GeniX

Installation and Operation Manual

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Dear Customer,

Welcome to the GeniX Installation and Operation Manual. This manual provides operational instructions for the GeniX Beam Delivery System. Please read it thoroughly before using this equipment.

The GeniX Beam Delivery System is a standard component in many analytical instruments. It is also available as a "stand-alone" item for use by academic or industrial research organizations.

The GeniX Beam Delivery System is designed to be simple to set up and operate. However, should you encounter any problems that are not addressed by this manual, please contact the Technical Support Department of Xenocs at the address below.

XENOCS SA
19, rue François Blumet
F-38 360 Sassenage
FRANCE
Tel: + 33 (0)4 76 26 95 40
Fax: + 33 (0)4 76 26 95 49
Email: support@xenocs.com
Web: www.xenocs.com

1 SAFETY: RISKS AND PRECAUTIONS

1.1 ELECTRICAL

1.1.1 Risks

The GeniX control unit contains voltages high enough to cause sever injury to persons, including heart failure, respiratory failure, or severe burning. Under no circumstances should unauthorized personnel open the control unit.

Figure 1 : Icon indicating the presence of electrical hazards.

The GeniX system is designed to meet the safety requirements of EC/UL norms. The areas presenting potential electrical hazards are clearly labeled with the icon in **Erreur ! Source du renvoi introuvable.**. These areas may contain the voltages listed below:

- High voltage (> 10 kV DC)
- Medium voltage (100 - 250 V AC)
- Low voltage (24 Volts DC)

1.1.2 Precautions

By default, the GeniX should be powered off completely and unplugged from the wall socket before performing any maintenance or repair work. If power must be maintained to perform a particular maintenance or repair task, several important rules should be respected:

- Only authorized persons are to perform maintenance or repair tasks, in compliance with all local laws and regulations. (French law: C18 510; 14/12/1988).
- If performing maintenance or repair tasks with the GeniX connected to a power outlet, maintenance personnel should wear individual protection equipment such as 1000 V insulating gloves and safety glass with UV filter. This list is non-exhaustive – consult local safety authorities for full protection measures to be taken.

1.2 RADIATION PROTECTION

Figure 2 : Icon indicating the presence of radiation hazards.

1.2.1 Risks

X-ray photons constitute ionizing radiation, which could lead to significant injury to humans or other biological systems. The main consequence of over-exposure is a drastic increase in the risk of leukemia or cancer. The legal exposure limits are determined by the local radiation safety authorities.

1.2.2 Precautions

The GeniX system is certified by an independent radiation safety organization accredited by the French government to emit a dose lower than 1 µSv/h at any point no closer than 10 cm to the GeniX head, excepting of course the exit point of the X-ray beam. However, this in no way diminishes the responsibility of the user in case of misuse of the instrument.

For maintenance tasks (e.g. adjusting the optics, aligning the X-ray beam with other equipment…) that oblige persons to work without the benefit of the complete safety protocol several rules should be respected:

- Only authorized persons should be allowed to perform such tasks. It is the user's responsibility to check with the local radiation safety authorities and to follow all applicable laws and regulations.
- The end of collimator has to perfectly block with adapted piece (made in lead).
- Check with a Geiger-Müller detector (Xenocs recommends Fujifilm Inspector) that the efficient dose flux is lower than 1µSv/h at a distance of 10 cm around the system.
- If you suspect a leak, contact your local radiation protection officer for assistance.

1.3 CHEMICAL HAZARDS

Figure 3 : Icon indicating the presence of chemical hazards.

1.3.1 Risks

The X-ray tube has a beryllium window. The dust and vapor of beryllium are very toxic if inhaled or ingested. Xenocs therefore recommends the following precautions:

1.3.2 Precautions

- Do not touch the Be window with bare hands.
- Do not clean the Be window with any chemical products.

- Maintenance persons should wear appropriate safety glasses and gloves when manipulating the X-ray tube.
- Do not dismantle the X-ray tube
- Return damaged tubes in adapted packaging to Xenocs (contact Xenocs Technical Support Department for more information).

1.4 OTHER HAZARDS

Figure 4 : Icon indicating general hazard.

There are a number of other hazards present in the Genix, including (but not limited to) the following:

- Water chiller contain a number of potentially hazardous features includes hot or cold plates, compressed gases, and moving mechanical parts (e.g. in recirculating pump).
- Safety precautions must be taken when moving the heavy components such as chiller, GeniX controller or GeniX head.
- If in doubt regarding the safety of any procedure, feel free to contact Xenocs Technical Support Department for assistance (note that contacting Xenocs does not free the user from the obligation to follow all applicable laws and regulations).

1.5 ENVIRONMENTAL POLICY

The design of GeniX is made to meet the requirements of European standards such as the RoHS rules. The materials used for the construction of GeniX system, such as stainless steel or brass, are recyclable. Due to beryllium parts, the X-ray tube should not be discarded in conventional waste. Please return all undesired X-ray tubes to Xenocs for disposal.

2 WARRANTY

The standard warranty period is one (1) year from the date of acceptance of the GeniX.

The warranty is limited to either repair or replacement of the relevant part, to be decided by Xenocs. If Xenocs deems that a return of defective item(s) to Xenocs is necessary, the shipment of said items shall be paid for by Xenocs.

The warranty does not apply if the defect is caused by:

- normal wear and tear;
- improper use (as determined by Xenocs), including but not limited to the use of the GeniX with interlocks defeated
- use of the GeniX in an environment at variance with the environment described in the user's manual;
- modification of the GeniX that has not been approved by XENOCS in written form.

3 TECHNICAL DESCRIPTION OF GENIX

3.1 THEORY OF X-RAY OPTICS

The Xenocs FOX optics use the principle of Bragg diffraction to reflect X-rays. A multilayer coating assures constructive interference of the reflected rays, as described by Bragg's law. Since only rays satisfying Bragg's law are reflected, a multilayer coating also serves as a natural band-pass filter. The thickness of the individual layers in the multilayer stack are chosen so that only the K_α lines (Cu K_α, Mo K_α – depending on design) are reflected, whereas the other energies are strongly absorbed (see **Erreur ! Source du renvoi introuvable.**).

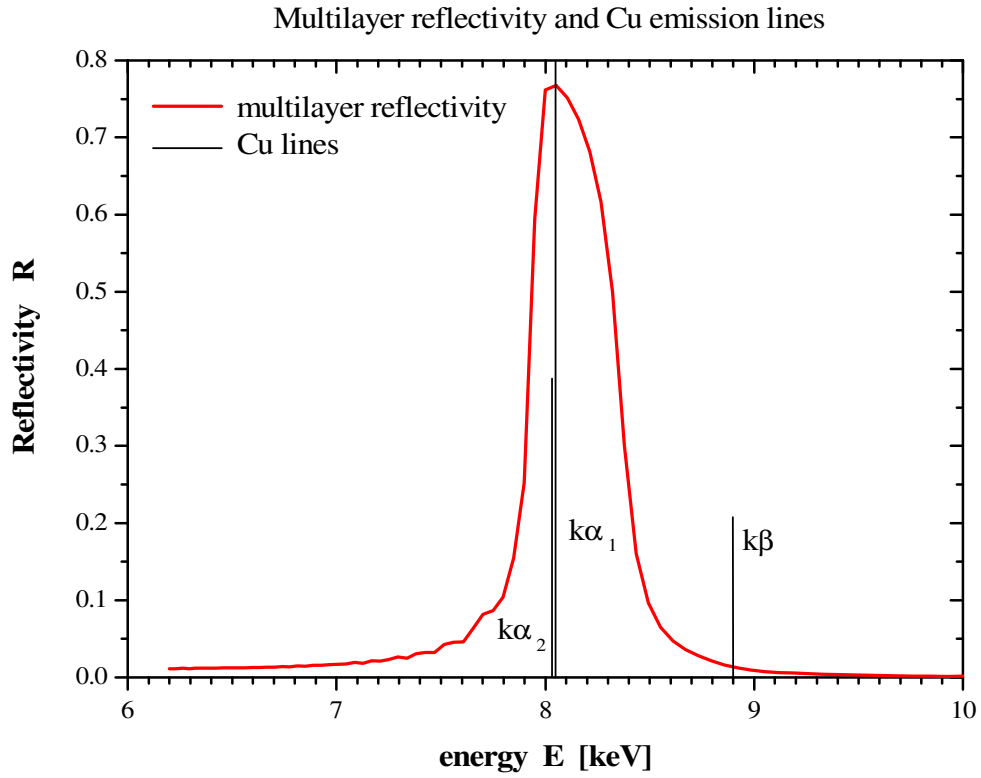


Figure 5 : Typical reflectivity curve of a W/Si multilayer optic designed to match Cu Kα emission lines.

The geometrical shape of the mirror is that of a section of an ellipsoid of revolution (or a paraboloid of revolution for a collimating mirror) as shown in **Erreur ! Source du renvoi introuvable.**. With this shape, each ray coming from the left focus (the source) will pass through the right focus (the image). For extended sources (when the source may not be approximated as a point), the image size will be proportional to the source size. The length of

the mirror and the useful width is defined to optimize flux while keeping a reasonably low divergence.

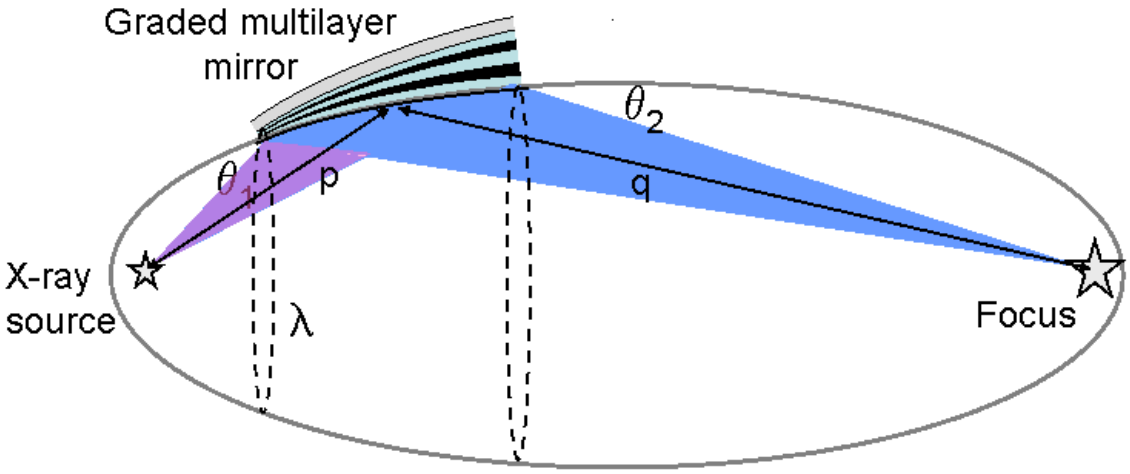


Figure 6 : Ellipsoidal mirror with lengths p and q indicated. This schematic represents the focusing case. For a collimating mirror with $q = \infty$ we would get a parallel beam, and the ellipsoid of revolution would be a parabaloid of revolution.

Because the incident angle of X-rays coming from the source varies along the length of the mirror, the multilayer coating thickness must be graded longitudinally so that the Bragg condition is met at each point of the mirror.

This patented design has several advantages over the other X-ray focusing/collimating systems:

- Xenocs' FOX optics collect more flux than double reflection mirrors,
- They are wavelength selective bandpass filters (they yield monochromatic radiation),
- They have higher average reflectivities due to the single-reflection,
- They are very easy to align because only one reflection is involved.
- Due to larger flux collection angles, they produce more stable X-ray beams

3.2 COMPONENTS OF GENIX

3.2.1 Integration conditions in your installation

3.2.1.1 Components

The GeniX system consists of 4 components: 1) the GeniX head, 2) the control unit, 3) the chiller, and 4) the vacuum pump – see photos below.

Figure 7 : GeniX head (in back) and control unit (in front). Remote indicator box is shown at right.

Figure 8 : Chiller for GeniX system.

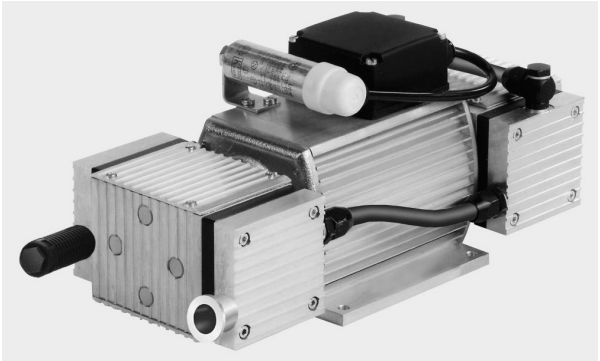


Figure 9 : Dry pump for GeniX system.

3.2.1.2 Size of the system

The control unit and the chiller can be placed in 3U racks. If you do not have such installation to receive systems, the following conditions must be respected:

1. A free space above and under each element is necessary particularly if the covers are not perforated.

2. The space behind each unit must be at least 15 cm to allow proper ventilation of the system.

The space required to accommodate the GeniX head depends on the mirror type purchased. For the larger versions, at least 600 mm horizontal space is needed. This space includes that needed for proper connection of the cooling water hoses. The height of the GeniX head is 330 mm, and the width is 200 mm.

The pump measures 32 X 15 X 15 cm^3, and should be placed on the floor to absorb vibrations (which are very minor).

3.2.1.3 Connections to foresee

3.2.1.3.1 Electrical connections

With the system completely installed, you will use 5 power connections – one for each of the following items:

1. the control unit
2. the chiller
3. the pump
4. the MAR CAM
5. the pindiode.

3.2.1.3.2 Water connections

In the event that you did not purchase a chiller from Xenocs, the outside diameter of hose that connects the chiller to the GeniX head is 6 mm. If your water hoses are different dimensions, you must provide the appropriate adaptors to enable Xenocs to complete the installation.

3.2.1.3.3 Vacuum connection

In the event that you did not purchase the vacuum pump from Xenocs, the outside diameter of the vacuum tube that connects the pump to the GeniX head is 4 mm. If your vacuum tubes are different dimensions, you must provide the appropriate adaptors to enable Xenocs to complete the installation.

3.2.2 Control Unit

Figure 10 : Front panel of GeniX control unit and the remote status box.

Figure 11 : Left side of control unit front panel, with components marked.

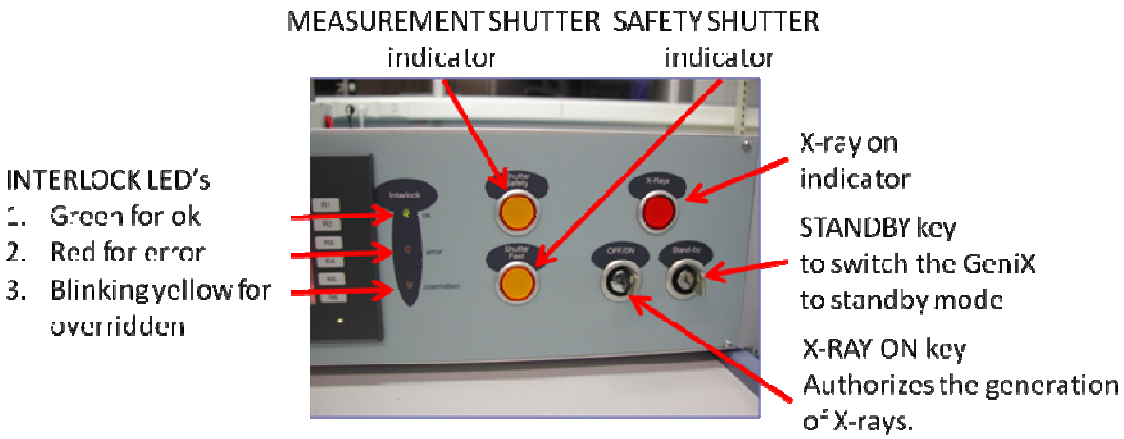


Figure 12 : Right side of control unit front panel, with components marked. Note that for the two keys, vertical is off, horizontal is on.

3.2.2.1 Interface Buttons

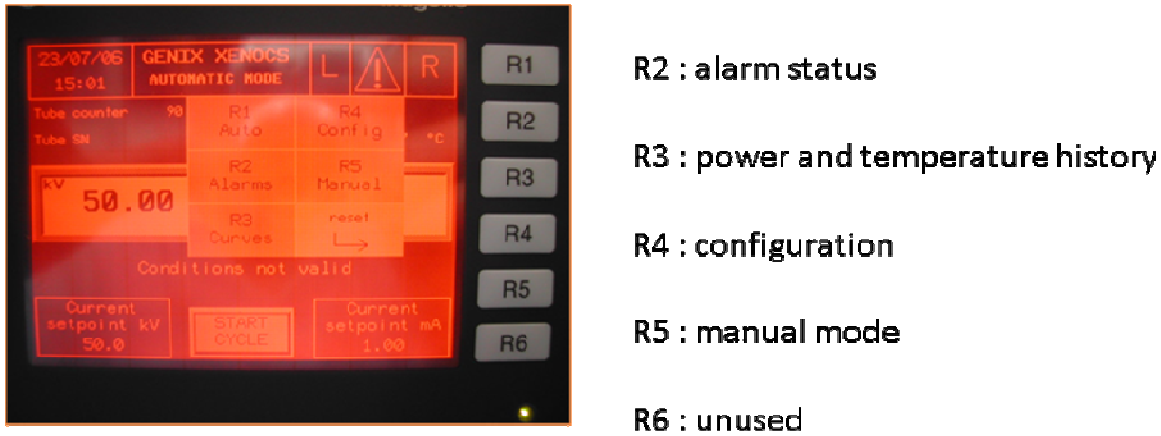


Figure 13 : The user interface touch-screen with the menu buttons functions indicated.

3.2.2.2 Expert mode

Expert mode is only to be used by authorized personnel, as defined by the local radiation safety authorities. Under no circumstances should the GeniX be operated in expert mode by unqualified personnel.

If it is necessary to operate the GeniX with the interlocks defeated, for example to align the optics, it is possible using the expert mode. To place the GeniX in expert mode, simply insert the expert mode key and turn it to the horizontal position (see **Erreur ! Source du renvoi introuvable.** below). The touch screen will flash red, and the GeniX will emit a periodic audible signal. With the GeniX in this mode, it is possible to operate the GeniX with the following interlocks defeated.

1. Door interlock
2. Cover protection

3. Vacuum
4. Red lamps

This mode is manually chosen by turning the key located on the back of the controller as shown on figure 13.

3.2.2.3 Controller Details – back side

The following figures show the connections for the back side of the GeniX control unit. Note that all connections are unique, so it is not possible to improperly connect the cables.

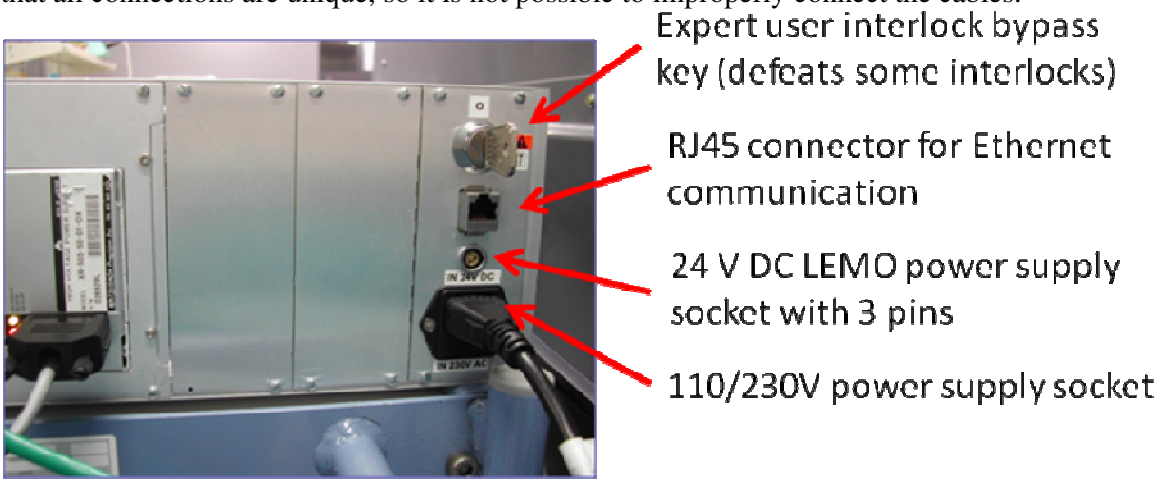


Figure 14 : Detail of back side of GeniX control unit.

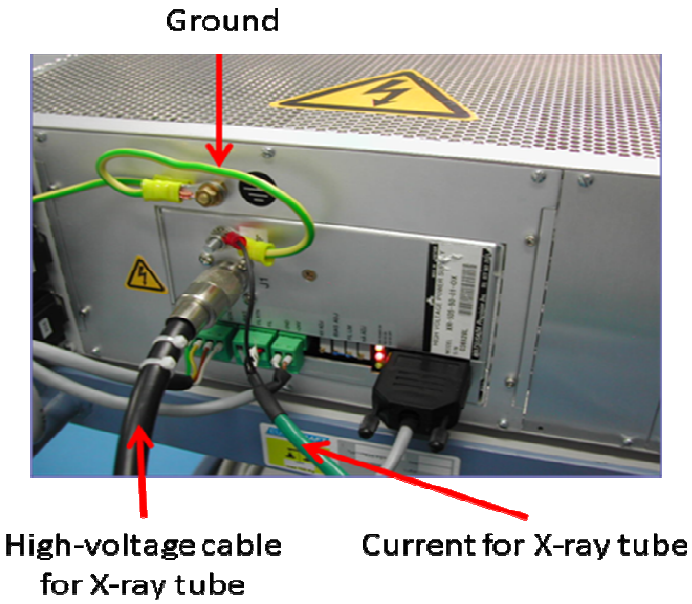


Figure 15 : Detail of back side of GeniX control unit.

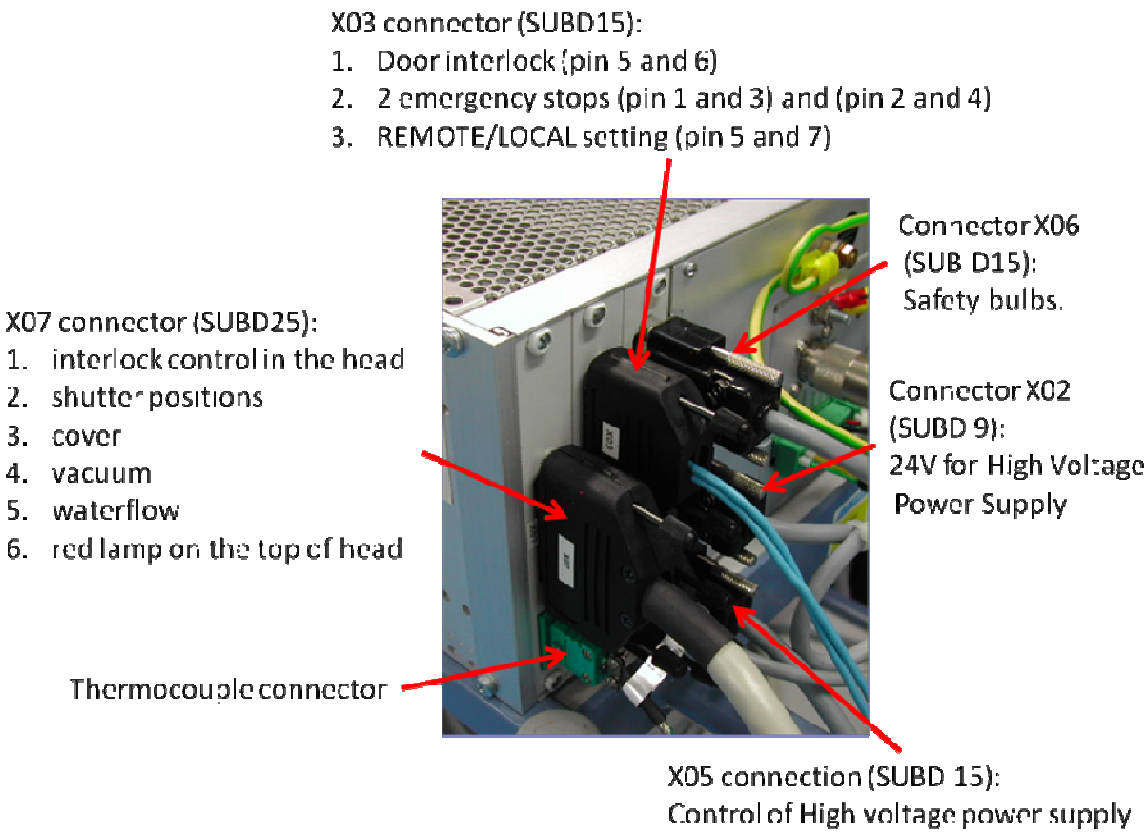


Figure 16 : Detail view of connections on back of Genix control unit.

When connecting the cables, especially the connections X03, X05, and X07, ensure that they are securely and properly connected.

Description of X03 connector:

1. Door interlock: This enables you to ensure your safety by shutting down power if the doors to your X-ray cabinet are accidentally opened. When system is installed we will ask you the authorization to bypass this safety or to install it on your X-ray cabinet.

2. Emergency stop: this connection allows you to wire an emergency stop button far from the system, so that the user can keep this button near the work area to shut the system down in case of emergency.

3. Remote/Local pins: With these pins connected, the GeniX can be controlled remotely via a computer. (cf 4.3 Remote Control)
   Note that manual (touch-screen) control of the GeniX is disabled.

3.2.2.4 Interlock Failure Correction

If one of the interlocks is open, then

1. the red "error" interlock LED will be illuminated;
2. the touch screen will become red and list the open interlocks

3. correct the fault
4. reset the fault on the list by pushing the "ACQUIT" button

If all interlocks are closed, the green interlock LED will indicate system is "ok", and the display will become orange again, as shown below in **Erreur ! Source du renvoi introuvable.**.

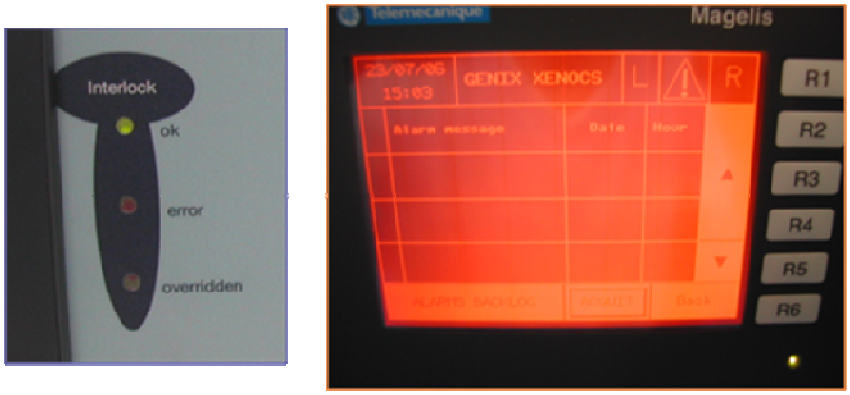


Figure 17 : View of interlock LED and interlock screen after interlocks have been closed and "ACQUIT" button pressed. Note interlock screen color is orange instead of red, indicating that all interlocks are closed.

If one of the interlocks is not properly corrected, then the touch screen will remain red, the interlock error LED will remain on, and the GeniX will not be authorized to produce X-rays. Only when the user has successfully closed all interlocks will the system become functional again (after pushing the "ACQUIT" button).

3.2.2.5 Interlock list

Tube Temperature

This interlock is triggered if the X-ray tube temperature exceeds 45 °C.

Initial GeniX State	Action	Affect on GeniX State
GeniX operating in normal mode[1]	Any action increasing the tube temperature	X-ray tube high voltage shut off
GeniX operating in expert mode	Any action increasing the tube temperature	X-ray tube high voltage shut off after 10 seconds

Red Lamp
This interlock is triggered if the red safety bulb in the remote status box is damaged.

Table 1: Red lamp interlock state table.

Initial GeniX State	Action	Affect on GeniX State
GeniX operating in normal mode	Red bulb is broken	X-ray tube high voltage shut off

[1] i.e. not expert mode (see § 3.2.2.22)

• GeniX operating in expert mode • Shutters open or closed	Red bulb is broken	Nothing happens: system functions normally and operations can be dangerous for the operator.

Vacuum

This interlock is triggered if the beampath vacuum is broken.

Table 2: Vacuum interlock state table.

Initial GeniX State	Action	Affect on GeniX State
• GeniX operating in normal mode • Collimator and cap mounted on mirror	Vacuum broken	X-ray tube high voltage shut off
• GeniX operating in normal mode • Collimator mounted on mirror	Cap removed	X-ray tube high voltage shut off
• GeniX operating in normal mode • Mirror and collimator under vacuum	Cap and collimator removed	X-ray tube high voltage shut off
• GeniX in normal mode, but not started • Mirror mounted	Vacuum tube connected directly between sensor and mirror GeniX control unit started	Nothing happens
GeniX operating in expert mode	Vacuum broken	Nothing happens

Door Interlock

This interlock is triggered if the door of X-ray hutch is not properly closed. The wiring external to the GeniX control unit for this interlock must be connected by the user. The functioning of this interlock depends on the state of the interlock and the safety shutter (it is independent of the state of the fast shutter), as shown below. Note that the first table is for the GeniX operating in *normal* mode, the second for the GeniX operating in *expert* mode. For all combinations not noted in the tables, nothing happens – the GeniX continues to function normally.

Table 3 : Door interlock state table for GeniX operating in *normal* mode.

Initial GeniX State	Action	Affect on GeniX State
• Safety shutter open • X-ray enclosure doors closed	Open door of X-ray enclosure	• X-ray tube high voltage shut off • Safety Shutter closes
• Safety shutter closed • X-ray enclosure doors closed	Open door of X-ray enclosure	Nothing happens: system is safe
• Safety shutter closed	Attempt to open safety	• Safety shutter will not

• X-ray enclosure doors open	shutter	open • X-ray tube high voltage NOT shut down • GeniX state unchanged

Table 4: Door interlock state table for GeniX operating in *expert* mode.

Initial GeniX State	Action	Affect on GeniX State
• Safety shutter open • X-ray enclosure doors closed	Open door of X-ray enclosure	• Green LED blinks on remote indicator box • "Door opened" displayed on control unit screen
• Safety shutter closed • X-ray enclosure doors closed	Open door of X-ray enclosure	Nothing happens: system is safe
• Safety shutter closed • X-ray enclosure doors open	Open safety shutter	• Safety shutter does not open • Green LED blinks on remote indicator box • "Door opened" displayed on control unit screen

Water Flow

This interlock is triggered if there is improper water flow in the cooling system.

Table 5: Water flox interlock state table.

Initial GeniX State	Action	Affect on GeniX State
GeniX operating in normal mode	Any action decreasing water flow under 1,2 L/min	X-ray tube high voltage shut off
GeniX operating in expert mode	Any action decreasing water flow under 1,2 L/min	X-ray tube high voltage shut off

Safety Shutter Interlock

Switches off the power if safety shutter is not confirmed to be in the expected position (note that the expected position may be either open or closed). **Note that this interlock does not check the state of the fast shutter state. Indeed this shutter is not a safety element but is only to facilitate measurements.**

Table 6: Shutter interlock state table.

Initial GeniX State	Action	Affect on GeniX State
• GeniX operating in normal mode • Safety shutter open or closed	Push safety shutter button	If the state of the shutter is not detected for > 1 second, the X-ray high voltage is shut off
• GeniX operating in expert mode	Push safety shutter button	Nothing happens

• Safety shutter open or closed		

Cover protection
Switches off the power if the cover is not in position.

Initial GeniX State	Action	Changes in GeniX State
1. GeniX operating normal mode[2] 2. Cover protection on the GeniX	Removing this cover	1. X-ray tube high voltage shut off
1. GeniX operating in expert mode 2. Cover protection on the GeniX	Removing this cover	1. Nothing happens. In this case safety of users can be not ensure by GeniX.

3.2.2.6 Cold Start Procedure

1. Verify that the Emergency Shut-Off button is in the extended position.
2. Switch the main power on by pushing in the green button on the left side of the control unit front panel.
3. After few seconds, the green interlock ok LED should light, indicating that all interlocks are ok.
4. Press the arrow on the screen to go to the “automatic mode” screen, or press the R1 menu button.
5. Turn the XRAY ON key to horizontal. The red x-ray on lamp should light.
6. Turn the STANDBY key to horizontal, and wait while the GeniX ramps up the voltage and current to the standby level. (30 kV, 0.4 mA).
7. When the the GeniX reaches standby power, wait a few minutes, then turn the STANDBY key to off (vertical).
8. Press the START CYCLE button on the touch screen, and wait while the GeniX automatically ramps up to the nominal power. Normally, nominal power is full power (50 kV, 1 mA), but it may be configured by the user. If your nominal power is not the power desired, enter the configuration screen (R4) and enter your desired nominal power settings.
9. Once nominal power is reached, the GeniX is ready for use.

[2] i.e. not expert mode (see § 3.2.2.22)

Figure 18 : View of the introduction screen (left) and the automatic mode screen (right).

3.2.2.7 Starting From Standby

To bring the GeniX up to nominal power from standby, simply execute the instructions given above for cold-starting beginning at step 7.

3.2.2.8 Stop Procedure

1. Verify that both the safety and the fast shutter are closed.
2. Turn the STANDBY key to on (horizontal).
3. Wait for the GeniX to ramp down to the standby power.
4. Turn the STANDBY key to OFF (vertical).
5. Go to the manual screen of the touch screen (R5)
6. Reduce the current to zero.
7. Reduce the voltage to zero.

IMPORTANT
The current must be reduced to zero before the voltage is decreased below 10 kV, otherwise the source could be destroyed.

8. Turn the XRAY ON key to off (vertical)
9. Switch off the main power by pushing in the power off button on the left of the control unit front panel (see **Erreur ! Source du renvoi introuvable.**).
10. Let the water chiller run for a few minutes to evacuate the residual heat from the GeniX head.

3.2.3 Optical Head

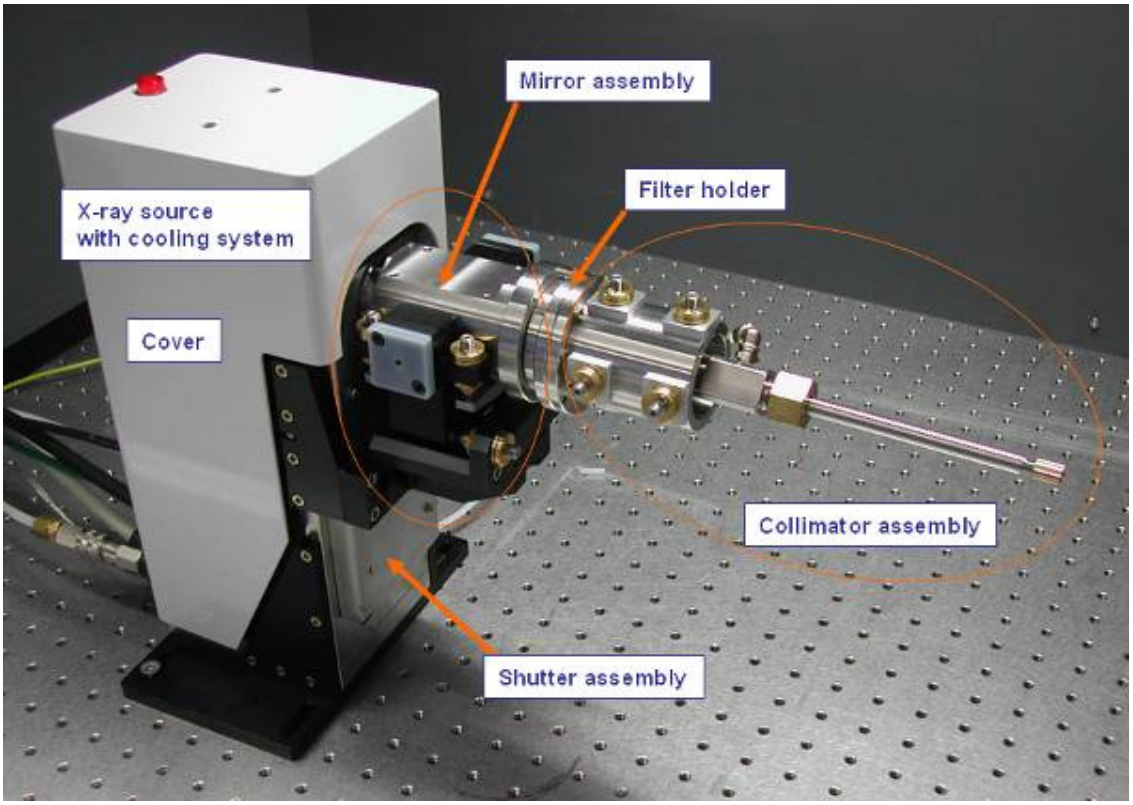


Figure 19 : View of GeniX optical head.

Filter holder and collimator assembly are optional. So GeniX is delivered without these two tools.

Note that the shutter assembly contains two shutters: a fast and a safety shutter. These do not have the same function.

- The fast shutter is designed for data acquisition, and not for radiation safety. It has a switching time in the 10's of milliseconds, and is designed for continuous cycling (opening and shutting rapidly many times).
- The safety shutter is designed for radiation safety, but not for data acquisition. It is not designed to open rapidly, and is not designed for continuous cycling.

3.2.4 Roughing Pump

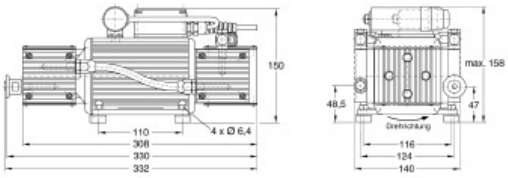
The roughing pump is an optional component If the roughing pump is not purchased from Xenocs, care should be taken to ensure that the chiller used respects the following specifications:

- Oil free;
- Able to maintain a pressure of ≤1 mbar.

Furthermore, vacuum fittings to connect to plastic tubing with an outside diameter of 4 mm will be necessary.

FOX 2D
Optional Accessories

VACUUM PUMP



Vacuum pump for pure pumping and evacuation of air and gases capable of providing a 100% oil-free operation. It is gas-tight and will not require any maintenance. The noise levels produced by the pump when linked to a vacuum system remain below 53dB (A).

Advantages to the user

- Dry compressing, free of oil and hydrocarbons
- Low ultimate pressure
- KF flange at the intake port
- Fully equipped with cable, switch (ON/OFF) and plug
- Better performance and smaller size through the use of structured diaphragms
- Lower maintenance costs and long maintenance intervals through the use of high-quality and well-proven components
- Simple maintenance by staff of the customer
- Uniform appearance
- Can be operated in any position

3.2.5 Chiller

The chiller is an optional component. If the chiller is not purchased from Xenocs, care should be taken to ensure that the chiller used respects the following specifications:

- A flow rate of 1.2 L/min in GeniX head;
- A stable temperature of 25°C in GeniX head.

Furthermore, fittings to connect to plastic tubing with an outside diameter of 6 mm will be necessary.

GeniX
Optional Accessories

WATER-TO-AIR CHILLER

- Compact 19" rack enclosure
- Good temperature stability
- Reliable operation
- Low noise and vibration levels
- Low maintenance
- 200 W - 2.4 KW cooling capacity
- Flow rate: 0.5 - 17 l/min, 4 - 12 HU high
- Alternative table top design

The chiller may be filled using normal tap water. However, it is advised to add an anti-algae solution to avoid algae buildup, notably in the filter. In addition, it is advised to change the water completely and wash the filter if necessary approximately once per month. The drain is located under the front right corner of the chiller.

4 INSTALLATION OF GENIX

4.1 CONNECTION OF ALL ELEMENTS

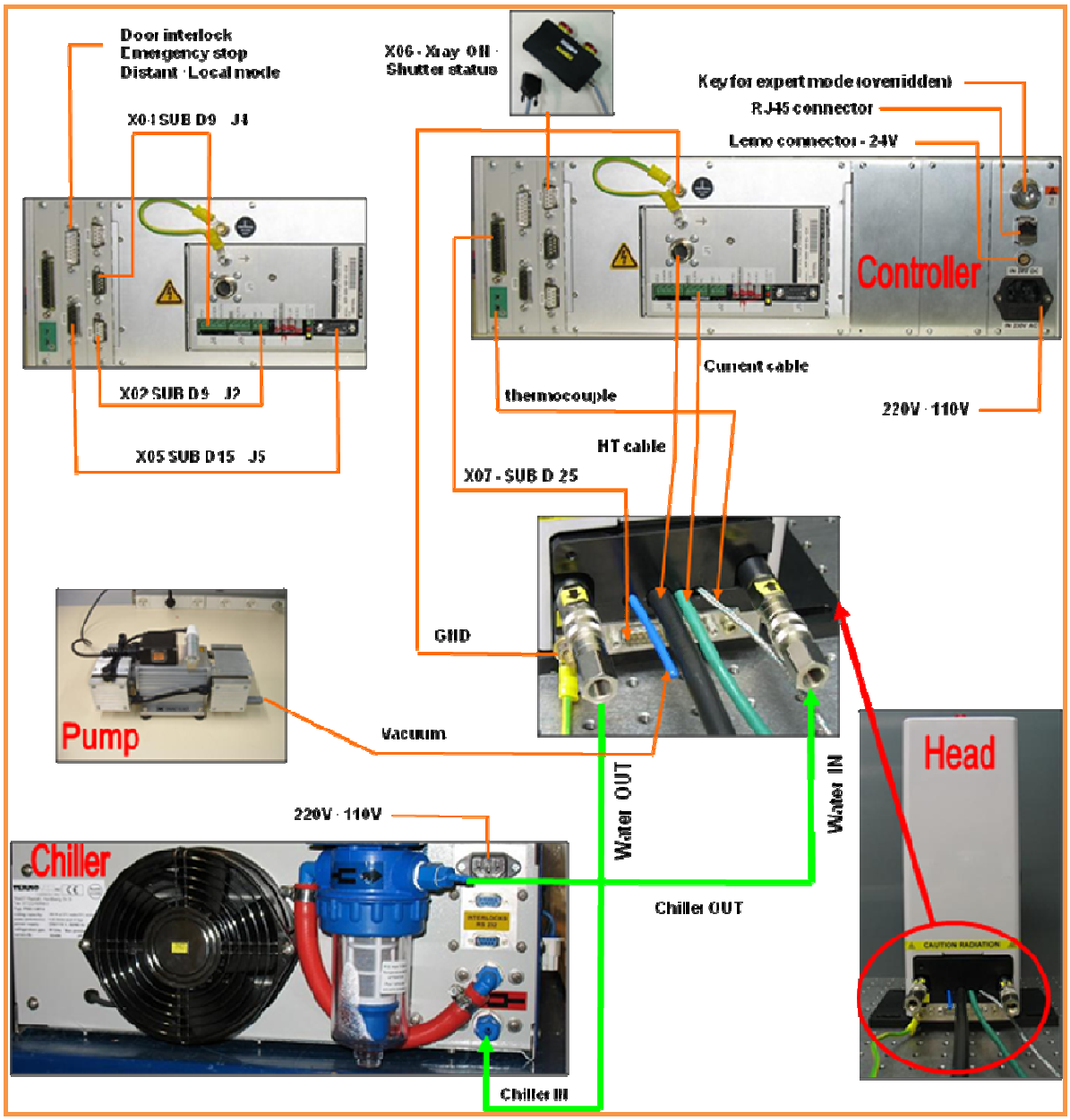


FIGURE 20 : Diagram showing the connections for the various GeniX units (optical head, control unit, chiller, and vacuum pump).

Do not forget to connect the ground to the optical head, control unit, and to the ground of the bench where system is placed. It is very important to ensure the same voltage on all of these points to prevent a risk of over-voltage.

4.2 ALIGNMENT PROCEDURE

For ease of alignment, and to ensure an optimum alignment, Xenocs recommends using a PIN-diode and an X-ray camera. These items may be purchased from Xenocs if needed. The alignment procedure described hereunder assumes procession of these elements. This procedure describes the complete alignment of the GeniX, including the alignment of the collimator and the pinholes, even though these are optional elements.

4.2.1 Safety precautions

Alignment must be done under safe conditions. To ensure your safety, consult your local radiation safety officer. Xenocs cannot be responsible for injuries due to radiation exposure.

It is advised to work with a Geiger Müller radiation detector, which Xenocs can supply if need be. Note that the X-ray camera and the PIN-diode supplied by Xenocs are equipped with shielding to prevent radiation leakage under normal use.

4.2.2 Description of Alignment Screws

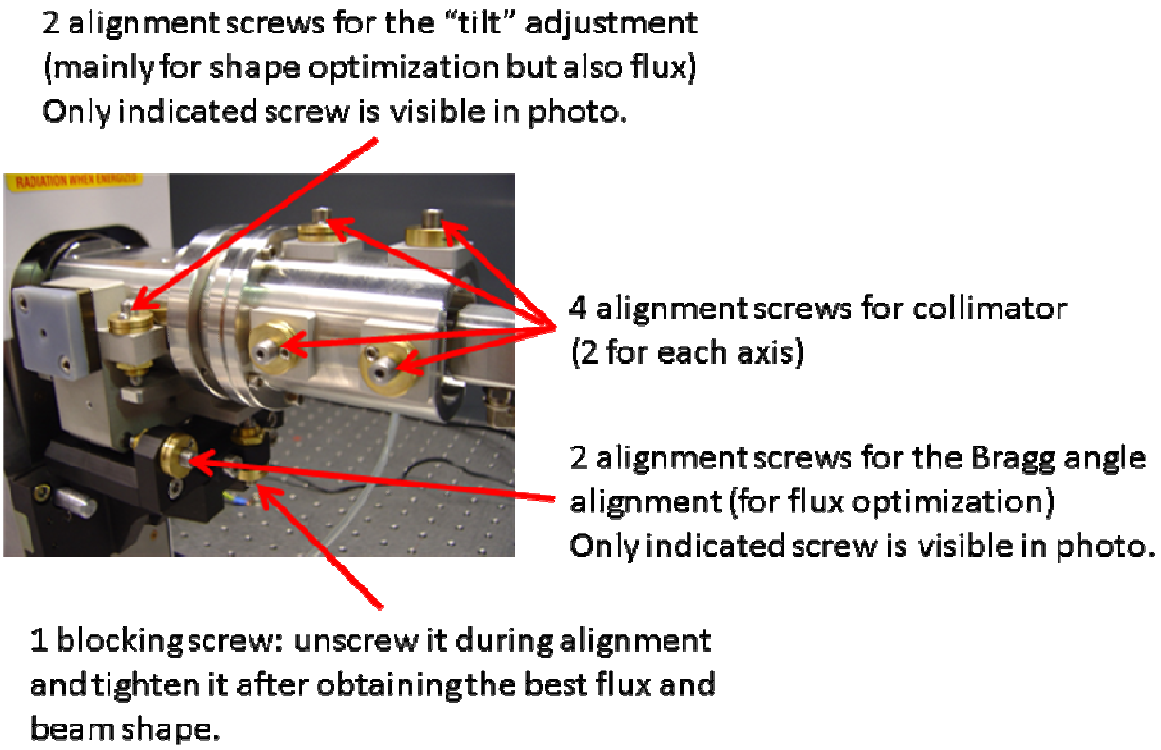


FIGURE 21 : View of opto-mechanics showing alignment screws. Note that one tilt and one of the Bragg alignment screws are not visible in the photo because there are located on the far side of the GeniX optical head.

On all alignment screws there is a small lock-screw that enables the operator to lock the alignment screws in position when alignment is optimum. Do not forget to loosen these screws before adjusting the alignment screws.

4.2.3 Use of the X-ray Camera and PIN-diode to Monitor Beam

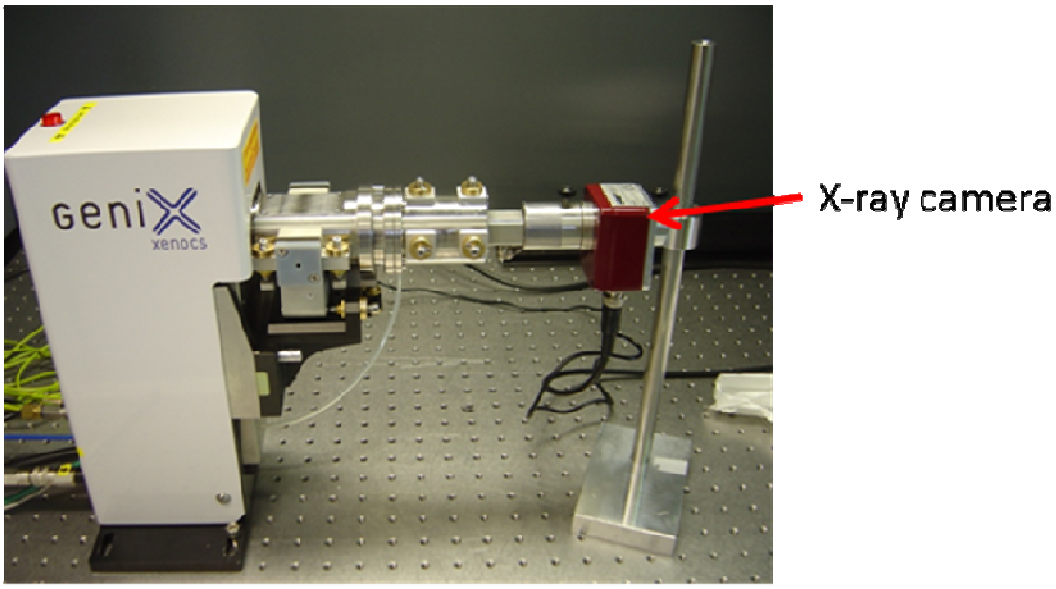


FIGURE 22 : View of GeniX optical head with X-ray camera positioned to monitor beam.

To monitor the beam profile, position the X-ray camera as shown in FIGURE 22. Connect the BNC cable of the X-ray camera to a monitor and view beam on monitor. To protect against radiation leakage, ensure that the collimator is completely inserted into the sleeve of the X-ray camera, as shown in FIGURE 22.

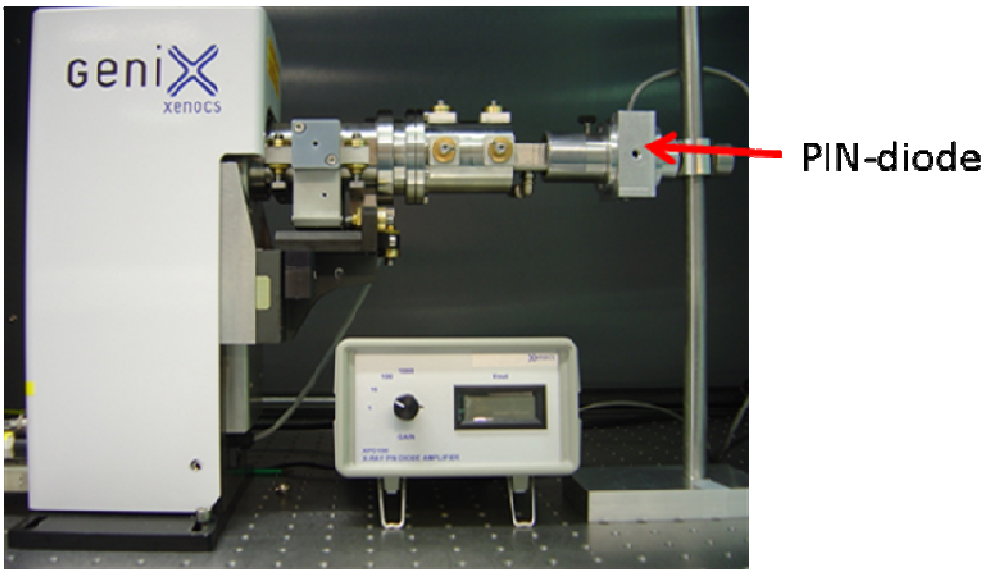


FIGURE 23 : View of GeniX optical head with PIN-diode positioned to monitor the beam.

To monitor the beam flux, position the PIN-diode as shown in FIGURE 23. Connect the PIN-diode cables as shown below in FIGURE 24

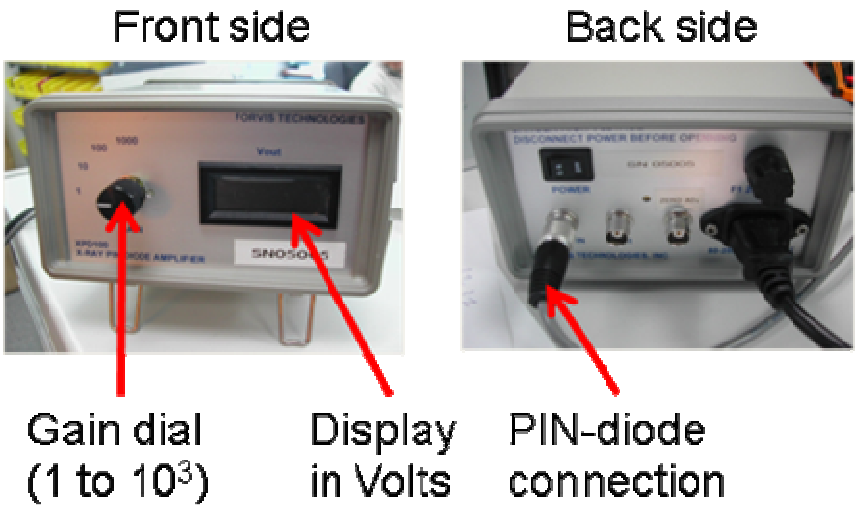


FIGURE 24 : View of front and back of PIN-diode.

Care should be taken to avoid exceeding 5 Volts on any given gain setting. Each PIN-diode has been calibrated and the formula for calculating the absolute flux value from the voltage reading is attached to the top of the PIN-diode housing. This formula takes the form

$$CPS = \frac{\kappa \times (V - V_b) \times 10^3}{g},$$

where *CPS* refers to the X-ray flux in counts per second, κ is the calibration factor (and is noted on the PIN-diode and in its manual), V is the voltage reading, V_b is the voltage baseline reading (reading with no X-rays impinging on PIN-diode), and g is the gain factor (1,10,100, or 1000). For a GeniX that generates Cu K-alpha radiation, a typical reading at the output of the mirror is on the order of 3 to 4 on a gain of 10 which represents a flux of several 10^8 X-rays per second.

4.2.4 Optimizing the X-ray Beam

Your GeniX has been aligned in the factory, but some minor adjustment may be necessary due to vibrations and shocks encountered during transport.

4.2.4.1 Verify X-ray beam with X-ray camera

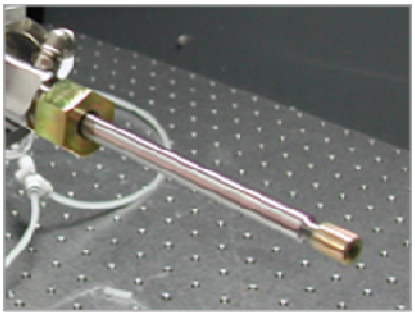


FIGURE 25 : View of collimator tube.

Remove the collimator tube from the GeniX head, and mount the X-ray camera at the output of the collimator tube mount, as shown in FIGURE 22. With a BNC cable, connect the X-ray camera to a monitor (not supplied by Xenocs). Also ensure that the X-ray camera is receiving power. Loosen the lock screws that fix the alignment screws (see FIGURE 21).

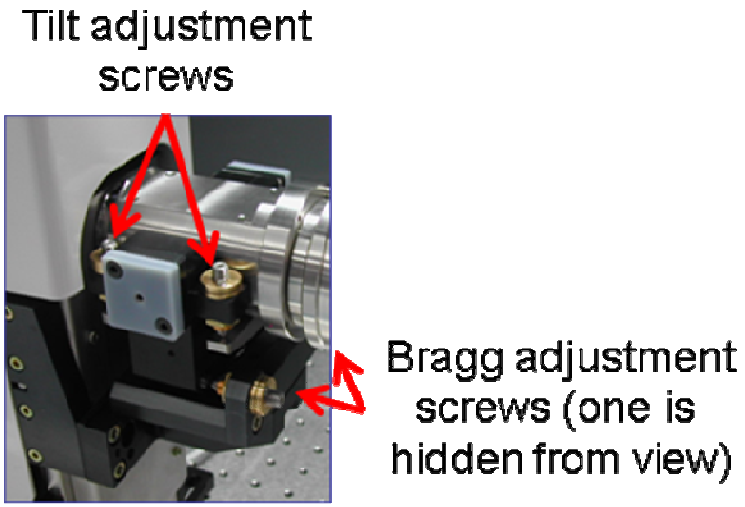


FIGURE 26 : View of Bragg and tilt adjustment screws on GeniX optical head.

Place a radiation monitor near the junction of the X-ray camera and the GeniX, then ensure that all radiation protection elements are in place (e.g. doors to X-ray hutch), then power up the GeniX as described in § 3.2.2.6 or 3.2.2.7 (see page 21). Open the X-ray shutters (both the safety and the fast shutters) and verify visually and audibly that the radiation monitor does not detect an excessive dose of radiation. If so, verify that the end of the GeniX collimator mount is completely inserted into the sleeve of the X-ray camera, as shown in FIGURE 22. Consult you local radiation safety authorities if you have any questions about radiation safety.

If the radiation detector does not detect excessive radiation, you can defeat the appropriate interlock using the expert mode key on the back of the GeniX (see § 3.2.1.4 on page 16), so that you can access the GeniX in order to tune the optic. The first thing to do is to sweep the radiation detector around the entire GeniX optical head, especially around the junction between the GeniX collimator mount and the X-ray camera. Once you have verified that there is no radiation leakage, you may begin tuning the optics, as described below.

A typical image of the X-ray beam is shown below in FIGURE 27. If you do not see an X-ray beam, or see a much smaller beam than is shown below, turn the Bragg adjustments screws (see FIGURE 26, above) to maximize the brightness of the beam in the image. Note that there are two adjustment screws (push-pull system), so that one screw should be loosened and the other tightened. Be meticulous in this step so that you can return to the original position if need be (i.e. count revolutions of each screw). Sweep the Bragg angle around the original position, and you should find the beam without difficulty. If not, contact Xenocs for help.

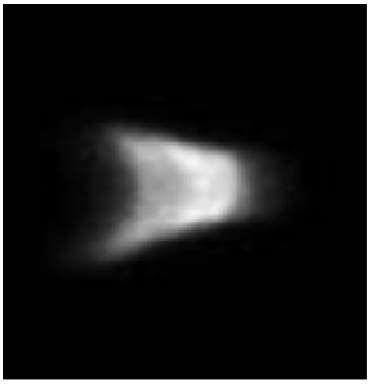


FIGURE 27 : Image of X-ray beam at output of collimator mount.

If one views the direct beam at the output of the collimator mount, as shown below in FIGURE 28, then the Bragg angle adjustment is incorrect.

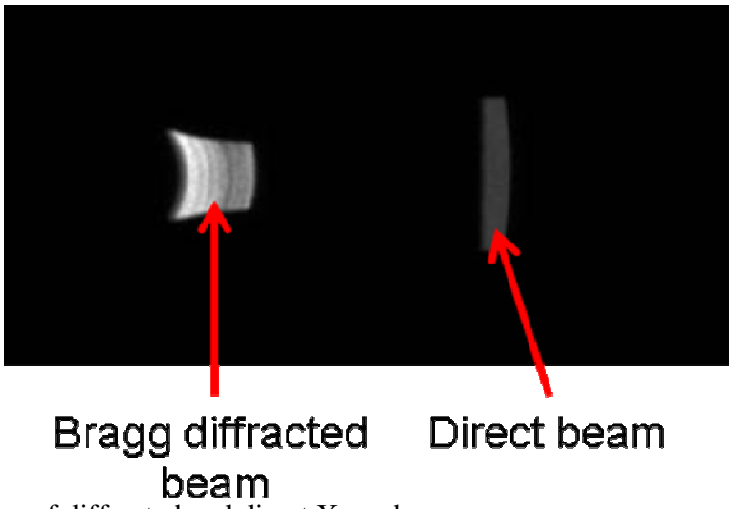


FIGURE 28 : Image of diffracted and direct X-ray beams.

Once you have the Bragg angle aligned, tighten the screws slightly so that the alignment will hold while you proceed with the tilt angle adjustment. The tilt screws are shown in FIGURE 26. Adjust these screws to make the beam as symmetric as possible (top to bottom, or about a horizontal line). For example, note that in FIGURE 27 the lower left corner of the X-ray beam is more elongated than the upper left corner. This indicates a mis-alignment of the tilt – these corners should be more equivalent in size and intensity.

Once you have thus optimized the beam visually using the X-ray camera, you may proceed to the fine tuning of the optic.

4.2.4.2 Fine tune optic to maximize flux

To fine tune the optic to maximize the flux, first shut the GeniX shutters (both safety and fast shutters), then replace the X-ray camera by the PIN-diode (see FIGURE 23). Set the PIN-diode gain to unity, and then repeat the radiation check procedure as described above for positioning the X-ray camera.

Once it is verified that there is no radiation leakage, make small adjustments of the Bragg angle to maximize the reading on the PIN-diode. It is possible that a gain setting other than unity will be necessary for this procedure. Note that the tilt adjustment will not affect the intensity at this point. Note that if the visual alignment procedure is properly done, one should not expect a large gain in flux due to fine tuning the optic.

Once the intensity is maximized tighten the Bragg and tilt screws, and lock them in place using the lock screws. Position the blocking screw (see FIGURE 21) so that it just makes contact with the mechanic block above it, and tighten the lock screw. Verify that the X-ray flux has not diminished from its maximum value.

4.2.4.3 Confirm alignment with X-ray camera

To ensure that the beam is properly aligned, replace the PIN-diode by the X-ray camera and observe the beam profile again. Ensure that the GeniX shutters are closed when doing this, and verify the absence of radiation leakage again, as described above. The beam profile should be as described in § 4.2.4.1 (page 29). If so, you may shut the GeniX shutters, and proceed with the alignment of the collimator. If not, either repeat the alignment procedure, or contact Xenocs for assistance.

4.2.4.4 Precise alignment with a pinhole

Before placing the collimator tube on the GeniX optical head, close the X-ray shutters and ensure that no colleagues can possibly open the shutters unwittingly while you are positioning the collimator tube. Before working in the beam path, use the radiation detector to ensure that no ionizing radiation is present.

With these safety precautions in place, screw the alignment tube onto the end of the collimator mount (see FIGURE 29). At this point, the pinhole mount should not be screwed onto the end of the collimator tube.

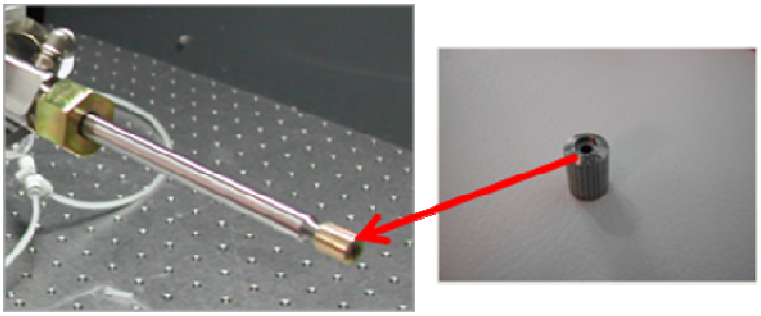


FIGURE 29 : View of the collimator tube and the pinhole mount.

Place the PIN-diode at the collimator tube, making sure that the collimator tube is completely inserted into the sleeve of the PIN-diode. With the PIN-diode gain at the appropriate setting, open the GeniX shutters (using the same safety procedures as outlined above). In addition, it is advisable to place some extra radiation shielding around the junction between the collimator tube and the PIN-diode (leaded tape works well). Before beginning the alignment of the collimator tube, verify with a radiation detector that no leakage is present.

Once your safety is assured, you may adjust the horizontal and vertical push-pull adjustment screws of the collimator mount to maximize the X-ray flux detected by the PIN-diode. Once this is done, close the GeniX shutters, again ensuring that no colleague can open them inadvertently, and screw the pinhole mount onto the end of the collimator tube (ensure that a 1 mm or 300 µm pinhole is in the pinhole mount). Reposition the PIN-diode at the output of the collimator tube (as well as the shielding), open the GeniX shutters and verify that there is no radiation leakage. With your safety assured, proceed to maximize the flux detected by the PIN-diode using the push-pull alignment screws of the collimator mount.

Once the maximum flux is achieved, shut the GeniX shutters and tighten the push-pull alignment screws and lock them in place with the lock screws. Open the GeniX shutters and verify that the maximum flux is still present on the PIN-diode. Once this is accomplished the GeniX is ready for use.

4.3 REMOTE CONTROL

By connecting pins 5 and 7 on the X03 connector, the GeniX can be controlled remotely via a computer (see Figure 16). The following table sum up the different words enabling the computer to command every function of the programmable controller. Note that the communication is performed with an Ethernet module in relation with the TWIDO programmable controller.

The direct line with the Ethernet module must be connected with a crossed Ethernet cable.

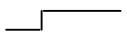
Communication parameters :
IP address : 85-16-44-113
under network mask : 255-255-0-0
link address : 85-16-0-1

The Ethernet module is connected to the programmable controller with a communication board of type MODBUS rtu . See documentation.

http://www.niobrara.com/html/manuals.html

GeniX Product
Ethernet version
July 2006
ETHERNET variables

Name	Data Type	Device Address	read	write	
REMOTE_MODE	Discrete	%M210	yes		1=remote
XRAY_ON	Discrete	%M211	yes		1=xray on
STANDBY_ON	Discrete	%M212	yes		1= standby cycle on
AUTO_CYCLE_ON	Discrete	%M213	yes		1= automatic cycle on
CONDITIONS_AUTO_OK	Discrete	%M214	yes		1= conditions for automatic cycle OK
FAULTS	Discrete	%M219	yes		1= 1 or more faults
X-RAY LIGHT FAULT	Discrete	%M220	yes		1= fault
SHUTTER LIGHT FAULT	Discrete	%M221	yes		1= fault
DOOR CLOSING FAULT	Discrete	%M222	yes		1= fault
COVER FAULT	Discrete	%M223	yes		1= fault
VACUUM FAULT	Discrete	%M224	yes		1= fault
WATERFLOW FAULT	Discrete	%M225	yes		1= fault
SAFETY SHUTTER FAULT	Discrete	%M226	yes		1= fault
TEMPERATURE FAULT	Discrete	%M227	yes		1= fault
ASSEMBLY FAULT (NOT APPLICABLE)	Discrete	%M228	yes		1= fault
RUN_CONTROLLER	Discrete	%M234	yes		pulse every second 
INTERLOCK_OK	Discrete	%M235	yes		1=interlock ok
S_SHUTTER_CLOSED	Discrete	%M236	yes		1= safety shutter closed
S_SHUTTER_OPENED	Discrete	%M237	yes		1= safety shutter open
FAST_SHUTTER_CONFIGURED	Discrete	%M238	yes		1= fast shutter configured
OVERRIDEN_ON	Discrete	%M239	yes		1= overriden on
CONTROL_OPEN_FAST_SHUTTER	Discrete	%M245		yes	 pulse 1 = open fast shutter
CONTROL_CLOSE__FAST_SHUTTER	Discrete	%M246		yes	 pulse 1 = close fast shutter
CONTROL_OPEN__SAFETY_SHUTTER	Discrete	%M247		yes	 pulse 1 = open safety shutter
CONTROL_CLOSE_SAFETY_SHUTTER	Discrete	%M248		yes	 pulse 1 = close safety shutter
RESET_FAULTS	Discrete	%M249		yes	 pulse 1 = reset faults
CONTROL_STANDBY_MODE	Discrete	%M250		yes	 1= control standby mode

CONTROL_High Voltage	Discrete	%M251		yes		1= control HV
CONTROL_AUTOMATIC_CYCLE	Discrete	%M252		yes		pulse 1 = control auto cycle

High Voltage (HV)	Integer	%MW50	yes		50.00 = # # # # #	kV (ex: 50.00=5000)
Current (I)	Integer	%MW51	yes		1.00 = # # #	mA (ex: 1.00=100)
SET_POINT_HV	Integer	%MW52		yes	50.0 = # # #	kV (ex: 50.0=500) mini :310 maxi :500
SET_POINT_I	Integer	%MW53		yes	1.00 = # # #	mA (ex: 1.00=100) mini :41 maxi :100
READING_TEMPERATURE	Integer	%MW54	yes		50.0° = # # #	°C (ex 27.0=270)
COUNTER_MINUTES	Integer	%MW55	yes		# # # # #	
COUNTER_HOURS	Integer	%MW56	yes		# #	

FIGURE 30 : input / output for software development

Words MW60, MW61, MW62, MW63 image of Input/Output CONTROLLER

Words	Input / output controller	Action description
%MW60:X0	%I0.0	INPUT_MAINTENANCE
%MW60:X1	%I0.1	INPUT _STANDBY
%MW60:X2	%I0.2	INPUT _HV_ON
%MW60:X3	%I0.3	INPUT _SAFETY_SHUTTER_ON
%MW60:X4	%I0.4	INPUT _FAST_SHUTTER_ON
%MW60:X5	%I0.5	FREE
%MW60:X6	%I0.6	INPUT _FAULT_LIGHT1
%MW60:X7	%I0.7	INPUT _FAULT_LIGHT2
%MW60:X8	%I0.8	INPUT _DOORS_ CLOSED
%MW60:X9	%I0.9	INPUT _SOURCE_IN_POSITION
%MW60:X10	%I0.10	INPUT _SAFETY_SHUTTER_CLOSED
%MW60:X11	%I0.11	INPUT _SAFETY_ SHUTTER_OPEN
%MW61:X0	%Q0.0	FREE
%MW61:X1	%Q0.1	FREE
%MW61:X2	%Q0.2	OUTPUT_SAFETY_SHUTTER
%MW61:X3	%Q0.3	OUTPUT _FAST_SHUTTER
%MW61:X4	%Q0.4	OUTPUT _INTERLOCK_OK
%MW61:X5	%Q0.5	FREE
%MW61:X6	%Q0.6	OUTPUT _INTLCK_TEMP_SHUTTER_WATER
%MW61:X7	%Q0.7	OUTPUT _INTLCK_VACUUM_HV_VSHUTTER
%MW62:X0	%I1.0	INPUT _SOURCE_COVER_IN_POSITION
%MW62:X1	%I1.1	INPUT _VACUUM_SENSOR
%MW62:X2	%I1.2	INPUT _FLOWMETER_SENSOR
%MW62:X3	%I1.3	INPUT _REMOTE_SENSOR
%MW62:X4	%I1.4	FREE
%MW62:X5	%I1.5	FREE
%MW62:X6	%I1.6	FREE
%MW62:X7	%I1.7	INPUT _VALIDATION_INTERLOCK
%MW63:X0	%Q2.0	OUTPUT _LIGHT_FAULT_INTERLOCK
%MW63:X1	%Q2.1	OUTPUT _LIGHT_MAINTENANCE_POSITION
%MW63:X2	%Q2.2	OUTPUT _LIGHT_HV_FRONT_PANEL
%MW63:X3	%Q2.3	FREE
%MW63:X4	%Q2.4	OUTPUT _LIGHT_SHUTTER
%MW63:X5	%Q2.5	OUTPUT _LIGHT_DEVICE_POWER
%MW63:X6	%Q2.6	FREE
%MW63:X7	%Q2.7	FREE

FIGURE 31 : software words

Engagement Conditions

1. Remote mode

To operate in remote mode connect pins 5 and 7 in the X03connector at the back of the controller box.

Pin 5 and 7 connected : Remote mode
Pin 5 and 7 disconnected : Manual mode (front panel)

IMPORTANT : The change of mode « Remote – Local » can be done only with X-ray OFF.

Attention : With the « overriden » key at the back of the controller, the « Manual » mode is forced.
In « Remote » mode, all the manual controls are locked.

2. Control « fast shutter » OPEN : %M245 (pulse 1)

Conditions :
To be in mode « Remote »
Configuration : fast shutter « YES » in the configuration panel for Magelis
Input « interlock » OK (No faults)
X-RAY ON

3. Control « fast shutter » OFF : %M246 (pulse 1)

Conditions :
To be in mode « Remote »

Attention : The closing of the fast shutter is automatic when :
Power switch ON
X-RAY OFF
Input « interlock » NOK (one or more faults)
Fast shutter not configurated in the configuration panel for Magelis

4. Control « safety shutter » ON : %M247 (pulse 1)

Conditions :
To be in mode « Remote »
Do not control « shutter OFF» (%M248)
Input « interlock » NOK (one or more faults)
X-RAY ON
Doors of the enclosure are closed

5. Control « fast shutter » OFF : %M248 (pulse 1)

Conditions :
To be in mode « Remote »

Attention :
The closing of the safety shutter is automatic when :
Power switch ON
X-RAY OFF
Input « interlock » NOK (one or more faults)

6. Control « reset faults» : %M249 (pulse 1)

Conditions :
To be in mode « Remote »
Fault origin corrected

7. Control « standby» : %M250 (1=Standby on 0= standby off)

Conditions :
To be in mode « Remote »
X-RAY ON
Input « interlock » OK (No faults)
Voltage<> 30 kV or Current<> 0,4 mA (not to be already in standby mode)

Attention :
The transition to 0 of the control %M250 will stop the standby cycle in progress and the values « voltage » and « current » will stay at the current values during transition.
After X-RAY OFF, the standby cycle in progress will stop and the « voltage » and « current » values will be placed at 0.
After X-RAY ON and if the control Standby %M250 is at 1, the standby cycle will automatically restart.

8. Control « X-RAY» : %M251 (1=X-RAY ON 0=X-RAY OFF)

Conditions :
To be in mode « Remote »
Input « interlock » OK (No faults)

Attention :
X-RAY OFF will automatically stopped standby cycle in progress or automatic cycle in progress. The « voltage » and « current » values will be placed at 0.
The emergence of a fault will force X-RAY OFF . After correction of the fault, reset of the fault and if the control %M251 is at 1, X-RAY will be automatically ON .