Front end components to the Solaris bending magnet section 02BM

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Owner:	Marcin Zając; mar.zajac@uj.edu.pl
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Revision history

Version	**Date**	**Description**	**Sign**
1.0	12.11.2013	Technical and functional description of bending magnet (BM) front end	Marcin Zając
2.0	04.02.2019	Major changes in component description, functionality and sequence for BM front end	Marcin Zając
2.1 2.2 2.3	21.02.2019 13.03.2019 15.05.2019	Radiation safety requirements in section 4.6. Heat absorber requirements in section 4.2. The fixed mask2 requirements in section 4.7.	Marcin Zając
3.0 3.1	03.02.2020 22.11.2023	Major changes in component description and sequence The material definition for the main components in paragraph 4	Marcin Zając

Authors:

Marcin Zając

1 Introduction

This Appendix provides a background to the technical part of the set of the devices and components between storage ring and beamline, hereinafter called as front end or in short FE, for the bending magnet source procurement procedure for the Solaris storage ring (1.5 GeV). It is based on specification and related documents for previous Solaris' front end tenders and discussion with experts in that subject and identifies the needed functionality; it proposes some design on a conceptual level as well as listing the required main components. The vendor is free to suggest modifications or alternative solutions to the scheme suggested in this Appendix. In this case the vendor shall clearly indicate the technical advantages and disadvantages of these alternatives as well as their possible impact on the price. The buyer, however, reserves the right to reject any modifications that the buyer considers detrimental to the operation or performance of the front end.

Abbreviation glossary
PDR = preliminary design review
FDR = final design review
FAT = factory acceptance test/tests
SAT = site acceptance test/tests
XBPM = x-ray beam position monitor
BM = bending magnet
OFHC = oxygen-free high thermal conductivity

2 Background and dimensions

The limited distance between the storage ring exit flange and the closer surface of the ratchet wall requires a compact design for the front end components. An initial flange (DN63CF) as an end of the storage ring vacuum chamber is installed on section from the very beginning. The distance between the centre of the bending magnet (the source) to the downstream CF63 flange is 2013.5 mm. This marks the end of the storage ring vacuum system and where the front end section starts. The design distance from the storage ring vacuum system exit flange and the lead and iron shield at the ratchet wall is 5028 mm, the lead and iron shield is 200 mm thick all together and the ratchet wall is 806.9 mm thick that the outer side of the wall is then situated at 8050 mm from the source. The space available for the vacuum components together with supports in the FE area is limited especially in the lateral direction. General limitation is: 250 mm to the left and 300 mm to the right looking from the side of the radiation source from the theoretical trajectory of the bending magnet photon beam axis. Possible first girder mounting can be placed in the area between the Double Bend Achromat (DBA) concrete supports. This support should sustain first part of the front end including first ion pump, fixed mask1, heat absorber – photon shutter and all metal vacuum valve plus already installed ion pump for storage ring vacuum chamber.

Important is to remember about already existing equipment like storage ring vacuum ion pump and others which will influence the support shape and solution for that front end section (see Figure 1). Because of the obstruction of the achromat stand support, cable trays and trench in the slab for water and electrical infrastructure the support for first FE section should be compact. It is forbidden to install FE components support to the concrete DBA block. The following girders/supports of the front end devices can start approximately 4078 mm from the source and shall be dedicated for the subsequent front end section devices (vacuum tubes, movable aperture/slits, pumping units, safety shutters, etc.). Intentionally the free space between BM concrete block and following support should be left and it is set to approximately 600 mm.

a)

b)

Figure 1. The images of the storage ring in the first part of the bending magnet front end area, a). for dedicated storage ring section where new front end will be installed, b) for already existing and installed first front end section.

All detailed restrictions for chambers, supports/girders and FE infrastructure (water, compressed air, cable trace, etc.) related with occupied space are defined and described in Appendix MECH3-BM02. The supports for the components should finish before above mentioned lead and iron shield. Next device after fixed mask1, heat absorber and all metal vacuum valve in the front end section will be a vacuum tubes. The vacuum tubes should be installed on separate rigid support filled with the dry sand (for future XBPM device - out of scope of this project) and its support should be placed downstream

last concrete DBA support. The following elements will be movable SLITS, YAG screen, double cooling safety shutter, 2nd fixed mask and wall tube. Additionally, the last chamber from the FE section will be located downstream ratchet wall at the experimental hall area. It is vacuum vessel with a filter assembly (2 filter racks, 3 slots for foils in each rack) ,a triggering gauge for fast valve and a beryllium window. The design of the front end for the bending magnet source must not, however, exclude the possibility for later add on of insertion device front ends. This will impose some restrictions in the available space as indicated in Appendix MECH3-BM02 where the FE components and their supports must allow the possible later installation of a special support for the neighbouring insertion device front end at 0º. Due to that limitation the girders and components should be designed in the compact way not exceed transversal space limitations marked at the drawing respect to the beam axis.
The first and good approximation assumes that the future insertion device front end will have shape and dimensions as already installed front end section in the storage ring section 06. All details and restrictions can be discussed during design phase.

3 General design consideration

3.1 All specifications for the deliverables of this package are described in this document and related Appendixes. If the Supplier cannot find required specifications in this document to be able to develop the tender, the Supplier should contact the procurement responsible for clarification.

3.2 The individual front end components shall be designed to handle the power load from the photon beam. A power density exceeding 8 W/mm^2 in grazing incidence shall at not occur unless Glidcop is used. The reported absorbed powers in paragraph *5 Heat Load and BM source* shall only be considered as indications and shall be confirmed by the vendor.

3.3 The cooling scheme shall be designed so that no heat dissipates to the vacuum chamber or supports.

3.4 The stability requirements in operation shall be met under the condition of ±1.0°C temperature variation in the front end area.

3.5 The design of the vacuum chambers shall include ion pumps, TSP pumps (if necessary), valves and bellows. The pumping speed and model of the pumps will be defined by the vendor latest at the preliminary design stage. Differential (DI) sputter ion pumps equipped with heaters shall be used. Small sputter ion pump controllers shall be used for all sputter ion pumps. Appendix VAC1 contains details of the standard vacuum components used in SOLARIS. If the proposed mechanical solution requires special pumps, the Supplier should include these in the tender.

3.6 The vacuum chamber weldings (flanges, seals, and all integral, non-instrumentation components) shall be bakeable to a temperature suitable to reach the required vacuum level and this temperature shall be given in the documentation. Water lines that are feed into the vacuum chamber shall have no direct water to vacuum joints.

3.7 A sufficient number of rotatable flanges shall be provided.

3.8 A schematic drawing of the vacuum system indicating the placement and sizes of the flanges shall be provided for approval by SOLARIS in the preliminary design review.

3.9 The height of the photon beam axis is 1300 mm above the floor level. The photon beam from the bending magnet is horizontal and parallel to the floor.

3.10 The design of the front end components does not always allow ion pumps to be attached straight on the components. In these cases an attached pumping unit shall be foreseen. The units represent one vacuum section should consist of a vacuum chamber with an ion pump, a right angle valve (DN40 or DN63) for pre-pumping and a spare ports. The vendor is responsible for designing the front end with a suitable amount, location and sizes of all the pump systems to reach the base pressure (vacuum level) $\leq 5 \times 10^{-10}$ mbar within 48 hours after bake out and vacuum level $\leq 1 \times 10^{-9}$ mbar with photon beam (see Appendix VAC1). A total Helium leak rate should be $\leq 2 \times 10^{-10}$ mbar*l/s. As a first approximation/assumption to obtain specified vacuum parameters it is considered to use 4-5 ion sputter pump (See Figure 2). The Residual Gas Analyser (RGA) shall be installed in that Safety shutter-stoppers or Filter assembly and trigger unit using independent all metal angle valve on one DN40 port. The location of RGA depends on the RGA type offered by Contractor (for details see Appendix VAC1).

3.11 Edge-welded bellows shall be installed upstream and downstream of all movable components. Hydro-formed bellows should be used only as a transition between pipes to ensure small positioning errors and thermal expansion movements during bake out operation. The range of all bellows should be defined by the supplier and according with the movements of the components.

3.12 All right-angle valves for pre-pumping should be installed on the right site of the chambers looking from source site or from the top.

3.13 The size of the vacuum pipes from 1st fixed aperture to vacuum tubes upstream SLITS should preferably be DN40. The size of the vacuum pipes after from SLITS should be appropriate to the beam size and pumping requirements but not be bigger than DN63 and the supplier should propose the size depending on the design of the components.

3.14 The geometry of the active beam elements should exclude possibility for direct and straight path of photoelectrons to the sputter ion pumps, especially for heat absorber (photon shutter) and cooling safety shutters.

3.15 Threads should comply to metric standard. All ion pumps shall be supported by support structures in a manner that allows the pumps to be removed without dismounting the chambers. To fulfil that general rule the additional structure on the chamber supports should be foreseen to install fixed dimension portable shelf with movable rails. One such shelf should be delivered together with front end components.

3.16 All motor driven motions must be equipped with high duty limit switches and encoders. The Contractor is responsible for preparing intermediate patch panels between motorized elements and SOLARIS standard motion controllers (IcePAP) – if applicable, see Appendix CS1. The location of the patch panels on the support of motorized element will be defined at design phase but it is forbidden to install them on the left side of the support looking from source site.

4 The components and preliminary design draft

A preliminary design and feasibility study has been performed by Solaris Team to indicate the preferred position of the individual front end components. The front end section design is summarized in *Table 1*. "Position" is the distance from the center of the bending magnet (source) to the center of the component and shall be taken as approximate position with accuracy of few mm.

Component	Provided by	Position (centre) [mm]	Support #
The downstream surface of the DN63 CF storage ring (SR) vacuum system flange	Solaris	2013.5	-
Pumping unit (ion pump no 1 – IP1)	Contractor	2241.5	1
Fixed mask1 (FM1)	Contractor	2321	1
Heat absorber (HA) [photon shutter]	Contractor	2520	1
All metal gate valve 1 (V1)	Contractor	2731	1
Fast valve 1 (FV)	Contractor	2883	1
Vacuum tubes with support for future XBPM	Contractor	4200	2
Movable aperture (vertical and horizontal SLITS) with IP 2	Contractor	5130	3
Gate valve 2 (V2)	Contractor	5989	4
Fluorescent screen (FLSC)	Contractor	6100	4
Safety shutter-stoppers (SS1 & SS2) with IP 3	Contractor	6323 and 6543	4
Fixed mask2 (FM2)	Contractor	6713	4
Ratchet Wall beam pipe	Contractor	-	4 & 5
Gate valve 3 (V3)	Contractor	8538	5
Filter assembly and trigger unit with IP4 (FATU)	Contractor	8790	5
Beryllium window (BW)	Contractor	9090	5
Other			
Standard vacuum components (defined in the main Procurement documentation: *Technical description*.	Contractor		

Table 1. The individual components of the front end, provider, suggested position including proposition onto which support.

Large modifications such excluding or adding components or changing the order between individual components shall be indicated already in the tender and needs to be agreed with SOLARIS latest in the preliminary design phase. Details of the modifications are due to be discussed already in the preliminary design report.

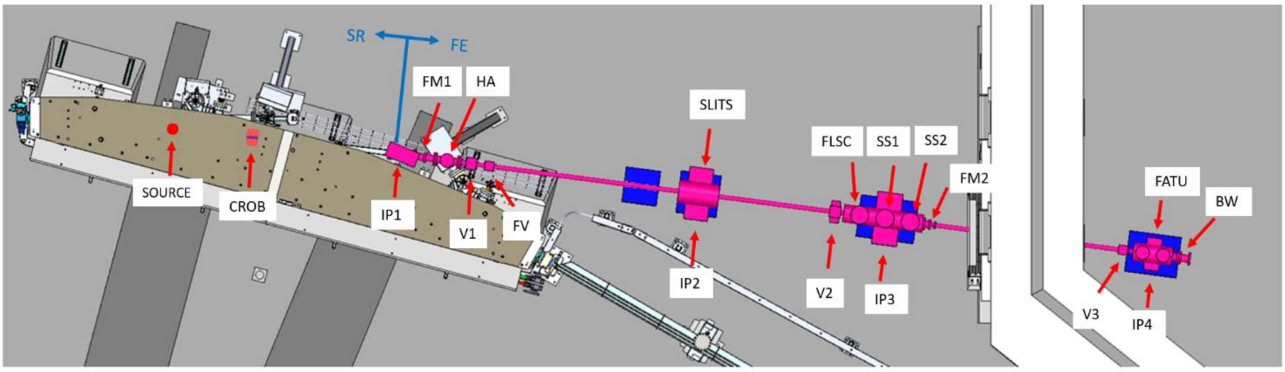

Figure 2. The components mounted on individual supports with proposed positions for the ion pumps in the front end layout.

<u>4.1. Fixed Mask1 (FM1)</u>

4.1.1. There shall be a fixed mask in the first section of the front end. The total acceptance angle for the aperture shall be 6 mrad*3 mrad (hor*vert) which at the suggested position 2.32 m from the source would then correspond to an opening of 13.88 mm x 6.94 mm. The fixed mask is expected to be mounted on the first support.

4.1.2. The mask is basically a UHV nipple with an axial length of about 150 mm with a 30 mm thick OFHC copper block brazed on it in the centre. The opening must have a rectangular shape with a size that intercepts the specified fan and the entry should be conical.

4.1.3. The fixed mask shall be water cooled. The cooling scheme of the mask shall be given in detail including FEM calculations in the FDR, if design change respect to the 3D model.

4.1.4. The design shall provide means for temperature monitoring of the surfaces of the mask that is expected to be exposed by the photon beam.

4.1.5. The design shall include an ion pump located upstream FM1. The pumping speed of ion pump will be defined by the vendor latest at the PDR (IP1 in Fig.2).

4.1.6. The proposed solution is to use the already designed fixed mask for Solaris BM front end. The drawing and technical parameters can be found in Appendix FE2.

<u>4.2. Heat Absorber (HA) [photon shutter]</u>

4.2.1. There shall be a heat absorber in the front end, positioned approximately at 2.52 m from the source and mounted on the support #1.

4.2.2. The heat absorber shall be designed to sustain the heat loads of the bending magnet source with finally defined opening of the upstream fixed mask1 (FM1).

4.2.3. The heat absorber shall be water cooled. The cooling scheme of the absorber shall be given in detail including FEM calculations in the FDR, if design change respect to the 3D model.

4.2.4. The heat absorber should be moved pneumatically in and out of the beam. The absorber shall obstruct the X-ray beam in the bottom position to ensure closure by gravity in case of pneumatic or electrical failure. Each position shall have two redundant sensors to indicate open and closed position (in total 4 sensors).

4.2.5. The design may provide means for temperature monitoring of the surfaces of the absorber that is expected to be exposed by the photon beam but this functionality is not mandatory.

4.3. Vacuum tubes with dedicated support for the future X-ray Beam Position Monitor (XBPM)

4.3.1. Spatial information on the incoming X-ray beam shall be recorded. This could be done in the future with an X-ray Beam Position Monitor.

4.3.2. The suggested position of the future XBPM is 4.20 m from the source. The Contractor should provide dedicated support filled with dry sand.

4.4. Movable Apertures (SLITS)

4.4.1. The front end for BM source shall be equipped with a system that can define the beam size in both horizontal and vertical directions from the maximum beam size defined by the upstream front end components to fully closed with an accuracy of at least 0.005 mm and repeatability of 0.005 mm or better. The movable blades shall have a travel range that ensures a several mm overlap between them. The opening of one blade versus chamber axis shall be of at least 16 mm and closing of one blade versus chamber axis of at least 7 mm. In the documentation should be written the values of the encoder positions when active slit edge for each blade is located at the beam axis position (chamber axis). These values should be determined with accuracy of 0.2 mm.

4.4.2. This system shall be able to handle a photon beam delivering from BM source. A system with inclined surfaces, e.g. four separate/independent movable slits/blades made of OFHC copper block situated after each other positioned approximately 5.13 m from the source could do that. These apertures are expected to be mounted on support #3.

4.4.3. The movable blades/slits shall be water cooled. The cooling scheme of the SLITS shall be given in detail in the FDR, if design change respect to the 3D model.

4.4.4. The resolution, accuracy, repeatability and stability requirements shall be met in operation, with all systems (vacuum, thermocouples, water cooling etc.) connected and running.

4.4.5. The actuators of the slits/blade shall be provided with absolute linear encoders (“instant on”) with an appropriate resolution. All electronics shall be shielded from the radiation in the front end area.

4.4.6. The system shall include electrical limit/over travel switches to ensure that the movement stops electrically via interlock signals. The position of these switches shall be adjustable.

4.4.7. The design shall include the ion pump. The pumping speed of the pump will be defined by the vendor latest at the PDR (IP2 in Fig.2).

4.5. Fluorescent screen (FLSC)

4.5.1. A fluorescent screen shall be included for alignment purposes; the screen is expected to withstand the full power of the photon beam defined by fixed mask1.

4.5.2. The FLSC is basically a thick OFHC copper block with cooling system and with scale plot at the upstream surface. The screen shall be mounted after the movable aperture (SLITS) approximately at 6.10 m from the source and on support #4.

4.5.3. The screen shall be water cooled. The cooling scheme of the FLSC shall be given in detail in the FDR, if design change respect to the 3D model.

4.5.4. The screen should be moved pneumatically in and out of the beam. The “in beam” screen position should have an accuracy and reproducibility of 0.05 mm or better.

4.5.5. The screen shall have sensors to indicate in and out position.

4.5.6. The design should include an observation window where a CCD camera can be mounted. The orientation of the dedicated viewport will be defined during PDR.

4.6. Safety shutter-stoppers (SS1&SS2)

4.6.1. There shall be two safety shutter-stoppers for redundancy purpose. These can, however, be mounted in the same vacuum chamber, positioned approximately at 6.32 m and 6.54 m from the source, respectively, and on support #4.
4.6.2. The shutter-stopper shall consist of a cylindrical Tungsten or Densiment 180 block which is shaded by a water cooled OFHC copper block that is moved in a vacuum chamber by means of a pneumatic actuator. The water cooled copper plate is the shutter; it should have at least a diameter of 75 mm, a copper pipe is bent and brazed on the copper plate. The tungsten block is the stopper; it must have a minimum diameter of 65 mm. The length of copper must be approximately 10 mm and tungsten must be 75 mm. The tungsten block must be fixed together to the water cooled copper plate to the main support, this assembly is called shutter-stopper or shopper block unit. A thermocouple (K type) is fixed on the copper plate to measure the temperature. The cooling scheme of the copper absorber shall be given in detail including FEM calculations in the FDR, if design change respect to the 3D model.
4.6.3. The blocks shall be pneumatically driven and have two positions: open position and closed position. Each position for each block shall have two redundant sensors to indicate open and closed position (in total 8 sensors). The blocks shall obstruct the bremsstrahlung in the bottom position to ensure closure by gravity in case of pneumatic or electrical failure.
4.6.4. The design shall provide means for temperature monitoring of the surfaces of the absorber that is expected to be exposed by the photon beam.
4.6.5. An ion pump and if necessary TSP shall be attached directly to the vacuum chamber (IP3 in Fig.2). The pumping speed will be defined by the vendor latest at the PDR.
4.6.6. The proposed solution is to use the designed safety shutter-stoppers installed at Solaris. The technical drawing and technical parameters can be found in Appendix FE2.

4.7. Fixed Mask2 (FM2)

4.7.1. There shall be a second fixed mask in the front end which limiting radiation fan of the synchrotron radiation delivered to the beamline. The total acceptance angle for the aperture shall be 1.5 mrad * 0.9 mrad (hor*vert). The fixed mask2 is expected to be mounted downstream safety shutter-stoppers as separate vacuum element with two CF flanges.
4.7.2. The mask is basically a UHV nipple with an approximately 35 mm thick OFHC copper block brazed in the centre on DN40 vacuum tube. The opening must have a rectangular shape with a size that intercepts the specified fan and the entry should be conical.
4.7.3. The fixed mask2 shall be water cooled. The cooling scheme of the mask shall be given in detail in the FDR, if design change respect to the 3D model.
4.7.4. The proposed solution is to use the design similar to the fixed mask1 installed at Solaris. The drawing and technical parameters can be found in Appendix FE2. The total opening/acceptance angle of the mask can be designed for particular beamline performance and shall be provided for approval and needs to be agreed with Purchaser latest in the preliminary design phase.

4.8. Ratchet Wall Beam Pipe

4.8.1. There shall be a vacuum pipe through the ratchet wall. The wall thickness is 806.9 mm plus upstream 200 mm iron and lead shielding. The lead shielding begins 7.04 m from the source. The pipe should have a diameter of 40 mm.
4.8.2. The vacuum pipe shall have flanges in both ends. The upstream flange shall not be closer than 350 mm from ratchet concreate shielding wall and the downstream flange shall not be closer than 300 mm from ratchet concreate shielding wall.
4.8.3. The vacuum pipe shall have permanent pre-mounted heating stripes for baking.

4.9. Filter assembly and Trigger Unit (FATU)

4.9.1. The filter assembly and trigger unit will be combined into one unit. At the FE section the fast closing valve will be triggered from a devices installed in the FATU situated just after the ratchet wall. The unit centre shall be localized approximately 8.79 m from the source. This unit is expected to be mounted on support #5.
4.9.2. The FATU unit shall be equipped with trigger gauge, a right angle valve used for pre-pumping, an upstream DN40 pneumatic all-metal gate valve, at least two spare DN40 ports and an ion pump, (IP4 in Fig.2). The pumping speed of the ion pump will be defined by the vendor latest at the PDR.
4.9.3. The upstream end of the DN40 vacuum valve has to be not closer than 300 mm from the ratchet wall.
4.9.4. The front end for BM source shall be equipped with a filter assembly unit system that can suppress the beam intensity from the maximum beam intensity to the smaller one and/or shape the energy spectrum. The filter slots should have certain dimensions (horizontal x vertical: 20 mm x 10 mm) and move with an accuracy of at least 0.01 mm and repeatability of 0.01 mm or better. The centre of the movable filter shall have a travel range with few mm over travel versus beam axis.
4.9.5. This filter assembly shall be able to handle a photon beam from BM source defined by upstream fixed mask2.
4.9.6. A system shall be equipped with 2 racks of 3 filter slots each with the filter thickness from 0.01 to 3 mm.
4.9.7. The resolution, accuracy, repeatability and stability requirements shall be met in operation, with all systems (vacuum, thermocouples, water cooling etc.) connected and running.
4.9.8. The actuators of the filter drive shall be provided with absolute linear encoders (“instant on”) with an appropriate resolution. All electronics shall be shielded from the radiation in the front end area.
4.9.9. The system shall include electrical limit/over travel switches to ensure that the movement stops electrically via interlock signals. The position of these switches shall be adjustable.
4.9.10. The suggested length (flange to flange along the beam) of the unit is approximately 450 mm.

4.10. Beryllium window (BW)

4.10.1. There shall be a beryllium window in the last section of the front end. The thickness of beryllium window shall be 0.25 mm. The total opening angle for the beryllium material shall be minimum 2 mrad * 1.1 mrad (hor*vert). To have some safe margin for synchrotron radiation cone the required dimension is approx. 20 mm x 10 mm (h x v). These values are based on the assumption that beryllium window will be located not closer than 9.09 m from the source. If beryllium window will be closer than 9.1 m from source, the 20 mm x 10 mm (h x v) opening should stay. The beryllium window is expected to be mounted on the exit port of the FATU as a separate component.
4.10.2. The device is basically a UHV nipple with an axial length of about 100-150 mm with a thick OFHC copper block with only beryllium material on it in the centre.
4.10.3. The beryllium window shall be water cooled. The BW shall be able to handle a photon beam delivering from BM source and defined by fixed mask2.
4.10.4 The beryllium window should withstand a pressure of 1.20 atmosphere. During normal operation (beam on the window), the beryllium window will be in UHV on both sides.

5 Heat load and BM source

At the beginning the geometry related with source in storage ring should be defined. Few important dimensions describe limitations for the radiation cone.
The distance between the centre of bending magnet and the first edge of the crotch absorber: 838.44 mm, the distance between the centre of bending magnet and the downstream edge of the crotch absorber: 891.60 mm, the distance between the centre of bending magnet and the centre of the crotch absorber: 865.02 mm. All distances were measured in the theoretical beam direction.

The storage ring fixed crotch absorber opening is as follow: ± 9.1 mm in horizontal direction (± 10.3 mrad) and ± 6.9 mm in vertical direction (± 7.8 mrad). It defines radiation cone delivered to the front end section. Based on the above mentioned source - crotch absorber distances for all geometry calculations it can be assumed that defined crotch absorber opening (aperture) is located 890 mm from the source.
Due to crotch absorber opening the first part of the FE section has to be constructed using DN63 CF tubes until limited radiation cone pass the first fixed mask.

The Supplier should present all necessary FEA calculations of most critical components (fixed mask1, heat absorber, shutter-stoppers) during the FDR.
No detailed heat load analysis on all front end components has been performed by Solaris personnel and its subcontractors. The reported absorbed powers in paragraph 5 shall only be considered as indications and shall be confirmed by the vendor. The table below represents only a first approximation on the absorbed power in the different front end components when the source is bending magnet. The maximum of power density is small and the value do not exceed 15 W/mrad^2 (to be confirmed by Contractor during design phase).

The FDR of the front end shall be complimented with detailed power calculations to ensure that:
- The power density on any exposed surface shall not exceed the safety limit of 8 W/mm^2 unless Glidcop is used (see *paragraph 3.2*)
- The temperature on these areas in normal operation shall not exceed the baking temperature of the system (120-200°C).

For OFHC components shall also the following criteria be fulfilled:
- Cycles for fatigue more than $1x10^5$ cycles (strain <0.1%)
- Maximum gradient for temperatures: DTmax <150ºC
- Stress Maximum = 60 MPa

For Glidcop components shall also the following criteria be fulfilled:
- Cycles for fatigue more than $1x10^5$ cycles (strain < 0.2%)
- Maximum gradient for temperatures: DTmax < 300°C
- Stress Maximum = 250 MPa

In connection with the FDR the Finite Element Analysis (FEA) calculations shall be done to estimate the stress, strain, maximum temperature and cooling on all exposed items, if design change respect to the 3D model.

All exposed items in the FE shall be water cooled.

A detailed (ray tracing) study where the positional and angular tolerances of the electron beam as well as the manufacturing and positional tolerances of the individual FE components shall be made during the preliminary design phase to ensure that no surfaces that are not designed to accept heat load are in contact with the synchrotron beam.

<table>
<tr><th rowspan="2">Item</th><th rowspan="2">Distance from source [mm]</th><th rowspan="2">Aperture H x V [mrad]</th><th colspan="2">Bending magnet</th></tr>
<tr><th>Incid-Power [W]</th><th>Abs-Power [W]</th></tr>
<tr><td>SR absorber (CROB)</td><td>890</td><td>20 x 15.6</td><td>980</td><td>790</td></tr>
<tr><td rowspan="2">Fixed mask1 (FM1)</td><td rowspan="2">2313.5</td><td rowspan="2">6 x 3</td><td>190</td><td>140</td></tr>
<tr><td colspan="2">6.0 x 3.0 mrad^2</td></tr>
<tr><td>Heat absorber (HA)</td><td>2520</td><td></td><td>50</td><td>0 / 50</td></tr>
<tr><td>Movable aperture (SLITS)</td><td>5130</td><td>6 x 3</td><td>50</td><td>36 / 50</td></tr>
<tr><td>Fluorescent screen (FLSC)</td><td>6100</td><td>6 x 3</td><td>50</td><td>0 / 50</td></tr>
<tr><td>Safety shutter-stopper1</td><td>6323</td><td>6 x 3</td><td>50</td><td>0 / 50</td></tr>
<tr><td>Safety shutter-stopper2</td><td>6543</td><td>6 x 3</td><td>50</td><td>0 / 50</td></tr>
<tr><td rowspan="2">Fixed mask2 (FM2)</td><td rowspan="2">6713</td><td rowspan="2">1.5 x 0.9</td><td>50</td><td>30</td></tr>
<tr><td colspan="2">1.5 x 0.9 mrad^2</td></tr>
<tr><td>Filter assembly (FATU)</td><td>8790</td><td>3 x 1.2</td><td>20</td><td>0 / 20</td></tr>
<tr><td>Beryllium window (BW)</td><td>9090</td><td>3 x 1.2</td><td>20</td><td>15</td></tr>
<tr><td>Other</td><td></td><td></td><td></td><td></td></tr>
<tr><td>V1, V2, V3, FV</td><td></td><td></td><td></td><td>0</td></tr>
</table>

Table 2. Apertures dimensions and incident and absorbed power on the bending magnet Front End as an example.

6 Support structure and alignment

6.1 The general mechanical requirements for supports, support structures and alignment procedure are described in the Appendix MECH1, MECH3-BM02 and ALIGN1, respectively.

6.2 The length, width and height of each support will be individually determined from the requirements of the different components and will be developed by Contractor. The collaboration with Purchaser during the PDR & FDR processes will be related with general establishment of support functionality.

6.3 The proposed design for the front end include 5 different supports together with a filter assembly triggering unit where emphasis has been on isolating sensitive components from possible sources of vibration and limit the length and width of each support to ensure ease of handling. The final amount of necessary support structures depends on the design and will be defined by Vendor during design period.

6.4 The contractor shall mount the components on a stiff support frame.

6.5 The supports will provide a possibility to manually align the complete set of mounted components on each frame with an accuracy of typical 0.1 mm. If higher accuracy is required or individual components need very precise alignment with respect to each other, the Contractor must add additional alignment possibilities in agreement with the SOLARIS. The Contractor shall equip the different components or frames with fiducials (laser tracker target nests) for alignment. Targets shall be positioned in agreement with the Purchaser. The Contractor is required to identify the relationship between the optical axis and the target nests on the device (fiducialization). All details related with alignment and fidualization process are described in the Appendix ALIGN1.

6.6 The final fine adjustment to 0.1 mm accuracy will be performed by the SOLARIS Alignment group after bake out process.