

Design of a cryogenic capacitive liquid level sensor

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The Light-Only Liquid Xenon (LoLX) experiment is designed to study scintillation light and characterize the performance of silicon photomultipliers (SiPMs) in a liquid xenon (LXe) medium. To ensure the SiPMs are functioning properly, it is necessary to verify that all of them are submerged. LoLX therefore requires a LXe level sensor. Outgassing requirements, cryogenic temperature, space constraints and the low relative permittivity of LXe ($\epsilon_{LXe} = 1.85$) prohibit the use of standard liquid level sensors.

We developed a highly sensitive capacitive liquid level sensor which consists of sinusoidal electrodes inside a flexible Kapton printed circuit board. The liquid level sensor is 30 cm long with a capacitance of 35.4 ± 0.1 pF. The capacitance is read by a FDC1004 evaluation board and an Arduino Uno, and then sent to the LoLX slow control system to be converted to a liquid level. From measurements made in sunflower oil ($\epsilon_{oil} = 3.29$), we calculated that the sensitivity of the sensor in LXe will be 0.1889 ± 0.0001 pF/cm, which is orders of magnitude higher than liquid level sensors used by other groups. We plan to cross-calibrate the sensor in LXe with temperature-sensitive resistors as fixed-point sensors once it has been installed. Commissioning in LXe is planned at the next run of LoLX in March 2024.

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