**User’s Manual**

**V1.0**

**SAIM Scanner V3**

*by Marshall J. Colville*

Paszek Research Group

# Table of Contents

[1 Table of Contents 2](#_Toc820862)

[2 General Information 3](#_Toc820863)

[2.1 System Overview 3](#_Toc820864)

[2.2 Organization 4](#_Toc820865)

[2.3 System requirements 4](#_Toc820866)

[3 Hardware (SSv3 Controller) 5](#_Toc820867)

[3.1 Device layout 6](#_Toc820868)

[3.2 Connect accessories 7](#_Toc820869)

[4 Software (SSv3 Control Panel) 7](#_Toc820870)

[4.1 Install 8](#_Toc820871)

[4.1.1 Download 8](#_Toc820872)

[4.1.2 Pt grey (option) 8](#_Toc820873)

[4.1.3 VC runtimes 8](#_Toc820874)

[4.2 Controller 8](#_Toc820875)

[4.2.1 Overview 8](#_Toc820876)

[4.2.2 Menu 9](#_Toc820877)

[4.2.2.1 Settings 9](#_Toc820878)

[4.2.2.2 Logging 10](#_Toc820879)

[4.2.2.3 Demo Mode / About Device 11](#_Toc820880)

[4.2.2.4 About SSV3 device / SSv3 Control Panel 11](#_Toc820881)

[4.2.3 Controller Communications 12](#_Toc820882)

[4.2.3.1 Connecting 13](#_Toc820883)

[4.2.3.2 HID (USB human interface device) 13](#_Toc820884)

[4.2.3.3 Reset 14](#_Toc820885)

[4.2.4 Scanning Controls 15](#_Toc820886)

[4.2.4.1 Overview 16](#_Toc820887)

[4.2.4.2 Scanning beam Controls 16](#_Toc820888)

[4.2.4.3 Control Menu 16](#_Toc820889)

[4.2.4.4 Advanced Mode 16](#_Toc820890)

[4.2.4.4.1 Advanced settings 17](#_Toc820891)

[4.2.4.4.2 Calibration 17](#_Toc820892)

[4.2.5 Laser Controls 19](#_Toc820893)

[4.2.5.1 Overview 19](#_Toc820894)

[4.2.5.2 Laser Intensity 19](#_Toc820895)

[4.2.5.3 Shutter Control 19](#_Toc820896)

[4.2.5.4 SW Trigger 19](#_Toc820897)

[4.2.6 Laser Profiles 20](#_Toc820898)

[4.2.6.1 Overview 20](#_Toc820899)

[4.2.6.2 Laser Profiles Menu 20](#_Toc820900)

[4.2.7 Scan Angle Sequences 22](#_Toc820901)

[4.2.7.1 Overview 22](#_Toc820902)

[4.2.7.2 Sequence Menu 22](#_Toc820903)

[4.2.8 Experiment Design 24](#_Toc820904)

[4.2.8.1 Overview 24](#_Toc820905)

[4.2.8.2 Experiment Menu 24](#_Toc820906)

[4.3 Trouble shooting 26](#_Toc820907)

[5 Human Interface Device (HID) 26](#_Toc820908)

# General Information

## System Overview

Scanning Angle Interference Microscopy Scanner V3 (SAIM Scanner V3, SSv3) is a device, which allows controlling a variety of peripheral devices. This device consists of two parts: **SAIM Scanner V3 Controller** and **SAIM Scanner V3 Control Panel.**

*About SAIM Scanner V3 Controller*

SSv3 controller is an embedded hardware synchronization platform for prototype super resolution optical microscopy. Currently, it is targeted for Scanning Angle Interference Microscopy (SAIM) using azimuthal beam scanning. The hardware has a wide array of capabilities and was developed with flexibility and expandability as a major project goal.

*About SAIM Scanner V3 Control Panel*

SSv3 control panel is designed to be an intuitive UI for operating the SSv3 controller. Provides flexible SAIM experiment design as well as real0time control for other imaging modalities.

## Organization

This user’s manual consists of two sections: Hardware and Software.

Hardware section provides a detailed description of Hardware components of this device and its accessories. This section includes 3 sub-sections: Device, Connect accessories and Adapter.

Software section explains how to install the program and use it with a detailed description of system functions. This section includes 8 sub-sections: Overview, Menu, Controller Communications, Scanning Controls, Laser Controls, Laser profiles, Scan Angle Sequences and Experiment Design.

## System requirements

Please check that your computer condition meets or exceeds the following system requirement before installing SAIM Scanner V3 Control Panel.

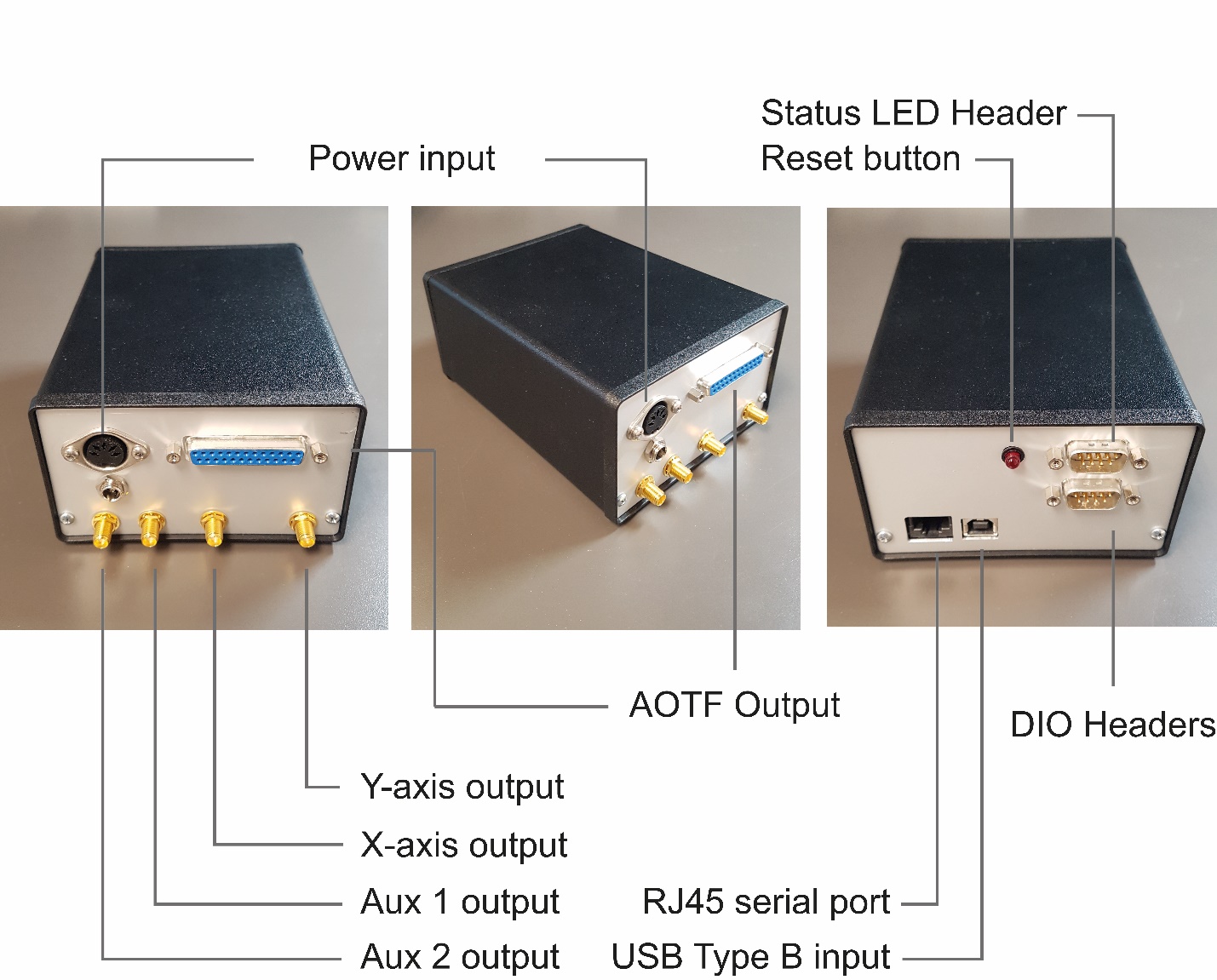
|  |  |
| --- | --- |
| **Operating System** | **Windows 10, 8.1, 8, 7** |
| **CPU** |  |
| **RAM** | **256 MB? (2GB Recommended)** |
| **Available disk space** | **200MB?** |

# Hardware (SSv3 Controller)

SSv3 controller is an embedded hardware synchronization platform for prototype super resolution optical microscopy. Currently, it is targeted for Scanning Angle Interference Microscopy (SAIM) using azimuthal beam scanning. The hardware has a wide array of capabilities and was developed with flexibility and expandability as a major project goal.

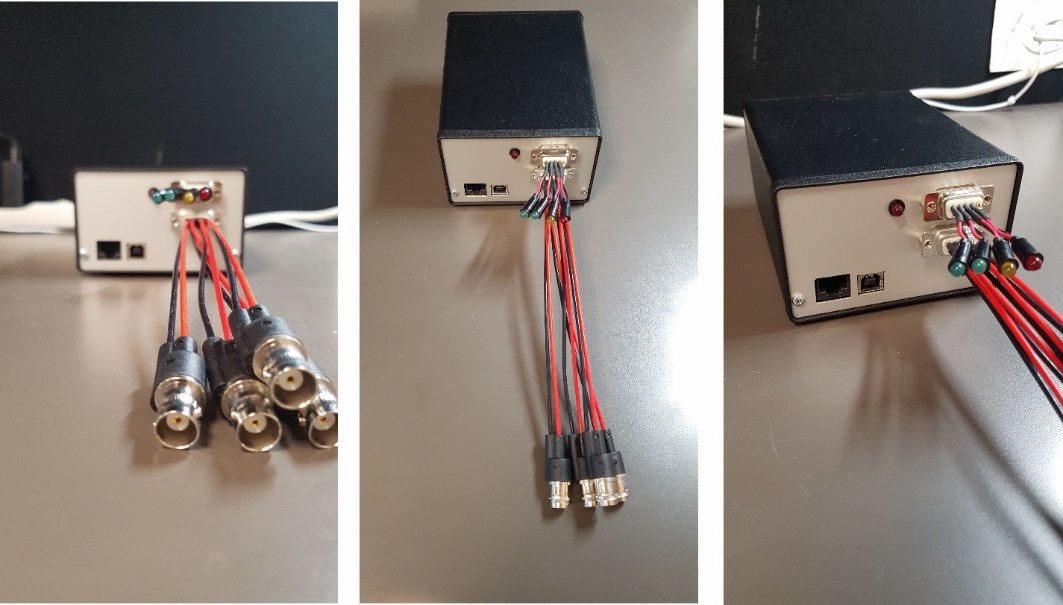
Hardware section provides a detailed description of Hardware components of this device and its accessories.

## Device layout



|  |  |
| --- | --- |
| **Name** | **Description** |
| Power input | Power input (-12Vdc, 5Vdc, +12Vdc) |
| Aux 1 & 2 Output | Dual 10 bit high-speed bipolar analog outputs with 0-10 V adjustable references. |
| X & Y-axis output | Dual waveform outputs with high-speed independent per-axis amplitude and DC bias control |
| USB Type B input | USB HID interface for broad compatibility |
| RJ45 serial port | Reconfigurable serial communications port (UART, SPI) |
| AOTF Output | 8-channel 10 bit 0-10V analog outputs. |
| Status LED Header | 10V digital global blank |
| DIO Headers | 4 reconfigurable DIO pins. 3 interruptible inputs for hardware synchronization. |

## Connect accessories



Two accessories are available. Status LED Header and DIO Headers

# Software (SSv3 Control Panel)

SSv3 control panel is designed to be an intuitive UI for operating the SSv3 controller. Provides flexible SAIM experiment design as well as real0time control for other imaging modalities.

Software section explains how to install the program and use it with a detailed description of system functions

## Install

Install section explains how to install the program: Download, Unzip, save path, setting for pt grey and VC runtimes.

### Download

SSv3 Control Panel is available from https://github.com/mjc449/SAIMscannerV3

1. Direct download: Click ‘Download ZIP’

2. Git Bash: Clone with HTTPS: https://github.com/mjc449/SAIMscannerV3.git

### Pt grey (option)

Flycapture sdk version

### VC runtimes

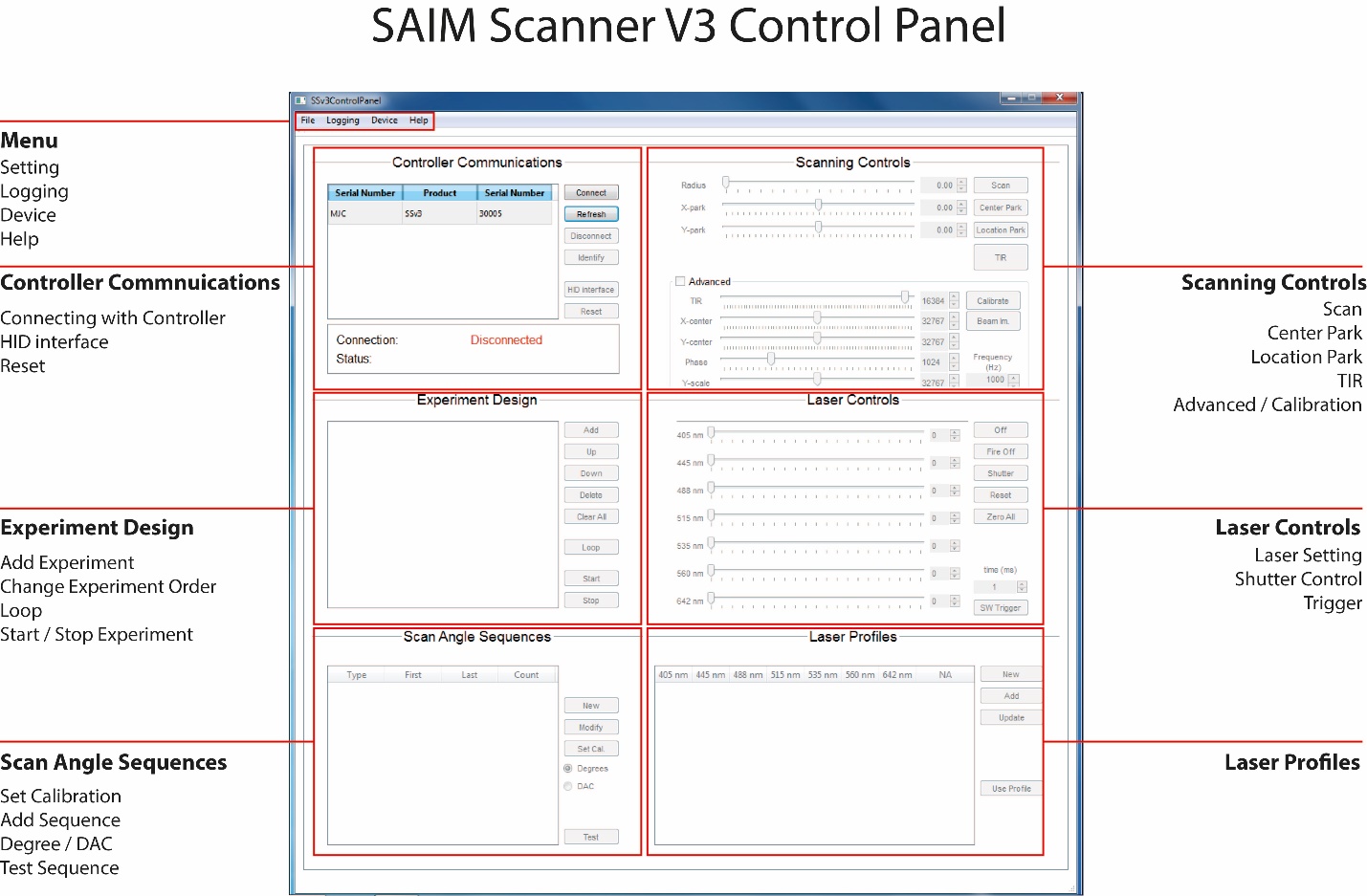
Download the latest version Microsoft website.

## Controller

Controller section provides how to use the SAIM Scanner V3 Control Panel. This section includes a detailed description for Overview, Menu, Controller Communications, Scanning Controls, Laser Controls, Laser Profiles, Scan Angle Sequences, and Experiment Design.

### Overview

SAIM Scanner V3 Control Panel is a Graphic User Interface software, which consists of 7 sub-sections. Menu section can save/load the settings of Control Panel and run the experiment logger. Controller Communications section can connect/disconnect with a SAIM Scanner V3 and check the connection status of the product. Other 6 sections can control laser profile, scanning setting, scan angle setting, and experiment design.



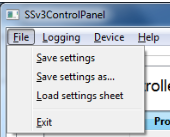
### Menu

Menu section provides information about software settings, experiment logger. This section consists of Settings, Logging, Demo Mode, and About SSV3 device / SSv3 Control Panel.

#### Settings

Settings saves SAIM Scanner V3 control panel configuration. The following values are saved.

- Calibration constant, X and Y Center, TIR radius, Phase, Frequency, Y Scale



To save settings,

1. Click ‘File’ and ‘Save settings’

2. Set the directory and save the ‘settings.cfg’

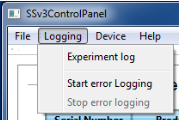
To load settings,

1. Click ‘File’ and ‘Load settings sheet’

2. Select the ‘setting.cfg’ file what you want to load.

(can be used to restore to reset) -> reset funtion

#### Logging

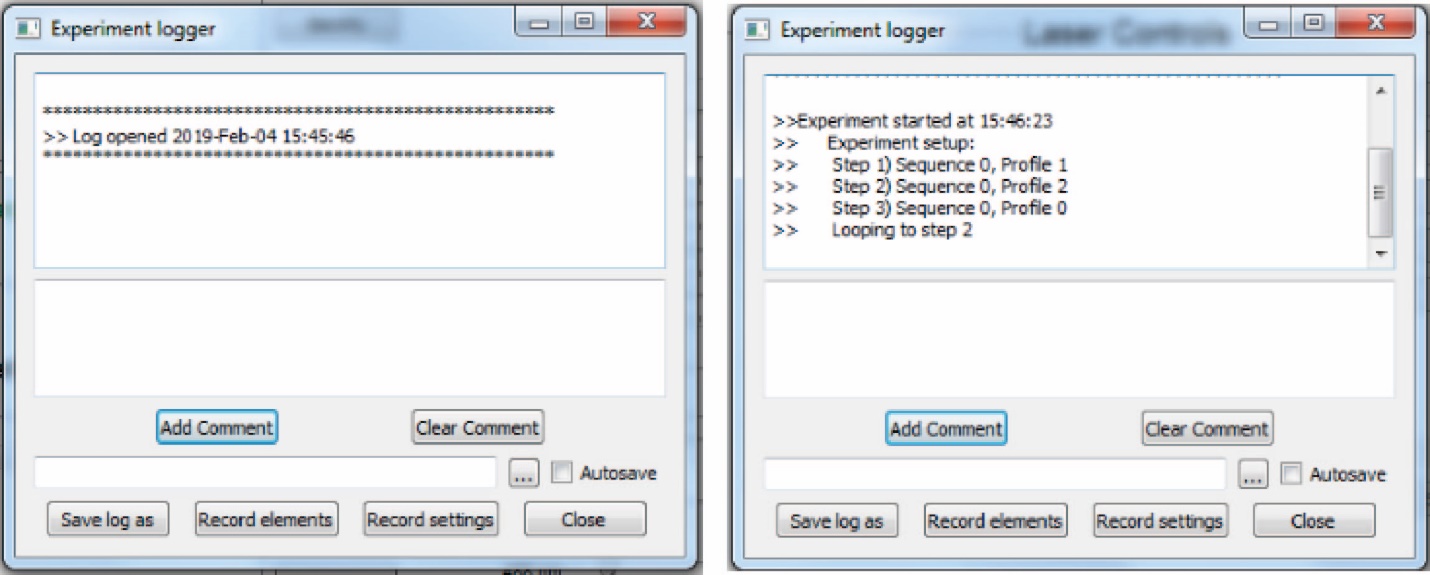


To Identify any errors that occur during the experiment or Identify any experimental records, **recommend using Experiment Logger**

To start logger,

1. Click ‘Logging’ and ‘Experiment log’

2. Click ‘Start/Stop error Logging’ to start/stop logger.



- ‘Add / Clear Comment’: Add/Clear any comments on the experiment.

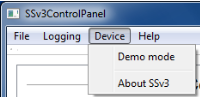
- ‘Save log as’: Save log file as.

- ‘Autosave’: Click the check-box and select the directory to save log file.

- ‘Record elements’: Save elements log.

- ‘Record settings’: Save settings log.

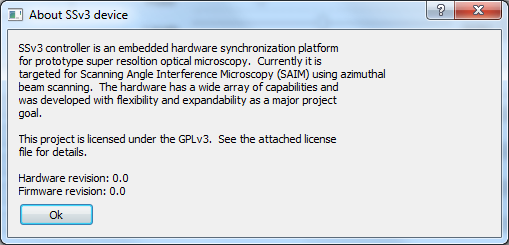
#### Demo Mode / About Device

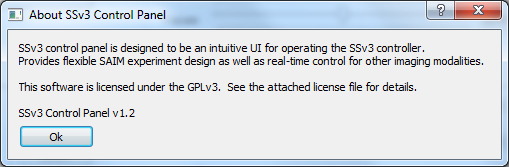


1. Click ‘Device’ and ‘Demo mode’ to access Demo mode.

2. Demo mode can control SSv3 Control Panel without connection to SAIM Scanner V3.

#### About SSV3 device / SSv3 Control Panel



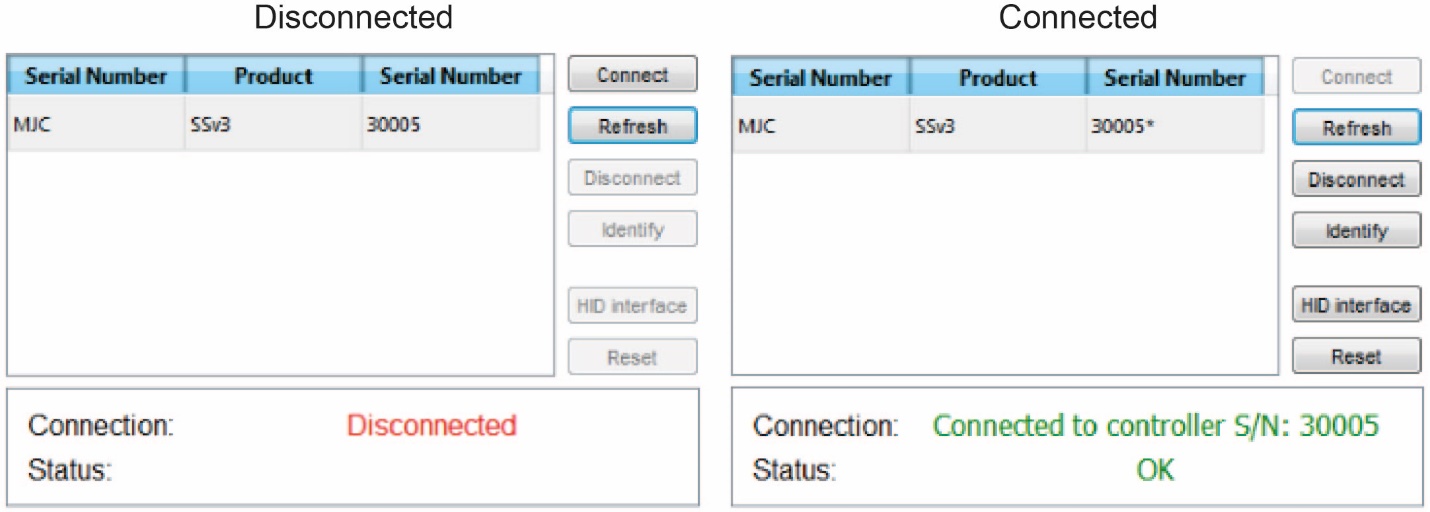


### Controller Communications

Controller Communications section explains how to connect/disconnect to a product

#### Connecting

When SAIM Scanner product is connected to your computer, display panel shows product information: Serial Number, Product, Serial Number.



To connect to SAIM Scanner product, follow these steps:

1. Click the product what you want to connect to. (If your product is not on the list, please check connection between your computer and the product and click ‘Refresh’)

2. Click ‘Connect’. If the status shows ‘OK’, your computer and the product are well connected.

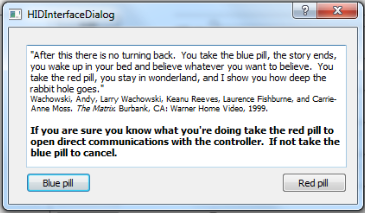
(If it shows ‘Error’, please check the connection between computer and product.)

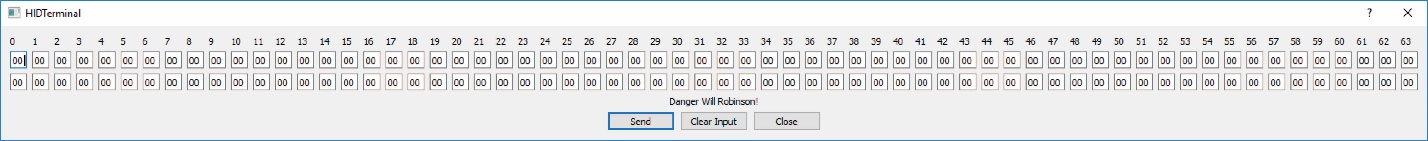
3. Click “Disconnect’ when your experiment is done.

#### HID (USB human interface device)

1. Click ‘HID’ to access USB human interface device.

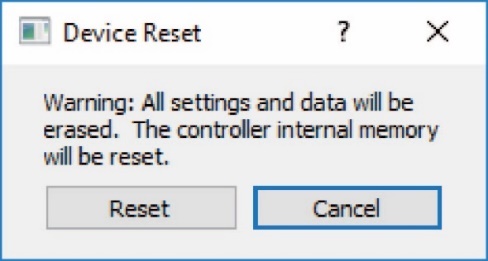
2. Click ‘Red pill’ to open direct communications with the controller.





To control the controller with HID, please go to S**ection 5. HID**

#### Reset

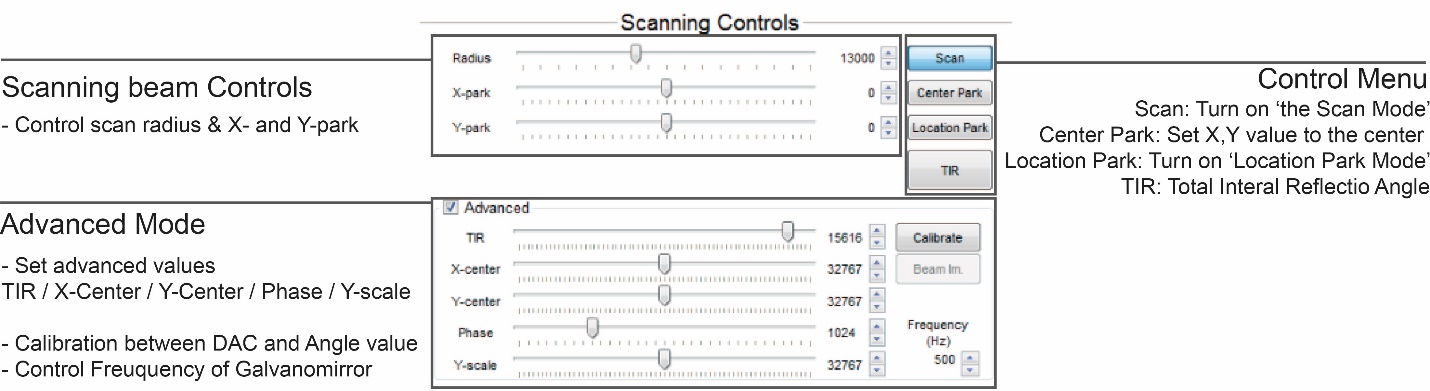


Click ‘Reset’ to reset the device. The stored data will be erased, and the device is restored to the default setting.

### Scanning Controls

Scanning Controls section explains how to control scanning beam. This section consists of Scanning beam controls, Control menu, Advanced mode, and Calibration.

#### Overview



#### Scanning beam Controls

Control scan radius and X- & Y-park with DAC or angle value. These values are be input via mouse or keyboard.

#### Control Menu

In this menu, 4 control buttons can be used to control scanning beam.

**Scan**: Turn on/off ‘the Scan Mode’.

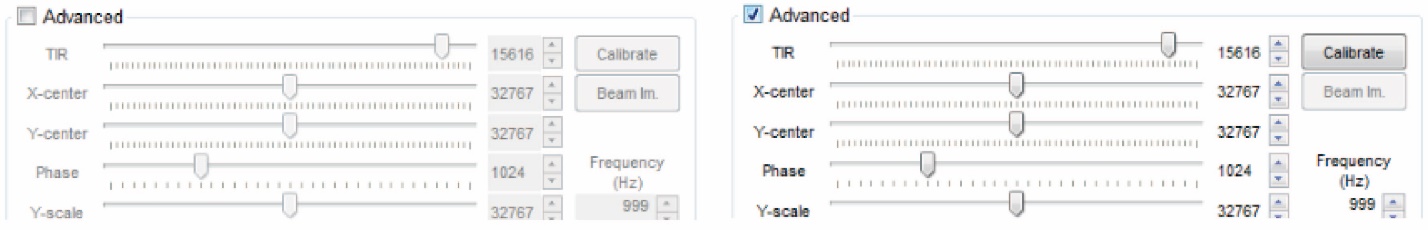
**Center Park**: Set X,Y value to the center.

**Location Park**: Turn on/off ‘Location Park Mode’

**TIR**: Total Internal Reflection Angle

#### Advanced Mode

Click ‘Advanced’ button, Advanced mode is activated.



##### Advanced settings

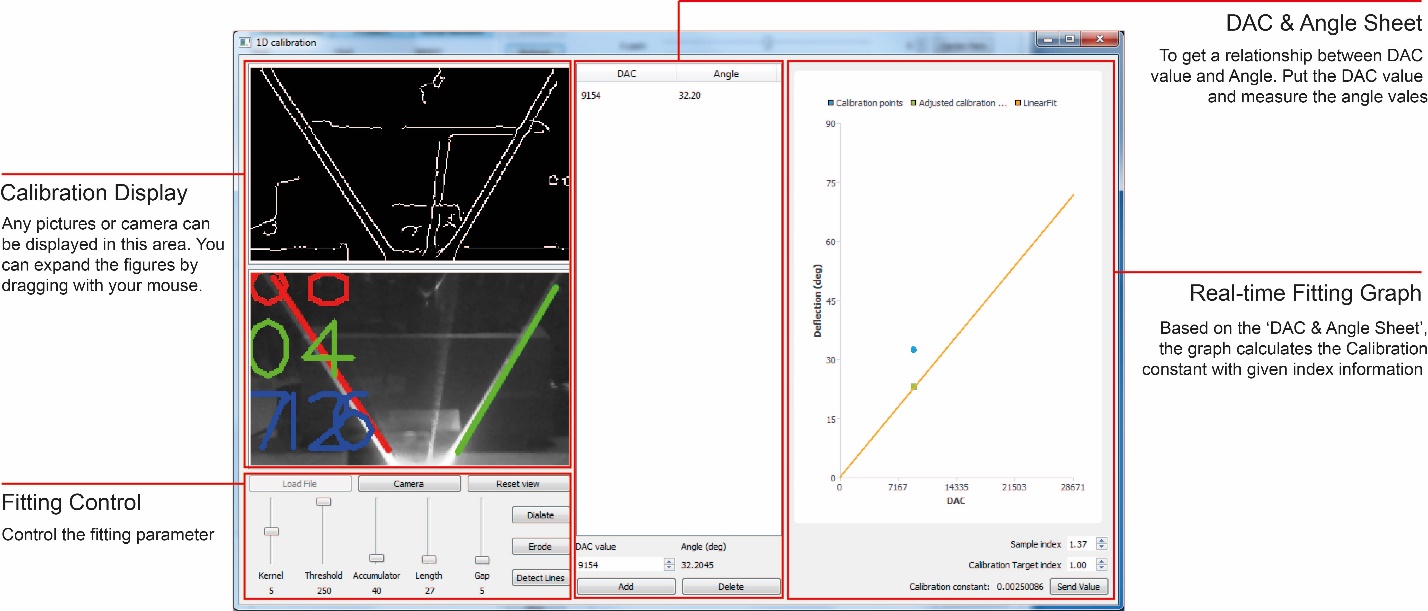
1. Set TIR radius / X,Y Center / Phase / Y-scale values.

2. Change the Frequency of Galvano mirror.

##### Calibration

Scanning Angle Interference Microscopy, a fluorescence-based nanoscale interferometric approach, is very sensitive to alignment. **Calibration should be done for every experiment to obtain precise values.**

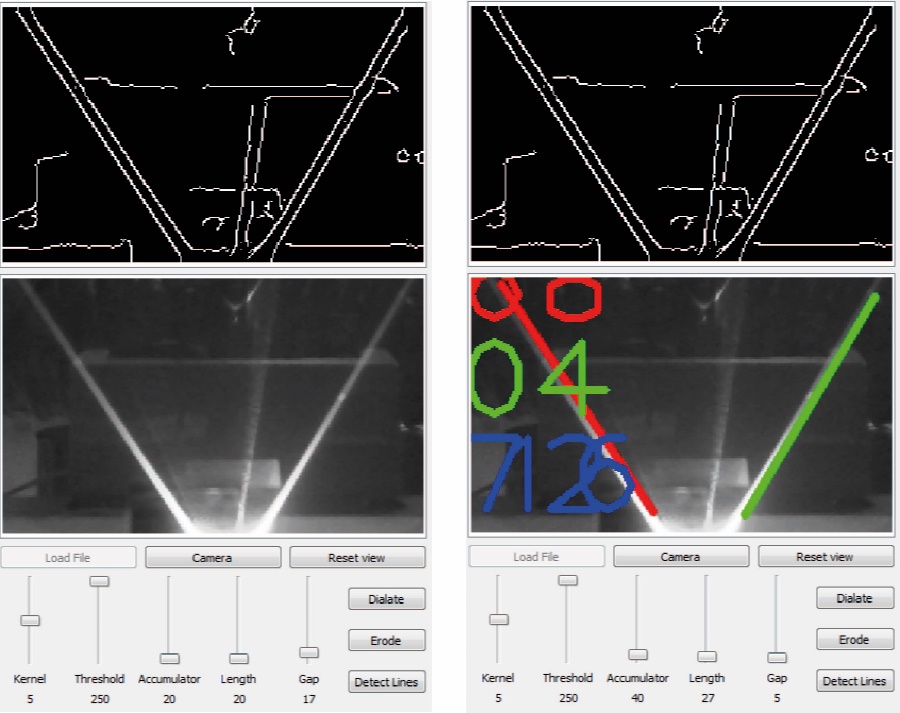
- Click ‘Calibration’ button, 1D calibration window will be opened.

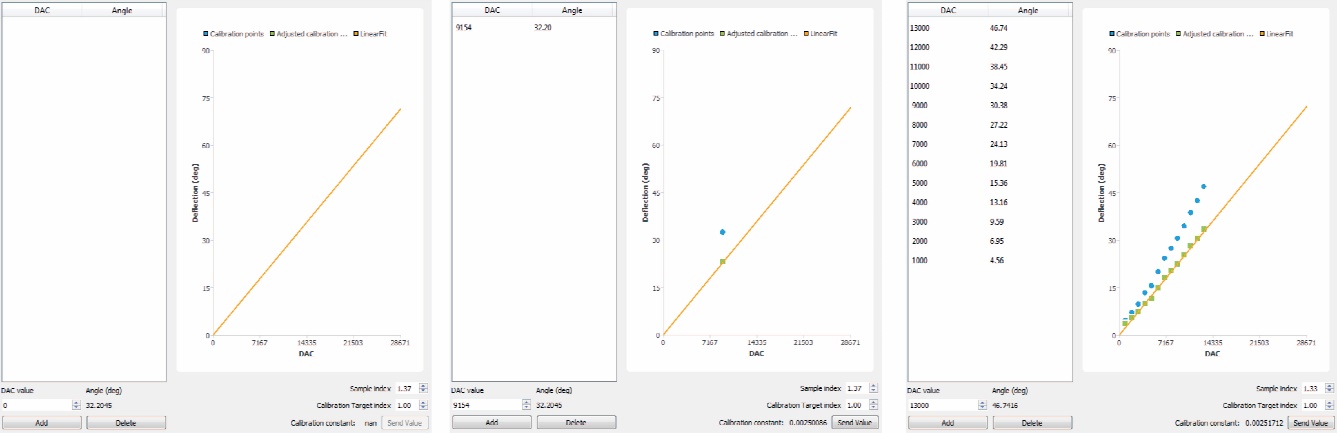


- Calibration window consists of

1. Calibration Display: Any pictures or camera can be displayed in this area. All images can be expanded by mouse-dragging

2. Fitting Control: To fit well, you can adjust all parameters: Kernel, Threshold, Accumulator, Length, Gap, Dilate, and Erode. Click ‘Detect Line’ to fit the lines as shown below. The angle between two straight lines is automatically shown in DAC & Angle Sheet.





Tips for fitting

- Adjust Kernel & Threshold values so that the two straight lines are visible well.

- Magnify the image by mouse-dragging.

- Adjust Accumulator, Length, Gap values until the two straight lines fit well.

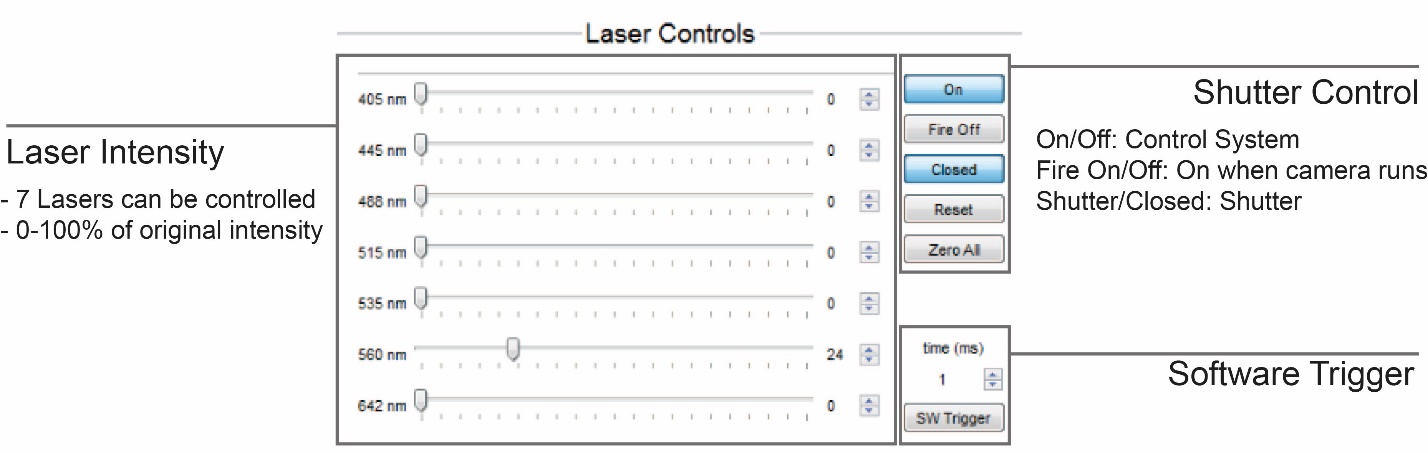
- If fitting does not work, please use the ‘Dilate’ and ‘Erode’.

- Recommended to measure angle value with the DAC from 1000 to 13000.

### Laser Controls

Laser Controls section explains how to control laser intensity and shutter. This section consists of Laser Intensity, Shutter Control, and Software Trigger

#### Overview



#### Laser Intensity

7 lasers (405 nm, 445 nm, 488 nm, 515 nm, 535 nm, 560 nm, and 642 nm.) can be controlled. This intensity value is not the absolute value but a relative intensity value. For example, ’50’ means 50% of original laser intensity.

#### Shutter Control

1. On/Off: Control System On/Off.

2. Fire On/Off: The shutter opens only when the CCD or camera is operating.

3. Open/Closed: Shutter opens/closed when this button is ‘Open’/’Closed’ .

4. Reset:

5. Zero All: Set all laser intensity to 0 value.

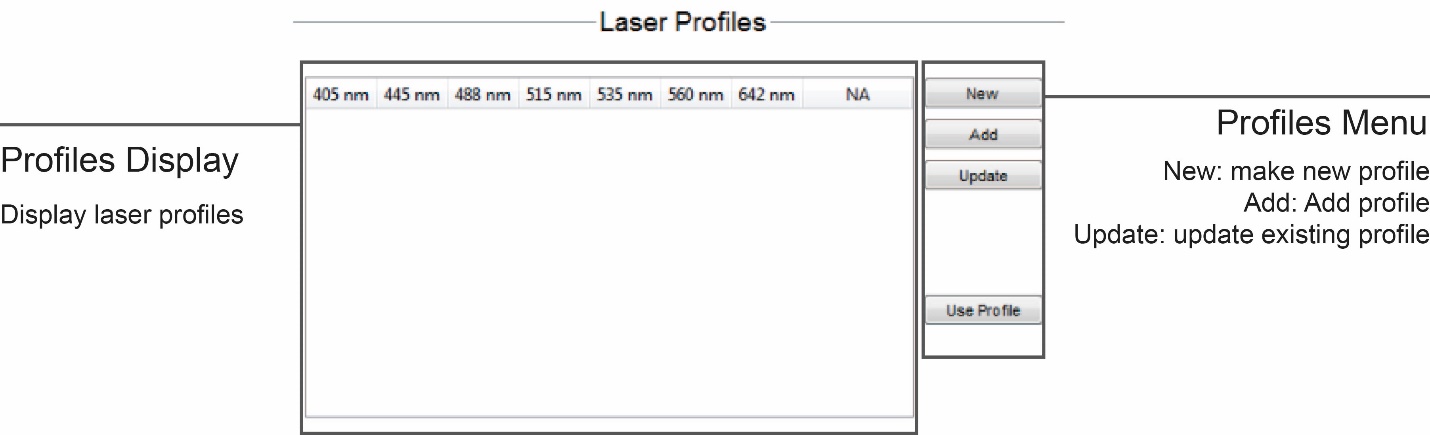
#### SW Trigger

Click ‘SW Trigger” after entering the trigger time.

### Laser Profiles

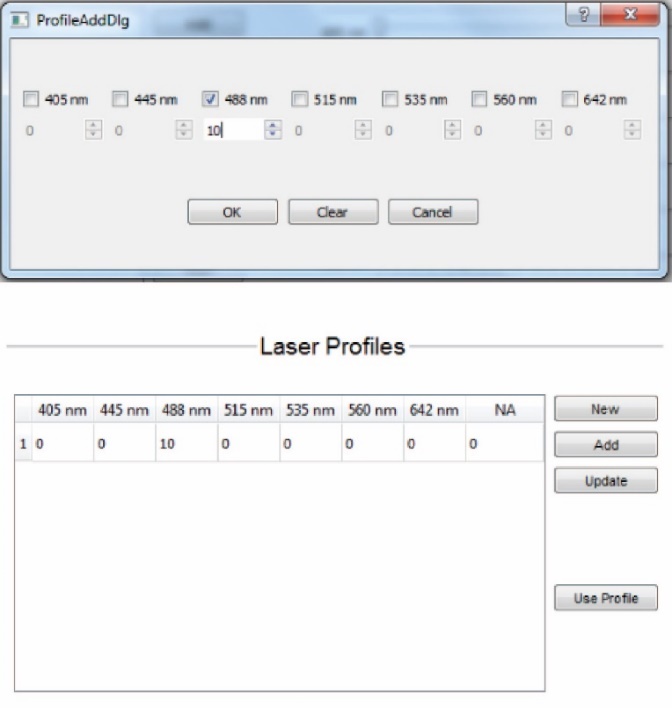
Laser Profiles section provides how to set profiles for lasers. This section consists of Profiles Display, and Profiles Menu.

#### Overview



#### Laser Profiles Menu

1. Click ‘New’ to make new laser profile.



2. Select the laser wavelength and intensity.

3. Click ‘OK’ (Click ‘Clear’ if you want to clear the profiles)

4. The laser profile you chose is shown in the Profile Display below.

Or, you can make new laser profile through Laser Control.

5. Select the laser type and intensity in the Laser Control.

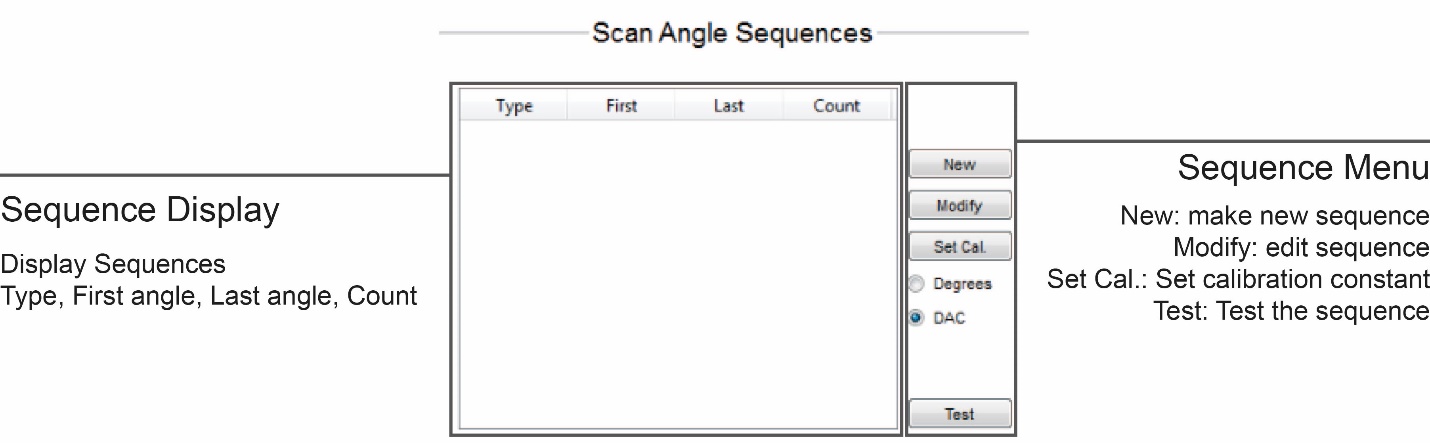
6. Click ‘Add’ and the laser profile you chose is shown in the Profile Display.

7. Click ‘Update’ when you want to change the laser profile.

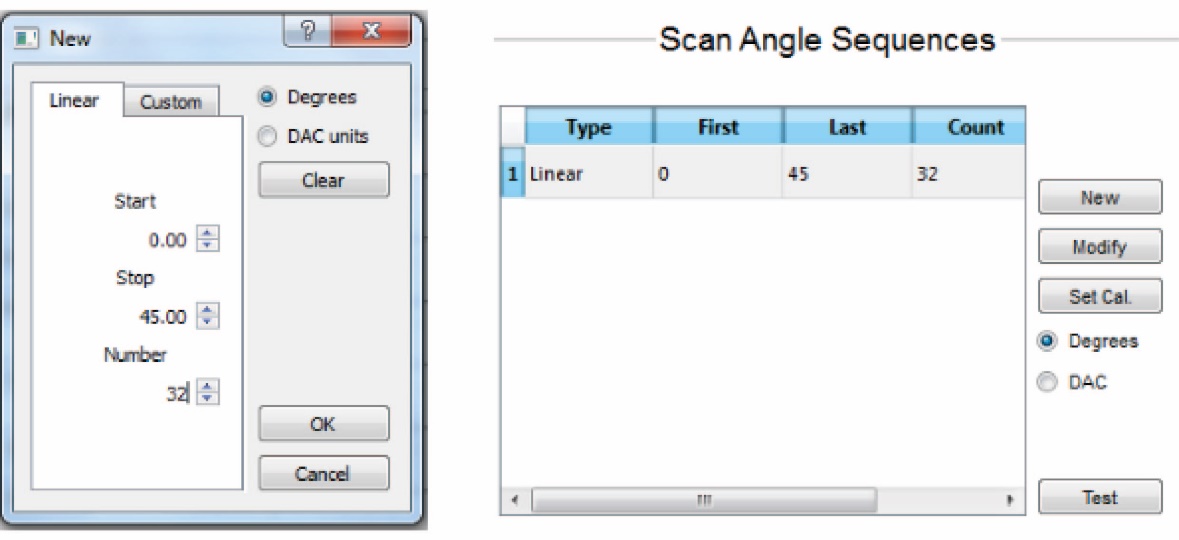
### Scan Angle Sequences

Scan Angle Sequences section provides how to set scan angle sequences. This section consists of Sequence Display, and Sequence Menu.

#### Overview



#### Sequence Menu



1. Click ‘New’ to add new scan angle sequence.

2. When a new window opens, choose unit (Degree or DAC) on the right.

3. Input start angle, stop angle and number.

- Start angle: Laser angle at the beginning.

- Stop angle: Laser angle at the end.

- Number: The step number between start angle and stop angle.

4. The scan angle sequence (sequence #, type, first angle, last angle, and step count) is shown in the Sequence Display

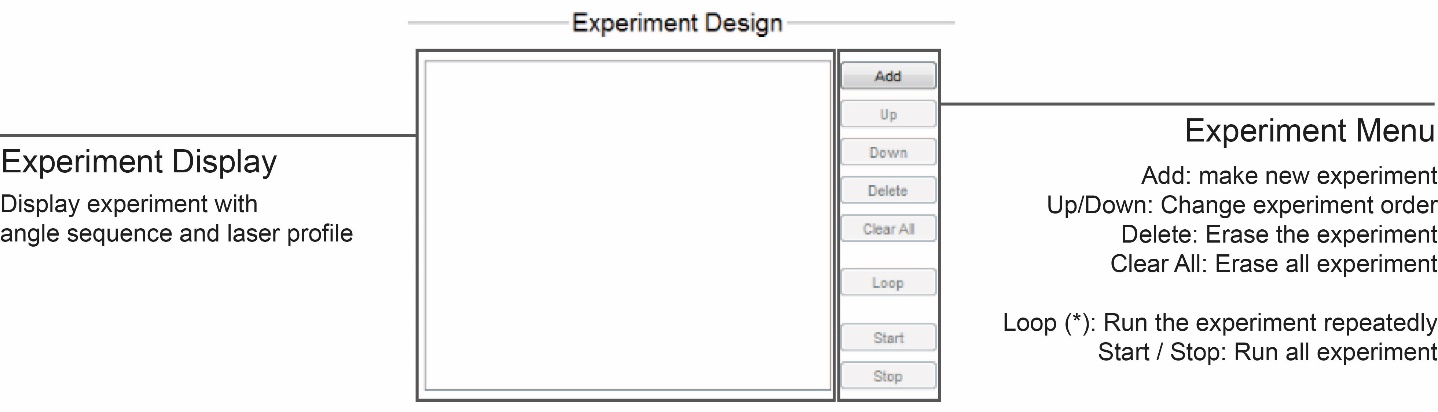
5. Click ‘Modify’ when you want to change the sequence.

6. Use ‘Custom’ when you want to use custom sequence not linear scan angle sequences.

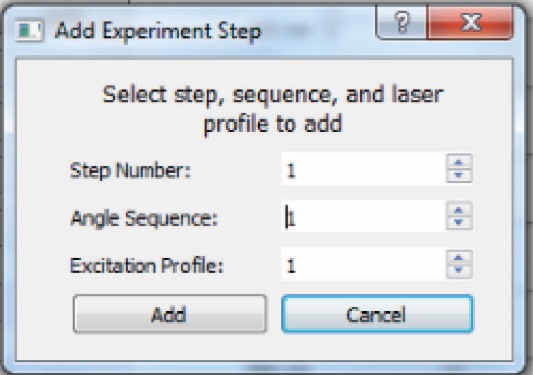
### Experiment Design

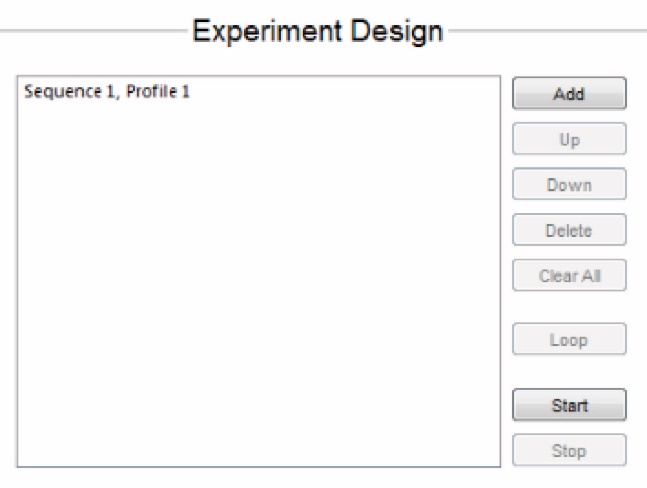
Experiment Design section explains how to design the experiment with Laser Profiles and Scan Angle Sequence. This section consists of Experiment Display, and Experiment Menu.

#### Overview



#### Experiment Menu





1. Click ‘Add’ to add new experiment.

2. When a new window opens, select step number, angle sequence, and laser profile.

- Step Number: Experiment Number

- Angle Sequence: Scan Angle Sequence what you want to use

- Laser Profile: Laser Profile what you want to use

3. Click ‘Add’ once you have made your selection.

4. Your experiment (sequence #, Profile #) is shown in the Experiment Display.

5. Click ‘Start’ / ‘Stop’ to start/stop the all experiments. Experiment goes from top to bottom.

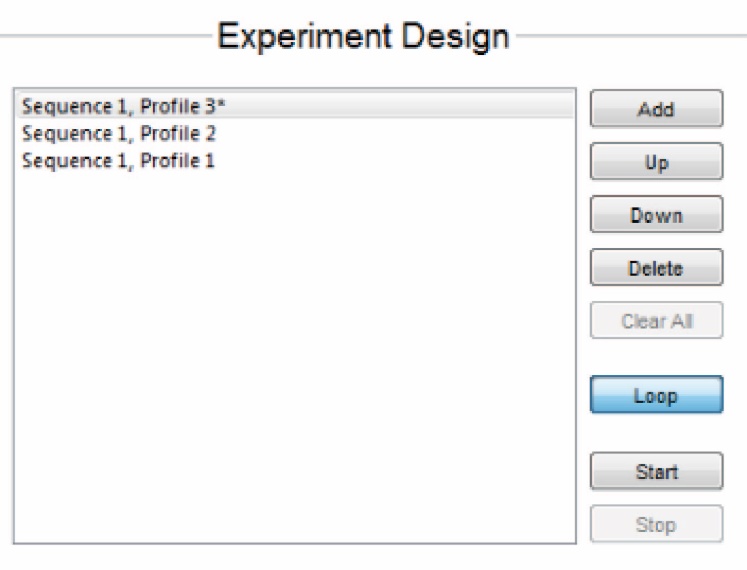
6. Modify your experiment (‘Up’ / ‘Down’ / ‘Delete’ / ‘Clear All’)

- ‘Up’ / ‘Down’: change the order of experiments.

- ‘Delete’: delete the experiment

- ‘Clear All’: delete all experiments.

7. Click ‘Loop’ to use one experiment repeatedly. Star (\*) is shown in the experiment.



## Trouble shooting

If the tips below do not solve your problem, please contact Paszek Research Group

(Marshall J. Coville)

# Human Interface Device (HID)

//Command ID defines

//0x0X are control commands

#define CMD\_BLINK\_PWR 0x00

#define CMD\_VISOR 0x01

#define CMD\_BLINK\_PWR\_VAR 0x02

//0x1X are scan commands

#define CMD\_SET\_RADIUS 0x10

#define CMD\_SET\_CTR 0x11

#define CMD\_SET\_TIRF 0x12

#define CMD\_CIRCLE\_SCAN 0x13

#define CMD\_TIRF\_SCAN 0x14

#define CMD\_LOC\_PARK 0x15

#define CMD\_DISC\_SCAN 0x16

#define CMD\_DISC\_SCAN\_OFF 0x1E

#define CMD\_CENTER\_PARK 0x1F

//0x2X are DDS commands

#define CMD\_SET\_FREQ 0x20

#define CMD\_DEFAULT\_FREQ 0x21

#define CMD\_SET\_PHASE 0x22

#define CMD\_DEFAULT\_PHASE 0x23

#define CMD\_MCLK\_TOGGLE 0x24

#define CMD\_WAVE\_RS 0x25

#define CMD\_WAVE\_CLR\_RS 0x26

//0x3X are AUX\_DAC commands

#define CMD\_CONST\_AUX 0x30

#define CMD\_MID\_AUX 0x31

#define CMD\_ZERO\_AUX 0x32

//0x4X are AOTF commands

#define CMD\_GLOBAL\_HIGH 0x40

#define CMD\_GLOBAL\_LOW 0x41

#define CMD\_CHANGE\_CH 0x42

#define CMD\_LOAD\_PROFILE 0x43

#define CMD\_OPEN\_SHUTTER 0x44

#define CMD\_CLOSE\_SHUTTER 0x45

#define CMD\_TOGGLE\_OPEN 0x46

#define CMD\_ADD\_PROFILE 0x4C

#define CMD\_DELETE\_PROFILE 0x4D

#define CMD\_DEL\_ALL\_AOTF 0x4E

#define CMD\_AOTF\_RESET 0x4F

//0x5X are interrupt commands

#define CMD\_FIRE\_ON 0x50

#define CMD\_FIRE\_OFF 0x51

//0x6X are triggering commands

//0x7X are SC <-> SC communications

//0x8X are experiment commands

#define CMD\_GET\_SEQ\_USB 0x80

#define CMD\_DEL\_SEQ 0x81

#define CMD\_ADD\_SEQ\_LIN 0x82

#define CMD\_ADD\_EXP 0x83

#define CMD\_ADD\_NODE\_START 0x84

#define CMD\_ADD\_NODE\_END 0x85

#define CMD\_ADD\_LOOP 0x86

#define CMD\_START\_EXP 0x87

#define CMD\_PAUSE\_EXP 0x88

#define CMD\_RESUME\_EXP 0x89

#define CMD\_RESTART\_EXP 0x8A

#define CMD\_DEL\_EXP 0x8B

#define CMD\_DEL\_NODE\_START 0x8C

#define CMD\_DEL\_NODE\_END 0x8D

#define CMD\_COUNT\_STEPS 0x8E

#define CMD\_STOP\_EXP 0x8F

//0x9X are SimpleSAIM commands

#define CMD\_LOAD\_SIMPLE\_HALF 0x90

#define CMD\_LOAD\_SIMPLE\_FULL 0x91

#define CMD\_DIRECTION 0x92

#define CMD\_START\_SIMPLE 0x93

#define CMD\_START\_DITHERED 0x94

#define CMD\_STOP\_SIMPLE 0x95

#define CMD\_STEP\_COUNT 0x96

//0xAX are Mirror Detector commands

#define CMD\_SET\_MD\_RADIUS 0xA0

#define CMD\_MD\_ON 0xA1

#define CMD\_MD\_OFF 0xA2

//0xFX are special function commands

#define CMD\_TS\_PERIOD 0xF0

#define CMD\_CHECK\_MEM 0xFD

#define CMD\_SEND\_STAT 0xFE

#define CMD\_RESET\_CPU 0xFF