

# The LappiSat Space Program – Expanding Observatory Quality Geophysical Measurements to Orbits

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Credit: Eija & Elsa Tanskanen, aurora photo Jouni Envall

# Sodankylä Geophysical Observatory (SGO)



67.25°N

- The Sodankylä Geophysical Observatory has pioneered in the research of aurora borealis and the related fluctuations in the near-Earth magnetic environment for over a 100 years.
- Main research areas include magnetic disturbances, geomagnetic activity, ionospheric composition and disturbances, radio science, seismic activity, and cosmic rays.
- First sets of variometer measurements from 1880's.
- Continuous measurements since Jan 1, 1914.
- 27 locations, spanning from Svalbard (78°N) to Antarctica.

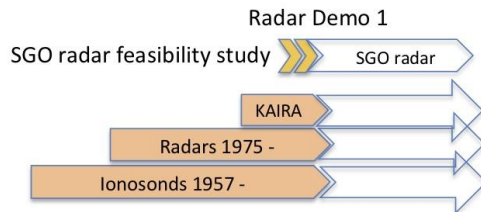
*It has been a time-honored tradition at SGO to design, develop and construct the observatory's most critical measurement instruments in-house.*



# Monitoring Near Earth Environment

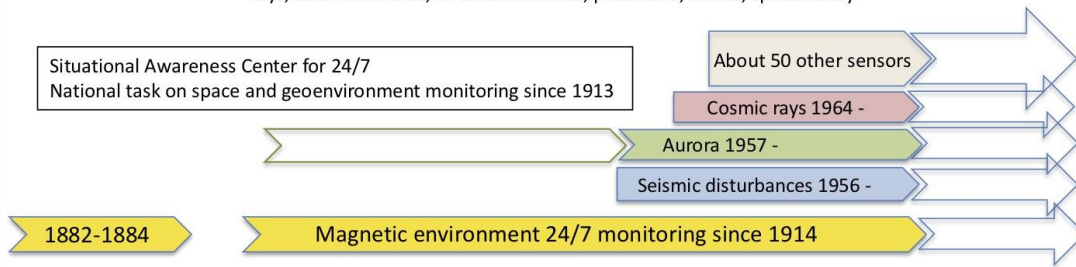
## Radars and SST-capability (SST)

What is measured? Content and structure of ionosphere, satellite orbits, Space debris, solar storms, flares, radio disturbances.



## Space weather monitoring and situational awareness (SSA/SWE)

What is monitored? Space weather and space climate, geohazards, auroral substorms, particle storms, cosmic rays, seismic hazards, GPS-disturbances, pulsations, waves, space safety.



# LappiSat Program



- The first Finnish satellites were launched in 2010's. As a byproduct the new wave of space engineers emerged.
- In 2020 SGO decided to bring some of that know-how to Lapland (Lappi).
- LappiSat program will
  1. Establish a Space Technology Center in SGO's Tähtelä campus in Sodankylä.
  2. Build and operate satellites with scientific payloads.
  3. Provide education in the field of space technology and instrument building.
  4. LappiSat-1 will take the first step in expanding SGO's measurement network to space.



# The first mission – LappiSat-1

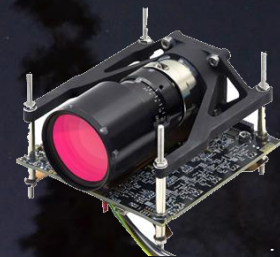
- 6U CubeSat.
- Polar LEO, altitudes 500 – 750 km in consideration.
- The scientific payload of the satellite will consist of instruments observing the aurorae and the related magnetic disturbances of the near-Earth space environment.
- The instruments will be designed and built mainly at SGO.
- The development of the satellite will be led and coordinated by SGO.
- Scientific instruments
  - Auroral imagers.
  - Auroral photometer.
  - CubeMAG™.
- On-board demonstrations
  - 6 DOF Propulsion (attitude control and de-orbiting).
  - Radiation tolerant systems.



# Auroral Imagers



- Science Camera
  - Optimized for scientific observations of the auroral oval.
  - Final specifications TBD.
  - E.g. spectrally filtered images, or integration over the entire spectrum (B/W).
  - I will leave it to the science team!
- Outreach Camera
  - Optimized for ordinary orbital photography.
  - Aesthetically pleasing color images of aurorae.
  - Used for public outreach, education etc.



(Pictures for illustration purpose only)





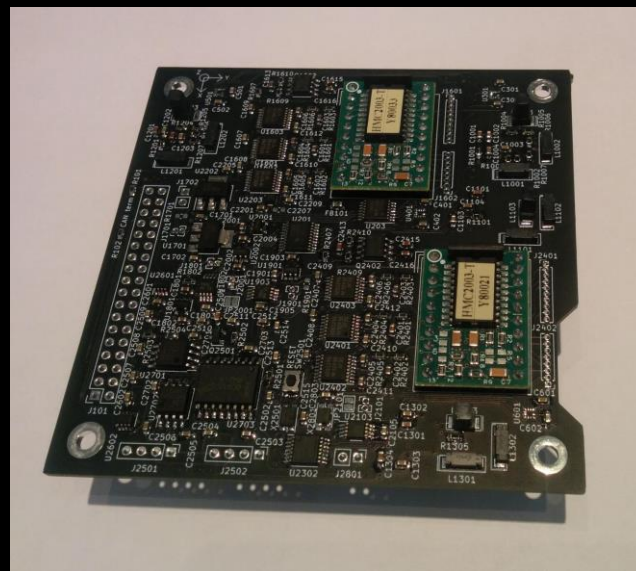
# Auroral Photometer

- Auroral photometer: device taking measurements of the intensity of auroae at several narrow wavelength bands, centered at e.g. 427.8, 557.7, and 630.0 nanometers.
- Observing the different emission bands simultaneously gives scientifically valuable information of the aurorae.
- Examples:
  - 427.8 nm → electron flux.
  - 427.8 nm & 630 nm → characteristic energy of precipitating electrons.
  - Time lag between 427.8 nm and 557.7 nm → change of molecular oxygen.
- Photometer:
  - Each channel contains a detector (e.g. avalanche photodiode) with control electronics, a spectral filter, and suitable input optics.
  - For each measurements channel, an auxiliary channel is needed to measure the dark signal.
  - In addition: central microcontroller unit, memory, and data interface.

# CubeMAG™



- A miniaturized magnetometer for small satellites.
- Fully in-house designed and built.
- Compact design allows a variety of applications.
- Single PCB solution optionally with external sensors, e.g. mounted on a boom outside of the satellite body.
- Target resolution of the instrument is 1 nT.

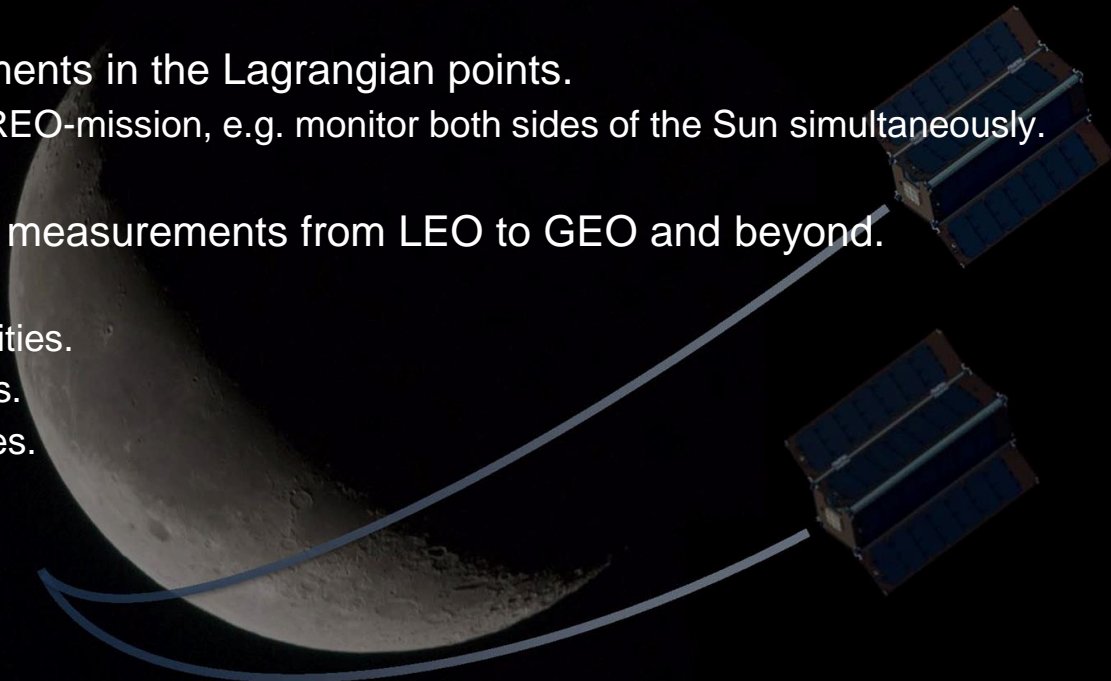






# Future Missions

- Upcoming small satellite launch opportunities to the Moon.
- Solar and magnetic measurements in the Lagrangian points.
  - CubeSat variant of the STEREO-mission, e.g. monitor both sides of the Sun simultaneously.
- A fleet of satellites performing measurements from LEO to GEO and beyond.
  - Cost.
  - Multiple spacecraft opportunities.
  - Redundancy on observations.
  - Wide-scale usage possibilities.





**Thank You**

