

ESA Technology Programmes: Focus on GSTP in Support to “Innovative Substitution”

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Technology Programme Office, ESA

ESTEC, 11th June 2019

- ESA Technology Programmes
- TDE – Technology Development Element
- GSTP – General Support Technology Programme
 - GSTP Element Structure: Element 1 “Develop” (Work Plan / Frameworks); Element 2 “Make”; Element 3 “Fly”
- TDE & GSTP for Innovative Substitution
 - TDE Examples of REACH related activities
 - GSTP Examples of REACH related activities
 - GSTP in support to “Innovative Substitution”
- Dissemination and promotion of technology results

Technology Programmes Objectives

-  **Enabling** missions of ESA and national programmes by developing technology
-  Fostering **innovation** by creating new products
-  Supporting the **competitiveness** of European industry
-  Improve European **technological non-dependence** and availability of European sources for **critical technologies**
-  Facilitate **spin-in** from outside the space sector



Technology Programmes Overview



Mandatory programmes

CTP (Science Core Technology Programme)

TDE/TRP (Technology Development Element)

Optional programmes

GSTP (General Support Technology Programme)

ARTES

ARTES AT (Advanced Technology)

ARTES C&G (Competitiveness and Growth)

EOEP (Earth Observation Envelope Programme)

SciSpacE (Science in Space Environment)

ExPeRT (Exploration Preparation, Research & Technology)

ETP (Exploration Technology Programme)

EGEP (European GNSS Evolution Programme)

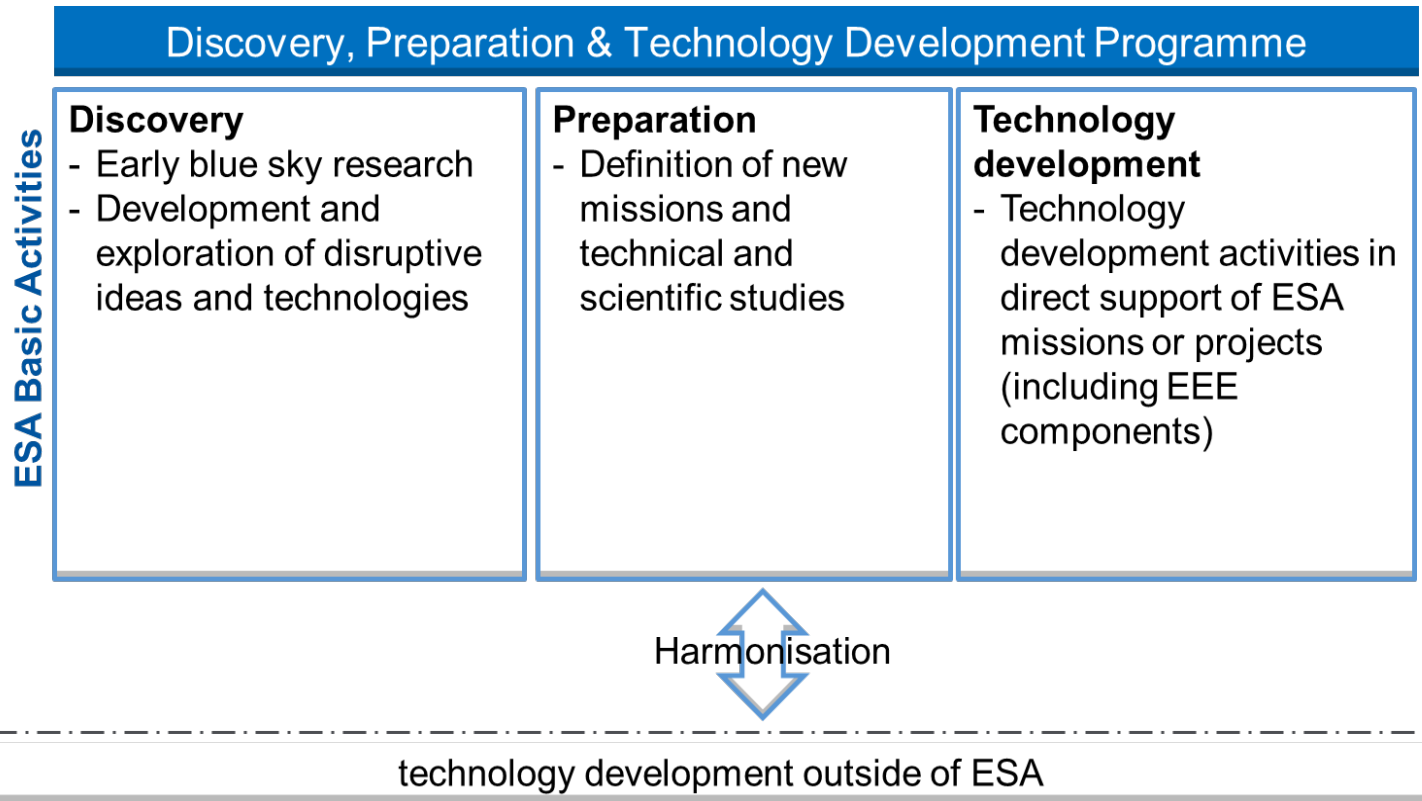
NAVISP–Navigation Innovation and Support Programme

FLPP (Future Launchers Preparatory Programme)

TRL	TDE	CTP	GSTP	ARTES CC	ARTES ScyLight	EOEP	SciSpacE	ExPeRT	ETP	EGEP	NAVISP	FLPP
TRL 9 Actual system "flight proven" through successful mission operations	Light Blue		Light Blue									
TRL 8 Actual system completed and accepted for flight ("flight qualified")	Light Blue		Light Blue									
TRL 7 Model demonstrating the element performance for the operational environment	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue
TRL 6 Model demonstrating the critical functions of the element in a relevant environment	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue
TRL 5 Component and/or breadboard critical function verification in a relevant environment	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue
TRL 4 Component and/or breadboard functional verification in laboratory environment	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue
TRL 3 Analytical and experimental critical function and/or characteristic proof-of-concept	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue
TRL 2 Technology concept and/or application formulated	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue
TRL 1 Basic principle observed and reported	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue

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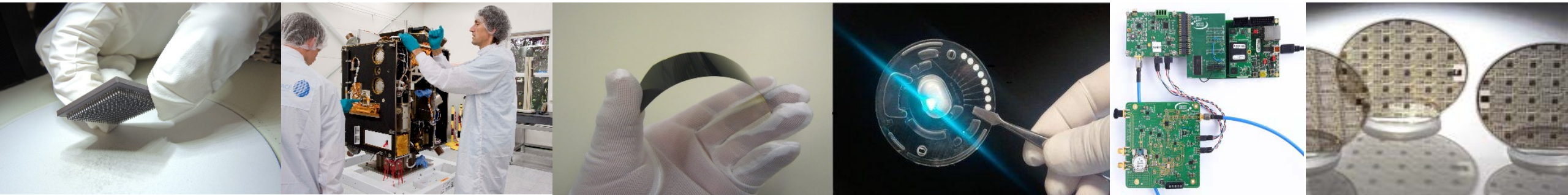
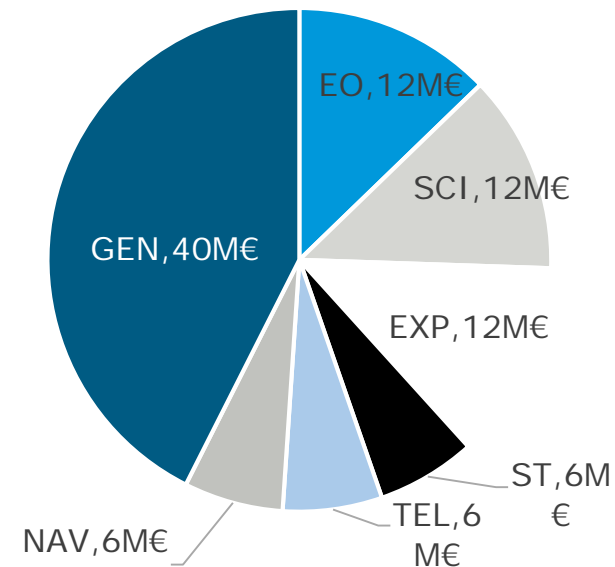
Technology Development Element (TDE), formerly TRP

- Covers **all** technology disciplines & applications up to TRL 4
- Based on two-year work plans, with yearly updates
- 55 M€ in industrial contracts per year

Technology Development Element

TDE enables innovation in-line with ESA's objectives

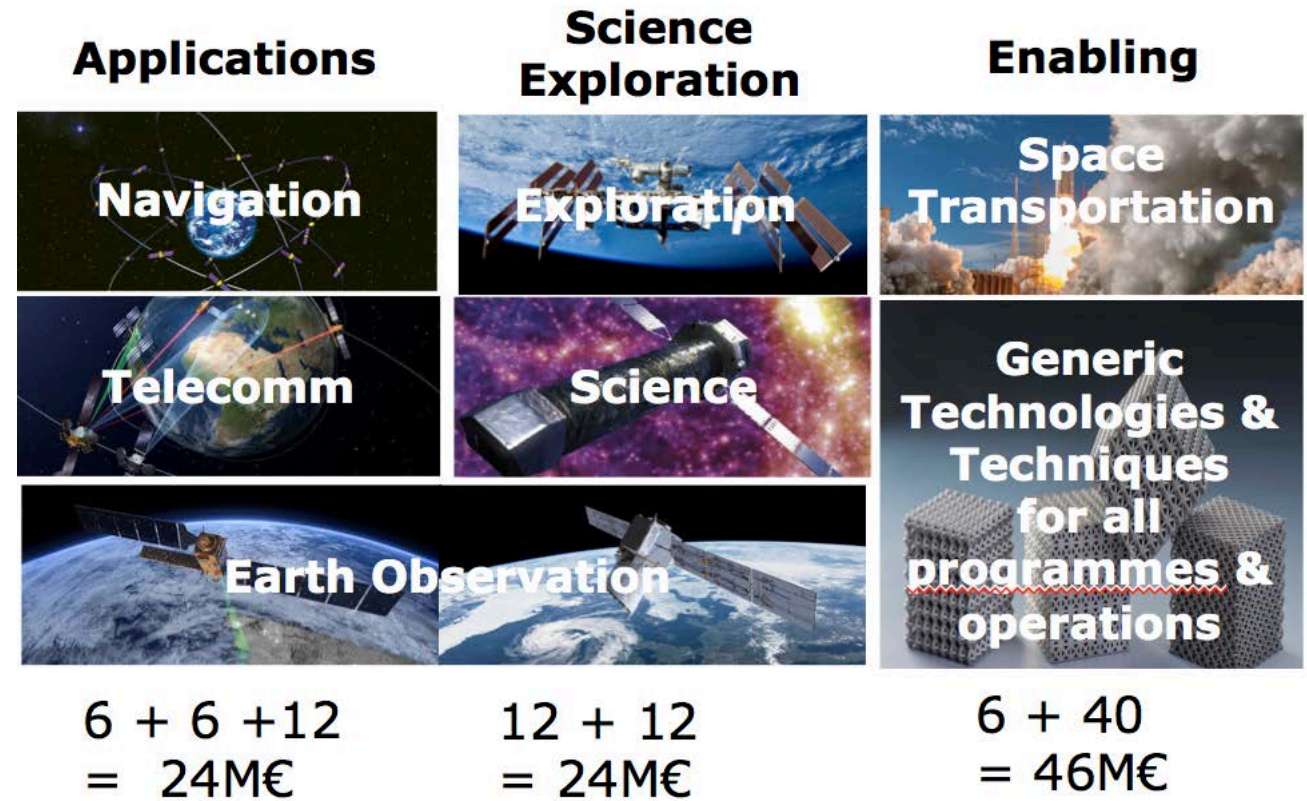
- **Mandatory** for all member states as one of the elements of the Discovery, Preparation and Technology Development programme
- only ESA technology programme supporting all of ESA's fields of activity across the **entire spectrum** of technical disciplines and applications
- **Average annual commitment** (industrial contracts) ~ **€55 million**



New Technology Development Element workplan (2019-2020)



- Volume: €94 million
- Plan presented at the November IPC
- Work plan for 2019 approved by IPC on the 25th of February 2019
- Invitations to tender for each activity are published throughout the year: **see emits.esa.int**

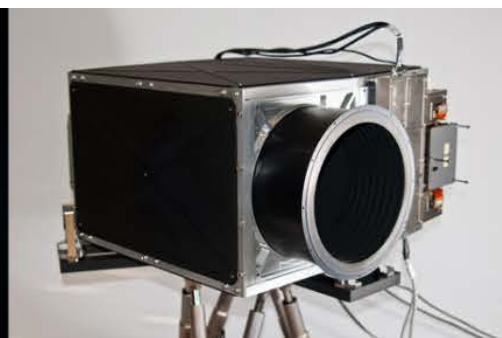
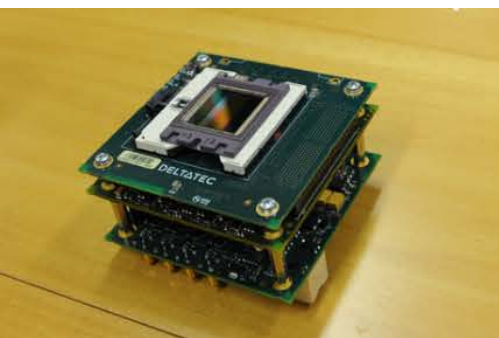
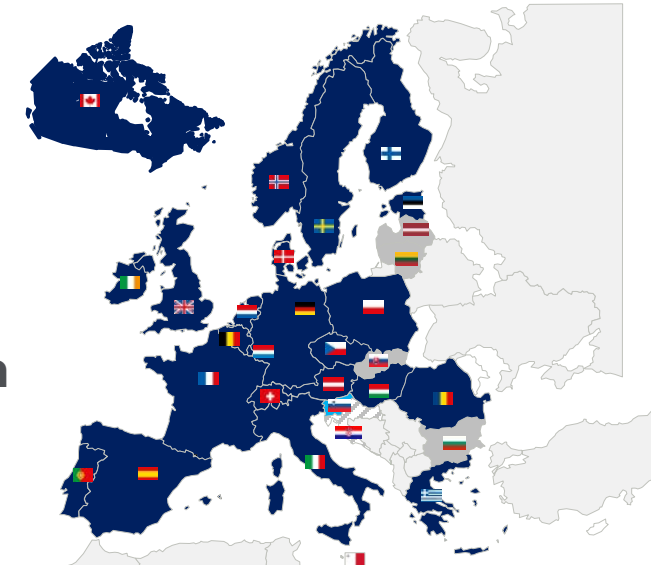


General Support Technology Programme



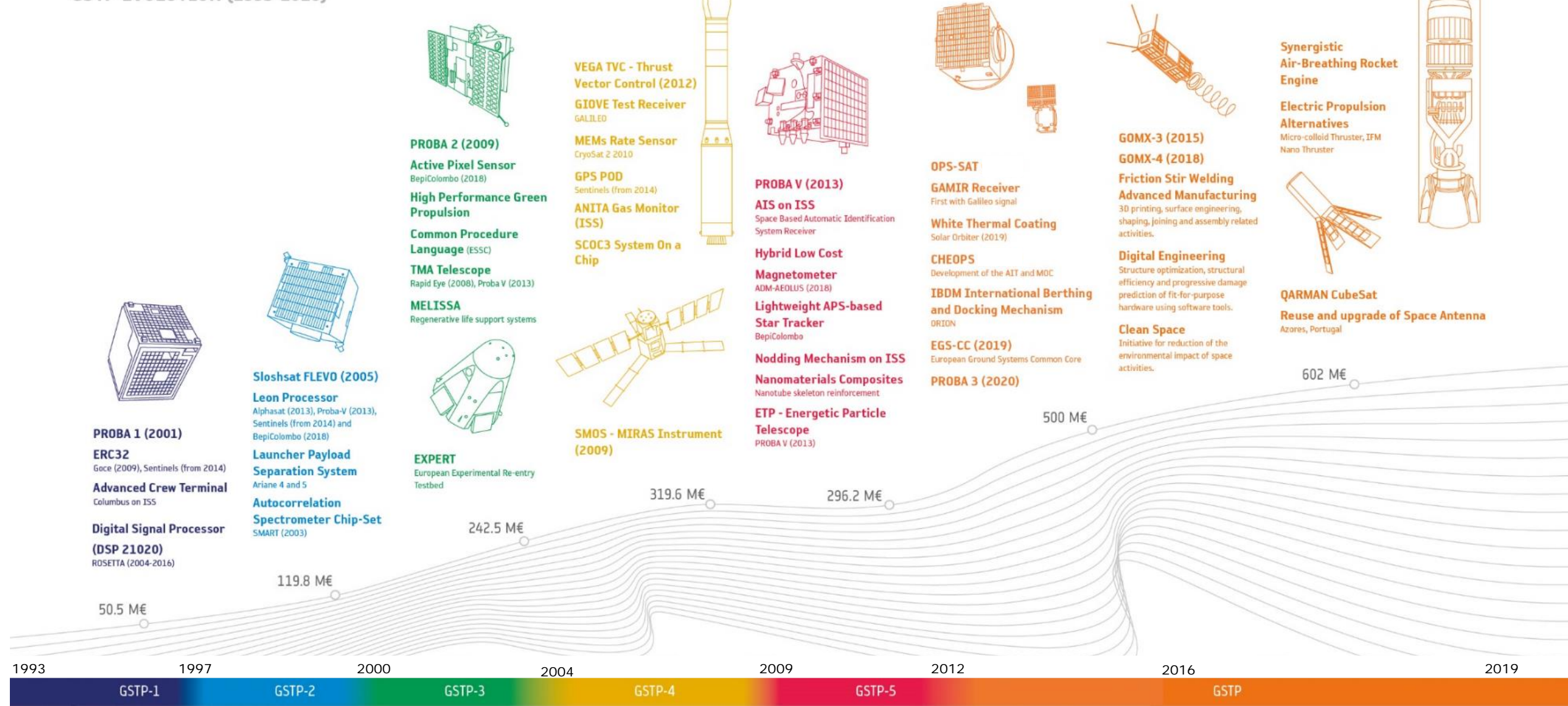
GSTP ensures the right technology with the right maturity is available at the right time

- Part of **ESA's Optional Programmes**
- Covering **all technology disciplines** and applications except Telecommunications
- GSTP subscription since 2013 1,100M€ million
- **Average annual commitment** (industrial contracts) ~ **€90 million**
- **Work plans**, with yearly updates, and multiyear activities / frameworks (e.g. de-risk) / **Announcement of Opportunity**



GSTP 25 YEARS

GSTP EVOLUTION (1993-2020)



GSTP Participation



Every single one of ESA's Member States and Canada and Slovenia opt in to GSTP.

% financial contribution of each country to the overall GSTP envelope.

Total GSTP Subscriptions:
GSTP (2013 -): 1,100 MEuros

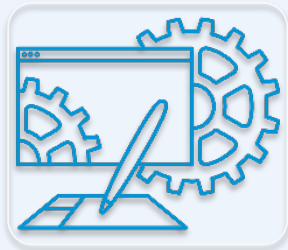


GSTP Element Structure

ELEMENT 1

Develop

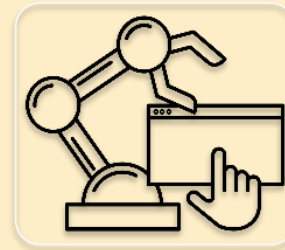
Development of technologies and products from low TRL to qualification Platform, Payload, Ground Segment and Engineering tools



ELEMENT 2

Make

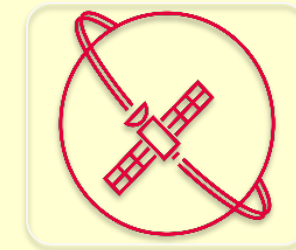
Market driven, industry initiated, co-funded direct negotiation activities for technology maturation leading to products



ELEMENT 3

Fly (Small Missions)

Envelope which hosts projects such as satellites (for technology demonstration), ISS payloads, technology flight opportunities



Element 1- Work Plan

Element 1 - Frameworks



GSTP Element 1 "Develop": Compendia



- The GSTP E1 Develop Compendium is a **compilation of activity proposals that are considered top priority for ESA.**
- Activity proposals and selection of activities made by representatives of the technical and application domains and internally coordinated.
- It covers all application domains (with the exception of Telecommunication) and specific areas.
- The **objective** of the Compendium is **to trigger discussions among industry and Delegations** of the GSTP Participating States with the aim that the activities are supported and implemented within the GSTP WP.

The GSTP E1 "Develop" Compendium of Potential Activities 2017 (ref. ESA-GSTP-TECT-PL-005452), issued in June 2017 includes 143 Activities (~140M€).



GSTP Element 1 Develop: Work Plan (WP)

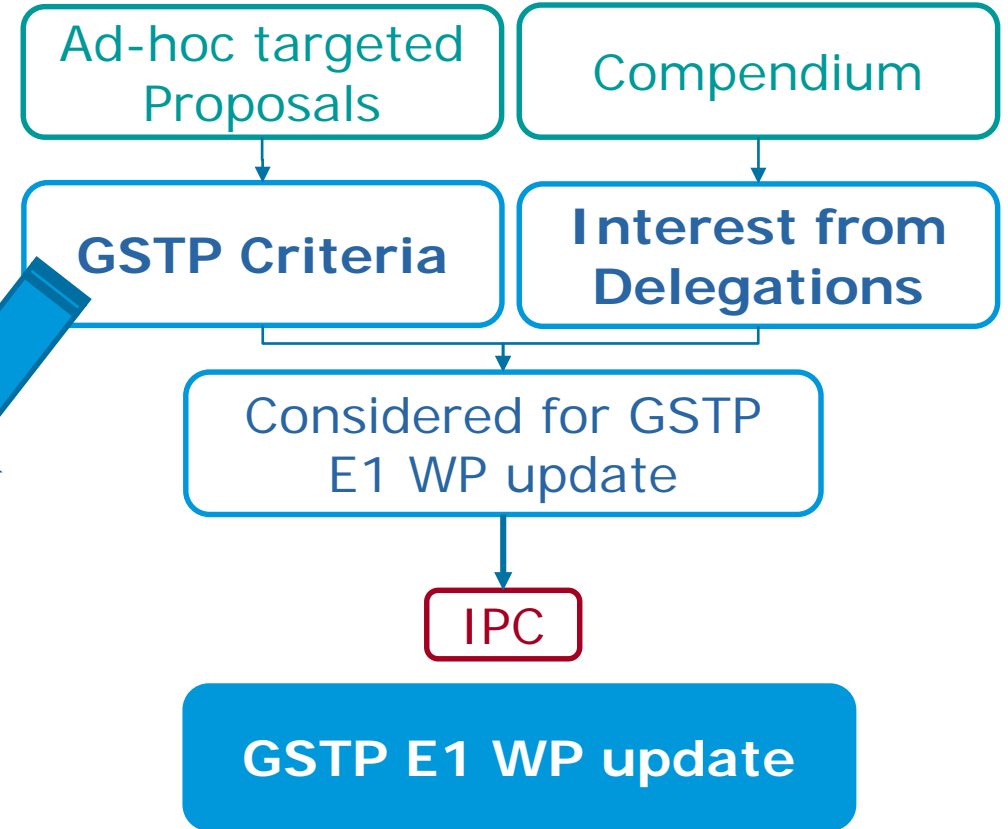


Development of technologies and products from low TRL to qualification Platform, Payload, Ground Segment and Engineering tools

Activities to develop of technologies and products that are ESA driven and/or to develop industrial capabilities in ESA Member States

- Programmatic: TRLs, Application, Consistency of scope /deliverables /TRLs,
- Continuation of previous activities (TRP, GSTP...)
- Innovation? Competitiveness? Enabling mission?
- Industrial sustainability / Capacity Building
- Interest from Delegations + Funds Availability

Proposal GSTP E1 WP update





GSTP Element 1 - Develop: Frameworks



- Roughly 10-25 activities approved in GSTP work plan 5 x per year (including activities from the Compendia and ad-hoc proposals).
- **Frameworks introduced to implement specific types of activities faster**
- Frameworks in operation:
 - G61A-036QT, Assessing the use of Advanced Manufacturing to improve and expand space hardware capabilities
 - G617-241TA, Assessments to prepare and de-risk technology developments
 - GT17-136TI, Activities to bridge national technology developments
 - GT17-137TI, Preparation of enabling space technologies/capabilities



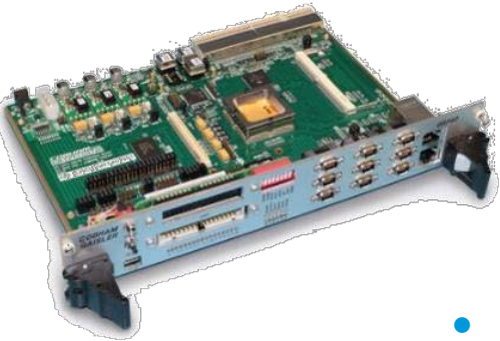
GSTP Element 1 - Develop: Frameworks



G617-241TA, Assessments to prepare and de-risk technology developments

Aim: evaluate added value, address critical issues, orient follow-on activities

- Activities include at least one of the following tasks:
 - Analysis of specifications, development actions, schedule and cost
 - Assessment of the benefits and disadvantages of the solution with respect to the state-of-the-art
 - Assessment of critical issues related to using a given technology for a specific application, using analysis/simulation and/or breadboarding
- <200 K€ (<80 K€ for studies) / Duration maximum 9 months
- 100 activities initiated so far for more than 18 M€ in 15 countries
- **ESA procurement time: 3-4 months**



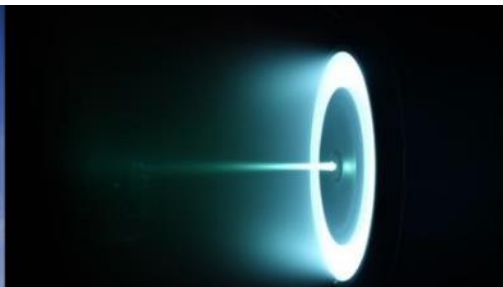
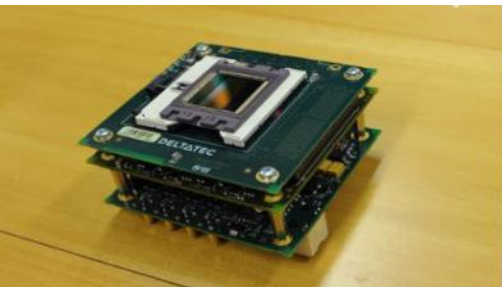


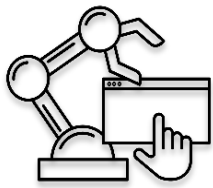
GSTP Element 1 - Develop: Frameworks



GT17-137TI, Preparation of enabling space technologies/capabilities

- targeted and coordinated development of capabilities in a given ESA Member State or across different Member States
 - nominal technology development activities, with typical deliverables
- < €500K per activity
- Support received from 7 Member States.
- 4 contracts and 11 under procurement / **ESA procurement time: 5 months**





GSTP Element 2 - Make – New Approach

New Call for Proposals published in EMITS - AO9834

**Segment 1
Market Oriented
Opportunities**

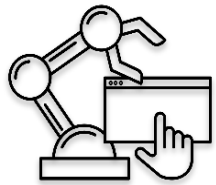
**Segment 2
Company Strategy
Oriented Opportunities**

**Segment 3
National Priority
Opportunities**

- **Segment 1:** For market oriented activities, entities implement the classical approach and propose product developments targeting commercial market opportunities. They present the nominal business case.
- **Segment 2:** Entities propose developments of strategic relevance (i.e. leverage non-space capabilities for space, expand operations in the space domain or maintain strategic know-how).
- **Segment 3:** Entities propose activities that address specific priorities of ESA Member States. Countries may wish to maintain and develop capabilities that serve different national space considerations.

Economic Operator	Pre-outline	Outline Proposal	Full Proposal
Entry Point 1: Mature (entities with established market/product experience & with financial solidity)			+
Entry Point 2: Intermediate maturity level (with limited experience for the targeted market/product)		+	+
Entry Point 3: Limited maturity (entities just created and/or limited commercial market/product experience)	+	+	+





GSTP Element 2 Make



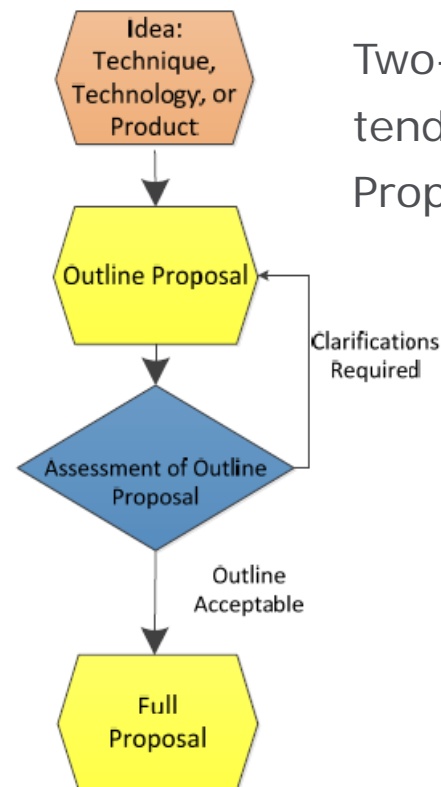
Objective: offer to industry a mechanism for submitting at any time **unsolicited proposals** for market-oriented technology activities.

A realistic business plan to be included – customer well identified (not only ESA projects)

Funding schemes (percentage ESA funding):

TRL of development		Univ. and Institutions*	SME	Non-SME
Min	Max			
3	5	100	75	75
5	7	100	75	50

* Universities and research institutes participation limited to 30% of the overall activity budget. Universities and research institutes are not eligible to lead a consortium as Prime Contractors. Examples of involvement: access to labs, dissemination of research results that can be commercialized by industry.



Two-steps approach tendering process: Outline Proposal, then Full Proposal

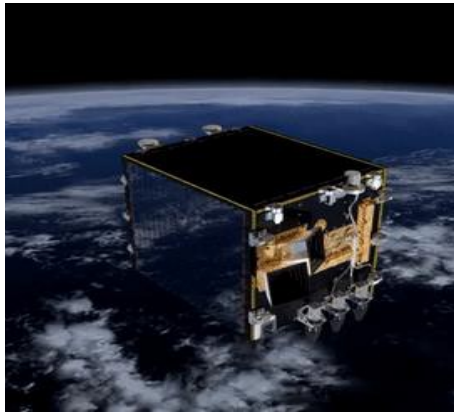




GSTP Element 3 Fly



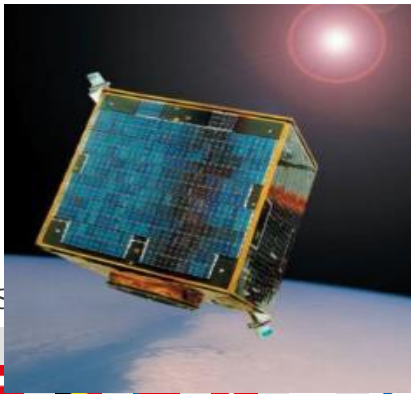
- In-orbit Demonstration of technologies and products
 - Target TRL is **7-8**
 - Essential for products requiring **flight heritage** for customers
 - Does **not** include technology development (Element 1)



- Flight **opportunities** are identified with ESA projects and launchers, with National agencies and with primes, and with commercial missions

- Accommodation/assessment study framework
 - Experiment accommodation (e.g. materials experiments)
 - Sound rocket / launcher service studies
 - In-orbit demonstration related systems (systems, payloads...)

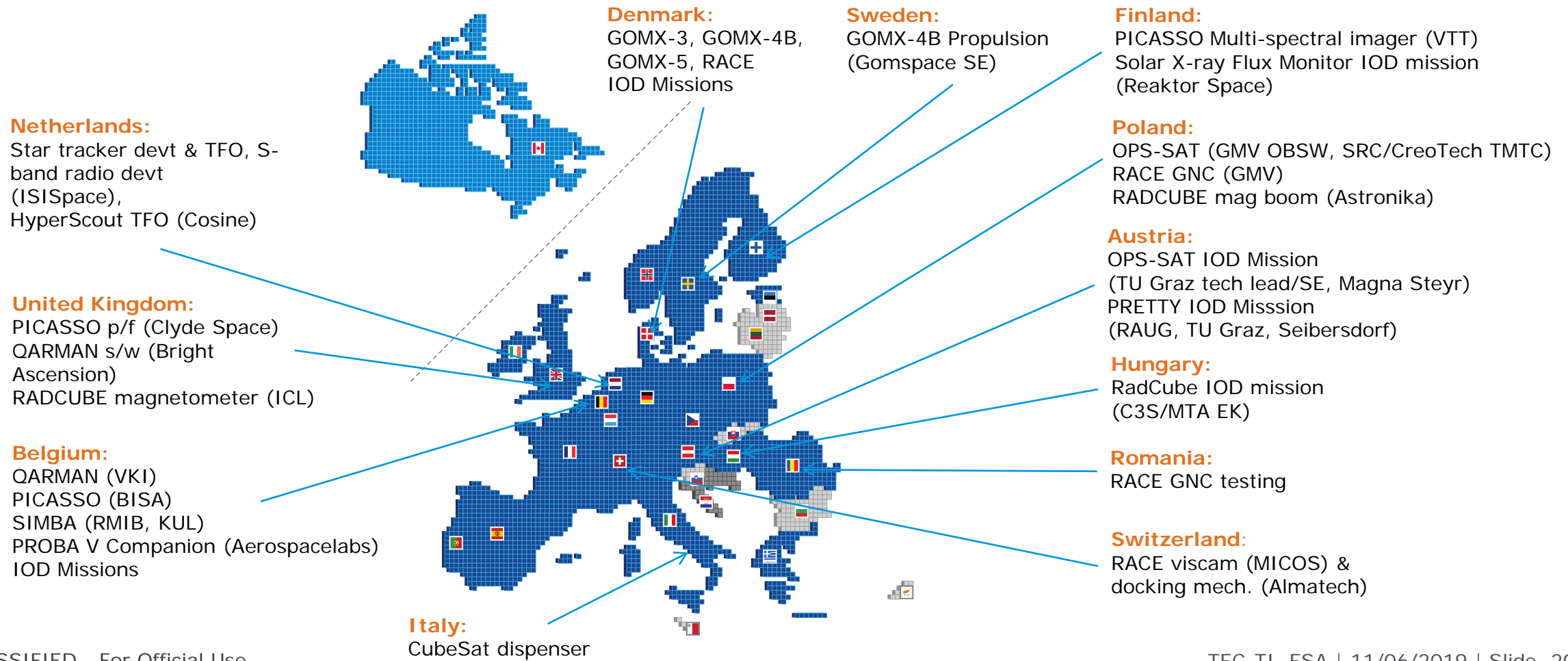
- Cubesat framework



IOD CubeSat mission implementation in GSTP



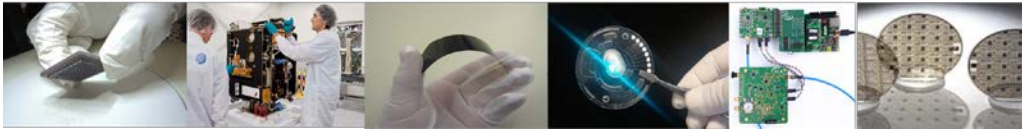
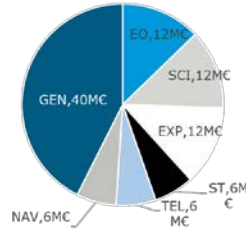
>16 MEuro in ESA GSTP FLY Element since 2013 for 12 IOD CubeSat missions



Technology Development Element

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TDE & GSTP for Innovative Substitution

General Support Technology Programme

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TDE Examples of REACH Related Activities



Activity Reference	Title	Budget (k€)	Start Year	Status
T719-405MP	HAN-based monopropellant assessment	350	2014	Closed
T715-502MS	REACH treatment of the pyrotechnics initiators powder	275	2016	Closed
T724-405QT	Compatibility of Welded Propellant Systems with New Green Propellants	300	2015	Ongoing
T724-406QT	Fingerprinting of Materials and Processes	250	2015	Ongoing
T721-404MT	Electrically Conductive Black Primer	300	2015	Ongoing
T919-013MP	Assessment of high performance green propellants	150	2015	Ongoing
T724-502QT	Development of green polyurethane materials for use in spacecraft and launcher applications	300	2017	Ongoing
T724-501QT	REACH obsolescence management for Materials & Processes	200	2016	Ongoing

Activity Reference	Title	Budget (k€)	Planned Start Year	Status
T423-601ED	Reliability of Lead free/pure tin component terminations	300	2019	Under Procurement
T724-607SY	Life Cycle Assessment of Green Electronics for Space	250	2020	To be approved

Keep a look on EMITS' Invitations To Tender (ITTs) for other activities of potential relevance.



Development of green polyurethane (PU) materials for use in spacecraft and launcher applications



Roadmap: Clean Space

Contractor: Toseda (CZ), Ariane (DE), LIWC (LV)		ESA Budget:	296 k€
	Initial TRL: 3	Target TRL: 4	TO: M. Holynska
Start of Activity : 2017	End of Activity : 2019		

Objectives:

To develop polyurethane formulations for coating and potting applications with reduced human toxicity by elimination of toxic isocyanate chemistry and ensuring full REACH-compatibility. This shall at the same time allow further performance enhancement compared to established materials (e.g. environmental stability, permeability, thermal resistance).

Achievements, status and benefits (activity to be finalized in June 2019):

- WP1:** Analysis of the market / literature on "green" PUs and PUs for space applications with development of a technical specifications
- WP2:** Development and test plan for green PUs
- WP3:** Preliminary development and testing of green PUs
- WP4:** Development of a manufacture plan and test plan for green PUs
- WP4:** Manufacture and testing of the green PUs
- WP4:** The final analysis and conclusions

- Alternative chemical routes leading to PUs and tuning with nanoadditives
- Avoiding of the use of toxic isocyanates, content of renewable materials (up to 60%) implemented
- Use of natural sources of polyols
- Application as conformal coatings, potting materials, rigid foams



Next steps:

Finalization of the full testing, final review in July 2019.



Electrically Conductive Black Primer



*Roadmap: Advanced materials
and material technology / Clean space*

Contractor: Toseda (CZ) / Frezite (PT)		ESA Budget:	295 k€
	Initial TRL: 2	Target TRL: 4	TO: M. Holynska
Start of Activity : 2017	End of Activity : 2019		

Objectives:

development of a multifunctional primer for simplification of surface treatment combination of the properties: high emissivity, non-Cr(VI) corrosion protection, electrical conductivity.

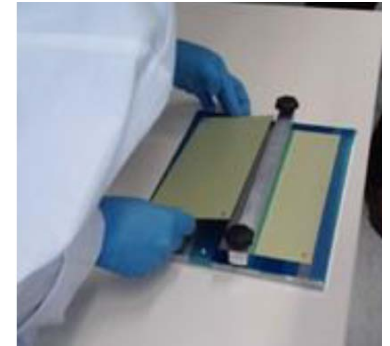
Achievements, status and benefits (activity to be finalized in May 2019):

- WP1:** Analysis of the market / literature, identification of the benchmark representatives and typical application conditions
- WP2:** Manufacturing of selected primers and their preliminary testing
- WP3:** Manufacture of the selected two primers and their full testing
- WP4:** Analysis of the outputs and conclusion

Good results so far and formulation of a primer replacing BR127 (BR127 is affected by REACH in Europe) developed in the course of this activity.

Next steps:

Finalization of full testing and synthesis of up-scaled primers, final review in July 2019.



GSTP Examples of REACH Related Activities



Activity Reference	Title	Budget (k€)	Status
G61C-002SY	Life Cycle Assessment (LCA) of manufacturing processes and space materials	400	Closed
G61C-005MP	Hydrogen Peroxide Storability/Compatibility Verification	1,000	Ongoing
GT1Z-508MP	LMP-103S Monopropellant Qualification (Batch 1)	1,400	Ongoing





GSTP in Support to Innovative Substitution The Fundamentals



- Programmatic fit as a basic condition:
 - TRLs
 - Application
- Optional Programme - Subject competing with classic technology developments and hot topics (Additive Manufacturing, Artificial Intelligence...).
- Proposed technology development to be assessed in the larger context:
 - Benefit for the company – capabilities, competitiveness leading to financial and industrial sustainability
 - Strategic need for the Participating State



GSTP in Support to Innovative Substitution The Industrial / Product Dimension



Flavor of activities proposals for GSTP – guidelines and key issues for consideration:

- Space-led or non space led development (investment to Create or Adapt)
- European Dimension – keep European capability or shift from non-European to European
- Product oriented
- Supply chain / Supplier / Sourcing
- Building capabilities / Sustainability
- Seed funding for technology
- Industrialization (technology of the product ... not procurement of equipment)
- Qualification
- ... ultimate possibility: in-orbit demonstration

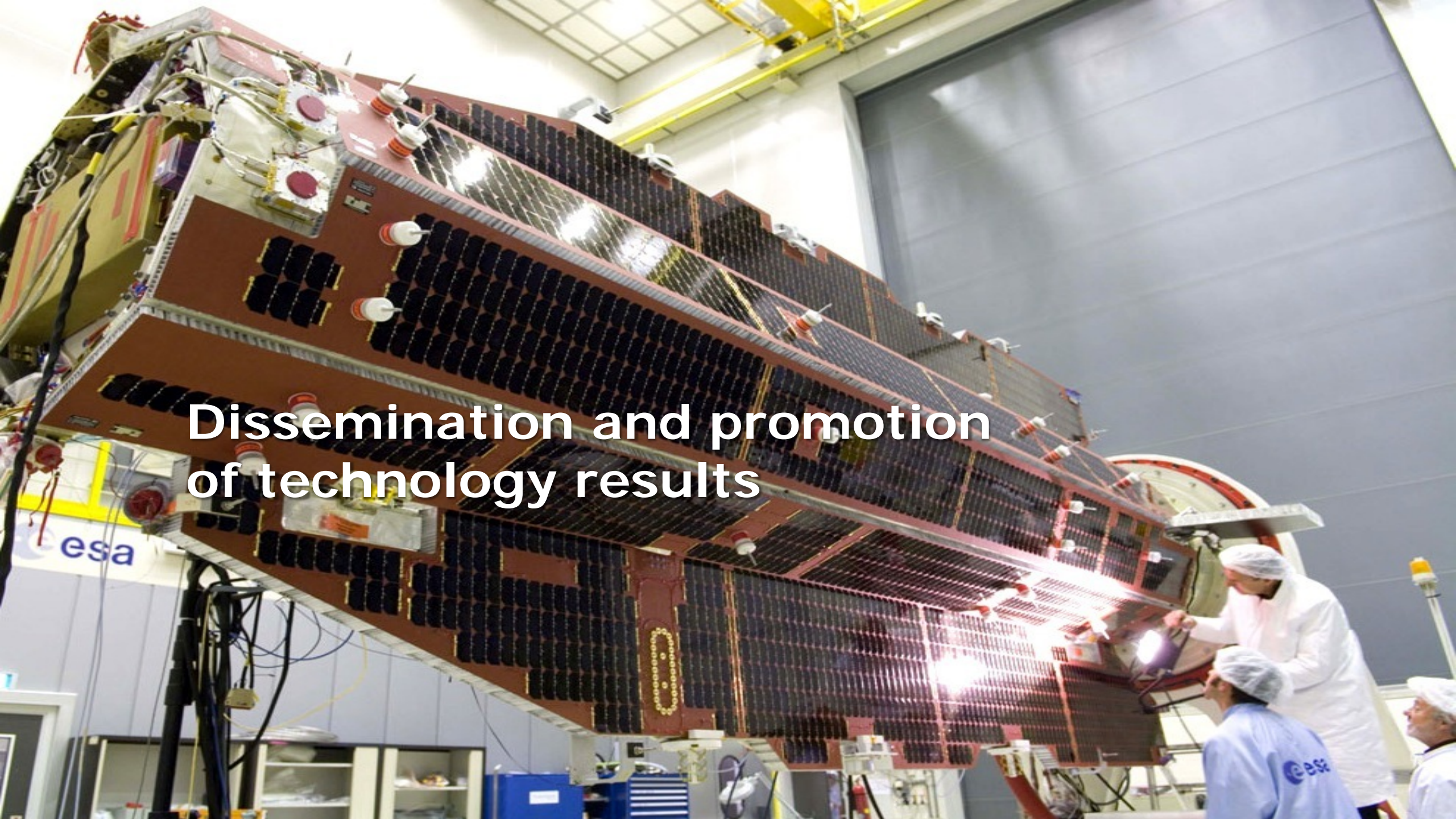
Early research / feasibility studies...not covered!

TRLs – ECSS Definition for Material & Processes (ECSS-E-HB-11)



TRL	Testing requirements	M&P requirements	Legal/regulatory requirements
1	-	-	-
2	-	-	-
3	Feasibility test Analytical test	Materials and processes assessed for manufacturability and availability. Definition of supply chain requirements.	General assessment of obsolescence risks (supply chain, regulatory) for materials and processes. Full assessment of exposure to environmental regulations (e.g. REACH, RoHS) other obsolescence risks for materials and processes in line with product life-cycle. Lessons learned
4	Test configuration, relevant environment, and results recorded in traceable manner. Implementation of Test Readiness Review (TRR).	Function of critical materials and processes recorded and followed up. Materials performance and process parameters characterised at elementary level.	
5	Implementation of Test Review Board (TRB).	Representative materials performance and process parameters characterised in relation to their end-use.	ECSS-Q-ST-70 and ECSS-Q-ST-70-71 and relevant level 3 standards are applicable.
6	Test plan with relevant technical and PA expertise. Test reports Analytical report	Processes are in place to ensure manufacturability and quality for production of demonstrator. Materials performance and process parameters characterised in relation to their end-use.	
7	QM Test plan with relevant technical and PA expertise. QM Test reports	Full capability is in place for manufacturing QM model in relevant (controlled) environment.	
8	FM Test plan with relevant technical and PA expertise. FM Test reports	Flight model is built	Flight acceptance
9	In orbit operation report	In orbit operation	Flight proven



A large satellite is being assembled in a cleanroom. The satellite is a rectangular structure with a brown frame and numerous dark solar panels. It is suspended by a crane. Several technicians in white cleanroom suits and hairnets are working on the satellite. One technician is using a tool on the right side of the satellite. The cleanroom has a grey wall and a large window. The ESA logo is visible on the left side of the satellite's frame.

Dissemination and promotion
of technology results

esa

esa

ESA website: Shaping the future



The screenshot shows the ESA website's 'Shaping the Future' page. At the top, there is a navigation menu with links: EUROPEAN SPACE AGENCY, ABOUT US, OUR ACTIVITIES, CAREERS AT ESA, FOR MEDIA, FOR EDUCATORS, and FOR KIDS. Below this is a blue banner with the text 'shaping the future' and the ESA logo. A secondary navigation bar includes 'ESA', 'SPACE ENGINEERING & TECHNOLOGY', and 'SHAPING THE FUTURE'. The main content area features a breadcrumb trail: 'ESA > Our Activities > Space Engineering & Technology > Shaping the Future'. A search bar is located on the right. The central focus is a video player showing a satellite in space, with a blue button labeled '→ IRPN' and the text 'Image Recognition and Processing for Navigation'. To the right of the video is a sidebar with three items: 'EMITS' with an '@' icon, 'How to do Business with ESA' with a handshake icon, and 'GSTP Annual Report 2016 (pdf)' with a report cover icon. On the left side of the page, there are two vertical menus. The first menu, 'Technological Achievements', includes 'ESA's Technology Programmes', 'R&D Results', and 'Technology Events'. The second menu, 'Technology Development - TRP', includes 'General Information', 'Work Plan', 'StarTiger', 'ITI', 'Technology Development - FAQ', and 'GSTP' (with sub-links for 'General Information' and 'Elements'). At the bottom of the video player, there is a 'Archive' link.

General information on the TDE and the GSTP programmes

Main achievements within technology programmes

Contacts with the Team

http://www.esa.int/Our_Activities/Space_Engineering_Technology/Shaping_the_Future



Space Engineering & Technology Final Presentation Days

- ✓ Advertise the achievements of the ESA technology programmes,
- ✓ Disseminate the results from recently completed R&D technology activities to a diverse and wide audience,
- ✓ Cover a broad range of technology developments from different technical competence domains,
- ✓ Bring together technology experts from European Industry, Academia and ESA to discuss Space R&D,
- ✓ Provide a forum for participants to share their views on R&D directions, strategies, technologies and investments.

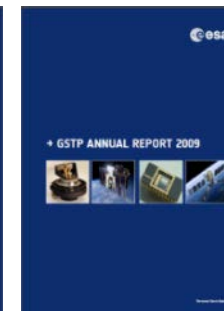
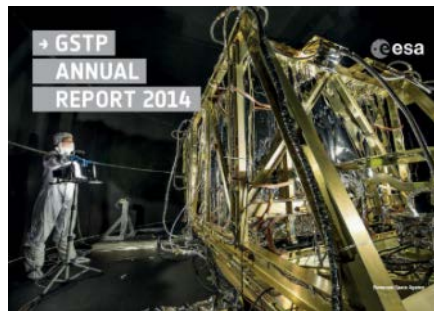


GSTP on the ESA web pages



GSTP annual reports available online:

<https://esamultimedia.esa.int/docs/GSTP/GSTPAnnualReport2017.pdf>



Thank you for your attention

Point of Contact:

TRP.Management@esa.int

GSTP.Management@esa.int

Visit the GSTP Web side on “Shaping the Future”:

http://www.esa.int/Our_Activities/Space_Engineering_Technology/Shaping_the_Future/About_the_General_Support_Technology_Programme_GSTP