MicroBooNE and R&D towards future liquid Argon experiments

I am a member of the MicroBooNE experiment at the University of Berne, Switzerland. As the experiment is situated at Fermilab, I propose to spend an extended period of time on site, starting from the middle of 2013. I am currently working on the assembly of the MicroBooNE TPC at Fermilab during short stays at Fermilab. As part of my work am the Calibration Working group convener, and will coordinate the efforts of getting from the experiment from the mechanically build TPC to the data taking instrument for research.

The MicroBooNE experiment will use a liquid Argon Time Projection Chamber (LAr TPC), of the kind that has been successfully tested and operated by the ArgoNeuT and ICARUS collaborations. As the largest LAr TPC in the U.S., MicroBooNE will not only investigate the anomalous excess of low energy events in MiniBooNE and make the first low energy neutrino cross section measurements in Argon, but also act a benchmark for future multi kiloton LAr TPC in the US, namely LBNE.

As both the MicroBooNE and LBNE detectors will be surface based, they will be exposed to a large flux of cosmic rays. While the electron drift time in the LAr TPC is about six times larger than the ion drift, a large accumulation of positively charged Argon will be present in the detector during operation. To gain the required purity for electron drift times of 2-3 ms, needed to readout the tracks left by ionizing particles, a dedicated purification system will be installed. Due to the intended flow of the Argon, local electric field concentrations of the Argon ions can reach a level similar to the drift field. These fields will lead to potential distortions in the geometry of tracks.

We have proven in test demonstrations at Bern, that one can ionize Argon with a UV laser and that the resultant laser tracks can be used to correct non-uniform drift fields. Thus, the usage of UV laser system was approved by the MicroBooNE collaboration to map the TPC volume and correct for the static influence of the local field distortions. Additionally the UV laser system will allow an independent way to measure the purity of the Argon, and thus provide a quick way to crosscheck the TPC calibration. The will be the first operation of a UV laser system operating in a LAr TPC situated in a neutrino beam.

Over the coming months, I will be involved in the design, development and testing of this steerable UV laser system at the University of Bern, where we will develop and thoroughly test a prototype to establish the final design and create the required safety, hazard and manual operation documentations by spring 2014.

As my duties involve a large fraction of hands-on work and coordination efforts, I spend a significant amount of time at Fermilab to realise the installation of the UV laser system in the MicroBooNE TPC. This stay is intended to have a duration from march 2013 up to march 2015. While my salary will be provided by the University of Berne, I am applying for the Intensity Frontier Fellowship to help finance the extra costs of housing and a rental car on site at Fermilab. The main goal of my stay will be the commissioning of the UV laser system in the MicroBooNE experiment in spring 2014 and the calibration and commissioning of the MicroBooNE TPC itself. Additionally I will prepare the physics data analysis to be performed at Bern.

While at Fermilab, I also plan to take part in research and analysis activities of the liquid Argon group at Fermilab during my time there. Specifically, I plan to continue analysis of ArgoNeut data and take part in the future LAriAT experiment, which plans to expose a liquid Argon TPC in a dedicated test beam in the MCenter line at Fermilab. The experiment began assembly and preparation in spring 2013.

Together, these efforts will provide further support to the LBNE group, which will be faced with similar problems as MicroBooNE due to the space charge effect present in the surface based detector.

Additional Information:

Experimental study of electric breakdowns in liquid argon at centimetre scale http://arxiv.org/abs/1401.6693
The mass-hierarchy and CP-violation discovery reach of the LBNO long-baseline neutrino experiment http://arxiv.org/abs/1312.6520
Neutrinos http://arxiv.org/abs/1310.4340
LAr1-ND: Testing Neutrino Anomalies with Multiple LArTPC Detectors at Fermilab http://arxiv.org/abs/1309.7987
Design and operation of ARGONTUBE: a 5 m long drift liquid argon TPC http://arxiv.org/abs/1304.6961