

## Research Report

### ICRR Inter-University Research Program 2020

Research Subject: Constraining systematics at T2K and SuperKamiokande oscillation analyses using neutrino-nucleus interaction models
Principal Investigator: Juan Antonio Caballero Carretero (University of Seville)
Participating Researchers: Juan Manuel Franco Patiño (University of Seville) Jesús González Rosa (University of Seville) Raúl González Jiménez (Complutense University of Madrid) José Manuel Udías Moinelo (Complutense University of Madrid) Maria Benedetta Barbaro (University of Turin and INFN) T. William Donnelly (Massachusetts Institute of Technology (MIT)) Kimihiro Okumura (University of Tokyo, ICRR) Yoshinari Hayato (University of Tokyo, ICRR) Guillermo D. Megias (University of Tokyo, ICRR)
Summary of Research Result : - Due to the Covid-19 pandemic, the research could not be conducted as initially planned. - ICRR Inter-University Research Program's Committee has approved the request to carry over the research budget for the fiscal year 2021. - We will also continue this project on FY2021 under the ICRR Inter-University Research Program 2021.  In spite of the current situation and travel limitations, the outcomes of these projects have been presented at: T2K Collaboration meetings: - <i>Link to G. D. Megias' talk at T2K NIWG March 2020 online collaboration pre-meeting.</i> - <i>Link to G. D. Megias' talk at T2K July 2020 General Cross Section Workshop.</i> IPMU-ICRR joint seminars: - <i>Link to G. D. Megias' talk at IPMU-ICRR Joint Seminar.</i> Neutrino 2020 International Conference: - <i>Link to G. D. Megias' poster at Neutrino 2020 Conference.</i> NUSTEC 2021 International Conference: - <i>Link to J. Gonzalez-Rosa's talk at NUSTEC 2021 Workshop.</i>  In connection with this project, progresses on the development and optimization of neutrino interaction models (SuSAv2-MEC and RMF models) for the analysis of semi-inclusive and STV measurements of interest for T2K and SK has been also recently published: · <i>Constraints in modeling the quasielastic response in inclusive lepton-nucleus scattering.</i> R. González-Jiménez, M.B. Barbaro, J.A. Caballero, T.W. Donnelly, N. Jachowicz, G.D. Megias, K. Niewczas, A. Nikolakopoulos, J.M. Udías. Phys. Rev. C 101, 015503 (2020). DOI link, · <i>Semi-inclusive charged-current neutrino-nucleus cross sections in the relativistic plane wave impulse approximation.</i> J.M. Franco-Patino, J. Gonzalez-Rosa, J.A. Caballero, M.B. Barbaro. Phys. Rev. C 102, 064626 (2020) DOI link

· *Neutrino energy reconstruction from semi-inclusive samples*. R. González-Jiménez, M. B. Barbaro, J. A. Caballero, T. W. Donnelly, N. Jachowicz, G. D. Megias, K. Niewczas, A. Nikolakopoulos, J. W. Van Orden, J. M. Udías. arXiv:2104.01701 [nucl-th] (2021).

· *Theoretical description of semi-inclusive neutrino-nucleus data in the relativistic plane wave impulse approximation*. J. M. Franco-Patino, M. B. Barbaro, J. A. Caballero, G. D. Megias. Manuscript in preparation (2021).

Work is in progress with Prof. Hayato-san (ICRR) on a joint analysis of low-energy nuclear effects at T2K, Ninja and SK kinematics in comparison with SuSAv2-MEC and RMF models. Also, in collaboration with Hayato-san and other T2K and SK researchers, a first implementation of the inclusive and semi-inclusive RMF-1p1h models in NEUT is expected in the next months. This will allow the reweight of several parameters for the oscillation analysis, the study of nuclear-medium effects, and a comparison between nuclear optical potentials and cascade models in generators, among other issues. The outcomes of this research will be published in coming months.

With regard to the ICRR Research Program, the University of Seville group (J. A. Caballero, G. D. Megias and others) has recently applied for a 3-year R&D project of the Spanish Ministry of Science in which Prof. Hayato-san (ICRR) has been included as collaborator. The University of Seville consider this collaboration a research line of strategic interest and has recently approved a special allocation to support the participation of their researchers in T2K. Thus, a formal proposal of the University of Seville to officially join the T2K Collaboration will be submitted shortly.

No.