HPLK
User Manual

Component Products Group

39 Manning Road
Billerica, Massachusetts 01821

GSIL P/N: 7OM-1060
Rev D

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1 INTRODUCTION

GSI Lumonics presents the HPLK™ Series, a dynamic focusing scanhead offering substantial flexibility to integrators utilizing lasers in their manufacturing or lab environment. The HPLK Series optical leveraging allows for smaller spot sizes and larger field sizes than traditional f-theta two axis systems. In addition, the HPLK series can adjust to varying working distances, particularly useful for product lines with different sized parts or curved working surfaces.

Each HPLK combines GSI Lumonics' XY Scanhead with dynamic focusing technology, control electronics, PC interface, and software into a three-axis laser beam deflection system. You can form a complete laser scanning system by combining a laser and a PC with an HPLK system, controlling it with your custom application software. This computer-controlled system precisely deflects focused laser beams to perform industrial laser processing tasks.

The information in the following manuals familiarizes the user with the theory and operation of the HPLK hardware. The user needs to consider important laser safety considerations when utilizing any laser device.

1.1 ESD WARNING

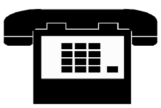
The OEM electronics that *GSI Lumonics* manufactures - including galvanometers and servo controllers - are electrostatic discharge (ESD) sensitive. Improper handling could therefore damage these electronics. *GSI Lumonics* has implemented procedures and precautions for handling these devices and we encourage our customers to do the same. Upon receiving your components, you should note that it is packaged in an ESD-protected container with the appropriate ESD warning labels. The equipment should remain sealed until the user is located at a proper static control station.

Note: Any equipment returned to the factory must be shipped in anti-static packaging.

A proper static control station **should** include:
1. A soft grounded conductive tabletop or grounded conductive mat on the tabletop.
2. A grounded wrist strap with the appropriate (1 Meg) series resistor connected to the tabletop mat and ground.
3. An adequate earth ground connection such as a water pipe or AC ground.
4. Conductive bags, trays, totes, racks or other containers used for storage.
5. Properly grounded power tools.
6. Personnel handling ESD items should wear ESD protective garments and ground straps.

1.2 Customer Support

GSI Lumonics has support services to address your questions or concerns with either the product or manual you are using. Before calling for assistance, be sure to refer to any appropriate sections in the manual that may answer your questions. Call GSI Lumonics' Customer Service Department Monday through Friday between 8 A.M. and 5 P.M. local time (GMT –05:00 Eastern Time (US & Canada)).
The customer service personnel will be able to give you direct assistance and answers to your questions.



CALL

North America	Europe	Asia
39 Manning Rd.	Einsteinstrasse 2	Technoport Kamata, 16-1
Billerica, MA 01821	D-85716 Unterschleissheim	Minami-Kamata 2-Chome
U.S.A.	Germany	Ohta-Ku Tokyo 144-0035
TEL: (978) 439-5511	TEL: (089) 31707 0	Japan
FAX: (978) 663-0044	FAX: (089) 31707 250	TEL: (81) 3 5714 0380
scanning@gsilumonics.com	sales.components@gsilumonics.com	FAX: (81) 3 5714 0335
		oed-sales@gsilumonics.co.jp

Website: http://www.gsilumonics.com/cpg/

1.3 Warranty Information

The Customer shall examine each shipment within 10 days of receipt and inform GSI Lumonics of any shortage or damage. If no discrepancies are reported, GSIL shall assume the shipment was delivered complete and defect-free. *GSIL* warrantees products against defects up to 1 year from manufacture date, barring unauthorized modifications or misuse. Repaired product is warranted 90 days after the repair is made, or one year after manufacture date - whichever is longer.

Contact Customer Service to obtain a Return Materials Authorization number *before returning any product for repair*.

All orders are subject to the GSIL Terms and Conditions and Limited Warranty. Visit www.gsilumonics.com/cpg/ for the latest version of these documents and other useful information.

IMPORTANT: Line Scan Engines are normally tuned, serialized and warranted as a matched set for optimum performance. Mismatched components diminishes performance and void the warranty. A matched set typically consists of galvanometer motor, mirror load, electronic driver board and interface cable.

Customers assume all responsibility for maintaining a laser-safe working environment. OEM customers must assume all responsibility for **CDRH** (Center for Devices and Radiological Health) certification.

1.4 Unpacking

The package you receive includes those items listed in the packing list.

1. **Carefully** unpack the contents from the box.
    - Cut the rubber band holding the dynamic focusing module lens in place and pull the rubber band through the unit.
2. Save shipping container and packaging material in case you need to return unit for service.
    - Firmly hold dynamic focusing module lens in place with rubber band if shipping unit, see figure 1.1 below.
3. Check contents of the box against the packing list to ensure all parts were received.
4. Inspect each item to ensure it was not damaged during shipment.

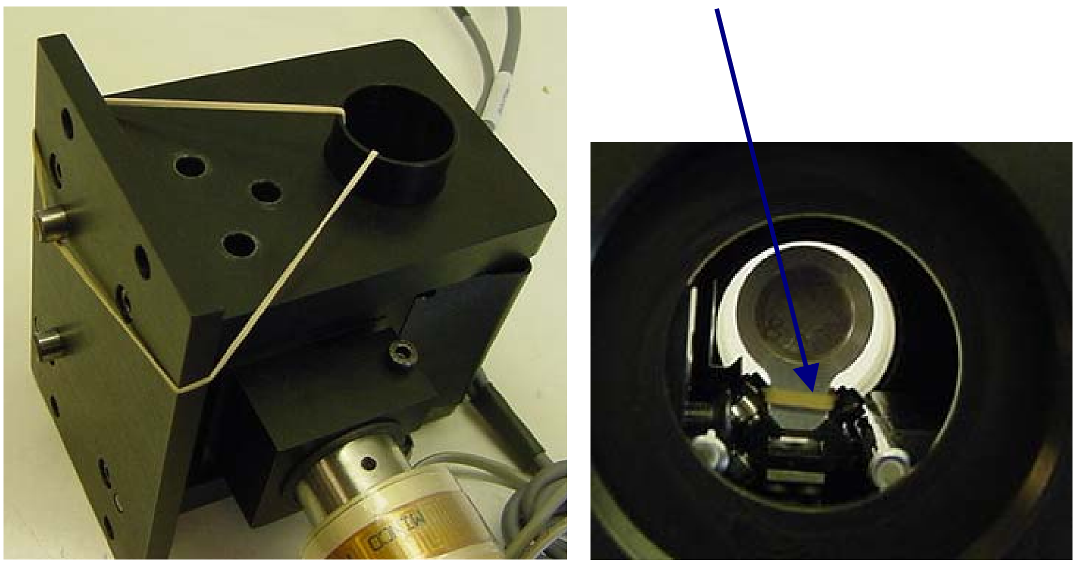


Figure 1.1: Cut and pull out rubber band when unpacking. If later shipment required, firmly hold lens in place with rubber band as shown.

2 SAFETY AND WARNINGS

The United States Food and Drug Administration, through the Center for Devices and Radiological Health (CDRH), has promulgated regulations (21 CFR parts 1000 and 1040) controlling the safety of lasers and laser products for sale or manufacture in the United States.

This section is a guide to the specific areas of this product where laser safety should be addressed. GSI Lumonics HPLK systems are designed to provide maximum flexibility and ease of use. Such a design inherently requires the user to assure the overall safety of the configuration in use.

Note: Prior to operating any configuration of the GSI Lumonics HPLK systems, you must make a thorough analysis of system safety. Key information for this purpose is contained in this manual. You should become familiar with all this information before proceeding.

A full description of laser hazard analysis is beyond the scope of this manual. A technical survey of laser safety requirements can be found in **ANSI Z136.1**, **"American National Standard For the Safe Use of Lasers"**. This is available from:

American National Standards Institute, Inc.
1430 Broadway
New York, New York 10018
www.ansi.org

Among the many other sources of laser safety information, the following institution offers several excellent publications:

The Laser Institute of America
5151 Monroe Street, Suite 118W
Toledo, Ohio 43623
www.laserinstitute.org

Your Laser Safety Officer or a competent specialist in this field should make final analysis of all safety features. The first consideration in a safety analysis is the laser mated to the GSI Lumonics HPLK system. The Laser Class label on the device indicates the approximate hazard level of the laser. Refer to **ANSI Z136.1** for definitions of laser classes and labeling information. Note that, besides radiation, lasers may present other hazards, e.g. electric shock or creation of poisonous fumes.

The GSI Lumonics HPLK Systems provide you with the ability to aim the laser beam over a roughly pyramidal volume. The divergence of the focused beam beyond the focal point, which is a function of the lenses selected and their position, can cause radiation to exit the pyramid. When analyzing safety, you must consider all regions within this aiming pyramid, the divergent beam, and the effects of all focal possibilities in the zone of hazard. Reflections must also be considered.

2.1 Laser Shutter Installation

A laser attenuator (shutter) is not included with the HPLK. Because each laser is unique, it is the user's responsibility to ensure that such a device is incorporated in the installation in conformance with CFR regulations (1040.10[f][6]), which reads as follows:

> A beam attenuator is required on Class II, IIIa, IIIb and IV laser systems. The beam attenuator is a mechanical or electrical device such as a shutter or attenuator that blocks emission. The beam attenuator blocks bodily access to laser radiation above Class I limits without the need to turn off the laser. The beam attenuator must be available for use at all times during operation. Power switches and key controls do not satisfy the attenuator requirement.

The beam shutter should be installed immediately after the laser. The following figure shows the recommended location of the shutter.

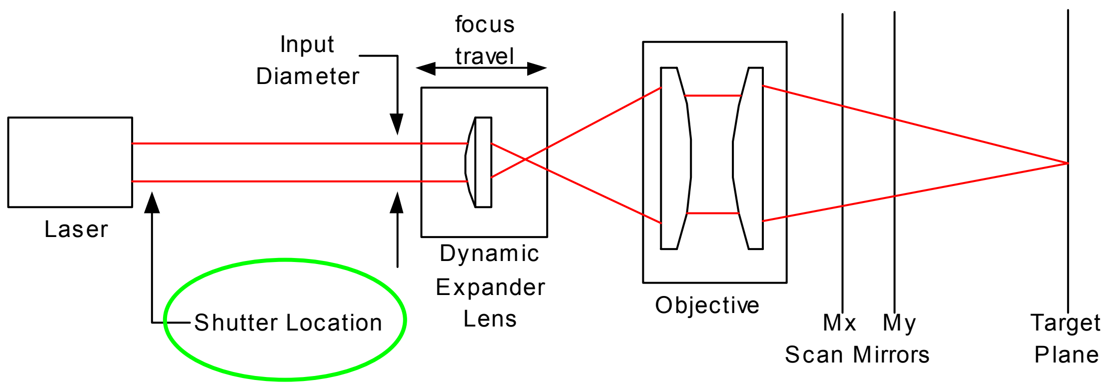


Figure 2.1: The laser's internal and external optical path towards the target plane. Note the location of the shutter as close to the laser as possible.

We strongly recommend that you specify a laser with a vendor-supplied shutter mechanism. If this is not possible, consult the laser vendor to design a proper safety shutter.

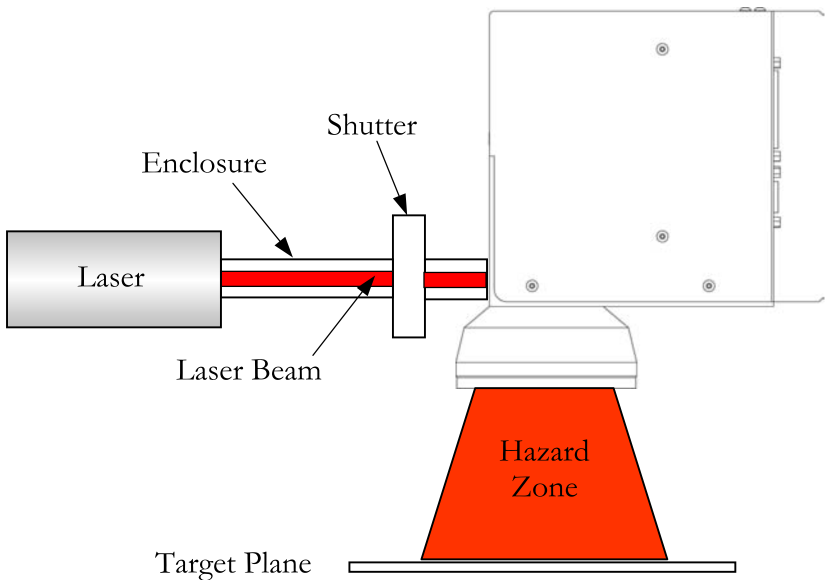


Figure 2.2: Hazard zones within the optical path. The shutter should be as close to the laser as possible. Enclose all hazards zones if possible, otherwise eye protection must be worn.

2.2 Installation Safety Requirements

Safe operation requires that the controller software be able to shutdown the laser power as a scanning safeguard in the case of unusual scanner behavior.

In all cases, we recommend that you fully enclose and interlock the zone of hazard for your application to prevent possible opening while the laser is energized. When laser radiation exceeding Class 1 levels may exit the enclosure, protection for eyes must be available.

At no time should you stare into the beam, place any parts of your body in the beam path, or expose yourself to reflections of powerful beams. Use only a Class I HeNe Laser for alignment. If this is not possible, use the available laser's lowest power setting and remote beam sensing technique.

Using optical instruments with this product increases eye hazard.

GSI Lumonics HPLK Systems are labeled in conformance to the requirements of 21 CFR parts 1000 and 1040.

3 GENERAL DESCRIPTION

3.1 HPLK Numbering Convention

The HPLK series employs a numbering convention to describe what optics, electronics, and mirror/galvo sizes are includes with each model. The first digit in the number corresponds to the optics and mirror coatings provided for the designed laser type. The second digit indicates the electronics in the system. The last two digits correspond to the mirror size. Each mirror size has an accompanying galvo model. Finally, many of the HPLKs have different available input beam diameters, which the –XX number represents.

HPLK 1330-9: CO_2 optics and mirror coatings, MiniSAX electronics, 30mm mirrors run by the M3, and a maximum 9mm input beam diameter.

The following lists the corresponding type or model for each number:

Laser Type (first digit):

1 = CO_2	10,640nm (infra-red)
2 = Nd: YAG	1,064nm (near infra-red)
3 = Visible	450nm – 700nm
4 = UV	325nm – 360nm
5 = Argon	480 – 514nm

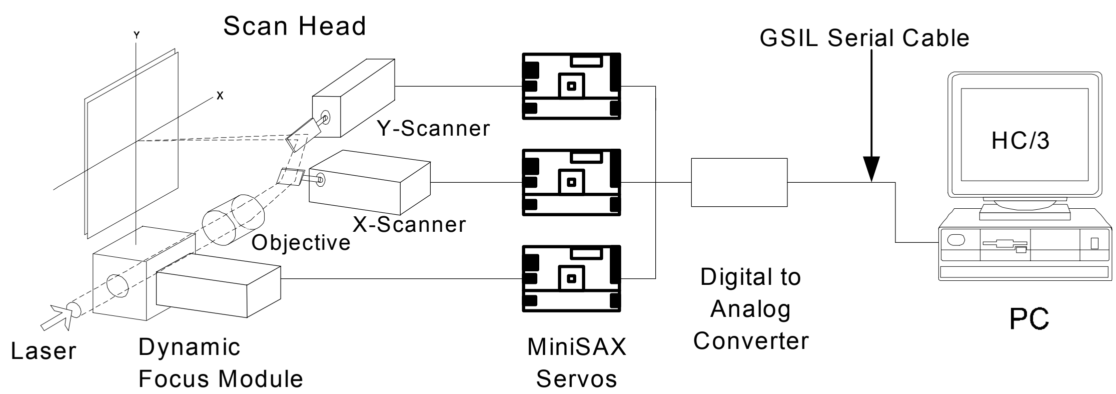
Electronics (second digit):
1 = EDD (obsolete)
2 = DAE (legacy)
3 = MiniSAX

Mirror – Galvo (third and fourth digits):
10 = 10mm mirrors run by the M2 galvo
15 = 15mm mirrors run by the M2 galvo
20 = 20mm mirrors run by the M3 galvo
30 = 30mm mirrors run by the M3 galvo
30BE = 30mm Beryllium mirrors run by the M3 galvo
50BE = 50mm Beryllium mirrors run by the M3 galvo

Input Beam Diameter (dash number):
-6 = Maximum 6mm input beam diameter (legacy)
-9 = Maximum 9mm input beam diameter (replaces 6mm models)
-17 = Maximum 17mm input beam diameter.

3.2 HPLK Component Descriptions

All HPLKs utilize post-objective scanning. That is, the scanning element (XY Scanhead) is positioned in the optical path after (post) the imaging element (objective lens). Post-objective scanning permits both fixed focus and dynamic focus laser beam configurations. The HPLK Series employs a dynamic focus module in all standard variations.



3.2.1 XY Scanhead Module

The XY Scanhead Module is an OEM unit with a laser safe enclosure. The enclosure optically seals the input beam aperture and provides an output aperture that limits exposure to radiation outside the intended scan field. The hazard zones for direct scan beams, stray beams and reflected beams are shown in section 2.1 Laser Shutter Installation.

The XY Scanhead deflects the laser beam in the X and Y axes under the control of the X and Y galvanometers that are attached to the mirrors. These galvanometers are closed loop, limited rotation, servomotors.

3.2.2 Z Focus Module

The Dynamic Focus Module is a unique Z-axis scanning element that adjusts focus on the fly via a PostGrid software generated look-up table. The Dynamic Focus Module contains a lens cell (the dynamic expansion lens) that translates along its optical axis under precise motion control. The Dynamic Focus Module, like the X and Y scanners, is a galvanometer-driven device, a closed-loop, limited rotation, servomotor. It receives its control signal and power from the D-to-A Card.

In the dynamic focus HPLKs the mounting fixture of the moving lens within the Dynamic Focus Module is adjustable. This allows precise optical alignment of the dynamic expansion lenses.

A laser-safe enclosure installed on the translator couples to the input and output beam tube couplers of the module. All the linear translator modules use the same adjusting mount, safety enclosure, and input coupler. Each HPLK has a specific dynamic expansion lens set and exit tube.

3.2.3 Objective Lens

The Objective Lens couples the beam from the dynamic expansion element through the XY Scanhead and onto the target field as a focused spot. Its focal length, the distance from the dynamic expansion lens, and the focal length of the dynamic expansion lens determine the working distance of the target as well as the leverage ratio between the translator motion and the motion of the focused spot.

3.2.4 Controller Electronics

The HC/3 residing in PC and the Digital-to-Analog card residing in the electronics module are the link between the PC based controller software and the scanners.

3.2.5 Additional Options – Protection Window Kits

GSI Lumonics offers additional protection window kits for CO_2 and Nd: YAG lasers to prevent the Scanhead mirrors being contaminated from nearby sources, such as beam splatter and environment chemicals.

Check with a GSLI technical sales representative for the latest version and compatibility.

HPLK MODEL	LASER TYPE	PROTECTION WINDOW
HPLK1330	CO_2 (infra-red)	000-3012514
HPLK1350	CO_2 (infra-red)	000-3012514
HPLK2330	YAG (near infra-red)	000-3012515
HPLK4315	Ultraviolet	N/A
HPLK4320	Ultraviolet	N/A
HPLK5320	Argon	N/A

3.3 Theory of Operation

3.3.1 Dynamic Focus HPLKs

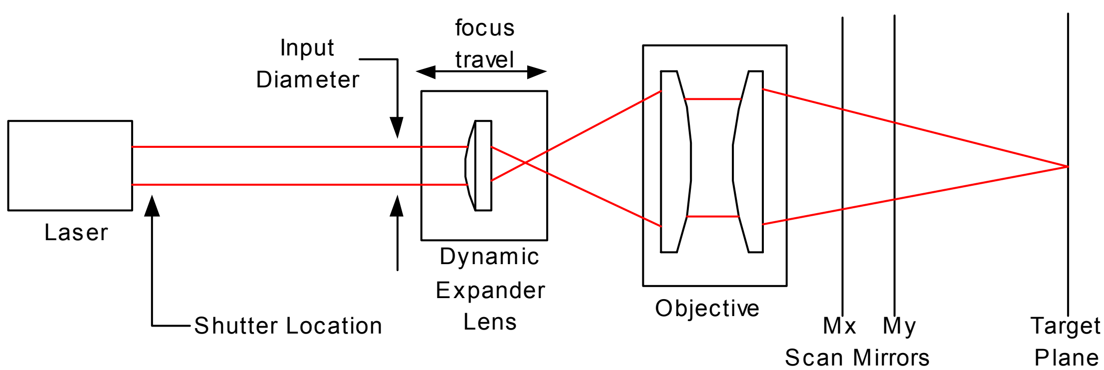
The dynamic expansion lens, located in the Dynamic Focus Module, travels up and down the optical axis to produce an exact focus at each coordinate of the flat field. Digital geometric correction adjusts focus according to scanning geometry through a software look-up table on the fly.

3.3.2 Optical Path Descriptions

For all HPLKs, we strongly recommend that you use a Laser with an internal shutter mechanism. If this is not possible, consult the laser vendor to design a proper safety shutter that, when activated, will eliminate all possibility of exposure exceeding Class I limits.

The Safety shutter should be located immediately adjacent to the laser and attached to the HPLK via the beam tube couplers provided, as shown in each of the figures in this section. This is the user's responsibility.

3.3.2.1 HPLK 1330, 1350, 4315, 4320, 5320



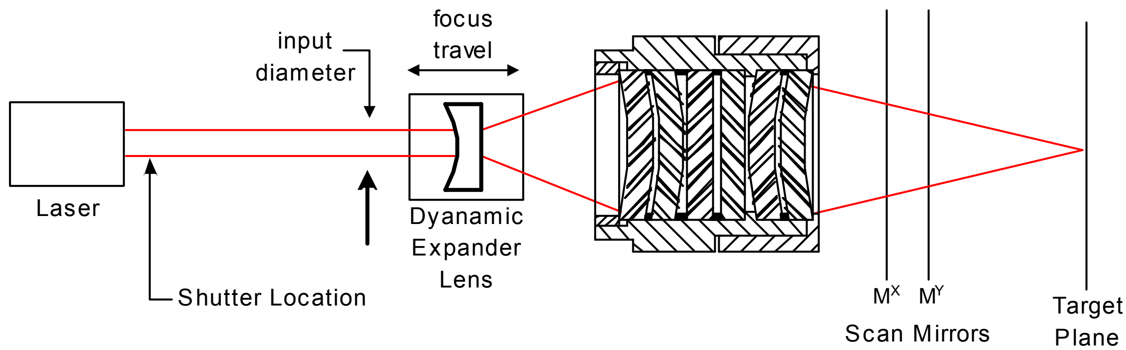
The raw laser beam enters the optical system either directly or by using turning mirrors for easier alignment of the system. The first turning mirror, M_1, directs the beam onto the rail, intersecting M_2 at precisely the optical axis of the rail. M_2, also an adjustable mirror, is used to angularly align the beam exactly parallel and centered to the optical axis of the imaging system.

The dynamic expander lens causes the beam to diverge strongly, thereby expand quickly on its way to the imaging objective.

The objective lens re-images the beam waist formed by the dynamic expander lens onto the target plane. Motion of the dynamic expansion lens via the linear translator varies the image range from the scanhead, hence producing dynamic focus. This lens is of the constant aperture type. The objective continues to image with a constant output aperture.

The mirrors M^X and M^Y are located in the XY Scanhead. They fold the beam and direct it by angular deflection to scan on the target plane.

3.3.2.2 HPLK 2330



The raw laser beam enters the optical system either directly or by using turning mirrors for easier alignment of the system. The first turning mirror, M_1, directs the beam onto the rail, intersecting M_2 at precisely the optical axis of the rail. M_2, also an adjustable mirror, is used to angularly align the beam exactly parallel and centered to the optical axis of the imaging system.

The dynamic expander lens causes the beam to diverge strongly, thereby expand quickly on its way to the imaging objective. The HPLK2330 uses a negative element, thereby creating virtual waist behind the lens. The beam leaves the lens diverging. The Objective lens re-images the beam waist formed by the dynamic expander lens onto the target plane. Motion of the dynamic expansion lens via the linear translator varies the image range from the Scanhead; hence dynamic focus. With minor system disassembly and removal of elements in the YAG objective, the focal length is changed thereby accommodating various scan radii. The mirrors M^X and M^Y are located in the XY Scanhead. They fold the beam and direct it by angular deflection to scan on the target plane.

3.3.3 Input Beam Aperture

The CO_2 HPLKs have two (-9 and/or –17) varieties of input apertures to correspond with the system laser source. The two varieties allow matching the entrance beam diameter with the beam source eliminating the need for a beam expander avoiding the compression of a beam. Lasers will vary in their output beam size and divergence. Check your laser manual or with your laser manufacture to acquire these two factors. After attaining the laser output beam size and divergence, calculate the HPLK input beam size based on the distance the DFM module will be from the laser source. Whether the result is below 9mm or between 9mm and 17mm will determine the HPLK model most appropriate for your system.

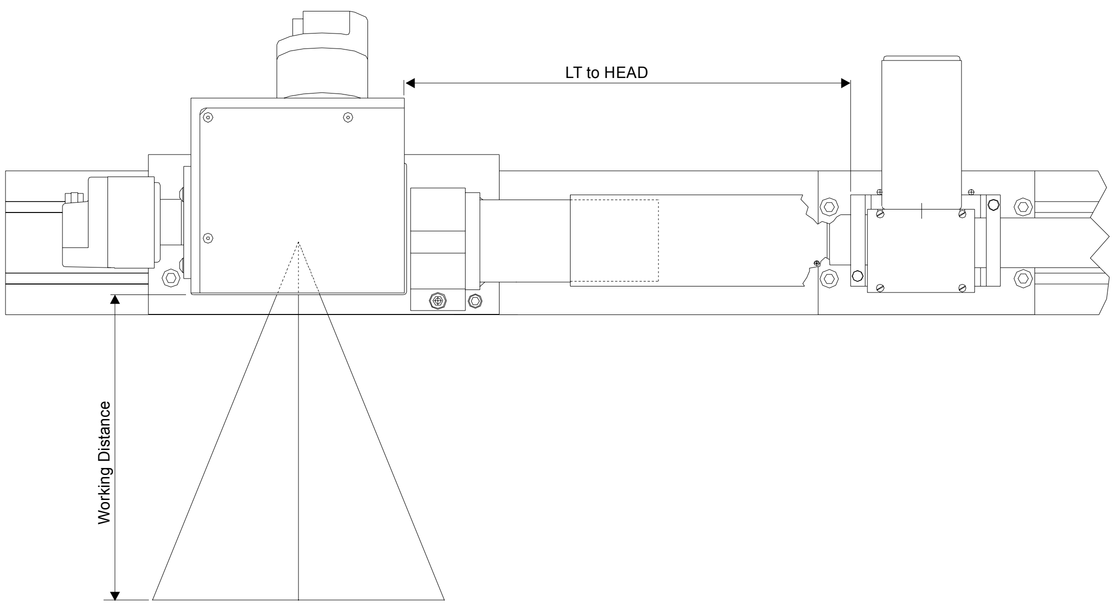
4 PLANNING AND PREPARATION

Before assembling your system, we suggest planning and preparing your system to make the setup easier. Consider doing all of the following before setting up your system:

- Find the optimal field size and working distance for your application. Follow the instructions in the following section 4.1 Determining Field Size and Working Distance to determine the ideal balance of field size vs. spot size.
- Consequently determine the appropriate location of the target, Scanhead, Dynamic Focus Module, laser, and any other associated equipment in relation to each other.
- Determine the input beam diameter and required hardware to achieve it: beam-expander or beam-reducer, aperture stop, etc.
- If using the HPLK 2330 or 4320, determine and setup the appropriate lens configuration.
- Gather any other necessary hardware for your setup: i.e. optical rail, turning mirrors, etc.
- Preliminarily mount hardware.

4.1 Determining Field Size and Working Distance

HPLKs can be configured for a variety of field sizes. Each field size will result in a different size of the focused spot in the target, require a different working distance (distance from the Scanhead to the target), relocate the distance between the Scanhead and the Dynamic Focusing Module (DFM to Head), and necessitate a different correction-file.



4.1.1 Using a Standard Configuration

You can consult a GSI Lumonics' chart in Appendix A: Specifications for the range of field sizes and the relation between the field size and spot-size. The charts below give some specific set point examples.

	HPLK 1330-9		HPLK 1330-17		HPLK 1350-9		HPLK 1350-17	
Laser / Wavelength	CO_2 infrared 10,600 nm		CO_2 infrared 10,600 nm		CO_2 infrared 10,600 nm		CO_2 infrared 10,600 nm	
Field Size Range (mm x mm) [1]	10 to 2,000		10 to 2,000		10 to 2,000		10 to 2,000	
Example Fields	**Small**	**Large**	**Small**	**Large**	**Small**	**Large**	**Small**	**Large**
Field Size (mm x mm)	100	400	100	400	100	400	100	400
Working Distance (mm)	102.4	522.7	84.1	449.9	73.8	464.5	73.8	464.5
LT to Head Spacing (mm)	214.32	169.4	154.5	112.4	315.6	275.2	318.0	240.0
Correction-File Name	c100b1	c400b1						
Input Beam Diameter (mm)	9	9	17	17	9	9	17	17
Spot Size Diameter (μm) [2]	120	350	97	295	96	202	76	207
Writing Speed* (mm/s) [3]	400	1700	100	1700	Contact	Contact	Contact Factory	Contact Factory

***Note CO_2 HPLKs (above) are available with Beryllium Mirrors, contact factory for more details.**

	HPLK 2330		HPLK4320		HPLK5320			
Laser / Wavelength	YAG infrared 1,064 nm		HeCd ultraviolet 325-350 nm		Ar^+ visible 488-514 nm			
Field Size Range (mm x mm) [1]	30 to 3,000		100 to 2,500		100 to 2,500			
Example Fields	**Small**	**Large**	**Small**	**Large**	**Small**	**Large**	**Small**	**Large**
Field Size (mm x mm)	100	400	200	800	200	800		
Working Distance (mm)	102.35	522.72	244.0	1085	244.0	1085		
LT to Head Spacing (mm)	91.6	78.4	89.9	39.4	171.3	118.6		
Correction-File Name	yag100b1	yag400a1	uv200b1	uv800b1	ar200a1	ar800a1		
Lens configuration (YAG only)	3+2 lenses	3+1 lenses						
Input Beam Diameter (mm)	9	9	1.3-3.3	1.3-3.3	2.4	2.4		
Spot Size Diameter (μm) [2]	15	40	10	32	14	60		
Writing Speed (mm/s) [3]	400	1700	1200	4500	1200	4500		

1. For Field Size requirements beyond this range contact GSI Lumonics
2. Theoretical value with input beam quality (M^2) < 1.5
3. Preliminary writing speed.

4.1.2 Creating a Custom Configuration

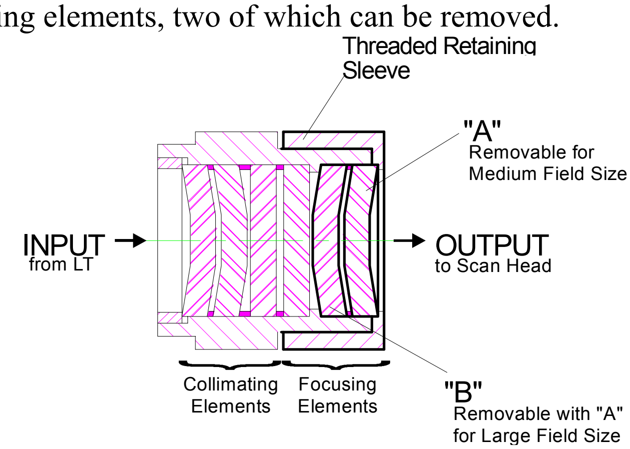
You can use the PostGrid program and generate your own correction-file for your specific field size or working distance. Load the following Configuration-files from within the PostGrid program. PostGrid will give you the numbers for working distance, LT to Head spacing (approx.) and a theoretical value for the spot-size and depth of focus of your configuration.

Note: the given LT to head spacing represents a relative value only. Fine adjustments may be needed to improve focusing quality.

HPLK	Remark	PostGrid Config-File
1330-9	9 mm Input	1230-9.con
1330-17	17mm Input	1230-17.con
1350-9	w. spacer (12"x 12" optics)	1150-a.con
1350-9	w/o spacer (18"x 18" optics)	1150-b.con
1350-17	17mm Input	1250-17.con
2330	3+1 lens, for fields > 370 mm	b2130-1.con
2330	3+2 lenses, for fields 150 - 370 mm	b2130-2.con
2330	3+3 lenses, for fields 60 - 150 mm	b2130-3.con
4320	with 10 mm focal length lens in LT for 1.3 mm input	b4120-10.con
4320	with 15 mm focal length lens in LT for 2.0 mm input	b4120-15.con
4320	with 25 mm focal length lens in LT for 3.3 mm input	b4120-25.con
5320	2.4 mm input	b5120.con

4.2 Lens Configuration for HPLK2330

To achieve the smallest possible spot-size, the HPLK2330 allows you to modify the optics of the objective-lens for different field sizes. The objective lens consists of 3 collimating elements and 3 focusing elements, two of which can be removed.



4.2.1 For Fields 60 to 150 mm

3+3 lens configuration: All lenses are installed. This is how the unit is normally shipped. Use the configuration-file "b2130-3.con" with the PostGrid program to generate correction files.

4.2.2 For Fields 150 - 370 mm

3+2 lens configuration: The last focusing element ("A") has to be removed.
Use the configuration-file "2130-2.con" with the PostGrid program to generate correction files.

To remove element:

1. Remove the objective lens from the Scanhead.
2. Unscrew retaining sleeve.
3. Remove lens element “A” by pointing objective downward and tapping on the sides. The lens has a very tight fit in the objective tube. Warm up the assembly (hair dryer) and use a rubber suction device if lens won’t come out. Make sure the lens slides out parallel or it might get stuck.
4. Insert aluminum spacer and screw retaining sleeve back on.
5. Install lens on Scanhead.

4.2.3 For Fields >370 mm

3+1 lens configuration: The last two focusing elements (“A” and “B”) have to be removed. Use the configuration-file “2130-1.con” with the PostGrid program to generate correction files.

To remove elements:

1. Remove the objective lens from the Scanhead.
2. Unscrew retaining sleeve.
3. Remove lens element “A” by pointing objective downward and tapping on the sides. The lens has a very tight fit in the objective tube. Warm up the assembly (hair dryer) and use a rubber suction device if lens won’t come out. Make sure the lens slides out parallel or it might get stuck.
4. Remove spacer and lens element “B” following the procedure above.
5. Screw retaining sleeve back on.
6. Install lens on Scanhead.

4.3 Lens configuration for the HPLK 4320

For optimal system performance, the HPLK 4320 comes with three different linear translator lenses. For input beam diameters up to 1.3mm, use the DFM lens with 10mm focal length. For input beam diameters up to 2.0mm, use the DFM lens with 15mm focal length. For input beam diameters up to 3.3mm, use the DFM lens with 25mm focal length.

5 LASER INSTALLATION & ALIGNMENT

The flexibility and versatility of the HPLK requires precision alignment. This section covers mechanical assembly and alignment of the laser used in your HPLK setup.

These procedures represent the steps and sequences required for optimum system performance. Any other techniques may result in system misalignment or failure. Read the procedures thoroughly before attempting to set up your rail.

The alignment of laser systems is dangerous if you are careless! Read the list of safety warnings below.

- Never operate the laser without being absolutely sure where the beam is pointing. Be certain the beam is properly terminated in a suitable diffuse beam dump.
- Do not touch any mirror or lens surfaces. Wear finger cots or cotton gloves when handling optics.
- Do not operate laser without wearing laser safety goggles.
- Never look directly into beam.
- For this procedure, a CCD camera and remote monitor is recommended for viewing beam position with YAG and visible lasers.
- Any person performing this procedure must be cleared through the user's Laser Safety Officer or his deputy.
- Do not allow beam exposure on skin.
- Have proper Laser-safe lab.
- Evaluate any diffuse or specula reflections for laser hazards.
- When the laser is ON, procedures must be carried out from a remote, laser-safe location, i.e. hands-on, laser-active procedures must be avoided.

5.1 Optical Rail

The procedure shows a typical alignment rail. You are responsible for providing an equivalent method for the mounting and alignment of the HPLK components.

We strongly recommend that you make provisions for semi-permanent mounting at this point to minimize the risk of damaging equipment or accidentally exposing yourself to laser radiation. You can accomplish this by bolting the rail to an optical table or some other rigid structure.

5.2 HeNe Alignment Laser

For safety reasons we recommend the use of a low power visible laser for the initial alignment of the system. It is the most convenient if your laser has a built-in pointing laser (HeNe laser or visible laser diode). Otherwise we suggest you set up a low power visible laser beam to be collinear with your working laser and use the low power visible laser for the initial alignment. Start using your working laser only after you are close to alignment and have a good understanding of the beam path.

5.3 Laser Installation

The laser attenuator (shutter) is not included with the HPLK. Because each laser is unique, it is the responsibility of the user to ensure that such a device is incorporated in the installation in conformance with CFR regulations (1040.10[f][6]), which reads as follows:

> A beam attenuator is required on Class II, IIIa, IIIb and IV laser systems. The beam attenuator is a mechanical or electrical device such as a shutter or attenuator that blocks emission. The beam attenuator blocks bodily access to laser radiation above Class I limits without the need to turn off the laser. The beam attenuator must be available for use at all times during operation. Power switches and key controls do not satisfy the attenuator requirement.

We strongly recommend that you specify a laser with a vendor-supplied shutter mechanism. If this is not possible, consult the laser vendor to design a proper safety shutter. Refer to figures in section 2.1 Laser Shutter Installation to locate the beam shutter position for your HPLK.

Mount the laser, beam-expander, turning-mirror, and input-aperture stop. Establish the laser beam in the required position relative to the rail.

A typical complete setup is shown in figure 5.1 below. You may also setup your system on a single straight axis where the laser shines directly into the Dynamic Focus Module, but turning mirrors allow for easier fine adjust of the beam path rather than moving the entire laser assembly.

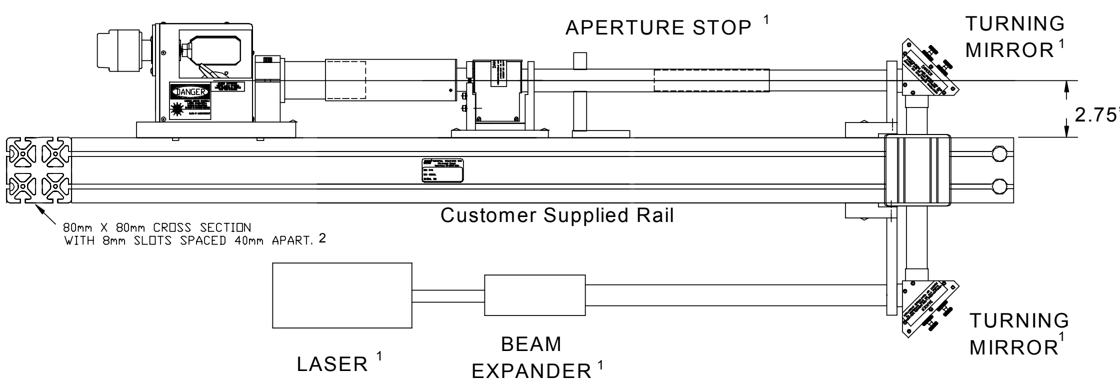


Figure 5.1: Typical complete system setup. Note the location of the laser, beam expander, and turning mirrors for simple adjustment of laser beam alignment. All paths of the laser should be completely enclosed from the surrounding environment.

Notes:
1. Customer supplied.

5.4 Laser Alignment

In this step the laser beam position relative to the rail (and therefore later the Scanhead) is established. Depending on your particular setup this is achieved by moving the laser, the rail, or - most conveniently - by utilizing two turning mirrors.

It is crucial for the safe performance of the system to carry out the alignment procedure extremely accurately.

1. Create target surfaces for aligning the laser to the rail. We suggest mounting a tube parallel to the rail to align the laser beam. Mount the Scanhead to the rail at this time and affix the tube orthogonal to the entrance of the scanhead, see section 6.1 Scanhead mounting for mounting of the scanhead. The tube ensures that the laser is completely enclosed during alignment. In addition, by aligning the laser to the center of the entrance and exit of the tube, the beam will be known to travel straight into the HPLK hardware. A sample tube is shown in figure 5.2 below.

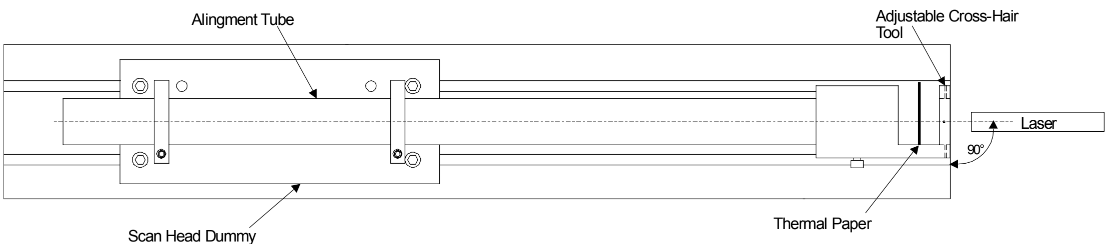
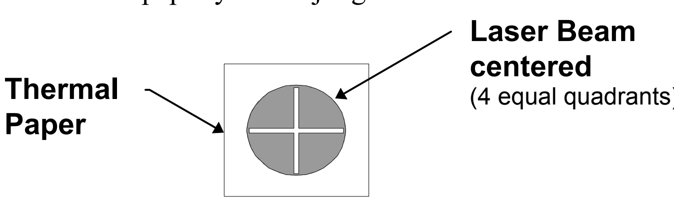


Figure 5.2: Example of an alignment tube.

2. Slide a cross hair on the laser input side of the alignment tube and affix a suitable target material (e.g. thermal paper) onto the cross hair.
3. Center the laser to the cross hair. Look at the dot the HeNe laser creates on the image. If a HeNe cannot be used, employ thermal paper as a target behind the cross hair and fire the laser at low power just long enough to mark the thermal paper. By the image on the cross hair or the mark on the thermal paper you can judge if the laser beam is centered to the cross hair.



4. Insert the cross hair on the rear of the alignment tube and center the laser to the rear aperture.
5. Repeat above until the laser is aligned and centered to both the input aperture AND the rear aperture.

6 HPLK Installation & Alignment

The flexibility and versatility of the HPLK requires precision alignment. This section covers mechanical assembly, alignment, and focusing procedures of each module used in the HPLK techniques.

Note: Any relative motion between the rail and target or the rail and the laser negates any previous alignment procedures.

6.1 Scanhead mounting

Consider mounting Scanhead before aligning the laser. Slide the dowel pins of the Scanhead in the rail slot and support the Scanhead to prevent dropping and severe damage. Use four M8 socket head cap screws to screw the Scanhead on the rail.

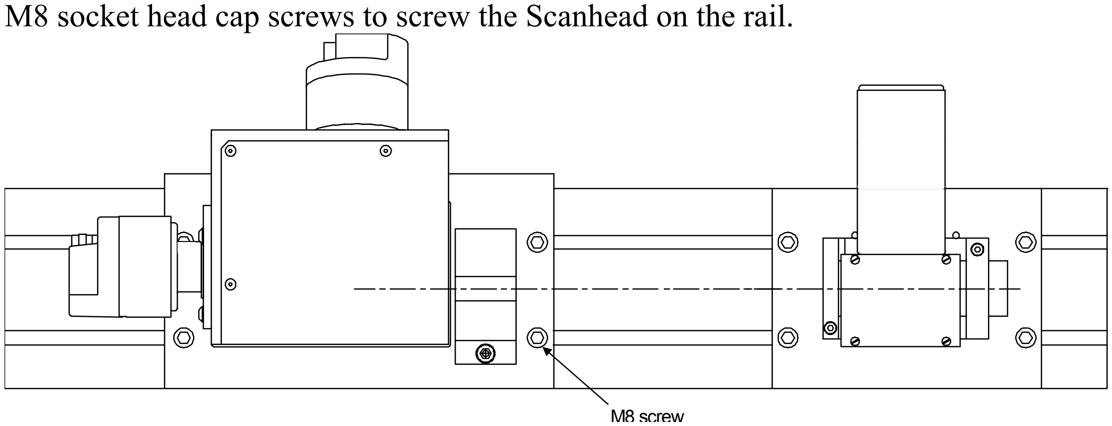


Figure 6.1: Mounting of Scanhead to rail.

6.2 DFM Mounting and Preliminary Alignment

This section describes how to align the DFM to the established reference laser-beam position. Alignment is done by moving the DFM module in its bracket. The translator should be pre-aligned with a HeNe laser. Use the higher power laser for final alignment only.

1. Loosen the clamps holding the alignment tube and slide the tube far enough back to make space for the mounting of the DFM module in between the alignment tube and last turning mirror (see Figure 5.1).
2. Be sure the laser beam is correctly aligned to the optical axis of the rail (follow instructions in section 5.4 Laser Alignment)
3. Mount the DFM to the rail in the appropriate position. Slide the dowel pins of the DFM (Dynamic Focusing Module) in the rail slot and support the LT to prevent dropping and severe damage during tightening of the four M6 socket head cap screws. Make sure it is securely fastened.

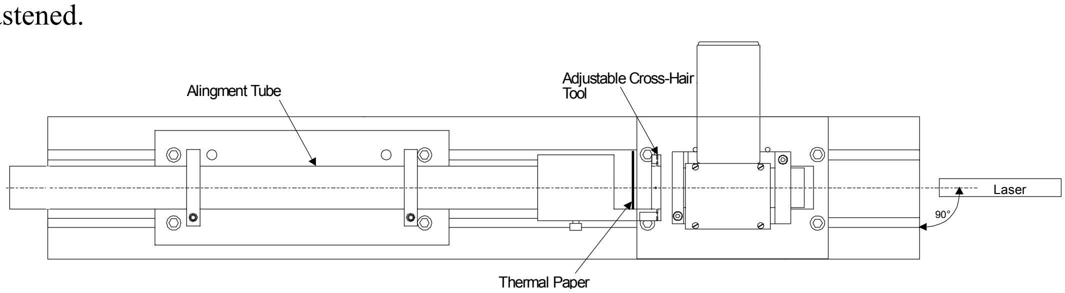


Figure 6.2: Installation of the DFM

4. Loosen the three (3), 8-32 socket head cap screws that attach the translator to its bracket until the force of their spring washers just holds their position. Slightly tighten one screw to secure translator position.

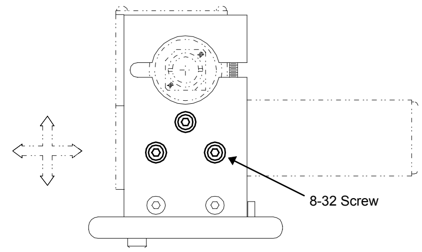


Figure 6.3: Mounting holes of the internal DFM components that securely hold the internal components to the DFM module.

5. Slide a cross hair on the laser input side of the alignment tube and insert a suitable target material (e.g. thermal paper) in the slot of the cross hair.
6. Slide the DFM towards the alignment tube. Because of the optics inside the DFM, the laser beam will be strongly diverging at the output of the DFM. Move the cross hair to a position where the beam has diverged to approximately 0.5" to 1" (12 to 25 mm) diameter.
   The expansion of the beam caused by the translator lens may make the beam too weak to mark targets. If possible, use a camera to view the beam. Alternatively the DFM can be moved closer to the cross hair target for a more concentrated image.
7. Find the position of the output beam on the target.
8. Center the beam on the target by loosening the three (3), 8-32 socket head cap screws holding the translator and moving the translator laterally. Use thermal paper as a target behind the cross hair and fire the laser at low power just long enough to mark the thermal paper. By the image of the cross hair on the thermal paper you can judge if the laser beam is centered to the cross hair.
9. Tighten all three 8-32 socket head cap screws holding the LT in its bracket.
10. Verify that the laser beam is still centered.
11. Re-install the Scanhead and objective lens on the rail and make all necessary interconnections (follow interconnections section.).
12. Remove alignment tube from system.

6.3 Mounting of Objective Assembly

Be sure to make any necessary changes to the lens assembly before mounting if you are using the HPLK 2330, 4310, 4315, or 4320. See section 4.2 Lens Configuration for HPLK2330 and section 4.3 Lens configuration for the HPLK 43XX series for more information.

Slide the protection tube on the Objective lens. Insert the Objective Lens in the Scanhead lens holder clamp and tighten the 3/16" socket head cap screw.

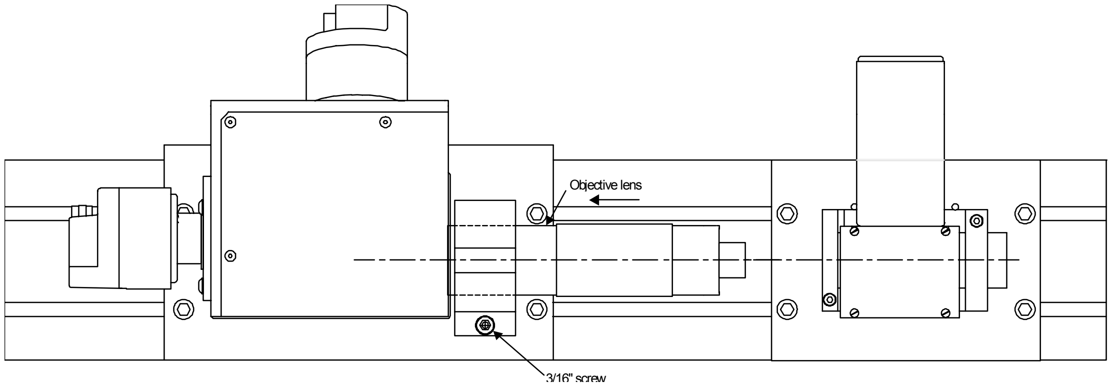


Figure 6.4: Clamping objective lens to Scanhead.

Slide protection tube towards the DFM and tighten the 7/64" socket head cap screw of the objective lens protection tube holder.

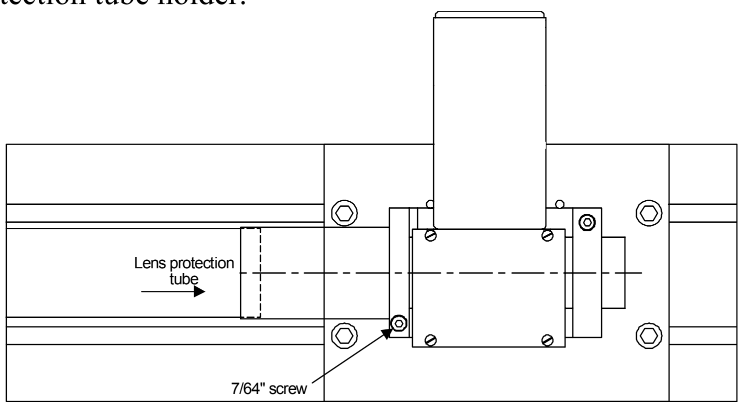


Figure 6.5: Joining objective lens to DFM.

6.4 Establish Target Plane

Establish the target plane where objects will be marked. Refer to section 4 Planning and Preparation and use PostGrid software to determine the working distance. Consider making the target plane on an adjustable mount for precision setup control.

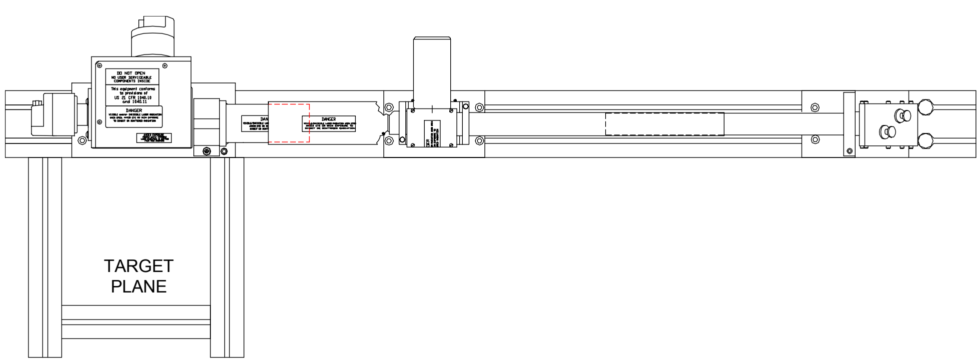


Figure 6.6: Example of target plane location with respect to rail setup of HPLK.

7 Final Configuration & Test Procedures

7.1 HC/3 and Software Installation

The purpose of the HC/3 is to provide a hardware link between the CPU and the XY Scanhead. The HC/3 card is designed to be installed into a PC-type computer.

Install PC-MARK MT or WinMCL software. You need to have the software running in order to perform the final alignment of the system.

For more information and installation procedure refer to the relevant manual. Section 8 Operational Resources lists several of the manuals associated with the PC software and hardware.

7.2 Interconnections

Warning! It is crucial that you complete the following steps carefully to avoid errors that may cause radiation exposure or equipment damage.

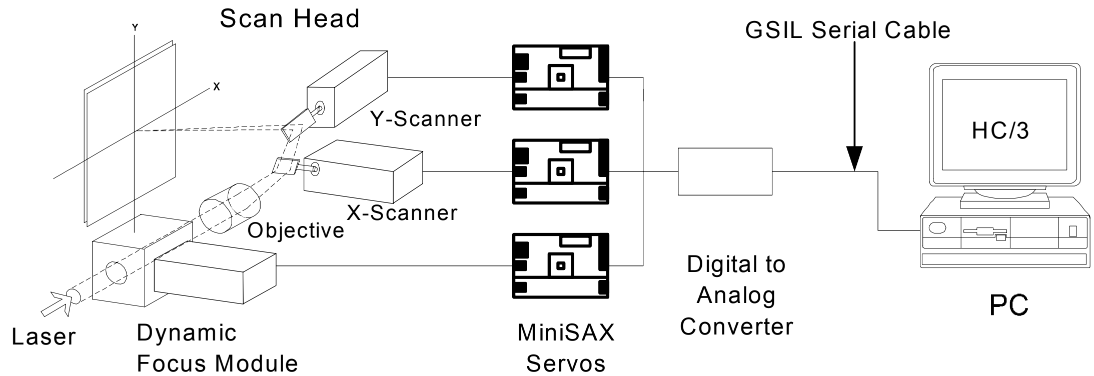


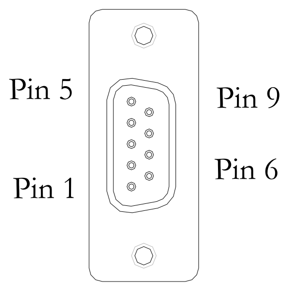
Figure 7.1: Wiring interconnections.

1. Connect the power cable to the Power Connector. Make sure that the power supply is configured for the correct input power voltage. Refer to section 7.3 Power Supply Requirements.
2. Install the galvanometer cables as follows:
   - Look for the axis delineation sticker on each galvo and find the corresponding MiniSAX servo. Plug in the cables to their mating connector.
   - Make certain that the cables marked "X" match up with the servo marked "X", likewise for "Y" and "Z."
   - Route the cables to the electronics and tie-wrap in place to prevent accidental damage to connections.
3. Connect servo electronics to the PC based HC/3 through the GSI Lumonics 25 Pin serial cable.
4. Connect laser interface cables. Refer to the HC/3 manual (see section 8 Operational Resources) for more information.

7.3 Power Supply Requirements

Supply the following power to the electronics module:

Voltage: +/-15V +60% -20%
Current: min. 2A, 3.5A peak
Ripple: less than or equal to 0.2%
Noise: less than or equal to 0.5% DC to 30MHz

INTERFACE	PIN	ASSIGNMENT
 9-Pin D-sub (Male) Power Connection	4, 5, 9 3, 7, 8 1, 2, 6	+Vin GND -Vin

7.4 Static Inspection

The static inspection procedure verifies the proper operation of the equipment. It should be carried out prior to laser operation. Before beginning, insure all AC and laser power is OFF.

7.4.1 XY Scanhead Module

1. Perform a static visual inspection. Do not remove the protective cover.
2. Shine a light source into the input and output apertures to inspect mirror surfaces.
3. Inspect for visible damage such as:
    - Loose or missing screws.
    - Loose or improperly connected scanner cables.
    - Dirty, cracked or scratched mirrors.

7.4.2 Z Module

1. Remove the top cover of the DFM and perform a static mechanical inspection.
2. Loosen the four 2-56 screws in slotted holes on the top and side covers. Remove the covers, retaining the two screws that join the top and side covers.
3. Examine the exposed guide rails and lens surfaces for visible contamination. It may be necessary to remove the module from the rail. If you must do so, first mark the cart position on the rail with tape.
4. Remove the input tube from the clamp.
5. While holding the exit tube to objective, loosen the setscrews. While holding the translator cart, loosen the (4) socket head cap screws and slide the cart so the exit tube disengages.

6. Remove the (4) socket head cap screws from the rail, using one hand to keep the rail from dropping.
7. Remove the exit tube assembly by loosening the 8-32 socket head cap screw 2 turns.
8. Sight through either end of the translator bore.
9. Reassemble in reverse order, leaving the cover off for the first power-up test.
10. With the driver OFF, verify that the translator carriage slides smoothly by gently pushing it back and forth approximately 13 mm.

7.5 Final System Configuration

You should familiarize yourself with the operation of the PC-MARK MT or WinMCL software before you attempt the final configuration of the system. The procedures described in this section require that you know how to operate the software. It will be necessary to load correction-files, set laser parameters and generate and mark objects.

Before starting configuration, warm up the system for at least 20 minutes.

7.5.1 Configuration for a Standard Field Size

The following section uses the values for the configuration of a 400 mm field with an HPLK1330-9 as an example. Use the procedures outlined in section 4 Planning and Preparation to determine the values for your system.

1. Load PC-MARK MT or WinMCL software and load the calibration-file for the desired field size.
   Example: *400 mm field with HPLK1330-9:* File-Name = "c400b1"
2. With the laser off, position the scanners in their center position by marking a small feature in the center of the field (e.g. a period).
3. Move the LT (Linear Translator) to the appropriate position for that field size and tighten it down.
   Example: *400 mm field with HPLK1330-9:* LT to Head = 169.1 mm
4. Position a piece of thermal paper or another suitable material (non-reflective!) in the center of the marking plane and another one (or one large piece of marking material) in the corner of the field.
5. Verify that the target plane is at the nominal distance from the Scanhead
   Example: *400 mm field with HPLK1330-9:* Working distance = 522.7 mm.

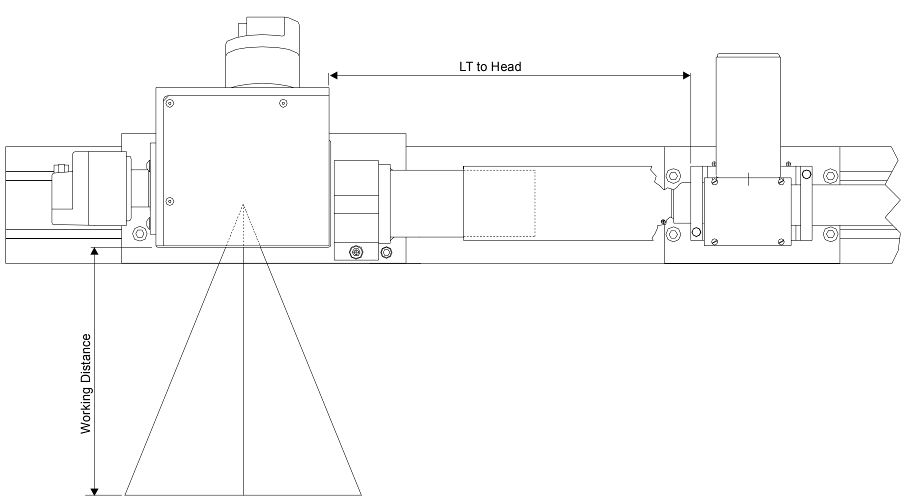


Figure 7.1: Important relative dimensions in the HPLK.

7.5.2 Fine Focus Adjustment

This adjustment is necessary because different lasers diverge at different rates. It is important to maintain the exact working distance while the LT to Head spacing can be adjusted empirically for the best focus.

1. Turn the laser on and alternately mark a small spot in the center of the field and in the corner of the field. Make sure that the right calibration-file is loaded!
2. While marking, find the best focus of the laser on the work piece by moving the entire DFM back and forth.

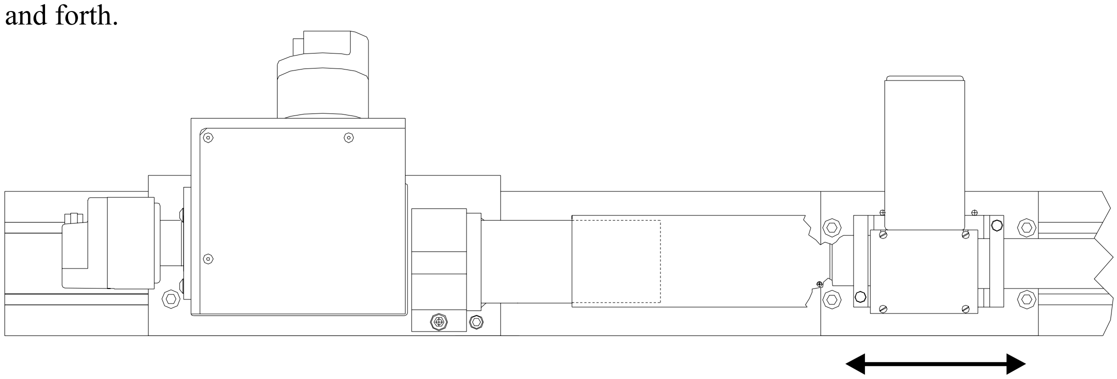


Figure 7.2: Fine adjustment of the location of the DFM will be necessary due to variation in divergence rates from laser to laser.

3. After achieving the best focus in the center AND the corner: turn the laser off and tighten the mounting screws of the DFM cart. Make sure that the cart is pressed downwards against the slots.
4. Fine adjustments can be made by adjusting the "OFFSET" pot of the Z-axis MiniSAX, see figure 7.3 below. Do not touch the other pots!

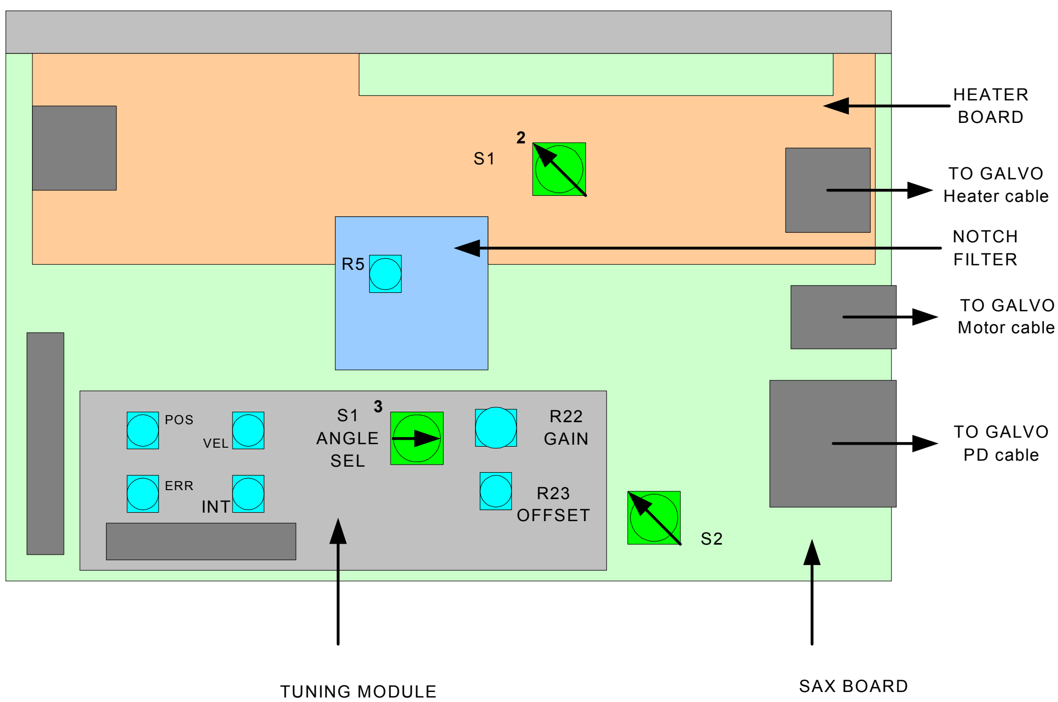


Figure 7.3: Components of the MiniSAX board. Note location of Offset pot on Tuning Module.

7.5.3 Configuration for Custom Field Sizes

Other field sizes within the field size range are possible by adjusting the working distance and the DFM to head spacing. The appropriate correction file needs to be loaded to achieve focusing in the center and in the corner of the field. Refer to the "PostGrid" software manual for how to generate your own correction files and to the PC-MARK MT or WinMCL manual for how to load a correction file.

For multiple system OEM design-ins contact GSI Lumonics Technical Customer Support for possibilities beyond the configuration options presented in this manual.

7.6 Operational Check

1. Apply power to the power strip. The scanners and translator may perform a few erratic motions in the first seconds. For up to 15 seconds this is normal. Mechanical limit stops protect each unit.
2. Run a test pattern (e.g. "BOX.job") program from the PC to see that each servo is "scanning". Refer to the Software manuals for details on operation.
3. Test your laser interface circuit before connecting it to the laser. To do so, use a voltmeter on the laser signal. Run a test program and verify laser signal is ON during vectors and OFF in between by monitoring galvo movement. The polarity of the laser modulation can be changed via jumper settings. Refer to the appropriate HC/3 manual for details.
4. Test any user-installed safety interlocks by testing continuity across the interlock cable connections at the laser. The circuit should be closed ONLY when all interlocks are closed.
5. Replace all covers.

7.7 Adjustments for two Field Sizes

If you plan to switch back and forth between two distinct field sizes the following steps might help you to make this quick and easy. Field size A is assumed to be larger than field size B.

1. Make the necessary adjustments for field size A by following the procedure of section "7.5.1 Configuration for a Standard Field Size", page 24.
2. Install a Stop Block or other suitable device which lets you reproduce the position of the LT precisely to the left of the LT.
3. Move the LT cart to the approximate position for field size B.
4. Load the calibration-file for the field size B.
5. Set the working distance for the field size B. Verify that the target plane is at the nominal distance from the Scanhead.
6. Turn the laser on and alternately mark a small spot in the center of the field and in the corner of the field. Make sure that the right calibration-file is loaded!
7. While marking, find the best focus of the laser on the workpiece by moving the entire LT back and forth. Do not use the OFFSET pot for fine adjustments as this would negate the previous adjustment for field size A.
8. After achieving the best focus in the center AND the corner: turn the laser off and tighten the mounting screws of the LT cart. Make sure that the cart is pressed downwards against the slots.
9. Install a Stop Block or other suitable device which lets you reproduce the position of the LT precisely to the right of the LT.

8 OPERATIONAL RESOURCES

COngradulations! Your HPLK system should now be and ready to use. Refer to the following manuals for further information on operating the HPLK or associated materials. Be sure to have all laser operation manuals handy for laser operation and troubleshooting notes.

Equipment	Manual Name	GSILumonics Part #
HPLK Hardware	HPLK User Manual	7OM-1060
MiniSAX Servo	MiniSAX User Manual	176-25016
PostGrid Calibration Software	PostGrid User Manual	176-25005
Laser Hardware	See laser manufacture or one of the manuals below.	
PC Mark MT	PC-Mark MT Command Reference	176-25008
PC Mark MT	PC-Mark MT Programmers Manual	176-25015
WinMCL	WinMCL32 Manual	E70-21610

Because these HPLKs are designed to be custom-configured by each user, it is impossible to include in this manual comprehensive operational procedures beyond the modular level. We recommend that you prepare your own detailed operations procedure based on the above material and your own knowledge of how your configuration operates.

9 MAINTENANCE

All the components of the scan system (less the laser) are designed to be maintenance-free with the exception of cleaning exposed optics. Only daily safety inspections are recommended for fixed installations. If the system is moved, do static, first power-up, and alignment procedures on the unit. See section 7 Final Configuration & Test Procedures for details.

Perform all of the following inspections with laser power Off.

9.1 Periodic Maintenance

Like any high quality optical system, it is important that care be exercised in handling the equipment to minimize system degradation and possible hazards. For optimum performance, all optics must be clean. Some optical coatings, however, are delicate and can be damaged by frequent cleaning.

9.1.1 Initial Service

If you suspect after the first day or minutes of operation that there is contamination, inspect the XY module by shining a light source through the input and output apertures. Do not remove the XY module cover.

Examine the XY mirrors to determine the extent of contamination. If the mirrors are contaminated, consult the factory to arrange for a cleaning by GSLI personnel. You should also examine the lens face towards this module and clean if necessary. Do not remove other assemblies. Evidence of contamination may be useful in developing alternate maintenance.

All contamination on optical surfaces must be removed prior to operation or serious damage and/or hazard may result.

9.2 Recommended Daily Service

- Check that all cables and connections are intact.
- Visually inspect safety enclosures for improper cracks and gaps.
- Perform any procedures required by the laser manufacturer.
- Check all adjustment screws to make certain they have not been tampered with. A torque sealant is recommended for this.

9.3 Lens / Protection Glass Cleaning

Optical materials and coatings are relatively soft and incorrect cleaning techniques can lead to surface damage and drastically reduced component life.

Surface contamination can be of different kinds:

- Dust, grease and other air-borne particles.
- Products from the laser process - back spatter or burned-in particles.
- Organic contamination caused by talking, coughing or sneezing near the exposed optical surface.

The primary goal is to avoid any contamination by appropriate protection of the exposed optics!

The basic cleaning technique described here is intended to help prolong the component life by minimizing surface damage during the cleaning process.

Special care should be exercised in cleaning a lens that does not have a protection window

9.3.1 Basic Cleaning Procedure

Make sure that the laser is off before performing any inspections! Wear finger cots or cotton gloves when handling optics for inspection.

1. Surface dust and loose particles must be blown form the component using an air bulb, ideally one with a non-return valve.
2. Always use cloth or cotton buds which are moistened with pure acetone. Never use cleaning materials that are dry.
3. Use a soft, lint-free lens cloth. The cloth must be moistened with pure acetone, laid gently on one edge of the component and drawn in a continuous movement to the opposite edge. **DO NOT APPLY PRESSURE or RUB! Rubbing may cause permanent surface marks.**
4. Blow away residue liquid in one direction with an air bulb.
5. Make sure that no visual contaminants remain on the optical surface.
6. Stubborn stuck-on particles may require an attempt to dislodge them by the local application of a cotton bud moistened with pure acetone. Repeat (3) after dislodgement.
7. Organic contamination cannot usually be removed using solvents such as acetone. The residue should be removed using distilled water and a lens cloth prior to finishing per (3) above.

9.3.2 Back-spatter / Burned-in Damage

Some forms of back-spatter can be reduced or removed using the basic cleaning process. In general, however, metallic back-spatter or laser-burned-in damage cannot be removed by cleaning. If the extent of the contamination is sufficient to cause process problems (e.g. thermal lensing), then consideration should be given to replacement of the contaminated component. Contact GSILumonics Customer Support or protection window supplier for information on replacing the protection window.

9.4 Mirror Cleaning Procedure

Although the mirrors can be replaced by the user, we **do not recommend** you do so. Furthermore, GSI Lumonics **does not recommend cleaning front surface mirrors.** Mirrors damaged by cleaning are **not included under the warranty**. The surface of these mirrors damage easily. Prevention of hard dust particles from being entrained in the process and causing scratches is difficult. In many cases, small defects in the mirror's surface may be less harmful than the surface damage resulting from continued cleaning. Cleaning requires special equipment typically not available to typical users.

There are times, however, when cleaning the mirror becomes a necessity, e.g. stains such as fingerprints must be removed immediately to prevent permanent etching of the reflective surface. The information below includes general recommendations for those special occasions when mirrors must be cleaned.

Remove lint from mirrors with a jet of low pressure clean air or nitrogen. Blowing on front surface of mirrors with mouth deposits moisture that may stain the finish.

A thin overcoating of silicon monoxide protects most mirrors from oxidation. Like many optical coatings, it is easily damaged when attempts are made to clean the mirror surface with a dry tissue.

The safest method of cleaning is to place a piece of lens tissue wet with reagent grade (highly pure) alcohol. Lay the wet tissue over the surface of the mirror, gently agitate it, then slide the tissue off. If an uneven film remains when dry, repeat the process, but use a jet of low pressure clean air or nitrogen to quickly spread remaining liquid. This should remove the problem blemishes.

- Note that the mirror is not rubbed.
- Do not let solvent enter the bonded zone of the mirror.
- Do not let solvent enter the scanner bearings. When wetting the mirror's surface, hold the Scanhead at an angle so that the liquid does not wet the scanner. If any solvent is found in the bearings of the scanner, the warranty is voided.

10 GLOSSARY

Dynamic Focus Module: The Dynamic Focus Module contains a lens cell (the dynamic expansion lens) that translates along its optical axis under the precise control of the linear translator. The linear translator, like the X and Y scanners, is a galvanometer-driven device, a closed-loop, limited rotation, servomotor.

Galvanometer: A scanner with limited rotation magnetic torque motor with position feedback. The galvanometer (galvo) rotates a mirror to direct the laser beam.

HC/3: A PC based board that provides the hardware link between your PC and the HPLK. The HC/3 is fully compatible with PC-MARK MT (multi-tasking) or WinMCL software.

HPGL: HP® Graphics Language, a graphics format which PC-MARK MT can translate into vector data for scanning.

HPLK: High Performance Laser Kits Scanning system for variable field sizes utilizing Z-axis dynamic focusing. Complete beam positioning packages also include an XY End-User Scanhead, PC resident HC/3 card, PC-MARK MT or WinMCL software, and MiniSAX servo electronics.

MiniSAX: The MiniSAX is the power interface between the galvanometers and the stream of digital commands output from the D-to-A card. The D-to-A card obtains its digital commands from the PC through the HC/3 card.

Objective Lens: The objective lens expands the laser beam and refocuses it through the XY Scanhead at a fixed distance onto the target plane.

XY Scanhead: The end user XY Scanhead deflects the laser beam in the X and Y axes under the control of the X and Y galvanometers that are attached to the mirrors. These galvanometers are closed loop, limited rotation, servomotors.

Software:

MMCL: A low level program that serves to optimize and output vector lists according to a set of parameters when scanning is initiated. Resulting control of the scanners and laser system are synchronized in real time.

WinMCL: Developer level, Windows© NT based macro command language. Programs can be written in a Visual C++ environment to invoke positioning. The language also supports some laser control features. It interfaces with both the HC/2 and HC/3 card.

PCMark MT: (multi-tasking) A powerful front-end macro command language. PC-MARK MT accepts application commands to place text and graphics in the marking field and translates them into the appropriate lists of vectors. Users may also write their own PC-MARK MT programs in any one of many popular software languages. MMCL is utilized as the link to the HC/3 card.

Job Editor: A menu-driven application program of PC-MARK MT that provides an extensive graphics user interface and file management. It allows the user to manipulate HPGL based graphics with an accurate real preview of one's job.

11 APPENDIX A: SPECIFICATIONS

11.1 HPLK Performance

The following table describes the theoretical performance of the HPLKs described in this manual at two example field size settings. Optical performance criteria are based on the design equations for each particular lens set.

	HPLK 1330-9		HPLK 1330-17		HPLK 1350-9		HPLK 1350-17	
Laser / Wavelength	CO_2 infrared 10,600 nm		CO_2 infrared 10,600 nm		CO_2 infrared 10,600 nm		CO_2 infrared 10,600 nm	
Field Size Range (mm x mm) [1]	10 to 2,000		10 to 2,000		10 to 2,000		10 to 2,000	
Example Fields	**Small**	**Large**	**Small**	**Large**	**Small**	**Large**	**Small**	**Large**
Field Size (mm x mm)	100	400	100	400	100	400	100	400
Working Distance (mm)	111.3	449.9	84.1	449.9	73.8	464.5	73.8	464.5
LT to Head Spacing (mm)	219.6	172.2	154.5	112.4	315.6	275.2	318.0	240.0
Correction-File Name	c100b1	c400b1						
Input Beam Diameter (mm)	9	9	17	17	9	9	17	17
Spot Size Diameter (μm) [2]	112	310	97	295	96	202	76	207
Max Power, CW (W/cm^2)	450	200						
Max. Pulse Power 100ns (MW/cm^2)								
Writing Speed* (mm/s) [3]	400	1700	400	1700	Contact	Contact	Contact	Contact
Repeatability (μm) [4]	3	12	3	12	3	12	3	12
Resolution (μm) [5]	3	12	3	12	3	12	3	12
***Note CO_2 HPLKs (above) are available with Beryllium Mirrors, contact factory for more details.**								

	HPLK 2330		HPLK4320		HPLK5320			
Laser / Wavelength	YAG infrared 1,064 nm		HeCd ultraviolet 325-350 nm		Ar^+ visible 488-514 nm			
Field Size Range (mm x mm) [1]	30 to 3,000		100 to 2,500		100 to 2,500			
Example Fields	**Small**	**Large**	**Small**	**Large**	**Small**	**Large**	**Small**	**Large**
Field Size (mm x mm)	100	400	200	800	200	800		
Working Distance (mm)	102.35	522.72	244.0	1085	244.0	1085		
LT to Head Spacing (mm)	91.6	78.4	89.9	39.4	171.3	118.6		
Correction-File Name	yag100b1	yag400a1	uv200b1	uv800b1	ar200a1	ar800a1		
Lens configuration (YAG only)	3+2 lenses	3+1 lenses						
Input Beam Diameter (mm)	9	9	1.3-3.3	1.3-3.3	2.4	2.4		
Spot Size Diameter (μm) [2]	15	40	10	32	14	60		
Max Power, CW (W/cm^2)	150	150	80	80	80	80		
Max. Pulse Power 100ns (MW/cm^2)	100	100	N/A	N/A	N/A	N/A		
Writing Speed (mm/s) [3]	400	1700	1200	4500	1200	4500		
Repeatability (μm) [4]	3	12	6	24	6	24		
Resolution (μm) [5]	3	12	6	24	6	24		

1. For Field Size requirements beyond this range contact GSI Lumonics
2. Theoretical value with input beam quality (M^2) < 1.5
3. Preliminary writing speed.
4. Preliminary
5. Value represents 2 bit resolution in a16 bit system.

Please note that all performance specifications are based on theoretical calculations.

A definition of the specific terms associated with laser scanning in the above performance chart follows:

Laser: The mirrors and lenses in each HPLK series are designed for a specific laser wavelength. To characterize a laser, the following are required:

- Wavelength to determine coatings and optical materials used in the system.
- The maximum allowable laser beam power for the optical system of the HPLK, specified as Continuous Wave or Peak Pulsed Watts.

Configuration: The first digit of the HPLK model number is the type laser to be used with the HPLK. For example, HPLK11xx is for CO_2 laser. The second digit represents the electronics included in the package. The last two digits define the mirror size.

Field Size: The size of the target field that may be scanned, defined in terms of the total peak-to-peak X and Y target.

Input Beam Diameter: The diameter of the laser beam as it enters the dynamic expansion lens can be computed from the laser divergence and the distance between the laser output window and the dynamic focus lens.

Clear Aperture: This is the maximum allowable diameter that laser radiation is allowed to occupy when entering the system. The user should prevent exceeding this with a beam stop if necessary.

Spot Size: The diameter of the laser spot at the target field (The 25% peak irradiance contour is a typical criteria).

Scan Radius: The distance from the scan element (mirror) to the target plane. In two-mirror scanning, the scan radius is the distance from the Y mirror to the point on the target plane where the line intersects perpendicularly. The variable D is used for this dimension.

Writing Speed: The maximum speed the laser spot can achieve on the target field while staying within the line straightness specifications.

Jump Speed: The maximum speed while accelerating to full speed within two spot diameters of travel.

Line Straightness: The local straightness errors occurring within a scanned length 1/10 of the field size.

Position Accuracy: The deviation from true position of a line over the full field, including bow.

Repeatability: The difference in the acquired positions when a scanner repeatedly accesses the same coordinate, measured for a period of five minutes.

Resolution: The smallest possible beam movement. This is limited by the resolution of the DAC.

11.2 LT1320A Performance

	VALUE		DESCRIPTION
Linearity	±0.0015"	±0.038mm	Deviations from true optical axis position.
Resolution	±0.0015"	±0.038mm	Linear motion resulting from a core bit step: travel/256 bits.
Repeatability	±0.0005"	±0.013mm	Accuracy with which the translator can be returned to its former position.
Aperture	.512"	13 mm	Largest possible clear aperture of installed lens element or lens cell.
Travel:			Movement from one position to another.
Active	0.393" P-P	10.0 mm P-P	
Static Adds	±0.1911"	±4.85mm	
Speed:			Rate of change of position with time: dv/dt.
Random	0.591"	15 mm	Maximum velocity achievable while maintaining linearity.
Slew	15" /s	381 mm/s	Time to move between any two positions with 1% settling.
Mechanical Dimensions	2" x 5" x 3"	50.8 x 127 x 76.2 mm	L x W x H

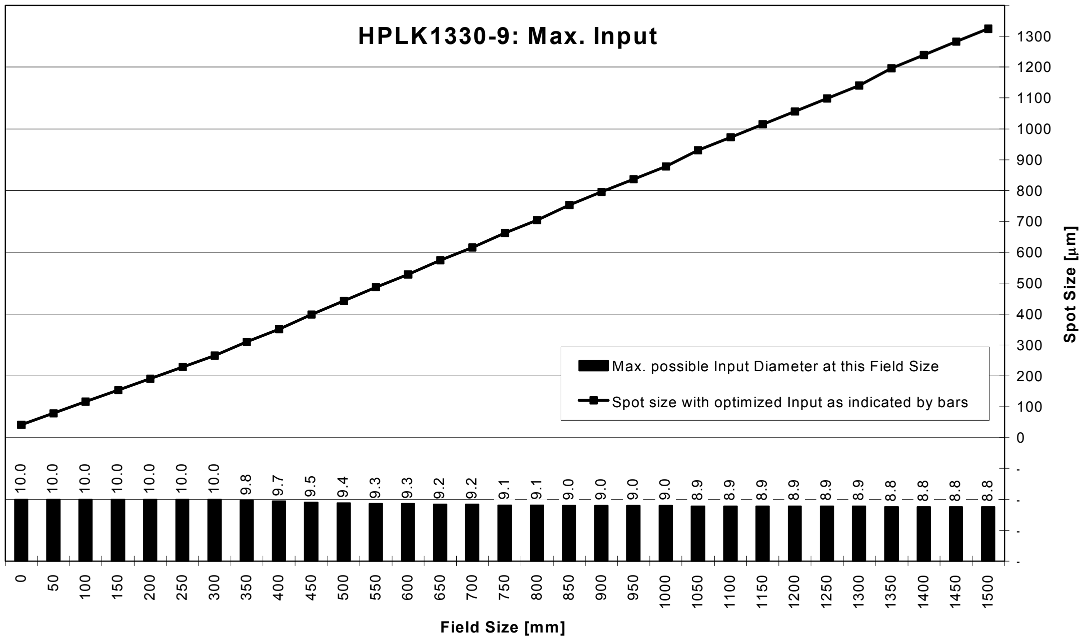
11.3 Mirror Specifications

	CO_2	YAG	UV	Ar^+
Mirror Aperture	30 mm, 50mm	30 mm	15mm, 20 mm	20 mm
Wavelength	10,600 nm	1,064 nm	325-360 nm	480-514 nm
Coating	Dielectric On Metal	Dielectric	Dielectric	Dielectric
Reflectivity (average) @ Wavelength (nm)	99% @ 10,600 80% @ 633	99.5% @ 1,064 80% @633	98% @ 325-350 95% @ 350-360 45% @ 633	98.5% @ 480-514
Flatness @ Wavelength	$\lambda/4$	$\lambda/4$	$\lambda/4$	$\lambda/4$
Power Capability, CW (W/cm²)	500	500	500	500
Pulse Power Capability, 100 ns pulse (MW/cm²)	100	100	100	100
Surface Quality (Scratch/Dig)	40/20	40/20	20/10	40/20

11.4 Beam Diameter / Field Size / Spot Size

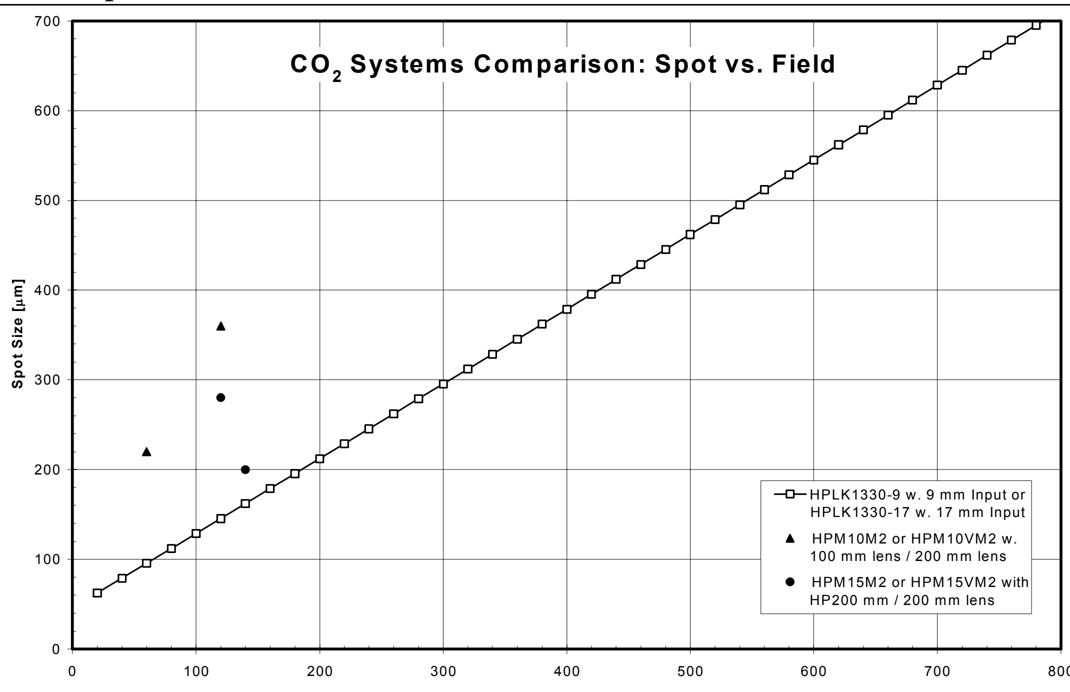
11.4.1 HPLK1330-9 (30mm CO_2)

The 9 mm aperture accommodates a larger beam which allows for increase power handling especially at smaller fields.



All data shown is based on theoretical modeling and is presented for relative comparison only!

11.4.2 Comparison: HPLK1330 and HPM10/15

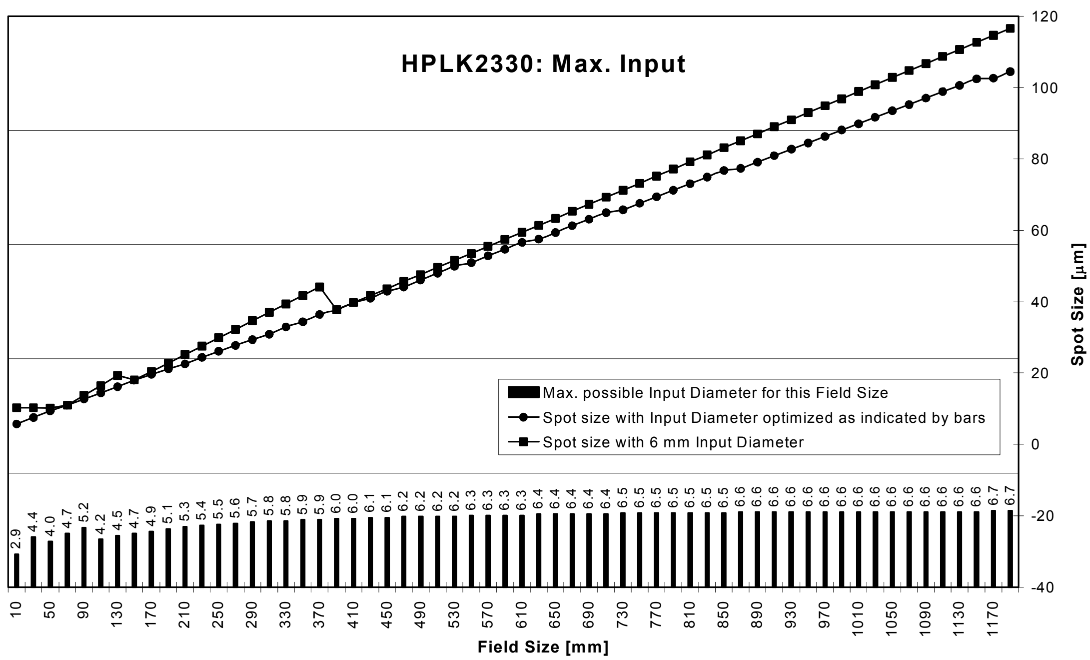


All data shown is based on theoretical modeling and is presented for relative comparison only!

11.4.3 HPLK2330 (30mm YAG)

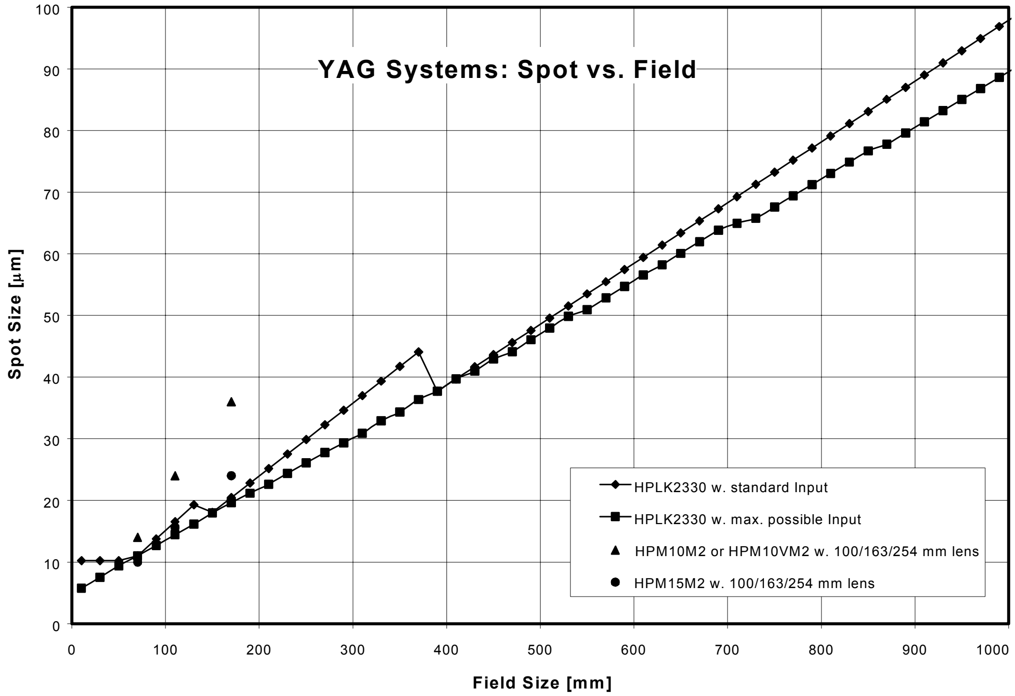
- The bars indicate the maximum input beam diameter which can be used for a specific field size
- The line through the circles shows the associated spot size
- The line through the squares indicate the spot size with the following:
  - ⇒ 6 mm diameter input beam for fields from 60 mm - 130 mm (3+3 elements; all lenses installed)
  - ⇒ 6 mm diameter input beam for fields 150 mm - 370 mm (3+2 elements; 1 lens removed)
  - ⇒ 6 mm diameter input beam for fields > 370 mm (3+1 elements; 2 lenses removed)

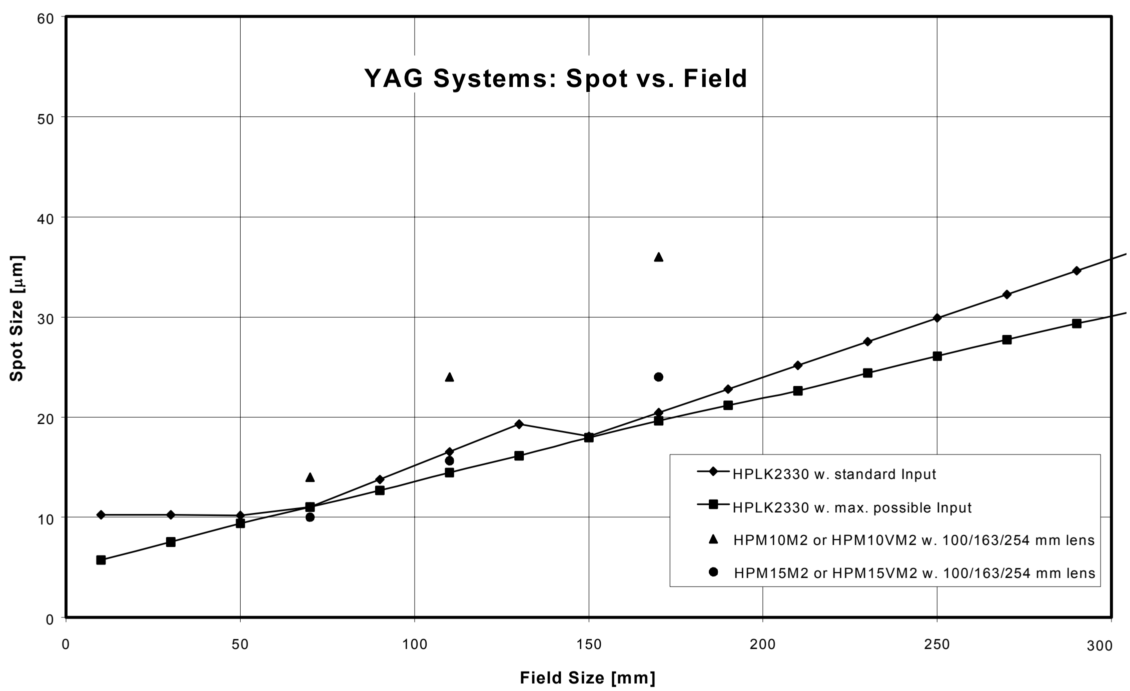
Minimum possible field size approximately: 10 x 10 mm with 3 mm input beam
Minimum possible field size approximately: 25 x 25 mm with 4 mm input beam
Maximum possible field size approximately: 3,000 x 3,000 mm



All data shown is based on theoretical modeling and is presented for relative comparison only!

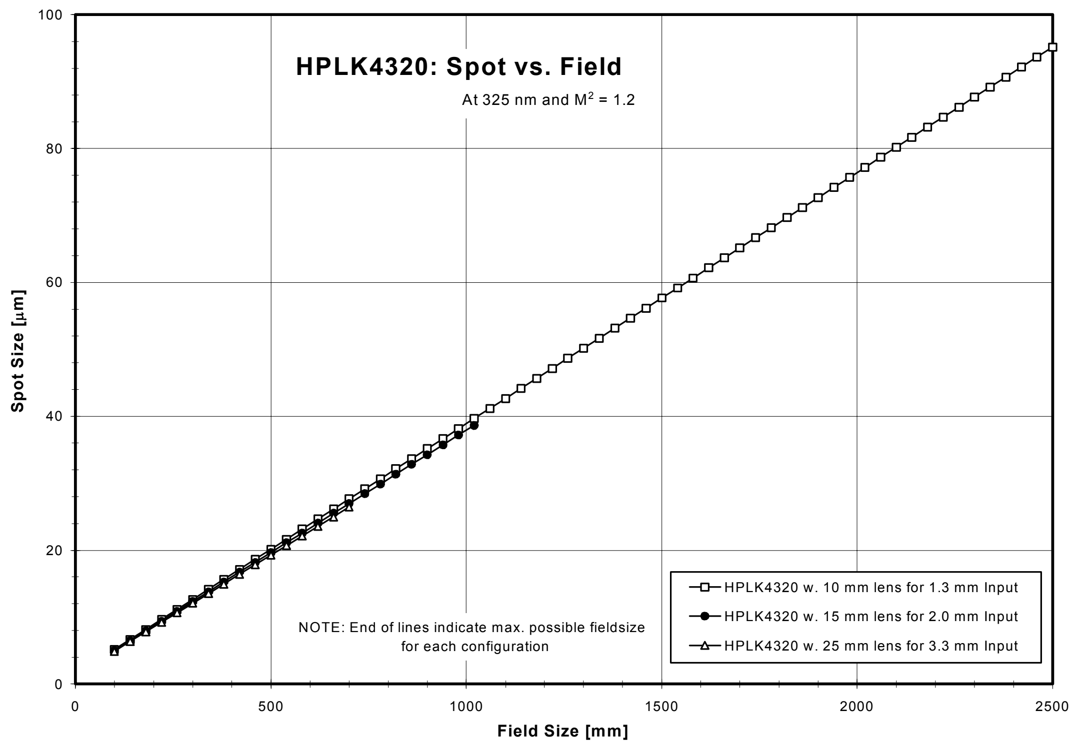
11.4.4 Comparison: HPLK2330 and HPM10/15





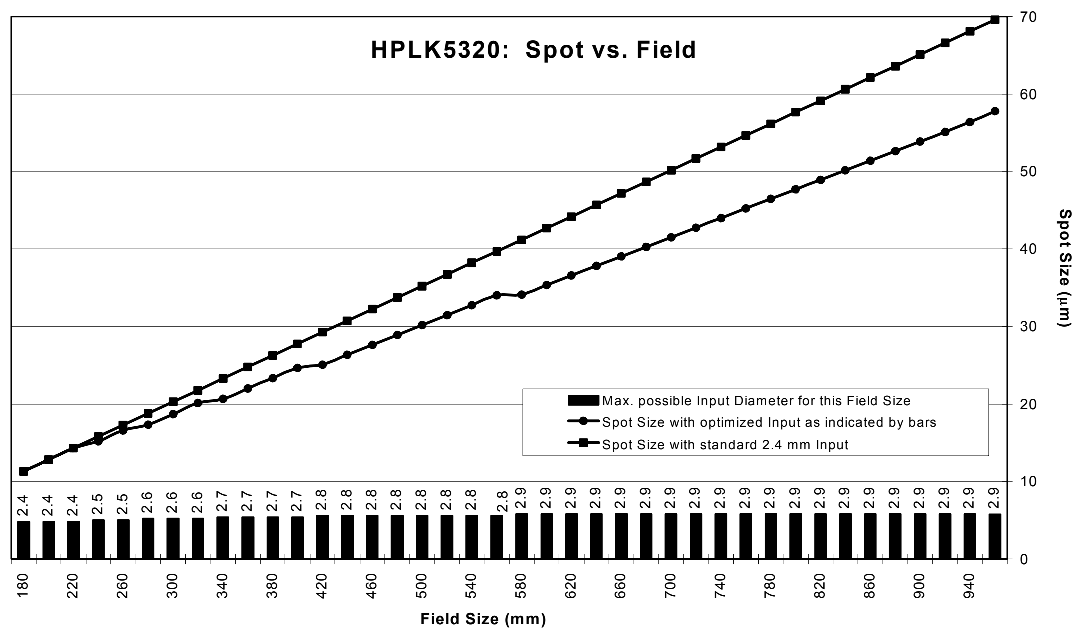
All data shown is based on theoretical modeling and is presented for relative comparison only!

11.4.5 HPLK4320 (20 mm UV)



All data shown is based on theoretical modeling and is presented for relative comparison only!

11.4.6 HPLK5320 (20mm Argon)



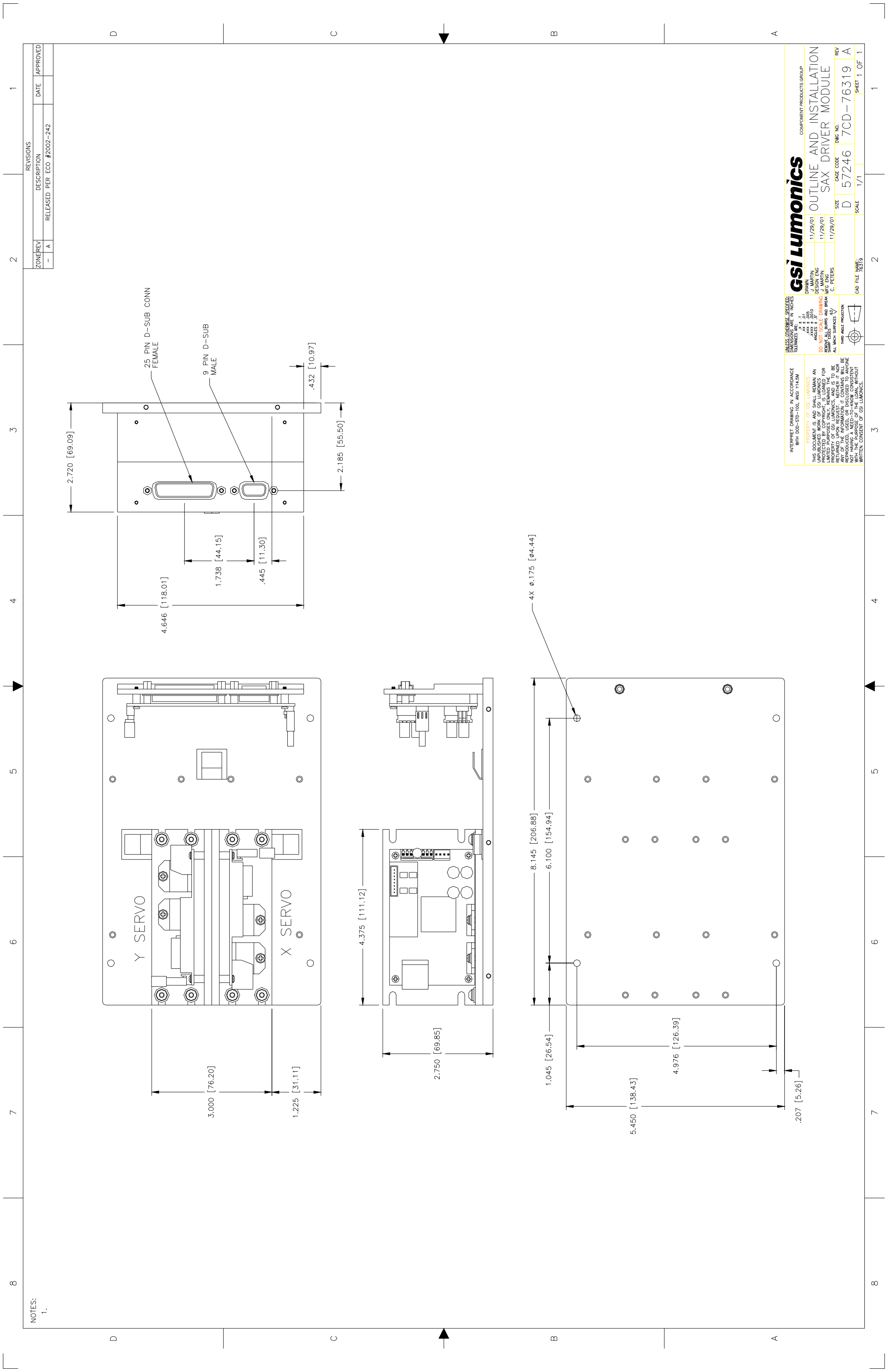
All data shown is based on theoretical modeling and is presented for relative comparison only!

12 APPENDIX B: OUTLINE DRAWINGS

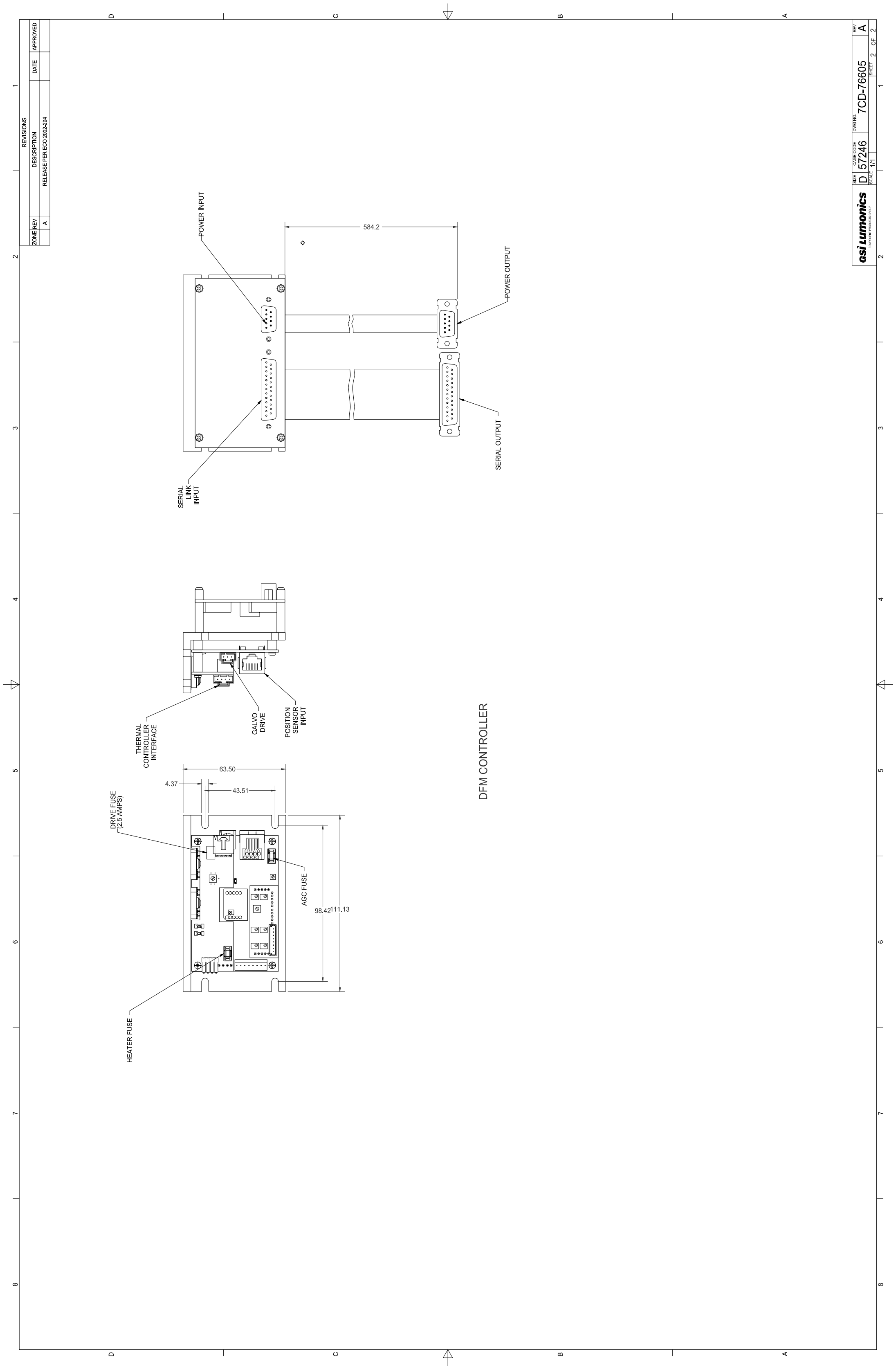
The chart below lists all the outline and installion drawings on the following pages. If you need furthur information please contact the Technical Service department of the GSI Lumonics Component Products Group.

Description	Drawing Number
XY Head MiniSAX Driver Module	7CD-76319
DFM MiniSAX Driver Module	7CD-76605
HPLK 1330-9, CO_2 30mm	7CD-76601
HPLK 1330-17, CO_2 30mm	7CD-76770
HPLK 1350-9, CO_2 50mm	7CD-76685
HPLK 1350-17, CO_2 50mm	7CD-76737
HPLK 2330, YAG 30mm	7CD-76611
HPLK 4315, UV 15mm	7CD-76658
HPLK 4320, UV 20mm	7CD-76741
HPLK 5320, AR 20mm	7CD-76749

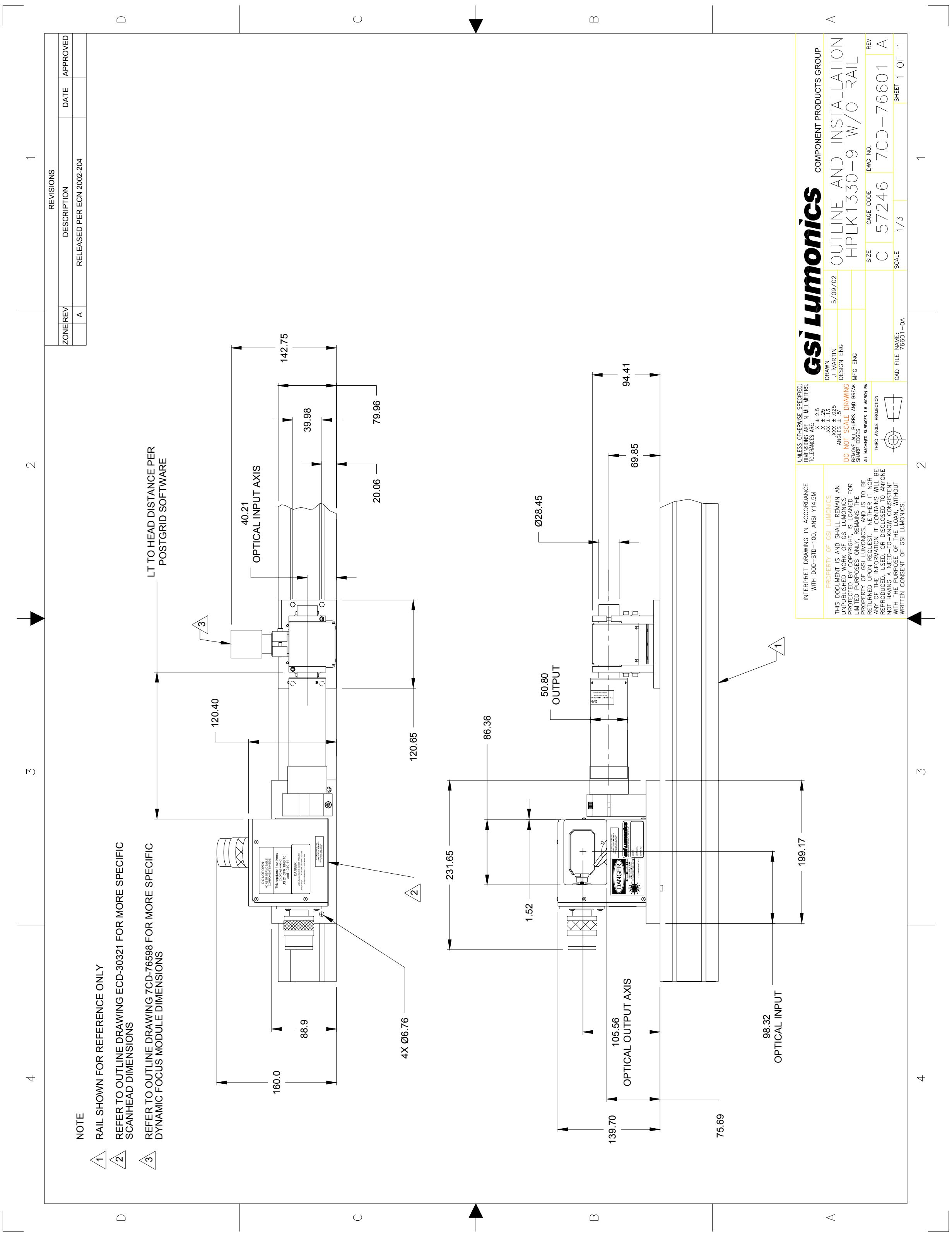
12.1.1.1 Outline Drawing: Dual MiniSAX Driver Module



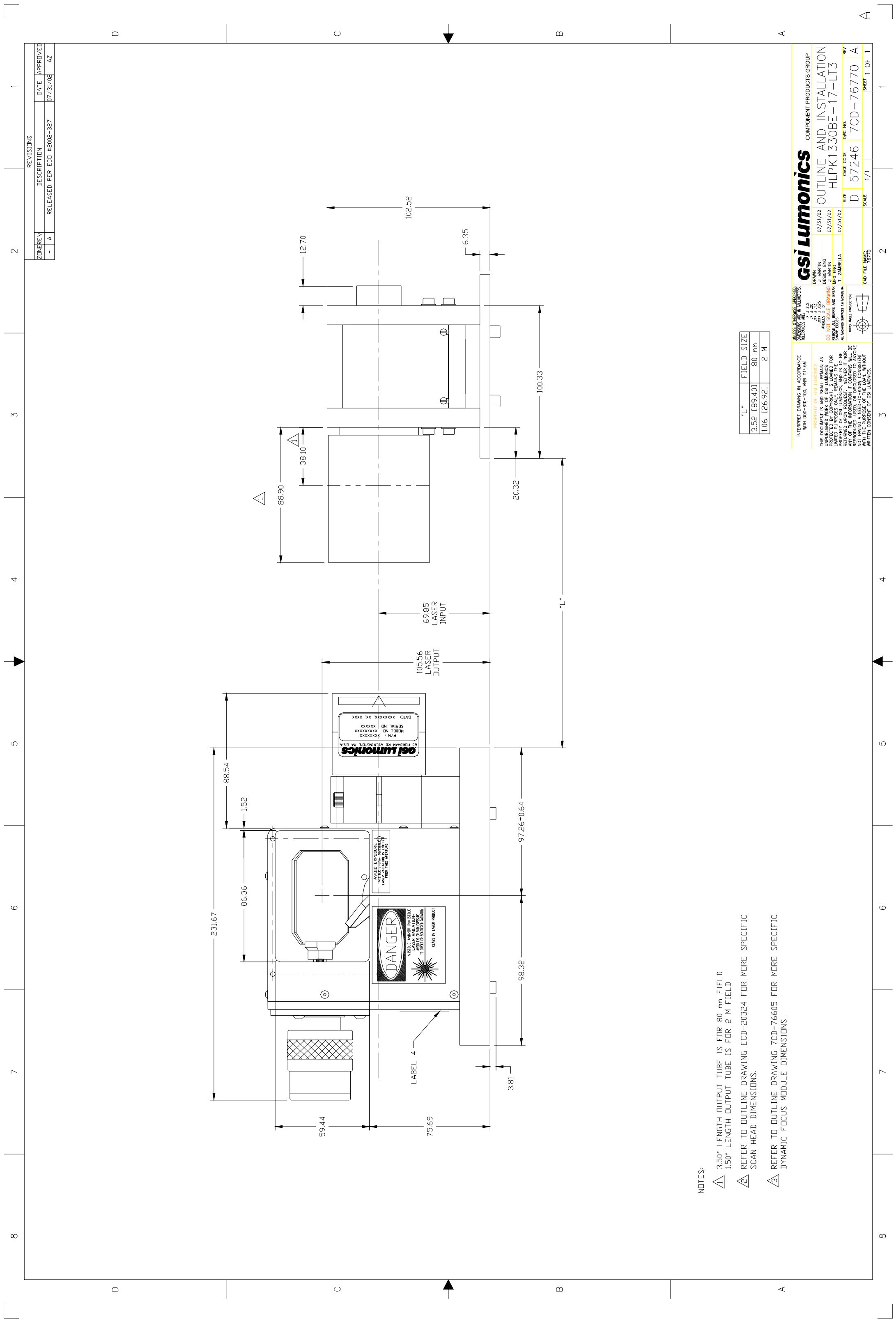
12.1.1.2 Outline Drawing: DFM MiniSAX Driver Module



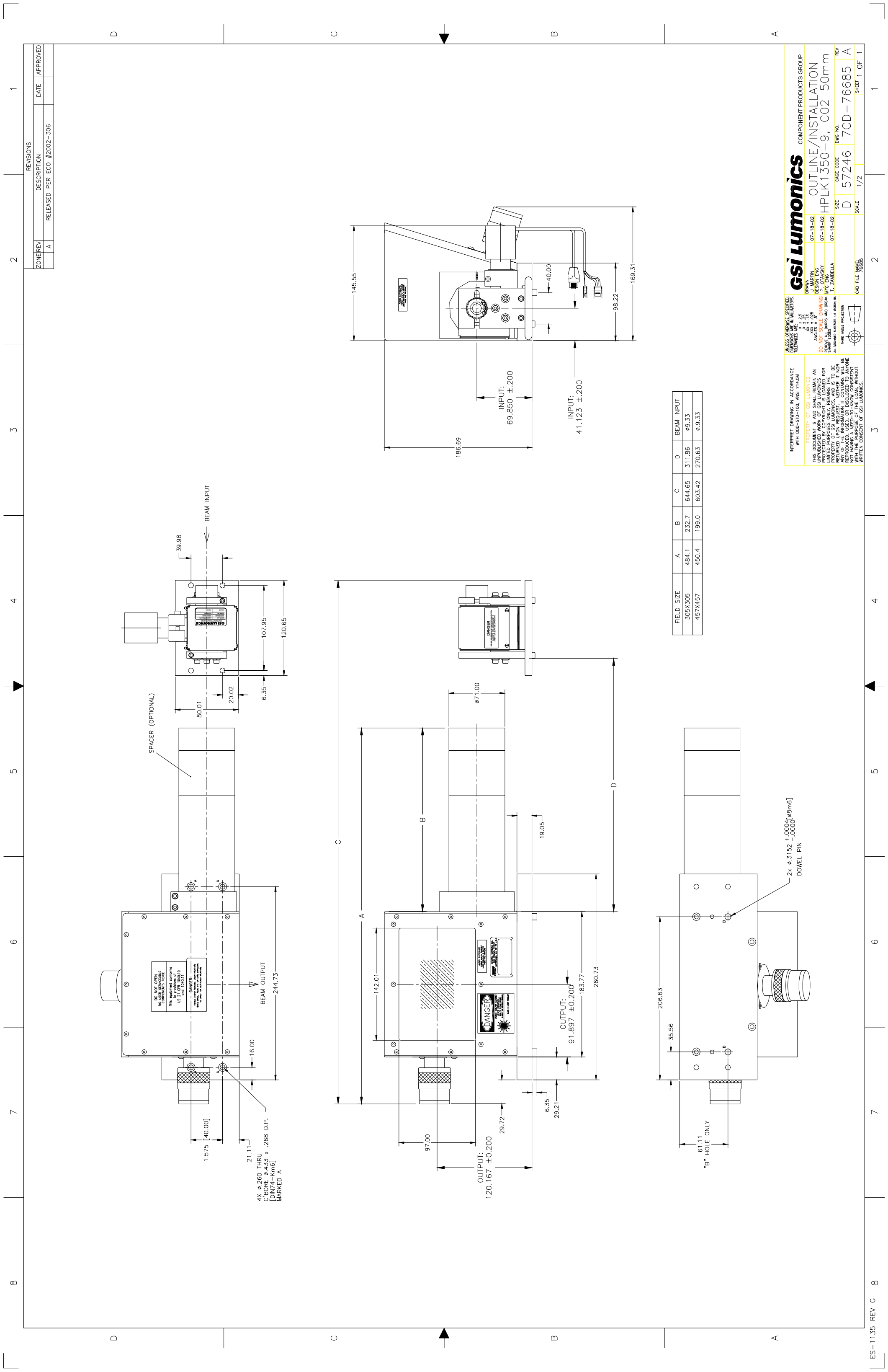
12.1.1.3 Outline Drawing: HPLK 1330-9, CO_2 30mm



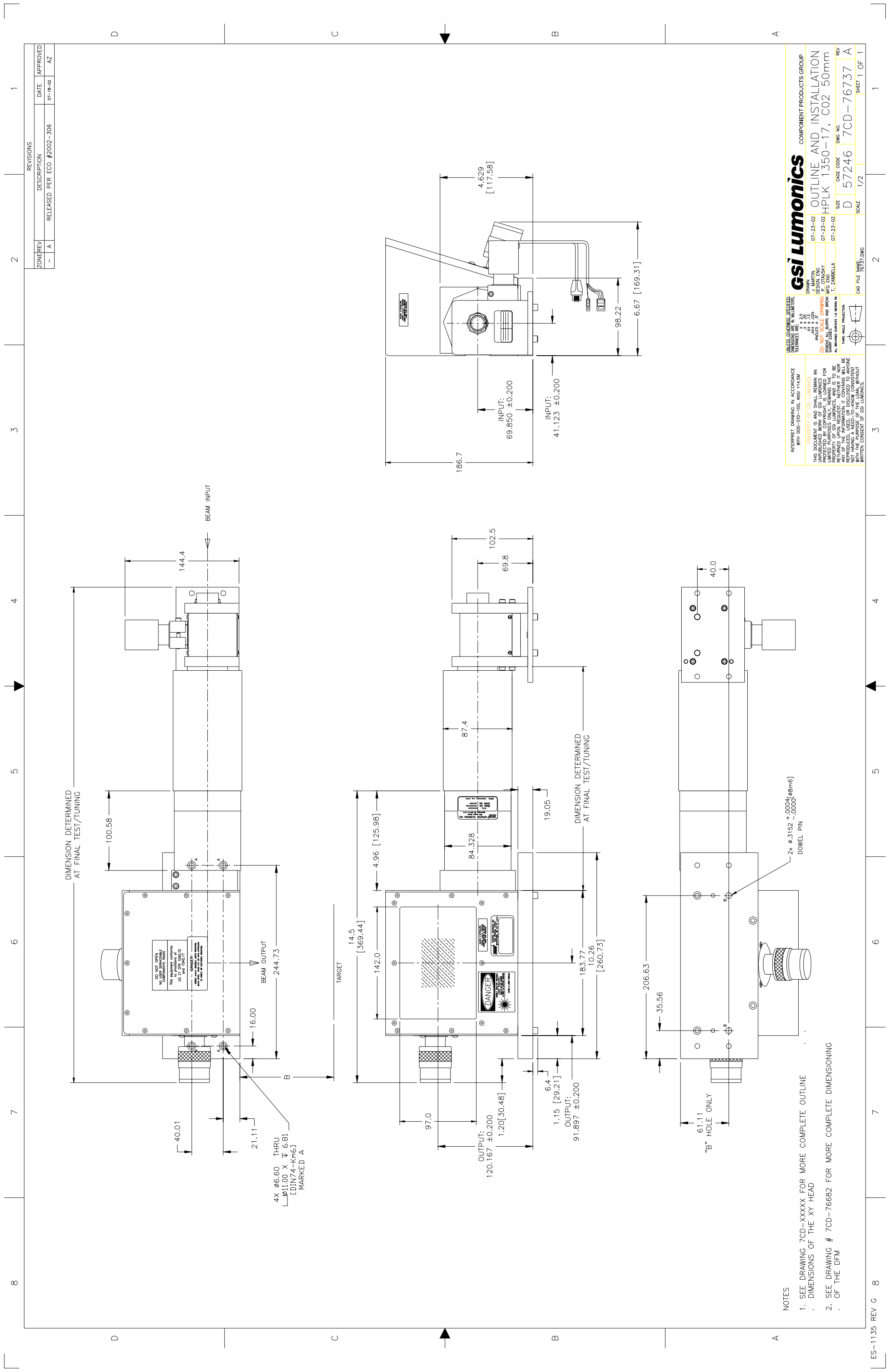
12.1.1.4 Outline Drawing: HPLK 1330-17, CO_2 30mm



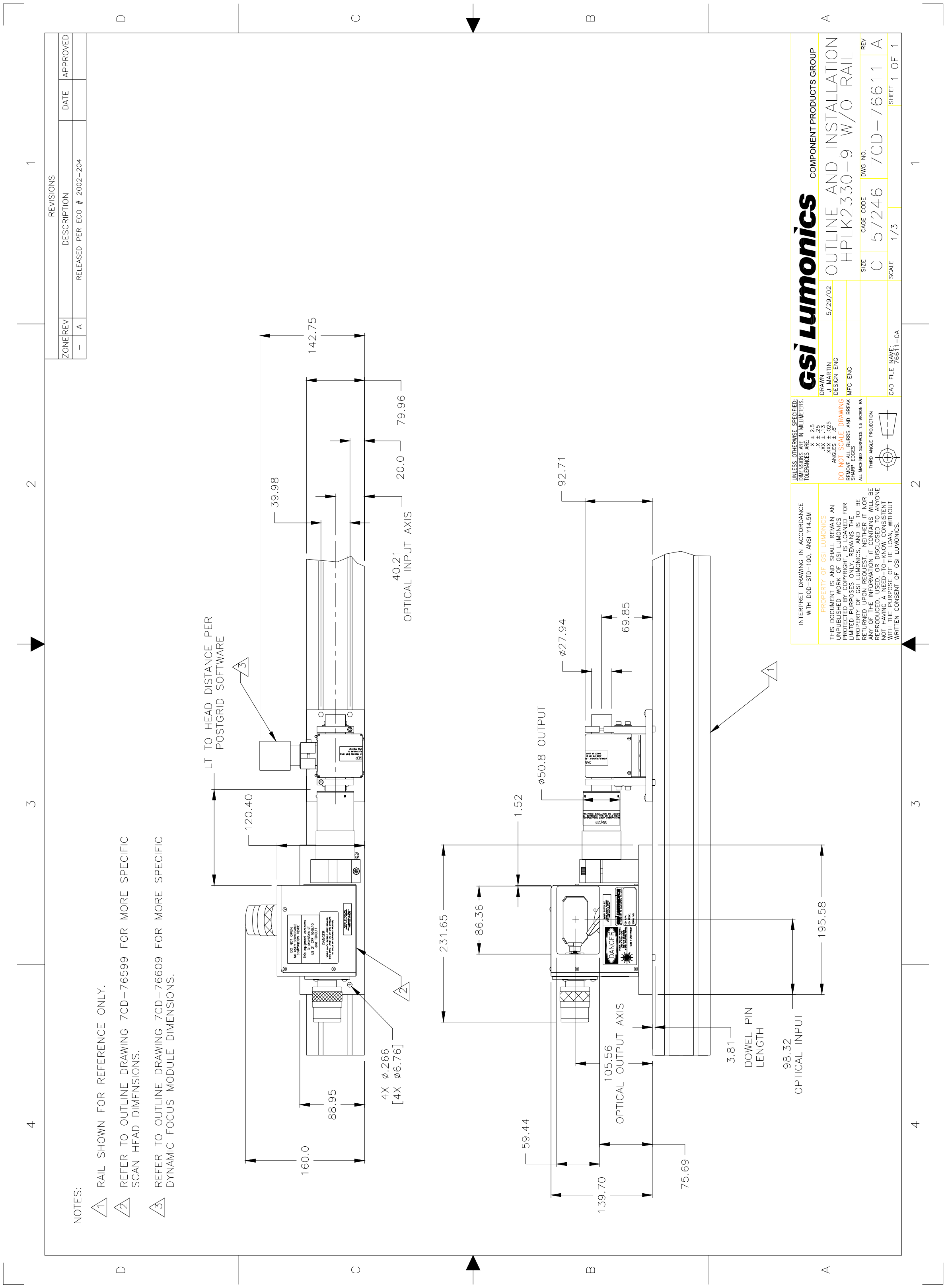
12.1.1.5 Outline Drawing: HPLK 1350-9, CO_2 50mm



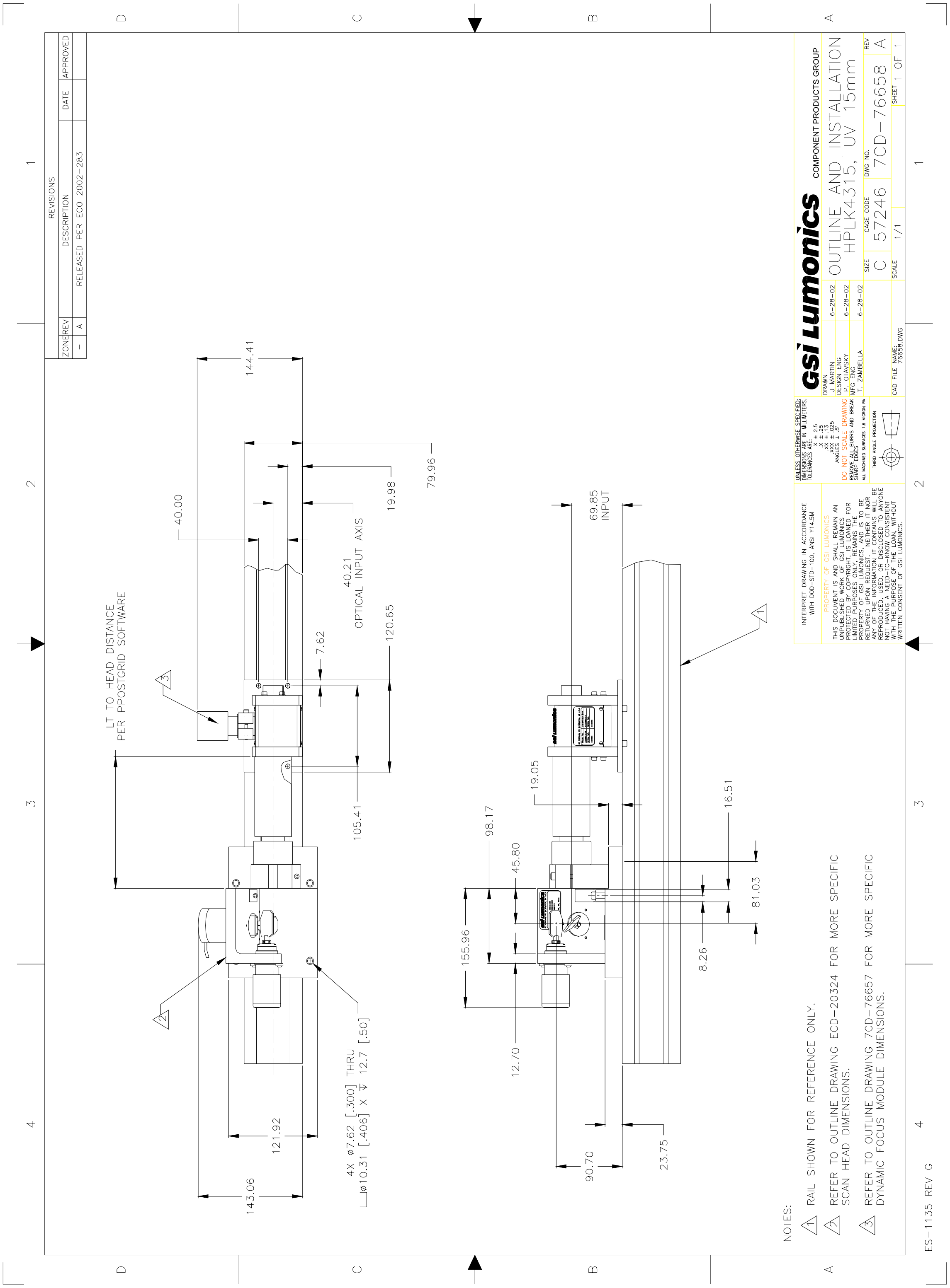
12.1.1.6 Outline Drawing: HPLK 1350-17, CO_2 50mm



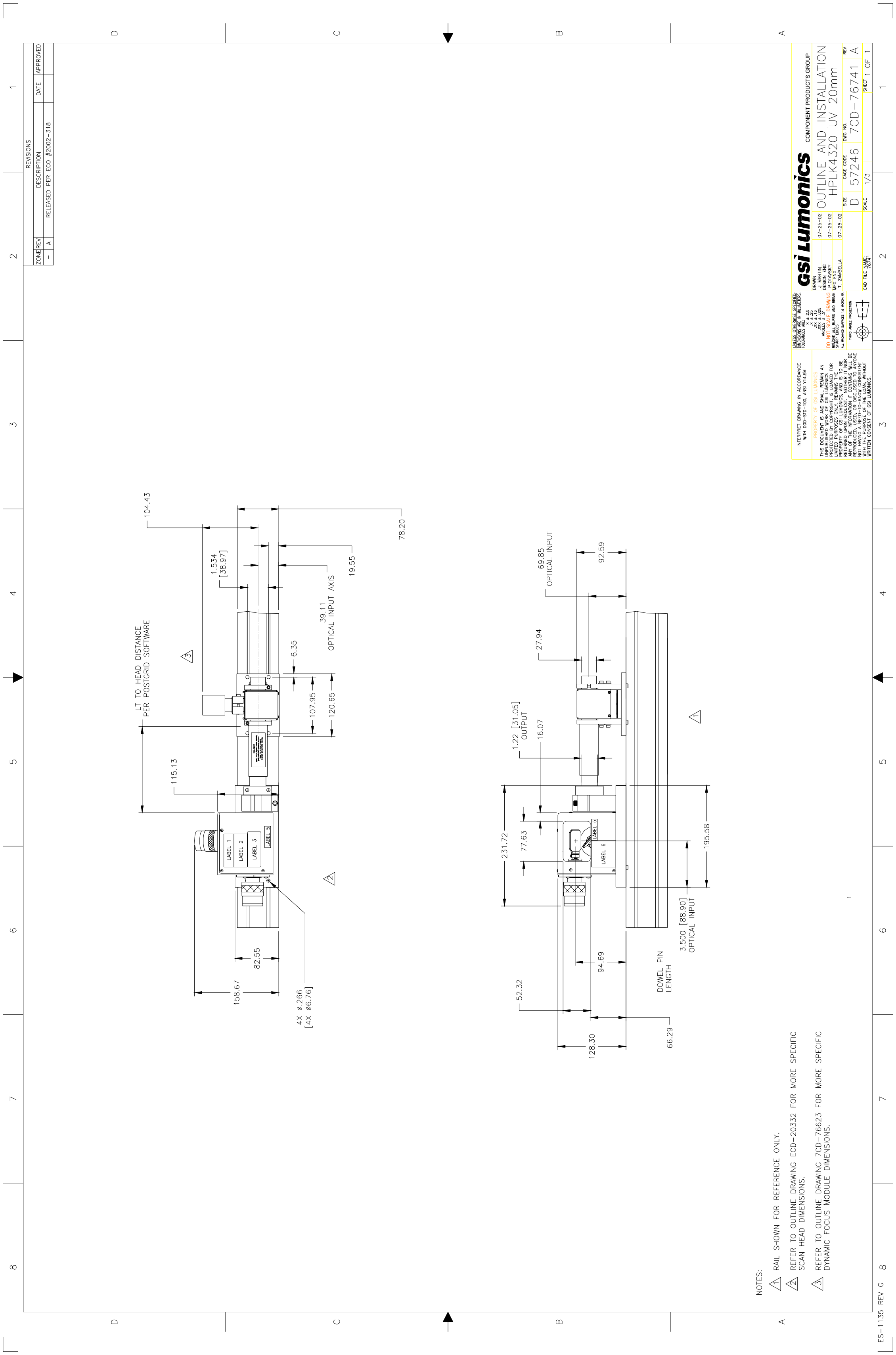
12.1.1.7 Outline Drawing: HPLK 2330, YAG 30mm



12.1.1.8 Outline Drawing: HPLK 4315, UV 15mm



12.1.1.9 Outline Drawing: HPLK 4320, UV 20mm



12.1.1.10 Outline Drawing: HPLK 5320, AR 20mm