INDEX OF SPECIFIC TECHNICAL PRESCRIPTIONS FOR THE DRAWINGS AND MANUFACTURE OF SIX SCRAPERS FOR THE ESS MEBT

MEBT-BI-SC90-05

1 Object

The purpose of this document is to define the technical and functional characteristics of six Scrapers together with their actuator, which must be delivered by the contractor. These six Scrapers are part of the MEBT that ESS-Bilbao will deliver as part of the "in-kind" contribution to the European Spallation Source project.

ESS Bilbao will deliver the complete 3D model, which should be taken as the final conceptual model from which the contractor should make the tolerance adjustments and the fabrication blueprints before launching the fabrication itself. Both Scrapers and Actuators have the same geometry in the six cases. Any modification the contractor needs to make in the design in order to comply with the requirements and functionality of the instrument must be consulted and approved by ESS-Bilbao.

This document includes the following list of tasks to be carried out by the contractor:

- Realization of the fabrication blueprints of all the pieces present in the 3D model.
- Study of manufacturing procedures based on the specification given on this document.
- Procurement and supply of all materials
- Machining and manufacturing of all the components.
- Realization of all the measurements and tests to ensure compliance with the specifications.
- The guarantee of the geometrical conformity of the components following the specifications.
- Cabling in and out vacuum.
- Cleaning and storage according to specifications.
- Packing and shipping to ESS-Bilbao facilities.
- Complete manufacturing documentation and verifications including complete metrology reports.

2 Technical requirements

ESS-Bilbao is responsible for the final conceptual design of Scrapers and Actuators and will provide the 3D files for all the components. The contractor will be responsible for the tolerance adjustment of the final 3D model, for the slight modifications needed to make when necessary in the conceptual design to reach the final 3D model to mechanize fulfilling the functionality of the instrument and for defining the manufacturing requirements to fulfil the specifications. The contractor will be also responsible for the definition and application of the necessary controls to ensure a quality assurance plan during the fabrication. **Once the instrument has been machined and assembled the contractor should assure the positioning of the blade according with the specifications described on section 2.2.**

2.1 Scraper Instrument

The section of a particle beam is composed of two main zones: a central zone, in which the largest amount of particles is concentrated, and a peripheral zone, known as halo, in which the particle concentration is much smaller. The beam halo is normally discarded, causing particles to collide on one or more instruments known as Scrapers, thus allowing only the central zone of the beam to be transmitted to the next section of the accelerator. This instrument consists of a thin plate of a material with a high resistance to the impact of the particles of the beam, assembled on another of stainless steel to which is coupled a cooling system. This instrument known by the name of Scraper is the object of this contract, being necessary six that will be placed in different parts of the MEBT.

Figure 1 shows an outline of the instruments.

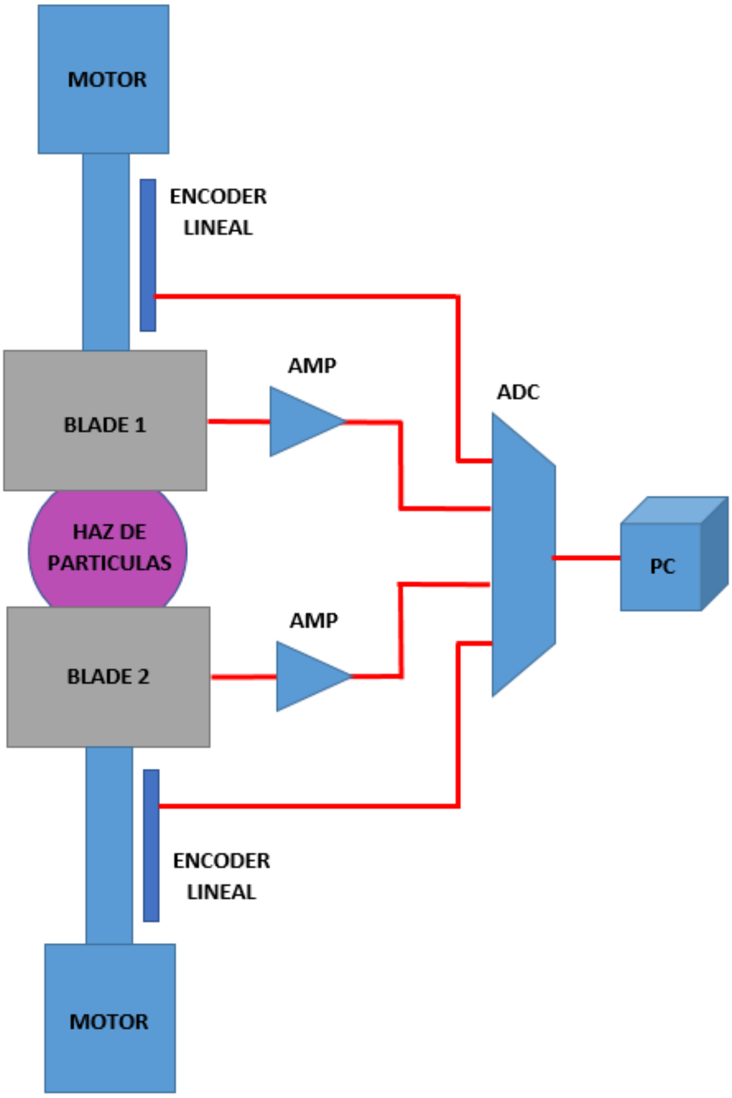


Figure 1:Two Scrapers diagnostic outline.

2.2 Specifications

Each scraper consists of: a water-cooled blade and an actuator. Figure 2 shows a front view of the instrument where the various important parts of the Scraper are marked for the realization of the accumulation calculation of mechanical errors. The description of these errors is shown in Table 1. These errors will be considered as a reference, and the contractor may use others based on his experience for the elaboration of detailed drawings, as long as he ensures compliance with a relative error of **no more than 0.5 degrees between the angular position of the blade and the angular position of the fixed flange of the actuator with respect to its ideal positions in all its axes**.

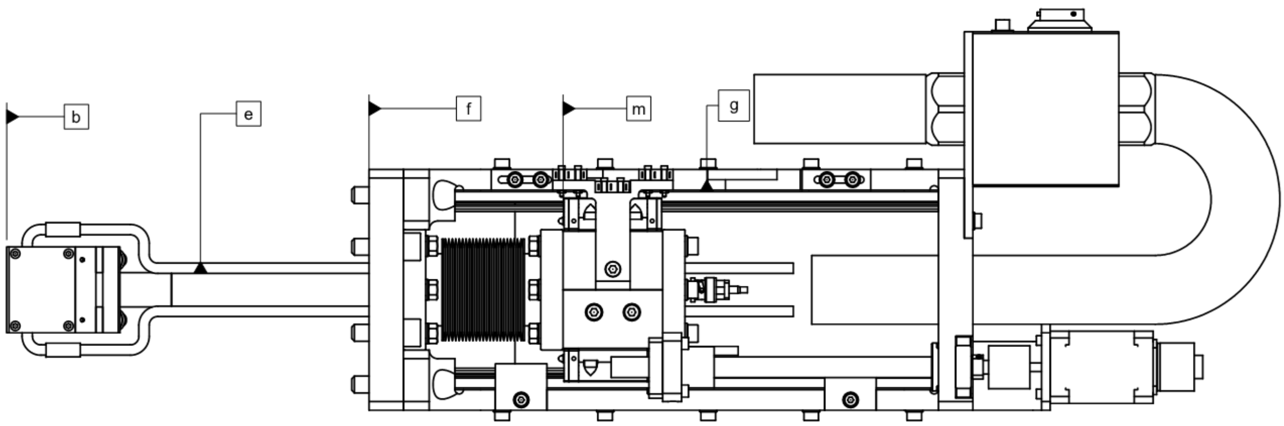


Figure 2: Scraper elements to take into account for the calculation of accumulation of mechanical errors.

Table 1: Description and responsibility of the mechanical errors considered

Error	Description	Responsable
$\Delta\alpha_{fg}$	Angular error between the fixed flange of the actuator (f) and the linear guides (g)	Contractor
$\Delta\alpha_{gm}$	Angular error between the guide (g) and the movable flange of the actuator (m).	Contractor
$\Delta\alpha_{me}$	Angular error between the movable flange of the actuator (m) and the axis (e).	Contractor
$\Delta\alpha_{eb}$	Perpendicularity between the axis (e) and the blade (b).	Contractor
$\Delta\alpha_{fb}$	Resulting angular error between the fixed flange of the actuator and the reference plane of the blade.	Contractor

2.3 Mechanical description

An image of the complete System is shown in Figure 3. The main components of the system are Blade and Actuator. Due to the space constraint and the difficulty of integrating all the instruments in the MEBT, the size of the device must be restricted to the projection volume of an area of 100 by 140 millimeters, except for the connector panel, which by its position away from the flange of the actuator and by its function of holding the cables with a suitable radius of curvature, the projection volume could be exceed by 80mm in the X direction.

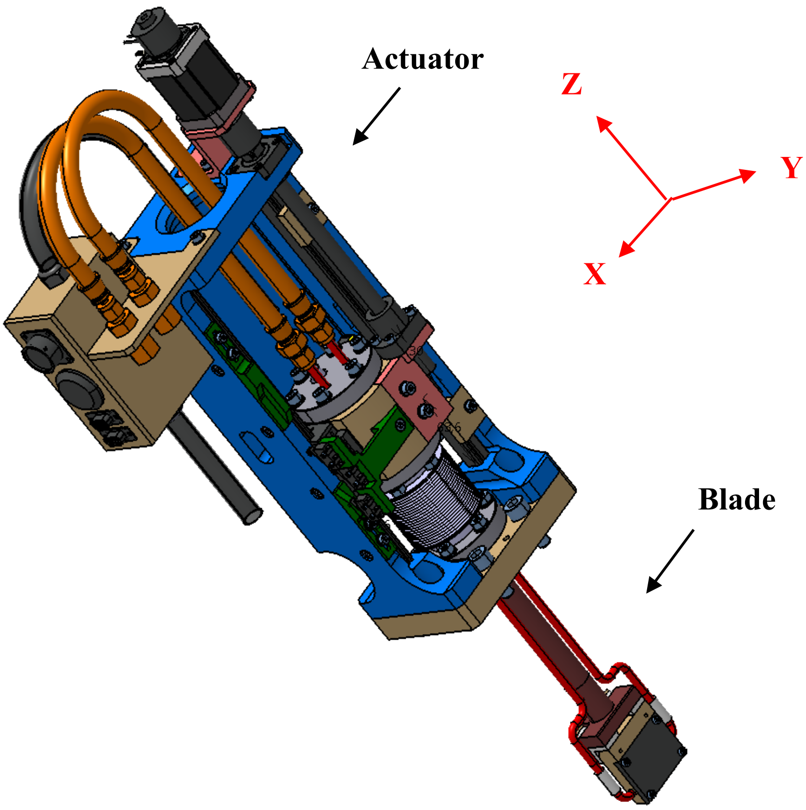


Figura 3:Diseño mecánico de actuador y Scraper,

The distance between the fixed flange of the actuator and the end of the blade must be between 151 mm in the initial position of movement and 211 mm in the final position.

2.3.1 Blade

An image of the Blade conceptual design is shown in Figure 4.

The principal components are:

- A) TZM Plate
- B) Cooling plate
- C) Cooling plate insulators
- D) Cooling plate holding piece
- E) Shaft
- F) Shaft holding piece
- G) Cooling pipes
- H) Cooling hose

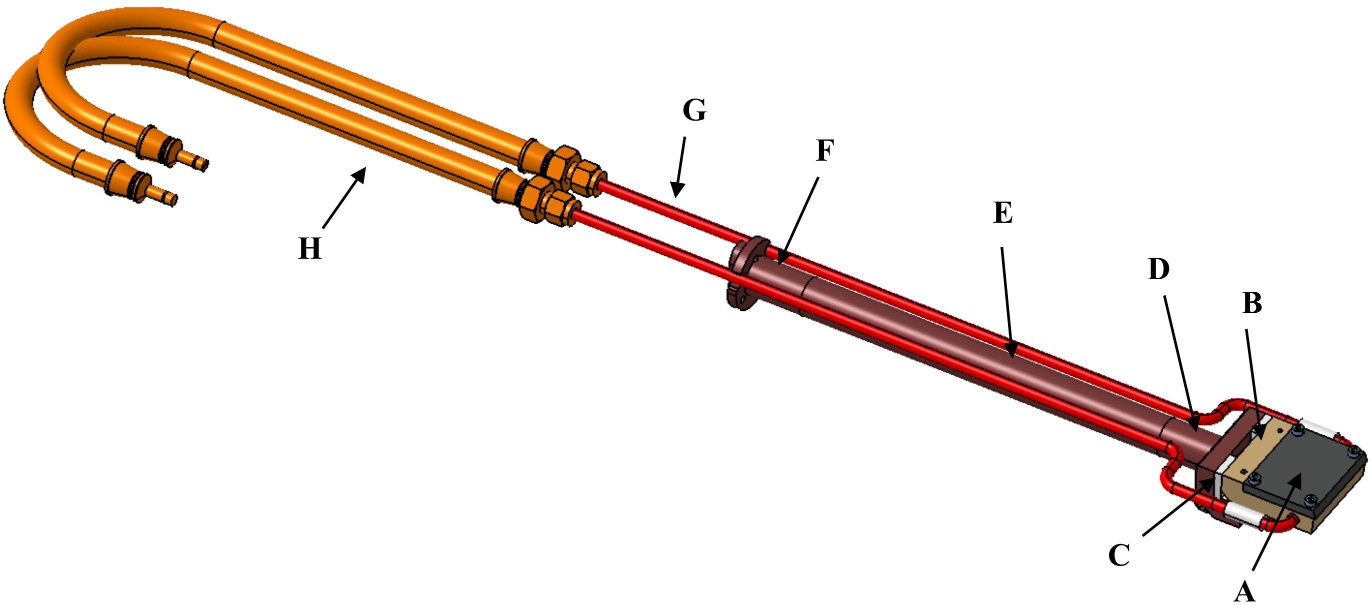


Figure 4: Blade mechanical design

Figure 5 shows a detail view of the TZM plate assembly on the Cooling Plate. The lower face (A) must be machined with an edge at 15 degrees, and exceed by at least 1 mm to the cooling plate.

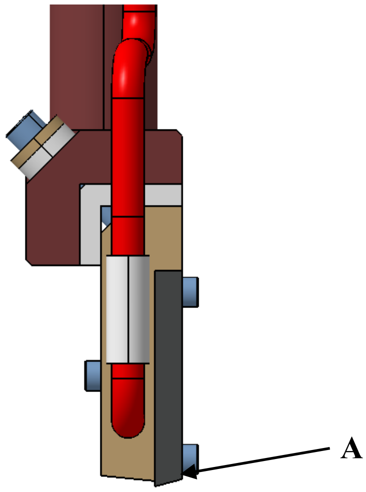


Figure 5: TZM plate assembly.

A detailed view of the shaft is shown in Figure 6. The shaft must be hollow to place the signal cables through it. The shaft must be welded at one end to the cooling plate holding piece and the other to the shaft holding piece. Welding shall ensure the relative position of all components to meet the requirements specified in Section 2.2.

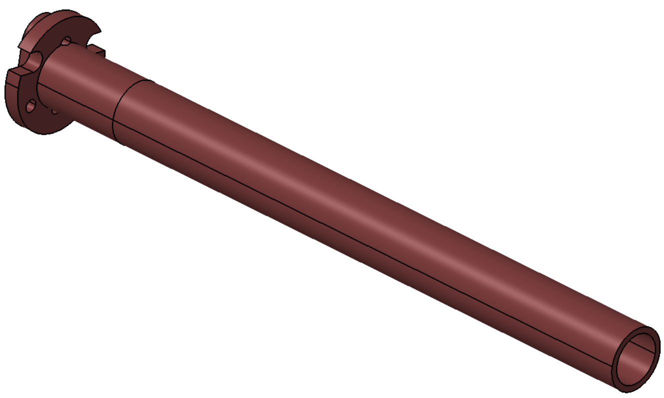


Figure 6: Shaft mechanical design.

A detailed view of the shaft holding piece is shown in Figure 7. This piece has two lateral grooves (A) for inserting the cooling tubes, a machining (B) that ensures the positioning of the instrument always in the same position with respect to the actuator and auxiliary holes (C) to avoid the formation of virtual air traps in the instrument.

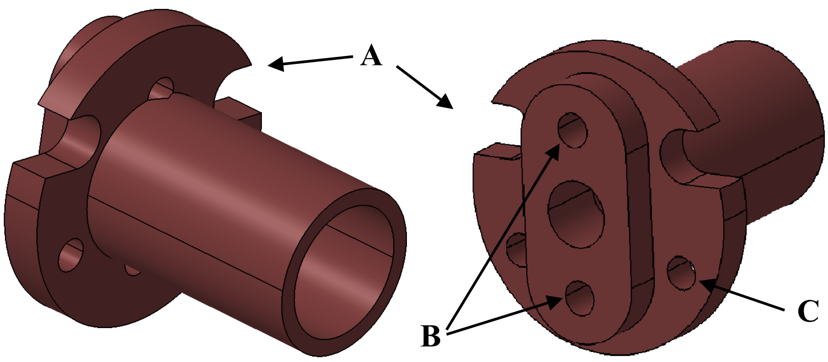


Figure 7: Shaft holding piece mechanical design.

The Blades cooling circuit consists of 6mm diameter stainless steel pipe and must be welded to both the vacuum feedthrough and the instrument. Figure 8 shows a possible assembly process where the contractor can use others based on his experience. The contractor shall in any case ensure compliance with the specifications described in Section 2.2.

The assembly protocol is detailed below:

- A commercial vacuum feedthrough with two welded stainless steel cooling pipes and a BNC connector (A) will be used.
- The next step is to assemble the following actuator components: Shaft Support, Bellow and Rectangular Flange (B).
- The next step is the welding of a new section of the cooling circuit (C). This section includes the radii of curvature required to adapt the cooling circuit to the instrument, as well as two insulating cylinders intended to avoid electrical contact between the blade and the ground reference.
- Next, the blade is assembled together with the shaft to the remaining already installed parts (D). To do this, the vacuum feedthrough of the instrument will be separated by a sufficient distance to reach the inside, where the shaft fastening screws are located. At this point in the assembly process, the blade signal cable must also be connected to the BNC connector on the vacuum feedthrough. Once the shaft has been screwed from the inside and the signal cable connected, the vacuum feedthrough will be returned to its initial position, placing the cooling tubes in their final position.

- Finally, once the shaft is assembled and correctly aligned, the cooling tube is welded to the instrument.

The contractor shall include at the ends of both refrigeration tubes a 6mm pipe hose connector on one side, which will be connected to the refrigeration tube itself, and a 6mm tube adapter from the other, which will be connected to a cooling feedthrough located in the Actuator. Cooling feedthrough must be fitted with a 6mm tube fitting from one end and female BSP thread at the opposite end. A recommended supplier for each component is shown in Table 7.

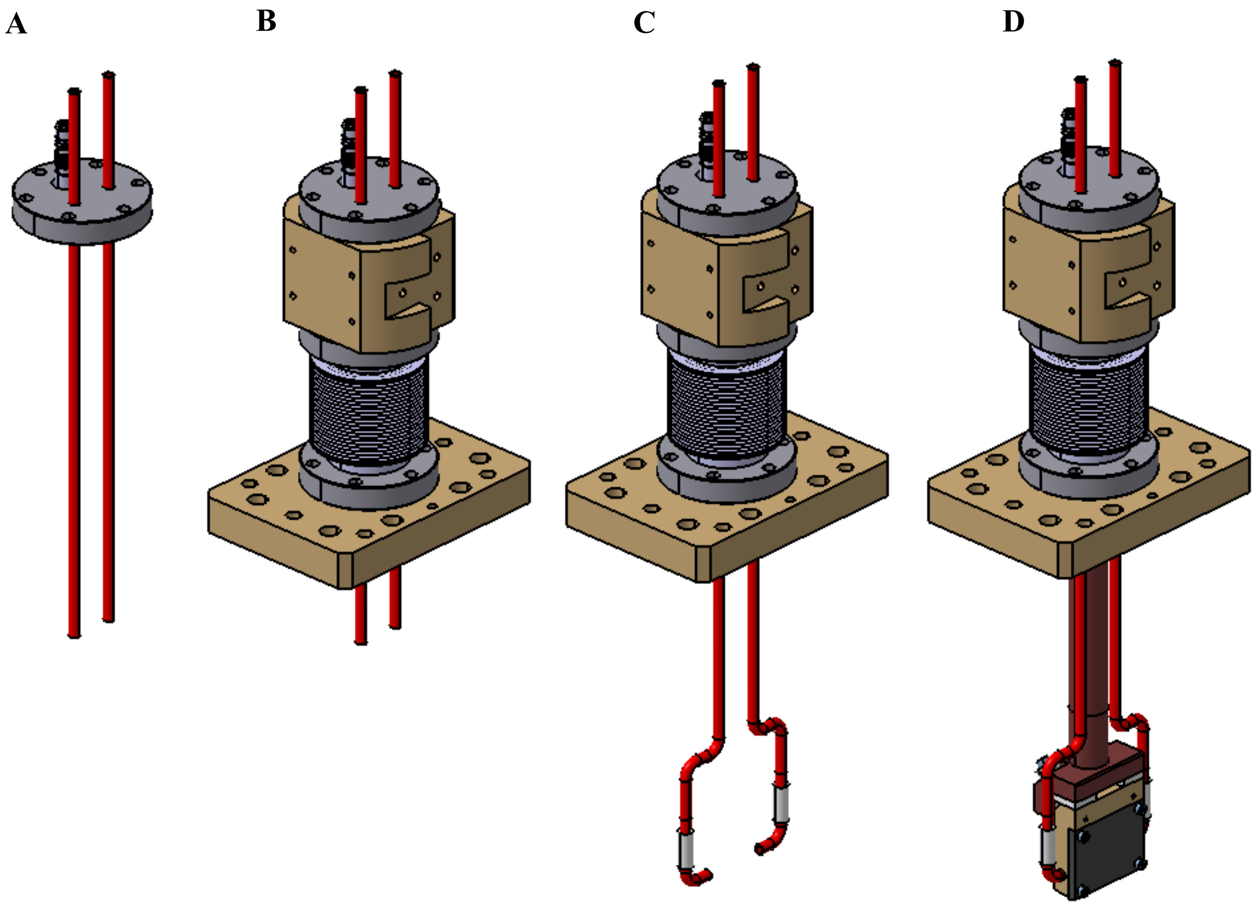


Figure 8: Procedure of assembly of refrigeration system.

2.3.2 Actuator

A picture of the Actuator design is shown in Figure 9.

The main component of the Actuator are:

- A) Rectangular Flange
- B) Bellow
- C) Guides Support
- D) Shaft Support
- E) Spindle Support
- F) Vacuum Feedthrough
- G) Linear Guides
- H) Spindle
- I) Travel Limit Switches
- J) MPS Limit Switch
- K) Limit Switches Support
- L) Limit Switch triggers
- M) Motor
- N) Break
- O) Linear Encoder
- P) Patch Panel
- Q) Cables Protections
- R) Mechanical Limits
- S) Cooling Feedthrough

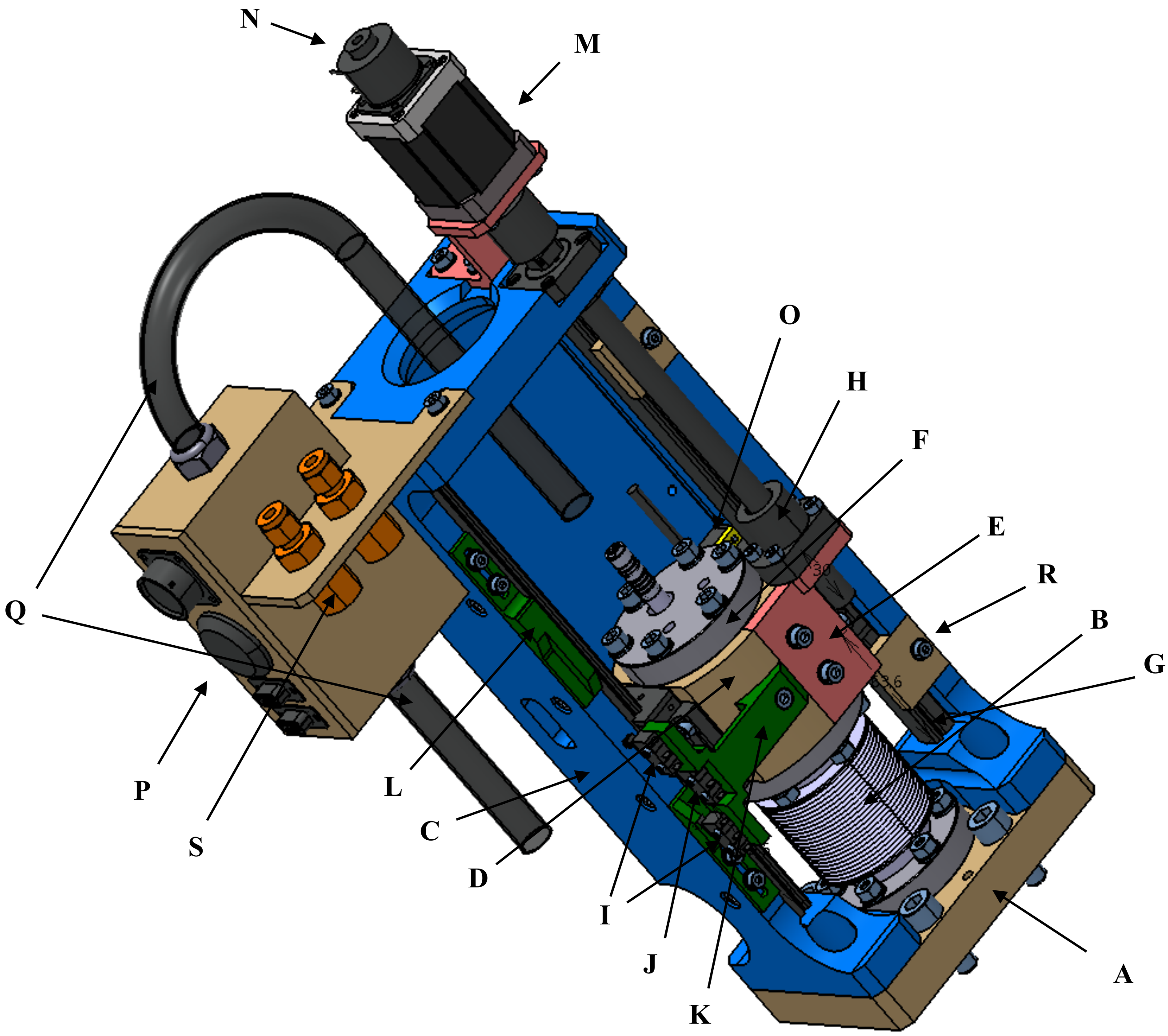


Figure 9: Actuator mechanical design.

The actuator should have a total axial stroke of 60 mm. Two limit switches should be placed in the travel limits to indicate the reaching to the final or initial position (I). An additional limit switch (J) should be placed in the beginning of the travel to have an indication of the blade insertion. This last limit switch will be used by Machine Protection System purposes. The limit switches position and functionality is described in Annex IV. A pair of mechanical limits (R), placed 10 mm from the Limit Switch in the movement direction, should be used to protect the integrity of the instrument in case of a failure of the travel limit switches. The bellow (B) should be a total stroke of 80 mm and will be fixed between the rectangular flange (A) and the shaft support (D). The movement of the shaft support is driven by two linear guides (G) placed one in front of the other.

A detailed view of the rectangular flange is shown on Figure 10. This piece has four different screw patterns. The first one (A) is to fix the Guides Support to the Rectangular Flange, the second one (B) is to fix the Rectangular Flange to the Vacuum Vessel, the third one (C) is to fix the Bellow to the Rectangular Flange and the last one (D) is to insert two precision pins to have a reproducibility in the actuator positioning. In the centre of the piece a **CF40 vacuum knife** should be machined in order to close vacuum between the Rectangular Flange and the Bellow. The dimension of the CF40 vacuum knife should be checked with the standard[1], the dimensions including in the 3D model can be considered as a guidance.

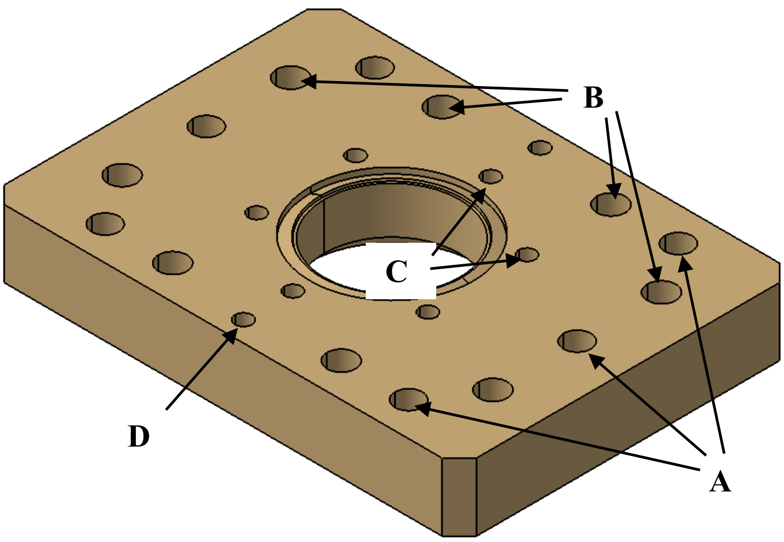


Figure 10: Rectangular Flange mechanical design.

[1] ISO/TS 3669-2:2007(E)

The surface of the Rectangular Flange which is in contact with the flange of the vacuum vessel shall have a surface quality sufficient to ensure the Ultra High Vacuum sealing of the instrument using aluminium wire as a sealing element.

A detailed view of the Guide Support is shown in Figure 11. The objective of this piece is to support the linear guides with rigidity and precision. To assure the proper assembly of the linear guides a surface (A) should be grinding during the fabrication to have a good mechanical precision reference to be used during the linear guides assembly.

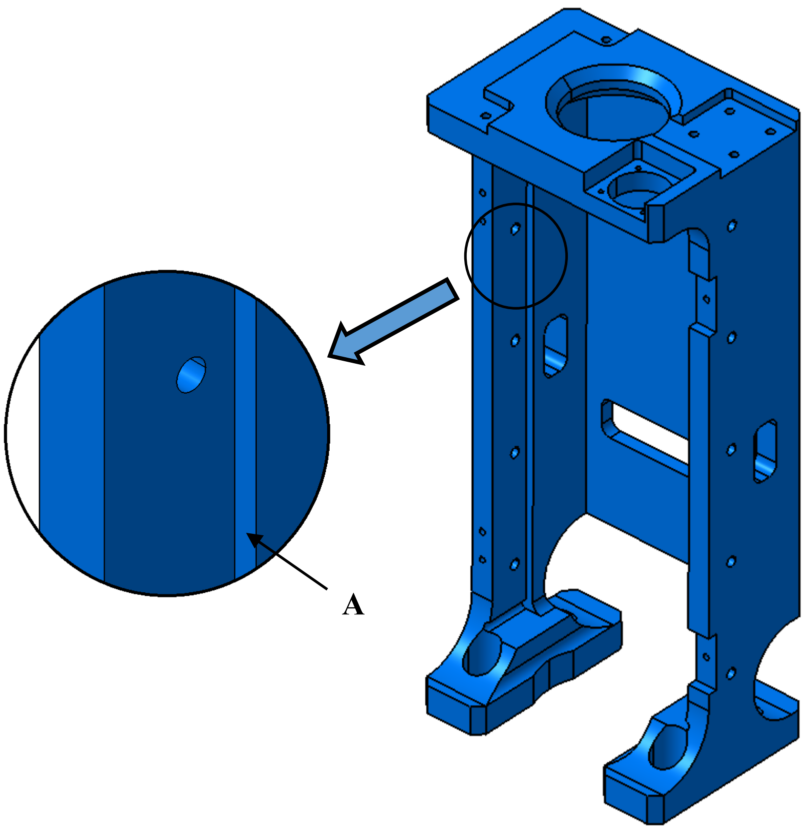
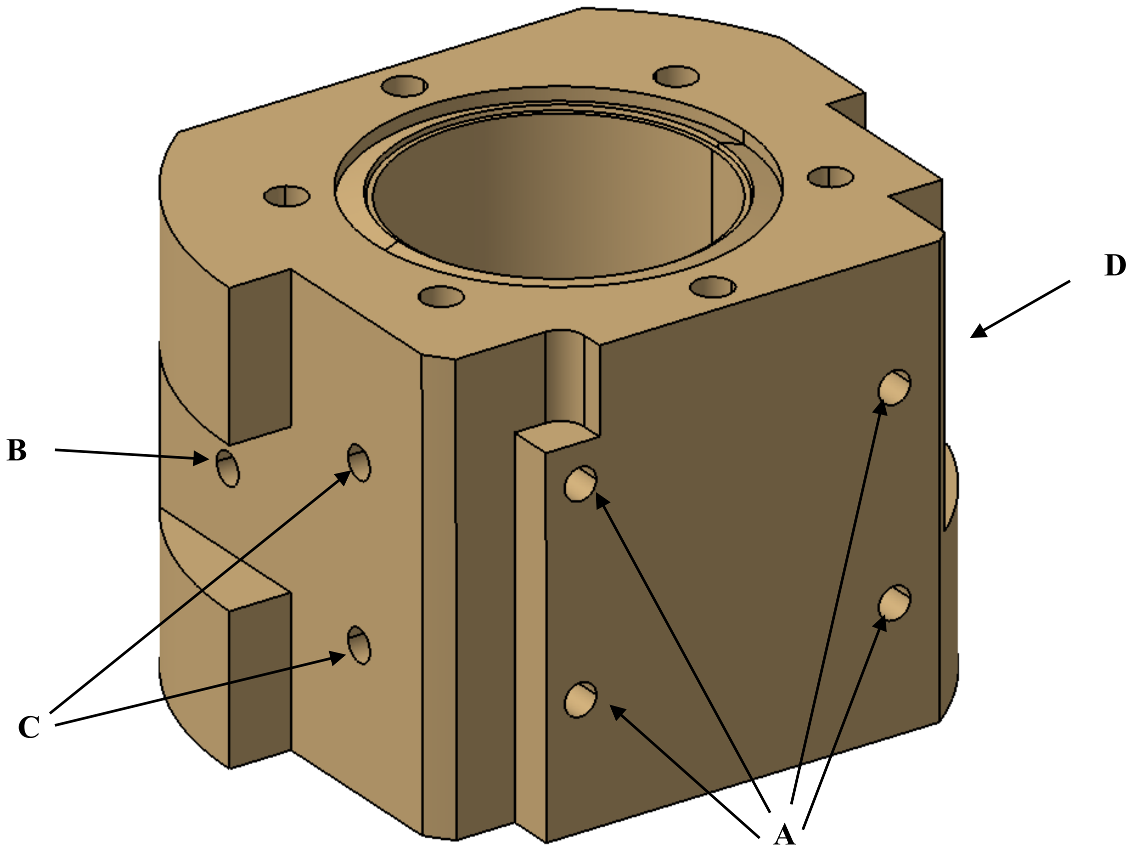


Figure 11: Guides Support mechanical design.

A detailed view of the shaft support is shown in Figure 12. On both sides of the piece a pattern of four holes (A) should be mechanized to fix this piece to the linear guides. In the front side of the piece two patterns of one (B) and two (C) holes should be mechanized to fix the Limit Switches Support and the Spindle Support respectively. On the rear side, a mechanization should be done to place the encoder in position (D). Finally, on the top and bottom faces a **CF40 vacuum knife** should be machined to close vacuum between Shaft Support and Bellow in one side and between Shaft Support and Vacuum Feedthrough on the other side. The dimension of the CF40 vacuum knife should be checked with the standard[2], the dimensions including in the 3D model are a guidance.



2.4 Cabling

This section describes the path of both vacuum and air wiring.

Figure 12: Shaft Support mechanical design.

[2] ISO/TS 3669-2:2007(E)

All the commercial elements related to the wiring already selected are listed in Table 7. All references in this specification or in its annexes to specific brands, goods or technical specifications must be understood in the sense of art. 117.4 of the Consolidated Text of the Public-Sector Contract Law, so that the tenderer may propose others, provided that he proves by any suitable means that the solutions he proposes fulfil in an equivalent way the requirements defined in the corresponding technical prescriptions. For this purpose, a technical report by the manufacturer or a test report prepared by an officially recognized technical body may constitute an appropriate means of proof.

Figure 13 shows the back side of the blade. The design includes a fixing screw (A) for the signal cable, intended for the measurement of the current signal incident on the blade. This cable must be positioned from this screw to the vacuum feedthrough through the axis of the instrument.

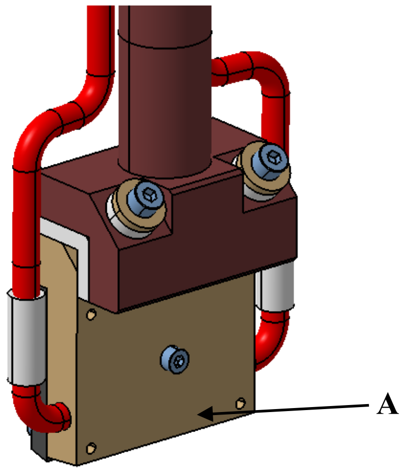


Figure 13: Blade cabling.

An overview of the actuator cabling is shown in Figure 14. The signal cable, represented in red in the figure, is placed from the blade to the triaxial connector located on the vacuum feedthrough (A) and from the vacuum feedthrough to the acquisition box (B). The first section should be coaxial, being compatible with conditions of Ultra High Vacuum. The second section, at atmospheric pressure, shall be composed of triaxial cable.

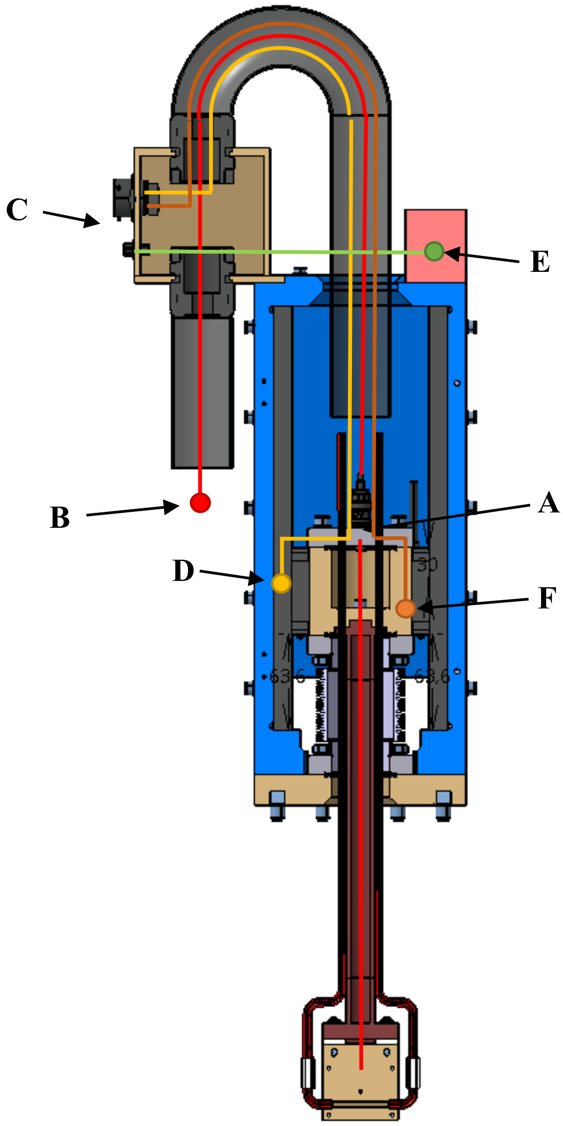


Figure 14: Scraper Cabling.

The limit switches cables are represented in yellow and are placed into the cables protector from the limit switches position (D) to the patch panel (C).

The motor and brakes cables are represented in green and are placed from the motor position (E) to the patch panel (C).

Finally, the encoder cable is represented in orange and is placed into the cables protector from the encoder position (F) to the patch panel (C).

The patch panel should be configured as indicated in Figure 15. A Souriau type connector should be used for the motor and brake connections (A). A LEMO connector (B) should be used for the MPS Limit Switch. Finally, for the rest of the elements two DB9 connectors need to be used, one for the travel limit switches (C) and the other one for the encoder (D).

A connection should be placed on top and bottom sides of the patch panel (E) to fix the cables and cables protectors.

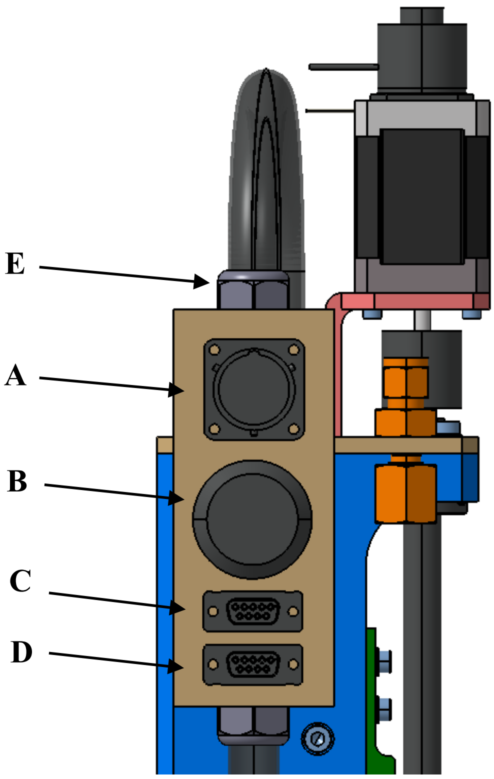


Figure 15: Patch Panel configuration.

The contractor should be responsible for all the cabling and connectors based on the previous indications. The contractor shall also be responsible for the choice of cables based on the following mandatory characteristics[3].

- Requirements for cables in Vacuum Chambers:
    - Halogen free according to IEC 60754-2
    - Low smoke density according to IEC 61034
    - Flame retardant according to IEC 60332-1
    - Non-flame propagating according to IEC 60332-3
    - All cables shall have an overall braided screen made of copper or tinned copper. The braiding may be in combination with an aluminium foil.

- Requirements for cables at atmospheric pressure:
    - Halogen free according to IEC 60754-2
    - Low smoke density according to IEC 61034
    - Flame retardant according to IEC 60332-1
    - Non-flame propagating according to IEC 60332-3
    - XPE, PUR o EPR/EPDM are the recommended isolation materials for cables at this radiation levels.
    - All cables shall have an overall braided screen made of copper or tinned copper. The braiding may be in combination with an aluminium foil.

[3] The documents ESS-0064007 and ESS-0034035 include, in addition to the mandatory characteristics mentioned above, others of recommended use for the selection of cable types.

2.5 Components to be supplied by ESS-Bilbao

ESS-Bilbao shall supply a collection of 3D files of all the pieces of the Scrapers. The list of 3D files is shown on Table 2 and Table 3.

Table 2: Collection of Scraper 3D files.

3D File Name	Description	Material	Units
MEBT-SC-1000-ESS	Scraper		
MEBT-SC-1100-ESS	Blade Assembly		
MEBT-SC-1101-ESS	TZM Plate	TZM	1
MEBT-SC-1102-ESS	Cooling Plate	SS316L	1
MEBT-SC-1103-ESS	Cooling Plate Insulators	Macor	2
MEBT-SC-1104-ESS	Cooling Plate holding piece	SS316L	1
MEBT-SC-1105-ESS	Shaft	SS316L	1
MEBT-SC-1106-ESS	Shaft holding piece	SS316L	1
MEBT-SC-1107-ESS	Insulator washer	Macor	2

Table 3: Colection of Actuator 3D files.

3D File Name	Description	Material	Units
MEBT-SC-1200-ESS	Actuator Assembly		
MEBT-SC-1201-ESS	Guides Support	TBD	1
MEBT-SC-1202-ESS	Rectangular Flange	SS316L	1
MEBT-SC-1203-ESS	Shaft Support	SS316L	1
MEBT-SC-1204-ESS	Spindle Support	SS316L	1
MEBT-SC-1205-ESS	Limit Switches Support	Aluminium	1

MEBT-SC-1206-ESS	Limit Switch trigger 1	Aluminium	1
MEBT-SC-1207-ESS	Limit Switch trigger 2	Aluminium	1
MEBT-SC-1208-ESS	Encoder Support	Aluminium	1
MEBT-SC-1209-ESS	Motor Support	Aluminium	1
MEBT-SC-1210-ESS	Patch Panel	Aluminium	1
MEBT-SC-1211-ESS	Patch Panel Box	Aluminium	1
MEBT-SC-1212-ESS	Cooling feedthrough support	Aluminium	1
MEBT-SC-1213-ESS	Mechanical Limit	Aluminium	2

2.6 Blueprints

The contractor will be responsible of elaborate all the blueprints of every piece of the Scraper and Actuator designs. The contractor will be also responsible of the choosing of all the tolerances to assure the requirements described on section 2.2. The blueprints should be checked and approved by ESS-Bilbao prior to the fabrication.

2.7 Materials

The Contractor must purchase all the materials for the fabrication of all the components of the six Scrapers, including the materials required in Table 2 and Table 3. The materials must be verified according to internationally recognized standards (AISI).

The TZM plate (MEBT-SC-1101-ESS) will be fabricated with TZM grade 363/364. A surface treatment should be applied to the plate to eliminate machining defects and reach roughness of ~ 1 μm.

The following material are prohibited in Ultra High Vacuum Applications[4].

- Brass
- Standard Hard Solder
- All Plastic
- Silicon of Sulphur based machining lubricants when machining any components (only water-soluble machining lubricants are permitted)
- Any material containing: Zinc, Cadmium, Phosphorus, Sodium, Selenium, Potassium or Magnesium
- Soft Solder
- Electrical Solder
- ASTM tipe 303
- Free cutting stainless steel
- All Glues and Greases
- GE Varnish
- Anodized surfaces or any mechanically polished components

2.8 Manufacturing

The Contractor must propose in a conceptual way the fabrication process to follow to ensure the compliance with the specifications described on section 2.2.

The fabrication method must be compatible with 10-7 mbar vacuum applications[5]. To ease preparation for vacuum cleaning, the machining liquids must be free of silicones and halogens to avoid contamination of the material. The contractor must propose the type of cutting oil to be used and the characteristics of it, to ensure that the material is not contaminated.

The surfaces must be milled or turned. No surface of any of the vacuum component shall be terminated any type of mechanical abrasion.

[4] As specified by the ESS Vacuum Handbook Part 1.
[5] As specified by the ESS Vacuum Handbook Part 3.

The under vacuum components are listed in Table 4.

Table 4: Under vacuum components.

3D File Name	Description
MEBT-SC-1100-ESS	Blade Assembly
MEBT-SC-1202-ESS	Rectangular Flange
MEBT-SC-1203-ESS	Shaft Support (inner faces)

2.9 Vacuum elements mechanical unions

The mechanical fastening elements (screws, etc.) in vacuum should be silver plated and especially suitable for Ultra High Vacuum applications. The mechanical unions will be made avoiding the possible appearance of air traps[6].

The fastening elements for all the closing vacuum elements should be also silver plated to avoid possible screw thread damage.

2.10 Welded joints.

The welds will be executed by professional welders certified according to ISO standards for steel.

Vacuum welds shall be made by the TIG method. The use of other types of welding processes will be notified to ESS-Bilbao for approval.

The standards that apply to welding procedures are:

- ISO 9606-1: 1994 Approval testing of welders — Part 1: Steels
- ISO 15614-1: 2004 Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys
- ISO 5817: 2005 Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections

As a reference, the contractor can consult the document "ESS Vacuum Handbook Part 3 - ESS Vacuum Design & Fabrication"[7].

[6] As specified by the ESS Vacuum Handbook Part 3.
[7] ESS Vacuum Handbook Part 3.

2.11 Cleaning

Prior to delivery to ESS-Bilbao, all the components must be cleaned in order to be ready for the assembly. All the surface of the pieces to be placed under vacuum listed in Table 4 should be provided free of contamination, grease, or other substances no Ultra High Vacuum compliance[8].

The Contractor shall establish and deliver together with the tender a detailed cleaning procedure appropriate to its manufacturing facilities. The procedure, including the properties of the cleaning products selected, will be submitted to ESS Bilbao for approval.

2.12 Storage, packaging and shipping

The contractor is responsible for storage, packaging and transportation to the ESS-Bilbao facilities all the components listed in Table 2 and Table 3. The Contractor shall ensure that the equipment is stored in an area where the condition of the components is not altered[9].

The Contractor shall propose a packaging system to send the manufactured parts to the ESS Bilbao facilities.

The packaging must protect all the components against any types of hazards that may occur during transportation.

[8] As specified by the ESS Vacuum Handbook Part 3.

[9] As specified by the ESS Vacuum Handbook Part 3.

3 Verifications and tests

3.1 Verifications to be done by the contractor

All the pieces will be subjected to complete metrology campaign. All the tolerances less than 0.1mm of all the pieces directly related to fulfilling the specifications commented in section 2.2 should be documented as a part of the **Manufacturing and Quality Assurance** documentation. The Contractor shall submit its proposed metrology procedures for approval to ESS-Bilbao.

ESS-Bilbao reserves the right to be present, or be represented by an external organization of its choice, to follow all the tests carried out by the contractor or one of its subcontractors. The Contractor must notify at least 10 business days prior to the proposed date of any of such test.

The Contractor shall supply all tools, equipment and personnel necessary to perform all the tests required to ensure compliance with the specifications.

Verifications to be carried out by the contractor are specified in the following subsections.

3.1.1 Raw Material

The contractor shall include all the documentation of all the chosen material, including the mechanical properties as well as the chemical composition.

3.1.2 Metrology

The contractor shall deliver a Manufacturing and Quality Assurance document including all the measurements and test of the distance with tolerances under 0.1mm of all the pieces directly related to fulfilling the specifications commented in section 2.2.

3.1.3 Hydraulic tests

The refrigeration circuit must be pressurized up to 16 bar to verify the absence of leakage and correct assembly of the different components. After one hour, the pressure must be reduced by less than 2% compared to the initial pressure (0.3 bar). After the test, the channel should be emptied and dried properly with compressed air.

3.1.4 Prueba de detección de fugas

Leak testing must be performed according to EN 1779 - A1 with a calibrated UHV leak detector connected to one of the CF vacuum ports, covered with a helium-filled plastic wrap for 10 minutes. The result should not give an overall leakage rate greater than $2.0 \cdot 10^{-11}\ Pa \cdot m^3/s$ ($2.0 \cdot 10^{-10}\ mbar \cdot l/s$) at room temperature[10]. The Contractor shall submit its proposed leak detection equipment and procedures for approval to ESS-Bilbao.

If before the test of leakage, the circuit has been subjected to tests of pressure with water will be necessary to realize a bake-out. Bake-out is necessary to remove water which, freezing during the pump down, could create a virtual leak. The test sequence should be: water pressure test, bake out (100 ° C for 12 hours), leak detection.

3.1.5 Electrical testing

The Contractor must perform an operation test to verify the correct functioning of the system of acquisition of the signal induced in the blade due to the impact of the ion beam.

The test will evaluate that the cable connections are correctly made and no loss of current or parasitic current is observed. This test will be performed with an external voltage source directly connected on the TZM plate. The tests will ensure that the collector current is the same on the external BNC port. The tests shall be carried out with a rated current of 1 mA.

[10] As specified by the ESS Vacuum Handbook Part 4.

3.2 Verifications to be carried out by ESS-Bilbao

ESS-Bilbao reserves the right to repeat all the tests listed in Section 3.1 before giving appropriate acceptance. These acceptance tests will be carried out within a maximum of one month from the delivery at the ESS-Bilbao facility.

The Contractor will be informed of any detection of non-compliance with the requirements. In his case, the Contractor may, at his expense, send an inspector to verify the findings of ESS-Bilbao. The parts that prove to be unsatisfactory will be returned to the contractor, at their cost, for repair or replacement according to a written program of mutual agreement.

4 Delivery

4.1 Provisional Delivery Calendar

Table 5: Delivery Calendar

Milestone	Delivery Term
Contract Formalization	T0
Delivery of Blueprints	T1 = T0 + 1 month
Acceptance of Blueprints	T2 = T1 + 1 month
Manufacture and delivery of Scraper 1 and Verification Documents	T3 = T2 + 2 months
Acceptance of Scraper 1	T4 = T3 + 1 month
Manufacture and delivery of 2, 3, 4, 5 and 6 and Verification Documents	T5 = T4 + 4 months
Acceptance of 2, 3, 4, 5 and 6	T6 = T5 + 2 month
Total Duration of the Project	**11 months**

In no case will the delivery date exceed 11 months after contract formalization.

4.2 Acceptance and guarantee

Acceptance will be given by ESS-Bilbao only after all the articles have been delivered in accordance with the conditions of the documentation, all the specified tests have been successfully completed and the complete records of the metrology, tests and other certificates have been supplied to ESS-Bilbao. The Contractor shall supply to ESS-Bilbao the complete documentation within a maximum of **five working days** before each shipment of equipment manufactured for ESS-Bilbao.

5 Other conditions

Compliance with the business obligations established by the Law on the Prevention of Occupational Risks, as well as the regulations and regulations that may be applicable in your case vr. Gratia (Technical Building Code, RD 314/2006 of 17 March, RD 1836/1999 Regulation on nuclear and radioactive facilities, RD 783/2001 Regulation on health protection against ionizing radiations, Regulations on Workplaces, etc.). The process of development of the work or activity, object of the specifications, shall be considered as many measures as are necessary to comply with the Green Public Contracting Plan of the General Administration of the State and its Public Agencies and the Social, Order PRE / 116/2008, of 21 January.

5.1 Follow-up of work in progress

The Contractor shall assign a responsible person for the technical execution of the contract and its monitoring.

A one-page written report detailing the progress of the production situation will be sent to ESS Bilbao every two weeks until the end of the contract.

5.2 General Directives

The contractor will follow the following EU directives for the manufacture of the product:

- 2006/42/EC Machinery’s essential health and safety requirements
- 2014/35/EU Low Voltage Directive
- 2014/30/EU EMC emission and immunity
- 2014/68/UE Pressure Equipment
- 2011/65/EU RoHS Restriction of Hazardous Substances in Electrical and Electronic

6 Technical Documentation

The Technical documentation will be presented in the form required in the Specific Administrative Clauses and signed by the legal representative of the company.

In the technical documentation envelope, in addition to the two copies requested, a copy of this documentation in electronic format will be included. The inclusion of such support does not exempt from the delivery of documentation as required by the Specific Administrative Clauses.

7 Contact

Table 6: Contact information

Name	Telephone	E-mail
Álvaro Vizcaíno	+34 94 607 68 56	avizcaino@essbilbao.org
Ibon Bustinduy	+34 94 607 68 51	ibustinduy@essbilbao.org

Annex I: Commercial components recommended

Table 7: Commercial components recommended in 3D design

Name	Supplier	Item Reference	Units per SC
Linear Guides	NSK	N1S15	2
Skids	NSK	NAS15EMZ	2
Encoder	SIKO	MSK 1000	1
Encoder Connector	--	DB9 Type	1
Limit Switches	OMRON	SS-01GL2-E	3
Limit Switches Connector	--	DB9 Type	1
MPS Limit Switch Connector	LEMO	EGG.4K.312.CYM	1
Spindle	NSK	VSP1205N1D0500PP	1
Spindle support	NSK	WBK08-11	1
Stepper Motor	NANOTEC	ST4118D3004	1
Motor and Break Connector	SOURIAU	UT00128SH	1
Break	NANOTEC	BKE-0.4-5.0	1
Bellow	VACOM	*Custom-made.*	1
Vacuum Feedthrough	ALLECTRA		1
Coaxial vacuum cables	ALLECTRA		0.5m
Triaxial air cables	ALLECTRA		2.5m
Cooling Hose	SWAGELOK		
Cooling Feedthrough	SWAGELOK		

**The same or equivalent component should be used.*

Annex II: Motor axis torque calculations

All the calculation of torque has been done considering the actuator in vertical position as the worst-case scenario.

The torque calculation could be divided in two main components: the torque due to inertias during acceleration and the torque due to static forces. In this case, due to a low value of velocity and acceleration, the torque due to static forces will be the dominant factor of the equation so the calculation will be done without the consideration of inertias.

There are two static forces to be considered: the weight of the load and the atmospheric pressure over the vacuum flange. In the worst case, when the motor is pulling the load, the total force applied is the summation of the two.

Considering a total weight of the instrument to move inside the vacuum vessel of $m_L = 4Kg$ the force due to this mass could be calculated as:

$$F_L = m_L \cdot g = 39.2N$$

The force produce by the atmospheric pressure over the flange could be calculated as $F_P = \Delta P \cdot EA$, where ΔP is the pressure difference between the vacuum and atmospheric pressure (in N/m2 units) and EA is the Effective Area of the selected bellow (m2), in this case a CF40 Bellow.

Considering a pressure difference of $101325 \, {}^{N}\!/_{m^2}$ and an effective area of the bellow of $0.00273m^2$ the force due to the atmospheric pressure over the vacuum flange is:

$$F_P = \Delta P \cdot EA = 276N$$

The total contribution of static forces is:

$$F_T = F_L + F_P = 315.82N$$

Considering a pitch of the spindle of $p = 5 \, {}^{mm}\!/_{rev}$ the total torque applied by the motor is:

$$T_T = F_T \cdot \frac{p}{2\pi} = 0.251Nm$$

With this value of torque a commercial motor and a commercial break from NANOTEC have been selected. The reference of this motor and break can be consulting in Table 7.

The evolution of the torque applied by the motor with respect to the velocity of the instruments is shown in Figure 16.

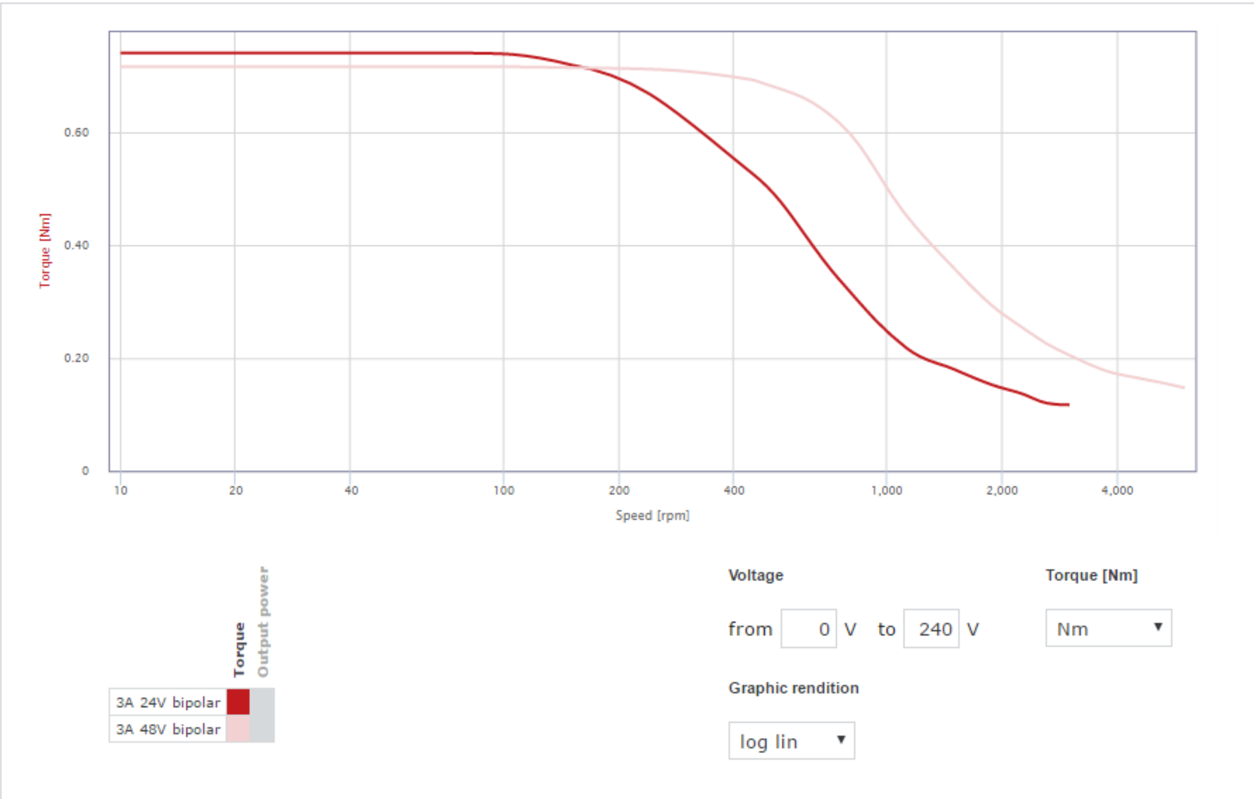


Figure 16: Torque/Velocity curves of motor ST4118D3004

Considering a spindle pitch of $p = 5\,{}^{mm}/_{rev}$ and an instrument linear velocity of $10\,{}^{mm}/_{s}$ the angular velocity of the motor axis is 120 rpm. This angular velocity is in the range of maximum torque of the curve.

The selected break has a holding torque of 0.4 Nm. Considering the calculated value of torque this value of holding torque is enough to maintain the instrument in position during a power failure.

Annex III: Linear guides stiffness considerations

One of the most important parameters of the linear guides is the stiffness, the declination of the instrument with respect to the pitching moment applied to the linear guide.

A simplified calculation has been done to validate the using of this model of linear guide in the particular case of the Scraper actuator. Therefore, a single linear guide has been considered in this calculation to move the instrument inside the vacuum vessel.

The momentum applied to the linear guide by the instrument could be calculated as:

$$M = W \cdot D \cdot \sin\theta$$

where W is the total weight of the instrument, D the distance between the clamping face and the centre of inertia of the instrument and θ the angle between the vector W and the axis of movement of the instrument.

Considering a total weigh of 3.4 kg, a distance between the clamping face and the centre of inertia of 150 mm and an angle of 45º the momentum applied is:

$$M = 34 \cdot 0.15 \cdot \sin(45^{o}) = 3.6Nm$$

The Figure 17 shows a graphic with the declination of the instrument with respect to the pitching moment applied to a N1S15 Linear Guide. Using the momentum calculated previously the instrument will have a declination of $1.4 \cdot 10^{-4} rad$.

Considering a total distance of the instrument of 325 mm, the total displacement of the Scraper tip will be:

$$d = 325 \cdot tg(0.008) = 45\mu m$$

With the consideration of using only one linear guide a total displacement of the Scraper tip of $45\mu m$ will appear. This value will be reduced in the real model with two linear guides placed one in front of the other.

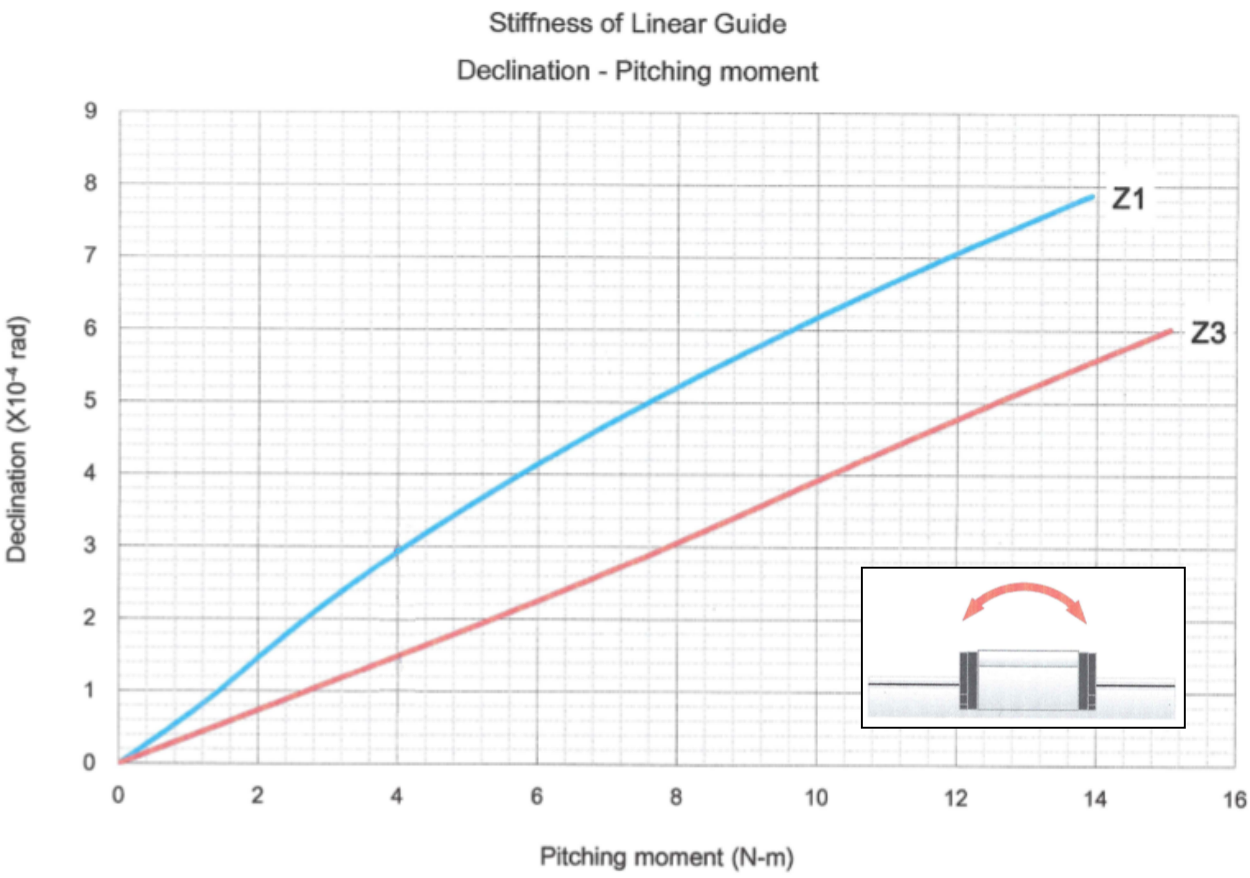


Figure 17: Stiffness of Linear Guide N1S15 from NSK

Annex IV: Limit Switches functionality

The limit switches position and functionality of the actuator are shown in Figure 18. Two limit switches should be used to have a reference of the blade travel between the initial point to the final point. The total distance between this two limit switches should be 60 mm. These limit switches should be close in the initial or final position and remain open during the rest of the travel.

An additional limit switch should be added for Machine Protection System purposes. This limit switch should be placed as close as possible of the initial SC travel limit switch. The MPS switch should be close when the blade is in parking position and should remain open during the blade travel.

Two mechanical limits should be placed to avoid collisions or bellow damages in case of a limit switch failure. The mechanical limits should be placed with a distance of 80 mm between each other and a distance of 10mm to the initial or final SC travel limit switches .

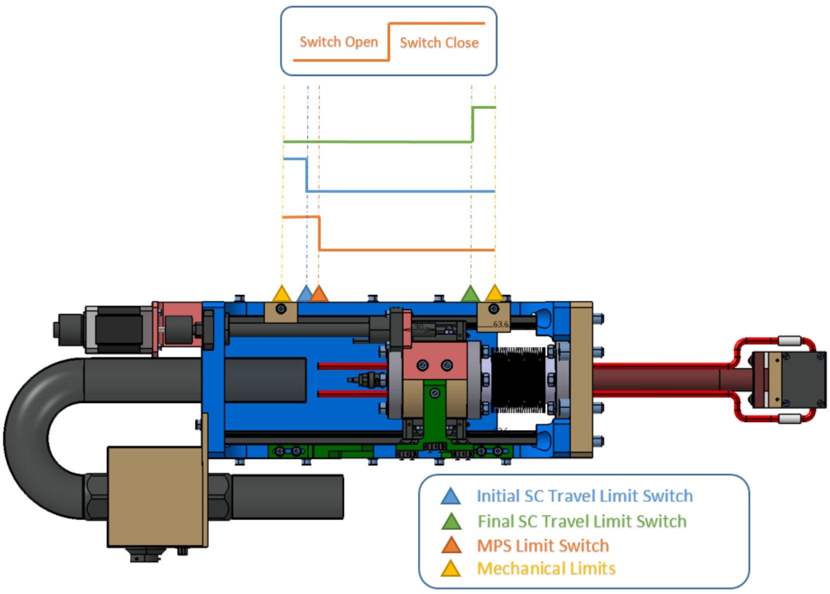


Figure 16: Switches position and finctionality