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JOURNAL DE PHYSIQUE
Colloque C3, supplément au n°3, Tome 45, mars 1984

SEARCH FOR NEUTRINO OSCILLATION AT BUGEY

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Résumé - Le flux des $\bar{\nu}e$ produits par le coeur d'un réacteur PWR de Bugey a été utilisé pour rechercher les oscillations neutrino à l'aide de la réaction $\bar{\nu}_e + p \to e^+ + n$. Les mesures ont été effectuées à 2 distances : 13,5 m et 18,5 m. Environ 50 000 évènements neutrino ont été détectés à la première position et 25 000 évènements à la seconde position. L'analyse des résultats est en cours d'achèvement.

Abstract - The high flux of low energy $\bar{\nu}_e$ 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 $\bar{\nu}_e + p \to e^+ + n$.
Measurements have been performed at two distances (13.5 and 18.5m). About 50 000 $\bar{\nu}_e$ events have been collected at the first position and 25 000 $\bar{\nu}_e$ events at the second one. Data analysis is almost completed.

Introduction

The high flux of low energy $\bar{\nu}_e$ produced by the core of a PWR reactor (2785 MW_{th}) of Bugey power plant is used to search for evidence of neutrino oscillations through the inverse beta decay reaction $\bar{\nu}_e + p \to e^+ + n$. 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 avantage of the high ν_e flux available at the Bugey basement (2.10^{-13} ν_e/cm^2 sec. at 13.5 m and 10^{13} ν_e/cm^2 sec at 18.5 m ; as compared to the 10^{12} $\bar{\nu}_e/cm^2$ 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 ^{3}He wire-chambers. The liquid scintillator serves as proton target, prompt positron detector and neutron moderator. The thermalized neutrons are detected by the neighbouring ^{3}He-counters. A neutrino event is signed by the delayed coincidence between target cell and ^{3}He 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 achived 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 systematical ($\lesssim$ 3 %) and statistical errors. Assuming a simple two state oscillation model, ($\nu_e \to \nu_x$), our experiment is most sensitive in the range of Δm^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.

Ref. 1 : Caltech, ILL-ISN Grenoble, Munich collaboration, H. Kwon et al - Phys. Rev. D. 24 (1981) 1097.