DESIGN, CONSTRUCTION, AND OPERATION OF SMALL COSMIC RAYS DETECTORS AT UNIVERSIDAD DE GUANAJUATO, MEXICO

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RESUME. Since 30 years ago Universidad de Guanajuato students and professors have participated in many international experimental high Energy physics collaborations, working at Fermilab USA, mainly [1]. Slow progress, and a tendency to impoverish, has observed in the development of this area of science in Mexico. We have disregarded the scientific and technological development of Mexico, preparing students, and collaborating, outside. Graduate students do not contribute to the economical-technologic development of Mexico, and private industry does not participate.

To remediate this situation and improve the level of science and technology in Mexico, we have created the Laboratory for elementary particles (laboratorio de partículas elementales [2]). Here students of the three levels –BSc, Master, and PhD in physics- design, construct, calibrate and operate small cosmic rays detectors. Some equipment local vendors, and small enterprises, participate.

We consider that this new way of proceeding will benefit the scientific relations with international collaborations, improve the scientific and technological preparation of students, force the participation of local industry, and contribute to the economic development of Mexico.

We present this strategy, some physical results obtained with the constructed equipment, and some conclusions.

1. Introduction

Since 30 years ago Universidad de Guanajuato students and professors have participated in many international experimental high Energy physics collaborations, working at Fermilab USA, mainly [1], this is inside the tradition started by Leon M. Lederman in the late 1970. Figure 1.

Figure 1. From Symmetry, Fermilab, SLAC.

Up to these days, there are many scientific groups in experimental high energy physics working in Mexico. Guanajuato (Laboratorio de Partículas Elementales, Universidad de Guanajuato), San Luis Potosí (Universidad Autónoma de San Luis Potosí), Michoacán (Universidad Michoacana de San Nicolás de Hidalgo), Yucatán (CINVESTAV), Chiapas (Universidad de Chiapas), México City (UNAM. CINVESTAV, IBERO), Puebla (Benemérita Universidad Autónoma de Puebla), Guadalajara (Universidad de Guadalajara), and Culiacán (Universidad Autónoma de Sinaloa). These groups collaborate with CERN (http://home.cern/) or with Fermilab (http://www.fnal.gov/). They really do not locally create technology.

Slow progress, and a tendency to impoverish, has observed in the development of this area of science in Mexico, for we do not generate our own projects in Mexico, we collaborate. We lack of a national laboratory.

We have disregarded the scientific and technological development of Mexico, preparing students, and collaborating, outside. Locally, we have almost nothing.

Graduate students do not contribute to the economical-technologic development of Mexico, and private industry does not participate, for the above situation.

2. The Laboratory for Elementary Particles (El Laboratorio de Partículas Elementales)

To remediate this situation and improve the level of science and technology in Mexico, we have created the Laboratory for elementary particles (laboratorio de partículas elementales [2]). Here students of the three levels –BSc, Master, and PhD in physics- design, construct, calibrate and operate small cosmic rays detectors. Some local equipment vendors –computer, material, electronic equipment-, and small enterprises –electronic design and fabrication-, participate. The laboratory has two areas: Radiation Detectors - mechanics, electronics, calibration-, and High Performance Computing. There are about nineteen associated students in this laboratory. 15 bachelor students, 1 master student, and three doctoral students. Figure 2.

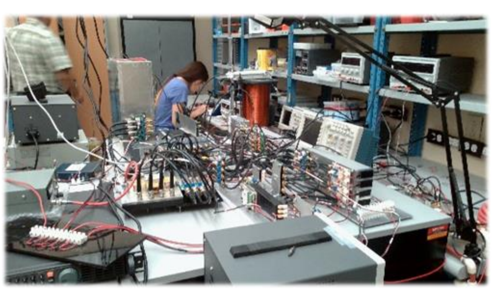

Figure 2. Laboratorio de Particulas elementales. One view.

3. Design, Construction, and Run of Small Cosmic Rays Detectors

There is a big project to create a 1 cubic meter detector of 10 000 channels, based on different technologies. This is under planning and design. To accomplish this big detector, there have been many tests and studies. We have planned, design, constructed, and tested eleven small cosmic rays detectors, as follows: one hybrid basic detector cell, with both Cerenkov and ionization detector channels, two of each detector channels; it works very well, see the presentation at this ICHEP 2016. One three Aluminum block cosmic rays detector, it runs very well, see the presentation at this ICHEP 2016. One 10 cm X 10 cm X 1 cm 4 glass channel detector. One four Aluminum channel detector. One four Polymaq channel detector. One three channel cosmic rays detector. One six electron gas channel detector. One four mini wire chamber detector. One three channel time of flight system. One 32 channel cosmic rays detector. All prototypes are designed to get analogical and digital signal.

This technology was planned, designed, constructed, tested, and run by the associated students to this laboratory of elementary particles. All the basic electronics was planned, designed, and created. Figure 3-8. Cosmic ray detectors. Figure 9. Electronics.

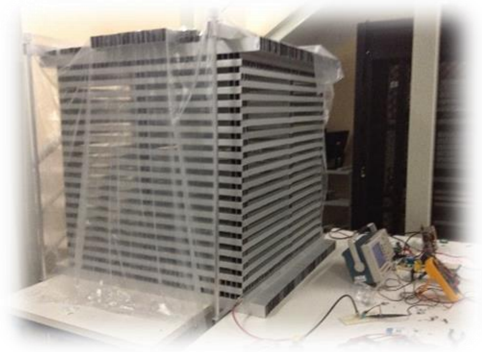

Figure 3. M3 cosmic ray detector. 10 000 channels.

Figure 4. Four channel mini multiwire chamber detector.

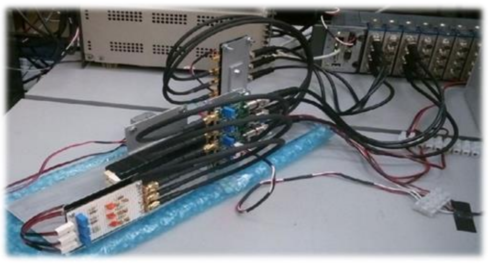

Figure 5. Six channel electron gas detector.

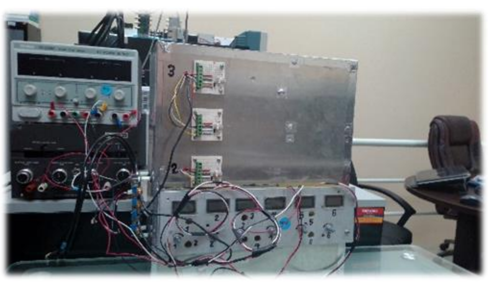

Figure 6. Three channel cosmic ray detector.

Figure 7. Setup to test PMT's.

Figure 8. Experimental setup to create and measure a uniform magnetic field.

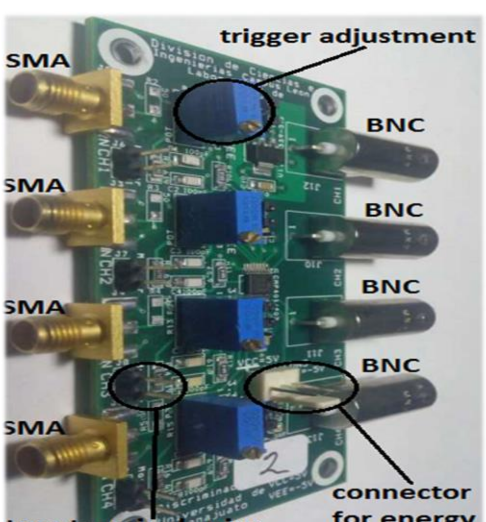

Figure 9. Electronic board. Analogical and logical signals.

Students learn how to create, test and run technology for cosmic ray detection.

Big detectors are created with the integration of many small detectors.

Figure 10-11. Student team and constructed Equipment.

Figure 10. Team and equipment at Fermilab.

4. Results

There are some results obtained with these equipment.

The technical training of 19 students. Students are prepared to create technology based on basic science.

Ten small prototypes for cosmic ray detectors. All detectors run very well.

Figure 11, the display of all prototypes properly working.

Figure 11. Equipment properly working.

All equipment piece was tested for digital and analogical signal. Figure 12. Some results. All equipment was characterized by the number of counts as function of applied high voltage. Figure 13. Some results. All equipment was run for cosmic ray flux. Figure 14. Some results.

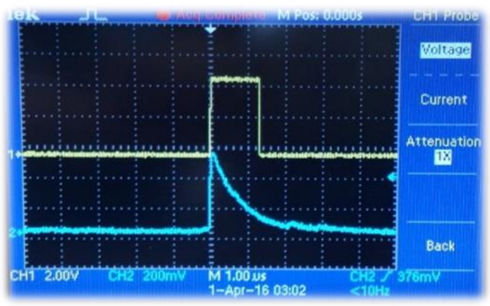

Figure 12. Analogic and digital signals. An example.

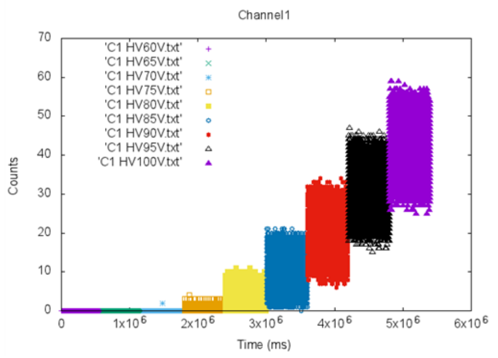

Figure 13. Characterization of equipment. Counts as function of high voltage.

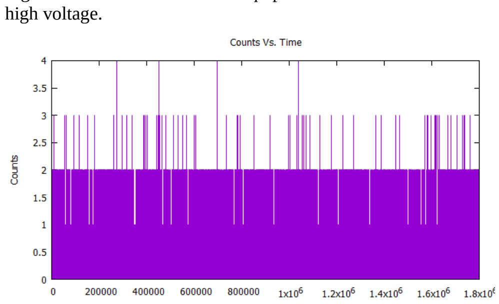

Figure 14. Counts as function of time from cosmic rays. An example. Cosmic rays flux is not constant.

5. Conclusions

We consider that this new way of proceeding –create local facilities and scientific training- will benefit the scientific relations with international collaborations, improve the scientific and technological preparation of students, force the participation of local industry, and contribute to the economic development of Mexico.

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7. References

[1] http://www.symmetrymagazine.org/article/march-2014/30-years-of-inter-american-collaboration.

[2] http://laboratoriodeparticulaselementales.blogspot.mx/.

Laboratorio de Partículas Elementales

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