

Research Result Report ICRR Inter-University Research Program 2023

Research Subject: Towards a multiphysics liquid Xe TPC with scintillation and charge multiplication

Principal Investigator: Konstantinos Nikolopoulos

Participating Researchers:

Patrick Knights, Thomas Neep, Lex Millins, Hiroyuki Sekiya

Summary of Research Result :

The prototype electrode structure, developed in 2022-23, was successfully tested in liquid nitrogen to ensure robustness to the mechanical stresses of cooling. During a

trip to the laboratory, the electrode was also tested in nitrogen gas in the setup in the Kamioka Observatory.

The first tests demonstrated the ability to apply the voltages required without electric discharges. Based on these measurements, refinement of the electrode design

was performed, reducing the length and diameter of the needle.

During a second trip to Kamioka Observatory, an improved prototype electrode

was tested in liquid xenon in the full setup (Fig.1 and Fig.2).

A ^{241}Am source was used to provide a source of α - particles in the xenon. An S2

signal (Fig. 3) coming from the amplification of ionization electrons from the α -particle interactions observed above 2kV and voltages of up to 6kV were achieved (Fig. 4).

This is the first demonstration of proportional amplification in liquid xenon that does not use a thin wire

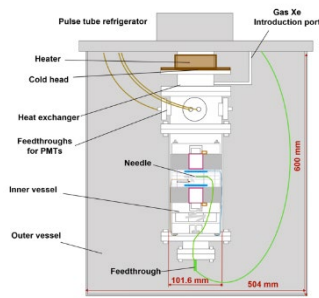


Fig1 Kamioka Setup

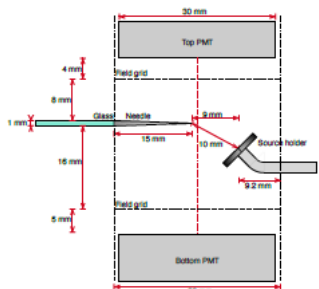


Fig 2: Set-up in Kamioka.

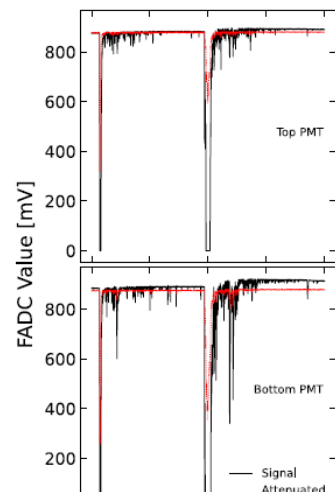


Fig 3: Example pulse in the Top and Bottom PMTs showing S1 and S2, as the first and second principle peaks.

or conventional micropattern detector structure and is the subject of a publication under review. These results will be presented at international conferences next year.

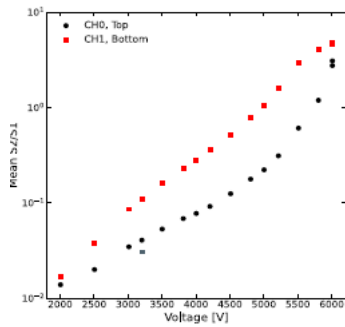


Fig 4: Mean S2/S1 as a function of voltage.

In the next steps, the scale-up of this electrode design will be investigated, incorporating needle-like amplification structures into a multielectrode structure, like that used in spherical proportional counters. Further tests will be required to determine the contamination levels and investigate the radiopurity if components are used so that they can be incorporated into XMASS in the future.

No.