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WIMP tracking with cryogenic nuclear emulsion

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Directional dark matter search experiment enable us to reveal the presence of Weakly Interacting Massive Particles (WIMPs). A promising detector of directional measurement is a fine-grained nuclear emulsion consisting of fine silver bromide crystals with 20 nm or 40 nm size. A critical issue for the success of the emulsion dark matter search experiment is to discriminate the nuclear recoil tracks and electron background tracks which come from stopping beta rays of ^{14}C decay in the emulsion. Since the intrinsic electron events will be significant background, a electron rejection power of at least 10^{-8} is needed.

We present a novel cryogenic approach to reject the electron background that makes use of phonon effect in nuclear emulsion. Since nuclear recoil tracks increase temperature of silver bromide crystals in the emulsion by producing phonon in the crystal, this approach allows us to extract nuclear recoil tracks and to achieve no sensitivity to electron tracks by operating the emulsion at LN_2 temperature.

For proof of principle, we have been investigating the sensitivity of fine-grained nuclear emulsions as function of temperature by exposing to gamma rays and ion beams from an ion implant system in range of 77 – 300 K. Results of gamma ray exposure indicate a dramatically reduction of the electron sensitivity with decreasing temperature. The nuclear track data is being analyzed.

First results on the performance will be presented.

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