

# ***AP/MALDI (ng) HR and AP/MALDI (ng) UHR Source*** **for Thermo Mass Spectrometers** **(LTQ Ion Trap, LTQ Orbitrap, Orbitrap Elite, Velos, Velos Pro, Exactive, and Q Exactive, Orbitrap Fusion, TSQ Quantiva, TSQ Endura)**

Installation, Operation, and Maintenance Manual



## **Warning**

The optical parts of the *AP/MALDI (ng) HR* or *AP/MALDI (ng) UHR* sources should be handled with **extreme** care. Touching the optical parts with one's bare hand/fingers, storing, or exposing them to dirty/dusty environments can result in permanent damage to the optical components.

For maintenance and/or repairs, please contact your sales agent or the manufacturer directly:

### **MASSTECH, INC.**

6992 Columbia Gateway Dr.  
Suite 160  
Columbia, MD 21046 USA

Phone: (443) 539-1758  
Fax: (443) 539-1759  
E-mail: [msms@apmaldi.com](mailto:msms@apmaldi.com)

Last revision: November 11, 2017



Table of Contents

**PREFACE** ..... III

**1 INTRODUCTION: AP/MALDI (NG) HR AND AP/MALDI (NG) UHR: AN ION SOURCE FOR MASS SPECTROMETERS WITH ATMOSPHERIC PRESSURE INTERFACE** .....1

    1.1 QUICKSTART OPERATION ..... 3

**2 AP/MALDI BASIC PRINCIPLES**.....5

**4 SAFETY PROCEDURES WHILE USING THE AP/MALDI ION SOURCE**.....7

    4.1 SAFETY PRECAUTIONS ..... 7

    4.2 OPERATOR CONTROLS AND INDICATORS ..... 9

**5 SOURCE INSTALLATION**.....11

    5.1 CHECKING THAT ALL COMPONENTS HAVE BEEN RECEIVED ..... 11

    5.2 INSTALLATION OF THE SOURCE ..... 16

    5.3 WIRING OF THE SOURCE AND CONTROL UNIT: ..... 21

    5.5 SOURCE REMOVAL AND UNINSTALLATION ..... 26

**6 SAMPLE PREPARATION** .....27

    6.1 LOADING/UNLOADING THE TARGET PLATE ..... 28

**7 AP/MALDI OPERATION**.....33

    7.1 INSTALLING THE TARGET SOFTWARE AND USB DRIVERS: ..... 33

    7.2 STARTING THE TARGET SOFTWARE ..... 34

    7.3 POSITIONING/SIZING OF THE RED (LASER) CROSS-HAIRS ..... 36

    7.4 CALIBRATION OF THE VIDEO CAPTURE SAMPLE POSITIONING SYSTEM ..... 38

    7.5 FINDING THE LASER SPOT POSITION ..... 43

    7.6 RUNNING THE AP/MALDI ON THE THERMO MS INSTRUMENT ..... 45

    7.6 SETTING THE PARAMETERS OF THE THERMO MASS SPECTROMETERS ..... 49

    7.7 AP/MALDI UHR OPERATION ..... 47

    7.9 MANUAL MODE OF OPERATION ..... 47

    7.10 AUTOMATED MODE OF OPERATION ..... 49

    7.11 THE AUTOMATED MODE OF OPERATION: CONFIGURING THE XCALIBUR FOR THE EXTERNAL TIMING MODE ..... 55

    7.12 ZOOM MODE OPERATION ..... 58

**8 MAINTENANCE —TROUBLESHOOTING THE SOURCE**.....68

    8.1 PROBLEM: INSUFFICIENT ION PRODUCTION - LACK OF THE LASER POWER BEING DELIVERED TO THE TARGET SPOT ..... 68

    8.2 PROBLEM: THE LASER BEAM IS NOT WELL-FOCUSED ..... 69

    8.3 PROBLEM: THE LASER BEAM FOCAL POINT AT THE TARGET PLATE IS NOT PROPERLY ALIGNED WITH THE CAPILLARY EXTENSION ..... 71

    8.4 PROBLEM: THE ION TRANSPORT INTO THE MS INSTRUMENT IS CLOGGED/BLOCKED ..... 75

    8.5 PROBLEM: SPECTRAL RESPONSE WITH HIGH BACKGROUND AND MASS-SHIFTED ION PEAKS ..... 76

**9 LITERATURE**.....77

**10 WARRANTY INFORMATION – SIX MONTH LIMITED WARRANTY** .....78

**APPENDIX A: SPECIFICATIONS FOR AP/MALDI(NG) HR AND AP/MALDI(NG) UHR ION SOURCES** .....79

**APPENDIX B: WARNING AND IDENTIFICATION LABELS** .....80

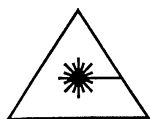
**APPENDIX C: COORDINATE CORRECTION** .....81

## PREFACE

The following symbols are used in this manual to indicate material that should especially be noted because it relates to safety issues.





This symbol in the manual margin is used to emphasize the presence of important operating instructions related to safety; especially during installation, un-installation, maintenance, and troubleshooting.



This symbol in the manual margin is used to alert the operator to potential dangerous exposure to hazardous invisible laser radiation.



Operators are strongly encouraged to read this manual before installation, un-installation, operation, maintenance, or troubleshooting. Operators should pay special attention to paragraphs marked by  and .



DO NOT ATTEMPT services or repairs that are not covered in the Troubleshooting Section, Section 8, of this manual. For services and repairs beyond those specifically provided in the Troubleshooting Section, contact the manufacturer:

**MassTech Inc.**  
**ATTN: Service Department**  
**6992 Columbia Gateway Drive**  
**Suite 160**  
**Columbia, MD 21046**  
**USA**

**Phone #: (443) 539-1758**  
**E-Mail: [msms@apmaldi.com](mailto:msms@apmaldi.com)**

(This Page is left intentionally blank)

## 1 INTRODUCTION: AP/MALDI (NG) HR AND AP/MALDI (NG) UHR: AN ION SOURCE FOR MASS SPECTROMETERS WITH ATMOSPHERIC PRESSURE INTERFACE

### Atmospheric Pressure Matrix-Assisted Laser Desorption/Ionization – AP/MALDI:

The AP/MALDI source is designed to produce ions of different analytes under atmospheric pressure conditions from a mixture of the matrix and the analyte microcrystals; this is done by irradiating these crystals with UV laser pulses. These ions are analyzed by the mass spectrometer, which is equipped with atmospheric pressure interface. The mechanism of the **AP/MALDI** ion production is similar to that of a **conventional (vacuum) MALDI**. The main difference is that the AP/MALDI produces ions under the atmospheric pressure conditions **outside** of the instrument's vacuum housing. The main consequences are as follows:

- The AP/MALDI source is an external ionization source. It is designed to be easily interchangeable with other sources such as the ESI, APCI, nanospray, DART, etc.
- The replacement of the target (sample) plates is a simple and quick process because the AP/MALDI source operates under atmospheric pressure; the source does not need to re-establish vacuum after sample is loaded.
- The AP/MALDI source is designed as an additional external source for the mass spectrometer. The process of the mass spectra measurement is completely decoupled with the sample ionization process. Thus, the AP/MALDI inherits all the power of the Thermo instruments: the high mass resolution, sensitivity, stability of calibration, MS<sup>n</sup> capability, powerful data processing, and spectra interpretation software. However, it also inherits all the limitations such as the mass range. *The AP/MALDI source, like the conventional MALDI source, produces mostly single-charged ions.*
- The AP/MALDI has a softer ionization technique compared with conventional vacuum MALDI. This is an important advantage when an unstable molecular mass of the analyte (in the gas phase) is measured. A detailed discussion of this phenomenon and some examples are found in publications [1, 2].

- The AP/MALDI source operates under the normal ambient pressure conditions similar to the ESI sources. The AP/MALDI and ESI sources are interchangeable and typically provide complimentary analytical information. The appropriate use of both the ESI and AP/MALDI sources provide the opportunity to cover the broad range of problems in modern analytical chemistry [1-3].

The *AP/MALDI (ng) HR* and *AP/MALDI (ng) UHR* sources are designed to significantly reduce the spot size for the laser beam on the sample compared to earlier versions of AP/MALDI. This enables “High Resolution,” more specifically, higher lateral resolution. By employing the “Zoom Mode”, one can create and monitor the ion signal and relate it to its location. More information about the “Zoom Mode” is included in Chapter 7.12.

## 1.1 QUICKSTART OPERATION

This section covers the basic operation of the AP/MALDI (ng) source after the AP/MALDI (ng) source, Target Software, and the Thermo Mass Spectrometer have been properly installed and set-up.

Once the ion source is installed, according to Section 5 of this manual, the operation steps are as follows in the section below.



**NOTE:** All installation and uninstallation procedures **must** be done with the power turned “Off.” Before proceeding, the user is strongly urged to read the safety procedures in Section 4 of this manual.

1. Close the ion source, turn the unit “On”, and wait for the controller to initialize (The blue LED on the Power switch should first turn dim and then bright again). Run the Target Software on the PC connected to the mass spectrometer. Wait until the initialization is completed and the “Ready” notification is displayed in the status field of the Target Software.
2. Since the Thermo Software (LTQ Tune, Tune, or Orbitrap Fusion etc.) is normally optimized for the electrospray source, the user must adjust the software’s parameters so that it is optimized for the AP/MALDI :

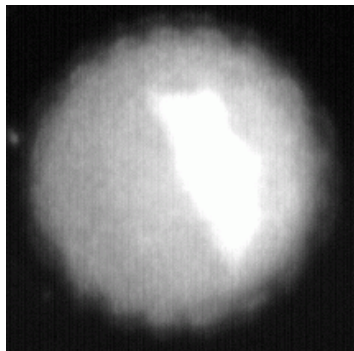
Set the software to the following initial settings:

Plate Voltage: 2 kV

Injection Time: 200ms

3. Prepare the sample(s) according to Section 6 of this manual; the sample preparation procedures are similar to methods used for the conventional (vacuum) MALDI.
4. Load the target plate containing the sample(s) into the target plate holder according to Section 6.1 of this manual. Ensure that the user closes the source completely.
5. Use the Target Software to fire the laser and test the samples. To operate the software in the manual mode (spot by spot spectra measurement), make sure that the auto sequence toolbar and zoom mode icons are unchecked. Then, choose a desirable spot to analyze (like A1) using the Target Software. Adjust the position of the laser using the target image on the computer screen, if necessary. Start the laser firing; the user then has the option to

use the spiral/raster motion in the Target Program. Now, the user can repeat the procedure for other spots (a detailed explanation of the automatic operation is included as Section 7.5 of this manual).



*Figure 1 An Ideal Starting Sample Spot*

6. When the user finishes the data acquisition, he/she must complete the following: stop the data acquisition (by using the Thermo Software), put the mass spectrometer to the “Standby Mode”, and stop both the laser firing and target motion (by using the Target Software “Stop” toolbar icon). Then, use the “Eject” button, wait for the motion to stop, open the source, pull up the x-y stage assembly, and remove the used target plate.
7. Replace the old target plate with one that has new sample spots, gently push down the x-y stage assembly, close the ion source, press the “Eject” button under Target Software, and repeat step 5 to get the spectra from a new target plate.

## 2 AP/MALDI BASIC PRINCIPLES

This section will focus on the description of the AP/MALDI process.

### Ion Source:

A simplified schematic of the AP/MALDI (*ng*) source is represented in Fig. 2.1.

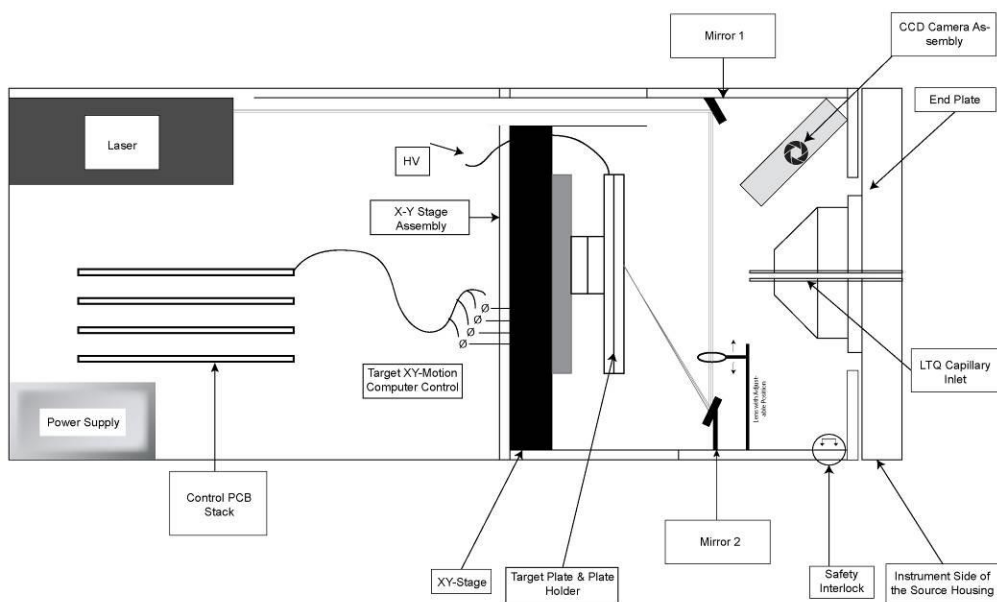


Figure 2.1 Simplified Schematic Diagram of the AP/MALDI (*ng*) Source that is Installed on Thermo Instrument

The AP/MALDI Ion Source has a monolithic source housing. The source is attached to the mass spectrometer atmospheric pressure interface flange. All ions produced inside the source travel toward the inlet orifice of the mass spectrometer with a stream of steady gas flow created by the suction, which is provided by the mass spectrometer inlet. The source housing contains all the components to make it work: the laser, optics, x-y stages with the target plate holder, and control electronics. The MALDI samples are deposited onto the surface of a replaceable target plate that is slipped into a target plate holder as described in chapter 5; the samples can be deposited on the surface of each target plate. The high voltage (typically 2 kV) is applied between the sample plate and capillary inlet of the mass spectrometer to assist the transportation of the ions toward the inlet orifice.

The sample material deposited on the surface of the target plate is irradiated with the laser light. The high repetition rate (all-solid-state Nd:YAG laser) has a wavelength 355 nm, is mounted inside a control unit, and has a repetition rate range of 100-10000 Hz for both the AP/MALDI (*ng*) *HR* and AP/MALDI (*ng*) *UHR* (Appendix A contains a list of specifications for the laser).

The CCD camera and imaging optics enable the user to monitor the target plate motion and sample evaporation processes on the computer monitor. Inside the source housing, there is also a source of visible light to illuminate the target plate surface. The AP/MALDI ion source can be easily opened to replace the target plates. A safety interlock prevents the laser from being switched “ON” or the HV to be applied to a target plate if the source is opened.

The source communicates with the Target Software via the Ethernet connection from the source to the MS instrument’s computer. The Target Software controls the target plate motion and laser firing , which are important features of the AP-MALDI source.

## 4 SAFETY PROCEDURES WHILE USING THE AP/MALDI ION SOURCE



If operated properly, the AP/MALDI ion source is safe. No special knowledge of laser or electrical safety is necessary to operate the source. However, there are two potentially hazardous factors connected with the AP/MALDI source installation, operation, and maintenance/ troubleshooting:

1. Invisible coherent UV irradiation 355 nm, up to 10  $\mu$ J per pulse
2. High voltage up to 5 kV DC

In order to insure the necessary safety measures, the manufacturer of this product has implemented protection measures for the users by housing (shielding) a reliable interlocking of the source components from the UV radiation and high voltage. Therefore, the AP/MALDI source power needs to be turned “OFF” during installation/uninstallation.

### 4.1 Safety Precautions



This section describes important precautions that must be observed during the AP/MALDI (ng) source **installation/un-installation, operation, and maintenance**. Appropriate precautions can be divided into the following stages:

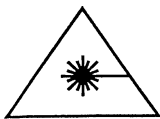


- **Installing/Un-installing:** Before the source is installed/un-installed onto the mass spectrometer, the mass spectrometer must be in either in the “Standby” or “Shutdown” mode. The same rules, described in the operator’s manual for the replacement of the standard sources (electrospray/nanospray/APCI), are applicable for AP/MALDI as well.



Never switch the power “ON” of the AP/MALDI(ng) source before the source is completely installed.

As stated earlier, when uninstalling the device, make sure that the MS is in the “Standby” or “Shutdown” mode. The user must also switch the power of the AP/MALDI (ng) source to the “OFF” mode; then he/she may detach the source or begin any of the disassembling operations. The AP/MALDI (ng) source safety interlocks the safeguard mode, which prevents the user from accidental application of the high voltage or laser radiation when the source and control unit are covered in their housing units.



- **Target Plate Loading/Unloading:** The user needs to open the AP/MALDI source to load/unload the target plate. For safety purposes, it is mandated that the user first switch the instrument to either the “Standby” or “Shutdown” mode and stop the laser firing (click on the “Stop” button on the AP/MALDI ion source in the Target Software) **so that the “Laser ON” indicator on the front panel of control unit is “OFF.”** After that, proceed with loading/unloading of the sample(s) as described in Section 6.1 of this manual. If by accident the source is opened while the instrument is recording the spectrum (HV is ON) and/or the laser is firing, the AP/MALDI (ng) source safety interlocks automatically switches the high voltage and the laser to the “OFF” mode.

**Caution: The target plate and translation stages may be hot!**



- **Mass Spectra Recording:** During the data acquisition the source is closed and attached to the MS instrument, which excludes any possibility of high voltage shock or laser radiation exposure. If the source is opened by accident while the MS instrument is recording the spectrum (HV is “ON”) and/or the laser is firing, the AP/MALDI source automatically initiates the safety interlocks switch the high voltage and the laser to the “Off” mode.

**DO NOT ATTEMPT services or repairs that are not covered in the Troubleshooting Section, Section 8 of this manual. For services and repairs beyond those specifically provided in Section 8, contact the manufacturer:**

MassTech, Inc.  
6992 Columbia Gateway Dr.  
Suite 160  
Columbia, MD, 21046  
USA

+1 (443) 539-1758 – Please ask to be directed to the MassTech Sales Department.

## Remember:



- Never defeat or bypass interlocks
- Never open the cover of the unit
- Never switch the power “ON” at the control unit if the AP/MALDI source is not properly attached to the mass spectrometer.

### 4.2 Operator Controls and Indicators

The two figures below illustrate the front and back plate of the AP/MALDI (ng) control unit.

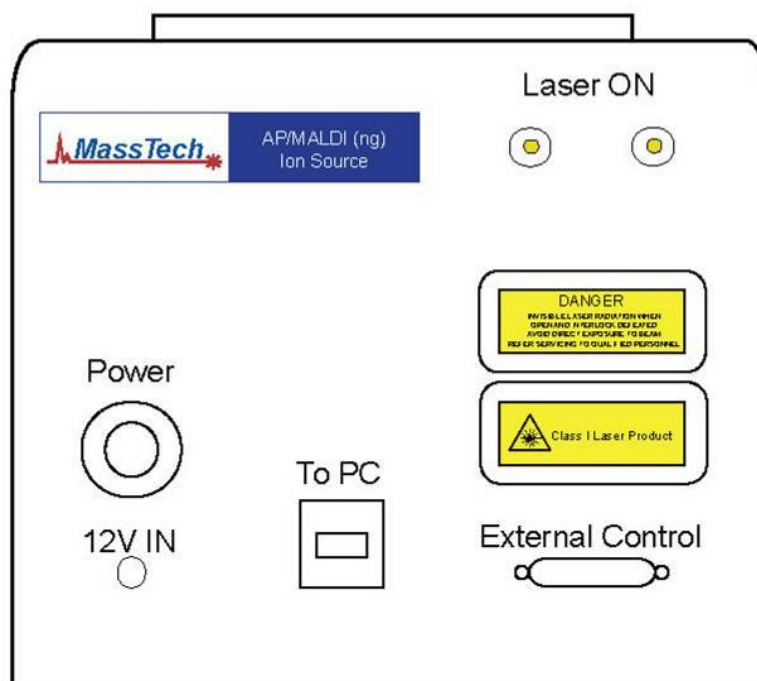
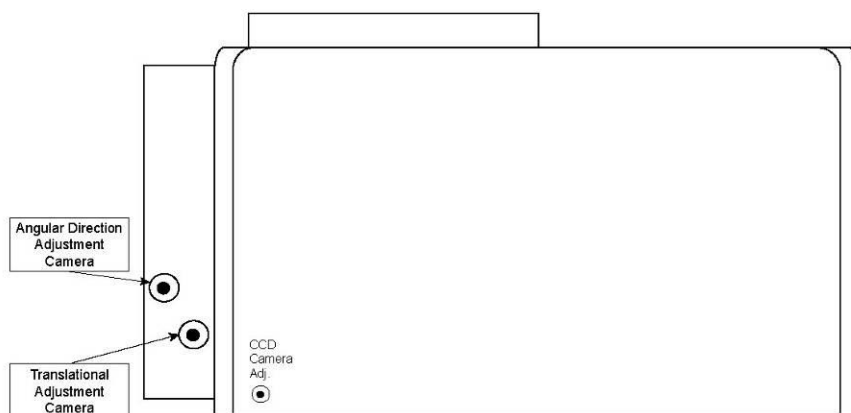
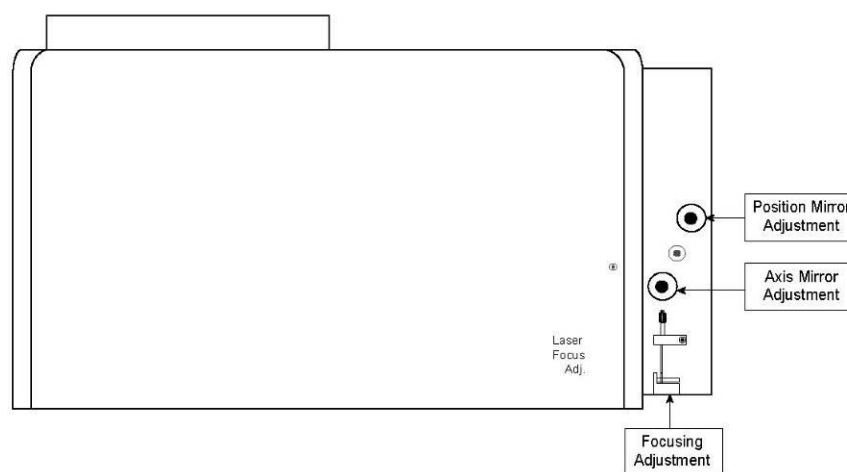


Figure 4.1 The Control Unit's Forepart of the Source



*Figure 4.2 The Control Unit's Side A of the Source*



*Figure 4.3 The Control Unit's Side B of the Source*

## 5 SOURCE INSTALLATION

### 5.1 Checking that all Components have been received

Before the user starts installing the source, he/she must ensure that all necessary parts and accessories have been delivered. Figures 5.1 through 5.6 (below) show these components and introduce some definitions as well as the part names used in the installation explanations.

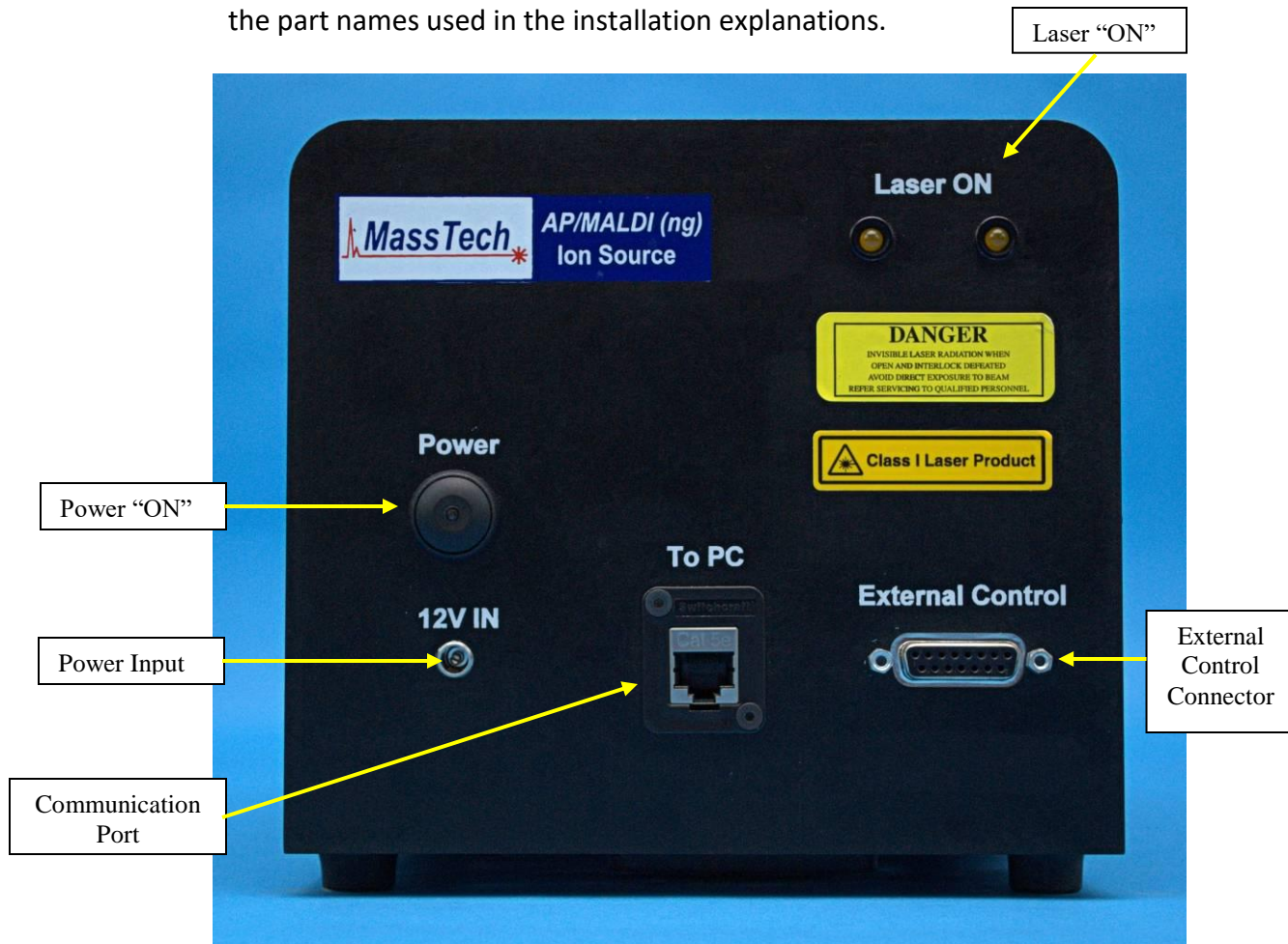


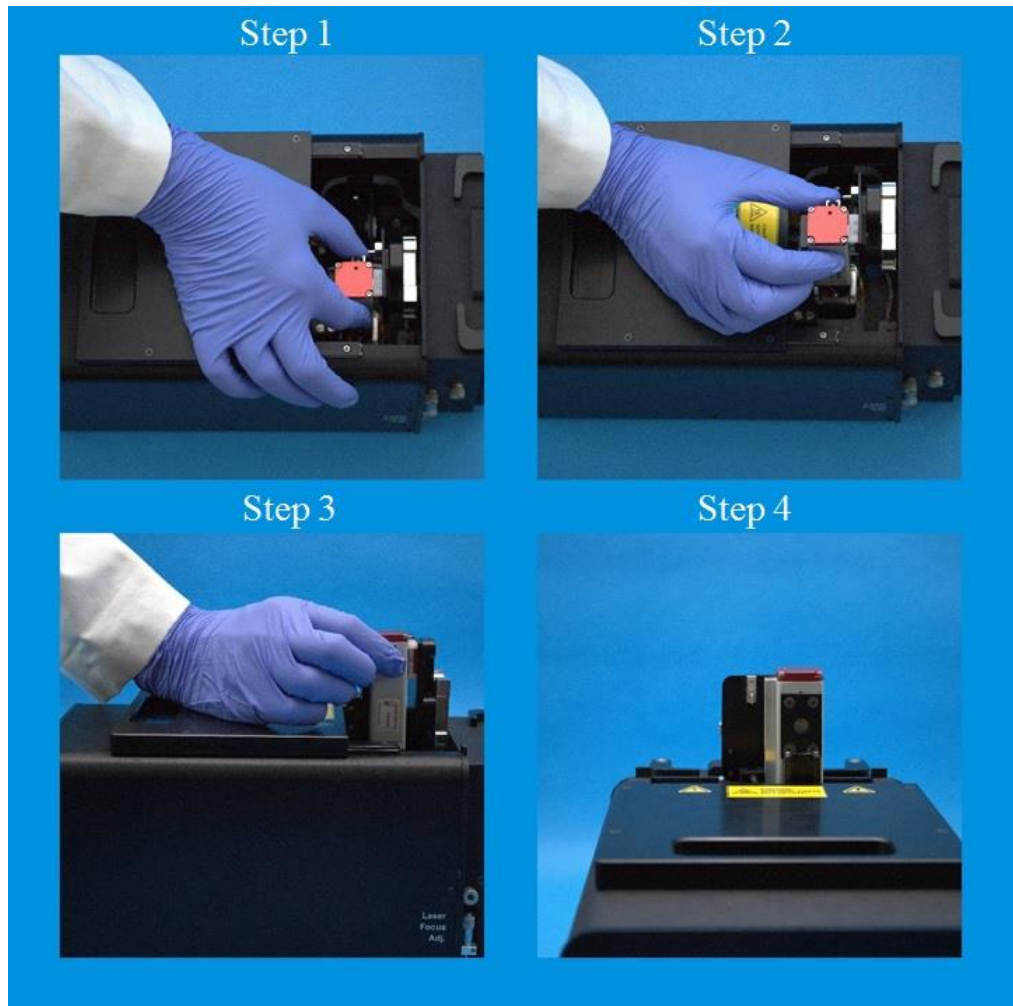
Figure 5.1 Front View of the Control Unit



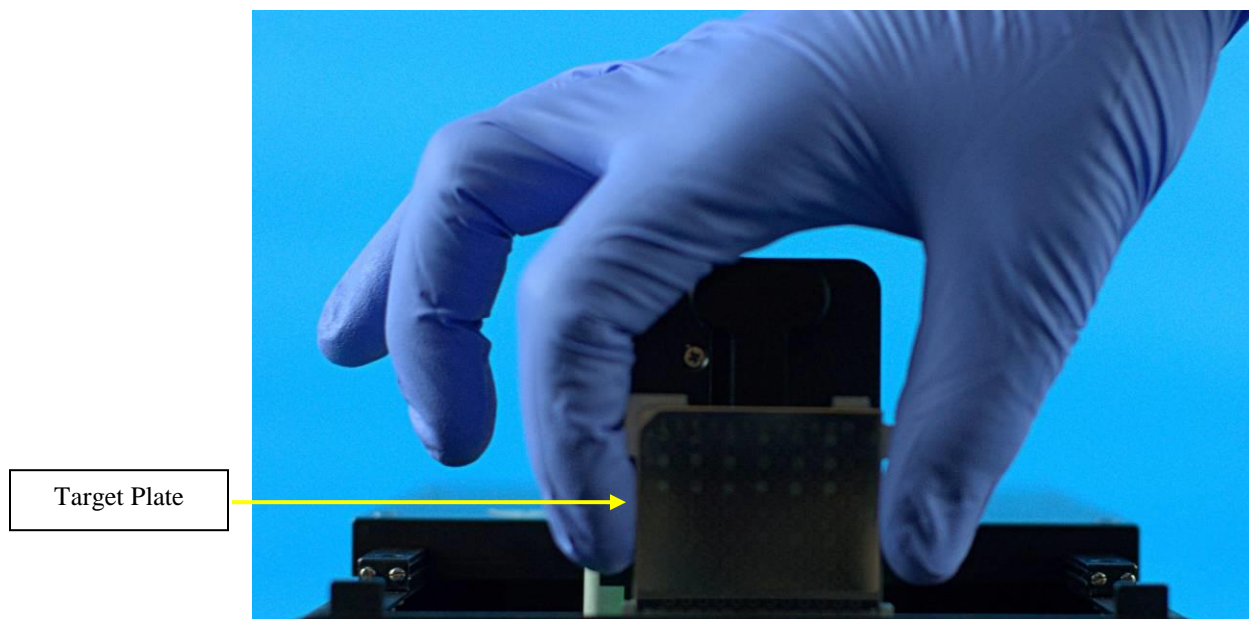
Figure 5.1b Side/Bottom View of the Control Unit with Serial Number



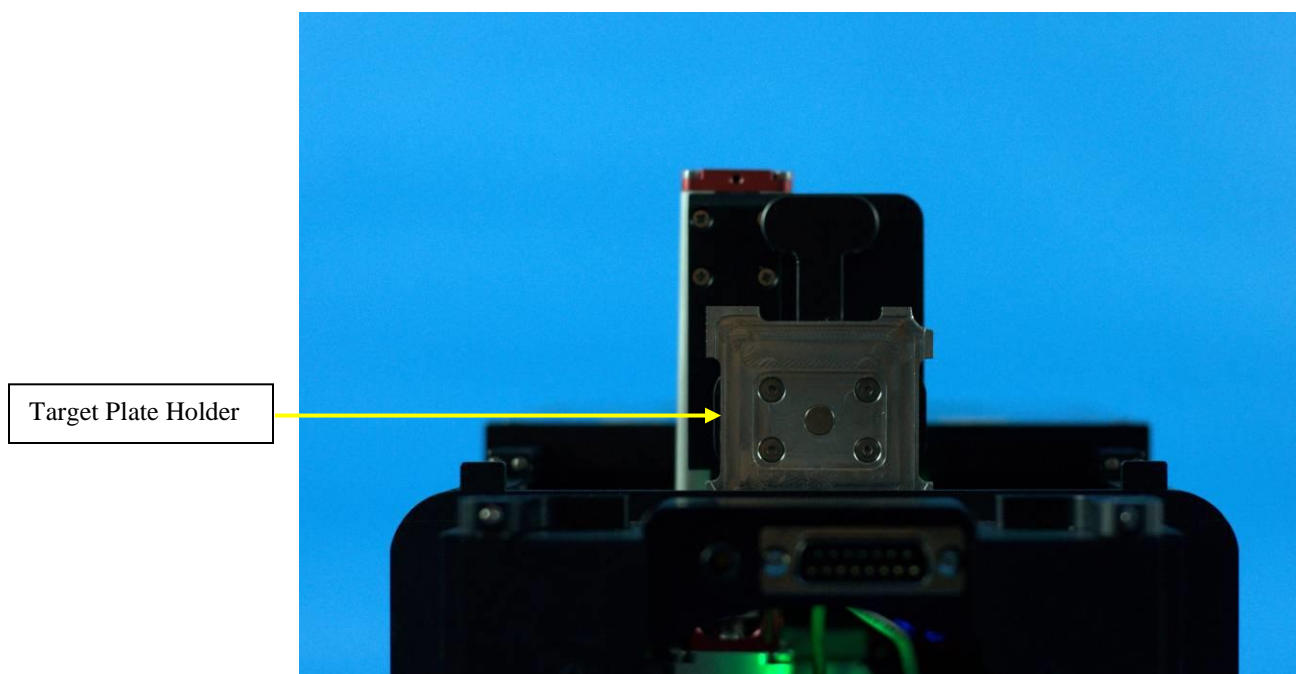
Figure 5.2 Ion Source for the Thermo Mass Spectrometer



*Figure 5.3 Preparing the source for loading the Target Plate*

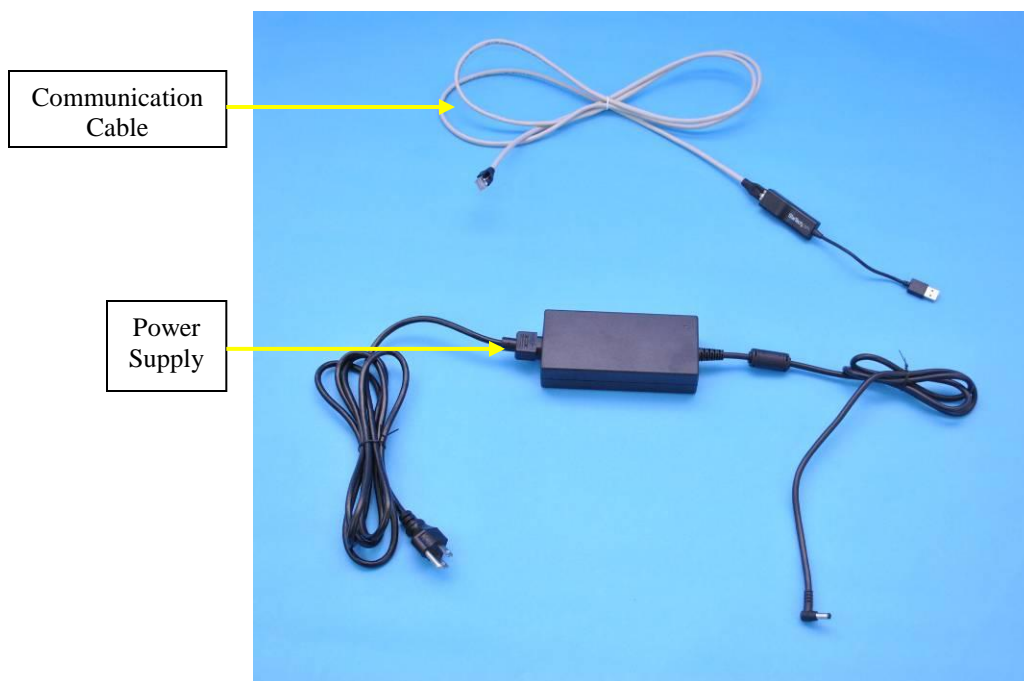


*Figure 5.4 AP/MALDI (ng) Ion Source Opened with Target Plate*



*Figure 5.5 AP/MALDI (ng) Ion Source Opened with Target Plate Holder*

Figure 5.3 illustrates the AP/MALDI ion source opened, which contains a 192-spot Opti-TOF target plate holder with a plate loaded plate. Figure 5.4, on the other hand, illustrates the ion source opened with just the target plate holder in position.

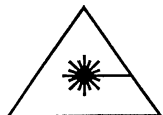


*Figure 5.6 Communication Cable and Power Supply*

### 5.2 Installation of the Source



**Installing/Uninstalling:** Before the source is installed, uninstalled, or replaced onto the mass spectrometer, the mass spectrometer must be in either the “Standby” or “Shutdown” mode. The same rules, as described in the mass spectrometer operator’s manual regarding the replacement of the standard sources (electrospray/nanospray/APCI), are applicable for the AP/MALDI as well.



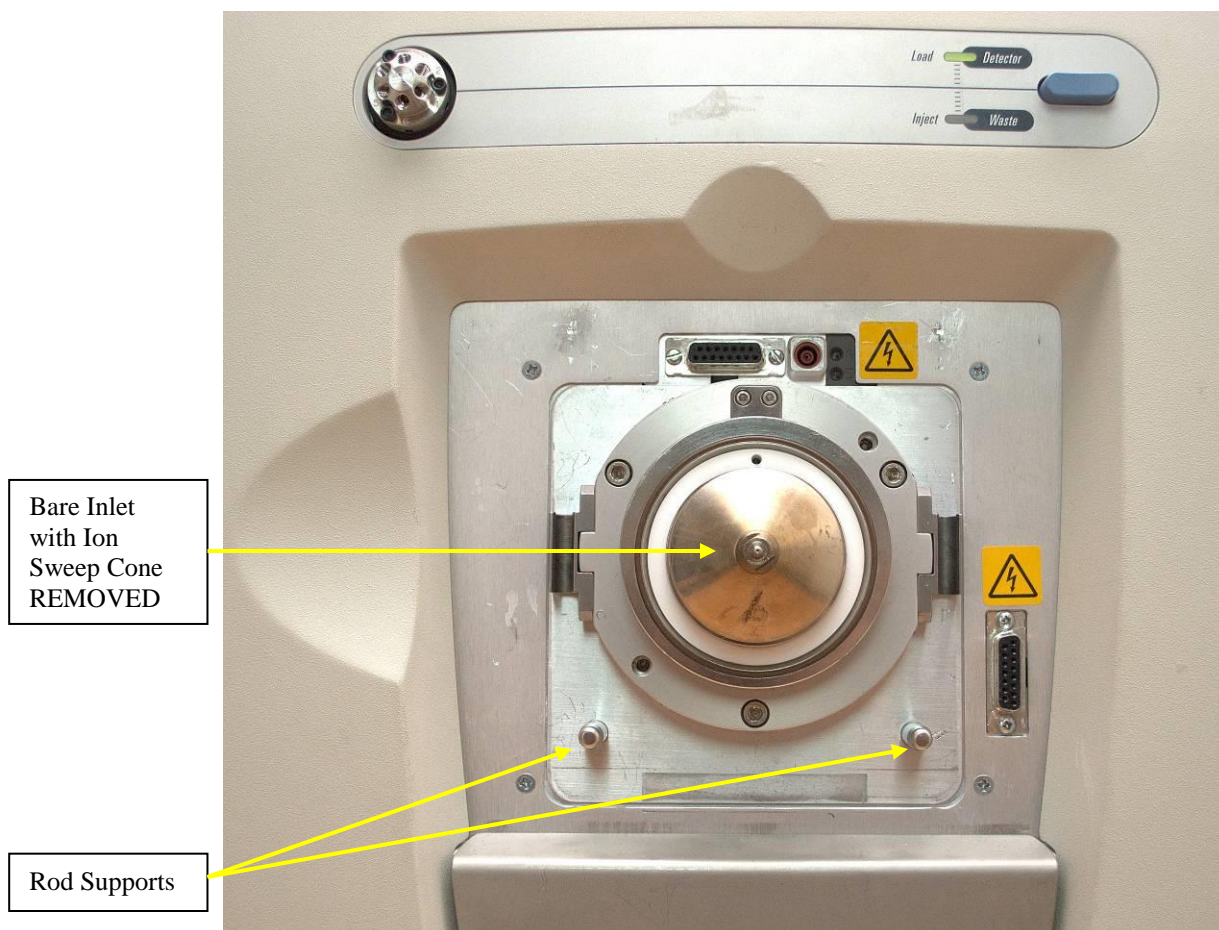
**Never** switch the power “ON” at the rear panel of the AP/MALDI (ng) control unit before the source is **completely installed**.



Remove the current source from the mass spectrometer; this action will result in an empty inlet flange (Fig. 5.8). **The ion sweep cone must also be removed (CAUTION – the ion sweep cone may be hot).** The mass spectrometer inlet should look like Fig. 5.7 when it is ready for the AP/MALDI (ng) installation.

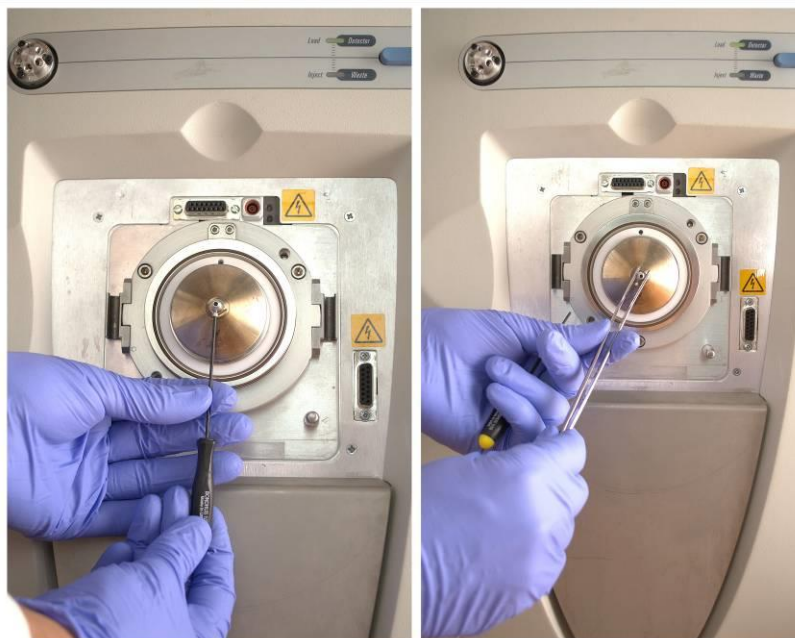


*Figure 5.7 The Mass Spectrometer without the Ion Source and Ion Sweep Cone Attachment*



*Fig 5.8a Bare Inlet of the Mass Spectrometer*

Figure 5.8a shows the bare inlet of the mass spectrometer before the AP/MALDI ion source is attached. NOTE: That the ion sweep cone (shown below) has been removed in Figure 5.8c.



*Fig 5.8b Capillary Extender Installation*



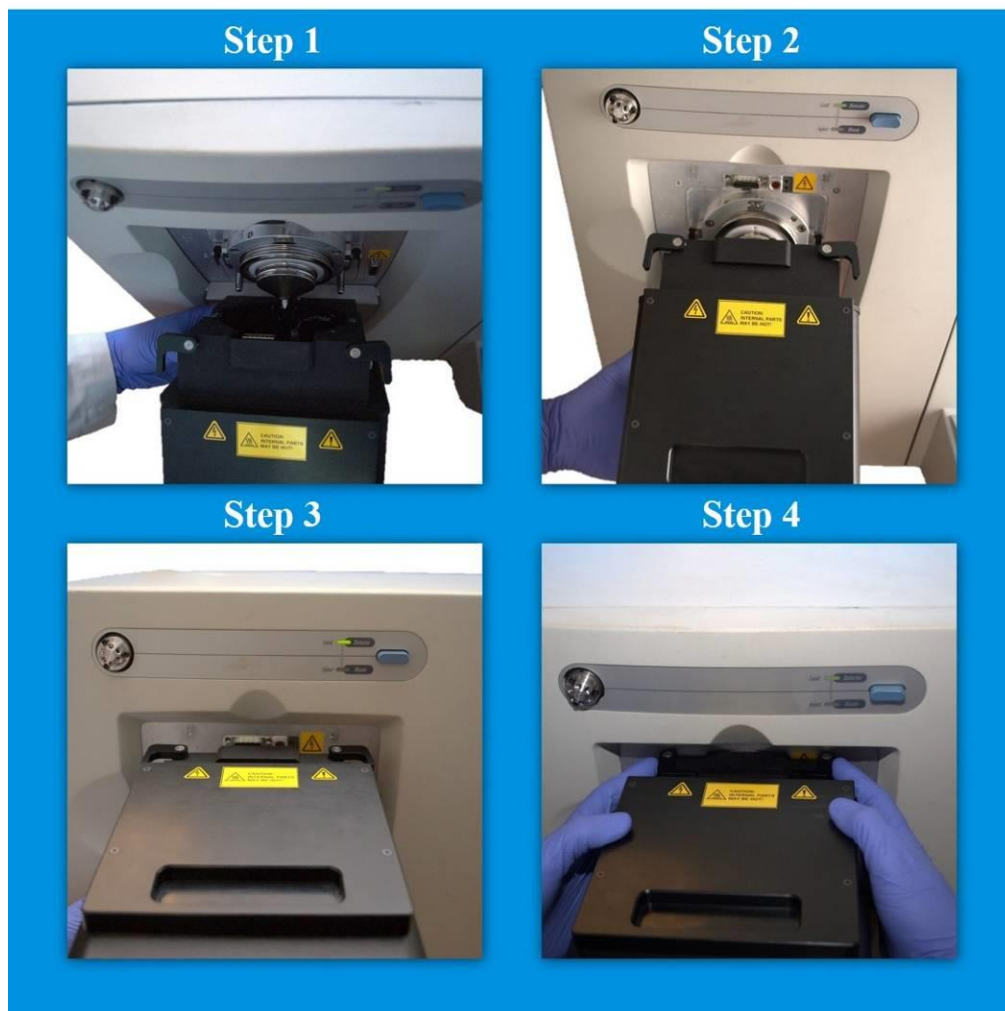
*Fig 5.8c The Ion Sweep Cone Removed Prior to Source Installation*



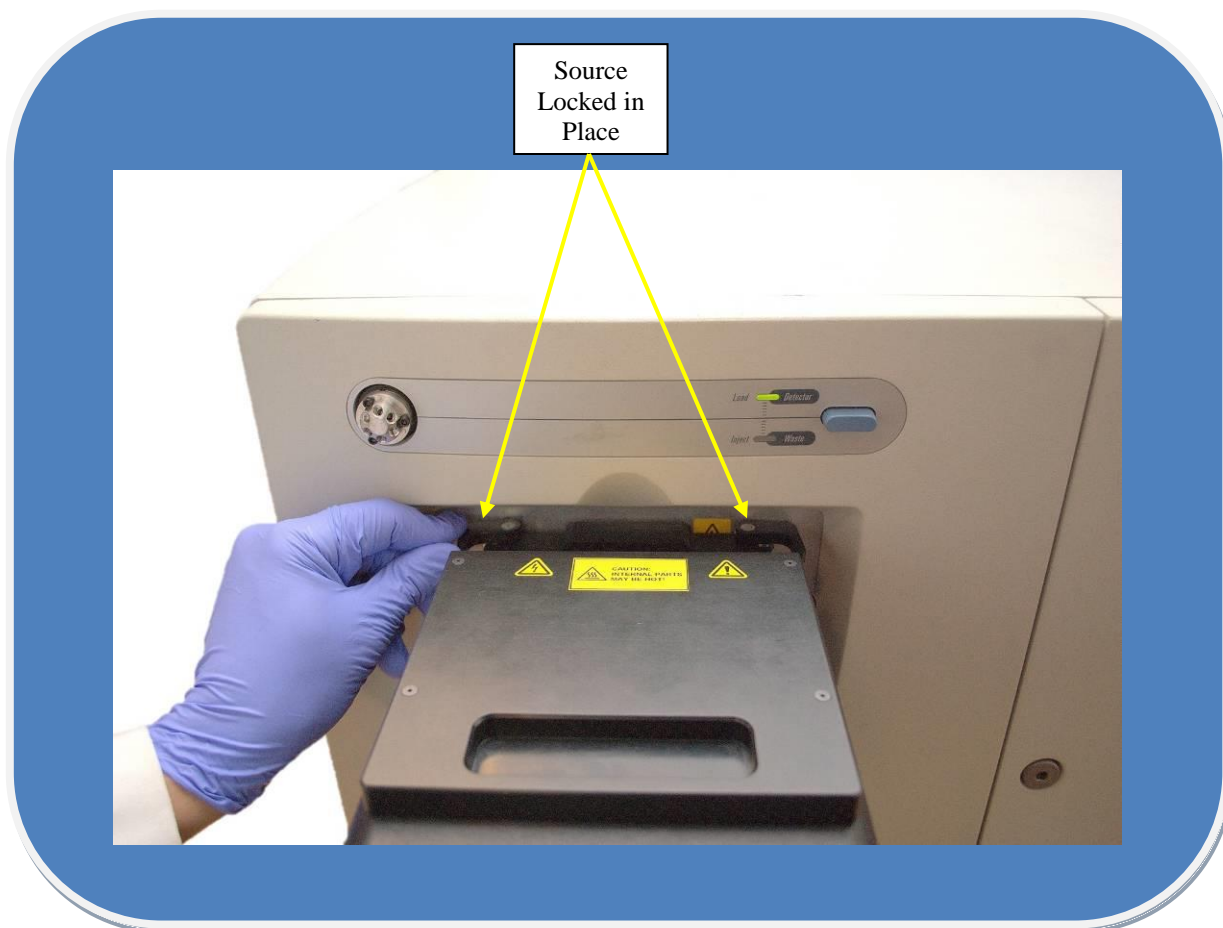
**CAUTION: The ion sweep cone may be hot!**

Next, the capillary extension needs to be installed on the inlet capillary (Figure 5.8b). Since the inlet capillary is already hot, tweezers or similar tools are needed to hold and secure it in place.

Next, mount the AP/MALDI ion source onto the mass spectrometer as one would do for a standard ESI source and making sure to line up the AP/MALDI source with the rod supports (see Fig. 5.9). To lock the source into place, the user must turn the black levers inwards toward the machine (Fig. 5.10).



*Figure 5.9 Installation Steps for the AP/MALDI (ng) Source to the Mass Spectrometer*



*Fig 5.10 Locking the AP/MALDI (ng) Source onto the Mass Spectrometer*

### 5.3 Wiring of the Source and Control Unit:



Ensure that the power on the control unit is "OFF" until the source is wired to the control unit.

Connect the black power cord and USB Cable B to the corresponding connectors at the rear plate of the control unit.

**No adjustment is necessary for ~110/~127/~220/~240V AC!**



*Fig 5.11 Upside-Down Image of the Source*



*Fig 5.12 AP/MALDI (ng) Source with Power, PC, and External Control Cables*

The Ethernet cable (Fig. 5.12) should be attached to the Ethernet jack labeled “To PC” and the other end should be connected to USB-Ethernet adapter, which in turn, is connected to the USB port of the user’s computer. The cable connections should resemble the setup shown in Fig. 5.13 and 5.14.



*Fig 5.13 AP/MALDI (ng) Source with Power, PC, and External Control Cables*



*Fig 5.14 Completed Source Installation*

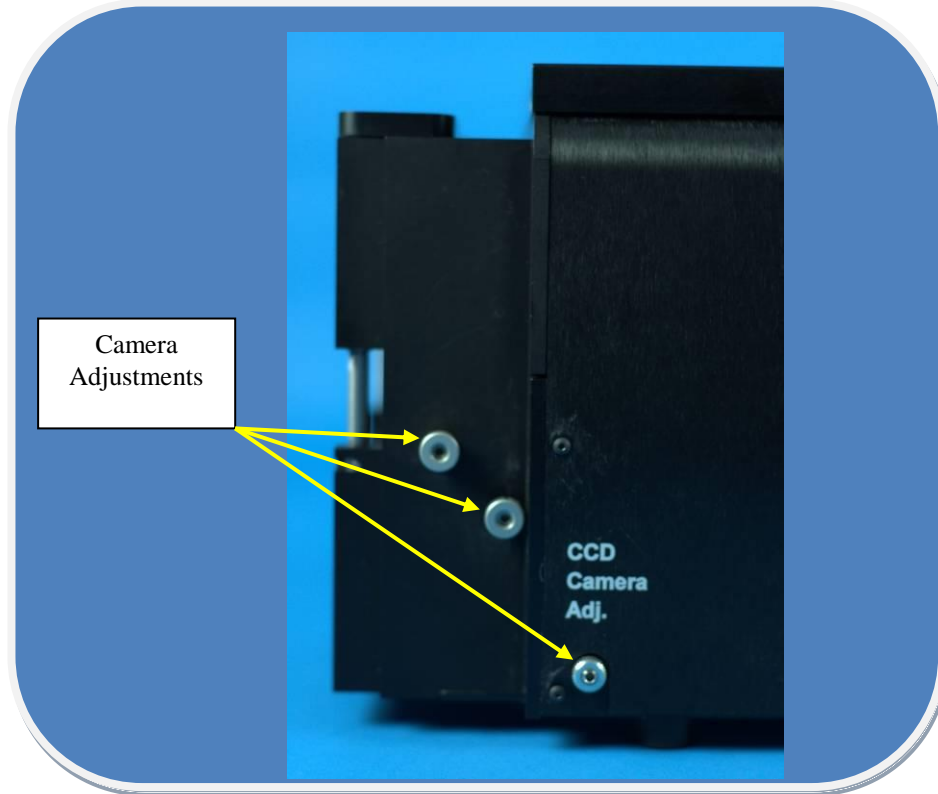


### Before Switching on the Power "On"

1. Ensure that the connectors are firmly connected.
2. Now it is safe to turn on the control unit.

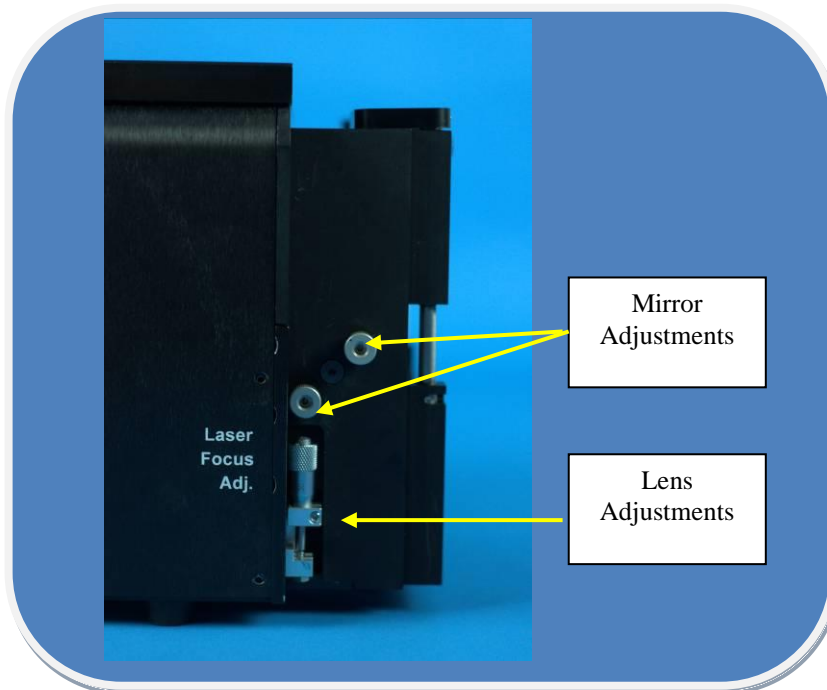
### **5.4 Fine Adjustments to the Source**

The unit comes pre-tuned, but if necessary, the fine adjustments to the imaging (e.g. sharpness of an image) can be made as shown in Figs. 5.15.



*Fig 5.15 Camera adjustments*

This procedure can be safely performed even if the source is "ON" and the laser is firing; simply turn the knobs as necessary.



*Fig 5.16 Laser Focusing Adjustments*

If necessary, the fine adjustments to the laser positioning and focusing can be made as shown in Fig. 5.16. More details are in Sections 8.2 and 8.3.

### **5.5 Source Removal and Uninstallation**

When the user needs to remove the AP/MALDI ion source in order to put another device on the MS, he/she must follow the directions below:



1. Set the MS Instrument to either the “standby” or “OFF” mode.
2. Turn the power on the unit to the “OFF” mode.
3. Then, uninstall the source by reversing the installation procedure as described in Section 5.2.

## 6 SAMPLE PREPARATION

The same sample preparation techniques and the same matrix used for the conventional MALDI vacuum can be used for the AP/MALDI sample preparation. The main difference, with the vacuum AP/MALDI, is that the crystal size has no direct influence on the spectrum quality. A typical molar ratio of a sample-to-matrix is between 1:100 and 1:10,000.

Prepare several standard samples for testing the AP/MALDI (ng). The following steps below are deemed as a typical sample preparation procedure:

- Carefully clean the target plate surface
- For the standards test, a  $\alpha$ -Cyano-4-hydroxycinnamic acid ( $\alpha$ -CHCA) matrix is recommended
- Mix a 1:1 matrix and analyte solution that is composed of the standard peptides (Angiotensin II, Bradykinin 1-7, P<sub>14</sub>R and/or similar peptides) with a concentration of approximately 500-1000 fmole/ $\mu$ L.
- Deposit a droplet of 0.5-2  $\mu$ L of the mixture on the target surface and allow it to dry (alternatively, the matrix and analyte solutions can be deposited on the target separately and then allowed to dry).



*Figure 6.1 Spotting of Several Standard Samples*

Figure 6.1 shows the spotting of several standard samples on a target (sample) plate for testing by the AP/MALDI. The sample preparation procedure is similar to the original MALDI experiments.

## 6.1 Loading/Unloading the Target Plate

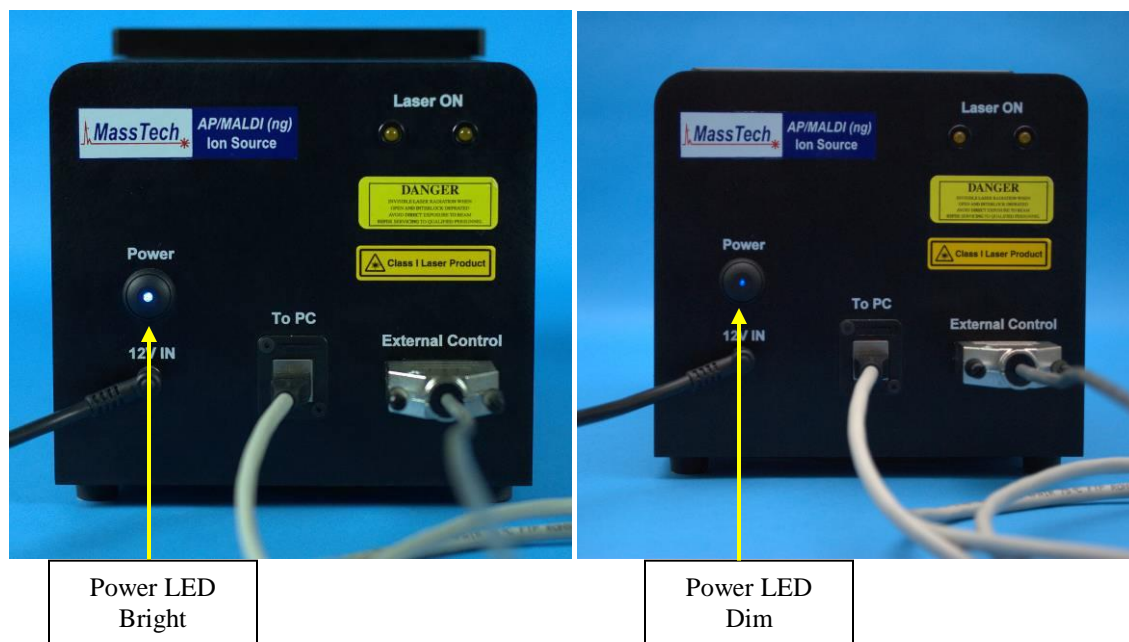


Figure 6.2 Bright and Dim Power LED Lights



The user needs to first open the AP/MALDI source to load or unload the target plate. The user must then put the mass spectrometer in either the “Standby” or “Shutdown” mode. To stop the laser firing, click on the “Stop” button in the Target Software **so that the Laser “ON” indicator on the front panel of control unit is “OFF.”** After that, proceed with loading or unloading of the target plate.

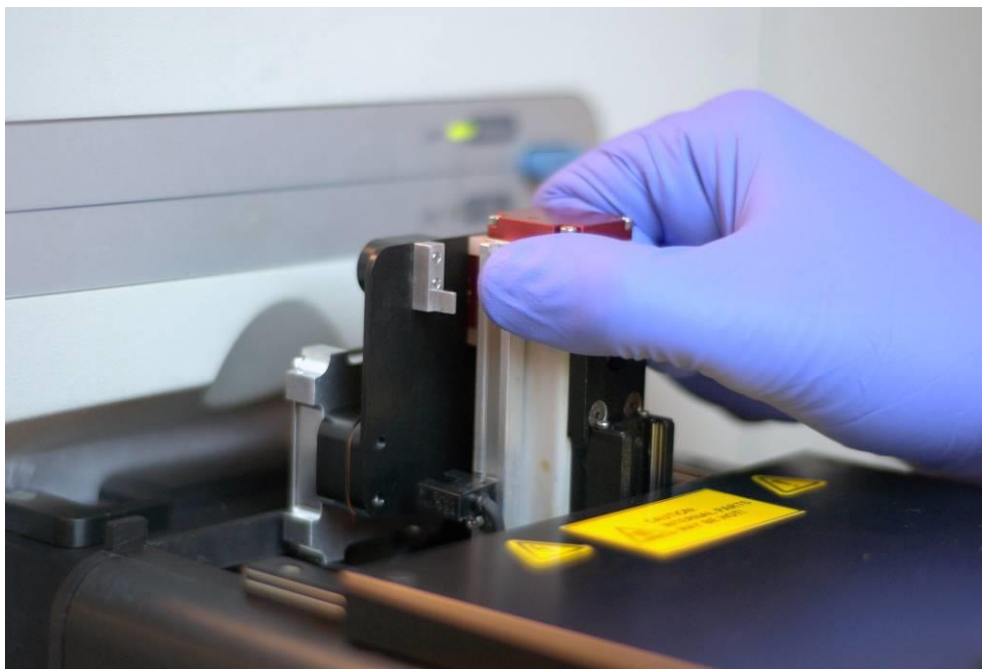


To open the source, pull the top door on the source cover away from the MS instrument to reveal the Y stage and plate holder inside the source (Figure 6.3). Pull gently the Y stage up to the upright position (the stage will be held in this position by magnets - Figure 6.4).

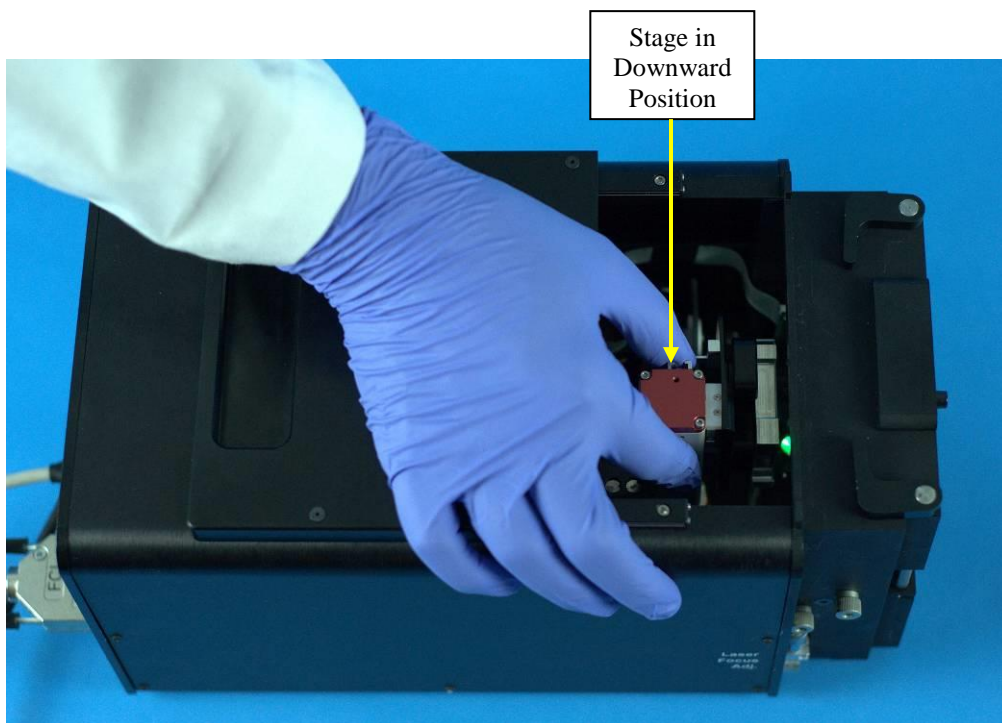
**Caution – The target plate and translation stages may be hot when unloading!**



*Figure 6.3 Source Open*



*Figure 6.4 Handling the Target Plate in the Upright Position*



*Figure 6.5 Holding the Source Stage in Downward Position*



## AP/MALDI Ion Source

---

Insert new target plate (with the prepared sample spots) into the target plate holder; the plate is held in place by a magnet. Then, gently push the Y stage with the loaded plate back into the downward position (figure 6.5).

When the source is closed, there should be a "click" sound, which corresponds to the sliding door engaging the interlock switches.



*Figure 6.6 Source Closed*

Figure 6.6 shows the source "clicked" into the close position after the target (sample) plate is loaded. Notice that there is no gap between the two halves of the ion source.

[This page was intentionally left blank]

## 7 AP/MALDI OPERATION

### 7.1 Installing the TARGET Software and USB Drivers:

The Target Version 8.0 Software is used to control the AP/MALDI target motion and laser firing operation.

To install the Target Software, follow these steps (under the Windows operating system, the user will need the administrator's access):

1. Download the Installer Package, which can be found on the Downloads page from [apmaldi.com](http://apmaldi.com); the Installer Package will be under the Downloads for AP/MALDI (ng) and AP/MALDI (ng) Section.
2. Insert the installation CD and run the Setup.exe Program from the user's CD drive.
3. Choose the desirable location and folder name for the Target Software. By default, the folder name is: **C:\Program Files\MasTech\**
4. Follow the next few dialog boxes to completion.

After the Target Software installation process is completed, it is recommended for the user to create a shortcut from the desktop to the Target.exe.

To install the software and enable the USB communication on the control unit, follow these steps (under Windows, the user will need the administrator's access):

1. **DO NOT** connect the control unit to the PC through cable B. If the cable is plugged in, unplug it at from any/all sides.
2. Download the Target Software self installation package from the [www.apmaldi.com](http://www.apmaldi.com).
3. Connect both the control unit and computer with cable B.
4. Turn "ON" the power to the control unit.
5. The computer should detect the "New Hardware Found."
6. Follow the next remaining dialog boxes to completion.

## 7.2 Starting the TARGET Software

Start the Target Program by either double-clicking on the desktop shortcut, or the target.exe file. The window (Fig. 7.1) will soon appear.

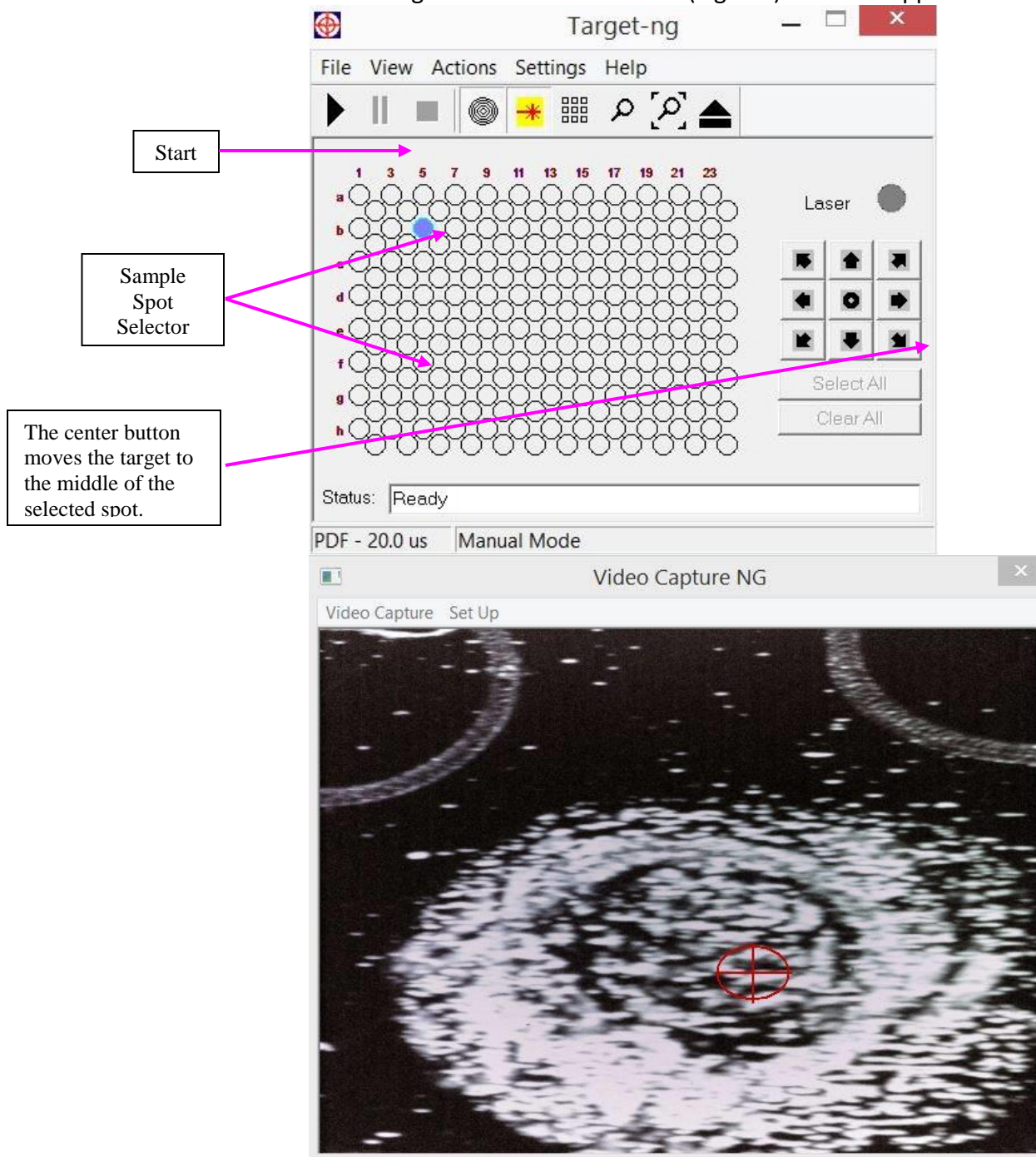


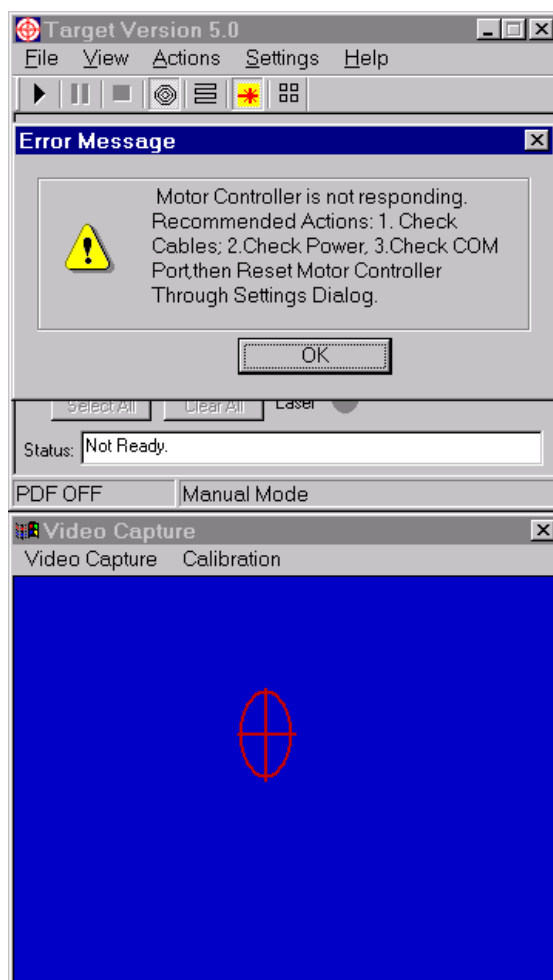
Figure 7.1 The Target Software Started, Properly Initialized, and Ready

At this moment, the initialization of the XY stages will start automatically. If everything has been connected properly, the user will see the target motion

on the video capture screen. During initialization, the target moves to its different limit positions. After initialization, the target plate's first sample position is A1 (the upper left hand corner of the target (sample) plate).

If the "Power On" indicator on the control unit is in the "Off" mode, or if the control unit is not properly wired to the computer, the user will get the message shown in Fig. 7.2. Once the problem has been corrected, then reinitialize the software by going through the following steps: **Settings>Set Parameters>General>Init Motors**.

The Target Software can also be reinitialized by exiting and restarting the program.



*Figure 7.2 Error Message*

After the AP/MALDI source initializes, there can still be instances when the system is in a "Not Ready" state (see Fig. 7.3). The "Not Ready" status can be a result of the housing source being open – in which case simply close the source. Another possibility for the "Not Ready" status is that an interlock is open. Check the housing source,

and when closed, make sure the fiber optic is tightly secured to the connector.

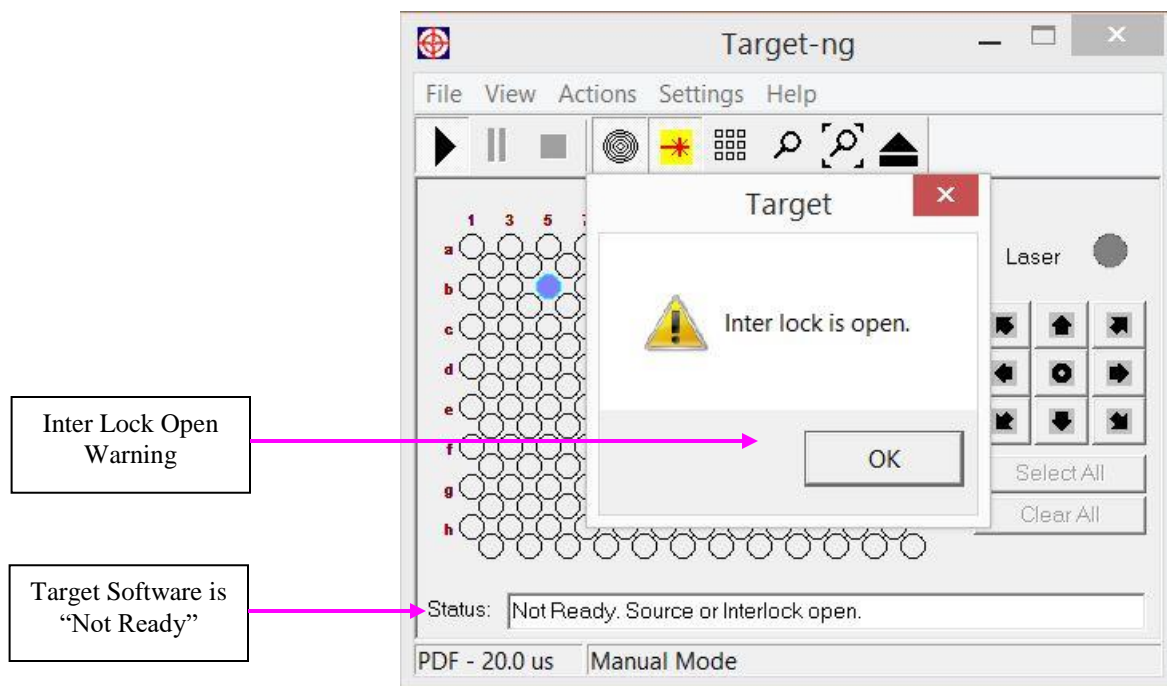


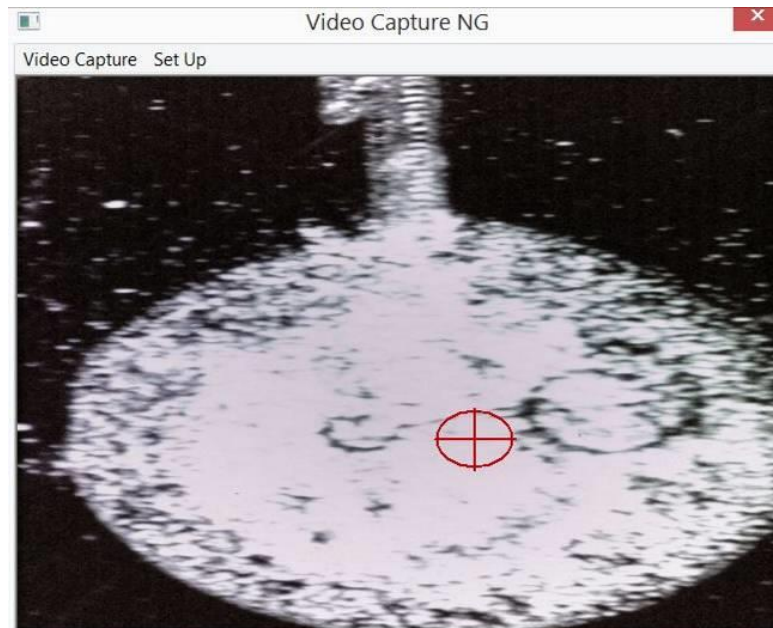
Figure 7.3 Target Software Showing the “Not Ready” State

### 7.3 Positioning/Sizing of the Red (Laser) Cross-Hairs

The red-cross hairs on the video capture image are used as an indicator for the laser position and size. The position and size of the red cross-hairs in the video capture image should correspond to where the laser is firing and the approximate size of the laser beam area.

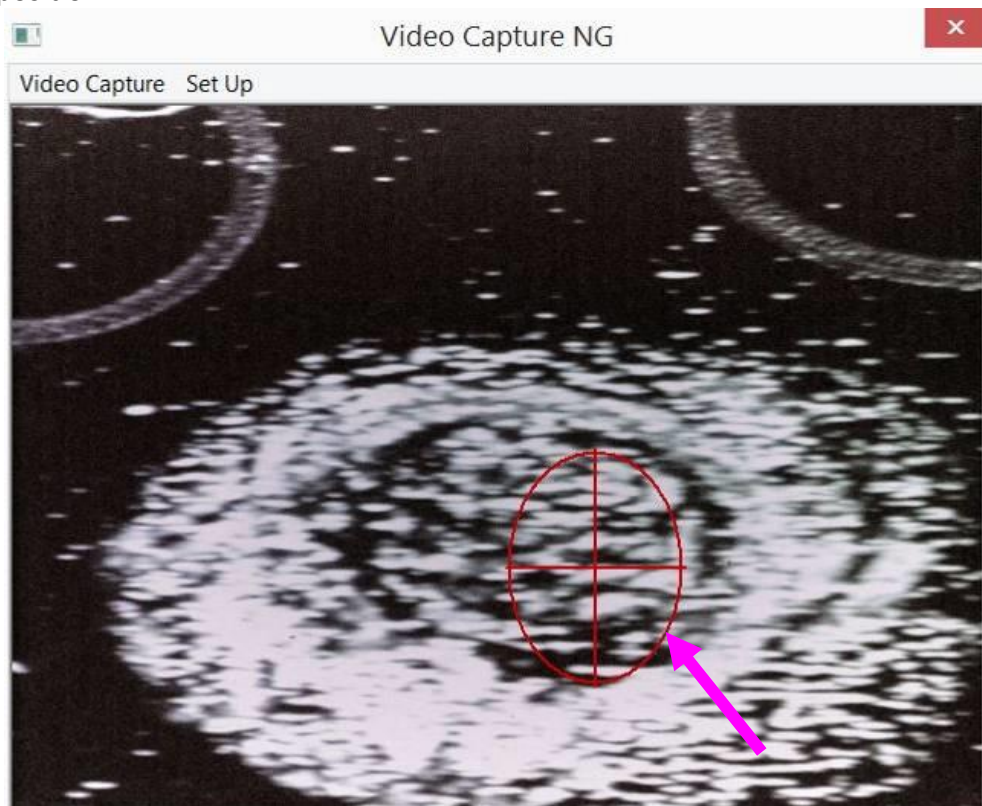
**NOTE:** The red cross hairs are simply an indicator and do not physically adjust the position of the laser.

Adjust the position of the red cross hairs to coincide with the burn mark of the laser. It is easy to this with spiral/raster motion deactivated, and using a dense matrix. Hold down the *Ctrl* key and drag and drop the red crosshairs to the position do where the laser is firing (Fig. 7.4).



*Figure 7.4 Positioning the Red (Laser) Cross Hairs*

Positioning the red laser cross hairs is done by placing the mouse at its center, *pressing Ctrl*, and then dragging the red cross hairs to the desired position.

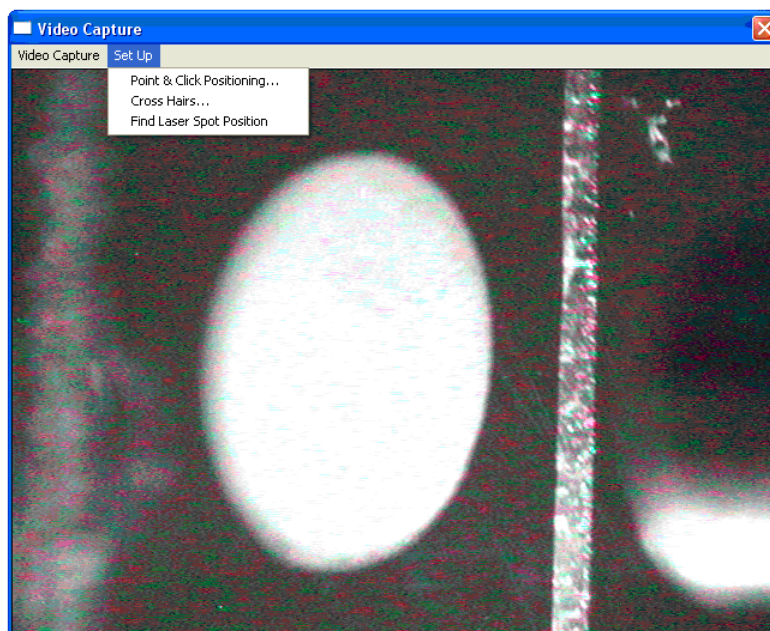


*Figure 7.5 Resizing the Crosshair*

The laser can be resized by placing the mouse at the center of the red cross hairs, pressing *Shift*, and then dragging the mouse to the resize the area.

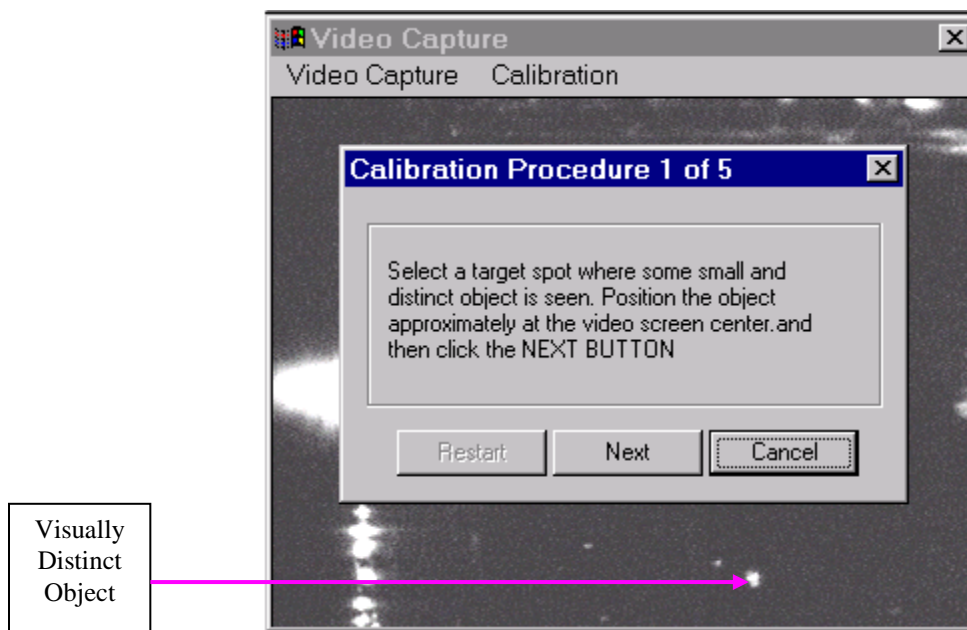
### 7.4 Calibration of the Video Capture Sample Positioning System

To move the position of the sample that needs to be laser irradiated, a “point-and-click” system has been developed through the video capture imaging system. This “point-and-click” system uses the mouse pointer to choose a desired location on the sample image; double-clicking the left mouse button will move the sample to the desired location. Before this system can be accurately utilized, it **must** be calibrated. The user can calibrate the positioning of the “point-and-click” under the video capture menu bar. He/she will click the “Set Up” icon and then choose the “Point & Click Positioning” option (Fig. 7.6).



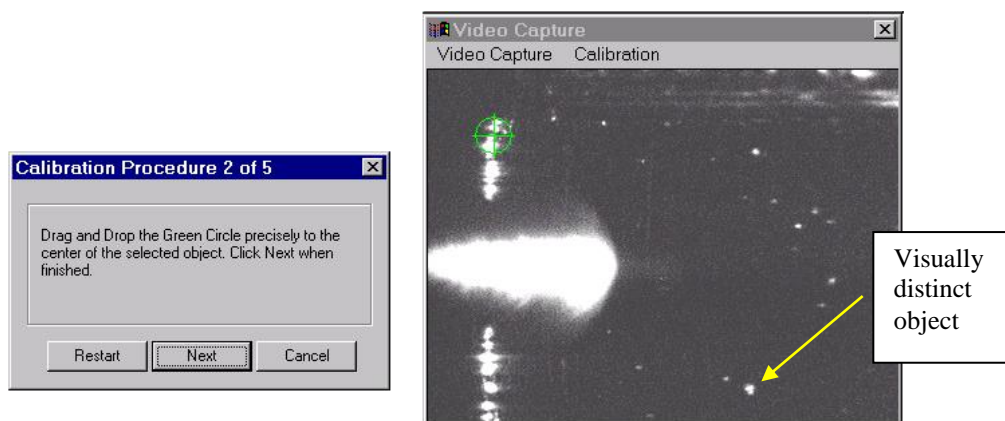
*Figure 7.6 Start of the Video Capture Sample Positioning Calibration Procedure*

Following the calibration, a five-step procedure will be described in the upcoming dialog boxes. The first step is to ensure that there is a distinct visual object on the screen (see Fig. 7.7). A sample plate with an ablated or dilute matrix can be used. If there is no distinct visual object select another spot, or prepare a new sample (Section 6). Advance through Step 1 by clicking “Next” (Fig. 7.7).

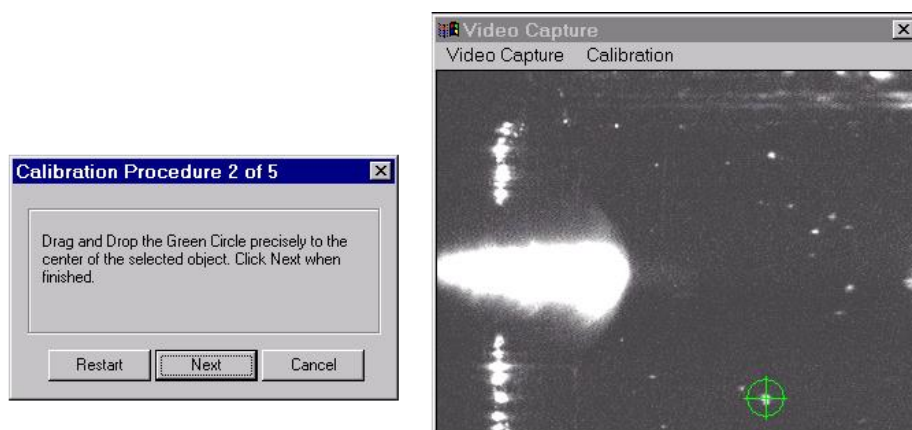


*Figure 7.7 Step 1 of the Video Capture Sample Positioning Calibration*

In Step 2 Figure 7.8a shows the position of the original green target on the video capture screen. Drag and immediately drop the green target icon to the visually distinct object in the lower right hand quadrant (Fig. 7.8b). Then, click "Next."

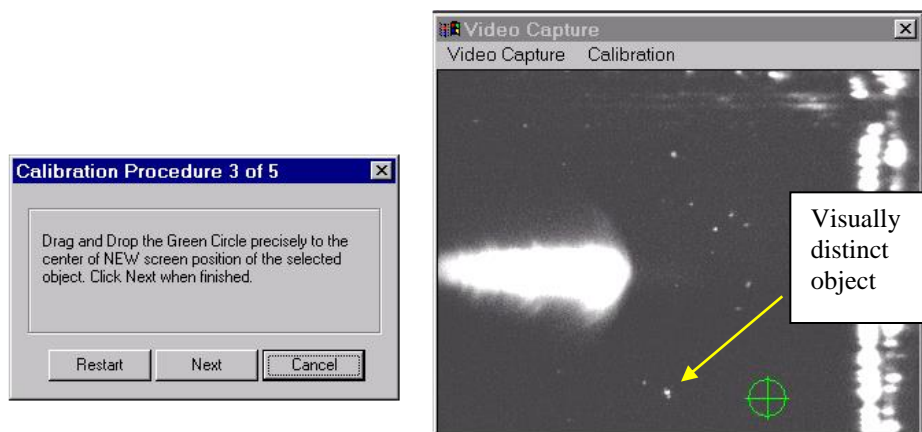


*Figure 7.8a Step 2 of the Video Capture Sample Positioning Calibration showing the position of the original green target.*

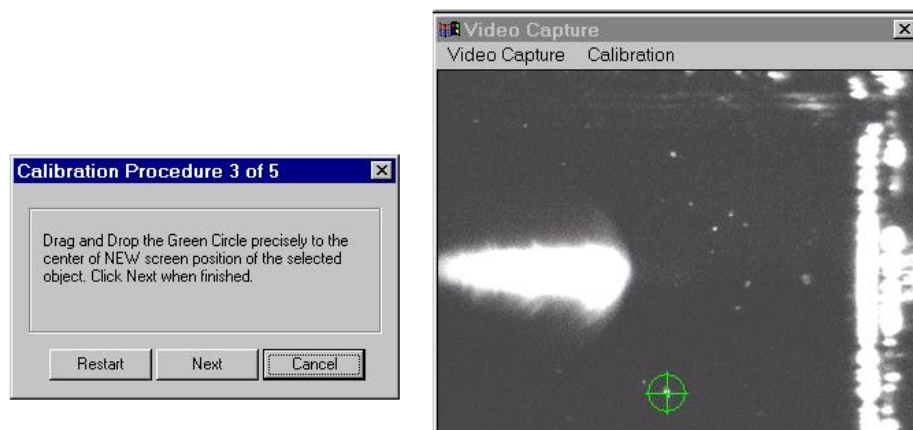


*Figure 7.8b Step 2 of the Video Capture Sample Positioning Calibration showing the green target dragged to a visually distinct object in the lower right hand quadrant.*

In Step 3 (Fig. 7.9), the target plate moves horizontally. Watch where the visually distinct object moves to (Fig. 7.9a). When it stops, drag and drop the green target icon to the new position of the visually distinct object (Fig. 7.9b). Then, click “Next.”

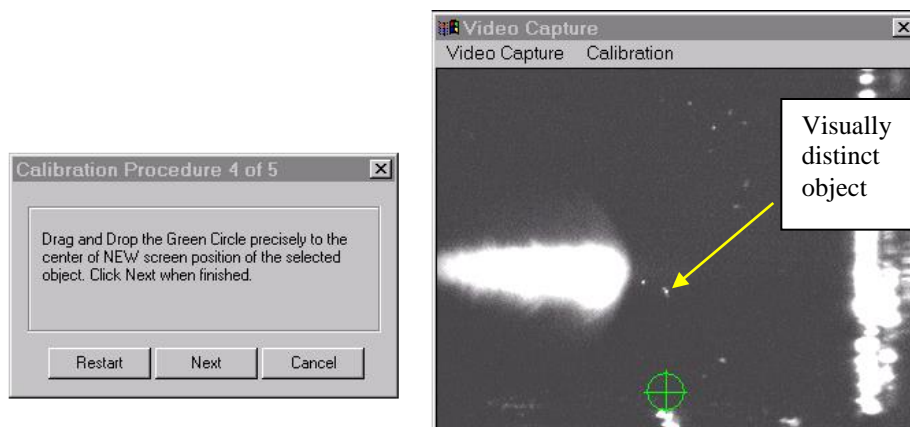


*Figure 7-9a Step 3 of the Video Capture Sample Positioning Calibration showing the visually distinct object moved horizontally away from the green target.*

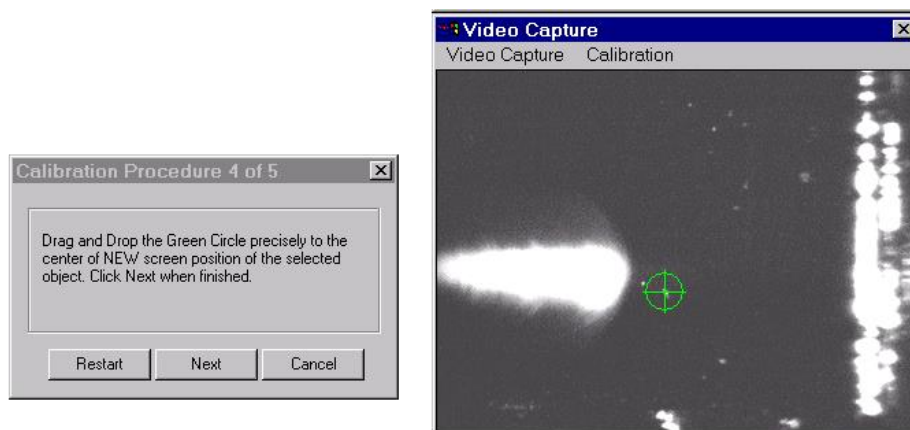


*Figure 7-9b Step 3 of the Video Capture Sample Positioning Calibration showing the green target dragged and dropped back on top of the visually distinct object.*

In Step 4 (Fig.7.10), the target plate moves vertically. This time it moves vertically. Watch where the visually distinct object moves to (Fig. 7.10a). Drag and drop the green target icon to the new position of the visually distinct object (Fig. 7.10b); then, click "Next."

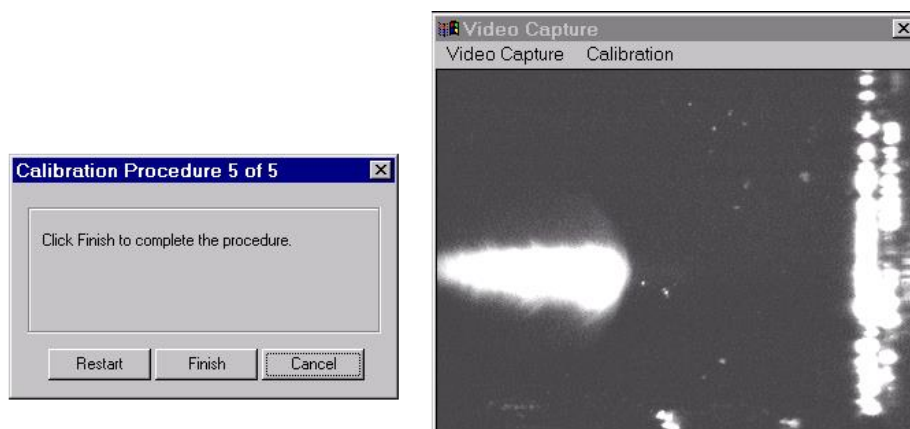


*Figure 7-10a Step 4 of the Video Capture Sample Positioning Calibration showing the visually distinct object moved vertically away from the green target.*



*Figure 7-10b Step 4 of the Video Capture Sample Positioning Calibration showing the green target dragged and dropped back on top of the visually distinct object.*

In Step 5 (Fig. 7.11), click “Finish” to accept the new calibration. The “Cancel” button keeps the original calibration and the “Restart” button allows for the user to recalibrate the system again.



*Figure 7-11 Step 5 of the Video Capture Sample Positioning Calibration.*

Now, use the mouse pointer and (double-click the left mouse button) verify that the sample moves to the desired location.

### **7.5 Finding the Laser Spot Position**

To get the maximum sensitivity, the user needs to put the laser spot between the capillary inlet of the mass spectrometer and the image of the capillary inlet. This can be done through the Find Laser Spot Position procedure started in the Set Up drop-down menu.

In Step 1, drag and drop the green target icon to the capillary inlet of the mass spectrometer (Fig. 7.12). In Step 2, drag and drop the green target icon to the image of the capillary inlet of the mass spectrometer (Fig. 7.13). Then click “Next.” Now the user should see the red cross hair between the capillary inlet of the mass spectrometer and the image of the capillary inlet.



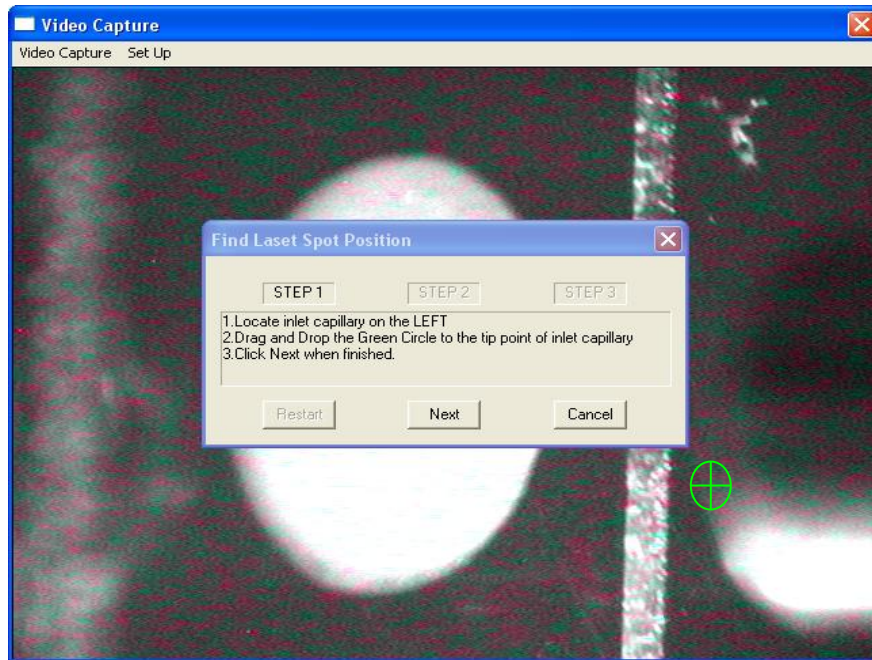


Figure 7.12 Step 1 Of Find Laser Spot Position procedure

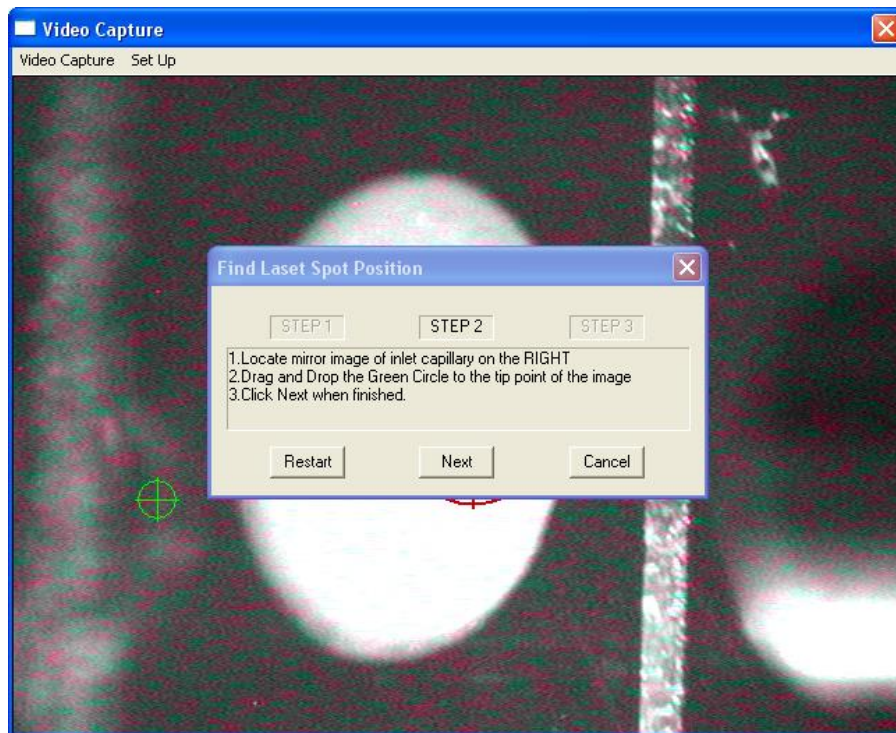


Figure 7.13 Step 2

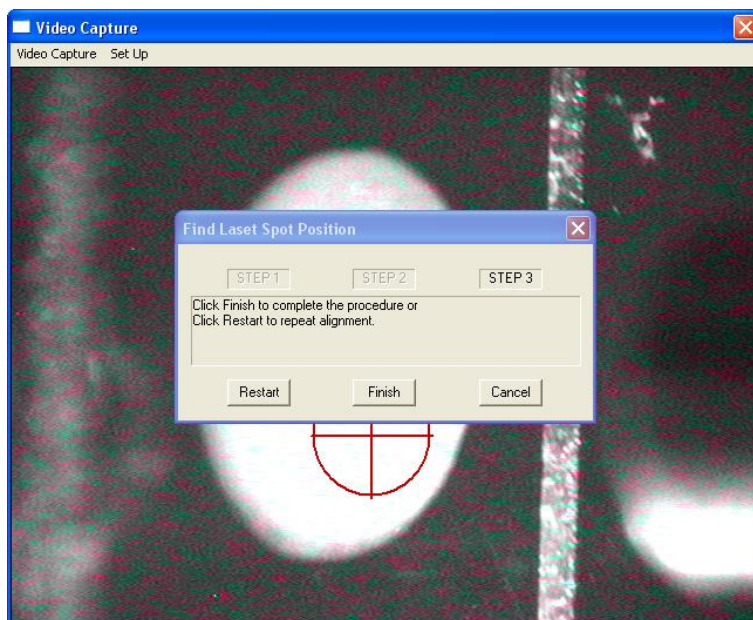


Figure 7.14 Step 3

## 7.6 Running the AP/MALDI on the Thermo MS Instrument

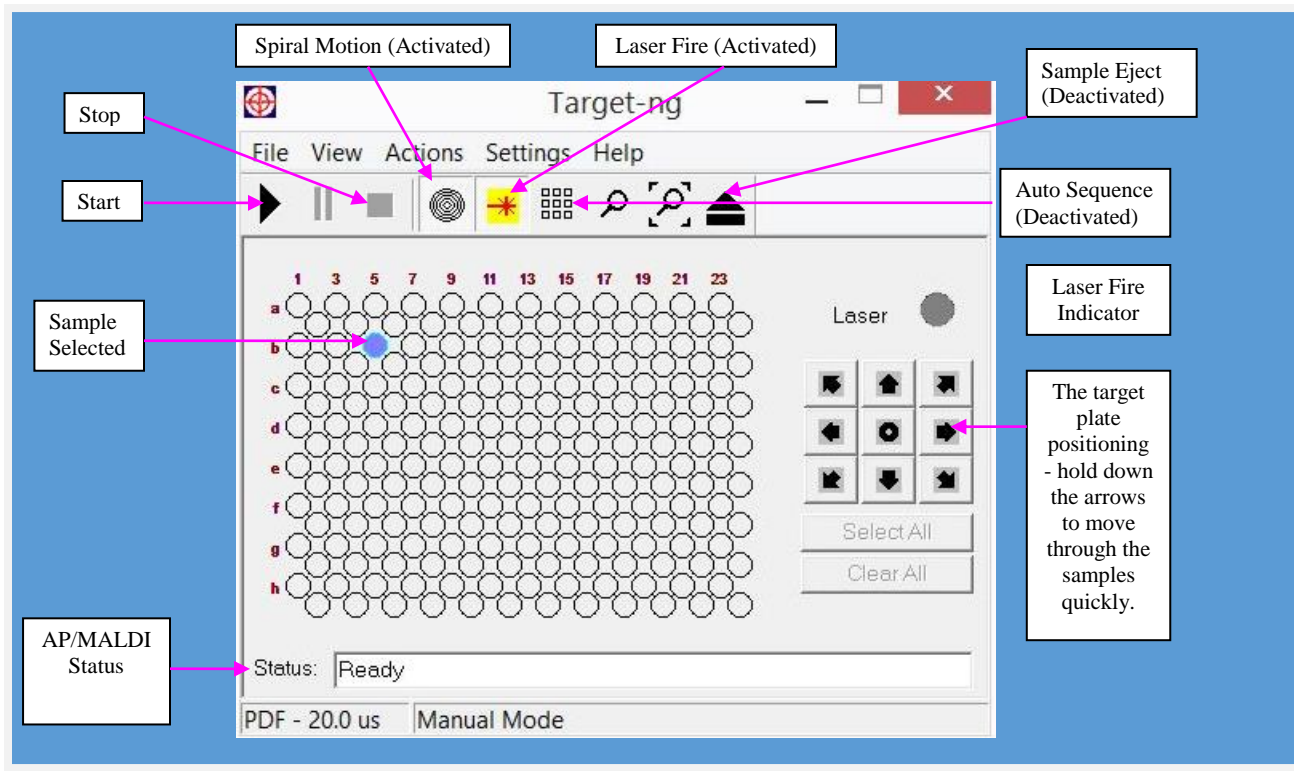





Figure 7.15 Target Software Controls

There are two modes of operations for the Target Software: manual (auto sequence toolbar icon is deactivated) and auto sequence. The user can switch between the modes by pressing the auto sequence toolbar icon  (Fig. 7.15). In the manual mode, only one sample on the "target plate" can be selected. Click any spot in the target plate field and the target plate will move to the selected position. The user can shift the position of the spot by clicking the arrow buttons placed around the center button as shown in Fig. 7.15, or through holding down on the arrow buttons to advance to the next sample faster. Click the center button to restore the central spot position.

In the auto sequence mode, multiple samples can be pre-selected. Use the clear all/select all buttons to select/clear all the spots. To select a continuous series of spots, follow the required procedures:

- Click the first spot.
- Pressing/holding down the *Shift* button, click the last spot.
- To choose selected spots, press *CTRL* and click the spots needed for analyzing.

To start the actions, press the "PLAY"  icon. The "PLAY" button also activates other features depending on what other toolbar icons (Auto Sequence/Laser and Fire/Spiral/Raster Motions) are activated. To stop ALL activated actions, press the "STOP"  icon.

Note, that even after the actions have started (i.e., the "PLAY" button has been pressed), the user can manually shift the spot by clicking on the video capture image. The user can additionally switch the laser to the "ON" or "OFF" mode, and start/stop the spiral motion by activating/deactivating the appropriate button(s).

In the auto sequence mode, after the "PLAY" button has been pressed, the target plate moves to the upper left of the selected spots. Then the laser starts firing and the target plate spirals slowly around the initial position (if the default spiral and laser fire buttons are used (i.e. if activated)). After a pre-selected time, all actions stop automatically and the target moves to the next pre-selected spot; the same selected spiraling motion will occur if originally activated. The process is repeated until the last spot is finished (or the "STOP" button is pressed). The order of sample testing is from left to right (in every row) and from the top to bottom rows. Additional time delays can be introduced between the samples and between the rows.

To change the various program parameters such as the: spiral/raster motion properties, laser frequency, auto sequence mode timing and so on, click the "Settings" button and edit the parameter(s) as it is shown in Figs. 7.16 to 7.19 below.

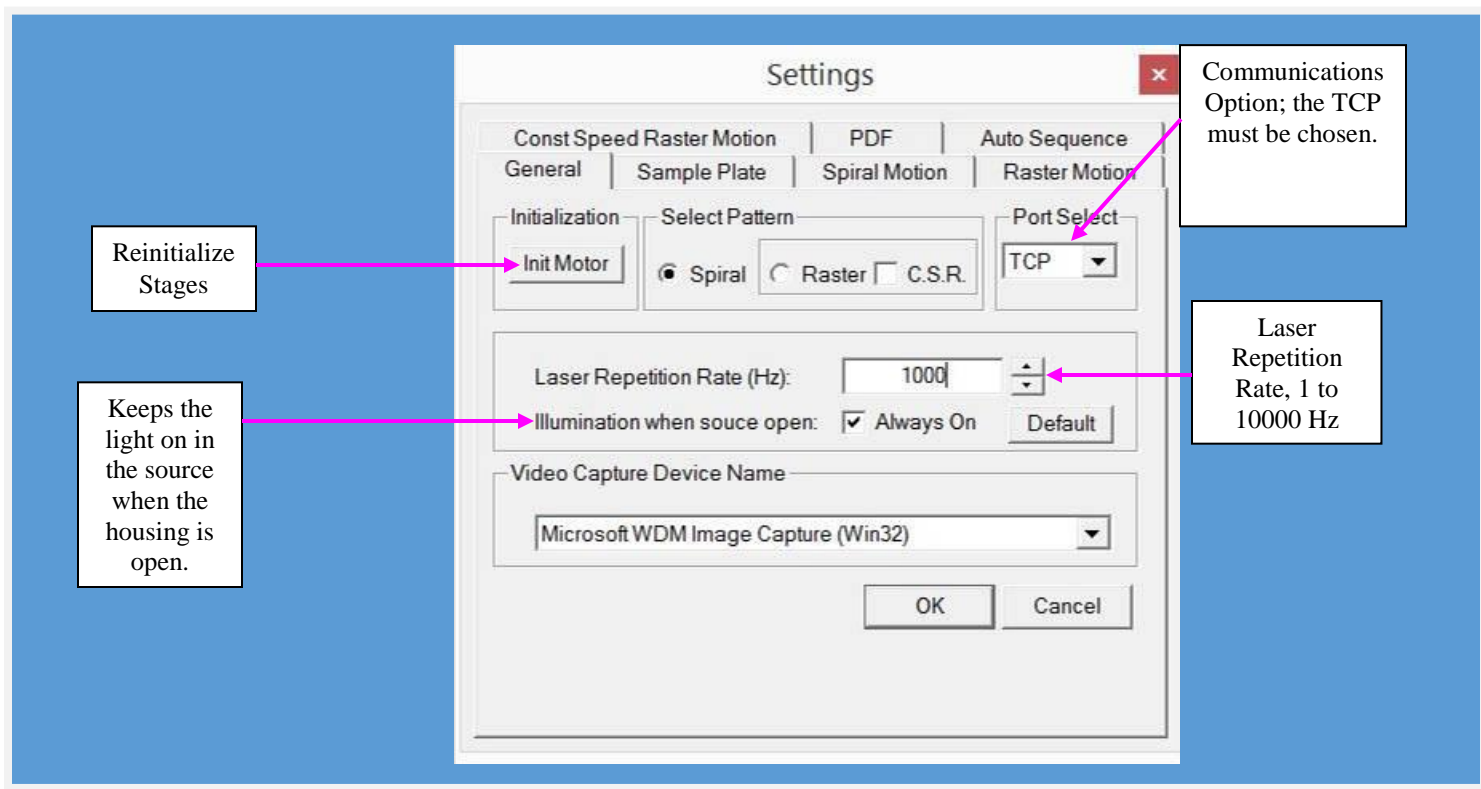


Figure 7.16 General Settings in the Target Software

There are three different sample plate patterns that can be selected during the MS data acquisition to desorb the fresh regions of the sample surface by laser radiation. The spiral motion and raster images can all be seen in Fig. 7.16. The parameters of the patterned motion can be adjusted using the two separate pages of the setting dialog function: spiral and raster motion, correspondingly. The spiral or raster motions can be used if the acquisition of long enough MS signal is desirable. A relatively weak MS/MS data recording would be expected during the signal accumulation if using either motions.

Note: Constant Speed Raster Motion (CSR) tab under the Settings Window is obsolete; do not use it. To use CSR, use "Zoom Mode" (Section 7.12).

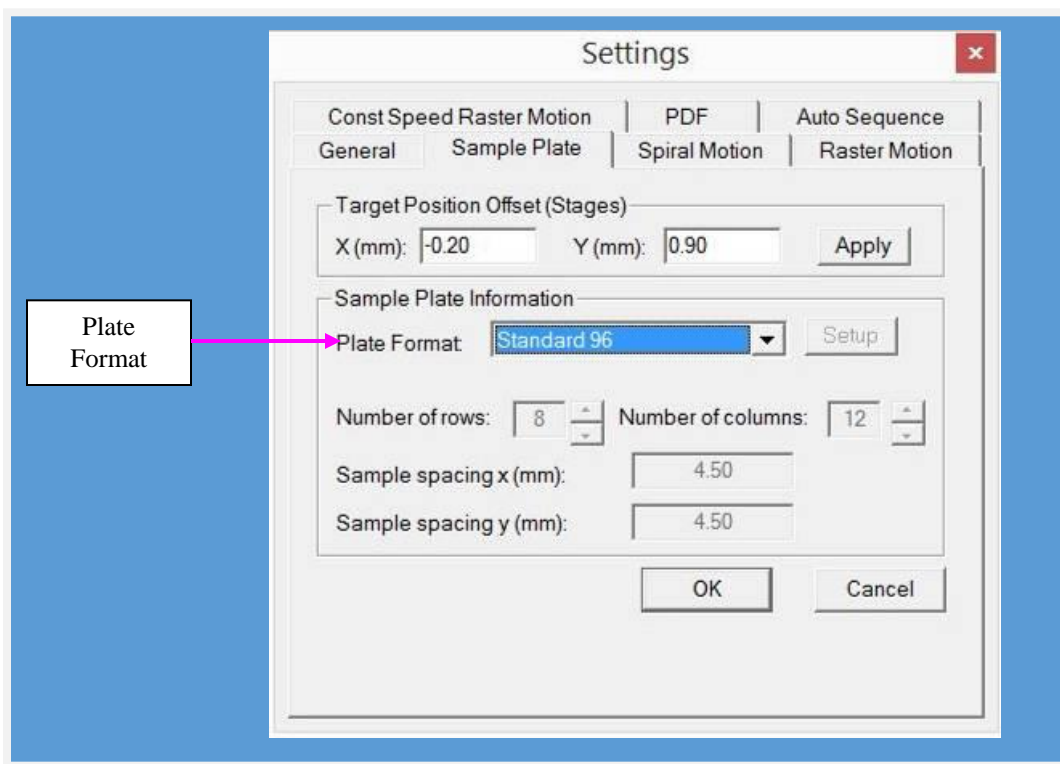


Figure 7.17 Sample Plate Settings in the Target Software

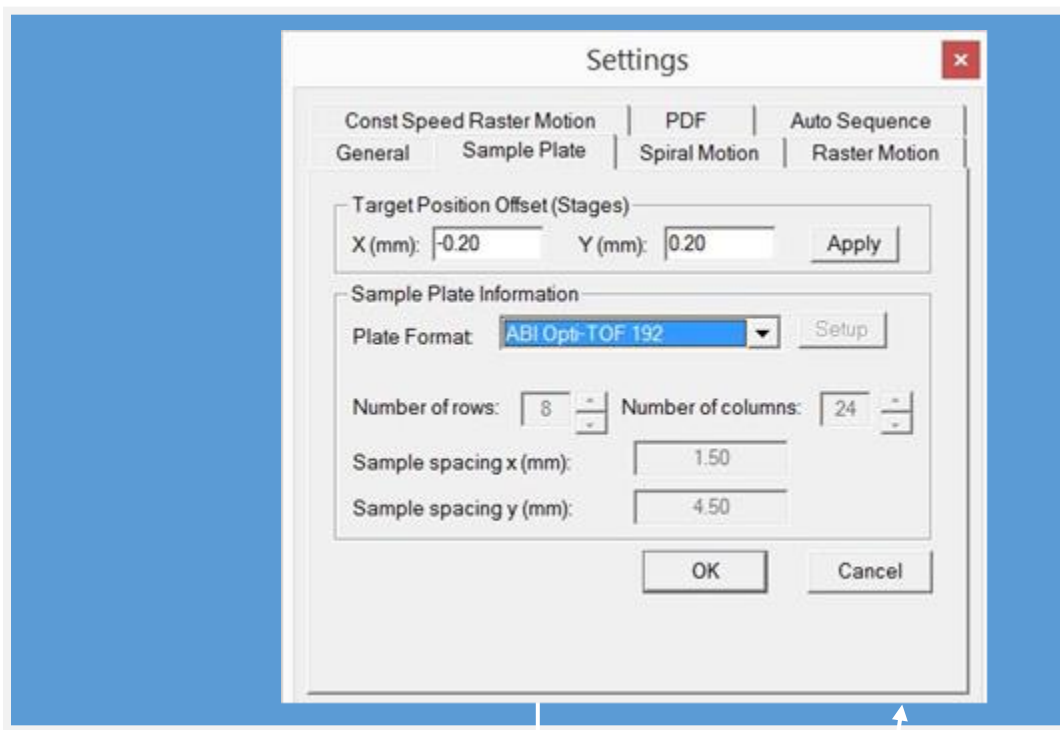


Figure 7.18 Plate Formats Supported by the Target Version 7.0 and the AP/MALDI Ion Source

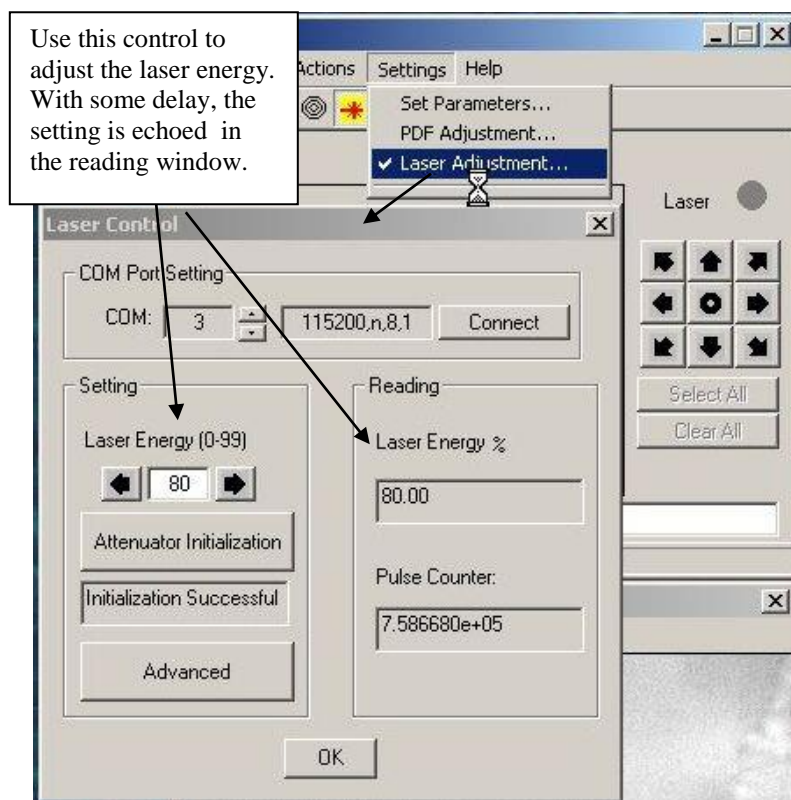


Figure 7.19 Laser Adjustment Dialog

To adjust the laser attenuation, use the dialog box shown in Fig. 7.19 (accessed through the **Settings** -> **Laser Adjustment** menu item).

The AP/MALDI source is ready for operation after the user has completed the following:

1. Hardware/software installation
2. Sample preparation
3. Successful run of the Target Software

## 7.7 Setting the Parameters of the Thermo Mass Spectrometers

To run the AP/MALDI on the MS instrument optimally, the following tuning procedure of the Thermo Xcalibur Program is recommended:

# AP/MALDI Ion Source

- Tune the instrument in ESI mode before switching the source to the AP/MALDI mode and save the corresponding tune-file; refer to the MS Operator's Manual.
- Typical parameters that represent a good starting points for the AP/MALDI measurements are shown in Figure 7.20.

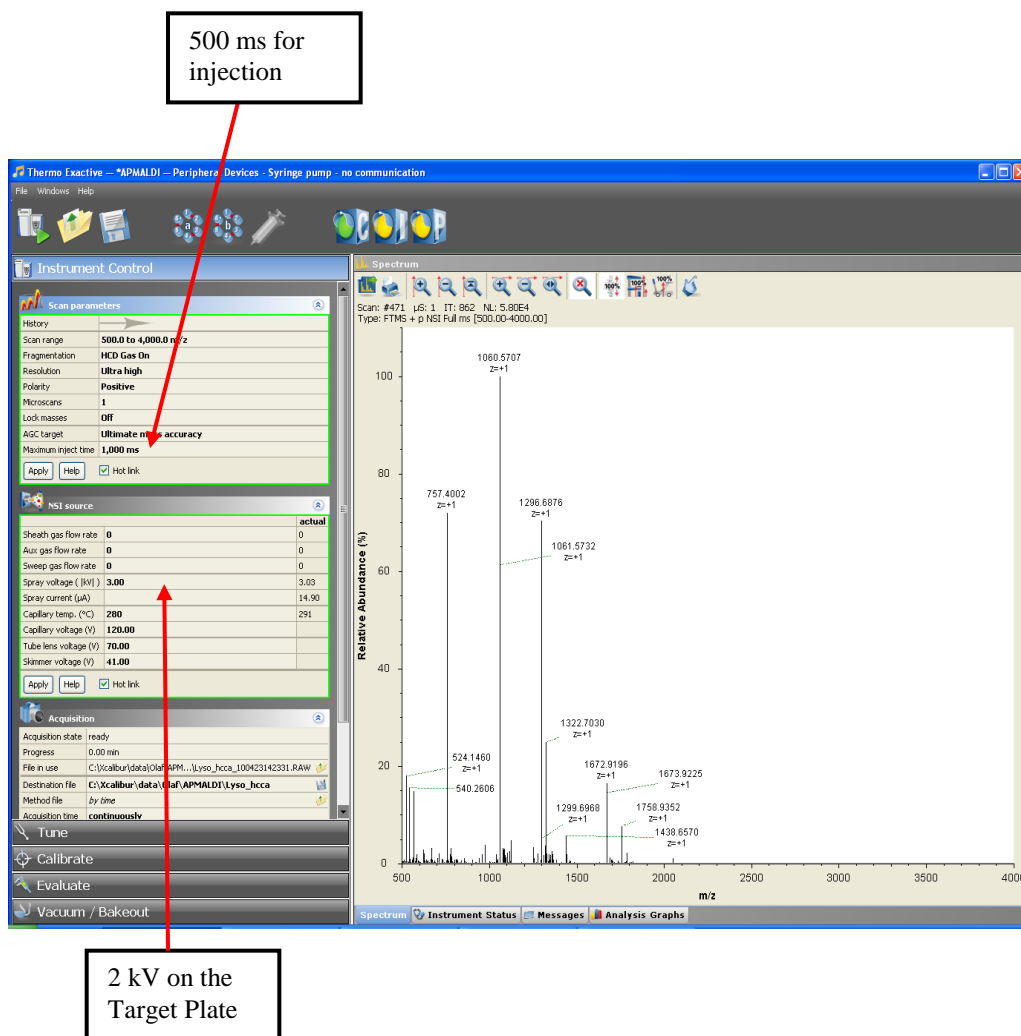


Figure 7.20 Good Parameters for the Capillary HV (2000 V) and Injection (Accumulation) Time (500 ms)

- **Drying gas and nebulizing gas settings:** The AP/MALDI process does not utilize drying or nebulizer gas. The source settings in the XCalibur control software, in most cases, are recognized as the MALDI source. In some Thermo MS systems, if such recognition does not happen, the user needs to set the ion source as nanoESI.

- Laser pulse energy and frequency may be easily tuned through the Target Software (see Fig. 7.16 and 7.19). Typically the user should tune the attenuation for the maximum signal only once, for every matrix type ( $\alpha$ -CHC, DHB and so on).
- The final recommendation is how to choose between the manual and spiral/raster target motion control in the **TARGET** program. Typically, the signal from one spot deteriorates in 5-20 seconds (depending on the matrix, sample preparation, and laser attenuation). The target can be shifted manually to another spot within the same sample; however, the manual target motion will produce an ion signal that is unstable over the acquisition time. If the user needs a long and stable signal, he/she should start the laser firing and then initiate either of the predefined target motion patterns (spiral or raster motion). This mode will enable the user to continuously expose fresh parts of the sample to laser irradiation. The spiral motion will give the user a stable AP/MALDI signal for 10-20 seconds; this is sufficient for MS and MS/MS experiments.
- Fig. 7.20 represents a screen copy made during an AP/MALDI spectrum measurement of CHCA matrix. The user can easily switch between the *XCalibur* and *TARGET* Programs to operate both the MS and AP/MALDI source from the same computer. An alternative method for the user is to run the program on separate computers.

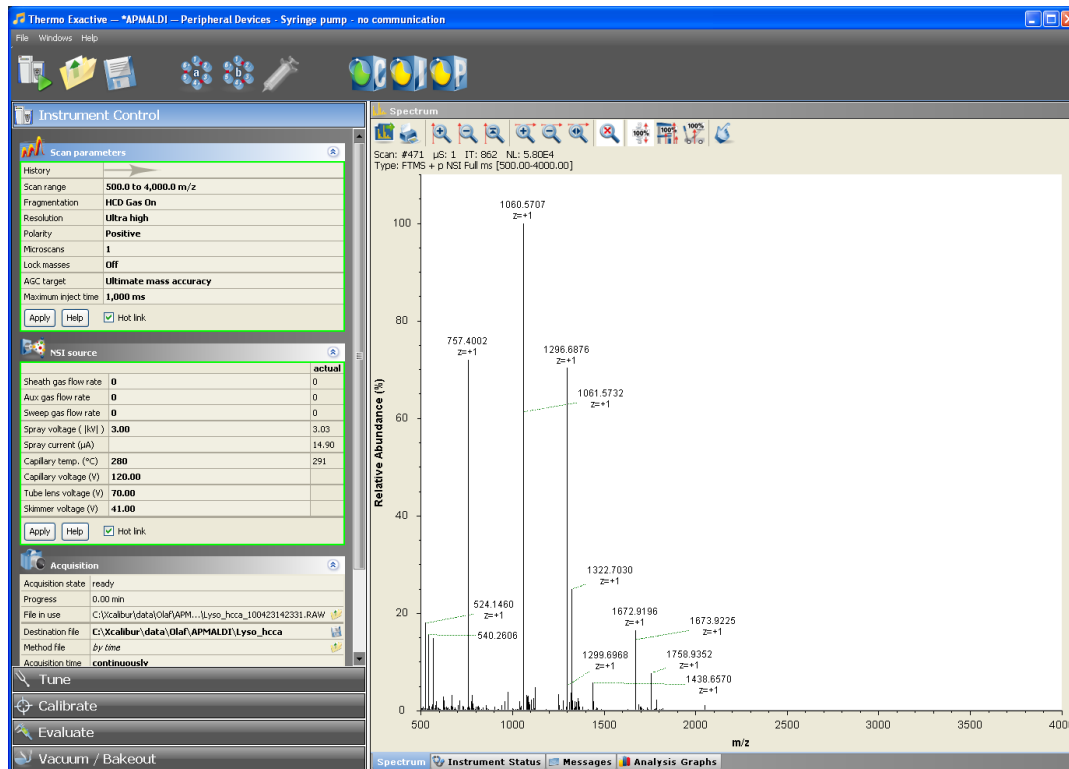


Figure 7.21 Operation of the Target Software

To further enhance the throughput of the AP/MALDI setup, de-focus the UV laser by readjusting the micrometer position on the source right side. There is a scale on the side of the micrometer to facilitate this adjustment.

Then increase the laser energy in Target Software so that roughly the same laser fluence (energy/area) is maintained (Figure 7.19). The purpose behind this exercise is to generate more analyte ions per laser shot.

The user should tune the focusing tube position, laser energy, and frequency while optimizing the signal intensity for a standard chemical. The AP/MALDI is sensitive to the laser fluence. If the fluence is too high, there can be an increased chemical noise and poor analyte signal to noise ratio (S/N). If the fluence is too low, the analyte peaks may not be present due to insufficient ionization energy. Carefully adjust the laser energy and focusing until the signal is optimal. An improvement in signal intensity by a factor of an additional 2 to 3 is reasonable in these laser-related adjustments.

### 7.8 *AP/MALDI(ng) UHR Operation*

1. Spot Size: (visible-note the laser spot on CCD image is about 5-10 times bigger than the actual laser beam measured by the burn)
2. Spot Shape: For spot shape optimization, both the mirror and the lens may need to be adjusted.
3. Signal: ion counts are typically less than standard AP/MALDI. The ion count dissipates to zero in 1-2 seconds if the user remains at the same spot. The spiral motion velocity should be 15 mm/sec. Therefore, by quickly moving the stages/ laser on the sample, on scan obtain similar ion counts.
4. Watch the Injection Time: it may be too high if the user observes space charge effect (peaks on the MS will appear at higher mass and will be broad).
5. See the Troubleshooting section for fine tune of the laser spot size.

### 7.9 *Manual Mode of Operation*

Manual control means that the user controls the data acquisition in an interactive real-time manner. Most of the acquisition parameters can be accessed and changed during the data acquisition using the Xcalibur Tune Plus Program and Target features. The data acquisition in Xcalibur is started independently from the target position and laser control within the Target Software. The spectra acquired will depend on which sample is currently located near the inlet capillary and parameters. Some of the samples and parameters include the following:

1. Laser frequency
2. Laser energy
3. Speed of the target plate accessible via Target Software
4. The amount of voltages on the capillary
5. Octopole and ion optics voltages that area accessible via Xcalibur

Saving the spectral data is the responsibility of the user and is done using appropriate Xcalibur functions.

The procedure for operating in the manual mode consists of several basic steps:

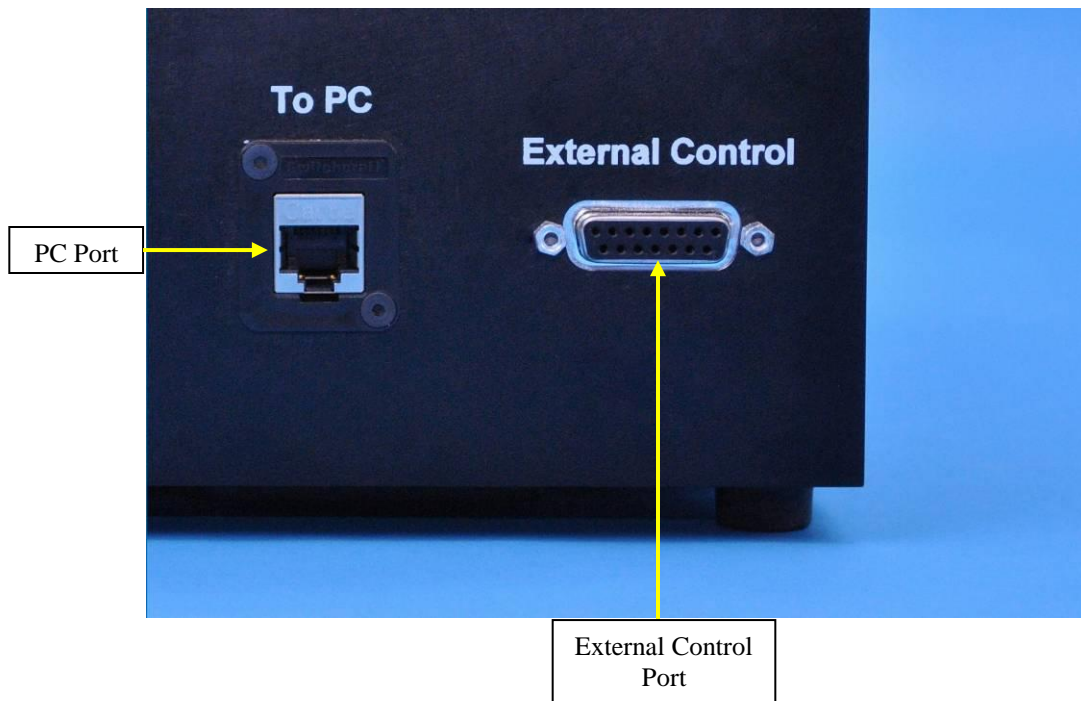
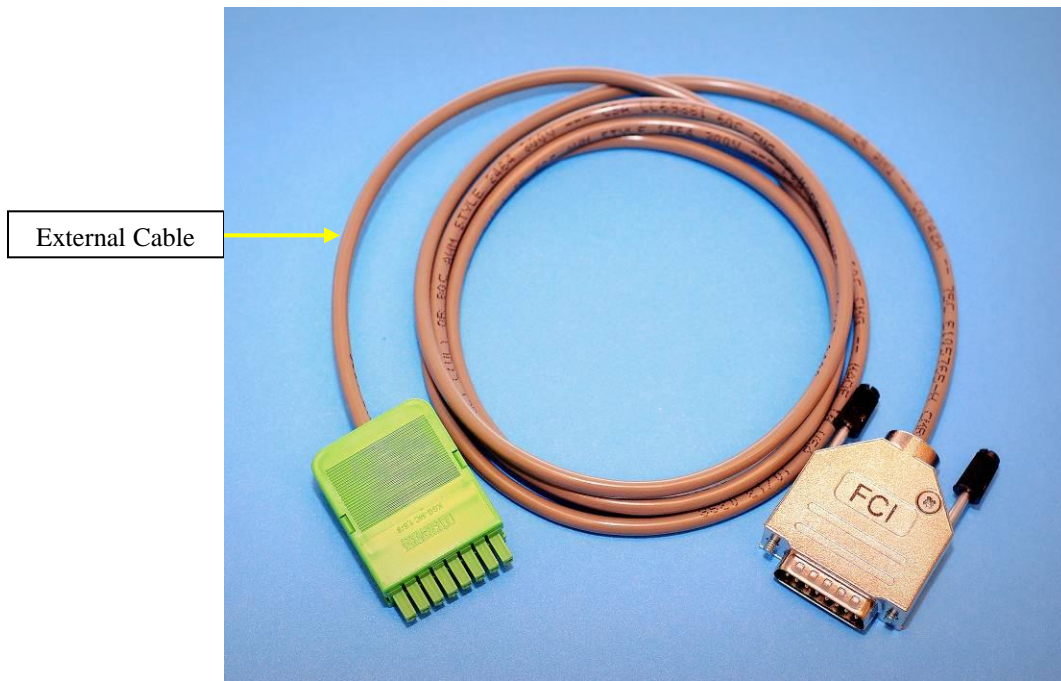
1. Deactivate the “Auto Sequence” button in the Target Software window (See Fig. 7.15 for its location in the software).
2. Start the data acquisition using the Xcalibur Software (refer to the previous Setting Parameters Section (Section 7.5) in this manual or the Thermo’s Xcalibur Software Manual for more details).
3. Set desired Target settings (using the settings dialog window).
  - 3.1. Set the desired laser energy and repetition rate.
  - 3.2. Activate the “Laser Fire” button and “Spiral Motion” button (if desired).
4. Click on the desired sample using the sample spot selector (map) provided in the Target Software window (see Fig. 7.1). The target plate will move to this sample position and stop near its center (this is observable on the video capture imaging system).
5. Press the “Play” button in the Target Software window to start the AP/MALDI operation.
6. Adjust the desired laser energy using the micrometer knob on the control unit front panel, or position the laser spot on the sample.
  - 6.1. Use the “Point-and-Click” or “Manual Motion Control” arrow buttons in the Target software window while observing the sample on the video capture screen).
7. Save the data acquired (when necessary) by using Xcalibur Software.
8. Press the “Stop” button in the Target Software window to end the AP/MALDI operation.

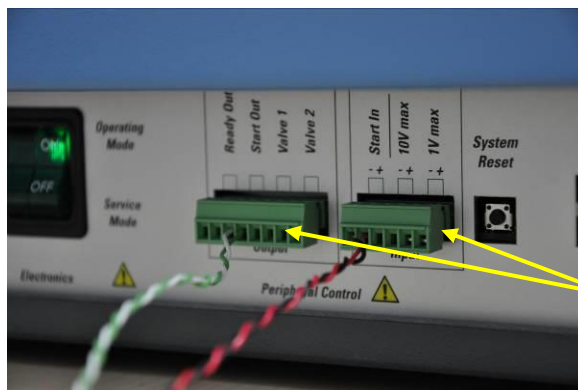
9. Repeat steps 3-8 to acquire one or more spectras from the same (or different) sample.
10. Stop data acquisition on the Xcalibur Program.

### ***7.10 Automated Mode of Operation***

In the manual mode of operation, described in the previous section, the user acquires the spectra of different target spots (samples) one by one. The automated mode of operation enables unattended recording of multiple spectra for several samples as a batch. The Target Software provides two modes: the internal timing and automate mode of the data acquisition. Since the procedures of the configuring and running automation modes are similar to a family of various MS instruments of the Thermo Electron, Inc. (LCQ, LTQ, LTQ-FT or LTQ-Orbitrap, exactive), it is described below for LCQ instrument.

The first mode, that is called internal timing mode; there is no synchronization of the AP/MALDI source operation with the mass spectrometer data acquisition. On the mass spectrometer side, the user starts the continuous data acquisition/recording. However, on the AP/MALDI side, the user can select multiple spots, set the acquisition time per spot, and run all the selected spots automatically one by one. The timing of the experiment is controlled by Target Software; after the acquisition of last spot is finished, the user should stop data acquisition of Exactive manually. A major disadvantage of this regime is that the spectra for the different samples are recorded in a single spectrum under the same file name. The user can extract the spectra for the individual samples based on the retention time of the corresponding spectra (during data processing).





Automation Cable: The exactive side of the panel connection is plugged into the “Peripheral Control” port.

*Figure 7.22 External Control Cable and Its Connections*

Figure 7.22 shows the external control and its connection to the rear panel of the AP/MALDI’s control unit and to the side panel of exactive. The second automated mode, the external timing, enables the user to record the spectra of various individual samples; the recorded spectra are in separate files under separate user-defined names. The exactive communicates with the AP/MALDI source through an exchange of the bi-directional “Start” and “Ready” signals. The AP/MALDI’s external control cable connects to the rear panel through using the peripheral control port; the cable and its connection point are shown in the Fig. 7.22.

The selection between the two automation modes is implemented in the “Auto Sequence” tab of the “Settings” dialog box in the Target Software (the dialog is activated through “Settings” menu item); this is shown in Fig. 7.23.

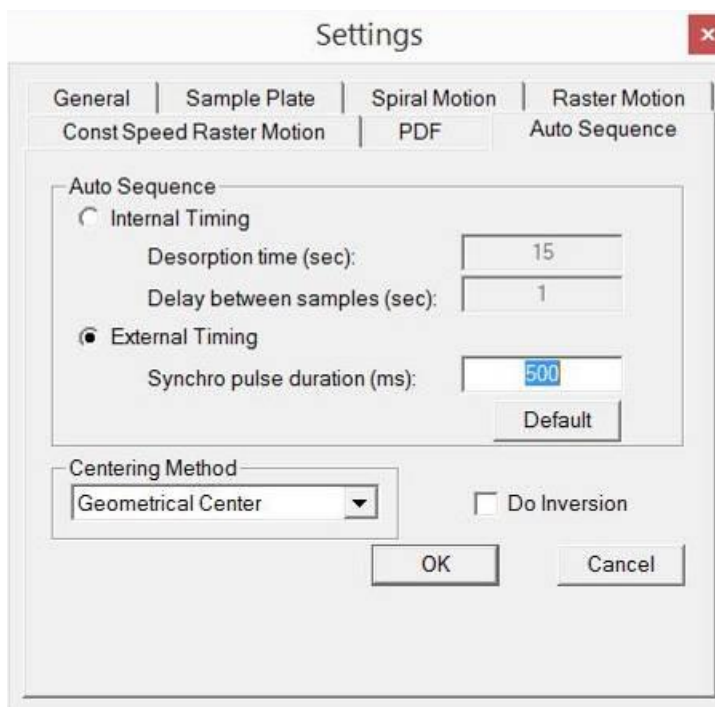


Figure 7.23 Auto Sequence Settings

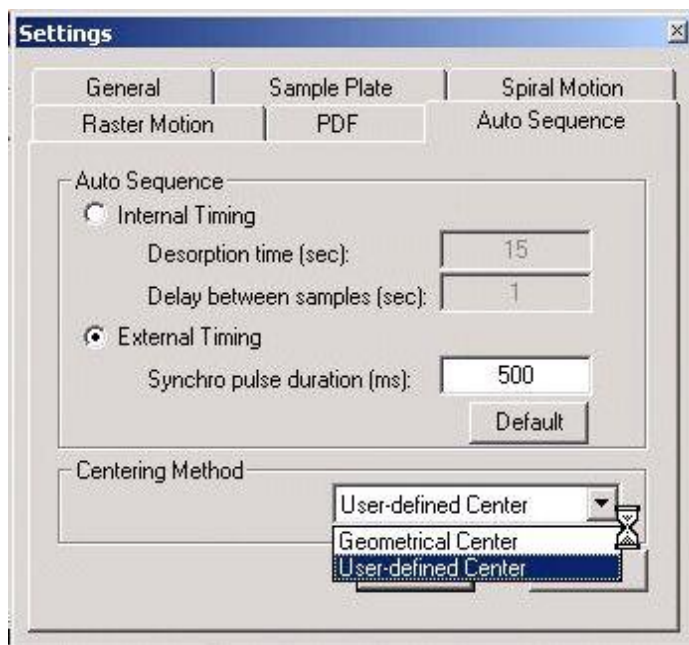


Figure 7.24 Selection of the Sample being Centered

Different modes of the auto sequence mode are available in the software and include geometrical centering (geometry) and user-defined centering (manual), which can be seen in Fig. 7.24. The geometrical centering mode is used when the center of entire sample, which is spotted on the target plate, is precisely in the same spot in each sample cell. This is useful for the automated mode, which controls the spotters. The user-defined centering helps the user establish the center position of the samples on a target plate. When the user is manually hand spotting of samples, the user-defined centering mode may be helpful. The user-defined centering mode also allows the user to tell the Target Software where the center of the sample is for each spot that needs to be analyzed.

The procedure for in the user to operate the source in the auto sequence mode can be found below:

1. For the external timing mode, connect the “External Control” connector (located on the control unit’s rear panel) to the Thermo MS system’s Peripheral Controls” port (Fig. 7.22).
2. Check that the “Auto Sequence” button is activated in the main Target Software window (see Fig. 7.15) and that the “External Timing” radio button in the Target’s “Settings Dialog” window is activated as well (see Fig. 7.23).
3. Make sure that the “Auto Sequence” button is activated in the main Target Software window (see Fig. 7.15). For the internal timing mode, click the “Internal Timing” radio button in the Target’s “Settings Dialog” window (see Fig. 7.23).
  - a. For external control, click the “External Timing” radio button; 500 ms in the figure is the appropriate duration of “Start” pulse.
4. Select the desired position(s) on the sample spot selector (map) in the main Target Software window by first using the “Clear All” or “Select All” buttons while simultaneously pressing the *Shift* or *Ctrl* keyboard buttons and clicking on the sample map.
  - a. Selecting the sample spots is similar to using the mouse for selecting files in the Windows operation system. Use the *Ctrl* button to make multiple selections that can be located at different areas of the target plate, or use the *Shift* button too. The selected samples will be executed in order from left-to-right, starting from the highest row on the map and then moving to the next lower row.

5. For the “Internal Timing” mode, the “Start” button continues the data acquisition/recording in Tune-Plus Program of the Xcalibur package. Then, click on the “Play” button in the TARGET Software window to start AP/MALDI operation.
  - a. The data acquisition will continue during the time specified for the spot selected, which is known as the desorption time (Fig. 7.23). When the data acquisition from the first sample is done, the laser firing is automatically stopped (by the software) and the target moves to the next sample spot. The current sample is indicated by a blinking color. The process will be repeated until the last sample spot has been analyzed. Finish the data recording in Tune-Plus Program.
  
6. For the “External Timing” mode, the user will need to first configure the Xcalibur Software, which includes both the instrument and sequence setup. The Tune-Plus Program cannot be used for automated data acquisition in the external timing mode. **The procedure for the tuning of the automated analysis is described in the chapter 7.11; this can only be used for the Xcalibur Software.**
  
7. After Xcalibur is properly configured, the user needs to start the sequence run and then wait for the following status message to appear: “Waiting for contact closure” and then click on the “PLAY” button in the Target Software window to start the AP/MALDI operation.
  - a. The data acquisition will continue during the time specified for the segment in Xcalibur Software. When the data acquisition from the first sample is done, the laser firing stops until the target moves to the next sample spot. This process will be repeated until the last sample spot has been analyzed. The sample positions on the map, where the data have been collected, are shown by a solid color.

## 7.11 The Automated Mode of Operation: Configuring the Xcalibur for the External Timing Mode

### I. The Instrument Setup:

1. If the user is currently running the Tune-Plus Program, close it.
2. Run the Xcalibur/Instrument Setup Program.
3. The user has the option to create or edit an existing instrument method file. If the user chooses to select an existing file, he/she must open an instrument method file that is appropriate for the user's experiment (see Thermo Xcalibur Software Manual for details). Then, click on the contact closure tab (see Fig. 7.25 below).

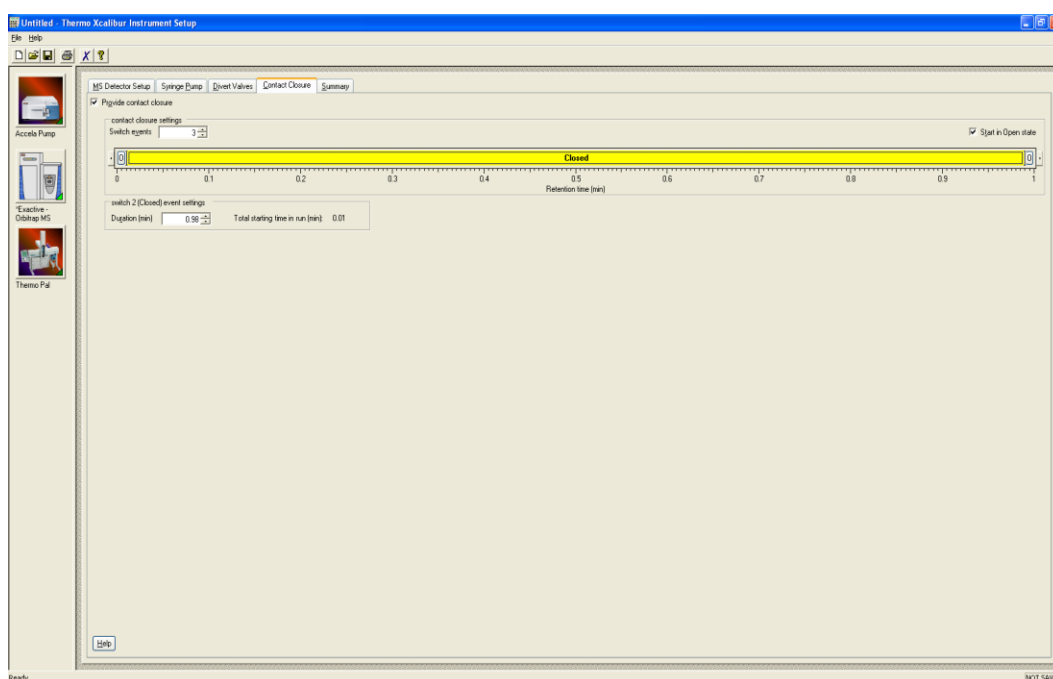


Figure 7.25 Instrument Set Up

Figure 7.25 shows the contact closer when it is configured for the external timing and automated AP/MALDI data recording.

4. Make changes to this page so it looks exactly like that shown in Fig. 7.25 including:
  - Checking the “Use contact closure” check box
  - “Number of contact positions:” 3
  - “Position at start of run:” Open
  - “Contact position duration (min):” 0.01 when Position 1 or 3 is selected

- Save the settings to the instrument method file and close the Instrument Setup Program. These settings ensure that the signals on contacts 1-2 of the “Peripheral Control” connector control the laser firing by the *TARGET* Software. They will be used later during data acquisition. If the user can prepare several different instrument methods for the different types of experiments and experiment durations, he/she must make sure that the contact closure profile for every method looks like it is shown in Fig. 7.25.

## II. The Sequence Setup:

- Run the Xcalibur/Sequence Setup Program.
- Create the Xcalibur Sequence or open an existing Xcalibur Sequence file (see the ThermoXcalibur Software Manual for specific details). The number of samples in the sequence setup window table (see Fig. 7.26) should correspond to the total number of samples selected for the analysis.

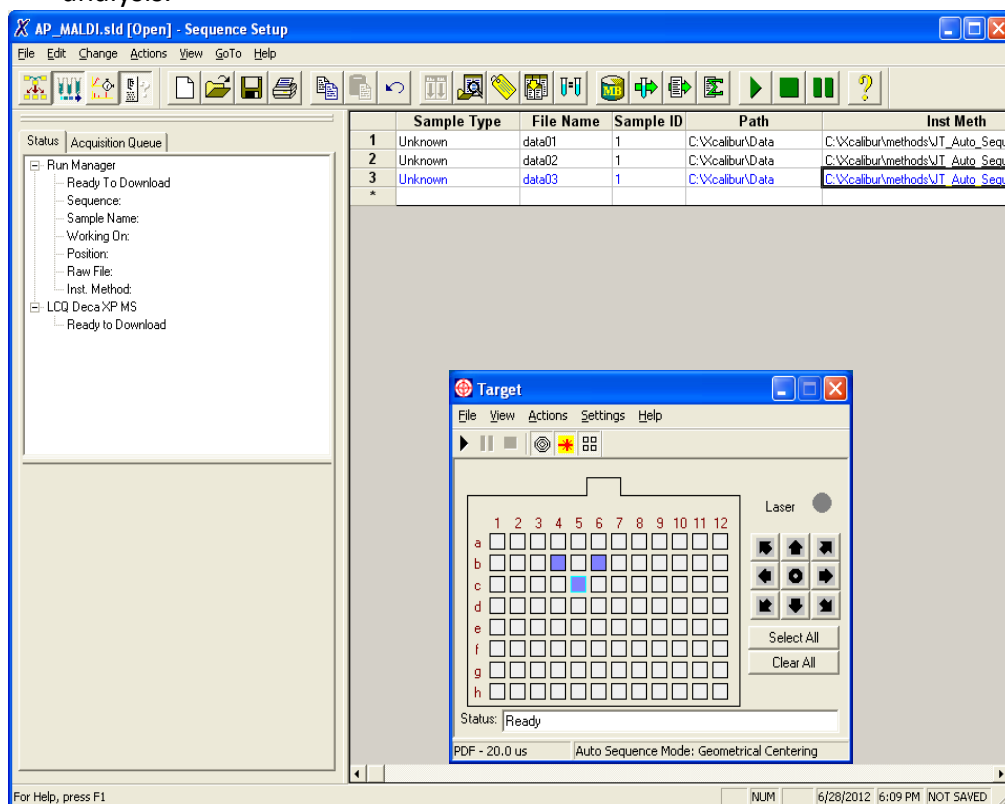


Figure 7.26 Xcalibur/Instrument Setup/Sequence Setup and Target

Figure 7.26 shows the sequence setup that is configured for the external timing and automated AP/MALDI 3 sample data recording process.

The lines in the table are run sequentially, and every line in the table corresponds to the sample selected in Target window as they are run one-by-one (Fig. 7.26). Please use the help/sequence setup menu in the Xcalibur/Sequence Setup Program for more details on the creation and editing of the Sequence Setup table. Make sure that all files in the instrumental method column of the table are saved with contact closure settings, which is described in the previous step above in Figure 7.25. The files where the acquired data will be saved are shown in the file name column.

### III. Data Acquisition:

8. Go to the Actions/Run Sequence menu to open the run sequence dialog window (see Figure 7.27 below).

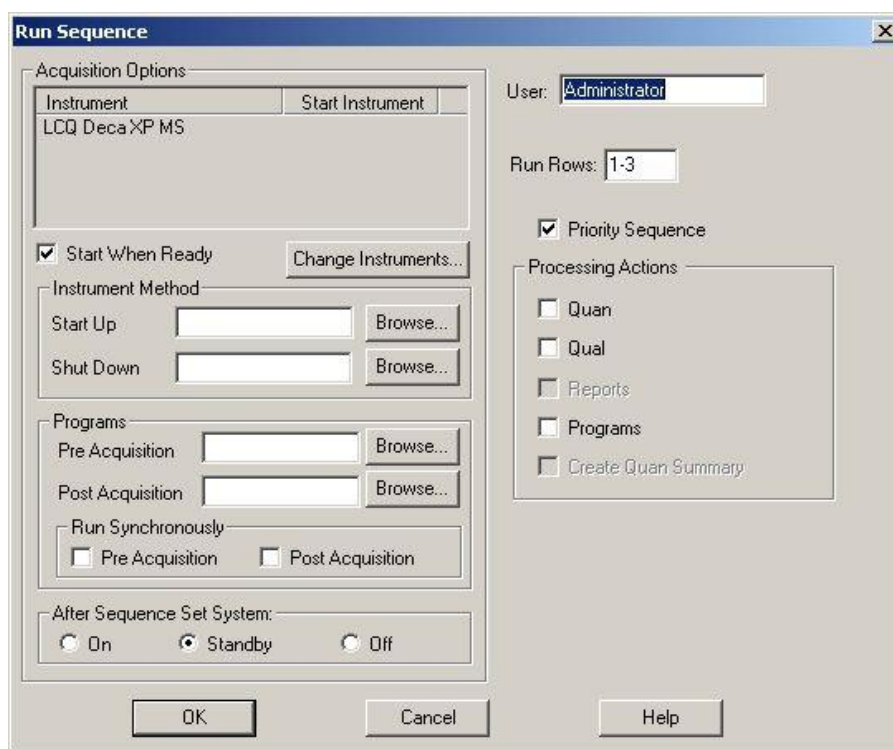


Figure 7.27 Starting the Sequence Run

9. Make sure that Exactive is **not** chosen as the start instrument and that the “Start When Ready” check box is checked, like in the example above.
  - a. Leave the “Start Up” and “Shut Down” fields empty.
10. Describe all rows, e.g., 1-20, in the “Run Rows:” field.
  - a. Check the “Priority Sequence” check box to run the sequence immediately. Click
11. “Change Instruments...” button (see Fig. 7.27); the dialog “Change Instruments In Use” will immediately start.

- a. The first column should contain only one instrument, the LCQ.
- b. The column “In Use” for the MS instrument must contain “Yes”; the column “Start Instrument” **must be empty**. If it is not, then highlight and delete “Yes” mark in “Start Instrument” column (by pressing “Del” keyboard key). Finally, click the OK button to run the sequence.

The user should refer to the “Run Sequence Help” if he/she has any problems changing the settings. The settings in the run window ensure that the Exactive is properly triggered by the AP/MALDI hardware.

12. In the Status page of the Xcalibur/Sequence Setup Program window, the user will see a downloading message at the Exactive status line and then a waiting for the contact closure message.
13. After the waiting for the contact closure message is displayed in the sequence setup window (see Fig. 7.26), press the PLAY button in the Target Software window to start AP/MALDI operation.
  - a. The running message will be displayed in the Exactive status line, which later will be replaced by the waiting for the contact closure message when the data acquisition from the first sample is completed. This process will be repeated until the last sample is analyzed. The sample positions, on the map where the data have been collected, are shown by a solid color. The current sample, however, is shown by a blinking color.

### 7.12 *Zoom Mode Operation*

#### **Introduction**

A new feature, the AP-MALDI zoom mode, is introduced in Version 7 of the Target Software. The goal of the software is to:

1. Give the user more flexibility and options to run both the Target and MS Software together.
2. Create position information with the necessary details to create a map of ion signals.
3. Export the position information for the post processing of the data.

The description of the test procedure (in the Motion Modes section below) introduces the user to the capabilities of the AP-MALDI zoom mode.

#### **Motion Modes: CSR and Pixel Map**

The two different options that can be used for the AP-MALDI zoom mode include the constant speed raster motion (CSR) and pixel map, which can be seen in Figure 7.12.1. Both options have two different scan patterns that are

available for use, which include the flyback and meandering modes displayed in Figure 7.12.2. The flyback mode includes line scans that move in the same direction (horizontally and vertically), while the meandering mode's line scans move in alternating directions so that the total scan time is minimal.

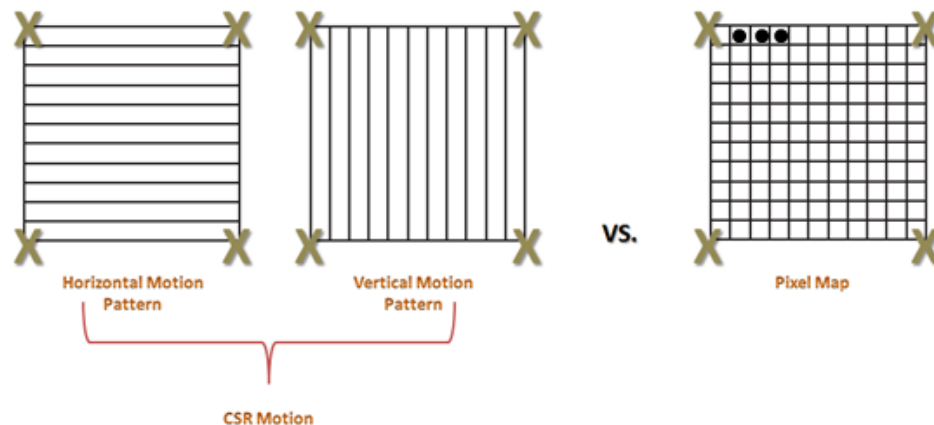


Figure 7.12.1 CSR Mode vs. Pixel Map Mode

Note: In the CSR mode, the laser fires constantly as the stage moves (except during transitions from one row/column) to the next. In the pixel map mode, the laser only fires within the pixel points.

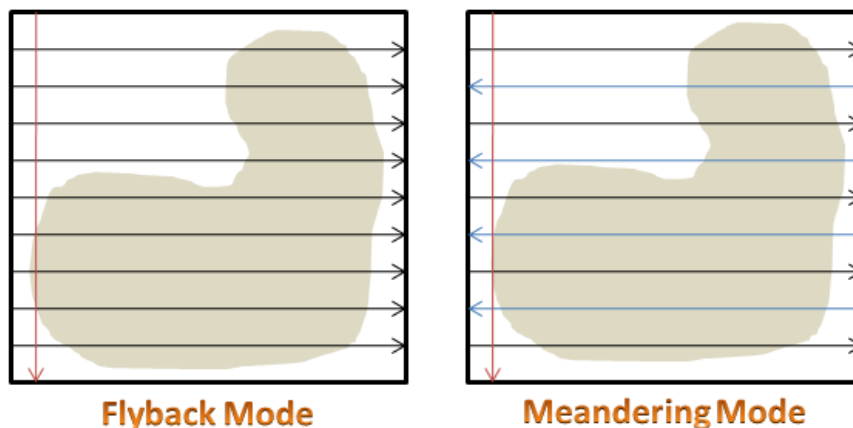


Figure 7.12.2 Flyback Mode vs. Meandering Mode

Based on the specific needs of the sample and available instrumentation, the user needs to decide which zoom mode should be used. When making this decision, the user should consider the following preliminaries:

1. If the number of pixels are larger than the number of data files that the MS Software (e.g. XCalibur, Analyst, MassHunter) can handle, the CSR mode should be used. Each line will be a separate file.

2. The availability of the handshaking option (available in the Thermo Q Exactive Instrument Software) enables the use of one file for all the pixels. The use of such instruments creates a very efficient setup for the pixel map mode.
3. The scan time cannot be too long, as each pixel needs at least one mass spectrum per scan. If there is no mass spectrum available for a given pixel, the result of the scan will show an empty pixel (i.e. the number of scans is greater than the number of pixels). The amount of time the laser will fire To tune the pixel, the overall scan time for each MS scan needs to be known and should be minimized. Finding out how long the scan time is, depends on the MS software; e.g. for the XCalibur Program the overall scan time is displayed in two places:
  - a. During the Acquisition - the scan is usually displayed as the ST in the LTQ tune window.

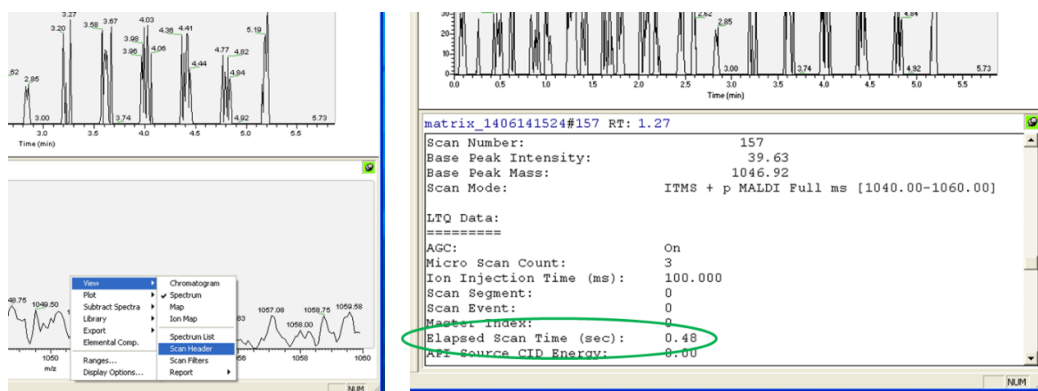


Figure 7.12.3 Viewing the Scan

- b. Qual Browser- right click to the MS window and select the **View >Scan Header** (the user needs to look for the “Elapsed Scan Time”-see Figure 7.12.3).
4. If the sample area is more than 10 mm X 10mm, using the meandering mode is advised; the flyback mode can require a long transition time.

## Test Sample Preparations

1. On a cleaned AP/MALDI sample plate, spot a 0.5  $\mu$ L of Angiotensin II solution (FW: 1046.18- or any other sample that is available – the suggested amount is 100 fmol/ $\mu$ l) near the top left hand corner of the plate. The solution must be pre-mixed with a matrix that consist of 1 mg/ml CHCA in 70% Acetonitrile and 0.1% TFA.

2. Spot the solution two more times so that the spots form a right triangle; more specifically, the spots will act as the endpoints (see Figure 7.12.4). Each spot should be approximately 1 mm (in distance) from the original point; try to avoid having the samples touch one another.

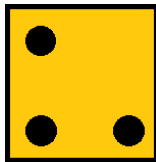


Figure 7.12.4 End Point Shapes

## Creating the Test Data in the CSR Mode

1. Choose the zoom type in the **General** tab (see Figure 7.12.5):
  - a. **Settings>Zoom Parameters>General**  
**Zoom Type** → CSR
2. When completed, press **Apply**.

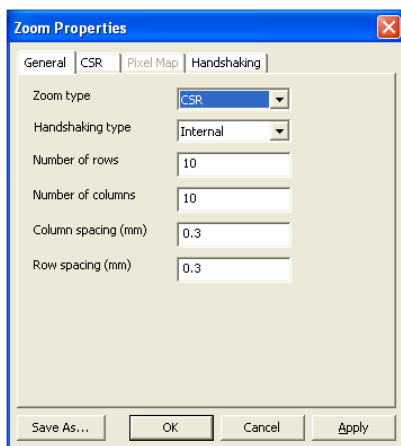


Figure 7.12.5 CSR –General

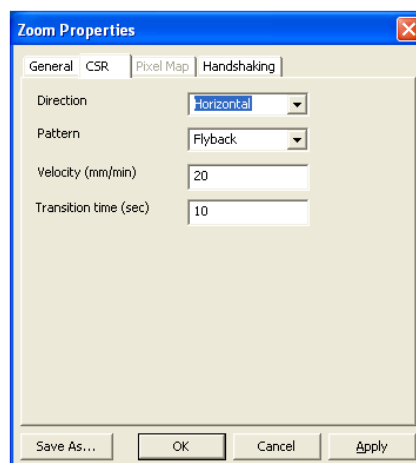


Figure 7.12.6 CSR Specific

3. Choose the **CSR** tab (see Figure 7.12. 6):  
**Direction** → Horizontal  
**Pattern** → Flyback or Meandering  
**Velocity (mm/min)** → 20  
**Transition Time (sec)** → 10
  - a. The user must click the **Save As** button in order for the position file to be active; this file is known as the raster XML file.

- b. When the file has been named, click the **Save** button.

## **Creating the Test Data in the Pixel Map Mode:**

- a. Choose the zoom type in the **General** tab (see Figure 7.12.7):  
**Settings>Zoom Parameters> General/ Zoom Type→Pixel Map Handshaking Type →Internal**
- b. The remaining properties should be specified to the user's needs. In this case, the number of columns and rows were 10, while the spacing used was 0.3mm.
- c. The user must click the **Save As** button in order for the position file to be active; this file is known as the *raster XML file*.

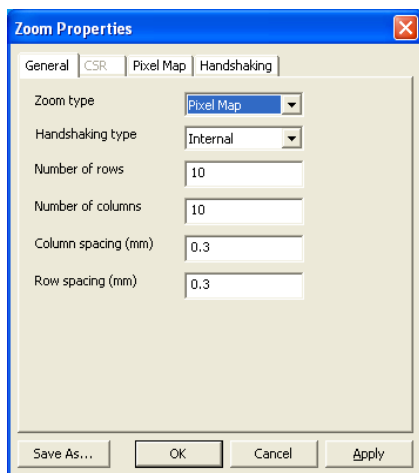


Figure 7.12.7 Pixel Map General Settings

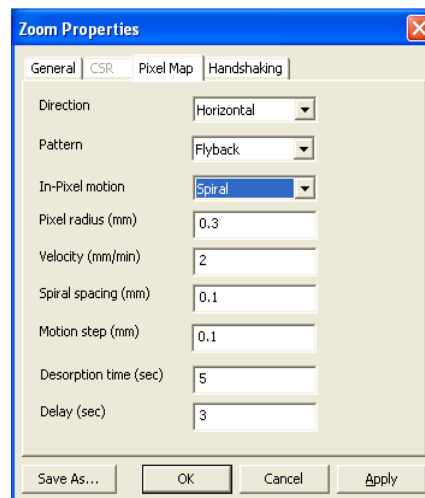


Figure 7.12.8 Pixel Map Properties

2. When completed press the **Apply** button and then immediately following, press **OK**.
3. Choose the necessary properties for the data in the **Pixel Map** tab; the properties should be specified to the user's needs. Figure 7.12.8 shows a screenshot of the default settings:
  - a. The in-pixel motion is typically enabled only when the "pixed area" is larger than the spot size.

- b. The desorption time refers to the laser 'on' duration.
- c. The delay time refers to the delay between the laser on.

Note: The handshaking action is needed only for the external synchronization.

4. In the **Handshaking** tab, set the **Pulse Duration** to 500 (see Figure 7.12.9).

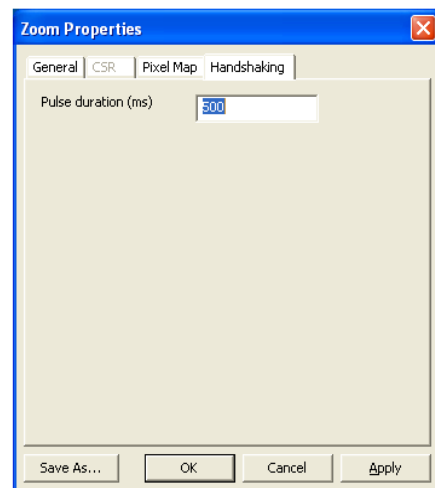




Figure 7.12.9 Pulse Duration

- a. Then, press the **Apply** and then **OK** button once all the zoom properties are set. **Pulse Duration (ms) → 500.**
  - b. It is highly recommended to use the 500(ms) for the **Pulse Duration.**
5. Then press **Apply** and **OK.**

## Acquiring the Data

1. In the Target program, this button  is used to enable the zoom mode. This  button, on the other hand, is used to scan the total area of the sample.
2. Now, the user needs to get the mass spectrometer ready.
3. The Target Software has a calculator that informs the user of the total acquisition time (found at the bottom of the CSR tab; the MS should scan for that period. Once finished, press **OK** and close the dialog box.
4. Set the scanning to a narrow mass range(see Figure 7.12.10):  
In the **Define Scanning** tab (on the mass spectrometer) set the beginning mass range from 1040 – 1060 (**Scan Mode> Define Scan**)

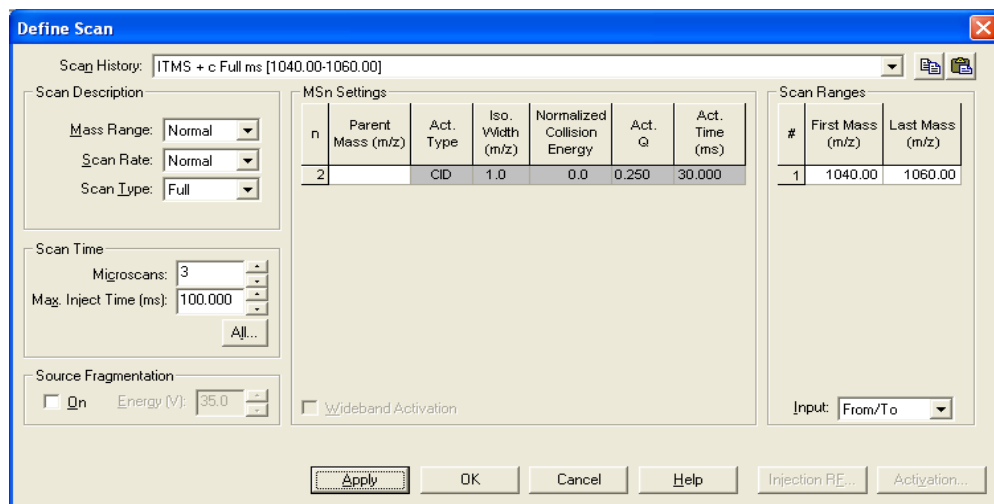



Figure 7.12.10 Define Scan as shown in XCalibur

- Next, press **Apply** and immediately following that action, push the **OK** button before closing the window.

The number of minutes for the MS data acquired is the same, or slightly more to the time calculated by the Target Software.

- Turn on the laser.



- Start the scan by pressing start  on the Target Program, which activates the laser and sample motion scan. The filename needs to be the same as the user's raster XML file.
- Next, acquire the data using the MS immediately following the start from the Target Software. (If MS software has the option, contact closure can be used to synchronize Target and MS Start) When acquiring the data, the user needs to make sure that only the single scans save and that no summation is used.

### Processing the Test Data with Thermo Image Quest (Thermo .raw files only)

Thermo ImageQuest (version 1.1.0 or later) can create images directly from the .raw files and the raster XML file (see above) created under Target software.

In order to ensure ImageQuest matching the raw file with raster xml file, the user needs to ensure identical file names of the raw file and the raster xml file. For example, if the raw file name is 'mydata1234.raw', then the raster xml file name should be 'mydata1234.xml'. When ImageQuest asks for

'MALDIPos not found' prompt, the user just should click 'no' and your image should appear instantly.

Note: when saving raster xml, make sure to click apply before saving.

### Processing the Test Data with demo software (any format files that can be converted to mzML)

*Note: The steps outlined here are for demonstration purposes only. They involve freely available software that is not supported by MassTech. There may be alternative ways of doing similar tasks by other commercially available software.*

There are few major steps needed to create the images from the gathered MS data:

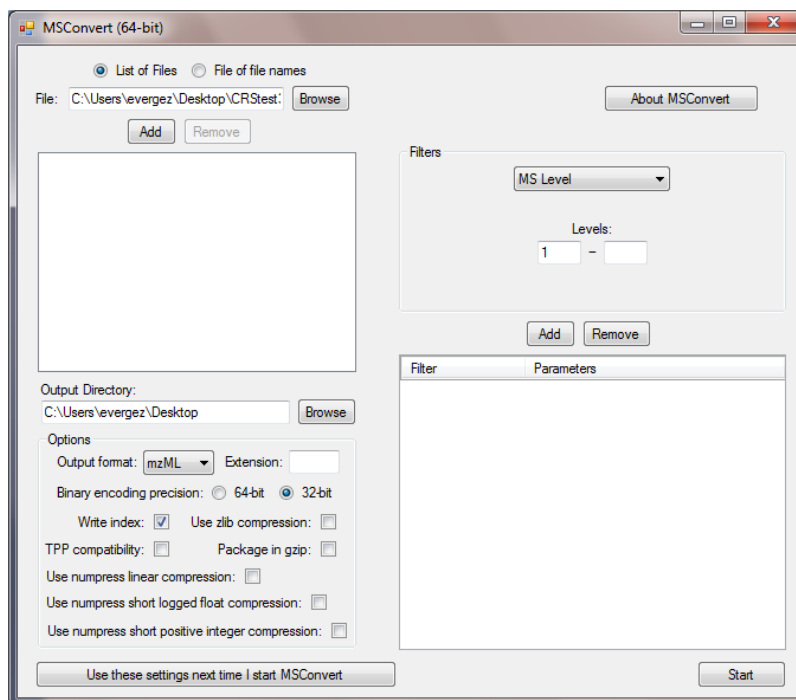


Figure 7.12.11 MS Convert Settings

- Converting the raw data file to the mzML format.
  - Converting the mzML formatted data file to an imzML data file with the help of position information.
  - Create digital images from the imzML data file.
1. The native data from the mass spectrometer in order to create a universal mzML; this allows for the data file to be properly formatted. Use the Proteowizard Software, which is available at the following website: [proteowizard.sourceforge.net](http://proteowizard.sourceforge.net). The MS Component will be used, which can be found directly on the website's download page..

- a. Download the MS Convert (if not installed on the user's computer).
  - b. Launch the MS Convert and load the *Xcalibur RAW file* into the browser.
  - c. The user should use the settings shown in Figure 7.12.11 to convert the data file.
2. If successful, the user should have an mzML data file that should be somewhat larger than the original MS data file (e.g. Thermo, AB Sciex, Agilent). If unsuccessful, the user will get either an error message or a file with no data in it. Check the settings if there is an issue. In some cases, the data files may be too big (especially Windows XP created files; they cannot be larger than 2 GB) or corrupt.
  3. Next, find the Raster XML file created by the Target Software and the mzML file; make a copy of the files and place them in a folder that is easily accessible.

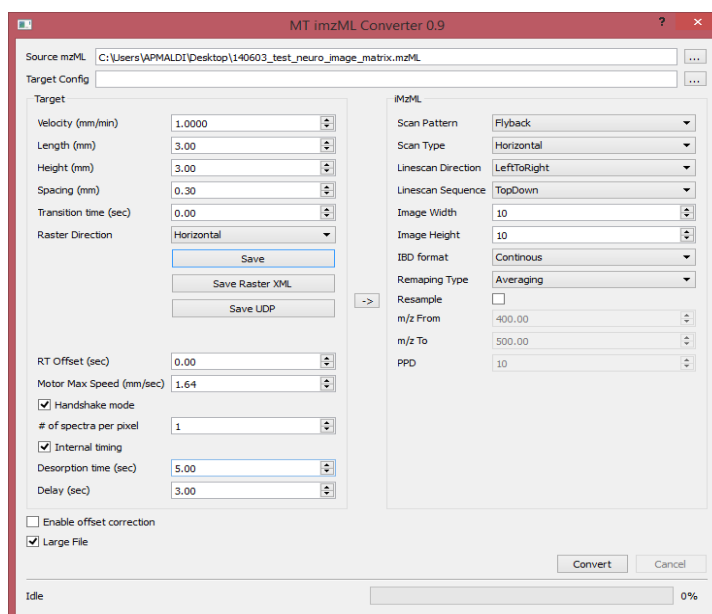



Figure 7.12.12 The MT imzML Converter 0.9

4. Open the MT imzML Converter- the demo software provided by MassTech. Populate the dialog box with the information as shown in Figure 7.12.12.
  - a. When completed, press the  button to set the figures. Then press the “Convert” button.
5. If successful, the user will have an imzML data file that is somewhat smaller than the original mzML data file.

- Next, the user will be able to open the imzML data file with the appropriate software. Here the Datacube Explorer by FOM Institute-AMOLF. <http://www.amolf.nl/download/datacubeexplorer/> is shown.
- When the file is open, the default settings will point to the lowest m/z available in the user's MS data file. Also, the user needs verify that there is a decent number of ion counts appearing at the MS display; MassTech recommends x amount of ions to be present.

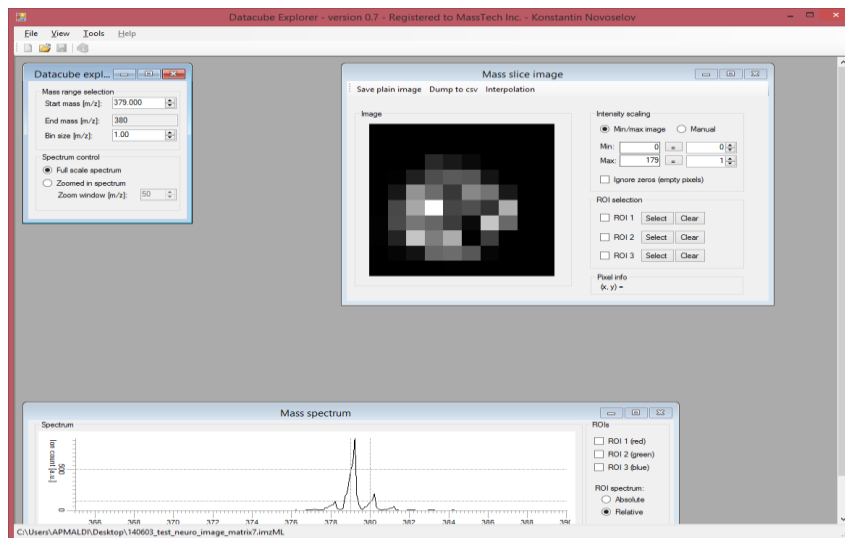


Figure 7.12.13 Datacube Explorer – Version 0.7

- By changing the minimum/maximum value and selecting the appropriate m/z interval, the user's test data should look like in Figure 7.12.13.
- Now the zoom mode is ready use. Please contact MassTech Inc. if there are any questions or concerns.

#### Notes:

- If the user needs an area larger than 30x30 mm, please inform MassTech; the limit may be stretched based on the sample plate geometry.
- Verify that the cross hair is located where the laser beam hits the sample.
- MassTech recommends the scanning narrow mass for specific applications: for example, if the user is interested in m/z 750, the scan range should only be 740-760; define scanning is based on the sample. MassTech used 1040 – 1060 because the analyte was at 1046; the user's analyte may be different.
- Due to the nature of the CSR motion, once scanning on a row starts, the process is unable to be stopped. Therefore, if the user needs to stop a run, he/she should click on "Stop" button and wait until the current row is finished.

- The Laser energy is dependent upon the sample; if the laser is too high then the sample erodes while on the target plate.
- Please do not hesitate to call or e-mail for more information

### 8 MAINTENANCE —TROUBLESHOOTING THE SOURCE.

The AP/MALDI ion source does not require regular maintenance.



**DO NOT ATTEMPT services or repairs that are not covered in the Troubleshooting Section. For services and repairs beyond those specifically provided in the Troubleshooting Section, contact the manufacturer:**

**MassTech Inc.  
ATTN: Service Department  
6992 Columbia Gateway Dr.  
Suite 160  
Columbia, MD, 21046  
(443)539-1758**

The AP/MALDI(ng) source comes supplied, completely tuned, and ready for operation. However, there are several reasons why the MS signal might decrease significantly or even disappear at times. The following sections describe possible symptoms with the machine's remedies.

#### **8.1 PROBLEM: Insufficient Ion Production - Lack of the Laser Power being delivered to the Target Spot**

1. To test for a lack of laser power hitting the target spot, prepare several target spots with a dense  $\alpha$ -CHCA matrix ( $\alpha$ -CHCA provides the brightest fluorescence and the lowest pulse energy necessary for this test).
2. Set the laser energy to full power (e.g., 90-100%).
3. Fire the laser and watch the computer's video capture screen.
4. If there is a blinking spot on the computer's video capture screen, the user needs to see if the matrix crystals at that spot are disappearing at maximum (100%) laser level while the laser spot is gradually decreased (for CHCA matrix without the beam attenuation, the crystals should disappear in 5-15 seconds). If they disappear, then laser power is sufficient.
5. If the laser crystals do not disappear in 5-15 seconds at the blinking spot and tightest laser focusing, then laser power is NOT sufficient.

6. If the laser power is NOT sufficient, the user has three options to fix the problem.  
unit.

- i. Try to improve the focus of the laser beam on the target. To do this, adjust the position of the focus micrometer as described in Section 8.2. Make sure the tightest focus is observed within the range of the micrometer dial.
- ii. Try to improve the position of the laser beam relative to the MS inlet which is described Section 8.3

\* If these actions do not help, call MassTech Inc. for assistance and ask to speak with the Service Department.

### 8.2 **PROBLEM: The Laser Beam is not Well-Focused**

Goal 1: To increase the laser fluence, i.e. energy per unit area ( $\text{J}/\text{cm}^2$ ) of the irradiation spot by adjusting the laser spot size.

1. Locate the Laser Focus adjusting micrometer on the right side of the source.
2. Set micrometer dial at the maximum (mm) position.
3. Disable the spiral/raster so that the laser light strikes the same spot
4. Start the laser firing at maximum power (not necessarily 99%-See section on AP/MALDI UHR)
5. Using the camera, the user will be able to see how fast the matrix desorbs.
6. If the spot does not desorb quickly, turn micrometer to get dial at down 1 or 2 mm less and repeat the experiment.
7. Once the user sees that the matrix is desorbed in less than a minute, the focus position may be tuned with a smaller (0.3mm) dial step to get better focusing.

The above focusing procedure may be good enough for general use, typically associated with the HR source (25-100  $\mu\text{m}$  laser spot size). To get smaller laser spot (down to 10  $\mu\text{m}$ ) typically required for UHR performance additional tune-up efforts are required as described below.

Goal 2: To focus the laser spot size to about 10  $\mu\text{m}$  size.

Note: a microscope may be necessary to use in this focusing optimization procedure to see the laser burn marks if a laser spot size as small as 10  $\mu\text{m}$  is desirable.

1. Once the alignment procedure described in Section 8.3 below is completed, optimization of the laser focusing requires additional effort to ensure minimum laser spot size.
2. To ensure this, a special matrix solution is prepared (CHCA 4 mg/mL in Acetone). 3  $\mu$ L of this solution is smeared to an area on a clean AP-MALDI plate: 3 by 20 mm wide. It should dry immediately. You can do this at 50 °C hotplate to quicker evaporation.  
Tip: A Sharpie® permanent ink pen can be used instead of the special matrix solution above in this focusing optimization procedure (it has slightly low laser threshold for ink evaporation so the laser energy should be readjusted at the end of this procedure to match the matrix threshold).
3. Locate portions of the matrix that is uniform and thin.
4. Set Laser Energy to minimum level where laser burn is noticeable.
5. Set up a 3x5 pixel map run with 50  $\mu$ m spacing in the Target software Zoom mode. Try to move the lens adjustment micrometer by steps of 25 units (250  $\mu$ m). At each step, run the pixelmap.
6. Observe the change of shape in the laser burn. Note/record the position.
7. Determine the first range of observable burn marks by looking at the best lens positions.
8. Put the lens position at the middle of the first range. Reduce the laser energy to the minimum when the laser burn is still observable. Repeat steps 5-7 to determine a new lens range. Repeat steps 5-7 until the range is made as small as 50 units (500  $\mu$ m).
9. At this new range of 50 units, move the lens adjustment by steps of 10 units (100  $\mu$ m).
10. Observe the change of shape in the laser burn. Note/record the position.
11. Reduce the laser energy by 10% and repeat steps 9 and 10.
12. Determine a new range by looking at the best 3 lens positions.
13. At this new range of 30 units, reduce the laser energy again and move the lens adjustment by steps of 5 units (50  $\mu$ m).
14. Observe the change of shape in the laser burn. Note/record the position.
15. If necessary, repeat steps 12-14. The goal is to find a minimum laser energy and lens position corresponding to the best focusing conditions within 3-5 units (30-50  $\mu$ m) of the laser lens micrometer. At minimal laser energies, the laser burn spots should look like that at the top picture below.

Tip: Alternatively, the pixelmap run can be done by 10x5 pixels and you can move the lens adjustment at each row.

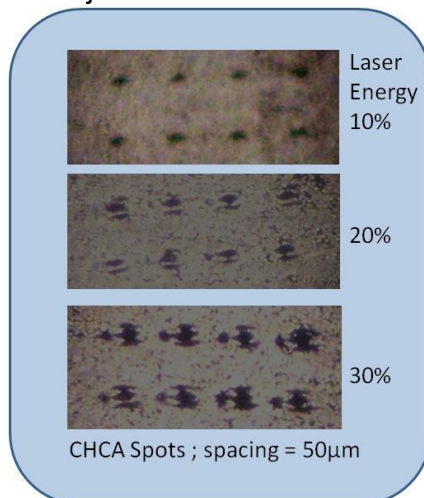


Figure 8.1 Laser burns at the CHCA matrix at various laser energy levels

### 8.3 **PROBLEM: The Laser Beam Focal Point at the Target Plate is not Properly Aligned with the Capillary Extension**



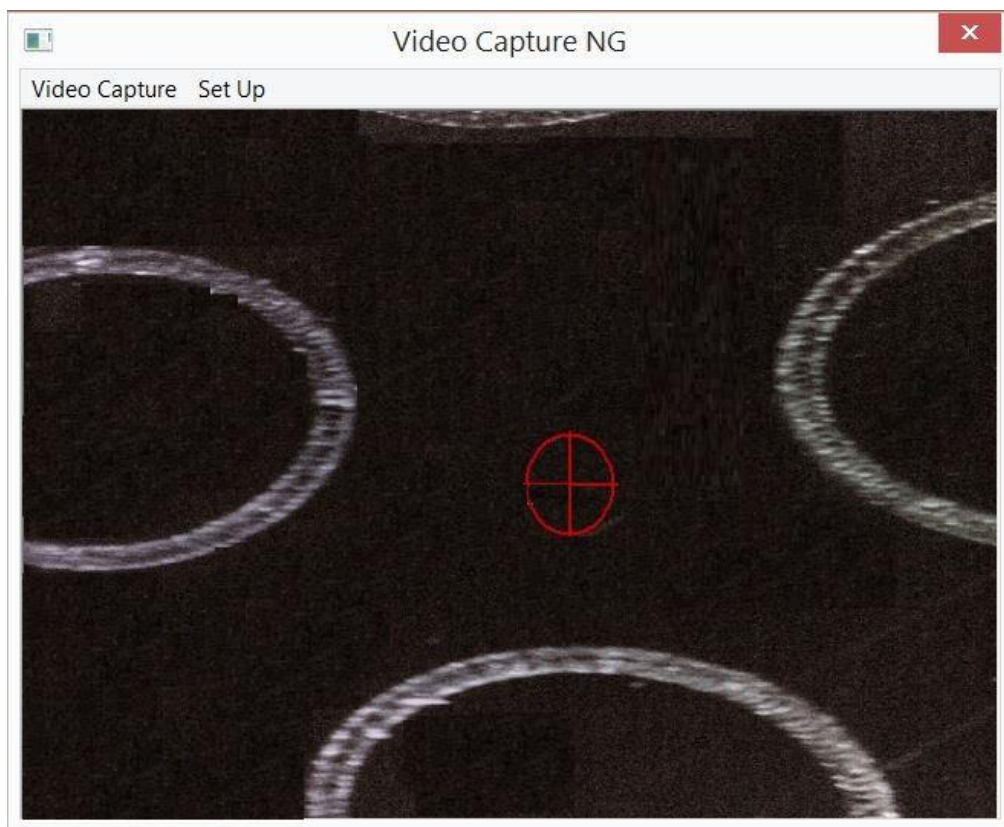
Figure 8.2 AP/MALDI (ng) installed on LCQ instrument

The goal of this procedure is to improve the source's sensitivity by aligning the laser beam focal point at the target plate surface with the capillary extension.

**Safety:** The procedure is performed from outside the source housing with the source closed. The position of the laser beam is monitored on the video capture screen. As a result, the **procedure is safe** and can be performed with both the MS instrument and AP/MALDI source switched to the “ON” mode.

**Step 1.** First, the user needs to determine if the laser spot is properly aligned or misaligned.

- Prepare several target spots with 1-2  $\mu\text{L}$  of undiluted matrix (it could be either a pure matrix solution or matrix/any analyte mixture).
- After drying, insert the target plate into the source, close it, switch it the “ON” mode (if it was not switched before) and run the Target Software (if this was not done already).
- Choose any empty (blank) target position. The picture on the video capture screen should look as follows (Fig. 8.3):

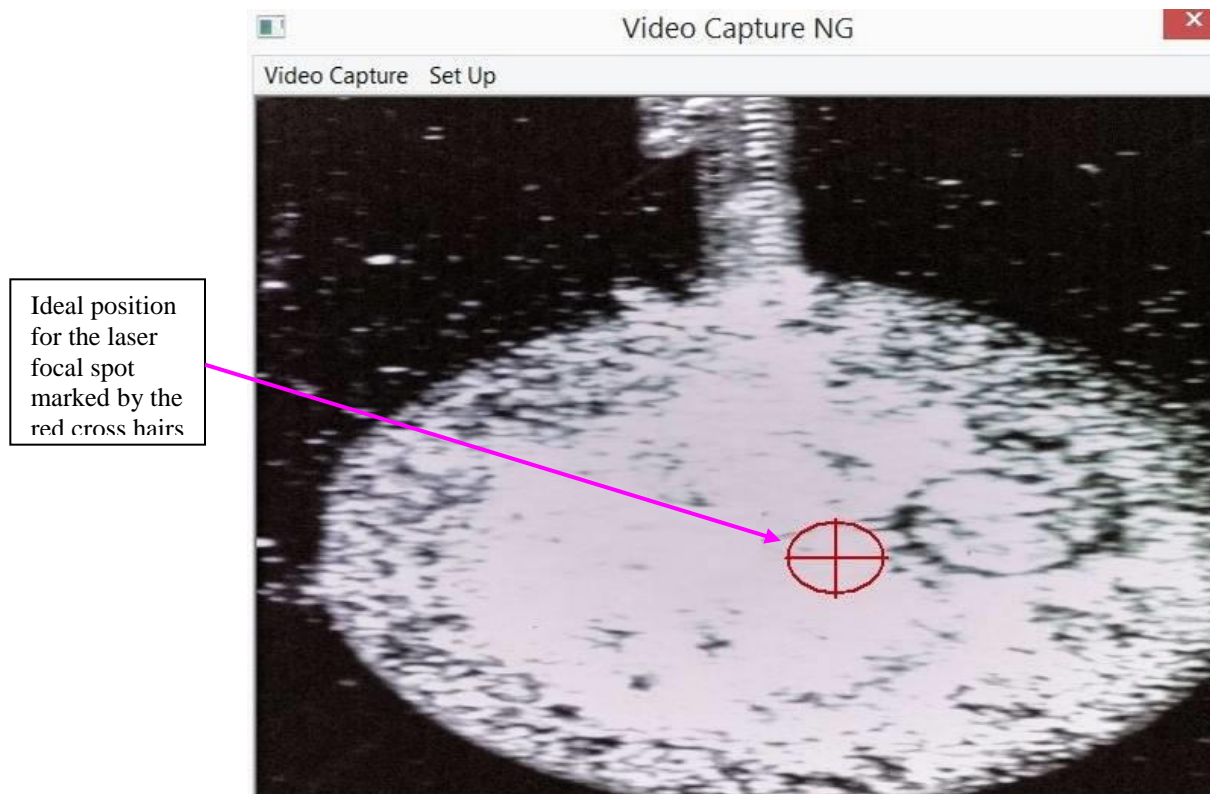


*Figure 8.3 Blank Sample Spot on the Video Capture Screen*

Both the capillary extension tip image and its reflection are not well focused; to ensure that the user identifies the images correctly, move the target in any direction with the arrow keys of the Target Program. The images of the

capillary extension tip and its reflection are still, while the image of the target plate moves.

The ideal position for the laser focal spot on the target surface plane is at the middle of the imaginary line that connects the image of the capillary extension tip and the image of its reflection. In order to determine the real position of each sample spot, move the target plate to a position where a matrix was deposited to see the matrix burns.



*Figure 8.4 Image of the Matrix Crystals*

**Step 2.** Switch the laser to the "ON" mode and turn the spiral/raster motion to the "OFF" position. Set the maximum laser through Target Software so that the matrix crystal's evaporation (at the place where the laser beam is focused) can be seen (Figure 8.4).

By comparing the location of the ablation hole with the ideal position shown by the red cross-hairs, the user can see how the laser focus is close to its ideal position.

**Step 3.** Continue with the same spot. Turn the laser to the maximum power (minimum attenuation) by pressing the “ON” position. Using thumb nuts on the right side of the source adjust the laser spot position to the “ideal” position (designated by red cross-hairs).

The user needs to look at the video capture screen for the corresponding motion of the laser focal spot. The objective is to move that spot as close as possible to its ideal position which lies at the middle of the imaginary line that connects the capillary extension tip.

Now the user can set the best laser energy that appropriate for his/her matrix. Alternatively, the position of the laser focal spot can be adjusted by rotating the based on the quality of the MS signal by a trial-and-error method.

Tip: A good laser spot alignment can be checked by measuring the ion signal intensity upon the voltage applied between the MS inlet capillary and the MALDI target plate. If the alignment is done properly the signal intensity monotonically increases when the voltage is increased from 500 to 2500 V.

### **8.4 PROBLEM: the Ion Transport into the MS Instrument is Clogged/Blocked**

Goal: To determine if the ion transport path to the MS is blocked.

1. To test for a clogged ion transport (in the MS instrument) prepare several target spots with a dense  $\alpha$ -CHCA matrix. A  $\alpha$ -CHCA provides the brightest fluorescence and the lowest pulse energy necessary.
2. Set the attenuation to full laser power.
3. Fire the laser and watch the computer screen for a larger beam.
4. If the user can see a blinking spot on the computer screen, he/she needs to check if the matrix crystals at that spot are disappearing. For CHCA matrix without the beam attenuation the crystals should disappear within 5-15 seconds. If they disappear, then:
  - a. Ensure that the MS interlock is operating properly.
  - b. Ensure that the MS Control Program is configured as described in this manual.
  - c. Ensure that the probe preparation & matrix material are being used properly.
  - d. If all above are checked, the system should show at least spectral noise. If there is no chemical noise, the capillary may be clogged and require cleaning with a thin wire.
  - e. Finally, ensure that the MS instrument operates properly with the electrospray instrument attaches. The problem may be with the Exactive instrument rather than the source.

### **8.5 PROBLEM: Spectral Response with High Background and Mass-Shifted Ion Peaks**

Sometimes the AP/MALDI allows too many ions into the ion trap so that the space-charge effects can occur in the trap. It may be necessary to reduce the injection time of the ion trap to 100ms or less so that the trap does not become saturated. An alternative way to solve this problem would be to adjust the laser energy so that fewer ions are generated.

**We are ready to provide you any technical assistance! Call us at (443) 539-1758 or e-mail the problem to: [msms@apmaldi.com](mailto:msms@apmaldi.com)**

## 9 LITERATURE

1. Victor V. Laiko, Michael A. Baldwin, Alma L. Burlingame, "Atmospheric Pressure Matrix-Assisted Laser Desorption/Ionization Mass Spectrometry", *Analytical Chemistry*, Vol. 72, No.4, 2000, pp. 652-657.
2. Victor V. Laiko, Susanne C. Moyer, Robert J. Cotter, "Atmospheric Pressure MALDI/Ion Trap Mass Spectrometry", *Analytical Chemistry*, v.72, No.21, 2000, pp. 5239-5243.
3. Susanne C. Moyer, Robert J. Cotter, "Atmospheric Pressure MALDI", *Analytical Chemistry*, Sept 2002, pp. 469A-476A.
4. Phillip V. Tan, Victor V. Laiko, Vladimir M. Doroshenko, "Atmospheric Pressure MALDI with Pulsed Dynamic Focusing for High Efficiency Transmission of Ions into a Mass Spectrometer", *Analytical Chemistry*, v. 76, No. 9, 2004, pp. 2462-2469.

### *ADDITIONAL REFERENCES*

Miller CA; Yi DH; Perkins PD. "An Atmospheric Pressure Matrix-assisted laser Desorption/Ionization Ion Trap with enhanced sensitivity" *Rapid Commun. Mass Spectrom.* 2003, 17 (8): 860-868.

Moyer SC; Marzilli LA; Woods AS; Laiko VV; Doroshenko VM; Cotter RJ. "Atmospheric Pressure Matrix-assisted laser desorption/ionization (AP MALDI) on a Quadrupole Ion Trap Mass Spectrometer" *Int. J. Mass Spectrom.* 2003, 226(1); 133-150.

Doroshenko VM; Laiko VV; Taranenko NI; Berkout VD; Lee HS. "Recent developments in atmospheric pressure MALDI mass spectrometry" *Int. J. Mass Spectrom.* 2002, 221(1):39-58.

### 10 WARRANTY INFORMATION – SIX MONTH LIMITED WARRANTY

MassTech, Inc. provides to the original purchaser the following limited warranty from date of invoice.

MassTech, Inc. warrants each AP/MALDI(ng) instrument and its components to be free from defects in material and workmanship. Liability under this warranty covers servicing of the instrument when returned from the customer's facility within the United States pre-paid to our factory. MassTech, Inc. will repair any component(s) or part(s) that it finds to be defective during the period of this limited warranty, which is six months from the date of invoice. Should a defect become apparent, the original purchaser must first notify MassTech, Inc. at (443) 539-1758 of the suspected defect and request a Return Merchandise Authorization number (RMA#). The instrument (or suspect components) should be carefully packaged in the original container (if the original shipping container has been lost, trashed, or damaged, another one must be purchased from MassTech, Inc. prior to shipping). Then, mark the original container with the RMA#, and ship prepaid to:

**MassTech, Inc.  
Attn: Service Dept.  
6992 Columbia Gateway Dr.  
Suite 160  
Columbia, MD, 21046**

The instrument will be repaired in the shortest possible time and returned prepaid by the same shipping method as received by the factory. During the warranty period, no charge will be made to you for parts, service, or labor.

This limited warranty is void if the instrument has been damaged by accident, misuse, negligence, act of God, or serviced by any other person not authorized by MassTech, Inc. The warranty also does not apply to units that have had the serial lot number altered, defaced or removed.

This limited warranty contains the entire obligation of MassTech, Inc. and no other warranties expressed, implied, or statutory are given. No representative or employee of MassTech, Inc. is authorized to assume any further liability or grant any further warranties except as set herein.

MassTech, Inc. disclaims liability for indirect, incidental or consequential damages. Exclusion or limitation of incidental or consequential damages are not permitted by some states and this limitation or exclusion may not apply to you. Warranty rights vary from state to state; and, therefore, you may have other rights in addition to those provided by this warranty.

## APPENDIX A: SPECIFICATIONS FOR AP/MALDI(NG) HR AND AP/MALDI(NG) UHR ION SOURCES

Type of ionization	Atmospheric pressure (AP) matrix-assisted laser/desorption ionization (MALDI)
Laser wavelength	355 nm (Nd:YAG DPSS laser)
Laser repetition rate	1-10 kHz
Laser energy	<3 $\mu$ J/pulse
Minimum laser spot size	AP/MALDI(ng) HR: 25-30 $\mu$ m AP/MALDI(ng) UHR: ~10 $\mu$ m
Maximum laser spot size	50-100 $\mu$ m (depending on matrix)
Limit of detection	1 femtomole/sample (Bradykinin) (typically)
Mass range	Limited by mass spectrometer
Available sample plate formats	Sciex Opti-TOF (192 spots) Agilent/MassTech (96 spots) 25-mm wide microscope slides
X stage travel distance	55 mm
Y stage travel distance	40 mm
Accuracy of X-Y stages	<10 $\mu$ m
Modes of operation	Manual Automated (for multiple spots) Pattern (for MS imaging)
Sample monitoring	CCD camera
Available for MS manufacturers	Agilent Technologies Bruker Daltonics SCIEX Thermo Fisher Scientific
Interchangeability	Interchangeable with ESI, APCI and other AP sources within minutes
Synchronization with MS	LC protocol (Contact Closure)
Control software platform	Windows 7
Control Interface	Ethernet RJ-45 or USB
Dimensions	33cm(L)x17cm(H)x18cm(W)
Weight	6 kg
Power	95-240 VAC, 80 W

## APPENDIX B: WARNING AND IDENTIFICATION LABELS

Danger – Laser Inside label (on the front panel)

Laser Class 1 product label (on the front panel)

Hot temperature sign (on the top door)

High Voltage sign (on the top panel)

Attention sign (on the top panel)

Serial number label (at the bottom)

CE sign (at the bottom)



### APPENDIX C: COORDINATE CORRECTION

For large samples or large automated batches, level plate alignment can be essential. Small inaccuracies (skew) in stage or plate installation can be magnified over large distances, and in the worst case, large samples may need manual adjustment during analysis because the laser dot will not hit the desired spot. In order to address this, MassTech wanted a simple way for customers to be able to correct for a skewed stage or plate before they began their sample run. The newest version of Target software includes a coordinate correction feature, which allows the user to compensate for potential plate misalignment. This feature works with plates that use a rectilinear well (or spot) layout. In order to use this feature, the user must “calibrate” the plate first.

Coordinate correction calibration is multi step procedure. At the first stage user must define custom rectilinear plate and find corresponding target position offset using Sample Plate tab of the Settings dialog (see Figure 1). The target offset (top left corner target) needs to be entered, and the number of rows and columns as well as sample spacing needs to be entered (providing rectangular bounds for the target space). Assuming that the laser has been aligned properly, and that you have placed the red crosshairs at the location of the laser output, the laser dot should hit the top left corner target when you enter the data correctly.

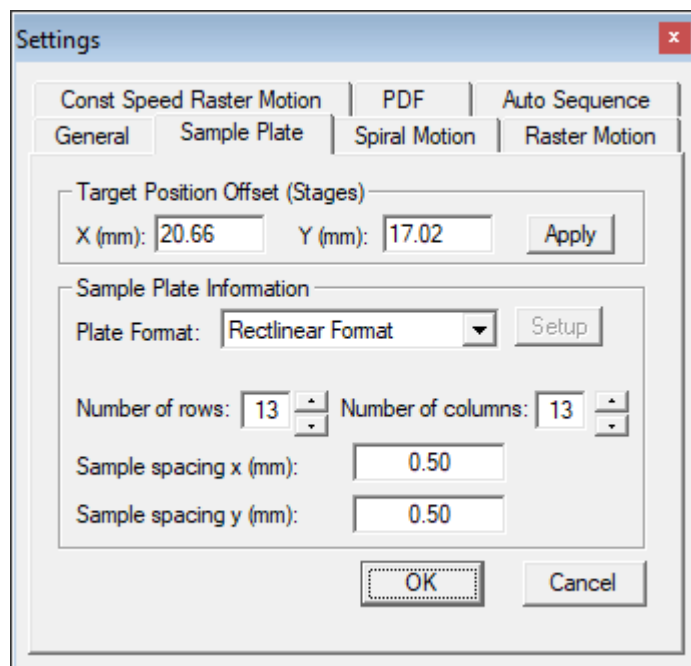


Figure 1. Sample Plate Settings

Custom sample plate alignment can be verified by navigation to the corner sample spots by clicking them in Sample Spot Selector widget. Red cross hair should be located at the center of the corresponding spots in case of perfect alignment. If the laser dot hits the sample well or spot effectively throughout the sample, then no coordinate correction is needed.

However, in the case of improper alignment, which may be caused by a plate or stage slightly skewed, you may see the red crosshair offset from the intended sample spot (as shown on Figure 2). In this case coordinate correction can be used for compensation of that misalignment.



Figure 2. Top left sample spot in case of misalignment

The "Coordinate correction" wizard can be invoked by selecting Settings->Coordinate Correction... menu item in Target.

The wizard window will appear on the screen as shown on Figure 3. Read the instructions and press Next when ready.

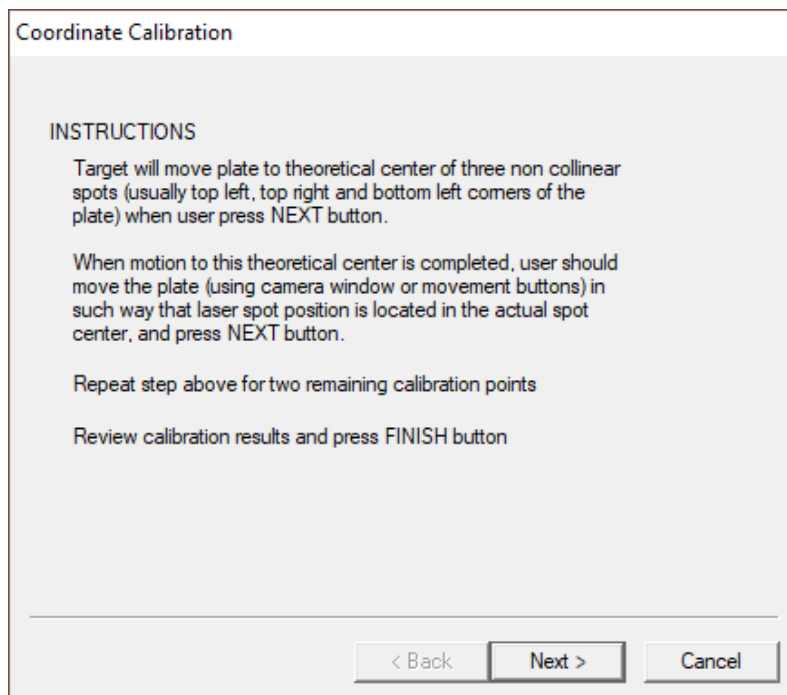
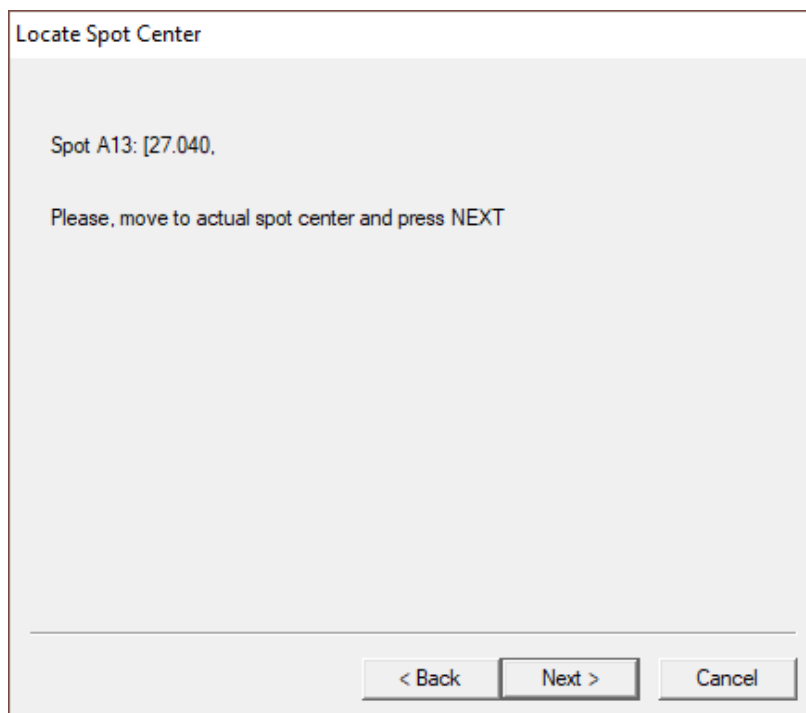


Figure 3. Coordinate Correction Calibration Wizard Start Page

Target will move to the upper left sample spot when the user presses “Next”. The user should then position the sample plate in such way that laser spot (or red crosshair) position is located in the correct spot center by double clicking in the video capture window to move the spot center to the laser spot (or red crosshair).



Then press Next and repeat this step for the bottom left spot and top right spot (see Figure 4). After that, the “Done” page will appear showing the resulting coordinate transformation (Figure 5). Accept calibration results by pressing Finish button. Coordinate correction can be enabled/disabled in Target by accessing the Settings->Enable CC menu item. In case of proper coordinate correction red cross hair (or laser spot) should be located at exact spot centers, when Sample Spot Selector widget is used for navigation.

Figure 4. Coordinate Correction Calibration Wizard Locate Spot Center Page

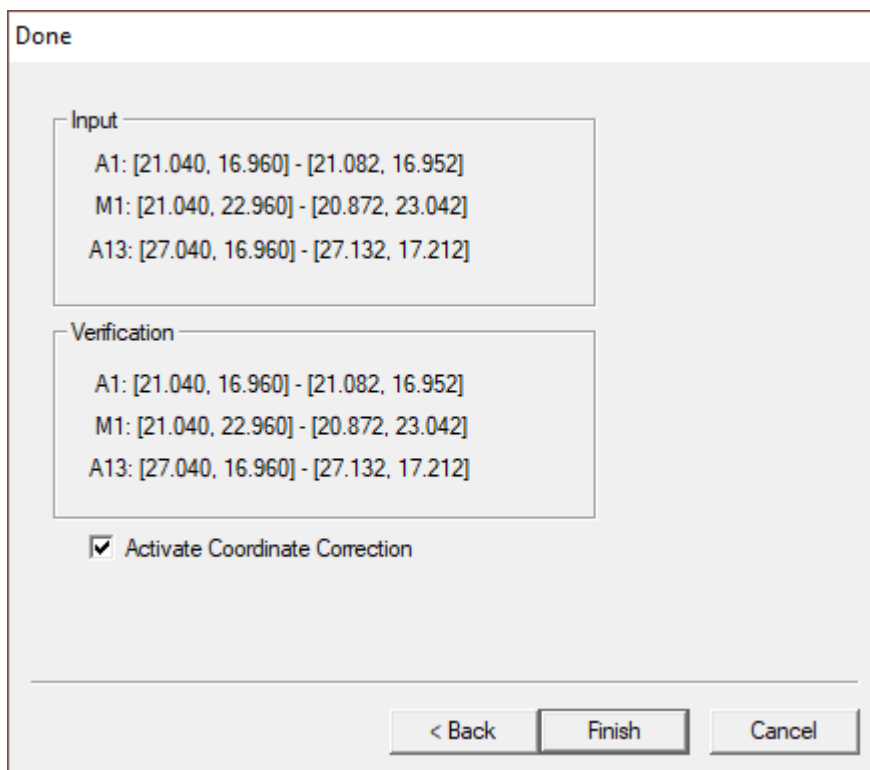


Figure 5. Coordinate Correction Calibration Wizard Done Page

You should now be able to click on any spot or well in Target and the laser spot should fall on the appropriate spot.