SLS-TME-TA-1998-0015
December, 1998

Specifications of the SLS Front End for the Protein Crystallography Beamline 6S

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1. Introduction

The Swiss Synchrotron light Source (SLS) is a dedicated high brightness Synchrotron Radiation Source presently under construction at the Paul Scherrer Institute (PSI) in Villigen, Switzerland. The construction started in Summer 1998. The SLS is scheduled to start operation in summer 2001.

These specifications cover the design, materials, manufacture, cleaning, testing, delivery and assembly of the Front End (X06SFE) that will be installed in the SLS Protein Crystallography Beamline (X06S). Tenderers are requested to comment upon the specifications and are encouraged to make alternative proposals to the PSI in addition to the quotation according to these specifications. However, after the contract has been placed, departures from the then agreed specifications will not be allowed, except with written permission of the PSI.

2. General Description

The X06SFE (see drawing 30040.35.006) consists of a set of Ultra High Vacuum (UHV) components mounted on frames, with associated control cables and fluid supply.

The main functions of X06SFE are:

- Storage ring vacuum protection
- Absorption of radiation when the beamline is shut-down
- Beam definition
- Vacuum measurement
- Beam-position monitoring

The following documents are integral parts of these specifications:
- UHV materials and technologies for SLS front ends and beamlines, SLS-TME-TA-1998-0014
- Quality assurance requirements, ESRF/ENG/89/02

2.1 X06SFE components

The overall view of the front-end with the main mechanical components is shown in the drawing 30040.35.006.
The mechanical components are arranged in 5 groups:

a) Type A components:
components that define the front-end axial structure.

b) Type V components:
vacuum components connected to the A type components.

c) Type P components:
pneumatic components.

d) Type W components:
water tubing circuits.

e) Type S components:
support and adjustment components.

2.1.1 Type A components
The A type components are shown in drawing 30040.35.007.

A1. Vacuum pipe, CF40F (fixed flange)/CF40R (rotatable flange), with inner diameter 39 mm and axial length 336.21 mm.

A2. Mini gate valve, manually-actuated, VAT series 01, DN40 CF-F, with axial length 35 mm.

A3. Vacuum pipe, CF40F/CF40R, with axial length 222 mm.

A4. Hydroformed metal bellows, CF40F/CF40R, with inner diameter 39 mm and axial length 126 mm.

A5. Vacuum pipe, CF40F/CF40R, with inner diameter 39 mm and axial length 410 mm.

A6. Pumping chamber, CF40F/CF63R, with axial length 624 mm.
Laterally, one CF40 flange and one CF63 flange which are coaxial with the beam, are used to connect to the other parts of the X06SFE (A5, A7). The inner diameter of pipe is 39 mm for CF40 flange and is 66 mm for CF63 flange.
One CF150R flange is in the horizontal position. It is used to connect to an ion pump (V1) in the horizontal position.

A7. Hydroformed metal bellows, CF63F/CF63R, with inner diameter 66 mm and axial length 150 mm.

A8. The first Diaphragm (1^{st} DI), CF63F/CF40F, with axial length 220 mm.
It must be made according to the drawing 30040.36.001, and must fulfill the following specifications:
The OFHC copper block has cylinder-shaped ends, onto which two tubes are brazed for connection to flanges. On the top of the cylinder-shaped ends, there are three 6 mm diameter holes for alignment purposes.
Inside the OFHC copper block, there is a tapered rectangular opening with dimensions at the narrowest point of 4.9 mm horizontal by 2 mm vertical. The angle of the wall with respect to the center line of the cone is 2° for each side, the upper and lower walls.
There are 12 identically configured water channels in the both the upper and lower parts of the block. Water enters through the central 6 channels and returns via the two outer sets of 3 channels.
Two covers, brazed onto the upper and lower parts of the block, cover the water channels. On each cover there is one port for water in, two ports for water out and two holes for inserting thermocouples.
There are four horizontal holes in the OFHC copper, two on each side, for inserting thermocouples. In total, there are eight thermocouples.
There are three support feet, which adjust 1^{st} DI to a given position within ± 0.05 mm and can be fixed in that position.
Summary of main parts:
a) two flanges, CF63F and CF40F, and their nipples
b) one OFHC copper block and two covers
c) eight thermocouples
d) support frame and feet

A9. Hydroformed metal bellows, CF40F/CF40R, with inner diameter 39 mm and axial length 126 mm.

A10. Photon Shutter (PSH), CF40F/CF40R with axial length 420 mm.
It must be made according to drawing 30040.26.002, and it must fulfill the following specifications:
The shutter essentially consists of a vacuum chamber, inside of which is placed a water-cooled copper head that can be moved in the vertical direction by means of a pneumatic manipulator.
The vacuum chamber is a cylinder of 300 mm inner diameter, on which are mounted:
-two lateral CF40F/CF40R flanges coaxial to the beam, used to connect to the parts A9 and A11 of the X06SFE,
-one CF300F flange on the top for connecting the pneumatic manipulator and water-cooled copper head system,
-two CF100F flanges closed by blank flanges,
-two CF40F flanges: one to mount a cold-cathode pressure gauge (V2) and another to mount a Pirani pressure gauge with a zero-length CF40/CF16 reduction (V3),
-one CF150R flange at the bottom of the chamber with a nipple to connect an ion pump (V4). On this nipple there is one CF63R flange onto which a right-angle all-metal valve (V5) for connecting a roughing pump system.
It must be possible to place the copper head in two positions: an upper position in which the first diaphragm aperture is completely free and a lower position in which the first diaphragm aperture is completely occluded. In the absence of air pressure and/or electrical power, the copper head must move completely down, occluding the first diaphragm aperture.
The water-cooled copper head must be made according to the drawing 30040.26.003.
In the center part, the copper head surface is tilted 3° with respect to the horizontal plane, and 15° in each end region. It has a rectangular shape, in order to completely occlude the diaphragm aperture.
There are water channels outside of the vacuum environment in the upper part of the head and covered by a brazed plate. There are 12 identically configured water channels, water enters through the central 6 channels and returns via the two outer sets of 3 channels.
Two long tubes are connected to the copper head for inserting two thermocouples (K type) which monitor the temperatures close to the beam spot. The position is indicated in the drawing 30040.26.003.
A welded bellows (Standard Bellows P/N 425-320-4-EE) with a CF300R flange and a plate is welded together to form a vacuum pipe, at whose end is a CF63R flange, which is used to connect to the CF63 flange on the water-cooled copper head. The CF300R flange is not only the cover flange of the chamber, but it is also the base plate of the manipulator.
The pneumatic manipulator basically consists of three columns, two fixed plates, a movable carriage, a microswitch box and a pneumatic actuator. The plate at the end of the bellows will be connected to the movable carriage. On the top fixed plate, there are three holes of 6 mm diameter for alignment purposes. The stroke of this manipulator should be 50 mm.
The pneumatic actuator has the following characteristics: stroke 25 mm, bore 80 mm, Viton sealed. It must have a repeatability of $\pm$ 0.2 mm when the copper head reaches the lower position.
A counter with a range of 1-10000 is installed to record the number of operating strokes.
The copper head positions must be detected by means of the positive action of two pairs (for safety considerations) of bakeable microswitches that must be activated only when the diaphragm aperture is

completely closed or free. The four microswitches are mounted in a box, and their position is adjustable.
The chamber connects to the three support feet which adjust PSH to a given position within ⌖0.1 mm and can be fixed in that position.
Summary of main parts:
a) vacuum chamber
b) copper head
c) bellows system
d) pneumatic manipulator
e) vacuum components
f) thermocouple
g) support system

A11. All-metal gate valve (VG1), pneumatically-actuated, VAT series 48, DN40 CF-F, with axial length 72 mm.

A12. Vacuum pipe, CF40R/CF40R, with inner diameter 39 mm and axial length 94 mm.

A13. Fast valve (FV), VAT Series 77, DN40 CF-F, with axial length 60 mm.

A14. Hydroformed metal bellows, CF40F/CF40R, with inner diameter 39 mm and axial length 126 mm.

A15. Vacuum pipe for lead wall, CF40F/CF40R, with inner diameter 39 mm and axial length 200 mm. There is a wall built of lead bricks covering this vacuum pipe. The lead brick frame is not included in this specification. The lead bricks will be mounted after theX06SFE is installed in site. Therefore the space around the pipe must be free.

A16. Beam Stopper (ST), CF40F/CF40R, with axial length 372 mm.
It must be made according to drawing 30040.26.005, and it must fulfill the following specifications:
It consists of a cylindrical tungsten block that, by means of a pneumatic manipulator and movable carriage, can be moved in a vacuum chamber, occluding completely the beamline vacuum pipe.
The vacuum chamber is a cylinder of 250 mm inner diameter. Two lateral CF 40 flanges coaxial to the beam, are used to connect to the parts A15 and A17 of the X06SFE. Two CF63 flanges and the CF150R flange at the bottom of the chamber are closed by blank flanges. On the top there is one CF250F flange for connecting the manipulator and tungsten block assembly.
The manipulator is the same as that of the PSH (A10). The pneumatic actuator has the following characteristics: stroke 50 mm, bore 80 mm, Viton sealed.
The tungsten block assembly, shown in drawing 30040.26.006, has a minimum diameter of 50 mm and a length of 180 mm. When the pneumatic actuator shaft is extended, the beamline vacuum pipe must be completely occluded by the tungsten block, and the beamline vacuum pipe must be completely free when the shaft is retracted. In the absence of air pressure and/or electric power or vacuum, the tungsten block must move completely down, occluding the beamline pipe.
The tungsten block positions are detected by means of the positive action of two pairs (for safety considerations) of bakeable microswitches, that are activated only when the beamline pipe is

completely closed or free. The four microswitches are mounted in a box, and their position is adjustable.
The chamber connects to the three support feet which adjust ST to a given position within ⌖0.1 mm and can be fixed in that position.
Summary of main parts:
a) vacuum chamber
b) tungsten block system
c) pneumatic manipulator

A17. Vacuum pipe, CF40F/CF40R, with inner diameter 39 mm and axial length 410 mm.

A18. Hydroformed metal bellows, CF40F/CF40R, with inner diameter 39 mm and axial length 126 mm.

A19. The second Diaphragm (2^{nd} DI), CF40F/CF40F, with axial length 220 mm.
It must be made according to the drawing 30040.36.004, and must fulfill the following specifications:
The OFHC copper block has cylinder-shaped ends, onto which two tubes are brazed for connection to flanges. On the top of the cylinder-shaped ends, there are three 6 mm diameter holes for alignment purposes.
Inside the OFHC copper block, there is a tapered rectangular opening with dimensions at the narrowest point of 4.6 mm horizontal by 1.2 mm vertical. The angle of the wall with respect to the center line of the cone is 2° for each side, the upper and lower walls.
There are identically configured water channels, covers and thermocouples as 1^{st} DI.
Under the frame of 2^{nd} DI, there is a two direction stage (30040.36.005), which can move 2^{nd} DI in vertical and horizontal directions in a range of ±5 mm with a resolution of 0.01 mm. Both motorized and manual movements are necessary; the movement must be irreversible; the driving motors are stepping motors, which will be supplied by PSI. One microswitches stops the motor when it reaches the limit position. The load capacity should be carefully considered, as 2^{nd} DI will be moved together with two bellows (A18, A20) under vacuum.
There are three support feet to adjust 2^{nd} DI to a given position within ⌖0.05 mm and are can be fixed in that position.
Summary of main parts:
a) two CF40 flanges and their nipples
b) one OFHC copper block and two covers
c) eight thermocouples
d) two direction stage
d) support frame and feet

A20. Hydroformed metal bellows, CF40F/CF40R, with inner diameter 39 mm and axial length 126 mm.

A21. Filter (FI), CF40F/CF40R, with axial length 372 mm.
It must be made according to drawing 30040.36.010, and it must fulfill the following specifications:
The vacuum chamber is a cylinder of 250 mm inner diameter. Two lateral CF 40 flanges coaxial to the beam, are used to connect to the parts A20 and A22 of the X06SFE. On the top a CF250F flange is covered by a CF250 flange, on which a filter holder is fixed. A water-cooling feedthrough and two

CF40F flanges are also fixed onto it. As the filter holder is not included in this specification, the top CF250 flange will be a blank type. The filter holder will be sent by PSI to the supplier for final assembly.
There are two CF100F flanges on the chamber, they are closed by blank flanges. The CF150R flange at the bottom of the chamber is connected to an ion pump (V6) with a nipple.
Summary of main parts:
a) vacuum chamber and cover blank flange
b) vacuum components

A22. Hydroformed metal bellows, CF40F/CF40R, with inner diameter 39 mm and axial length 126 mm.

A23. Vacuum pipe, CF40F/CF40R, with inner diameter 39 mm and axial length 1195 mm.

A24. Hydroformed metal bellows, CF40F/CF40R, with inner diameter 39 mm and axial length 126 mm.

A25. Vacuum chamber, CF40F/CF40R, with axial length 265 mm.
Laterally, two CF40 flanges which are coaxial with the beam, are used to connect to the other parts of the X06SFE (A24, A26).
On the top CF150F flange there is a blank CF150 flange. The bottom CF150 flange is connected to a nipple. There is a CF63 flange on the nipple, onto which a right-angle all-metal valve (V9) is mounted for connecting a roughing pump system.
There are five CF40 flanges on the chamber; they connect to:
- VAT high-vacuum sensor for a fast valve (V11)
- cold-cathode pressure gauge (V8)
- Pirani pressure gauge (V7)
- bypass circuit; the bypass circuit consists of bellows, elbows and a mini gate valve (V10)
- one blank flange.

A26. Beryllium-window, CF40, with axial length 24 mm.
This is not included in this specification, it will be sent by PSI to the supplier for final assembly.

A27. Vacuum-T, CF40R/CF40R, with axial length 163 mm.
This is a T-type vacuum component. Laterally, two CF40R flanges, coaxial to the beam, are used to connect to the other parts of the X06SFE (A26, A28).
Through a right angle elbow and a bellows, a CF40F flange is connected to the mini gate valve (V10), which is on the bypass circuit.
Before evacuating through the port of right-angle all-metal valve (V5) on A10 or (V9) on A25, the mini gate valve (V10) must be open. In this way there is no force acting on the beryllium foil of A26 during pumping. V10 is closed when the high-vacuum is reached.

A28. Mini gate valve, pneumatic actuator (VG2), VAT series 01, DN40 CF-F, with length 35 mm.

The total axial length of X06SFE is 6781.21 mm.

The distance from the last flange of X06SFE to the middle point of the radiation sourceX06SID is 14500 mm.

2.1.2 Type V components

All the V type components are shown in drawing 30040.35.008.

V1. Ion Pump, Varian, VacIon Plus 300, CF150; mounted on the Pumping chamber (A6).

V2. Cold-cathode pressure gauge, Balzers IKR 270 DN40 CF-F; mounted on the PSH (A10).

V3. Pirani pressure gauge, Balzers, TPR260 DN16 CF-R; mounted on the PSH (A10).

V4. Ion Pump, Varian, VacIon Plus 300, CF150; mounted on the PSH (A10).

V5. Right-angle all-metal valve, VAT Series 57, DN63-CF; mounted on the PSH (A10).

V6. Ion Pump, Varian, VacIon Plus 300, CF150; mounted on the FI (A21).

V7. Pirani pressure gauge, Balzers, TPR260 DN16 CF-R; mounted on the Vacuum chamber (A25)

V8. Cold-cathode pressure gauge, Balzers IKR 270 DN40 CF-F; mounted on the Vacuum chamber (A25).

V9. Right-angle all-metal valve, VAT Series 57, DN63 CF; mounted on the Vacuum chamber (A25).

V10. Mini gate valve, VAT series 01, manual actuator, DN40 CF; mounted on the Vacuum chamber (A25).

V11. Fast valve high-vacuum sensor, VAT, series 77, DN40 CF; mounted on the Vacuum chamber (A25).

2.1.3 Type P components

These components constitute the pneumatic circuit, which permits the actuation of all the pneumatically-actuated components. Excluded are the pneumatic actuators mounted on A10, A11, A13, A16 and A28, which are already considered as sub-components of type A components.

PSI does not provide a detailed design of the pneumatic system of X06SFE; this is the responsibility of the supplier. The location of the pneumatic circuit main connection and the positions of each branch circuit are indicated in drawing 30040.35.009.

The functional scheme of the pneumatic system is shown in drawing 30040.35.012.

The pneumatic circuit consists of five branches which supply the pneumatic actuators of components A10, A11, A13, A16 and A28. This circuit must be connected to the main pneumatic circuit of the SLS storage ring through the connector (PC). Downstream from the connector, there is a main valve (PV), a condensation water discharger (PD) and an air treatment unit (PU), composed of a filter and a pressure switch with a pressure gauge. The condensation water discharger (PD) must be placed at the lowest point of the circuit. Two quick connectors (QC) are placed at the inlet and outlet.

In each branch there is a non-return valve (PN) and a reservoir (PR) which allow temporary operation of the components in case of pressure failure.

The pneumatic actuators are driven by means of solenoid valves. The PSH (A10) and ST (A16) actuators are driven by the five-way valves (PSV1 and PSV3). The solenoid valves are biased; in the absence of current, the solenoid valves PSV1 and PSV3 must close A10 and A16, respectively. Further downstream, the valve flow controls (PF1, PF2, PF3 and PF4) permit regulation of the opening and closing time, which must be set to 3 seconds when the components are under vacuum.

The all-metal valve (A11) and the mini gate valve (A28) are driven by five-way valves (PSV2 and PSV4); no flow controls are required. The fast valve (A13) has its own solenoid valve, but since its working pressure is 0.5 M Pa, a pressure reducer (R) is required.

All the pneumatic components must be fixed to the same support structure as the A-type components. All tubes must be made of copper. The inner diameter of the tubes must be 8 mm. There is a long tube (FH) for extending the circuit to the outside of the SLS shielding wall; its exact length will be defined after the X06SFE is installed on site.

The system will work at 0.7 MPa pressure with the exception of the fast valve (A13), which will work at 0.5 M Pa.

FESTO pneumatic components must be used. The supplier is required to supply a list of model numbers for all the pneumatic components, together with detailed drawings of this system.

2.1.4 Type W components

These components constitute the water tubing circuit which supplies the type A cooled components (A8, A10, A19, A21 and A26).

PSI does not provide a detailed design of the water tubing of X06SFE; this is the responsibility of the supplier. The location of the water tubing circuit main connection and the positions of each branch circuit are indicated in drawing 30040.35.010.

The functional scheme of the water cooling system is shown in drawing 30040.25.013.

The inlet and outlet water main connectors are denoted C_{in} and C_{out}. Following the inlet connector (C_{in}) an electrically-actuated valve (G), a pressure gauge (PI) and a manual valve (VS) are placed. The valve (G) must be provided with an open/closed position microswitch (I). Before the outlet connector (C_{out}), there is a one way valve (V0) and a manual valve (VS); the end of the inlet and outlet pipes should be closed by tapped plugs.

The material of the water tubes must be stainless steel AISI 316 L; aluminum is not allowed in any component (valves, seals, etc.) of the circuit. Nitril seals must be used. All the tubes must be insulated to avoid water condensation.

The maximum inlet pressure is 1 MPa. Demineralized water will be used.

Each branch tube consists of one needle valve (V), two flexible stainless steel hoses (TF), one flow switch (FS) and one flow meter (FI) - all of these subunits are connected by the branch tube to a particular water-cooled component (A8, A10, A19, A21 and A26). FS and FI must be included in a single unit.

The needle valves (V) must have detachable hand-wheels.

The supplier is required to send a list of model numbers for all the water circuit components together with the detailed drawings of this system.

2.1.5 Type S components

These components support all the other components of the X06SFE.

The beam height is 1400 mm above the floor, therefore the supports must hold all the components at this height.

All the supports must be designed in such a way that they are able to position the components with travel in three directions of ±25 mm. Angular adjustments of ±2° must be possible.

All the supports must be highly stable; if a lateral load of 3000 N is applied, the supported components should not move more than 1 mm. All resonant frequencies of the loaded supports must be higher than 50 Hz. All the components must be attached to the support such that the vacuum forces cannot overload the bellows or move the components by more than 0.1 mm. The support must allow the disassembly of each component without the necessity of moving the others.

The supports must be made of steel; therefore surface painting is required. Each part must be painted with at least one primer and one high-grade coat of paint. The paint should be insoluble in acetone. The color will be rose. No painting is allowed on machined surfaces or stainless steel parts.

When all the X06SFE components are assembled, it must be possible to move all the S components in three individual modules with a crane; the supplier must provide suitable eyebolts.

Under each ion pump there is an adjustable mechanism. It will hold the pump in the normal working position, and it can be lowered and separated from the pump during the dismounting and mounting procedures.

The support system of X06SFE consists of 2 main modules (S1, S2), 1 pump support (S) and 5 pipe supports (S5). All of these should be fixed to the floor by bolts.

PSI does not provide detailed drawings of these supports; these must be made by the supplier and approved by PSI.

In drawing 30040.35.011, the maximum dimensions of these supports are given.

S1 Support: approximate axial length 2950 mm. This component must support A8, A10, A11, A13, A16, A17, A19 and A20. It must be possible to move with a crane the overall support with all the components mounted on it; it must be possible to move or replace each component and to align it with respect to the others.

The space around A15 must be free, one support will be inserted in that place in the future.

It must be kept free in the close ring side part of S1 support.

There are four holes of 6 mm diameter on the top plate of the support to serve as reference points.

There are two groups of feet: five adjustable feet and four fixed feet.

The adjustable feet are attached to the floor by bolts. Using them, the support can be easily moved and fixed into position. The fixed feet are lowered down only after the S1 reaches its final position.

S2 Support: approximate axial length 600 mm. This component must support A23, A25, A26, 27, A28, and the components of the bypass circuit: it must be fixed to the floor by bolts. It has the same requirements as for S1.

It must be kept free in the close ring side part of S2 support.

There are three adjustable feet. They are the same type as described for S1.

S3 Support: This is used to support the ion pump on A6.

S4 Supports: These are universal supports to individually hold A3, A5, A17, A23 and other units. The supported pipe diameter can vary from 35 to 80 mm.

The supports must have two directional adjustments, both perpendicular to the beam axis: ±20 mm in the vertical direction and ±15 mm in the horizontal direction.

2.2 X06SFE systems

2.2.1 Electrical system

All the vacuum instruments (such as the Pirani and cold-cathode gauges, ion pumps, etc.) and motors will be connected directly to their controllers. All their cables are not objects of these specifications. PSI will provide a special set of cables for test purposes.
The bake-out heating elements, the thermocouples and the valves must be wired by the supplier.
All the metallic parts of the frame must be grounded.
Cable trays (cross-section: 200 mm x 100 mm) on the supports are requested.
The locations of cable trays and the positions for connection boxes must be approved by PSI.

2.2.2 Bake-out system

The bake-out system design is requested from the supplier. This system should be mounted in such a way that the following conditions are satisfied:
- the heaters must be strip heaters and flange heaters;
- it must be divided into a maximum 8 zones; each zone must have a K-type thermocouple and draw a maximum power of 1 kW from 220V 50 Hz;
- the maximum power should not exceed 8 kW;
- all the thermocouples used for the bake-out must be reliably fixed to the components and be easily disassembled;
- all the heaters and the thermocouples must be identified by a thermally-resistant labeling system;
- all the heaters must be covered by aluminum foils.

The bake-out procedure will use heaters, flange heaters (CF flanges and blankets), K-type thermocouples and aluminum foils. The temperature controllers will be supplied by PSI. Glass fiber insulation material must be avoided in this system.
The location of power connectors and the positions of thermocouples must be approved by PSI.

2.2.3 Pneumatic system

See section 2.1.3 of this specification.

2.2.4 Water cooling system

See section 2.1.4 of this specification.

2.3 Alignment and assembly

The alignment must be done by conventional mechanical and optical instruments.

2.3.1 Alignment of individual components

a) PSH assembly:

The PSH copper head center must be adjusted to the center of the chamber, and its tilted angle with respect to the center axis of the chamber must be 3°.

There are reference holes outside of the chamber. The relative positions of the shutter head and the reference holes must be recorded in an alignment protocol.

b) ST assembly:

The ST head must be at the center of ST chamber when in the lowered position.

c) FI assembly:

The FI holder must be at the center of FI chamber.

2.3.2 Module alignment and assembly

The lower position of the PSH copper head center must be in the center of the aperture of 1st DI, and its tilted angle with respect to the center axis of the aperture of 1st DI must be 3°.

The 1st DI and 2nd DI must be well aligned, and the two direction stage in the 2nd DI must be set in the middle point of the stroke after the 2nd DI has been aligned.

The filter holder position should be checked, it must be well aligned respect to the apertures of two diaphragms.

There are reference points on the top plate for each support. Each component must be positioned according to the reference holes on the component with respect to the reference points on the support. The relative positions between them must be recorded in an alignment protocol. The flanges of the A-type components coaxial to the beam must be positioned to within 1 mm with respect to the beam axis.

2.3.3 Alignment and installation on site

The final alignment on site will be done by PSI surveying group, and it is therefore not included in the quotation. The SLS alignment network should be used to install the three modules into position. Before the three modules are connected together, the alignment of the critical components 1st DI (A8), PSH (A10), ST(A16), 2nd DI(A19) and FI(A21) must be rechecked.

3. Scope of Supply

3.1 X06SFE

The X06SFE, as defined in the section 2 of this specification, will be delivered to PSI. It must be fully tested and aligned and must include the bake-out, water-cooling and pneumatic systems.

3.2 Time schedule

The supplier will provide a detailed time and manpower plan for all the work in this specification within three weeks of placing the contract. The manpower plan will include and specify the key personnel concerned with this contract.

3.3 Drawings

The supplier will produce all the drawings which are necessary to manufacture each component and to assemble and align the complete X06SFE as required in this specification, including drawings of tools and temporary fixtures.

All the drawings will be sent to PSI as soon as they are available. The PSI will require approximately four weeks to check the drawings. This check is needed to verify the compatibility of the drawings with the specification, and the manufacturing of the components can only begin after completion of this check. The PSI will then take possession of all the drawings and will be free to use them to manufacture items elsewhere.

All the drawings must be classified according to the PSI classification system, which will be provided by PSI within two weeks after the contract is placed. Printed copies of the complete final drawings, together with the drawing list, must be sent to PSI at the latest one month after delivery of X06SFE.

CAD drawings are required; the supplier is asked to give to PSI floppy disks with the main drawings in DWG (Autocad ver.13 or higher) or DXF format. The PSI will provide an example of the standardized Autocad format of the drawings. The CAD drawings in electronic form must be sent to PSI together with the printed drawings.

3.4 Tools and temporary fixtures

The supplier will provide the PSI with a list of all tools and jigs required during the manufacture of X06SFE, together with drawings and descriptions of these items. After completion of the contract, the PSI will take possession of them.

3.5 Certificates and reports

The following material certificates must be provided by the supplier:

-AISI 316LN-ESR

-Copper OFHC

-Tungsten

The following set of inspection documents is required at the end of the contract:

- reports of leak test, accuracy test and vacuum test
- records of bake-out temperature, brazing process and alignment reference

-the system assembling and disassembling procedure

- technical documents concerning components purchased by the contractor

4. Standardization

4.1 Flanges and fittings

All the flanges and the gaskets must be Conflat (CF) type.
If not otherwise specified, vacuum chambers and pipes must be made of stainless steel AISI 304L, the flanges must be made of AISI 316LN-ESR, and the gaskets must be made of OFHC copper. The manufacturer must be approved by PSI; PSI reserves the right to require machining drawings for each type of flange, together with a material quality-control certificate, including chemical analysis, mechanical properties and iron content. Each flange must be stamped with the name of the producer and the material used.
All the A-type components have two flanges coaxial to the beam axis. If not otherwise specified, the beam-inlet flange must be rotatable and the beam-outlet flange fixed. Other rotatable flanges can be inserted whenever necessary.
Unless otherwise specified, the standard stainless steel bolts used for the final flange assembly shall be A4-80 Class, according to the UNI 7323 or similar standard; hexagon screw heads are requested for these bolts.
All the bolts must be silver-plated, according to UNI ISO 4521.
Bellows other than the types suggested by PSI may be used only after the approval of PSI.
In any case, bellows must never be handled without clean gloves (on both the inner and in the outer surfaces); particular care must be taken in order to avoid that machining chips or dust fall inside the bellows. Particular care must be taken during assembly to assure that they are never forced by axial torque.

4.2 Vacuum pipes and free length

The following dimensions are suggested for the standard pipe:
When the outside diameter (OD) is smaller than 100 mm, the pipes cannot be welded.
-OD 19.00 with wall thickness 1.50 mm
-OD 42.40 with wall thickness 1.60 mm
-OD 70.00 with wall thickness 2.00 mm
When the outside diameter (OD) is larger than 100 mm, the pipes can be welded.
-OD 108.00 with wall thickness 2.90 mm
-OD 156.00 with wall thickness 3.00 mm
-OD 206.00 with wall thickness 3.00 mm
-OD 256.00 with wall thickness 3.00 mm
-OD 306.00 with wall thickness 3.00 mm

The free length is the length of pipe which is welded to the flange to provide space to connect the flanges. The following dimensions are suggested to use in most cases:
-CF16 30 mm
-CF40 45 mm
-CF63 60 mm
-CF100 65 mm
-CF150 65 mm
-CF200 70 mm
-CF250 70 mm

4.3 Microswitches

All the microswitches must be bakeable types; PSI suggests to use the products of Caburn UHV, Lewes, UK : model VH5LR for external use and model VH3 for internal use.

4.4 Thermocouples

All the thermocouples are of the K-type. PSI will suply them with a diameter of 1 mm.

4.5 Identification mark

With the exception of the valves, bellows and reducing pieces, it is required that the supplier provides type-A components with an identification mark made on a stainless steel label by chemical etching or electroengraving.

The orientation of the marking must be such that it remains visible after assembly. The marking caption will be communicated by PSI to the contractor after placement of the order.

5. Inspection and Tests

All components must undergo a check of all the dimensions on the drawings, and all tolerances on the drawings must be fulfilled.

Two weeks before each test, a document with a description of the test procedure must be presented to PSI for approval. This document should describe in detail:
-test procedure followed
-time schedule of the tests
-location where the test will be performed
-instruments to be used
-list of personnel involved in the tests and their tasks
-schematic drawings of the test set-up

The following tests must be performed by the supplier:

a) Leak test and vacuum test:
as described in UHV Materials and Technologies for SLS Front End and Beamline, SLS-TME-TA-1998-0014;

b) Alignment check:
as described in section 2;

c) Accuracy test:
Accuracy tests of the two direction stage of the 2nd DI (A19) must be performed when 2nd DI connects to two bellows (A18 and A20) and they are under vacuum.
The displacement-resolution measurement: the specified resolution must be verified at 10 different points of the overall travel, approximately equally-spaced. It is the responsibility of the supplier to choose the proper instrumentation to perform these tests.
The supplier is required to propose and perform the tests needed to verify the fulfillment of all the requirements concerning the mounting accuracy of all components and their alignment tolerances on the frame.

d) Functional test:
It must be verified that the 1st Diaphragm aperture will be completely occluded when the SPH (A10) is in the lower position and will be completely free when in the upper position.
The same check must be performed for the ST (A16).

e) Welding and Brazing quality check:
The copper heads for 1st DI (A8), PSH (A10) and 2nd DI (A19) are brazed components, and they must be carefully checked before the support pipe is closed. A test with water circulating inside them under a water pressure 1 M Pa and flow rate 0.2 Kg/s must be made without leakage.
The specification for the brazing process must be proposed by the contractor for PSI approval. The execution of the brazing process is entirely the responsibility of the contractor.

6. Packing and Delivery

The supplier is required to take responsibility for packing and transportation of the entire X06SFE to the SLS site at PSI. The X06SFE must be equipped with blank flanges and filled with dry nitrogen. All modules must be equipped with properly-shaped covers to prevent the X06SFE from being contaminated with dust, water, etc. The handling and transportation jig must be perfectly clean and degreased. Wherever necessary, components must be covered with adequate protection. Adequate packing and protection must be provided to prevent damage during transportation. The X06SFE (with and without its packaging) must be transportable by crane.

The following is to be displayed clearly on the outside of the packaging:
-addressed to SLS/PSI CH-5232 Villigen, Switzerland
-the PSI contract number
-the weight of the loaded package
-support points for transport and lifting

7. Quality assurance requirements

PSI prefers that manufacturers are registered to comply with ISO 9001 or an equivalent national standard.
The requirements of PSI for quality assurance are stipulated in the specification ESRF/ENG/89/02 "Quality assurance requirements".

Control visits by PSI representatives must be possible, as described in the supply contract.
In addition, a mandatory control will be carried out at the following points:
-during bake-out and vacuum tests
-during the accuracy and functional test
-before the final assembly
In order to schedule such inspections, it is required that PSI receive announcements of such events with two weeks advance notice.

8. Drawings and Components supplied by PSI

8.1 List of annexed drawings

1/	30040.35.006	General layout
2/	30040.35.007	Axial component layout
3/	30040.35.008	Vacuum component layout
4/	30040.35.009	Pneumatic system layout
5/	30040.35.010	Water tubing circuit layout
6/	30040.35.011	Support component layout
7/	30040.35.012	The functional scheme of the pneumatic system
8/	30040.35.013	The functional scheme of the water tubing system
9/	30040.36.001	The first diaphragm assembly
10/	30040.26.002	Photon shutter assembly
11/	30040.26.003	Photon shutter head
12/	30040.36.004	The second diaphragm assembly
13/	30040.36.005	The second diaphragm with two stages assembly
14/	30040.36.006	The second diaphragm horizontal stage assembly
15/	30040.36.007	The second diaphragm vertical stage assembly
16/	30040.26.005	Beam stopper assembly
17/	30040.26.006	Beam stopper head
18/	30040.36.010	Filter chamber
19/	30040.26.020	Photon shutter head box
20/	30040.26.021	Photon shutter head cover
21/	30040.26.022	Photon shutter head pipes and plates
22/	30040.26.023	Photon shutter pipe for thermocouple
23/	30040.26.036	Photon shutter heat box and cover

8.2 List of components supplied by PSI

-Beryllium-window	1 piece
-Balzers IKR270 DN40 CF-F Cold-cathode pressure gauge	2 pieces
-Balzers TPR260 DN16 CF-R Pirani pressure gauge	2 pieces
-Varian VacIon Plus 300 l/s ion pump	3 pieces
-VAT series 48, DN40 CF-F, pneumatically actuated, all-metal gate valve	1 piece
-VAT series 57, DN63 CF, manually actuated, right-angle all-metal valve	2 pieces
-VAT series 77, DN40 CF-F, fast valve high-vacuum sensor	1 piece
-VAT series 77, DN40 CF-F, fast valve	1 piece
-VAT series 01, DN40 CF-F, manually actuated, mini gate valve	2 pieces
-VAT series 01, DN40 CF-F, pneumatically actuated, mini gate valve	1 pieces
-motors	2 pieces
-K-type thermocouples	21 pieces

9.3 List of components supplied by PSI for test purposes

-Balzers pressure gauge controller
-Varian ion pump controller
-bake-out controller
-motor controller
-a set of test cables