Overview of ESA's Earth Observation Technology

ESAs Perspectives on EO Technology

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Devising Earth Observation Missions

Living Planet Program

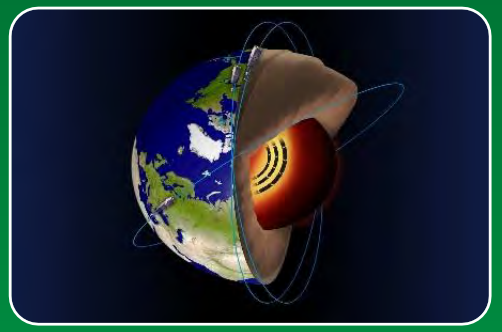
Research Missions

Member States

Earth Explorers

& Scouts

Ideas from science partners in MS (Open Calls)



Also Mission of Opportunity with partners outside MS (NGGM with NASA)

Earth Watch Missions

Copernicus

Meteorology

InCubed

Member States

Other

Altius
TRUTHS
Artic Weather Sat - STERNA
PNRR
- IRIDE (IT)
- Atl.Const (ES)
- PL
- GR

- User needs from institutional partners & industry

FutureEO Programme (formerly EOEP) shapes the future of EO

EARTH EXPLORERS

Pioneering scientific and technical excellence

cryosat
ICE

goce
GRAVITY FIELD

smos
WATER

swarm
MAGNETIC FIELD

aeolus
WIND

earthcare
CLOUD AND AEROSOL

biomass
FOREST CARBON
EE-07

flex
PHOTOSYNTHESIS
EE-08

forum
THERMAL RADIATION
EE-09

harmony
SURFACE DYNAMICS
EE-10

PROGRAMME OF THE EUROPEAN UNION

Copernicus Europe's eyes on Earth

co-funded with esa

Sentinel-Next Gen. under definition

Expansion missions : 1st launch (CO2M) in 2026

CHIME

Copernicus Hyperspectral Imaging Mission for the Environment

soil properties
crop health
raw materials
biodiversity
water quality

ROSE-L

L-band Radar Observing System

geohazards
polar ice
forest management
food security
maritime surveillance

LSTM

Land Surface Temperature Monitoring

sustainable agriculture
water resources management
drought
urban heat islands

CIMR

Copernicus Imaging Microwave Radiometer

sea-ice concentration
sea-surface temperature
polar maritime security
global ocean and cryosphere
soil moisture and vegetation

CO2M

Copernicus Anthropogenic Carbon Dioxide Monitoring

carbon dioxide and methane from human activity

CRISTAL

Copernicus Polar Ice and Snow Topography Altimeter

sea-ice thickness
ice sheets and glaciers
snow
polar oceanography
coastal and inland waters

EO Technology vision : aligned with ESA's Technology Strategy

Higher performance / cost ratio

Largest part

- **New Measurements/ EO instruments** (enabler)
  - **Higher spatial, temporal, radiometric, spectral** resolution
  - **Full spectrum** 

  - Disruptive: e.g. "Quantum Sensing" 

Generic e.g. via BA, GSTP

- Lower recurring **development cost / faster adoption**
  - **Platform Standardisation** & multi source suppliers
  - **Spin-in** techno: e.g. COTS
  - Lifetime & flexibility (FPGAs)
  - Digitalisation (e.g. MBSE, others)
  - **CleanSpace** (e.g. demisable, EoL disposal)
- **Big Data & Analytics** (AI enabler) & Data continuity

Miniaturisation and constellations

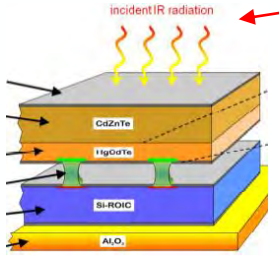
- More **autonomous** platform & operations & synchronisation
- **Distributed** Ground Segment

Not limited to LEO: also HEO & GEO orbits relevant for EO

EOP technology (across and beyond ESA missions)

Instruments (Optical + RF) from components to full models) - the largest investment

Detectors
→ SWIR for CO2M
→ TIR for LSTM
→ Hyperspectral for CHIME
→ Others



Large Deployable Antenna
→ Designed for CIMR, ROSE-L, Hydroterra, S1NG
→ Candidate for National/Commercial

FULAS (Laser source)
→ Candidate for Aeolus-2
→ Baseline for Merlin (CNES, DLR)

Platform & Space-Ground Communications

AGGA ASIC
GPS/Galileo receiv.
all Sentinels, MetOp-SG RO
Earth Expl.,
many commercial

MiniRIT e-propulsion
→ **candidate for NGGM & commercial**

ADHA & Std P/F
→ Increased modularity & interchangeability
→ **All future EO missions**

K-band downlink
MetOp-SG, HPCM,
→ commercial

DataFlow–Ground I/F
Sentinel-NG, Constellations

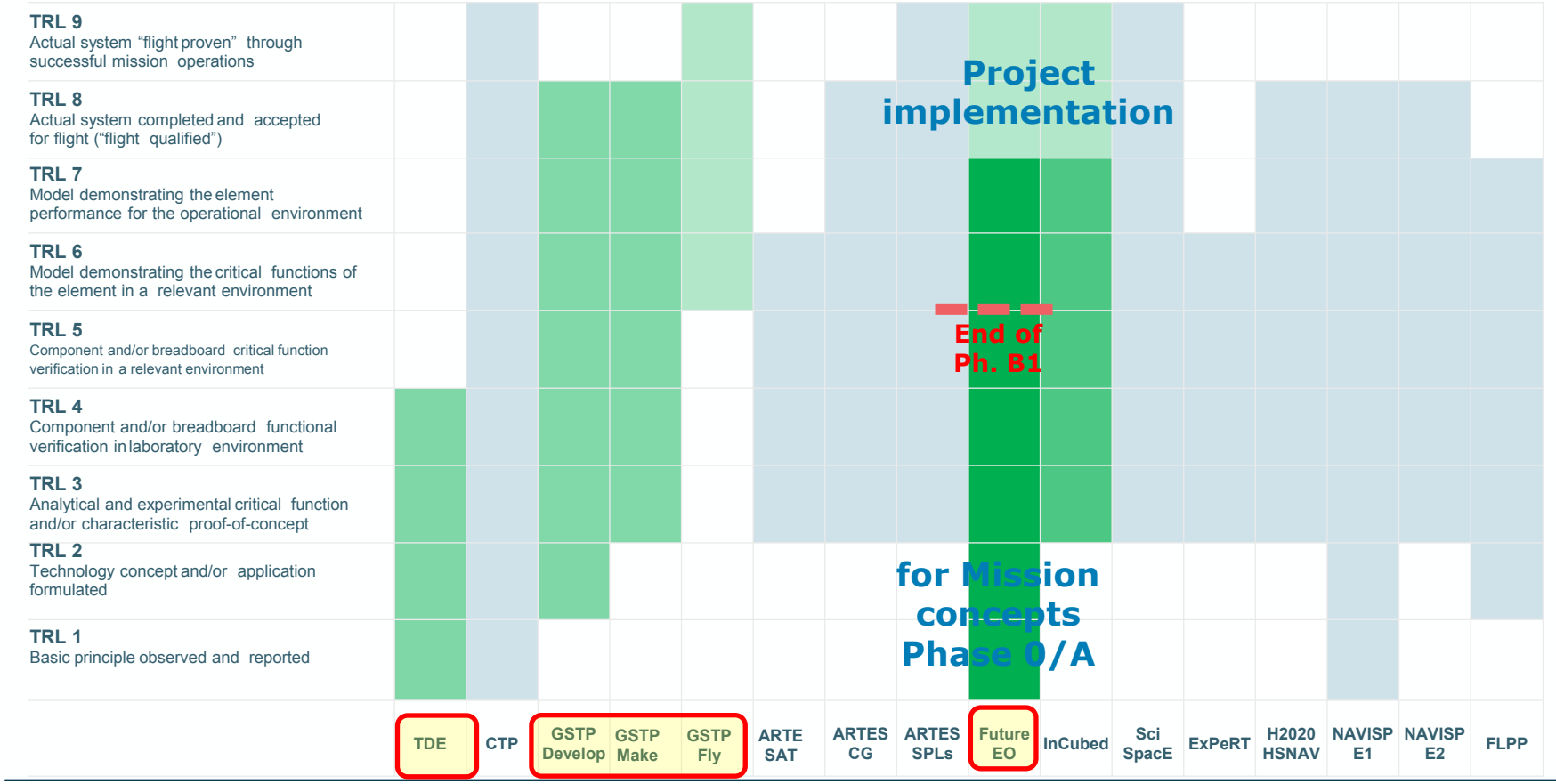
Also Airborne Campaigns
- Aeolus collocations
- ACADIA for CO2M
- OSCAR – Ku-band (SEASTAR)

and Big Data Analytics
- Acquisition / Organization / Analysis / Infor.
- Φ-lab

ESA Programmes with a strong Technology Component

EOP Technology mainly under 3 programmes – no substantial growth:

- **FutureEO**: ~10 M€/yr + 10 M€ (or 30-40% of Ph.0/A studies) - varies every year - (up to TRL 5/6)
- **TDE: ~6.5 M€/yr - up to TRL 3-4**
- **GSTP: ~10 M€/yr : higher TRLs (product / commercial driven)**



- **TDE** - Technology Development Element
- **GSTP** - General Support Technology Programme
  - Element 1 – Develop (fully funded)
  - Element 2 – Make (co-funding)
  - Element 3 – Fly
- **FutureEO**
  - **Block-1 incl. Technology** and Mission Definition
  - Block-2 - Research Missions Implementation
- **Incubed** -
  - Some upstream projects often include Technology

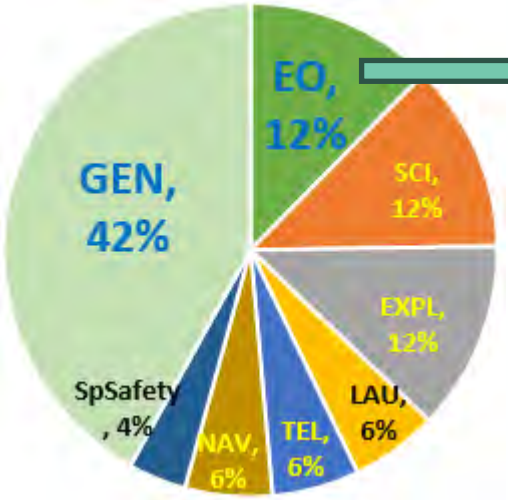
Techno in FutureEO + TDE ~ 30 M€ / yr

- it is 2-3 times smaller than NASA –ESTO
  - NASA Earth Science Techno Off. ESTO ~ 100 M$ / yr
  - when NASA Earth Science Div. and ESA-EOP have similar annual budgets

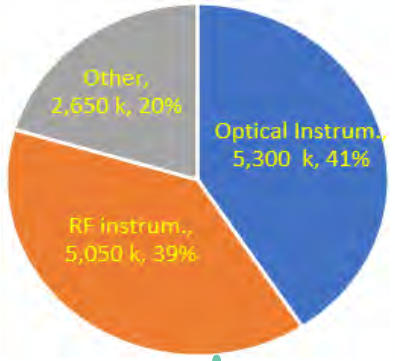
(see BUD-4 on pg. 4) + other NASA budget links

TDE 2023-2024 - Workplan

TDE 2023-2024 Workplan
~ 105 M€ in 2 years

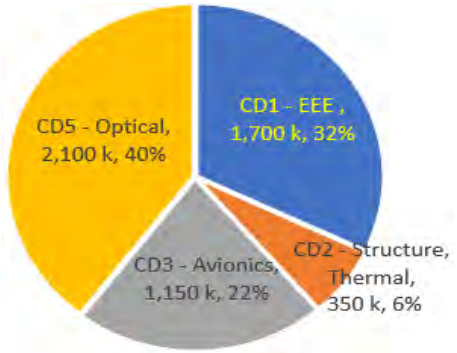


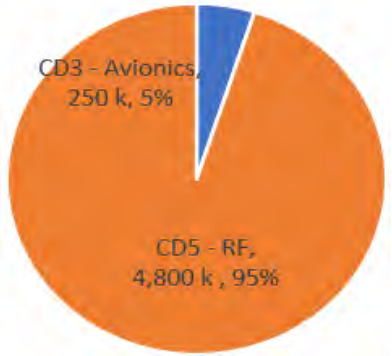
EO part = 13 M€ (29 activities)
(in 2 years)

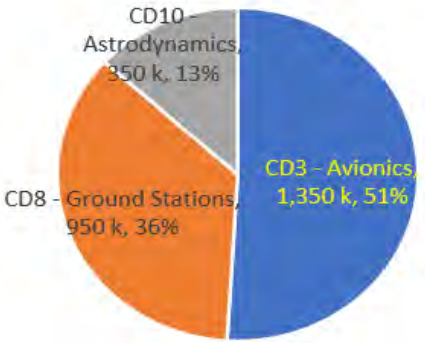


80 % of EO part for instruments

= Optical Instruments 5.3 M€ + Microwave Instruments 5.05 M€ + Others: Platform, Comms, … 2.65 M€

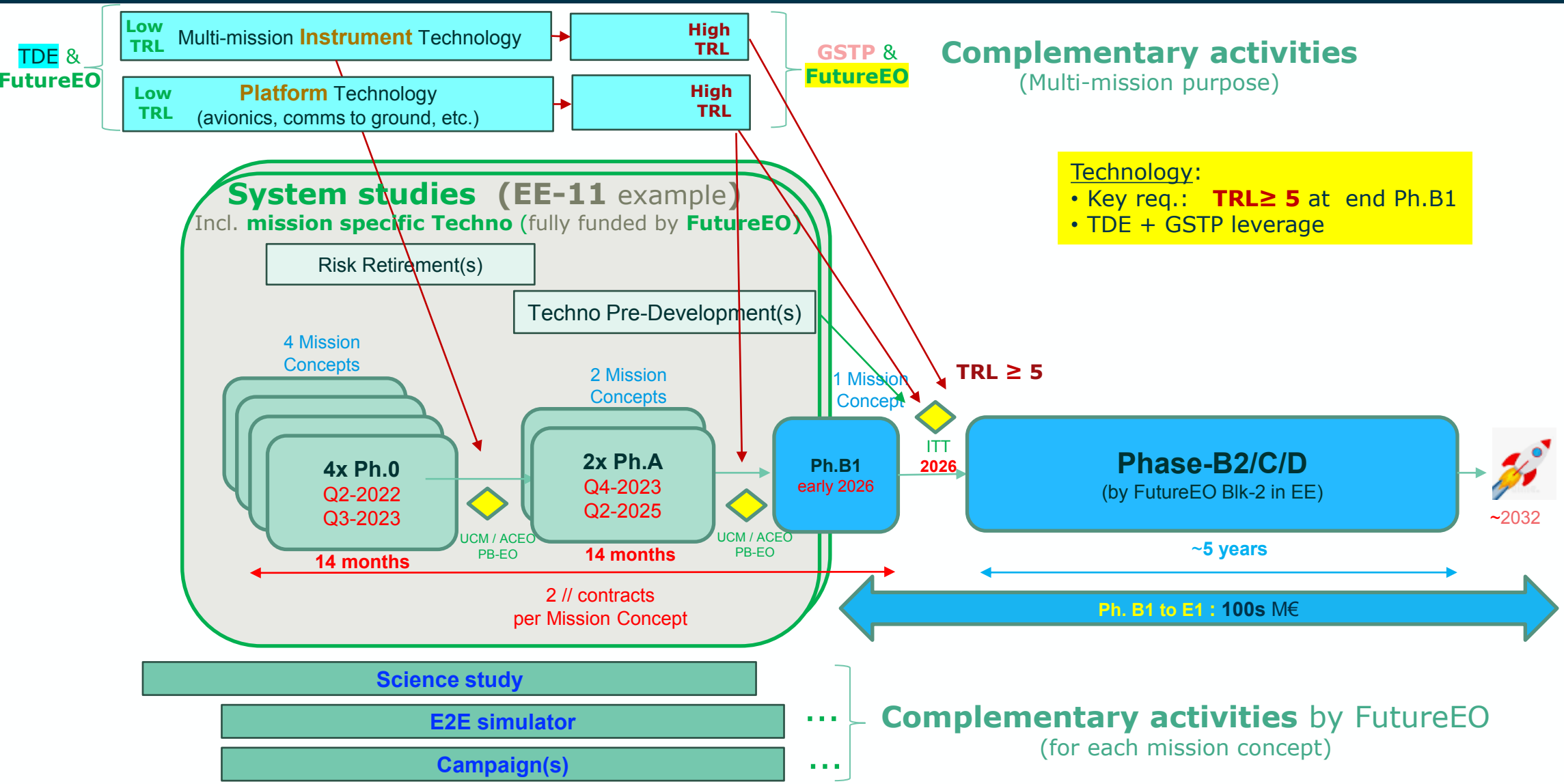






Similar (~10%) of EOP part within GSTP Workplans

Timeline : Technology vs Mission



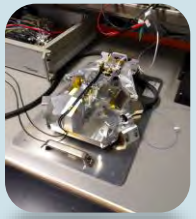
FutureEO Programme - Block-1 Scope

Mission Definition & Feasibility (Ph.0/A) - as per CMIN22

→ Target TRL 5
SRL 5

- **Earth Explorer-12** : ≤ 4 mission concepts in **Ph.0** ; ≤ 2 in Ph.A ; Implem. after CMIN28
- Scout-next : ≤ 4 mission concepts in Consolidation Phase; ≤ 2 for Implem. after CMIN25
- Sent-2 NG : **Phase A/B1** → higher resolution, same swath wrt 1st Gen
- Sent-3 Optical NG: **Phase A/B1** → higher resolution, same swath wrt 1st Gen

Technology Maturation



- Instrument maturation
  - as part of Ph.0/A)
  - support to not selected EE-11, future Meteo Missions
  - new low TRL concepts, miniaturisation
- Other Preparatory : e.g. architectural / system studies
  - In synergies with DPTD / GSTP for EO
  - Standard Platform + Communications
  - Frequency Management

Science & Applications (with EOP-S)

- BoostFutureEO in
  - Step-1: Strategy = update of Living Planet Challenges
  - Step-2: New EO Mission Ideas (NEOMI)
  - Step-3/4 : as part of Ph. 0/A
- End-to-End Simulation :
  - as part of Ph. 0/A
  - also enable new EO concepts (low SRL)
- Campaigns (in-situ, airborne)

EO Science Strategy Foundation Study – Update of Living Planet Strategy

ESA EO Science Strategy Challenges:

The existing strategy outlines 25 challenges across 5 Earth science domains

- **Isolated domains** → fails to addresses interconnectedness and inter- dependencies
  - Move towards more **integrated earth system approach** is required.
- **Systematic traceability** → connect EO with **international policies and agendas.**
- **Periodic review and adaptation** for the outlined challenges
  - New **shorter 6-year cycle** in preparation for the future EO strategy

→ Led by Assimila (UK) - June-2023 Workshop - atpi.eventsair.com/science-strategy-workshop-2023/

Mission Definition & Feasibility (Ph.0/A) → Target TRL 5 SRL 5

Technology Maturation
- Instrument maturation
- Other Preparatory

Science & Applications (with EOP-S)
- BoostFutureEO
  - **Step-1 Living Planet Challenges**
  - Step-2:, 3/4 :
- End-to-End Simulation & Campaigns

Outcome: mid-end 2024

→ Priorities in Science → will help focus of Technology (applicable to EE-13, others)