



# DSIAC TECHNICAL INQUIRY (TI) RESPONSE REPORT

## Laser/Light-Emitting Diode (LED) Target Illuminator

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## ABOUT DSIAC

The Defense Systems Information Analysis Center (DSIAC) is a U.S. Department of Defense information analysis center sponsored by the Defense Technical Information Center. DSIAC is operated by SURVICE Engineering Company under contract FA8075-14-D-0001.

DSIAC serves as the national clearinghouse for worldwide scientific and technical information for weapon systems; survivability and vulnerability; reliability, maintainability, quality, supportability, and interoperability; advanced materials; military sensing; autonomous systems; energetics; directed energy; and non-lethal weapons. We collect, analyze, synthesize, and disseminate related technical information and data for each of these focus areas.

A chief service of DSIAC is free technical inquiry (TI) research, limited to 4 research hours per inquiry. This TI response report summarizes the research findings of one such inquiry. For more information about DSIAC and our TI service, please visit [www.DSIAC.org](http://www.DSIAC.org).

## ABSTRACT

The Defense Systems Information Analysis Center (DSIAC) received an inquiry requesting information on invisible lasers, light-emitting diodes (LEDs), or other technologies for target illuminators at technology readiness level (TRL) 6 or higher, preferably TRL 9. A DSIAC subject matter expert (SME) contacted a variety of original equipment manufacturers, government organizations, and contractors. Additionally, the SME searched the Defense Technical Information Center (DTIC) Research and Engineering (R&E) Gateway database, laser vendor websites collected from the Directed Energy Professional Society (DEPS), Photonics West Exhibitors, and well-known manufacturers in the field. The SME stated that there are many off-the-shelf fiber lasers that appear to satisfy the majority of the stated requirements. Typically, the most difficult requirement to achieve is the shock and vibration (mostly due to lack of information from the manufacturers), but the industrial nature of these lasers may make them suitable. Additionally, the power source for the lasers prove to be challenging as some require two- or three-phase power. Based on the SME's research, the IPG Photonics YLR-1000 laser appeared to be the best fit to the requirements and has been previously ruggedized by Fibertek, Inc. for use in an airborne application.

# Contents

<b>ABOUT DSIAC.....</b>	<b>ii</b>
<b>ABSTRACT .....</b>	<b>iii</b>
<b>1.0 TI Request .....</b>	<b>1</b>
1.1 INQUIRY .....	1
1.2 DESCRIPTION .....	1
<b>2.0 TI Response .....</b>	<b>2</b>
2.1 SUMMARY OF FINDINGS .....	2
2.1.1 OEMs.....	4
2.1.2 Fibertek, Inc. ....	5
2.1.3 DARPA .....	5
2.1.4 DTIC Search .....	6
<b>REFERENCES.....</b>	<b>7</b>

## 1.0 TI Request

### 1.1 INQUIRY

What technologies are available as a target-illumination laser, light-emitting diode (LED), or other for use on fixed-wing aircraft?

### 1.2 DESCRIPTION

The inquirer requested information on lasers, LEDs, or other technology for target illuminators at the technology readiness level (TRL) 6+, preferably TRL 9. The inquirer stated that the system would be used for target illumination for imagery and should meet the following specifications:

- The illuminator should be invisible to the naked human eye.
- The illuminator should also operate in the 1.0–1.6  $\mu\text{m}$ /short-wave infrared (SWIR) part of the spectrum.
- The optical output power should be approximately 1 kW continuous wave (CW).

The inquirer also requested information regarding size, weight, and power (SWaP) and operational considerations/limitations, such as vibration, altitude, temperature, etc.

## 2.0 TI Response

A Defense Systems Information Analysis Center (DSIAC) subject matter expert (SME) contacted several U.S. government agencies and industrial companies to request information on a target illuminator that met the inquirer's specifications, including the following:

- Defense Advanced Research Projects Agency (DARPA).
- Directed Energy Joint Technology Office (DE-JTO).
- Directed Energy Professional Society (DEPS).
- Coherent, Inc.
- RPMC Lasers.
- Fibertek, Inc.

The SME also searched the Defense Technical Information Center (DTIC) Research and Engineering (R&E) Gateway database for information from original equipment manufacturers (OEMs), academia, the U.S. Department of Defense (DoD), and other government agencies. Additionally, the SME searched laser vendor websites collected from DEPS, Photonics West Exhibitors, and well-known manufacturers in the field. Pertinent findings were summarized and compiled in this report.

### 2.1 SUMMARY OF FINDINGS

Table 1 summarizes the lasers identified by DSIAC that potentially meet the inquirer's requirements. There are many commercial off-the-shelf (COTS) items that generally meet most of the requirements but may need to be modified for appropriate platform requirements. Most systems do not provide information regarding environmental ruggedness besides temperature and humidity as shock and vibration data are not present. Furthermore, many of the systems identified in Table 1 require alternating current (AC) power—at times, two-phase or three-phase—due to the large optical powers generated along with separate liquid cooling units (not included in SWaP). The DSIAC SME noted that due to the limited time given to complete this search and the lack of response from some of the contacted contractors, there are likely more ruggedized versions of industrial lasers available from companies such as Raytheon, Lockheed, and Northrop Grumman. However, the IPG YLR-1000 laser, identified in Table 1, appears to meet the inquirer's system requirements and was previously ruggedized by Fibertek for use in an airborne application. Specifically, Fibertek, Inc. ruggedized the YLR-1000 for mounting in an Apache helicopter[1].

**Table 1: Comparison of Potential Laser Systems [2–8]**

Manufacturer	Model number	Wavelength (nm)	Output power (watts)	Volume (mm × mm × mm)	Weight (kg)	Beam quality	Wall plug efficiency
IPG [2]	YLR-1000	1070	1000	448 × 680 × 177	70	1.1	--
	YLR-1500		1500				
IPG [3]	ELS-2000	1567	2000	856 × 806 × 1206	350	--	18%
SPI Lasers [4]	redPower Prism 1 kW	1075–1080	1000	2 U (88 mm) × 445 × 550	--	1.1	~30%
	redPower Prism 1.5 kW		1500	2 U (88 mm) × 445 × 702			
	redPower Prism 2 kW		2000	2 U (88 mm) × 445 × 702			
nLight [5]	CFL-1000	1070	1000	480 × 677 × 177	--	1.1	--
	CFL-1200		1200				
Lumentum [6]	YLE2100	1080	2100	--	--	--	--
Coherent [7]	HighLight FL1000CSM	1070	1000	751 × 953 × 584	150	--	~30%
	HighLight FL1500CSM		1500				
	HighLight FL2000CSM		2000				
	HighLight FL2500CSM		2500				
Laserline [8]	LDM Line	900–1080	1000	480 × 220 × 636	50	--	~25%
			2500	480 × 220 × 636			
			3500	480 × 220 × 636			

Manufacturer	Model number	Wavelength (nm)	Output power (watts)	Volume (mm × mm × mm)	Weight (kg)	Beam quality	Wall plug efficiency
			5000	480 × 220 × 705	110		
			6000	480 × 220 × 705	110		
Convergent Photonics [9]	CF1000	1070–1080	1000	501 × 89 × 787	23.5	--	32%

### 2.1.1 OEMs

#### IPG Photonics

IPG Photonics is one of the most popular fiber laser companies for both DoD and industrial applications. While their ELS-2000 series of fiber lasers provides a source in the 1567-nm band, it requires three-phase power and has a high SWaP [3]. However, the YLR-1070 series is rack mounted, has relatively low SWaP, and was previously installed in aircraft [1, 2].

#### SPI Lasers

SPI Lasers of the United Kingdom sells industrial laser systems. Their redPOWER prism series of lasers is rack mounted, has relatively low SWaP, and runs off 48 volts of direct current (VDC) [4].

#### nLight

nLight is a semiconductor and fiber laser company that produces a single-mode, rack-mounted fiber laser that seems to fit most of the requirements for this application. However, it requires 200–240 volts of alternating current (VAC) and is not rugged [5].

#### Lumentum

Lumentum is an optical component company that primarily builds laser transmitter components. Their Corelight series of fiber lasers is rack mounted. The company’s datasheets provided limited information, but they are one of the few manufacturers that provided specifications for shock and vibration [6].

#### Coherent

Coherent is a large industrial and scientific laser manufacturer and has numerous products across both pulsed and continuous wave systems, from ultraviolet through infrared. The HighLight FL Single Mode Series of lasers best meets the inquirer’s requirements; however, these lasers require three-phase AC power and large cooling units, and their SWaP may limit their applications [7].



### Laserline

Laserline is a German company that produces industrial lasers. Their LDM series has high power, but has a large SWaP and requires three-phase power [8].

### Q-Peak

No information on this type of laser was available on the Q-Peak website, although the DSIAC SME noted that they may have potentially built suitable lasers on government contracts.

### Raytheon

Although it was not possible to contact Raytheon Electronic Systems within the timeframe of the request, it is known that they have previously built tracking illuminator lasers (TILLs) for the Airborne Laser Program (ABL).

### Northrop Grumman

Although it was not possible to contact Northrop Grumman Space Systems within the timeframe of the request, the DSIAC SME noted that they have previously built beacon illuminator lasers (BILLs) previously for the ABL.

### Furukawa Electric

It was not possible to contact Furukawa Electric, a Japanese electronics company, but the DSIAC SME noted that they do produce high-power industrial lasers.

### Convergent Photonics

Convergent Photonics is an industrial laser manufacturer whose CF series of fiber lasers is the closest fit to the requirements. The system is rack mountable, has the lowest stated SWaP of any of the observed systems, and requires one-phase 90/230/264 VAC [9].

## 2.1.2 Fibertek, Inc.

Fibertek is a contract laser manufacturer, not an OEM. They expressed that they could create a custom laser with the specifications, but it most likely wouldn't be necessary as IPG Photonics has a suitable laser. However, the IPG laser is potentially not as rugged as would be required. Fibertek has worked with a government customer to modify a COTS laser, so it met airworthiness requirements to be mounted in an Apache helicopter [1].

## 2.1.3 DARPA

DARPA's Autonomous Real-Time Ground Ubiquitous Surveillance–Infrared (ARGUS-IR) aimed to provide persistent surveillance, high-resolution aerial infrared photographs with sufficient image resolution to distinguish dismounted soldiers. This system does not have any active illuminators [10].

#### 2.1.4 DTIC Search

A DTIC search for “shortwave infrared,” “SWIR,” “illumination laser,” “track illumination laser,” “beacon illumination laser,” “CW,” “kW,” and “high power” did not result in any information on systems that fit the requirements.

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