IDS-NF: initial division of responsibilities within the Physics and Performance Evaluation Group

The IDS-NF Steering Group

1 Scope

The main priorities of the PPEG are the evaluation of the physics performance of the IDS-NF baseline setup, the comparison to its alternatives (such as beta beams), and the building of the physics case, a process that was started within the ISS.

2 Physics performance

The evaluation of the performance will include changes required by the detector and accelerator working groups. In addition, phenomenological questions will be raised and developed, such as:

- P1 What is the physics case for the ECC detector, both concerning standard and non-standard neutrino physics?
- P2 What kind of new physics could a Neutrino Factory be sensitive to?
- P3 How can the near detector(s) be useful for new physics searches?
- P4 Are there any interesting non-baseline setups for a Neutrino Factory?
- P5 What is the potential among golden, platinum, and silver channels in unveiling standard and non-standard neutrino physics?
- P6 Do we want a higher muon energy for searches of non-standard physics?
- P7 Can we use neutral currents as a physics signal and what would they be good for?
- P8 What are the observables measureable with best precision? Are these really the oscillation parameters or some combinatons thereof? Is that somehow relevant for phenomenology?
- P9 What performance indicators other than the θ_{13}, the mass hierarchy, and CP violation (δ) discovery reaches are relevant for future facilities? For example, deviations from θ_{23} maximal, the θ_{23} octant, etc.
- P10 How to quantify precision?

In principle, all these questions should be addressed to the phenomenology community, such as on the webpage and on a mailing list. Some of the questions are partially answered in the literature, such as for specific physics models, but the final physics case should be as inclusive as possible.

For P4, we anticipate that a version of the low energy Neutrino Factory should be evaluated as soon as a more specific design is available. As far as P10 is concerned, the precision in the θ_{13}-δ plane may be shown at different test points on a shorter timescale. A more dedicated analysis of the quantification and relevance of precision should be coordinated with EUROnu [1], and may be possible on the respective timescale.

From the experimental point of view, another set of questions should be addressed:

- E1 What is the potential of a near detector to cancel systematic errors? What is the impact of systematics at all?
- E2 What are the required characteristics of the near detector, such as technology, number of detectors, etc.?

E3 How robust is the baseline setup, such as with respect to muon decay splitting between neutrinos and antineutrinos, the value of Δm^2_{31}, luminosity, detector mass/muon decay splitting between shorter and longer baseline?

E4 Can the physics potential be optimized by different analysis cuts in the far detector? (possibly different versions of detection threshold versus backgrounds)

E5 What's the highest possible event rates in an ECC, such as to utilize $P_{\mu\to\tau}$?

For instance, for E1, the PPEG may provide information to the other working groups how well the flux normalization has to be known.

3 Comparison with alternatives

A comparison to alternatives (such as beta beams) or different experiment classes (such as superbeam upgrades) should be performed in collaboration with EUROnu, since there is a strong overlap of interests. The reference for the Neutrino Factory will be the current IDS-NF baseline setup.

4 Building the physics case and connection to theory

Building the physics case should be a priority on the timescale of the Interim Design Report (2010) [2]. For that, both the theory community should be included (such as by organizing a workshop), and specific theoretical questions should be posted, such as:

T1 Which models would predict θ_{13}, delta, the theta23 octant, and the deviation from maximal mixing with precision?
What is the precision we need to measure these parameters from a theoretical point of view? How does that depend on the model parameters?

T2 What is the connection between high energy and low energy CP-violation in see-saw models? How does that relate to the CP violation measurement at the Neutrino Factory?

T3 What models predict neutrino masses as well as new physics at the TeV scale which is testable at the LHC? What is the role of a Neutrino Factory in testing these models?

T4 Study of muon physics.

T5 How to search for new physics? Can we use unitarity bounds?

T6 Is there a connection between the quark and lepton sector? And if so, would we need to achieve the same precision in the measurements as in the quark sector?

T7 How can tri-bimaximal mixing be best studied at a Neutrino Factory?

T8 What would a value of $\theta_{13} = 0$ indicate? How small θ_{13} is good enough?

T9 How does a Neutrino Factory measurement relate to other experiment classes, such as charged lepton flavour violation, LHC, $0\nu2\beta$ decay, etc. For instance, can one obtain clues on the required sensitivities from that?

Since this activity is relevant for EUROnu as well, a collaboration should be sought.

References

1. http://hepwww.rl.ac.uk/euro-neutrino/
2. https://www.ids-nf.org/wiki/FrontPage/Documentation?action=AttachFile&do=get&target=IDS-NF-001.pdf