



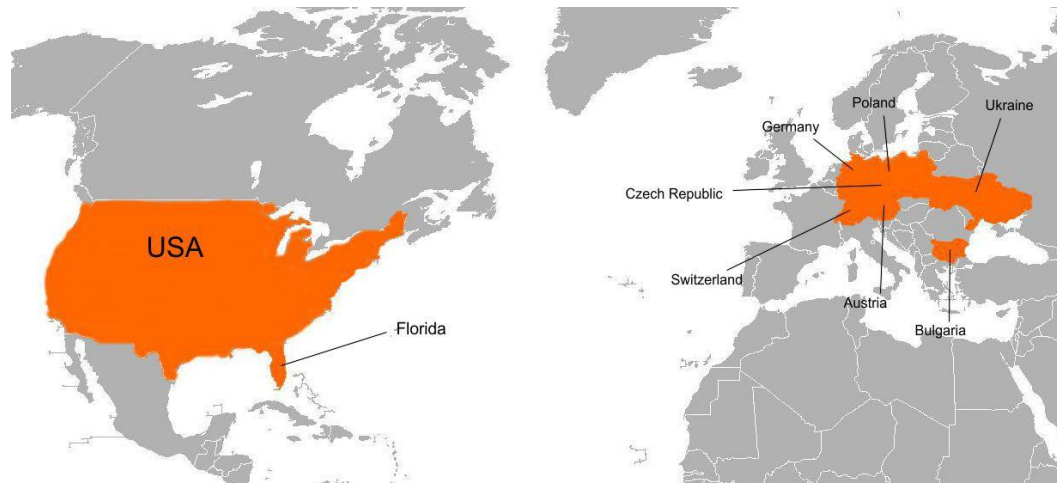
esc Aerospace is an agile **product neutral systems integrator** with the depth of experience of a larger corporation. Our size, low overhead, extensive solutions partnerships and global reach enable us to meet the highest complexity technological challenges and meet our clients' needs with **best value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

Czech Optical Cluster 21.11.2019

Satellites, flight software & hardware, radiation monitors SpacePix®, Drones, C-UAS systems

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

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

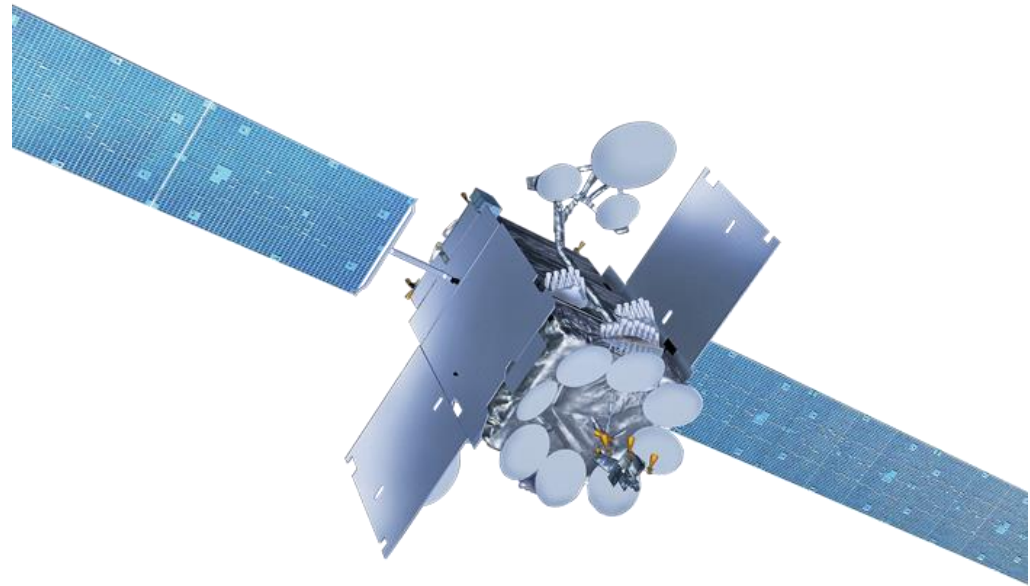
Space Missions

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

Defence Products – Avionics for Drones



- **5 generations**
- **since 2008**
- **timeline:**



2005

2007

2009

2011

2013

2015

2017

2019

2021

CPU1G



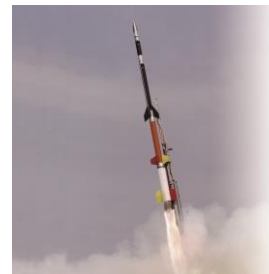
CPU2G



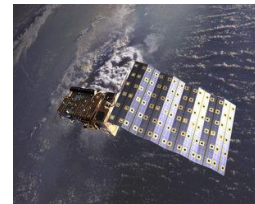
CPU3G



CPU4G



CPU5G



CPU6G



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

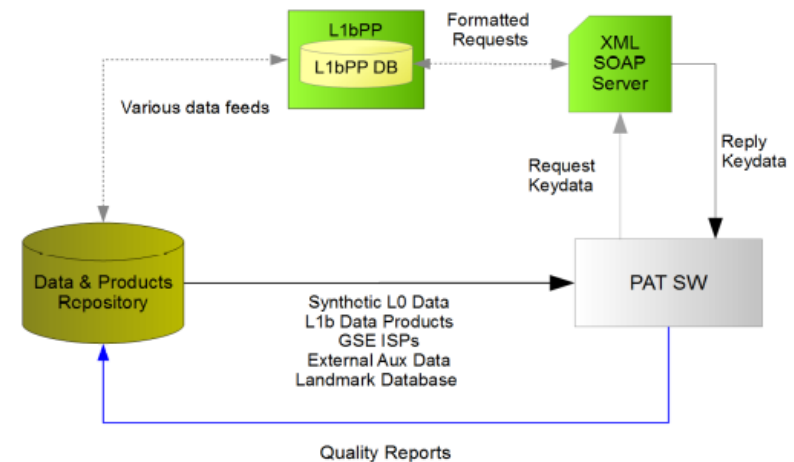
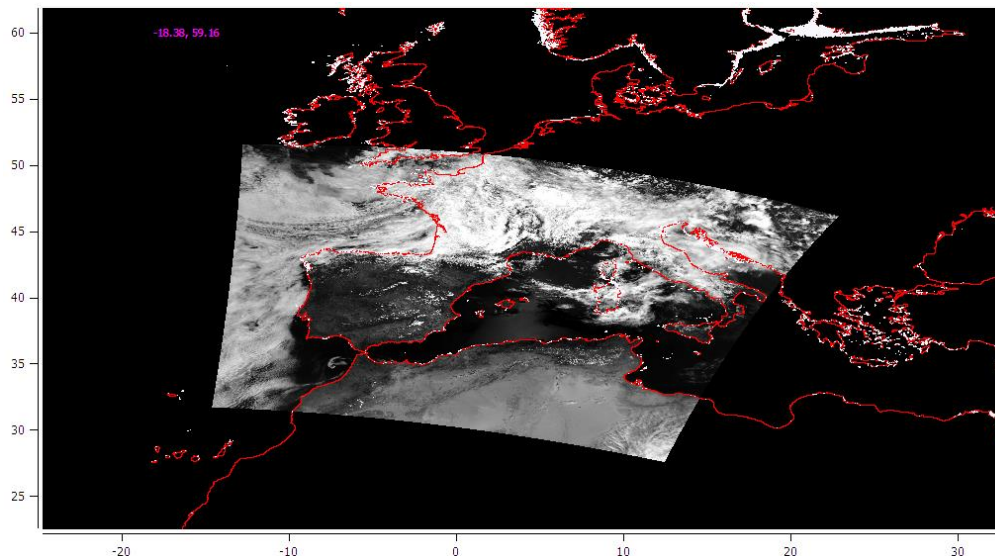
- The Solar Orbiter (SOLO) is one of the Cosmic vision M-Class ESA missions.
- The mission goal is to understand (and even predict) how the Sun creates and controls the Heliosphere.
- STIX (Spectrometer Telescope for Imaging X rays) is one of the SOLO's on-board remote sensing instruments.
- STIX provides 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

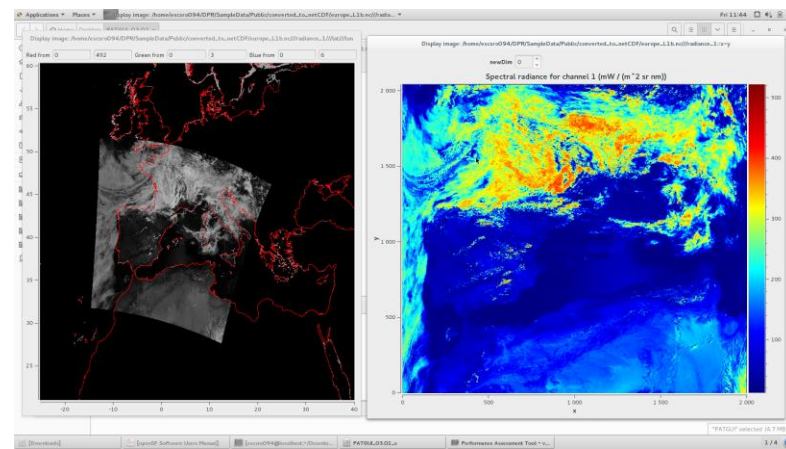
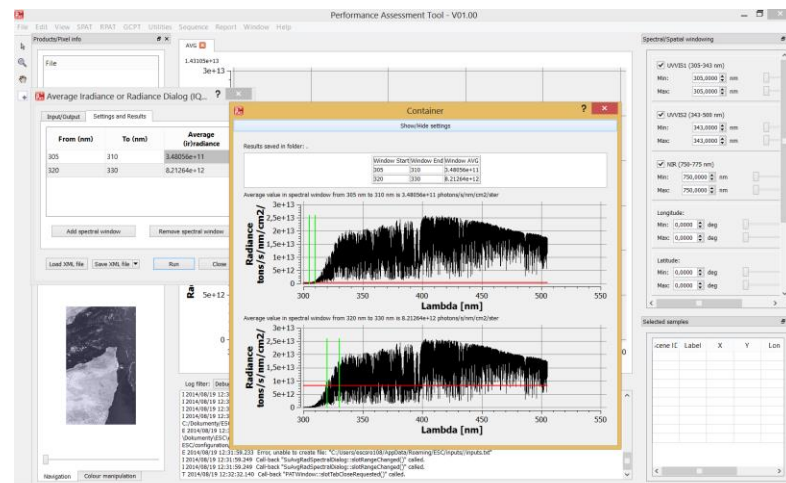


Performance Assessment Tool (PAT)

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

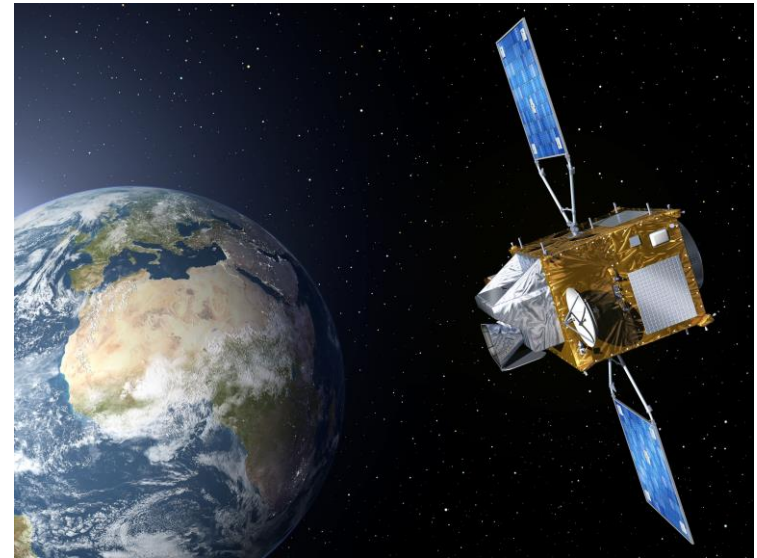
- Fully user driven, intuitive GUI
- Processing large data input (10 GB+) at a time
- Scalable performance based on HW platform
- Network based data-acquisition and storage, local operations available on demand
- Multiple/Generic 3rd party database import & support
- Supports integration into openSF; 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)



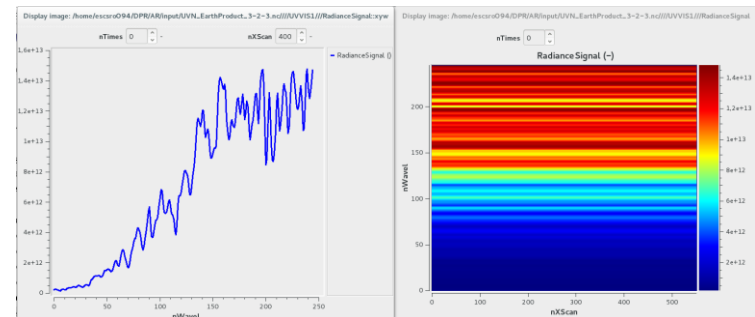
SENTINEL-4 UVN PAT 3/3

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



Re-entry 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

Re-entry 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

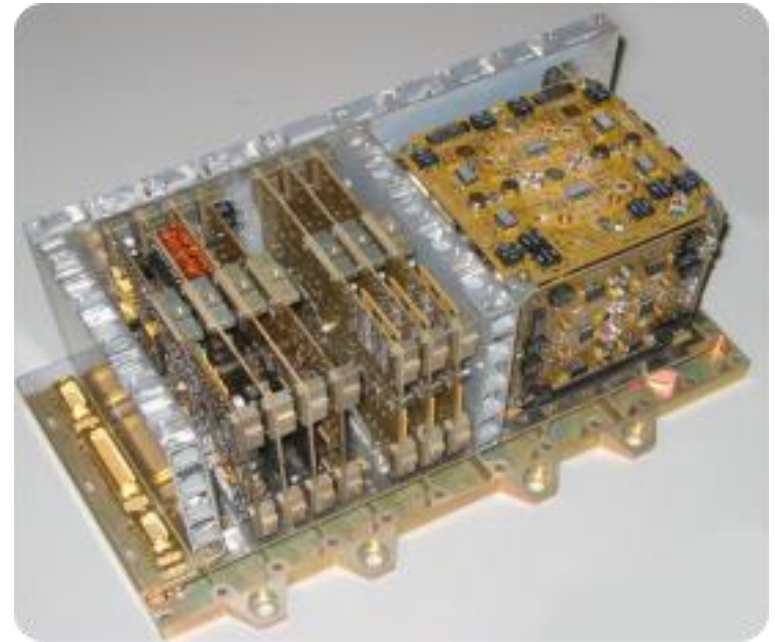
SWARM Micro-accelerometer 1/2

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

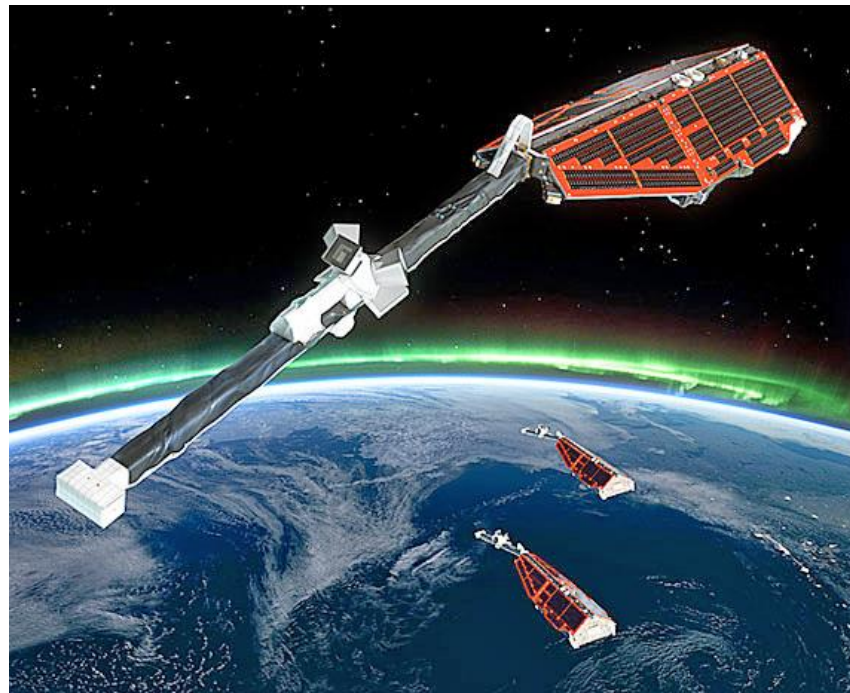


Micro-accelerometer © VZLÚ

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

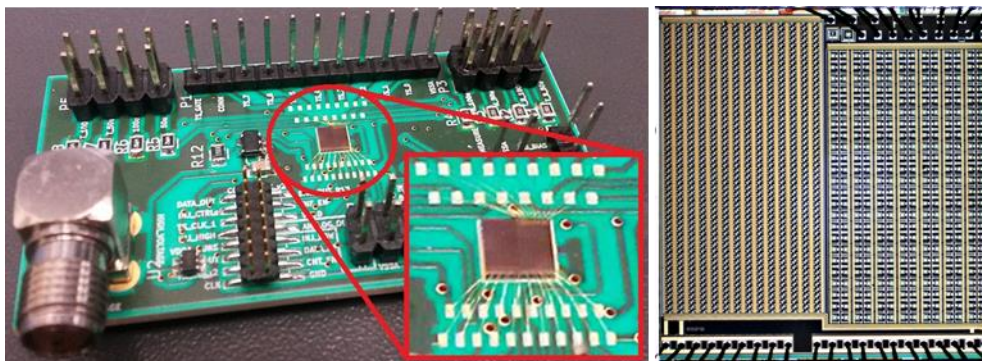


SpacePix®

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® - 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)**

SpacePix® - Manned Space



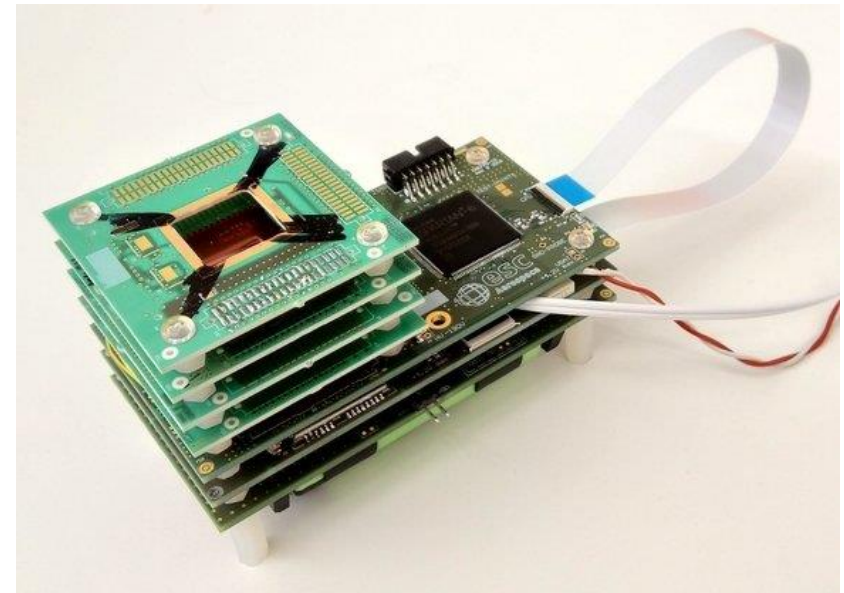
https://www.nasa.gov/mission_pages/station/research/experiments/1043.html

- **ISS Medical Operations Requirement Document (MORD)** - monitoring and measurement of (1) radiation doses absorbed by human tissue, (2) charged particles and neutron radiation inside the ISS, and (3) charged particles outside the ISS during extra-vehicular activities (EVAs). (3 active monitoring instruments installed)
- **Passive Radiation Area Dosimetry** - fixed locations. Info necessary to identify areas that have a relatively high exposure rate (i.e. avoidance areas). Exposure rates and change with vehicle altitude, attitude, internal vehicle configuration, number and location of modules, position in solar cycle, etc. Passive dosimeters are not affected by power loss to other monitoring instruments.
- **Active Radiation Area Monitoring** - continuous info to ground controllers identifying areas to avoid low dose rate areas to use as “storm shelters.”
- **Spectrometers are required to resolve the LET spectra into contributions from radiation source terms** (i.e., GCR, trapped protons, solar particle event protons, etc). LET spectrometers need to be portable and capable of reaching most locations inside the vehicle.
- **Internal Time-resolved Charged-Particle Monitoring** - provides accurate radiation source term for computing organ-level exposure and the resulting risk.
- **Neutron Monitoring** - neutron contribution to crew exposures.

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



Satellite payload on 3U Sat Socrat-R

- **SpacePix – model & assembled instrument on the Socrat-R**
- launched **5.7.2019**

Czechs have developed new SpacePix Detectors® for the study of cosmic weather

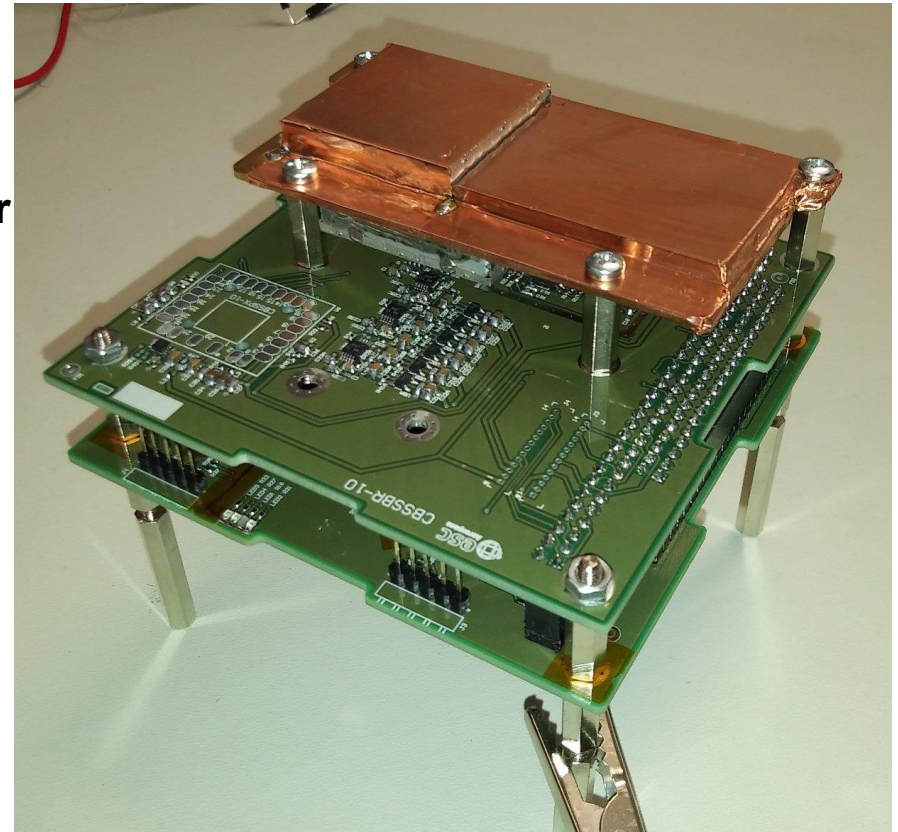
On Friday 5. 7. The 2019 has been sent to the orbit around the Earth by the satellite Socrat-R, whose instrumentation was also played by Czech academic institutions and companies. The primary mission is to monitor the cosmic weather and the radiation field around Earth. To perform this task will be used unique monolithic pixel detectors developed at the Faculty of Nuclear and physical engineering CTU supplemented with PIN diode open-source Dosimeter developed at the Institute of Nuclear Physics ASCR. The Czech part of the satellite apparatus was designed within the consortium of FJFI CTU, ESC Aerospace s.r.o. and ÚJF AVČR.

The construction and production of the whole instrument was

ensured by the Czech company esc Aerospace with the contribution of FJFI CTU in Prague, ÚJF and Universal Scientific Technologies s.r.o. The radiation-resistant new generation detectors were developed in the Czech Republic at FJFI in the framework of the TA ČR and the MPO grants. These projects are a spin-off project of the CZECH Competence Centre TE01020069. The PIN-diode dosimeter was developed on the part of the CRRAT project.

Launch of the Soyuz 2.1 b/Fregat carrier could be watched online on Friday 5. July 2019 at 7:41 PM CET here:

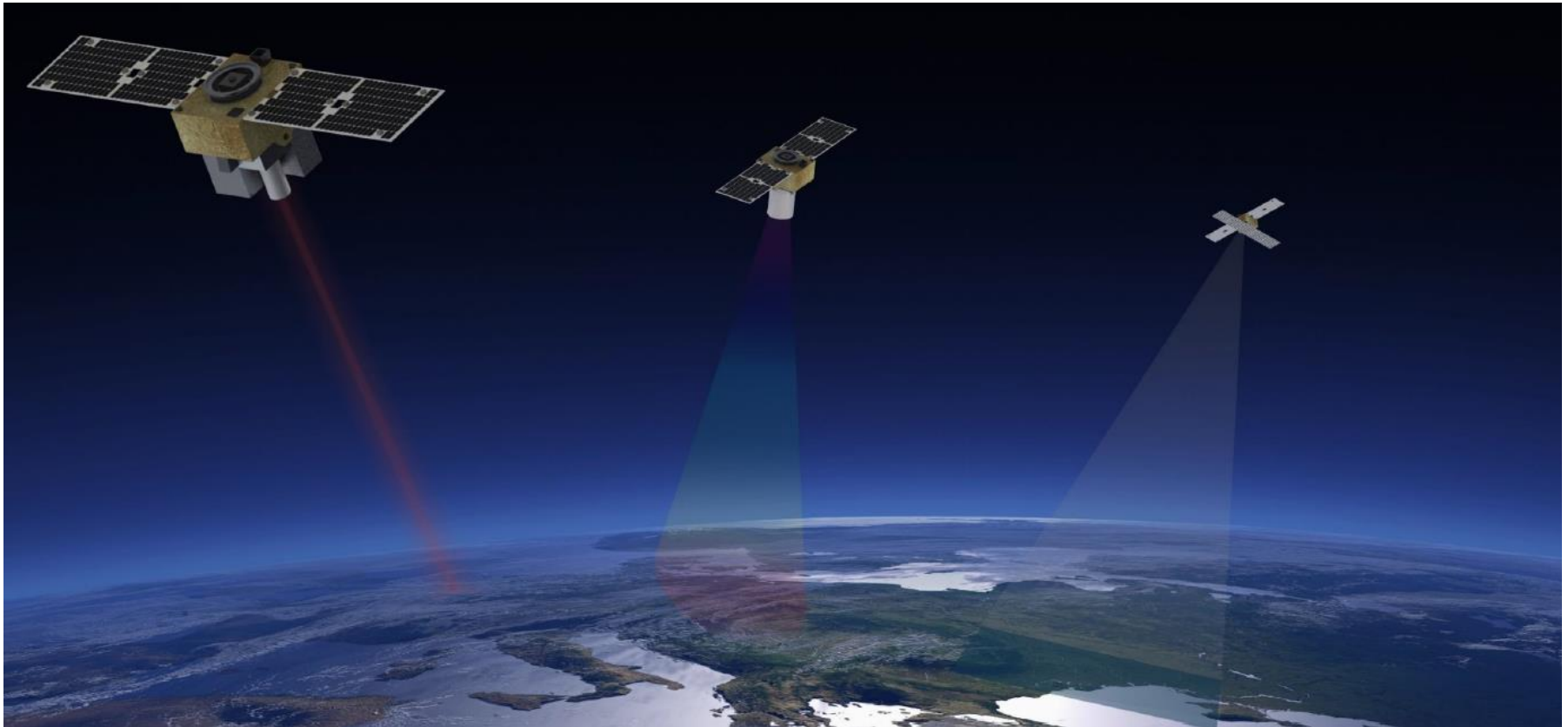
<https://lnkd.in/dXwyDBq>



Future megaconstellations

Micro-satellites

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



First Quantum Encryption Satellite 1/3



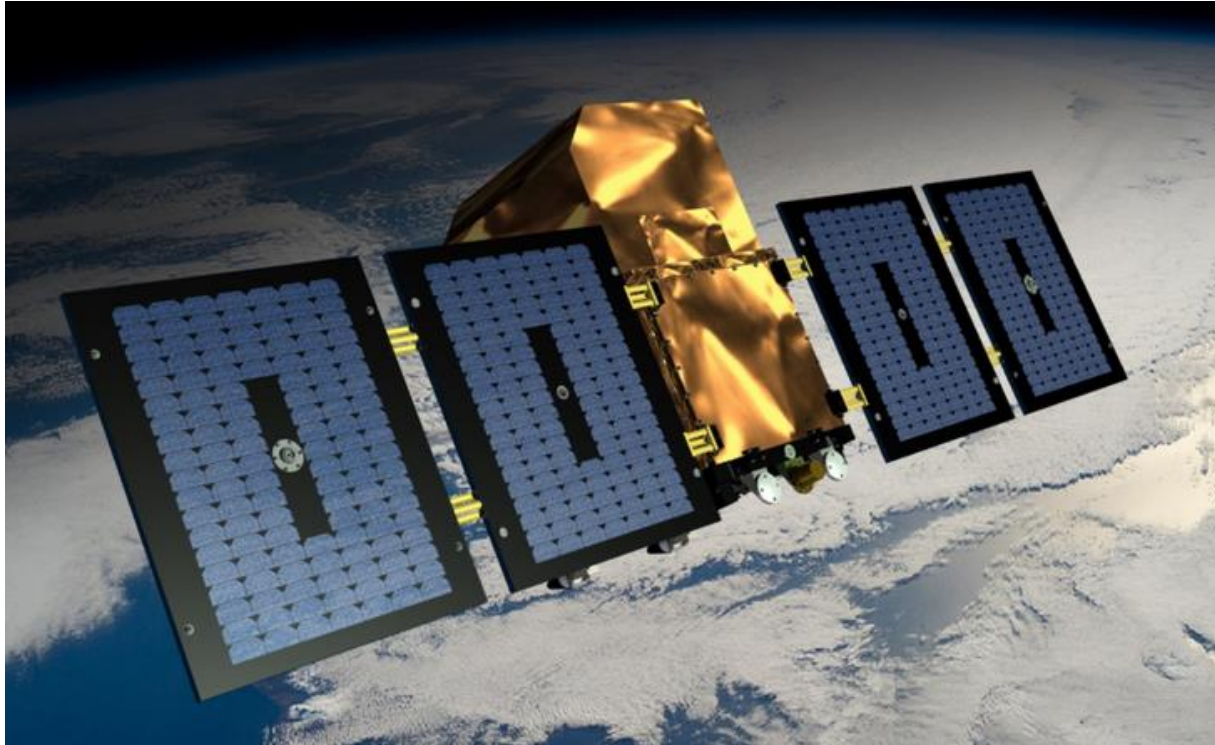
- D/TIA partners develop first **Quantum Encryption Satellite**
- On 31st August 2018, the European Space Agency via its Directorate of Telecommunication and Integrated Applications signed a contract to develop the first European Quantum Key Distribution Satellite (QKDSat).



First Quantum Encryption Satellite 2/3



- QKDSat is a highly innovative project, the first of its kind, which will validate **Quantum Key Distribution via satellite technologies**.



- The contract covers the development of **service** delivery through a pre-operational deployment, prior to an full **global commercial service** via multiple satellites in the near future.

First Quantum Encryption Satellite 3/3



- The installation of **Ground Optical Communications Terminals** to support the projected market needs
- The contract will enable the industry of ESA Member States to take the lead in an important, new and growing field of **secure communications**.



- Quantentechnologie für sichere Kommunikation - Optische Bodenstation

Emerging game-changers - QKD

Quantum Key Distribution Programme Mission

- The world's first commercial global Quantum Key Distribution ("QKD") network
- The system will use a constellation of LEO satellites
- **Programme Mission**
 - Design,
 - develop,
 - validate technologies
 - and service viability of an innovative QKD end-to-end system, including satellites, operated from Europe

**Quantum Key
Distribution (QKD)
Markets: 2019-2028**



A blue rectangular box containing the text "Space as cyber security enabler" in a white, sans-serif font. The background of the slide is a composite image showing the Earth's horizon from space, with a network of white lines and circular icons containing padlock symbols overlaid on the globe, representing a global cyber security network.

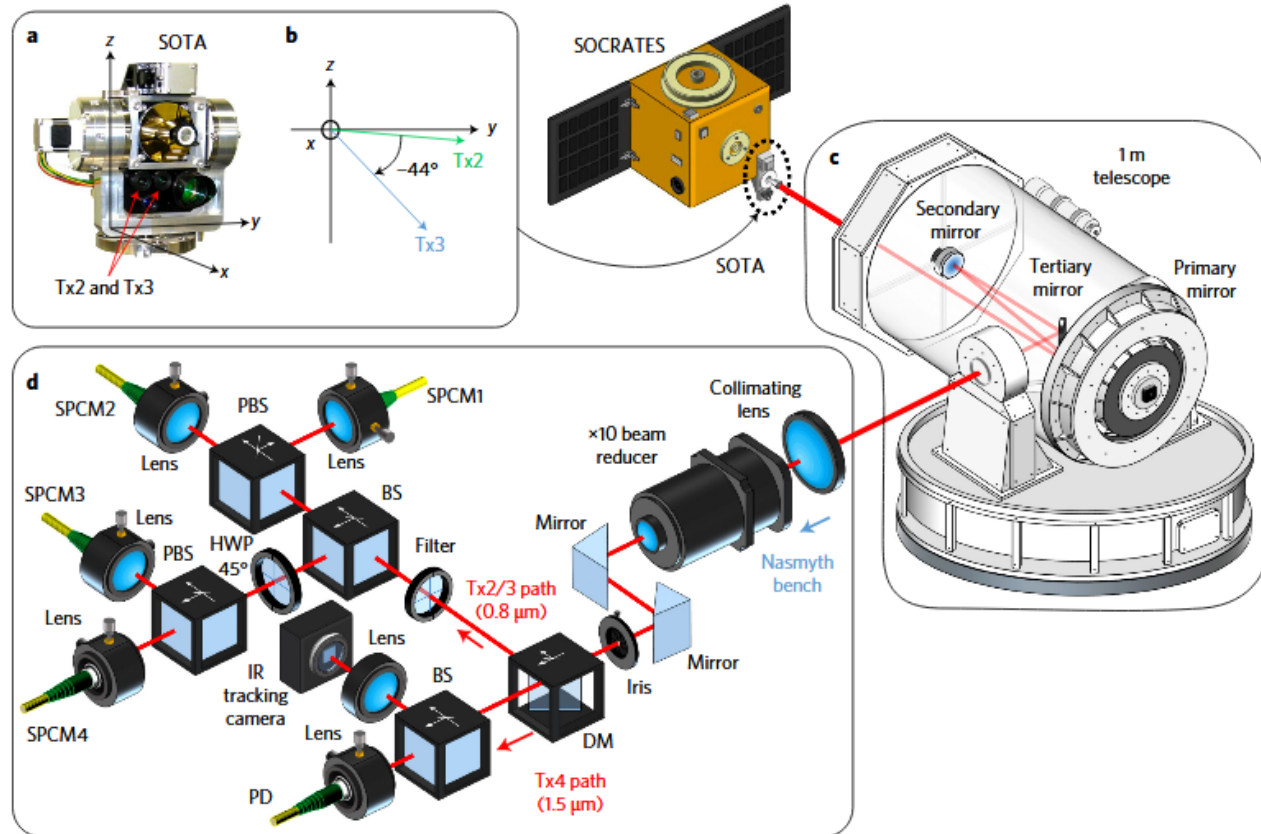
Space as cyber security enabler

- **VALUE OF SPACE CYBER SECURITY**
- Space could play a key role in the development of new cyber security solutions aimed at reducing vulnerabilities and enhancing cyber resilience in the vertical markets mentioned above.



- **Satellite Communications (Satcom)**
- Satellite communications offer a unique alternative to the transmission of data through the terrestrial internet, where they can be more vulnerable to potential malicious attacks.

- **Satellite Communications (Satcom)**
- Used as a primary communication means or as back-up to terrestrial networks, Satcom can therefore enhance the security of sensitive data transmissions and storage.
- The development of **satellite-based Quantum Key Distribution (QKD) technology will provide**
 - **innovative, reliable and highly secure**
 - **cryptographic key distribution**
 - **for geographically-dispersed networks**
 - **operated by**
 - **telecommunications operators,**
 - **financial organisations,**
 - **infrastructure providers**
 - **and institutions.**



Transmitter and receiver systems on-board nanosatellites
DEMONSTRATING MINIATURISED, ENTANGLED PHOTON-PAIR
SOURCES ON BOARD NANO SATELLITES TO ENABLE QKD MISSIONS

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