Innovative research satellites in Sweden

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Swedish National Space Board

- Governmental space agency under the Ministry of Education and Research
- Responsible for national and international activities related to space and Earth observation
- Satisfy Sweden’s need of space infrastructure
- Promote Swedish space industry and space research
- Annual budget ~100 M€
- Established in 1972
Why national satellites?
### National/multilateral scientific satellites

<table>
<thead>
<tr>
<th>Satellite</th>
<th>Country</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viking</td>
<td>Sweden</td>
<td>1986-1987</td>
</tr>
<tr>
<td>Freja</td>
<td>Sweden, Germany</td>
<td>1992-1996</td>
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<tr>
<td>Astrid</td>
<td>Sweden</td>
<td>1995-1995</td>
</tr>
<tr>
<td>Astrid-2</td>
<td>Sweden</td>
<td>1998-1999</td>
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<tr>
<td>Munin</td>
<td>Sweden</td>
<td>2000-2001</td>
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<tr>
<td>Odin</td>
<td>Sweden, Canada, Finland, France</td>
<td>2001-</td>
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<tr>
<td>Prisma</td>
<td>Sweden, France, Germany, Denmark</td>
<td>2010-2015</td>
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</tbody>
</table>
Odin

- Radiometer for studies of the atmosphere and astronomical objects.
- Launched on 20 February 2001, close to 16 years in operation.
- 405 Articles (364 Atmosphere, 33 Astronomy)
- 25 PhD theses
- 28 Master theses

Telescope:
Offset Gregorian 10 micron accuracy RMS
Aluminized carbon fibre composite

Radiometer front-end:
Four 500 GHz receivers, one 119 GHz
Frequency tuned mixers/LO's, optics
Active cooling of mixers, amplifiers

Back-end:
800 MHz auto correlators
1 GHz AOS, 3 filters
150-1000 kHz resolution
100 Mbyte mass memory
0.7 Mb/s down link

Position sensors:
Star trackers
Sun sensors
Magnetometers
Gyros

OSIRIS:
UV/optical slit
spectrograph
IR imager

Sun shield
PRISMA - Autonomous Formation Flying
Contributions from Swedish scientists to ESA space science projects
JUICE World Class Science Instruments
InnoSat platform

Baseline specification:

• Payload mass: 15 kg (total mass 40 kg)
• Payload size: 65×53×43 cm
• Power: 45 W on orbit average
• Data volume: 180 MBytes per day
• Limb pointing accuracy:
  5 km absolute pointing error
  0.5 km absolute knowledge error
• Sun-synchronous polar “terminator” orbit
• Lifetime: 2 years
First mission is MATS

- **Mesospheric Airglow/Aerosol Tomography and Spectroscopy**
- Studies of waves in the middle atmosphere and their influence on climate
- Mass: ~40 kg
- Low cost, around 12 M€ incl. instruments
- Launch: 2019
Current developments, future outlook

- Second call for proposals using the InnoSat platform for launch in 2021. Improved power capability allows wider range of orbits.

- Candidates under study during 2017:
  - **DICE** – Dual-frequency Ice Cloud Explorer, providing climate data for ice cloud characteristics.
  - **SIW** – Stratospheric inferred winds, a small satellite to explore middle atmospheric wind structure and related constituents fields.
  - **SPHINX** – Satellite polarimeter for high energy X-rays, opening a new window on the brightest explosions in the universe.

- University cubesats being developed as well

- Policy for avoiding space debris – orbit decay within 25 years
Orbital launches from the Esrange Space Center?
Conclusions

• Experimental scientists have progressed from;
  1. Sounding rockets and stratospheric balloons
  2. Satellites (small, low-cost, national, focused)
  3. Large international, interplanetary missions

• Constant need to maintain the two first options in order to;
  – Develop new scientific groups in new disciplines
  – Develop new instrumentation, qualify for flight
  – Maintain proficiency in managing projects, groups, students

• Excellent opportunities for industry to work together with academia on advanced projects.