Technology Programmes and the General Support Technology Programme

Slovenia
17/09/2018

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- TRP/TDE
- GSTP
  - Evolution and Structure
  - Element 1
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- 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 the availability of European sources for **critical technologies.**

- Facilitate **spin-in** from outside the space sector

Technology Programmes Overview

Mandatory Programmes

Science Core Technology Programme (CTP),

Basic Technology Research Programme (TRP)

Optional Programmes

General Support Technology Programme (GSTP)

Earth Observation Envelope Programme (EOEP) and InCubed

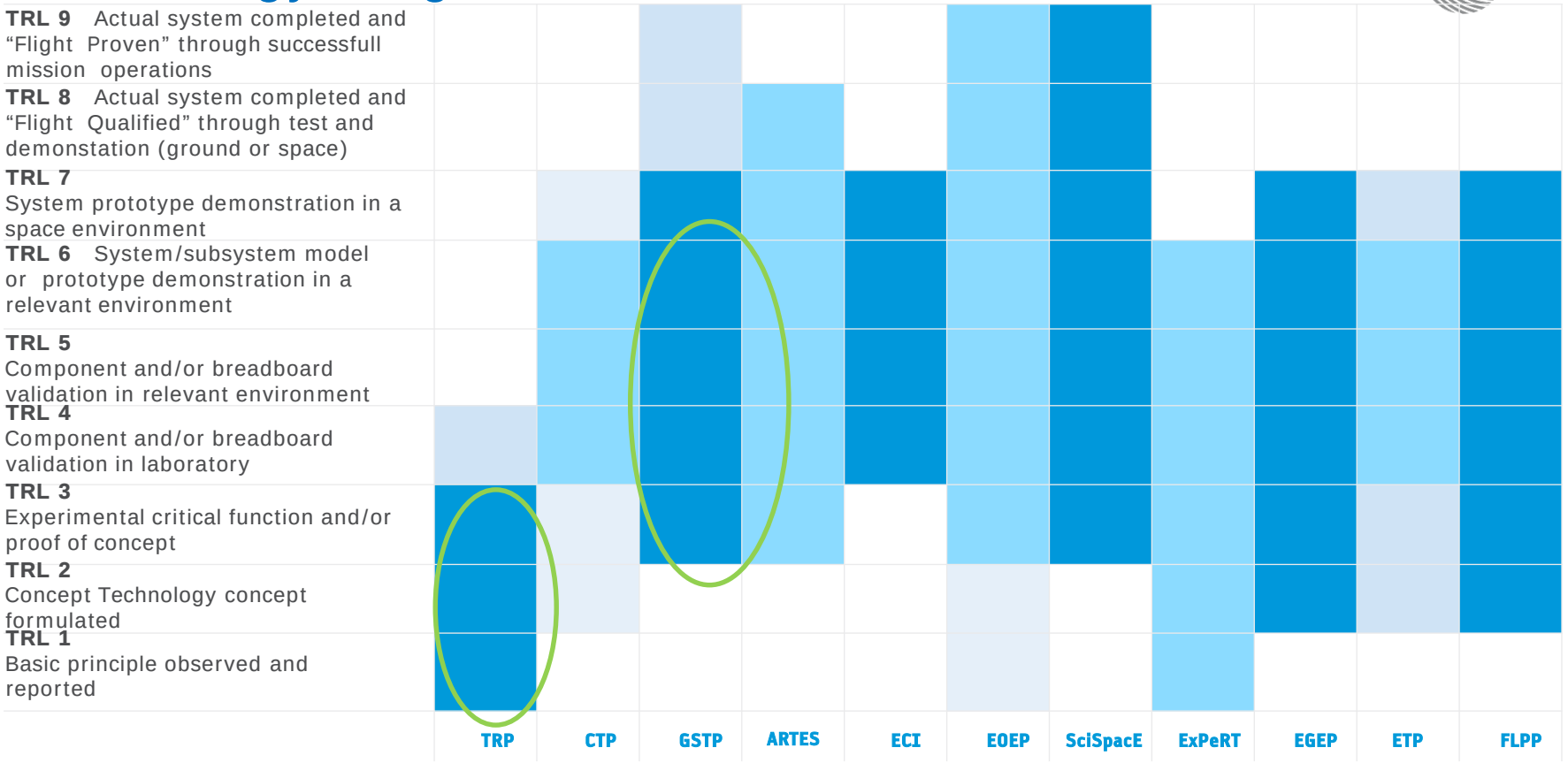
Advanced Research in Telecommunication Systems (ARTES)

European GNSS Evolution Programme (EGEP) and Navigation innovation and Support Programme (NAVISP)

Future Launchers Preparatory Programme (FLPP)

Robotic Exploration (ETP), European Exploration Envelope Programme (E3P) with Science in Space Environment (SciSpacE) and Exploration Preparation, Research and Technology (ExPeRT)

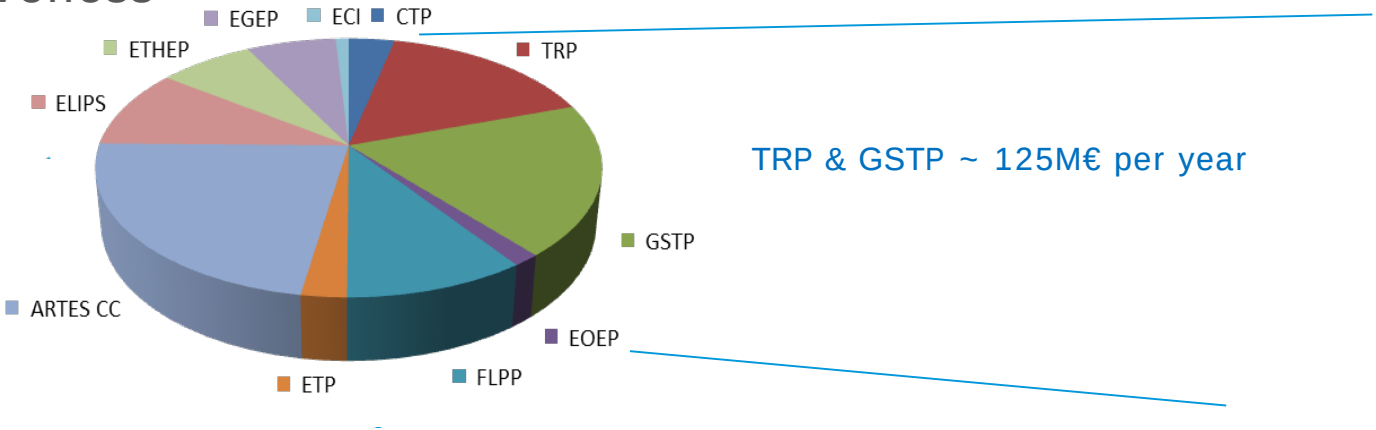
Technology Programmes: TRLs



European Space Technology Budget

European Space Institutional Technology R&D average yearly budget of over **740M€**

~ 400 M€ ESA funding/year in ESA technology development lines help prepare over **4B€** of investments in missions / launchers / space infrastructures developments and for European industry's competitiveness



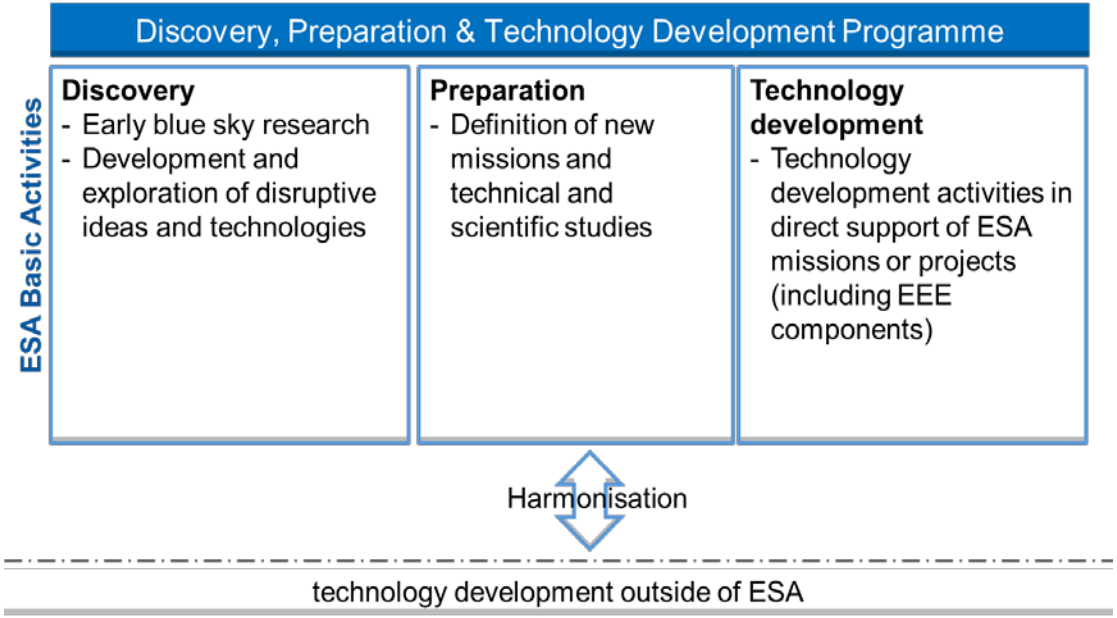
TRP & GSTP ~ 125M€ per year

Discovery, Preparation & Technology Development

The **Technology Development Element (TDE)** is work-plan based and is the new name for the Technology Research Programme (TRP)

The current TDE work plan is being implemented until mid 2019.

The new TDE work plan is under preparation for 2019-20

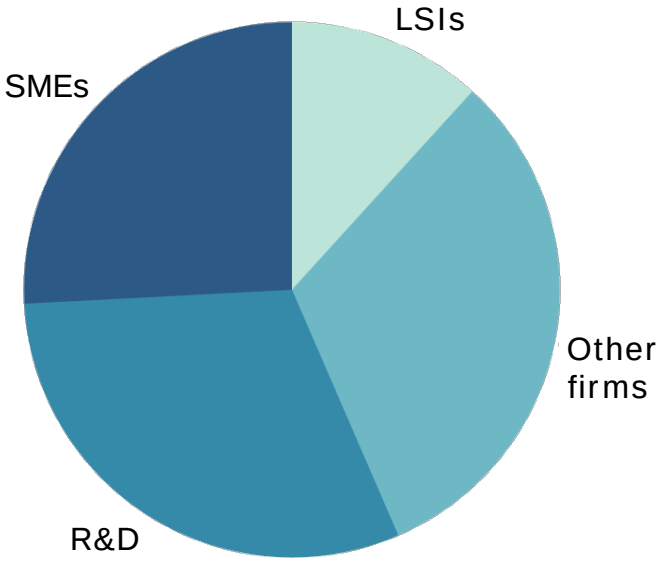


Technology Development Element - TDE (ex. TRP)

Part of ESA Mandatory Programmes

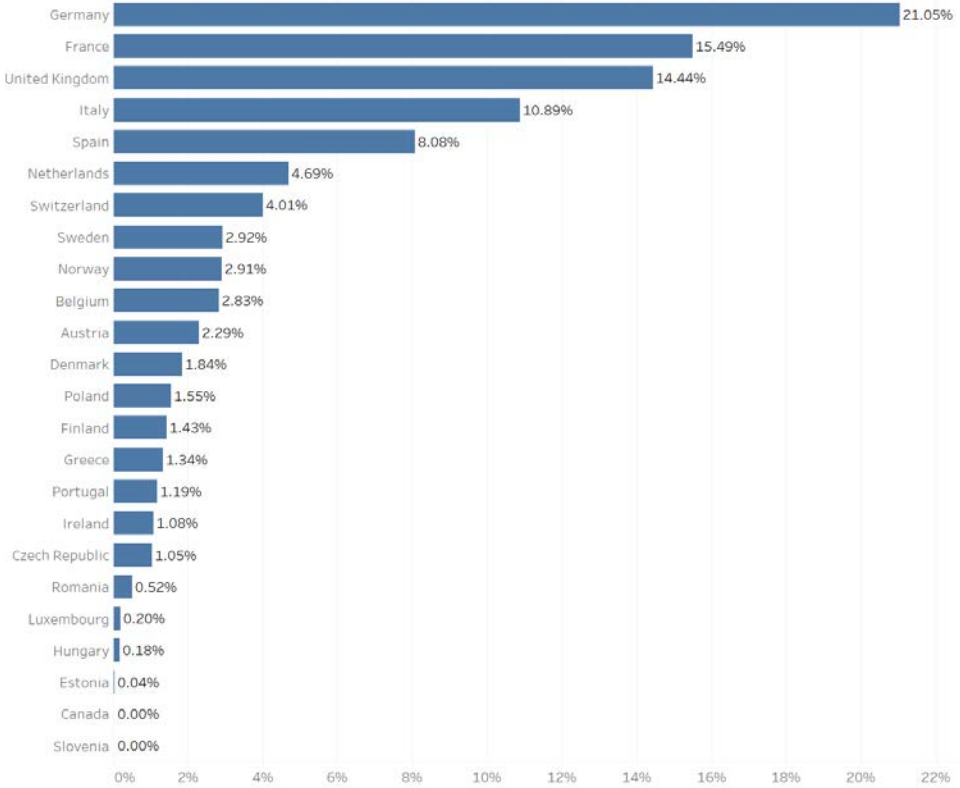
- Covering all technology disciplines & applications
- Based on two-year Work Plans, with yearly updates
  - 2019-20 Work Plan in preparation

- 461 TDE activities closed since 2016
- 115 M€ TDE activities contracted since the start of 2016



Countries participating in TRP activities

Activities Country Distribution (2013 to 2018)



Current TRP workplan

Order of 150-200 activities, representing over 80 MEuros

Invitations to tender for each activity are published throughout the year (see emits.esa.int)

TRP WORK/PROCUREMENT PLAN 2017
List of Activities

ESA/IPC(201
Annex I, Page 5 of

3 - Exploration

3 - 01 - Communications

Approval	Programme Reference	Activity Title	Budget (k€)			PP	Cty	SW Clause Applicability	Remarks
			2016	2017	2018				
IPC	T307-501EE	X-band Multi-Beam Electronically Steerable Antenna for Deep Space Habitat		650		C		N/A	
IPC	T307-502EE	Ka band multibeam reconfigurable phased array antenna for future exploration missions		650		C		N/A	
		TOTAL 3 - 01 - Communications		**1300**					

3 - 02 - Ground segment and operations

Approval	Programme Reference	Activity Title	Budget (k€)			PP	Cty	SW Clause Applicability	Remarks
			2016	2017	2018				
IPC	T305-502EC	GNC preliminary design for rendezvous and docking in NRO orbits around the Moon		500		C		Operational S/W	
	T306-501ET	Very high data rate receiver for the Earth-Space link in the 22 GHz frequency for future moon exploration missions		350		C(2)		N/A	
IPC	T312-501GS	Redesign of the ESA Deep Space Antennas feed system to support future Moon missions		500		C(1)		N/A	
		TOTAL 3 - 02 - Ground segment and operations		**1350**					

ESA/IPC(2017)3
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TRP WORK/PROCUREMENT PLAN 2017
Activity Description

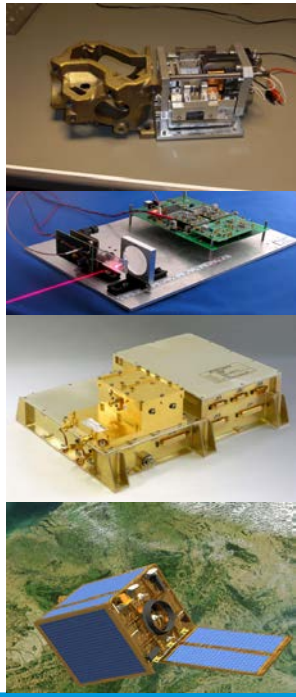
3 - Exploration

3 - 02 - Ground segment and operations

Programme Reference	T305-502EC				**TD**	05	
Activity Title							
GNC preliminary design for rendezvous and docking in NRO orbits around the Moon							
Objectives							
To design and prototype the GNC system for rendezvous and docking in Near Rectilinear Orbits (NRO) around the Moon.							
Description							
The ISS Exploration Capabilities Study (IECS) is a joint study undertaken by ESA in cooperation with the 4 other ISS partners: NASA, JAXA, Rosscosmos, and CSA. In the IECS study, the human exploration programme for the period 2021-2030 is addressed. In this study it is proposed that in the first half of the 2020(s), a joint programme could start by building a Cis-Lunar Transport Habitat (CTH) vehicle. The CTH will be placed on a NRO orbit around the Moon. Safety of underlying trajectories is critical for rendezvous to human-tended infrastructure. Hence the rendezvous trajectories are designed to ensure maximum safety and in particular safe free drift (passive safe trajectories). It is therefore important to understand the relative target-chaser dynamic in the three body problem of a NRO orbit. The emphasis is placed on the relative dynamics and the guidance part of the GNC system since the rendezvous is performed in a high elliptical orbit in the Earth-Moon 3-body problem. The design of the guidance algorithms shall include passively safe trajectories as well as active collision avoidance manoeuvres. Optimal guidance and control algorithms will include all constraints to provide a feasible solution in every control loop. The guidance and control algorithms are prototyped in reliable, space-qualified processors. Tasks to accomplish the objectives are as follows. - Requirements gathering and analysis: this comprises the mission scenarios analysis and extraction of requirements. This task covers an exhaustive system analysis study about rendezvous trajectory design considering safety requirements, GNC techniques and technologies, thus arriving at requirement specifications of a reference rendezvous scenario and GNC simulation tool. This task provides a preliminary design analysis of the overall rendezvous strategy including rendezvous trajectory design down to GNC level, including the definition of the simulation tool, leading the selection of the guidance and control algorithms. This tasks also includes the collision avoidance manoeuvres, hold points, safe spheres, retreat areas, etc. - Design: the guidance and control algorithms will be designed using analysis tools to assess the performances in nominal scenario considering the uncertainties (in particular from navigation chain). It comprises the design of a non-linear simulation tool covering as well GNC performance verification, robustness and benchmarking. - Preliminary development and implementation of the algorithms: The task is related to the development of the non-linear simulation tool, and coding and integration of the selected GNC algorithm(s) into the simulation tool. This task shall cover the full development of the simulation tool and the inclusion of the algorithms. The simulation tool permits the autocoding of the algorithms for real-time testing. - Demonstration of prototype to TRL 3. This task is devoted to the testing of GNC algorithms in the simulation tool and a prototype in a PIL system. The testing shall comprise a full 6DoF closed loop simulations, including trajectory safety, GNC performances, robustness verification and validation. MonteCarlo analysis shall be performed for the most relevant parameters of the flight of the vehicles and in particular to refine requirements on the navigation specifications. Guidance, and control algorithms shall be bench marked in a real-time Processor-In-the-Loop (PIL) testbench to achieve confidence in the design. - Synthesis: It contemplates the elaboration of a set of recommendation to the Agency for future work.							
Deliverables							
Other: Documentation, software, PIL prototyping							
Application/Need Date							
ESA Exploration Programme / 2018							
Duration (Months)	12	**Current TRL**	1	**Target TRL**	3	**SW Clause**	Operational S/W
Applicable THAG Roadmap	N/A					**Roadmap Consistent?**	not consistent

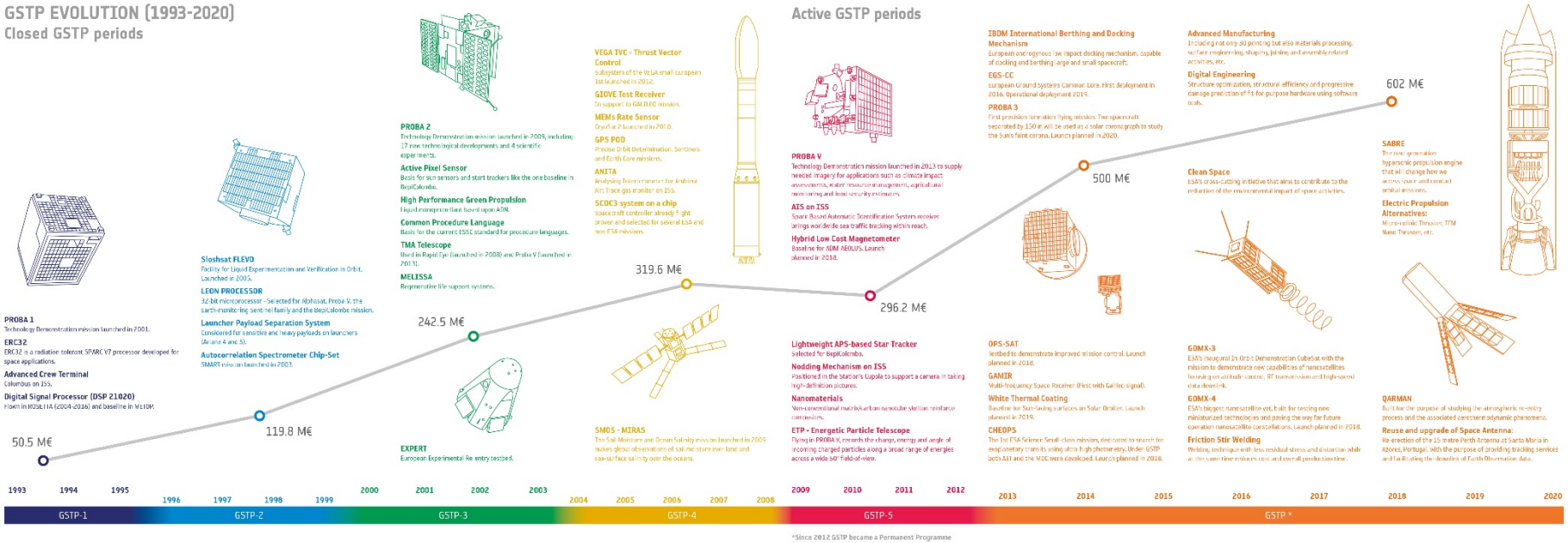
General Support Technology Programme

- Part of **ESA's Optional Programmes**
- All ESA Members (22), Cooperating (Canada) and Associated (Slovenia) States are participating.
- Each Participating State decides upon:
  - The amount of its participation.
  - The technological activities to support.
- Covering **all technology disciplines** and applications except Telecommunications (covered by ARTES)
- **Work Plans,** with yearly updates, and multiyear activities
- Latest Ministerial Council (CM16) ~ 450 M€ subscription
- **Average annual commitment** (industrial contracts) around **80 M€**. Further increase envisaged.



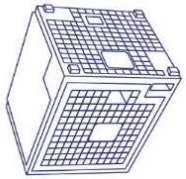
The GSTP ensures the right technology with the right maturity are available at the right time

GSTP Evolution– 25 Years Developing Technology



GSTP EVOLUTION (1993-2020)

Closed GSTP periods

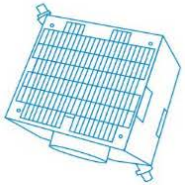


PROBA 1
Technology Demonstration mission launched in 2001.

ERC32
ERC32 is a radiation-tolerant SPARC V7 processor developed for space applications.

Advanced Crew Terminal
Columbus on ISS.

Digital Signal Processor (DSP 21020)
Flown in ROSETTA (2004-2016) and baseline in METOP.

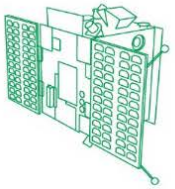


Sloshsat FLEVO
Facility for Liquid Experimentation and Verification in Orbit. Launched in 2005.

LEON PROCESSOR
32-bit microprocessor –Selected for Alphasat, Proba-V, the Earth-monitoring Sentinel family and the BepiColombo mission.

Launcher Payload Separation System
Considered for sensitive and heavy payloads on launchers (Ariane 4 and 5).

Autocorrelation Spectrometer Chip-Set
SMART mission launched in 2003.



PROBA 2
Technology Demonstration mission launched in 2009, including 17 new technological developments and 4 scientific experiments.

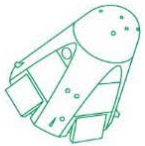
Active Pixel Sensor
Basis for sun sensors and start trackers like the one baseline in BepiColombo.

High Performance Green Propulsion
Liquid monopropellant based upon ADN.

Common Procedure Language
Basis for the current ESSC standard for procedure languages.

TMA Telescope
Used in Rapid Eye (launched in 2008) and Proba V (launched in 2013).

MELISSA
Regenerative life support systems.



EXPERT
European Experimental Re-entry testbed.

VEGA TVC - Thrust Vector Control
Subsystem of the VEGA small European 1st launched in 2012.

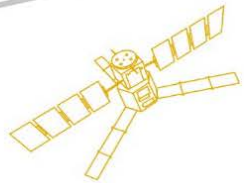
GIOVE Test Receiver
In support to GALILEO mission.

MEMs Rate Sensor
CryoSat 2 launched in 2010.

GPS POD
Precise Orbit Determination, Sentinels and Earth Care missions.

ANITA
Analysing Interferometer for Ambient Air: Trace gas monitor on ISS.

SCOC3 system on a chip
Spacecraft controller already flight proven and selected for several ESA and non-ESA missions.



SMOS - MIRAS
The Soil Moisture and Ocean Salinity mission launched in 2009 makes global observations of soil moisture over land and sea-surface salinity over the oceans.

50.5 M€

119.8 M€

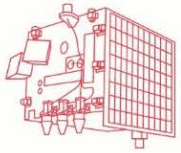
242.5 M€

319.6 M€

1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008

GSTP-1 GSTP-2 GSTP-3 GSTP-4

Active GSTP periods



PROBA V
Technology Demonstration mission launched in 2013 to supply needed imagery for applications such as climate impact assessments, water resource management, agricultural monitoring and food security estimates.

AIS on ISS
Space Based Automatic Identification System receiver brings worldwide sea traffic tracking within reach.

Hybrid Low Cost Magnetometer
Baseline for ADM-AEOLUS. Launch planned in 2018.

296.2 M€

Lightweight APS-based Star Tracker
Selected for BepiColombo.

Nodding Mechanism on ISS
Positioned in the Station's Cupola to support a camera in taking high-definition pictures.

Nanomaterials
Non-conventional matrix/carbon nanotube skelton reinforce composites.

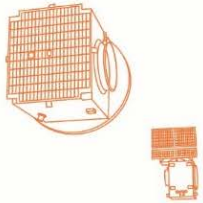
ETP - Energetic Particle Telescope
Flying in PROBA V, records the charge, energy and angle of incoming charged particles along a broad range of energies across a wide 50° field-of-view.

IBDM International Berthing and Docking Mechanism
European androgynous low impact docking mechanism, capable of docking and berthing large and small spacecraft.

EGS-CC
European Ground Systems Common Core. First deployment in 2016. Operational deployment 2019.

PROBA 3
First precision formation flying mission. Two spacecraft separated by 150 m will be used as a solar coronagraph to study the Sun's faint corona. Launch planned in 2020.

500 M€



OPS-SAT
Testbed to demonstrate improved mission control. Launch planned in 2018.

GAMIR
Multi-frequency Space Receiver (First with Galileo signal).

White Thermal Coating
Baseline for Sun-facing surfaces on Solar Orbiter. Launch planned in 2019.

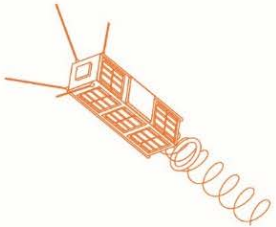
CHEOPS
The 1st ESA Science Small-class mission, dedicated to search for exoplanetary transits using ultra-high photometry. Under GSTP both AIT and the MOC were developed. Launch planned in 2018.

Advanced Manufacturing
Including not only 3D printing but also materials processing, surface engineering, shaping, joining and assembly related activities, etc.

Digital Engineering
Structure optimization, structural efficiency and progressive damage prediction of fit-for-purpose hardware using software tools.

602 M€

Clean Space
ESA's cross-cutting initiative that aims to contribute to the reduction of the environmental impact of space activities.



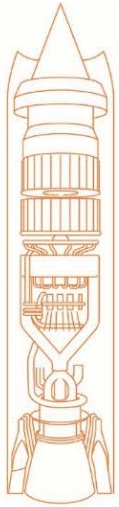
GOMX-3
ESA's inaugural In-Orbit Demonstration CubeSat with the mission to demonstrate new capabilities of nanosatellites focusing on attitude control, RF transmission and high-speed data downlink.

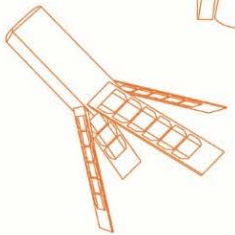
GOMX-4
ESA's biggest nanosatellite yet, built for testing new miniaturized technologies and paving the way for future operation nanosatellite constellations. Launch planned in 2018.

Friction Stir Welding
Welding technique with less residual stress and distortion while at the same time reduces cost and overall production time.

SABRE
The next generation hypersonic propulsion engine that will change how we access space and conduct orbital missions.

Electric Propulsion Alternatives:
Micro-colloid Thruster, IFM Nano Thruster, etc.





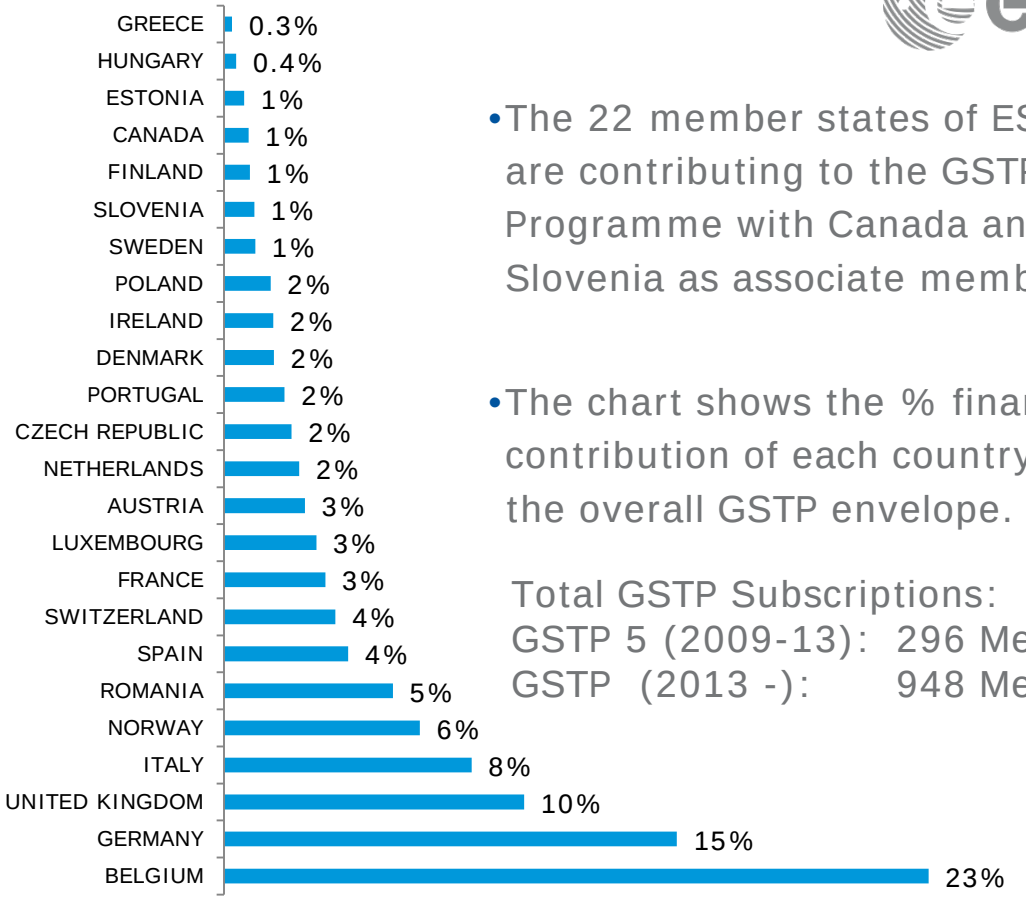
QARMAN
Built for the purpose of studying the atmospheric re-entry process and the associated aerothermodynamic phenomena.

Reuse and upgrade of Space Antenna:
Re-erection of the 15 metre Perth Antenna at Santa Maria in Azores, Portugal, with the purpose of providing tracking services and facilitating the downlink of Earth Observation data.

2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020

GSTP-5 | GSTP *

GSTP Participation



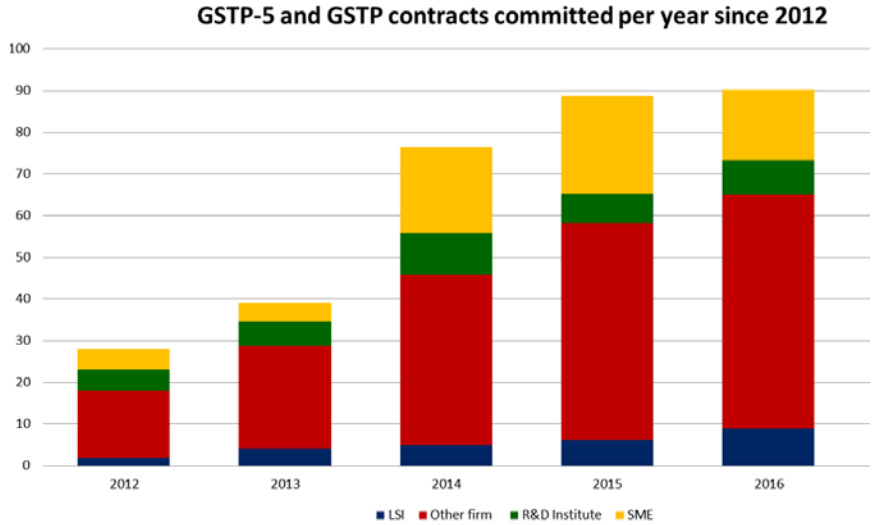
- The 22 member states of ESA are contributing to the GSTP Programme with Canada and Slovenia as associate members.

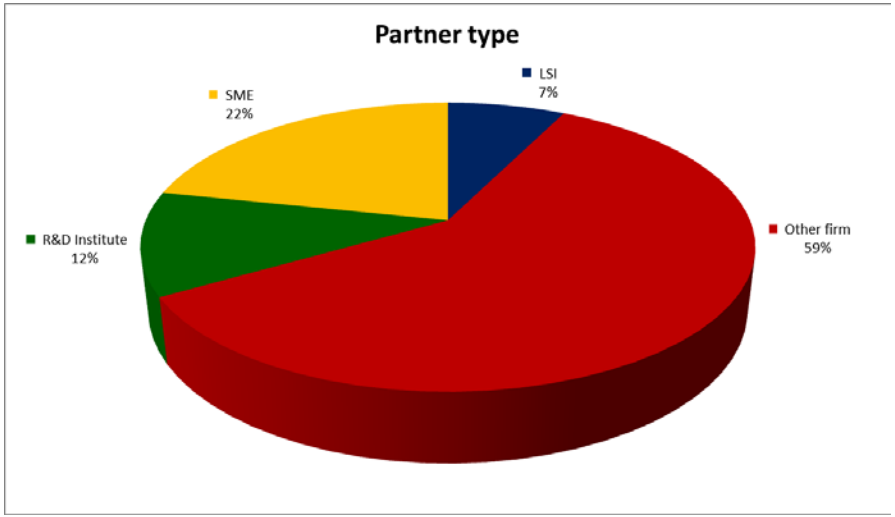
- The chart shows the % financial contribution of each country to the overall GSTP envelope.

Total GSTP Subscriptions:
GSTP 5 (2009-13): 296 Meuros
GSTP (2013 -): 948 Meuros

GSTP Contract Overview

- Between 2012 and 2017 Q3, GSTP activities for a total value of 360M€ were contracted.
- Between 2012 and 2017 Q3, an average of about 50 GSTP activities were closed each year.
- An average GSTP activity lasts for about 24 months and has a budget of 600K€.





* The values for Proba-3 and Proba-V GSTP activities are not included in the figures.

GSTP Elements Structure

ELEMENT 1

Develop

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

ELEMENT 2

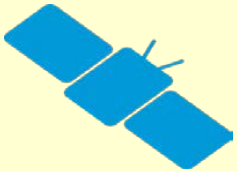
Make

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

ELEMENT 3

Fly (Small Missions)

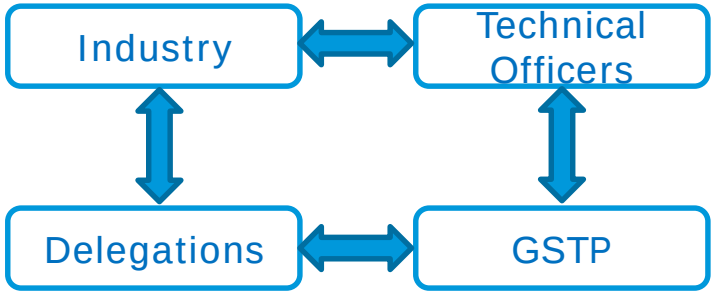
Envelope which hosts components such as Proba 3, cubesats, ISS payloads, technology flight opportunities



Activities require **Letter(s) of Support(s)** from interested / relevant GSTP Participating States

GSTP Element 1 "Develop": **Work Plan**

Communication Loop

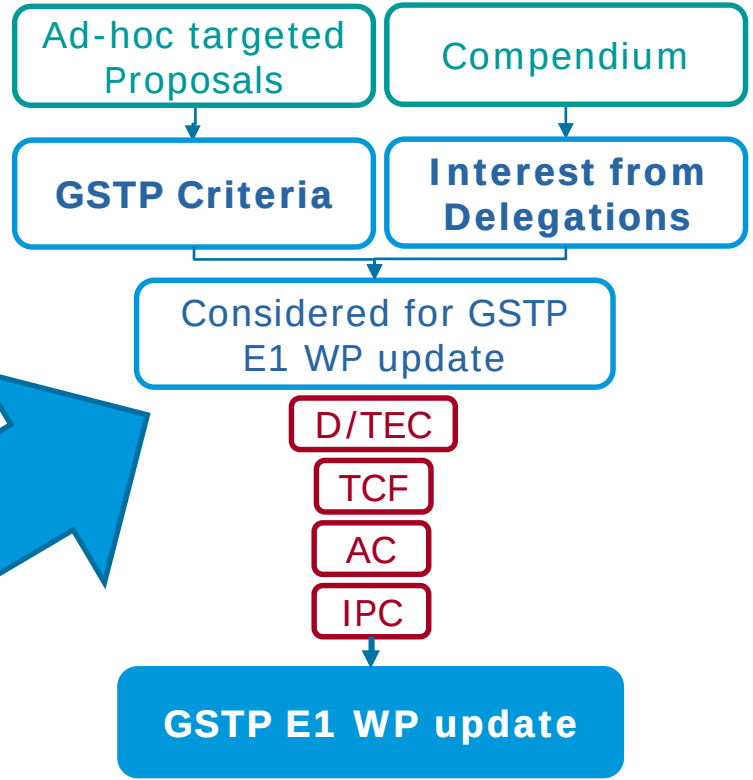


When interest from industry on activities is expressed, they shall be brought to the attention of the GSTP Management.

First screening will be done by the GSTP.

If pre-selected, activity will be included in the GSTP E1 WP update that needs the endorsement/approval of D/TEC and internal and external committees.

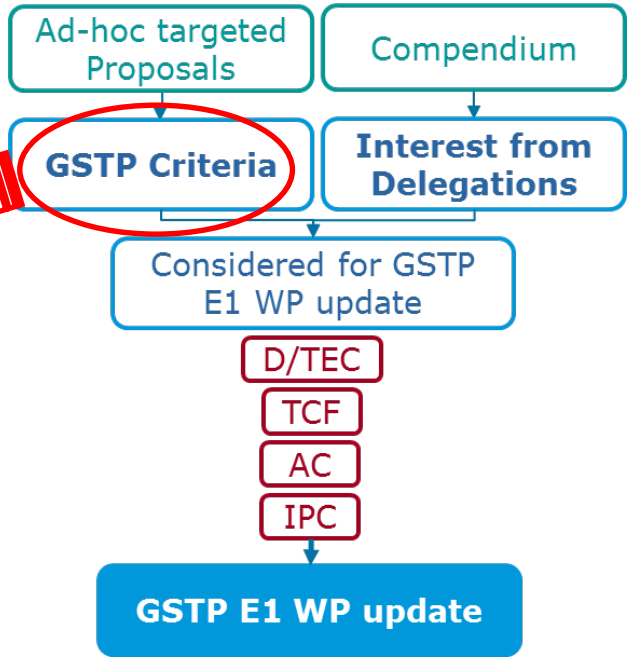
Proposal GSTP E1 WP update



GSTP Element 1 "Develop": **Work Plan**

GSTP Criteria

- Programmatic (fit with the objectives of the programme)
  - TRLs
  - Application Domain
  - Consistency of scope/deliverables/TRLs
  - Duplication in other programmes?
- Continuation of previous activities (TRP, GSTP… ESA prog.)
- Innovation? Competitiveness? Enabling mission?
- Industrial sustainability / Capacity Building
- National Strategy
- Interest from Delegations + Funds Availability



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": **Compendia**

GSTP E1 "Develop": **Compendium 2017**

Design to Produce

Programme Reference	Activity Title	Budget (k€)
GT1P-001MX	Procedure viewer and authoring tool for ground AIV/AIT applications	1,200
GT1P-002SW	Optimization by Digital Engineering applied in Projects	800
GT1P-003SY	Exploring Enhanced Procurement in a Fully Digital Environment	700
GT1P-004ED	Improvement of design and product, based on analysis of data from embedded sensors	1,500
GT1P-005ED	Embedded Sensors for AIT	800
GT1P-006SY	Digital Engineering Hub Pathfinder (CD09)	800
GT1P-007MX	Multidisciplinary 3D Digital Models for AIT environment	700
	Total	**6,500**

Ref. Number: GT11-012GS **Budget (k€):** 500

Title: **Tri-band (S/X/K) feed system design for future EO missions**

Objectives: The objective of the activity is so far EO missions have been operated in S-Band (TT&C) and in X-Band (payload data). In the future TT&C services will migrate to X-Band and payload data will be transmitted in K-Band. The objective of this activity is to design a feed that will be able to operate in S/X/K-Band to cover running and upcoming EO missions.

Description: The layout of the 14m X/K-Band antenna developed under a previous GSTP activity will be used as starting point to define the feed specifications. A trade-off among different feed configuration will be performed. After selection of the preferred solution the feed will be designed including diplexers/filters and tracking couplers. Mechanical drawings will be prepared and critical components will be manufactured and tested in order to de-risk the project.

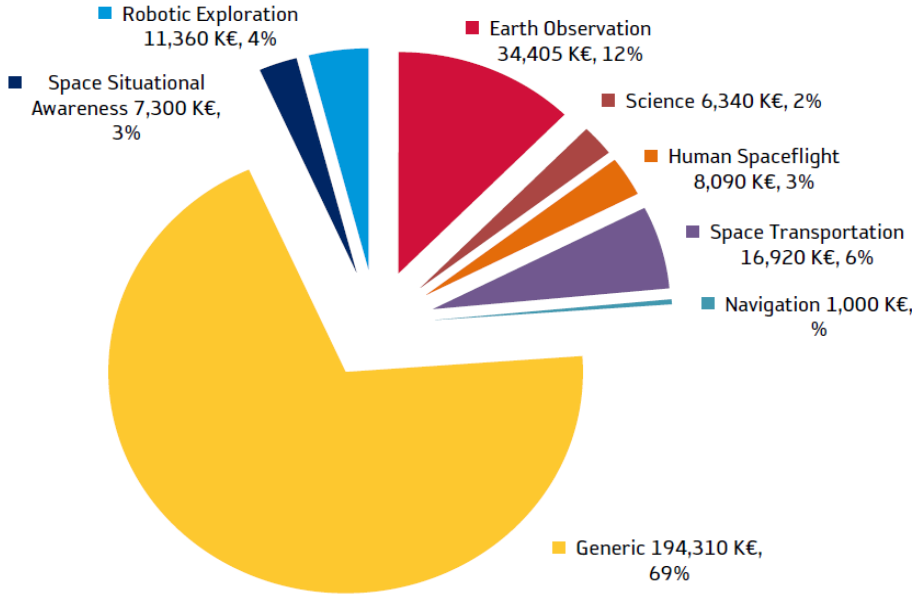
Deliverables: Breadboard

Current TRL: 3 **Target TRL:** 5 **Duration (months):** 18

Target Application/ Timeframe: All future Earth Observation missions.

Applicable THAG Roadmap: Ground Station Technology (2015).

GSTP Element 1 “Develop”: **Activities in the Workplan**



Domains	Number of activities	Budget (k€)	Budget share
Earth Observation	29	34,405	12.3%
Science	5	6,340	2.3%
Human Spaceflight	12	8,090	2.9%
Space Transportation	10	16,920	6.0%
Navigation	1	1,000	0.4%
Generic			
Advanced Manufacturing	16	19,900	7.1%
AIM	7	3,400	1.2%
Clean Space	28	18,396	6.6%
EGS-CC	1	1,433	0.5%
Generic	189	128,781	46.0%
Sabre	4	22,000	7.9%
SAVOIR	1	400	0.1%
Space Situational Awareness	5	7,300	2.6%
Robotic Exploration	8	11,360	4.1%
Grand Total	316	279,725	100%

Table 1: Distribution of GSTP Element 1 DEVELOP activities by Domain

GSTP Element 1 – Develop:
Proposal Preparation for typical workplan activities

Activities are published on EMITS / ESA-STAR:

- Intended Invitations to Tender for upcoming activities
- Invitations to Tender for activities

Typical content of proposal:

- Cover letter
- Declaration of Compliance and Key Acceptance Factors,
- Technical proposal,
- Management & Administrative proposal,
- Implementation proposal,
- Financial proposal and
- Contractual proposal

GSTP Element 1 - Develop:
Proposal Preparation for typical workplan activities

Evaluation Criteria:

1. Background and experience of the company (ies) and staff (including adequacy of proposed facilities)
2. Understanding of the requirements and objectives and discussion of problem areas
3. Quality and suitability of proposed programme of work; adequacy of engineering approach
4. Adequacy of management, costing and planning for the execution of the work
5. Compliance with administrative tender conditions and acceptance of contract conditions

GSTP Element 1 - Develop : **Frameworks**

Typically, activities are approved at a committee in the GSTP workplan updates

- 5 IPCs per year, preparation ongoing for the November IPC
- Roughly 10-25 activities per update

Frameworks were recently introduced to enable the faster implementation of specific types of activities

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**

G61A-036QT, Assessing the use of Advanced Manufacturing to improve and expand space hardware capabilities

- 5 MEuro framework (already approved at IPC)
- Maximum 250 KEuro per activity, expected activity duration: 12 months
- Tasks
  - Impact analysis of the use of advanced manufacturing to improve the existing product portfolio or to expand it
  - Selection of a few potential product improvement or expansion opportunities
  - Preliminary design and breadboarding (including testing) to verify and validate analysis for selected opportunities
  - Review of the impact analysis and preparation of a development and qualification plan
- 9 contracts placed in Germany, Austria and Slovenia in 2017 for 2.3 Meuro
- ESA Procurement time: 4 months
- Output expected in Q4 of 2018

GSTP Element 1 - Develop : **Frameworks**

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

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

- Activities include at least one of the following tasks:
  - Analysis of specifications, assessment of development actions, schedule and cost
  - Assessment of the benefits (performance, cost, lead time, risks…) and disadvantages of the potential solution with respect to the state-of-the-art
  - Assessment of potential critical issues related to using a given technology for a specific application, using analysis/simulation and/or breadboarding and testing
- <200 K€ (<80 K€ for studies) / Duration maximum 9 months

- 32 activities initiated in 2017 for 5 M€ in 6 countries / 23 contract placed
- ESA procurement time: 3-4 months

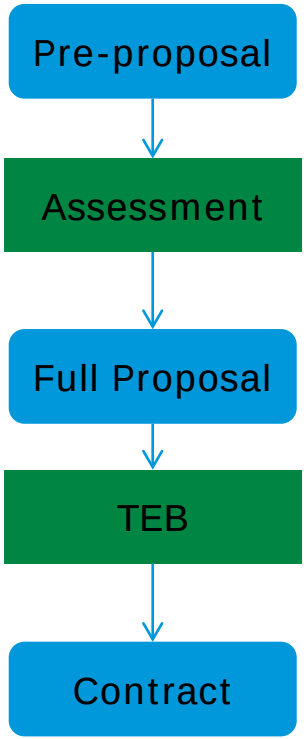
GSTP Element 1 Framework Activities:
Assessments to prepare and de-risk technology developments

Frame Activity:

- Framework approved in Work Plan
- Individual activities in framework do not need IPC approval

Successful De-Risk activity ➔ Potential follow-on with **detailed and reliable** development plan (cost, tasks, schedule…) ➔ better definition of a Workplan activity, smoother procurement and implementation overall

GSTP Element 1 Framework Activities:
Assessments to prepare and de-risk technology developments



Pre-proposal consists of :

- Technical and Application Part (Application, technical objectives, engineering approach, technical feasibility/risks, technical implementation)
- Management Part (Background, Facilities, Organisation, Planning, Deliverables)
- Financial Part (Overall price, Detailed price breakdown, Cost for follow-on steps)

Full proposal builds on the pre-proposal

- Provision of more detailed information and formal proposal elements (e.g. PSS forms)

GSTP Element 1 - Develop : **Frameworks**

GT17-136TI, Activities to bridge national technology developments

- Framework approved at the February 2018 IPC
- Streamline the transition from a national programme to the GSTP
  - accelerate/facilitate ESA procurement perspectives (timeliness, continuity…)
  - Provide technical/programmatic advice to ensure quality of national R&D activity output and allow for a clear starting point and activity plan for an ESA activity

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

- Framework approved at the April 2018 IPC
- targeted and coordinated development of capabilities in a given ESA Member State or across different Member States
- nominal technology development activities, with typical deliverables
- 8 MEuro envelope, with limit of 500 KEuro per activity
- Support received from 3 participating States (also interest from others)
- First procurements under preparation

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)

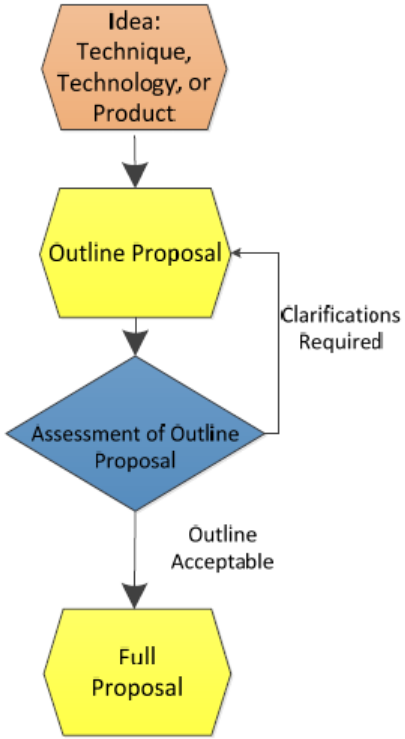
Funding schemes:

	SME	Non SME	Research Inst. & Universities
TRL <= 5	Up to 75%	Up to 75%	Up to 100% (<30% total)
TRL > 5	Up to 75%	Up to 50%	Up to 75%

Permanent call open in EMITS (AO7935)

90 activities now ongoing cover a broad range of products from component to systems level

GSTP Element 2 “Make”



An Outline Proposal shall describe the:

1. Product and Technology, 2. Business Opportunity, 3. Target Users/Customers, 4. Market Potential, 5. Competition

6. Financial Indicators (Project Costs, Product Cost/Price, Revenues/Profits, 7. Value Chain, 8. Market Introduction Plan

9. Activities (technical work, deliverables…)

The following content for a Full Proposal

A. Cover Letter

B. Executive Summary

C. Business Plan

D. Technical Proposal

E. Management and Administrative Proposal

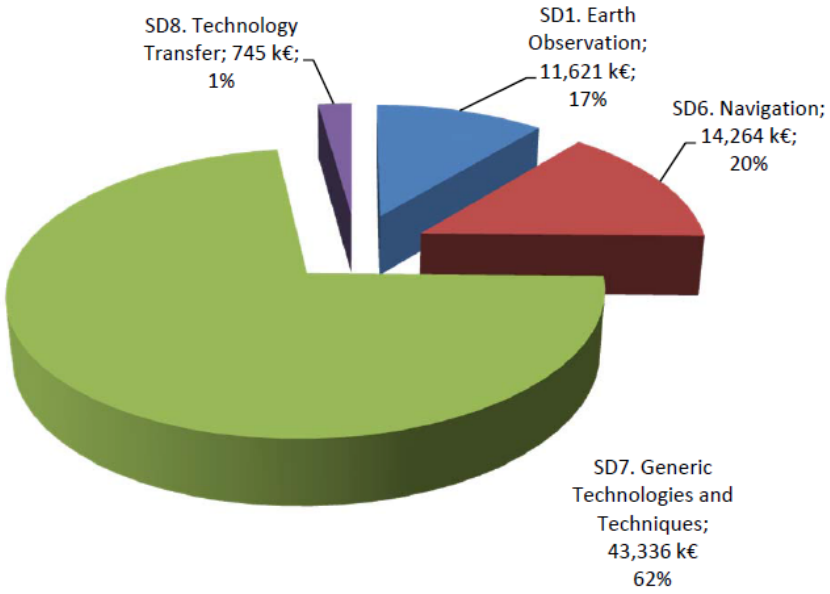
F. Implementation Proposal

G. Financial Proposal

GSTP E2 “Make”: Status of activities

Service Domains	Activities & Proposals (Active Portfolio) [1]	ESA Budget (k€)
1. Earth Observation	10	11,621
6. Navigation	13	14,264
7. Generic Technologies and Techniques	66	43,336
8. Technology transfer	2	745
Grand Total	**91**	**69,966**

Table 1: Distribution of GSTP Element 2 “Make” Active Portfolio by Service Domain



GSTP Element 3 “Fly”

- In-orbit Demonstration of technologies and products
- Target TRL is **7-8** (FM is qualified and integrated in the final system ready for flight)
- Essential for products requiring **flight heritage** for commercial customers
- Development and consolidation of capabilities in Member States
- Does **not** include technology development (shall be Element 1)
- Flight **opportunities** are identified with ESA projects and launchers, with National agencies and with primes, and with commercial missions.
- Framework (accommodation studies): instrument developments, technology maturation

GSTP Element 3 “Fly”

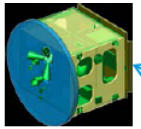
Subject	Number of awarded activities
Missions studies	8
Platform Demonstration Missions	7
Payload Demonstration Missions	2
Operations Demonstrators	1

Examples of ongoing activities

- OPS-SAT
- GOMX-3 In-orbit Demonstration (IOD)
- GOMX-4B In-orbit Demonstration
- Cold gas propulsion system IOD
- VIRSI IOD
- Mission for IOD of small Hall Effect Thruster
- RadCube IOD mission implementation

GSTP: PROBA–3

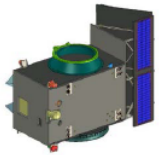
Occulter, 190 kg,
120 Mb/orbit, 50
m/s



Two satellites in HEO, *600x60000*
With inter-satellite links
relative NAV sensors, metrology
Two years lifetime

Payload:
coronagraph,
breadboard
Startiger

Formation flying:
Distance, resizing : 25 – 250 m
Position Precision < 1 mm



Coronagraph, 330 kg,
280 W, 9 Gb/orbit,
125 m/s

S-band

Autonomous
operation
Data collecti

Dissemination to users
experiment providers
Verification benches

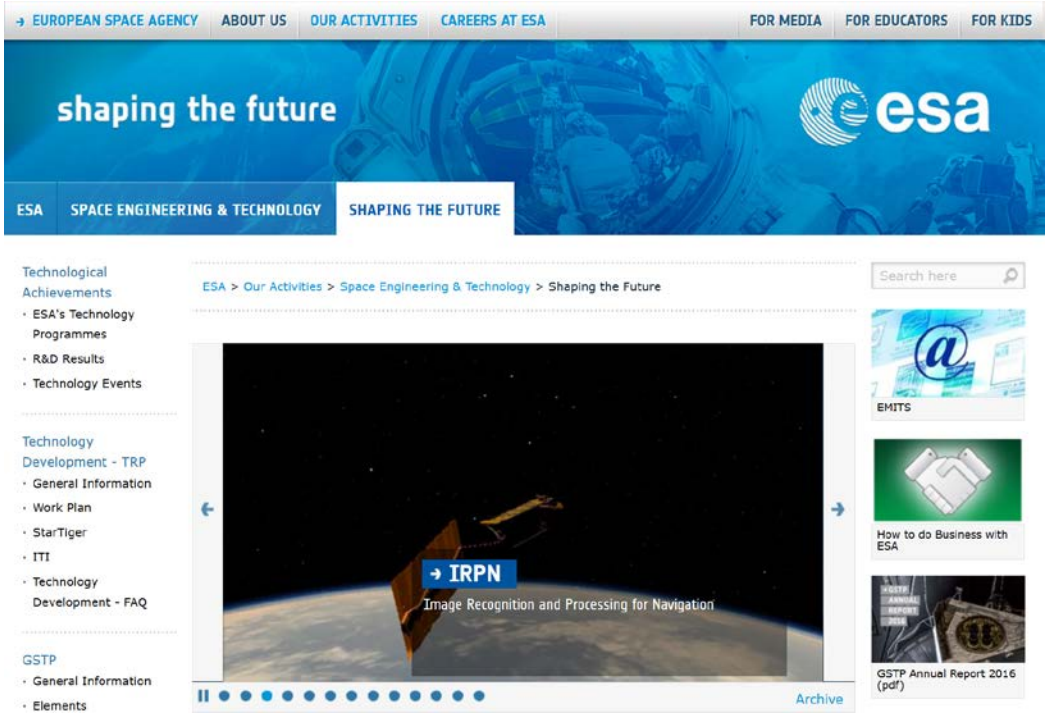
European Space Agency

Slovenian involvement in GSTP

Three activities are currently being procured or being executed:

G61A-036QT	Assessing the use of Advanced Manufacturing to improve and expand space hardware capabilities
GT1G-003SW	EGS-CC Bus Adaptation
GT17-121ED	Space Rated Microcontroller Softcore Product Development

ESA External website: Shaping the future



General information on the TRP and the GSTP programmes

Main achievements within technology programmes

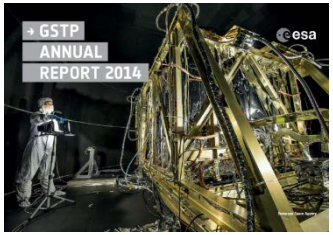
Contacts with the Team

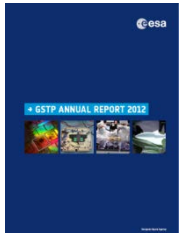
http://www.esa.int/Our_Activities/Space_Engineering_Technology/Shaping_the_Future

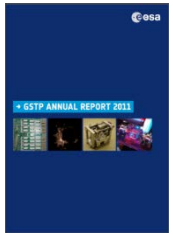
GSTP on the ESA web pages

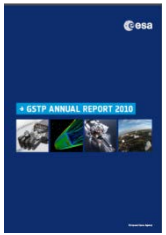
GSTP annual reports available on-line:

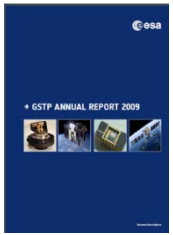
https://esamultimedia.esa.int/docs/GSTP/GSTPAnnualReport2016.pdf











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.

The last Space Engineering & Technology Final Presentation Days were held in June 2018 (ESA/ESTEC)

The next SET-FPD event is scheduled for November 2018 with focus on Exploration related technologies

GSTP 25th Anniversary - 11th-12th October 2018

Hosted by Portuguese Space delegation (FCT) in The Pavilhão do Conhecimento, in Lisbon, GSTP Team will be pleasured to celebrate with you 25 year of growth and success in Fostering & Sustain European Technology development.

It will be a good opportunity to discuss together about:

- GSTP Technology impact on mission enabling, innovation, competitive, non-dependence
- Continuous improvements in cooperation among ESA industries
- Incentive to SMEs participation in GSTP through competitiveness and sustainability
- Technology Challenges of the future

GSTP 25 YEARS
General Support Technology Programme

Final notes…

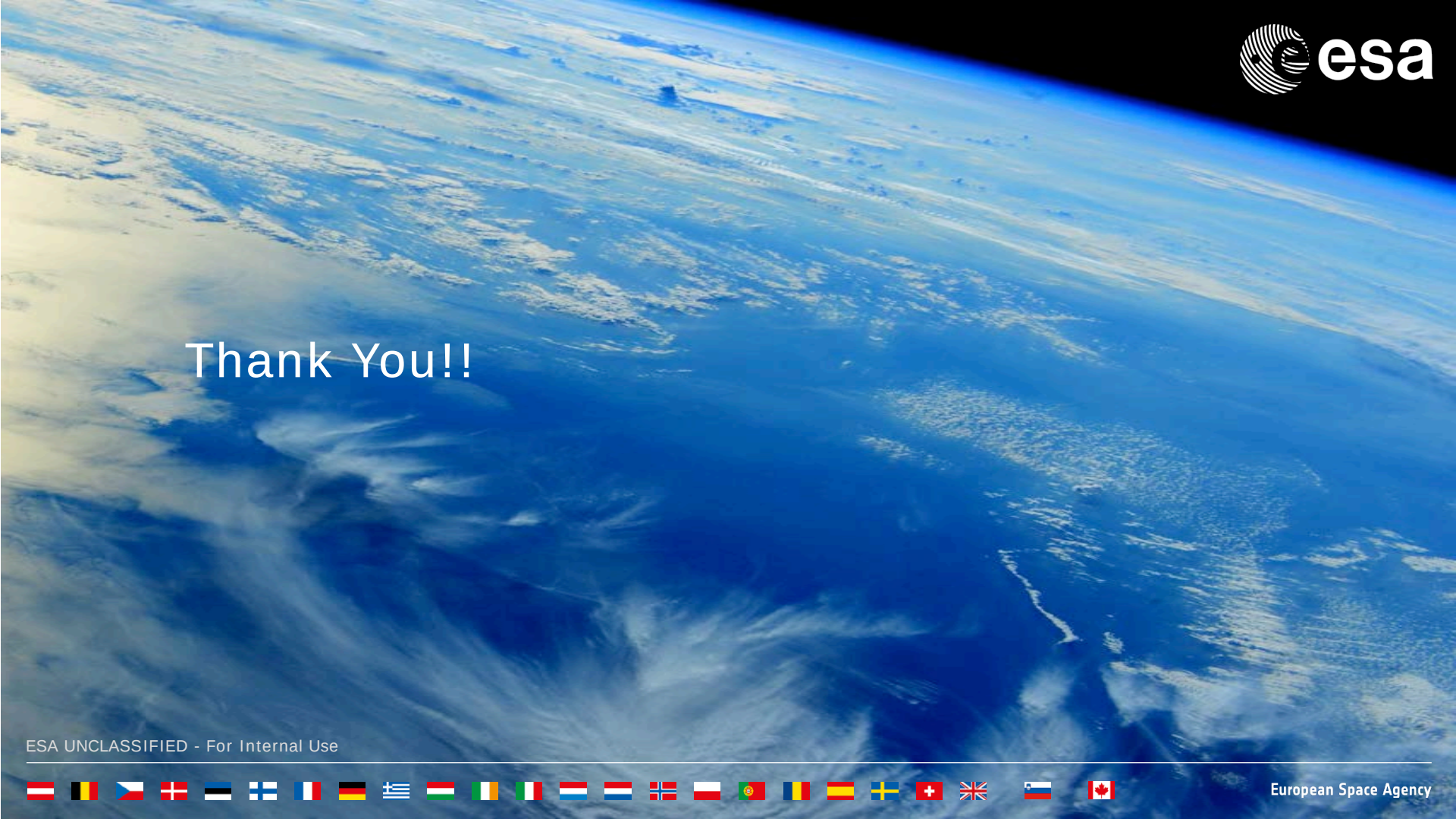
TDE WP 2019-2020 in preparation

GSTP Structure:

- Element 1:
  - 3 ‘Compendia’ of activity ideas are published for your consultation and for discussion
  - Workplan with over 400 activities (running/in procurement)
  - New framework activities:
    - E.g. Assessments to prepare and de-risk technology developments
- Element 2: Announcement for market oriented opportunities EMITS (AO7935)
- Element 3: In-orbit demonstration

GSTP Dissemination and promotion:

- Shaping the Future Website, GSTP Annual Reports
- Space Engineering & Technology Final Presentation Days
- GSTP 25 Years Event - Lisbon 9th-10th October 2018



LeoPCDU Evolution Engineering Model (EM) in the range <1kW for Earth Observation & Science

Contractor name: Airbus DS Crisa (ES)	Budget: 200 KEuro Duration: 15 months

Background and justification
This activity aims at extending the competitiveness of the already consolidated LeoPCDU product for missions in the range of < 1 kW, fully in line with the market requirement trends and the evolution observed in the products of our competitors. The idea behind this modularity is to get the optimum PCDU architecture from the recurrent cost, electrical, mechanical, and thermal behavior points of view, as well as an optimum and modular easy to manufacture concept, easy to repair in case of need

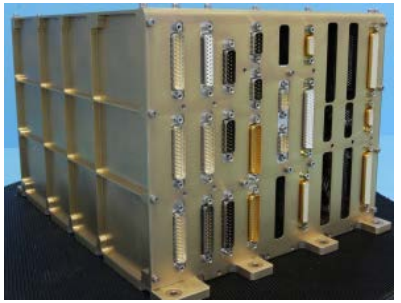
Objective
To develop a reduced version of a new Power Conditioning and Distribution Unit intended to serve the needs of spacecraft with power requirements in the range of ~500W to < 1 kW.

Achievements and status
An Engineering Model has been manufactured for design validation. The EM unit has been tested including E&F, ESD & EMC tests.

Benefits (vs expectation)
The results of this activity consolidate our position as PCDU supplier for low to medium power mission - 5 LeoPCDU-EVO.

Next steps
EM Thermal Test in reduced temperature range and PFM MAIT to complete the PCDU product qualification.

Initial TRL	Current /	Final	and / or Target TRL
2	5	5	9 (MERLIN mission by 2019)



LeoPCDU-EVO configuration

Module	Min.	Max.
DHS I/F	1	1
DET	1	2
BATT/MEA	1	2
DISTRIBUTION	0	6
DEPLOYMENT	0	2
TOTAL	3	13

Adaptive deformable mirrors for space instruments

Muenster Univ. of Applied Sciences (Germany)	Budget (830 kEuros incl. CCN) Duration (48 months incl. CCN)

Background and justification
As increasing needs for higher resolution for both Science and Earth Observation optical payloads demand larger primary mirrors, Active Optics constitutes an enabling technology for future large missions, correcting issues linked to manufacturing, integration, commissioning, thermo-elastic variations. The development of space-compatible deformable mirrors is a crucial building block of future active correction loops.

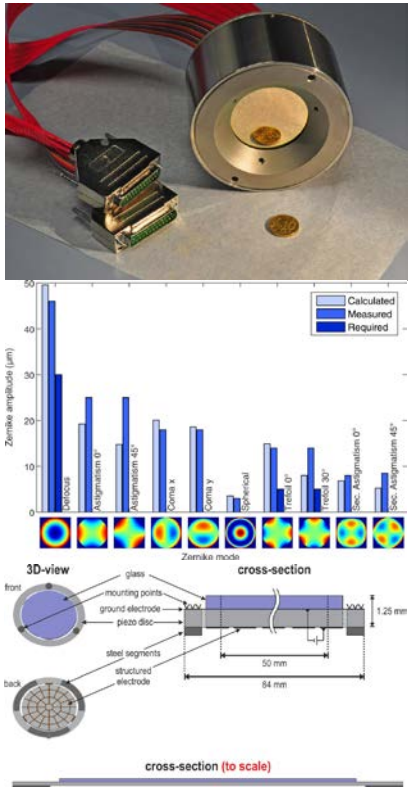
Objective
Develop a deformable mirror prototype for space instruments, able to correct typical aberrations introduced by space conditions (gravity release, thermo-elastic deformation, etc…) for future large aperture instruments, and potentially sustaining high power laser flux (for LIDAR applications).

Achievements and status
Within this activity, a deformable mirror design was successfully implemented, allowing a large and accurate wavefront correction range. Prototype tests demonstrated as well the robustness of the design to thermo-vacuum conditions (incl. cryogenic), radiations, laser flux and mechanical loads.

Benefits (vs expectation)
This deformable mirror constitutes an ideal candidate for a pupil-conjugate corrective element inside an active correction chain for a large primary mirror.

Next steps
A followup R&D activity aiming at further improving the maturity of the design (e.g. piezo material characterization, drift mitigation strategies, updated structural model) is currently under discussion.

Initial TRL	Current/	Final	and/or Target TRL
2	-	4	-



Advanced Particle Filters

NanoSpace (Sweden)	Budget: 400 + 400 (co-funded) keuro Duration 48 months

Background and justification

This project set out to develop a range of advanced particle filters suitable for satellite propulsion applications. The idea was to utilize the extremely precise manufacturing processes available from Micro-Electro-Mechanical System (MEMS) technology to manufacture ultra-precise particle filters with absolute rating between 2 and 20 micron.

Objectives

The objective was to develop a family of filters up to TRL-8 suitable for both high pressure gaseous feed systems as well as liquid propellant feed system using hydrazine, MON/NTO, and various “green propellants”.

Achievements and status

The outcome of this project was very successful in the sense that all filter variants increased their Technology Readiness Level (TRL) from the starting point.
One of the filter designs has even reach the first flight and is thus at TRL-8.
The most challenging application is in a chemical propulsion system for a typical telecommunication satellite in GEO. For this filter design TRL-5 was reached, but this development is continuing within ESAs Artes program and a fully qualified filter is expected to be ready in 2017.

Benefits (vs expectation)

This project has brought some new products to the market and others will follow after the next step. These are novel European, ITAR free products.

Next steps

Next step is finalise the development also for the very demanding telecom segment

Initial TRL	*Current/*	*Final*	*and/or Target TRL*
3	5-8	8