

# Referee report on the Projects Daya-Bay and JUNO (JINR participation)

(referee Antonio Ereditato; [antonio.ereditato@lhep.unibe.ch](mailto:antonio.ereditato@lhep.unibe.ch))

The report given to the Program Advisory Committee of JINR on 26 June 2017 outlines the proposal submitted by JINR neutrino physics researchers to extend their participation in the Daya-Bay and JUNO experiments in China, for the period 2018-2020.

Several projects worldwide are planned to address some of the outstanding open issues in the study of the PMNS neutrino mixing-matrix, such as the neutrino mass eigenvalue hierarchy and the existence of a possible CP violation phase. The relevance of these physics subjects and the smallness of the expected effects set serious constraints to the projects and justify their complexity, their long-term schedules and their cost.

Daya-Bay and its larger-scale follow up JUNO experiments are in some sense unique in the international scenario. Daya-Bay has made a fundamental discovery by measuring a non-zero  $\theta_{13}$  mixing angle, a major result in neutrino physics, by studying the anti-neutrino flux from nuclear reactors. Its scientific scopes for the next few years will still be very relevant; much more is expected to come from JUNO, a larger and complex liquid scintillator neutrino reactor detector, whose main goal will be the a first determination of the mass hierarchy at the 3-4 sigma level by 2026.

The experiments have been thoroughly discussed in previous meetings of the JINR PAC. One can stress here that the JINR group has been very active and productive, both in the running and exploitation of the data from Daya-Bay, and in the preparation of JUNO. One can mention, in particular for Daya-Bay, the studies aimed at background rejection, the oscillation analysis conducted by the JINR group, and a search for sterile neutrinos. These activities will naturally phase out in the future, although the data analysis should still allow narrowing the errors in the determination of the oscillation parameters ( $\theta_{13}$  in particular).

As far as JUNO is concerned, being JINR a major international player within the international collaboration, the group took relevant responsibilities: production of the PMTs' high voltage units, the Top Tracker detector based on the experience gathered with the OPERA target tracker, calculations for the realization of the Helmholtz coils needed to properly shield the inner detector against the Earth magnetic field, and more. All this, in addition to the contributions to the development of the analysis software tools and to the collaboration management (level 2 and level 3 managers).

Having said that, the referee opinion is very positive, provided that a visible participation of the JINR group in JUNO be guaranteed for the future, also thanks to the financial support of JINR.

In relation to the request for a three-year extension of the Daya-Bay/JUNO projects, the referee notes that:

- 1) The effort on Daya-Bay should be reduced correspondingly to the ramping up of the JUNO activities. The participation should be concentrated on the work of PhD students, in the position of writing excellent theses on data analysis such to include original physics results.
- 2) The JUNO physics case should be carefully monitored by JINR management in relation to the international competition in view of the potential cancellation of the Taishan NPP cores, that would lead to a longer data taking period (7.5 years) needed to achieve the aimed at goals on the mass hierarchy determination.
- 3) The work on the JUNO PMT system must have first priority: this is the flagship hardware contribution from JINR.
- 4) The scientific contributions from JINR researchers have been so far very good in terms of presentations to conferences and number of published papers. However, an effort must be paid concerning the education and training of students. Only 3 PhD theses were completed so far. This is reflected in the average age of the group (40 years) and in the presence of only 3 bachelor and 6 PhD students out of 32 group members.
- 5) As mentioned above, the JINR group is large. One should make sure that the impact to the experiment be proportionally high. The referee sees that there are several cases where only a marginal contribution is expected for the future years by group members.
- 6) As far as the financial resources, the referee would like to have a better clarification of the requested funds for the major effort on the HV: the level of detail on the estimates is lower that for the other subprojects, despite the quantitative relevance. The request for travel money seems to be excessive, also taking into account the overlap between Daya-Bay and JUNO. The referee is puzzled by the coincidence that the estimate for the needed travel money adds up to exactly 500 k\$.

The referee, in conclusions, proposes that, given the considerations expressed above, the project (continuation of the Daya-Bay experiment and participation in JUNO) be approved and funded with the highest priority for the next three years, provided that a clarification on the points raised above is given by the applicants.



Prof. Dr. Antonio Ereditato