Development of Mercury Dust Detector Using a PZT Sensor onboard BepiColombo MMO Mission

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A Mercury Dust Detector (MDM) is installed on a peripheral plate of the BepiColombo MMO space craft. The detector MDM is characterized by an array of piezoelectric lead-zirconate-titanate (PZT) elements. It can determine the momentum, the incoming direction and the velocity at impact of the cosmic dust around Mercury. The scientific interest is to reveal the origin variations of interplanetary meteoroid complex near-Mercury.

Four PZT elements, each area is 5 cm x 5 cm and 1mm in thickness, are assembled to achieve the total sensitive area of 100 cm^2. The response at impact is measured by a flash A/D converter of its sampling rate ~40Ms/s. This configuration is possible to distinguish real events from junk events. As shown in figurer 1, the speed at impact can be determined by measuring the rise time of a solitary-shaped signal. The total weight of MDM is less than 0.6kg; PZT detector is about 0.2 kg, and circuits include box and connectors about 0.4 kg. Nominal power is less than 3W. The detector MDM is considered to be heat-resistant up to ~300 ℃ and against radiation.

Calibration experiments of MDM are to be made using the Van de Graaff micro-particle accelerator of Univ. Tokyo, HIT (Ag, C particles, max speed ~ 10 km/s), and that of the Max-Plank-Institute for Nuclear Research at Heidelberg, MPI-K (Fe, Ag, C particles, max speed ~ 70 km/s).

Keywords: cosmic dust; interplanetary meteoroid; dust detector; Mercury; Bepi Colombo; PZT
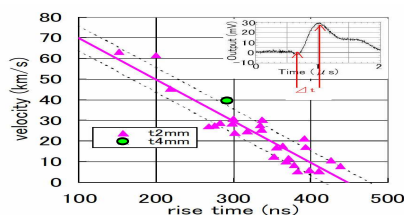

Figure 1: Rise time vs. velocity of the PZT signals using Van de Graaff micro-particle accelerator in MPI. The rise time is defined as in the inset.