BROOKHAVEN NATIONAL LABORATORY
LASER CONTROLLED AREA
STANDARD OPERATING PROCEDURE (SOP)

This document defines the safety management program for the laser system listed below. All American National Standard Institute (ANSI) Hazard Class 3b and 4 laser systems must be documented, reviewed, and approved through use of this form. Each system must be reviewed annually.

System description: Class IV Nd:YAG laser, operated at 3rd harmonic (λ=355 nm) Max pulse energy = 11 mJ, max repetition rate = 10 Hz
Location: West end of Bldg 1006 (STAR Wide Angle Hall), south of DX magnet in RHIC tunnel

LINE MANAGEMENT RESPONSIBILITIES

The Owner/Operator for this laser is listed below. The Owner/Operator is the Line Manager of the system and must ensure that work with this laser conforms to the guidance outlined in this form.

Owner/Operator: See Page 22 for Signatures		
Name: Scott W. Wissink	*Signature:*	*Date:*

AUTHORIZATION

Work with all ANSI Class 3b and 4 laser systems must be planned and documented with this form. Laser system operators must understand and conform to the guidelines contained in this document. This form must be completed, reviewed, and approved before laser operations begin. The following signatures are required.

C. Weilandics

BNL LSO printed name	***Signature***	***Date***
Asher Etkin		

ES&H Coordinator printed name	***Signature***	***Date***

APPLICABLE LASER OPERATIONS
x General Operation x Alignment Service/Repair x Specific Operation x Fiber Optics

ANALYZE THE LASER SYSTEM HAZARDS

Hazard analysis requires information about the laser system characteristics and the configuration of the beam distribution system.

LASER SYSTEM CHARACTERISTICS					
Laser Type *(Argon, CO2, etc)*	Wavelengths	ANSI Class	Maximum Power of Energy/Pulse	Pulse Length	Repetition Rate
Nd:YAG	355 nm (1064 and 532 nm internal to laser head)	IV	11 mJ / pulse @ 355 nm	4-6 ns	10 Hz max

☐ **Cryogen Use**

Describe type, quantity, and use.

none

☐ **Chemicals & Compressed Gasses**

Describe type, quantity, and use.

none

☒ **Electrical Hazards**

Description *(Describe the power supply to the system).*

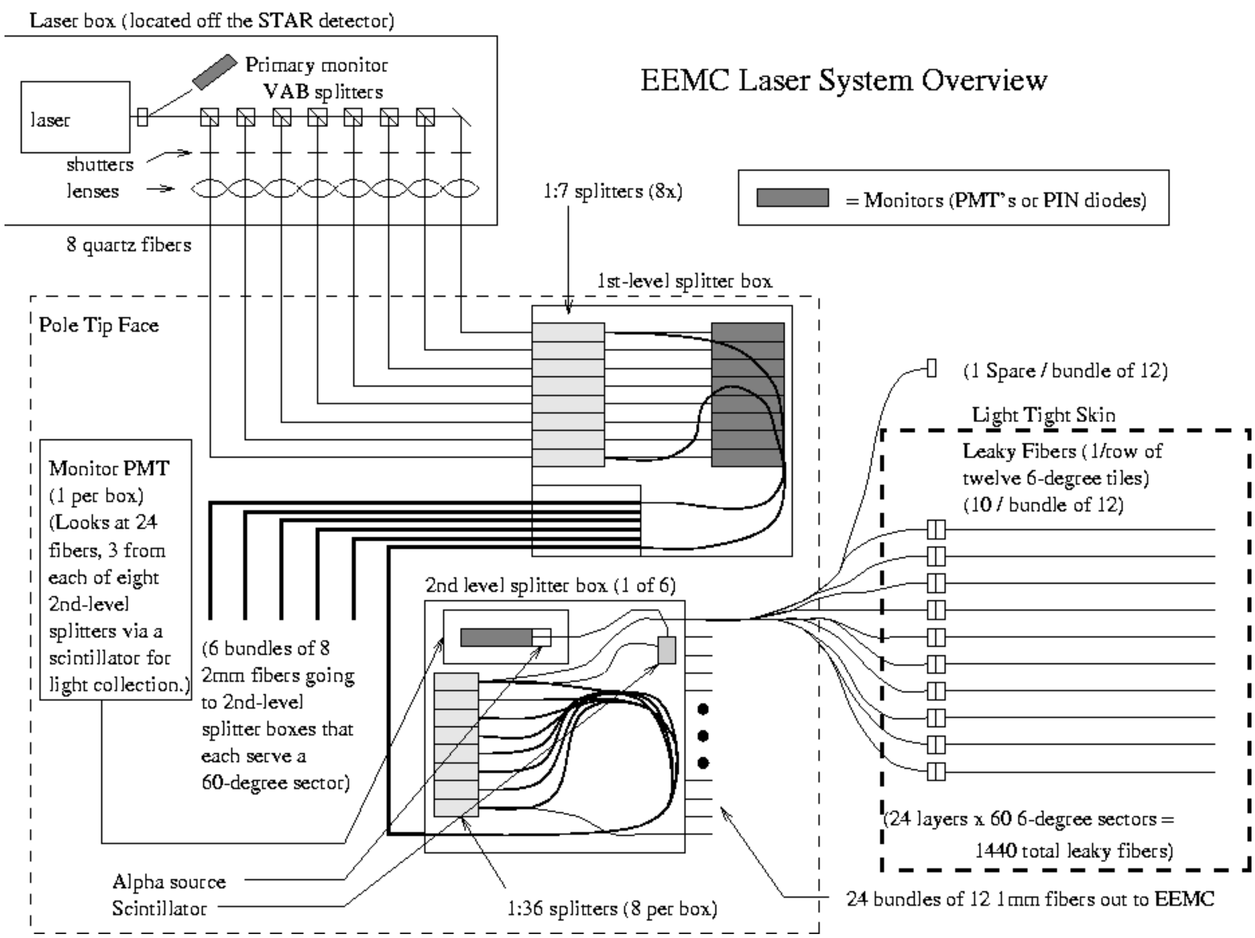
The power supply (external to the lasing head) is supplied by the manufacturer, and is rated at 120 VAC, 60 Hz, 250 watts. Potentially lethal voltage levels exist inside the power supply.

☐ **Other Special Equipment**

Description *(Equipment used with the laser(s)).*

The laser head itself contains the actual Nd:YAG lasing rod, a remotely controlled optical attenuator (1/2-wave plate followed by a cubic beam splitter), the 2nd and 3rd harmonic generators, and two 90° totally reflecting mirrors. The laser head is mounted on a 2′x5′ commercial optical bench inside an interlocked aluminum box. This box also contains a single 90° mirror, a diffraction grating, a PMT and resistive base, seven partially reflecting mirrors, eight focusing lenses, eight neutral density filters, and eight 2-m lengths of high-damage threshold quartz optical fiber. Light exits the box via eight SMA bulkhead connectors, then passes through eight 21-m lengths of quartz fiber to the 1st-level splitter box. This box contains a single block of Spectralon and eight PIN diodes and preamplifier electronics, plus connectors for the six bundles of 2-mm plastic fiber that pass light to the six 2nd-level splitter boxes. Each of these boxes contains a block of Spectralon for the splitting cavities, a single PMT and base, and many connectors for the 1-mm fibers that carry light to the individual EEMC megatiles.

A schematic overview of the system configuration illustrating the role of much of this equipment is provided below. This is explained in more detail in the following section of this document.



Laser System Configuration: Describe the system controls *(keys, switch panels, computer controls),* beam path and optics *(provide a functional/block diagram for complicated beam paths)*.

Laser operation is keyed (key is removable from power supply). All controls are provided via an RS-232 cable from either the manufacturer-supplied control panel or a local PC with ethernet connection. The setting of the optical attenuator, the flashlamp high voltage, and the laser firing repetition rate are controlled over this cable, as well as starting and stopping (or pausing) the laser from firing. The only 'beam path' is within the primary aluminum box; outside of this box, the laser light is always fully contained within either splitting cavities or optical fibers. The schematic on the previous page may be useful while reading the following description of the configuration for the STAR EEMC (**E**ndcap **E**lectro**M**agnetic **C**alorimeter) laser system.

The laser system includes components located in the RHIC tunnel just west of the STAR WAH, on the back of the west poletip of the STAR magnet, and within the EEMC itself (which is mounted on the front of the same poletip). The UV laser resides inside an interlocked (and lockable) aluminum box, on a table in the RHIC tunnel, just south of the DX magnet. A series of seven partially reflecting mirrors, mounted on an optical table within this box, are used to form eight beams of roughly comparable intensity (I_{max} = 1.3 mJ[1]), each of which is focused down into 600-μm diameter single strand silica core optical fibers. These 8 fibers transport the UV light to the back of the poletip and into a single "1st-level splitter box," located near the top of the magnet. Within this light-tight box, the light from each fiber emerges into a diffuse reflective cavity, and a fraction of the light (~5%[1]) is captured by seven 2-mm diameter plastic optical fibers, chosen for their excellent transmission (low attenuation) in the UV. Bundles of eight 2-mm fibers then carry the light to six "2nd-level splitter boxes," distributed around the outer edges of the back of the west poletip. Inside these boxes, the light from each fiber is distributed among a large number (36) of high-transmission 1-mm fibers, using a second type of diffuse reflective cavity. Each of the resulting 1440 1-mm fibers then transports a very small fraction (~1:10^6) of the initial UV light around to the front of the poletip and into a special `leaky' fiber that is embedded within every EEMC megatile. As the laser light propagates through this fiber, a set of precision scribes made along the fiber surface injects a small pulse of UV light into each of the 12 individual tiles. The laser energy, level of splitting, and 'leak' sizes have been chosen so that each EEMC tower PMT can "see" a light pulse comparable in intensity to that produced by the shower of a 150 GeV electron, while an attenuator internal to the laser head (and remotely adjustable) will allow us to simulate the light response of a minimum-ionizing particle as well.

Associated with each of the three levels of splitting are different types of monitoring. Inside the primary box, a single PMT views ~1% of the laser output light (through a neutral density filter), which is deflected from the main beam using a special diffraction grating. After the first splitting on the poletip, one of the seven 2-mm fibers from each cavity injects its light onto the face of a photodiode. Information from the PMT and the PIN diodes will be used to monitor the actual output intensity and the relative intensities of the 8 beams from the primary box. Finally, each of the six 2nd-level splitter boxes contains a single PMT, which provides event-by-event normalizations for each laser pulse seen by the towers within that 60° sector.

[1] All values based on detailed attenuation and splitting efficiencies calculations, verified by measurements at IUCF.

DEVELOP CONTROLS
IDENTIFY ES&H STANDARDS

Recognition, evaluation, and control of laser hazards are governed by the following documents.

American National Standards Institute (ANSI) Standard for Safe Use of Lasers;
(ANSI Z136.1-2000)

Laser Safety Subject Area

Brookhaven National Laboratory Environment Safety and Health Standard: 1.5.3 INTERLOCK SAFETY FOR PROTECTION OF PERSONNEL

ENGINEERING CONTROLS

☒ Beam Enclosures	☒ Protective Housing Interlocks	☐ Other
☒ Beam Stop or Attenuator	☒ Key Controls	
☒ Activation Warning System	☒ Other Interlocks	
☐ Ventilation	☒ Emission Delay	

Describe each of the controls in the space provided below this text. Interlocks and alarm systems must have a design review and must be operationally tested every six months. Controls incorporated by the laser manufacturer may be referenced in the manuals for these devices. **Attach a copy of the design review documentation and a written testing protocol. Attach or keep elsewhere any completed interlock testing checklists to document the testing history.**

Engineering Controls Description:

1. Beam enclosures: the laser beam is always fully contained within Spectralon splitting cavities or inside optical fiber, except for the initial splitting inside the primary box. This box is light-tight and interlocked to kill laser power if opened.

2. Beam stop or attenuator: The laser head contains a manual shutter at the exit aperture that can stop the beam. The beam(s) to individual quartz fibers can be temporarily blocked with thin pieces of Spectralon. The only attenuation of the beam occurs in the commercial optical attenuator located inside the lasing head, or in a few high-damage threshold neutral density filters located in front of several of the monitor detectors.

3. Activation warning system: When the laser is operating with the lid to the primary box open, a warning light indicating that UV light is present will be posted at the access to the area enclosure (at the top of the ladder needed to reach the laser area).

4. Protective housing interlocks: The actual laser head is enclosed in a protective housing (provided by the vendor) that prevents access to radiation in excess of Class I limits, except

for the output beam. This housing is light-tight and interlocked to kill laser power if opened (see item 6. below). Laser operation is interrupted if the laser head cover is removed. The laser power supply, which contains high voltages, is also powered down if its cover plate is removed.

5. Key controls: The power supply cannot be energized unless a removable key is in place and turned. During extended periods of access to the STAR Wide Angle Hall, this key will be locked in a cabinet in the STAR trailer.

6. Other vendor-supplied interlocks: The manufacturer has installed interlocks such that laser operation will be interrupted if:

   - The laser head cover is removed (item 4. above)
   - The control cable (RS-232) is detached from the power supply
   - The laser head umbilical cable is detached
   - Cooling water temperature is too high or too low
   - Remote interlock is not satisfied (see immediately below)

7. User-supplied interlocks: The IUCF group has installed interlocks to ensure that laser operation will be interrupted if:

   - The primary box lid is opened
   - Anyone attempts to enter the laser area. This is implemented using an infra-red sensor which has been mounted directly outside the enclosure curtain.

8. Emission delay: When the laser system is first turned on, or after it has been interrupted by an interlock not being satisfied, a restart involves two steps – pressing a START/STANDBY button, which sounds an audible alarm (beep) for seven seconds, followed by pressing the FIRE LASER button. Thus, after an interrupt, the laser can not be re-fired for at least seven seconds. The actual delay is somewhat longer, because the START/STANDBY button can only be energized if the flashlamp voltage has been run to zero. Thus, to restart laser firing:

   - Run flashlamp voltage to zero
   - Push START/STANDBY button
   - Wait 7 seconds
   - Push FIRE LASER button
   - Set flashlamp voltage to desired value

   If a PC is used, rather than the control panel, a series of RS-232 commands are issued instead of pushing buttons, but the above sequence (including the delay) must still be followed.

9. Other: an enclosure curtain, made of material opaque in the near UV, optically isolates the primary box area from the STAR WAH. Access to the enclosure is physically limited to a single entrance.

ADMINISTRATIVE CONTROLS

☒ Laser Controlled Area ☒ Signs ☒ Labels ☐ Operating Limits

The format and wording of laser signs and labels are mandated by BNL and ANSI standards. Only the standard signs are acceptable. Standard signs are available from the BNL Laser Safety Officer.

All lasers must have a standard label indicating the system's wavelength, power, and ANSI hazard class. Required labels must remain legible and attached. The manufacturer should label commercial systems.

Standard Operating Procedures (SOP) are required for laser system operation, alignment, and maintenance. The SOPs need only contain the steps necessary to perform these tasks and identify when and where posting and personal protective equipment is required. SOPs must be approved by the BNL Laser Safety Officer and should be kept with this program documentation.

Administrative Controls Description:

Laser Controlled Area: The laser is normally operated fully enclosed (Class 1). If it becomes necessary to perform maintenance or service on the laser and associated optics, a temporary laser controlled area will be established in the laser enclosure.

Signs: Appropriate laser signs are posted at the entrance to the laser area.

Labels: Appropriate warning labels are posted on the cover of the laser and splitters. Additional labels have been attached to the quartz fibers that extend from the primary box to the 1st-level splitter box.

Sets of operating procedures and associated checklists have been developed for routine operation and special operations for the EEMC UV laser system, as well as for verification of the laser interlock system. The distinction is that routine operation does **not** involve firing the laser with the lid of the primary box open, in which case the laser beam is fully enclosed along its entire path. For alignment and certain maintenance tasks (special operations), the lid needs to be open. During these tasks, additional precautions and procedures must be in place, as outlined below. Prior to performing any special operations, the Laser Interlock System checklist must also be complete.

Current copies of the SOP, checklists, and Operator's Manual are to be kept in the drawer of the table on which the primary laser box is mounted. The log of completed checklists is also kept in this drawer.

Only authorized and properly trained laser operators, i.e., those who are listed in and who have signed this document, may perform the following procedures:

1.0 Routine operations:

1.1 Sign out the laser power supply key from the cabinet in the STAR trailer.

1.2 Check that the removable access ladder is in place and available.

1.3 Inspect primary, 1st-, and 2nd-level splitter boxes to ensure that no interconnecting fibers have been disconnected or removed.

1.4 Verify the integrity of the enclosure curtain.

1.5 Ensure that no unauthorized persons are within the curtained enclosure.

1.6 Check that the lid of the primary laser box is closed and latched.

1.7 Verify from the logs that operation of the primary box lid interlock has been checked within the last six months.

1.8 Turn on AC power, use key to enable power supply.

1.9 Use remote or local control to energize laser to needed intensity.

2.0 Alignment and maintenance procedures – _primary box lid may be open_

2.1 Carry out items 1.1 – 1.6, as listed above.

2.2 Set up all laser warning signs entry interlock and close entry barrier.

2.3 Check that all operators inside enclosure have authorized eye protection on.

2.4 Turn on AC power, use key to enable power supply.

2.5 Verify operation of the Laser Interlock System, see 3.0 below.

2.6 Use remote or local control to energize laser to needed intensity.

3.0 EEMC Laser Interlock verification procedures – _primary box lid will be open_

3.1 Carry out items 2.1 – 2.4, as listed above.

3.2 Close the manual shutter on the laser head.

3.3 Check that the flashlamp voltage is set to zero.

3.4 Test the primary box interlock, following the checklist procedures.

3.5 Test the infra-red sensor interlock, following the checklist procedures.

Beyond the above steps, the procedures followed depend on the specific task to be carried out. Details of these procedures, such as aligning the partially reflecting mirrors, ensuring that the beam is fully (>80%) focused into the quartz fibers, checking the positioning of the monitor phototube, etc., will be documented elsewhere. From a safety standpoint, we note that all of these procedures are to be performed with the UV laser firing far below its maximum rated intensity. **While focusing the individual laser beams into the eight quartz fibers, for**

example, the laser intensity is attenuated (internal to the laser head) down to about 1% of its rated capacity. During these procedures, the ambient (room background) light intensity is also kept high, to constrict the pupils of the eyes. No extraneous mirrors or sharply reflective surfaces are allowed inside the primary box, and diffusely reflective or absorptive surfaces are used for all beam stops. To ensure that these precautions are followed, they have been incorporated into the Special Operations procedural checklist, for all tasks in which the primary box lid may be open.

There are no maintenance procedures for the 1^{st}- and 2^{nd}-level splitter boxes that will require the laser to be firing. During the (rare) occasions when these boxes are open, or when any of the interconnecting fibers have been removed, the laser will be disabled by removing and locking up the power supply key.

CONFIGURATION CONTROL

Prepare and attach a checklist to be used for configuration control of any protective housings, beam stops, beam enclosures, and any critical optics *(mirrors or lenses that could misdirect the beam and result* *in personnel hazard)*. Include entries to ensure placement of required signs and labels and status of interlock verification. Completed checklists must be posted at the laser location. The checklist does not have to be redone unless there has been a system modification, extended shutdown, or change of operations.

Three checklists are attached to this document. The items on two of the checklists follow very closely the set of procedures listed as items 1.0 and 2.0 above for Administrative Controls, corresponding to either routine (primary box lid remains closed) or special / alignment (lid may be open) operations. The third checklist specifies the procedures to be followed to verify correct operation of the EEMC Laser Interlock System.

All operations of the EEMC laser which could involve personnel hazards (mirror alignment, interlock verification, etc.) require that at least one checklist be completed and signed by the authorized laser operator. The completed checklists are kept in a log, so all recent activity can be monitored. The log will be used to ensure that a complete verification of the interlock system is performed at least once a year. Verification of the interlock system (primary box lid and entry access) must also be performed every time the laser is to be fired with the box lid open, for maintenance and/or optical alignment.

PERSONAL PROTECTIVE EQUIPMENT

☒ Eye Wear ☐ Skin Protection

Eye Wear: All laser protective eyewear must be clearly labeled with the optical density and wavelength for which protection is afforded. Eyewear should be stored in a designated sanitary location. Color - coding or other distinctive identification of laser protective eyewear is recommended in multi laser environments. Eyewear must be routinely checked for cleanliness and lens surface damage.

Skin Protection: For UV lasers or lasers that may generate incidental UV in excess of maximum permissible exposure (MPE), describe the nature of the hazard and the steps that will be taken to protect against the hazard.

EYE WEAR SPECIFICATIONS		
Laser System Eyewear Identification	Wavelengths	Optical Density
Elvex LG-0601/18	180 – 380 nm 10,600 nm	6 5

EYE WEAR REQUIREMENTS				
Laser Type *(Argon, CO2, etc)*	Wavelengths	Intra-beam Optical Density	Diffuse Optical Density	NHZ
Nd:YAG(laser head)	355 nm	4.5 OD(10 sec.) 2.5(1% pwr.)	1 OD (600 sec.) NA(1% pwr)	0.7 meters NA
Laser box(fiber)	355 nm	3.6 OD(10sec.) 1.6(1% pwr.)	0.15 OD (600 sec.) NA	0.24 meters NA
1st level splitter(bundle) output	355 nm	3.6 OD(10sec.) 1.6(1% pwr.)	0.2 OD (600 sec.) NA	0.25 meters

Note: the above calculations assume **no** divergence of the beam. Supplementary calculations as an appendix have been included which take into account nominal spreads of 10 and 20 degrees. It is a good idea to always wear the protective eyewear indicated, especially since the luminous transmission for this eyewear is high and would not impede vision. The Nominal Hazard Zone (NHZ) is that distance beyond which from a diffuse reflecting surface the reflected intensity ceases to be a hazard (specified for 600 seconds viewing).

Define eyewear optical density requirements by calculation or manufacturer reference and list other factors considered for eyewear selection. The BNL Laser Safety Officer will assist with any required calculations.

1. For invisible beams, eye protection against the full beam must be worn at all times unless the beam is fully enclosed.
2. For visible beams, eye protection against the full beam must be worn at all times during gross beam alignment.
3. Where hazardous diffuse reflections are possible, eye protection with an adequate Optical Density for diffuse reflections must be worn within the nominal hazard zone at all times.

4. If you need to operate the laser without wearing eye protection against all wavelengths present, explain the precautions that will be taken to prevent eye injury.

TRAINING

LASER SAFETY TRAINING

Laser Operators must complete sufficient training to assure that they can identify and control the risks presented by the laser systems they use. Owners/Operators and Qualified Laser Operators must complete the BNL World Wide Web based training course (BNL course #TQ-LASER).

Qualified Laser Operators must also complete system-specific orientation with the system owner/operator. **System-specific training must be documented with a checklist that includes**

- Trainee name and signature
- Owner/Operator signature
- Date
- Brief list of topics covered
  - Review of this program documentation
  - Review of SOPs

All laser safety training must be repeated every two years.

<u>**System-specific training for the STAR EEMC laser :** See Attachment 1</u>

MEDICAL SURVEILLANCE

Operators of ANSI Class 3b and 4 laser systems must complete a baseline medical eye examination prior to laser system operation. Any qualified ophthalmologist may complete this exam. BNL has arranged for this service from the following local physicians:

Dr. Charles Rothberg 331 East Main St. Patchogue, NY 11772	The Ophthalmic Center Dr. Basilice 3400 Nesconset Highway East Setauket, NY 11733	East End Eye Associates Dr. Sherin 669 Whiskey Road Ridge, NY 11961
631 758-5300 $65 per exam	631 751-2020 $60 per exam	631 369-0777 $125 per exam

Personnel using physicians other than those listed must have their examination records forwarded to the BNL Occupational Medicine Clinic.

FEEDBACK AND IMPROVEMENT

Comments and suggestions for improvement should be directed to BNL-Laser Safety Officer, Chris Weilandics (X2593; weil@bnl.gov).

LASER USER QUALIFICATION

Personnel qualified to work with this laser system are listed below. These Qualified Laser Operators must understand the information and conform to the requirements contained in this document. For training and medical surveillance, enter the date of completion.

Qualified Laser Operators:

Basic Laser Training	Job-Specific Training	Medical Surveillance	Printed Name	Signature	Owner/Oper. Initial/date
8/22/02		8/21/02	Scott Wissink (W5782)		
8/30/02		8/21/02	Greg Rakness (T8189)		
3/11/02		9/19/00	Alexei Lebedev (21605)		

See Page 23 for Signatures

Nominal Ocular Hazard Distances Calculations

Because the beam emanating from the optical fibers typically has a fairly high divergence, Nominal Ocular Hazard Distance(NOHD) calculations have been supplied. The NOHD is the distance, beyond which viewing the direct beam, for the time specified(in this case 10 seconds) ceases to become a hazard. Where the viewing distance approaches or extends beyond a "standard" viewing distance of 20 cm(or, about 8 inches) the NOHDs have been printed in bold type.

Conservative assumptions have been made with respect to the calculations, namely, the following apply:
Laser head output: 11mJ per pulse, beam divergence negligible
Laser box fiber output: 1.4mJ per pulse(each fiber).
First level splitter bundle output: 1.6mJ per pulse(per bundle of 8).
Divergence: example full angle divergences of 10 degrees and 20 degrees were applied. It was felt that these would be typical if not conservative estimates of the spread of the beam.
Fiber transmission loss: no internal or junction fiber losses are assumed.
Pulse Repetition Frequency(PRF): the maximum PRF of 10 Hz was used
Maximum Permissible Exposure: the conservative thermal ($0.56t^{0.25}$)limit was applied, where t is the pulse length(4ns); hence the resultant single pulse MPE is $4.5 mJ/cm^2$.

Appendix 1:
Nominal Ocular Hazard Distances Calculations

Output	Divergence	10 sec. NOHD
Laser Head (full power) 11mJ/pls	10 degrees (0.175 radians)	**98.6cm**
	20 degrees (0.350 radians)	**49.3cm**
Laser Head (1% power) 0.01mJ/pls	10 degrees (0.175 radians)	9.8cm
	20 degrees (0.350 radians)	4.9cm
Laser Box (full power) 1.4mJ/pls/fiber	10 degrees (0.175 radians)	**35.2cm**
	20 degrees (0.350 radians)	**17.6cm**
Laser Box (1% power) 14µJ/pls/fiber	10 degrees (0.175 radians)	3.47cm
	20 degrees (0.350 radians)	1.73cm
1st level splitter output (full power) 1.6mJ/pls/bundle	10 degrees (0.175 radians)	**37.3cm**
	20 degrees (0.350 radians)	**18.6cm**
1st level splitter output (1% power) 16µJ/pls/bundle	10 degrees (0.175 radians)	3.7cm
	20 degrees (0.350 radians)	1.8cm

Appendix 1:

LASER SYSTEM-SPECIFIC TRAINING CHECKLIST

Laser User:	
Laser Owner:	
Laser System:	

Topic	User Signature / Date	Owner Signature / Date
General Laser Safety • Laser classifications • Laser hazards • Maximum permissible exposure • Good practice in the lab		
Read and understand Chapters 1, 2, and 4 of the laser Operator's Manual, supplied by New Wave Research, Inc. These chapters cover basic laser safety (including features specific to the Polaris Nd:YAG laser being used), a description of the laser itself (including components internal to the laser head), and procedures for standard operation of the laser (including the manufacturer-supplied interlocks).		
LCA Interlock Instruction • Configuration • Operation		
Description of Laser Output Characteristics • Wavelength • Pulse energy • Average power		
Associated electrical hazards • Power supply • PMT detectors		
Normal Operation • Power on/off • Shutter operation • Normal experimental configuration • Nominal hazard zone		
Non-Normal Operation*		

• Gross alignment • Troubleshooting		

Appendix 2:

Procedure checklist for alignment and maintenance

of the EEMC Laser

(Only authorized and properly trained laser operators listed in the SBMS Laser Controlled Area SOP*

may perform these steps. The lid of the primary box may be open.)

- Sign out the laser power supply key from the cabinet in the STAR trailer.
- Check that the removable access ladder is in place and available.
- Inspect primary, 1st-, and 2nd-level splitter boxes to ensure that no interconnecting fibers have been disconnected or removed.
- Verify the integrity of the enclosure curtain.
- Ensure that only authorized operator are within the curtained enclosure.
- Verify that operation of the primary box lid interlock: follow procedures and complete appropriate section of the "Laser Interlock Checklist.".
- Set up laser warning sign at top of ladder and lighted sign at the access point.
- Check that the infra-red beam sensor is installed, and verify its operation: follow procedures and complete the "Laser Interlock Checklist."
- Check that all operators inside laser enclosure are wearing authorized eye protection.
- Turn on AC power, use key to enable power supply.
- Use local control to energize laser to needed intensity

* These individuals are listed in the EEMC Laser SBSM SOP as "Qualified Laser Operators"

Additional safety steps for all lid-open operations

- Enable Infra-Red Interlock Mode.
- Ensure there are no mirrors or sharply reflective surfaces anywhere inside the primary box, other than those rigidly attached to the optical bench.
- Ensure that any temporary beam stops to be employed are diffusely reflective or absorptive.
- Set and keep the laser output intensity as low as possible during all alignment procedures.
- Do not leave the curtained area at any time while the lid is open.
- Disable Infra-Red Interlock Mode upon completion of alignment and maintenance operation.

Operator's name (print): ____________________________ date: ___________________

Signature: ____________________________

Appendix 3:

Procedure checklist to verify the operation

of the EEMC Laser interlock system

(These procedures may be performed only by authorized

*and properly trained laser operators.**

The lid of the primary box will be open during some steps.)

- Sign out the laser power supply key from the cabinet in the STAR trailer.
- Check that the removable access ladder is in place and available.
- Close the manual shutter on the laser head.
- Close the lid to the primary laser box.
- Turn on AC power, use key to enable the power supply.
- Set flashlamp voltage to zero.
- Put on authorized eye protection .
- Close the manual shutter on the laser head.

Testing the primary box interlock:

- Disable Infra-Red Interlock Mode.
- Close the lid to the primary laser box.
- Push the "stand-by" button; verify that laser is ready to fire (stand-by light remains on after 7-second warning beep).

- Open the box lid; verify that laser control reverts to "stop" mode.
- Verify that laser cannot be returned to "stand-by" mode with lid open.
- Close box lid; verify that laser can now be returned to "stand-by" mode.

<u>Testing the infra-red beam sensor interlock:</u>

- Enable Infra-Red Interlock Mode.
- Check that sensor system is installed and receiving AC power.
- Remove any interruptions to the IR beam (red light should go off).
- Push the "stand-by" button; verify that laser is ready to fire (stand-by light remains on after 7-second warning beep).
- Interrupt the IR beam; verify that laser control reverts to "stop" mode.
- Remove interruption; verify that laser can now be returned to "stand-by" mode.
- Disable Infra-Red Interlock Mode.

Operator's name (print): ___________________________ date: ___________________

Signature: ___________________________

[*] These individuals are listed in the EEMC Laser SBSM SOP as "Qualified Laser Operators"

Appendix 4:

Procedure checklist for standard operation of the EEMC Laser

(Only authorized and properly trained laser operators may perform these operations)*

— Sign out the laser power supply key from the cabinet in the STAR trailer.

— Check that the removable access ladder is in place and available.

— Inspect primary, 1st-, and 2nd-level splitter boxes to ensure that no interconnecting fibers have been disconnected or removed.

— Ensure that no unauthorized persons are within the curtained enclosure.

— Check that the manual shutter is open on the laser head.

— Ensure that the lid of the primary laser box is closed and latched.

— Verify that operation of the primary box lid interlock has been checked within the previous six months.

— Disable Infra-Red Interlock Mode

— Turn on AC power, use key to enable power supply.

— Use remote or local control to energize laser to needed intensity.

Operator's name (print): ___________________________ date: ___________________

Signature: ___________________________

* These individuals are listed in the EEMC Laser SBSM SOP as "Qualified Laser Operators"

BROOKHAVEN NATIONAL LABORATORY
LASER CONTROLLED AREA
STANDARD OPERATING PROCEDURE (SOP)

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System description:	Class IV Nd:YAG laser, operated at 3rd harmonic (λ=355 nm) Max pulse energy = 11 mJ, max repetition rate = 10 Hz
Location:	West end of Bldg 1006 (STAR Wide Angle Hall), south of DX magnet in RHIC tunnel

LINE MANAGEMENT RESPONSIBILITIES

The Owner/Operator for this laser is listed below. The Owner/Operator is the Line Manager of the system and must ensure that work with this laser conforms to the guidance outlined in this form.

Owner/Operator: mSc.

Name: Scott W. Wissink *Signature:* Scott W. Wissink *Date:* 11/12/03

AUTHORIZATION

Work with all ANSI Class 3b and 4 laser systems must be planned and documented with this form. Laser system operators must understand and conform to the guidelines contained in this document. This form must be completed, reviewed, and approved before laser operations begin. The following signatures are required.

C. Weilandics C. Weilandics 11/12/03

BNL LSO printed name	***Signature***	***Date***
Asher Etkin	[signature]	11/12/2003
ES&H Coordinator printed name	***Signature***	***Date***

Dr. Charles Rothberg
331 East Main St.
Patchogue, NY 11772

631 758-5300
$65 per exam

The Ophthalmic Center
Dr. Basilice
3400 Nesconset Highway
East Setauket, NY 11733

631 751-2020
$60 per exam

East End Eye Associates
Dr. Sherin
669 Whiskey Road
Ridge, NY 11961

631 369-0777
$125 per exam

Personnel using physicians other than those listed must have their examination records forwarded to the BNL Occupational Medicine Clinic.

FEEDBACK AND IMPROVEMENT

Comments and suggestions for improvement should be directed to BNL-Laser Safety Officer, Chris Weilandics (X2593; weil@bnl.gov).

LASER USER QUALIFICATION

Personnel qualified to work with this laser system are listed below. These Qualified Laser Operators must understand the information and conform to the requirements contained in this document. For training and medical surveillance, enter the date of completion.

Qualified Laser Operators:

Basic Laser Training	Job-Specific Training	Medical Surveillance	Printed Name	Signature	Owner/Oper. Initial/date
8/22/02	11/7/2003	8/21/02	Scott Wissink (W5782)	Scott Wissink	S.W. 11/12/03
8/30/02	11/7/2003	8/21/02	Greg Rakness (T8189)	[signature]	S.W. 11/12/03
3/11/02	11/7/2003	9/19/00	Alexei Lebedev (21605)	[signature]	S.W. 11/12/03

Nominal Ocular Hazard Distances Calculations

Because the beam emanating from the optical fibers typically has a fairly high divergence, Nominal Ocular Hazard Distance(NOHD) calculations have been supplied. The NOHD is the distance, beyond which viewing the direct beam, for the time specified(in this case 10 seconds) ceases to become a hazard. Where the viewing distance approaches or extends beyond a