

**Laboratory/ research team** : Laboratoire Leprince Ringuet / T2K-JUNO-HK group

**Title** : **On the way to the determination of the Neutrino Mass Hierarchy with JUNO**

In 2015, the Nobel Prize in Physics was awarded "*for the discovery of neutrino oscillations*", thus confirming once more the interest and the importance of Neutrino Physics for a clear understanding of Particle Physics.

Despite this extraordinary tribute, two quantities related to neutrino oscillation are still unknown: the sign of  $|\Delta m_{213}|$  (Mass Hierarchy, MH) and the CP violation phase ( $\delta_{CP}$ ). In particular, MH evaluation is not only fundamental for the  $\delta_{CP}$  measurement, but is also a key parameter in neutrino astronomy and cosmology.

The determination of MH is actually the main goal of the JUNO (Jiangmen Underground Neutrino Observatory) experiment, presently under construction in Kaiping (China). JUNO will be the biggest (20kt) liquid scintillator detector ever built, with unprecedented energy resolution (3%), thanks to the use of 17000 large Photo Multipliers Tubes (PMTs). By detecting reactor antineutrinos produced 53km away from the detector, JUNO is expected to determine the MH at  $3\sigma$  level in about 6 years.

The data taking is expected to begin in 2020 and the collaboration is presently heavily engaged on the optimisation of each component of the detector.

In particular, the LLR group is involved in three main aspects of this challenging phase of the experiment :

1. The optimisation of the **Top Tracker (TT)**, aiming for accurately reconstruct the cosmic muons surviving underground which represent one of the main sources of background. The development of a Trigger System and participation in the construction of DAQ system are envisaged.
2. The optimisation of the PMT read-out system of the Central Detector (CD) via a « **multicalorimetry** » approach : an additional system of small (3 inches) PMTs, ensuring linearity and uniformity in the energy reconstruction, has just been approved by the collaboration and further studies and R&D are urgently needed.

3. The determination of the radioactive level of the different detector components, in order to comply with the «low background» requirements.

Thus, the PhD student will have the opportunity to participate in different aspects of the experiment, and to acquire skills and competences in different domains, in particular :

\* **software** : Monte Carlo simulation for the detector design optimisation (TT and CD) and the development of analysis technique for the multicalorimetry approach

\* **hardware** : test of trigger and DAQ cards developed for the Top Tracker

\* **data analysis**: participation in the data taking campaign and in the analysis of material for the radioactivity characterisation, to be performed in the Laboratoire Souterrain de Modane.

The successful candidate will also present his work during the Collaboration Meetings in China and Europe and in relevant Conferences.

## **Links**

<http://english.ihep.cas.cn/rs/fs/jun00815/>

<http://polywww.in2p3.fr/spip.php?article1828>

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