Time Link Calibration Using Two Mobile TWSTFT Stations for T2K Experiment

M. Fujieda[1], T. Gotoh[1], R. Ichikawa[1], R. Tabuchi[1], M. Aida[1], H.G. Berns[2,4], C. Bronner[3], K. Connolly[4], P. Destefano[4], N. Dreyer[4], M. Dziewiecki[5], C. Greenley[6], R. Kurjata[5], Y. Hayato[7], T. Kutter[6], T. Maruyama[8], C. Metelko[9], O. Perevozchikov[6], E. Reinherz-Aronis[10], K. Sakashita[8], K. Suzuki[3], W. Toki[10], A. Weber[9], J. Wilkes[4], M. Ziembicki[5]

[1]National Institute of Information and Communications Technology, Koganei, Tokyo, Japan
[2] Crocker Nuclear Laboratory, University of California Davis, Davis, USA
[3]Department of Physics, Kyoto University, Kyoto, Japan
[4]Department of Physics, University of Washington, Seattle, USA
[5]Institute of Radioelectronics, Warsaw University of Technology, Warsaw, Poland
[6]Department of Physics and Astronomy, Louisiana State University, Louisiana, USA
[7]ICRR, University of Tokyo, Kamioka, Japan
[8]IPNS, KEK, Tsukuba, Japan
[9]Department of Physics, University of Liverpool, Liverpool, United Kingdom
[10]Department of Physics, Colorado State University, Colorado, USA

Email: miho@nict.go.jp

T2K[1] (Tokai to Kamioka) is a long-baseline neutrino experiment in Japan, and is studying neutrino oscillations. T2K experiment sends an intense beam of muon neutrinos emitted from J-PARC[2] in Tokai to Kamioka at a distance of 295 km. T2K experiment uses GPS system to synchronize the timing between Tokai and Kamioka, hence an understanding of the synchronization system is essential. To improve the time resolution, dual-frequency GPS receivers were installed and time transfer experiment started last year.

Fig. 1: Experimental setup.

The National Institute of Information and Communications Technology (NICT) performed the time link calibration using two mobile two-way satellite time and frequency transfer (TWSTFT) stations. The two stations with 1.2-m dishes were installed at Tokai and Kamioka after the internal delay difference between them was measured at NICT by a common-clock measurement. The time transfer between Tokai and Kamioka had been performed for three days. The closure-delay variation was evaluated after the trip. We estimated the internal delay difference between the two GPS receivers with a total uncertainty of 1 ns and confirmed that the time transfer results achieved by TWSTFT and GPS agreed well. The calibration procedure and uncertainty budget will be presented in this paper.

[1] T2K Nucl.Instrum.Meth. A659 (2011) 106-135.

[2] J-PARC. http://j-parc.jp/