

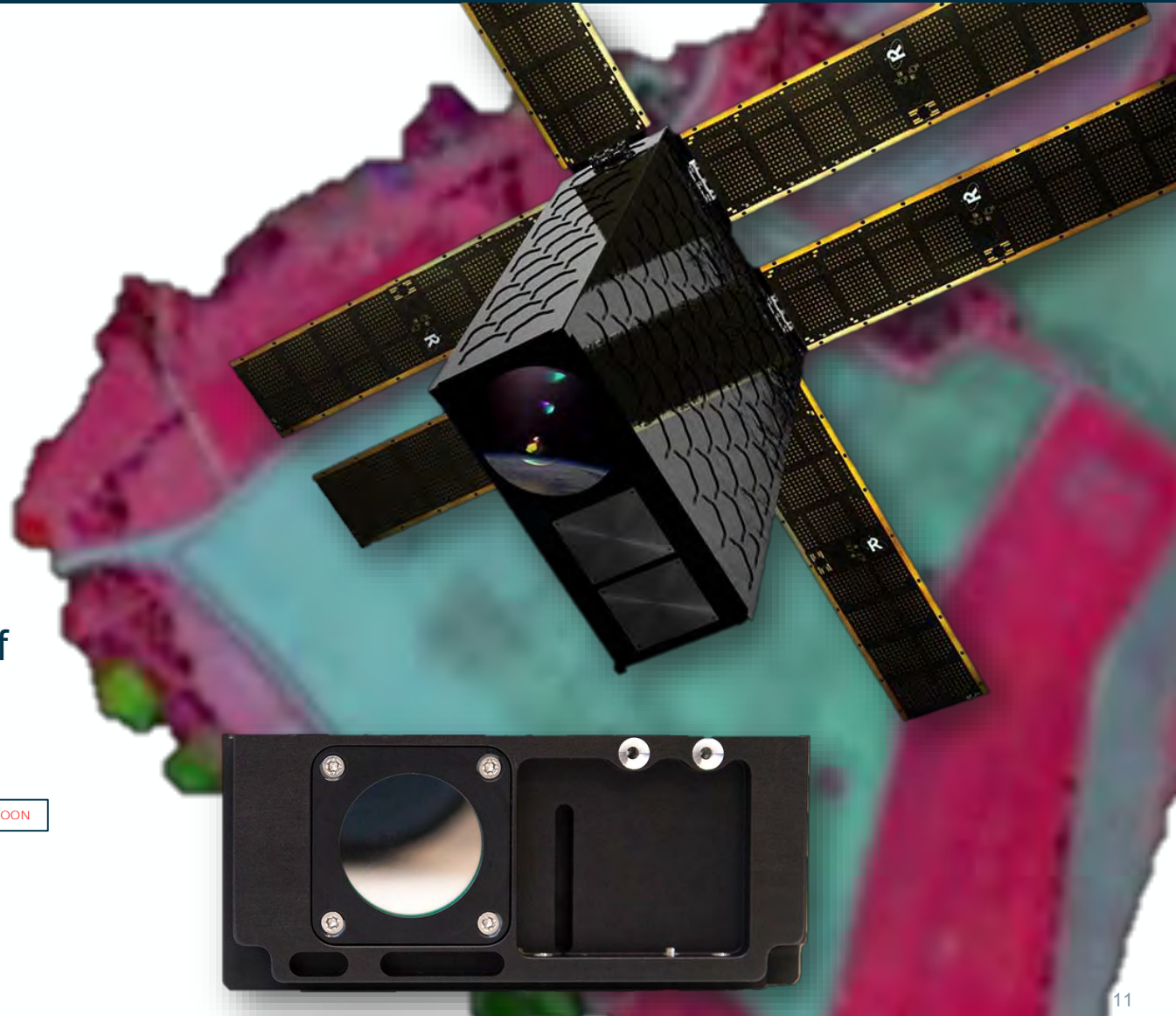
Hyperfield

- Constellation of small hyperspectral satellites to provide global, daily data
- Comparable performance to previous larger scientific satellites using a miniature hyperspectral imager
- 20 m GSD with adequate SNR
- Advanced (AI/ML) analytics and extensive ground truth data
- Affordable service
- InCubed project will co-finance the development of the constellation demonstrator
- **Demonstrator launch in late 2022**

incubed.phi.esa.int/portfolio/hyperfield

COMING SOON

Reaktor Space Lab



FSSCat and Φ -sat-1 experiment

UPC (ES), winner of Copernicus Master Challenge (2017)

- 2 Tyvak (IT) Endeavour 6U Cubesats were integrated as follow:
 - Sat-A equipped with Flexible Microwave Payload FMPL-2 (GNSS-R + L-band radiometer)
 - Sat-B equipped with HyperScout-2 + Φ -sat-1 experiment
 - Both satellites embark an Inter Satellite Link (Optical and RF), provided by **Golbriak Space (EE)**,
- FSSCAT Satellites launched on 03-Sep-2020 onboard Vega PoC SSMS
 - Successful end to end experiments for both Sats

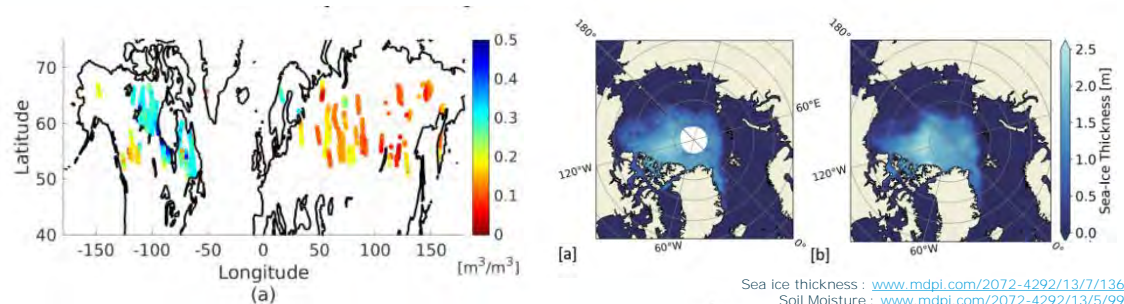


Φ -sat-1 Experiment

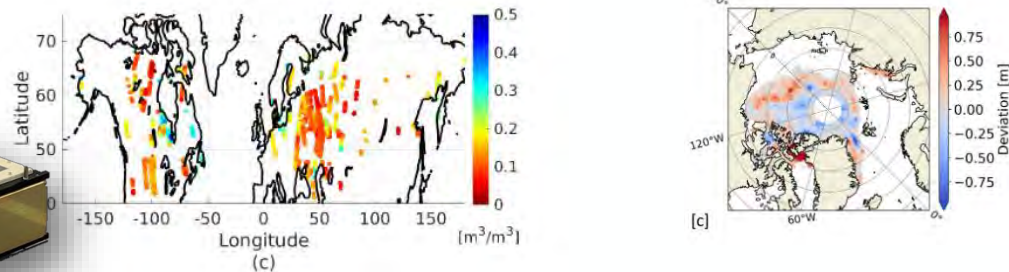
Goal: Demonstrate Onboard Cloud Detection using AI

- Hyperscout-2 Payload – **Cosine (NL)**
- Use of Myriad2 VPU (COTS, low power, small size, radiation tested) – **Ubotica (IL)**
- Training dataset from Sentinel-2 – **Sinergise (SL)**
- Inference Engine (based on a ML algorithm) design and training – **University of Pisa (IT)**

- In flight end to end experiments successfully performed
- Very promising preliminary results
- Final results will be soon presented in a dedicated paper



Sea ice thickness : www.mdpi.com/2072-4292/13/7/1366
Soil Moisture : www.mdpi.com/2072-4292/13/5/994

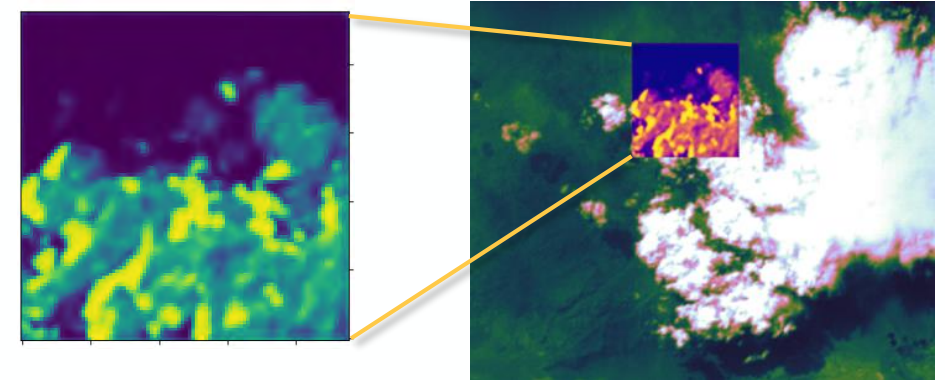


Combined MWR and GNSS-R SM estimations

SIT measurements

AI-computed Cloud mask

Cloud mask superimposed on Benchmark hyperspectral image



Φ-sat-2 and future activities

Based on the successful experience of the FSSCAT mission a Φ-sat-2 call was issued to explore the benefits of onboard AI for future EO applications

- 16 proposals were evaluated (2.74 M€ budget), winning proposal from Open Cosmos (UK)
- Phase 1 - 4 months feasibility study (**approaching completion**)
- Phase 2 - 12 months of development/implementation + 12 months of operations
- Space segment will be based on a recurring OC 6U Cubesat Platform equipped with a Simera Sense MultiScape100 capable of 7 Bands in the VNIR with a GSD of 4.75 m @ 500 km orbital altitude and the Myriad 2 board



ESA Φ-WEEK
11-15 October 2021
Virtual Event

phiweek.esa.int

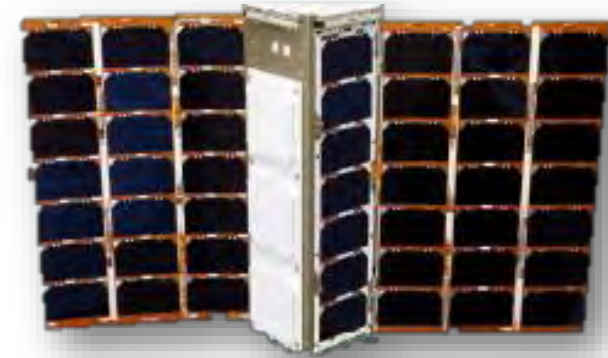
Specific sessions on:

- Φ-sat-1 results
- Φ-sat-2 progress



ESA ARTES programme funded since 2018

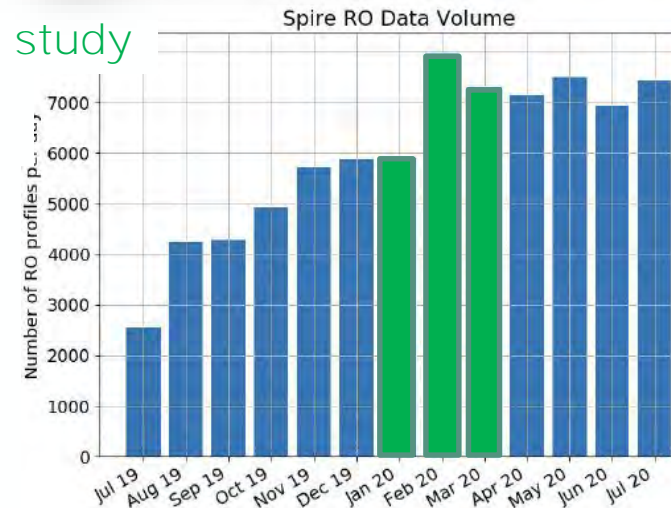
- GNSS-RO and GNSS-R payloads (designed in Glasgow)
- Launch of 10 sats (not all EO-driven)



EOP funding

- Impact studies with ECMWF, UK-MetOffice, Eumetsat
→ Very good RO quality (2021)
- Evaluation data available also via EarthNet programme
- InCubed 2021: innovative GNSS-RO polarimetric, incl. one launch

Data used in Impact study
> 7k profiles/day
(i.e. x10 MetOp-C)

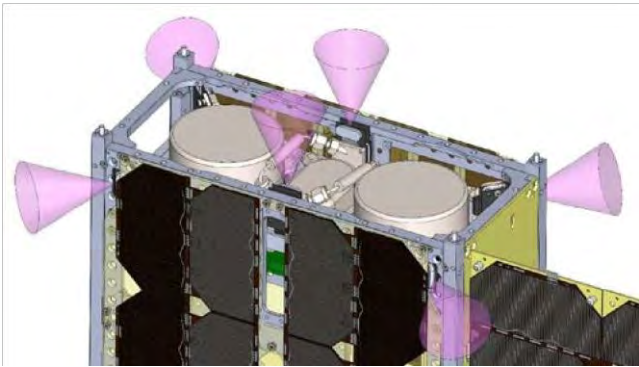


1st European Pilot data-buy by EUMETSAT (Q3-2021)

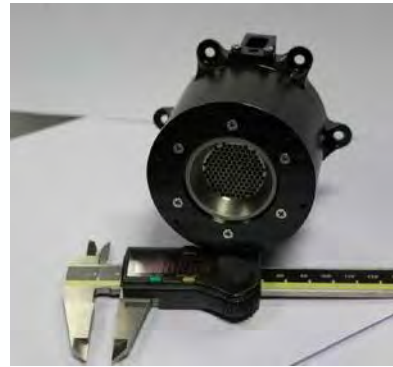
- 9 M€ data buy (3 years) from Spire
- Complex European setup (ESA – EUM – Weather agencies), but catching up with earlier NOAA initiatives

<https://www.eumetsat.int/first-eumetsat-will-buy-meteorological-data-commercial-supplier>

Examples of Technology Developments (TDE/GSTP)



**6 DoF
Cold Gas Propulsion
(GomspaceSE)**



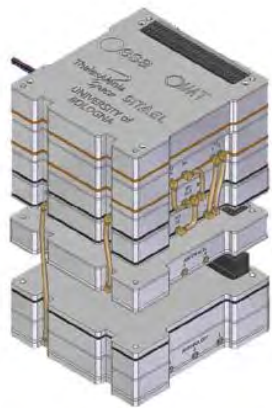
**RIT 3.5 Gridded Ion Engine
(Mars Space UK)**



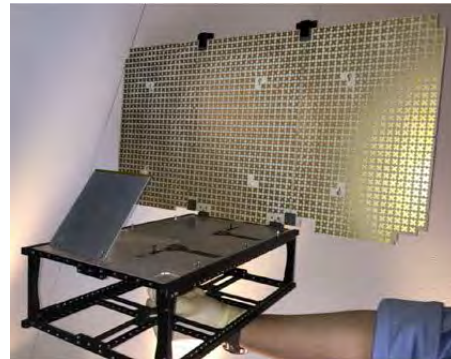
**Solar Array Drive Assembly
(IMT IT)**



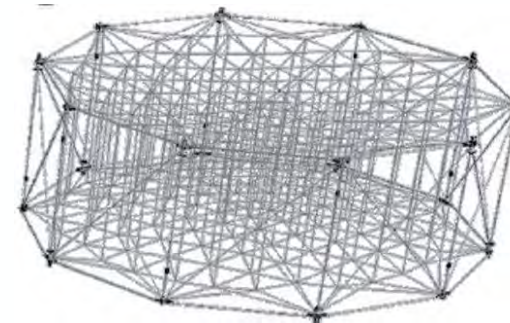
**Multi-Parallel Micro-Pumped
Loop(Demcon, NLR, ISIS NL)**



**X-band Deep Space Transponder
(IMT, TAS-I, Sitael, UniBoIT)**



**X-band Reflectarray antenna
(TICRA, GomspaceDK)**



**Ka-band Reflector antenna
(LSS DE)**



**X to Ka-band Reflector
antenna
(Comet IngenieriaES)**

EOP part of this ESA-WG led by D/TEC and established in mid-2021

Objectives :

- 1) increase [awareness](#) and [coordination](#) (CubeSat-related), incl. missions, sys & technology, I/F other WG (COTS)
- 2) [share resources](#) related to CubeSats, incl. Lessons Learned & Equipment DBs from development & in-flight experience
- 3) coordinate tailoring of [ECSS engineering & quality standards](#) applicable to different types of CubeSat mission
- 4) Establish+maintain a set of [engineering guidelines](#) suitable for use by CubeSat industry
- 5) Establish an Agency-wide position on [legal & regulatory matters](#) impacting the execution of the Agency's CubeSat projects
 - e.g. Launchers for ESA funded projects, frequency management
- 6) Build up [networks of expertise](#), collective use of facilities and infrastructure across the Agency

Also Φ-week has sessions of Technologies and Launchers

IOD (driven by D/TEC)



EO payloads

QARMAN (3U)
studying atmosphere re-entry

PRETTY (3U)
demonstrating GNSS reflectometry

GENA-SAT (6U & 12U)
demonstrating commercial IOD/IOV services

SIMBA (3U)
monitoring climate variables

In Ph. C/D
GOMX-5 (12U)
demonstrating next generation constellation technologies

M-ARGO (12U)
demonstrating asteroid rendezvous and identifying in-situ resources

Launched Sep-2020

GOMX-4B (6U)
demonstrating constellation technologies

PROBA-V Companion (12U)
Imaging Vegetation

CubeSpec (6U)
stellar spectroscopy from space

Definition
Implementation
Operation

GOMX-3 (3U)
demonstrating new platform technologies

RACE (2x6U)
demonstrating rendezvous and docking

RadCube (3U)
measuring space radiation and magnetic field

PICASSO (3U)
studying the atmosphere

CSC (2x6U)
EC IOD/IOV

Sunstorm (2U)
measuring X-Ray fluxes

LUMIO & VMMO (2x12U)
measuring lunar surface impact hazards & in-situ resources

Led by D/TEC, under GSTP Element 3 (Fly) programme

New Financial Framework Partnership Agreement (FFPA) with EC

- Covers Galileo, Copernicus, etc.
- also 55 M€ (41 M€ Industrial) allocated to ESA for IOD/IOV

Cassini programme of EC (1 B€ during 2021-2027) - not ESA, but still interesting (incl. one IOD/IOV action)

The initiative is open to all areas of the EU Space Programme, and covers both upstream (e.g. nanosats, launchers, etc.) and downstream (i.e. products/ services enabled by space data)

See https://ec.europa.eu/defence-industry-space/eu-space-policy/space-research-and-innovation/cassini_en

SmallSats and NanoSats

- Growing in ESA and in multiple forms :
 - Scouts: science-driven
 - InCubed : commercial
 - Φ -sat(s) in EOP and IOD in D/TEC
 - More coordination within ESA to support industry
- Form (size) not specified by ESA
- Excellent complement to flagship ESA missions
 - fast technology / EO technique demonstration
 - Low cost and potential scalability to constellations

ESA EO: Market pull (User driven: EE, Copernicus, Meteo) + Techno push (enabler for new calls)

- We need more technology developments to de-risk and enable innovation
- Advisable to partner with scientists (not techno-push only)

living planet symposium

BONN
23–27 May
2022

TAKING THE PULSE
OF OUR PLANET
FROM SPACE

<https://lps22.esa.int/>

