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Earth Observation Directorate
ESA/ESTEC

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1. **The Living Planet Programme**
   - Earth Observation Envelope Programme (EOEP)
   - Overview of Missions in relation to the EOEP

1. EO Preparatory Activities
   - Earth Explorers
     - EE7 Status
     - EE8 Status
     - EE9 and EE10
   - Operational Missions (Sentinels, Metop etc)
   - Sentinel Convoy Studies

3. ESA Technology
   - ESA Technology Programmes
   - End to End Technology Process
   - TRP Plan 2011-13 and concept development overview
   - Example 1 : Wavemill preparatory activities
   - Example 2 : Gravity field mapping and monitoring
   - Example 3 : GEO High resolution optical preparatory activities
   - Example 4 : 26 GHz downlink (Preparation to Implementation)

The ESA E.O. Strategy – "Living Planet"

ESA's Living Planet Programme (LPP)
comprises two main components:

1. Science and Research element
including Earth Explorer missions
Aim: To better understand the Earth System

2.Earth Watch Element
including EUMETSAT and GMES Space component
Aim: To facilitate long term monitoring and the delivery of EO data for operational services

The Earth Observation Envelope Programme

The Earth Observation Envelope Programme (EOEP) is the key to implementing the Living Planet Strategy. It represents a stable planning environment within which new types of environmental sensing technologies and the missions that will fly them are prepared.

EOEP comprises two main components:

a) the *Earth Explorer Component*

This component comprises the definition, development, launch and operations of Earth Explorer missions (platform, payload and ground segment). Its purpose is to respond to the needs identified by the EO scientific community.

b) the *Development and Exploitation Component*

The Development and Exploitation component includes all preparatory activities for future missions, including Earth Observation Preparation Activities (EOPA), Earth Watch Definition (EWD) and Instrument Pre-Development (IPD), Support to Science Element (STSE), Data User Element (DUE) and Value Adding Element (VAE) It addresses both science-themed Earth Explorer candidates and operational Earth Watch missions**:**

- Preparatory activities for Earth Explorer and Earth Watch,
- Instrument Pre-Development for Earth Explorer and Earth Watch type missions
- Preparation of programme proposals for optional Earth Watch type programmes,
- Mission Exploitation/Market Development.
- Multi mission ground segment

The Earth Observation Envelope Programme

- The EOEP is run as an optional ESA programme which is run in five-year cycles
- The current EOEP-3 runs between 2008 and 2012
- It provides a long-term, rolling environment for the planning of new activities, exploitation of results, contingency response and continuity of missions e.g. Envisat etc.
- At present EOEP-4 is being prepared (2013-2017)

ESA Earth Observation Missions

Living Planet

Earth Explorer

Research driven

Core Missions

GOCE
17/03/09

ADM-Aeolus
2013

EarthCARE
2013

Biomass/ CoReH2O/ PREMIER

EE7

Opportunity Missions

CryoSat-2
08/04/10

SMOS
02/11/09

Swarm
2012

CarbonSat FLEX

EE8

Continuity of Missions

ERS-2
1995 – 2011

Envisat
2002 - present

Missions within EOEP

Earth Watch

Operational Service driven

Operational Meteorology

- Meteosat
- MSG
- EPS (MetOp)
- MTG
- MetOp SG

GMES

- Sentinel 1
- Sentinel 2
- Sentinel 3
- Sentinel 4 (MTG)
- Sentinel 5 precursor
- Sentinel 5 (MetOp-SG

Missions outside EOEP but preparatory work is within EOEP

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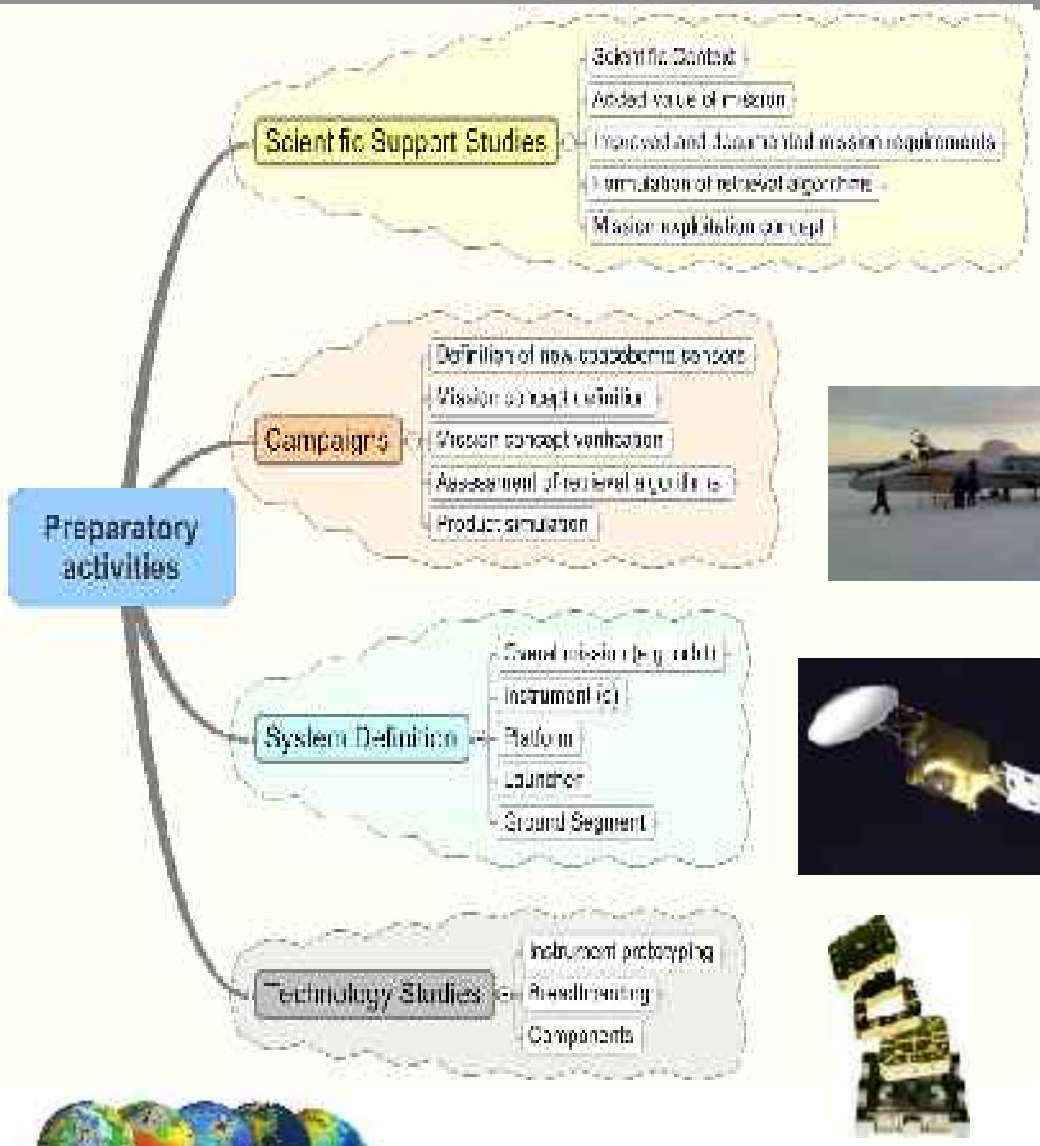
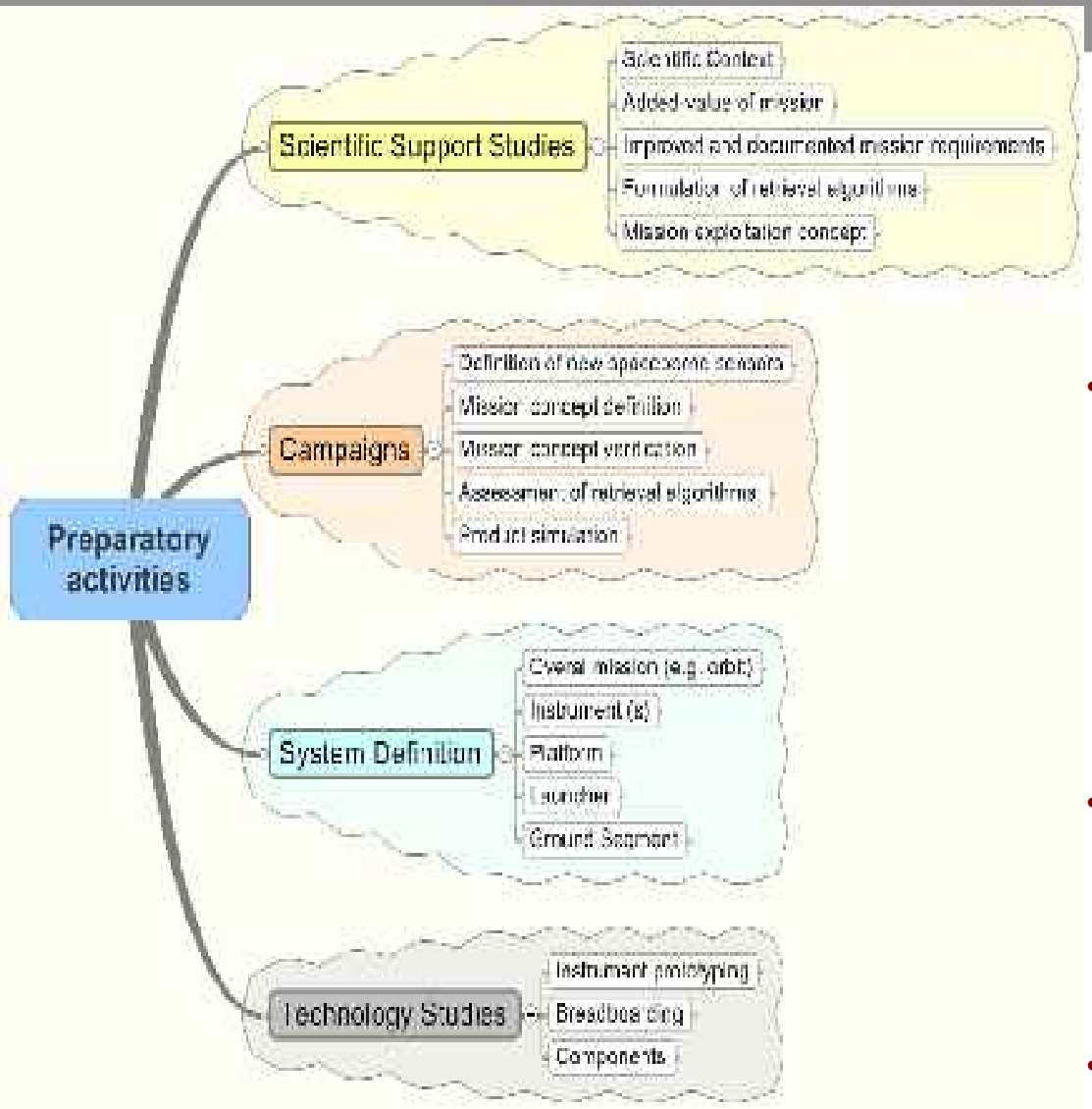
Overview of Earth Observation Preparatory Activities



1. EOEP preparatory activities include all necessary activities to define and evaluate future EO space borne missions (EE, GMES, meteorological,..)
2. Driving elements include:
   - Scientific challenges summarised in "The Changing Earth", SP-1304
   - Associated observation, mission and technology requirements
   - Mission preparation through Phase-0 (Pre-feasibility) and Phase-A/B1 (Feasibility)
   - Foster new ideas, cooperation opportunities and prepare technologies, also for European independent capabilities
   - ESAC recommendations

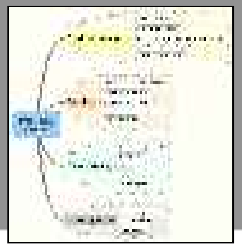
Funding for Earth Observation Preparatory Activities



Funding depends the nature of the activity as stated in the Living Planet strategy e.g. science / operational.

ESA Earth Observation available funding sources for preparatory activities

- **EOEP: e.g.**
  - Earth Observation Preparation Activities (EOPA)
  - Instrument Pre-Development (IPD)
  - Earth Watch Definition (EWD)
  - Support to Science Element (STSE)
- **ESA Technology Programmes e.g.**
  - Technology Research Programme (TRP)
  - General Support to Technology Programme (GSTP)
- **ESA General Studies Programme** (GSP)



EECM Phase A: what does it mean ?

Example: BIOMASS (candidate EE7 mission)

System

- BIOMASS Phase A System Study (x2), addressing:
  - Space segment : payload, platform
  - Mission analysis and operations
  - Launcher
  - Ground segment
  - Critical technologies
  - Programmatics

Technology

- Large P-Band SAR antennas critical breadboard (x2)
- Very Large P-Band Antennas performance verification methodology & Facilities
- P-Band HPA technology assessment
- Very large space antenna aperture – demo model
- P-Band Reflector antenna Feed elements
- P-band ice sounding radar demo development
- P-band passive sub-array development
- Very large space antenna aperature architecture trade-off (x2)
- SSPA breadboard (incl. circulator/switch, power divider and calibration coupler) (x2)
- Study of P-Band transponder with ionospheric correction capabilities (x2)

Science and Campaigns

- Development of algorithms for forest biomass retrieval
- Study of ionospheric disturbance mitigation schemes
- Assessment of the BIOMASS retrieval error on flux
- P-Band SAR wave interaction and information retrieval
- Analysis of BIOMASS secondary objectives

- TropiSAR campaign (completed)
- TropiScat campaign (planned)
- BioSAR 2 camapign (completed)
- BioSAR 3 campaign (on-going)

End-to-end Performance Evaluation and System Support

- BIOMASS End-to-End Mission Performance Simulator
- OpenSF end-to-end (E2E) simulator framework infrastructure
- Modern attitude control of EO satellites with large flexible elements (x2)

= EOPA
= IPD
= TRP / GSTP
= GSP

Coordinated Preparatory Activities

Earth Explorer Core Missions

Step 1
Call & Selection for Step 2

Preparing the call → Proposal & evaluation

Step 2
Assessment

Phase 0 activities

Step 3
Phase A/B1

Phase A/B1 activities

→ Further Development

Coordinated Preparatory Activities

Science → Studies → Studies and Campaigns

System → Phase 0 Studies (Competition) → Phase A/B1 Studies (Competition)

Technology → TRL 1 - 3 → TRL 3 - 5

Studies and Campaigns, Phase A/B1 Studies (Competition), TRL 3 - 5 → Further Development

Coordinated Preparatory Activities

Earth Explorer Opportunity Missions

Preliminary Development
e.g. National funding,
Additional funding

Step 1
Call & Selection

Preparing the call & evaluation

Step 2
Phase A/B1

Phase A/B1 activities

Further Development

Coordinated Preparatory Activities

Science → Studies and Campaigns

System → Phase A/B1 Studies (Competition)

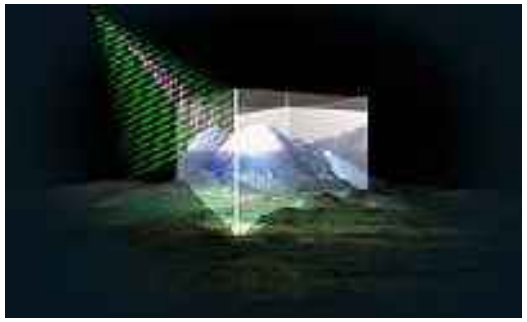
Technology → TRL 3 - 5

Studies and Campaigns, Phase A/B1 Studies (Competition), TRL 3 - 5 → Further Development

Earth Explorer 7 (Core Missions) Status

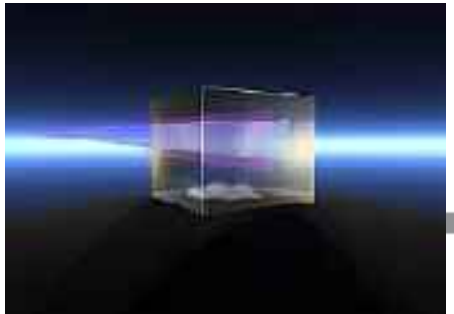
- **Status:** 2 industrial Phase A system studies for each of the 3 mission candidates are progressing well. Preliminary Requirements Reviews (PRR) are on-going.
  - Biomass : September 2011
  - CoReH20 : July and September 2011
  - PREMIER : September and October 2011

- **BIOMASS:** single satellite carrying a P-band SAR **to provide continuous global interferometric and polarimetric radar observations of forested areas.**



- **CoReH2O / Snow mission:** single satellite with dual frequency (X, Ku), dual-polarisation SAR **to observe snow / ice at high spatial resolution**

- **PREMIER: 3D fields of atmospheric composition in upper troposphere and lower stratosphere with** an infrared limb-imaging spectrometer and a mm-wave limb-sounder. Designed to fly with Metop



Earth Explorer 8 Evaluation

- 31 proposals were received
- The proposals were reviewed by 4 scientific evaluation panels chaired members of the Earth Science Advisory Committee (ESAC)
- All proposals were evaluated both scientifically and technically against 7 evaluation criteria. Two specific criteria:
- Total industrial cost = 100 Meuro (2009 economic conditions)
- Feasibility of a 2018 launch must be demonstrated
  e.g. (TRL 5 at end of Phase A/B1)

Earth Explorer 8 Selected Mission Candidate Status

- **Status:** The procurement process for the Phase A/B1 activities for both mission candidates has started. **FLEX**: ITT issued in May, **Carbonsat**:ITT issued in Aug.

- **FLEX:** to provide global maps of vegetation fluorescence, which can be converted into an indicator of photosynthetic activity -> to improve our understanding of how much carbon is stored in plants and their role in the carbon and water cycles
- Designed to fly with Sentinel-3

- **CarbonSat:** to quantify and monitor the distribution of carbon dioxide and methane -> for a better understanding of the sources and sinks of these two gases and how they are linked to climate change.
- Designed to fly with Sentinel-3

Earth Explorer 8: ESAC Recommendations

- Recommended proposals for further scientific or technological development:

1. **Accurate** - Climate benchmark for profiling greenhouse gases & thermodynamic variables & wind from space
2. **CloudIce** - Global cloud ice retrievals
3. **EXCALIBUR** - **EX**periment on **CA**rbon dioxide by **LI**dar for **B**iosphere and climate **UR**gency
4. **E. Motion** - Earth System Mass Movement Mission
5. **FORUM** - **F**ar Infrared **O**utgoing **R**adiation **U**nderstanding & **M**onitoring
6. **GEOSAT** - **GEO**synchronous **S**AR for **A**tmosphere & **T**errain observation
7. **GLACIES** - **GLAC**iers & **I**cy **E**nvironment **S**ounding
8. **OCAPI** - **O**cean **C**olour **A**dvanced **P**ermanent **I**mager
9. **SPECL** - Spaceborne Multi-**SPE**ctral **C**anopy **L**idar
10. **TIREX** - **T**hermal **I**nfra**R**ed **Ex**plorer
11. **TRUTHS** - **T**raceable **R**adiometry **U**nderpinning **T**errestrial and **H**elio **S**tudies

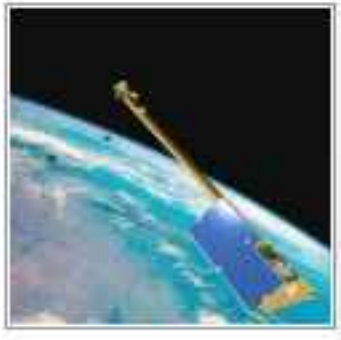
- Selected missions have priority
- Very limited funds in EOEP-3
- Scope in EOEP-4 depends on level of subscription

Lead Proposers from UK

Future Earth Explorer Calls EE9 and EE10

- EE9 aims to be an Earth Explorer Core mission call around the 2013 time frame.

- EE10 aims to be an Earth Explorer Opportunity call around the 2014 time frame



ESA Earth Observation Missions

Living Planet

Earth Explorer

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Continuity of Missions

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1995 – 2011

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Missions outside EOEP but preparatory work is within EOEP

GMES dedicated missions: Sentinels

Sentinel 1 – SAR imaging
All weather, day/night applications, interferometry
x 2 satellites, 693 km, SSO dawn-dusk orbit

2013 / 2015

Sentinel 2 – Multi-spectral imaging
Land applications: urban, forest, agriculture,..
Continuity of Landsat, SPOT
x 2 satellites, 786 km, SSO, LTDN 10:30 am

2013 / 2016

Sentinel 3 – Ocean and global land monitoring
Wide-swath ocean color, vegetation, sea/land
surface temperature, altimetry
x 2 satellites, 814 km, SSO, LTDN 10:00 am

2013 / 2017

Sentinel 4 – Geostationary atmospheric
Atmospheric composition monitoring, trans-
boundary pollution

2019

Sentinel 5 – Low-orbit atmospheric
Atmospheric composition monitoring
(S5 Precursor launch in 2014, x 1 satellite)

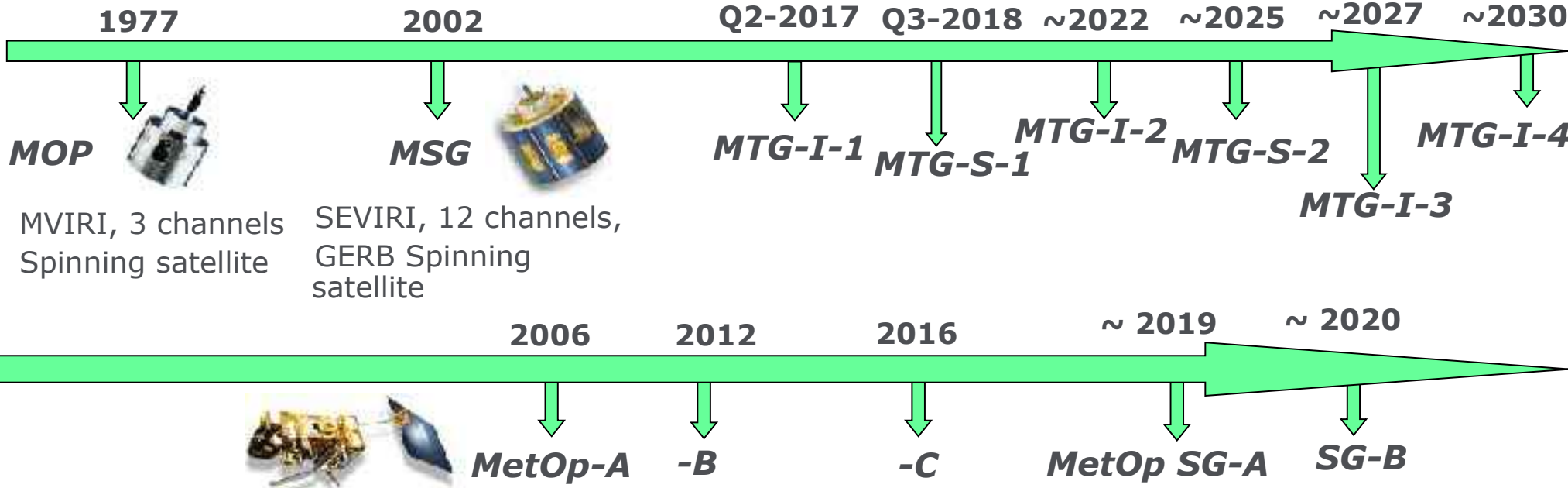
2020+

Sentinel spacecraft lifetime = 7 years, with consumables for 12 years

EUMETSAT operated missions timeline

For MTG two types of missions are proposed comprising six satellites focusing on Nowcasting and Numerical Weather Prediction (NWP):

- 4 x MTG-I (Imaging) missions: dedicated to operational meteorology, with emphasis on 'nowcasting' and very-short-term forecasting.
- 2 x MTG-S (Sounding) missions



EUMETSAT = European Organization for the Exploitation of Meteorological Satellites
ESA is the R & D agency for EUMETSAT missions

LTDN: 9.30 am, 817 km

Preparatory activities for operational missions

EOEP activities with similar complexity as for EE but no competition among missions

For meteorological missions:

- User community and relevant interfaces managed by EUMETSAT
- End-to-end mission definition and requirements under EUMETSAT responsibility

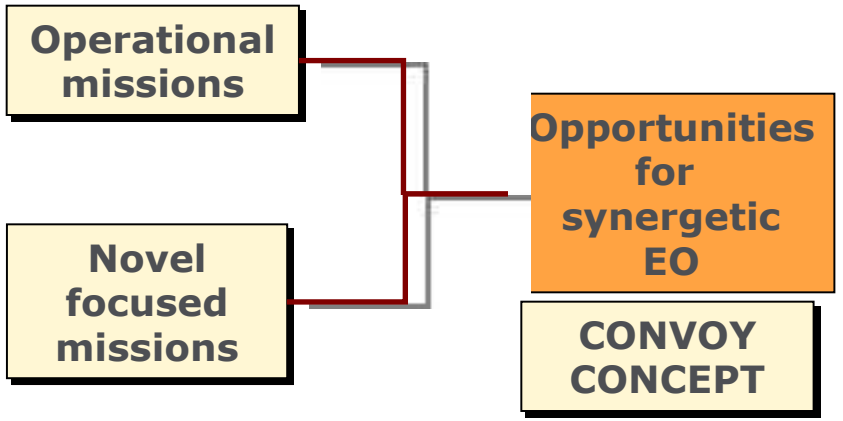
≅ additional complexity in the consolidation of mission/system requirements and observation needs vs. engineering trades due to programmatic aspects, e.g. external instruments provision

For GMES missions:

- Definition of GMES architecture and definition of each Sentinel mission up to Phase A/B1
- Mission requirements from initial user requirements and GMES Service Element interactions with European Commission (iteration and validation)
- Identification of new mission needs, e.g. Sentinel-5p and Jason-CS

Future Ideas – Earth Observation Convoy Studies

- Both EE8 selected missions candidates will be designed to fly with Sentinel-3.
- Studies on Convoy missions are presently on-going
- Over the next few years, a number of new **long-term** operational EO satellite series will be launched by Europe.
- This will provide a capacity for systematic, continuous and long-term EO
- This stable space borne operational capacity is **based on enhanced continuity** of the different satellite series.
- This capability represents an excellent platform to design **novel focused missions** which would fly with these operational missions:
  - Synergetic EO opportunities
  - New EO science objectives can be met
  - Unachievable with single satellite measurement
  - What is possible??



Convoy Studies funded by STSE

- Three activities have been defined and have been initiated following a "user driven" approach:

- Theme 1: Use of novel and additional observations for **Ocean & Ice** research & applications
  (Astrium, NERSC, Enveo and Polar Imaging)
  Presentation by Karl Atkinson in next session

- Theme 2: Use of novel and additional observations for **Land** research & applications
  (SSTL, University of Leicester, Astrium Ltd)
  2 day workshop for Land applications at ESTEC 31st October and 1st November
  Aim: to engage a wider group of expert users to discuss user needs and preliminary mission concepts

- Theme 3: Use of novel and additional observations for **Atmosphere** research & applications
  (Proposals have been received and are being evaluated)

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ESA Technology Programmes

EO technology activities are part of the ESA End-to-End Process on Technology

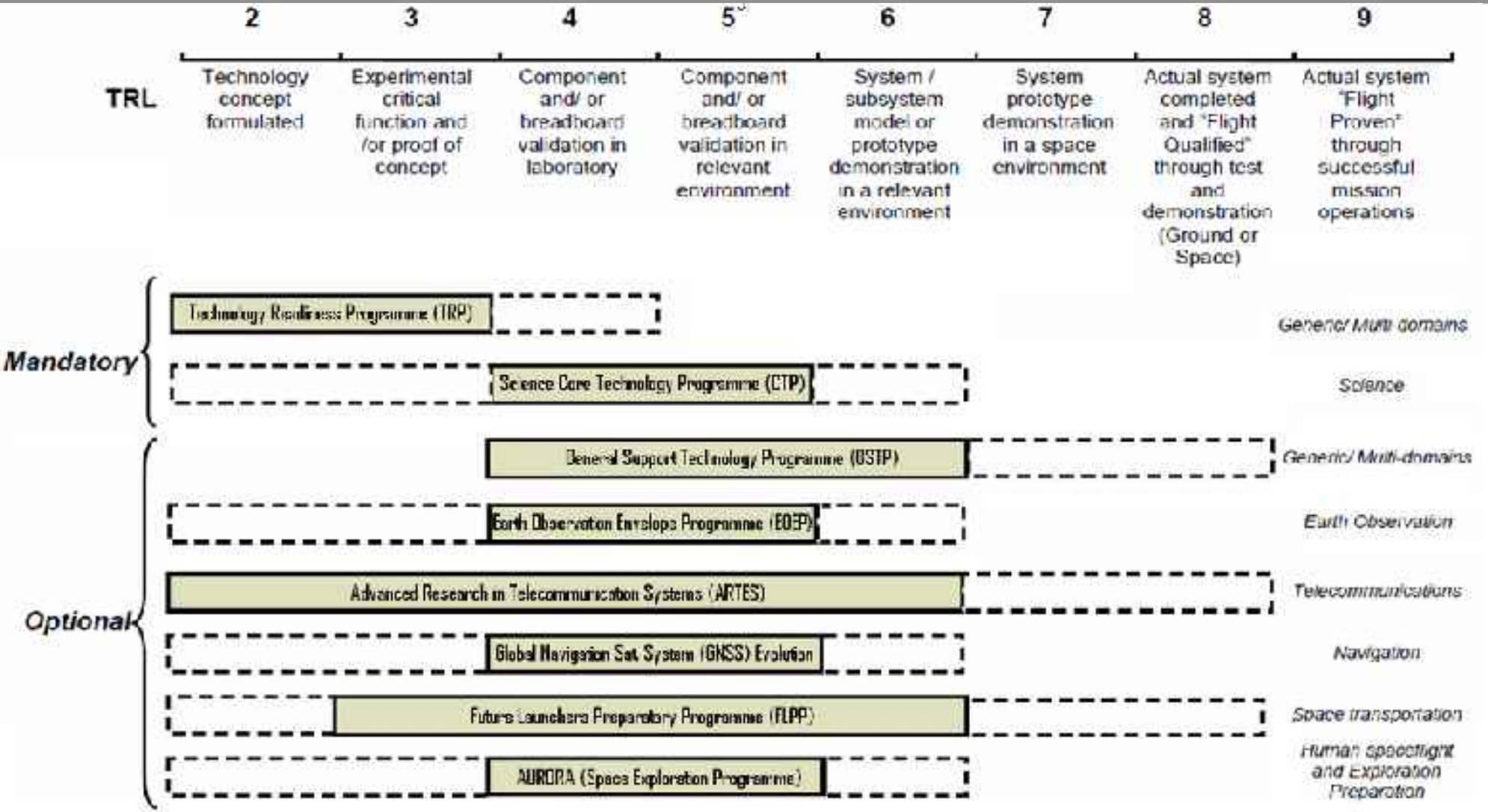
The main goal is to drive all technology programmes by requirements defined with and for the users (EO, Science, Telecoms, etc) aiming at:

1. Preparing the technologies for future projects in a timely manner
2. Stimulating technology innovation
3. Supporting European industry's competitiveness
4. Ensuring European non-dependence on critical technologies

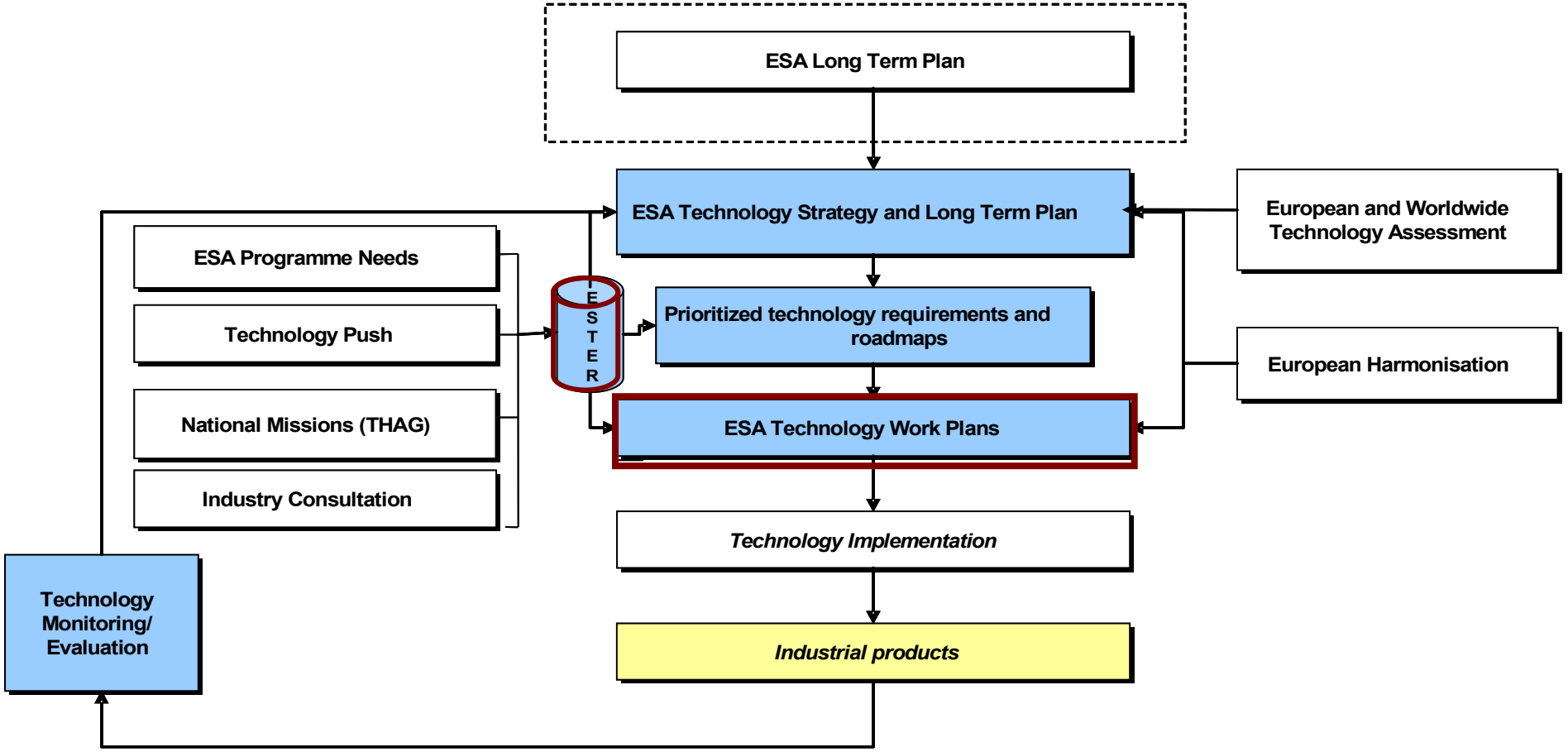
ESA's technology programmes:

- at corporate level : TRP, GSTP
- at EOEP level : EOPA for early developments (TRL up to 3) and IPD for higher TRL to mature instrument technologies and key payload subsystems
- Activities can be funded by the EOEP or by one of the technology programmes. It is possible e.g. where
- two parallel studies are identified that one activity can be funded by a technology programme e.g. TRP and and the second activity is funded by EOEP.

ESA Technology Programmes vs. TRL



ESA End to End Technology Process



- Under the supervision of a dedicated Director' Sub-Committee on Technology
- ESTER: European Space Technology Requirements Database
- THAG: Technology Harmonisation Advisory Group

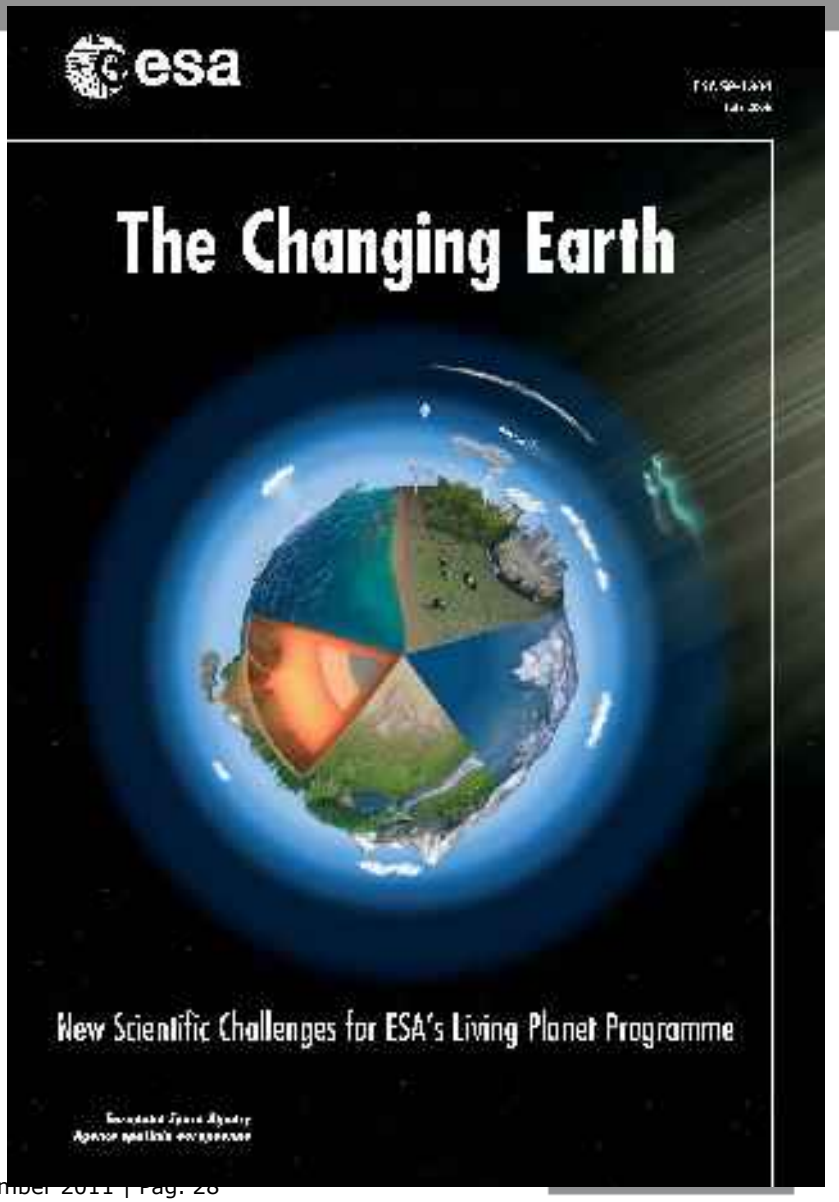
Technology Driven by Science

ESA's EO strategy is used to define:

- Scientific challenges
- New observation requirements
- Technology challenges and
- Technology requirements and activities

The prioritised requirements are used to define workplans, based on the scientific "drive" and from other inputs e.g. the likely evolution of the GMES programme.

EO is a vast field and despite streamlining through the process would require much higher resources to advance all technologies of interest.



How are future activities defined?

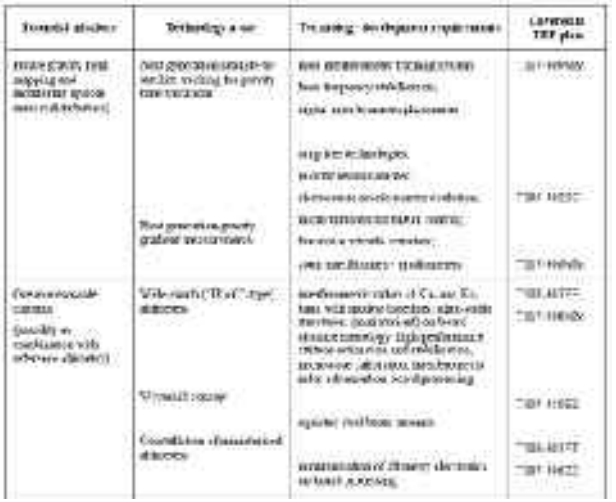
- In 2010 Earth Observation technology challenges and plans were presented and iterated.
- These were then used as input for workplans.
- In the document 13 potential mission concepts and 4 topics on more generic needs (structures, thermal control, data handling, communications, ground segment) have been defined.

Science

New observations

EO Technology challenges

Workplans

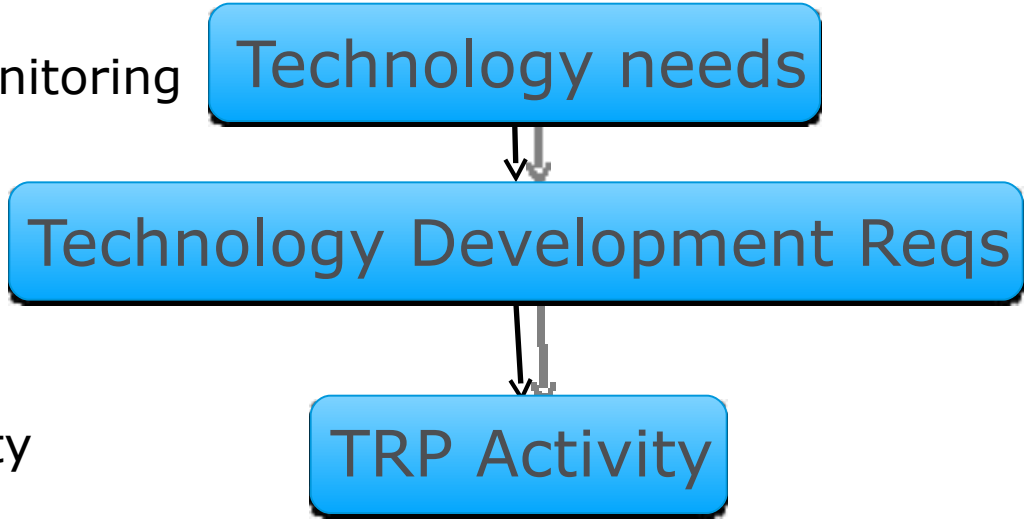


- Optimising use of limited resources
- EOEP provides a stable and flexible environment for EO R&D activities.
- EOEP lines currently insufficient to advance all identified technology of interest

Activities funded by EOEP
Activities funded by corporate programmes

Potential Future Missions presented in the TRP plan (2011 – 2013)

1. Future gravity field mapping and monitoring
2. **Ocean mesoscale currents**
3. In-land waters
4. Air-sea interactions
5. Ice sheet (sounding) and glaciers
6. Atmospheric processes and air quality
7. High resolution thermal infrared
8. High resolution from GEO (coastal monitoring and ocean colour)
9. High resolution soil moisture and ocean salinity
10. SAR imagery for land change detection and topography
11. Maritime surveillance
12. Next generation high resolution wide swath SAR imagery
13. Next generation high resolution land optical



Example 1: TRP Planning for Future Ocean Mesoscale Current Measurement

Potential Mission: Ocean mesoscale currents

Technology Area: Wide swath altimeters

Constellation of miniaturised altimeters

Technology Development Requirements

- Interferometric SAR Ku/Ka-band
  - ultra stable structure
  - mini on board distance metrology
  - high performance attitude
  - estimation and stabilization
  - microwave calibration
  - on-board processing
- Squinted dual-beam antenna
- Altimetry electronics & O/B processing
  Miniaturiation

T107-307EE:
Interferometric antennas at Ku/Ka for wide swath altimetry (baseline 2.5 m)
Target TRL: 3

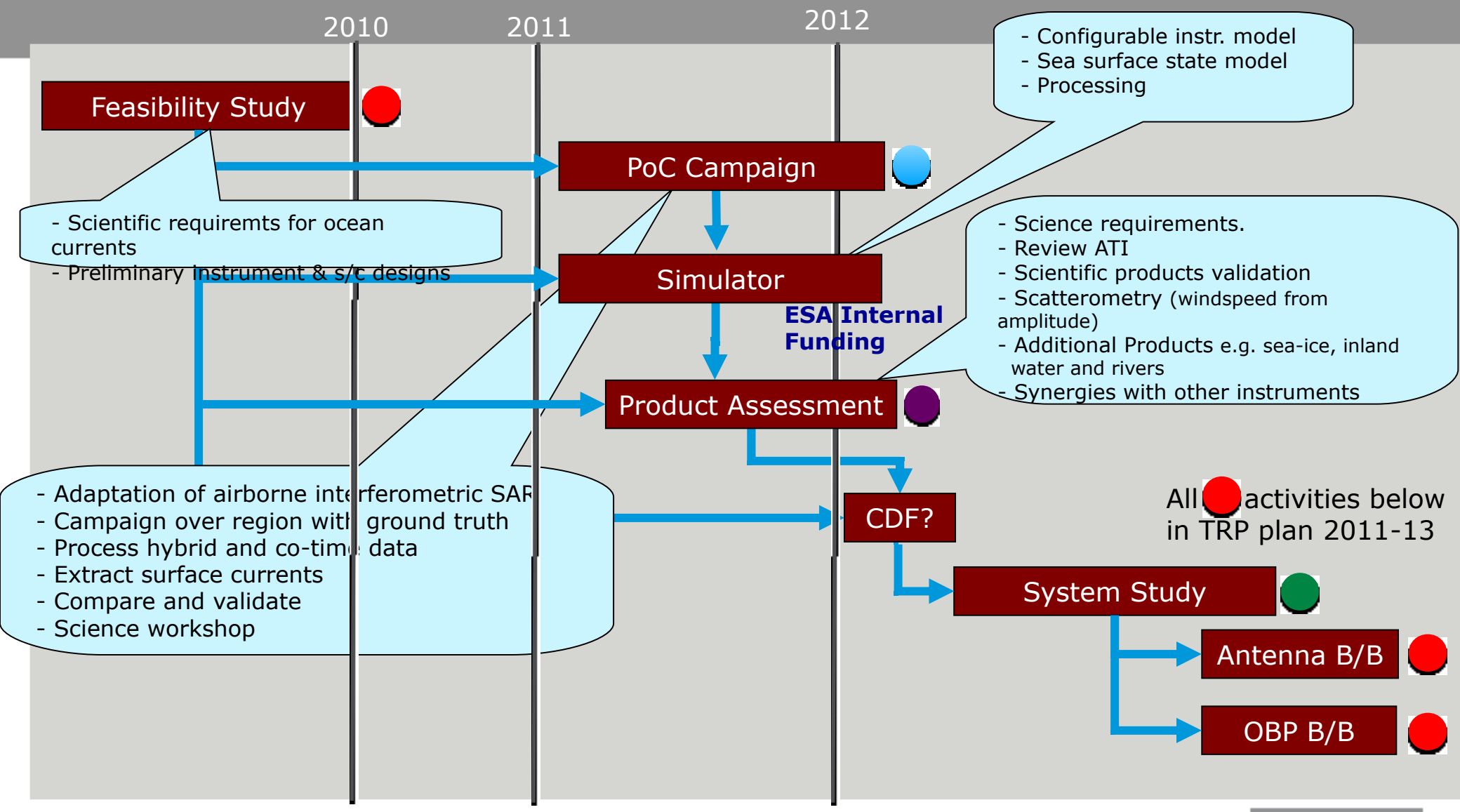
T117-308MM:
Compact optical attitude transfer system
Target TRL: 3

T107-310EE:
Wavemill antenna concept & critical breadboarding
Target TRL: 3

T106-301ET:
Miniaturised altimeter study
Target TRL: 2

T107-306EE:
Compact Ku/Ka-band altimetric antenna for LEO constellation
Target TRL: 2

Example 1: Overview of Wavemill related activities



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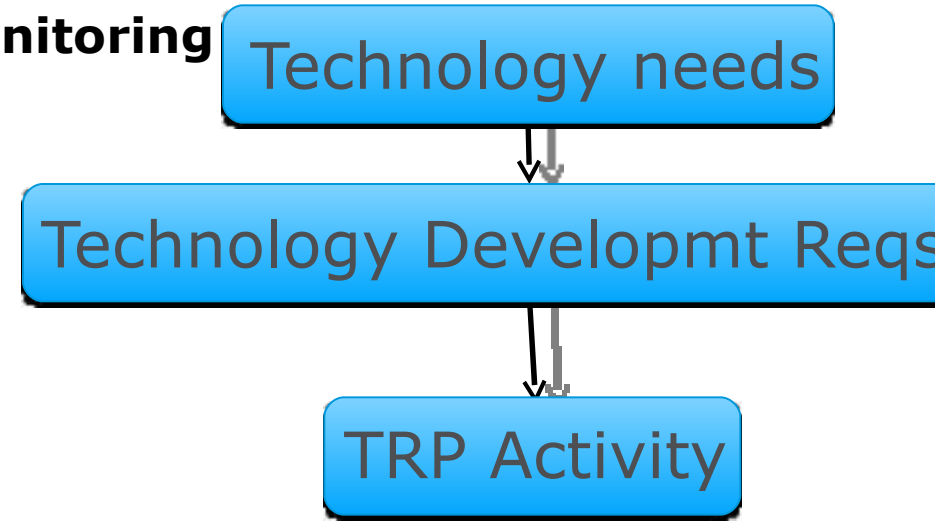


TRP Planning for Future Gravity Field Mapping and Monitoring Activities

Potential Mission: Future Gravity Field Mapping and Monitoring

Technology Area: Next Generation sat to sat tracking for gravity time variations
Next generation gravity gradient measurement

Technology Development Requirements

- Laser interferometer tracking system
- Laser Frequency stabilization
- Digital interferometer phasemeter
- Drag free technologies
- In-orbit lessons learnt
- Electrostatic accelerometer evolution
- Microthrusters for 6DOF control
- Low noise attitude actuators
- Atom interferometry gradiometry

T117-309MM:
Laser Stablilsation Unit for Interferometric Earth Gravity Measurement

Target TRL: 4

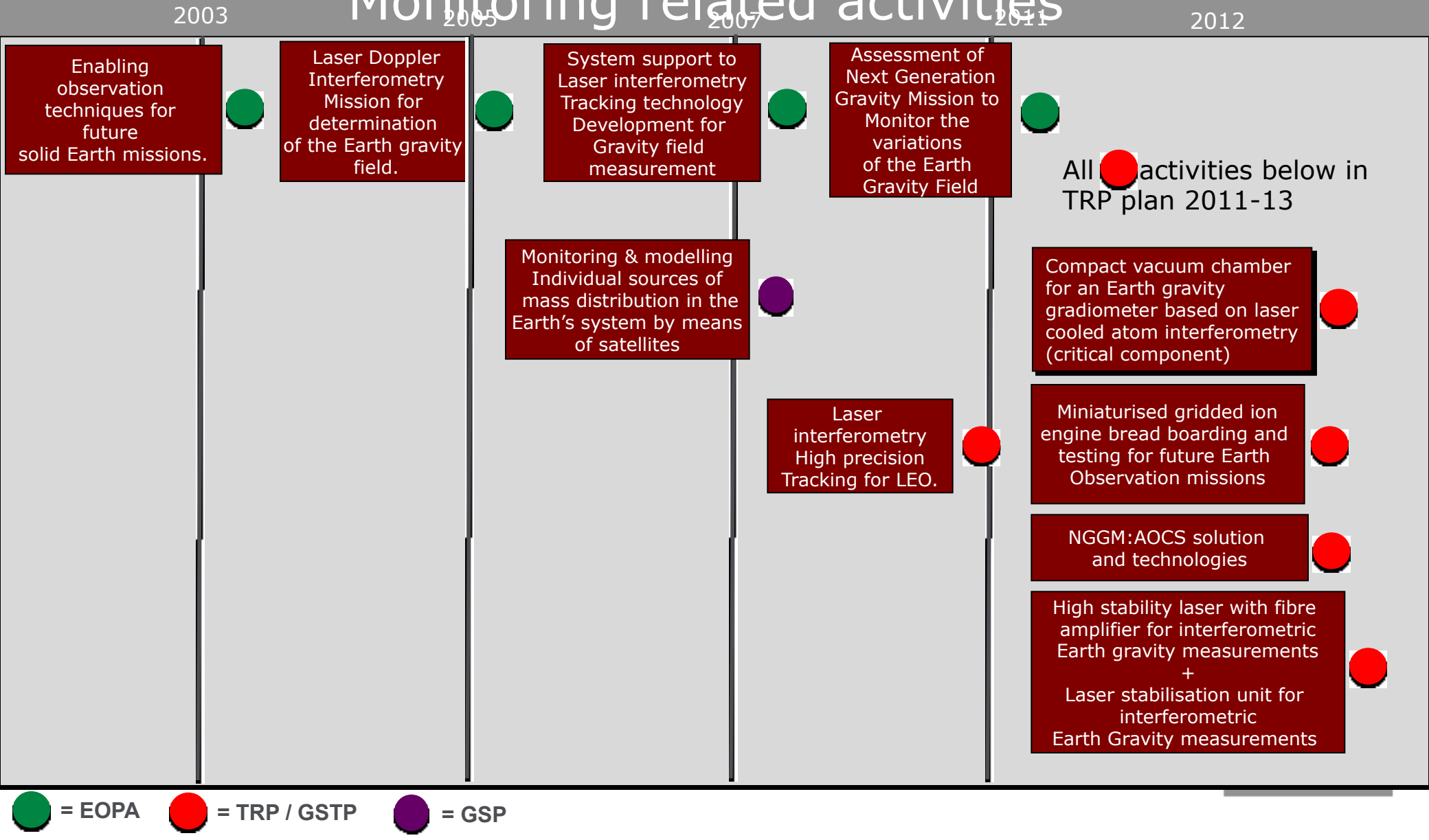
T105-302EC:
NGGM:AOCS solutions & technologies (identify critical h/w & s/w for feasibility and design drivers)

Target TRL: 3

117-306MM:
Compact vacuum chamber for an Earth gravity gradiometer based on laser cooled atom interferometry (critical component)

Target TRL: 3

Example 2: Overview of Gravity Mapping and Monitoring related activities



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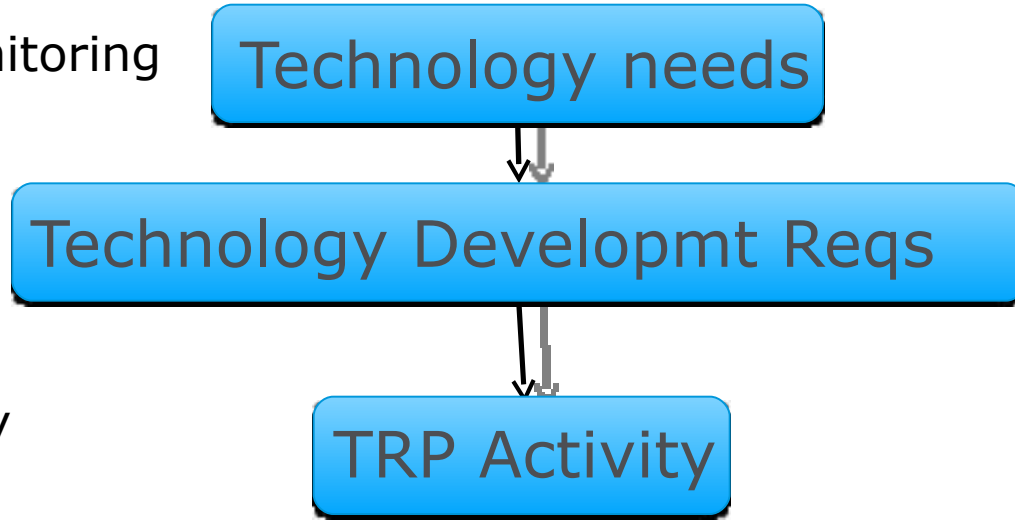
8. **High resolution from GEO (coastal monitoring and ocean colour)**
9. High resolution soil moisture and ocean salinity
10. GMES/Security: SAR imagery for land change detection and topography
11. GMES/Security: Maritime surveillance
12. GMES evolution: next generation high resolution wide swath SAR imagery
13. GMES evolution: next generation high resolution land optical



TRP Planning for HR GEO Activities

Potential Mission: High resolution imagery from GEO (coastal monitoring and ocean colour)

Technology Area: AOCS, image processing and navigation from GEO
Large telescope and relative opto-electronic elements

Technology Development Requirements

- Estimation and image interpolation
- High speed digital processing technology
- Large aperture monolithic telescopes
- Large dichroic plates
- On-board calibration for large apertures
- Large focal plane detectors
- Image stabilisation techniques

T105-301EC:
AOCS and image navigation and registration for EO from GEO
Target TRL: 3

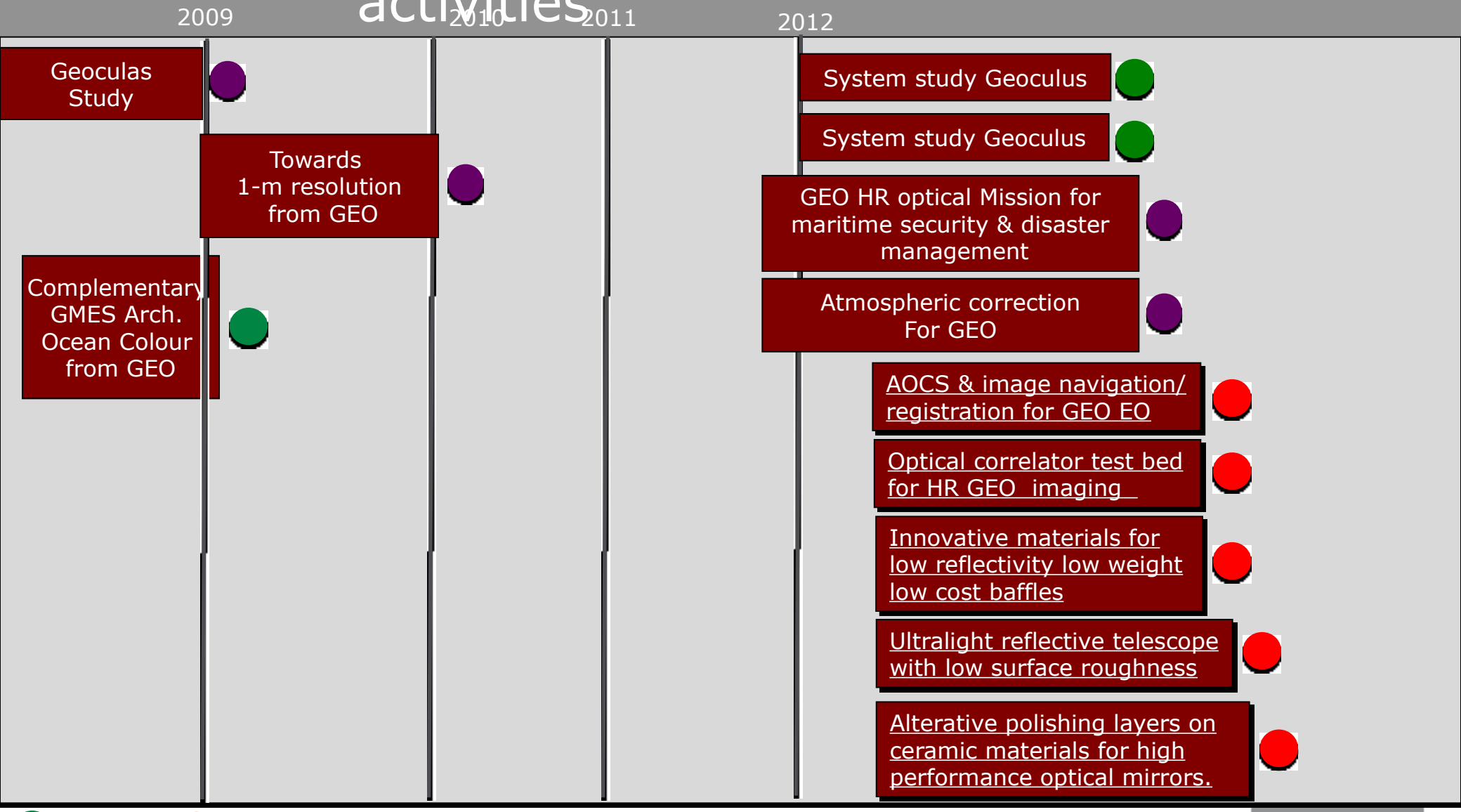
T116-312MM:
Optical correlator test bed for high resolution imaging from GEO
Target TRL: 3

T116-302MM:
Innovative materials for low reflectivity low weight low cost baffles
Target TRL: 3

T116-303MM:
Ultralight reflective telescope with low surface roughness
Target TRL: 4

T116-309MM:
Alterative polishing layers on ceramic materials for high performance optical mirrors.
Target TRL: 2

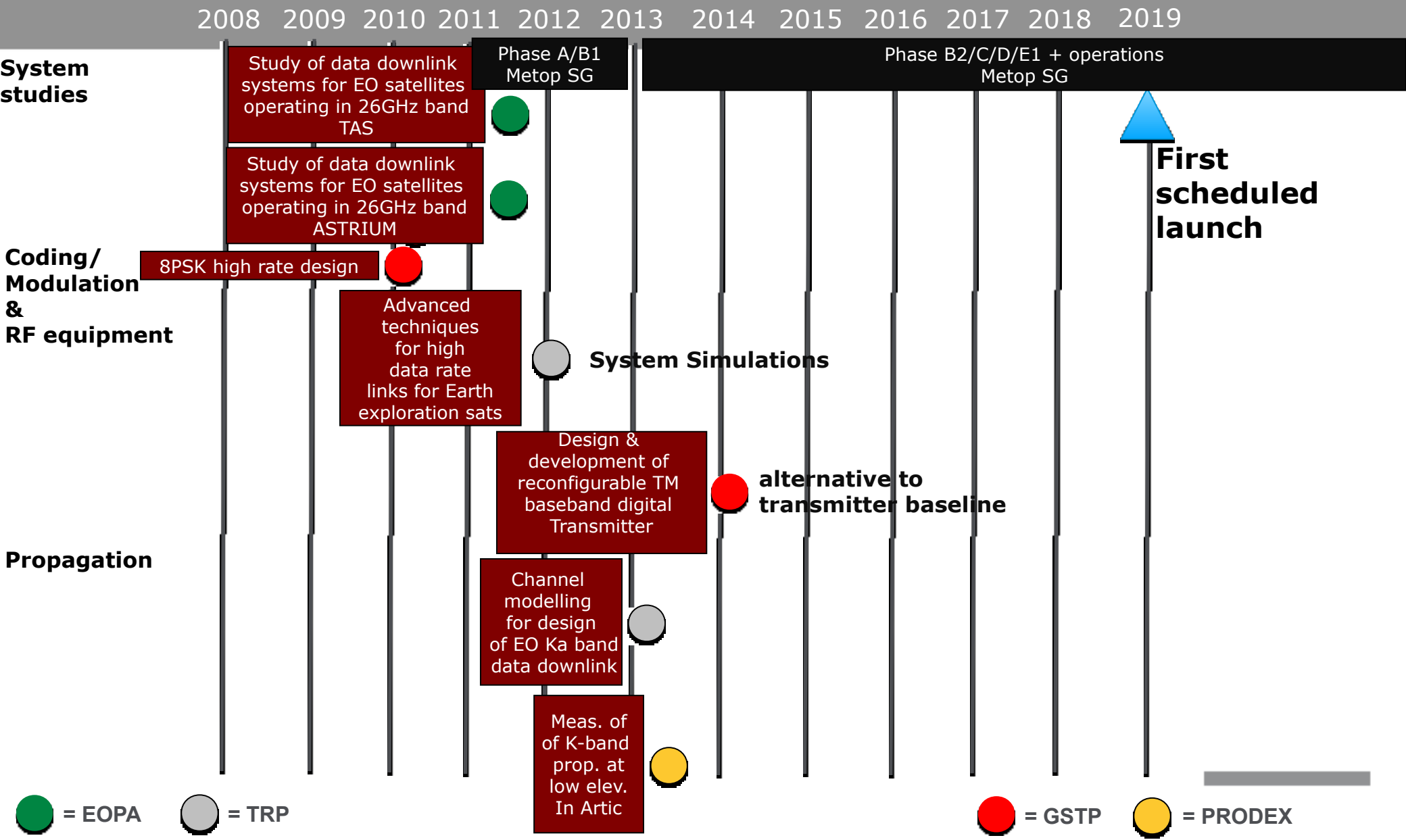
Example 3: Overview of HR from GEO related activities



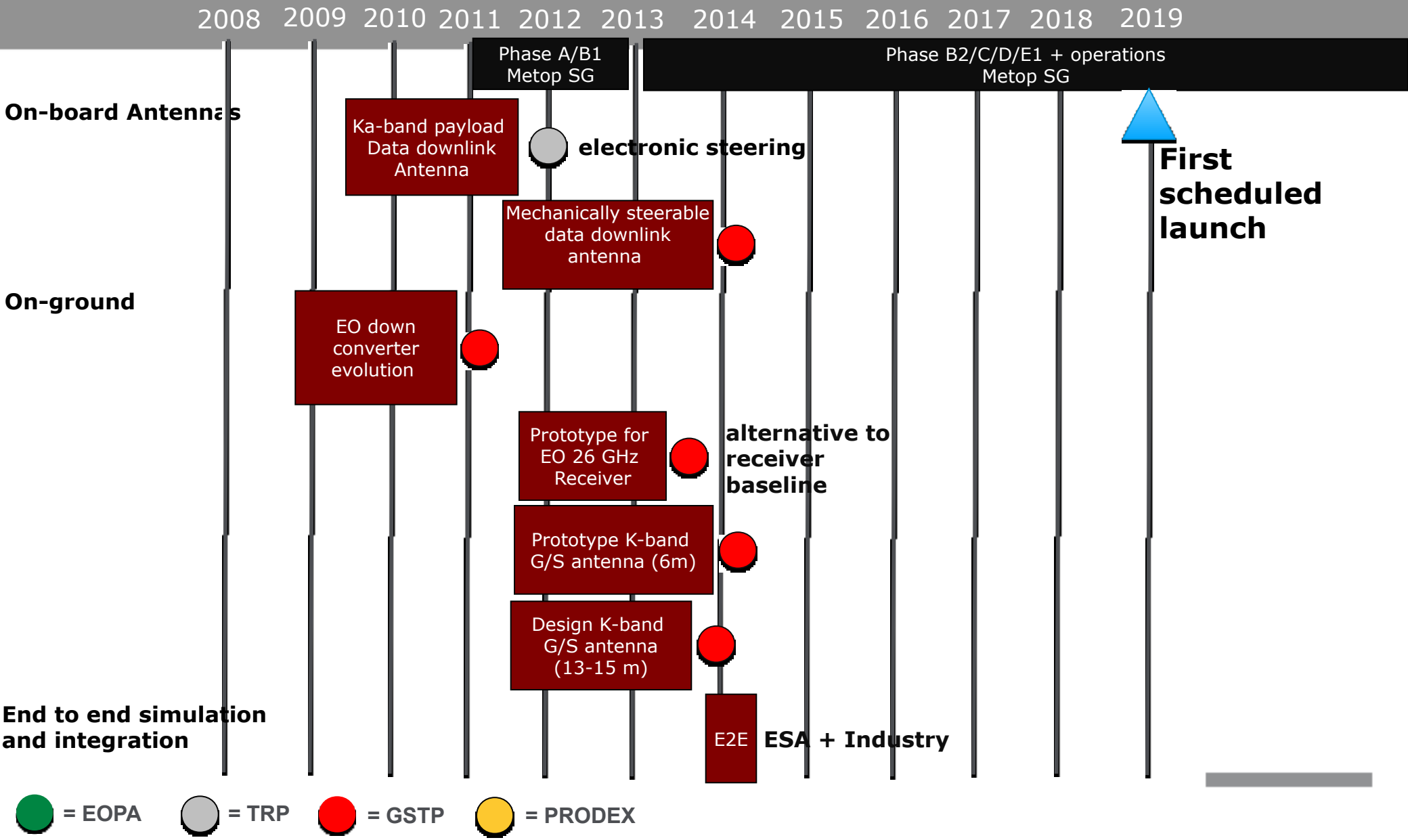
= EOPA = TRP / GSTP = GSP

All activities in TRP plan 2011-13

Example 4: Overview of 26GHz Downlink Development Preparation to Implementation



Overview of 26GHz Downlink Development Preparation to Implementation



Conclusions

1. Technology Support for EE missions and MetOp Second Generation is well underway.
2. Coordinated preparatory activities to ensure science, system and technological coherence.
3. Satellites being designed to fly together:
    a. PREMIER flying with Metop (EE7 mission candidate)
    b. Carbonsat flying with Sentinel 3 (EE8 mission candidate)
    c. FLEX flying with Sentinel 3 (EE8 mission candidate)
    d. Earth Observation Convoy studies: Ocean and Ice, Land and Atmosphere applications
4. Support for selected EE7 and EE8 mission candidates are under way or planned – again limited by resources available.
5. For recommended (non-selected) EE8 mission concepts the support is limited (EOEP-3). EOEP-4 needs member state support at the Ministerial (2012) for these activities.

Additional Slides

Sentinel–1: C-band SAR mission (1)

Applications:

- monitoring sea ice zones & the arctic environment
- surveillance of marine environment
- monitoring land surface motion risks
- monitoring of land surfaces: forest, water, soil and agriculture
- mapping in support of humanitarian aid in crisis situations

4 nominal operation modes:

- **Strip map**
  (80 km swath, 5 m x 5 m res. (range x azimuth))
- **Interferometric wide swath**
  (250 km swath, 5 m x 20 m res.) with burst synchronisation for interferometry
- **Extra wide swath**
  (400 km swath, 20x40 m res.)
- **Wave**
  (5x5 m res, leap-frog sampled images of 20x20 km at 100 km along the orbit)

Dawn dusk orbit at 693 km mean altitude

Sentinel–2: Superspectral imaging mission

Applications:

- generic land cover maps
- risk mapping and fast images for disaster relief
- generation of leaf coverage, leaf chlorophyll content and leaf water content

Pushbroom filter based multi-spectral imager with 1 spectral bands (VNIR & SWIR)

Spatial resolution: 10, 20 and 60 m

Swath: 290 km

5 days repeat cycle (cloud free) with 2 satellites

Sun synchronous orbit at 786 km mean altitude

Sentinel–3: Ocean & global land mission

Applications:

- Sea/land colour data and surface temperature
- sea surface and land ice topography
- coastal zones, inland water and sea ice topography
- vegetation products

Sun synchronous orbit at 814.5 km mean altitude over geoid

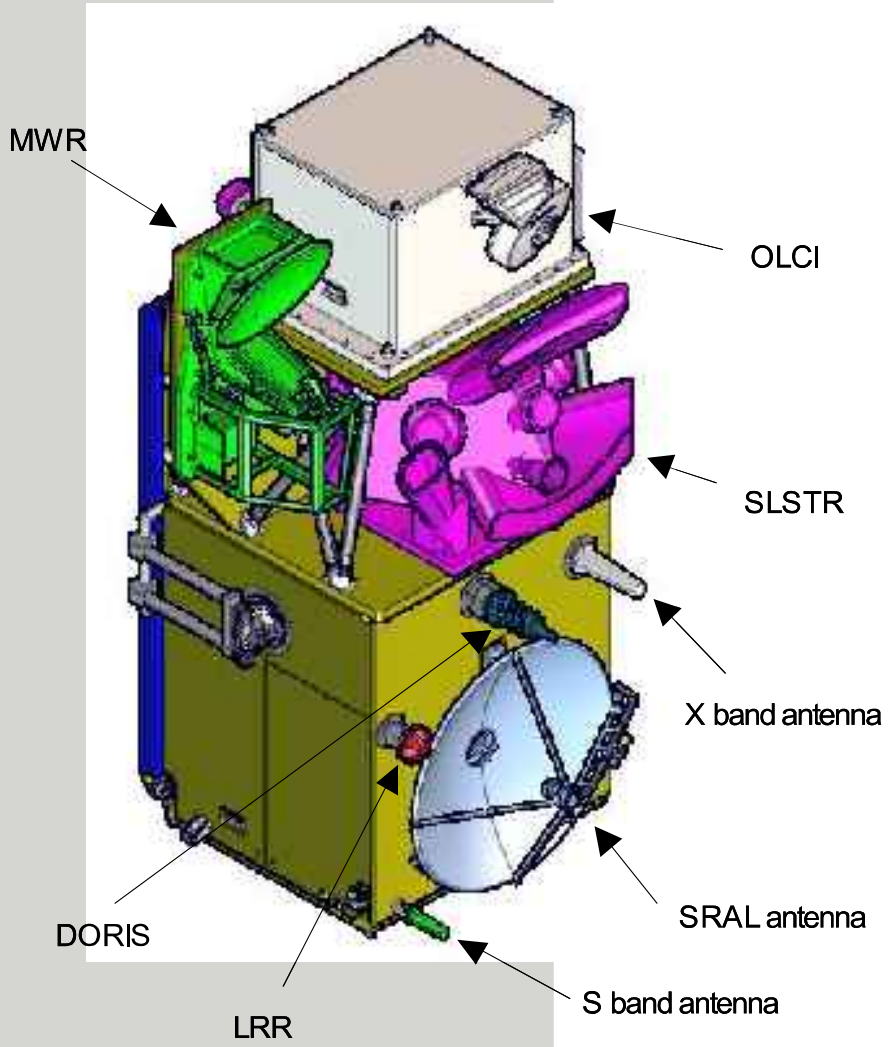
27 days repeat cycle

Sentinel–3: mission instruments

- **Ocean and Land Colour Instrument (OLCI):**
  5 cameras, total swath of 1270 km;
  8 bands (in VIS) for open ocean (low res),
  15 bands (in VIS) for coastal zones (high res).
  In total 21 bands ranging from 400 to 1020 nm.
  Spatial sampling: 300 m @ SSP
  Radiometric accuracy: absolute: 2 %, relative: 0.1%

- **Sea and Land Surface Temperature Radiometer (SLSTR):**
  9 spectral bands ranging from 0.55 to 12 um;
  0.5 km resolution (VIS, SWIR)
  1 km resolution (MWIR, TIR)
  TIR NEDT: 0.05 K; Swath: 180-rpm dual-view scan, nadir (1420 km) & backwards (750 km)

- **RA package:**
  3-cm accuracy SRAL Ku-C altimeter with LRM and SAR measurement modes, supported by MWR and POD (with LRR, GPS, DORIS)



Sentinel–4: GEO atmospheric mission

Applications:

- monitoring changes in the atmospheric composition (e.g. ozone, NO_2, SO_2, BrO, CHOCHO, formaldehyde and aerosol) at high temporal resolution
- tropospheric variability

Narrow field spectrometer covering
UV (305-400 nm),
Visible (400-500 nm)
Near-IR (750-775 nm) bands

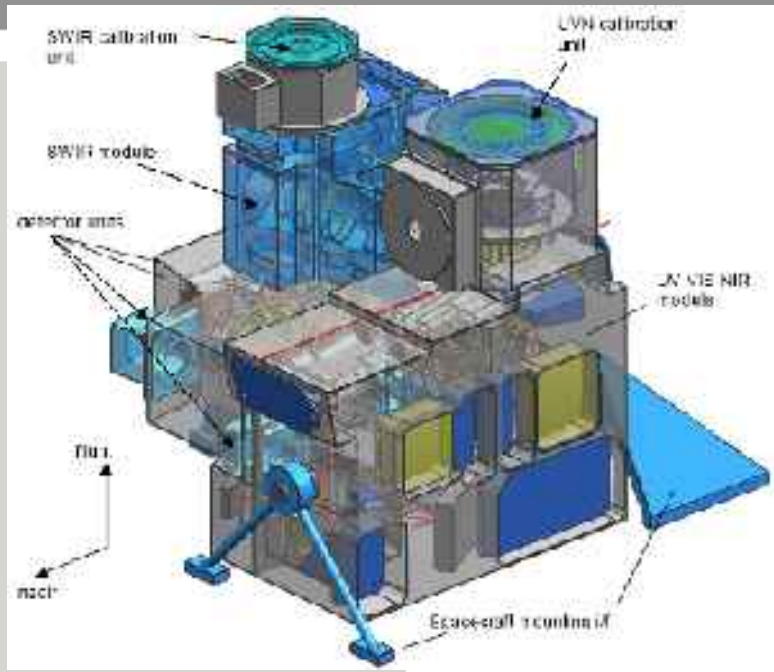
Spatial sampling 5-50 km and spectral resolution between 0.05 nm and 1 nm (depending on band)

Geostationary orbit, at 0° longitude

Embarked on MTG-S and operated by EUMETSAT

Sentinel 4, final negotiations for the Phase B2,C/D activities have been completed in January and the consortium, led by Astrium (D) formally kicked off in mid February

Sentinel–5: LEO atmospheric mission



Applications:

- monitoring changes in the atmospheric composition (e.g. ozone, NO_2, SO_2, BrO, formaldehyde and aerosol) at high temporal (daily) resolution
- tropospheric variability

Pushbroom grating 5 channels spectrometer ranging from:

270 to 495 nm (UV)

400-500 nm Visible

710-775 nm (NIR)

2314-2382 nm (SWIR)

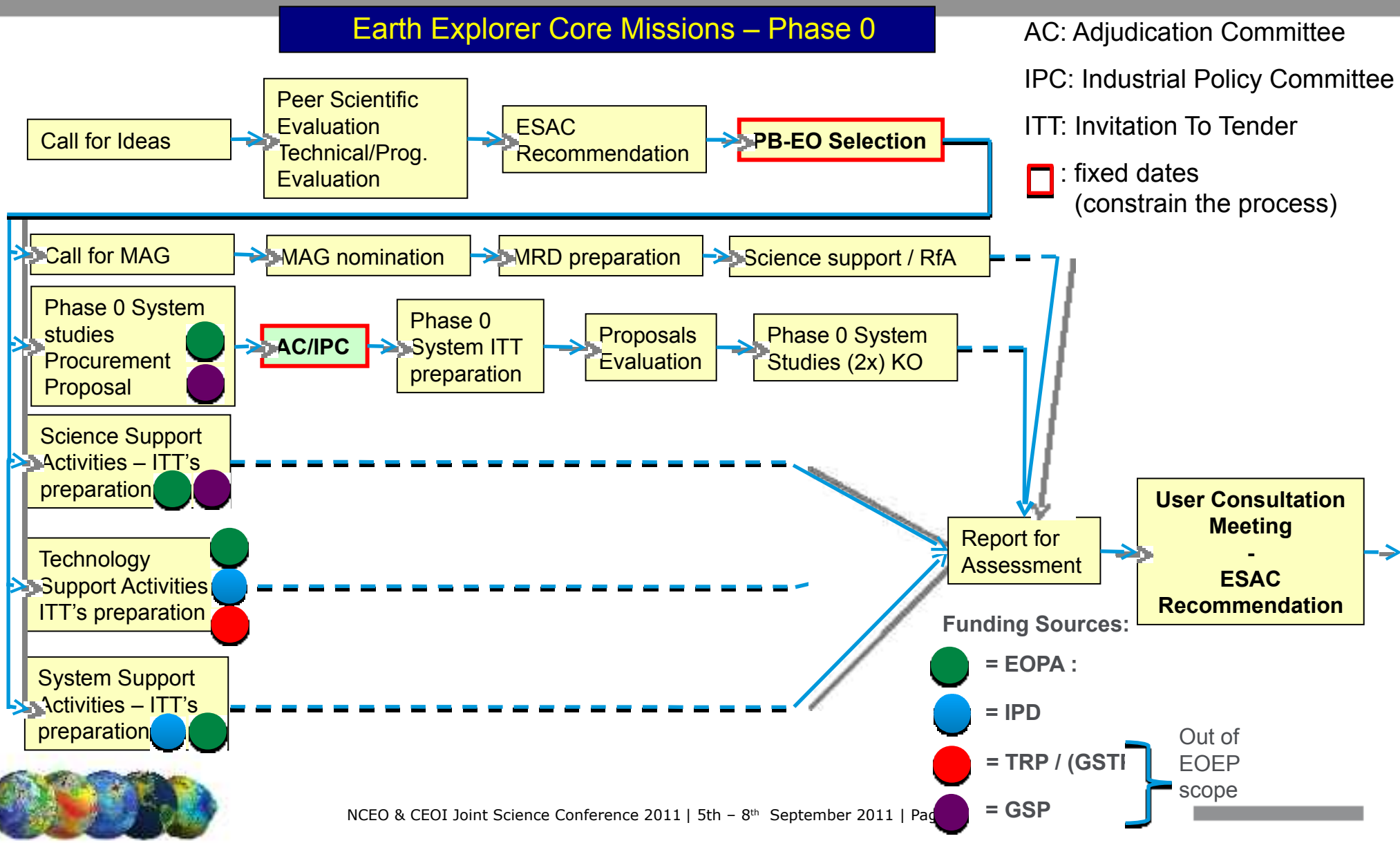
spectral resolution between 0.25 nm and 1.1 nm

Low Earth orbit (reference altitude of about 824 km)

Sentinel-5 precursor to fill data gaps (2014-2019)

Sentinel-5 embarked on MetOp SG and operated by EUMETSAT

EECM: The process in practice… I



EECM: The process in practice… II