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(A4 format)

HIGH PURITY GE GAMMA-RAY SPECTROMETER ON JAPANESE LUNAR POLAR ORBITER SELENE.

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The SELENE project, the first mission of Japan to the moon, is in progress. The mission is to be launched in 2006. SELENE is a lunar polar orbiter at its altitude 100km, and in operation for one year. If possible it will be extended by more one year at a lower altitude.

This note serves to describe a gamma-ray spectrometer (GRS) onboard SELENE. Its structure is shown in Fig.1 and its appearance including a radiator is shown in Fig.2. This is aimed to remote sensing elemental materials over the entire lunar surface and to make global mapping. In particular, we are interested in the major elements, such as Mg, Al, Si, Fe and so on, and natural radioactive elements like K,Th and U etc. By the measurements, we study the origin, evolution and structure of the moon. Also it is interested in a signature of hydrogen, because it would prove evidence of existing water on the surface.

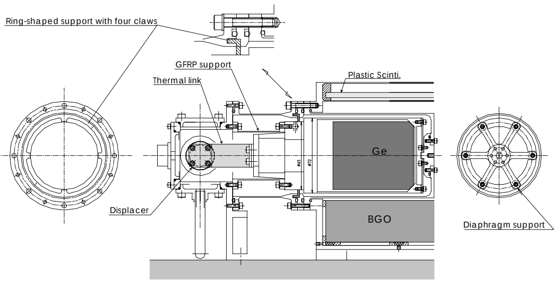

Fig. 1. Structure of the gamma-ray spectrometer (GRS).

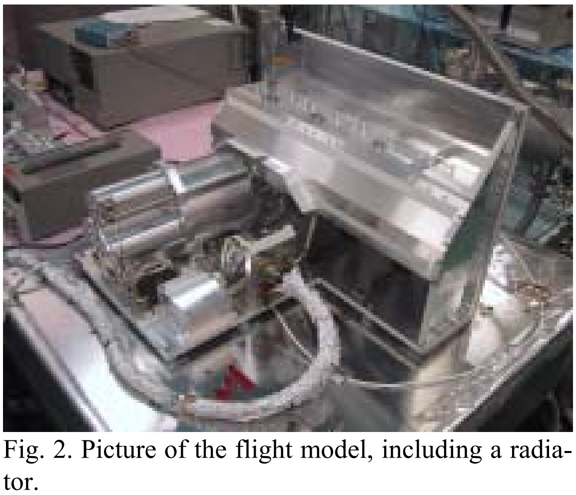

Fig. 2. Picture of the flight model, including a radiator.

GRS consists of three parts; gamma-ray detector (GRD), compressor driver unit (CDU) and gamma-ray and particle electronics (GPE). Since GRD plays a major role of GRS, this note is exclusively concerned with GRD.

GRD is expected to identify elements uniquely and to be operated more than one year. For this purpose, a highly purified Ge detector is employed as a main detector, by which gamma-rays can be detected in the energy range from 0.1 to 12 MeV with a considerably high detection sensitivity. Its active volume is 252cc (manufactured by Eurisys Measures). The Ge crystal is encapsulated with an aluminum container, canister..

The Ge detector should be kept below 90K, in order to avoid possible damages from radiation. It is retained at ~80K, by means of a mechanical cryostat.

The main part of the cryostat is a Stirling cryocooler, which is composed of compressor and cold head. The cryocooler is driven with 17V at 52Hz. Then its cooling capacity is 2W at 80K with an input power of 53W.

The cryocooler has two characteristic features: One is a dual-opposed-pistons compressor, with which effects of mechanical vibration is considerably suppressed. Accordingly, the energy resolution of GRD is expected to be better than 3keV at 1MeV. The other is a long-term operation. Up to now, it has been achieved a normal operation beyond 33,000hrs in a laboratory life-time test.

The Ge detector is surrounded by a BGO crystal and a plastic scintillator. The former is of a horseshoe shaped. The asymmetric shape makes it efficient to veto gamma-rays from the SELENE vehicle and leakage photons from the Ge detector, as well as to avoid charged particles. The latter faces the lunar surface opposed to the vehicle and to veto charged particles.

Performance of the Ge detector is carried out by using the flight model.

GRD is well examined against vibrations at launch, which was simulated by applying an AT level.

As for the cryocooling performance, since the canister has a heat load of 1.8W in total, the cooling capacity is sufficient to keep the whole system at ~80K, when the ambient is at room temperature.

Indeed, it takes less than 24hrs to arrived at ~80K from room temperature.

The energy resolution was examined by cooling the detector at ~80K. As one of results, two gamma peaks from a ^{60}Co source are shown in Fig.3. The energy resolution was achieved to be 3keV fwhm at 1.33MeV.

From this result, it is anticipated to identify 2.223MeV photons from the capture reaction, n+p→d+γ, by discriminating 2.210MeV photons from Al and 2.235MeV photons from Si, which are abundantly populated on the lunar surface.

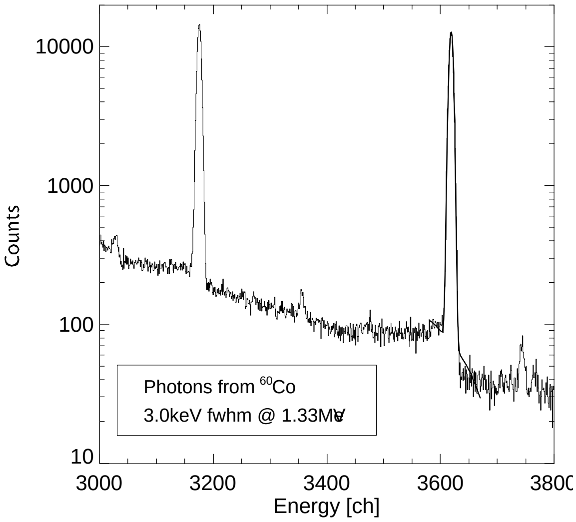

Fig. 3. Observed photon peaks of 1.17 and 1.33 MeV photons from a ^{60}Co source.