



T040016 - 05 - R

DRWG NO. REV. GID

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ASSEMBLY NO.

D040068

W.I.P. TASK LIST (CONTROLS PROTOTYPE)

TITLE: - Advanced LIGO Suspensions Caltech Quadruple Pendulum Controls Prototype (ETM) Task Summary

NOTE: - CALTECH WILL ORDER AND BUY ALL OF THE PARTS ASSOCIATED WITH THE CONTROLS PROTOTYPE.

#	DESCRIPTION	COORDINATOR	NUMBER	REQUIRED	COMMENT	CONSULTANT	LINKING SECTIONS	#	PRIMAVERA SECTION																																																																																																															
								AS	PC	AF																																																																																																														
<p><b>TO DO</b> Add more related documents            Thomas &amp; JHR to add link the task list to the plan - ON HOLD!  <b>ADDED</b> rev 05 includes updates by CIUT and MPL June 17th 2004</p>																																																																																																																								
<p><b>QUAD SECTIONS</b></p> <table border="1"> <tr> <td>1</td> <td>OVERALL ASSEMBLY</td> <td>CIT</td> <td>D040068</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>2</td> <td>SUSPENSIONS</td> <td>CIT</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>3</td> <td>STRUCTURE</td> <td>JHR</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>4</td> <td>JIGS (inc CATCHER)</td> <td>JHR</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>5</td> <td>GLASS CONCEPT</td> <td>CAC</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>6</td> <td>MODELLING + SOFTWARE</td> <td>CIT</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>7</td> <td>SPRINGS</td> <td>RAL</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>8</td> <td>INSTALLATION TOOLING</td> <td>JHR</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>9</td> <td>ELECTRONICS</td> <td>MB</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>10</td> <td>DOCUMENTS</td> <td>CIT</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </table> <p><b>SUMMARY INFORMATION</b> Page 6 of 6</p>											1	OVERALL ASSEMBLY	CIT	D040068								2	SUSPENSIONS	CIT									3	STRUCTURE	JHR									4	JIGS (inc CATCHER)	JHR									5	GLASS CONCEPT	CAC									6	MODELLING + SOFTWARE	CIT									7	SPRINGS	RAL									8	INSTALLATION TOOLING	JHR									9	ELECTRONICS	MB									10	DOCUMENTS	CIT								
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	OVERALL ASSEMBLY LAYOUT	CIT				MPL / NAR																																																																																																																		
	isolation of suspension from structure	CIT			With potentially ~ 100 earthquake stops it would be nice to be able to use a continuity test or equivalent to test suspension																																																																																																																			
	MODELLING	NAR				CIT / MB																																																																																																																		
	pitch of a MC and ETM	NAR			request to apply a pitch at top mass and record motion at test mass																																																																																																																			
	INTERFACE																																																																																																																							
	SEI																																																																																																																							
	COC																																																																																																																							
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2	<b>SUSPENSION</b>																																																																																																																							
	<b>OSEMS</b>	RAJ			90 HEADS COMING FROM GLA																																																																																																																			
	local control (hybrid)	JHR																																																																																																																						
	Head	RAJ	D030105		parts made in Glasgow	CIT		P50610	100																																																																																																															
	Adjustment	RAJ			parts made in Glasgow	CIT		Q50620	100																																																																																																															
	Winding	JHR			Winding done at vendor used for LIGO I osems																																																																																																																			
	Assembly	HA			Assembly done at Caltech	BT	structure / tablecloth / top mass / EC	F50640, A506																																																																																																																
	SolidWorks Assembly	CIT				RJ	structure + tablecloth																																																																																																																	
	global control																																																																																																																							
	<b>HYBRID DESIGN</b>	CIT			Previously thinking of using LIGO 1 design by JHR		modelling	F50950, Q50960, q51074																																																																																																																
	<b>TOP MASS</b>	MPL																																																																																																																						
	top mass assembly	MPL				CIT / NAR		d51074	50																																																																																																															
	magnet assembly	MPL				HA																																																																																																																		
	magnet assembly for pitch / roll	MPL				HA																																																																																																																		
	moving mass pitch adjuster	MPL			using analysis in LIGO-T030716																																																																																																																			
	suspended mass wire clamps	MPL			Previously RAL, swapped with rotational adjuster (agreed informally with IW and MPL)																																																																																																																			
	pitch adjustment for suspended mass wire clamps	MPL			required?																																																																																																																			
	copper section of eddy current damper	CIT			refer to ECD																																																																																																																			
	blade assembly	RAL			refer to Blades in Springs																																																																																																																			
	bench test of blade on mass	MPL																																																																																																																						
	FEM	MPL			Blade wrt main section of mass	CIT	Report by Dan Mason																																																																																																																	
	<b>UPPER INTERMEDIATE MASS</b>	MPL						d51074	50																																																																																																															





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W.I.P. TASK LIST (CONTROLS PROTOTYPE)

TITLE: - Advanced LIGO Suspensions Caltech Quadruple Pendulum Controls Prototype (ETM) Task Summary

NOTE: - CALTECH WILL ORDER AND BUY ALL OF THE PARTS ASSOCIATED WITH THE CONTROLS PROTOTYPE.

#	DESCRIPTION	COORDINATOR	NUMBER	REQUIRED	COMMENT	CONSULTANT	LINKING SECTIONS	PRIMAVERA SECTION
	Upper Intermediate mass assembly	MPL				CIT / NAR		
	suspended mass wire clamps	MPL			reference note on line 57	MPL		
	global control osem holders				4 global control osems		modelling	
	blade assembly	RAL			refer to Blades in Springs			
	Upper intermediate reaction mass assembly	MPL			almost equivalent to upper int mass with alt T-section for osems			
	FEM	MPL			Blade wrt main section of mass	CIT	Report by Dan Mason	
	<b>PENULTIMATE MASS</b>	CIT						
	penultimate mass assembly	CIT	D040132	DONE		MPL / NAR		D51090 25
	drawings	CIT						
	mass clamp assembly	CIT			discuss with IGR	MPL		
	<b>PENULTIMATE REACTION MASS</b>	CIT						
	penultimate reaction mass assembly	CIT	D040142	DONE		MPL / NAR		D51090 25
	drawings	CIT						
	mass clamp assembly	CIT			refer to penultimate mass assembly			
	osems	CIT			depends on choice, reference action in SUS			
	mounting osems	CIT						
	<b>TEST MASS + REACTION TEST MASS</b>	CIT						
	test mass assembly	CIT	D040038	DONE	includes removable alum faces			D51090 50
	drawings	CIT						
	test mass assembly	CIT	D040053	DONE	includes glass faces			
	drawings	CIT						
	reaction test mass assembly	CIT	D040161	DONE	includes removable alum faces			
	drawings	CIT						
	reaction test mass assembly	CIT	D040165	DONE	includes glass faces for electrostatic drive			
	drawings	CIT						
	sapphire concept	MPL		DONE				
	support for single pendulum test	CIT		DONE				
	support for double pendulum test	CIT		DONE				
	support for double pend with reaction chain	CIT		Sep-04	Have lab jack that works with 40kg mass work with RAJ on concept / bench test for catcher			
	Glass faces for test and reaction test mass	HA		ORDERED	7740 Pyrex for controls prototype includes electrostatic drive pattern by RAJ	CIT / MPL		
	<b>TABLECLOTH</b>							
	top assembly	JHR				CIT / MPL	structure, top mass, earthquake stops	
	upper intermediate assembly	JHR				CIT / MPL	structure, top mass, earthquake stops	
	alternative design (compatible with interferometric sensor)	RAL			reference idea from email by CAC		OSEM work at Birmingham	
	<b>ROTATIONAL ADJUSTER</b>	MPL						
	assembly for top blades	IW			swap for wire clamps able to do once document is passed to IW from SUS (MPL, AG, CIT) REF: LIGO-T040118 by MPL, CIT and AG MC TOP BLADE ROTATIOANL ADJUSTER DESIGN	RAL / CIT	top blade clamps blade assembly + structure	D51080 20
	Concept				Prototype tested at Caltech by MPL , CIT			
	FEA				ETM concept developed by MPL , AG, CIT			
	other suspended blades?				are they required?			
	<b>EDDY CURRENT DAMPERS</b>	CIT			AG considered wrt suspended masses	JHR / MPL		
	4 x 4 assembly	CIT			further support from ECD paper group	AG	structure / tablecloth / top mass / ose	D50720, F5073
	adjustment	CIT			further support from ECD paper group	AG		Q50740, D5071



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<b>3 STRUCTURES</b>										
	<b>TOP STRUCTURE</b>	<b>DC</b>			Based on forthcoming requirements	JHR/ CIT	Suspension + Catcher			
	Requirements document	<b>JHR</b>				<b>CIT, MPL</b>				
	Analysis, FEA	CIT / JHR			+ LIGO-T030044 and MC Preliminary Results	DC / LJ		d51110	100	
	SolidWorks	JHR			DC, MPL and CIT created versions			d51072		
	Detail	JHR								
	Top half	JHR						d51070	90	
	Lower half	JHR			refer to catcher section					
	<b>TABLE CLOTH CLAMPS</b>	<b>JHR</b>								
	Assembly	JHR			Adjustment wrt suspensions structure			tablecloth + structure	d51070	10
	Adjustment	?								
	<b>NON ASSOCIATED SUSPENSION PARTS</b>	<b>JHR</b>								
	Earthquake Stops	JHR						d51100	60	
	Stiffening concepts	JHR						d51100	30	
	Shims	JHR			between SEI and Structure			d51100	10	
<b>4 JIGS</b>										
	<b>TOP / UPPER INT MASS ASSEMBLY RIG</b>	<b>RAL</b>								
	assembly rig	RAL				<b>MPL</b>				
	mass support	RAL				<b>MPL</b>	D033254, D512	15		
	<b>GAZEBO</b>	<b>JHR</b>								
	Gazebo design	JHR	<b>DONE</b>		KM to aid as per SUS meeting 10 Feb 04		Installation tooling for SEI	D033254, D512	10	
							SEI table + stay clear zones			
	<b>WIRE JIGS</b>	<b>RAL</b>				<b>MPL / CIT</b>				
	top blade to top mass wire jig	*			clamp to clamp		top mass	D033254, D512	30	
	middle blades to upper intermediate mass wire jig	*			clamp to clamp		top mass			
	bottom blades to penultimate mass wire jig	*			clamp to clamp and loop		penultimate mass			
	penultimate mass to test mass wire jig	CIT			clamp to clamp		test mass + test mass clamp assembly			
	advanced "dial a jig" (one jig for all)	RAL			* Depends on outcome of adjustable jig?					
	<b>CATCHER</b>	<b>RAJ</b>								
	initial	RAJ				JHR/CAC/CIT	structure + suspension	D51100	20	
	wrt structure and e stops etc ...	JHR			refer to structure section					
	support	RAJ				JHR/CAC/CIT	structure + suspension	D51100	10	
	glass concept	RAJ				JHR/CAC/CIT		D51100	10	
	adjustment	RAJ			refer to glass section					
	<b>I BLADE DEFLECTION JIG</b>	<b>RAL</b>								
	assembly	RAL			RAL to explore alternate design to cover all blades			D033254, D512	15	
	<b>VERTICAL ADJUSTMENT</b>							D033254, D512	15	
	+/- 500 g	<b>MPL</b>								
	Winches	<b>JHR</b>								
	<b>ASSEMBLY TECHNIQUES (metal masses)</b>	<b>RAJ</b>			see section below for glass	JHR/CAC/CIT		D033254, D512	15	
	Metal masses									
	Catcher									
	Structure									
<b>5 GLASS (CONCEPT)</b>										
	<b>EAR</b>	<b>CAC</b>			Pass on comments re thickness and get comments on metal concept					
	penultimate mass				Flats, wire separation, wedge, position of flat, chamfer etc ...			D50490	50	
	test mass				wrt access around structure / catcher etc ...			D50490	50	
	<b>TEST MASS</b>	<b>CAC</b>								
	Assembly							F50460	100	
	<b>FIBRES / RIBBONS</b>	<b>CAC</b>								
	fibres / ribbons							Q504800	50	



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TITLE: - **Advanced LIGO Suspensions Caltech Quadruple Pendulum Controls Prototype (ETM) Task Summary**  
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	<b>ASSEMBLY TECHNIQUES</b>	<b>CAC</b>			Support from SUS and DES team			
	Monolithic Catcher							Q504800 50
	Catcher wrt Structure							D0403322 50 D0403322 50
<b>6</b>	<b>MODELLING AND SOFTWARE</b>							
	<b>TOOLS</b>							
	MATLAB 6.5	<b>NAR</b>			EXPAND			
	Thermal Noise Dynamics for local control							d51020 100
	Global Control							d51030 100
	Refinements / design guidance							d51035 100
	Compare with requirements and prototype test report							D51040 100 d51050 100
	MATHEMATICA	<b>MB</b>						
	EXCEL 2000 or 2002	-						
	IDEAS 9	<b>JHR</b>						
	ANSYS 8.0 (including workbench)	<b>CIT</b>						
	<b>CAD + FILE STORAGE</b>							
	SolidWorks 2003	<b>CIT</b>			SolidWorks 2004? When?	<b>MPL</b>		
	Pro-Engineer 2001	<b>IW</b>						
	PDMWorks 2004	<b>CIT</b>			June 2004?	<b>MPL</b>		
	LIGO-DCC	<b>LT</b>			Requirements for file storage?			
	.PDF files with embedded .STEP or SAT or ?	<b>MPL</b>				<b>CIT</b>		
	<b>CALCULATORS</b>							
	Flexure Point							
	Suspension Model							
	Osem count							
	Osem Type							
<b>7</b>	<b>SPRINGS</b>							
	<b>BTF</b>							
	assembly	<b>RAL</b>						
	prototyping	<b>RAL</b>						
	<b>CANTILEVER BLADE ASSEMBLIES</b>							
	Top Blade assembly	<b>RAL</b>			RAL to consider BTF wrt top stage of a quad	<b>MVP , CIT</b>	structure + suspension	D51080 20
	Rotational Adjuster	<b>RAL</b>			refer to rotational adjuster		rotational adjuster	
	Top Blades	<b>RAL</b>		<b>31-May-04</b>				
	Blade clamps	<b>RAL</b>					structure + suspension + Rotational adjuster	
	blade wire clamps	<b>RAL</b>			support top mass		structure + suspension	
	blade guard	<b>RAL</b>					structure	
	blade eddy current dampers	<b>RAL</b>			ref work done by CIT / RJ		structure + suspension + blade guard	D50680, F5069 33
	vertical adjustment	<b>RAL</b>			previously library of clamps		required	
	Middle blades assembly	<b>RAL</b>			MVP , CIT		top mass + suspension	D51080 20
	Rotational Adjuster	<b>MPL</b>						
	Middle blades	<b>RAL</b>		<b>31-May-04</b>				
	blade clamps	<b>RAL</b>					top mass + suspension	
	blade wire clamps	<b>RAL</b>			support upper intermediate mass		top mass + suspension	
	blade eddy current dampers	<b>RAL</b>			ref work done by CIT / RJ		top mass + suspension	D50680, F5069 33



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#	DESCRIPTION	COORDINATOR	NUMBER	REQUIRED	COMMENT	CONSULTANT	LINKING SECTIONS	PRIMAVERA SECTION
	vertical adjustment	RAL			previously library of clamps		required?	
	Bottom blades assembly	RAL			MVP , CIT		upper intermediate mass + suspensi	D51080 20
	Rotational Adjuster	MPL						
	Bottom blades	RAL		31-May-04				
	blade clamps	RAL					upper intermediate mass + suspension	
	blade wire clamps	RAL			support penultimate mass		upper intermediate mass + suspension	
	blade eddy current dampers	RAL			ref work done by CIT / RJ		upper intermediate mass + suspensi	D50680, F5065 33
	vertical adjustment	RAL			previously library of clamps		required?	
	<b>BLADE ANALYSIS</b>							
	design	NAR			from modelling and existing knowledge	CIT, MVP		D51080 20
	design	RAL			from BTF, linked through blade committee			
	process	-			blade committee			
	transmissibility	JG						
	creep	-			blade committee			
	stress concentrations	-			blade committee			
8	<b>INSTALLATION and Alignment TOOLING</b>	KMd			Doug Cook, Ken Mailand, Mike smith		Ken Mason visiting Caltech June 2004	D033255, D513
	Moving table				Allows suspension to be moved from optical table to cart			
	Adjustable support table				For use both in and outside tank		Class B clean	
					Adjusts in vertical, pitch, yaw, long and side			
9	<b>ELECTRONICS</b>							
	ELECTRONICS	JH				DR		REFER TO PRIMIVERA
	Glasgow	DR						
	Caltech	JH						
	WIRING	JHR			JH, LJ and JHR to liaise			
	D-SPACE	MB						
	ELECTROSTATIC DRIVE + ELECTRONICS	JHR			KAS, MPL to liaise with JHR			REFER TO PRIMIVERA
10	<b>DOCUMENTS</b>							
	LIGO DCC #'s	CIT			refer to DCC and PDMWorks vault			
	LIGO-T040118	MPL			MC TOP BLADE ROTATIOANL ADJUSTER DESIGN		comments added by CIT	CIT / AG
	Quad Questions	JHR			based on visit by RAJ and NAR May 2004			
	LIGO-T040095	MPL			DESIGN BRIEF Upper Int Mass for ETM CPTYPE			
	LIGO-T040096	MPL			PDS Upper Int Mass for ETM CPTYPE			
		MPL			DESIGN BRIEF Top Mass for ETM CPTYPE			
		MPL			PDS UpperTop Mass for ETM CPTYPE			
	LIGO-T040112	MPL			Summary of CAD File format compatibility tests			CIT, IW
	LIGO-T040013	CIT			ETM CPTYPE INFORMATION RELATED TO DESIGN OF LOWER MASSES			NAR, HA, MPL
	<b>SUMMARY INFORMATION</b>							
	SYSTEM: -				ADVANCED LIGO SUSPENSIONS			



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#	DESCRIPTION	COORDINATOR	NUMBER	REQUIRED	COMMENT	CONSULTANT	LINKING SECTIONS	PRIMAVERA SECTION
	<b>SUB-SYSTEM: -</b>	<b>SUS</b>						
	<b>NEXT ASSEMBLY: -</b>	<b>QUAD ETM (PROTOTYPE)</b>						
	<b>LOCATION: -</b>	Caltech PDMWorks Vault (131.215.115.155)						
	<b>LINKS: -</b>	DESIGN MEETING, (DM) and			SUSPENSION WEEKLY MEETING (ALIGO_SUS)			
		<a href="http://www.ligo.caltech.edu/%7Ectorrie/QUAD_ETM/quad_etm%20setup.html">http://www.ligo.caltech.edu/%7Ectorrie/QUAD_ETM/quad_etm%20setup.html</a>			<a href="http://www.ligo.caltech.edu/SUS.html">http://www.ligo.caltech.edu/SUS.html</a>			
	<b>DOCUMENT INFO: -</b>	<b>DENSITY</b>	kg/m <sup>3</sup>		kg/m <sup>3</sup>			
		Copper	8.90E+03		Alum	2.70E+03		
		Steel	7.80E+03		Silica	2.20E+03		
	<b>TAP SIZE</b>	2-56	+ 0.003 OVERSIZE TAP					
		4-40	TO 1/4-20	+ 0.005 OVERSIZE TAP		discuss requirements on taps etc ... with Larry Jones		
	<b>CHECK</b>	All tapped holes to be checked with custom GO-NO GO GAUGE from Accu-Gauge						
	<b>HOLES</b>	refer to T030118 by MPL						
	<b>MATERIALS</b>	Stainless Steel - 300 Series			300 SSTL		Silver Coated Stainless Steel	
	(FROM)	Aluminium - 6061-T6			6061-T6-Al		Maraging Steel - Marval 18	
	<b>COMMENTS</b>	Unless otherwise stated dimensions are in inches or dual dimensions with inches as the lead dimension Document numbers are etched into parts in all parts Scribe Marks and # are required for machined assemblies - in order to keep together after cleaning e.g. D020449, D020318, D020319, D020316 Most tapped holes go clear through. Any blind holes have vent holes and or vented screws. Interfacing of parts very important - therefore require prototyping Stainless part USE Silver Coated Stainless Bolts Aluminium part USE Stainless Bolts IGR, Caltech and MIT use SOLIDWORKS (RAL use Pro-E) - STEP is default translator ALL PARTS ARE IN IMPERIAL TO ANSI STANDARD ASSEMBLIES - show GROVES IN PLATES WITH SHIMS / WIRE DIAMETER - show MACHINING required on clamps All notes on a drawing should be contained in one area unless they are for internal use only. Numbering should not be repeated for different notes on the same drawing.						