

Achievement report of Dispatching Researchers Abroad Program in 2021

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<input type="radio"/> (1) Researcher exchange program <input checked="" type="radio"/> (2) Dispatching young researchers abroad program <input type="radio"/> (○ for either)	Research reference number : R3
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Purpose	Water purification for neutron veto system of XENONnT
Country /institute/schedule	Italy / LNGS (INFN) / June 28 th – September 15 th

Research achievement (including publication list): The neutron veto (nVeto) detector based on the Gd-loaded water Cherenkov technology of Super-Kamiokande is one of three detector components newly added in XENONnT, is being commissioned, and is purposed to reject the radiogenic neutron events, which creates nuclear recoil background. To operate the nVeto, we (XENON collaboration) need to care about: the water purification system to maintain the low impurity of water filled in the nVeto, monitor the amount of Gd salt dissolved in water, and monitor the water transparency. In this 80-days trip to LNGS, I joined in these studies, took onsite shifts, and was involved in other tasks in order to prepare for the Science Run of XENONnT.

1. Assemble water purification system: Gd plays an important role in nVeto because it has the largest neutron capture cross-section of all stable nuclei. Gd sulfate octahydrate salt, $Gd_2(SO_4)_3 \cdot 8H_2O$, is dissolved in nVeto. It is needed to remove all impurities in the water but not Gd salt. For this purpose, the Gd water purification system (GdWPS), a technology in the EGADS experiment, was brought to XENONnT. By the end of June, the GdWPS components were shipped from U.S. to LNGS, and in July, other collaborators (Kai Martens – IPMU, Marco Selvi – Bologna, Francesco Lombardi – Mainz) and I worked together to check the components in the water loop system, electronic components for monitor and control the water loop, assemble a water flush system used for flushing the membranes of the GdWPS, and install the electrical panels for the GdWPS with the help from a professional company. By the time I left, most of the electrical components were tested, and we will travel to LNGS again by the end of this year to operate the GdWPS and check its stability.
2. Determine Gd amount with AAS system: To achieve the 90% neutron tagging efficiency, it is decided to load 0.2% Gd in water. After dissolving Gd salt, it is necessary to monitor the amount of Gd in water. For this future task, in August, Prof. Kai Martens and I contacted two specialists in the LNGS chemistry lab (Stefano Nisi and Marco Balata) to use the Perkin Elmer AAnalyst 800 Atomic Absorption Spectrometer-Flame/Furnace (AAS) to make some tests for Gd quantity measurements. A Gd Lumina Hollow Cathode Lamp was brought from Japan to use for this purpose. We made several tests using both furnace and flame to measure Gd concentration in different samples and were trying to optimize the procedure to minimize the systematic uncertainty for spectroscopy. We are working on an analysis software to analyze the raw data from the AAS.
3. Transparency measurement: Water transparency is also an important factor for our nVeto water Cherenkov detector. The Shimadzu UV-2600i spectroscopy was shipped to LNGS chemistry lab for this purpose. I conducted different transparency measurements with air samples, pure water samples, nVeto water samples, and Gd-loaded water samples. The results were checked by the in-situ analyst software of the spectroscopy, which showed understandable behaviors between different samples. The raw data files are now being analyzed to estimate the uncertainty and reproducibility.
4. Online monitor for nVeto detector: I have worked with other experts in DAQ and nVeto teams of XENONnT to develop the online monitor of the nVeto detector. It is an important task and needs to be deeply involved in the streaming analysis for XENON, which is called straxen. By the beginning of September, the new version of straxen was released with a new data type, that I added, used for speedy streaming analysis at event builder computer. The first version of this monitor with a Slack bot option is being finalized.