

ASTRODYNAMICS SYMPOSIUM (C1)  
Attitude Dynamics (1) (1)

Author: Mr. Nikolas Korn  
Technische Universität Berlin, Germany

Mr. Frank Baumann  
Technische Universität Berlin, Germany

Mr. Ronny Wolf  
Technische Universität Berlin, Germany

Prof. Klaus Briß  
Technische Universität Berlin, Germany

## MULTIFUNCTIONAL OPTICAL ATTITUDE DETERMINATION SENSOR FOR PICOSATELLITES

**Abstract**

With progressive miniaturization, high-resolution Earth observation CubeSats are becoming more and more important. As a result, the requirements for attitude determination sensors are increasing constantly. While magnetometers and Sun sensors are reaching their accuracy limits, more precise sensors, like star trackers, are either too big, too heavy or their power demand is exceeding the capabilities of a CubeSat. In a novel approach a cost-effective, highly integrated attitude determination sensor was developed. Using state of the art MEMS gyroscopes, magnetometers and a CMOS imager, it was possible to install this sensor in a fully redundant 0.25-unit CubeSat. By combining sensor fusion and in-orbit calibration, the robustness was increased and the pre-flight calibration effort reduced.

The first sensors will be integrated into the TU Berlin's BEESAT family on BEESAT-5 to -8. The satellites will be launched at the end of 2017, beginning of 2018. On each of the four 0.25-unit CubeSats two optical sensors will be conversely aligned, enabling either attitude determination or visual Earth observation. In attitude determination mode the system can operate either in low power mode using only calibrated gyroscope and magnetometer data or in full power mode using the image sensor as well. In the latter case, the optical sensor can act as an Earth horizon sensor or as a star tracker. Running in Earth observation mode the system provides wide field 1080p full HD imagery.

The multifunctional attitude determination sensor could significantly reduce the size and power demand. For future missions a sensor in every axis is now feasible in a single-unit CubeSat. Such an array could further increase the attitude determination accuracy and robustness. The presentation gives an insight into the sensors design and its parameters.