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Cosmogenic activation study in the NaI(Tl) Crystals for COSINE-100 experiment

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COSINE-100 is a direct dark-matter (WIMP) search experiment that uses an underground array of low background NaI(TI) scintillating crystals as a target/detector in the Yangyang deep underground laboratory. In spite of the underground experimental environment, the detector array and surrounding materials still contain some radioactive nuclides that were primarily produced by previous exposures to cosmic rays. Studies of the time-dependent contamination levels of these cosmogenic radioactive isotopes are required in order to understand these backgrounds to rare event search experiments. In this presentation, results of studies of cosmogenic nuclide contaminations in the COSINE-100 detector materials and comparisons to MC simulations will be presented.

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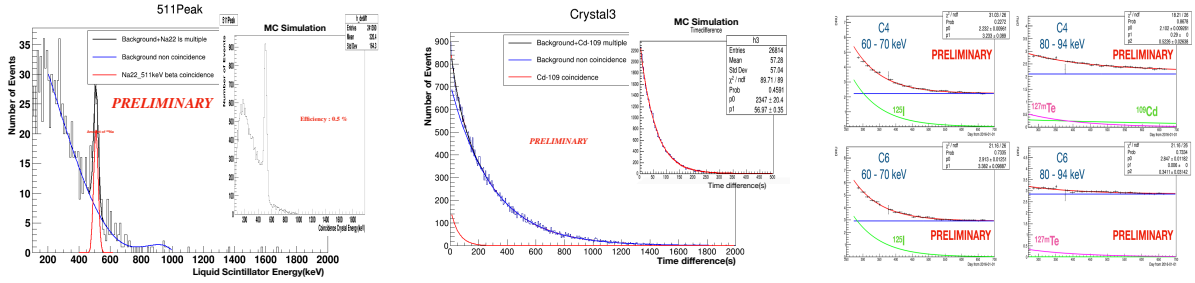
1. Cosmogenic Isotopes and Summary

COSINE-100 experiment using eight NaI(Tl) crystals had underground radioactivity cooling times that ranged from several months to three years, there are still background contributions due to the long-lived cosmogenic isotopes that were activated by cosmic rays while they were on the surface. The major cosmogenic components are ^{22}Na, ^{109}Cd, ^{125}I and Te components. Here, we calculated amount of cosmogenic isotopes and compared with MC simulation.



(a) (b) (c)

Figure 1: (a) Triple coincidence events in the same crystal with Double coincidence. Black line is total events and blue line is background evnets and red line is ^{22}Na events. (b) Time difference in Crystal 3. blue line is background events and red line is ^{109}Cd events in the crystal. The meanlife time is 56.29 sec here, it shows red line means ^{109}Cd events. (c)Time difference in crystal 4 and 6 by I and Te component. Green line is ^{125}I and pink line is ^{127m}Te.

Table 1: Summary of COSINE-100 cosmogenic isotopes activity.

I/C	Crystal1	Crystal2	Crystal3	Crystal4	Crystal6	Crystal7
^{3}H	0.27 ± 0.040	0.095 ± 0.031	0.18 ± 0.056	0.23 ± 0.050	0.075 ± 0.040	0.070 ± 0.032
^{22}Na	0.78 ± 0.18	0.67 ± 0.16	0.56 ± 0.11	0.90 ± 0.15	0.55 ± 0.14	0.69 ± 0.19
^{109}Cd	0.013 ± 0.008	0.003 ± 0.006	0.06 ± 0.006	0.10 ± 0.007	0.002 ± 0.007	0.015 ± 0.005
^{125}I	-	-	0.09 ± 0.01	0.56 ± 0.02	0.59 ± 0.02	0.62 ± 0.02
^{121m}Te	-	-	0.17 ± 0.03	0.46 ± 0.03	0.20 ± 0.03	0.19 ± 0.03
^{125m}Te	-	-	-	0.1 ± 0.1	0.037 ± 0.12	0.039 ± 0.11
^{127m}Te	-	-	0.066 ± 0.012	0.176 ± 0.009	0.114 ± 0.011	0.105 ± 0.011

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