TELEDYNE
PHOTON MACHINES
Everywhereyoulook™

Analyte G2 Excimer Laser Ablation System

Site Preparation Guide

Manual Part Number 6100-0003 Rev 2.6

Product Overview

The Analyte G2 excimer laser ablation system is a complete, high performance, excimer laser ablation workstation in a compact package that is designed for high energy density 193 nm operation. All materials required for interfacing with an ICP-MS are provided, except for the laser gases, the carrier gases, and their respective containers with pressure regulators.

This document describes how to prepare your laboratory for the Analyte G2. Please review this document in its entirety and provision for the Analyte G2 prior to its arrival.

The Analyte G2 laser ablation system will arrive in a single wooden crate measuring 135 x 80 x 160 cm that weighs 584 kg gross. A pallet jack or forklift is required. Move the crate to a dry, clean area immediately upon arrival and maintain room temperature. Installation is performed by trained service engineers from Teledyne Photon Machines.

Safety Considerations

Before the Analyte G2 arrives, all laboratory personnel should become familiar with this safety information. Your organization may also have specific requirements; provide this information to the person responsible for laser safety (this person is usually called a Laser Safety Officer).

Overview

WARNING	INJURY HAZARD **The Analyte G2 contains internal components that present severe electrical and radiation hazards. Improper operation or servicing can result in death, blindness, other injury or material damage. Only qualified personnel should operate or service this equipment.**

It is important to read the following safety precautions in detail to prevent bodily injury and damage to the Analyte G2 laser ablation system or any interfacing devices. Use only as specified.

Potential health and safety hazards are discussed in greater detail in the remainder of this section, including but not limited to:

- Eye Damage from Direct or Reflected Laser Beam Exposure
- Skin Damage, including increased risk of cancer, from Direct or Reflected Laser Beam Exposure
- Fire Danger from Laser Beam and Electrical Components
- Electrical Shock Hazard
- Inhalation Hazard and Stored Energy Hazard from Compressed Gases

Laser light poses safety hazards that are not associated with conventional light sources. Special precautions must be observed when operating, maintaining, or servicing the Analyte G2. The safe use of high-powered lasers requires that each operator be fully trained and that all personnel working in proximity to the laser are aware of the dangers involved.

Teledyne Photon Machines assumes no liability related to use of this product.

Optical Safety

Lasers are classified by the US Food and Drug Administration according to the health hazards associated with exposure to their emitted beam, based on power and wavelength. Class 1 lasers are considered eye-safe and require no special safety measures during operation or maintenance. Class 4 lasers can produce instantaneous and permanent blindness or serious injury to the eye or skin and require stringent safety measures during operation and maintenance. The Analyte G2 falls under both of these categories, depending on the mode in which it is used.

The Analyte G2 utilizes excimer laser sources which can produce high-intensity laser beams in the ultraviolet (UV) portion of the spectrum. The specific wavelengths produced is 193 nm.

The Analyte G2 meets the requirements for Class I laser device when all panels are closed. Safety interlocks prevent operation with panels opened or removed. To ensure safe operation, the interlocks must never be defeated. With any portion of the housing removed, or the sample chamber removed or disassembled, the Analyte G2 can emit Class 4 laser radiation.

WARNING	INVISIBLE RADIATION HAZARD **Infrared and ultraviolet radiation are invisible, so the hazard they present is not immediately obvious. Direct or reflected exposure to infrared, visible, or ultraviolet laser beams can cause blindness or vision impairment without warning. Reflected energy can be dangerous whether specular or diffuse. It is extremely important that anyone who might be exposed to direct or reflected Class 4 laser radiation wear suitable safety glasses.**

Skin Exposure Safety

Laser radiation is a high-intensity beam of well-collimated light that can propagate substantial distances without substantial loss of intensity. The radiation emitted is non-ionizing under normal circumstances, but can cause thermal damage to tissue due to radiation absorption. Generally, the maximum permissible radiation exposure for skin is several times greater than for the eye. Safety measures with regard to radiation hazards are therefore based mainly on dangers to the eye, but exposure to the skin should be carefully avoided as well.

Direct or reflected laser radiation can cause burns as well as an increased risk of cancer.

WARNING	INJURY HAZARD **Use the system only when all safety features are working. When operated as designed with the laser enclosure closed, the Analyte G2 meets Class 1 laser safety requirements and so requires no special precautions. However, the device contains internal components categorized as Class 4. Conformance to Class 1 is maintained by design features and safety systems which normally prevent exposure to these hazards. The Analyte G2 is a Class 4 device when these features are disabled or inoperative.**

Fire Safety

The energy of the excimer lasers used in the Analyte G2 at any of the wavelengths involved is sufficient to produce a spark or explosion hazard if directed carelessly. The laser beam or its reflection can ignite combustible or volatile substances such as solvents. If non-oxidizing gas purge is used, the purge gases will generally prevent combustion in the sample chamber, and the safety features built into the Analyte G2 should prevent laser energy from propagating outside the device.

Electrical Safety

There are no user-serviceable electrical parts in the laser power supplies or other components of the Analyte G2. The manufacturer must carry out service procedures on power supply electronics. General rules of electrical safety should be followed at all times. Most maintenance procedures which require removal of portions of the protective housings, such as cleaning optical components, require no operation of the Analyte G2 laser system and they should be conducted only after the following steps are completed:

1. Turn the laser system off.
2. Unplug the AC power cord at both ends and remove it.
3. Allow 5 minutes for the internal capacitors to discharge.

WARNING	ELECTROCUTION HAZARD The laser head and power supply of the Analyte G2 contain electrical circuits operating at lethal levels of voltage and current. Do not operate the laser system with either power supply or laser head covers removed except during maintenance procedures described in this manual.

Compressed Gas Safety

WARNING	**INHALATION HAZARD** **The laser ablation system uses pressurized gas containing fluorine, which is toxic and corrosive and may cause serious injury if inhaled. Provide adequate ventilation at all times. Learn and follow your laboratory's safety policy for caustic gases. If a gas release is suspected, do not enter the room without protective equipment including self-contained breathing apparatus.**

WARNING	**COMPRESSED GAS HAZARD** **All compressed gases are potentially hazardous because of the high pressure stored inside the cylinder. A sudden release of pressure can cause injuries by propelling a cylinder or whipping a line. This product is intended for use only by qualified operators who have been trained in safe laboratory practices and compressed gas handling.**

Safety Features

The following safety features are incorporated into the Analyte G2 and conform to government regulations to provide safe laser operation. With any safety issues, please contact Teledyne Photon Machines for resolution of difficulties or assistance with repairs.

Beam Delivery Housing

The standard Analyte G2 excimer laser beam is entirely enclosed by a protective housing which prevents access to radiation in excess of Class I limits and blocks stray radiation. The excimer laser beam exits the laser into the light-tight safety enclosure and is fully contained. The enclosure has redundant interlocks which should not be defeated. If a defect in the enclosure or the interlocks is suspected, operation should not continue until the defect is repaired.

Laser Housing

The electrical components associated with the excimer laser used in Analyte G2 are enclosed in a protective housing that limits exposure to dangerous electrical hardware. The covers should be removed only by trained personnel performing maintenance.

Interlocks

The Analyte G2 features the following interlocks which prevent operation in specific unsafe conditions:

- Remote Interlock Tripped – This interlock allows the user to disable the system based on some remote triggering event, such as a door opening. The use of this interlock is optional.
- Translucent Safety Shield – The interlock secured to the safety shield will activate whenever the safety shield is opened or removed.

Applicable Regulations

Laser Classification

Government standards and regulations specify that laser-based products be classified according to the output power or energy, and laser wavelength. The standard Analyte G2 is supplied as a Class 1 device, while non-standard configurations are available as Class 4 devices. These non-standard systems are identified by model numbers other than those covered by this manual and will be clearly labeled as Class 4 devices.

In either case, the excimer laser incorporated into the Analyte G2 is classified as Class IV based on 21 CFR, subchapter J, part II, section 1040-10(d) and Class 4 based on EN 60825-1, Clause 9 of the European Community Standards.

General Laser Safety

Teledyne Photon Machines recommends that laser users become more familiar with laser safety practices and the applicable regulations than is possible by reading this manual. The American National Standards Institute (ANSI) publishes a good overview titled 'American National Standard for the Safe Use of Lasers' (ANSI Z136.1-2014). This publication provides recommendations for the safe use of lasers and laser systems that operating at wavelengths between 180 nm and 10 µm. The publication is available from:

Laser Institute of America
12424 Research Parkway, Suite 125
Orlando, FL 32826
(407) 380-1553
www.laserinstitute.org/publications/safety_bulletin/laser_safety_info/

Site Requirements

Environment

The Analyte G2 is an analytical instrument intended for use in a laboratory environment. Dust and humidity can result in degradation of the optical components having an adverse effect on the performance of the system. Maintain humidity of < 60%.

For optimal performance room temperature should be kept within 68° to 75° Fahrenheit (20° to 24° Celsius).

Electrical

The Analyte G2 requires a single power cord. The power supply is fused and power distribution to all electronics is internal to the system.

The power outlet should be located within 2 meters of the system.

NOTE

Please indicate the preferred connector type when you schedule installation. There are various configurations; if you do not specify a connector type, the power cable will be sent with the standard connector shown below.

POWER: 210 to 240 VAC

50/60 Hz

10A

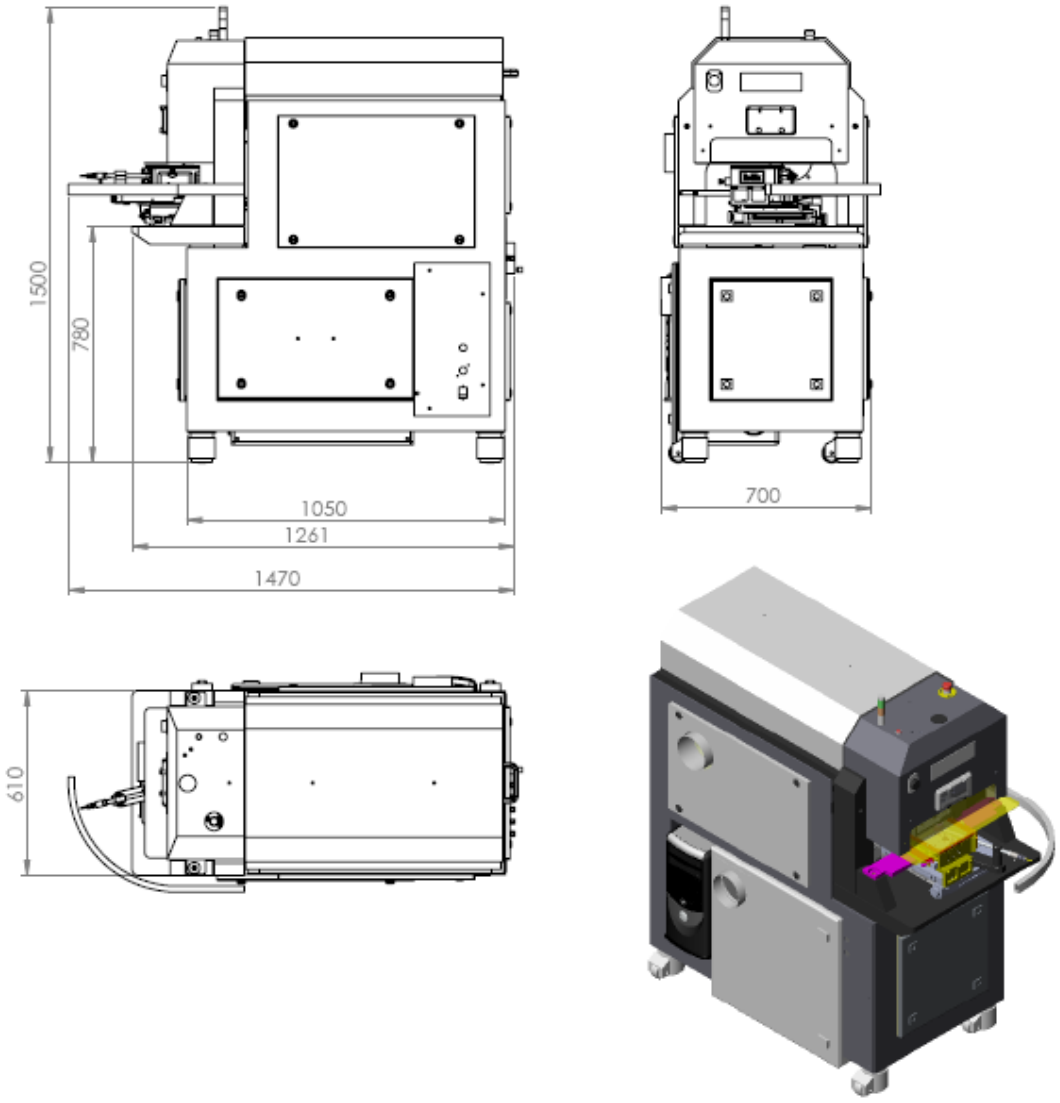
STANDARD U.S. CONNECTOR – 3 pole, L6-20P NEMA (specify alternative connector if needed).

WARNING	SHOCK HAZARD **The Analyte G2 is designed for use with grounded electrical outlets only. This is an important safety feature. Operating the system ungrounded will result in an increased risk of electrical shock and equipment damage.**

Space

The Analyte G2 is a self-contained mobile workstation on locking roller casters. The premix gas bottle and helium gas bottles (not provided—see page 9) are mounted within the cart. Overall dimensions are shown below.

The distance between the Analyte G2 and ICP-MS should be kept to a minimum to ensure efficient transport of the entrained analyte from the sample chamber to the torch.



NOTE

Vent the 125 mm OD exhaust ports from the laser to outside of the room if desired.

Keep in mind that the cables and tubing could create a trip hazard. Place the laser ablation system away from high-traffic walkways.

Computer

An integrated computer with 22” flat screen monitor is provided. The system operates from the integrated ICP-MS host computer. The computer uses the Microsoft Windows® 10 operating system.

Ventilation

The exhaust system must support a flow rate of 2800 L/m (100 cfm). Exhaust air comes from two sources: 100 L/m (3.5 cfm) cooling air exhaust from the laser, and 2667 L/m (94.2 cfm) from the gas cabinet. The exhaust system should be attached using flexible hoses having an inner diameter of approximately 125 mm. If the hosing run is longer than 3 m, an additional exhaust booster fan may be needed.

The exhaust can be vented to the room; however, venting the air to the outdoors or into a filter system as a safety precaution is recommended.

The heat generated by the laser is less than 150 watts. The exhaust air contains small amounts of ozone, which is produced in all high voltage switching systems. The O_3 concentration is less than the OSHA Permissible Exposure Limit (PEL) of 0.1 ppm. In addition, the exhaust air can contain corrosive and hazardous gases in the rare event of damage to the laser chamber, laser window/mirror or the gas system.

The laser ablation system uses pressurized gas containing fluorine, which is toxic and corrosive and may cause serious injury if inhaled. Follow your laboratory’s safety policy for caustic gases.

Gas Requirements

You must supply the necessary gas sources.

> **NOTE**
>
> INSTALLATION CANNOT BE SCHEDULED UNTIL THE LASER GASES ARE ON-SITE. DELIVERY TIME CAN BE AS LONG AS 4 TO 6 WEEKS.

There are three separate gas systems associated with the laser ablation system: 1) gases associated with the laser itself; 2) beam purge gases; 3) sample gases carrying analyte to the MS. These systems are completely isolated from each other.

Note that the He and ArF bottles mentioned below for the laser must be purchased with the size, purity, and fitting style specified. Alternative sources, bottles, or grades ***cannot*** be used as a substitute for the dedicated laser He bottle that goes inside the laser system.

Laser Gases

The ATLEX short pulse excimer laser used in the Analyte G2 requires two dedicated gas bottles for operation: ArF laser gas and He flush gas. These bottles remain permanently attached to the laser. Provisioning for the correct gas bottles is an essential part of site preparation.

All required plumbing and regulators ***are included with the Analyte G2*** for these Laser Gas and Flush Gas bottles only. This plumbing extends into a small, closed gas cabinet below the laser where the two small gas bottles reside. If bottles other than the size listed are purchased, they will not fit into this cabinet and the system cannot be installed.

CAUTION	**Use only the specified gas.** Linde Electronics and Specialty Gases is the ***only*** factory approved premix laser gas supplier. Gases provided by other suppliers can result in serious damage to the laser and will void the warranty.

Linde Electronics and Specialty Gases
A division of Linde Gases N.A. LLC
1 Greenwich St.
Suite 100
Stewartsville, NJ 08886

www.lindepremiumproducts.com

customerservice.esg.us.lg@linde.com

phone 1-800-932-0624

The supplier maintains a specific stockpile of gas for Teledyne; when ordering, be sure to mention that you are a Teledyne customer.

Certified Laser Gas

ATL ArF_2 mixture in a 7 liter steel bottle with DIN #14 connector

Linde PN 24099405

Excimer Grade Fluorine ATL ARF-2

DIN 477 No 14 for Premix

Cylinder Size 030

Liters: 1000

Psig: 2000

> **NOTE**
>
> If you are re-installing an older laser ablation system, with an ATL laser serial number less than 130204, order PN 24086541 Excimer Grade Fluorine ATL ARF-1 (ArF_1).

Flush Gas

Helium (UHP 99.999%) in a 7 liter steel bottle with DIN #6 connector

Linde PN: 24086592

Excimer Grade Helium RG

DIN 477 No 6 for Helium

Cylinder Size 030

Liters: 1000

Psig: 2000

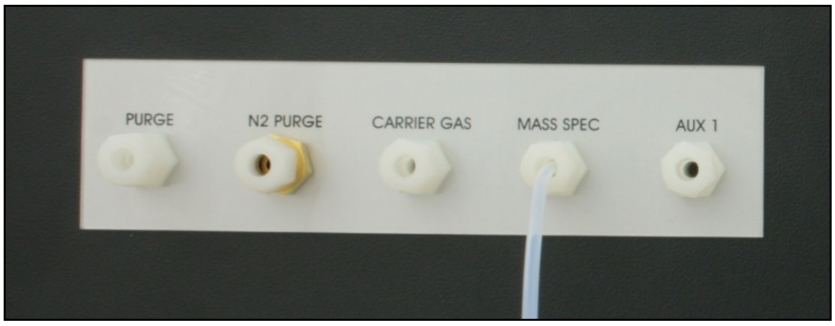
Other Required Gases

Beam Purge Gas

Approximately 2 L/min of nitrogen gas (UHP ≥99%) is channeled through the optical train when the laser is firing to suppress the formation of ozone and minimize absorption of 193 nm laser light in air. The N_2 pressure must be regulated at the tank down to 30 psi max.

> **NOTE**
>
> ¼" O.D. 1/8" I.D. Tygon® tubing should be used to connect to the Swagelok® connector of the rotameter provided with the system. The rotameter regulates the 2 to 3 L/min to the optical train. The user must supply a regulator for their purge gas bottle as well as tubing to connect to the Swagelok fittings on the back of the Analyte.

ICP-MS Sample Carrier Gas



The convention is to channel helium gas (99.998% purity) into the sample chamber and supplement this with argon make-up gas using a Y junction (provided) after the sample chamber. Both gases should be made available (0.1 to 2 L/min) on site at the time of installation.

When using argon as "make up" gas the Y junction is typically located just before the torch. The Analyte G2 comes with mass flow controllers to regulate the supply of helium through the sample chamber. However, the argon make up gas must be regulated by a mass flow controller as well. Often the ICP-MS has an auxiliary supply of argon that is suitable for this purpose. An optional mass flow controller can be provided with the Analyte G2 or added during installation. Contact the Teledyne Photon Machines dealer for additional information.

If the mass flow controllers used to regulate the argon make-up gas is supplied by Teledyne Photon Machines then the pressure from the gas tanks / cylinders to the mass flow controllers must be regulated at the tank down to 30 psi max.

> **NOTE**
>
> Use ¼" OD 1/8" I.D. Tygon tubing to connect purge gas and carrier gas to the Swagelok connectors provided with the system. The user must supply regulator(s) for their carrier gas bottle(s), and tubing to go from the regulator(s) to the Swagelok connectors on the back of the Analyte. Tubing and a torch bulb to go from the Analyte to the ICP-MS are provided.

Optional Nitrogen Gas Supply

If the optional low-flow N_2 mass flow controller is installed, then a regulated supply of N_2 needs to be available for connection.

Getting Help

Teledyne Photon Machines is a brand of Teledyne CETAC Technologies. If you need further assistance, contact us at:

Teledyne Photon Machines
Customer Service & Support
366 Gallatin Park Drive
Bozeman, MT 59715, USA

Phone (406) 586-2667

Fax (406) 600-9744

Email robin.jones@teledyne.com

http://www.cetac.com

Site Prep Checklist & Installation Scheduling Form

Please satisfy the items in this checklist then return the form to schedule installation of your Analyte G2 laser ablation system.

210 – 240VAC outlet with mating connector readied	
ArF_2 premix gas received from Linde	
Helium flushing gas received from Linde	
Helium carrier gas supply, including 2-stage regulator with 1/4" OD or 6 mm OD to laser ablation system	
N_2 purging gas supply, including 2-stage regulator with 1/4" OD or 6 mm OD to laser ablation system	
Argon make-up gas supply regulated by ICP nebulizer line or external mass flow controller	
Crate inspected for damage (notify factory if any)	
Crate moved to the lab or just outside of lab	
Mass spectrometer(s) confirmed operational	

Location of Equipment:

User Name _____

Institution _____

Street _____

City _____

State / Country _____

Postal Code _____

Key Contact _____

Telephone _____

Email _____

Mass Spec Make/Mode _____

I certify that all installation requirements listed above have been met and that the laboratory is prepared for the installation.

Signature:_____ Date: _____

Please sign and email this form to robin.jones@teledyne.com