PhD in Information Technology and Electrical Engineering

Università degli Studi di Napoli Federico II

PhD Student: Francesco Fienga

XXIX Cycle

Training and Research Activities Report – First Year

Tutor: prof. Giovanni Breglio – coTutor: eng. Salvatore Buontempo

1. Information

I received the MSc. cum laude in Experimental Particle Physic the 17th July 2013 with the thesis: *"Differential single-top measurements at CMS"*.
From April 2013 to March 2014 I worked at CERN being involved in the upgrade of the CMS detector. During this period I had the chance to come in touch with the fiber optic sensor technology and its applications in harsh environments like the CERN experimental facilities.
From April 2014 I started my PhD in Information Technology and Electrical Engineering at the University of Naples Federico II. For the first year I didn't receive a scholarship but for the second and third years I will receive a scholarship within the *POR Campania FSE 2007-2013/2014 - 2020 Asse IV - V Obiettivo operativo i2)1)m)*.
From June 2014 to February 2015 I received a scholarship as part of the research project *VEM, Virtual Energy Management, CUP: E61H13000000008* on the topic *"Studio finalizzato alla definizione e progetto di sistemi optoelettronici"*, *Rif. Borsa DIETI 14/2014, Prot. 2014/0050962*.
My tutors are prof. Giovanni Breglio (UNINA) and eng. Salvatore Buontempo (CERN/INFN).

2. Study and Training activities

	Credits First Year								
		1	2	3	4	5	6		
	Estimated	bimonth	bimonth	bimonth	bimonth	bimonth	bimonth	**Total**	**Check**
Modules	**18**					3	2 **+ 9**	**5**	**20 - 40**
Seminars	**13**				4.4		0.8	**5.2**	**5 - 10**
Research	**34**	7	5	5	5	8	5	**35**	**10 - 35**

Modules

- EuroProgettazione (*ad-hoc course*)
- Integrated Photonics (*master course*), exam to be done in March.
- Three core issues for the internet: things, security and economics (*occasionally provided*)

Seminars

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- Nano-carbon based components and materials for high frequency electronics. (4 hours).
- Efficient service distribution in next generation cloud networks. (4 hours)
- Seminars followed at the Summer School for Early Stage Researchers entitled "Optical fibre sensors: from research to real world" organized by the COST Action TD1001 OFSESA, Novel and Reliable Optical Fibre Sensor Systems for Future Security and Safety Applications. Certificate with the list of the seminars attached. (18 hours)

3. Research activity

My research activity is focused on the development of innovative fiber optic sensors to be used in harsh environment such as the particle physics detectors and accelerators. For this purpose I'm collaborating with the CERN group of fiber optic sensors, with the IMCB-CNR and with the INFN-Napoli.

In particular I'm working on the development of a novel magnetic field sensors based on a clad-etched Fiber Bragg Grating (FBG) integrated with magnetic fluid, whose refractive index changes as a function of the applied magnetic field.
As it is well known, the reflected wavelength (λ_B) of FBG has correlation with its effective refractive index (n_{eff}) and grating pitch (Λ). In general conditions, the n_{eff} of FBG is not influenced by the external refractive index. However, if fiber cladding diameter is reduced along the grating region to certain extent, the n_{eff} is significantly affected by external refractive index. The FBG refractive index sensors are based on the interactions between the fundamental mode and the external medium. From this result it follows that, in principle, it is possible to realize a magnetic sensor by using a FBG as SRI sensor immersed in a magnetic fluid. The magnetic fluid is a stable, water based, colloidal solution of ferromagnetic nanoparticles (Fe_3O_4) whose behaviors in magnetic fluid are dependent on the external magnetic field, so the refractive index of magnetic fluid is shown to be magnetic field dependent. In particular, the magnetic fluid's refractive index will decrease when the magnetic field is increasing.
During this first PhD year I developed a method to etch the fiber (HF acid) in a safety way and a procedure to deep the etched FBG into a suitable holder filled with the magnetic fluid. Than I performed preliminary tests at CERN. More tests will be performed during next year with the aim of validate the behavior and the operational rage of this FBG magnetic field sensor.

4. Products

At the present no paper has been released. Two papers are in preparation and will be submitted to the conference Fotonica 2015.

5. Conferences and Seminars

During the first year I didn't attend any conference.
I attended the Summer School for Early Stage Researchers entitled *"Optical fibre sensors: from research to real world"* held September 1 to September 3, 2014 in Chandolin, Switzerland.

6. Activity abroad

During the first year I've been at CERN to perform preliminary test on the magnetic field sensor and to take part in the commissioning of the iPipe project. This is a very challenging project in which, in collaboration with the CERN-CMS fiber optic sensor group, we have installed four arrays of FBG sensors on the central beam pipe of the LHC accelerator in the CMS experimental cavern. The central beam pipe is a very fragile beryllium pipe long 3m and with a diameter of 10cm. It's placed in the center of the CMS experiment and it's the place where the billions of proton-proton collision will happen during the LHC operation.
The aim of our project is to continuously monitor the temperature and the eventual deformations of the pipe. In fact each array contain 7 strain sensors (glued on the beam pipe) and 9 temperature sensors.
I took part in the installation of the arrays, the calibration of the sensors and the analysis of the first data developing some code in C++.

These are the days I spent at CERN during this first PhD year:
01/03/2014 - 27/03/2014, 19/05/2014 - 26/05/2014, 04/09/2014 - 14/09/2014, 02/12/2014 - 13/12/2014, 03/02/2015 - 07/02/2015.

Tutorship

No tutorship as been given during the first year.