# SLM+ v1.0.14/15 integral software User Guide, 2025

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## SLM+ Program Description:

SLM+ software v1.0.14/15 is currently used to automatically record (expose) a series of images, either digital or analog, of projected 2D images and/or linearly translated (or rotated) stepper motor driven stages supporting real 3D objects onto a planar hologram photosensitive surface, through a sequentially linearly translated (moved) stepper motor driven slit aperture.

SLM+ can drive two linear translation stages and one rotation stage individually or simultaneously. Possible combinations are one Fuyu linear (X) + one Velmex linear (Y) + one Velmex rotation stage or all three Velmex stages (two linear + one rotation stage). The linear stages can be moved with accuracy of 0.01mm and the rotation stage with an accuracy of 0.01 degree. There is an on/off switch for each stage and a separate either/or switch for the X stage to notify the software if the X stage will be the Fuyu or Velmex stage. **(Put in exact model #s)**

SLM+ can also drive a pin-registered Optical Printer Projector Head (OPPH) which can hold, and advance, either analog 35mm or 16mm movie film. See *Figure 11*.

SLM+ can open and close a customized NRC model 845 shutter controller connected to any compatible model of NRC shutter head (model 846 or 846HP), in a controllable sequence with the translation stage movement, and a controllable *settling time* (between exposures) after movement of any programmed translation stage movements and/or OPPH movie frame advancement.

The exposure time (the amount of time the shutter is *open* to allow a laser to expose the holographic photosensitive material) can be set to repeat with a maximum accuracy down to one millisecond and is entered in thousandths of a second (as are the *settling time* and *initial settling time*). The shutter exposure time *can also be pre-set and varied by different specified amounts for* EACH exposure during a sequence if desired.

A rectangular gray indicator turns green to indicate active movement of any translation stage and/or the OPPH and, a separate similar rectangle indicates that the shutter is open or closed.

SLM+ drives an Arduino Uno which is the microprocessor controller through which all the above actions are controlled. SLM+ is connected to the Arduino by a long *active* USB cable going to the laptop on which SLM+ resides. The laptop is connected by HDMI cable to an LCoS SLM and/or LCD screen on the hologram optical table. *If SLM+ does not recognize connection to either the LCoS SLM or LCD, SLM+ won't load an image sequence - however other functions will work including shutter on/off and movement of stages and OPPH.*

The SLM+ laptop can drive the system from HDMI & USB cabling in either the hologram studio or the darkroom. (**Add pre-exposure checklist, e.g., beam not blocked, hood closed, etc.**).

**Additional Hardware:**

- Laser with its own on/off sequence and separate laptop with its own software controller. Cobolt & Genesis lasers have their own laptops. Not required for SLM+ operation.
- Chiller with on/off switch (if required for laser). Not required for SLM+ operation.
- Shutter controller with on/off switch. Not required for SLM+. (**Might be required for shutter settings on SLM+ to turn on/off, etc. – haven't tested**).
- Arduino master on/off switch (above hologram studio system UPS near ceiling). *Required to be ON for SLM+ operation.*
- LCD separate "strip PCB" on/off switch for its driver PCB board. *Needs to be ON and green (not red) if LCD is to be the digital imaging device for loading an SLM+ image sequence.*

# SLM+ Program Operation:

## Pre SLM+ boot tasks:

- Turn on Windows 11 Home laptop.
    - Make sure desired digital image sequence is in its own folder on laptop desktop.
- Turn on Arduino on/off switch.
- Plug USB cable from Arduino into laptop.
- Plug in HDMI cable from LCoS SLM or LCD into laptop.
    - If LCD, turn ON LCD on/off switch on "strip PCB".
- Turn on chiller on/off switch (if needed for laser).
- Turn on laser.

**SLM+ opens to the SLM+ tab.** See *Figure 2*.

The SLM+ software has four menus across the top, **File**, **Examples**, **Help**, and **VISA Resources**.
Just below the menus are four tabs, **SLM+**, **Move Home**, **Image Sequence**, and **LCD**.

## SLM+ tab Entry and notification windows, switches and notification rectangles from left to right, top to bottom: See *Figure 2*

### SLM+ tab USAGE:

This first tab is the **main entry portal** for setting up the specifications necessary to run and expose a sequence of frames, primarily to create a laser viewable master (H1) hologram composed of a series of abutting slit exposures. It can also be used for other exposure types.

**Example**: Assuming that a sequence of digital frames will be used to create the H1 hologram, the following settings might be used:

- The Fuyu X stage would be enabled by **switching the X Stage to ON position** and **selecting the Fuyu Stage switch position (default).** The Fuyu X Stage sequentially moves the slit.
    - The Y Stage, Rotation Stage, and OPPH would all remain in the OFF position.

- If using a 2mm wide slit plate as the slit, **-2.00** would be entered in the *"X mm to move"* entry window. This will cause the Fuyu X Stage to move the slit **upward** on the hologram plate by 2mm after each exposure cycle to reposition it for the next exposure.
    - Entries in the Y and Rotation Stage entry windows will be ignored if those stages have not been turned ON.
- A suitable settling time needs to be entered in the *"Move/Settling Time"* entry window. For a 60 second settling time between exposures, **60000** milliseconds is entered.
- The Shutter is activated in three steps:
    - The *"Shutter Enable"* is **switched ON**.
    - The *"Single/Multiple Shutter Delays"* is **switched to Single**.
    - A suitable exposure time is entered in the *"Open Time"* entry window. For a three second exposure, **3000** milliseconds is entered.
- An *"Initial Settling Time (ms)"* can be entered, e.g., 5 minutes (300 seconds), **300,000** milliseconds.

This **completes necessary entries on the SLM+ tab** and we now move to the **Image Sequence tab** (Figure 3). In this example, (see Image Sequence tab USAGE) once a computer folder with the desired digital image sequence is loaded into the Image Sequence tab, and any desired adjustments and entries are made there, we will **return to the SLM+ tab** to click the Run Sequence button to start the H1 master recording sequence of exposure cycles (after checking all items on the **studio master checklist**).

**SLM+ tab item descriptions:**

*"VISA Resource"* notification window, at upper Left, just under the row of tabs:

This **notification window** indicates COM port of laptop through which SLM+ communicates with the Arduino Uno microprocessor via USB cable. If there is no COM port listed there, SLM+ has not autodetected Arduino and there is no communication with Arduino. *The "VISA Resources" MENU is inactive and, unlike the prior LabView software, has no purpose in this incarnation (see Figure 1).*

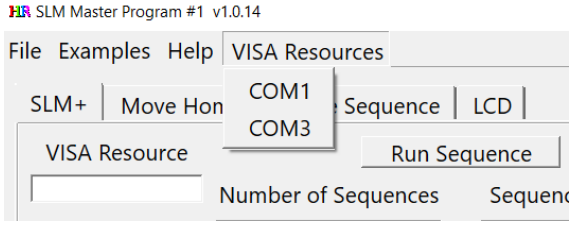



*Figure 1, inactive VISA Resource menu.*

*"Run Sequence"* rectangular button, to right of VISA Resource window at top center just under Image Sequence and LCD tabs:

This rectangular **push button** is **pressed once** to initiate a "run" of exposures and should only be clicked **after** all entries have been double checked. **Currently, if there is no image folder loaded into the Image Sequence tab, an error will occur saying "Open folder with images first". This was intended as a "guardrail" but is actually a BUG. To add insult to injury, no image folder can be loaded into the Image Sequence tab if neither the LCoS SLM nor LCD is connected.**

*"PAUSE"* and *"STOP"* buttons at far-right top of SLM+ tab:
These two **push buttons** are grayed out until the *"Run Sequence"* button has been pressed. Once the *"Run Sequence"* button is pressed, the letters turn red and the Run Sequence can be temporarily paused (PAUSE), where it is, so the sequence can be continued **OR** the entire sequence can be immediately ended (STOP). The PAUSE button stops the internal timer exactly where the cycle was paused. It becomes a RESUME button and, when pressed, continues the Run Sequence timer where it left off. The STOP button z**eroes out** the Run Sequence and allows no RESUME.

*"Number of Sequences"* and *"Sequence #"* entry/notification windows:
The *Number of Sequences* window is both a **notification and entry window** as noted below. The *Sequence #* window is a **notification only window**. The first provides the user with a notification of total number of exposure cycles (sequences) that will be run and, the second, shows how many sequence exposure cycles have been COMPLETED.

The *"Number of Sequences"* is automatically set when a folder of images is "opened" from the *Image Sequence* tab using the File menu.

The *"Number of Sequences"* can be changed manually, either by direct keyboard entry or by using the up/down arrows at right of window. For example, the number of sequences can be reduced from a few hundred to 3, **after** a folder of images has been loaded via the Image Sequence tab, that is, for example, if the user would like to test that the shutter, settling time and/or slit movement sequence cycles are operating correctly, or, for example, the user would like to expose a sequence of rotations or linear movements of real object(s) mounted on one of the linear or rotation stages with the slit to animate a real object. **This inability to run the X, Y. Rotate stages without first loading an image folder into the Image Sequence tab, further complicated by the fact that either the LCD or LCoS SLM has to be connected for an image folder to be loaded into the Image Sequence tab in the first place, is a BUG.**

*"X Stage Switch"* directly below the VISA Resource window:
An **"either/or" switch** allowing the user to switch between a Fuyu or Velmex "stepper motor/lead screw" driven linear stage. The Fuyu stage moves the "slit plate" in increments as small as 0.01mm. The Velmex stage is used for other purposes and does not currently move a slit. (The switch is necessary since the lead screw, of the two different linear stages, rotates through 360 degrees a different number of steps). In almost all cases, the switch should be on Fuyu.

*"X Stage", "Y Stage", "Rotation"* to right of *X Stage Switch*:
These are **on/off switches** for each stage. The switches for unused stages should be in the OFF position. The X Stage switch always needs to be enabled (ON), regardless of whether the Fuyu or Velmex is used, if either X stage is to be used.

*"Enable OPPH"* to far right of X Stage Switch and X, Y, & Rotation Stage switches:
This **on/off switch** enables functionality of the analog Optical Printer Projector Head (OPPH) film movement. This allows either 35mm or 16mm movie film to be sequentially advanced and projected in

lieu of, or together with digital imagery and/or actual objects (see OPPH appendix for OPPH operation details). In theory, this should be able to be used independently of a digital input source (LCD/LCoS SLM) or simultaneously with shutter, settling time, and X, Y, Rotation Stages, all triggered by "Run Sequence" button. (See *Figure 11*). ***This functionality was tested independently (to verify communication and advancement of the OPPH). However, it may be subject to the BUG noted in the "Run Sequence" and "Number of Sequences" descriptions previously noted since it was not tested in combination with the X/Y/R stages.***

*"LCD"* square dialog box with *"LCD (only)"* checkbox & *"LCD Timer"* window, at far left just below the Fuyu/Velmex either/or switch:
**Non-functional** - removed from this tab beginning with v1.0.15. (See *Figure 5* & *Figure 6*).

*"X mm to move", Y mm to move", "Degrees of Rotation"* entry windows, in a row just to right of "LCD" square dialog box:
These three **entry windows** can be changed manually, either by direct keyboard entry or by using the up/down arrows at right of window after an initial number has been entered (**need to check if a number has to be entered first for the arrows to function**). Entries are in millimeters and are accurate to a hundredth of a mm (0.01mm) and can be either positive or negative.

***The entry values, if positive, move away from the stage stepper motor, and towards the stepper motor if negative*.**

**mm move USAGE:** In the case of using the X Stage with the Fuyu stage enabled to move a slit plate, **when the slit moves upward (toward motor), a negative value is required**. Usually, the value will be the exact width of the slit. Currently, there are six slit plates with widths of 0.37mm, 0.74mm, 1.0mm, 2.0mm, 3.2mm, and 6mm. With the current Data Optics 5101 plateholder setup with custom length legs, there are plateholder leg stops at the bottom of the H1PH legs on which to rest the bottom edge of the hologram plate when mounting to the legs for subsequent exposure. **That height is 92mm from the surface of the hologram table**. The bottom edge of the slit needs to be aligned at exactly 92mm to optimize the number of possible slit plate exposures for a given hologram plate. See the **Move Home** tab description for more operation details on this.

*"OPPH/Stages moving/settling"*, notification rectangle at far right of row starting with *"LCD", "X", "Y", "Degrees of Rotation"*:
This grayed-out **notification rectangle** turns green when OPPH and/or Stages, are moving or settling time is active.

*"x count", "y count", "R count"* notification windows, at tab center directly below "X, Y mm to move/Degrees of Rotation":
These **notification windows** show the number of sequence cycles each stage has completed of Run Sequence, if any.

*"Move/Settling Time"* entry window, at far right of "x, y R count" notification windows:
Settling time **entry window** is for entering desired settling time between end of slit and/or stage movement and beginning of shutter opening for exposure time. Entered in thousandth of a second where one second = entry of 1000. The current usual settling time is 60 seconds = entry of 60000 milliseconds. (**Going to do a series of tests to calculate minimum time yielding 100% successful slit exposures**).

*"Shutter Enable"* switch, at far left below "LCD" square dialog box:
This is an **on/off switch** to activate shutter. **(i.e. enables one way communication from the software to the shutter hardware).**
"Open Time" entry window, just to right of "Shutter Enable" switch:
This **entry window** is for entering exposure time, per sequence cycle, if the same exposure time is desired for every exposure in the Run Sequence. Entered in thousandths of a second where one second = entry of 1000 milliseconds.

*"Single/Multiple Shutter Delays"* either/or switch, just to right of *"Open Time"*:
This **either/or switch**, in the *"Single"* position, makes all shutter exposure times in a Run Sequence the same amount of time as entered in the previous *"Open Time"* window described above. The switch, in the *"Multiple"* position, **should allow** each individual shutter time to be set to a different amount of time and activates the entry window to the right. (**the values for Multiple Times is a UI placeholder, and needs to be connected in the software with this functionality**).

*"Multiple Times"* entry window, just to right of *"Single/Multiple"* switch:
This **entry window** allows the user to set the number of exposures desired - each exposure has its time set separately. For example, if the Run Sequence has 10 exposure cycles, "10" is entered. The amount of time for EACH exposure is then entered, one below the next, in the large **entry box** just to the right of the *"Multiple Times"* entry window in thousandths of a second, e.g., one second = 1000 milliseconds. (**the values for Multiple Times is a UI placeholder, and needs to be connected in the software with this functionality**) (See *Figure 12*).

*"Shutter Open Indicator"*, notification rectangle at far right of "Shutter Enable" row:
This grayed-out **notification rectangle** turns green when shutter is open, and exposure is occurring. Note: The indicator for the shutter should be calibrated/synchronized manually before operating, since there is no way for the software to check what the current state of the shutter is (open/closed). The operator must verify that the shutter is open (green) or closed (gray).

*"Initial Settling Time (ms)"* entry window, at left bottom of SLM+ tab:
This **entry window** is for the **FIRST settling time only** just after Run Sequence button is pushed to start a run. This gives time for the room air currents to calm down if SLM+ tab Run Sequence button is pushed while in studio. If the laptop with the SLM+ software is in the darkroom outside the laser studio with the laser studio door closed, this time can be zero or very short. Entered in thousandth of a second where one second = entry of 1000 milliseconds.

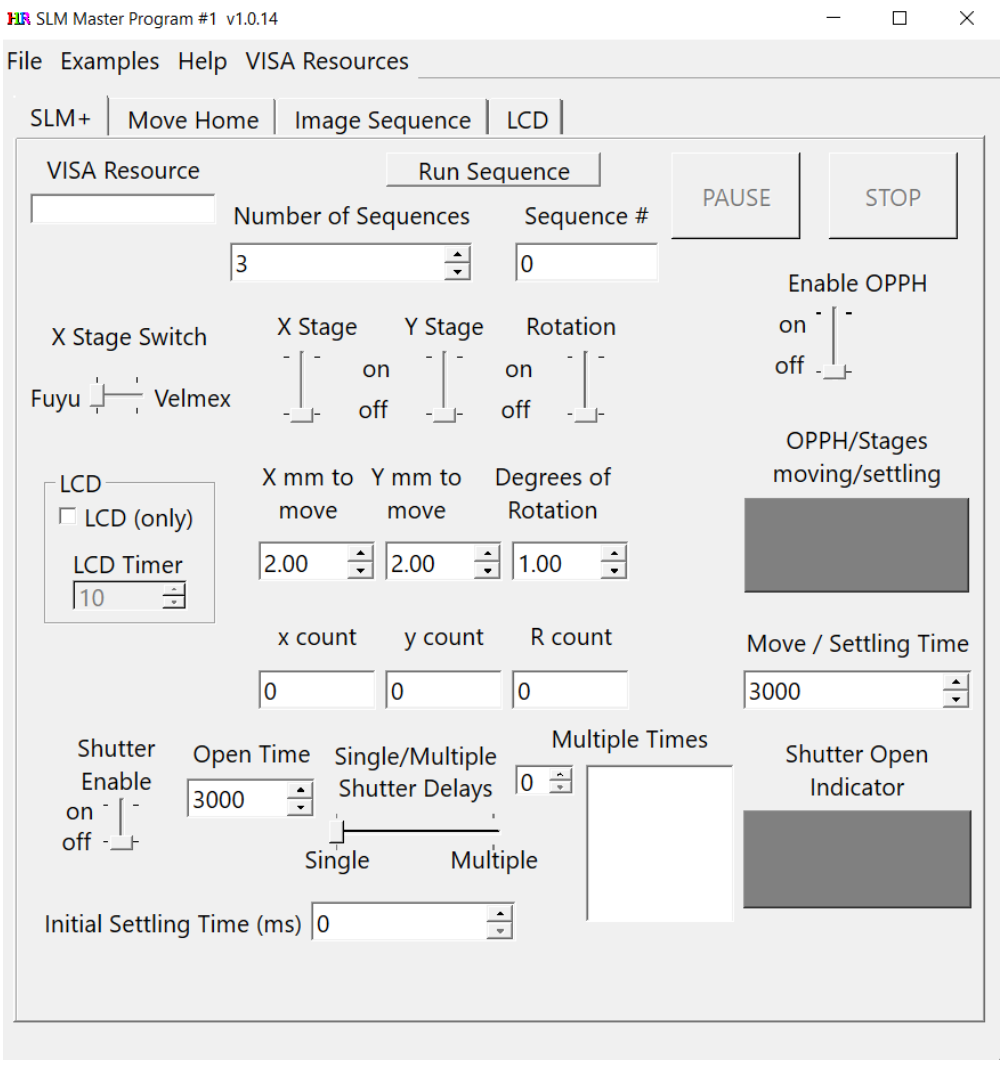



*Figure 2 Main SLM+ tab to which program opens.*

## Image Sequence tab Entry windows, sliders and option/radio buttons from left to right, top to bottom: See *Figure 3*.

**Image Sequence tab USAGE:**
First, an image sequence needs to be loaded into the **Image Sequence tab**. This assumes that an image sequence has already been prepared and is in a folder on the laptop running SLM+.

There should be nothing else in the target folder other than sequentially numbered digital image files. The files do not have to be numbered consecutively but must be sequential.

Open the **File menu** at the left top corner of the SLM+ software. Click on **Open** and navigate to the desired folder location. **Desktop** is a convenient folder location although any location is ok. **Click on the folder. Do not open the folder**. Click on the **Select Folder** button at bottom right of the file manager (File Explorer) window. You will now see the files loaded into the Command Line style DOS window (usually behind the SLM+ software GUI) and, when all are loaded, the first image in the sequence will open as an image in the **Image Sequence tab** window. The **horizontal slider at the bottom, just below the image window, can now be used to scroll through the loaded image sequence.**

**Image Size & File Type limitations:**
File size is limited only by available RAM on laptop. If the image folder doesn't exceed available RAM, images will load. OpenCV 3rd party library is used for file types and file types that are loadable are only limited by that. Lossless file extensions such as .png, .bmp, .tif or .tiff are recommended as opposed to lossy file types such as .jpg.

**Image Orientation:**
Assuming H2 white light viewable transfer is to be top lit, when recording H1 laser viewable master, the top of the image to be recorded should face toward the reference beam in the recording setup.

**Image Scale & Sequencing:**
The **Image Sequence tab** has five sets of controls to control image the image on the projection screen of the hologram setup - scale (size), rotation, flip, translation, and frames of the image sequence to keep and skip (Keep & Step) allowing the user to achieve the desired image size, location and orientation. Actions set in **these controls affect the entire image sequence**.

**Image Sequence tab item descriptions:**
*"Scale"* vertical slider, far left bottom just above horizontal image sequence slider:
**Vertical slider** expands/contract image in LCD/LCoS SLM projection screen, scale **limits are 1-200% of the original image**. **Default is 100%**. There are two radio selection buttons to left of slider to select *Bicubic* or *Bilinear* scaling. **Default is Bicubic**.
https://en.wikipedia.org/wiki/Bicubic_interpolation

OpenCV - INTER_CUBIC, INTER_LINEAR
https://docs.opencv.org/4.9.0/da/d54/group__imgproc__transform.html

*"Translate"* entry windows, with buttons for UP, DOWN, LEFT, RIGHT, just to right of *Scale* slider:
There is an **entry window** for the UP, DOWN buttons and a **separate entry window** for the LEFT, RIGHT buttons. **Entries are in "pixels"**. An entry is made and the desired button is pushed.
The user can adjust the location of the image precisely on the image projection screen.

*"Rotation"* radio buttons, just below *Translate* dialog box:
There are **four radio buttons**. Selections are **"0", "90", "180", and "270" degrees**. The user can rotate the image to the desired orientation, e.g., upside down, or facing right or left. *Rotation* rotates the entire image around the **image center-point**.

*"Flip"* radio buttons, just to right next to *Translate* & *Rotation* dialog boxes:
There are **four radio buttons**. Selections are **"None", "Horizontal", "Vertical", and "Both Axes"**. An **example of usage:** if finished H2 hologram is to be laminated to a first surface mirror and the image is desired to remain viewable in the same flip orientation as recorded in order to maintain text as readable instead of reversed. **Reason:** a white light transmission hologram is usually recorded so that the emulsion faces the viewer when displayed. When laminated with a clear cover glass, this remains true. However, when laminated to a first surface mirror, the emulsion faces the first surface mirror, and the image is reversed side to side (horizontally) when displayed. The horizontal flip function corrects this. *Flip* rotates the image 180 degrees along the appropriate **linear axis** of the image.

*"Image Seq."* entry windows and checkbox, far right bottom:
This dialog box has two entry windows and one checkbox. (Note: these entries are **disabled by default. Once an image sequence has been loaded, these entries are enabled**).

**Reverse** (the checkbox), between the two entry windows, allows the user to **reverse the order in which each image is presented** to the projection screen. That is, instead of starting with the first image in the image sequence (the lowest numbered), the program will start by presenting the last image (the highest numbered). This can prevent the recorded images from being viewed with the incorrect perspective rotation in the hologram. This determines the direction of rotation of an image sequence, clockwise or counterclockwise, when the image sequence is viewed in the Image Sequence tab window when using the horizontal scroll pointer along the bottom of the Image Sequence tab window.

In the current physical setup, the slit moves from the bottom to the top of the hologram plate while making exposures. The bottom of the H1 master plate, when being recorded, corresponds to the image, as viewed from the right side of the final hologram. For the final hologram to look like an actual object/scene, the image sequence must be viewed rotating **COUNTERCLOCKWISE** when moving the horizontal scroll pointer left to right to review the image sequence.

**Step**, (the top entry window), **allows the user to skip frames**, between exposures, in the image sequence. **Step 2** will skip every other frame in the sequence (e.g., 1, 3, 5, 7, 9,…). **Step 3** will expose every third frame in the sequence (e.g., 1, 4, 7, 10, 13,…) etc. This entry can be changed manually, either by direct keyboard entry or by using the up/down arrows at right of window after an initial number has been entered.

**Keep**, (the bottom entry window), **allows the user to Keep a specified number of sequential frames**, each time, before skipping the number of frames specified above in the **Step** entry window. **Step 1, Keep 1:** keeps all frames. **Keep 1, Step 2:** skips every other frame (1,3,5,7,9, etc.). **Keep 2, Step 2:** keeps 2 frames and then skips a frame, keeps 2 frames and then skips a frame (exposures: 1,2, 4,5, 7,8, etc.). This entry can be changed manually, either by direct keyboard entry or by using the up/down arrows at right of window after an initial number has been entered.

## ***"Step", "Keep"* usage considerations:**

This analysis is based on actual H1 masters recorded with this system so far.
Considerations are

- **Image sequence field of view (FOV),** that is, the number of degrees of image parallax seen by the hologram viewer.
- **Length of H1** master plate.
- **Available slit widths** that can be used for exposures, e.g., 1mm, 2mm, 3.2mm, 6mm, etc., length.
- **Total time required to expose the H1 master plate.**

**Image sequence FOV** is determined by the first and last frames in the sequence.
**Length of H1**, that is the physical distance available to span the image sequence FOV between first & last frames, and the number of image sequence frames available, will determine slit width to be used and the appropriate settings in the **Step** and **Keep** controls. The current rule of thumb is no less than 2 frames per degree to obtain a smooth looking final hologram image – that is, no perceptible "jumps" between frames when viewing the final hologram image. These jumps can be exacerbated if a part of the image is projected towards the viewer beyond the plane of the surface of the hologram. **Total time required to expose H1** can be a consideration. The current system is using a settling time between exposures of 60 seconds (1 minute), If, as in Example 2 below, there are 254 exposures, that means 4.23 hours devoted just to settling time plus the duration of each exposure, usually between 25 – 90 seconds.

**Example 1:**

- Image sequence FOV = 60 degrees
- Number of frames provided in image sequence = 600 (10 frames per degree).
- Length of H1 = 11.8" (300mm)

We were fortunate here to have an evenly divisible number of frames compared to the length of the H1 master plate. The 600 exposures, divided by 4 equaled 150 exposure of 2.5 frames per degree of image FOV. This allowed the use of a 2mm slit width to expose every fourth frame of the image sequence for 150 exposures and a Step/Keep setting of **Keep 1, Step 4**.

**Example 2:**

- Image sequence FOV = 180 degrees
- Number of frames provided in the image sequence = 360 (2 frames per degree)
- Length of H1 = 10" (254mm).

We are already at the rule of thumb limit of no less than 2 frames every degree. The narrowest slit width currently available is 1mm, which only allowed 254 of the 360 available frames to be used to cover the desired 180-degree FOV. 106 frames (360-254=106) will have to be eliminated to preserve the desired 180-degree FOV. If we Keep 2, Step 2, we'll have 14 too many frames left. (360/3 = 120). If we Keep 3, Step 2, we'll leave 16mm (~2/3") (360/4 = 90), of unused & unexposed H1 master plate at the top (left side of final image). A solution was to **Keep 2, Step 2**, while trimming 7 frames off each end of the sequence. This kept an even FOV on each side of the image while only losing 3.5 degrees of FOV each from right and left sides for a total 173-degree FOV in the final hologram. The first 7 and last 7 frames were deleted from the image sequence folder before loading it into the Image Sequence tab.

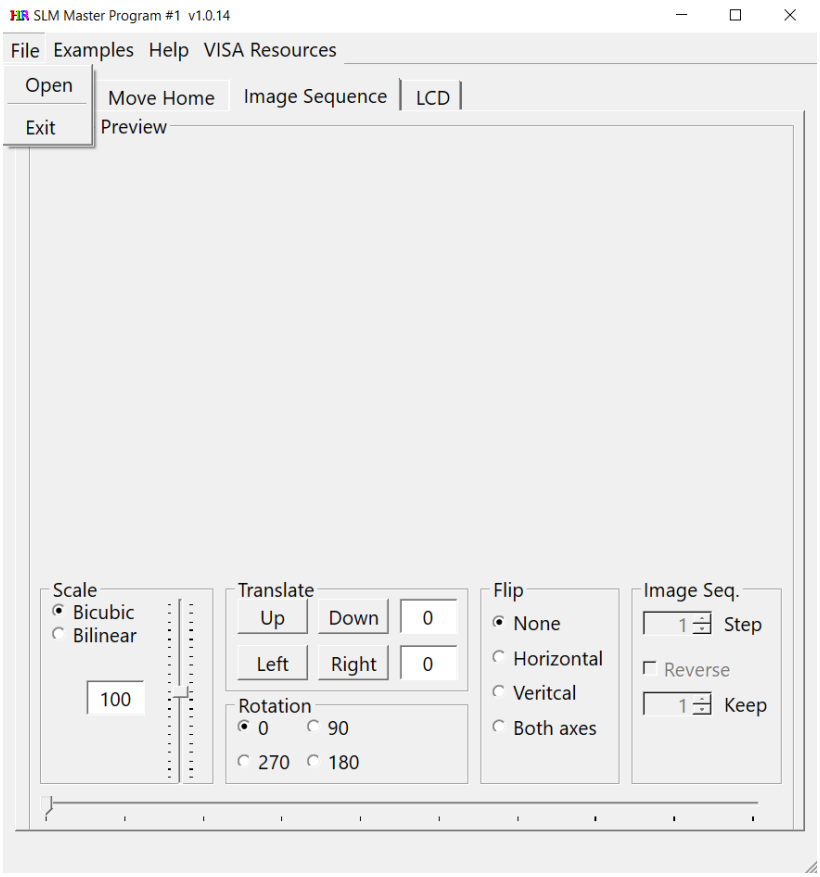



*Figure 3 Image Sequence tab with File>Open menu*

## Move Home tab Entry windows, sliders and option/radio buttons for from left to right, top to bottom: See *Figure 4.*

**Move Home tab USAGE:**
This is a very useful general utility tab for operating the shutter and translation stages without requiring the user to load an image sequence in the Image Sequence tab or turn on an LCD or LCoS SLM. **Move Home tab settings are independent of, & have no effect on, SLM+ tab settings!!!**

**Move Home tab item descriptions:**
*"X Stage Switch"* directly below the Move Home tab:
An **"either/or" switch** allowing the user to switch between a Fuyu or Velmex "stepper motor/lead screw" driven linear stage. The Fuyu stage moves the "slit plate" in increments as small as 0.01mm. The Velmex stage is used for other purposes and does not currently move a slit. (The switch is necessary since the lead screw, of the two different linear stages, rotates through 360 degrees a different number of steps). In almost all cases, the switch should be on Fuyu.

*"X Stage", "Y Stage", "Rotation"* just below *X Stage Switch*:
These are **on/off switches** for each stage. The switches for unused stages should be in the OFF position. The X Stage switch always needs to be enabled (ON), regardless of whether the Fuyu or Velmex is used, if either X stage is to be used.

*"X mm to home", Y mm to home", "Rotation to home"* entry windows, in a row just under *X,Y Rotation* stages:
These three **entry windows** can be changed manually, either by direct keyboard entry or by using the up/down arrows at right of window after an initial number has been entered (**need to check if a number has to be entered first for the arrows to function**). Entries are in millimeters and are accurate to a hundredth of a mm (0.01mm) and can be either positive or negative.

***The entry values, if positive, move away from the stage stepper motor,*** *and* ***towards the stepper motor if negative*****.**

**mm to home USAGE:** In the case of using the X Stage with the Fuyu stage enabled to move a slit plate, **when the slit moves upward (toward motor), normally a negative value is required**. However, the Move Home tab has controls that eliminate the need for a minus sign to be entered (see *Move X Backward (UP)* below). Usually, the value will be the exact width of the slit. Currently, there are six slit plates with widths of0.37mm, 0.74mm, 1.0mm, 2.0mm, 3.2mm, and 6mm. With the current Data Optics 5101 plateholder setup with custom length legs, there are plateholder leg stops at the bottom of the H1PH legs on which to rest the bottom edge of the hologram plate when mounting to the legs for subsequent exposure. **That height is 92mm from the surface of the hologram table**. The bottom edge of the slit needs to be aligned at exactly 92mm to optimize the number of possible slit plate exposures for a given hologram plate. After an exposure sequence is finished, this is used to reposition the slit plate to its correct start position, that is the bottom edge of the slit aperture at 92mm above the optical table which places it at the bottom edge of the hologram plate.

*"x count", "y count", "R count"* notification windows, at tab center directly below *"X, Y mm to home/Rotation"*:
These **notification windows** show the number of sequence cycles each stage has completed, if any, of entries in entry windows directly above.

*"Move X Backward (Up)", "Move X Forward (Down)", "Move Y Backward", "Move Y Forward", "Move R CW", "Move R CCW"*, buttons along right side of tab:
These **push buttons** enable the respective stages to move the amounts entered in the *"X mm to home", Y mm to home", "Rotation to home"* entry windows.

*"Shutter Open Indicator"*, notification rectangle at far right bottom just below the various "Move" buttons:
This grayed-out **notification rectangle** turns green when shutter is open, and exposure is occurring.

*"Open Shutter", "Close Shutter"* buttons at bottom right of Move Home tab:
These **two push buttons** enable the named shutter functions and turn on/off the *"Shutter Open Indicator"* rectangle just above.

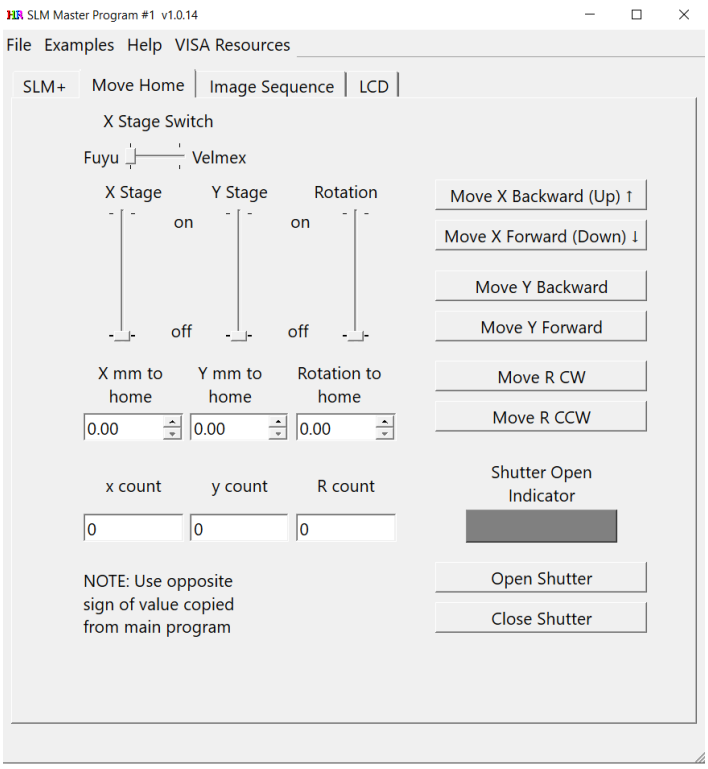



*Figure 4 Move Home tab, useful for setting up & testing*

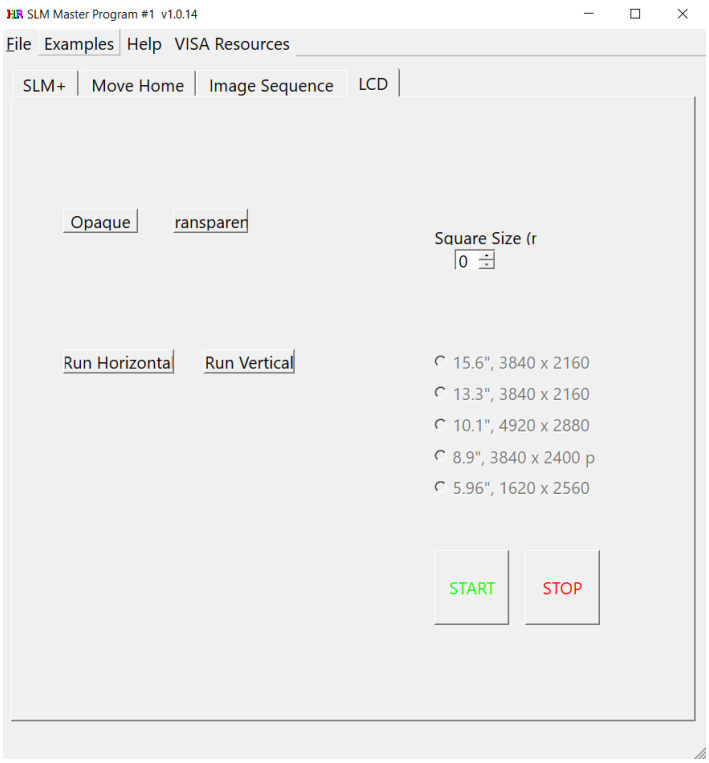



*Figure 5 v1.0.14 original version LCD tab (obsolete)*

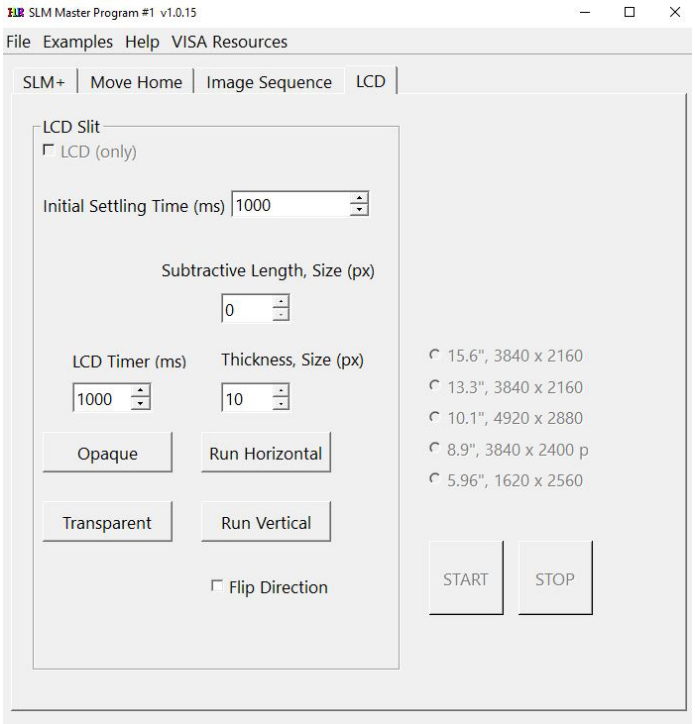



*Figure 6 v1.0.15 newer version of LCD tab*

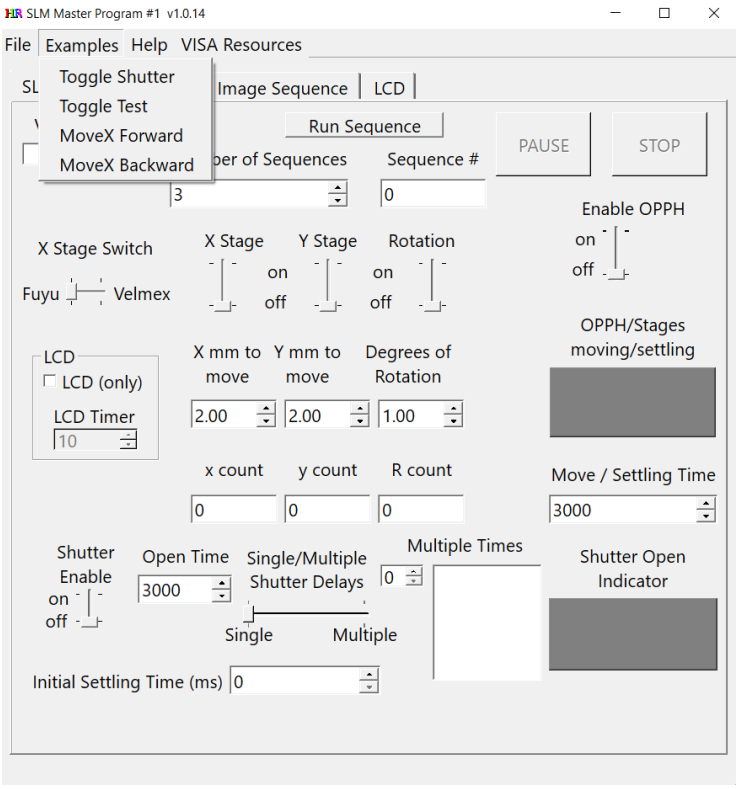



*Figure 7 Examples tab (for developer testing – not user useful)*

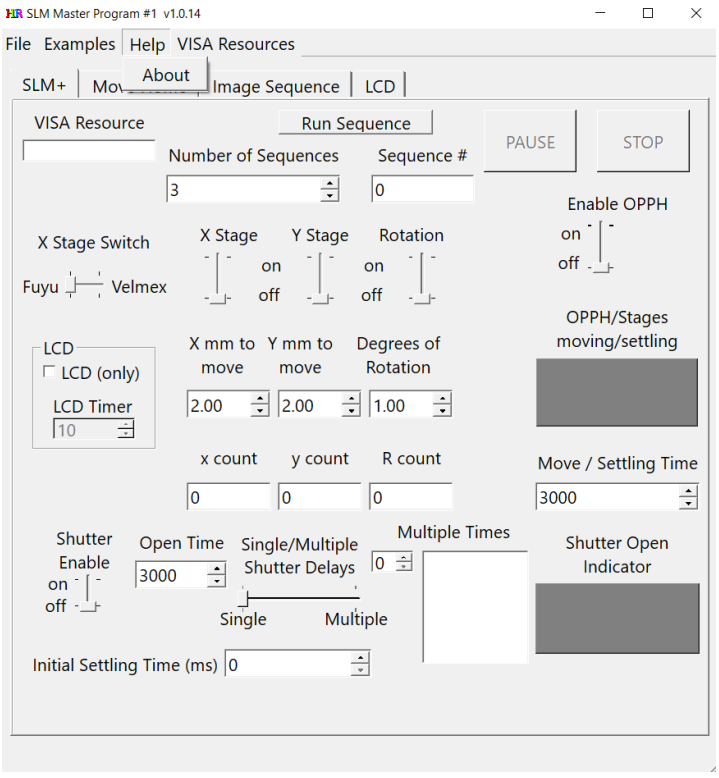



*Figure 8 Help tab showing* about *menu item*

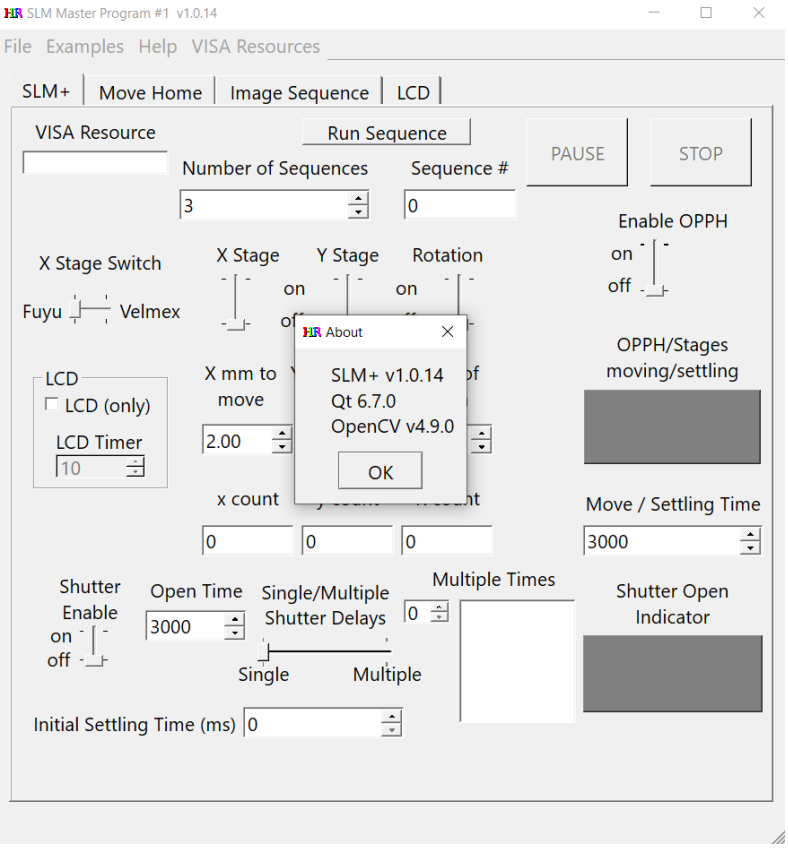



*Figure 9 Help tab, showing About SLM+ versioning*

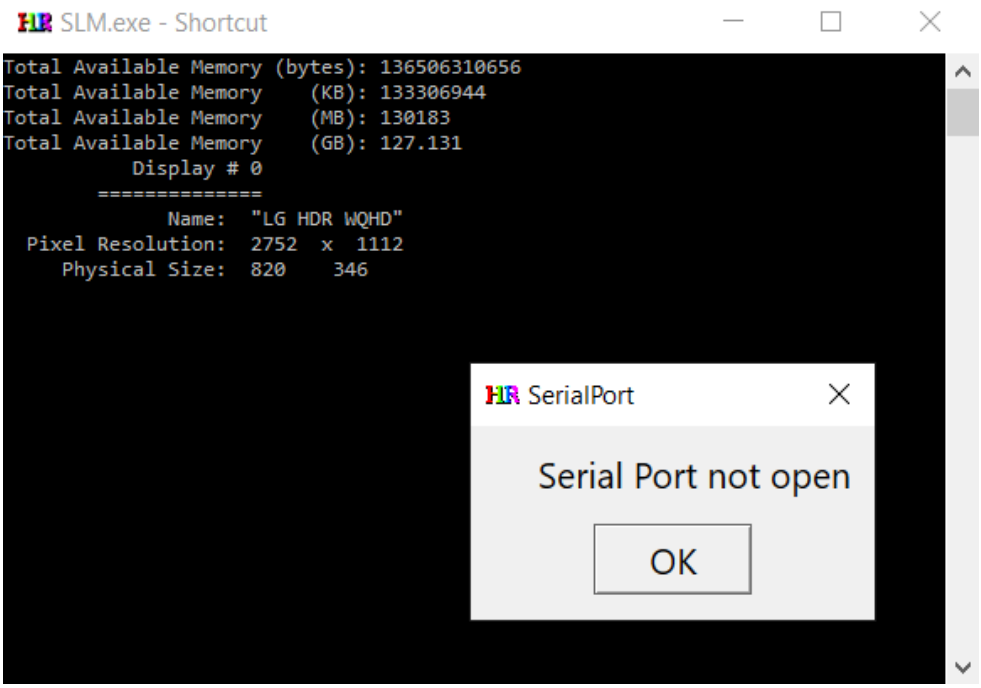



*Figure 10 DOS utility screen, showing Serial Port warning screen*

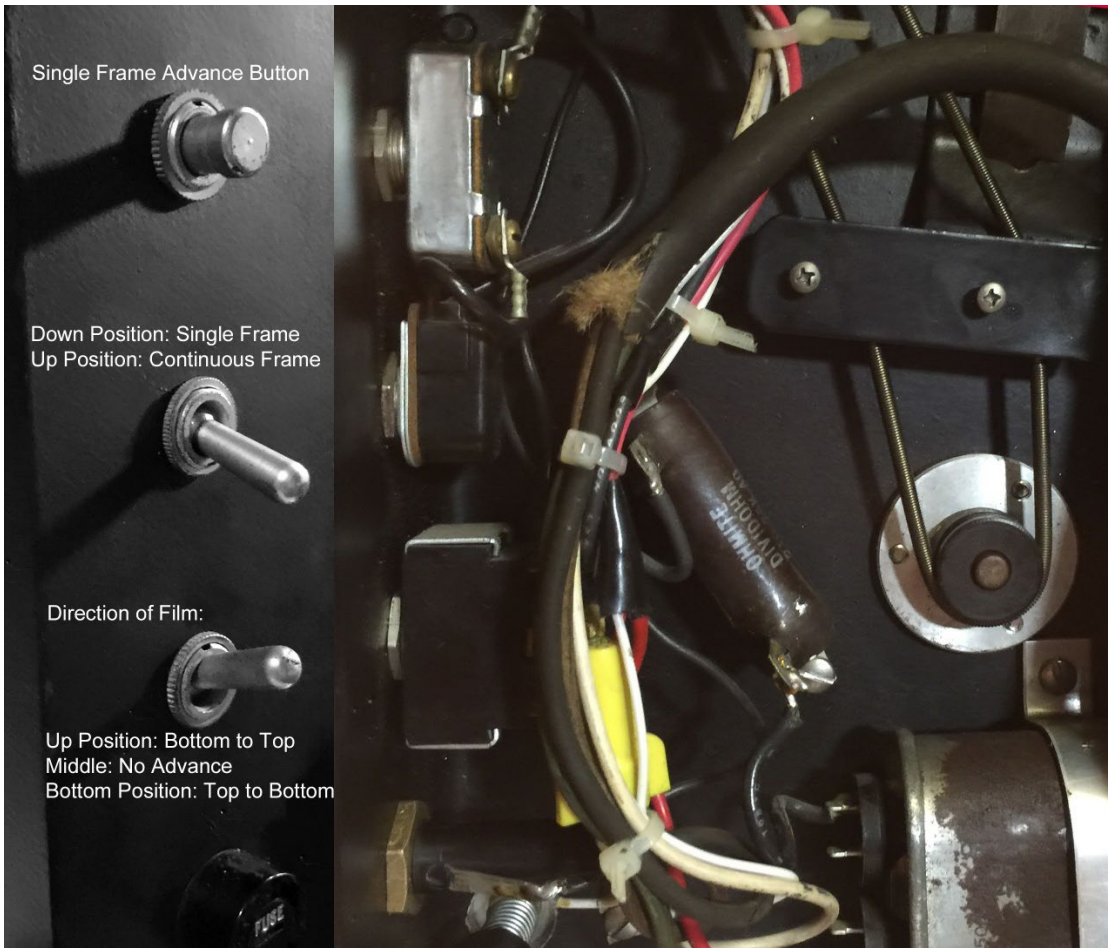



*Figure 21 Optical Printer Projector Head (OPPH) switch settings*

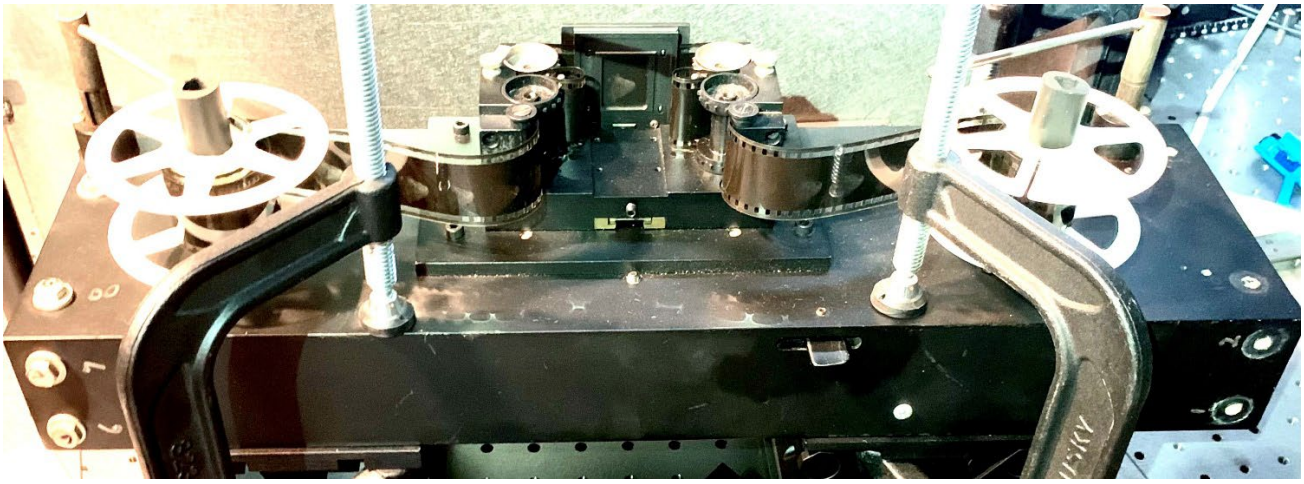


*Figure 13 OPPH with 35mm film*

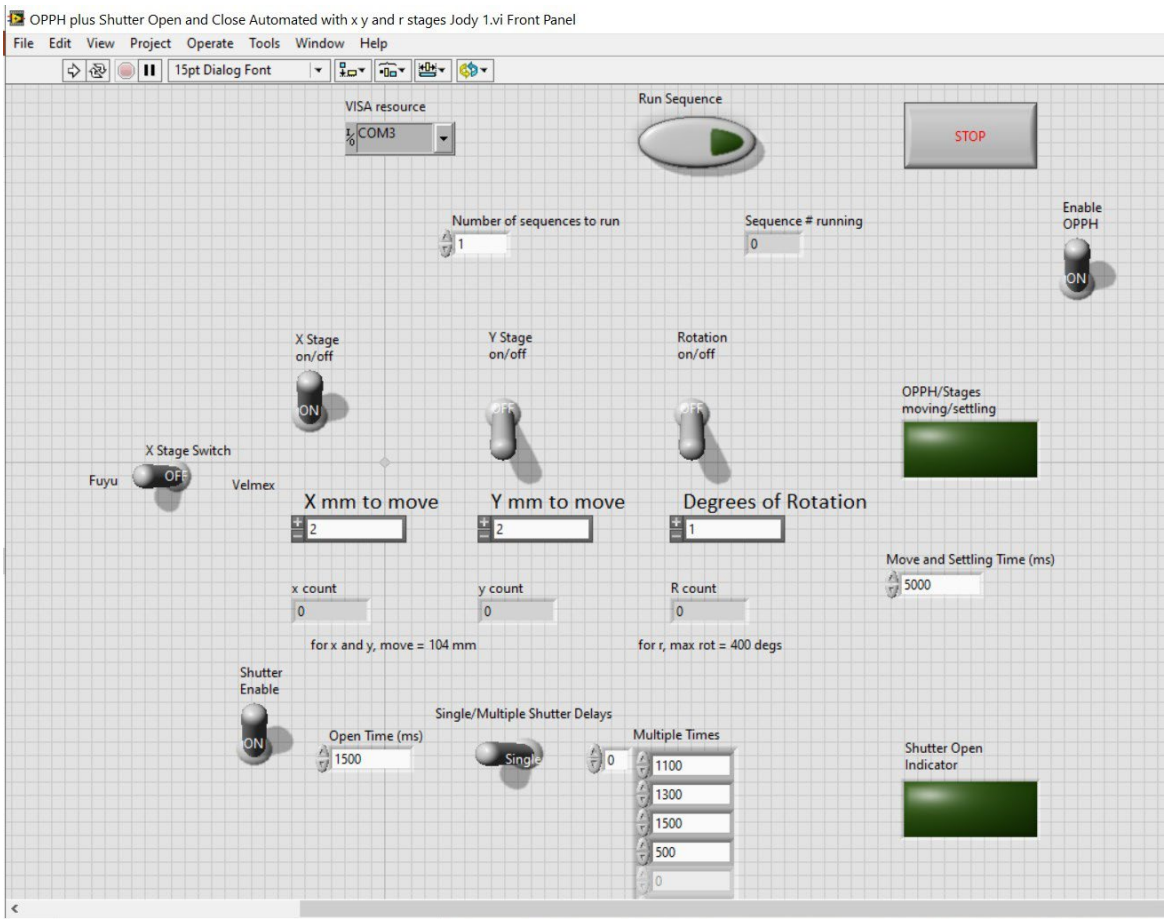
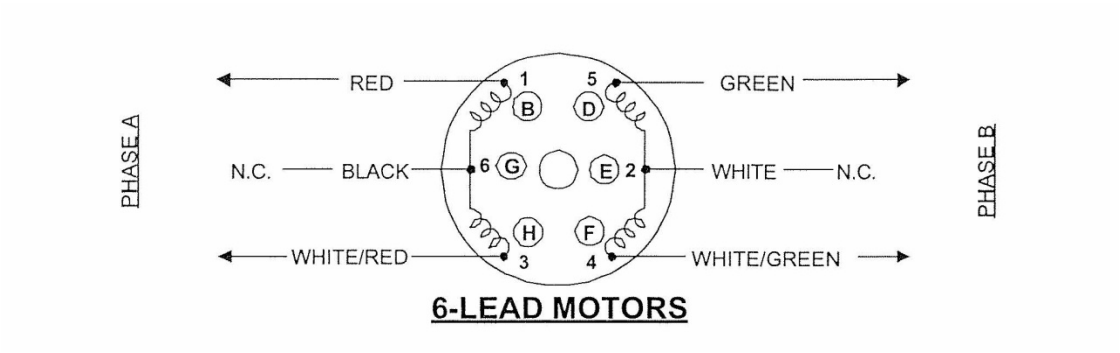



*Figure 12 Multiple shutter times example from old LabView version.*

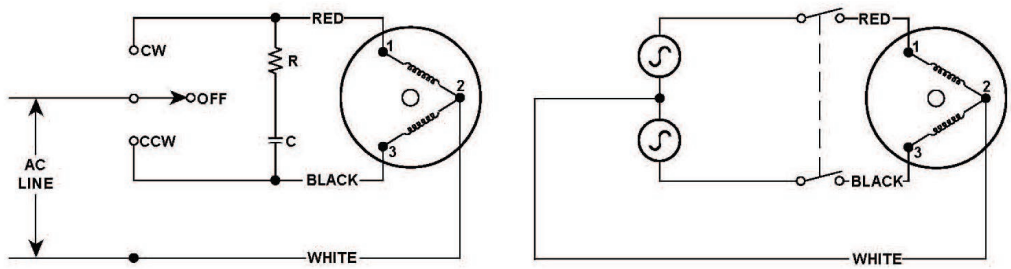

*Figure 14 FUYU slit stage with NEMA 23 stepper*

| **M092-FD08** (DC Stepper) | **M061-FD08** (DC Stepper) | **SS50** (AC Stepper) |
|---|---|---|
| NEMA 34 | NEMA 23 | NEMA 34D |
| Unipolar | Unipolar | One winding? |
| 6 leads | 6 leads | |
| 200 oz. in. (LS08 is 150) | 35 oz. in. (LS08 is 60) | 50 oz. in. |
| spec: BM101025 | BM101025 | BM131405 |
| 200 steps per rev | 200 steps per rev | 72 rpm @ 60Hz |
| 3.0v, 4.0A | 1.25v, 3.8A | 120v, 0.3A |
| **Two 3ft Velmex Linear stages** | **One Velmex Rotation stage (& FUYU?)** | **OPPH film drive** |

**WIRING DIAGRAMS:**




6-LEAD MOTORS




SINGLE-PHASE OPERATION




TWO-PHASE OPERATION

CONNECTION DIAGRAM A (2-PHASE MOTORS)

FUYU Information:
500mm stroke 140mm/s max speed CNC Linear guide for printer (20" stepper motor drive slide)
12/18/2016, cdfuyu, $185.00, for moving slit or plate for H1 integral holograms
Mika Deng, mika@fuyuautomation.com, Chengdu FuYu Technology Co., Ltd., No.1455 M.Sec.4, Xihanggang Ave., Shuangliu, Chengdu(610207), Shpng: Hong Kong BSL Co, Ltd., ALOCE-52997, No2 Xing Wei, Rd Fuyong Logistic Park, Hong Kong HK

- 2nd one bought Oct 17 2024 ebay for half the price. NEMA 23 stepper motor.

**LCD:**
DBT133TIU40E0, mono. a-Si TFT-LCD, DuoBond, 337.82mm (13.3”),
Outline size: 302.36(W)×176.94(H)×1.228mm, 11.9 x 6.966 x 0.0483
Active area: 293.76(W)×165.24(H), 11.565 x 6.5”, pixel pitch: 76.5*76.5 um
Resolution: 3840×RGB×2160 (UHD,332PPI), contrast ratio: 800:1 (Typ.),
Display mode: New mode2, Normally black, transmissive
Transmittance: 4-5% UV, cabling HDMI power 12V, driver board

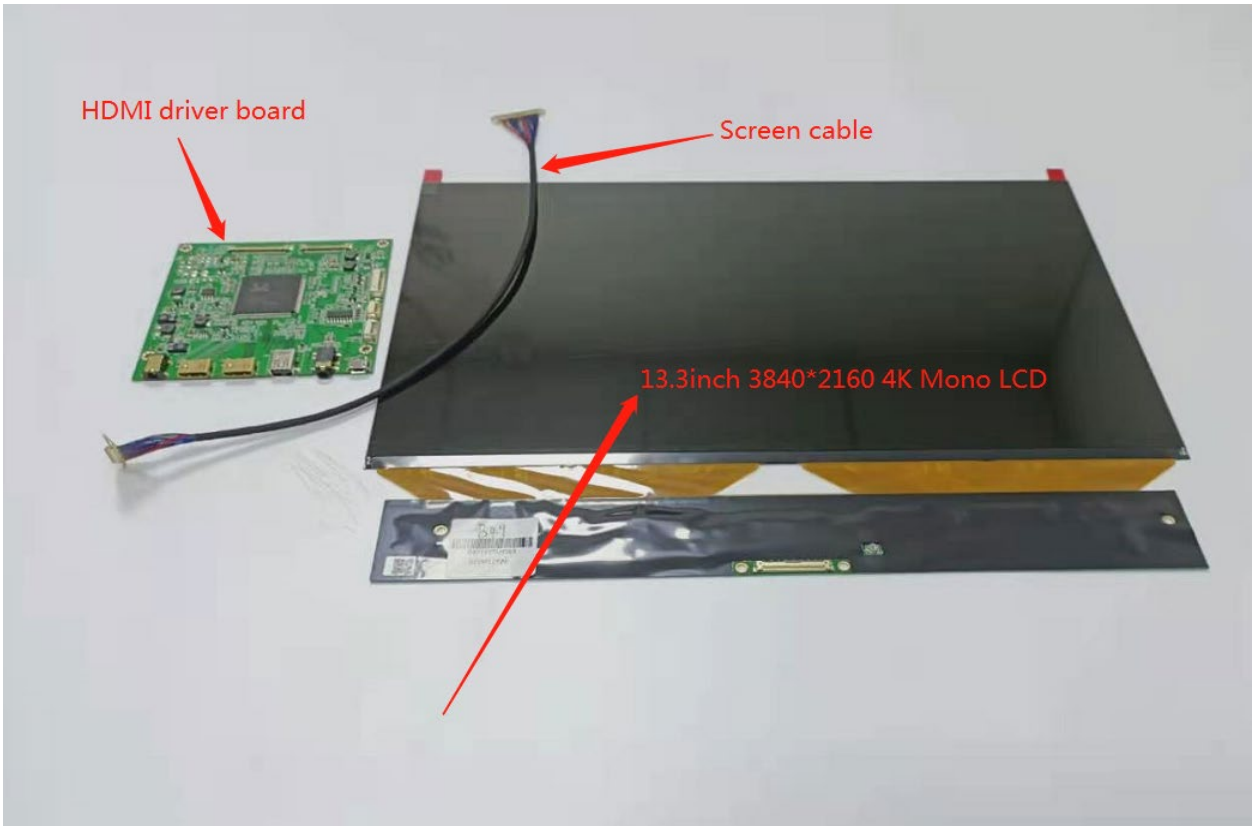



*Figure 15 DuoBond monchrome 4K 13.3" LCD, active area: 11.565 x 6.5"*

**Newport Model 845HP Digital Shutter System**
Important manual pages are:
v, 3, 4, 5, 6

**pg V**

## Specifications

Model 845HP Digital Shutter System:

| | |
|---|---|
| Operating Temperature | 0° to 70° Centigrade |
| Operating Relative Humidity | 10% to 90%, Noncondensing |
| Power Consumption | <14 Watts |
| Shipping Weight | 3.5 lbs. |

Controller: (Model 845HP)

| | |
|---|---|
| Exposure Duration | 10 msec - 990 sec |
| Timing Accuracy | 0.05% ± 10 microseconds |
| Max. Repetition Rate | 10 Hz Operating Modes: |

TIME: Timed shutter opening
MANUAL: Open and close shutter independent of time setting
START: Initiates timed or manual shutter operation
RESET: Closes shutter
DELAY: Optional 10 second delay before opening

| | |
|---|---|
| Pushbutton Cable Length | 96 in. (2.44 m) |
| Power Requirements | 115 VAC @ 0.1 A, or 220 VAC @ 0.05 A, 50/60 Hz |
| Controller Dimensions | 3.25 x 6.0 x 6.25 in. (8.25 x 15.25 x 15.9 cm) |

Shutter: (Model 846HP)

| | |
|---|---|
| Aperture | 5.6 mm |
| Max. Incident Power | 5 Watts (846HP) (spread over total aperture) |
| Response Time with | < 3 msec Model 845HP controller |
| Electrical Input | Positive (open) or negative (close) pulse, 5-30 V amplitude |
| Coil Impedance | 13 Ohms |
| Coil Inductance | 6.2 mH |
| Max. Coil Dissipation | 3 Watts |
| Shutter Cable Length | Integral 96 in. w/ 4 pin DIN connector (2.44 m) |
| Head Dimensions | 2.25 x 1.35 x 1.14 in. (57.2 x 34.3 x 29 mm) |

## Section 2 Principles of Operation

The Newport Model 845HP Shutter Controller is a self-contained control unit. It uses discrete CMOS IC's to develop the necessary logic for control of the Model 846HP Shutter for a variety of

applications. Figure 2-1 illustrates the layout of the controller. Reference drawing #1 (Section 6) contains the actual schematic layout of the controller.

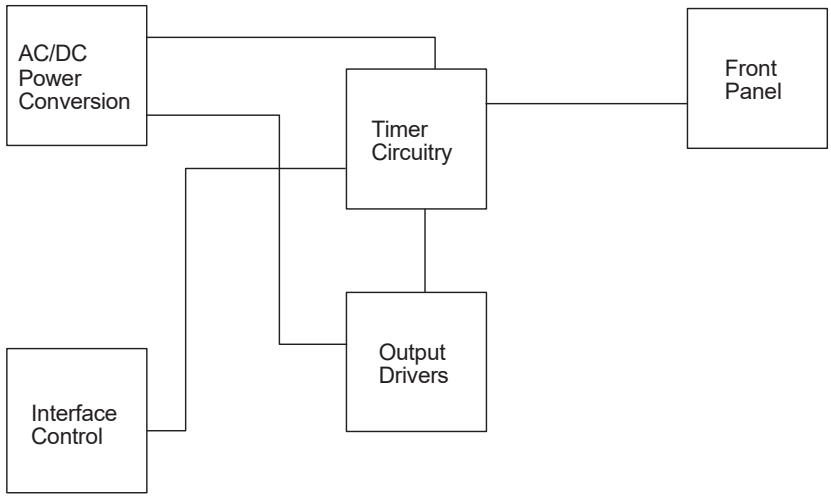



Figure 2-1 Model 845HP Controller Block Diagram

### 2.1.1 AC/DC Power Conversion

AC voltage from the plug is transformed into DC power for the driver circuitry and regulated down to +5VDC for the logic circuitry. The layout provides for selection of 110VAC or 220VAC operation by changing jumpers on the board.

### 2.1.2 Front Panel

Switches on the front panel of the 845HP Controller permit the user to turn the unit on and off, set the mode of operation, and, where allowed, program the time delay before operation. The length of programmed delay is manually set by using the digital rotary switches provided.

### 2.1.3 Timer Circuitry

The output of a precision 100KHz oscillator is divided down using the settings of the front panel digital rotary switches to provide a pulse of a programmed length to the output drivers. This pulse is accurate to 0.05% ± 10 microseconds.

### 2.1.1 Output Drivers

The high power output transistors are driven by the output logic circuitry in such a way that a positive power pulse is sent to the shutter in one of two directions, thereby controlling the opening and closing of the shutter. To open the shutter, the output control logic drives pin 1 of J2 (black) positive with respect to pin 4 of J2 (red). To close the shutter, the circuitry effectively reverses the polarity of these outputs, making pin 4 of J2 positive with respect to pin 1 of J2. J2 is a 4-pin "DIN" style connector located on the back panel with a pin-out defined as follows:

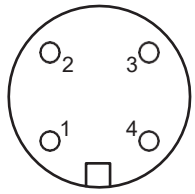
| J2 Pin # | Function |
|---|---|
| 1 | Positive pulse with respect to pin 4 to open |
| 2 | No connection |

| | |
|---|---|
| 3 | No connection |
| 4 | Positive pulse with respect to pin 1 to close |

The DIN plug output follows the standard DIN pin definition convention as in Figure 2.

Connector J2

| PIN | Wire Color |
|---|---|
| 1 | Black |
| 2 | N/C |
| 3 | N/C |
| 4 | Red |
| Tab | Gray (case ground) |




TAB

Figure 2-2. 4-PIN Standard "DIN" Connector viewed from back panel. This connector is the Shutter-to-Controller Interface

### **2.1.4** Interface Control

The Model 845HP Controller provides a capability for remote manual or computer operation through a 5-pin "DIN" style connector J1 on the back panel. Although initial set-up must be accomplished using the front panel to pre-program delay times, start, stop, and reset commands may be issued to the 845HP Controller through the interface. The inputs and outputs are "active high" and are protected at 5.1V maximum with zener diodes. +5VDC and ground pins are also provided on J1. The Pins are defined as follows:

| J1 Pin # | Function |
|---|---|
| 1 | Signal Ground |
| 2 | Start (input) — opens shutter or begins automatic timer sequence |
| 3 | Reset (input) — closes shutter, resets timer |
| 4 | +5VDC (output) — for manual switch |

| | |
|---|---|
| | or relay operation of inputs |
| 5 | Busy (output) — controller is busy and unavailable for command inputs |

The DIN plug output follows the standard DIN pin definition convention as in Figure 3.

Connector J1

| PIN | Wire Color |
|---|---|
| 1 | Black |
| 2 | Blue |
| 3 | Green |
| 4 | Red |
| 5 | Yellow |
| Tab | Gray (case ground) |

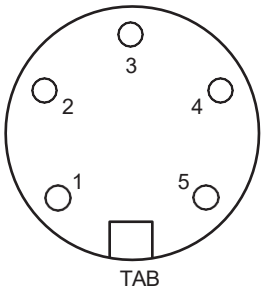



Figure 2-3. 5-PIN Standard "DIN" Connector viewed from the back panel. This connector is the Remote Conntrol Assy/Controller Interface as well as the Computer Interface.

## Model 846HP Shutter

The Model 846HP Shutter is a simple but highly reliable design that contains only one moving part — the shutter blade. Tests of this design have shown a service life in excess of one million operations.

The shutter blade in this new design has only two positions — open and closed. Once moved into either the open or closed position, the blade will remain in that position without further application of power. The holding force in either of the two stable positions is such that only a high lateral acceleration will toggle the shutter in the absence of physical contact with the shutter blade.

In normal operation (such as with the Model 845HP Controller), +5VDC is applied to the actuator coil of the shutter as follows:

| | |
|---|---|
| To open the shutter: | apply +5VDC on connector pin 1 with respect to pin 4. |
| To close the shutter: | apply +5VDC to connector pin 4 with respect to pin 1. |

The shutter coil may be operated continuously at +5VDC without damage. At this voltage level, the shutter will open and close in approximately 10 millisec- onds. For faster operation, it may be pulsed at higher voltages (up to 30VDC), but the 3 Watt maximum power dissipation limit must be observed.

Using the Model 845HP Controller, the shutter will open and close in <3 msec.

## CAUTION

**Exceeding the 3 Watt power dissipation limit of the coil may result in shutter failure.**

here are the variables that can be adjusted (from the SLM+ tab) in real-time (after 'run sequence' has been pressed), or after hitting pause, and stop of course.

Initial settling time
Number of sequences to run
Sequence number
Move and settling time

Sliders
---
x stage
y stage
rotation
shutter
opph