Precision neutrino physics has entered a new era with pressing questions to be addressed at short and long baselines, and with increasing interest and development of Liquid Argon Time Projection Chambers (LArTPCs). These open volume liquid argon TPCs drift ionization electrons from passing charged particles to readout wire chamber planes at the edge of the detector. The signals are then combined to form 2D and 3D photo-quality-like millimeter scale images of the charged particles in the detector.

The ICARUS collaboration pioneered this technology in Europe. Interest in LArTPCs in the US has grown recently, starting with the ArgoNeuT LArTPC experiment which ran in the NuMI beamline at Fermilab in 2009 and is now producing physics results, and followed by MicroBooNE, which is currently under construction and scheduled to begin running in 2014. LBNE has also made a technology choice to use an LArTPC for the far detector design.

Detailed study and calibration of these detectors is a critical step to understanding the output response of LArTPCs; it is required for a range of energies ($\mathcal{O}(0.2-2)$ GeV) relevant to upcoming experiments like MicroBooNE, and future experiments such as LAr1 and long-baseline LAr experiments at the Intensity Frontier. The Fermilab Test Beam Facility (FTBF) is the ideal place to do these studies, providing beams of not only a range of known energies, but also a selection of different particle types. A test beam also provides a controlled environment in which to tune simulations and to develop tools for particle identification (PID), calorimetry, and event reconstruction without relying solely on simulation.

A phased program is proposed to fully characterize the response of LArTPCs. The decision to develop the plan in two phases stems from the need for initial results on a relatively short time scale in order to be maximally useful for MicroBooNE. Capitalizing on the use of existing equipment, such as the ArgoNeuT TPC and cryostat, facilitates quick turnaround so that the detector can be ready for data-taking on a short time scale. Several valuable measurements can be made with this small detector during Phase-I while the design of the larger Phase-II detector is being finalized. The first phase will provide a calibration of the *charge to energy* conversion for single particle tracks, and the second phase will extend the program to cover another essential category of calibration, *detected energy to incident energy*, by ~fully containing electromagnetic and hadronic showers.

Charged particles that slow down and stop inside the LAr volume of the TPC produce tracks with increasing charge density toward the track end as a consequence of the increasing stopping power (energy loss per unit track length, dE/dx) at decreasing kinetic energy. Measurements of dE/dx *vs.* residual range along a track represent a powerful method for particle identification with LArTPCs. The single track calibration achieved by determination of the charge-to-energy conversion requires precise measurements of electron-ion recombination in the argon for a range of dE/dx and different electric field values (in the $\sim 300-1000$ V/cm range). Phase-I will focus on the determination of the charge recombination factors and the impact of charge recombination on particle identification through dE/dx measurements for a variety of different particles, including protons, kaons, pions, and muons. Additionally, the direct experimental measurement of electron/photon separation will be crucial input to MicroBooNE in addressing its primary physics goal of understanding the MiniBooNE low energy excess.

In Phase-II, a larger LArTPC will be used to expand on the Phase-I program by containing particle showers in both the transverse and longitudinal directions. Reconstruction of collective topologies (as opposed to single tracks) will permit the precise calibration of detected energy to incident energy as well as the characterization of the size and features of electromagnetic and hadronic showers. This will include studies of $e \rightarrow$ EM showers and the contribution of soft gammas down to low energy thresholds, $\pi \rightarrow$ hadronic showers and the "invisible" components which would bias a calorimetric energy reconstruction, and determination of the e/π ratio in LAr. The possibility of developing "TPC/imaging-aided calorimetric measurements" may provide a new method for investigating energy deposition mechanisms at an unprecedented level of detail.

The Phase-II program also intends to provide a testing ground for LAr detector subsystems that are under development for use in future experiments. LAr technology is continually progressing; the Phase-II detector will be designed with the flexibility to host these subsystems to help inform the design of future experiments. Some areas of active development include: cold readout electronics for signal-to-noise optimization, new designs of wire plane assemblies, electron charge drift over longer distance, scintillation light detection and signal extraction techniques, and cryostat insulation schemes.

The entire program is based on the availability and semi-permanent use of a pure low momentum tertiary beam of muons, pions, kaons, and protons (both signs) at the FTBF in the M-Center beamline. An international collaboration including more than ten groups has been formed, and is presently active with detector design, upgrade of existing components, and MC simulations. Detector assembly for Phase-I is underway, in preparation for data-taking in Summer 2014.