Operator's Manual
SSA™
Single Shot Autocorrelator

COHERENT
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Preface

This document contains user information for the Single Shot Autocorrelator (SSA™).

NOTICE!
Read this Operator Manual carefully before operating the laser or this equipment for the first time. Special attention should be given to the material in Section Two: Laser Safety.

DANGER
Use of controls or adjustments or performance of procedures other than those specified in this operator's manual may result in hazardous radiation exposure.

DANGER
Use of the system in a manner other than that described herein may impair the protection provided by the system.

Export Control Laws Compliance

It is the policy of Coherent to comply strictly with U.S. export control laws.

Export and re-export of lasers manufactured by Coherent are subject to U.S. Export Administration Regulations, which are administered by the Commerce Department. In addition, shipments of certain components are regulated by the State Department under the International Traffic in Arms Regulations.

The applicable restrictions vary depending on the specific product involved and its destination. In some cases, U.S. law requires that U.S. Government approval be obtained prior to resale, export or re-export of certain articles. When there is uncertainty about the obligations imposed by U.S. law, clarification must be obtained from Coherent or an appropriate U.S. Government agency.

Products manufactured in the European Union, Singapore, Malaysia, Thailand: These commodities, technology, or software are subject to local export regulations and local laws. Diversion contrary to local law is prohibited. The use, sale, re-export, or re-transfer directly or indirectly in any prohibited activities are strictly prohibited.

Signal Words and Symbols in this Manual

This documentation may contain sections in which particular hazards are defined or special attention is drawn to particular conditions. These sections are indicated with signal words in accordance with ANSI Z-535.6 and safety symbols (pictorial hazard alerts) in accordance with ANSI Z-535.3 and ISO 7010.

Signal Words

Four signal words are used in this documentation: **DANGER**, **WARNING**, **CAUTION** and ***NOTICE***.

The signal words **DANGER**, **WARNING** and **CAUTION** designate the degree or level of hazard when there is the risk of injury:

DANGER!
Indicates a hazardous situation that, if not avoided, will result in death or serious injury. This signal word is to be limited to the most extreme situations.

WARNING!
Indicates a hazardous situation that, if not avoided, could result in death or serious injury.

CAUTION!
Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.

The signal word "***NOTICE***" is used when there is the risk of property damage:

NOTICE!
Indicates information considered important, but not hazard-related.

Messages relating to hazards that could result in both personal injury and property damage are considered safety messages and not property damage messages.

Symbols

The signal words **DANGER**, **WARNING**, and **CAUTION** are always emphasized with a safety symbol that indicates a special hazard, regardless of the hazard level:

This symbol is intended to alert the operator to the presence of important operating and maintenance instructions.

This symbol is intended to alert the operator to the danger of exposure to hazardous visible and invisible laser radiation.

This symbol is intended to alert the operator to the presence of dangerous voltages within the product enclosure that may be of sufficient magnitude to constitute a risk of electric shock.

This symbol is intended to alert the operator to the danger of Electro-Static Discharge (ESD) susceptibility.

This symbol is intended to alert the operator to the danger of crushing injury.

This symbol is intended to alert the operator to the danger of a lifting hazard.

This symbol is intended to alert the operator to the danger of a fire hazard.

SECTION ONE: SAFETY

WARNING!
The use of controls or adjustments or performance of procedures different from those specified in this manual can cause dangerous radiation exposure.

Review this safety section completely before Single Shot Autocorrelator operation. The Coherent Single Shot Autocorrelator is not a laser and is not a laser hazard. But, the Single Shot Autocorrelator is used with amplification of short laser pulses. The Single Shot Autocorrelator therefore shows a laser exposure hazard. The user must know all aspects of laser safety. Read the safety section of all laser manuals supplied with the laser system.

Hazards

Hazards related to lasers are generally categorized as:

- Exposure to laser radiation that can damage the eyes or skin
- Electrical hazards generated in the laser power supply or associated circuits
- Chemical hazards caused by contact of the laser beam with volatile or flammable substances or released as a result of laser material processing

The above list is not an exhaustive list. Anyone operating the laser must consider the interaction of the laser system with its specific working environment to identify any potential hazards.

Electrical Safety

WARNING!
Normal operation of the Single Shot Autocorrelator does not require access to the internal circuits. Removal of cover can expose the user to possible lethal electrical hazards.

Recommended Precautions and Guidelines

Obey all safety warnings below:

1. Disconnect main-power lines before working on any electrical equipment.
2. Do not short or ground the power supply output. Protection against possible hazards requires correct connection of the ground terminal on the power cable and a sufficient external ground. Check these connections at installation and at future intervals.
3. Never work on electrical equipment unless there is another qualified person in the same room. This person must know the operation and hazards of the equipment and be qualified to help.
4. Keep one hand away from the equipment to decrease the danger of electrical current flow through the body.
5. Always use approved, tools with insulation.
6. Special measurement procedures are required for this system. A technician must understand system operation and must select ground references for related electronics.

WARNING!
Use of controls or adjustments or performance of procedures other than those specified in the manual can expose users to hazardous radiation.

NOITICE!
Use of the system in a manner different from that described in this manual can impair the protection provided by the system.

Safety Features and Compliance with Government Requirements

The following features are incorporated into the instrument to conform to several government requirements. The applicable United States Government requirements are contained in 21 CFR, Subchapter J, part 1040 administered by the Center for Devices and Radiological Health (CDRH). The European Community requirements for product safety are specified in the Low Voltage Directive (LVD) (published in 73/23/EEC and amended in 93/68/EEC). The Low Voltage Directive requires that lasers comply with the standard EN 61010-1/IEC 61010-1 "Safety Requirements For Electrical

Equipment For Measurement, Control and Laboratory Use". Compliance of this laser with the LVD requirements is certified by the CE mark.

CE Compliance

The Single Shot Autocorrelator conforms to the following standards and directives as applicable:

Directives:

2006/95/EC	Low Voltage Directive (LVD)
2004/108/EC	Electromagnetic Compatibility (EMC)
2011/65/EU	RoHS 2 Directive

Safety Standards:

EN 61010-1:2010

EMC Standard:

EN 61326-1:2013

RoHS Standard:

EN 50581:2012

Environmental Compliance

RoHS Compliance

The RoHS directive restricts the use of certain hazardous substances in electrical and electronic equipment. All components of the Single Shot Autocorrelator system are RoHS compliant.

China-RoHS Compliance

The China-RoHS directive restricts the use of certain hazardous substances in electrical and electronic equipment. Refer to the figures below for product components that are China-RoHS compliant. There are different labels for the laser head and electronics controller.

Waste Electrical and Electronic Equipment (WEEE, 2002)

The European Waste Electrical and Electronic Equipment (WEEE) Directive (2002/96/EC) is represented by a crossed-out garbage container label. The purpose of this directive is to minimize the disposal of WEEE as unsorted municipal waste and to facilitate its separate collection. See the China-RoHS label.

Location of Safety Labels

Refer to Figure 1-1 for the location of all safety labels. These include warning labels indicating removable or displaceable protective housings, apertures through which laser radiation is emitted, and labels of certification and identification [CFR 1040.10(g), CFR 1040.2, and CFR 1010.3/ EN 60825-1/IEC 60825-1, Clause 5].

Location and Environment

Before installation, select a suitable location for the Single Shot Autocorrelator. Coherent recommends that the Single Shot Autocorrelator be located in a laboratory-type environment that is free from dust and drafts, with low humidity (50-90%, non-condensing) and does not exhibit temperature fluctuations greater than ± 5°C.

The environmental rating of the altitude for laser operation must be below 10,000 feet and for non-operating laser must be below 25,000 feet.

Rear Panel

Front Panel

Figure 1-1. SSA Safety Label Locations

Side Panel (1)

Side Panel (2) & Top

Figure 1-1. SSA Safety Label Locations (Continued)

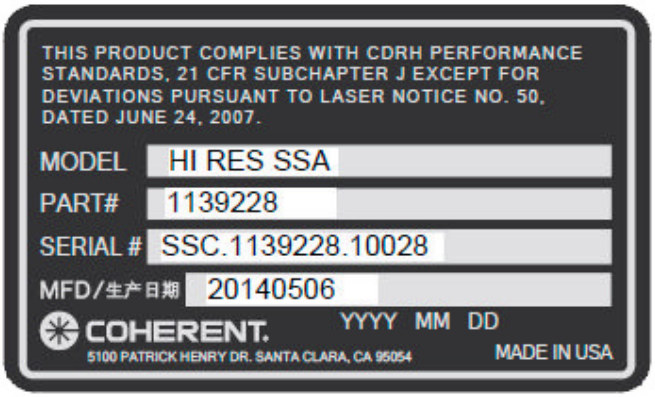
1. Laser Hazard Warning

2. Avoid Exposure Label

3. Important! Reference Operator Manual

4. Max Current, Operating Voltage & Fuse Rating

Figure 1-2. Safety Label Names



5. Manufacturing Serial Number

6. China RoHS Compliance Label

7. CE Label

8. Electrical Shock Warning

Figure 1-2. Safety Label Names (Continued)

Utility Requirements

Table 1-1. Utility Requirements

PARAMETER	REQUIREMENT
SSA AC Voltage	
Power Cord	Certified 3-conductor power cord, 16 AWG. < 10 ft (3 m) length and rated for 10 A minimum. The Controller power cord provided in the ship-kit is rated for 1625 W.

Sources of Additional Information

The following are some sources for additional information on laser safety standards and safety equipment and training.

Laser Safety Standards

Safe Use of Lasers (Z136.1)
American National Standards
Institute (ANSI)
1430 Broadway
New York, NY 10018
Tel: (212) 354-3300

Occupational Safety and Health Administration (OSHA)
U.S. Department of Labor
200 Constitution Avenue N.W.
Washington, DC 20210

A Guide for Control of Laser Hazards
American Conference of Governmental
and Industrial Hygienists (ACGIH)
6500 Glenway Avenue, Bldg. D-7
Cincinnati, OH 45211
Tel: (513) 661-7881

Laser Safety Guide
Laser Institute of America
12424 Research Parkway, Suite 130
Orlando, FL 32826
Tel: (407) 380-1553

Equipment and Training

Laser Focus Buyer's Guide
Laser Focus World
One Technology Park Drive
P.O. Box 989
Westford, MA 01886-9938
Tel: (508) 692-0700

Photonics Spectra Buyer's Guide
Photonics Spectra
Berkshire Common
Pittsfield, MA 01202-4949
Tel: (413) 499-0514

Lasers and Optronics Buyer's Guide
Lasers and Optronics
301 Gibraltar Dr.
P.O. Box 650
Morris Plains, NJ 07950-0650
Tel: (210) 292-5100

SECTION TWO: DESCRIPTION AND SPECIFICATIONS

The Single Shot Autocorrelator (SSA) measures the second order autocorrelation of amplified ultrafast laser pulses with durations from 30 femtoseconds (fs) to 4 picoseconds (ps). The SSA can be used over a broad range of energies and wavelengths. The SSA is ideal for variety of laser systems that includes Ti:sapphire.

In the SSA, the laser pulses are divided into two beams, which are then non-colinearly frequency-doubled in a nonlinear crystal. The relative wavefront tilt produces a spatial time delay in the frequency-doubled signal. The time delay causes an autocorrelation of the temporal intensity profile of the ultrafast pulse. The autocorrelation is detected by a CCD diode array, which is read out on a standard laboratory oscilloscope.

Figure 2-1. Single Shot Autocorrelator (SSA)

The SSA has two basic modes of operation: femtosecond and picosecond. In the femtosecond mode, the geometric wavefront tilt introduced by non-colinearly crossing the beams in the crystal is sufficient to measure subpicosecond pulses. In picosecond mode, one of the mirrors is replaced by a diffraction grating. The diffraction grating introduces additional wave front tilt and allows accurate measurement of pulses with a FWHM to a maximum of 4 ps. In both cases, a variable delay line is included, providing accurate synchronization of the two beams.

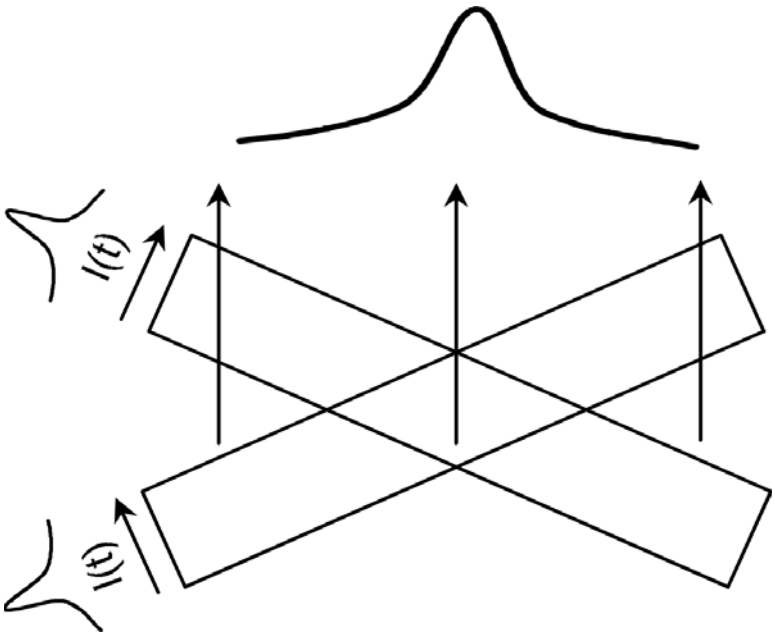


Figure 2-2. Two Tilted Wave Fronts Yielding an Autocorrelation

Optical Layout

To make the SSA compact, the optical path is arranged in a vertical orientation.

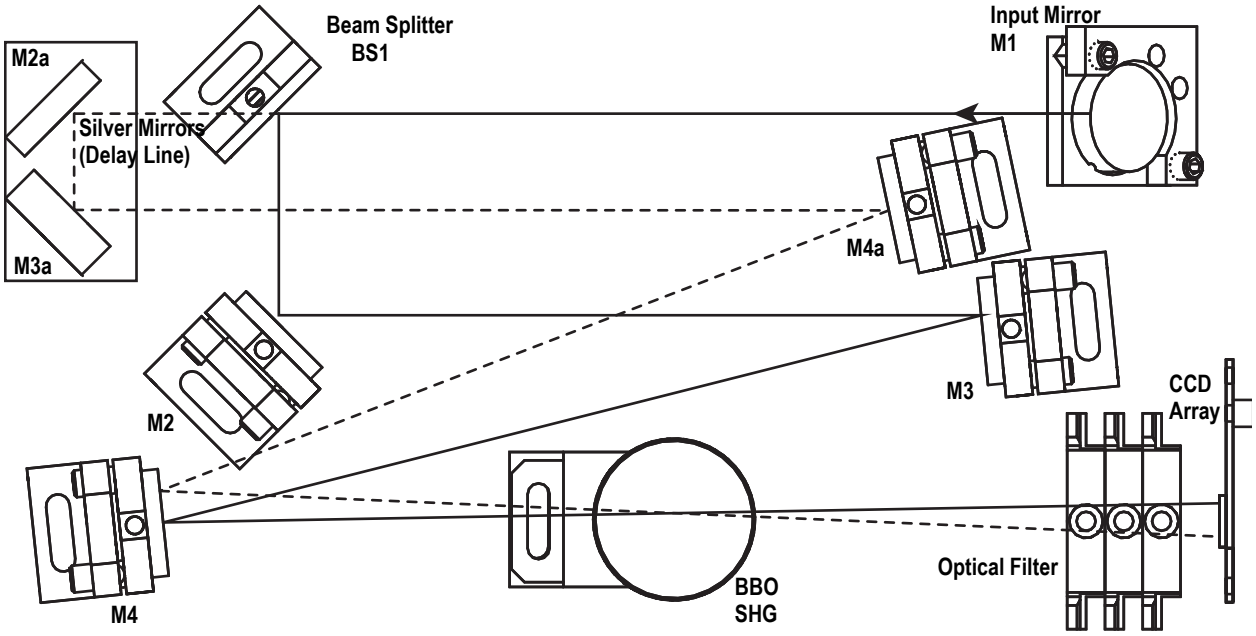


Figure 2-3. SSA Optical Layout

Operation is as follows:

1. Ultrafast laser pulses (such as those produced by the Coherent Mira, Legend or Libra system) enter the autocorrelator by the input aperture on the side of the SSA.
2. A partial reflector (M1) picks off and directs a small portion of energy into the autocorrelator. For low-energy laser pulses replace the partial reflector with a high reflector (silver mirror).
3. The beam is divided into two beams by a 50% beam splitter (BS1) as shown in Figure 2-4:
4. Both beams are directed to the nonlinear BBO SHG. A variable delay line (M2a and M3a) allows the user to calibrate the SSA in order to determine the laser pulse width.
5. The two beams cross in the BBO crystal where the autocorrelation is generated.
6. An optical filter (BG18; blue filter) is used to filter the fundamental wavelengths. Neutral density filters are also provided

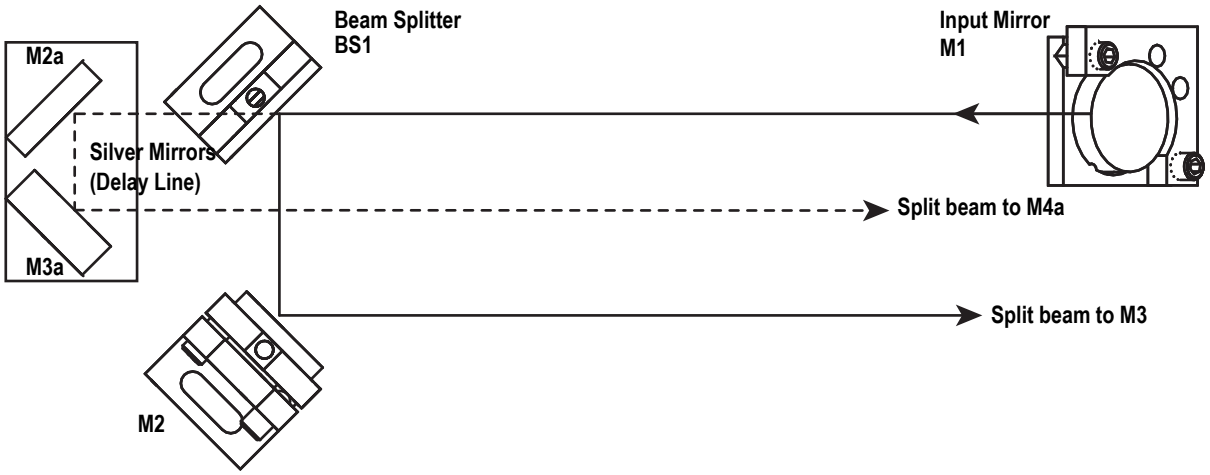


Figure 2-4. Beam Splitter Location

to be used if the CCD array is saturated from too much laser light. The autocorrelation is detected on a CCD array and then displayed on an oscilloscope as shown in Figure 2-5.

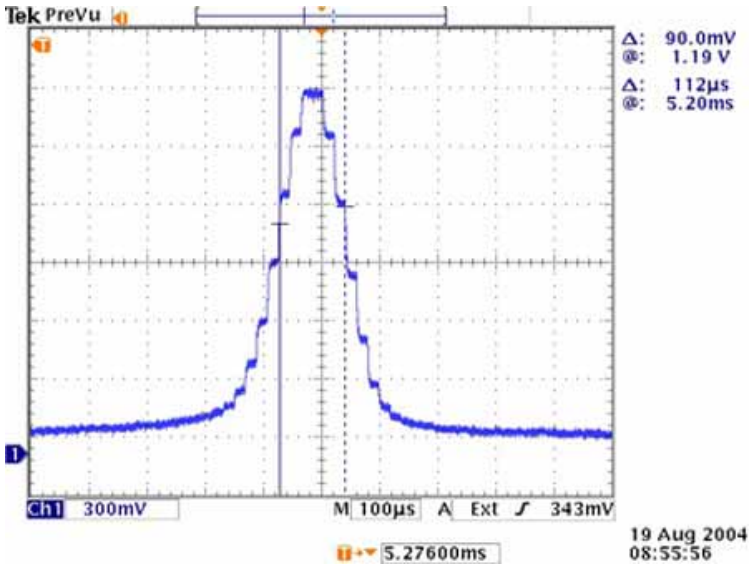


Figure 2-5. Typical Autocorrelation

Configurations

The SSA can be configured to measure the duration of femtosecond (30-300 fs) pulses or picosecond (1-4 ps) pulses:

- *SSA-F* is the femtosecond version for the measurement of subpicosecond pulses
- *SSA-P* can measure pulses up to approximately 4 ps.

The difference between the two versions is that the SSA-P contains a 1200 lines/mm grating in the M3 position instead of the reflective silver mirror (see Figure 2-6). The grating introduces additional wavefront tilt, which allows measurement of longer pulses.

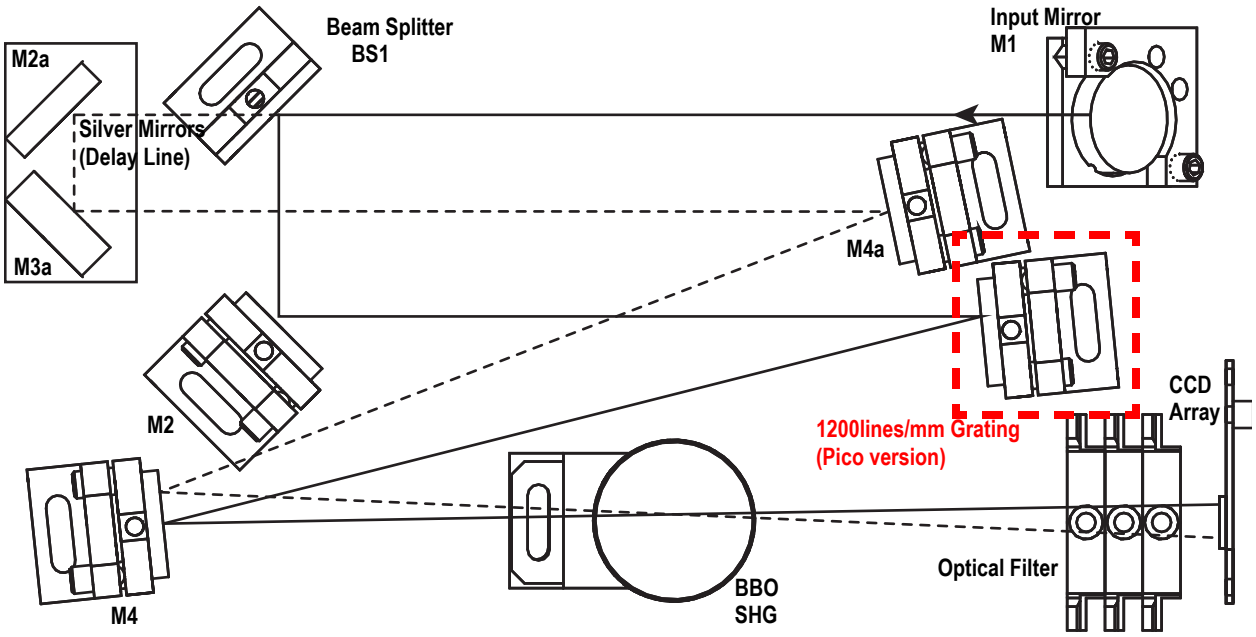


Figure 2-6. SSA-P Optical Layout

The picosecond configuration is optional and is only included if ordered. Unless specified, the SSA is delivered in the femtosecond configuration.

The SSA is configured for operation at Ti:sapphire wavelengths ranging from 750 to 850 nm. The SHG is BBO cut for 800 nm. Other crystals can be purchased from Coherent or ordered with the SSA.

Specifications

Table 2-1. Specifications

INPUT REQUIREMENTS	
Energy	>50 µJ
Wavelength:	680-1100 nm
Pulse length:	SSA-HR 20-50 fs SSA-F 50-500 fs SSA-P 500 fs-2 ps 500 fs-20 ps (Picosecond version at 800 nm)
Beam diameter:	2-8 mm
Polarization:	Linear
PERFORMANCE	
Maximum sampling rate	100 Hz (externally triggered)
Sampling rate	100 Hz (internally triggered)
Input trigger required	TTL compatible high impedance, >20 µsec
Power required	100-240 VAC, 50/60 Hz
SSA-F	
Range	50-500 fs
Resolution	5 fs
SSA-HR	
Range	20-50 fs
Resolution	2 fs
SSA-P (REQUIRES SSP OPTION)	
Range (wavelength-dependent)	1-4 ps (800 nm)
Resolution (wavelength-dependent)	0.085 ps (800 nm)

Dimensions

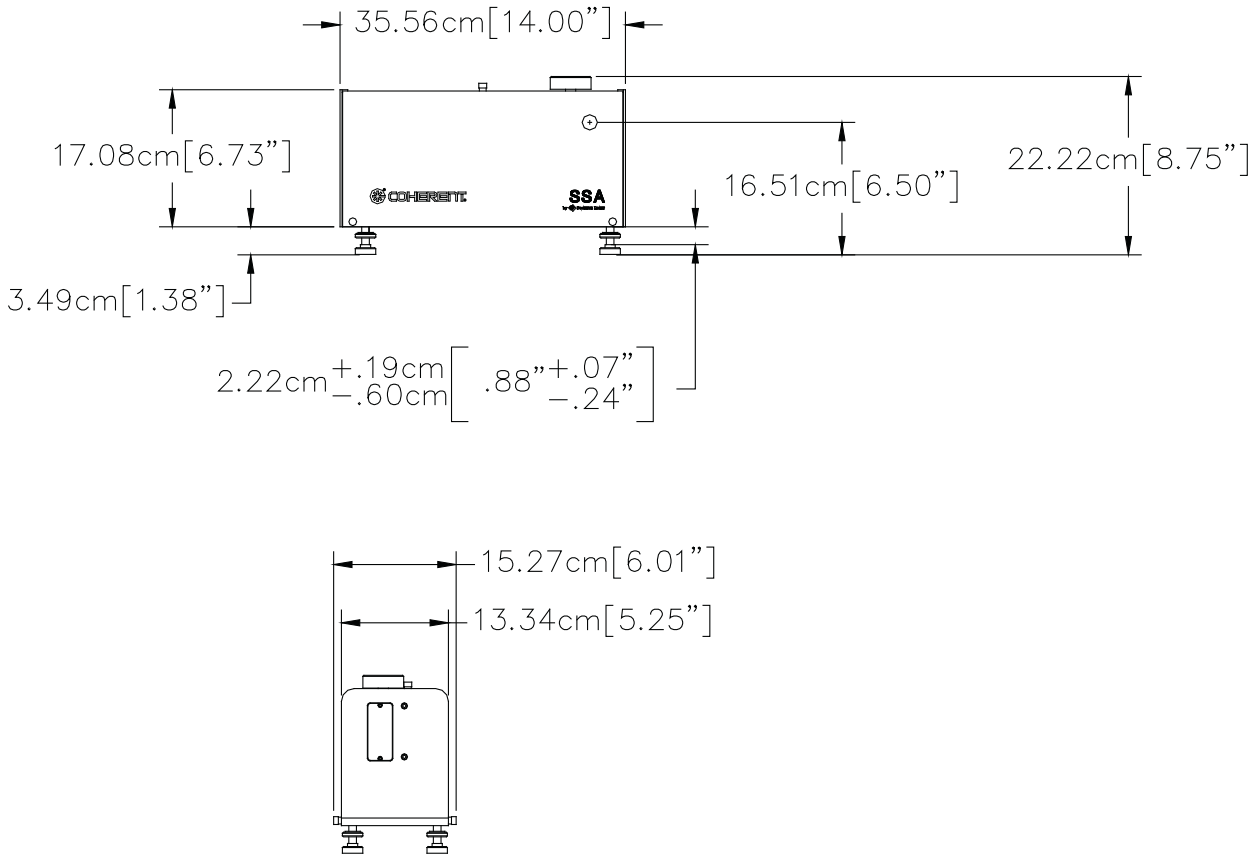


Figure 2-7. Dimensions

SECTION THREE: OPERATION AND ALIGNMENT

DANGER
Laser safety eye wear is required whenever hazardous exposure to laser light is possible.

Refer to the applicable Operator's Manual or Safety Label to confirm the wavelengths generated by the lasers in operation.

Unpacking

Carefully unpack the SSA and remove the cover. Confirm that no damage occurred during shipment. If you detect damage notify the shipping company and to Coherent.

Normally the SSA is shipped with a SHG that is cut at an angle of 44.5° for Ti:sapphire wavelengths that ranges from 750 to 850 nm. Any SHGs purchased for other wavelengths are also included.

The following is included with the autocorrelator:

- **SSA Autocorrelator**
- **Three neutral density filters**:
  - 0.5 OD
  - 1.0 OD
  - 2.0 OD
- **Band pass filter**. This is a BG18 filter that transmits Ti:sapphire second harmonic, but not the fundamental. You may have ordered an SSA for another wavelength, at your option. If an SSA for another wavelength was ordered, a compatible filter is included.
- **Crystal assembly**, cut for use at 800 nm. Other crystals can be included if specified at the time of purchase.
- **High reflector** to replace the input mirror (partial reflector) for low energy input
- **Grating (optional)** for picosecond operation
- **Mirror adjustment knobs**
- **Spare 1/2-amp fuse**
- **Power cable**

Initial Set-up

Use the adjustable feet to adjust the height of the SSA to match the height of the laser beam. Remove the cover.

The SSA is aligned at the factory before shipment. Internal mirror adjustments are not necessary to get autocorrelation.

Center the input beam through the input aperture and rotate the SSA while observing the trace on an oscilloscope. If an autocorrelation is not readily visible, refer to"Complete Alignment Procedure" on page 3.

The input mirror in the SSA is a partial reflector (~ 5%). This design allows the user to lose only a small percentage of the pulse energy for autocorrelation measurements while simultaneously conducting an experiment.

If the input pulse energy is < 50 μJ, Coherent recommends replacing the partial reflector with the high reflector mirror (included). The user must first determine which mirror is best suited for the particular experimental set-up before continuing with the operation and alignment sections of this manual.

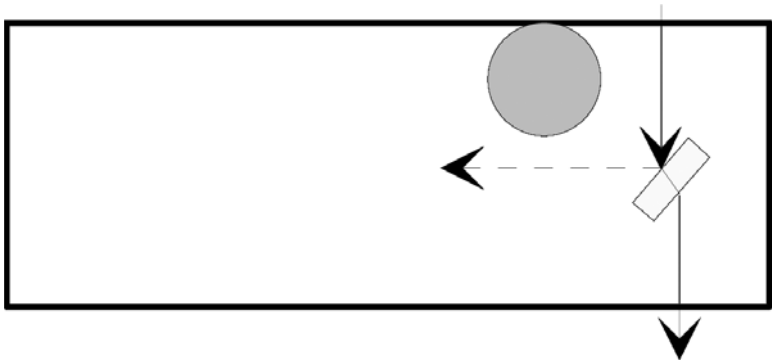


Figure 3-1. Top View of the Beam Path Through the SSA Using the Partial Reflector

Complete Alignment Procedure

Refer to the optical layout in Figure 3-2 and photo in Figure 3-3.

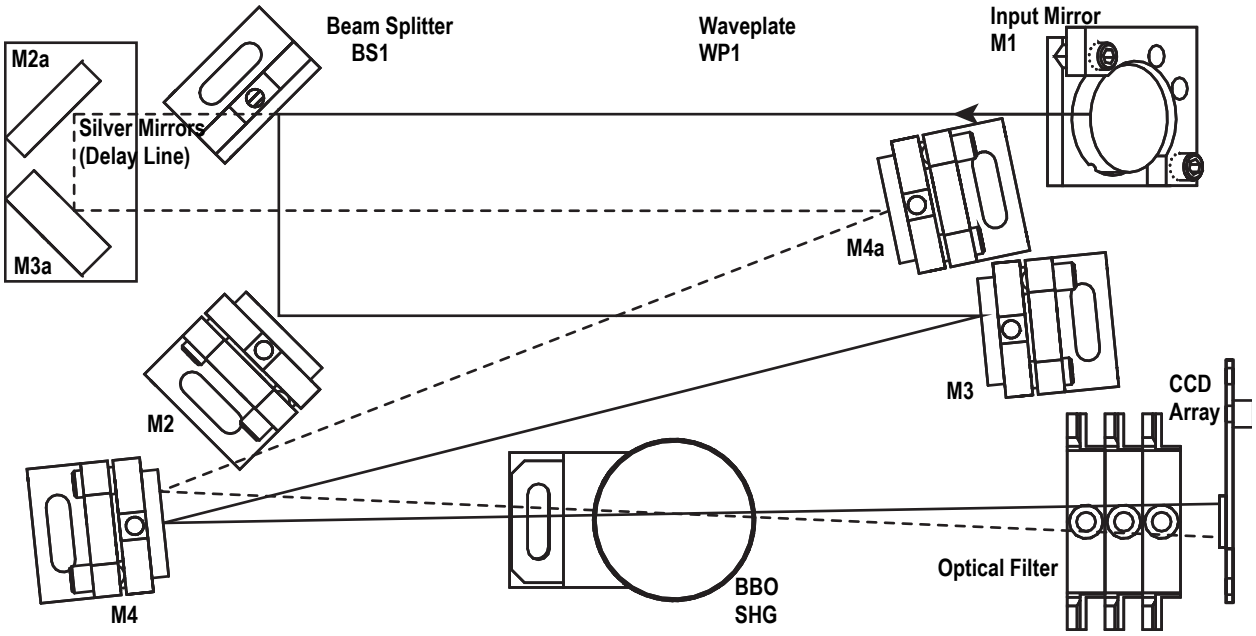


Figure 3-2. SSA Optical Layout

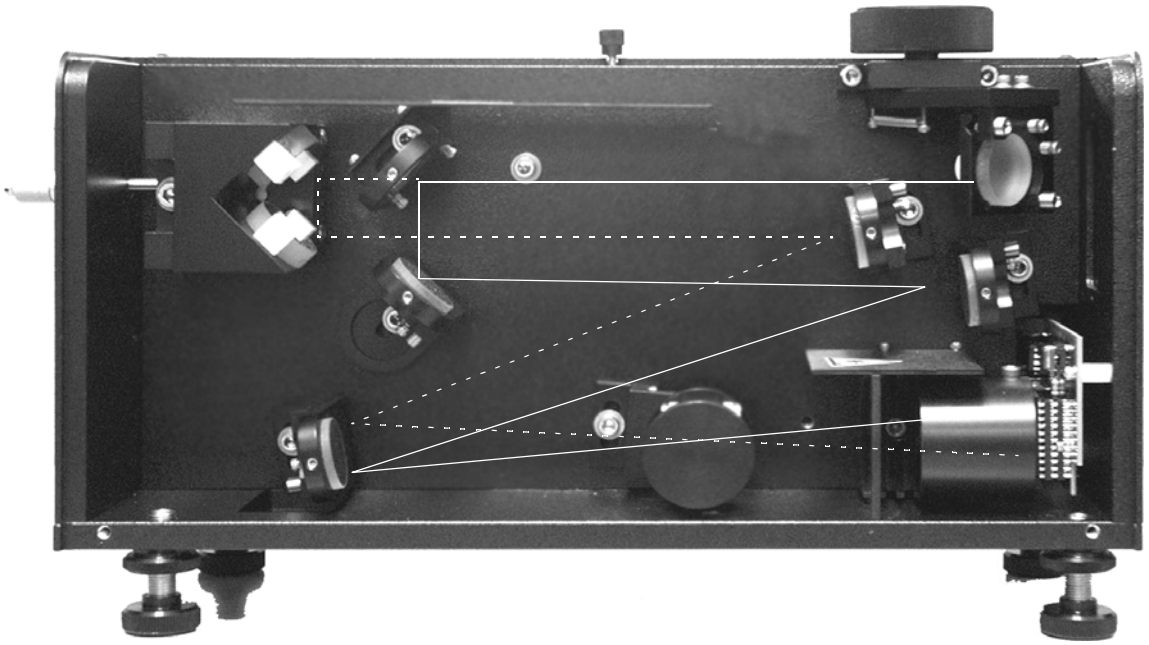


Figure 3-3. SSA, Front, Cover Removed

1. Make sure that the laser source is optimized for power and mode.
2. Make sure that the SSA is turned off.
3. Install the four legs, then put the SSA in a perpendicular position to the output of the laser system.
4. Use an IR viewer, to confirm that the incoming beam hits the center (both vertically and horizontally) of the first turning mirror M1. The turning mirror may be a reflective silver mirror or a single-coated anti-reflective beam splitter. If the beam splitter is currently installed, and the unit is severely misaligned, switch to the silver mirror to ease alignment.
5. Use the four adjustment feet to adjust the height of the SSA. Center the beam vertically to M1 and confirm unit is level to the table.
6. For horizontal placement, slide the unit laterally so that the beam hits the mirror at center. Use the four leg clamps supplied to secure the unit to the tabletop.
7. Put a white piece of paper (for example, a business card) directly in front of the silver mirror M4a.
    a.) Make sure that the beam is not clipped on the mirror.
    b.) If clipping is visible, make a slight vertical and/or horizontal adjustment to the 90° turning mirror, M1 until clipping is not visible. Horizontal centering of the beam on the silver mirror is not critical.
8. Put a white piece of paper directly in front of the silver mirror M3.
    a.) The beam from the 50% beam splitter, BS1, should also hit the silver mirror without clipping or spilling off any part of the silver mirror aperture.
    b.) If the beam is spilling off the mirror aperture, make horizontal and/or vertical adjustments to M2 so the beam is on the mirror surface without clipping.
9. Temporarily block the beam from entering the SSA.
10. Remove the SHG mount from its holder.
11. Remove any filters that are currently installed in the filter holder covering the CCD array.
12. Allow the beam to enter the unit.
13. Visually confirm where the two beams from M4 hits the CCD array. If the alignment is correct, the two fundamental beams hits the upper and lower edges of the CCD array.

14. If one or both of the beams does not hit the upper and lower edges of the CCD array, a vertical and/or horizontal adjustment to M4a and/or M3 is necessary.

15. To access to M4a and M3, remove the square access port behind M4a with a 3-32” ball-driver, as shown in Figure 3-4.

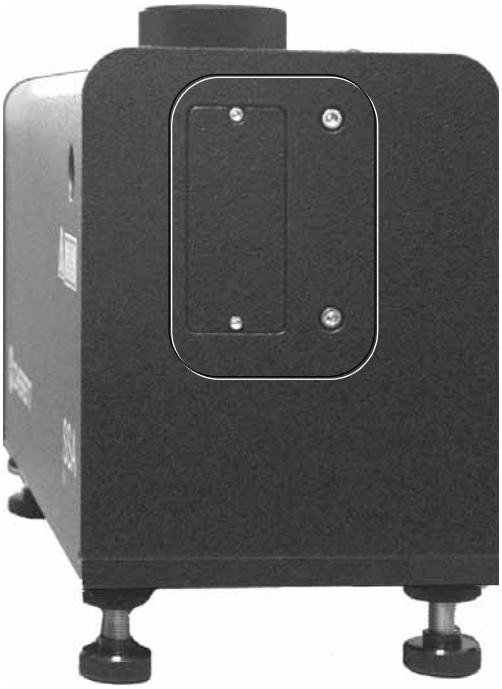


Figure 3-4. Access Port to M4a and M3

16. Use a 1/8” ball driver to adjust M4a to adjust the beam at the bottom of the array. Adjust M3 to adjust the beam at the top of the array.

17. Adjust M4a and M3 so that the two beams are symmetric at the upper and lower edges of the array.

    a.) Make sure that both beams are within the mirror aperture of M4 without clipping.

    b.) If one or both beams appear to be spilling off any part of M4, loosen and move the entire mount vertically until both beams hit the aperture of the mirror evenly in the vertical axis.

    c.) Pitch the mirror mount so that the two beams are propagating towards the top and lower edges of the CCD array again.

    d.) Secure the mirror mount to the SSA mounting plate.

e.) If necessary, make small adjustments to M4a and M3.

18. Temporary block the beam from the SSA.

19. Install the SHG in its mount, make sure that the arrow on the crystal assembly points toward the CCD array, as shown in Figure 3-5.

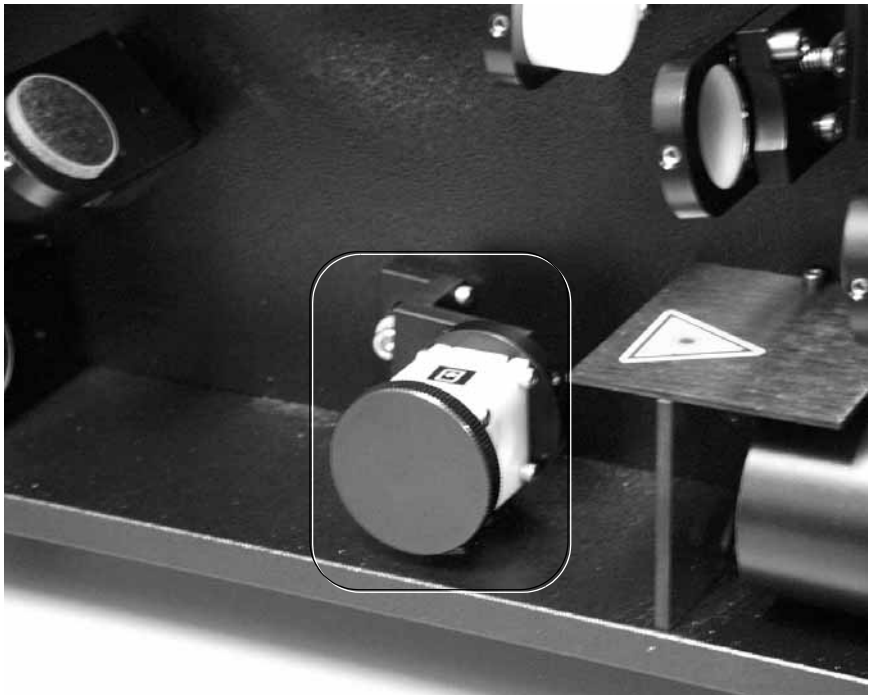


Figure 3-5. Second Harmonic Generation Crystal

20. Let the beam to enter the SSA.

21. If necessary, position the crystal and mount vertically so the crystal aperture is centered to the passing beams such that no clipping is visible.

22. Replace the filters into the filter holder. Make sure that the blue filter (BG-18) is re-installed first.

23. Put a white piece of paper between the crystal and filters.

24. Rotate the SHG housing slightly, so that the doubled autocorrelation is visible on the paper (see Figure 3-6).

    a.) If the signal is not readily visible, a mismatch in path length between the two individual beams can be the cause. Adjust the position of M2a and M3a with the external micrometer to correct the mismatch.

    b.) Use the micrometer to adjust the variable delay stage.

c.) If autocorrelation is still not visible, refer to "Optimizing the SSA Autocorrelation" on page 7.

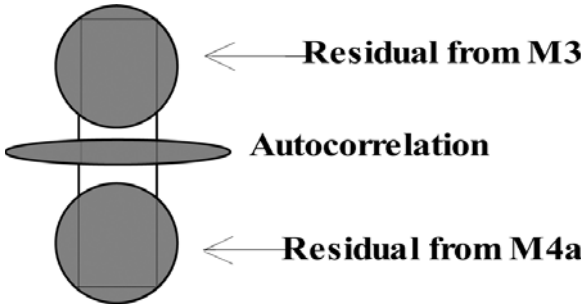


Figure 3-6. Typical Autocorrelation Beam Pattern

Optimizing the SSA Autocorrelation

1. Depending which mirror is in position M1 (partial or high reflector), place the required filter(s) in the filter holder slots. Install the blue BG18 filter first.
2. Start the SSA.
3. Set the time base of the oscilloscope to 1 ms/div.
4. Use an oscilloscope and the micrometer knob to adjust the delay stage. Look for the autocorrelation signal to reach maximum amplitude as the signal sweeps across the oscilloscope screen.

If no autocorrelation appears, rotate the SHG angle slightly while looking for the autocorrelation trace on the scope. If there is sufficient angle on the crystal, the second harmonic of either of the fundamental beams will appear as shown in Figure 3-7 and Figure 3-8.

When the autocorrelation is present, the signal is typically located at the center of the scope window as shown in Figure 3-9.

5. Make sure that the monitored signal is not saturating the CCD. The signal level should be less than 800 mV.
   a.) If the signal is higher, rotate the 1/2 wave plate (WP1) slightly to decrease the intensity of the autocorrelation.
   b.) If saturation is still evident, insert or replace one of the existing filters in the holder.
6. Make slight rotations to the SHG while looking for the signal to peak in amplitude on the oscilloscope. When rotation of the crystal is optimized, the fundamental beams will not be visible (Figure 3-10).

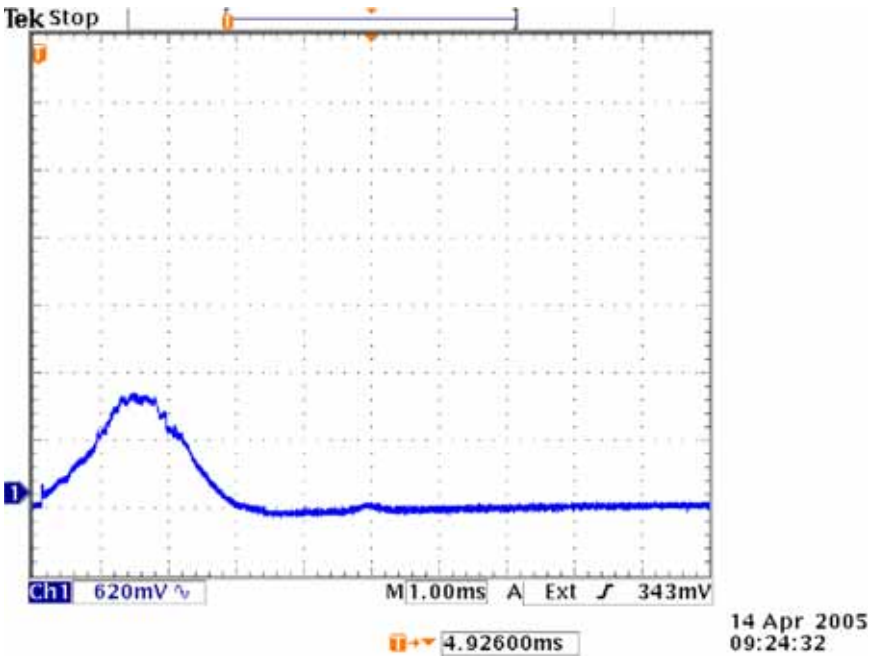


Figure 3-7. The Doubled Output Corresponding to the Beam Located at the Top of the Array

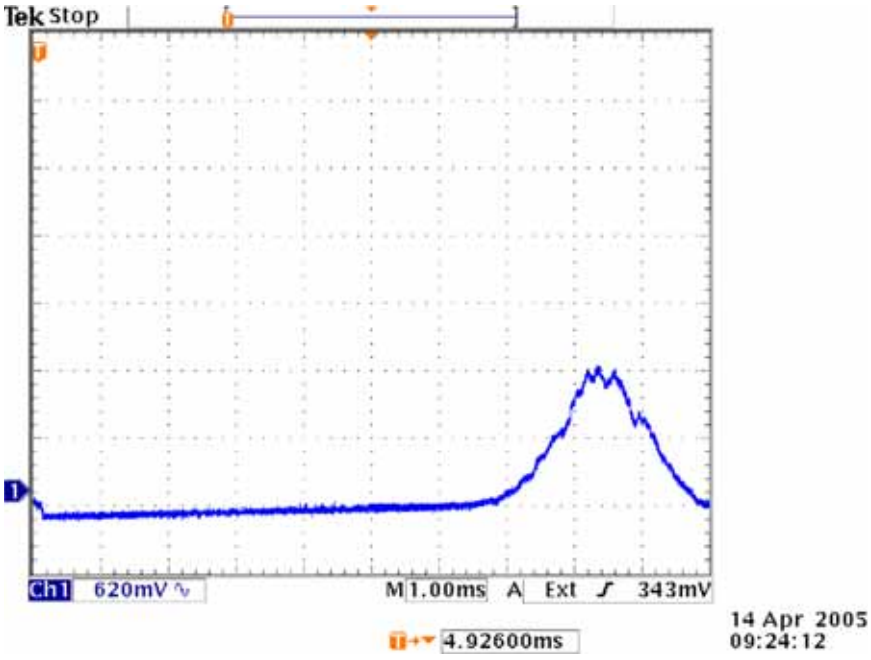
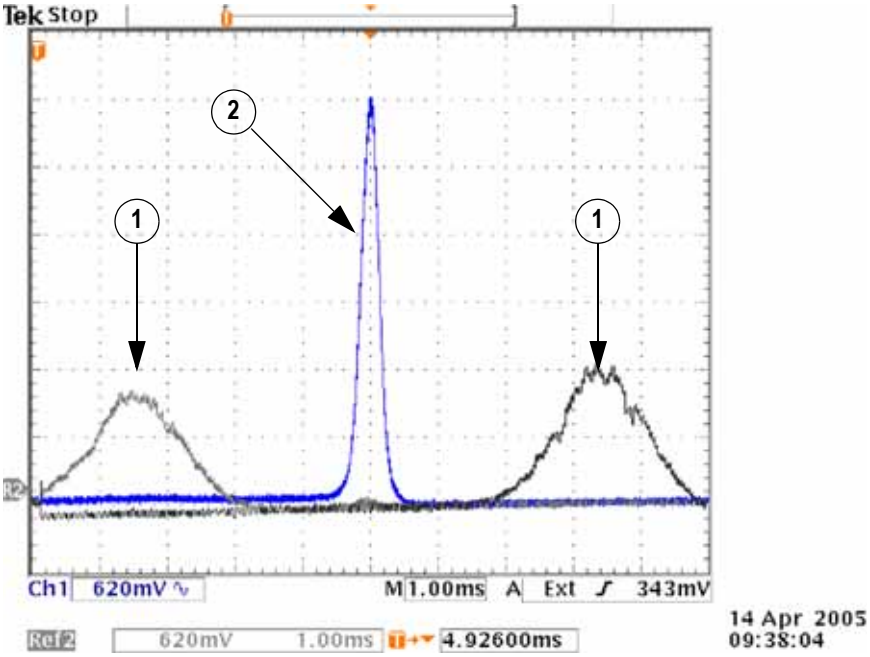


Figure 3-8. The Doubled Output Corresponding to the Beam Located at the Bottom of the Array

7. Adjust the length of the compressor horizontal retro-reflector for the sharpest autocorrelation.
8. Adjust the 1/2 wave-plate if saturation is indicated again.



1: Individual doubled legs as a function of crystal angle

2: Autocorrelation signal

Figure 3-9. Three Superimposed Traces

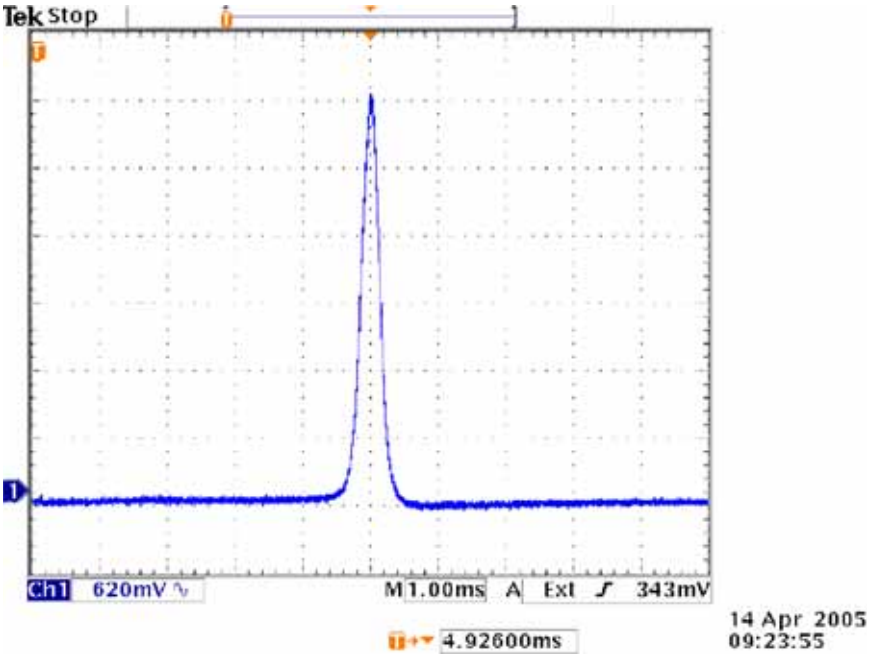


Figure 3-10. Typical Autocorrelation Signal

Converting SSA from Femtosecond to Picosecond Operation

1. Momentarily block the input beam into the SSA.
2. Use a 3/16" ball driver, hold with one hand the variable delay block (see Figure 3-11) and move the block from its sliding stage one hole closer to the 50% splitter.

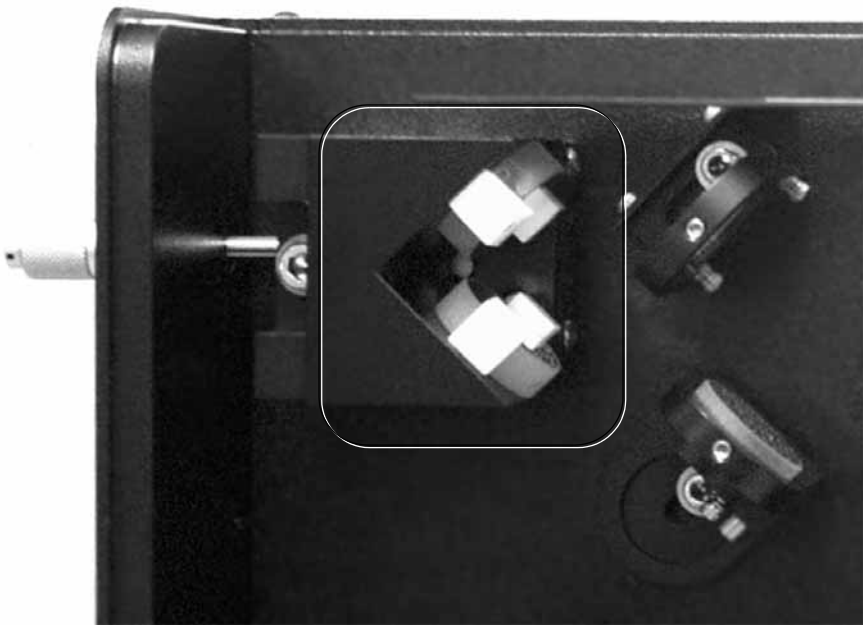


Figure 3-11. Variable Delay Block

3. Secure the variable delay block to the sliding stage base plate. Make sure that the top of the mount is flush with the top edge of the "V" block.
4. With a 5-32" ball driver, remove the M3 mirror mount housing from the SSA main plate.
5. Wear finger cots or latex gloves. Replace the silver mirror with the 1200 ln/mm grating holder. The grating is oriented in the mount so that the side of the grating that has the arrow mark is on the top. Make sure that the grating holder is mounted so the grating edge is as square to the side of the mirror mount as possible (Figure 3-11).
6. Using care not to scratch the grating, replace the complete mount in its original position on the SSA main plate. Tilt the mount until it is near its original position.
7. Secure the mount loosely, so it can still be rotated manually.

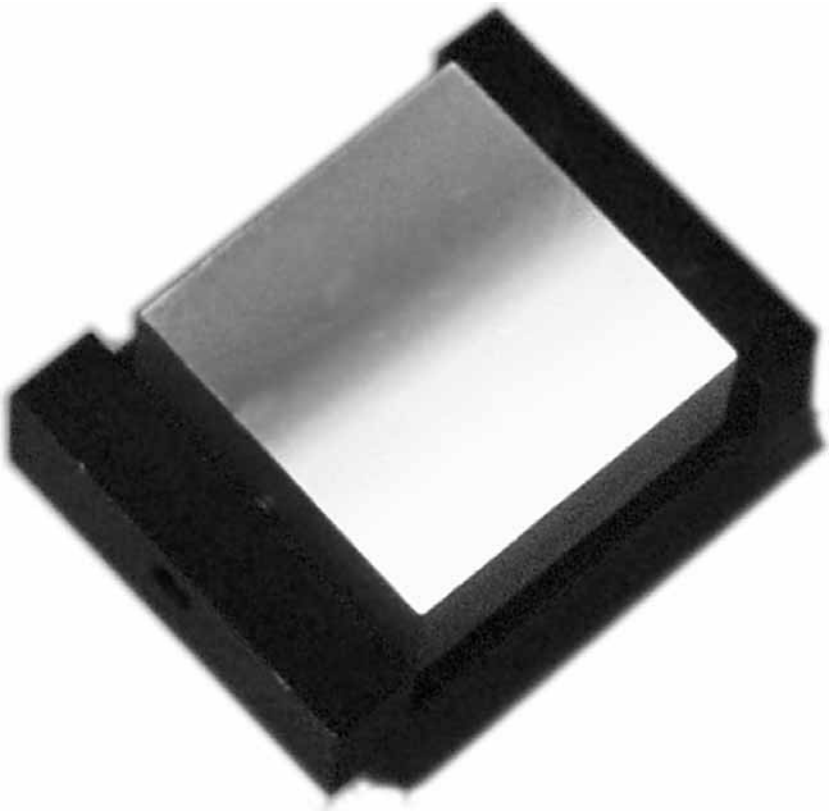


Figure 3-12. 1200 Line Grating

8. Put a white piece of paper directly in front of M4.
9. Let the beam to enter the SSA.
10. Rotate the grating mount so that the first order reflection off the grating is visible at or near the aperture of mirror M4. The incident angle is approximately 45°. Therefore, the zero order reflection reflects off the grating and hits the cover plate below the grating.

NOTICE!
An IR viewer may be necessary to view the first order reflection.

11. Tighten the grating mount to the main plate of the SSA.
12. Remove the paper from in front of M4. Place the paper in front of the filter holder.
13. Use a 1/8” ball driver to make minor adjustments to the X and Y axes of the grating mount. The first order reflection must be visible propagating directly through the BBO crystal aperture without indication of clipping.

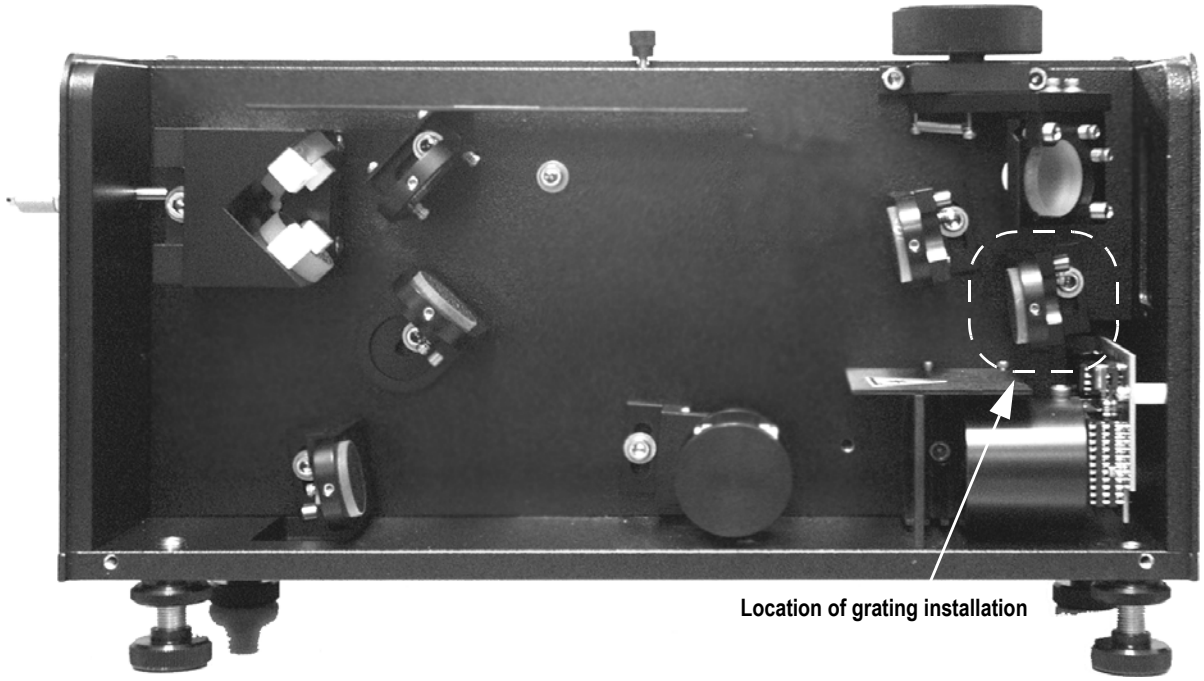


Figure 3-13. SSA Grating Installation

14. Make slight adjustments to M4a, so the beam entering from that leg is also visible propagating through the BBO crystal without indication of clipping.
15. Refer to "Optimizing the SSA Autocorrelation" on page 7 to get autocorrelation.

Electrical Set-up

1. Put the SSA power cord into an AC outlet. The SSA will accept voltages from 100 V to 240 V, 50/60 Hz, directly.
2. Turn on the SSA.
3. Connect the oscilloscope to the SSA as shown in Figure 3-14. The SSA samples at a rate of about 100 Hz; that is, the CCD is read out to the oscilloscope at 100 Hz. If the laser repetition rate is less than 100 Hz, use the SSA in EXTERNAL TRIGGER mode and supply an external trigger to the SSA.

NOTICE!
If the system uses a flash lamp pump laser; use a BNC "T" off the "lamp sync" output to supply the "External" TTL trigger to the SSA.

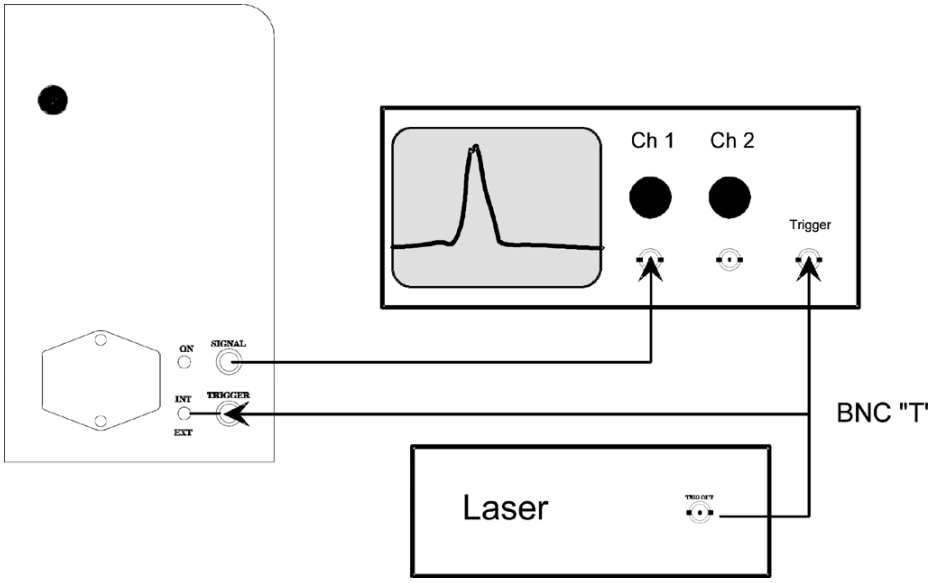


Figure 3-14. SSA Triggering in "Ext"

4. If the laser repetition rate is greater than 100 Hz, switch to INTERNAL TRIGGER mode with the trigger select switch. The switch is next to the on/off switch of the SSA. The SSA provides a time-averaged autocorrelation of input pulses every 10 ms.

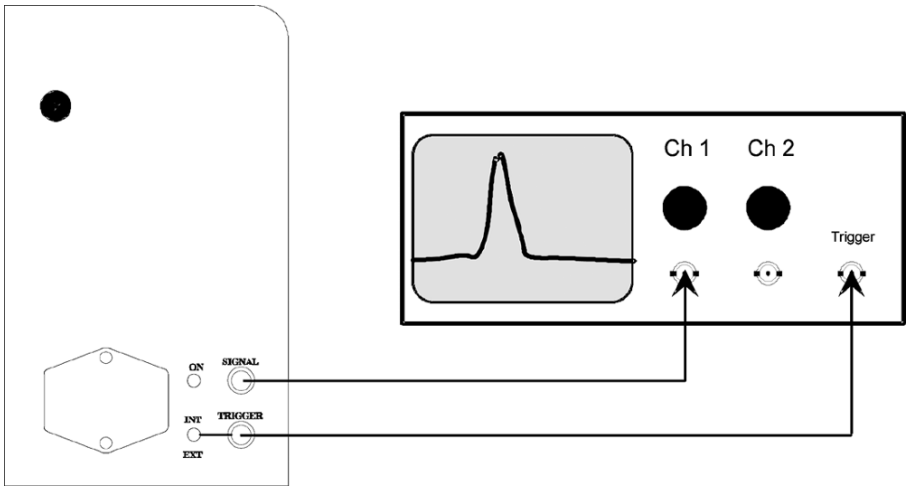


Figure 3-15. SSA Triggering in "Int"

5. If operating in "Ext" mode, make sure that the trigger signal is sufficient to trigger the autocorrelator. The trigger signal requires a TTL-compatible, high-impedance trigger. Its dura-

tion *must* be greater than 20 μsec. Operate the oscilloscope on the 2 ms/div range for set-up.

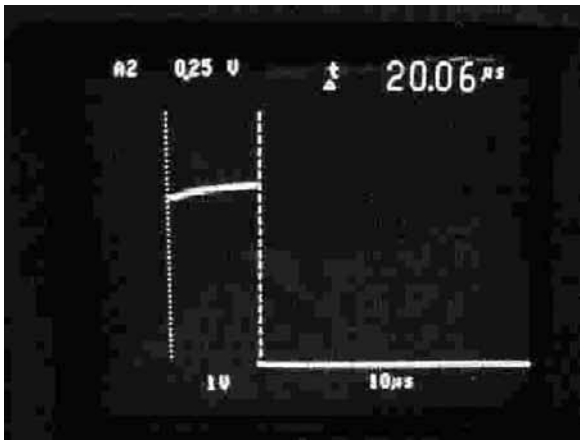


Figure 3-16. Typical Internal Trigger from SSA (1 MegaOhm Termination)

Operation

1. Lower the room lights.
2. If the autocorrelation signal is saturating the CCD, either rotate the wave plate or add some ND to attenuate the signal on the CCD.
   a.) A combination of wave plate adjustment and neutral density filter selection should provide a signal as shown in Figure 3-17.
   b.) If there is some background illumination of the CCD, there will be a small DC offset on the signal. The offset will disappear when the CCD cover and the SSA cover are in position.

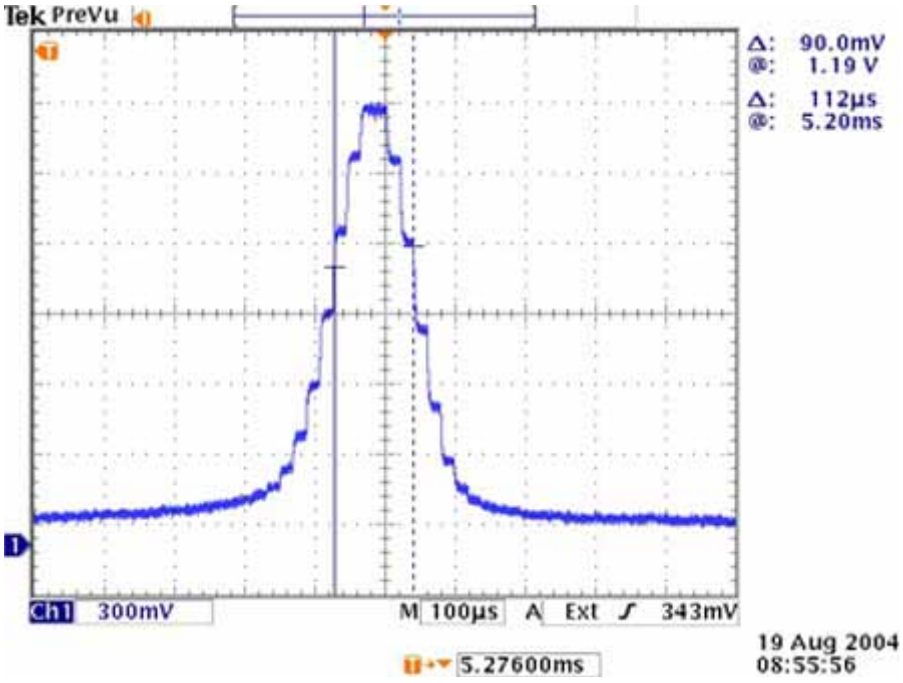


Figure 3-17. Typical Femtosecond Autocorrelation

3. Adjust the delay line and crystal angle to optimize the amplitude of the signal. Attenuate the signal as shown above if necessary.
4. Make sure that the CCD cover is as close to the last filter in the filter holder as possible.
5. Replace the SSA cover.
6. Turn on room lights if necessary.

Calibration

Use the micrometer attached to the side of the SSA to calibrate the SSA.

1. Get an autocorrelation trace on the oscilloscope (as described in the previous section).
2. Adjust the delay line micrometer. The autocorrelation will move across the oscilloscope screen. (Adjust the oscilloscope time base if necessary).
3. Record the reading on the micrometer.
4. Adjust the micrometer a fixed amount; for example, 40 microns.
5. Measure the amount the *peak* of the autocorrelation has moved in μsecs.
6. Calculate the calibration factor, as shown in the following example.

Example:

If the micrometer is adjusted 40 microns, and the peak of the autocorrelation moves 313 μsec, then:

Distance the delay stage has moved	= 40 microns
Optical path length change (two times micrometer change)	= 80 microns
Optical delay change (microns/sec) $\left(\frac{40}{3 \times 10^{14}}\right)$	= 266 fsec
Amount peak moved on oscilloscope	= 313 μsec
Calibration (266 fsec / 313 μsec)	= 0.85 fsec/μsec

Note: The micrometer in your SSA may be measured in inches. If this is the case, make the appropriate conversion to metric when calibrating the unit.

Interpretation of Autocorrelations

An autocorrelation always indicates that a pulse is broader than it actually is. It is relatively simple to predict the autocorrelation width (and shape) for a given temporal profile. Note, however, that the converse is not true. It is not possible to derive the original pulse-width or shape given the autocorrelation, unless some assumption is made about the input pulse. This is relatively simple to do because the characteristics of the laser system are normally well-defined.

As a guide, to derive the true pulse duration, divide by $\sqrt{2}$ for a Gaussian pulse or 1.55 for a hyperbolic secant squared pulse. When in doubt, divide by 1.5.

SECTION FOUR: CONTROLS, INDICATORS AND FEATURES

SSA

Rear

Figure 4-1. SSA Controls, Indicators and Features

Front

Left Side (from front)

Figure 4-1. SSA Controls, Indicators and Features

Right Side (from front)

1. Trigger In Port
2. ON/OFF Indicator
3. Signal In
4. Sync Out (Internal)
5. Sync Out (External)
6. On/Off Switch
7. Fuses (behind panel)
8. Access Port to M4a and M3
9. AC Inlet
10. Access Port to M2a and M3a
11. Beam Output
12. M1 Turning Knob
13. Beam Input

Figure 4-1. SSA Controls, Indicators and Features

SECTION FIVE: MAINTENANCE AND TROUBLESHOOTING

DANGER
Be careful when the SSA is operated with the covers removed. The optics are in vertical configuration. The vertical configuration can cause the reflections to travel upwards. This is true of reflections from the SHG. Wear protective eye wear to protect the eyes from all wavelengths used.

The SSA requires minimum and easy maintenance. However, some routine operations are recommended to keep the system in good operating order.

Cleaning Optics

NOTICE!
Do not touch the grating to clean the 1200 line. Contact with the grating can scratch or damage the grating. Use a dust blower to remove dust.

The most common maintenance procedure is cleaning the optics. Clean the optics carefully. Use soft optical tissue and spectral-grade methanol or acetone. Wear finger cots or latex gloves when the optics are held.

Tools and Materials

- Spectral-grade methanol or acetone
- Lens tissues
- Finger cots or latex gloves
- Hemostats (surgical pliers)
- Eyedropper

Steps

1. Wash your hands.
2. Hold one sheet of lens tissue over the optic to be cleaned.
3. Use the eyedropper to place a single drop of methanol on top of the lens tissue.
4. Drag the lens tissue across the optic one time only.
5. If a residue of solvent remains the optic, repeat the procedure with less solvent and a new lens tissue. Repeat the procedure until no residue remains.

For hard-to-reach optics and prisms:

1. Wear finger cots or latex gloves.
2. Fold a piece of lens tissue repeatedly until a pad of approximately 1 cm in width is created.
3. Hold the pad with a pair of hemostats so approximately 3 mm of the folded edge protrudes from the hemostat blades.
4. Saturate the pad with methanol or acetone and shake dry.
5. Gently swipe the optic from one end to the other. Be careful that the tip of the hemostats does not scratch the optic to be cleaned.
6. If necessary, repeat the operation with a clean tissue.

Troubleshooting

This section contains a general troubleshooting guide. This guide is provided to help isolate some of the problems that can occur while the SSA is in operation. A complete repair procedure is beyond the scope of this manual.

Contact Coherent customer service (800-367-7890) for more assistance.

Troubleshooting Guide

Use this guide if the SSA does not function correctly. If the corrective actions do not fix the problem and the SSA does not perform up to specification, contact your Coherent service representative.

Autocorrelation profile looks asymmetric:

[ ] SSA not correctly aligned.

[ ] The filters are dirty or have fingerprints on the surfaces.

Autocorrelation profile appears flat at the top:

[ ] Too much laser light to the CCD array –CCD array is saturated.

LED not illuminating upon activation of SSA:

[ ] Make sure that the AC cord is connected correctly into the AC source line.

[ ] Confirm that power switch is in the ON position.

[ ] Check fuse inside the AC receptacle housing located within the ON/OFF switch.Use a flat-head screw driver at the top of the AC receptacle to remove panel.

LED is on but no trigger trace is visible on the oscilloscope:

[ ] If the laser repetition rate is greater than 1 kHz, make sure that the “Ext/Int. trigger switch on the SSA is in the INTERNAL position. If < 100 Hz, make sure the switch is in the EXTERNAL position and an external trigger is supplied.

No autocorrelation visible on oscilloscope:

[ ] Variable Delay line for SSA is out of range.

[ ] Too much filter attenuation.

[ ] SSA not aligned.

[ ] The laser pulse-duration is very long.

PARTS LIST

The following parts can be ordered by contacting Coherent Customer Service at 1-800-367-7890 inside the US. Outside the US, Coherent Customer Service may be contacted by calling 1-408-764-4557.

Table A-1. Parts List

DESCRIPTION	PART NUMBER
Femtosecond version of the SSA	SSA-F
Picosecond option	SSP
Beamsplitter	705-3636
High Reflector mirror (Silver mirror)	705-1070
KDP crystal for default operation (Ti:sapphire laser wavelengths)	712-1242
2" x 2" filter, OD = 0.5	707-1551
2" x 2" filter, OD = 1.0	707-1552
2" x 2" filter, OD = 2.0	707-1553
2" x 2" filter, BG18	707-1554
2" x 2" filter, KG-3	707-4482

SINGLE SHOT AUTOCORRELATOR WARRANTY

Coherent, Inc. warrants to the original purchaser (the Buyer) only, that the laser system, that is the subject of this sale, (a) conforms to Coherent's published specifications and (b) is free from defects in materials and workmanship.

Laser systems are warranted to conform to Coherent's published specifications and to be free from defects in materials and workmanship for a period of twelve (12) months. This warranty covers travel expenses for the first ninety (90) days. For systems that include installation in the purchase price, this warranty begins at installation or thirty (30) days from shipment, whichever occurs first. For systems which do not include installation, this warranty begins at date of shipment.

Optical Products

Coherent optical products are unconditionally warranted to be free of defects in materials and workmanship. Discrepancies must be reported to Coherent within thirty (30) days of receipt, and returned to Coherent within ninety (90) days. Adjustment is limited to replacement, refund or repair at Coherent's option.

Conditions of Warranty

On-site warranty services are provided only at the installation point. If products eligible for on-site warranty and installation services are moved from the original installation point, the warranty will remain in effect only if the Buyer purchases additional inspection or installation services at the new site.

For warranty service requiring the return of any product to Coherent, the product must be returned to a service facility designated by Coherent. The Buyer is responsible for all shipping charges, taxes and duties covered under warranty service.

Parts replaced under warranty shall become the property of Coherent and must be returned to Coherent, Inc., Santa Clara, or to a facility designated by Coherent. The Buyer will be obligated to issue a purchase order for the value of the replaced parts and Coherent will issue credit when the parts are received.

Other Products

Other products not specifically listed above are warranted to, (a) conform to Coherent's published specifications and (b) be free from

defects in materials and workmanship. This warranty covers parts and labor and is for a period of twelve (12) months from the date of shipment.

Responsibilities of the Buyer

The Buyer must provide the appropriate utilities and operating environment outlined in the product literature and/or the Preinstallation Manual. Damage to the laser system caused by failure of Buyer's utilities or the Buyer's failure to maintain an appropriate operating environment, is solely the responsibility of the Buyer and is specifically excluded from any warranty, warranty extension, or service agreement.

The Buyer is responsible for prompt notification to Coherent of any claims made under warranty. In no event will Coherent be responsible for warranty claims later than seven (7) days after the expiration of the warranty.

Limitations of Warranty

The foregoing warranty shall not apply to defects resulting from:

1. Components or accessories with separate warranties manufactured by companies other than Coherent.
2. Improper or inadequate maintenance by Buyer.
3. Buyer-supplied interfacing.
4. Operation outside the environmental specifications of the product.
5. Improper site preparation and maintenance.
6. Unauthorized modification or misuse.

Coherent assumes no responsibility for customer-supplied material.

The obligations of Coherent are limited to repairing or replacing, without charge, equipment which proves to be defective during the warranty period. Repaired or replaced parts are warranted for the duration of the original warranty period only. This warranty does not cover damage due to misuse, negligence or accidents, or damage due to installations, repairs or adjustments not specifically authorized by Coherent.

This warranty applies only to the original Buyer at the initial installation point in the country of purchase, unless otherwise specified in the sales contract. Warranty is transferable to another location or to another Buyer only by special agreement which will include additional inspection or installation at the new site.

THE WARRANTY SET FORTH ABOVE IS EXCLUSIVE IN LIEU OF ALL OTHER WARRANTY, WHETHER WRITTEN, ORAL OR IMPLIED, AND DOES NOT COVER INCIDENTAL OR CONSEQUENTIAL LOSS. COHERENT SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANT-ABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

GLOSSARY

°C	Degrees centigrade or Celsius
°F	Degrees Fahrenheit
µ	Microns
µrad	Microradian(s)
µsec	Microsecond(s)
$1/e^2$	Beam diameter parameter
AC	Alternating current
AGC	Automatic gain control
Amp	Amperes
BPF	Band pass filter
CDRH	Center for Devices and Radiological Health
cm	Centimeter(s)
CW	Continuous wave
DC	Direct current
EMC	Electromagnetic compliance
GHz	Gigahertz
Hz	Hertz
IR	Infrared
kg	Kilogram(s)
kHz	Kilohertz
LED	Light emitting diode
LVD	Low voltage directive
m	Meter(s)
mAmp	Milliampere(s)
MHz	Megahertz
mm	Millimeter(s)
mrad	Milliradian(s)
msec	Millisecond(s)
mV	Millivolt(s)
mW	Milliwatt(s)
Nd:YAG	Neodymium doped yttrium aluminum garnet
nm	Nanometer(s)
OEM	Original equipment manufacturer
PZT	piezo-electric transducer

RF	Radio frequency
rms	Root mean square
Rx	Receive
TEM	Transverse electromagnetic (cross-sectional laser beam mode)
Tx	Transmit
VAC	Volts, alternating current
VDC	Volts, direct current
W	Watt(s)

INDEX

Single Shot Autocorrelator (SSA) Operator's Manual

Part No. 1063015, Rev AC