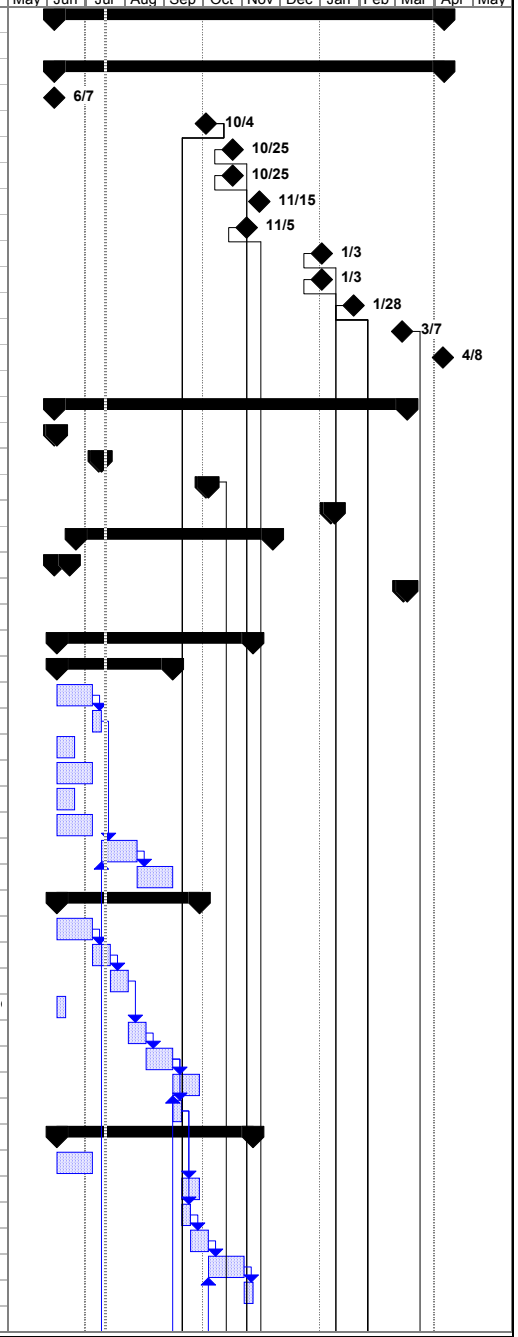
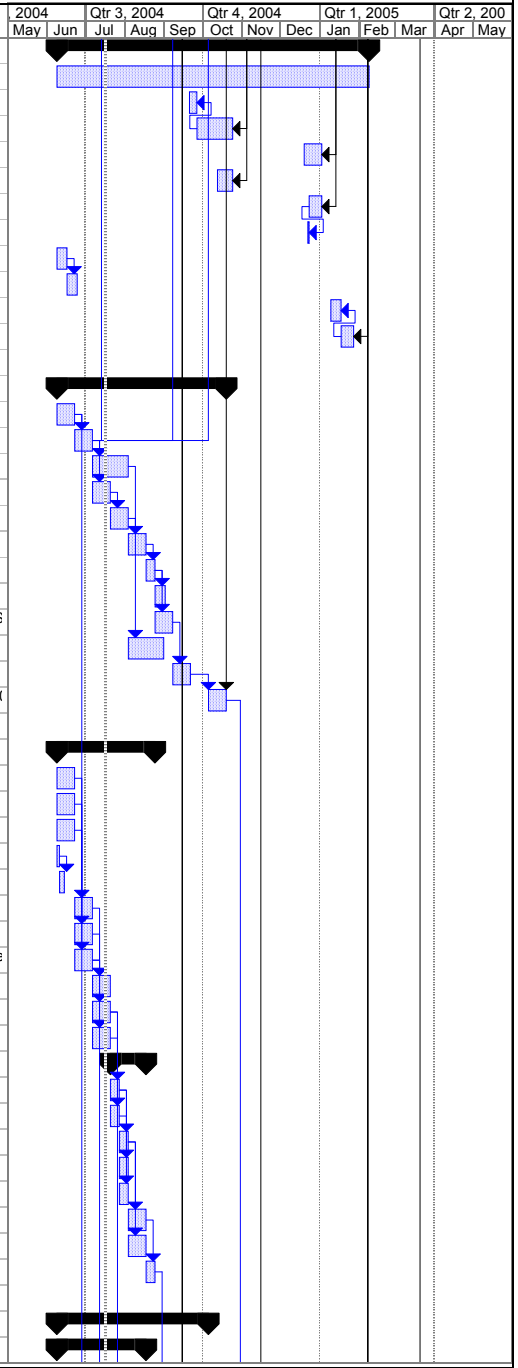
ExAOC Conceptual Design Work Breakdown Structure

ID	WBS	Task Name	Work	Duration	Start	Finish	Resource Names
1	**1**	**ExAOC Conceptual Design**	**16,261.6 hrs**	**220 days?**	**6/7/04**	**4/8/05**	
2							
3	**1.1**	**Project Milestones**	**0 hrs**	**220 days?**	**6/7/04**	**4/8/05**	
4	1.1.1	Commence work	0 hrs	1 day?	6/7/04	6/7/04	
5	1.1.2	Down-select science instrument	0 hrs	1 day?	10/4/04	10/4/04	
6	1.1.3	Deliver draft of Initial OCDD	0 hrs	1 day?	10/25/04	10/25/04	
7	1.1.4	Deliver draft of Initial FPRD	0 hrs	1 day?	10/25/04	10/25/04	
8	1.1.5	Submit Design Study Documentation Outline	0 hrs	1 day?	11/15/04	11/15/04	
9	1.1.6	Deliver preliminary WBS, schedule, and budget	0 hrs	1 day?	11/5/04	11/5/04	
10	1.1.7	Deliver revised Initial OCDD	0 hrs	1 day?	1/3/05	1/3/05	
11	1.1.8	Deliver revised Initial FPRD	0 hrs	1 day?	1/3/05	1/3/05	
12	1.1.9	Deliver Design Study Documentation	0 hrs	1 day?	1/28/05	1/28/05	
13	1.1.10	Conceptual Design Study Review (CoDR)	0 hrs	1 day?	3/7/05	3/7/05	
14	1.1.11	Completion of all work	0 hrs	1 day?	4/8/05	4/8/05	
15							
16	**1.2**	**Meetings And Travel**	**2,096 hrs**	**199 days?**	**6/7/04**	**3/10/05**	
17	**1.2.1**	**kick-off workshop @ UCSC**	**400 hrs**	**2 days**	**6/7/04**	**6/8/04**	
22	**1.2.2**	**science workshop @UCB**	**240 hrs**	**2 days**	**7/12/04**	**7/13/04**	
25	**1.2.3**	**mid-term review @ HIA**	**384 hrs**	**2 days**	**10/4/04**	**10/5/04**	
31	**1.2.4**	**pre-CoDR @ UCSC**	**360 hrs**	**3 days**	**1/10/05**	**1/12/05**	
36	**1.2.5**	**monthly status**	**480 hrs**	**110.5 days**	**6/24/04**	**11/25/04**	
52	**1.2.6**	**other**	**160 hrs**	**10 days?**	**6/7/04**	**6/18/04**	
58	**1.2.7**	**CoDR**	**72 hrs**	**3 days**	**3/8/05**	**3/10/05**	
62							
63	**1.3**	**Science Case**	**646 hrs**	**110 days**	**6/9/04**	**11/9/04**	
64	**1.3.1**	**direct imaging of young exoplanets**	**270 hrs**	**65 days**	**6/9/04**	**9/7/04**	
65	1.3.1.1	estimate the distribution of young planets	40 hrs	20 days	6/9/04	7/6/04	Graham[25%]
66	1.3.1.2	evaluate the uncertainties in this distribution	10 hrs	5 days	7/7/04	7/13/04	Graham[25%]
67	1.3.1.3	construct a catalog	40 hrs	10 days	6/9/04	6/22/04	Patience[25%],Song[25%]
68	1.3.1.4	develop detection techniques for ExAOC data	40 hrs	20 days	6/9/04	7/6/04	Doyon[25%]
69	1.3.1.5	develop methods and algorithms for measurement of orbital elements	20 hrs	10 days	6/9/04	6/22/04	Marcy[25%]
70	1.3.1.6	optimize the spectroscopy capabilities of the science instrument	40 hrs	20 days	6/9/04	7/6/04	Oppenheimer[25%]
71	1.3.1.7	design the planet search observing programs	40 hrs	20 days	7/14/04	8/10/04	Graham[25%]
72	1.3.1.8	summarize desired instrument specsand generate design-trade tools	40 hrs	20 days	8/11/04	9/7/04	Graham[25%]
73	**1.3.2**	**imaging of debris disks**	**200 hrs**	**80 days**	**6/9/04**	**9/28/04**	
74	1.3.2.1	construct a tool kit for simulating images (including polarization)	40 hrs	20 days	6/9/04	7/6/04	Kalas[25%]
75	1.3.2.2	develop methodology for optical detection of disks	20 hrs	10 days	7/7/04	7/20/04	Kalas[25%]
76	1.3.2.3	develop algorithms for determination of disk properties	20 hrs	10 days	7/21/04	8/3/04	Kalas[25%]
77	1.3.2.4	explore how planetary signatures are imprinted on detected disks	30 hrs	5 days	6/9/04	6/15/04	Chiang[25%],Wu[25%],Johnston
78	1.3.2.5	construct the catalog of target stars for debris disk imaging	20 hrs	10 days	8/4/04	8/17/04	Kalas[25%]
79	1.3.2.6	design the debris disk observing programs	30 hrs	15 days	8/18/04	9/7/04	Kalas[25%]
80	1.3.2.7	summarize desired instrument specs and generate design-trade tools	30 hrs	15 days	9/8/04	9/28/04	Kalas[25%]
81	1.3.2.8	summarize desired instrument specs and generate design-trade tools, 2	10 hrs	5 days	9/8/04	9/14/04	Graham[25%]
82	**1.3.3**	**adjunct science program**	**176 hrs**	**110 days**	**6/9/04**	**11/9/04**	
83	1.3.3.1	solar system science	40 hrs	20 days	6/9/04	7/6/04	Marchis[25%]
84	1.3.3.2	evolved stars	20 hrs	10 days	9/15/04	9/28/04	Chiang[25%]
85	1.3.3.3	evolved stars, 2	20 hrs	5 days	9/15/04	9/21/04	Graham[25%],Johnstone[25%]
86	1.3.3.4	extragalactic science: structure of AGN torii	20 hrs	10 days	9/22/04	10/5/04	Graham[25%]
87	1.3.3.5	design associated observing programs	56 hrs	20 days	10/6/04	11/2/04	Marchis[25%],Graham[10%]
88	1.3.3.6	summarize desired instrument specs and generate design-trade tools	20 hrs	5 days	11/3/04	11/9/04	Marchis[25%],Graham[25%]
89							



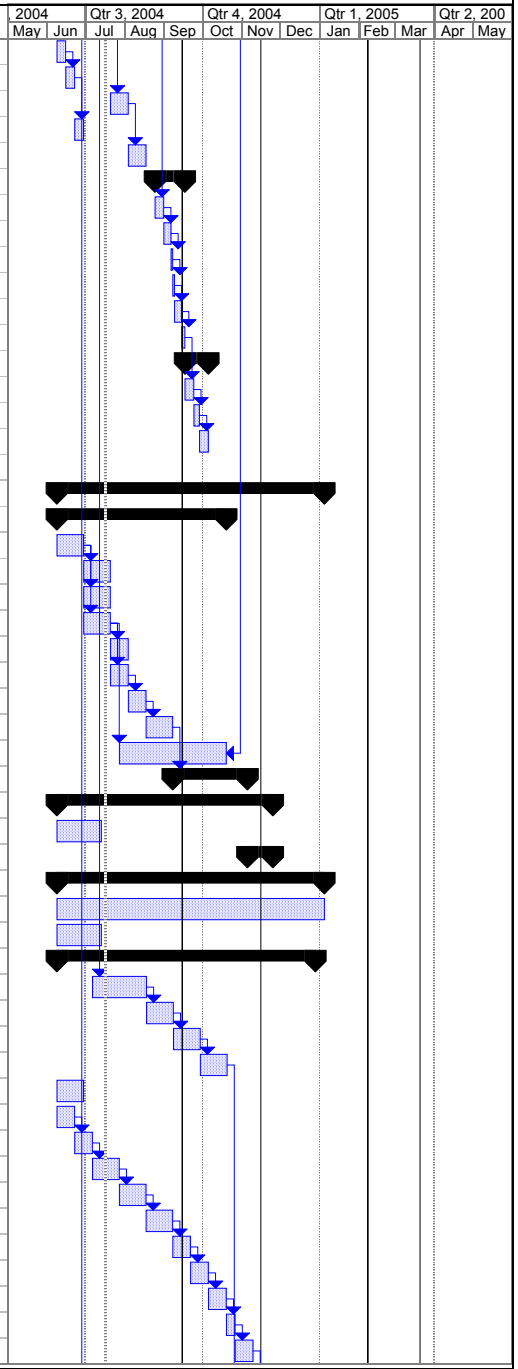
ExAOC Conceptual Design Work Breakdown Structure

ID	WBS	Task Name	Work	Duration	Start	Finish	Resource Names
90	**1.4**	**System Engineering**	**508.4 hrs**	**175 days**	**6/9/04**	**2/8/05**	
91	1.4.1	general system oversight	70 hrs	175 days	6/9/04	2/8/05	Murowinski[5%]
92	1.4.2	OCDD development	16 hrs	4 days	9/21/04	9/27/04	Murowinski[50%]
93	1.4.3	draft initial OCDD	80 hrs	20 days	9/27/04	10/25/04	Macintosh[50%]
94	1.4.4	revision to final OCDD	40 hrs	10 days	12/20/04	1/3/05	Macintosh[50%]
95	1.4.5	draft initial FPRD	62.4 hrs	8 days	10/13/04	10/25/04	Murowinski[60%],Baril[60%]
96	1.4.6	revision to final FPRD	48 hrs	6 days	12/24/04	1/3/05	Murowinski[50%],Baril[50%]
97	1.4.7	compliance matricies	8 hrs	1 day	12/23/04	12/24/04	Baril
98	1.4.8	review of reuse of Gemini designs	24 hrs	6 days	6/9/04	6/16/04	Murowinski[50%]
99	1.4.9	ICD assessment	48 hrs	6 days	6/17/04	6/24/04	Murowinski[50%],Baril[50%]
100	1.4.10	summary of key analyses and trades	48 hrs	6 days	1/10/05	1/18/05	Murowinski[50%],Baril[50%]
101	1.4.11	final document preparation and review	64 hrs	8 days	1/18/05	1/28/05	Murowinski[50%],Baril[50%]
102							
103	**1.5**	**Error Budget And Performance Analysis**	**748 hrs**	**95 days**	**6/9/04**	**10/19/04**	
104	1.5.1	determine speckle lifetime for various noise sources	40 hrs	10 days	6/9/04	6/22/04	Macintosh[50%]
105	1.5.2	generate analytic error budget	40 hrs	10 days	6/23/04	7/6/04	Macintosh[50%]
106	1.5.3	integrate multiwavelength imaging into error budgets	80 hrs	20 days	7/7/04	8/3/04	Marois[50%]
107	1.5.4	use full AO simulations to design noise model for Fourier simulations	80 hrs	10 days	7/7/04	7/20/04	Macintosh[50%],Poyneer[50%]
108	1.5.5	use analytic simulations to map out d/dt/magnitude space	40 hrs	10 days	7/21/04	8/3/04	Macintosh[50%]
109	1.5.6	validate analytic simulations against Fourier simulation	40 hrs	10 days	8/4/04	8/17/04	Macintosh[50%]
110	1.5.7	generate long-exposure Fourier simulations for selected cases	4 hrs	5 days	8/18/04	8/24/04	Macintosh[10%]
111	1.5.8	optomechanical error budgets	24 hrs	6 days	8/25/04	9/1/04	Murowinski[50%]
112	1.5.9	generate error budget for optical system	160 hrs	10 days	8/25/04	9/7/04	Macintosh[50%],Bauman[50%],S
113	1.5.10	explore additional error sources (chromatic, scintillation, etc.)	80 hrs	20 days	8/4/04	8/31/04	Marois[50%]
114	1.5.11	add additional error sources to analytic and Fourier models	40 hrs	10 days	9/8/04	9/21/04	Macintosh[50%]
115	1.5.12	generate complete error/performance budget for strawman design	120 hrs	10 days	10/6/04	10/19/04	Macintosh[50%],Oppenheimer[5(
116							
117	**1.6**	**Overall Computer Architecture**	**524 hrs**	**55 days**	**6/9/04**	**8/24/04**	
118	1.6.1	identify preliminary requirements for the overall computer system, U	32 hrs	10 days	6/9/04	6/22/04	Deich[40%]
119	1.6.2	identify preliminary requirements for the overall computer system	8 hrs	10 days	6/9/04	6/22/04	Palmer[10%]
120	1.6.3	identify preliminary requirements for the overall computer system, H	32 hrs	10 days	6/9/04	6/22/04	Dunn[40%]
121	1.6.4	decide whether to base CoD on Linux or another OS	8 hrs	2 days	6/9/04	6/10/04	Palmer[50%]
122	1.6.5	decide whether to base CoD on new API or EPICS interface	8 hrs	2 days	6/11/04	6/14/04	Palmer[50%]
123	1.6.6	investigate reuse of existing computer HW/SW, U	16 hrs	10 days	6/23/04	7/6/04	Deich[20%]
124	1.6.7	investigate reuse of existing computer HW/SW	20 hrs	10 days	6/23/04	7/6/04	Palmer[25%]
125	1.6.8	investigate reuse of existing computer HW/SW, H	120 hrs	10 days	6/23/04	7/6/04	Dunn[50%],Saddlemyer[50%],Ve
126	1.6.9	develop preliminary system data flows, U	24 hrs	10 days	7/7/04	7/20/04	Deich[30%]
127	1.6.10	develop preliminary system data flows	8 hrs	10 days	7/7/04	7/20/04	Palmer[10%]
128	1.6.11	develop preliminary system data flows, H	40 hrs	10 days	7/7/04	7/20/04	Wooff[50%]
129	**1.6.12**	**define preliminary HW/SW interfaces between subsystems:**	**176 hrs**	**20 days**	**7/21/04**	**8/17/04**	
130	1.6.12.1	Supervisor and components controller (software only)	24 hrs	5 days	7/21/04	7/27/04	Deich[60%]
131	1.6.12.2	Supervisor and components controller (software only), H	40 hrs	5 days	7/21/04	7/27/04	Wooff
132	1.6.12.3	Supervisor and AO Computer (SCC/AOC), U	8 hrs	5 days	7/28/04	8/3/04	Deich[20%]
133	1.6.12.4	Supervisor and AO Computer (SCC/AOC)	16 hrs	5 days	7/28/04	8/3/04	Palmer[40%]
134	1.6.12.5	Supervisor and AO Computer (SCC/AOC), H	40 hrs	5 days	7/28/04	8/3/04	Wooff
135	1.6.12.6	Supervisor and Science Instrument Computer (SCC/SIC)	8 hrs	10 days	8/4/04	8/17/04	Deich[10%]
136	1.6.12.7	Supervisor and Science Instrument Computer (SCC/SIC), H	40 hrs	10 days	8/4/04	8/17/04	Dunn[50%]
137	1.6.13	as necessary, create prototype implementations for testing	32 hrs	5 days	8/18/04	8/24/04	Deich[80%]
138							
139	**1.7**	**Supervisory / Components Controller Computer (SCC)**	**392 hrs**	**85 days?**	**6/9/04**	**10/5/04**	
140	**1.7.1**	**Supervisor**	**200 hrs**	**50 days**	**6/9/04**	**8/17/04**	



ExAOC Conceptual Design Work Breakdown Structure

ID	WBS	Task Name	Work	Duration	Start	Finish	Resource Names
141	1.7.1.1	identify preliminary software requirements for the Supervisor	40 hrs	5 days	6/9/04	6/15/04	Wooff
142	1.7.1.2	identify actions required for all top level sequence commands	40 hrs	5 days	6/16/04	6/22/04	Wooff
143	1.7.1.3	define a preliminary ExAOC to DHS interface	40 hrs	10 days	7/21/04	8/3/04	Dunn[50%]
144	1.7.1.4	identify data required from the TCS or SIR records within Gemini	40 hrs	5 days	6/23/04	6/29/04	Wooff
145	1.7.1.5	define a preliminary interface with the telescope	40 hrs	10 days	8/4/04	8/17/04	Saddlemyer[50%]
146	**1.7.2**	**Components Controller**	**112 hrs**	**17.5 days?**	**8/25/04**	**9/17/04**	
147	1.7.2.1	identify prelim. SW requirements for the Components Controller	32 hrs	5 days?	8/25/04	8/31/04	Deich[80%]
148	1.7.2.2	identify component control requirements, especially precision and rate	24 hrs	3.75 days?	9/1/04	9/6/04	Deich[80%]
149	1.7.2.3	evaluate competing motion controllers	8 hrs	1.25 days?	9/6/04	9/7/04	Deich[80%]
150	1.7.2.4	evaluate competing controller boards	8 hrs	1.25 days?	9/8/04	9/9/04	Deich[80%]
151	1.7.2.5	identify unusual control issues and specify solutions	24 hrs	3.75 days?	9/9/04	9/14/04	Deich[80%]
152	1.7.2.6	investigate motion controller hardware/software reuse	16 hrs	2.5 days?	9/15/04	9/17/04	Deich[80%]
153	**1.7.3**	**Engineering User Interface**	**80 hrs**	**12.5 days?**	**9/17/04**	**10/5/04**	
154	1.7.3.1	identify prelim. SW requirements for the Engineering UI	32 hrs	5 days?	9/17/04	9/24/04	Deich[80%]
155	1.7.3.2	ensure that all aspects of the computer system will support a UI	16 hrs	2.5 days?	9/24/04	9/28/04	Deich[80%]
156	1.7.3.3	in conjunction with others, develop a strawman UI	32 hrs	5 days?	9/29/04	10/5/04	Deich[80%]
157							
158	**1.8**	**Adaptive Optics System**	**3,084.8 hrs**	**150 days?**	**6/9/04**	**1/4/05**	
159	**1.8.1**	**AO optical conceptual design, including WFS**	**270 hrs**	**95 days**	**6/9/04**	**10/19/04**	
160	1.8.1.1	with science inst. developers, identify AO relay and WFS requs.	30 hrs	15 days	6/9/04	6/29/04	Bauman[25%]
161	1.8.1.2	design optics for AO relay and WFS	60 hrs	15 days	6/30/04	7/20/04	Bauman[50%]
162	1.8.1.3	identify candidate vendors for optical components	10 hrs	15 days	6/30/04	7/20/04	Bauman[8%]
163	1.8.1.4	estimate optical train emissivity and throughput	10 hrs	15 days	6/30/04	7/20/04	Bauman[8%]
164	1.8.1.5	tolerance AO relay and WFS	30 hrs	10 days	7/21/04	8/3/04	Bauman[38%]
165	1.8.1.6	establish optic mounting schemes and requirements	40 hrs	10 days	7/21/04	8/3/04	Bauman[50%]
166	1.8.1.7	sketch alignment procedure	30 hrs	10 days	8/4/04	8/17/04	Bauman[38%]
167	1.8.1.8	evaluate technical, cost, and schedule risks	20 hrs	15 days	8/18/04	9/7/04	Bauman[17%]
168	1.8.1.9	write optical design/tolerancing document	40 hrs	60 days	7/28/04	10/19/04	Bauman[8%]
169	**1.8.2**	**AO mechanical conceptual design**	**186 hrs**	**42.86 days?**	**9/8/04**	**11/5/04**	
187	**1.8.3**	**WFS**	**116.8 hrs**	**121.57 days?**	**6/9/04**	**11/25/04**	
188	1.8.3.1	investigate candidate CCDs	40 hrs	25 days	6/9/04	7/13/04	Palmer[20%]
189	**1.8.3.2**	**WFS mechanical conceptual design**	**76.8 hrs**	**13.71 days?**	**11/5/04**	**11/25/04**	
200	**1.8.4**	**DM**	**1,240 hrs**	**150 days**	**6/9/04**	**1/4/05**	
201	1.8.4.1	4k MEMS feasibility study	1,200 hrs	150 days	6/9/04	1/4/05	BMC
202	1.8.4.2	investigate alternative DMs	40 hrs	25 days	6/9/04	7/13/04	Palmer[20%]
203	**1.8.5**	**Algorithms**	**900 hrs**	**145 days?**	**6/9/04**	**12/28/04**	
204	1.8.5.1	investigate issue of invisible mode filtering and cleaning	80 hrs	30.3 days?	7/7/04	8/18/04	Veran2[33%]
205	1.8.5.2	investigate need / feasibility of modal gain optimization	40 hrs	15.15 days?	8/18/04	9/8/04	Veran2[33%]
206	1.8.5.3	investigate splitting wave-front correction between 2 DMs & TTM	40 hrs	15.15 days?	9/8/04	9/29/04	Veran2[33%]
207	1.8.5.4	investigate adaptive predictors	40 hrs	15.15 days?	9/29/04	10/20/04	Veran2[33%]
208	1.8.5.5	Lavigne effort	120 hrs	15 days	6/9/04	6/29/04	Lavigne
209	1.8.5.6	develop automated calibration for MEMS device	40 hrs	10 days?	6/9/04	6/22/04	Poyneer[50%]
210	1.8.5.7	use automation to fully characterize MEMS device	40 hrs	10 days?	6/23/04	7/6/04	Poyneer[50%]
211	1.8.5.8	study impact of actuators outside of aperture	60 hrs	15 days?	7/7/04	7/27/04	Poyneer[50%]
212	1.8.5.9	study impact of clipping of actuators due to large aberrations	60 hrs	15 days?	7/28/04	8/17/04	Poyneer[50%]
213	1.8.5.10	study impact of dead of actuators on the MEMS	60 hrs	15 days?	8/18/04	9/7/04	Poyneer[50%]
214	1.8.5.11	discuss hidden modes, FTR mode space, software issues with HIA	40 hrs	10 days?	9/8/04	9/21/04	Poyneer[50%]
215	1.8.5.12	design FTR filters	40 hrs	10 days?	9/22/04	10/5/04	Poyneer[50%]
216	1.8.5.13	study FTR noise propagation	40 hrs	10 days?	10/6/04	10/19/04	Poyneer[50%]
217	1.8.5.14	incorporate FTR to frequency-domain modeling	20 hrs	5 days?	10/20/04	10/26/04	Poyneer[50%]
218	1.8.5.15	analyze quadcell gain changes in closed loop	40 hrs	10 days?	10/27/04	11/9/04	Poyneer[50%]



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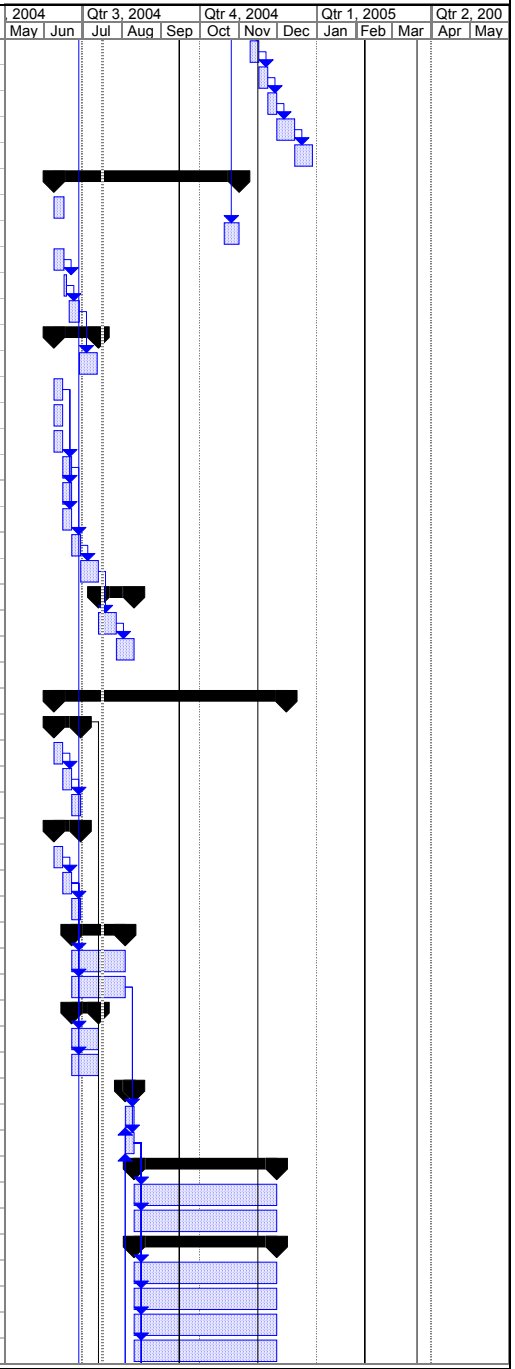
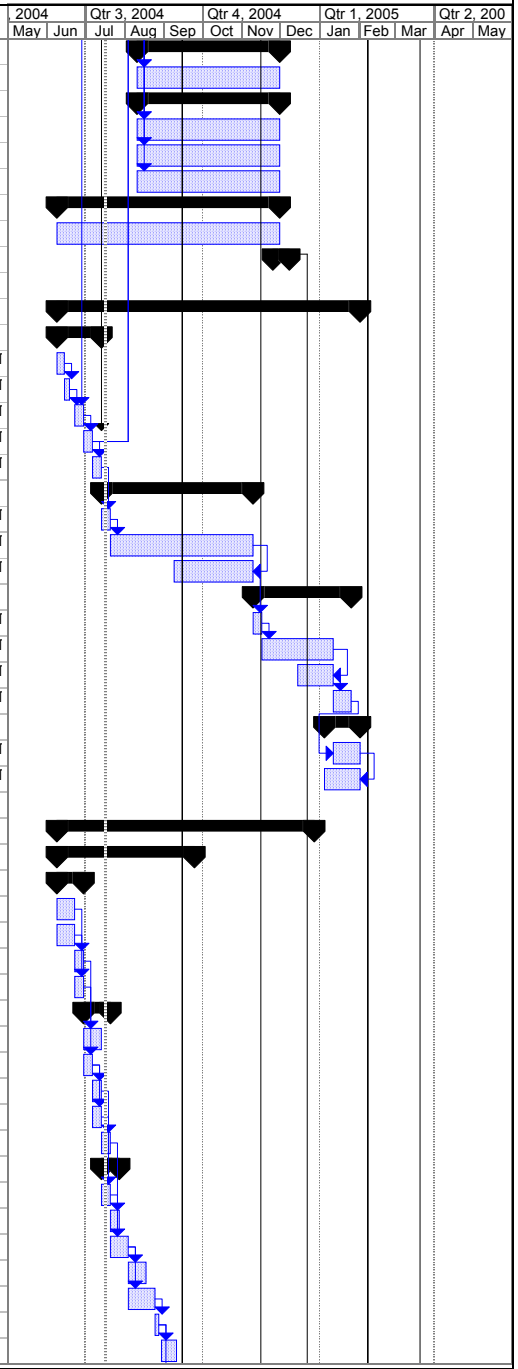
ID	WBS	Task Name	Work	Duration	Start	Finish	Resource Names
219	1.8.5.16	spec out total computational burden for end-to-end simulation	20 hrs	5 days?	11/10/04	11/16/04	Poyneer[50%]
220	1.8.5.17	install Arroyo locally and run sample simulations as provided in suite	20 hrs	5 days?	11/17/04	11/23/04	Poyneer[50%]
221	1.8.5.18	evaluate simulation options and time requirements	20 hrs	5 days?	11/24/04	11/30/04	Poyneer[50%]
222	1.8.5.19	write improved MEMS module for simulations	40 hrs	10 days?	12/1/04	12/14/04	Poyneer[50%]
223	1.8.5.20	write improved WFS module for simulations	40 hrs	10 days?	12/15/04	12/28/04	Poyneer[50%]
224	**1.8.6**	**Adaptive Optics Computer (AOC)**	**100 hrs**	**103.33 days?**	**6/9/04**	**11/1/04**	
225	1.8.6.1	identify all probable capabilities that the AOC will have to have	24 hrs	6 days?	6/9/04	6/16/04	Palmer[50%]
226	1.8.6.2	identify diagnostic/telemetry data	20 hrs	7.58 days?	10/20/04	11/1/04	Veran2[33%]
227	1.8.6.3	refine computational requirements for AOC capabilities	24 hrs	6 days?	6/9/04	6/16/04	Palmer[50%]
228	1.8.6.4	produce a timing diagram for AOC capabilities	8 hrs	2 days?	6/17/04	6/18/04	Palmer[50%]
229	1.8.6.5	refine internal interface requirements (i.e., bus requirements)	24 hrs	6 days?	6/21/04	6/28/04	Palmer[50%]
230	**1.8.7**	**Adaptive Optics Computer (AOC) Software**	**192 hrs**	**25 days?**	**6/9/04**	**7/13/04**	
231	1.8.7.1	identify preliminary software requirements for the AOC	32 hrs	10 days?	6/29/04	7/12/04	Palmer[40%]
232	1.8.7.2	identify and diagram software processes	10 hrs	5 days?	6/9/04	6/15/04	Palmer[25%]
233	1.8.7.3	identify and diagram software processes, H	20 hrs	5 days	6/9/04	6/15/04	Veran2[50%]
234	1.8.7.4	identify and diagram software processes, H2	20 hrs	5 days	6/9/04	6/15/04	Herriot[50%]
235	1.8.7.5	define and document preliminary inter-process data-flows	10 hrs	5 days?	6/16/04	6/22/04	Palmer[25%]
236	1.8.7.6	define and document preliminary inter-process data-flows, H	20 hrs	5 days	6/16/04	6/22/04	Veran2[50%]
237	1.8.7.7	define and document preliminary inter-process data-flows, H2	20 hrs	5 days	6/16/04	6/22/04	Herriot[50%]
238	1.8.7.8	produce preliminary high-level structure charts for processes	20 hrs	5 days?	6/23/04	6/29/04	Palmer[50%]
239	1.8.7.9	as necessary, produce and test prototype code	40 hrs	10 days?	6/30/04	7/13/04	Palmer[50%]
240	**1.8.8**	**Adaptive Optics Computer (AOC) Hardware**	**80 hrs**	**20 days?**	**7/14/04**	**8/10/04**	
241	1.8.8.1	specify a preliminary hardware design (to establish feasibility)	40 hrs	10 days?	7/14/04	7/27/04	Palmer[50%]
242	1.8.8.2	as necessary, run prototype code on a simplified hardware	40 hrs	10 days?	7/28/04	8/10/04	Palmer[50%]
243							
244	**1.9**	**Coronagraph**	**929.2 hrs**	**130.43 days?**	**6/9/04**	**12/8/04**	
245	**1.9.1**	**determine dynamic range of four coronagraph designs**	**88 hrs**	**15 days**	**6/9/04**	**6/29/04**	
246	1.9.1.1	choice of initial 4 designs	32 hrs	5 days	6/9/04	6/15/04	Sivaramakrishnan[20%],Soumme
247	1.9.1.2	create input & output descriptions for simulations	32 hrs	5 days	6/16/04	6/22/04	Sivaramakrishnan[20%],Makidon
248	1.9.1.3	assemble each coronagraph simulation	24 hrs	5 days	6/23/04	6/29/04	Sivaramakrishnan[20%],Makidon
249	**1.9.2**	**simple data reduction pipeline to produce dynamic range**	**80 hrs**	**15 days**	**6/9/04**	**6/29/04**	
250	1.9.2.1	design dynamic range script	32 hrs	5 days	6/9/04	6/15/04	Sivaramakrishnan[20%],Makidon
251	1.9.2.2	write dynamic range script	24 hrs	5 days	6/16/04	6/22/04	Makidon[20%],Soummer[20%],O
252	1.9.2.3	test dynamic range script on existing test files	24 hrs	5 days	6/23/04	6/29/04	Makidon[20%],Soummer[20%],O
253	**1.9.3**	**investigate optics, stop and apodizer tolerances**	**100 hrs**	**30 days**	**6/23/04**	**8/3/04**	
254	1.9.3.1	spot and apodizer numerical tolerancing	52 hrs	30 days	6/23/04	8/3/04	Sivaramakrishnan[7%],Soummer
255	1.9.3.2	optical alignment tolerancing	48 hrs	30 days	6/23/04	8/3/04	Makidon[3%],Sivaramakrishnan[
256	**1.9.4**	**investigate stop and apodizer fabrication**	**48 hrs**	**15 days**	**6/23/04**	**7/13/04**	
257	1.9.4.1	identify and contact companies	24 hrs	15 days	6/23/04	7/13/04	Oppenheimer[20%]
258	1.9.4.2	write specifications for quotes	24 hrs	15 days	6/23/04	7/13/04	Oppenheimer[20%]
259	**1.9.5**	**downselect to 2 designs**	**48 hrs**	**5 days**	**8/4/04**	**8/10/04**	
260	1.9.5.1	design presentation to project	24 hrs	5 days	8/4/04	8/10/04	Oppenheimer[60%]
261	1.9.5.2	write up design choices, outline tech challenges for each of 2	24 hrs	5 days	8/4/04	8/10/04	Sivaramakrishnan[60%]
262	**1.9.6**	**ZEMAX optical design**	**80 hrs**	**80 days**	**8/11/04**	**11/30/04**	
263	1.9.6.1	design 1	40 hrs	80 days	8/11/04	11/30/04	Oppenheimer[6%]
264	1.9.6.2	design 2	40 hrs	80 days	8/11/04	11/30/04	Makidon[6%]
265	**1.9.7**	**optical simulation of detailed designs**	**136 hrs**	**80 days**	**8/11/04**	**11/30/04**	
266	1.9.7.1	interfacing with End-to-End simulations	16 hrs	80 days	8/11/04	11/30/04	Makidon[3%]
267	1.9.7.2	scintillation, polarization effects: quantitative estimation	40 hrs	80 days	8/11/04	11/30/04	Sivaramakrishnan[6%]
268	1.9.7.3	design 1	40 hrs	80 days	8/11/04	11/30/04	Soummer[6%]
269	1.9.7.4	design 2	40 hrs	80 days	8/11/04	11/30/04	Sivaramakrishnan[6%]



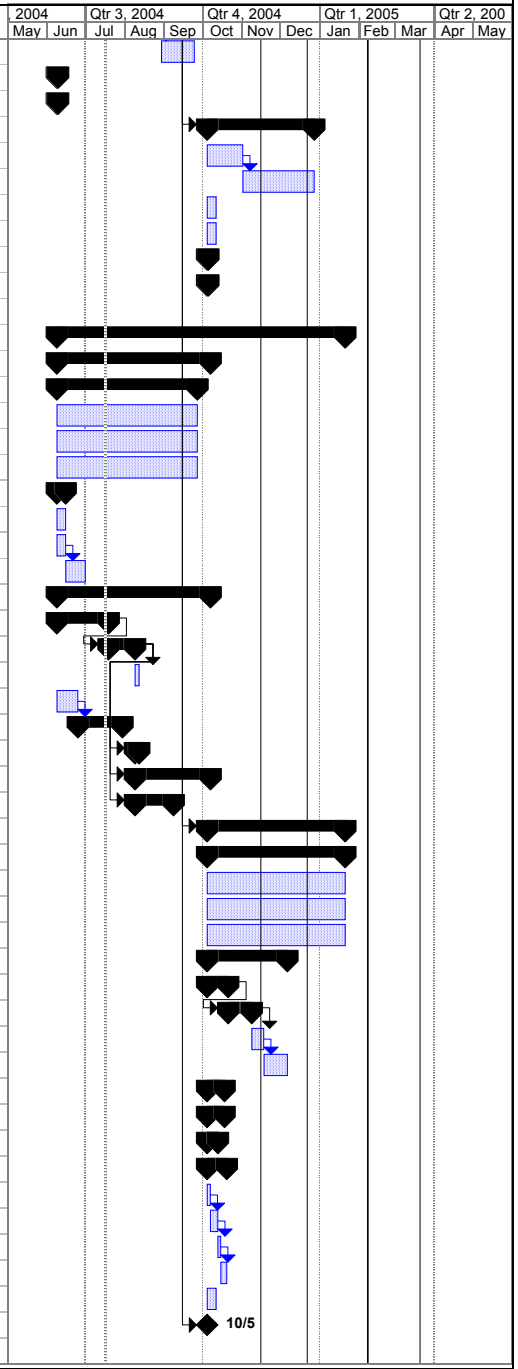
ExAOC Conceptual Design Work Breakdown Structure

ID	WBS	Task Name	Work	Duration	Start	Finish	Resource Names
270	**1.9.8**	**dynamic range predictions**	**89.6 hrs**	**80 days**	**8/11/04**	**11/30/04**	
271	1.9.8.1	data reduction of simulated data	89.6 hrs	80 days	8/11/04	11/30/04	Makidon[12%],Soummer[2%]
272	**1.9.9**	**estimating simulation errors from critical components**	**70 hrs**	**80 days**	**8/11/04**	**11/30/04**	
273	1.9.9.1	phase errors from apodizers	20 hrs	80 days	8/11/04	11/30/04	Soummer[3%]
274	1.9.9.2	phase errors from stops	20 hrs	80 days	8/11/04	11/30/04	Digby[3%]
275	1.9.9.3	analytical/numerical tolerancing	30 hrs	80 days	8/11/04	11/30/04	Sivaramakrishnan[5%]
276	**1.9.10**	**proposal preparation and documentation**	**140 hrs**	**125 days**	**6/9/04**	**11/30/04**	
277	1.9.10.1	reporting for the duration of project @4hr/wk	140 hrs	125 days	6/9/04	11/30/04	Sivaramakrishnan2[14%]
278	**1.9.11**	**coronagraph conceptual mechanical design**	**49.6 hrs**	**8.86 days?**	**11/25/04**	**12/8/04**	
286							
287	**1.10**	**Calibration**	**1,467.2 hrs**	**170 days?**	**6/9/04**	**2/1/05**	
288	**1.10.1**	**Subsystems Requirements, Definitions, and Interfaces**	**128.8 hrs**	**25 days**	**6/9/04**	**7/13/04**	
289	1.10.1.1	Science Target Characteristics	22.4 hrs	4 days	6/9/04	6/14/04	WallaceKent[25%],Green[25%],T
290	1.10.1.2	Telescope Working Environment	22.4 hrs	4 days	6/15/04	6/18/04	WallaceKent[25%],Green[25%],T
291	1.10.1.3	Wavefront Sensor Error Budgets	28 hrs	5 days	6/23/04	6/29/04	WallaceKent[25%],Green[25%],T
292	1.10.1.4	Coronagraph Candidates	28 hrs	5 days	6/30/04	7/6/04	WallaceKent[25%],Green[25%],T
293	1.10.1.5	Calibration Stimulus Definition	28 hrs	5 days	7/7/04	7/13/04	WallaceKent[25%],Green[25%],T
294	**1.10.2**	**Calibration Simulation and Analysis**	**722.4 hrs**	**85 days?**	**7/14/04**	**11/9/04**	
295	1.10.2.1	Define interactions with other subsystem simulations	28 hrs	5 days	7/14/04	7/20/04	WallaceKent[25%],Green[25%],T
296	1.10.2.2	Stand-alone simulations of high contrast WFS methods	448 hrs	80 days	7/21/04	11/9/04	WallaceKent[25%],Green[25%],T
297	1.10.2.3	Integrated modeling of high contrast wave front sensor	246.4 hrs	44 days?	9/9/04	11/9/04	WallaceKent[25%],Green[25%],T
298	**1.10.3**	**Evaluation and Ranking**	**420 hrs**	**55 days?**	**11/10/04**	**1/25/05**	
299	1.10.3.1	Post simulation requirements and interfaces review	28 hrs	5 days?	11/10/04	11/16/04	WallaceKent[25%],Green[25%],T
300	1.10.3.2	Exercise simulations of wavefront sensor and calibrations	224 hrs	40 days?	11/17/04	1/11/05	WallaceKent[25%],Green[25%],T
301	1.10.3.3	Laboratory test of calibration routines	112 hrs	20 days?	12/15/04	1/11/05	WallaceKent[25%],Green[25%],T
302	1.10.3.4	Calibration ranking and evaluation	56 hrs	10 days?	1/12/05	1/25/05	WallaceKent[25%],Green[25%],T
303	**1.10.4**	**Selection of leading wavefront sensor and calibration candidates**	**196 hrs**	**20 days?**	**1/5/05**	**2/1/05**	
304	1.10.4.1	Candidate selections	84 hrs	15 days?	1/12/05	2/1/05	WallaceKent[25%],Green[25%],T
305	1.10.4.2	Written findings	112 hrs	20 days?	1/5/05	2/1/05	WallaceKent[25%],Green[25%],T
306							
307	**1.11**	**Integral Field Unit (IFU)**	**1,336 hrs**	**144 days?**	**6/9/04**	**12/27/04**	
308	**1.11.1**	**Pre down-select**	**776 hrs**	**78 days?**	**6/9/04**	**9/24/04**	
309	**1.11.1.1**	**Work with coronagraph team**	**144 hrs**	**15 days**	**6/9/04**	**6/29/04**	
310	1.11.1.1.1	determine Coronagraph and pupil locations	80 hrs	10 days	6/9/04	6/22/04	McElwain
311	1.11.1.1.2	determine Coronagraph and pupil locations, O	16 hrs	10 days	6/9/04	6/22/04	Larkin[20%]
312	1.11.1.1.3	rotating or non-rotating field	40 hrs	5 days	6/23/04	6/29/04	McElwain
313	1.11.1.1.4	rotating or non-rotating field, O	8 hrs	5 days	6/23/04	6/29/04	Larkin[20%]
314	**1.11.1.2**	**Sensitivity vs. resolution**	**208 hrs**	**15 days**	**6/30/04**	**7/20/04**	
315	1.11.1.2.1	detector wavelength range	80 hrs	10 days	6/30/04	7/13/04	Larkin[20%],McLean[80%]
316	1.11.1.2.2	atmospheric modelling - OH contamination	40 hrs	5 days	6/30/04	7/6/04	McElwain
317	1.11.1.2.3	backgrounds from sky and stars	40 hrs	5 days	7/7/04	7/13/04	McElwain
318	1.11.1.2.4	backgrounds from sky and stars, O	8 hrs	5 days	7/7/04	7/13/04	Larkin[20%]
319	1.11.1.2.5	spectral nulling vs. resolution	40 hrs	5 days	7/14/04	7/20/04	McElwain
320	**1.11.1.3**	**Slicing technique (lenslets?)**	**80 hrs**	**10 days**	**7/14/04**	**7/27/04**	
321	1.11.1.3.1	spectral spacing (overlap)	40 hrs	5 days	7/14/04	7/20/04	Larkin
322	1.11.1.3.2	vendor capabilities (fill factor)	40 hrs	5 days	7/21/04	7/27/04	Larkin
323	1.11.1.4	polarimetry	80 hrs	10 days	7/21/04	8/3/04	McElwain
324	1.11.1.5	define basic sizes and characteristics	80 hrs	10 days	8/4/04	8/17/04	McElwain
325	1.11.1.6	define basic sizes and characteristics, O	48 hrs	15 days	8/4/04	8/24/04	Larkin[20%],McLean[20%]
326	1.11.1.7	decide on reflective vs. refractive components	24 hrs	3 days	8/25/04	8/27/04	Larkin
327	1.11.1.8	modelling of spectrograph performance	80 hrs	10 days	8/30/04	9/10/04	McElwain



ExAOC Conceptual Design Work Breakdown Structure

ID	WBS	Task Name	Work	Duration	Start	Finish	Resource Names
328	1.11.1.9	modelling of spectrograph performance, O	32 hrs	20 days	8/30/04	9/24/04	Larkin[20%]
329	**1.11.1.10**	**Travel**	**0 hrs**	**1 day?**	**6/9/04**	**6/9/04**	
331	**1.11.1.11**	**Miscellaneous**	**0 hrs**	**1 day?**	**6/9/04**	**6/9/04**	
335	**1.11.2**	**Post down-select**	**560 hrs**	**60 days?**	**10/5/04**	**12/27/04**	
336	1.11.2.1	sampling techniques (up-the-ramp)	160 hrs	20 days	10/5/04	11/1/04	Weiss
337	1.11.2.2	model flexures effect on sensitivity	320 hrs	40 days	11/2/04	12/27/04	Kress
338	1.11.2.3	measure scattering within OSIRIS	40 hrs	5 days	10/5/04	10/11/04	OSIRIS team
339	1.11.2.4	cost modelling of best model	40 hrs	5 days	10/5/04	10/11/04	Larkin
340	**1.11.2.5**	**Travel**	**0 hrs**	**1 day?**	**10/5/04**	**10/5/04**	
342	**1.11.2.6**	**Miscellaneous**	**0 hrs**	**1 day?**	**10/5/04**	**10/5/04**	
346							
347	**1.12**	**Multi-Wavelength Imager**	**2,180 hrs**	**162.13 days?**	**6/9/04**	**1/21/05**	
348	**1.12.1**	**Pre down-select**	**1,255 hrs**	**86.88 days**	**6/9/04**	**10/7/04**	
349	**1.12.1.1**	**Project General**	**150 hrs**	**78.13 days**	**6/9/04**	**9/27/04**	
350	1.12.1.1.1	Management (project)	50 hrs	78.13 days	6/9/04	9/27/04	INO[8%]
351	1.12.1.1.2	Technical Management	50 hrs	78.13 days	6/9/04	9/27/04	INO[8%]
352	1.12.1.1.3	Technical Management	50 hrs	78.13 days	6/9/04	9/27/04	UdeM[8%]
353	**1.12.1.2**	**Scientific Requirements**	**80 hrs**	**5 days**	**6/9/04**	**6/15/04**	
354	1.12.1.2.1	Science Case input (UdeM)	40 hrs	5 days	6/9/04	6/15/04	UdeM
355	1.12.1.2.2	OCDD input	40 hrs	5 days	6/9/04	6/15/04	UdeM
356	1.12.1.3	Dual-Beam Imaging	90 hrs	11.25 days	6/16/04	7/1/04	UdeM
357	**1.12.1.4**	**4-lambda Multi-colour Detector Assembly (MCDA)**	**935 hrs**	**86.88 days**	**6/9/04**	**10/7/04**	
358	**1.12.1.4.1**	**System Requirements (UdeM)**	**120 hrs**	**28.75 days**	**6/9/04**	**7/19/04**	
363	**1.12.1.4.2**	**Preliminary System Design (UdeM-INO)**	**115 hrs**	**14.38 days**	**7/19/04**	**8/9/04**	
370	1.12.1.4.3	ROM cost estimate (INO)	40 hrs	3.75 days	8/9/04	8/12/04	INO,UdeM
371	1.12.1.4.4	Performance Simulation (UdeM)	100 hrs	12.5 days	6/9/04	6/25/04	UdeM
372	**1.12.1.4.5**	**Performance simulations (UdeM)**	**200 hrs**	**25 days**	**6/25/04**	**7/30/04**	
375	**1.12.1.4.6**	**Data Reduction pipeline (UdeM)**	**40 hrs**	**3.75 days**	**8/9/04**	**8/12/04**	
378	**1.12.1.4.7**	**Optical Design (INO)**	**230 hrs**	**43.75 days**	**8/9/04**	**10/7/04**	
390	**1.12.1.4.8**	**Optical Coatings & Micro-Optics (INO)**	**90 hrs**	**22.5 days**	**8/9/04**	**9/8/04**	
397	**1.12.2**	**Post down-select**	**925 hrs**	**78.13 days?**	**10/5/04**	**1/21/05**	
398	**1.12.2.1**	**Project General**	**150 hrs**	**78.13 days**	**10/5/04**	**1/21/05**	
399	1.12.2.1.1	Management (project)	50 hrs	78.13 days	10/5/04	1/21/05	INO[8%]
400	1.12.2.1.2	Technical Management	50 hrs	78.13 days	10/5/04	1/21/05	INO[8%]
401	1.12.2.1.3	Technical Management	50 hrs	78.13 days	10/5/04	1/21/05	UdeM[8%]
402	**1.12.2.2**	**Mechanical Design**	**445 hrs**	**45 days**	**10/5/04**	**12/6/04**	
403	**1.12.2.2.1**	**Opto-mechanical Design**	**135 hrs**	**12.5 days**	**10/5/04**	**10/21/04**	
412	**1.12.2.2.2**	**Cryostat Design**	**150 hrs**	**12.5 days**	**10/21/04**	**11/8/04**	
417	1.12.2.2.3	Thermal Enclosure	60 hrs	7.5 days	11/9/04	11/18/04	INO
418	1.12.2.2.4	Mechanical Interface (space frame, ISS interface plate)	100 hrs	12.5 days	11/18/04	12/6/04	INO
419	**1.12.2.3**	**Electronic Design**	**150 hrs**	**9.75 days**	**10/5/04**	**10/18/04**	
420	**1.12.2.3.1**	**Detector Electronics**	**100 hrs**	**9.75 days**	**10/5/04**	**10/18/04**	
425	**1.12.2.3.2**	**Instrument Control**	**50 hrs**	**6.25 days**	**10/5/04**	**10/13/04**	
429	**1.12.2.4**	**Instrument Control Software**	**140 hrs**	**11.25 days**	**10/5/04**	**10/20/04**	
430	1.12.2.4.1	Software requirement (input-output)	30 hrs	2.5 days	10/5/04	10/7/04	INO,UdeM
431	1.12.2.4.2	Component controller software	40 hrs	3.75 days	10/7/04	10/13/04	INO,UdeM
432	1.12.2.4.3	Temperature controler software	30 hrs	2.5 days	10/13/04	10/15/04	INO,UdeM
433	1.12.2.4.4	Instrument controler software	40 hrs	2.5 days	10/15/04	10/20/04	INO,UdeM
434	1.12.2.5	Alignment Plan	40 hrs	5 days	10/5/04	10/11/04	INO
435	1.12.2.6	Science Instrument Down-Select	0 hrs	1 day?	10/5/04	10/5/04	
436							



ExAOC Conceptual Design Work Breakdown Structure

ID	WBS	Task Name	Work	Duration	Start	Finish	Resource Names
437	**1.13**	**Overall Mechanical/Electrical Architecture**	**430 hrs**	**150.07 days?**	**6/9/04**	**1/5/05**	
438	1.13.1	initial mechanical functionality matrix	40 hrs	10 days?	6/9/04	6/22/04	Lockwood[50%]
439	1.13.2	initial layout	60 hrs	10.71 days?	6/23/04	7/7/04	Wallace[70%]
440	1.13.3	bench	80 hrs	14.29 days?	12/8/04	12/28/04	Lockwood[70%]
441	1.13.4	enclosure	30 hrs	5.36 days?	12/28/04	1/5/05	Lockwood[70%]
442	1.13.5	motion control	200 hrs	35.71 days?	6/23/04	8/11/04	Alcott[70%]
443	1.13.6	electronics enclosure	20 hrs	3.57 days?	8/11/04	8/17/04	Wallace[70%]
444							
445	**1.14**	**Integrated Model Study**	**306 hrs**	**90 days**	**6/9/04**	**10/12/04**	
449							
450	**1.15**	**Project Management**	**1,142 hrs**	**175 days?**	**6/7/04**	**2/4/05**	
451	1.15.1	UCSC contract charge	0 hrs	1 day?	6/7/04	6/7/04	
452	1.15.2	technical management	420 hrs	175 days	6/7/04	2/4/05	Macintosh2[30%]
453	1.15.3	administrative management	560 hrs	175 days	6/7/04	2/4/05	Palmer2[40%]
454	**1.15.4**	**Canadian Management**	**132 hrs**	**150 days**	**6/7/04**	**12/31/04**	
455	1.15.4.1	Cdn coordination	96 hrs	150 days	6/7/04	12/31/04	Murowinski[3%],Ford[5%]
456	1.15.4.2	SOW and contract development: UdeM and INO	36 hrs	8 days	6/7/04	6/16/04	Murowinski[25%],Ford
457	**1.15.5**	**mechanical/electrical management**	**30 hrs**	**145.13 days**	**6/8/04**	**12/28/04**	
488							
489	**1.16**	**Documents And Final Instrument Proposal**	**472 hrs**	**214 days**	**6/9/04**	**4/4/05**	
490	1.16.1	provide inputs for deliverable documents	0 hrs	170 days	6/9/04	2/1/05	
491	1.16.2	technical editing	160 hrs	80 days	10/8/04	1/28/05	techEditor[25%]
492	1.16.3	provide draft text for final instrument proposal	0 hrs	170 days	6/9/04	2/1/05	
493	1.16.4	merge draft text from collaborators into a single document	0 hrs	20 days	12/31/04	1/28/05	
494	1.16.5	provide WBS, schedule, and budget inputs, preliminary	64 hrs	5 days	10/15/04	10/22/04	Oppenheimer[20%],WallaceKent
495	1.16.6	provide WBS, schedule, and budget inputs, preliminary, U	16 hrs	5 days	10/15/04	10/22/04	Cowley[20%],Deich[20%]
496	1.16.7	provide WBS, schedule, and budget inputs, preliminary, H	24 hrs	5 days	10/15/04	10/22/04	Dunn[20%],Murowinski[20%],Ver
497	1.16.8	merge WBS, schedule, and budget inputs, preliminary	0 hrs	10 days	10/22/04	11/5/04	
498	1.16.9	provide WBS, schedule, and budget inputs, final	128 hrs	10 days	12/17/04	12/31/04	Oppenheimer[20%],WallaceKent
499	1.16.10	provide WBS, schedule, and budget inputs, final, U	32 hrs	10 days	12/17/04	12/31/04	Deich[20%],Cowley[20%]
500	1.16.11	provide WBS, schedule, and budget inputs, final, H	48 hrs	10 days	12/17/04	12/31/04	Veran[20%],Murowinski[20%],Du
501	1.16.12	merge WBS, schedule, and budget inputs, final	0 hrs	20 days	12/31/04	1/28/05	
502	1.16.13	provide project plan for final instrument	0 hrs	20 days	12/31/04	1/27/05	
503	1.16.14	provide budget for final instrument	0 hrs	20 days	12/31/04	1/27/05	
504	1.16.15	provide management plan for final instrument	0 hrs	20 days	12/31/04	1/27/05	
505	1.16.16	adjustments as per CoDR	0 hrs	20 days	3/8/05	4/4/05