

Project Management WBS Dictionary

WBSNo	WBSDesc	WBSDef	WBSName	WBSDate
LIGO.4.14.....	Project Office	All activities related to the management, administration, and systems engineering. This includes quality assurance and safety, reliability, EMI/EMC, document control, cost/schedule reporting and control systems, configuration management, systems engineering, and general computing. This is a summary level WBS element only; no costs are allocated to this WBS element.	P. Lindquist	12/12/02
LIGO.4.14.1.....	Project Management	Director, Deputy Director, Faculty Summer Salaries, Visitor's Note: Adding Outreach person (1 FTE) under this WBS element – may create new WBS element LIGO.4.14.9	P. Lindquist	12/12/02
LIGO.4.14.2.....	Project Controls	Cost/Schedule Reporting and Control Systems, Subcontract Management, NSF Reporting	P. Lindquist	12/12/02
LIGO.4.14.3.....	Quality Assurance and Safety	Quality Planning, Quality Engineering, Quality Assessment, Quality Control, Asafety Planning, Safety Engineering, Safety Assessment, Safety Assurance	W. Tyler	12/12/02
LIGO.4.14.4.....	Consultants & Legal Services	Consultants and legal service costs deemed necessary for outside review or support at the direction of the Director or Deputy Director.	P. Lindquist	12/12/02
LIGO.4.14.5.....	System Engineering	All system engineering activities for the advanced LIGO detector are covered under this WBS element. Note that the costs for systems engineering are independent of the number of installed interferometers. This is a summary level WBS element; No costs are associated with this WBS element.	D. Coyne	12/12/02
LIGO.4.14.5.1.....	Modeling and Simulation Development	This WBS element includes all system level modeling and simulation development which is not included in the end-to-end (E2E) development under WBS LIGO.4.12. This includes any identified need in improvements, modifications, corrections and maintenance of Bench, the FFT Tool, Melody Tool and similar system level modeling tools. Currently the only identified model development needs in support of advanced LIGO (other than E2E) are (1) improvements in the Melody thermal-mechanical model by comparing against numerical finite element results of thermo-elastic distortions due to substrate absorption, (2) inclusion of the thermo-elastic distortion of the AR surface of an optic into Melody and (3) various Melody user interface features. This WBS element does not include the application of modeling/simulation tools to advanced LIGO (which is covered under WBS element LIGO.4.14.5.3.2 and LIGO.4.14.5.4.2), but rather the development, enhancement, maintenance and upgrade of the tools themselves. This effort does not include any developments of the E2E code (which are covered under WBS element LIGO.4.?). Nor does this WBS element include any development of Matlab based servo-control models (which are covered under the ISC WBS LIGO.4.?).	D. Coyne	12/12/02
LIGO.4.14.5.2.....	System conceptual design & requirements	The development and documentation of the system requirements and of the system design, at the conceptual level, are covered under this WBS element. At this phase in the design, the major system trade-off studies and open systems issues, and an approach for their resolution, are defined. The principal trade studies and open issues defined for the advanced LIGO system include (but are not limited to): 1) optic substrate material (sapphire or fused silica) 2) readout scheme (DC versus RF) and implications for the output mode cleaner and output mode matching telescope 3) definition of optics requirements with consideration of active thermal compensation 4) optical layout with horizontal or vertical wedges for the core optics and definition of the optical readout beams The principal deliverables of this WBS element are: 1) System requirements document 2) System design document 3) Generic System Requirements 4) Integrated System Test & Development Plan (essentially the plan for use of the LASTI, Gin Gin and 40m test beds) 5) Conceptual Design and Requirements Review (CDR) for the advanced LIGO system	D. Coyne	12/12/02
LIGO.4.14.5.3.....	System Preliminary Design	The development and documentation of the system requirements and of the system design, at the preliminary design (PD) level, are covered under this WBS element. In this phase in the design, all of the major system trade-off studies and systems issues, which were identified at the system conceptual design & requirements review, are addressed (if not resolved). Any trade studies and open systems issues remaining at the time of the PD review are identified and plans for their resolution in the final design phase are defined. This is a summary level WBS element only; no costs are allocated to this WBS element.	D. Coyne	12/12/02
LIGO.4.14.5.3.1.....	System definition/design	The development and documentation of the system requirements and of the system design, at the preliminary design (PD) level, are covered under this WBS element. The principal deliverables of this WBS element are: 1) System requirements document (PD update) 2) System design document (PD update) 3) Generic System Requirements (PD update) 4) Integrated System Test & Development Plan (essentially the plan for use of the LASTI, Gin Gin and 40m test beds) 5) Preliminary Design Review (PDR) for the advanced LIGO system	D. Coyne	12/12/02
LIGO.4.14.5.3.2.....	System simulation	All application of system level simulation and modeling in support of advanced LIGO system development is covered under this WBS element. This WBS element is specifically for application of the simulation tools, not the development of the tools (which is covered under WBS element LIGO.4.14.5.1). This effort includes application of the E2E code, the FFT code, Bench and Melody. The principle deliverables of this effort are as follows: 1) Plant Matrix: define the optical plant matrix for use by the ISC system in controls design 2) FFT Optics Simulation: use the signal recycled FFT code to look at issues concerning the core optics requirements, starting specifically with the requirements for substrate homogeneity.	D. Coyne	12/12/02

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		<ul style="list-style-type: none"> 3) Spatiotemporal and Thermal Distortion: use Melody to look at the stability of cavities with g-factors very close to one. Measured mirror phase maps (LIGO I optics) will be put into Melody, at first by computing their mode-mixing matrices and using these as the mirror matrices, and on a longer time scale by incorporating such mirror maps as added mirror distortions in Melody. The eventual aim is to see how much analysis that incorporates mirror distortions can actually be done with Melody, rather than the FFT model. 4) Optics Phase Maps: get the most current mirror phase maps in a useful form, both for continued FFT modeling, and for the Melody work above. An open question is how to extend the 150mm map diameter over the full mirror diameter, ~300mm in LIGO II. 5) Lock Simulation Studies: using E2E examine the requirements for angular alignment and residual velocity for robust locking 6) Projected System Performance: maintain a projected noise limit performance power spectral density plot for the system based upon the system and subsystem parameters and results of the latest R&D and design information using Bench 		
LIGO.4.14.5.3.3.....	Requirements flow down	Assistance to the subsystem groups in interpreting and flowing down requirements from the system level to the subsystem requirements level during the PD phase. In particular, redefining requirements if/as needed in trade-off with other system parameters.	D. Coyne	12/12/02
LIGO.4.14.5.3.4.....	Technical configuration mgmt	<p>Technical oversight of the system configuration in the PD phase, including (but not limited to):</p> <ul style="list-style-type: none"> 1) Optical layout: Define and maintain a ray trace analysis of the entire interferometer 2) Physical integrated layouts: Define and maintain a CAD model of the integrated physical layout of all detector elements 3) System Block Diagrams: Define and maintain block diagrams for the integrated control and data systems 4) Mass budget: Define and track the mass, c.g. position and moments of inertia for all components on the in-chamber optics tables; arbitrate mass limits between subsystems if/as needed 	D. Coyne	12/12/02
LIGO.4.14.5.3.5.....	Interface Management	Define and coordinate interface requirements between the subsystems in the PD phase.	D. Coyne	12/12/02
LIGO.4.14.5.3.6.....	Subsystem Readiness reviews	The responsibility for conducting design and readiness reviews of the subsystems falls to the system engineering group. This includes defining and often leading the review panels, organizing the reviews, inviting outside reviewers, writing the review reports and following up on recommended actions from the reviews. The following reviews are required of every subsystem: conceptual design and requirements review (CDR), preliminary design review (PDR), final design review (FDR), installation readiness review (IRR) and acceptance reviews (as deemed necessary). This WBS element covers the effort during the PD phase for the detector system.	D. Coyne	12/12/02
LIGO.4.14.5.3.7.....	System Test and Evaluation	<p>This WBS element covers:</p> <ul style="list-style-type: none"> a) the labor to direct, evaluate and interpret the system level testing, as defined in the planning under WBS element LIGO.4.14.5.3.1. The principal deliverables from this effort are reports on the results of the system level testing applied to the advanced LIGO system. b) The labor, materials, equipment and supplies to perform materials qualification tests for the LIGO vacuum system. These tests are pan-subsystem and thus the responsibility of the systems engineering group. Screening tests are done via Residual Gas Assay (RGA) analysis with a mass spectrometer. Final qualification testing is done by exposing a high irradiance optical cavity to the material and verifying that the rate of increase in loss (scatter and absorption separately) is less than requirements. Note that the processing of components for use in the LIGO vacuum system is not covered by this (or any other systems engineering WBS element; Processing components for use in the LIGO vacuum system (cleaning, baking, RGA) is the responsibility of the subsystem groups. <p>Note that the labor, equipment, materials and supplies required to perform the system level testing are defined under the WBS elements for the LAST, 40m and Gin Gin programs, as well as the subsystem WBS elements associated with supporting these system level test facilities. This effort is strictly for systems engineering direction and interpretation of the results of these system tests.</p>	D. Coyne	12/12/02
LIGO.4.14.5.3.8.....	Reliability	This is a Level Of Effort (LOE) task for Reliability Engineering for the detector in the PD phase, including Reliability Planning, Reliability Assessments and recommendation for Reliability Assurance. Note that execution of the recommended actions falls to the subsystem groups and is not covered under this WBS element.	D. Coyne	12/12/02
LIGO.4.14.5.3.9.....	EMI/EMC	This is a Level Of Effort (LOE) task for Electromagnetic Interference (EMI) support in the PD phase, including EMI assessment and control planning. Note that execution of the recommended actions falls to the subsystem groups and is not covered under this WBS element.	D. Coyne	12/12/02
LIGO.4.14.5.4.....	System Final Design	<p>The development and documentation of the system requirements and of the system design, at the preliminary design (FD) level, are covered under this WBS element. In this phase in the design, all of the major system trade-off studies and systems issues, which were identified at the system preliminary design review, are addressed (if not resolved). All trade studies and systems issues should be closed by the time of the final design review (FDR).</p> <p>This is a summary level WBS element only; no costs are allocated to this WBS element.</p>	D. Coyne	12/12/02
LIGO.4.14.5.4.1...	System definition/design	<p>The development and documentation of the system requirements and of the system design, at the final design (FD) level, are covered under this WBS element. The principal deliverables of this WBS element are:</p> <ul style="list-style-type: none"> 1) System requirements document (FD update) 2) System design document (FD update) 3) Generic System Requirements (FD update) 4) Integrated System Test & Development Plan (essentially the plan for use of the LASTI, Gin Gin and 40m test beds) 5) Final Design Review (FDR) for the advanced LIGO system 	D. Coyne	12/12/02
LIGO.4.14.5.4.2.....	System simulation	All application of system level simulation and modeling in support of advanced LIGO system development is covered under this WBS element. This WBS element is specifically for application of the simulation tools, not the development of the tools (which is covered under WBS element LIGO.4.14.5.1). This effort includes application of the E2E code, the FFT code, Bench and Melody. The principle deliverables of this effort are updates or refinements of the deliverables defined	D. Coyne	12/12/02

Project Management WBS Dictionary

WBSNo	WBSDesc	WBSDef	WBSName	WBSDate
		under WBS element LIGO.4.14.5.3.2		
LIGO.4.14.5.4.3.....	Requirements flow down	Assistance to the subsystem groups in interpreting and flowing down requirements from the system level to the subsystem requirements level during the FD phase. In particular, redefining requirements if/as needed in trade-off with other system parameters.	D. Coyne	12/12/02
LIGO.4.14.5.4.4.....	Technical configuration mgmt	Technical oversight of the system configuration in the FD phase, including (but not limited to): 1) Optical layout: Define and maintain a ray trace analysis of the entire interferometer 2) Physical integrated layouts: Define and maintain a CAD model of the integrated physical layout of all detector elements 3) System Block Diagrams: Define and maintain block diagrams for the integrated control and data systems Mass budget: Define and track the mass, c.g. position and moments of inertia for all components on the in-chamber optics tables; arbitrate mass limits between subsystems if/as needed	D. Coyne	12/12/02
LIGO.4.14.5.4.5.....	Interface Management	Define and coordinate interface requirements between the subsystems in the FD phase.	D. Coyne	12/12/02
LIGO.4.14.5.4.6...	Subsystem Readiness reviews	The responsibility for conducting design and readiness reviews of the subsystems falls to the system engineering group. This includes defining and often leading the review panels, organizing the reviews, inviting outside reviewers, writing the review reports and following up on recommended actions from the reviews. The following reviews are required of every subsystem: conceptual design and requirements review (CDR), preliminary design review (PDR), final design review (FDR), installation readiness review (IRR) and acceptance reviews (as deemed necessary). This WBS element covers the effort during the FD phase for the detector system.	D. Coyne	12/12/02
LIGO.4.14.5.4.7.....	System Test and Evaluation	This WBS element covers the labor to plan, direct, evaluate and interpret the system level testing, as defined in the planning under WBS element LIGO.4.14.5.4.1. The principal deliverables from this effort are reports on the results of the system level testing applied to the advanced LIGO system. Note that the labor, equipment, materials and supplies required to perform the system level testing are defined under the WBS elements for the LAST, 40m and Gin Gin programs, as well as the subsystem WBS elements associated with supporting these system level test facilities. This effort is strictly for systems engineering direction and interpretation of the results of these system tests.	D. Coyne	12/12/02
LIGO.4.14.5.4.8.....	Reliability	This is a Level Of Effort (LOE) task for Reliability Engineering for the detector in the FD phase, including Reliability Planning, Reliability Assessments and recommendation for Reliability Assurance. Note that execution of the recommended actions falls to the subsystem groups and is not covered under this WBS element.	D. Coyne	12/12/02
LIGO.4.14.5.4.9.....	EMI/EMC	This is a Level Of Effort (LOE) task for Electromagnetic Interference (EMI) support in the FD phase, including EMI assessment and control planning. Note that execution of the recommended actions falls to the subsystem groups and is not covered under this WBS element.	D. Coyne	12/12/02
LIGO.4.14.5.5.....	Fabrication/Installation/Commissioning Support	Note changed the title from "Fabrication/Installation phase oversight (LOE)" to "Fabrication/Installation/Commissioning Support" Evaluate system level trade-offs if/as needed to address design revisions prompted by fabrication or installation practicalities (e.g. acceptance of optic surface figure which may exceed specifications). Provide overall technical direction of the detector development. This is a Level Of Effort (LOE) task.	D. Coyne	12/12/02
LIGO.4.14.6.....	Documentation	Control, Storage, and Distribution of all Project Documentation including Technical Publications, Management Letters and Memoranda, Contract Documentation, Drawings, Graphics, Presentations, etc.	P. Lindquist	12/12/02
LIGO.4.14.7.....	Administration	Administrative Support Personnel, Supplies, Communications Expenses	P. Lindquist	12/12/02
LIGO.4.14.8.....	General Computing	Personal Computers, Work Stations, Servers, Network Hardware, and related Software Applications and Administrative Support. This is a summary level WBS element only; no costs are allocated to this WBS element.	L. Wallace	12/12/02
LIGO.4.14.8.1.....	General Computing - CIT	Personal Computers, Work Stations, Servers, Network Hardware, and related Software Applications and Administrative Support Specifically at CIT and for the additional staff added for adv. LIGO development.	L. Wallace	12/12/02
LIGO.4.14.8.2.....	General Computing - MIT	Personal Computers, Work Stations, Servers, Network Hardware, and related Software Applications and Administrative Support Specifically at MIT and for the additional staff added for adv. LIGO development.	L. Wallace	12/12/02
LIGO.4.14.8.3.....	General Computing - LHO	Personal Computers, Work Stations, Servers, Network Hardware, and related Software Applications and Administrative Support Specifically at LHO and for the additional staff added for adv. LIGO development.	L. Wallace	12/12/02
LIGO.4.14.8.4.....	General Computing - LLO	Personal Computers, Work Stations, Servers, Network Hardware, and related Software Applications and Administrative Support Specifically at LLO and for the additional staff added for adv. LIGO development.	L. Wallace	12/12/02
LIGO.4.14.9	Outreach	NOTE: ADDED WBS ELEMENT – SEE NOTE UNDER WBS LIGO.4.14.1 Costs to support outreach and educational efforts.	P. Lindquist	1/30/2003