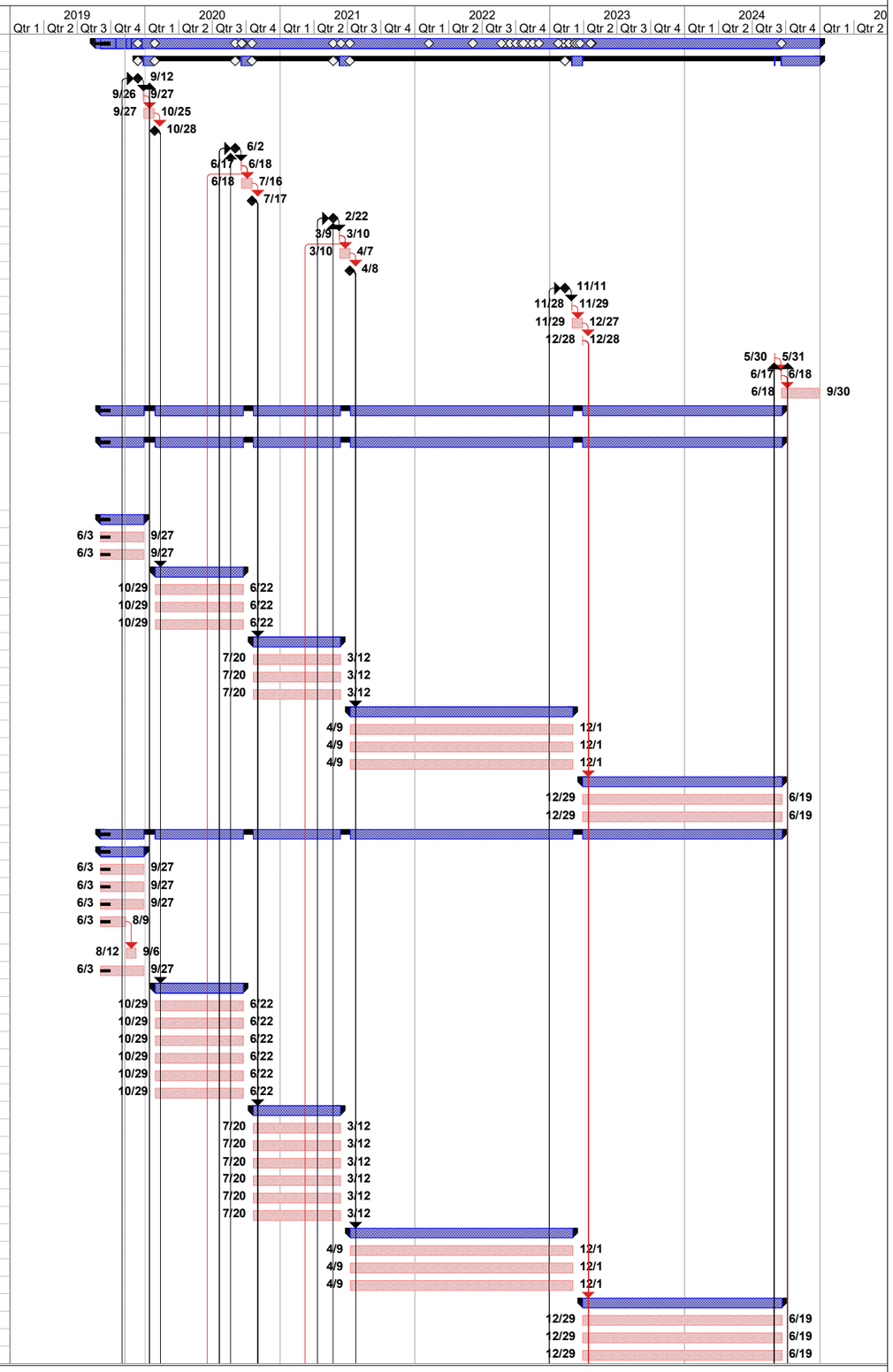
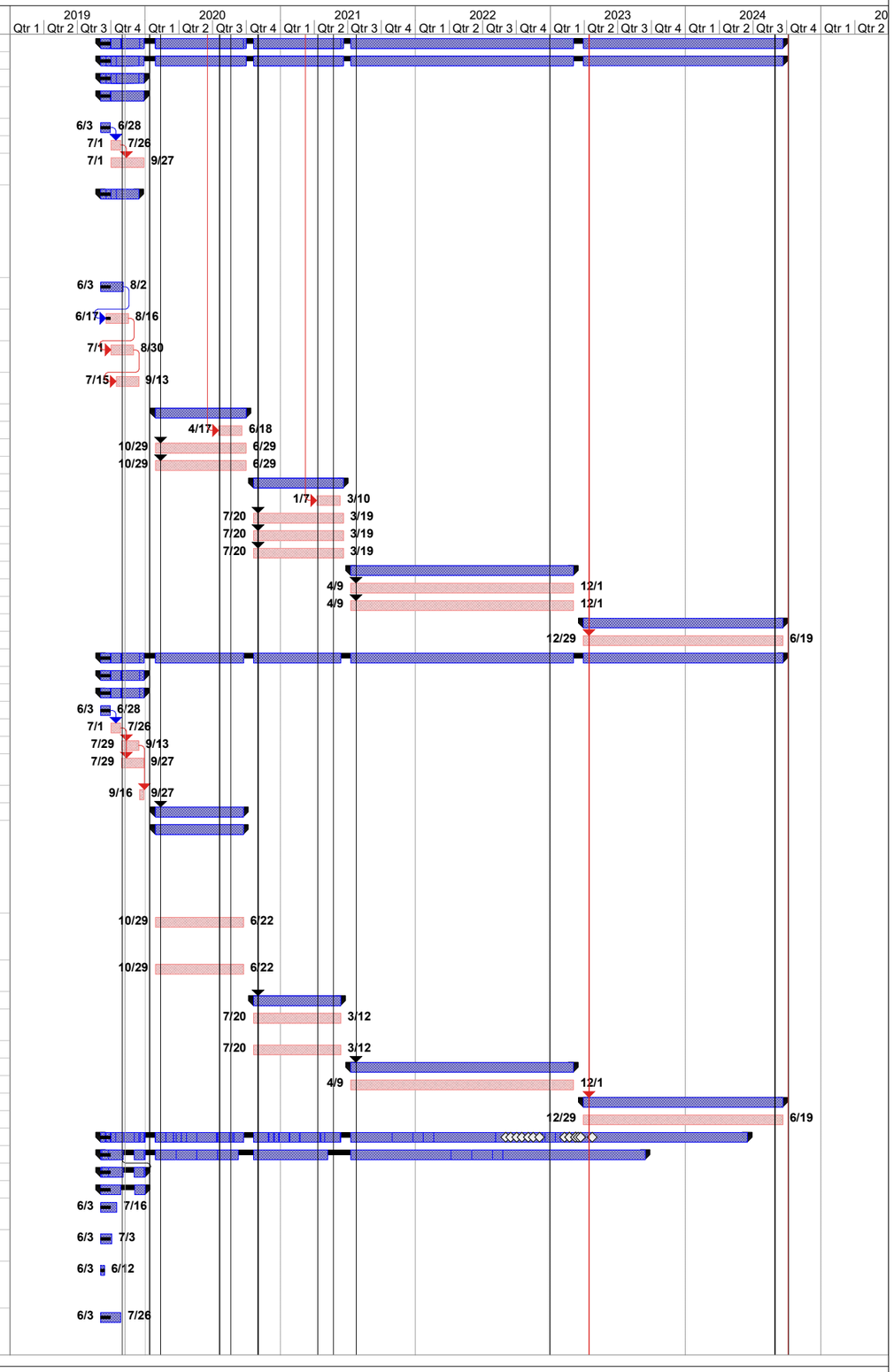
Gemini GNAO/RTC Work Breakdown Structure, 7/29/19

ID	WBS	Task Name	Start	Finish	Work	Duration	Resource Names	Predecessors	Cost
1	1	GNAO/RTC Project	Mon 5/20/19	Mon 9/30/24	86,301.63 hrs	280.2 wks			$6,436,173.80
2	1.1	Meetings And Milestones	Thu 9/12/19	Mon 9/30/24	10,638.4 hrs	263.6 wks			$864,415.90
3	1.1.1	Submit documentation for CoDR	Thu 9/12/19	Thu 9/12/19	0 hrs	0.2 wks		119FS-3 wks,	$0.00
4	1.1.2	CoDR	Thu 9/26/19	Fri 9/27/19	288 hrs	0.4 wks	BlainC_P,BlankA_P,Cavedo	3FS+1.8 wks	$22,047.04
5	1.1.3	CoDR Response and Closeout	Fri 9/27/19	Fri 10/25/19	792 hrs	4 wks	CavedoniC_P[35%],ChinnB_	4	$59,501.12
6	1.1.4	CoDR concludes, PD commences	Mon 10/28/19	Mon 10/28/19	0 hrs	0.2 wks		5	$0.00
7	1.1.5	Submit documentation for PDR	Tue 6/2/20	Tue 6/2/20	0 hrs	0.2 wks		171FS-3 wks,	$0.00
8	1.1.6	PDR	Wed 6/17/20	Thu 6/18/20	288 hrs	0.4 wks	BlainC_P,BlankA_P,Cavedo	7FS+2 wks	$22,047.04
9	1.1.7	PDR Response and Closeout	Thu 6/18/20	Thu 7/16/20	792 hrs	4 wks	BlainC_P[25%],BlankA_P[2	8	$59,501.12
10	1.1.8	PDR concludes, CD commences	Fri 7/17/20	Fri 7/17/20	0 hrs	0.2 wks		9	$0.00
11	1.1.9	Submit documentation for CDR	Mon 2/22/21	Mon 2/22/21	0 hrs	0.2 wks		131FS-3 wks,	$0.00
12	1.1.10	CDR	Tue 3/9/21	Wed 3/10/21	288 hrs	0.4 wks	AndersenM_C,BlainC_C,Bla	11FS+2 wks	$22,707.68
13	1.1.11	CDR Response and Closeout	Wed 3/10/21	Wed 4/7/21	792 hrs	4 wks	BlainC_C[25%],BlankA_C[2	12	$61,283.76
14	1.1.12	CDR concludes, Build commences	Thu 4/8/21	Thu 4/8/21	0 hrs	0.2 wks		13	$0.00
15	1.1.13	Submit documents for Pre-I&T Review	Fri 11/11/22	Fri 11/11/22	0 hrs	0.2 wks		363FS-3 wks	$0.00
16	1.1.14	Pre-I&T Review	Mon 11/28/22	Tue 11/29/22	288 hrs	0.4 wks	AndersenM_B,BlainC_B,Bla	15FS+2 wks	$23,389.44
17	1.1.15	Pre-I&T Response and Closeout	Tue 11/29/22	Tue 12/27/22	792 hrs	4 wks	ScharwaechterJ_P[40%],Bla	16	$62,858.48
18	1.1.16	Pre-I&T Review concludes, I&T commences	Wed 12/28/22	Wed 12/28/22	0 hrs	0.2 wks		17	$0.00
19	1.1.17	Final document review	Thu 5/30/24	Fri 5/31/24	288 hrs	0.4 wks	AndersenM_I,BlainC_I,Blanl	145FS-3 wks,	$24,814.56
20	1.1.18	First Light	Mon 6/17/24	Tue 6/18/24	288 hrs	0.4 wks	AndersenM_I,BlainC_I,Blanl	19FS+2 wks	$24,814.56
21	1.1.19	Project Cleanup and Closeout	Tue 6/18/24	Mon 9/30/24	5,742.4 hrs	14.8 wks	ScharwaechterJ_I[80%],Blai	20	$481,451.10
22	1.2	Project Management, including non-subsystem-specific SE	Mon 6/3/19	Wed 6/19/24	13,818 hrs	263.6 wks			$1,175,590.42
23	1.2.1	Project Mannagement (PM), including: project oversight; technical management; schedule, budget, and scope management; procurement and subcontract management; reporting and reviews; and other communications.	Mon 6/3/19	Wed 6/19/24	9,230 hrs	263.6 wks			$816,875.70
24	1.2.1.1	Conceptual Design	Mon 6/3/19	Fri 9/27/19	850 hrs	17 wks			$59,473.70
25	1.2.1.1.1	Project Management	Mon 6/3/19	Fri 9/27/19	680 hrs	17 wks	PalmerD_P		$55,114.80
26	1.2.1.1.2	Project Coordinator	Mon 6/3/19	Fri 9/27/19	170 hrs	17 wks	BlankA_P[25%]		$4,358.90
27	1.2.1.2	Preliminary Design	Tue 10/29/19	Mon 6/22/20	1,700 hrs	34 wks		6	$155,546.60
28	1.2.1.2.1	Project Management	Tue 10/29/19	Mon 6/22/20	1,020 hrs	34 wks	PalmerD_P[75%]		$108,109.80
29	1.2.1.2.2	Project Coordinator	Tue 10/29/19	Mon 6/22/20	340 hrs	34 wks	BlankA_P[25%]		$11,400.20
30	1.2.1.2.3	AOS Subcontract Management	Tue 10/29/19	Mon 6/22/20	340 hrs	34 wks	BlainC_P[25%]		$36,036.60
31	1.2.1.3	Critical Design	Mon 7/20/20	Fri 3/12/21	1,700 hrs	34 wks		10	$160,214.80
32	1.2.1.3.1	Project Management	Mon 7/20/20	Fri 3/12/21	1,020 hrs	34 wks	PalmerD_C[75%]		$111,353.40
33	1.2.1.3.2	Project Coordinator	Mon 7/20/20	Fri 3/12/21	340 hrs	34 wks	BlankA_C[25%]		$11,743.60
34	1.2.1.3.3	AOS Subcontract Management	Mon 7/20/20	Fri 3/12/21	340 hrs	34 wks	BlainC_C[25%]		$37,117.80
35	1.2.1.4	Build / Implement	Fri 4/9/21	Thu 12/1/22	3,440 hrs	86 wks		14	$320,719.80
36	1.2.1.4.1	Project Management	Fri 4/9/21	Thu 12/1/22	1,720 hrs	86 wks	PalmerD_B[50%]		$193,414.00
37	1.2.1.4.2	Project Coordinator	Fri 4/9/21	Thu 12/1/22	860 hrs	86 wks	BlankA_B[25%]		$30,598.80
38	1.2.1.4.3	AOS Subcontract Management	Fri 4/9/21	Thu 12/1/22	860 hrs	86 wks	BlainC_B[25%]		$96,707.00
39	1.2.1.5	Integration And Test	Thu 12/29/22	Wed 6/19/24	1,540 hrs	77 wks		18	$120,920.80
40	1.2.1.5.1	Project Management	Thu 12/29/22	Wed 6/19/24	770 hrs	77 wks	PalmerD_I[25%]		$91,861.00
41	1.2.1.5.2	Project Coordinator	Thu 12/29/22	Wed 6/19/24	770 hrs	77 wks	BlankA_I[25%]		$29,059.80
42	1.2.2	GNAO/RTC Systems Engineering	Mon 6/3/19	Wed 6/19/24	4,588 hrs	263.6 wks			$358,714.72
43	1.2.2.1	Conceptual Design	Mon 6/3/19	Fri 9/27/19	456 hrs	17 wks			$26,037.92
44	**1.2.2.1.1**	**Configuration Management**	**Mon 6/3/19**	**Fri 9/27/19**	**68 hrs**	**17 wks**	**SE1_P[10%]**		**$4,048.20**
45	1.2.2.1.2	Technical team management/coordination	Mon 6/3/19	Fri 9/27/19	68 hrs	17 wks	ProvostN_P[10%]		$4,048.20
46	1.2.2.1.3	Risk Management	Mon 6/3/19	Fri 9/27/19	68 hrs	17 wks	ProvostN_P[10%]		$4,048.20
47	1.2.2.1.4	Top level systems architecture definitiion and Conceptual Design Iteration	Mon 6/3/19	Fri 8/9/19	120 hrs	10 wks	EbbersA_P[10%],ProvostN_		$5,360.88
48	1.2.2.1.5	External Interface definition and management	Mon 8/12/19	Fri 9/6/19	64 hrs	4 wks	ProvostN_P[20%],RamboldV	47	$4,982.40
49	1.2.2.1.6	Generate and manage error budget	Mon 6/3/19	Fri 9/27/19	68 hrs	17 wks	SivoG_P[10%]		$3,550.04
50	1.2.2.2	Preliminary Design	Tue 10/29/19	Mon 6/22/20	1,088 hrs	34 wks		6	$82,013.44
51	1.2.2.2.1	Configuration Management	Tue 10/29/19	Mon 6/22/20	136 hrs	34 wks	SE1_P[10%]		$10,587.60
52	1.2.2.2.2	Technical team management/coordination	Tue 10/29/19	Mon 6/22/20	136 hrs	34 wks	ProvostN_P[10%]		$10,587.60
53	1.2.2.2.3	Risk Management	Tue 10/29/19	Mon 6/22/20	136 hrs	34 wks	ProvostN_P[10%]		$10,587.60
54	1.2.2.2.4	Top level systems architecture refinement	Tue 10/29/19	Mon 6/22/20	408 hrs	34 wks	EbbersA_P[10%],ProvostN_		$30,378.32
55	1.2.2.2.5	External Interface refinement and management	Tue 10/29/19	Mon 6/22/20	136 hrs	34 wks	RamboldW_P[5%],ProvostN		$10,587.60
56	1.2.2.2.6	Refine and manage error budget	Tue 10/29/19	Mon 6/22/20	136 hrs	34 wks	SivoG_P[10%]		$9,284.72
57	1.2.2.3	Critical Design	Mon 7/20/20	Fri 3/12/21	1,088 hrs	34 wks		10	$84,469.60
58	1.2.2.3.1	Configuration Management	Mon 7/20/20	Fri 3/12/21	136 hrs	34 wks	SE1_C[10%]		$10,904.48
59	1.2.2.3.2	Technical team management/coordination	Mon 7/20/20	Fri 3/12/21	136 hrs	34 wks	ProvostN_C[10%]		$10,904.48
60	1.2.2.3.3	Risk Management	Mon 7/20/20	Fri 3/12/21	136 hrs	34 wks	ProvostN_C[10%]		$10,904.48
61	1.2.2.3.4	Top level systems architecture refinement	Mon 7/20/20	Fri 3/12/21	408 hrs	34 wks	EbbersA_C[10%],ProvostN_		$31,288.16
62	1.2.2.3.5	External Interface refinement and management	Mon 7/20/20	Fri 3/12/21	136 hrs	34 wks	ProvostN_C[5%],RamboldV		$10,904.48
63	1.2.2.3.6	Refine and manage error budget	Mon 7/20/20	Fri 3/12/21	136 hrs	34 wks	SivoG_C[10%]		$9,563.52
64	1.2.2.4	Build / Implement	Fri 4/9/21	Thu 12/1/22	1,032 hrs	86 wks		14	$85,232.88
65	1.2.2.4.1	Configuration Management	Fri 4/9/21	Thu 12/1/22	344 hrs	86 wks	SE1_B[10%]		$28,410.96
66	1.2.2.4.2	Technical team management/coordination	Fri 4/9/21	Thu 12/1/22	344 hrs	86 wks	ProvostN_B[10%]		$28,410.96
67	1.2.2.4.3	Risk Management	Fri 4/9/21	Thu 12/1/22	344 hrs	86 wks	ProvostN_B[10%]		$28,410.96
68	1.2.2.5	Integration and Test (I&T)	Thu 12/29/22	Wed 6/19/24	924 hrs	77 wks		18	$80,960.88
69	1.2.2.5.1	Configuration Management	Thu 12/29/22	Wed 6/19/24	308 hrs	77 wks	SE1_I[10%]		$26,986.96
70	1.2.2.5.2	Technical team management/coordination	Thu 12/29/22	Wed 6/19/24	308 hrs	77 wks	ProvostN_I[10%]		$26,986.96
71	1.2.2.5.3	Risk Management	Thu 12/29/22	Wed 6/19/24	308 hrs	77 wks	ProvostN_I[10%]		$26,986.96



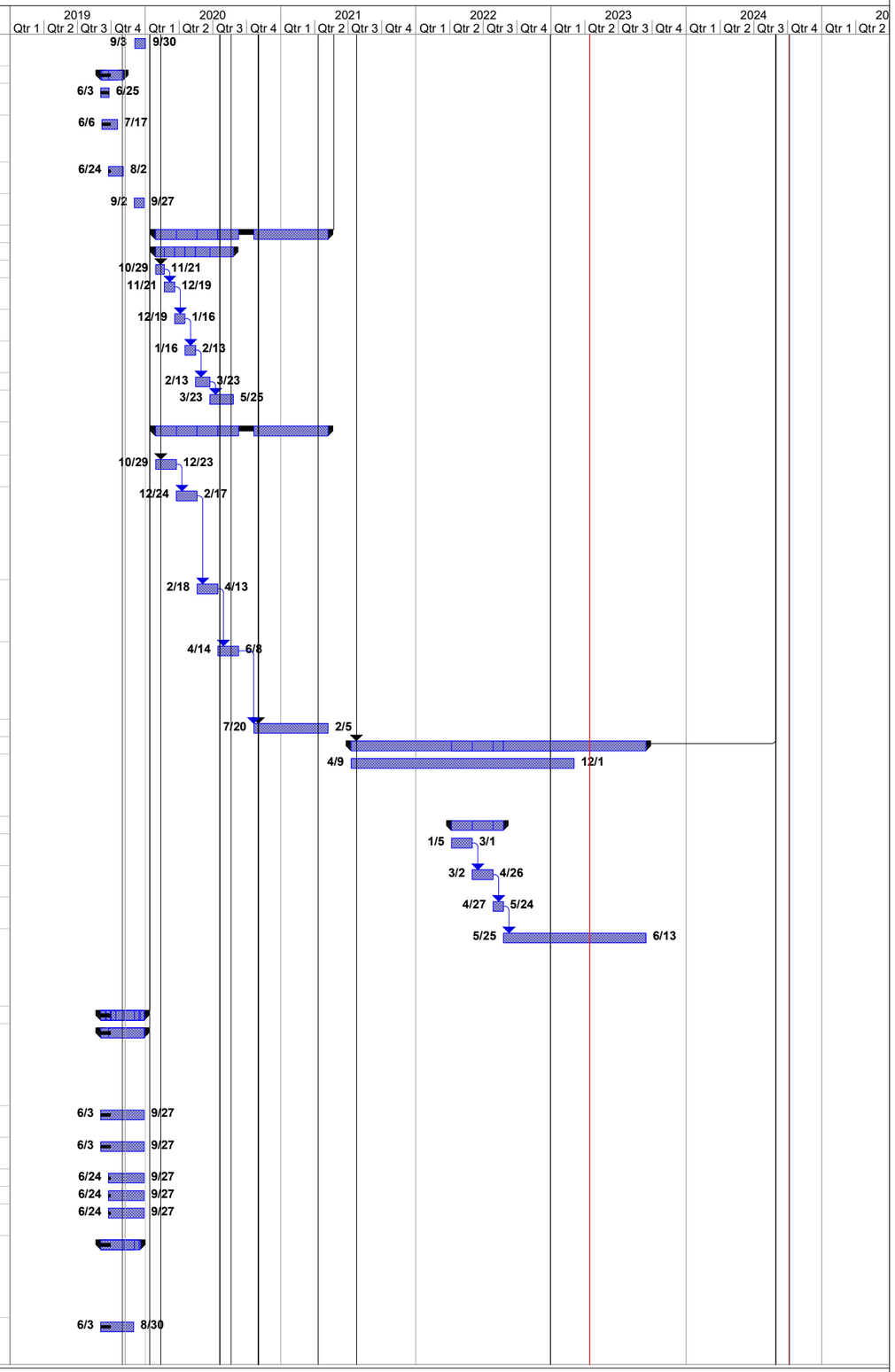
Gemini GNAO/RTC Work Breakdown Structure, 7/29/19

ID	WBS	Task Name	Start	Finish	Work	Duration	Resource Names	Predecessors	Cost
72	1.3	Science, including the AOWG	Mon 6/3/19	Wed 6/19/24	9,464 hrs	263.6 wks			$644,695.56
73	1.3.1	Science	Mon 6/3/19	Wed 6/19/24	4,832 hrs	263.6 wks			$339,214.44
74	1.3.1.1	Conceptual Design	Mon 6/3/19	Fri 9/27/19	640 hrs	17 wks			$37,314.72
75	1.3.1.1.1	Prepare science cases and derive scientific requirements	Mon 6/3/19	Fri 9/27/19	100 hrs	17 wks			$5,734.68
76	1.3.1.1.1.1	Collect science case input	Mon 6/3/19	Fri 6/28/19	16 hrs	4 wks	AndersenM_P[10%]		$0.00
77	1.3.1.1.1.2	Derive science requirements	Mon 7/1/19	Fri 7/26/19	32 hrs	4 wks	AndersenM_P[20%]	76	$2,184.64
78	1.3.1.1.1.3	Finalize CoDR version of science case document	Mon 7/1/19	Fri 9/27/19	52 hrs	13 wks	AndersenM_P[10%]	77FS-4 wks	$3,550.04
79	1.3.1.1.2	Prepare Concept of Operations document together with technical team using flowed-down requirements from science team and AO working group. This includes initial strategies for commissioning and acceptance tests. This includes visiting a GeMS run at GS.	Mon 6/3/19	Fri 9/13/19	540 hrs	15 wks			$31,580.04
80	1.3.1.1.2.1	Derive LGS concept of operations together with LGS team	Mon 6/3/19	Fri 8/2/19	126 hrs	9 wks	ProvostN_P[5%],AndersenM		$4,934.60
81	1.3.1.1.2.2	Derive AO system concept of operations together with AO team	Mon 6/17/19	Fri 8/16/19	126 hrs	9 wks	ProvostN_P[5%],AndersenM	80FS-7 wks	$6,908.44
82	1.3.1.1.2.3	Derive software requirements together with software team	Mon 7/1/19	Fri 8/30/19	144 hrs	9 wks	ProvostN_P[5%],AndersenM	81FS-7 wks	$10,164.96
83	1.3.1.1.2.4	Derive science operational concepts together with SOS team	Mon 7/15/19	Fri 9/13/19	144 hrs	9 wks	SivoG_P[5%],ProvostN_P[5	82FS-7 wks	$9,572.04
84	1.3.1.2	Preliminary Design	Tue 10/29/19	Mon 6/29/20	876 hrs	35 wks			$59,804.52
85	1.3.1.2.1	Review/update science cases for PD	Fri 4/17/20	Thu 6/18/20	36 hrs	9 wks	AndersenM_P[10%]	8FS-9 wks	$2,457.72
86	1.3.1.2.2	Update concepts of operations for PD	Tue 10/29/19	Mon 6/29/20	420 hrs	35 wks	ScharwaechterJ_P[30%]	6	$28,673.40
87	1.3.1.2.3	Participate in preparing acceptance test plan	Tue 10/29/19	Mon 6/29/20	420 hrs	35 wks	ScharwaechterJ_P[30%]	6	$28,673.40
88	1.3.1.3	Critical Design	Mon 7/20/20	Fri 3/19/21	1,016 hrs	35 wks			$71,445.12
89	1.3.1.3.1	Review/update science cases for CD	Thu 1/7/21	Wed 3/10/21	36 hrs	9 wks	AndersenM_C[10%]	12FS-9 wks	$2,531.52
90	1.3.1.3.2	Update concepts of operations for CD	Mon 7/20/20	Fri 3/19/21	280 hrs	35 wks	ScharwaechterJ_C[20%]	10	$19,689.60
91	1.3.1.3.3	Participate in updating acceptance test plan	Mon 7/20/20	Fri 3/19/21	280 hrs	35 wks	ScharwaechterJ_C[20%]	10	$19,689.60
92	1.3.1.3.4	Participate in preparing commissioning plan	Mon 7/20/20	Fri 3/19/21	420 hrs	35 wks	ScharwaechterJ_C[30%]	10	$29,534.40
93	1.3.1.4	Build / Implement	Fri 4/9/21	Thu 12/1/22	1,376 hrs	86 wks			$99,649.92
94	1.3.1.4.1	Participate in updating acceptance test plan	Fri 4/9/21	Thu 12/1/22	688 hrs	86 wks	ScharwaechterJ_B[20%]	14	$49,824.96
95	1.3.1.4.2	Participate in updating commissioning plan	Fri 4/9/21	Thu 12/1/22	688 hrs	86 wks	ScharwaechterJ_B[20%]	14	$49,824.96
96	1.3.1.5	Integration And Test	Thu 12/29/22	Wed 6/19/24	924 hrs	77 wks			$71,000.16
97	1.3.1.5.1	Participate in acceptance testing	Thu 12/29/22	Wed 6/19/24	924 hrs	77 wks	ScharwaechterJ_I[30%]	18	$71,000.16
98	1.3.2	AO Working Group	Mon 6/3/19	Wed 6/19/24	4,632 hrs	263.6 wks			$305,481.12
99	1.3.2.1	Conceptual Design	Mon 6/3/19	Fri 9/27/19	356 hrs	17 wks			$19,522.68
100	1.3.2.1.1	Define trade off tasks based on science inputs	Mon 6/3/19	Fri 9/27/19	356 hrs	17 wks			$19,522.68
101	1.3.2.1.1.1	Review science cases drivers	Mon 6/3/19	Fri 6/28/19	16 hrs	4 wks	SivoG_P[10%]		$0.00
102	1.3.2.1.1.2	Participate in defining AO trade offs	Mon 7/1/19	Fri 7/26/19	64 hrs	4 wks	SivoG_P[20%],MarinE_P[20	101	$4,560.96
103	1.3.2.1.1.3	Participate in performing AO trade offs	Mon 7/29/19	Fri 9/13/19	28 hrs	7 wks	SivoG_P[10%]	102	$1,911.56
104	1.3.2.1.1.4	Design and do simulations to support trades and to inform other decisions	Mon 7/29/19	Fri 9/27/19	216 hrs	9 wks	SivoG_P[10%],CatalaL_P[5(	102	$10,865.52
105	1.3.2.1.1.5	Review/Update GNAO AO documentation	Mon 9/16/19	Fri 9/27/19	32 hrs	2 wks	SivoG_P[40%]	103	$2,184.64
106	1.3.2.2	Preliminary Design	Tue 10/29/19	Mon 6/22/20	1,088 hrs	34 wks		6	$59,616.96
107	1.3.2.2.1	Review Concept of Operations document together with technical team using flowed-down requirements from science team and AO working group. This includes initial strategies for commissioning and acceptance tests.	Tue 10/29/19	Mon 6/22/20	1,088 hrs	34 wks			$59,616.96
108	1.3.2.2.1.1	Review/update AO top-level requirements based on science cases for PDR (including consultation with science team)	Tue 10/29/19	Mon 6/22/20	136 hrs	34 wks	SivoG_P[10%]		$9,284.72
109	1.3.2.2.1.2	Detailed AO simulations adapted to selected PD design	Tue 10/29/19	Mon 6/22/20	952 hrs	34 wks	SivoG_P[20%],CatalaL_P[5(		$50,332.24
110	1.3.2.3	Critical Design	Mon 7/20/20	Fri 3/12/21	544 hrs	34 wks		10	$38,254.08
111	1.3.2.3.1	Review/update AO top-level requiremets based on science cases for CDR	Mon 7/20/20	Fri 3/12/21	136 hrs	34 wks	SivoG_C[10%]		$9,563.52
112	1.3.2.3.2	PI Support	Mon 7/20/20	Fri 3/12/21	408 hrs	34 wks	SivoG_C[30%]		$28,690.56
113	1.3.2.4	Build / Implement	Fri 4/9/21	Thu 12/1/22	1,720 hrs	86 wks		14	$124,562.40
114	1.3.2.4.1	PI Support	Fri 4/9/21	Thu 12/1/22	1,720 hrs	86 wks	SivoG_B[50%]		$124,562.40
115	1.3.2.5	Integration and Test (I&T)	Thu 12/29/22	Wed 6/19/24	924 hrs	77 wks		18	$63,525.00
116	1.3.2.5.1	Participate in bench performance verification	Thu 12/29/22	Wed 6/19/24	924 hrs	77 wks	SivoG_I[20%],CatalaL_I[10%		$63,525.00
117	**1.4**	**Laser Guide Star Subsystem (LGS)**	**Mon 6/3/19**	**Fri 3/15/24**	**26,472.56 hrs**	**250 wks**			**$1,927,919.32**
118	**1.4.1**	**LGS Systems Engineering**	**Mon 6/3/19**	**Tue 6/13/23**	**7,496.36 hrs**	**210.4 wks**			**$563,579.00**
119	**1.4.1.1**	**Conceptual Design**	**Mon 6/3/19**	**Mon 9/30/19**	**573.9 hrs**	**17.2 wks**			**$17,806.30**
120	**1.4.1.1.1**	**LGS Subsystem requirements definition**	**Mon 6/3/19**	**Mon 9/30/19**	**258.4 hrs**	**17.2 wks**			**$6,499.91**
121	1.4.1.1.1.1	Generate LGS Top Level Functional Flow Break Down	Mon 6/3/19	Tue 7/16/19	100 hrs	6.25 wks	RamboldW_P[10%],MarinE_		$2,770.29
122	1.4.1.1.1.2	Flow Top Level Requirements to LGS from top level science Requirements (First Draft)	Mon 6/3/19	Wed 7/3/19	72 hrs	4.5 wks	MarinE_P[5%],MorenoC_P[5		$615.62
123	1.4.1.1.1.3	Generate LGS Functional Requirements and compare against existing GN and GS LGS requirements (First Draft)	Mon 6/3/19	Wed 6/12/19	22.4 hrs	1.6 wks	MarinE_P[5%],BassettJ_P[2		$0.00
124	1.4.1.1.1.4	Update Requirements based on Interface Definition, Conops, Trade Study Results etc, Add rationale	Mon 6/3/19	Fri 7/26/19	48 hrs	8 wks	BassettJ_P[15%]		$1,868.40



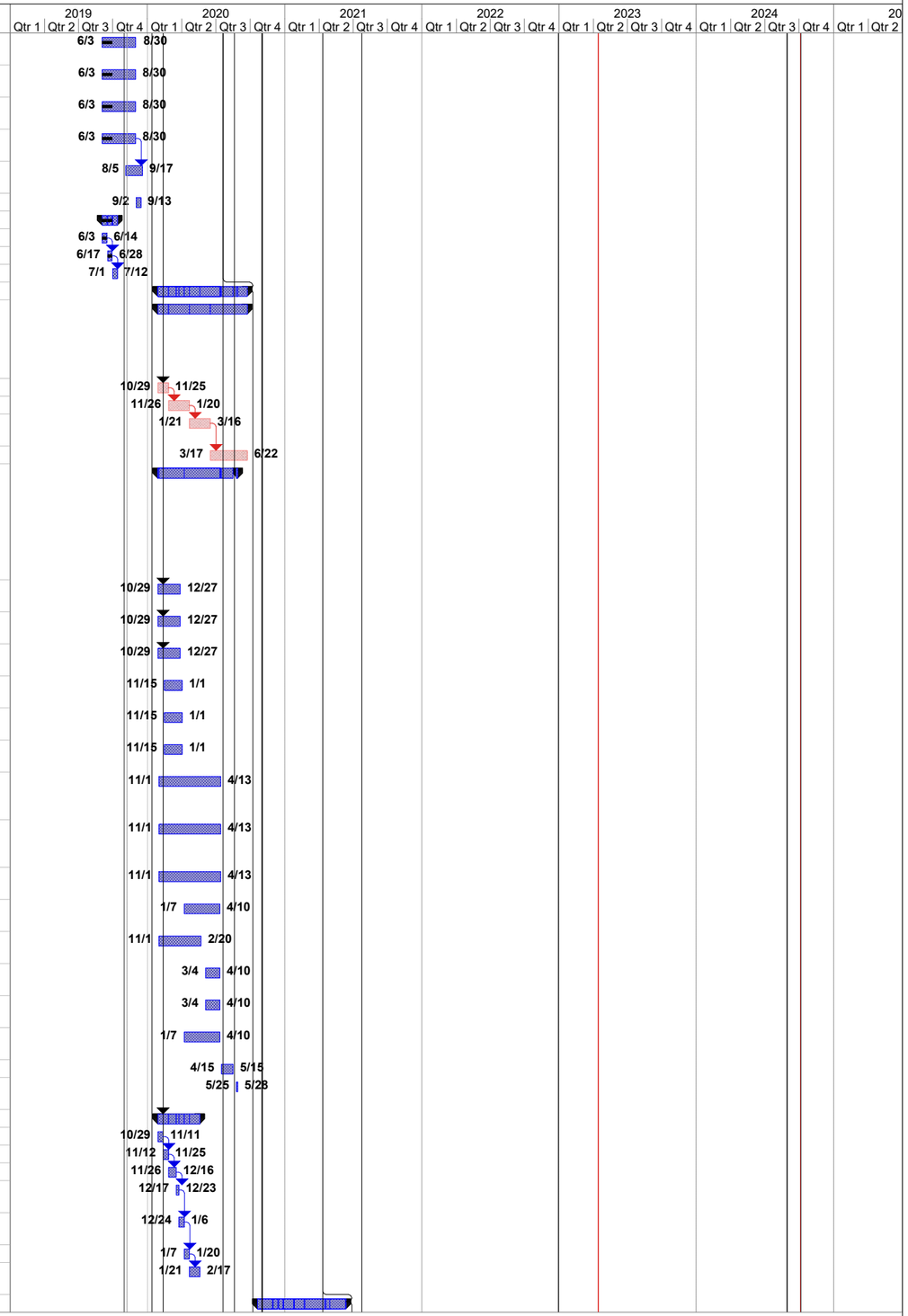
Gemini GNAO/RTC Work Breakdown Structure, 7/29/19

ID	WBS	Task Name	Start	Finish	Work	Duration	Resource Names	Predecessors	Cost
125	1.4.1.1.1.5	Finalize Export LGS Subsystem Requirements Document for CoDR	Tue 9/3/19	Mon 9/30/19	16 hrs	4 wks	BassettJ_P[10%]		$1,245.60
126	**1.4.1.1.2**	**Generate LGS ConOps**	**Mon 6/3/19**	**Fri 8/2/19**	**299.5 hrs**	**9 wks**			**$10,060.79**
127	1.4.1.1.2.1	Describe GeMS LGSF System and Reason for Change	Mon 6/3/19	Tue 6/25/19	71.5 hrs	3.25 wks	RamboldW_P[10%],MarinE_		$0.00
128	1.4.1.1.2.2	Describe GNAO LGSF System Operation, including safety system, diagnostics, alignment, etc. (1st Draft)	Thu 6/6/19	Wed 7/17/19	132 hrs	6 wks	RamboldW_P[10%],MarinE_		$4,203.99
129	1.4.1.1.2.3	Review, Update LGSF Conops, incorporate into GNAO conops	Mon 6/24/19	Fri 8/2/19	96 hrs	6 wks	RamboldW_P[10%],MarinE_		$5,856.80
130	1.4.1.1.3	Review and provide input on LGS documentation package	Mon 9/2/19	Fri 9/27/19	16 hrs	4 wks	BassettJ_P[10%]		$1,245.60
131	**1.4.1.2**	**Preliminary and Critical Design**	**Tue 10/29/19**	**Fri 2/5/21**	**2,642.46 hrs**	**66.8 wks**			**$197,053.70**
132	**1.4.1.2.1**	**Generate LGS Interface requirements definition**	**Tue 10/29/19**	**Mon 5/25/20**	**550.46 hrs**	**29.82 wks**			**$40,793.38**
133	1.4.1.2.1.1	Define LGSF Functional External Interfaces	Tue 10/29/19	Thu 11/21/19	104.46 hrs	3.48 wks	RamboldW_P[10%],MarinE_	6	$7,815.72
134	1.4.1.2.1.2	Generate LGS Interface Control Document for LGS - RTC First Draft	Thu 11/21/19	Thu 12/19/19	72 hrs	4 wks	EbbersA_P[20%],ProvostN_	133	$5,279.44
135	1.4.1.2.1.3	Generate LGS Interface Control Document for LGS - TLC First Draft	Thu 12/19/19	Thu 1/16/20	72 hrs	4 wks	EbbersA_P[20%],ProvostN_	134	$5,279.44
136	1.4.1.2.1.4	Generate LGS Interface Control Document for LGS -TCC First Draft	Thu 1/16/20	Thu 2/13/20	72 hrs	4 wks	EbbersA_P[20%],ProvostN_	135	$5,279.44
137	1.4.1.2.1.5	Update, ReviewEnvironmental Requiremnts	Thu 2/13/20	Mon 3/23/20	32 hrs	5.33 wks	MarinE_P[5%],CavedoniC_F	136	$2,414.61
138	1.4.1.2.1.6	Review, Update, Finalize PDR Drafts of ICDs	Mon 3/23/20	Mon 5/25/20	198 hrs	9 wks	RamboldW_P[10%],MarinE_	137	$14,724.72
139	**1.4.1.2.2**	**LGS Design Systems Engineering and Oversight**	**Tue 10/29/19**	**Fri 2/5/21**	**2,092 hrs**	**66.8 wks**			**$156,260.32**
140	1.4.1.2.2.1	Continue to Refine Functional Analysis, LGS Requirements, andConops	Tue 10/29/19	Mon 12/23/19	320 hrs	8 wks	MarinE_P[50%],CavedoniC_	6	$23,782.08
141	1.4.1.2.2.2	Define the Physical Architecture (or Product Breakedown Structure) of LGS, by decomposition of the Functional Architecture, defined from Functional Analysis and Allocation, and LGS decomposition processes.	Tue 12/24/19	Mon 2/17/20	320 hrs	8 wks	MarinE_P[50%],CavedoniC_	140	$23,782.08
142	1.4.1.2.2.3	Define Design Solution of the Physical Architecture that satisfy the ConOps and the de-composed (flowed down, derived and allocated) set of subsystem requirements.	Tue 2/18/20	Mon 4/13/20	320 hrs	8 wks	MarinE_P[50%],CavedoniC_	141	$23,782.08
143	1.4.1.2.2.4	Decompose requirements to component level, generate low level specifications	Tue 4/14/20	Mon 6/8/20	320 hrs	8 wks	MarinE_P[50%],CavedoniC_	142	$23,782.08
144	1.4.1.2.2.5	Provide SE/WPM oversight	Mon 7/20/20	Fri 2/5/21	812 hrs	29 wks	MarinE_P[50%],BassettJ_P[	143,10	$61,132.00
145	**1.4.1.3**	**Build and Integration and Testing (I&T)**	**Fri 4/9/21**	**Tue 6/13/23**	**4,280 hrs**	**113.6 wks**		**14**	**$348,719.00**
146	1.4.1.3.1	LGS Fabrication Systems Engineering and Oversight, including change control, interface management, acceptance testing review and oversight, etc.	Fri 4/9/21	Thu 12/1/22	2,580 hrs	86 wks	MarinE_B[50%],BassettJ_B[		$206,529.00
147	**1.4.1.3.2**	**LGS Verification**	**Wed 1/5/22**	**Tue 5/24/22**	**600 hrs**	**20 wks**			**$48,030.00**
148	1.4.1.3.2.1	Generate detailed LGS acceptance plan and procedure	Wed 1/5/22	Tue 3/1/22	240 hrs	8 wks	MarinE_B[50%],BassettJ_B[		$19,212.00
149	1.4.1.3.2.2	Participate in LGS Acceptance testing, including all verification tests and analyses	Wed 3/2/22	Tue 4/26/22	240 hrs	8 wks	MarinE_B[50%],BassettJ_B[	148	$19,212.00
150	1.4.1.3.2.3	Review and approve Acceptance Test results	Wed 4/27/22	Tue 5/24/22	120 hrs	4 wks	MarinE_B[50%],BassettJ_B[	149	$9,606.00
151	1.4.1.3.3	Support LGS Integration and Test, including development of integration test plan, implementing plan, lead anomaly resolution, lead interface management, perform tests, review and document results	Wed 5/25/22	Tue 6/13/23	1,100 hrs	55 wks	MarinE_I[25%],BassettJ_I[2	150	$94,160.00
152	**1.4.2**	**Conceptual Design**	**Mon 6/3/19**	**Fri 9/27/19**	**972 hrs**	**17 wks**			**$50,559.94**
153	**1.4.2.1**	**Provide CoD of BTO layout for competing LGSF options. Provide optical performance, pricing difference, and fabrication comparison for consideration. Demonstrate that different designs can meet the project performance requirements.**	**Mon 6/3/19**	**Fri 9/27/19**	**304.8 hrs**	**17 wks**			**$19,693.75**
154	1.4.2.1.1	Define functional optical requirements for propsed LGSF options	Mon 6/3/19	Fri 9/27/19	54.4 hrs	17 wks	CavedoniC_P[3%],Schneide		$3,089.22
155	1.4.2.1.2	Define functional opto-mechanical requirements for propsed LGSF options	Mon 6/3/19	Fri 9/27/19	54.4 hrs	17 wks	CavedoniC_P[3%],Schneide		$3,089.22
156	1.4.2.1.3	Prepare conceptual optical design	Mon 6/24/19	Fri 9/27/19	56 hrs	14 wks	SchneiderT_P[10%]		$3,861.52
157	1.4.2.1.4	Prepare conceptual opto-mechanical layout	Mon 6/24/19	Fri 9/27/19	84 hrs	14 wks	CavedoniC_P[5%],Schneide		$5,792.28
158	1.4.2.1.5	Prepare cost and scheduld estimates for proposed LGSF options	Mon 6/24/19	Fri 9/27/19	56 hrs	14 wks	SchneiderT_P[10%]		$3,861.52
159	**1.4.2.2**	**Prepare MEP (Mechanical, Electrical, and Plumbing) Deliverable for CoD including 3-d mechanical layouts, mechanical balancing plans, mechanical mounting plans, electrical power plans and plumbing service plans.**	**Mon 6/3/19**	**Tue 9/17/19**	**507.2 hrs**	**15.4 wks**			**$28,159.39**
160	1.4.2.2.1	Prepare conceptual 3-d layouts for the proposed LGSF option(s) (including necessary LLTs, LHs, ECs, BTOs & LHXs)	Mon 6/3/19	Fri 8/30/19	156 hrs	13 wks	KangS_P[10%],SchneiderT_		$8,020.08



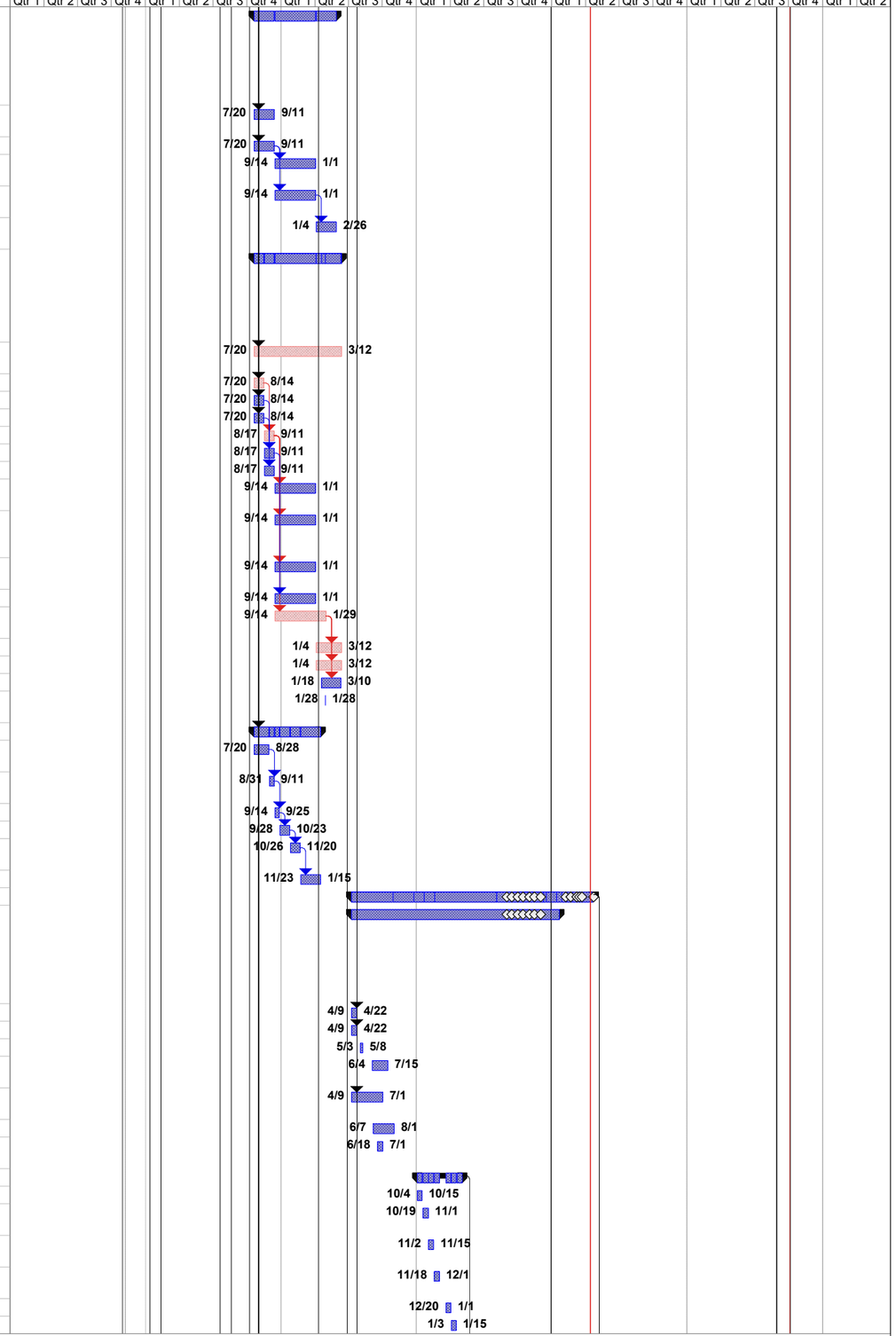
Gemini GNAO/RTC Work Breakdown Structure, 7/29/19

ID	WBS	Task Name	Start	Finish	Work	Duration	Resource Names	Predecessors	Cost
161	1.4.2.2.2	Prepare conceptual balancing plans for the proposed LGSF option(s)	Mon 6/3/19	Fri 8/30/19	52 hrs	13 wks	CavedoniC_P[10%]		$2,673.36
162	1.4.2.2.3	Prepare conceptual mounting schemes for the proposed LGSF option(s)	Mon 6/3/19	Fri 8/30/19	104 hrs	13 wks	CavedoniC_P[10%],KangS_		$5,346.72
163	1.4.2.2.4	Prepare conceptual plumbing service plans for proposed LGSF option(s)	Mon 6/3/19	Fri 8/30/19	52 hrs	13 wks	CavedoniC_P[10%]		$2,673.36
164	1.4.2.2.5	Prepare conceptual electrical power service plans for the proposed LGSF option(s)	Mon 6/3/19	Fri 8/30/19	52 hrs	13 wks	KarewiczS_P[10%]		$2,673.36
165	1.4.2.2.6	Prepare conceptual MEP cost and schedule estimates for the proposed LGSF option(s)	Mon 8/5/19	Tue 9/17/19	51.2 hrs	6.4 wks	KarewiczS_P[10%],Cavedor	164FS-4 wks	$3,802.11
166	1.4.2.2.7	Prepare CoD MEP Documents	Mon 9/2/19	Fri 9/13/19	40 hrs	2 wks	KarewiczS_P[10%],MarinE_		$2,970.40
167	**1.4.2.3**	**Control Computer Software**	**Mon 6/3/19**	**Fri 7/12/19**	**160 hrs**	**6 wks**			**$2,706.80**
168	1.4.2.3.1	Refine laser to LIS electronics interface	Mon 6/3/19	Fri 6/14/19	40 hrs	2 wks	KarewiczS_P[50%]		$0.00
169	1.4.2.3.2	Define LIS changes to support multiple lasers	Mon 6/17/19	Fri 6/28/19	80 hrs	2 wks	EbbersA_P[50%],KarewiczS	168	$0.00
170	1.4.2.3.3	Define motor control options for BIM/BTO	Mon 7/1/19	Fri 7/12/19	40 hrs	2 wks	EbbersA_P[50%]	169	$2,706.80
171	1.4.3	Preliminary Design	Tue 10/29/19	Mon 6/22/20	3,319.8 hrs	34 wks			$245,185.75
172	1.4.3.1	Provide preliminary optical design concept for LGSF units that include Zemax optical design model of BTO, 3-D mechanical model layout of BTO, initial build and alignment plan, and cost analysis.	Tue 10/29/19	Mon 6/22/20	668 hrs	34 wks			$49,605.68
173	1.4.3.1.1	Define full optical requirements for LGSF	Tue 10/29/19	Mon 11/25/19	80 hrs	4 wks	SchneiderT_P[50%]	6	$5,940.80
174	1.4.3.1.2	Prepare preliminary optical design	Tue 11/26/19	Mon 1/20/20	80 hrs	8 wks	SchneiderT_P[25%]	173	$5,940.80
175	1.4.3.1.3	Prepare preliminary opto-mechanical design layout	Tue 1/21/20	Mon 3/16/20	144 hrs	8 wks	SchneiderT_P[25%],Cavedc	174	$10,693.44
176	1.4.3.1.4	Prepare preliminary design for BTO enclosure	Tue 3/17/20	Mon 6/22/20	364 hrs	14 wks	KangS_P[20%],KarewiczS_I	175	$27,030.64
177	**1.4.3.2**	**Prepare MEP Deliverable for PD including 3-d mechanical layouts, mechanical assembly drawings, mechanical balancing plans and balancing hardware assembly drawings, mechanical mounting assembly drawings, electrical power plans and plumbing service plans.**	**Tue 10/29/19**	**Thu 5/28/20**	**2,131.8 hrs**	**30.5 wks**			**$158,307.47**
178	1.4.3.2.1	Refine mechancial functional requirements for down selected LGSF option	Tue 10/29/19	Fri 12/27/19	69.6 hrs	8.7 wks	CavedoniC_P[20%]	6	$5,168.50
179	1.4.3.2.2	Refine electrical functional requirements for down selected LGSF option	Tue 10/29/19	Fri 12/27/19	69.6 hrs	8.7 wks	KarewiczS_P[20%]	6	$5,168.50
180	1.4.3.2.3	Refine plumbing functional requirements for down selected LGSF option	Tue 10/29/19	Fri 12/27/19	69.6 hrs	8.7 wks	CavedoniC_P[20%]	6	$5,168.50
181	1.4.3.2.4	Define mechanical ICDs for down selected LGSF option	Fri 11/15/19	Wed 1/1/20	107.2 hrs	6.7 wks	KangS_P[20%],CavedoniC_		$7,960.67
182	1.4.3.2.5	Define electrical ICDs for down selected LGSF option	Fri 11/15/19	Wed 1/1/20	26.8 hrs	6.7 wks	KarewiczS_P[10%]		$1,990.17
183	1.4.3.2.6	Define plumbing ICDs for down selected LGSF option	Fri 11/15/19	Wed 1/1/20	26.8 hrs	6.7 wks	CavedoniC_P[10%]		$1,990.17
184	1.4.3.2.7	Prepare preliminary mechanical layouts for down selected LGSF hardware (including necessary LLTs, LHs, ECs, BTOs & LHXs)	Fri 11/1/19	Mon 4/13/20	372.8 hrs	23.3 wks	KangS_P[30%],CavedoniC_		$27,684.13
185	1.4.3.2.8	Prepare preliminary mechanical balancing plan and sequence of balancing for down selected LGSF	Fri 11/1/19	Mon 4/13/20	93.2 hrs	23.3 wks	CavedoniC_P[10%]		$6,921.03
186	1.4.3.2.9	Prepare preliminary mechanical mounting assembly drawings for down selected LGSF	Fri 11/1/19	Mon 4/13/20	559.2 hrs	23.3 wks	CavedoniC_P[20%],KangS_		$41,526.19
187	1.4.3.2.10	Prepare preliminary electrical power one-line diagrams for down selected LGSF	Tue 1/7/20	Fri 4/10/20	54.8 hrs	13.7 wks	KarewiczS_P[10%]		$4,069.45
188	1.4.3.2.11	Prepare preliminary plumbing schematic for down selected LGSF	Fri 11/1/19	Thu 2/20/20	128 hrs	16 wks	CavedoniC_P[10%],KangS_		$9,505.28
189	1.4.3.2.12	Prepare preliminary MEP cost estimates for down selected LGSF	Wed 3/4/20	Fri 4/10/20	44.8 hrs	5.6 wks	CavedoniC_P[10%],Karewic		$3,326.85
190	1.4.3.2.13	Prepare preliminary MEP schedule estimates for down selected LGSF	Wed 3/4/20	Fri 4/10/20	44.8 hrs	5.6 wks	CavedoniC_P[10%],Karewic		$3,326.85
191	1.4.3.2.14	Prepare technical specifications, solicit quotes and receive quotes for long-lead item(s) - LHX	Tue 1/7/20	Fri 4/10/20	137 hrs	13.7 wks	KangS_P[10%],KarewiczS_I		$10,173.62
192	1.4.3.2.15	Prepare PD MEP Documents	Wed 4/15/20	Fri 5/15/20	257.6 hrs	4.6 wks	KarewiczS_P[10%],Cavedor		$19,129.38
193	1.4.3.2.16	Review and address PD MEP Comments, Concerns & Questions	Mon 5/25/20	Thu 5/28/20	70 hrs	0.7 wks	KarewiczS_P[50%],Cavedor		$5,198.20
194	**1.4.3.3**	**Control Computer Software**	**Tue 10/29/19**	**Mon 2/17/20**	**520 hrs**	**16 wks**		**6**	**$37,272.60**
195	1.4.3.3.1	Analyze all I/O needs	Tue 10/29/19	Mon 11/11/19	40 hrs	2 wks	KarewiczS_P[50%]		$2,970.40
196	1.4.3.3.2	Choose Motor Control solution for BIM/BTO	Tue 11/12/19	Mon 11/25/19	80 hrs	2 wks	EbbersA_P[50%],Schneider	195	$5,677.20
197	1.4.3.3.3	Define BTO control architecture and functions.	Tue 11/26/19	Mon 12/16/19	120 hrs	3 wks	EbbersA_P[50%],RamboldV	196	$8,731.20
198	1.4.3.3.4	Define interface/control functions for new heat exchanger	Tue 12/17/19	Mon 12/23/19	40 hrs	1 wk	EbbersA_P[50%],KarewiczS	197	$2,838.60
199	1.4.3.3.5	Review current Toptica EPICS laser control solution	Tue 12/24/19	Mon 1/6/20	40 hrs	2 wks	EbbersA_P[50%]	198	$2,706.80
200	1.4.3.3.6	Define fast steering mirror (FSM) control	Tue 1/7/20	Mon 1/20/20	40 hrs	2 wks	EbbersA_P[50%]	199	$2,706.80
201	1.4.3.3.7	Define contents of consolidated Laser Control Console	Tue 1/21/20	Mon 2/17/20	160 hrs	4 wks	EbbersA_P[50%],RamboldV	200	$11,641.60
202	1.4.4	Critical Design	Mon 7/20/20	Fri 3/12/21	3,616.4 hrs	34 wks			$274,092.35



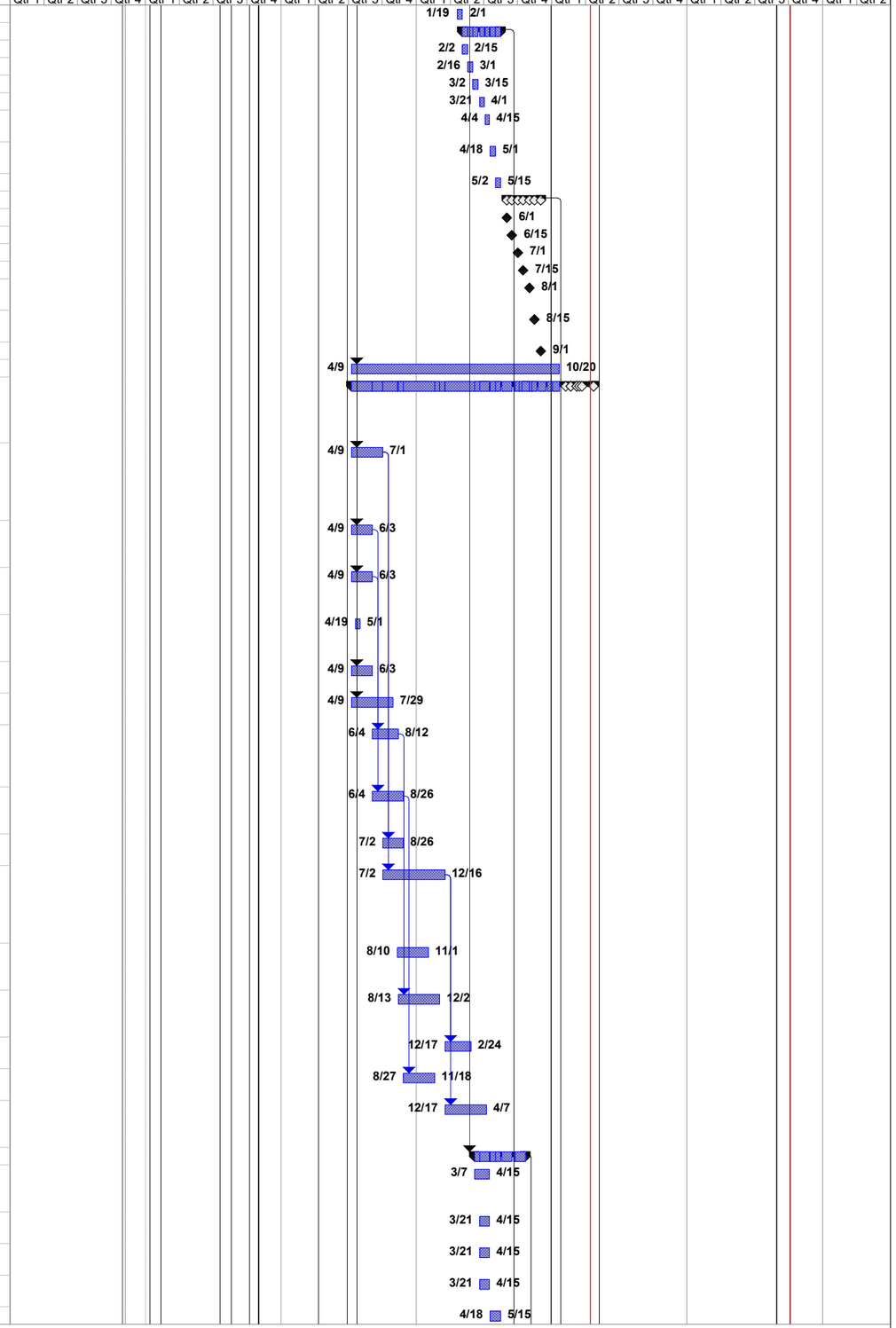
Gemini GNAO/RTC Work Breakdown Structure, 7/29/19

ID	WBS	Task Name	Start	Finish	Work	Duration	Resource Names	Predecessors	Cost
203	**1.4.4.1**	**Provide finalized optical design and analysis for LGSF units. Provide finalized 3-D mechanical model layout as well as schematic drawings for all necessary parts. Provide electrical diagram for all electronic parts. Provide parts list and final prices.**	**Mon 7/20/20**	**Fri 2/26/21**	**924.8 hrs**	**32 wks**			**$70,156.54**
204	1.4.4.1.1	Prepare comprehensive optical layout and analysis	Mon 7/20/20	Fri 9/11/20	80 hrs	8 wks	SchneiderT_C[25%]	10	$6,118.40
205	1.4.4.1.2	Prepare finalized opto-mechanical parts list	Mon 7/20/20	Fri 9/11/20	144 hrs	8 wks	SchneiderT_C[25%],Cavedc	10	$11,013.12
206	1.4.4.1.3	Prepare 3-D model of BTO optical bench and enclosure	Mon 9/14/20	Fri 1/1/21	288 hrs	16 wks	KangS_C[20%],SchneiderT_	205	$22,026.24
207	1.4.4.1.4	Prepare electrical diagram for opto-electronic parts	Mon 9/14/20	Fri 1/1/21	140.8 hrs	16 wks	SchneiderT_C[2%],Karewicz	205	$10,768.38
208	1.4.4.1.5	Prepare build, integration, and testing plans for LGSF units	Mon 1/4/21	Fri 2/26/21	272 hrs	8 wks	Tech2_C[5%],Tech3_C[5%]	207	$20,230.40
209	1.4.4.2	Prep MEP Delivs for CD including 3-d mech layouts, assem & fab drawings, mech balancing plans & HW assem & fab drawings, mech mounting plans, assem & fab drawings, electrical power plans install drawings & plumb service plans & install & spec procures	Mon 7/20/20	Fri 3/12/21	1,899.6 hrs	34 wks			$145,281.41
210	1.4.4.2.1	Release and track purchase order(s) for agreed long lead MEP items (LHX)	Mon 7/20/20	Fri 3/12/21	136 hrs	34 wks	CavedoniC_C[10%]	10	$10,401.28
211	1.4.4.2.2	Refine mechanical functional requirements	Mon 7/20/20	Fri 8/14/20	32 hrs	4 wks	CavedoniC_C[10%],KangS_	10	$2,447.36
212	1.4.4.2.3	Refine electrical functional requirements	Mon 7/20/20	Fri 8/14/20	16 hrs	4 wks	KarewiczS_C[10%]	10	$1,223.68
213	1.4.4.2.4	Refine plumbing functional requirements	Mon 7/20/20	Fri 8/14/20	32 hrs	4 wks	CavedoniC_C[20%]	10	$2,447.36
214	1.4.4.2.5	Refine mechanical ICDs	Mon 8/17/20	Fri 9/11/20	64 hrs	4 wks	CavedoniC_C[20%],KangS_	211	$4,894.72
215	1.4.4.2.6	Refine electrical ICDs	Mon 8/17/20	Fri 9/11/20	16 hrs	4 wks	KarewiczS_C[10%]	212	$1,223.68
216	1.4.4.2.7	Refine plumbing ICDs	Mon 8/17/20	Fri 9/11/20	32 hrs	4 wks	CavedoniC_C[10%],KangS_	213	$2,447.36
217	1.4.4.2.8	Prepare critical mechanical layout, assembly, and fab drawings	Mon 9/14/20	Fri 1/1/21	256 hrs	16 wks	KangS_C[30%],CavedoniC_	214	$19,578.88
218	1.4.4.2.9	Prepare critical mechanical balancing plan and sequence of balancing telescope thru Build Sequence	Mon 9/14/20	Fri 1/1/21	128 hrs	16 wks	CavedoniC_C[20%]	214	$9,789.44
219	1.4.4.2.10	Prepare critical mechanical mounting assembly and fab drawings	Mon 9/14/20	Fri 1/1/21	320 hrs	16 wks	CavedoniC_C[10%],KangS_	214	$24,473.60
220	1.4.4.2.11	Prepare critical electrical power fab drawings	Mon 9/14/20	Fri 1/1/21	192 hrs	16 wks	KarewiczS_C[30%]	215	$14,684.16
221	1.4.4.2.12	Prepare critical plumbing schematic and fab drawings	Mon 9/14/20	Fri 1/29/21	80 hrs	20 wks	CavedoniC_C[10%]	214	$6,118.40
222	1.4.4.2.13	Prepare critical MEP cost estimates	Mon 1/4/21	Fri 3/12/21	80 hrs	10 wks	CavedoniC_C[10%],Karewic	221FS-4 wks	$6,118.40
223	1.4.4.2.14	Prepare critical MEP schedule estimates	Mon 1/4/21	Fri 3/12/21	80 hrs	10 wks	KarewiczS_C[10%],Cavedor	221FS-4 wks	$6,118.40
224	1.4.4.2.15	Prepare CD MEP Documents	Mon 1/18/21	Wed 3/10/21	425.6 hrs	7.6 wks	KarewiczS_C[10%],Cavedor	221FS-2 wks	$32,549.89
225	1.4.4.2.16	Review and address CD MEP Comments, Concerns & Questions	Thu 1/28/21	Thu 1/28/21	10 hrs	0.1 wks	KangS_C,KarewiczS_C[50%		$764.80
226	**1.4.4.3**	**Control Computer Software**	**Mon 7/20/20**	**Fri 1/15/21**	**792 hrs**	**26 wks**		**10**	**$58,654.40**
227	1.4.4.3.1	Design BTO software (produce detailed design doc)	Mon 7/20/20	Fri 8/28/20	240 hrs	6 wks	EbbersA_C[50%],RamboldV		$17,985.60
228	1.4.4.3.2	Design LIS changes (produce detailed design doc)	Mon 8/31/20	Fri 9/11/20	80 hrs	2 wks	EbbersA_C[50%],KarewiczS	227	$5,847.20
229	1.4.4.3.3	Design interface changes (if needed)	Mon 9/14/20	Fri 9/25/20	40 hrs	2 wks	EbbersA_C[50%]	228	$2,788.00
230	1.4.4.3.4	Design fast steering mirror (FSM) control	Mon 9/28/20	Fri 10/23/20	80 hrs	4 wks	EbbersA_C[50%]	229	$5,576.00
231	1.4.4.3.5	Design Laser Control Console (produce detailed design doc)	Mon 10/26/20	Fri 11/20/20	160 hrs	4 wks	EbbersA_C[50%],RamboldV	230	$11,990.40
232	1.4.4.3.6	Design interface to new heat exchanger	Mon 11/23/20	Fri 1/15/21	192 hrs	8 wks	KarewiczS_C[50%],EbbersA	231	$14,467.20
233	1.4.5	Build	Fri 4/9/21	Sat 1/21/23	9,868 hrs	93.2 wks			$694,206.28
234	**1.4.5.1**	**Order and receive optical parts and tools necessary to build and align LGSF units. Build BTO units in lab and order BTO enclosure from vendor after soliciting quotes. Integrate, align, and test BTO, Laser Head, and LLT in lab before attaching components.**	**Fri 4/9/21**	**Thu 10/20/22**	**2,620 hrs**	**80 wks**			**$183,957.60**
235	1.4.5.1.1	Order optical and opto-mechanical components	Fri 4/9/21	Thu 4/22/21	60 hrs	2 wks	SchneiderT_B[75%]	14	$4,726.80
236	1.4.5.1.2	Solicit quotes for BTO enclosure builds	Fri 4/9/21	Thu 4/22/21	8 hrs	2 wks	SchneiderT_B[5%],Cavedor	14	$630.24
237	1.4.5.1.3	Receive BTO enclosures	Mon 5/3/21	Sat 5/8/21	8 hrs	1 wk	SchneiderT_B[10%],Cavedc		$630.24
238	1.4.5.1.4	Assemble optical components of 3 BTO optical benches and enclosures in lab	Fri 6/4/21	Thu 7/15/21	360 hrs	6 wks	SchneiderT_B[50%],Tech3_		$23,937.60
239	1.4.5.1.5	Build software controls for BTO opto-electronics	Fri 4/9/21	Thu 7/1/21	480 hrs	12 wks	EbbersA_B	14	$34,459.20
240	1.4.5.1.6	Wire BTO opto-electronics	Mon 6/7/21	Sun 8/1/21	160 hrs	8 wks	Tech2_B[50%]		$9,656.00
241	1.4.5.1.7	Test full BTO functionality in lab with alignment laser	Fri 6/18/21	Thu 7/1/21	120 hrs	2 wks	EbbersA_B[50%],KarewiczS		$9,174.00
242	**1.4.5.1.8**	**Laser System #1**	**Mon 10/4/21**	**Tue 2/1/22**	**680 hrs**	**17.4 wks**			**$47,850.80**
243	1.4.5.1.8.1	Receive LLT #1 for acceptance test in lab	Mon 10/4/21	Fri 10/15/21	80 hrs	2 wks	Tech3_B[50%],SchneiderT_		$5,565.20
244	1.4.5.1.8.2	Integrate LLT #1 on BTO #1 optical bench for testing	Tue 10/19/21	Mon 11/1/21	80 hrs	2 wks	SchneiderT_B[50%],Tech3_		$5,565.20
245	1.4.5.1.8.3	Receive Toptica laser #1, conduct acceptance testing in lab	Tue 11/2/21	Mon 11/15/21	80 hrs	2 wks	SchneiderT_B[50%],Tech3_		$5,565.20
246	1.4.5.1.8.4	Integrate Toptica laser #1, LLT #1, and optical bench for testing and qualification	Thu 11/18/21	Wed 12/1/21	80 hrs	2 wks	SchneiderT_B[50%],Tech3_		$5,565.20
247	1.4.5.1.8.5	Receive LLT #2 for acceptance test in lab	Mon 12/20/21	Sat 1/1/22	80 hrs	2 wks	SchneiderT_B[50%],Tech3_		$5,565.20
248	1.4.5.1.8.6	Integrate LLT #2 onto LGSF 1	Mon 1/3/22	Sat 1/15/22	80 hrs	2 wks	Tech3_B[50%],SchneiderT_		$5,565.20



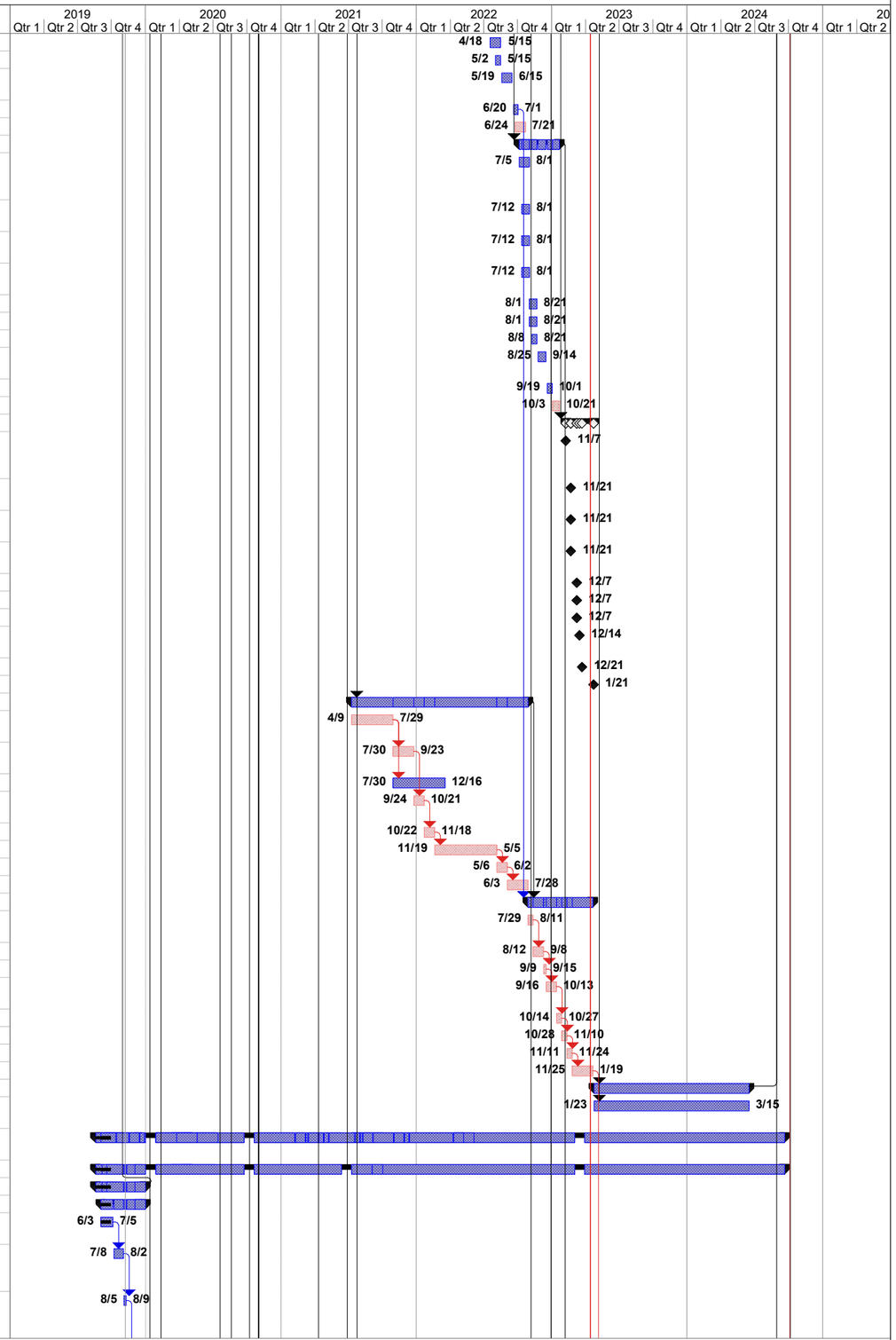
Gemini GNAO/RTC Work Breakdown Structure, 7/29/19

ID	WBS	Task Name	Start	Finish	Work	Duration	Resource Names	Predecessors	Cost
249	1.4.5.1.8.7	Test full functionality of LGSF 1 in lab	Wed 1/19/22	Tue 2/1/22	200 hrs	2 wks	EbbersA_B,Tech3_B[50%],S		$14,459.60
250	**1.4.5.1.9**	**Laser System #2**	**Wed 2/2/22**	**Sun 5/15/22**	**680 hrs**	**14.6 wks**			**$47,850.80**
251	1.4.5.1.9.1	Receive LLT #3 for acceptance test in lab	Wed 2/2/22	Tue 2/15/22	80 hrs	2 wks	SchneiderT_B[50%],Tech3_		$5,565.20
252	1.4.5.1.9.2	Integrate LLT #3 on BTO #2 for testing	Wed 2/16/22	Tue 3/1/22	80 hrs	2 wks	Tech3_B[50%],SchneiderT_		$5,565.20
253	1.4.5.1.9.3	Receive LLT #4 for acceptance test in lab	Wed 3/2/22	Tue 3/15/22	80 hrs	2 wks	SchneiderT_B[50%],Tech3_		$5,565.20
254	1.4.5.1.9.4	Integrate LLT #4 on BTO #2 for testing	Mon 3/21/22	Fri 4/1/22	80 hrs	2 wks	SchneiderT_B[50%],Tech3_		$5,565.20
255	1.4.5.1.9.5	Receive Toptica laser #2, conduct acceptance testing in lab	Mon 4/4/22	Fri 4/15/22	80 hrs	2 wks	SchneiderT_B[50%],Tech3_		$5,565.20
256	1.4.5.1.9.6	Integrate Toptica laser #2, LLTs #3+4, and BTO for testing and qualification (LGSF 2)	Mon 4/18/22	Sun 5/1/22	80 hrs	2 wks	SchneiderT_B[50%],Tech3_		$5,565.20
257	1.4.5.1.9.7	Test full functionality of LGSF 2 in lab	Mon 5/2/22	Sun 5/15/22	200 hrs	2 wks	EbbersA_B,Tech3_B[50%],S		$14,459.60
258	**1.4.5.1.10**	**Laser System #3 (if needed)**	**Wed 6/1/22**	**Thu 9/1/22**	**0 hrs**	**13.2 wks**			**$0.00**
259	1.4.5.1.10.1	Receive LLT #5 for acceptance test in lab	Wed 6/1/22	Wed 6/1/22	0 hrs	0 wks	SchneiderT_B[50%],Tech3_		$0.00
260	1.4.5.1.10.2	Integrate LLT #5 on BTO #3 for testing	Wed 6/15/22	Wed 6/15/22	0 hrs	0 wks	SchneiderT_B[50%],Tech3_		$0.00
261	1.4.5.1.10.3	Receive LLT #6 for acceptance test in lab	Fri 7/1/22	Fri 7/1/22	0 hrs	0 wks	SchneiderT_B[50%],Tech3_		$0.00
262	1.4.5.1.10.4	Integrate LLT #6 on BTO #3 for testing	Fri 7/15/22	Fri 7/15/22	0 hrs	0 wks	SchneiderT_B[50%],Tech3_		$0.00
263	1.4.5.1.10.5	Remove old Toptica laser from telescope for integration into BTO #3	Mon 8/1/22	Mon 8/1/22	0 hrs	0 wks	SchneiderT_B,CavedoniC_E		$0.00
264	1.4.5.1.10.6	Integrate Toptica laser #3, LLTs #5+6, and BTO #3 for testing and qualification (LGSF 3)	Mon 8/15/22	Mon 8/15/22	0 hrs	0 wks	SchneiderT_B[50%],Tech3_		$0.00
265	1.4.5.1.10.7	Test full functionality of LGSF 3 in lab	Thu 9/1/22	Thu 9/1/22	0 hrs	0 wks	SchneiderT_B,EbbersA_B,T		$0.00
266	1.4.5.1.11	BTO optics detailed documentation	Fri 4/9/21	Thu 10/20/22	64 hrs	80 wks	SchneiderT_B[2%]	14	$5,041.92
267	**1.4.5.2**	**Receive, Build and Install MEP hardware and systems including all necessary alignment tools, mounting hardware and telescope balancing hardware for LGS**	**Fri 4/9/21**	**Sat 1/21/23**	**4,808 hrs**	**93.2 wks**			**$325,444.28**
268	1.4.5.2.1	Solicit final quotes and release orders for all fabricated hardware including LLT mounts, LH mounts, EC mounts, BTO mounts, LHX mounts, alignment tools and balancing hardware	Fri 4/9/21	Thu 7/1/21	96 hrs	12 wks	CavedoniC_B[20%]	14	$7,562.88
269	1.4.5.2.2	Solicit final quotes and release orders for all electrical components including cabling, electrical devices, cable trays and enclosures	Fri 4/9/21	Thu 6/3/21	64 hrs	8 wks	Tech2_B[10%],KarewiczS_E	14	$4,452.16
270	1.4.5.2.3	Solicit final quotes and release orders for all plumbing components including hoses, control valves, sensors and gauges	Fri 4/9/21	Thu 6/3/21	32 hrs	8 wks	CavedoniC_B[10%]	14	$2,520.96
271	1.4.5.2.4	Receive and perform on-site off-telescope LHX acceptance & verification test (must complete prior testing Toptica lasers in Lab)	Mon 4/19/21	Sat 5/1/21	48 hrs	2 wks	KarewiczS_B[10%],Tech1_E		$3,504.36
272	1.4.5.2.5	Install and test LHX cooling system including end-of-day telescope balancing	Fri 4/9/21	Thu 6/3/21	320 hrs	8 wks	KarewiczS_B[10%],Tech1_E	14	$21,447.36
273	1.4.5.2.6	Complete necessary Job Safety Analysis (JSA) for the installation of hardware on telescope	Fri 4/9/21	Thu 7/29/21	64 hrs	16 wks	Tech1_B[5%],CavedoniC_B	14	$4,452.16
274	1.4.5.2.7	Receive, assemble and prep off-telescope Electrical hardware including conduit runs, cable trays, enclosures, connectors and patch panels	Fri 6/4/21	Thu 8/12/21	160 hrs	10 wks	Tech2_B[30%],KarewiczS_E	269	$10,393.20
275	1.4.5.2.8	Receive, assemble and prep off-telescope Plumbing hardware including hose runs, cable trays, valves , meters & sensors	Fri 6/4/21	Thu 8/26/21	288 hrs	12 wks	KarewiczS_B[10%],Tech2_E	270	$19,150.08
276	1.4.5.2.9	Receive, assemble and prep off-telescope Balancing Hardware	Fri 7/2/21	Thu 8/26/21	64 hrs	8 wks	Tech2_B[15%],CavedoniC_I	268	$4,157.28
277	1.4.5.2.10	Receive, assemble and prep off-telescope Mechanical hardware including EC/LH mounting hardware, BTO mounting hardware, LLT mounting hardware and alignment hardware	Fri 7/2/21	Thu 12/16/21	576 hrs	24 wks	KangS_B[20%],Tech1_B[20	268	$41,838.72
278	1.4.5.2.11	Demo out and/or relocate telescope hardware and services interfering with LGSF installation including (+/-) Y Center Section items	Tue 8/10/21	Mon 11/1/21	288 hrs	12 wks	KangS_B[10%],Tech1_B[40		$19,150.08
279	1.4.5.2.12	Install Electrical hardware including conduit runs, cable trays, enclosures & connectors including daily end-of-day telescope balancing	Fri 8/13/21	Thu 12/2/21	352 hrs	16 wks	KarewiczS_B[10%],Tech2_E	274	$23,012.48
280	1.4.5.2.13	Install mechanical balancing hardware including daily end-of-day telescope balancing	Fri 12/17/21	Thu 2/24/22	200 hrs	10 wks	CavedoniC_B[10%],Tech1_I	277	$12,807.20
281	1.4.5.2.14	Install telescope plumbing services including daily end-of-day telescope balacing	Fri 8/27/21	Thu 11/18/21	240 hrs	12 wks	CavedoniC_B[10%],Tech1_I	275	$15,368.64
282	1.4.5.2.15	Install mechanical interface hardware for LLTs, BTOs & LHs includng daily end-of-day telescope balancing	Fri 12/17/21	Thu 4/7/22	352 hrs	16 wks	Tech1_B[40%],KangS_B[5%	277	$23,012.48
283	1.4.5.2.16	Laser System #1	Mon 3/7/22	Thu 7/21/22	944 hrs	19.8 wks		242	$63,895.04
284	1.4.5.2.16.1	Install Laser System #1 equipment mounts (EC/LH/BTO/LLT) including end-of-day telescope balacing	Mon 3/7/22	Fri 4/15/22	144 hrs	6 wks	Tech1_B[40%],CavedoniC_I		$9,575.04
285	1.4.5.2.16.2	Install Laser System #1 Toptica EC & LH includng end-of-day telescope balancing	Mon 3/21/22	Fri 4/15/22	96 hrs	4 wks	Tech1_B[40%],CavedoniC_I		$6,383.36
286	1.4.5.2.16.3	Install Laser System # 1 BTO including end-of-day telescope balancing	Mon 3/21/22	Fri 4/15/22	96 hrs	4 wks	CavedoniC_B[20%],Tech1_I		$6,383.36
287	1.4.5.2.16.4	Install laser System #1 LLTs A&B including end-of-day telescope balancing	Mon 3/21/22	Fri 4/15/22	96 hrs	4 wks	CavedoniC_B[20%],Tech1_I		$6,383.36
288	1.4.5.2.16.5	Mechanically align Laser System #1	Mon 4/18/22	Sun 5/15/22	96 hrs	4 wks	Tech1_B[40%],CavedoniC_I		$6,383.36



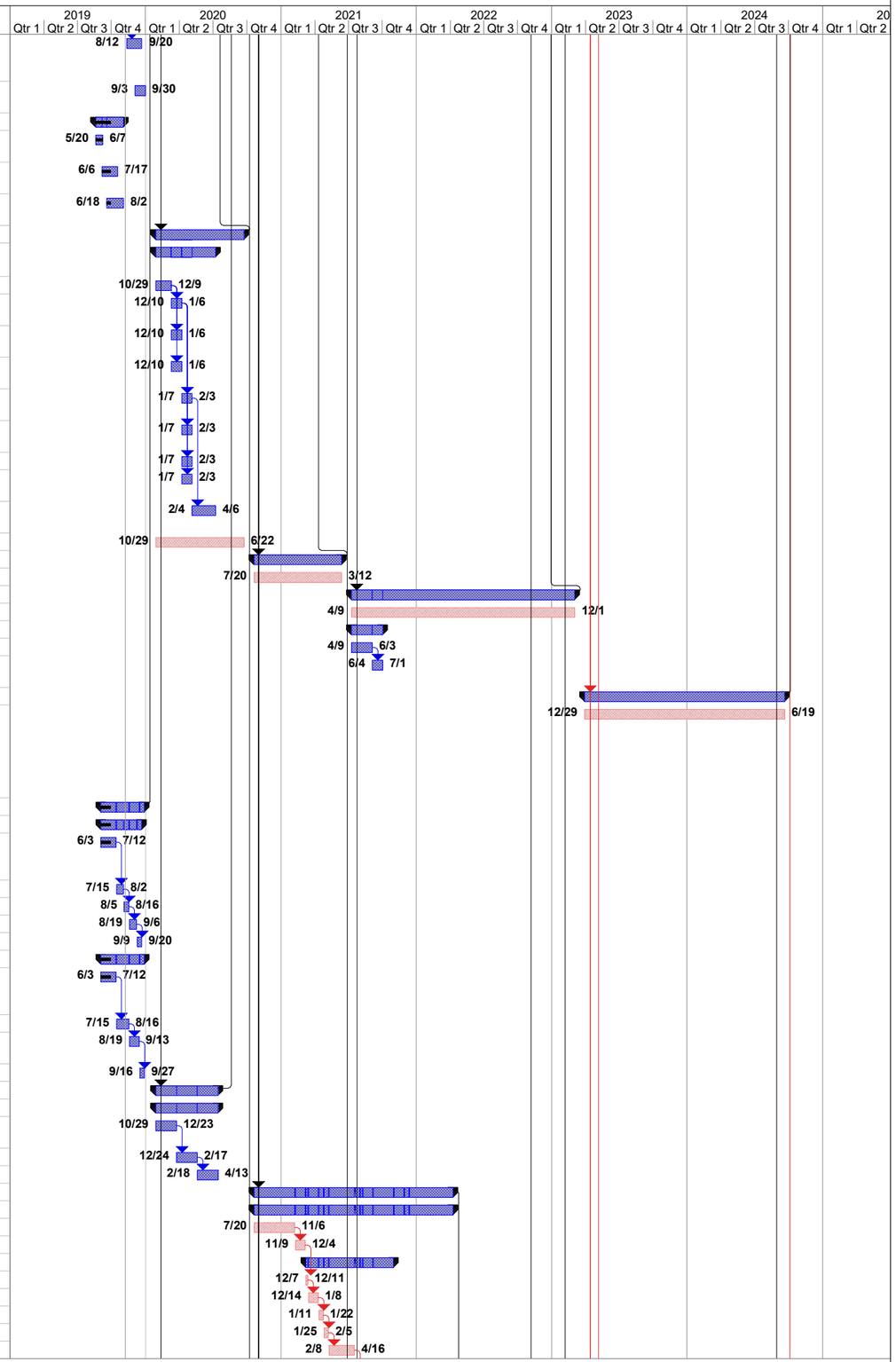
Gemini GNAO/RTC Work Breakdown Structure, 7/29/19

ID	WBS	Task Name	Start	Finish	Work	Duration	Resource Names	Predecessors	Cost
289	1.4.5.2.16.6	Install and test power to Laser System #1	Mon 4/18/22	Sun 5/15/22	96 hrs	4 wks	Tech1_B[20%],Tech2_B[40%		$5,793.60
290	1.4.5.2.16.7	Install and test cooing to Laser System #1	Mon 5/2/22	Sun 5/15/22	48 hrs	2 wks	CavedoniC_B[20%],Tech1_I		$3,191.68
291	1.4.5.2.16.8	Install and test communicaiton and control to Laser System #1	Thu 5/19/22	Wed 6/15/22	96 hrs	4 wks	EbbersA_B[20%],Tech2_B[2		$6,749.44
292	1.4.5.2.16.9	Optically align Laser System #1	Mon 6/20/22	Fri 7/1/22	48 hrs	2 wks	SchneiderT_B[20%],Tech3_		$3,191.68
293	.4.5.2.16.10	Integrate and commission Laser System #1	Fri 6/24/22	Thu 7/21/22	128 hrs	4 wks	CavedoniC_B[20%],Karewic		$9,860.16
294	1.4.5.2.17	Laser System #2	Tue 7/5/22	Fri 10/21/22	720 hrs	15.8 wks		250	$48,719.20
295	1.4.5.2.17.1	Install Laser System #2 equipment mounts (EC/LH/BTO/LLT) including end-of-day telescope balacing	Tue 7/5/22	Mon 8/1/22	96 hrs	4 wks	CavedoniC_B[20%],Tech1_I		$6,383.36
296	1.4.5.2.17.2	Install Laser System #2 Toptica EC & LH includng end-of-day telescope balancing	Tue 7/12/22	Mon 8/1/22	72 hrs	3 wks	CavedoniC_B[20%],Tech1_I		$4,787.52
297	1.4.5.2.17.3	Install Laser System #2 BTO including end-of-day telescope balancing	Tue 7/12/22	Mon 8/1/22	72 hrs	3 wks	CavedoniC_B[20%],Tech1_I		$4,787.52
298	1.4.5.2.17.4	Install laser System #2 LLTs A&B including end-of-day telescope balancing	Tue 7/12/22	Mon 8/1/22	72 hrs	3 wks	CavedoniC_B[20%],Tech1_I		$4,787.52
299	1.4.5.2.17.5	Mechanically align Laser System #2	Mon 8/1/22	Sun 8/21/22	72 hrs	3 wks	Tech1_B[40%],CavedoniC_I		$4,787.52
300	1.4.5.2.17.6	Install and test power to Laser System #2	Mon 8/1/22	Sun 8/21/22	72 hrs	3 wks	Tech1_B[20%],Tech2_B[40%		$4,345.20
301	1.4.5.2.17.7	Install and test cooing to Laser System #2	Mon 8/8/22	Sun 8/21/22	48 hrs	2 wks	CavedoniC_B[20%],Tech1_I		$3,191.68
302	1.4.5.2.17.8	Install and test communicaiton and control to Laser System #2	Thu 8/25/22	Wed 9/14/22	72 hrs	3 wks	EbbersA_B[20%],Tech2_B[2		$5,062.08
303	1.4.5.2.17.9	Optically align Laser System #2	Mon 9/19/22	Sat 10/1/22	48 hrs	2 wks	SchneiderT_B[20%],Tech3_		$3,191.68
304	.4.5.2.17.10	Integrate and commission Laser System #2	Mon 10/3/22	Fri 10/21/22	96 hrs	3 wks	CavedoniC_B[20%],Karewic		$7,395.12
305	1.4.5.2.18	Laser System #3 (if needed)	Mon 11/7/22	Sat 1/21/23	0 hrs	10.8 wks		258	$0.00
306	1.4.5.2.18.1	Install Laser System #3 equipment mounts (EC/LH/BTO/LLT) including end-of-day telescope balacing	Mon 11/7/22	Mon 11/7/22	0 hrs	0 wks	CavedoniC_B[20%],Tech1_I		$0.00
307	1.4.5.2.18.2	Install Laser System #3 Toptica EC & LH includng end-of-day telescope balancing	Mon 11/21/22	Mon 11/21/22	0 hrs	0 wks	CavedoniC_B[20%],Tech1_I		$0.00
308	1.4.5.2.18.3	Install Laser System #3 BTO including end-of-day telescope balancing	Mon 11/21/22	Mon 11/21/22	0 hrs	0 wks	CavedoniC_B[20%],Tech1_I		$0.00
309	1.4.5.2.18.4	Install laser System #3 LLTs A&B including end-of-day telescope balancing	Mon 11/21/22	Mon 11/21/22	0 hrs	0 wks	CavedoniC_B[20%],Tech1_I		$0.00
310	1.4.5.2.18.5	Mechanically align Laser System #3	Wed 12/7/22	Wed 12/7/22	0 hrs	0 wks	CavedoniC_B[20%],Tech1_I		$0.00
311	1.4.5.2.18.6	Install and test power to Laser System #3	Wed 12/7/22	Wed 12/7/22	0 hrs	0 wks	Tech1_B[20%],Tech2_B[40%		$0.00
312	1.4.5.2.18.7	Install and test cooing to Laser System #3	Wed 12/7/22	Wed 12/7/22	0 hrs	0 wks	CavedoniC_B[20%],Tech1_I		$0.00
313	1.4.5.2.18.8	Install and test communicaiton and control to Laser System #3	Wed 12/14/22	Wed 12/14/22	0 hrs	0 wks	KarewiczS_B[20%],EbbersA		$0.00
314	1.4.5.2.18.9	Optically align Laser System #3	Wed 12/21/22	Wed 12/21/22	0 hrs	0 wks	Tech3_B[40%],SchneiderT_		$0.00
315	.4.5.2.18.10	Integrate and commission Laser System #3	Sat 1/21/23	Sat 1/21/23	0 hrs	0 wks	SchneiderT_B[20%],Cavedc		$0.00
316	1.4.5.3	Control Computer Software Implementation	Fri 4/9/21	Thu 7/28/22	1,760 hrs	68 wks		14	$131,383.20
317	1.4.5.3.1	Implement LIS design in PLC (includes BTO door switches)	Fri 4/9/21	Thu 7/29/21	320 hrs	16 wks	KarewiczS_B[50%]		$25,209.60
318	1.4.5.3.2	Implement LIS design in EPICS (providing UI for PLC implementation)	Fri 7/30/21	Thu 9/23/21	160 hrs	8 wks	EbbersA_B[50%]	317	$11,486.40
319	1.4.5.3.3	Implement LHX interface in PLC	Fri 7/30/21	Thu 12/16/21	400 hrs	20 wks	KarewiczS_B[50%]	317	$31,512.00
320	1.4.5.3.4	Implement LHX interface in EPICS (providing UI for PLC implementation)	Fri 9/24/21	Thu 10/21/21	80 hrs	4 wks	EbbersA_B[50%]	318	$5,743.20
321	1.4.5.3.5	Implement changes to TLEI (if needed)	Fri 10/22/21	Thu 11/18/21	80 hrs	4 wks	EbbersA_B[50%]	320	$5,743.20
322	1.4.5.3.6	Implement BTO	Fri 11/19/21	Thu 5/5/22	480 hrs	24 wks	EbbersA_B[50%]	321	$34,459.20
323	1.4.5.3.7	Implement fast steering mirror (FSM) control	Fri 5/6/22	Thu 6/2/22	80 hrs	4 wks	EbbersA_B[50%]	322	$5,743.20
324	1.4.5.3.8	Implement Laser Control Console	Fri 6/3/22	Thu 7/28/22	160 hrs	8 wks	EbbersA_B[50%]	323	$11,486.40
325	1.4.5.4	Control Computer Software Test	Fri 7/29/22	Thu 1/19/23	680 hrs	25 wks		316,292	$53,421.20
326	1.4.5.4.1	Test LIS Interface for each Laser (Toptica EC to LIS PLC)	Fri 7/29/22	Thu 8/11/22	40 hrs	2 wks	KarewiczS_I[50%]		$3,343.20
327	1.4.5.4.2	Test LIS shuttering sequences with all lasers	Fri 8/12/22	Thu 9/8/22	160 hrs	4 wks	EbbersA_I[50%],KarewiczS_	326	$12,779.20
328	1.4.5.4.3	Test access door interlocks and bypasses.	Fri 9/9/22	Thu 9/15/22	40 hrs	1 wk	EbbersA_I[50%],KarewiczS_	327	$3,194.80
329	1.4.5.4.4	Test all BTO functionality (motors, loops, status, error handling)	Fri 9/16/22	Thu 10/13/22	120 hrs	4 wks	EbbersA_I[50%],SchneiderT	328	$9,436.00
330	1.4.5.4.5	Test any new features	Fri 10/14/22	Thu 10/27/22	40 hrs	2 wks	EbbersA_I[50%]	329	$3,046.40
331	1.4.5.4.6	Test LHX	Fri 10/28/22	Thu 11/10/22	80 hrs	2 wks	EbbersA_I[50%],KarewiczS_	330	$6,389.60
332	1.4.5.4.7	Test fast steering mirror (FSM) control	Fri 11/11/22	Thu 11/24/22	40 hrs	2 wks	EbbersA_I[50%]	331	$3,046.40
333	1.4.5.4.8	Test Laser Control Console	Fri 11/25/22	Thu 1/19/23	160 hrs	8 wks	EbbersA_I[50%]	332	$12,185.60
334	1.4.6	Integrate and Test (I&T)	Mon 1/23/23	Fri 3/15/24	1,200 hrs	60 wks		233	$100,296.00
335	1.4.6.1	Provide I&T support and Final Document Preparation	Mon 1/23/23	Fri 3/15/24	1,200 hrs	60 wks	CavedoniC_I[15%],Schneid	233	$100,296.00
336	1.5	Adaptive Optics Subsystem (AOS) (mostly a subcontract)	Mon 5/20/19	Wed 6/19/24	10,142 hrs	265.6 wks			$736,475.46
337	1.5.1	AOS System Engineering	Mon 5/20/19	Wed 6/19/24	4,962 hrs	265.6 wks			$382,070.26
338	**1.5.1.1**	**Conceptual Design**	**Mon 5/20/19**	**Mon 9/30/19**	**520 hrs**	**19.2 wks**			**$23,343.50**
339	**1.5.1.1.1**	**AOS Subsystem Requirements Definition**	**Mon 6/3/19**	**Mon 9/30/19**	**250 hrs**	**17.2 wks**			**$14,061.24**
340	1.5.1.1.1.1	Generate AOS Top Level Functional Flow Break Down	Mon 6/3/19	Fri 7/5/19	80 hrs	5 wks	MontesV_P[25%],SivoG_P['		$1,171.38
341	1.5.1.1.1.2	Flow Top Level Requirements to AOS from top level science Requirements (Second Draft)	Mon 7/8/19	Fri 8/2/19	72 hrs	4 wks	MontesV_P[20%],ChirreE_P	340	$5,432.88
342	1.5.1.1.1.3	Generate AOS Functional Requirements and compare against existing GN and GS LGS requirements (Second Draft)	Mon 8/5/19	Fri 8/9/19	18 hrs	1 wk	RamboldW_P[10%],Montes'	341	$1,358.22



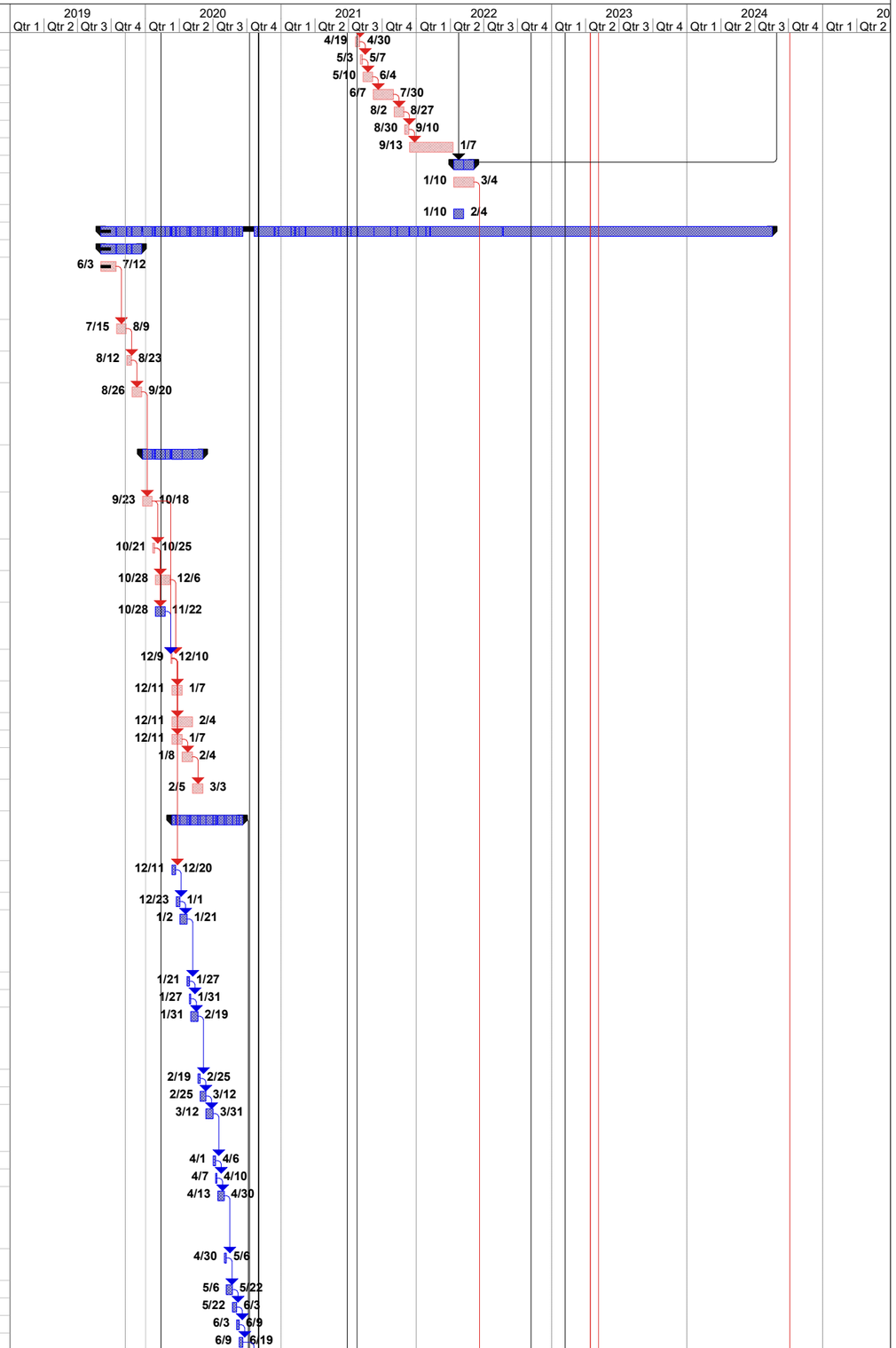
Gemini GNAO/RTC Work Breakdown Structure, 7/29/19

ID	WBS	Task Name	Start	Finish	Work	Duration	Resource Names	Predecessors	Cost
343	1.5.1.1.1.4	Update Requirements based on Interface Definition, Conops, Trade Study Results etc, Add rationale	Mon 8/12/19	Fri 9/20/19	48 hrs	6 wks	MontesV_P[15%],ProvostN_	342	$3,607.56
344	1.5.1.1.1.5	Finalize Export AOS Subsystem Requirements Document for CoDR	Tue 9/3/19	Mon 9/30/19	32 hrs	4 wks	BassettJ_P[5%],RadwickJ_F		$2,491.20
345	**1.5.1.1.2**	**Generate AOS Concept of Operations**	**Mon 5/20/19**	**Fri 8/2/19**	**270 hrs**	**11 wks**			**$9,282.26**
346	1.5.1.1.2.1	Describe GeMS System and Reason for Change	Mon 5/20/19	Fri 6/7/19	66 hrs	3 wks	MontesV_P[30%],SivoG_P['		$0.00
347	1.5.1.1.2.2	Describe GNAO AOS System Operation (1st Draft)	Thu 6/6/19	Wed 7/17/19	84 hrs	6 wks	MontesV_P[10%],SivoG_P['		$2,646.96
348	1.5.1.1.2.3	Review, Update AOS Conops, incorporate into GNAO conops	Tue 6/18/19	Fri 8/2/19	120 hrs	6.67 wks	MontesV_P[10%],EbbersA_		$6,635.30
349	1.5.1.2	Preliminary (subcontract)	Tue 10/29/19	Mon 6/22/20	980 hrs	34 wks		6	$73,613.56
350	**1.5.1.2.1**	**Generate AOS Interface Requirements Definition**	**Tue 10/29/19**	**Mon 4/6/20**	**708 hrs**	**23 wks**			**$52,438.36**
351	1.5.1.2.1.1	Define AOS Functional External Interfaces	Tue 10/29/19	Mon 12/9/19	144 hrs	6 wks	MontesV_P[20%],ChirreE_P		$10,621.44
352	1.5.1.2.1.2	Generate AOS Interface Control Document for AOS - RTC First Draft	Tue 12/10/19	Mon 1/6/20	80 hrs	4 wks	MontesV_P[5%],EbbersA_P	351	$5,873.52
353	1.5.1.2.1.3	Generate LGS Interface Control Document for AOS - TLC First Draft	Tue 12/10/19	Mon 1/6/20	80 hrs	4 wks	MontesV_P[5%],EbbersA_P	351	$5,873.52
354	1.5.1.2.1.4	Generate LGS Interface Control Document for AOS -TCC First Draft	Tue 12/10/19	Mon 1/6/20	80 hrs	4 wks	MontesV_P[5%],EbbersA_P	351	$5,873.52
355	1.5.1.2.1.5	Update, Review Electrical Interface Requirements	Tue 1/7/20	Mon 2/3/20	24 hrs	4 wks	ProvostN_P[5%],MontesV_F	352	$1,810.96
356	1.5.1.2.1.6	Update, Review Mechancial Interface Requirements	Tue 1/7/20	Mon 2/3/20	40 hrs	4 wks	MontesV_P[5%],ChinnB_P['	352	$2,999.12
357	1.5.1.2.1.7	Update, Review Service Requirements	Tue 1/7/20	Mon 2/3/20	40 hrs	4 wks	MontesV_P[5%],ChinnB_P['	352	$2,999.12
358	1.5.1.2.1.8	Update, Review Environmental Requirements	Tue 1/7/20	Mon 2/3/20	40 hrs	4 wks	MontesV_P[5%],ChinnB_P['	352	$2,999.12
359	1.5.1.2.1.9	Review, Update, Finalize CoDR Drafts of ICDs	Tue 2/4/20	Mon 4/6/20	180 hrs	9 wks	MontesV_P[10%],EbbersA_	355	$13,388.04
360	1.5.1.2.2	provide SE oversight	Tue 10/29/19	Mon 6/22/20	272 hrs	34 wks	ProvostN_P[20%]		$21,175.20
361	1.5.1.3	Critical Design (subcontract)	Mon 7/20/20	Fri 3/12/21	272 hrs	34 wks		10	$21,808.96
362	1.5.1.3.1	provide SE oversight	Mon 7/20/20	Fri 3/12/21	272 hrs	34 wks	ProvostN_C[20%]		$21,808.96
363	1.5.1.4	Build (subcontract)	Fri 4/9/21	Thu 12/1/22	880 hrs	86 wks		14	$72,313.44
364	1.5.1.4.1	provide SE oversight	Fri 4/9/21	Thu 12/1/22	688 hrs	86 wks	ProvostN_B[20%]		$56,821.92
365	**1.5.1.4.2**	**AOS Verification**	**Fri 4/9/21**	**Thu 7/1/21**	**192 hrs**	**12 wks**			**$15,491.52**
366	1.5.1.4.2.1	Review Vendor's AOS Acceptance Test Plan	Fri 4/9/21	Thu 6/3/21	128 hrs	8 wks	ProvostN_B[20%],MontesV_		$10,327.68
367	1.5.1.4.2.2	Review and Approve Acceptance Test results	Fri 6/4/21	Thu 7/1/21	64 hrs	4 wks	ProvostN_B[20%],MontesV_	366	$5,163.84
368	1.5.1.5	Integration and Testing (I&T)	Thu 12/29/22	Wed 6/19/24	2,310 hrs	77 wks		18	$190,990.80
369	1.5.1.5.1	Lead AOS Integration and Test in conjunction with the AOS subcontractor, including development of integration test plan, implementing plan, lead anomaly resolution, lead interface management, Perform tests, review and document results	Thu 12/29/22	Wed 6/19/24	2,310 hrs	77 wks	MontesV_I[25%],SivoG_I[25		$190,990.80
370	1.5.2	Conceptual Design	Mon 6/3/19	Fri 9/27/19	660 hrs	17 wks			$37,130.00
371	**1.5.2.1**	**Optical Engineering**	**Mon 6/3/19**	**Fri 9/20/19**	**320 hrs**	**16 wks**			**$17,822.40**
372	1.5.2.1.1	refine conceptual optical design including layout of the AOB, optical elements, and coatings	Mon 6/3/19	Fri 7/12/19	120 hrs	6 wks	ChirreE_P[50%]		$2,970.40
373	1.5.2.1.2	perform preliminary tolerancing analysis	Mon 7/15/19	Fri 8/2/19	60 hrs	3 wks	ChirreE_P[50%]	372	$4,455.60
374	1.5.2.1.3	perform preliminary throughput analysis	Mon 8/5/19	Fri 8/16/19	40 hrs	2 wks	ChirreE_P[50%]	373	$2,970.40
375	1.5.2.1.4	assess risks in the conceptual optical design	Mon 8/19/19	Fri 9/6/19	60 hrs	3 wks	ChirreE_P[50%]	374	$4,455.60
376	1.5.2.1.5	documentation preparation	Mon 9/9/19	Fri 9/20/19	40 hrs	2 wks	ChirreE_P[50%]	375	$2,970.40
377	**1.5.2.2**	**Mechanical Engineering**	**Mon 6/3/19**	**Fri 9/27/19**	**340 hrs**	**17 wks**			**$19,307.60**
378	1.5.2.2.1	refine conceptual mechanical design including structural, science path, LGSWFS, and NGSWFS	Mon 6/3/19	Fri 7/12/19	120 hrs	6 wks	ChinnB_P[50%]		$2,970.40
379	1.5.2.2.2	preliminary thermal and flexure studies	Mon 7/15/19	Fri 8/16/19	100 hrs	5 wks	ChinnB_P[50%]	378	$7,426.00
380	1.5.2.2.3	preliminary optomechanical tolerancing analysis	Mon 8/19/19	Fri 9/13/19	80 hrs	4 wks	ChinnB_P[50%]	379	$5,940.80
381	1.5.2.2.4	documentation preparation	Mon 9/16/19	Fri 9/27/19	40 hrs	2 wks	ChinnB_P[50%]	380	$2,970.40
382	**1.5.3**	**Preliminary Design**	**Tue 10/29/19**	**Mon 4/13/20**	**960 hrs**	**24 wks**		**6**	**$64,963.20**
383	**1.5.3.1**	**Control Computer Software**	**Tue 10/29/19**	**Mon 4/13/20**	**960 hrs**	**24 wks**			**$64,963.20**
384	1.5.3.1.1	Adaptive Optics Subsystem Components Controller Design	Tue 10/29/19	Mon 12/23/19	320 hrs	8 wks	SW1_P		$21,654.40
385	1.5.3.1.2	Instrument Sequencer Design	Tue 12/24/19	Mon 2/17/20	320 hrs	8 wks	SW1_P	384	$21,654.40
386	1.5.3.1.3	Graphical User Interface Design	Tue 2/18/20	Mon 4/13/20	320 hrs	8 wks	SW1_P	385	$21,654.40
387	1.5.4	Critical Design	Mon 7/20/20	Fri 1/7/22	3,080 hrs	77 wks		10	$217,852.80
388	1.5.4.1	Control Computer Software	Mon 7/20/20	Fri 1/7/22	3,080 hrs	77 wks			$217,852.80
389	1.5.4.1.1	Implement AOS Components Controller	Mon 7/20/20	Fri 11/6/20	640 hrs	16 wks	SW1_C		$44,608.00
390	1.5.4.1.2	Implement Instrument Sequencer	Mon 11/9/20	Fri 12/4/20	160 hrs	4 wks	SW1_C	389	$11,152.00
391	1.5.4.1.3	Implement Graphical User Interface	Mon 12/7/20	Fri 7/30/21	1,360 hrs	34 wks			$96,046.00
392	1.5.4.1.3.1	Infrastructure	Mon 12/7/20	Fri 12/11/20	40 hrs	1 wk	SW1_C	390	$2,788.00
393	1.5.4.1.3.2	AOS Components Controller	Mon 12/14/20	Fri 1/8/21	160 hrs	4 wks	SW1_C	392	$11,152.00
394	1.5.4.1.3.3	LGSF Components Controller	Mon 1/11/21	Fri 1/22/21	80 hrs	2 wks	SW1_C	393	$5,576.00
395	1.5.4.1.3.4	Loop Control	Mon 1/25/21	Fri 2/5/21	80 hrs	2 wks	SW1_C	394	$5,576.00
396	1.5.4.1.3.5	Telemetry Display	Mon 2/8/21	Fri 4/16/21	400 hrs	10 wks	SW1_C	395	$27,880.00



Gemini GNAO/RTC Work Breakdown Structure, 7/29/19

ID	WBS	Task Name	Start	Finish	Work	Duration	Resource Names	Predecessors	Cost
397	1.5.4.1.3.6	NGS Configuration	Mon 4/19/21	Fri 4/30/21	80 hrs	2 wks	SW1_B	396	$5,743.20
398	1.5.4.1.3.7	Instrument Sequencer display and control	Mon 5/3/21	Fri 5/7/21	40 hrs	1 wk	SW1_B	397	$2,871.60
399	1.5.4.1.3.8	Calibration	Mon 5/10/21	Fri 6/4/21	160 hrs	4 wks	SW1_B	398	$11,486.40
400	1.5.4.1.3.9	Misc. screens	Mon 6/7/21	Fri 7/30/21	320 hrs	8 wks	SW1_B	399	$22,972.80
401	1.5.4.1.4	Implement GIAPI interfaces	Mon 8/2/21	Fri 8/27/21	160 hrs	4 wks	SW1_B	400	$11,486.40
402	1.5.4.1.5	Implement Safety Interlocks	Mon 8/30/21	Fri 9/10/21	80 hrs	2 wks	SW1_B	401	$5,743.20
403	1.5.4.1.6	Telemetry storage and access control	Mon 9/13/21	Fri 1/7/22	680 hrs	17 wks	SW1_B	402	$48,817.20
404	1.5.5	Build / Implement / Incrementally Integrate & Test	Mon 1/10/22	Fri 3/4/22	480 hrs	8 wks		387	$34,459.20
405	1.5.5.1	Control Computer Software Testing of Mechanical Components	Mon 1/10/22	Fri 3/4/22	320 hrs	8 wks	SW1_B		$22,972.80
406	1.5.5.2	Finalize And Perform Acceptance Tests	Mon 1/10/22	Fri 2/4/22	160 hrs	4 wks	SW1_B		$11,486.40
407	1.6	Real-Time Computer (RTC)	Mon 6/3/19	Fri 5/17/24	15,766.67 hrs	259 wks			$1,087,077.13
408	1.6.1	RTC Systems Engineering	Mon 6/3/19	Fri 9/20/19	476 hrs	16 wks			$27,445.72
409	1.6.1.1	flow-down GNAO / GeMS system requirements to the RTC and generate RTC Functional Requirements and compare against existing GN and GS LGS requirements.	Mon 6/3/19	Fri 7/12/19	120 hrs	6 wks	PalmerD_P[10%],ProvostN_		$3,487.60
410	1.6.1.2	write a draft of the final test document to assure that the requirements can be tested against.	Mon 7/15/19	Fri 8/9/19	80 hrs	4 wks	JenkinsD_P[50%]	409	$3,736.80
411	1.6.1.3	design external RTC interfaces and generate ICDs.	Mon 8/12/19	Fri 8/23/19	100 hrs	2 wks	HirstP_P[20%],PalmerD_P[4	410	$7,363.24
412	1.6.1.4	start a Design Document and Users Manual to serve as input to the CoDR documentation package (and to be kept up to date as the project progresses).	Mon 8/26/19	Fri 9/20/19	176 hrs	4 wks	HirstP_P[20%],PalmerD_P[4	411	$12,858.08
413	1.6.2	Select computer hardware (for GeMS) and a software package; then procure it and bring it up (this is to serve as development/test platform)	Mon 9/23/19	Tue 3/3/20	864 hrs	23.4 wks			$61,028.48
414	1.6.2.1	select an existing AO RTC software package to serve as the baseline for RTC software development	Mon 9/23/19	Fri 10/18/19	160 hrs	4 wks	PalmerD_P[20%],RamboldV	412	$12,858.08
415	1.6.2.2	participate in AO RTC package training (this is a training place holder)	Mon 10/21/19	Fri 10/25/19	120 hrs	1 wk	RamboldW_P,JenkinsD_P,F	414	$9,222.00
416	1.6.2.3	analyze the requirements for and select AO peripheral interfaces for GeMS	Mon 10/28/19	Fri 12/6/19	264 hrs	6 wks	RamboldW_P[40%],Jenkins	415	$18,166.32
417	1.6.2.4	analyze the requirements for and select/configure a computer platform for GeMS, including OS	Mon 10/28/19	Fri 11/22/19	32 hrs	4 wks	PalmerD_P[5%],RamboldW	415	$2,941.44
418	1.6.2.5	hold a special review of the software package and hardware selections.	Mon 12/9/19	Tue 12/10/19	64 hrs	0.4 wks	PalmerD_P,RamboldW_P,J	414,416,417	$5,384.64
419	1.6.2.6	procure software package, including support as required	Wed 12/11/19	Tue 1/7/20	16 hrs	4 wks	RamboldW_P[10%]	418	$1,245.60
420	1.6.2.7	procure the AO peripheral interfaces for GeMS	Wed 12/11/19	Tue 2/4/20	32 hrs	8 wks	RamboldW_P[10%]	418	$2,491.20
421	1.6.2.8	procure the computer platform for GeMS	Wed 12/11/19	Tue 1/7/20	16 hrs	4 wks	RamboldW_P[10%]	418	$1,245.60
422	1.6.2.9	bring up the GeMS hardware platform and optimize for performance	Wed 1/8/20	Tue 2/4/20	80 hrs	4 wks	JenkinsD_P[50%]	421	$3,736.80
423	1.6.2.10	install drivers for GeMS AO peripherals and test, as hardware becomes available	Wed 2/5/20	Tue 3/3/20	80 hrs	4 wks	JenkinsD_P[50%]	422	$3,736.80
424	**1.6.3**	**Design the adaptation of the AO RTC package to GeMS and design new code as needed. This is the design phase for RTC software.**	**Wed 12/11/19**	**Fri 6/19/20**	**2,746.67 hrs**	**27.47 wks**			**$184,713.33**
425	1.6.3.1	adapt AO RTC package infrastructure to GeMS/GNAO needs	Wed 12/11/19	Fri 12/20/19	160 hrs	1.6 wks	JenkinsD_P[75%],PalmerD_	418	$10,760.00
426	1.6.3.2	TLC interface software	Mon 12/23/19	Wed 1/1/20	160 hrs	1.6 wks	JenkinsD_P[75%],PalmerD_	425	$10,760.00
427	1.6.3.3	NGS camera interface software (the 'Design' work for this is higher than normal, wrt 'Implementation', to accommodate GeMS legacy hardware)	Thu 1/2/20	Tue 1/21/20	266.67 hrs	2.67 wks	JenkinsD_P[75%],PalmerD_	426	$17,933.33
428	1.6.3.4	NGS tip/tilt computation	Tue 1/21/20	Mon 1/27/20	80 hrs	0.8 wks	JenkinsD_P[75%],PalmerD_	427	$5,380.00
429	1.6.3.5	TT interface software	Mon 1/27/20	Fri 1/31/20	80 hrs	0.8 wks	JenkinsD_P[75%],PalmerD_	428	$5,380.00
430	1.6.3.6	LGS cameras interface software (the 'Design' work for this is higher than normal, wrt 'Implementation', to accommodate GeMS legacy hardware)	Fri 1/31/20	Wed 2/19/20	266.67 hrs	2.67 wks	JenkinsD_P[75%],PalmerD_	429	$17,933.33
431	1.6.3.7	centroider	Wed 2/19/20	Tue 2/25/20	80 hrs	0.8 wks	JenkinsD_P[75%],PalmerD_	430	$5,380.00
432	1.6.3.8	reconstructor	Tue 2/25/20	Thu 3/12/20	240 hrs	2.4 wks	JenkinsD_P[75%],PalmerD_	431	$16,140.00
433	1.6.3.9	DMs interface software (the 'Design' work for this is higher than normal, wrt 'Implementation', to accommodate GeMS legacy hardware)	Thu 3/12/20	Tue 3/31/20	266.67 hrs	2.67 wks	JenkinsD_P[75%],PalmerD_	432	$17,933.33
434	1.6.3.10	slow focus detector software	Wed 4/1/20	Mon 4/6/20	80 hrs	0.8 wks	JenkinsD_P[75%],PalmerD_	433	$5,380.00
435	1.6.3.11	slow focus computation	Tue 4/7/20	Fri 4/10/20	80 hrs	0.8 wks	JenkinsD_P[75%],PalmerD_	434	$5,380.00
436	1.6.3.12	LGS zoom interface software (for slow focus) (the 'Design' work for this is higher than normal, wrt 'Implementation', to accommodate GeMS legacy hardware)	Mon 4/13/20	Thu 4/30/20	266.67 hrs	2.67 wks	JenkinsD_P[75%],PalmerD_	435	$17,933.33
437	1.6.3.13	telescope offload and LGS pointing control software	Thu 4/30/20	Wed 5/6/20	80 hrs	0.8 wks	JenkinsD_P[75%],PalmerD_	436	$5,380.00
438	1.6.3.14	telemetry date streaming/archiving software	Wed 5/6/20	Fri 5/22/20	240 hrs	2.4 wks	JenkinsD_P[75%],PalmerD_	437	$16,140.00
439	1.6.3.15	telemetry data display software	Fri 5/22/20	Wed 6/3/20	160 hrs	1.6 wks	JenkinsD_P[75%],PalmerD_	438	$10,760.00
440	1.6.3.16	investigate PSF reconstruction	Wed 6/3/20	Tue 6/9/20	80 hrs	0.8 wks	JenkinsD_P[75%],PalmerD_	439	$5,380.00
441	1.6.3.17	reconstructor matrix generation	Tue 6/9/20	Fri 6/19/20	160 hrs	1.6 wks	JenkinsD_P[75%],PalmerD_	440	$10,760.00



Gemini GNAO/RTC Work Breakdown Structure, 7/29/19

ID	WBS	Task Name	Start	Finish	Work	Duration	Resource Names	Predecessors	Cost
442	1.6.4	Implement and test code to provide GeMS functionality as designed in the previous set of tasks. This is the implementation and testing phase for the RTC software (not to be confused with Integration and Test).	Mon 7/20/20	Fri 9/10/21	6,000 hrs	60 wks			$421,414.40
443	1.6.4.1	adapt DARC infrastructure to GeMS/GNAO needs	Mon 7/20/20	Wed 7/29/20	160 hrs	1.6 wks	JenkinsD_C[75%],PalmerD_	10,441	$11,082.56
444	1.6.4.2	TLC interface software	Thu 7/30/20	Fri 9/11/20	640 hrs	6.4 wks	JenkinsD_C[75%],PalmerD_	443	$44,330.24
445	1.6.4.3	NGS camera interface software	Mon 9/14/20	Wed 9/23/20	160 hrs	1.6 wks	JenkinsD_C[75%],PalmerD_	444	$11,082.56
446	1.6.4.4	NGS tip/tilt computation	Thu 9/24/20	Tue 10/27/20	480 hrs	4.8 wks	JenkinsD_C[75%],PalmerD_	445	$33,247.68
447	1.6.4.5	TT interface software	Wed 10/28/20	Fri 11/6/20	160 hrs	1.6 wks	JenkinsD_C[75%],PalmerD_	446	$11,082.56
448	1.6.4.6	LGS cameras interface software	Mon 11/9/20	Wed 11/18/20	160 hrs	1.6 wks	JenkinsD_C[75%],PalmerD_	447	$11,082.56
449	1.6.4.7	centroider	Thu 11/19/20	Fri 12/4/20	240 hrs	2.4 wks	JenkinsD_C[75%],PalmerD_	448	$16,623.84
450	1.6.4.8	reconstructor	Mon 12/7/20	Tue 2/16/21	1,040 hrs	10.4 wks	JenkinsD_C[75%],PalmerD_	449	$72,036.64
451	1.6.4.9	DMs interface software	Wed 2/17/21	Fri 2/26/21	160 hrs	1.6 wks	JenkinsD_C[75%],PalmerD_	450	$11,082.56
452	1.6.4.10	slow focus detector software	Mon 3/1/21	Wed 3/10/21	160 hrs	1.6 wks	JenkinsD_B[75%],PalmerD_	451	$11,415.04
453	1.6.4.11	slow focus computation	Thu 3/11/21	Fri 3/26/21	240 hrs	2.4 wks	JenkinsD_B[75%],PalmerD_	452	$17,122.56
454	1.6.4.12	LGS zoom interface software (for slow focus)	Mon 3/29/21	Wed 4/7/21	160 hrs	1.6 wks	JenkinsD_B[75%],PalmerD_	453	$11,415.04
455	1.6.4.13	telescope offload and LGS pointing control software	Thu 4/8/21	Fri 4/23/21	240 hrs	2.4 wks	JenkinsD_B[75%],PalmerD_	454	$17,122.56
456	1.6.4.14	telemetry date streaming/archiving software	Mon 4/26/21	Tue 6/8/21	640 hrs	6.4 wks	JenkinsD_B[75%],PalmerD_	455	$45,660.16
457	1.6.4.15	telemetry data display software	Wed 6/9/21	Thu 7/22/21	640 hrs	6.4 wks	JenkinsD_B[75%],PalmerD_	456	$45,660.16
458	1.6.4.16	investigate PSF reconstruction	Fri 7/23/21	Mon 8/9/21	240 hrs	2.4 wks	JenkinsD_B[75%],PalmerD_	457	$17,122.56
459	1.6.4.17	reconstructor matrix generation	Tue 8/10/21	Fri 9/10/21	480 hrs	4.8 wks	JenkinsD_B[75%],PalmerD_	458	$34,245.12
460	1.6.5	Perform final testing, integration, and first-light for new GeMS RTC	Mon 9/13/21	Fri 11/5/21	800 hrs	8 wks			$57,075.20
461	1.6.5.1	finalize the final test document and execute it	Mon 9/13/21	Mon 10/4/21	320 hrs	3.2 wks	JenkinsD_B[75%],PalmerD_	459	$22,830.08
462	1.6.5.2	finalize all documentation and release	Tue 10/5/21	Tue 10/26/21	320 hrs	3.2 wks	JenkinsD_B[75%],PalmerD_	461	$22,830.08
463	1.6.5.3	support GeMS integration and first-light (with the new RTC)	Wed 10/27/21	Fri 11/5/21	160 hrs	1.6 wks	JenkinsD_B[75%],PalmerD_	462	$11,415.04
464	1.6.6	Procure the hardware for GNAO and port the RTC, as developed above, to GNAO.	Mon 11/8/21	Fri 5/20/22	2,800 hrs	28 wks	JenkinsD_B[75%],PalmerD_	463	$199,763.20
465	1.6.7	Provide ongoing support through build and integration	Mon 5/23/22	Fri 5/17/24	2,080 hrs	104 wks	JenkinsD_I[25%],RamboldW	464	$135,636.80
466									
467	1.7	Overall project Preliminary Design	Tue 10/29/19	Fri 7/17/20	0 hrs	37.8 wks		6	$0.00
468	1.8	Overall project Critical Design	Mon 7/20/20	Fri 4/9/21	0 hrs	38 wks		10	$0.00
469	1.9	Overall project Build	Fri 4/9/21	Wed 12/28/22	0 hrs	89.8 wks		14	$0.00
470	1.10	Overall project I&T	Thu 12/29/22	Tue 6/18/24	0 hrs	76.8 wks		18	$0.00
471	1.11	AOS Preliminary Design	Tue 10/29/19	Fri 7/17/20	0 hrs	37.8 wks		6	$0.00
472	1.12	LGS PD concludes	Tue 6/23/20	Tue 6/23/20	0 hrs	0.2 wks		171	$0.00
473	1.13	AOS Critical Design	Mon 7/20/20	Fri 4/9/21	0 hrs	38 wks		10	$0.00
474	1.14	RTC design complete	Fri 6/19/20	Mon 6/22/20	0 hrs	0.2 wks		424	$0.00
475	1.15	LGS CD concludes	Mon 3/15/21	Mon 3/15/21	0 hrs	0.2 wks		202	$0.00
476	1.16	RTC -- GeMS RTC deployed	Mon 11/8/21	Mon 11/8/21	0 hrs	0.2 wks		463	$0.00
477	1.17	AOS control computer ready for integration	Mon 3/7/22	Mon 3/7/22	0 hrs	0.2 wks		405	$0.00
478	1.18	RTC -- GNAO RTC ready for integration	Mon 5/23/22	Mon 5/23/22	0 hrs	0.2 wks		464	$0.00
479	1.19	LGS laser system 1 installed and commissioned	Fri 7/22/22	Fri 7/22/22	0 hrs	0.2 wks		283	$0.00
480	1.20	AOS Build	Fri 4/9/21	Wed 12/28/22	0 hrs	89.8 wks		14	$0.00
481	1.21	LGS laser system 2 installed and commissioned	Mon 10/24/22	Mon 10/24/22	0 hrs	0.2 wks		294	$0.00
482	1.22	LGS control computer tested and ready	Fri 1/20/23	Fri 1/20/23	0 hrs	0.2 wks		333	$0.00
483	1.23	AOS I&T	Thu 12/29/22	Tue 6/18/24	0 hrs	76.8 wks		18	$0.00
484	1.24	First Light	Wed 6/19/24	Wed 6/19/24	0 hrs	0.2 wks		20	$0.00