Contribution ID: **82** Type: **01** - 分会报告

Background simulation of a low background gamma ray spectrometer with an array of five germanium detectors

Friday, 10 May 2024 17:20 (20 minutes)

Material screening and selection in rare-event search experiments, such as dark matter direct detection experiments, neutrinoless double-beta decay ($0\nu\beta\beta$) experiments, and neutrino detection experiments, presents a significant challenge due to the high requirement of purity. The cosmic rays and cosmogenic radioactivity are drastically decreased with thick rock overburden as shielding, and materials in rare-event search experiments exhibit radio-purity levels in the μBq/kg range. Commonly employed techniques for material screening and selection include inductively coupled mass spectrometry (ICP-MS), neutron activation analysis (NAA), and gamma ray spectrometry. Among these techniques, gamma ray spectrometry stands out for being widely used due to its advantages of low background, high energy resolution, non-destructive measurement capabilities, and straightforward pre-processing steps. The main factors that affect the performance of gamma ray spectrometers are the detection efficiency and background counting rates.

The China Jinping Underground Laboratory (CJPL) is the deepest underground laboratory in the world, which was constructed in the middle of the traffic tunnels with a vertical rock overburden of 2400 m. The first phase of CJPL (CJPL-I) has provided low background environment for two dark matter experiments, CDEX and PandaX . The construction of the second phase of the Jinping laboratory (CJPL-II) started at the end of 2014 and and the cavern excavation was completed in 2017. CJPL-II will provide space for more underground experiments to meet the growing space demands from rare event searching experiments. Raw materials of concrete and other materials were screened and selected by three HPGe spectrometers named GeTHU detectors before used. GeTHU detectors currently achieve sensitivity for primordial U/Th contaminations at a level of mBq/kg.

A new ARray of GermaniUm gamma ray Spectrometer (Argus) is established in Hall-C at CJPL-II for material radioactive screening at a level of μBq/kg. Most underground gamma ray spectrometers use a single germanium crystal, whose size and mass are limited by the crystal growth technology. By using an array of five detectors to increase the sensitive volume and optimizing the shape of the sample, the limitation of detection efficiency is eliminated. Based on Monte Carlo simulation, special attention in the construction of the spectrometer is devoted to achieve low background rates, which would be possible to reach the level of 10 counts per kilogram of germanium per day in the energy region of 60-2700 keV with methods of background control. In this study, we will introduce the configuration and Monte Carlo simulation of ARGUS. The MDA at the level of 10 μBq/kg for U/Th decay chain could be achieved with a measurement time of 100 days.

Collaboration (if any)

Primary authors: Prof. MA, Hao (Tsinghua University); ZENG, Zhi (Tsinghua University)

Presenter: CHEN, Jikai (Tsinghua University)

Session Classification: 11 - 低本底技术

Track Classification: 11 - 低本底技术