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Installation of ECAL Monitoring Light Source [1)]

Liyuan Zhang, Kejun Zhu, Ren-yuan Zhu

California Institute of Technology, Pasadena, CA 91125, USA

Duncan Liu

Jet Propulsion Laboratory, Pasadena, CA 91109, USA

Abstract

This note presents a plan for the installation of the monitoring lasers for $PbWO_4$ electromagnetic calorimeter. Overall installation requirements, including chilled water, electricity and network, for the laser system are discussed. The floor layout, utility supplies, safety implementation and the protocol of communication with DAQ for the installation at H4 site are described. A brief summary is given for the final installation at USC55.

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1 Overall Installation Requirements

The CMS ECAL monitoring light source consists of two laser systems, their corresponding diagnostics, fiberoptic switches, a monitor and a PC based controller. Figure 1 is a schematic showing the conceptual design of the monitoring light source and high level distribution. Each laser system, installed on a $3' \times 5' \times 2''$ optical table, consists of an Nd: YLF pump laser and a tunable Ti:Sapphire laser.

An infrared light source is currently under consideration to be added to the monitoring light source. Corresponding modifications will be made when this light source is baselined.

1.1 Chilled Water

Each ND:YLF laser needs chilled water of 7 to 18°C with pressure of 1 to 7 kg/cm^2 and fluence of 16 to 24 l/min, as shown in Figure 1.

1.2 Equipment and System Rack

Table 1 lists equipment for each laser system to be installed on floor or on shelf mounted on the corresponding optical table. Table 2 lists remain equipment to be mounted on system racks.

Table 1: Summary of Equipment on Floor or Shelf Mounted on Optical Table

#	Item	Input	Output	Manufacture	$l \times w \times h$ (cm)	Power (VA)
1	GPIB Bus Ext.	BNC	GPIB	ICS	$30 \times 22 \times 10$	28
2	GPIB→RS-232	GPIB	4 RS-232	ICS	$20 \times 19 \times 4$	12
3	Digital Delay	GPIB	3 BNC	Stanford	$36 \times 21 \times 12$	70
4	He-Ne Power			Edmund	$16 \times 21 \times 7$	15
5	Ti:S Controller	RS-232	RS-232	Quantronix	$36 \times 26 \times 18$	20
6	YLF Power	RS-232		Quantronix	$87 \times 56 \times 52$	a
7	Ti:S LBO Cool.	RS-232		Neslab	$40 \times 26 \times 63$	b
8	Transformer	380V	220V	Excel	$50 \times 25 \times 65$	-
Total						**131**

a. Nd:YLF Laser requires 3 Phase, 400 V, 50 Hz, 30 A/Phase, **10,000** VA.
b. Neslab cooler requires power supply of 220 V, 50 Hz, 10A, **1,650** VA.

Table 2: Summary of Equipment on System Racks

#	Crate	Input	Output	Contents	Manufacture	h (cm)	Power (VA)
1	CAMAC	80 Lemo	GPIB	ADC/Gate	Kinetic/LeCroy	32	1,000
2	Switch 1	FC	80 FC	Optical Switch	DiCon	19	150
3	Switch 2	FC	2 FC	Optical Switch	DiCon	19	150
4	Monitor 1	40 FC	Lemo	40 PIN Diode	Hamamatsu	14	0
5	Monitor 2	40 FC	Lemo	40 PIN Diode	Hamamatsu	14	0
6	Spect 1	RS-232	Lemo	Monochromator	Optometrics	14	100
7	Spect 2	RS-232	Lemo	Monochromator	Optometrics	14	100
8	Time 1	3 BNC	GPIB	Digital Scope	Agilent	18	220
9	Time 2	3 BNC	GPIB	Digital Scope	Agilent	18	220
Total						**162**	**1,940**

The signal input, signal output, manufacture, dimension and power consumption are listed in these tables. The total height of equipment in Table 2 is 162 cm arranged in **two system racks**, as shown in Figure 2. Some equipment listed in Table 1 may also be installed on shelf in system racks.

1.3 Electricity

The Nd:YLF Laser requires electrical power of 3 Phase, 400 V, 50 Hz and 30 A/Phase, with a power consumption of 10,000 VA. The Neslab Ti:Sapphire cooler requires electrical power of single phase, 220 V, 50 Hz and 10 A, with a power consumption is about 1,650 VA. The remain equipment requires a single phase power supply of about 2,400 VA. The electrical power requirement for each laser system thus includes **a three phase, 400 V, 30A, and two single phase, 220 V, 10 A**.

1.4 Network

The system also needs **a 10/100 base T Ethernet connection** for PC to communicate with the DAQ computer.

1.5 Weight

The optical table weights about 300 kg, which provides effective vibration isolation. The Nd:YLF power supply weights 160 kg. The total weight for each laser system is about **460 kg**.

2 Installation at H4

2.1 Laser Room Layout

The monitoring light source will be installed in an area of 2.5×3.0 m in air-conditioned barracks at H4. Figure 3 shows the layout of the laser room containing two optical tables and two racks.

The floor of the barracks will be raised by 40 cm to let air flow. Solid support will be provided for optical tables so that standard leg length can be used. This makes these legs also use able for USC55 installation. Figure 4 shows the location of legs for two optical tables. Additional solid support may be needed for the IR light source.

The utility outlets will be provided on the other 4 m wall, as illustrated in Figure 5. The electrical outlets will be under raised floor. The $1''$ NPT female connectors of the inlet and the outlet for the chilled water are installed at about 1.7 m above the raised floor to allow valves, filters, pressure gauges and regulator be installed on wall at convenient height. This figure shows utility allows installation of three sets of laser systems. While we know exactly two laser systems, the utility of the third IR light source is yet to be defined. All equipment after outlets will be provided by Caltech.

2.2 Safety

Detailed safety instructions were provided by G. Roubaud of CERN Safety group. Each laser is to be registered two months before installation. Figure 6 shows the implementation of the laser safety at H4. The laser room is enclosed with wall paint dark gray. An interlock is provided to close all laser shutters in case of unexpected opening of the laser room door or ceiling. The interlock also functions if optical fibers used to transport laser pulses were accidentally broken. This is achieved by the level 2 TTL input, i.e. the “light return signal” in Figure 6, provided by the monitoring level 2fanouts. It is a TTL signal at high level if the level 2 fanouts receive laser pulse. It should be at low level if the laser pulse does not reach level 2 fanouts because of, e.g. accidentally broken fiber. The interlock is bypassed by a manual switch during maintenance and operation when no laser pulse is sent to transport fibers. In addition to the interlock an emergency stop button, which turns off all lasers, are also implemented.

Warning labels and alarm lamps will be installed at the door of the laser room. The flashing warning lamp is powered through the power switch on the safety box. One can not turn on any laser unless the power of safety box is on, i.e. the flashing warning lamp is turned on.

2.3 Communication with DAQ

During monitoring, the control PC of the light source will function in the slave mode. The communication of the PC with the H4 DAQ will be carried out through Ethernet. At the beginning of each run, the DAQ checks/sets laser parameters by sending a command file of 5 integers, and laser acknowledges the DAQ by sending a command file of 5 integers. When laser finishes its setting and the DAQ is satisfied with laser setting, DAQ sends a nim trigger signal to the light source and the later acknowledges by sending a nim timing signal to the DAQ, indicating a laser pulse of defined wavelength and intensity is sent to the defined switch channel. The delay between the DAQ trigger and the laser pulse is about 5 μs and can be adjusted. Our light source can accommodate trigger rate up to a few kHz if necessary. The wavelength change, however, takes about a minute. Depending on the distance the channel change may also take up to a minute. The protocol of communications between the DAQ and the light source is defined as follows.

1. The DAQ command file to the light source:

COMMAND TYPE (int)	0: request light source parameters
	1: set light source parameters
WAVELENGTH (int)	0: 440 nm
	1: 500 nm
ENERGY (int)	0 – 99 % of laser power, in 1% step
SWITCH CHANNEL (int)	1 – 80
CHECKSUM (int)	Bitwise inversion of the sum of preceding 4 data

2. The light source acknowledge file to the DAQ:

COMMAND TYPE (int)	0: setting in progress
	1: setting finished, the light source is ready
WAVELENGTH (int)	0: 440 nm
	1: 500 nm
ENERGY (int)	0 – 99 % of laser power, in 1% step
SWITCH CHANNEL (int)	1 – 80
CHECKSUM (int)	Bitwise inversion of the sum of preceding 4 data

3 Installation at USC55

Figure 7 shows a schematic for the laser installation in the USC55, where two rooms with individual door are designed to observe safety requirements.

Acknowledgments

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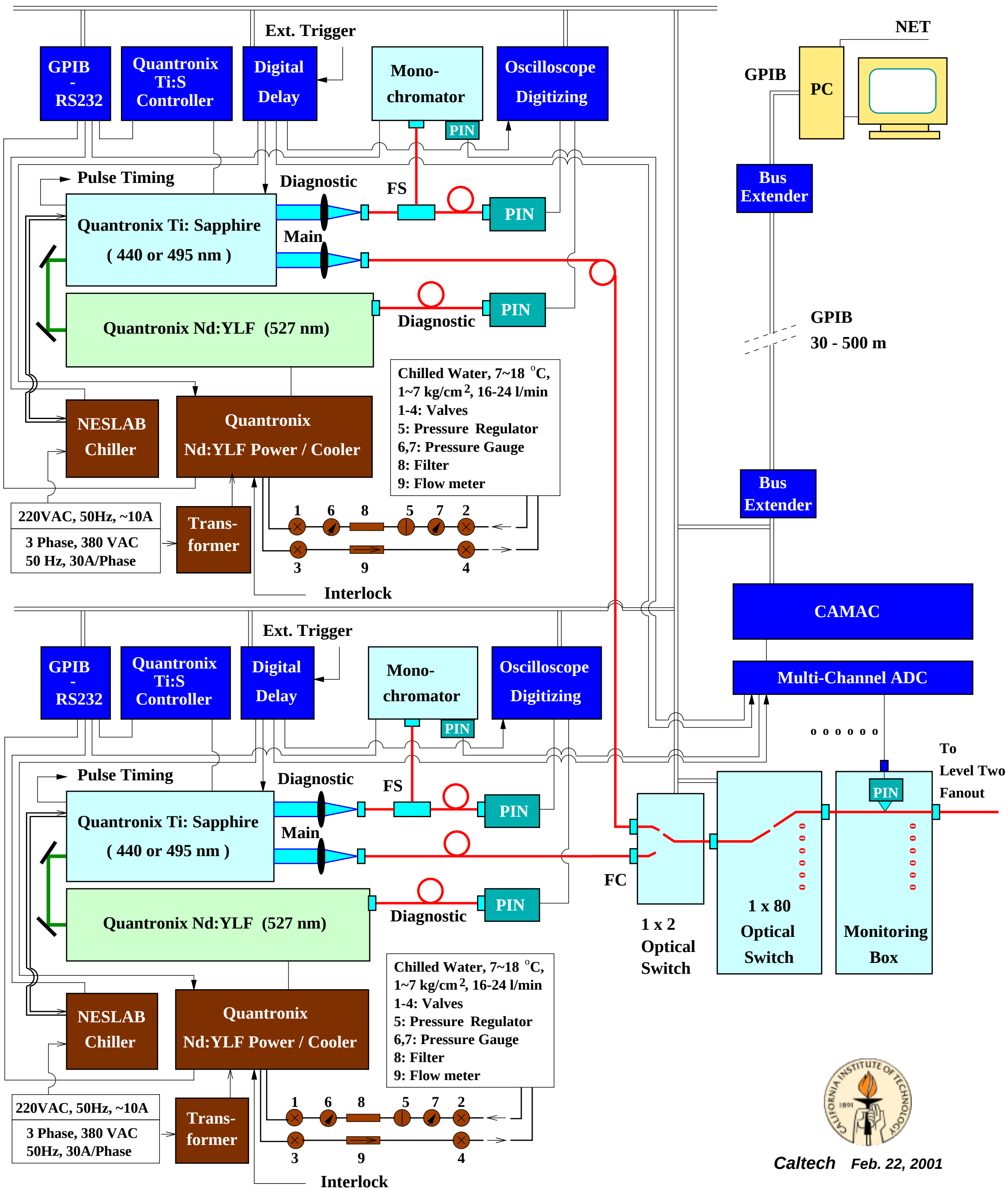

Figure 1: A conceptual design of the monitoring light source and high level distribution system.

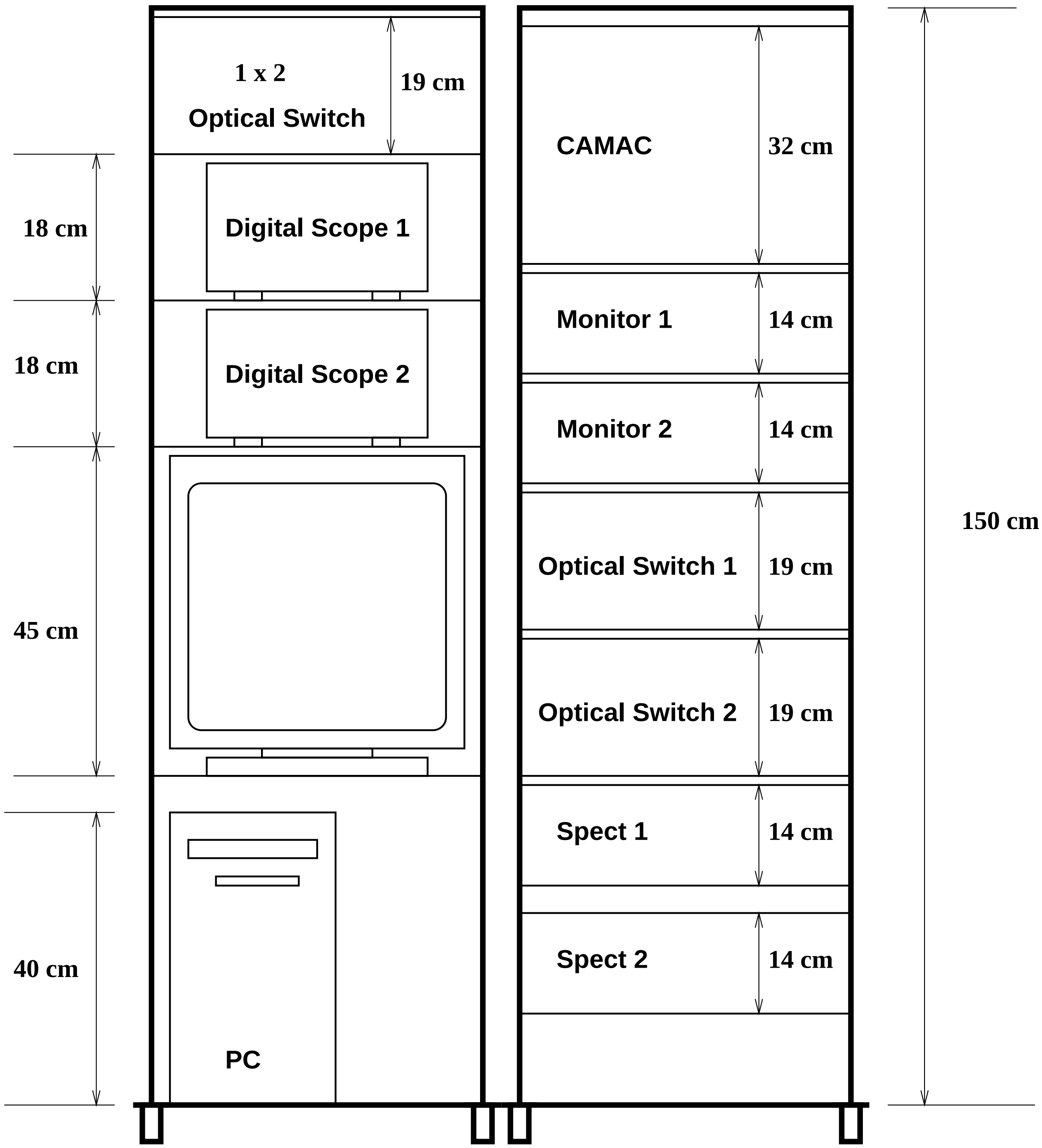

Figure 2: A schematic showing the layout of two system racks.

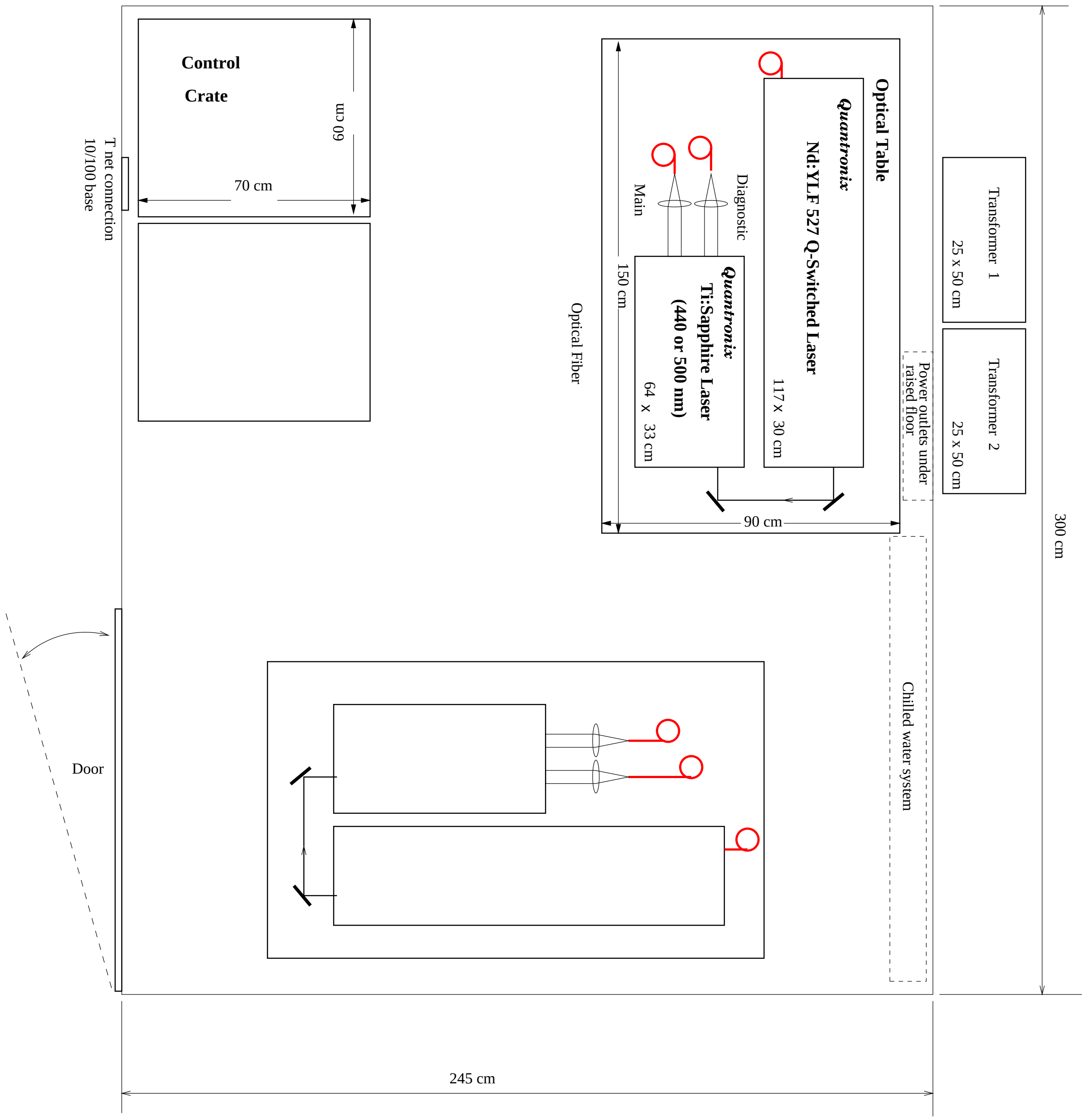

Figure 3: A schematic showing the laser installation at H4 for beam test.

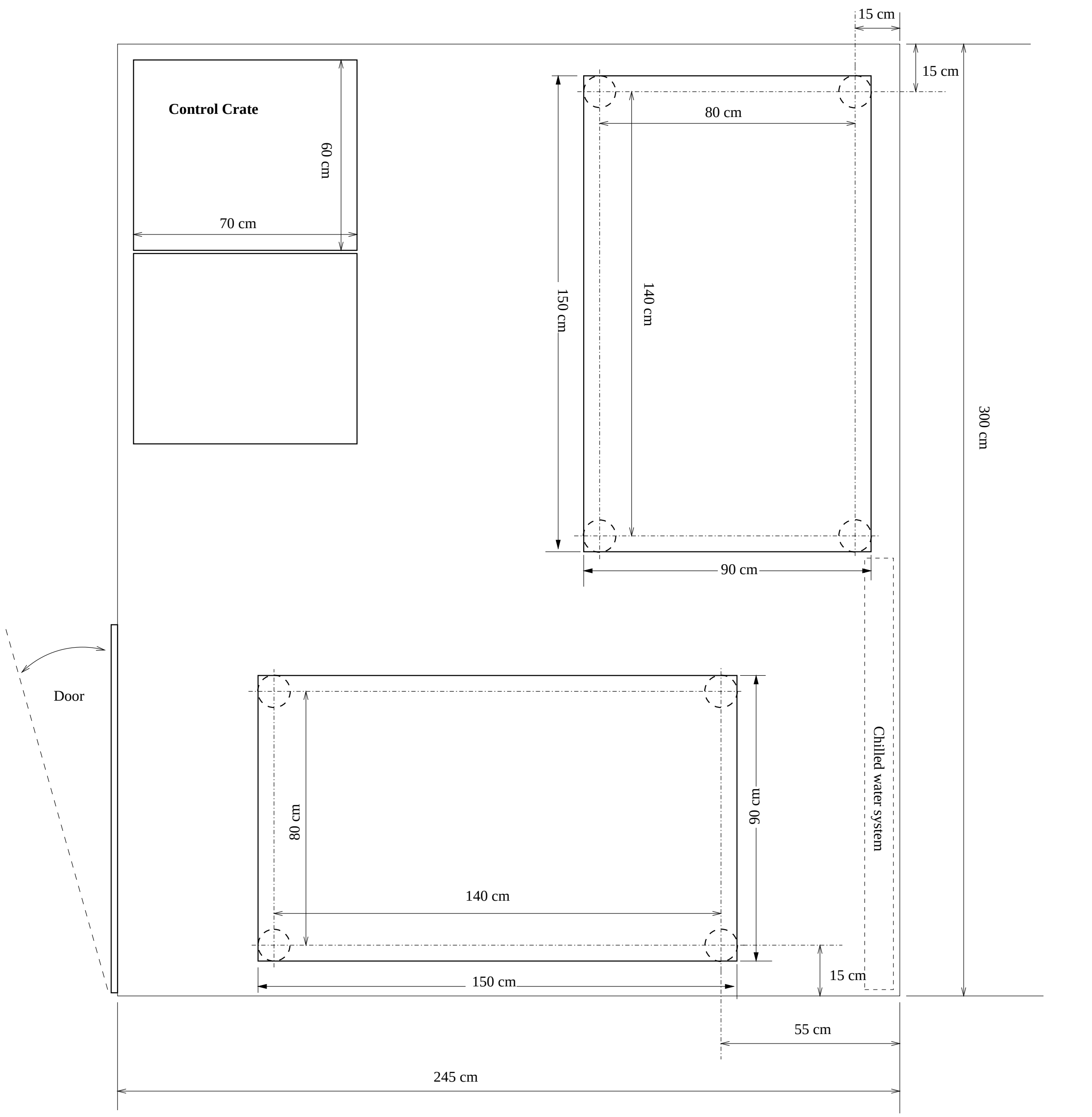

Figure 4: A schematic showing the floor layout and position of solid support for legs of optical tables.

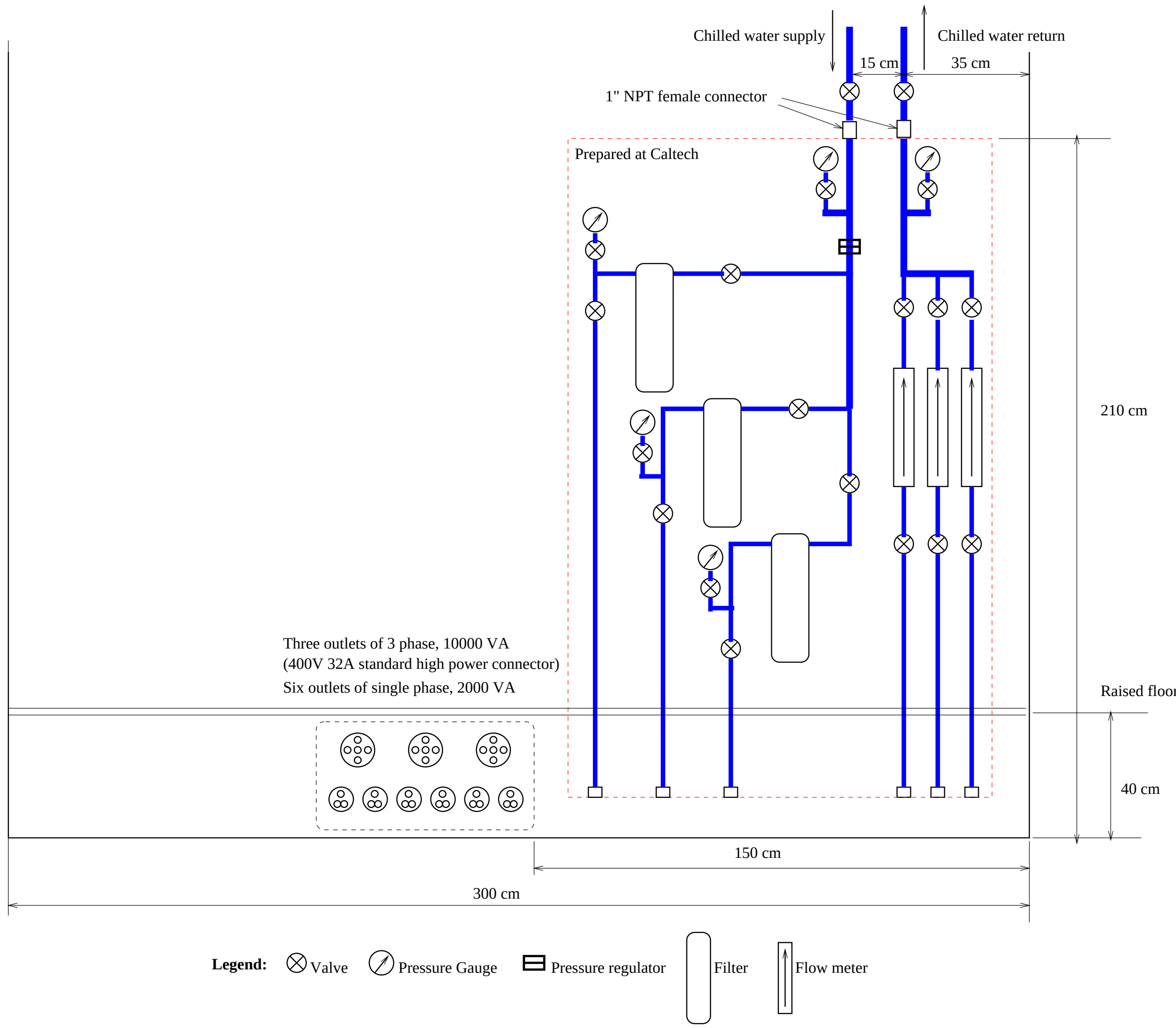

Figure 5: A schematic showing utility installation on wall in barracks at H4.

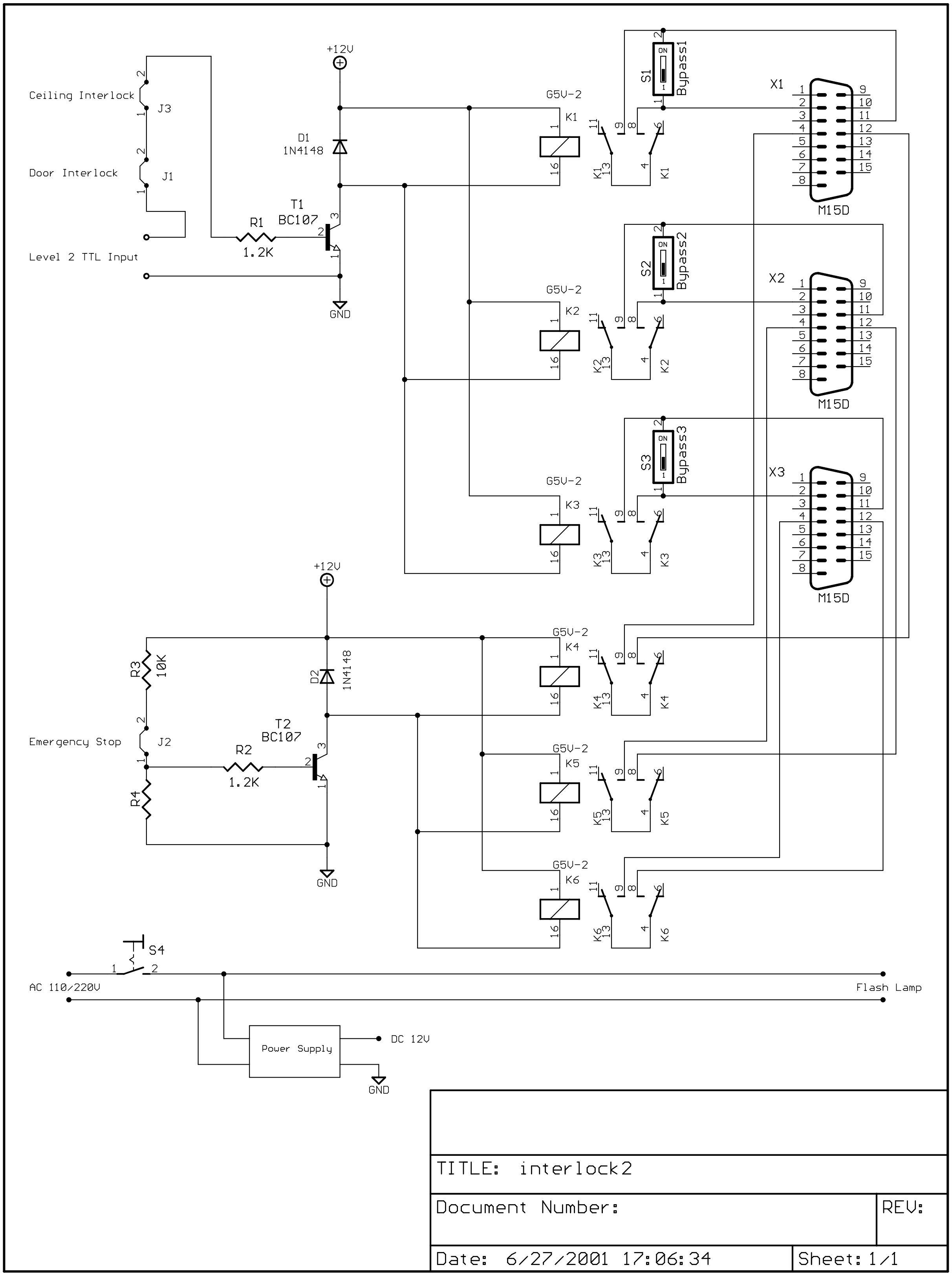

Figure 6: A schematic showing the implementation of the laser safety.

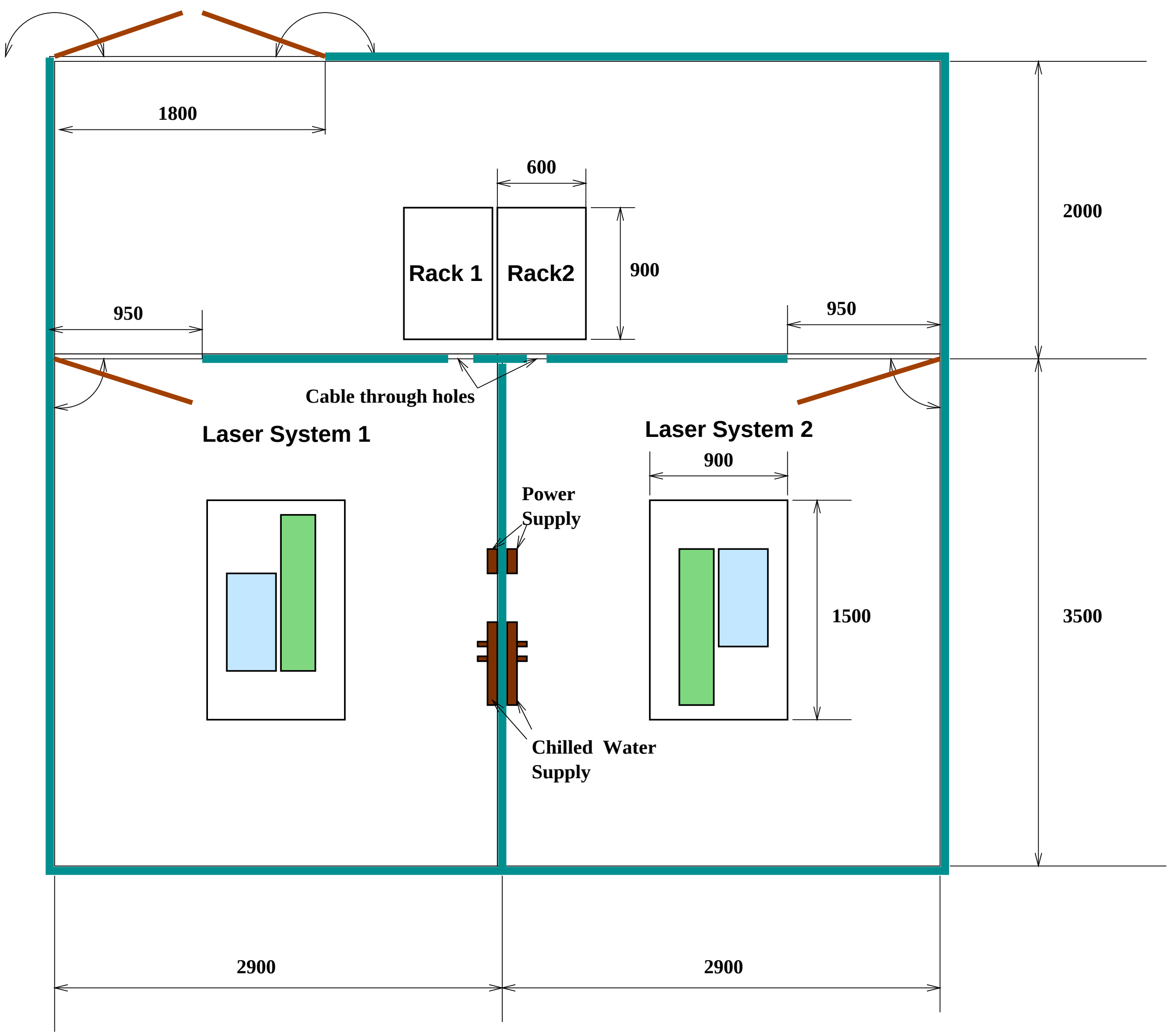

Figure 7: A schematic showing the laser installation at USC55.