BELLAMARE

ISIIS-DPI Plankton Shadowgraph Cameras

USER MANUAL

Manual Reference: UM_ISIIS-DPI_0226_revA1

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Table of Content

1. Specifications

1.1 Depth Rating & Material

- Depth Rating: 1,000 meters
  Material: Hard anodized 6061-T6 aluminum cylinder, end-caps and view-port retainer ring
  Synthetic Sapphire viewport
  Acetal brackets
  Aluminum 6061-T6 channel
  Stainless Steel Hardware

- Depth Rating: 60 meters
  Material: Acetal Cylinder and end-caps, stainless steel view-port retainer ring
  Synthetic Sapphire viewport
  Acetal brackets
  Aluminum 6061-T6 channel
  Stainless Steel Hardware

1.2 Connectors

- Camera Enclosure:
  Power: MCBH2M (1: Ground, 2: Power), Ethernet: MCBH8M-CAT (wired as T568B)
  Associated Dummy-plugs: MCDC2F & MCDC8F with locking sleeves
- LED Light Enclosure:
  Power: MCBH2M (1: Ground, 2: Power)
  Associated Dummy-plugs: MCDC2F with locking sleeves

1.3 Camera

- Standard area-scan camera:
  5 MP (2240 px x 2048px), 20 FPS, ⅔” sensor, 3.45 µm pixel size, 8 bits, Global Shutter, GigE, monochrome, C-mount
- Standard line-scan camera:
  2k (2048 px x 1 px), 51 kHz, 7 µm pixel size, 8 bits, Global Shutter, GigE, monochrome, C-mount

1.4 Light

- Standard: Blue 465 nm - 485 nm
  Blue illumination provides the highest shadowgraphy contrast because it is strongly absorbed by particles while being efficiently transmitted by seawater.

- Optional: Red: 624 nm - 634 nm
  Red illumination may be preferred in some behavioral studies, but provides lower contrast for shadowgraphy imaging.

1.5 Power

- Power Input: 12 VDC (area-scan) 12-24 VDC (line-scan)
- Power Consumption: 6 W typical (3 W for camera + 3 W for LED light)

1.6 Electrical Protection

- Camera and LED driver are both reverse-polarity resistant

1.7 Dimensions and Weights

ISIIS-DPI Model	Dimensions with rail & brackets	Weights
ISIIS-DPI P75	L 840mm x W 141mm x H 221mm	60m version: in air: 7.6 Kg – in water: 1.9 Kg 1000m version: In air: 9.4 Kg – in water: 3.7 Kg
ISIIS-DPI P100	L 1000mm x W 155mm x H 291mm	60m version: In air 11.2 Kg – in water: 3.0 Kg 1000m version: In air: 13.8 Kg – in water: 5.7 Kg
ISIIS-DPI P125	L 1130mm x W 185mm x H 345mm	60m version: In air: 14.2 Kg – in water: 3.9 Kg 1000m version: In air: 18 Kg – in water: 7.7 Kg
ISIIS-DPI T424	L 598mm x W 132mm x H 130mm	1000m version: in air: 5.5 Kg | in water: 3.5 Kg

See Appendix 1 for ISIIS-DPI Plankton Cameras dimensional drawings
See Appendix 2 for dimensional drawings of the Mounting Beams
See Appendix 3 for dimensional drawings of the Mounting Brackets

1.8 Resolution and Taxa size recommendation

ISIIS-DPI Models	Theoretical Pixel Resolution	Recommended Taxa Size
ISIIS-DPI P75	26 µm/pixel	> 300 µm
ISIIS-DPI P100	30 µm/pixel	>500 µm
ISIIS-DPI P125 area-scan	46 µm/pixel	> 1 mm
ISIIS-DPI P125 line-scan	60 µm/pixel	> 1 mm
ISIIS-DPI T424	8.5 µm/pixel	> 50 µm

1.9 Volume sampling and Data Storage Requirements

ISIIS-DPI Model	Field of View	Recommended Depth of Field	Volume per Frame	Max. Water Flow	*Volume per min.	*Max. GB/Hr
ISIIS-DPI P75	48 x 48 mm	120 mm	0.27 L	3.25 knots	577 L	116 GB/Hr
ISIIS-DPI P100	61 x 61 mm	200 mm	0.74 L	3.25 knots	1,223 L	116 GB/Hr
ISIIS-DPI P125 area-scan	80 x 80 mm	300 mm	1.92 L	5.75 knots	4,657 L	415 GB/Hr
ISIIS-DPI P125 line-scan	115 x 115 mm	300 mm	3.95 L	5.75 knots	8,880 L	415 GB/Hr
ISIIS-DPI T424	18.3 x 18.3 mm	3.5 mm	1.1 mL	.5 knots no strobe .7 knots w/ strobe	1.5 L	381 GB/Hr

*These values represent theoretical maxima and should be used for planning storage and telemetry margins.

1.10 Cables

Subsea Cable Power Y-Cable Power-in: MCIL2M Power-out: 2x MCIL2F	
Subsea Cable Ethernet MCIL8F-CAT MCIL8M-CAT	
Topside Ethernet Deck Connection MCBH8F-CAT RJ45 coupler CAT6e cable	
Topside Power Cable Pigtail MCIL2F	
Tether Hybrid Ethernet + Power Wet-ends: MCIL8F-CAT & MCIL2F Dry End: RJ45 & power pigtail	

2. General Description

2.1 Introduction

The **ISIIS–DPI Plankton Camera (ISIIS-DPI)** is a next-generation imaging system designed to quantify plankton communities at fine spatial and temporal scales. Using high-speed imaging—deployable at tow speeds exceeding 5 knots—and collimated shadowgraph illumination, ISIIS-DPI captures detailed *in situ* images of ichthyoplankton, gelatinous zooplankton, and marine particles without disturbing their natural behavior. Its large sampled volume enables robust estimates of organism abundance, size structure, and behavior across oceanographic gradients, making ISIIS-DPI a field-proven platform for studying trophic dynamics, recruitment processes, and biological–physical interactions with unprecedented resolution.

ISIIS-DPI Plankton Camera systems employ a shadowgraph technique in which light from an LED source passes through a plano-convex lens to form a collimated beam across the sampled water volume. Organisms within this volume cast shadows that are refocused and projected onto a camera sensor. This approach provides several key advantages, including a high depth of field, telecentric imaging (constant magnification regardless of object distance), and sharp outlines of organisms and internal structures—features that are well suited for automated image analysis and classification.

ISIIS-DPI systems can be configured with either line-scan or area-scan cameras. Line-scan cameras are optimized for deployments at constant tow speeds, typically in the ~5-knot range. Area-scan cameras support more flexible operational modes, including variable tow speeds, vertical profiling, and stationary deployments such as moorings.

What's in the Name?

ISIIS*, short for In-Situ Ichthyoplankton Imaging System, was originally developed in 2005 to image large volumes of water and study ichthyoplankton patchiness in the Gulf Stream off the coast of Florida. As the system evolved, its defining strength became clear: the ability to image a large depth of field while capturing far more than just plankton. To reflect this broader capability,* ***DPI*** *was added to the name, standing for Deep-focus Particle Imager.*

Bellamare has developed multiple ISIIS-DPI Plankton Cameras over the years and offers four standard configurations, enabling imaging of taxa from 50 µm and larger. Custom configurations are also available—contact us to discuss specific application requirements.

ISIIS-DPI P75:

The ISIIS-DPI P75 is designed for researchers seeking to quantify and visualize planktonic organisms and particles at the mesoplankton scale. It is optimized for imaging organisms approximately 300 µm and larger, making it particularly well suited for studies focused on copepod-sized taxa, larval stages, aggregates, and gelatinous organisms, all within their natural spatial distributions.

ISIIS-DPI P100:

The ISIIS-DPI P100 is a mid-size imaging solution designed for studies requiring increased sampled volumes while maintaining high-quality imaging of mesoplankton and fragile organisms. Offering a very similar resolution as the P75, it is particularly well suited for investigations where maximizing water volume per image is critical.

ISIIS-DPI P125:

The ISIIS-DPI P125 is the workhorse of the ISIIS-DPI family, designed for high-speed, large-volume sampling of plankton 1 mm and larger. Proven on long-term ecological transects, it supports broad spatial surveys where consistency and coverage are essential. Its ability to operate at higher tow speeds makes it ideal for ecosystem-scale studies, sparse populations, and gelatinous organisms. The P125 is the preferred solution for demanding towed vehicle deployments.

ISIIS-DPI T424:

The ISIIS-DPI T424 was developed to quickly resolve large phytoplankton chains, such as diatoms, that are difficult to classify in standard in situ imagery. It provides essential phytoplankton context to help interpret zooplankton distributions and grazing dynamics. Simple, rugged, and fast, the T424 complements ISIIS-DPI Plankton Cameras by turning ambiguous features into meaningful biological categories—directly in the field.

Safety Warnings

- Do not operate the *ISIIS-DPI Plankton Cameras* outside of their rated depths.
- Always power off the unit before opening any end-cap.
- Use only the specified voltages and cables.
- Failure to follow instructions may result in equipment damage or data loss.

2.2 Quick Start / Reality Check (For Experienced Users)

If you have previously deployed ISIIS-DPI systems, this section summarizes the minimum steps required to verify readiness before a deployment. It is not a replacement for the full manual, but a practical reminder of the critical checks that prevent common field issues.
This quick start assumes the system is mechanically assembled on its beam and that all required cables are available.

A. Power

- Supply regulated 12 VDC (area-scan) or 12–24 VDC (line-scan).
- Minimum continuous power capability: 6 W (0.5 A at 12 VDC).
- After applying power, verify:
    - Blue illumination visible through the LED enclosure viewport.
    - Nominal power draw (~6 W).
- Allow ~20 seconds for the camera to complete boot-up.

B. Network

Connect the camera Ethernet to a dedicated network adapter on the host computer.

- Ensure the adapter is configured for GigE Vision operation (see Section 3.3).
- Verify you have assigned an IP address to the network adapter (e.g., 10.0.1.2 / 255.255.255.0).
- Verify the camera IP is on the same subnet and visible in Basler Pylon Viewer.

C. Camera Configuration

- Open Basler Pylon Viewer and confirm the camera is detected.
- Load the appropriate User Set stored in the camera.
    - Verify that the correct User Set is selected as the Default Startup Set.
- Start live view and confirm stable streaming (no dropped frames, no error messages).

D. Exposure Check

- Adjust exposure so the image appears light to medium gray.
- Avoid:
    - Fully white images (overexposure)
    - Very dark images (underexposure)
- Typical exposure values fall between ~28 μs and 150 μs, depending on configuration and water conditions.

E. Optical Check

- Clean the camera viewport thoroughly using a lint-free cloth and appropriate cleaner.
- Inspect the live image:
  - No large dark regions
  - No asymmetric shading
  - No obvious vignetting
- If dark areas are present, perform a quick alignment adjustment (see Section 4.5).

F. Data Check

- Confirm expected frame rate × image size matches available:
  - Disk write speed
  - Available storage duration
- If using AVI recording, remember the 2 GB file size limit in Pylon Viewer.
- Prefer image sequences or JADE-based acquisition for long deployments.

2.3 Pre-Deployment Checklist

This checklist consolidates critical steps that should be completed before every deployment. Skipping any of these checks can result in degraded data quality or data loss during a mission.

A. Mechanical & Sealing

- ☐ Camera and LED enclosures securely mounted to the beam.
- ☐ All fasteners still tightened evenly (star pattern where applicable).

  If, for any reason, the enclosures were opened, ensure that the
  - ☐ O-rings were cleaned, and lightly greased.
  - ☐ O-ring grooves were clean and free of debris.
  - ☐ End-caps were fully seated and closed properly.
- ☐ Extraction threaded holes on the end-caps lightly greased and nylon screws installed.

B. Optics

- ☐ Camera viewport cleaned (no fingerprints, grease, salt residue).
- ☐ Live image checked for:
  - ☐ Uniform illumination
  - ☐ Absence of shadows or vignetting
- ☐ Focus verified if enclosure spacing was changed.

C. Electrical & Power

- ☐ Correct power cable connected (Y-cable to camera and LED).
- ☐ Regulated power supply confirmed within voltage range.
- ☐ System power draw verified (~6 W typical).
- ☐ No exposed or stressed cables.

D. Network & Camera

- ☐ Network adapter configured for GigE Vision.
- ☐ Static IP assigned to host adapter.
- ☐ Camera IP verified and reachable.
- ☐ Camera detected reliably in Pylon Viewer.
- ☐ Correct User Set loaded and verified.
- ☐ Live image streaming stable (no dropped frames).

E. Data & Storage

- ☐ Acquisition method selected
  - ☐ Pylon Viewer AVI - “manual acquisition”
    - ☐ Output directory verified.
  - ☐ Pylon Viewer Tiff image sequence
    - ☐ Output directory verified.
  - ☐ Sixclear JADE Basler Camera plugin.
    - ☐ Full Review of Config File
    - ☐ Camera serial number entered (real camera not a camera emulation)
    - ☐ Output directory checked
    - ☐ AVI recording enabled
    - ☐ Recording process verified: user-controlled vs automated “State Machine”
- ☐ Expected data rate calculated and confirmed against available storage
- ☐ Test recording performed and reviewed.

F. Final Sanity Check

- ☐ Expected tow speed (for selected Frame Per Second)
- ☐ Exposure adjusted for anticipated turbidity.
- ☐ No camera error observed.
- ☐ Camera streams at expected FPS

2.4 Overview, Connectors and Cables

A. Overview

The ISIIS-DPI imaging system consists of two subsea enclosures mounted facing each other:

- a camera enclosure, and
- an LED projector enclosure.

The camera enclosure can be identified by its end-cap, which is fitted with two connectors and may be slightly longer than the LED projector enclosure. The LED projector enclosure is fitted with a single connector, as shown in Figure 2.

	
Camera Enclosure	**LED Enclosure**

Fig 1: End-caps

B. Connectors

- **Camera End-cap Connectors:**

  1 x MCBH8M-CAT: 8-pin ethernet connector wired as T568-B
  1 x MCBH2M: 2-pin connector, Pin 1: Ground, Pin 2: +Vin (+12 VDC)

- **LED End-cap Connectors:**

  1 x MCBH2M: 2-pin connector, Pin 1: Ground, Pin 2: +Vin (+12 VDC)

C. Cables

- **Power:**

Standard ISIIS-DPI systems are supplied with a subsea Y power cable. The two power output legs terminate in 2-pin female inline connectors and mate with the camera and LED enclosures. The power input side is fitted with a 2-pin male inline connector.

For deck operation, a 2-pin female cable with pigtail conductors may be used to connect the system to a regulated 12 VDC power supply capable of delivering at least 6 W (0.5 A) of continuous power.

	
Subsea Y power cable Pin 1: Ground Pin 2: +12 VDC	**Topside Pigtail Cable** Interfaces with the subsea cable Pin 1 (Black): Ground Pin2 (White): +12 VDC

Fig 2: Power Cables

- **Ethernet:**

A subsea Ethernet cable is supplied to connect the ISIIS-DPI camera enclosure to an external electronics bottle, controller, or data recorder (for example, a SIDEKICK system).

For deck connectivity, systems are supplied with an MCBH-to-RJ45 adapter solution, allowing direct connection to a laptop..

	
Subsea Ethernet Cable Typical length 4-6 ft	**Topside Ethernet Cable Solution** MCBH8F-CAT with 6 ft long Cat6e cable

Fig 3: Ethernet Cables

2.5 Beam & Brackets

Bellamare mounts ISIIS-DPI enclosures on rigid structural supports, typically aluminum channels, to provide stable, precise, and long-lasting alignment. These beams feature multiple perforated mounting holes, allowing users to adjust the spacing between enclosures and select a depth of field appropriate for their specific research application.

The enclosures are securely held in place using durable plastic brackets, typically machined from acetal. All fasteners use **¼-20 threads**. Hex-head screws and nuts require a **7/16 in wrench** for tightening and loosening.

Note: Any change in the distance between the two enclosures requires the camera to be refocused. Proper refocusing ensures that the optimal focus plane remains centered at the midpoint between the two viewports. See Section 4.2 for re-focusing the camera.

Appendix 2 shows the different beams and their holes pattern.
Appendix 3 provides dimensional references for the different bracket

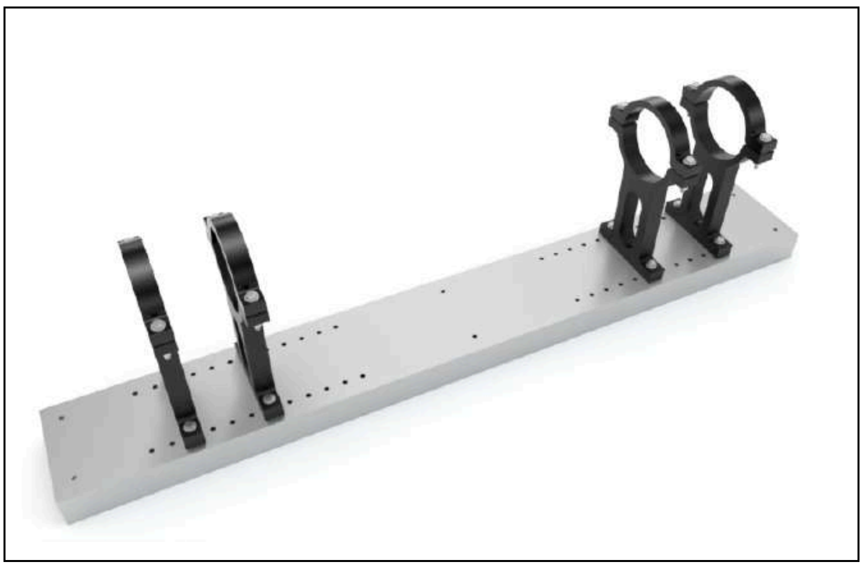


Fig 4: Typical Mounting Beam and Brackets

3. System Setup and Configuration

3.1 Required Software

ISIIS-DPI Plankton Camera systems use Basler industrial cameras. To connect to, configure, and operate these cameras, users must install the **Basler Pylon Viewer software**. This requirement applies even when using **Sixclear JADE** and its associated **Basler Camera plugin**, such as during operation on towed underwater vehicles or when working with SIDEKICK systems.

Basler Pylon Viewer is a standalone application that enables users to:

- Discover connected cameras
- Configure network and camera parameters
- Verify camera operation and image quality

The software is available free of charge from the Basler website:
https://www.baslerweb.com/en-us/software/pylon/pylon-viewer/

During installation, ensure that the components appropriate to your camera interface are selected. For ISIIS-DPI systems using Gigabit Ethernet (GigE Vision) cameras, the following components must be installed and therefore go to the “Custom” installation window and select: pylon Runtime, pylon Data Processing, GigE Camera Support, USB Camera Support,Camera Emulation Support, pylon Viewer, Camera User’s Manuals, DirectShow Support, TWAIN Driver, SDKs, Firmware Updater.

Fig 5: Pylon installation Screen

Once installed, Pylon Viewer is used to confirm camera connectivity, set basic operating parameters, and verify image quality prior to operation with any ISIIS-DPI data acquisition software.

3.2 Power

Connect the supplied subsea Y-power cables to the camera and LED enclosures, ensuring proper connector alignment and secure mating. Apply a regulated 12 VDC power supply capable of delivering at least 6 W (0.5 A) of continuous power to the system.

Upon power-up, verify that a blue LED is visible through the LED enclosure viewport. This indicates that the illumination system is active. Confirm a nominal system power draw of approximately 6 W under normal operating conditions.

After power is applied, the camera requires approximately 20 seconds or longer to complete its boot sequence. During this time, launch Basler Pylon Viewer and verify that the camera appears in the device list before proceeding with network configuration or image acquisition.

3.3 Network and Camera Configuration

A. Getting situated

Below are screenshots of the main Basler Pylon Viewer window. When the camera is powered and connected to your computer, it will appear in the Device Pane, listed under its communication protocol, GigE, for ISIIS-DPI Plankton Cameras.

To connect to the camera, click the **Slider** icon in the **Toolbar** once you have **selected your camera** in the **Device Pane**. To start a continuous **image stream**, click the **video camera icon**. Camera configuration parameters are accessed through the **Feature Pane**. If certain features appear unavailable (grayed out), stop the live image stream and try again.

Additional operational information is displayed beneath the live-view window, including camera frame rate, data bandwidth, error messages, and image resolution.

A.1 Main Window

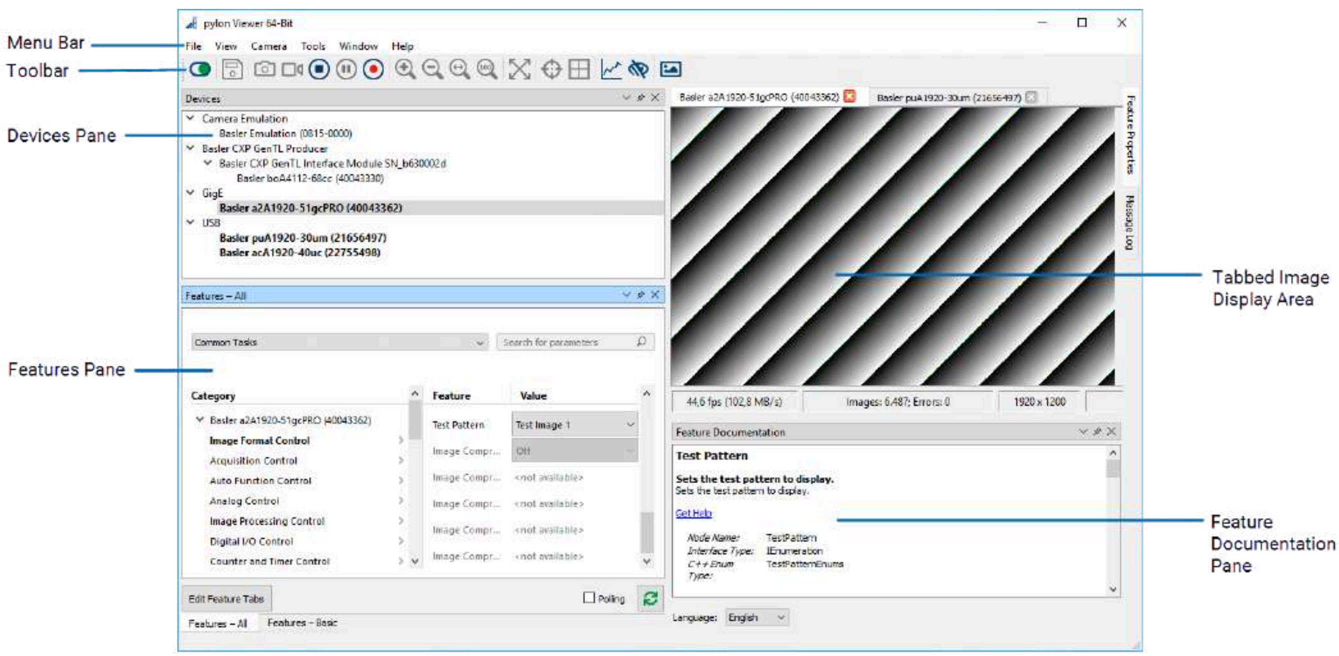


Fig 6: Pylon Viewer Main Screen

A.2 Toolbar Buttons

Icon	Function
	Open/close the device currently selected.
	Save the current image.
	Capture a single image.
	Capture images continuously.
	Start recording with the current settings. If you want to change any settings, open the Recording Settings pane via the Window menu.
	Pause the recording.
	Stop capturing images or stop a recording.
	Zoom into the image.
	Zoom out of the image.
	Make the image fit into the image display area.
	Restore the image to its original size.
	Display your image in full-screen mode.
	Show/hide a crosshair in the image display area.
	Show/hide a grid in the image display area.
	Open/close the Histogram pane.
	Open/close the Sharpness Indicator pane.
	Let the camera automatically make all settings necessary to get a good image under current conditions.

Fig 7: Pylon Viewer Icons

B. Network Configuration

Before connecting to the camera, we must ensure the network adapter of your computer (which is using the pylon GigE Vision filter driver) is configured properly.

In order to do so, you can use the **pylon IP Configurator**.

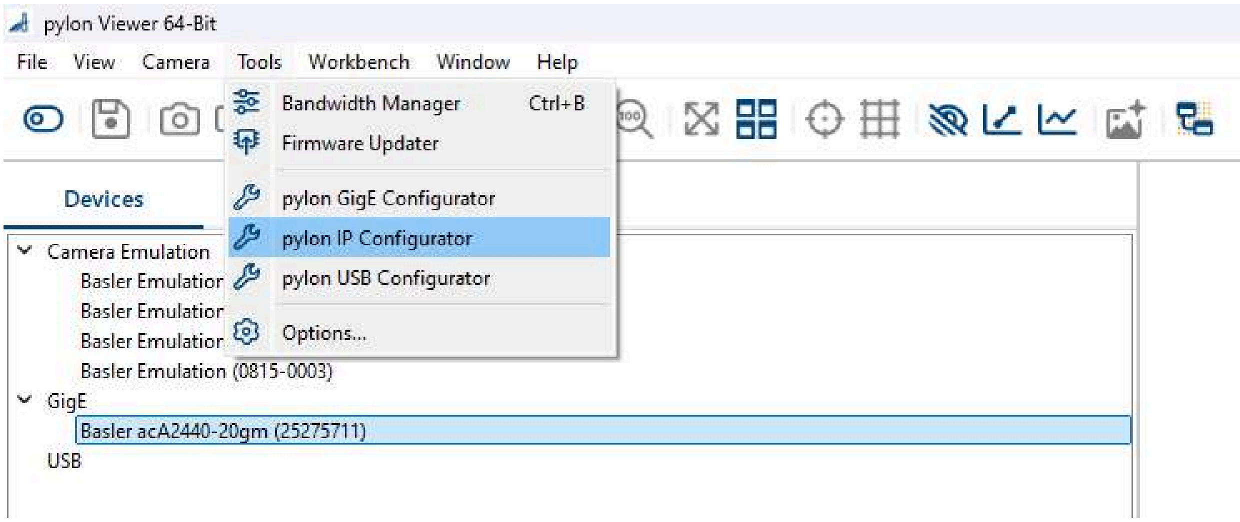


Fig 8: Pylon IP Configurator Menu Location

B.1 Changing the Network Adapter Connections (Windows):

Right click your “Ethernet” connection and select “Properties”

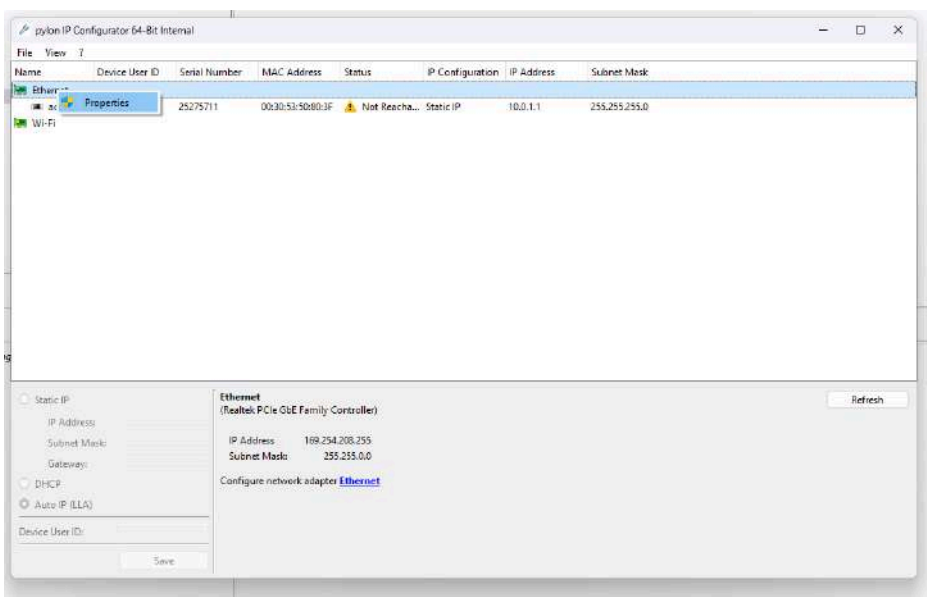


Fig 9: Pylon IP Configurator Window

This action brings you to the Ethernet Properties of your computer. Notice, all the items selected by default are the following:

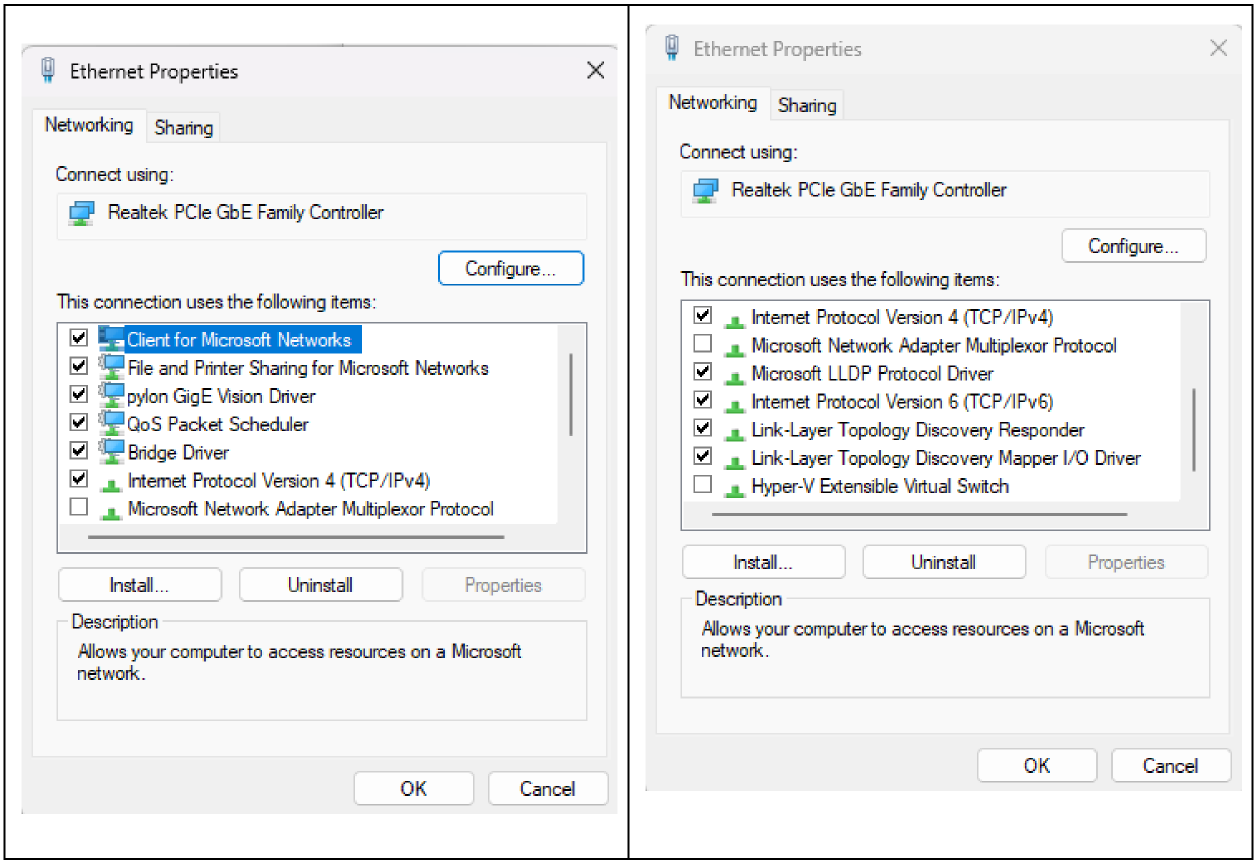


Fig 10: Ethernet Properties Connection “Items”

For all network adapters using the pylon GigE Vision filter driver, Basler recommends disabling protocols or services that may interfere with the pylon driver.

Disable protocols or services as follows (only two items are selected):

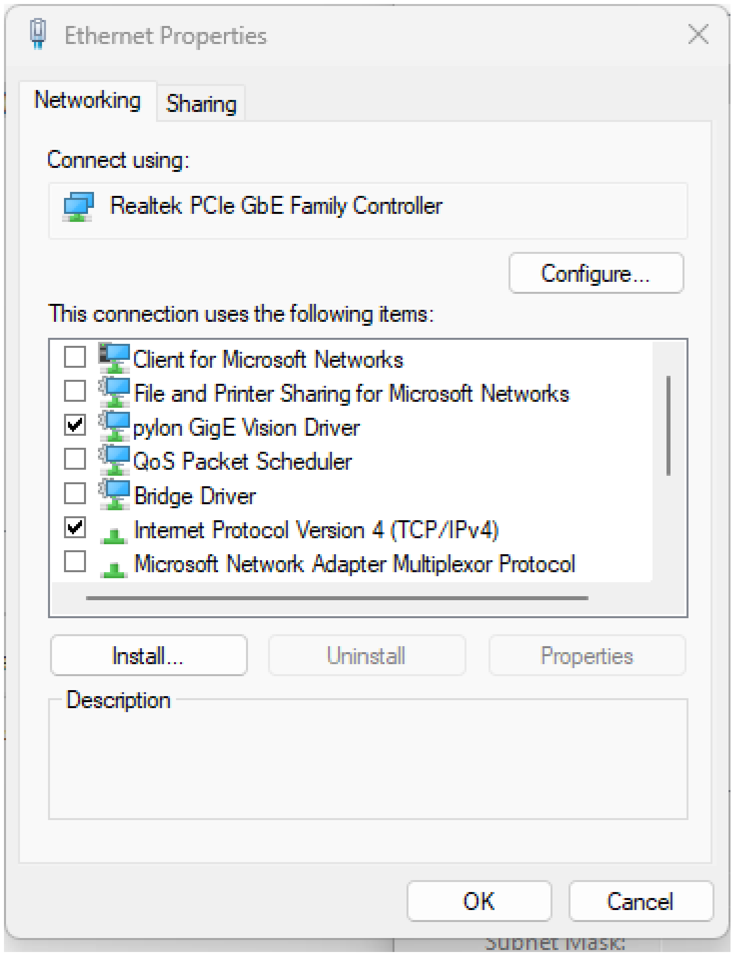


Fig 11: Ethernet Properties Connection "items" set for Basler Cameras Connectivity

Repeat this step for all applicable network adapters.

B.2 Changing the Network Adapter Properties

For all network adapters using the pylon GigE Vision filter driver, Basler recommends optimizing the adapter properties.

To optimize the adapter properties:

Click Configure: the configuration window of the network driver opens.

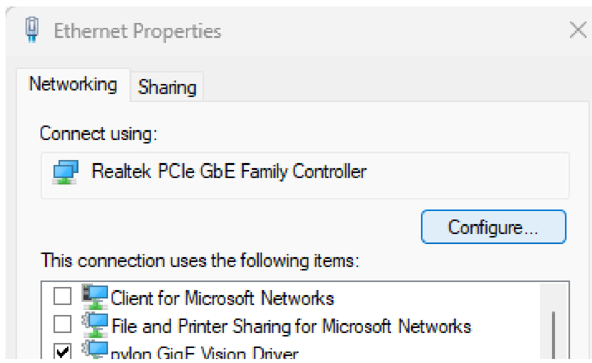


Fig 12: Click Configure to Access the Advanced Section

Click Advanced:

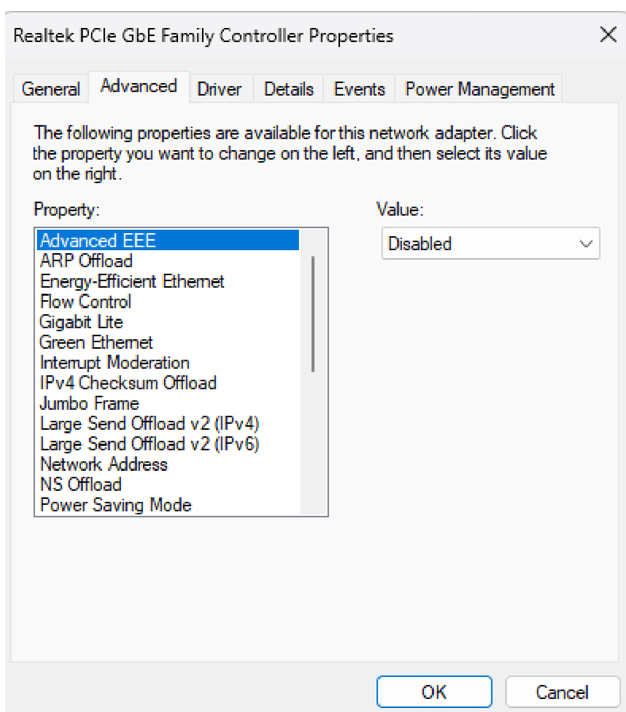


Fig 13: Advanced Section Properties

Adjust the following properties (see note below):

a. Set the Jumbo Frames[a] property to its maximum value.
   If there is no Jumbo Frames property, select the parameter that relates to frame size and set it to its maximum value.
b. Select the parameter that relates to the receive (Rx) ring buffer or number of receive descriptors[b] (e.g., Receive Descriptors) and set it to its maximum value.
c. Select the parameter that relates to the interrupt moderation rate or number of CPU interrupts[c] (e.g., Interrupt Moderation Rate) and set it to a low value, e.g., 1000. The way to set the number of CPU interrupts may differ for your network adapter. You may have to use a separate parameter to enable the interrupt moderation.
d. Select the parameter that relates to speed and duplex mode (e.g., Speed and Duplex Mode) and set it to automatic (e.g., Auto Negotiation).

Repeat steps 2 to 5 for all applicable network adapters.

Depending on the network adapter model, the parameter names of your network adapter may differ from the ones used above. Also, the way to set the parameters may differ, and some parameters may not be available.

Once you have Configure the Networking Adapter and changed its properties, click OK and exit or the changes won't be saved

B.3 Fixing the IP Address of your Network Adapter

Return to the Network Adapter window on your computer and highlight “Internet Protocol Version 4 (TCP/IPv4) and click “properties”

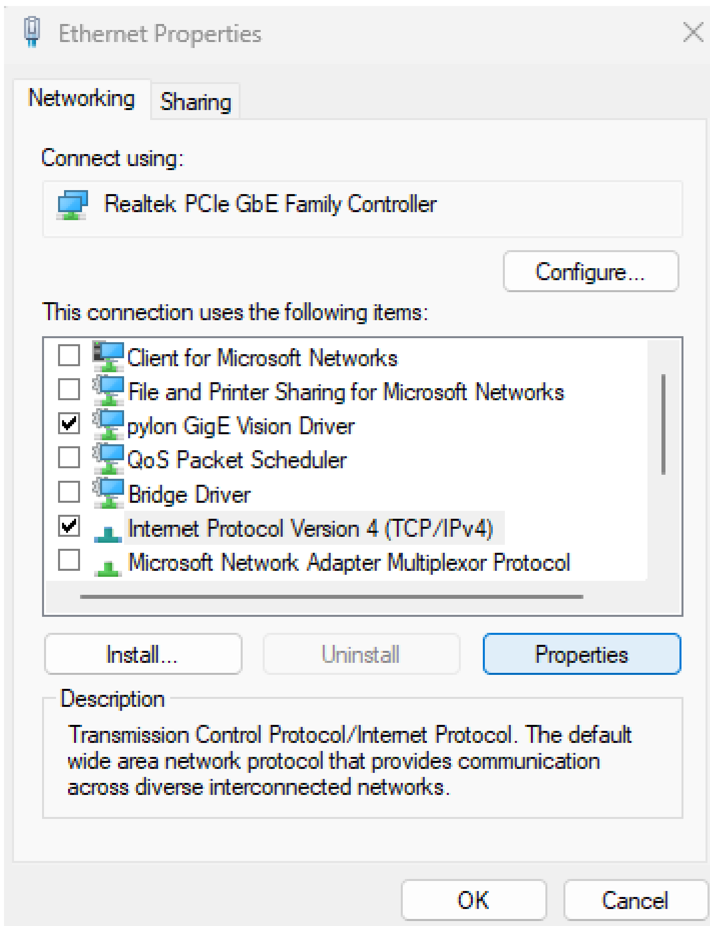


Fig 14: Select Internet Protocol Version 4 (TCP/IPv4)

In the new window, select “use the following IP address” and enter, for your first camera:

IP address: 10.0.1.2
Subnet Mask: 255.255.255.0

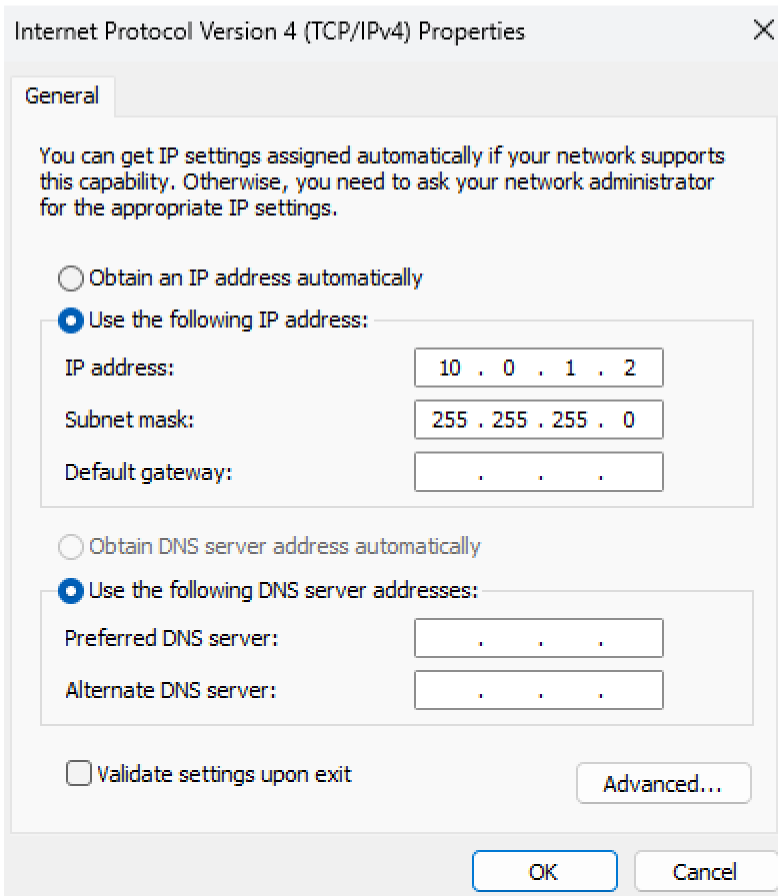


Fig 15: IP address Window

Assign the following address to any other cameras you may use:

IP address: 10.0.2.2
Subnet Mask: 255.255.255.0

IP address: 10.0.3.2
Subnet Mask: 255.255.255.0

etc.

Click OK and then Close the Ethernet Properties window.

B.4 Fixing the IP Address of your camera

Use the pylon IP Configurator window to match the IP address of your camera to your network Adapter. These changes will stay in place even when the camera is powered off and back on again.

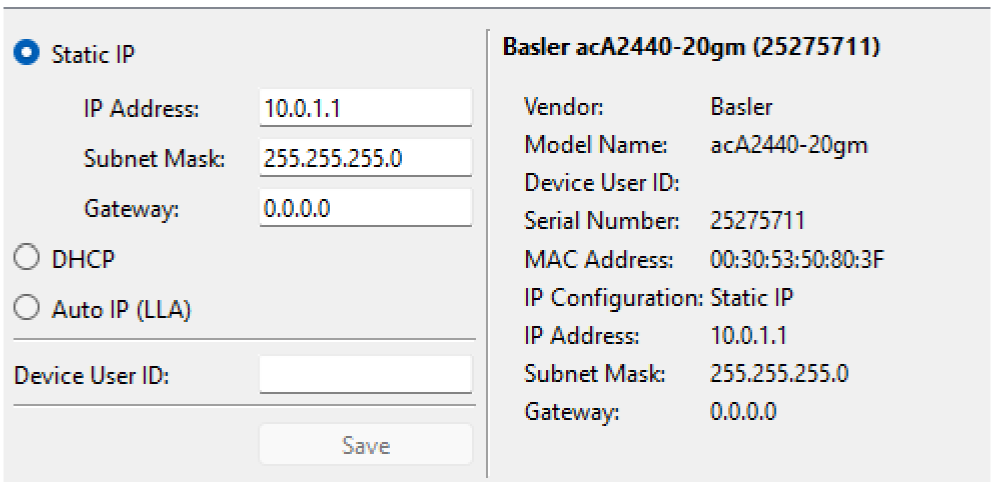


Fig 16: Assigning a Static IP to the Camera

A **static IP address** is an IP address that is manually assigned to the camera and remains unchanged across power cycles. When configuring a static IP, ensure that the camera is on the **same subnet** as the selected network adapter and that the camera's IP address is **unique** on the network.

For example, if the network adapter is configured as **10.0.1.X**, the camera IP address must share the same first three octets (**10.0.1.**), where **X** is any unused value from **0 to 255** that does not conflict with the network adapter or other devices.

To the right of the network adapter information is the **Refresh** button. **Clicking this button updates the displayed network adapter and camera information**, ensuring that all values shown are current before proceeding with configuration, as shown on the following screen:

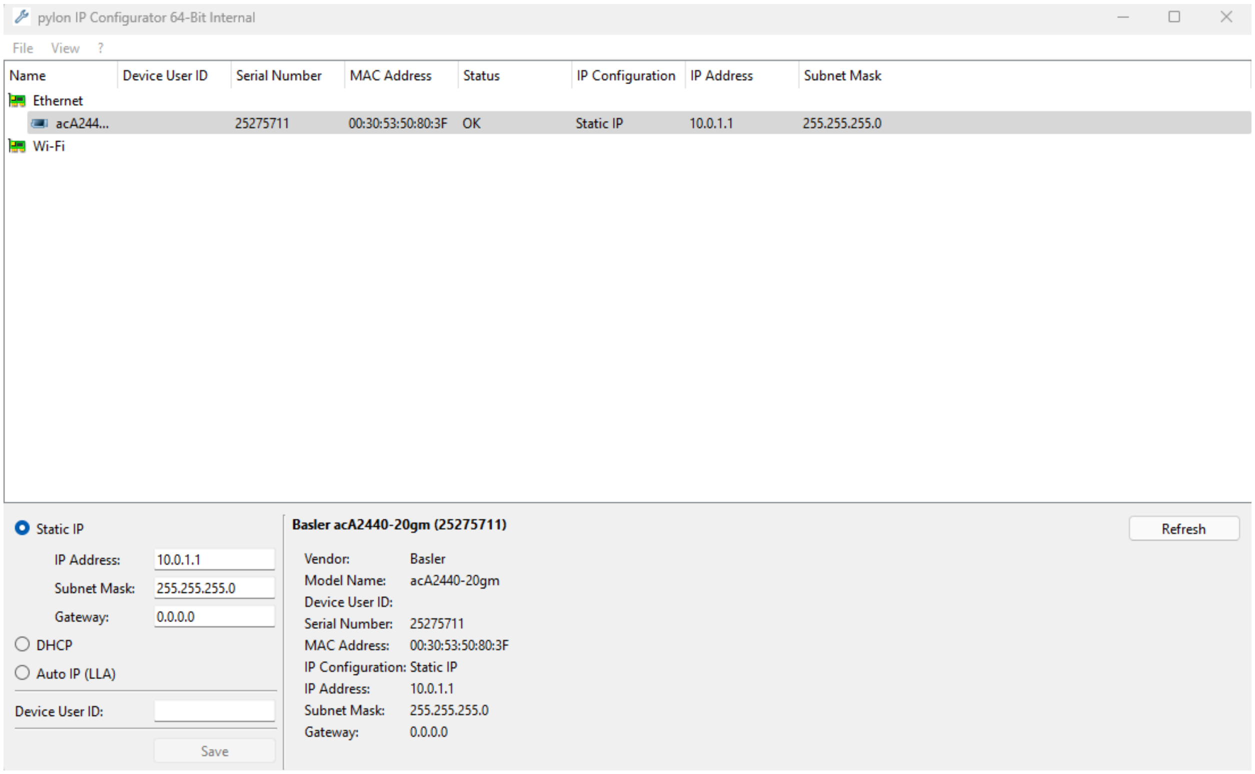


Fig 17: pylon Viewer showing a successful configuration

Hint text is displayed in the lower right area of the window.
If a camera is not reachable because of a problem with the IP address, the hint text will tell you how to fix the problem. The following screenshot shows an example:

Fig 18: pylon Viewer showing an error message

<u>C. Camera Configuration using Basler Pylon Viewer</u>

<u>C.1. Exposure, FPS, Image Size</u>

When first opening the live view, the image may appear completely white due to severe overexposure. The first parameter that should be adjusted is the **exposure time**.

In the **Feature** pane, navigate to **Acquisition Control** and set the exposure to a value between **28 µs and 150 µs**. Shorter exposure times are preferred, as they minimize motion blur.

For optimal shadowgraph imaging, the resulting image should appear light to medium gray rather than bright white or dark. This exposure range preserves contrast across the full dynamic range of the scene.

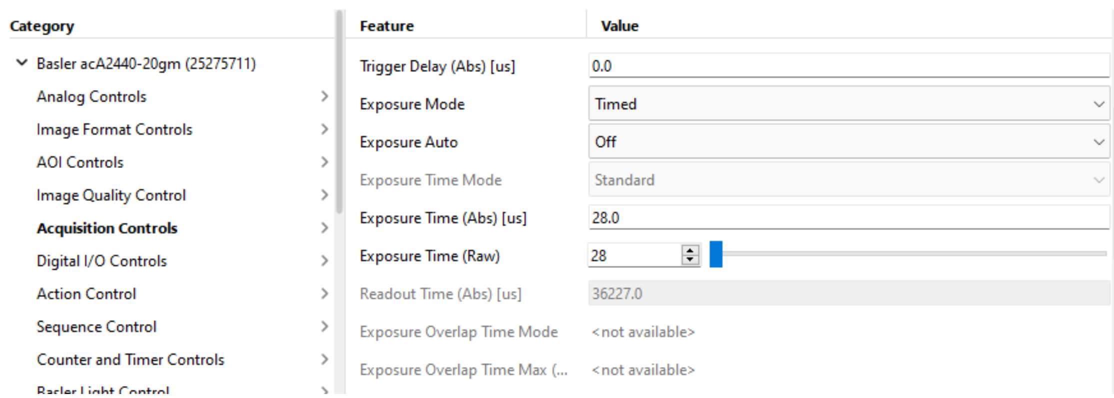


Fig 19: Exposure Time

In **Acquisition Control**, you can also set the camera frame rate using **Acquisition Frame Rate (Abs)**. Ensure that the **Enable Acquisition Frame Rate** option is checked before adjusting the frame rate value.

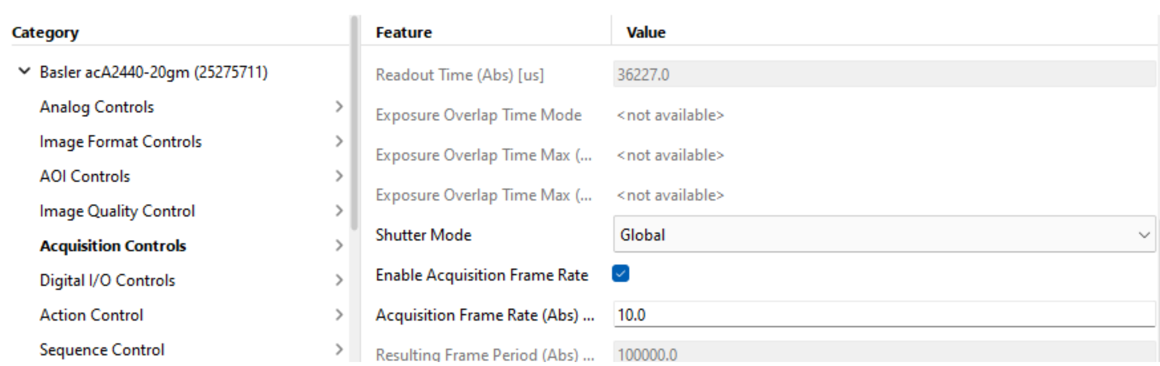


Fig 20: Forcing Exposure Time

AOI (Area of Interest) controls define the image dimensions (**Width × Height**) and allow the image to be cropped to fit precisely within the viewport. Adjusting the AOI also lets you control the image aspect ratio and overall data size.

Reducing the AOI by disabling unused pixels decreases the image size (fewer megabytes per frame), which in turn reduces data throughput and can allow higher frame rates when required.

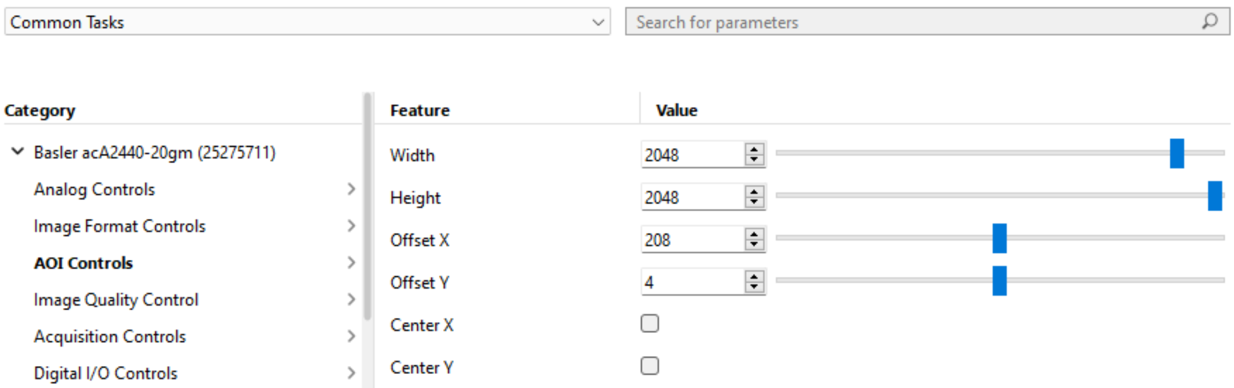


Fig 21: Setting your Field of View

C.2 Transport layer

When a GigE Vision camera transmits image data, the data stream is segmented into **GVSP (GigE Vision Streaming Protocol) packets**. These packets are transmitted sequentially from the camera to the host computer over Ethernet, where they are reassembled into complete image frames by the driver.

Two key camera parameters control how this data is transmitted and have a direct impact on **network bandwidth usage, packet loss, and host CPU load**:

- Packet Size
- Inter-Packet Delay

Inter-Packet Delay

The **Inter-Packet Delay** parameter inserts a pause between the transmission of consecutive packets within a single image frame. For example, if the Inter-Packet Delay is set to **1000 ticks**, the camera waits 1000 clock ticks after sending one packet before transmitting the next packet of the same frame.

Introducing an inter-packet delay reduces instantaneous network load and helps prevent congestion, particularly when **streaming multiple cameras simultaneously**. This technique is often very effective for improving transmission robustness on shared Ethernet links.

However, increasing the Inter-Packet Delay reduces the effective data throughput. Excessive delay can therefore limit the **maximum achievable frame rate**, especially at high image resolutions.

Packet Size

Packet Size defines the maximum payload size of each GVSP packet. Larger packets reduce protocol overhead and lower CPU load on the host, as fewer packets are required per frame. For this reason, packet sizes should generally fall into the **jumbo packet** range (≥1500 bytes), provided that all network components support them.

That said, network interface cards (NICs), switches, and media converters have practical limits. If packet sizes exceed what a device can reliably handle, packets may be dropped. Conversely, very small packet sizes (e.g. <500 bytes) greatly increase packet count, which can overflow NIC buffers and also result in dropped packets.

Recommended Strategy

The goal is to find a **balanced combination of Packet Size and Inter-Packet Delay** that provides reliable image transmission while minimizing bandwidth usage and host CPU load.

In multi-camera systems, robustness can be further improved by assigning **slightly different Inter-Packet Delay values to each camera**. Staggering the packet timing in this way helps interleave (or "weave") packet streams more evenly on the network, reducing burst collisions and smoothing overall traffic on shared links.

Typical values that have proven effective are:

- Packet Size: ~4000 bytes for multi-camera systems
- Packet Size: up to ~9000 bytes for single-camera systems (when all network hardware supports jumbo frames)
- Inter-Packet Delay: ~400 ticks, or approx. 10% of Packet Size value (with small offsets between cameras, e.g. 400, 450, 500 ticks)

This approach promotes stable streaming performance, particularly when multiple cameras share the same Ethernet interface, switch, or telemetry link.

Telemetry and Bandwidth Considerations

In telemetry applications using the MOOG Media Converter, the maximum available throughput is approximately 310 MB/s. Installing additional boards on the MOOG motherboards (such as serial cards) reduces the bandwidth available to the Ethernet ports. As a rule of thumb, assume a reduction of approximately 35 MB/s per additional cards.

It is good practice to limit the bandwidth allocated to each camera to less than 100 MB/s in multi-camera systems to maintain margin and ensure stable operation. This can be achieved by reducing the image size (AOI) and/or lowering the frame rate.

Transport Layer Setting

All network-related streaming parameters are configured in the **Transport Layer** section of the **Features** pane in Basler Pylon Viewer. These settings directly affect bandwidth usage, packet loss behavior, and overall streaming stability.

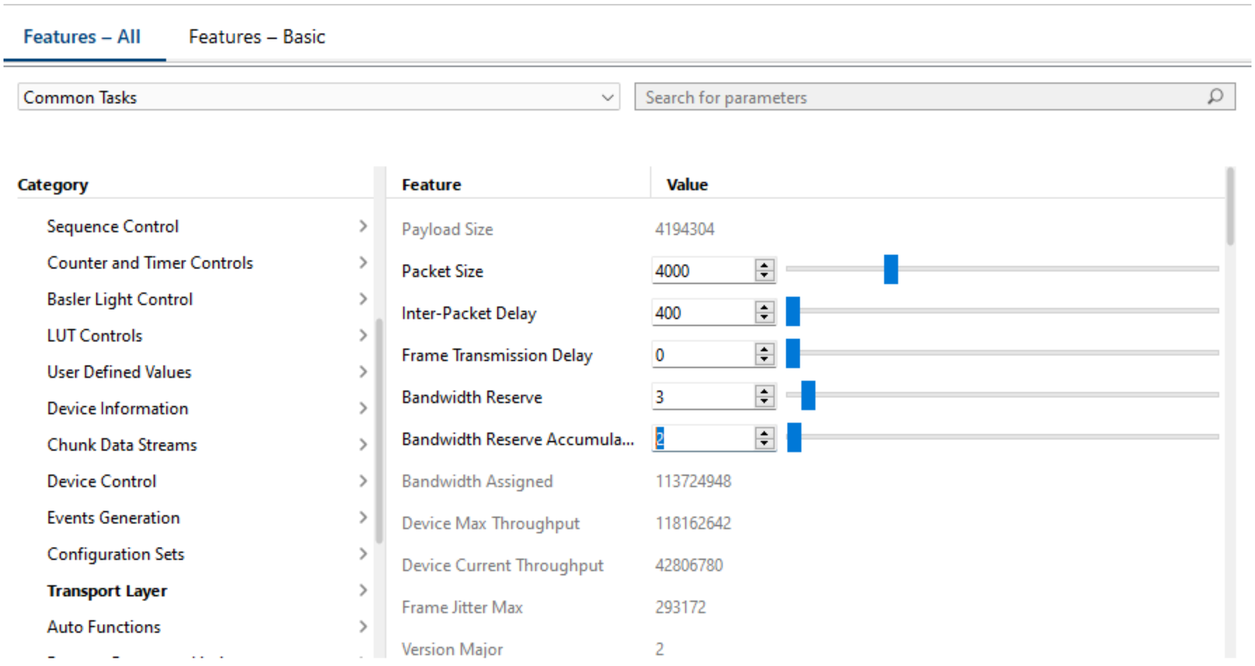


Fig 22: Transport Layer Settings

Packet Size

Set **Packet Size** to a high value that is compatible with your network hardware:

- For **single-camera systems**, use a value as high as possible, typically **up to but below 9000 bytes**, provided that jumbo frames are supported end-to-end.
- For **multi-camera systems**, a value around **4000 bytes** is recommended to balance robustness and throughput.

Inter-Packet Delay

Set **Inter-Packet Delay** as follows:

- **Single camera:** set to **0**
- **Multi-camera systems:** set to approximately **10% of the Packet Size**, and use **slightly different values for each camera** to stagger packet transmission

Frame Transmission Delay

Frame Transmission Delay should always be set to **0**. This parameter delays the start of frame transmission and is not useful for ISIIS-DPI operation.

Bandwidth Reserve Parameters

The **Bandwidth Reserve** parameters control how much additional transmission capacity the camera keeps available to handle **packet resends** during transient network disturbances.

Bandwidth Reserve specifies the amount of bandwidth reserved for packet resends, expressed as an **integer reserve level**, not a percentage. Internally, this value is used by the camera to calculate how much resend traffic it can accommodate relative to the assigned bandwidth.

A higher value increases tolerance to packet loss and retransmissions, but may slightly increase transmission jitter if many resends occur.

Keep this value range from **at 2 or 3**, with **3** being a good default for most ISIIS-DPI deployments.

Bandwidth Reserve Accumulation defines a multiplier that sets how many frame periods' worth of resend capacity can be accumulated and temporarily used during abnormal conditions, such as:

- EMI bursts
- Momentary congestion on telemetry links
- Shared network contention

This parameter effectively creates an **accumulator pool** for packet resends.

> Example:
> If the current Bandwidth Reserve setting allows up to **5 packet resends per frame**, and **Bandwidth Reserve Accumulation** is set to **2**, the accumulator pool can support up to:
> 5 × 2 = **10 packet resends** during a short disturbance.

Increasing this value improves robustness but may increase **Frame Jitter**, since resend bursts can delay the transmission of the next frame.

Use **low accumulation values: 1 or 2**

Bandwidth and Throughput Checks

Verify that the Assigned Bandwidth is within the physical limits of the network:
- For standard Gigabit Ethernet, the assigned bandwidth must be below 125 MB/s
- In multi-camera systems, ensure that the sum of all camera bandwidths stays comfortably below the available link capacity

Monitor the following indicators:
- Device Max Throughput
- Device Current Throughput

The current throughput should remain below the assigned and maximum limits with sufficient margin.

Reduce bandwidth usage by Lowering frame rate or reducing image size (AOI)

Frame Jitter Evaluation

Frame Jitter Max indicates the maximum delay (in ticks) before the transmission of the next frame, caused by packet resend bursts. If the bandwidth reserve accumulation is set high, a burst of resends during one frame can delay the start of the next frame transmission.

At 20 frames per second, each frame must be transmitted within 50 ms.
Conversion reference:

- 10,000 ticks = 1 ms

As a rule of thumb:

- Frame Jitter Max should be well below 50 ms
- Ideally, it should remain below 20–30 ms to maintain stable frame timing

  Example:
  A reported jitter of 290,000 ticks corresponds to 29 ms, which is acceptable but approaching the upper limit.

Note on Bandwidth Allocation and Telemetry

The ***Bandwidth Assigned*** parameter should not be interpreted as a fixed reservation of network capacity. When the camera is transmitting below this value, the remaining bandwidth on the telemetry link remains available for other traffic, such as command, control, or auxiliary sensors.

To ensure reliable coexistence with other telemetry data, camera bandwidth must be managed through image size, frame rate, and transport-layer timing parameters rather than through the assigned bandwidth value alone.

C.3 User Sets and persistent camera settings

Basler cameras support **User Sets**, which allow you to save, recall, and automatically restore groups of camera parameters. A **User Set** (also referred to as a *configuration set*) stores nearly all camera settings required for operation, with a few internal parameters excluded.

Some User Sets are factory-defined and read-only. These are referred to as Factory Sets and cannot be modified.

User Sets are stored in the camera's **non-volatile memory**, allowing settings to persist across power cycles.

Saving a User Set

Saving the current camera configuration to a User Set is a four-step process. The camera must be idle (not acquiring images) to save a User Set.

1. Adjust camera parameters until the camera is operating exactly as desired.
2. In the **Features pane**, set **User Set Selector** to the desired destination (e.g., **User Set 1**).
3. Set the Default Startup Set to **User Set 1**
4. Execute the User Set Save command.

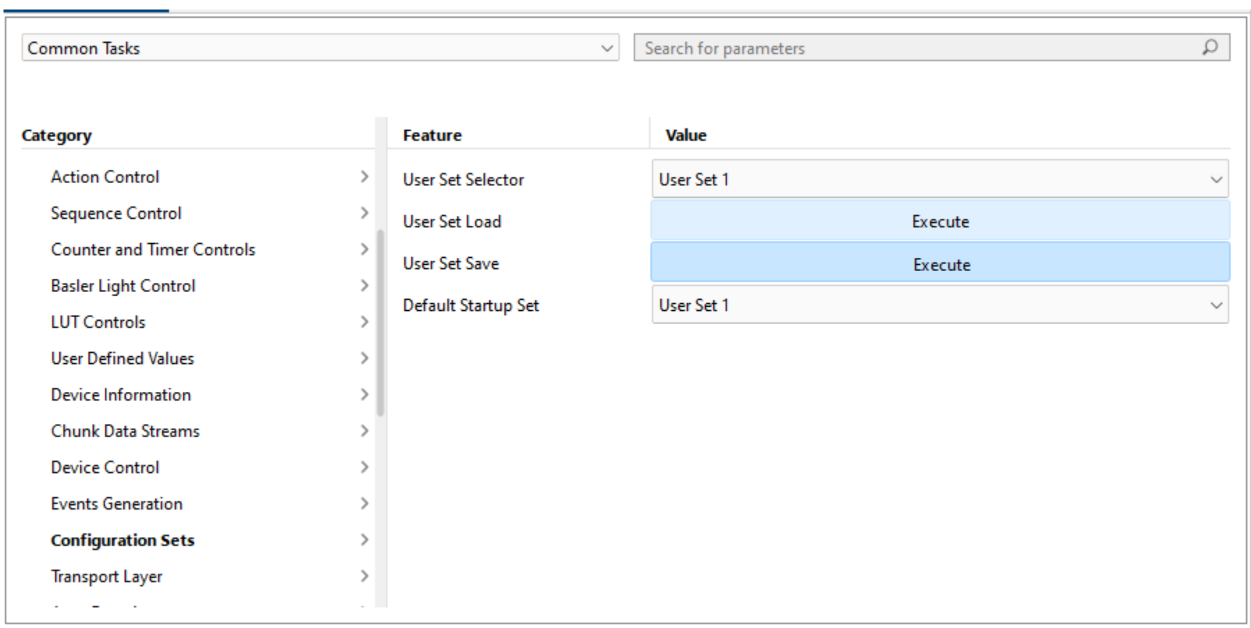


Fig 23: Saving a User Set

3.4 Image Acquisition and Saving

A. Saving images using Basler Pylon tools

Pylon Viewer allows users to record data from the camera either as a **video** or as a **sequence of still images**. For most ISIIS-DPI Plankton Camera applications, recording as video is preferred, using **raw (uncompressed)** frames stored in an AVI container.

The recording menu can be accessed via:
Toolbar Menu → Window → Recording Settings

AVI Recording Limitations
Pylon Viewer has a known limitation when recording AVI files: once an AVI file reaches **2 GB**, Pylon Viewer generates an error and stops recording. In addition, recording cannot be automatically continued into a new file or folder.

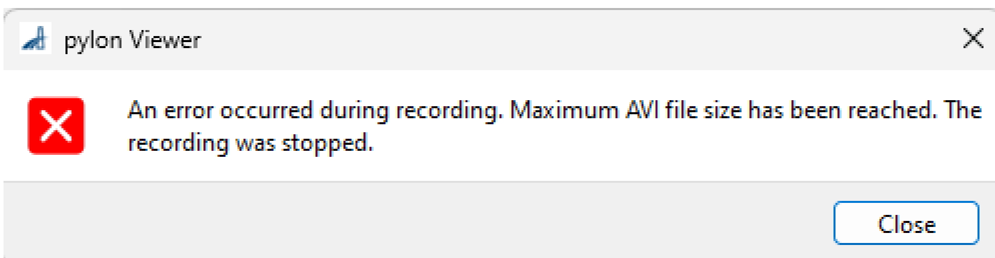


Fig 24: Typical Message when recording AVI with pylon Viewer

A.1. Recommended AVI Recording Settings

When recording in AVI format:

- **Playback speed**: Do **not** set playback speed to match the capture rate
- **Compression**: **Disabled** (raw images only)
- **Destination folder**: Ensure the correct destination folder is selected before recording

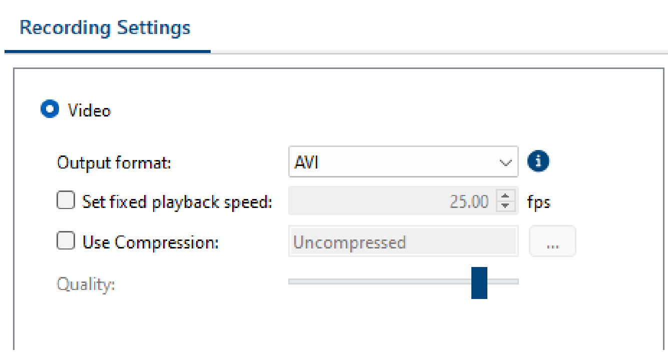


Fig 25: pylon Viewer AVI Recording Settings

A.2 Saving as a Sequence of Still Images

Due to the file size limitations of AVI recording, it is often preferable to save data as a **sequence of still images** instead of a single video file. This method avoids the 2 GB limit and allows for continuous acquisition over long deployments.

The **recommended settings** for recording a sequence of still images are shown in the screenshot below.

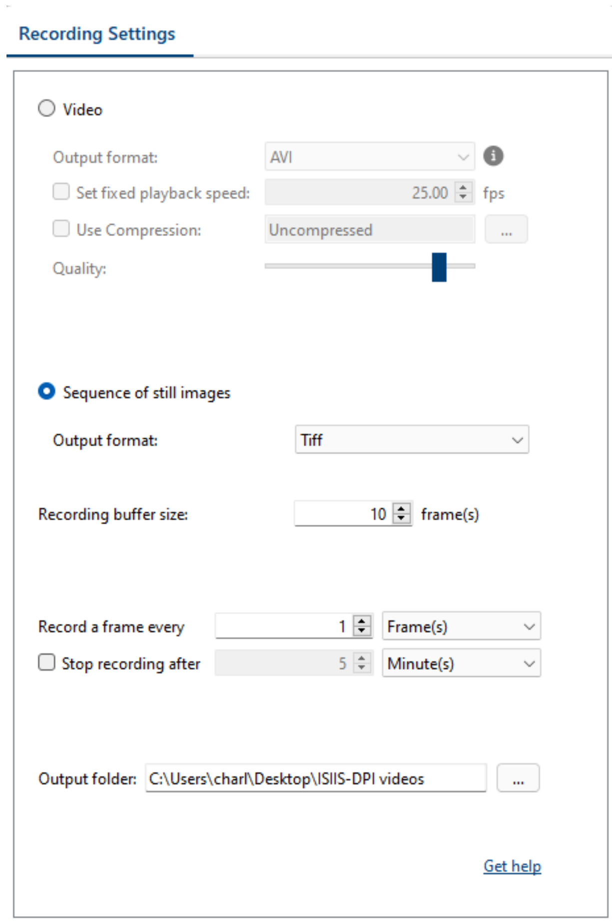


Fig 26: pylon Viewer Still Images Recording Settings

B. Saving Images using Sixclear Jade

JADE by Sixclear is a modular data-handling software built around a **publisher–subscriber architecture**. In JADE, each data source, such as a sensor measurement, or system event, is published to a shared data pool. Any plugin can subscribe to this data and access it in real time.

A **plugin** is a functional module within JADE that performs a specific role, such as image recording, data visualization, triggering relays, or forwarding data to external systems. Plugins operate independently and do not need direct knowledge of each other; they simply react to the data streams they subscribe to.

This decoupled architecture enables:

- Parallel processing of the same data by multiple plugins
- Flexible system configuration without software redesign
- Easy extension by adding or removing plugins as needed

As a result, JADE provides a robust and scalable framework for instrument control, synchronized data logging, and event-driven actions.

This user manual does not attempt to document the full capabilities of the JADE software platform. Instead, it focuses on the **Basler Camera plugin**, describing its purpose, user interface, configuration options, and its role in saving image data within a JADE-based acquisition system.

B.1. Overview

The Basler Camera plugin provides control over the Basler cameras used in our ISIIS-DPI Plankton Camera systems. Cameras managed by the plugin are highly configurable, including the ability to show/hide a real-time viewer, record AVI video files, and to set any available camera parameters. As a standard workflow, camera parameters (such as exposure, gain, pixel format, etc.) are typically configured using **Basler Pylon Viewer** and saved directly to the camera as a *User Set*. This approach ensures consistent and repeatable camera configuration at startup, as described in Section **3.3.3.C – User Sets**.

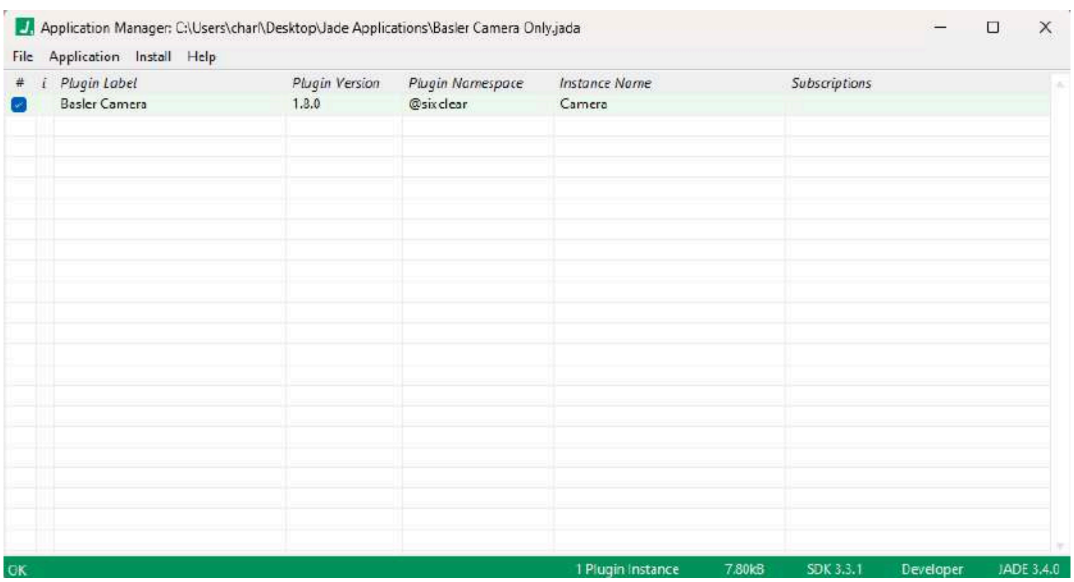


Fig 27: Jade Manager Window with Basler Camera Plugin

B.2. User Interface

The Basler Camera plugin user interface presents a list of all configured cameras detected by the system. For each camera,**exposure time** and **gain** can optionally be exposed for real-time adjustment during operation.
The interface also includes a **Diagnostics** panel that is dynamically updated during acquisition. This panel provides key performance and health information, including acquisition rates, bandwidth statistics, disk metrics, and other performance characteristics.

These diagnostics are intended to help operators verify correct operation, identify bottlenecks, and ensure reliable image acquisition and available recording storage during experiments or deployments.

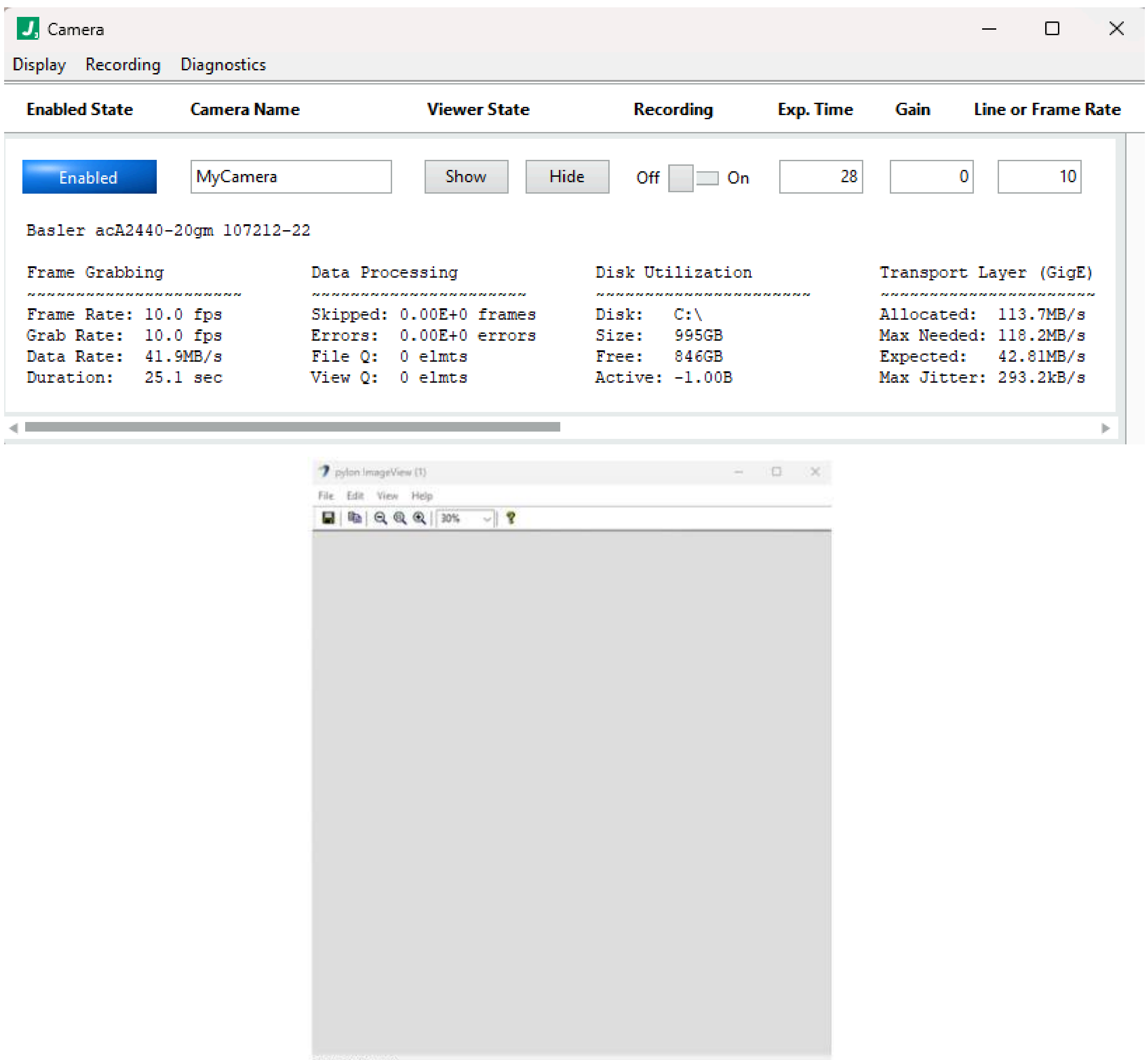


Fig 28: Basler Camera UI

The main control row provides direct access to the most commonly used camera functions:

- **Viewer State (Show / Hide)**: Opens or closes the live-view window for the selected camera. Disabling the live view can reduce CPU and GPU load during long recording sessions.
- **Recording (On / Off)**: Starts or stops video recording for the camera using the currently selected recording settings.
- **Exposure Time, Gain, Line Rate / Frame Rate**: When enabled, these fields allow selected camera parameters to be adjusted in real time during acquisition. Availability depends on the camera model and current acquisition mode.

Below the control row, the **Diagnostics section** provides continuously updated feedback grouped into four categories:

- **Frame Grabbing**: Displays acquisition frame rate, grab rate, data rate, and acquisition duration.
- **Data Processing**: Reports skipped frames, processing errors, and internal queue usage.
- **Disk Utilization**: Shows the active recording disk, total capacity, free space, and current write activity.
- **Transport Layer**: Provides camera interface statistics such as allocated bandwidth, required bandwidth, expected throughput, and jitter (notably for GigE cameras).

These diagnostic indicators validate system performance, especially when operating multiple cameras, high frame rates, or sustained long-duration recordings.

B.3. Basler Camera Plugin Configuration File (Example)

Each JADE plugin (referred to as a JADC) exposes a JSON configuration file. In the JADE UI, most fields show a short description when you hover over the parameter name. For this manual, we highlight the key fields using line numbers from the example below.

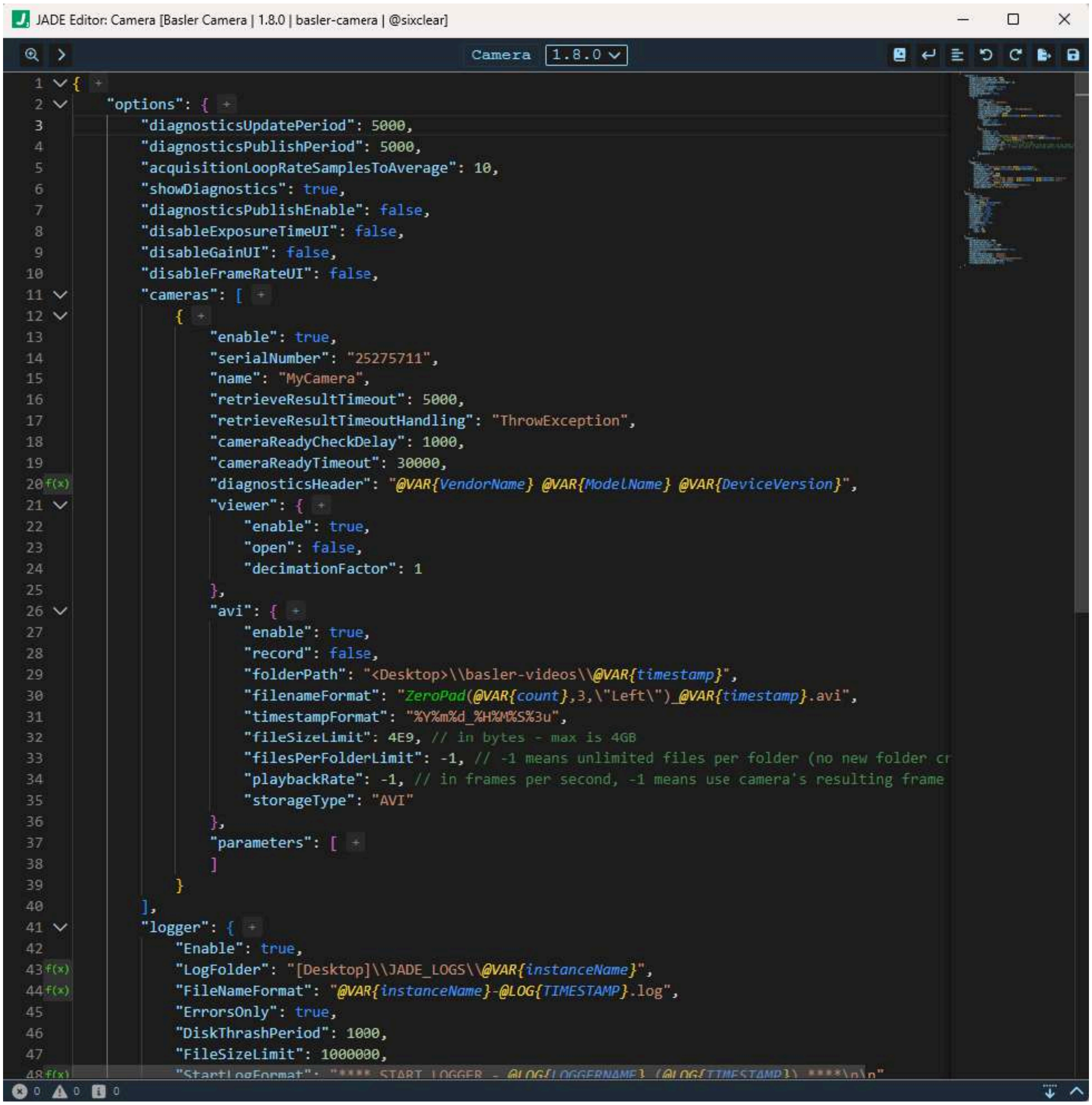


Fig 29: Basler Camera Config. File

B.4. Key settings to understand

- **Camera identification (serial number)**
  - **Line 14 – `serialNumber`**: Enter the camera's serial number to uniquely identify which Basler device the plugin should attach to. This is the primary way the plugin finds the intended camera, especially when multiple cameras are connected.
- **Viewer behavior (live view)**
  - **Line 22 – `viewer.enable`**: Enables the live-view capability for that camera.
  - **Line 23 – `viewer.open`**: If set to `true`, the live-view window opens automatically when the plugin starts.
  - **Line 24 – `viewer.decimationFactor`**: Reduces display workload by showing only every **N^th^** frame in the viewer (for example, `decimationFactor: 5` displays 1 frame out of 5). This is useful on embedded or low-power computers where decoding and rendering every frame may impact acquisition or recording performance.
- **AVI recording configuration**
  - **Line 27 – `avi.enable`**: Must be `true` to enable AVI recording features.
  - **Line 28 – `avi.record`**: If set to `true`, recording starts automatically when the plugin (and panel) opens.
  - **Line 29 – `avi.folderPath`**: Defines where AVI files are stored. In this example, the plugin creates a timestamped folder under the user's Desktop. When file size or file-count limits are reached, a **new folder is automatically created**, named using the timestamp of the **first frame recorded in that folder**.
  - **Line 30 – `avi.filenameFormat`**: Defines how individual AVI files are named. Filenames include a timestamp derived from the acquisition start. Within a folder, each file can be temporally referenced relative to the folder's start time.
  - **Line 31 – `avi.timestampFormat`**: Specifies the format used for timestamps embedded in folder and file names.
  - **Line 32 – `avi.fileSizeLimit`**: AVI files are limited to **4 GB maximum**; set the limit at or below `4E9` bytes. (Larger values are not supported by the AVI container and will not work reliably.)
- Within a folder, image timing can be reconstructed deterministically: given the camera frame rate, each successive frame (or AVI segment) corresponds to an increment of **1 / FPS** seconds from the timestamp of the first frame. For example, at 10 FPS, the second frame corresponds to *timestamp + 0.1 s*, the third to *timestamp + 0.2 s*, and so on. This provides a consistent temporal reference even when recording is split across multiple files or folders.
- **Camera parameters block**
  - **Line 37 – `parameters`**: Can be left empty (`[ ]`) when parameters are managed through **Pylon Viewer + User Sets** (recommended workflow). You only need entries here if you want JADE to explicitly force specific parameters at runtime.
- **Panel auto-open behavior**
  - **Line 55 – `panel.open`**: When `true`, the plugin window opens automatically when the plugin starts running.

4. Optical Alignment and Focus Adjustment

4.1 Initial Optical Alignment

Each ISIIS-DPI Plankton Camera is supplied securely fastened to its mounting frame, including the beam and associated brackets or vehicle support hardware. The camera is equipped with a fixed-focus lens that is factory-set to focus at the mid-plane, corresponding to the midpoint between the camera enclosure viewport and the illumination (LED) enclosure viewport. The spacing between enclosures, and therefore the system depth of field, is calibrated for the original mission configuration.

Several key aspects of the optical alignment should be understood. The illumination system is designed to project a uniform light field toward the camera viewport, with the LED assembly aligned to face the camera lens directly. The illumination optics are collimated and factory-set; under normal operation, there is no reason to adjust the LED position or orientation.

The camera and lens assembly are also collimated, but the exact axial position of the camera relative to the illumination is more sensitive. Small shifts in camera position can affect focus uniformity and illumination homogeneity, particularly in field conditions. For this reason, minor camera position adjustments may be required during setup or troubleshooting, as described in the following sections.

4.2 Focus Adjustment Procedure

There is no reason to readjust focus unless (1) the **depth of field is changed** by modifying the spacing between the illumination (LED) enclosure and the camera enclosure, or (2) **misalignment shadows** appear in the image. Any change in enclosure spacing requires refocusing because the system is designed to target the **mid-plane** between the two viewports, so that focus degradation remains as uniform as possible for particles located closer to, or farther from, that plane.

A. Disassembly and access to the focus ring

1. **Remove the end-cap fasteners** from the camera enclosure.
2. Using the supplied **soft-tip extraction set screws**, gently extract the end-cap assembly. Do not pry on sealing surfaces.
3. **Remove the O-rings** from the end-cap. This allows the end-cap assembly to be reinserted repeatedly, flush against the enclosure flange (its real position), with ease.

B. Focus adjustment (iterative)

1. Manually adjust the **lens focus** by a small increment.
2. Reinsert the end-cap assembly (without O-rings) fully against the pod flange so the camera is seated in its true operating position.
3. Acquire an image and evaluate focus (better / worse / optimal).
4. Repeat the adjust–reinsert–evaluate cycle until best focus is reached at the intended mid-plane.

This step is easiest with two people: one observing the live image, and the other adjusting the focus ring and holding the end-cap assembly seated. When working alone, a practical method is to use **quick-clamps with rubber pads** to hold the end-cap assembly flush while you evaluate the image.

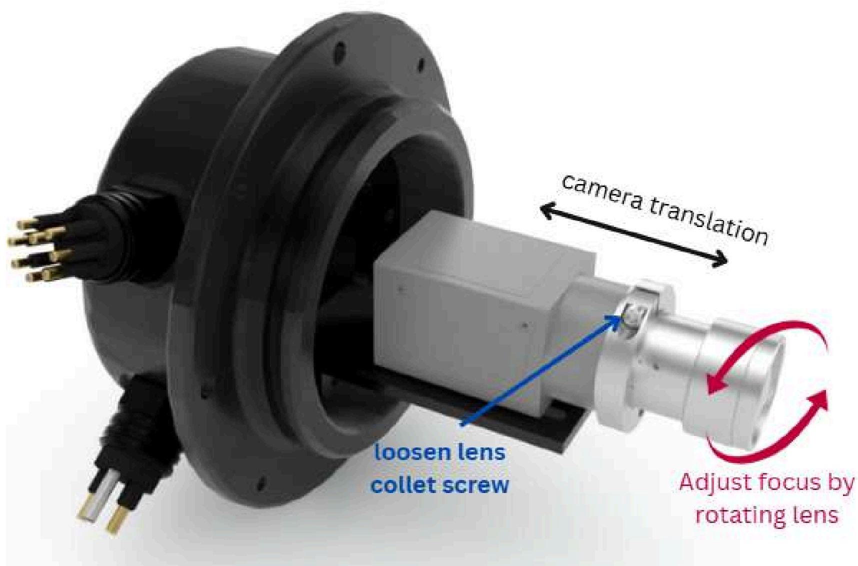


Fig 30: ISIIS-DPI Plankton Camera: Internal Camera and Lens

C. Reassembly and sealing

Reassembly follows the same steps in reverse, but careful attention to sealing and hardware practices is essential:

1. **Lock the focus setting** by securing the collet screw. A small dab of **hot glue** can be used as an added vibration-resistant restraint.
2. Replace the **desiccant bag** if needed.
3. **Triple-check** that all internal components and fasteners are secure and that no tools or loose parts remain inside.
4. Ensure the **O-ring grooves** are clean and free of debris.
5. Clean the O-rings and apply a light coating of **O-ring grease** (preferably **Molykote specialty O-ring grease**).
6. Apply a very light film of O-ring grease on the sealing surfaces and we recommend adding a light coat to the flanges as well (end-cap flange and cylinder flange). It provides a bit of added protection against oxidation.

7. Insert the end-cap assembly and tighten the fasteners using an **opposite “star” pattern** to ensure even compression.

   (Verify that the **fiberglass insulating hardware** prevents direct stainless-on-stainless contact (washer/nut/screw head isolation), to reduce galvanic issues and seizing.)

8. As a final step, apply a small dab of grease into the **threaded extraction holes** in the end-cap (used for the extraction set screws), then reinstall the **nylon plug screws**. These plugs prevent dirt ingress and reduce corrosion/oxidation in the threads.

4.3 Recommended Targets and Test Conditions

The most rigorous focus and resolution calibration procedure consists of using a **USAF 1951 resolution target** placed precisely at the system’s mid-field position. The camera is first focused at this location to achieve optimal sharpness. The target is then translated forward and backward along the optical axis, and the smallest resolvable element groups (“blocks”) are recorded at each position. This allows the user to determine the system’s spatial resolution, expressed in **line pairs per millimeter (lp/mm)**, and to generate a resolution-versus-position curve characterizing overall system performance.

In field conditions, however, the use of calibrated resolution targets is often impractical. A reliable alternative is to use a **perfectly flat acrylic ruler**, ideally with a lightly scratched surface. In addition to providing a convenient reference for verifying the system’s field-of-view dimensions, the fine scratches on the acrylic surface serve as high-contrast features for focus adjustment. Optimal focus is achieved when individual scratch lines appear at their minimum apparent width; any increase in line thickness indicates a deviation from best focus.

For **line-scan cameras**, focus adjustment is inherently more challenging, as image formation requires relative motion between the target and the camera. In field applications, a practical solution is to secure a short section of acrylic ruler to a screw mounted in a handheld drill and rotate it at a steady speed. The resulting data should be recorded and reviewed after acquisition, allowing the user to stop and assess image sharpness. This method can produce usable results but requires practice and patience, and careful control of rotation speed.

An alternative approach is to have a second operator translate the ruler manually across the field of view while maintaining a constant speed and keeping the ruler flat and centered between the optical pods. In practice, this method is difficult to execute reliably, as even small deviations in flatness, speed, or positioning can affect the apparent focus. It may however be the most practical solution.

Users should be aware that all field-based focus and calibration procedures represent **best-effort adjustments** and are inherently limited by environmental conditions and handling constraints. For optimal calibration accuracy, repeatability, and system characterization, the instrument should be returned to the factory for alignment and calibration whenever possible.

4.4 Verification Before Deployment

Prior to every deployment, it is essential to thoroughly clean the camera viewport. During handling and storage, the optical window can accumulate grease, fingerprints, streaks, and salt deposits, all of which significantly degrade image quality. A contaminated viewport can also trap small air bubbles during immersion, further reducing image clarity and contrast.

The system uses **sapphire viewports**, which are extremely resistant to scratching under normal handling. However, this durability does not eliminate the need for proper cleaning practices. Dirty or abrasive cloths can still leave residues or fine surface contamination, and should never be used. The use of inappropriate chemicals can damage coatings, seals, or surrounding materials.

The viewport should be cleaned using a standard glass cleaner (e.g., a Windex-type solution) or isopropyl alcohol, which is typically readily available on research vessels. Harsh solvents such as **acetone**, as well as other aggressive chemicals, should never be used. After cleaning, the window must be wiped dry using a clean, lint-free microfiber cloth to prevent streaking or residue.

In addition to optical cleanliness, users should anticipate the expected water conditions prior to deployment. Water with high particulate content or biological activity absorbs and scatters more light, which can reduce image brightness and contrast. Camera exposure settings should therefore be adjusted in advance to account for anticipated turbidity and light attenuation.

4.5 Troubleshooting Optical Shadows and Misalignment

Shadows visible in the image are most commonly caused by slight misalignment between the camera enclosure and the illumination enclosure. To correct this, loosen the plastic brackets that secure the camera enclosure to the beam and gently adjust its position until the darker areas disappear.

If the shadows persist, the issue may originate from the camera itself. When operating in the field and returning the system for maintenance is not possible, open the camera enclosure end cap and verify that no components are loose. In some cases, the camera lens may have partially unthreaded.

To further assess alignment, loosen the camera mount and carefully shift the camera backward by a few millimeters. You can then proceed with the **Focus Adjustment Procedure** to verify both alignment and focus. If uniform illumination cannot be achieved without significant camera displacement, the system should be returned for factory alignment.

Why are we backing the camera up slightly?

The process of re-collimating the illumination onto the camera lens can be challenging, as the plano-convex lenses used in the system introduce optical aberrations and do not produce perfectly uniform illumination. When the camera is positioned exactly at the nominal focal plane, these illumination non-uniformities and angular variations in the light field can become more pronounced, appearing as shadowed regions in the image. To reduce this effect, the camera should be moved slightly backward (typically by a few millimeters), which helps spatially average the illumination and produce a more uniform image.

5. Post-Deployment Maintenance & Corrosion Prevention

5.1 Routine Protection

Before long-term or repeated deployments, apply a protective coat of LPS-3 to all exposed metallic surfaces of your subsea enclosures to prevent corrosion and oxidation.
After application, wipe off any excess lubricant.

5.2 After Each Recovery

After every recovery from seawater:

- Rinse the enclosure thoroughly with freshwater to remove salt deposits.
- After your mission, clean the entire enclosure using freshwater and mild dish soap.
- Allow the enclosure to dry completely, then reapply a coat of LPS-3 before storage.

5.3 Addressing Corrosion or Pitting

If you observe signs of corrosion or pitting on aluminum surfaces:

- Clean the affected area with a soft wire brush to remove oxidation.
- Temporarily seal the cleaned spot with heavy grease.
- When possible, apply epoxy over the area for long-term protection.
  Note: J-B Weld is recommended for its ease of use and strong adhesion.

6. Miscellaneous

6.1. General Disclaimer

This manual is provided “as is” without warranty of any kind, either express or implied, including but not limited to the implied warranties of merchantability or fitness for a particular purpose. Bellamare reserves the right to make changes to the product or this manual without notice.

6.2. Electrical Hazard Disclaimer

Improper handling of power connections may result in damage to the device or connected instruments. Only trained personnel should attempt internal repairs or modifications.

6.3. Warranty and Support

This product is covered by a limited one-year warranty against defects in materials and workmanship. Damage caused by misuse, improper installation, or unauthorized modifications is not covered under this warranty. For support, contact Bellamare. Normal wear and tear resulting from salt-water immersion are not covered.

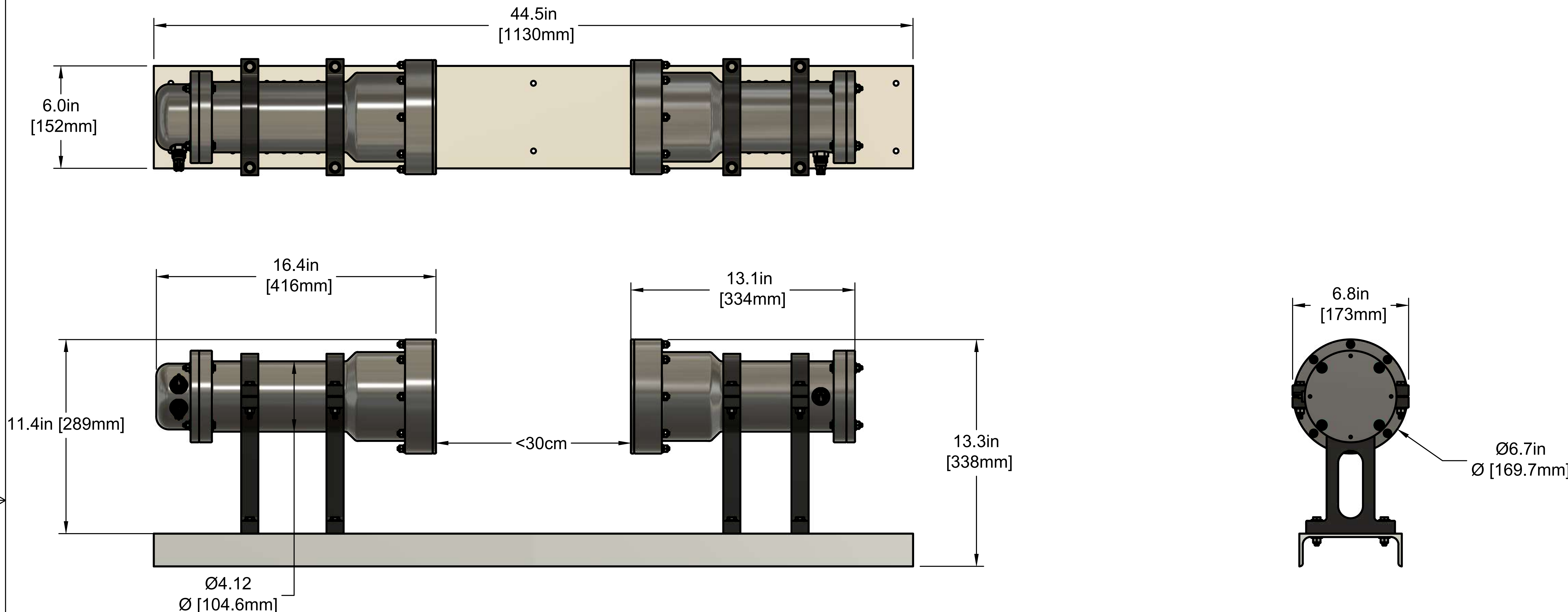
6.4. Intellectual Property Notice

The ISIIS-DPI Plankton Cameras hardware, software, and JADE-based configurations are proprietary systems developed by Bellamare and Sixclear, Inc. Unauthorized duplication or reverse engineering is strictly prohibited.

6.5. Data Responsibility Clause

Bellamare is not liable for any loss of data or missed acquisition events related or not to the use of its equipment or services.

Appendix 1: Dimensional Drawings



1,000m Depth Rating:
Hard Anodized Aluminum Cylinders & End-caps | Sapphire Viewport
Weight in air: 18Kg
Weight in water: 7.7Kg

60m Depth Rating:
Acetal Cylinders & Stainless Steel End-caps & Retainer Rings | Sapphire Viewport
Weight in air: 14.2Kg
Weight in water: 3.9Kg

Dimensions:	inch
Tolerances:	.XX: ±..01
	.XXX: ±..005
	X°: ±1°

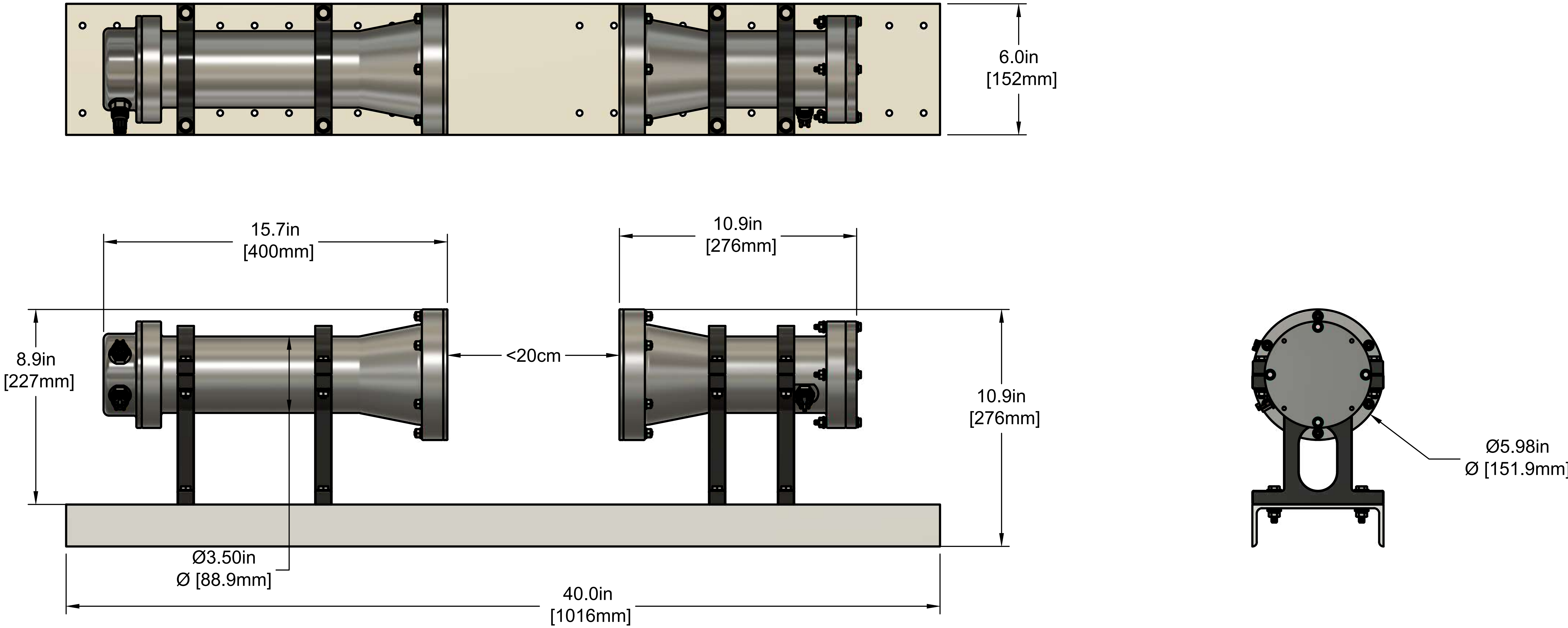
BELLAMARE

PROJECT
ISIIS-DPI_P125

TITLE
ISIIS-DPI P125 Plankton Camera General Dimensions

APPROVED	CC	2/06/26
CHECKED		
DRAWN	Charles Cousin	10/2/2024

SIZE	CODE	DWG NO	REV
B		ISIIS-DPI P125 Dim	A
SCALE 1:6		WEIGHT	SHEET 1/1



<u>1,000m Depth Rating:</u>
Hard Anodized Aluminum Cylinders & End-caps | Sapphire Viewport
Weight in air: 13.8Kg
Weight in water: 5.7Kg

<u>60m Depth Rating:</u>
Acetal Cylinders & Stainless Steel End-caps & Retainer Rings | Sapphire Viewport
Weight in air: 11.2Kg
Weight in water: 3.0Kg

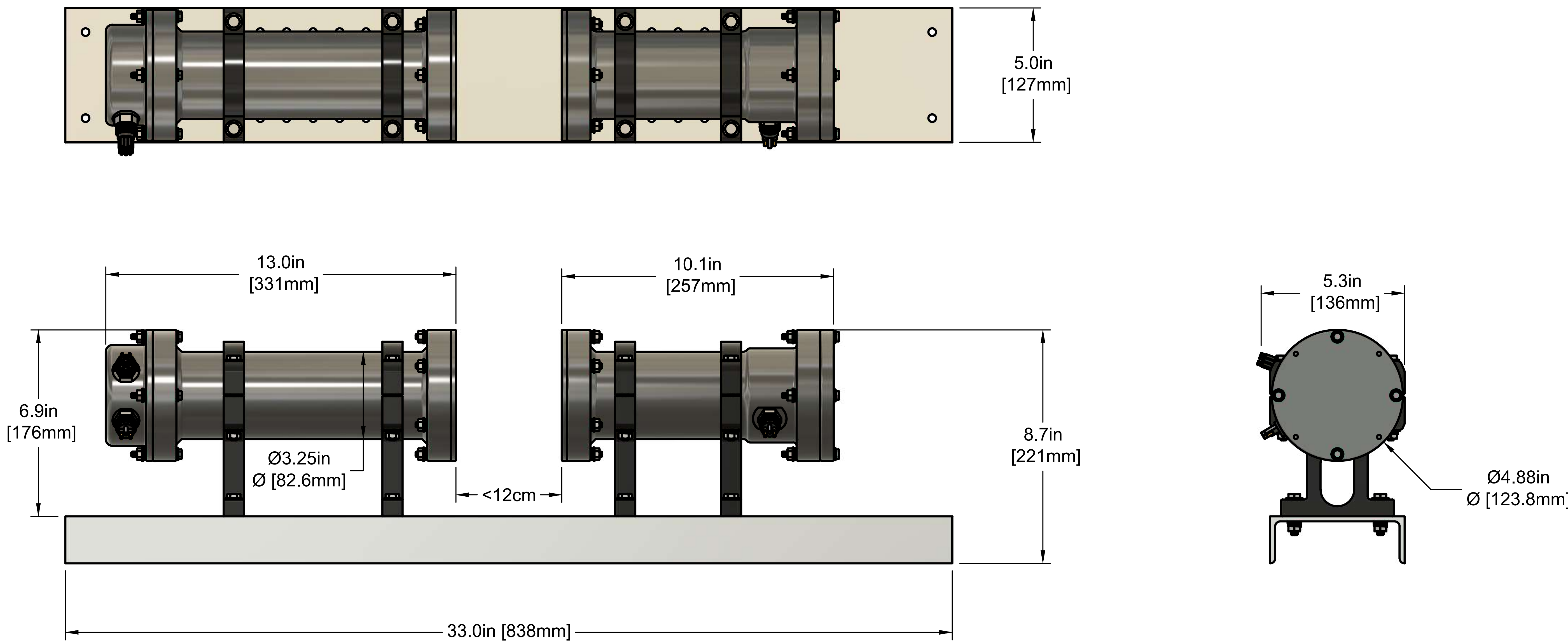
Dimensions:	Inches
Tolerances:	.XX: ±.01
	.XXX: ±.005
	X°: ±1°

BELLAMARE

PROJECT
ISIIS-DPI P100

TITLE
ISIIS-DPI P100 Plankton Camera General Dimensions

APPROVED CC 2/06/26	SIZE B	CODE	DWG NO ISIIS-DPI P100 Dim		REV A
CHECKED					
DRAWN Charles Cousin 2/6/2026	SCALE 1:5		WEIGHT	SHEET 1/1	



<u>1,000m Depth Rating:</u>
Hard Anodized Aluminum Cylinders & End-caps | Sapphire Viewport
Weight in air: 9.4Kg
Weight in water: 3.7Kg

<u>60m Depth Rating:</u>
Acetal Cylinders & Stainless Steel End-caps & Retainer Rings | Sapphire Viewport
Weight in air: 7.6Kg
Weight in water: 1.9Kg

Dimensions:	Inches
Tolerances:	.XX: ±.01
	.XXX: ±.005
	X°: ±1°

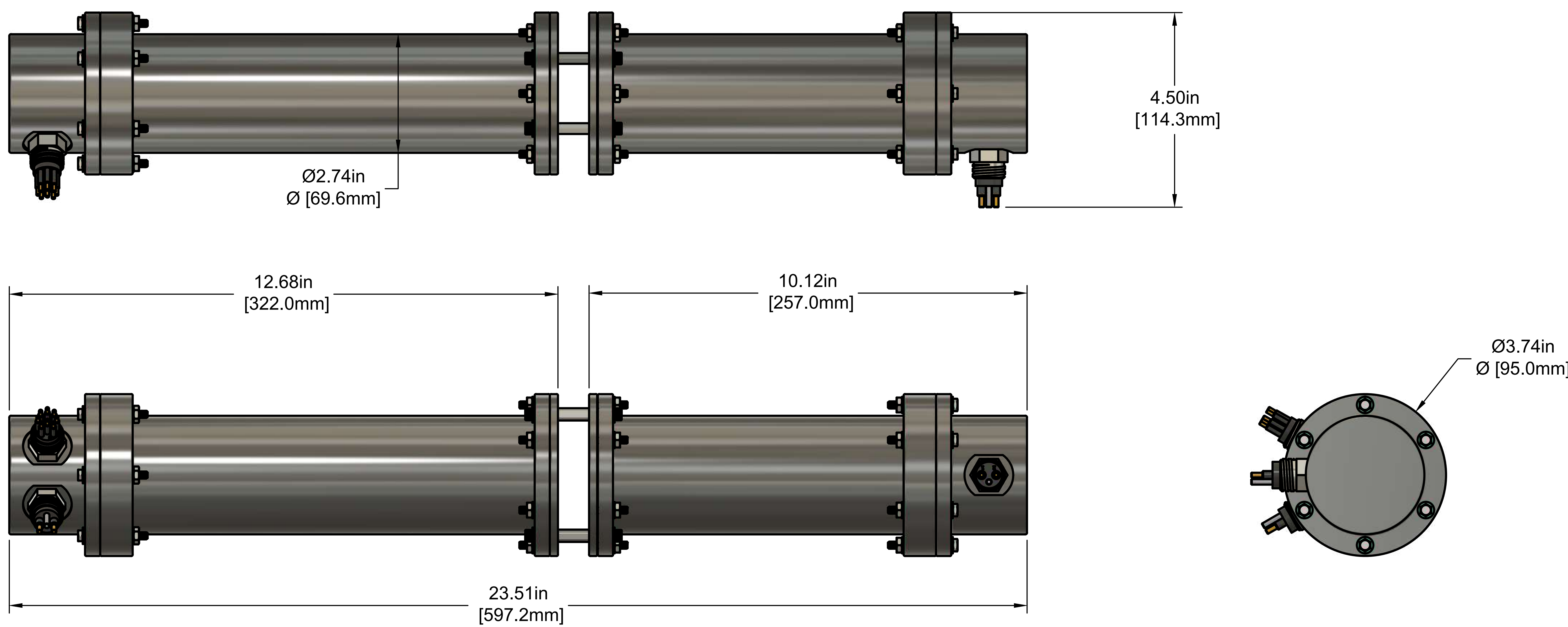
BELLAMARE

PROJECT
ISIIS-DPI P75

TITLE
ISIIS-DPI P75 Plankton Camera General Dimensions

APPROVED	CC	2/06/26
CHECKED		
DRAWN	Charles Cousin	2/6/2026

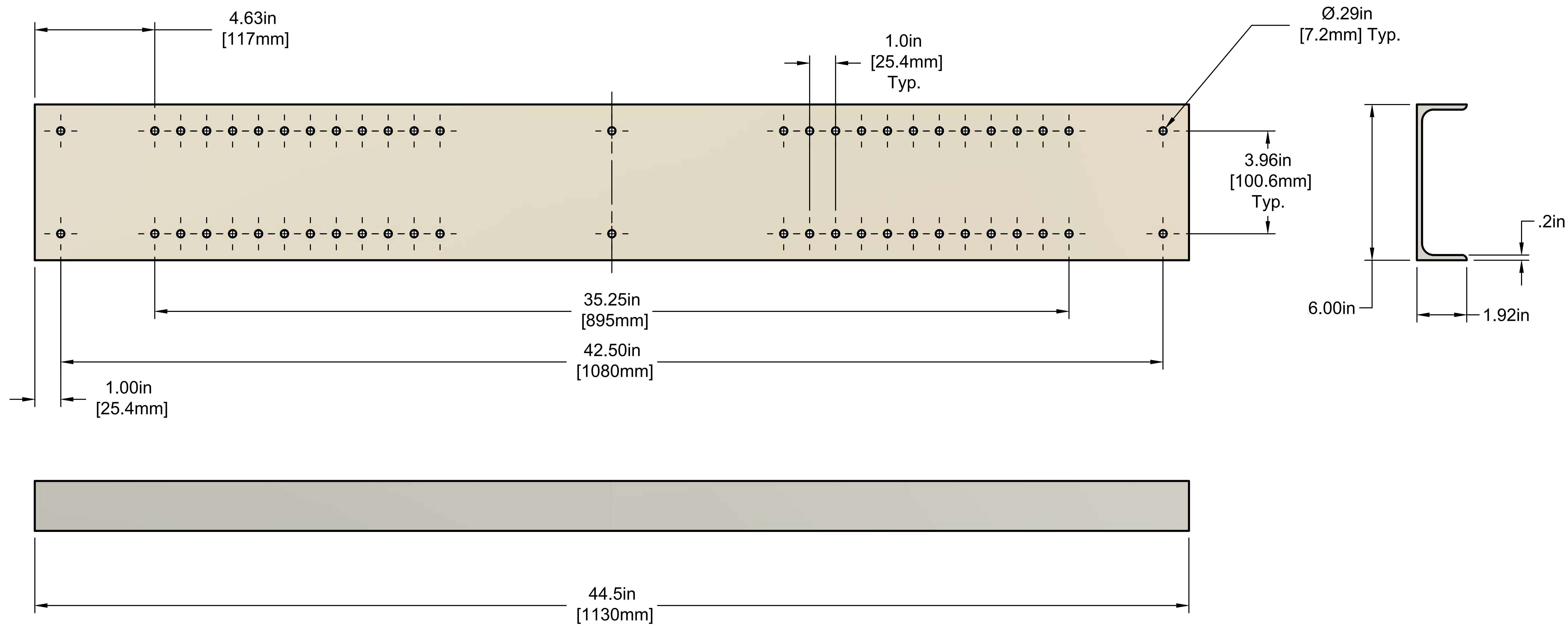
SIZE	CODE	DWG NO	REV
B		ISIIS-DPI P75 Dim	A
SCALE 1:4		WEIGHT	SHEET 1/1



1,000m Depth Rating:
Hard Anodized Aluminum Cylinders & End-caps | Sapphire Viewport
Weight in air: 5.5Kg
Weight in water: 3.5Kg

Dimensions:	Inches	PROJECT ISIIS-DPI T424			
Tolerances:	.XX: ±.01	TITLE ISIIS-DPI T424 Plankton Camera General Dimensions			
	.XXX: ±.005				
	X°: ±1°				
APPROVED CC	2/06/26	SIZE B	CODE	DWG NO ISIIS-DPI T424 Dim	REV A
CHECKED					
DRAWN Charles Cousin	2/7/2026	SCALE 1:2.5	WEIGHT	SHEET 1/1	

Appendix 2: Standard Beams Dimensions and Holes Pattern



Material:	Aluminum 6061-T6 Channel, 6x1.92x.2
Quantity:	1
Dimensions:	Inch
Tolerances:	.XX: ±.01
	.XXX: ±.005
	X°: ±1°

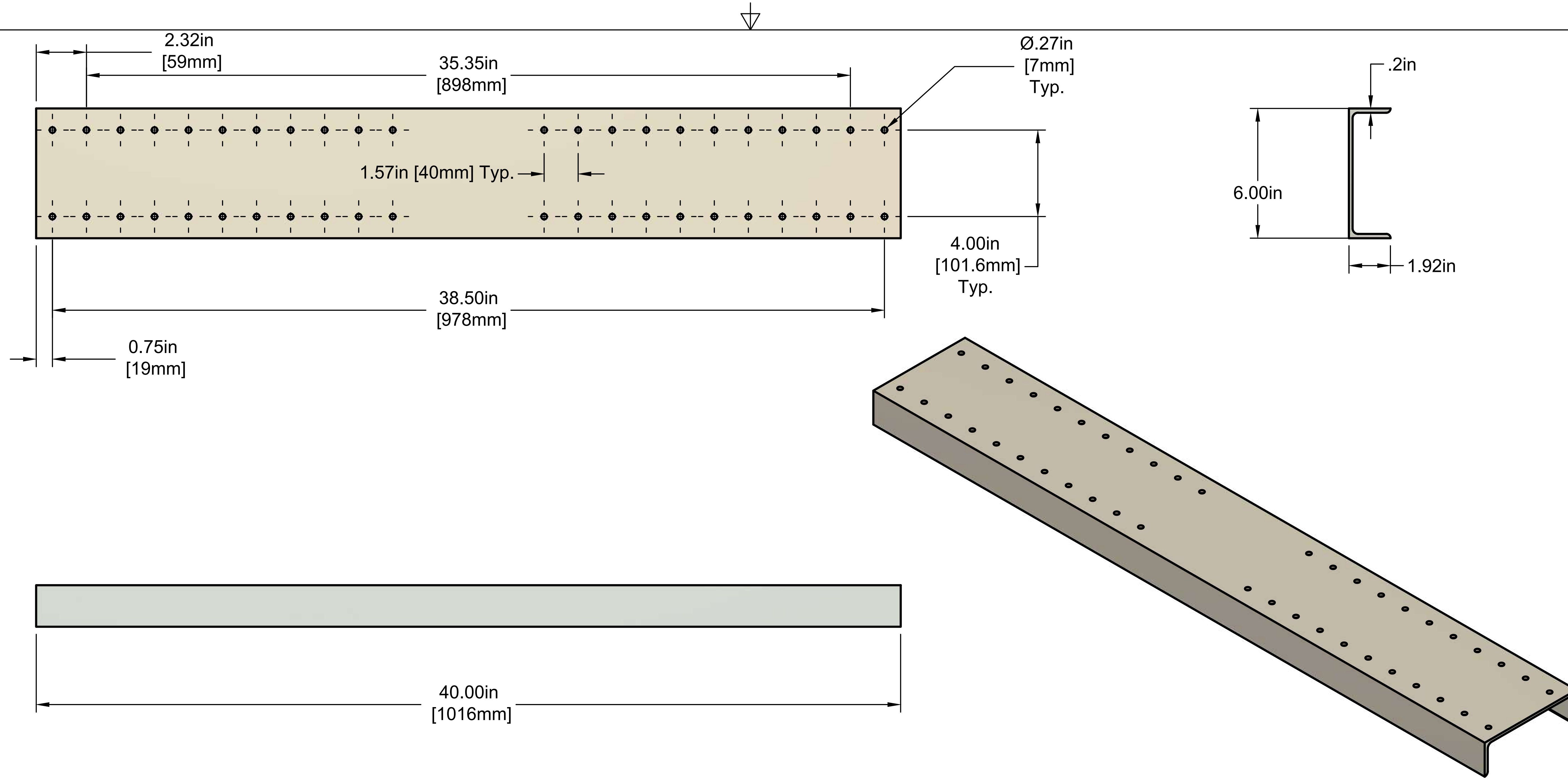
PROJECT
ISIIS-DPI P125

TITLE
ISIIS-DPI P125 Mounting beam

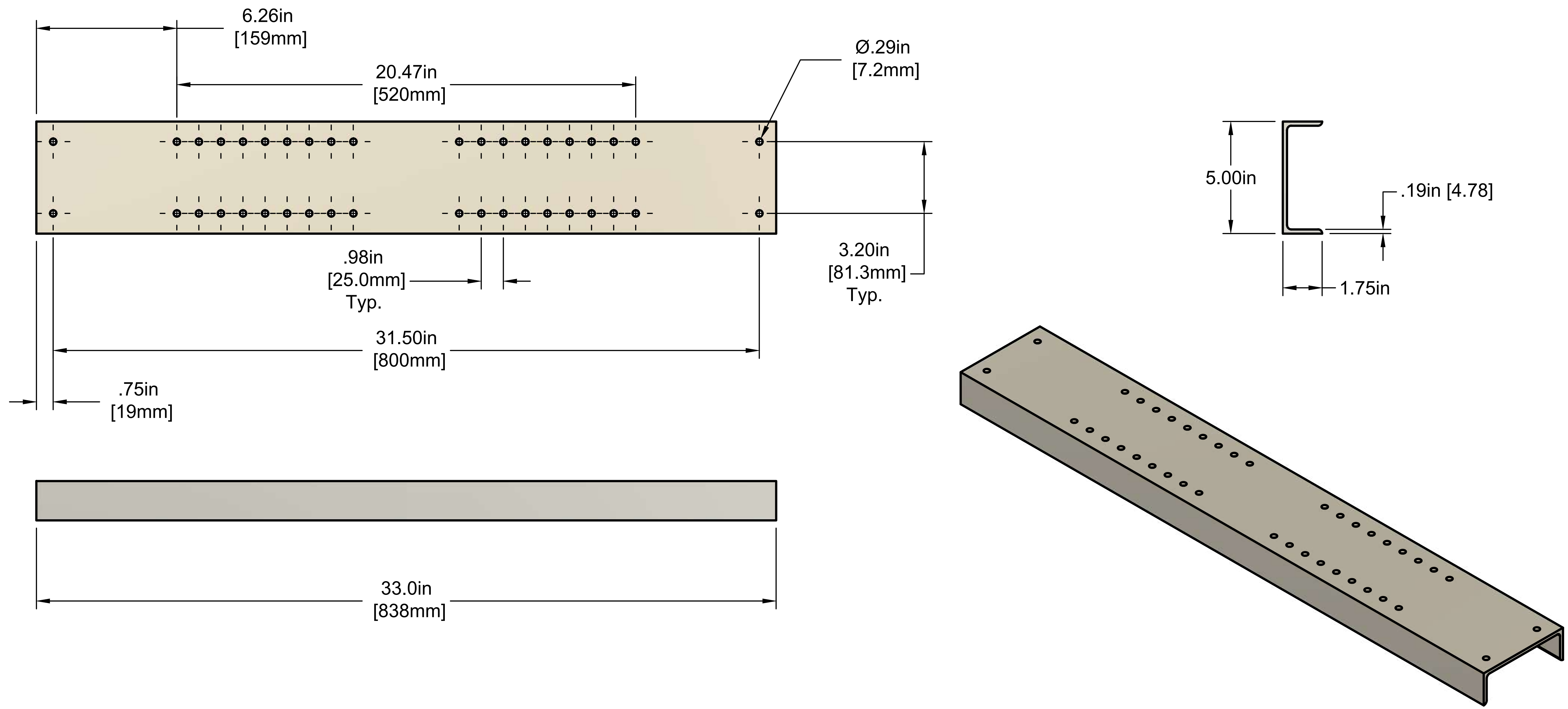
BELLAMARE

APPROVED CC		2/06/26
CHECKED		
DRAWN	Charles Cousin	2/6/2026

SIZE	CODE	DWG NO	REV
B		ISIIS-DPI P125 Beam	A
SCALE 1:4	WEIGHT		SHEET 1/1

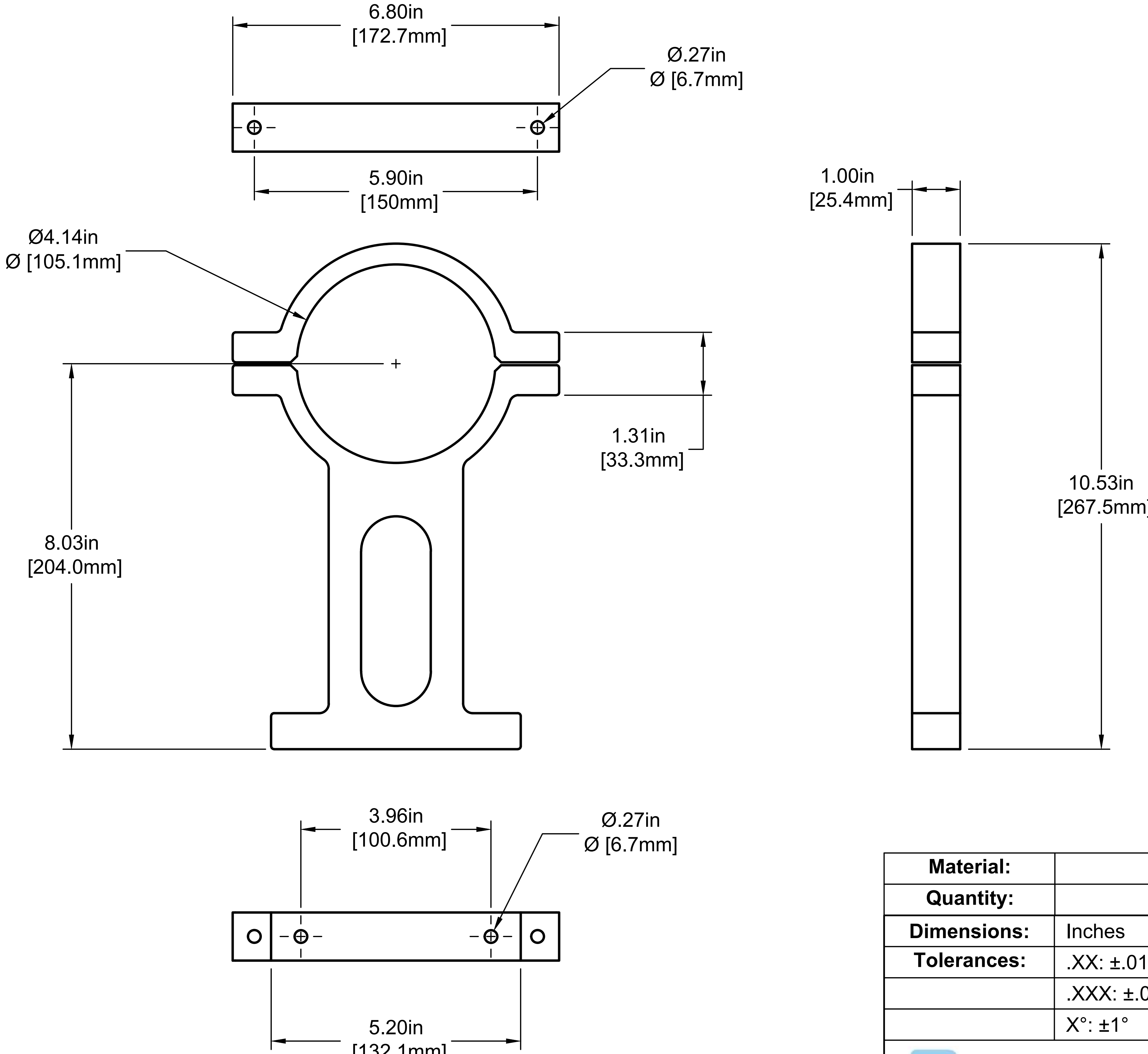


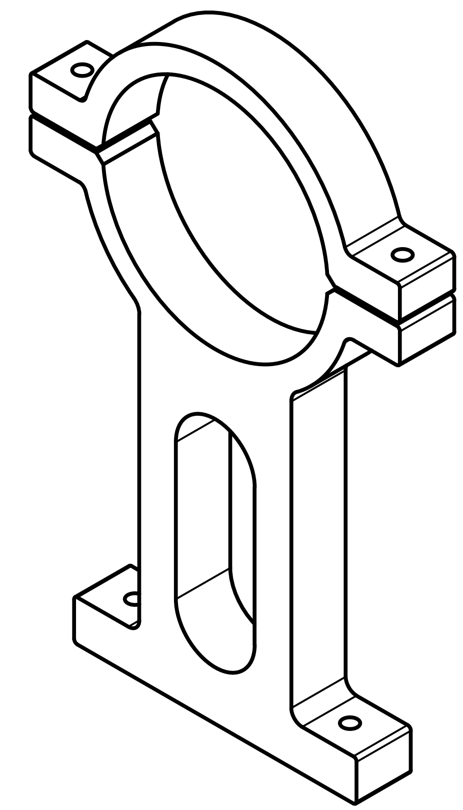
Material:	6061-T6 Aluminum Channel 6x1.92x.2				
Quantity:	1				
Dimensions:	Inch	PROJECT ISIIS-DPI Plankton Cameras			
Tolerances:	.XX: ±.01				
	.XXX: ±.005	TITLE ISIIS-DPI P100 Mounting Beam			
	X°: ±1°				
BELLAMARE					
APPROVED CC 2/06/26		SIZE B	CODE	DWG NO ISIIS-DPI P100 Beam	REV A
CHECKED					
DRAWN Charles Cousin 2/6/2026		SCALE 1:5	WEIGHT		SHEET 1/1



Material:	Aluminum 6061-T6, 5x1.75x.188			
Quantity:	1			
Dimensions:	Inches	PROJECT ISIIS-DPI P75		
Tolerances:	.XX: ±.01			
	.XXX: ±.005	TITLE ISIIS-DPI P75 Mounting beam		
	X°: ±1°			
BELLAMARE				
APPROVED CC 2/06/26		SIZE B	CODE	DWG NO ISIIS-DPI P75 Beam
CHECKED				REV A
DRAWN Charles Cousin 2/6/2026		SCALE 1:5	WEIGHT	SHEET 1/1

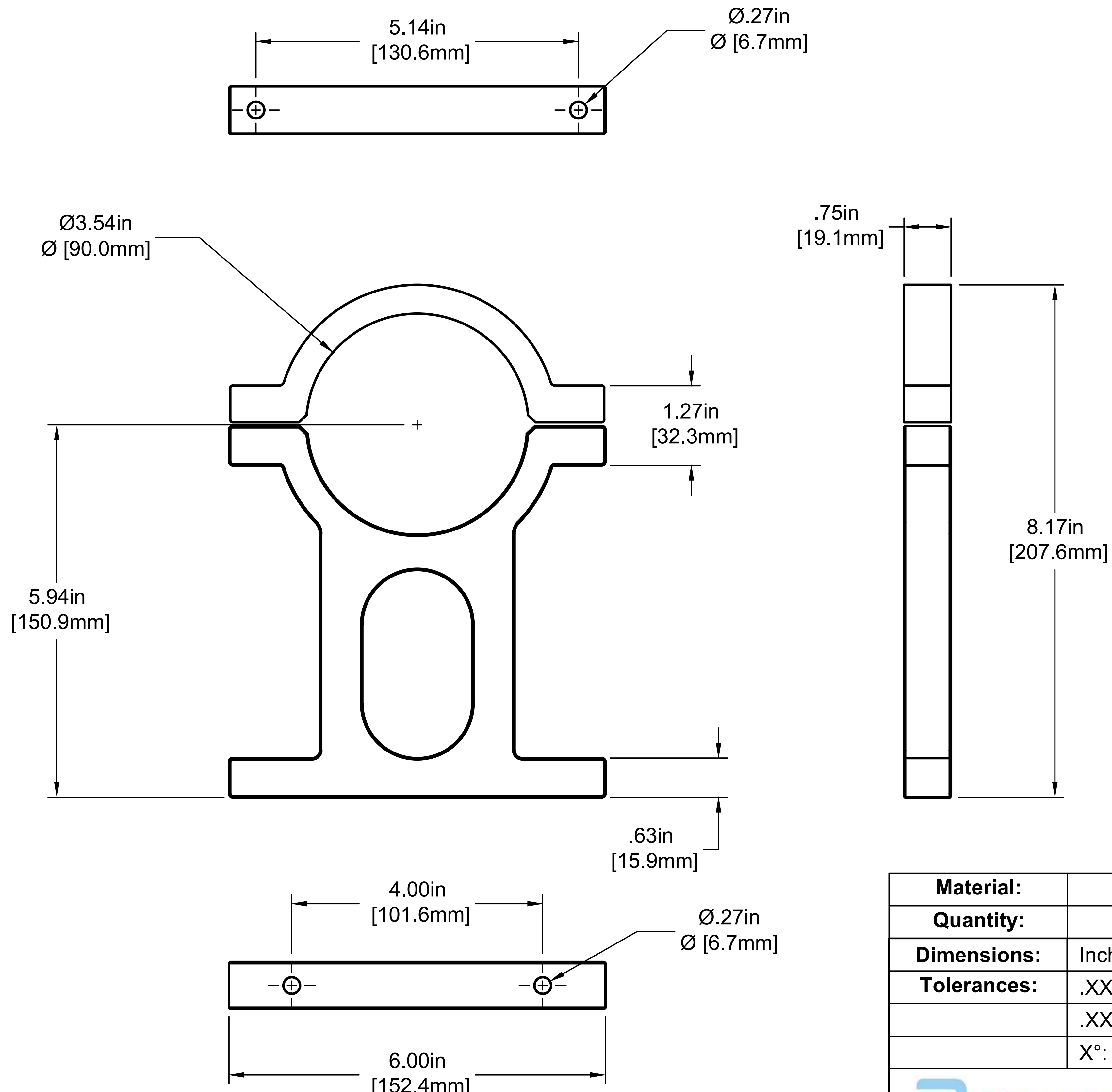
Appendix 3: Standard Bracket Dimensions

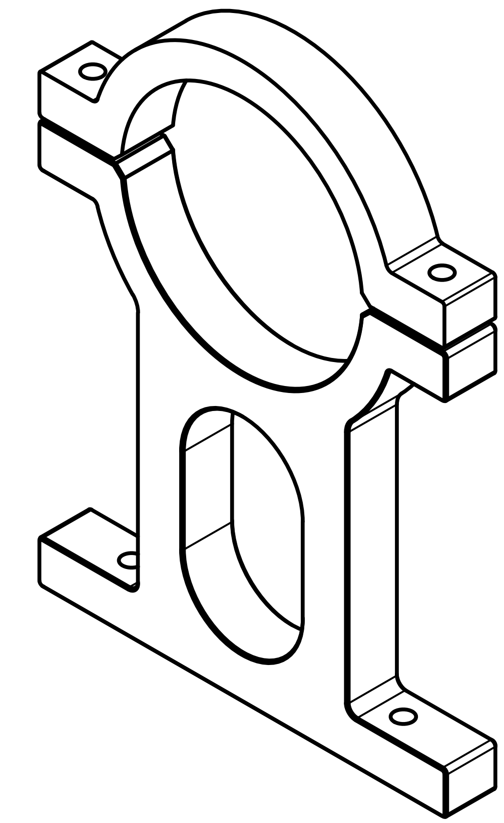




Note: For use with 1/4-20 fasteners or equivalent

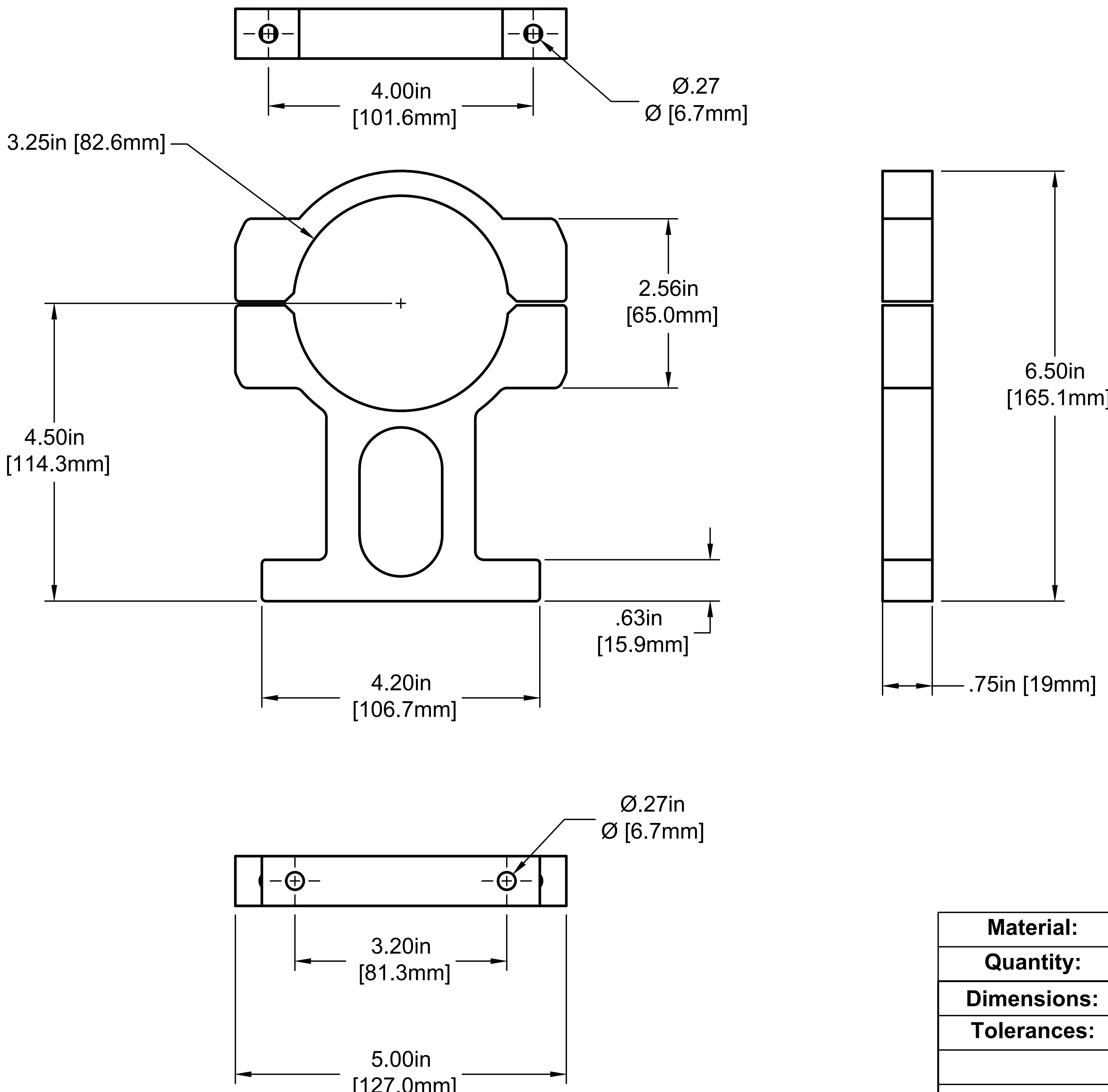
Material:	Black or White Acetal or HDPE					
Quantity:	4 per ISIIS-DPI P125					
Dimensions:	Inches	PROJECT ISIIS-DPI P125				
Tolerances:	.XX: ±.01					
	.XXX: ±.005	TITLE ISIIS-DPI P125 Mounting Bracket				
	X°: ±1°					
BELLAMARE						
APPROVED CC	2/06/26	SIZE B	CODE	DWG NO ISIIS-DPI P125 Bracket		REV A
CHECKED						
DRAWN Charles Cousin	2/7/2026	SCALE 1:2.5		WEIGHT	SHEET 1/1	

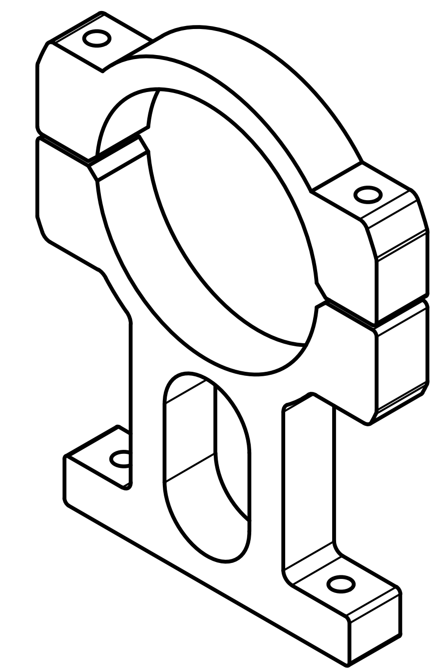




Note: For use with 1/4-20 fasteners or equivalent

Material:	Black or White Acetal or HDPE				
Quantity:	4 per ISIIS-DPI P100				
Dimensions:	Inches	PROJECT ISIIS-DPI P100			
Tolerances:	.XX: ±.01				
	.XXX: ±.005	TITLE ISIIS-DPI P100 Mounting Bracket			
	X°: ±1°				
BELLAMARE					
APPROVED CC 2/06/26		SIZE B	CODE	DWG NO ISIIS-DPI P100 Bracket	REV A
CHECKED					
DRAWN Charles Cousin 2/6/2026		SCALE 1:2 (From parent)	WEIGHT	SHEET 1/1	





Note: For use with 1/4-20 fasteners or equivalent

Material:	Black or White Acetal or HDPE
Quantity:	4 per ISIIS-DPI P75
Dimensions:	Inches
Tolerances:	.XX: ±.01
	.XXX: ±.005
	X°: ±1°

BELLAMARE

PROJECT
ISIIS-DPI P75

TITLE
ISIIS-DPI P75 Mounting Bracket

APPROVED CC 2/06/26	SIZE	CODE	DWG NO		REV
CHECKED	B		ISIIS-DPI P75 Bracket		A
DRAWN Charles Cousin 2/6/2026	SCALE 1:2 (From parent)		WEIGHT	SHEET 1/1	