# PPMSat: Precise Positioning Mission with a micro-Satellite

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We proposed a small LEO (Low Earth Orbit) satellite mission with a high precision accelerometer (ACC) and an integrated GPS receiver system. The mission is expected fruitful scientific outcomes; not only GPS occultation and H-L SST (High-Low Satellite to Satellite Tracking) observations but also neutral air drags observations in the ionosphere and thermosphere. The science targets of the mission are (1) low degree gravity fields recovery by means of H-L SST, (2) sounding of the atmosphere and the Ionosphere by means of GPS occultation measurements, (3) observation of neutral atmosphere in the ionosphere and thermosphere by means of an ACC and GPS tracking, and (4) experiments of GPS reflection measurements for sea surface heights and sea surface wind speeds.

To achieve these scientific goals, on board ACC and GPS receiver system are key technologies. As for the ACC, we are developing a new type of accelerometer based on a laser interferometer as a position sensor. Laser interferometers have several advantages such as high resolution, low-drift performance, and in-situ calibration referred to the wavelength of light. The designed ACC has following advantages; (1) 1-2 orders higher sensitivity compared with the electrostatic sensors, (2) onboard calibration based on the laser wave length, (3) low interaction between the test mass and detecting device due to optical detection system, (4) low thermal and electric noise due to no electric device on the test mass, and (5) low cost and short developing period by employing consumer parts.

Onboard GPS receiving system should provide GPS occultation measurements data, GPS reflected signals and POD data. The occultation measurements require high sampling frequency of more than 50 Hz, very high sensitivities and the capability of the signal detection (sensitivity) to negative elevation angles. The occultation antennas should be attached at front, rear and/or sides of the satellite body to gain the occultation signals, while the POD antenna is necessary attached on the top and the reflection antenna at the bottom. The receiver should receive the signals from multi-GPS satellites at the different sampling frequencies at the same time. Although the development of the required GPS receiver itself is not an easy task to complete, we can improve the firmware based on an appropriate consumer model and develop small antennas suited for the occultation and reflection measurements.

One of the important requirements to the satellite bus is earth oriented attitude control. This is indispensable for the occultation and reflection measurements. In addition, a polar orbit may be preferable for a good coverage of the Earth. The required electric power is the primarily factor to define the number of solar cells and the size of satellite consequently. We estimate the total weight is about several tens kilograms.

The cost of this kind of small satellite is much smaller than the ordinary earth observation satellites. Moreover, if a compact integrated package of the ACC and the GPS receiver will be developed in future, it can be easily mounted on any LEO satellites. A large number of such LEO satellites will be expected to enable the low cost Earth's environments monitoring with high temporal and spatial resolutions.