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Instrumentation Development for XLZD - The Ultimate Liquid Xenon Rare Event Observatory

Thursday, 21 May 2026 13:30 (30 minutes)

XLZD will feature a next-generation dual-phase liquid xenon (LXe) time projection chamber (TPC) with a 60–80 tonne active target. Building on the experience made with the LZ and XENONnT experiments, the detector scales the current technology by more than a factor of 10 in mass. This scale-up will enable searches for weakly interacting massive particles down to the neutrino fog, as well as searches for neutrinoless double beta decay of Xenon-136 and other rare processes.

Achieving these physics goals requires overcoming substantial hardware and instrumentation challenges. The TPC must be scaled to nearly 3 m in diameter and 4 m in height, while simultaneously meeting stringent requirements on intrinsic radioactivity, in particular from Radon-222 and Krypton-85. This necessitates a focused research and development (R&D) program, for example: XLZD's TPC demands robust, low-radioactivity, electrodes and a high-voltage delivery system. Spurious electron emission from cathodic surfaces must be mitigated through optimized materials and surface treatments. The cryostat must minimize radon emanation while supporting ~100 tonnes of LXe, requiring advanced welding techniques and possibly surface coatings. Reducing backgrounds from radionuclide impurities will require online cryogenic distillation, thorough material selection and design optimisation, complemented by nested vetoes. The rate of accidental coincidences from lone S1 and S2 signals increase with volume, motivating dedicated R&D to reduce spurious pulses.

This talk will summarize the R&D carried out so far within the XLZD collaboration and provide an outlook on the remaining work required to ensure technological readiness for an ultimate-scale LXe observatory.

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