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Specifications of the Shielded Hutch (X02DA-ES) and Vacuum Tube Shield (X02DA-BGT) for the X-ray Tomographic Microscopy (XTM) beamline of the Swiss Light Source

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Specifications for:

One Shielded Hutch for High-Energy Synchrotron Radiation Experiments

The lead-shielded hutch is to be fabricated according to ESRF Design 'A1', including walls, doors, windows, chicanes and media supports. The hutch walls must accurately fit to the existing SLS tunnel shielding. Pre-construction surveying and radiation testing will be performed by PSI staff accompanied by contractor representatives.

1 Project Overview

The Swiss Light Source (SLS) is a 2.4 GeV, 400 mA electron storage ring, operated at the Paul Scherrer Institut (PSI) in Villigen, Switzerland. The SLS started its operation in summer 2001 and currently five beamlines are open for users. In the immediate future, two additional beamlines will start their operation. The next beamline to be built is the X-Ray Tomographic Microscopy beamline (XTM). The new beamline will be dedicated to high-throughput microtomographic investigation at the micron- and submicron level, as well as real-time radiology.

The schematic layout of the XTM beamline is depicted in Fig. 1. The new beamline will be located at the X02DA port of the SLS and will receive photons from a 3.1 T superbend. The beamline has been designed to provide monochromatic as well as white beam to the experimental station.

The front-end includes SLS standard radiation safety equipment as well as an aperture system to reduce Bremsstrahlung and the total radiation power. The maximal angular extension of the photon beam, defined by the aperture, is ±1.0 mrad horizontally and ±0.3 mrad vertically. A CVD diamond window of 100 microns thickness separates the UHV section of the machine from the HV section of the front-end.

During operation of the SLS, the shielded hutch will provide radiation protection to users, whose main place of work will be in unshielded control hutches located adjacent to the shielded hutch as well as all persons on the experiments floor. The shielded hutch is to be made of steel and lead, conforming to the ESRF design ‘A1’ from 12.03.99

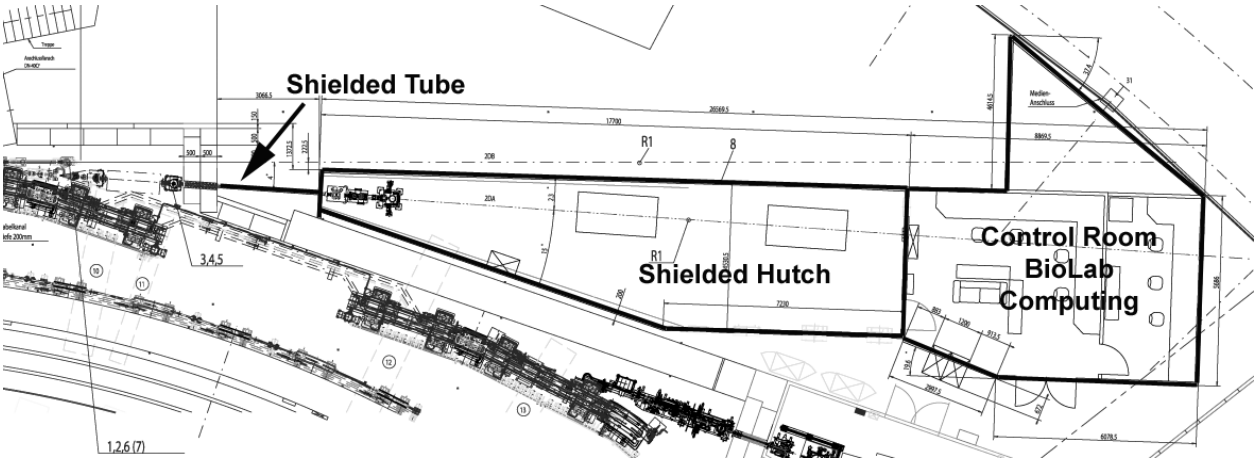

Figure 1: Layout of the XTM beamline X02DA.

2 Summary

This specification applies to one lead-shielded hutche for the X-Ray Tomographic Microscopy beamline (see Drawing 0-30040.15.004w). This will be denoted X02DA-ES. The existing tunnel shielding of the SLS forms parts of the walls in X02DA-ES. The hutch is to be configured and fabricated by the Contractor according to the design 'A1' of the ESRF (European Synchrotron Radiation Facility, Grenoble, France). The shielded hutch will be delivered to PSI in pieces, to be assembled on site by the contractor.

The hutch walls must fit without radiation leaks to the existing SLS tunnel shielding. The roofs are to be removable with an overhead crane to allow the installation of heavy equipment. The hutch includes standard features such as single and double hinged doors with Pb-glass windows, and several types of chicanes: fluids, electrical, experiment electrical, ventilation entrance and exit, and exhaust. Provision is to be made for the mounting of fluid pipes and electrical cables on the inside and outside walls of the hutch.

The hutch has to have its own crane (500 kg capacity), moving along rails for the specified path (see Drawing 0-30040.15.004w) and ESRF drawing 00.65.1198). The hutch has to have an internal height of 3.5 m, and the individual floor area (including wall thickness) is 63.35 m^2. It is possible that this floor area will change slightly (±5%) during the design phase.

Tenderers are requested to comment upon the specification and are encouraged to make alternative proposals to PSI in addition to the quotation for the given specification.

3 Specifications

3.1 The SLS Experiments Hall and Tunnel Shielding

The following material represents technical information on the SLS experiments hall and tunnel shielding of which the Contractor shall take due account in his offer.
A floor plan of the experiments hall is given in Drawing 0-30010.055d, showing the locations of the beamline X02DA and indicating the geometry of the tunnel shielding wall. The floor of the experiments hall is 38 cm of reinforced concrete, with short and long-term Young's modules of 30 and 10 GPa, respectively, and a compression strength of 25 MPa, covered with a 2 cm thick cement layer. The maximum permissible load on the floor by a vehicle is 10 tons/wheel. Creating trenches or large holes in the floor of the experiments hall is strictly forbidden, but drilled holes up to 20 mm in diameter and 150 mm in depth are permitted. The floor is specified to be flat to within ±4 mm over a distance of 20 m; however measurements have revealed local deviations as large as ±10 mm over 5 m. The temperature in the hall will vary in the range 22 to 28°C from winter to summer.

The details of the tunnel shielding wall at the Beamline X10SA is shown in Drawings 1113/8D and 1113/9B. Note that the front-end wall is located at sector 26. The shielding wall is 2.8 m high, and, as indicated, it is built from a combination of cast concrete, movable concrete blocks, movable high-density concrete blocks and smaller assorted pieces of concrete. The removable upper layer of tunnel roof beams (thickness: 0.42m) is located atop this wall. The dimensions and position of these shielding components are accurate to ±10 mm. The hutch cannot use the movable blocks as structural support, but it is possible to fix lead parts to them to ensure radiation tightness. Where fixed or movable concrete shielding is present, no lead shielding is necessary. It is not possible to drill into the high-density concrete blocks.

During the hutch design phase, PSI will make an accurate survey data of the position of the tunnel shielding elements and the profile of the floor under the hutch walls. As far as possible, the Contractor shall avoid placing hutch pillars on slab joints. It is the responsibility of the Contractor to have a representative visit the SLS site during the design phase to discuss and agree on all aspects of the survey.

3.2 General Requirements

3.2.1 Radiation Tightness

Radiation tightness at the joints of the panel structure, doors, windows, chicanes, penetrations, junctions between the hutch and the concrete floor slab and walls, and junctions between the roof and the walls of the hutches, is the most important aspect of this work, and must receive the Contractor's special attention. The PSI safety group shall carry out radiation tests during the SLS machine operation. It is required that a representative of the Contractor be present during these tests. Any local leak above 0.12 μSv/h (at a nominal current of 400 mA) found during the radiation test shall be repaired at the Contractor's expense.

The vendor shall commit him to respect the given tolerances within the contractual price. The manufacturing tolerances shall in no way give rise to leaks. The methods of manufacturing shall be adapted such that the result conforms to specifications.

3.2.2 Construction

For the shielded hutch of beamline X02DA, the SLS proposes to use the ESRF design 'A1'(from 12.03.99), for which permission has been obtained from the director of the ESRF. The detailed specifications are given in the Appendix, including pertinent descriptions of features such as wall and roof panels and joints, hinged doors, lead-glass windows, support of fluids and cable trays, survey penetrations as well as various chicanes

and tube shielding. This information is proprietary to the ESRF and cannot be made available to third parties nor used by the Contractor in other construction projects without the express, written permission of the ESRF.

The junction between the lead hutch and the storage ring concrete tunnel should be executed as it was already done for the existing (ID) lead hutches at the SLS (see also the technical note SLS-TME-TA-1999-0009B enclosed in the Appendix; it should be noted that the dimensions given therein need to be adapted to the dimensions given in this specifications).

Other special considerations are:
1) The radiation-tight joints to the existing fixed and movable concrete shielding must be designed in such a way that the concrete roof beams of the shielding tunnel can safely be removed with an overhead crane without damaging the shield hutches (for details of the roof beams, see Drawing 1113/9B).
2) The shielded hutch X02DA-ES share a wall with the unshielded control hutch (to be fabricated using a wood-rockwool sandwich construction). On the exterior of these shielded hutch walls, suitable rails must be available to support the roofs of the unshielded hutches (Jordal-rails from floor to roof at approx. 1000 mm distance to each other).
3) The construction of door hinges should prevent the door from sliding down because of its own weight.

The shielded hutch will be air-conditioned using cold water, brought in and out through fluids chicanes in pipes to cool an internal air circulation, and an additional air stream that is brought in and out through ventilation chicanes. The ESRF “ventilation entrance chicane” and “ventilation exit chicane” (see Drawings 00.65.1158 and 00.65.1164) will be used for input and output, they are to be mounted on the roofs or high on the walls, respectively. Within the hutches, the cooled air will be distributed by cloth tubes (250 mm in diameter), which are suspended either from the roof or from stretched horizontal wires. The air cooling system requires a space of 500 mm between the roof and the crane guide.

The Contractor will deliver to PSI the fabricated hutch and will assemble it on site. The Contractor is requested to provide a time schedule for the assembly. This schedule should indicate the intended usage of the big overhead crane (maximum load = 16 tons). Radiation tests of the assembled hutch will be performed, in the presence of a Contractor representative.

3.2.3 Materials

3.2.3.1 Lead

All lead parts produced shall have a minimum relative density of 11.3 g/cm^3. They shall be free of visible cracks and holes and free of grease, oil or any other slippery substance. Pb-glass windows must have an equivalent Pb-thickness at least equal to the minimum Pb-thickness.

The given lead thickness values are minimum thicknesses.

Attention shall be paid by the Contractor to all lead parts assemblies, in order to guarantee full contact between pieces. The lead parts shall not be damaged, hammered or otherwise spoiled before or during assembly.

The lead/steel panels intended for the walls and roofs shall be made in single pieces, with neither welding nor assembly.

It is strictly forbidden to perform welds not clearly indicated on the drawings approved by PSI during the design phase. Welds which are not easily accessible after assembly shall be checked with ultrasound before assembly in order to guarantee the minimum specified lead thickness.

3.2.3.2 Steel

All steel and welding materials shall have minimum yield strength of 230 MPa. The Contractor shall provide the corresponding certificates.

All steel parts shall have the following corrosion protection: Frames of wall panels and roof elements, roof frame and ground frame shall be cleaned, sand-blasted and coated with zinc primer. Steel panels, doors, chicanes, cover joint profiles and all steel lining sheets shall be made from electro zinc sheets (class 1 - two faces - 2.5 microns - degreased, passivated and phosphatized).

3.2.3.3 Glue

The Contractor shall provide PSI with the specification of any glue he intends using. A quality control procedure for bonding lead and steel shall be defined, to achieve long-term stability of the bond in a radiation environment.

3.3 Specific Requirements

3.3.1 Experimental Hutch X02DA-ES

3.3.1.1 Principal Layout

The experimental hutch X02DA-ES of the X-Ray Tomographic Microscopy (XTM) superbend beamline is shown in Drawings 0.30040.15.018 Page 1 and Page 2.

The hutch is 3.5 m high (internal height) and has 5 walls: 4 of them are Pb-walls, one of them is principally formed by the existing tunnel shielding. There are three 90^o corners and two non 90^o corners. The floor area of the hutch is 63.35 m^2.

The minimum lead thickness of the side walls is 3 mm, of the back wall 5 mm and the minimum roof thickness is 2 mm. On the rear side of the hutch X02DA-ES one Bremsstrahulung wall needs to be included. This has a thickness of 7 cm and a square area of 0.5 x 0.5 m^2 and is centered at the position of the beamline port X02DA. It is strongly preferred to have this Bremsstrahlung wall on the inside of the hutch and the design has to assure that there are no radiation leaks between the Bremsstrahlung and the hutch back wall.

X02DA-ES has one single-wing hinged door, with a window. This door represents the entrance from the control hutch and is connected to the LAC. The construction of door hinges should prevent the door from sliding down under the force of its own weight. There are two electrical chicanes, one experiment electrical chicane, one fluid chicane and three ventilation chicanes (entrance, exit and exhaust). An internal crane (500 kg capacity) movable along a specified path shall be installed.

3.3.1.2 Components of the Radiation Shielding

Component	Ref. Design
2 Electrical chicanes	ESRF : 00.65.1157
1 Fluid chicane for fluids and gases	ESRF : 00.65.1156
Ventilation inlet (located on the roof)	ESRF : 00.65.1164
Ventilation outlet (located on the roof)	ESRF : 00.65.1164
1 experiment electrical chicane	ESRF : 00.65.1171
1 exhaust chicane	ESRF : 00.65.1164
Single-wing hinged door with a Pb-glass window	ESRF : 00.65.1151/60/62
An internal, manually operated crane (500 kg) movable on rails along the specified path shall be installed.	ESRF : 00.65.1161

3.3.2 Vacuum Tube Shield X02DA-BGT

The vacuum tube shield X02DA-BGT provides radiation shielding of the 63 mm vacuum tube which runs for a length of 3.0 m between the concrete wall (front-end exit) and the shielded hutch X02DA-ES, as shown in Drawing 0-30040.15.004w. It shall provide a minimum lead thickness of 10 mm and shall conform to the ESRF drawing 00.65.1166. Special considerations, as indicated in the ESRF drawing, are required for the transitions to the shielded hutch and the concrete wall, for the CF-flange joints and for the tube supports.

3.3.3 Alignment

The tenderer should keep in mind while designing that alignment markers (dimensions: 110 mm (height) x 70 mm (width)) will be installed by PSI above the beam trajectory in a height of *2.0* m. Further alignment markers will be installed by PSI on the painted floor

4 Deliverables

4.1 Design Phase

The design phase is to be completed within 4 weeks of the placement of the order. The following items shall be delivered to PSI by this time:

- A time and manpower schedule of all activities covered by the contract.
- The quality assurance documents for all activities covered by the contract.
- The list of operations to be performed in the factory prior to delivery of the units to PSI.
- A report containing lists and detailed descriptions of components, materials and suppliers or subcontractors.

- A complete list of the quantities of components, materials, etc. to be purchased by the Contractor to build the hutch.
- All drawings used in the manufacture of the shielded hutch in printed and electronic form, according to PSI specifications AN94.02.02. The drawings will become the property of PSI, and PSI (by agreement with the ESRF) will have free use of them.
- Calculation notes on the mechanical stability of the hutch structure and the load on the Experiments Hall floor.

4.2 Manufacturing Phase

The manufacturing phase shall not begin without written approval of PSI, covering both engineering and radiation safety aspects.

5 Quality Control

The Contractor shall certify that he operates under a quality assurance system that complies with the 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" from 12/9/1989, see Appendix.

A mandatory control will be carried out by PSI at the completion of the design phase and prior to the start of the manufacturing phase. The Contractor shall give PSI two weeks advance notice of this event.

PSI reserves the right to visit the contractor, upon reasonable prior notice, to review progress of the manufacturing process.

The contractor shall notify PSI immediately for review and approval of any design changes, fabrication discrepancies, changes in documented schedules or other commitments according to this specification and all terms of the purchase order.

6 Packing and Shipping

The Contractor is responsible for the packing and transport of all parts necessary to the assembly of the hutches to the SLS site (Villigen). Adequate packing and protection must be provided to prevent damage during transport. Packing cases shall be non-returnable. The maximum weight of each individual case is 1500 kg. PSI shall be notified prior to shipping of any piece exceeding this weight.

The shipping address for items X02DA-ES and X02DA-BGT is:

Swiss Light Source
Paul Scherrer Institut
CH-5232 Villigen PSI (Materialannahme)
Attention: Dr. Marco Stampanoni

Besides the shipping address, the following is to be displayed clearly on the outside of the packaging:

- The PSI contract number
- The weight of the loaded package
- Support points for transportation and lifting, as well as the location of the centre of gravity.

7 Tentative Time Schedule

After signing of the contract there will be a joint design meeting at PSI. The vendor is requested to have the construction of X02DA-ES at PSI finalized by April 1th , 2005.

8 Drawings and Appendices

8.1 List of Appendices

- ESRF Safety Hutches Design ‘A1’ (detailed specification)
- ESRF Technical Services Division: Quality Requirements. ESRF/ENG/89/02.
- PSI Technical Note: SLS-TME-TA-199-0009B
- PSI Technical Specification : AN94.02.02.

8.2 List of Attached Drawings

8.2.1 PSI drawing

- 0-30040.15.004w X02DA – Layout XTM beamline
- 0-30010.055d SLS – Beamlines Overview
- 1113/8D Wände Speicherring + Linac, Rohbau 1 (not in scale)
- 1113/9B Decke Speicherring + Linac, Rohbau 1 (not in scale)
- 0-30040.15.018, Page 1 X02DA-ES Layout
- 0.30040.15.018, Page 2 X02DA-ES Section A-A of the X02DA-ES
- 30040.55.014 Layout Jordal rails

8.2.2 ESRF Beamline General Standard Hutches Drawings (not in scale)

00.65.1145	Location of items
00.65.1146	Door sill
00.65.1147	Alignment & survey penetrations
00.65.1148	General cross section
00.65.1149	Panels mounting sequence
00.65.1150	Wall panel's elements
00.65.1151	Wall panel's elements for doors
00.65.1152	Cover profiles
00.65.1153	Roof elements
00.65.1154	Window in panel walls
00.65.1155	Window in door
00.65.1156	Fluids chicane
00.65.1157	Electrical chicane
00.65.1158	Ventilation chicane
00.65.1159	Chicanes cutouts
00.65.1160	Doors cross sections
00.65.1161	Service loads on hutch
00.65.1162	Doors details
00.65.1163	Tunnel tube shielding
00.65.1164	Tubular ventilation exit chicane
00.65.1165	Lead profiles
00.65.1166	Shell tube shielding
00.65.1167	liquid nitrogen chicane
00.65.1168	Bremsstrahlung walls
00.65.1169	HLS Chicane
00.65.1170	Liason to concrete wall
00.65.1171	Experiment electrical chicane
00.65.1192	Wall panel's elements
00.65.1193	Panel elements for doors
00.65.1194	Cover profiles
00.65.1195	Roof elements
00.65.1196	Liaison to concrete walls
00.65.1197	Joints
00.65.1198	Service in hutch 3400