Person: Kubarovsky, Valery (vpk@jlab.org)
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Jefferson Lab
Thomas Jefferson National Accelerator Facility

Operational Safety Procedure Review and Approval Form # 65638
(See ES&H Manual Chapter 3310 Appendix T1 Operational Safety Procedure (OSP) and Temporary OSP Procedure for Instructions)

Type:	***LOSP*** Click for OSP/TOSP Procedure Form Click for LOSP Procedure Form		
Serial Number:	***ENP-17-65638-LOSP***		
Issue Date:	***2/21/2017***		
Expiration Date:	***1/21/2020***		
Title:	***LOSP for RICH PMT test stand***		
Location: (where work is being performed) Building Floor Plans	***Technology & Engineering Development - 1603***	Location Detail: (specifics about where in the selected location(s) the work is being performed)	
Risk Classification: (See ES&H Manual Chapter 3210 Appendix T3 Risk Code Assignment)	Without mitigation measures (3 or 4): With mitigation measures in place (N, 1, or 2):	***3*** ***1***	
Reason:	This document is written to mitigate hazard issues that are : ***Determined to have an unmitigated Risk code of 3 or 4***		
Owning Organization:	***PHALLB***		
Document Owner(s):	***Kubarovsky, Valery (vpk@jlab.org)*** Primary		

Supplemental Technical Validations

Lasers Class 3B or 4 (Ultraviolet, Infrared, and Visible Light) (Bert Manzlak, Jennifer Williams)

Document History

Revision	Reason for revision or update	Serial number of superseded document
2	***Revision 1 expired Change the name of Division Safety Officer***	

Comments for reviewers/approvers:	***The setup was not changed. The interlocks shut down laser and PMT HV.***

Attachments

Procedure: ***6410T1Form_v2_1.pdf***
THA: ***THA __ LOSP RICH Test Stand _ February 2017.pdf***

Additional Files:

Convert to PDF

Review Signatures	
Additional Authorization : Physics ES&H Liaison	**Signed** on 2/20/2017 2:16:17 PM by Bert Manzlak (manzlak@jlab.org)

Approval Signatures	
Division Safety Officer : PHALLB	**Signed** on 2/20/2017 3:39:15 PM by Patrizia Rossi (rossi@jlab.org)
Org Manager : PHALLB	**Signed** on 2/20/2017 3:44:07 PM by Patrizia Rossi (rossi@jlab.org)
Safety Warden : Technology & Engineering Development - 1603	**Signed** on 2/21/2017 8:35:08 AM by Todd Ewing (jtewing@jlab.org)
Subject Matter Expert : Lasers Class 3B or 4 (Ultraviolet-> Infrared-> and Visible Light)	**Signed** on 2/20/2017 2:16:27 PM by Bert Manzlak (manzlak@jlab.org)

Laser Operational Safety Procedure (LOSP) Form

(See ES&H Manual Chapter 6410 Appendix T1 Laser Operational Safety Procedure)

Serial Number: _____

(Assigned by ESH&Q Document Control x7277)

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

Issue Date:		**Expiration Date:**	
Title:	**LOSP for RICH PMT test stand**		
Location:	High Bay area TED building (BLDG. 55)		
Description of Project	Class 3b laser is used to test MAPMT for RICH detector		
Document Owner(s):	Valery Kubarovsky / Andrey Kim	**Date:**	02/17/2017

Laser Inventory

Laser Serial #	Laser Class	Wavelength(s)	Maximum Power/Energy
618	3B	465.5 nm	5000mW

Approval Signatures:	Print / Signature	Date:
Laser System Supervisor:	Dan Carman	
Laser Safety Officer:	Bert Manzlak	
Division Safety Officer	Ed Folts	
Department or Group Head:	Volker Burkert	
Other Approval(s):	Doug Higinbotham	
	(Safety Warden / Acknowledgement only)	

Document History:

Revision:	Reason for revision or update:	Serial number of superseded document
2	Revision 1 expired	

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 Operational Safety Procedure Form describes the necessary controls and procedures during the work with Multi-Anode PMT test stand for the CLAS12 RICH detector in Hall B. To ensure that users are not exposed to laser-related hazards the laser stays enclosed inside the black box during all phases of operation. The closed box allows for classification of our setup as a Class 1 system, since laser light can't escape the closed enclosure and reach users eyes.

The black box contains one Class 3B Picosecond Diode Laser - a diode laser that emits very short optical pulses with pulse widths down to 20 ps (FWHM) with a fixed wavelength of 470 nm. The laser is used to deliver the optical photons to the surface of the individual pixels of the MAPMT allowing us to test each of 64 channels. Several Neutral Density filters attenuate the laser beam and provide the specified number of photons.

Jefferson Lab has developed engineering and administrative controls to control the hazard issues associated with the use of lasers. Please refer to Jefferson Lab's ES&H Manual Chapter 6410 for more information on the laser safety program and regulations.

The principal contacts:

1. Andrey Kim (x6356) – laser setup operator
2. Valery Kubarovsky (x5647) – laser setup operator
3. Daniel Carman (x5586) – Hall-B Laser System Supervisor (LSS)
4. Albert Manzlak (x7556) – JLab Laser Safety Officer (LSO)

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.

The laser may only be operated by personnel who have completed the following:

- The laser safety course SAF114O
- The laser-specific training course SAF158

- Completed proper medical monitoring by JLab Occupational Medicine Department (MED ø2)
- Read the ES&H Manual Chapter 6410 Laser Safety Program
- Read LOSP Form (this document)
- Signed the list of authorized laser operators

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

This PiLas laser system is classified as a class 3B laser product according to IEC 60825-1, Ed 1.2, 2001-08 during all procedures of operation.

The laser diode emits radiation in the 470 nm spectral region. It is emitted through the attached optical fiber guiding the laser light.

The PiLas is a compact system generating ultra-short optical pulses using diode lasers. The system consists of a control unit and an optical head with the electrical driver and the laser diode. The optical head is configured to emit short light pulses. Each head is individually adjusted to the laser diode to achieve optimal pulse emission performance down to a pulse width of 15 to 50 ps and optical peak powers between 50 and 1500 mW.

The principal laser system components:

- Optical head: PiL047X
  - SN#618
- Laserdiode: WT899
  - Chip: BA2611-1
- Control unit: EIG2000DX
  - Max. PRF 1MHz, K25+26
  - SN#618
- Laserdiode collimator: 50CL-A4.5-01

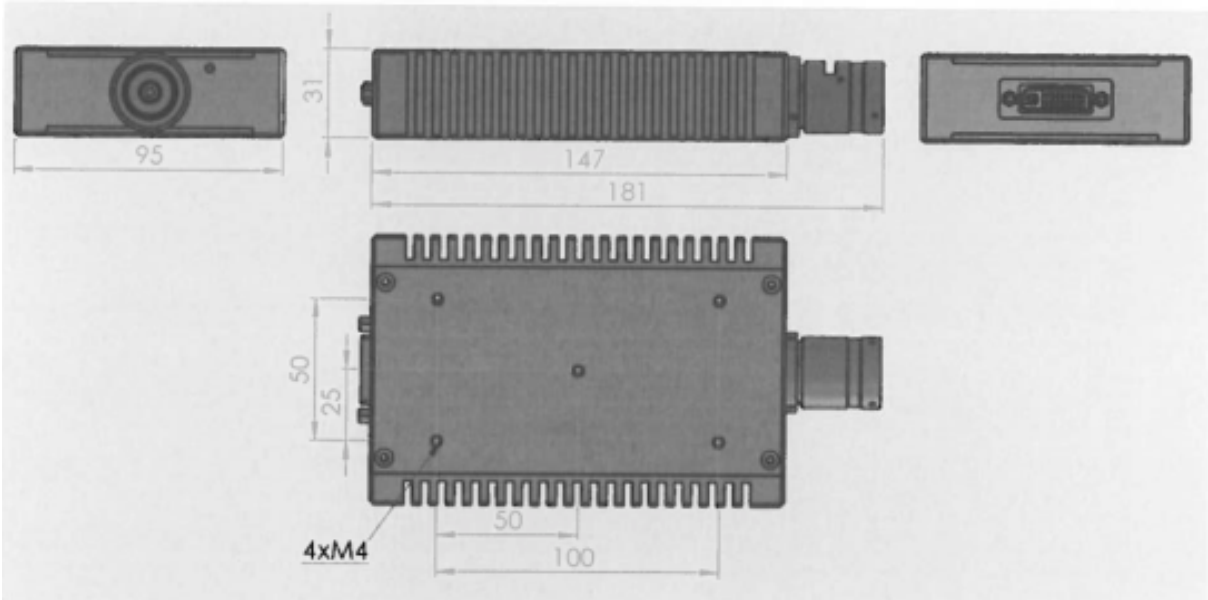
- Focal length: 4.5 mm
- Numerical aperture: 0.55
- Beam diameter ($1/e^2$): 3.1mm x 1.3 mm @ 0.5m
- Beam divergence ($1/e^2$): <0.5mrad

- Fiber coupler: 60SMS-1-4-A11-01
  - Focal length: 11 mm
  - Numerical aperture: 0.25

- Fiber: P5-460A-PCAPC-1
  - Index-type: SI
  - Core/MFD: 3.0 micrometer
  - Numerical aperture: 0.13
  - Connectors: FC/APC-FC/PC

- Fiber collimator: PiLFC-11
  - Focal length: 11 mm

The optical head is electrically connected to the Laser connector of the control unit with the cable PIL-MH-02 and can be mounted by five M4 threads on the bottom plate for mounting.



Laser head dimension and mounting scheme.

The laser is delivered with a fiber coupling unit and an aligned single mode fiber to it as standard. The fiber coupling unit is plugged into the main optics housing delivered with the standard collimating head. The laser beam coupler is fixed to the main housing with three hexagon socket set screws at the end of the main housing.

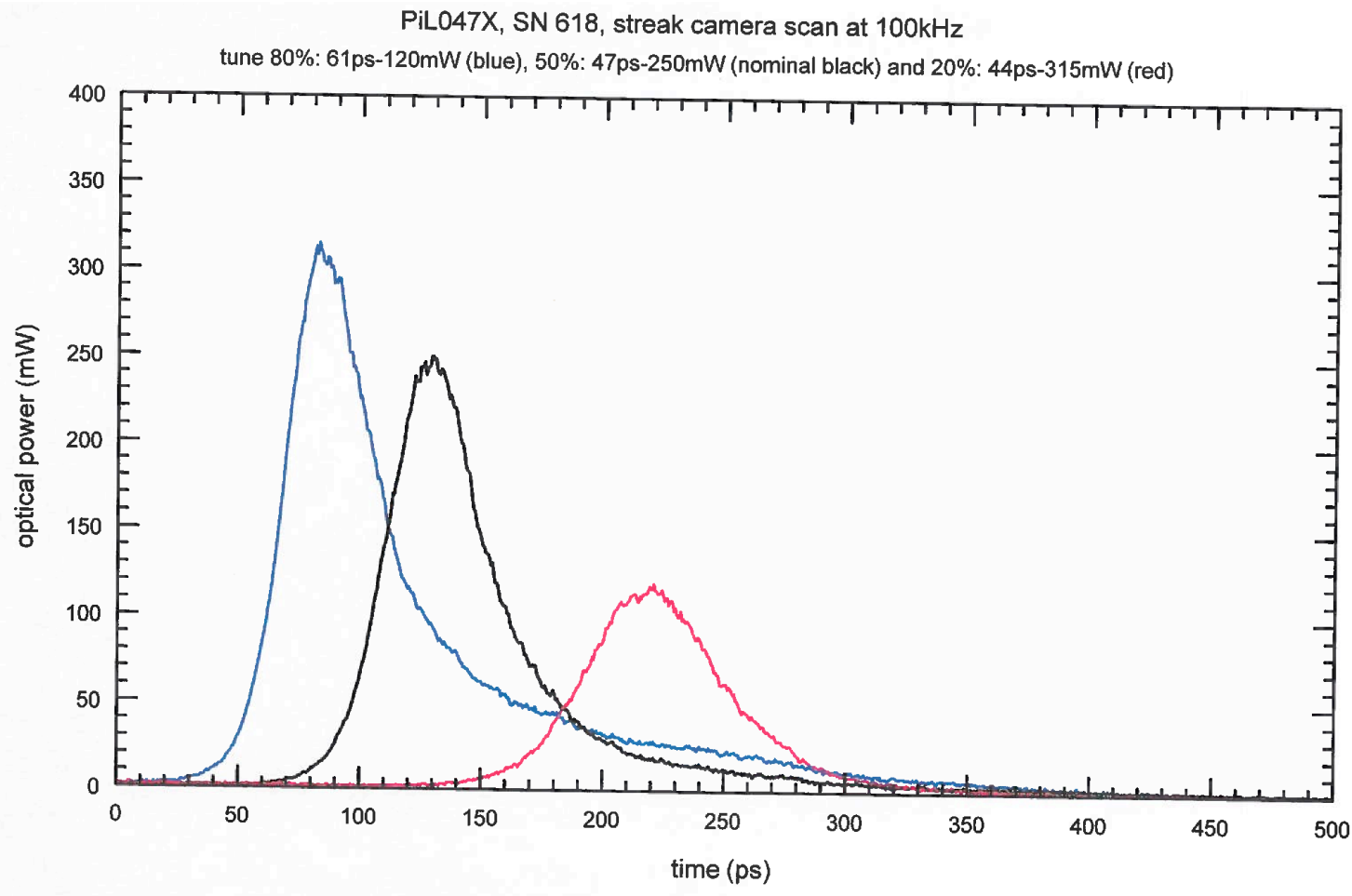
The fiber collimator is used to collimate the divergent output beam of the fiber. A micro focus can be used for focusing the collimated laser beam delivered by the fiber collimator to a small spot size (<0.2 mm). The focus spot is roughly one focal length away. The micro focus is inserted into the fiber collimator and is fixed with three small slotted headless set screws at the front end of the main housing of the fiber collimator. The procedure needs to be done only once since the focus value should stay unchanged during the whole measurements. The focusing is performed with open box and switched off laser. The divergence is checked later with the black box closed and switched on laser using the beam profiler.

The optical fiber, fiber collimator and main housing, called laser head, are placed inside the black box. The laser head is connected to the outside controller unit via long DVI cable, that exits the box together with all other cables through a light-proof passage.

TEST MEASUREMENTS

Frequency scan with oscilloscope, photodetector and optical power meter:

Frequency	Tune (%)	FWHM (ps)	RMS – Jitter (ps)	Delay (ns)	Av. power (µW)	Peak power (mW)
1 kHz	50	49	1.7	31.4	0.0141	250
10 kHz	50	49	1.7	31.4	0.141	250
100 kHz	50	49	1.6	31.4	1.41	250
200 kHz	50	49	1.6	31.4	2.86	250
500 kHz	53	49	1.6	31.4	7.07	250
1 MHz	57	49	1.6	31.4	14.0	250



General Specifications

Control Unit EIG2000DX

Internal trigger:	
Repetition rate	100Hz to 125 MHz
Frequency resolution	<0.1 ppb
Frequency stability	<50 ppm
External trigger input (TTL):	
Amplitude	+5 V max.
Trigger level states	TTL
Input impedance	50 Ω
Pulse width	>3.5 ns
Connector type	BNC
Frequency range	Single shot to 125 MHz
Delay(1)	33ns
External trigger input (variable):	
Amplitude	±10 V max.
Trigger level states	-4.8 V ... +4.8V
Input impedance	50 Ω
Pulse width	>3.5 ns
Connector type	BNC
Frequency range	Single shot to 125 MHz
Delay(1)	38ns
Synchronization (trigger) output:	
Amplitude	+2.5 V @ 50 Ω load
Output impedance	50 Ω
Pulse width	50 % duty cycle for internal oscillator >3.5 ns for external trigger
Connector type	BNC
Delay(2)	24ns
Remote Interlock	
Voltage	+5 V
Loop resistance	<1 Ω
Connector type	2.5mm mono TS (jack connector)
Remote control:	
Connector type	USB 2.0
Connector type	RS232
Temperature:	
Temperature drift trigger delay	10 ps/K
Warm up time (operating)	15 min
Power:	
Line voltage	100 V ... 240VAC
Line frequency	50 Hz ... 60 Hz
Power consumption	<20 W
Fuses rating for 230V AC	500 mA slow acting (5mmx20mm)
Connector type	standard IEC C13/C14 Power Plug
Environment (operating), also for the Optical Head:	
Temperature	25 °C ± 10 °C
Relative humidity	30 % to 70 %
Size of Control Unit:	236 x 89 x 316 (width x height x depth, mm^3)
Size of Optical Head (w/o optics):	95 x 31 x 147 (width x height x depth, mm^3)
Weight:	
Control unit and head	5 kg

Notes:

(1) Delay between electrical signal at trigger input BNC plug and optical pulse at last optical surface.

(2) Delay between electrical signal at trigger out BNC plug and optical pulse at last optical surface.

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 BEAM HAZARDS

The closed black box is considered to be in a Class 1 condition since the laser beam can't leave the enclosure. Specifically designed interlock automatically turns the laser off when black box is open.

CAUTION. Use of controls or adjustments or performance of procedure other than those specified in this document may result in hazardous radiation exposure.

NON-BEAM HAZARDS

There are physical hazards other than laser radiation can be associated with laser operations. The following non-beam hazards exist:

- Electric shock: Before switching on the instrument, make sure it has been properly grounded through the supplied AC power cable to a socket outlet with a protective earth contact. Electrostatic discharge (ESD) on or near the connectors can damage electronic devices inside the instrument. Personnel should touch the metal frame of the instrument for a second before touching any connector.

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).

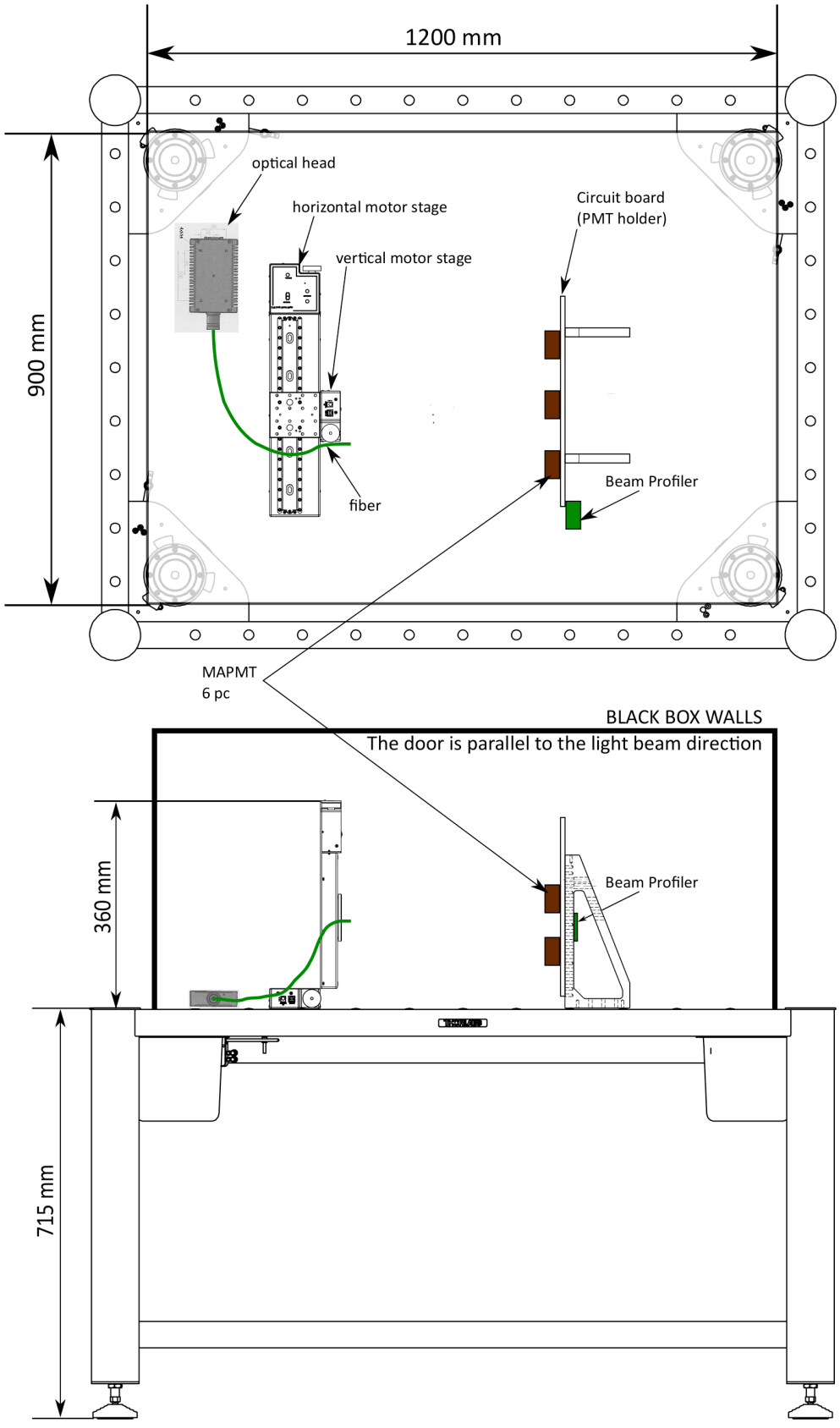
There is one PiLas system on the optical table inside the black box. The laser is used for testing of MAPMTs for the RICH detector in CLAS12. The laser beam is guided through the optical fiber connected to the moving platform driven by two motorized stages. The level of fiber doesn't exceed the height of 1.1m, keeping the beam path out of the normal eye-level zone.

The fiber is fixed in the cage system with the neutral density filters on the laser beam path within the 15cm distance from the fiber. The ND filters attenuate the beam which is directed to the MAPMT placed on the circuit board. The light that passes the ND filters consists of a few photons and clearly has no danger to the eyes. The filters need to be removed during the alignment procedure.

During the laser operation the black box is closed preventing the possibility of unintentional interception of the beam, either directly or by specular reflection. The specific alignment procedure was developed to adjust laser position without need to open the box.

The table layout is shown on the following page to give the schematic representation of laser beam location in MAPMT test setup.

TABLE LAYOUT



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).

Since the MAPMT of choice has 64 channels distributed evenly on its surface, the precise knowledge of the laser beam spot on the surface of the PMT is required. So the laser beam alignment is performed to identify the beam spot position and profile for the test of the MAPMT's individual channels.

The setup designed to fix the fiber collimator on the moving platform driven by the motorized stages provides the preliminary alignment. The fiber collimator is placed in the special holder that is mounted in the 30mm cage system. The cage system uses four rigid steel rods on which a few optical components are mounted along a common optical axis:

- Holder to mount fiber collimator
- Filter mount to hold the 1 in. neutral density filter
- Motorized filter mount with 6 neutral density filters to provide different number of photons on the MAPMT surface

The cage system setup has an optical axis parallel to the optical table and, thus, provides the preliminary alignment of laser beam. The fiber collimator holder is designed to allow ±4° tip and tilt adjustment without cage rod interference. Once the desired position of the laser beam is achieved, locking setscrews on the rear plate of holder can be used to secure the rods in the desired place.

The motorized stages and camera are fixed on the optical table with known initial coordinates. This allows to perform alignment with the black box closed. The laser spot is directed to the beam profiler, and its position and size are stored. This position is taken as an origin of the coordinate system. The circuit board and PMTs are fixed, and their coordinates are known relative to the profiler window position. Using the computer software to control the motorized stages, the laser beam can be directed to any PMT pixel on the circuit board.

Once the beam position is secured the CCD Camera Beam Profiler is used to analyze the beam's 2D power distribution, providing the actual size and shape of the beam spot.

Laser Controls	•Describe all controls (administrative and engineering). (If a different control is recommended the rationale for not using a typical/recommended control.)

CONTROLS:

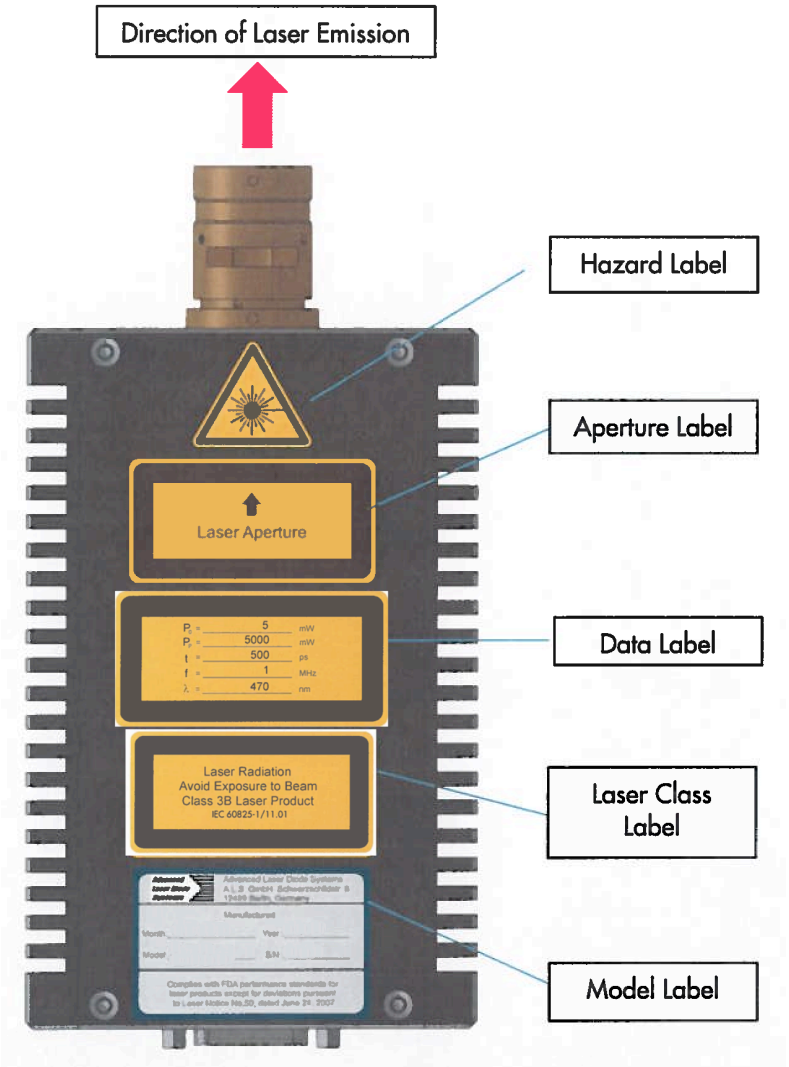
- The laser control area will be posted with a danger sign indicating the laser class. The table layout will be posted as well.
- The key to turn the laser on will be kept separate from the laser when the setup is not in use to prevent unintentional operation.
- The safety control of laser system will be checked every six months using the Checklist Inspections list.
- Only trained, authorized personnel are permitted to operate the laser equipment.
- The interlock, provided by manufacturer, is located on the rear side of the control unit and connected to the door sensor to prevent laser operation with open box.

Required Calculations	•Maximum permissible exposure. •Optical density. •Nominal hazard zone.

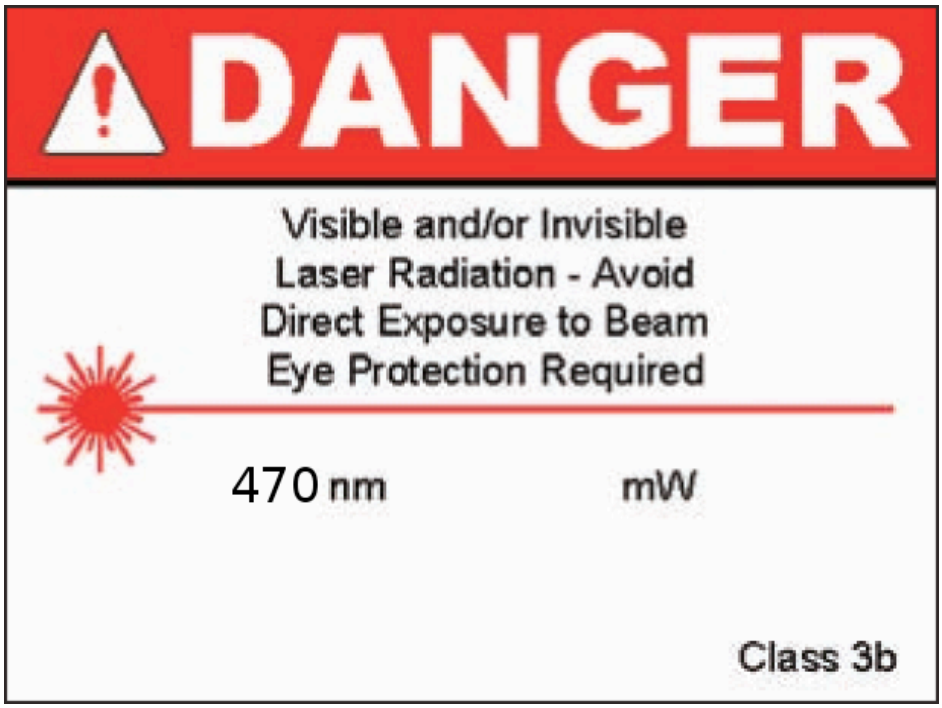
OD, MPE and NHZ calculations are not required since the setup is always under Class 1 condition. No personal protective equipment is necessary.

Labeling/Posting (See ES&H Manual Chapter 6410 Appendix T5 Laser Labeling/Posting Requirements	•Equipment/area labeling/posting requirements. •Area signs.

According to laser safety regulations, the following class 3B laser product explanatory label with the relevant laser parameters is placed on the laser optical head. For the detailed laser parameters please see the section with specifications. The data label, aperture label and hazard label are used as well.



The laser safety sign is displayed on the door of black box. The sign has large legible text providing the clear and concise indication of the laser system in use, even though the box is operating 100% of time under Class 1 condition. The example of area posting sign is shown below.



Authorized/Trained Individuals	
Print Name/Signature	**Date**

1.0 Revision Summary

Revision 1 – 01/06/14 – Updated to reflect current laboratory operations.

ISSUING AUTHORITY	TECHNICAL POINT-OF-CONTACT	APPROVAL DATE	EFFECTIVE DATE	EXPIRATION DATE	REV.	
ESH&Q Division	Albert Manzlak	01/06/14	01/06/14	01/06/15	1	

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Jefferson Lab
Thomas Jefferson National Accelerator Facility

Task Hazard Analysis (THA) Worksheet

(See ES&H Manual Chapter 3210 Appendix T1
Work Planning, Control, and Authorization Procedure)

Click For Word

Author:	V. Kubarovsky	Date:	02-20-17	Task #: If applicable	

Complete all information. Use as many sheets as necessary

Task Title:	LOSP for RICH PMT Test Stand			**Task Location:**	TEDF Room 1603 / high bay
Division:	Physics	**Department:**	Hall B	**Frequency of use:**	Daily
Lead Worker:	A. Kim				
Mitigation already in place: Standard Protecting Measures Work Control Documents	Laser safety interlock engineered into the Test Stand				

Sequence of Task Steps	Task Steps/Potential Hazards	Consequence Level	Probability Level	Risk Code (before mitigation)	Proposed Mitigation (Required for Risk Code >2)	Safety Procedures/ Practices/Controls/Training	Risk Code (after mitigation
1	Test PMTs / Eye exposure, injury	1	1	1	Follow LOSP / Safety Interlocks	LOSP / LOSP / SAF 113 O and laser specific training	N

Highest Risk Code before Mitigation:		Highest Risk Code after Mitigation:	

When completed, if the analysis indicates that the Risk Code before mitigation for any steps is "medium" or higher (RC≥3), then a formal Work Control Document (WCD) is developed for the task. Attach this completed Task Hazard Analysis Worksheet. Have the package reviewed and approved prior to beginning work. (See ES&H Manual Chapter 3310 Operational Safety Procedure Program.)

Task Hazard Analysis (THA) Worksheet

(See ES&H Manual Chapter 3210 Appendix T1
Work Planning, Control, and Authorization Procedure)

Form Revision Summary

Periodic Review – 08/13/15 – No changes per TPOC
Revision 0.1 – 06/19/12 - Triennial Review. Update to format.
Revision 0.0 – 10/05/09 – Written to document current laboratory operational procedure.

ISSUING AUTHORITY	TECHNICAL POINT-OF-CONTACT	APPROVAL DATE	REVIEW DATE	REV.
ESH&Q Division	Harry Fanning	08/13/15	08/13/18	0.1

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By signing this page, you testify that you have read, understand, and agree to abide by the procedure specified in the above referenced work control document:

Serial Number: ENP-17-65638-LOSP

Title: LOSP for RICH PMT test stand

Name	Signature	Date