Flavio Cavanna
IF Fellow (and Yale U.)
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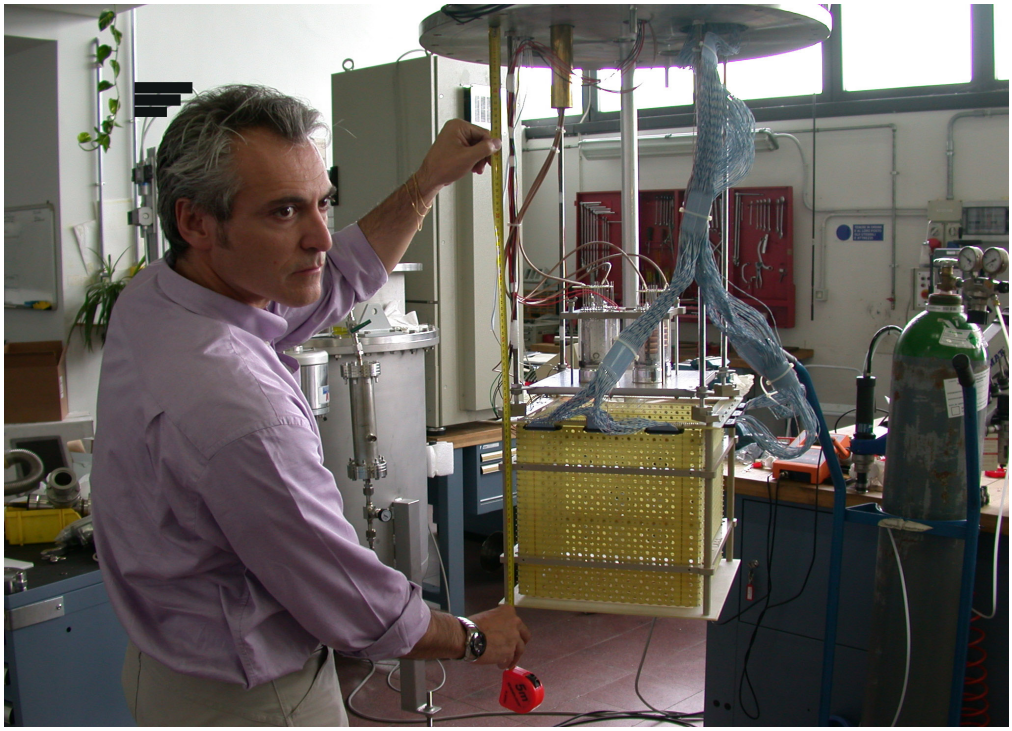
Liquid Argon at the FNAL Intensity Frontier



Neutrino physics with liquid Argon TPC detectors represents the specific field of my scientific interest and competence since more than twenty years.
Attracted by the vast potentialities of the short and long baseline neutrino program in the US, since 2007 I joined ArgoNeuT, the first, small scale LArTPC experiment in the US for precise neutrino cross section measurements in the few-GeV energy range. In 2011 I moved to the US (as visiting faculty at Yale University) for a full time involvement in the neutrino Intensity Frontier program.

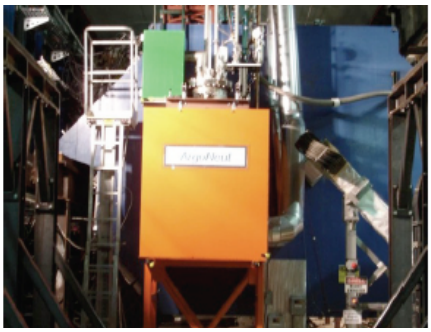
My research plan in the near term focuses on two main goals:

- the completion of the experimental set-up, commissioning and operation of the **LArIAT** experiment at the FNAL Test Beam Facility, its data analysis and the full achievement of the physics results.
- the operation of the **MicroBooNE** experiment at the FNAL Booster Neutrino Beam, detector performance characterization and neutrino cross-sections measurements.

In the medium term, I plan to participate to the **LAr1-ND** project recently proposed at FNAL as extension of the current short-baseline program (sterile neutrino search with a near-far LAr detector configuration, LAr1-ND being a new relatively small scale LArTPC acting as near detector and the MicroBooNE detector in the far locations).

In the longer term I plan to progressively increase my participation to the **LBNE** activity, in particular in the detector design (e.g. Scintillation Light read-out system) and with prototyping possible new technical solutions.

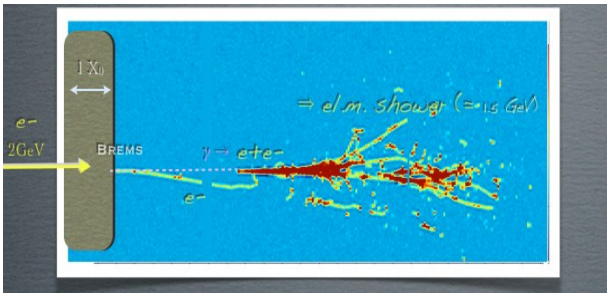
ArgoNeut in the NuMI beam

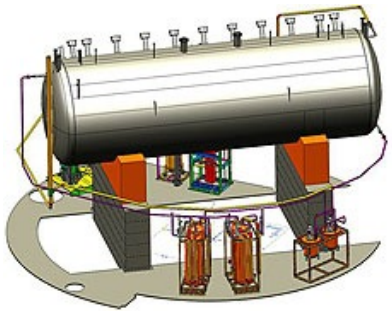


LArIAT at the Meson Hall

□-to-□ separation in LArIAT

MicroBooNe in the BNB beam





LArIAT

A full characterization of the LArTPC performance with test beams is a necessary step, probably the last remaining step, for the complete assessment of this new technology for neutrino and rare events detection.

The physics objectives of **LArIAT** are definitively relevant for all future LArTPC experiments and for MicroBooNE and LBNE in particular:

- PId information, based on direct measurement with beam particles of known type, will greatly enhance confidence in accurate event topology reconstruction.
- Separation efficiency and sample purity for electron-induced vs. photon-induced showers have never been experimentally measured, and current indications rely on MC simulations. Characterization with electron (and bremsstrahlung photon) beams will provide experimental confirmation for the separation efficiencies and through it further strengthening of the physics case for both MicroBooNE (identification of the low-energy $\square_e$ excess observed by MiniBooNE) and LBNE(measurement of the CP violating phase from oscillation into electron (anti)neutrinos) through enhanced signal to background separation.
- Sign determination without magnetic field can be obtained for stopping particles in LArTPC by statistical analysis based on topological criteria (i.e. capture vs decay). LBNE large volume can allow for efficient $\square^+/\square^-$ separation for contained tracks as soon as the event topology following $\square^-$ capture is fully understood experimentally from LArIAT.
- Pion interaction cross section on Argon target in the different inelastic channels is also *per se* an interesting physics topic with great impact on the topological separation of neutrino events and understanding of nuclear effects in neutrino interactions.
- Low momentum Anti-p may allow the first study of hadron star topology/composition from Anti-p/p annihilation at rest in Argon. This information is considered very relevant for nnbar-oscillation search with LBNE detector.

MicroBooNE

MicroBooNE is going to be the only large LArTPC operating on a neutrino beam in the near future and the first in the US. Its role for the entire LAr neutrino program is of paramount importance.

Among the physics goals of MicroBooNE, cross-section measurements for the different topologies are probably the first to be achievable. Precise cross-section determination is experimentally accessible through the sophisticated event reconstruction capability of the LArTPC combined with the unprecedented high signal-to-noise level provided by the MicroBooNE cold electronics,

Cross section measurements in LAr are relevant for any future long and short baseline oscillation study. The new topological approach developed by ArgoNeuT for cross section determination when supported, as in MicroBooNE, by higher statistics and much better event containment can really provide exhaustive results on this front.