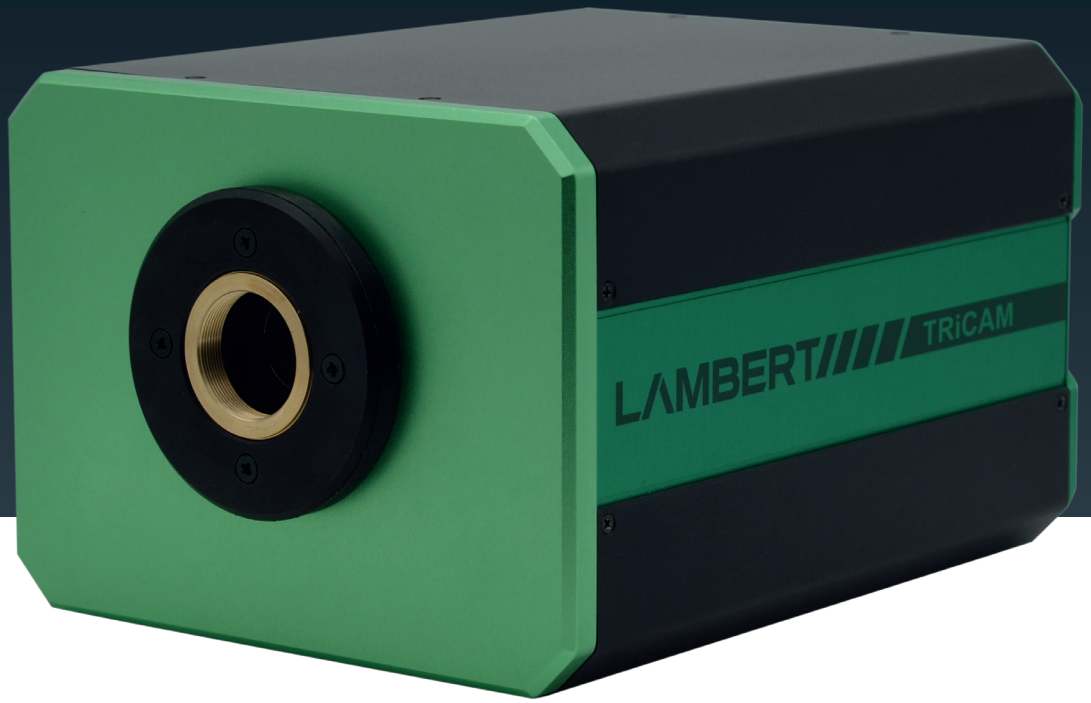
LAMBERT
REIMAGINE DETECTION

CAMERA

TRiCAM

Intensified CMOS Camera



The TRiCAM is a compact intensified camera.

It is designed for scientific and industrial applications that require low-light imaging and/or nanosecond exposures. With built-in signal generators, the TRiCAM is capable of ultra-short exposures through fast gating and frequency-domain imaging using lock-in detection.

Ultra-short Gating

The camera's effective exposure time can be reduced to < 3 ns (FWHM) for time resolved imaging, or capturing very fast events.

Programmable Signal Generator

TRiCAM delivers sub-nanosecond precision for precise synchronization of the event with the exposure.

Easy Coupling

Packed into a compact aluminium enclosure, it is easy to attach the TRiCAM to any fluorescence microscope.

High-sensitivity Intensifiers

You can choose from a wide variety of high-sensitivity image intensifiers to match the spectral needs of your application.

Fiber-optically Coupled

Our experienced engineers couple the sensor to the image intensifier for 10 - 20 times more light efficiency, in a compact and light weight form.

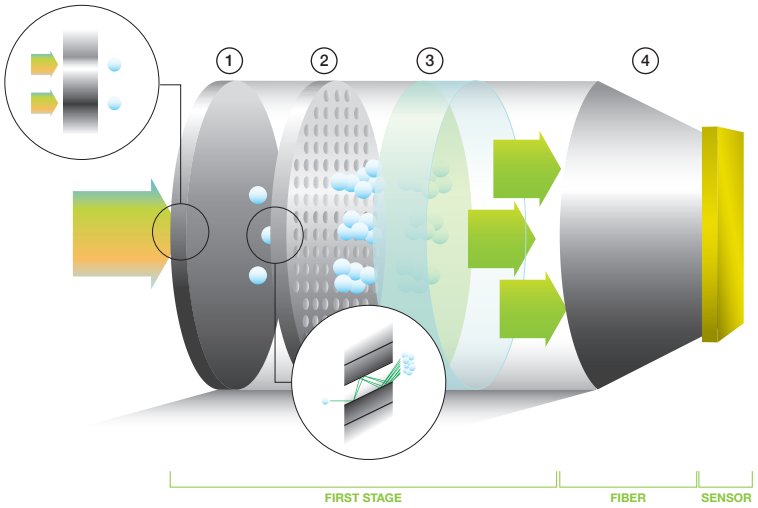
Intensify Your Camera

The TRiCAM platform can be highly customised and used to intensify non-intensified cameras.

Intensifier working principle

Photons are converted into electrons at the photocathode (**1**). These are accelerated towards the micro-channel plate (**2**) by an electric field and hit the channel walls. Depending on the voltage across the channel, multiple electrons are generated by secondary emission.

This cloud of electrons is accelerated towards the anode screen (**3**), where the electrons are converted back into photons by the phosphor layer, and these photons are transferred to the camera by a fibre-optic taper (**4**).



Applications

Laser Induced Fluorescence (LIF)

Time-gated luminescence

Bio- and chemiluminescence imaging

Plasma physics

Single photon imaging

Particle Image Velocimetry (PIV)

Solar PV and LED characterization

Combustion research

Single-molecule imaging

Fluorescence Lifetime-Imaging Microscopy (FLIM)

Förster Resonance Energy Transfer (FRET)

Time-gated Raman / Laser Induced Breakdown Spectroscopy (LIBS)

Time-resolved imaging & spectroscopy

Diffuse Optical Tomography (DOT)

Gating capability

Burst Mode

Set response to a preset number of synchronisation pulses.

If the number of pulses is reached, further input pulses will be ignored.

Number of input pulses in a burst can range between 1 and 1,000,000.

Cycled Gating

Change gate settings between two successive camera frames.

Rapidly switch gate settings in a couple of nanoseconds.

Up to three different gate timing settings can be preset.

Multiple Exposures

A single sync pulse gives rise to a preset number of output pulses.

Number of output pulses per input can be set between 1 and 1,000,000.

Frequency of output pulse train can be set between 0.05 Hz and 4 MHz.

Operating conditions

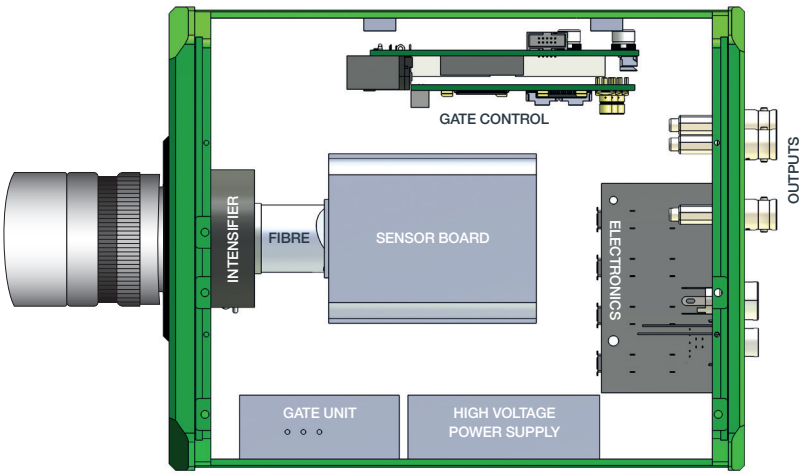
	Minimum	Typical	Maximum
Supply voltage	12 Vdc	-	15 Vdc
Power		1 W	
Operating temperature	5°C	-	40°C
Operating humidity (non-condensing)	20%	-	80%
Input lens mount		C-mount, F-mount*	

* Other lens mounts available upon request

Intensified CMOS camera layout

When the TRiCAM is mounted to a microscope or lens, the incoming light is focused onto the entrance window of the image **intensifier**. The image intensifier converts the optical image to electrons, amplifies this electron image, and re-converts the electrons into photons. A **fibre** optic plate guides the amplified optical image to the CMOS module for registration and read-out (**sensor board**).

For time-resolved imaging the image intensifier is used as an electro-optical shutter during the process of image acquisition. This uses a signal generated by the **gate unit** and **gate control**. The camera provides multiple **output** signals for accurate synchronisation of external equipment such as a pulsed light source.



Camera specifications

	TRiCAM 174	TRiCAM 425
Sensor	IMX 174	IMX 425
Image sensor	1920 x 1200 pixels; 5.86 µm square pixels	1600 x 1104 pixels; 9 µm square pixels
Dynamic range	72 dB	72 dB
Max frame rate at full resolution	162 fps	213 fps
Readout noise	7.0 e^-	4.7 e^-
Integration time control	0.005 ms - 3.2 s	0.003 ms - 20 s
Digitisation	10 or 12-bit (selectable)	8 or 12-bit; 16-bit gain bracketing mode
Selectable Region of Interest (ROI)	1920 x 1200 @ 128 fps (12-bit) or 162 fps (10-bit)	1600 x 1104 @ 213 fps (8-bit) or 137 fps (12-bit) 1600 x 32 @ 1777 fps (8-bit) or 1502 fps (12-bit)
Sensor coupling	Tapered fibre optics 1.33:1 (18 mm), 1.89:1 (25 mm)	Fibre optic plate 1:1 (18 mm), 1.43:1 (25 mm)
Triggering	External trigger input LVTTL; Trigger output LVTTL	
Lens mount	C-mount (F-mount upon request)	
Intensifier models	Single or dual MCP Gen II or Gen III (filmless)	
Input diameter	18 mm (standard), 25 mm (optional)	
Phosphors	P43 (standard), P46 and P47 (optional)	
Photon gain (typical)	**S20:** 40,000; **S25:** 30,000; **GaAs:** 40,000; **GaAsP:** 50,000	
Equivalent background input	**S20:** 0.006 photo e^-/pix/s; **S25:** 0.008 photo e^-/pix/s; **GaAs:** 0.024 photo e^-/pix/s; **GaAsP:** 0.006 photo e^-/pix/s	
Spatial resolution bare intensifier	**Gen II:** up to 69 lp/mm; **Gen III:** up to 64 lp/mm	

Camera specification options

Below is the range of options from which we can configure your TRiCAM camera.
Contact our sales team to discuss your specific requirements for a detailed specification.

1. DIAMETER

18 mm

Optional
25 mm

2. PHOTOCATHODE

		Photon Gain	Diameter	
S20	<200 - 900 nm	40,000	18	25
S20B	<200 - 650 nm	40,000	18	25
S25	200 - 900 nm	30,000	18	25
Blue/UV	<200 - 650 nm	30,000	18	
Green	<400 - 650 nm	30,000	18	
Red	<400 - 900 nm	30,000	18	
GaAs	<400 - 900 nm	40,000	18	25
GaAsP	<350 - 650 nm	50,000	18	25
GaAsP enh.	<350 - 750 nm	45,000	18	25

3. GATE

		Diameter	
<200 ns	(typ. <100)	18	
>50 ns	(typ. <100)		25
40 ns		18	25
30 ns	(target 25)	18	25
10 ns		18	25
<3 ns		18	25

4. REPETITION RATE

100 kHz	(min 40 ns)
300 kHz	(min 3 ns)
1000 kHz	(min <30 ns)

5. FIBRE COUPLING (18 mm)

1.33:1

1:1

Optional 25 mm

1.89:1

1.43:1

6. OPTIONS

Phosphor:	P46, P47 (P43 as standard)
F-mount:	on request (C-mount standard)
Double MCP:	2 MCP
High Dynamic Range	(HR)
High Output Brightness	(HG)

Gating units

The TRiCAM can be used as an ultra-fast electro-optical shutter by gating the image intensifier and thereby reducing the effective exposure time. Time domain gating eliminates motion blur and significantly widens the range of light levels at which the camera can be used.

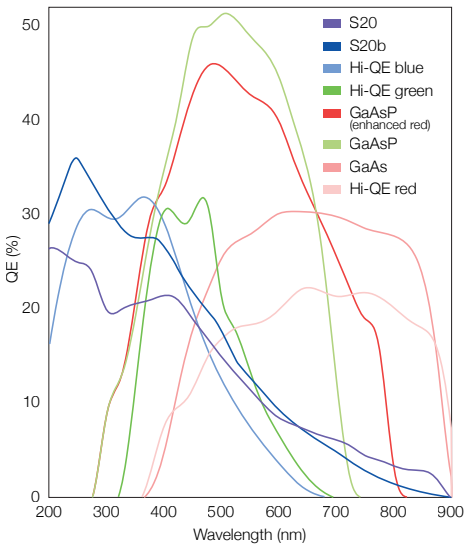
The user has full control of the camera gate pulse width, delay and gain through either the dedicated Capture software or the software SDK. The software supports an array of gating modes, including synchronisation of the internal oscillator to an external source. The standard camera has two additional output channels (output A and B) synchronised with the gate frequency. For both channels the user has control of the delay time as well as the pulse width and polarity.

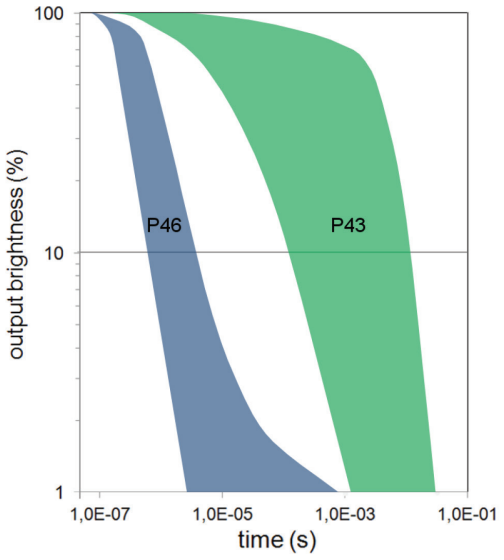
Gating	Max Repetition
3 ns	300 kHz
30 ns	1 MHz
40 ns	100 kHz
>50 ns	1 MHz / 300 kHz

Gating specification

CONTROL UNIT	
Gain control	✓
Gate control	✓
Anode current limiter	✓
Internal trigger generator	✓
Programmable gate pattern	3 presets
Shutter control	Optional
Additional TTL outputs	2
GATING PROPERTIES	
Width range	10 ns - 10 s
Resulting min pulse width (increments)	10 ns (10 ns)
Pulse repetition rate	< 10 MHz
Delay jitter (width)	10 ns (< 250 ps RMS)
Insertion delay	20 ns
Trigger input	✓

Spectral response and phosphor decay time



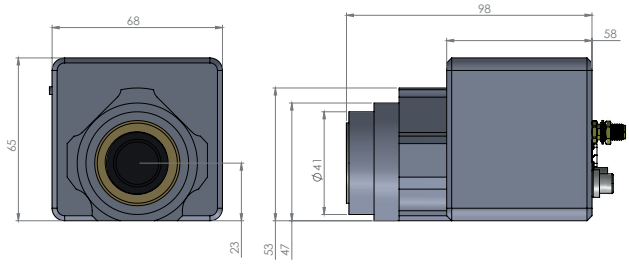


Phosphor	Efficiency	Decay time to 10%	Decay time to 1%
P43 (standard)	20 photons/e-/kV	1.5 ms	3 ms
P46 (optional)	6 photons/e-/kV	500 ns	2000 ns

P47 available on request for certain configurations

Custom TRiCAM options

Custom Housing & Cooling: We can tailor the camera's physical design by providing custom housings, such as a more compact version, and integrating improved cooling solutions to meet your specific environmental and operational needs.



Ruggedisation: We specialise in designing and building ruggedised intensified cameras engineered to withstand high G-forces and microgravity environments.

Intensifier Cooling: Optimise your intensifier's performance and reduce thermal noise by choosing from our advanced cooling options, including air cooling, Peltier (thermoelectric) cooling, or a high-performance water-cooled system.

PIV Mode: For fluid dynamics and flow visualization, the TRiCAM can be equipped with a specialised Particle Image Velocimetry (PIV) mode, enabling the capture of two full-resolution images with an extremely short inter-frame time, down to nanoseconds.

Integrate Your Own Sensor: If your application requires a specific sensor, we offer the unique option to integrate your own camera module or sensor into the TRICAM system.

Mechanical Shutter: Add an optional integrated mechanical shutter to protect the image sensor from light exposure during setup or to prevent artifacts like phosphorescence from the intensifier during long integration times.

Custom Mounting: We can design and manufacture custom mounting plates and adapters to ensure seamless mechanical integration of the TRiCAM with your existing equipment, such as a spectrograph or optical breadboard.

Fiber-Coupled Spectrograph: For ultimate convenience in spectroscopy, we offer a fully integrated, fibre-coupled intensified spectrograph system based on a high-performance Czerny-Turner configuration.

Firmware and interfaces

Custom Firmware & I/O: The camera's firmware can be modified for your unique requirements, such as implementing a programmable gate delay train for complex timing sequences or customising the functionality of I/O ports and connectors.

Custom Data Interfaces: To ensure compatibility with your data acquisition system, we offer a wide range of camera interface options, including CoaXPress (CXP), Camera Link (CL), USB, and SDI.

Software customisation

Application-Specific Layout: We can customise our software's user interface to create an application-specific layout, streamlining your workflow by displaying only the controls and information relevant to your experiment.

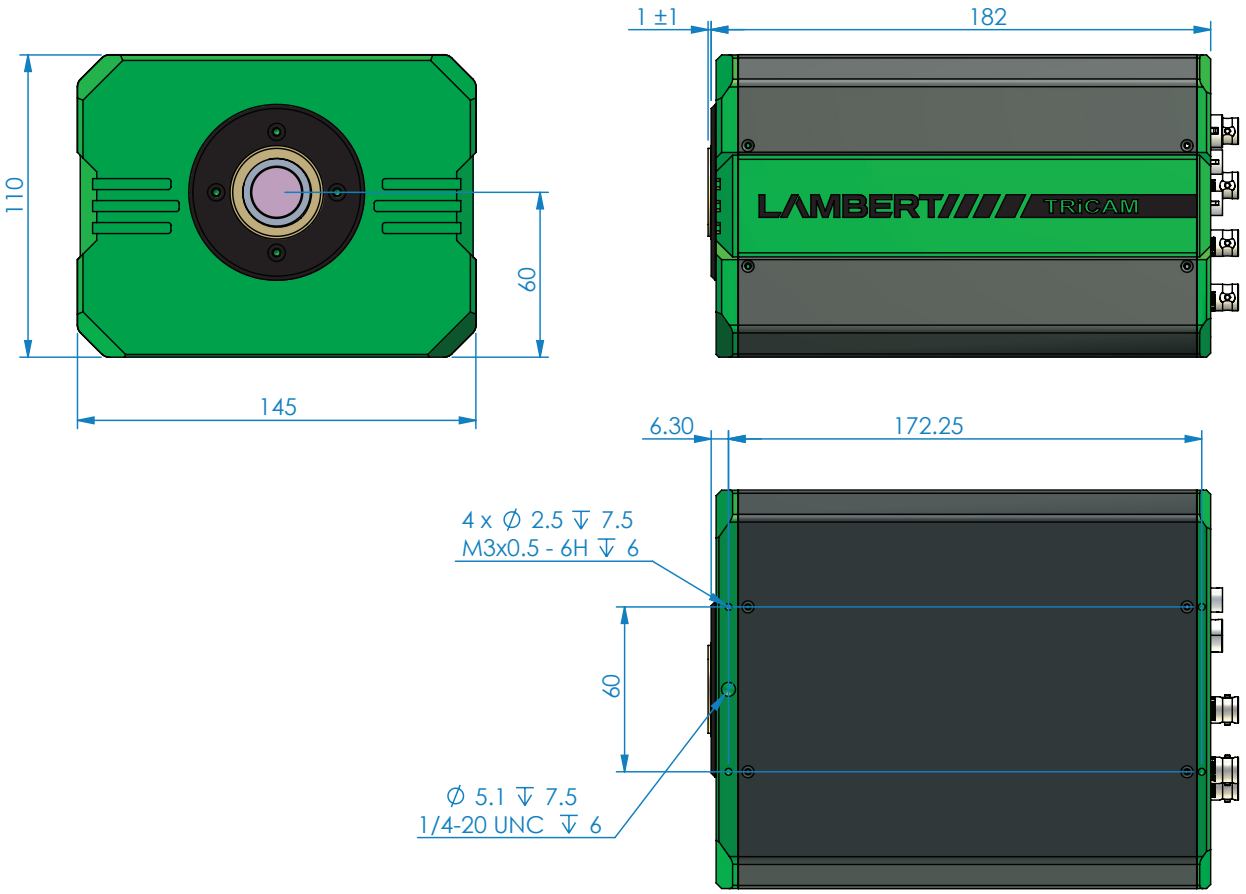
Integrated Analysis: Go beyond simple image acquisition by requesting application-specific analysis functions be built directly into the software for real-time data processing and immediate results.

ImageJ/Fiji Integration: Effortlessly transfer your captured data to popular open-source scientific imaging platforms with a dedicated 'Send to ImageJ/Fiji' function for advanced analysis.

Python API: Automate your experiments and integrate the TRiCAM into larger systems using our powerful Application Programming Interface (API) for Python.

Software Development Kit (SDK): For full control and the development of your own custom applications, a comprehensive Software Development Kit (SDK) is available, providing all the necessary tools for deep-level integration.

Technical drawing



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Lambert Instruments is dedicated to development, production and worldwide sales of products for **time resolved imaging at low-light levels**.

Our mission is to enable our users to **reveal previously unseen phenomena**. Our products provide a possibility to record fast events at low-light conditions. Together with our software, we **reimagine detection** to offer complete solutions to challenging imaging problems.