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The BIRD MISSION is completed for Launch with the PSLV-C3 in 2001

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Abstract: DLR has a longstanding experience in the Earth observation. BIRD is the first complete satellite with payload which has been developed and built by DLR. The main BIRD payload is a bispectral IR pushbroom sensor dedicated to recognise and analyse high temperature events (HTE) such as forest fires, coal seam fires and volcanic activities on Earth surface.

The design-to-cost mission BIRD is to demonstrate new and compact infrared imaging sensor technologies as well as small satellite technologies for a micro-satellite with a total mass less than 100 kg. The BIRD satellite and payload have been completed. BIRD is scheduled for a piggy back launch together with an Indian remote sensing satellite in the middle of 2001.

Zusammenfassung: *Die Bird-Mission ist vorbereitet für den Start mit PSLV-C3 2001.* BIRD ist der erste komplett im DLR entwickelte und gebaute Satellit mit Nutzlast. Die Hauptnutzlast von BIRD ist ein Zweikanal-Infrarot-Pushbroom-Sensor, der für die Erkennung und Analysierung von Hochtemperaturereignissen, wie zum Beispiel Waldbrände, Kohleflözbrände und vulkanische Aktivitäten auf dem Festland, bestimmt ist.

BIRD soll sowohl neue und kompakte Infrarot-Bildsensor-Technologien demonstrieren als auch Kleinsatellitentechnologien für Mikrosatelliten mit einem Totalgewicht unter 100 kg. Der Satellit BIRD und die Nutzlast sind fertiggestellt. Im Oktober 2001 ist BIRD für einen „Huckepack"-Mitstart mit einem indischen Fernerkundungssatelliten vorgesehen.

Introduction

Fire has a deep and increasing impact on the life on our planet. Current spaceborne sensor systems can be used to generate products of fire susceptibility evaluating time-series of vegetation state data, occurrence and coarse location of active fires, as well as smoke and burnt areas (fire scars). However, existing and planned operational space-borne sensors show serious limitations (e. g. partly channel saturation leading to reduced high temperature event discrimination, spatial resolution worse than 1 km) if accurate geophysical parameters have to be obtained. The Bi-spectral Infra-Red Detection (BIRD) small satellite mission is a technology demonstrator of new infrared pushbroom sensors dedicated to the recognition and quantitative characterisation of HTE on the surface of the Earth and for small satellite technologies. The starting point of the BIRD development was the successful completion of the feasibility study "Fire Recognition System for Small Satellites" by OHB-System and DLR in 1995.

Mission Objectives

The BIRD mission has to answer scientific and technological questions. The primary mission objectives are:

- test of a new generation of infrared array sensors adapted to Earth remote sensing with an adaptive radiometric dynamic range,
- detection and scientific investigation of High Temperature Events (HTE) such as forest fires, volcanic activities, and coal seam fires,

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Tab. 1: Spacecraft bus components.

Subsystem	**Components**
Attitude Control and Navigation System	2 star sensors (accur.: 10 arcsec) 3 axis gyroscope system (resol.: 2.7 arcsec) 1 3-axis magnetometer 1 GPS receiver 4 pair Sun sensors 4 reaction wheels (max. >0.3 Nms) 3 magnetic torquers (max. 3 Am2) ACS computer like board computer on-board navigation system
Board Computer (OBDH)	Power PC core, 8MB SDRAM, 2 MB Flash, Real Time Operation System
Telemetry & Telecommand System	low gain and high gain (2dBic max.) S-band antennas, S-band receiver S-band transmitter (BPSK, max. 5 W RF power), PCM encoder
Structure & Mechanisms	ground plate, electronics plate, payload platform, frames, connection elements, deploy mechanism, eject mechanism
Power System & Harness	power generation: 3 solar arrays with Si high-□-cells; power storage: 8 NiH2 cells, 12 Ahrs; charge regulation: direct energy transfer; power distribution: unregulated 20 V bus
Thermal Control System	MLI, spacecraft radiator, IR sensor system radiator, heat pipes, heaters, temperature sensors

- test of small satellite technologies, such as an attitude control system using new star sensors and new actuators, an on-board navigation system basing on a new orbit predictor and others.

Furthermore, BIRD has a number of secondary mission objectives:

- scientific issues related to the diagnostics of vegetation conditions and change and the discrimination of smoke and water vapor clouds by combination of stereo and IR data,
- testing of an on-board neural network classificator experiment.

Spacecraft BUS

The BIRD space segment is a 3-axis stabilized micro satellite without a propulsion system. The satellite consists of a box-shaped main body. The complete main body is covered by MLI with cuttings for the instruments and radiators. Deployable solar arrays and the eject mechanism are mounted on the body. Fig. 1 gives a general view to the BIRD spacecraft and the main components. The payload is mounted on a special platform and takes 1/3 of the body volume and the total mass of the spacecraft. The special designed platform is close connected with the satellite bus to keep the line of sights of the instruments under all circumstances very stable. Due to this design conception the spacecraft bus and the payload platform are easy separable. This allows to modify the BIRD spacecraft easily for other missions with quite different payloads. Tab. 1 gives an overview of the subsystems of the BIRD spacecraft bus. Special characteristics of the BIRD spacecraft bus are:

- 3-axis stabilized micro satellite bus of the 100 kg-class
- spacecraft bus designed for operations in a circular or elliptical low Earth orbit (LEO) and at any inclination
- bus is prepared and qualified for a PSLV-launch into a low Earth orbit, but is easy adaptable for a lot of launchers into LEO
- supplies up to 200 W peak power for the payload up to about 20 min in one orbit
- high pointing accuracy (7 arcmin)

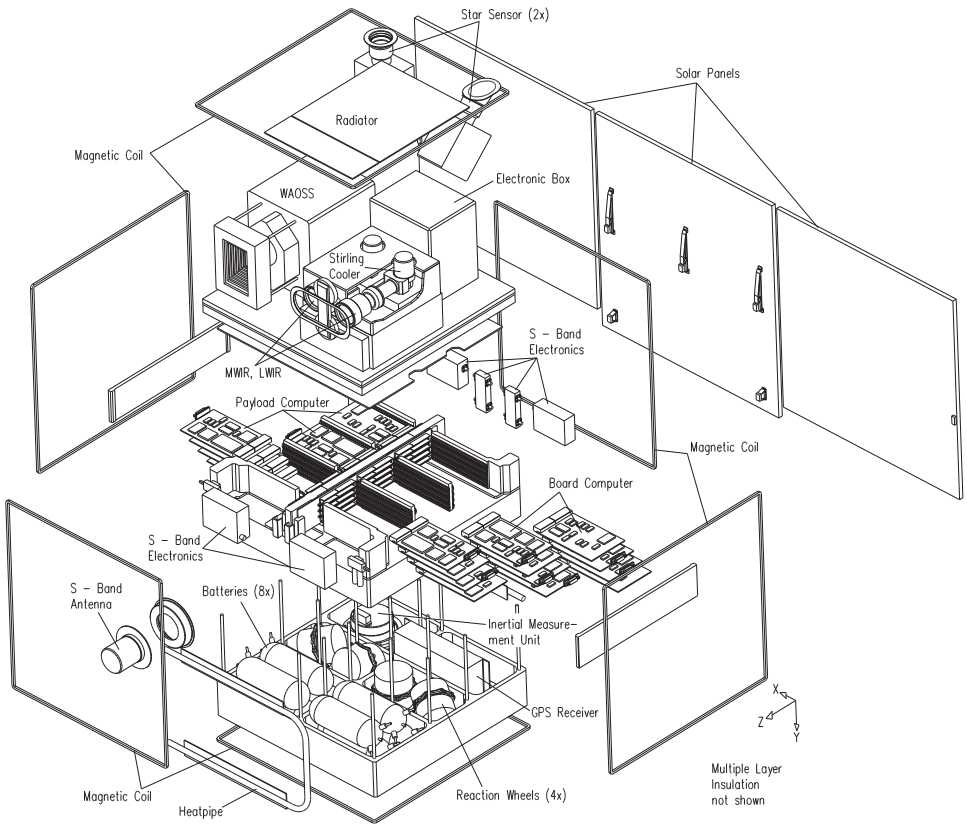

Fig. 1: Explosive view of the BIRD spacecraft.

- on-board navigation system with a high position accuracy (< 100 m)
- down link data rate: 2 Mbps (S-Band)
- design life time: 1 year

Payload

The payload of BIRD consists of:

- the Infrared Sensor system dedicated for hot spot recognition and investigation,
- the Wide-Angle Opto-electronic Stereo Scanner WAOSS-B for vegetation analysis and fire "false alarm" rejection,
- a payload data handling system to control the instruments and the data storage of a 10-minute's data take,
- an on-board classificator experiment, basing on a neural network chip.

Tab. 2 gives an overview on the characteristics of the BIRD instruments. Because of the high peak power consumption of the BIRD payload it is not possible to assure a continuous observation of Earth, but a data take with a duration of 10 min only in one orbit. The data volume can be dumped down simultaneously or stored in a mass memory (2×1 Gbit). BIRD is an experimental satellite to test new technologies and scientific evaluation methods so there is no need in continuous payload operations.

Cooperation

The BIRD small satellite Earth observation mission is a research and development project of the German Aerospace Center (DLR) executed by the DLR Institute of Space Sensor Technology and Planetary Exploration, the German Space Operation Center and the German Remote Sensing Data Center.

Tab. 2: Characteristics of the BIRD instrumentation at an average orbit altitude of 572 km.

	WAOSS-B	MWIR	TIR
Wavelength	600–670 nm 840–900 nm	3.4–4.2 µm	8.5–9.3 µm
Focal length	21.65 mm	46.39 mm	46.39 mm
Field of view	50°	19°	19°
f-number	2.8	2.0	2.0
Detector	CCD lines	CdHgTe Arrays	CdHgTe Arrays
Detector cooling	passiv, 20°C	Stirling, 80 K	Stirling, 80 K
Pixel size	7 µm × 7 µm	30 µm × 30 µm	30 µm × 30 µm
Pixel number	2880	2 × 512 staggered	2 × 512 staggered
Quantization	11 bit	14 bit	14 bit
Ground pixel size[1]	185 m	372 m	372 m
Swath width[1]	533 km	190 km	190 km

WAOSS-B Wide Angle Opto-electronic Stereo Scanner
MWIR Medium Wave Infrared Sensor
TIR Thermal Infrared Sensor

Other non-DLR project participants are the German Gesellschaft für Mathematik und Datenverarbeitung (GMD), Astrium Jena-Optronik GmbH, Astro- und Feinwerktechnik GmbH, Global Fire Monitoring Center at University Freiburg, and Technical University Berlin. BIRD is furthermore supported by scientific Co-Investigators from France, Spain, Turkey, Finland, Greece, Portugal, Italy, Russia, Brasil, USA, Canada and Germany.

Fig. 2: BIRD payload platform with instruments at the calibration facility.

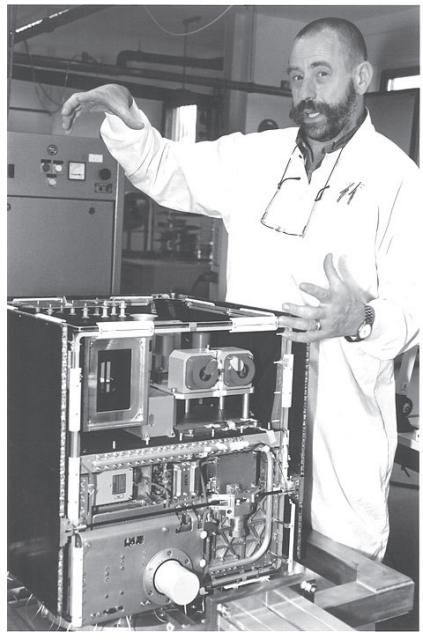

Fig. 3: Structure Thermal Model of the BIRD satellite without MLI.

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