

Author

Nikhef

RecipientTender Ned

Abstract

The document describes the Technical Specifications for the E-TEST Vibration Isolation tender.

Document Status

Revision	Date	Comment	Reviewed by	Approved by
0	09/14/2022	Document initiated		
1	13/10/2022	Scope of supply updated		
2	08/11/2022	Finalized		

Revision History

Revision	Date	Description
0	09/14/2022	Document initiated

1 Documentation and Acronyms

1.1 Abbreviations/Acronyms

Abbreviation	Description
E-TEST	Project about site study and technology development for the Einstein Telescope
BOM	Bill of Materials
UHV	Ultra-high vacuum
AP	Active vibration isolation platform
IP	Inverted pendulum
GAS	Geometric Anti-Spring
VIS	Vibration isolation system
MAR	Marionette: cryogenic payload steering suspension stage

2 Scope of supply

Scope of supply is the production of the mechanical components of the **vibration isolation system** (VIS) and of the **cryogenic platform** (CP) of the E-TEST prototype facility. The VIS consists of four sub-systems (an impression of the assemblies is shown in Fig.2): a six-degrees of freedom active isolation stage, so-called **active platform** (AP), an ultra-low natural frequency **inverted pendulum** (IP) horizontal isolator, a **geometric anti-spring filter** (GAS) for additional vertical attenuation and a pendulum stage (**marionette**) for steering the cryogenic payload in the angular degrees of freedom. The CP provides the mechanical interface between the mirror and the 20K radiation heat exchanger and serves as test-bed for the advanced and cryogenic environment compatible inertial sensors developed within the project.

The parts must be produced according to the attached Bill of Materials (BOM) and production drawings. The requirements for the parts in terms of manufacturing procedures, finishing, packaging for delivery are described in Section 3 of this document.

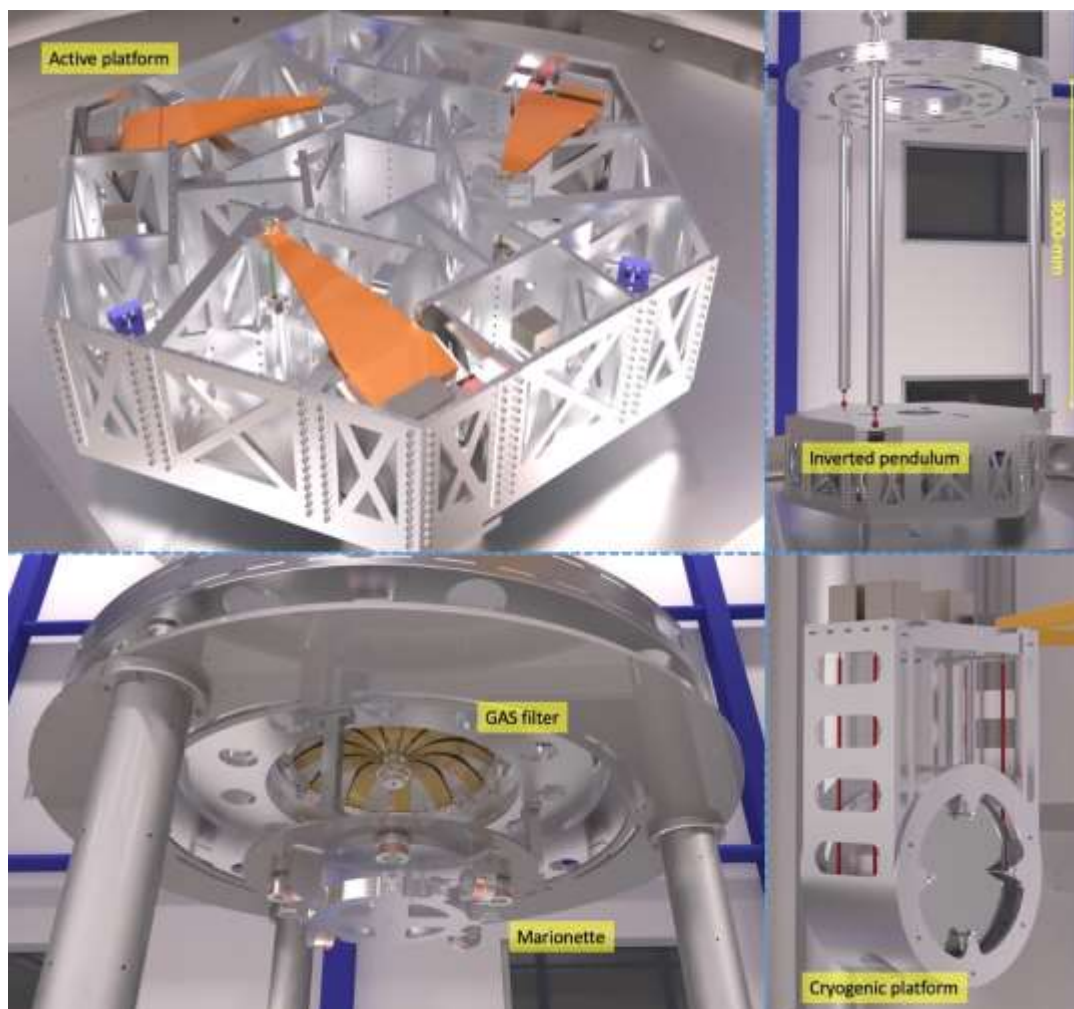


Figure 2 CAD views of the VIS sub-systems.

3 Technical specifications

3.1 UHV compatibility

The VIS assemblies will operate in UHV vacuum environment. The expected residual pressure inside the E-TEST Prototype vacuum chamber is **10^{-9} mbar**. Reaching and stably maintaining these conditions is possible by keeping strict policies on the selection of materials and components, and on the cleanliness of all surfaces in order to minimize outgassing. Particular care is taken to avoid contamination of the surfaces by hydrocarbons. Irreversible damage to the coating of the ultra-high quality optics of the E-TEST prototype could in fact be caused by **hydrocarbons** volatiles burned on their surface by the high power laser beams used in the experiment.

For these reasons, the Contractor is requested to comply with the following requirement:

- Req.1. All parts shall be delivered **precision cleaned** according to the IEST-STD-CC1246E Standard.

Although, as regards the surface of the machined mechanical components, the standard methods of **precision cleaning** have proven to guarantee the required level of cleanliness, for the precision cleaning to be successful, restrictions and practices must be followed during manufacturing and handling of the parts. Therefore, the following additional requirements must be met by the Contractor:

3.1.1 Materials

- Req.2. Only materials indicated in the drawings may be used.
- Req.3. All materials are to be virgin material: no weld repairs or plugs is allowed; no recycle material is permitted. This is necessary to prevent the presence of voids causing virtual leaks inside the vacuum system that might spoil the achievable residual pressure. Voids may also include an uncontrolled content of contaminants that might potentially cause damages to the optics.
- Req.4. Use of cast raw material is forbidden to avoid presence of voids and related virtual leaks. For example, when choosing aluminum tooling plates as starting material to machine parts, the supplier must verify whether the tooling plate is cast or rolled: only the rolled one is acceptable for use in UHV environment.

3.1.2 Machining

- Req.5. During machining and all subsequent handling of the part or assembly, any unnecessary contamination of the part or assembly should be avoided. In particular:

o it is recommended to handle the parts with gloves starting from the end of the machining, through the gross cleaning up to the packaging.

o the machining environment must be free of oil/coolant mist.

o Residues due to the machining process (i.e. machining fluids, material chips) should be removed immediately after each machining step to avoid a build-up of dry in of contaminants.

Req.6. Any machining fluid used for cooling and/or lubrication should not stain or corrode the parts and should be completely removable from the machined parts. For this reason, we require the suppliers to use fully synthetic or semi-synthetic, water soluble (not simply miscible) coolants for both machining and tapping. Coolants containing Chlorine, Sulphur, Zinc, Phosphorus or Silicone are forbidden. Any machining fluid proposal from the supplier must be approved by Nikhef, and any parts found to have been machined with fluids that contravene these requirements will be rejected.

Req.7. All surfaces shall be machined to remove oxides and mill finished to achieve 1.6 μm Ra roughness. Machined surfaces must not have smeared metal or galling because these conditions can trap contaminants which could out-gas when the part is in service in the vacuum environment. No as-received or as-rolled rough surfaces will be accepted unless otherwise noted on the drawing. Exception is made for parts not practical to machine:

- a. Extruded tubular sections (as seamless tubes): since machining the interior surface and the outer radius on the corners is prohibitive, the parts will be accepted "as extruded" or "as rolled", provided that they are electro-polished to remove all surface oxides and potential embedded contaminants. For aluminum parts, chemical cleaning/etching by acid process shall be applied.
- b. Thin sheet: sheet metal shall be purchased in the 2B finish condition.

Req.8. Grinding or lapping with abrasive wheels, clothes, stones or paper is forbidden as well as sanding. Manual finishing of surfaces with stainless steel wool is allowed.

3.1.3 Gross cleaning prior to precision cleaning

Req.9. Parts shall be prepared deburred and free of scale, oxidation, particulates, greases, oils, minerals, ink.

- a. All inks should be removed with solvent such as acetone or isopropanol.
- b. Use soap and water to remove machining fluids. Thoroughly rinse soap with clean water (preferably DI or distilled water).
- c. Parts should be dried thoroughly with clean air, nitrogen, or lint-free cloth.

- d. Gross cleaning shall be performed in a facility (building or room) that is isolated from general shop practices (e.g. machine operations, welding or aerosol applications). Isolation should also include separate air-handlers to minimize re-contamination.

3.1.4 Welded assemblies

- Req.10. This tender includes welded aluminum assemblies that will have to be compatible with an Ultra-high vacuum environment. For this reason, we require the following guidelines to be followed for the preparation of the parts to be assembled and for the cleaning of the assemblies:
- All weldments shall be TIG with full penetration to prevent formation of virtual leaks such as voids and cavities.
 - The welding process must be conformed to ISO-3824-2 standard.
 - All welds shall be performed with an inert backing gas, appropriate for the to-be-welded material, as to prevent the underside of the weld and the adjacent material from oxidizing.
 - The parts shall be de-burred and cleaned, removing all possible machining residues. Use only clean carbide burrs. Grinding, or use of abrasive cloth or paper, is not allowed. All inks should be removed with solvent such as acetone or isopropanol.
 - The parts shall then be washed with alkaline soak cleaner.
 - The weldments shall be cleaned/etched by acid and/or caustic process. At this step Scotch-Brite or similar mildly abrasive pads can be used. This is the only step where Scotch-Brite is permitted.
 - The acid formulation, time and temperature should be chosen to achieve slight chemical etching (less than 0.015-mm).
 - The weldments shall be rinsed with clean water and the assemblies dried.

3.2 Functional Requirements

- Req.11. The following precedence shall be used by the Contractor in interpreting the documents in case of conflicting requirements. In case of conflict between various documents, the Contractor is requested to raise the discrepancy to Nikhef. The first document has the highest precedence:
- The Purchase Order and its Terms and Conditions
 - This Technical Specification Document
 - Specifications mentioned in the drawings
- Req.12. The parts shall be manufactured according to the specifications as mentioned in the BOM.

Req.13. All parts mentioned in the BOM must be delivered.

3.3 Packing and shipping

3.3.1 Packing

Req.14. All parts to be shipped shall be first dried from cleaning fluids and then packed in protective foil. Accepted protective foil are: polyethylene film, PET-G film, aluminum vacuum packing foil (Clima foil) and oil-free aluminum foil.

Req.15. Packaging shall be such that handling and transport shall not damage the parts or break its cleanliness.

3.3.2 Shipping

Req.16. All parts shall be delivered to:

Precision Mechatronics Laboratory
University of Liege
Allee de la Decouverte 4000
4000 Liege
Belgium

4 Annex Drawing package

In an attachment a zipped file with all drawings and the bill of materials are packed, see below:

“E_TEST_Vibration_Isolation_Drawings-Annex-II.zip”