

PROPULSION SYSTEM TESTING CAPABILITIES AT TUM: EXISTING AND CURRENTLY IN DEVELOPMENT

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Abstract: With the growing importance of space for the societal and economic success of nations, the regional government of Bavaria mandated the Technical University of Munich (TUM) to strengthen its space activities. In this context and building on decades of experience and work performed at TUM in the field, the new Chair of Space Propulsion and Mobility was created. The Chair aims to strengthen its educational, research, and entrepreneurial work to actively bring innovation in the space ecosystem in Europe with its two pillars - numerical and experimental.

This paper presents testing infrastructure both existing and currently being developed at the Chair. The infrastructure allows the testing of full-scale propulsion systems for in-space applications as well as sub-scale testing of access-to-space propulsion systems. A hopper platform is also being developed for hardware-in-the-loop research and for in-flight testing. For in-space propulsion testing two-main test cells are available, one of which is depicted in Figure 1c. MoRaP is a mobile test cell for testing thrusters up to 500N. It is currently being modified to be used with hydrogen and oxygen in smaller thrust ranges. For subscale research of liquid rocket engines, the test cell GAR1.5, located at its premises in Garching, allows to test thrusters with up to 1.5 kN. It has been largely used for heat transfer investigation and testing of liquid oxygen and methane combustion chambers and cooling channels (Figure 1b). Cold flow characterisation of pumps and valves can be performed with the KonRaT test cell depicted in Figure 1a. Table 1 provides an overview of the test benches and their main characteristics.

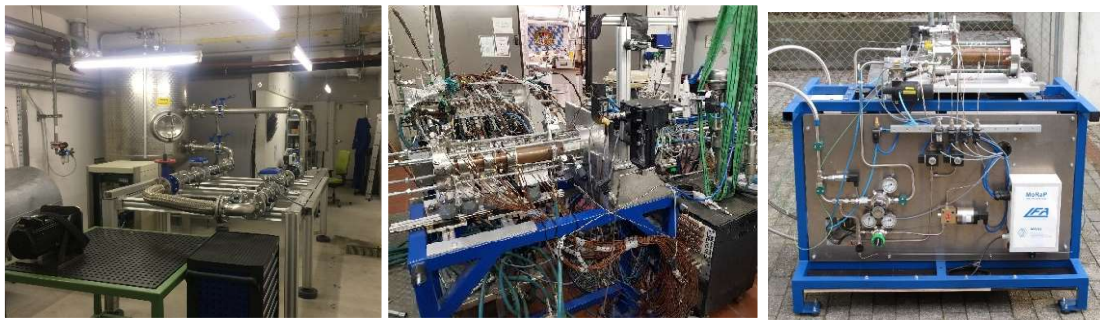


Figure 1: (a) KonRaT; (b) GAR1.5; (c) MoRaP

Table 1: Main Characteristics of TUM Testing Infrastructure for Space Propulsion and Mobility **Blue = in development, Green = operational**

	KonRaT	WEP	MoRaP	GAR1.5	OP40	CFS	AIReP
Hot/Cold Flow	cold	hot	hot	hot	hot	cold	Hot & cold
Application	Pump/valve characterisation	H2O-electrolysis propulsion	Teaching Mobile test platform	Ignition Heat transfer 3D printed components Cooling	Upperstage & lander propulsion	Injection characterisation & component oscillation	flight demonstration
Thrust	n.a.	<10N	<500N	1.5kN	<40 kN	n.a.	<10kN
Propellants	H2O	GOx, GH2	L/GOx, GCH4, GH2	L/GOx, GH2, GCH4	L/GOx, GH2, GCH4, C3H8	tbd	tbd
Pressure	Up to 10 bar	Up to 15 bar (CC)	Up to 20 bar (CC)	Up to 60 bar (CC)	Up to 80 bar (CC)	tbd	tbd