Systematics for T2K/Hyper-K (Review Talk)

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Hyper-Kamiokande is a proposed next generation underground water Cherenkov detector. Presented here is a review of sensitivities and dominant uncertainties associated with measurements of CP violation and non-maximal mixing in the 2-3 sector.

KEYWORDS: CP violation, non-maximal mixing, Hyper-Kamiokande

1. Introduction

Hyper-Kamiokande (Hyper-K) is a proposed one-megaton water-Cherenkov detector with potential to study the oscillation of accelerator neutrinos, atmospheric neutrinos, neutrinos of astrophysical origin, nucleon decay and more [1]. It is the next step in a Japan based neutrino program currently lead by Super-Kamiokande and Tokai to Kamioka (T2K) which provide world leading measurements of neutrino oscillation parameters and limits on nucleon decay. The accelerator based neutrino programme within Hyper-K aims to improve on the sensitivity achieved by the T2K experiment which uses Super-Kamikokande as a far detector. T2K has been phenomenally successful in measuring neutrino oscillation parameters, reporting the first indication of a non-zero θ_{13} and producing the current world leading measurement of the 2-3 sector oscillation parameters Δm^2_{32} and θ_{23} [2].

A large mixing angle (θ_{13}) in particular has opened the possibility of measuring charge-parity violation (CPV) in neutrino oscillation experiments such as T2K and Hyper-K. As the measurement of CPV is dependent on the asymmetry in the appearance of ν_e and $\bar{\nu}_e$ from ν_μ and $\bar{\nu}_\mu$ respectively, the vast improvement in appearance channel statistics available from an experiment such as Hyper-K are vital to the discovery.

Hyper-K aims to improve on the T2K experiment in its statistical power and with reduced susceptibility to systematic uncertainties. Hyper-K will have a baseline of 295 km (the first disappearance maximum for 0.6 GeV ν_μ) from the J-PARC accelerator facility, currently producing 30 GeV protons at a beam power of approximately 350 kW. Current estimates predict a beam power beyond 1 MW for the Hyper-K era. The upgraded beam power, coupled with the increase in fiducial volume from Super-K(~25x), result in a significant improvement in the statistics available for a CPV search.

Improvements such as stronger focusing horns, Gadolinium doping and water based near detectors are proposed and expected to reduce systematic uncertainties in oscillation analyses. Improvements to the focusing horns aid by limiting the amount of wrong sign background contamination, a problem especially during $\bar{\nu}$ running. Gadolinium doping can be used for a rough statistical separation of ν from $\bar{\nu}$ and CCQE[1] from CCnQE[2] events by tagging events with a delayed signal produced when neutrons from the neutrino interaction are captured by Gadolinium nuclei [3]. CCnQE and $\bar{\nu}$ interactions are more likely to result in neutron ejection from the interacting nucleus than CCQE and

[1] Charge current quasi-elastic
[2] Charge current non quasi-elastic