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Specification of the Filters and Slits Assemblies for the X-ray Tomographic Microscopy (XTM) beamline (X02DA) of the Swiss Light Source

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1. Introduction

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 located at 6480 mm from the source separates the UHV section of the machine from the HV section of the front-end.
The optical system described in this call will be installed in this HV section of the front-end and consist of a fixed-exit double crystal/multilayer monochromator (DCMM).

These specifications cover the supply of design, materials, manufacture, cleaning, testing and delivery of the filters and slits assemblies to be installed in the XTM beamline X02DA of SLS. Tenderers are requested to comment the specifications and are encouraged to make alternative proposals to the PSI in addition to the quotation according to these specifications. After the contract has been placed, modification from the agreed specifications will not be allowed, except with written permission of PSI.

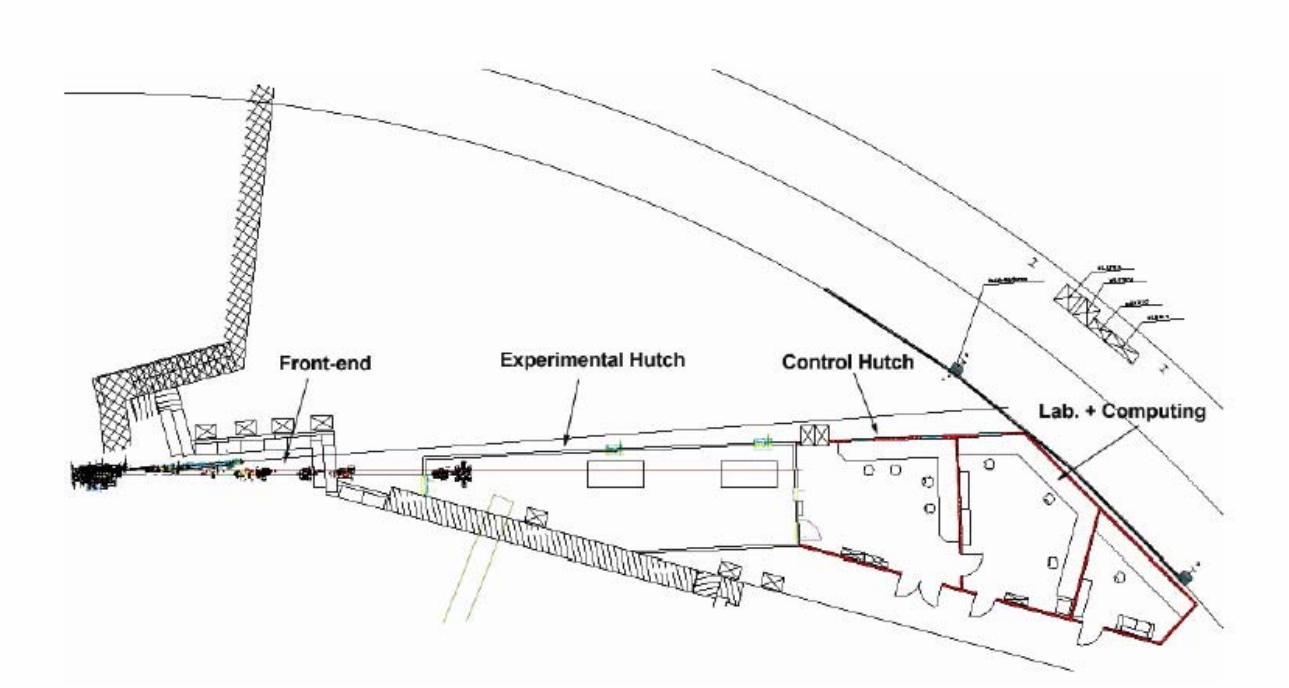


Figure 1: Layout of the XTM beamline X02DA.

2. General Description

The two assemblies are High Vacuum components mounted on a frame, with associated control cables and fluid supply.
The following document is an integral part of these specifications:
- UHV Materials and Technologies for SLS Front Ends and Beamlines (Modified version, July 2001), SLS-TME-TA-1998-0014

2.1. Design concept

The two assemblies will be installed in the Experimental Hutch and mounted on the same support. On the top of each chamber there are four holes of 6^{H7} mm diameter for alignment purposes. The chambers are mounted on a support by a set of kinematic mounting shown in the drawing 2-30040.26.087, which adjust the chamber to a given position within +/- 0.1 mm and can be fixed in that position.
Along the beam direction the filters are mounted first and then the slits assembly. The two chambers are connected with an edge-welded bellow.

2.2. Filters

The vacuum chamber is a cylinder of 200 mm inner diameter, with the following components:
- two lateral flanges CF100 coaxial to the beam,
- one CF100R flanges on the top, used to fix a filter manipulator
- one CF150R flange on the top for the ion pump
- three CF100R flanges at the bottom, used to fix three filter manipulators,
- four CF40F flanges in horizontal position on the right side (beam direction).

The four filter heads are identical. A similar filter head shown in the drawing 1-30040.31.313a and a similar chamber shown in the drawing 0-30040.31.310.
Each of the filter head consists of a water-cooled assembly with bellows and manipulator.
On each filter head there are four windows in the center of blocks with the dimensions of 35 mm horizontal and 12 mm vertical. It must be possible to mount different filter materials of thickness up to 5 mm. The filters are fixed by clamps and will be supplied and mounted by PSI. The design of the filters is sketched in Figure 2. A K-type thermocouple is brazed on the CF40 flange for monitoring the temperature on the filter head.
The four manipulators are mounted three from the bottom and one from the top of the chamber, see Figure 3. The manipulator basically consists of one housed linear bearing with two anti-rotary keys, a frame and a stepping motor. The plate at the end of the bellows will be connected to the movable carriage. The manipulator drives the aperture on the head to a given position.
The stroke of this manipulator should be 100 mm, a resolution of 0.05 mm and a backlash less than 0.05 mm. A load capacity of 300 N is required. Both motorized and manual movements are necessary; the movements must be irreversible; the driving motors are stepping motors. An encoder is not necessary.
Two microswitch are mounted in frame and their position are adjustable. They stop the motor when it reaches the limit position. A home switch is mounted on the open position and must be adjustable.
On the top of the chamber is a CF150R flange to mount an ion pump (Varian VacIon Plus 300), supplied by PSI.

2.3. Slits

The vacuum chamber is a cylinder, with the following components:
- two lateral flanges CF100 coaxial to the beam,
- four CF100R flanges, used to fix the slit manipulators

The four slits, two in the vertical and two in horizontal directions are identical. Each of them consists of water-cooled assembly with bellows and manipulator. The maximum opening is 50 mm horizontal and 50 mm vertical.
A possible solution for the water cold copper slit head is shown in the drawing 2-30040.26.393. The slits head is a rectangular shape copper plate. The head edges are used to define the beam dimension and have to be straight. A bent OFHC copper pipe is brazed to the copper plate for cooling. A K-type thermocouple is inserted into the plate to monitor the temperature. A tungsten plate is fixed onto the copper plate. Each head should have 25 mm overlap with respect to the chamber center.
The manipulator assembly is shown in the drawing 0-30040.26.412. It has a maximum travel of 50 mm, a resolution of 0.005 mm and a backlash of less than 0.005 mm. A load capacity of 300 N is required. Both motorized and manual movements are necessary: the movements must be irreversible; the driving motors are stepping motors. An Optical encoder with a resolution of 0.001 mm and stroke of 50 mm, shown in drawing 1-30030.28.059, is used to detect the position of the copper head. The two microswitches are mounted in the limit position and there are adjustable.

2.4. Support

The nominal beam height is 1407 mm above the floor, therefore the support must hold both filter and slits chamber at this level. It must be highly stable: if a lateral load of 3000 N is applied, the supported components should not move more than 2 mm. All resonant frequencies of the loaded support must be higher than 50 Hz.
The support must be made of steel; therefore surface painting is required. It 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 blue with the code RAL5010. No painting is allowed on a machined surface or stainless steel parts.
When all the components are assembled, it must be possible to move them with a crane; the supplier must be provide suitable eyebolts. It must be possible to move or replace each component and to align it with respect to the others.
There are four fixed feet which should be attached to the floor by bolts.

2.5. Alignment

The alignment must be done by conventional mechanical and optical instruments.
For both the horizontal and the vertical slits pair, the edges of the heads must be parallel to one another within 0.01 mm. The edge of the horizontal slits is perpendicular to the vertical slits within less than 0.1°.
The relative positions between inner slits and the four reference holes on each chamber must be recorded in the alignment protocol.

3. Scope of Supply

3.1. Two assemblies

The slits and filter assemblies, as defined in the section 2 of this specification, will be delivered to PSI. It must be fully tested and aligned.

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. The delivery time is three months after contract signed.

3.3. Drawings

The supplier will produce all the drawings which are necessary to manufacture each component and to assemble and align the complete X02DA chambers 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 one week 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 one week 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. CAD drawings are required; the supplier is asked to give to PSI CD disks with the main drawings in DWG (AutoCAD ver.13 or higher) or DXF format.

3.4. Tools and temporary fixtures

The supplier will provide the PSI with a list of all tools and jigs required during the manufacture, 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 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 flanges and gaskets must be of Conflat (CF) type. The manufacturer must be Balzers. If not otherwise specified, vacuum chambers and pipes must be made of stainless steel AISI 304L. The flanges must be made of AISI 316LN forgings and the gaskets must be made of silver plated OFHC copper. The flange material requirements and the cleaning and pre-baking procedures are described in the attached document "UHV materials and technologies for SLS front ends and beam lines", (modified version, July 2001) SLS-TME-TA-1998-0014.
The standard stainless steel bolts and silver plated nuts used for the final flange assembly shall be A4 Bumax 109 class. Hexagon screw heads are requested for these bolts.
All the 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.

4.2. Stepping motors, encoders, end-switches and thermocouples

Any stepping motors used to move should be a 2 phase motor with 6 or 8 leads. PSI suggests to use Vexta PK267JB 2-phase motors. PSI will supply 8 pieces.
The encoders should be Numerik Jena LIK 22, supplied by PSI.
All microswitches must be bakeable and type is Cherrycorp, D4 2U W9 RA.
The thermocouples are of the K-type. PSI will supply them with a diameter of 1 mm.

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 SLS UHV Materials and Technologies for SLS Front Ends and Beamlines (Modified version, July 2001), SLS-TME-TA-1998-0014;

b) Alignment check:
as described in section 2;

c) Accuracy test:
Accuracy tests of the vertical slits and the horizontal slits manipulators must be performed under vacuum load according to the following procedure (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) Welding and Brazing quality check:
The copper heads for the slits and filters 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. Quality assurance requirements

PSI prefers that manufacturers are registered to comply with ISO 9002 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 positioning, resolution and repeatability measurements
- before the final assembly

In order to schedule such inspections, it is required that PSI receives announcements of such events with two weeks advance notice.

7. Packing and Delivery

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

The following is to be displayed clearly on the outside of the packaging:
- address to:
  Dr. Marco Stampanoni
  Swiss Light Source
  Paul Scherrer Institut
  CH-5232 Villigen PSI
- the PSI contract number
- the weight of the loaded package
- support points for transport and lifting
- tilt indicators

8. Drawings, Figures and Tables

8.1 List of appendix drawings:

- Figure 2: Filter chamber design
- Figure 3: Filter position
- 0-30040.26.310: similar filter assembly X05
- 1-30040.26.313a: similar filter head assembly X05
- 1-30040.26.087a: Kinematics support
- 1-30040.26.394: similar slits head assembly
- 0-30040.26.412a: Manipulator assembly
- 1-30030.28.059: HPS Messvorrichtung 50 mm

Figure 2: Filter position

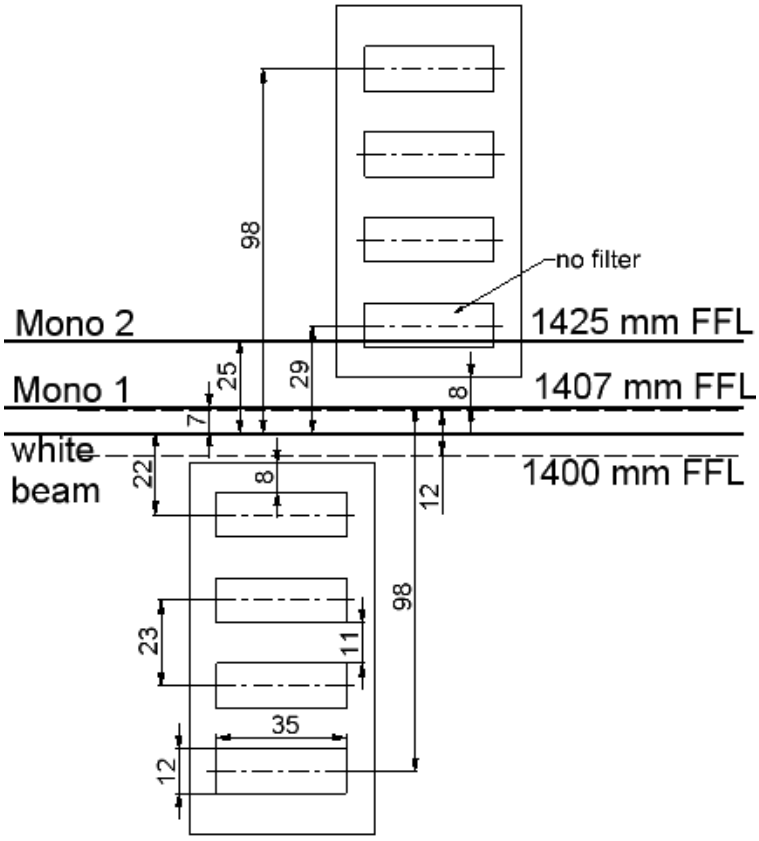
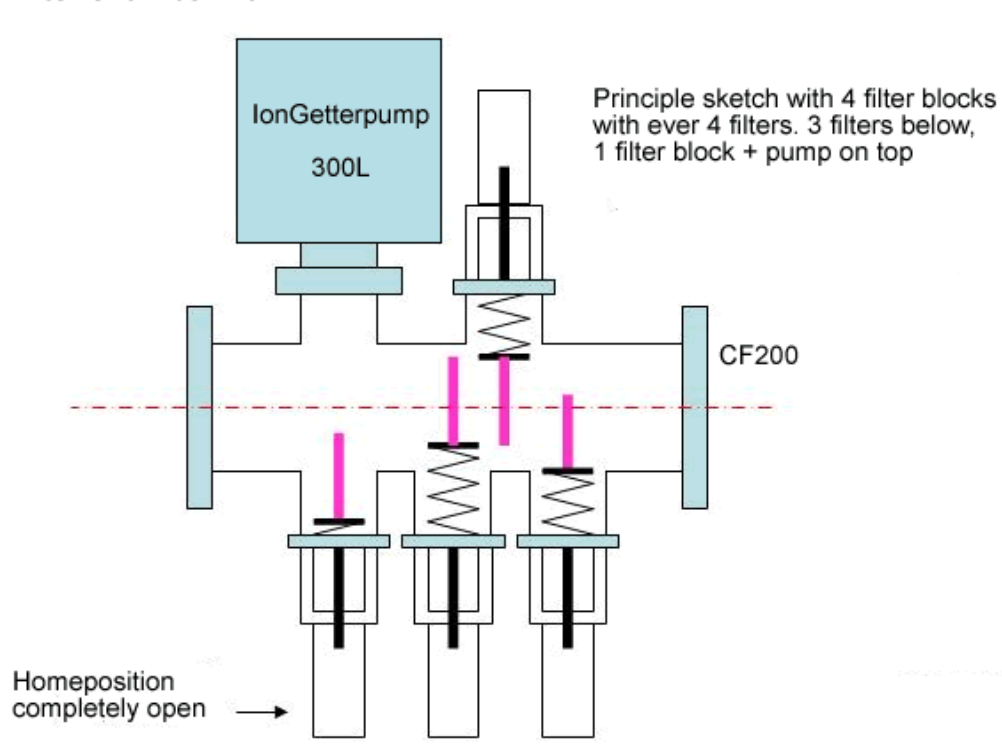
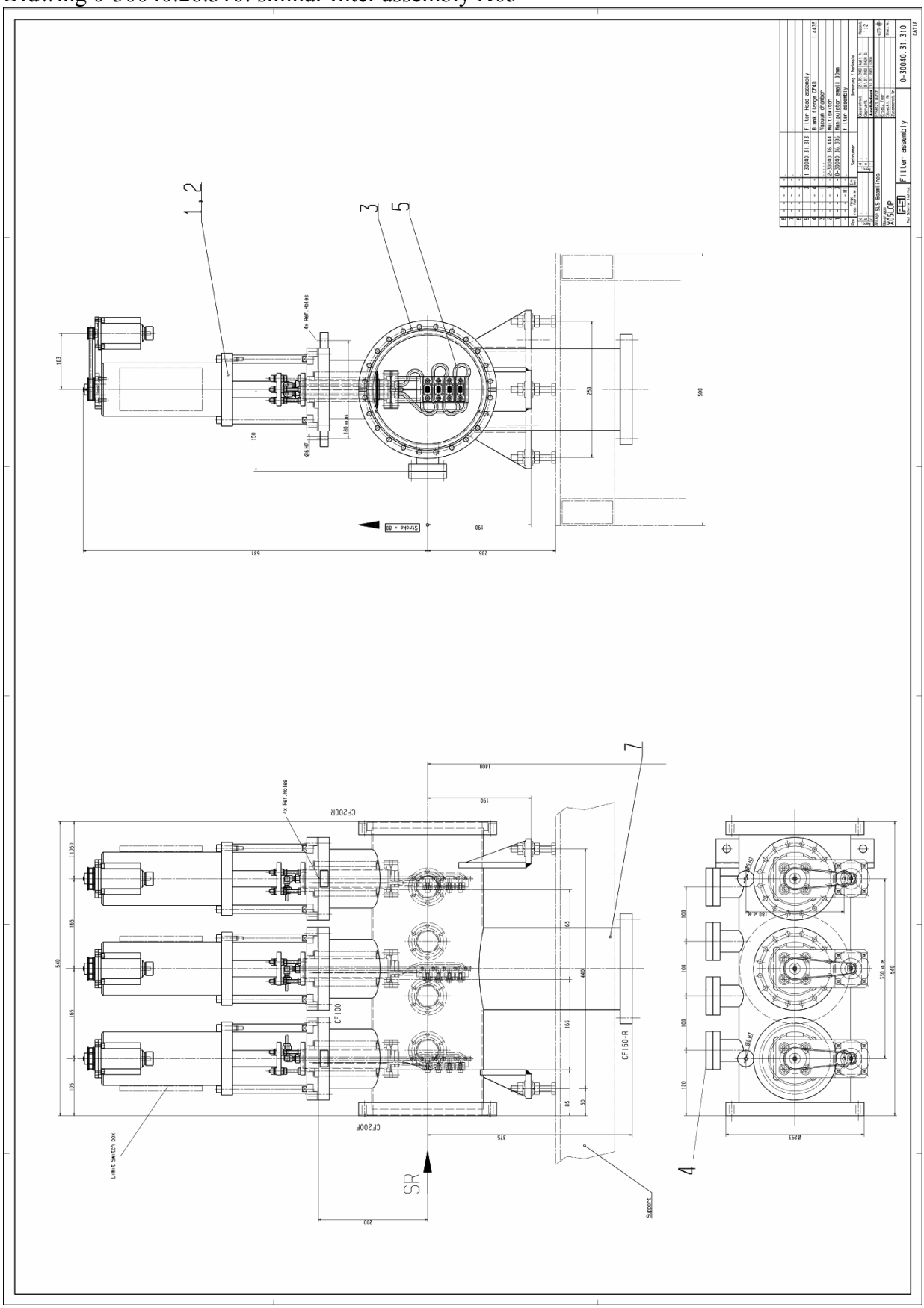


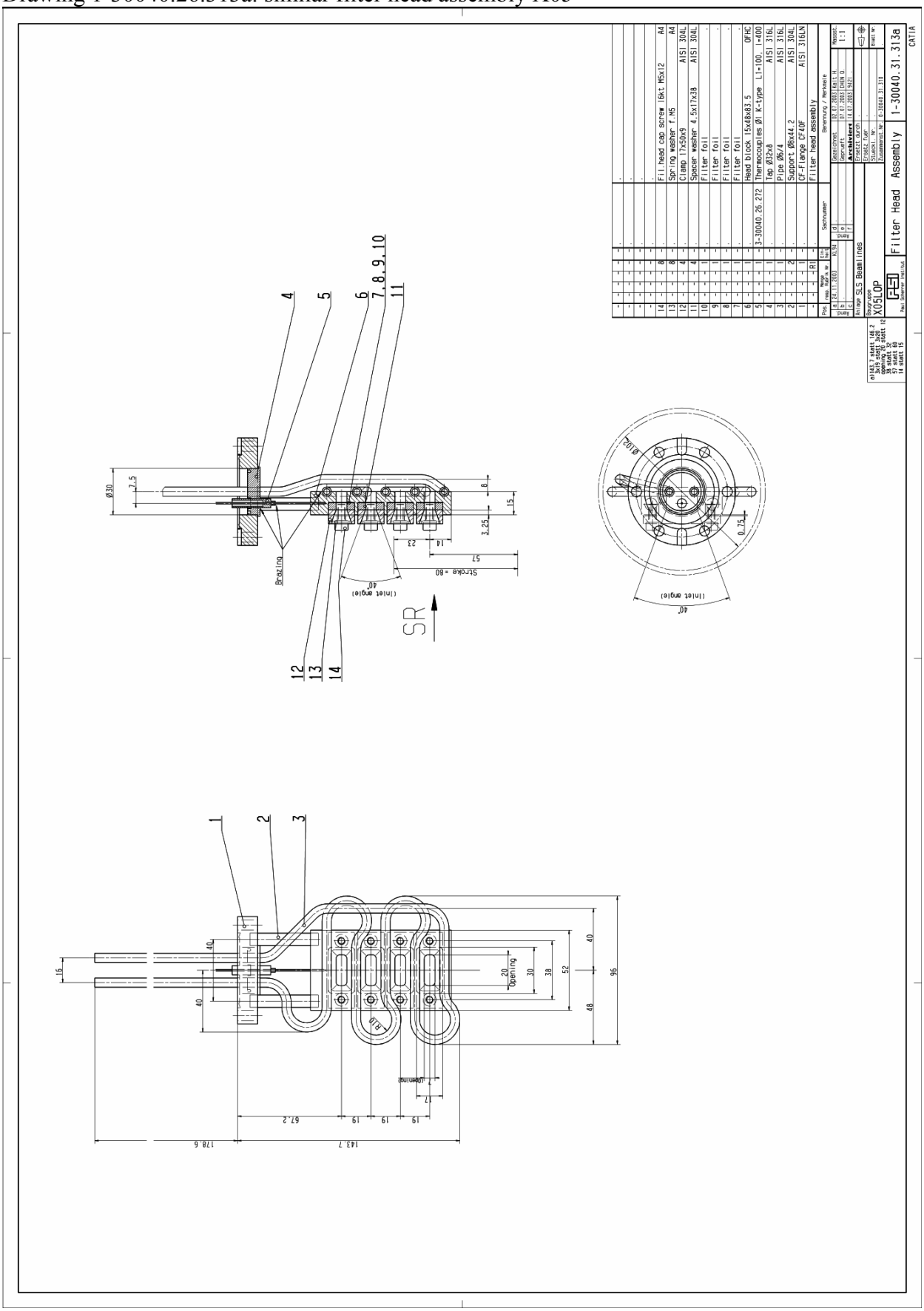
Figure 3: Filter chamber design



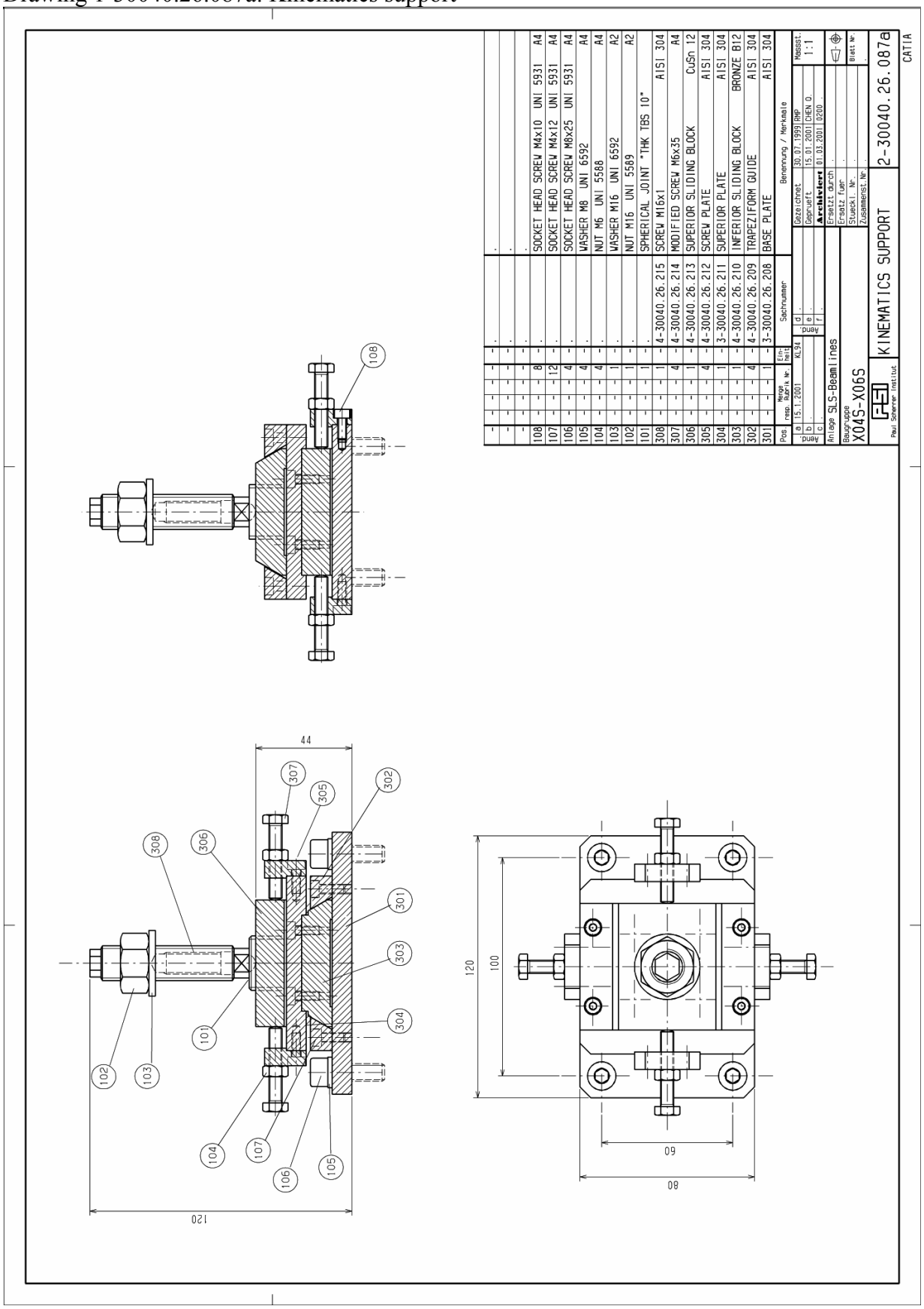
Drawing 0-30040.26.310: similar filter assembly X05



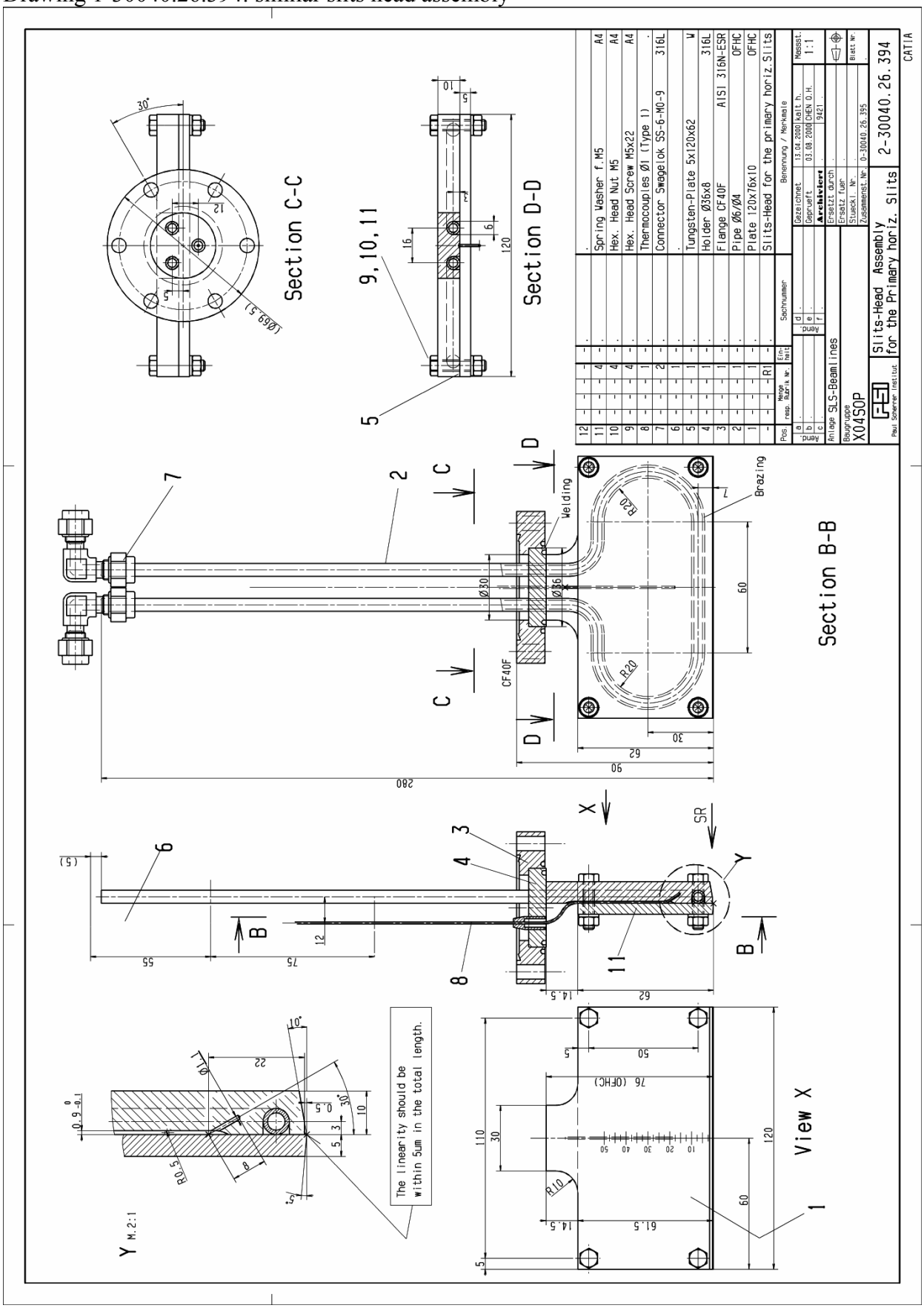
Drawing 1-30040.26.313a: similar filter head assembly X05



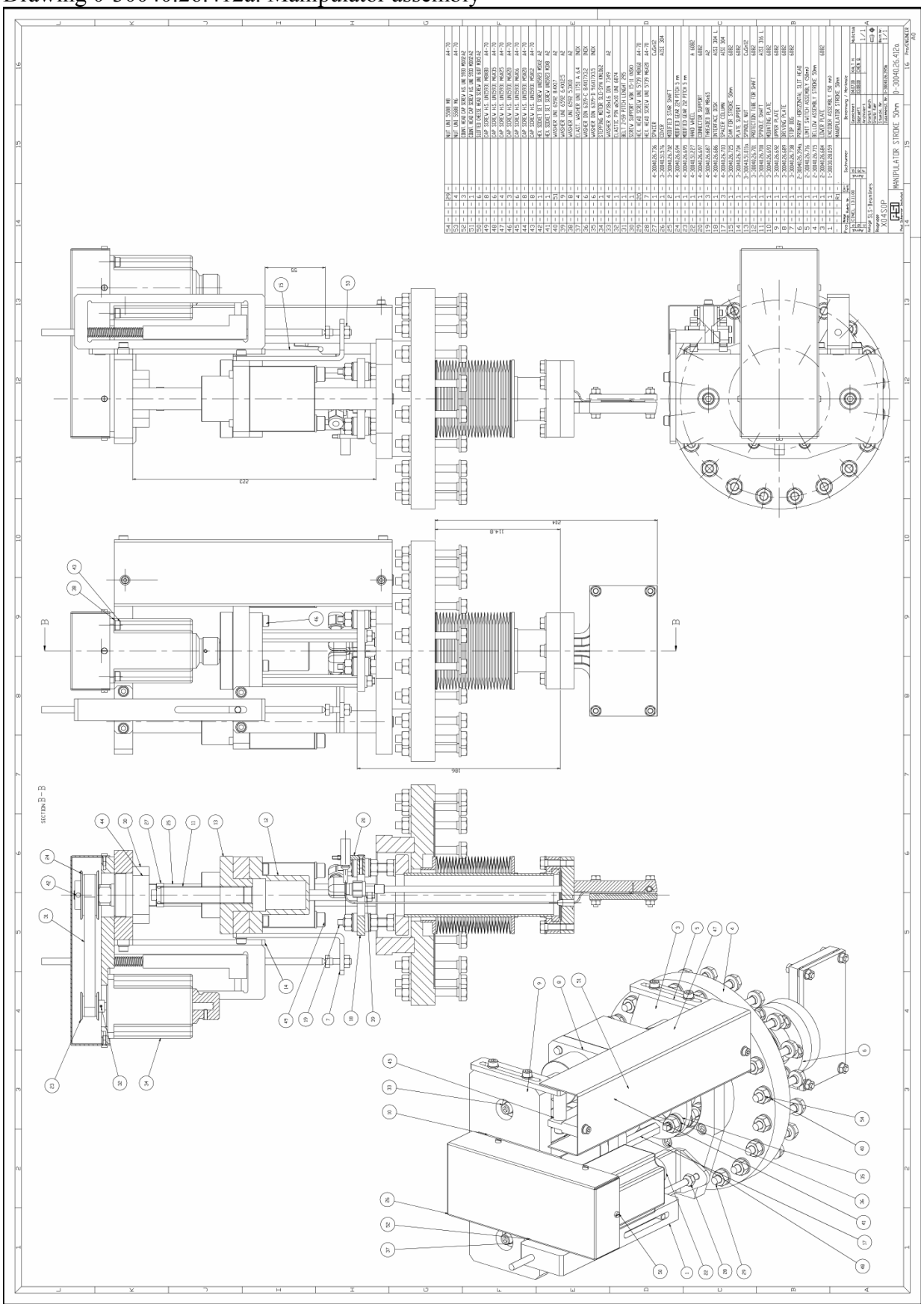
Drawing 1-30040.26.087a: Kinematics support



Drawing 1-30040.26.394: similar slits head assembly



Drawing 0-30040.26.412a: Manipulator assembly



Drawing 1-30030.28.059: HPS Messvorrichtung 50 mm