F. Slow Control System

A Slow Control System (SCS) was developed to monitor all essential run-time parameters of the XENON10 experiment, controlling the status of various hardware components, triggering alarms and transmitting important parameters.

The SCS monitors over 290 parameters, which include gas pressure, cryogenic temperatures, flow rate, liquid level, grids and PMTs high voltages, DAQ trigger and acquisition rate, room temperatures and detector inclination. Figures 10 is an example of the detector parameters monitored by the SCS during the dark matter run.

The SCS consists of 4 parts: (i) server, (ii) monitor client, (iii) alarm client, and (iv) history plotter. The server establishes communication with all the different instruments monitored, makes all the parameters available for the clients, and stores the information to disk. The monitor client allows each user access to all the parameters monitored over the last 24 hours. The alarm client triggers the alarm system in case one of the preassigned parameters falls outside the allowed range. Alarms are sent via email and as text messages to the cell phones of the appropriate personnel. In addition to this automated system, the LNGS personnel continuously monitors the gas pressure. The history plotter allows the user to access the information stored for each parameter for any particular time.

The SCS is a platform independent software developed exclusively for the XENON10 experiment using the Java programming language. The communication between the different SCS components is done with Java Remote Method Invocation (RMI).

III. THE XENON10 SHIELD

The XENON10 detector is protected from external background by a cubic steel-framed structure, consisting of 20 cm high-density polyethylene (HDPE) inside of 20 cm Pb; a schematic is shown in Fig. 12. The Pb was supplied in $5 \times 10 \times 20$ cm bricks and was stacked so as to avoid any line-of-sight penetration along the cracks. The outer 15 cm of Pb have an activity in ^{210}Pb of about 560 ± 90 Bq/kg, while the inner 5 cm are a low-background Pb obtained from *Fonderies de Gentilly* [37]. It was measured at a germanium counting facility [32, 33] to have an activity in ^{210}Pb of (17 ± 5) Bq/kg. Specific activities for various shield components are shown in Table I.

A Monte Carlo simulation shows that 20 cm Pb results in an attenuation of the external gamma flux larger than 10^5 while its internal activity leads to a contribution of less than 0.32 cts/keVee/kg/day (dru) ($E < 25$ keVee) to the raw event rate inside the shield cavity. With the additional self-shielding of the outer 2 cm of Xe (as used in the WIMP search data analysis [11]), the contribution of the Pb activity to the electron recoil background drops

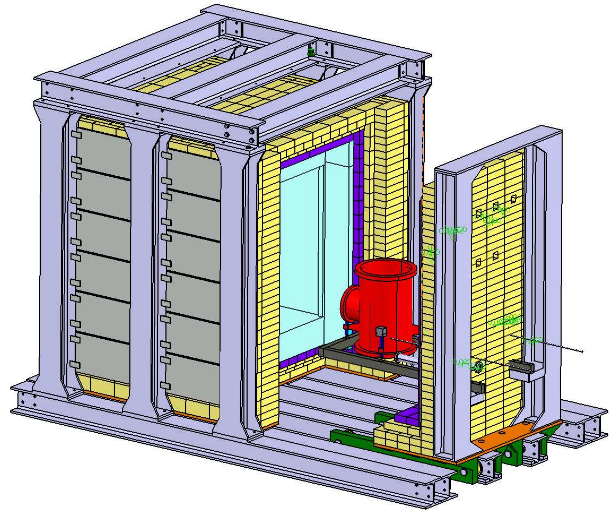

FIG. 12: (Color online) The XENON10 shield structure. Common and low-radioactivity Pb bricks are shown in yellow and purple respectively, while polyethylene is light blue. Not shown are the 20cm of polyethylene on the "door" and the 15cm below the shield structure.

below 0.05 dru ($E < 25$ keVee), becoming sub-dominant (see Fig. 13).

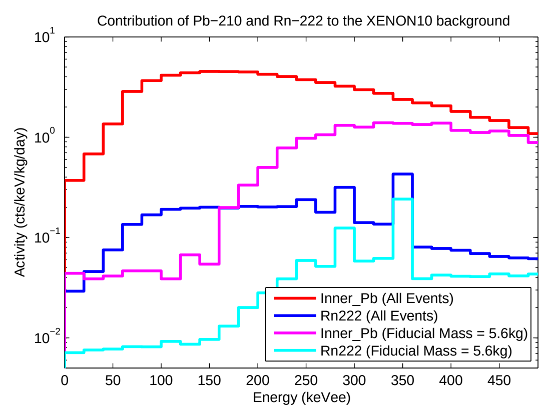

FIG. 13: (Color online) Simulated contributions of ^{210}Pb (17 Bq/kg) and ^{222}Rn (5 Bq/m^3) to the XENON10 background, for the entire 14 kg active volume (red, blue) and also for a 5.6 kg fiducial volume (cyan, magenta); the fiducial volume corresponds to 2 cm Xe self-shielding (radial) and 3 cm each (Top/Bottom).

The 20 cm of HDPE provides reduction of external fast-neutron flux by a factor of 90. Placing the Pb outside the HDPE has the benefit that the neutron scattering on the Pb reduces the energy of the neutrons, thus increasing the efficacy of the HDPE. The dominant source of neutrons is expected from (α, n) and fission reactions in the surrounding rock, as well as from cosmogenic production in the rock and Pb. The ambient neutron flux from natural radioactivity in the rock has been measured to be about 4×10^{-6} n/cm^2/s [38, 39], and from this the in-