SNIPE
(Small scale magNetospheric and Ionospheric Plasma Experiment)

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Abstract:

The SNIPE (Small scale magnetospheric and Ionospheric Plasma Experiment) mission of Korea consists of four 6-U Cubesats. The satellites will be launched in year 2020 into a polar circular orbit at an altitude of ~500 km. Each satellite carries Langmuir Probes measuring ionospheric plasma density and temperature, fluxgate magnetometers to reconstruct geomagnetic field vectors, and high-energy particle detectors diagnosing electron precipitation from the terrestrial radiation belt. During the mission lifetime of 6 months the SNIPE constellation will gradually change the inter-satellite distance and the flight formation, which is realized by cold gas thrusters onboard. The main target of the SNIPE mission is to resolve small-scale (<200 km) structures of ionospheric plasma and high-energy particles as well as the concomitant perturbations of geomagnetic field. The bus and payload data will be downloaded in the UHF and S-band frequencies. As a secondary and indirect data link to the ground, the SNIPE will also carry Iridium modules.
1. Mission Overview
Snipe
The SNIPE constellation

- Four 6-U Cubesats
- polar circular orbit
- altitude of ~500 km
Brief descriptions

- New idea: formation flight of multiple cubesats to disentangle temporal and spatial variations
- How: KASI will launch SNIPE mission that consists of four nanosatellites in 2020.
- SNIPE (Small scale magNetospheric and Ionospheric Plasma Experiment)
  - Constellation of four 6U-Nanosats (~10 kg for each satellite)
  - Formation Flying (Slow separation from 10 km to >100 km over a few months)
  - Design life Time: 1 year (Science operation time: 6 months)
  - Orbit: ~500 km, Polar Orbit
  - Launch in 2020
Science Targets:

to resolve small-scale (<200 km) structures

- Spatial scale and energy dispersion of electron microbursts (Jaejin Lee)
- Temporal and spatial variations of plasma trough during magnetic storms (Young-Sil Kwak)
- Temporal and spatial variations of electron density and temperature in polar cap patches (Young-Sil Kwak)
- Measuring length of coherence for bubbles/blobs (Jaeheung Park)
- Large amplitude disturbance of field aligned current (Ensang Lee/Junga Hwang)

Additional Science

- EMIC waves at the top of ionosphere (Junga Hwang)
Micro-scale structures

> 10 km

10 – 1,000 km
Breakthrough Technologies

• Cubesat Formation Flight

• Iridium Communication
2. Science Payloads
Payload Overview
Solid State Telescope

- Energy Range: 100 – 400 keV
- Energy Channel: 16
- Geometric Factor: 0.02 [(cm² sr)^{-1}]
  \[\rightarrow\text{Max. Flux:} \sim 1 \times 10^6 \text{ [(cm}^2 \text{ s sr)}^{-1}]\]
- Field of view: 37°
- Two sensors: Parallel and Perpendicular to the geomagnetic field
- Sampling rate: 10 Hz (Normal)
  100 Hz (Max)
Magnetometer

- Range: -50,000 – 50,000 nT
- Noise Amplitude (FWHM): 1 nT
- AD conversion bit: 24 bits (0.006 nT)
- Sampling rate: 10 Hz
- Two magnetometer sensor: The difference indicates internal/outer noise sources
- Magnetometer operation mode
- Minimum power operation in night side → ~10 min a day
- Electron density: $2 \times 10^3 - 2 \times 10^6 / \text{cm}^3$
- Basically follow STSAT-1 LP
- Probe size: $\phi 1\text{mm} \times 100\ \text{mm}$
- Time resolution:
  - 10 sec: full I-V Curve $\rightarrow$ Ne, Te
  - 1 sec: Te (On board Calculation)
  - 0.1 sec: Fixed Voltage $\rightarrow$ Ne
3. Bus system
When fully deployed…
## Components of the Bus System

| ADCS         | Three-axis attitude control by reaction wheels  
|             | → Field align attitude control during microburst observation  
|             | Accurate GPS system for position and velocity determination  
|             | Attitude information from Sun Sensor, Star Tracker, Magnetometer  
|             | Pointing Accuracy: < 3°  
|             | Point Knowledge Accuracy: ±0.5° for roll & yaw  
|             | ±0.75° for pitch  |
| CDHS        | Time Sync between OBC and payloads  
|             | Communication between OBC and payloads with CAN BUS protocol  |
| EPS         | Deployable solar panel (> 50 W)  
|             | High capacity Li-ion batteries (> 40Whr)  |
| COMS        | UHF Commend/Telemetry Uplink/downlink - 437.5 MHz (9.6 kbps)  
|             | S-band Up/Downlink: 2.2 GHz (1 Mbps)  
|             | Iridium Communication  |
| Propulsion  | High performance micro-thruster (Cold Gas Thruster)  
|             | Thrust : 20 mN  
|             | Del-V : 50 m/s  |
Thruster Specification

PROPELLANT: R-236fa

DRY MASS: about 1 kg

THRUSTERS: 4 nozzles
Formation Flight Strategy

Free Separation (Commissioning Phase) ~1 month

Along track formation (Drift Recovery) 2-3 months

Cross track formation 2-3 months

No Control (Extended mission)
IRIDIUM NEXT Communication

- Back-up communication in initial phase ground contact
- Spacecraft health check before ground contact
- Real time monitoring of thruster operation
- Payload operation command upload when magnetic storms occur
4. Ground Stations
Korea Astronomy and Space Science Institute (KASI)
7-m S-band antenna

UHF antenna

https://map.naver.com/
MISSION TEAM

ABOUT SNIFE
SCIENCE
SATELLITE
TEAM
DATA
DOCUMENT

Project Manager
Lee, Jaejin

System Engineering
Hwang, Junga

Science
Kwak, Young-Sil

Mission Operation
Park, Jaeheung

Payload
Sohn, JongDae

Iridium Payload
Park, Won-Kee

Formation Flying
Park, Han-Earl

Mission Assurance
Nam, Wookwon

Mechanical Structure
Jo, Gyeongbok

Flight Software
Lee, Jongkil

Magnetometer
Kim, HyangPyo

Orbital Analysis
Song, Ho sub

Science
Choi, Jong-Min

Spacecraft
KARI

Formation Flying
Yonsei Univ., Korea
For more information, please visit our website:

http://kswrc.kasi.re.kr/snipe/
Thank you for your attention.
We look forward to cooperating with you!