

# Laser Operational Safety Procedure (LOSP) Form

(See [ESH&Q Manual Chapter 6410 Appendix T1](#)  
[Laser Operational Safety Procedure](#))

**Serial Number:** ACC-11-006-LOSP

(Assigned by [ESH&Q Document Control](#) x7277)

**\*Attach the Task Hazard Analysis (THA) related to this procedure**

<b>Issue Date:</b>	7-06-2011	<b>Expiration Date:</b>	7-06-2014
<b>Title:</b>	Twisted photon experiment		
<b>Location:</b>	Bldg 90 Room 118		
<b>Description of Project</b>	This LSOP describes the laser system used to excite photoemission in GaAs using twisted photon light in order to measure QE and polarization.		
<b>Document Owner(s):</b>	James McCarter	<b>Date:</b>	07-06-2011

### Laser Inventory

#	Laser Type	Laser Class	Wavelength(s)	Maximum Power/Energy
1.	1-Diode	3B	785 nm	0.05 W
2.	_____	_____	_____	_____
3.	_____	_____	_____	_____
4.	_____	_____	_____	_____
5.	_____	_____	_____	_____

Approval Signatures:	Print	Signature	Date:
Laser System Supervisor:	James McCarter	_____	_____
Laser Safety Officer:	Dick Owen	_____	_____
Division Safety Officer:	Harry Fanning	_____	_____
Department or Group Head:	Matt Poelker	_____	_____

### Document History:

Revision:	Reason for revision or update:	Serial number of superseded document
0	New experiment, new laser	

**Distribution:** ESH&Q Document Control (x7277, MS6B); affected area(s); Document Owner; Division Safety Officer

**Introduction** – In areas containing more than one laser, define operational sequence or parameters.

This Laser Standard Operating Procedure (LSOP) addresses all aspects of safety and conduct specific to the operation and maintenance of the lasers used in building 90 room 118, commonly referred to as: EEL 118.

The Laser System Supervisor (LSS) is James McCarter.

email: [mccarter@jlab.org](mailto:mccarter@jlab.org)

Extension: 7856

A copy of the LSOP and related safety information is posted online at:

[http://www.jlab.org/accel/inj\\_group/laser\\_safety/twisted\\_photon.html](http://www.jlab.org/accel/inj_group/laser_safety/twisted_photon.html)

The approved physical copy of this LSOP is kept in room 118 of building 90 on the equipment rack for the micro-Mott polarimeter.

### Personnel

Only those authorized by the LSS are permitted to enter the location noted on the cover sheet of this document.

List:

- Training and qualification requirements (including refresher training).
- Medical requirements.
- Spectator protection requirements.

A list of authorized laser personnel is maintained locally on this LOSP.

Accidental Eye Exposure: Accidental eye exposure to a laser beam requires **immediate medical attention** whether injury is apparent or not. If possible, the individual should remain and be transported in the upright position.

Spectator Protection Requirements: Laser Workers may escort Spectators in an interlocked laser area during alignment mode only after ensuring that the spectator is wearing appropriate safety eyewear. *Spectators must have received prior permission from the Laser System Supervisor before entering the interlocked laser area during alignment mode.*

### Laser

Define:

- Laser system specifications.
- Define laser system components.
- Copy of laser operating manuals or reference the location of the manual(s).

Diode laser supplied by collaborators from University of Nebraska, Lincoln, at 785 nm and power less than 50 mW.

The approved physical copy of this LSOP is kept at the Injector Test Stand control room safety board

### **Lasers that can be installed and operated in the room are listed below:**

Description: Diode lasers - Used as a direct optical source for an experiment on the laser table or used as to “seed” other lasers for wavelength or temporal control.

Type of Laser / Class	Semiconductor diode laser / class 3B
Manufacturer	Ultimate manufacturers are unknown. Diodes are supplied by Thorlabs, Qphotonics, etc.

Model Numbers	Multiple model numbers. This information is not consequential for safety. All diodes are treated with equal concern based on power, wavelength, and beam shape.
Serial Numbers	Diode lasers are easily damaged and frequently replaced. Furthermore, vendors do not mark serial numbers on the diode housings because they are often too small. For this reason, serial numbers of seed lasers are not recorded in this LSOP.
Wavelength range	785 nm
Power Range	0.05 W or less
Mode (i.e., time structure)	CW operation only, no pulse structure
Beam Diameter (collimated, typical)	3mm
Divergence (uncollimated, typical)	10 degrees parallel, 30 degrees perpendicular to laser junction.

### Hazards and Mitigation

Define:

- Laser-specific hazards.
- Occupational exposure hazards beyond laser light (e.g. fumes, noise, etc.).
- Credible non-beam hazards (e.g. environmental hazards).
- Describe all required [personal protective equipment ES&H Manual Chapter 6410 Appendix T2 Laser Personal Protective Equipment \(PPE\)](#) (include: clothing requirements (e.g.: no reflective jewelry, etc.).

#### Laser Specific Hazards

*Hazard:* The laser(s) described in this LOSP may produce optical energies that can cause temporary or permanent damage to the eyes.

*Mitigation:* This hazard is mitigated by training, professional conduct, optical beam-line layout, adherence to the *Use and Alignment procedures* listed in this document, and proper selection of laser protective eyewear by affected workers. The selection of laser protective eyewear is determined by the wavelength and power of the laser(s) in use as referenced in the *Required Calculations* section. Non-affected workers are protected by the system enclosure and room interlock system.

Clothing Requirements: Laser workers must not wear jewelry or clothing that presents a specular reflection hazard. Spectators are not permitted to access the beamline, so there are no restrictions on spectators other than the eyewear requirement.

## Laser Environment

System designs, including interlocks, require hazard evaluation review by SME.

Define:

- Layout of the [laser controlled area](#) and/or table. (Show beam location in relation to user (waist height preferable).)
- [Interlock](#) schematic (or similar) (including smoke detector interlocks).
- Room lighting conditions during laser use and alignment procedure(s).
- Targets.
- Primary and all likely beam paths (open or enclosed).

- The laser system for the twisted photon experiment is on an optical breadboard. This is placed adjacent to the micro-Mott polarimeter's normal optical breadboard, which contains a steering mirror system for translation of the beam, attenuation and polarizing elements for the light and a vertical deflector into the Mott polarimeter source chamber.

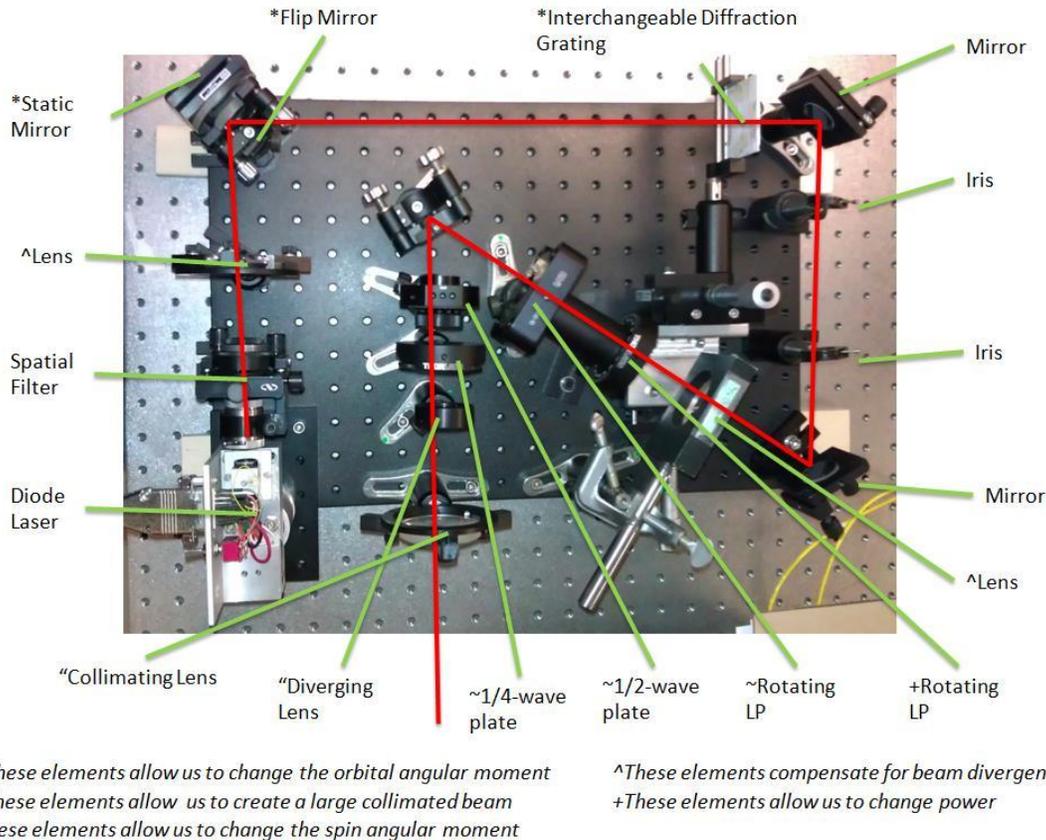


Figure 1: Twisted photon optics breadboard being added to micro-Mott optical system. Laser (lower left) passes through various optical elements then is sent into micro-Mott steering and deflection optics.

- The path of the laser beam is maintained within the perimeter of the affixed table containing the vacuum set up and within a height of 8" above the table surface. Optical cloth hung around the laser set up and perimeter of the vacuum table protects personnel sitting at the desk workstation and in the rest of room 118.
- The laser controlled area is shown below. This drawing shows beam location in relation to workers. It also shows a typical table layout. The laser system supervisor shall maintain and propagate the latest actual layout to all laser workers as changes are made to the table or laser area.
- The beam from the laser travels in a beam path indicated on the drawing attached in Section 9.
- The ultimate beam target is either a laser power meter or the GaAs photocathode for electron production (biased at -250 V) in the Micro-Mott source vacuum chamber.

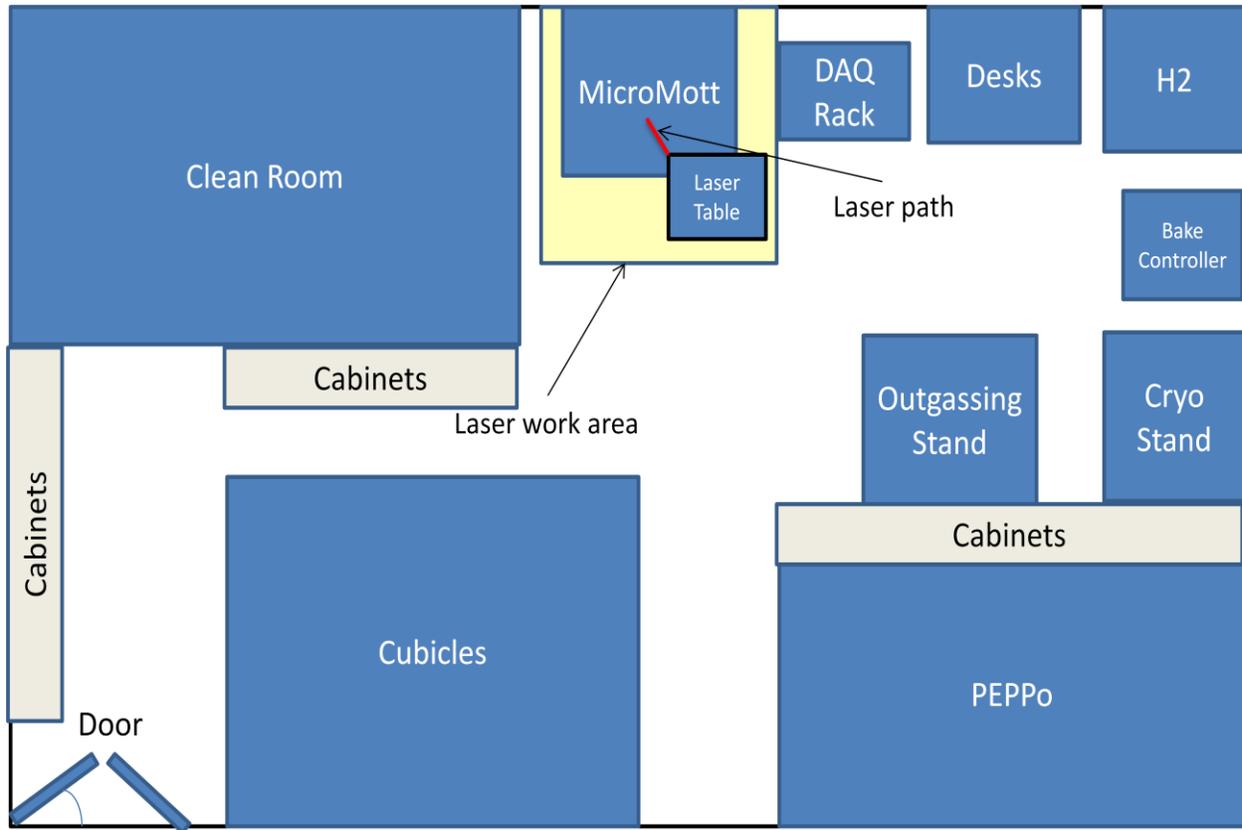


Figure 1. LASER AREA AND TYPICAL BEAM PATH.

**Written Procedure  
for Use  
and  
Alignment**

Provide:

- All process steps – including unattended operation controls.
- All process steps for detailed alignment – Include manufacturer’s protocols for alignment.
- Maintenance and service.
- Off-normal and emergency procedures (e.g. beam loss, fire).

## Procedural Considerations

1. Watches, rings, dangling badges, necklaces, reflective jewelry are taken off before any alignment activities begin. Non-reflective tools are used when beam is present.
2. Access to the room/area is limited to authorized personnel only during alignment mode.
3. Consider having someone present to help with the alignment.
4. All equipment and materials needed are present prior to beginning the alignment
5. All unnecessary equipment, tools, combustible material (if fire is a possibility) is removed to minimize the possibility of stray reflections and non-beam accidents.
6. Persons conducting the alignment have been authorized by the LSS

## Alignment Methods to be used for this laser system:

1. There shall be no intrabeam viewing with the eye.
2. Co-axial low power lasers should be used when practical for alignment of the primary beam.
3. Intrabeam viewing is to be avoided by using cameras or fluorescent devices.
4. Reduce the beam power through the use of ND filters, beam splitters and dumps, or reducing power at the power supply. Avoid the use of high-power during alignment.
5. Laser Protective Eyewear shall be worn at all times during alignment.
6. Beam Control- the beam is enclosed as much as practical, the shutter is closed as much as practical during course adjustments, optics/optics mounts are secured to the table as much as practical, beam stops are secured to the table or optics mounts.
7. Areas where the beam leaves the horizontal plane shall be labeled.
8. Any stray or unused beams are terminated.
9. Invisible beams are viewed with IR/UV cards, business cards or card stock, craft paper, viewers, 3x5 cards, or similar technique. Operators are aware that specular reflections off some of these devices are possible.
10. Normal laser hazard controls shall be restored when the alignment is completed. This includes enclosures and covers.

## Off-normal and Emergency Procedures

In Case of Fire, leave the area immediately and pull the nearest fire alarm. Notify the LSS after mitigating the emergency.

## Maintenance & Service

Routine maintenance of the laser systems consists of realignment and cleaning. These procedures are described in the vendor manuals and are typically considered "general knowledge" to laser workers trained on a specific system.

Laser Controls	<ul style="list-style-type: none"> <li>Describe all <a href="#">controls</a> (<a href="#">administrative</a> and <a href="#">engineering</a>). (If a different control is recommended the rationale for not using a typical/recommended control.)</li> </ul>
Laser Safety Eyewear	To be worn at all times when Laser Workers perform laser work with open class 3b or greater beam paths or any potential for exposure exists.
Laser Enclosures	The class 3b laser is completely enclosed via optical shielding during running as much as possible during alignment.
<p>The administrative controls are the contents of this LOSP, the labels affixed to the lasers themselves, and the signage posted. These controls supplement the PPE requirements.</p>	

Required Calculations	<ul style="list-style-type: none"> <li><a href="#">Maximum permissible exposure</a> (MPE).</li> <li>Optical density (OD).</li> <li><a href="#">Nominal hazard zone</a> (NOHD).</li> </ul>
<p>The MPE (max. permissible exposure), NOHD (nominal optical hazard distance), and OD(optical density) requirement for the eyewear are calculated using software package Easy Haz Industrial LSO (V2.12) by Laser Professionals Inc.</p>	
<p>Laser parameters needed to calculate these values:</p> <p><b>Assumptions:</b></p> <ul style="list-style-type: none"> <li>Beams always collimated.</li> <li>Beams are circular.</li> <li>CW beams: exposure 10 seconds for IR lasers, 0.25 seconds for visible lasers</li> <li>7mm pupil diameter limiting aperture</li> <li>Collimated beam diameter is a "worst case" 1.5mm and lowest possible divergence of 0.2mrad.</li> </ul> <p><b>Results are shown in the table below:</b></p>	

Laser Wavelength	Worst case pulsed conditions	Max average power at stated pulse conditions	Worst case Collimated Beam Diameter (mm)	MPE Ocular (W/cm <sup>2</sup> )	MPE Skin (W/cm <sup>2</sup> ) CW	NOHD (meters)	Required OD (eyewear)
diode laser, 785	CW only – no	50 mW	1.5	1.45e-3	2.96e-1	2.5	2.94

nm	pulse structure						
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**Remarks:**

1. OD rating printed on eyewear must exceed the calculated value of required OD.
2. For a given wavelength band, the lower wavelength of the band is the most restrictive. This value is used for the calculations to provide the greatest safety factor.

<p align="center"><b>Labeling/Posting</b>          (See <a href="#">ES&amp;H Manual Chapter 6410</a>  <a href="#">Appendix T5 Laser Labeling/Posting</a>  <a href="#">Requirements</a>)</p>	<ul style="list-style-type: none"> <li>• Equipment/area labeling/posting requirements.</li> <li>• Area signs.</li> </ul>
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Authorized/Trained Individuals	
Print Name/Signature	Date
James McCarter	
Joan Dreiling	
John Hansknecht	
Marcy Stutzman	
Nathan Clayburn	
Dominic Ryan	

## 1.0 Revision Summary

**Revision 1 – 12/05/10** – Updated to reflect current laboratory operations.

ISSUING AUTHORITY	TECHNICAL POINT-OF-CONTACT	APPROVAL DATE	EFFECTIVE DATE	EXPIRATION DATE	REV.
ESH&Q Division	<a href="#">Dick Owen</a>				1

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### **Appendix A – Lock, Tag & Try**

The micro-Mott source chamber is routinely accessed to insert new photocathodes. To prevent accidental exposure to laser radiation during this activity LOCK/TAG/TRY must first be applied to the manual gate valve separating the photocathode chamber from the electron beam optics. This manual valve is constructed of stainless steel and fully seals the load lock chamber from the remainder of the vacuum and laser systems.

Procedure for load lock photocathode chamber follows:

1. Close the manual photocathode valve.
2. Apply LOCK and TAG to handle of manual gate valve.
3. TRY to open manual gate valve and if unsuccessful continue, otherwise STOP and contact the LSS.
4. Load lock gun is now secured from laser radiation.
5. Perform and complete load lock gun vacuum work.
6. Remove the LOCK and TAG from the manual gate valve.

The remaining system (mico-Mott chamber) is rarely accessed. Under these special circumstances the laser system will be powered off and lockout/tagout applied to the using a lockout device suitable for securing the power cable.