The HLMA project: determination of high Δm^2 LMA mixing parameters and constraint on $|U_{e3}|$ with a new reactor neutrino experiment

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In the forthcoming months, the KamLAND experiment will probe the parameter space of the solar large mixing angle (LMA) MSW solution as the origin of the solar neutrino deficit with $\bar{\nu}_e$'s from distant nuclear reactors. If however the solution realized in nature is such that $\Delta m^2_{sol} \gtrsim 2 \cdot 10^{-4}$ eV^2 (thereafter named the HLMA region), KamLAND will only observe a rate suppression but no spectral distortion and hence it will not have the optimal sensitivity to measure the mixing parameters. In this case, we propose a new medium baseline reactor experiment located at Heilbronn (Germany) to pin down the precise value of the solar mixing parameters. In this paper, we present the Heilbronn detector site, we calculate the $\bar{\nu}_e$ interaction rate and the positron spectrum expected from the surrounding nuclear power plants. We also discuss the sensitivity of such an experiment to $|U_{e3}|$ in both normal and inverted neutrino mass hierarchy scenarios. We then outline the detector design, estimate background signals induced by natural radioactivity as well as by in-situ cosmic ray muon interaction, and discuss a strategy to detect the anti-neutrino signal 'free of background'.