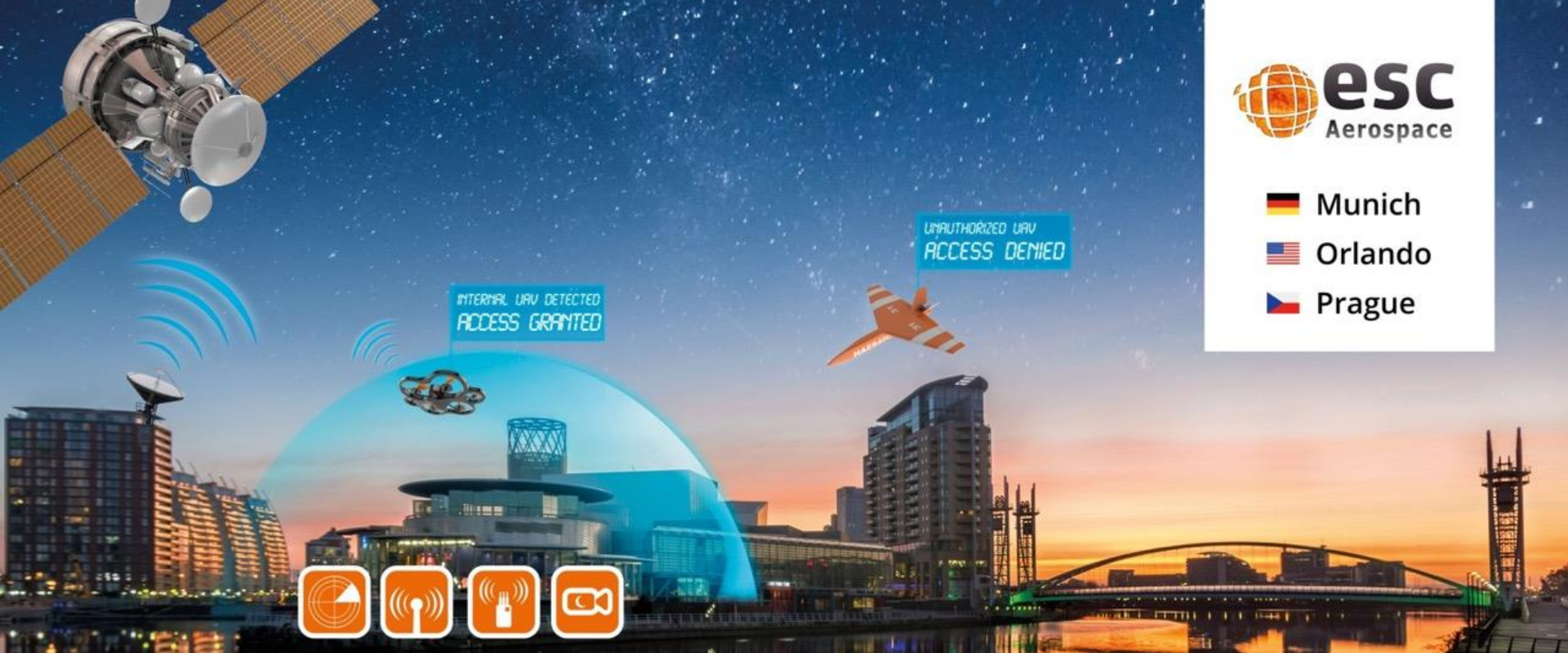




esc Aerospace is an agile **product neutral systems integrator** with the depth of experience of a larger corporation. Our size, low overhead, extensive solutions partnerships and global reach enable us to meet the highest complexity technological challenges and meet our clients' needs with **best value solutions**.

Satellites, flight software, radiation monitors SpacePix®

14.5.2019

Company Overview 1/3

esc Aerospace is an expert in areas of **Avionics**, Autonomous Software, Counter-Unmanned Aerial Systems (**C-UAS**) and Guidance, Navigation & Control (**GNC**) systems. esc Aerospace offer services as a leading SME in innovative R&D projects with a focus on aerospace satellite payload chains modeling, as well as target drone defense services to eliminate the threats and to localize the radioactive waste (CBRN services). esc Aerospace offers also **space qualified On-Board Control Systems**, full design of space qualified payloads and a consultancy to satellite design, its implementation, testing and preparations for a rocket launch.



Company Overview 2/3

esc Aerospace offer a product range of various **On-Board Control Systems** for vehicles and payloads, ranging from ionizing radiation hardened detectors to Data Relays and Sense & Avoid Systems. Commercial products include the **3rd generation** of UAS/RPAS avionics with an Autopilot, Trajectory Management and Tracking functions; the **4th generation** of GNC avionics has been developed for Launchers and Missiles, Micro-Satellite Instrumentation and Mini-Satellites. The **5th generation** is a miniaturized and highly reliable system that enables UAS/RPAS to perform SWARM functions. esc Aerospace develops systems based on a revolutionary ASIC designed for a wide range of space and non-space radiation measurements payloads (**6th generation**). It can be deployed as a miniaturized radiation detector with the capability of identifying radiation in early warning systems. esc Aerospace has recently presented its UAS/RPAS flight simulator. The AERO/SPACE FLIGHT SIMULATOR is targeted for expert users of UAS/RPAS and includes various aircraft and advanced options such as full autopilot.

esc Aerospace is building a new **satellite Communication Ground Station**, near to Prague, to monitor own satellite payloads, such as mentioned radiation detector payloads (Radiation orbital monitor based on the **SpacePix®** sensor). esc Aerospace has prepared several concepts of nano- and micro-satellites. These platforms could be used for EO monitoring and reconnaissance.

Company Overview 3/3

Economic indicators

Type of company:	Limited Liability Company
Company founded:	1999
Certificates:	ISO 9001, ECSS, NATO clearance

Business offer

- On-Board Control Systems, OBC, GNC
- Flight Software programming for various satellites
- Satellite Communication Ground Station
- UAS/RPAS avionics with an Autopilot, Trajectory Management, Tracking and SWARM functions
- UAS/RPAS flight simulator; simulations with augmented reality/VR
- C-UAS drone detection system services / CBRN services - ionizing radiation hardened detectors
- EGSE (Electrical Ground Support Equipment), SCOE / On-site engineering support
- Quality Assurance / Project and Configuration management / Research & Development

Lines of Business

escSPACE™



Space Systems & Applications

escITSEC™



Cyber Security & Systems

escDRONES™



Full Service UAS Integrator

escSPACE™



Space Systems & Applications



On-board systems

- Qualified flight software
- Avionics & On-board Computer (OBC)
- Radiation monitor & sensor systems



Applications

- Secure & resilient communications leveraging **SATCOM**
- Data analytics



Test systems (EGSE / SCOE)

Cyber Security & Systems

escITSEC™



Processes (IT, OT, products)

- Strategy consulting (CISO) / Project management
- Assessment, design, improvement & audits (ISO 27001)



People

- Tailored user awareness
- Training (product & process)



Technologies (Concept, PoC & impl.)

- Network: Firewall, IDS, IPS, ...
- Endpoint: VM, AV, exploit prevention
- Information Security: DLP, Data Privacy

Full Service UAS Integrator

escDRONES™



Product neutral systems integrator – extends enterprise security to the airspace:

- escCUAS™ – Counter UAS
- escMSAP™ – Multi Service Aerial Platform
- escMMS™ – Mission Management System



escUTM™

UAS Traffic Management integration

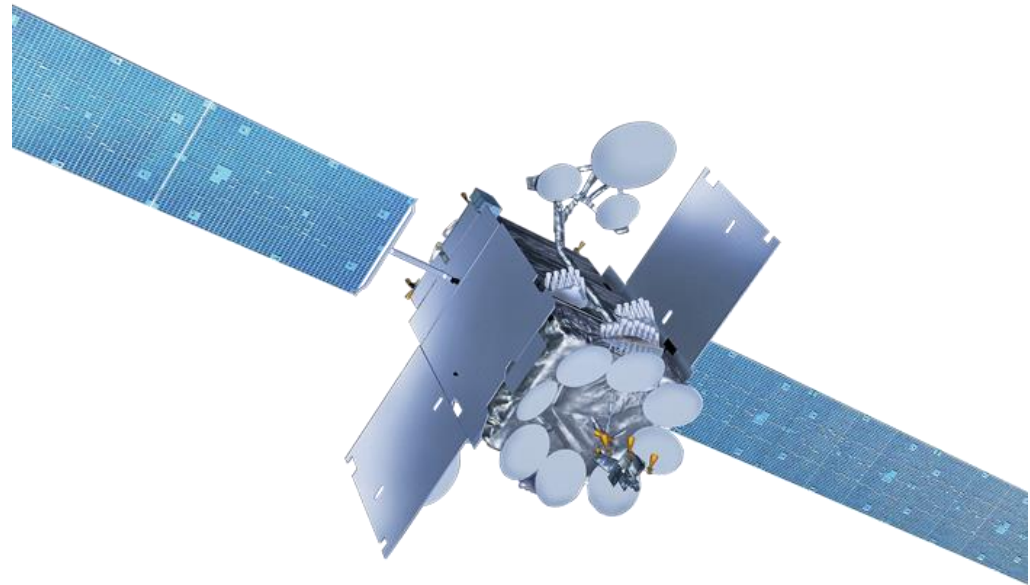
Space Missions

Early projects

- **MIMOSA** (Czech micro-satellite, 2003)
- **CZCUBE** (cubesat camera FSW in 2006)
- **CORONAS-Photon** (2007-2008)
- **SWARM** (micro-accelerometer, 2013)

Recent projects for ESA

- **Solar Orbiter**, instrument STIX
- **IRIS**, SatCom project
- **MTG**, payload simulation in Matlab
- **Sentinel 4**, instrument UVN
- **MetOp Second Generation**
- **Demise Observation Capsule**



Inmarsat-5 F4 (I-5 F4) © Inmarsat

Customers:

- Airbus, Thales, OHB, RUAG, Inmarsat

STIX Instrument On-board Software 1/2



- StartUp SW - Mission critical SW (stored in PROM)
- Application SW (stored in FLASH memory)

STIX On-board Software features

- Control of the instrument and interface to the spacecraft
- SpaceWire link interface, using the 'CCSDS packet transfer protocol' and ESA Packet Utilization Standard (PUS) TC/TM interface
- Housekeeping data acquisition and reporting
- FDIR (Failure detection, isolation and recovery) with a high level of autonomy



Solar Orbiter © ESA

STIX Instrument On-board Software 2/2



- Science data acquisition and storage in the instrument internal mass memory
- On-board data processing: Autonomous based on user parametrisation and Selective based on user TC requests – possible to select data from the instrument internal archive in the mass memory
- SW developed in C language
- HW target: Leon 3FT IP core in FPGA

Mission Background

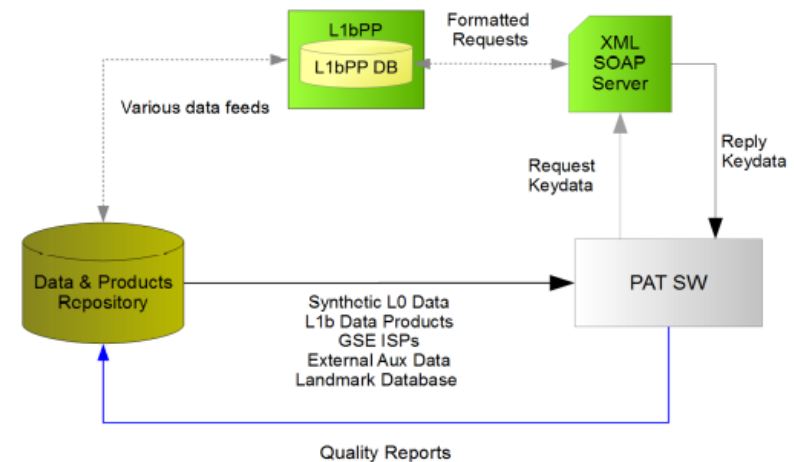
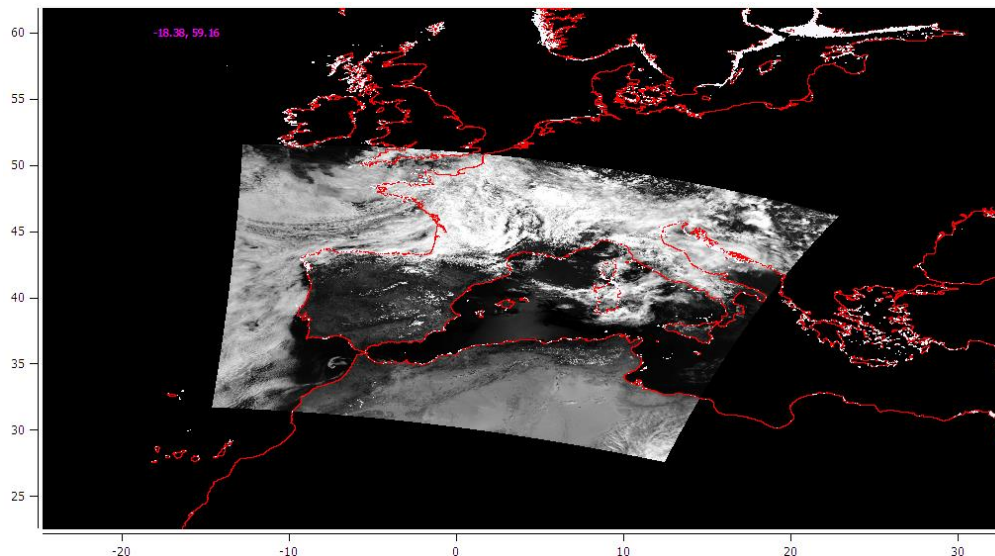
- The Solar Orbiter (SOLO) is one of the Cosmic vision M-Class ESA missions.
- The mission goal is to understand (and even predict) how the Sun creates and controls the Heliosphere.
- STIX (Spectrometer Telescope for Imaging X rays) is one of the SOLO's on-board remote sensing instruments.
- STIX provides imaging spectroscopy of solar thermal and non-thermal X-ray emissions from approx. 4 to 150 keV, with unprecedented sensitivity and spatial resolution (near perihelion), and good spectral resolution.
- Launch: 2020

SENTINEL-4 UVN PAT 1/3

- Ground-segment data processing SW

PAT Goals:

- To post-process the L1bPP outputs
- to assess the Radiometric Image Quality, the Spectral Performance,
- and the Geometric Image Quality



SENTINEL-4 UVN PAT 2/3

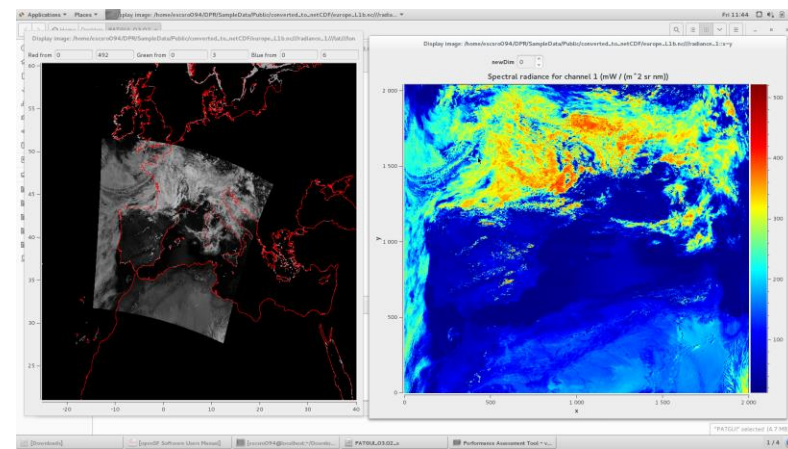
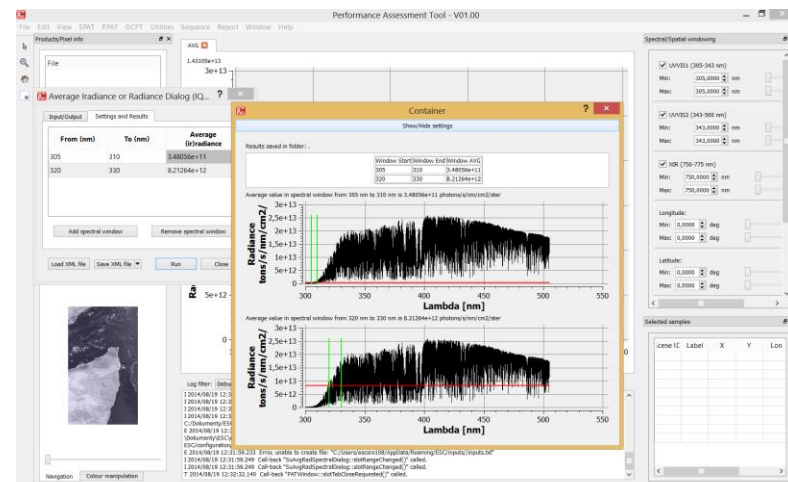


Performance Assessment Tool (PAT)

The PAT is part of the Sentinel-4 UVN Instrument Quality Tool, which generates Quality Reports of the Sentinel-4 UVN Data Products.

PAT processing SW features

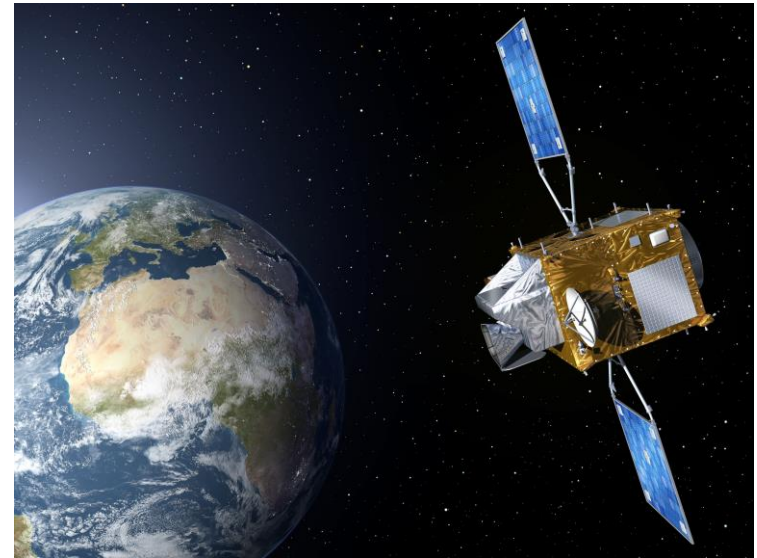
- Fully user driven, intuitive GUI
- Processing large data input (10 GB+) at a time
- Scalable performance based on HW platform
- Network based data-acquisition and storage, local operations available on demand
- Multiple/Generic 3rd party database import & support
- Supports integration into openSF; allows also flexible scientific functions addition
- Preview style operation available to generate sessions for full data processing, including automation of large sessions
- Graphical manipulation of data and scientific report generation
- Output to common file types (PDF, doc)



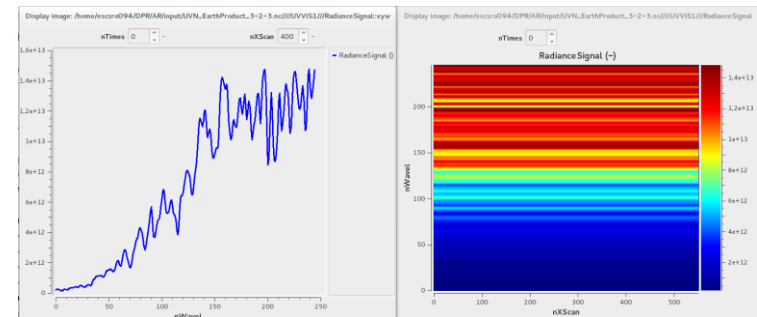
SENTINEL-4 UVN PAT 3/3

Mission background

Sentinel-4 is a payload that will be embarked upon a Meteosat Third Generation-Sounder (MTG-S) satellite in geostationary orbit scheduled to launch in 2019. Sentinel-4 is dedicated to atmospheric monitoring. The Dual spectrometers will provide first ever continuous observation of the atmosphere from a geostationary orbit. The MTG Satellite platforms will hold position at an altitude of 36,000 kilometres and will allow seamless observations of Europe and North Africa to be taken hourly. The system (constellation of satellites) will include 6 satellites, of which 2 are designated as Sounding satellites. They are a part of the Copernicus Programme.



Sentinel-4 instrument on the MTG-S satellite © ESA



Capsule 1/2

Capsule capabilities

- Independent re-entry capsule qualified to 'rideshare' with no impact on launcher payloads or operation
- Robust, modular design for the 3rd / 4th stages of a multitude of launch vehicles
- Miniaturised sensors and electronics in a versatile and extendable sensor suite
- Full nano-satellite capabilities
- Observation cameras on host vehicle and capsule
- **Onboard software for autonomous mission performance and in-flight data transfer**
- Safe and controlled stage separation after passivation
- ITAR-free equipment



Demise Observation Capsule © ESA

Capsule 2/2

Mission background

With the growing number of operating satellites (e.g. constellations) and space debris, and with the setting up of de-orbitation requirements, a better understanding and mastering of atmospheric re-entry has now become of utmost importance. It is essential for the success of the mission (regarding to limiting in-orbit risks and returning spacecraft to be retrieved), for public safety (population on ground exposed to collision and toxic risks), and for technology enhancement.



Capsule on a Vega rocket © ESA

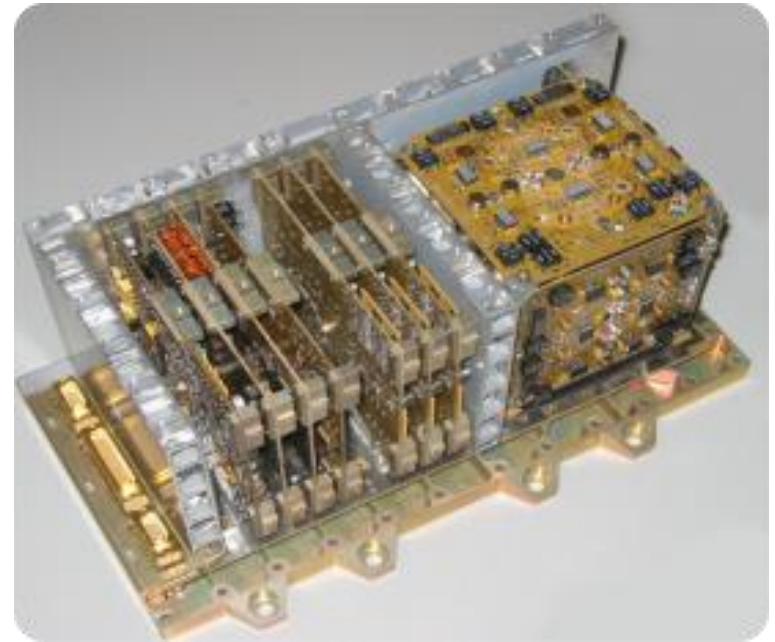
SWARM Micro-accelerometer 1/2

esc Aerospace designed, developed and qualified the Accelerometer Instrument On-Board SW, including:

- StartUp SW – Mission critical SW (stored in PROM)
- Application SW (stored in FLASH memory)

Accelerometer On-board Software features

- Science and Housekeeping data acquisition using multiple AD converters, time-stamped with accuracy better than 1 millisecond
- ESA Packet Utilization Standard (PUS) TC/TM interface
- SW developed in C language, time critical routines in Assembly
- HW target was a significant performance constraint for the SW – x51 family 8-bit microcontroller (Space qualified 80C32E at 12 MHz with only 268 Dhrystones / 0.153 VAX MIPS)
- Priority scheduler for optimal utilization of limited CPU performance

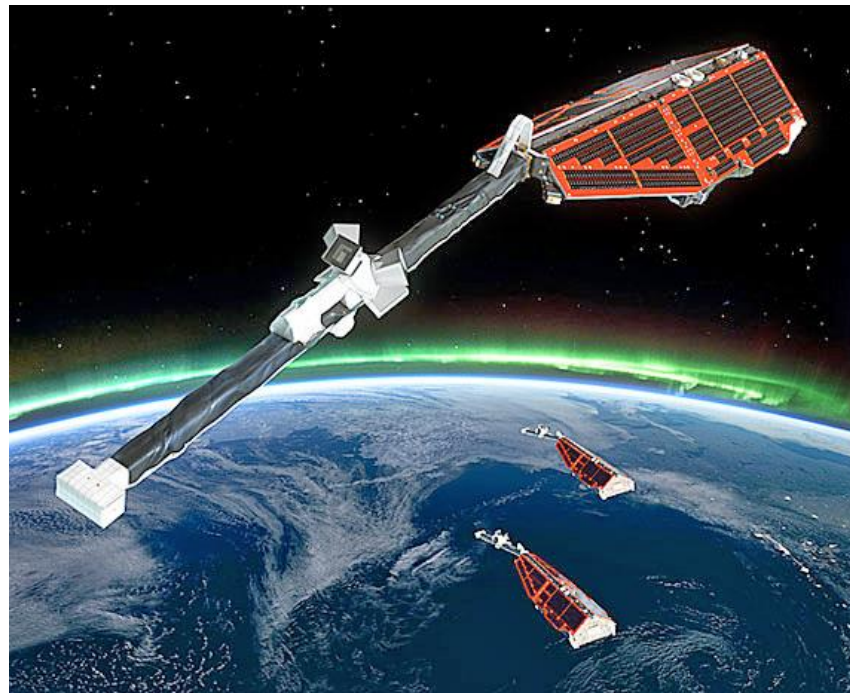


Micro-accelerometer © VZLÚ

SWARM Micro-accelerometer 2/2

Mission background

The SWARM mission objective is to provide the best survey ever of the geomagnetic field and the first global representation of its variations on time scales from an hour to several years. SWARM, a constellation mission (3 identical satellites), simultaneously obtains a space-time characterisation of both the internal field sources in the Earth and the ionospheric-magnetospheric current systems.

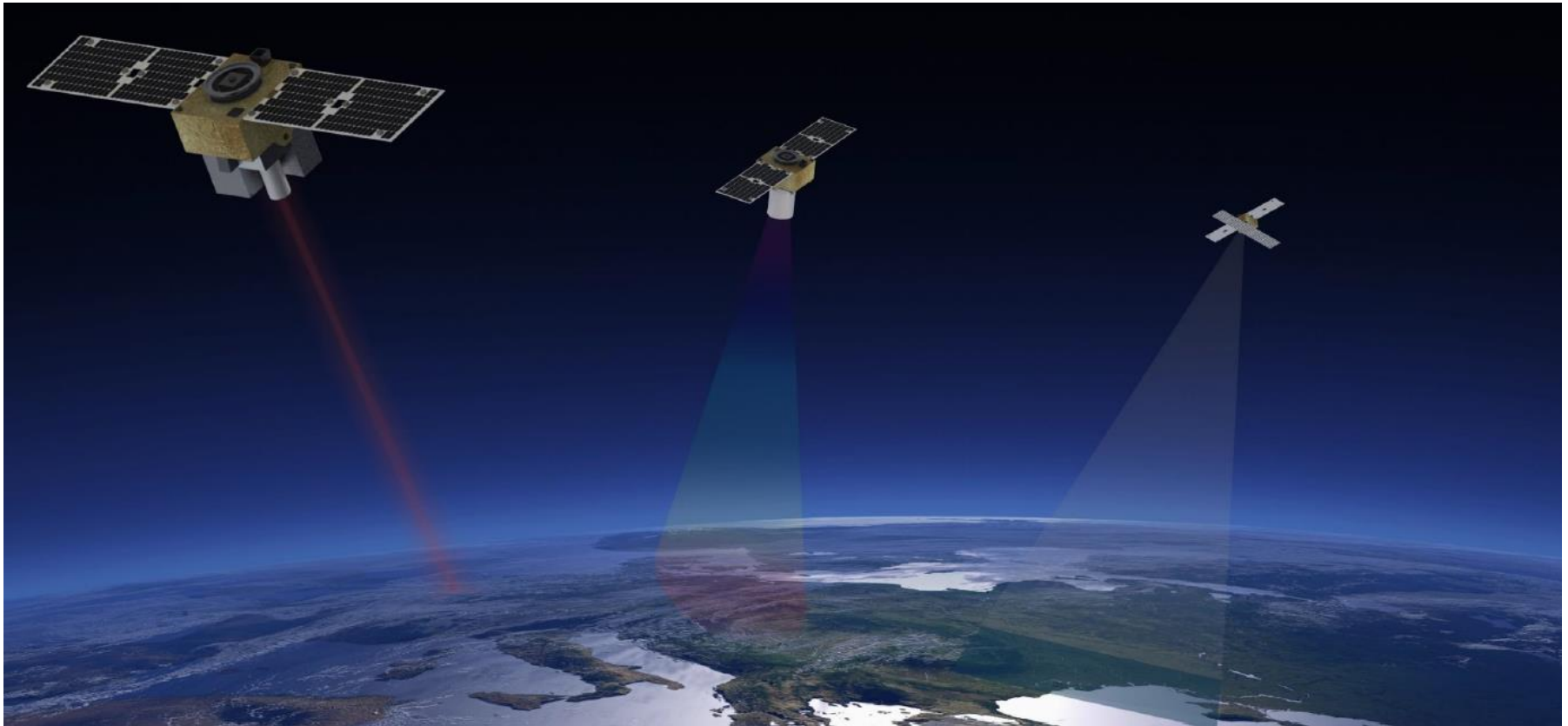


SWARM satellites © ESA

Future Megaconstellations

Micro-satellites

- Low-cost, modular
- Multi-Mission
- Launch mass: 20 - 100 kg
- Payload power: 15 - 100 W



Future Disruptive Technologies 1/2



Electromagnetic Spectrum Dominance

- Combined radar, communications, and electronic warfare functions based on European Active Electronically Scanned Arrays for military applications

Future Disruptive Defence Technologies

- o Challenging the future
- o Emerging game-changers – **Quantum Technologies**

Unmanned Systems

- o European **Detect and Avoid (DAA) function** based on new sensors and processing for RPAS integration into air-traffic management
- o Development of a low-observable **tactical RPAS** with the capability to provide near real time information and with modern self-protection
- o European High Altitude Platform Station (Euro-HAPS) solution for Union defence

Future Disruptive Technologies 2/2



- Airborne electronic attack capability
- Naval platform technologies for defence purposes, including those able to operate in extreme climates and geographical environments
- **Persistent earth observation from space with automated interpretation of data and information, including artificial intelligence, cloud solutions and real time on-board processing by sensors**
 - o Software suite enabling real-time cyber defence situational awareness for military decision-making
 - o Software suite solution, enabling real-time cyber threat hunting and live incident response, based on shared cyber threat intelligence
- **CBRN detection capabilities** and medical countermeasures
- **Space-based early warning and military space situational awareness and surveillance, including GEO surveillance and identification services**, and networking through standardized and secure data exchange.

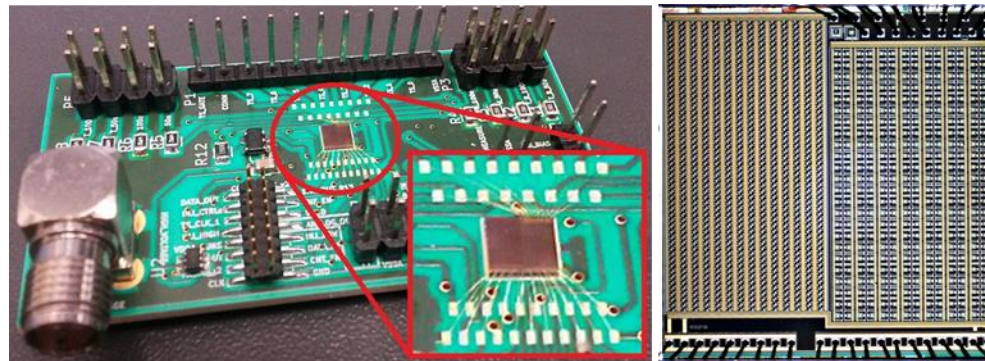


SpacePix®

SpacePix - Product Overview



- SpacePix[®] family of products provide multiple **radiation detection applications** based on a highly reliable and accurate ASIC designed for radiation sensing in a space and on-ground environment.
- Radiation-tolerant monolithic pixelated detector with 60 μm pitch developed in a 180 nm Silicon-on-Insulator (Sol) technology
- **Reconstruction of electrons, proton and heavy ion hits in radiation harsh environment** with a detection capability up to 10^8 particles/cm²



SpacePix[®] detector

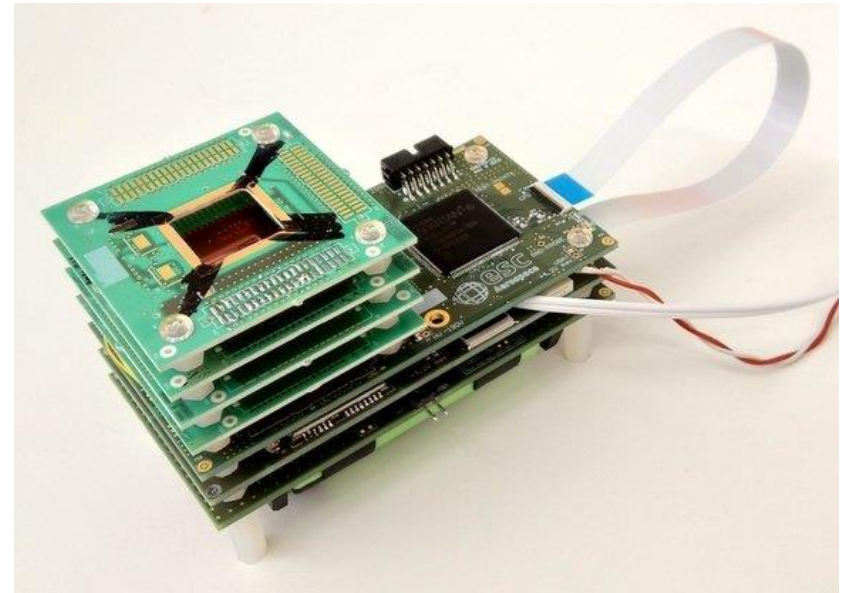
Applications



- **Space Applications**
 - **Radiation monitoring as part of other equipment health/safety monitoring**
 - **Personal or living environment dosimeter for manned space missions**
 - **Scientific instruments to investigate the origin, frequency and character of the galactic and extra-galactic sources (particle telescope, soft X-Ray sensor)**
- **Other non-space potential applications**
 - All other industrial and research areas where ionized particle detection is needed
 - **Thermonuclear reaction monitoring in fusion control**
 - **Safety in handling alpha and beta sources of radiation**
 - **Monitoring of conforming to Treaty on the Non-Proliferation of Nuclear Weapons (identification of isotopes, active interrogation)**
 - **Modern radiotherapy methods applying accelerated protons or heavy ions**
 - **Industrial (non-destructive testing)**

Satellite payloads / UAV payloads

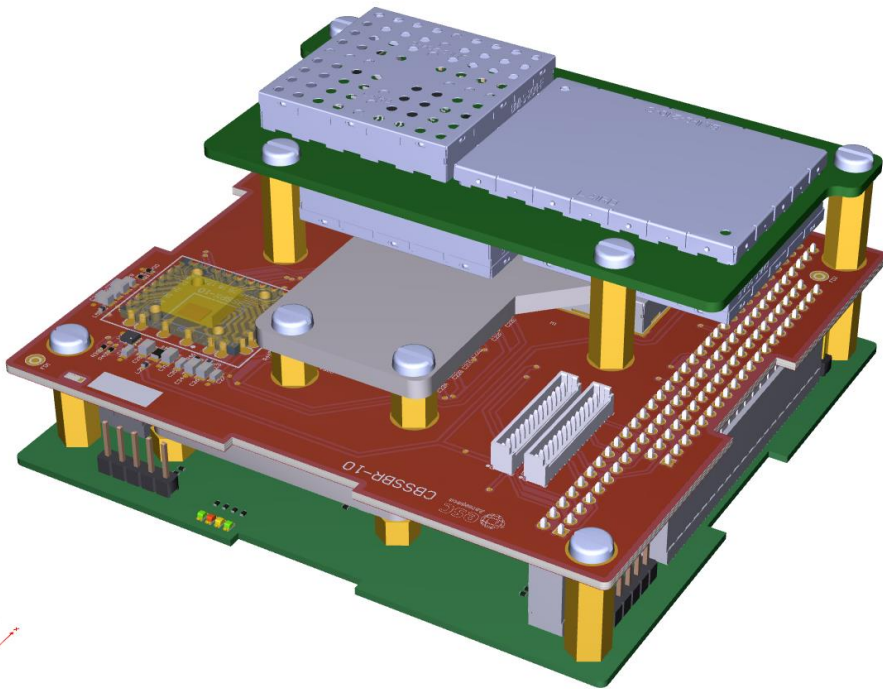
- **LORDS-II** - Light Orbital Dosimeter System
- **SpacePix** - is a pixel sensor chip designed for space dosimetry, which will fly on
 - **Socrat-R** - Russian CubeSat
 - **VZLUSAT-2** - Czech CubeSat
- **X-chip-03** - pixel detector chip designed for radiation imaging and advanced dosimetry applications, equipped with fast data interface for imaging of fast phenomena
- **CRREAT** - UAV payload
- **VIGIL** - UAV payload



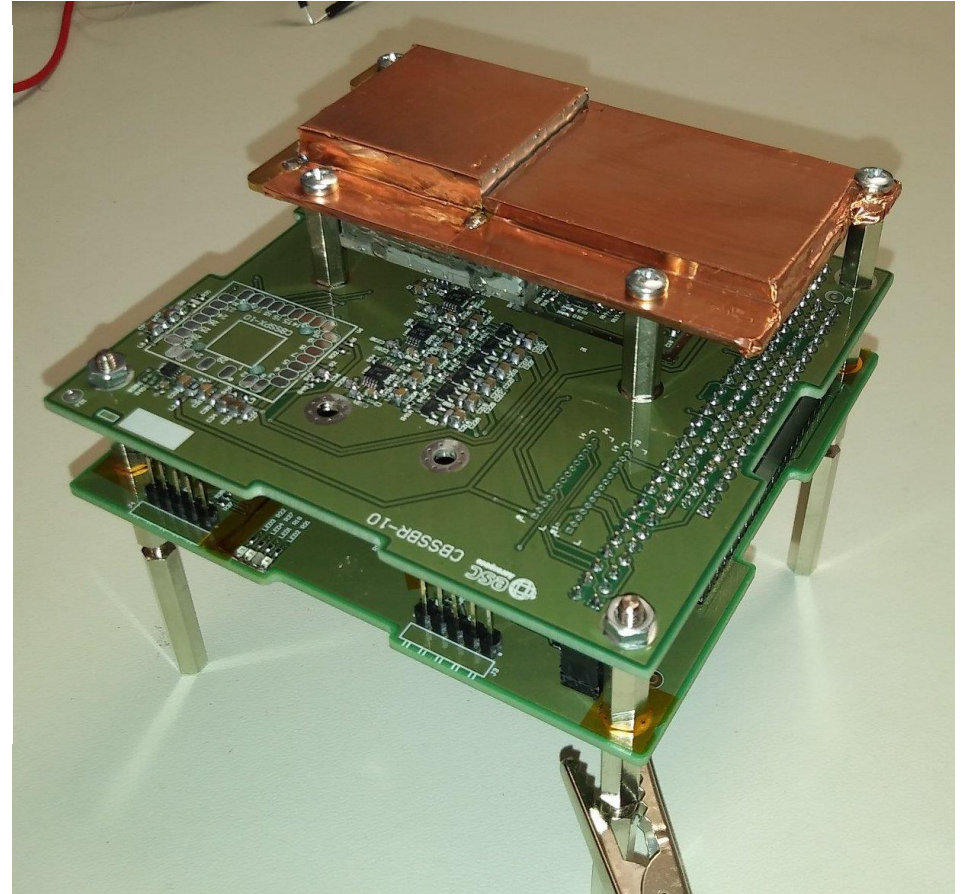
CRREAT UAV payload detector

Satellite payloads / 3U Cubesat

- **SpacePix®** – model & assembled instrument on the **Socrat-R**



SpacePix® Cubesat payload detector, a model



SpacePix® Cubesat payload detector, assembled

Product – Avionics for Drones & Micro-Satellites



- **6 generations**
- since 2005, timeline:



2005 2007 2009 2011 2013 2015 2017 2019 2021



CPU1G



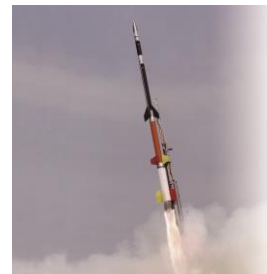
CPU2G



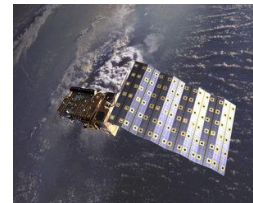
CPU3G



CPU4G



CPU5G



CPU6G



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