Measurements of liquid xenon response to low-energy particle interactions with the Xurich II experiment

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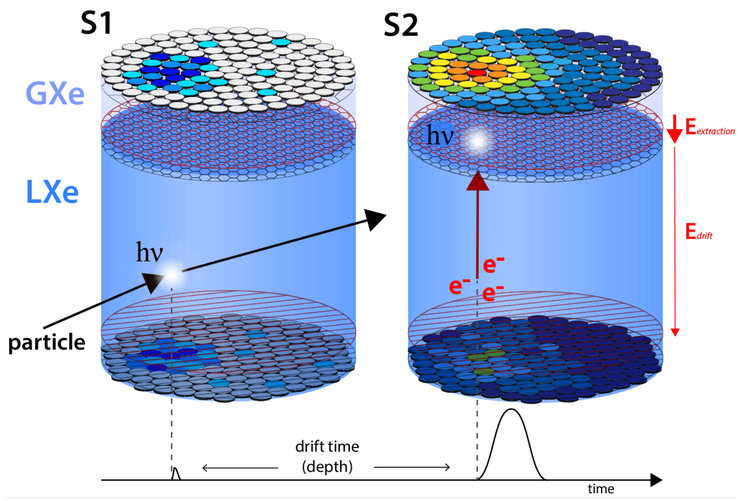
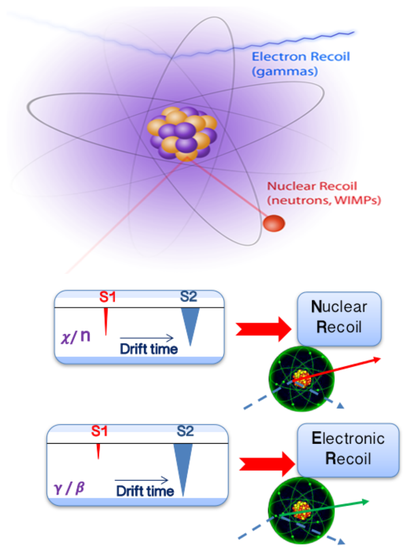
The Xurich II experiment aims to study the intrinsic xenon properties for particle detection (absolute scintillation and ionization yields for electronic and nuclear recoil) down to a few keV. In particular to improve the uncertainties of current measurements adding the dependency at different drift fields. The detector will be also used as R&D facility for next generation experiments using liquid xenon.

Dual-phase Time Projection Chamber:



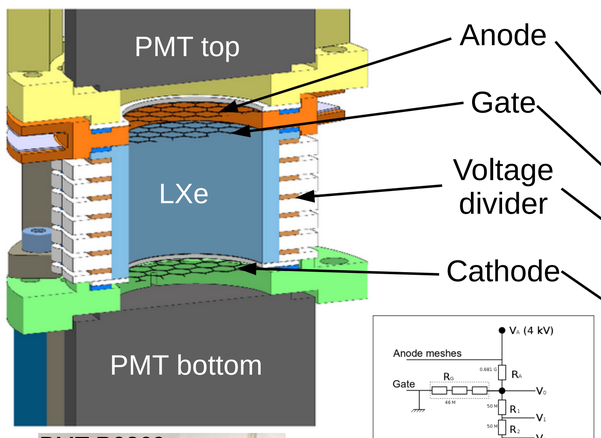
- S1 signal from prompt scintillation
- S2 electro-luminescence signal from drifted and extracted electrons in the gas phase
- Interaction depth from delay time between S1 and S2
- X-Y position from PMT patterns in top and bottom arrays (not for single PMT)
- Electronic and nuclear recoil discrimination based on S2/S1 ratio



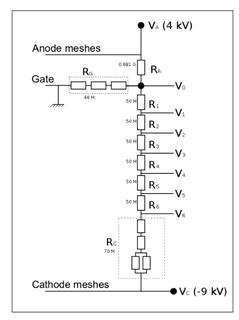
Experimental Setup:

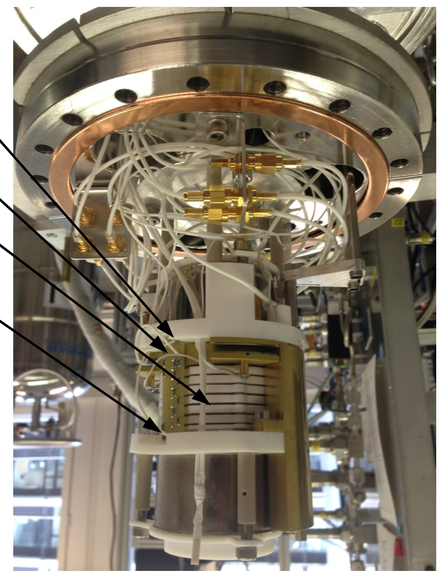
- Dual-phase LXe TPC: 3.1 cm high and 3.1 cm wide
- 68 g LXe with a maximum drift time of ~20 µs
- Two PMTs, one on top and one on the bottom: 2-inch, Hamamatsu Photonics R9869, with QE ~35% for the xenon scintillation light (178 nm)
- Cathode up to 6 kV: Drift field up to 2 kV/cm
- Anode at 4 kV: Extraction field ~10 kV/cm
- Xenon gas constantly purified by circulation through a hot metal getter: electron life-time τ~200 µs and electron mean-free-path x~40 cm

$S2_{corrected} = S2 \cdot e^{dt/\tau}$ and $x = \tau \cdot v$ where v = electron drift velocity



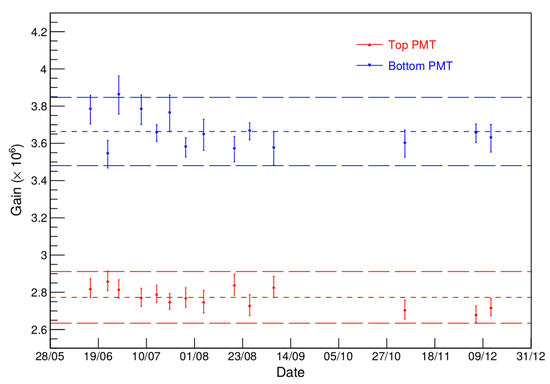
PMT R9869



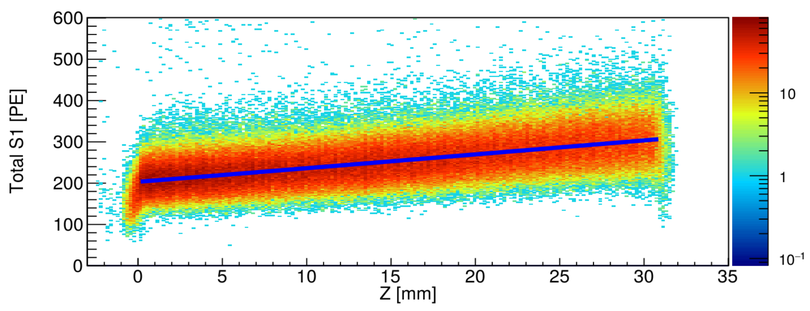


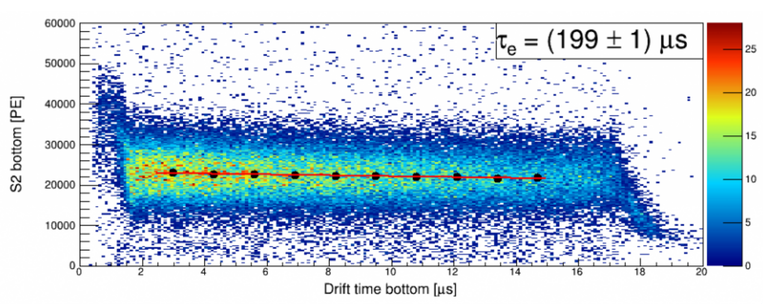
Detector Characterization:

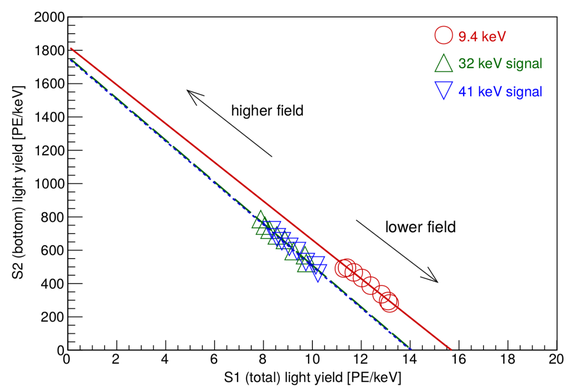
- LED calibrations to monitor the PMTs gain
- Gain stable within 3% RMS



- ^{83m}Kr is injected through the recirculation gas system into the xenon volume for calibrations
- The 32.1 keV and 9.4 keV mono-energetic peaks are used for signal corrections and detector calibration
- S1 varies by 10% in the target volume due to position-dependent light collection efficiency
- Determined light and charge yields at different drift fields

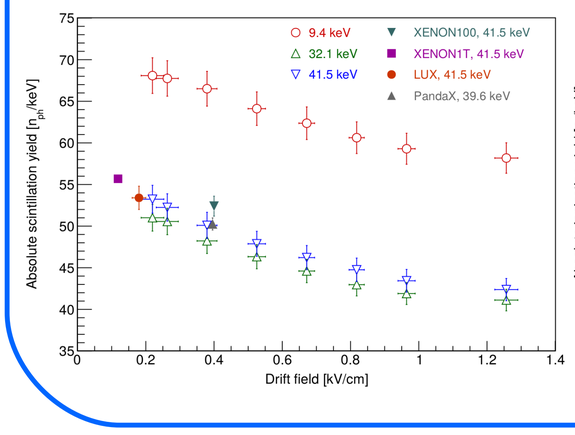


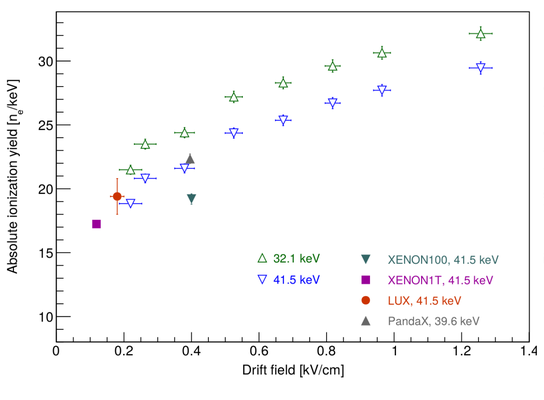


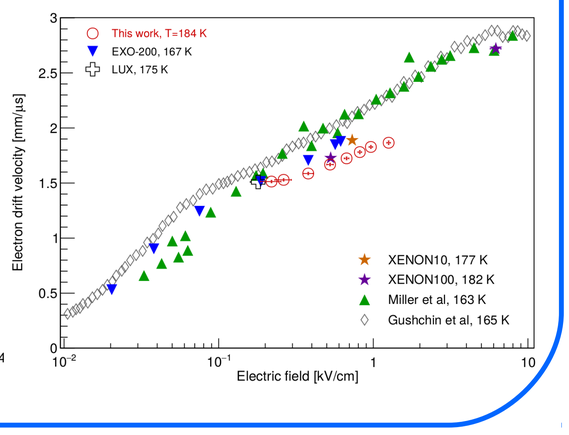


Results:

- Absolute photon yield of liquid xenon
- Absolute ionization yield of extracted electrons in gas phase
- Electron drift velocity dependence with the applied field







Outlook:

- Detector upgrade with SiPM arrays
- 3D position reconstruction
- Demonstrate the SiPM technique in dual-phase TPCs for next-generation experiments