the Li ions emitted in the boron capture reaction. Given that the hospital linac emits photons in bunches with a rate of 100-300 Hz and lasting a few microseconds, it is possible to acquire data in the interbunch period where only the slow neutrons survive and no background is present. The detector has been calibrated with the standard boron carrier solutions and has a minimum detectable threshold of 5 ppm. In collaboration with the S. Luigi Orbassano Hospital (Turin, Italy), we have performed a kinetic curve analysis on therapeutically explanted lungs (because of adenocarcinoma or mesothelioma) ex-vivo perfused with a solution of BPA (the boron carrier) and blood. Samples have been taken every 20 minutes and then

analyzed with the in-hospital system in view of the BNCT application to lung tumours [230].

Detector Development

Since 2008, I have been collaborating first with the ***FACTOR*** (Fiber Apparatus for Calorimetry and Tracking with Optoelectronics Readout) and then with the ***TWICE*** (Techniques for Wide range Instrumentation in Calorimetry Experiments) INFN projects for the development of a readout system for calorimetry in high energy physics and space applications based on Silicon PhotoMultipliers. My group is responsible for the development of the frontend electronics (based on commercial ASICs) and the readout one (based on the VME standard) for the SiPMs manufactured by FBK-irst and several detectors: shashlik lead-scintillator calorimeters, scintillating bar trackers, crystal (LYSO and $PbWO_4$) calorimeters. My group is also responsible for all the tests on the CERN extracted beams and on the BeamTest Facility at the Frascati INFN National Laboratories where the calorimeters performance is evaluated using a silicon tracking system of several modules whose area ranges from 2×2 cm^2 to 9.5×9.5 cm^2 depending on the beam features (dimension and divergence).
At present we are using the SiPMs developed by the TWICE collaboration and the electronics for two different applications:

- the ***SQUOP*** **(Silicon photomultipliers for QUantum OPtics)** INFN project for the application of the SiPMs to quantum optics, a topic which is completely new for the Commissione Nazionale V but could open new fields of investigation. The project requires to collaborate with FBK-irst in order to optimize the SiPM technology maximizing the PhotoDetection Efficiency, reducing the crosstalk to below 10% and reducing the dark count rate. Tests are being performed, while in parallel the mechanical system to cool the SiPMs and interfacing them with the fibers is being designed.

- my group is testing the possibility of developing a dosimeter for electron and photon radiotherapy beams consisting of scintillating fibers readout by large dynamic range SiPMs. The dosimeter will feature also boron doped fibers for the detection of the neutron contamination of high energy photon beams in order to estimate the unwanted dose to the patient. Tests are being performed with the first prototype.

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