The Double Chooz Experiment

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The Importance of Θ_{13}

At the HEPAP meeting on July 13, 2007, the Neutrino Scientific Assessment Group (NUSAG) presented its report on the most recent charge, to make recommendations on possible future neutrino experiments fed by a megawatt proton beam. They recommend a program of R&D on both detector technologies and the beam so that decisions can be made as soon as the size of $\sin^2 2\theta_{13}$ is known.

From the July 27, 2007 letter from HEPAP transmitting the NuSAG report on the future of the US neutrino physics program

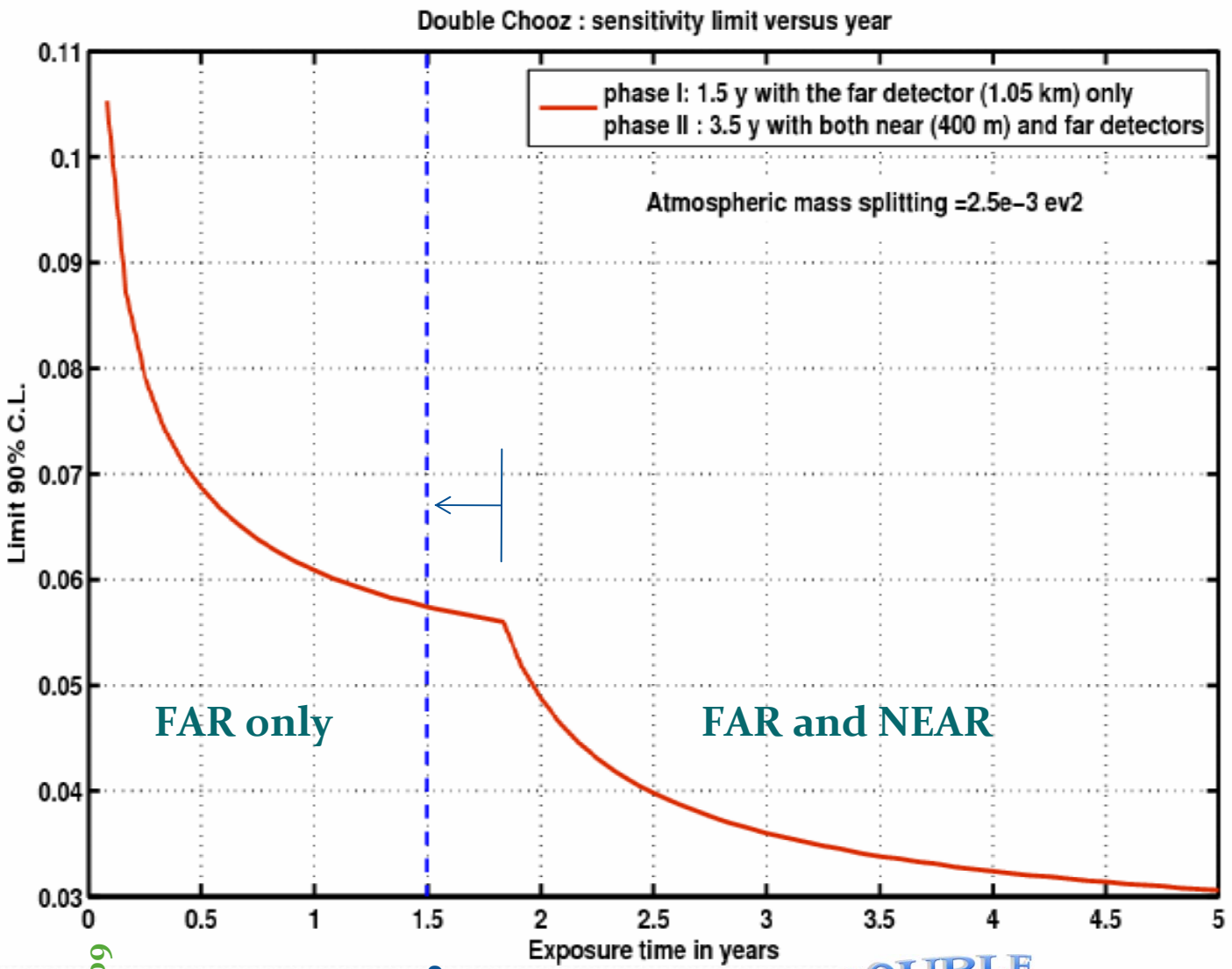
NOvA, T2K, Project X, DUSEL, Beta Beams, Neutrino Factory?

From the NuSAG report itself...

(a) **Large $\sin^2 2\theta_{13}$:** If $\sin^2 2\theta_{13}$ is near the present limit, say $\sin^2 2\theta_{13} \gtrsim 0.1$, it may be possible to establish CP violation with a detector of fiducial mass smaller than 100 kilotons at the off-axis NOνA site. Such an experiment may not resolve the neutrino mass hierarchy by itself. If such an experiment is operated at the same $\langle E_\nu \rangle / L$ as an upgraded T2K experiment so that the oscillation parameters are the same and the difference is dominated by the matter effect, improved sensitivity to the mass hierarchy can be achieved [13]. This speculation should be quantified in future studies.

(b) **Medium $\sin^2 2\theta_{13}$:** If $\sin^2 2\theta_{13} \gtrsim 0.03$, an experiment of the type discussed in this report should be built. It would have a large reach in the exploration of CP violation and—with a baseline greater than 1000 km—it could determine the neutrino mass spectrum ordering. Again, a cooperative program with T2K could extend the mass hierarchy sensitivity for an experiment with a baseline less than 1000 km, but this option needs further study. The scientific capabilities of experiments discussed by NuSAG are discussed in Section 3.5 of this report.

(c) **Small $\sin^2 2\theta_{13}$:** If $\sin^2 2\theta_{13} \lesssim 0.03$, the experiments that are considered in this report may not be able to resolve the neutrino mass hierarchy and establish CP violation with certainty. In this case, a new approach will be needed such as the beta beam source under study in Europe, or a neutrino factory. Should one of these technologies prove feasible, it would provide a neutrino source with a well understood spectrum and minimal irreducible background from beam neutrinos with the same flavor as the neutrinos of the appearance channel.


Double Chooz : sensitivity limit versus year
phase I: 1.5 y with the far detector (1.05 km) only
phase II : 3.5 y with both near (400 m) and far detectors
Atmospheric mass splitting =2.5e−3 ev2
Limit 90% C.L.
0.11
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Exposure time in years
FAR only
FAR and NEAR
June, 2009
Dec, 2010

Double Chooz

- At the March, 2006 HEPAP meeting the panel voted unanimously that Double Chooz should have high priority
- Since then, NSF has responded with almost $3M in support for three NSF groups
- DOE proposal for $4.8M was not approved.
- Japan, Spain, Brazil, U.K. joined. They were able to assume some of proposed US-DOE scope
- DOE proposal for $1.3M submitted for remaining items
- This small amount of money could have a significant impact for the whole U.S. program
- ***We ask for HEPAP to officially reiterate its support***