

Referee report on the Project T2K phase 2-Hyper-K (JINR participation)

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The report given to the Program Advisory Committee of JINR on 21 June 2021 outlines the proposed, future activities of the JINR neutrino physics researchers on the T2K phase 2 and Hyper-K experiments in Japan, aimed at contributing to the project for the years 2022-2024. The experiments are presented to the PAC for the first time and the group is seeking for approval.

Some of the most outstanding particle physics results obtained in the last twenty-five years came from the study of neutrino oscillations, originally postulated by Bruno Pontecorvo. Experiments conducted with atmospheric and solar neutrinos, confirmed with man-made reactor and accelerator neutrinos, allowed us to build a coherent scenario pointing to the existence of neutrino mixing (PMNS matrix) and oscillations, the first indication of physics beyond the Standard Model of particles and interactions. For the next decade and beyond, the research in the field will try to address fundamental open questions: the possible existence of a CP violating phase in the PMNS matrix and the neutrino mass eigenstates hierarchy. In additions, the optimal use of the envisioned detectors will imply the parallel ability to look for matter instability and to detect the next (close) supernova explosion.

There are two major projects which have been proposed long ago and are being prepared by the international neutrino community. They are the DUNE/LBNF project in the USA and the Hyper-K in Japan, the latter, as the new generation of the Kamiokande, Super-Kamiokande, K2K, T2K series. The two experimental approaches are different, although they have similar scientific goals. DUNE exploits large liquid argon imaging TPCs, while Hyper-K is based on the water Cherenkov technique. Both are very large and complex scientific enterprises at a level similar to that of the LHC in terms of cost, timeline (10-20 years) and consistency of the collaborations.

A group of JINR researchers, some of them formerly engaged in the Mu2e project in the USA and also involved in the COMET project at J-PARC in Japan, are proposing to join Hyper-K and its precursor, the T2K phase 2 experiment. The group includes 22 people and 14.5 FTEs, out of which 7 young scientists. The JINR group is joining an INR group already well established in the Japanese projects, with a solid scientific recognition and a long-standing experience in neutrino physics, notably in Japan.

The JINR group intends to participate in an ongoing effort, already well defined by the T2K and Hyper-K collaborations: assembly and maintenance of the 3D scintillation active target of the T2K phase 2 near detector (Super-FGD). In this respect, they intend to work together with the preexisting INR group through a dedicated memorandum of understanding. Although the JINR group is (globally) not a recognized player in neutrino physics, apart from notable exceptions, their experience with plastic scintillators could be helpful for the planned realization of the new detector. The hardware activities should be complemented by an involvement on the data analysis work (essentially T2K phase 2 and test beams for the two years of this request).

The referee is rather critical with this proposal. The main reasons are spelled out below:

- 1) Approving this two-year activity must be decoupled from the approval of the >15 years participation in the future Hyper-K experiment. The latter is probably to be considered for the next 7-year plan, given the high level of engagement of JINR which is required to have a visible role in such a very-large, international, scientific enterprise. Participation in Hyper-K should be well thought and regulated by a MoU at the highest level of JINR and of the host laboratory, and not considered as a simple analytical prolongation of a two-year preliminary approval of the activities in T2K phase 2.
- 2) The proposed hardware contribution is not original and has not the scientific footprint of JINR researchers. This is instead the case for the INR group, since long time a key player of the Japanese neutrino program. In this respect, this involvement does not qualify as a sufficient scientific contribution for the whole T2K phase 2 and Hyper-K experiments. The specific competences of the proponents are excellent but not (as a group) on neutrino physics. This could naturally lead to a less than prominent role in the very competitive Japanese neutrino-physics environment.
- 3) In line with what has been (is being) done for other research fields, JINR should better engaged in a few projects (even just one) for each research line, in order to ensure a concrete and visible contribution in a demanding international environment and a well identified and formally regulated support from the laboratory. The next few decades of research in neutrino oscillation physics and astroparticle physics topics will be addressed by DUNE and Hyper-K. The JINR laboratory should decide the strategy to be adopted. The referee is strongly convinced that the optimal choice would be to join one single (well supported) project with a very strong and qualified participation, well defined from the beginning, agreed within the international partners and monitored in the same way it is done at JINR, for example, for the LHC and NICA projects.

Having said that, the referee only considers the two-year participation on the realization of the near detector of T2K phase 2 and proposes to postpone any discussions on the Hyper-K project until the next 7-year plan will be defined, and the strategy of the laboratory decided. The personal opinion of the referee, though, is to not approve the T2K phase 2 participation in the present conditions, for the arguments given in 2).



Prof. Dr. Antonio Ereditato