Infrared Remote Sensing and Demonstration of Small Satellite Technologies by the BIROS Satellite in the DLR FireBIRD Mission

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Abstract

Forest- and vegetation fires have become more and more out of control worldwide resulting in a devastating impact on the world's environment. Beside the detection of the fire hotspot itself it is important to evaluate different parameters to support the work of the firefighters (e.g. mean fire temperature, length-of-fire front, cluster size and fire location). On the other hand fires around the world have a major impact on the atmosphere and influence the climate. This influence can be calculated by the *fire-radiative -power* (FRP) which measures the radiant energy released per time unit by the fires.

The German Aerospace Center (DLR) is making a major contribution to fire detection with the FireBIRD constellation. This constellation consists of the two satellites TET-1 (Technology Experiment Carrier) built by industry, launched in 2012 and BIROS (Bi-spectral Infrared Optical System) built by DLR in Berlin and launched in 2016. A new compact bi-spectral infrared system was developed for both satellites capable to detect and evaluate smaller fires and hot spots compared to other infrared remote-sensing systems (e.g. *Modis* sensor, *Sentinel-3*). The BIROS satellite is also carrying different new technological experiments for the in-orbit demonstration of features for the next generation of remote sensing satellites.

The BIROS primary mission objectives are:

- Test of a two-satellite-constellation together with TET for infrared remote sensing of high-temperature events (HTE) on Earth surface
- Active fire detection and monitoring and analysis of results

The secondary mission objectives consist of:

- Development and test of new high-torque-wheels (HTW) for high agility
- Development and test of a small cold-gas propulsion system for station keeping and proximity operations
- Formation flying with BEESAT-4 satellite from TU-Berlin (separation from BIROS) with InterSatellite-Link
- Experiments of space debris analysis in using laser reflectors
- Real-time information generation (on-board) and extraction of fire attributes with distribution to the user via an *Orbcomm* modem

The main payload is a multi-sensor system designed to fulfill the scientific requirements under the conditions of a micro satellite. The sensor system consists of the following main components: an infrared sensor system based on cooled CdHgTe detectors in the medium infrared (3.4-4.2µm), a thermal infrared channel (8.5-9.3µm) and 3-line CCD-pushbroom camera with green-, red- and near/infrared -channel. The BIROS satellite bus was funded as a DLR external-project by the German Ministry of Education and Research (No. 01LK0904A). All other mission segments are covered by DLR.

The scientific mission results will be demonstrated by different examples of fire products and applications taken around the world. The in-orbit results for the technological experiments will show on one hand the potential for new space components as "smart devices". On the other hand these new technologies and methods on board BIROS will initiate new applications and research topics for the next generation of small satellites: for e.g. remote sensing, on-board autonomy, formation-flying or space-robotics.