# Bill of Materials

This bill of materials (BOM) contains **EVERYTHING** needed to build a setup. From the less memorable screw to the super expensive syringes used for reward delivery.

> **NOTE**
>
> This BOM is destined to the people from the Champalimaud Foundation (CF). Nonetheless, the goal is that people outside CF are also able to order everything and build the setup.

> **WARNING**
>
> This BOM specifies the part numbers used by the lab for these setups, but not every component needs to be of a specific part number.
>
> The only things that need to be of a specific model are the Harp Devices, the Behavior Poke Port Breakout v1.1, the Poke Small v1.1 and the 12V Power Supplies.
>
> It's possible to use a different camera model, but please confirm that the camera can be used in Bonsai (although for some cameras the Bonsai workflow will probably need to be adapted).

## Harp

This section contains the setup components that relate to the Harp devices somehow (except for the Camera that has a section of its own).

### Devices

The Harp devices are assembled by the Hardware and Software Platform, so place an Agendo request to order them.

> **WARNING**
>
> For people outside of the Champalimaud Foundation, it's possible to order the Harp devices in the Open Ephys Production Site.
>
> It's also possible to assemble the devices in-house with the right equipment since all of them are under an open source license. Some devices (like the Harp SyringePump) must be built in-house since they are not sold externally.

| Item | Description | Amount | Observations |
|---|---|---|---|
| Harp Behavior | General-purpose Harp board | 1 | - |
| Harp SoundCard | Delivers the auditory stimulus | 1 | - |
| Harp Audio Amplifiers | Amplifies the auditory stimulus | 2 | 1 Harp Audio Amplifier per speaker |
| Harp ClockSynchronizer | Synchronizes the timestamps from every Harp device | 1 | - |
| Harp SyringePump | Device used for reward delivery | 2 | - |
| Harp CurrentDriver | Drives/controls the LED/laser used in optogenetics | 1 | Optional |

## Peripherals

For this part of the BOM, a peripheral is considered to be anything that either interacts with the Harp devices or is needed make the different devices work and/or interact with each other.

| Item | Description | Amount | Part Number | Part of the Harp Device kit | Agendo | Observations |
|---|---|---|---|---|---|---|
| Behavior Poke Port Breakout v1.1 | Makes the ethernet ports pins from the Harp Behavior available | 3 | - | ✗ | ✓ | Connects to the Harp Behavior |
| RJ-to-RJ cables | - | 3 | IM1037 | ✗ | ✗ | Connects the Harp Behavior to the Behavior Poke Port Breakout v1.1 |
| Poke Small v1.1 | Board with infrared beam to detect animal pokes | 3 | - | ✗ | ✓ | Connects to the Behavior Poke Port Breakout v1.1 |

| Item | Description | Amount | Part Number | Part of the Harp Device kit | Agendo | Observations |
|---|---|---|---|---|---|---|
| 3.5 mm-stereo-audio-jack-to-bare-wires | - | 3 | BC-A3ML006F | ✗ | ✗ | Connects the Poke Small v1.1 to the Behavior Poke Port Breakout v1.1 |
| 5 mm white/blue LED | Placed on the box lid to give cues to the animal | 1 | - | ✗ | ✗ | Connects to the LED0 pins of the Harp Behavior |
| 3 mm green LED | Placed in the central poke to give cues to the animal | 1 | - | ✗ | ✗ | Connects to the LED1 pins of the Harp Behavior |
| RCA-to-RCA cables | - | 2 | - | ✓ | ✗ | Connects each Harp Audio Amplifier to the Harp SoundCard |
| Speakers | Deliver the auditory stimulus | 2 | *TODO* | ✗ | ✗ | 1 speaker per Harp Audio Amplifier |
| Banana Plug | 4 mm Triple Contact Plug (Black or Red) - Pack of 10 units | 4 | 557-0100 | ✗ | ✗ | Connects the speakers to the Harp Audio Amplifiers |
| 10 ml Glass Syringe | Hamilton 1000 Series Gastight Syringes: Luer Lock Syringes, | 2 | Hamilton 81620 | ✗ | ✗ | Used for the Harp SyringePump |

| Item | Description | Amount | Part Number | Part of the Harp Device kit | Agendo | Observations |
|---|---|---|---|---|---|---|
| | TLL Termination | | | | | |
| 4-way Stopcock | Pack of 10 units | 2 | Masterflex 30600-04 | ❌ | ❌ | Attaches to the end of the syringe (1 per Harp SyringePump) |
| Nylon Male Luer Fitting | Pack of 25 units | 2 | Masterflex MFLX45505-31 | ❌ | ❌ | Attaches to one end of the stopcock (1 per Harp SyringePump) |
| Nylon Female Luer Fitting | Pack of 25 units | 2 | Masterflex 45502-00 | ❌ | ❌ | Attaches to one end of the stopcock (1 per Harp SyringePump) |
| Spouts | Used in reward delivery | 2 | B14200 100 BULK | ❌ | ❌ | Used in reward delivery. Glued to the physical lateral pokes |
| Flexible Tubing | Masterflex Tygon E-3603 Non-DEHP Tubing - 15 meters per unit | 2 | Masterflex 06407-71 | ❌ | ❌ | Connects the spouts to one of the luer fittings (either male or female) |
| Mini USB cable | - | 5/6* | AK-300130-018-S | ✔ | ❌ | Connects the Harp boards to the computer |
| Micro USB cable | - | 1 | - | ✔ | ❌ | Used to upload sounds to the Harp SoundCard |
| 3.5 mm-stereo- | - | 4/5* | *TODO* | ❌ | ❌ | Connects the Harp ClockSynchronizer to |

| Item | Description | Amount | Part Number | Part of the Harp Device kit | Agendo | Observations |
|---|---|---|---|---|---|---|
| audio-jack-to-jack cable | | | | | | every other Harp device |
| 12V Power Supply** | AC/DC Wall Mount Adapter 12V 12W | 9/10* | VER12US120-JA | ✔*** | ❌ | 1 is used to power the LED strip that illuminates the behavior box, the remaining are used to power the Harp devices |
| BNC-to-bare-wires conector** | | 1 | 810-4605 | ❌ | ❌ | Connects the LED strip to the power supply |

* if the Harp CurrentDriver is being used

** the number of power supplies can be decreased as explained in the subsection below

*** the power supply used to power the LED strip that illuminates the behavior box must be ordered separately

## Reducing the number of power supplies

From the table above, it's pretty noticeable that a lot of power supplies are required, which takes up a lot of space and power outlets. It's possible to use the same power supply for different devices according to their characteristics. The devices can be grouped in the following way:

- Harp Behavior, Harp SoundCard and Harp CurrentDriver*
- V+ of the Harp Audio Amplifiers
- V- of the Harp Audio Amplifiers
- Both Harp SyringePumps

From the list above, it's possible to switch the last line from the previous table with the lines from the table below.

| Item | Description | Amount | Part Number | Comes with Harp Device | Agendo | Observations |
|---|---|---|---|---|---|---|
| 12V Power Supply | AC/DC Wall Mount Adapter 12V 12W | 5 | VER12US120-JA | ✔*** | ✘ | 1 is used to power the LED strip that illuminates the behavior box, the remaining are used to power the Harp devices |
| 2-to-1 cables for the 12V power supplies | - | 4/3* | | ✘ | ✔*** | - |
| 4-to-1 cables for the 12V power supplies | - | 0/1* | | ✘ | ✔*** | - |

* if the Harp CurrentDriver is being used

# Mechanical Components

This section contains the mechanical components of the setup that were developed and assembled in-house.

> **WARNING**
>
> The files for the mechanical components are not currently available online and can't also be ordered, so people outside of the Champalimaud Foundation will have to develop and assemble their own.

| Item | Description | Amount | Part Number | Observations |
|---|---|---|---|---|
| Behavior box | - | 1 | - | Made of acrylic |
| Physical pokes | - | 3 | - | Preferably made of metal, but can also be 3D printed |
| Speaker holder | - | 2 | - | Preferably made of metal, but can also be 3D printed |
| Speaker holder pole | Hollow alluminium tube | 2 | - | - |
| Box LED holder | - | 1 | - | 3D printed |

# Camera

This section contains the hardware needed to setup the camera and fix it to the lid of the behavior box. Click here to go to the camera configuration instructions.

| Item | Description | Amount | Part Number | Observations |
|---|---|---|---|---|
| FLIR Camera | | 1 | BFS-U3-16S2M-CS | - |
| Camera Lens | | 1 | A4Z2812CS-MPIR | - |
| Camera USB cable | USB-A to Micro-B Straight with Thumbscrews, 3 Meters | 1 | CEI USB3-1-1-2-3M | This cable MUST be connected to a USB 3.0 port for performance |
| Camera GPIO cable | 6 Pin Female Straight Plug (Hirose HR10A-7P-6S) to Flying Leads, 3 Meters | 1 | CEI MVA-50-3-X-3 | Connects to the Harp Behavior to trigger/monitor the camera frames |
| Tripod Adapter | BFS 30 mm BFLY CM3 Tripod Adapter | 1 | ACC-01-0003 | Used to fix the camera to the Thorlabs poles in the behavior box |
| Thorlabs 75mm post | Ø12.7 mm Optical Post, SS, M4 Setscrew, M6 Tap, L = 75 | 1 | TR75/M | Connects to the camera |

| Item | Description | Amount | Part Number | Observations |
|---|---|---|---|---|
| | mm | | | |
| Thorlabs 150mm post | Ø12.7 mm Optical Post, SS, M4 Setscrew, M6 Tap, L = 150 mm | 1 | TR150/M | Fixes the camera structure to the box lid |
| Thorlabs post clamp | Rotating Clamp for Ø1/2" Posts, 360° Continuously Adjustable, 5 mm Hex | 1 | SWC/M | Fixes both Thorlabs posts to each other |
| M6 Screw | 15/16 mm | 1 | | Fixes the longer post to the behavior box lid |
| M6 Setscrew | M6 x 1.0 Stainless Steel Setscrew, 16 mm Long, 25 Pack | 1 | SS6MS16 | Connects the Thorlabs post to the Camera |

# Others

This section contains the remaining components needed for the setup. None of these components needs to be the exact model present on the list. It just corresponds to the models that have been used by the lab, but feel free to use different ones, as long as they work.

| Item | Description | Amount | Part Number | Observations |
|---|---|---|---|---|
| Computer | Mini PC Blackview MP100 Mini PC AMD Ryzen 7 5825U/16GB/512GB SSD | 1 | MP100(16+512)-BLACK | - |
| Screen | - | 1 | - | - |
| HDMI cable | - | 1 | - | - |
| Keyboard | - | 1 | - | - |
| Mouse | - | 1 | - | - |
| USB Hub | HUB USB 3.0 TP-Link UH700 7 Ports | 1 | P004616 | - |
| Power extension with 6 electrical | Must be appropriate to 90˚ plugs | 1 | | To plug all of the power supplies in a setup |

| Item | Description | Amount | Part Number | Observations |
|---|---|---|---|---|
| outlets | | | | |
| KVM switch | | - | | Optional: useful in case one wants to use the same screen + mouse + keyboard kit in different computers |
| 12V LED Strip | | 1 | | - |
| Optogenetics Light Source | - | - | - | Optional |

# Software Installation

The task's software is composed by the Bonsai workflow, which contains the task logic, and by small Python scripts that perform some operations at the beginning and at the end of the a session (namely, parsing both input and output files from/to more human readable formats). In order to facilitate the deployment of the project and with reproducibility in mind, the Bonsai workflow was developed inside a Bonsai environment and the Python scripts uses uv to create and maintain the Python virtual environment.

To install the task's software, follow the steps:

1. Download the source code from the latest project release and unzip it. Alternatively, clone the repository.
2. Run `./Setup.cmd` to install the Bonsai environment and the Python environment. An application window will appear which is used to specify the COM port each Harp device corresponds to and the paths to the configuration files and the output directory.
3. Download the configuration files templates (`animal.yml`, `setup.csv`, `training.csv`) from the release mentioned in step 1 and place them wherever it's more convenient.
4. After configuring every parameter present in the application, click on the `Update Configuration` button. The button will generate the `./src/config/config.yml` file, which is a hard-coded file used by both the Python scripts and the Bonsai workflow. Close the application window.

> **CAUTION**
>
> Please don't move or delete the `./src/config/config.yml` file! If, for some reason, any of the paths or COM ports need to be changed, re-run the `Setup.cmd` script.

# Additional Software

## Spinnaker Drivers

In order to use the FLIR camera to record the sessions, the Spinnaker drivers MUST be installed as well. It's mandatory that the computer has the version 1.29.0.5 of the drivers installed, since the version supported by Spinnaker Bonsai Package. After opening the installer, follow the steps below:

1. Click on `Next`. Then, accept the terms and click on `Next` again.
2. Select `Application Development` and click on `Next`.
3. Deselect `GigE Driver` and click on `Next`.
4. Deselect the `I will use GigE Cameras.` checkbox and click on `Next`.
5. Finally, click on `Install`.

# FFmpeg

The task's code makes use of the FFmpeg software to save the video recordings in the disk, because it allows the video to be recorded with higher framerates, without loss of image quality and by making a better use of the computer's resources than the native `VideoWriter` Bonsai node.

FFmpeg can be installed with WinGet by running the following command in the Terminal:

```
winget install Gyan.FFmpeg
```

# Harp Devices Setup

In order to use the Harp devices, the USB drivers and each devices's firmware must be installed. The installer for the USB drivers can be downloaded here. The Firmware section contains the instructions for installing each board's firmware.

> **NOTE**
> The Harp devices are usually delivered with the firmware already installed, but it may be useful to know how to install the firmware (for example: in case a new firmware version that solves a particular bug is released)

## Firmware

For most devices, it's possible to install the corresponding firmware in two different ways.

### Firmware Download

1. Go to the Harp Tech GitHub organization.
2. Search for the board's repository. The name of the repository follows the format device.[*board_name*] (for example, device.behavior).
    - **Note:** The Harp Audio Amplifier is not considered a device by itself, but a peripheral for the Harp SoundCard, so there isn't a firmware to be installed for this board.
3. Click on `Releases` and search for the latest firmware release, whose name follows the format fw[*firmware_version*]-harp[*harp_core_version*] (for example, fw2.2-harp1.13).
4. Download the latest version of the firmware binary corresponding to the hardware version of the board being used. The firmware binary name follows the format [*board_name*]-fw[*firmware_version*]-harp[*harp_core_version*]-hw[*hardware_version*]-ass[*assembly_version*].hex (for example, Behavior-fw3.2-harp1.13-hw2.0-ass0.hex).
    - **Note:** For the Harp SoundCard, an additional firmware binary must be downloaded (the PIC32 firmware).

### Via Harp Convert to CSV GUI

If the Harp Convert to CSV GUI is already installed, skip to step 3. If it's not already installed, but other Labview-based Harp board GUI is, skip to step 2 instead.

1. Install the LabView Runtime and reboot the computer.
2. Install the latest version of the Harp Convert to CSV GUI.
3. Open the Harp Convert to CSV GUI.
4. Click on `Options` and write "bootloader" in the `List` textbox. The *Update Firmware* window should appear.

5. Choose the communication port (*COMx*) of the board whose firmware is going to be installed.
6. Select the firmware binary to be installed and click on `Update`.
    - **Note:** For the Harp SoundCard, during the installation of the firmware, select the PIC32 firmware when the application asks for the 32 bits device firmware.

## Via Bonsai

As explained at the beginning of the section, it is not possible to install the Harp SoundCard firmware through this method. Skip to step 4 if the Bonsai environment is already installed.

> ⊗ **CAUTION**
>
> It is not possible to use this method to install the firmware of the Harp SoundCard.

1. Install Bonsai.
2. Open Bonsai and click on `Manage Packages`.
3. Install the following packages:
    - Bonsai - Harp Library
    - Bonsai - Harp Design Library
4. Start a new workflow and add a Device node from the Harp package to it.
5. Change the `PortName` property of the node to the communication port (*COMx*) of the board whose firmware is going to be installed.
6. Double-click on the Device node. The *Device Setup* window should appear.
7. Click on `Bootloader>>`. The *Device Setup* should expand.
8. Click on `Open...` to select the firmware binary to be installed and then click on `Update`.

# Calibration Protocols

Some of the hardware used in the task requires calibration. Since the calibration protocols are already written somewhere else, they can be found by clicking in the name of the protocols from the list below:

- Speaker Calibration
- Harp SyringePump Calibration
- Optogenetics LED Calibration (*Not available yet*)

# Camera Configuration

The setups need a camera to record the sessions and to monitor the task in real time. Since there's a need for the video to be recorded with some specific settings, this section contains instructions explaining how to configure PointGrey and FLIR cameras, which are the two types of cameras used.

## Desired Camera Settings

As mentioned above, there is a need for the camera used in the setup to have some specifications, namely:

- a frame rate if 100 fps.
- the ability for the camera to send a pulse to the Harp Behavior every time a frame is being acquired.
- the ability to receive a pulse from the Harp Behavior when the animal is poking in the central port (by making one of the Behavior's digital outputs mimic the central port digital input).

## FLIR

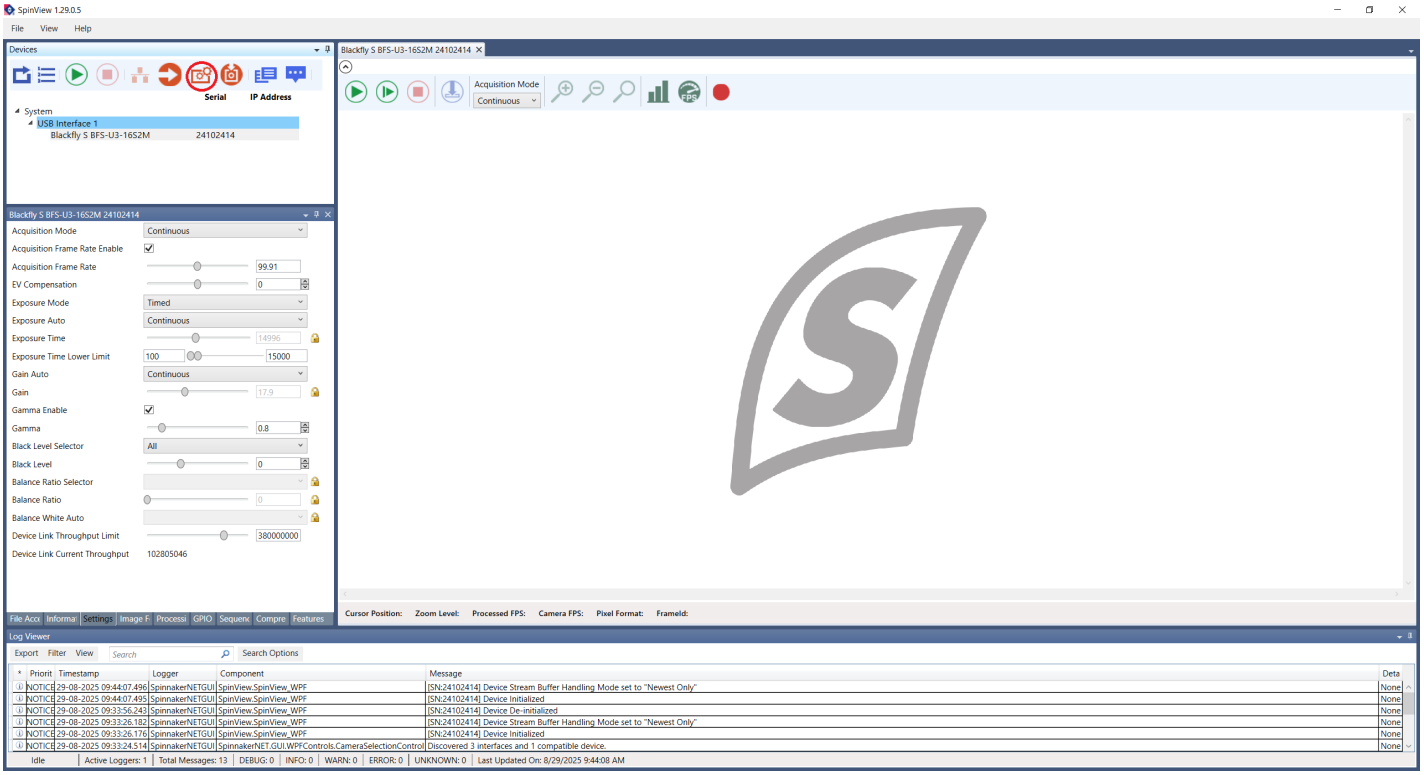
After installing the Spinnaker Drivers, connect the camera to the computer in an USB-3.0 port (connecting it to an USB-2.0 port limits the camera's capabilities, namely the frame rate).

## Firmware Update

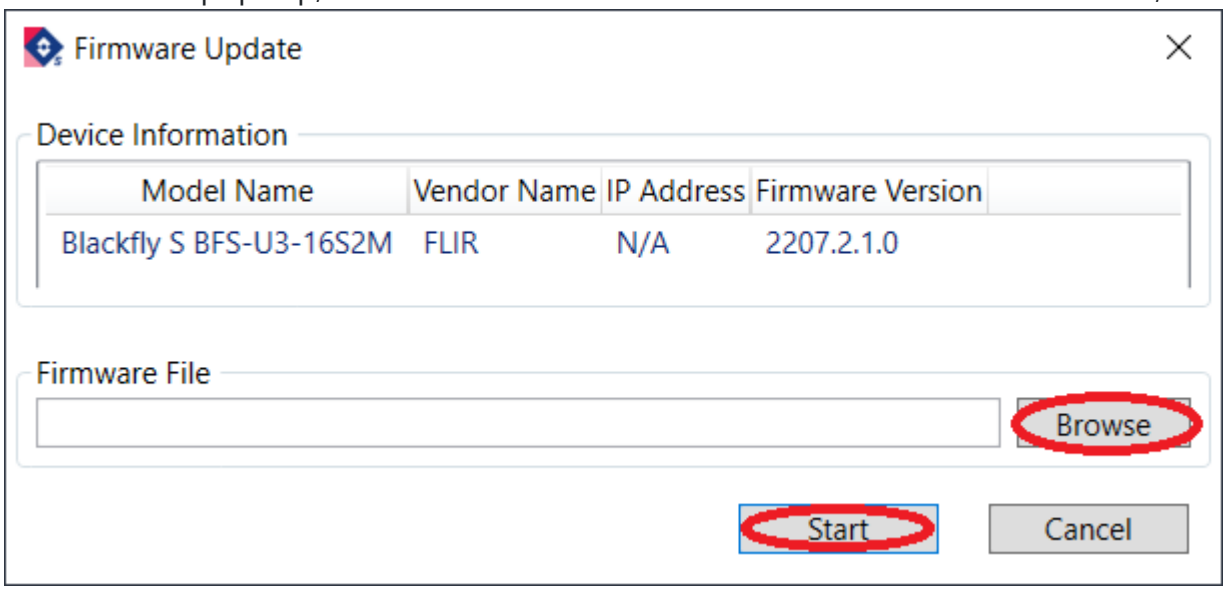
In order to access the state of the GPIO pins in the camera model BFS-U3-16S2M-CS, it's necessary that the firmware version 2207.2.1.0 is installed. Follow the instructions to verify the firmware version currently installed and install a different version in case it's necessary.

1. Open the SpinView software.
2. Select the camera to be configured.

3. Click on the `Update Device Firmware` icon.




4. After a new window pops up, click on its `Browse` button to choose the firmware file. Then, click on `Start`.

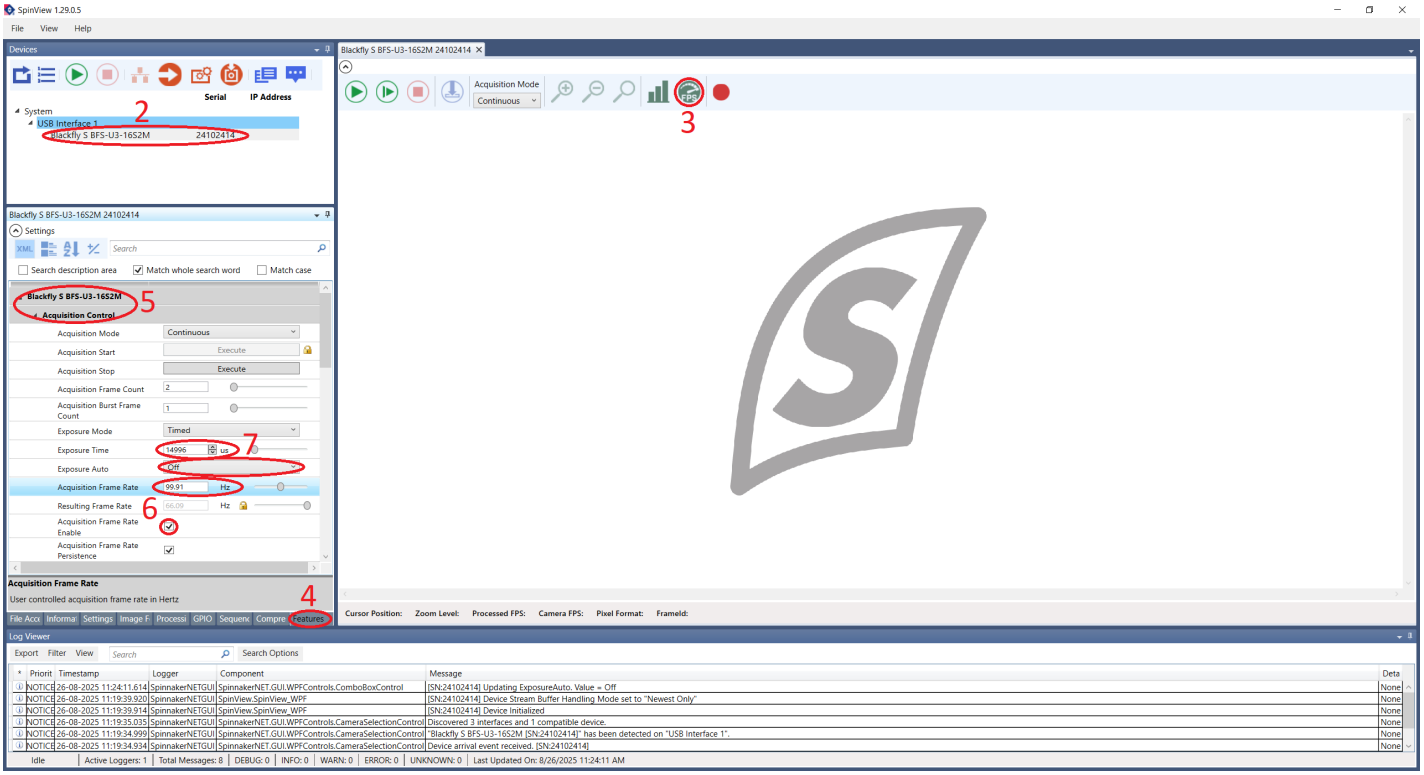



# Camera Configuration

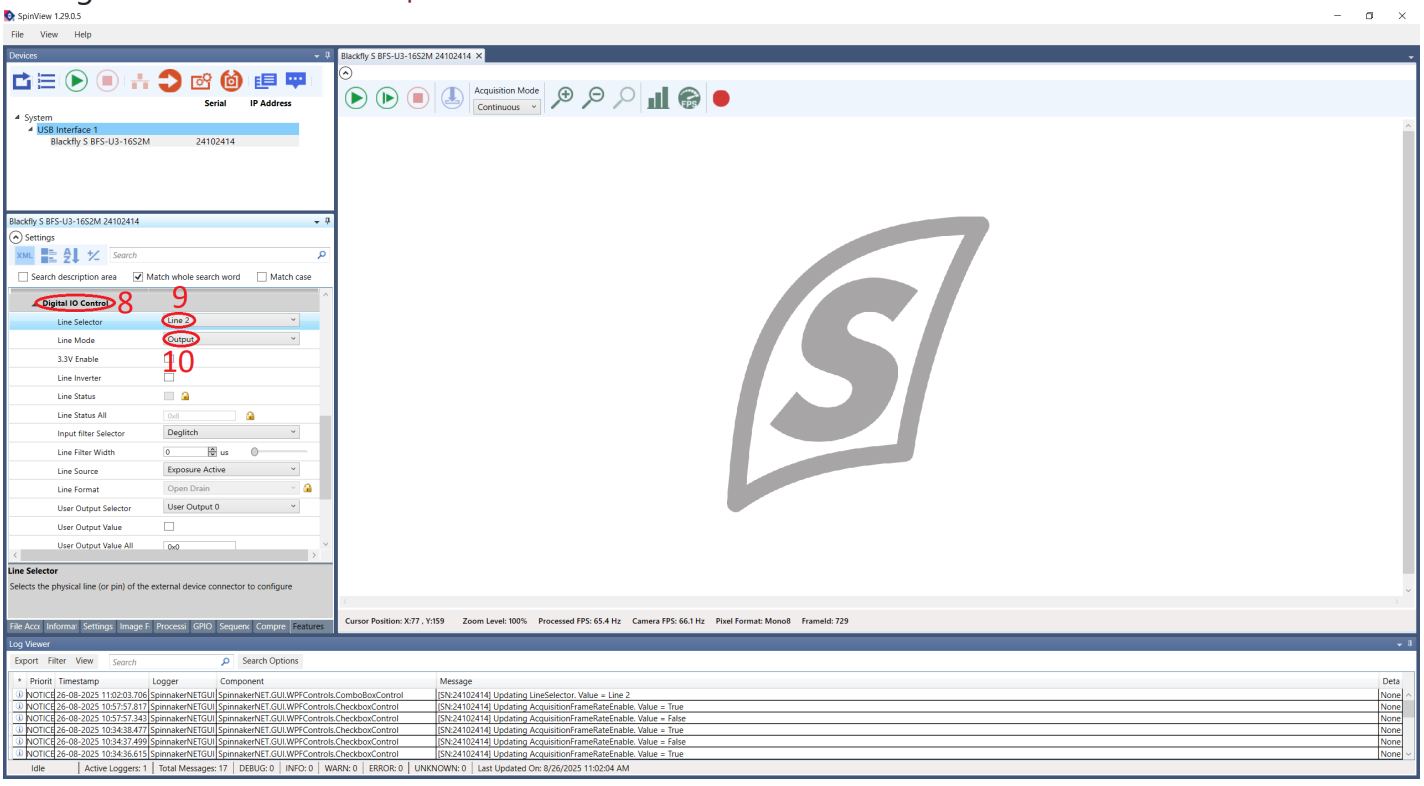
After having the correct firmware version installed, follow the instructions to configure the camera.

1. Open the SpinView software.
2. Select the camera to be configured.
3. Click on the `Optimize camera frame rate` button (see the figure below).
4. Click on `Features`.
5. Click on the camera model name and then on `Acquisition Control`.

6. Change the `Acquisition Frame Rate` parameter to the desired value. Confirm that the `Acquisition Frame Rate Enable` setting is checked.
7. Change the `Exposure Auto` setting to `Off` and adjust the `Exposure Time` to the maximum possible so that the acquisition stays stably at 100 FPS.

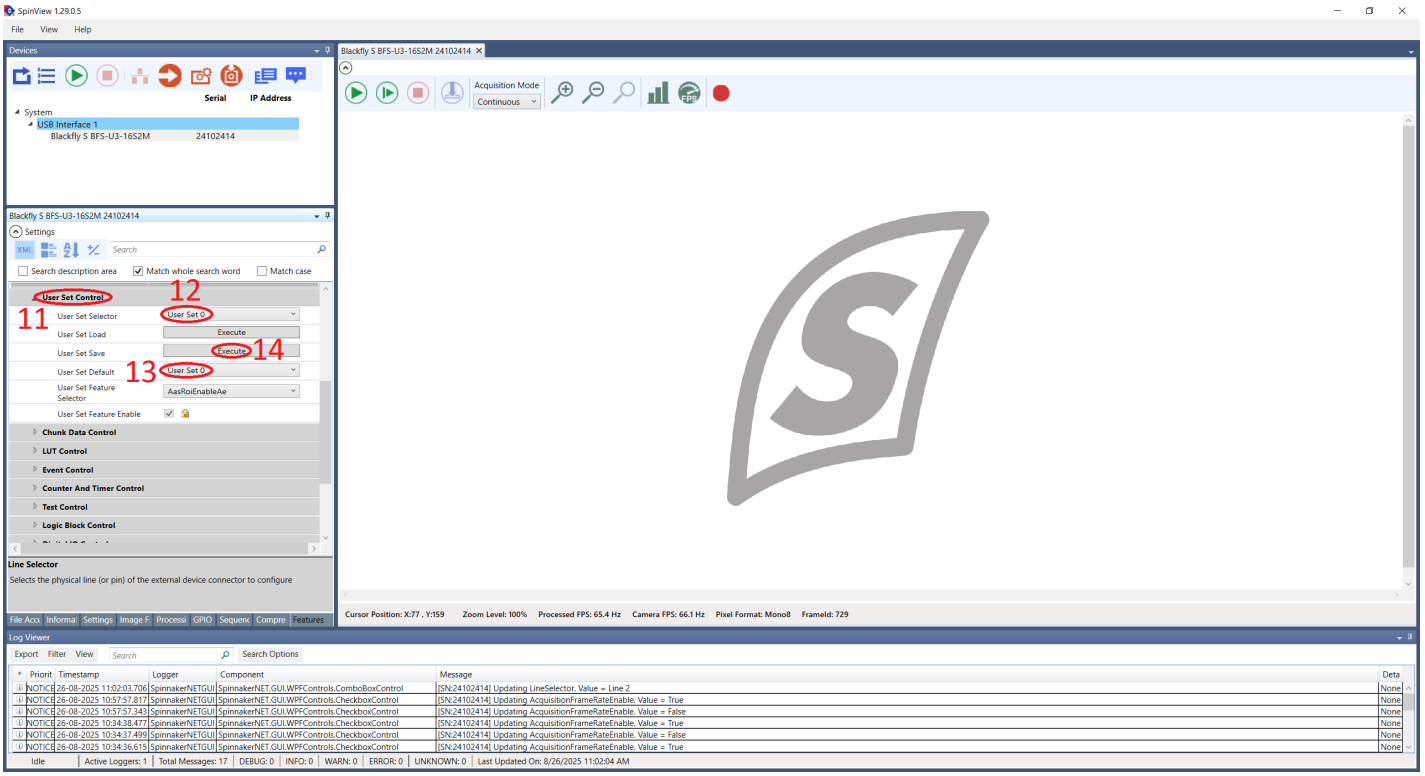



8. Close the `Acquisition Control` section and open the one named `Digital IO Control`.
9. Select the `Line 2` in the `Line Selector` parameter.
10. Change the `Line Mode` to `Output`.

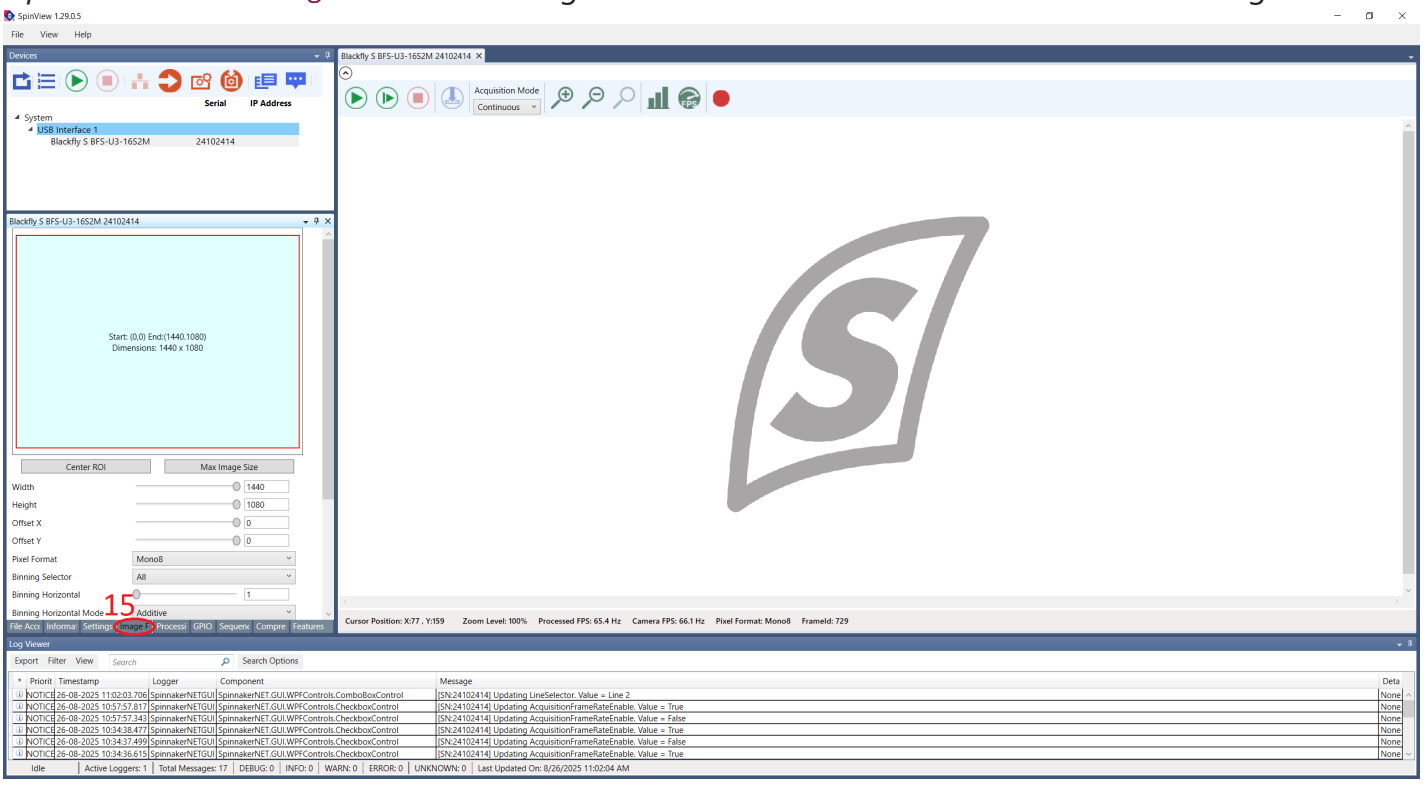



11. Close the `Digital IO Control` section and open the one named `User Set Control`.

12. Select an `User Set Selector` other than `Default`.
13. Select the same User Set in the `User Set Default` parameter.
14. Finally, click on the `User Set Save` button to save the current User Set.




15. *Optional*: Click on `Image Format` to change the camera resolution and save the User Set again.



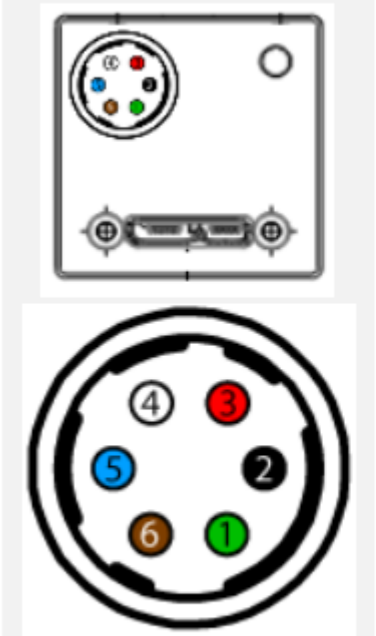

# Hardware Connections

In order for the camera to be able to communicate with the Harp Behavior, it's necessary that the camera GPIO cable is connected. The following connections shall be made:

- Line 2 (pin 3) from the camera to the Behavior's DI3 pin.
- Line 0 (pin 2) from the camera to the Behavior's DO0 pin.

> **WARNING**
>
> Don't forget to connect the camera's grounds (pins 5 and 6) to the Harp Behavior's GND pins!

## Blackfly S Cased Models




| Diagram | Color[1] | Pin | Line | Function | Description |
|---|---|---|---|---|---|
| | Green | 1[2] | 3 | $V_{AUX}$ | Auxiliary Input Voltage (DC) |
| | | | | GPI | Non-isolated Input |
| | Black | 2 | 0 | OPTOIN | Opto-isolated Input |
| | Red | 3[2] | 2 | VOUT | Camera Power Output |
| | | | | GPIO[3] | Non-isolated Input/Output |
| | White | 4 | 1 | OPTOOUT[3] | Opto-isolated Output |
| | Blue | 5 | N/A | Opto GND | Opto-isolated Ground |
| | Brown | 6 | N/A | GND | Camera Power Ground |

1—GPIO cable assembly wire colors
2—Dual function pin
3—Open drain output, requires pullup resistor

## GPIO Cable Color Code

The color code for the CEI MVA-50-3-X-3 camera GPIO cable is as follows:

| Pin | Color |
|---|---|
| 1 | White |
| 2 | Brown |
| 3 | Green |
| 4 | Yellow |
| 5 | Gray |

| Pin | Color |
| --- | --- |
| 6 | Pink |
| H | Shield |

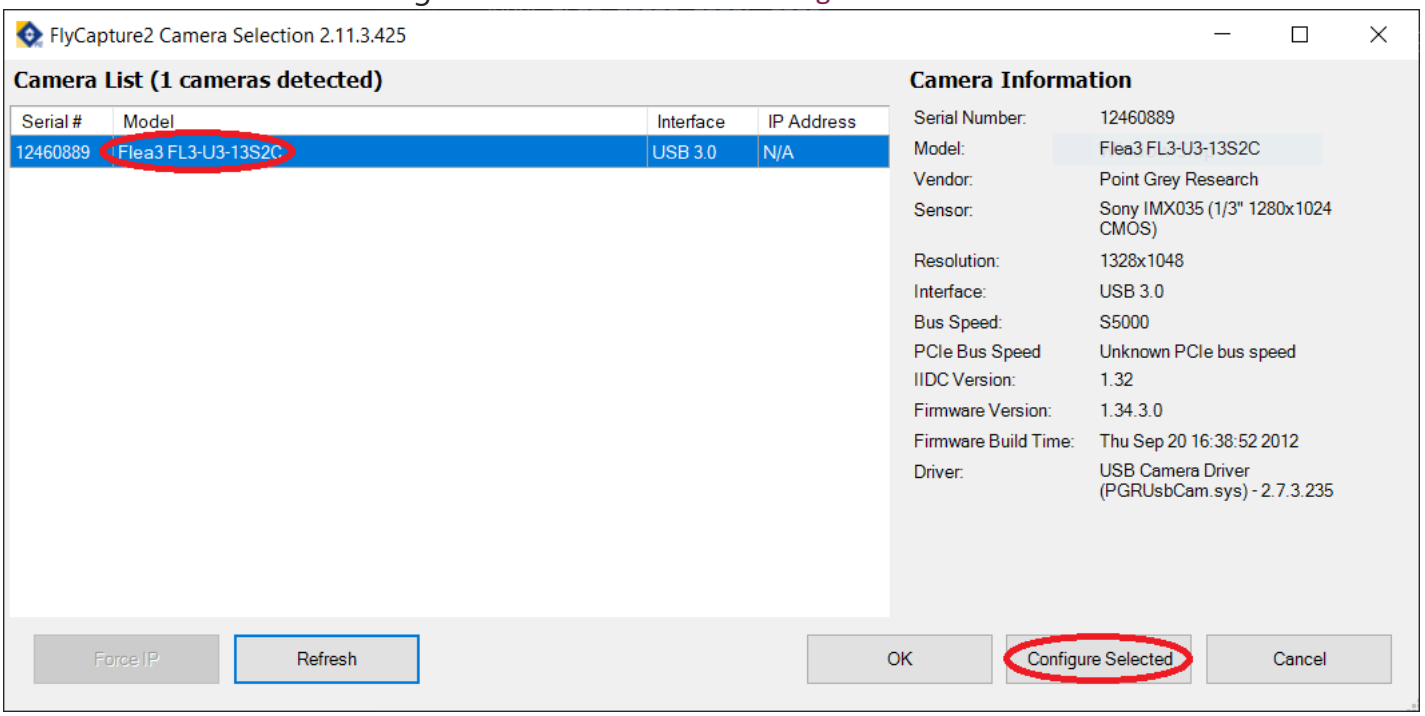
# PointGrey

After installing the PointGrey Drivers, connect the camera to the computer in an USB-3.0 port (connecting it to an USB-2.0 port limits the camera's capabilities, namely the frame rate).

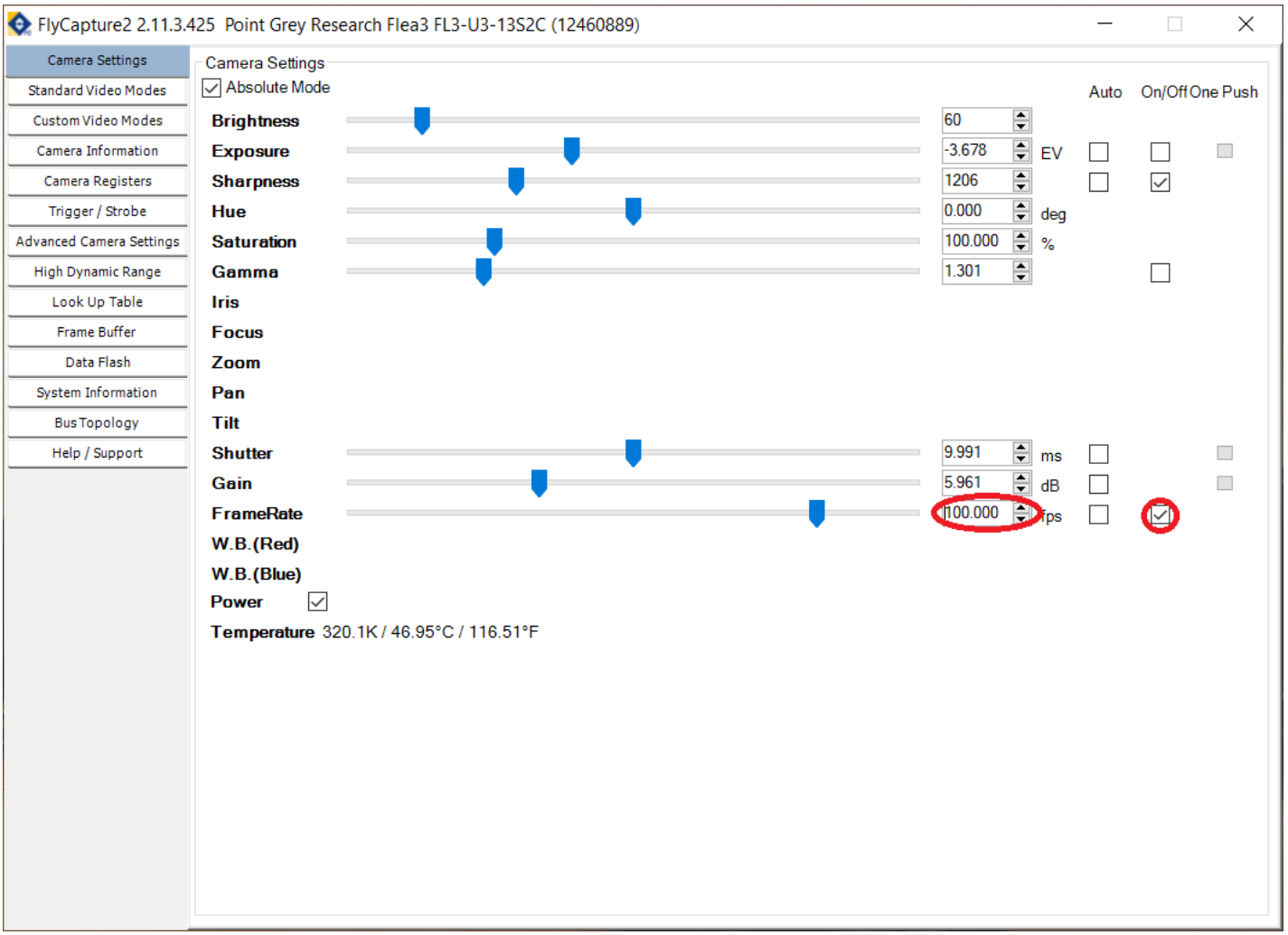
## Camera Configuration

To configure a PointGrey camera follow the instructions below.

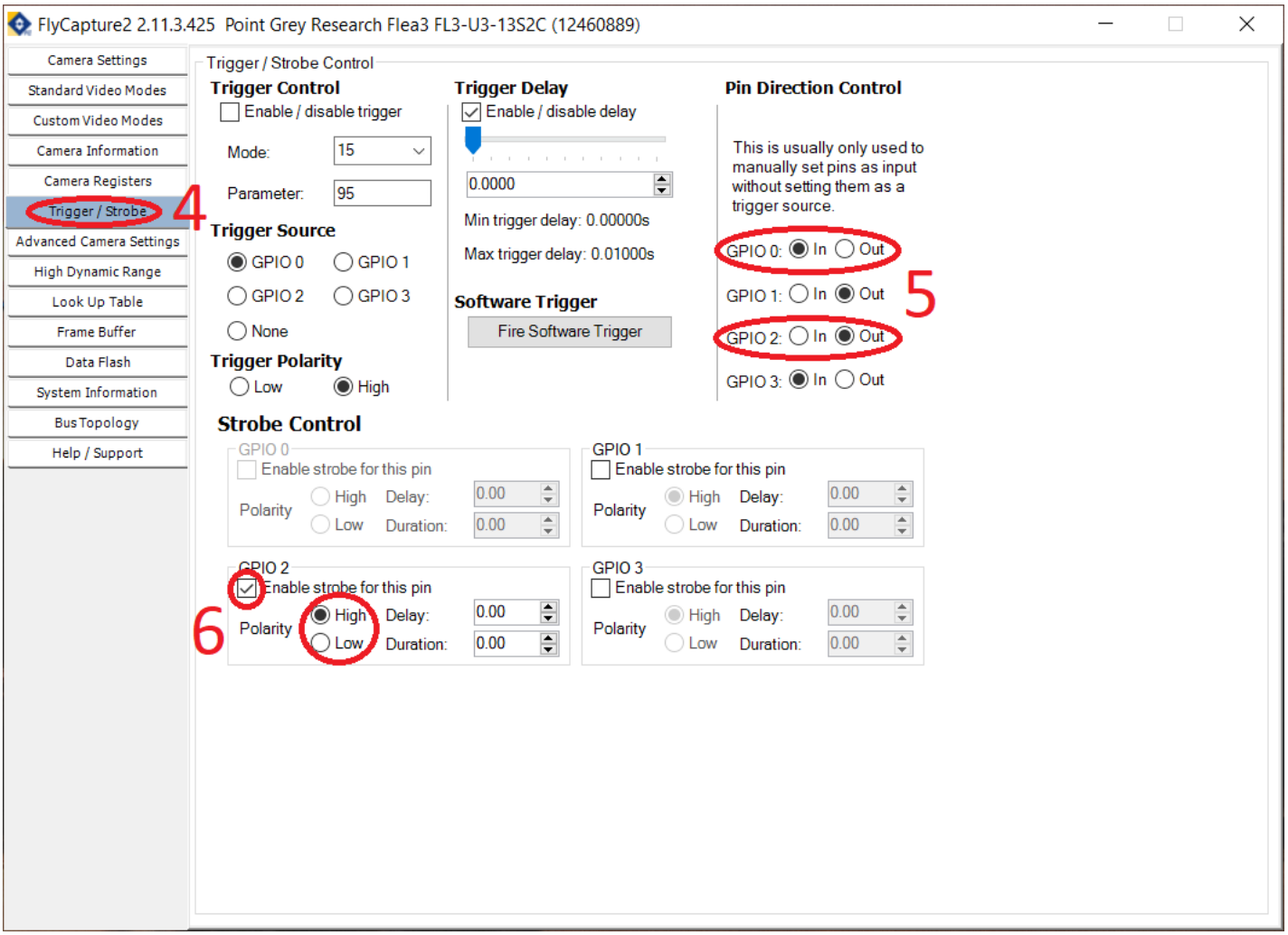
1. Open the Point Grey FlyCap2 software.
2. Select the camera to be configured and click on the `Configure Selected` button.



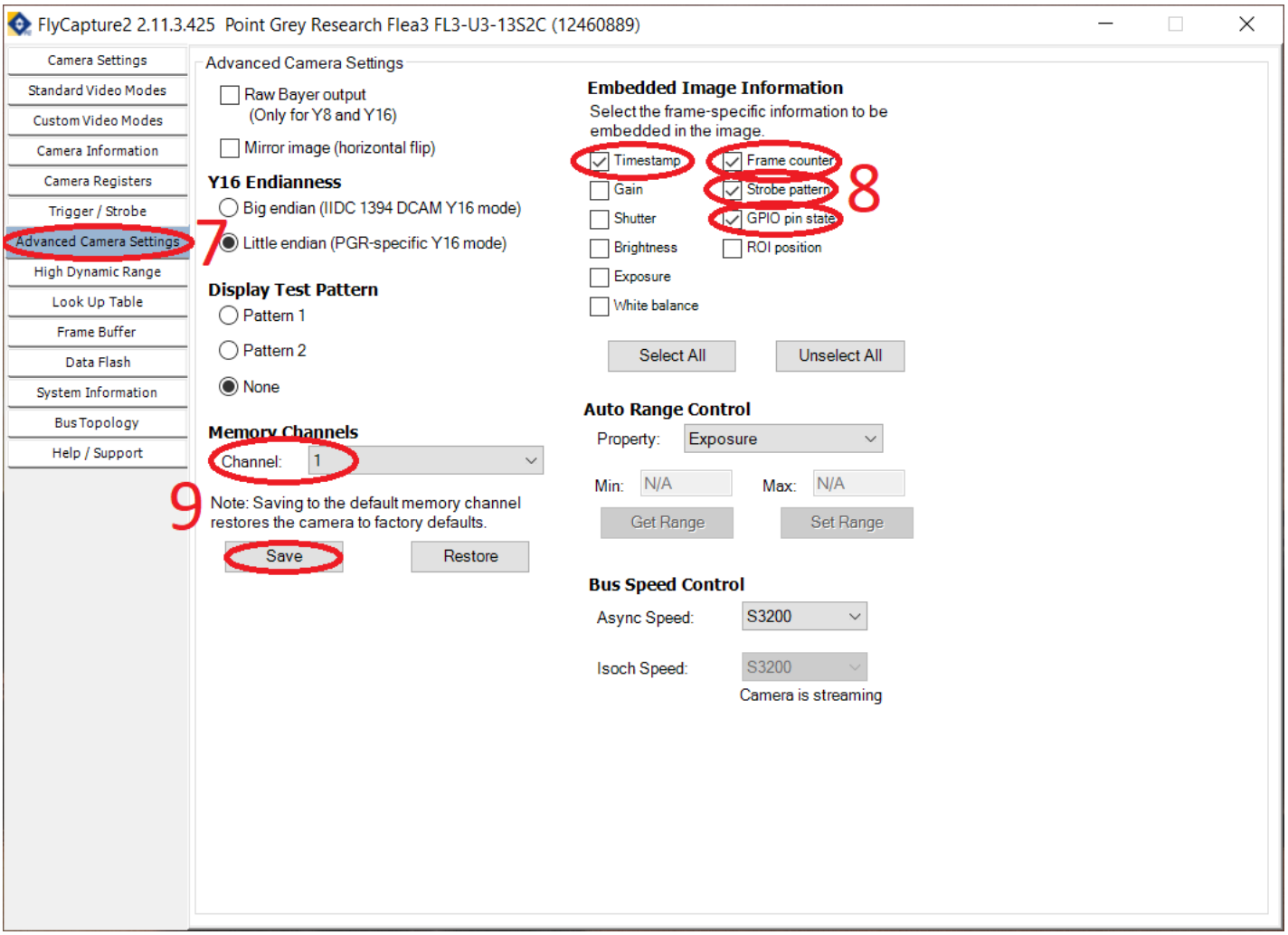

3. In the `Camera Settings` tab, activate the `On/Off` checkbox from the `FrameRate` row and modify its value.



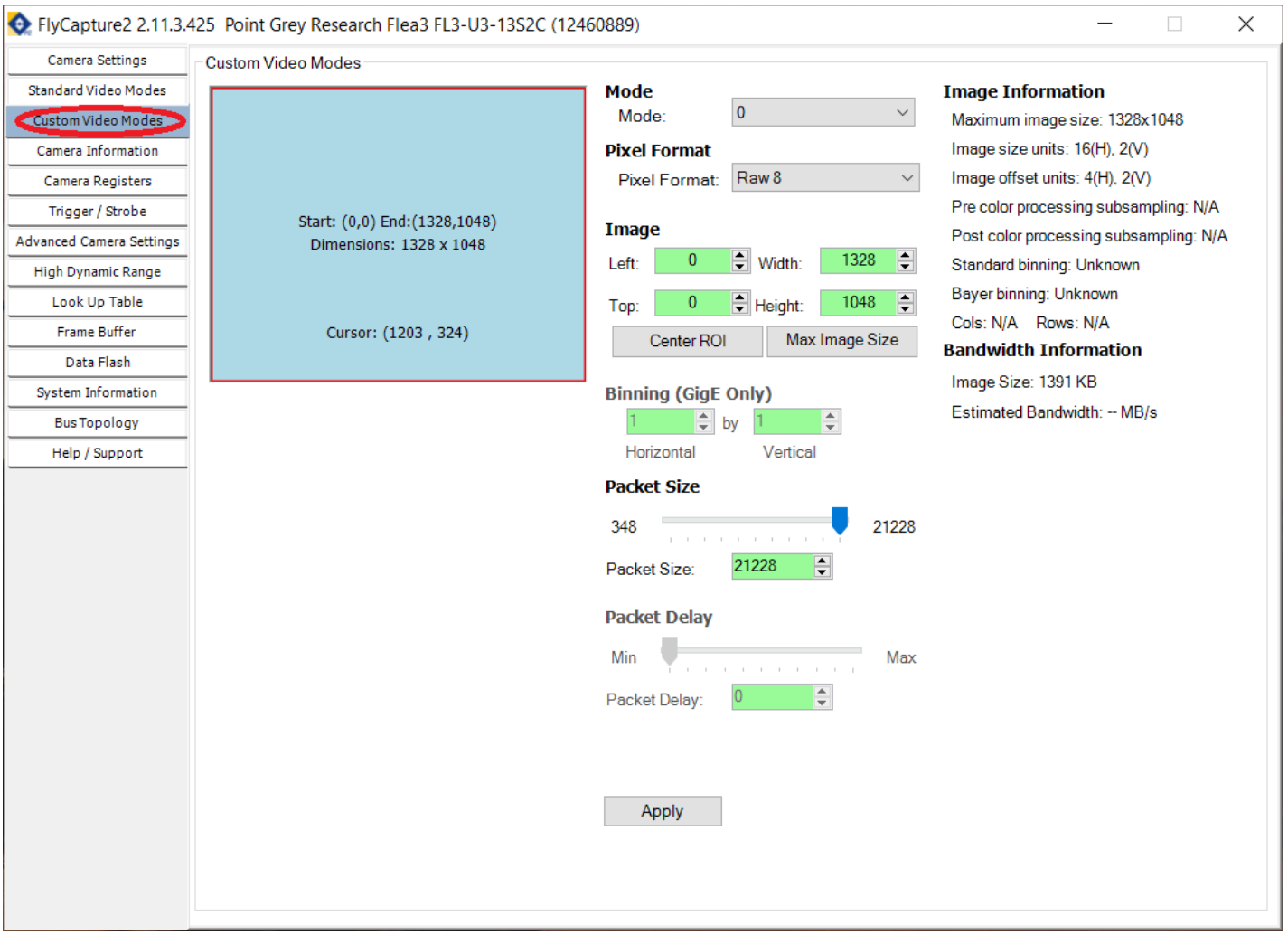

4. Go to the `Trigger / Strobe` tab.
5. Select the GPIO 0 to be an input and the GPIO 2 to be an output.
6. Under `Strobe Control`, activate the `Enable strobe for this pin` checkbox for GPIO 2 and change the polarity to `High`.




7. Go to the `Advanced Camera Settings`.
8. In the `Embedded Image Information`, select the following fields:
    - Timestamp
    - Frame counter
    - Strobe pattern
    - GPIO pin state
9. In the `Memory Channels` section, select a channel different from `Default` and click on `Save` to save the current configuration.




10. *Optional:* Go to the `Custom Video Modes` and modify the camera resolution. Then save the camera configuration again.




# Hardware Connections

Since the GPIO cable used by the PointGrey cameras is different from the one used by the FLIR cameras, the connections that need to be made between the camera and the Harp Behavior are also different. The connections should be made as follows:

- Pin 1 (I0) from the camera to the Behavior's DO0 pin.
- Pin 3 (IO2) from the camera do the Behavior's DI3 pin.

> **WARNING**
>
> Don't forget to connect the camera's grounds (pins 5 and 6) to the Harp Behavior's GND pins!

| Diagram | Pin | Function | Description |
|---|---|---|---|
|  | 1 | I0 | Opto-isolated input (default Trigger in) |
| | 2 | O1 | Opto-isolated output |
| | 3 | IO2 | Input/Output/serial transmit (TX) |
| | 4 | IO3 | Input/Output/serial receive (RX) |
| | 5 | GND | Ground for bi-directional IO, $V_{EXT}$, +3.3 V pins |
| | 6 | OPTO_GND | Ground for opto-isolated IO pins |
| | 7 | $V_{EXT}$ | Allows the camera to be powered externally |
| | 8 | +3.3 V | Power external circuitry up to 150 mA |

**NOTE**

In the actual GPIO cable, the color of the cable corresponding to pin 5 might be purple instead of brown!

# Task Configuration

After setting up both the hardware and the software needed for the task, there's just one more step to follow before start running the task: configuring it.

Despite the task having a common structure, there are small variations to the task that can be achieved by tweaking inumerous configurations. Additionally, there's a need to input the calibration parameters for different pieces of hardware (speakers, SyringePumps, etc), which vary from setup to setup. Because of this, 3 different configuration files were created:

- `animal.yml` - This file contains task configurations that are not level-dependent and/or don't change throughout a session. Some of the parameters present in this file can be updated based on the previous session. Every animal has its own file (`[animal_name].yml`), so one can think of this file as some sort of ID. A description of each animal-specific setting can be found here.
- `training.csv` - Generally, the configurations that can be set in this file are task parameters that can change a lot during the training phase of an animal. Each line of the file is a different training level the animal has to progress to/through. It can be assumed that when the animal reaches the last level, it's ready for the "actual" experiment. A description of each training-specific setting can be found here.
- `setup.csv` - The settings that can be found in this file don't usually change the logic of the state machine, but are necessary for the setup to be working correctly (for example: equipment calibration parameters). Each line of this file is a different setup, so it's possible to have a single file stored in a drive containing the configurations for every setup and "point" to that file from the pre-configuration script (the application mentioned in the Software Installation page). A description of each setup-specific setting can be found here.

# Output Directory

It is intended that all data from every animal is saved in a single directory (the output directory). Look at the following example of an output directory.

```
output/
└──batch/
    └── RAT0001/
        └── 241001/
            ├── cam_metadata_143123.csv
            ├── out_241001.csv
            ├── video_143123.avi
            ├── config/
            │   ├── animal_143123.yml
            │   ├── setup_143123.csv
            │   └── training_143123.csv
            ├── events/
```

```
│   └── 143123
│       ├── behavior
│       │   ├── behavior_0.bin
│       │   ├── ...
│       │   ├── behavior_122.bin
│       │   └── device.yml
│       ├── soundcard
│       ├── left_pump
│       ├── right_pump
│       └── current_driver
├── plots/
│   ├── block_1.png
│   ├── block_2.png
│   └── block_3.png
└── unparsed_out/
    └── out_143123.json
```

Inside the output directory there is a folder for every animal. Inside each animal's folder there is a folder for every session day, whose name is in the `YYMMDD` format, and inside every session day folder there are different files and folders types:

- `out_YYMMDD.csv` - this is the file that contains the final output structure for the session. This file is generated by a Python script that runs after Bonsai closes and that joins the different `out_hhmmss.json` files that can be found inside the `unparsed_out` directory.
- `video_hhmmss.mp4` - this is the video recorded during the session.
- `cam_metadata_hhmmss.csv` - this is the file containing metadata directly saved from the camera for every frame recorded in `video_hhmmss.mp4`, so for each frame it's possible to know the camera timestamp, the frame ID and the state of the camera GPIO pins.
- `config/`- this directory contains a copy of the configuration files used in the session. The files are saved with the names: `animal_hhmmss.yml`, `setup_hhmmss.json` and `training_hhmmss.csv`.
- `events/` - this directory contains a directory for each time Bonsai was initialized during the session named `hhmmss/`, which, in turn, has a directory for every Harp device (example: `behavior/`), which, in turn, has the binary files that contain every message sent by the device during the session (`[device_name]_X.bin`, where `X` is the register number) and the file containing the `device.yml` (the device metadata file).
- `plots/`- this directory is where the figures containing plots with some metrics regarding the animal's performance are saved. A figure per block is saved with name `block_X.png` (where `X` is the block number).
- `unparsed_out/`- this directory contains the raw output structure saved in (a fake) JSON directly from Bonsai and that will be convert into a single CSV file. The files saved follow the name `out_hhmmss.json`.

**NOTE**

In order to avoid losing or overwriting data in case there's a need to restart the workflow, most of the files and directories are saved with a suffix `hhmmss` corresponding to the time at which the workflow was started.

**CAUTION**

Don't store any other files in the output directory that are not generated automatically during a session and don't change the names of the files. Some operations - auto-update of configuration files, the numbers in the file names - depend on the files saved by the task's software and on the way they are saved.

If there's a need to manually save other files related to the experiment, please do it somewhere else.

# Running the Task

After having everything else setup, the only thing left is to run the task. To do it, follow the steps:

1. In the task's directory, double-click on the `./Run.cmd` script.
2. Answer the initial prompts. Then, the bonsai workflow will open and the task will start with the GUI that allows the user to monitor the task in real-time and interact with some aspects of it.

# Initial prompts

The goal of the initial prompts is to ease up launching the task without the need for the user to change the configuration files manually every session, specially for parameters that depend on the data saved in the previous session (like the trial number) and for repetitive operations (like choosing the animal the will perform the task). Below, you can find the prompts with a brief description of what it does and what answers are valid.

1. Hello! :) Let me know who you are, please:

   This prompt only accepts letters and spaces and the first character **must** be a capital letter. Examples of valid answers are: `John Doe` or `JD`.

2. Are you training an animal from which batch?

   This prompt accepts alphanumeric answers (with underscores, but the underscore can't be the first or last character). An example of a valid answer is: `batch_name`.

3. Which furry friend is going to be joining us?

   This prompt accepts an animal ID, which is composed by 2 to 6 capital letters followed by 4 digits: Examples of valid answers are: `ANIMAL0000` or `RAT0055`.

4. Get parameters from last session (fixation time, reaction time, lnp_time and training_level)? [y/n]

   This prompt only accepts `y` and `n` as valid answers and only appears in case the animal input in 3. already started training previously. If the answer is affirmative, the values from fixation time, reaction time, LNP time and training level are read from the last trial done by the animal and written in the animal's `animal.yml` file.

5. What is the training level the animal should stop progressing? (You can leave blank if the animal can progress until the last level)

   This prompt only accepts a number up to 2 digits.

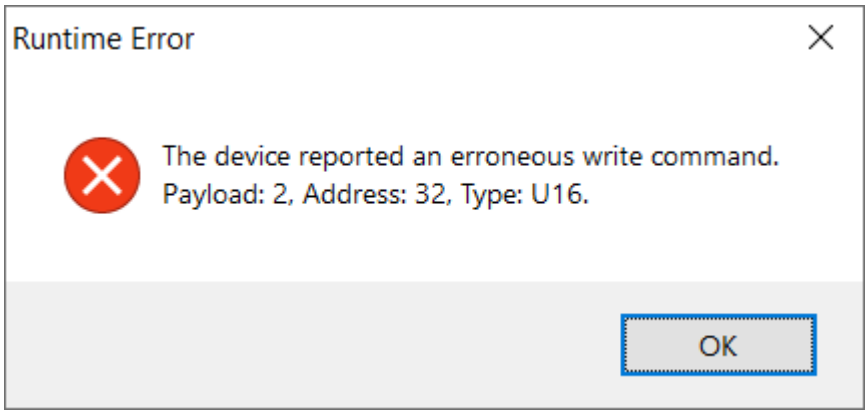
In addition to the prompts mentioned above, the startup script also looks at the data saved from the last session and updates the session number and the block number automatically.

# Known Issues

This project is still being actively developed and maintained. However, since this project is composed by a lot of small parts, it's normal that some issues are discovered and, by one reason or another, can't be addressed right away. Here's a list of known issues and how to deal with them for now.

## Harp SoundCard Crash

It's not yet known when or why this crash happens, but it's known that it's an issue related to the Harp SoundCard firmware that makes the whole workflow explicitly crash.




If the crash shown in the above figure occurs, unplug the Harp SoundCard and plug it again before restarting the workflow.