Ilaria Vai

Born in Pavia, 27th March 1989

Via Vittorio Veneto 120, 27020, Dorno (PV), Italy

+39 0382 987414 (Office), +39 333 9462263 (Cell)

Ilaria.vai@pv.infn.it, ilaria.vai@cern.ch, ilaria.vai02@ateneopv.it

Education

CERN COOPERATION ASSOCIATE – INFN SIMILFELLOW | JANUARY-DECEMBER 2016 | CERN

- Project title: Performance of Micropattern Gaseous Detectors for the phase II upgrade of the muon system of the CMS experiment
- Project content: I am currently taking care of the development and test of new micropattern gaseous detectors for the phase II upgrade of the CMS experiment. In particular I am organizing and developing the setups for measurements to be performed during 2016 at the SPS North Area and at the Gamma Irradition Facility (GIF++) at CERN. I am also involved in the Geant4 simulations of the new prototypes, aimed at evaluating the sensitivity of these detectors to the background of the CMS muon system. My project also includes the development of the DCS for the GE11 station, in particular I am taking care of the design of the gas panel.

PHD IN PARTICLE PHYSICS | NOVEMBER 2013-NOW | UNIVERSITY OF PAVIA, PAVIA

- Main project: My PhD project is involved in the context of the CMS GEM collaboration, whose aim is the development of Gas Electron Multiplier detectors for the upgrade of the CMS muon system. I am presently responsible for the development of the gas system panel of the detector control system (DCS) for the slice test of 2016. On the other hand I am also working on the development of new prototypes of micropattern gaseous detectors to be installed in the next phases of LHC. In the context of the R&D Phase II working group of the GEM Collaboration, I am the responsible person for the characterization and test of the new prototypes.
- Advisor: Prof.ssa Cristina Riccardi

MASTER DEGREE | OCTOBER 2011-OCTOBER 2013 | UNIVERSITY OF PAVIA, PAVIA

- Laurea Magistrale in Scienze Fisiche
- Course of study: Particle physics
- Thesis title: Study of Neutron-induced Single Event Effect on the RPC Front- End Chips for the CMS experiment
- Advisor: Prof.ssa Cristina Riccardi
- Coadvisor: Prof. Paolo Vitulo
- Thesis available at: http://www.infn.it/thesis/index.php
- Abstract: The project I was involved in regarded the study of the failure mode of electronics when operated in a high radiation environment. The specific motivation rises from the need to understand the lifetime and the

behavior of the front-ends and memories that are used in the detectors in the high energy experiments that are currently running at collider machines like the LHC at CERN. For this reason we have exploited the facility TRIGA Mark II Research Reactor of the Pavia University to characterize the CMS RPCs front-end chips to neutron-induced damages and measure the Single Event Upset cross section.

- Grades obtained: 110/100 cum Laude

CERN SUMMER STUDENT | JULY-AUGUST 2013 | CERN

- Project: Radiation damage study on diamond sensors of the ALICE Beam Condition Monitoring system
- Supervisor: Dott. Antonio di Mauro
- Report available at: http://cds.cern.ch/record/1595210
- Abstract: The project regarded the analysis of the functioning of diamond sensors of the Beam Condition Monitoring system of the ALICE experiment. The aim of this system is to detect beam failures, like deviations for the usual trajectory, that can damage the experimental area. I have developed a LabView interface used for the measurement of the working parameters of every sensor of this system, in particular for the measurement of the dark current and of the current induced by two ^{90}Sr sources. The results showed a global increase of the dark current and, for some sensors, also an anomalous response to the sources, confirming the hypothesis of a damage induced by radiation.

BACHELOR'S DEGREE | OCTOBER 2008-OCTOBER 2013 | UNIVERSITY OF PAVIA, PAVIA

- Thesis title: An experiment for measuring g with a beam of anti-hydrogen
- Advisor: Prof.ssa Cristina Riccardi
- Thesis available at: http://www.infn.it/thesis/index.php
- Abstract: The thesis has analyzed the operation and potentiality of the AEGIS experiment at CERN, which aims at measuring the gravitational acceleration on anti-hydrogen atoms. This measurement will be performed using a moiré interferometer.
- Grades obtained: 102/110

SECONDARY SCHOOL DIPLOMA | 2008 | LICEO SCIENTIFICO T.TARAMELLI, PAVIA

- Grades obtained: 100/100

Research activity

CMS EXPERIMENT

Resistive Plate Chambers electronics: I have started my activity in the context of the CMS experiment in 2013 as a master student. My project was focused on the study of the effect of radiation on the front end electronics of the Resistive Plate Chambers (RPC) installed in the muon system of the CMS experiment. The high η region of the muon system, the region closest to the beam line, is characterized by a high rate of background, whose major components are neutrons and photons. Neutrons are produced by the hadronic interactions in the inner part of the detector and by the interactions of protons of the beam with the collimators; photons instead come from neutron capture. The presence of this radiation can damage the electronics mounted on the detector: the

nature of the damage can be manifold, but during my thesis work I focused only on one kind of issue, namely the *Single Event Effects* (SEE). This is due to the interaction of a single particle with a sensitive node of a circuit and it can be induced both by charged and neutral particles, through the production of secondary charged particles that effectively induce the ionization. I analyzed in particular SEE induced by neutrons on the front end board of the RPC, using the LENA reactor in Pavia as neutron source. During the first part of my work, I have analyzed the standard behavior of the front end board in laboratory, in order to understand their unbiased working conditions, which represent the pedestal of our measurement with neutrons. I have developed a DAQ system based on LabView interfaces, able to register all the spurious signals induced by neutrons and to set the working parameters of the board without extracting them from the irradiation area. In particular the DAQ was composed by a VME scaler, to count the events induced by neutrons and register them, and by a software already existent for the control of the parameters of the board and readapted for our purposes. As already pointed out above, the neutrons source was the Triga Mark II reactor in Pavia, able to produce neutrons up to 18 MeV. The neutron flux in the irradiation position was measured with the neutrons activation technique, and the behavior of the chip was monitored at different working conditions. The SEE cross section was then calculated as the ratio between the rate of events induced by neutrons and the incident neutron flux. The results of this work were approved by the CMS RPC Collaboration and presented at the Italian conference "Congresso Nazionale SIF 2014".

Resistive Plate Chambers detectors: in the first months of my PhD I participated to a measurement aimed to measure the resistivity of RPC detectors never installed in CMS after ten years from their production. This was done to evaluate the natural aging of the materials. Both barrel size and endcap size RPC were analyzed and the resistivity value measured was compared with the nominal value at the production. The results of this work were as well approved by the CMS RPC Collaboration and presented at the Italian conference "Congresso Nazionale SIF 2014".

Gas Electron Multiplier: my PhD project is developed in the context of the GEM Collaboration of the CMS experiment. The aim of the GEM Collaboration is the development of Gas Electron Multiplier detectors, to be installed in the high η region of the CMS muon system: this is the region closest to the beam line and thus characterized by the highest fluxes and background rates of all the muon system. During my first year of Ph.D., my activity was focused on the analysis of the response of the new detectors to the background of the CMS muon cavern, in particular neutrons and photons. I planned and organized a test with the aim of measuring the sensitivity of GEM detectors to neutrons at the Cyclotron Resource Centre in Louvain-la-Neuve (Belgium). The setup of this test was composed by a GEM prototype, read-out with the Gastone chip and with a DAQ based on LabView software. I developed the DAQ system in order to have an acquisition chain able to: discriminate the signals, with a Constant Fraction Discriminator (CFD), make logical connections and count the number of events induced by neutrons, with a scaler. In addition, I characterized the detector and verified the correct operation of the DAQ system, both at CERN and at INFN-Bari laboratory, prior to the Louvain test. After the finalization of the setup, I have organized its transport and installation back and forth to the Louvain facility. During the irradiation, I coordinated the measurements to be performed and the data acquisition: data taking was performed with three distinct values of incident neutron flux and many different values of thresholds applied to the CFD, in order to acquire data over a wide spectrum of working conditions of the detector. After the return of the chamber from Louvain, I have also performed a further test in order to exclude possible permanent damages on the detector: it was perfectly working after the irradiation, without degradation in its performances. The whole activity and all the measurements have been presented in many GEM Hardware internal meeting.

Right now, my participation at the GEM project is focused on two aspects:

- Development of the gas system panel of the detector control system (DCS) for the first GEM station, GE1/1, to be installed in CMS in 2018/2019.

- Research and development of new micropattern gaseous detectors to be installed in the future (2020 and later) in the high η region of the CMS experiment.

Starting from the first point, the group I have joined is developing the Detector Control System (DCS) for the GEM slice test in 2016. The DCS is the system that controls the operation of the detectors installed in high energy physics experiments in general and in particular in CMS. It is composed by three main panels, the High Voltage (HV) panel, the Low Voltage (LV) panel and the gas system panel. I am the responsible person for the gas system and for this reason in the last months, with the collaboration of the CERN Gas Group, I have been preparing the sketch of the gas lines and instruments to be implemented in the DCS. In September 2015 I also followed the course WinCC-OA and JCOP Framework Course at CERN, in order to learn how to use the WinCC-OA software, on which the DCS is based. The system is going to be tested on a cosmic stand, which will be used for the quality control of the GEM detectors to be installed in the late 2016 slice test. The system will then be optimized for the slice test configuration and included in the full DCS system of the CMS experiment. This will also be the basis on which the final DCS system for the GE1/1 station, to be installed during Long Shutdown 2, will be founded.

On the micropattern gaseous detectors side, in May 2015 I joined the GEM R&D phase II group, whose aim is the development of detectors to be used in the next phases of LHC operation. I am presently the responsible person, within the R&D Phase II group, for the characterization of these new detectors. Preliminary tests on two prototypes were performed in May 2015. The first one is the so called Back-to-Back (B2B) Stacked-GEM detector, a prototype composed by a stack of two 10x10 cm^2 Triple-GEM detectors, coupled in such a way that the two drift regions are adjacent, while the two readout boards sit on the external sides. The second prototype is the Fast Timing Micropattern (FTM) detector, on which my activity was focused in the following months. This detector is based on a series of fully resistive WELL structures, where the multiplication develops in the holes of a 50 μm-thick kapton foil, coated on both sides with resistive material. It is composed of two independent amplification stages with 250 μm-thick drift regions. I performed the full characterization of the detector with an X-Ray source, using two different gas mixtures, Ar/CO2 70/30 and Ar/CO2 97.5/2.5. The results of this first set of tests show that the detector is working properly: the signal was observed from the both the readout pad and the drift cathode, through a capacitive coupling, proving the transparency of the layers. In addition, the detector response is linear with the incident flux and the behavior with different drift fields is compatible with what expected from literature (arXiv:1411.2466v1, arXiv:1503.05330v1). Between the two gas mixtures the Ar/CO2 70/30 has been selected, as it gives the more stable working conditions for the detector. The results of this first characterization has been presented at the MPGD2015 International Conference. In addition, measurements with cosmic rays have been performed in order to develop a working setup for the test beam carried out between October and November 2015, with the aim of measuring the time resolution of the prototype. I have coordinated the measurements and shifters crew for the whole duration of the test beam, whose result was the measurement of the time resolution with muon and pion beams, that turned out to be of the order of 1.5-2.5 ns, in good agreement with the theoretical expectations. The results of characterization and test beam were presented in February 2016 at the Vienna Conference on Instrumentation (VCI2016).

Right now I am following the development of the new prototypes of FTM detector, that are going to be produced: they have a structure similar to the previous version, but two material solution have been tried. On one side we have developed a fully PCB-based prototype, with amplification regions made by 200 μm-thick PCB foils. On the other hand a prototype more similar to the first version, kapton based but with 125 μm-thick amplification region is going to be produced. As soon as it will be ready, it will be first of all characterized with an X-Ray source and then tested in test beams at the SPS North Area and at the Gamma Irradiation Facility (GIF++), in presence of huge gamma background.

In May/June 2016 I have also organized and took part to two test beam periods dedicated to the characterization of the baseline prototype for the ME0 station, the B2B Stacked-GEM already described above. The aim of the test beams was to characterize the prototype, measuring efficiency, space resolution and time resolution with

two gas mixtures, Ar/CO2 and Ar/CO2/CF4. Right now I am involved in the analysis of the data acquired during these two periods.

PROJECT "MONSTER"

The aim of the MONSTER project is to develop a new technique, based on the use of cosmic rays, for the continuous static monitoring of the reciprocal alignment between parts, also not directly visible between them, of civil and mechanical infrastructures with a strong vertical development.
The prototype of this system foresees a tracker composed by layers of plastic scintillating fibers coupled to silicon photomultipliers (SiPM). My contribution to this project was the development of a DAQ system, based on LabView, that is able to take the signals from the SiPM, discriminate between the good signals and the noise with the use of constant fraction discriminators, and then make a coincidence for the efficiency estimation. In addition to this, the DAQ foresees also a tracking system, made with I/O Registers, that is able to reconstruct the trace of the muons crossing the three planes of the prototype.

Responsibility

· Co-convener of the FTM detector R&D working group (in the R&D Phase II Upgrade Office)

· Responsible for CMS GEM DCS Gas Panel

Partecipation to schools and workshops

XXVII SEMINARIO NAZIONALE DI FISICA NUCLEARE E SUBNUCLEARE "FRANCESCO ROMANO" | 4 – 11 JUNE 2015 | OTRANTO (LE), SERRA DEGLI ALIMINI 1

· http://www.ba.infn.it/~otranto/2015/otrantofr.html

9TH JOINT FERMILAB CERN HADRON COLLIDER PHYSICS SUMMER SCHOOL - HCPSS 2014 | 11TH AUGUST – 22ND AUGUST 2014 | FERMILAB, BATAVIA, ILLINOIS (USA)

· http://projects.fnal.gov/hcpss/hcpss14/

INFN WORKSHOP ON FUTURE DETECTORS FOR HL-LHC - IFD2014| 11-13 MARCH 2014 | TRENTO, ITALY

· http://events.unitn.it/en/ifd2014

5TH INTERNATIONAL SCHOOL OF TRIGGER AND DATA ACQUISITION -ISOTDAQ 2014 | 28TH JANUARY – 5TH FEBRUARY 2014 | WIGNER RESEARCH CENTRE FOR PHYSICS, BUDAPEST, HUNGARY

· http://isotdaq2014.wigner.mta.hu/

Conferences

CONGRESSO NAZIONALE SIF 2014 | 22-26 SEPTEMBER 2014 | PISA, ITALY

· Oral presentation: *Preliminary Longevity and Radiation Damage studies for CMS Resistive Plate Chambers*

INCONTRI DI FISICA DELLE ALTE ENERGIE IFAE2015 | 8-10 APRIL 2015 | UNIVERSITÀ DI ROMA TOR VERGATA, ROMA, ITALY

- Poster: *Development and performance of Triple-GEM detectors for the Upgrade of the Muon System of the CMS experiment (Sviluppo e performance dei rivelatori Triple-GEM per l'upgrade del Sistema a Muoni dell'esperimento CMS)*, Ilaria Vai on behalf of the CMS GEM Collaboration

XIII PISA MEETING 2015 – FRONTIER DETECTORS FOR FRONTIER PHYSICS | 24-30 MAY 2015 | LA BIODOLA, ISOLA D'ELBA, ITALY

- Poster: *Test Beam and Irradiation Test results of Triple-GEM detector prototypes for the Upgrade of the Muon System of the CMS experiment,* Ilaria Vai on Behalf of the CMS GEM Collaboration

MPGD2015 – 4TH INTERNATIONAL CONFERENCE ON MICROPATTERN GASEOUS DETECTORS | 12-15 OCTOBER 2015 | TRIESTE, ITALY

- Oral presentation: *R&D on a novel Fast Timing Micropattern (FTM) gaseous detector,* B. Dorney, I.Vai, P. Vitulo, F.Fallavollita, S. Salva, M. Maggi, S. Franchino, R. de Oliveira, A. Sharma, J.Merlin

14TH VIENNA CONFERENCE ON INSTRUMENTATION | 15-19 FEBRUARY 2016 | VIENNA, AUSTRIA

- Oral presentation: *R&D on a new type of micropattern gaseous detector: the Fast Timing Micropattern detector*, Ilaria Vai on Behalf of the CMS GEM Collaboration

Teaching and outreach

TUTOR FOR THE COURSE: "TIROCINIO DI ORIENTAMENTO E FORMATIVO" FOR THE A.A 2013/2014 | JUNE 2014 | UNIVERSITY OF PAVIA

TUTOR FOR "EUROPEAN RESEARCH NIGHT – NOTTE EUROPEA DEI RICERCATORI" | SEPTEMBER 2014 | INFN PAVIA

- Organizer and tutor for the stand: "Hey kids…you can be a scientist!", aimed to show simple physics experiments to kids for fun.

TUTOR FOR "INTERNATIONAL MASTERCLASSES – HANDS ON PARTICLE PHYSICS"| 9TH MARCH 2015 | INFN PAVIA

- Talk: "Identificazione di W, Z e H in CMS", preparatory talk for the analysis exercise.
- Tutor for the analysis exercise "Identificazione di W, Z e H in CMS"

Honors and awards

DEGREE AWARD (PREMIO DI LAUREA) "GIULIO MUSITELLI"S | JUNE 2015 | UNIVERSITY OF PAVIA

- http://www.unipv.eu/site/home/naviga-per/laureati/premi-di-studio.html

Scientific associations

From 2013:

· INFN – Istituto Nazionale di Fisica Nucleare

· CERN User (CMS experiment)

Languages

ITALIAN

· Mother tongue

ENGLISH

· Actual level: C1 (Very good Listening, Speaking, Reading and Writing)

· B2 level certification: 2008 **First Certificate in English**, Council of Europe Level B2, ESOL Examinations

· B1 level certification: 2006 **Preliminary English Test**, Council of Europe Level B1, ESOL Examinations

FRENCH

· Actual level: A1 (Basic knowledge in Listening, Speaking, Reading and Writing)

Computer skills

OPERATING SYSTEM

· Windows

· Linux

APPLICATIONS

· Word, Excel, PowerPoint

· Browser: Internet Explorer, Mozilla Firefox, Google Chrome

PROGRAMMING

· C++ (basic knowledge)

· ROOT

· LabView

· Geant4

· ANSYS (basic knowledge)

· SPICE (basic knowledge)

· WinCC-OA (PVSS)

MARKUP LANGUAGE

· LaTeX

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