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Quest for Very Compact Antineutrino Detectors for Safeguarding Nuclear Reactors

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Monitoring the status of a reactor and its fissile content in a continuous mode using antineutrinos is one of challenging topics for safeguarding. Detectors deployed thus far require volumes of several cubic meters. In our search for a very compact antineutrino detector we have investigated an indirect method for antineutrino detection. In a first test of this hypothesis de Meijer et al. we found an upper limit of (Δλ/λ)=(-1±1)*10-4 at a flux change of 2.5*10ˆ10cm-2s-1 at the 2MW reactor at Delft, NL.
We continued our search for effects on β+-decay at the nuclear power plant Koeberg, South Africa. Here we report on two sets of measurements, one in 2011, another from December 2012 - February 2014. In the first experiment a LaBr3 detector was used. La has a natural radioactive isotope, decaying by either β- or EC, hence the effect of reactor-status change could be measured during background measurements: no effect was observed. With a 22Na source an effect in the count rate was observed between reactor-OFF and reactor-ON which was not considered to be reliable, since an amplifier broke down and had to be replaced during the ramp-up of the reactor.
In the recent measurement a 0.4L NaI detector coupled via a PMT to a PMT-base MCA was used. After overcoming a number of technical problems a stable condition has been reached. Again an effect has been observed in the count rate during two reactor changes. Provided that this effect is only due to antineutrinos affecting β+-decay, this result would correspond to a change in decay constant (Δλ/λ)= (-0.52±0.11)*10ˆ-4 at a flux change of 1.0*10ˆ13 cm-2s-1. We are in the process to investigate instrumental effects as alternative explanations.

Country or International Organization

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