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Mobility and lifetime of 220-Rn daughters

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Noble (argon, xenon) or inert (nitrogen) gases are extensively utilized in experiments looking for rare nuclear events at low energies, for which reduction of backgrounds is crucial. Highly radio-pure detectors (e.g. HPGe diodes in LAr, LAr/LXe TPCs) are in direct contact with the gases, being exposed to the intrinsic impurities during assembly, handling and operation. Therefore ^{222}Rn daughters plating out on the detectors' surfaces (especially long-lived ^{210}Pb) may significantly contribute to the overall background index.

A measurement method of mobility and ionic lifetime of alpha emitters from the ^{220}Rn decay chain is presented, based on a teflon-made, 20 cm tube, instrumented on one end with a large area (1 cm^2) Si-PIN diode as alpha-particle detector. Opposite to the detector a ^{228}Th surface alpha-source is placed on a movable holder. The high voltage divider resistors, located in the groove outside the tube, form the electric field. The alpha-activity registered by the diode varies with the field strength and the source distance for each gas tested. Opposite polarities of ions produced in energetic alpha and beta decays were tested.

The choice of ^{220}Rn chain over ^{222}Rn is based on the fact that the shorter nuclear life-time of ^{220}Rn and ^{216}Po allows for easy determination of their mobility and ionic lifetime in the setup described. A typical mobility of positively charged Po-216 measured is on the order of 1.3 cm^{2}s^{-1}V^{-1}, while the ionic lifetime is approximately 10 s (and much longer for ultra-pure gases). Foreseen are measurements of the ionic properties in cryogenic liquids, being highly relevant for such setups as DarkSide (LAr TPC) or Gerda (HPGe in LAr), where energetic alpha or beta decays present in the ^{222}Rn products entering the experiments' active volumes may mimic the signal of interest for these experiments. Properties of the ionized ^{222}Rn daughters deduced from the conducted measurements are therefore outlined.

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