Mini-WRK Facility Description

The Mini-WRK (WeltRaumKammer, German for Space Chamber), also known as µWRK, is used for thermal vacuum testing of samples and smaller parts, including the testing of component functionality like heaters, actuators, or release mechanisms. Its main difference to our larger test facilities is the extended temperature range of [+350;-190] °C under vacuum or [+300;-180] °C under inert gas atmosphere. For short time, the upper service temperature may be increased to 400 °C.
Additionally, the test facility may be equipped with an induction heating system, allowing testing of small samples up to 1,350 °C.
Technical Key Properties shall be described in this Document:

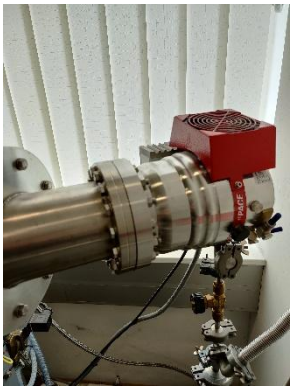
Chamber Setup

The µWRK is made of a barrel-type vacuum chamber with an inner diameter of 500 mm and a depth of 320 mm. The chamber is entirely made of stainless steel. A water-cooled shroud insert allows testing in an extended temperature range.

Vacuum Generation and Control

The vacuum system consists of the following key components:

a. Vacuum Generation



Rotary Vane Pump Pfeiffer Vacuum DUO20 M, capable of replicating the pressure drop of the ARIANE 5 launch profile; vacuum down to ~5x10^{-3} mbar.
Turbomolecular Pump Pfeiffer Vacuum HiPace 300, allowing an operational pressure down to ~10^{-6} mbar, depending on actual test configuration and device under test.

b. Vacuum Measurement and Pressure Control

Typical configurations are Pfeiffer Vacuum PKR251 full-range gauge for general testing, or an APR family (APR 250/260/280) piezo sensor for tests in various gas atmospheres and at pressure down to a few mbar.
The facility can be operated at a defined vacuum pressure, ranging from the 10^{-5}mbar range to ambient pressure, under defined gas atmosphere (air, inert gas, specific gas atmosphere such as Martian atmosphere). Corrosive atmosphere is currently not feasible.
Pressure is controlled by means of a Pfeiffer Vacuum EVR 116 electronically controlled dosing valve, and a bypass line to the vacuum pumping system.
The vacuum is measured and controlled by a Pfeiffer Vacuum RVC300 controller unit.

High vacuum sensors are cleaned in regular intervals by an AAC-internal procedure and then checked against an internal reference; a calibration will only be performed on special request by customer.

Heating / Cooling Systems

For heating of the samples, three different systems are available:

a. Process Plate – electrically heated and LN2 cooled

This set-up is commonly used for thermal cycling or thermal vacuum bake-out. It consists of a copper-made process plate with the following key features:

- Dimensions: 340x300 mm
  - For sample fixation, equipped with a 50x50mm grid of M5 threads
- Maximum temperature: 350 °C continuous, up to 400 °C short-term
- Minimum temperature -190 °C under vacuum, -180 °C under nitrogen gas
- Heating/Cooling Range up to 8 K/min
- Various copper shields for improved thermal homogeneity available
- Operation Modes:
  - Heating: Electrical, using the Eurotherm units and thyristor
  - Cooling: LN2 based, intermittent cooling by electrically operated valves

b. Inductive Heating System

For high temperatures and high heating rates, an induction-heating system IEW TTH8 G is available. Key features are:

- Heating Power: 6 kW
- Automatic optimisation of operation frequency for best possible performance
- Heating Rate and maximum temperature depending on test item; for small metallic samples with 10 mm diameter, up to 100K/second
- Non-metallic and non-conductive samples require susceptor tubes for indirect heating (susceptor, e.g. graphite or ODS-Pt/Rh) heated by induction, sample heated by radiation from the susceptor

c. Radiation Heating System

Specific test environments require radiation heating. The µWRK can been equipped with a highly versatile radiation heating system with the following key properties:

- Flexible system based on high performance OTS halogen radiators
- Power density: up to 100 kW/m^2
- Size and shape of heating area can be adjusted to customer specifications
- Testing under vacuum or under gas atmosphere feasible (not in the pressure range from ~0.05 to 5 mbar due to electric arcing)

Temperature Control and Temperature Measurement

The different heating methods as described before require thorough consideration of the most appropriate temperature measurement and control. Key factors are

- Expected maximum temperature
- Position of the temperature measurement

For all test environments, the temperature control is achieved by an Eurotherm 2416 PID controller, allowing multi-step temperature programming and control.
The temperature is usually measured by a Type K shielded thermocouple. For special test cases, pyrometers of various range and type available

For measuring the sample temperature:

- 16 Type K shielded thermocouples (0.5 mm Inconel)
- The Type K thermocouples are connected to the main control computer using Datexel DAT 3018 signal converters.
- The entire control loop (sensor/signal converter) is regularly calibrated according to AAC´s internal QA procedures.

Signal and Power Feedthroughs

For operating and measuring customer hardware inside the chamber, several signal and power feedthroughs, based on Sub-D connectors, are available. Key features are:

- 9, 15, or 25 pin type available
- Vacuum side: male connector
- Air side. Male connector
- Pins not crossed out (airside crossed-out cables available)

Additional Support Equipment

- For specific applications the measurement of electrical properties (e.g. electrical resistivity, voltage, current) is required. For this purpose, a Keithley 2700 Multimeter equipped with Keithley 7700 multiplexer is available. Up to 20 channels may be read out simultaneously. This device is also used to read the PT100 temperature sensors (if installed).
- For operating heaters, actuators, or other electrical component, several power supplies with various output power, voltage, and current are available.
- To assess the amount of material evaporated from the sample during the thermal vacuum test a TQCM (**T**emperature-controlled **Q**uartz **C**rystal **M**icrobalance) may be installed.
- For RGA analysis (**R**esidual **G**as **A**nalysis) a quadrupole mass spectrometer can be attached to the chamber.
- All devices listed above are controlled by PC. The TherESA software to control all devices and to record all parameters has been developed at AAC.

Table of Equipment

To summarise the information given above, Table 1 lists the equipment used at the WRK test rig. Additional equipment not exclusively used for the WRK is compiled in Table 2.

Table 1: List of equipment for WRK test rig

Equipment	Type	Ser.Nr	Remark
Rotary vane pump	Pfeiffer DUO 20 M	21205125	
Turbo pump	Pfeiffer HiPace 300	16854274	
Vacuum Controller	Pfeiffer RVC300	PF 100792	Controller for EVR116 valve and vacuum gauges
Vacuum control valve	Pfeiffer EVR 116	44236052	Electro-mechanical dosing valve
Vacuum gauge	Pfeiffer APR 280	44205597	Piezo transducer, 1-1,300 mbar
Vacuum gauge	Pfeiffer PKR 251	44443194	Full Range Gauge (combined Pirani and cold cathode/inv. magnetron
Induction Generator	IEW TTH8 G	2004 072	With adapting transformer for small coils / high current
Temperature Controller	Eurotherm 2416	FC1307003021	
Thermocouples	16 x Type K 0.5 mm dia shielded thermocouples	n/a	Manufacturer: ICCP, Austria

Table 2: List of additional equipment not permanently used for µWRK test rig

Equipment	Type	Serial Nr	Remark
Multimeter	Keithley 2700	4045974	with Keithley 7700 multiplexer
PT100 thermo-elements	OMEGA Thinfilm RTD Element F3105	n/a	Optional. Only on request.
TQCM Sensor Unit	BeamTec / McVac Inc. Twin Sensor Head Model MV-700-009S	n/a	6 MHz crystal
TQCM Controller	Colnatec EON-LT	20160812AAC	
RGA	ThermoScientific Smart IQ+	1703-01-182-3	Quadrupol mass spectrometer; range 0-200 amu
Calibration furnace	Ametek CTC-650 B RS232	620568-00905	

List of Consumables

The standard consumables are listed in Table 3 below. Other consumables may be used if agreed on between AAC and Customer.

Table 3: Permitted consumables in the WRK test rig

Consumable	Quality	Vendor / Article ID#
Cleaning fluids – General Use: • Acetone • Ethanol • 2-Propanol	 technical grade technical grade 99.5%	 W. Neuber's Enkel Roth Lactane VWR
Cleaning fluids – Sensitive Test Items: • 2-Propanol (mostly used) • Acetone • Ethanol • n-Pentane	 AnalaR NORMAPUR ACS/REAG.PE/REAG.USP IR grade TechniSolv reinst AnalaR NORMAPUR zur Analyse	 VWR Chemicals Roth Lactane VWR Chemicals VWR Chemicals
Cleaning Tissue: • Standard: White paper tissues • Optional: Cleanroom Wipers	 OTS non-linting	 Various suppliers VWR 115-0036
Mounting samples and thermo-sensors: • Kapton tape	ECSS-Q-ST-70-02C passed	RS-Components Art.-No. 436-2778
Purging / Venting: • Nitrogen (standard) • Argon (on request) • Carbon dioxide (on request)	 Grade 5.0, 99.999% from Tank Grade 5.0, 99.999% Grade 3.0, 99.9%	 Messer Austria
Thermal Shielding / Homogenisation: • Aluminium foil • Multi-layer isolation (T_m 150 °C)	 OTS MLI Coolcat 2	 Various suppliers RUAG Space Austria

Contact

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