Modeling for Surface Background in PandaX–II Detector

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Abstract:
This work models the surface backgrounds in the energy window (0-10 keV) for WIMP search in the PandaX-II detector. The surface backgrounds in this region are dominant by the $\beta$ decay of $^{210}$Pb ($T_{1/2}=22.2$ y), which is the daughter of $^{222}$Rn, a noble-gas radioisotope in the $^{238}$U decay chain. Due to charge loss effect of surface events, their ionization-to-scintillation ratio mixed with nuclear recoils, leading to undistinguishable backgrounds in the region of interest. Because the mechanism for the charge loss remains unknown, a data-driven model is developed to estimate the surface backgrounds.

Method:
Estimate the background from the wall leakage into the fiducial volume with the probability distribution function (PDF) of the surface backgrounds.
- Define the soft wall for different Z and azimuth angle.
- Modeling radial part, $p_r$.
- Smooth $p_r$ with kernel density estimator (KDE).

Soft wall construction:
- Soft wall: the median position of the reconstructed events for $^{214}$Po daughters (green), $^{214}$Pb, and $^{214}$Bi.
- $r_p$, the distance to wall is defined according to $^{214}$Po, $^{214}$Bi data with $p_l$ from $^{214}$Po data to blind the WIMP search data.

Result:
The wall model is checked with Run 10 data of PandaX-II (77.1 days live-time).

Conclusion:
The wall models for different position reconstruction algorithms are consistent with each other. This work will allow us to include more xenon into data analysis as we can estimate the amount of surface events.

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Main Reference: