LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

LIGO Laboratory / LIGO Scientific Collaboration

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Concept For Variable Load Clamp for ETM/ITM Monolithic Assembly

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Variable load clamp
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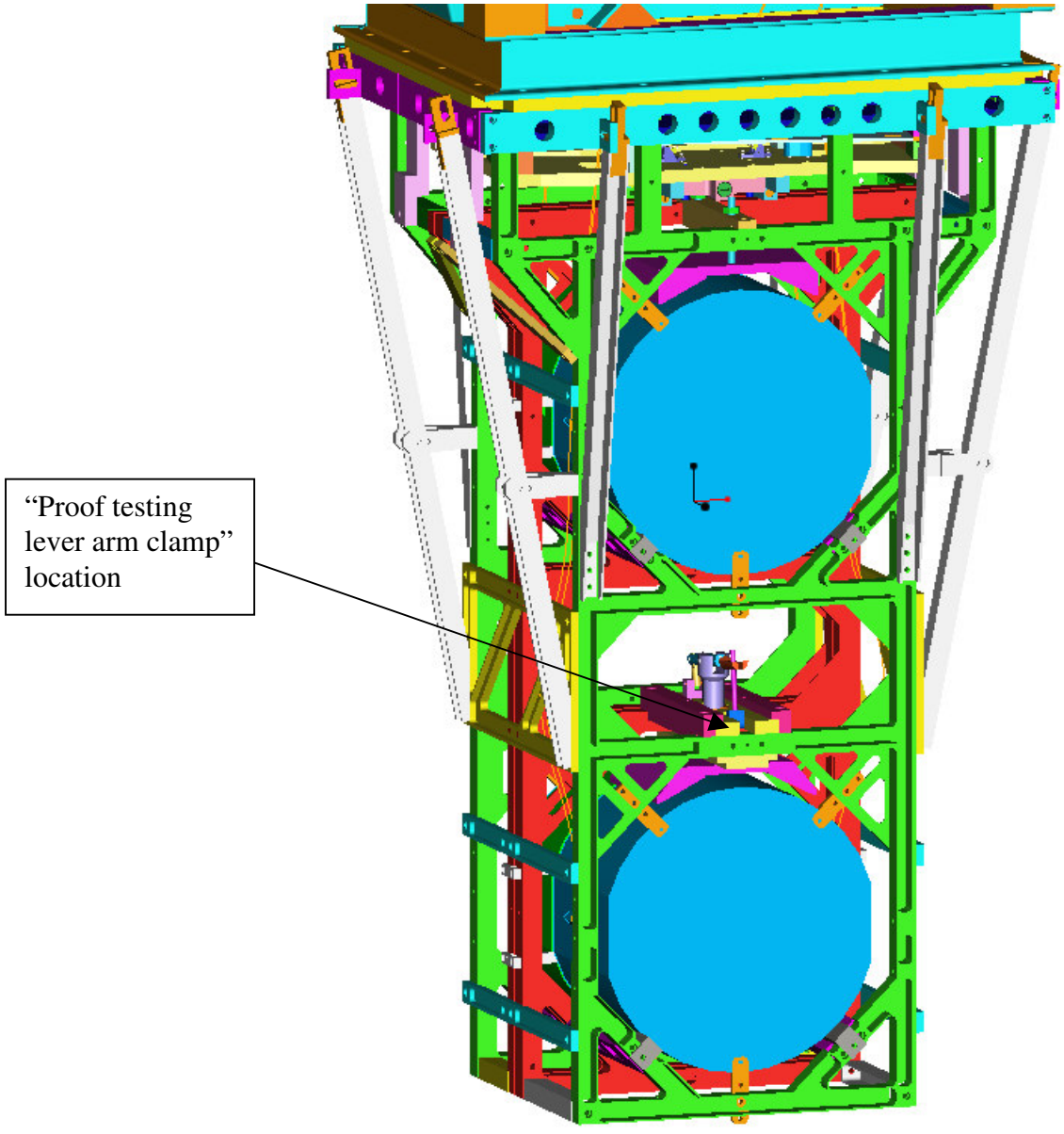
The purpose of the "proof testing lever arm clamp" is to fulfil the following roles:

- To provide clamping of the test mass during the welding process
- To provide an 8kg (20% of mass) downward force on the test mass, in order to proof load the fibres and the ears, to check that the fibres/ the bonded joints, and the ears on the masses are strong enough
- To provide clamping of the test mass and reaction test mass for transportation purposes, i.e. keeping the masses safe as the lower structure is moved from A to B, and during mounting to the upper structure
- Possibly to provide a harbour for the safety stops that will be fitted to the lower structure



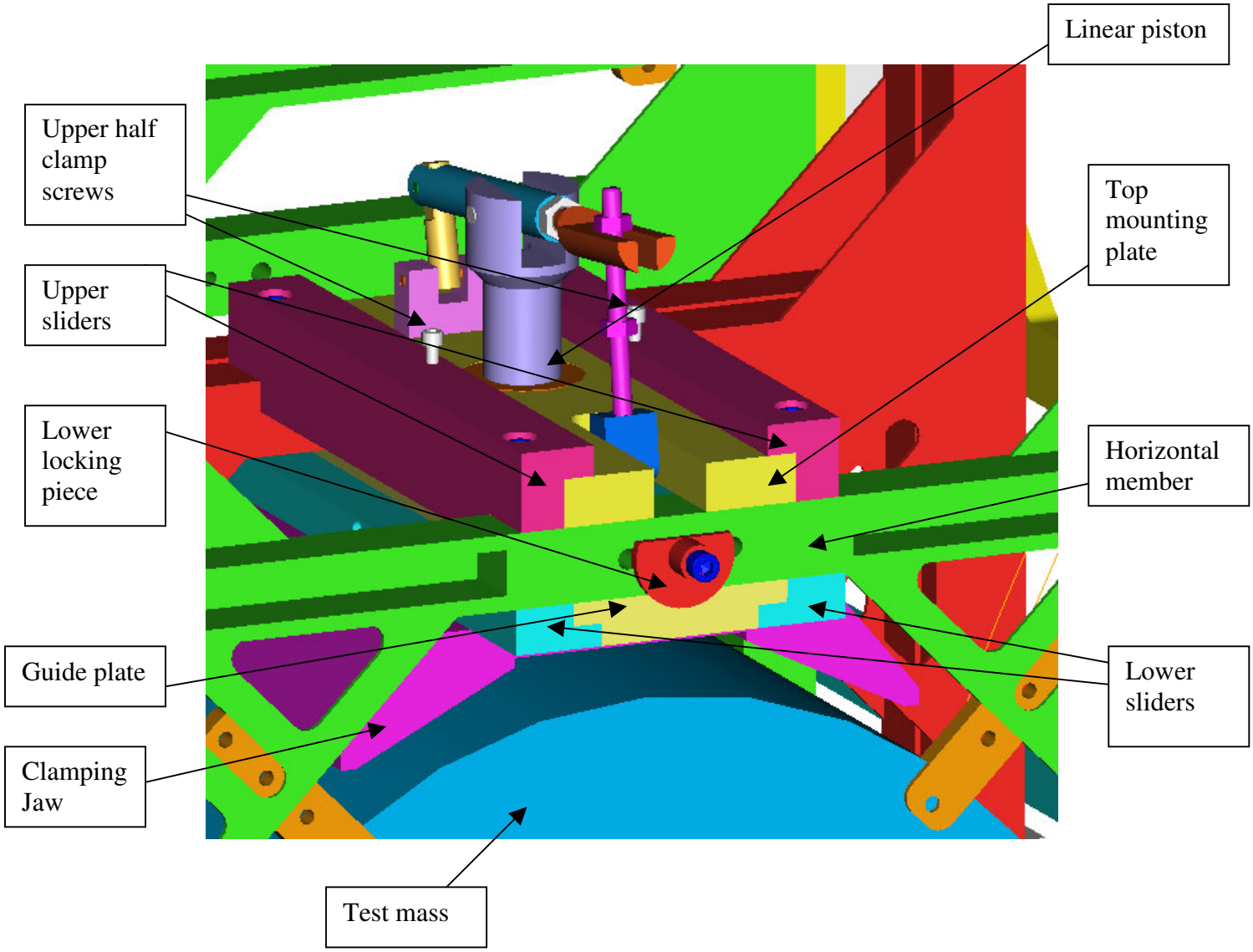
The clamp is mounted to the lower structure on “sliders”, which are bolted to the horizontal struts above the test mass. The sliders allow the variable load clamp to be added to, and removed from the lower structure without the risk of damaging the test mass or ribbons.

Due to the position of the cross member in the lower structure, the proof testing lever arm clamp is made in two parts, which can be removed separately, one above the horizontal member, and one below.

The upper half of the clamp

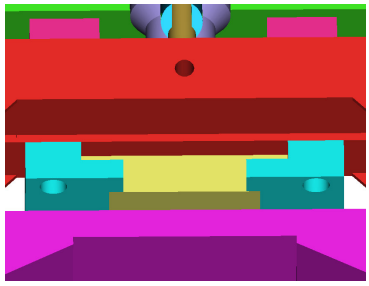
The upper half of the proof testing lever arm clamp consists of a jacking mechanism, which drives a linear piston through the top mounting plate, and exerts force on the clamping jaw, which in turn exerts a clamping force on the test mass. When a suitable clamping force has been reached, using the jacking system, the clamp can be locked in place, and the structure can be moved from A to B, without the risk of the masses falling out.

This half of the clamp can be slid in above the horizontal member and locked in place using the “upper half clamp screws”



The lower half of the clamp

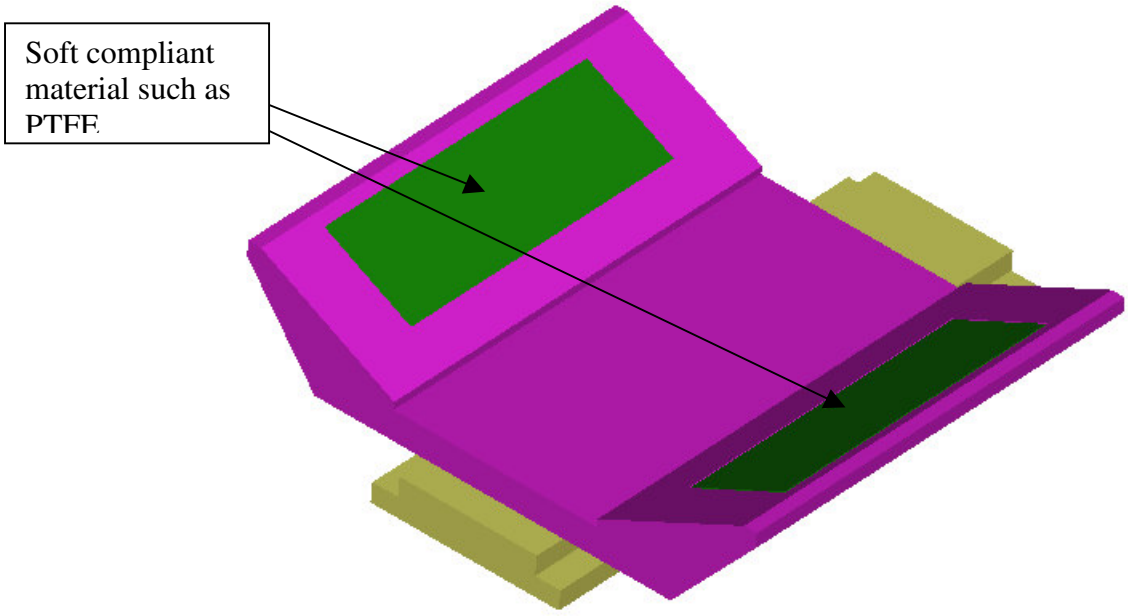
The lower half of the clamp consists of a guide plate, (which constrains the piston to a linear motion) and the clamp jaw, which provide the contact faces between the proof testing lower arm clamp, and the test mass.



This half of the clamp can be slid it place underneath the horizontal member of the lower structure, and locates on some stops, (as shown inset). The "lower locking piece" can then be turned through 180 degrees and the screw holding it tightened, in order that the lower piece is held in place against its stops.

The "clamping jaw" can be locked in place above the test mass, and used to harbour the safety stops (not shown in the model)

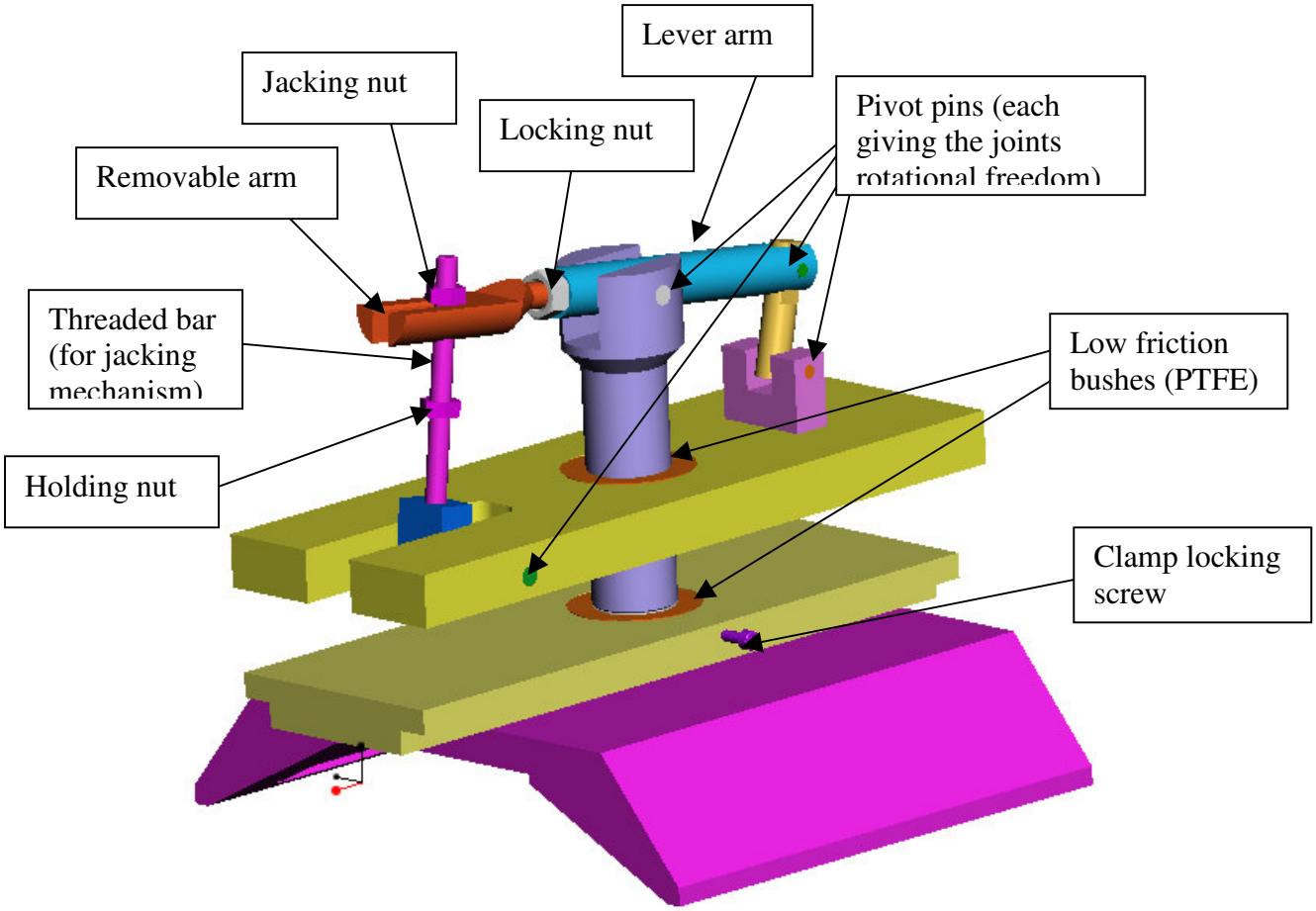
The underside of the clamping jaw has been designed with large recessed areas. These recesses provide a place to insert a soft compliant material (pads), which will protect the test masses when the clamping jaw comes into contact with them.



These pads are particularly important for the welding process, where it may be that a considerable amount of force is exerted on the masses, by the clamp, in order to get the necessary fibre stretch.

In the diagram, I have suggested PTFE for these pads, but this is open to debate, and will be looked into more closely.

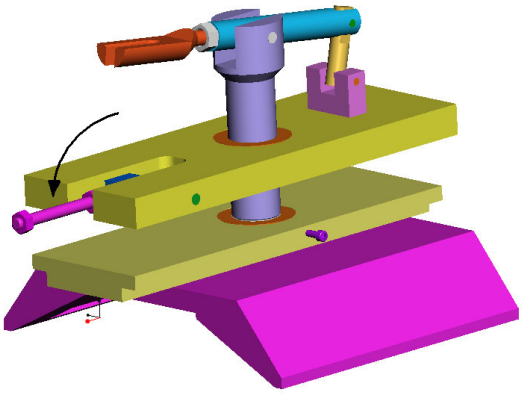
“Proof testing lever arm clamp” mechanism



As the jacking nut is rotated clockwise, the piston is pushed downward through the low friction bushes, and the clamp jaw exerts pressure on the mass. When the clamping force is not needed, the clamp jaw can be held high up, away from the mass by slackening off the jacking nut, raising the removable arm up to its top position, and either tightening the clamp locking screw, or locking the holding nut up, against the removable arm.

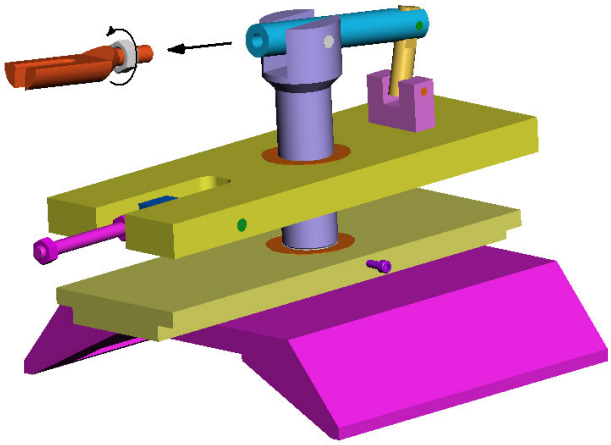
Using the "proof testing lever arm clamp" to create a 8kg (20% of mass) downward force:

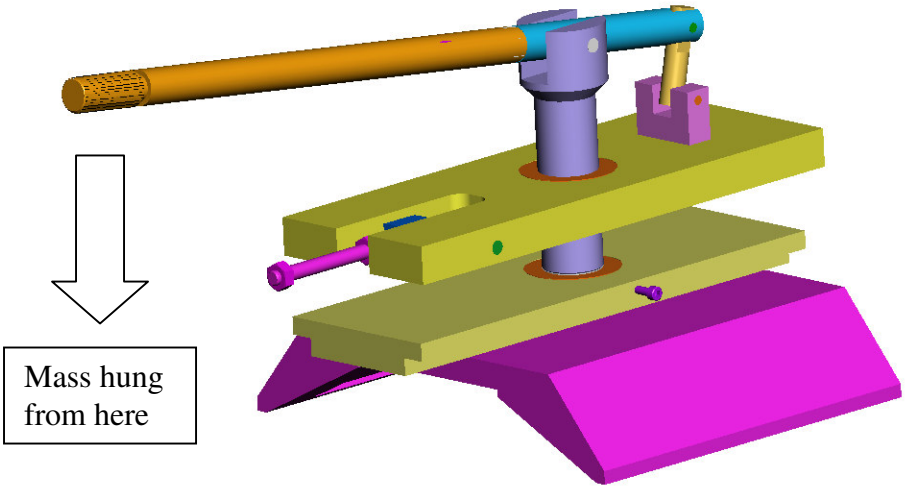
In order to create an 8kg downward force, the removable arm is replaced by a longer arm, which can have a mass hanging from it.



The jacking nut is released, and the threaded bar is rotated on its pivot pin, following the arrow, until it is resting on the horizontal member of the lower structure.

Slacken off the locking nut, to release the removable arm, which can then be unscrewed and taken away.



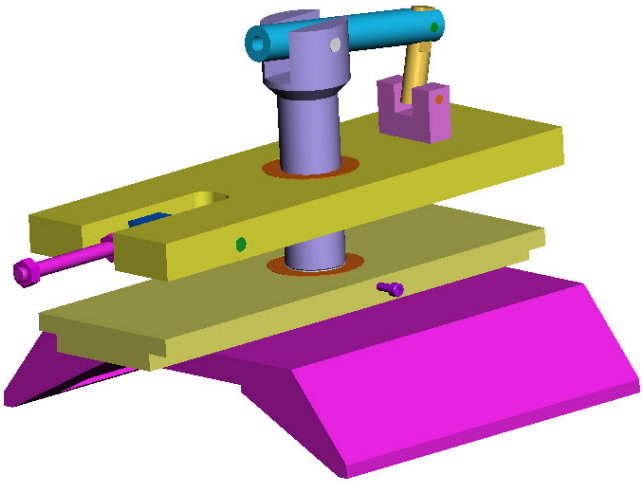


A longer arm can now be screwed into the lever arm, and a mass can be hung from it, out away from the test mass

Proof testing lever arm clamp; Removal

Top half/ bottom half separation:

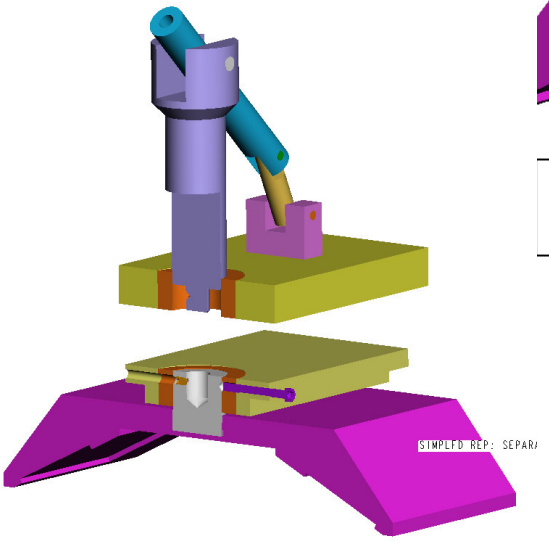
As mentioned previously, the "proof testing lever arm clamp" must be separated into two pieces, in order for it to be removed from the structure. The following procedure can be followed in order to do this:

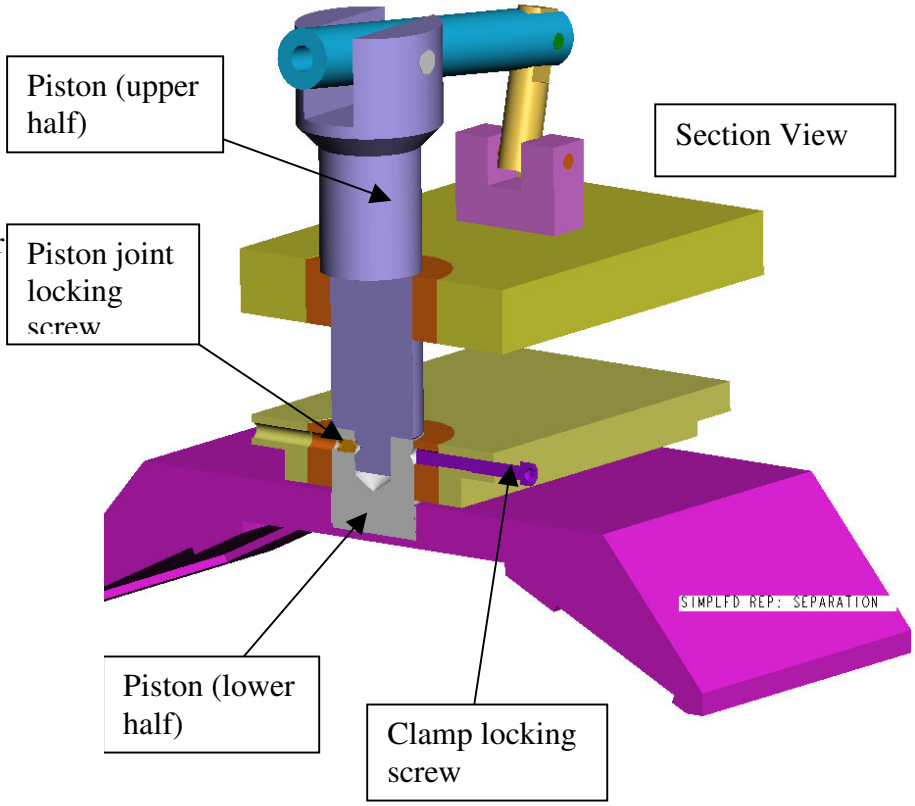


The clamp is raised to its full height, and the clamp locking screw is tightened; thus the clamp is held in place above the test mass.

The "removable arm" is unscrewed from the clamp, and taken away.

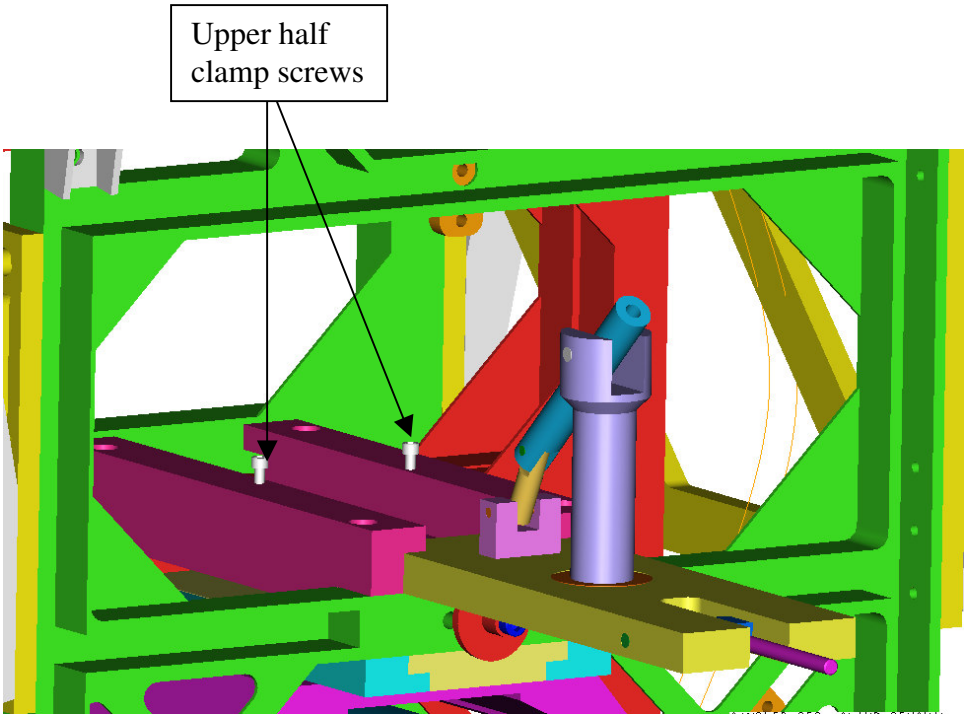
The piston joint locking screw is then loosened off, so that the "piston upper half" and the "piston lower half" become independent from each other. The upper half of the piston can then be raised up until its lowest point is above the bottom face of the top mounting plate (as shown below)



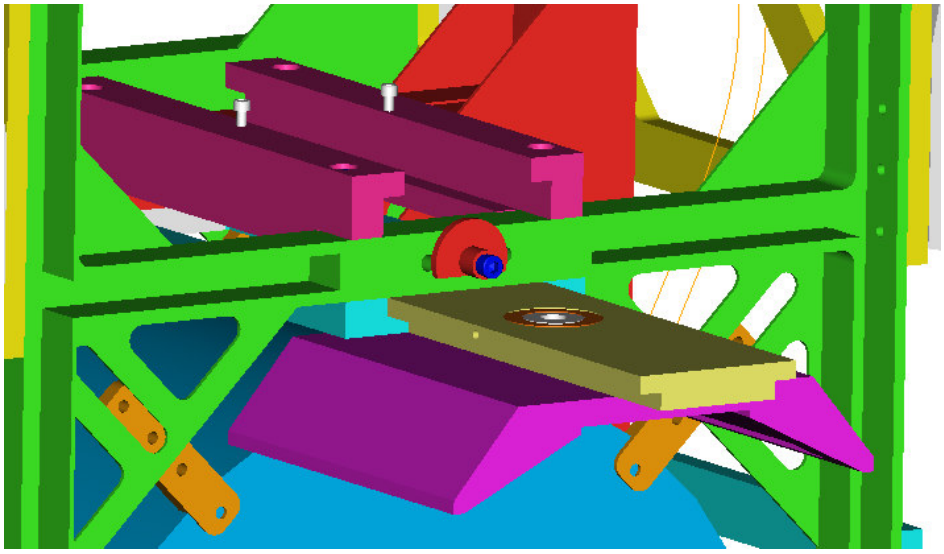


Removal of the two halves from the structure:

The “upper half clamp screws” can be loosened off, and the top half of the clamp can be slid out from the structure.

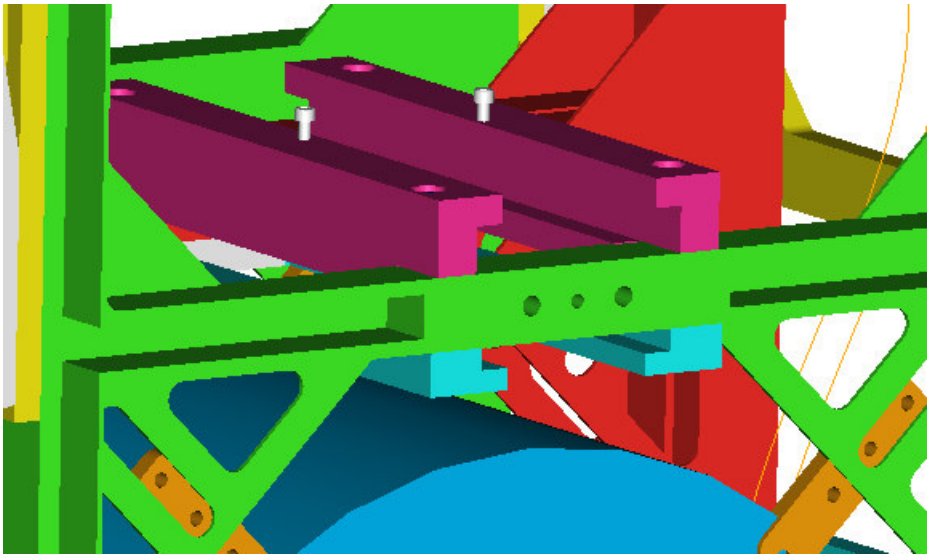


The lower locking piece can now be rotated through 180 degrees, out of the path of the lower part of the clamp, which can then be slid out of the structure



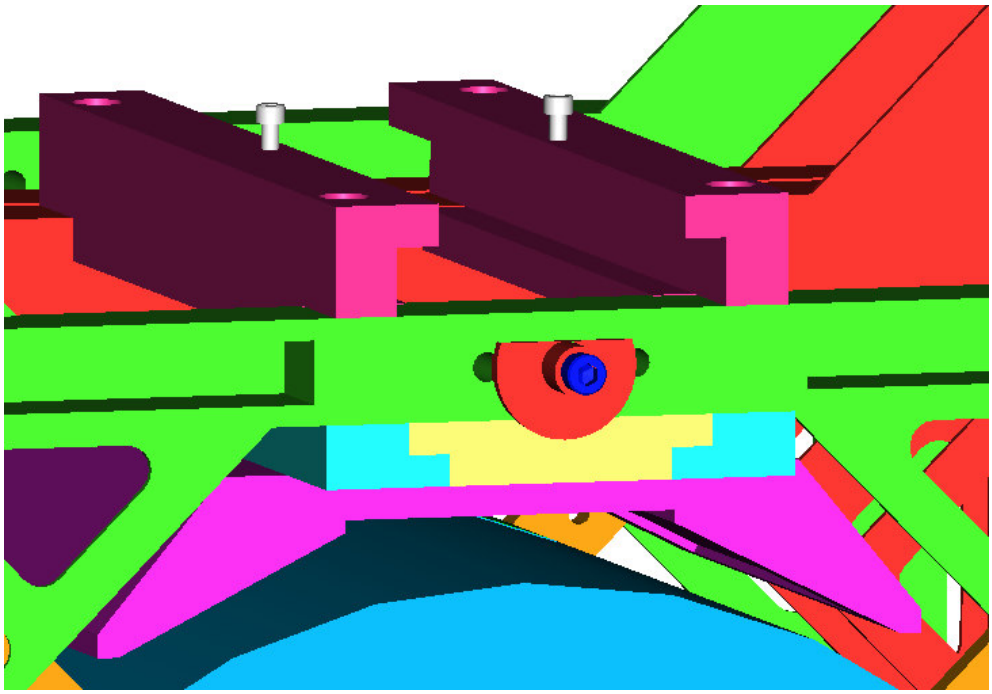
The lower structure now looks as shown below:

The proof testing lever arm clamp is not present



<u>Use of the clamp to provide a harbour for the safety stops:</u>

Alternatively, the lower part of the clamp could be left within the structure, on its own, as shown below, in order to be a very effective harbour for the safety stops, which is the last of the requirements for the clamp.



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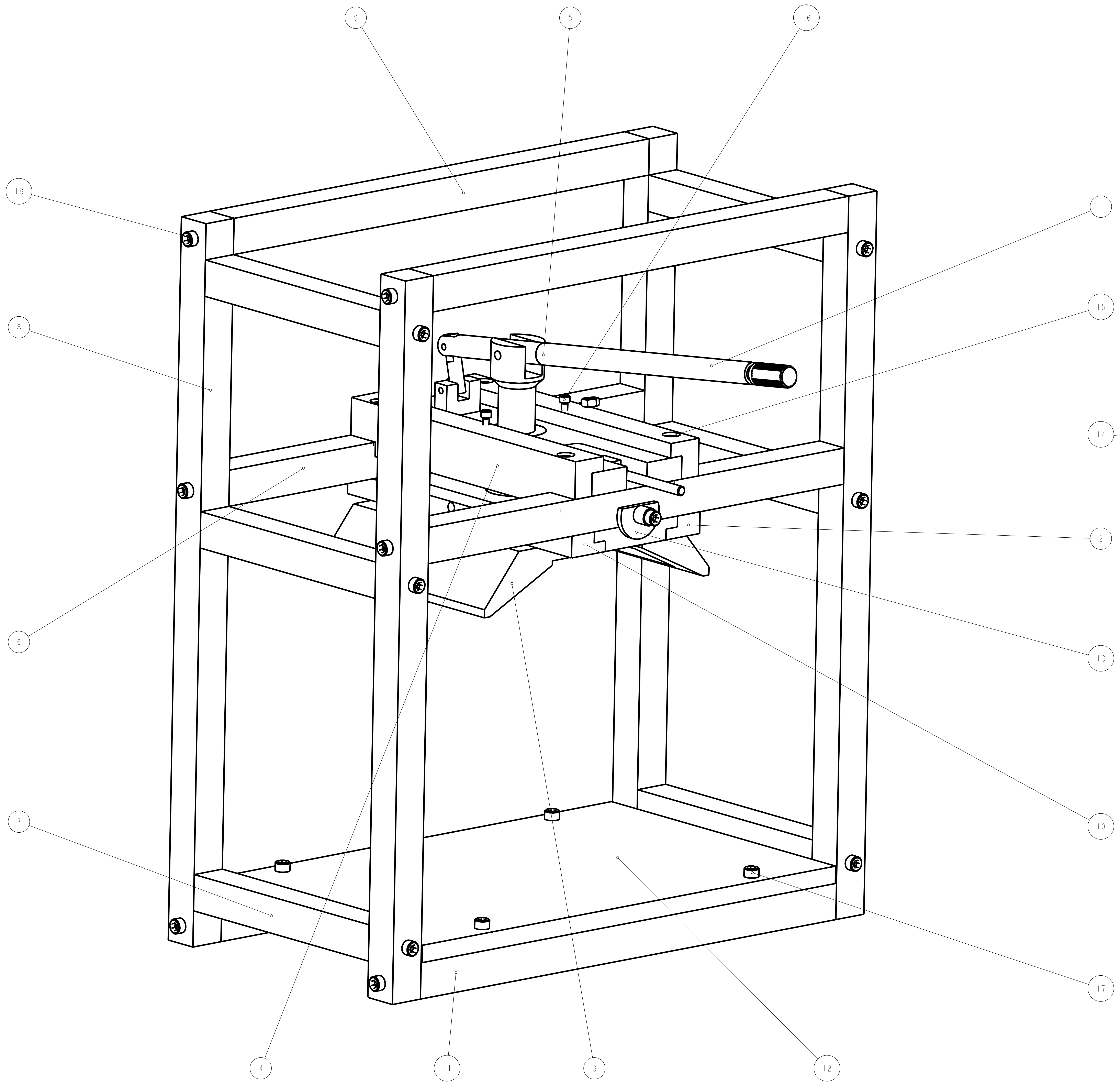
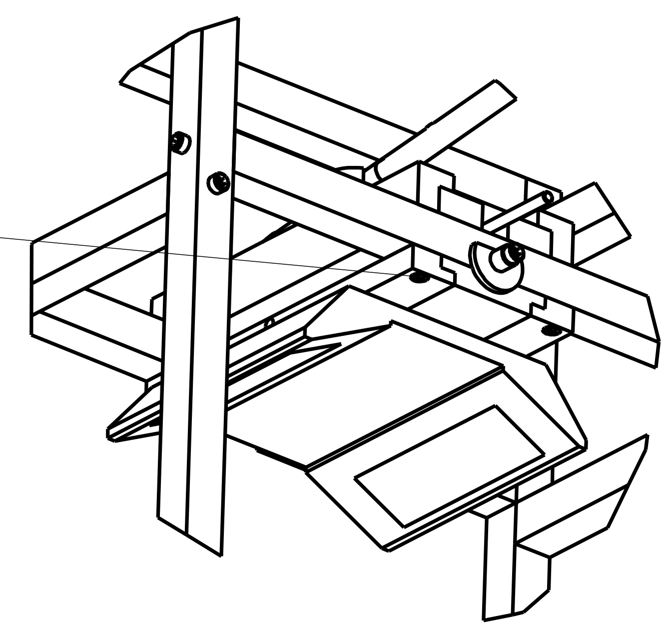
PROJECTION

THIS DRAWING CONFORMS TO B.S. 8888





SCALE 1:2

ITEM	MODEL No. DRG No. / CAT No.	TITLE	DRG Y/N	QTY	REMARKS
1	TD-1084-850	8KG HANGING ARM		1	.
2	TD-1084-877	LOWER SLIDER 2		1	.
3	TD-1084-880	PROOF TEST CLAMP-BTM HALF		1	.
4	TD-1084-885	TOP SLIDER		2	.
5	TD-1084-886	PROOF TEST CLAMP-TOP HALF		1	.
6	TD-1084-931	FR & BK CROSS MEMBERS		2	.
7	TD-1084-932	R & L CROSS MEMBERS		6	.
8	TD-1084-933	VERTICAL MEMBERS		4	.
9	TD-1084-934	FR & BK TOP CROSS MEMBER		2	.
10	TD-1084-935	LOWER SLIDER 1		1	.
11	TD-1084-936	FR & BK BTM CROSS MEMBER		2	.
12	TD-1084-937	BASE PLATE		1	.
13	TD-1084-938	LOCKING PEICE		1	.
14		1/4" 20 UNC X 1" CAP HEAD		4	
15		1/4" 20 UNC X 1.25" CAP HEAD		4	
16		8-32 UNC X 0.625" CAP HEAD		2	
17		M6 x 25mm Cap Head Screw		4	
18		M6 x 35mm Cap Head Screw		25	

ISSUE	DATE APPD	MOD. No.	DRN. BY	CHKD BY.	APPD BY.	STATUS
A	23/SEP/05	------.	J O'DELL	TMH	TMH	REL

TOLERANCES UNLESS STATED: ±- mm, ±- °

FINISH: CLEAN, GREASE FREE, REMOVE ALL BURRS

ORIGINAL SCALE: 1:1, DO NOT SCALE

MATERIAL & SPEC.: SEE DRAWINGS ---------

SURFACE TEXTURE µm: SEE DRAWINGS, ✓ UNLESS STATED

USED ON THIS

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TITLE

PROOF TEST CLAMP-TEST RIG
PROOF TEST CLAMP

LIGO ADR039

A0	TD-1084-930	SHEET 1 OF 1	A