Test needs for Europe

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27/06/2024

A growing New Space sector requesting access to test

Presentation with focus on Propulsion Tests* but other domains are also at stake:

	Germany		France		Spain		Italy		Eastern EU		Northern EU		Small countries central EU	
Test area	Demand	Supply	Demand	Supply	Demand	Supply	Demand	Supply	Demand	Supply	Demand	Supply	Demand	Supply
Propulsion & stage testing	H	MH	H	LM	M	L	L	L	LM	L	LM	M	M	MH
General	L	L	L	M	LM	MH	L	LM	LM	L	L	L	M	MH
Mechanical	LM	H	L	L	LM	MH	L	LM	LM	L	L	L	M	MH
Structural integrity	LM	M	MH	M	M	L	L	LM	LM	LM	LM	M	M	M
Thermal	LM	M	M	LM	LM	MH	LM	M	LM	LM	LM	L	M	H
Electrical and radio-frequency	LM	H	LM	L	LM	M	LM	LM	L	L	L	L	M	MH

Note: Overview only considers publicly accessible test capacities; L = low testing demand/supply capacity, LM = low medium testing demand/supply capacity, M = medium testing demand/supply capacity, MH = medium high testing demand/supply capacity, H = high testing demand/supply capacity

Minor capacity gap | Medium capacity gap | Significant capacity gap

*Table from EC Study: Study on improving access to test facilities for EU new space transportation solutions

Gaps have been identified for:

- Propulsion Testing

- Electrical testing: (EMC, radiofrequency, passive intermodulation and multipaction testing)

- as well as acoustic testing for the environmental area.

Test facility landscape

Three key archetypes of test facilities in the EU

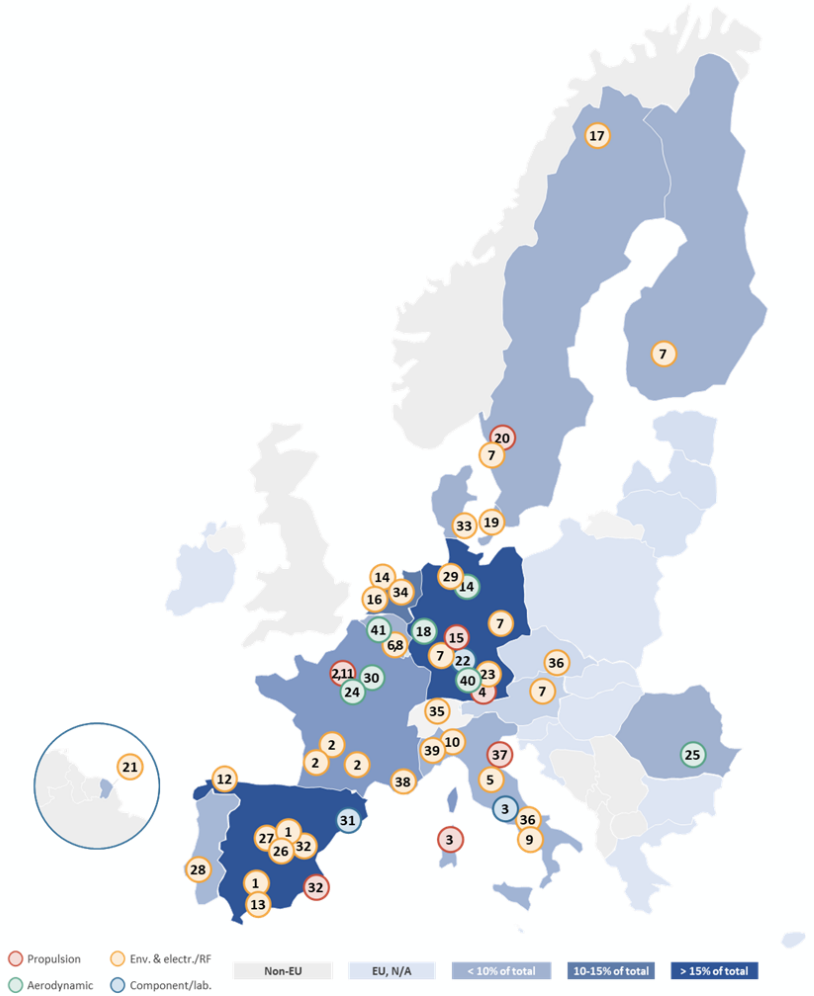
- Institutional: complex networks of accumulated public infrastructure
- Commercial: privately established centres and facilities
- Project-specific: facilities built up by demand-side players

Most facilities in the EU are publicly accessible

Majority of available facilities fall under the commercial archetype

Environmental testbenches lead all other types

ID	Test centre/facility	Archetype
1	ALTER	Commercial
2	ArianeGroup	Project-specific
3	Avio	Project-specific
4	Bayern-Chemie	Commercial
5	Beamide	Project/Comm.
6	BeBlue-Cryotech	Commercial
7	Beyond Gravity	Commercial
8	Centre Spatial de Liège	Inst./Comm.
9	CIRA	Inst./Comm.
10	Centrotecnica	Project/Comm.
11	CNES BAMOCRY	Inst./Comm.
12	CTA	Commercial
13	DEKRA	Commercial
14	DNW	Institutional
15	DLR	Institutional
16	ESA ESTEC / ETS	Institutional
17	Esrange	Commercial
18	European Transonic Windtunnel	Institutional
19	FORCE Technology	Commercial
20	GKN Aerospace	Project/Comm.
21	Guiana Space Centre	Institutional
22	HyImpulse	Project-specific
23	IABG	Commercial
24	ICARE	Institutional
25	INCAS	Inst./Comm.
26	Instituto Univ. de Microgravedad	Inst./Comm.
27	INTA	Inst./Comm.
28	ISQ	Commercial
29	Omnidea-RTG	Commercial
30	ONERA	Institutional
31	Pangea Aerospace	Project-specific
32	PLD Space	Project-specific
33	Poul la Cour Tunnel	Institutional
34	Royal Netherlands Aerospace Centre	Inst./Comm.
35	RUAG	Institutional
36	S.A.B. Aerospace	Commercial
37	T4i	Project-specific
38	Thales	Commercial
39	TÜV SÜD (Italy)	Project/Comm.
40	Universität Bundeswehr München	Institutional
41	von Karman Institute	Institutional



Propulsion test requests

The difficulty: a huge variety of test requests

Europe counts with a wide variety of liquid propulsion test benches covering an expansive range of configurations

Operating environment	Sea level conditions	Partial high altitude simulation conditions	Full high altitude simulation conditions	
Integration level	Component testing	Subsystem testing	System testing (full engine)	Stage testing
Propellants	Cryogenic benches	Semi-cryogenic benches	Non-cryogenic benches	
Pressure level	High-pressure fed benches	Low-pressure fed benches		

TYPE	SUBTYPE	OXIDIZER	REDUCER	COMPANY
Solid				CELESTIA AEROSPACE
				B2SPACE
				ORBIT BOY
Hybrid		LOX	HDPE	HYPRSPACE
		LOX	Paraffin	HYIMPULSE TECHNOLOGIES
		N2O	Paraffin	SPACE FOREST
Liquid	Cryogenic	LOX	LCH4	MAIA SPACE
		LOX	LCH4	SIRIUS SPACE SERVICES
		LOX	LCH4	ZERO 2 INFINITY
		LOX	LCH4	DARK SPACE
		LOX	LCH4	BLACK ARROW SPACE TECHNOLOGIES
		LOX	LCH4	THE EXPLORATION COMPANY
		LOX	LNG	PANGEA AEROSPACE
		LOX	LPG	OPUS AEROSPACE
		LOX	LPG	ORBEX
		LOX	LC3H8	ISAR AEROSPACE
	Semi-cryogenic	LOX	RP-1	ROCKET FACTORY AUGSBURG (RFA)
		LOX	RP-1	LATITUDE
		LOX	SAF	POLARIS RAUMFLUGZEUGE
		LOX	Kerosene	SIDEREUS SPACE DYNAMICS
		LOX	Kerosene	PLD SPACE
	Non-cryogenic	HTP	Kerosene	DAWN AEROSPACE
		HTP	Kerosene	THE EXPLORATION COMPANY
		HTP	Kerosene	SKYRORA

Propulsion test requests

The current need will evolve.

New Space
current need

***low* thrust**
F<200kN

For Low Earth Orbits

Current
Legacy
Engines

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high thrust
200< F< 1500kN

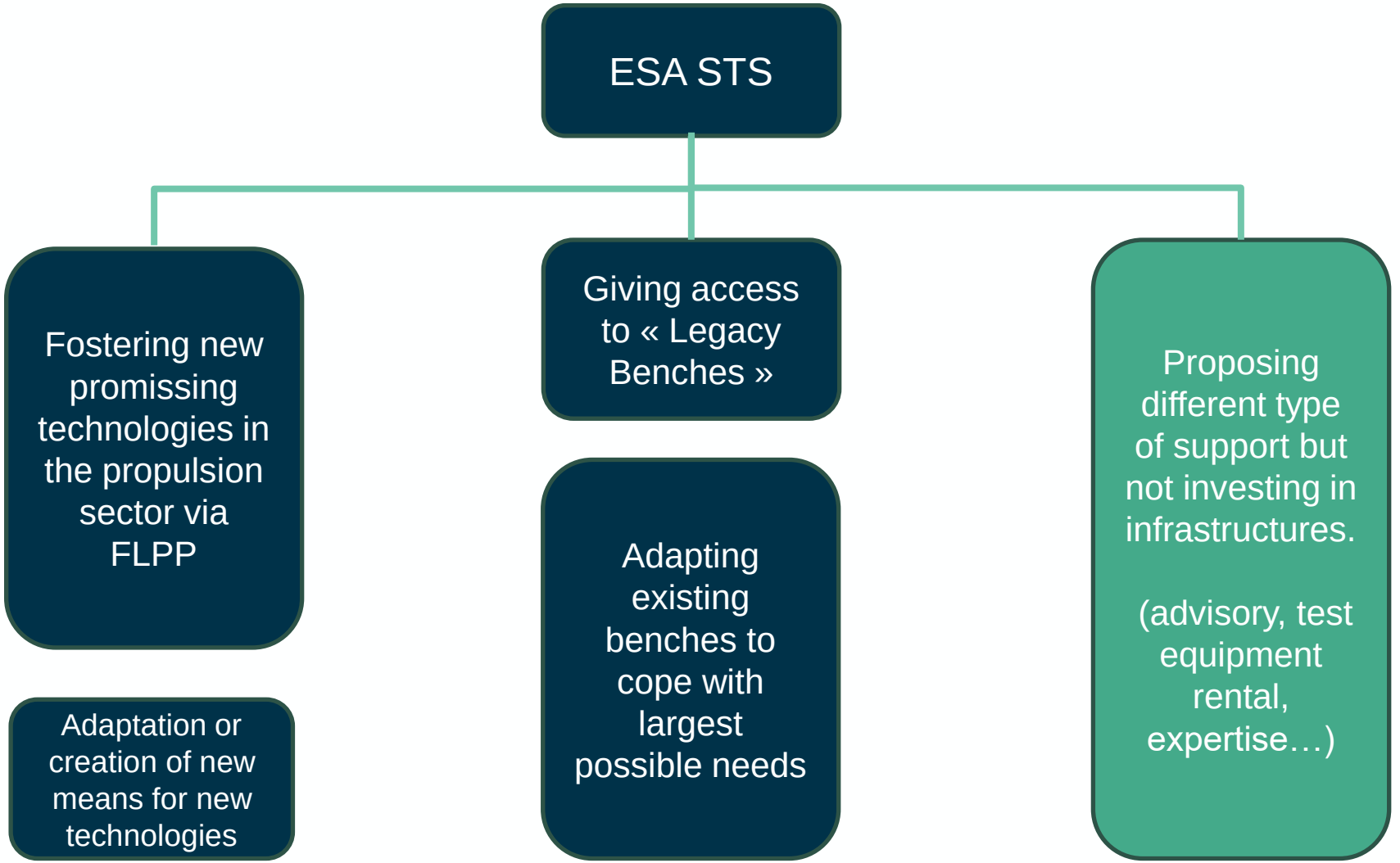
for A6 or Vega E

Future engines- Full Flow Staged Combustion

***Very* high thrust**
F > 1500kN

for interplanetary missions or large inspace infrastructures

Propulsion test requests – how to answer to the requests?



Propulsion test requests – how do we contribute to the answer to the requests – some supports ESA is preparing

Community	Animate a test bench operator community
Internet Page	on which you can find valuable data about test benches in Europe
Expert pool	for technical, safety and administrative matters
Equipment rental	Helping to run tests
Attractivity	Cost reduction, greening actions
Documentary Support	Propose downscaled standards for testing and qualification
Up to action 17	...