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SEARCH FOR NEUTRINO OSCILLATION AT BUGEY


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Résumé - Le flux des νe produits par le cœur d'un réacteur PWR de Bugey a été utilisé pour rechercher les oscillations neutrino à l'aide de la réaction νe + p → e⁺ + n. Les mesures ont été effectuées à 2 distances : 13.5 m et 18.5 m. Environ 50 000 événements neutrino ont été détectés à la première position et 25 000 événements à la seconde position. L'analyse des résultats est en cours d'achèvement.

Abstract - The high flux of low energy νe produced by the core of a PWR reactor of Bugey power plant has been used to search for evidence of neutrino oscillations through the inverse beta decay reaction νe + p → e⁺ + n. Measurements have been performed at two distances (13.5 and 18.5 m). About 50 000 νe events have been collected at the first position and 25 000 νe events at the second one. Data analysis is almost completed.

Introduction

The high flux of low energy νe produced by the core of a PWR reactor (2785 MWth) of Bugey power plant is used to search for evidence of neutrino oscillations through the inverse beta decay reaction νe + p → e⁺ + n. The previous experiment at ILL-Grenoble, [ref.1], has shown that oscillations if they exist in the eV range would happen only with a small mixing angle. To reduce both the statistical and systematical uncertainties, we have undertaken a two distance measurement taking advantage of the high νe flux available at the Bugey basement (2.10⁻¹³ νe/cm² sec at 13.5 m and 10¹³ νe/cm² sec at 18.5 m ; as compared to the 10¹² νe/cm² sec at ILL).

Experimental set-up

The detector, similar to the one previously used at the ILL reactor ref.1, consists of five planes of six target cells filled with liquid scintillator (321 liters of NE 235C), alternated with four ³He wire-chambers. The liquid scintillator serves as proton target, prompt positron detector and neutron moderator. The thermalized neutrons are detected by the neighbouring ³He-counters. A neutrino event is signed by the delayed coincidence between target cell and ³He chamber.

The detector is completely surrounded by 7 cm of low activity lead, 10 cm of veto counters filled with liquid scintillator, 25 cm of bored water and 10 cm of lead. For both positions, the same designs of shielding are used and the amount of material overhead is more than 25 cm of water equivalent, reducing the muon flux by more than a factor of 5. In addition, the remaining fast neutrons are rejected by the pulse shape discrimination technique. Background was measured for both positions during the annual shut-down of the reactor in March-April 1983 and no significant reactor associated accidental background was found. Stabilities of apparatus were controlled on line and have been frequently checked using gamma and neutron sources.
The detector efficiency mapping using calibrated Sb(Be) neutron source have been achieved in July 1983. About 50 000 neutrino-events have been detected at 13.5 m and 25 000 at 18.5 m.

The data analysis is almost completed. The final results on the oscillation of neutrinos from the present experiment could be soon presented.

The aim of our present experiment is to measured with high statistics the neutrino spectrum at two distances and thus to reduce drastically both the systematic (≤ 3 %) and statistical errors. Assuming a simple two state oscillation model, $(\nu_e + \nu_x)$, our experiment is most sensitive in the range of $\Delta m^2$ from few $eV^2$ down to $0.03$ $eV^2$ and a limit of mixing angle $\sin^2 2\theta \lesssim 0.07$ could be attained.