**Abstract**

The CubeSat program MOVE, for "Munich Orbital Verification Experiment," was initiated in 2006 at the Institute of Astronautics (IAT) of the Technische Universität München (TUM), Germany. The primary objective of the program is the hands-on education of students. The first CubeSat of the program, called First-MOVE, was launched on November 21th, 2013.

This program's second CubeSat, MOVE II, is currently under development and shall be a 2U satellite, thus enabling the scientific use of nanosatellites beyond the 1U satellite bus of First-MOVE. MOVE II will evolve the subsystems that were developed in-house. In terms of the scientific payload for the MOVE II mission, the 1U Multi-purpose Active-target Particle Telescope (MAPT), developed by the Physics Department of TUM, aims to measure the flux of antiprotons trapped in the Earth's magnetic field at very low energies. The 1U-sized bus of MOVE II with its flexible interfaces is designed to accommodate a multitude of payloads. MOVE II is due to be launched into space late 2017.

**Scientific Objective**

- Measure the flux of antiprotons trapped in the inner Van Allen belt in the 25 to 100 MeV energy range (Antiproton Flux in Space mission)
- Complementary to measurement of PAMELA experiment [1]
- Understanding the interactions of high-energy cosmic rays with Earth's atmosphere and magnetosphere (trapping, transport mechanisms)

**Evolved 1U Bus**

- Re-Usable Deployable Structures
  - SMARD
    - Non-destructive & re-usable hold-down and release mechanism based on shape memory alloy technology
    - Reset by mechanical spring, facilitating quick and easy testing
    - Successfully tested on REXUS 18 sounding rocket [3]
  - Redundant Antenna Deployment Mechanism
    - Antennas folded into deployment structure
    - Nominal deployment via solar panels
    - Back-up deployment via +Z-movement of structure

**Improved Command and Data Handling**

- Full functionality of MOVE-II's on-board computer required at all times
- High degree of failure tolerance, assuring dependability while using COTS hardware
- Centralized system architecture based on an application processor core
- Autonomous software-independent debugging and diagnostic functionality
- Based on the Linux operating system and strong software-driven error protection
- Minimization of error sources through software re-use and error correction

**Attitude Determination & Control**

- Determination with magnetometers and sun sensors
- Control based on magnetic torquers, etched into PCBs

**Electrical Power Supply**

- Deployable solar panels in X-wing configuration
- Average power 4 W at 600 km / 60°
- Active overcurrent and overvoltage protection for each subsystem

**Improved Communications**

- Full-duplex UHF/VHF transceiver
- Experimental S-Band transceiver (half-duplex, up to 1 Mbit/s)
- Novel data-link layer protocol (Nanolink)
- Stainless steel half-dipole UHF/VHF antennas
- S-band patch antenna

**The Multi-purpose Active-target Particle Telescope (MAPT)**

- 900 channel active-target tracking particle detector
- Active volume: scintillating plastic fibers
- Photodetectors: KETEK silicon photomultipliers
- Custom FPGA-based data acquisition electronics
- Sensitive to ions in 10 MeV/in to 500 MeV/in range
- Identification of ion species using Bragg curve spectroscopy technique
- Successfully tested on BEXUS 18 balloon mission [2]

**Generic Payload Interface**

**Antiproton Detector**

**The Evolution of the CubeSat Program MOVE**

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