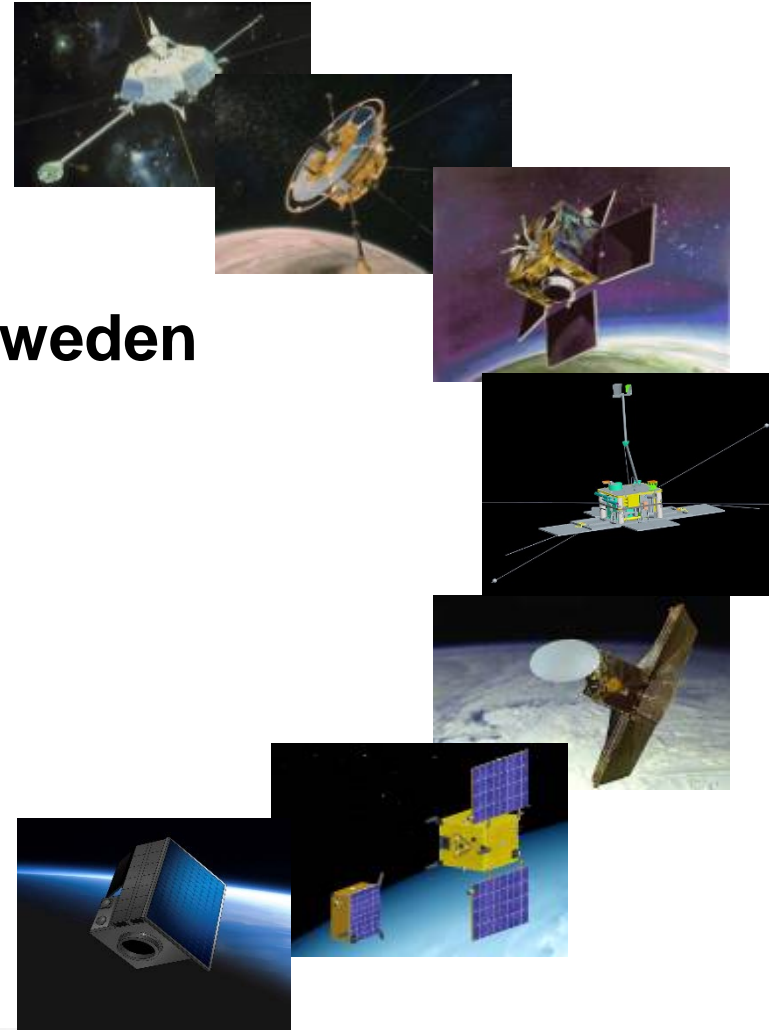


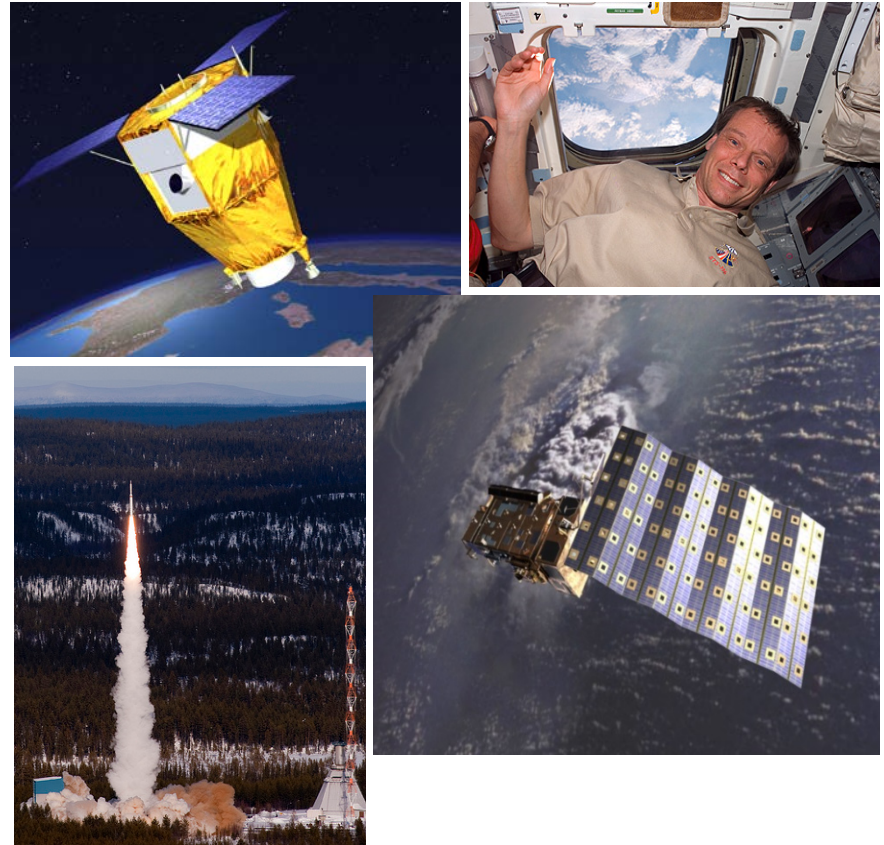
Innovative research satellites in Sweden

Dr. Olle Norberg
Director-General
Swedish National Space Board



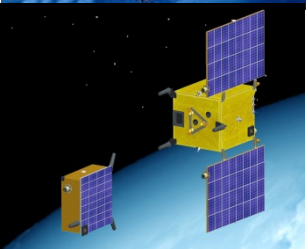
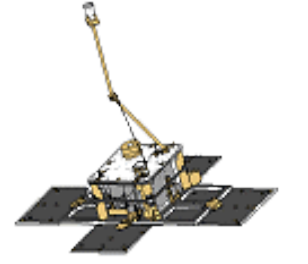
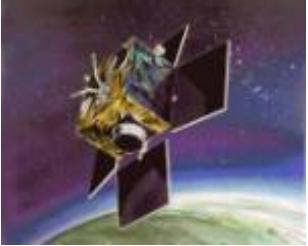
Swedish National Space Board

- 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





National/multilateral scientific satellites



Viking

Sweden

1986-1987

Freja

Sweden, Germany

1992-1996

Astrid

Sweden

1995-1995

Astrid-2

Sweden

1998-1999

Munin

Sweden

2000-2001

Odin

Sweden, Canada,
Finland, France

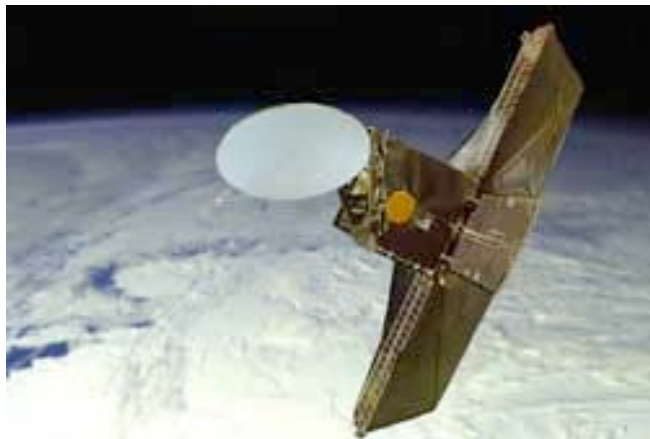
2001-

Prisma

Sweden, France,
Germany, Denmark

2010-2015

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:

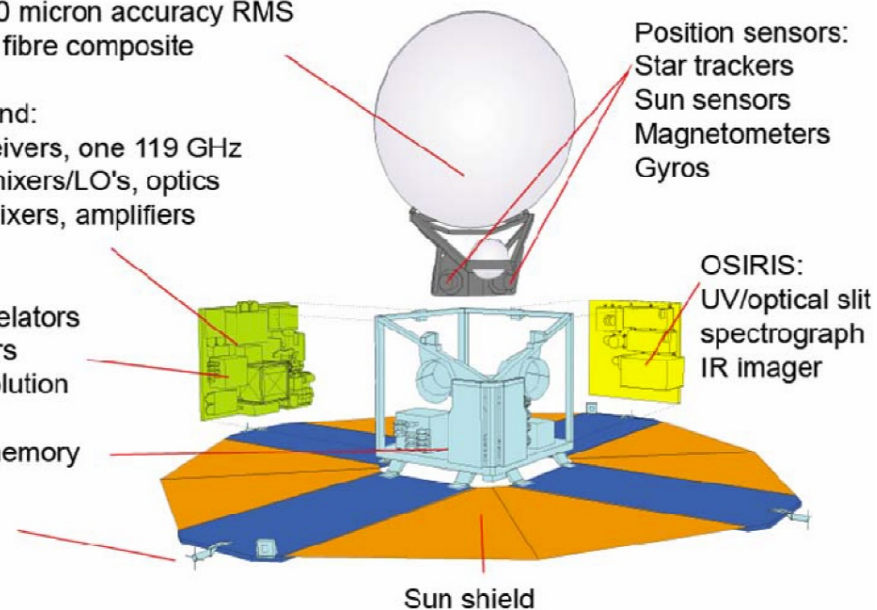
Four 500 GHz receivers, one 119 GHz
Frequency tuned mixers/LO's, optics
Active cooling of mixers, amplifiers

Back-end:

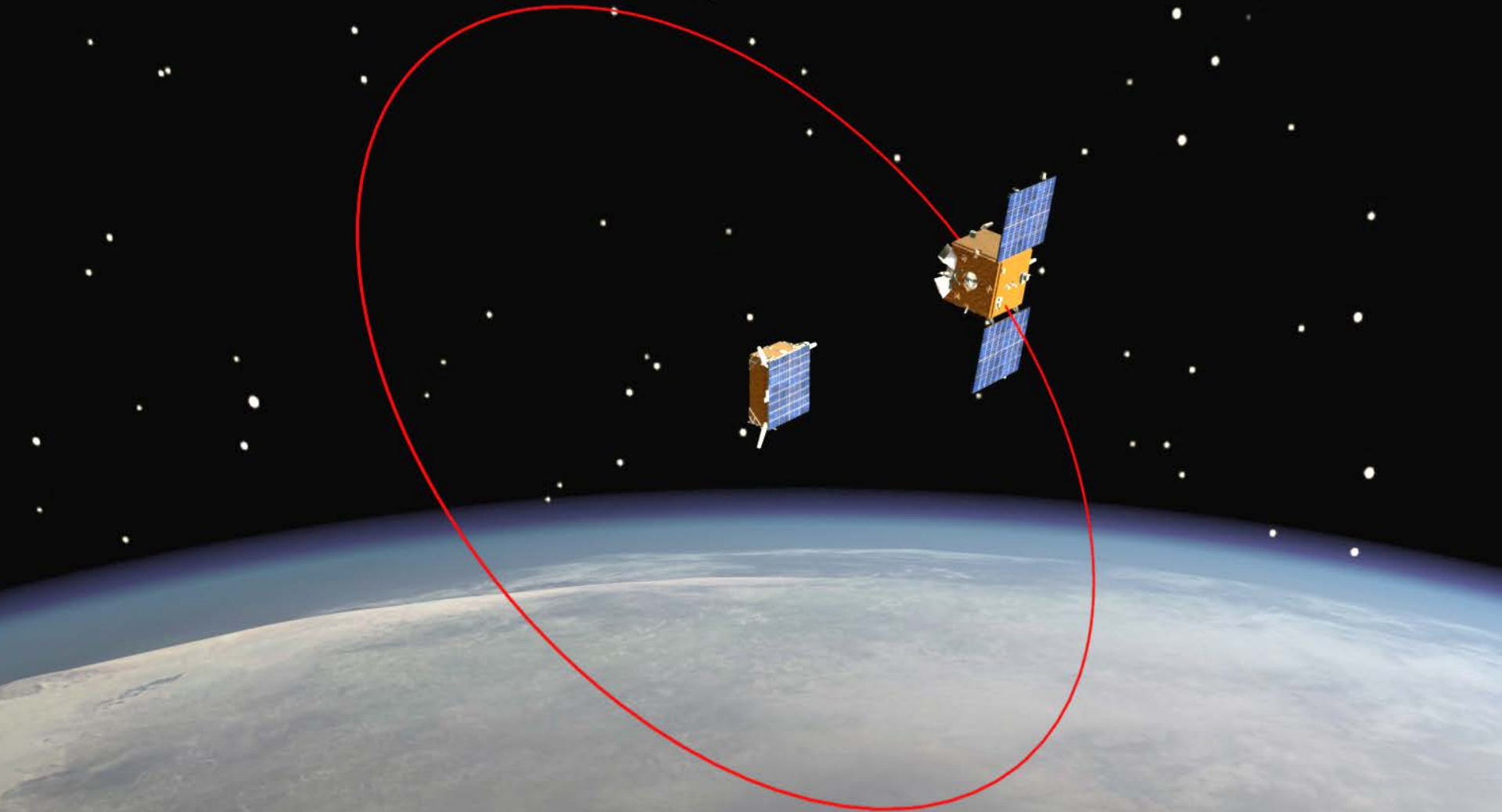
800 MHz auto correlators
1 GHz AOS, 3 filters
150-1000 kHz resolution

100 Mbyte mass memory

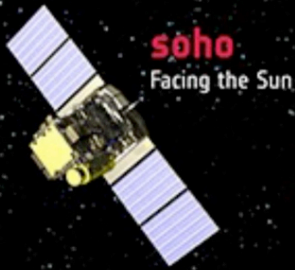
0.7 Mb/s down link



PRISMA - Autonomous Formation Flying



Contributions from Swedish scientists to ESA space science projects



soho
Facing the Sun



venus express
Studying Venus' atmosphere



juice
Characterising the conditions of ocean-bearing moons around Jupiter



bepicolombo
Exploring Mercury



proba-2
Observing coronal dynamics and solar eruptions



cassini-huygens
Studying the Saturnian system and landing on Titan



solar orbiter
The Sun up close



cluster
Measuring Earth's magnetic shield



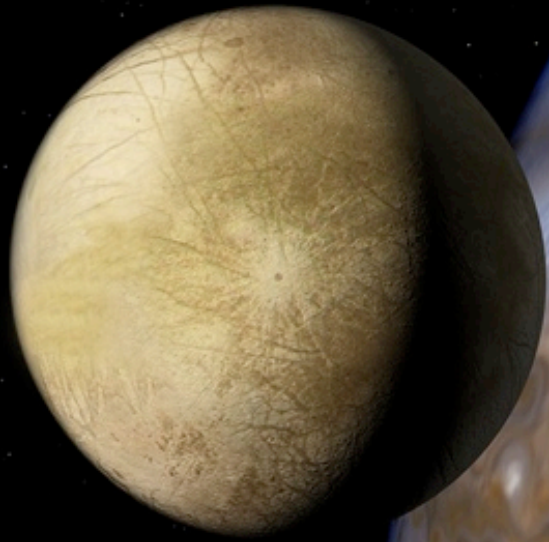
mars express
Investigating the Red Planet



rosetta
Chasing a comet



→ **ESA'S FLEET IN THE SOLAR SYSTEM**

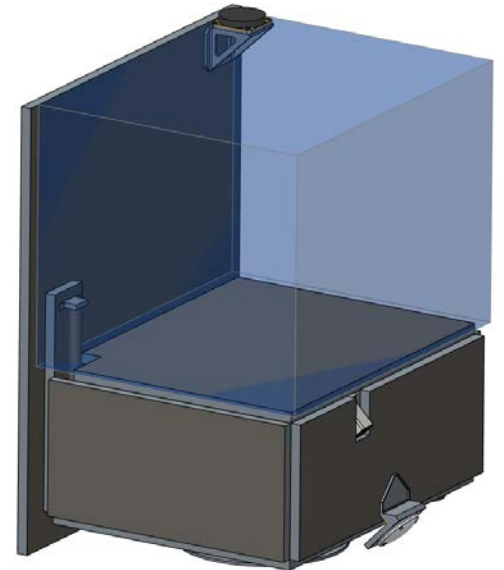


JUICE

InnoSat platform

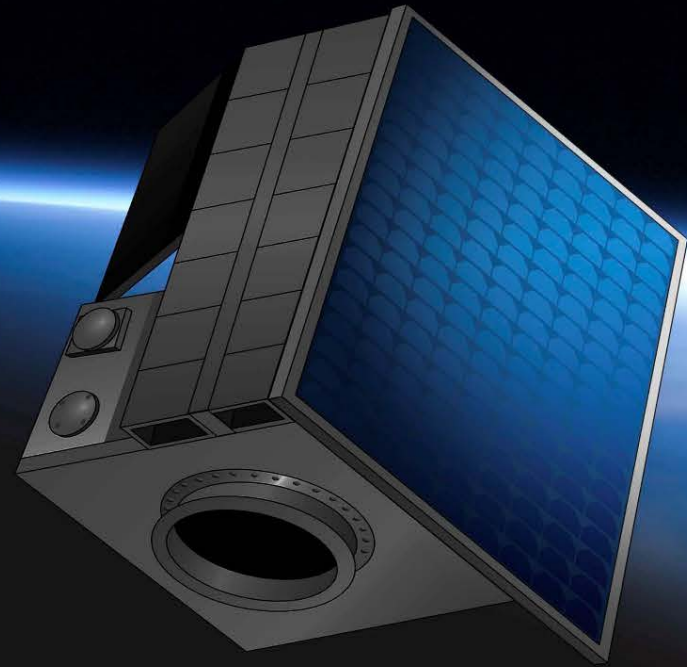
Baseline specification:

- 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.