nSight-1: Earth Observation and Science in 2U

Presented at SmallSat
Logan, Utah
9 August 2017
QB50 Project

28 Cubesats from the International Space Station

QB50-ISS
- 28 Cubesats
- Altitude 415km
- Inclination 51.6deg
- Launch on 16th March 2017
- Atlas-V Rocket from Cape Canaveral (USA)

8 Cubesats on the PSLV Indian Rocket

QB50-PL
- 8 Cubesats
- Altitude 500km
- Sun Synchronous Orbit 97.1deg
- Part of the Science Campaign
- Launch on 21st April 2017
- PSLV Rocket from Satish Dhawan Space Centre

Logos of various organizations involved in the project.
South African QB50 Satellites:

- ZA AeroSat (QB50 AZ01)  
  Stellenbosch University

- nSight 1 (QB50 AZ02)  
  SCS Space
1 Overview

Complete satellite weighs only 2.5 kg

- Part of the international QB50 constellation
- Deployed from the ISS

Payloads:

- SCS “Gecko” imaging payload
  - 30-meter resolution colour RGB “snapshot” camera
  - Integrated data storage
  - Integrated image processing
- FIPEX atmospheric science instrument (supplied by University of Dresden)
- Radiation mitigation VHDL coding experiment (Nelson Mandela Metropolitan University)
Deconstructing nSight-1
South-African developed components in red

Antenna module
- UHF/VHF Transceiver (CPUT)
- EPS and Battery
- Break-out board
- Flight Software
- OBC and ADCS (CubeSpace)
- Hinged solar panel deployment
- SCS Gecko Imager
- FIPEX (TU Dresden)
Designed imaging capability

30m GSD, 61km x 32km RGB (Bayer) snapshot

Rio de Janeiro
(simulated using LANDSAT8)
SCS Gecko Imager

- Modular design
- Compatible with CubeSats
- High-speed high-capacity mass data storage
- FPGA processor for real-time image processing
- High frame rate capability (for larger optics)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Form factor</td>
<td>&lt; 1U</td>
</tr>
<tr>
<td>Mass</td>
<td>&lt; 480 g</td>
</tr>
<tr>
<td>GSD</td>
<td>31 m from ISS orbit</td>
</tr>
<tr>
<td>Image Sensor</td>
<td>2.2 Megapixel RGB</td>
</tr>
<tr>
<td>Storage</td>
<td>128 GB</td>
</tr>
<tr>
<td>Rad. tolerance</td>
<td>Tested to 30 krad TID</td>
</tr>
<tr>
<td>Space heritage</td>
<td>2017 !</td>
</tr>
</tbody>
</table>
Order online (CubeSatShop.com)

SCS Gecko imager

€18,000

The Gecko imager is an easy-to-integrate imaging solution for your CubeSat mission. A customizable high performance mass storage unit is integrated into the compact design. The Gecko imager offers mechanical compatibility with standard frames.

RGB images are captured at up to 5 frames per second† using a matrix sensor in snapshot (global shutter) mode.

Image data is captured directly to the integrated mass storage. Data may be streamed out to an on-board computer and downlinked a lower data rate, as required.

Reliable operation achieved by using a combination of proprietary hardware and space-proven ruggedized optics.

Availability: 12 – 16 weeks

Quantity 1

Request more info
SCS Gecko Sensor Unit (SU)

Sensor PCB  Flexible strain relief  Connector

- Several digital sensor models supported
- Drivers for sensor selection:
  - spectral bands (RGB, multispectral, hyperspectral)
  - pixel pitch
  - physical size (multiple sensors for increased swath)
  - frame rate (high freq. full-frame; single snapshot; line scan)
SCS Gecko Control Unit (CU)

- Mass data storage (128 GB or more)
- Automatic wear levelling
- Error-correction
- High data capture rate
- Thumbnails
- RGB Bayer demosaicing
- JPEG2000 (post nSight-1)

PC/104 form-factor (~100 mm x 100 mm x 15 mm)
On-board Computer

- CubeSpace (South Africa)
- Attitude control software
- General housekeeping
- JPEG Image Compression
Image Processing

- Snapshot matrix imaging (global shutter)
- nSight-1 implements:
  - Uncompressed RAW
  - Full resolution 8-bit RGB JPEG (4:4:4 or 4:2:2)
  - JPEG thumbnails (8x downsampled)
  - Automated image metrics
- Future (current) models: JPEG2000 on FPGA
Thumbnail mode

- < 5 kilobyte each
- Download several thumbnails per overpass (using UHF!)
Selective download

- Select usable images for high resolution download
ADCS sensors & actuators

- Earth nadir sensor
- Coarse + fine sun sensors
- 1x Reaction wheel
- 3x Magnetorquer
- Maintains nadir-pointing orientation
FIPEX (Flux-Φ-Probe Experiment)

- Developed by TU Dresden, Germany
- Time-resolved behaviour of atomic and molecular oxygen in Earth’s thermosphere
Final preparation (Oct 2016*)

* 6 months after project start
Vibration testing
nSight1 with thermal cladding
Happy engineers
Launch! (18 April 2017)

Atlas V OA-7 launch – Photo: United Launch Alliance
Arrival at the ISS (22 April 2017)

OA-7 Cygnus capture at the ISS – Photo: NASA
Deployed from the ISS

25 May 2017

51.6°, 400km orbit.
Expected lifetime: 12-18 months.
Deployment!

51.6°, 400km orbit.
Expected lifetime: 12-18 months.
Our ground station

- At Houwteq facilities near Grabouw, Western Cape
- UHF/VHF (soon also S-Band)
- SCS Space 100m² clean room on same site
ADCS stabilization

Detumbling result as measured by the Y-axis rate sensor
Magnetometer Calibration

Before calibration
(\(\sigma = 2.848 \mu T\))

After calibration
(\(\sigma = 0.365 \mu T\))
Houston, we have no problem!

6 July 2017, 18:00:52 (UTC)

Houston, Texas
(One of the first downloaded nSight-1 images)
Imaging success

British Columbia, Canada
Imaging success

Mecca, Saudi Arabia
Imaging success

Salar de Uyuni, Bolivia
Imaging success

Eastern Cape, South Africa
Imaging success

California, USA
SCS Aerospace Group:

- Engineering Services
- Satellite Components
- Satellite Products
- Information Systems
SCS Gecko: our Smallest Imager

- 480 g (complete payload)

<table>
<thead>
<tr>
<th></th>
<th>Gecko</th>
<th>Chameleon</th>
<th>Monitor</th>
<th>Iguana</th>
<th>Tegu</th>
<th>Basilisk (SCS.450)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>0.5 kg</td>
<td>2 kg</td>
<td>6 kg</td>
<td>10 kg</td>
<td>28 kg</td>
<td>125 kg</td>
</tr>
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