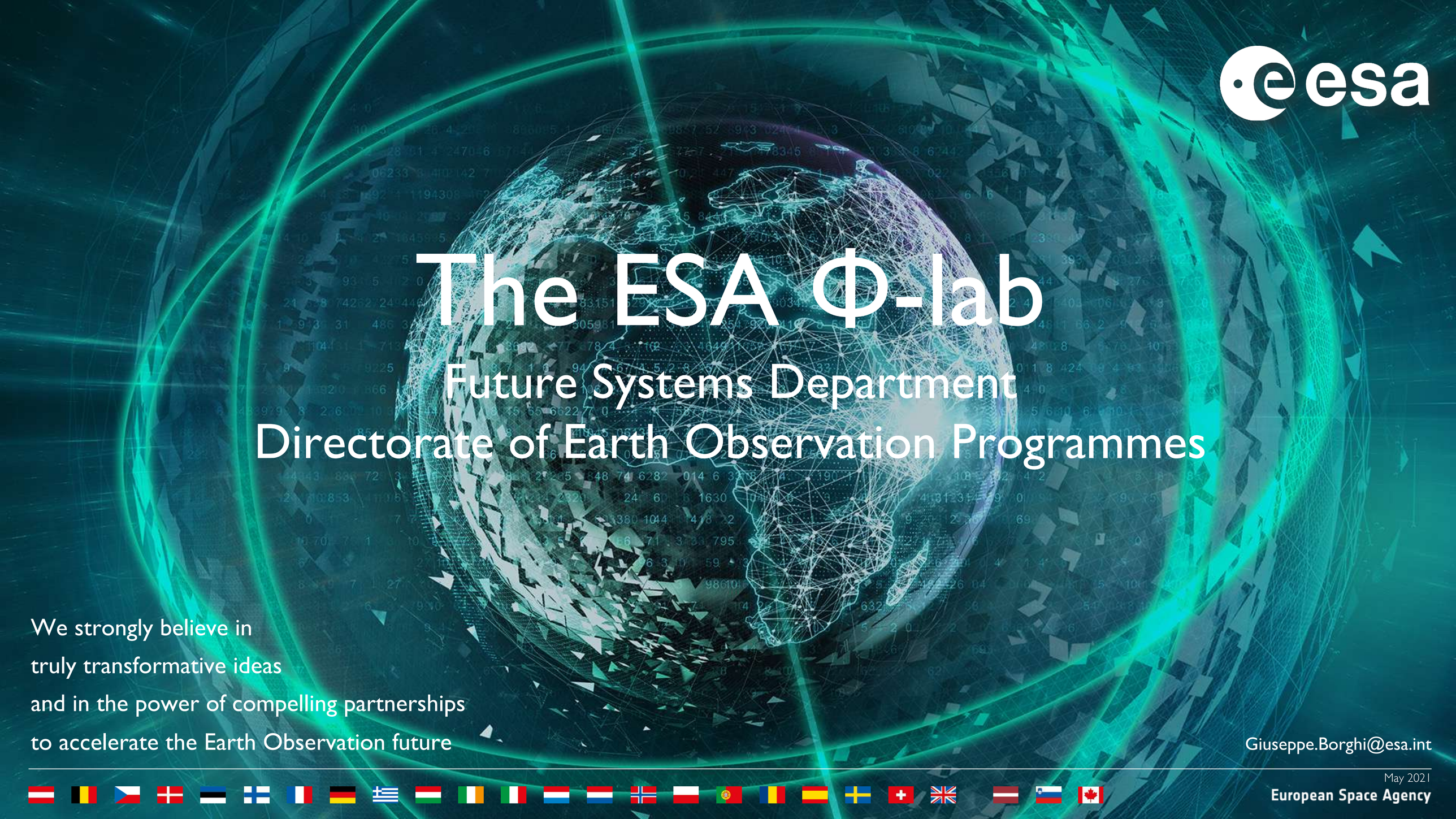


The ESA Φ-lab

Future Systems 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

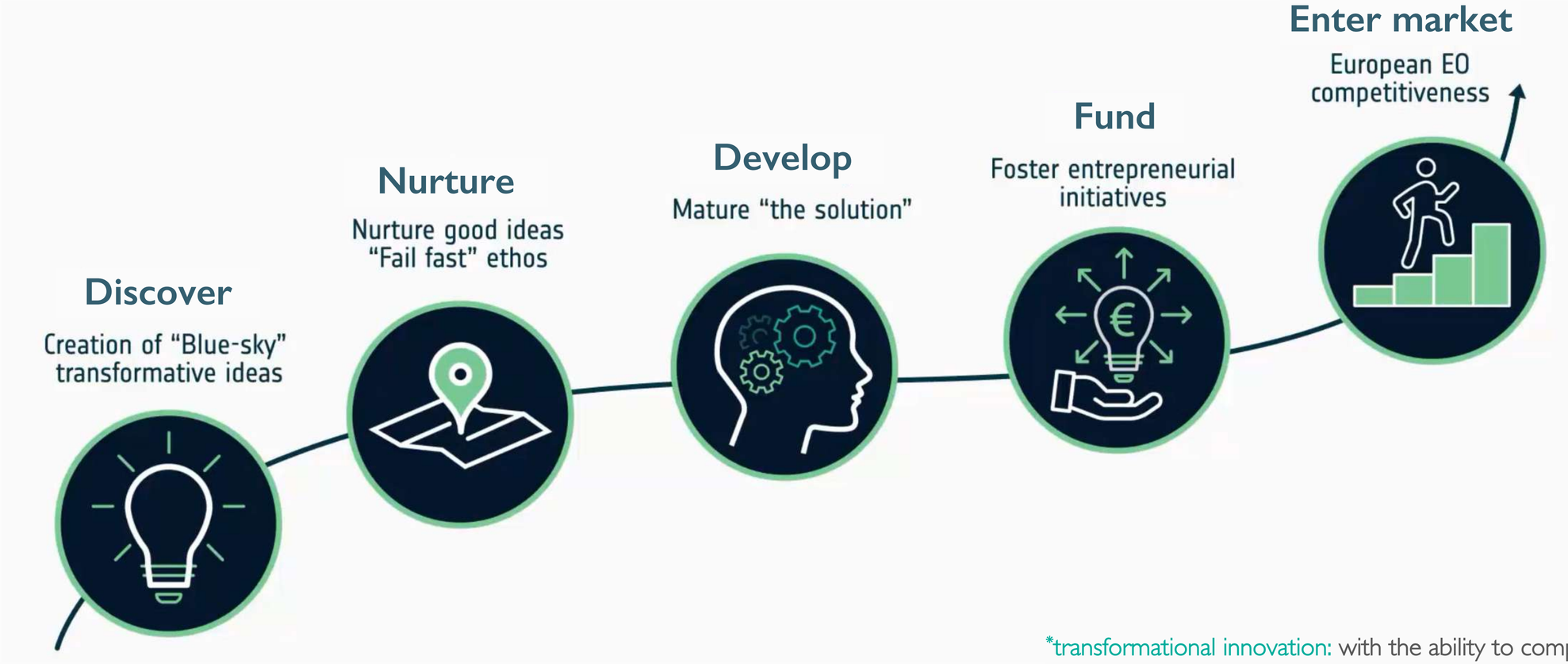
Giuseppe.Borghi@esa.int

May 2021
European Space Agency

The ESA Φ-lab – What ?

Φ-lab
innovate and apply
under-one-roof

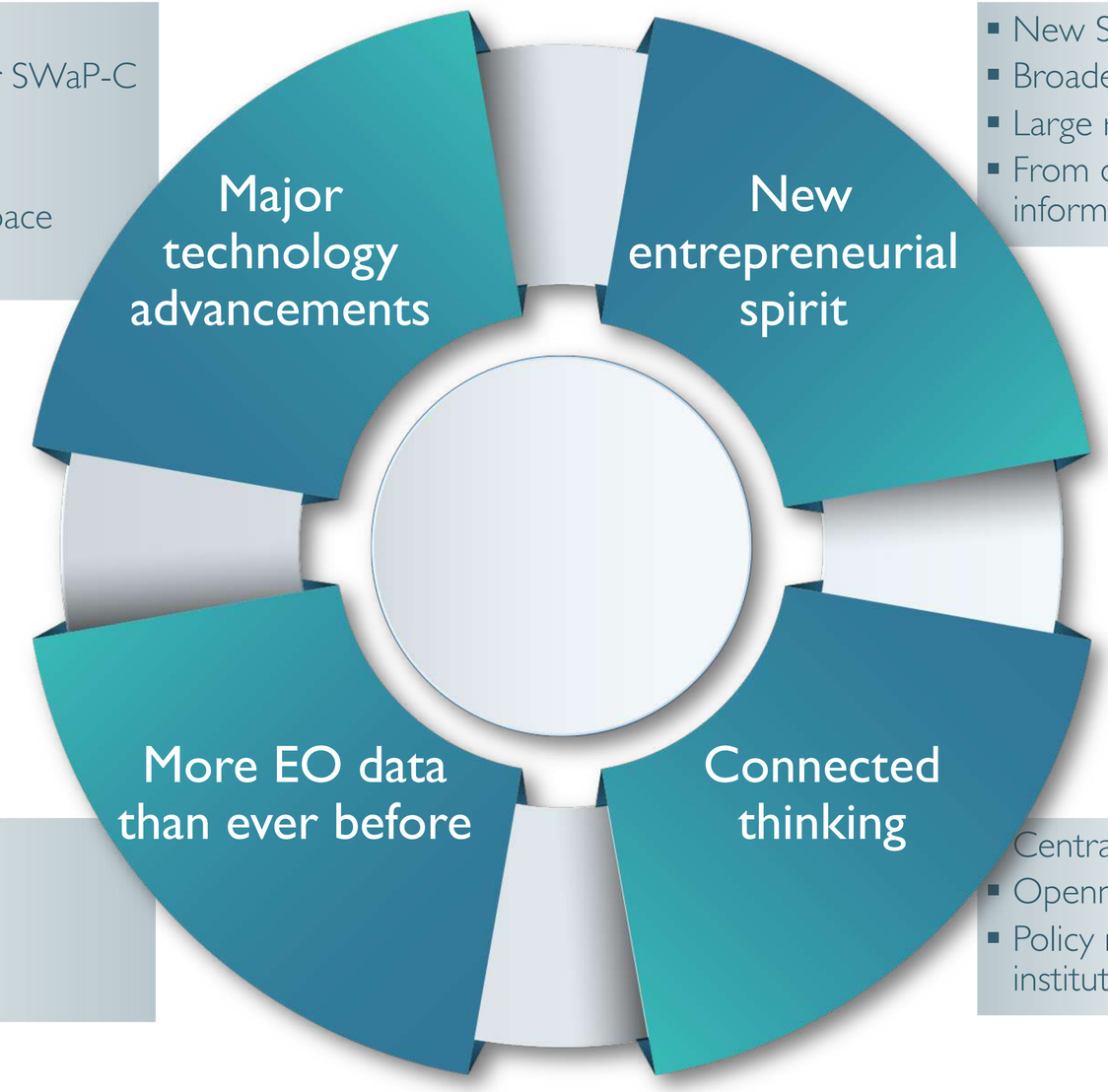
Accelerate the future of Earth Observation
via transformational innovation*
strengthening Europe's world-leading competitiveness



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

The Earth Observation perfect storm

- Lower access 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?

Space economy

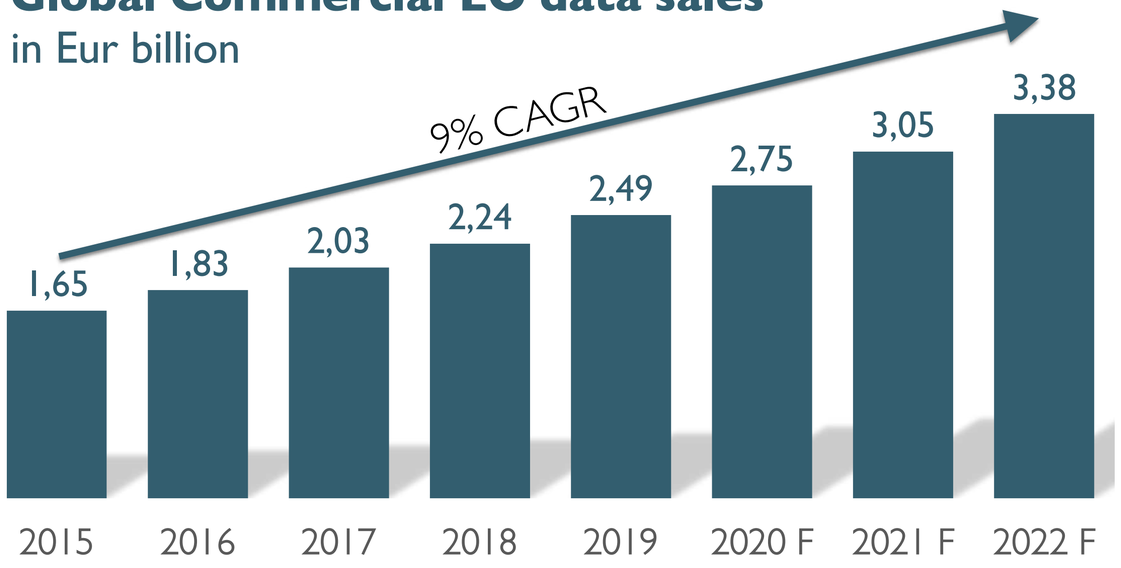
€309bn

+6.7%

Growing 2x of global economy

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

Global Commercial EO data sales
in Eur billion



Source : European Commission & EARSC

European EO service market

€1.4 bn last 12 months

+9.7%
Total revenue

+11%
Number of companies

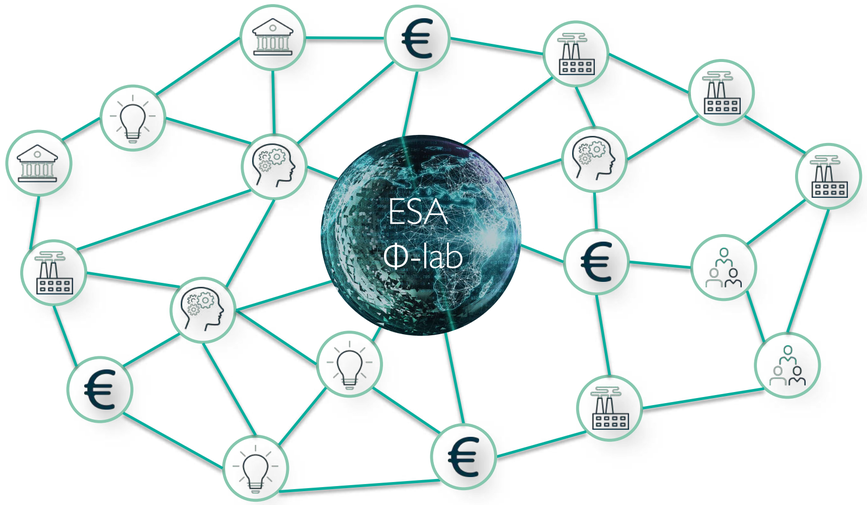
+17%
Number of employees

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, and collaborative environment
- Implement investment actions from ESA MSs or in the investors market
- Act as facilitator to foster competitiveness growth and entrepreneurial initiatives



Bridge

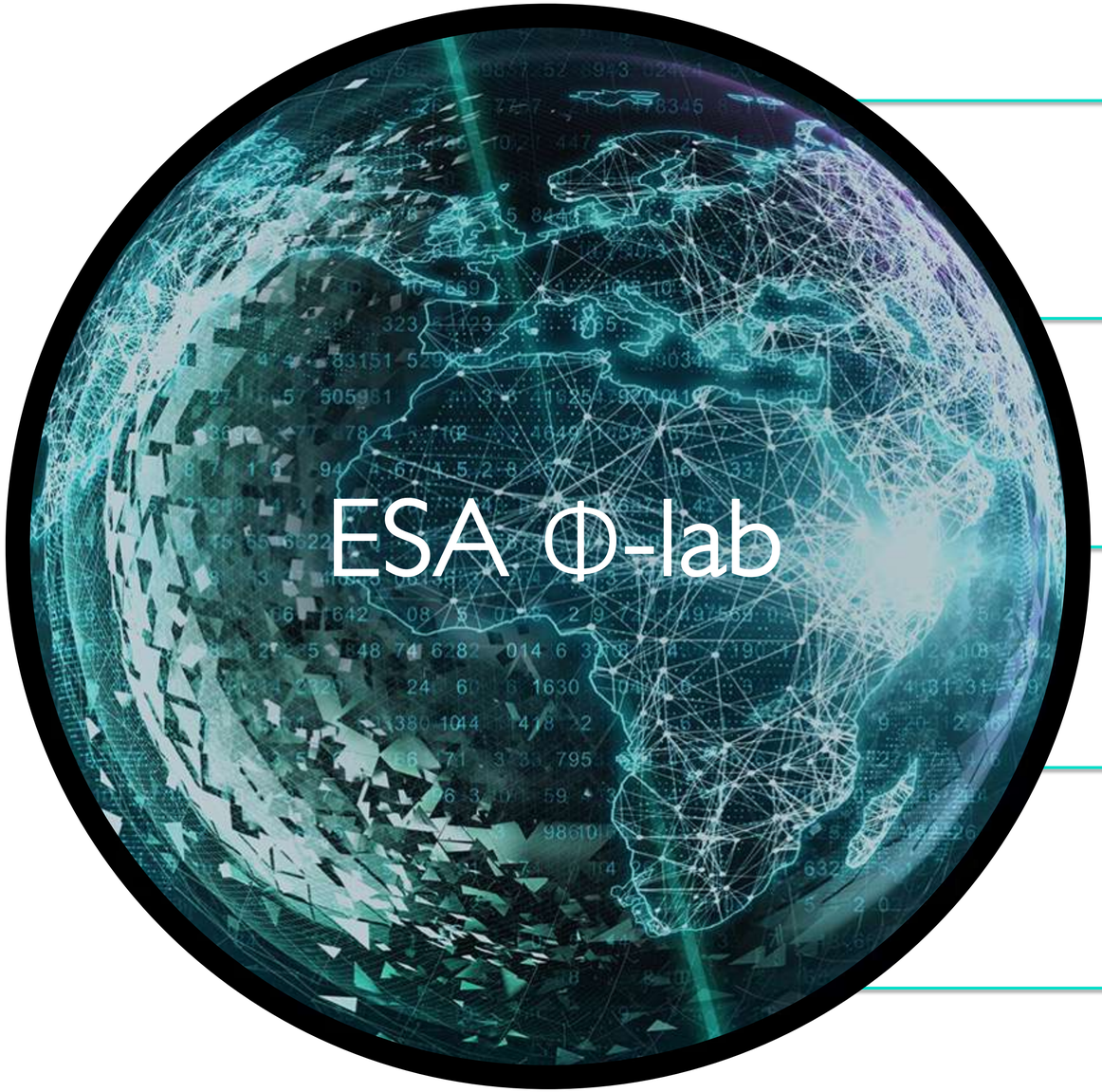
- Be the bridge between the European start-ups, New Space operators, Investors, ICT players, EO world leaders, ESA, Member States and EC
- Act as hub stimulating, connecting, and developing a growing ecosystem of talents and capabilities across Europe

The ESA Φ-lab location and people

- Established end 2017
- Based in ESRIN, Frascati – Italy

- About 30 members
  - ESA Staff
  - Research Fellows
  - Industry and Academia Visiting researchers
- 12 external collaborations

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

Innovation Technologies axis and Applications

AXIS I

Artificial Intelligence and Machine Learning

AI4EO
Detection & Classification, Physic-aware AI, Data Fusion, Prediction, Super-resolution, Quality Control, Calibration, Inversion, Virtual reality

AXIS II

Quantum Computing

QC4EO
AI-enhanced Quantum Initiative for EO

To solve demanding Earth observation problems by using quantum computing and AI

AXIS III

Internet of Things, Blockchain, Cognitive Space

- Flight HW
- Flight SW applications
- Downstream applications
- End to end systems
- Business models

The ESA Φ-lab successes*

2 + 1?
Contribution to AI powered satellites:
Φ-sat-1 (launched on 02/09/20)
Φ-sat-2 (under development)
ESA operational mission (under assessment)

12
External collaborations with companies, agencies, research centres and private investors

€103m
InCubed programme value

28
53M€ funded activities @ 62% average co-funding
3 already generating revenue

AI4EO
Setting the European R&D agenda on AI4EO

10
Visiting Professors

26 + 12
Publications on peer reviewed journals and conferences

12
Visiting researchers

*The ESA Φ-lab successes: as of April 2021

Working with us

- **Visiting Researchers (Industrial, Scientific and Research)**

  We host representatives from industry, or academia who can propose to work with us on their own innovative case study, getting access to ESA EO huge competence, our computing resources, and facilities. They usually stay with us from 4 weeks for a full immersion up to 2 years for a more strategic partnership

- **Research Fellowships**

  ESA's postdoctoral Research Fellowship offers scientists and engineers the possibility of two years in the lab to carry out research on case studies of yours and Φ-lab interest

- **Co-funded PhD**

  ESA Co-fund PhDs with industries or research institution on shared topics

- **Young Graduate Traineeships (YGT)**

  ESA's YGT scheme is aimed at Master degree graduates to work with us for one year to gain valuable experience in cutting edge EO activities

- **Visiting Professor**

  Visiting Professors help Φ-lab in setting the research agenda identifying the most valuable scientific problems and methodologies. We count now 10 among the most representative professional researchers in Europe

(some) Collaborations and parternships

The ESA Φ-lab Offices

Φ-lab Explore Office

Explore the innovation universe

and connect

EO sensor revolution

with the digital revolution

Φ-lab Invest Office

Stimulate competitiveness growth

fostering entrepreneurial initiatives

by investment actions from ESA MSs

and the investors market

The ESA Φ-lab Explore Office

Our goal is to enable a connected network of talents to brings together expertise and ideas from researchers, industry, ICT players, innovators and investors to foster scalable learning from EO data, Earth Science and Computer Science

We operates as a ESA 'hub' within the network of EO academic and industrial researchers across Europe and globally

- Research Lab
- Flag Ships
- Φ-lab Community
- Challenge Program

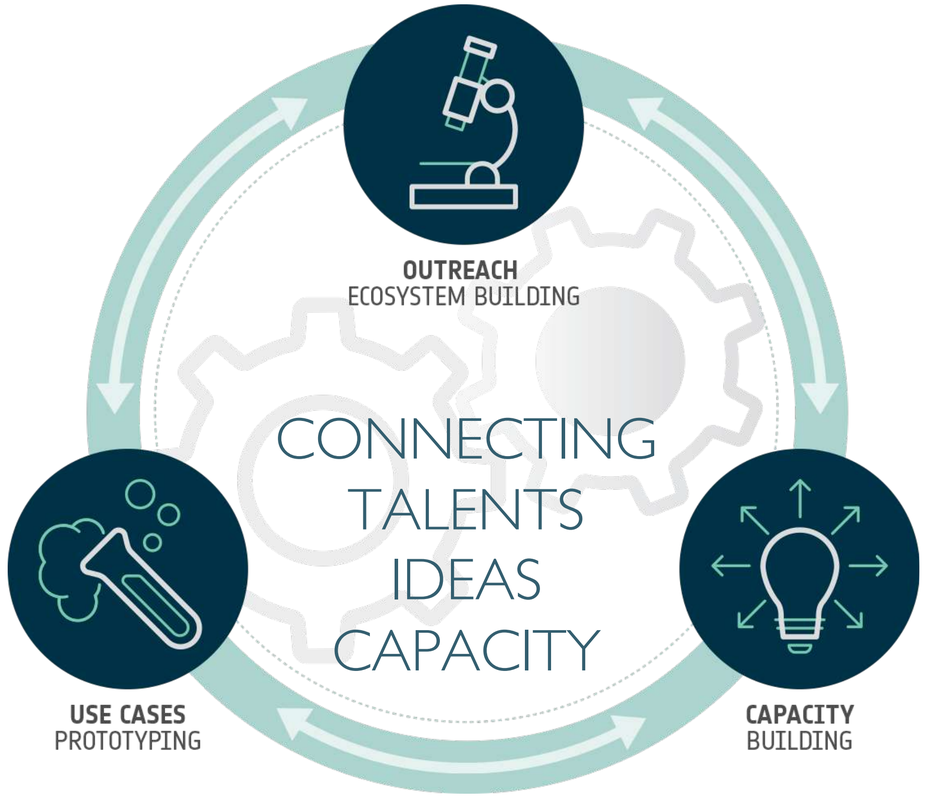
Link to ESA Φ-lab Explore Office - Research & Innovation strategy, 2020

Innovation cycle to deliver transformative and viable ideas

We work on

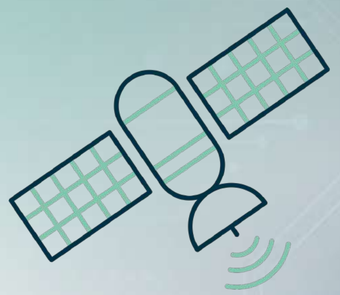
Φ-lab Explore innovation cycle is

- Focus on a meaningful problem
- Connect expert partners
- Enable solutions developing capacity
- Experiment "fail and recover fast" on use cases



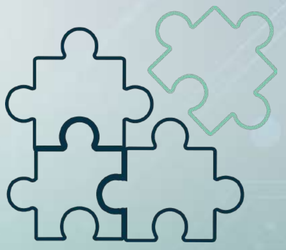
AI opening a new dimension for EO

On Board Autonomy



Process Automation

Data Science

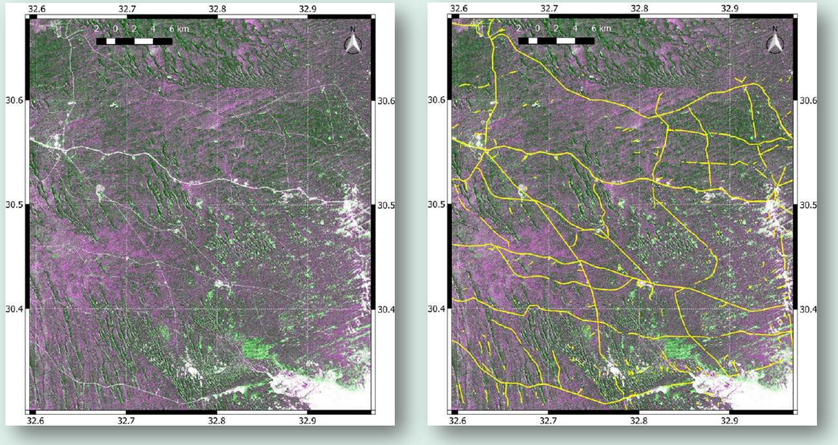


Detection/ Classification

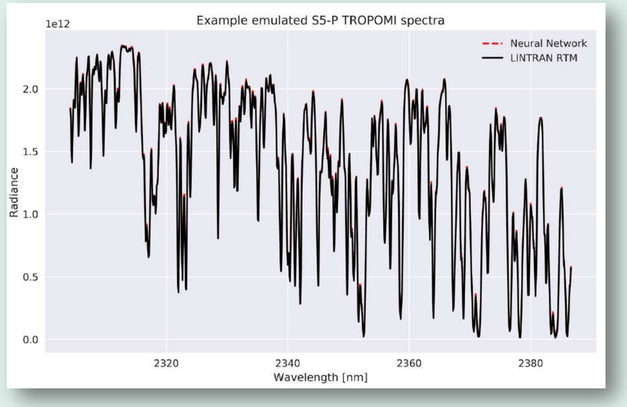
Big Data Analytics

Super Resolution

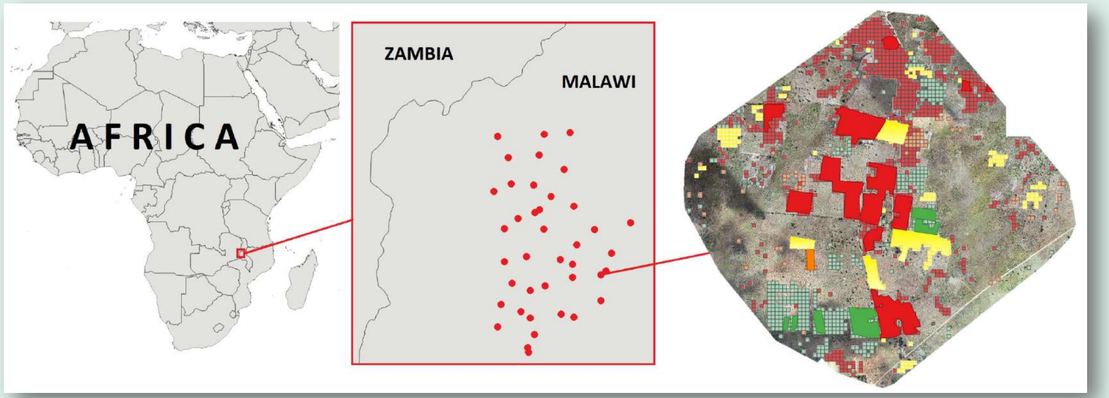
EXPLORE Use Cases – Some examples



Infrastructure monitoring in desert regions



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



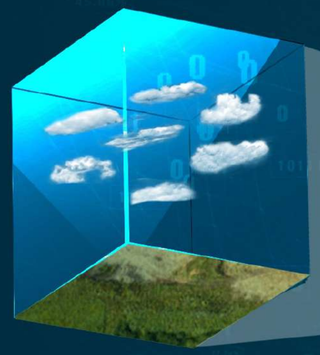
Crop types mapping using drones,
Copernicus Sentinel-2 and daily life images

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

QC4EO

AI-enhanced Quantum Computing for EO

The Destination Earth initiative AI4DTE



OBSERVATION

LEARNING

MODELS

INFERENCE

PREDICTIONS

POLICIES

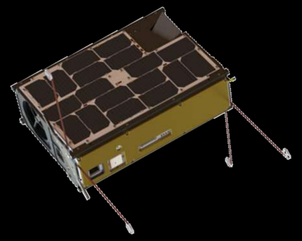
AI-SW (SomeWhere)

European Commission

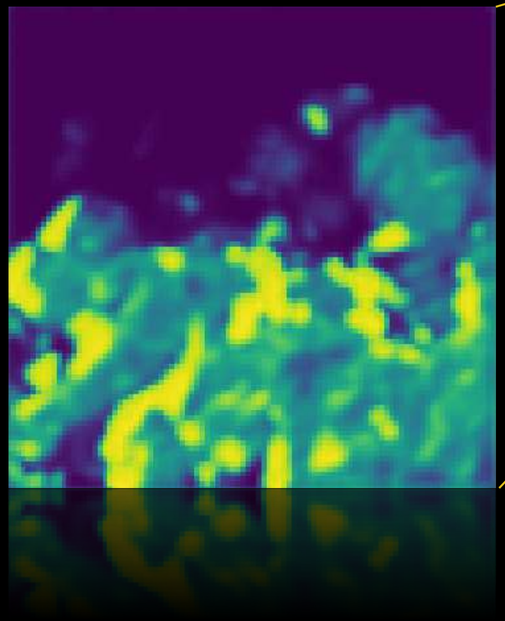
ECMWF

EUMETSAT

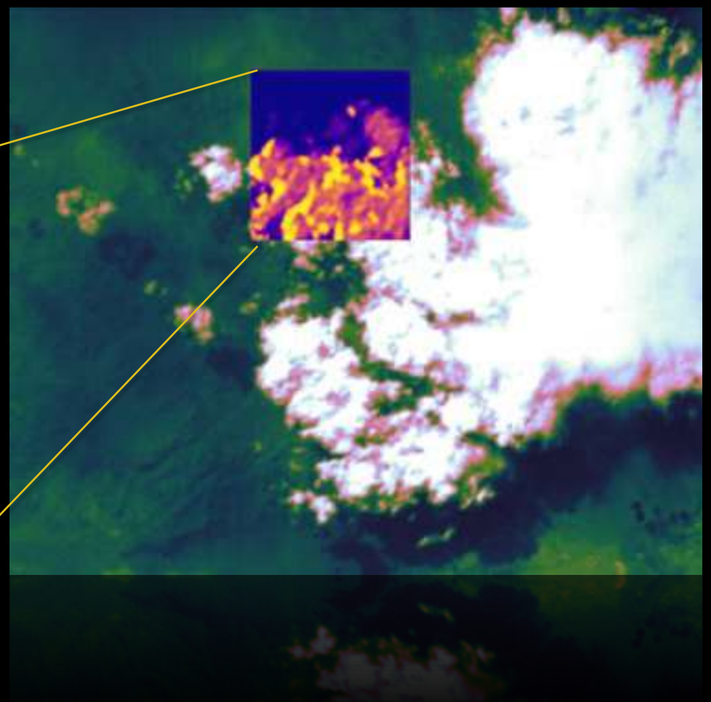
Φ-sat-1 is delivering its first data



AI-computed Cloud mask



Cloud mask superimposed on the hyperspectral image



The Myriad 2 chip

Image: Maximilien Brice/CERN

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

The ESA Φ-lab Invest Office

Our goal is to stimulate and develop all transformative actions that ESA can leverage to strengthen European EO industrial competitiveness and leadership

In this role ESA behaves as de-risking partner and facilitator stimulating competitive growth of the economic operator. ESA is not the end customer

Φ-lab co-invest program

Invest Action

Φ-lab Community

The ESA Φ-lab Invest Office

Φ-lab co-invest program

Offers Public Private Partnership investment opportunities to support and develop innovative and commercially viable products and services. Encourages high-risk/high-potential developments mitigating the technical and financial risks. Currently it is implemented via the ESA InCubed+ Program

Invest Action

Accelerates access to risk capital tools for innovation funding to our ecosystem, in particular start-ups and SMEs

Φ-lab Community

Fosters industry-to-industry and industry-to-academia synergies and cooperation to accelerate adoption of innovative business solutions

Investing in Industrial Innovation Programme-InCubed

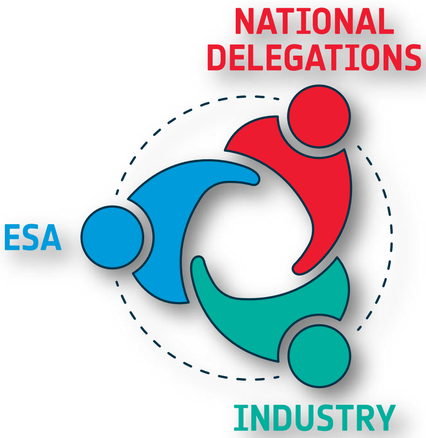
What is it industry-led commercial programme in Earth Observation

Focus develop innovative & commercially viable products and services

Scope anything from building satellites to data platforms, flight HW and SW and innovative business models

When Always, it is an open call

Who ESA, National Delegations, and Industry



InCubed.phi.esa.int

Personalised guidance technical and commercial support

Zero equity and IPR full ownership co-funding

ESA stamp of credibility

Access to ESA EO facilities and Φ-lab

Membership of the Φ-lab community

The ESA Φ-lab Invest Action

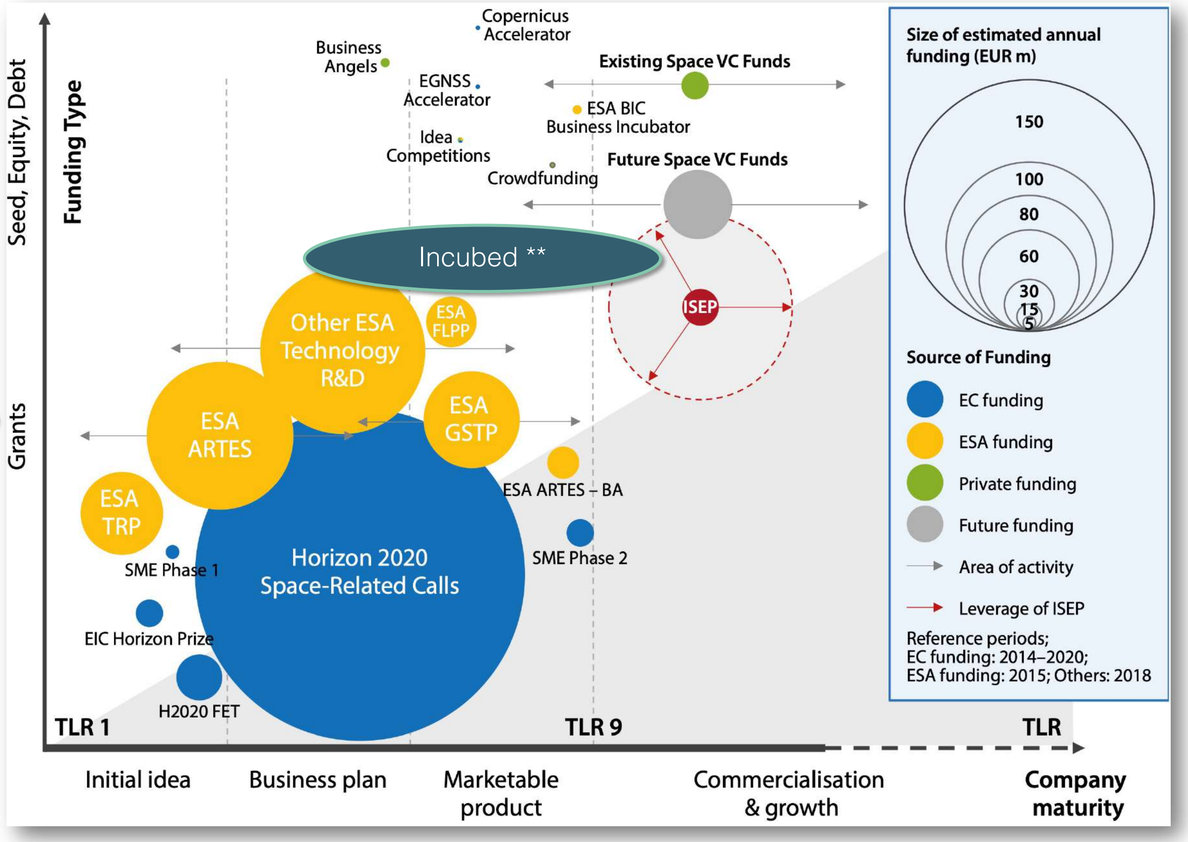
Aim

Accelerate access to risk capital for innovation risk funding for our ecosystem, in particular start-ups and SMEs

How

- Acting as EO technical and business expert, the "Φ-lab stamp"
- Promoting business cases in the investor community
- Reducing investors and industry venture risks
- Educating and facilitating start-ups access to funding tools
- Attracting community of investors, business angels, VC and Investment banks in the Φ-lab community

Overview of space-focused financial instruments in Europe*



* from EIB report The future of European space sector – link

** InCubed programme is not in EIB report, this picture position it in the context

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

The ESA Φ-lab Innovation Model

Earth Observation Community

Earth Observation assets

Artificial Intelligence & ICT

Entrepreneurship

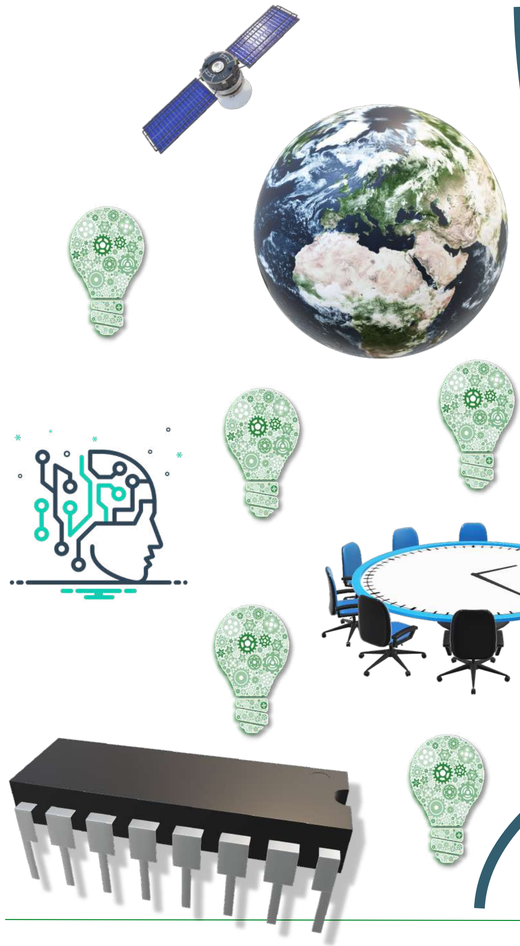
Disruptive ideas deliver waves of transformational innovations

Sustainable Economy

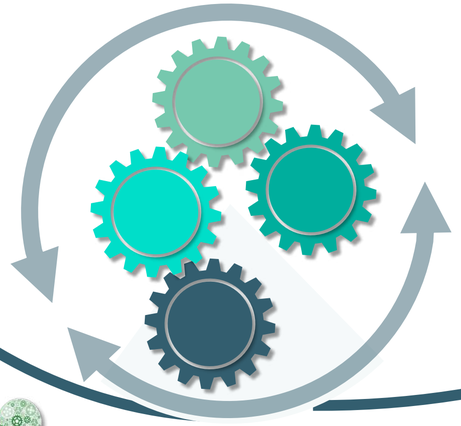
European Competitiveness

Economic Growth

Transformational Innovation



Transformational Innovation engine



Opportunity potential

Incremental innovation

Discover

Nurture

Develop

Fund

Enter market

Thank you for your attention

Giuseppe.Borghi@esa.int

To know more, visit our website:

philab.phi.esa.int