

The 21 Century COE Project  
Exploring New Science by Bridging Particle-Matter Hierarchy

**Short-term Foreign Researchers**

**Research Report**

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Host Researcher in Tohoku University: Atsuto Suzuki

Your Stay Period in Japan: From November 11/2003 to January 9/2004

Title of Research in Japan: KamLAND calibration

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Please write a research report of one or more pages and submit it with this cover to your host researcher till the end of this March.

My work stay was devoted to deep exploring of KamLAND antineutrino detector response and development of new calibration procedures and methods. Such a research was especially necessarily before high voltage system for detector's PMTs was upgraded. Any significant changes in hardware of the detector lead to changes in the detector response, understanding of which is subject for detector recalibration. Additionally, in order to control drift in response of the KamLAND detector with time we need to perform regular calibration monitoring.

The significant part of detector calibration can be performed only by inserting various radioactive and light sources into detector. To complete detector understanding before it was upgraded we performed follows calibrations: visible wave length laser calibration deployment: November 21/2003; uv wavelength laser calibration deployments: November 26, December 17/2003; calibrations and monitoring with  $^{60}\text{Co}$  radioactive source: November 14, 23, December 3, 12, 24, 29/2003, January 7/2004; calibration with  $^{68}\text{Ge}$  radioactive source: December 24/2003.

Since KamLAND is a ultra low background detector any calibration of it require significant efforts to protect detector from any contamination in time of calibration deployments, another requirement is to keep detector performance unchanged as in time of calibration as well after calibration is finished. To achieve that goal all calibration we performed were carefully prepared with especial attention to cleaning procedures and protection of detector from radon contamination.

Another interesting investigation performed in time of the my work stay was dedicated to study temperature distribution inside of the KamLAND liquid scintillator. That study was important for better understanding of systematic on number of target inside of sensitive volume of the detector and was critically important to understand thermodynamic processes in our detector (directions of heating and cooling). For that study we certified (surface contamination, compatibility with scintillator) a thermo-probe, which then have been deployed on different depths into detector, so temperature gradients were well understood.