Mechanical standards for design

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Filename:	Appendix MECH1 - Mechanics

Revision history

Version	Date	Description	Autor
2.0	2019-01-31	Upgrade to version 2.0	Brzyski, Nowak
2.1	2019-04-18	Change of numbering in chapter one	Brzyski, Nowak
2.2	2019-09-13	Add information M12 anchor and holes in supports Fi20 (2.2); generalized record (2.14)	Brzyski, Nowak
2.3	2023-03-01	2.6 – Update	Marcel Piszak
2.4	2024-01-22	2.8 Added information about STEP structure; 2.12 Removed IGS from 3D acceptable files	Paweł Nowak
2.5	2024-12-10	2.8 Updated and removed information about the requirement for production documentation	Paweł Nowak
2.6	2025-03-13	2.12 Updated and removed information about the requirement for production documentation; table modification	Paweł Nowak

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Contents

1. General technical assumptions for the construction of the mechanical components

The specification covers issues related to mechanical aspects as necessary for the construction of the storage ring, front end and beamlines components including technical documentation, assumptions with respect to project delivery terms, information concerning the applied materials, production, cleaning, testing and delivery of the components to be installed in SOLARIS. The drawings included in the document are of informational nature.

1.1. General description

The beamline must be situated within the area of the storage ring and the experimental hall. The available site sizes are as follows:

- **a)** Intersection between two DBAs (Double Bend Achromats) is 3335 mm. An insertion device may to be installed in this area and a vacuum section including the vacuum chamber covered with the NEG coating from the inside, two tapers (mechanic and vacuum elements responsible for the laminar change of the section of the vacuum chamber between the double bend achromat chamber and the undulator chamber) and two units of RF vacuum valves cutting off the vacuum section. The relevant vacuum components must be supported depending on the space availability.
- **b)** Front End section – the area between the bending magnet measured from the vacuum chamber flange to the first beamline vacuum component located in the experimental hall. It includes also the concrete ratchet wall. Ratchet wall of the storage ring and radiological protection is a dead area where no infrastructure is to be installed. It is only used as a passage tunnel for a beam of photons between the storage ring and the experimental hall and its respective sizes are 800 mm for the concrete wall and 250 mm (for insertion device)/200mm (for bending magnet) for the iron shield plate together with lead wall and support. The vacuum chamber is to be situated in this area.
- **c)** Experimental hall – the area is available solely for the users during the synchrotron operation. The beamline components and equipment used in the transmission of the photon beam to the end stations including the end stations are to be situated here.

1.2. The space available for the storage ring

When designing the insertion device components, vacuum chambers and supports to be built in the Front End area and the straight section of the storage ring, the adjoining areas should be taken into account which may have a material effect on the space available in connection with the beamline construction.

- **a)** On the interior side of the straight section, between the two consecutive bending magnets, there is a cable duct including high current and voltage cables controlling the bend achromats.
- **b)** At the height of each of the bend magnets there two ducts in the floor (the so-called trenches), which are used for a safe connection of the devices mounted within the

ring to the devices situated in the service gallery. Parts of the trenches exit to the outside of the DBA – to the external side of the ring rendering anchoring of the support of the vacuum element in this place impossible. Any potential supports installed in this place must be positioned in such a way and have such a shape so as not to block access to the duct.

c) The height of the storage ring tunnel is maximum 2600 mm. When designing the Front End components and the insertion devices, one has to take into account the height of the area and admissible deviations in height up to 50mm. All elements must be designed so that the peak point or at the point of maximum protrusion of one of the components the maximum size was 2550 mm.

d) Additionally, all elements to be installed inside the storage ring must be designed so as to enable their transport in the opening of the experimental hall above the storage ring wall (of the height of 2900 mm from the floor of the experimental hall) and the highest point of the crane hook (3120 mm from the top surface of the storage ring tunnel wall) while keeping the safe margin above the ring and a safe cone angle for the slings. Based on the provided data, the Contractor is required to design individual elements so as to enable or present the transport guidelines and user instructions concerning the machine. The entire transport procedure must be agreed before the commencement of the installation process.

e) The ceiling of the storage ring is covered with concrete slab layers of varied dimensions. During the installation process, they will be removed by the Client into a safe place so as not to block the transportation route.

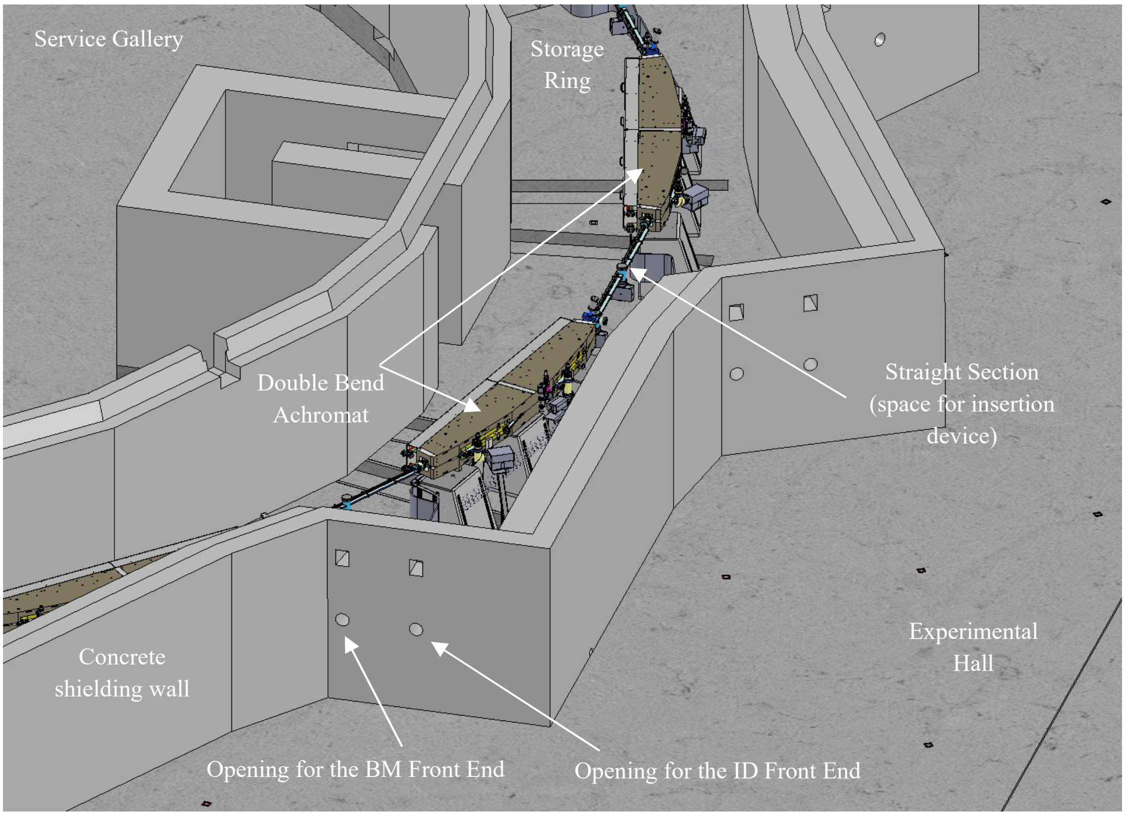
f) Due to transportation space, access to the components and a potential space required for the future components in the area between DBA and inner ratchet wall (front end section), the space available for the vacuum components in this area is limited especially in the lateral direction. General limitation is: (i) 350mm to the left and 250mm to the right looking from the side of the radiation source from the theoretical trajectory of the insertion device photon beam and (ii) 250mm to the left and 300mm to the right looking from the side of the radiation source from the theoretical trajectory of the bending magnet photon beam. The specific limitations vary for different parts along this section and are described in the separate document (appendix MECH3). On the internal side of the storage ring, there is an area reserved for the radiation protection. Radiation screens (shields) are planned in this area with lead bricks size +/- 350mm from the beam axis and 250mm thick.

g) Between concrete stands supporting DBA there are two ducts in the floor (trenches). Around the trench there is undercut 55 mm width, and 5 mm depth. This undercut is used as a place for steel plate which cover the trench so upper surface of the steel plate is equal with the surface of the floor. The design of the Front End must allow access to the media in the trench, so it must allow to elevate cover plate.

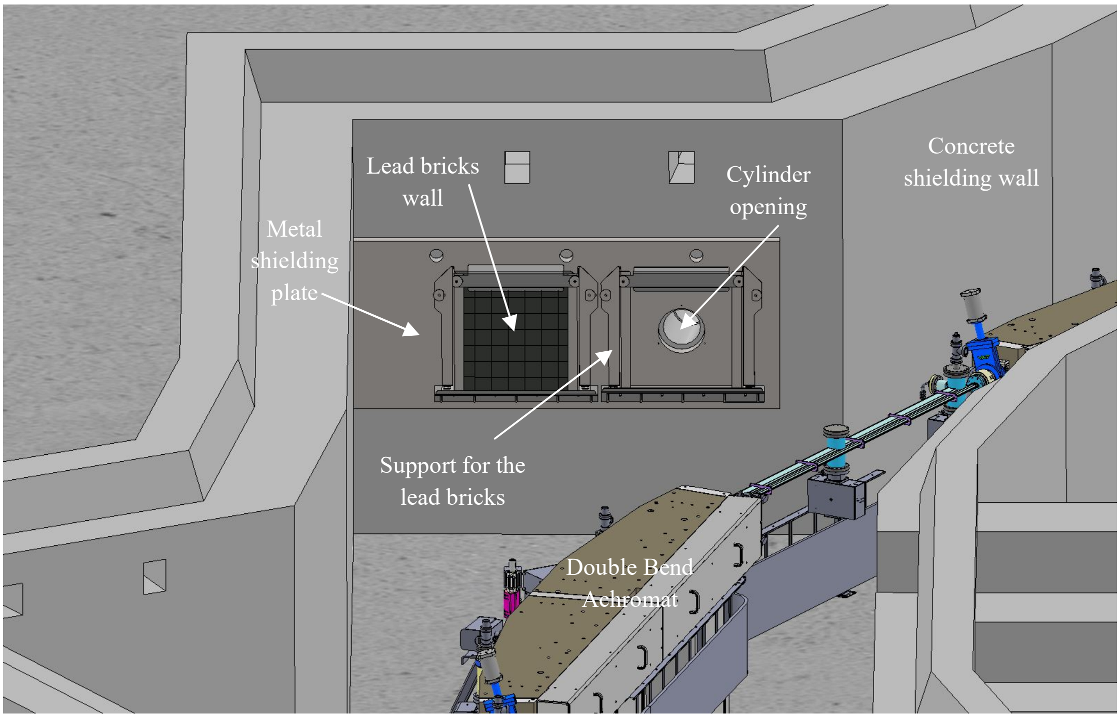
h) In the area provided for the Front End, there is a gap where can not be designed any support. This gap is between 5070,4 and 6017 mm from the insertion device source.

i) The cylinder openings inside the ratchet wall of the storage ring vary in diameter: from the interior side, they are 225mm and 200mm on the outside respectively. Each of the parts is 400 mm in length.

The main elements of ratchet wall of the storage ring are presented in Drawing 1 and Drawing 2.



Drawing 1 *View of the storage ring wall from the side of the experimental hall.*



Drawing 2 *View of the internal wall of the storage ring.*

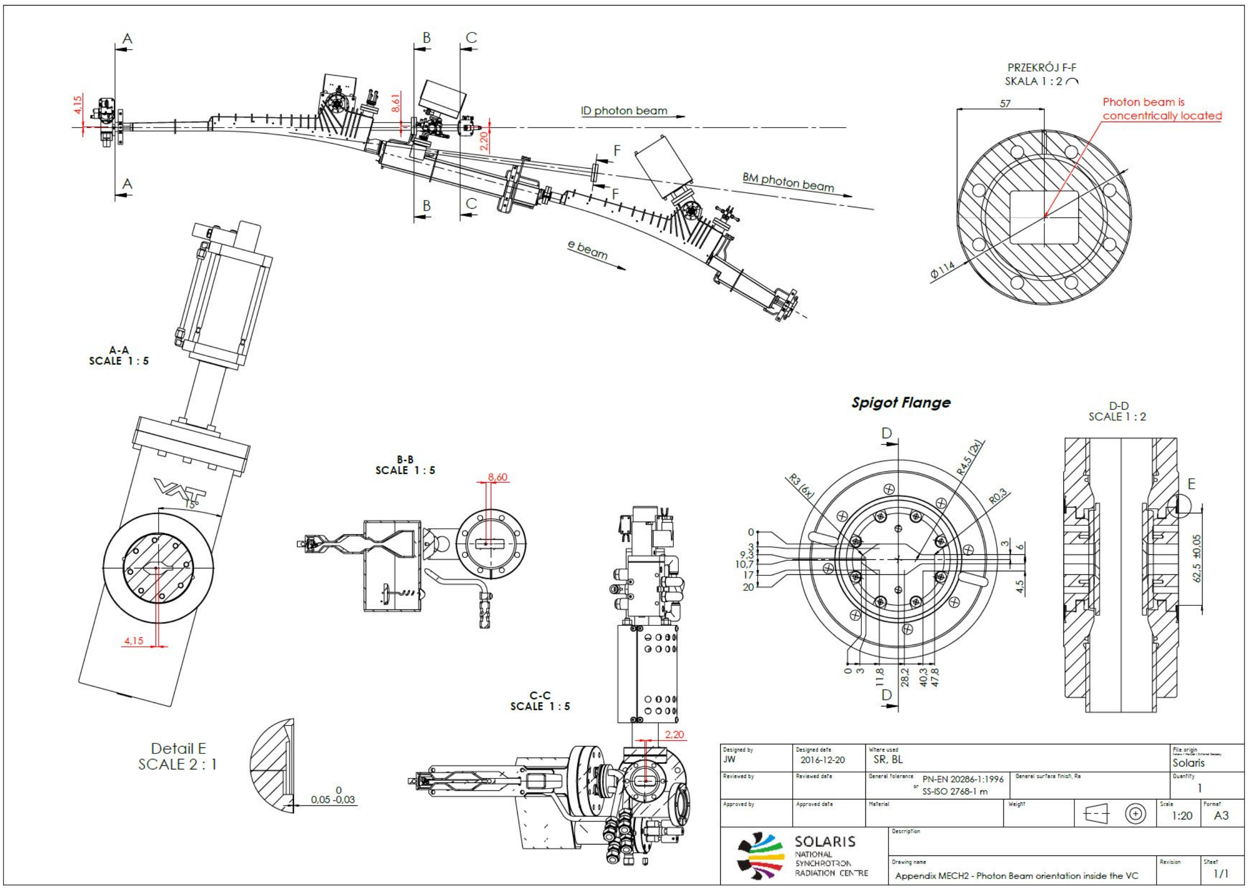
1.3. The space available at the experimental hall

The experimental hall for each beamline is divided into sections where each beamline is to be fit and enable creation of the transport route. Additionally, beside the elements of the beamline, in the separated areas, there will also be elements forming part of the infrastructure such as electrical switchgear, cabinets with electronics (the so-called racks), electric cables, water pipes, etc. In view of the above, during the design stage, free space should be provided for the individual elements of the beamline and the undermentioned details should be agreed with the Client:

a) Bearing pillars for the electrical cables, IT cables as well as water and compressed air.
b) The transport route, which constitutes an undeveloped area of the hall with the width of 1300 mm enabling free access to two adjoining beamlines
c) The dimensions of the hutch, which upon the signing of the specification are not known because they depend on the design of the x-ray optics of the beamline.

1.4. The assumptions underlying the theoretical beam of photons coming out from the insertion device or bending magnet

The photons produced in the synchrotron are transmitted to the end station. In order to design the front end and beamline elements assuming the theoretical route they are to travel, attention should be drawn to the geometry and structure of the storage ring. The reference shall be the mutual situation of the vacuum flanges with respect to the theoretical photon trajectory. Attention should be also drawn to the fact that in the horizontal plane, the axis of the photon beam coincides with the axis of the vacuum flange and the dislocation only takes place on the vertical planes. Detailed orientation is presented on the drawing below and in an appendix MECH2 to this specification.



Drawing 3 *Location of photons with respect to characteristic vacuum flanges.*

Characteristic dimension:

- **a)** The distance from the axis of the vacuum flange at the entry to the DBA for VK1 chamber is 4.15 mm centrifugally (section A-A).
- **b)** The distance from the axis of the vacuum flange at the exit from the DBA for the straight section between chambers VK1 and VK5 is 8.6 mm centripetally (section B-B).
- **c)** The distance from the axis of the vacuum flange at the exit from the DBA vacuum section for VK5 chamber is 2.2 mm centrifugally (section C-C).
- **d)** The BM photon beam and vacuum flange at the exit from the DBA vacuum section for VK1 are concentrically located (section F-F).

2. Structural assumptions for the front end and the beamline elements

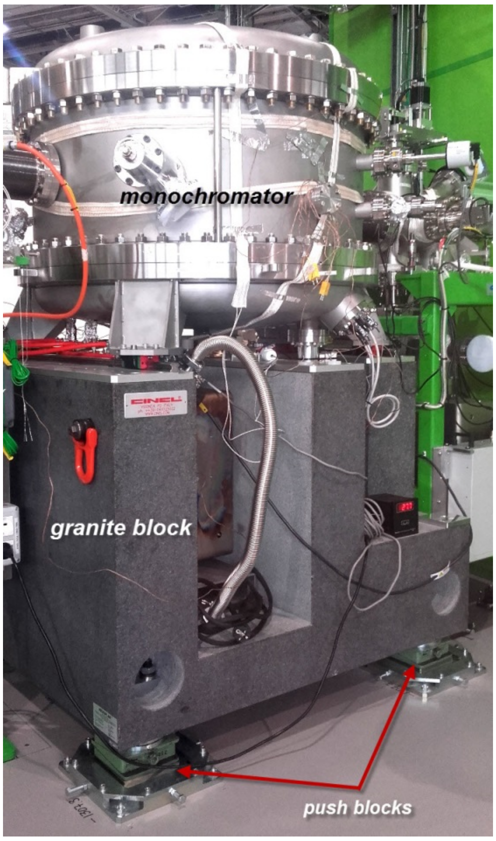
2.1. Supports for the vacuum chambers

The Client requires designing the support system which will enable safe use of the front end and the beamline and protect it against influence of external factors such as mechanical damage, corrosion or vibrations. Furthermore, the supports and their mutual situation should be such that the distance between the flanges and the chambers were not subject to longitudinal deflection and increase of the distance between the UHV (ultra high vacuum) connection and what follows the unsealing of the system. Due to the variety of the constituent elements, the supports should be varied and match the sizes, weight and the intended functions. Particular attention should be paid to the optical components of the beamline which must be placed on stable elements thus minimising the influence of the vibrations from the environment. The supports need to be made from granite, concrete or steel profiles/shapes filled with the sand ensuring proper stability and vibration damping. A preferred solution is to use the structure for which the percentage share of the granite/concrete will be as big as possible.

2.2. The placement of the supports

Each of the supports must be connected to the floor for protection of the supports and the elements resting on them against mechanical damage. Additionally, also due to unhomogeneous nature of the experimental hall and -storage ring, which directly converts into surface flatness tolerances. The tolerances of the performance of the experimental hall slab are averagely ±10mm between lowest and highest part of the floor. Theoretical distance from beam axis to the floor surface is 1300mm. In their solution, the Contractor must take into account a possibility of height compensation. Detailed floor flatness data for the construction area (shape grid) will be provided by the Client during the conceptual stage of the components construction. The height compensation may be carried out using additional washers of suitable shape mounted under the support foot or by applying a mechanical height compensation system (see: Drawing 4 and Drawing 5).

Drawing 4 *A model support system of vacuum chamber using metal supports*



Drawing 5 *A model of system vacuum chamber support system using the granite supports*

In a situation where an element is to be annchored in the floor, the anchoring system permanently protecting the suporting element against translocation should be used. A recommended solution is the HILTI or equivalent system sutiable for the mass, centre of gravity and the function performed by the anchored element and the element situated on it. Required solution are anchors with the internal screw M12 thread. In a situation where the construction required to use external thread anchors, it is necessary to contact the Solaris team and obtain written confirmation. The holes in the supports for M12 bolts should have a minimum 20 mm diameter.

2.3. The sizes of the elements in the transport route context.

All components must be designed so as to enable their transportation using the crane and/or pallet or fork lifts from the loading area to the assmbly site: within the storage ring, or the experimental hall without dismantling the service bridge. Due to the building's construction, during the design of the components, attention should be drawn to the space under the bridge which is 2880 mm from the floor service. It means that the elements are to be adequately lower (or enable full dismassembly) because they have to be transported underneath using e.g. a pallet or fork lift.

In a situation where it is not possible to meet the above condition, information about the case should be provided to the Client at the design stage of the component as soon as possible.

2.4. Material

All metal components performing the support functions must be made from structural steel, aluminium, or, if recommended, from stainless steel, or other metal if it is justified structurally and functionally. Depending on the element, its design and functions, materials for the individual segments may vary. It is important for the components designed in consideration of rigidity and strength of the entire structure while maintaining its stability. Additionally, all surfaces exposed to the effect of external factors which may corrode need to be protected and painted. Additionally, the interfacing elements such as bearings, spherical surfaces or screw connections, if justifiable on technological grounds, must be protected with grease against excessive friction of the interfacing elements. The colour of supports is to be determined during the design stage and match the RAL colours.

2.5. Component installation

Prior to the commencement of the production of the elements in the storage ring, the straight section and the front end as well as in the experimental hall, all segments must be previously provided to the Client in digital version as step and/or iges file enabling full integration with the synchrotron 3D model. Following Client’s verification of the situation, shape and size of the elements in the context of the entire machine, the Contractor shall be required to provide the Client with information confirming the correctness of the structure of the entire constructed elements. A relevant person shall be advised of any change to the documentation on the side of the Client to verify its effect on the environment.

The scope of the installation process for which the Contractor and the Purchaser are responsible for, is defined in the main procurement document. Moreover the Contractor shall be required to provide complete documentation denoting the manner of assembly, transport and installation as well as additional, non-standard tools as required for the installation.

2.6. Vibrations

The dynamic structural system, which consists of vacuum chambers and its supports, must not be characterised by resonant frequencies less than 55 Hz. All components that may be the source of mechanical vibrations of frequency less than 80 Hz must be isolated from their supports by means provided by the Contractor, as per the Client’s specification. This in particular concerns components with rotating elements such as vacuum pumps, water pumps, electric motors, fans, etc.

2.7. Sizes

The nominal sizes of the front end and the beamline components (this also concerns the extreme positions of the movable elements such as, for example, manipulators of sample transfers) must be kept and may not exceed the sizes assumed for the front end and the beamline describe in point 1.3.

2.8. Technical documentation

The Contractor is required to provide full technical documentation in digital form including technical drawings in PDF format and their file equivalents in DWG or DXF form. The documents and the drawings will be used solely for informational purposes. For 3D models, a preferred format is STEP. Purchaser requires sharing of a 3D model which is an assembly model (tree of elements) i.e. containing single parts grouped into assemblies, which are then grouped into higher-level assemblies, up to the highest assembly, which is an assembly of the entire system. The result of converting a step file must be a set of files (single parts and assemblies), not one file. The final drawing and 3D format should be submitted electronically - to be agreed with the Client. All annotations on drawings must be in English.

2.9. Changes

The Contractor may change the design; however, each change made following the Client's approval of the final design must be reported to and agreed with the Client. As and where necessary, the Contractor is required to submit suitable 3D drawings and/or 2D documentation.

2.10. Language

The entire documentation, guidelines and standard descirptions must be in English.

2.11. Transport

a) Each of the supports and vacuum chambers, if determined in the specification and installation process, must be provided with anchoring components and caps enabling transport of the element, and in the case of their lack – clear instructions on how to transport it.

b) The anchoring system should be located in the places enabling smooth connection of the entire element to the crane or fork lift without damaging its sub-components as well as its safe transport on the truck.

c) If the assembly of the anchoring system be not possible due to complexity of the entire structure, the Contractor should provide the adapter enabling free and safe transport within the SOLARIS area. This type of system should be applied not only in the supporting elements but also in the vacuum chambers, manipulators and other elements which at any time of the installation or future use shall require it and facilitate the assembly.

d) All elements must be protected against mechanic damage, dusting and dampness which may significantly reduce the efficiency of the equipment.

e) All fragile components which might be damaged during transport to Solaris and inside the building prior to its installation in the target place must be mounted in a visible place with the shock shield and /or inclination sensors.

f) Transport handles and openings must be kept in ideal cleanness and degreased. If necessary, the components may be covered with a protective coating. To protect them against damage in transport suitable packaging and protection has to be provided.

2.12. The Contractor obligations

The Contractor undertakes to provide the following:

a) Detailed schedule showing all the activities related to the agreement and manufacturing.
b) Detailed and complete set of drawings and documentation for the dedicated tools or equipment which must be used in the installation process and service period.
c) For each component, the following documents should be delivered (with respect to mechanics):
   I. Information specifying the aplied materials and (if justified) relevant certificates.
   II. 3D Model in the step format (detailed information in section 2.8).
   III. Complete 2D assembly documentation of all components excluding production drawings in dwg or dxf as well as pdf format.
   IV. Assembly instruction concerning individual componet (this concerns the non-standard elements in particular).
   V. The document containing information with the results of all tests requiring approval of the Client including verification and control of the sizes.

2.13. Equipment and drawing property right

Equipment and drawing property right issues issues will be stipulated in the agreement with Contractor.

2.14. 3D documentation

The Client undertakes to provide 3D documentation in the iges or step format representing part of the synchrotron and experimental hall enabling the design of the individual components. It should improve the quick verification of potential collisions.

After completing the project stage, the Contractor is obliged to send a 3D model of the project in order to perform metrological measurements allowing to exclude possible collisions of the designed components with the existing infrastructure.

2.15. A contact person

In the beginning of the Agreement performance, the Contractor will appoint a contact person (persons) (for technical issues), who will be responsible for the communication with the Client. The Client will appoint a contact person who will perform the contact functions for Solaris with respect to drawing documentation.

2.16. Quality certificate

The Contractor and his subcontractor should have a suitable and current quality certificate issued by a relevant Quality Assurance Organization such as ISO 9001:2008 or its equivalent with respect to design, production and testing of all the systems and equipment provided by it. The CE marking will be used in all places and on all equipment where required.

2.17. ISO standard

All equipment should use connections and shapes as per the ISO metric standard.

2.18. European Safety Regulations

Parts / equipment of the Contractor should be fully compatible with the prevailing Polish and European Safety Regulations and standards and recommendations of IEC (International Electrotechnical Commission). The equipment is to be manufactured in consideration of the best engineering practices available at the time of construction.