HORIBA
Scientific

T64000 System

User Manual

Part Number: 31 087 146

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NOTICE TO THE USER

This manual should not be construed as any representation or warranty with respect to the unit named herein. Occasionally, changes or variations exist in the unit that are not reflected in the manual. Generally, should such changes or variations exist and affect the product significantly, a release note would accompany the manual. In such a case, be sure to read the release note before using the product.
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NP/T64000.fm - 10/07/2009

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Thank you for choosing HORIBA Scientific

HORIBA Scientific is the world leader in Raman spectroscopy, designing and manufacturing state of the art dispersive Raman spectrometer systems for over four decades.

We have been at the forefront of Raman spectroscopy since its infancy, introducing ground breaking innovations such as the first Raman microscope and the world's first commercial remote Raman sampling probe.

HORIBA Jobin Yvon Raman Division today comprises of the combined expertise of the HORIBA Jobin Yvon, Dilor and SPEX companies and is proud of having more than 3000 Raman systems installed worldwide. Well equipped applications Labs and technical support enable HORIBA Jobin Yvon to provide services right through from the earliest proof of principle investigations. With a broad range of technologies available, HORIBA Jobin Yvon can uniquely provide solutions in analytical, research and industrial measurements.

Following the established high performance Raman systems of the Jobin Yvon, Dilor, and SPEX brands, the new T64000 series II triple spectrometer system is a versatile, high performance, research grade system.

- **Three stage monochromator with optics, aperture and coupling optimized for performance and stability,**
- **Multiple motorized switching mirrors for ease of operation Multiple entrance and exit ports**
- **Directly coupled microscope options (and Macrochamber if required) rigidly coupled to the spectrometer,**
- **A large choice of options and components to enable full customizing of the system e.g. gratings, detectors and sampling optics enabling operation from the UV to the NIR. The actual instrument may differ slightly in appearance from images and illustrations shown in this manual depending upon which options are included within your chosen system.**

If you have any questions regarding the installation or the maintenance of your instrument, please contact one of our representatives:

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Warranty

HORIBA Jobin Yvon warranties each instrument for two years from the date on which the equipment leaves the plant. The warranty is limited to repair of operating or manufacturing defects which come to light in that period. It shall apply in said period only if the equipment has been used properly. It will determine inter alia in event of faulty maintenance or use, or of repairs by the Buyer or a third party. The Seller's warranty does not cover «consumable parts» (such as filaments, zeolite joints, electron multipliers, electronic components, membranes, diaphragms, crucibles, glass, etc.).
In the case of components covered by the manufacturer's warranty, such as computers, the Seller shall cooperate with the Buyer in enforcement of the manufacturer's warranty, but the Seller assumes no obligation for such components.

The warranty is limited to replacement of parts found by the Seller to be defective. To be able to claim the benefit of said warranty, the Buyer will have to advise the Seller by return-receipted registered mail within 28 days of discovery of the defects which come to light. The contractual warranty is limited, at the Seller's option, to reconditioning or replacement of parts found by it to be defective, expenses of dismantling, reinstallation and technicians' travel excepted. All warranty work shall be done by the Seller or a contractor of its choosing according to its instructions. All shutdown-related expenses shall in any event be incumbent on the Buyer.

The warranty does not cover the following:

- **Any malfunction attributable to improper operation**
- **Any malfunction attributable to repair or modification by any party not authorized by HORIBA Jobin Yvon**
- **Any malfunction attributable to the use in an improper environment**
- **Any malfunction attributable to violation of the instructions in this manual**
- **Any malfunction attributable to operations in the manner not specified in this manual**
- **Any malfunction attributable to natural disasters, or accidents or mishaps not involving HORIBA Jobin Yvon**
- **Any deterioration in appearance attributable to corrosion, rust, and so on.**
- **Consumables and replacement of consumables**
- **Products of other companies**

THE SELLER MAKES NO OTHER TACIT OR IMPLIED WARRANTY. IT SHALL HAVE NO LIABILITY FOR INJURY TO THIRD PARTIES, DIRECT OR INDIRECT, COMMERCIAL OR FINANCIAL INJURY, CONSEQUENTIAL DAMAGES, OR FOR ANY OTHER REASON.

Obligations

The products are for professional application, and the Seller's acceptance of an order is with the understanding that only qualified individuals, trained and familiar with users' procedures, will handle them. If Buyer fails to observe this obligation, Buyer agrees to hold the Seller harmless from any liability resulting from the operation of the products.

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S1 Summary

This User Manual contains the facilities design and equipment installation requirements for the T64000 System.

S2 Purpose

The purpose of the document is to enable the facilities manager at the customer site, and HORIBA Jobin Yvon representatives and service engineers, to prepare for the installation of the T64000 System and to determine the necessary requirements for the environment in which the T64000 System is to be installed. It also provides a guidelines and directions for the correct use and operation of the T64000 system.

S3 Intended Readers

This document is intended for customers, HORIBA Jobin Yvon representatives, sales and service engineers.

S4 General instructions

 WARNING: The T64000 System must not be operated without prior reading of this document.

The user manual contains important information on how to operate the T64000 System correctly, safely and most efficiently. Observing these instructions will enable safe operation of the equipment and will help to avoid accidental damage, to reduce repair costs and to increase the instrument lifetime and reliability.

HORIBA Jobin Yvon equipment is perfectly safe as long as it has been properly installed and is operated according to the instructions which are given in this instruction manual.

The installation of the equipment is to be strictly carried out by properly trained personnel who are designated by HORIBA Jobin Yvon and should not be attempted by the end user.

This manual must always be available whenever operating the equipment.

Any person working with the T64000 system, whether it is an engineer or an operator, must be aware of the statements enclosed within this document and apply its contents. Tasks requiring familiarity with the manual include; routine operation (including setting up), sample loading, and instrument troubleshooting.

 WARNING: **Never make any modifications, additions or conversions to the equipment (especially those which might affect safety) without the supplier approval. This also applies to the installation and adjustment of safety devices and accessories.**

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In the event of safety relevant modifications or changes in the behavior of the T64000 during operation, stop the equipment, and namely the laser source, immediately and report the malfunctioning to HORIBA Jobin Yvon or your authorized local representatives.

S5 Warnings

- **Performance of any procedures not specified by the manufacturer may result a hazardous radiation exposure. This includes removal of covers with laser power ON. There is no user maintenance or service internal to the system with power ON.**
- **When covers or enclosures are removed for any reason extreme care must be taken to prevent the beam being viewed directly by external optics or mirror.**
- **There are no user maintenance parts for the T64000 System. The System, including peripherals, must never be opened with the exception of parts mentioned in this manual. Maintenance must only be performed by a designated members of HORIBA Jobin Yvon Service Team or by authorized local representatives.**

S6 Laser Radiation Safety

- **The T64000 is class 3b or 4 and depends on the laser source's class the customer is going to use with. It is important that the user understands which version of the system he will be operating and familiarizes himself with the appropriate safety precautions.**
- **The maximum acceptable laser parameters for a laser included in the T64000 are:**
  - **Beam diameter <5 mm**
  - **Wavelengths range 200-1100nm**
  - **Beam divergence <1 mrad**
  - **Maximum laser power acceptable 10W (visible range) for class 2, 400mW (UV range) for class 3R, 2.2W (near IR) for class1. These values correspond to the LEA values for each range of wavelengths when safety position (red button) is commuted.**
- **During installation of T64000 System, be careful that the laser source installation complies with all the legal safety requirements during operation, maintenance and service.**
- **Laser sources used with the T64000 constitutes a hazard to personnel during periods of operating and servicing**
- **Lasers are high intensity light sources producing visible or invisible light at specific wavelengths. This concentrated energy in a narrow laser beam may cause damage to biological tissues, especially to eyes. To use lasers safety, it is important to understand that laser's required final product safety classification is determined by essentially three elements: the laser's power, wavelength and housing.**

Class 3B laser system: Laser beams and reflected beams could be dangerous. Diffused reflected beams in most cases do not present any problem.

Class 4 laser system: Laser beam represents an acute hazard to the skin and eyes from direct and scattered radiation. Fire hazard must be considered.

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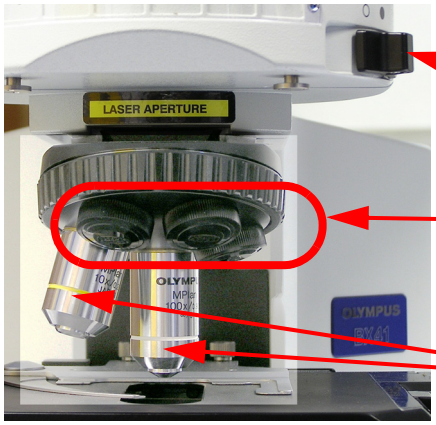
- **The T64000 System itself does not included the laser sources. On request the laser sources can be ordered but are not integrated inside the T64000 System. The end-user must comply the legal and safety requirements during the installation and the use of the lasers. The beam path from the laser source to the T64000 must be secured by the user with an adequate housing when installing the laser source. Additional safety labels must be stick on the exposed parts.**
- **The various parts of the T64000 giving access to the laser beam have been secured by the means of enclosures and tubes from the laser source input to the microscope. These tubes are firmly tightened and prevent any exposure from the operator to any laser radiation.**
- **To use the Instrument, it is necessary to access to the laser beam, particularly for the microscope and the macro sample compartment to place and adjust the position of the sample into the beam.**
- **Some parts of the laser path between microscope or macro sample output to monochromator input are not housed (light diffused by the sample). See Figure 1-1, "Laser path and label (upper view)", page 14.**

The following precautions must be observed

- Refer to your laser source manual for specific safety requirements.
- In case of modification of the laser source, the T64000 labelling may be adapted to conform the laser source class.
- Personnel must never look directly into the laser beam and should wear protective eye wear at all times if protective covers are removed while the laser is switched on.
- All personnel in the vicinity of the laser should also be ordered to wear protective eyewear, if protective covers are removed while the laser is switched on. Only qualified and trained personnel should be permitted to operate the laser.
- Precautions must be taken to ensure that there are no reflecting objects in the path of the laser beam, e.g. gold ring on the finger.
- Warning signs indicating the area in which the laser is enclosed should be clearly displayed.
- Local and national regulations governing the safe use of lasers should be adhered to at all times.
- Ensure that the laser is properly ventilated using a suitable exhaust. Do not connect the exhaust to breathing air systems (i.e. air conditioning or ventilation systems).
- Viewing laser beam with certain optical instruments (eye loupes, magnifiers, binoculars or telescopes) within a distance of 100 mm may pose an eye hazard and must therefore be avoided.
- The extracting fan located at the rear of the laser must not be blocked at any time.
- The laser warning labels affixed to the system according to the safety regulations (see warning chapter) must not be removed.
- The laser can only be switched on with the key switch. This prevents inadvertent or unauthorised starting of the laser. It cannot be operated with the key in the OFF position and the key cannot be removed in ON position.
- If mishandling of the instrument or of the safety devices results nevertheless in direct eye exposure to the laser beam, the exposed operator should consult a doctor or a competent eye testing institution.
- Caution: Use of controls or adjustments or performance of procedures, other than those specified within this manual may result in hazardous radiation exposure.
- Caution: The laser exit is through the microscope objective. Before the System use, check that all objectives or caps are mounted on the microscope as shown below.



Example: two objectives are mounted on a 5-location turret

White light shutter switch

Three caps are mounted in the unused objectives on the microscope turret. These block the laser from exiting from these positions.

Mounted objectives

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S7 User visual indicators

The laser can only be switched ON with the key switch located on the laser source. When the key is turned on, an indicator shows that the laser source is ON. The key prevents inadvertent or unauthorised starting of the laser.

S8 Laser Safety Key and filters

Laser Safety Key

Laser Safety key main function is to cut off the laser incidence beam.

A laser shutter with filters have been mounted on the laser path just before the Micro/Macro commutation. The Safety Laser key cuts the laser beam when the key is turned to ON. This prevents inadvertent or unauthorized activation of the laser. As further precaution, the key cannot be removed in OFF position. Remove the control key when the laser or System is not in use.

This key belongs to the laboratory responsible or to the authorized person using the T64000, it is strictly personal. Remove the control key when the laser or System is not in use.

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- «Safety shutter ON»: In this position, the T64000 is unusable, a shutter keeps the beam from going into the microscope and the macro chamber.
- «Safety shutter OFF»: In this position, microscope and macro chamber are usable. In this position, all personnel in the vicinity of the laser should also be ordered to wear protective eyewear according to the laser wavelengths and power (see charts 1.0 below).

Density filters wheel

This density filters wheel has 2 functions:

- Security recommendations for personal protection
- Laser beam attenuation for sample protection

Security recommendations: The following charts provide security recommendations for the user, it shows the power threshold of the laser beam above which it is necessary to wear security glasses. These thresholds correspond to the EMP (allowed maximum exposure) relative to the 60825 EN safety standards, they have been calculated according to the density filters:

	Laser source max power (Threshold for glass wearing)						
Wavelengths Range (nm)	**Without any DO**	**DO 0.3**	**DO 0.6**	**DO 1**	**DO 2**	**DO 3**	**DO 4**
200 to302.5 (30s exposure)	If P>0.78 µW	P>1.57µW	P>3.14 µW	P>7.8 µW	P>78,5 µW	P>785 µW	P>7.8 mW
302.5 to 315 (30s exposure)	P>0.8 µW	P>1.6 µW	P>3.3 µW	P>8.3 µW	P>83 µW	P>830 µW	P>8.3 mW
315 to 400	P>78.5 µW	P>157µW	P>314µW	P>785 µW	P>7.85 mW	P>78.5 mW	P>785 mW
400 to 700	P>385 µW	P>770µW	P>1.5mW	P>3.8 mW	P>38.4 mW	P>384 mW	P>3.8 W
700 to 1100	P>384 µW (700 nm); P>2.98mw (1100nm)	P>720 µW (700nm); 6mW (1100nm)	P>1.4mW (700nm); 12mW (1100nm)	P>3.84 mW (700nm); 30mW (1100nm)	P>38.4 mW (700nm); 300mW (1100nm)	P>384 mW (700nm); 3W (1100nm)	P>3.84 W (700nm); 30 W (1100nm)

Chart 1.0 «Glass wearing recommendations as function of wavelengths ranges»

This chart shows the necessity to wear the security glass in particular when UV laser is used.

S9 List of safety labels

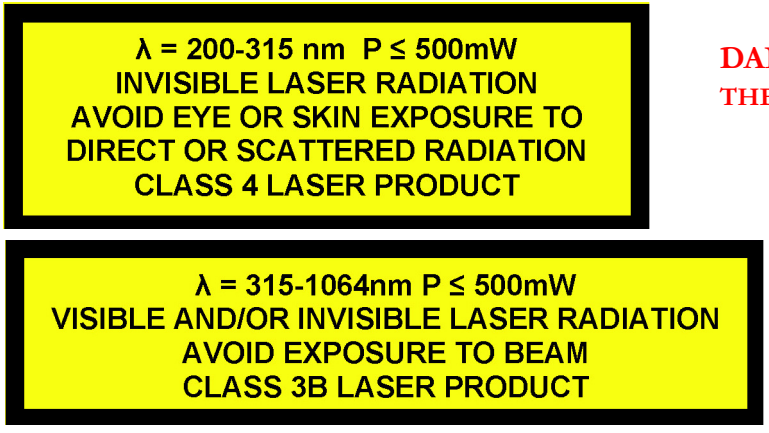
The following safety labels are affixed to the system and/or to the optional parts according to the different options installed. Not all the labels will be present where a class 1 safety enclosure has been included.

Labels 1 to 5 indicate a hazardous situation where there is a risk of serious injury due to possible laser radiation.

Label 1

The T64000 System operates with laser source(s) emitting visible and/or invisible continuous laser radiation typically below 500 mW. The class of the laser product is 3B or 4.

The laser class depends on the end user laser source and must be placed on the laser source. This label will also be placed near to the «identification label» (see Figure 1-3, "Labels (lateral view)", page 15)



DANGER! AVOID EXPOSURE OF THE LASER BEAM TO THE EYES

Figure 1.1 Safety label 1

Label 2

DANGER! DURING OPERATION, THE LASER BEAM IS EMITTED IN THE T64000 SYSTEM

Figure 1.2 Safety label 2

Label 3

A laser beam is emitted through that aperture.

DANGER! AVOID EXPOSURE TO THE BEAM.

Figure 1.3 Safety label 3

Label 4

The T64000 System has panels which is fixed in place and secured by screws. These panels must not be opened or removed. Doing so may pose a risk to accidental exposure to the laser beam(s) and will invalidate any warranty.

Figure 1.4 Safety label 4

DANGER! the laser product class may increase if covers or casings are removed. Dangerous visible and/or invisible laser beams may become accessible and pose a possible risk to exposure.

Label 5

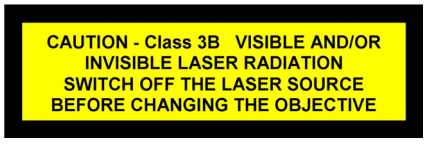


Figure 1.5 Safety label 5

DANGER ! Microscope objectives are designed to be removed or switched over during normal operation and are not protected by any safety interlocks. SWITCH off the laser before changing or replacing microscope objectives.

NOTICE: if one (or several) objectives are not mounted on the microscope turret, the empty positions must be blocked with a suitable cap. Replacement or additional cap can be purchased from HORIBA Jobin Yvon if required.

Label 6

CAUTION

Indicates a situation where equipment could be damaged; or there is a risk of minor injury.

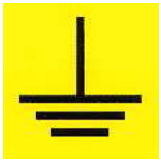
(Symbol depends on particular situation: see the additional Microscope manual)

Label 7

This symbol located on a device indicates that the device can be moved and could caution should be taken to avoid a potential injury.

Location: on the motorized XY Stage
Never put your fingers on the XY Stage during the moving sequence.

Label 8



Identifies any terminal which is intended for connection to an external conductor for protection from electric shock in case of a fault, or the terminal of a protective earth (ground) electrode. Located on the Spectra-Link.

Label 9

Recycling

This symbol located ON A DEVICE shows that this DEVICE HAS BEEN PLANNED FOR ECOLOGICAL DESTRUCTION AT ITS END-OF-LIFE.

S10 Labels location

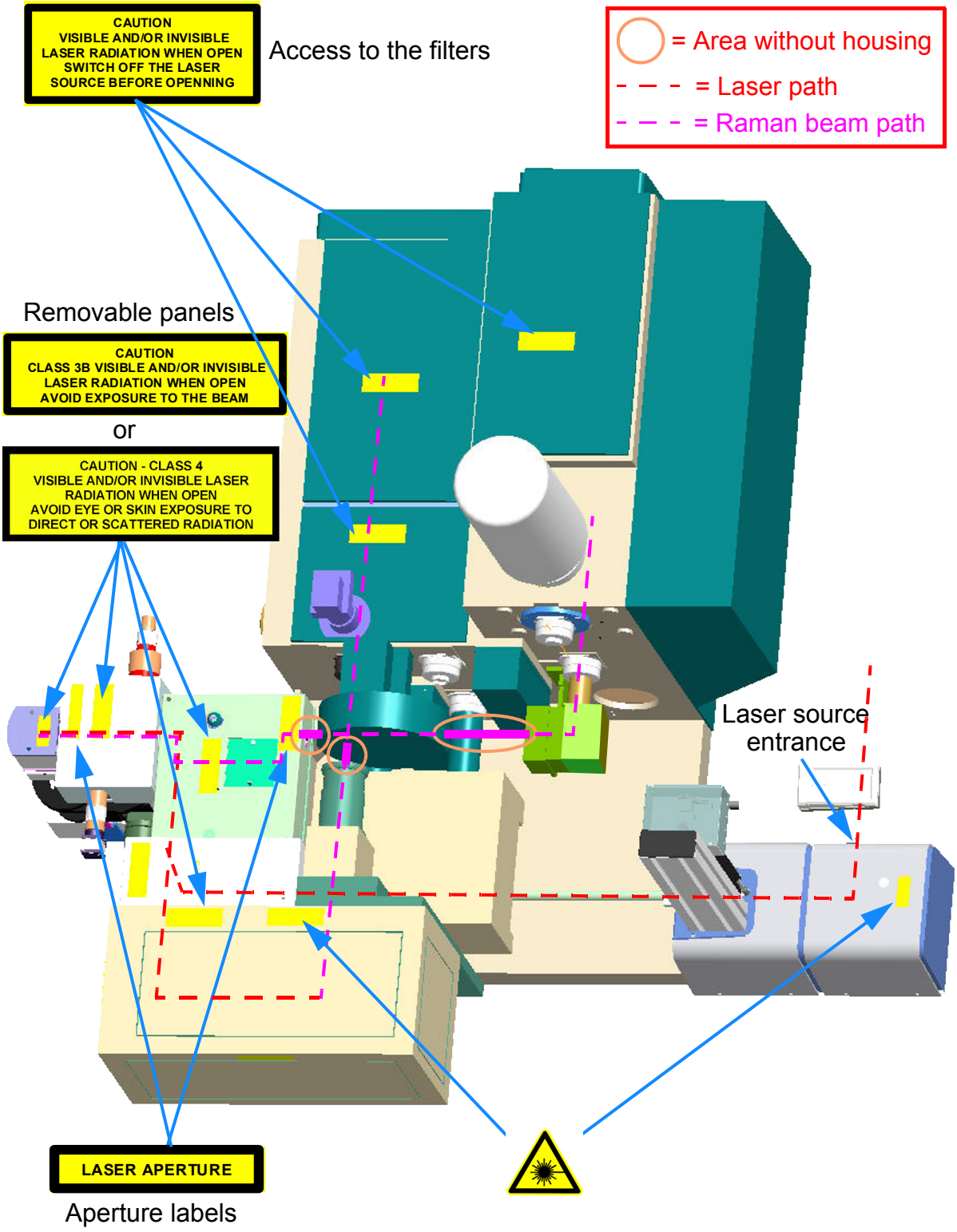


Figure 1-1 Laser path and label (upper view)

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Figure 1-2 Labels (front view)

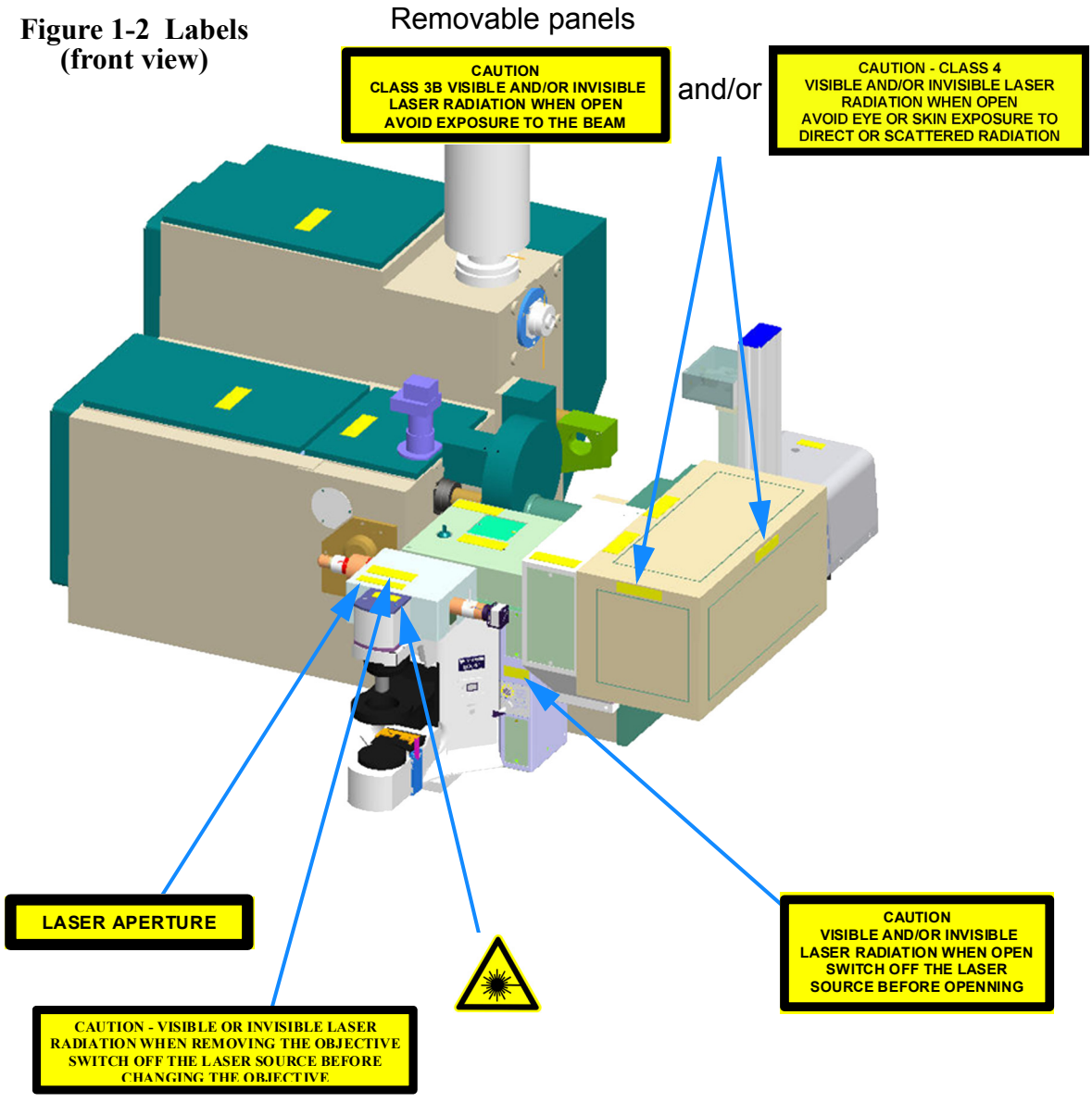
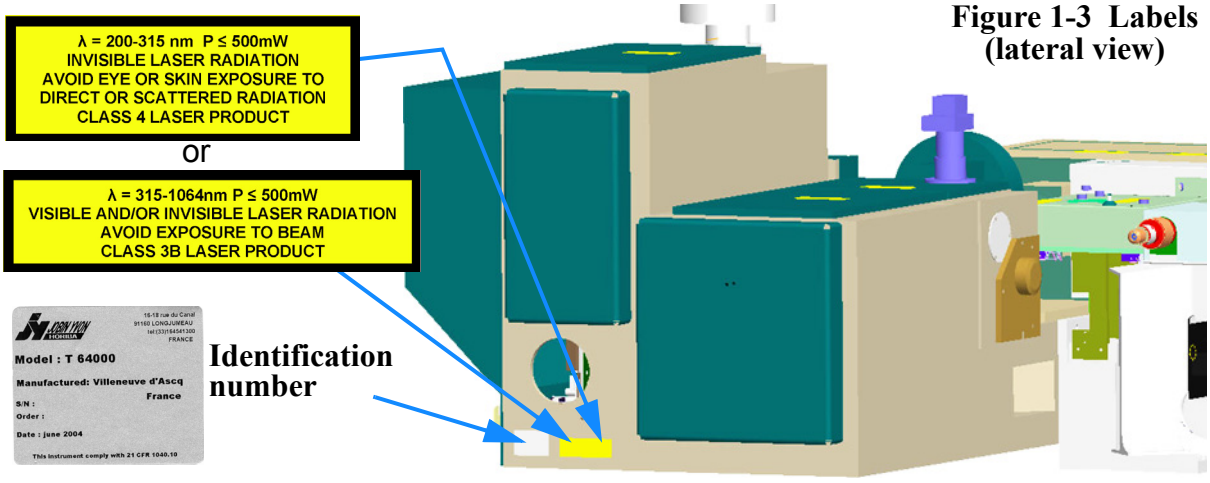


Figure 1-3 Labels (lateral view)



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Contents

CHAPTER 1

T64000 System

The T64000 System Series II is a new generation, fully computerized, triple spectrograph/scanning spectrometer system. Unlike the current generation of Raman spectrograph in which spectrometer control and data acquisition are independent functions, requiring different software and hardware, the T64000 System has an integrated software and hardware package which combines all functions in a simplified, easy-to-use fashion. The package contains a large number of security and validity tests, which are only possible with the complete integration of all functions. Conceived initially for the demanding performance of Raman spectroscopy, the T64000 is also superbly adapted to most other spectroscopic techniques. As the software allows the T64000 System to be used in wavelength and wavenumber units, other spectroscopic techniques such as fluorescence, luminescence and absorption/transmission can also be easily performed on both macro and micro samples. The ability to use the T64000 as a single or triple (with subtractive or additive premonochromator stages) spectrometer with either standard scanning or multichannel acquisition of data, permits the user to optimize the spectrometer to the spectral and sampling requirements. This flexibility is achieved without having to disturb the sample under investigation and is completely automated.

For industrial research or analytical laboratories the T64000 System is the safest, easiest to operate, and most flexible spectro-analytical system available.

1.1 System Installation

1.1.1 Packaging

The T64000 System is delivered in packaging designed for protection during shipment. However, if the packaging is damaged, or it appears after unpacking that the instrument has defects, fill out the necessary forms with the shipper (the guarantee is limited to 3 days).

It is recommended that the original packaging materials be saved for possible storage or transport of the instrument. Should it be necessary to send the instrument back to the factory, contact Jobin Yvon or your local representative for prior approval. Pack the instrument in its original packaging if undamaged. Otherwise contact your local representative for new

packaging material. Once the «return» slip has been received, send the instrument to the address that has been specified by your local representative.

1.1.2 Installation

The T64000 System must be installed and started by HORIBA Scientific or an approved representative.

1.1.3 Software Installation

The Software has to be installed and started up by HORIBA Jobin Yvon or an approved representative. Therefore, the installation procedure is detailed in the Software User Manual.

1.1.4 Operating Defects

If an operating defect exists, even after carefully reading this manual, contact HORIBA Scientific or your local representative for prior return approval. If the instrument is returned to the factory, the fault should be explained as clearly as possible.

1.1.5 Composition of the equipment

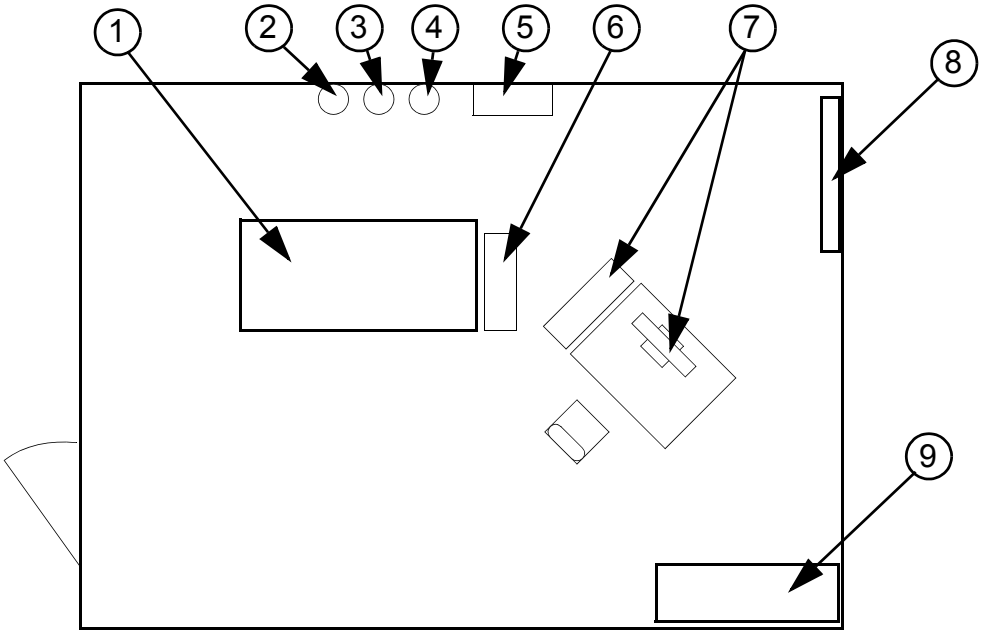
The T64000 System is composed of the following:

- Basic System,
- Optional Sub-units,
- Accessories.

1.1.6 Requirements

See the «requirements list» delivered with the quotation.

Figure below shows a sample installation for the T64000 System.



1 T64000 unit

2 Water supply (Monochannel/Multichannel Detectors, Laser Source)

3 Nitrogen supply (specific experiments)

4 Water outlet

5 Line power distribution box + ground cable

6 SpectraLink controller

7 Computer and monitor

8 Window air conditioner

9 Storage (for software + accessories)

1.1.6.1 Water Supply

The water supply is necessary for cooling the PMT.

- Water inlet/outlet flow: 0.6 l/min (about 10 gal/hour).
- Water temperature: Best result will be reached at 10°C.

A water supply is also necessary for the Laser Source; refer to the manufacturer user manual.

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1.1.6.2 Liquid Nitrogen (LN_2) Supply

The Liquid Nitrogen is required for a CCD Detector which includes a Dewar recipient mounted on the CCD chip. The Liquid Nitrogen is filled inside the Dewar and thus the CCD detector can be cooled up to -196 °C (-320 °F).

1.1.6.3 Nitrogen (N_2) Supply

The nitrogen supply is required for specific experiments. The nitrogen flow must be very low, regulated by a control with gauge. The average flow rate must be approximately 0.5 l/ min.

The nitrogen supply can also be required for:

- Laser source: Protection of the windows from the dust,
- Experiments: Air free samples,

  etc...

1.1.6.4 Liquid Nitrogen (LN_2) Supply

The Liquid Nitrogen is required for a CCD Detector which includes a Dewar recipient mounted on the CCD chip. The Liquid Nitrogen is filled inside the Dewar and thus the CCD detector can be cooled up to -196 °C (-320 °F).

1.2 Description

The table "T64000 Options Concept" on page 23 shows the options and accessories for the System.

All the options are organized around a **Basic** configuration which includes the following sub-units:

Entrance double stage monochromator in a subtractive mount including:

- 1 manual axial entrance slit 0 - 2 mm with a height limiter,
- 1 manual intermediate slit 0 - 50 mm with a height limiter,
- 2 fixed mirrors on each side of the intermediate slit,
- 1 fixed mirror in front of the exit slit (lateral entrance slit of spectrograph stage),
- 1 horizontal shaft with 2 gratings cassette holders,
- 1 set of aberration corrected holographic gratings 76 x 76 mm 1800 gr/mm.

Spectrograph stage including:

- 1 manual lateral entrance slit 0 - 25 mm with a height limiter,
- 1 horizontal shaft with a grating cassette holder,

- 1 aberration corrected holographic grating 76 x 76 mm 1800 gr/mm in a cassette,
- 1 top exit for a multichannel detector.

New SpectraLink Controller delivered with:

- 2 Motor Driver (MDR) boards for controlling the scanning of the 2 monochromators,
- 1 computer interface card.

LabSpec Software

LabSpec Software developed for Windows, supplied with two computer package dongles, permitting multichannel and monochannel detection, data acquisition, Raman mapping and a wide range of data treatment and storage options. This software also includes macro programming capabilities.

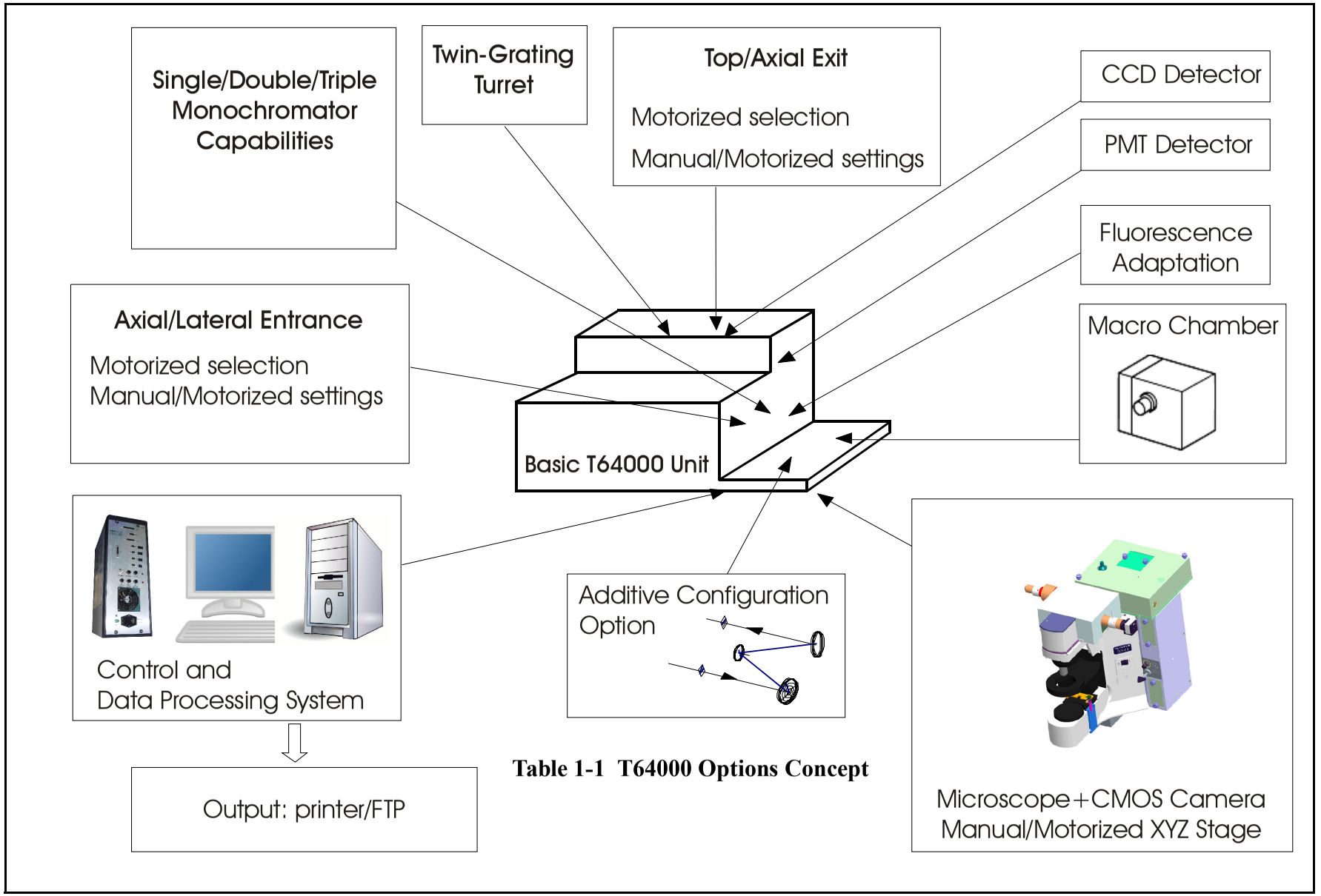

Table 1-1 T64000 Options Concept

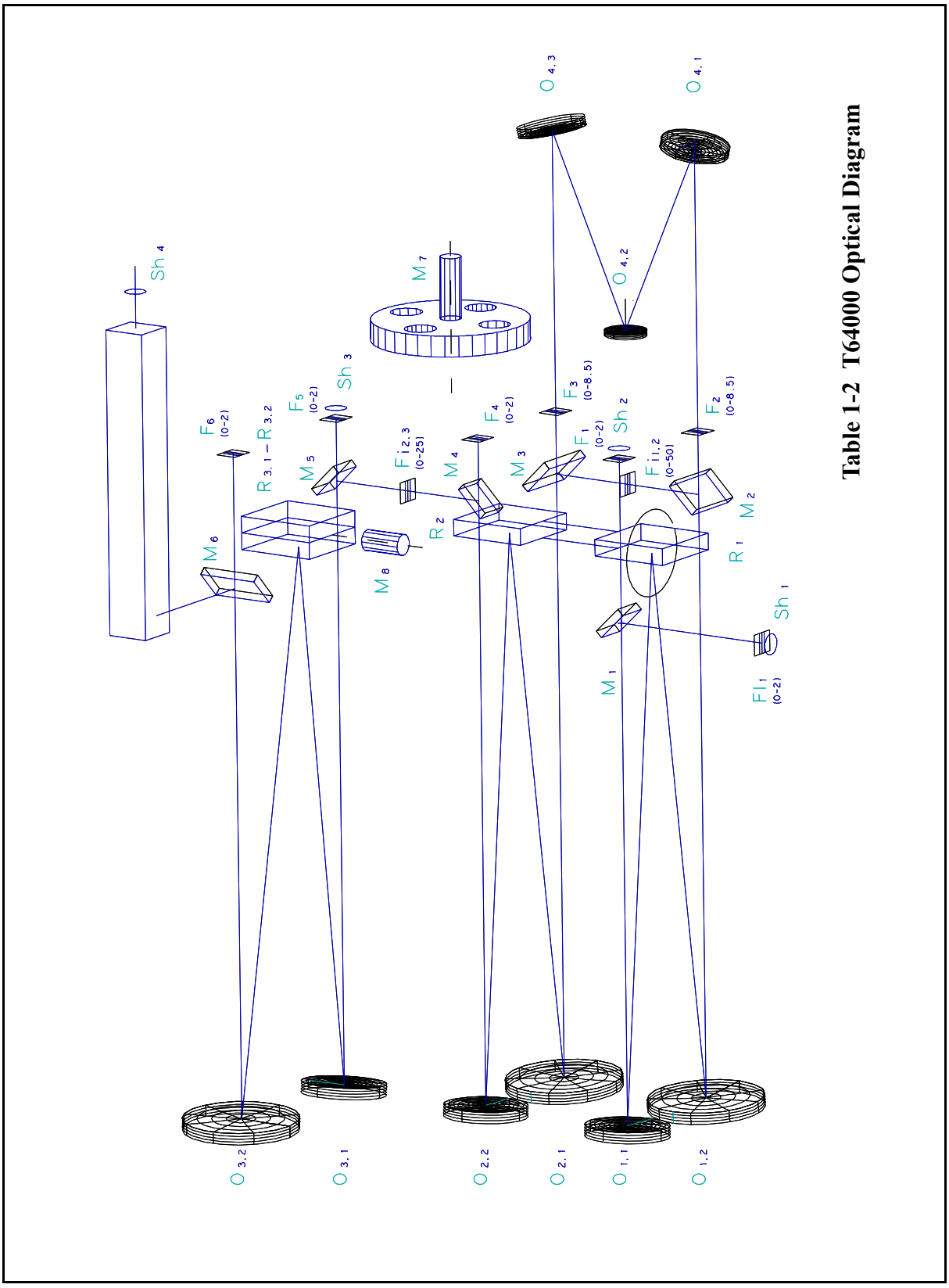

Table 1-2 T64000 Optical Diagram

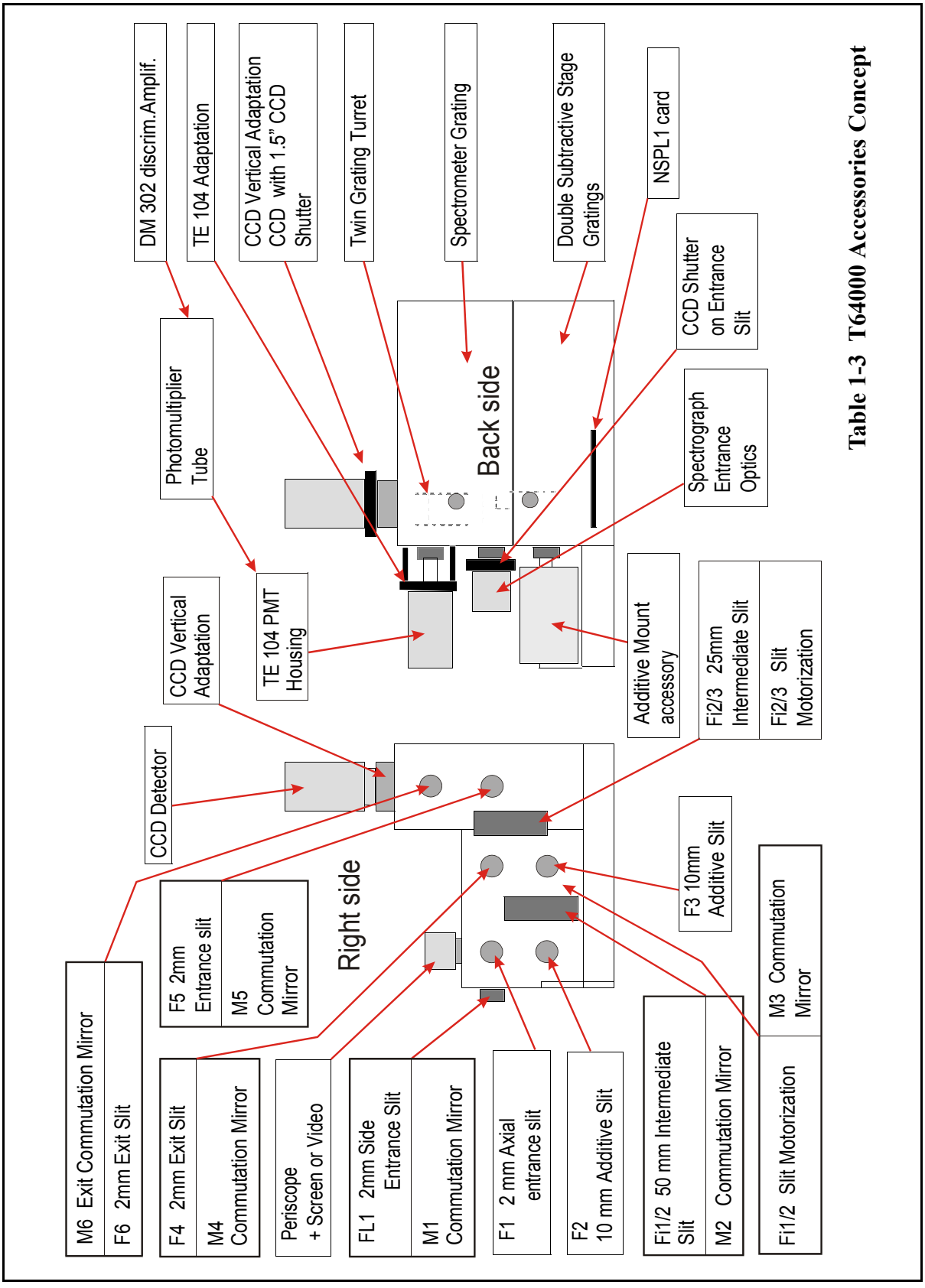

Table 1-3 T64000 Accessories Concept

1.2.1 Monochromator/Spectrograph

Subtractive configuration double stage monochromator includes the following components (see figure 1-4):

- One manual axial entrance slit 0-2 mm with height limiter (No.1, figure 1-4),
- One manual intermediate slit 0-50 mm with height limiter (No.4, figure 1-4),
- Two fixed mirrors on each side of the intermediate slit (No.3 and 5, figure 1-4),
- One fixed mirror in front of the exit slit (No.7, figure 1-4),
- One set of aberration corrected holographic gratings (1800 gr/mm, 76 x 76 mm) (No.2 and 6, figure 1-4).

Third stage in spectrograph configuration includes the following components (see Figure 1):

- One manual intermediate slit 0-25 mm with height limiter (No.8, figure 1-4),
- One fixed mirror ensuing the intermediate slit (No.9, figure 1-4),
- One aberration corrected holographic grating (1800 gr/mm, 76 x 76 mm)(No.10, figure 1-4),
- One top exit for the Multichannel Detector (CCD-Charge Coupled Device, LN2 cooled Linear InGaAs detector, etc...).

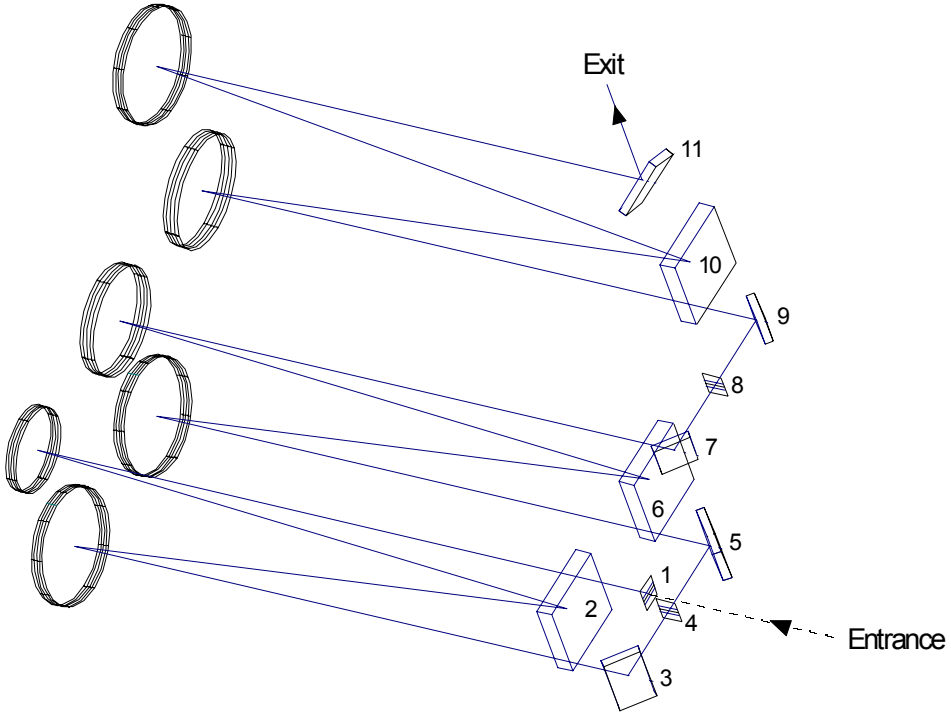

Figure 1-4 Basic configuration Optical Diagram

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1.2.2 SpectraLink

The new SpectraLink includes the cards which controls the motorized hardware of the instrument. Without option, it includes 2 Motor drivers to control the scanning of the double monochromator and the scanning of the spectrograph. It also includes, of course, the interface board for PC communication. On its basic state, it already includes all of the connectors (rear panel) for future options or accessories. Additional cards are plugged on the front panel.

Figure 1-5 SpectraLink Rear Panel

1.3 Interconnection

The T64000 System is a Raman diffusion spectrometry system. A wide variety of options are available to allow users to perform analysis in minimal time, thanks to the modular options and the specific Software developed by HORIBA Scientific, Jobin Yvon technology.

The figure 1-6 shows the T64000 Interconnection.

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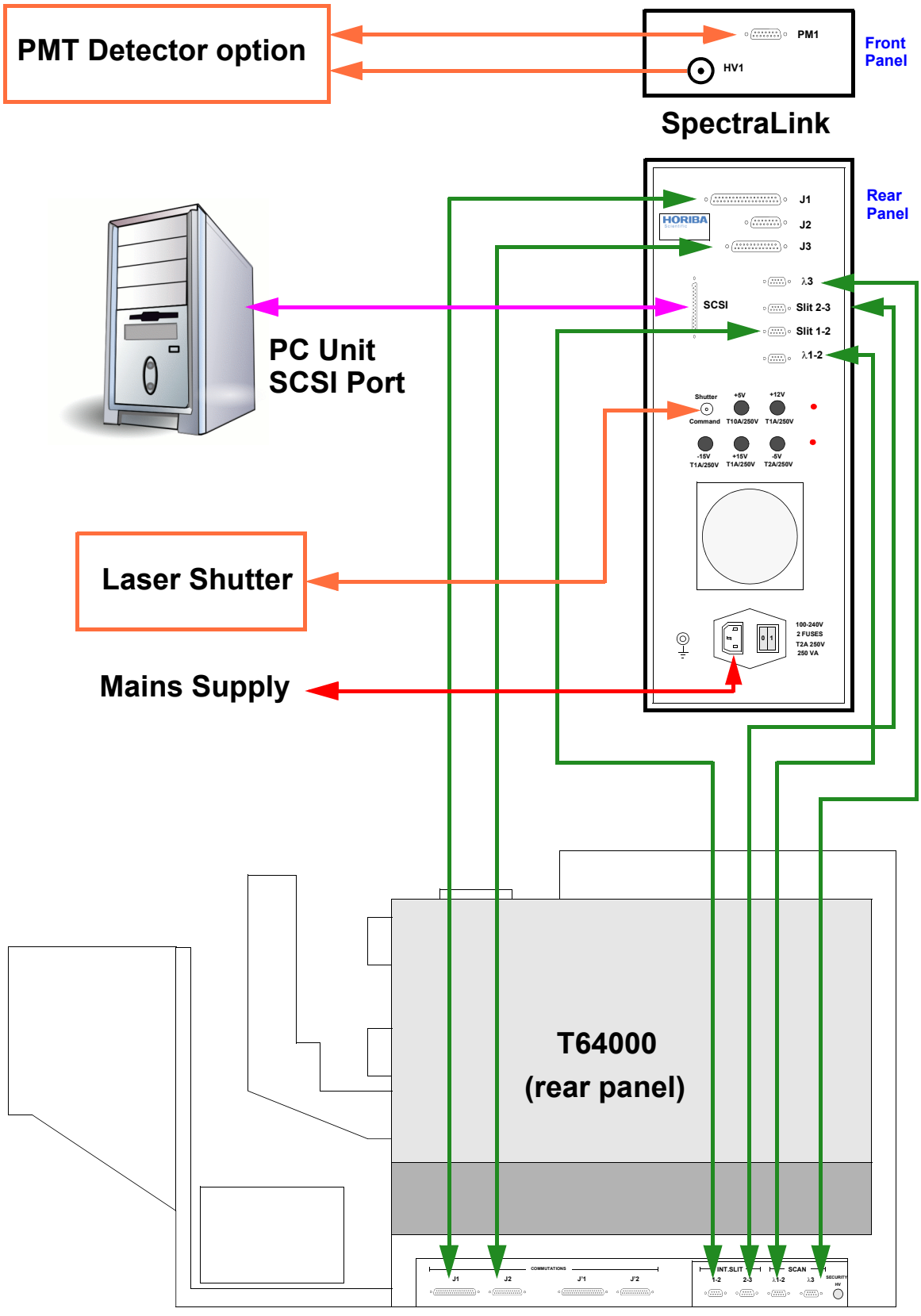

Figure 1-6 T64000 System Interconnection

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1.4 Specifications

1.4.1 Optical

Features:

- Three stage monochromator with optics, aperture and coupling optimized for performance and stability.
- Multiple motorized switching mirrors for ease of operation
- Multiple entrance and exit ports
- Directly coupled microscope options (and Macrochamber if required) rigidly coupled to the spectrometer
- A large choice of options and components to enable full customizing of the system e.g. gratings, detectors and sampling optics enabling operation from the UV to the NIR

Specifications:

- Focal length: 640 mm (single stage)
- 3 x 640 mm (triple additive)
- Low frequency: < 100 cm^{-1} (single stage)
  typically 2 – 5 cm^{-1} (double filter stage)
- Stray light rejection: 10-14 at 20 cm^{-1} (514 nm laser)
- Step size: 0.00066 nm (with 1800 gr/mm gratings)
- Reproducibility: better than 1 pixel
- Gratings: 100 to 3600 gr/mm (covering UV-NIR)

Tables of dispersions:

300 gr/mm grating

Wavelength		Spectrograph stage dispersion		Triple Additive dispersion	
nm	cm^{-1}	nm/mm	cm^{-1}/mm	nm/mm	cm^{-1}/mm
200	50000	5.12	-1280.46	1.71	-426.82
300	33333.33	5.11	-567.25	1.70	-189.08
400	25000	5.09	-317.96	1.70	-105.99
500	20000	5.07	-202.74	1.69	-67.58
600	16666.67	5.05	-140.23	1.68	-46.74
700	14285.71	5.03	-102.59	1.68	-34.20
800	12500	5.00	-78.19	1.67	-26.06
900	11111.11	4.98	-61.49	1.66	-20.50
1000	10000	4.96	-49.56	1.65	-16.52

600 gr/mm grating

Wavelength		Spectrograph stage dispersion		Triple Additive dispersion	
nm	cm^{-1}	nm/mm	cm^{-1}/mm	nm/mm	cm^{-1}/mm
200	50000	2.54	-635.93	0.85	-211.98
300	33333.33	2.52	-280.46	0.84	-93.49
400	25000	2.50	-156.38	0.83	-52.13
500	20000	2.48	-99.10	0.83	-33.03
600	16666.67	2.45	-68.07	0.82	-22.69
700	14285.71	2.42	-49.41	0.81	-16.47
800	12500	2.39	-37.33	0.80	-12.44
900	11111.11	2.35	-29.07	0.78	-9.69
1000	10000	2.32	-23.17	0.77	-7.72

900 gr/mm grating

Wavelength		Spectrograph stage dispersion		Triple Additive dispersion	
nm	cm^{-1}	nm/mm	cm^{-1}/mm	nm/mm	cm^{-1}/mm
200	50000	1.68	-420.69	0.56	-140.23
300	33333.33	1.66	-184.46	0.55	-61.49
400	25000	1.63	-102.11	0.54	-34.04
500	20000	1.60	-64.15	0.53	-21.38
600	16666.67	1.57	-43.60	0.52	-14.53
700	14285.71	1.53	-31.26	0.51	-10.42
800	12500	1.49	-23.27	0.50	-7.76
900	11111.11	1.44	-17.81	0.48	-5.94
1000	10000	1.39	-13.91	0.46	-4.64

1200 gr/mm grating

Wavelength		Spectrograph stage dispersion		Triple Additive dispersion	
nm	cm^{-1}	nm/mm	cm^{-1}/mm	nm/mm	cm^{-1}/mm
200	50000	1.25	-312.76	0.42	-104.25
300	33333.33	1.23	-136.15	0.41	-45.38
400	25000	1.19	-74.66	0.40	-24.89
500	20000	1.16	-46.35	0.39	-15.45

1200 gr/mm grating

600	16666.67	1.12	-31.03	0.37	-10.34
700	14285.71	1.07	-21.83	0.36	-7.28
800	12500	1.02	-15.87	0.34	-5.29
900	11111.11	0.95	-11.79	0.32	-3.93
1000	10000	0.89	-8.85	0.30	-2.95

1800 gr/mm grating

Wavelength		**Spectrograph stage dispersion**		**Triple Additive dispersion**	
nm	cm^{-1}	nm/mm	cm^{-1}/mm	nm/mm	cm^{-1}/mm
200	50000	0.82	-204.22	0.27	-68.07
300	33333.33	0.78	-87.21	0.26	-29.07
400	25000	0.74	-46.55	0.25	-15.52
500	20000	0.70	-27.83	0.23	-9.28
600	16666.67	0.64	-17.68	0.21	-5.89
700	14285.71	0.56	-11.53	0.19	-3.84
800	12500	0.48	-7.46	0.16	-2.49
900	11111.11	0.37	-4.52	0.12	-1.51
1000	10000	0.21	-2.13	0.07	-0.71

2400 gr/mm grating

Wavelength		**Spectrograph stage dispersion**		**Triple Additive dispersion**	
nm	cm^{-1}	nm/mm	cm^{-1}/mm	nm/mm	cm^{-1}/mm
200	50000	0.597	-149.33	0.199	-49.78
300	33333.33	0.559	-62.06	0.186	-20.69
400	25000	0.508	-31.74	0.169	-10.58
500	20000	0.443	-17.71	0.148	-5.90
600	16666.67	0.358	-9.94	0.119	-3.31
700	14285.71	0.241	-4.92	0.080	-1.64
800	12500	0.036	-0.56	0.012	-0.19

3600 gr/mm grating

Wavelength		Spectrograph stage dispersion		Triple Additive dispersion	
nm	cm^{-1}	nm/mm	cm^{-1}/mm	nm/mm	cm^{-1}/mm
200	50000	0.372	-93.09	0.124	-31.03
300	33333.33	0.318	-35.36	0.106	-11.79
400	25000	0.239	-14.91	0.080	-4.97
500	20000	0.107	-4.26	0.036	-1.42

Fast Comparison table

	Single Spectrometer dispersion nm/mm (cm^{-1}/mm)			*Triple additive dispersion nm/mm (cm^{-1}/mm)*		
Grating	**at 300nm**	**at 500nm**	**at 800nm**	**at 300nm**	**at 500nm**	**at 800nm**
300	5.11 (567.3)	5.07 (202.7)	5.0 (78.2)	1.70 (189.1)	1.69 (67.6)	1.67 (26.1)
600	2.52 (280.5	2.48 (99.1)	2.39 (37.3)	0.84 (93.5)	0.83 (33.1)	0.80 (12.4)
1200	123 (136.2)	1.16 (46.4)	1.02 (15.9)	0.41 (45.4)	0.39 (15.5)	0.34 (5.3)
1800	0.78 (87.2)	0.70 (27.8)	0.48 (7.46)	0.26 (29.1)	0.23 (9.3)	0.16 (2.5)
2400	0.56 (62.1)	0.44 (17.7)	0.04 (0.56)	0.19 (20.7)	0.148 (5.9)	0.01 (0.19)
3600	0.318 (35.36)	0.107 (4.26)	-	0.106 (11.79)	0.036 (1.42)	-

1.4.2 Electrical

- The SpectraLink is connected to the main by a removable cord.
- Consult the laser source user manual for special electrical safety requirement.
- A full electrical specification of the SpectraLink is detailed in the table below.

Electrical detail	Data	Remarks
Installation Category	II	
Safety Class	1	
Pollution degree	2	
Mains supply: Voltage variation Phase Frequency Frequency variation	115 / 230 VAC ± 10% Single 50/60 Hz ± 2%	The fuse must be selected following the line voltage
Nominal system power consumption	250 VA	

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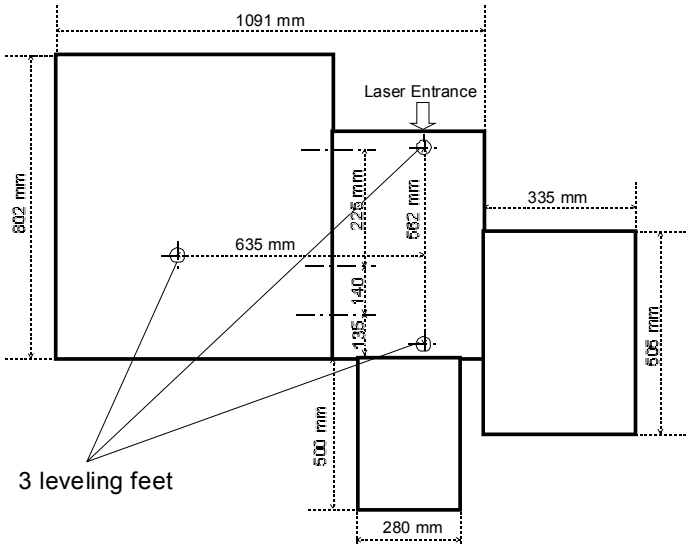
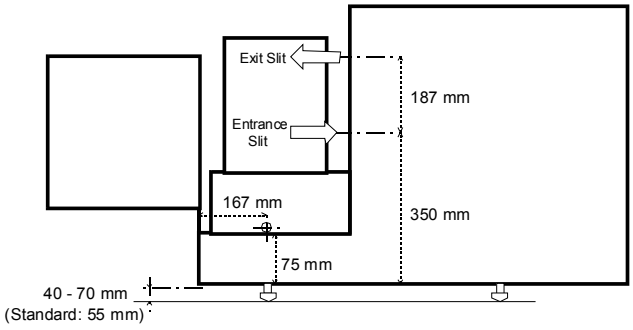
Mains unit fuse	115 Volts: T 2,5 A 250V 230 Volts: T 1 A 250V	
Grounding	T64000 is a class 1 instrument and must be connected to the ground. Refer to local regulations	

For safe servicing of the instrument, always remove the main cord before opening the rack.

1.4.3 Overall Dimensions





- **Weight**: 162 kg

WEIGHT PRECAUTION: T64000 Unit weights 162 kg. According to the mover staff, test the weight of the load to ensure it can be lifted securely; if not, make adjustments:
→ grip the load securely
→ protect hands against pinch points

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1.4.4 Environmental conditions

Environmental conditions	Conditions	Remarks
Indoor use		
Operating temperature	between +18°C and +25°C in a ± 1°C range	air conditioning with air regulation is required
Relative Humidity	Up to 80%	No condensation
Altitude	Max 2000 meters	

The room in which the instrument is installed must be properly ventilated.

1.4.5 Storage

If this unit has to be stored before it is installed, it must be kept in a store room where the storage conditions are listed in the following table:

Storage	Conditions	Remarks
Temperature	+5 to +40°C	
Humidity	Up to 80% RH	No condensation
Packing requirements	Special packing	Must stay closed during storage to prevent moisture and dust entering the unit

1.4.6 Cleaning Instructions

The outside part of the unit should be cleaned once a year to mainly get rid of dust. Use a lint free cloth with 90° alcohol. Do not use any other chemical products.

No cleaning should be undertaken inside the optical parts of the instrument, and namely the optical drawer and spectrograph.

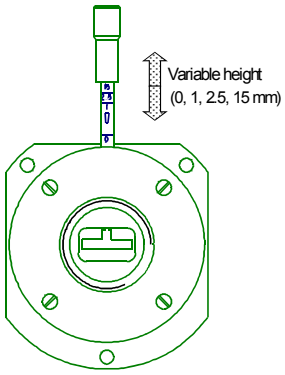
Before cleaning the SpectraLink Unit, switch OFF the unit and remove the mains cable. Never clean the inside of the SpectraLink Unit.

1.5 Detailed Description

The ***Description*** chapter has explained the elements or sub-units of the T64000 Basic Configuration. Numerous options and accessories can be added to enlarge the use or improve automation. This chapter will list and describe each of the most important options/accesso-

ries. The detailed and non exhausted list has been added and the end of this manual, in the Appendix section.

1.5.1 1st Stage Lateral Entrance Slit

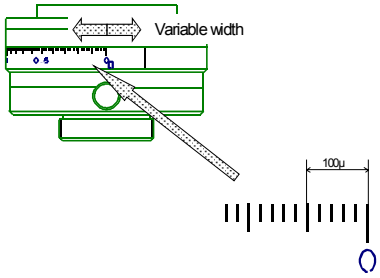


Destination T64000 Double Stage Monochromator

Description Used in System which required two selectable entrances. 0-2mm width and 0, 1, 2.5, 15mm height limiter.

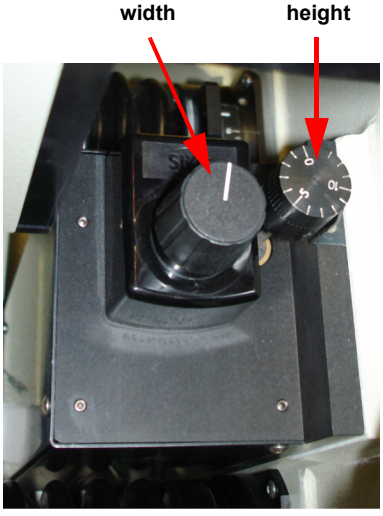
Option
1 SMA connector fiber adapter
2 FC fiber adapter

Additional This option is delivered with a motorized commutation mirror



Requirements Commutation card (T-COM)

1.5.2 Intermediate Slit Motorization



Destination T64000 Double Stage Monochromator

Description Computerizes the 0-50mm slit width with manual 0-15 height.

Option **1** Stokes-Anti Stokes accessory

Additional none

Requirements delivered with MDR motor driver card and cable.

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1.5.3 Spectrograph Lateral Entrance Slit

Destination T64000 Spectrograph lateral entrance slit (intermediate slit between the double monochromator and the spectrograph)

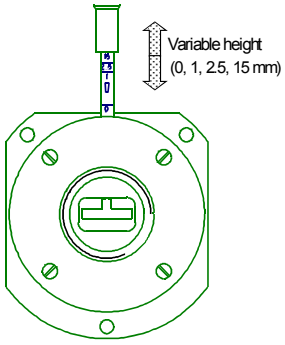
Description Computerizes the 0-25 mm slit width with manual 0-15mm height. lateral entrance slit of the spectrograph (intermediate slit between the Double Monochromator and the Spectrograph).

Option none

Additional delivered with MDR motor driver card and cable.

Requirements none

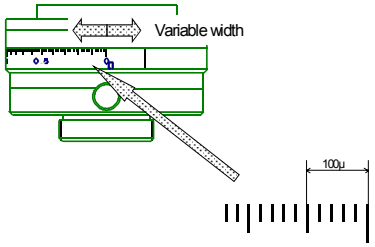
1.5.4 Manual Axial Entrance Slit



Destination T64000 Spectrograph

Description Used in System configuration which requires a selectable third stage entrance. 0-2mm slit width and 0, 1, 2.5, 15mm height limiter.

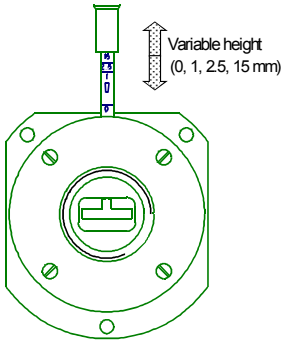
Option none



Additional This option is delivered with a motorized commutation mirror

Requirements Commutation card (T-COM)

1.5.5 2nd Stage Manual Axial exit Slit

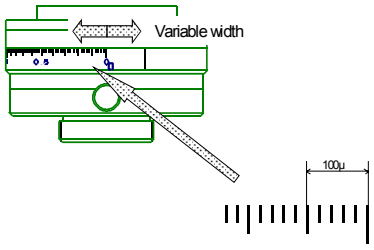


Destination T64000 Double Stage Monochromator

Description Used in System requiring a second stage axial exit. 0-2mm slit width with 0, 1, 2.5, 15mm height limiter.

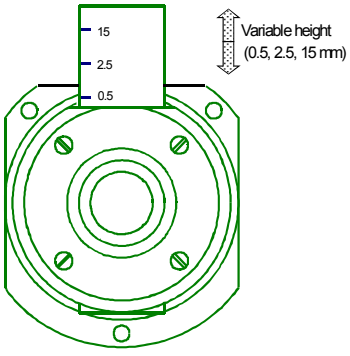
Option none

Additional This option is delivered with a motorized commutation mirror



Requirements Commutation card (T-COM)

1.5.6 Double Additive Adaptation



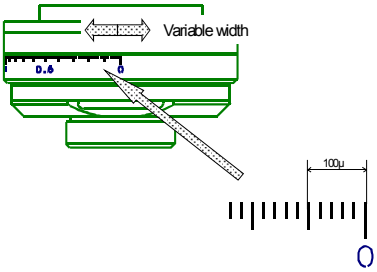
Destination T64000 Double Stage Monochromator

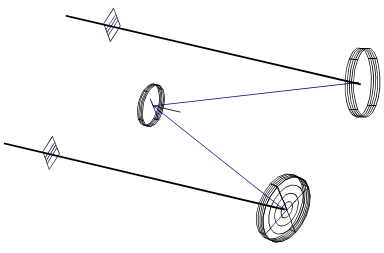
Description Used in System configuration which requires a double additive stage optical configuration.

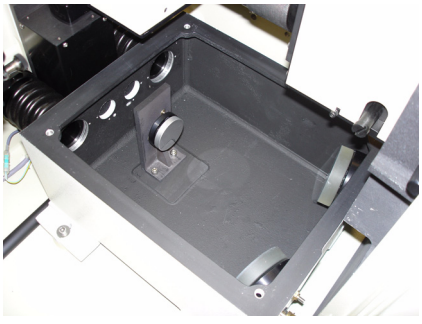
Option none

Additional none

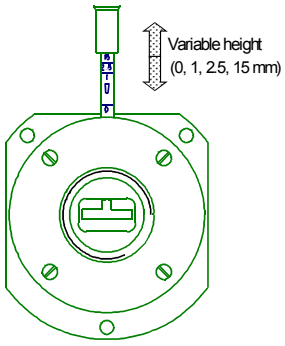
Requirements
- Commutation card (item T-COM)
- Double Additive mount accessory







1.5.7 Spectrograph Axial Exit

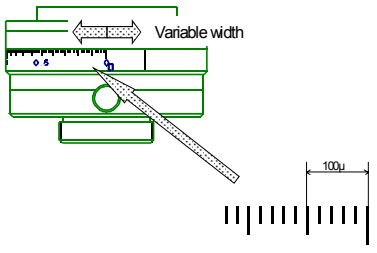


Destination T64000 third Stage

Description Used in System configuration which requires selectable third stage exits.

Option
1 0-2mm slit width with height limiter
2 Axial Multichannel Port

Additional This option is delivered with a motorized commutation mirror

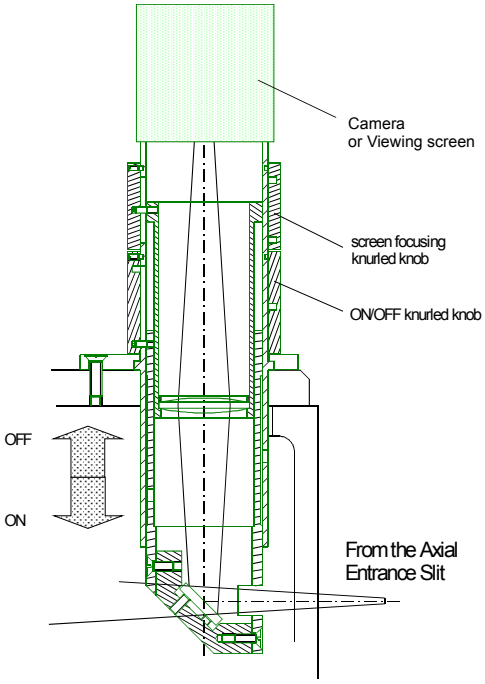


Requirements
- Commutation card (T-COM)
- Recommended adaptation ref1 with feet for reinforcing the stability of any HJY LN2 CCD mounted on axial exit.
- Recommended adaptation ref2 with feet for reinforcing the stability of any HJY LN2 CCD mounted on axial exit when a fiber adapter is mounted on axial entrance slit of the Spectrograph Stage

1.5.8 Viewers

Destination T64000 double monochromator

Description Swing away periscope with screen or video camera. This device allows the user to monitor the alignment of the sample image on the entrance slit.



Option
1 Viewer for Visible range supplied with a viewing screen
2 Viewer for Visible range supplied with a C mount adapter and density filters attachment (Camera not included)
3 Viewer for UV-Visible range, down to 240nm, supplied with a C mount adapter and density filters attachment (Camera not included).

Additional Color Camera 1280x1024 pixels with cable

Requirements none

1.5.9 Micro/Macro/Single/Triple Entrance Commutation Wheel for Visible Range

Destination T64000 System

Description The Micro/Macro/Triple/Single Commutation Sub-unit commutes the analyzed beam to four different paths:
- From the microscope to the double premonochromator entrance,
- From the microscope to the third stage entrance,
- From the macro sample compartment to the double premonochromator entrance,
- From the macro sample compartment to the third stage entrance.

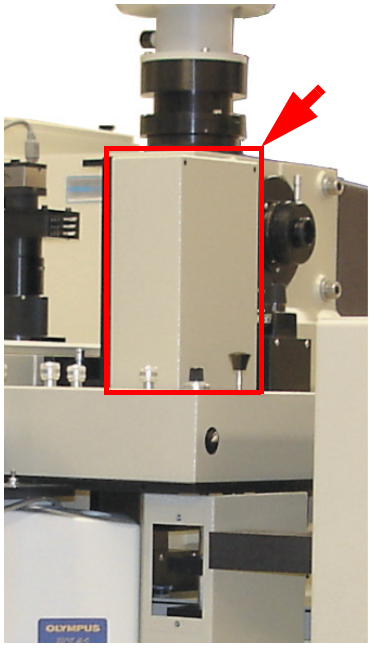
Option
1 Micro/Macro/Triple/Single Commutation wheel
2 For System equipped only with a Visible Microscope for selecting either triple/single configuration
3 For System equipped only with a Visible Macrochamber for selecting either triple/single configuration

Additional none

Requirements For Visible range only.
Required when using Visible Macrochamber and/or Visible Microscope.

1.5.10 Micro/Macro/Single/Triple Entrance Commutation for UV-VIS Range

Destination Located on the Double Monochromator Entrance.



Description The Raman beam exiting from the Microscope or the Macrochamber must be redirected to the Double Monochromator Entrance Slit or the Entrance Slit Spectrograph. A Collimation mirror is used to focalize the beam.

Option
1 Micro only to Single/Triple for Visible range,
2 Macro only to Single/Triple for Visible range.

Additional none

Requirements see above

1.5.11 Micro/Macro Mirror

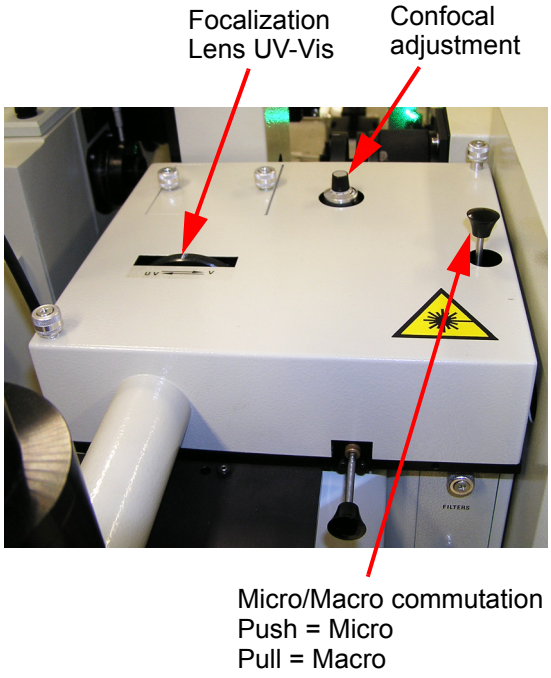
Destination T64000 with Microscope and Macrochamber

Description Swing away mirror which commutes the laser beam to Microscope or Macro-chamber

Option none

Additional none

Requirements Microscope and Macro-chamber



1.5.12 Confocal Microanalysis System

Destination T64000 System

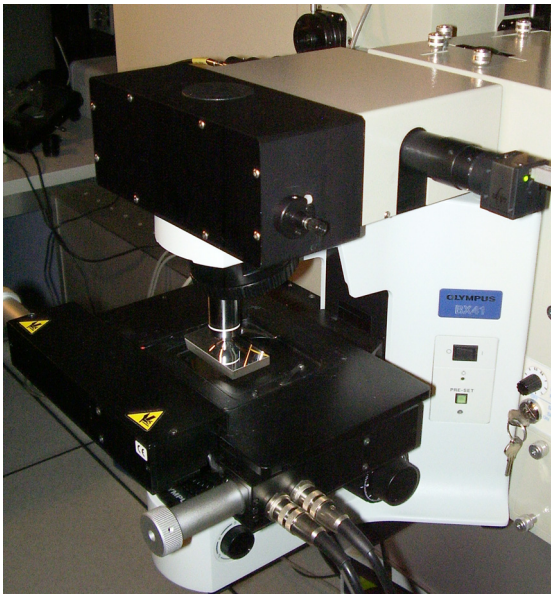
Description This System added to the Basic T64000 allows to use micro samples for Raman analysis. Due to numerous accessories, they are listed in the Appendix Chapter.

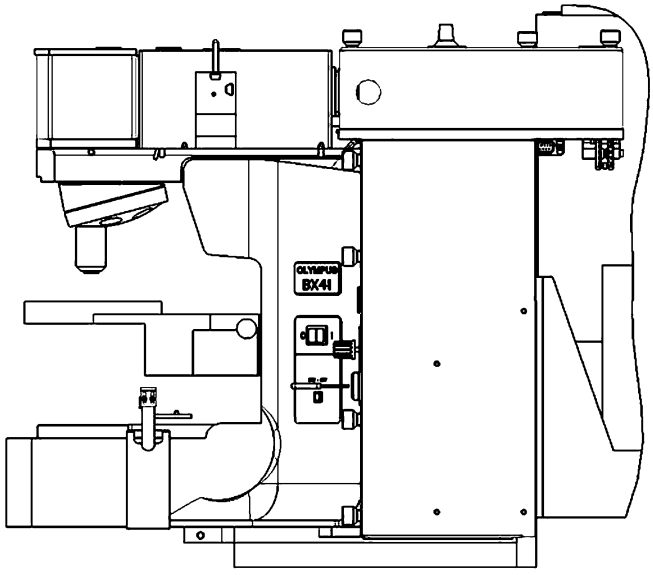
Option Many different microscope types are available:
- Visible Standard (as shown on the photo),
- Visible open microscope (free space below the objectives),
- Visible standard with line scan feature,
- UV-Visible,
- UV-Visible open version,
- Visible Inverted microscope,
- UV-Visible Inverted microscope

See detailed composition of each option in the "Appendix" on page 66

Additional The Micro/Macro/Triple/Single Commutation sub-unit is required for the signal which exits the microscope and enters the T64000 third stage (see page 39).
Video Camera: neutral Density Filters are required. These filters are located on the Laser Entrance path.

Microscope operation instructions: please refer to the manufacturer manual delivered with each System.





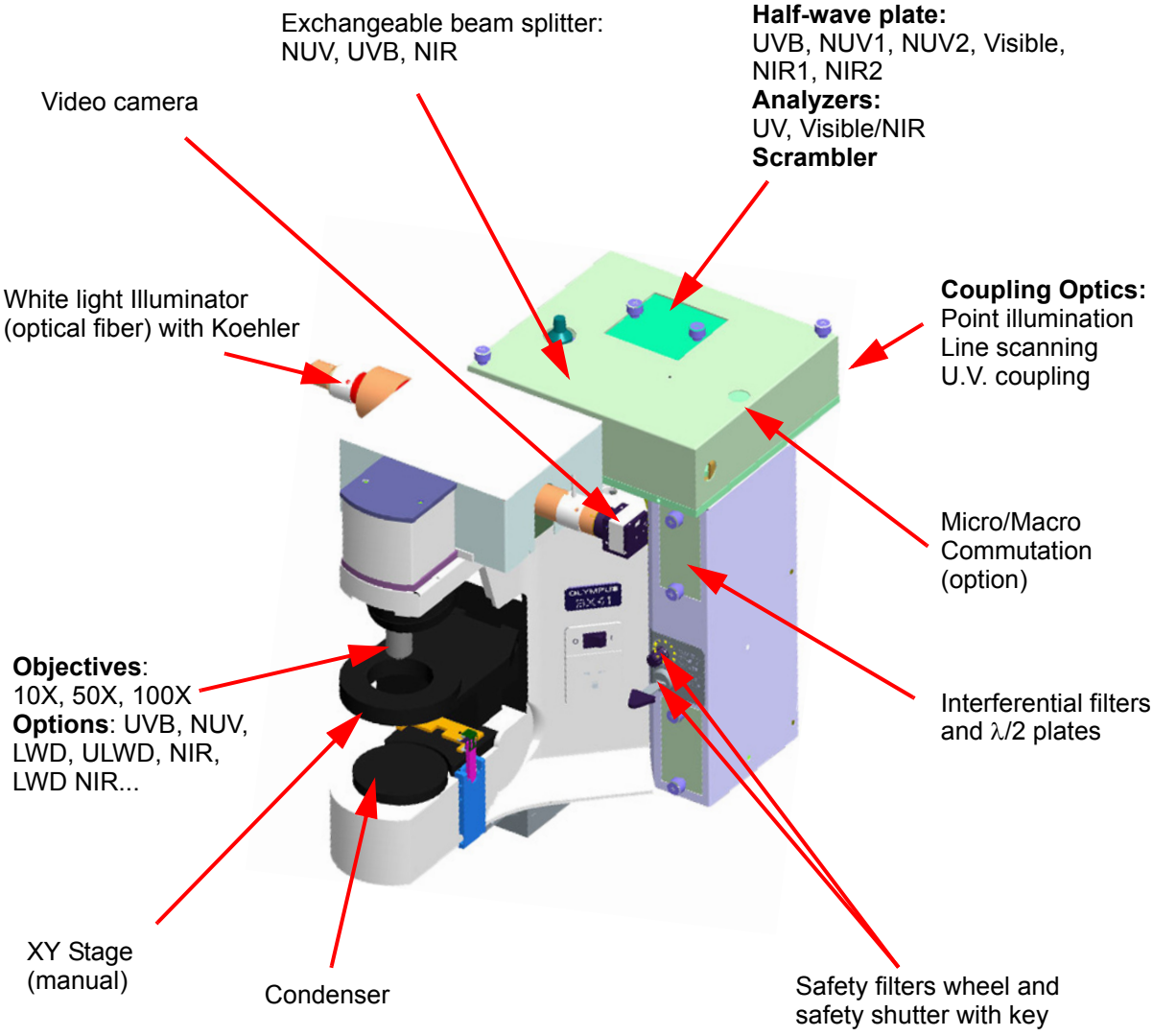
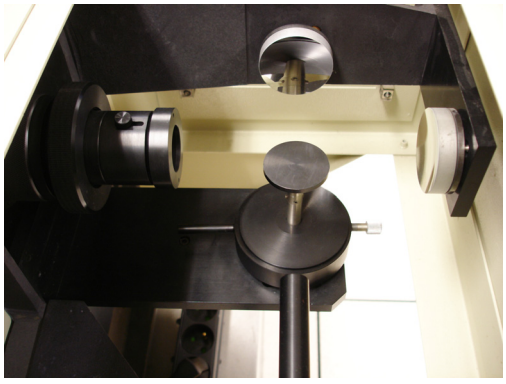


Figure 1-7 Microscope general presentation
(see the options in the "Appendix" on page 66)

10/07/2009

1.5.13 Macroanalysis System



Destination T64000 System

Description This option is used to perform analysis on various samples sizes and structures which cannot be processed by the Microanalysis System.

Option There are different options according to your needs:
- Visible version,
- UV-Visible version,
- Laser periscope for lifting the beam of a laser installed at the front of the system up to the level of the entrance axis of the Macrochamber,
- Macrochamber attachment with laser shutter, interference filter and half wave plate holders. To be used at entrance of the Macrochamber when no laser entry is on the system.

See detailed composition of each option in the "Appendix" on page 66.

Requirements The overall configuration must be known to adapt the devices.

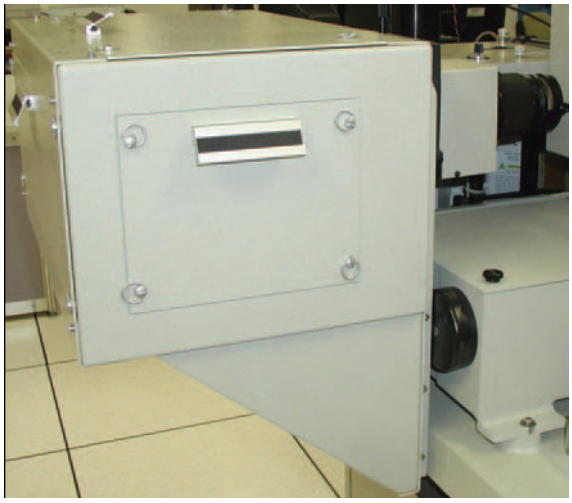
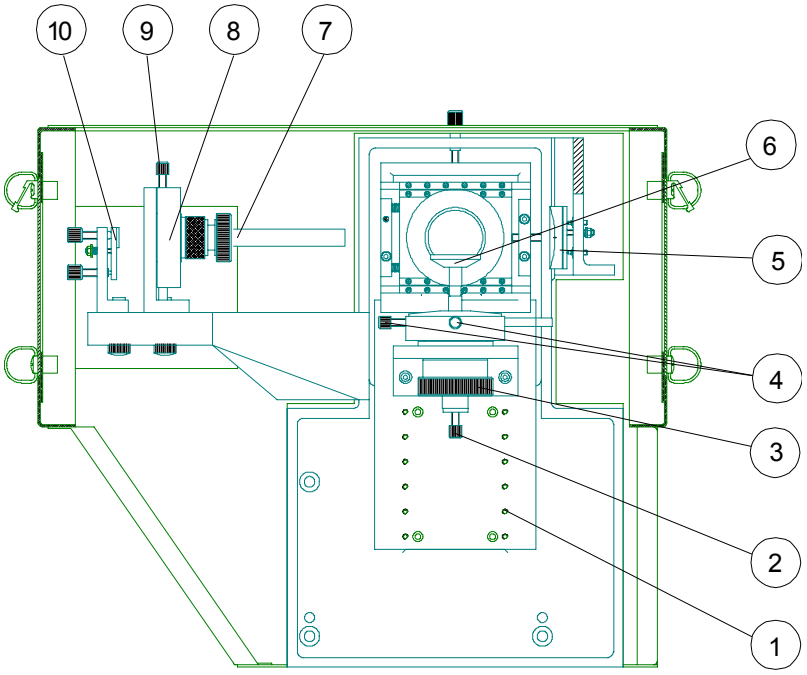
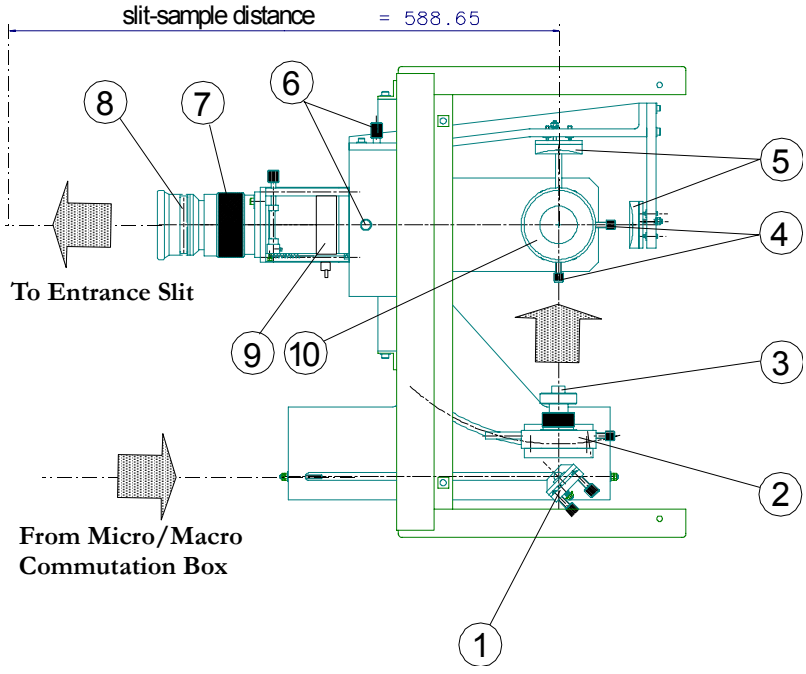


Figure 1-8 Macrochamber overall view



1 Step by step vertical adjustment of the sample platform
2 Vertical fine-tune adjustment of the sample platform
3 Knurled button to remove the platform
4 XY fine-tune of the sample platform
5 Back collecting mirror
6 Platform
7 Optional focusing adaptor
8 Optical focusing input device
9 Fine-tune adjustment of the input device
10 Input mirror

Right View



1 Step by step vertical adjustment of the sample platform
2 Vertical fine-tune adjustment of the sample platform
3 Knurled button to remove the platform
4 XY fine-tune of the sample platform
5 Back collecting mirror
6 Platform
7 Exit focusing adaptor
8 Filters holder
9 Back scattering mirror
10 Three-directional sample orientation platform

Top View

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1.5.14 Stokes/Antistokes accessory

Destination T64000

Description The stokes and Antistokes simultaneous measurements can be performed with the T64000 Instrument using a dedicated accessory. This accessory replaces the standard height limiter on the intermediate slit by a special height limiter (2, 3 and 4mm) with a central mask to eliminate the excitation beam.

Option none

Additional none

Requirements none

1.5.15 Two-Grating Turret Motorization

Destination T64000 Spectrograph

Description With this option, the grating change will be controlled by the Software.

Option None

Additional None

Requirements Commutation card (T-COM)

1.5.16 CCD Detector

Destination T64000 axial exit slit (third Stage)

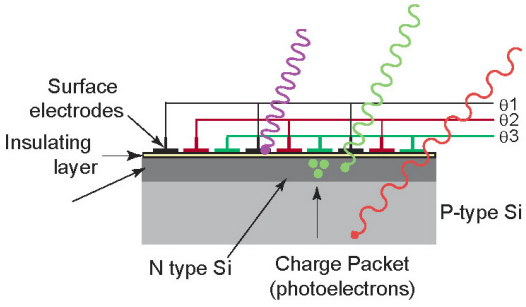
Description Most high end spectroscopic CCD sensors are two dimensional with rows and columns of pixels. Sensors used in spectroscopy are typically between 25 mm and 28 mm long and between 3 mm and 12.5 mm high, corresponding closely with the size of the focal planes of modern spectrographs.The fabrication methods employed can be modified to optimize sensitivity in the UV, VIS or NIR regions of the spectrum.

HORIBA Scientific offers a wide variety of sensors providing several alternatives in balancing wavelength response, sensitivity and price. There are two main categories of CCD sensors: Front Illuminated and Back Illuminated.

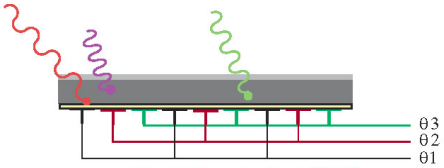
Front Illuminated CCDs are designed so that the light is incident on the CCD, but must pass through the CCDs silicon gate before reaching the optically active silicon. Standard front illuminated CCDs (FIVS) are best used for applications where reduced UV response and high full well potential (dynamic range) are desirable.

Cryogenic LN^2 cooling series

Thermoelectric cooling series



Front Illuminated CCD



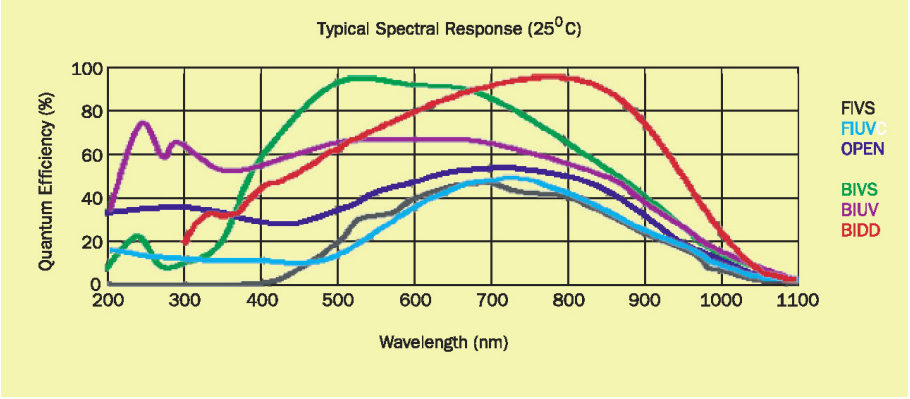
Back Illuminated CCD

Deep UV response of a front illuminated chip is enhanced by either adding a lumogen coating to the CCD (FIUV) or by etching a small opening on the electrodes to allow UV light to pass to the silicon. The latter type is known as (photoelectrons) an Open Electrode (OPEN) CCD. Front illuminated chips are free from etaloning Front Illuminated CCD effects due to their thickened substrate.

Back Illuminated CCDs are physically thinned so that the capture zone is closer to the surface which improves the UV quantum efficiency. Optimized antireflection coatings also help in improving the photo conversion and therefore, the quantum efficiency of the sensor (Choose BIVS for Visible optimized CCDs).

For Visible to NIR measurements (600 nm to 1000 nm), Back-Illuminated Deep Depletion (BIDD) CCDs have been created to increase NIR response over standard Back Illuminated CCDs and to reduce etaloning effects.

Each chip type has its own quantum efficiency and noise characteristics. The graph shows the typical QE curves for each type of CCD chip.When selecting a CCD remember that the signal to noise ratio increases as a square root of the increase in the quantum efficiency. For example, selecting a CCD with 4 times the QE will increase the signal-to-noise by a factor of 2.



Sensor selection should be based upon image size on the entrance slit of the spectrograph, whether the sensor is responsive in the spectral region of study, and if it is sensitive enough to distinguish the signal from the accumulated noise, within any temporal constraints of the measurement. Quantum efficiency becomes an issue only when the light level approaches the lowest limits of detectability.

Option see “Appendix” on page 66 or CCD HORIBA catalogue.

Additional see “Appendix” on page 66 or CCD HORIBA catalogue.

Requirements none

Installation Please refer to the CCD User Manual delivered with the CCD Detector.

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1.5.17 Monochannel Detection System

The system described below is the regular Photon Counting Detection System. Many other different configurations are available according to the applications.

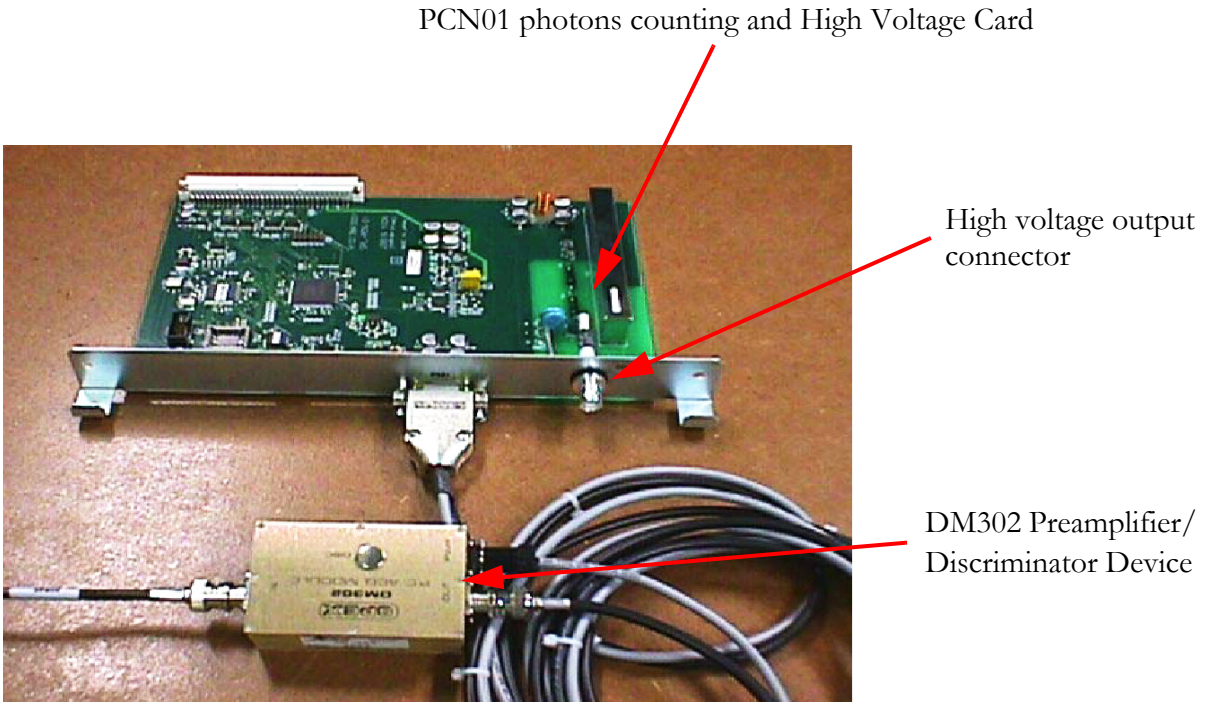
Destination T64000 System

Description A Photon Counting Detection System in the visible range usually incorporates the following devices:
-AsGa photocathode photomultiplier in a LCT50 housing. The housing includes a Peltier effect cooling device.
-Discriminator amplifier with cable,
-PMT housing adaptor (axial exit slit only).

Option none

Additional none

Requirements DM302 preamplifier/discriminator device
PCN01 photons counting and High Voltage card
(figure below shows the electronic devices)
CCD Shutter is required on each entrance slit (T-SHUTTER)



1.5.17.1 Detailed Description

- **General**

The detection occurs as follows: a group of lenses focuses the light beam from the exit slit on the photosensitive element of the photomultiplier.

A discrimination amplifier amplifies the signal from the photomultiplier. The assembly is powered by a separate power supply.

The Monochannel detector is housed in a parallelepiped metal box equipped with the following accesses:

- A coaxial connector marked «anode»,
- A coaxial connector marked «cathode»,
- A power supply connector for Peltier effect cooling system,
- Inlet/Outlet water circulation used for the Peltier effect cooling system.

The Monochannel Detection Unit will be mechanically and optically adapted using a LCT50 Housing adapter (see figure 1-9 and figure 1-10)

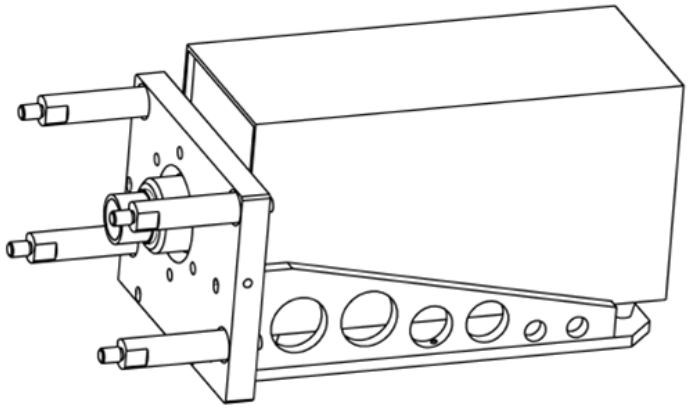


Figure 1-9 LCT50 Optical Adaptation

performance	**50 °C cooling below cooling liquid at 15 °C**
regulation	**±0.1 °C for ±5 °C change in liquid temperature at 20 °C**
cool- down time	**120 minutes**
window material	**double walled pyrex (quartz optional)**
supply	**220 V; 50-60 Hz; 150 W (110 V, 60 Hz optional)**
connectors	**signal: BNC (TNC optional); HV: MHV (SHV optional)**
connecting cables	**1.5 m**
weight	**housing: 5.5 kg, power supply: 5.9 kg**

Figure 1-9 LCT50 Optical Adaptation

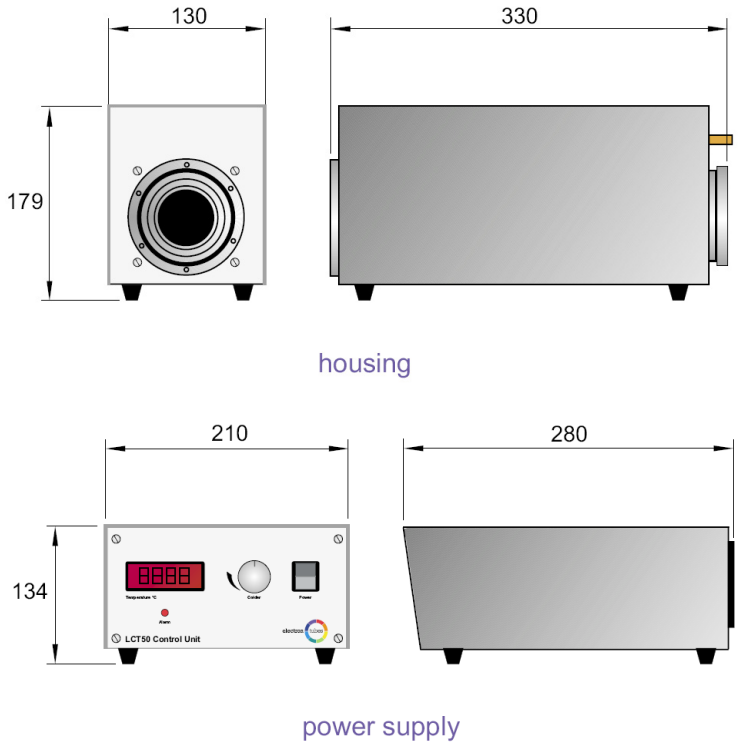


Figure 1-10 LCT50 dimensions

- **Photomultiplier Tube Principle**

  A photomultiplier tube is an electronic tube using photoemission effect to convert an incident radiation (ultraviolet to infrared) into an electrical signal, which is amplified to a usable level by means secondary electron emission (See figure 1-11).

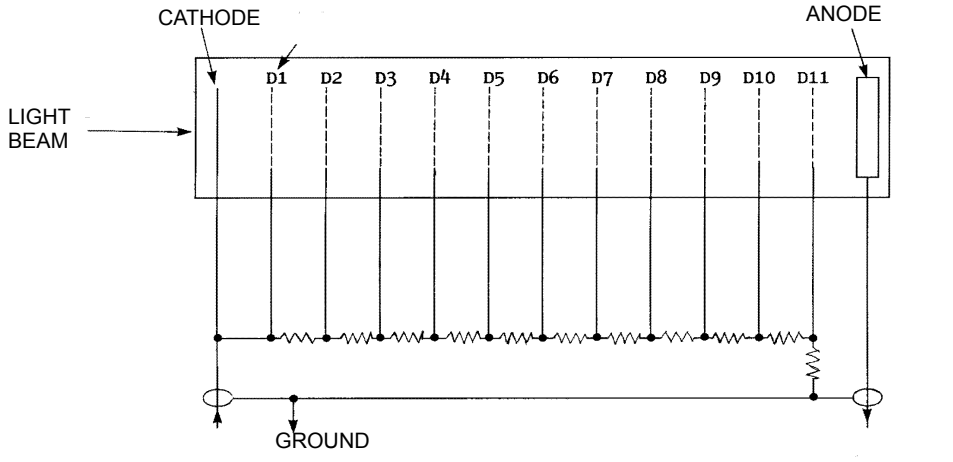


Figure 1-11 Photomultiplier Tube principle

- **Amplification**

The current provided by the photomultiplier is very small, and therefore must be amplified. The amplifier is located in the photomultiplier in order to avoid connection losses. It provides the following functions:

- 100X amplification of the signal from the photomultiplier. This function is performed by a discriminator amplifier.

- **Power supply access**

The power supply pack is housed in a metal parallelepiped box. The front panel includes the following components:

- «ON-OFF» switch,
- 10A fuse,
- Peltier power supply failed LED indicator.

- **Cooling system specifications**
  - Cooling temperature, depending on room temperature: - 35°C nominal,
  - Maximum room temperature: + 52°C,
  - Maximum water temperature: + 24°C,
  - Minimum water flow: 0.5 l/mn

CHAPTER 2

Getting Started

2.1 Preparation

After the T64000 System has been installed and started up by HORIBA Jobin Yvon or an approved representative, the user should follow certain rules and recommendations, listed below.

2.1.1 Safety

Read carefully the Safety instructions described in the chapter "General safety Instructions" on page 5.

2.1.2 Hardware Foresights

The CCD detectors must not be continuously exposed to bright light, especially in the ultra-violet wavelengths. This exposure will increase dark current. This damage can occur independent of power applied to the device. The camera head is supplied with a protection cover.

Most of the electronic components utilized in the detector system are highly electrostatic sensitive. Full ESD (ElectroStatic Discharge) handling procedures of the components of the system are essential. Failure to comply will damage the system.

Improper use or grounding of the T64000 System could damage the system and/or present the user with a potentially lethal hazard.

Do not connect or disconnect the cables while the System is on. The resulting power surges may damage the Units.

- **Reliability**

Electronic and electric circuits are subject to the following constraints whenever the unit is turned on or off:

- a brief transient period subjecting certain components to a severe operating mode,
- a slow transient period (several hours) during which the electric and electronic circuits will progressively reach a stable operating mode, from both electronic and thermal viewpoints.

It is thus strongly advised to leave the unit turned on, with the exception of the light source, the computer and monitor unit.

- **Reproducibility**
  - Extreme temperature variations within a short period of time can influence measurement results.
  - For example, measurement reproducibility will be optimal if a temperature regulation of 1 °C is observed.
- **Powered on the system**

The first time the T64000 System is connected to a power supply, or after a long shutdown period, the need for an electronic and thermal stabilization period should be taken into account in order to obtain good results.

For example, the following minimum periods should be taken into account:

- Mechanical and optical part of the T64000 unit: approximately 24 hours in a climate-controlled, regulated environment,
- SpectraLink: approximately 30 min,

2.1.3 Use

The T64000 System unit may be used after it has been installed by HORIBA Jobin Yvon or an authorized representative.

Only general guidelines for use will be given, since every element or sample analysis procedure has its own specific characteristics related to the nature of the element or sample.

2.2 Using T64000 with the Microanalysis System

2.2.1 Preliminary

The T64000 System has been installed and implemented by HORIBA Jobin-Yvon/or an authorized representative,

- Check to ensure that the T64000 Unit and its sub-assemblies are correctly connected to the power, water (laser, PMT Housing..) and nitrogen (multichannel CCD detector),
- The use of specific accessories are detailed in the Description section.

2.2.2 Procedure

1	**If the T64000 System is not powered ON, follow the following procedure:** **1** Open the water circulation for PMT Detector housing and laser (if necessary) **2** Open the Nitrogen circulation (if needed) **3** If the System is equipped with the optional CCD Camera, the following steps must be ensued: **4** Turn the power to ON on the CCD electronic unit, **5** Fill up the CCD Dewar vessel with the Nitrogen, **6** Wait for the decreasing of the CCD head temperature (up to 140°K or -133°C). This temperature can be controlled using the Software (see Software User Manual). This step should take up to 2 hours. Refer to the CCD User Manual to know how long the CCD temperature will be kept, **7** NEVER CUT OFF THE POWER SUPPLY OF THE CCD ELECTRONIC UNIT. In such case, it would be necessary to empty the Dewar vessel before restarting the electronic unit. **8** If the CCD camera is a UV coated version, never expose the CCD window to the sun or to fluorescent light source. **9** Power ON the PMT Detector (if applicable) **10** Power ON the SpectraLink,

1	**11** Power ON the Computer and the screen. **12** Switch the laser source ON: please refer to the Manual delivered with the unit. **13** Do not forget to wait for temperature stabilization. Estimation time for each sub-unit is the following: **14** PMT Detector: Maximum cooling temperature will be reached in several hours. To get the best performance in dark noise we recommend to keep the SpectraLink turned on so that the PMT is kept powered and to never stop the water circulation in the PMT housing. **15** SpectraLink: this unit must be powered for at least 30 minutes. **16** CCD Detector: please refer to the explanations detailed in the related User Manual. **17** Laser: please refer to the Manual delivered with the unit. **18**
2	Load the LabSpec software. The software has been already installed and setup performed. Please refer to the LabSpec User Manual.

Push down the Micro/Macro selector (see "Micro/Macro Mirror" on page 40) and **(6)** figure 2-2,

Position your sample on the Microscope Stage. Refer to the Microscope User Manual.

Confocal feature:

The T64000 Microanalysis System includes an integrated confocal microRaman system. The confocal microscope is coupled to the Single/Triple stages spectrometer.

On the incoming path, the laser beam is reflected towards the microscope by the means of a special filter (dielectric edge filter) used in injection/rejection mode.

On the return path to the spectrograph, the Raman back scattered light is fully transmitted through the filter towards the confocal slit-hole adjusted by a rotative button **(7)** located on the Micro/Macro Commutation Box. If several laser wavelengths are used, a focalization adjustment (chromatic aberration compensation) can be made with the button **(8)**.

The Single/Triple spectrometer disperses the multichromatic Raman signal onto the detector (PMT, CCD ..).

Once the confocal slit hole is set, the analysis point can be focused on a specific Z axis value. The figure 2-1 shows how a confocal pinhole determines the optical slice thickness of a sample. Thus, if the sample is located on a motorized XY stage it becomes easy to make an analysis surface inside a sample using the mapping feature. Using a Z motorized Sample Stage, this measure can be completely automated. A 3-D Raman image can be then obtained.

3

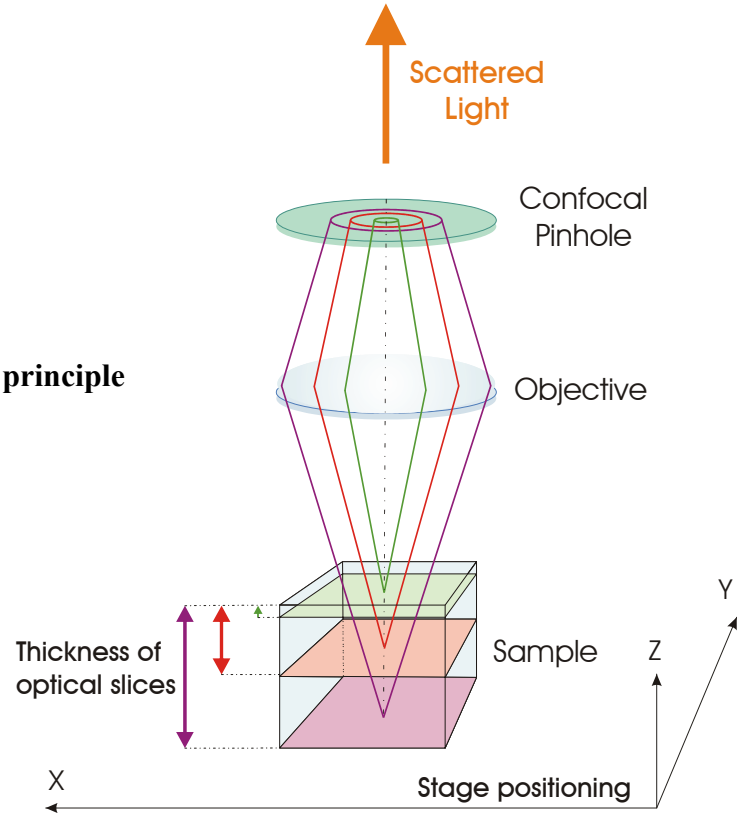


Figure 2-1 Confocal principle

4

From the LabSpec software, follow the standard acquisition procedure described below (see the LabSpec User Manual for detailed explanation):

1 Select the appropriate 3rd stage grating:
- 1800 g/mm for a high resolution
- 300 or 600 g/mm to make a one shot spectrum
- 1200 g/mm which is infrared optimized. (only for NIR version)

2 Select the correct grating setting in the software. If you change the grating, do not forget to go to the zero order position (in the software). This will give the correct calibration for the particular grating you will use.

3 Set the spectrograph to the desired spectral position.

4 Select the size of the confocal hole and the slit aperture.

5 Select the acquisition time and the number of accumulations (this will improve the signal/noise ratio).

Then you have 2 possibilities:

- The icon  : is a spectrum adjustment, so it can help you to maximize the signal (the new spectrum refreshes the old one and so on...). No repeated accumulations or extended spectral ranges are acquired.
- If you press the icon  it will make a spectrum accumulation and stop.

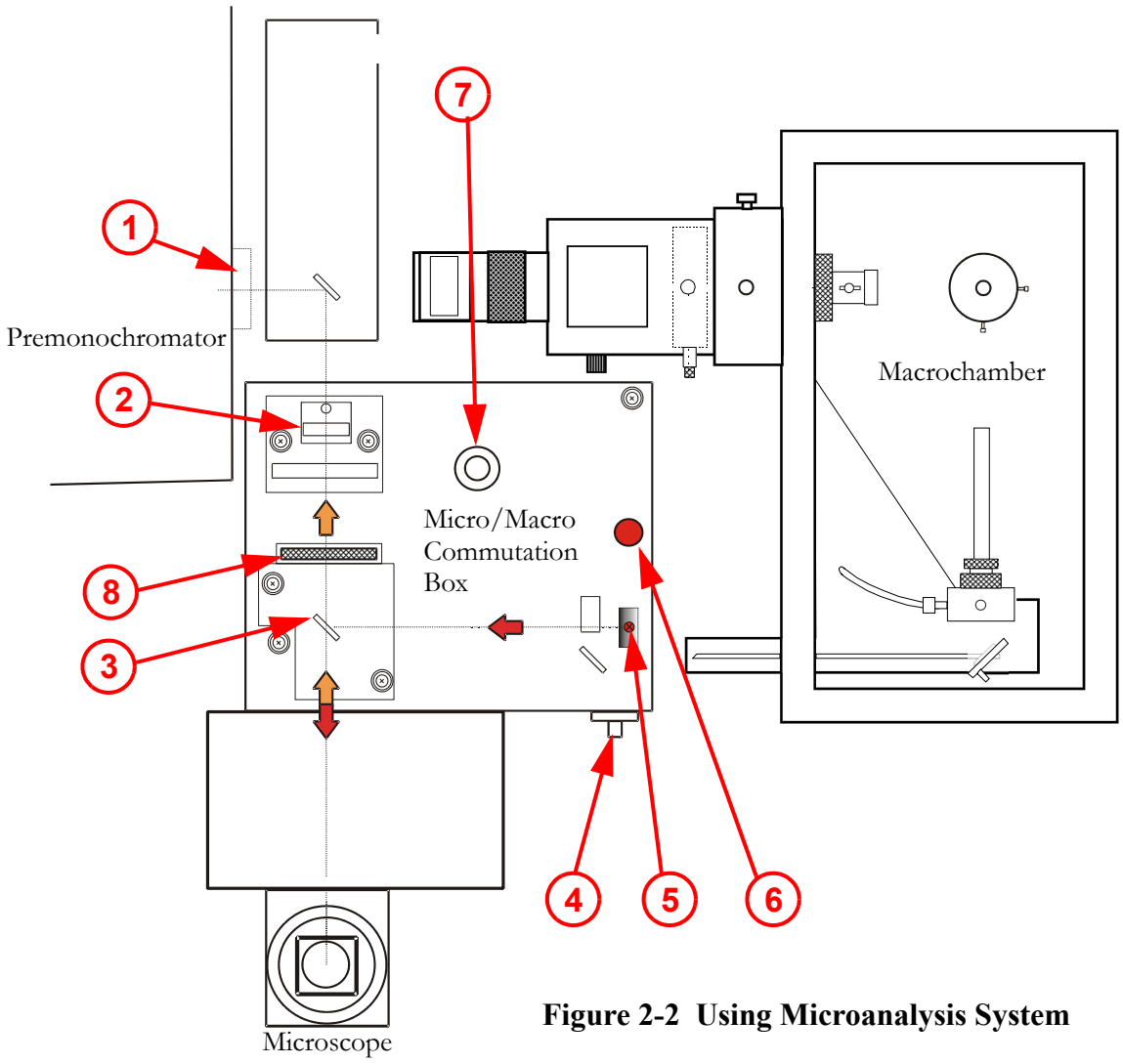


Figure 2-2 Using Microanalysis System

1. Premonochromator Entrance Slit
2. Filter holder (scattered beam)
3. Beam splitter
4. Laser Filter wheel with 6 neutral density filters
5. Laser vertical entrance axis
6. Micro/Macro commutation button
7. Confocal hole adjustment
8. Lens focusing adjustment of the scattered beam to the confocal hole. This is required when several laser wavelengths are used (axial chromatism aberration compensation)

2.3 Using T64000 with the Macroanalysis System

2.3.1 Preliminary

The T64000 System has been installed and implemented by HORIBA Jobin-Yvon/or an authorized representative,

- Check to ensure that the T64000 Unit and its sub-assemblies are correctly connected to the power, water (laser, PMT Housing..) and nitrogen (multichannel CCD detector),
- The use of specific accessories are detailed in the Description section.

2.3.2 Procedure

1	**If the T64000 System is not powered ON, follow the following procedure:** **1** Open the water circulation for PMT Detector housing and laser (if necessary) **2** Open the Nitrogen circulation (if needed) **3** If the System is equipped with the optional CCD Camera, the following steps must be ensued: **4** Turn the power to ON on the CCD electronic unit, **5** Fill up the CCD Dewar vessel with the Nitrogen, **6** Wait for the decreasing of the CCD head temperature (up to 140°K or -133°C). This temperature can be controlled using the Software (see Software User Manual). This step should take up to 2 hours. Refer to the CCD User Manual to know how long the CCD temperature will be kept, **7** NEVER CUT OFF THE POWER SUPPLY OF THE CCD ELECTRONIC UNIT. In such case, it would be necessary to empty the Dewar vessel before restarting the electronic unit. **8** If the CCD camera is a UV coated version, never expose the CCD window to the sun or to fluorescent light source. **9** Power ON the PMT Detector (if applicable) **10** Power ON the SpectraLink, **11** Power ON the Computer and the screen. **12** Switch the laser source ON: please refer to the Manual delivered with the unit.

13 Do not forget to wait for temperature stabilization. Estimation time for each sub-unit is the following:

PMT Detector: Maximum cooling temperature will be reached in several hours. To get the best performance in dark noise we recommend to keep the SpectraLink turned on so that the PMT is kept powered and to never stop the water circulation in the PMT housing.

SpectraLink: this unit must be powered for at least 30 minutes.

CCD Detector: please refer to the explanations detailed in the related User Manual.

Laser: please refer to the Manual delivered with the unit.

2

Load the LabSpec software. The software has been already installed and setup performed. Please refer to the LabSpec User Manual.

3

1 Pull down the Micro/Macro selector (see "Micro/Macro Mirror" on page 40) and **(6)** figure 2-2,

2 Open the Macro-sample compartment,

3 Place a sample on the sample holder **(14)** located in the macro-sample compartment,

4 Turn the XYZ adjustment screws as to perform a Raman-type light emission through the collimator lens at the output of the macro-sample compartment. The following devices can be fine tuned:

- Mirror orientation **(11)**
- Entrance beam focusing **(12)** or change the entrance focusing adapter **(13)** -option-
- XYZ sample holder adjustment **(14)**
- collecting image focusing **(16)** or change the exit focusing adapter **(15)** -option-
- T64000 entrance slit focusing with the transfer optics **(20)**

NOTE: These adjustments would be easier using the Macro Camera Viewer or/and the entrance slit Viewer (Screen or Camera).

5 Place an entrance filter (for example, an interferential laser filter) in the filter holder **(22)** located on the T64000 front panel below the Micro/Macro Communication box (useful to eliminate the plasma lines of the laser).

6 Insert the exit filters (for example: analyzer, polarizing, half-wave, quarter-wave plate) **(21)**,

7 If the T64000 System is equipped with a Viewer sub-unit (optional), the settings can be fine-tuned; the Viewer is located on the premonochromator entrance.

4

From the LabSpec software, follow the standard acquisition procedure described below (see the LabSpec User Manual for detailed explanation):

1 Select the appropriate 3rd stage grating:
- 1800 g/mm for a high resolution
- 300 or 600 g/mm to make a one shot spectrum
- 1200 g/mm which is infrared optimized. (only for NIR version)

2 Select the correct grating setting in the software. If you change the grating, do not forget to go to the zero order position (in the software). This will give the correct calibration for the particular grating you will use.

3 Set the spectrograph to the desired spectral position,

4 Select the slit aperture,

5 Select the acquisition time and the number of accumulations (this will improve the signal/noise ratio)

Then you have 2 possibilities:

- The icon  : is a spectrum adjustment, so it can help you to maximize the signal (the new spectrum refreshes the old one and so on...). No repeated accumulations or extended spectral ranges are acquired.
- If you press the icon  it will make a spectrum accumulation and stop.

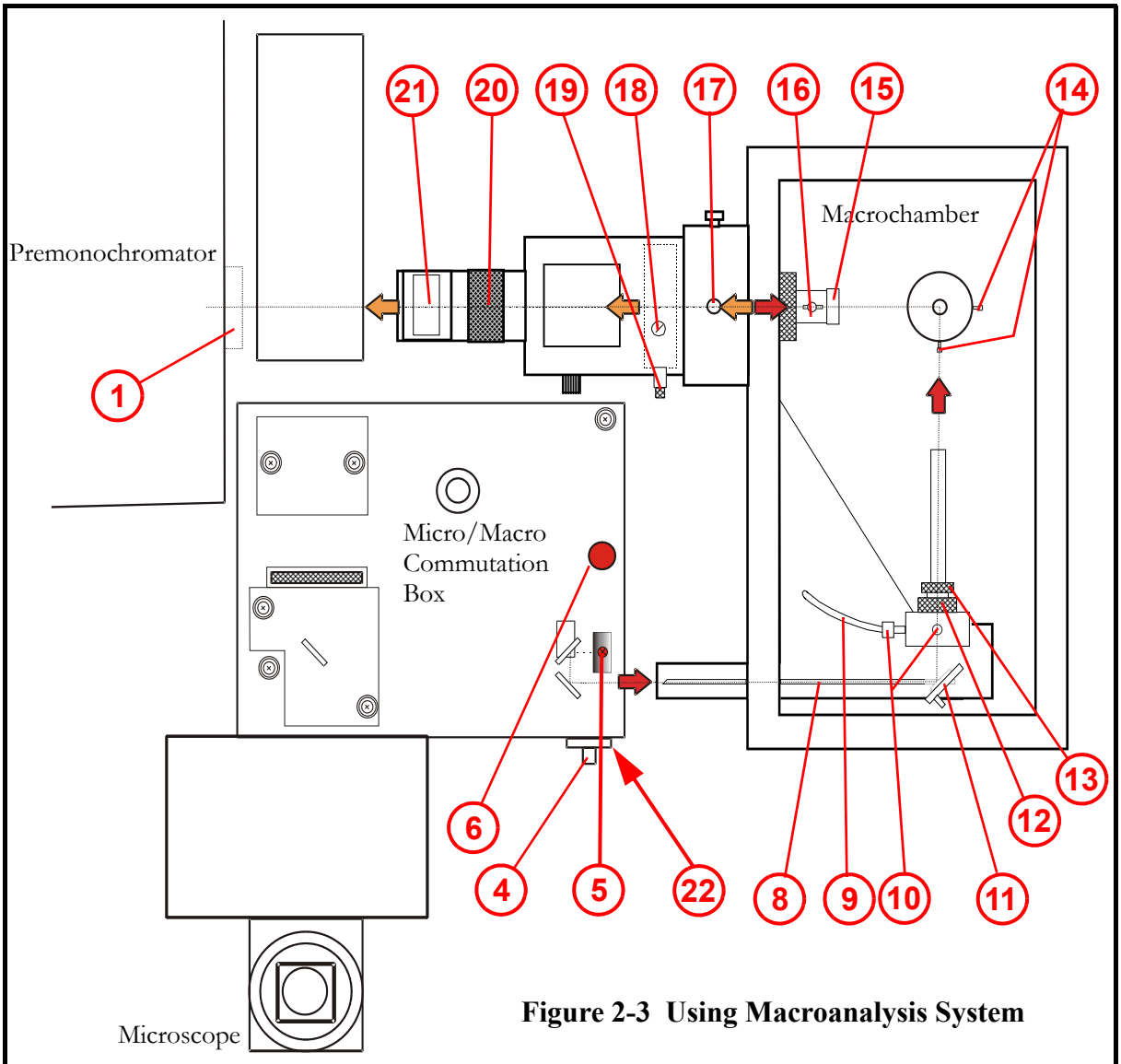


Figure 2-3 Using Macroanalysis System

1. Premonochromator Entrance Slit
2. Filter holder (scattered beam), see figure 2-2, page 57
3. Beam splitter, see figure 2-2, page 57
4. Laser Filter wheel with 6 neutral density filters
5. Laser vertical entrance axis
6. Micro/Macro commutation knob
7. Confocal hole adjustment, see figure 2-2, page 57
8. Mirror sliding rail
9. Focusing lens sliding rail
10. Entrance optics XZ adjustments
11. Mirror
12. Focusing lens adjustment
13. Focusing lens adaptor
14. XYZ sample holder adjustment
15. Collecting lens adaptor
16. Collection lens focusing adjustment
17. XY adjustment
18. Back-scattering mirror
19. Back-scattering selector with the fine tune knob
20. Transfer optics to entrance slit focusing adjustment
21. Holder for analyzer, half-wave or quarter wave plates
22. Access to entrance filters holder

2.4 Using T64000 with the Back-scattering Macroanalysis System

2.4.1 Preliminary

The T64000 System has been installed and implemented by HORIBA Jobin-Yvon/or an authorized representative,

- Check to ensure that the T64000 Unit and its sub-assemblies are correctly connected to the power, water (laser, PMT Housing..) and nitrogen (multichannel CCD detector),
- The use of specific accessories are detailed in the Description section.

2.4.2 Procedure

1	**Please follow the powered ON procedure described in the step 1, page 58.**
2	Load the LabSpec software. The software has been already installed and setup performed. Please refer to the LabSpec User Manual.
3	**1** Pull down the Micro/Macro selector (see "Micro/Macro Mirror" on page 40) and **(6)** figure 2-2, **2** Open the Macro-sample compartment, **3** Place a sample on the sample holder **(14)** located in the macro-sample compartment, **4** Displace the mirror **(11)** along the sliding rail by slightly unscrewing the knurled knob below the mirror holder, **5** Install the Back-Scattering mirror by sliding the **(19)** knob. This will perform a rough adjustment by steps. Fine tune the position using the rotative part of the **(19)** knob and the a and b screws located on the mirror holder (see figure 2-4, page 64). **6** Turn the XYZ adjustment screws as to perform a Raman-type light emission through the collimator lens at the output of the macro-sample compartment. The following devices can be fine tuned: - Mirror orientation **(11)** - XYZ sample holder adjustment **(14)** - collecting image focusing **(16)** or change the exit focusing adapter **(15)** -option- - T64000 entrance slit focusing with the transfer optics **(20)** NOTE: These adjustments would be easier using the Macro Camera Viewer or/and the entrance slit Viewer (Screen or Camera).

	7 Place an entrance filter (for example, an interferential laser filter) in the filter holder **(22)** located on the T64000 front panel below the Micro/Macro Communication box (useful to eliminate the plasma lines of the laser). **8** Insert the exit filters (for example: analyzer, polarizing, half-wave, quarter-wave plate) **(21)**, **9** If the T64000 System is equipped with a Viewer sub-unit (optional), the settings can be fine-tuned; the Viewer is located on the premonochromator entrance.
4	From the LabSpec software, follow the standard acquisition procedure described below (see the LabSpec User Manual for detailed explanation): **1** Select the appropriate 3rd stage grating: - 1800 g/mm for a high resolution - 300 or 600 g/mm to make a one shot spectrum - 1200 g/mm which is infrared optimized. (only for NIR version) **2** Select the correct grating setting in the software. If you change the grating, do not forget to go to the zero order position (in the software). This will give the correct calibration for the particular grating you will use. **3** Set the spectrograph to the desired spectral position, **4** Select the slit aperture, **5** Select the acquisition time and the number of accumulations (this will improve the signal/noise ratio) Then you have 2 possibilities: - The icon  : is a spectrum adjustment, so it can help you to maximize the signal (the new spectrum refreshes the old one and so on...). No repeated accumulations or extended spectral ranges are acquired. - If you press the icon  it will make a spectrum accumulation and stop.

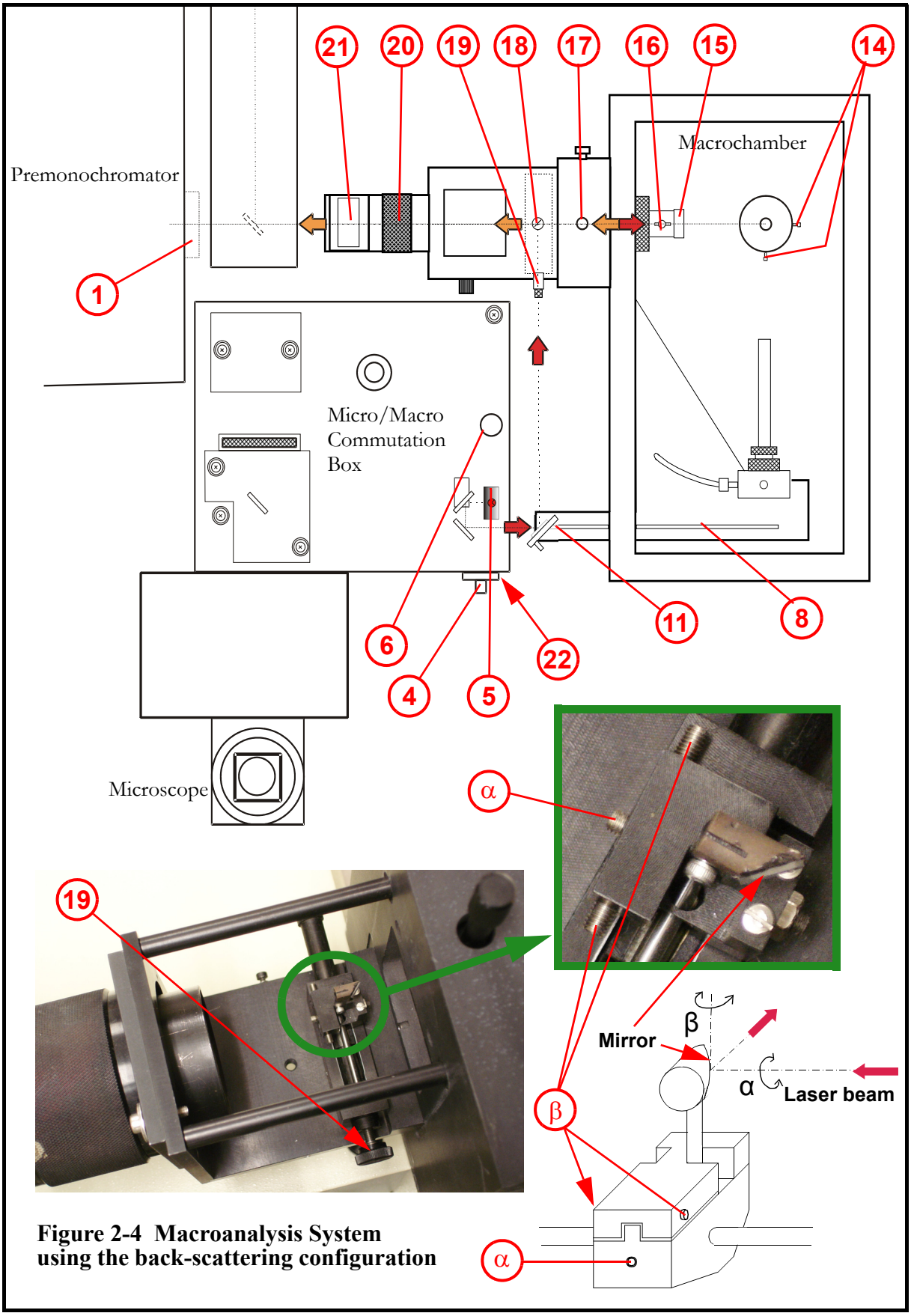


Figure 2-4 Macroanalysis System using the back-scattering configuration

1. Premonochromator Entrance Slit
2. Filter holder (scattered beam), see figure 2-2, page 57
3. Beam splitter, see figure 2-2, page 57
4. Laser Filter wheel with 6 neutral density filters
5. Laser vertical entrance axis
6. Micro/Macro commutation knob
7. Confocal hole adjustment, see figure 2-2, page 57
8. Mirror sliding rail
9. Focusing lens sliding rail
10. Entrance optics XZ adjustments
11. Mirror
12. Focusing lens adjustment
13. Focusing lens adaptor
14. XYZ sample holder adjustment
15. Collecting lens adaptor
16. Collection lens focusing adjustment
17. XY adjustment
18. Back-scattering mirror
19. Back-scattering selector with the fine tune knob
20. Transfer optics to entrance slit focusing adjustment
21. Holder for analyzer, half-wave or quarter wave plates
22. Access to entrance filters holder

CHAPTER 3

Appendix

This chapter lists the Options and Accessories available for T64000 System. This list is not exhaustive. Please ask us for an accessory you have not found here.

REFERENCE	DESCRIPTION
	1- BASIC INSTRUMENT
T-64000	Basic T64000 configuration *(see description below)* **BASIC CONFIGURATION INCLUDING:** • Entrance double stage monochromator in a subtractive mount including: • 1 manual axial entrance slit 0 - 2 mm with a height limiter • 1 manual intermediate slit 0 - 50 mm with a height limiter • 2 fixed mirrors on each side of the intermediate slit • 1 fixed mirror in front of the exit slit (lateral entrance slit of spectrograph stage) • 1 horizontal shaft with 2 gratings cassette holders • 1 set of aberration corrected holographic gratings 76 x 76 mm 1800 gr/mm **Spectrograph stage including:** • 1 manual lateral entrance slit 0 - 25 mm with a height limiter • 1 horizontal shaft with a grating cassette holder • 1 aberration corrected holographic grating 76 x 76 mm 1800 gr/mm in a cassette • 1 top exit for a multichannel detector **New Spectra Link Controller delivered with:** • 2 Motor Driver (MDR) boards for controlling the scanning of the 2 monochromators (Refer to 2.3.3. for electronics extensions) • 1 computer interface card **LABSPEC Software** LabSpec Software developed for Windows, supplied with two computer package dongles, permitting multichannel and monochannel detection, data acquisition, Raman mapping and a wide range of data treatment and storage options. This software also includes macro programming capabilities.
	2- OPTIONS
	2.1 Entrance Double stage options
	2.1.1 Manual lateral entrance slit

T-LAT-ENT-SLIT-S1	Manual lateral entrance slit. Includes a 0-2 mm slit with a height limiter and a motorized commutation mirror. *Requires the Commutation card (item T-COM)*
T-SMA-SLIT-ADAPT	Fiber adaptor to be mounted on any T64000 entrance slit.With SMA connector. Allows to focus on a slit equipped or not with a CCD shutter with a 4X magnification visible optics
T-FC-SLIT-ADAPT	Fiber adaptor to be mounted on any T64000 entrance slit.With FC adaptor.Allows to focus on a slit equipped or not with a CCD shutter with a 4X magnification visible optics
	2.1.2 Intermediate slit 0 - 50 mm
T-INT-SLIT-S1S2	Motorization of the width of the slit including stepping motor adaptation supplied with MDR motor driver board and cable.
T-SAS	Stokes-Anti Stokes accessory. Replaces height limiter with central masks 1, 2 and 4mm wide for blocking the laser beam in the center of the range collected on the multichannel detector
	2.1.3 Sets of 2 gratings, delivered prealigned in cassettes
T-RG300-XXX-DS	300 gr/mm ruled gratings, XXX=blaze wavelength in nm [500, 600 or 1000]
T-RG600-XXX-DS	600 gr/mm ruled gratings, XXX=blaze wavelength in nm [300, 400, 500, 630, 750 or 1000]
T-ACHG600-XXX-DS	600 gr/mm blazed aberration corrected holographic gratings, XXX= correction wavelength in nm [500, 750]
T-BHG600-500-DS	600 gr/mm blazed holographic gratings (at 500 nm)
T-ACHG900-750-DS	900 gr/mm blazed aberration-corrected holographic gratings (at 750 nm)
T-BHG1200-XXX-DS	1200 gr/mm blazed holographic gratings, XXX=blaze wavelength in nm [330, 500, 630, 750 or 900]
T-HG1800-DS	1800 gr/mm standard holographic gratings (450 - 850 nm)
T-BHG1800-XXX-DS	1800 gr/mm blazed holographic gratings, XXX=blaze wavelength in nm [250,400, 500]
T-BHG2400-XXX-DS	2400 gr/mm blazed holographic gratings, XXX=blaze wavelength in nm [250, 330 or 400]
T-HG3600-DS	3600 gr/mm standard holographic gratings (200 - 450 nm)
	2.1.4 Double Additive configuration adaptation
T-ADD-ADAPT	Includes 2 manual intermediate slits (0 -10 mm) and motorized commutation mirrors. *-Requires the Commutation card (item T-COM.)* -Requires the Double Additive mount for using the instrument in the triple additive dispersion configuration (item T-ADDMOUNT)
	2.1.5 Viewers (Permit to check the image of the entrance slit to maximize the alignment of sample)
T-SCR-VIEW	Viewer for Visible range supplied with a viewing screen
T-VIDEO-VIS-VIEW	Viewer for Visible range supplied with a C mount (adapted to most color or black and white video cameras). Supplied with density filters attachment *(camera not included)*
T-VIDEO-UV-VIEW	Viewer for UV- Visible range, down to 240 nm supplied with a C mount (adapted to most color or black and white video cameras). Supplied with density filters attachment *(camera not included)*
USB CAMERA	Color camera 1280x1024 pixels with cable
	2.1.6 Manual axial exit slit of the second stage
T-EX-SLIT-S2	Manual axial exit slit of the second stage. Includes a 0-2 mm slit with a height limiter and a motorized commutation mirror. *Requires the Commutation card (item T-COM.)*

	2.2 Spectrograph stage options
	2.2.1 Additional gratings, delivered prealigned in cassettes
T-RG300-XXX-SP	300 gr/mm ruled grating, XXX=blaze wavelength in nm [500, 600 or 1000]
T-RG600-XXX-SP	600 gr/mm ruled grating, XXX=blaze wavelength in nm [300, 400, 500, 630, 750 or 1000]
T-ACHG600-XXX-SP	600 gr/mm blazed aberration corrected holographic grating, XXX= correction wavelength in nm [500, 750]
T-BHG600-500-SP	600 gr/mm blazed holographic grating (at 500 nm)
T-ACHG900-750-SP	900 gr/mm blazed aberration corrected holographic grating (at 750 nm)
T-BHG1200-XXX-SP	1200 gr/mm blazed aberration corrected holographic grating, XXX=blaze wavelength in nm [330, 500, 630, 750 or 900]
T-HG1800-SP	1800 gr/mm standard holographic grating (450 - 850 nm)
T-BHG1800-XXX-SP	1800 gr/mm blazed holographic grating, XXX=blaze wavelength in nm [250,400, 500]
T-BHG2400-XXX-SP	2400 gr/mm blazed holographic grating, XXX=blaze wavelength in nm [250, 330 or 400]
T-HG3600-SP	3600 gr/mm holographic grating (200 - 450 nm)
	2.2.2 Lateral entrance slit 0-25 mm
T-INT-SLIT-S2S3	Motorization of the width of the slit including stepping motor adaptation supplied with MDR motor driver board and cable.
	2.2.3 Manual axial entrance slit
T-ENT-SLIT-S3	Manual axial entrance slit. Includes a 0-2 mm slit with a height limiter and a motorized commutation mirror. *Requires the Commutation card (item T-COM.)*
	2.2.4 Motorized 2-gratings turret
T-TUR	Motorized 2-gratings turret. Includes the motor adaptation. *Requires the Commutation card (item T-COM.)*
	2.2.5 Axial exit
T-EX-SLIT-S3	Manual axial exit slit. Includes a 0-2 mm slit with a height limiter and a motorized commutation mirror. *Requires the Commutation card (item T-COM.)*
T-MULTI-PORT	Axial Multichannel Port. Includes the multichannel detector port and a motorized commutation mirror. *Requires the Commutation card (item T-COM.)-Also see next 2 lines*
T-ADAPT1-LN-CCD	Adaptation with feet for reinforcing the stability of any HJY LN2 CCD mounted on axial exit
T-ADAPT2-LN-CCD	Adaptation with feet for reinforcing the stability of any HJY LN2 CCD mounted on axial exit when a fibre adaptor is mounted on axial entrance slit of spectrograph stage
	2.3 Accessories for the system
T-SILVCOAT	Special silvered coating on all reflective optics of the system for improving its throughput in the visible-NIR range. Only for working above 380 nm.
	2.3.1 Additive mount accessory
T-ADD-MOUNT	Additive mount accessory. *Requires the adaptation T-ADD-ADAPT*
	2.3.2 Sampling attachments
	2.3.2.1. Laser entry items
T-BENCH-1LAS	Bench at back of T64000 holding coupling optics for making lasers enter the instrument. Equipped with one fixed mirror for reflecting laser beam at 90°

T-BENCH-2LAS	Bench at back of T64000 holding coupling optics for making lasers enter the instrument. Equipped with one fixed and one swing-away mirrors
T-BENCH/FILT-2LAS	Bench at back of T64000 holding coupling optics for making lasers enter the instrument. Equipped with one fixed and one swing away mirrors together with a laser filtering column
T-MACRO-LAS-ENTRY	Laser entry attachment including laser shutter, interference filter and half-wave plate holders. Necessary for a configuration with only a macrochamber when lasers are installed at the back of the spectrometer. *(Not required when the system is delivered with a microscope as it is included in this attachment)*
T-BPF-HOLD	Holder for ½ inch bandpass filter to be used on laser beam at entrance of system equipped with a microscope or with a macro laser entry attachment (Item T-MAC-LAS-ENTRY)
BPF1-XXX	Bandpass filter for eliminating the plasma lines of the laser (XXX= 488, 514, 532, 633, 661, 785 and 830 nm). *Delivered mounted in T-BPF-HOLD*
BPF2-XXX	Bandpass filter for eliminating the plasma lines of the laser (XXX=325, 355, 364, 442, 457, 568, 647 and 1064 nm). *Delivered mounted in T-BPF-HOLD*
T-LAMBDA/2-HOLD	Holder for ½ inch half wave plate to be used on laser beam at entrance of system equipped with a microscope or with a macro laser entry attachment (Item T-MAC-LAS-ENTRY)
T-LAMBDA/2-UVB	½ inch Lambda/2 plate in holder for UVB range (250 nm) to be used on laser beam at entrance of system equipped with a microscope or with a macro laser entry attachment (Item T-MAC-LAS-ENTRY)
T-LAMBDA/2-NUV1	½ inch Lambda/2 plate in holder for NUV range (325 nm) to be used on beam at entrance of system equipped with a microscope or with a macro laser entry attachment (Item T-MAC-LAS-ENTRY)
T-LAMBDA/2-NUV2	½ inch Lambda/2 plate in holder for NUV range (350 nm) to be used on beam at entrance of system equipped with a microscope or with a macro laser entry attachment (Item T-MAC-LAS-ENTRY)
T-LAMBDA/2-VIS	½ inch Lambda/2 plate in holder for Visible range (400-700 nm) to be used on laser beam at entrance of system equipped with a microscope or with a macro laser entry attachment (Item T-MAC-LAS-ENTRY)
T-LAMBDA/2-NIR1	½ inch Lambda/2 plate in holder for NIR1 range (750 - 800 nm) to be used on laser beam at entrance of system equipped with a microscope or with a macro laser entry attachment (Item T-MAC-LAS-ENTRY)
T-LAMBDA/2-NIR2	½ inch Lambda/2 plate in holder for NIR2 range (800-900 nm) to be used on laser beam at entrance of system equipped with a microscope or with a macro laser entry attachment (Item T-MAC-LAS-ENTRY)
	2.3.2.2. Manual Macro/Micro Mirror
T-MACMIC-MIR	Manual macro/micro entry swing away mirror. Required on the laser incidence beam for commuting laser from Macrochamber to microscope when the system is equipped with both attachments
	2.3.2.3. Manual Macro/Micro/Single/Triple Commutations
T-COM-VIS-WHEEL	Manual Macro/Micro/Single/Triple commutation wheel for visible range. *Required when using both visible macrochamber and visible microscope.*
T-COM-MICRO	Manual commutation device to be used when the system is equipped with only a visible microscope for selecting either triple or single configuration
T-COM-MACRO	Manual commutation device to be used when the system is equipped with only a macrochamber for selecting either triple or single configuration

	2.3.2.4. Single monochromator options
T-SINGLE-VIS	Single monochromator option for visible range. Permits to enter directly the 3rd stage. *Requires an axial entrance slit (item T-ENT-SLIT-S3) on the spectrograph stage and either a commutation wheel (item T-COM-VIS-WHEEL) or a micro or macro commutation device (T-COM-MICRO or T-COM-MACRO)*
T-SINGLE-UV	Single monochromator option for UV-Visible range. Permits to enter directly the 3rd stage. *Requires an axial entrance slit (item T-ENT-SLIT-S3.) on the spectrograph stage*
T-SINGLE-NIR	Single monochromator option for Visible-NIR range.(up to 1500 nm) Permits to enter directly the 3rd stage. *Requires an axial entrance slit (item T-ENT-SLIT-S3.) on the spectrograph stage*
T-RF-TILTER	Rayleigh rejection filter tilting holder
T-EDG-FILT1-XXX	Dielectric Edge filter XXX = wavelength in nm [Set of wavelengths: 229 nm, 244 nm, 257 nm, 266 nm]
T-EDG-FILT2-XXX	Dielectric Edge filter XXX = wavelength in nm [Set of wavelengths: 325 nm, 355 nm, 364 nm, 442 nm, 457 nm, 473 nm, 568 nm]
T-EDG-FILT3-XXX	Dielectric Edge filter XXX = wavelength in nm [Set of wavelengths: 488 nm, 514 nm, 532 nm, 632 nm, 752 nm, 785 nm, 830 nm]
T-SHN-FILT1-XXX	Super Notch+ filter for XXX = wavelength in nm [Set of wavelengths 473 nm, 568 nm, 752 nm, 830 nm, 860 nm, 1064 nm]
T-SHN-FILT2-XXX	Super Notch+ filter for XXX = wavelength in nm [Set of wavelengths: 442 nm, 633 nm, 647 nm, 785 nm]
T-SHN-FILT3-XXX	Super Notch+ filter for XXX = wavelength in nm [Set of wavelengths: 457 nm, 488 nm, 514 nm, 532 nm]
T- SMA-ADAPT-SINGLE	Fiber adaptor on the single monochromator option mirror attachment.With SMA connector. Allows to focus on the axial entrance slit of spectrograph stage with a 4X magnification optics
T- FIB-ADAPT-SINGLE	Fiber adaptor on the single monochromator option mirror attachment. With FC connector. Allows to focus on the axial entrance slit of spectrograph stage with a 4X magnification optics
	2.3.2.5. Confocal microanalysis attachments and accessories/options
	2.3.2.5.1 Confocal microanalysis attachments

T-VIS-MICRO	Visible confocal microanalysis attachment for punctual analysis delivered with: - Laser entry attachment including laser shutter, and interference filter and half-wave plate holders - An XY manual mechanical stage - A Koehler illumination for reflected white light over wide field - An internal illumination for transmitted white light supplied with an Abbe condenser - A revolver equipped with 3 plan achromatic objectives: - 10X visible, NA = 0.25, WD = 10.6 mm - 50X visible, NA = 0.75, WD = 0.37 mm - 100X visible, NA = 0.9, WD = 0.21 mm - White light illumination by transmission through Abbe condenser - A high definition 1280x1024 pixels USB colour camera for simultaneously visualising the sample under white light illumination and the laser spot - A continuously manually adjustable confocal pinhole from several microns to 1.2 mm to define with accuracy the size of the analysed volume. - Coupling optics to focus the Raman beam on the entrance slit of the spectrograph (lens system) - A visible half wave plate and analyser on Raman beam - A filter wheel with 6 neutral density filters (0.3, 0.6, 1, 2, 3 and 4)
T-VIS-OPEN-MICRO	Open Visible confocal microanalysis attachment for punctual analysis delivered without any bottom frame for offering a totally free space below the objectives. Delivered with: - Laser entry attachment including laser shutter, and interference filter and half-wave plate holders - An XY manual mechanical stage - A Koehler illumination for reflected white light over wide field - A revolver equipped with 3 plan achromatic objectives: - 10X visible, NA = 0.25, WD = 10.6 mm - 50X visible, NA = 0.75, WD = 0.37 mm - 100X visible, NA = 0.9, WD = 0.21 mm - White light illumination by transmission through Abbe condenser - A high definition 1280x1024 pixels USB colour camera for simultaneously visualising the sample under white light illumination and the laser spot - A continuously manually adjustable confocal pinhole from several microns to 1.2 mm to define with accuracy the size of the analysed volume. - Coupling optics to focus the Raman beam on the entrance slit of the spectrograph (lens system) - A visible half wave plate and analyser on Raman beam - A filter wheel with 6 neutral density filters (0.3, 0.6, 1, 2, 3 and 4)

T-LINE-SCAN-MICRO	Visible confocal microanalysis attachment for punctual and line scanning analysis. Delivered with: - Laser entry attachment including laser shutter, and interference filter and half-wave plate holders - Confocal Line scanning attachment including 2 scanners vibrating for illuminating a line on sample and imaging it on the entrance slit of the spectrometer - An XY manual mechanical stage - A Koehler illumination for reflected white light over wide field - An internal illumination for transmitted white light supplied with an Abbe condenser - A revolver equipped with 3 plan achromatic objectives: - 10X visible, NA = 0.25, WD = 10.6 mm - 50X visible, NA = 0.75, WD = 0.37 mm - 100X visible, NA = 0.9, WD = 0.21 mm - White light illumination by transmission through Abbe condenser - A high definition 1280x1024 pixels USB colour camera for simultaneously visualising the sample under white light illumination and the laser spot - A continuously manually adjustable confocal pinhole from several microns to 1.2 mm to define with accuracy the size of the analysed volume. - Coupling optics to focus the Raman beam on the entrance slit of the spectrograph (lens system) - A visible half wave plate and analyser on Raman beam - A filter wheel with 6 neutral density filters (0.3, 0.6, 1, 2, 3 and 4)
T-UV/VIS-MICRO	UV-Visible confocal microanalysis attachment for punctual analysis. Delivered with: - Laser entry attachment including laser shutter, and interference filter and half - Laser entry attachment including laser shutter, and interference filter and half-wave plate holders - An XY manual mechanical stage - A Koehler illumination for reflected white light over wide field - An internal illumination for transmitted white light supplied with an Abbe condenser - A revolver equipped with 3 plan achromatic objectives: - 10X visible, NA = 0.25, WD = 10.6 mm - 50X visible, NA = 0.75, WD = 0.37 mm - 100X visible, NA = 0.9, WD = 0.21 mm - White light illumination by transmission through Abbe condenser - A high definition 1280x1024 pixels USB colour camera for simultaneously visualising the sample under white light illumination and the laser spot - A continuously manually adjustable confocal pinhole from several microns to 1.2 mm to define with accuracy the size of the analysed volume. - Achromatic coupling optics to focus the Raman beam on the entrance slit of the spectrograph (mirror design) - A visible half wave plate and analyser on Raman beam - A filter wheel with 6 neutral density filters (0.3, 0.6, 1, 2, 3 and 4)

T-UV/VIS-OPEN-MICRO	Open UV-Visible confocal microanalysis attachment for punctual analysis. Delivered with: - Laser entry attachment including laser shutter, and interference filter and half-wave plate holders - An XY manual mechanical stage - A Koehler illumination for reflected white light over wide field An internal illumination for transmitted white light supplied with an Abbe condenser - A revolver equipped with 3 plan achromatic objectives: - 10X visible, NA = 0.25, WD = 10.6 mm - 50X visible, NA = 0.75, WD = 0.37 mm - 100X visible, NA = 0.9, WD = 0.21 mm - White light illumination by transmission through Abbe condenser - A high definition 785x480 pixels USB colour camera for simultaneously visualising the sample under white light illumination and the laser spot - A continuously manually adjustable confocal pinhole from several microns to 1.2 mm to define with accuracy the size of the analysed volume. - Achromatic coupling optics to focus the Raman beam on the entrance slit of the spectrograph (mirror design) - A visible half wave plate and analyser on Raman beam - A filter wheel with 6 neutral density filters (0.3, 0.6, 1, 2, 3 and 4)
T-ADAPT-MICRO-INV-VIS	Adaptation of an inverted IX71 inverted microscope replacing the standard BX41 model on the spectrometer. The microscope is hardly coupled to the spectrograph on the same work bench for maximum mechanical stability and ease of use. The standard version includes: white light illumination by reflection and transmission, a binocular, one condenser IX2-LWUCD/0.55 WD = 27 mm, one colour video camera on top of the binocular, two objectives UPFL 20X/0.50 and UPFL 40X/0.75 corrected for viewing through a slide. All standard options of IX71, including a large range of objectives, are available on request.
T-ADAPT-MICRO-INV-UV	Adaptation of an inverted IX71 inverted microscope replacing the standard BX41 model on the spectrometer. The microscope is hardly coupled to the spectrograph on the same work bench for maximum mechanical stability and ease of use. The standard version includes: white light illumination by reflection and transmission, a binocular, one condenser IX2-LWUCD/0.55 WD = 27 mm, one colour video camera on top of the binocular, two objectives UPFL 20X/0.50 and UPFL 40X/0.75 corrected for viewing through a slide. All standard options of IX71, including a large range of objectives, are available on request.
	2.3.2.5.2 Microscope accessories
IL-TR-BXFM	White light device for illumination by transmission for BXFM microscope
IL-TR-KO-BXFM	White light Koehler device for illumination by transmission for BXFM microscope
MOT-OBJ-REV	Motorized objective revolver
	2.3.2.5.3 Objectives
	Visible= 400-800 nm, NUV= 325-500 nm, UVB= 240-360 nm, NIR>800 nm, NA= Numerical Aperture, WD= Working Distance, (LWD= Long Working Distance, ULWD= Ultra Long Working Distance)
OBJ15XUVB	15X UVB objective, NA = 0.32, WD = 8.5 mm
OBJ40XUVB	40X UVB objective, NA = 0.50, WD = 1 mm
OBJ15XNUV	15X NUV objective, NA = 0.32, WD = 8.5 mm
OBJ40XNUV	40X NUV objective, NA = 0.50, WD = 1 mm

OBJ60XNUVFL	60X objective, 350-950 nm, NA = 0.90, WD = 0.2 mm
OBJ5XVIS	5X visible objective, NA = 0.10, WD = 19.6 mm
OBJ10XVIS	10X visible objective, NA = 0.25, WD = 10.6 mm
OBJ50XVIS	50X visible objective, NA = 0.75, WD = 0.37 mm
OBJ100XVIS	100X visible objective, NA = 0.90, WD = 0.21 mm
OBJ50XLWDVIS	50X LWD visible objective, NA = 0.50 WD = 10.6 mm
OBJ50XULWDVIS	50X ULWD visible objective, NA = 0.45 WD = 17 mm
OBJ100XLWDVIS	100X LWD visible objective, NA = 0.80 WD = 3.4 mm
OBJ10XNIR	10X NIR objective, NA = 0.30, WD = 11 mm
OBJ50XNIR	50X NIR objective, NA = 0.80, WD = 0.5 mm
OBJ100XNIR	100X NIR objective, NA = 0.90, WD = 0.28 mm
OBJ50XLWLNIR	50X LWD NIR objective, NA = 0.55, WD = 8 mm
OBJ100XLWDNIR	100X LWD NIR objective, NA = 0.75, WD = 4.7 mm
MACRO/CH-VIS	Visible macro lens of 40 mm focal length on an horizontal exit equipped with a 10mm x 10mm cell holder for Visible range, provided with a spherical back mirror to get a multipass effect. The signal intensity can be increased by more than a factor 3 with clear liquids.
MACRO/CH-UV	UV macro lens of 40 mm focal length on an horizontal exit equipped with a 10mm x 10mm cell holder for UV range, provided with a spherical back mirror to get a multipass effect. The signal intensity can be increased by more than a factor 3 with clear liquids.
	2.3.2.5.4 Microscope Raman polarisation components
T-LAMBDA/2-MICRO-UVB	
T-LAMBDA/2-MICRO-NUV	
T-LAMBDA/2-MICRO-VIS	
T-LAMBDA/2-MICRO-NIR1	
T-LAMBDA/2-MICRO-NIR2	
T-LAMBDA/4-MICRO-UVB	
T-LAMBDA/4-MICRO-NUV	
T-LAMBDA/4-MICRO-VIS	
T-LAMBDA/4-MICRO-NIR1	
T-LAMBDA/4-MICRO-NIR2	

T-SCR-MICRO	
T-POL-MICRO- UVB	
T-POL-MICRO- NUV	
T-POL-MICRO- VIS	
T-POL-MICRO- NIR1	
T-POL-MICRO- NIR2	
	2.3.2.5.5 Microscope Mapping Options
XY75x50	XY motorised stage, X = 75 mm - Y = 50 mm for BX41 and BXFM microscopes - step size = 0.1 µm. Including positioning joystick, controller, computer interface card, drive electronics and software. Allows automated positioning of samples and acquisition of Raman maps.
T-AUTOFOC-VIS-P	Visible autofocus device (400 nm - 800 nm) to be used with a Piezo stage. Including the necessary opto-mechanical attachment and detection system for controlling the focus at the surface of the sample with accuracy and speed. Ideal for automated mapping analysis of rough samples. Requires one of the piezo stages described hereafter.
T-AUTOFOC-VIS-M	Visible autofocus device (400 nm - 800 nm) to be used with a motorized Z stage. Including the necessary opto-mechanical attachment and detection system for controlling the focus at the surface of the sample with accuracy and speed. Ideal for automated mapping analysis of rough samples. Only required when no autofocus for a piezo stage is included. Requires a motorized Z stage.
T-AUTOFOC-UV-P	UV autofocus device (330 nm - 360 nm) to be used with a Piezo stage. Including the necessary opto-mechanical attachment and detection system for controlling the focus at the surface of the sample with accuracy and high speed. Ideal for automated mapping analysis of rough samples. Requires one of the piezo stages described hereafter.
T-AUTOFOC-UV-M	UV autofocus device (330 nm - 360 nm) to be used with a motorized Z stage. Including the necessary opto-mechanical attachment and detection system for controlling the focus at the surface of the sample with accuracy and high speed. Ideal for automated mapping analysis of rough samples. Only required when no autofocus for a piezo stage is included. Requires a motorized Z stage
T-PIEZOZ100	Piezo Z stage. Maximum Z displacement = 80 µm (+/-40µm) including a servo control loop for maximizing precision of positioning. The minimum step size and precision is 0.1 micron. The unit is screwed on the microscope objective revolver and is compatible with all the objectives. Requires an IEEE card
T-PIEZOZ350	Piezo Z stage. Maximum Z displacement = 300 µm (+/-150µm) including a servo control loop for maximizing precision of positioning. The minimum step size and precision is 0.1 micron. The unit is screwed on the microscope objective revolver and is compatible with all the objectives. Requires an IEEE card
T-ZMOT	Micrometric motorised Z stage: the maximum distance of movement depends on the objective working distance. The minimum step size is 0.5 micron. The movement is controlled by software or by joystick. Requires a motorized XY stage
T-ZMOT-ELEC	Micrometric motorised Z stage: the maximum distance of movement depends on the objective working distance. The minimum step size is 0.5 micron. The movement is controlled by software or by joystick. To be ordered when no XY motorized stage is included in the configuration
	2.3.2.5.6- Microscope Off-Axis Option

T-OFF AXIS-ILLUM	Off-axis Laser illumination system. Laser is directed onto the sample from the T64000 coupling optics and not through the microscope objective allowing a higher rejection of the reflected laser beam on sample. Angle is adjustable between approximately 90° and 65°. Signal collection via a microscope objective 50XULWD and excitation via a lens of 15.8mm focal length
	2.3.2.6. Macro sample attachment
	Will not require the laser entry attachment (item T-LAS-ENTRY) and the macro/micro entry swing away mirror (item T-MACMIC) when there is no microscope. The entry of the laser will then be directed at level of the chamber axis and will only require the shutter and filter attachment (item T-MACRO-ENTRY)
T-MACRO-VIS	Visible macro sample chamber. Permits to excite the sample under variable angle from 90° to back scattering. - XYZ sample holder - solid sample plattform - analyser and half wave plate on collecting beam - glass collection optics F = 80 mm and glass focusing optics F = 100 mm - back scattering mirror (does not include back collecting mirrors and Liquid cell with holder)
T-MACRO-UV	UV-Visible macro sample chamber. Permits to excite the sample under variable angle from 90° to back scattering. - XYZ sample holder - solid sample plattform - analyser and half wave plate on collecting beam - silica collection optics F = 80 mm and silica focusing optics F = 100 mm - back scattering mirror (does not include back collecting mirrors and liquid cell with holder)
T-MACRO-PERISCOPE	Laser periscope for lifting the beam of a laser installed at the front of the system up to the level of the entrance axis of the macrochamber
T- MACRO-ENTRY	Macrochamber attachment with laser shutter, interference filter and half wave plate holders. To be used at entrance of the macrochamber when no laser entry (T-LAS-ENTRY) is on the system
T-FOC-LENS-200	Macrochamber glass focusing optics F = 200 mm
T-FOC-LENS-150	Macrochamber glass focusing optics F = 150 mm
T-FOC-LENS-30	Macrochamber glass focusing optics F = 30 mm
T-COL-LENS-160	Macrochamber glass collection optics F = 160 mm
T-COL-LENS-30	Macrochamber glass collection optics F = 30 mm
T-BACK-COL-MIR	Macrochamber back collecting mirrors
T-CELL-HOLDER	Macrochamber liquid cell holder (liquid cell not included)
T-FURNACE	Macrochamber furnace for solid samples (up to 400°C)
T-GONIO	Macrochamber goniometric head
T-CAPILLARY	Macrochamber capillaries holder (diameter below 2 mm) and tube holder (diameter 6 mm)
T-SCRAMBLER	Macrochamber scrambler in its holder
T-GAS CELL	Macrochamber gas cell (windows perpendicular to laser beam)
T-SPIN CELL	Macrochamber spinning cell for powers and liquids
T-METTLER TUBES	Macrochamber package of 150 Mettler tubes

T-LIQUID CELL	Macrochamber liquid cell 0.3 cc
	2.3.3 Electronics extensions
T-COM CARD	Commutation card with cables
T- MONO CARD	Monochannel detection card and necessary cables including a high voltage power supply programmable from 0 up to 2000 V and a photon counting acquisition module with cable
	2.3.4 Monochannel detection system parts
T-PMTADAPT	Adaptor on axial exit slit of spectrograph stage for LCT50 PMT housing
T-AMPDISC	Amplifier discriminator and cable
T-ASGA PMT	AsGa photocathode PMT (noise below 10 cps) (PN 43.921.349)
T-PMT HOUSING	PMT cooled housing
	2.3.5 Computerization of system
T-COMPUTER	Pentium Computer
T-PRINTER	Color printer with cable
	2.3.6 Multichannel/CCD detectors
T-TE-0E-1024x256	MPP (MultiPin Phase) air cooled open electrode 1024x256 pixels CCD. Working from 200 up to 1050 nm with a quantum efficiency > 30% between 500 nm and 800 nm. Pixel size: 26 x 26 µm. Chip size: 26.6 x 6.7 mm. Typical read out noise: 4 ē/pixel. Dark noise: < 0.002 ē/pixel/sec at -70°C
T-TE-BIUV-2048x512	MPP air cooled UV-Visible Back Illuminated 2048x512 pixels CCD. Working from 220 up to 700 nm with a quantum efficiency > 40% between 220 and 400 nm and > 60% above. Pixel size: 13,5 x 13,5 µm. Chip size: 27,65 x 6,91 mm. Typical read out noise: 3 ē/pixel. Dark noise: < 0.002 ē/pixel/sec at -70°C
T-LN-OE-1024x256	MPP LN_2 cooled open electrode 1024x256 pixels CCD. Working from 200 nm to 1050 nm with a quantum efficiency > 40% between 200 nm and 900 nm. Pixel size: 26 x 26 µm. Chip size: 26.6 x 6.7 mm. Typical read out noise: 4 ē/pixel. Typical dark noise: 0.5 ē/ pixel/hr at -133°C. Including a 3L LN_2 Dewar for 72hr autonomy.
T-LN-BIDD-1024x256	MPP LN_2 cooled Back Illuminated Deep Depleted 1024x256 pixels CCD. Working from 300 nm to 1050 nm with a quantum efficiency of 90% at 800nm and > 60% between 500 nm and 900 nm. Pixel size: 26 x 26 µm,. Chip size: 26.6 x 6.7 mm. Typical read out noise: 4 ē/pixel. Typical dark noise: 2 ē/pixel/hr at -133°C. Including a 3L LN_2 Dewar for 72hr autonomy.
T-LN-BIUV-1024x256	MPP LN_2 cooled Back Illuminated 1024x256 pixels CCD. Working from 200 nm to 700 nm with a quantum efficiency > 50% between 250 nm and 700 nm. Pixel size: 26 x 26 µm. Chip size: 26.6 x 6.7 mm. Typical read out noise: 5 ē/pixel. Typical dark noise: 0.3 ē/ pixel/hr at -133°C. Including a 3L LN_2 Dewar for 72hr autonomy.
T-LN-BIUV-2048x512	MPP LN_2 cooled Back Illuminated 2048x512 pixels CCD. Working from 200 nm to 700 nm with a quantum efficiency >50% between 250 nm and 700 nm. Pixel size: 13.5 µm. Chip size: 27.65 x 6.91 mm. Typical read out noise: 3 ē/pixel. Typical dark noise: 0.3 ē/ pixel/hr at -133°C. Including a 3l LN_2 Dewar for 72hr autonomy.
T-LN-IGA512x1-50	LN_2 cooled Linear InGaAs array detector of 512 pixels. Working from 800 nm to 1550 nm with a quantum efficiency of 80% between 1000 nm and 1500 nm. Pixel size: 50 µm x 500 µm. Array length: 25.60 mm. Read out noise: 900-1000 ē/pixel (High Sensitive Mode (HiS)) or 9000-10000 ē rms (High Dynamic Range Mode (HiD)). Fixed pattern noise: < 1,5 kē /sec at 133 °C. Including a 3L LN_2 Dewar for 72hr autonomy.

T-SHUTTER	CCD shutter mounted on axial entrance slit supplied with electronics (23880142) and cable (41195032)
T-ADDSHUTTER	Additional CCD shutter (required on every other entrance slit)

CHAPTER 4

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