Flavio Cavanna
FERMILAB - Visiting Scientist

permanent address*: Physics Department - University of L'Aquila (Italy) and INFN GranSasso*

IF Fellowship Closeout Report

Research Program

My Research Statement submitted in July 2013 for the application to the IF Fellowship 2014 included the completion of the experimental set-up, commissioning and begin operation of the **LArIAT** experiment at the FNAL Test Beam Facility, the commissioning and operation of the **MicroBooNE** experiment at the FNAL Booster Neutrino Beam and to progressively increase my participation to the **LBNE** activity, in particular in the detector design (e.g. Scintillation Light read-out system). All these activities at FNAL were greatly facilitated by the IF Fellowship funding and most of my goals have been thus successfully achieved.

LArIAT

An extended program for the **LArIAT (T1034)** experiment was defined 2013 and included the realization of a tertiary (low energy) beam line at the FTBF. I'm serving as *co-Spokesperson* for the first LArIAT experimental phase and the coordination of efforts in the beam line design and in detector construction required a careful optimization of the resources available. This activity greatly benefitted of the continued stay at FNAL. based on IF funding. The MCenter beam line has been refurbished and an extracted, low momentum new beam line (target, collimators and bending magnets) has been set up in the MC7 enclosure from a common effort by the FTBF and the LArIAT teams. A set of dedicated beam detectors (tracking chambers, ToF, Veto paddles and Cherencov counters) have been installed along the beam line for momentum and particle ID. The beam line and counters have been successfully commissioned during the summer run, from June to Sept. 2014. I proposed the realization of a set of two aerogel Cherenkov counter with refraction indexes chosen to provide different thresholds for muon to pion discrimination. The Cherenkov counters were designed at Fermilab in collaboration with T. Maruyama and K. Lang and W. Flanagan, and are now being fabricated at KEK and at Texas-Austin.

In parallel, the LArTPC with a new set of wire planes, the scintillation light detection systems, the DAQ system and the external cryogenic and LAr purification system have been assembled at LAB6 and fully tested. The cryostat has been recently moved to MC7 in the tertiary beam line and is now ready for commissioning.

A full GEANT4 MC simulation code embedded in the LArSoft package has been developed and the LArIAT MC production for large statistics of events in the beam line is now nearly completed.

Besides the role of coordination of the different effort and experimental activity during the beam line commissioning phase, thanks to extended stay at FNAL with the IF Fellowship, I had the opportunity to directly work on the development, test and installation of the scintillation light detection system in particular of the SiPM array and its read-out electronics, and to the MC analysis of muon sign separation without magnetic field obtained for stopping particles in LArTPC by statistical analysis based on topological criteria (capture vs decay). These activities were carried out with the fundamental help of a FNAL-INFN summer student (I. Nutini) and in collaboration with the U. of Chicago group (D.Schmitz and W. Foreman) and with the FNAL group (in particular H. Wenzel, P. Krycinski, R. Acciarri)

Proposal

- LArIAT: Liquid Argon In A Testbeam", F. Cavanna, M. Kordoski, J. Raaf and B. Rebel, arXiv:1406.5560 [physics.ins-det] 28 Jun 2014

MicroBooNE

The MicroBooNE experiment during the first half of 2014 underwent a careful review and upgrade of the high voltage system. I was nominated member of the Technical Board for the review process and selection of the solutions to be implemented to mitigate the risk of voltage breakdown. The possibility of daily discussions and close connections with the MicroBooNE teams working at FNAL on developments and tests of different solutions made easier and effective the review process up to the completion of the HV system upgrade, and after that, of the final assembly and installation of the experiment. The MicroBooNE detector just obtain CD-4 and is now ready for commissioning.

In parallel, as Co-Convenor of the *MicroBooNE CrossSection Working group*, I have been promoting and coordinating the activity of the group with the aim of having all analysis tools ready by time the experiment will start taking data. The close collaboration with M. Soderberg (FNAL/Syracuse) and with the MicroBooNE spokespersons (B. Fleming and S. Zeller) and Project Manager (G. Rameika) were essential components of my MicroBooNE activity at FNAL during my IF fellowship.

LAr1ND and SBN program

At the beginning of 2014 a SBN experiment at FNAL has been proposed as an important component of the IF neutrino program toward the realization of the Long Baseline Neutrino Facility. The SBN program is based on the realization of LAr1ND, a ~100 t new LArTPC detector in the near location, 110 m from the target, of a series of three detector along the Booster Neutrino Beam line, MicroBooNE and ICARUS being the intermediate and the far station, respectively. I was nominated Member of the LAr1ND Detector Design Oversight Board with the role of coordination of the specialty sub-groups dedicated to the different components of the experimental layout The review process was an important step toward the realization of the CDR, and once again the continued stay at FNAL during the initial stage of the experiment, with the collaboration forming and the proposal taking shape allowed to be part of an important and exciting moment of the experiment. In particular, I was co-proponent of the high-efficiency Scintillation Light System option for in LAr1-ND, together with University of Chicago and Yale and Manchester U. scientists. This system represents a large scale implementation of the scintillation light detector implemented in LArIAT and provides with an augmented collection sensitivity, allowing a more efficient use of the energy deposition into scintillation light by ionizing particles. Most of the development carried out in view of the LAr1ND proposal has been performed at FERMILAB during my IF fellowship.

Recent Invited Lectures, Plenary Talks, Colloquia (2014)
[partially supported by IF Fellowship funding]

- "The Liquid Ar TPC R&D effort at FNAL", invited plenary talk at the 7th conference on 'Large TPCs for Low Energy Rare Events' - Dec. 15-18, 2014 - Paris, France.
- "SuperNova Neutrino Detection with LArTPC", invited talk at the UCLA Workshop on Supernova Neutrino Detection and Sterile Neutrino Dark Matter Search - Nov. 20, 2014.
- "LArIAT: a liquid Argon TPC in a charged particle test-beam", invited seminar at Northwestern University - Nov. 3, 2014.
- "SuperNova Neutrino Detection with LArTPC", invited talk at the Town Meeting on Fundamental Symmetries, Neutrinos, Neutrons and Astrophysics, Chicago September 28, 2014.
- "The detection of back-to-back proton pairs in Charged-Current neutrino interactions with the ArgoNeuT detector", invited talk at the Intensity Frontier Seminar Series, FNAL July 17, 2014.
- "Overview of SuperNova Experiment Sensitivity with LArTPC, invited talk LBNE Physics Workshop (May, 2014, Santa Fe - NM)
- "DETECTOR R&D: LIQUID ARGON R&D OPPORTUNITIES IN THE US", invited talk at the ICFA Neutrino Panel Workshop, FNAL - Jan. 28-29, 2014.

Recent publications in refereed journals (2014)

1. The detection of back-to-back proton pairs in Charged-Current neutrino interactions with the ArgoNeuT detector in the NuMI low energy beam line,
Acciarri R, et al. (ArgoNeuT Collaboration), PHYS REV D 90, 012008 (2014), and arXiv:1405.4261v1 [nucl-ex]
2. First Measurement of Neutrino and Antineutrino Coherent Charged Pion Production on Argon,
Acciarri R, et al. (ArgoNeuT Collaboration), arXiv:1408.0598, in press Phys. Rev. Lett. (2014)
3. Liquid Argon Time Projection Chamber Research and Development in the United States.
C. Bromberg et al., JOURNAL OF INSTRUMENTATION 9 T05005 (2014), arXiv:1307.8166v2 [physics.ins-det]
4. Measurements of Inclusive Muon Neutrino and Antineutrino Charged Current Differential Cross Sections on Argon in the NuMI Antineutrino Beam,
Acciarri R. et al. (ArgoNeuT Collaboration), PHYS REV D 89, 112003 (2014), arXiv:1404.4809 [hep-ex]