

## **Description of the Subject of Public Procurement**

### **A set of devices and components between the storage ring and the beamline, referred to as the Front end**

The purchase is carried out as part of the investment project Construction of a beamline for research using small-angle X-ray scattering financed by the Ministry of Science and Higher Education (IA/SP/564156/2023)

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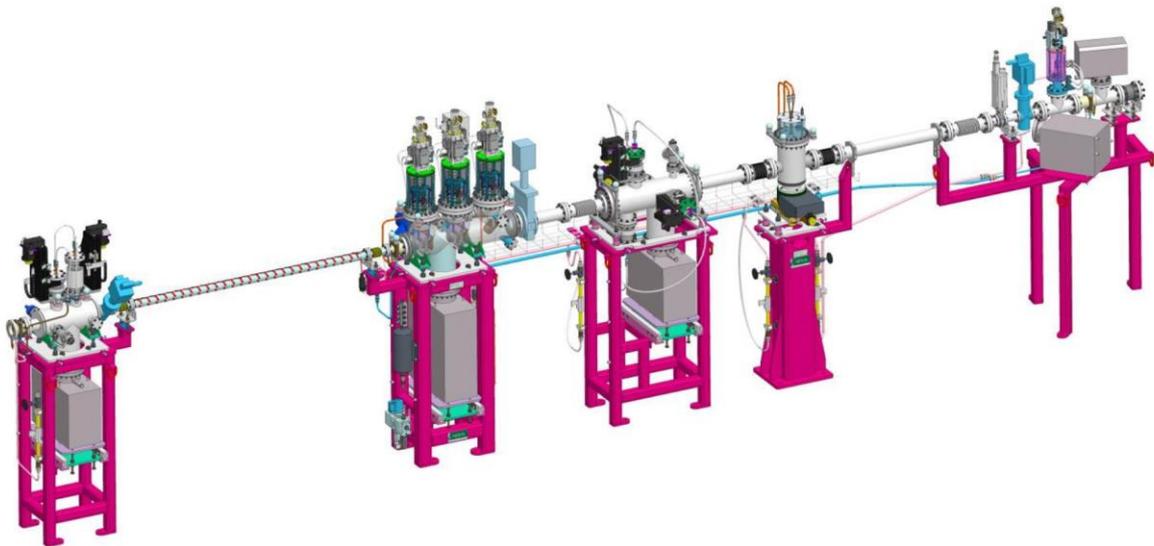
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## 1 General information

The object matter of the procedure (order) is the design, manufacturing, testing and delivery of a set of devices between storage ring and SMAUG beamline (constructed within IA/SP/564156/2023 project coordinated by Adam Mickiewicz University, Poznań – hereinafter called: AMU or Purchaser), hereinafter called as front end or in short FE, and related subsystems like compressed air components, cooling tubes, cable trays together with required documentation at National Synchrotron Radiation Centre SOLARIS (hereinafter called: SOLARIS).

Within the scope of the Agreement, the Contractor is required to provide a suitable design of the mechanical system of the complete front end section (including 3D designs) in consideration of the required parameters and edge conditions such as the existing infrastructure of the storage ring and synchrotron radiation source characteristics.

SOLARIS has a conceptual design of the FE section with the possibility of using it in the purchasing process under this tender (Figure 1). SOLARIS has only general assemblies of individual subsystems without manufacturing drawings, hence the need for the Contractor to design individual components. Any modifications such as excluding or adding components or changing the order between individual components shall be indicated already in the tender offer phase and require the Ordering Party's acceptance latest in the preliminary design phase. Description and general functional assumptions of particular front end components can be found in Appendix FE1-BM.



*Figure 1. The front end section layout together with cooling water system and compressed air components.*

The SOLARIS synchrotron is the 3<sup>rd</sup> generation source of the electromagnetic radiation based on the 1.5 GeV storage ring. It is characterized by a low emittance of 6 nm·rad, and the maximum current of the electron beam of 500 mA. The magnetic lattice of the ring is composed of 12 identical achromatic “cells” – Double-Bend Achromat (DBA) each of which constitutes a single, iron block. Twelve straight sections have been designed each of 3335 mm

in length. Ten of them will be available for different types of devices generating electromagnetic radiation (insertion devices).

The parameters of the radiation source are presented in the Appendix SOURCE. These are the starting data for calculations of the bending magnet (BM) x-ray optics of the front end section and thermal loads of the front end components.

Abbreviation glossary

PDR = preliminary design review

FDR = final design review

FAT = factory acceptance test/tests

SAT = site acceptance test/tests

FE = the set of devices between storage ring and beamline, called as the front end

BM = bending magnet

## 2 *General specification of the scope of delivery*

Contractor undertakes to deliver to the Purchaser a complete front end system as well as all necessary vacuum components according to SOLARIS standards (Appendix VAC1 and VAC2). The front end will be installed in the storage ring tunnel section 02FEBM.

The front end is made up from ultra-high vacuum components (UHV) mounted on supports with the control, pneumatic and cooling water systems.

The main tasks of the FE are the following:

- Protection of personnel and devices against radiation and enabling safe access into the optics hutch, when the beamline is closed,
- Limit/restrict the thermal load from the synchrotron light for the components located downstream of the front end section,
- Protection of the vacuum in the storage ring and ensuring pumping system and pressure level measurement in this section,
- To monitor the position of the synchrotron light.

### 2.1 *The detailed scope of delivery*

The detailed scope of delivery is listed in the following sections.

#### 2.1.1 *Included*

- a) Design and delivery of the Front end components with supports for one complete set including chambers, devices, connection pipes, bellows, consumables as necessary for the FE section assembly (screws, washers, caps, seals, connectors, etc.) and all other nonstandard tools.
- b) Pneumatic and cooling system design and construction (pneumatic actuators, compressed air installation within particular component and between chambers constituting one complete system, water flow switches, flexible cooling pipes, water cooling installation between chambers and within particular component constituting one cooling system).

- c) In- and ex-vacuum cabling, electrical connectors in a common interface box (patch panel) for each girder. The design of the internal wiring of the units is the responsibility of the Supplier.
- d) Vacuum components according to standards for Solaris described in Appendix VAC1 and VAC2 (vacuum valves – all metal gate valves, all metal angle valves, fast valve; ion pumps; residual gas analyzer (RGA); vacuum gauge for triggering fast valve).
- e) Preliminary design report and final design report.
- f) Power supplies and controllers (for ion pumps, fast valve, vacuum gauge for fast valve, RGA, cables between controller and device for: fast valve, gauge and RGA).
- g) Motors, encoders and limit switches.
- h) Report analyzing the thermal behaviour of heat absorbers, fixed apertures, cooling safety shutters and movable slits.
- i) Technical and engineering drawings, assembly drawings and 3D models.
- j) Functional description or manuals.
- k) The Factory Acceptance Tests (FAT), supervision of the Contractor's employee (if required by Contractor) during the SAT performed by the Awarding Authority at SOLARIS, including the training of the Ordering Party's representatives in handling the subject of the contract performed during FAT.

#### *2.1.2 Excluded*

- a) Motion control hardware (controllers and drivers). Appendix CS1 contains details of the motion control standard at SOLARIS.
- b) Installation of the front end vacuum chambers and components with supports, obtaining UHV conditions.
- c) Control system (configuration, installation, GUIs).
- d) The synchrotron radiation filters for installation in the Filter Assembly.
- e) Diagnostic measurement devices and controllers (Libera Photon for XBPM, camera for fluorescent screen).
- f) Cabling (buying, laying, prefabricating and connecting cables) between components/patch panels and rack. Except delivery of cables for fast valve and triggering vacuum gauge.

#### *2.1.3 The elements and scope of work delivered/made by Purchaser*

The elements and scope of work described in the following points will be delivered/made by Purchaser.

- a) The CCD camera used for the beam visualization on fluorescent screens will be delivered by Purchaser.
- b) Frame/backbone infrastructure for the front end section. In the direct vicinity of the components Purchaser is to install all the necessary IT network terminals, electrical switchgear for predefined sockets and electronic racks, sets of signal cables, cooling water and compressed air lines. This also concerns carrying posts for infrastructural installations. The cooling water and compressed air pipes will be run to main manifold connectors situated directly on the Contractor delivered equipment or suitable connection

boards mounted on the equipment supports according to specifications in the Appendix WAT-CW1 and WAT-CA1.

- c) PLC Safety System for the FE and storage ring protection. MPS and PSS – design, detailed coordination, performance and installation of the system as per the guidelines presented by the Contractor.
- d) Configuration of all controllers, power supplies, equipment, electronics, diagnostic elements into a complete set.
- e) Electronic devices and controllers for the front end diagnostic elements, i. e. XBPM readout module with dedicated cabling, HV power supplies.
- f) Providing connection to the mains for the controller/s and driver/s.
- g) Providing Ethernet connection between the racks, network switches and control system computers.
- h) Providing the IT infrastructure for the controller, i.e.: servers, network switches and cabling, connection to the desired server, placing in the rack cabinet.
- i) Providing Tango Controls system backbone including properly configured virtual machines, Device Servers for SOLARIS standard devices as well as integration of all control system (including Device Servers supplied by the Contractor).
- j) Providing GUI-s.
- k) Providing Control System computers with the operating systems if needed.
- l) Providing IcePAP controllers for the motors/encoders and their configuration.
- m) Cables and installation of cables for the motors of slits, shutters, movable masks etc. for the progressive/translation and rotary motions where applicable, from the racks with IcePAP controllers to the patch panels located on the support of the motorized element.
- n) Purchase and installation of cables for the standard vacuum components except fast valve, gauge triggering fast valve and RGA.
- o) Electronic equipment racks. The Purchaser provides the racks of a selected type for the front end components.
- p) Reflectors for the front end vacuum chamber geometry measurements will be ensured by Purchaser.
- q) Sub-assembly transport within the area of the synchrotron is to be ensured by the Purchaser employees. The weight limit for the individual unit is 8 tons.

## 2.2 *Requested information*

- a) The tender shall include sufficient information to evaluate the performance of the front end. In particular power density performance, photon beam exit stability and possibility for accurate determination of the photon beam position are important for the operation. These subjects should be described in detail and if possible accompanied with suitable reference systems. The heat load calculations can be postponed to the final design meeting.
- b) The vendor shall provide a table of proposed motor and encoder models for each motorized axes, including range, repeatability, full step motion resolution and accuracy of each movement. All required data are subscribed in the Appendix CS1.

- c) The vendor shall at latest at the preliminary design review (PDR) provide a table of required ion pumps and TSP pumps (if necessary) including pumping capacity.
- d) The vendor shall state any preliminary requirements on the cooling water e.g. flow, supply pressure etc. or other media to be supplied by Purchaser.
- e) The vendor must present at the final design review (FDR) meeting a list of recommended spare parts including prices.

### 2.3 The main limitations and list of components

It has to be emphasised that a major limitation for the ordered set of components is the distance between the external flange of the storage ring and the proximate surface of the ratchet wall and additional iron and lead shielding and lateral limitations for supports and devices related with bending magnet front end section. One has to take into consideration available space for the location of the supports and individual elements of the FE. The more detailed information concerning space limitations is given in the Appendixes MECH1, MECH2, MECH3-BM02, MECH4-BM02, MECH5-BM02 and MECH6-BM02.

The Contractor shall verify the entire thermal power load and thermal power density Accepted by the individual elements of the front end and prepare a relevant project in consideration of the instability and possible damage caused by increased temperature. The FE shall be provided with the fixed masks, heat absorber (photon shutter), slits and cooling safety shutter absorbing the entire power heat load generated by the BM source.

The Contractor will design, manufacture and deliver complete front end section with compressed air and water cooling system of particular components. The FE section will be connected with water cooling infrastructure by Purchaser using flexible tubes (delivered by SOLARIS) connected to main manifold of water inlet and outlet of the FE section (for details see the guidelines for the scope of the project and execution of the compressed air and the cooling water system given in Appendix WAT-CA1 and WAT-CW1, respectively).

The front end shall comprise the following elements (starting from the source), see *Table 1*.

<b>Component</b>
The storage ring vacuum system – finished with DN63 CF flange (SOLARIS site)
Edge welded bellow and pumping unit (ion pump no 1 – IP1)
Fixed mask1 (FM1)
Heat absorber (HA) [photon shutter]
All metal gate valve 1 (V1)
Fast valve 1 (FV)
XBPM
Movable aperture (vertical and horizontal slits) with IP2 (SLITS)
Gate valve 2 (V2)
Fluorescent screen (FLSC)
Safety shutter-stoppers (SS1 & SS2) with IP3
Fixed mask2 (FM2)
Ratchet Wall beam pipe

Gate valve 3 (V3)
Filter assembly and trigger unit with IP4 (FATU)
Beryllium window (BW)
Standard vacuum components (ion sputter pumps, all-metal gate valves, all-metal angle valves, fast valve (FV), gauge triggering FV, RGA, controllers for vacuum components (IPs, RGA, FV, gauge)

*Table 1. The list of the main components for the complete front end section.*

Description and general functional assumptions of particular front end components can be found in Appendix FE1-BM. The Appendix FE2 contains top assemblies of the front end section fragments and conceptual drawings of technical solutions for some elements, including: fixed masks, heat absorber, system of movable slits, safety shutters with cooling and filter holders.

The front end section contains several standard vacuum components (ion pumps, gate and angle valves). The table below is a list of standard vacuum components used in vacuum chambers according to the conceptual design. The number of pumps and the selection of the required pumping speed to obtain the desired base vacuum are the responsibility of the Contractor and depend on the technical solutions for individual elements. The table below is a general assumption for the conceptual design of individual vacuum sectors

Vacuum component	Model	Amount
Ion pump	75S-DI-4V-SC-220-N	1
Ion pump	300T-DI-8S-SC-220-N	2
Ion pump	500T-DI-8S-SC-220-N	1
All-metal angle valve	54132-GE02-0001	4
All-metal angle valve	54136-GE02-0001	1
All-metal gate valve	48132-CE44-AHJ1	2
All-metal gate valve	48236-CE44-AHJ1	1
Fast valve	75232-CE44-0006	1
Fast valve controller (contain sections: fast closing system VF-2, HV sensor x 2, control and valve)	770VF-16NN-AHN1-0026	1

*Table 2. List of standard vacuum components used in the front end section.*

### *3 Additional conditions*

#### *3.1 Schedule (design, manufacturing, delivery)*

The Contractor has to present a detailed schedule of all the activities referred to in these terms of reference.

- a) The time schedule shall contain milestones (design reviews, tests and delivery) and give a

rough overview about the design and manufacturing process that allows for an easy communication of the project progress.

- b) The time schedule shall contain delivery dates etc. for all parts to be provided by the Purchaser.
- c) The time schedule shall contain dates/periods for meetings, on-site visits etc.
- d) The time schedule shall contain delivery dates for documentation prior to milestones.

<b>Milestone</b>	<b>Points to fulfil before the milestone is considered completed</b>	<b>Deadline</b>
Start up meeting/video-conference	Time schedule	Until the end of 1 <sup>st</sup> month from signing the contract
PDR (Preliminary Design Review)	The Contractor should have identified all technical issues and proposed technical solutions	Until the end of 3 <sup>rd</sup> month from signing the contract
FDR (Final Design Review)	Detailed design completed. Acceptance of FDR by the Contracting Authority gives approval prior to manufacturing.	Until the end of 5 <sup>th</sup> month from signing the contract
FAT (Factory Acceptance Tests) and training	Agreed tests should have been completed by the Contractor and approved by Purchaser. Local staff has been trained by the Contractor with respect to proper maintenance and safe service of the provided equipment.	Until the end of 17 <sup>th</sup> month from signing the contract
Delivery of the front end components	The goods should have been delivered to the agreed address and inspected for possible damage.	Until the end of 17 <sup>th</sup> month from signing the contract
SAT (Site Acceptance Tests)	Agreed tests should have been completed by Purchaser under supervision of the Contractor (if required) and the delivered equipment should have passed all performed tests successfully.	Until the end of 19 <sup>th</sup> month from signing the contract

Table 2. The time table of the project with main milestones (TBD – to be defined)

### 3.1.1 Preliminary and final design review

A preliminary design review (PDR) and a final design review (FDR) shall be foreseen. The approval is to be granted within 2 weeks from obtaining all necessary documents related with certain review/milestone. The UAM and SOLARIS approval will be limited to examination of the design with respect to the requirements stated in the technical specification of the Object of the order and the Contractor's offer. Any approval does not influence the

Contractor responsibility for the overall performance and achieving the required operating characteristics.

All communication shall be in English. The Contractor shall appoint a project manager who throughout the whole undertaking acts as key contact for Purchaser. Meetings can take place at the Purchaser or at the Contractor's site or via video conference. All parties shall cover for their own travel and hotel expenses and will not be reimbursed by the other party.

Preliminary design shall contain:

- a) Technical description of the front end components,
- b) Preliminary scheme of the cooling system for all delivered components requiring water cooling,
- c) Preliminary scheme of the compressed air system,
- d) Number and type of motors for motorized axes, number and type of required encoders.

Final design shall contain:

- a) Detailed technical description of the front end components,
- b) The 2D and 3D model and drawings of the front end components including all elements with defined position of all required connectors (water, compressed air, power plugs, cable connectors, patch panels, etc),
- c) Finite element analysis calculations for elements exposed to synchrotron radiation (allowing estimation of the maximum temperature and cooling efficiency of the proposed solution). It is required to provide calculations at least for first fixed mask, heat absorber, slits and safety shutter-stoppers,
- d) Detailed scheme of the electrical wiring and supply,
- e) Detailed scheme of the cooling system for all delivered components requiring water cooling,
- f) Detailed scheme of the compressed air system for all delivered components requiring compressed air,
- g) Final list for the motorized axes (number and type of motors for motorized axes, number and type of required encoders),
- h) All the necessary information necessary to design the control system of the front end section,
- i) The list of the scope of installation work for both Parties.

The acceptance of the FDR for particular components of the front end section by Purchaser gives approval prior to their manufacturing.

*3.1.2 Factory and site acceptance tests*

The Contractor shall foresee witness points during the assembly of critical parts. The FAT and SAT shall be foreseen. The scope of the FAT and SAT shall be agreed at the FDR meeting. The Contractor shall submit an agenda for the FAT. The agenda for SAT should be agreed between both Parties depending on installation obligations. Each Party shall submit an agenda for the SAT for their scope of work.

During Factory Acceptance Tests all standard tests shall be performed (vacuum tests,

hydraulic function tests, mechanical metrology on all motorized motions, all electrical components shall be tested). The Contractor has to provide hardware and software needed to perform all tests of motion. All electrical components (switches, temperature sensors etc) shall be tested at the FAT. All the tests are described in this document in section *4.1 Factory acceptance tests*. The front end components should be prepared for installation. The Supplier shall mount all components on each respective frame belonging to one support. The Supplier shall align all components on each respective frame with respect to each other and to the fiducialization points and provides fiducialization data.

The Purchaser shall conduct the SAT under supervision of the Contractor (if required) no later than two months after accepted assembled delivery. All necessary consumables as necessary for the front end section assembly (screws, washers, caps, seals, connectors, required cooling water and compressed air circuits prefabricated components, etc.) and all other nonstandard tools will be delivered by Contractor. At the SOLARIS site, the pre-assembled sub-systems on each dedicated support will be aligned and checked. The documentation describing safety procedures during the assembly and disassembly process of each subassembly and the whole system should be provided to Purchaser and SOLARIS centre not later than one month prior to the delivery of a particular sub-assembly. Few pumping stations equipped with the turbomolecular pump with required pumping capacity and quadrupole mass spectrometer as well as bakeout controllers with heating tapes and thermocouples, bakeout jackets and aluminium foil will be provided during SAT by Purchaser. The SAT should be planned without photon beam in front end part. It is impossible to test the Front end components at full heat load within the scope of the SAT. The Purchaser therefore expects that the Supplier takes responsibility for obtaining required base pressure with photon beam in that section and for failure free performance of the Front end components under full heat load within the warranty.

### *3.1.3 Installation*

The installation process for the front end section can be performed during facility shutdown period and will be performed by Purchaser after contract finish.

## *3.2 Design and drawings of the front end section*

### *3.2.1 General requirements*

The detailed design shall contain a geometrical scheme of the front end vacuum chambers based on calculations and simulations confirming the achievement of the section specification. The AMU and SOLARIS approval will be limited to examination of the drawings with respect to vacuum and functional suitability of the design and does not influence the Sellers responsibility for the overall performance. The drawings must be updated as a result of any modification (as-built drawings). On completion of the contract (latest together with the delivery of the Front end elements) the Contractor shall supply hard copy and one soft copy of the assembly drawings and the manual (including technical data, procedures for system assembly, disassembly, maintenance and service).

The Contractor will provide guidelines and detailed information (described below) which

will be the base for design and construction of the whole section infrastructure. All design guidelines for compressed air, water cooling, electricity, signal cables and IT infrastructure shall be delivered together with the FDR meeting report. All data required for the motorized axes configuration (see Appendix CS1) shall be delivered within 2 months from the design approval (FDR meeting).

### *3.2.2 Mechanical requirements*

The design will be provided in 2D (DWG or DXF) and 3D (STEP or IGES) formats and will include the location of the components: vacuum components and vacuum chambers, together with supports. The drawings will be the base for the project of the infrastructure (power electrical installation, low-current cable installation, cooling water and compressed air installations, IT infrastructure, radiation protection shielding and PLC system).

### *3.2.3 Electrical requirements*

The Contractor will present an ideographic diagram of electrical and signal installation for all components of the front end. Also provided shall be requirements for sockets, interfaces located in the front end section. The Contractor will provide guidelines for the low-current installation design (signal cables) – location of the connection points at the devices and their types (2D and 3D models).

### *3.2.4 Cooling water and compressed air requirements*

The Contractor will provide guidelines for the cooling water installation and compressed air (location of the connection points at the devices, their types and required flows, pressure drops, 2D and 3D models). The FE section will be connected with water cooling infrastructure by Purchaser using flexible tubes (delivered by SOLARIS) connected to main inlet and outlet connectors of the FE section water manifold. The final location of the main water manifold will be defined during design period but the preferable location is just on the slit unit support. Water lines that are feed into the vacuum chamber shall have no direct water to vacuum joints. The Contractor shall state the need for stabilized water temperature (temperature tolerance) for cooling of sensitive and synchrotron radiation beam defining elements. All details can be found in Appendix WAT-CW1 and WAT-CA1.

### *3.2.5 IT infrastructure requirements*

The Contractor will provide guidelines for the IT infrastructure – front end component location, 2D and 3D models, number of Ethernet interfaces needed to control the equipment foreseen in the project. The control system for all the FE elements will be based on the Tango Controls system (<http://www.tango-controls.org/>) (see Appendix CS0 and CS1).

The Device Server level software of Tango Control System for devices that are not SOLARIS standard will be delivered by Contractor. Detailed responsibility matrix for Control System tasks is presented in Appendix CS2-BM02. All control system software delivered by the Contractor shall be written in Python and be compatible with versions 2.7 and 3.5 of that language. It has to be licensed under an open-source license (e.g. GPL, LGPL, MIT, etc.). Device Servers must have unit tests written with test context (a part of PyTango, Python binding to TANGO), in-line functional documentation in Sphinx-compatible format and user

guides.

### *3.2.6 PLC systems*

The PLC systems is divided to two subsystems: Machine Protection System (MPS) and Personal Safety System (PSS). The Contractor is to deliver guidelines for the PLC safety systems designs including connections at front end components and their kind (2D and 3D models). All design guidelines shall be delivered within 2 months of the front end components design approval (FDR).

- a) The Contractor will provide specification of all equipment which will be connected to the PLC systems, in particular wiring diagrams of on board interfaces and external connectors, voltage and current requirements etc.
- b) It's preferred that all equipment served by PLC safety systems shall accept 24VDC signals as a standard voltage level.

### *3.2.7 Alignment*

The Contractor is required to provide all the delivered devices with reference nests for the reference points. The location of the reference points needs to be agreed with the Contracting Authority in the design stage. The Purchaser will supply the Contractor with the required number of nests before fiducialization procedure within the deadline agreed with the Contractor. Together with delivery of the equipment and devices, the Contractor delivers documentation necessary for the positioning of the front end components including information on the situation of the reference points with respect to the beam axis (fiducialization documentation) surveyed during the post-production measurement (see Appendix ALIGN1). Positioning of the front end components and supports are to be made by the SOLARIS employees based on the documentation delivered by the Contractor.

## *3.3 Compliance with SOLARIS standards*

The IcePAP motion controllers will be delivered by Purchaser. All other elements will be delivered by the Contractor as ready for connection with the systems and technologies applied at SOLARIS and will be consistent with the standards described in the attachments. Exceptions from this rule are admissible solely where it is not possible to include standard elements in the Contractor's design. Such exceptions must be explained and discussed with the SOLARIS centre team. Other technical solutions if propose and production modes must be presented to the Purchaser in writing for approval. Approval, if granted will be in writing.

## *3.4 Quality control*

Upon request of Purchaser the Contractor will present original certificates concerning the used materials determining their content, physical and chemical properties mainly for the materials which need to be used in the case of UHV sub-assemblies. Also possible will be audits and inspections during the section production.

### *3.5 Assembly identification*

Identification marking on the stainless-steel plate mounted on the vacuum chamber, chemically etched or electrically engraved must enable identification of each subassembly separately.

### *3.6 Packaging and delivery*

All sub-assemblies of the FE components are to be delivered to the Purchaser by the Contractor. All subassemblies will be shipped in protection against damage or pollution during transport. All vacuum flanges shall be protected with blinds or mechanical covers to safeguard the surface of flange seals and prevent pollution of the FE elements. Where necessary, the FE section elements shall be protected with suitable protection material. Suitable packaging and protection is to be ensured. The transported sub-assemblies of the front end components (including transport boxes or without them) shall be rigid so it is possible to raise them using the fork lift or crane without the risk of damage.

## *4 Contract completion*

### *4.1 Factory acceptance test (FAT)*

The Contractor is required to carry out and documented the following tests at the factory.

#### *4.1.1 Vacuum tests*

The Contractor is required to perform all vacuum tests at FAT stage. The tests shall be conducted according to Appendix VAC1, *Section 4. Acceptance tests*. The declaration of performance and performance of the outgassing rate tests for all vacuum sectors is one of the criteria for offer evaluation.

#### *4.1.2 Mechanical tests*

Verification of all mechanical movements in the designed range shall be performed.

#### *4.1.3 Adjustment tests*

The Contractor is required to check the settings of all elements of the front end section on supports.

#### *4.1.4 Electrical tests*

- a) Wiring test
- b) Continuity tests
- c) Functional tests: all cables and connections will be checked as per the following items: checking the consistency with the electrical design, concerning end switches, position encoders and all electro-mechanical subassemblies will be carried out using the relevant controlled for consistency with their specifications. All remotely controlled devices will be checked for correct operation. Compressed air actuators, motorized actuators, motorize

axes and end switches will be verified with respect to the entire operating specified range.

#### *4.1.5 Hydraulic tests*

The Contractor is required to check internal cooling channels of each equipment by dry leak test with compressed air.

#### *4.1.6 Motion tests*

The motorised and unmotorised axes motion tests will be carried out in regarding total travel movements and limit switches activation. Additionally for all motorized axes measurements of an accuracy, resolution and motion repeatability parameters shall be performed. The position of the limit switches will be measured in reference to the absolute encoder position, marker 0 (zero) of incremental encoder or reference switch and written to the report. The tests shall be conducted with mounted encoders and external measuring devices. All control lines (Home, Limit+, Limit-, Disable) should be tested with hardware compatible with control lines electrical interface shown in the Appendix CS1 *Section 3.2*.

The Purchaser shall be entitled to witness all tests that may be necessary under the terms of this specification, and shall be informed about the tests at least 3 weeks in advance. The test results must be documented and form an integral part of the required documentation.

### *4.2 Final site acceptance test on the construction site (SAT)*

The SAT shall be planned without photon beam in the front end section. The exact time of the SAT, as well as, its detailed scope and manner of its conducting are to be described and shall be agreed upon at the FDR meeting. The SAT will be carried out after accepted assembled delivery of all front end elements and will consist of at least the following tests:

#### *4.2.1 Vacuum tests*

All vacuum tests defined in the *Section 4. Acceptance tests* in the Appendix VAC1 except outgassing test.

#### *4.2.2 Mechanical test*

Mechanical operation test.

#### *4.2.3 Electrical tests*

- a) Wiring test,
- b) Continuity tests,
- c) Functional tests: all cables and connections will be checked as per the following items: checking the consistency with the electrical design, concerning end switches, position encoders and all electro-mechanical subassemblies will be carried out using the relevant controlled for consistency with their specifications. All remotely controlled devices will be checked for correct operation. Compressed air actuators, motorized actuators, motorize axes and end switches will be verified with respect to the entire operating specified range.

#### 4.2.4 Hydraulic function

The following tests are required in particular: static water pressure tightness for all water circuits.

#### 4.2.5 Motorization tests

Total travel movements with limit switches activation will be tested for all motorised axes. Those tests will have to be conducted using IcePAP controllers and mounted encoders.

### 5 Documentation provided by the Contractor

Documentation necessary for the approval of project milestones (e.g. PDR, FDR, FAT, SAT) shall be submitted sufficiently prior to these occasions.

Documentation for all the mounted sub-assemblies regarding front end section shall cover at least the following:

- a) Stock-taking document concerning all the delivered equipment included their serial numbers, dates of delivery, names of manufacturers named as per the sub-assembly drawing code as well as stock-taking document of all the delivered cables.
- b) Executive designs including 3D (STEP or IGES format) and 2D (DWG or DXF format) models of the supplied equipment in the sense of assembly drawings. It is responsibility of the Contractor to ensure that the information in the drawings is correct and complete.
- c) Description of technical parameters of the regular services and maintenance. The Contractor shall supply the manual (procedures for system installation, assembly, disassembly, maintenance and service). The cost of all documentation shall be included in the contract. Together with documentation the drill plan of all required anchor holes for complete front end section supports installation shall be provided. The location and size of the holes shall be defined as projection to the concrete floor respect to the photon beam axis from the source.
- d) Instruction manual and electrical schemes.
- e) Instruction manual and water PID and schemes.
- f) The results of the motion tests, vacuum measurement reports and media (water) pressure tests performed during FAT.
- g) Documentation of the fiducialization (procedure and results-coordinates).

### 6 Attachments

The terms of reference document is appended with the following attachments. The Attachments include technological descriptions used in SOLARIS, which the Contractor shall observe and comply with. Attachments constitute an integral part of the Terms of Reference.

- a) Appendix MECH1 – Mechanics
- b) Appendix MECH2 – Photon Beam orientation inside the VC2
- c) Appendix MECH3-BM02 – Description of the BM02 front end area
- d) Appendix MECH4-BM02 – Dimensions of the BM02 front end area

- e) Appendix MECH5-BM02 – Dimensions of the BM02 front end area 2
- f) Appendix MECH6-BM02 – Dimensions of the BM02 cable trays
- g) Appendix ALIGN1 – Guidelines in field of alignment
- h) Appendix WAT-CW1 – Cooling water basic standards
- i) Appendix WAT-CA1 – Compressed air basic standards
- j) Appendix VAC1 – Guidelines for UHV Components at Solaris
- k) Appendix VAC2 – Technologies and materials for SOLARIS UHV devices
- l) Appendix CS0 – SOLARIS Control System Standards
- m) Appendix CS1 – Motion Control Standard
- n) Appendix CS2-BM02 – Detailed responsibility matrix for Control System tasks
- o) Appendix FE1-BM – Guidelines for BM front end 02BM – general
- p) Appendix FE2 – components
- q) Appendix SOURCE – synchrotron radiation source parameters