

# Swedish Institute of Space Physics

Institutet för rymdfysik

Olle Norberg, Director-General



# IRF, EISCAT and LTU share the Space Campus in Kiruna



# About IRF

- Established in 1957 by the Royal Swedish Academy of Sciences
- Government authority since 1973, under Ministry of Education and Research
- Kiruna (head office, 65), Uppsala (40), Lund (3), Umeå (2)
- Government grant / external funding: 50% - 50%
- 4 professors, 8 associate professors, ~35 researchers, ~14 Ph.D. students, ~ 35 engineers and software developers
- Very international – 45 colleagues with an international background from 23 different nations

# IRF's research

- Observing geophysical and atmospheric parameters – approx. 50 different instruments in northern Sweden. Long term measurement series.
- Space and atmospheric research using ground based instruments, including EISCAT, as well as on rockets and stratospheric balloons.
- Solar system research using our own instruments on spacecraft in the solar system.

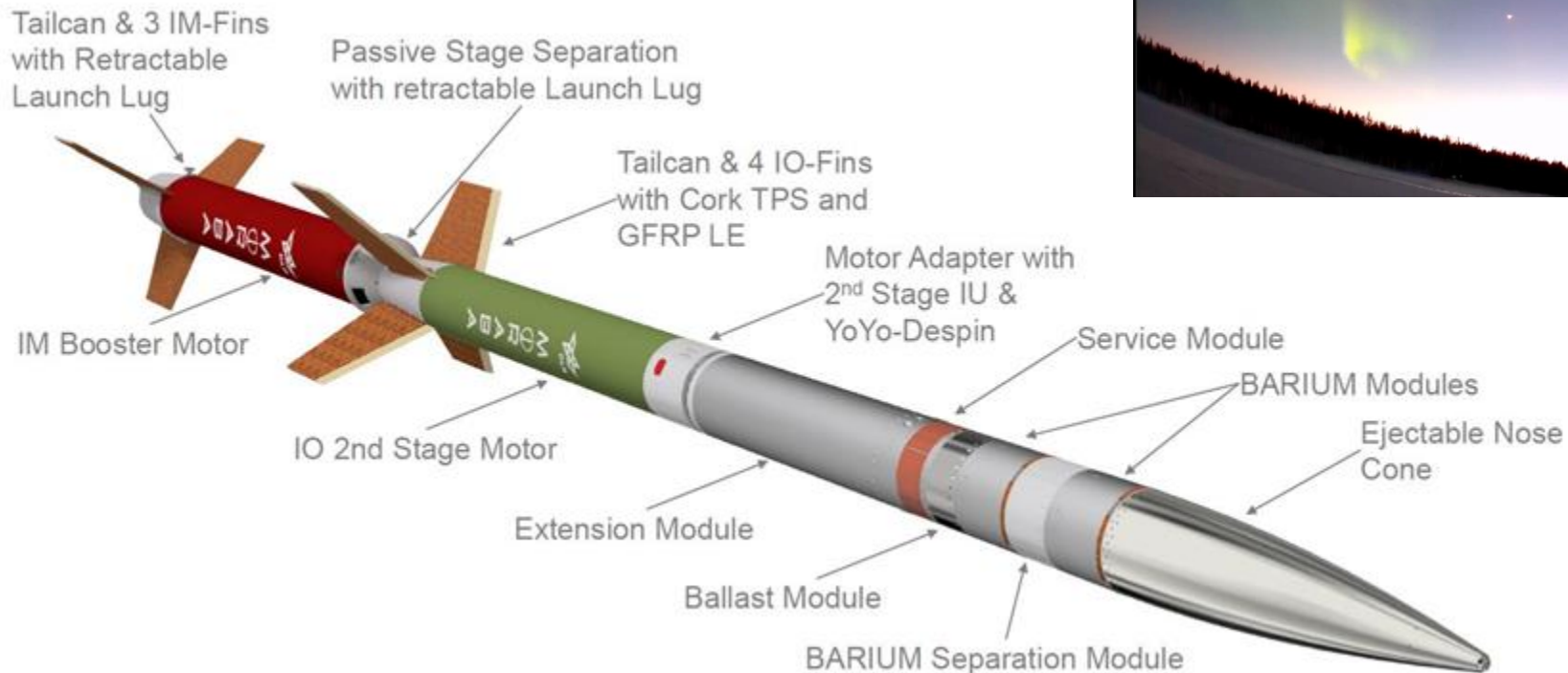
## Observatory measurements since 1950's

- 3 Ionosondes
- 3 Magnetometers
- 3 All-sky cameras
- 7 ALIS\_4D auroral imagers
- 2 Riometers
- 4 Infrasound stations
- mm-wave radiometer (Ozone)



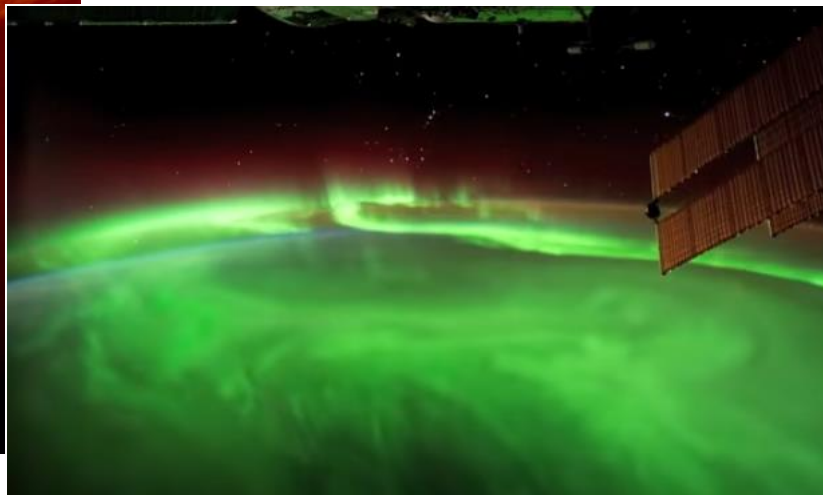
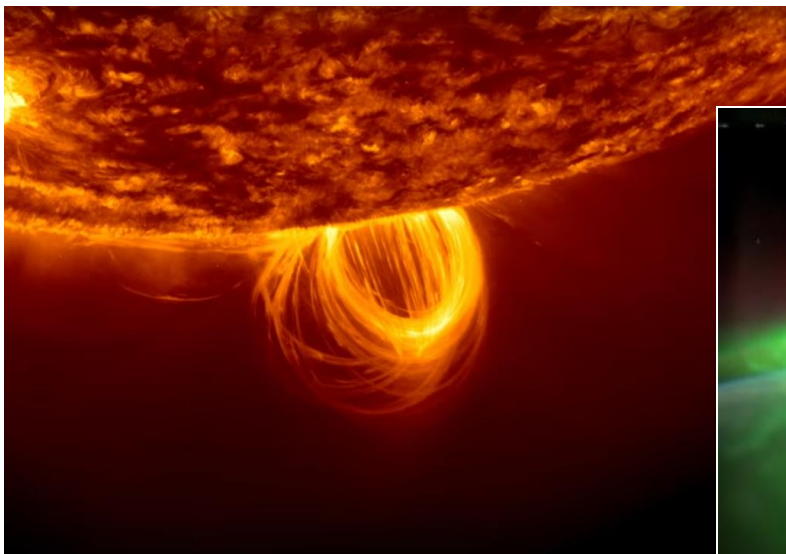
# BROR sounding rocket on March 23, 2023

- Two-stage rocket to 240 km apogee
- Barium releases at 8 different altitudes for studies of ionosphere dynamics
- Excellent data from ground instruments
- Also lots of external images and videos



# Applications of our research: Space Weather

- How does solar storms and the space environment affect infrastructure in space and on the ground?
- Observations, research, forecasts and alerts
- Stakeholders: ESA and its Space Weather Service Network users, Swedish Armed Forces, power grid operators, Swedish Civil Contingencies Agency



# IRF Aurora Alert

- Provides an alert (push notice) when the IRF all-sky camera in Kiruna detects visible aurora
- Available for iPhone/iPad and Android



**IRF Aurora Alert** 4+

Swedish Institute of Space Physics

[www.spaceweather.se](http://www.spaceweather.se)

[firmament.irf.se](http://firmament.irf.se)

# Applications of our research: Space Safety

- IRF studies the orbits, dynamics, and size distribution of space objects
- Research and development of orbit determination of space objects using both radar and optical stations.
- IRF:s contribution to Space Situational Awareness: research and method development



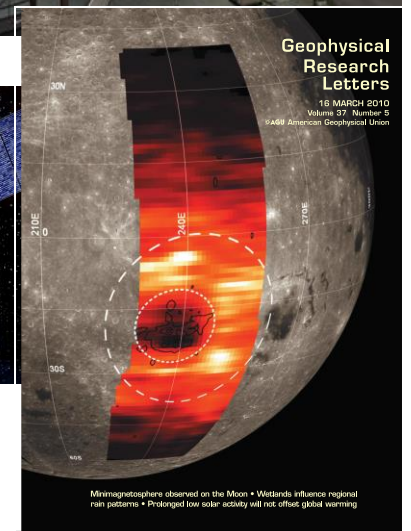
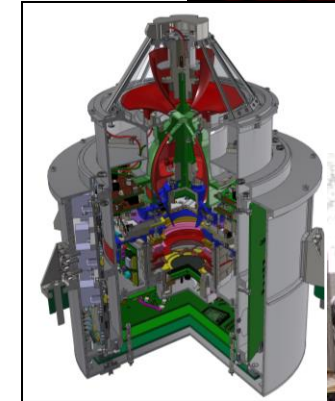
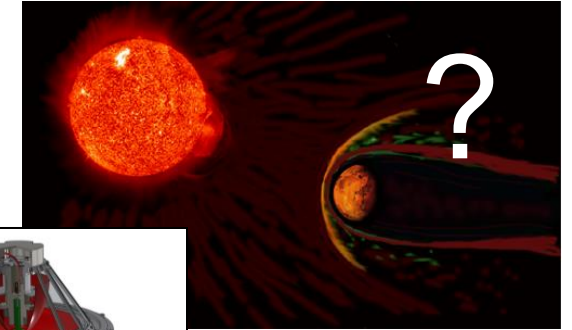
# Solar wind interaction with planets, moons, asteroids, and comets

IRF has specialized in research regarding space plasma – charged gas particles and the electric and magnetic fields in the space plasma.  
World leading in developing and building certain instrumentation in this area.



# Our scientific cycle

- Science questions →
- Measurement requirements →
- Instrument design →
- Manufacturing →
- Test, qualification, calibration →
- Delivery to the mission agency →
- Operations →
- Data analysis →
- Publications → science questions



# Spacecraft currently used by IRF

IRF has 15 instruments in operation on 13 spacecraft:

4 x NASA Magnetospheric Multi Scales (MMS)

3 x ESA Swarm

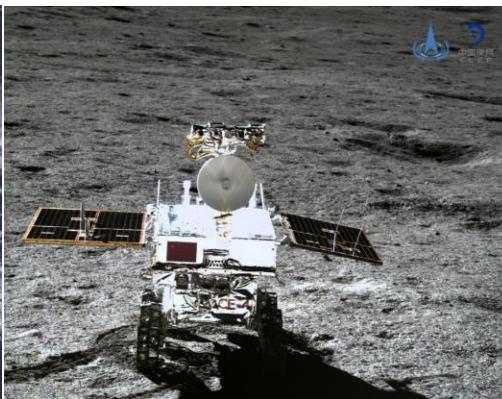
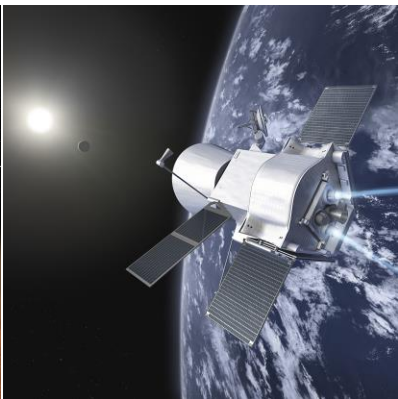
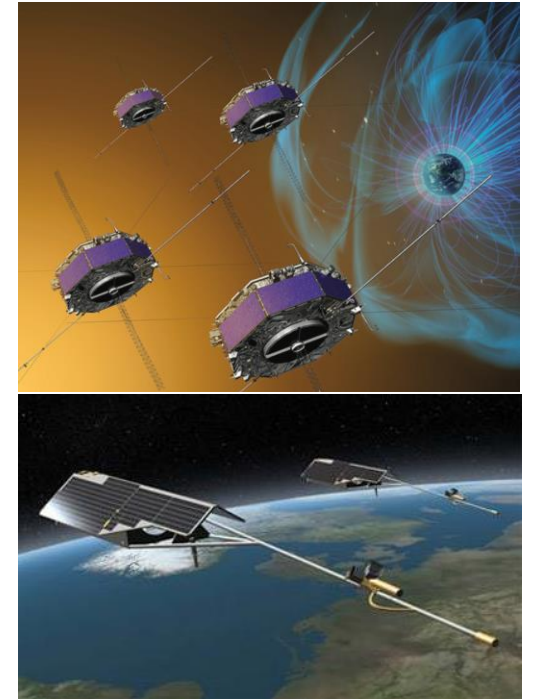
1 x ESA Mars Express (Mars, 22 years!)

2 x ESA + JAXA BepiColombo (→ Mercury, 2026)

1 x CNSA Chang'e 4 (lunar rover on far side, 6 years)

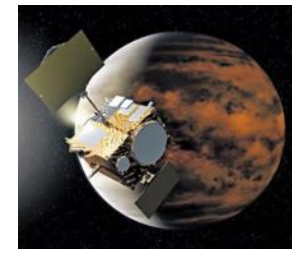
1 x ESA Solar Orbiter (orbit close to the Sun)

1 x ESA Juice (→ Jupiter)





# Projects under development



<b>Mission</b>	<b>Destination</b>	<b>Agency</b>	<b>Launch</b>	<b>Experiment</b>
AYAP 1	Moon, polar orbit	Türkiye	2027	Lunar Neutrals Telescope
Venus Orbiter	Venus , polar orbit	India	2028	Venus Neutrals Analyzer
Ramses	asteroid Apophis	ESA	2028	Ramses Plasma Spectrometer
Comet Interceptor	fly-by of a comet	ESA	2029	Neutrals, Ions, Electrons
TBD	Lunar surface	ESA	TBD	Neutrals, Ions, Electrons

ESA's JUICE, Jupiter Icy Moons Explorer, launched on 14 April 2023  
Arrives at Jupiter in July 2031  
Will study the icy moons Europa, Ganymede, and Callisto



## MEET THE TEAM: INSTRUMENT PRINCIPAL INVESTIGATORS

[Click here](#) for a full list of Juice instruments with technical descriptions, principal investigators, co-principal investigators and lead funding agencies.



### Optical camera system (JANUS)

**Pasquale Palumbo**  
Università degli Studi di Napoli  
Parthenope  
Italy



### UV imaging spectrograph (UVS)

**Randy Gladstone**  
Southwest Research Institute  
USA



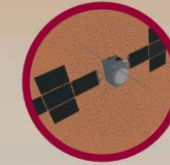
### Radar sounder (RIME)

**Lorenzo Bruzzone**  
Università degli Studi di Trento  
Italy



### Radio science experiment (3GM)

**Luciano Iess**  
Sapienza Università di Roma  
Italy



### Particle environment package (PEP)

**Stas Barabash**  
Institutet för rymdfysik  
Kiruna, Sweden



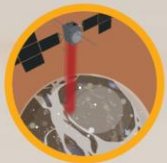
### Visible and infrared imaging spectrometer (MAJIS)

**François Poulet**  
Institut d'Astrophysique Spatiale  
France



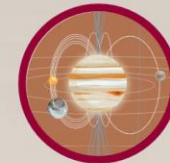
### Sub-millimetre wave instrument (SWI)

**Paul Hartogh**  
Max-Planck-Institut für  
Sonnensystemforschung  
Germany



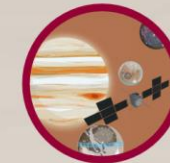
### Laser altimeter (GALA)

**Hauke Hussmann**  
DLR Institut für Planetenforschung  
Germany



### Magnetometer (J-MAG)

**Michele Dougherty**  
Imperial College London  
United Kingdom



### Radio and plasma wave instrument (RPWI)

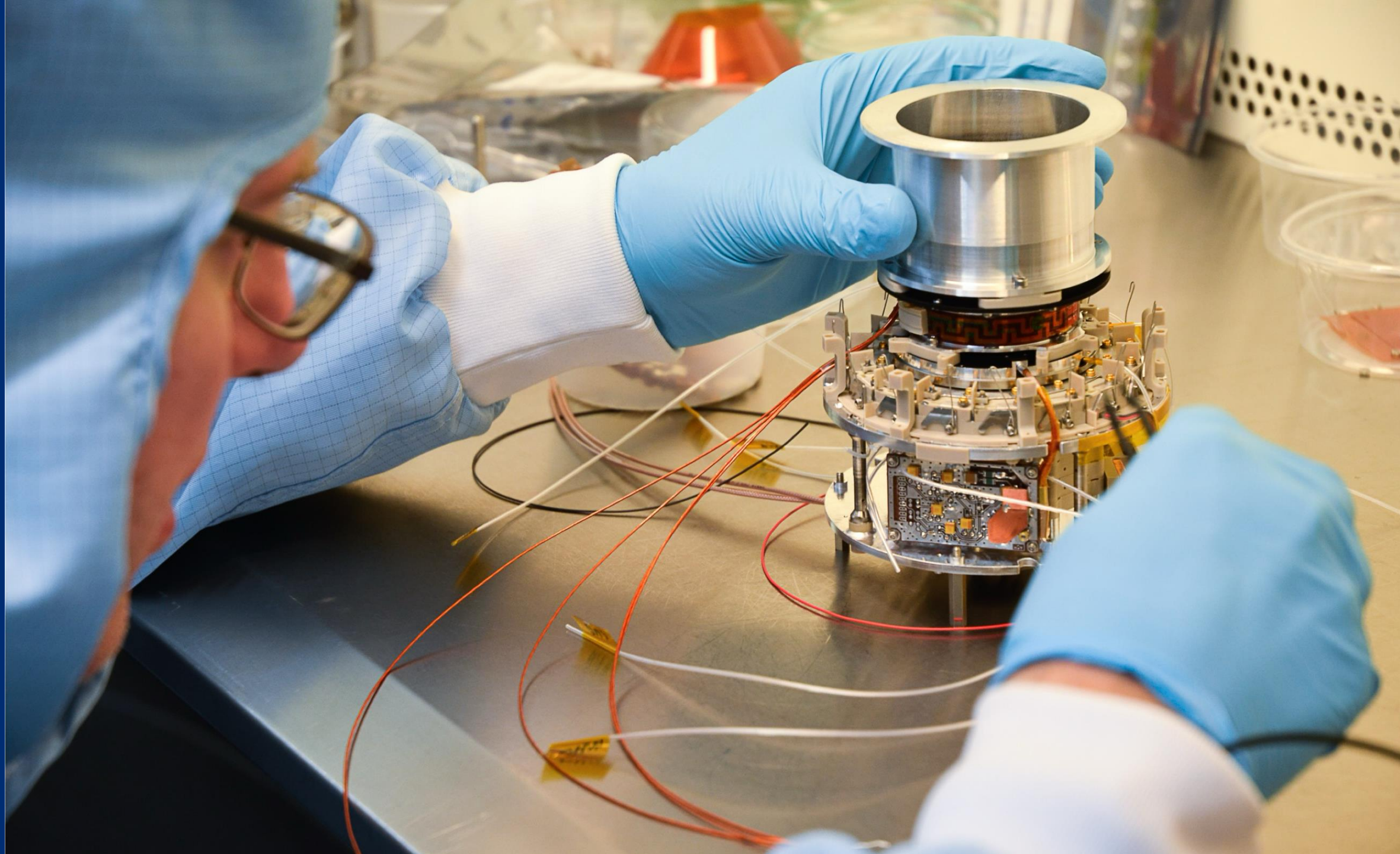
**Jan-Erik Wahlund**  
Institutet för rymdfysik  
Uppsala, Sweden

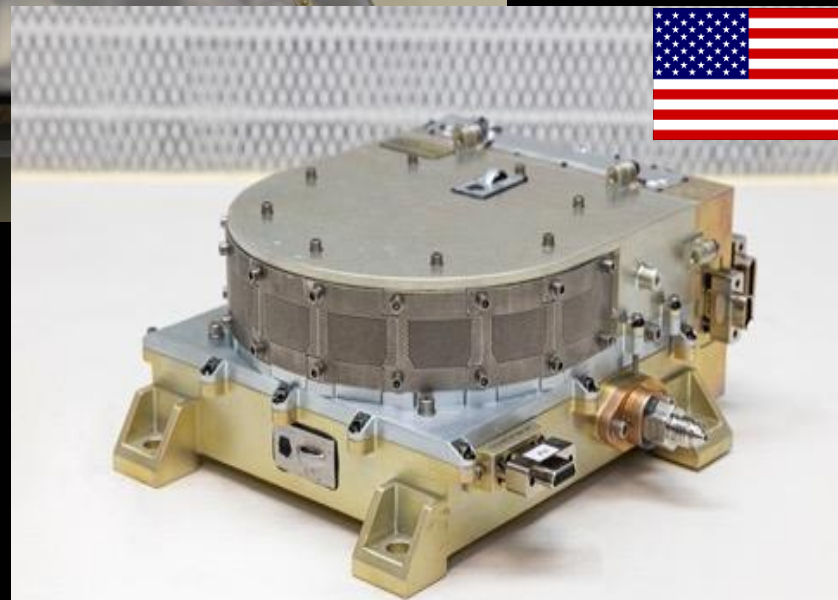


### Planetary Radio Interferometer & Doppler Experiment (PRIDE)

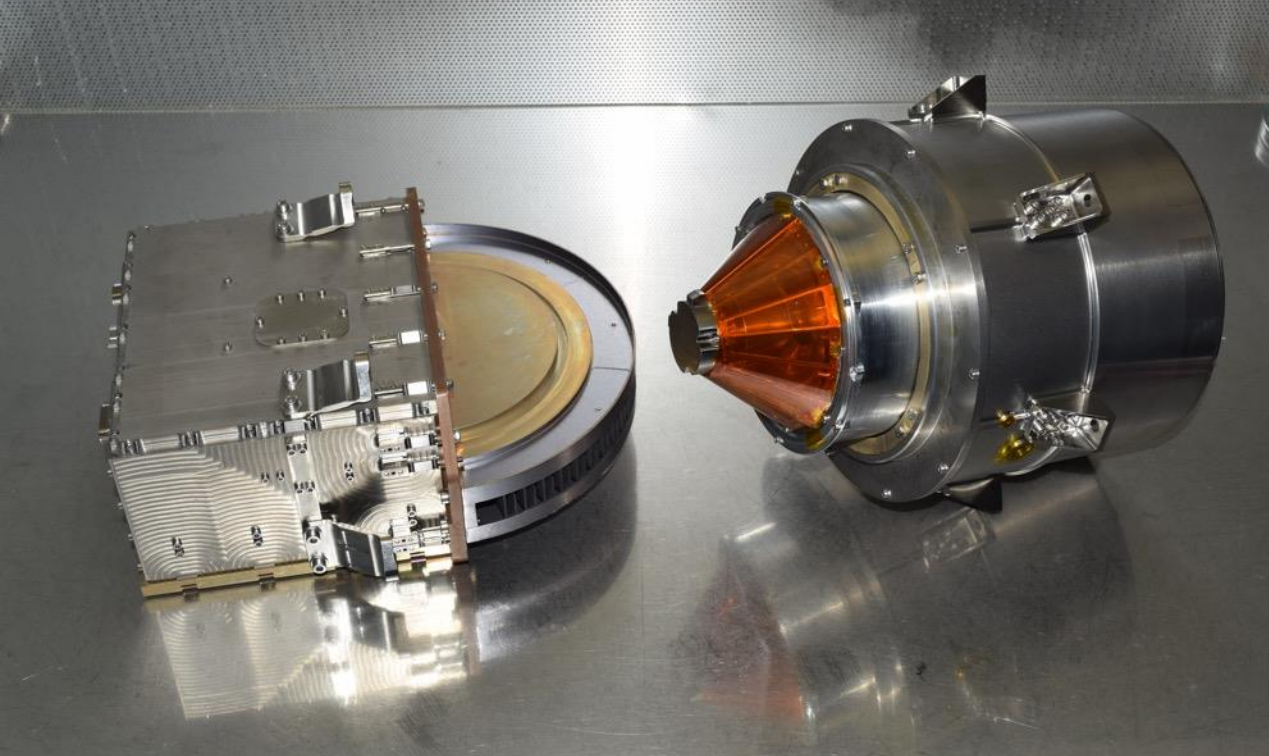
**Leonid Gurvits**  
Joint Institute for VLBI ERIC and Technische Universiteit Delft  
Netherlands





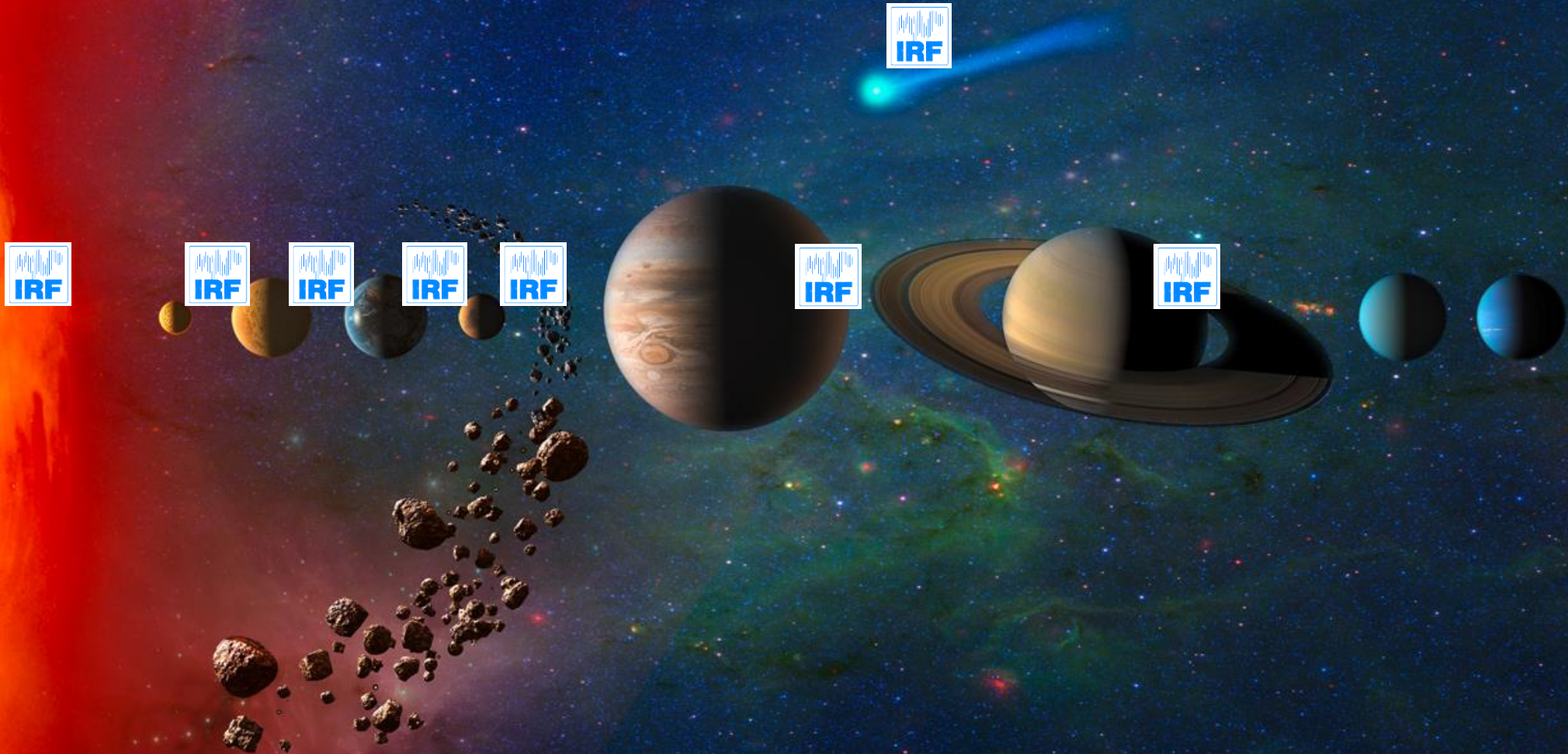


# The Particle Environment Package



57 years with instruments in Earth orbit

37 years in the Solar System



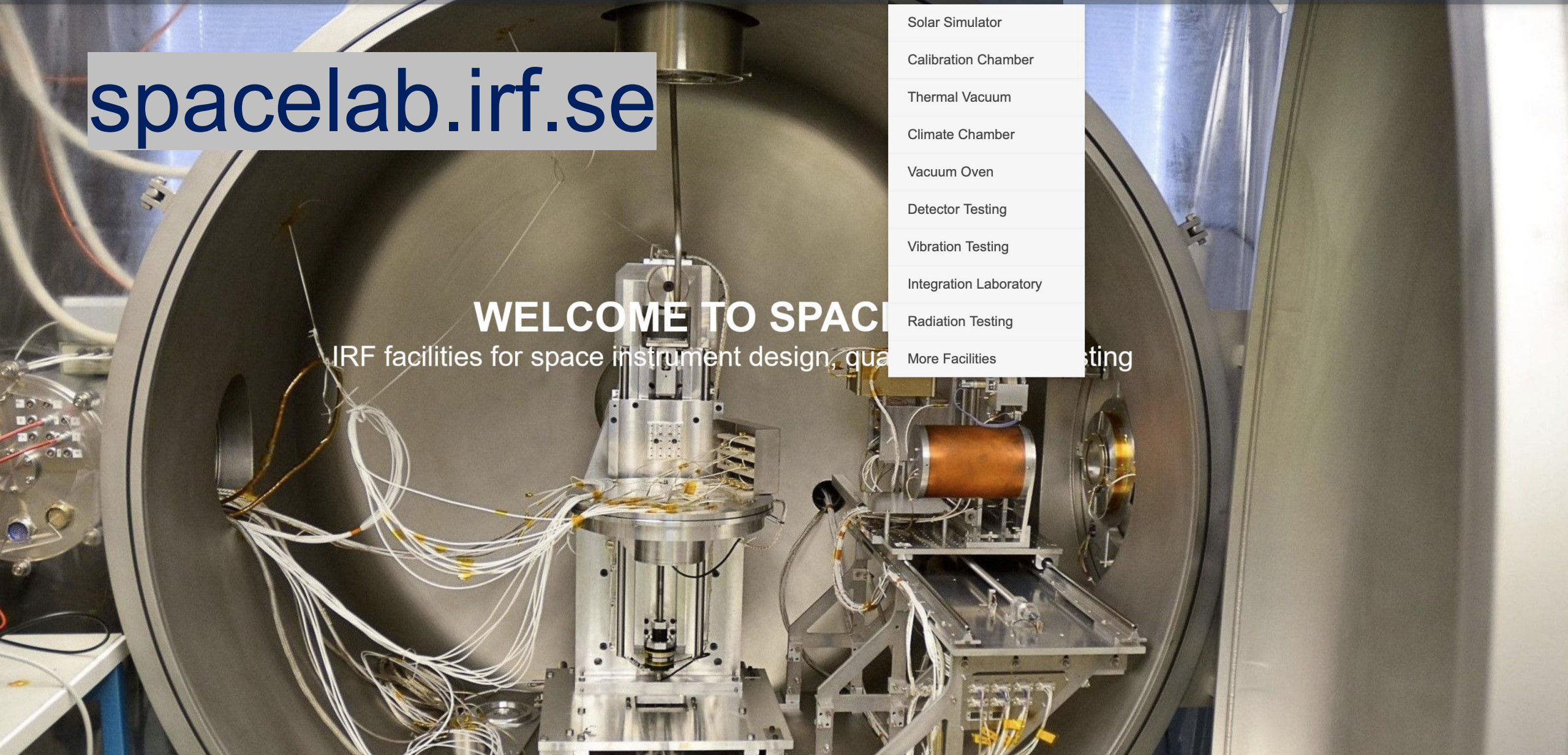
spacelab.irf.se

- Solar Simulator
- Calibration Chamber
- Thermal Vacuum
- Climate Chamber
- Vacuum Oven
- Detector Testing
- Vibration Testing
- Integration Laboratory
- Radiation Testing
- More Facilities

# WELCOME TO SPACE

IRF facilities for space instrument design, qual

testing



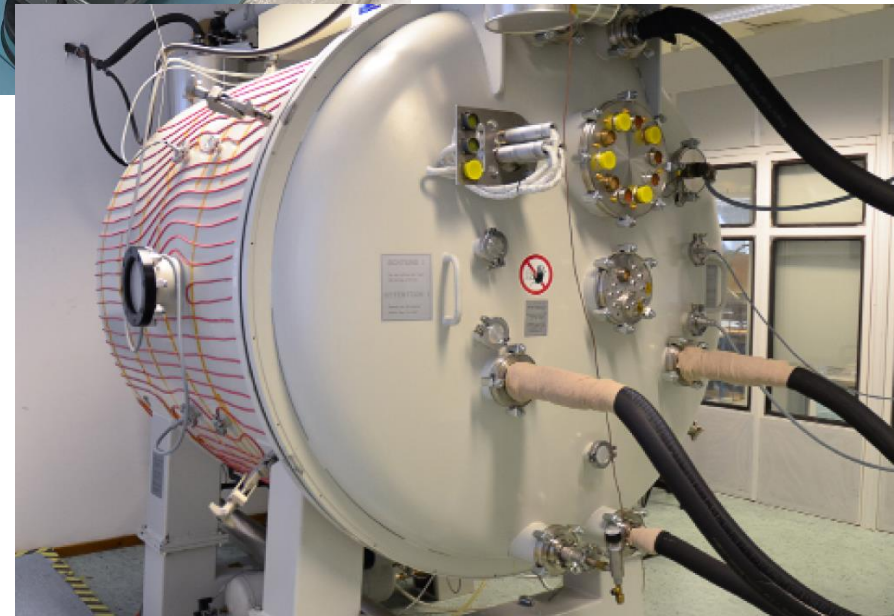
# Examples of IRF SpaceLab facilities



Radiation



Vibration



Solar balance and thermal vacuum