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Detectors For Science Working Group

Neutrino part _ Attempt to prioritization

A. Fava

Pre-retreat meeting #3

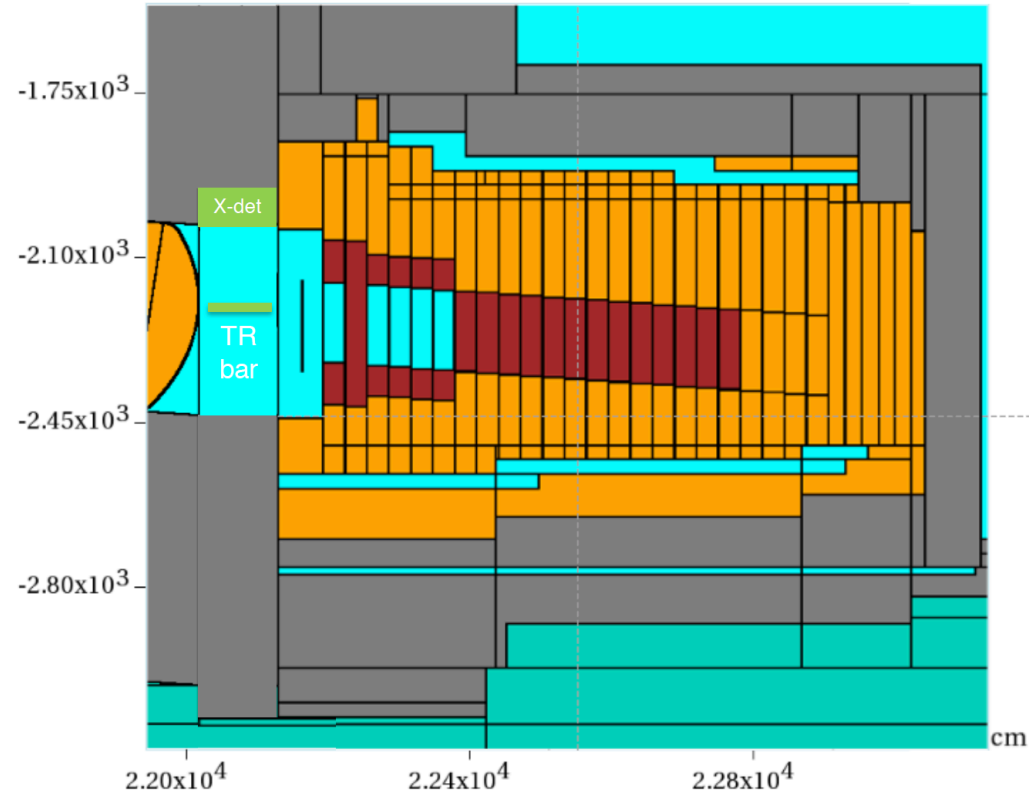
10 May 2019

Topics of discussion 2017-2019

- Neutrino Detector R&D for the Mid- to Long-Term ([B. Rebel](#))
- Magnetized LAr TPCs ([T. Strauss](#))
- Scintillation light in Lar ([F. Cavanna](#))
- In-chase target measurements for LBNF ([L. Bellantoni](#))
- Infrared light in liquid argon ([C. Escobar](#))

Criticalities for LBNF

- Measurement of hadrons in the decay pipe.
- Transition radiation detector as an alternative to “traditional” spectrometer.
- Several challenges:
 - pure transition X-ray detectors are needed, in order to avoid being killed by μ signal;
 - permanent magnet needs to be radiation hard;
 - calibration is indispensable to extract the absolute spectrum;
 - alignment;
 - thermal shock;
 - etc.

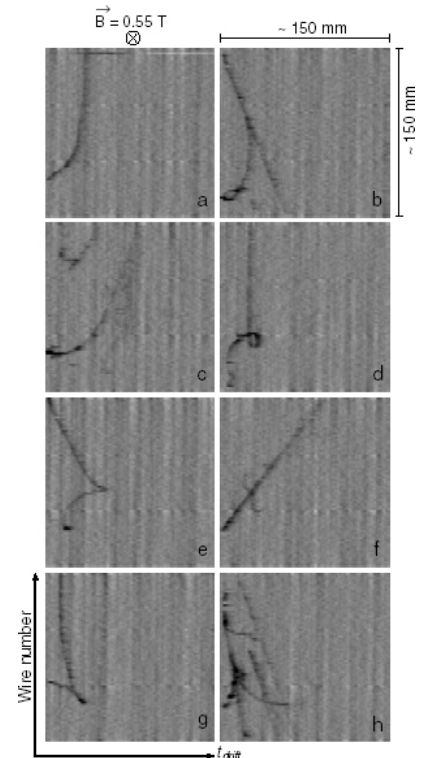


R&D for DUNE LAr-TPC detectors

- Several areas where Fermilab is positioned to make key contributions to the DUNE LAr-TPC detectors.
 - Novel photo detection systems capable of increasing sensitivity to low energy depositions: NIR light collection, dopants, ARAPUCA, etc.
 - Realizing conditions for stable operations of drift HV system.
 - Improving spatial resolution and electronic noise in ionization readout, e.g. pixelated front-end.
- The neutrino community could benefit from broader scope technology developments
 - ASIC design;
 - High-speed links to increase throughput and allow for continuous readout (for example for Supernova neutrino applications).

Additional needs for DUNE near detectors

- Pile-up of neutrino interactions in an intense beam like LBNF at the near position can become a problem with the long drift times of LAr-TPCs.
High pressure gas argon TPC is being developed at Fermilab to complement the liquid argon detector.
- Possibility to measure the charge and momentum of particles in magnetic field is attractive, but high field is needed for electrons that start showering in few cm.
Alternatives to classic UA1 style magnets are superconducting Helmholtz coils. R&D opportunities for Helium-free solution based on magnesium diboride (MgB_2).



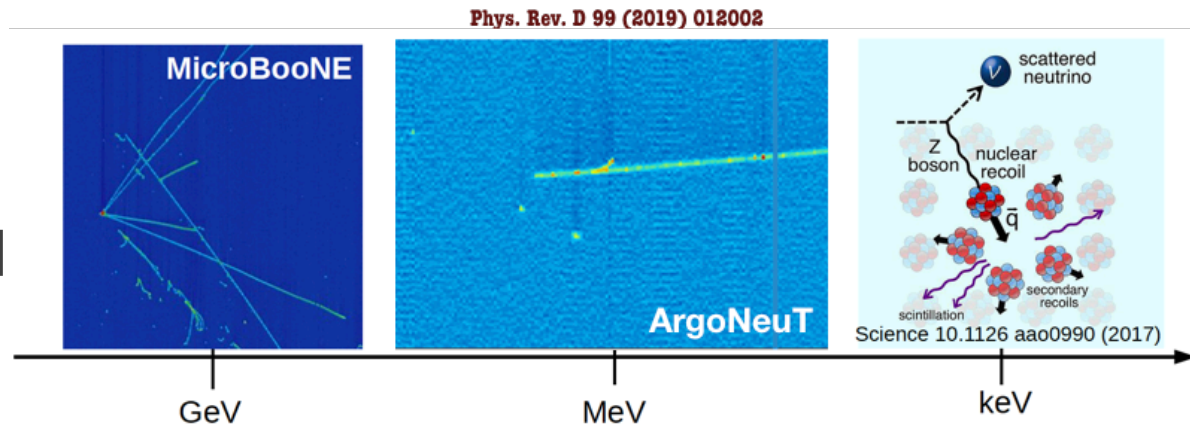
Beyond DUNE: tau neutrino detection

- Only sector in neutrino oscillation far from «precision» measurement is ν_τ appearance.
- Challenges related to detection:
 - Need 10's of microns resolution (τ is very short lived) and prefer automated readout - silicon?
 - Need a lot of mass - silicon isn't so helpful with that
 - (Almost) totally active detectors are great for identifying the vertex, but only practical with a relatively massive active material
 - We can't lose the τ in the passive material
- Could benefit from joint efforts with energy frontier applications.

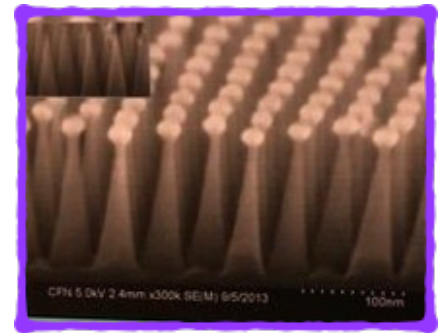
Beyond DUNE: low energy ionization in LAr-TPC

- Detection of nuclear recoils via ionization in LAr-TPC, as complementary to scintillation light, potentially promising tool for coherent neutrino scattering and dark matter searches.

- Need to improve at least 2 orders of magnitude compared to state of the art.



- R&D to investigate feasibility of multiplication of drift electrons in close proximity of sub-micrometric anode structures.



Attempt to prioritization

- Higher interest and/or feasibility
 - Scintillation light in LAr;
 - HV feedthroughs for LAr;
 - high pressure gas argon TPC.
- Medium interest and/or feasibility
 - amplification in liquid argon;
 - high-speed data link;
 - ASIC development.
- Lower interest and/or feasibility
 - transition radiation detectors for beam decay pipe;
 - detectors for ν_τ ;
 - magnetization of LAr volume.