The European Space Technology Master Plan

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TEC-H
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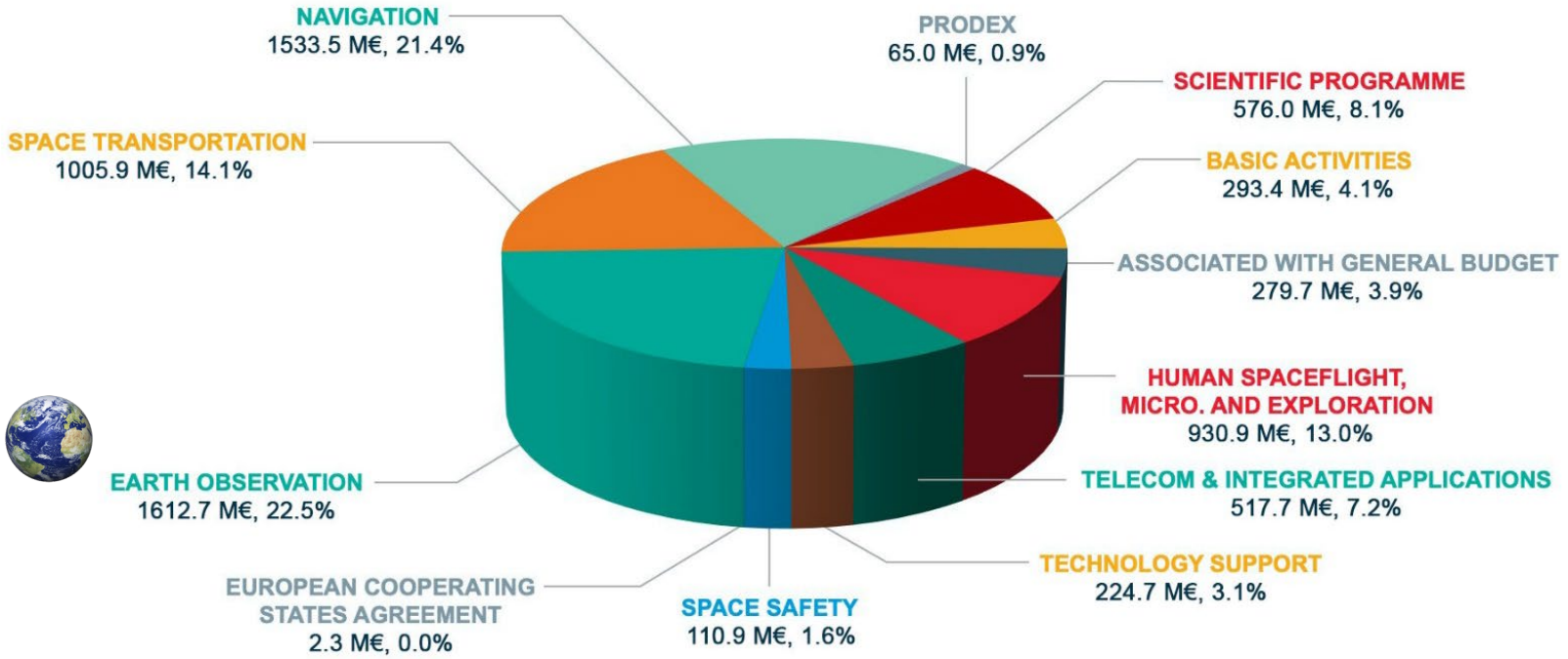
PURPOSE OF ESA

"To provide for and promote, for exclusively peaceful purposes, ***cooperation*** *among European states in* ***space research and technology*** *and their space applications."*

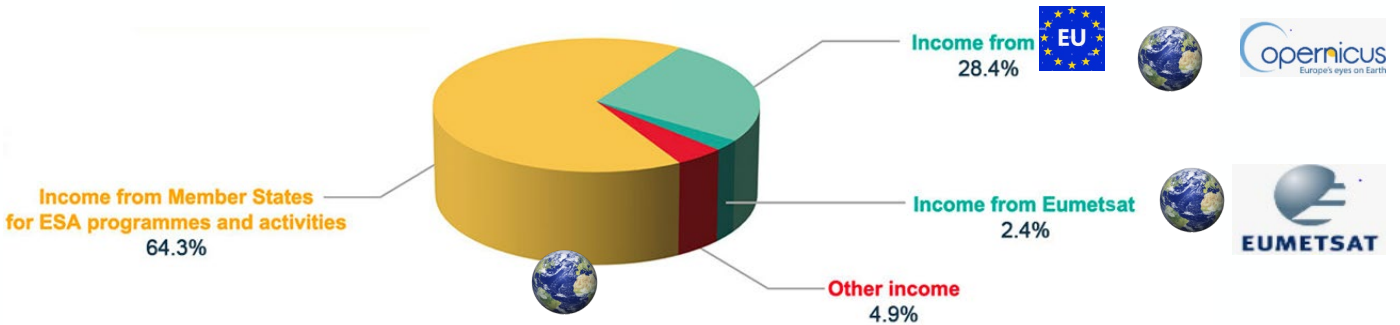
ESA Convention - Article 2

ESA BUDGET BY DOMAIN FOR 2022: 7.15 B€*



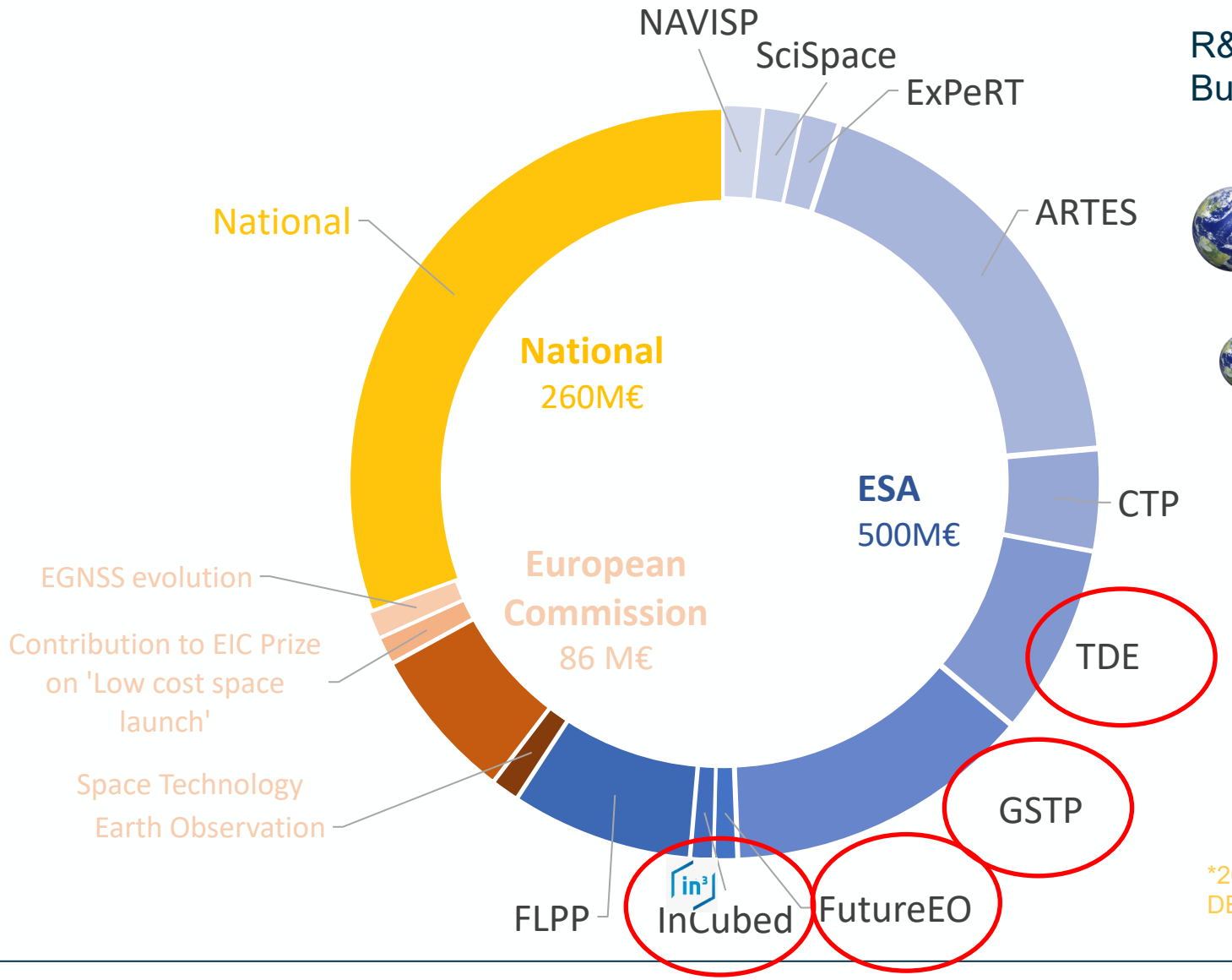
*includes activities implemented for other institutional partners

From CMIN
(Member States)



EUROPEAN SPACE TECHNOLOGY BUDGETS (2020)

(ref. ESTMP 2021)



R&D activities for space technologies in Europe
Budget nearly **850 M€** in 2020

- **FutureEO** – Future EO Programme, Development and Exploitation Components
- **InCubed** – Investing in Industrial Innovation
- **TDE** - Technology Development Element
- **GSTP** - General Support Technology Programme
- **CTP** - Science Core Technology Programme
- **ARTES** - Advanced Research in Telecommunications Systems Core Competitiveness
- **SciSpacE** - Science in Space Environment
- **ExPeRT** - Exploration, Preparation, Research and Technology
- **NAVISP** – Navigation Innovation and Support Programme
- **FLPP** - Future Launchers Preparatory Programme

*2020 budget estimation provided by the following countries: CA, CZ, FI, FR, DE, HU, IT, NL, NO, PT, SI, ES, SE, CH

ESA Programmes and Initiatives with a strong Technology R&D Component

EOP Technology under 3 programmes:

- **FutureEO**: ~7 M€/yr + 30-40% of Ph.0/A studies (varies every year)
- **TDE:** ~6.5 M€/yr - up to TRL 3-4
- **GSTP**: ~10 M€/yr - higher TRLs

- TDE - Technology Development Element
- CTP - Science Core Technology Programme
- GSTP - General Support Technology Programme
  - Element 1 – Develop
  - Element 2 - Make
  - Element 3 – Fly
- ARTES CC - Advanced Research in Telecommunications Systems Core Competitiveness
  - ARTES Advanced Technology
  - ARTES Competitiveness & Growth
- ARTES SPLs – ARTES Strategy Programme Lines
- FutureEO – Future EO Programme, Development and Exploitation Components
  - Block-1 incl. Technology and Mission Definition
  - Block-2 flying Research Missions
- SciSpacE - Science in Space Environment
- ExPeRT - Exploration, Preparation, Research and Technology
- H2020 HSNAV – Horizon 2020 Satellite Navigation Programme
- NAVISP – Navigation Innovation and Support Programme
  - Element 1 – Innovation in Satellite Navigation
  - Element 2 – Competitiveness in PNT
- FLPP - Future Launchers Preparatory Programme

ESA AGENDA 2025

5 ESA PRIORITIES FOR 2025

- Strengthen ESA–EU relations
- Boost commercialisation for a green and digital Europe
- Strengthen space for safety and security
- Address programme challenges
- Complete the ESA transformation

Copernicus Europe's eyes on Earth

R&I

vision.esa.int

ESA TECHNOLOGY AND ENGINEERING TARGETS

30%

IMPROVEMENT OF SPACECRAFT **DEVELOPMENT TIME** BY 2023

10X

ONE ORDER OF MAGNITUDE BETTER **COST EFFICIENCY** WITH EVERY GENERATION

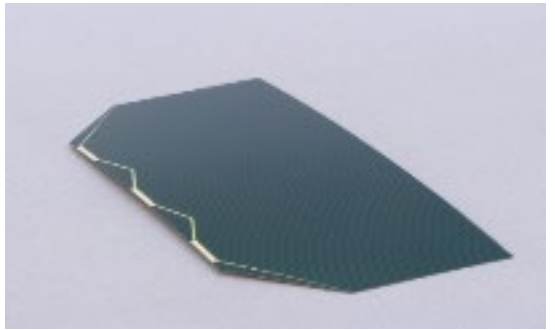
30%

FASTER DEVELOPMENT & **ADOPTION** OF INNOVATIVE TECHNOLOGY

2030

TARGET FOR INVERTING EUROPE'S CONTRIBUTION TO **SPACE DEBRIS**

3D visualisation system at ESA's Concurrent Design Facility (©ESA)



Unprecedented 30% more-efficient spacecraft solar cell (©Azur Space)

Martian meteorite on Earth calibrates camera bound for Mars (©ESA)

ESA's e.Deorbit mission is developing robotic arms and nets to capture Envisat (©ESA)

EUROPEAN TECHNOLOGY COORDINATION AND PLANNING

european space technology harmonisation

ESCC European Space Components Coordination

esa EUROPEAN DEFENCE AGENCY ....

JTF on Technology Non-Dependence

European Mapping, Roadmaps, Strategies

esa	European Commission	Member States National .....
ESA Technology Strategy	Horizon Europe SRIA	National strategies, Roadmapping
ESA Technology Programmes: TDE, GSTP,…	EU Programmes: Horizon Europe,.. …	National Technology Programmes …

HARMONISATION: AN INCLUSIVE PROCESS

- → Over 2 decades of operation
- → 52 active roadmaps
- → 10 technology topics / year
- → Extensive consultation process

*Eurospace, SME4Space, ESRE, EARTO, etc..

EUROPEAN SPACE TECHNOLOGY MASTER PLAN (ESTMP)

- Unique reference on European Space Technology
- 2021 ESTMP is 5th Edition jointly published with the European Commission (EC)
- Over a 100 contributors: 31 countries, EC, European Defence Agency (EDA), ESA programmes and experts

Contact for copies: **ESTMP@esa.int**

ESTMP CONTENT

- A snapshot of the space sector in the global context
- European Institutional space technology budgets
- Overview of all ESA/EU (31) Member States organisation of national space technology and budgets
- Technology Harmonisation and roadmaps
- ESA technology programmes
- EC and EDA technology programmes and initiatives

Contact/request for copies: **ESTMP@esa.int**

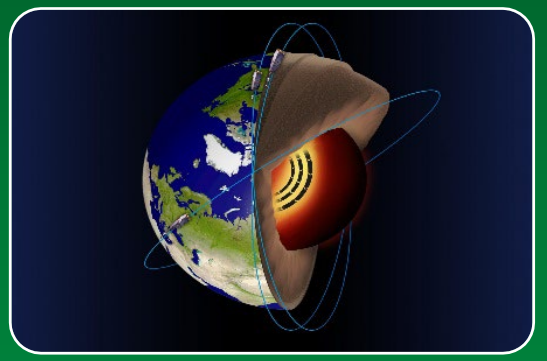
User Driven (SCI or App) **- (LIVING PLANET PROGRAMME)**

Research Missions

Member States

Earth Explorers

& Scouts



Open Calls :
Ideas from **science** partners

Earth Watch Missions

EU

Copernicus

EUMETSAT

Meteorology

Industry

InCubed

(co-funded)

- User needs from institutional partners & industry

FutureEO Block-1 view

(Foundations and Concepts)

- strategic entry-point
- synergetic effect

Customised EO

Commercialisation

Operational EO

Meteorology

Copernicus

Research Missions

(FutureEO Block-2)

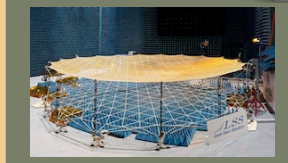
Earth Explorers

Scouts

FutureEO - Blk.1

Mission Definition
&
Technology + Science / App

(incl. Campaigns + simulators)



Mission Implementation
CMIN_n + (1 or 2)

CMIN_n

Competitiveness (beyond ESA missions)

BASIC ACTIVITIES

Earthnet Heritage Space

DPTD

GSTP

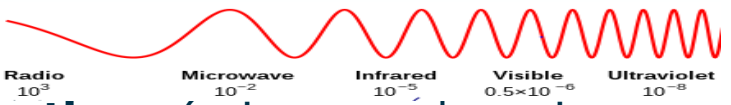
EU techno

National techno

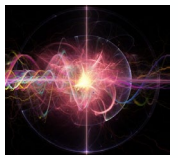
EO TECHNOLOGIES AND TECHNIQUES ARE COMPLEX

New + Higher performance Instruments - (hungry for more knowledge)

- **Higher** spatial, temporal, radiometric **resolution**
- **Full EM spectrum**



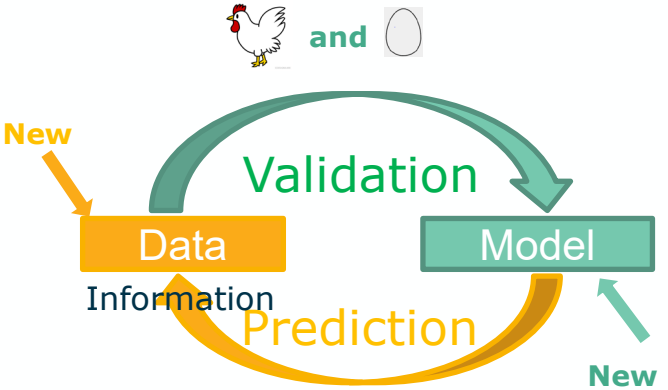
- Very **diverse observations** (science – observing geometry)
- Adopt **disruptive** : e.g. quantum sensing



EO Science & applications (EO Techniques) are complex

- data from >1 instrument → more models + data fusion
- well calibrated (incl. in-situ measurements)

➔ Big Data **Analytics**



There is much more: Systems / Architecture

including Commercial / NewSpace , …

➔ need to focus

More information on platform provided in later sessions

Other Technology Sessions

ID	Session Title	Theme	Nb. Sessions	Day	Time	Room
B9.07	Technologies in National Agencies for EO	Space Techno	1	Mon	13:30	H1.01
B9.04	Platform and Communications technology for future EO	Space Techno	1	Mon	15:40	H1-01
B9.02	New Mission Concepts	Not selected missions	2	Tue	08:30	H1-01
B9.06	AI@edge and Emerging Computing Paradigms for the Future of EO	Space Techno	1	Tue	10:40	Garden Room
B9.05	Microwave Instrument Technology for EO	Space Techno	1	Tue	13:30	H1-01
B9.03	Optical Instrument Technology for EO	Space Techno	1	Tue	15:40	H1-01
B7.04	CubeSats at NASA	NewSpace	1	3-Wed.	10:40	H2-02
B7.03	New Space missions with small and nanosatellites	NewSpace	2	4-Thu	13:30	H2-02
B7.05	GNSS RO – GNSS-R	NewSpace	1	5-Fri	08:30	Berlin
E1.05	New Space missions in InCubed	NewSpace	1	5-Fri	10:40	Berlin

C3	Emerging EO Technology in ESA and fostering European non-dependency		Agora	Wed.	12:30

B9.07 Title	Presenter
The European Space Technology Master Plan	ESA
Technology Developments in the German EO Programme	DLR
CNES Earth Observation Programme overview - key examples of innovative technological EO developments	CNES
Italian Space Agency technologies for the future of EO	ASI
UK EO Technology Development	UKSA
NASA Earth Science Technology development for future missions	NASA

EOP Technology Needs

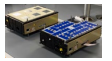
EOP Technology needs

- New + higher performance (EO instruments)
- Higher efficiency (incl. platform / operations)

Market pull (User driven: EE, Copernicus, Meteo) **+ Techno push** (enabler for new **Mission Calls**)

- **focus** on the best : **competitive** processes

Driven by **institutional** (**Large Satellites**),
but opening to **constellations** (incl. **small sats**)



→ **EO Architecture**

FutureEO Programme

- Unique **synergizer** to build the EO ecosystem
- **Enabler** / entry to the **whole range of ESA EO missions**
- Knowledge hunger → more ideas than resources

→ competitiveness and beyond

GSTP
National
Cassini
Private initiatives
EUMETSAT

Conclusion

- Technology development is fundamental to:
  - enable missions
  - strengthen competitiveness and ensure non-dependence
- Continued investment is needed, in coordination at European level (by ESA, National, EC, EDA + Industry)
- ESA-led Technology Harmonisation, working together with European institutional and industrial stakeholders
  - map current + roadmap for future developments
- European Space Technology Master Plan:
  - a concrete product of European cooperation on space technology
  - provides overview through the Technology Harmonisation
- EO technology is challenging and multi-dimensional
  - a combination of market (user) pull/mission driven and technology push for future Calls
- FutureEO programme (in ESA):
  - the key enabler for the whole range of EO missions
  - also key within ESA (Envelope-nature = flexibility)