First measurement of electron anti-neutrino disappearance using the JUNO experiment

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The Standard Model of Particle Physics is the theory describing the behaviour of the elementary particles that constitute all known matter. While the Standard Model has been extremely successful to describe nature, there is one phenomenon that was not foreseen in this theory: Neutrino Oscillations. Indeed neutrinos, which are elementary particles in the Standard Model, were expected not to have a mass, and without a mass neutrinos cannot oscillated between flavors. However at the turn of the last century neutrinos were discovered to oscillate between flavors, which runs counter to the expectation from the Standard Model and proves that neutrinos have masses. This fundamental discovery awarded the 2015 Nobel prize to the two experiments that demonstrated it using atmospheric and solar neutrinos: Super-Kamiokande and SNO.

Since this discovery, several experiments have studied this phenomenon. However there are still some parameters that haven't been measured yet. One of these unknowns is the neutrino mass ordering, that is which of the neutrinos is the lightest. The determination of this ordering could be essential to understand by which mechanism neutrinos get their mass and also to check expansion models of the Universe.

Answering that question is the main goal of JUNO experiment [1, 2] in preparation in China. JUNO is expected to reach a sensitivity to measure the neutrino mass ordering of more than 3 σ after 6 years of data taking using reactor neutrinos. With this data, JUNO will also make it possible to precisely measure several parameters regulating neutrino oscillations, which will allow us to start testing the mixing matrix unitarity. In addition to reactor neutrinos, JUNO will also perform measurements on solar neutrinos, atmospheric neutrinos, supernovae neutrinos, among others.

JUNO is an international collaboration, regrouping 77 institutions all around the world. For the determination of the neutrino mass ordering, the experiment will use neutrinos from many nuclear power plants with a total power of 36 GW. The detector will be at $\sim$53 km from the cores of the reactors, and the target will be made of a liquid scintillator making it possible for us to detect electron anti-neutrinos emitted by the reactor cores through the inverse beta decay reaction. The scintillation light will be collected by about 18k 20" photomultiplier tubes (PMT) and 25k 3" PMTs. The central detector, composed of the liquid scintillator inside an acrylic sphere, will be surrounded by a water pool, which will also be equipped with PMTs to make it possible the detection of atmospheric muons via their Cherenkov light to control the cosmogenic background. An additional detector, the Top Tracker, will be installed above the central detector and the water pool to further identify atmospheric muons. The construction of the experimental hall in southern China is close to being completed, and data taking is expected to be start in 2022.

The IPHC group is one of the main responsible groups for the Top Tracker (TT) of JUNO, which is already built and sent to China. A prototype of the TT in Strasbourg is used to test the new electronics and track reconstruction software.

A successful Ph.D. student starting in 2021 is expected to take part in the final steps of the construction of the detector. The student also will be heavily involved in the beginning of the data taking with JUNO up to the first results produced by the experiment. The student will be expected to perform the first determination of the cosmogenic background in JUNO using Top Tracker data, and to participate in the first measurements of neutrino oscillations parameters produced by JUNO using reactor electron anti-neutrinos.

[1] JUNO website: http://juno.ihep.cas.cn

[2] F. An *et al.* [JUNO Collaboration], J. Phys. G **43** (2016) no.3, 030401 [arXiv:1507.05613].