angle (two flavor mixing) or an appropriate combination of neutrino mixing matrix elements.
The current generation of reactor experiments, performed at about 1 km baseline, have reached $\Delta m^2 < 10^{-3}$ eV^2 [9] and demonstrated that the atmospheric neutrino anomaly is not due to $\nu_\mu \leftrightarrow \nu_e$ oscillations.

In KamLAND this proven concept will be implemented at an unprecedented baseline. The 16 commercial nuclear power stations, generating about 30% of Japan's electrical power, deliver a $\overline{\nu}_e$-flux of $1.3 \cdot 10^6$ cm^{-2}s^{-1} (for $E_\nu > 1.8$ MeV) at the Kamioka mine. About 78% of this flux comes from 6 reactor stations forming a well defined baseline of 139-214 km. This "arrangement" of power stations around Kamioka makes KamLAND possible.

In KamLAND we will make use of the inverse beta decay reaction $\overline{\nu}_e + p \rightarrow e^+ + n$ which offers a relatively "high" cross section ($\sim 6 \cdot 10^{-43}$ cm^2/fission), low threshold (1.8 MeV) and a correlated event signature. The 1000-ton active liquid scintillation target of KamLAND offers a large number of protons and allows a convenient calorimetric measurement of the positron energy together with the possibility to detect the reaction neutrons by delayed capture on protons through $n + p \rightarrow d + \gamma(2.2MeV)$ ($\tau \approx 180\mu s$). The chosen reaction allows a measurement of the neutrino energy. At full reactor power and no neutrino oscillations we expect a reaction yield of about 3 per day.

Figure 1 shows expected positron spectra calculated for KamLAND. The mass-mixing parameters used fall into the LMAS. They would result in (a) distorted spectrum and (b) a suppressed event rate. The positron yield suppression can reach up to a factor 2 for oscillation parameters in the LMAS. A precise knowledge of the expected neutrino flux and spectrum is needed to compute an expectation value for the reaction rate. To do this we will monitor the power and fuel composition of all 51 Japanese power reactors on a daily basis. An agreement has been reached with all Japanese power producers which will give us access to this information.

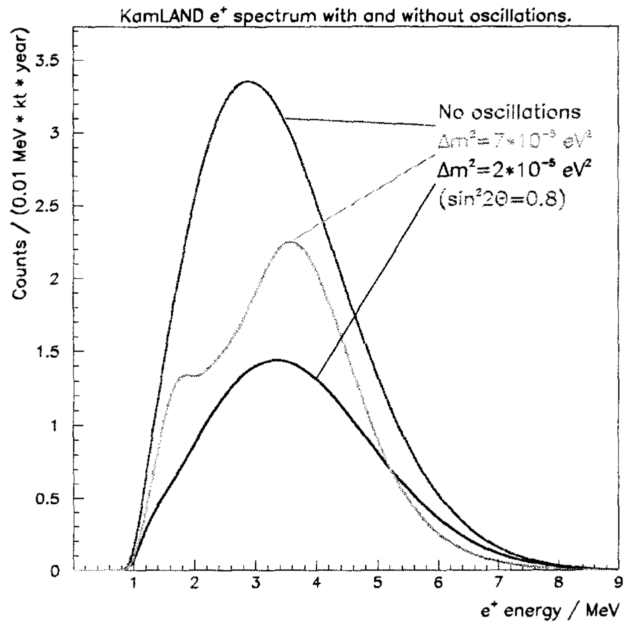

Figure 1. Calculated positron spectra for KamLAND. The two mass-mixing parameter combinations corresponding to the LMAS result in strong spectral deformation compared to the no-oscillation spectrum.

2. The Detector

Figure 2 sketches a cross-sectional view of the KamLAND detector. The active 1000-ton liquid scintillation target, contained in a thin plastic balloon, is suspended by a system of ropes in a mineral oil buffer. The scintillator is a mixture of 80% paraffin and 20% pseudocumene using 1.5 g/l PPO as fluor. The buffer oil is contained in a spherical vessel made from stainless steel. The hole assembly is viewed by 1280 17" and 652 20" PMTs, which are attached to the steel container. The PMTs are separated by 3 mm thick acrylic sheets from the rest of the mineral oil buffer to limit liquid convection and hence Radon transport. Scintillator formulation and PMT coverage have been chosen to allow positron-proton par-

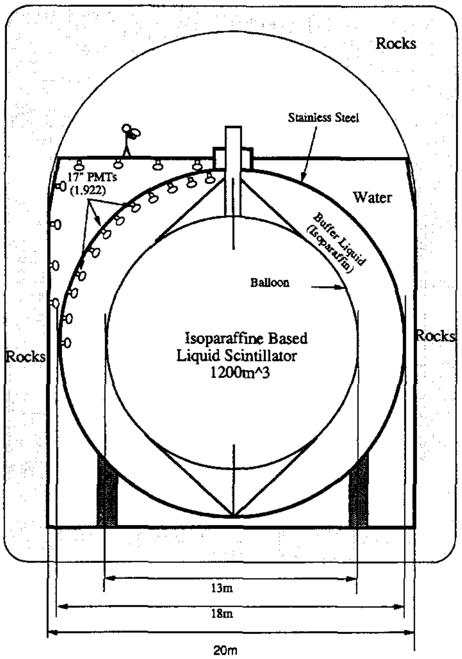

Figure 2. Schematic view of the KamLAND detector.

ticle identification by pulse shape analysis. The outside cylindrical volume is filled by water, acting as passive shield and water Cerenkov muon-veto detector.

The large detector size puts stringent requirements on the optical transparency of the scintillator. Due to the low energy of the neutrino signal the scintillator has to have a high light yield as well. Based on laboratory tests we are expecting a resolution of about 150 photoelectrons/MeV. The event vertex will be reconstructed using PMT timing information. As of the writing of this article the detector tank had been installed, fully instrumented with PMTs and installation of the acrylic sheets had been concluded. Test containment balloons of various size (including a full size one) have been successfully deployed. A scintillator purification plant is in an advanced stage of construction.

The data taking electronics will consist of buffered waveform digitizers for each PMT channel which will allow for dead-timeless data taking to up to a kHz rate. Correlated events will be reconstructed off-line. The event trigger will be provided by a field programmable gate array. This adds flexibility as the trigger can be reconfigured according to the needs.

3. Expected Background

The expected event yield of 2-3 neutrino interactions per day and kton of detector, combined with the low energy of the events (1-8 MeV), which are within the range of natural and artificial radioactivity, requires vigorous background control. However, the correlated signature of the chosen neutrino detection reaction, resulting in a delayed coincidence within several hundred μs, makes this a manageable problem. We distinguish two classes of background: (a) random coincidences and (b) correlated background. To estimate these backgrounds we performed a detailed Monte Carlo study.

Random coincidence background is mainly caused by radioactivity. It is minimized by selecting all construction materials for their content of radioactivity by means of low background gamma spectroscopy, neutron activation analysis and mass spectroscopy. Major background components are due to the PMT glass, the balloon holding ropes and the liquid scintillator. While the former ones can be countered by a more or less restrictive fiducial volume cut off-line we estimate that the liquid scintillator should not contain more than 10^{-14} g/g of U/Th and 10^{-10} g/g K. KamLAND's large size allows a 1 m fiducial volume cut from the containment balloon, still leaving 600 tons of active detector.

Radioactive Rn gas, constantly released from all surfaces, is well soluble in organic solvents. Convection of the liquid can hence transport it near the detector. To limit its contribution to the background the buffer is divided into two sections by thin acrylic sheets. They separate the PMTs from the fiducial volume. The scintillator containment balloon has been engineered from a novel composite film which has a low Rn perme-