Annual Report from the PandaX Collaboration, Dec. 2019

Executive summary: PandaX (particle and astrophysical xenon) observatory uses xenon as target to search for WIMP particles and to study fundamental properties of neutrinos. In summer 2019, the PandaX-II experiment accomplished all the designed goals, and the operation was officially terminated. The total dark matter exposure is about 140-ton-day. The collaboration has been focusing on constructing the PandaX-4T (4-ton liquid xenon target) experiment in the B2 hall of CJPL-II. In parallel, the PandaX-III experiment, with a 100-kg high pressure gas xenon TPC (HpgTPC), is being prepared at SJTU. This is a technological pathfinder for this unique approach to search for the neutrinoless double beta decay (NLDBD) in ^{136}Xe.

PandaX-II: science and systematics studies

In 2019, systematics and technical studies were performed using the PandaX-II detector. They include novel methods of calibrations, upgrade of trigger/electronics system, ways to improve the energy linearity and resolution at higher energies for the NLDBD signals, etc. Based on the neutron calibration data, PandaX collaboration published a novel data-driven method to give a robust evaluation of the neutron background contribution in dark matter signal region [1].

The PandaX-II operation was completed in July 2019, with an approximate accumulated exposure of 140 ton-day for dark matter search. For the final WIMP analysis, the low energy dark matter data is still blinded, with an expected release in 2020.

Based on the full exposure data, PandaX collaboration published a new result on the NLDBD search using the data in the high energy region [2], a highlighted article on Chinese Physics C. From this analysis, a lower limit for decay half-life of 2.1×10^{23} yr was set at 90% confidence level. This is the first ever NLDBD result from a liquid xenon dark matter experiment.

Next phase DM experiment: PandaX-4T

We are constructing the PandaX-4T detector with a sensitive target of 4-ton liquid xenon, with an expected lowest sensitivity to WIMP-nucleon spin-independent cross section of 10^{-47} cm^2, with a 6-ton-year exposure [3].

In the B2 hall of CJPL-II, the construction of the ultrapure water tank (900 m^3) to house the PandaX-4T detector was completed. Ultrapure water production system was installed and passed the acceptance tests. For detector assembly, Class 10000 and 1000 clean rooms are built. A radon-removal system is in operation to provide radon-free (<1 Bq/m^3) air to the Class 1000 clean room.

From the fall of 2019, the subsystems components of PandaX-4T detector were transported gradually to CJPL-II. The assembly of the detector is expected to take a full year, when the experiment will switch to its commissioning phase.

The PandaX-III experiment

The PandaX-III experiment aims to search for NLDBD of ^{136}Xe with HpgTPC[4]. We are pushing for the deployment of the first 100-kg module to CJPL-II by 2021. Construction of the low background stainless steel pressure vessel has been finished. We are fabricating the gas circulation and purification system, external calibration system, and internal gaseous calibration system, the last of which piggy-backs key R&D efforts from PandaX-4T. A new test production of Micromegas is done by CERN. Three micromegas modules has been delivered to SJTU and are been tested. Meanwhile, we kept working on software and simulation. REST, the software framework for gaseous TPC analysis, with key contribution from PandaX-III, will be released as an open source package soon. With REST, we studied signal and background identification capability of traditional track reconstruction techniques [5]. Further development with Kalman filter is been explored.

References:

[1] Q. Wang et al. (PandaX-II Collaboration), arXiv:1907.00545, accepted by Sci. China Phys. Mech. Astron.

[2] K. Ni et al. (PandaX-II Collaboration), Chinese Physics C, Vol 43, 113001 (2019)

[3] H. Zhang et al. (PandaX-4T Collaboration), Sci. China Phys. Mech. Astron. 62 (2019), 031011

[4] X. Chen et al. (PandaX-III Collaboration) Sci. China Phys. Mech. Astron. (2017) 60: 061011

[5] J. Galan et al. (PandaX-III Collaboration) Journal of Physics G: Nuclear and Particle

Physics accepted [arXiv:1903.03979].