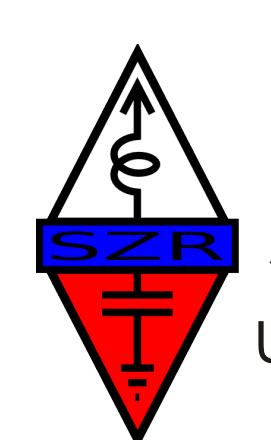
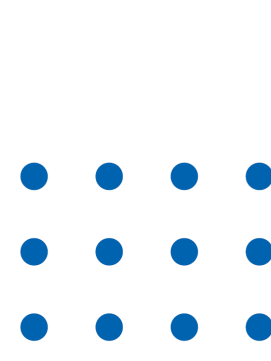




# skCUBE

## Slovak first satellite



### THE MAIN MISSION

First Slovak satellite skCube-1 is a cube with side length of 10 cm (1U) belonging to a category of cubesats. The main scientific objectives of the mission is to construct maps of the globe in the ultraviolet part of the spectrum.

#### Key features:

- 1 unit CubeSat
- Mass ~1,0 kg
- 2W average power generation from solar cells
- 437 MHz telemetry radio transceiver
- Experimental transmission of images in 2.4 GHz band
- 600-800 km polar orbit

#### Mission phases:

- Deployment of antennas
- De-tumbling
- Establishment of communication with ground control
- Stopping of rotation
- Realization of experiment
- Taking pictures of Earth
- HAM radio experiments

### EPS (ELECTRICAL POWER SYSTEM)

EPS is responsible for energy collection from the solar panels, its storage to LiFePO4 batteries and distribution in satellite. With focus on maximal effectiveness, the system is using MPPT technology to gain maximum energy from solar panels. Redundant measurement and evaluation system is performing measurements of all required voltages and currents and is able to react on any power usage exceeding allowed limits quickly. Due to suitable voltage of LiFePO4 is the system build without output converter.

- 12 solar cells with 30% effectivity
- Power from solar cells ~2W
- LiFePO4 accumulators 2x1100mAh
- System without output converter

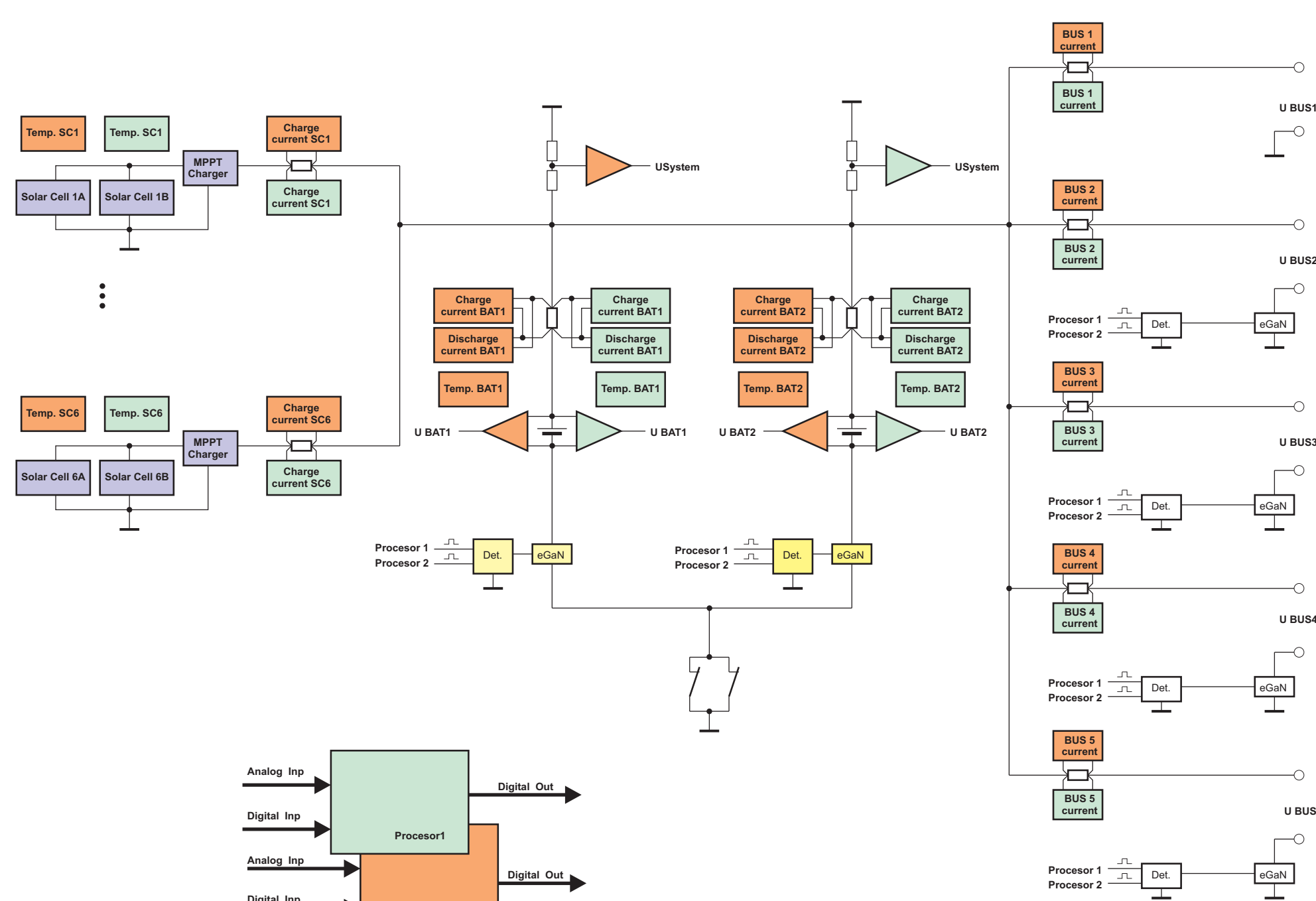


Fig. 1 - Block schematic of EPS

### CHDS (COMMAND AND DATA HANDLING SYSTEM)

CHDS is cold swaped redundant system realized with two microcontrollers MSP430. Super master is equipped with radiation hardened logic. Development of own RTOS is based on technology of safety critical systems. This system is controlling other parts of satellite, transmission and collection of data and performs calculations of system ADCS.

- 2x MSP430 microcontroller
- Proprietary RTOS
- Redundant system cold-swap
- Ferroelectric memory (FRAM)
- Software complies with safety standards MISRA C
- Sequencer for command execution from Earth

### COM (COMMUNICATIONS)

Amateur radio 70 cm band is used for transmission of telemetry by AX.25 protocol with bit speed of 9600 baud's. Used modulation is GMSK with maximum allowed bandwidth. Redundant system for telemetry transmission.

- 2x dipole antenna
- 70cm amateur band for telemetry transmission
- Transmission power 1W
- Telemetry transmission with AX.25 packets or CW
- 70cm radio amateur digipeater

The cubesat will enable the high-speed data transfer of Earth pictures in 2.4 GHz ISM band. Implementation of own communication protocol based on FEC codes.

- Patch antenna with RHCP polarization
- ISM band 2.4GHz
- Transmission power 350mW

### CAM (CAMERA)

Is dedicated to the Earth images acquisition by high quality camera chip with resolution of 750 x 480 pixels. For image processing purposes the 32-bit MCU with ARM Cortex-M4 core is used.

- Lens 4,4mm FL, Aperture F# 1.9 FOV 65°
- RAW images with a resolution of 750x480px and 24-bit color depth
- ARM processor for image processing
- Image analysis and classification
- Implementation of JPEG compression
- 16MB FLASH memory for storage
- Low power consumption ~200mW

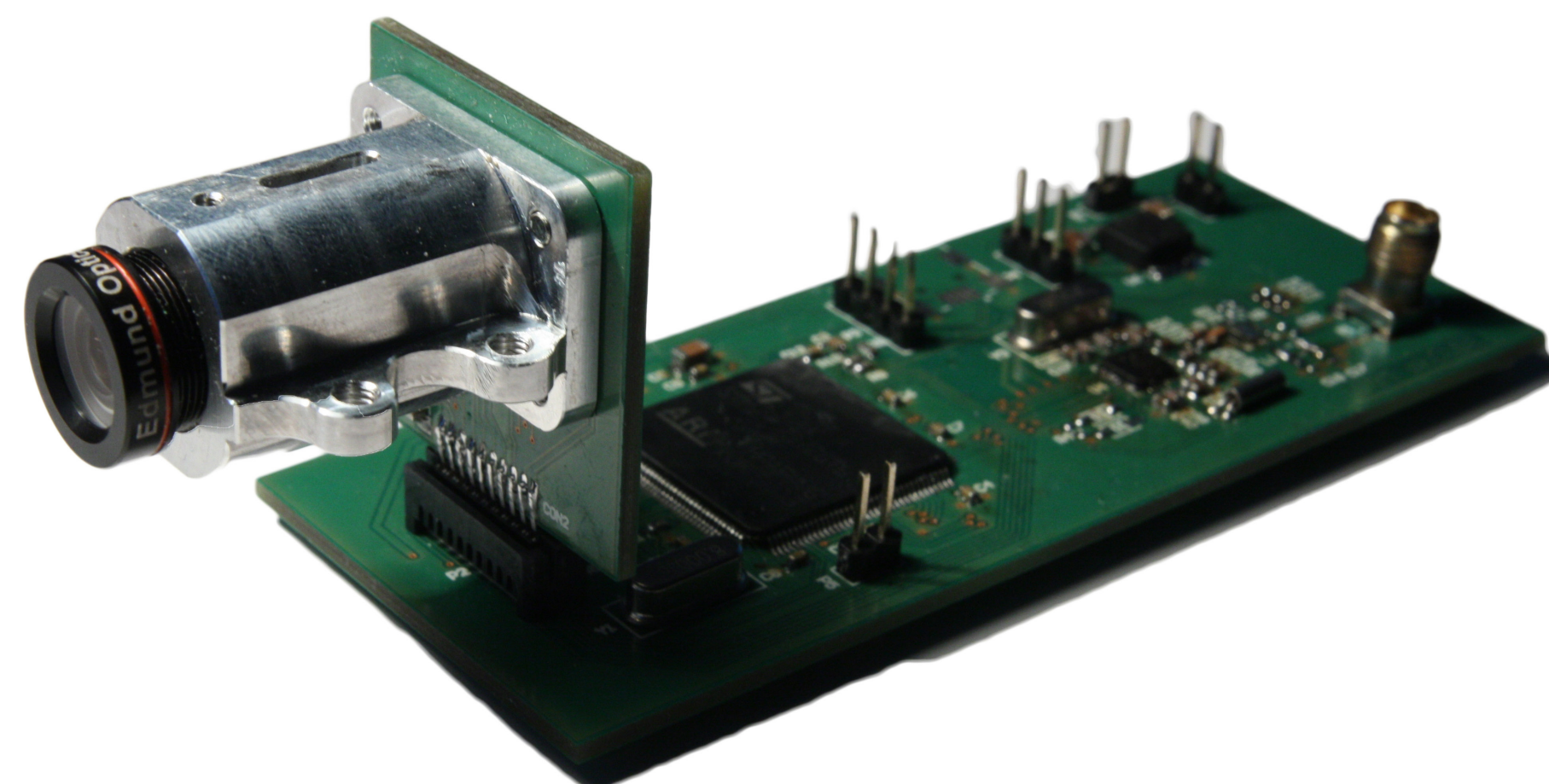


Fig. 2 - Camera prototype for testing

### ADCS (ATTITUDE DETERMINATION AND CONTROL)

Determination of satellite position is based on on-board sensors. Scanned parameters are intensity of Earth's magnetic field, satellite's angular rotation, position of Sun and position of Earth's horizon. The satellite collect the information of its position in the space by combination of the measured parameters.

Subsequent position correction is based on interaction of on-board electromagnets and Earth's magnetic field. Satellite position control takes place in 2 steps. First one slows down satellite's rotation and the second one controls the exact orientation of satellite in space. The active elements of orientation system are unique coils built with a core with extremely low hysteresis.

For testing of ADCS, a 3D earth magnetic field simulator with Helmholtz coils and spherical air bearing was developed. For stopping of initial rotation (de-tumbling) is used B-dot algorithm.

- 3x magnetorquers with ultra-low hysteresis
- 6x PSD sunsensor
- 4x earth sensor
- Magnetometer
- Gyroscope

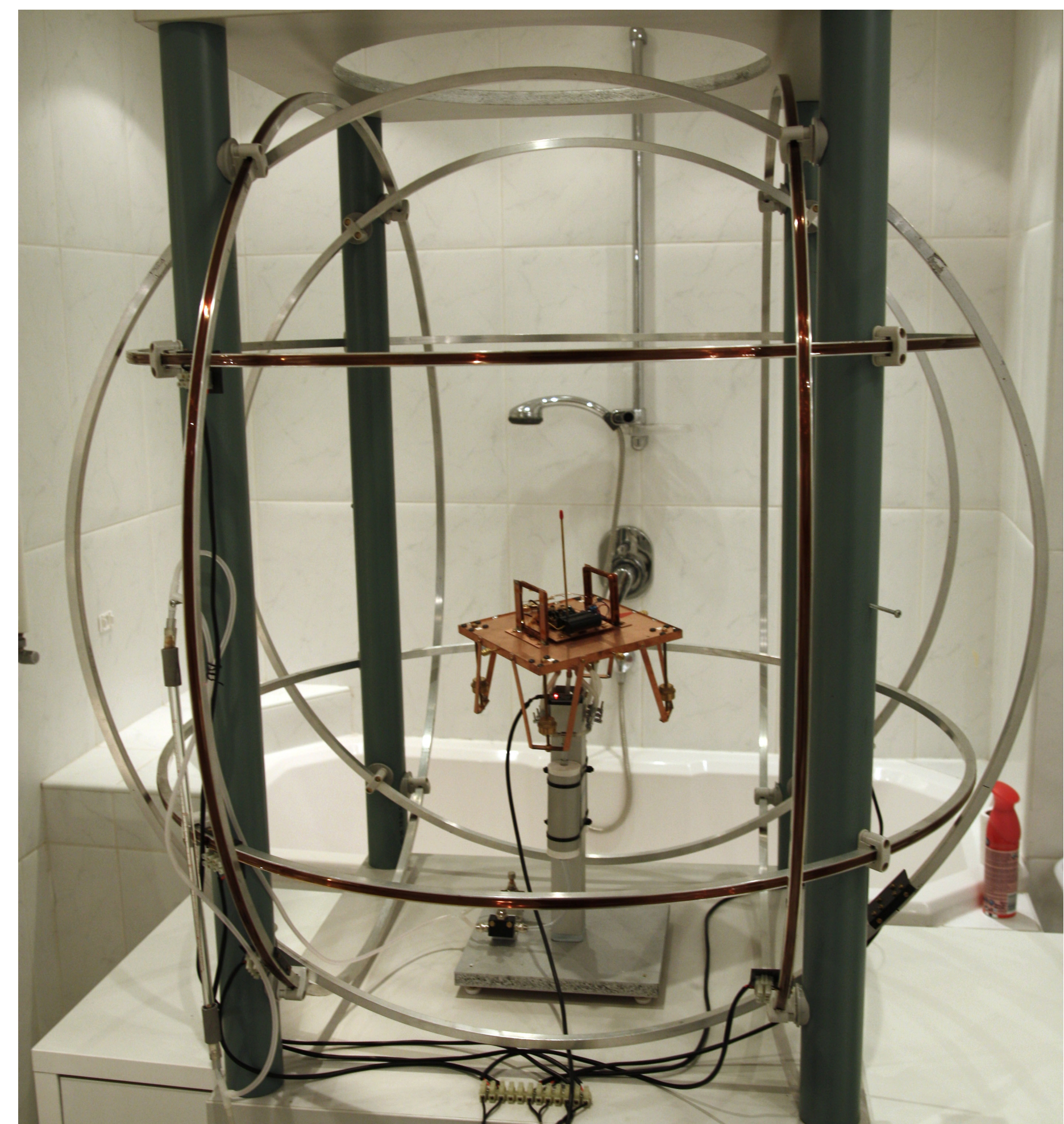


Fig. 3 - 3D magnetic field simulator

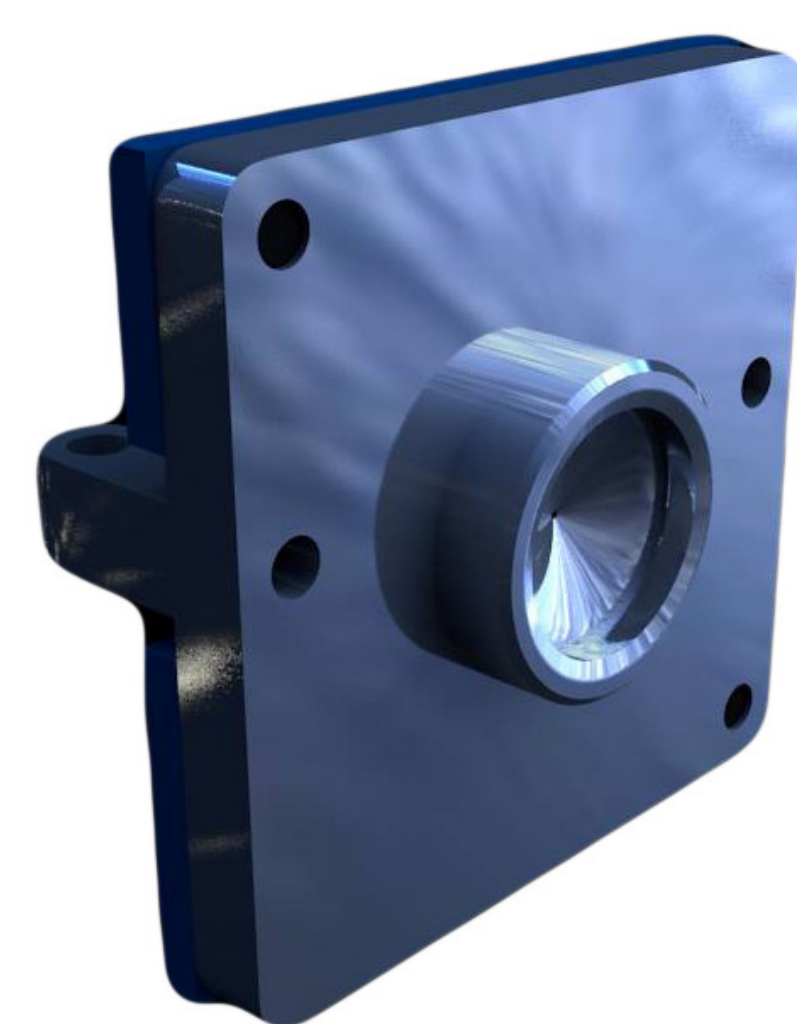


Fig. 4 - Sun sensor

### EXP (EXPERIMENT)

Scientific part of the mission is dedicated to analysis of UV background dynamics on the dark side of the Earth. UV background is determined by molecular interactions at upper atmosphere and is changing over the 11 years solar cycle, it undergoes seasonal changes during a year and is also changing during a night. Also, the dynamics is dependent on temperature of upper atmosphere. Moreover, it depends also on a position on Earth. A map of UV radiation will contribute to our understanding of temperature dynamics and the processes taking place in the upper part of Earth's atmosphere. Photo sensitive piece of this device is photomultiplier Micro-PMT.

### STR (STRUCTURE)

Skelet is made of dural, which provides the required stiffness, endurance and heat conduction. Two solar panels are placed on each side of the cube. There are 5 pieces of PCB connected with 104 pin connector inside the skelet. Dipole antennas and patch antenna will be deployed at the bottom of the satellite.

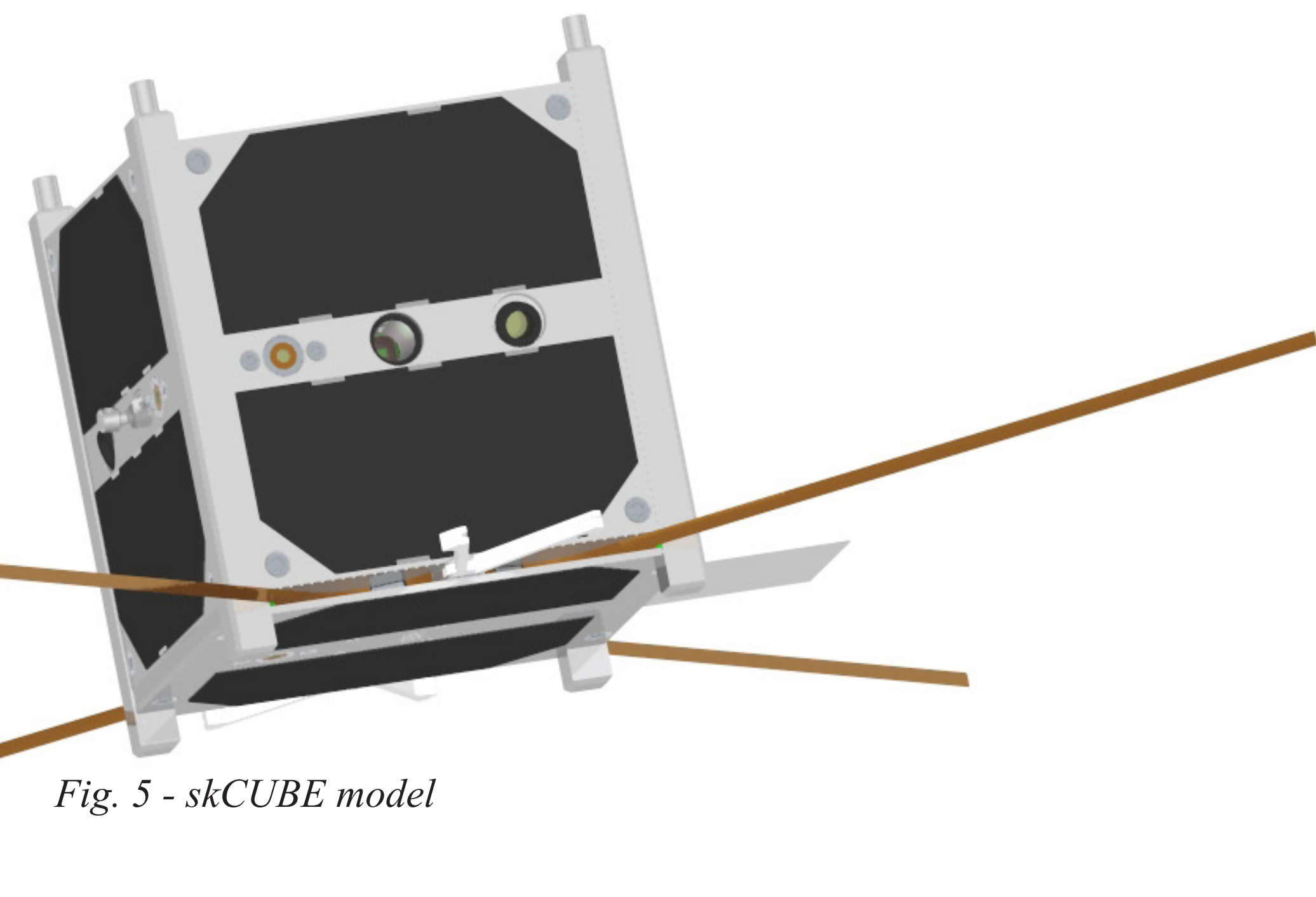
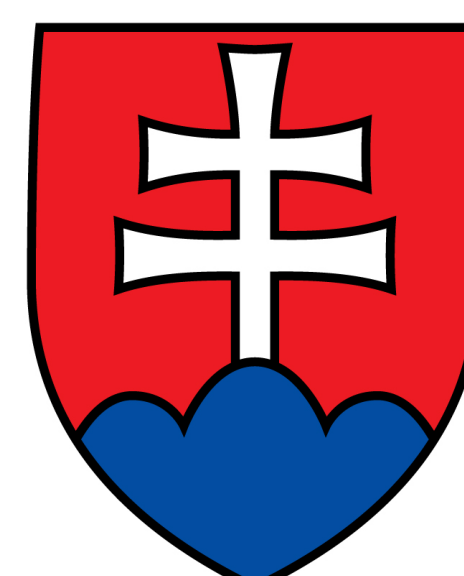


Fig. 5 - skCUBE model

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