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Ground station for Lunar Laser Raging : condition and upgrade using present SLR station

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The paper presents a study of the ground station for the LLR (Lunar Laser Ranging) experiment in Selene2. The science goal of the LLR is to get better understanding of inner structure of the Moon and other principal physics through lunar orbit, lunar solid tides, and lunar rotation.

The current SLR (Satellite Laser Ranging) network on the Earth has about 30 operational stations and they track regularly about 30 earth orbiting satellite in which the most distant target is up to geosynchronous satellite(GEO) or about 40,000 km. A few stations can track retro-reflector arrays on the Moon which has distance of 380,000 km from the Earth. The signal strength from moon is as -40 dB weak as one from GEO because of space loss if all other conditions including the target cross section are same.

We plan to range the Moon from a Japanese ground station in two major steps. The first step is to acquire returned photons from the lunar retro-reflectors by upgrade of the existing SLR station to assess technology used and figure out necessary requirement for each subsystem and software. In the second step, full-scale development and installation in an ideal location will be planned. As the first demonstration site, the SLR station in Koganei is selected which has 1.5 m diameter telescope but does not have good atmospheric seeing.

The pointing stability of the telescope and the atmospheric seeing are the most important factors for LLR. We will monitor the seeing during ranging, and the adaptive optics approach will be taken for basic development by using tip-tilt mirrors, wavefront sensors and control software.

A tracking laser for long-distance target is to be introduced in a transmitting pass, which has 532nm wavelength, nominal repetition rate of 2 kHz, energy per pulse of 5 mJ and pulse width of about 20 nanoseconds. The kHz ranging engine (KRE), composed of a range gate generator and epoch timer (A033-ET) with newly developed control software, is capable of 2 kHz operation to control the tracking laser and data I/O. It can also control the present 20 Hz picoseconds laser by triggering using 1/100 divider. The requirements of LLR stations are investigated in terms of technology and site condition, and the upgrade of the present SLR station will be discussed.

Keywords: LLR, SLR