**Improving Internal Radiopurity in NaI(Tl) Crystals for Dark Matter Search Experiments**

Keonah Shin[1], Cheol Ho Lee[1], Chorok Byeon[1], Hyun Su Lee[1], Alain Iltis[2], Olga Gileva[1]*

[1]*Center for Underground Physics, Institute for Basic Science (IBS), Daejeon, 34126, Korea*
[2]*Damavan Imaging, Troyes, 10430, France*
Corresponding Author Email: gilevaolga@ibs.re.kr

The COSINE project, a flagship experiment at the Center for Underground Physics (CUP), IBS, aims to detect dark matter through direct WIMP searches using high-purity NaI(Tl) scintillation detectors. While NaI(Tl) crystals offer excellent light yield and low energy thresholds, their sensitivity is limited by internal radioactive contaminants, specifically $^{40}$K and $^{210}$Pb, which produce backgrounds in the low-energy region of interest. Achieving ultra-pure NaI powder is therefore a critical prerequisite for the next phase of the experiment, COSINE-200.

In this presentation, we report on the large-scale purification of NaI using a highly efficient fractional recrystallization method developed at CUP. Starting with crystal-grade raw powder containing potassium concentrations between 250–700 ppb, we have successfully produced several hundred kilograms of purified NaI with K levels consistently below 20 ppb. This ultra-low background powder, characterized by minimal moisture content and superior radiopurity, has been utilized to grow large-scale crystals via the Kyropoulos and Bridgman methods.

We will highlight our technical progress over the past few years, including the performance of these grown crystals that exhibit high light yields and ultra-low internal backgrounds. Furthermore, we discuss the qualification processes for raw powders from various global suppliers to ensure a scalable and reliable supply chain for future dark matter search experiments.

This work is supported by the Institute for Basic Science (IBS) under project code IBS-R016-A1,