Available online at www.sciencedirect.com
ScienceDirect
Nuclear Physics B Proceedings Supplement 00 (2010) 1–1
Nuclear Physics B Proceedings Supplement

Neutrino oscillations physics with the Neutrino Factory

Andrea Donini[a], Patrick Huber[b], Silvia Pascoli[c], Walter Winter[d], Osamu Yasuda[e]

[a] *Instituto Física Teórica UAM/CSIC, Cantoblanco, E-28049 Madrid, Spain*
[b] *Department of Physics, Virginia Tech, Blacksburg, VA24061, USA*
[c] *IPPP, Department of Physics, Durham University, Durham DH1 3LE, United Kingdom*
[d] *Institut für theoretische Physik und Astrophysik, Universität Würzburg, D-97074 Würzburg, Germany*
[e] *Depart. of Physics, Tokyo Metropolitan University, Minami-Osawa, Hachioji, Tokyo 192-0397, Japan*

Abstract

We discuss recent results and current issues of the IDS-NF (International Design Study for the Neutrino Factory) physics and performance evaluation group (PPEG).

Keywords: Neutrino oscillations, Neutrino Factory

The optimization and performance study of the Neutrino Factory is often performed using the GLoBES ("General Long Baseline Experiment Simulator") software [1] . For example, the two-baseline optimization, including the potential presence of a new physics effect, has been reviewed in Ref. [2]. It has been demonstrated that the combination of $L_1 \simeq 4000\,\mathrm{km}$ and $L_2 \simeq 7500\,\mathrm{km}$ is optimal, and the optimization does not change even in the presence of this new physics.

A recently often discussed topic are the benefits of near detectors and the treatment of systematics. For example, in Ref. [3], the near detectors have been explicitely simulated with corresponding beam spectra. As one of the most interesting results, the two-baseline Neutrino Factory described above is relatively robust with respect to, *e.g.*, cross section uncertainties, even in the absence of near detectors, whereas a one-baseline Neutrino Factory has to rely on the cross section measurement in the near detectors. Another issue of current discussions is the impact and treatment of $\nu_e \to \nu_\tau \to \tau^- \to \mu^-$ [4] and $\bar{\nu}_\mu \to \bar{\nu}_\tau \to \tau^+ \to \mu^+$ [5] contaminations, which are unavoidable due to the branching ratio of 17% from τ into μ, and the inability of the detector to separate the τ interaction vertex.

A low energy version of the Neutrino Factory with $E_\mu \simeq 4 - 5\,\mathrm{GeV}$ has been considered. Very interesting, because of the low muon energies, the "platinum" $\nu_\mu \to \nu_e$ channel may be considered in such an experiment [6]. In a staged program, such a low energy version may be the first step to discover $\sin^2 2\theta_{13}$, if not found before [7].

Recent discussions of new physics searches at the Neutrino Factory include, *e.g.*, the search for sterile neutrinos [8], the potential discovery of non-unitarity in the neutrino sector coming from heavy fermion mediators [9], or the discrimination of scalars versus fermions as heavy mediators, leading to non-standard interactions and non-unitarity, respectively [10].

[1] P. Huber, M. Lindner and W. Winter, Comput. Phys. Commun. 167 (2005) 195, hep-ph/0407333 ; P. Huber et al., Comput. Phys. Commun. 177 (2007) 432, hep-ph/0701187.
[2] J. Kopp, T. Ota and W. Winter, Phys. Rev. D78 (2008) 053007, 0804.2261.
[3] J. Tang and W. Winter, Phys. Rev. D80 (2009) 053001, arXiv:0903.3039.
[4] A. Donini, J. Gomez Cadenas and D. Meloni, (2010), arXiv:1005.2275.
[5] D. Indumathi and N. Sinha, Phys.Rev. D80 (2009) 113012, arXiv:0910.2020.
[6] A. Bross et al., Phys. Rev. D81 (2010) 073010, 0911.3776.
[7] J. Tang and W. Winter, Phys. Rev. D81 (2010) 033005, 0911.5052.
[8] A. Donini et al., JHEP 08 (2009) 041, 0812.3703.
[9] S. Antusch et al., Phys.Rev. D80 (2009) 033002, arXiv:0903.3986.
[10] D. Meloni et al., JHEP 04 (2010) 041, 0912.2735.