

# The TUBSAT Attitude Control System: Flight Experience with DLR-TUBSAT and MAROC-TUBSAT

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## ABSTRACT

The core of the attitude control system of the latest TUBSAT models contains three independent control loops, each consisting of a momentum/reaction wheel (IRE) and a fibre optic laser gyro (LITEF). The central processor of the spacecraft sets the targets for the loops and is then free for other tasks. The following modes of operation are available:

1. Current control of the wheel
2. Speed control of the wheel
3. Torque control of the wheel
4. Rate control of the loop
5. Integrated rate (angle) control of the loop.

The wheels can be operated as momentum wheels or reaction wheels depending on the mission requirement and availability of additional sensors.

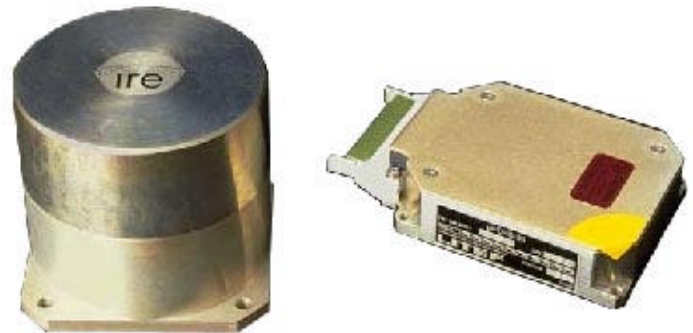


Fig.1: Reaction Wheel and Gyro

On DLR-TUBSAT for example, the outer loop is closed with a man in the loop by quickly analysing the results of the satellite imager and uplinking control commands in a joy-stick mode. The interactive control of DLR-TUBSAT will be shown on analogue video tapes with high resolution (6 m pixel resolution) images.

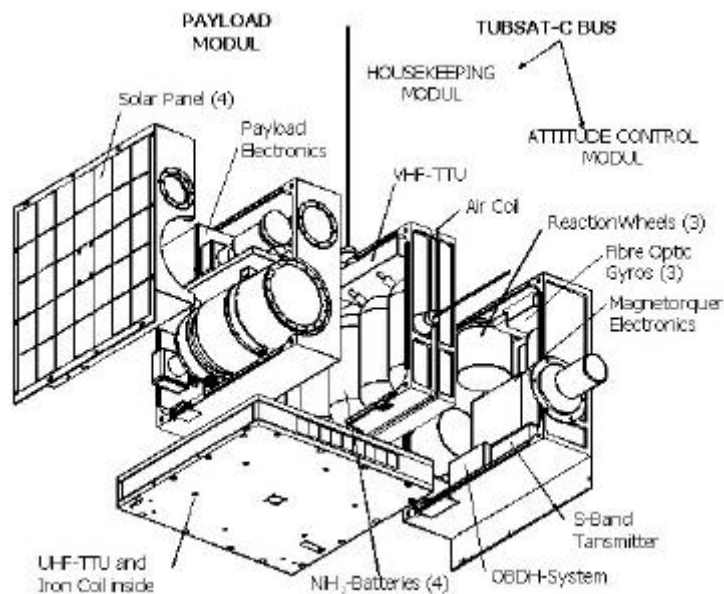


Fig.2: DLR-TUBSAT exploded view

The attitude control of MAROC-TUBSAT is based on a momentum bias system where at least one wheel is maintained in a high speed control mode. During hibernation all the other wheels and gyros can be disabled. The direction of the momentum vector is controlled in very long intervals (once per day or less) by the on-board star sensor. Due to special disturbance torque compensation techniques, the drift rate of the momentum vector could be reduced to less than  $1^\circ/\text{day}$ .

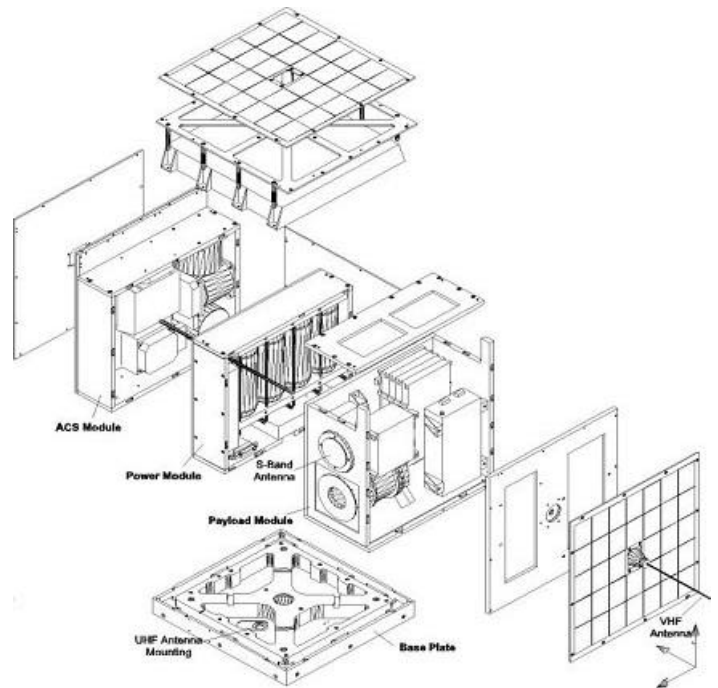


Fig.3: MAROC-TUBSAT exploded view

The autonomous control capacity of MAROC-TUBSAT will be demonstrated by high quality digital pictures in the near infrared spectral band (865 nm) with 300 m pixel resolution. The MAROC-TUBSAT data have been received by the DLR ground station of the German Remote Sensing Data Center (DFD) in Neustrelitz.

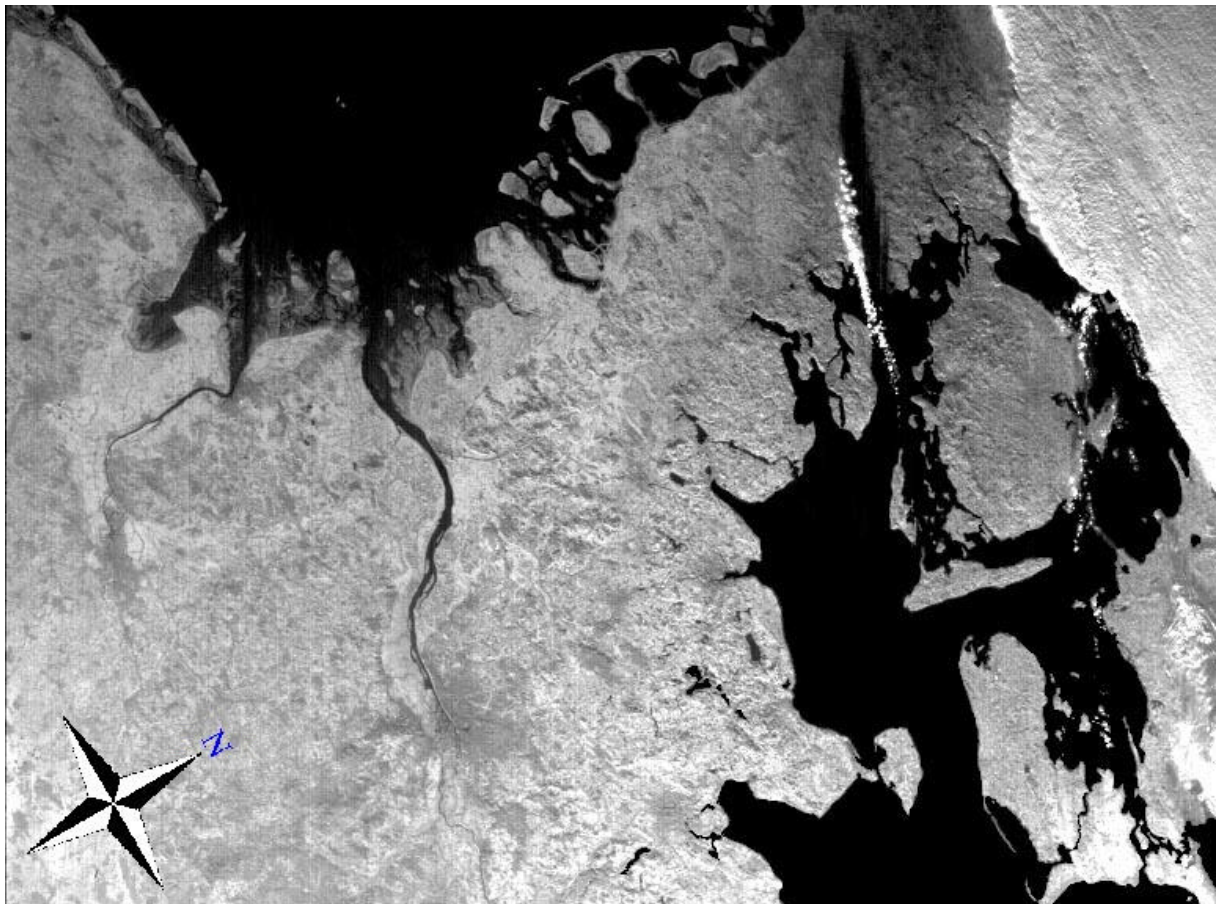


Fig.4: Mouth of river Elbe, 12.12.2003, MAROC-TUBSAT



Fig.5: Death Sea, 08.01.2003, MAROC-TUBSAT

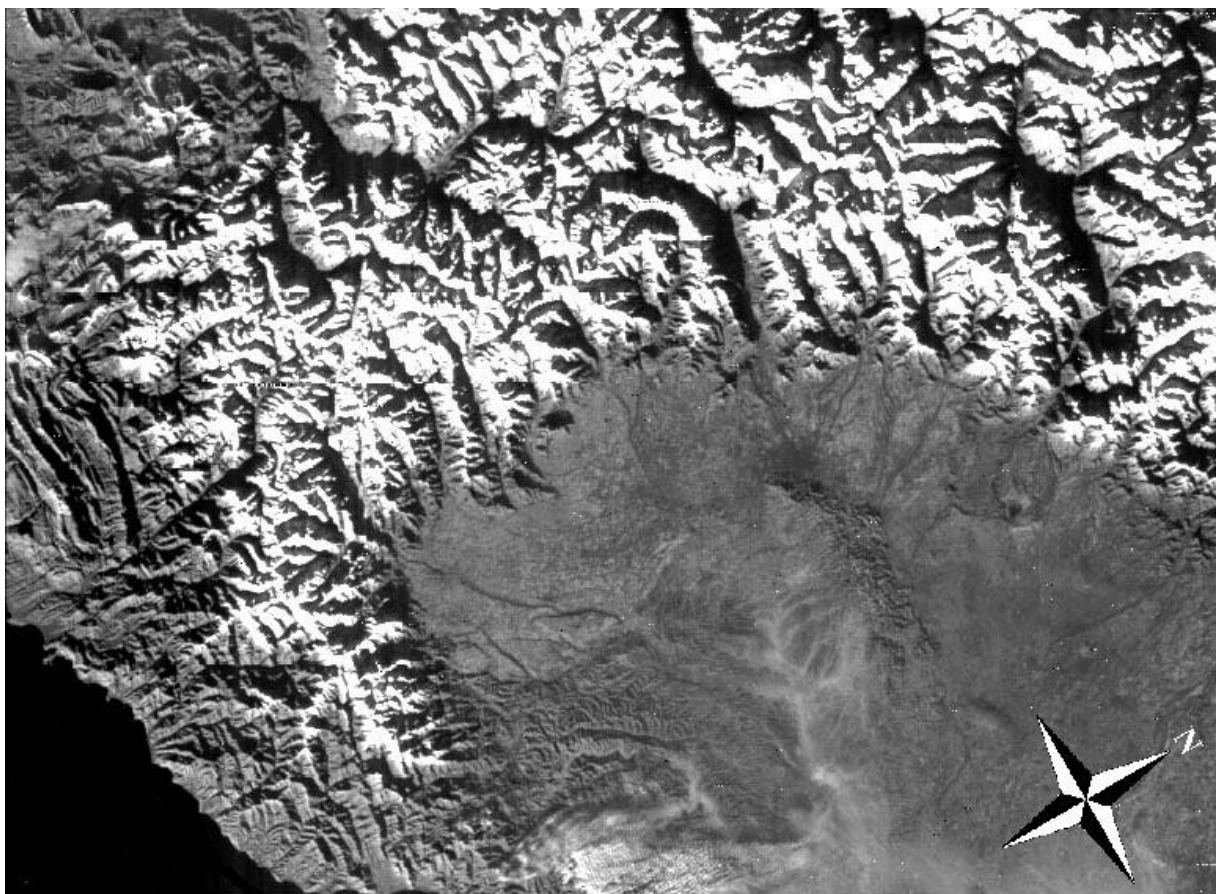


Fig.6: Turin and Alps, 19.12.2002, MAROC-TUBSAT