Φ-lab

The ESA Φ-lab

Science, Applications & Climate Department
Directorate of Earth Observation Programmes

We strongly believe in
truly transformative ideas and in
the power of compelling partnerships
to accelerate the Earth Observation future

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European Space Agency

The ESA Φ-lab – What ?

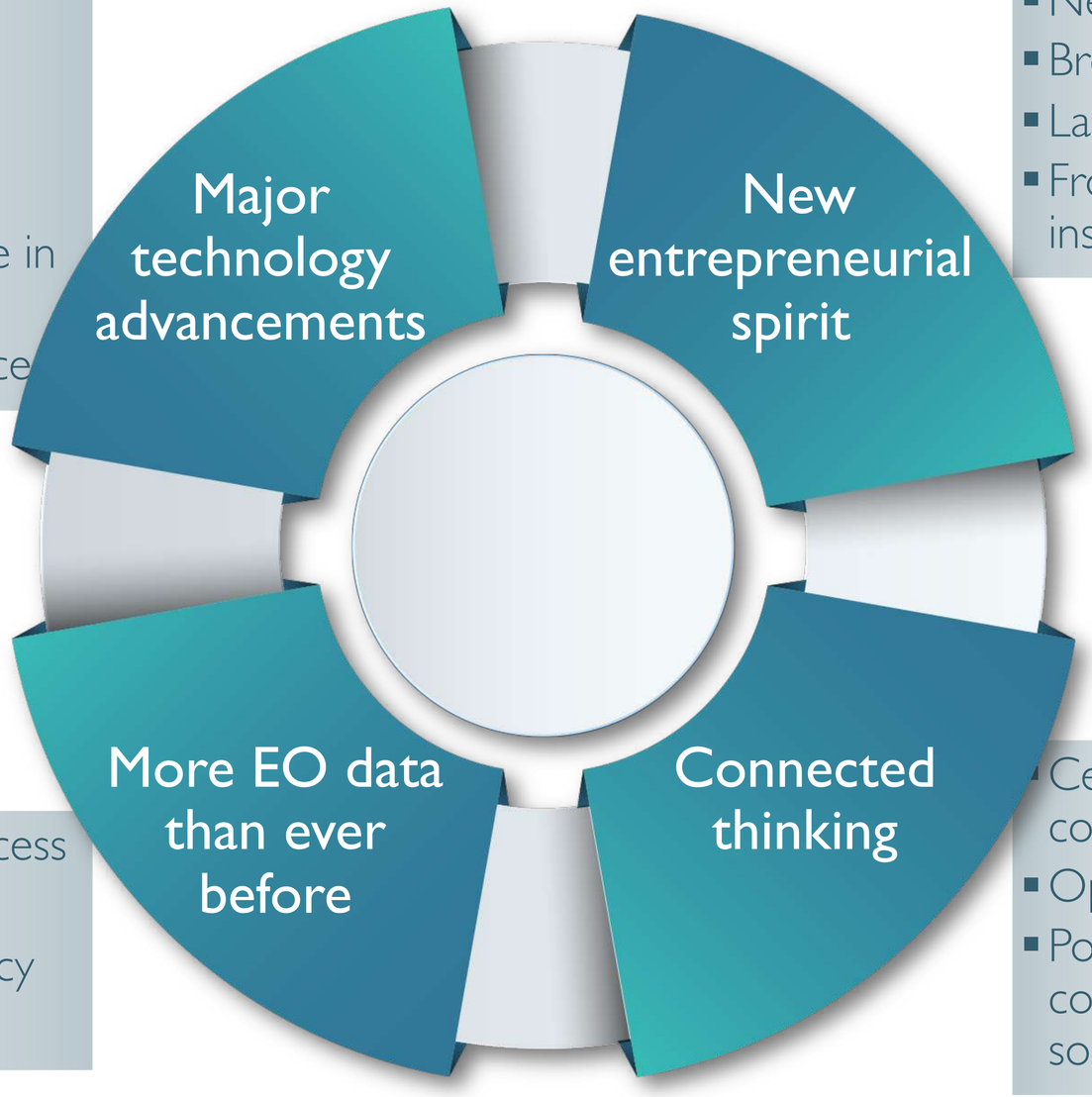
Φ-lab
innovate and apply
under-one-roof

Accelerate the future of Earth Observation
via transformative/disruptive innovation*
strengthening Europe's world-leading competitiveness

*transformational innovation: with the ability to completely transform or create entire industries via new technologies

The Earth Observation perfect storm

- Lower access to space costs
- Smart sensors, better performance, lower SWaP-C
- Commercial constellations
- Cloud computing
- Huge computational power available in space
- Artificial Intelligence and IOT in space

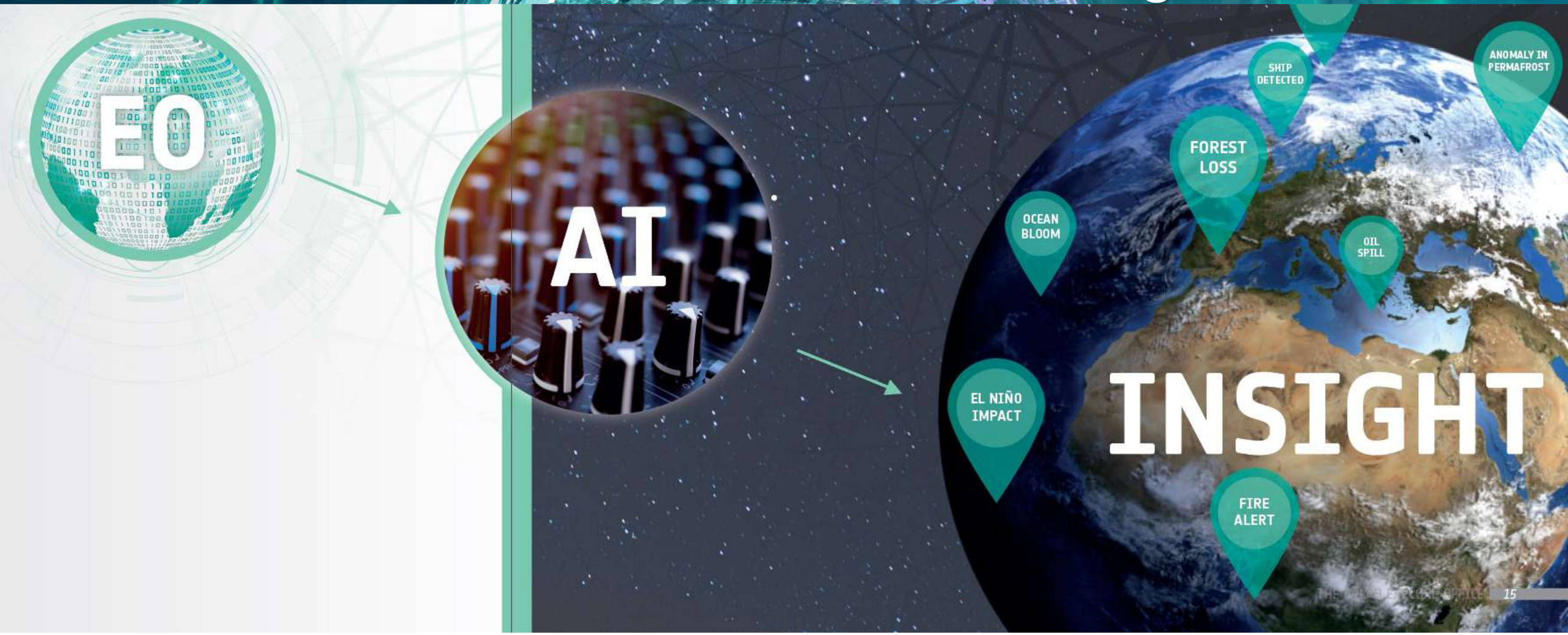


- New Space players
- Broaden customer base
- Large risk capital investments
- From data services to actionable insight and information

- Huge data availability and easiest access
- Constellations with richer sensors
- Copernicus free and open data policy
- IoT in space is coming

- Centralised vs distributed and connected thinking
- Openness toward risky innovation
- Policy makers more open to commercial space vs institutional space solutions

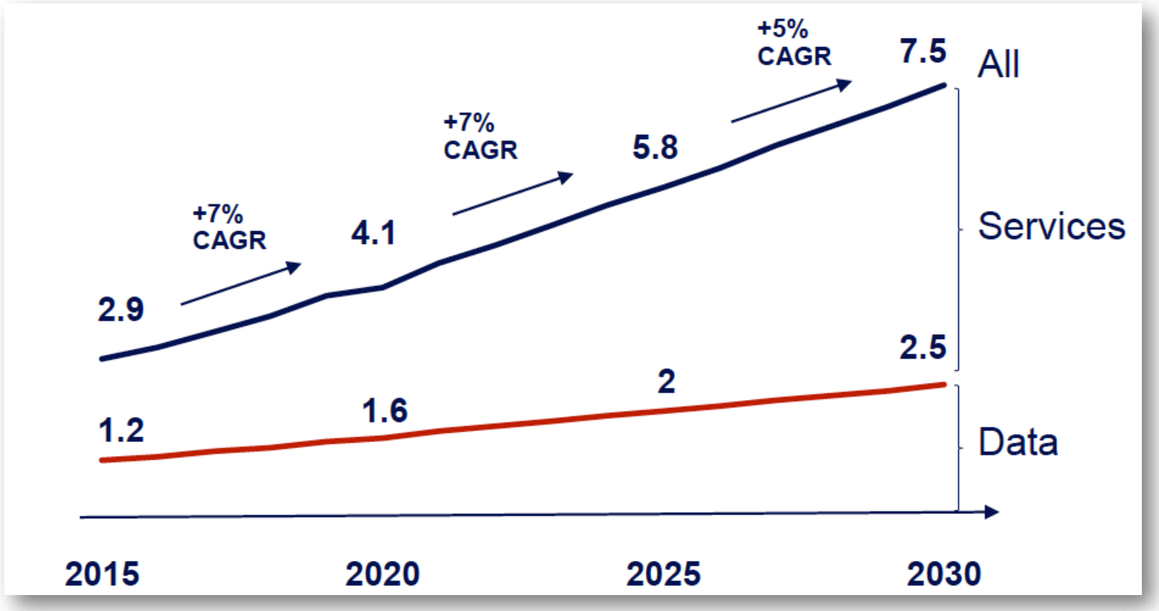
The ESA Φ-lab – Why ? From EO data to Insights



from Earth Observation to Earth Cognition

The ESA Φ-lab – Why?

EO Growth data and VAS



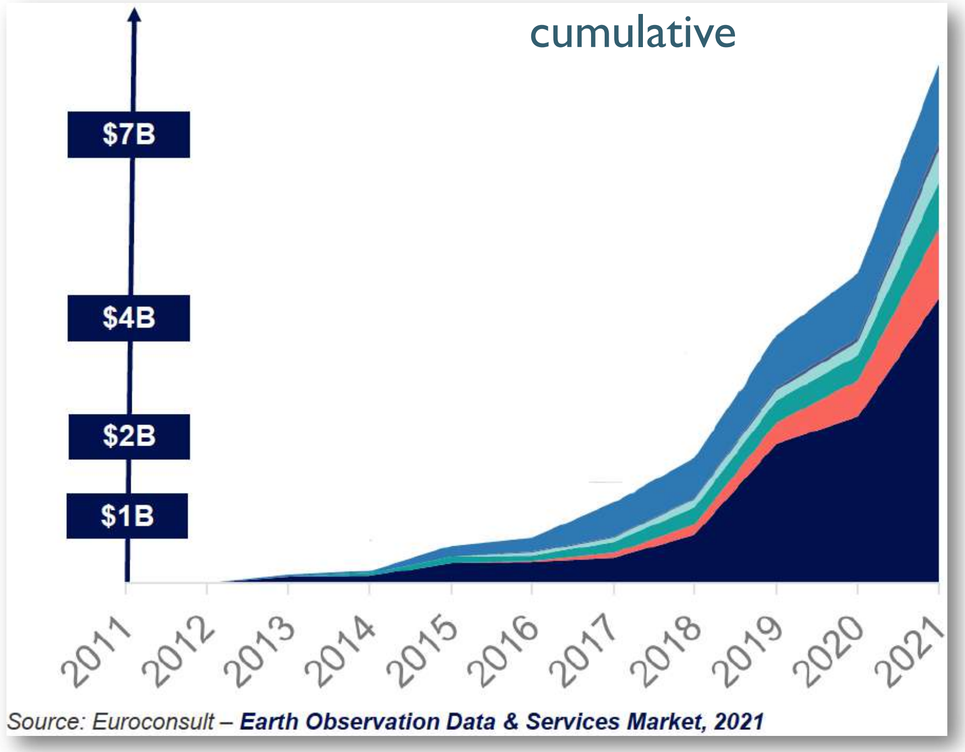
European EO service market

€1.71b revenues (EARSC Industry Survey 2021)

>10%	+24%	+17%
Sustained growth	Number of companies	Number of employees

Source : European Commission, Euroconsult and EARSC

EO private investments



Source: Euroconsult – ***Earth Observation Data & Services Market, 2021***

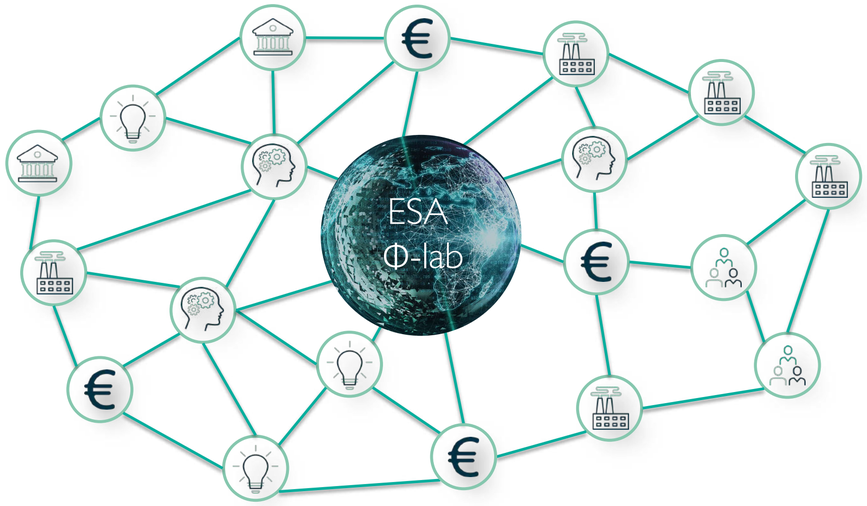
- Take advantage of the EO perfect storm
- Boost European competitiveness
- Develop and mature the EO market

The ESA Φ-lab – How?

Φ-lab aims to become "the reference" for the transformational innovation and a key influencer (by reputation and authority) in the Earth Observation ecosystem

Catalyst

- Attract EO academic and industrial researchers to generate transformative ideas
- Exploit fail fast ethos, rapidly prototyping concepts
- An informal but rigorous, multi-disciplinary, collaborative environment
- Act as facilitator to foster competitiveness growth and entrepreneurial initiatives
- Implement investment actions from ESA MSs or in the investors industry

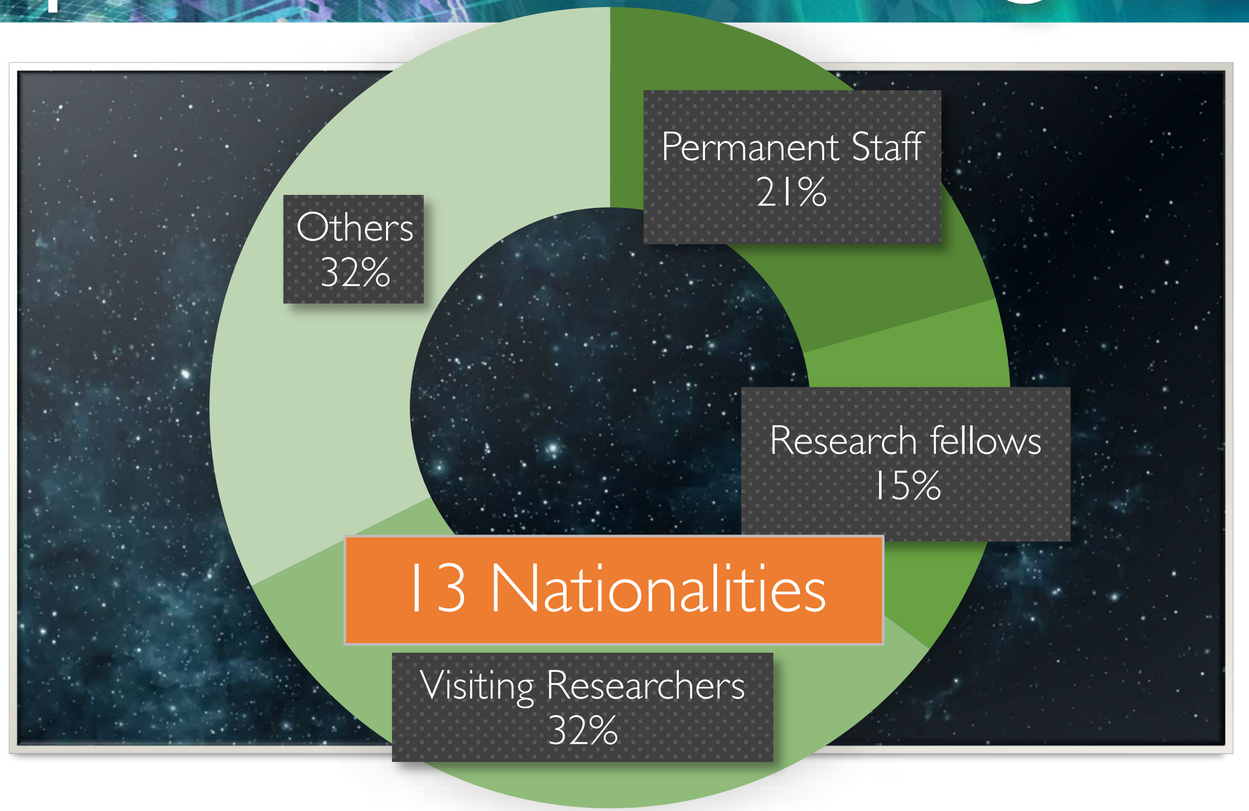


Bridge

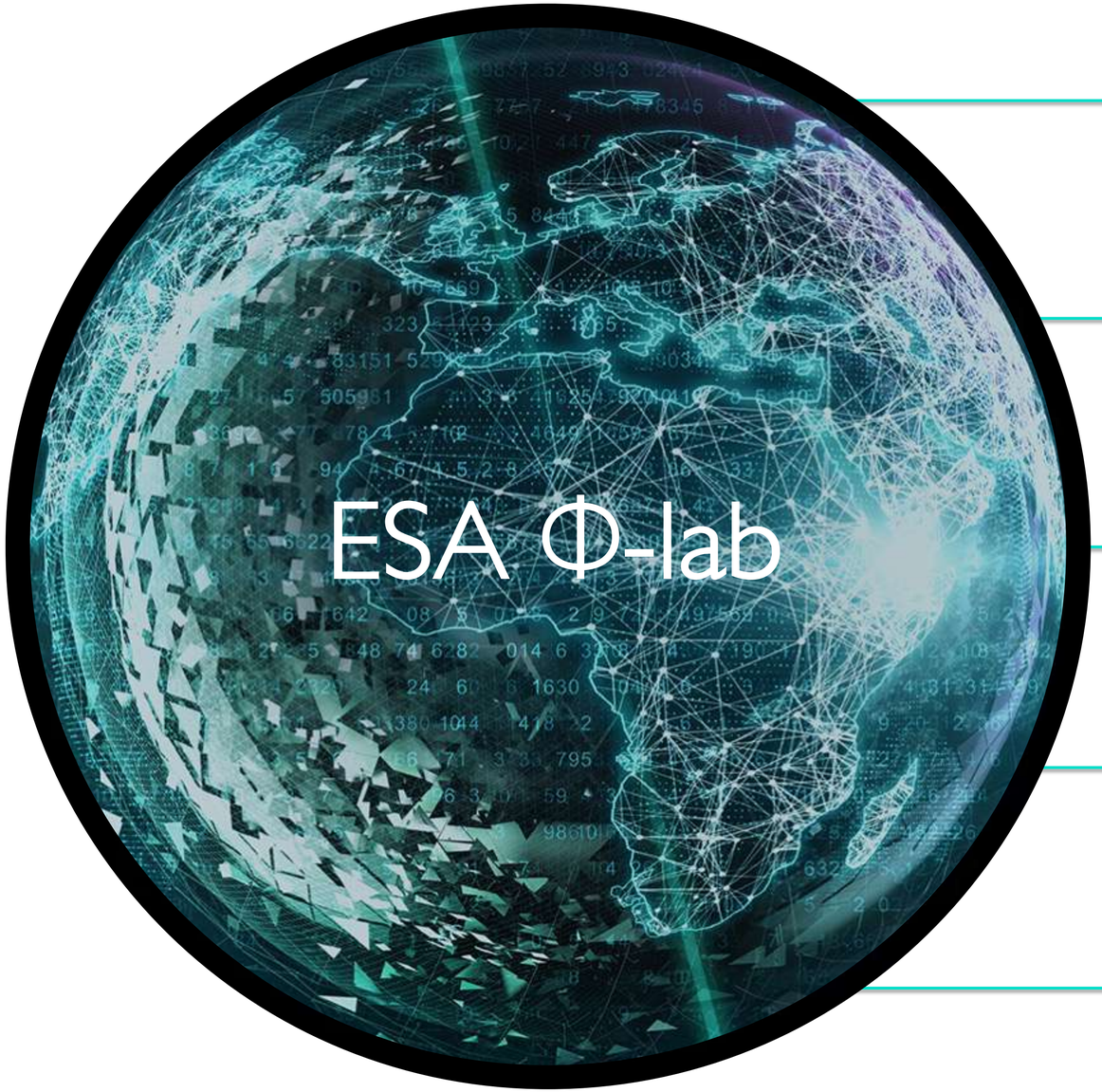
- Be the bridge between the European start-ups, academic and industrial researchers, New Space operators, Investors, ICT players, EO world leaders, and ESA
- Act as hub stimulating, connecting, and developing a growing ecosystem of talents and capabilities across Europe

The ESA Φ-lab location and people

- Based in ESRIN, Frascati – Italy
- Established end 2017
- About 35 members
- 19 strategic partnerships



The ESA Φ-lab tools



Research Lab
Our collaborative and open research environment

Φ-lab Challenges
To stimulate transformational innovation

Φ-lab Community
Our network of companies, researchers, professors and key institutions

Invest Action and InCubed
To facilitate access to innovation investments

Flagships programme
Key programmes as targets of our transformational innovations

Collaboration opportunities at Φ-lab

No funding

Join the open Φ-lab as an Industrial or University Researcher, Visiting Professor, Research Fellow, PhD, etc. to explore together transformational ideas

With funding

1. Φ-lab's **Invitation To Tender** on EMITS
   - ML, QC, Edge comp., Web 3.0, Collaborative Research Network, etc..
2. **Open Discovery Ideas Channel** : co-funded research or researchers
3. **EO Science4Society** : no SOW, 150K, 12 months
4. **InCubed** : development of commercially successful products or services

Innovation Technologies axis and Applications

AXIS I	AXIS II	AXIS III
Artificial Intelligence and Machine Learning	Quantum, Neuromorphic, Edge Computing	IOT, Blockchain, Web 3, Cognitive Space

- Flight HW
- Flight SW applications
- Downstream applications
- End to end systems
- Innovative business models

Some of Φ-lab successes*

6
Contributed to AI powered satellites

19
External collaborations with companies, agencies, research centres and private investors

€181M
InCubed fund size

64
Activities funded @62% co-funding rate

90+
Publications on peer reviewed journals and conferences

10+
Visiting Professors

20+
Visiting researchers

AI4EO
QC4EO
Contributing to European R&D agenda

*The ESA Φ-lab successes: as of March 2023

(some) Collaborations and parternships

The ESA Φ-lab Offices

Φ-lab Explore Office

Explore the innovation universe
connecting EO sensor revolution
with the digital revolution

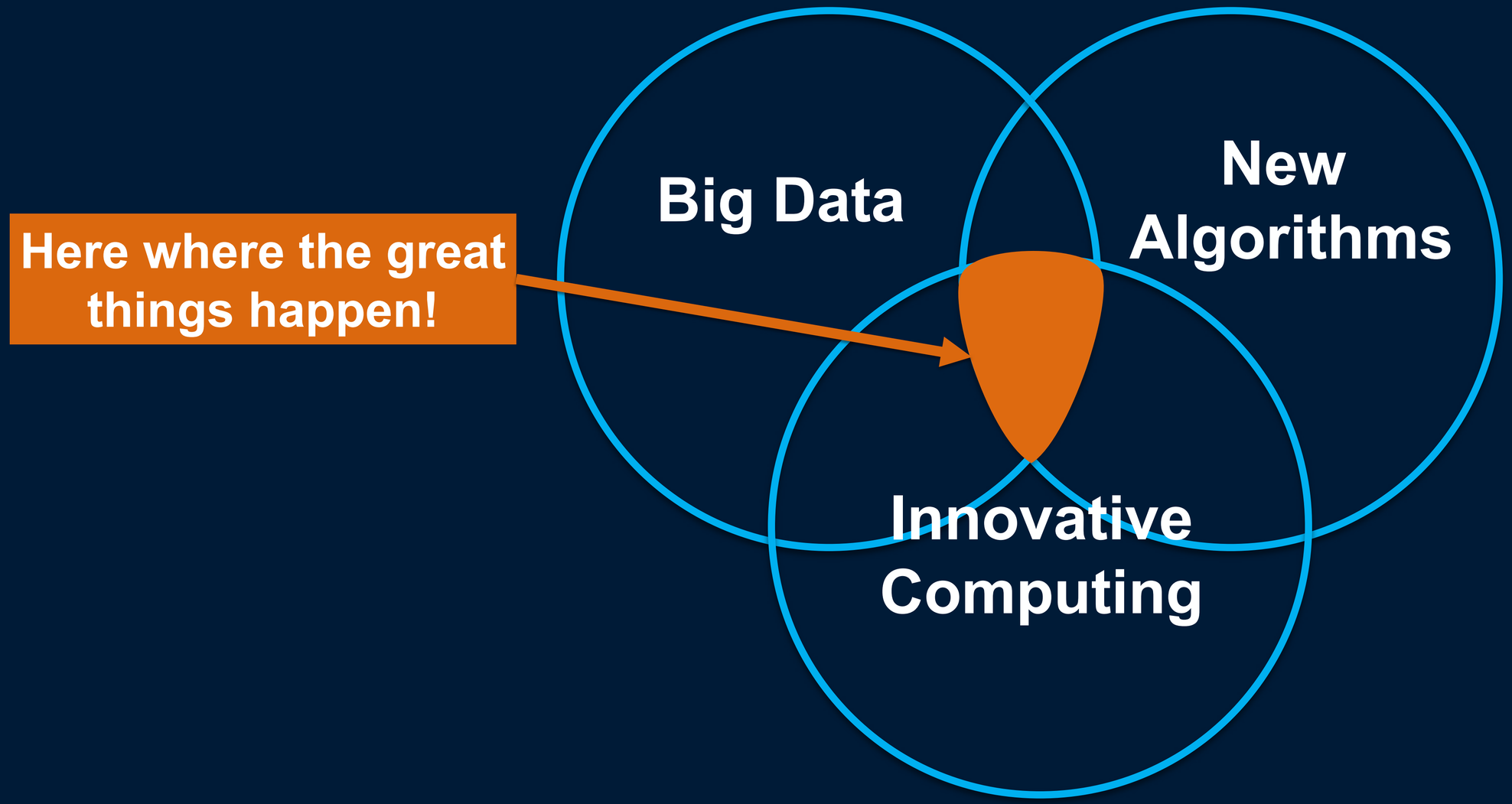
Team of Researchers
and an innovation seed funding (FutureEO)

Φ-lab Invest Office

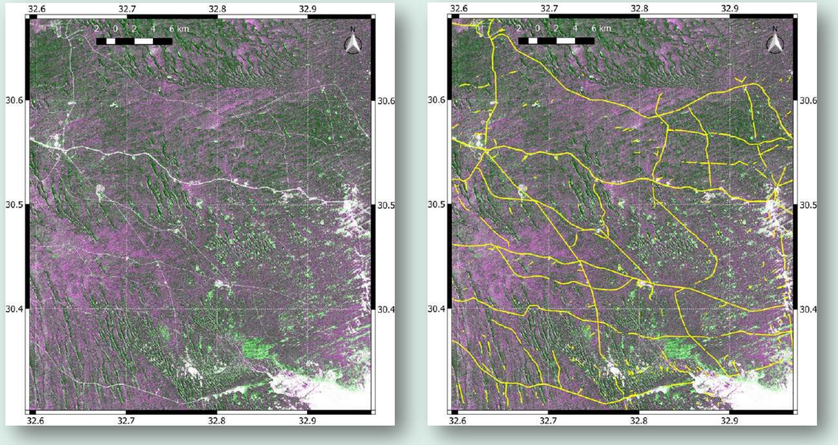
Stimulate competitiveness fostering entrepreneurial
initiatives growth with investment actions from ESA MSs
and private investors

Team of Business Innovators
and commercial co-funding programme (InCubed)

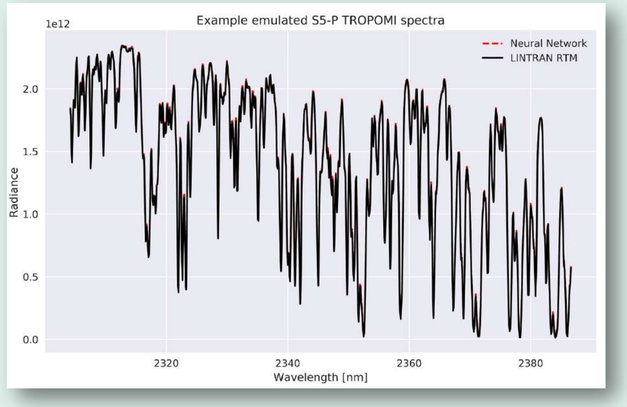
The ICT, AI and ML Revolution in EO



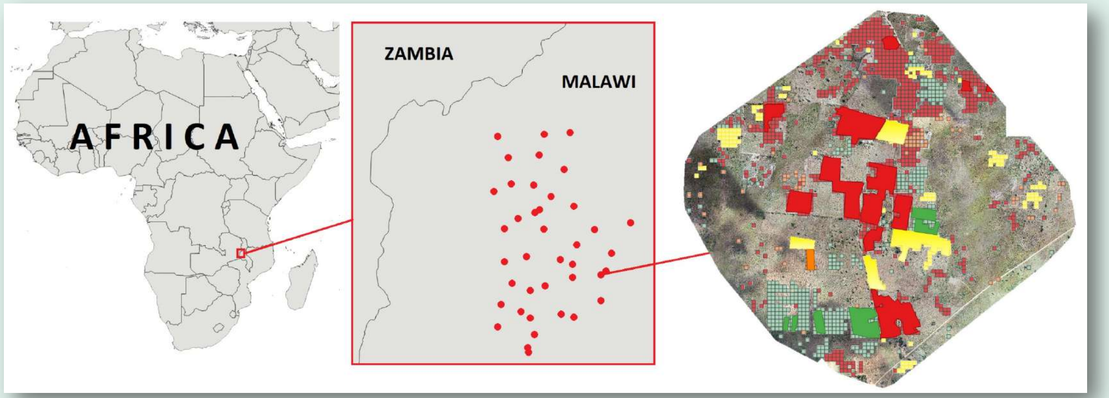
EXPLORE Use Cases – Some examples



Infrastructure monitoring in desert regions



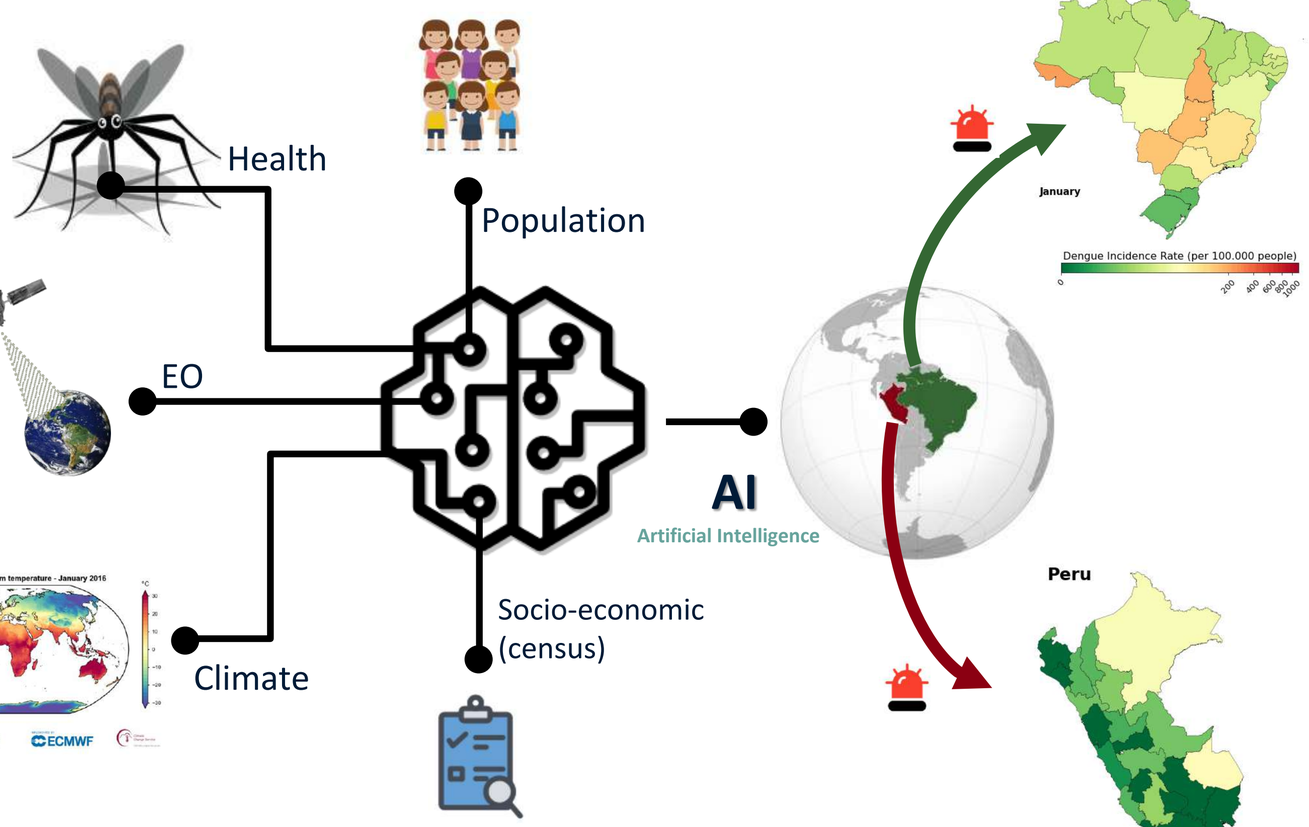
Physics-aware machine learning emulation of RTMs
Copernicus Sentinel-5p methane retrieval



Crop types mapping using drones,
Copernicus Sentinel-2 and daily life images

Use of AI for SAR image for on-board
object detection and classification

Quantifying health-risk with EO data and AI (application to Dengue)



UNESCO | IRCAI Global AWARD

Top 100 AI solution for SDGs

to Φ-lab team for their work on forecasting dengue outbreaks with UNICEF

GLOBAL TOP 100
GLOBAL TOP 100
PROMISING PROJECT
PROMISING PROJECT

"This project is a perfect example of collaboration between a humanitarian organisation and a research entity to support the UN SDGs."

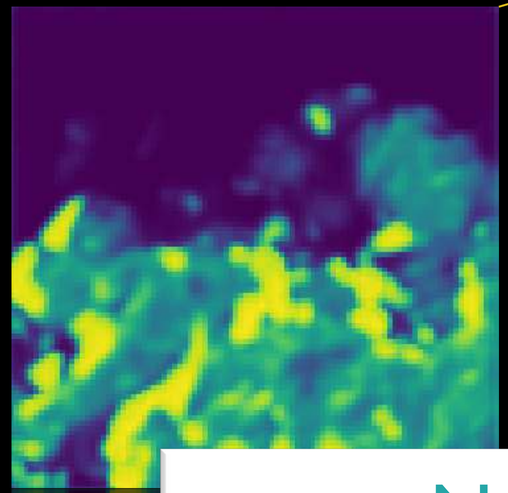
Dohyung Kim
Lead Data Scientist at the UNICEF Office of Global Innovation.

QC4EO

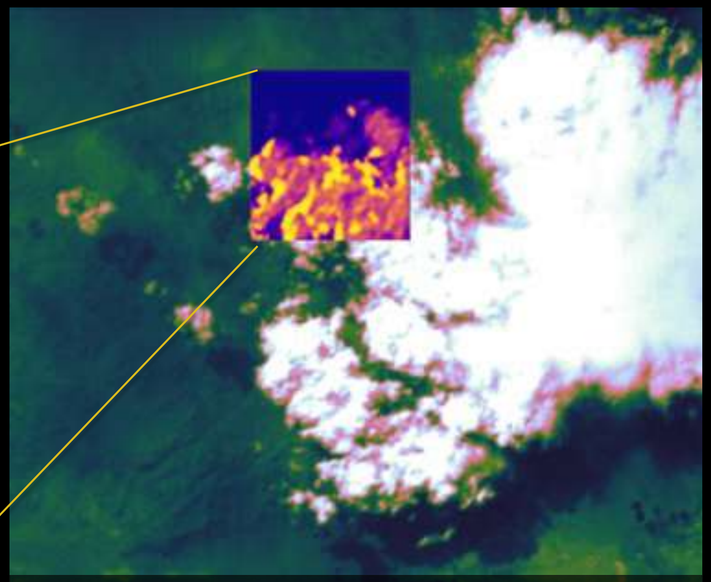
AI-enhanced Quantum Computing for EO

Φ-sat-1 is the first AI-powered European EO mission

AI-computed Cloud mask



Cloud mask superimposed on the hyperspectral image



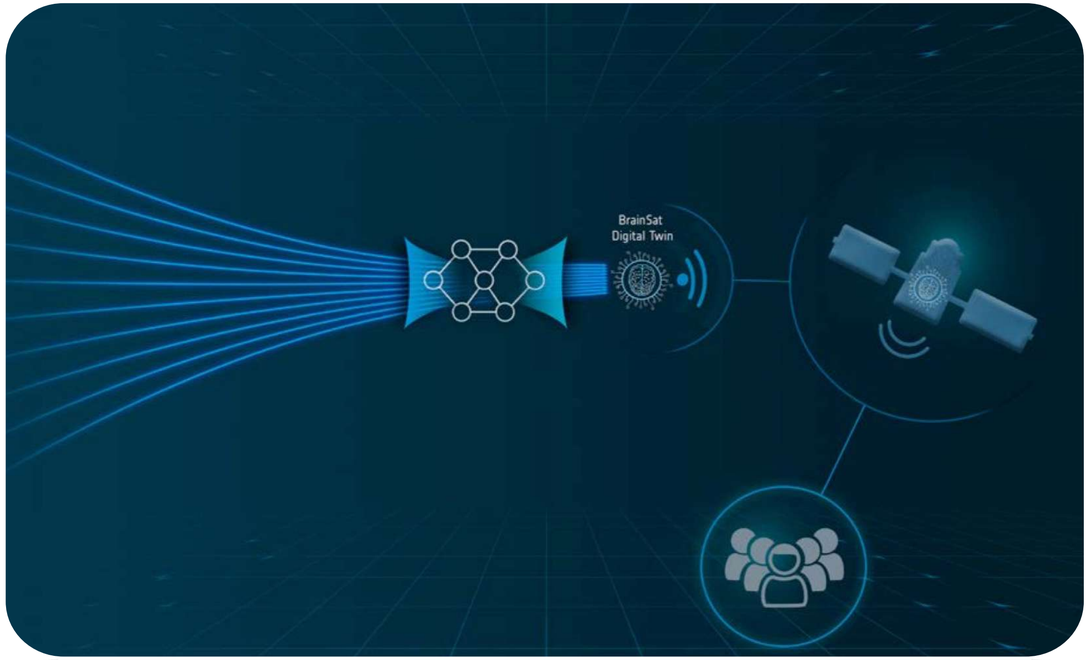
Now AI on Φ-sat-2,
On Copernicus expansion missions and more..

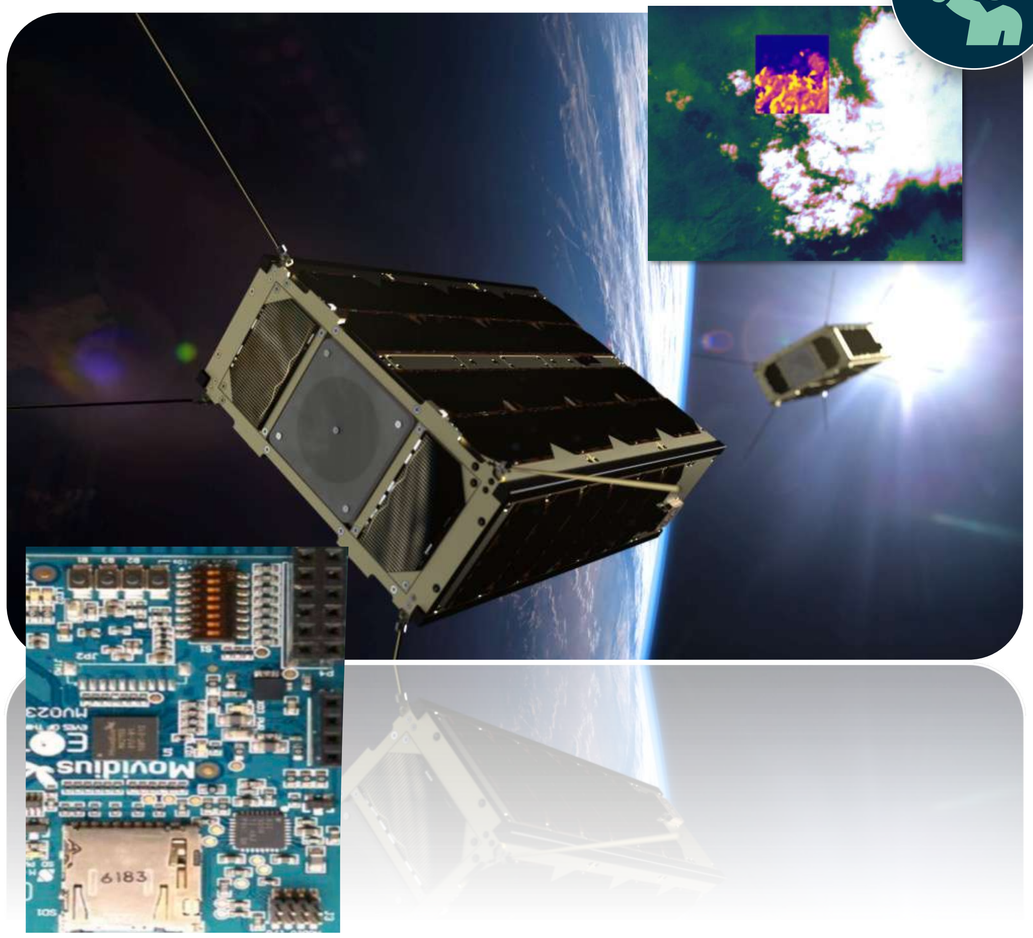
The Myriad 2 chip

Image: Maximilien Brice/CERN

AI chip and the Φ-sat-1 neural networks are perfectly working with the expected performance

Edge Computing in Earth Observation

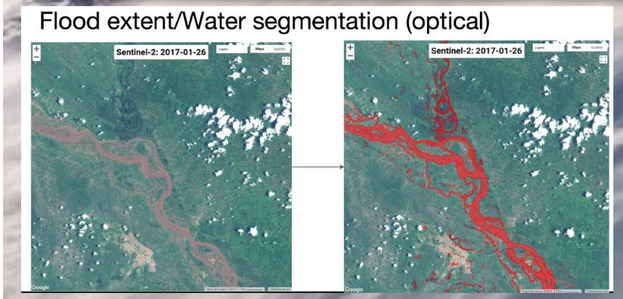


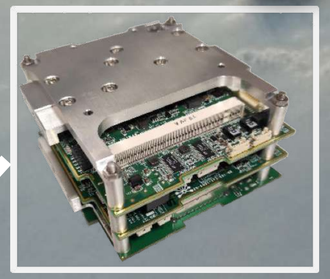


> *The value of satellite-based EO no longer grows with the ability to collect and transmit data back to Earth, it increasingly lies with the ability to transmit customer-relevant insight in real-time.*
>
> **Peter Platzer,**
> *Spire, Φ-week 2019*

Actionable insight in space, low latency, autonomy

Europe has precursors: Cognitive Cloud Computing Node in Space running suite of Machine Learning Apps





Nebula payload
On-orbit Cloud
Computing Node
(UNIBAP SpaceCloud)

Re-programmable
AI Brain

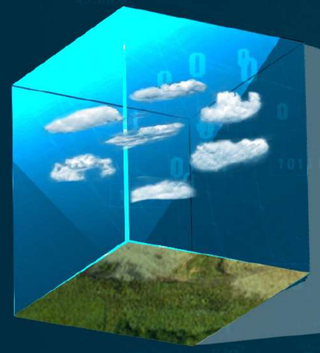
Testing “Worldfloods” which have the ability to identify flooding and send down a flood map to emergency responders seconds after image acquisition. The Machine Learning SpaceCloud App is developed by the Frontier Development Lab (FDL), a partnership led by Trillium Technologies with the University of Oxford and ESA

D-Orbit Wild Ride Mission, launched 30 June 2021
ION Platform with 6 cubesats, 20+Machine Learning Apps on SpaceCloud

D-ORBIT UNIBAP FDL

SPACECLOUD UNIBAP D-ORBIT WILD RIDE - ION SCV 003

The Destination Earth : AI4DTE



OBSERVATION

LEARNING

MODELS

INFERENCE

PREDICTIONS

POLICIES

AI-SW (SomeWhere)

European Commission

ECMWF

EUMETSAT

The ESA Φ-lab Offices

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Explore the innovation universe
connecting EO sensor revolution
with the digital revolution

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and an innovation seed funding (FutureEO)

Φ-lab Invest Office

Stimulate competitiveness fostering entrepreneurial
initiatives growth with investment actions from ESA MSs
and private investors

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and commercial co-funding programme (InCubed)

Boost European EO commercialisation

Fast Innovation and Talents

Generate unique competitive advantage via talent creation and fast disruptive innovation

+

Mitigate/Share Risks

Mitigate industrial Dev. and Mkt. risks exploiting ESA huge technical, programmatic, and industry understanding and via anchor customer actions

+

Access to Risk Capital

Stimulate private risk capital, and synergise with the public ones to scale up

+

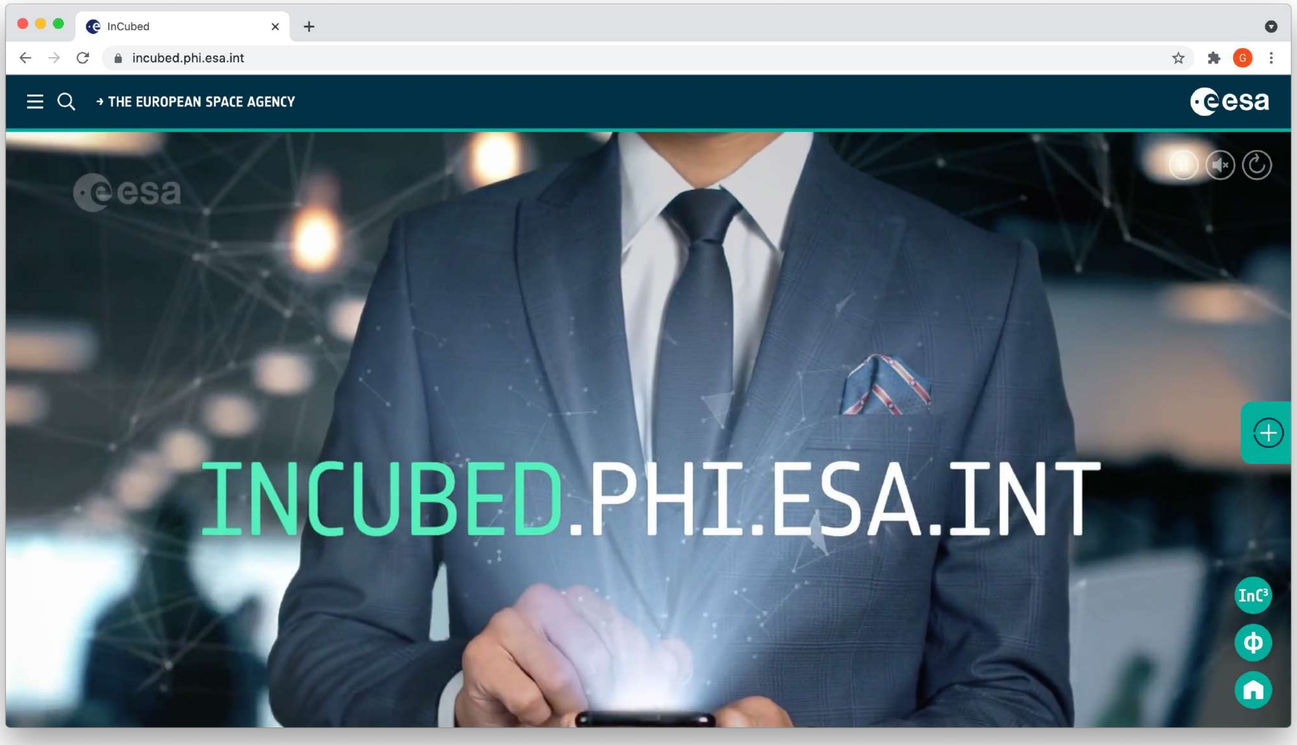
Easy Regulations

New Space tailored regulations and procurement rules minimizing burden and uncertainty

ESA roles

1. ENABLER of a sustainable commercial EO by closing know-how and technology gaps
2. PARTNER the development of innovative product/services to reduce dev and fin risk
3. CUSTOMER of commercial products and services to reduce market risks (e.g. anchor customer)

Φ-lab run Investing in Industrial Innovation (InCubed)



€181M
InCubed fund size

64
Activities funded
@62% co-funding rate

100k€ to >15m€
Project size

NATIONAL DELEGATIONS

ESA

INDUSTRY

Personalised technical and commercial guidance

Zero-equity and zero-IPR

ESA stamp of credibility

Privileged access to commercial services enabling your development

Access to ESA EO facilities and Φ-lab community

InCubed Activities – Some examples

Innovative solutions for VHR EO satellites, AOCS and the Instrument for high-quality VHR satellite imagery and geo-analytics

deimos elecnor group | SURREY | TELEDYNE e2V Everywhereyoulook™

MultiSpectral Companion Mission

To provide a daily global coverage, high quality multispectral data product, with interoperability with Sentinel-2 data products.

aerospacelab

ai4eo SOLUTION FACTORY

Combine EO data and AI tools to identify new business cases addressed with customized solutions, created in a knowledge base and modules repository factory

DFKI | VISION IMPULSE

AIX SMART IN-ORBIT DATA PROCESSING

AI-express (AIX) is a hybrid edge ecosystem based on state-of-the-art technologies (AI with dedicated processing units and Blockchain) targeting reactivity, responsiveness, and low-latency

planetek italia | AIKO INFINITE WAYS TO AUTONOMY | D-ORBIT

InCubed Activities – Some examples

EO PLUG-IN HUB

Improve potato production yield. A paradigm change for Earth observation integration in the agro-food industry

GeoVille HLB research and consultancy in agriculture HERMESS eodc

Signaleyes
A clear view on change

SignalEyes analyses spatial changes in objects including buildings, trees, water courses and roads.

NEO

HyperScout-2 for the FSSCAT mission. Miniaturized hyperspectral and thermal imaging coupled with Artificial Intelligence for breakthrough operational space missions

cosine

mantis

MANTIS is a demonstration mission to develop, build, launch and operate an innovative nanosatellite that will fly a high resolution camera

OPEN COSMOS Terrabotics Space to Earth Analytics SATLANTIS

Thank you for your attention

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