

Third Facility TNA Periodic Report

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Version 1

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The two planned milestones in the reference period (from 7/2017 to 7/2018) have been fulfilled in due time. The WP4 has activated the two selection rounds of the TA1 program evaluating the proposals that have been submitted in the two relevant semesters. Indeed starting with the second semester as for decision of the AHEAD MGT the TA1 program has adopted an always-open call system with a fixed selection date scheme so that proposal can be submitted at any time. At the AHEAD MGT meeting held in Rome on March 2017, in order to introduce an additional element of flexibility in the access program and to cope with request coming from possible interested teams, it has been further decided to adopt a selection procedure that provide a fast (within about 1 month from the submission) reply to proponent teams. Finally taking into account one of the referee recommendation since June 2017 the TA1 program accommodate as valid access pure mentoring visits at the offered facility, namely visits that do not necessarily are followed by access to actual use of the facilities. All those changes have been implemented in order to ease the participation of the guest teams to the TA1 program.

Notwithstanding those improvements no proposal has been submitted during the 5th semester. In the meantime the project i) has implemented a wider dissemination of the call by a series of closer interaction with the Italian APRE (Agency for the Promotion of European Research) that has promoted the AHEAD TA1 call and ii) has stimulated a more proactive role of the facility teams. During the 6th semester covering the last period of AHEAD program two proposals have been submitted.

The two proposals are from a SME team, and from a research team, respectively. Both proposals have been submitted in the last week of June 2017. The proposals have been promptly distributed by WP coordinator to the 5 members of the selection panel (Salvatore Sciortino, Graziella Branduardi-Raymont, Bruna Bertucci, Agata Rozanska and Wojciech Hajdas) asking for a reply by July 13th. In both cases the majority of panel members have expressed their positive evaluation in due time.

The first proposal from the SME team has been considered centred on quite a topical activity, space debris mitigation, that is very relevant to development of any future space program and the requested facilities have been considered well suited to development of the program. After the positive scientific evaluation by the selection panel, the WP coordinator has analysed the proposal to verify the eligibility of the proposed activities according to EU rules and has informed via email the proponent Italian team that they cannot access, under the AHEAD TNA program, the facilities hosted in Italy, while they can access the two other facilities, they asked for, hosted in other countries and can also perform the mentoring/preparatory visits they have asked for. The facility contact points as well as the proponent have been informed of the successful evaluation to agree on the way to proceed further with the caveat that all activities need to be concluded not later than February 25th 2019.

The second proposal from the science team addresses a topic at the core of High Energy Astrophysics, specifically of gamma-ray space polarimeter, and the asked facility (LARIX@Ferrara) appears to be just right for the measurements that they need. The facility contact point and the proponent have been informed of the successful evaluation to proceed further on scheduling of the preparatory visit and actual facility measurements with the caveat that all activities need to be concluded not later than February 25th 2019

It is worth to notice that both proposals ask for a substantially longer visits than originally planned in the TA1 program; as matter of fact the quest for long visit emerges clearly even with the limited statistics accumulated so far.

Regarding the two other proposals approved at the end of 4th semester and confirmed in the mean time by the proponents, the actual access to the facility has been postponed due to some delay in the availability of the hardware to test. A preparatory visit at the LARIX facility in Ferrara has already been performed on December 2017.

The approved program at the Perugia/Terni University has been conducted during July 2018. We attach a detailed report of the very successful visits that have been performed.

Facility call announcement is available at <http://ahead.iaps.inaf.it> and <http://ahead.astropa.inaf.it>. Facility call and facility detail descriptions is available at <http://ahead.astropa.inaf.it> .

Report on AHEAD-TNA activities @ University of Perugia

On may 4th 2017, the proposal “Environmental Test Campaign of UTTPS system for AMS-02” was submitted to the Call n.2 of the AHEAD TNA “Access to Ground Calibration and Test Facilities” by Dr. Georg Schwering from RWTH Aachen, Germany and approved by the TNA selection panel on June 11th, 2017.

The UTTPS has been designed to extend the lifetime of the Tracker Thermal Control System (TTCS), of the AMS-02 experiment orbiting on the International Space Station since 2011. The TTCS is a two phase mechanically pumped CO₂ loop, the UTTPS will provide a new reservoir of CO₂ for the TTCS system and a new set of pumps to pump the fluid in the circuit. Fig. 1 shows a 3D drawing of the whole system, with dimensions of about 1067x82x41 cm³ and a total weight of about 120 kg.

It consists of the following main components:

- four pumps
- two vessels filled with CO₂ (Re/Fill system, and accumulator)
- heat exchanger
- filters and absolute pressure sensors APS
- a radiator on top
- valves (operated by hand or electronically controlled) to separate various sections
- seven gas connectors, which four are used to connect to the TTCS in space

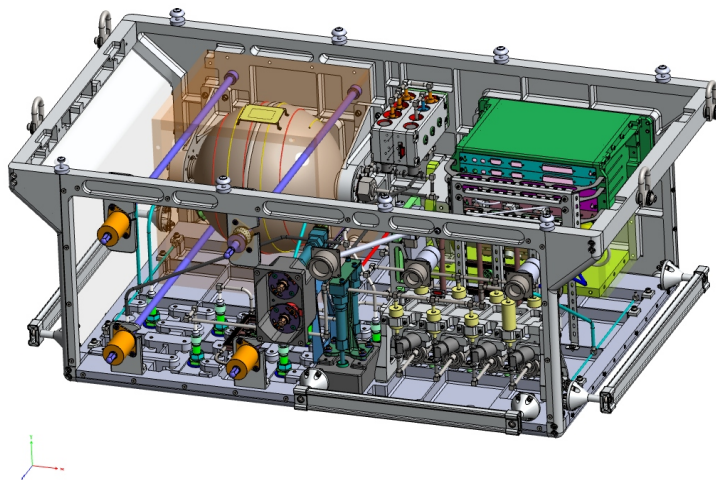


Figure 1 : : UTTPS 3D drawing. For a better view the side planes and the Radiator on top have been taken out.

Given the size/weight of the UTTPS, the extended dimensions of the TVT chamber of SERMS laboratory in the Terni Space Lab facilities of UniPG have insured the possibility to perform the full qualification procedure in one site, thus minimizing the transport of the UTTPS system among different laboratories to perform different steps of the qualification campaign.

In the proposal to AHEAD, it was requested to perform the mechanical (vibration test), thermal (thermovacuum test), electric (EMI/EMC tests) space qualification of the UTTPS qualification model (QM) developed at Aachen within the context of an international collaboration (AMS-02) under the control and verification of NASA.

In particular were foreseen:

- a) a preparatory visit to the facilities as part of the quality insurance process required by NASA, to show the facility to the NASA office and formally agree on the qualification procedure;
- b) a preliminary EMI/RMC test on the engineering model (EM) of the electronics control box Qualification Model of the UTTPS (optional);

- c) vibration, sine sweep and random, over the three axis
- d) thermo-vacuum test
- e) EMI/EMC tests according to SSP 30328 and to SSP 30327.

For a total estimated duration of the tests of ≈ 15 days (12 @ SERMS + 3 @ CEM) to be carried in fall 2017 (Sept-Oct.2017).

Preparatory visit

The Preparatory visit was held in Terni on July 18-19, 2017. It consisted of a two-day meeting among the different participants to the project, the NASA representative and the personnel of the test facilities and a careful inspection of the available test equipment was performed by the team, defining the adequacy of the SERMS/CEM for the test.

Initial requirements for the test procedures were defined, and representatives of the Test Space Lab facilities officially inserted in the UTTPS internal communication lists to rapidly exchange information on the tests and needed support equipment. Support for the visit was granted by AHEAD project to Dr. Schwering, from Aachen RWTH.



Figure 2: Preparatory Visit of the UTTPS team to the SERMS facility



Figure 3: Left: Visit to the clean room and TVT Chamber, Right: Discussion on the Vibration test



Figure 4: Visit to the CEM lab and discussion on the EMI/EMC test

Test Campaign

The test campaign started in July 2018, due to delays in the assembly of the UTTPS system, mostly related to part procurements, and in the preparation of the Ground Support Equipment (GSE) needed for the UTTPS functional verification before, during and after the tests.

The UTTPS and GSE equipment were delivered to Terni on July 18, 2018.

Over the time interval between the preparatory visit and start of the test campaign contacts between the UTTPS team and the UniPG team were constantly kept via regular tele-conferences and the variations to the original test schedule and procedures agreed among the parts.

Main discussion between the UTTPS and the facility were regarding:

- the installation of accelerator sensors for the vibration tests within the UTTPS
- the temperature profiles and operating conditions during the thermal test in vacuum: in particular, profiting of the upgrade of the TVT chamber with a new cold plate irrigated with a mixture of liquid-gaseous nitrogen, a temperature profile was agreed to test the UTTPS system in an extended temperature interval between -140°C and $+50^{\circ}\text{C}$.
- the definition of available support material (chillers, cabling) for the GSE needed to operate the UTTPS and the setup for its installation. The GSE provides both CO_2 and control electronics to operate the UTTPS. Due to the complexity of the system, it was decided to integrate the GSE with the TVT chamber over the full test campaign. using the feed through of the chamber as an unique interface between GSE and UTTPS.
- safety procedures regarding the storage and use of the CO_2 bottles needed to fill /empty the UTTPS circuits under operation.

The different phases of the test campaign are reported in table 1, where main activities and roles of the UTTPS and UniPG teams have been also described.

Figures 5-10 report images of the UTTPS installed on the shaker (Fig.5-6), of the installation and post-test verification in the TVT (Fig.7-8), the TVT test temperature profile (Fig.9) and of UTTPS in the semi-anechoic chamber (Fig.10).

Main changes with respect to the proposal are:

- the vibration (phase b in table 1), was reduced due to a failure just on the first day of the test. During the random vibration along x-axis with random 6.8 g RMS three screws fixing the radiator on top of the UTTPS were damaged. The test was stopped and not resumed since required a re-working of the structure to be done in Aachen. Only minor problems to the UTTPS functionalities were found after this failure that did not prevent to properly run the TVT test, although it implied prolonged functional tests and visual inspections of the system in phases c) and e) to verify possible damages hidden in the interior of the UTTPS enclosure.

- the TVT test was extended. Different scenarios of UTTPS operation needed to be tested which required a more complex temperature profile for the test (Fig. 9).
- The GSE required to operate the UTTPS and verify the functionality of its different elements was more complex than originally foreseen, this implied several days of mounting/dismantling of the test setup prolonging the occupancy of the laboratory.

| Phases | Time period | Main activities | UTTPS team | UniPG team |
|--------|---------------|--|--|--|
| | 18-Jul | Delivery of UTTPS and GSE in Terni | Inspection of the material post shipment. | Incoming procedure of the material, handling and placement of boxes. |
| a) | 19-23 Jul | GSE setup in clean room, UTTPS functional test after shipment | GSE setup and operation. UTTPS functional tests. | Support to GSE setup. Vibration fixture mounting and vibration test setup. |
| b) | 24-Jul | Vibration test. | Operations on UTTPS. Inspection after vibration test. | Vibration test running. Dismounting of the test. |
| c) | 25-30 Jul | Verification of the UTTPS after Vibration test. Preparation of the TVT test | Functional tests on UTTPS. Preparation of the TVT test. | Logistic Support to the UTTPS team. Preparation of the TVT test. |
| d) | 31-Jul/13 Aug | TVT test 24h/7d | Functional tests on UTTPS | TVT chamber control and monitoring. |
| e) | 16-18 Aug | Verification of the UTTPS after Vibration and TVT test | Dismounting and visual inspection of the UTTPS. Test of single elements. | Logistic support to the UTTPS team. |
| f) | 20-22 Aug | Preparation for the EMI/EMC Test | GSE removal from TVT and transfer to EMI/EMC facility | Support to GSE dismounting from TVT and mounting in EMI/EMC facility. |
| g) | 3-7 Sep | EMI/EMC Test: setup, test, dismounting | UTTPS operation and GSE dismounting | Test and support to GSE dismounting |
| h) | 08-Sep | Packing and delivery for shipment | Packing | Outgoing procedure of the material, handling and placement of the boxes. |

Table 1: Main phases and activities of the UTTPS test campaign at UniPG

Table 2: Details of the costs on AHEAD project for the UTTPS test campaign

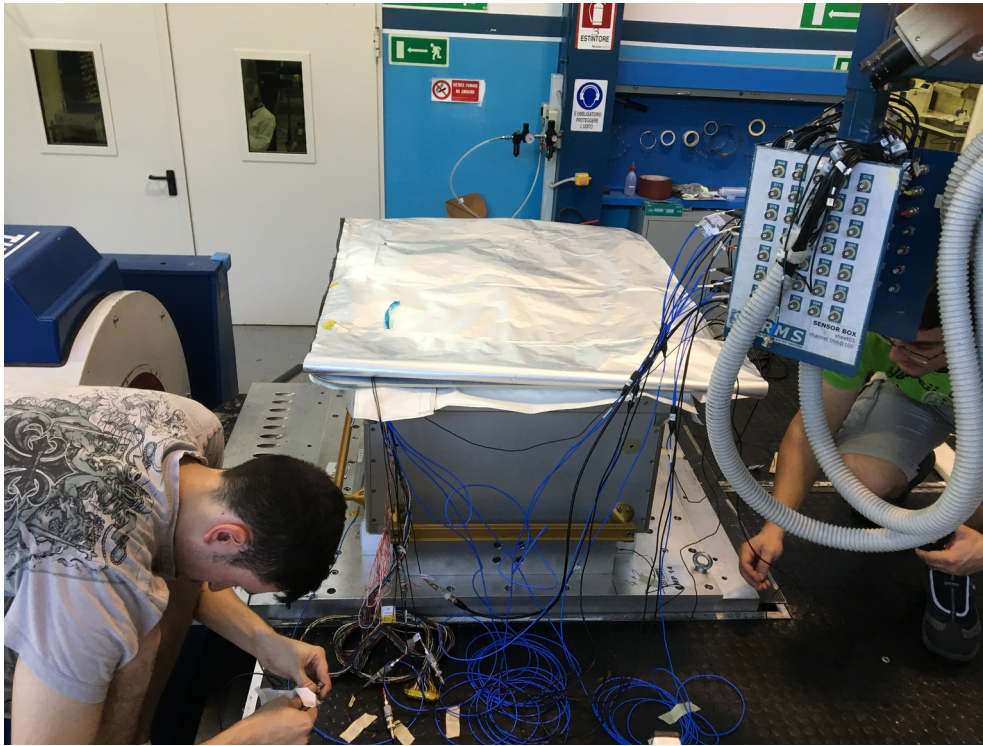


Figure 5: Instrumentation of the UTTPS for the vibration test

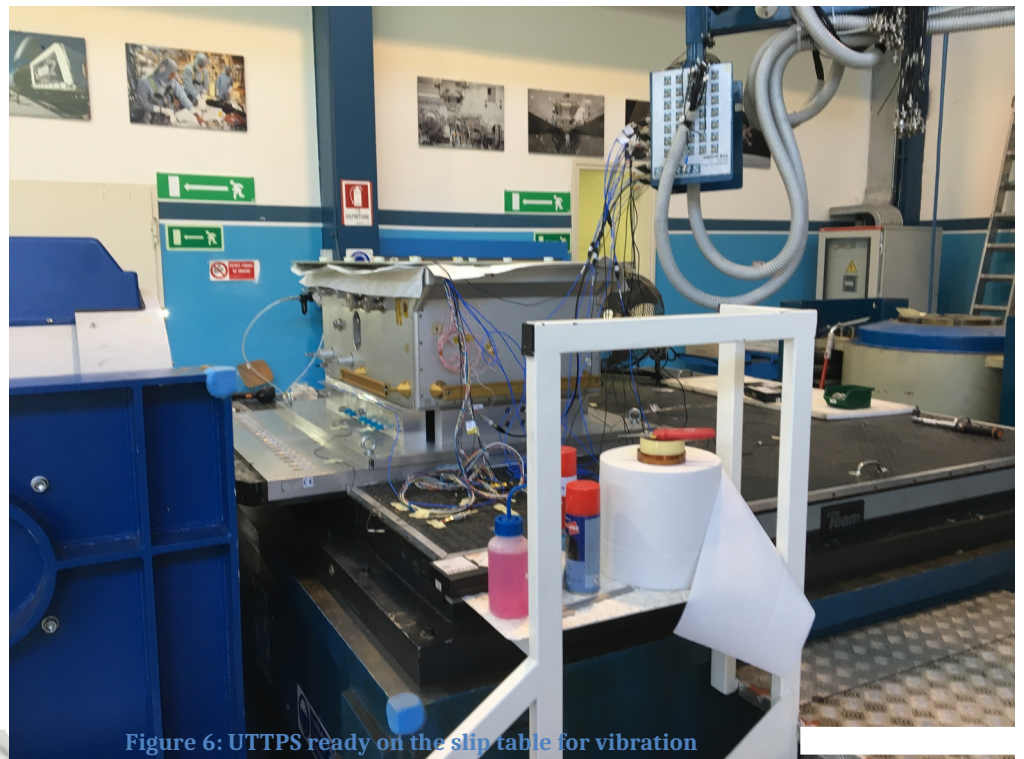
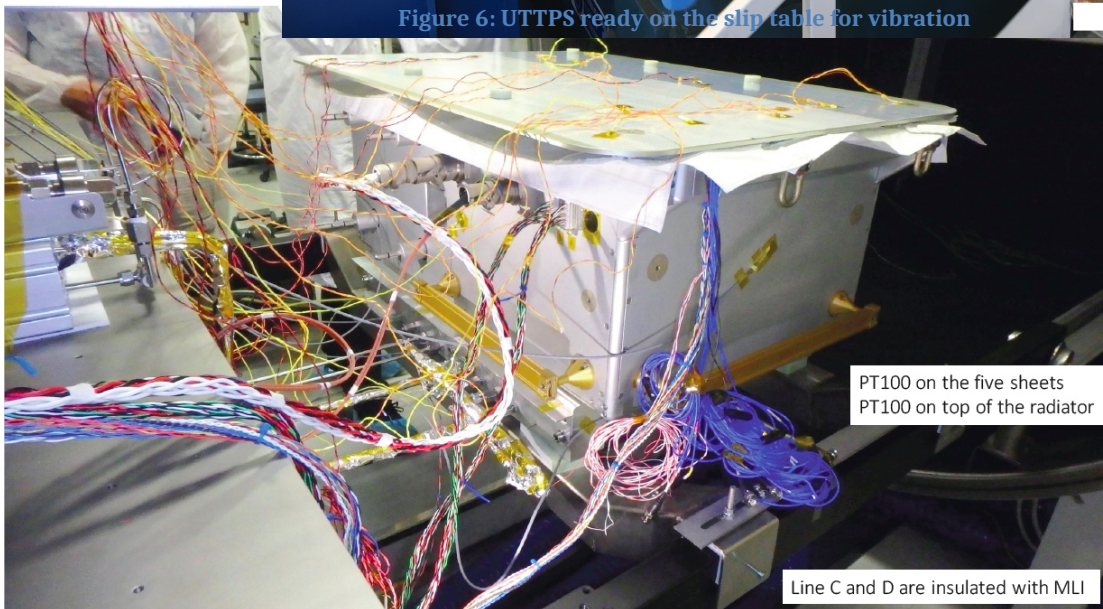


Figure 6: UTTPS ready on the slip table for vibration



PT100 on the five sheets
PT100 on top of the radiator

Line C and D are insulated with MLI



Install UTTPS with GSE

Load UTTPS to TV chamber

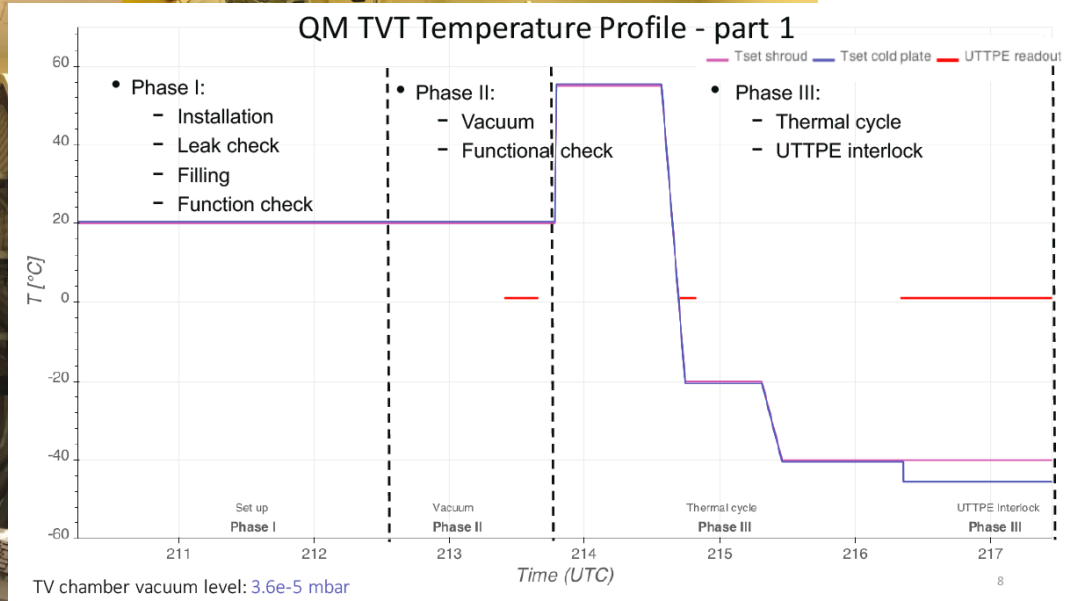


Figure 8: UTTPS Installation in TVT and end of test verification QM TVT Temperature Profile - part 2

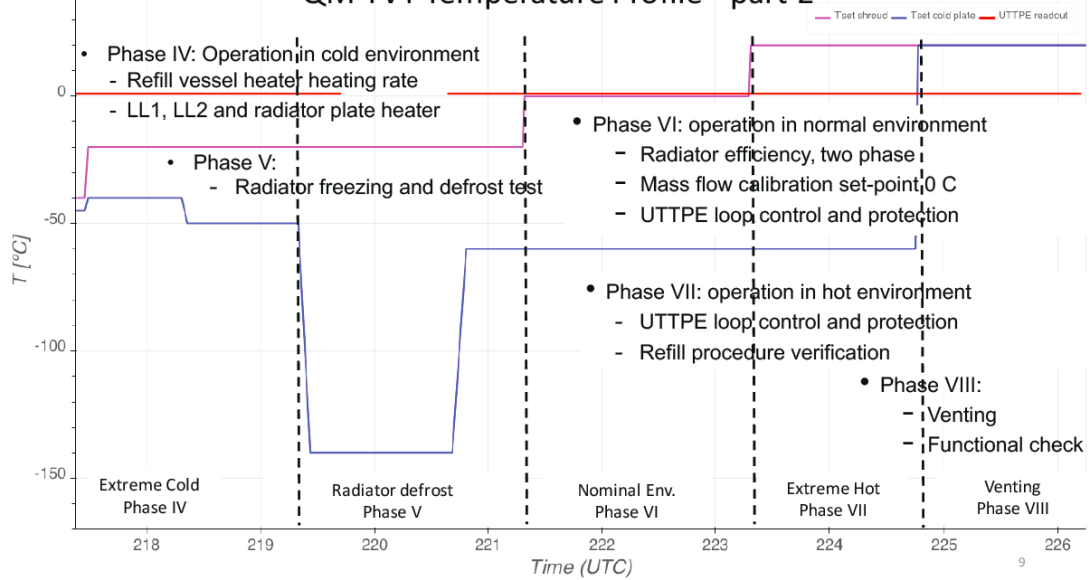


Figure 9 : UTTPS QM Test Temperature profile as measured on different elements of the TVT chamber over the test.