MASTA 2015 (Micro-Satellite Technology) Team Pilot Project Final Poster

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PAYLOAD

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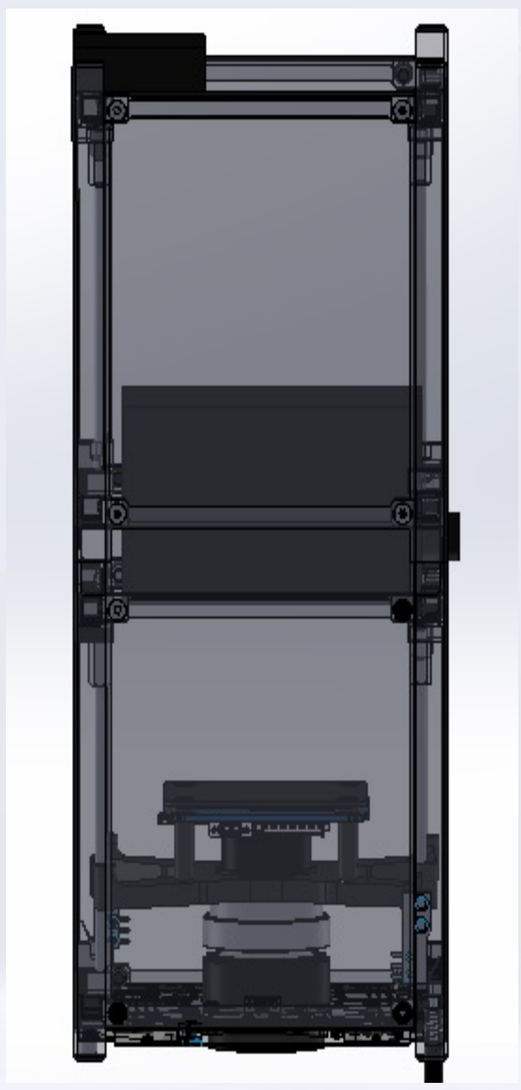
INTRODUCTION

The QY-1 CubeSat payload will have a camera for observation the earth. The downlink data rate is quite limited, and the satellite can only communicate with the ground station for a short period of time a few times a day. If a suitable compression algorithm, it will be possible to download more images, which is preferable due to the short life-time of the satellite.

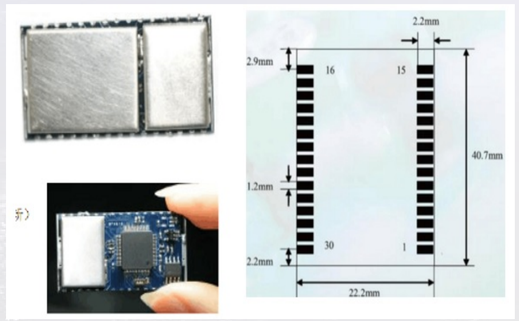
The QY-1 CubeSat payload will have an Ion and Neutral Mass Spectrometer (INMS) to analyze the low mass ionized and neutral particles in the spacecraft ram direction to get the major constituents in the lower thermosphere, i.e., O, O2, N2.

The QY-1 CubeSat payload also will have a GPS to determine position, velocity and time autonomously.



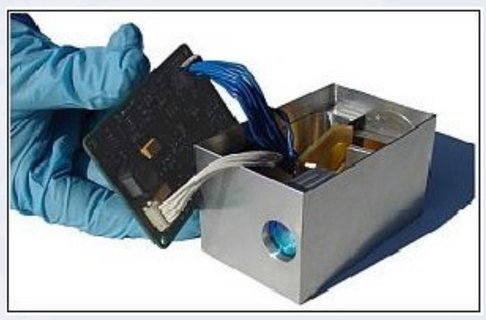
GLOBAL NAVIGATION POSITION

The mission of the GPS is the tracking (position, velocity and time autonomously) of the CubeSat and the GPS bauidu BMOS2-100 is to select to use and is show in the next figure.



BMOS2-100(thumb machine) Satellite Navigation receiver is a BD/GPS receiver by which we can realize the switch between GPS and BD navigation without hardware update. BMOS2-100 highly integrate RF, baseband processing and positioning software, thus can provide high accuracy data of three-dimensional position, velocity and time, as well as original observation data, etc. The thumb machine has the charac-

ARGUS 1000 SPECTROMETER



Argus is a miniature technology demonstration instrument, the objective is to detect greenhouse gas constituents in the near infrared region using Earth-shine spectra. Argus features only an along-track footprint of 1km x 1km (there is no scan capability in cross-track). Initial tests will be carried out to detect pollution plumes of industrial origin. Argus has demonstrated and validated the detection of greenhouse gases.

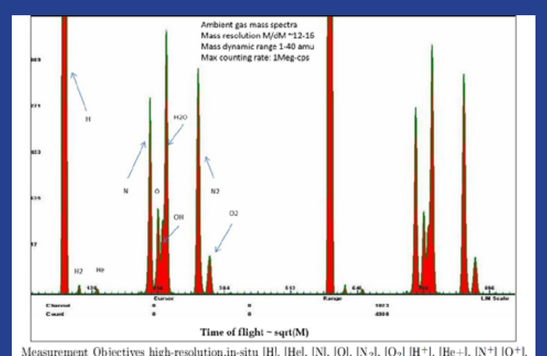
Argus uses an adjacent spectral range 900-1700nm to record nadir spectra of the radiation emitted from a 1km footprint under the spacecraft's path. The gaseous composition of the air mass along the instrument's line of sight may be inferred through measurement of absorption features associated with a particular gas. Argus will observe carbon dioxide, methane, carbon monoxide, hydrogen fluoride and water-absorption bands in order to determine near-surface column amounts for pollution monitoring.

ATMOSPHERICCONSTITUENT	OBSERVEDABSORPTION
Carbon Dioxide (CO_2)	1.24 μm (10^{-21} mol cm^{-2}) 1.42 μm (10^{-22} mol cm^{-2})
Water (H_2O)	0.90 μm (10^{-21} mol cm-2) 1.2 μm (10^{-21} mol cm^{-2}) 1.4 μm (10^{-19} mol cm^{-2})
Carbon Monoxide (CO)	1.63 μm (10^{-22} mol cm^{-2})
Methane (CH_4)	1.67 μm (10^{-20} mol cm^{-2})
Hydrogen Fluoride (HF)	1.265 μm (10^{-19} mol cm^{-2})

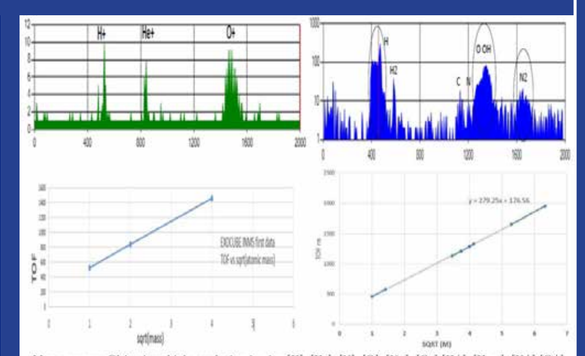
Argus measurements of atmospheric species.

ARGUS 1000 RESULTS

Measurements of atmospheric neutral and ion composition and density are needed not only for studies of the dynamic ionosphere-thermosphere-mesosphere system but simply to dene the steady state background atmospheric conditions. Remote sensing measurements of atomic oxygen density at altitudes between 80-95km have shown that the density can vary by over an order of magnitude. This causes deviations from the densities estimated by MSIS (a well known empirical model of earth's atmosphere) by up to a factor of four. CubeSats provide an ideal platform for an ion/neutral mass spectrometer capable of obtaining the in situ measurements that are critical to understanding this complicated system, see in the figures the result of the observation with CubeSat (ExoCube Team)



Measurement Objectives high-resolution,in-situ [H], [He], [N], [O], [N_2], [O_2] [H^+], [He+], [N^+] [O^+], [N_2^+], [O_2^+] (image credit: ExoCube Team).



Measurement Objectives high-resolution,in-situ [H], [He], [N], [O], [N_2], [O_2] [H^+], [He+], [N^+] [O^+], [N_2^+], [O_2^+] (image credit: ExoCube Team).

CAMERA

The payload of QY-1 CubeSat will have a camera for observation of the earth and atmospheric phenomenon. Is necessary know the requirements to select what kind of camera is the best to use in the QY-1 CubeSat. The following requirements are taken into account when choosing a camera: slow consumption of energy and long battery life, not exceed mass budget, the protocols that will be to use in the CubeSat is I2C, is important to keep in mind that the images need to be downloaded to earth over a slow rate communication link.

NANOCAM C1U

Is a flexible and modular system of camera to rapidly implement tailored imaging systems based on costumer requirements. It has a 3MP, 10 bit color, CMOS based detector and acquires the image at a resolution of 2048 H x 1536 V pixel. This covers about 165 km x 125 km for a spatial resolution of 80 m. The imaging CMOS detector, with a frame rate of 12 frame/s, gives a total capture time of 83.3 ms.

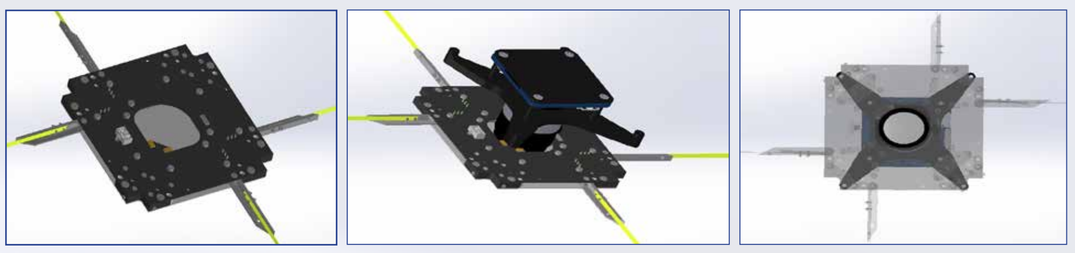
The Nanocam C1U (see figure) use I2C serial communication protocol in multi-master mode to communicate with the OBC for command and data transfer and its processor has the following speciation:

210MIPS processor,
32MB on board RAM,
2GB solid state storage,
JPEG compression.

POSITION OF THE CAMERA

There are only two possible positions of the camera lens, is position are in the nadir and zenith, which results in maximum lens diameters of either 34mm and is decided that it will be situated at the bottom of the satellite, with its lens pointing in the nadir direction.

When it comes to weight, it is beneficial that the camera is as lightweight as possible. But one should keep in mind that in addition to the total weight constraint of 2.66kg, the CubeSat specification also requires that the mass center of the whole satellite stays within a certain radius from the geometrical center. Since the camera is situated at the bottom, it might be necessary to move the batteries or other heavy parts to compensate.



The antenna module on the nadir plane of the satellite must have a hole for the lens of the camera payload to pass through. As no hardware is yet determined for the payload, assumptions has to be made regarding this hole. One possibility is to have the hole centered such that the lens passes through the feed gaps of the dipoles. The radius of this hole is 35mm for two reasons; (1) It is bigger than the lens of the camera which has been considered that has the biggest lens (34mm diameter) and (2) it is the biggest hole could possibly tin between the antenna elements.

DOWNLOAD CAPACITY OF CAMERA

The downlink capacity at the ground station is how much data that can be downloaded from the satellite, is an important parameter when deciding which compression scheme to choose for the payload data. This issue is closely related to the antennas and the communication module, and therefore a estimate the download capacity for the communication link between the satellite and the ground station was development in the TT&C Subsystem Final Report for QY-1 CubeSat. The results for different BitRate are show in the next table.

BITRATE	AVERAGECAPACIVITY
9600	171kB/day
4800	85kB/day
1200	21.4kB/day

Downlink capacivity.

COMPRESSION

The BitRate in the QY-1 CubeSat will be 4800 and the average download capacity of 85kB/day for an orbital altitude of 400 km and minimum angle of elevation 10 degree, but it will be assumed that only half of this capacity is available for the payload data. A resolution of 256 X 256 pixels in JPEG has been assuming for transferring, because the images with resolution of 2048 x 1536 had about 1.5 Mb and other image in RGB24 are to big to be transferred.