Group 4:
Innovative Science Produced by Nano-Satellite Observation

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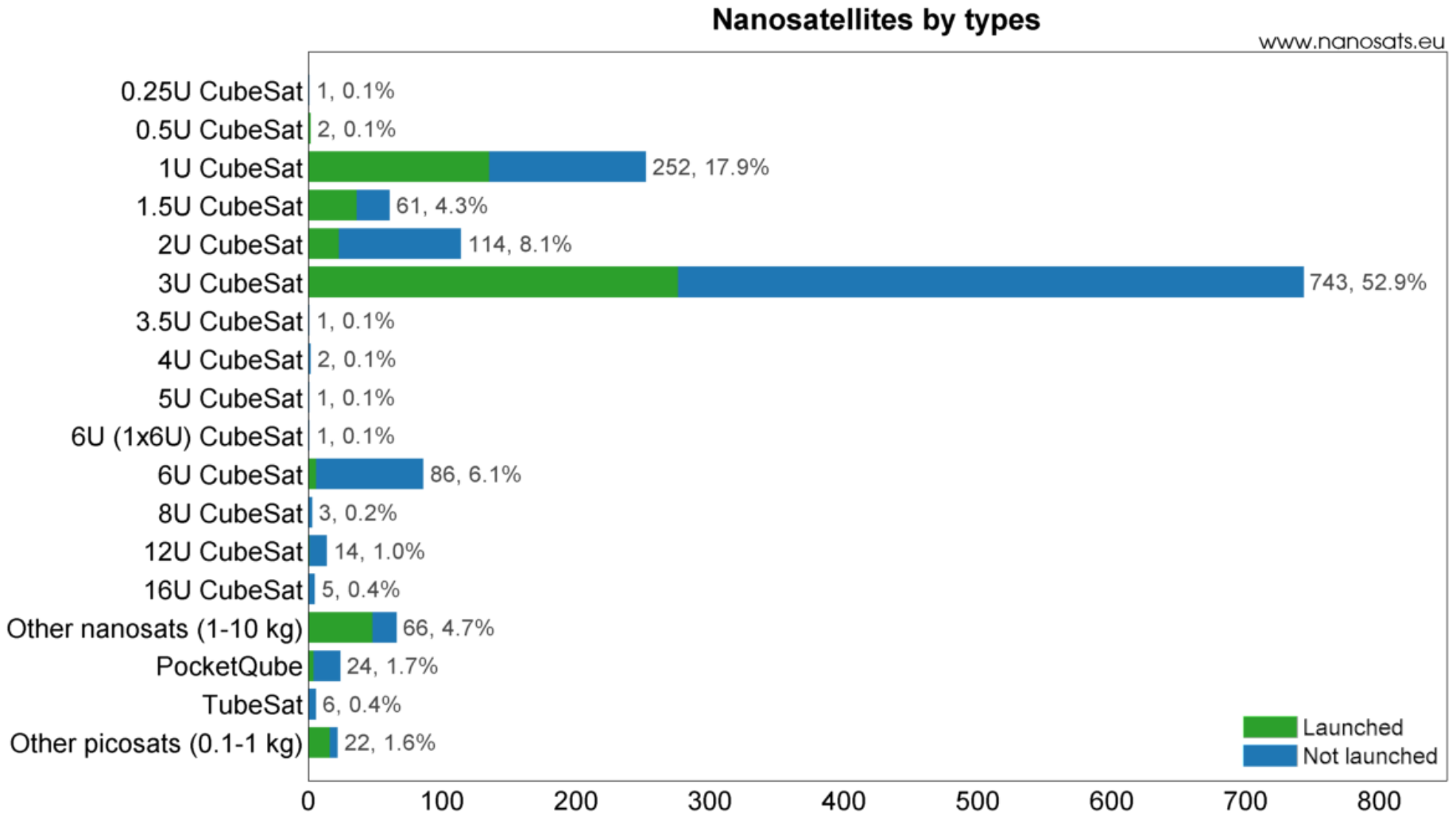
6 Participants (8 persons in total)
[4: Science background,
4: Engineering background]

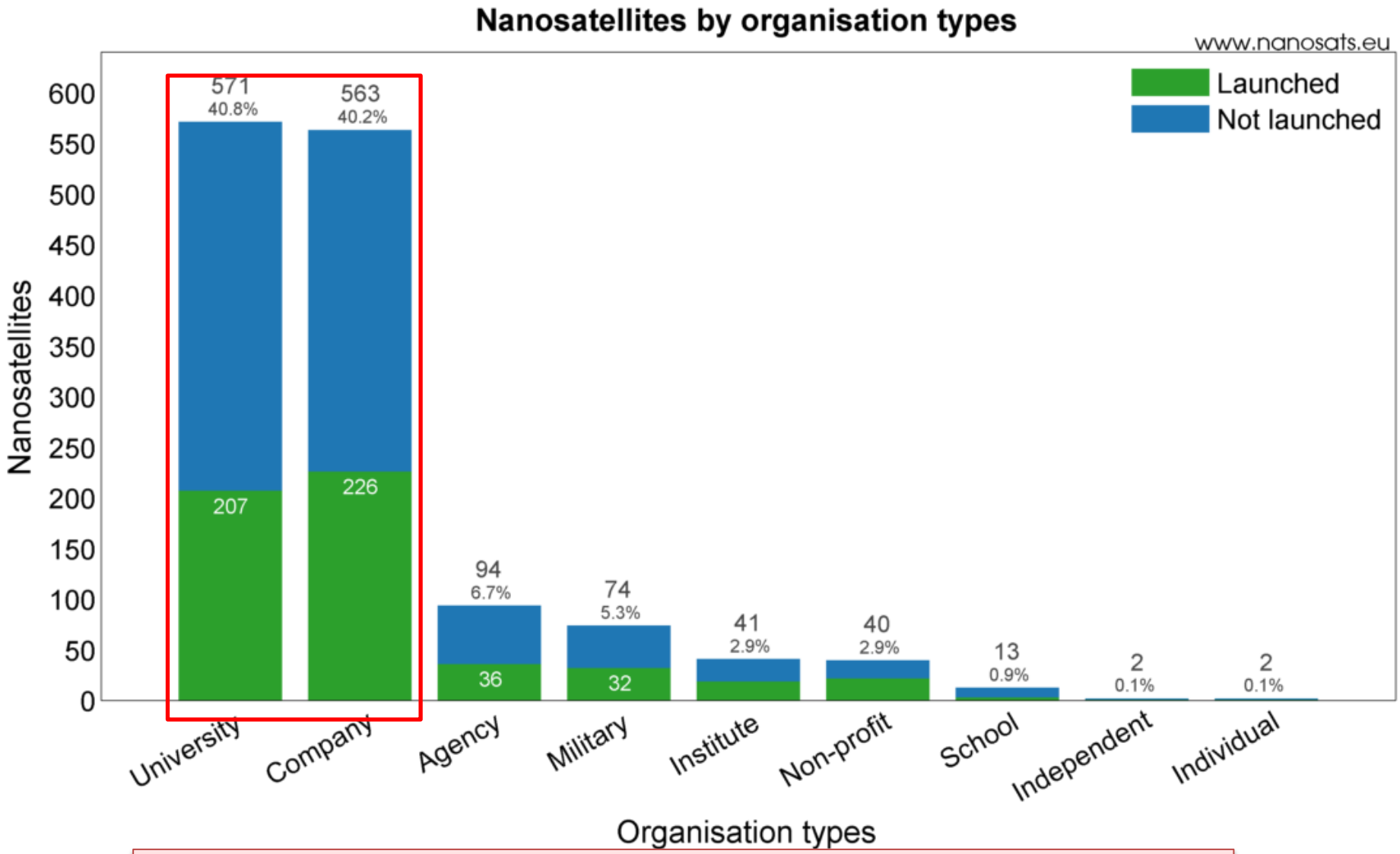
Participants (Group 4)

- Masashi Kamogawa (Moderator)
- Mariana Bogdanova (Assistant)
- Hiroki Uto
- Yasuyuki Miyazaki
- Zdravko Dimitrov
- Himmat Panag
- David Lam
- Jordan Bozmarov

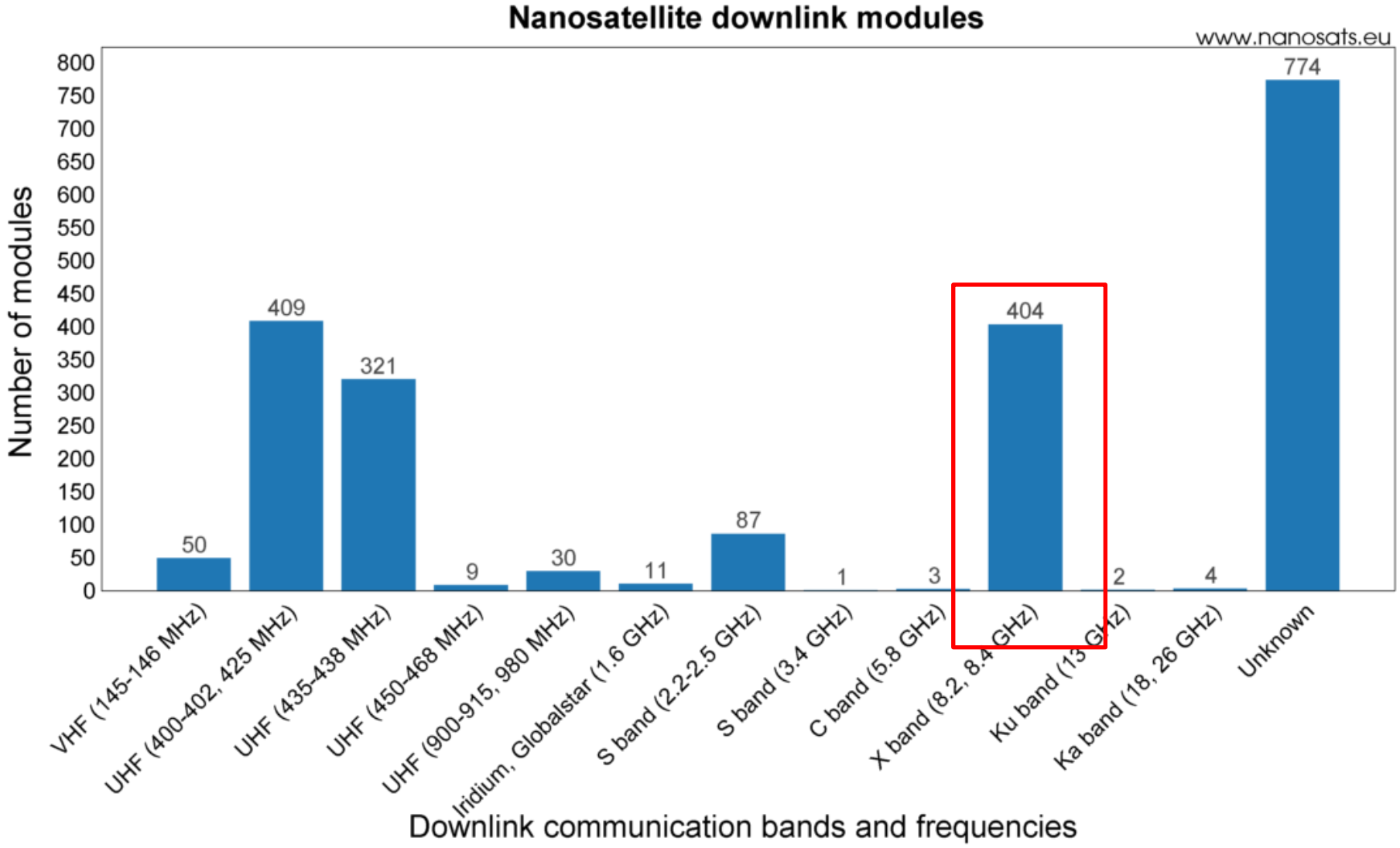
Our motivation

- Can Cubesat observe practical scientific data?
- Were there scientific papers using Cubesat data?
- What is the plausible missions for Cubesat?


Nanosatellites by types
www.nanosats.eu
0.25U CubeSat
0.5U CubeSat
1U CubeSat
1.5U CubeSat
2U CubeSat
3U CubeSat
3.5U CubeSat
4U CubeSat
5U CubeSat
6U (1x6U) CubeSat
6U CubeSat
8U CubeSat
12U CubeSat
16U CubeSat
Other nanosats (1-10 kg)
PocketQube
TubeSat
Other picosats (0.1-1 kg)
1, 0.1%
2, 0.1%
252, 17.9%
61, 4.3%
114, 8.1%
743, 52.9%
1, 0.1%
2, 0.1%
1, 0.1%
1, 0.1%
86, 6.1%
3, 0.2%
14, 1.0%
5, 0.4%
66, 4.7%
24, 1.7%
6, 0.4%
22, 1.6%
Launched
Not launched
0
100
200
300
400
500
600
700
800



It seems to easily employ ambitious missions.



Note! Not the number of satellites. Some have 2 downlink modules. Amateur radio transponders or satellite-to-satellite links usually not included.

Downlink of practically sampled data is available.

Recent scientific results

- Most relevant Cubesat for Science:

  Radio Aurora Explore (NASA-NFS / 3U)

- Ionospheric irregularities
- Energetic electron precipitation
- Space weather

What is better mission for Cubesat?

- Current Cubesat can use X-band communication.
- University and company are major developers.
- Many instruments are currently feasible for CubeSat.
- Good resolution is difficult to obtain.

(in particular, camera and spectrometer)

What is feasible mission?

- Earthquake electromagnetic precursor
- Tsunami real-time monitoring
- Lunar mission (energetic particles around magnetotail, material resource)
- Animal behavior
- Microgravity, energetic charged particles, vacuum experiment for biology, material science etc.
- Radio noise temperature of passive measurement by two Cubesats (Microwave Radiometer)

Earthquake electromagnetic precursor

- Electromagnetic wave measurement
  (○ Electric field, × Magnetic field)
- In-situ plasma measurement (Langmuir probe)
- Long term observation (no interruption).
- Robust Cubesat is required.

Tsunami real-time monitoring

- Ship-GPS measurement - AIS communication

→Ship number depends on season, weather etc.

- Ionospheric monitoring (TEC measurement)

⇒Alternative method

Lunar mission (energetic particles around magnetotail, material resource)

- Langmuir probes (magnetotail)
- Particle measurement (magnetotail)
- Spectrometer (material on the surface)
- Magnetic field (local magnetic field survey)

-> Concurrent two missions depends on space inside the satellite.

Animal behavior

1) Is anomalous behavior before the earthquake true?

2) Do animal feel magnetic field?

- Trackers embedded in the animal
- Store and forward system
- Several Cubesats are required.

Microgravity, energetic charged particles, vacuum experiment for biology, material science etc.

- Small biology probe (microscope etc.)
- Small material probe

Radio noise temperature of passive measurement by two Cubesats (Microwave Radiometer)

To create real-time map of noise temperature for the differential data.

- Antenna with very low noise temperature
- Synchronous detector

Conclusion

- Scientists push Cubesat developers to employ their scientific mission.
- Special sensors for Cubesat should be developed.
- Cubesat mission produces more data affordable for the science.