Operating Instructions

A1500V-7

Inline Sputter-System

Original • 10/2012_V1.1 EN

LEYBOLD OPTICS

System manufacturer and publisher

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1 Use and data

1.1 Information about these Operating Instructions

1.1.1 Scope of delivery and structure of system documentation

The technical documentation for the A1500V-7 Inline Sputter-System (referred to as «A1500V-7» in the following) encompasses a number of documentation items.

The parts of the documentation are stored electronically (PDF documents) on two CD-ROMs. The printout of the Operating Instructions is also included in the delivery. Fig. 1-1, 11 shows the structure and scope of the technical documentation included in the delivery of the A1500V-7.

CD 1 Technical Handbook ▪ Operating Instructions ▪ Software-Handbook ▪ DataLogger-Handbook ▪ Supplier's Documentation ▪ Media Diagrams (Vacuum, Gas, Water, Air) ▪ Circuit Diagram	
CD 2: Electronic spare parts catalogue ▪ Spare part documentation in database format	
Printout of the documents stored on the CD 1 This folder must be kept next to the machine	

Tab. 1-1 *Structure of the system documentation*

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1.1.2 Structure of the safety notices

The following safety notices indicate the different danger levels.

⚠DANGER

In high-risk situations, especially where there is danger of serious injury or death.

⚠WARNING

In medium-risk situations, where a lack of attention to the notice can lead to physical injury or comprehensive material damage.

⚠CAUTION

For low-level risks. Ignoring this notice can lead to mild physical injury.

CAUTION

Ignoring this notice can lead to material damage or faulty products.

1.1.3 Symbols and notational conventions

The following symbols are used in these Operating Instructions:

Symbol/notation	Meaning
➢	One-step instruction or instruction of several steps, which order is irrelevant.
1 **2** **2.1** **2.2**	Instruction, which consisting of several steps in a defined order. Steps within an instruction consisting of several steps.
▪ ▪	List items
Chapter 1.1.3 Symbols and notational conventions, 🗎 12	Cross-reference to chapter 1.1.3 on page 10.

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Symbol/notation	Meaning
Automatic > Overview	Menu path in the software
3 GUI: ... ➢ GUI: ...	Steps which are described the operating at the graphical user interface (GUI)
[Vacuum]	Button on the graphical user interface. The text or the symbol between the square bracket corresponded the description or the symbol on the button.

Tab. 1-2 *Symbols and notational conventions*

	This symbol draws attention to information contained in another document section or outside the documentation, e.g., circuit diagrams.

NOTE!
For technical requirements, which must strictly be adhered to.

1.1.4 Use of these Operating Instructions

These Operating Instructions contain the information required for the proper operation of the A1500V-7.

- The Operating Instructions are delivered with the A1500V-7 and are an essential part of the product. They must be kept in an accessible, visible place next to the A1500V-7.

NOTE!
A notice with heading «Read the instruction manual» must be hung in a clearly visible place on the system

- Always ways keep this operating instructions available for reference.
- Leybold Optics would like to point out that the product illustrations and photos used in this user manual may different from actual machine configuration.

Product life phases
The Operating Instructions and the Maintenance Instructions describe all product life phases of the A1500V-7. They consist of the system conditions and applications that follow manufacturing: transport, installation, commissioning, operation, maintenance, service, storage and finally disposal. Each related chapter can be found easily via the table of contents in the instruction manuals.

Software-Handbook
The delivery of the A1500V-7 includes a Software-Handbook which describes the graphical user interface. The Software-Handbook includes information on the operation of the A1500V-7 and is an essential part of the system documentation. In the PDF-file of these Operating Instructions you can open the Software-Handbook by clicking the link Software-Handbook.

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Supplier's documentation
The delivery of the A1500V-7 includes separate operating instructions for individual system components. They include important safety information and are essential parts of the system documentation. The safety instructions contained therein must be strictly adhered to. The information contained in the supplier's documentation is required in particular for the maintenance and service of the respective components.

You will find a list of all the supplier's documentation in the supplier's documentation on CD 1.

Circuit diagrams and technical descriptions
The necessary circuit diagrams and technical descriptions are stored as PDF files in the technical handbook on CD 1. If you are navigating in the PDF file of the Operating Instructions, you can open the respective circuit diagram by clicking the link, e.g. circuit diagram. It is helpful to set the PDF reader so that the linked document is opened in a new window.

1.2 Using the system

1.2.1 Proper use

The A1500V-7 is a vertical, at -7° tilted inline sputter system for coating of glass with molybdenum. The process consists of the deposition of a thin molybdenum nucleation layer (Mo) and a thicker molybdenum leading layer (Mo) in conjunction with the gas argon (Ar).
The sputtering of the nucleation layer and the leading layer are realized with different gas pressure. For this an efficient gas-, pressure separation is between the sections.

- ➢ Adhere to the safety instructions in Chapter 2 Safety, 🗎 31 for all processes carried out with the A1500V-7.
- ➢ Adhere to the safety regulations in the relevant process instructions if coating processes developed by Leybold Optics are used.

Any application exceeding the bounds of these specifications is considered improper use and can lead to serious personal injury or material damage. Leybold Optics will not be held responsible for any damages resulting in such a case.

Further requirements of proper use are:

- ➢ Read and adhere to these Operating Instructions.
- ➢ Adhere to the technical data, see Chapter 1.3.1 Component designations, 🗎 17
- ➢ Complete the maintenance work on schedule, see Chapter 7.3 Maintenance plans, 🗎 175

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1.2.2 Improper use and non-adherence to regulations

Any application of the A1500V-7 not adhering to the specifications in Chapter 1.2.1 Proper use, 14 is considered as improper use and is permissible only with written permission from Leybold Optics GmbH (Leybold Optics). Leybold Optics will not be held responsible for any personal injury or material damage resulting from improper use.

NOTE!
The use of gases not specified constitutes improper use. There can be no liability for damages resulting in such a case.

The vacuum system is designed solely for the specified gases. The vacuum system is not suitable for toxic or explosive gases.

The use of toxic or radioactive materials without additional safety precautions is expressly forbidden and will void warranty!

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1.3 System identification

Name plate

The name plate identifies the system and provides information about customer-specific adaptations, if available. When communicating with Leybold Optics, you should always supply all the details on the name plate. With this information, the Leybold Optics customer service can provide you with the support you need in the shortest time possible, see Chapter 2.10 Leybold Optics Service, 63.

The name plates are attached to the main switch cabinet CCMS and to the system (process module).

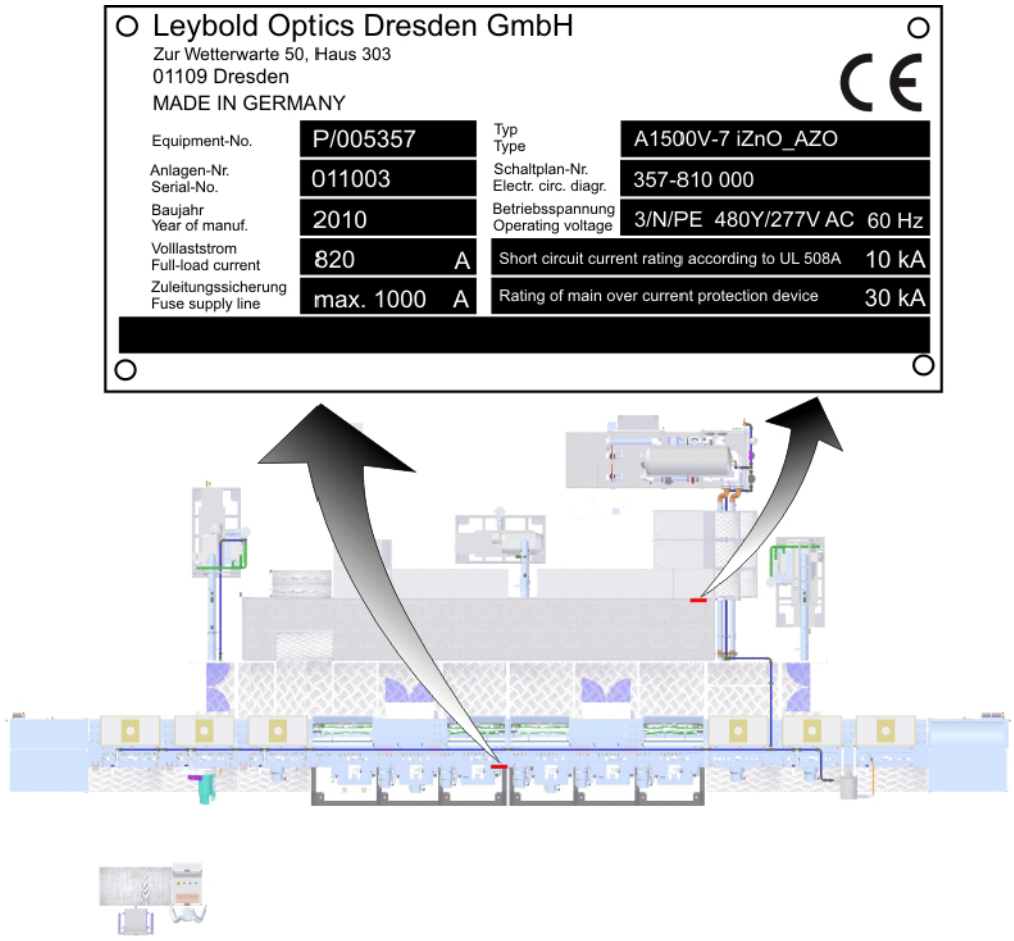

Fig. 1-1 *Name plate*

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1.3.1 Component designations

Each component of the A1500V-7 that can be controlled by the software can be identified by the component designation. This designation is a combination of letters and digits. The letters identify the type of component. The first two digits of the designation identify the module and/or the location in the system, the following two digits identify the component in the module and the last two digits identify the number of the component in the module.

Example: +B2PT01 is the turbo pump 01 located in buffer module B2.

+P1GEN02 is the sputtering power supply 02 located in process module P1.

NOTE!
The designation for electrical equipment consists of 3 parts: «=», «+» and «-».
- **«=»: plant designation**
- **«+»: location -/component designation, see Chapter 1.3.1 Component designations, 17**
- **«-»: electrical designation**

See circuit diagram on CD 1 for more information.

1.3.2 Location -/component designation

The following tables show the abbreviations of the modules:

Abbreviation	Component
Lx	Load lock module
Bx	Buffer module
Px	Process module
Vx	module independent pumping station

Abbreviation	Component
Tx	Transfer module (cross transport)
HDLx	Handling module

The following tables show the abbreviations of the machine components:

Valves:

Abbreviation	Component
VG	Gas valve
VB	Venting valve
VD	Throttle valve
VM	Measuring valve

Abbreviation	Component
VP	Purge gas valve
VS	Gate valve, high vacuum valve
VV	Fore-vacuum valve
VW	Water valve

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Pumps:

Abbreviation	Component	Abbreviation	Component
PC	Cryogenic pump	PR	Roots pump
PD	Oil diffusion pump	PT	Turbo pump
PI	Ion getter pump	PV	Screw pump

Vacuum **M**easurement:

Abbreviation	Component	Abbreviation	Component
MC	Capacitance diaphragm gauge	MS	Residual gas analysis, mass spectrometer
MI	Bayard alpert gauge	MP	Penning gauge
MK	Combi gauge	MT	Pirani gauge

Process components:

Abbreviation	Component	Abbreviation	Component
ETCH	Etcher	IS	Ion or plasma source
GLE	Glow discharge unit	GEN	Process power supply
MAG	Magnetron	MTCH	Matchbox
MFC	Gas flow controller	MFM	Gas flow meter
MOP	Process controller	PREG	Pressure regulator
TREG	Temperature regulator	TH	Heating, cooling unit
ESV	Electron beam evaporator	TV	Thermal evaporator
SH	Evaporator shutter	EGC	Electron beam gun controller

Process measurement:

Abbreviation	Component	Abbreviation	Component
TLM	End of target life time monitor	TCM	Thickness measurement and control
OES	Optical emission spec-troscopy	XRF	X-ray fluorescence anal-ysis
XTAL	Crystals	ICM	Ion current monitor
FC	Faraday cup	RSQ	Square resistance monitor

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Drive (German = **A**ntrieb):

Abbreviation	Component	Abbreviation	Component
AD	Rotating drive	AH	Lifting drive
AK	Carrier drive	AP	Drum drive
AS	Shifting drive	AW	Winding drive
AR	Control drive	AL	Locking drive

Sensors:

Abbreviation	Component	Abbreviation	Component
SG	Safety light curtain	SF	Gas flow switch
SD	Door switch	SDH	Cover switch
SL	Compressed air switch	SN	Emergency stop
SC	Position switch	SP	Pressure switch
SW	Water flow switch	SWT	Water flow switch target
SWU	Water flow switch magnetron environment	SWG	Water flow switch generator
SWL	Water flow switch leakage	SWN	Water flow switch matchbox

Tab. 1-3 *Abbreviations of component designations*

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1.4 Technical data

NOTE!
The information in the machine card is valid.

1.4.1 Dimensions and weights

The following illustration shows the standard installation of the most important A1500V-7 system components.

Refer to the layout plan on CD 1 of your system for more detailed information about the system dimensions.

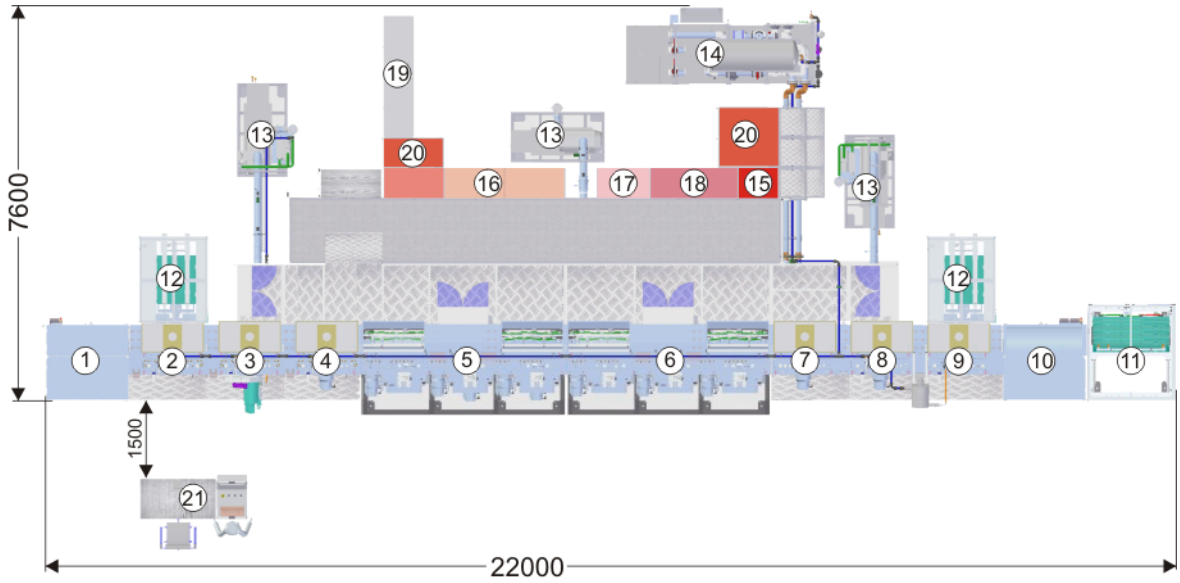

Fig. 1-2 Dimensions of the A1500V-7 (approximate data in mm)

Pos.	Unit	Width (mm)	Depth (mm)	Height (mm)	Weight (kg)
1	Transfer module T1	1680	1500	3000	1000
2	Load lock module L1	1300	1500	3500	3600
3	Buffer module B1	1300	2700	3500	3600
4	Buffer module B2	1300	2700	3500	3600
5	Process module P1	2700	3000	3500	14000
6	Process module P2	2700	3000	3500	14000
7	Buffer module B8	1300	2700	3500	3600
8	Buffer module B9	1300	2700	3500	3600

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Pos.	Unit	Width (mm)	Depth (mm)	Height (mm)	Weight (kg)
9	Load lock module L9	1300	1500	3500	3600
10	Transfer module T9	1680	1500	3000	1000
11	Carrier depot (cpl.)	1660	2240	3040	1000
12	Loading / unloading module Option removed	1600	3300	3000	1500 (per)
13	Roughing station with SV630, WSU 2001 and SV40 (3 pcs.)	2056	1125	1490	1300 (per)
14	Water cooling system	3700	1100	2000	2000
15	Electrical cabinet (9 pcs.)	600	600	2200	300 …400
16	Electrical cabinet (9 pcs.)	1200	600	2200	400 …500 (per)
17	Electrical cabinet (9 pcs.)	1000	600	2200	400 …500
18	Electrical cabinet (9 pcs.)	1200	600	2200	400 …500
19	Electrical cabinet (9 pcs.)	1200	600	2200	400 …500 (per)
20	Generator cabinet (2 pcs.)	600	1000	2200	200 …400 (per)
21	Operator station CCPC CCOS	 1600 600	 700 750	 1200 1700	 50 150
22	Polycold	1050	710	1690	550

Tab. 1-4 Dimensions and weights (approximate data)

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1.4.2 Media supply

For the proper use and performance of the system the input values listed here and their tolerances must be adhered to. You can find more detailed information about the input values and the operating conditions of individual system components in the following documents:

- Machine card
- Circuit diagram
- Media diagrams
- Installation plan
- Supplier's documentation

1.4.2.1 Electrical supply

See machine card and circuit diagram on CD 1 for more detailed information about the system's electrical energy supply.

Installation data

Voltage	3 × 480Y/277 V (+6%, -10%)
AC power supply	3 Phases, N, PE; (wye with solidary grounded neutral)
Frequency	60 Hz ±1%
Wave form	In compliance with VDE standard
Wiring and safety regulations	In compliance with VDE 0100, VDE 0113 and VGB 3

Tab. 1-5 *Electrical installation data*

Performance data

Nominal power	526 kW
Apparent power (maximum)	640 kVA
Nominal current (maximum)	768 A

Tab. 1-6 *Electrical performance data*

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1.4.2.2 Process and venting gases

	See machine card and media on CD 1 for more detailed information about the system's process gas supply.

Process and venting gases must be supplied by the customer.

Process gases	Argon (Ar) Argon/Oxygen (Ar/O_2) (90 % Ar, 10 % O_2) Oxygen (Ar/O_2)
Venting gas	Compressed air, see Chapter 1.4.2.3, 23
Quality	5.0 (99.999 %)
Pressure	1…3 bar
Temperature	Approx. 20 °C

Tab. 1-7 Process and venting gases

NOTE!

➢ **Observe the appropriate safety regulations and measures when special gases are being used.**

1.4.2.3 Compressed air

	See machine card and media on CD 1 for more detailed information about the system's process gas supply.

Pneumatic and blow out

Compressed air quality classes to DIN 8573-1	Residual oil content: class 2 Other characteristics: class 4
Operating pressure	5…7 bar
Operating pressure for blow-out circuit	1…3 bar
Temperature of dew point	3 °C

Tab. 1-8 Compressed air specifications - pneumatics and blowing out

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Venting

Compressed air quality classes to DIN 8573-1	Residual oil content: class 1 Other characteristics: class 2
Operating pressure	0…3 bar
Temperature of dew point	-40 °C

Tab. 1-9 *Compressed air specifications - venting*

1.4.2.4 Exhaust air

Exhaust air	3× 600 m^3/h
Exhaust air per pump station	≤ 600 m^3/h
Temperature	Room temperature + 30 K
Maximum overpressure	Normal pressure +200/-50 mbar

Tab. 1-10 *Exhaust air specification*

1.4.2.5 Water supply

NOTE!

➢ **Observe the required water volume specified by the Leybold Optics assembly plan.**

Water volume

The water flow rate must be sufficient to activate the installed water monitors. It does not supply any information about the expected average water consumption.

See machine card and media on CD 1 for more detailed information about the system's process gas supply.

Operational data

Inflow pressure	2 …5 bar
Heat exchanger pressure drop	approx. 1.5 bar
Inlet temperature (see also section «Dew point», 🗎 25)	11 °C ±2K
Average refrigerating capacity	330 kW

Tab. 1-11 *Water operational data*

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Water quality

NOTE!

➢ **The customer is responsible for the adherence to the water quality.**

Primary circuit

Carbonate hardness	4…6°dH
pH value	7.5…9.0
Electric conductivity	600 µS/cm ±200
Particle size	< 100 µm

Secondary circuit

Carbonate hardness	4…6°dH
pH value	7.5…8.5
Electric conductivity	200 µS/cm +100/-50
Particle size	< 100 µm
Suspended sediments	< 10 mg/l
Sulphate (SO_4)	< 150 mg/l
Chloride (Cl)	< 100 mg/l
Ammonium (NH_4)	< 2 mg/l
Iron (Fe)	< 0,2 mg/l
Nitrate	< 50 mg/l

Microorganisms protection

In case of algal formation and/or cloudiness, add biocide to the water (e.g. «Nalco 77352»). The mixture ratio is 50–150 g/m³ (50–150 ml/m³), whereas 100 g (100 ml) of biocide increases the electric conductivity by approx. 100 µS/cm.

Dew point

NOTE!

➢ **Avoid the condensation of air humidity on the supply lines. The temperature of the compressed air must be at least 3°C above the dew point of the ambient air.**

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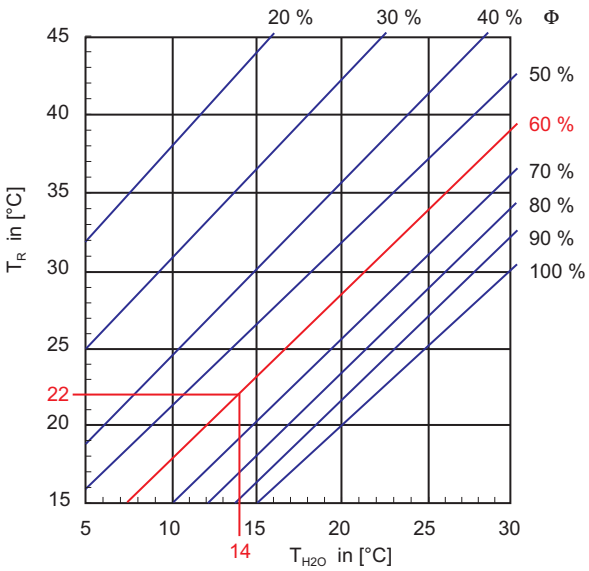
The illustration shows the dew point diagram, illustrating the minimum water temperature T_{H20} at which no condensate generation occurs, depending on the room temperature T_R and the relative air humidity Φ. An example for reading the dew point at a room temperature of 22°C and a relative air humidity of 60% is indicated in red.



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1.4.3 Performance data

Vacuum parameters process module	
Specifications for a clean and degassed chamber without carriers and substrates	
Process initial pressure after a pumping time of t > 4 h	2.7 x 10^{-6} mbar
Final pressure after a pumping time of t > 12 h	1.3 × 10^{-6} mbar

Power supplies for magnetrons	
Power	2 × 40 kW

Power supply for ion source	
Power	1.5 kW (3 kV / 500 mA)

Substrate heaters	
Front- and back side heater wall in module L1	ca. 38.5 kW
Front- and back side heater wall in module B1	ca. 38 kW
Front- and back side heater wall in module B2	ca. 38 kW
Front- and back side heater wall in module P1	ca. 45 kW
Front- and back side heater wall in module P2	ca. 23 kW

Magnetron target	
Length	1500 mm
Inner diameter	5"
Thickness	14 mm
Material	iZnO, AZO
Material utilization	> 70 Vol.-%

Transport system	
Speed range	0.2…16 m/min
Operating speed with cycle time per substrate of 60 s	0.87 m/min

Substrates	
Height	1200 mm ±0.8 mm

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Substrates	
Depth	500 mm ±0.8 mm
Thickness	1.9 ±0.3 mm

Carrier	
Height	1710 mm
Depth	1180 mm

1.4.4 Sound pressure level

NOTE!

➢ **Measure the workplace-related noise level at the assembly location of the A1500V-7. It may be necessary to take noise protection measures, e.g., wearing ear protectors.**

Noise level at the A1500V-7 <70 dBA
Assuming that the pump stations of the system are installed in sound enclosures, there is a resulting sound pressure level of <70 dBA for the typical operating personnel workplace.

1.4.5 Ambient conditions

The data for the ambient temperature and air humidity are in line with NN conditions.

NOTE!
The operation of the A1500V-7 with deviating values for temperature, air pressure and air humidity (with reference to NN) is only permissible if there is an appropriate agreement with Leybold Optics.

Temperature	20…30 °C
Relative air humidity	10…60 %
Height above sea level	max. 1000 m

Tab. 1-12 *Ambient conditions*

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1.5 EC Declaration of Conformity of the machinery

(Machine Directive 2006/42/EC)

Hereby the manufacturer

LEYBOLD OPTICS Dresden GmbH
Zur Wetterwarte 50, Haus 303
01109 Dresden
GERMANY

declares that the machine described below

Generic denomination:	Inline Sputter System
Function:	Coating of substrates in vacuum
Model/ Type:	A1500V-7
Machine number:	P/005357+P/005388
Project number:	xxxxxx

- fulfils all the relevant provisions of the Directive mentioned above.
- fulfils relevant provisions of the following other EC Directives:
  Electromagnetic Compatibility Directive (04/108/EC)

The safety objectives of the Low Voltage Directive (2006/95/EC) according to Annex I, No. 1.5.1 of the EC Machine Directive are applied.

The instruction file the machinery is compiled in accordance with part A of Annex VII of the Directive mentioned above.

Person authorised to compile the technical file:

LEYBOLD OPTICS Dresden GmbH
Zur Wetterwarte 50, Haus 303
01109 Dresden
GERMANY

[Place, Date]

……

[Name, function]

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2 Safety

2.1 General safety guidelines for the user

The customer is responsible for the adherence to the general safety guidelines in all work carried out on and with the A1500V-7.

2.1.1 User qualifications

These Operating Instructions apply exclusively to technically qualified personnel, who have been trained by Leybold Optics or have completed an instruction course for the A1500V-7. This instruction course must have been carried out with the authorization of Leybold Optics. Only technically qualified personnel is capable of correctly interpreting the safety regulations contained in these Operating Instructions and of applying them in practice in a concrete situation.

Persons who have not been trained by Leybold Optics or have not received instruction for the A1500V-7 under the authorization of Leybold Optics are deemed unauthorized. Unauthorized persons are not permitted to carry out any work on the A1500V-7. Leybold Optics will not be held responsible for any claims resulting from failure to observe these conditions.

➢ Read Chapter 2 Safety, 🗎 31 before working with the A1500V-7. It contains important information concerning your personal safety.

2.1.2 Operation

The system may only be used properly, see Chapter 1.2.1 Proper use, 🗎 14. Any work instruction or working method which could infringe on the safety of the personnel or the A1500V-7 is forbidden. The accident prevention guidelines specific to the industry and the locality must always be adhered to.

2.1.3 Workplace

Conditions

The customer must, by means of appropriate instructions and controls, maintain the orderliness and cleanliness of the workplace and surroundings of the A1500V-7.

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Safety equipment
It is forbidden to be shut down or alter the safety equipment.
When making modifications, the operator must prepare an appropriate safety concept and install the required safety equipment.

Warning signs
Easily visible warning signs in the operating rooms must draw attention to any remaining dangers. The customer is obliged to check at regular intervals the completeness and readability of the warning and safety signs installed on the system. Damaged warning signs must be replaced immediately. You will find the contact address for acquiring the warning signs in Chapter 2.10 Leybold Optics Service, 63.

Waste material
The customer is responsible for the environment-friendly disposal of any ecologically harmful waste products of the process.

2.1.4 Use of these Operating Instructions

NOTE!
A notice with the heading «Read the instruction manual» must be placed clearly visible at the system.

Reading and understanding
It is the responsibility of the customer that every person working on or with the A1500V-7, in any product life phase, has read and understood the relevant sections of these Operating Instructions. This especially applies to Chapter 2 Safety, 31.

Storage
The Operating Instructions are delivered with the A1500V-7 and are an essential part of the product. They must be kept in an accessible, visible place next to the A1500V-7. The customer can order additional copies of the Operating Instructions from Leybold Optics, see Chapter 2.10 Leybold Optics Service, 63.

Completeness
You must only use the complete original copy of these Operating Instructions. The information in the Operating Instructions include cross-references to other sections which contain important information. Incomplete copies or copies of individual pages cannot convey all the information in the Operating Instructions.

⚠WARNING

Incomplete Operating Instructions.

Missing safety instructions resulting from an incomplete copy of the Operating Instructions can lead to serious or fatal injuries or material damage.

- ➢ Always work with a complete original copy of these Operating Instructions.
- ➢ Do not copy any individual pages.

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2.1.5 Transport, installation and commissioning

The A1500V-7 may only be transported, installed and commissioned under the supervision of authorized and technically qualified personnel from Leybold Optics.

Power and material supply
The customer provides the connections for the supply of electricity, compressed air, water, etc. to the A1500V-7 with the required performance and quality levels, see Chapter 4 Installation, 113 and any supplementary information in the technical specifications.

Supply lines
Electrical supply cables, water pipes and gas pipes must be kept separately from one another and must be led to the A1500V-7 under protection from mechanical stress. They must be laid in such a way that the safety and reliability of the A1500V-7 is not affected negatively.

Gas bottles
Gas bottles must be stored, transported and secured in accordance with the regulations.

Waste gases
The waste gases from the vacuum pumps must be channelled through condensate separators and directed outside, see Chapter 4.3.3 Disposing of the exhaust gases from the pumps, 119.

Acceptance test
When commissioning the system, the customer is responsible for carrying out an acceptance test in line with the applicable local accident prevention regulations. This applies in particular to the electrical equipment of the system, pressure containers and cryo-technical components.

Upon successful completion of the acceptance test, the acceptance certificate is signed by an authorized representative of Leybold Optics and an authorized representative of the customer.

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2.1.6 Maintenance and service

The customer is obliged only to operate the A1500V-7 in a technically faultless condition. All maintenance and service work must be carried out in accordance with the instructions in Chapter 7 Maintenance, 167 and Chapter 8 Service, 247.

Shutting down
For all maintenance and service work, you must have the A1500V-7 in the operating state specified for that work. Make sure that the power supply to the relevant system parts is switched off and is secured against switching on again. Also use warning signs for this purpose.

Safety equipment
Only remove safety equipment after the A1500V-7 has been brought to a complete stop and then has been released. Before switching the system on again, make sure that all the removed safety equipment has been reinstalled.

2.1.7 Spare parts

⚠WARNING

Use of non-original spare parts.

The use of foreign parts can lead to malfunctions. This can lead to serious or fatal injuries or considerable material damage.

➢ When carrying out maintenance and service work, only use original spare parts from Leybold Optics.

Ordering
Send all orders, including the order numbers and the exact name of the spare parts, to Leybold Optics. You will find details of the names and order numbers in the parts catalogue.

Contamination report
The A1500V-7 is delivered with one or more forms for the contamination report on parts, which you send to Leybold Optics for inspection or repair. This report applies to components which were involved in the creation of the vacuum or were placed in the vacuum.

Please include the fully completed and signed form in the consignment. Leybold Optics will not accept vacuum components without a valid form. The component returned to you is accompanied by a new contamination report.

Replacement of electrical components
When some electrical components have been replaced, the parameter settings of the new components must be carried out in line with the supplier's documentation.

Adaptations
Consult Leybold Optics before modifying the system. Unauthorized adaptations and alterations which affect the safety of the A1500V-7 are not permitted. Changes to the software may only be carried out when expressly permitted by Leybold Optics in written form.

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Final checks
After maintenance or service work, check that all the safety equipment is installed and functioning properly. Check the safety equipment especially after working on the electrical system. This applies in particular to the ground wire current path and the safety circuits.

Notification rule
The customer is obliged to notify Leybold Optics immediately concerning any changes or irregularities that have been observed in the A1500V-7.

Retesting
The customer is responsible for having repeat tests carried out on the system in line with the locally applicable accident prevention regulations. This applies in particular to the electrical equipment of the system, pressure containers and cryo-technical components.

2.1.8 Disposal

The customer must dispose of the A1500V-7 in line with the applicable regulations. He can consign the system to a licensed private collection company or a public one, or can recycle or dispose of the system himself, see Chapter 9.2 Disposal, 274.

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2.2 Safety signs on the system

Safety labels are used on the A1500V-7 to warn the user of the potential dangers caused by system components at the corresponding location.

NOTE!

- **Do not remove safety labels.**
- **Periodically inspect and clean the safety labels.**
- **Replace any safety labels that are damaged and any safety labels that are no longer clearly legible.**

2.2.1 Safety label format

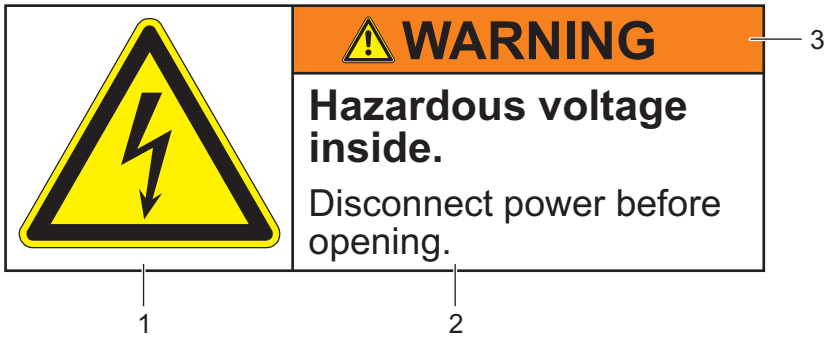

Fig. 2-1 *Safety label format*

1 Safety symbol
2 Message panel
3 Danger level

Safety symbol
The safety symbol is a graphical representation to supplement or substitute the text message in the message panel.

The safety symbols are classified into three symbol groups:

Symbol group	Design	Meaning	Example
Hazard symbol	Yellow triangle with black border and black pictogram	Indicates a hazard symbolized by the pictogram in the hazard symbol.	
Prohibition signs	White disc with red border and black pictogram	Prohibits an action or the usage of objects in the vicinity of the system.	
Mandatory signs	Blue disc with white pictogram	Requires an action or the usage of objects (e.g. personnel protective equipment).	

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See Chapter 2.2.2 Significances of the safety symbols, 🗎 37 for a description of the safety symbols.

Message panel
The message describes the type of hazard, potential consequences of the hazard and/or avoidance actions to be taken.

Danger level
The danger levels are described in Chapter 1.1.2 Structure of the safety notices, 🗎 12.

2.2.2 Significances of the safety symbols

The following safety symbol stickers are used on the A1500V-7. The related hazards are described in detail in Chapter 2.7 Hazards, 🗎 48.

Hazard symbols

Hazard symbol	Meaning	Hazard symbol	Meaning
	Identifies a potential danger to cause injury or harm.		Used to indicate hazards arising from chemicals that may destroy living tissue on contact.
	Used to indicate hazards arising from dangerous and/or lethal voltage.		Identifies a potential of crushing the body due to mechanical assemblies.
	Used to indicate hazards arising from strong magnetic fields.		Used to indicate hazards arising from chemicals that may explode.
	Identifies the presence of potentially dangerous levels of non-ionizing radiation.		Used to indicate fire hazard arising from chemicals that have a low flash point and boiling point, and gases that catch fire in contact with air.
	Used to indicate heating operation or hot surface that can be harmful.		Used to indicate hazards arising from chemicals that may cause damage to health.
	Used to indicate cooling operation or cold surface that can be harmful.		Used to indicate hazards arising from toxic chemicals.
	Identifies a potential of crushing the upper limbs due to mechanical assemblies.		Identifies a potential of hands getting trapped by rotating elements.
	Identifies a danger by pressurized gas bottles.		Identifies a danger of crushing by improper handling of suspended loads.

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Hazard symbol	Meaning	Hazard symbol	Meaning
	Used to indicate hazards arising from pressurized system parts.		Identifies a danger of cuts by sharp objects.
	Identifies a danger of falling off.		Identifies a danger of tripping.

Prohibition signs

Prohibi-tion sign	Meaning	Prohibi-tion sign	Meaning
	Do not enter the area if you are fitted with electronic implants.		Do not touch

Mandatory signs

Mandatory sign	Meaning	Mandatory sign	Meaning
	Wear goggles.		Wear gloves.
	Wear safety boots.		Read the instruction.
	Wear an overall.		

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2.3 Access rights

2.3.1 Personnel groups

The customer assigns different rights to his personnel, depending on training and authorization. These Operating Instructions differentiate between the following personnel groups:

Operating personnel
Operating personnel operate the A1500V-7 during normal operation. Normal operation consists only of the following activities:

- Carrying out coating processes via the graphical user interface
- Loading and unloading the load lock chamber with substrates
- Periodic maintenance work as listed in the maintenance schedule

Personnel with «Operator» access rights must have completed a A1500V-7 training course. This training course must be carried out by Leybold Optics or by equally qualified personnel authorized by the operating firm.

Supervisor
Supervisors have all the rights of operating personnel. In addition, they carry out all the maintenance and service work necessary for the problem-free operation of the system. This in particular consists of:

- Periodic maintenance work as listed in the maintenance schedule, see Maintenance Instructions
- Repair of mechanical and electrical components
- Dismounting the system and unpacking system parts
- Correcting malfunctions and errors
- Prepare and modify formulas
- Assign appropriate password levels to other persons

Personnel with «Supervisor» access rights must have completed a A1500V-7 supervisor training course. This training course must be carried out by Leybold Optics or by equally qualified personnel authorized by the operating firm. In addition, an electrotechnical qualification is required for work on electrical components.

Service
The access right «Service» is assigned Leybold Optics personnel only and allows full access to the system functions.

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2.3.2 Access to the operating rooms

⚠WARNING

Negative influence on pacemakers and other electronic implants by strong magnetic fields.

➢ Do not enter the area surrounding the A1500V-7 (minimum distance 5 meters) if you are fitted with electronic implants.

The system owner is responsible for ensuring that only authorized personnel have access to the operating rooms of the A1500V-7.

2.3.3 Control and passwords

Control
During the sputter process, the operating personnel controls the A1500V-7 mainly by means of the operating terminal, see Chapter 5.6 Operator terminals, 🗎 129.

The A1500V-7 can be controlled in different operating modes. Access to these operating modes is protected by a password, and is dependent on the authorization of the operating personnel. The access levels are structured in steps, which correspond to technical knowledge and responsibility of the personnel. This means that one requirement of each access level is the complete understanding of the previous levels.

One operating mode is defined for each of the personnel groups described in Chapter 2.3.1 Personnel groups, 🗎 39.

Passwords/Login information
Access to the software components and user interface is protected by passwords. These passwords are dependent on the access authorization of the user groups. The table Tab. 2-1, 🗎 40 shows the standard user groups that have been pre-defined by Leybold Optics and the passwords that allow access to the individual system software programs. After login information has been entered (password and user name) in the corresponding login window the system software can be accessed fully.

Access level/ User group	Login (user name)
Operator	*Operator*
Supervisor	*)
Service	*)

Tab. 2-1 *Password summary*
**) access protected (Login information will be handed over by Leybold Optics)*

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NOTE!
The passwords are handed over by the responsible personnel from Leybold Optics during the system acceptance.

- **Keep your password secret to avoid any misuse!**

Each user should change the pre-defined password as soon as possible.

Detailed information for the login procedure see Chapter 6.4 Logging on and off, 143.

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2.4 Electrical safety concept

NOTE!
The electrical safety concept of the A1500V-7 allows the integration into a superordinate locking device. If necessary the emergency stop circuit can be used for superordinate and/or up or down stream system. The necessary connection types exist.

The electrical safety concept of the A1500V-7 is based on EN954-1. The risk graph EN954-1 was used up for the definition of the risk for the functional safety.

The selected safety switch devices guarantee hardware-sided the observance of the defined risk assessment. In it all safety protection are functionally defined. Thereby it is guaranteed that emergency-stop registration occurs in the necessary safety level. All safety locking are realized according to the requirements to guarantee the personal safety with all machine states.

2.4.1 Main switch

With the main switch you can switch the system off completely and prevent it from unintentional re-start. When danger is apparent, the main switch may be used for an emergency machine off as well.
The circuit breaker is located at the control cabinet main switch CCMS, see Fig. 3-24, 🗎 110.

The main switch is described in Chapter 5.1 Main switch, 🗎 123.

2.4.2 Emergency Machine Off (EMO) buttons

If a dangerous situation arises during operation of the A1500V-7, you can shut down the system by pressing one of the Emergency Machine Off (EMO) buttons. Several emergency off buttons are installed to the system.

Locations of the EMO buttons

- Operating terminal CCOS
- Buffer module B2
- Buffer module B8
- Control unit of the transfer module T1
- Control unit of the transfer module T9
- Door of the control cabinet CCMD01
- Module distribution cabinet P1KK01
- Module distribution cabinet P1KK02

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See circuit diagram on CD 1 for more information about the locations of the EMO buttons.

For a description of the EMO buttons see Chapter 5.3 Emergency Machine OFF (EMO) button, 125.

Consequences of pressing an EMO button

- Cathode, ion source, heater and pumps switch off
- Transport drives
- Process door drives stop
- The coating process is interrupted. Data is saved.
- Vacuum valves shut
- Sluice valves between the vacuum chambers remain in their current position
- Gas valves shut
- Valves for the cooling of magnetrons open
- Gate valves before cryo pumps shut

NOTE!
The cooling water system is not integrated in EMO-circle to avoid overheating of the components.

Power supply or operability of those parts that do not impose immediate danger (e.g., PLC, PC) remain energized after an emergency machine off.

Switching the system on again
Switching the system on again after an emergency machine off is described in Chapter 6.2.2 Switching on, 140.

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2.4.3 Safety switches

The chamber doors, the covers of the process doors and the doors of the manual load and unload modules each are equipped with a safety switch. If the corresponding door is open or the cover is dismounted, the safety circuit is interrupted and a lock against switching on again is engaged.

Fig. 2-2 *Safety switch*

	See circuit diagram on CD 1 for more information about the locations of the safety switches.

	⚠DANGER
	Injuries and danger by manipulated safety switches. ➢ Do not remove the safety switches. ➢ Do not bypass the related safety switches.

Chamber doors
The following components in the sputter machine will be switched off and secured against switching on again:

- Process gas inlet (valves are closed)
- Sputtering power supplies
- Transport drive system
- Pumping system (high vacuum operation not allowed)
- Heater

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Covers of the process doors
The following components at the process doors are interrupted and secured against switching on again:

- Sputtering source(s)
- Rotary magnetron drives
- Ion source

Doors of the manual load and unload modules T1 and T9
The carrier is stopped and the driving motors are switched off.

Using the operational control the safety switch can be deactivated for manual load/unload of the substrates and carriers, see Chapter 5.5 Control unit for the manual access, 🗎 128.

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2.5 Software interlocks

Because of the large number of integrated software interlocks and their connections with one another, the following is just an overview of the most important locking situations.

Locking situations:

- Fore-vacuum pumps: The fore-vacuum pumps can only be switched on when
  - all service/process doors are closed
  - the cooling water system is running
  - the carrier transport is switched off

- The turbo pumps run-up when
  - all service/process doors are closed
  - the fore-vacuum pressure has reached $p < 5 \times 10^{-2}$ mbar
  - the cooling water system is running

- Sputtering sources in standby-mode (P_{out} = 0 kW): the high voltage can only be switched on when
  - all service/process doors are closed
  - the covers of the process doors are closed
  - the turbo pumps are running

- Sputtering sources in operating-mode: the high voltage can only be switched on when
  - the standby-mode meets the requirements (see above)
  - the cooling water system is running
  - the carrier transport is running
  - the target rotation is running

- Substrate heaters: the substrate heaters can only be switched on when
  - the cooling of the ferrofluidic sealed feedthrough is switched on
  - the service/process doors are closed
  - the chamber cooling flows error-free
  - the carrier transport is running
  - the vacuum chambers are evacuated
  - the target rotation is running

- Venting: The sputtering power supplies and the substrate heaters are disconnected from the mains before the chamber is vented.

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2.6 How to react to dangerous situations

In dangerous situations the A1500V-7 can be stopped by pressing one of the EMO buttons.

- Press an EMO button if danger for life and limb exists or you notice smoke or smell a fire and switch off the main switch
- Press an EMO button if you hear unusual noises. When the system is being pumped down, a change in the sound of the roughing pumps is normal.

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2.7 Hazards

The A1500V-7 employs state of the art technology and was built in line with the recognized safety regulations. It has been subjected to comprehensive safety test and approval processes. However, there still are possible dangers and risks involved in the use of the system. Several dangerous situations may result from improper operation or maintenance of the system.

2.7.1 Heavy components

⚠WARNING

Danger of crushing by improper handling of suspended loads.

Improper handling of heavy parts during transportation, mounting, and dismounting can lead to serious crushing, fractures and death. In particular, this applies for:

- Magnetrons
- Vacuum chamber doors
- Components of the vacuum system, in particular vacuum pumps, vacuum chambers, and valves
- Carrier depot and carrier magazine

➢ Use applicable equipment to lift and transport heavy components.

➢ When transporting system parts with a lifting device, adhere to the maximum load capacity.

➢ Wear safety shoes and a helmet.

➢ Ask a second person to help, if necessary.

➢ Always maintain a safe distance from suspended loads.

➢ Never stand beneath a hanging load.

NOTE!
Only authorized personnel may operate forklifts, crane trucks and lifting devices.

2.7.2 Target materials

NOTE!
The A1500V-7 is designed for coating processes using the target materials specified in Chapter 1.2.1 Proper use, 🗎 14

Leybold Optics will not be held responsible for the use of non-specified, dangerous materials.

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⚠CAUTION

Health hazards from process materials

Depending on the process, the interior of the process chamber and the substrate carriers may be contaminated with metals, metal dust and toxic substances hazardous to health.

- ➢ Always wear an approved protection mask against fine dust with particle filter P3, gloves and work clothes with long sleeves if you work on the open system.
- ➢ Avoid the inhalation of dust.
- ➢ Follow the instructions in the safety data sheets of the used process materials. Specified protective measures must be complied with precisely.

NOTE!
The latest editions of the safety data sheets from the material manufacturer or supplier must be kept or placed visibly close to the system.

- ➢ **Strictly adhere to the instructions in the safety data sheets for the coating materials.**

2.7.3 Process gases

⚠WARNING

Dangerous process gases.

Dangerous substances in the process gas and vacuum lines, in the vacuum pumps and in the exhaust gas of the pumps can cause numerous dangers which may lead to serious or lethal personnel injuries.

- ➢ Make sure that the process gas pipes are tight.
- ➢ Prior to maintenance and service work: Close all valves of the gas supply and drain the lines.
- ➢ Carefully read the safety data sheets for the involved process gases. Adhere to all the prescribed protective measures, see Chapter 2.11 Material Safety Data Sheets (MSDS), 63.
- ➢ Always adhere to the relevant local and national regulations when using dangerous gases.

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⚠WARNING

Suffocation by high gas concentrations.

The inhalation of high gas concentrations, for example when opening a process chamber or working on the gas supply, can cause suffocation.

- ➢ Before carrying out maintenance work, close all the gas valves, shut down the system and empty the gas pipes.
- ➢ Follow the safety data sheet for argon and oxygen gas.

NOTE!
The A1500V-7 is designed for coating processes using the process gases specified in Chapter 1.4.2.2 Process and venting gases, 🗎 23. Leybold Optics will not be held responsible for the use of non-specified, dangerous gases.

NOTE!
The latest editions of the safety data sheets from the gas supplier must be kept or placed visibly close to the system.

- ➢ **Strictly adhere to the instructions in the safety data sheets for the process gases.**

2.7.4 Chemical substances

Source of danger	Hazard
Fore-vacuum pumps	Health hazard from pump oils, vapors and exhaust gases
Vacuum pumps and vacuum lines	Health hazard from toxic substances resulting from the process
Interior of the process chambers	
Cooling water	Health hazard due to corrosion protection and biocide additives
Operating and auxiliary materials	Health hazard due operating and auxiliary materials (oils, greases, cleaning agents, solvents and other chemical substances).
Polycold	Health hazard from refrigerant

Tab. 2-2 *Dangers resulting from chemical substances*

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⚠CAUTION

Health hazards by oils, vapors and exhaust gases from the fore-pumps.

The inhalation or ingestion of vacuum oils or vapors, or their contact with the eyes or skin, can lead to health hazards.

- ➢ Allow the pumps to cool down to 30°C before carrying out maintenance or repair work.
- ➢ Wear gloves when working with pump oil.
- ➢ Strictly adhere to the instructions on the safety data sheet for the pump oil. If the safety data sheet is not available, obtain it from the manufacturer.
- ➢ Do not operate the fore-pumps without an oil fume filter in the exhaust pipe. The exhaust gas pipe must lead to an exhaust gas channel or directly outside. If the exhaust gases are not channelled outside, the machine must not be operated.
- ➢ Follow all the international, national and regional regulations when dealing with pump oil, vapors, filters, etc.

⚠CAUTION

Health hazards from process materials.

Depending on the process, the interior of the process chamber and the substrate carriers may be contaminated with metals, metal dust and other toxic substances hazardous to health.

- ➢ Always wear an approved protection mask against fine dust with particle filter P3, gloves and work clothes with long sleeves if you work on the open system.
- ➢ Avoid the inhalation of dust.
- ➢ Follow the instructions in the safety data sheets of the used process materials. Specified protective measures must be complied with precisely.

⚠CAUTION

Health hazard by contact with irritating or poisonous materials.

Contact with the skin and with the eyes and inhalation of cleaning agents and solvents can impair your health.

- ➢ Always use cleaning agents and solvents according to international, national and local specifications.
- ➢ Always observe the specific safety regulations and the safety data sheets when dealing with auxiliary materials (oils, greases, cleaning agents, solvents and other chemical substances).

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⚠CAUTION

Health hazards due to corrosion protection and biocide additives in the cooling water.

Contact with the cooling water irritates the eyes and skin. The inhalation of vapors and ingestion of cooling water is hazardous to health.

- ➢ Adhere strictly to the instructions on the safety data sheets for the corrosion protection and biocide additives. If the safety data sheet is not available, you must obtain it from the manufacturer.
- ➢ Blow out the cooling water circuit before opening it.
- ➢ Do not allow cooling water to enter the environment or drainage system.
- ➢ Wear suitable protective clothing (gloves, goggles, overalls) during maintenance and service work on water circuit.
- ➢ Follow all international, national and regional regulations when handling corrosion protection and biocide additives.

⚠CAUTION

Health hazards from refrigerant in the cooling system circuit of the Polycold.

The inhalation of refrigerant vapors or the contact of the refrigerant with the eyes or skin may lead to health hazards.

- ➢ Avoid contact of the refrigerant with eyes or skin.
- ➢ Wear protective gloves, safety goggles and work clothes with long sleeves.
- ➢ Make sure that there is sufficient ventilation during storage, handling and usage of the refrigerant.
- ➢ If necessary, wear a self-sustaining breathing apparatus.
- ➢ Follow the instructions in the safety data sheets of the refrigerant. Specified protective measures must be complied with precisely.

NOTE!
The latest editions of the safety data sheets from the material manufacturer or supplier must be kept or placed visibly close to the system.

- ➢ **Strictly adhere to the instructions in the safety data sheets for the materials.**

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2.7.5 Electrical energy

Source of danger	Lethal electric shock by touching parts connected to:
Electrical cabinets	Mains voltage
Operating terminal and PCs	
For-vacuum pumps	
Turbo pumps	
Cryo pumps and cryo compressor	
Polycold	
Transport system drive	
Substrate heaters	
Process door drives	
Rotary magnetron drives	
Power supplies (magnetrons, ion source)	Main voltage at input High voltage at output
Magnetrons	High voltage of the power supplies
Ion source	

Tab. 2-3 Dangers resulting from electrical energy

⚠DANGER

Lethal electric shock by touching live parts.

The system includes live and at high voltage parts. 480 V AC are always present at the power input of the main switch in the main switch cabinet. This is independent from the position of the main switch.

In the control cabinets voltage is present at the cables marked orange and the sockets marked yellow even with disconnected main switch.

Touching live parts may cause a lethal electric shock.

- ➢ Turn off the system and de-energize it before you carry out any maintenance or service work on the system.
- ➢ Ground the equipment and secure the system against switching on again.
- ➢ Discharge the magnetrons and their surroundings with the grounding rod.
- ➢ Switch off the Data logger PC and the UPS before you work on it.
- ➢ Ensure that all persons keep a safe distance to parts which are connected to the electrical supply before you switch the system on again.

NOTE!
Only instructed personnel with electrotechnical training is permitted to carry out work on the electrical equipment.

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2.7.6 Thermal energy

Source of danger	Hazard
Fore-vacuum pumps	Danger of burns
Load lock module L1, Buffer modules B1, B2: ▪ Front side and rear side heaters ▪ Halogen lamps	
Process module P1: ▪ Ion source ▪ Front side and rear side heaters	
Process module P2: ▪ Magnetrons and their surroundings (shielding plates, targets) ▪ Front side and rear side heaters	
Load lock module L9, Buffer modules B8 and B9: ▪ Halogen lamps	
Carriers and substrates	
Servo motors of the transport system	
Cryo compressor	
Cryo pumps	Danger of cold burns
Polycold ▪ Refrigerant pipes	

Tab. 2-4 *Dangers resulting from thermal energy*

⚠CAUTION

Burns by touching hot components.

The following components are heated during the process and may cause burns:

- Sputtering cathodes and surroundings, in particular shielding plates and targets
- Ion source
- Substrate heaters
- Interior of the process chambers
- Carriers and substrates
- Servomotors of the transport system
- Halogen lamps

➢ Wait until the affected components have cooled down to room temperature before starting to work on them.

➢ Wear protective gloves and work clothes with long sleeves.

➢ Cover the door heating elements with protective coverings resistant to temperature.
Secure the open (buffer-, load lock-) chamber door with the wedge against closing.

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⚠CAUTION

Burns by touching hot forepumps.

Forepumps can exceed temperatures of 70 °C. Contact with the housing can cause burns.

- ➢ Wear protective gloves and work clothes with long sleeves.
- ➢ Do not leave any easily inflammable objects (e.g. cleaning rags, etc.) on the pumps.

⚠CAUTION

Burns by touching hot cryo compressor.

The cryo compressor can exceed temperatures of 70 °C. Contact with the housing can cause burns.

- ➢ Wear protective gloves and work clothes with long sleeves.
- ➢ The compressor pump is hot after operating. Wait for the pump to cool down before working on the inside of the compressor.
- ➢ Do not leave any easily inflammable objects (e.g. cleaning rags, etc.) on the pumps.

⚠CAUTION

Cold burns by very cold components

The cryo pump components, the cold trap and other components of the cooling generator are extremely cold. Contact with these parts and their connecting pipes can lead to cold burns.

- ➢ Wait until all components have warmed to room temperature before starting to work on them or their surroundings.
- ➢ Wear protective gloves and work clothes with long sleeves.

2.7.7 Mechanical energy

Source of danger	Hazard
Media supply:	
▪ Compressed air system	Danger of injuries by bursting parts
▪ Cooling water system	
▪ Process gas system	

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Source of danger	Hazard
Transport driving system:	
▪ Toothed wheels	Danger of crushing by rotating parts
▪ Belts	
▪ Shafts	
▪ Carrier	
Modules:	
▪ Service and process doors	Danger of crushing when opening and closing the service doors
▪ Transfer modules T1 and T9	Danger of crushing by moving parts
▪ Carrier depot	
Vacuum system:	
▪ Vacuum pumps	Danger of crushing by moving parts
▪ Sluice valves	Danger of crushing by accidental movement of the valves.
▪ Gate valves	

Tab. 2-5 *Dangers resulting from mechanical energy*

⚠WARNING

Crushing by massive components: chamber doors.

When opening and closing the doors of the vacuum chambers, there is danger of contusion.

➢ Make sure no one stays within the movement area of the service unit when opening or closing a service door.

➢ Secure the open (buffer-, load lock-) chamber door with the wedge against closing.

⚠WARNING

Crushing by valves.

There is danger of crushing through unintentional movements of these valves.

➢ When carrying out service work on such a valve, secure it against unintentional movement, e.g., by blocking.

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⚠WARNING

Crushing by moving components: transfer modules, carrier, carrier depot.

There is a danger of crushing by movement of the carriers and during work at the transfer modules and at the carrier depot.

- ➢ Secure the transport system against switching on again before carrying out maintenance or service work.
- ➢ Make sure no one reaches into the danger areas before activating the drive.
- ➢ Move the support of the carrier depot carefully and make sure that it snaps in place.

⚠WARNING

Hands getting trapped by rotating elements.

There is a danger of hands getting trapped by gear wheels, shafts and belts when the transport system drive is activated.

- ➢ Secure the transport system against switching on again before carrying out maintenance or service work.
- ➢ Make sure no one reaches into the danger areas before activating the drive.

⚠WARNING

Injuries by unintentional start-up of the fore-vacuum pumps.

The unintentional start-up of a pump may cause serious injuries.

Prior to carrying out works on a pump:

- ➢ Switch off the power supply of the pump and secure it against switching on again.

⚠WARNING

Eye or skin injuries when opening pressurized system parts (water supply, process gas supply and compressed air system).

- ➢ Shut off the supply to the system and release the pressure before carrying out any work on these parts.

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⚠WARNING

Injuries by exploding gas bottles.

Pressurized gas bottles can explode and cause serious injuries and damage if mishandled.

- ➢ Make sure that the gas installations comply with international, national and local safety regulations for handling pressurized gas bottles.

2.7.8 Glass and splinters of material

⚠CAUTION

Cuts by splinters of glass.

Glass splinters in the module and/or on the carriers may cause cuts.

- ➢ Wear protective clothing (protective goggles, protective gloves, safety boots, clothes with long sleeves).
- ➢ Use a vacuum cleaner to remove the glass splinters.

⚠CAUTION

Injuries by splinters of coating material.

When removing the sputter shieldings, splinters of coating material may spall off. This may cause injuries.

- ➢ Always wear protective goggles or a face protection shield when removing sputter shieldings.
- ➢ Always wear protective gloves and protective clothing with long sleeves when removing sputter shieldings.

2.7.9 Strong magnetic fields

⚠WARNING

Negative influence on pacemakers and other electronic implants by strong magnetic fields.

- ➢ Do not enter the area around the process doors, if you are wearing electronic implants (minimum distance 5 meter).

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⚠WARNING

Crushing by strong permanent magnets.

The permanent magnets of the magnetron produce strong magnetic fields, these can lead to serious crushing, fractures or fatal injuries.

- ➢ Make sure that here is a safe distance of 1.00 m in all directions to other permanent magnets, and there is a safe distance of 0.50 m to other ferromagnetic materials when working with permanent magnets of the magnetron.
- ➢ Only use anti-magnetic tools.

⚠CAUTION

Contusions to service personnel and damage to electronic equipment by strong magnetic fields.

The permanent magnets of the cathodes have strong magnetic fields. These fields can:

- cause contusions when objects snap shut
- make electronic equipment and magnetic cards useless

- ➢ Deposit credit cards, watches, floppy disks etc., aside at a safe distance (approx. 5 m) from the cathodes and the ion source.
- ➢ Do not use magnetized tools when working on the cathode or ion source.

2.7.10 Platforms, stairs and ladders

⚠CAUTION

Danger of falling off the platforms, the stairs or a ladder.

There is a danger of falling off during maintenance and service work on components installed in the upper regions or on the top of the module chambers.

- ➢ Move cautiously in the area between the carrier back transport and the electrical cabinets.
- ➢ Do **not** remove the safety railings from the platforms.
- ➢ Do **not** set foot on the top of the chambers.
- ➢ Make sure that the ladder has stable footing before you climb on it.

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2.7.11 Electromagnetic radiation

⚠WARNING

Thermal effects on tissue by electromagnetic radiation.

The RF sputtering power supplies generate high frequency electromagnetic radiation. This radiation is absorbed by biological tissue and may subsequently provoke thermal effects.

- ➢ Operate the RF power supplies only if closed.
- ➢ Do not bypass the related safety switches and safety equipment.
- ➢ Check the RF sealing in the process doors for damage in regular intervals.
- ➢ Replace damaged RF sealings.

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2.8 Grounding rod

The A1500V-7 is equipped with 4 grounding rods.

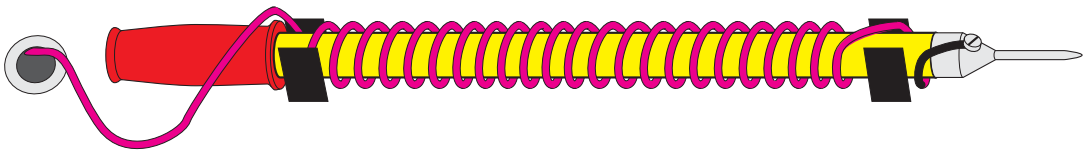

Abb. 2-3 *Grounding rod*

Locations of the grounding rods
- 1 grounding rod at process module P1
- 1 grounding rod at process module P2
- 1 grounding rod at generator cabinet CCPS01
- 1 grounding rod at generator cabinet CCPS02

Grounding components
Work with the grounding rods always in the following way:

1 Before starting any work on the opened cathode sputtering device and on all electrical powered components switch off all parts that can carry dangerous voltages/charges.

2 Secure the components against switching on again.

3 Ground the components with the grounding rod. Start with the nearest components

4 Cover adjacent parts which may carry levels of residual voltage with insulating material or discharge them, too.

5 Keep the grounding rod connected to the component where the service work is done.

Always ground the following components:

- Sputter targets or target backing plates of the cathode sputtering devices
- Ion source
- Electrical components in the generator cabinets

Safety

➢ Only service personnel with special electrical training is permitted to install and ground the grounding rod

➢ Visually inspect the grounding rods regularly

➢ Immediately eliminate any faults of the grounding system or insulation damages.

➢ Damaged grounding rods are to be exchanged, in any case.

	For more detailed information on the grounding rod refer to the supplier documentation on CD 1

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2.9 Measures against vibration and noise

2.9.1 Measures against vibration

Because of the stability of the A1500V-7, there normally are no special measures necessary to prevent the transference of system vibrations. Vibration absorbers are installed at the pump frames.

2.9.2 Measures against noise

After the installation of the A1500V-7, you must carry out a workplace-related noise measurement, if necessary noise protection measures must be taken.

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2.10 Leybold Optics Service

Address:

Leybold Optics GmbH

Zur Wetterwarte 50/ Haus 303
D-01109 Dresden

Tel.: 0049 (0) 351/8669516
Fax: 0049 (0) 351/8669542

E-mail: info@leyboldoptics.com

Leybold Optics Website
Please find the contact addresses (phone numbers, fax numbers, e-mail addresses) on our Website. There also is current technical information on our products.

http://www.leyboldoptics.com

2.11 Material Safety Data Sheets (MSDS)

The customer is responsible for the procurement of the current material safety data sheets (MSDS) for all of the substances it uses (process gases, operating media, cleaning solutions, etc.). We recommend that you file the MSDS after this page.

Read the MSDS carefully and follow all the instructions. Do not remove the MSDS from the Operating Instructions.

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3 Design, Functions

3.1 Process fundamentals

3.1.1 Cathode sputtering

Cathode sputtering is a technique for creating thin layers. The coating material is removed from a target by bombarding it with ions. The removed material is deposited on a substrate.

3.1.1.1 Plasma

A plasma is required to conduct a sputter process. A plasma is an ionized gas. It can be created by exposing gas under reduced pressure to a static electrical field or a high-frequency alternating field.

Igniting the plasma

The following discussion assumes that argon is used as the working gas and is converted to a plasma by applying a static electrical field. In this case, the negative pole of the voltage is at the target, i.e. the target is the cathode. The positive pole of the voltage is generally connected with chassis ground.

Due to the ionizing radiation (cosmic radiation and natural radioactivity) that is always present, any gas has a certain small ion content. This means that some atoms of the working gas form into positive argon ions and negative electrons, in accordance with the reaction

$Ar \rightarrow Ar^{+} + e^{-}$

Due to the electrical field, these argon ions are accelerated and they migrate to the cathode. The free electrons migrate to the anode. The migrating particles collide with additional atoms and ionize them with their kinetic energy. This process is repeated many times, causing an exponential increase in the number of argon ions and electrons. The plasma ignites.

Gas pressure

To maintain a plasma at a voltage of a few hundred volts, the pressure of the working gas must be between around 10^{-4} and 10^{-1} mbar. If the pressure is set too high, the migrating particles will collide with the gas atoms before reaching the minimum level of energy required for ionization. On the other hand, if the pressure is too low, the particle density will be low, reducing the probability of collisions.

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3.1.1.2 Sputtering

After the plasma has ignited, many positive argon ions strike the target (Fig. 3-1, 66). Due to their large mass, they have a very large momentum. This momentum transfers to the atoms on the target's surface, ejecting individual or entire clusters of atoms. When the ions impact heat is created, raising the temperature of the target. For this reason the target is cooled with water.

The atoms blasted from the target move freely in the process chamber; some are deposited on the substrate. This is known as «sputtering». With masks, the area of the substrate to be coated can be limited. Fig. 3-1, 66 illustrates the typical case, with the substrate carrier arranged parallel to the target.

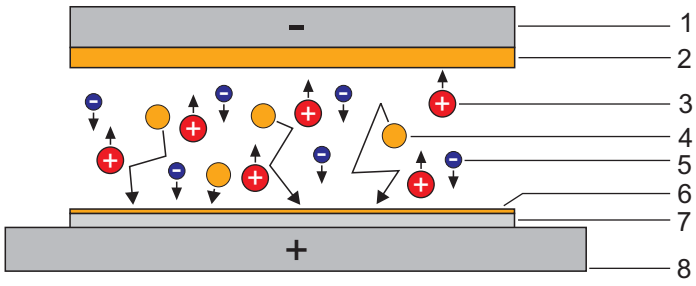

Fig. 3-1 *Principle of cathode sputtering*

1 Cathode (minus pole)
2 Target
3 Gas ions
4 Particle of the target material
5 Free electrons
6 Deposited layer
7 Substrate
8 Substrate carrier and anode (plus pole)

There are two great advantages of cathode sputtering, compared with thermal depositing of material:

- The sputtering process is largely stochastic. This means the chemical composition of the deposited layer agrees with the target, even when sputtering alloys or chemical compounds.

- With sputtering, the energy of the particles is much higher than with thermal depositing. This improves the layer's adherence and forms a compact layer structure even at low substrate temperatures.

The properties of the layer, i.e., layer thickness and thickness distribution, depend on the following factors:

- Sputter power, regulated by the sputter current supply
- Process pressure, controlled via the flow rate of the process gas and the throttling of the pumping capacity
- Process duration
- Cleanliness of all components in the process chamber; e.g., substrates, carrier, etc.
- Residual gas pressure
- Substrate temperature
- Angle between the target and substrate surface

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3.1.2 Magnetron technology

The magnets in the cathode support the process of electron discharge directly in front of the cathode. The magnet field compels the free electrons to additional circular movements so that they all move in helical (spiral) paths. This lengthens the electron path. In turn, a higher degree of dissociation of the process gas is produced and the plasma homogeneity is increased. The magnetic field focuses the ion blasting. Eventually, an erosion profile (erosion groove) is formed, raising the temperature at the target. Circulating cooling water channels protect the cathode and the area around it from overheating.

Magnetron technology offers the following advantages over conventional sputtering methods:

- Results in a stable and homogeneous plasma
- Good utilization of the target
- Allows lower sputter voltage (i.e. low particle energy)
- Works with low process gas pressure

3.1.3 Plasma excitation with pulsed DC

When the plasma is excited with a constant DC, the layer characteristics can be affected by the process gas pressure, the substrate temperature and a bias voltage (substrate bias).

When the DC is transformed into current pulses, the impulse current can be set higher. These high current densities change the kinetics of the sputter process in a manner that the layer characteristics can additionally be affected by the pulse mode and the pulse parameters. Thus, higher deposition rates and high process stability can be reached with significantly lower substrate temperatures.

Additionally, the periodic interruption of the DC-magnetron discharges reduces the development of arcs and hence minimizes the defects in the deposited layers.

3.1.4 Ion source

A basic requirement for optimal adhesion of deposited coatings is a clean and receptive substrate surface.

Since all substrates are exposed to atmospheric conditions prior to the coating process, the substrate surface acquires a thin coating of water, oxides and other impurities. This reduces the adhesion of the deposited coatings on the substrate. To create good adhesive properties, many substrates must be pretreated.

At the substrate pretreatment by ion bombardment the substrate is bombarded with gas ions of the ion source. Molecules on the surface of the substrate are removed and the surface activated for coating. The removed particles are evacuated together with the process gas or settle on the chamber surface. Argon is frequently used as an inert process gas.

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3.2 System overview

3.2.1 Design

The A1500V-7 is a vertical sputter machine with chambers tilted 7° towards the targets. This prevents deposition of particles on the substrates. The A1500V-7 comprises a total of 11 modules (see Fig. 3-2, 🗎 68) subsequently passed in one direction by the substrates during the process.

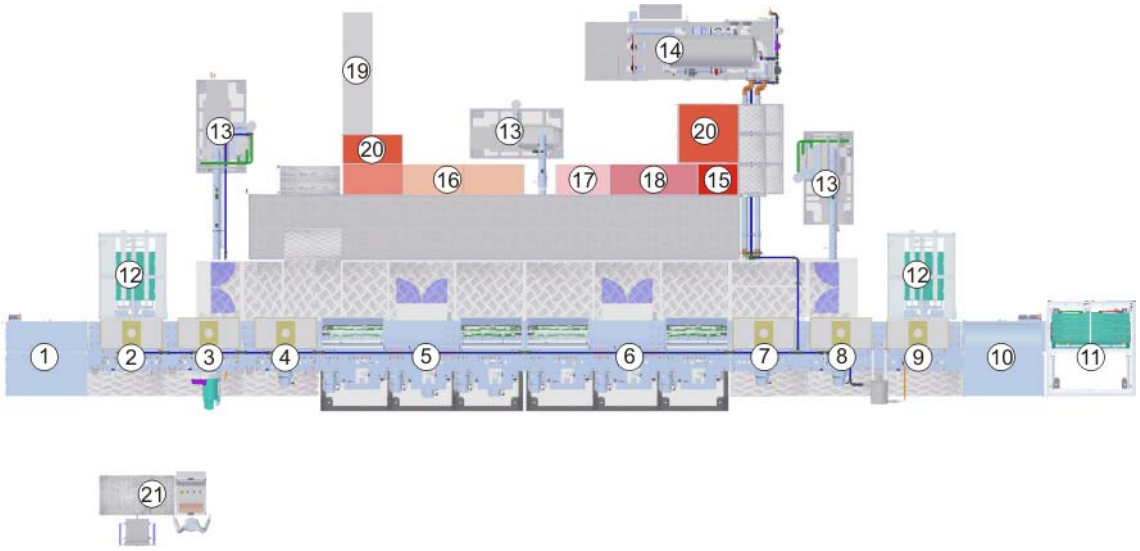

Fig. 3-2 *System overview of the A1500V-7.*

Item	Component	Description
1	Transfer module T1	Chapter 3.3.1, 🗎 75
2	Load lock module L1	Chapter 3.3.2, 🗎 76
3	Buffer module B1	Chapter 3.3.4, 🗎 79
4	Buffer module B2	Chapter 3.3.4, 🗎 79
5	Process module P1	Chapter 3.3.5, 🗎 81
6	Process module P2	Chapter 3.4, 🗎 85
7	Buffer module B8	Chapter 3.3.4, 🗎 79
8	Buffer module B9	Chapter 3.3.4, 🗎 79
9	Load lock module L9	Chapter 3.3.2, 🗎 76
10	Transfer module T9	Chapter 3.3.1, 🗎 75
11	Carrier depot	Chapter 3.4.2, 🗎 87
12	Loading / Unloading module Option removed	Chapter 3.3.3, 🗎 78

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Item	Component	Description
13	Roughing station	Chapter 3.6.2, 98
14	Water preparation system	Chapter 3.7, 101
15 - 19	Electrical cabinets	Chapter 3.11.1, 110
20	Generator cabinets	Chapter 3.11.1, 110
21	Operator station	Chapter 5.6, 129
22	Polycold	Chapter 5.6, 129
	Carrier back transport	Chapter 3.4.4, 90

3.2.2 Process

The following simplified diagram is used to illustrate an example of a possible process sequence of the A1500V-7.

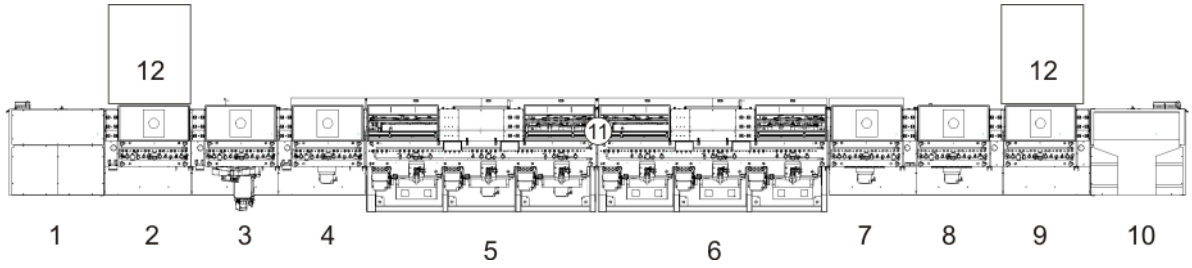

Fig. 3-3 *Schematic diagram of the A1500V-7 (top view)*

1 Transfer module T1
2 Load lock module L1
3 Buffer module B1
4 Buffer module B2
5 Process module P1
6 Process module P2
7 Buffer module B8
8 Buffer module B9
9 Load lock module L9
10 Transfer module T9
11 Carrier back transport
12 Loading / unloading module Option removed

During the automated production, there are up to 14 carriers in the system.

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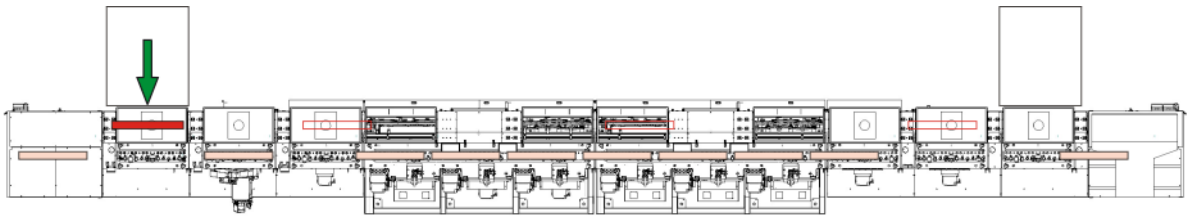
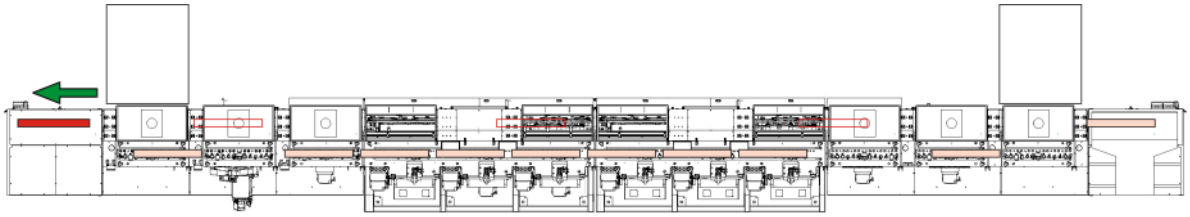
Substrate loading

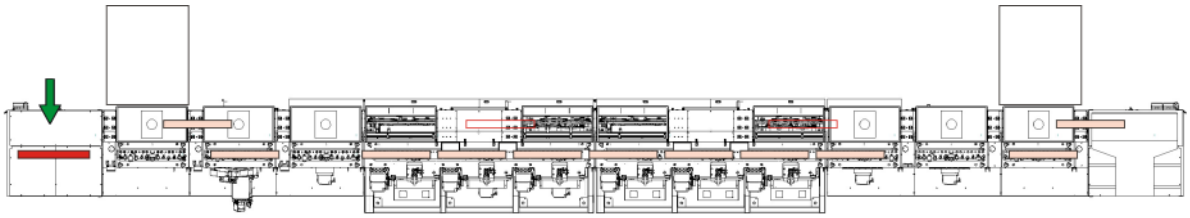
1 A loading robot of the loading module on the rear side of load lock module L1 places the substrate into the carrier so that the coating side shows in movement direction of robot (see arrow in the following figure).



2 The carrier support of the transfer module T1 moves to the charge position and the carrier is transported into the transfer module T1.

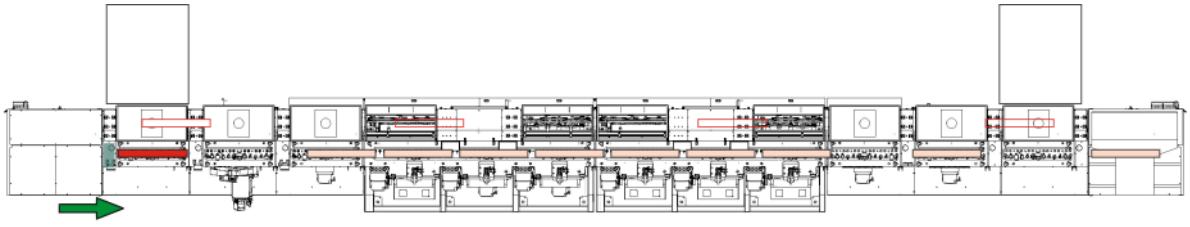


3 The carrier support of the transfer module T1 moves to the discharge position.



4 As soon as the load lock module L1 is free and vented, the gate valve L1VS01 opens.

5 The carrier is transported into the load lock module L1.



6 The gate valve L1VS01 closes.

7 The fore-vacuum pump station L1PV01 evacuate the load lock module L1 to fore-vacuum (definition see Chapter 10.1 Glossary, 279).

Substrate heating

8 The heaters in the load lock module L1 preheat the substrate. Thermoelements in the chamber measure the heater temperatures.

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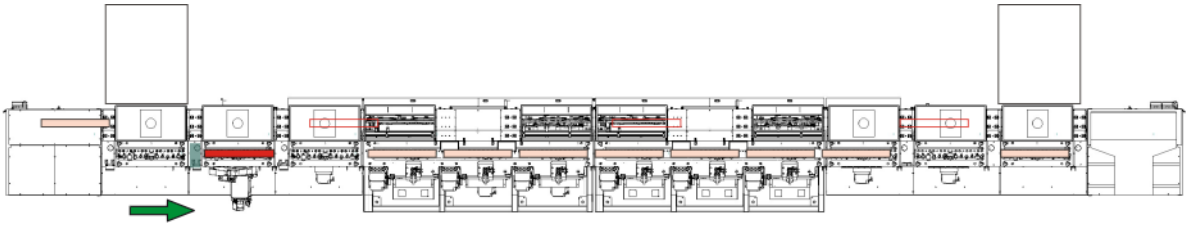
9 When the fore-vacuum is reached in the load lock module L1 and the buffer module B1 is free, the gate valve B1VS01 opens.

10 The carrier is transported into the buffer module B1. The heaters in the buffer module B1 heat the substrate. Thermoelements in the chamber measure the heater temperatures.

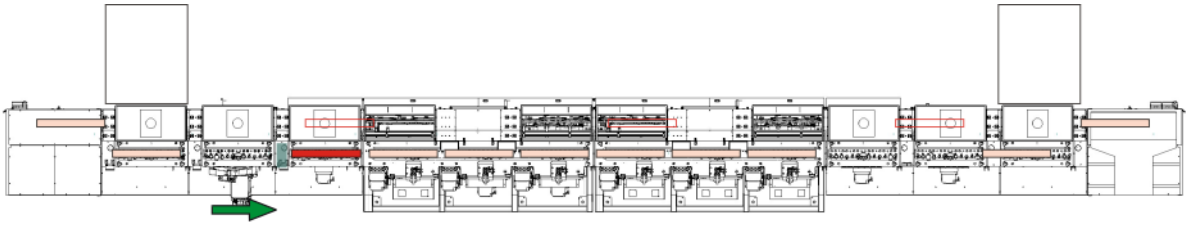


11 The gate valve B1VS01 closes.

Docking the carrier to the CSF (Continuos Substrate Flow)

12 When the prior carrier is taken out far enough of the buffer module B2, the gate valve B2VS01 opens.

13 The carrier is transported into the buffer module B2.

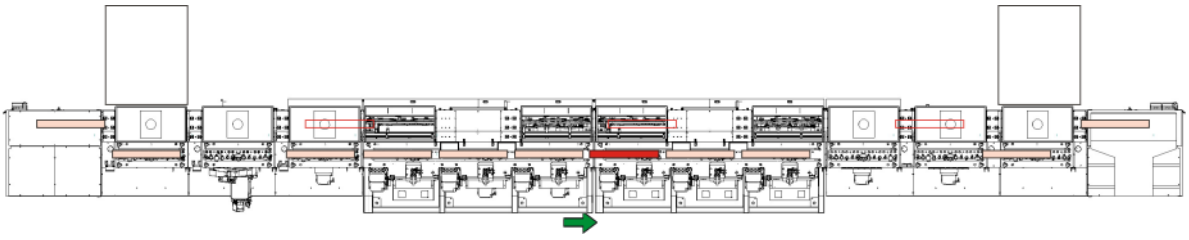


14 The gate valve B2VS01 closes.

15 When the sensor B2SC03 recognizes the end of the carrier chain, the carrier is docked to the CSF, see Chapter 3.4.3 Process transport system, 88.

Substrate coating

16 The carrier is moving with the defined, constant transport speed through the process modules. With it the substrates are coated with iZnO and AZO. The plasma characteristics and the transport speed define the layer thickness. In the end reaches the carrier to the head of the chain in the buffer module B8.



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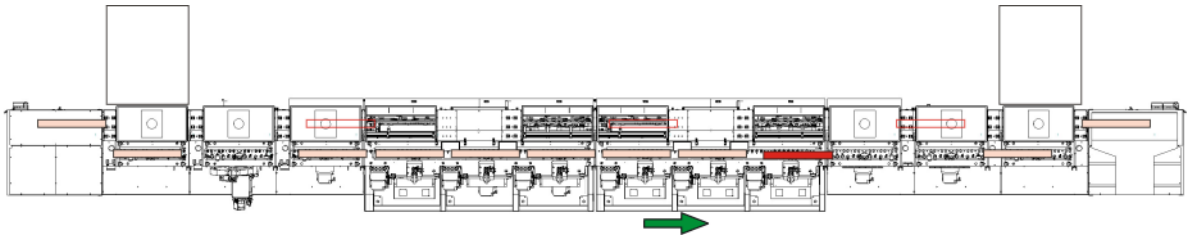
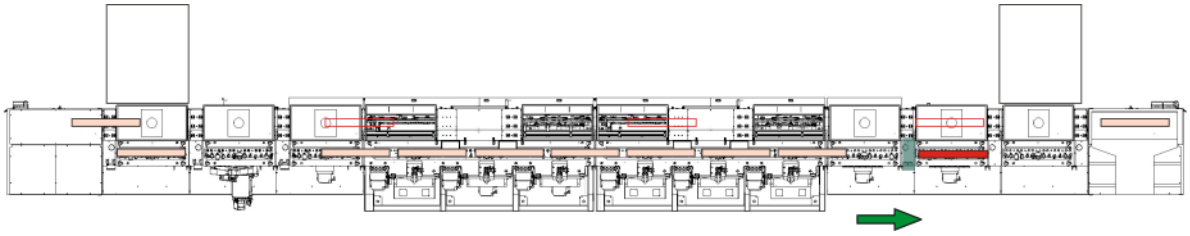
Undocking the carrier from the CSF and substrate cooling

17 When the carrier is in the buffer module B8, the carrier is uncoupled from the csf, see Chapter 3.4.3 Process transport system, 88.



18 When the buffer module B9 is free, the gate valve B8VS01 opens.

19 The carrier is transported into the buffer module B9.

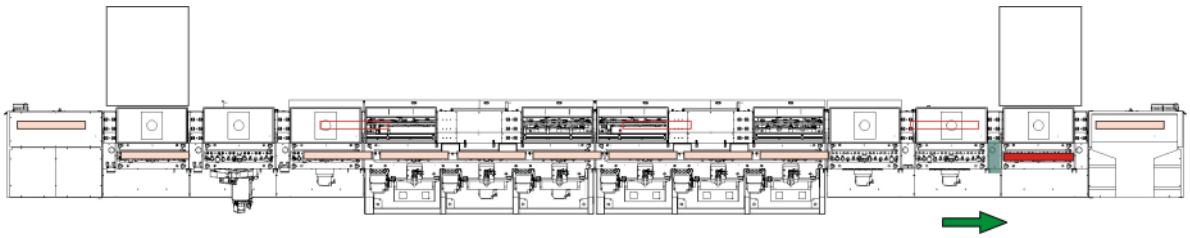


20 The gate valve B8VS01 closes.

21 The water in the cooling plates in the buffer module B9 carries away the heat emitted from the substrates.

22 When the load lock module L9 is free and vented, the gate valve B9VS01 opens.

23 The carrier is transported into the load lock module L9.



24 The gate valve B9VS01 closes.

25 The cooling of the substrate with water-cooled panels is continued.

26 The carrier support of the transfer module T9 moves to the charge position.

27 The load lock module L9 is vented and the gate valve L9VS01 opens.

28 The carrier is transported into the transfer module T9.

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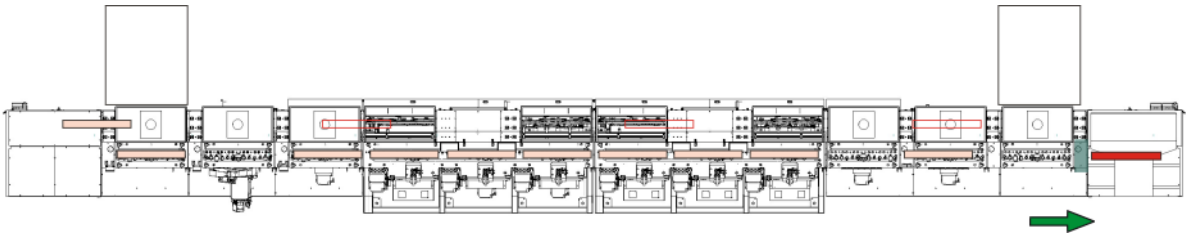
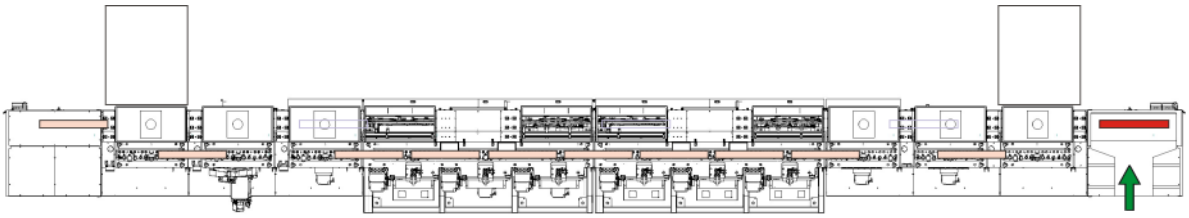


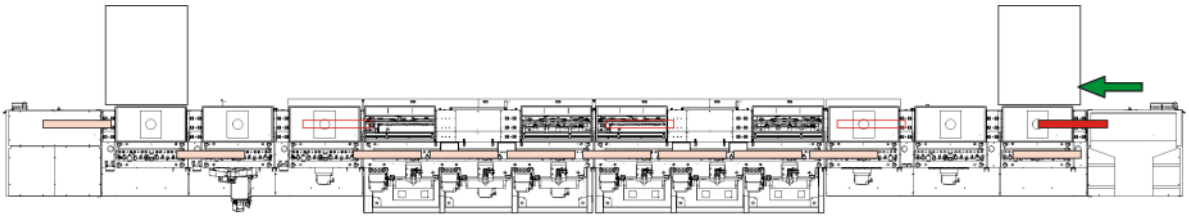
29 The gate valve L9VS01 closes and the fore-vacuum pump station L9PV01 evacuate the load lock module L9.

30 The carrier support of the transfer module T9 moves to the discharge position.

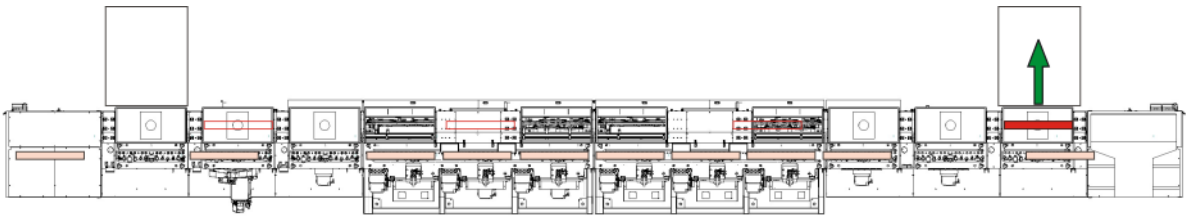


Substrate unloading

31 The Carrier is transported at the rear side of the chambers to the unloading module (back transport).

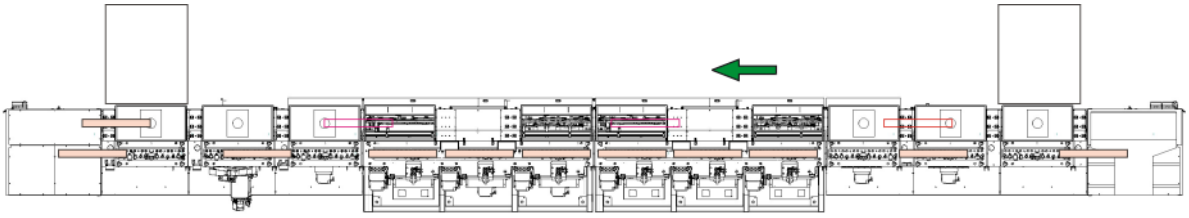


32 The robot at the unloading station unloads the substrate.



Carrier return

33 The empty carrier is transported to the loading module.



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3.3 Description of the modules

The basic functions of the modules are described in the following chapters:

- Transfer modules T1 and T9, see Chapter 3.3.1, 🗎 75
- Load lock modules L1 and L9, see Chapter 3.3.2, 🗎 76
- Loading / unloading module → Option removed, see Chapter 3.3.3, 🗎 78 →Option removed
- Buffer modules B1, B2 and B8, B9, see Chapter 3.3.4, 🗎 79
- Process module P1, see Chapter 3.3.5, 🗎 81
- Transport system, see Chapter 3.4, 🗎 85

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3.3.1 Transfer modules T1 and T9

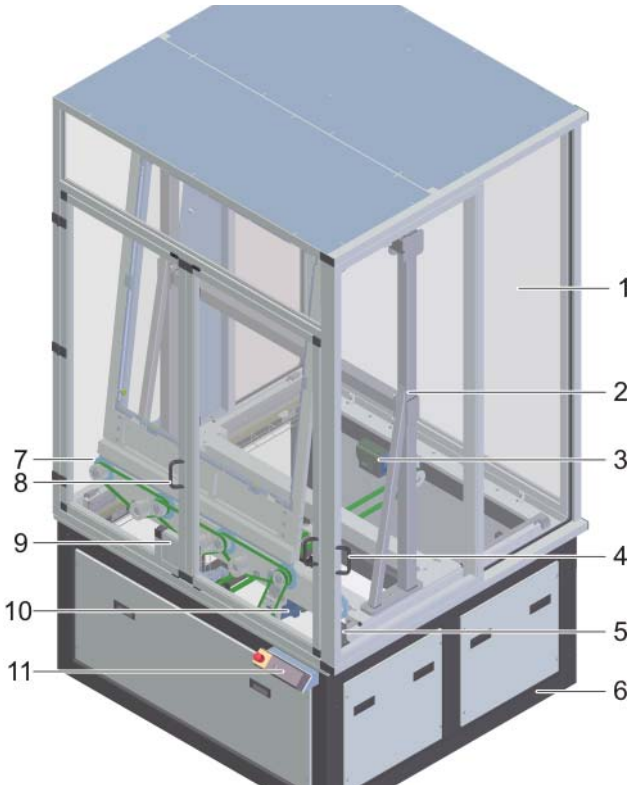

Fig. 3-4 *Transfer module T1*

1 *Housing*
2 *Carrier support*
3 *Drive motor of the carrier support (movement transversal to the process direction)*
4 *Side sliding door*
5 *Magnetic locking of the side sliding door*
6 *Frame*
7 *Transport wheel*
8 *Flap door*
9 *Magnetic locking of the flap door*
10 *Drive motor of the transport system (movement in process direction)*
11 *Control unit*

Automatic operation
The transfer module T1 takes over the carrier loaded with uncoated substrate from the loading station at the back of the load lock module L1 and places the carrier in the load lock module L1.

The transfer module T9 takes over the carrier loaded with coated substrate from the load lock module L9 and transfers it to the carrier back transport.

Transport wheels (7), driven by a servo motor (10) over toothed belts, move the carrier in the process direction. The carrier support (2), also driven by a servo motor (3), transports the carrier transversal to the process direction.

Manual operation
The control unit (11) allows the operator to interrupt the carrier transfer process for manual carrier exchange. The carrier stops in unloading position and the flap door (8) and the side sliding door (4) are released, see Chapter 6.7.1 Manual access request and finish, 🗎 152.

Through the side sliding door (4) the carriers can be transferred between the transfer module T9 and the carrier depot, see Chapter 3.4.2 Carrier depot, 🗎 87 and Chapter 6.7.2 Exchanging substrate carriers, 🗎 153.

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3.3.2 Load lock modules L1 and L9

The load lock modules L1 and L9 are the interface between atmosphere and high-vacuum (Definition see Chapter 10.1 Glossary, 279). The vacuum chambers are separated from each other by sluice valves to pump down to fore-vacuum to lock in or to lock out.

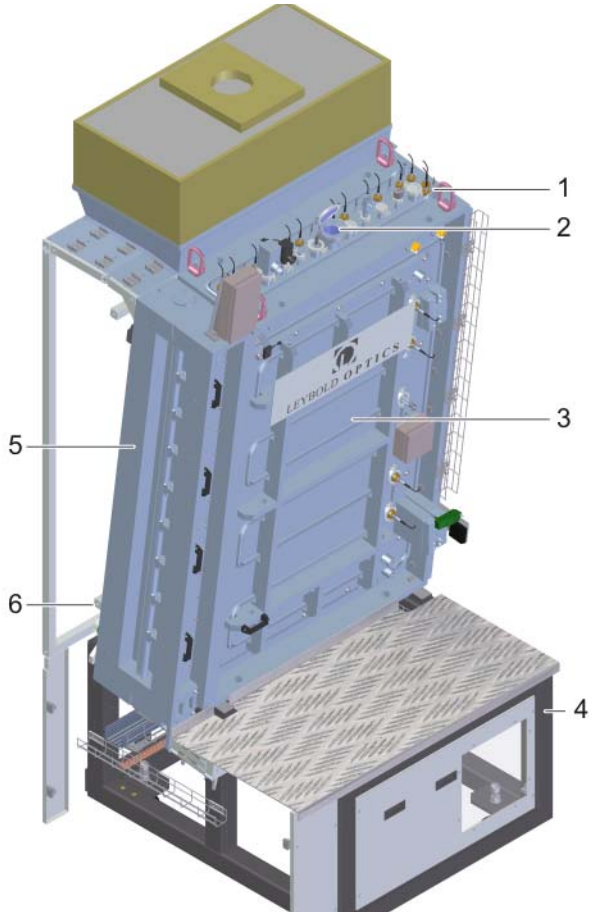

Fig. 3-5 *Load lock module L1*

1 Vacuum chamber
2 View port
3 Service door
4 Frame
5 Sluice valve
6 Carrier back transport

The load lock modules are equipped with the following components:

Design

- The vacuum chamber (1) is made of stainless steel with welded external water channels for chamber cooling, see Chapter 3.7.1 Water preparation system TPW 330, 101. The inside of the vacuum chamber is electro-polished and the outside is glass-pearled.
- Screwed horizontally pivoted service door (3) to the front of the vacuum chamber for easy access during maintenance.
- The frame (4) supports the vacuum chamber and all the media distributions. Screwed coverings secure the components in the frame against unauthorized access.

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Vacuum

- The chamber is pumped by a separate fine-vacuum pumping station through two fore-vacuum connections with a suction line distributor at the bottom side of the vacuum chamber, see Chapter 3.6 Vacuum system, 🗎 97.
- The sluice valve (4) separates the load lock module from the transfer module, see Chapter 3.6 Vacuum system, 🗎 97
- Flange which separates the load lock module from the buffer module. The flange is water-cooled to protect the sealings.
- Connection with an anti-turbulence device on the top of the module for venting the chamber.
  There is an air preheater mounted on top of the load lock module L9.

Transport

- The carriers are transported by the carrier transport system in the vacuum chambers and by the carrier back transport at the back of the vacuum chambers, see Chapter 3.4 Transport system, 🗎 85.
- The substrate loading module is installed at the back of the load lock module L1, see Chapter 3.3.3 Loading / unloading module → Option removed, 🗎 78
- The substrate unloading module is installed at the back of the load lock module L9, see Chapter 3.3.3 Loading / unloading module → Option removed, 🗎 78.
- A view port (2) with mirror observation system is mounted to the top of the chamber and a halogen lamp is mounted inside the vacuum chamber.

Heating and Cooling

- Load lock module L1: Heating with radiation shield.
  The heaters are mounted to the inner side of the service door (front heater) and to the inner rear side of the vacuum chamber (rear side heater), see Chapter 3.5.4 Heating system, 🗎 94.
- Load lock module L9: Water-cooled plates of copper.
  The cooling plates are mounted to the inner side of the service doors and to the inner rear side of the vacuum chambers. They dissipate radiation and convection heat from the substrates and from the carriers.

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3.3.3 Loading / unloading module → Option removed

At the loading module on the back of the load lock module L1, the carriers in the carrier back transport are loaded with uncoated substrates. At the unloading module on the back of the load lock module L9, the coated substrates are unloaded from the carriers.

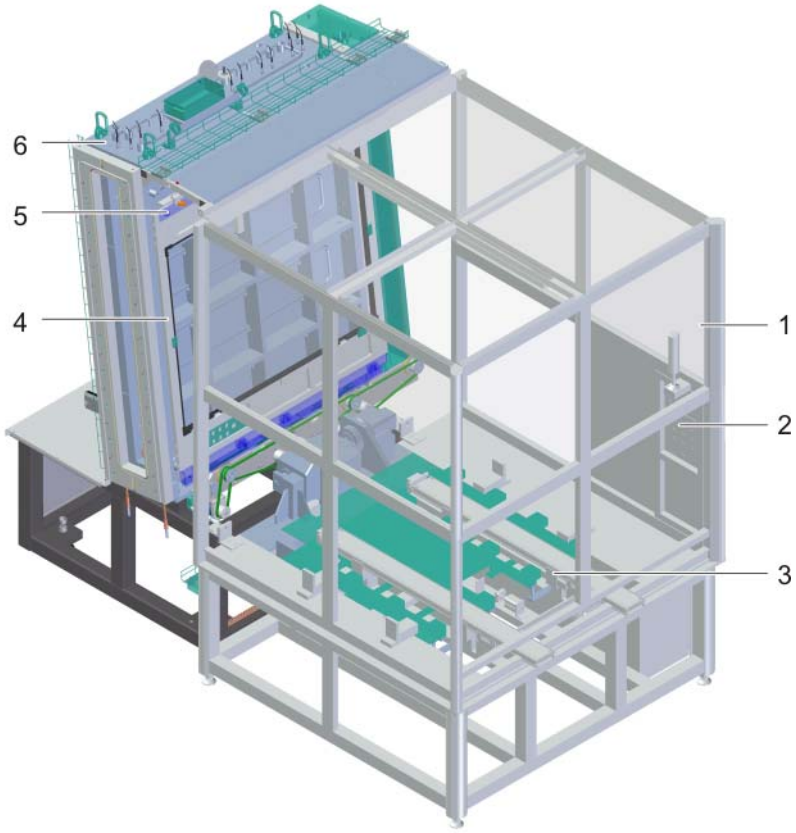

Fig. 3-6 *Loading MODULE (load lock module L1)*

1 Housing
2 Control panel
3 load/unload robot
4 Carrier
5 Carrier lock
6 Load lock module L1

Loading
With the surface to be coated upside, the substrate is horizontally moved into the handler module. The empty carrier (4) is stopped and unlocked (5) in the loading position of the carrier back transport. The robot (3) picks up the substrate with vacuum grippers from the bottom, swings it into vertical position (-7°) and places it on the carrier. The carrier is locked and then the carrier is transported to the transfer module T1.

Unloading
The carrier with the coated substrate is stopped in the unloading position. The unloading process is analog to the loading process. After unloading, the carrier back transport transports the empty carrier to the loading module.

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3.3.4 Buffer modules B1, B2 and B8, B9

The functions of the buffer modules are as follows:

- Buffer module B1: Pumping down to high-vacuum and further heating of the substrate to process temperature.
- Buffer module B2: Docking the carrier to the continued carrier chain and heating the substrate.
- Buffer module B8: Uncoupling the carrier from the continued carrier chain.
- Buffer module B9: Last chamber under high vacuum, cooling the substrate.

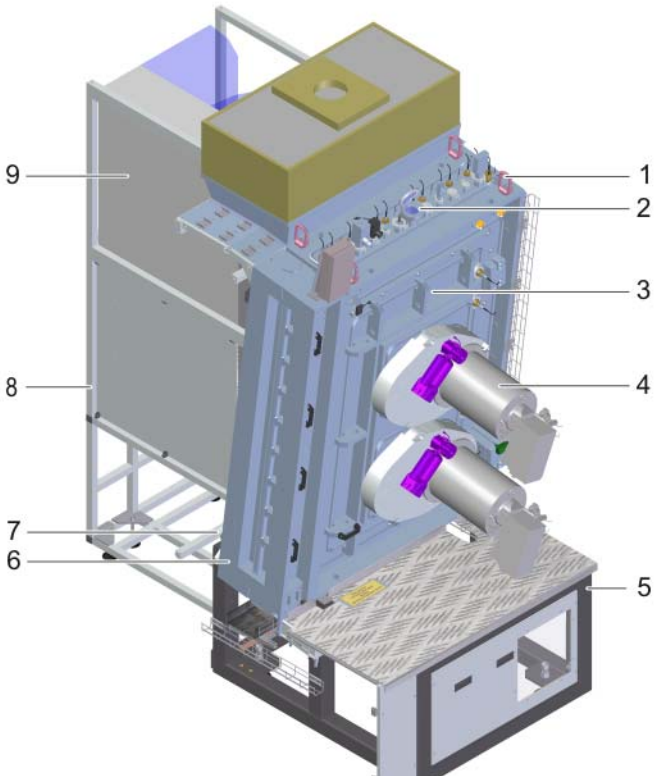

Fig. 3-7 *Buffer module B1*

1 Vacuum chamber
2 View port
3 Service door
4 Turbo pump
5 Frame
6 Sluice valve
7 Carrier back transport
8 Media frame
9 Module distribution cabinet

The buffer modules are equipped with the following components:

Design

- The vacuum chamber (1) is made of stainless steel with welded external water channels for chamber cooling, see Chapter 3.7.1 Water preparation system TPW 330, 101.
- Screwed horizontally pivoted service door (3) to the front of the vacuum chamber for easy access during maintenance.

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- The frame (5) supports the vacuum chamber and all the media distributions. Screwed coverings secure the components in the frame against unauthorized access.
- The media frame (8) at the back of the module supports the media distribution, see Chapter 3.7 Cooling water system, 101. The media frame is walkable and offers an easy access to the carrier back transport (7).

Vacuum

- Buffer module B1: Two cryo pumps (4) to pumped down to high-vacuum. The released gases are pumped down with the scroll pump SC30D during regenerating.
- Buffer module B2: One turbo pump is mounted to the service door.
- Buffer module B8 and B9: Two turbo pumps are mounted to the service door
- Connection on the top of the module for venting the module, see Chapter 3.8 Compressed air supply, 104.
- The sluice valve (6) separates the buffer module from the adjacent module, see Chapter 3.6 Vacuum system, 97
- Flanges at the chamber ends at which the sluice valves are mounted. The flanges are water-cooled to protect the sealings.

Transport

- The carriers are transported by the carrier transport system in the vacuum chambers and by the carrier back transport (7) at the back of the vacuum chambers, see Chapter 3.4 Transport system, 85.
- View port (2) with mirror observation system is mounted to the top of the chamber and a halogen lamp is mounted inside the vacuum chamber.

Heating and cooling

- Buffer modules B1 and B2: Heating with radiation shield.
  The heaters are mounted to the inner side of the service door (front heater) and to the inner rear side of the vacuum chamber (rear side heater). The heaters are heat the substrates before coating, see Chapter 3.5.4 Heating system, 94.
- Buffer module B9: Water-cooled plates of copper.
  The cooling plates are mounted to the inner side of the service doors and to the inner rear side of the vacuum chambers. They dissipate radiation and convection heat from the substrates and from the carriers.

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3.3.5 Process module P1

The process module P1 is used to clean the substrate surfaces.

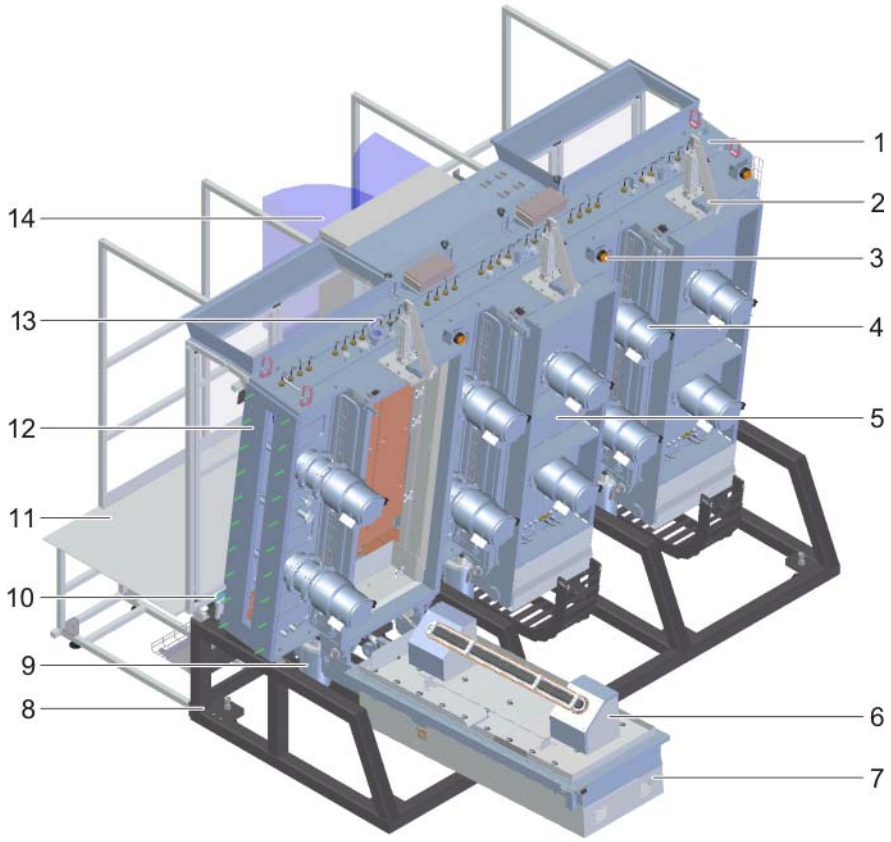

Fig. 3-8 *Process module P1*

1 Vacuum chamber
2 Lock of the service door
3 Door signal lamp
4 Turbo pump
5 Gas separation door (closed)
6 Ion source
7 Process door (opened)
8 Frame
9 Process door drive
10 Carrier back transport
11 Media frame
12 Flange
13 View port
14 Module terminal box

The process module is equipped with the following components:

Design

- The vacuum chamber (1) is made of stainless steel with welded external water channels for chamber cooling, see Chapter 3.7.1 Water preparation system TPW 330, 🗎 101.
- Three process doors (6) are mounted at the front of the vacuum chamber. They can be opened and closed with the process door drive (folding up and down) (9) for easy access during maintenance.
- The frame (8) supports the vacuum chamber and all the media distributions.
- The media frame (11) at the back of the module supports the media distribution, see Chapter 3.7 Cooling water system, 🗎 101. The media frame is walkable and offers an easy access to the carrier back transport (10).

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Vacuum

- 6 turbo pumps (4) are mounted in pairs between the process doors and 4 more are mounted in pairs at the two doors of the gas separation, see Chapter 3.6 Vacuum system, 97.
- Flanges (12) connect the process module to the adjacent modules, see Chapter 3.6 Vacuum system, 97. The chamber flanges are water-cooled.

Transport

- The carriers are transported by the carrier transport system in the vacuum chambers and by the carrier back transport at the back of the vacuum chambers, see Chapter 3.4 Transport system, 85.

Process

- The first process door is equipped wit an ion source (7), see Chapter 3.5.1 Ion source, 91. The supply equipment of the ion source on the outside of the process door is protected with covers against unauthorized access.
- Two view ports (13) with mirror observation system are mounted to the top of the chamber.

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3.3.6 Process module P2

The process module P2 is used to coat the substrates with AZO.

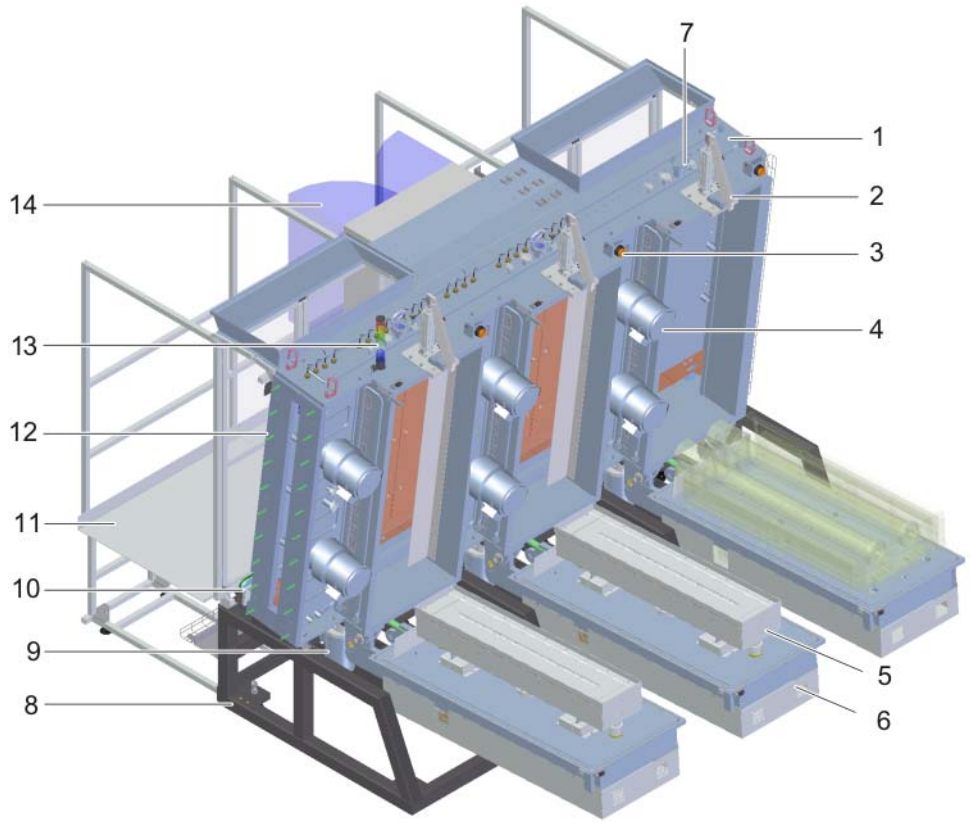

Fig. 3-9 *Process module P2*

1 Vacuum chamber
2 Lock of the service door
3 Door signal lamp
4 Turbo pump
5 Magnetron
6 Process door (opened)
7 View port
8 Frame
9 Process door drive
10 Carrier back transport
11 Media frame
12 Flange
13 Signal lamp
14 Module terminal box

The process module is equipped with the following components:

Design

- The vacuum chamber (1) is made of stainless steel with welded external water channels for chamber cooling, see Chapter 3.7.1 Water preparation system TPW 330, 101.
- Three process doors (6) are mounted at the front of the vacuum chamber. They can be opened and closed with the process door drive (folding up and down) (9) for easy access during maintenance.
- The frame (8) supports the vacuum chamber and all the media distributions.
- The media frame (11) at the back of the module supports the media distribution, see Chapter 3.7 Cooling water system, 101. The media frame is walkable and offers an easy access to the carrier back transport (10).

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Vacuum

- 6 turbo pumps (4) are mounted in pairs between the process doors, see Chapter 3.6 Vacuum system, 🗎 97.
- Flanges (12) connect the process module to the adjacent modules, see Chapter 3.6 Vacuum system, 🗎 97. The chamber flanges are water-cooled.

Transport

- The carriers are transported by the carrier transport system in the vacuum chambers and by the carrier back transport at the back of the vacuum chambers, see Chapter 3.4 Transport system, 🗎 85.

Process

- The first process door and the second process door are equipped with one planar magnetron (5), see Chapter 3.5.2 Planar magnetron, 🗎 92. The supply equipment of the magnetrons on the outside of the process door is protected with covers against unauthorized access.
- The third process door is prepared for installation of two rotary magnetron, see Chapter 3.5.3 Rotary magnetron, 🗎 93.
- Two view ports (7) with mirror observation system are mounted to the top of the chamber.

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3.4 Transport system

The transport system moves carriers through the vacuum chambers and transports the carriers at the back of the vacuum chambers to the loading / unloading station.

Optical sensors (photoelectric barriers in the vacuum- and process transport, reflex light scanner in the back transport) sample the position of the substrate carriers in the chambers and forward the position to the system control (PLC). This allows monitoring and controlling of the current positions of the substrate carriers in the system.

The transport system is composed of the following components:

- Carrier, see Chapter 3.4.1, 🗎 86
- Carrier depot, see Chapter 3.4.2, 🗎 87
- Process transport system, see Chapter 3.4.3, 🗎 88
- Carrier back transport, see Chapter 3.4.4, 🗎 90
- Transfer modules T1 and T9, see Chapter 3.3.1, 🗎 75

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3.4.1 Carrier

The carrier is made of aluminium alloy with an inserted stainless steel frame. Teflon pins avoid direct contact of the stainless steel frame to the substrate, thus protecting the glass from thermal stress and breaking. The substrate has an uncoated edge area of about 5 mm.
In addition, the carrier has a substrate holder device to prevent a substrate deformation during the coating.

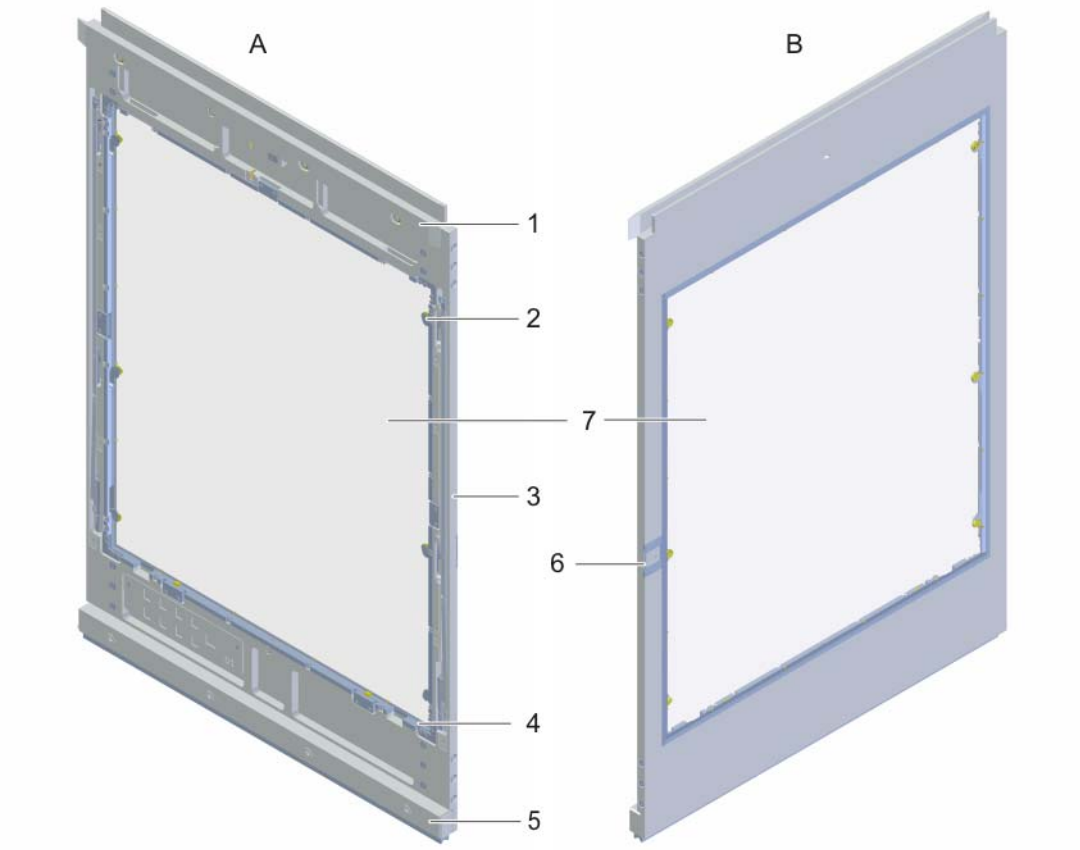

Fig. 3-10 *Carrier*

A Loading / unloading side:

1 Upper guide rail
2 Substrate holder (6 pcs.)
3 Carrier frame
4 Substrate frame

B Coating side:

5 Lower guide rail
6 Notch for test glasses
7 Substrates

The carriers are put on a wheel line. The lower guide rail (5) is thermal and isolated electrically in the carrier coupled. This way, the mechanical stress caused by the temperature gradient is minimized and the carrier can be used up to a temperature of 210°C. The upper guiding rail (1) is hung up on the upper guide rollers of the transport system.

The carrier frames (3) are equipped with notches for test glass (6) at the coating side. With the test glass the quality and stability of the process can be monitored, especially during start-up of the system after target exchange, see Chapter 6.7.5 Changing test glasses, 🗎 160.

The A1500V-7 can be loaded with a maximum of 15 carriers. They are loaded or removed over the carrier depot, see Chapter 3.4.2 Carrier depot, 🗎 87.

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3.4.2 Carrier depot

The carrier depot is used to exchange the carriers in the transport system without interrupting the production.

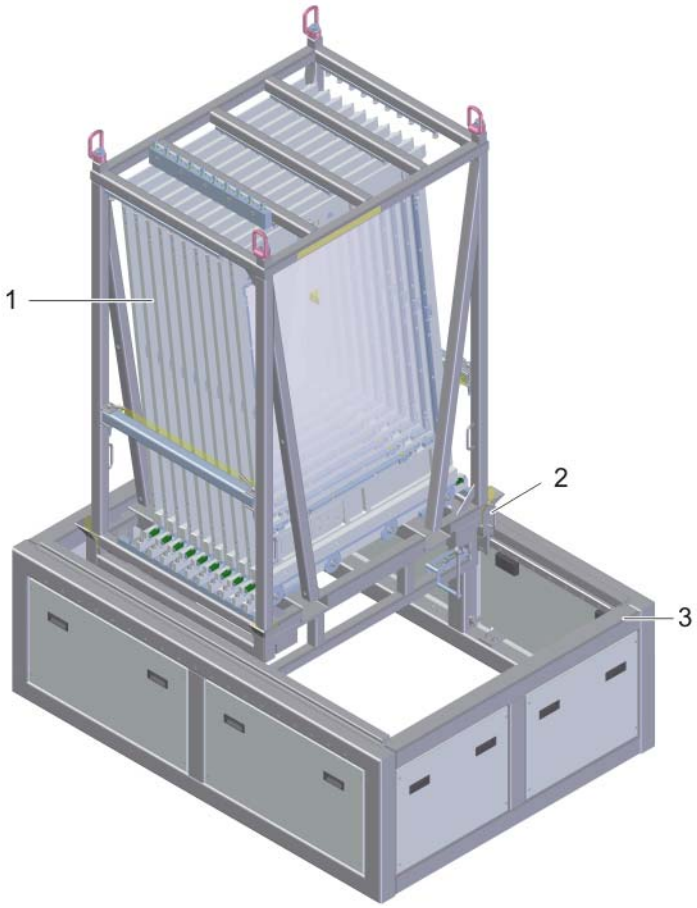

Fig. 3-11 *Carrier depot*

1 Carrier magazine
2 Support
3 Frame

The carrier depot is equipped with a carrier magazine (1) that can store up to 10 carriers. The carrier magazine is placed on a support (2) that can be moved perpendicular to the process transport direction and can be removed from there with a lifting device (crane, forklift).

For more information about the carrier loading and unloading procedures refer to Chapter 6.7 Loading and unloading the system manually, 151.

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3.4.3 Process transport system

The process transport system moves the carrier through the vacuum chambers actuated by servo motors. The speed of the carrier can be set in the visualization software.

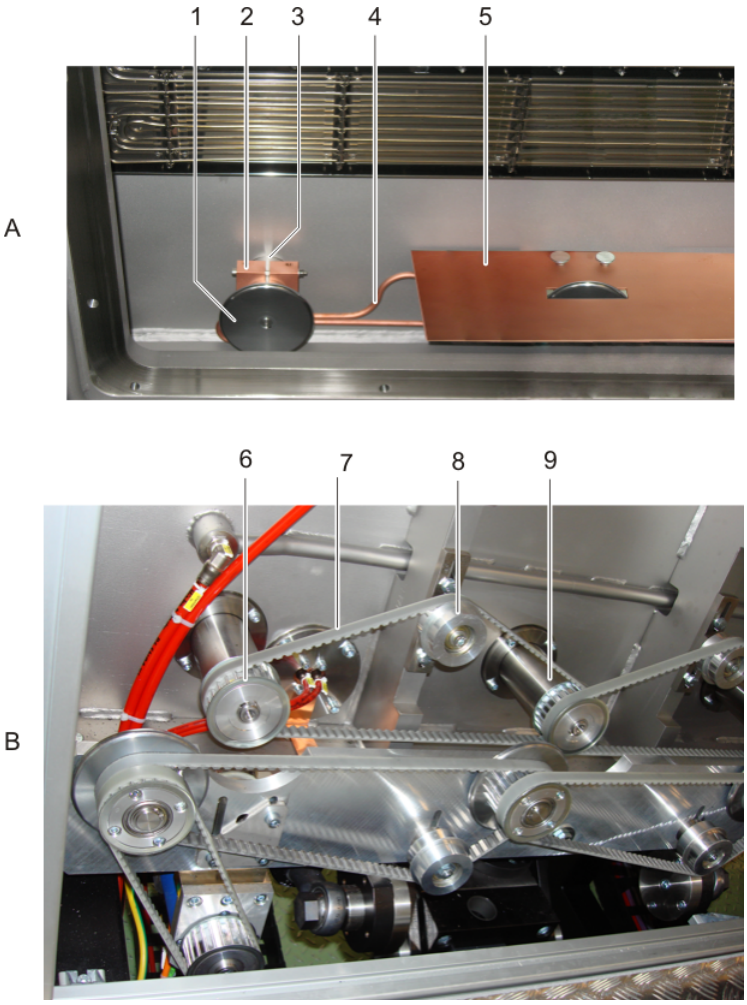

Fig. 3-12 *Process transport system*

A Vacuum side (inside the chamber):

1 Roller
2 Cooling jacket
3 Rotary feed-through
4 Cooling water pipe
5 Sputter shield

B Atmosphere side (chamber back-side):

6 Toothed wheel
7 Toothed belt
8 Tension roller
9 Rotary feedthrough

Transport rollers (1) are mounted inside the vacuum chamber. Via the rotary feedthroughs (3, 9), the transport rollers are coupled with toothed wheels (6) on rear side of the chamber. The toothed wheels are activated by servo motors.
With the lower guide rail on the transport rollers the carrier is moved through the vacuum chambers.

Each rotary feedthrough is indirectly cooled by a cooling jacket (2) that is connected to a cooling water pipe (4).
Exchangeable sputter shields (5) protect the drive system in the process chambers from being coated.

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Formation of the CSF (Continuous Substrate Flow)
The A1500V-7 is designed for the continuous operation of the sputter sources. For an effective utilization of the target material and to minimize the unwanted coating of the chamber walls, the carriers move through the process chambers next to each other in distance 10 … 15 mm.

The buffer module B2 is equipped with a special drive to dock the carrier at the CSF.
As soon as the sensor B2SO03 recognizes the end of the CSF, the next carrier is transported from the buffer module B1 into the buffer module B2. The transport speed is much higher than the CSF speed, which is defined by the rotation speed of the transport rollers in the process modules. When the sensor B2SO02 recognizes the front end of the carrier coming from B1, the transport speed in B2 is gradually slowed down to CSF speed in order to smoothly dock the carrier at the end of the CSF. The continuously changing position of the end of the CSF during this process is monitored and pre-estimated by the system control.

Dissolution of the CSF
The dissolution of the CSF is opposite to the formation. In the buffer module B8 the carrier to be undocked is accelerated above CSF speed and moved away from the CSF. Finally, the carrier is stopped in front of the gate valve B8VS01.

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3.4.4 Carrier back transport

The carrier back transport moves the carrier at the back of the vacuum chambers to the loading / unloading station actuated by servo motors.

In the carrier back transport the coated area of the substrates is facing towards the chamber rear sides. This way there is mechanical contact only to the uncoated area of the substrates during substrate loading and unloading.

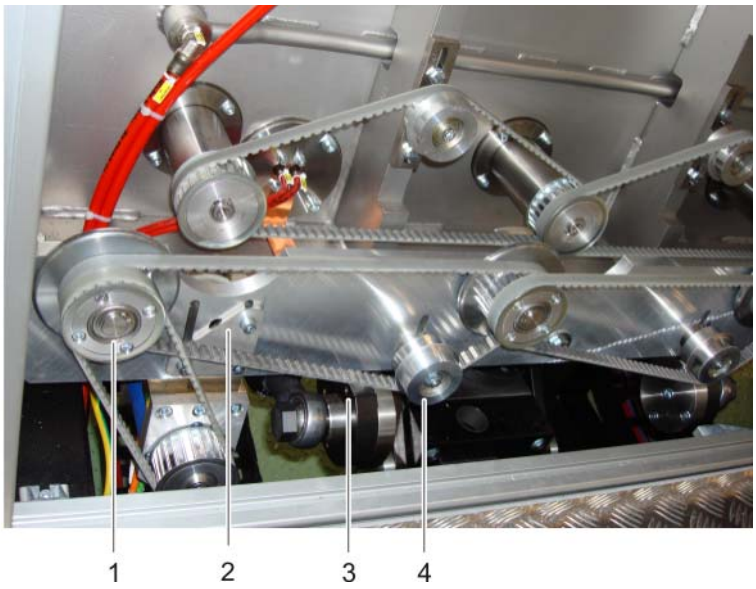

Fig. 3-13 *Carrier back transport (example: buffer module B9, without protection covering)*

1 Transport roller with toothed wheel
2 Mounting for driving motor
3 Toothed belt
4 Tension roller

Transport rollers (1) are installed at the back of the vacuum chambers. One transport roller and one toothed wheel are mounted to one driving shaft. The toothed wheels are coupled with toothed belts (3) which are activated by a motor (4). The carriers are moved on the rotary transport wheels. The upper guide rail of the carrier is held by guiding rollers in the guide rail of the chambers. Optical sensors at the guide rail monitor the positions of the carriers.

The carrier back transport moves the carrier to the unloading module at the back of the load lock module L9. At the unloading station the carrier is stopped and the coated substrate is unloaded. Then the empty carrier is transported to the loading module and loaded with a new substrate. Then the carrier is transported in the transfer module T1.

Except the loading / unloading modules, the carrier back transport is covered with transparent coverings and is accessible about slide doors.

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3.5 Process equipment

3.5.1 Ion source

The ion source is mounted on the first process door in the process module P1. It is used for surface cleaning and etching by DC sputtering in an argon plasma.

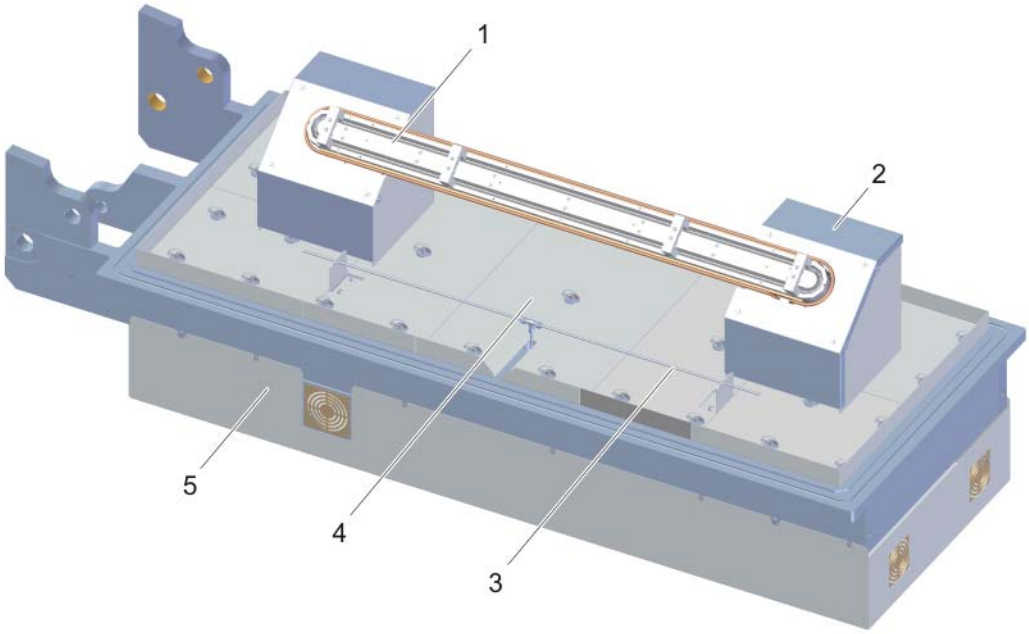

Fig. 3-14 *Ion source*

1 Etcher
2 Etching seat
3 Gas shower
4 Protection shields
5 Covering

- cleaning: used to clean the substrate prior to coating
- etching: used to improve the layer properties

In each case the ion source is power regulated.

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3.5.2 Planar magnetron

The planar magnetron is a flat cathode with a plate-shaped target.

Fig. 3-15 *Planar magnetron*

1 Anode
2 Target
3 Protecting covers of the media supply
4 Matchbox
5 Gas supply
6 Process door

Magnetron
The magnetron is operated with DC voltage.

To homogenize the plasma in front of the cathode and to increase the power density, the cathode is equipped with a permanent magnet set, located at the rear side of the target backing plates (2).

The targets are mounted onto a copper backing plate which is cooled during the operation with water and leads off the target's heat.

Target
The target consists of several segments made by pressing, sintering and refining. Ledges on the edge and in the middle of the cathode provide for the contact between the target segments and the water-cooled copper backing plate.

Installation
Each one planar magnetrons can be installed on the first process door and the second process door of process module P2. The matchboxes (4) and the media supply connections (electricity, cooling water, process gases) are mounted on the outsides of the process doors. Protecting covers (3) prevent direct access to the media connections, see Chapter 3.11.2 Power supplies of the sources, 112.

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3.5.3 Rotary magnetron

The rotary magnetron is a cathode with a cylinder-shaped target.

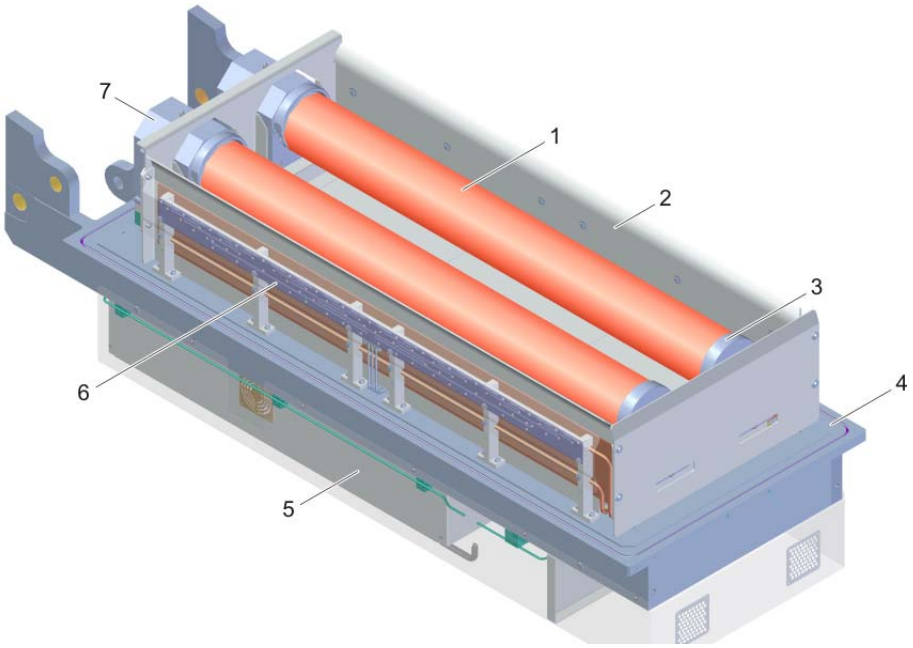

Fig. 3-16 *Installed rotary magnetron*

1 Cathode with target
2 Sputter shield (anode)
3 Floating bearing
4 Process door
5 Protecting covers of the media supply
6 Gas supply
7 End block with drive unit

The magnetron is operated with DC voltage.

The cathode is installed between the end block (7) and the floating bearing (3). During the coating process the cathode rotates around the longitudinal axis which results in an optimal utilization of the target. The rotating speed is factory fixed (8.61 min^{-1}).

To homogenize the plasma between the cathode and the substrate and to increase the power density, the cathode is equipped with an adjustable magnet bar.

Cooling water flows through the interior of the cathode and leads off the target's heat.

Installation
Two rotary magnetrons can be installed at the 3rd process door of the process module P2. The two rotary magnetrons on a process door can axially rotate in both directions. The drive motors and the media supply connections (electricity, cooling water, process gases) are mounted to the outsides of the process doors. Protecting covers prevent direct access to the media connections.

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3.5.4 Heating system

Heating systems are installed in the modules L1, B1, B2, P1 and P2. The heating systems are used to heat the substrates up to a certain temperature for optimal layer properties.

Every heating system is sectioned into an inner and outer heating zone. The heating zones are regulated separately to adjust the temperature profile on the entire substrate surface.

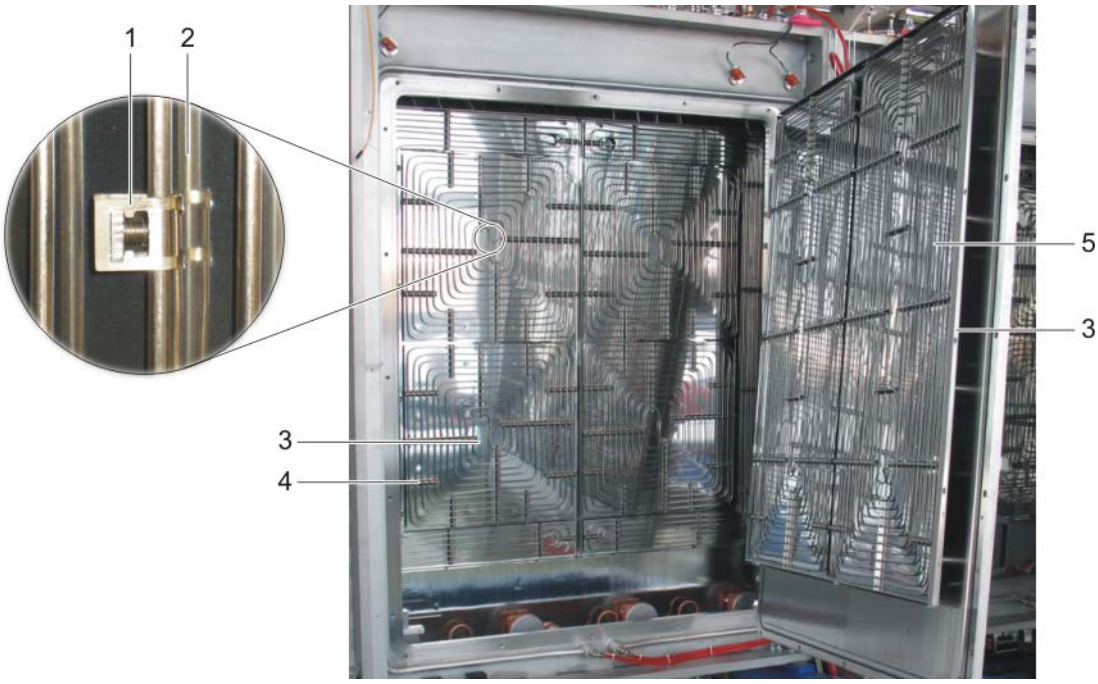

Fig. 3-17 *Heating system of the A1500V-7 (example)*

1 Thermocouple
2 Thermoelement
3 Radiation shield
4 Rear-side heater
5 Front-side heater

Preheat
In the modules L1, B1 and B2 the substrates are preheated. In this modules the heating system (4, 5) with radiation shield (3) are mounted to the inner side of the service door (front heater) and to the inner rear side of the vacuum chamber (rear side heater).

The substrate temperature depends on the temperature of the heating system and on the carrier transport speed.

	See circuit diagram on CD 1 for more detailed information about the wiring of the heating system.

Heating during the coating
In the process modules P1 and P2 the heating system are mounted to the inner side of the gas separations (front heater) and to the inner rear side of the vacuum chamber (rear side heater).

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Temperature measurement
The temperature of a heating zone is measured with a thermoelement (2) directly clipped to the heating pipes.

The substrate temperature is measured with infrared radiation pyrometers (IR-pyrometers). The IR-pyrometer is mounted on CaF2 windows at the outside of the vacuum chamber. The CaF_2 window is transparent to the infrared spectrum, which corresponds to the adjustable process temperatures.

At the following position flanges are for IR-pyrometers:

- always 3 pieces next to the inlet of the process modules P1 and P2 (rear side)
- always 3 pieces next to the outlet of the process modules P1 and P2 (rear side)
- always 3 pieces center of the turbo pumps mounted in pairs of the process modules P1 and P2 (front side)
- always 3 pieces next to the outlet of the process modules P1 and P2 (front side)

In the scope of delivery of the A1500V-7 2 pyrometer that measuring heads are in the center flange inlet side of the process module P1 and in the center flange outlet side of the process module P2 is included.

	For more detailed information on the IR-pyrometer refer to the supplier's documentation on CD 1.

3.5.5 Residual gas analyzer

The residual gas analyzer HPQ2S is for the residual gas monitoring. The HPQ2S is a quadrupole mass spectrometer which detect masses between 2 and 80 amu. The HPQ2S can be used by pressure of maximum 10^{-2} mbar and separated from the recipient with a shut-off valve.

The residual gas analyzer can be installed optional at the top of the process modules.

	For more detailed information on the RGA refer to the supplier's documentation on CD 1.

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3.5.6 Sheet resistance measurement

In the scope of delivery of the A1500V-7 a device for measuring the layer resistance of coated substrates is included. The measurement is based on the four point method. This four metal spikes of defined size and fixed distance pressed with a specific power to the substrate and measured at constant power the voltage drop between them.

The measuring device exists of a cylindrical probe, a fixture with pneumatic cylinder to the sinking of the sensor head on the substrate and an display unit. On every substrate three measurements are carried out in different positions. The data are transferred on to the control system and can be displayed with the help of the visualization programme on the operating terminal.

For more detailed information on the sheet resistance measurement system refer to the supplier's documentation section of the technical handbook on CD 1.

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3.6 Vacuum system

The coating process requires high-vacuum see Chapter 3.1 Process fundamentals, 65. The tasks of the vacuum system:

- Evacuate the vacuum chambers until the process pressure is reached. The evacuation time depends on the chamber volume and the condition of the chamber (clean and dry system).
- Monitor and maintain the vacuum during the coating phase.

Mechanical fore pumps are used to generate the fore-vacuum in all chambers. In addition, these pumps serve as fore pumps for the turbo pumps.

The creation of the vacuum is based on predefined pressure trigger values and is controlled completely by the control software. For safety purposes, all functions are interlocked by limit switches, flow monitors and temperature trigger values. When the pressure increases in an uncontrolled manner, a programmed sequence safely shuts the vacuum pumps down.

	See media on CD 1 for more detailed information about the system's vacuum system.

3.6.1 Vacuum valves

Sluice valve
There are valves at the inlets and outlets of the load lock chambers and buffer chambers, which are opened for carrier transfer only.

Gate valve
The gate valves separate cryo pumps from the buffer chamber B1.

Fore-vacuum and venting valves
Various pneumatically actuated valves are located in the fore-vacuum lines and on the chambers.

All valves are controlled by the system software and subjected to software interlocks depending on the system status, see Chapter 2.5 Software interlocks, 46.

	For more detailed information on the valves refer to the supplier's documentation on CD 1.

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3.6.2 Roughing station

The roughing stations are used to create the fore-vacuum in the vacuum chambers and for the high-vacuum pumps. There are 2 load lock pump stations and one process pump station.

- The lod lock pump stations consist of a:
  - Screw pump SP 630 F
  - Roots pump WSU 2001H
  - Auxiliary pump SV40 for gear chamber evacuation of the WSU 2001H

- The process pump station consists of a:
  - Screw pump SP 630 F
  - Roots pump WSU 2001

For more detailed information on the fore pumps refer to the supplier's documentation on CD 1.

3.6.3 Turbo pumps

Turbo pumps are used to evacuate the vacuum chambers B2 … B9 from fine-vacuum level to high-vacuum level. Two types of turbo pumps are used:

- HiPace S-2300: Evacuate the buffer modules B2 and B8, B9

- HiPace S-1200: Evacuate the process modules P1 and P2

For more detailed information on the turbo pumps refer to the supplier's documentation on CD 1.

3.6.4 Cryo pump

Two cryo pumps are used to evacuate the vacuum chamber B1 from fine-vacuum level to high-vacuum level.

The Cryo pump removes gases and vapors from the vacuum chamber by means of condensation and adsorption on very cold surfaces. The gases are not transferred through the cryo pump during the pump process, but instead remain in the pump chamber.

The cryo pump consists of a cold head and a vacuum vessel. An 80K condensing array, a 15K array, cold head station heaters, and an 80K radiation shield are located in the vacuum vessel. The cold station heaters and 15K array are secured to the cold head, which is welded to the vacuum vessel. The cold head provides cooling to the three arrays. Gases are removed from your vacuum chamber, thereby creating a vacuum when they are condensed or adsorbed on the cryogenically-cooled arrays.

The cryo pump have to be regenerated in regular time intervals. It is warmed up to room temperature by closed gate valve and the released gases are pumped off with the oil-free scrollpump SC30D.

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3.6.5 Cold traps

The buffer chamber B2 and process chamber P1are equipped with cold traps (Meissner traps).

Basically, the cold trap comprises a cold surface located in the vacuum chamber and connected to an external refrigeration unit. The system is a closed loop.

The cold trap is a special type of pump. Its pumping effect is based on the principle of condensation of water on a cold surface. The cold trap pumps the residual water vapor quickly and constantly out of the chamber. The cold surface is kept as low as possible (-70 °C… -140 °C) so that the water vapor from the air condenses as ice on the surface. The condensate (ice) that adheres to the cold surface relieves the entire pumping system during the evacuation and coating phase.

The cleaning power of the cold trap is reduced in proportion to the thickness of condensate (ice) on the cold surface. Therefore, the cold trap has to be heated up and blown out (regenerated) at regular intervals.

Polycold cryo-generator
The cold traps are connected directly to the external refrigeration unit Polycold, which is located next to the roughing stations.

The Polycold cryo-generator cools the coolant for the cold surfaces to the required temperature and maintains the coolant circuit in operation.

The cold traps control is process-dependent and is integrated into the process control of the pumping system.

- evacuation and coating phase: The cold surface is cooled to the lowest temperature.
- venting phase of the vacuum chamber: The cold trap is heated and the cold surface defrosted.

During normal operation, the external refrigeration unit is turned on and off with the plant electricity current. However, the main switch of the polycold device must be in the position -ON.

The cold trap can be automatically or manually controlled, depending on the type of operation selected on the operating panel.

	For more detailed information on the turbo pumps refer to the supplier's documentation on CD 1.

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3.6.6 Vacuum gauges

The following vacuum gauges are used in the vacuum system of the A1500V-7:

- Baratron (MC):
  To measure the process gas pressure (10^{-4} … 10^{-1} mbar).
- Wide Range Vacuum Measuring System (MK):
  For pressure measurement from the high-vacuum range up to atmospheric pressure (10^{-10} … 10^{3} mbar).
- Pirani transmitter (MT):
  For pressure measurement from the fore-vacuum range up to atmospheric pressure (10^{-3} … 10^{3} mbar).
- Pressure switches:
  For measurements of the pressure in the vacuum chamber by venting.

Fig. 3-18 *Vacuum gauges*

1 Baratron
2 Pirani transmitter
3 Wide Range Vacuum Measuring System
4 Pressure switch

The vacuum transmitters are connected via Profibus to the PLC. The gauge heads are installed at the top side of the individual chambers.

The pirani transmitter, Wide Range Vacuum Measuring System and pressure switches serves the vacuum control. On the basis of the measurement the vacuum pump control and the valve control are released. The baratrons serve for the pressure reading only.

	For more detailed information on the vacuum gauges refer to the supplier's documentation on CD 1.

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3.7 Cooling water system

3.7.1 Water preparation system TPW 330

NOTE!
The cooling water provided from the customer's water source must comply with the technical specifications for the system, see Chapter 1.4.2.5 Water supply, 24.

The A1500V-7 is equipped with a water preparation system with open circulation cooling. The water preparation system pipes the cooling water through a heat exchanger to the individual module manifolds. For recooling the heat exchanger is connected to the water supply on customer's side. A water tank with a maximum capacity of 1000 l is used to supply the modules with cooling water, even during consumption peaks. Furthermore, the water tank absorbs the water which has been blown out from the cooling water circuits.

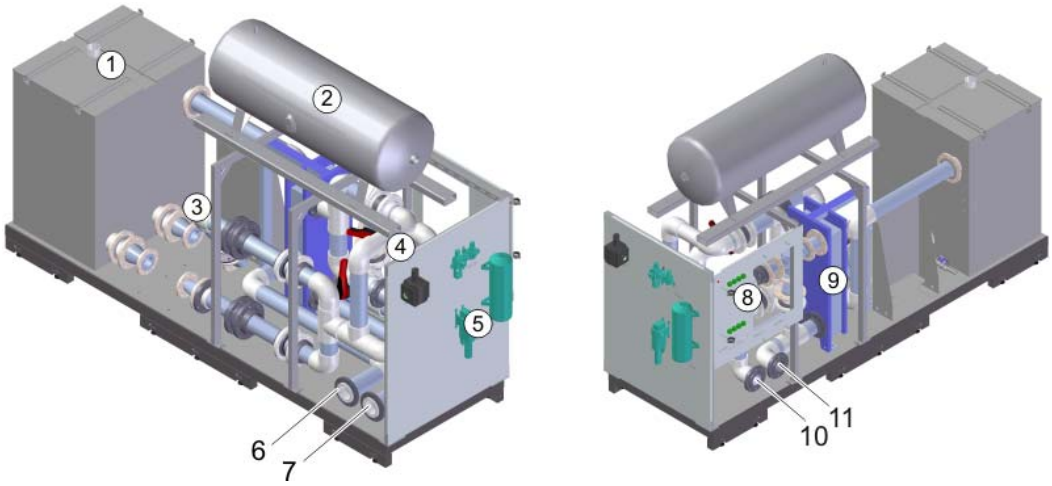

Fig. 3-19 *Water preparation system TPW 300 of the A1500V-7*

1 Water tank
2 Compressed air tank
3 Centrifugal pump
4 Filter
5 Compressed air supply
6 Cooling water outlet
7 Cooling water inlet
8 Gas supply
9 Plate heat exchanger
10 Cooling water outlet, customer's side
11 Cooling water inlet, customer's side

For more detailed information on the water preparation system refer to the supplier's documentation on CD 1.

The following components require cold water during the entire system operation:

- Screw pump
- Turbo pumps
- Chamber walls and doors
- Flanges between the chambers
- Cooling plates for the substrate cooling in the buffer modules B9 and L9

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- Transport rollers in the chambers
- Magnetrons and the environment
- Ion source
- Sputtering power supplies
- Air/water heat exchanger of the electrical cabinets CCMC, CCMD and CCSC
- Cryo compressor
- Polycold

On the framework of the water preparation system further components of the media supply are installed:

- Compressed air supply, see Chapter 3.8 Compressed air supply, 🗎 104
- Gas supply, see Chapter 3.9 Gas supply, 🗎 106

3.7.2 Water manifold

Each module is equipped with a water manifold that distributes the cooling water to the required places. The water manifolds are located in the media frame. To access the water manifolds, the protection covers of the media frames have to be removed.

Fig. 3-20 *Example of a water manifold of a module*

1 Throttle
2 Flow meter = switch
3 Manual shut-off valve in the water circuit inlet
4 Manual shut-off valve in the main supply outlet
5 Outlet of the blow-out circuit with manual shut-off valve (only used in special cases)
6 Inlet of the blow-out circuit with manual shut-off valve
7 Manual shut-off valve in the main supply inlet

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3.7.3 Bleeder valve

At the top side of the vacuum chambers and at the water manifolds for the cathodes, bleeder valves are installed.

The water circuits will be bleeded by loosening the screw cap (red). The bleeder valve closes automatically once the water circuit is bleeded completely.

Fig. 3-21 *Bleeder valve*

A vertical installation
B horizontal installation
C Bleeder valve cathode circuit

3.7.4 Blowing out the circuit

The water circuits are blown out with compressed air. The blow out process clears the remaining water from the components installed in the water circuits. The water circuits must be blown out before:

- Replacing a target
- Performing assembly works (mounting and dismounting) on water-cooled components, e.g. magnetrons
- The system is being shut down for a longer period

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3.8 Compressed air supply

Applications that use compressed air:

- Pneumatic control (of the valves) and blowing out the cooling water circuits, see Chapter 3.8.1, 🗎 104
- Venting the vacuum chambers, see Chapter 3.8.2, 🗎 105

3.8.1 Compressed air for the pneumatic control and to blow-out the cooling water circuits

The compressed air supply for the pneumatic control of the valves and to blow-out the cooling water circuits is effected by a compressed air maintenance unit. The compressed air maintenance unit is located on the water preparation system.

NOTE!
The compressed air supplied by the customer's network must satisfy the specifications set down in Chapter 1.4.2.3 Compressed air, 🗎 23.

Compressed air maintenance unit
The compressed air maintenance unit prepares the compressed air supplied by the customer's network (water separation, filtering, pressure regulation). After this the compressed air is routed to a reservoir and then forwarded to the valve terminals.

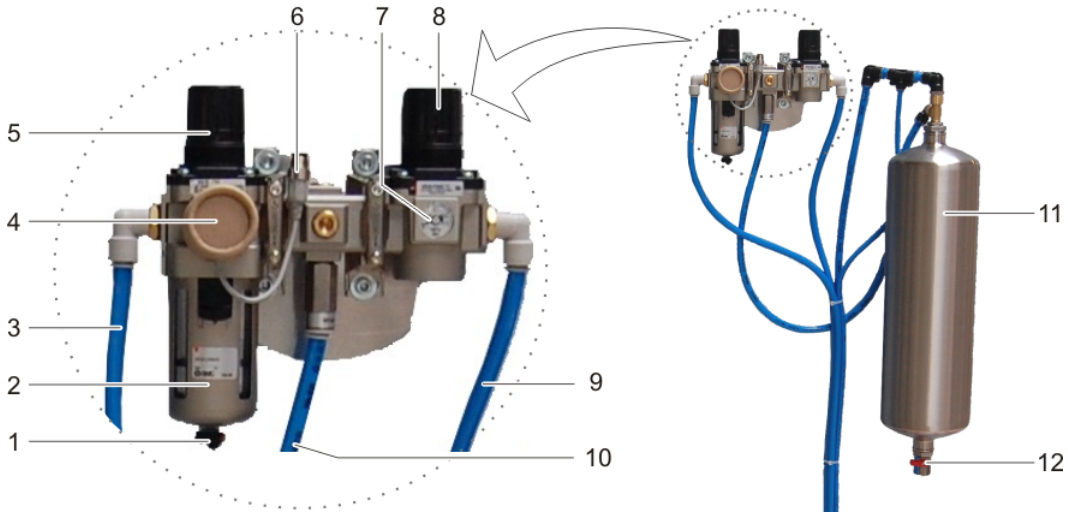

Fig. 3-22 *Compressed air maintenance unit*

1 Condensate drain
2 Condenser
3 Compressed air inlet
4 Operating pressure display
5 Control valve for operating pressure
6 Pressure switch
7 Display for blow out circuit pressure
8 Control valve for blow out circuit pressure
9 To blow out circuit
10 To system
11 Compressed air reservoir
12 Drain valve

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Compressed air reservoir
After the outlet (11) of the compressed air maintenance unit, there is a compressed air reservoir (12) that balances the fluctuations caused by the compressed air usage.

See media on CD 1 for detailed information about the compressed air supply for the pneumatic control and to blow-out the cooling water circuits.

3.8.2 Compressed air to vent the vacuum chambers

The compressed air to vent the vacuum chambers are supplied from house service connection.

The compressed air is routed to pneumatic valves on the top sides of the modules L1 … B2 and B8 … L9. Anti-turbulence devices inside the vacuum chamber L9 provide for a smooth air distribution during venting to protect the substrates against thermal stress.

A compressed air tank with a capacity of 500 l provides the required pressure compensation to lock in and to lock out. With it a short-time of maximum consumption is prevented which can cause a breakdown and/or oversized air consumption net of the customer.

Airstream heater
An electric airstream heater is used to heat up the compressed air (up to 100 °C) for venting the load lock module L9. During venting, the pre-heated air avoids a high temperature gradient that might cause stress in the substrates or cullet.

See media on CD 1 for detailed information about the compressed air supply for venting the vacuum chambers.

NOTE!
The vacuum chambers can be vented also with nitrogen, see Chapter 3.9.2 Nitrogen to vent the vacuum chambers, 106.

- **The change of venting between compressed air and nitrogen is made manually by the 3-way ball valve to the supply line.**

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3.9 Gas supply

3.9.1 Process gas supply

The process gases are supplied from house service connections (gas bottles optional). The interface is the gaspanel which is installed at the frame of the water preparation system. The process gases flow from the connections on the media interface panel via separate supply lines through mass flow controllers and shut-off valves to the gas inlet of the buffer modules and process modules. The gas correction factors can be set in the software.

See media on CD 1 for more detailed information about the system's gas supply and the maximum gas flows through the mass flow controllers.

NOTE!

- **Strictly adhere to the instructions on the safety data sheets for the gases used.**
- **Also adhere to the safety instructions in Chapter 2.7.3 Process gases, 🗎 49 when handling process gases and to the quality requirements for the gases used, see Chapter 1.4.2.2 Process and venting gases, 🗎 23.**

Along with the gases specified for the proper use of the system, other gases may be used as well. However, you must note the following:

NOTE!
Leybold Optics will not be held responsible for the use of non-specified, dangerous gases.

3.9.2 Nitrogen to vent the vacuum chambers

The venting of the vacuum chambers with nitrogen is analog the venting with compressed air, see Chapter 3.8.2 Compressed air to vent the vacuum chambers, 🗎 105.

NOTE!
The vacuum chambers can be vented also with compressed air, see Chapter 3.8.2 Compressed air to vent the vacuum chambers, 🗎 105.

- **The change of venting between compressed air and nitrogen is made manually by the 3-way ball valve to the supply line.**

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3.10 System control

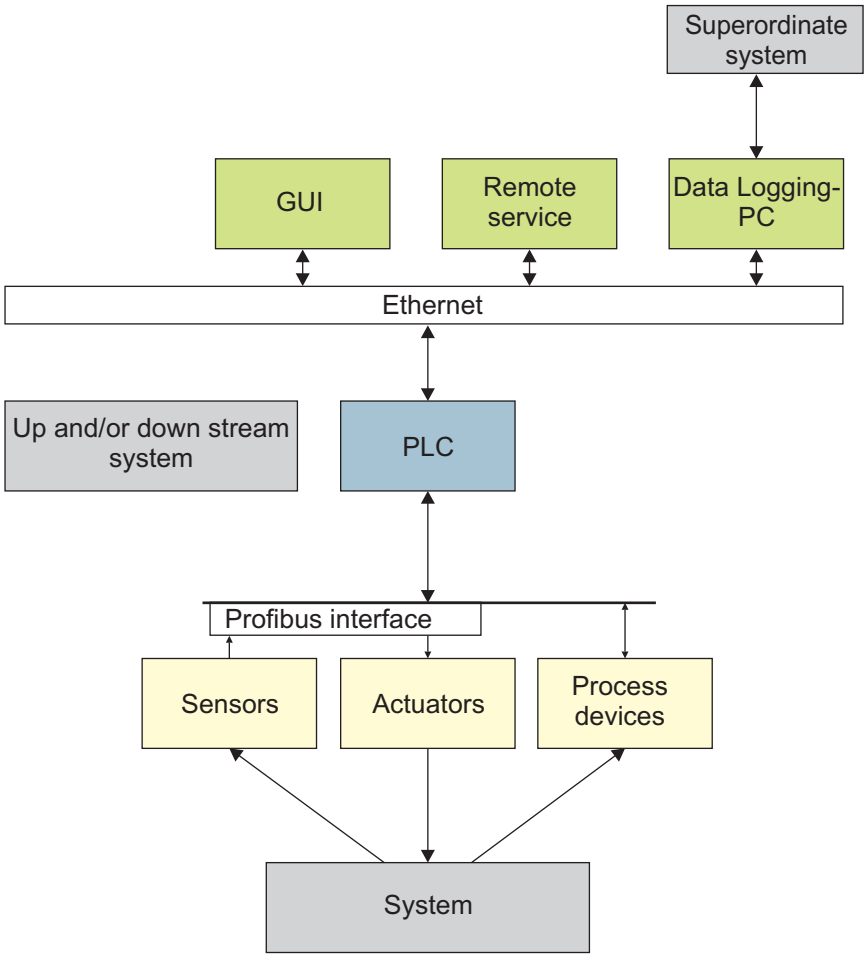

Fig. 3-23 *System control of A1500V-7*

The system control consists of multiple layers:

Graphical User Interface (GUI)
The user operates the system via the GUI. The A1500V-7 (Mo II) is equipped with one GUI located in the operator terminal.

The GUI communicates via Ethernet with the programmable logic control (PLC) which controls and monitors all processes on the system.

The software contains:

- Visualization of system parts and processes on the screen
- Process programming concerning recipes and recipe administration
- Visualization and error messages
- Manual control of system parts
- Control of access authorization

RS232 server and data logger PC
One RS232 server and one data logger PC are connected to the ethernet with following tasks:

- The RS232 server for remote service purposes
- The data logging PC takes on data storage

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Programmable Logic Control (PLC)
The PLC is connected with the system components via fieldbus (profibus). It receives and processes input from sensors, sends signals to actuators and communicates with process devices, such as:

- Vacuum control, e.g., pump down sequences, vent processes, pressure monitoring
- Control of the substrate carrier transport, e.g., carrier return system
- Control of process components, e.g., heaters (temperature control), process gases (flow control), sputtering power supplies (power output control)

Furthermore, a signal exchange with up and down stream systems is possible.

3.10.1 External communication

The external communication is connected to the internal communications network via a dedicated network card, router and/or modem. Depending on the configuration, the communications network has the following options to offer:

- Remote access for maintenance and software updates of the system
- Backups of process data via the local network
- Exchange of process data between different systems
- Archiving of batch logs in the local network
- Archiving of screenshots in the local network

NOTE!
Leybold Optics recommends when connection the system to the local network the installing a firewall between the internal and the external communication network.

➢ **A direct physical connection of the local network with the internal system network is allowed only with explicit approval by Leybold Optics.**

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3.10.2 Virus protection recommendations

There are two ways that viruses can get into the control PC:

- Via a data carrier (diskette, CD-ROM, memory stick etc.)
- Via the local area network

Protecting from viruses on data carriers

NOTE!
It is not permitted to install any software (virus scanners, games, etc.) apart from the pre-installed applications on the control PC, or to copy any data onto its hard disc.

Updates to the user-interface system will be carried out by Leybold Optics GmbH personnel. The data and programs necessary to do that are adequately checked for viruses.

Protecting against viruses from local area network
When connecting the system to the local area network, the operator of the system must ensure that there is adequate protection from viruses. However, it is not permitted to install a commercially available virus scanner on the control PC.

3.10.3 Note for important Windows Settings

The following settings have been set the Windows Operating System and must NOT be changed:

- TimeZone (Zeitzone) = GMT+0
- Automatic Daylight Saving Time (Sommer/Winterzeit-Umstellung) = OFF
- List Separator «,» (Comma) or Regional Settings (Ländereinstellungen) = Englisch (US)

NOTE!
Do not change settings of the operating system from the PC (Control Panel). Changes can cause problems by carry out following plant functions:
- **the data logger**
- **Trend history**
- **Loading/saving files**

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3.11 Electrical system

See circuit diagram on CD 1 for more detailed information about the systems electrical energy supply.

3.11.1 Electrical cabinets and module distribution cabinets

The A1500V-7 comprises the following cabinets, see Fig. 3-24, 110.

- One main switch cabinet (CCMS)
- Three main distribution cabinets (CCMD01, CCMD02, CCMD03)
- One servo controller cabinet (CCSC)
- One main control cabinet (CCMC)
- Four module distribution cabinets (B2KK01, P1KK01, P2KK01, B9KK01)
- Three generator cabinets (CCPS01, CCPS02, CCPS03)
- One operator terminal (CCOS)
- One operator station (CCPC)

Fig. 3-24 *Locations of the electrical cabinets*

The arising heat inside the electrical cabinets is led off by air/water heat exchangers that are connected to the cooling water system. The air/water heat exchangers are mounted on the top of the electrical cabinets, see Fig. 3-25, 111).

For more detailed information on the air/water heat exchanger refer to the supplier's documentation on CD 1.

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Main switch cabinet CCMS
The main switch cabinet contains the power supply, the main switch and one/more circuit breaker. The power is distributed from here to the main distribution cabinets.

Main distribution cabinets CCMDxx
The main distribution cabinets provides electrical power and control of the power devices such as pumps, sputtering power supplies, heaters and outgoing circuits for system control and transport system.
An EMO button is installed on the door of the cabinet CCMD01.

Servo controller cabinet CCSC
The servo controller cabinet contains the transport system control. A «service» switch is installed on the door of the cabinet to disconnect the cabinet from the network.

Main control cabinet CCMC
The main control cabinets contain the PLC, the safety control system and the network distribution.

Module distribution cabinets xxKKXX
The module distribution cabinets are located at the rear sides of the modules. They distribute the electrical power to the module components. They also receive and process all signals of the sensor-actuator-system.

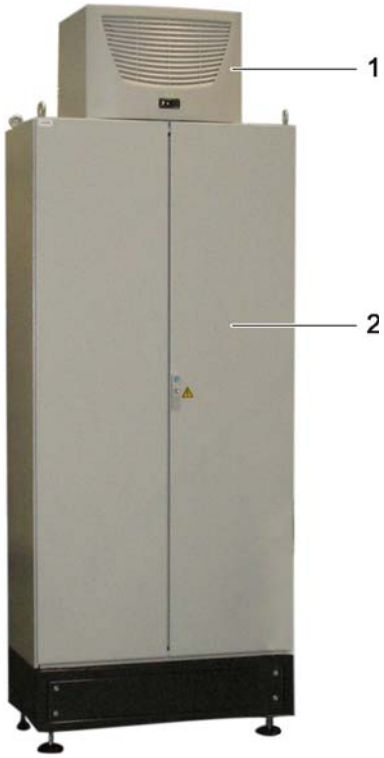

Fig. 3-25 Electrical cabinet

1 Air/water heat exchanger
2 Electrical cabinet

Generator cabinets CCPSx
The power generator cabinets contain the DC generators for the sputter sources, see Chapter 3.11.2 Power supplies of the sources, 🗎 112.

Operator terminal CCOS
See Chapter 5.6.1 Operator terminal CCOS, 🗎 129.

Operator station CCPC
See Chapter 5.6.2 Operator station CCPC, 🗎 130.

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3.11.2 Power supplies of the sources

Rotary magnetron
The rotary magnetrons are supplied with power by DC generators of the type Ascent 40.

Planar magnetron
The planar magnetrons are supplied with power by DC generators of the type Pinnacle+ 10kW.

Ion source
The ion source is supplied with power by the power supply of the type NHRR 4k01k2.

NOTE!
The power supply provides voltages up to 3 kV. Therefore, following standard applies for this device:

- **DIN EN 60204-11: 2000 Electrical equipment of machines ¡V Part 11: Requirements for high-voltage equipment for voltages over 1000 VAC or 1500 V DC and not exceeding 36 kV (IEC 60204-11: 2000)**

For more detailed information on the power supplies refer to the supplier's documentation on CD 1.

3.11.3 Uninterruptible Power Supply (UPS)

When switching off the system or in case of a power failure the UPS will continue to supply the Data Logging PC with power. This ensures that the control software can be quit in a controlled manner and that the operating system can be shut down.

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4 Installation

4.1 Transport

4.1.1 External transport

The A1500V-7 may only be transported in correspondingly packed. The transport firm contracted for this purpose must be specialized in heavy and fragile goods.

4.1.2 Internal transport

The installation site must comply with the requirements in Chapter 4.2 System location requirements, 115.

Transport with forklift or lift truck
The A1500V-7 is designed for each system module to be lifted from the floor individually with a suitable lift truck for transport to the appropriate location.

NOTE!
Only authorized personnel may operate forklifts and lifting devices.

Transport with crane
The following system parts have additional fittings for transportation by means of a crane:

- Vacuum chambers and service doors
- Carrier magazine
- Vacuum pumps
- Electrical cabinets
- Sputtering power supplies

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⚠WARNING

Danger of crushing by improper handling of suspended loads.

Improper handling of heavy parts during transportation, mounting and dismounting can lead to serious crushing, fractures and death. In particular, this applies for:

- Magnetrons
- Vacuum chamber doors
- Carrier magazine and carrier depot
- Components of the vacuum system, e.g., vacuum pumps, vacuum chambers, gate valves
- Electrical cabinets
- Power supply cabinets
- Sputtering power supplies

➢ When transporting system parts with a crane, only use brackets designed for that purpose.

➢ Wear safety boots.

➢ Ask a second person for help, if necessary.

➢ Always maintain a safe distance from suspended loads.

➢ Never stand beneath a hanging load.

NOTE!
Only authorized personnel may operate cranes and crane trucks.

NOTE!

➢ **Only use lifting chains or belts designed for lifting heavy loads.**

➢ **When transporting a combination of components, take into account the sum total of the weights of all the individual components. For information on the weights of the components refer to Chapter 1.4.1 Dimensions and weights, 🗎 20.**

Transport with air skates
For transportation by means of air skates, the route of transport should be unobstructed and the floor should be suitably even.

➢ Adhere to the specifications in machine card when transporting chambers with air skates.

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4.2 System location requirements

4.2.1 Ambient conditions

The A1500V-7 can only be operated correctly in a dust-free environment. You will find a detailed description of the required ambient conditions in Chapter 1.4.5 Ambient conditions, 28.

Vibrations
During the coating process, the A1500V-7 must not be subjected to significant vibrations.

- ➢ Make sure that there are no devices installed close to the A1500V-7 that cause strong vibrations.
- ➢ Make sure that the floor where the system is installed can absorb vibrations.

4.2.2 Operating media

The A1500V-7 must be supplied with the required operating media during operation, see Chapter 1.3.1 Component designations, 17.

- ➢ Lay the media pipes in accordance with the local safety regulations and the guidelines in the media drawings.

4.2.3 Space requirements

The safety clearance for the escape routes must be in line with the local safety regulations. Safety doors, covers, etc., have to allow access for maintenance and service work.

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4.3 Assembly

4.3.1 Setting up

NOTE!
The set-up and adjustment of the A1500V-7 modules will be carried out by Leybold Optics technicians.

➢ Roughly place the individual assemblies in accordance with the layout plan.

4.3.2 Media connections overview

Overview
Fig. 4-1, 🗎 116 shows the location of the media connections of the A1500V-7.

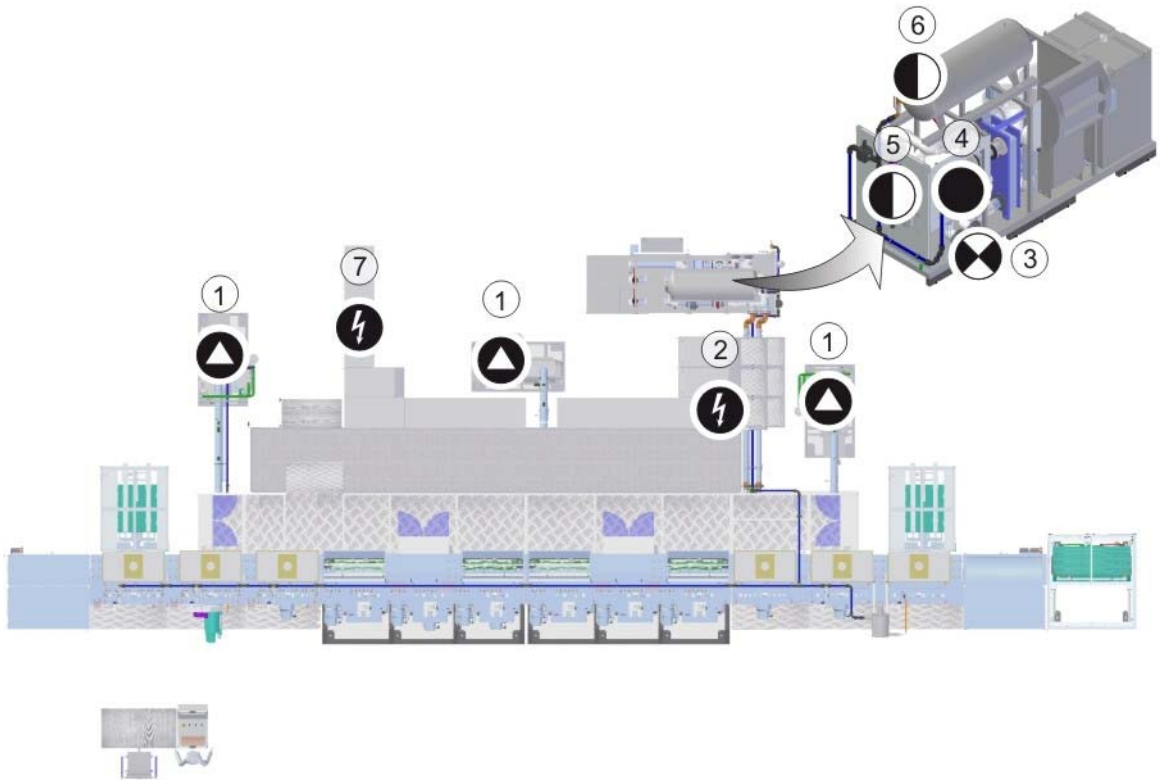

Fig. 4-1 *Positions of the media connections*

1 Fore-vacuum pumps: Exhaust gas connections
2 Electrical cabinet CCMS: Electrical connection
3 Water supply: Cooling water inlet and outlet
4 Gaspanel: Gas connection
5 Compressed air maintenance unit: Compressed air connection
6 Vent connection
7 Electrical cabinet CCMC: Control connection

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4.3.2.1 Electrical connections

➢ Install the electrical connections for the A1500V-7.

➢ Adhere to the specifications in Chapter 1.4.2.1 Electrical supply, 🗎 22.

⚠DANGER

Lethal electric shock by touching live parts.

The system includes live and at high voltage parts. 480 V AC are always present at the power input of the main switch in the main switch cabinet. This is independent from the position of the main switch.

In the control cabinets voltage is present at the cables marked orange and the sockets marked yellow even with disconnected main switch.

Touching live parts may cause a lethal electric shock.

- ➢ Turn off the system and de-energize it before you carry out any maintenance or service work on the system.
- ➢ Ground the equipment and secure the system against switching on again.
- ➢ Discharge the magnetrons and their surroundings with the grounding rod.
- ➢ Switch off the Data logger PC and the UPS before you work on it.
- ➢ Ensure that all persons keep a safe distance to parts which are connected to the electrical supply before you switch the system on again.

NOTE!
Only instructed personnel with electrotechnical training are permitted to carry out work on the electrical equipment.

NOTE!

- ➢ **Lay the cables between the control cabinet and the process unit so that there is sufficient distance between the signal cables and the power cables. This prevents noise or magnetic fields from affecting the signal cables.**
- ➢ **For the electrical connections, take note of the regulations of the electricity supply companies and, if applicable, those of the relevant national authorities.**

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4.3.2.2 Gas connection

NOTE!

➢ **Carry out the handling, connecting and securing of gas containers in accordance with the valid local and national regulations and guidelines at the end user's site.**

Process gas

➢ Connect the process gas supply lines to the A1500V-7.

➢ Adhere to the specifications in Chapter 1.4.2.2 Process and venting gases, 🗎 23.

Venting gas

➢ Connect the venting gas supply line to the A1500V-7.

➢ Adhere to the specifications in Chapter 1.4.2.2 Process and venting gases, 🗎 23.

4.3.2.3 Compressed air connection

⚠WARNING

Eye or skin injuries when opening pressurized system parts (water supply, process gas supply and compressed air system).

➢ Shut off the supply to the system and release the pressure before carrying out any work on these parts.

Pneumatic

➢ Connect the compressed air supply to the A1500V-7.

➢ Adhere to the specifications in Chapter 1.4.2.3 Compressed air, 🗎 23.

Venting

➢ Connect the air supply to the A1500V-7.

➢ Adhere to the specifications in Chapter 1.4.2.3 Compressed air, 🗎 23.

4.3.2.4 Water connection

➢ Connect the water supply to the A1500V-7.

➢ Adhere to the specifications in Chapter 1.4.2.5 Water supply, 🗎 24.

The water preparation system is already prepared for an extension that just requires to connect the inlet and the outlet.

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NOTE!

➢ **Do not use drinking water in combination with industrial water in the system.**

For safety reasons and for facilitating maintenance work, we recommend that the end user installs manual shut-off valves for the inlet and outlet of the water supply.

NOTE!

➢ **As regards the water connections and water disposal, adhere to the regulations of the responsible water supply board, water authority or the relevant national authority.**

4.3.3 Disposing of the exhaust gases from the pumps

➢ Adhere to the specifications in Chapter 1.4.2.4 Exhaust air, 🗎 24.

➢ Channel the exhaust gases through condensate separators from the fore-pumps to the outside.

➢ To prevent pressure from building up at the system exhaust support, ensure that the exhaust gas pipes are pressure- and tailback-free. Otherwise the diameter must be increased. This also applies to exhaust gas pipes merged from different pumps.

➢ If exhaust gas fans are installed, ensure that the pressure at the exhaust support is not less below pressure which is specified in machine card.

➢ Install the waste pipe so that it cannot be blocked by a condensate build-up.

➢ Separator containers with outlet taps must be installed at the lowest point of the pipe.

➢ Protect the exhaust gas outlet from rain or spray water.

➢ Place the waste pipe so that it does not end close to a fresh air inlet.

➢ When using special gases (oxygen, inflammable or explosive gases), follow the appropriate safety measures and regulations.

NOTE!

➢ **When installing the exhaust gas pipe, take into account the regulations regarding the permitted emission levels and the disposal in accordance with the relevant national or local regulations.**

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4.4 First commissioning

NOTE!
The first commissioning of the A1500V-7 has to be performed only by specially trained Leybold Optics service technicians. For this reason the commissioning procedure is not described in detail in these Operating Instructions.

4.4.1 Fundamental checks

NOTE!
The check of safety relevant parts and components has to be executed by trained expert personnel.

General

1 Check whether all preparatory and installation work has been carried out correctly.

2 Check in particular whether all the protective equipment has been installed and is functioning properly (e.g., safety covers, safety doors).

Cables

3 Carry out a precise visual check of all the mains connections (including the neutral wire and the ground) you have to connect during installation. Also check the wires that were removed before transportation. In particular, make sure that
- The cables are connected to the right terminals
- The terminals are insulated from one another (no single wires standing out of stranded cables and no wedged-in wire ends)
- The cables are connected securely. Stranded cables should be fitted with cable casings or pressed-on pins.

4 Check all the cable connections (visually and manually).

5 Check the ground connection plan, see circuit diagram

6 Perform a final commissioning test according to DIN EN 60204.

Pressure reduction valves

7 Check the functionality of all the pressure reduction valves.

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4.4.2 Revision checks

NOTE!
The revision check of safety relevant parts and components has to be executed by trained expert personnel

Safety circuits and protective system
The functioning of the safety circuits has to be proved by revision checks according to local regulations prior to the first commissioning, after modifications to the system or after maintenance works concerning safety relevant parts and components. The revision check also is necessary, when technical modifications to the safety circuits or the safety switches were executed.

Water circuits
Carry out the following tests:

1 Make sure that the flow monitors for the cooling water activate when the flow decreases below the specified minimum value. Repeat this test several times (at least five times).

2 Check the entire cooling water installation for leaks and damaged or fragile tubes.

Mechanical tests
Carry out the following mechanical tests:

1 Visually check all the wearing parts. For further details please consult the relevant instruction manuals.

2 Make sure that all the mechanical safety equipment (e.g., covers, locks, etc.) is installed correctly.

3 If mechanical or static changes are carried out on the system (e.g., drill holes in the reinforcing ribs), you must check the mechanical stability of the system. Reinforce the relevant parts, if necessary.

The revision check is confirmed in writing on an acceptance certificate by a person appointed by the end user.

4.4.3 Demonstration of the safety locks

When the A1500V-7 is being handed over to the end user, the functioning of the safety and locking circuits must be demonstrated. The A1500V-7 must have gone through a complete functional test and must be ready for operation.

The error-free functioning of the safety provisions must be confirmed in writing on the acceptance certificate by both, the end user and the Leybold Optics personnel.

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5 Operating elements

5.1 Main switch

With the main switch you can switch the power supply to the A1500V-7 on or off. The main switch is located on the main switch cabinet CCMS, see Fig. 3-24, 110.

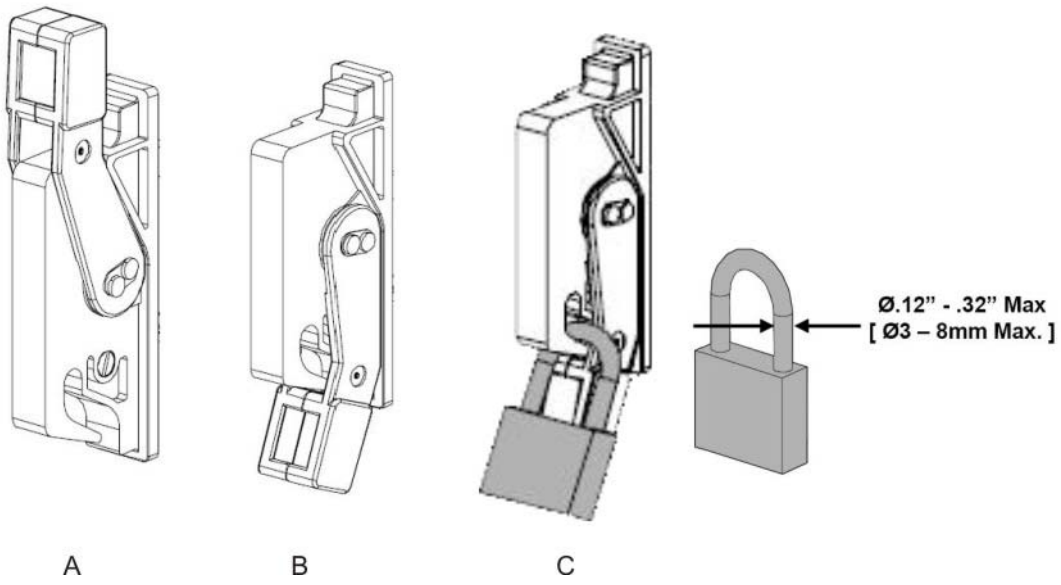

Fig. 5-1 *Main switch of the A1500V-7*

A «ON» position
B «OFF» position
C Locking

The positions of the main switch are as follows:

«O» or «OFF» position
In this position the complete system is switched off and the main switch can be locked.

«I» or «ON» position
In this position the complete system is switched on.
The main switch can be switched in «I» position when electrical voltage is to the power input. Otherwise, the internal control of the main switch cabinet locks switching on the main switch. Also the main switch cannot be switched on if the cabinet doors are not closed of the main switch cabinet CCMS. The doors are locked in the closed state against opening when the main switch is switched on. For maintenance work, it is possible to deactivated this lock, see Chapter 5.6.6 Key switches, 132.

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(Trip) position (released position)
When the current overload or short-circuit unit of the main switch is activated, the main switch moves to the released position. The main switch lever stands between «O» and «I» in horizontal position. In this case, you must first switch the main switch to «O» before you can switch it back to «I» again.

NOTE!
There always is a voltage present at the input for the main switch in the distribution cabinet. This is not affected by the position of the main switch.

In the electrical cabinets, the cables marked orange and the sockets marked yellow are energized even if the main switch is disconnected.

5.2 Maintenance switch

With the maintenance switch can be separated devices and equipment groups from the network and be secured against switching on again.

«I» or «ON» position
In this position the maintenance switch is switched on and the power supply to the devices is released.

«O» or «OFF» position
In this position the maintenance switch and the power supply to the devices is switched off. The switch can be secured against switching on again.

The A1500V-7 is equipped with several maintenance switches

Abb. 5-2 *Example Maintenance switch*

Locations of the maintenance switches

- door of the servo controller cabinet CCSC
  Switch off the power supply for the drives of the transport system.
- Cooling fan on the roof of the transfer module T9
- Water preparation system TPW 330

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	For detailed information for the function of the maintenance switches for water preparation system refer to the supplier's documentation on CD 1.

5.3 Emergency Machine OFF (EMO) button

If a dangerous situation arises during operation, you can shut down the system immediately by activating the EMO button. The A1500V-7 is equipped with several EMO buttons (Fig. 5-3, 125).

Fig. 5-3 *EMO button (example)*

The consequences of pressing an EMO button are described in Chapter 2.4.2 Emergency Machine Off (EMO) buttons, 42.

In the submenu «Errors > EM-Stop» the current states of the EMO buttons are represented by symbols, see Software-Handbook.

For the procedure of switching the system on again, see Chapter 6.2.2 Switching on, 140.

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5.4 Signaling devices

The A1500V-7 is equipped with different signalers:

Signal tower
The signal tower on the top of the process module P1 shows the operating status of the system.

Fig. 5-4 *Signal tower with buzzer*

The meaning of the signal colors are listed in the following table:

Color		Status	Meaning
	Red	Lighted	Current error that is acknowledged or the system is switched off.
		Blinking	Current error that is not yet acknowledged.
	Orange	Blinking	A warning is present.
	Green	Lighted	System is in the production mode (vacuum and transport run).
		Blinking	System is ready for production (vacuum).
	White	Lighted	The automatic mode runs.
		Blinking	The automatic mode starts.
	Blue	Lighted	The user requests a carrier stop with the control unit at a transfer module.
		Blinking	User request is executed, the carrier is in position and ready.

Tab. 5-1 *Meaning of the signal colors*

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Buzzer
The buzzer has 2 tones, which signals the following situations:

- Tone 1: An error is present
  buzzed (5 s) together with the red blinked light of the signal tower; buzzed (every 20 s) to acknowledgment the error at the operating terminal

- Tone 2: A process door is opened
  buzzes together with the blinking of door signal lamp.

Door signal lamp
A door signal lamp is mounted on top of each service door. The door signal lamp is blinking while the service door is moving.
Persons must maintain a safe distance from the movement area of the service door when the signal lamp is blinking.

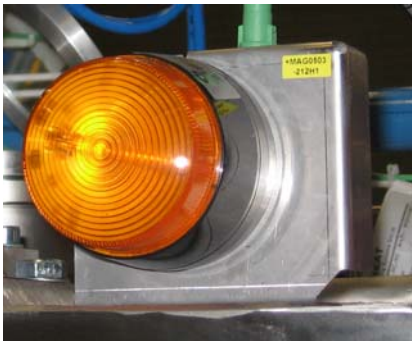

Fig. 5-5 *Door signal lamp*

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5.5 Control unit for the manual access

In the transfer modules T1 and T9 the carriers can be accessed manually (Chapter 3.3.1 Transfer modules T1 and T9, 🗎 75). Transfer module T9 is used to exchange carriers. Transfer module T1 is used to exchange test glasses and to unload substrates manually.

The loading/unloading areas are secured with doors. Prior to opening a door, the current transport procedure has to be stopped at a certain position and the monitoring of the door has to be deactivated for the duration of the access. For this purpose, control units are installed at the modules.

NOTE!
The time that is available for the manual access depends on the process. As a rule, it comprises half the cycle time a carrier needs. If this time is exceeded, the CSF cannot be maintained and the automatic mode is interrupted.

Fig. 5-6 *Control unit on the loading / unloading station*

A EMO button
1 Push button with white lamp: Carrier-Stop requested (or Carrier-Change requested on T9)
2 Blue lamp: Carry out the manual access
3 Signal horn for the manual access

White push button (1): «CARRIER STOP REQUESTED» or «CARRIER CHANGE REQUESTED»
Manual access is requested by pushing this button. The button lighted when the request is registered. The system control moves the carrier support of the transfer module to the save position for loading or unloading. When the lamp is blinking and the signal horn sounds the door can be opened.

To finish the manual access, the door has to be closed and then the white push button has to be pushed again.

Blue lamp (2): «CARRIER STOPPED» or «CARRIER CHANGED NOW»
This lamp shows the status of the manual access request:

- Lighted:
  Manual access can be carried out. The time that is available for the manual access depends on the process. As a rule, it comprises half the cycle time a carrier needs.
- Dark:
  No manual access is possible. If the door of the transfer module is opened, the transport is stopped and an error message is posted.

Signal horn (3)
The signal horn sounds once the manual access is requested.

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5.6 Operator terminals

The A1500V-7 is equipped with a operator terminal and a operator station to operate the system.

5.6.1 Operator terminal CCOS

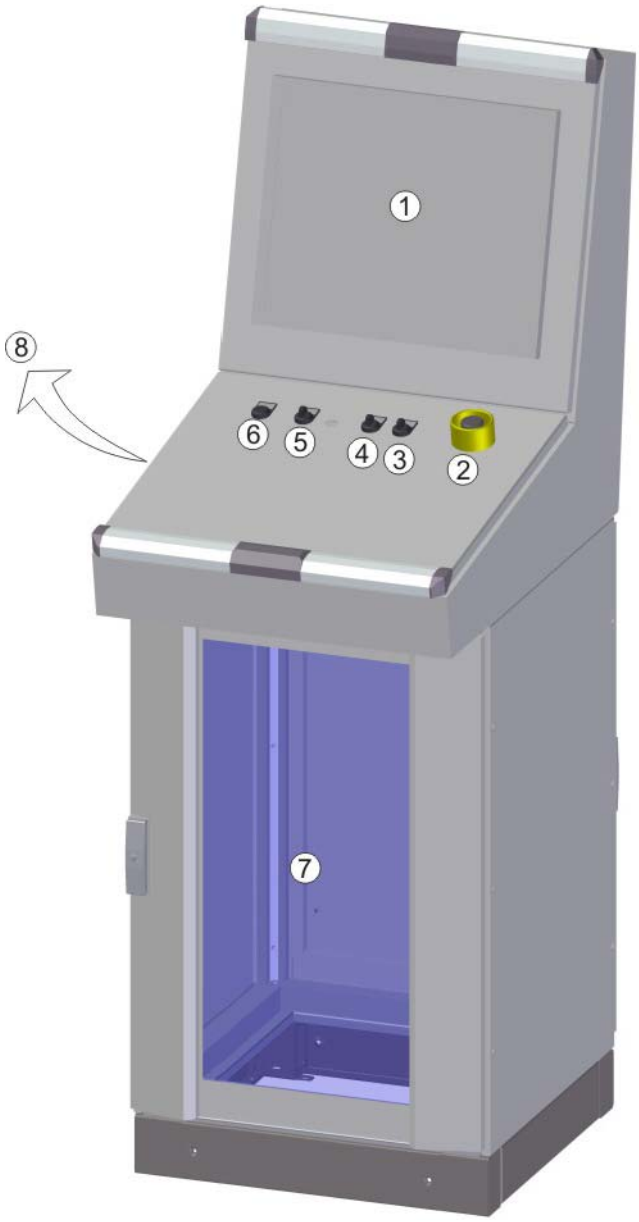

Fig. 5-2 *Operator terminal of the A1500V-7*

1 *Touchscreen*
2 *EMO button*
3 *Key switch «Enable gate valve»*
4 *Key switch «Setup mode transport»*
5 *Key switch «Magnetron door CLOSE/OPEN»*
6 *USB connection HMI*
7 *PC- cabinet*
8 *USB connection PC*

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Elements

- Touchscreen, see Chapter 5.6.3 Touchscreen, 🗎 131
- EMO button, see Chapter 2.4.2 Emergency Machine Off (EMO) buttons, 🗎 42
- Key switch «Enable gate valve», see Chapter 5.6.6 Key switches, 🗎 132
- Key switch «Setup mode transport»», see Chapter 5.6.6 Key switches, 🗎 132
- Key switch «Magnetron door CLOSE/OPEN», see Chapter 5.6.6 Key switches, 🗎 132
- USB connection HMI for transfer of data on the touchscreen.
- USB connection for transfer of data on the data logging pc.
- The lockable cabinet contain the system PC and the UPS.

5.6.2 Operator station CCPC

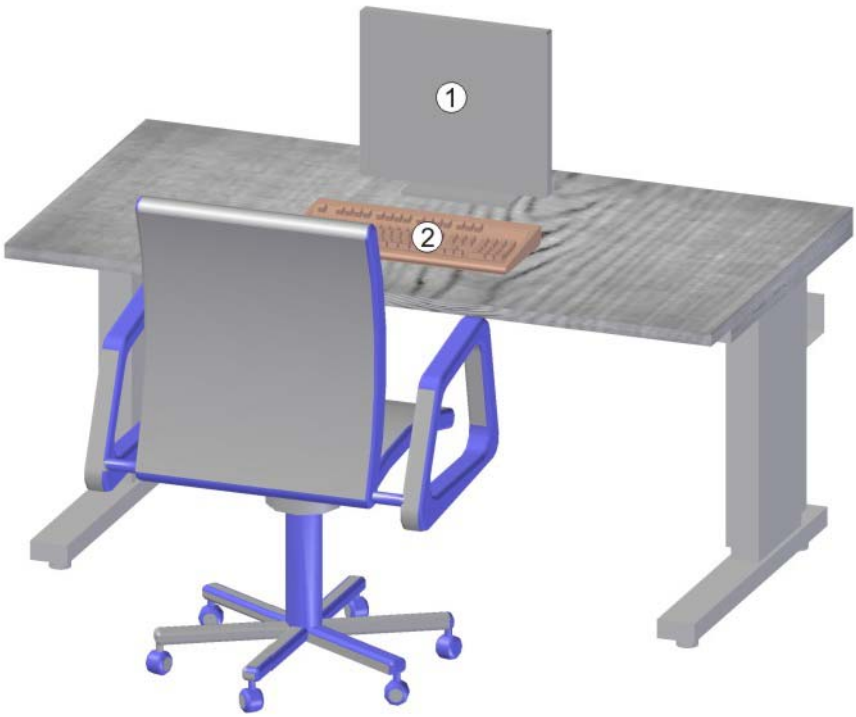

Abb. 5-3 *Operator station der A1500V-7*

1 Monitor for the Data Logger
2 Keyboard of Data Logger

Elements

- Monitor, see Chapter 5.6.4 Monitor, 🗎 131
- Keyboard and Mouse, see Chapter 5.6.5 Keyboard and mouse, 🗎 131

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5.6.3 Touchscreen

NOTE!

➢ **Do not use pointed or sharp objects (such as screwdrivers, tweezers, etc.) to operate the touchscreen as they will scratch the surface.**

The touch-screen is the main element of the GUI of the A1500V-7. At the same time it is used as output device, via the screen display and input device for the software.

A button on the touchscreen appears as a rectangular area on the screen. It is either colored or marked with a symbol or labelled (combinations of all three are possible).

Buttons are activated by pressing them gently on the touchscreen with the tip of a finger or with the touchpen. The function linked to the button is then executed.

Input fields must first be activated by touching them before a value can be entered.

5.6.4 Monitor

The TFT-screen is used as an output device for the Data Logger.

The Data Logger permanently logs and stores process data to the harddisk, see Data Logger - Handbook.

5.6.5 Keyboard and mouse

The keyboard and mouse are used as input device for the Data-Logger-PC. By means of the keyboard or mouse click by the cursor to the button. Press the left key to activates the button. The function linked to the button is then executed.The input fields must be activated to enter the values.

The keyboard is divided in the following fields:

- alphanumeric keys to input passwords, filenames and parameters in the input fields. Click by the cursor in the input field to activated for the input.
- numeric keys to input numeric values. Click by the cursor in the input field to activated for the input.
- special function to scroll in texts, delete of inputs and so on.

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5.6.6 Key switches

NOTE!
The keys may only be used by authorized operating personnel.
In order to prevent misuse:

- **Do not leave the keys in the locks when operating the system.**
- **Always remove the keys in order to prevent unauthorized system access.**

Key-operated push button «Magnetron door CLOSE / OPEN»
With this key switch the process doors can be opened or closed.

The positions of this key switch are as follows:

- «O» Position:
  In this position the door drive is switched off. You can insert and remove the key only in this position

- «I» or «CLOSE» Position:
  In this position the door drive is switched on and the service door is closed.

- «II» or «OPEN» Position:
  In this position the door drive is switched on and the service door is opened.

Key switch «Setup mode transport»
With this key switch the release of the carrier transport can be controlled.

The positions of this key switch are as follows:

- «O» or «OFF» Position:
  In this position the safety circuits are active.

- «I» or «ON» Position:
  In this position the safety circuits are bypassed and maintenance or service works can be carried out. So the transport drive is released when the vacuum chambers are opened. Also the door locking on the loading and unloading modules are deactivated so that the transversal transport is moved by opened door!

NOTE!
It must be ensure that nobody is working in a chamber or in the transfer modules if carriers are moved with activated key switch.
Only service personnel who knows about the risks should work at the carrier transport area while the key switch is activated.

Key switch «Enable gate valve»
With this key switch the compressed air supply to the pneumatic drives of the sluice valves XXVS0x is switched on or switched off.

The positions of this key switch are as follows:

- «O» or «OFF» Position:
  In this position the safety valve is switched off, which releases the compressed air supply of the sluice valve drives. The sluice valves do not movement.

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- «I» or «ON» Position:
  In this position the safety valve is switched on, which releases the compressed air supply of the sluice valve drives. The sluice valves are released for the control and movement.

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5.6.7 Software

The visualization software of the A1500V-7 comprises:

- System control via PLC
- Operation via keyboard
- Different user levels, password protected
- Menu bar with selection buttons for various main windows
- Visual observation of the process with moving screen displays
- Operation mode selection: Service mode and standard mode (manual and automatic)
- Handling of the configuration, settings and process parameters
- Error messages
- Help functions

For a detailed description of the visualization software refer to the Chapter 3.10 System control, 107.

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5.7 Rotary magnetron carrying aid

If a target change or maintenance work on the rotary magnetron is required, the carrying aid is used to attach the rotary magnetron to the crane.

Fig. 5-4 *Rotary magnetron carrying aid*

1 Eye
2 2 H-beam
3 Carrying straps
4 Support

To dismount the target of the rotary magnetron, the carrying straps (3) are looped around the target and then attached to the hooks of the H-beam (2). With the eye (1), the carrying aid is attached to a crane.

The target is dismounted from the end block while the crane is holding the rotary magnetron. After dismounting, the magnetron can be lifted and transported away from the service door. To replace a target, follow the instructions in Chapter 7.4.8 Changing the target of a rotary magnetron, 🗎 215.

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5.8 Service platform

The service platform is used for removing and mounting the protection shields in the process modules.

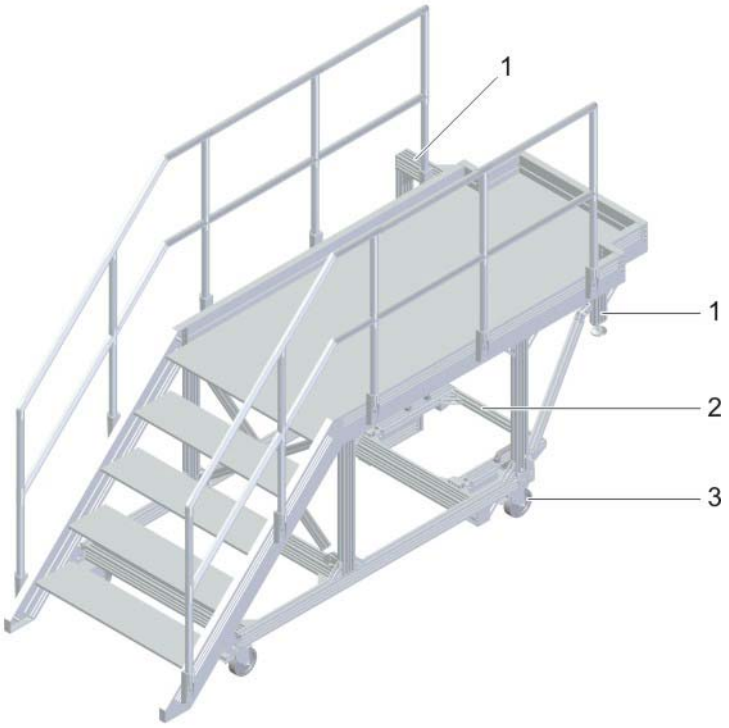

Fig. 5-5 *Service platform*

1 Base (2 pcs.)
2 Locking clamp
3 Lockable caster (4 pcs.)

Secure the service platform

1 Move the service platform over the opened process door that the locking clamp (2) slides over the frame, lifted the locking clamp if necessary.

2 Lock the lockable castors (4).

3 Support the both bases (1) on the frame.

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6 Operation

6.1 Introduction

6.1.1 Personnel qualifications

This chapter applies to personnel of the «Operator» qualification level or higher, see Chapter 2.3.1 Personnel groups, 🗎 39.

The system may only be switched on and operated by authorized personnel with the appropriate access rights. It is the end user's responsibility that the A1500V-7 is only operated by appropriately trained personnel.

If you have difficulties, or more specific questions, you may contact the Leybold Optics service department. For further information, see Chapter 2.10 Leybold Optics Service, 🗎 63.

6.1.2 Operation and safety

Operation
The user operates the A1500V-7 via the operating elements and the GUI of the operator terminal. The PLC controls and monitors all the system functions.

➢ Only operate the A1500V-7 after you have read and understood Chapter 2 Safety, 🗎 31 completely. Pay particular attention to the danger information specific to the system. For further information, seeChapter 2.7 Hazards, 🗎 48.

NOTE!
Leybold Optics assumes no responsibility for damage caused through the operation of the system by unauthorized personnel.

➢ **Adhere to the safety regulations in Chapter 2 Safety, 🗎 31 and the access rights.**

Cleanliness

➢ Carry out work inside the process modules only while wearing clean, lint-free gloves.

➢ Do not touch the components inside the vacuum chambers with bare hands.

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NOTE!
Only a clean process module can achieve a high throughput and effective process cycle times. Take note of the following rules:

- ➢ **Wear clean and lint-free gloves.**
- ➢ **Only bring dry, clean objects into the process chamber.**
- ➢ **Keep the use of vacuum greases and oils to a minimum.**

Refer to Chapter 7.5 Cleaning the system, 🗎 230 for carrying out cleaning work on the A1500V-7.

6.1.3 Operating modes

Selecting the operating mode
Select the required operating mode via the appropriate user access right (Chapter 2.3 Access rights, 🗎 39) in the menu «User», see Software-Handbook:

- Standard mode: Log on with access right «Operator» or «Supervisor»
- Service mode: Log on with access right «Service»

Standard mode

➢ The standard mode with the access right «Operator» is used for automatic production and suited for operating personnel. This operating mode limits some buttons and functions on the screens in relating to production processes.

➢ The standard mode with the access right «Supervisor» is used for creating and testing recipes and for optimizing process sequences and for maintenance and service tasks.

Service mode
The service mode requires access right «Service». The access right «Service» is assigned Leybold Optics personnel only and allows full access to the system functions.

NOTE!
The service mode is not suited for continuous production. In service mode security functions are partly disabled.

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6.2 Switching the system on

The A1500V-7 is a complex tool and it requires specific instructions to get such a system «On Line». This section lists a sequence of steps for starting the system in a manner that is safe for both the user and the equipment.

- Prepare the system: Chapter 6.2.1, 139
- Switch the system on:Chapter 6.2.2, 140

6.2.1 Preparing the system

Perform the following system checks:

1 Verify:
- Installation work on the A1500V-7 is completed
- All maintenance and service tasks are completed
- All components and supplies are ready for operation

2 In particular, check whether all the protective equipment on the A1500V-7 is in place and is functioning properly (e.g., safety covers, safety doors).

3 Make sure that the water supply is switched on and the static water pressure is set according to the specifications in Chapter 1.4.2.5 Water supply, 24.
First open the outlet of the cooling water, then the inlet

4 Inspect the water lines for leaks (wetness).

5 Make sure that the compressed air supply is switched on and the required pressure values are set according to the specifications in Chapter 1.4.2.3 Compressed air, 23.

6 Inspect the compressed air lines for leaks.

7 Make sure that the gas supply is switched on and the gas pressure values are set according to the specifications in Chapter 1.4.2.2 Process and venting gases, 23.

8 Inspect the gas lines for leaks.

9 Check the oil level of the fore-vacuum pumps at the sight glasses.

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6.2.2 Switching on

⚠DANGER

Lethal electric shock by touching live parts.

Parts of the system are connected to the mains supply or carry levels of high voltage. Touching live parts may cause a lethal electric shock.

➢ Ensure that all persons keep a safe distance to parts which are connected to the electrical supply before you switch the system on.

Use the following steps to switch the system on:

Checking the system

1 Make sure that the system is prepared for switching on, see Chapter 6.2.1 Preparing the system, 🗎 139.

2 Make sure that the following system components are switched on, i.e. the corresponding power switch is in position «On»:
- Sputtering power supplies
- Polycold
- Uninterruptible power supply (UPS)
- Maintenance switches
- Data Logger PC

3 Make sure that at the cryo compressor the system circuit breaker and the control circuit breaker is in position «On».

Powering the system

4 If the main power supply is locked (main switch in «OFF» or «O»-position or in «+»-position):
Turn the main switch to the «ON» or «I» position, see Chapter 5.1 Main switch, 🗎 123.
After switching on, the system control needs some time for running up.

5 GUI: Log on to the system control if it has been disconnected from the power supply, see Chapter 6.4 Logging on and off, 🗎 143.

6 GUI: Select the «Errors > Em-Stop» menu and make sure that all EMO buttons are unlocked.

7 GUI: Select the «Errors > Errors» menu and acknowledge pending error messages.

8 GUI: Select the «Media > Overview» menu.

9 GUI: Switch the main power on.

10 GUI: Acknowledge pending error messages again in the «Errors > Errors» menu. If further error messages occur, carefully check the affected components for defects.

11 Evacuate the system, see Chapter 6.5 Evacuating and venting the system, 🗎 144.

Now the system can be prepared for the production process, see Chapter 6.6 Checks before starting a process run, 🗎 149.

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6.3 Switching the system off

This section lists a sequence of steps for shutting the A1500V-7 system down in a manner that is safe for both the user and the equipment. This puts the system in an inoperable yet safe state which will be ready for cold start up.

1 End the process and remove all substrates from the system, see Chapter 6.8.3 Finishing the process, 164.

2 Switch the process components off (e.g. sputtering sources, heaters etc.)

Vacuum stop

3 Switch the vacuum pumps off.

Deactivating the water supply

4 Select the «Media > Overview» menu and deactivate the water supply.

Deactivating the main power supply

5 Select the «Media > Overview» menu and deactivate the power supply.
The system components that are not connected to the UPS are powered off.

Exit system control
Exit the system control only for a longer production interruption or when the A1500V-7 is decommissioned.

6 Log off from the system control, see Chapter 6.4 Logging on and off, 143.

Main switch

7 Turn the main switch to the «OFF» or «O» or in «+»-position, see Chapter 5.1 Main switch, 123

NOTE!
If any work is to be performed on the electrical equipment of the system:

Turn the main switch to the «OFF» position and protect it from being switched on, see Chapter 7.2.4 Locking out the main power, 172.

⚠DANGER

Residual voltage.

Even if the power supply is switched off, parts of the system may still be energized. Touching these parts may cause a lethal electric shock.

- ➢ Discharge all parts that may carry residual voltage with the grounding rod.
- ➢ Always discharge capacitors and components in opened power supplies.

Media supplies

8 Close the media supply lines:

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- First close the inlet of the cooling water, then the outlet
- Process gases
- Compressed air

If you want to deactivating the system: See Chapter 9.1.2 Deactivating the system, 273.

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6.4 Logging on and off

Logging on
Proceed as follows to log on at the system control:

1 Select the «User» menu.

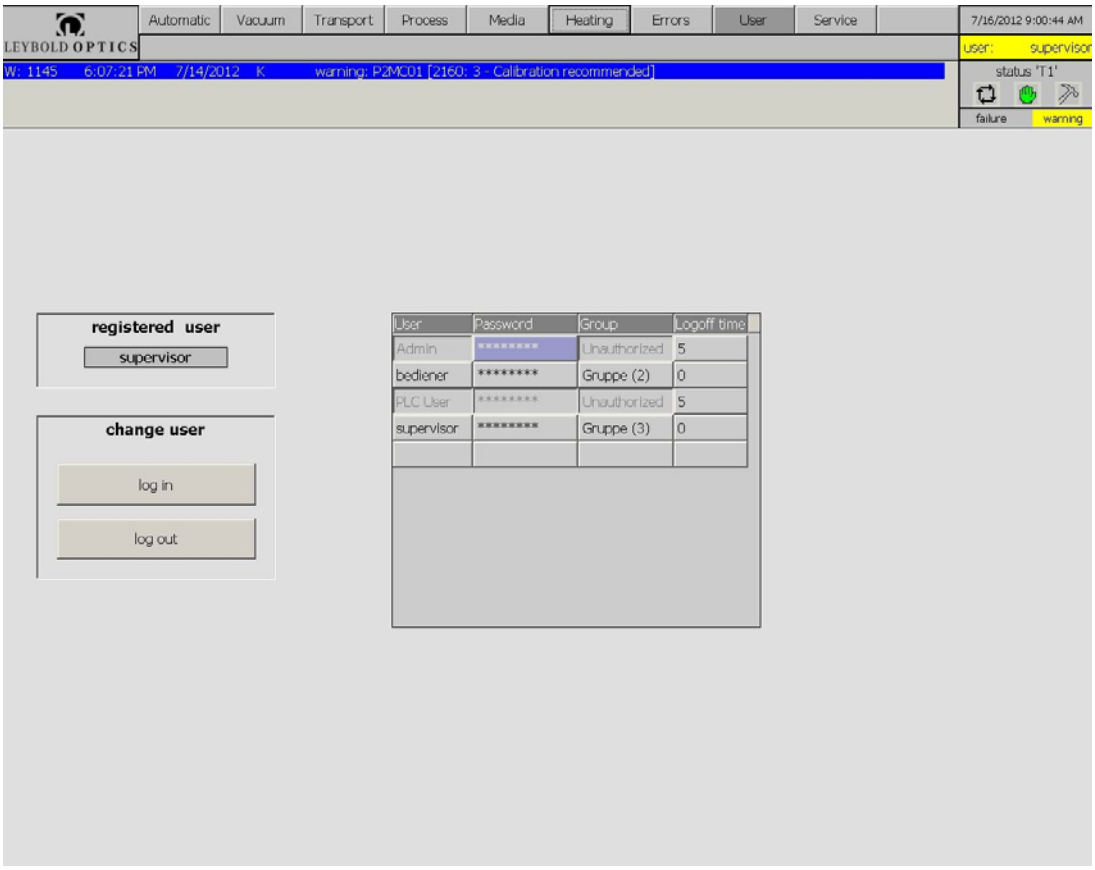

Fig. 6-1 *Screen page «user»*

2 Click the [log in] button.
A login window is shown.

3 GUI: Enter your user name and password and then click [ENTER].
Your user name is shown in the «registered user» field.

You can operate the system according to the access right that is assigned to your user name.

Logging off
Proceed as follows to log off from the system control:

1 Select the «User» menu.

2 Click the [log out] button.

You are logged off from the system control. To operate the system via the visualization software you have to log on.

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6.5 Evacuating and venting the system

The system control of the A1500V-7 comprises separate pumping and venting routines for the following areas of the vacuum system:

- Load lock module L1
- Load lock module L1 and Buffer module B1
- all modules
- Buffer module B9 and load lock module L9
- Load lock module L9

Pumping routine
At first the pumping routines evacuate the corresponding vacuum chambers to fore-vacuum. The pumping routine for the module B1 opens the gate valve which separates the cooled cryo pump from the chamber and evacuates the vacuum chamber to high-vacuum
The pumping routine for the modules B2…B9 starts the turbo pumps and evacuates the vacuum chambers to high-vacuum.

The procedure for evacuating the vacuum chambers is described in Chapter 6.5.1 Evacuating the system, 145.

Venting routine
At first the gate valve before the cryo pump will be closed and the turbo pumps will slow down some minutes and then vent the chambers to atmosphere pressure.

Pressure switches and safety valves prevent overpressure in the chambers.

The procedure for venting the vacuum chambers is described in Chapter 6.5.2 Venting the system, 147.

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6.5.1 Evacuating the system

NOTE!
Cold mechanical pumps will occasionally draw higher than normal current during initial powering and warming up. This can result in a trip of the circuit breaker.

➢ **Resetting the circuit breaker may be necessary to continue the mechanical start up of the pump.**

NOTE!
The following conditions must be met to evacuate the system:
- **The safety switches of the chamber doors are closed**
- **The cooling water flow is sufficient**

1 Make sure that the vacuum chambers are closed (doors, flanges, etc.). The safety switches of the doors must be closed.

2 GUI: Select the following menus depending on the areas to be evacuated:

area to be evacuated	menu	Button to evacuation
Load lock module L1	«Vacuum > Overview» or «Vacuum > L1-B2»	VACUUM MODULE L1 [L1 vacuum]
Load lock module L9	«Vacuum > Overview» or «Vacuum > B8-L9»	VACUUM MODULE L9 [L9 vacuum]
all modules	«Vacuum > Overview»	VAKUUM ALL [vacuum]
Load lock module L1 and buffer module B1	«Vacuum > L1-B2»	MODULE L1- B1 [L1-B1 vacuum]
Buffer module B9 and load lock module L9	«Vacuum > B8-L9»	MODULE B9-L9 [B9-L9 vacuum]

Tab. 6-1 *Menus and buttons for evacuating the individual vacuum system areas*

3 GUI: Press one of the button, see Tab. 6-1, 🗎 145.

The pump routine for the selected areas starts. The pumping routine is finished when the color of the pump symbols switches to green.

4 GUI: During evacuation, use the «Vacuum > Trend» menus to monitor the pressure.

5 Compare the pressure trend with a reference curve.

6 Perform a leak test and/or clean the chambers if adequate vacuum conditions are not reached in time, see Chapter 7.4.13 Checking the vacuum performance, 🗎 228

The software interlocks for various system functions, such as transport and sputtering, are released when the high vacuum trigger in the process chamber is reached (base pressure: see Chapter 1.4.3 Performance data, 🗎 27).

The cleanliness of the vacuum chambers determines the time span until high vacuum will be reached. This time is below 30 minutes for a clean system that has been previously vented with nitrogen.

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NOTE!

➢ **Pre-sputter the targets after evacuating the system and before starting production.**

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6.5.2 Venting the system

Prerequisites

The automatic production and the processes are finished, see Chapter 6.8.3 Finishing the process, 164.

- Chapter 6.8.3 Finishing the process, 164.

Venting the system
Proceed as follows to evacuate the entire system:

1 Switch the process components off (sputtering sources, heaters etc.).

2 Stop the transport.

3 GUI: Select the following menus depending on the areas to be vented

area to be vented	menu	Button to venting
Load lock module L1	«Vacuum > Overview» or «Vacuum > L1-B2»	VACUUM MODULE L1 [L1 vent]
Load lock module L9	«Vacuum > Overview» or «Vacuum > B8-L9»	VACUUM MODULE L9 [L9 vent]
all modules	«Vacuum > Overview»	VAKUUM ALL [vent]
Load lock module L1 and buffer module B1	«Vacuum > L1-B2»	MODULE L1- B1 [L1-B1vent]
Buffer module B9 and load lock module L9	«Vacuum > B8-L9»	MODULE B9-L9 [B9-L9 vent]

Tab. 6-2 *Menus and buttons for venting the individual vacuum system areas*

4 GUI: Press one of the button, see Tab. 6-2, 147.

all modules:
Press the button [Stop].
The turbo pumps will be switched off. The gate valve before the cryo pump will be closed.
Press the button [vent].
The turbo pumps will be slow down approx. 10 min. At first is vented with compressed air to the pressure trigger (turbo pumps will be slow down) and then with air to atmosphere. The gate valves are still closed and the cryo pumps are still cooled and fully functional.

5 A vacuum chamber is evacuated if the color of the corresponding pressure switch symbol is switches to green and the venting valve is closed (symbol gray).

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NOTE!
After venting the system:

- **Check the targets and replace them if necessary, see Chapter 7.4.8 Changing the target of a rotary magnetron, 215**
- **Remove dust and particles from the targets with an industrial vacuum cleaner.**
- **Check the isolation resistance between the targets and the parts in the surrounding area (cathode frame, housing etc.), see** resistance measurement.

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6.6 Checks before starting a process run

Checks
Perform the following checks before you start a recipe on the A1500V-7.

1 Make sure that the system has been switched on orderly, seeChapter 6.2 Switching the system on, 139.

2 Make sure that the targets have been pre-sputtered in the following cases:
- After inserting new targets
- When the targets have been exposed to atmosphere, i.e. the chamber has been vented
- After longer production breaks

3 GUI: On the screen pages of the visualization software, verify that the system works faultlessly, i.e. the associated icon appears colored green:

screen page	checks
Media > Overview	▪ Power supply on and ok ▪ Voltage supplies, safety circuit interlocks and sensors active ▪ Cooling water supply on and temperature according to the specifications in Chapter 1.4.2.5 Water supply, 24.
Media > XXMAG Media > XX-YY	▪ Cooling water supply of the magnetrons on ▪ Cooling water supply to the used components on
Vacuum > Overview	▪ Pressure in the vacuum chambers according to the specifications in Chapter 1.4.3 Performance data, 27
Process > Overview Process > XX-YY	▪ Power supplies are in an error-free state ▪ Process gas supply valves opened
Process > Data XX	▪ Sufficient target lifetime
Heating > Overview	▪ Heaters and heater temperatures ok

4 GUI: On the screen pages of the visualization software, verify that the recipe settings are correct:

screen page	checks
Automatic > Recipe	▪ CSF speed correct
Automatic > Recipe GEN	▪ Sputter sources used for the process are selected ▪ Power setpoints for the sputter sources are correct
Automatic > Recipe MFC	▪ MFCs of the process gases used in the process are selected ▪ Gas flow setpoints are correct
Automatic > Recipe PT	▪ speed frequency setpoints correct (throttling)
Automatic > Recipe X	▪ Heaters used for the process are selected ▪ Temperature setpoints are correct

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Loading carriers

5 GUI: In the «Transport > Overview» menu, start the transport drive.

6 Load the substrate carriers to the system, see Chapter 6.7 Loading and unloading the system manually, 🗎 151.

7 Make sure that the loading and unloading modules are operational and that sufficient substrates are available.

The system is now ready for the automatic production process, see Chapter 6.8 Automatic production, 🗎 161.

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6.7 Loading and unloading the system manually

⚠CAUTION

Cuts by splinters of glass.

Glass splinters in the module and/or on the carriers may cause cuts.

- ➢ Handle glass substrates with caution.
- ➢ Wear protective clothing (protective goggles, protective gloves, safety boots, clothes with long sleeves).
- ➢ Use a vacuum cleaner to remove the glass splinters.

NOTE!
For a regular production the number of carriers in the system must be between 13 … 15. The system control detects the number of carriers automatically.

- **Less carriers in the system cause inferior product quality and lead to stronger contamination of the process chambers.**
- **More carriers in the system cause a fault in the transport drive and in the process.**

The manual loading and unloading of the system consists of the following activities:

1 Exchanging the carriers, see Chapter 6.7.2 Exchanging substrate carriers, 🗎 153

2 Unloading the substrates from the carriers, see Chapter 6.7.3 Loading substrates/dummy-substrates manually, 🗎 158

3 Exchanging test glasses in the carriers, see Chapter 6.7.5 Changing test glasses, 🗎 160

The activities are carried out at the transfer modules. In the standard mode the operation area is protected by a folding door against access. The manual access has to be requested at the system control using the control unit, see Chapter 6.7.1 Manual access request and finish, 🗎 152.

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6.7.1 Manual access request and finish

On the transfer modules there are control units to request and finish the manual access.

Fig. 6-2 *Control unit on the loading / unloading station*

A EMO button
1 Push button with white lamp: Carrier stop request or Carrier exchange enabled
2 Blue lamp: Carry out the manual access
3 Signal horn for the manual access

Requesting manual access

➢ Press the white push button (1) to request manual access to the system control.
- The button lighted when the request is accepted.
- The transport is stopped when the carrier is at the access position.
- When the lamp is blinking the monitoring of the door (side sliding door or folding door) is deactivated and the door can be opened without triggering a system failure. This is signaled by the illuminated blue lamp (2) and the signal horn (3) sounds.

The time that is available for the manual access depends on the process. As a rule, it comprises half the cycle time a carrier needs.

Finishing the manual access

1 Close the door.

2 Press the white push button.

The normal system operation is continued:
- The transport in the transfer module is proceeded
- The monitoring of the door is activated

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6.7.2 Exchanging substrate carriers

Prerequisites

- There is at least one free space at the carrier depot.

Components of the carrier depot
The item numbers in the following sections refer to the numbers in this figure.

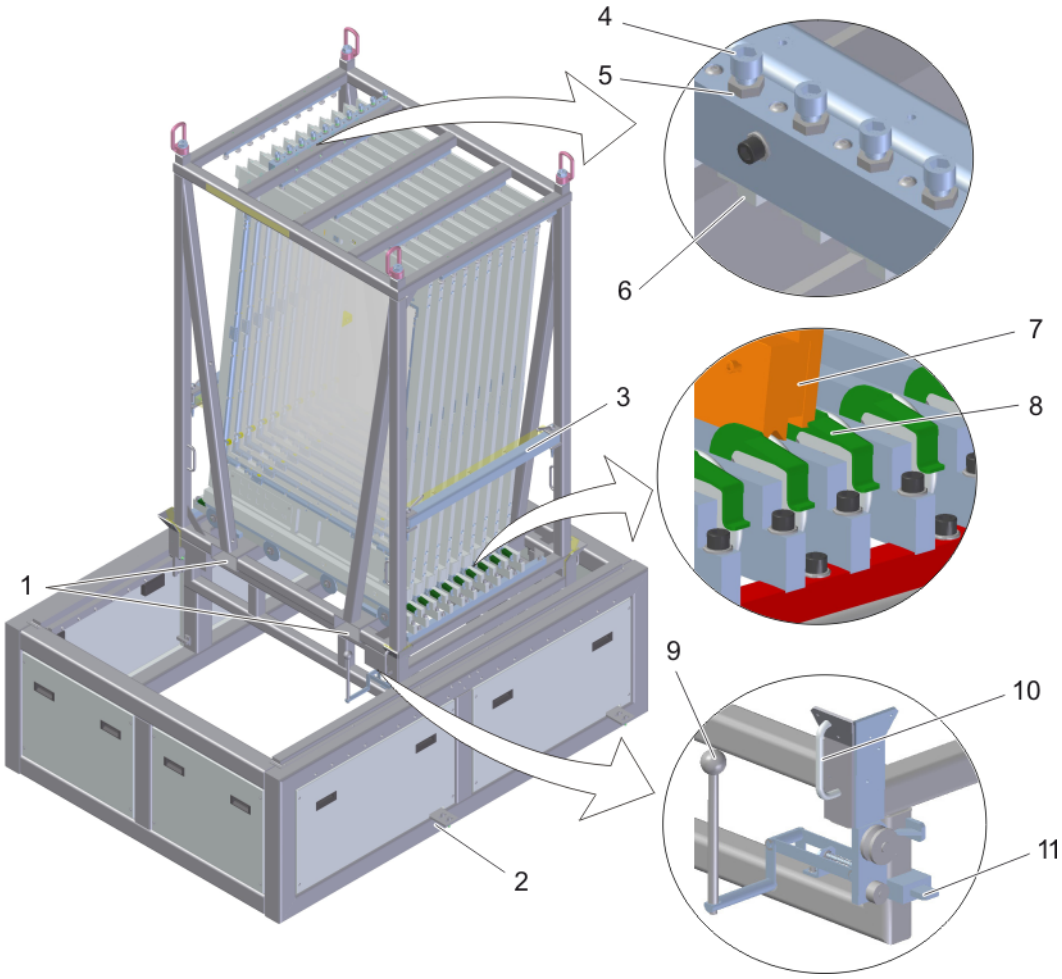

Fig. 6-2 *Components of the carrier depot*

1 Hollow section for transporting the magazine with a forklift
2 Coupling elements
3 Safety bar
4 Screw of the carrier tension jack
5 Counter nut
6 Clamp
7 Carrier
8 Latch
9 Lever of the locking device
10 Handle
11 Slider of the locking device

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6.7.2.1 Unloading and loading the carriers

Unload a carrier

1 On the transfer module side, remove the safety bar (3 in Fig. 6-2, 🗎 153) from the carrier magazine.

2 Move the carrier magazine to a position where the carrier can be slid into the carrier depot.

2.1 Unlock the support with the lever of the locking device (9 in Fig. 6-2, 🗎 153).

2.2 Take the support at the handle (10) and move it to a position where the carrier can be slid into the carrier depot.

2.3 Release the lever of the locking device (9 in Fig. 6-2, 🗎 153). The slide of the locking device (11) engages automatically.

3 Request manual access by the push button «CARRIER EXCHANGE REQUEST I/O» to the transfer module T9, see Chapter 6.7.1 Manual access request and finish, 🗎 152.
A carrier is provided in transfer module T9.

4 Open the folding door of the transfer module T9.
Remove the substrates and the test glass from the carrier, see Chapter 6.7.4 Unloading substrates/dummy-substrates manually, 🗎 160 and Chapter 6.7.5 Changing test glasses, 🗎 160.
Close the folding door of the transfer module T9.

5 Open the side sliding door of the transfer module T9.

6 Slide the carrier out of the transfer module T9 to the end stop in the carrier magazine.

Unload a cleaned carrier

7 Move the carrier magazine to a position where the carrier can be slid into the transfer module T9.

7.1 Unlock the support with the lever of the locking device (9 in Fig. 6-2, 🗎 153).

7.2 Take the support at the handle (10) and move it to a position where the carrier can be slid into the transfer module T9.

7.3 Release the lever of the locking device (9 in Fig. 6-2, 🗎 153). The slide of the locking device (11) engages automatically.

8 Press the latch (8 in Fig. 6-2, 🗎 153) at the loading position and slide the carrier into the transfer module T9.
Make sure that the carrier is positioned between the two outer light barriers.

9 Close the side sliding door of the transfer module T9. Finish the manual access.

10 Wait until the carrier is transferred to the carrier back transport.

11 Repeat the previous steps for all carriers.

12 On the transfer module side, mount the safety bar (3 in Fig. 6-2, 🗎 153) on the carrier magazine.

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6.7.2.2 Securing the carriers in the carrier magazine

The carriers have to be secured in the carrier magazine to avoid damage during transport.

⚠WARNING

Risk of injury by non-secured carriers in the carrier magazine.

During transport of the carrier magazine, non-secured carriers may fall off and/or may cause the displacement of the center of mass. This can lead to serious crushing, fractures and death.

➢ Prior to transport secure the carriers with the safety elements (safety bars, carrier tension jacks, latches).

1 Make sure that the spring-loaded latches (8 Fig. 6-2, 🗎 153) protect the carriers from slipping out of the carrier magazine.

2 Mount the safety bars (3) on both sides of the carrier magazine.

3 Fix all carriers with the corresponding carrier tension jack:

3.1 Turn the screw (4) until the clamp (6) is pressed against the carrier.

3.2 Tighten the screw (4) hand-tight.

3.3 Fix the hexagon socket screw with the counter nut (5).

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6.7.2.3 Transporting the carrier depot away

To transport the carriers away from the system the carrier magazine is lifted off the support with a forklift or crane. The frame and the support of the carrier depot remain at the system.

⚠WARNING

Risk of injury by improper transportation of the carrier magazine.

The carrier magazine weighs between 470 kg (empty) and 1000 kg (fully loaded). Improper transportation can lead to serious crushing, fractures and death.

- ➢ Before using a crane or a forklift make sure that it has a sufficient maximum load capacity.
- ➢ Hang the carrier magazine to all four eyelets.
- ➢ Before transportation make sure that the support is locked.
- ➢ Ask a second person for assistance, if necessary.
- ➢ Always maintain a safe distance from suspended loads.
- ➢ Never stand beneath a hanging load.

Prerequisites

- The carriers are secured in the carrier magazine, see Chapter 6.7.2.2 Securing the carriers in the carrier magazine, 🗎 155
- The slider of the locking device is latched (11 Fig. 6-2, 🗎 153).

Removing the carrier magazine from the carrier depot

1 By crane:
Attach lifting straps to the four eyelets of the carrier magazine and to the crane hook.

By forklift:
Guide the forklift tines into the hollow sections (1 in Fig. 6-2, 🗎 153).

2 Lift the carrier magazine off the support and transport it away.

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6.7.2.4 Transporting a carriers depot to the system

⚠WARNING

Risk of injury by improper transportation of the carrier magazine.

The carrier magazine weighs between 470 kg (empty) and 1000 kg (fully loaded). Improper transportation can lead to serious crushing, fractures and death.

- ➢ Before using a crane or a forklift make sure that it has a sufficient maximum load capacity.
- ➢ Hang the carrier magazine to all four eyelets.
- ➢ Before transportation make sure that the support is locked.
- ➢ Ask a second person for assistance, if necessary.
- ➢ Always maintain a safe distance from suspended loads.
- ➢ Never stand beneath a hanging load.

Prerequisites

- The carriers are secured in the carrier magazine, see Chapter 6.7.2.2 Securing the carriers in the carrier magazine, 🗎 155
- The slider of the locking device is latched (11 in Fig. 6-2, 🗎 153).

Placing the carrier magazine onto the carrier depot

➢ Lift the carrier magazine with a crane or forklift and place it on the support of the carrier depot.

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6.7.3 Loading substrates/dummy-substrates manually

1 Log on at the system control, see Chapter 6.4 Logging on and off, 143.

2 GUI: Select the «Transport > Overview» menu.

3 GUI: In the «Transport» area press the icon  .
The transport starts.

4 Request manual access by the push button «CARRIER STOP REQUEST I/O» to the transfer module T1, see Chapter 6.7.1 Manual access request and finish, 152.

5 Open the folding door of the transfer module T1.

6 Unlock the substrate holder at both sides of the carrier using the unlocking tool, see Chapter 6.7.3.1 Lock/Unlock substrate holder, 158

7 Place the substrate/dummy-substrate onto the carrier.

8 Lock the substrate holder at both sides of the carrier using the unlocking tool, see Chapter 6.7.3.1 Lock/Unlock substrate holder, 158

9 Close the folding door of the transfer module T1.

10 Finish manual access by the push button «CARRIER STOP REQUEST I/O» to the transfer module T1, se Chapter 6.7.1 Manual access request and finish, 152.

11 If the dummy-substrate should run several process cycles through the system (e.g., during the stabilization phase), secure the carrier against automatic loading and unloading as follows:

11.1 GUI: Select the «Transport > Carrier» menu.

11.2 GUI: In the «Release» column, click the table cell that is assigned to the corresponding carrier repeatedly until no more entry is shown in the table cell. Field [load/unload] in the «Release» column must be grey for the corresponding carrier.

The carrier is locked against the automatic loading and unloading.

12 Repeat the steps 4…9 to load further substrates/dummy-substrates.

When loading dummy-substrates in the stabilization phase, the automatic mode can be switched on as soon as the CSF is complete, see Chapter 6.8.1 Starting the recipe, 162.

6.7.3.1 Lock/Unlock substrate holder

The Unlocking/Locking of the substrate holder must be carried out on both sides of the carrier. Below this is described for one side of the carrier.

Unlock substrate holder

1 Insert the unlocking tool (4 at Fig. 6-3, 159) to the stop of the provided pocket below the locking mechanism (2) (step a - b).

2 Push up the locking mechanism using the unlocking tool (step c)

3 Securer the locking mechanism by further insertion of the unlocking tool to the stop. (step d).

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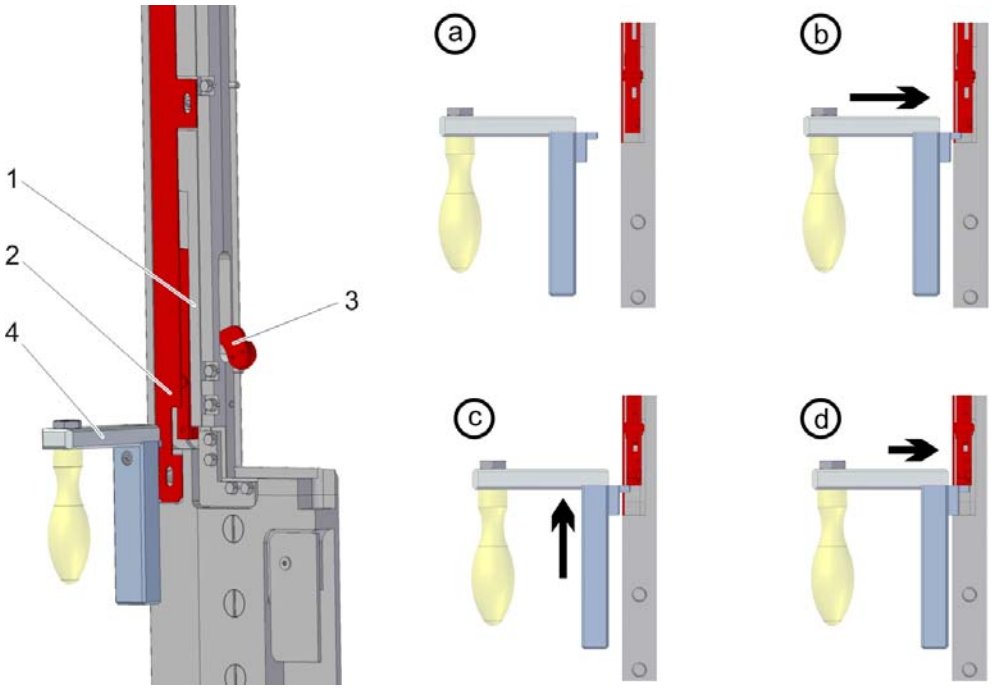

Abb. 6-3 *Unlock the substrate holder*

1 Frame carrier of the carriers
2 Carrier lock of the carriers
3 Substrate holder
4 Unlocking tool

Lock substrate holder

When removing the unlocking tool the locking mechanism returns automatically to its normal position.
If the locking mechanism is jammed, use the unlocking tool to lock the substrate holder.

1 Insert the unlocking tool in the recess between the locking mechanism and the frame carrier shown at Fig. 6-4, 159.

2 Press the locking mechanism (down) to its normal position by using the release tool.

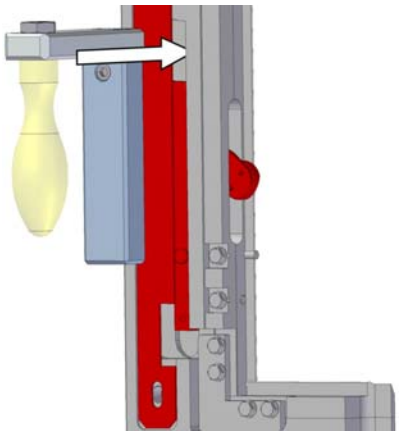

Fig. 6-4 *Lock the substrate holder*

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6.7.4 Unloading substrates/dummy-substrates manually

1 Request manual access by the push button «CARRIER STOP REQUEST I/O» to the transfer module T1, see Chapter 6.7.1 Manual access request and finish, 🗎 152.

2 Open the folding door of the transfer module T1.

3 Unlock the substrate holder at both sides of the carrier using the unlocking tool, see Chapter 6.7.3.1 Lock/Unlock substrate holder, 🗎 158

4 Remove the substrate/dummy-substrate from the carrier.

5 Close the folding door of the transfer module T1.

6 Finish manual access by the push button «CARRIER STOP REQUEST I/O» to the transfer module T1, see Chapter 6.7.1 Manual access request and finish, 🗎 152.

7 Release the carrier for automatic loading:

7.1 GUI: Select the «Transport > Carrier» menu.

7.2 GUI: In the «Release» column, click the table cell that is assigned to the corresponding carrier repeatedly until «Load» is displayed in the table cell.

The carrier is released for automatic loading.

7.3 Repeat the previous steps to unload further substrates/dummy-substrates.

6.7.5 Changing test glasses

The carrier frames are equipped with a notches for inserting test glasses on the coating side, see Chapter 3.4.1 Carrier, 🗎 86. With the test glasses the product quality can be monitored.

The test glasses are exchanged manually at the transfer module T1.

1 Request manual access by the push button «CARRIER STOP REQUEST I/O» of the b transfer module T1, see Chapter 6.7.1 Manual access request and finish, 🗎 152.

2 Open the folding door of the transfer module T1.

3 Take the coated test glasses from the notches and insert new test glasses.

4 Close the folding door of the transfer module T1.

5 Finish manual access by the push button «CARRIER STOP REQUEST I/O» to the transfer module T1, see Chapter 6.7.1 Manual access request and finish, 🗎 152.

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6.8 Automatic production

NOTE!
Only personnel with «Operator» access rights or higher, who have completed the required training and instruction courses, are authorized to run the system in automatic mode.

Before carrying out a coating process, the appointed personnel must have read and fully understood these Operating Instructions.

Prerequisites

- The system is prepared for switching on, see Chapter 6.6 Checks before starting a process run, 149,
- The recipes of the automatic production are available and tested, see Chapter 6.9 Editing recipes, 165.

Automatic system functions
Starting the automatic production using a recipe performs the following system functions without any further intervention from the operator:

- Starting of the transport system
- Setting the process gas flows
- Activating the control loops
- Switching all process devices to process performance

Typical procedure for a production process
A typical process consists of the following steps, in the given order:

1. Filling the system with dummy-substrates, see Chapter 6.7.3 Loading substrates/dummy-substrates manually, 158.
2. Starting the recipe, see Chapter 6.8.1 Starting the recipe, 162.
3. After the stabilization phase: Unloading the dummy-substrates and releasing the carriers for automatic loading and unloading, see Chapter 6.8.2 During the process, 163.
4. Monitoring the recipe, see Chapter 6.8.2 During the process, 163.
5. Finishing the recipe, see Chapter 6.8.3 Finishing the process, 164.

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6.8.1 Starting the recipe

Proceed as follows to start a recipe:

1 GUI: Select the recipe in the «Automatic > Recipe» menu.

2 Select the «Automatic > Overview» menu:

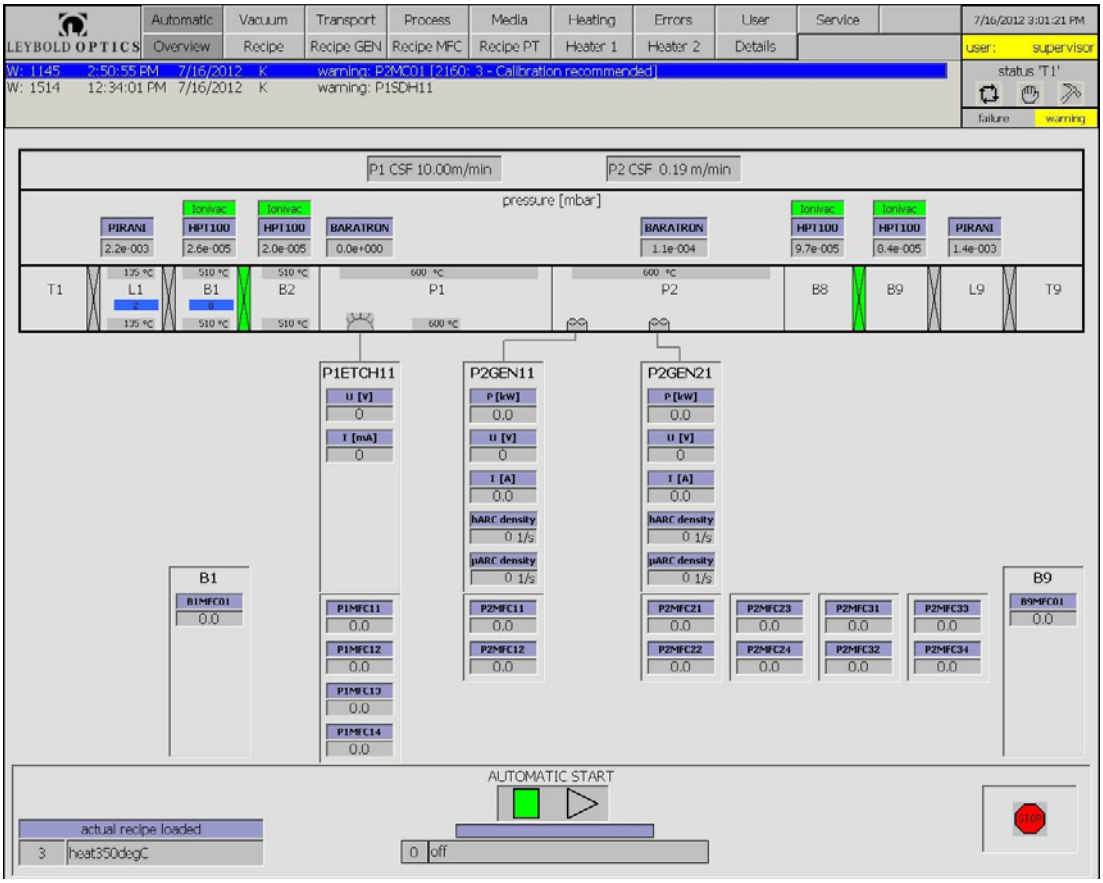

Fig. 6-5 *«Automatic > Overview» menu*

3 Press the icon  .

All components involved in the process are started and set to the values defined in the recipes. The robot for automatic substrate loading remains inactive.

NOTE!
After starting the process the system needs approx. 3 hours for process stabilization. During this stabilization phase no substrates are loaded to the system. To minimize the contamination of the process chambers, dummy-substrates are transported through the system.

4 Load and unload dummy-substrates during the stabilization phase, see Chapter 6.7.4 Unloading substrates/dummy-substrates manually, 160.

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6.8.2 During the process

Monitoring the process
Once the system is processing, the user can monitor the system's activities using various screens of the GUI, (see Software-Handbook):

- «Automatic > Overview»
- «Vacuum > Overview»
- «Transport > Overview»
- «Process > Overview»
- «Media > Overview»
- «Heating > Overview»

Checking the quality
Test glasses may be inserted manually into the carrier frames. After running through the coating process the test glasses may be removed and analyzed. This way the product quality can be tested while the process is running, see Chapter 6.7.5 Changing test glasses, 🗎 160.

Changing process parameters
Even in automatic mode, the parameter setpoints can be modified on the corresponding screens during processing to adapt the selected recipe. Note that the modified parameters are not automatically stored in the recipe. To store changed parameters into the recipe see Chapter 6.9 Editing recipes, 🗎 165

Error treatment
During operation it is possible that the system may post an error message. To resolve these situations, the system typically requires a response from the user and further action may be needed, see Software-Handbook:

- Warnings inform the user that a preventive measure should be performed for the indicated component. However, further operation of the component is possible.
- Errors inform the user that a corrective measure has to be performed for the indicated component. Further operation of the component is not possible, the automatic processing stops. The user has to confirm the error message.

Interrupting the process
If malfunctioning occurs during the operation, the process should be interrupted to keep danger for personnel as well as damage to the system and products to a minimum. Use one of the following ways to interrupt the running process:

➢ In dangerous situations press the next EMO button, see Chapter 2.6 How to react to dangerous situations, 🗎 47,

➢ In the «Automatic > Overview» menu, press the icon 

.

The automatic process is stopped immediately.
All process components and the gas supplies are switched off.

The transport system moves to the stand-by position, then switches off.

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6.8.3 Finishing the process

1 GUI: Select the «Automatic > Overview» menu.

2 After the last substrate to be coated has been loaded, press the icon  . for the loader and select [OFF].

The robot is deactivated and no new substrates will be loaded

3 Continue to load the dummy-substrates manually until the CSF completely consists of dummy-substrates.

4 In the «Automatic > Overview» menu, press the icon  .

The process functions (sputter sources, heater, process gas) are switched off in reverse start order.

The system is running empty, i.e. all substrates and dummy substrates that are still in the system are unloaded automatically.

When the system is empty the transport remains active for some time.

The process is regularly ended. Now a new recipe may be loaded to continue the automatic mode or the system may be switched into service mode.

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6.9 Editing recipes

NOTE!
Only personnel with «Supervisor» access rights is authorized to create and edit recipes, see Chapter 2.3.1 Personnel groups, 39.

For the production all substrates should pass through the same process sequence and are coated identically. The components will pass through repeatedly in the same order and operated with the same parameters (setpoints). A recipe allows the summary of the setpoints and functions for the sequence and with it the automation of the recipe run.

Editing recipe parameters

➢ Use the following menus to edit the parameters for the automatic process:
- «Automatic > Recipe»: Parameters for the CSF speed
- «Automatic > Recipe GEN»: Parameters for the sputtering sources
- «Automatic > Recipe MFC»: Parameters for the gas supplies
- «Automatic > Recipe PT»: Parameters for the throttling of the pump power
- «Automatic > Heater»: Parameters for the substrate heaters

The software accepts no parameter values out of the permitted range. This protects the system from damage.

Saving a recipe
Proceed as follows to save the recipe parameters:

1 Check the current recipe parameters in the «Automatic» menus

2 Select the «Automatic > Recipe» menu.

3 In the «Navigation» area, select a recipe ID and enter the recipe name /Record).

4 In the «Current Record» area, press the [Safe recipe] button.

The parameter set is saved with the selected recipe name and the appropriate ID number.

Updating recipe parameters
If testing has yielded a favorable parameter combination for the currently loaded recipe, these parameters may be stored directly into the recipe:

1 Check the current process parameters on the relevant overview screen pages.

2 Select the «Automatic > Recipe» menu.

3 In the «Current Record» area, press the [PLC → Edit] button.

The parameters are written from the control in the recipe. Note that the old parameters are overwritten at the moment only and to get lost without storing.

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Loading a recipe
Proceed as follows to start the recipe:

1 Select the «Automatic > Recipe» menu.

2 Select the required recipe.

3 In the «Current Record» area, press the [load recipe] button

4 Check the current parameters on the relevant overview screen pages.

5 In the «Current Record» area, press the [Edit → PLC] button (to write the recipe in the control).

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7 Maintenance

This chapter provides an overview of all the measures necessary for the maintenance of the A1500V-7.

The system can be operated with a minimum of difficulty when the measures for preventative maintenance and the specified working conditions and regulations are adhered to.

7.1 Safety information

When maintenance work is being carried out, personnel will spend a certain amount of time in dangerous areas of the system.

NOTE!
Before carrying out maintenance work on the A1500V-7, the appointed personnel must have read and fully understood Chapter 2 Safety, 🗎 31.

In particular, the safety instructions contained in Chapter 2.7 Hazards, 🗎 48 must strictly be adhered to.

⚠CAUTION

Risk of injury.

Some maintenance and service work requires personnel to access danger areas in and around the system.

- ➢ Wear safety boots and work clothes with long sleeves if carry out maintenance and service work.
- ➢ Wear protective gloves, protective goggles and an approved protection mask against fine dust.
- ➢ Do not use magnetized tools when working on the cathodes.

NOTE!
Responsibility of the user:
- **All work is carried out in accordance with the system maintenance plan**
- **The maintenance personnel have completed the training and instruction necessary for this work**

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7.2 Locking out system components

Components of the A1500V-7, which can pose a hazard must be decoubled from the power before maintenance and service work.

7.2.1 Basic rules

DANGER

Risk of electrical shock!
When working on electrical equipment the main switch have to be off and secured.

Observe the following safety rules:

- Disconnect mains
- Prevent reconnection
- Test for absence of harmful voltages
- Ground and short circuit
- Cover or close off nearby live parts

All work on the electrical equipment may only be performed by trained electricians

DANGER

Risk of electrical shock!
During work when the energy supplies are switched on

Some maintenance work requires the energy supply to be switched on (e.g., current or compressed air).

In this case:

- All work on the electrical equipment may only be performed by trained electricians.
- Proceed with utmost caution.
- Exactly adhere to the instructions in the relevant descriptions.

Personnel must access danger areas in and around the system to perform maintenance and service work. It may be necessary to remove protective covers. For reasons of safety, proceed as follows before you perform any maintenance or service work:

1 Vent the module chamber when planning to perform any maintenance work on it.

2 Vent the vacuum pumps when planning to perform any maintenance work on them.

3 The system has more than one type of primary energy and several sources of the same primary energy, e.g., current, compressed air, gas, water etc.
SHUT THEM ALL OFF! See Chapter 7.2.2 Lockout locations, 170.

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4 The system has several sources of **stored** energy, including movement, heat, capacitors, overpressure, etc.
REMOVE THIS ENERGY! See Chapter 7.2.2 Lockout locations, 170.

5 Do not perform any work on the system until you have fully understood the method of the procedure described in the lockout table, see Chapter 7.2.2 Lockout locations, 170

6 Attach a tag to every lockout location. This tag has to warn other persons that the component in question may not be switched on until the tag is removed by the authorized person. Tags must be in a language that everyone understands. The tag must provide the following information (see Fig. 7-2, 170):
- Warning text or prohibitive sign
- Name and telephone number of responsible person
- Date and time when component was locked

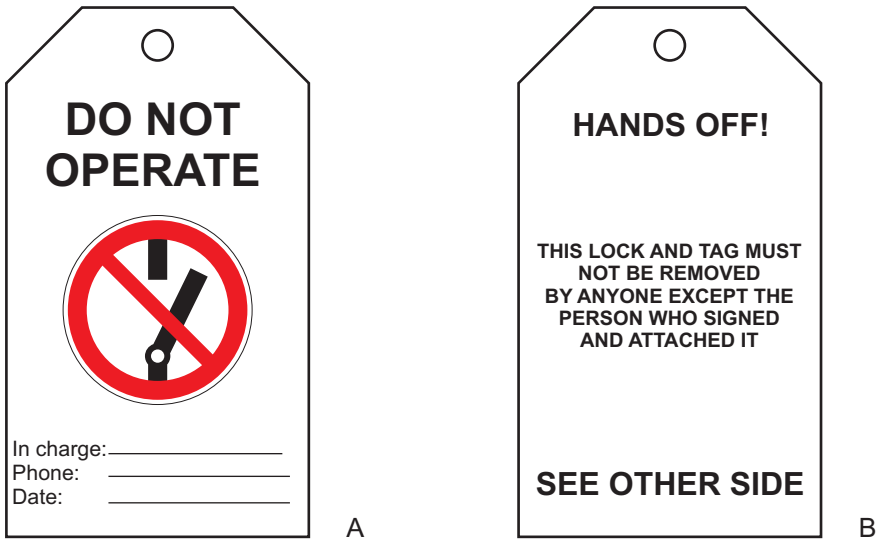

Fig. 7-1 *Lock tag (example)*

A front side *B Back side*

7 In the absence of further details, make sure you check the following before you resume system operation:
- All protective covers must be remounted correctly
- All parts, which do not belong to the system, must be removed
- All protective conductors must be reconnected

8 Perform a system safety check.

9 Perform all the steps in the lockout procedure in the reverse order and inform all concerned employees.

10 If you are uncertain about any part of the lockout procedure, get advice or contact your responsible safety official.

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7.2.2 Lockout locations

The diagram below shows all the locations at the A1500V-7 with connections which must be locked out. The symbols are explained in the lockout table.

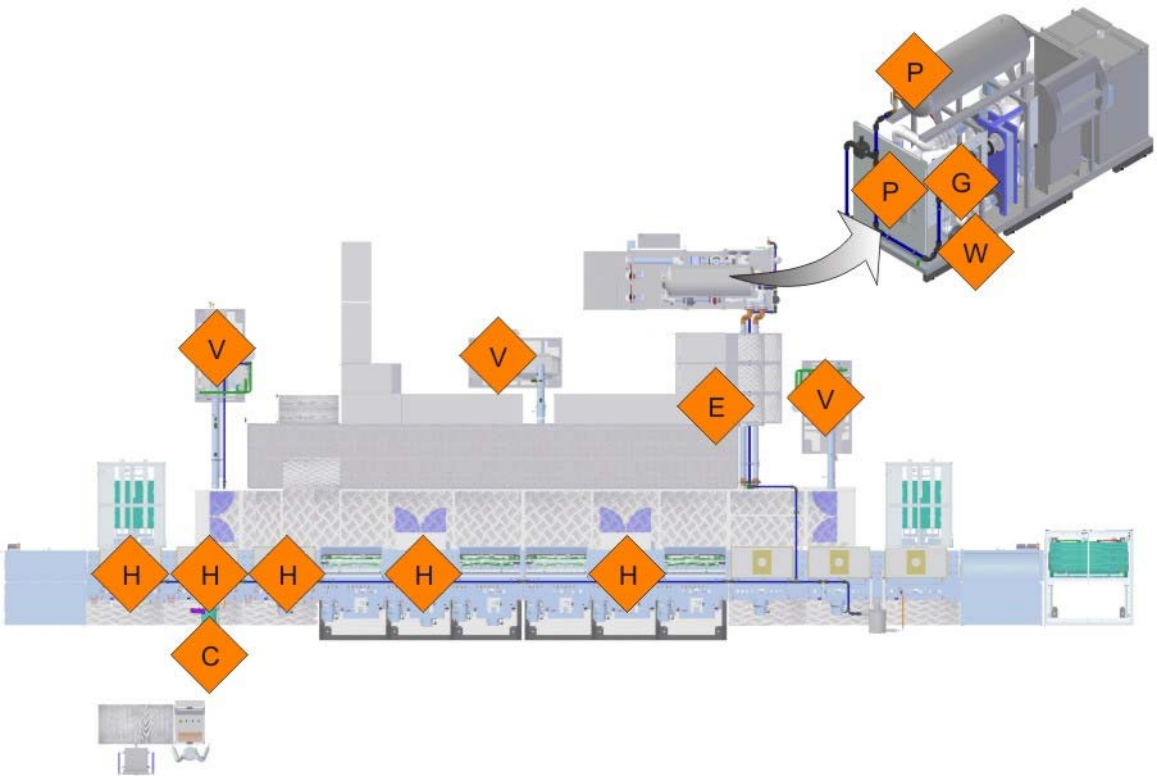

Fig. 7-2 *Lockout locations (view from above)*

NOTE!

➢ **Shut off or dismantle the various energy supplies in the exact order specified in the shut-off table.**

Energy type and source	Lockout location: Symbol explanation	Lockout or discharge procedure for energy sources	Check procedures
Vacuum	**V** Roughing pumps	Vent the system	
Heat	**H** ▪ Load lock module L1 ▪ Buffer module B1 and B2 ▪ Process modules P1 and P2 ▪ Carrier ▪ Substrates	Give the hot parts and surfaces sufficient time to cool down.	The temperature must be below 30°C to perform maintenance work at the modules.

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Energy type and source	Lockout location: Symbol explanation	Lockout or discharge procedure for energy sources	Check procedures
Cold	**C** Cryo pumps Polycold	Switch off the cryo pump and give the cold parts and surfaces sufficient time for warming up. Regenerate the cold trap, see Chapter 7.2.7, 174	The temperature must be above 0°C to perform maintenance work at the cryo pump and the pipes.
Electricity	**E** Main switch	Switch the main switch at the main distribution cabinet CCMS from «I» to «0». Padlock the switch and mark it, see Chapter 7.2.4, 172. Discharge all adjacent parts that might carry residual voltage with the grounding rod, see Chapter 2.8, 61.	Make sure that all components (pump drives, etc.) have been brought to a complete standstill and that no system functions may be started.
Compressed air	**P** Shut-off valve for Compressed air - pneumatic Shut-off valve for Compressed air - venting	Close the shut-off valve off at the maintenance unit and open the drain valve, see Chapter 7.4, 196. Close off the shutoff-valve at the compressed air supply (customer site) and mark the valve.	Make sure that the shut-off valve is closed completely and that the system is unpressurized (zero pressure reading).
Water pressure	**W** Shut-off valve for water inlet and water outlet	Close the inlet valve first. Wait until the pressure readings for inlet/outlet are stable. Then close the outlet valve and mark the valves.	Make sure that each of the shut-off valves is closed completely and that the system water pressure is zero.
Process gases and venting gas	**G** Shut-off valves for gas supply	Close the input valves and mark them, see Chapter 7.2.3, 172.	Make sure that each of the shut-off valves is closed completely and locked.

Tab. 7-1 *Lockout table*

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7.2.3 Locking out the gases

1 Locate the shut-off valve in the affected gas supply line at the customer side.

2 Switch the shut-off valve off.

3 Make sure that there is no gas flow:

3.1 Make sure that the gas supply for the relevant line is switched off.

3.2 Make sure that the gas flow at the GUI shows «0.0»e.

4 If necessary, empty the affected gas supply line.

5 Attach a lock tag to the lockout location, see Fig. 7-1, 169.

7.2.4 Locking out the main power

The voltages used by the A1500V-7 can cause injury or death. To avoid injury to personnel and damage to the equipment, using an approved lock out/tag out device on the main switch at the main distribution plate is recommended. This secures the main switch during maintenance of the electrical system.

Example devices:

- Pad lock
- Hasp with one or more padlocks
- Lock-out tag

The following is the recommended method of performing a lockout on the main power switch for the A1500V-7:

1 Vent all system chambers and/or put them in a safe state so that the system modules can be powered down (i.e. close gates, etc.).
- Use the system software if necessary, then shut the software down.

2 Power down all system pumps, blowers, heat exchangers, and any other support equipment powered by means of the separate power supplies.

3 Power down all separate power supply units around the system by switching off the appropriate breaker(s).

4 Set the main switch to the «OFF» position.

5 Fasten the lockout device onto the switch.

6 Tag the lockout device, see Fig. 7-1, 169.

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7.2.5 Locking out the pneumatic valves

The A1500V-7 uses the following pneumatically operated valves which can be a potential danger when performing chamber maintenance:

- sluice valves to isolate adjacent vacuum chambers
- gate valves to isolate the cryo pump from the vacuum chamber B1

To avoid crushing injuries to personnel and/or damage to the equipment, these valves should be manually disabled.

Proceed as follows:

➢ Sluice valve:
Lock the compressed air supply, see Chapter 7.2 Locking out system components, 🗎 168. If the compressed air is to remain switched on during the maintenance work, the pneumatic drives of the sluice valves can be switched off with the key switch «Enable gate valve», see Chapter 5.6.6 Key switches, 🗎 132.

➢ Gate valve:
Separate the gate valves from the compressed air supply.

NOTE!
Do not put screws or other iron parts down on the pneumatic cylinders. they might interfere with the position indicator.

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7.2.6 Locking out the compressed air supply

Locking out the compressed air for the pneumatic and to blow-out

1 Close the shutoff valve (1) at the maintenance unit.
(Unlocking: pull the valve up)

2 Depressurize the compressed air system by opening the drain valve (2) at the bottom of the compressed air tank.

3 Make sure that the shut-off valve is closed completely and that the system is unpressurized (pressure reading: «0»)

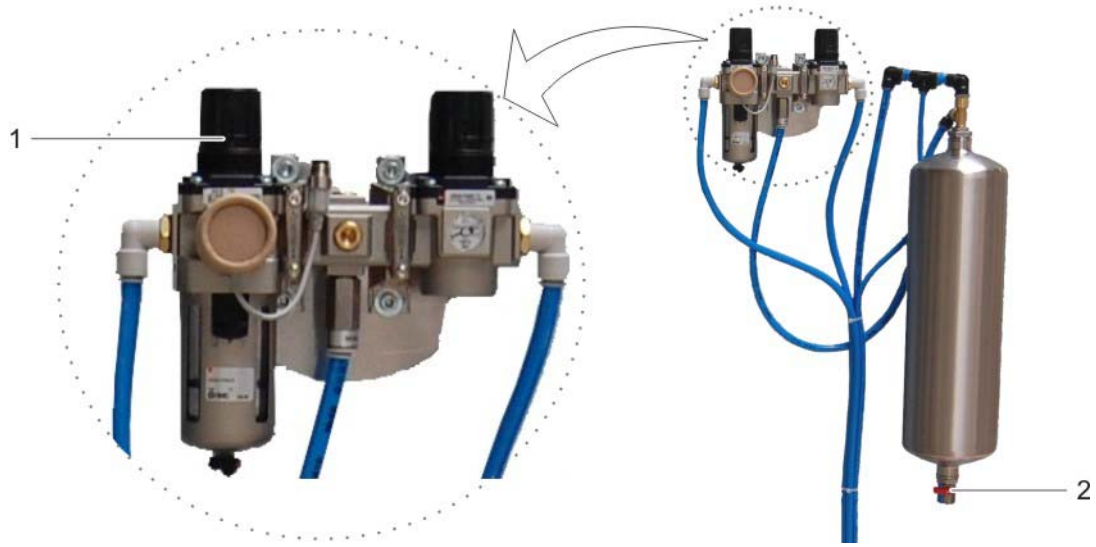

Fig. 7-3 *Switching off compressed air supply*

1 Shutoff valve at the maintenance unit *2 Drain valve at the compressed air tank*

Locking out the compressed air for venting
A compressed air tank, which provides the required pressure compensation to lock in and to lock out, is supplied from the house service connection.

1 Close the shutoff valve at the compressed air tank

2 Depressurize the compressed air system by opening the drain at the bottom of the compressed air tank.

3 Make sure that the shut-off valve (at house service connection) is closed completely and that the system is unpressurized (pressure reading: «0».

7.2.7 Regenerating a cold trap

1 GUI: Select the «vacuum> overview» menu, see Software-Handbook.

2 GUI: Press the associated cold trap icon and select «regenerate» in the context menu.

3 Wait until the cold trap is at room temperature.

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7.3 Maintenance plans

The design of the A1500V-7 minimizes the maintenance work requirement. If you adhere to the normal operating conditions, most of the components do not require any maintenance. It is sufficient to carry out visual checks at regular intervals. However, you should always pay attention to unusual sounds or malfunctions in the system between audits.

NOTE!
Some maintenance plans included apply to optional system components. Therefore the maintenance work is only relevant when the system is equipped with the applicable components.

7.3.1 Using the maintenance documents

The maintenance documents for the A1500V-7 mainly consist of:

- Maintenance plan
- Maintenance instructions

Maintenance plan
The maintenance plan provides an overview of the maintenance work to be carried out on the A1500V-7 system.

The maintenance work on the system is assembly-oriented for all the components to be maintained. Each maintenance plan has a tabular form, lists the component to be maintained, the work to be carried out and the maintenance intervals.

Maintenance Interval “Inter.”
Shows the cycle for maintenance work
h = Operating hours
d = Daily
w = Weekly
m = Monthly
a = Annual
p = Process dependent
* = Depending upon degree of contamination

Personnel “Pers.”
Shows who is responsible for carrying out maintenance work
OP = Operating personnel
MP = Maintenance personnel
SP = Service personnel
LO = Personnel “Leybold Optics”

Component/task	Inter.	Pers.	Remarks/Instructions
Venting valve ➢ Clean the filter element	3 m	MP	See Chapter 7.3.1

Fig. 7-4 Maintenance plan (example)

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Maintenance instructions
Comprehensive maintenance work is indicated by a cross-reference in the «Remarks/instructions» column of the maintenance plan. Such work is described in more detail in Chapter 7.4 Maintenance instructions, 196.

Maintenance intervals
The test and maintenance intervals indicated are the compulsory minimum requirements for normal system operation. Normal system operation amounts to 24h-operation 7 days a week.

Maintenance verification
Leybold Optics recommend the recording of all maintenance work in a logbook. Especially when several people are responsible for the maintenance of the system, this provides a reliable check which maintenance work was carried out and when.

NOTE!
In case of troubles on the A1500V-7 during guarantee Leybold Optics reserves the right to inspect the verifications of the carried out maintenance work.

- **The guarantee can go out if no maintenance work were carried out and/or there are no verifications of it.**

Responsibility
The maintenance plan only describes maintenance work that can be carried out by the operating firm. For work indicated by LO in the «Personnel» column of the maintenance plan, please contact Leybold Optics, see Chapter 2.10 Leybold Optics Service, 63.

Using the supplier's documentation
The maintenance and service of individual components of the system is described in detail in the supplier's documentation of the manufacturer.

Maintenance work to which the supplier's documentation is referred to has to be carried out in strict adherence to the information in the relevant operating instructions, see Chapter 1.1.4 Use of these Operating Instructions, 13.

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7.3.2 Turbo pump «HiPace S-2300» and «HiPace S-1200»

Only carry out maintenance work in conjunction with the supplier's documentation on CD 1.

Component/task	Inter.	Pers.	Remark/instructions
Turbo pump ➢ Check for unusual running noise	w	OP	To indicate of bearing damaged.
Oil ➢ Change	4 a	MP	Oil: F3 Refer to supplier's documentation.
Oil pump ➢ Clean ➢ Replace	*	MP	*) If, after a malfunction on account of insufficient oil, the pump no longer accelerates to the operating rotation speed, the oil pimp has to be cleaned or replaced. Refer to supplier's documentation.
Bearings ➢ Replace	4 a	LO	Only by LO service personnel.
Electronic Drive Unit TC 1200 ➢ Replace	*	MP	*) Pump does not start; None of the integrated LEDs glow on the TC 1200. Refer to supplier's documentation.
Silencer ➢ Clean ➢ Replace	 3 m 4 a	 MP MP	

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7.3.3 Cryo pump «onBoard 10» and Compressor «9600»

Only carry out maintenance work in conjunction with the supplier's documentation on CD 1.

Component/task	Inter.	Pers.	Remark/instructions
Cryo pump			
➢ Regenerate	p	OP	See Chapter 7.4.9, 🗎 222
➢ Clean	p	MP	Follow the procedures in the supplier's documentation.
Compressor			
➢ Check helium pressure and refill helium if necessary	m	MP	Check helium pressure in the off state - 16.5-17.2 bar. Helium refill, if the pressure under the minimum pressure. Refer to supplier's documentation.
➢ absorber replace	3 a	MP	Refer to supplier's documentation.

7.3.4 Oil-free Scroll pump «SC30D»

Only carry out maintenance work in conjunction with the supplier's documentation on CD 1.

Component/task	Inter.	Pers.	Remark/instructions
Bearings ➢ grease, replace it if necessary	a	SP	Refer to supplier's documentation.
Seals ➢ replace it if necessary	a	SP	Refer to supplier's documentation.

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7.3.5 Roots pump «RUVAC WSU 2001»

Only carry out maintenance work in conjunction with the supplier's documentation on CD 1.

Component/task	Inter.	Pers.	Remark/instructions
Oil level ➢ Check the level at the inspection glass and top it up, if necessary.	d	OP	Check before switching on the pump, and during operation. Oil: Anderol 555 Refer to supplier's documentation.
Oil quality ➢ Check the condition of the oil and change it, if necessary.	d	MP	Check before switching on the system. Normally the oil is clear and transparent. Change the oil if it looks dark. Oil: Anderol 555 Refer to supplier's documentation.
Oil ➢ Change the oil.	* 3000 h	MP	*) 1. Oil change: 500 h Oil: Anderol 555 Change the oil more frequently when pumping corrosive vapors or large amounts of dust or when frequently cycling from atmospheric to operating pressure Refer to supplier's documentation.
Pressure difference valve ➢ Clean the valve and the pressure balance line.	3 m	MP	Refer to supplier's documentation.
Dirt trap in the intake manifold ➢ Check and clean the dirt trap.	3 m	MP	A wire gauze is located in the intake port to collect foreign objects. It should be kept clean in order to avoid a reduction of the pumping speed. Refer to supplier's documentation.
Pump chamber/roots vacuum ➢ Check for dirt and deposits.	a	MP	If necessary, clean with cleaning materials or compressed air. Refer to supplier's documentation.
Fan and cooling ribs ➢ Clean the fan and the cooling ribs.	a	MP	In order to ensure a sufficient air flow for the motor and the pump's casing, the fan must be cleaned with a vacuum cleaner or clean brush when contaminated. Any coarse dirt should be removed from the cooling ribs of the motor and the pump.

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7.3.6 Rotary vane pump «SOGEVAC SV 40»

Only carry out maintenance work in conjunction with the supplier's documentation on CD 1.

NOTE!

➢ **Prior to performing maintenance work on the rotary vane pump, switch the circuit breaker off.**

Component/task	Inter.	Pers.	Remark/instructions
Oil level ➢ Check the level at the inspection glass and top it up, if necessary.	d	OP	The pump's oil level during operation must always be between the middle and top edge of the oil-level glass. If necessary, switch the pump off and add the correct quantity of oil. Oil: Anderol 555 Refer to supplier's documentation.
Oil quality ➢ Check the condition of the oil and change it, if necessary.	d	MP	Check before switching on the system. Normally the oil is clear and transparent. Change the oil if it looks dark. Always change the oil filter by the oil changing. Oil: Anderol 555 Refer to supplier's documentation.
Oil and Oil filter ➢ Change oil filter and oil.	* 500 - 1000 h / 6 m	MP	*) 1. Oil change: 150 h Always change the oil when the pump is switched off but still at working temperature. Oil: Anderol 555 Refer to supplier's documentation.
Exhaust filter ➢ Replace the filter.	a	MP	Oil mist escaping form the exhaust during operation indicates that the filter is probably clogged. Refer to supplier's documentation.
Gas ballast valve ➢ Clean the valve.	m	MP	Refer to supplier's documentation.
Inlet flange sifter ➢ Clean	6 m	MP	Clean with an appropriate solvent or compressed air. Refer to supplier's documentation.

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Component/task	Inter.	Pers.	Remark/instructions
Anti-suck back valve ➢ Check the valve.	6 m	MP	Clean with an appropriate solvent or compressed air. Refer to supplier's documentation.
Fan cover ➢ Clean the fan cover.	6 m	MP	Soiling of fan cover may lead to overheating of the motor and the pump. Refer to supplier's documentation.
Condensate separator ➢ Dehumidify the condensate separator.	p	MP	To dehumidify the pump from condensate, it has to be separated from the system with the shut-off valve. Please note that process gases and condensate may present a hazard to health. Refer to supplier's documentation.

7.3.7 Cold traps and Polycold

Only carry out maintenance work in conjunction with the supplier's documentation section of the technical handbook on CD 1.

Component/task	Inter.	Pers.	Remark/instructions
Refrigerant pipes ➢ Check for ice formation ➢ Check for non-isolated areas	P	MP	Regenerate cold trap if ice is formed on the pipes. Repair the isolation of the pipes. Refer to Polycold supplier's documentation.
Cold trap ➢ Check for ice formation	P	MP	Regenerate the pump if necessary. Refer to Polycold supplier's documentation.
Polycold ➢ Carry out required maintenance		MP	Refer to supplier's documentation.

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7.3.8 Screw pump «ScrewLine SP 630 F»

Only carry out maintenance work in conjunction with the supplier's documentation on CD 1.

Component/task	Inter.	Pers.	Remark/instructions
Oil level ➢ Check the level at the inspection glass and top it up, if necessary.	d	OP	The intervals between the regular checks should be based on the ambient conditions and your experience. Oil: Anderol 555 Refer to supplier's documentation.
Oil and Oil filter ➢ Change oil filter and oil.	a	MP	Change the oil while it is still warm and only while the pump is a standstill. Oil: Anderol 555 Refer to supplier's documentation.
Oil cooler ➢ Inspect the oil cooler for accumulated dirt and clean it, if necessary	p	MP	A dirty cooler may cause increased oil and pump temperatures and impair operation and reduce the service life of the pump. Refer to supplier's documentation
Cooling water supply ➢ Check the pressure at the inlet.	d	MP	The water pressure must not exceed the allowed maximum pressure. Refer to supplier's documentation.
Exhaust silencer ➢ Inspect and clean it, if necessary ➢ Draining out condensate	p	MP	Refer to supplier's documentation.
Dust filter (optional) ➢ Inspect, clean and change, if necessary.	p	MP	Refer to supplier's documentation.
Screw rotors ➢ Inspect and clean	p (6 m)	SP	Training by pump manufacturer required.
Pump chamber ➢ Inspect and clean	p (6 m)	SP	Training by pump manufacturer required.

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Component/task	Inter.	Pers.	Remark/instructions
Axial bearings ➢ Change	p (2 a)	SP	Training by pump manufacturer required.
Full-Service	43000 h	SP	Only authorized service personnel.

7.3.9 Vacuum valves

Only carry out maintenance work in conjunction with the supplier's documentation to the correspondent component, see supplier's documentation on CD 1.

Component/task	Inter.	Pers.	Remark/instructions
Venting valves			
➢ Clean the silencer	3 m	MP	
➢ Replace the silencer	4 a	MP	
Sluice valves			
➢ Visually check the seals and replace valve, if necessary.	*	MP	*) to every target change See Chapter 7.5.2, 🗎 232.
➢ Check functionality.	3 m	MP	
Vacuum valves ➢ Make sure that the valves are working and replace them, if necessary.	3 m	MP	Normal: no noticeable flow noises.
Gate valves			
➢ Check if the valves are functioning and replace them, if necessary.	3 m	MP	Refer to supplier's documentation.
➢ Visually check the seals and replace valve, if necessary.	3 m	MP	Clean sealing and sealing surfaces. Change damaged sealings. See Chapter 8.2.8, 🗎 271

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7.3.10 Vacuum gauges

	Only carry out maintenance work in conjunction with the supplier's documentation to the correspondent component, see supplier's documentation on CD 1.

Component/task	Inter.	Pers.	Remark/instructions
Pirani Transmitters (Loadlock-Transducer 901P-11)			Refer to supplier's documentation.
➢ Calibrate the transmitter.	2 w	MP	If pressure varies.
➢ Clean and replace the transmitter, if necessary.	6 m	MP	Use organic solvents, such as Isopropanol.
➢ Check plug and connecting cable.	6 m	MP	
Wide Range Vacuum Measuring System (HPT100)			Refer to supplier's documentation.
➢ Calibrate transmitter	3 m	OP	If pressure varies.
➢ Clean transducer	1 -4 w	OP	The frequency of the degassing depends on the degree of contamination during the process and the operation time. The degassing can be started by the „DEGAS" function, see Software-Handbook.
➢ Check plug and connecting cable.	6 m	MP	
Baratron Transmitter (628B.1MDF4B)			Refer to supplier's documentation.
➢ Clean and overhaul	a	MP	Use organic solvents, such as Isopropanol.
➢ Adjust the zero point.	p	OP	

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7.3.11 Vacuum chambers

Only carry out maintenance work in conjunction with the supplier's documentation on CD 1.

Component/task	Inter.	Pers.	Remark/instructions
Process chamber doors			
➢ Check the vacuum sealings for dirt or damage.	p	MP	See Chapter 7.5.2, 🗎 232. Change damaged sealings.
➢ Check the opening/closing device.	p	MP	Check the opening/closing device for unusual running noise. Refer to supplier's documentation.
➢ Check the shock absorber for oil leaks.	p	MP	If oil leaks, replace the shock absorber with a new or overhauled model. Refer to supplier's documentation.
➢ Replace the shock absorber with a new or overhauled model.	10 a	MP	Refer to supplier's documentation.
Process chamber interior ➢ Clean the process chamber	p	MP	See Chapter 7.5.4, 🗎 245.
Chamber view ports ➢ Clean the view ports and check them for damage ➢ Replace protective glass	p	MP	Do not use aggressive solvents. Replace damaged view ports immediately. See Chapter 7.5.3.9, 🗎 244.
Shutters of the view ports ➢ Clean the shutters.	p	MP	After installing check there is no collision See Chapter 7.5.3, 🗎 235.
Shielding plates and shutters ➢ Clean	p	MP	See Chapter 7.5.3, 🗎 235.
Chamber lamp ➢ Check and replace the lamp, if necessary.	3 m	MP	See Chapter 8.2.8, 🗎 271.
Leakage test ➢ Check the vacuum chambers for leaks.	3 m	MP	See Chapter 7.4.13, 🗎 228 **NOTE!** The cryo pumps on B1 have to switched off.

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7.3.12 Ion source

Component/task	Inter.	Pers.	Remark/instructions
Electrodes ➢ Clean cathode and anode surface	p	MP	See Chapter 7.4.8, 🗎 215.
Cathode ➢ Check for wear and tear	p	MP	Contact Leybold Optics when replacing the cathode is necessary.
Ion source interior ➢ Clean	p	MP	See Chapter 7.4.8, 🗎 215.
Sealings ➢ Check the sealings for dirt or damage	p	MP	Clean sealing and sealing surfaces. Change damaged sealings. See Chapter 7.5.2, 🗎 232

7.3.13 Planar magnetron

Component/task	Inter.	Pers.	Remark/instructions
Target ➢ Change the target.	p	MP	When the target lifetime has been reached (screen page «Process > XXMAG»). See Chapter 7.4.8, 🗎 215.
Cooling membrane ➢ visual inspection ➢ Replace damaged membrane	p*	MP	*) To every target change See Chapter 8.2.1, 🗎 249.
Sealings ➢ Check the vacuum sealings for dirt or damage. ➢ Replace damaged sealings	p	MP	See Chapter 8.2.1, 🗎 249.

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7.3.14 Rotary magnetron

Component/task	Inter.	Pers.	Remark/instructions
Target ➢ Change the target.	p	MP	When the target lifetime has been reached (screen page «Process > PXMAGxx»). See Chapter 7.4.8, 🗎 215.
Water circuit ➢ Check the water leak detection	d	OP	See Chapter 7.4.11 Checking the water supply, 🗎 225.
End block ➢ Change the sealings	a	MP	Clean sealing surfaces. Change damaged sealings.
➢ Check the sealings	m	MP	Refer to supplier‘s documentation.
➢ Check toothed belt for damage and correct tension.	m	MP	Replace the toothed belt and/or adjust its tension, if necessary.
➢ Change Toothed belt	2 a	MP	Refer to supplier‘s documentation.
Magnet bar ➢ Inspection	*	MP	*) to every target change Check for damages.
Drive motor ➢ Check for unusual running noise.	m	MP	Refer to supplier‘s documentation.
Shields ➢ Clean the shields	p	MP	See Chapter 7.5.3.3, 🗎 239.

7.3.15 Coupling elements

Component/task	Inter.	Pers.	Remark/instructions
Screws and nuts ➢ Check the screws and nuts and tighten them, if necessary.	3 m	MP	See Chapter , 🗎 176

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7.3.16 Transfer modules T1 and T9

	Only carry out maintenance work in conjunction with the supplier's documentation to the correspondent component, see supplier's documentation on CD 1.

Component/task	Inter.	Pers.	Remark/instructions
Carrier ➢ Check and clean the carrier.	w	MP	Check each substrate carrier for damage, exchange pins if necessary. Check the isolation resistance between the lower or upper rail and the carrier frame. Refer to supplier's documentation. Replace substrate carriers, if necessary.
Drive motor ➢ Check drive motor for unusual running noise.	w	MP	Refer to supplier's documentation.
Toothed belt ➢ Check belt for damage and correct tension.	w	MP	Replace the toothed belt and/or adjust its tension, if necessary. Refer to belt tension.
Linear guiding ➢ Clean ➢ Lubricate	 m 4 m	 OP MP	Remove cullet, dirt, and so on out of the guiding rail by a vacuum cleaner roller bearing grease on lithium base (dynamic viscosity 4500 mPas)

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7.3.17 Transport system

	Only carry out maintenance work in conjunction with the supplier's documentation to the correspondent component, see supplier's documentation on CD 1.

Component/task	Inter.	Pers.	Remark/instructions
Transport rollers ➢ Check transport rollers for correct installation and for wear and tear.	m	MP	Inspect the inside rollers on the opened chamber, e.g target change. Align or replace transport rollers, if necessary, see Chapter 8.2.3, 255
Driving motors ➢ Check for unusual running noise.	m	OP	Refer to supplier's documentation.
Planetary gear ➢ Check for unusual running noise	m	OP	Refer to supplier's documentation.
Rotary feedthrough ➢ Clean	m	MP	Refer to supplier's documentation.
Toothed belts ➢ Check belts for wear and tear and tension.	m	MP	Replace the toothed belt and/or adjust its tension, if necessary. Refer to belt tension.

7.3.18 Loading and Unloading modules

	Only carry out maintenance work in conjunction with the supplier's documentation to the correspondent component, see supplier's documentation on CD 1.

Component/task	Inter.	Pers.	Remark/instructions
Conveyer- and transportation belts ➢ Control for free movement, belt pre-stressing and a direct way, tightness of the transportation rolls and cleanness of the guiding elements	m	MP	Refer to supplier's documentation.
➢ Visual check for tearing and abrasion	d	OP	Refer to supplier's documentation.

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Component/task	Inter.	Pers.	Remark/instructions
Cables ➢ Control of the isolation	p	MP	Periodical control of the condition of the isolation especially the movable cables
Blower wheel ➢ Check filter pad within the blower wheel	m	MP	If necessary to be cleaned from the inside to the outside with pressured air.
Precision slide ➢ Check slide and the base plates for soiling. ➢ Check screw connections for a fix position.	m m	MP MP	The lubrication has to be made at the respective lubrication nipples according instruction of the manufacturer.
Pneumatic Cylinder ➢ Check for function and firm seat	p	MP	Lubricating when necessary. Refer to supplier's documentation.
Maintenance Unit ➢ Check whether pressure is set to 6 bar ➢ Check level of the condensate tank ➢ Check air filter	p p p	OP OP WP	If necessary to be drain and clean condensate tank. Clean air filter, if necessary
Suction gripper ➢ Check for soiling, plugging of the suction drills and damages at the suction lips	d	BP	Refer to supplier's documentation.
Vacuum generation ➢ Check	p	MP	Refer to supplier's documentation.
Valve cluster ➢ Check sound absorber	p	MP	If the buffer inlay is discolored yellowish/black or dark, it has to be cleaned or exchanged. Refer to supplier's documentation.

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7.3.19 Carrier depot

Component/task	Inter.	Pers.	Remark/instructions
Frame ➢ Check the screws and nuts and tighten them, if necessary.	a	MP	
➢ Wipe the linear guiding with fine mechanics oil.			An oil film protects the metal surfaces from corrosion. Make sure, that the carrier has no contact to lubricated parts.
➢ Check the snap rail for wear.			
Support ➢ Check screws and nuts and tighten them, if necessary.	a	MP	
➢ Check the guide rollers for running characteristics (no noises, concentricity).			
➢ Clean the guide rollers.			Clean them with a lint-free cloth.
➢ Check the function of the locking mechanism.			Smooth running, Backlash of the slide: ≤ 0.5 mm.
➢ Check carrier tension jack			Smooth running of the clamp, Backlash: ±1 mm
Carrier magazine ➢ Check screws and nuts and tighten them, if necessary	j	MP	
➢ Check the rollers of the bearing rail for wear and running characteristics (no noises, concentricity).			Align or replace rollers if necessary.
➢ Check the latches for function and smooth running.			
➢ Check the rollers of the roller conveyors for smooth and concentric running.			
➢ Check the carrier angle			Adjust it, if necessary.

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7.3.20 Gas supply

	Only carry out maintenance work in conjunction with the supplier's documentation to the correspondent component, see supplier's documentation on CD 1.

In addition to the tasks listed in the maintenance plans, the values specified in the technical data must be checked, see Chapter 1.4.2.2 Process and venting gases, 🗎 23.

Component/task	Inter.	Pers.	Remark/instructions
Gas pressure ➢ Check the inlet pressure.	d	OP	See Chapter 7.4.12, 🗎 227.
Gas stocks and gas bottles ➢ Check the fill level/pressure.	d	MP	
Gas lines ➢ Check for leakage.	w	OP	
Mass flow controllers ➢ Check	m	OP	
Filter ➢ Clean	a	MP	

7.3.21 Compressed air supply

	Only carry out maintenance work in conjunction with the supplier's documentation to the correspondent component, see supplier's documentation on CD 1.

In addition to the tasks listed in the maintenance plans, the values specified in the technical data must be checked, see Chapter 1.4.2.3 Compressed air, 🗎 23.

Component/task	Inter.	Pers.	Remark/instructions
System pressure ➢ Check and set the pressure, if necessary.	d	OP	See Chapter 7.4.10, 🗎 224.
Entire system ➢ Check for leaks.	w	OP	
Filter ➢ Check and replace it, if necessary	3 m	MP	

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7.3.22 Water supply

	Only carry out maintenance work in conjunction with the supplier's documentation to the correspondent component, see supplier's documentation on CD 1.

In addition to the tasks listed in the maintenance plans, the values specified in the technical data must be checked, see Chapter 1.4.2.5 Water supply, 🗎 24.

Component/task	Inter.	Pers.	Remark/instructions
Water pressure ➢ Check the inflow and outflow pressure.	d	OP	See Chapter 7.4.11, 🗎 225.
Water temperature ➢ Check the inflow and outflow temperature.	d	OP	
Water tank ➢ Check the fill level	d	OP	
Valves and flow controllers ➢ Check functionality	m	MP	
Water quality ➢ Check it	m	MP	check pH-value manually and calibrate 3D TRASAR
Water filters ➢ Check and clean the filters. ➢ Backflush the filters. ➢ Replace filter and seals.	 m 2 m 4 a	 MP MP MP	
Water hoses ➢ Inspect the water hoses for cuts and porous sections and replace it, if necessary	6 m	OP	
Heat exchanger ➢ Clean	*	MP	*) If the differential pressure rises above the specified pressure, see Chapter 1.4.2.5, 🗎 24.
Entire system ➢ Check for leaks.	m	MP	Refer to supplier's documentation.

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7.3.23 Electrical equipment

Only carry out maintenance work in conjunction with the supplier's documentation to the correspondent component, see supplier's documentation and circuit diagram on CD 1.

In addition to the tasks listed in the maintenance plans, the values specified in the technical data must be checked, see Chapter 1.4.2.1 Electrical supply, 22.

Component/task	Inter.	Pers.	Remark/instructions
Protective conductor system ➢ Check the entire system.	a*	SP	*) this interval is recommended by Leybold Optics Adhere to local regulations.
Complete electrical test ➢ Test the system.	a*	SP	*) this interval is recommended by Leybold Optics Adhere to local regulations.
Grounding rods ➢ Check the grounding rods.	a*	SP	*) this interval is recommended by Leybold Optics Adhere to local regulations. Check the functionality of the grounding rods.
Safety circuits ➢ Make sure that the safety circuits are working.	6 m	MP	Make sure that the EMO buttons and the safety locking are working.
Uninterruptable power supply (UPS) ➢ Check the battery.	p	SP	If the UPS fails the self-test the «replace battery» LED illuminates and the battery should be replaced. Refer to supplier's documentation
Programmable Logic Controllers (PLC) ➢ Check the battery.	p	SP	Change the battery, if required. Refer to supplier's documentation.
Operator terminal ➢ Clean the screens	p	OP	Only clean the screens when the monitors are switched off.
Electrical cabinets ➢ Check the condensate draining facility of the air/water exchanger.	p	SP	The condensate is channeled to the drain gutter through hoses at the back of the air/water exchangers. Refer to supplier's documentation.
Module distribution cabinets ➢ Clean filter pads ➢ Check if filter fans are functioning	*p	SP	*) Depending on contamination efficiency. Clean filter pad with compressed air. Replace it, if necessary.

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7.3.24 Safety equipment

Only carry out maintenance work in conjunction with the supplier's documentation to the correspondent component, see supplier's documentation and circuit diagram on CD 1.

Component/task	Inter.	Pers.	Remark/instructions
Safety switch door ➢ Visual inspection ➢ Check for tight fit	 * m	MP	*) by every opening
Safety switch cover ➢ Visual inspection ➢ Check for tight fit	 * m	MP	
Door signal lamp ➢ Visual inspection ➢ Check for tight fit	 * m	MP	
Signal tower ➢ Check	m	MP	Test in the menu «Service > System», button [check signal light and horn]. Refer to supplier's documentation.
Buzzer ➢ Check	m	MP	
Sputtering power supply ➢ Check interlock deactivation	a	MP	Refer to supplier's documentation.

7.3.25 Safety signs

Component/task	Inter.	Pers.	Remark/instructions
Entire system ➢ Inspect all safety labels on the A1500V-7. ➢ Replace any safety labels that are missing and any safety labels that are no longer legible.	a	MP	See Chapter 2.2, 🗎 36.

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7.4 Maintenance instructions

7.4.1 Required tools

- Wrench set
- Screwdriver set
- Allen wrench set
- Extractor, if applicable
- Spring-ring pliers
- Belt tension measurement instrument (Optibelt TTmini recommended)
- Torque wrench

Tightening torque

	For the tightening torque see instructions > torque on CD 1.

CAUTION

Damage through loose or overtorqued screwed connections.

Loose or overtorqued screwed connections may cause damage to the system components.

➢ Mount and check all screwed connections with a torque wrench.
➢ Do not use air impact wrenches.

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7.4.2 Recommended periodic inspections

The A1500V-7 should be inspected by trained maintenance personnel at regular intervals.

Interval	Controls
Daily inspections (inspection sequence with protocol)	**Process** ➢ Check for drifts: ▪ Process pressures and gas flows ▪ Cathode power ▪ Current ▪ Voltage ➢ Check substrates for: ▪ Arc tracks ▪ Color gradients (target material-dependent) ➢ Check the layer characteristics. **General system status** ➢ Make sure that: ▪ The transport is running smoothly ▪ The breaking of glass is uncommon ▪ The system components do not generate unusual noises ▪ No dirt accumulates in the substrate transport system inside and outside of the chambers
Weekly inspections	**Process** ➢ Check the characteristics of the film: ▪ Drift of the transmission (target material-dependent) ▪ Resistance ▪ Thickness **Vacuum** ➢ Check the fore-vacuum pumps for: ▪ Extra high temperature ▪ Unusual noises ▪ Oil level and oil color
Monthly inspections	**General system status** ➢ Check these components: ▪ Toothed belts of the transport system ▪ Transport bearings of the upper guiding rails of the transport system ▪ Water supply for leakages ▪ Sputtering power supplies for abnormalities ▪ Check helium pressure at the compressor

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7.4.3 Blowing out the water circuits

7.4.3.1 General information on blowing out water circuits

The water circuits must be blown out when:

- A target is being changed.
  In this case the fully automatic blow-out routine can be started with the visualization software.
- A water-cooled component is being removed.
  In this case the relevant water manifold can be separated from the water supply using the shut-off valves located in the module frame, see Media.
- The system is being shut down.
  In this case the entire system can be separated from the water main supply using the shut-off valves at the water supply.

Safety information

➢ The following safety measures and conditions apply to the blowing out of the water circuits.

⚠WARNING

Eye or skin injuries when opening pressurized system parts (water supply, process gas supply and compressed air system).

⚠CAUTION

Bursting components by excessively high air pressure.

Excessively high air pressure can damage components when blowing out the water circuit.

➢ Before starting the blowing out process, check the air pressure in the blow out circuit. The maximum blow out pressure must not exceed 2 bar.

NOTE!

➢ **Only blow out the water circuits when the user circuit is switched off. This means that the components connected to the water circuit in question (i.e. magnetrons, carrier drive) must be switched off.**

➢ **Only blow out a water circuit in conjunction with the water circuit diagram.**

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General procedures

- The water circuits of the magnetron cathodes are blown out by running a fully automatic blow-out routine that is started with the visualization software, see Chapter 7.4.3.2 Blowing out the water circuits of the magnetrons, 199
- All other water-cooled components are blown out by opening and closing the appropriate shut-off valves manually, see Chapter 7.4.3.3 Blowing out the water circuits manually, 201

7.4.3.2 Blowing out the water circuits of the magnetrons

Prerequisites

- The rotary magnetron is in vertical position (service door closed).
- You have read and fully understood Chapter 7.4.3.1 General information on blowing out water circuits, 198.

Blowing out the water circuit

1 GUI: Select the menu «Medien > PXMAG».

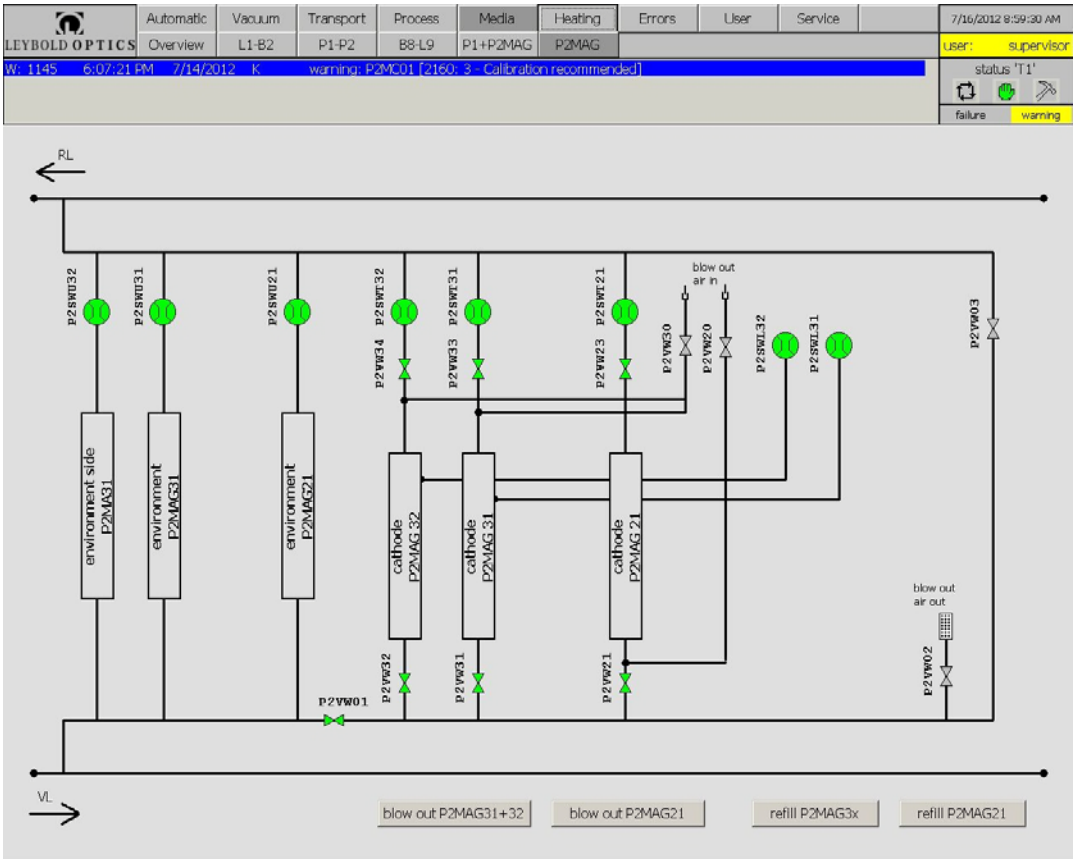

Fig. 7-5 *«Media > P2MAG» menu*

2 Press the [blow out PXMAGzy] button of the corresponding magnetron cooling water circuit.
After blowing out, the compressed air inlet is closed and the pressure in the water circuit is equalized by a bleeder valve near the water monitor.

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The blow-out routine is finished when the [blow out PXMAGzy] button illuminates green.

Secure the water circuit
After blowing out the water circuits are secured against unintentional refilling:

3 Close the manual shut-off valve in the inlet of the PXMAG cooling water circuit

4 Close the manual shut-off valve in the outlet of the PXMAG cooling water circuit.

NOTE!
If other magnetrons of the same water manifold are blown out, the manual shut-off valves have opened before and afterwards again closed.

- **manual shut-off valves in reverse order open, i.e. first in the outlet and then in the inlet of the water manifold.**

Refilling the water circuit

1 GUI: Select the «Media > PXMAG» menu of the corresponding magnetron cooling water circuit, see Fig. 7-5, 🗎 199.

2 Press the [refill] button to refilled the magnetron cooling water circuits.
The cooling water circuit is refilled with water.

NOTE!
It is not possible to refill a single magnetron cooling water circuit.

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7.4.3.3 Blowing out the water circuits manually

Prerequisites

- You have read and fully understood Chapter 7.4.3.1 General information on blowing out water circuits, 198.

Preparing the system

1 Locate the water manifold that contains the water circuit to be blown out.

2 Switch off all components connected to the water manifold.

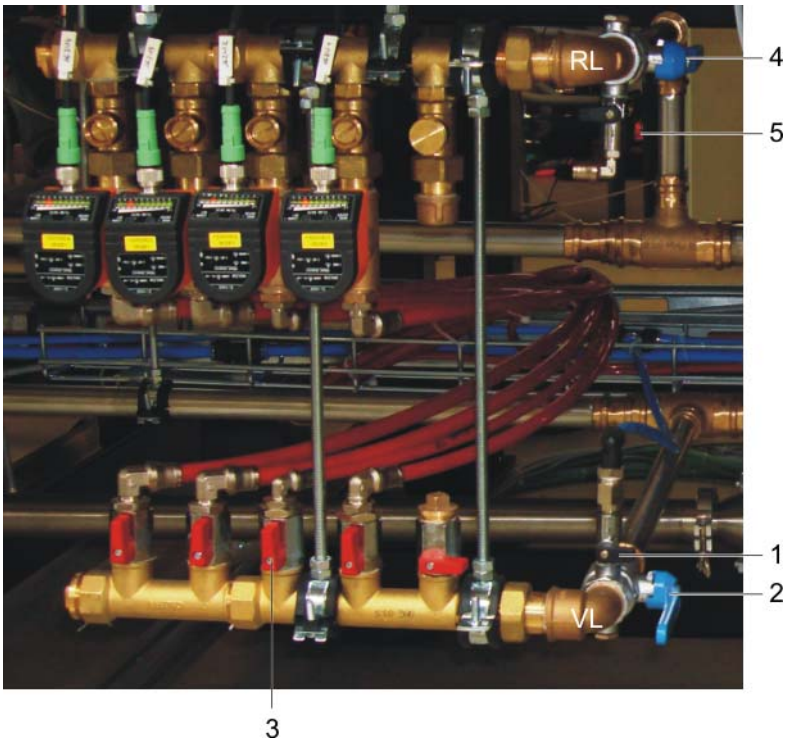

Fig. 7-6 *Water supply shut-off valves*

1 Shut-off valve of the air inlet, (VL) (blow out)
2 Shut-of valve of the water manifold, inlet (VL)
3 Shut-off valve of a component
4 Shut-of valve of the water manifold, outlet (RL)
5 Shut-of valve of the water outlet, (RL) (blow out)

3 Locate the manual shut-off valves of the water circuit to be blown out.

Isolating the water circuit

4 Close the manual shut-off valve (2) of the water inlet of the water manifold.

5 Close all manual shut-off valves (3) of the water circuits of the components that do not require to be blown out.

6 Ensure that the manual shut-off valves (3) of the water circuit(s) to be blown out are open.

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Opening the blow out circuit

7 Open the manual shut-off valve (1) of the air inlet at the inlet of the water manifold.

8 Wait several minutes to make sure that the water circuit is drained completely and then close the manual shut-off valve (1).

Refilling the water circuit
To refill the water circuit(s) after maintenance or service work:

➢ Open the manual shut-off valve (2) at the inlet of the water manifold.
The shut-off valve (1) must be closed.

➢ The system is filled with water.

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7.4.4 Opening and closing the service door

⚠DANGER

Lethal electric shock by touching live parts.

Parts of the system are connected to the mains supply or carry levels of high voltage. Even if the power supply is switched off, parts of the system may still carry residual voltage. Even when the main switch is turned off, dangerous voltages (230 V) are present in the uninterruptible power supply (UPS) and PC. Touching live parts may cause a lethal electric shock.

- ➢ Turn the system off and bring it in a voltage-free state before you carry out any maintenance or service work.
- ➢ Ground the equipment and secure the system against switching on again.
- ➢ Discharge all adjacent parts, which may carry residual voltage with the grounding rod.
- ➢ Always discharge capacitors and other components in opened power supplies.
- ➢ Ensure that all persons keep a safe distance to parts, which are connected to the electrical supply before you switch the system on again.

⚠WARNING

Crushing by massive components: chamber doors.

When opening and closing the doors of the vacuum chambers, there is danger of contusion.

- ➢ Make sure no one stays within the movement area of the service unit when opening or closing a service door.
- ➢ Secure the open (buffer-, load lock-) chamber door with the wedge against closing.

⚠CAUTION

Burns by touching hot components in the chamber.

The following components are heated during the process and can cause burns:

- Substrate heaters
- Interior of the process chambers
- Carrier and substrates
- Halogen lamps

- ➢ Wait until the affected components have cooled down to room temperature before starting to work on them.
- ➢ Wear protective gloves and work clothes with long sleeves.

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	CAUTION
	Contamination of chamber components through fingerprints. Fingerprints on components in the process chamber have a negative influence on the process and the vacuum performance. ➢ Protect the components in the process chamber and the inner chamber walls from contamination. ➢ Wear clean and lint-free gloves when performing maintenance or service work in the process chamber.

Locking out the energy supply

1 Vent the chamber, see Chapter 6.5 Evacuating and venting the system, 144.

Buffer modules only
Disconnecting the fore-vacuum line

2 Disconnect the fore-vacuum line from the connector (3) at the bottom right of the chamber.

3 Put protective caps (2) on the open ends of the fore-vacuum line to protect the vacuum system from contamination.

Opening the service door

4 Remove all hexagon head bolts (arrows) that attach the service door to the chamber.

5 Make sure that no one stays within the moving area of the service door.

6 Take the service door at the handle (1) and carefully open the door.

7 Locking:
Clamp the green wedge between the two hinge arms.

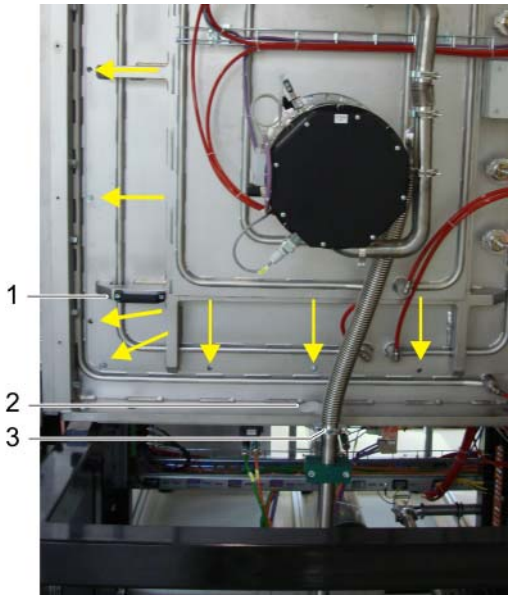

Fig. 7-7 Opening the service door of a buffer module

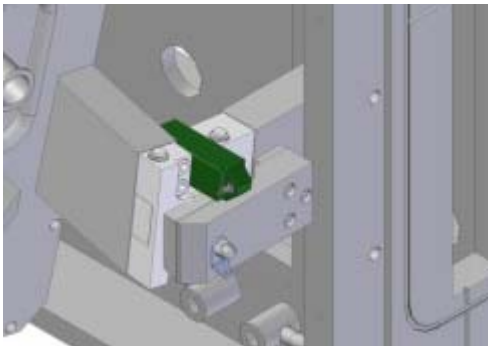

Fig. 7-8 Locking

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Closing the service door

8 Clean the chamber, see Chapter 7.5.4 Cleaning the vacuum chambers, 🗎 245.Clean the sealing surfaces and the seal at the service door. Follow the instructions in Chapter 7.5.2 Cleaning seals and sealing surfaces, 🗎 232.

9 Remove the locking (green wedge) of the hinge.

10 Take the service door at the handle (1) and carefully close the door.

11 Install and fasten the mounting bolts (arrows). Screw all bolts down evenly.

Connecting the fore-vacuum line (buffer modules only)

12 Clean the sealing surfaces and the seal at the disconnected fore-vacuum line. Follow the instructions in Chapter 7.5.2 Cleaning seals and sealing surfaces, 🗎 232.

13 Connect the fore-vacuum line to the connector (3).

Reinstating energies

14 Evacuate the vacuum chamber, see Chapter 6.5 Evacuating and venting the system, 🗎 144.

15 Reinstate any energies that were turned off, see Chapter 7.2.2 Lockout locations, 🗎 170

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7.4.5 Opening and closing the process door

Safety information

⚠DANGER

Lethal electric shock by touching live parts.

Parts of the system are connected to the mains supply or carry levels of high voltage. Even if the power supply is switched off, parts of the system may still carry residual voltage. Even when the main switch is turned off, dangerous voltages (230 V) are present in the uninterruptible power supply (UPS) and PC. Touching live parts may cause a lethal electric shock.

- ➢ Turn the system off and bring it in a voltage-free state before you carry out any maintenance or service work.
- ➢ Ground the equipment and secure the system against switching on again.
- ➢ Discharge all adjacent parts, which may carry residual voltage with the grounding rod.
- ➢ Always discharge capacitors and other components in opened power supplies.
- ➢ Ensure that all persons keep a safe distance to parts, which are connected to the electrical supply before you switch the system on again.

⚠WARNING

Crushing by moving process door.

When opening and closing the service door, there is danger of crushing.

- ➢ Make sure no one stays within the moving area of the service unit or in the immediate vicinity when opening or closing the service door.

⚠CAUTION

Burns by touching hot components in the chamber.

The following components are heated during the process and can cause burns:

- Magnetrons and surroundings, in particular shielding plates and targets
- Substrate heaters
- Interior of the process chambers
- Carrier and substrates

- ➢ Wait until the affected components have cooled down to room temperature before starting to work on them.
- ➢ Wear protective gloves and work clothes with long sleeves.

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CAUTION

Contamination of chamber components through fingerprints.

Fingerprints on components in the process chamber have a negative influence on the process and the vacuum performance.

- ➢ Protect the components in the process chamber and the inner chamber walls from contamination.
- ➢ Wear clean and lint-free gloves when performing maintenance or service work in the process chamber.

NOTE!
The service keys may only be used by authorized service personnel. In order to prevent misuse:

- ➢ **Do not leave the keys in the locks when performing maintenance or service works.**
- ➢ **Always remove the keys in order to prevent unauthorized system access.**
- ➢ **Keep the keys at a safe place which can only be accessed by authorized service personnel.**

Locking out energy supply

1 Vent the process chamber, see Chapter 6.5 Evacuating and venting the system, 144.

Opening the process door

NOTE!
Each process door has to be opened separately. It is not possible to open several process doors simultaneously.

2 GUI: Select the «Service > Doors» menu.

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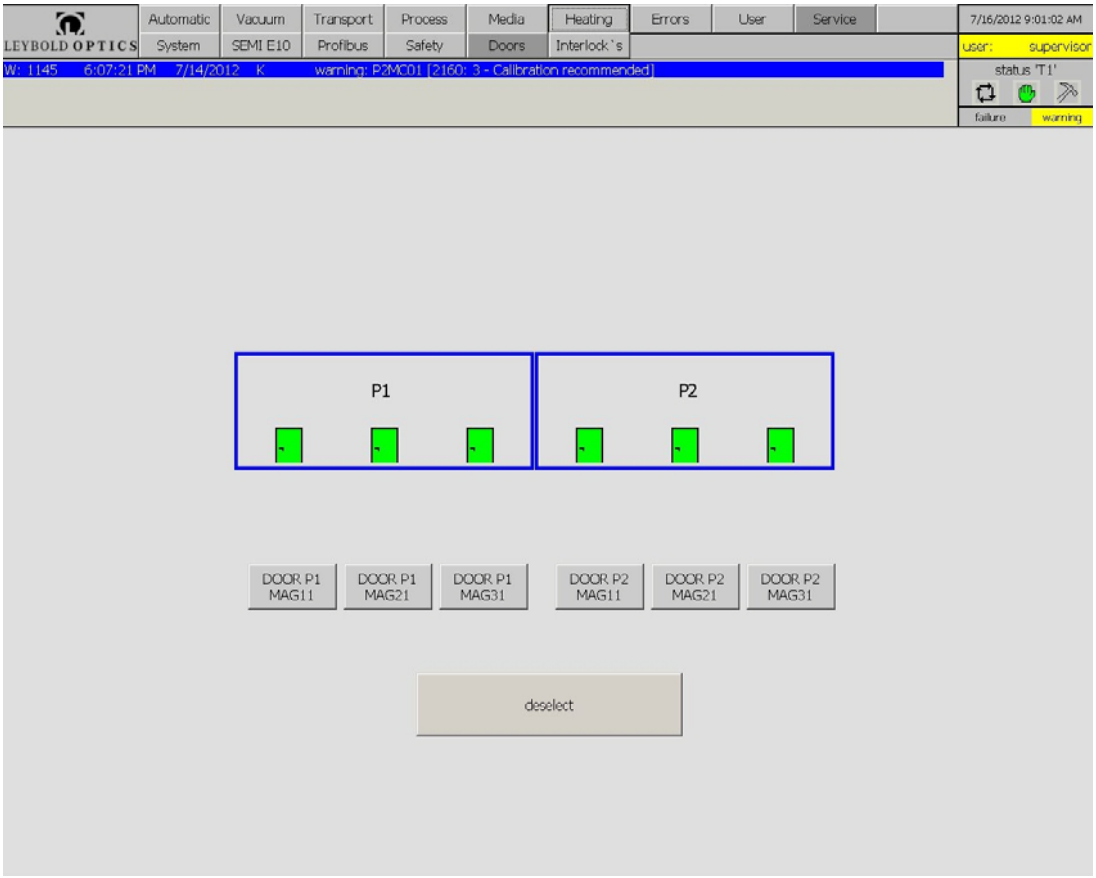

Fig. 7-9 *«Service > Doors» menu*

3 GUI: Select the process door with the [Door PX MAGyz] button

4 Make sure no one stays within the moving area of the process door.

5 At the operator terminal, turn the appropriate service key «MAGNETRON DOOR» into open position «DOWN», see Chapter 5.6.6 Key switches, 132. Keep the key in this position until the opening of the process door stops automatically.

6 Discharge all parts which might carry dangerous voltages (e.g., magnetrons) with the grounding rod.

When opening further process doors:

7 GUI: In the «Service > Doors» menu, press the [deselect] button.

8 Repeat the steps 3…6.

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Closing the process door

1 Clean the process chamber, see Chapter 7.5.4 Cleaning the vacuum chambers, 🗎 245.

2 Clean the sealing surfaces and the seal at the chamber door. Follow the instructions in Chapter 7.5.2 Cleaning seals and sealing surfaces, 🗎 232.

3 GUI: In the «Service > Doors» menu, press the [Door PX MAGxx/yy] button to close the process door.

4 At the operator terminal, turn the appropriate service key «MAGNETRON DOOR» into open position «UP», see Chapter 5.6.6 Key switches, 🗎 132. Keep the key in this position until the closing of the process door stops automatically and the door lock latches

When closing further process doors:

5 GUI: In the «Service > Doors» menu press the [deselect] button.

6 Repeat the steps 1…4.

Reinstating energies

7 Evacuate the vacuum chamber, see Chapter 6.5 Evacuating and venting the system, 🗎 144.

8 Reinstate any energies that were turned off, see Chapter 7.2.2 Lockout locations, 🗎 170

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7.4.6 Cleaning the ion source

⚠WARNING

Danger of crushing by improper handling of the ion source.

Improper handling of the ion source during dismounting can lead to serious fractures and damage to system components.

- ➢ Always maintain a safe distance from suspended loads.
- ➢ Follow the directions.

⚠CAUTION

Contusions to service personnel and damage to electronic equipment by strong magnetic fields.

The ion source has strong magnetic fields that may:
- interfere with pacemakers and other electronic implants
- cause contusions when objects snap shut
- make electronic equipment and magnetic cards useless

- ➢ Do not enter the area around the process doors (approx. 5 m), if you are wearing electronic implants.
- ➢ Do not use magnetized tools.
- ➢ Deposit credit cards, watches, floppy disks etc., aside at a safe distance (approx. 5 m) from the cathode.

The ion source has to be cleaned, when there are short circuits caused by particles.

Prerequisites

1 Switch off the power supply of the ion source.

2 Open the process door where the ion source is installed, see Chapter 7.4.5 Opening and closing the process door, 🗎 206.

3 Discharge the ion source with the grounding rod, see Chapter 2.8 Grounding rod, 🗎 61.

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Dismounting

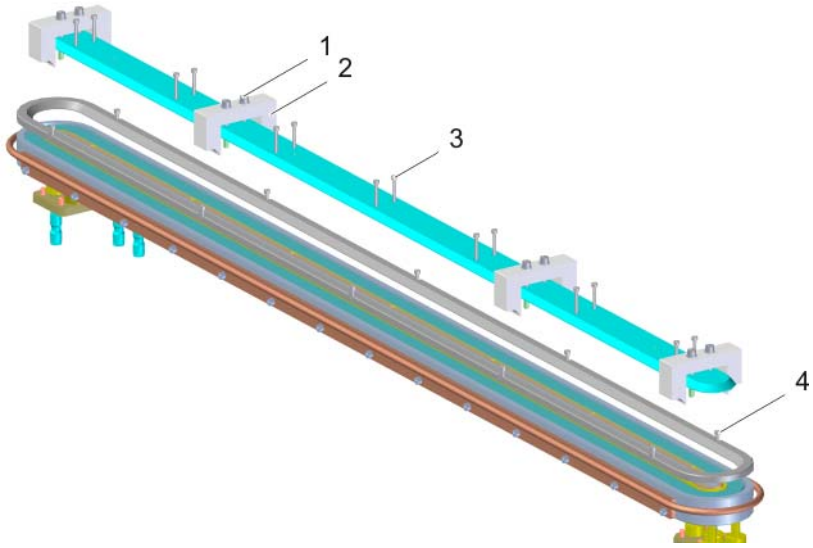

Abb. 7-10 *Ion source: Exploded view*

1 Socket screw with washer
2 Mounting aid
3 Screw of the plate
4 Screw of the ring

4 Mount the mounting aid (2) with the socket screws (M6 x 50) and washers (1).

5 Remove the screws of the plate (3).

6 Evenly tighten the screws (1), until the plate reached a distance of at least 10 mm.

7 Plate with the mounting aids lift off vertical up (min. 0.5 m over ion source) and remove (distance to the ion source min. 1 m).

8 Remove the screws for the ring (4).

9 Lift up the ring (possibly to intervene at the front sides with a screwdriver) and turn it 90° and remove it.

Cleaning

10 Remove the particles by using abrasive cloth and vacuum cleaner.

11 Check that there is no short circuit left.

Installing

12 Mounting the ion source in reverse order.

13 Remove the mounting aids.

Closing the process door

14 Clean the o-ring of the process door and the sealing surface, see Chapter 7.5.2 Cleaning seals and sealing surfaces, 232.

15 Close the process door, see Chapter 7.4.5 Opening and closing the process door, 206.

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7.4.7 Changing the target of a planar magnetron

⚠CAUTION

Contusions to service personnel and damage to electronic equipment by strong magnetic fields.

The permanent magnets of the cathodes have strong magnetic fields. These fields can:

- cause contusions when objects snap shut
- make electronic equipment and magnetic cards useless

➢ Deposit credit cards, watches, floppy disks etc., aside at a safe distance from the cathode.

➢ Do not use magnetized tools when working on the cathode.

Overview

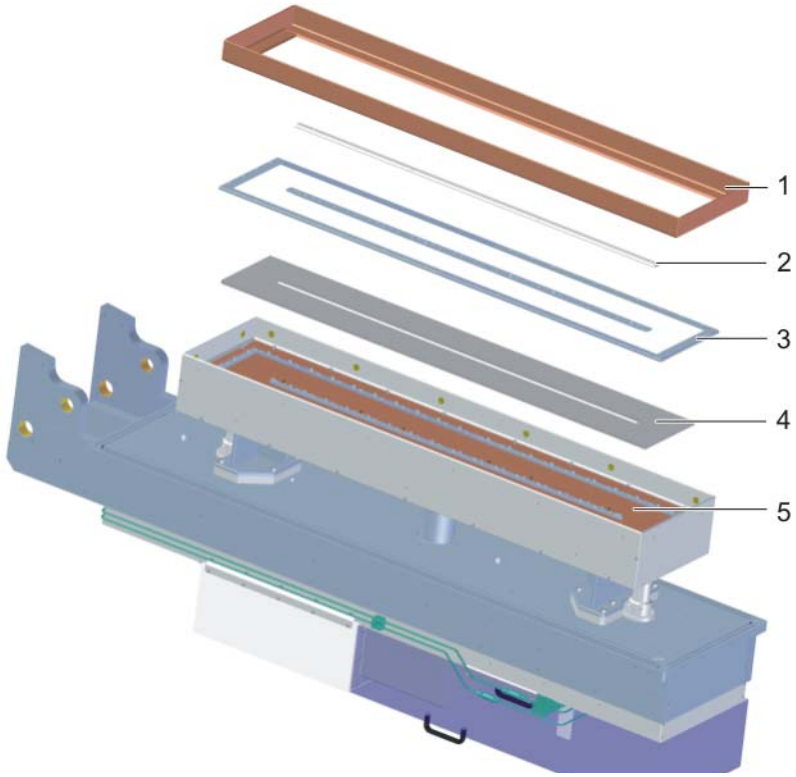

Fig. 7-11 *Exploded view of the planar magnetron components for target installation*

1 Anode frame
2 Covers of the inner clamping ledge
3 Clamping ledge
4 Target segments
5 Cooling membrane (cathode potential)

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Preparing the target change

1 Open the process door where the magnetron is installed, seeChapter 7.4.5 Opening and closing the process door, 🗎 206.

2 Discharge the cathode and the anode with the grounding rod, see Chapter 2.8 Grounding rod, 🗎 61.

3 Blow out the water circuit of the magnetron, see Chapter 7.4.3 Blowing out the water circuits, 🗎 198.

Removing the target

4 Remove the hexagon socket screws of the anode frame (1)

5 Remove the four parts of the anode frame.

6 Remove the covers of the inner clamping ledges (2).

7 Remove the clamping ledges (3):

7.1 Remove the outer clamping ledges.

7.2 Remove those hexagon socket screws from the inner clamping ledge, where the screw heads are slightly protruding, (see arrows in Fig. 7-12, 🗎 213).

7.3 Remove the inner clamping ledge.
Now the target segments (4) lie exposed on the magnetron

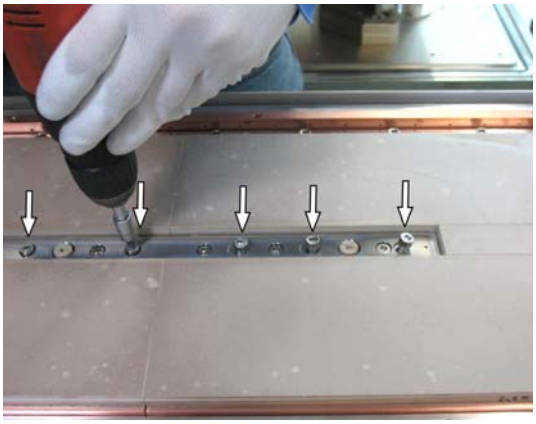

Fig. 7-12 Removing the inner clamping ledge

8 Take the target segments (4) out of the frame carefully. Make sure not to damage the cooling membrane (5) which is located underneath the target.

Check and clean the parts

9 Check the removed parts for contamination and clean them, if necessary, see Chapter 7.5.3.3 Replacing rotary magnetron shields, 🗎 239
Clean the clamping ledges (3 in Fig. 7-11, 🗎 212) with a abrasive fabric.

10 Check the sputter shields for contamination and clean them if necessary, see Chapter 7.5.3 Cleaning shielding plates and shutters, 🗎 235. Mount the sputter shields.

11 Check the cooling membrane for damage and clean it. Replace it if necessary, see Chapter 8.2.1 Replacing cooling membrane and O-rings of a planar magnetron, 🗎 249.

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Place the new target segments (see Fig. 7-13, 🗎 214)

12 Unpack the new target/target segments.

13 Clean the back sides of the target segments. Otherwise dirt particles may damage the cooling membrane when placing the target segments.

14 Carefully place the target segments (2) on the cooling membrane (1).
Pay attention not to damage the cooling membrane.

15 Make sure that the target segments are lying jointless on the cooling membrane and that the inner and outer edges of the target segments are aligned.

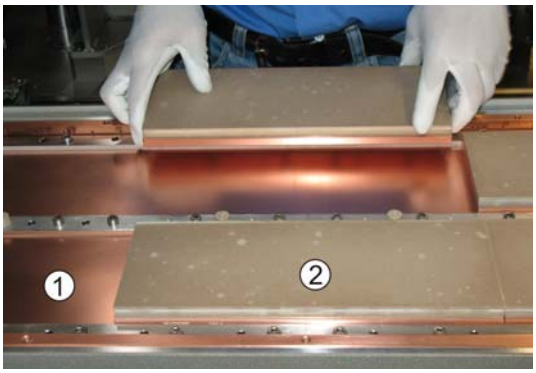


Fig. 7-13 Placing the new target segments

1 Cooling membrane
2 Target segment

Mount the clamping ledges and the anode frame (note tightening torque, see screw types**)**

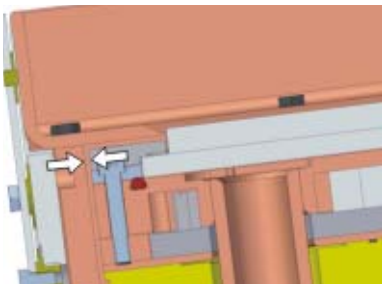
16 Install at first the inner clamping ledges and then the outer clamping ledges and tighten all screws evenly.

17 Mount the anode frame and tighten all screws evenly.

18 Make sure that there is a narrow gap between the clamping ledges and the anode plate.

19 Mount the covers of the inner clamping ledge.

20 tighten all screws evenly.



Check the installed target

21 Make sure that there is a narrow gap between the outer target edges and the anode frame and between the inner target edges and the covers of the inner clamping, see arrows in Fig. 7-14, 🗎 214.

22 Check the insulating resistance between the following components with an ohmmeter: (data are standard values; Anode = earth):
- Cathode - Anode: > 100 kΩ (dependent on the water quality)
- Cathode - inner cover ledge: ∞
- Anode - inner cover ledge: ∞

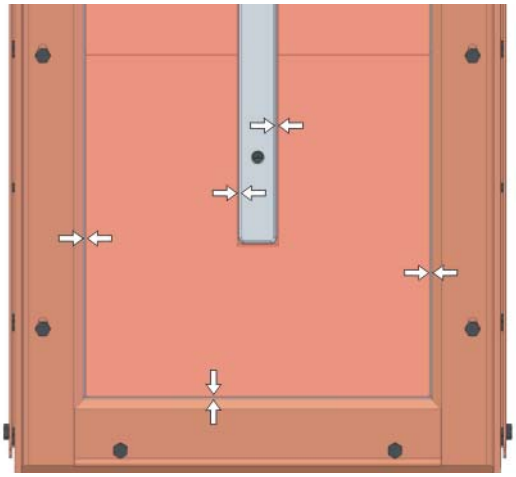


Fig. 7-14 Check the installed target

23 If the resistance is out of range remove the anode frame and clamping ledges and check the insulation of the target segments.

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7.4.8 Changing the target of a rotary magnetron

Once the target of a rotary magnetron has reached the end of its lifetime it has to be replaced with a new target. To avoid target breakage, should be a residual thickness of the target. The residual thickness is dependent on target material and manufacturer.

Safety information

⚠WARNING

Heavy target and magnet bar.

There is a danger of crushing during target change.

- ➢ Ask another person for assistance when handling the target and the magnet bar.
- ➢ Use the target carrying aid and a crane to transport the target.
- ➢ Wear safety boots.

⚠WARNING

Danger of crushing by improper handling of the target.

Improper handling of the target during dismounting can lead to serious fractures and damage to system components.

- ➢ Always maintain a safe distance from suspended loads.
- ➢ Never stand beneath a hanging load.

⚠CAUTION

Contusions to service personnel and damage to electronic equipment by strong magnetic fields.

The magnet bar of the rotary magnetron has strong magnetic fields that may:

- interfere with pacemakers and other electronic implants
- cause contusions when objects snap shut
- make electronic equipment and magnetic cards useless

- ➢ Do not enter the area around the process doors (approx. 5 m), if you are wearing electronic implants.
- ➢ Do not use magnetized tools when working on the cathode.
- ➢ Deposit credit cards, watches, floppy disks etc., aside at a safe distance (approx. 5 m) from the cathode.

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Overview

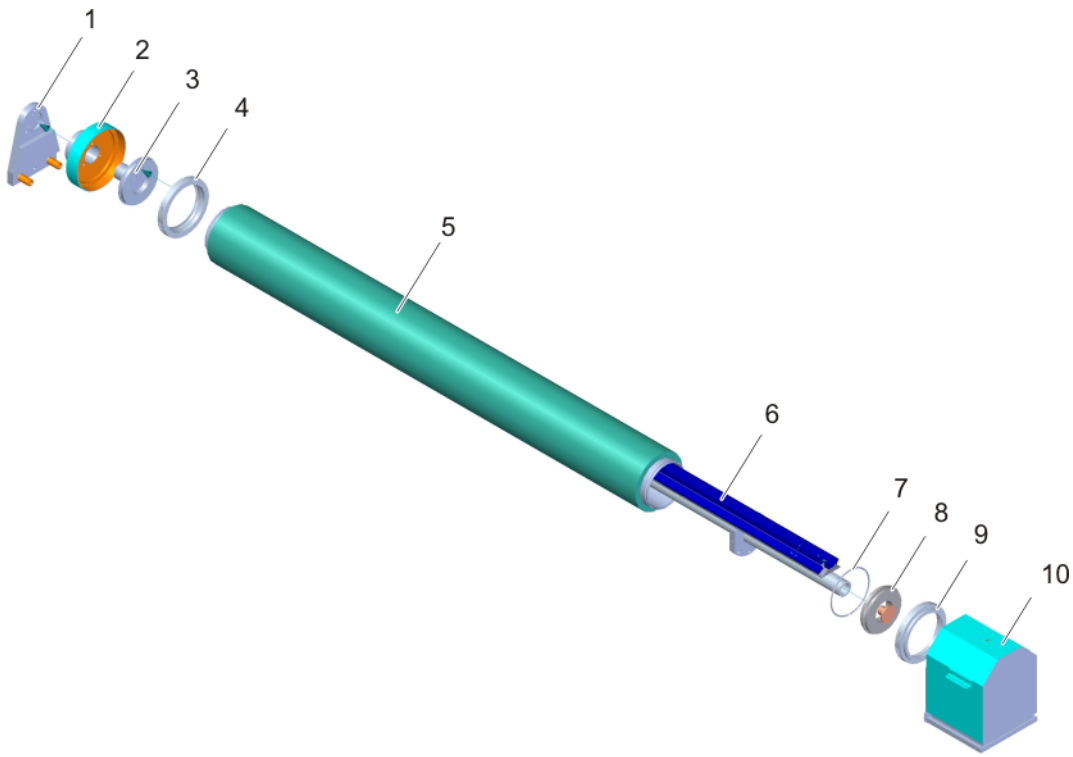

Fig. 7-15 *Rotary magnetron: Exploded view*

1 Floating bearing
2 End cap
3 Cap
4 Clamp
5 Target
6 Magnet bar
7 Brace
8 Mounting flange
9 Clamp
10 End bearing

Preparing the target change

1 Prepare v-shaped supports (stands, blocks) for holding the following parts during the target change:
- Old target tube
- Magnet bar (non-ferrous supports required)
- New target tube
- optional: supplied support (ceramic target)

2 Place the rotary magnetron carrying aid ready for use, see Chapter 5.7 Rotary magnetron carrying aid, 🗎 135.

Opening the process door

3 Vent the system, see Chapter 6.5.2 Venting the system, 🗎 147.

4 Blow out the water circuit of the rotary magnetron, see Chapter 7.4.3.3 Blowing out the water circuits manually, 🗎 201.

5 Open the process door where the rotary magnetron is installed Chapter 7.4.5 Opening and closing the process door, 🗎 206.

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Dismounting the shielding plates

6 Remove the shielding plates, see Chapter 7.5.3.3 Replacing rotary magnetron shields, 239

7 Clean the dismounted shielding plates.

Attaching the target to the crane

8 If the target is to be used again: Wrap the target in clean paper to protect its surface.

9 **Optionally**, by ceramic targets:
Lay the support of the target carefully around the cathode, and turn it around the cathode.

10 Loop the carrying straps of the carrying aid around the target.

11 Fix the H-beam of the carrying aid to a crane.

12 With the crane, place the H-beam of the carrying aid centrally above the target.

13 Fix the carrying straps to the H-beam.

14 Carefully tighten the carrying straps so that the crane holds the cathode in the current position but does not lift it.

Fig. 7-16 Cathode fixed to the crane

NOTE!

➢ **Make sure that the carrying straps are tightened evenly and that the cathode will not be lifted after the removal of the clamps.**
Otherwise, the end block might be damaged which results in vacuum and water leaks. This especially applies to the cathode with dismounted floating bearing.

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Removing the target

15 Loosen the clamp.
Pull the locking pin down of the floating bearing and pull the floating bearing from the cathode.

The clamp to the front side becomes unveiled.

16 Put a cloth beneath the clamp. Residual water may flow out of the cathode when the endcap is removed.

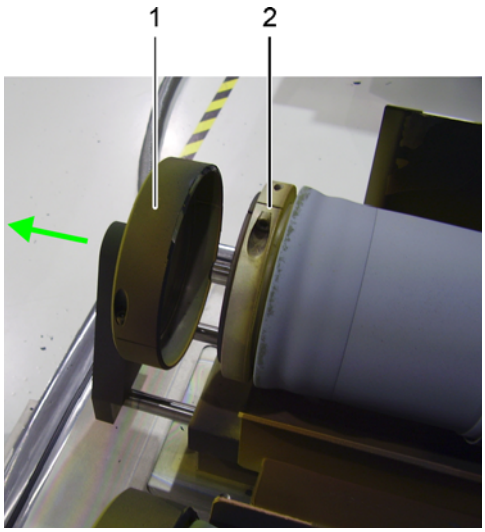

Fig. 7-17 Removing the floating bearing

1 Floating bearing
2 Clamp

NOTE!

➢ **Do not place the magnet bar onto a ferrous surface or near ferrous objects.**

17 Remove the end cap (3 in Fig. 7-18, 🗎 218).

18 Pull the magnet bar (2 in Fig. 7-18, 🗎 218) out of the cathode.

19 Place the magnet bar onto the prepared (non-ferrous) supports.

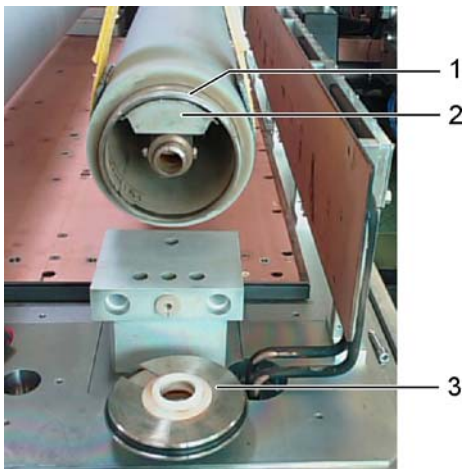

Fig. 7-18 End cap removed

1 Brace
2 Magnet bar
3 End cap

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20 At the end block, loosen the clamp screws and remove the clamp (3).

Now the cathode is held by the crane.

21 Using the crane, carefully take the cathode off the end block.
Use two or more people to guide targets away during the lift.

22 Place the cathode onto the prepared supports.

23 Remove the carrying straps and the support, if used.

24 Remove the braces (1 in Fig. 7-18, 🗎 218) from both ends of the cathode.

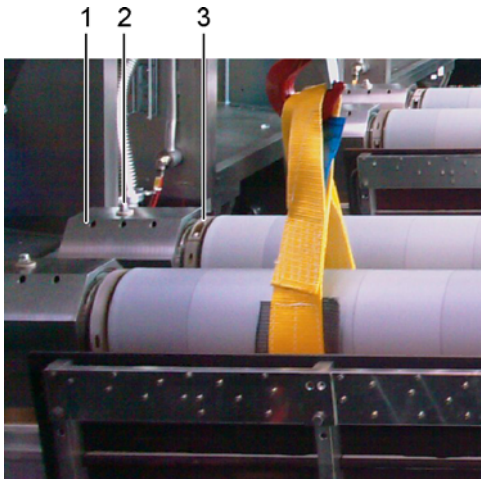

Fig. 7-19 End bearing of the rotary magnetron

1 Cover of the end block
2 Cap nut
3 Clamp

Cleaning the parts

25 Clean the removed parts as described in the supplier's documentation to rotary magnetron.

26 Clean the surrounding of the rotary magnetron with an industrial vacuum cleaner.

27 If necessary, remove the anode shields and/or the protective covers of the gas shower and clean them by sandblasting.

Preparing the new cathode

NOTE!

➢ **Handle the cathode with utmost care to avoid damage to the target materials and to the cathode ends.**

28 If necessary, mount the anode shields and the protective covers of the gas shower, see Chapter 7.5.3.3 Replacing rotary magnetron shields, 🗎 239.

29 Remove the protective wrapper from both ends of the cathode.

30 Clean the inner chamfers at the ends of the cathode with isopropanol and make sure that the chamfers are not damaged. The chamfers are the sealing surfaces.

31 Mount the carrying aid to the new target.

32 Mount the braces at both ends of the cathode.

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Moving the cathode to the mounting position

33 Fix the new target with the carrying straps to the H-beam so that the target tube can be lifted horizontally.

34 Using the crane, carefully move the target tube to the mounting position.

35 Make sure that the water sealing on the end block is clean and undamaged.

36 Insert the cathode into the end block. Make sure to an exact horizontal and/or axial adjustment to the end block.

37 Mount the clamp to the end block.

Installing the magnet bar

38 Put the magnet bar into the target tube and align it so that the magnet is oriented to the top side.

39 Push the magnet bar towards the end block and slightly oscillate it until it clicks into place.

Mounting the end cap

40 Check the sealing surface at the cathode and the O-ring at the end cap for damage and clean them, see Chapter 7.5.2 Cleaning seals and sealing surfaces, 232.

41 Mount the end cap at the open end of the target tube.

42 Mount the clamp.

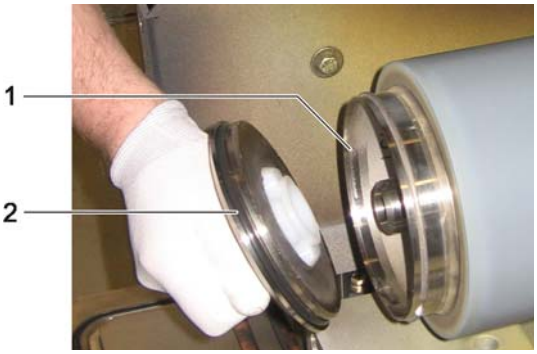

Fig. 7-20 Mounting the end cap

Abb. 7-21

1 Sealing surface
2 O-ring

Finishing the target change

43 Pull the locking pin of the floating bearing and mount the floating bearing.

44 Remove the carrying straps from the cathode and the support of the target, if used.

45 Mount the cleaned chamber protection shields, see Chapter 7.5.3.3 Replacing rotary magnetron shields, 239.

46 Remove the protective wrapper from the target.

47 Refill the water circuit of the rotary magnetron to check if the cathode is watertight, see Chapter 7.4.3.3 Blowing out the water circuits manually, 201. During refilling check the rotating rotary magnetron for grinding or scraping noises.

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Checking the target installation

48 Check the following insulating resistances using a multimeter. Also adhere to the note below.

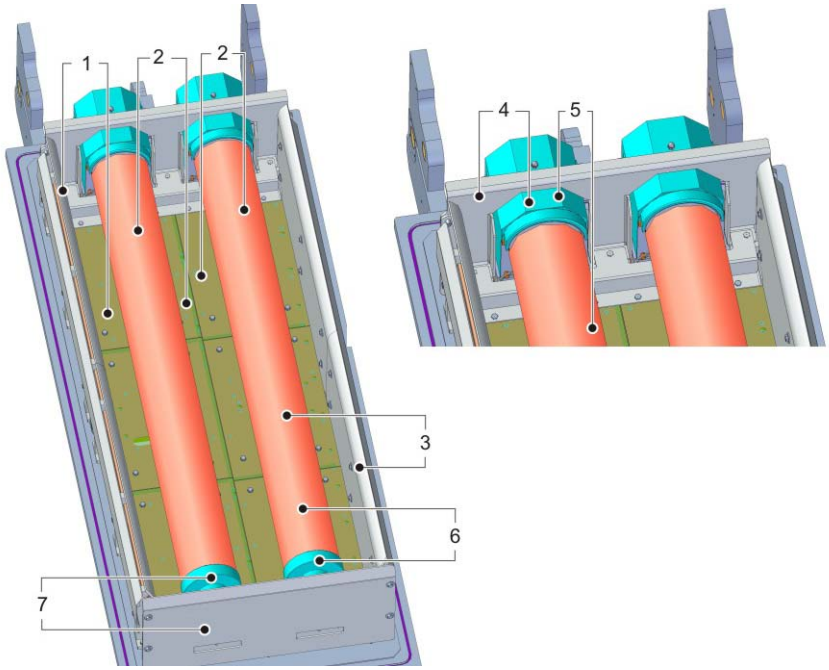

Fig. 7-22 *Contact points for resistance measurement of the rotary magnetron*

Pos.	Contact points	Benchmark
1	Anode - ground	80 kΩ
2	Anode - cathode	80 kΩ
3	Ground - cathode	80 kΩ
4	Cover of the end block - ground	∞
5	Cover of the end block - cathode	∞
6	Cathode - floating bearing	∞
7	Floating bearing - ground	∞

NOTE!
The benchmarks for the resistance measurements (1), (2) and (3) are subjects to the following conditions:
- **The cooling water flows through the magnetron**
- **The power supply is connected to the anode and cathode**

If the power supply is not connected, the measured resistance should be several MΩ. With a blown out cooling water circuit the resistance value is still higher.

The power amplifier of the connected power supply causes a diode effect. This results in a higher resistance in one direction.

➢ **Make sure that the resistance measurement with the multimeter is always performed in the same direction.**

➢ **If applicable, repeat the resistance measurement in opposite direction.**

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49 Record the measured resistance values in a measurement report.

50 If the resistance is smaller than the appropriate benchmark, make sure that
- the rotary magnetron does not contact the chamber protection shields at the end bearing,
- the end cap is installed properly.

Closing the process door

51 Clean the o-ring of the process door and the sealing surface, see Chapter 7.5.2 Cleaning seals and sealing surfaces, 232.

52 Close the process door, see Chapter 7.4.5 Opening and closing the process door, 206.

7.4.9 Regenerating the cryo pump

As the amount of condensed and absorbed gas in the pump increases, the temperature of the cryo pumps rises and the pumping speed declines. It is therefore necessary to regenerate cryo pumps at regular intervals to remove the entrapped gas. During regeneration the cold surfaces are heated to just above room temperature and all gases are removed from the cryo pump via the scroll pump. In order to check the status of the pump, a pressure rise measurement will be carried out. Having successfully carried out the measurement, the pump will be again evacuated and the cooling procedure started.

The regeneration can be started by visualization.

⚠WARNING

Danger of explosion by high concentration of flammable gases (e.g. O_2) or flammable gas mixtures (e.g. CO with O_2).
Danger of suffocation caused by high argon and nitrogen concentrations.

If during the regeneration the released gases are pumped off incorrectly, high concentrations of gases can form in the cryo pump. Depending on the gas type it can causing ignition of these highly concentrated gases.

Also may these gases at high pressure in the cryo pump by the overpressure valve in the environment and displace the breath air.

➢ Make sure before regenerating that the scroll pump is operate correctly.

➢ Monitor the function of the scroll pump, the vacuum valve and the pressure during regenerations.

NOTE!
The A1500V-7 is designed for coating processes using the process gases specified in Chapter 1.4.2.2 Process and venting gases, 23.
Leybold Optics will not be held responsible for the use of non-specified, dangerous gases.

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Regenerate the cryo pump in the following cases:

- before the temperatures of two heat levels reach the maximum
- before maintenance or service work at the cryo pump
- before longer production breaks

Duration of a total regeneration
The regeneration and recooling lasts 3 to 4 hours depending on how much gas is in the pump. In this time the another cryo pump is operational and a process with the A1500V-7 can be run.

➢ Check at the beginning of every maintenance and service work whether the cryo pump must be regenerated. Use down-time for regenerating of the cryo pump, if necessary.

Regenerates the cryo pump

1 GUI: Select the «Vacuum > L1-B2».

2 GUI: Close the corresponding valve between cryo pump and vacuum chamber (+B1VS02 or +B1VS03).
The scroll pump +B1PV01 is automatically switched on. If it is run up the corresponding valve between cryo pump and scroll pump (+B1VV01 or +B1VV02) opens.

3 GUI: Press the icon of the cryo pump to open a context menu and select [Regenerate].
- The cryo pump is switched off and the cold surfaces are heat up.
- The released gases are pumped out of the scroll pump.

If an error occurs during regeneration

	Find out possible causes and solutions with the help of the supplier's documentation to the cryo pump about errors during regeneration. See supplier's documentation on CD 1.

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7.4.10 Checking the compressed air supply

NOTE!
Lock and drain the compressed air lines before you work on them, see Chapter 7.2.2 Lockout locations, 170.

Only carry out maintenance work in conjunction with the supplier's documentation to the correspondent component, see supplier's documentation on CD 1.

Checking the pressure readings
The pressure in the compressed air lines should be checked at regular intervals.

➢ Check the following pressure readings and set the pressure with the corresponding control valves at the maintenance unit:
- Operating pressure: 5…7 bar
- Blow-out pressure: 1…3 bar

Checking the compressed air system for leaks

➢ Visually check the compressed air connections and tubes. Pay attention to noticeable flowing noises.

Checking the condenser

➢ Check the condenser of the maintenance unit for condensed water. If the condensate reaches up to 10 mm below the filter element, turn the bleeder screw open counterclockwise and release the condensate.
Check the compressed air tank and drain the condensate.

Checking the air filter

➢ Check the air filter on the maintenance unit. A dirty filter must be replaced.

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7.4.11 Checking the water supply

NOTE!
Lock and drain the water lines before you work on them, see Chapter 7.2.2 Lockout locations, 170.

Only carry out maintenance work in conjunction with the supplier's documentation to the correspondent component, see supplier's documentation on CD 1.

Checking the water quality

⚠DANGER

High voltage current transmitted by cooling water.

The cooling water that circulates through the planar magnetrons may transmit high voltage current if the conductivity of the water is too high. In this case touching water circuit components may cause a lethal electric shock.

➢ Measure the conductivity of the water in regular intervals.
- The electrical conductivity must not exceed 200 µS cm-1

➢ Check in regular intervals the water quality according to the specifications in Chapter 1.4.2.5 Water supply, 24.

Checking the pressure readings

➢ Check the following pressure readings in the water lines at regular intervals:
- Inflow pressure at the main supply: 5…7 bar
- Outflow pressure at the main supply: max. 1.5 bar
- Inflow pressures at the magnetrons: max. 5 bar
- Inflow pressures at the water-cooled screw pumps: 2…7 bar

Checking the temperature readings

➢ Check the temperature readings
- at the inflow and outflow of the main supply
- at the polycold

Checking the water circuit for leaks

➢ Visually check all water line connections and fittings.

➢ Replace connections and/or fittings, if you detect spilt water.

Each rotary magnetron is equipped with an internal water leak detection.

➢ heck the water flow through the flow monitors (PXSWLxx) in the leak detection lines of the rotary magnetrons. These flow monitors are mounted to the process doors. The current states of the flow monitors are shown in the visualization software.

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Checking and cleaning water filters of the water preparation system

If contaminated and/or after two months the water filter (Fig. 7-23, 🗎 226) at the cooling water inlet has to be cleaned.

1 Visually inspect the water filter (2).

2 Clean the contaminated water filter in the following way:

2.1 Make sure, that the ball valve (4) is opened.
Open the handwheel (1) in anti-clock-wise as far as it will go.

2.2 Close the handwheel in clockwise, till no more rinse water flows out

3 Visually inspect the water filter and repeat the cleaning, if necessary.

The water filter must be replaced if it has not become clean after several cleaning sequences.

4 Open the ball valve (3) to rinse dirt particles out of the dirt trap.

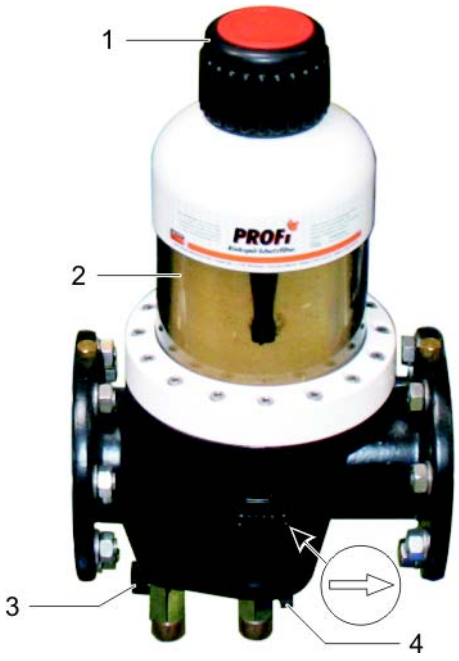

Fig. 7-23 Changing a water filter

Checking the valves and flow monitors

Check the function of the valves and flow monitors at regular intervals.

➢ Check the function of the valves and flow monitors by closing and opening the shut-off valves of the water circuits and observing the flow readings on the flow monitors.

➢ Check the sensor tip of each flow monitor for deposits.
Clean the sensor tip with a damp cloth. Use a commercial vinegar cleaning agent to remove lime deposits.

Checking the fill level of the water tank

➢ Check the fill level of the water tank at regular intervals. The fill level is shown in the view tube at the water tank and at the menu «Media > Overview».

➢ Refill water if the level is below 50%. Adhere to the specifications, see in Chapter 1.4.2.5 Water supply, 🗎 24.

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7.4.12 Checking the gas supply

NOTE!
Lock and drain the gas lines before you work on them, see Chapter 7.2.3 Locking out the gases, 172.

Only carry out maintenance work in conjunction with the supplier's documentation to the correspondent component, see supplier's documentation on CD 1.

Checking the gas pressure

➢ Check the pressure readings on the gas supply lines and/or gas bottles according to the specifications in Chapter 1.4.2.2 Process and venting gases, 23.

Checking the gas system for leaks

➢ Visually check the compressed air connections and tubes.

Checking the mass flow controllers

1 Turn the MFC on with setpoint 50%.

The actual value should reach the setpoint after a few seconds and the pressure in the chamber should rise.

2 Turn the MFC off.

The chamber pressure should reach the initial value after a short time.

➢ Replace the filtering element or ultrasonically clean it in regular intervals.

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7.4.13 Checking the vacuum performance

Base pressure test

1 Make sure that the individual vacuum parts, such as plate and sluice valves, pumps, valves in the pumping circuit and vacuum gauges, for all the modules are working properly.

2 Make sure that:
- The chamber walls are at room temperature
- Humidity in the hall according to the machine card is.

3 Vent the system with dry air. The air quality must adhere to the specifications in Chapter 1.4.2.3 Compressed air, 🗎 23.

4 Open the modules for 30 minutes. No personnel should work at the machine while the modules are opened.

5 Close the modules and make sure that the heaters are switched off.

6 Pump the vacuum chambers.

Once the turbo pumps have reached their final rotation speed, the purge gas supply is switched on automatically.

7 Switch the purge gas supply for the turbo pumps off manually by pressing the corresponding [purge on / purge off] button in the «Vacuum» menu.

8 Record a complete pump curve and compare it with earlier curves.

9 Check the final pressures after 12 hours.
The base pressure should be less than 2×10^{-6} mbar after 12 hours of pumping time.
The base pressure should be reached in all the modules irrespective of the positions of the gate valves (opened or closed).

10 Vent the load lock chamber and check the pressure in the process modules. The pinch valves between the modules must protect from gas leakages above 5×10^{-4} mbar·l·s^{-1}.

Process pressure test
The machine must provide a process pressure regulation in the range from 1.5×10^{-3} to 2.5×10^{-2} mbar with a maximal fluctuation of less than $\pm 0.3 \times 10^{-3}$ mbar in the pressure reading and frequency of the turbo pumps is from 60% to 100%.

➢ For each vacuum chamber, make sure that the pressure remains stable at 1.5×10^{-3}, 8×10^{-3} and 2.5×10^{-2} mbar.

➢ Use an appropriate argon flow and set the frequency of the turbo pumps is from 60% to 100%.

➢ Let a substrate carrier move through the chambers during the test.

➢ Make sure that the pressure remains stable for each pressure adjustment for approx. 5 minutes.

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Leak detection

➢ If the pressure tests have failed, check for leaks.
For this purpose a connecting piece with integrated valve is mounted at the intake line of each roughing station.

	Refer to the supplier documentation of your leak detection system when carrying out a leak detection.

NOTE!
By the leak detection the cryo pump have not operate or the gate valve between cry pump and chamber must be closed.

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7.5 Cleaning the system

The task of cleaning the system is divided into two phases for the purpose of the work involved:

- Cleaning the vacuum chambers, see Chapter 7.5.4 Cleaning the vacuum chambers, 245.
- Overall cleaning, see Chapter 7.5.5 Overall cleaning, 245. This phase is a more extensive cleaning of the system and is carried out after long production phases.

7.5.1 Safety notes

⚠WARNING

Damage to the lungs by inhalation of metallic and polymer dust.

The inhalation of dust can damage the lungs and lead to other health problems.

- ➢ Always wear a suitable breathing mask when carrying out work that may produce metallic or polymer dust.
- ➢ Wear disposable protective clothing with long sleeves and gloves.
- ➢ Dispose of the collected dust as special waste.

⚠CAUTION

Burns by touching hot components.

The following components are heated during the process and can cause burns.

- magnetrons and surroundings, in particular shielding plates and targets
- Substrate heaters
- Interior of the process chambers
- Carrier and substrates
- Halogen lamps

- ➢ Wait for the affected components to cool down to room temperature before working on them.
- ➢ Wear protective gloves and work clothes with long sleeves.

⚠CAUTION

Noxious cleaning materials.

Cleaning materials can contain substances hazardous to your health.

- ➢ Follow the safety instructions on the containers.
- ➢ When in doubt, always wear protective gloves and work clothes with long sleeves.
- ➢ Do not inhale the vapors.

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CAUTION

Damage to the seal surfaces.

The seal surfaces of vacuum components must not be scratched. If you clean seal surfaces with hard objects (screwdrivers, steel wool, sandpaper, etc.) you will cause scratches.

- Always use a cloth soaked in isopropanol to clean seal surfaces.

NOTE!
Only a clean process chamber can achieve a high throughput and effective process cycle times. Take note of the following rules:

- **Protect the components in the process chamber and the inner chamber walls from contamination.**
- **Wear clean and lint-free gloves when performing work in the chambers.**
- **Only bring dry, clean objects into the process chamber.**
- **Keep the use of vacuum greases and oils to a minimum.**

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7.5.2 Cleaning seals and sealing surfaces

Prerequisites

➢ Note the following regulations:
- For all cleaning work, adhere to the Technical Rule for Hazardous Substances (TRGS) No. 900 «Threshold limit values for air pollution at the workplace» as regards masks, vacuuming, etc.
- When cleaning seal surfaces and sealing rings, wear clean, lint-free gloves.
- In clean rooms, wear clean-room gloves and avoid the build-up of particles.

Permissible cleaning materials
For cleaning, you can use:

- Sand paper with a grain size of 400 or finer
- Scotch Brite
- Isopropanol, propanol 2
- Ethanol (ethyl alcohol) and acetone (propanone)
- Lint-free cloths, such as Dastex 400 series cloths

NOTE!

➢ **Do not use ethanol (ethyl alcohol) and acetone (propanone) for O-rings, because these substances corrode the rings.**

Cleaning sealing surfaces
Sealing surfaces made of steel, stainless steel or aluminium must be without scratches or marks. The permissible surface roughness, regardless of the vacuum area, is set at Rz = 6.3 µm.

Scratches and marks can be removed by sanding with sandpaper (grain size of 400) and Scotch Brite:

1 Sand in the direction of the metal's «grain». The depth of the sealing surface must not be altered.

2 Clean the surface with isopropanol and a lint-free cloth.

Cleaning sealing rings (sealing ring types)

- R-rings: Round sealing rings, made by vulcanizing or bonding a round band
- O-rings: Endless round sealing rings moulded as single pieces

The round sealing rings used can be made of the following materials:

Material	Abbreviation	Trade name
Fluorocarbon rubber	FKM, FPM	Viton®
Acrylonitrile butadiene rubber	NBR	Perbunan®

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Both materials are resistant to isopropanol, but are corroded by ethanol and acetone. In perfect condition, the rings have the following characteristics (Fig. 7-24, 233):

- Clean surface
- No damage (cracks, cuts, ridges or porous sections)
- Uniform diameter
- No tangible glued joints

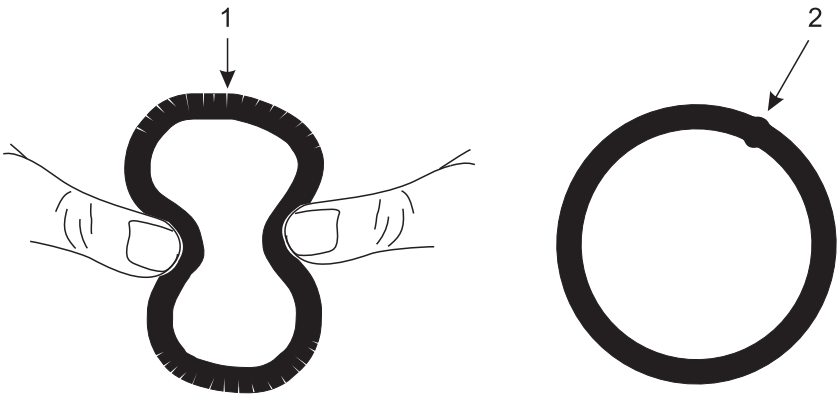

Fig. 7-24 *Checking an O-ring*

1 Cracks, cuts, porous sections
2 Swelling, bulge

Oils, grease, dust, talcum, etc. are cleaned from the rings in the following steps:

1 Pull the ring through a dry cloth to remove the bulk of the dirt.

2 Pull the ring through a cloth soaked in isopropanol to remove the finer dirt.

NOTE!
The following two steps must not be carried out if the O-ring can become hotter than 100°C. The materials must not exceed the following temperatures:
- **NBR (Perbunan) O-ring: 100°C**
- **FPM (Viton) O-ring: 200°C**
- **Leybold LITHELEN vacuum grease: 150°C**

3 Grease the ring lightly (very thin film) with vacuum grease (Leybold LITHELEN).

4 Pull the ring through a dry cloth, so that the surface and pores of the ring only remain lightly moistened by the vacuum grease.

NOTE!
Dust particles easily stick to lightly greased rings.

➢ **Install the ring at once and do not put it down beforehand.**

5 Make sure that the ring protrudes above the groove (relative to the sealing surface) by a uniform amount, see Fig. 7-25, 234. Depending on the thickness of the ring, the values are as follows:

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Ring thickness	Protrusion “x”
5 mm	0,8 mm
6 mm	1,1 mm
8 mm	1,9 mm

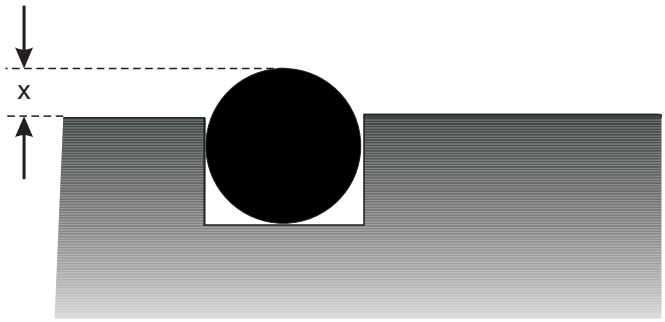

Fig. 7-25 *Protrusion “x” of a sealing ring above the sealing surface*

Cleaning the groove

The sealing surface of the groove must be clean as well. Proceed as follows:

6 Remove the O-ring. In doing this, you must not damage (scratch) the sealing surface of the groove or the O-ring. Sharp or pointed tools (e.g., screwdriver) must not be used.

7 Before the clean O-ring is installed, the groove is cleaned in the direction of rotation with a cloth soaked in ISO. You must wipe it in the same direction, not back and forth, see Fig. 7-26, 234.

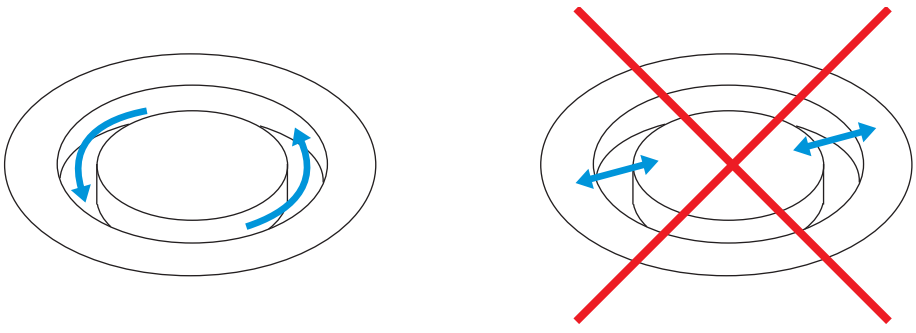

Fig. 7-26 *Direction for wiping the sealing groove*

Cleaning the installed O-ring

8 Clean particles and dust from the area around the ring with a vacuum cleaner.

9 Wipe the ring with a cloth soaked in isopropanol.

10 We recommend to take the ring out after a number of cleanings and clean the ring and the groove thoroughly. Replace the ring, if necessary.

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7.5.3 Cleaning shielding plates and shutters

⚠CAUTION

Contusions to service personnel and damage to electronic equipment by strong magnetic fields.

The permanent magnets of the cathodes have strong magnetic fields. These fields can:

- cause contusions when objects snap shut
- make electronic equipment and magnetic cards useless

➢ Deposit credit cards, watches, floppy disks etc., aside at a safe distance (approx. 5 m) from the cathode.

➢ Do not use magnetized tools when working on the cathode.

⚠CAUTION

Injuries by splinters of coating material.

When removing the sputter shieldings, splinters of coating material may spall off. This may cause injuries.

➢ Always wear protective goggles or a face protection shield when removing sputter shieldings.

➢ Always wear protective gloves and protective clothing with long sleeves when removing sputter shieldings.

CAUTION

Contamination of chamber components through fingerprints.

Fingerprints on components in the process chamber have a negative influence on the process and the vacuum performance.

➢ Protect the components in the process chamber and the inner chamber walls from contamination.

➢ Wear clean and lint-free gloves when performing maintenance or service work in the process chamber.

Cleaning cycles
The cleaning cycle of the shielding plates depends on process conditions and on quality standards.

➢ Check the shielding plates and shutters for contamination each time you have opened a vacuum chamber.

- Recommendation of Leybold Optics:
- When changing the targets
- When the target lifetime has been reached (10000 kWh)

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General procedure

NOTE!

➢ **Have an additional set of shielding plates and shutters ready for replacement to keep the down time at a minimum.**

1 Open the process chamber, see Chapter 7.4.5 Opening and closing the process door, 206.

2 Remove all shieldings and the appropriate fastening devices (screws, fittings, etc.) from the vacuum chamber and from the chamber door.
For the removal of the shieldings see:

-
-
- Replacing rotary magnetron shields, see Chapter 7.5.3.3, 239
- Replacing the iZnO/AZO-door shieldings, see Chapter 7.5.3.4, 240
- Replacing the gas separation protection shields, see Chapter 7.5.3.5, 241
- Replacing the chamber protection shields in P1, see Chapter 7.5.3.6, 242
- Replacing the chamber protection shields in P2, see Chapter 7.5.3.7, 243
- Replacing view port shutters, see Chapter 7.5.3.8, 244

3 Clean all removed parts (dry oil-free and free of sandblasting material) and check to accuracy of fit.

4 Mount all shieldings.

5 Close the process doors, see Chapter 7.4.5 Opening and closing the process door, 206.

	For more information to the shieldings (cleaning drawings, surface treatment) see also surface treatment (LHH-N 120.030E) on CD 1 and cleaning parts (94 …) in the spare parts catalogue on CD 2.

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7.5.3.1 Replacing ion source shields

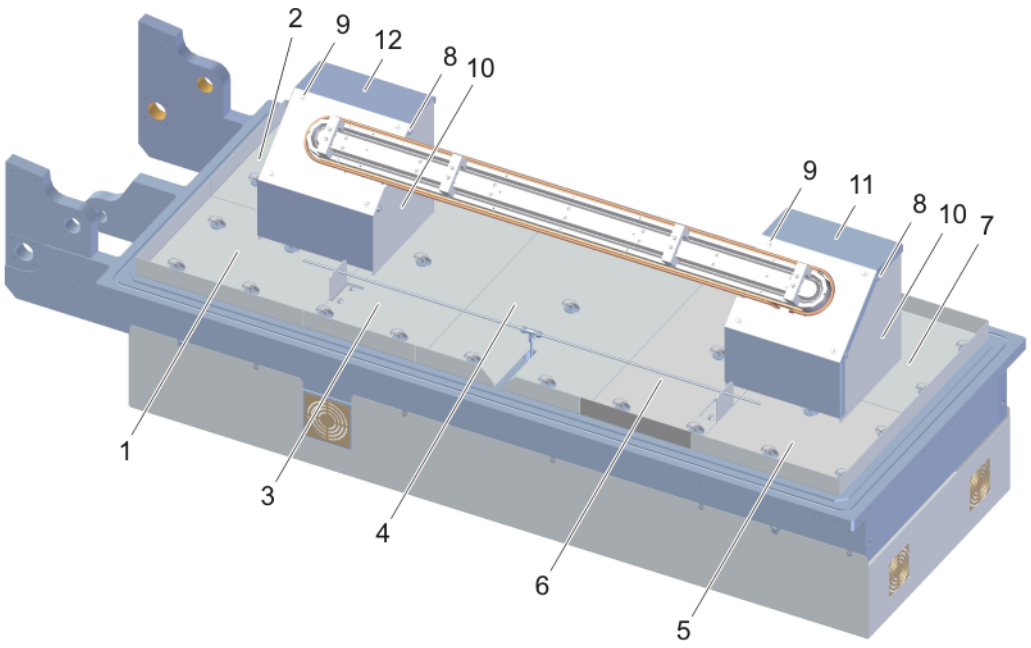

Fig. 7-27 *Replacing ion source shields*

1 Shield 1
2 Shield 2
3 Shield 3
4 Shield 4
5 Shield 5
6 Shield 6
7 Shield 7
8 Hexagon head screw with washer (4 pcs. per box)
9 Hexagon head screw with washer (4 pcs. per cover)
10 Box
11 Cover 1
12 Cover 2

Removing the shields

1 Remove the hexagon head screws (M 6 x 12) and washers (9).
Remove the covers (11, 12).

2 Remove the hexagon head screws (M 6 x 12) and washers (8).
Remove the boxes (10).

3 Remove the cotter pins.

4 Remove the shields (1 - 7).

Mounting the shields

➢ Mounting the shields in reverse order.

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7.5.3.2 Replacing planar magnetron shields

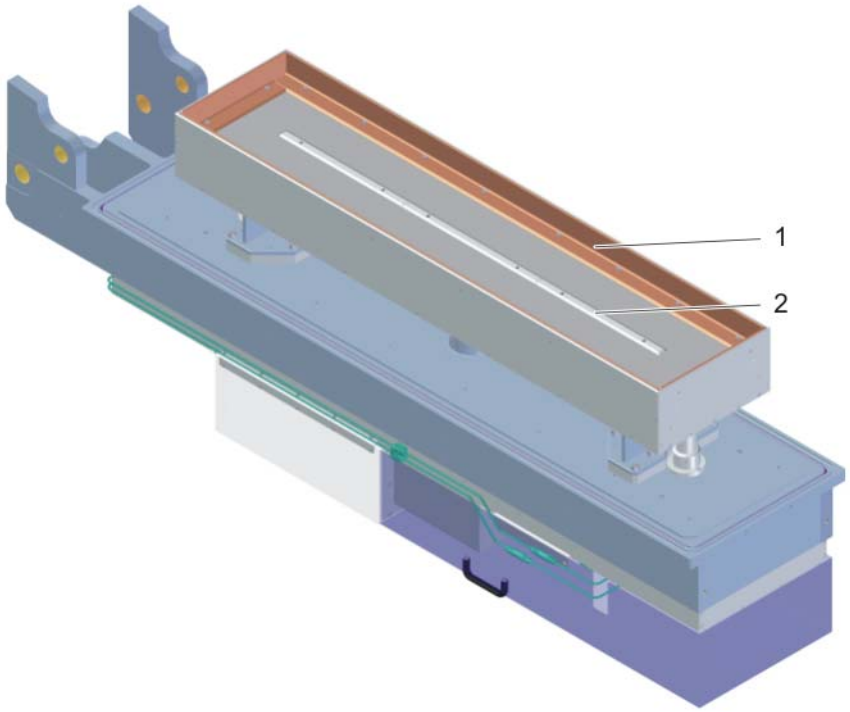

Fig. 7-28 *Planar magnetron shields*

1 Anode angle (2 along, 2 across)
2 Covers of the inner clamping ledge (3 pcs.)

Removing the shields

➢ Remove the angles (1).
At first the 2 angles at the front and then die 2 along.
The shieldings are fixed by hexagon socket screw.

➢ Remove the covers of the inner clamping ledge (2).

Mounting the shields

➢ Mounting the shields in reverse order.

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7.5.3.3 Replacing rotary magnetron shields

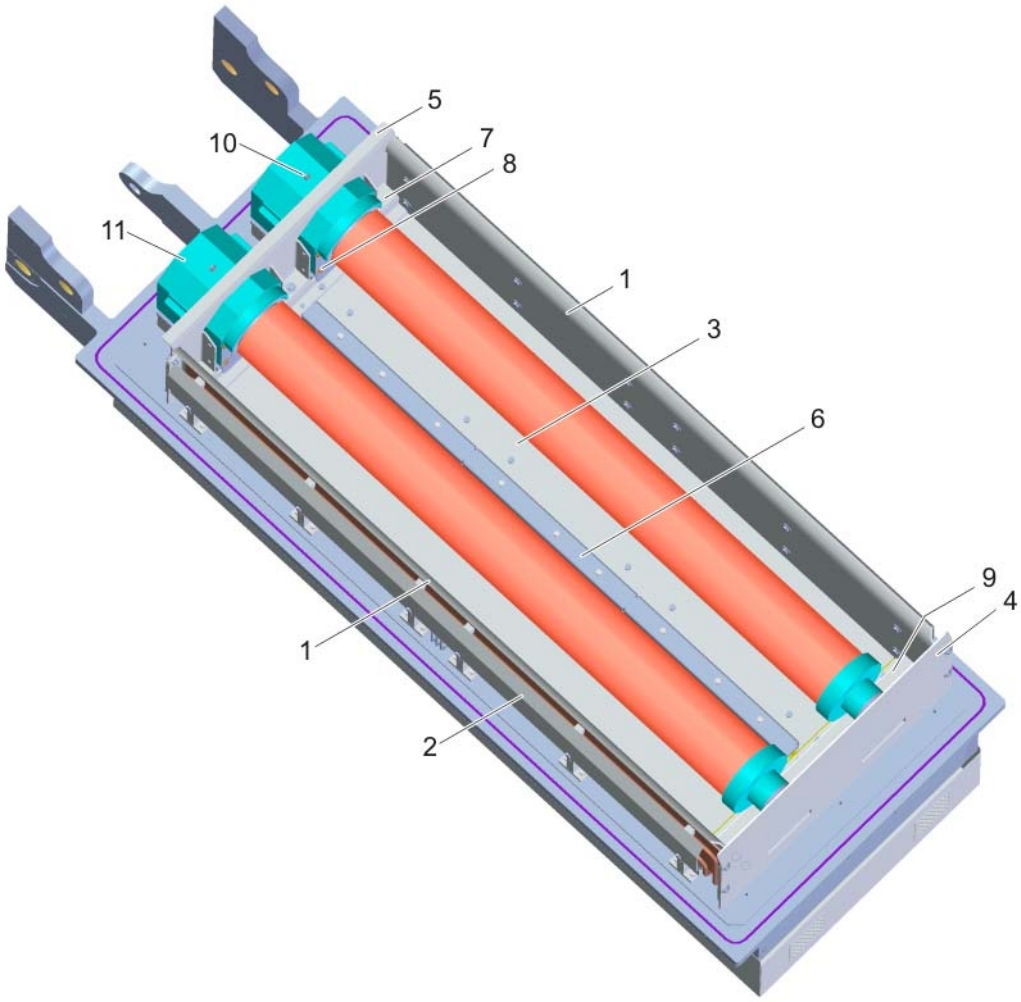

Fig. 7-29 *Replacing rotary magnetron shields*

1 Side shield (2 pcs.)
2 Shield gas douche (2 pcs.)
3 Anode shields (6 pcs.)
4 Shield at the supported counter centers
5 Shield at the end blocks
6 Cover ledge (3 pcs.)
7 Angle ledge
8 Shield of the end block (2 pcs.) with spring cotter pin (4 pcs.)
9 Angle ledge
10 Cap nut
11 Cover of the end block (2 pcs.)

Removing the shields

1 Remove the shields (4 and 5).

2 If necessary, remove the shields (2).

3 Remove the shields (1).

4 Remove the angle ledges (7, 9).

5 Remove the spring cotter pins (8) to the both magnetrons at the end blocks. Remove the both shields.

6 Remove the cap nuts (6) at the end blocks.

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7 Remove the both covers (11).

8 Remove the anode shields (3).

Mounting the shields

➢ Mounting the shields in reverse order.

7.5.3.4 Replacing the iZnO/AZO-door shieldings

The protection shields prevent the inner of the process chamber doors from being coated.

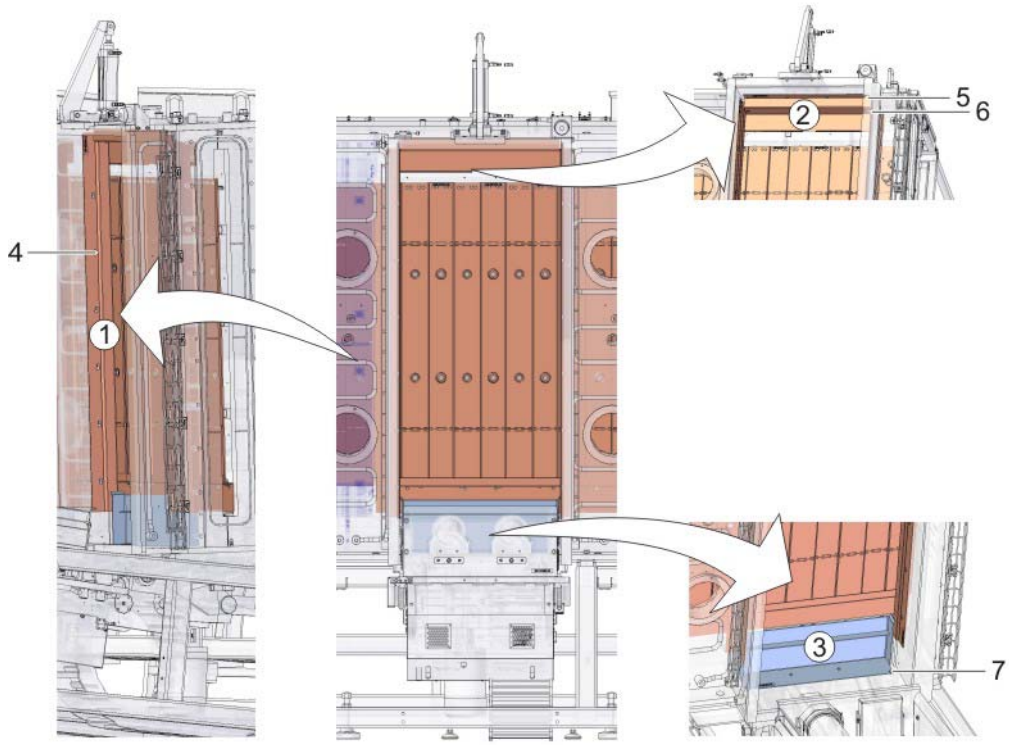

Fig. 7-30 *iZnO/AZO-door shieldings*

1 Side protection shield
2 Upper protection shield
3 Lower protection shield
4 Hexagon head screw of side protection shield (6 pcs.)
5 Hexagon head screw of the lower protection shield (4 pcs.)
6 Hexagon head screw of the upper protection shield (4 pcs.)
7 Hexagon head screw w with washer of upper protection shield (2 pcs.)

Removing the protection shields

1 Remove the hexagon head screw (5, 6, 7) on the protection shields (2, 3) on the upper and lower side of the vacuum chamber and take the protection shields out.

2 Loose the hexagon head screws of the side protection shields (4).

3 Slide the side protection shields (1) up and hang it out.

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Mounting the protection shields

➢ Install the protection shields in reverse order of the removal procedure.

7.5.3.5 Replacing the gas separation protection shields

The protection shields prevent the heaters from being coated.

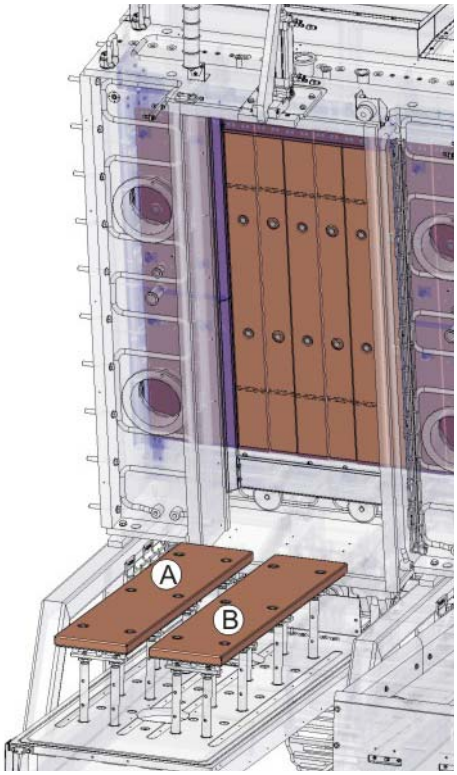

Fig. 7-31 *Protection shields of the heaters*

A Separation shield
B Separation shield

Removing the protection shields

1 Remove the hexagon head screw of the separation shields (A, B).

2 Remove the shields.

Mounting the protection shields

➢ Install the separation shields in reverse order of the removal procedure.

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7.5.3.6 Replacing the chamber protection shields in P1

The chamber protection shields prevent the heaters and the inner chamber back wall from being coated.

Fig. 7-32 *Replacing the chamber protection shields in P1*

1 Protection shield top left
2 Protection shield top
3 Protection shield top right
4 Protection shield down left
5 Protection shield down
6 Protection shield down right
7 Protection shield center left
8 Protection shield center
9 Protection shield center right
10 Protection shield with angle short
11 Protection shield with angle long

Removing the protection shields

1 Remove the screws of the top protection shields (1, 2, 3).

2 Remove the protection shields from right to left.

3 Remove the screws of the down protection shields (4, 5, 6).

4 Remove the protection shields from right to left.

5 Remove the screws of the top protection shields (7, 8, 9).

6 Remove the protection shields from right to left.

7 Remove the screws of the protection shields with angle (10, 11) and remove the shields.

Mounting the protection shields

➢ Install the protection shields in reverse order of the removal procedure.

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7.5.3.7 Replacing the chamber protection shields in P2

The chamber protection shields prevent the heaters and the inner chamber back wall from being coated.

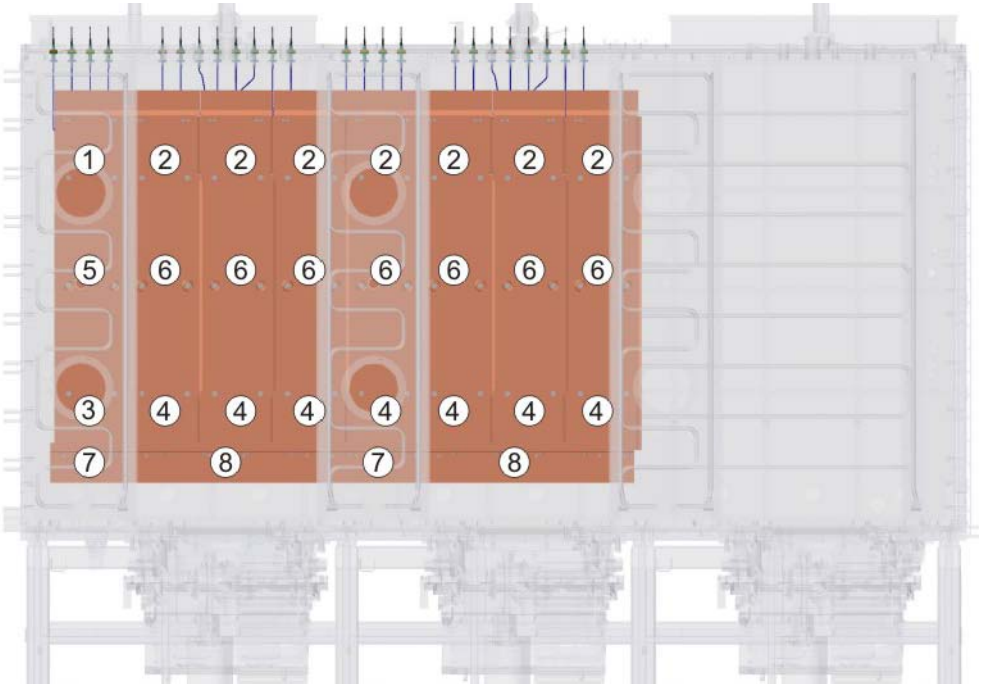

Fig. 7-33 *Replacing the chamber protection shields in P2*

1 Protection shield top left
2 Protection shield top
3 Protection shield down left
4 Protection shield down
5 Protection shield center left
6 Protection shield center
7 Protection shield with angle short
8 Protection shield with angle long

Removing the protection shields

1 Remove the screws of the top protection shields (1, 2).

2 Remove the protection shields from right to left.

3 Remove the screws of the down protection shields (3, 4).

4 Remove the protection shields from right to left.

5 Remove the screws of the top protection shields (5, 6).

6 Remove the protection shields from right to left.

7 Remove the screws of the protection shields with angle (7, 8) and remove the shields.

Mounting the protection shields

➢ Install the protection shields in reverse order of the removal procedure.

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7.5.3.8 Replacing view port shutters

The shutters prevent the view ports and pyrometers from being coated. You can open and close the shutters manually.

Removing the shutter

1 Loosen the hexagon socket screw (3).

2 Remove the clamping ring (2) with the shutter (4).

Installing the shutter

➢ Install the shutter in reverse order of the removal procedure.

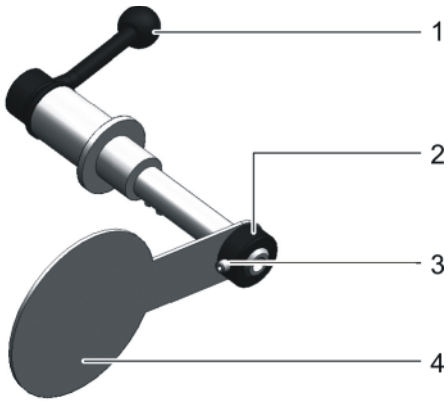

Fig. 7-34 View port shutter

1 Lever for opening and closing the shutter (chamber outside)
2 Clamping ring
3 Hexagon socket screw
4 Shutter (chamber inside)

7.5.3.9 Replacing the protective glass of the view port

Removing the view port

1 Loosen the 4 screws (4).

2 Remove the flange with cover and mirror (1)

3 Remove the ring (2).

4 Replace the protective glass (3).

Installing the shutter

➢ Assemble the view port in reverse order of the removal procedure

Fig. 7-35 View port

1 Flange with cover and mirror
2 Ring
3 Protective glass
4 Screw
5 Flange

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7.5.4 Cleaning the vacuum chambers

NOTE!
Adhere to the safety notes in Chapter 7.5.1 Safety notes, 230.

1 Carefully remove sputtering residue from the chamber floor and surface panels with a wire brush and emery cloth.

2 Remove dirt such as loose material residue and dust with an industrial vacuum cleaner. Vacuum-clean the entire chamber area thoroughly.

3 Wipe the sealing of the process chamber door with a dust-free, non-fibrous, isopropanol-soaked cleaning cloth.

4 If the vacuum sealing is damaged, it must be replaced.

5 Check the sealing surface for scratches and clean it if necessary, see Chapter 7.5.2 Cleaning seals and sealing surfaces, 232.

NOTE!
Cleaning materials and waste materials may be ecologically harmful and must be disposed of properly. For disposal considerations refer to the safety data sheets of the used materials.

7.5.5 Overall cleaning

The overall cleaning of the system encompasses the cleaning specified in the maintenance plans for the individual system components, see Chapter 7.3 Maintenance plans, 175.

NOTE!
When the entire system, including the vacuum system, pipes and pumps, has been cleaned thoroughly, we recommend to continuously operate the vacuum for 24 hours.

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8 Service

8.1 Introduction

This chapter provides an overview of all the measures necessary for servicing of the A1500V-7.

8.1.1 Safety information

When service work is being carried out, personnel will spend a certain amount of time in dangerous areas of the system.

NOTE!
Before carrying out service work on the A1500V-7, the appointed personnel must have read and fully understood Chapter 2 Safety, 🗎 31.

In particular, the safety instructions contained in Chapter 2.7 Hazards, 🗎 48 must be strictly adhered to.

8.1.2 Personnel qualifications

Carrying out service work applies only to personnel of the «Supervisor» qualification level or higher. For a definition of the personnel, see the Chapter 2.3 Access rights, 🗎 39.

NOTE!
It is the responsibility of the user that:
- **All work is carried out in accordance with the system maintenance plan**
- **The service personnel have completed the training and instruction necessary for this work**

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8.1.3 Using the supplier’s documentation

The maintenance and service of individual components of the system is described in detail in the supplier’s documentation from the manufacturer.

Maintenance work to which the supplier’s documentation is referred to must be carried out in strict adherence to the information in the relevant operating instructions, see Chapter 1.1.4 Use of these Operating Instructions, 13.

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8.2 Service instructions

CAUTION

If the process area is vented for maintenance and service work, the:

- chambers are to be cleaned, see Chapter 7.5 Cleaning the system, 🗎 230
- the resistance at the magnetrons is to be measured, see Chapter 7.4.8 Changing the target of a rotary magnetron, 🗎 215

8.2.1 Replacing cooling membrane and O-rings of a planar magnetron

When do the cooling membrane and the O-rings have to be replaced?
The cooling membrane must be replaced, if damages such as cracks, bulges or leaks are visible.

The O-rings underneath the cooling membrane must be replaced, if damages are visible, see Chapter 7.5.2 Cleaning seals and sealing surfaces, 🗎 232.
Moist spots on the target or on the cooling membrane may be the result of a damaged O-ring.

Overview

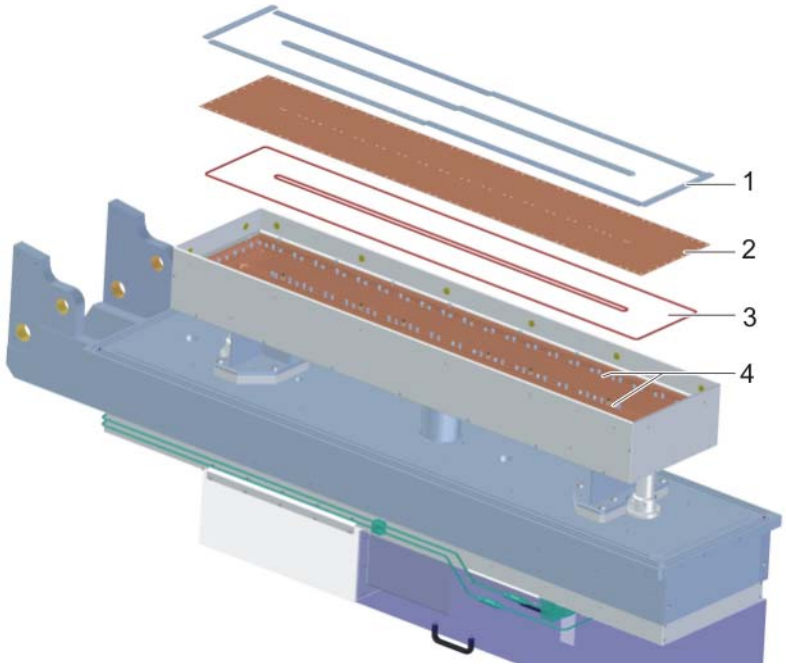

Fig. 8-1 *Replacing the cooling membrane and the O-rings*

1 Clamping ledges
2 Cooling membrane
3 O-rings
4 Sealing groove

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Removing the cooling membrane and the O-ring(s)

1 Remove the target from the planar magnetron, see Chapter 7.4.7 Changing the target of a planar magnetron, 212.

2 Remove the clamping ledges (1) of the cooling membrane, see Fig. 8-2, 250.

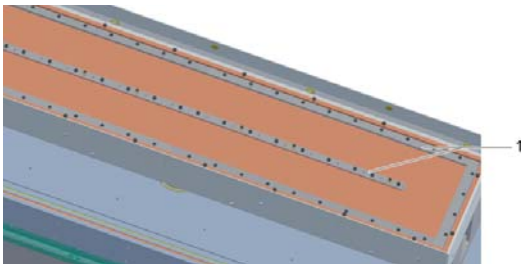

Fig. 8-2 Removing the clamping ledges

1 Clamping ledges

3 Carefully remove the cooling membrane (2), see Fig. 8-3, 250.

4 Carefully remove the O-rings (3) from the sealing grooves.

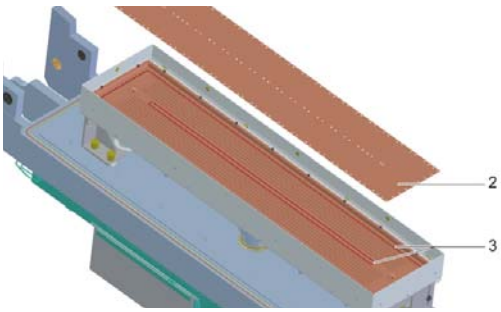

Fig. 8-3 Remove the cooling membrane

2 Cooling membrane
3 O-rings

Installing the cooling membrane and the O-ring(s)

1 Clean the cooling system of the planar magnetron with isopropanol and a lint-free cloth.

2 Check the sealing grooves for signs of scratches and clean them, see Chapter 7.5.2 Cleaning seals and sealing surfaces, 232.

3 Remove the new, clean O-ring from the special packing and insert it into the sealing groove.

4 Make sure that the O-ring is positioned properly and that it is not twisted or pinched.

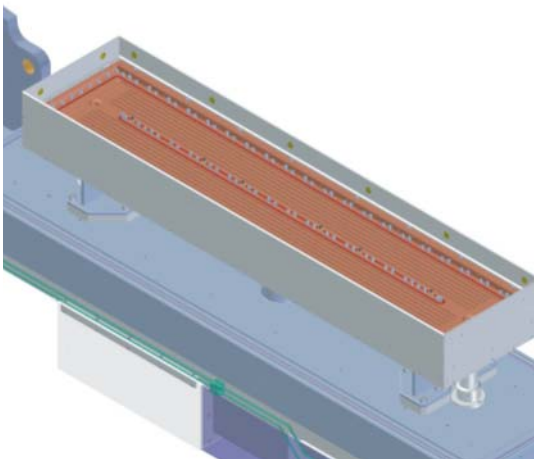

Fig. 8-4 Insert the o-rings

5 Carefully place the cooling membrane (2) on the O-ring.

6 Install the clamping ledges (1) of the cooling membrane. Tighten all screws evenly.

7 Install the target segments, see Chapter 7.4.7 Changing the target of a planar magnetron, 212.

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8.2.2 Replacing a toothed belt of the carrier transport system

⚠WARNING

Hands getting trapped by rotating elements.

There is a danger of hands getting trapped by rotating pulleys and belts.

- ➢ Secure the drive and make sure that it can not be switched on inadvertently before you perform any service work.
- ➢ Make sure that no-one reaches into the danger area before you activate the transport system again.

⚠CAUTION

Burns by touching hot servomotors of the transport system.

Servomotors are heated during the process and can cause burns.

- ➢ Wait for the servomotors to cool down to room temperature before working on them.
- ➢ Wear protective gloves and work clothes with long sleeves.

Preparations

1 Switch off the servo control of the transport system by the switch «Service» at the electrical cabinet CCSC, see Chapter 5.2 Maintenance switch, 🗎 124.

2 Secured the switch «Service» against switching on again.

3 Disconnect all motor connections.

Replacing the drive belt between the driving motor and the driving wheel
The drive belts are located at the following positions:

- Process transport system located at the side of the carrier back transport
- Carrier back transport
- Longitudinal transport in the transfer modules T1 and T9

1 Open the corresponding covering/door.

2 Loosen the straining screw (3).

3 Loosen the screws of the drive motor holder (1).

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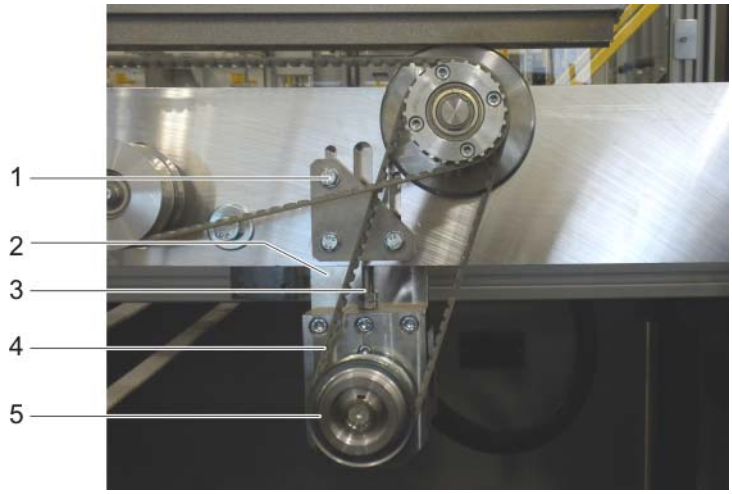

Fig. 8-5 *Drive system of the longitudinal transport of the carrier (example: transfer module)*

1 Screw
2 Drive motor holder
3 Straining screw
4 Drive belt
5 Toothed pulley on the shaft of the driving motor

4 Move the drive motor holder (2) along the elongated hole to release the tension on the drive belt (4).

5 Remove the drive belt.

6 Mount the drive belt and adjust its tension by following the dismounting-procedure in reverse order.

7 Belt tension, see belt tension.

8 Close all coverings/doors.

Replacing the transmission belt between adjacent toothed pulleys
The transmission belts are located at the following positions:

- Process transport system at the side of the carrier back transport
- Carrier back transport
- Carrier support in the transfer modules T1 and T9

NOTE!
An inner transmission belt can only be removed after the adjacent outer toothed belts have been removed.

1 Open the corresponding covering/door.

2 Loosen the screws of the tension pulley.
- The tension pulley of the process transport system is mounted at a guide rail (1 in Fig. 8-6, 🗎 253)
- The tension pulley of the carrier back transport (3 in Fig. 8-6, 🗎 253) is fixed at an elongated hole of the roll holder (5 in Fig. 8-6, 🗎 253).

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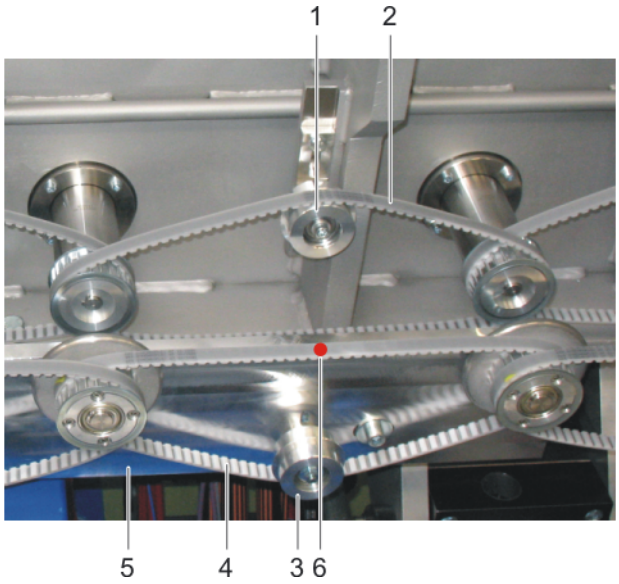

Fig. 8-6 *Transmission elements of the transport system*

1 Tension pulley guide rail of the process transport system
2 Transmission belt of the process transport system
3 Tension pulley of the carrier back transport
4 Transmission belt of the carrier back transport
5 Roll holder of the carrier back transport
6 Belt tension measuring point

3 Move the tension pulley along the elongated hole to release the tension of the transmission belt (2 or 4 in Fig. 8-6, 🗎 253).

4 Remove the transmission belt.

5 Mount the drive belt and adjust its tension by following the dismounting-procedure in reverse order.

6 Belt tension, see belt tension.

7 Close all coverings/doors.

Replacing the drive belt of the transfer transport
These drive belts are located below the carrier support in the transfer modules T1 and T9.

1 Open the folding door of the transfer module.

2 Loosen the screws (1 in Fig. 8-7, 🗎 254) of the toothed pulley holder (2).

3 Turn the straining screw (3) counter-clockwise until the drive belt (4) is lose.

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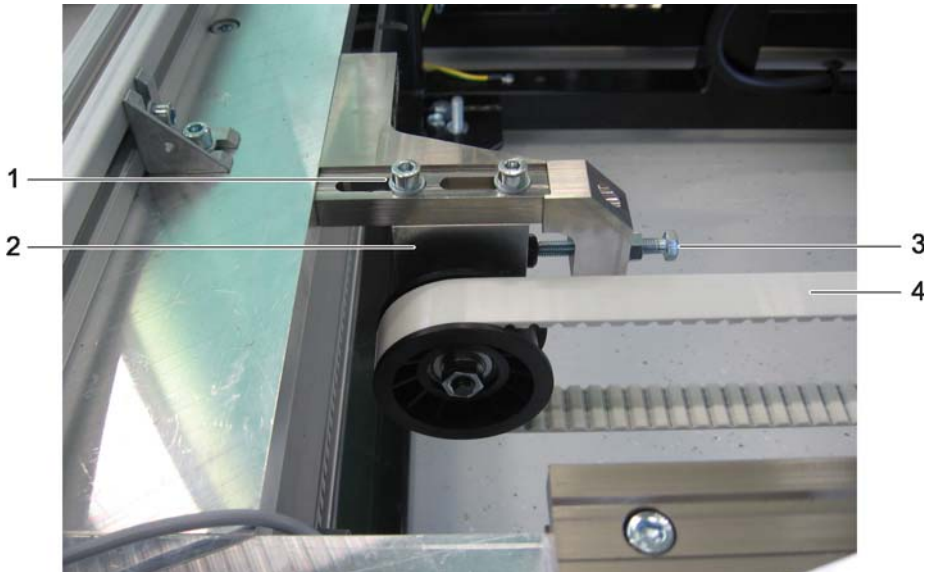

Fig. 8-7 *Drive of the transfer transport in the transfer module*

1 Screw
2 Toothed pulley
3 Straining screw
4 Drive belt

4 Remove the screws of the tappet that connects the carrier support to the drive belt and remove the tappet.

5 Remove the drive belt.

6 Mount the new toothed belt by following the dismounting-procedure in reverse order and adjust the tension.

7 Belt tension, see belt tension.

8 Close the folding door of the transfer module.

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8.2.3 Replacing a roller of the transport system

The proceedings for replacing the transport rollers of the process transport system and the rollers of the carrier back transport are different:

- Replacing a roller of the load lock and buffer modules, see Chapter 8.2.3.1, 🗎 255
- Replacing a roller of the process modules, see Chapter 8.2.3.2, 🗎 257
- Replacing a roller of the carrier back transport system, see Chapter 8.2.3.3, 🗎 259

8.2.3.1 Replacing a roller of the load lock and buffer modules

NOTE!
The transport rollers must be aligned accurately (accuracy < 1/10 mm). Replace each transport roller separately and align the new one to the adjacent transport rollers.

Preparations

1 Switch off the servo control of the transport system by the switch «Service» at the electrical cabinet CCSC, see Chapter 5.2 Maintenance switch, 🗎 124.

2 Secured the switch «Service» against switching on again.

3 Open the vacuum chamber, see Chapter 7.4.4 Opening and closing the service door, 🗎 203.

Removing the shieldings of the transport system (see Fig. 8-8, 🗎 255)

4 Loosen the knurled screws (1).

5 Remove the shielding (2) from the vacuum chamber.

Fig. 8-8 *Shieldings of the transport system in module L1*

1 Knurled screw
2 Transport roller
3 Shielding

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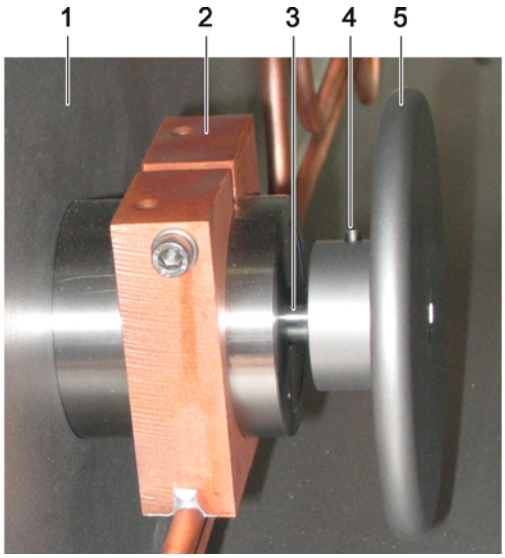
Removing the transport rollers (see Fig. 8-9, 256)

6 Measure the distance between the transport roller (5) to be replaced and the chamber back wall (1). Note down the measured value.



1 Chamber back wall
2 Cooling cuff
3 Drive shaft
4 Grub screw
5 Transport roller

Fig. 8-9 *Transport in the vacuum chamber*

7 Loosen the two grub screws (4) and take the roller (5) off the drive shaft (3).

8 Clean the chamber, see Chapter 7.5.4 Cleaning the vacuum chambers, 245.

Installing the transport roller

9 Put the new roller on the drive shaft.

10 Align the roller according to the noted value.

11 With a ruler, check the alignment to the adjacent transport rollers.

12 Tighten the two grub screws.
Make sure, that the socket head cap screw presses to the key and the grub screw (with brass head) presses to the drive shaft.

Installing the shieldings

13 Put the shielding (2 in Fig. 8-8, 255) on the cooling cuff (2 in Fig. 8-9, 256).

14 Screw the shielding with the knurled screws (1 in Fig. 8-8, 255).

Finishing the transport roller replacement

15 Switch on the servo control of the transport system by the switch «Service» on the electrical cabinet CCSC, see Chapter 5.2 Maintenance switch, 124.

16 At the operator terminal turn the «Service» key switch into «I» or «Service ON» position, see Chapter 5.6.6 Key switches, 132.

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17 Load a substrate carrier to the open chamber and make it oscillate on the replaced roller in order to check if the carrier transport is aligned evenly.
Select the menu «Transport > Overview» starts the transport.

NOTE!
The distance of the front of the carrier to the chamber passageway and to all front-sided chamber installations (heater, plates, etc.) should not be less than 10 ± 1 mm.

18 Close the vacuum chamber, see Chapter 7.4.4 Opening and closing the service door, 🗎 203.

19 At the operator terminal turn the «Service» key switch into «O» or «OFF» position, see Chapter 5.6.6 Key switches, 🗎 132.

8.2.3.2 Replacing a roller of the process modules

NOTE!
The transport rollers must be aligned accurately (accuracy < 1/10 mm). Replace each transport roller separately and align the new one to the adjacent transport rollers.

Preparations

1 Switch off the servo control of the transport system by the switch «Service» at the electrical cabinet CCSC, see Chapter 5.2 Maintenance switch, 🗎 124.

2 Secured the switch «Service» against switching on again

3 Open the vacuum chamber, see Chapter 7.4.4 Opening and closing the service door, 🗎 203.

4 If necessary, remove shielding covers (4 in Fig. 8-10, 🗎 257). Clean them by a vacuum cleaner, by more dirt, see Chapter 7.5.3 Cleaning shielding plates and shutters, 🗎 235

Removing the shieldings of the transport system (see Fig. 8-10, 🗎 257)

5 Loosen the knurled screws (1).

6 Remove the shielding (2) from the vacuum chamber.

Fig. 8-10 *Shieldings of the transport system in module P1*

1 Knurled screw
2 Transport roller
3 Shielding
4 Shielding cover

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Removing the transport rollers (see Fig. 8-9, 🗎 256)

7 Measure the distance between the transport roller (5) to be replaced and the chamber back wall (1). Note down the measured value.

8 Loosen the two grub screws (4) and take the roller (5) off the drive shaft (3).

9 Clean the chamber, see Chapter 7.5.4 Cleaning the vacuum chambers, 🗎 245.

Installing the transport roller

10 Put the new roller on the drive shaft.

11 Align the roller according to the noted value.

12 With a ruler, check the alignment to the adjacent transport rollers.

13 Tighten the two grub screws.
Make sure, that the socket head cap screw presses to the key and the grub screw (with brass head) presses to the drive shaft.

Installing the shieldings

14 Put the shielding (3 in Fig. 8-8, 🗎 255) on the cooling cuff (2 in Fig. 8-9, 🗎 256).

15 Screw the shielding with the knurled screws (1 in Fig. 8-8, 🗎 255).

16 Switch on the servo control of the transport system by the switch «Service» on the electrical cabinet CCSC, see Chapter 5.2 Maintenance switch, 🗎 124.

17 At the operator terminal turn the «Service» key switch into «I» or «Service ON» position, see Chapter 5.6.6 Key switches, 🗎 132.

18 Load a substrate carrier to the open chamber and make it oscillate on the replaced roller in order to check if the carrier transport is aligned evenly.
Select the menu «Transport > Overview» starts the transport.

NOTE!
The distance of the front of the carrier to the chamber passageway and to all front-sided chamber installations (heater, plates, etc.) should not be less than 10 ± 1 mm.

19 Close the vacuum chamber, see Chapter 7.4.4 Opening and closing the service door, 🗎 203.

20 At the operator terminal turn the «Service» key switch into «O» or «OFF» position, see Chapter 5.6.6 Key switches, 🗎 132.

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8.2.3.3 Replacing a roller of the carrier back transport system

Preparations

1 Switch off the servo control of the transport system by the switch «Service» at the electrical cabinet CCSC, see Chapter 5.2 Maintenance switch, 124.

2 Secured the switch «Service» against switching on again.

3 Open the coverings/doors of the carrier back transport.

Replacing a transport roller

4 Remove the toothed belts that actuate the transport rollers, see Chapter 8.2.2 Replacing a toothed belt of the carrier transport system, 251.

5 Remove the hexagon socket screw and the plain washer at the back of the roller holder and take the roller out of the holder.

6 To disassembly of the drive roller, loose the snap ring of the bolt and the socket head screw in the synchronizing disk. Then can put the roller from the raceway of a ball bearing.

7 Mount the new transport roller, the toothed pulley and the toothed belts in reverse order.

8 Belt tension, see belt tension.

➢ Look for synchronisation between the bolt and the drive roller.

9 Switch on the servo control of the transport system by the switch «Service» on the electrical cabinet CCSC, see Chapter 5.2 Maintenance switch, 124.

10 At the operator terminal turn the «Service» key switch into «I» or «Service ON» position, see Chapter 5.6.6 Key switches, 132.

11 Make a carrier oscillate on the replaced roller to check if the carrier transport is aligned evenly.

12 Close the coverings/doors of the carrier back transport.

13 At the operator terminal turn the «Service» key switch into «O» or «OFF» position, see Chapter 5.6.6 Key switches, 132.

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8.2.4 Replacing a rotary feedthrough

⚠WARNING

Hands getting trapped by rotating elements.

There is a danger of hands getting trapped by rotating pulleys and belts.

- ➢ Secure the drive and make sure that it cannot be switched on inadvertently before you perform any service work.
- ➢ Make sure that no one reaches into the danger area before you activate the transport system again.

⚠CAUTION

Burns by touching hot servomotors of the transport system.

Servomotors are heated during the process and can cause burns.

- ➢ Wait for the servomotors to cool down to room temperature before working on them.
- ➢ Wear protective gloves and work clothes with long sleeves.

Necessary number of persons
Two or more persons are needed to replace a rotary feedthrough.

1 Dismount the toothed belts that run over the toothed pulley of the rotary feedthrough to be replaced, see Chapter 8.2.2 Replacing a toothed belt of the carrier transport system, 🗎 251.

Preparing

2 Remove the transport roller, see Chapter 8.2.3 Replacing a roller of the transport system, 🗎 255.

3 Loosen the screw (1) of the cooling cuff (2) in the vacuum chamber.

4 Remove the screws of the rotary feedthrough.

5 1. person: Loosen the cooling cuff.

6 2. person: Pull the rotary feedthrough out of the vacuum chamber.

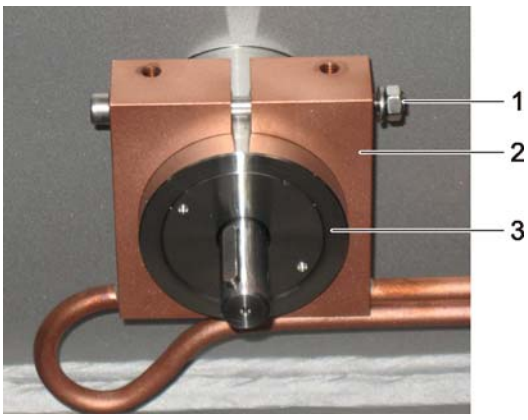

Fig. 8-11 Cooling cuff

1 Screw
2 Cooling cuff
3 Rotary feedthrough

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Dismantling the rotary feedthrough

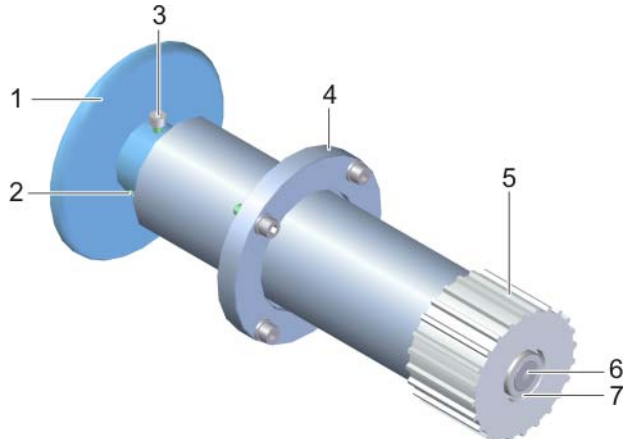

Fig. 8-12 *Rotary feedthrough*

1 Roller
2 grub screw with brass head
3 Socket head screw
4 Flange
5 Synchronizing disk
6 Countersunk bolt
7 Washer (curved)

7 Loosen the countersunk bolt (6) and remove the washer (7).

8 Put the synchronizing disk packet from the shaft.
If you use an extractor put it only to the shaft end!

9 Remove the fitting key.

10 Take the seal (2 in Fig. 8-12, 🗎 261) out of the sealing groove. Use a sealing extractor (5 in Fig. 8-13, 🗎 261) in order not to damage the seal and the sealing groove.

Preparing the new rotary feedthrough (see Fig. 8-13, 🗎 261)

11 Take the new rotary feedthrough (1) out of the packing.

12 Put the fitting key into the groove of the new rotary feedthrough.

13 Put the synchronizing package to the end of the shaft.

14 Fix the package with the disc and the countersunk bolt

15 Clean the seal and the groove with solvent (3) and grease the seal with vacuum grease, see Chapter 7.5.2 Cleaning seals and sealing surfaces, 🗎 232.

16 Put the seal into the sealing groove.

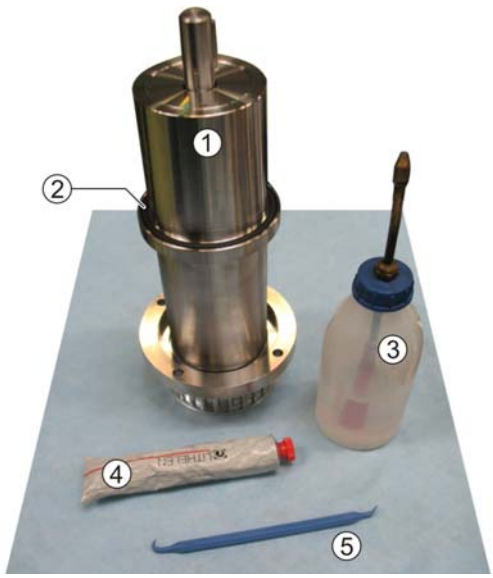

Fig. 8-13 *Preparing the rotary feedthrough*

1 Rotary feedthrough
2 Seal
3 Rubbing alcohol (Isopropanol)
4 Vacuum grease
5 Sealing extractor

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Replacing the rotary feedthrough

17 Remove all toothed belts, which handicap the replacing of the rotary feedthrough.

18 1. person: In the vacuum chamber, hold the cooling cuff (2 in Fig. 8-11, 🗎 260)

19 2. person: Insert the new rotary feedthrough, with the transport roller drive shaft ahead, into the vacuum chamber, while the 1. person moves the cooling cuff over the drive shaft.

20 Mount the rotary feedthrough by the fastening screws and tighten the screws evenly.

Mounting all components

21 Mount the toothed belts and adjust their tension, see Chapter 8.2.2 Replacing a toothed belt of the carrier transport system, 🗎 251.

22 In the vacuum chamber, mount the cooling cuff on the rotary feedthrough, see Fig. 8-11, 🗎 260.

23 Install the transport roller, see Chapter 8.2.3 Replacing a roller of the transport system, 🗎 255.

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8.2.5 Replacing a turbo pump

Safety information

⚠DANGER

Lethal electric shock by touching live parts.

The turbo pumps are connected to the mains supply. Touching live parts may cause a lethal electric shock.

- ➢ Turn the system off and bring it in a voltage-free state before you carry out any maintenance or service work on the A1500V-7.
- ➢ Ground the equipment and secure the system against switching on again.
- ➢ Ensure that all persons keep a safe distance to parts that are connected to the electrical supply before you switch the system on again.

⚠WARNING

Eye or skin injuries when opening pressurized system parts (water supply, purge gas supply, and compressed air system).

- ➢ Shut off the supply to the system and release the pressure before carrying out any work on these parts.

⚠WARNING

Danger of crushing by improper handling of suspended loads.

Improper handling of the turbo pump during dismounting can lead to serious fractures and damage to system components.

- ➢ Always guide the turbo pump during lifting.
- ➢ Wear safety shoes and a helmet.
- ➢ Ask a second person to help.
- ➢ Never stand beneath a hanging load.

Only carry out service work in conjunction with the supplier's documentation to the turbo pumps, see supplier's documentation on CD 1.

NOTE!
Necessary number of persons:
Three or more persons are needed to replace a turbo pump.
- **The first person operates the crane**
- **The second person guides the turbo pump**
- **The third person carries out the installation work**

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Locking out energy supply

1 Vent the vacuum chamber, see Chapter 6.5 Evacuating and venting the system, 144.
The turbo pumps are switched off and the fore-vacuum valve is closed.

2 Lock out the main power, see Chapter 7.2.4 Locking out the main power, 172.

3 Blow out the cooling water circuit of the turbo pump, see Chapter 7.4.3 Blowing out the water circuits, 198

Preparing the dismounting

4 Disconnect all turbo pump connections.

5 Draining the lubricant.
Drain of lubricants in installation position.

6 Wrap the turbo pump with two or more lifting straps so that it can be lifted securely. The center of gravity levels approximately with the fore-vacuum flange.

7 Attach the lifting straps to the hook of a crane.

8 Tighten the straps with the crane but do not lift the assembly yet.

Saving settings
Make the following steps, if you plan to replace the turbo pump:

9 Note down the profibus address.
This is not necessary, if the new turbo pump is reassembled with the old profibus control box.

Removing the turbo pump

10 Remove the lateral hexagon head bolts from the mounting flange, but **do not remove** the upper and lower hexagon head bolts.

11 Hold the turbo pump.

12 Carefully loosen the upper and lower hexagon bolts and observe the behavior of the turbo pump. If applicable, reposition the lifting straps to ensure that the crane will hold the turbo pump horizontally during dismounting.

13 Remove the two hexagon head bolts.

14 Take the centering ring from the mounting flange.

15 With the crane, carefully remove the assembly from the mounting flange.
With two or more persons, guide assembly components away from chamber components during the lift.
Avoid axial shocks. They might damage the bearings.

16 Place the turbo pump with the mounting flange upwards on a padded, level surface.

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Preparing the new turbo pump

17 Prepare the new turbo pump according to the instructions in the supplier's documentation.

18 Set the profibus address of the turbo pump to the required value.

19 Prepare the centering ring according to the instructions in the supplier's documentation.

20 Make sure that all O-rings and O-ring grooves are clean, see Chapter 7.5.2 Cleaning seals and sealing surfaces, 232.

Installing the turbo pump

21 Fix lifting straps to the ring bolts of the turbo pump and attach the straps to the hook of the crane.

22 Slightly lift the turbo pump and put it down horizontally.

23 Adjust the lifting straps so that the lifting device can hold the suspended turbo pump horizontally with the fore-vacuum flange pointing downwards.

24 Using the lifting device, carefully lift the turbo pump to the port. With two or more persons, guide assembly components away from chamber components during the lifting. Avoid axial shocks. They might damage the bearings.

25 Put the centering ring to the mounting flange of the turbo pump and hold it.

26 Align the turbo pump on the mounting flange.

27 Once the turbo pump is aligned on the mounting flange, fasten it with two opposing hexagon head bolts. Make sure that the centering ring is aligned properly.

28 Mount all hexagon head bolts and fasten them evenly.

29 Remove the lifting straps.

30 Fill lubricant in the turbo pump.
Fill in the lubricants in installation position.

Reinstating energies

31 Install all turbo pump connections.

32 Refill the cooling water circuit of the turbo pump, see Chapter 7.4.3 Blowing out the water circuits, 198

33 Reinstate any energies that were turned off, see Chapter 7.4 Maintenance instructions, 196

34 Evacuate the vacuum chamber, see Chapter 6.5 Evacuating and venting the system, 144.

35 Check the vacuum integrity, see Chapter 7.4.13 Checking the vacuum performance, 228.

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8.2.6 Replacing a cryo pump

Safety information

⚠DANGER

Lethal electric shock by touching live parts.

The turbo pumps are connected to the mains supply. Touching live parts may cause a lethal electric shock.

- ➢ Turn the system off and bring it in a voltage-free state before you carry out any maintenance or service work on the A1500V-7.
- ➢ Ground the equipment and secure the system against switching on again.
- ➢ Ensure that all persons keep a safe distance to parts that are connected to the electrical supply before you switch the system on again.

⚠WARNING

Eye or skin injuries when opening pressurized system parts (water supply, purge gas supply, and compressed air system).

- ➢ Shut off the supply to the system and release the pressure before carrying out any work on these parts.

⚠WARNING

Danger of crushing by improper handling of suspended loads.

Improper handling of the cryo pumps during dismounting can lead to serious fractures and damage to system components.

- ➢ Always guide the cryo pump during lifting.
- ➢ Wear safety shoes and a helmet.
- ➢ Ask a second person to help.
- ➢ Never stand beneath a hanging load.

⚠CAUTION

Extremely cold cryo pump components.

Components in the interior of the pump and the and the pipelines are cold. The touching of these components can cause cold burns.

- ➢ Wear protective gloves and work clothes with long sleeves.
- ➢ Wait until the affected components have warmed to room temperature before starting to work on them.

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NOTE!
Necessary number of persons:
Three or more persons are needed to replace a cryo pump.
- **The first person operates the crane**
- **The second person guides the cryo pump**
- **The third person carries out the installation work**

Locking out energy supply

1 Close the gate valve.

2 Press the «REGEN». key on the display.

2.1 Press «1» to start the regeneration.

2.2 Press «2» to confirm the start of the regeneration.

3 Once the cryo pump temperatures reaches 310 K:

3.1 Press «0» to abort the regeneration

3.2 Press «2» to confirm the regeneration abort.

4 Switch off the cryo compressor.

5 Switch off the scroll pump SC30D.

6 Disconnect the cryo pump connections:
- main power
- helium line
- compressed air supply
- for-vacuum line
- purge gas line

Preparing the dismounting

7 Wrap the cryo pump with two or more lifting straps such that it can be securely lifted.

8 Attach the straps to the portable crane.

Removing cryo pump

9 Remove the anchoring clips mounting the cryo pump to the vacuum flange.

10 Use a portable crane to carefully lift and remove the assembly from the mounting flange. Use two or more people to guide the assembly components away from chamber components when hoisting the pump.

11 Place the cryo pump flange down on a padded, level surface.

Installing cryo pump

12 Verify that all O-rings and O-ring grooves are clean, see Chapter 7.5.2 Cleaning seals and sealing surfaces, 232.

13 Wrap the cryo pump with two or more lifting straps such that it can be securely lifted.

14 Attach the straps to the portable crane.

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15 Using the portable crane, carefully lift and fit the cryo pump into the port.
Use two or more people to guide assembly components away from chamber components during the lift.

16 Aligned the cryo pump to the mounting flange.

17 Install and fasten the anchoring clips.

18 Remove the crane straps.

Reinstating energies

19 Installing the cryo pump connections:
- main power
- helium line
- compressed air supply
- for-vacuum line
- purge gas line

20 Switch on the cryo compressor.

21 Switch on the scroll pump SC30D.
The regeneration starts automatically.

22 If the regeneration is finished, evacuate the vacuum chamber, se Chapter 6.5.1 Evacuating the system, 145.

23 Open the gate valve.

24 Check the vacuum integrity, see Chapter 7.4.13 Checking the vacuum performance, 228.

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8.2.7 Replacing a high-vacuum/throttle valve

⚠WARNING

Crushing by high-vacuum/throttle valves.

There is danger of crushing through unintentional movements of these valves.

➢ When carrying out service work on such a valve, secure it against unintentional movement, e.g., by blocking.

⚠WARNING

Danger of crushing by improper handling of suspended loads.

Improper handling of the high-vacuum/throttle valve during dismounting can lead to serious fractures and damage to system components.

➢ Use applicable equipment to lift and transport heavy components.

➢ Never stand beneath a hanging load.

⚠WARNING

Eye or skin injuries when opening pressurized system parts (water supply, process gas supply and compressed air system).

➢ Shut off the supply to the system and release the pressure before carrying out any work on these parts.

Only carry out service work in conjunction with the supplier's documentation to the valve, see supplier's documentation on CD 1.

NOTE!
Three or more persons are needed to replace a high-vacuum/throttle valve.

Locking out energy supply

1 Vent the vacuum chamber, see Chapter 6.5.2 Venting the system, 🗎 147.

2 Regenerate the cryo pump.

3 Locking out the following energy sources:
- Main Power, see Chapter 7.2.4 Locking out the main power, 🗎 172
- High vacuum valve, see Chapter 7.2.5 Locking out the pneumatic valves, 🗎 173

Removing components

4 Remove the cryo pump see Chapter 8.2.6 Replacing a cryo pump, 🗎 266.

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5 Disconnect the compressed air line and the power cable.

Removing the valve

6 Fix lifting straps/chains to the ring bolts of the valve

7 Attach the straps/chains to a crane.

8 Make sure the lifting mechanism is set in such manner, that the straps/chains are tight, but do not lift the assembly yet.

9 With the lifting straps tightly secured to the crane, cautiously remove the screws mounting the valve to the vacuum chamber.

10 Using the crane, carefully remove the assembly from the mounting flange.
Use two or more people to guide assembly components away from chamber components during the lift.

11 Place the valve on a padded, level surface.

Installing the valve

12 Verify that all O-rings and O-ring grooves are clean, see Chapter 7.5.2 Cleaning seals and sealing surfaces, 232.

13 Fix lifting straps/chains to the ring bolts of the valve.

14 Attach the straps/chains to a crane.

15 Using the crane, carefully lift and fit the valve into the chamber port. Use two or more people to guide assembly components away from chamber components during the lift.

16 Aligned the valve to the mounting flange.

17 Install and fasten the screws (arrows) mounting the valve to the vacuum chamber.
Screw all bolts down evenly.

18 Remove the crane straps/chains.

Installing all other components

19 Connect the compressed air line and the power cable of the valve.

20 Install the cryo pump, see Chapter 8.2.6 Replacing a cryo pump, 266

Reinstating energies

21 Reinstate any energies which were turned off, see Chapter 7.2.2 Lockout locations, 170.

22 Evacuate the vacuum chamber, see Chapter 6.5.2 Venting the system, 147.

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8.2.8 Replacing a chamber lamp

	**⚠CAUTION** Hot chamber lamp. The halogen lamp wall reaches temperatures above 250 °C and can cause burns. ➢ Do not touch the surface of the halogen bulb with your bare hands. Wear gloves. ➢ Wait for the lamp to reach room temperature before touching it. ➢ Make sure that the electrical power is switched off before inserting, removing or cleaning the lamp.

Prerequisites

- The vacuum chamber is open, see Chapter 7.4.4 Opening and closing the service door, 203.
- The chamber lamp is switched off and cooled down to room temperature.

Locking out the energy

1 On the top of the load lock chamber, disconnect the chamber lamp from the power supply.

Removing the lamp

2 Loosen the clamps (2) of the lamp connection.

3 Remove the chamber lamp (3).

Installing and checking the new lamp

4 Install the new chamber lamp.

5 Make sure that the lamp is working:

5.1 Connect the chamber lamp to the power supply.

5.2 GUI: Switch the lamp on.

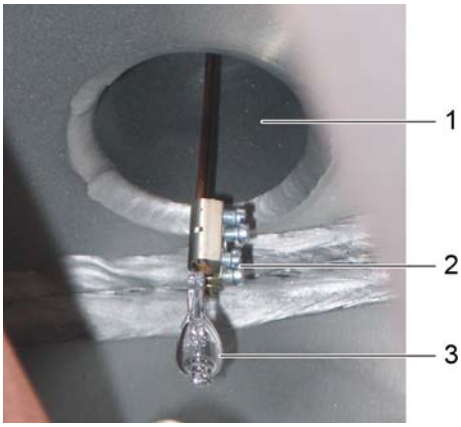

Fig. 8-14 Chamber lamp

1 Feedthrough in the chamber ceiling
2 Clamps
3 Lamp bulb

6 Close the vacuum chamber, see Chapter 7.4.4 Opening and closing the service door, 203.

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8.2.9 Adjusting PID control circuits

The temperatures of the substrate heaters are adjusted by PID control circuits.

NOTE!
Temperatures varying slightly around the setpoint are normal and do not impair the product quality. Only adjust a control circuit when it becomes instable, i.e. when the temperatures vary greatly around the setpoint.

Adjusting control circuit

1 GUI: Open the «Heating > Control» menu, see Software-Handbook:

2 GUI: Set the parameter for the PID control circuit.

- **2.1** Set the differential parameter («D») to 0.0 s.
- **2.2** Reduce the integral parameter («I») to a value 0 s … 1 s.
- **2.3** Optimize the proportional parameter («P») the current value begins to oscillate.
- **2.4** Increase the value of the integral parameter «I» until the oscillation disappears.
- **2.5** Slowly increase the value of the derivative parameter «D» so that the temperature does not oscillate.

3 GUI: Test the control circuit:

- **3.1** Observe the reaction of the regulation when switching on.
- **3.2** Observe the reaction of the regulation after interferences.
- **3.3** Observe if the current temperature value begins to oscillate.
- **3.4** For the flow controller: Make sure that the film thickness is even over the whole width of the substrate (in transport way).

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9 Storage and disposal

9.1 Storage

9.1.1 Storage conditions

The A1500V-7 may only be stored in its original packaging. You must note down the packaging symbols and adhere to the following storage conditions:

Temperature	10…50°C
Relative humidity	30…80% (non-condensing)

9.1.2 Deactivating the system

The A1500V-7 should only be shut down for longer breaks in production (longer than one to two weeks) or to carry out service or revision work.

In order to avoid contamination at the modules (mainly water vapor at the process chamber walls), the modules should remain evacuated when the system is shut down or they should be vented with pure, dry nitrogen to a pressure of 10…40 mbar.

1 Switch the system off, see Chapter 6.3, 141.

2 Disconnect the water supply and blow all the water circuits out with compressed air. This protects the water circuit from corrosion. It also protects the water circuit from damage through freezing, should the temperature drop below 0°C during storage.

3 Disconnect the compressed air supply.

4 Disconnect the power supply. Discharge all components which may carry residual voltage with the grounding rod or remove the circuit breaker.

5 Disconnect the gas supply. Lock the gas store and disconnect the gas lines.

6 Disconnect the exhaust lines of the vacuum pumps.

7 Disconnect Modem, MES and MFI.

8 Cover the system with plastic foil to protect it from dust.

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9.2 Disposal

9.2.1 Personnel qualifications

The operating firm can recycle or dispose of the system in accordance with the legal regulations. For proper dismantling of the system and sensible separation of materials, you require wide knowledge of mechanical procedures and in separating waste materials.

Additional qualifications
If dangerous materials as defined by guideline 91/689/EWG are being disposed of, the persons carrying out the work require additional knowledge in the following areas:

- Risks and dangers
- Disposal regulations
- Accident prevention regulations
- First aid measures

9.2.2 Safety regulations

➢ Read Chapter 2 Safety, 🗎 31, before you dispose of the system. Take note of all the danger information it contains and also read the safety data sheets in the appendix to the chapter.

9.2.3 Legal principles

According to the EU guideline 2008/98/EC the operating firm is obliged to decontaminate the system in such a way that the human health and the environment are not endangered.
The operating firm may consign the system to a licensed private collection company, a public one or may recycle or dispose of the system by itself.

NOTE!
If the operating firm has the A1500V-7 disposed of by a collection company, it also must give a copy of the Operating Instructions to the collection company. The Operating Instructions contain important information about the disposal of the system.

Notification rule
Companies that dispose of or recycle their own waste are subject to authorized permission and controls. Under certain circumstances they can be released from requiring authorized permission as long as they take the environmental protection requirements into account. Such companies are subject to the notification rule. You can obtain more detailed information from the official body responsible for environmental protection.

Outside the EU, the corresponding legal regulations generally apply.

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Environmental protection regulations
Waste must be recycled or disposed of so that human health is not endangered. You may only use processes and methods that are not harmful to the environment. You must take particular care that:

- Air, water and soil are not polluted
- Animal and plant life are not endangered
- There is no noise or odor disturbance
- Surroundings and scenery are not diminished

Sorting
After the system has been taken apart, the individual parts must be sorted into waste groups. This is carried out in line with the directory of the European Waste Catalogue (EWC) or similar regulations. The EWC applies to all waste, regardless of whether it is intended for disposal or recycling.

Waste management
The waste management must be carried out in line with the official waste management plans. They encompass, in particular:

- Type, amount and source of the waste
- General technical regulations
- Special provisions for particular waste
- Suitable areas for disposal sites and other disposal systems

Some of the information contained in the plans is as follows:

- Natural or legal persons entitled to manage the waste
- Estimated costs of the recycling and the disposal
- Measures for rationalizing the collection, sorting and treatment of the waste
- Designations for special waste

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9.2.4 Disposal: Operating materials for vacuum pumps

⚠CAUTION

The operating materials for the pumps are environmentally damaging.

Operating materials and parts contaminated with operating materials must not enter the drinking water supply.

- ➢ Dispose of the operating materials as special waste, even if only small amounts are involved.
- ➢ Return pump operating media for the A1500V-7 that is still in closed original containers to the supplier. Fill out and enclose a contamination declaration form.
- ➢ Classify operating media in opened containers as well as previously-used operating media as «oil-water mix» and bring it to a specialized hazardous waste disposal company.
- ➢ Use appropriate Personal Protection Equipment (PPE) for user safety and consult the supplier's documentation.
- ➢ Follow all local disposal regulations as required by law.
- ➢ Follow the safety data sheet and follow all the directions.

9.2.5 Disposal: Coating materials

⚠CAUTION

Coating materials are environmentally damaging.

Targets and parts or materials that are contaminated with it must not enter the natural environment.

- ➢ Dispose of the coating materials as special waste, even if only small amounts are involved.
- ➢ Return coating materials of the A1500V-7 that are still in closed containers to the supplier. Fill out and enclose a contamination declaration form.
- ➢ Follow the safety data sheet and follow all the directions.

➢ Used coating materials must be recycled as special waste in accordance with the local regulations.

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9.2.6 Disposal: Electrical and electronic materials

WEEE
The European Commission has released the Directive on Waste Electrical and Electronic Equipment (WEEE; 2002/96/EC). Since August 2005, producers are responsible for taking back and recycling electrical and electronic equipment.

Electrical and electronic materials may be environmentally damaging.

➢ Do not treat electrical and electronic equipment as unsorted municipal waste. Collect waste electrical and electronic equipment separately.

9.2.7 Disposal: Other parts and components

The components of the A1500V-7 are made up of the following materials:

Metals and alloys

- Aluminium (housing, covers, etc.)
- Copper (cooling plates, shieldings, electrical cables)
- Steel (profiles, fastening material such as screws, etc.)
- Stainless steel (vacuum chambers, shieldings)

Glass

- Glass (cover plates, in display instruments)

Plastics and rubber

- Plastics (instruction elements, tubes, sheeting, wheels, etc.)
- Rubber (sealing, silicon tubes)

Compound materials

- Electrical material (cables, motors, components)
- Electronic material (printed circuit boards, PC, screen)

Packaging

- Wood (packing crates)
- Polystyrene (padding material)
- Plastic (film)
- Iron (nails, etc.)

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10 Appendix

10.1 Glossary

Term	Meaning
Vacuum	Spatial area under low gas pressure; we differentiate between: ▪ Fore-vacuum: 10^{2}…10^{-1} Pa ▪ High-vacuum: 10^{-1}…10^{-5} Pa ▪ Ultra-high-vacuum: p < 10^{-5} Pa
Sputtering	Cathode sputtering; coating technique based on a gas plasma.
Substrate	The base material to be coated
Cathode	Negative pole of a device operated with DC current
Inert gas	Working gas that does not react chemically, e.g., the noble gas, argon
GUI	Graphical User Interface
PLC	Programmable logic control
UPS	Uninterruptible power supply
MFC	Mass flow controller; regulator for the flow of process gases
Pa	Pascal, pressure unit 1 Pa = 1 N/m^2 = 10^{-2} mbar = 10^{-5} bar
mbar	Pressure unit. This expression is out of date and has been replaced by Pa 1 mbar = 10^{2} Pa = 1 hPa.
sccm	Standard cubic centimeter per minute; gas flow in cm^3/min. under standard conditions (20°C, 1013 hPa)
slm	Standard liter per minute; gas flow in l/min under standard conditions (20°C, 1013 hPa)

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