LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

LIGO Laboratory / LIGO Scientific Collaboration

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Accommodation of Glasgow CO_2 laser fibre pulling & welding machine at LASTI for noise prototype installation – site visit October 2006

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Distribution of this document:
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1 Introduction

A site visit was made by Caroline Cantley to the LASTI facility at MIT to assess the space available and specify the basic requirements for the accommodation of the CO_2 laser fibre pulling & welding machine required for noise prototype assembly and installation.

This was considered to be the first of two visits prior to the proposed installation of the laser machine in April 2007. The 2nd visit will be carried out by Russell Jones in January 2007 to put the final requirements in place. Following this 2nd visit this document will be revised and further detail added.

In parallel with this Helena Armandula also took part in the visit to participate in the planning of the monolithic assembly installation and also to determine the potential facilities available for ear bonding and mass handling. Her findings are reported elsewhere.

David Ottaway, Ken Mason and Rich Mittleman of MIT were the hosts.

It should be noted that in addition to the images presented in this report video footage is also available in Glasgow showing the route the assembled monolithic stage will take from the CO_2 laser lab to the BSC. This is stored in Glasgow in the project sub-directory

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2 Proposed laboratory space

The proposed area for accommodation of the laser machine is one half of the “Large Optics Laboratory” which is situated just off the LASTI facility high bay and has double door entry adjacent to the HAM21 tank.

Figures 3 to 11 are photographs showing the proposed lab space. Note that this area is currently used for storage and general laboratory work and will be cleared and fitted to accommodate the CO_2 laser machine.

It is proposed that a laser curtain (supplied by MIT) will be placed across the large optics laboratory at the position of the central support pillar to divide the laboratory space up into the CO_2 laser lab and a separate general purpose lab for general access.

The proposed floor space for the laser lab is approximately 23’ 8’’ by 11’ 2” (7.2 m by 3.4 m).

The main limitation to the lab space offered is the ceiling height. Taking into account the suspended lights the maximum height which can be accommodated is approximately 7’ 10’’ (2.4 m).

This determines the height of optics bench that can be used to accommodate the laser machine and the height of the work table that can be used to accommodate the ribbon profiling machine.

The Lexan enclosure around the laser machine is approximately 1.9 m in height. Therefore the optics bench must be no more than approximately 0.5 m above floor level.

A plan drawing of the LASTI facility high bay is given in Figure 1. Note that this drawing is a few years out of date but the general vacuum system arrangement is correct. The approximate route from the laser lab to the BSC is marked in red (approx. 100 feet). However this requires updating in more detail in Revision 01 of this document once an updated drawing of the bay is available and following the 2nd site visit by Russell Jones.

Note that all dimensions and clearances stated in this report should be checked and confirmed during the 2nd site visit since only approximate values are given here. Physical overhead clearances for the top of the laser enclosure and ribbon profiling machine should be determined once the laboratory layout has been finalized.

3 General Requirements

3.1 Preliminary layout

Figures 2a and 2b show a proposed preliminary layout within the CO_2 laser lab. This has been presented for discussion and will be revised following the 2nd more detailed site visit. At present it allows the general requirements to be communicated.

3.2 Optics table

Initially Glasgow requested an optics table area of 2.5 m by 1.5 m. However, since there is an existing optics table available in the large optics laboratory it was decided that it was prudent to utilize this instead. This table has dimensions 4 feet by 10 feet (i.e. 1.22 m x 3.0 m) and is 1 foot thick (0.30 m). This is an imperial table with ¼-20 threads on a 1 inch pitch. Hence the CO_2 laser machine, which is currently designed in metric, must be modified to interface with this imperial table. This conversion will be relatively straightforward.

The table height must be < 0.5 m to allow the machine Lexan enclosure to clear the suspended ceiling lights. Hence the leg height must be approx. 0.2 m maximum. In addition to this, depending on the relative position of the ceiling strip lights, clearance will be required between the top of the enclosure and the lights so this gap may be further reduced. The legs can be simple support legs since there are currently no special vibration isolation requirements for operation of the laser machine within a normal laboratory environment. This is based on the assumption that the vibration levels in the laboratory are not unusually high for any reason. This should be confirmed during the 2nd site visit.

3.3 Power requirements

The proposed lab space has electrical sockets on the rear wall (14 off) and on the side wall adjacent to the high bay (8 off).

The general requirements for the laser machine and associated equipment are:

6 dedicated mains power sockets (2 for laser supply, 2 for motor supply and 2 for extension boards)

2 multi-way mains extension boards for electronics – these may be attached to the end of the optics bench for example.

10 local mains plugs to attach to laser, motors, power supplies and computer.

All of the equipment provided will be designed to use the local 110 V supply.

3.4 Water cooling

A closed loop stabilized water cooling unit will be used with the CO_2 laser so there is no requirement for additional plumbing & drainage. The preliminary location and dimensions of this chiller unit are shown in Figure 2a. The unit will be a 3-phase unit (60 Hz); 110 V. The thermal duty is approx 2 kW; ambient air temperature 30 ^oC.

The selection of the optimum unit to use has not been finalized. This will happen before the end of 06. Hence the full technical specification of the selected chiller unit will be confirmed and issued as part of the next revision of this document following the 2nd site visit by Russell Jones.

3.5 Benches, storage etc.

Two standard sized benches (e.g. 1.5 m by 0.7 m at approx. 0.9 m working height) are required for ribbon profiling and characterization as shown in Figures 2a and 2b. Note that the table height must be selected to enable the 1.5 m tall profiler to clear the ceiling height/lowest suspended strip light overhead. A third table or bench is required adjacent to the optics table for mounting the machine electronics and the PC for controlling the machine.

A ribbon storage cabinet will be supplied by the UK for temporary storage of pulled ribbons. This may be filled with an inert gas (probably Nitrogen) and will have approximate dimensions 1 m x 0.5 m x 0.5 m. Further details of the requirements for gas and confirmation of the dimensions of the cabinet will follow (TBD).

A glass stock material storage cabinet will also be required. It is hoped that this can be supplied by MIT. Details of the requirements for this will be presented and discussed during the 2nd site visit.

Storage for general mechanical components e.g. lab jacks, optical mounts, tools etc will also be required.

3.6 Laser safety

A laser curtain will divide the laser lab from the general lab area (MIT supplied). The two main lab doors will be interlocked to the laser and will have flashing warning signs. Standard CO_2 Class IV safety practices will be followed. Note that it is possible that the laser class could be relaxed depending on the final enclosure design and the final operating procedure. A full set of safety documentation will be issued by the UK in due course for approval by LIGO MIT and RAL.

3.7 Additional requirements

It would be extremely useful if floor space were made available outside the laser lab and within the general lab area for storage and unpacking of crates and boxes prior to assembly of the CO_2 laser machine.

4 From assembly to installation

CO_2 laser ribbon pulling and assembly (welding) of the monolithic stage will take place in the proposed laser laboratory.

Further to ribbon fabrication the ribbons will be characterized, proof tested and selected for application. This process will take place just prior to assembly, proof testing and installation of the monolithic suspension to minimize the time the ribbons are stored in air.

If ribbon storage is required prior to suspension assembly then they will be placed in an inert environment storage cabinet within the laser lab. This will be supplied by the UK and further details will follow in the next revision to this report.

A broad overview of the assembly and installation procedure is given below:

Assemble the clean-metal suspension on the seismic platform in the support stand.

Take (one half of) the lower structure to the welding machine using a soft trolley/forklift.

This can be done without any craning and is a journey of about 50 or 60 feet.

Place trolley adjacent to optics table (see Figure 2a) and align with respect to welding machine.

Install the glass masses and weld the ribbons + carry out necessary proof testing of monolithic stage.

Carefully return the half-lower structure (monolithic assembly) to the test stand using the trolley following the first part of the route marked up in Figure 1.

Re-integration of the lower and upper structure may take place at this stage or the 3 and 1 installation process will commence. A cartridge install is not possible with the seismic table at LASTI due to limited headroom.

The total distance between the laser lab and the BSC is approximately 100 feet.

Figure 1 shows the approximate journey between the laser lab and the BSC. The route has been numbered to correspond with the numbers on the photographs given in Figures 12 to 24. The narrowest part of this route is position ‘11’ given in Figure 22 where the gap between the pillar and SEI/SUS staging area is approx 3 feet 9 inches. This is considered to be easily wide enough for the soft trolley which will be used for the transportation of the lower structure housing the monolithic assembly.

Video footage of the proposed route is also available in Glasgow and stored in the project sub-directory

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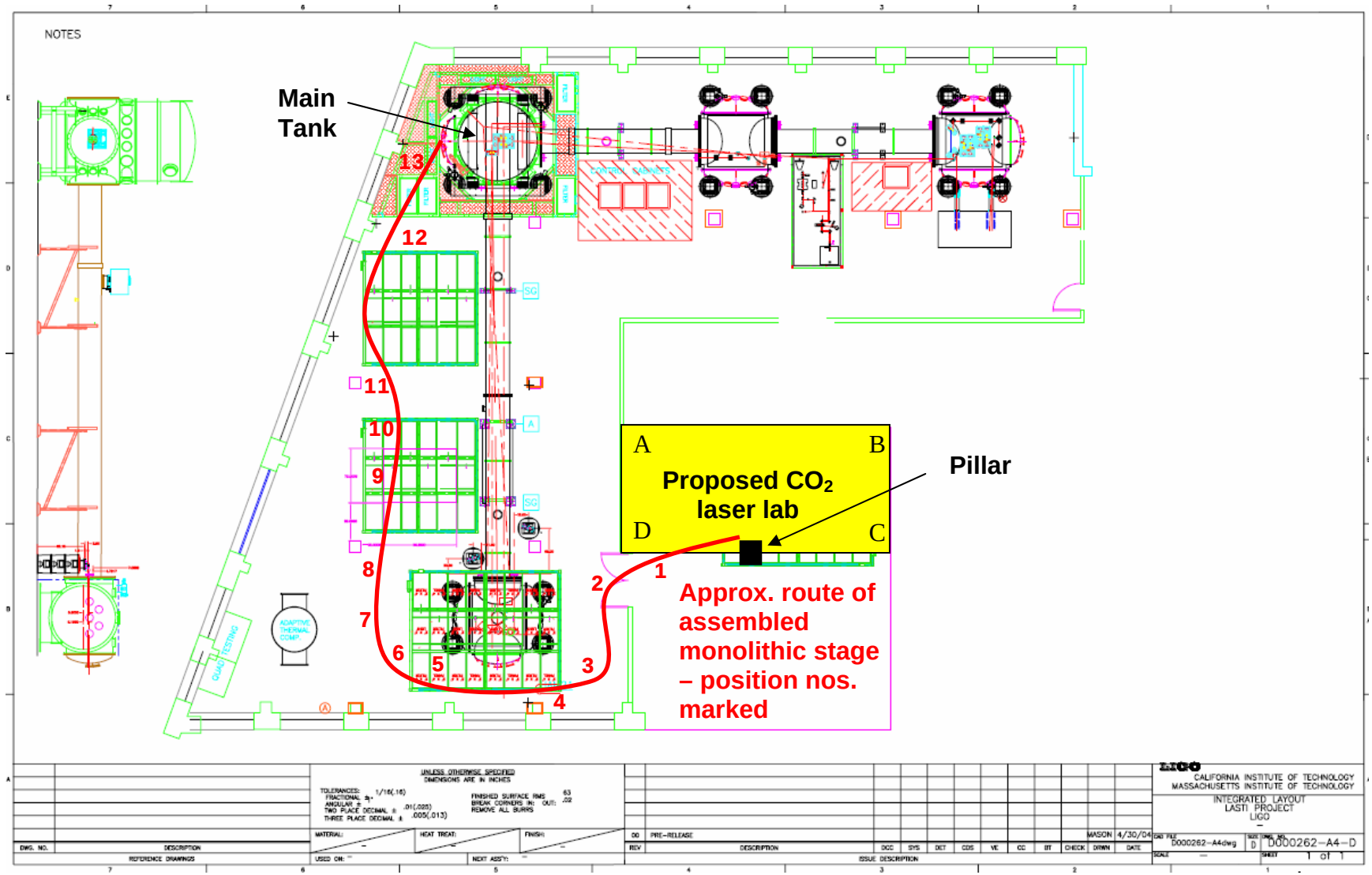

Figure 1 *LASTI Facility High Bay – note that this drawing is out of date but the general vacuum system arrangement is correct. The route shown should be updated in more detail once an updated drawing of the high bay is available.*

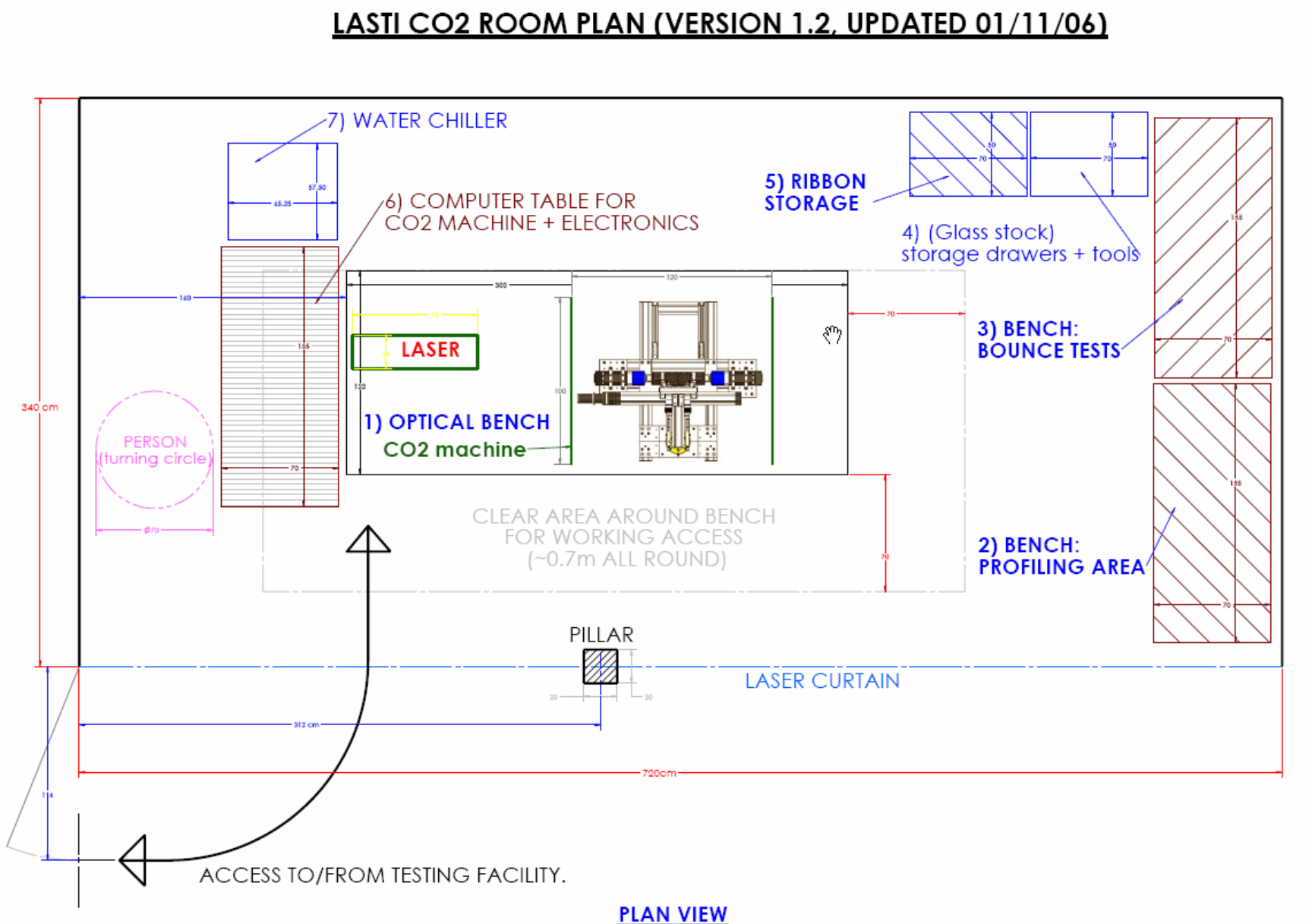

Figure 2a LASTI CO_2 lab preliminary layout – floor plan (for discussion)

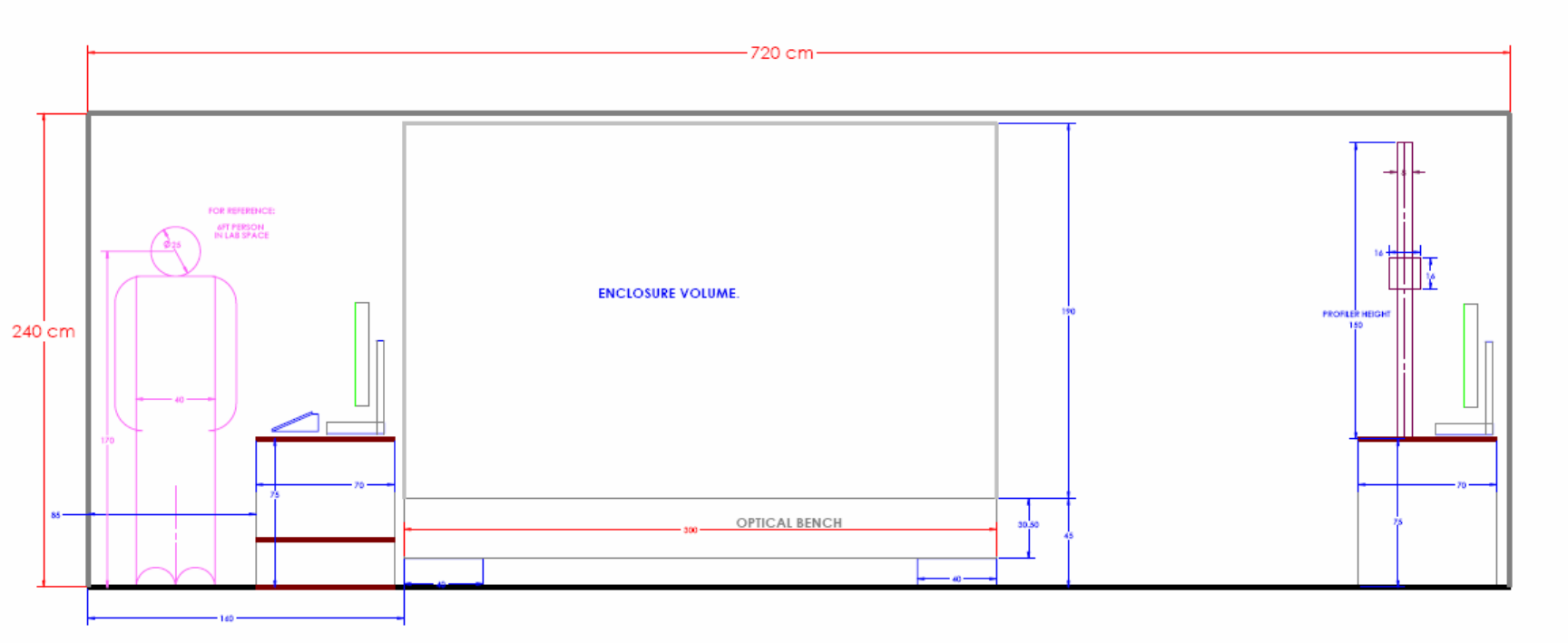

Figure 2b LASTI CO_2 lab preliminary layout - elevation

Figure 3 *CO_2 Laser Lab Area (view line 'C-B' of Fig 1). Lab main entrance door on RHS.*

Figure 4 *CO_2 Laser Lab Area (view line 'C-A' of Fig 1). Double doors to high bay on LHS of photo. Pillar across which laser curtain will hang at centre of photo.*

Figure 5 *CO_2 Laser Lab Area (view line 'C-D' of Fig 1). Double doors to high bay on LHS of photo.*

Figure 6 *CO_2 Laser Lab Area (view line 'D-A' of Fig 1). Double doors to high bay just off left of photo.*

Figure 7 *CO_2 Laser Lab Area (view line 'pillar-B' of Fig 1)*

Figure 8 *CO_2 Laser Lab Area (view line 'right of pillar-B' of Fig 1). Main entrance door to lab on RHS of photo. Height of lab limited by suspended tube lighting. Approx height ~ 2.4 m.*

Figure 9 *CO_2 Laser Lab Area (view line 'pillar-A/B' of Fig 1)*

Figure 10 CO_2 Laser Lab Area (view line 'pillar-A' of Fig 1)

Figure 11 *CO_2 Laser Lab Area (view line 'left of pillar-A' of Fig 1). Double doors to high bay on LHS of photo.*

Figure 12 *Route position **1** – laser lab on RHS, double doors to high bay on LHS*

Figure 13 *Route position **2** – just inside high bay after coming through double doors. Portable clean room on RHS will be removed.*

Figure 14 *Route position **3** – prior to 1st turn, portable clean room (curtain visible) will be removed.*

Figure 15 *Route position **4** – After 1st turn, from within portable clean room (which will be removed). HAM21 tank on RHS of photo.*

Figure 16 *Route position **5**. From within portable clean room (which will be removed).*

Figure 17 *Route position **6** – after leaving portable clean room, looking back towards HAM21 tank.*

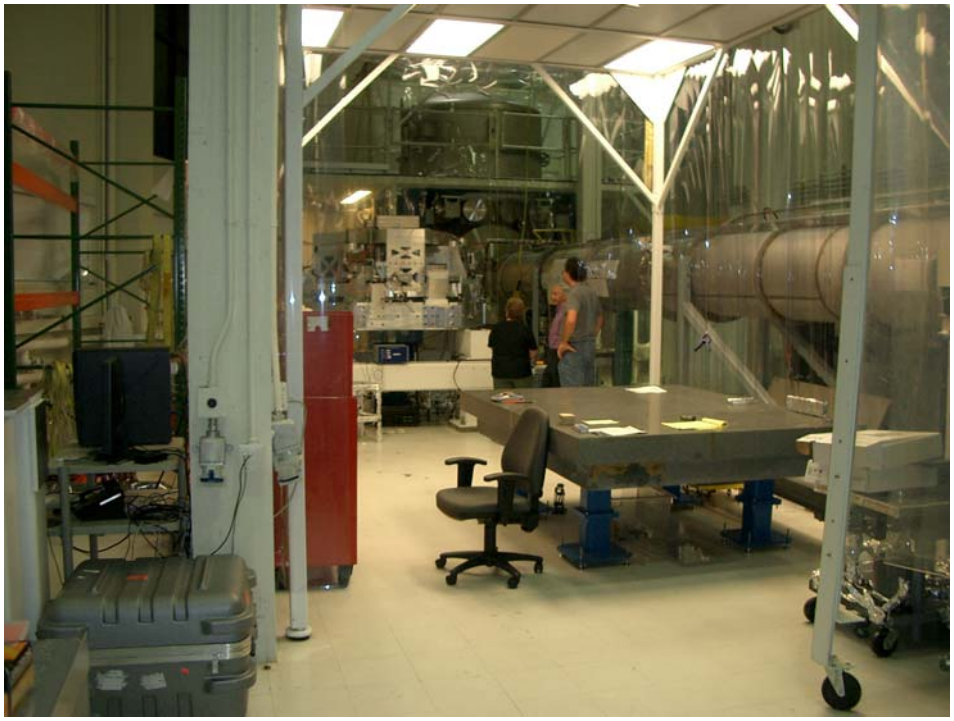

Figure 18 *Route position **7** – looking down towards main tank. SEI staging area visible in front of BSC.*

Figure 19 *Route position **8** – looking down towards BSC. SEI staging area visible.*

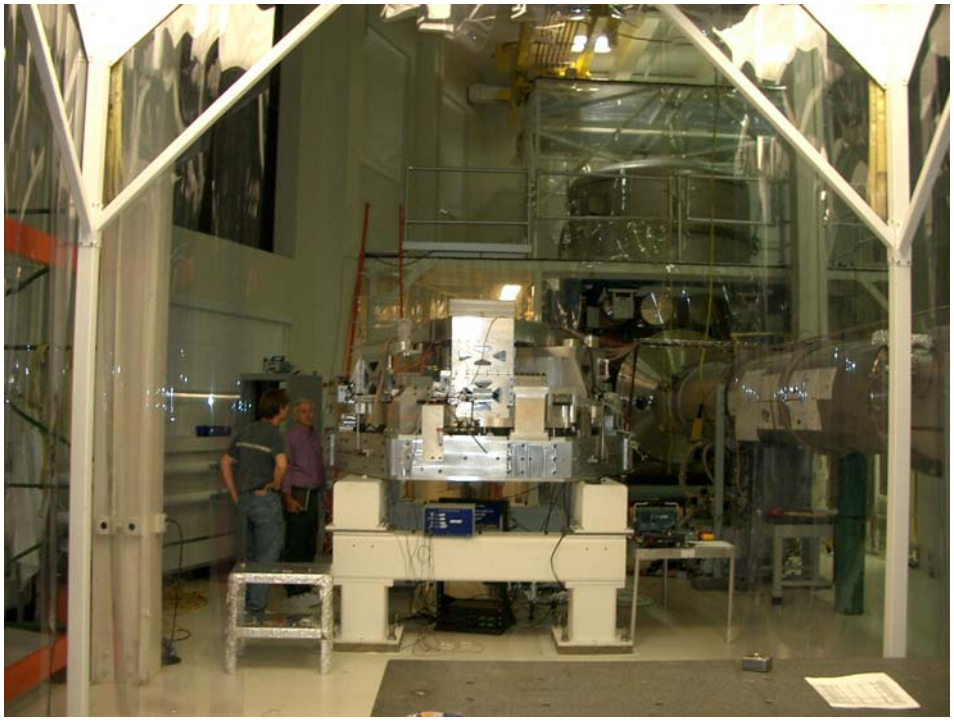

*Figure 20 Route position **9** – General view towards BSC. SEI staging area in foreground.*

*Figure 21 Route position **10** – General view towards BSC. SEI staging area in foreground.*

Figure 22 *Route position **11** - narrowest point in route beside SEI staging area – approx. 3 feet 9 inch gap*

Figure 23 *Route position **12** - access to BSC*

*Figure 24 Route position **13** - floor space at entrance to BSC*