The FNAL e938 Experiment: The Mexican Contribution to the MINERνA Collaboration

J. Félix*, J. Castorena*, A. Higuera*, M. R. Gutierrez*, G. Moreno*, M. A. Reyes*, Z. Urrutia*, G. Zavala†, J. G. Morfin** and The MINERνA Collaboration. FNAL e938‡

*Universidad de Guanajuato, División de Ciencias e Ingenierías, Departamento de Fisica, León GTO, 37150 México
†Universidad de Guanajuato, UCEA, Guanajuato GTO, México
**Fermi National Accelerator Laboratory, Batavia, Illinois. USA.
‡http://minerva.fnal.gov/

Abstract. The MINERνA (Main INjector ExpeRiment for νA) collaboration (http://minerva.fnal.gov//) is a neutrino scattering experiment which uses the NuMI beamline at Fermilab. It seeks to measure low energy neutrino interactions both to support neutrino oscillation experiments and to study the strong dynamics of the nucleon and nucleus that affect these interactions. It is currently in its final prototyping stage and is preparing for full-scale construction. The first detector module was completed in early 2006 and it is planned to begin taking data in 2009. We present an overview of this experiment, emphasizing the Mexican contribution, and giving the potential physics results that this collaboration can contribute to the physics of neutrino.

Keywords: Test Beam, Tracking Prototype, MINERνA, Cross section
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INTRODUCTION

The detection of electron antineutrino[1], more than fifty years ago, start a new course in high energy physics. For it triggered a vigorous field of research that continues up to these days[2, 3]: Neutrino physics.

Since those days up to today, there are many open problems in neutrino high energy physics: Neutrino oscillations, neutrino mass, neutrino-antineutrino identity, description of neutrino oscillations, neutrino geological problem, nature of neutrinos, precise determination of mixing parameters, CP violation, absolute value of hierarchy mass, relic neutrino, and many others[4].

There are many installed and proposed experiments trying to solve those problems -Underwater Neutrino Telescopes, Reactor Neutrino Oscillation Experiments, Long-Baseline Accelerator Neutrino Oscillation Experiments, Underground Detectors, etc.[5]-. One of those is MINERνA collaboration (FNAL e938)[6].

MINERνA EXPERIMENT

MINERνA experiment is a high statistics, high resolution, neutrino-antineutrino nucleon (nucleus) scattering experiment. It uses the neutrino-Main Injector beam line facility at FERMILAB.

MINERvA main goal is to measure low energy neutrino interactions to support neutrino oscillation experiments and to study the strong dynamics of the nucleon and nucleus that affects these interactions.

It is based on a compact and fully active detector for a dedicated study of neutrino interactions of multiple nuclear targets at Fermilab, it is seeking for high statistics measurements of neutrino-nucleus cross-sections in unprecedented detail, using targets of C, Fe and Pb, and a first study of neutrino induced nuclear effects. These results will be fundamental in present and future neutrino oscillation experiments to determine the incoming neutrino energy and separate oscillation backgrounds from signal.

Its detector is going to be located upstream MINOS detector (http://www-numi.fnal.gov/), allowing it to take full advantage of the well-known, high flux of the NuMI beam-line. Figure 1 shows the shape and relative location of MINERνA detector.

MINERνA is currently in its final full-scale construction and installation. It is planned to begin taking data in 2009 and planned to collect close to 1 million events of neutrino-nucleus/nucleon interaction, in each target (C, Fe, Pb), in four year run.

The physics goals that this experiment can address, beside others, are Quasi-Elastic Cross-Sections and Form Factors; Coherent Pion Production; The Resonance Production Region; Nuclear Effects in Neutrino Scattering; Precision measurement of parameters needed in Oscillation Experiments.

GENERAL CURRENT STATUS

There is a lot of progress in the construction and installation of MINERνA detector. The whole experiment consists mainly of three parts: Test Beam detector, Tracking prototype, and processing and analyzing data .

Test beam is under installation and commission. First tests have been performed, including multi-wire-proportional chambers, Time of flight system, Lead Glass calorimeter, and data acquisition. There is a bunch of data to analyze and to study and calibrate those detectors. Magnets, test beam detector, and new wire chambers will be installed early January 2009.

Tracking prototype is already constructed in its first stage and already operating, with cosmic rays, eight track modules. Some data collected for analysis and calibration. The analysis is under progress.

Early in January, 2009, the assembling underground will start.

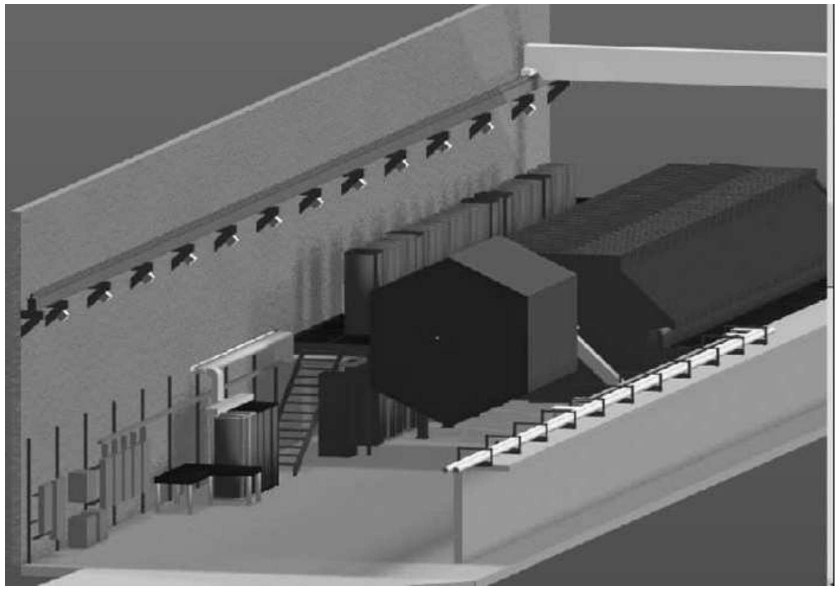

FIGURE 1. Relative location of MINERνA detector in the MINOS experiment underground hall. MINERνA detector is the front small hexagonal cross section figure.

MEXICAN CONTRIBUTION

Mexican team is formed by four professors, two Ph.D. students, and two MSc. students, currently. We expect to involve more graduate students and undergraduate students in the near future. Mexican team is currently working in Test Beam -one Ph.D. Student and one MSc. student- and in Tracking Prototype -one Ph.D. student and one MSc. student-.

In Test Beam we are working on Time of flight system -setting it up, studying its resolution, calibrating it, and analyzing data trying to identify particles; wire chamber system -setting them up-; Lead Glass calorimeter -setting it up and calibrating it-; and magnets -simulating and studying them-. We are planning to continue with these studies, including mapping the magnetic field, studying the wire chambers, and installing, operating, and analyzing the test beam detector. In general these studies must lead us to understand the beam components and the resolution of the beam that will let us identify particles.

In Tracking Prototype we are working on setting up the detector modules -installing them, cabling them, and testing and mapping them-; data acquisition -installing it, setting it up, and testing and operating it-; and data analysis -track reconstruction-. Early in January, 2009, tracking prototype will be installed underground. We are planning to contribute also with these jobs.

In processing and analysis data we are designing and assembling a multi-processor computer -20 processors- from the bare bones, preparing the communication between FERMILAB and Universidad de Guanajuato, and designing and planning another more powerful computer -512 processors-. These facilities will allow us to start other projects as to process all MINERνA data in FERMILAB or in Universidad de Guanajuato, data analysis, and probably operate MINERνA detector from Universidad de Guanajuato.

IMPACT OF MINERνA COLLABORATION IN MÉXICO

We expect, and it is happening now, that the impact of MINERνA collaboration be very strong in Mexico -especially at Universidad de Guanajuato-, mainly as follows: Preparation of human resources -at technical, undergraduate, graduate, and postdoctoral levels- in physics, engineering, and computational sciences; infrastructure -laboratory for radiation detection and data acquisition, laboratory for super computing, data processing and data analysis-; telecommunications between Fermilab and Universidad de Guanajuato -group meetings and remotely operation of MINERνA detector; scientific relations -installing and operating a Latin-American scientific network to promote scientific relations between Fermilab and Latin American Institutions-.

CONCLUSIONS

MINERνA experiment can issue many physics topics by its own and in support of other neutrino experiments around the wold. MINERνA collaboration is extremely helpful for Universidad de Guanajuato to develop new era in high energy physics at Instituto de Fisica (today División de Ciencias e Ingenierías, Campus León). Human resources, infrastructure, and facilites will be created in Mexico -Universidad de Guanajuato-.

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