WBS Number	Description	Unit	Unit Cost ($)	Quantity	Mfg M&S (K$)	Mfg Labor (Yrs)	Mfg Labor (K$)	EDIA Labor (Yrs)	EDIA Labor (K$)	Base Cost (K$)	CMS Cost (KCHF)
2	**Hadron Calorimeter**				**34,193**	**105.3**	**6,932**	**50.2**	**4,382**	**45,507**	**44,093**
2.1	Barrel Hadron Calorimeter (HB)				16,751	62.4	3,787	35.7	2,523	23,061	21,776
2.1.1	Mechanics				10,598	6.8	591	15.4	652	11,841	13,777
2.1.1.1	Design							13.0	423	423	
2.1.1.1.1	5 FTE-yrs: Jan'95-Sep'97			1,250				5.0			
2.1.1.1.2	8 FTE-yrs: Oct'97-Jun'99	en days	211	2,000				8.0	423	423	
2.1.1.2	Fabrication			36	5,357					5,357	6,964
2.1.1.2.1	brass plates	kg	2.50	40,000	3,600					3,600	4,680
2.1.1.2.2	hot rolling of plates	kg	0.69	40,000	994					994	1,292
2.1.1.2.3	stainless steel (304) inner plate	each	4,800	1	173					173	225
2.1.1.2.4	stainless steel (304) outer plate	each	9,700	1	349					349	454
2.1.1.2.5	less buy-back (40.0-22.3 t)	kg	-0.50	17,700	-319					-319	-414
2.1.1.2.6	ship plates to assembly site	wedge	5,000	1	180					180	234
2.1.1.2.7	brackets	wedge	5,000	1	180					180	234
2.1.1.2.8	rail support system (4 wedges)	wedge	50,000	4	200					200	260
2.1.1.3	Assembly and machining			36	4,257					4,257	5,535
2.1.1.3.1	brass plates	plate	2,660	31	2,969					2,969	3,859
2.1.1.3.2	stainless steel (304) inner plate	each	6,000	1	216					216	281
2.1.1.3.3	stainless steel (304) outer plate	each	5,400	1	194					194	253
2.1.1.3.4	bolts	wedge	4.00	2,000	288					288	374
2.1.1.3.5	assembly and face machining	wedge	6,400	1	230					230	300
2.1.1.3.6	ship assembled wedge to CERN	wedge	10,000	1	360					360	468
2.1.1.4	Installation				984	6.8	591	2.4	230	1,804	1,279
2.1.1.4.1	Barrel cradle			2	344	2.8	318	1.0	96	757	447
2.1.1.4.1.1	Engineering design	en day	423	175				0.7	74	74	
2.1.1.4.1.2	Drafting	df day	289	75				0.3	22	22	
2.1.1.4.1.3	I-beams/structure/base plates	cradle	20,000	1	40					40	52
2.1.1.4.1.3	Machine I-beams/structure/plates	ma day	447	10		0.1	9			9	

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2.1.1.4.1.4	Iron block actuator mounts (16)	cradle	125	16	4					4	5
2.1.1.4.1.4	Machine iron block actuator mounts	ma day	447	15		0.1	13			13	
2.1.1.4.1.5	Rails	cradle	2,000	1	4					4	5
2.1.1.4.1.5	Machine rails	ma day	447	15		0.1	13			13	
2.1.1.4.1.6	Lateral skid pad system (4)				4					4	5
2.1.1.4.1.7	Vertical/pitch adjustment				47	0.0	4			51	61
2.1.1.4.1.7.1	150-ton mechanical actuators (4)				24					24	31
2.1.1.4.1.7.2	3-way gear boxes (2)				4					4	5
2.1.1.4.1.7.3	transmission shafts (4)				2					2	3
2.1.1.4.1.7.4	Stepper motors (2)				8					8	10
2.1.1.4.1.7.5	gear reduction boxes (2)				3					3	4
2.1.1.4.1.7.6	pivot jack baseplates	total	1,000	1	1					1	1
2.1.1.4.1.7.6	machine pivot jack baseplates	ma day	447	5		0.0	4			4	
2.1.1.4.1.7.7	removable couplers (2)				1					1	1
2.1.1.4.1.7.8	constant velocity joints (2)				4					4	5
2.1.1.4.1.8	Air pad system (6 pads)	each	25,000	6	150					150	195
2.1.1.4.1.9	Gantry crane lifting fixture (4)	total	1,000	1	1					1	1
2.1.1.4.1.9	Machine gantry crane lifting fixtures	ma day	447	10		0.1	9			9	
2.1.1.4.1.10	Jacks (5 *2 jacks * 2 sides = 20)				80					80	104
2.1.1.4.1.11	Assembly	ma day	447	300		2.4	268			268	
2.1.1.4.1.12	Shipping to CERN				14					14	18
2.1.1.4.2	Barrel spider			2	115	0.4	40	0.5	51	206	150
2.1.1.4.2.1	Engineering design	en day	423	100				0.4	42	42	
2.1.1.4.2.2	Drafting	df day	289	30				0.1	9	9	
2.1.1.4.2.3	Screw actuators (18)	each	2,500	18	90					90	117
2.1.1.4.2.4	Structure-box beam	each	2,000	1	4					4	5
2.1.1.4.2.5	Jack pads	each	2,000	1	4					4	5
2.1.1.4.2.6	Attachment fixture	each	1,000	1	2					2	3
2.1.1.4.2.7	Bearing slides	each	500	1	1					1	1
2.1.1.4.2.8	Assembly	ma day	447	45		0.4	40			40	

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2.1.1.4.2.9	Shipping to CERN	each	7,000	1	14					14	18
2.1.1.4.3	Cryostat support post			2	19	0.1	13	0.1	13	45	25
2.1.1.4.3.1	Engineering design	en day	423	20				0.1	8	8	
2.1.1.4.3.2	Drafting	df day	289	15				0.1	4	4	
2.1.1.4.3.3	Structual steel (I-beams	each	2,000	1	4					4	5
2.1.1.4.3.4	Jack screws (3)	each	2,500	3	15					15	20
2.1.1.4.3.5	Assembly	ma day	447	15		0.1	13			13	
2.1.1.4.4	Spreader bar			2	7	0.0	4	0.1	8	19	9
2.1.1.4.4.1	Engineering design	en day	423	15				0.1	6	6	
2.1.1.4.4.2	Drafting	df day	289	5				0.0	1	1	
2.1.1.4.4.3	I-beam	each	500	1	1					1	1
2.1.1.4.4.4	mechanical acuator	each	2,500	1	5					5	7
2.1.1.4.4.5	adjustable screw foor	each	500	1	1					1	1
2.1.1.4.4.6	Assembly	ma day	447	5		0.0	4			4	
2.1.1.4.5	Lifting fixture			1	17	0.4	45	0.5	47	108	21
2.1.1.4.5.1	Engineering design	en day	423	90				0.4	38	38	
2.1.1.4.5.2	Drafting	df day	289	30				0.1	9	9	
2.1.1.4.5.3	I-beams	each	500	1	1					1	1
2.1.1.4.5.4	Ball screews (4)	each	1,000	4	4					4	5
2.1.1.4.5.5	Motors (2)	each	2,000	2	4					4	5
2.1.1.4.5.6	gear drive/sprocket	each	1,000	1	1					1	1
2.1.1.4.5.7	Assembly	ma day	447	100		0.4	45			45	
2.1.1.4.5.8	Shipping to CERN	each	7,000	1	7					7	9
2.1.1.4.6	Installation fixture			1	2	0.1	7	0.2	16	24	3
2.1.1.4.6.1	Engineering design	en day	423	30				0.1	13	13	
2.1.1.4.6.2	Drafting	df day	289	10				0.0	3	3	
2.1.1.4.6.3	I-beam stiffback	each	2,000	1	2					2	3
2.1.1.4.6.4	Cables (CERN)										
2.1.1.4.6.5	Come along/60-ton jacks	each		1							
2.1.1.4.6.6	Assembly	ma day	447	15		0.1	7			7	

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2.1.1.4.7	Other tooling				200					200	260
2.1.1.4.8	Assembly of Barrel				250	3.0	164			414	325
2.1.1.4.8.1	Techs (3 techs for 1 year)	ts day	655	250		3.0	164			164	
2.1.1.4.8.2	Rigging	days	2,000	125	250					250	325
2.1.1.4.9	Installation into Cryostat				30					30	39
2.1.1.4.9.1	Rigging	days	2,000	15	30					30	39
2.1.2	Optics				1,558	41.3	2,289	5.4	564	4,410	2,025
2.1.2.1	Optical system EDIA							5.0	529	529	
2.1.2.1.1	optics design (2 FTE for 1 yr)	en days	846	250				2.0	211	211	
2.1.2.1.2	production management (1 FTE)	en days	423	750				3.0	317	317	
2.1.2.2	Tile trays			2,957	809	16.0	912			1,720	1,051
2.1.2.2.1	4 mm SCSN81(m**2)	sqm	200	2,683	537					537	698
2.1.2.2.2	9 mm SCSN81(m**2)	sqm	449	274	123					123	160
2.1.2.2.3	2 mm plastic(m**2)	sqm	4.40	2,170	10					10	12
2.1.2.2.4	1 mm plastic(m**2)	sqm	2.20	2,170	5					5	6
2.1.2.2.5	Kapton tape(m)	m	0.17	14,026	2					2	3
2.1.2.2.6	Black tape (m)	m	0.17	17,451	3					3	4
2.1.2.2.7	Tyvek (m**2)	sqm	1.19	6,500	8					8	10
2.1.2.2.8	tedlar (m**2)	sqm	0.61	7,600	5					5	6
2.1.2.2.9	rivets	each	0.20	86,000	17					17	22
2.1.2.2.10	Glue				4					4	5
2.1.2.2.11	source tubes(m)	m	1.00	11,634	12					12	15
2.1.2.2.12	Couplers (source tubes)	each	5.00	2,448	12					12	16
2.1.2.2.13	optical connectors	each	2.00	2,700	5					5	7
2.1.2.2.14	Quartz connectors	each	5.00	324	2					2	2
2.1.2.2.15	positioning spring	each	7.00	2,160	15					15	20
2.1.2.2.16	1.34mm ball bit	each	50	400	20					20	26
2.1.2.2.17	thermwood machine (exists)			1							
2.1.2.2.18	thermwood code	ds days	370	250		1.0	93			93	
2.1.2.2.19	thermwood operator (2 techs for 3 yr	ts days	437	750		6.0	328			328	

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2.1.2.2.20	tile tray assembly (3 techs for 3 yrs)	ts days	655	750		9.0	491			491	
2.1.2.2.21	Lab 8 preparation				10					10	13
2.1.2.2.22	miscellaneous				20					20	26
2.1.2.3	Pigtails				304	10.0	546			850	395
2.1.2.3.1	Y-ll fiber (km)	km	1,333	54	72					72	93
2.1.2.3.2	clear fibers (km)	km	1,261	91	115					115	149
2.1.2.3.3	optical connectors	each	2.00	2,700	5					5	7
2.1.2.3.4	quartz fiber (km)	km	1,410	12	17					17	22
2.1.2.3.5	fiber scanner	each	30,000	1	30					30	39
2.1.2.3.6	fiber splicer	each	10,000	3	30					30	39
2.1.2.3.7	fiber polishers	each	10,000	3	30					30	39
2.1.2.3.8	connector polisher	each	5,000	1	5					5	7
2.1.2.3.9	assembly (4 techs for 2.5 yrs)	ts days	874	625		10.0	546			546	
2.1.2.4	Final assembly and testing				20	9.3	503	0.4	35	558	26
2.1.2.4.1	megatile scanner (FY'97)				20	0.3	12	0.4	35	67	26
2.1.2.4.1.1	Mechanical Engineering							0.2	15	15	
2.1.2.4.1.2	Electrical Engineering							0.2	20	20	
2.1.2.4.1.3	Parts				17					17	22
2.1.2.4.1.4	Maching/assembly					0.3	12			12	
2.1.2.4.1.5	Shipping & Setup				3					3	4
2.1.2.4.2	insert fibers	ts days	218	750		3.0	164			164	
2.1.2.4.3	test magatiles	ts days	218	750		3.0	164			164	
2.1.2.4.4	final packaging	ts days	218	750		3.0	164			164	
2.1.2.5	Optical Cables				237	2.0	109			346	308
2.1.2.5.1	optical connector molds	each	40,000	4	160					160	208
2.1.2.5.2	optical cable (m)	m	35	1,900	66					66	86
2.1.2.5.3	optical connectors	each	2.00	5,400	11					11	14
2.1.2.5.4	assembly (1 tech for 2 yrs)	ts days	218	500		2.0	109			109	
2.1.2.6	Shipping				38					38	49
2.1.2.6.1	shipping crates	each	500	54	27					27	35

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2.1.2.6.2	shipping to CERN	each	200	54	11					11	14
2.1.2.7	Installation into absorber				150	4.0	218			368	195
2.1.2.7.1	receiving/insp./inst. - CERN Bldg 168	ts day	874	250		4.0	218			218	
2.1.2.7.2	QA station - bldg. 168				50					50	65
2.1.2.7.3	Installation fixtures - bldg 168				20					20	26
2.1.2.7.4	Workstations	each	10,000	4	40					40	52
2.1.2.7.5	Portable source system	each	20,000	2	40					40	52
2.1.3	Readout Boxes	box	11,784	36	277	1.6	131	0.1	17	424	360
2.1.3.1	Design Engineering	eu hours	75	120				0.1	9	9	
2.1.3.2	Box outer enclosure				53	0.4	25			78	69
2.1.3.2.1	ext wall material (copper 1/4 inch)		913	5	5					5	6
2.1.3.2.2	water fittings		1.20	144	0					0	0
2.1.3.2.3	gas fittings		0.60	72	0					0	0
2.1.3.2.4	mounting bolts+brackets		5.00	288	1					1	2
2.1.3.2.5	aluminum cooling plates		2.10	19,048	40					40	52
2.1.3.2.6	copper plates		193	8	2					2	2
2.1.3.2.7	patch panel		72	72	5					5	7
2.1.3.2.8	technical support	tu hours	30	196		0.1	6			6	
2.1.3.2.9	machining + assembly	mu hours	35	540		0.3	19			19	
2.1.3.3	box internal structure				65	0.2	8			73	85
2.1.3.3.1	interior walls		913	6	5					5	7
2.1.3.3.2	sorting plate		72	72	5					5	7
2.1.3.3.3	tube support plate		72	72	5					5	7
2.1.3.3.4	calibration support plate		72	72	5					5	7
2.1.3.3.5	HPD Alignment and Fixturing		250	180	45					45	59
2.1.3.3.6	technical support	tu hours	30	196		0.1	6			6	
2.1.3.3.7	assembly	su hours	10	196		0.1	2			2	
2.1.3.4	box optical				145	0.8	47			192	189
2.1.3.4.1	fiber 940mm multiclad ps		0.90	56,304	51					51	66
2.1.3.4.2	fiber 300 mm multiclad ps		0.65	11,261	7					7	10

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2.1.3.4.3	fiber 200 mm quartz		25	432	11					11	14
2.1.3.4.4	Y11 Blocks		74	72	5					5	7
2.1.3.4.5	Delrin Cookies		24	180	4					4	6
2.1.3.4.6	sleeves		1.00	4,896	5					5	6
2.1.3.4.7	Connectors for ps fiber		5.00	3,024	15					15	20
2.1.3.4.8	Connectors/splitters for laser calibration		30	468	14					14	18
2.1.3.4.9	LEDs		21	144	3					3	4
2.1.3.4.10	Photodiodes and associated circuitry		133	108	14					14	19
2.1.3.4.11	Fiber Bundle assembly jigs		1,050	6	6					6	8
2.1.3.4.12	flycutting		50	180	9					9	12
2.1.3.4.13	technical support+assembly	tu hours	30	1,571		0.8	47			47	
2.1.3.5	Assembly and QC				13	0.2	12	0.1	8	33	17
2.1.3.5.1	Q/C fixturing		1,175	5	6					6	8
2.1.3.5.2	Q/C test equipment		7,500	1	8					8	10
2.1.3.5.3	Q/C Engineering	eu hours	75	100				0.1	8	8	
2.1.3.5.4	Q/C Technical	tu hours	30	393		0.2	12			12	
2.1.3.6	Installation					0.1	39			39	
2.1.3.6.1	install decoder boxes	ts days	218	36		0.0	8			8	
2.1.3.6.2	install cooling pipes	ts days	218	36		0.0	8			8	
2.1.3.6.3	install HV/LV cables	ts days	218	36		0.0	8			8	
2.1.3.6.4	install signal cables	ts days	218	72		0.0	16			16	
2.1.4	Photodetectors	wedge		36	763	1.0	54	1.0	106	923	992
2.1.4.1	NRE costs				168					168	219
2.1.4.2	HPD19	each	2,500	4	360					360	468
2.1.4.2a	spares/aging tests	each	2,500	0.4	36					36	47
2.1.4.3	HPD73	each	2,500	1	90					90	117
2.1.4.3a	spares/aging tests	each	2,500	0.1	9					9	12
2.1.4.4	Photodetector Testing			1	100	1.0	54	1.0	106	260	130
2.1.4.4.1	Phototransducer testing EDIA	en days	423	250				1.0	106	106	
2.1.4.4.2	Dark boxes and electronics	each	15,000	4	60					60	78

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2.1.4.4.3	Laser flasher & electronics	each	10,000	4	40					40	52
2.1.4.4.4	test photodetectors	tc days	218	248		1.0	54			54	
2.1.5	Front-end Electronics				1,276	1.3	80	4.6	379	1,734	1,658
2.1.5.1	QIE ASIC				257	0.4	23	1.4	115	394	334
2.1.5.1.1	Requirements Report								2 mo eng		
2.1.5.1.1.1	engineering	en days	423	40			0.2		17	17	
2.1.5.1.2	R&D and Test								1 mo eng,		
2.1.5.1.2.1	engineering	en days	423	20			0.1		8	8	
2.1.5.1.2.2	technical support	ts days	218	40			0.2		9	9	
2.1.5.1.3	Technical Design Report								1 mo eng,		
2.1.5.1.3.1	engineering	en days	423	20			0.1		8	8	
2.1.5.1.3.2	cost and schedule	en days	423	20			0.1		8	8	
2.1.5.1.4	ASIC Design								3 mo eng,		
2.1.5.1.4.1	engineering	en days	423	60			0.2		25	25	
2.1.5.1.4.2	technical support	ts days	218	20			0.1		4	4	
2.1.5.1.5	Multi-Project Wafer Run				5					5	7
2.1.5.1.6	Evaluation				4				1 mo eng,	4	5
2.1.5.1.6.1	engineering	en days	423	20			0.1		8	8	
2.1.5.1.6.2	technical support	ts days	218	40			0.2		9	9	
2.1.5.1.7	Multi-Project Wafer Run				5					5	7
2.1.5.1.8	Evaluation				1				1 mo eng,	1	1
2.1.5.1.8.1	engineering	en days	423	20			0.1		8	8	
2.1.5.1.8.2	technical support	ts days	218	40			0.2		9	9	
2.1.5.1.9	Five-Wafer Run				96					96	125
2.1.5.1.10	Test					1 week eng, 2 week tech					
2.1.5.1.10.1	engineering	en days	423	5		0.0	2			2	
2.1.5.1.10.2	technical support	tc days	218	10		0.0	2			2	
2.1.5.1.11	Production	each	20	6,624	132	2 week eng, 2 mo tech				132	172
2.1.5.1.11a	spares	each	20	662	13					13	17
2.1.5.1.11.1	engineering	en days	423	10		0.0	4			4	

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2.1.5.1.11.2	technical support	tc days	218	40		0.2	9			9	
2.1.5.1.12	QA/QC	each		7,286		1 min tech					
2.1.5.1.12.1	technical support	tc days	218	24		0.1	5			5	
2.1.5.2	ADC				49	0.3	17	0.2	17	83	64
2.1.5.2.1	Specifications								2 week en		
2.1.5.2.1.1	engineering	en days	423	10			0.0		4	4	
2.1.5.2.2	Prototype	each	10	25	0					0	0
2.1.5.2.3	Evaluate				3				1 mo eng,	3	4
2.1.5.2.3.1	engineering	en days	423	20			0.1		8	8	
2.1.5.2.3.2	technical support	ts days	218	10			0.0		2	2	
2.1.5.2.4	Modify Specifications								1 week en		
2.1.5.2.4.1	engineering	en days	423	5			0.0		2	2	
2.1.5.2.5	Pre-Prototype	each	8.00	100	1					1	1
2.1.5.2.6	Radiation Validate				5	2 week eng, 2 mo tech				5	7
2.1.5.2.6.1	engineering	en days	423	10		0.0	4			4	
2.1.5.2.6.1.1	technical support	tc days	218	40		0.2	9			9	
2.1.5.2.7	Acquisition	each	7.00	5,230	37					37	48
2.1.5.2.7a	spares	each	7.00	523	4					4	5
2.1.5.2.8	QA/QC	each		5,753		1 min tech					
2.1.5.2.8.1	technical support	tc days	218	19		0.1	4			4	
2.1.5.3	Channel Control ASIC	each			142	0.1	6	1.2	104	252	184
2.1.5.3.1	Requirements Report								2 mo eng		
2.1.5.3.1.1	engineering	en days	423	40			0.2		17	17	
2.1.5.3.2	Technical Design Report								1 mo eng,		
2.1.5.3.2.1	engineering	en days	423	20			0.1		8	8	
2.1.5.3.2.2	cost and schedule	en days	423	20			0.1		8	8	
2.1.5.3.3	ASIC Design								3 mo eng,		
2.1.5.3.3.1	engineering	en days	423	60			0.2		25	25	
2.1.5.3.3.1.1	technical support	ts days	218	20			0.1		4	4	
2.1.5.3.4	Multi-Project Wafer Run				5					5	7

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2.1.5.3.5	Evaluation				3				1 mo eng,	3	3
2.1.5.3.5.1	engineering	en days	423	20				0.1	8	8	
2.1.5.3.5.2	technical support	ts days	218	40				0.2	9	9	
2.1.5.3.6	Design Modifications								2 week en		
2.1.5.3.6.1	engineering	en days	423	10				0.0	4	4	
2.1.5.3.6.2	technical support	ts days	218	10				0.0	2	2	
2.1.5.3.7	Multi-Project Wafer Run				5					5	7
2.1.5.3.8	Evaluation				1				1 mo eng,	1	1
2.1.5.3.8.1	engineering	en days	423	20				0.1	8	8	
2.1.5.3.8.2	technical support	ts days	218	40				0.2	9	9	
2.1.5.3.9	Five Wafer Run				96					96	125
2.1.5.3.10	Test					1 week eng, 2 week tech					
2.1.5.3.10.1	engineering	en days	423	5		0.0	2			2	
2.1.5.3.10.2	technical support	tc days	218	10		0.0	2			2	
2.1.5.3.11	Production	each	15	1,950	29					29	38
2.1.5.3.11a	spares	each	15	195	3					3	4
2.1.5.3.12	QA/QC	each		2,145		1 min tech					
2.1.5.3.12.1	technical support	tc days	218	7		0.0	2			2	
2.1.5.4	Data Link				605	0.1	4	0.4	26	635	787
2.1.5.4.1	Specifications								1 mo eng		
2.1.5.4.1.1	engineering	en days	423	20				0.1	8	8	
2.1.5.4.2	Prototype	each	500	3	2					2	2
2.1.5.4.3	Evaluation								3 mo tech,		
2.1.5.4.3.1	engineering	en days	423	10				0.0	4	4	
2.1.5.4.3.2	technical support	ts days	218	60				0.2	13	13	
2.1.5.4.4	Acquisition	each	330	1,656	546					546	710
2.1.5.4.4a	spares	each	330	166	55					55	71
2.1.5.4.5	QA/QC				2	1 week eng, 2 week tech			software	2	3
2.1.5.4.5.1	engineering	en days	423	5		0.0	2			2	
2.1.5.4.5.2	technical support	tc days	218	10		0.0	2			2	

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2.1.5.4.5.3	software	cp days	423								
2.1.5.5	Voltage Regulator				17			0.2	12	29	23
2.1.5.5.1	Specifications								1 week en		
2.1.5.5.1.1	engineering	en days	423	5			0.0		2	2	
2.1.5.5.2	Prototype	each	3.00	30	0					0	0
2.1.5.5.3	Evaluation				1				1 week en	1	1
2.1.5.5.3.1	engineering	en days	423	5			0.0		2	2	
2.1.5.5.3.2	technical support	ts days	218	10			0.0		2	2	
2.1.5.5.4	Pre-Production Prorotype	each	3.00	100	0					0	0
2.1.5.5.5	Evaluation				5				1 week en	5	6
2.1.5.5.5.1	engineering	en days	423	5			0.0		2	2	
2.1.5.5.5.2	technical support	ts days	218	15			0.1		3	3	
2.1.5.5.6	Acquisition	each	2.00	5,230	10					10	14
2.1.5.5.6a	spares	each	2.00	523	1					1	1
2.1.5.6	3 Channel PCBs				76	0.2	9	0.7	53	139	98
2.1.5.6.1	Requirements Report								1 mo eng		
2.1.5.6.1.1	engineering	en days	423	20			0.1		8	8	
2.1.5.6.2	Technical Design Report								1 mo eng,		
2.1.5.6.2.1	engineering	en days	423	20			0.1		8	8	
2.1.5.6.2.2	technical support	ts days	218	20			0.1		4	4	
2.1.5.6.3	Prototype	each	50	25	1				1 mo eng,	1	2
2.1.5.6.3.1	engineering	en days	423	20			0.1		8	8	
2.1.5.6.3.2	technical support	ts days	218	40			0.2		9	9	
2.1.5.6.4	Assembly	each	10	25	0	2 wk tech				0	0
2.1.5.6.4.1	technical support	tc days	218	10		0.0	2			2	
2.1.5.6.5	Evaluation								0.5 mo en		
2.1.5.6.5.1	engineering	en days	423	10			0.0		4	4	
2.1.5.6.5.2	technical support	ts days	218	20			0.1		4	4	
2.1.5.6.6	Design Modifications								1 wk eng,		
2.1.5.6.6.1	engineering	en days	423	5			0.0		2	2	

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2.1.5.6.6.2	technical support	ts days	218	5				0.0	1	1	
2.1.5.6.7	Pre-Production Prototype	each	50	25	1	2 wk tech				1	2
2.1.5.6.7.1	technical support	tc days	218	10		0.0	2			2	
2.1.5.6.8	Evaluation								1 week en		
2.1.5.6.8.1	engineering	en days	423	5				0.0	2	2	
2.1.5.6.8.2	technical support	ts days	218	5				0.0	1	1	
2.1.5.6.9	Production	each	5.00	1,656	8					8	11
2.1.5.6.9a	spares	each	5.00	166	1					1	1
2.1.5.6.10	Assembly	each	35	1,822	64	1 wk tech				64	83
2.1.5.6.10.1	technical support	tc days	218	5		0.0	1			1	
2.1.5.6.11	QA/QC	each		1,822		3 min tech			software		
2.1.5.6.11.1	technical support	tc days	218	18		0.1	4			4	
2.1.5.6.11.2	software	cp days	423								
2.1.5.7	Backplane				31	0.2	9	0.5	41	81	40
2.1.5.7.1	Requirements Report								1 mo.eng		
2.1.5.7.1.1	engineering	en days	423	20				0.1	8	8	
2.1.5.7.2	Technical Design Report								1 mo.eng,		
2.1.5.7.2.1	engineering	en days	423	20				0.1	8	8	
2.1.5.7.2.2	technical support	ts days	218	40				0.2	9	9	
2.1.5.7.3	Prototype	each	450	5	2	2 tech hrs			0.5 mo.en	2	3
2.1.5.7.3.1	engineering	en days	423	10				0.0	4	4	
2.1.5.7.3.2	technical support	ts days	218	20				0.1	4	4	
2.1.5.7.3.3	technical support	tc days	218	1		0.0	0			0	
2.1.5.7.4	Assembly	each	500	5	3	1 tech week				3	3
2.1.5.7.4.1	technical support	tc days	218	5		0.0	1			1	
2.1.5.7.5	Evaluate								1 wk eng,		
2.1.5.7.5.1	engineering	en days	423	5				0.0	2	2	
2.1.5.7.5.2	technical support	ts days	218	5				0.0	1	1	
2.1.5.7.6	Design Modifications								1 wk eng,		
2.1.5.7.6.1	engineering	en days	423	5				0.0	2	2	

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2.1.5.7.6.2	technical support	ts days	218	5				0.0	1	1	
2.1.5.7.7	Pre-Production Prototype	each	450	5	2	1 wk eng, 1 wk tech				2	3
2.1.5.7.7.1	engineering	en days	423	5		0.0	2			2	
2.1.5.7.7.2	technical support	tc days	218	5		0.0	1			1	
2.1.5.7.8	Production	each	100	36	4					4	5
2.1.5.7.8a	spares	each	100	2	0					0	0
2.1.5.7.9	Assembly	each	525	38	20					20	26
2.1.5.7.10	QA/QC	each		38		3 tech hours			software		
2.1.5.7.10.1	technical support	tc days	218	23		0.1	5			5	
2.1.5.7.10.2	software	cp days	423								
2.1.5.8	Test Stands				99	0.2	11	0.1	11	121	129
2.1.5.8.1	Main Frame	each	12,000	5	60	2 week tech				60	78
2.1.5.8.1.1	technical support	tc days	218	10		0.0	2			2	
2.1.5.8.2	QIE Test Adapter	each	3,000	3	9	2 week tech				9	12
2.1.5.8.2.1	technical support	tc days	218	10		0.0	2			2	
2.1.5.8.3	PCB Test Adapter	each	3,000	4	12	2 week tech			2 week en	12	16
2.1.5.8.3.1	engineering	en days	423	10				0.0	4	4	
2.1.5.8.3.2	technical support	ts days	218	5				0.0	1	1	
2.1.5.8.3.3	technical support	tc days	218	10		0.0	2			2	
2.1.5.8.4	Control ASIC Test Adapter	each	3,000	3	9	2 week tech			2 week en	9	12
2.1.5.8.4.1	engineering	en days	423	10				0.0	4	4	
2.1.5.8.4.2	technical support	ts days	218	5				0.0	1	1	
2.1.5.8.4.3	technical support	tc days	218	10		0.0	2			2	
2.1.5.8.5	ADC Test Adapter	each	3,000	3	9	2 week tech				9	12
2.1.5.8.5.1	technical support	tc days	218	10		0.0	2			2	
2.1.6	Calibration Systems				298	3.2	192	0.2	30	520	387
2.1.6.1	Laser routing system				158	1.2	72	0.2	30	260	205
2.1.6.1.1	Laser (HB, HE, HF)	each	40,000	2	80					80	104
2.1.6.1.2	Dye cell				5					5	7
2.1.6.1.2.1	engineering	eu days	600	10				0.0	6	6	

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2.1.6.1.2.2	technician	tu days	240	10		0.0	2			2	
2.1.6.1.3	Neutral density filters				10					10	13
2.1.6.1.3.1	engineering	eu days	600	20				0.1	12	12	
2.1.6.1.3.2	technician	tu days	240	20		0.1	5			5	
2.1.6.1.3.3	control system				10					10	13
2.1.6.1.4	Additional optics				10					10	13
2.1.6.1.5	Commutator				5					5	7
2.1.6.1.5.1	engineering	eu days	600	20				0.1	12	12	
2.1.6.1.5.2	technician	tu days	240	20		0.1	5			5	
2.1.6.1.5.3	control system				10					10	13
2.1.6.1.6	Quartz fiber to splitters	m	10	200	2					2	3
2.1.6.1.7	18-fold splitters	each	2,000	4	8					8	10
2.1.6.1.8	Quartz fiber to decoder boxes	m	10	720	7					7	9
2.1.6.1.9	Connectors (2/fiber)	each	5	144	1					1	1
2.1.6.1.11	Quartz fiber to tiles	m	10	576	6					6	7
2.1.6.1.12	Connectors (2/fiber)	each	5	576	3					3	4
2.1.6.1.13	PIN diode mounting mechanics		150	6	1					1	1
2.1.6.1.14	PIN diode read-out electronics		50	6	0					0	0
2.1.6.1.15	Assembly (1 tech-year)	tu days	240	250		1.0	60			60	
2.1.6.2	Source routing system				140	2.0	120			260	182
2.1.6.2.1	Souce drivers	each	10,000	7	70					70	91
2.1.6.2.2	Sources	each	5,000	7	35					35	46
2.1.6.2.3	Controllers	each	5,000	7	35					35	46
2.1.6.2.4	Assembly labor	tu days	240	500		2.0	120			120	
2.1.7	Trigger/DAQ Electronics				343	0.7	40	4.7	386	769	446
2.1.7.1	Multi-Chip Modules				150	0.3	21	2.1	188	359	195
2.1.7.1.1	Specifications								3 mo eng		
2.1.7.1.1.1	engineering	en days	423	60			0.2		25	25	
2.1.7.1.2	Prototype	each	250	6	2				6 mo eng	2	2
2.1.7.1.2.1	engineering	en days	423	125			0.5		53	53	

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2.1.7.1.3	Test Adapter	each	3,000	1	3	2 week tech			2 week en	3	4
2.1.7.1.3.1	engineering	en days	423	10				0.0	4	4	
2.1.7.1.3.2	technical support	ts days	218	10				0.0	2	2	
2.1.7.1.3.3	technician	tc days	218	10		0.0	2			2	
2.1.7.1.4	Evaluation	each	2,500	1	3				2 mo eng,	3	3
2.1.7.1.4.1	engineering	en days	423	40				0.2	17	17	
2.1.7.1.4.2	technical support	ts days	218	40				0.2	9	9	
2.1.7.1.5	Pre-Production Prototype	each	150	30	5				3 mo eng	5	6
2.1.7.1.5.1	engineering	en days	423	60				0.2	25	25	
2.1.7.1.6	Evaluation								3 mo eng,		
2.1.7.1.6.1	engineering	en days	423	60				0.2	25	25	
2.1.7.1.6.2	technical support	ts days	218	125				0.5	27	27	
2.1.7.1.7	HB Production	each	100	1,260	126	1 mo eng				126	164
2.1.7.1.7a	spares	each	100	126	13	1 mo eng				13	16
2.1.7.1.7.1	engineering	en days	423	20		0.1	8			8	
2.1.7.1.8	QA/QC			1,386		10 min tech per MCM					
2.1.7.1.8.1	technician	tc days	218	46		0.2	10			10	
2.1.7.2	VME Modules				118	0.3	16	0.8	68	202	153
2.1.7.2.1	Specifications								1 mo eng		
2.1.7.2.1.1	engineering	en days	423	20				0.1	8	8	
2.1.7.2.2	Prototype	each	700	5	4				1 mo eng,	4	5
2.1.7.2.2.1	engineering	en days	423	20				0.1	8	8	
2.1.7.2.2.2	technical support	ts days	218	40				0.2	9	9	
2.1.7.2.3	Stuffing	each	100	2	0	3 week tech				0	0
2.1.7.2.3.1	technician	tc days	218	15		0.1	3			3	
2.1.7.2.4	Evaluation								2 mo eng,		
2.1.7.2.4.1	engineering	en days	423	40				0.2	17	17	
2.1.7.2.4.2	technical support	ts days	218	40				0.2	9	9	
2.1.7.2.5	Design Modification								2 week en		
2.1.7.2.5.1	engineering	en days	423	10				0.0	4	4	

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2.1.7.2.6	Pre-Production Prototype	each	600	5	3					3	4
2.1.7.2.7	Stuffing	each	100	2	0	3 week tech				0	0
2.1.7.2.7.1	technician	tc days	218	15		0.1	3			3	
2.1.7.2.8	Evaluation								1 mo eng,		
2.1.7.2.8.1	engineering	en days	423	20				0.1	8	8	
2.1.7.2.8.2	technical support	ts days	218	20				0.1	4	4	
2.1.7.2.9	HB Production	each	1,200	84	101	1 week tech				101	131
2.1.7.2.9a	spares	each	1,200	8	10	1 week tech				10	13
2.1.7.2.9.1	technician	tc days	218	5		0.0	1			1	
2.1.7.2.10	QA/QC			92		2 hour tech per module					
2.1.7.2.10.1	technician	tc days	218	37		0.1	8			8	
2.1.7.3	9U VME Crates				28	0.0	1	0.0	4	33	36
2.1.7.3.1	HB Production	each	5,000	5	25				2 week en	25	33
2.1.7.3.1a	spares	each	5,000	1	3				2 week en	3	3
2.1.7.3.1.1	engineering	en days	423	10				0.0	4	4	
2.1.7.3.2	QA/QC			6		4 hour tech per crate					
2.1.7.3.2.1	technician	tc days	218	4		0.0	1			1	
2.1.7.4	FED/DDU				44	0.0	2	1.5	107	154	57
2.1.7.4.1	HB Production	each	4,000	10	40				6 mo eng	40	52
2.1.7.4.1	spares	each	4,000	1	4				6 mo eng	4	5
2.1.7.4.1.1	engineering	en days	423	125				0.5	53	53	
2.1.7.4.1.2	technical support	ts days	218	250				1.0	55	55	
2.1.7.4.2	QA/QC			11		1 day tech per FED/DDU					
2.1.7.4.2.1	technician	tc days	218	11		0.0	2			2	
2.1.7.5	Data Link				4	0.0	0	0.2	17	21	5
2.1.7.5.1	HB Production	each	330	10	3			1 mo eng, 2 mo tech		3	4
2.1.7.5.1a	spares	each	330	1	0			1 mo eng, 2 mo tech		0	0
2.1.7.5.1.1	engineering	en days	423	20				0.1	8	8	
2.1.7.5.1.2	technical support	ts days	218	40				0.2	9	9	
2.1.7.5.2	QA/QC			11		1 hour tech per link					

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2.1.7.5.2.1	technician	tc days	218	2		0.0	0			0	
2.1.8	Voltage Supply Systems				225	1.2	76	2.1	165	466	293
2.1.8.1	16 KV DC-DC Converter				15	0.1	5	0.2	18	39	20
2.1.8.1.1	Specification								2 week en		
2.1.8.1.1.1	engineering	en days	423	10				0.0	4	4	
2.1.8.1.1.2	technical support	ts days	218	10				0.0	2	2	
2.1.8.1.2	Prototype	each	250	12	3					3	4
2.1.8.1.3	Test Stand	each	2,500	1	3	3 week tech			1 week en	3	3
2.1.8.1.3.1	engineering	en days	423	5				0.0	2	2	
2.1.8.1.3.2	technical support	ts days	218	5				0.0	1	1	
2.1.8.1.3.3	technician	tc days	218	15		0.1	3			3	
2.1.8.1.4	Evaluation								2 week en		
2.1.8.1.4.1	engineering	en days	423	10				0.0	4	4	
2.1.8.1.4.2	technical support	ts days	218	20				0.1	4	4	
2.1.8.1.5	Acquisition	each	250	36	9					9	12
2.1.8.1.5a	spares	each	250	4	1					1	1
2.1.8.1.6	QA/QC	each		40		2 week tech					
2.1.8.1.6.1	technician	tc days	218	10		0.0	2			2	
2.1.8.2	16 KV EMI Filter				1	0.1	3	0.2	18	23	2
2.1.8.2.1	Requirements Report								1 week en		
2.1.8.2.1.1	engineering	en days	423	5				0.0	2	2	
2.1.8.2.2	Technical Design Report								2 week en		
2.1.8.2.2.1	engineering	en days	423	10				0.0	4	4	
2.1.8.2.2.2	technical support	ts days	218	10				0.0	2	2	
2.1.8.2.3	Prototype	each	25	5	0	1 week tech				0	0
2.1.8.2.3.1	technician	tc days	218	5		0.0	1			1	
2.1.8.2.4	Evaluation								1 week en		
2.1.8.2.4.1	engineering	en days	423	5				0.0	2	2	
2.1.8.2.4.2	technical support	ts days	218	10				0.0	2	2	
2.1.8.2.5	Design Modification								1 week en		

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2.1.8.2.5.1	engineering	en days	423	5				0.0	2	2	
2.1.8.2.6	Pre-Production Prototype	each	25	5	0	1 week tech				0	0
2.1.8.2.6.1	technician	tc days	218	5		0.0	1			1	
2.1.8.2.7	Evaluation								1 week en		
2.1.8.2.7.1	engineering	en days	423	5				0.0	2	2	
2.1.8.2.7.2	technical support	ts days	218	5				0.0	1	1	
2.1.8.2.8	Acquisition	each	25	36	1					1	1
2.1.8.2.8a	spares	each	25	4	0					0	0
2.1.8.2.9	QA/QC					1 week tech					
2.1.8.2.9.1	technician	tc days	218	5		0.0	1			1	
2.1.8.3	16 KV Fast Trip				6	0.1	5	0.4	29	41	8
2.1.8.3.1	Requirements Report	each							2 week en		
2.1.8.3.1.1	engineering	en days	423	10				0.0	4	4	
2.1.8.3.2	R&D and Test								2 week en		
2.1.8.3.2.1	engineering	en days	423	10				0.0	4	4	
2.1.8.3.2.2	technical support	ts days	218	20				0.1	4	4	
2.1.8.3.3	Technical Design Report								2 week en		
2.1.8.3.3.1	engineering	en days	423	10				0.0	4	4	
2.1.8.3.3.2	technical support	ts days	218	10				0.0	2	2	
2.1.8.3.4	Prototype	each	50	5	0	1 week tech				0	0
2.1.8.3.4.1	technician	tc days	218	5		0.0	1			1	
2.1.8.3.5	Evaluation								1 week en		
2.1.8.3.5.1	engineering	en days	423	5				0.0	2	2	
2.1.8.3.5.2	technical support	ts days	218	10				0.0	2	2	
2.1.8.3.6	Design Modification								1 week en		
2.1.8.3.6.1	engineering	en days	423	5				0.0	2	2	
2.1.8.3.7	Pre-Production Prototype	each	50	5	0	1 week tech				0	0
2.1.8.3.7.1	technician	tc days	218	5		0.0	1			1	
2.1.8.3.8	Evaluation								1 week en		
2.1.8.3.8.1	engineering	en days	423	5				0.0	2	2	

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2.1.8.3.8.2	technical support	ts days	218	5				0.0	1	1	
2.1.8.3.9	Production	each	30	180	5	1 week tech				5	7
2.1.8.3.9a	spares	each	30	18	1	1 week tech				1	1
2.1.8.3.9.1	technician	tc days	218	5		0.0	1			1	
2.1.8.3.10	QA/QC					2 week tech					
2.1.8.3.10.1	technician	tc days	218	10		0.0	2			2	
2.1.8.4	Control				5	0.1	5	0.2	16	26	6
2.1.8.4.1	Requirements Report								1 week en		
2.1.8.4.1.1	engineering	en days	423	5				0.0	2	2	
2.1.8.4.2	Technical Design Report								2 week en		
2.1.8.4.2.1	engineering	en days	423	10				0.0	4	4	
2.1.8.4.2.2	technical support	ts days	218	10				0.0	2	2	
2.1.8.4.3	Prototype	each	100	5	1	2 week tech				1	1
2.1.8.4.3.1	technician	tc days	218	10		0.0	2			2	
2.1.8.4.4	Evaluation								1 week en		
2.1.8.4.4.1	engineering	en days	423	5				0.0	2	2	
2.1.8.4.4.2	technical support	ts days	218	10				0.0	2	2	
2.1.8.4.5	Design Modification								1 week en		
2.1.8.4.5.1	engineering	en days	423	5				0.0	2	2	
2.1.8.4.6	Pre-Production Prototype	each	100	5	1	1 week tech				1	1
2.1.8.4.6.1	technician	tc days	218	5		0.0	1			1	
2.1.8.4.7	Evaluation								1 week tec		
2.1.8.4.7.1	technical support	ts days	218	5				0.0	1	1	
2.1.8.4.8	Production	each	100	36	4	1 week tech				4	5
2.1.8.4.8a	spares	each	100	4	0	1 week tech				0	0
2.1.8.4.8.1	technician	tc days	218	5		0.0	1			1	
2.1.8.4.9	QA/QC					1 week tech					
2.1.8.4.9.1	technician	tc days	218	5		0.0	1			1	
2.1.8.5	Bias DC-DC Converter				7	0.0	1	0.1	11	19	9
2.1.8.5.1	Specifications								2 week en		

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2.1.8.5.1.1	engineering	en days	423	10				0.0	4	4	
2.1.8.5.1.2	technical support	ts days	218	10				0.0	2	2	
2.1.8.5.2	Prototype	each	150	6	1					1	1
2.1.8.5.3	Evaluation								1 week en		
2.1.8.5.3.1	engineering	en days	423	5				0.0	2	2	
2.1.8.5.3.2	technical support	ts days	218	10				0.0	2	2	
2.1.8.5.4	Acquisition	each	150	36	5					5	7
2.1.8.5.4a	spares	each	150	4	1					1	1
2.1.8.5.5	QA/QC					1 week tech					
2.1.8.5.5.1	technician	tc days	218	5		0.0	1			1	
2.1.8.6	Bias Fast Trip				2	0.1	3	0.1	12	17	3
2.1.8.6.1	Technical Design Report								2 week en		
2.1.8.6.1.1	engineering	en days	423	10				0.0	4	4	
2.1.8.6.2	Prototype	each	10	5	0	1 week tech				0	0
2.1.8.6.2.1	technician	tc days	218	5		0.0	1			1	
2.1.8.6.3	Evaluation								1 week en		
2.1.8.6.3.1	engineering	en days	423	5				0.0	2	2	
2.1.8.6.3.2	technical support	ts days	218	10				0.0	2	2	
2.1.8.6.4	Design Modification								1 week en		
2.1.8.6.4.1	engineering	en days	423	5				0.0	2	2	
2.1.8.6.5	Pre-Production Prototype	each	10	5	0	1 week tech				0	0
2.1.8.6.5.1	technician	tc days	218	5		0.0	1			1	
2.1.8.6.6	Evaluation								1 weel tec		
2.1.8.6.6.1	technical support	ts days	218	5				0.0	1	1	
2.1.8.6.7	Production	each	10	180	2					2	2
2.1.8.6.7a	spares	each	10	18	0					0	0
2.1.8.6.8	QA/QC					1 week tech					
2.1.8.6.8.1	technician	tc days	218	5		0.0	1			1	
2.1.8.7	Module				9	0.1	5	0.3	23	37	12
2.1.8.7.1	Requirements Report								1 week en		

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2.1.8.7.1.1	engineering	en days	423	5				0.0	2	2	
2.1.8.7.2	Technical Design Report								1 week en		
2.1.8.7.2.1	engineering	en days	423	5				0.0	2	2	
2.1.8.7.2.2	technical support	ts days	218	10				0.0	2	2	
2.1.8.7.3	Prototype	each	1,100	2	2	1 week tech			2 week en	2	3
2.1.8.7.3.1	engineering	en days	423	10				0.0	4	4	
2.1.8.7.3.2	technical support	ts days	218	40				0.2	9	9	
2.1.8.7.3.3	technician	tc days	218	5		0.0	1			1	
2.1.8.7.4	Evaluation								1 week tec		
2.1.8.7.4.1	technical support	ts days	218	5				0.0	1	1	
2.1.8.7.5	Design Modification								1 week en		
2.1.8.7.5.1	engineering	en days	423	5				0.0	2	2	
2.1.8.7.6	Acquisition	each	100	36	4	1 week tech				4	5
2.1.8.7.6a	spares	each	100	4	0	1 week tech				0	0
2.1.8.7.6.1	technician	tc days	218	5		0.0	1			1	
2.1.8.7.7	Stuffing	each	80	40	3					3	4
2.1.8.7.8	QA/QC					3 week tech					
2.1.8.7.8.1	technician	tc days	218	15		0.1	3			3	
2.1.8.8	6U VME Crate				4	0.0	1			5	6
2.1.8.8.1	Acquisition	each	2,000	2	4					4	5
2.1.8.8.1a	spares	each	2,000	0	0					0	1
2.1.8.8.2	QA/QC					1 week tech					
2.1.8.8.2.1	technician	tc days	218	5		0.0	1			1	
2.1.8.9	Software					0.2	18	0.0	2	20	
2.1.8.9.1	User Requirements Document								1 week en		
2.1.8.9.1.1	engineering	en days	423	5				0.0	2	2	
2.1.8.9.2	Code Writing					2 mo software					
2.1.8.9.2.1	software	cp days	423	40		0.2	17			17	
2.1.8.9.3	QA/QC					1 week tech					
2.1.8.9.3.1	technician	tc days	218	5		0.0	1			1	

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2.1.8.10	High Voltage Cable/Connector				98			0.2	17	115	128
2.1.8.10.1	Preproduction Prototype				5				3 week en	5	7
2.1.8.10.1.1	engineering	en days	423	15				0.1	6	6	
2.1.8.10.1.2	technical support	ts days	218	20				0.1	4	4	
2.1.8.10.2	Evaluation	100 ft	230	180	41				2 week en	41	54
2.1.8.10.2.1	engineering	en days	423	10				0.0	4	4	
2.1.8.10.2.2	technical support	ts days	218	10				0.0	2	2	
2.1.8.10.3	Cable Acquisition	100 ft	230	180	41					41	54
2.1.8.10.3a	spares	100 ft	230	36	8					8	11
2.1.8.10.4	Connector Acquisition	each	25	72	2					2	2
2.1.8.10.4a	spares	each	25	14	0					0	0
2.1.8.11	Barrel Low Voltage				76	0.5	28	0.2	19	123	99
2.1.8.11.1	Requirements Report								2 week en		
2.1.8.11.1.1	engineering	en days	423	10				0.0	4	4	
2.1.8.11.2	Technical Specifications								3 week en		
2.1.8.11.2.1	engineering	en days	423	15				0.1	6	6	
2.1.8.11.3	Prototype Acquisition	each	6,600	3	20					20	26
2.1.8.11.4	Test Load				1 week tech					1	1
2.1.8.11.4.1	technician	tc days	218	10		0.0	2			2	
2.1.8.11.5	Evaluation								2 week en		
2.1.8.11.5.1	engineering	en days	423	10				0.0	4	4	
2.1.8.11.5.2	technical support	ts days	218	20				0.1	4	4	
2.1.8.11.6	Radiation Tolerance Validation				3	1 week eng, 8 week tech				3	3
2.1.8.11.6.1	engineering	en days	423	5		0.0	2			2	
2.1.8.11.6.2	technician	tc days	218	40		0.2	9			9	
2.1.8.11.7	Prepare Bid Package				1 week eng						
2.1.8.11.7.1	engineering	en days	423	5		0.0	2			2	
2.1.8.11.8	Supply Acquisition	each	3,300	9	30					30	39
2.1.8.11.8a	spares	each	3,300	1	3					3	4
2.1.8.11.9	Cable Acquisition	100 ft	270	72	19					19	25

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2.1.8.11.9a	spares	100 ft	270	4	1					1	1
2.1.8.11.10	QA/QC on installed cable	unit		72	4 hour tech						
2.1.8.11.10.	technician	tc days	218	58		0.2	13			13	
2.1.9	Detector Control System				163	1.6	132	0.7	67	362	212
2.1.9.1	Toolkit				36	0.1	8	0.1	8	53	47
2.1.9.1.1	Barrel	each	10,000	1	10	4 week software			4 week en	10	13
2.1.9.1.1.1	engineering	en days	423	20				0.1	8	8	
2.1.9.1.1.2	software	cp days	423	20		0.1	8			8	
2.1.9.1.1.3	hardware		13	2	26					26	34
2.1.9.2	Arcnet				51	0.6	48	0.4	39	138	67
2.1.9.2.1	Barrel Spokes	each	200	36	7					7	9
2.1.9.2.2	Barrel Hub	each	7,000	2	14					14	18
2.1.9.2.3	Barrel Interconnect	each	2,000	2	4					4	5
2.1.9.2.4	Barrel Driver				3 mo software						
2.1.9.2.4.1	software	cp days	423	60		0.2	25			25	
2.1.9.2.5	CAN Interface Development				5	4 week eng, 8 week tech			4 week en	5	7
2.1.9.2.5.1	engineering	en days	423	20				0.1	8	8	
2.1.9.2.5.2	software	cp days	423	60				0.2	25	25	
2.1.9.2.5.3	engineering	en days	423	20		0.1	8			8	
2.1.9.2.5.4	technician	tc days	218	40		0.2	9			9	
2.1.9.2.6	Test Adapter	each	3,000	1	3	2 week tech			2 week en	3	4
2.1.9.2.6.1	engineering	en days	423	10				0.0	4	4	
2.1.9.2.6.2	technical support	ts days	218	5				0.0	1	1	
2.1.9.2.6.3	technician	tc days	218	10		0.0	2			2	
2.1.9.2.7	Barrel CAN Interface	each	500	36	18	1 week tech				18	23
2.1.9.2.7.1	technician	tc days	218	5		0.0	1			1	
2.1.9.2.8	QA/QC					2 week tech					
2.1.9.2.8.1	technician	tc days	218	10		0.0	2			2	
2.1.9.3	EPICS IOC				49	0.6	58			107	64
2.1.9.3.1	Front Ends	each	7,000	2	14	12 week software				14	18

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2.1.9.3.1.1	software	cp days	423	60		0.2	25			25	
2.1.9.3.2	QA/QC	each				1 week tech each					
2.1.9.3.2.1	technician	tc days	218	10		0.0	2			2	
2.1.9.3.3	TriDAS	each	7,000	5	35	12 week software				35	46
2.1.9.3.3.1	software	cp days	423	60		0.2	25			25	
2.1.9.3.4	QA/QC	each				1 week tech each					
2.1.9.3.4.1	technician	tc days	218	25		0.1	5			5	
2.1.9.4	EPICS IOC Bridge				2	0.0	1	0.1	6	10	3
2.1.9.4.1	Barrel High Voltage	each	1,000	2	2				2 week en	2	3
2.1.9.4.1.1	engineering	en days	423	10				0.0	4	4	
2.1.9.4.1.2	technical support	ts days	218	10				0.0	2	2	
2.1.9.4.2	QA/QC					1 week tech					
2.1.9.4.2.1	technician	tc days	218	5		0.0	1			1	
2.1.9.5	TTC				18	0.3	16	0.2	13	47	23
2.1.9.5.1	Barrel	each	500	36	18	2 day tech each			4 week en	18	23
2.1.9.5.1.1	engineering	en days	423	20				0.1	8	8	
2.1.9.5.1.2	technical support	ts days	218	20				0.1	4	4	
2.1.9.5.1.3	technician	tc days	218	72		0.3	16			16	
2.1.9.6	Software License				7					7	9
2.1.9.6.1	Barrel	each	1,000	7	7					7	9
2.1.10	Pre-production Prototypes				1,250	4	203	2	160	1,613	1,625
2.1.10.1	Wedge 1 (FY'97)				300					300	390
2.1.10.2	Wedge 2 - absorber		350,000	1	250					250	325
2.1.10.3	Wedge assembly				65			0.1	13	78	85
2.1.10.3.1	Engineering Design	en days	423	20				0.1	8	8	
2.1.10.3.2	Drafting	df days	289	15				0.1	4	4	
2.1.10.3.3	plate lifting fixture	each	15,000	1	15					15	20
2.1.10.3.4	Assembly table & "pushing fixture"	each	50,000	1	50					50	65
2.1.10.4	Wedge prototype tooling				120	0.5	27	0.4	44	191	156
2.1.10.4.1	Load Test Stand				113	0.5	27	0.4	44	184	147

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2.1.10.4.1.1	engineering design	en days	423	90				0.4	38	38	
2.1.10.4.1.2	drafting	df days	289	20				0.1	6	6	
2.1.10.4.1.3	mechanical actuators (jacks) (28)		70,000	1	70					70	91
2.1.10.4.1.4	load cells (28)		30,000	1	30					30	39
2.1.10.4.1.5	I-beam/support structure	structure	5,000	1	5					5	7
2.1.10.4.1.6	assembly (sr. tech)	ts days	218	125		0.5	27			27	
2.1.10.4.1.7	Rigging (4 days - in and out)	days	2,000	4	8					8	10
2.1.10.4.2	Shipping to CERN	each	7,000	1	7					7	9
2.1.10.5	Optics for PPP				37	3.0	167			204	49
2.1.10.5.1	Tile trays M&S				22					22	29
2.1.10.5.1	Tile trays labor					0.4	25.3			25	
2.1.10.5.1.1	2 techs for 6 months	tc days	437	125		1.0	55			55	
2.1.10.5.2	Pigtails M&S				8					8	11
2.1.10.5.2	Pigtails labor					0.3	15			15	
2.1.10.5.2.1	2 techs for 6 months	tc days	437	125		1.0	55			55	
2.1.10.5.3	Final assembly and testing					0.3	14			14	
2.1.10.5.4	Optical Cables M&S				7					7	9
2.1.10.5.4	Optical cables labor					0.1	3			3	
2.1.10.6	Readout Box				8	0.1	7			15	10
2.1.10.6.1	Readout Box M&S				8					8	10
2.1.10.6.2	Readout Box labor					0.1	7			7	
2.1.10.7	Photodetectors				26	0.0	2	0.0	3	30	34
2.1.10.7.1	Photodetector EDIA							0.0	3	3	
2.1.10.7.2	Photodetector M&S				26					26	34
2.1.10.7.3	Photodetector labor					0.0	2			2	
2.1.10.8	Test beam stand				400			1.0	100	500	520
2.1.10.8.1	Test beam stand EDIA							1.0	100	100	
2.1.10.8.2	Test beam stand M&S				400					400	520
2.1.10.9	Portable source system	each	20,000	1	20					20	26
2.1.10.10	Electronics	each	9,000	2	18					18	23

WBS Number	Description	Unit	Unit Cost ($)	Quantity	Mfg M&S (K$)	Mfg Labor (Yrs)	Mfg Labor (K$)	EDIA Labor (Yrs)	EDIA Labor (K$)	Base Cost (K$)	CMS Cost (KCHF)
2.1.10.11	High Voltage	each	3,000	2	6					6	8
2.2	Outer Barrel Calorimeter (HO-B)				3,221	6.2	395	3.0	303	3,919	4,187
2.2.1	Mechanics				200			2.0	200	400	260
2.2.1.1	Hangers onto Solenoid - EDIA							2.0	200	200	
2.2.1.1	Hangers onto Solenoid - M&S				200					200	260
2.2.2	Optics				1,428	2.3	130	0.5	57	1,615	1,856
2.2.2.1	Optical system EDIA							0.5	57	57	
2.2.2.1.1	optics design (2 FTE for 1 month)	en days	846	40				0.3	34	34	
2.2.2.1.2	production management (1 FTE)	en days	423	55				0.2	23	23	
2.2.2.2	Tile trays				899	1.2	69			968	1,168
2.2.2.2.1	10 mm BC408(m**2)	sqm	900	960	864					864	1,123
2.2.2.2.3	2 mm plastic(m**2)	sqm	4.40	704	3					3	4
2.2.2.2.4	1 mm plastic(m**2)	sqm	2.20	704	2					2	2
2.2.2.2.5	Kapton tape(m)	m	0.17	4,554	1					1	1
2.2.2.2.6	Black tape (m)	m	0.17	5,666	1					1	1
2.2.2.2.7	Tyvek (m**2)	sqm	1.19	2,110	3					3	3
2.2.2.2.8	tedlar (m**2)	sqm	0.61	2,467	2					2	2
2.2.2.2.9	rivets	each	0.20	27,920	6					6	7
2.2.2.2.10	Glue				1					1	2
2.2.2.2.11	source tubes(m)	m	1.00	3,777	4					4	5
2.2.2.2.12	Couplers (source tubes)	each	5.00	795	4					4	5
2.2.2.2.13	optical connectors	each	2.00	877	2					2	2
2.2.2.2.14	Quartz connectors	each	5.00	105	1					1	1
2.2.2.2.15	positioning spring	each									
2.2.2.2.16	1.34mm ball bit	each	50	130	6					6	8
2.2.2.2.17	thermwood machine	each	200,000	0	0					0	0
2.2.2.2.18	thermwood code	ds days	370	25		0.1	9			9	
2.2.2.2.19	thermwood operator (2 techs for 55 c	ts days	437	55		0.4	24			24	
2.2.2.2.20	tile tray assembly (3 techs for 55 day	ts days	655	55		0.7	36			36	

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2.2.2.2.21	miscellaneous				1					1	1
2.2.2.3	Pigtails				178	0.3	16			194	232
2.2.2.3.1	Y-ll fiber (km)	km	1,333	49	66					66	85
2.2.2.3.2	clear fibers (km)	km	1,261	31	39					39	50
2.2.2.3.3	optical connectors	each	2.00	877	2					2	2
2.2.2.3.4	quartz fiber (km)	km	1,410	12	17					17	22
2.2.2.3.5	fiber scanner	each	30,000	1	30					30	39
2.2.2.3.6	fiber splicer	each	10,000	1	10					10	13
2.2.2.3.7	fiber polishers	each	10,000	1	10					10	13
2.2.2.3.8	connector polisher	each	5,000	1	5					5	7
2.2.2.3.9	assembly (4 techs for .15 yrs)	ts days	874	19		0.3	16			16	
2.2.2.4	Final assembly and testing					0.7	36			36	
2.2.2.4.1	megatile scanner (FY'97)										
2.2.2.4.2	insert fibers	ts days	218	55		0.2	12			12	
2.2.2.4.3	test magatiles	ts days	218	55		0.2	12			12	
2.2.2.4.4	final packaging	ts days	218	55		0.2	12			12	
2.2.2.5	Optical Cables				339	0.2	9			347	440
2.2.2.5.1	optical cable (m)	m	35	9,600	335					335	436
2.2.2.5.2	optical connectors	each	2.00	1,753	4					4	5
2.2.2.5.3	assembly (1 tech for .15 yrs)	ts days	218	40		0.2	9			9	
2.2.2.6	Shipping				12					12	16
2.2.2.6.1	shipping crates	each	500	18	9					9	11
2.2.2.6.2	shipping to CERN	each	200	18	4					4	5
2.2.3	Readout Boxes	box	6,081	60	230	1.1	121	0.1	14	365	299
2.2.3a	Decoder Box (HOB-0)	decoder b	8,251	12	62	0.3	28	0.1	8	99	81
2.2.3.1	Design Engineering	eu hours	75	60				0.0	5	5	
2.2.3.2	Box outer enclosure				12	0.1	4			16	15
2.2.3.2.1	ext wall material (copper 1/4 inch)		913	1	1					1	1
2.2.3.2.2	water fittings		1.20	48	0					0	0
2.2.3.2.3	gas fittings		0.60	24	0					0	0

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2.2.3.2.4	mounting bolts+brackets		5.00	96	0					0	1
2.2.3.2.5	aluminum cooling plates		2.10	4,233	9					9	12
2.2.3.2.6	copper plates		193	2	0					0	0
2.2.3.2.7	patch panel		72	12	1					1	1
2.2.3.2.8	technical support	tu hours	30	33		0.0	1			1	
2.2.3.2.9	machining + assembly	mu hours	35	90		0.0	3			3	
2.2.3.3	box internal structure				13	0.0	1			14	16
2.2.3.3.1	interior walls		913	1	1					1	1
2.2.3.3.2	sorting plate		72	12	1					1	1
2.2.3.3.3	tube support plate		72	12	1					1	1
2.2.3.3.4	calibration support plate		72	12	1					1	1
2.2.3.3.5	HPD Alignment and Fixturing		250	36	9					9	12
2.2.3.3.6	technical support	tu hours	30	33		0.0	1			1	
2.2.3.3.7	assembly	su hours	10	33		0.0	0			0	
2.2.3.4	box optical				31	0.1	8			39	40
2.2.3.4.1	fiber 940mm multiclad ps		0.90	8,942	8					8	10
2.2.3.4.2	fiber 300 mm multiclad ps		0.65	1,490	1					1	1
2.2.3.4.3	fiber 200 mm quartz		25	120	3					3	4
2.2.3.4.4	Y11 Blocks		74	12	1					1	1
2.2.3.4.5	Delrin Cookies		24	36	1					1	1
2.2.3.4.6	sleeves		1.00	648	1					1	1
2.2.3.4.7	Connectors for ps fiber		5.00	432	2					2	3
2.2.3.4.8	Connectors/splitters for laser calibration		30	132	4					4	5
2.2.3.4.9	LEDs		21	24	0					0	1
2.2.3.4.10	Photodiodes and associated circuitry		133	36	5					5	6
2.2.3.4.11	Fiber Bundle assembly jigs		1,050	3	3					3	4
2.2.3.4.12	flycutting		50	36	2					2	2
2.2.3.4.13	technical support+assembly	tu hours	30	262		0.1	8			8	
2.2.3.5	Assembly and QC				7	0.0	2	0.0	4	13	9
2.2.3.5.1	Q/C fixturing		1,175	3	4					4	5

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2.2.3.5.2	Q/C test equipment		3,750	1	4					4	5
2.2.3.5.3	Q/C Engineering	eu hours	75	50				0.0	4	4	
2.2.3.5.4	Q/C Technical	tu hours	30	65		0.0	2			2	
2.2.3.6	Installation					0.0	13			13	
2.2.3.6.1	install decoder boxes	ts days	218	12		0.0	3			3	
2.2.3.6.2	install cooling pipes	ts days	218	12		0.0	3			3	
2.2.3.6.3	install HV/LV cables	ts days	218	12		0.0	3			3	
2.2.3.6.4	install signal cables	ts days	218	24		0.0	5			5	
2.2.3b	Decoder Box (HOB+-)	decoder b	5,539	48	167	0.8	93	0.0	6	266	217
2.2.3.7	Design Engineering	eu hours	75	40				0.0	3	3	
2.2.3.8	Box outer enclosure				38	0.2	11			49	50
2.2.3.8.1	ext wall material (copper 1/4 inch)		913	4	3					3	4
2.2.3.8.2	water fittings		1.20	192	0					0	0
2.2.3.8.3	gas fittings		0.60	96	0					0	0
2.2.3.8.4	mounting bolts+brackets		5.00	384	2					2	2
2.2.3.8.5	aluminum cooling plates		2.10	13,545	28					28	37
2.2.3.8.6	copper plates		193	6	1					1	1
2.2.3.8.7	patch panel		72	48	3					3	4
2.2.3.8.8	technical support	tu hours	30	87		0.0	3			3	
2.2.3.8.9	machining + assembly	mu hours	35	240		0.1	8			8	
2.2.3.9	box internal structure				38	0.1	3			41	49
2.2.3.9.1	interior walls		913	4	4					4	5
2.2.3.9.2	sorting plate		72	48	3					3	4
2.2.3.9.3	tube support plate		72	48	3					3	4
2.2.3.9.4	calibration support plate		72	48	3					3	4
2.2.3.9.5	HPD Alignment and Fixturing		250	96	24					24	31
2.2.3.9.6	technical support	tu hours	30	87		0.0	3			3	
2.2.3.9.7	assembly	su hours	10	87		0.0	1			1	
2.2.3.10	box optical				86	0.3	21			107	112
2.2.3.10.1	fiber 940mm multiclad ps		0.90	15,898	14					14	19

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2.2.3.10.2	fiber 300 mm multiclad ps		0.65	3,974	3					3	3
2.2.3.10.3	fiber 200 mm quartz		25	480	12					12	16
2.2.3.10.4	Y11 Blocks		74	48	4					4	5
2.2.3.10.5	Delrin Cookies		24	96	2					2	3
2.2.3.10.6	sleeves		1.00	1,728	2					2	2
2.2.3.10.7	Connectors for ps fiber		5.00	1,152	6					6	7
2.2.3.10.8	Connectors/splitters for laser calibration		30	528	16					16	21
2.2.3.10.9	LEDs		21	96	2					2	3
2.2.3.10.10	Photodiodes and associated circuitry		133	144	19					19	25
2.2.3.10.11	Fiber Bundle assembly jigs		1,050	2	2					2	3
2.2.3.10.12	flycutting		50	96	5					5	6
2.2.3.10.13	technical support+assembly	tu hours	30	698		0.3	21			21	
2.2.3.11	Assembly and QC				5	0.1	5	0.0	3	13	6
2.2.3.11.1	Q/C fixturing		1,175	2	2					2	3
2.2.3.11.2	Q/C test equipment		2,500	1	3					3	3
2.2.3.11.3	Q/C Engineering	eu hours	75	33				0.0	3	3	
2.2.3.11.4	Q/C Technical	tu hours	30	175		0.1	5			5	
2.2.3.12	Installation					0.1	52			52	
2.2.3.12.1	install decoder boxes	ts days	218	48		0.0	10			10	
2.2.3.12.2	install cooling pipes	ts days	218	48		0.0	10			10	
2.2.3.12.3	install HV/LV cables	ts days	218	48		0.0	10			10	
2.2.3.12.4	install signal cables	ts days	218	96		0.0	21			21	
2.2.4	Photodetectors				363	0.6	32			395	472
2.2.4.1	HPD19: HOB-0	each	2,500	36	90					90	117
2.2.4.1a	spares/aging tests	each	2,500	3.6	9					9	12
2.2.4.2	HPD19: HOB+-	each	2,500	96	240					240	312
2.2.4.2a	spares/aging tests	each	2,500	9.6	24					24	31
2.2.4.3	Test photodetectors	tc days	218	145		0.6	32			32	
2.2.5	Front-end Electronics				453	0.1	7			460	589
2.2.5.1	QIE ASIC				67	0.0	2			69	87

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2.2.5.1.1	Production	each	20	3,040	61					61	79
2.2.5.1.1a	spares	each	20	304	6					6	8
2.2.5.1.2	QA/QC and Monitoring	each		3,344		1 min tech					
2.2.5.1.2.1	technician	tc days	218	11		0.0	2			2	
2.2.5.2	ADC				18	0.0	2			20	24
2.2.5.2.1	Acquisition	each	7.00	2,400	17					17	22
2.2.5.2.1a	spares	each	7.00	240	2					2	2
2.2.5.2.2	QA/QC and Monitoring	each		2,640		1 min tech					
2.2.5.2.2.1	technician	tc days	218	9		0.0	2			2	
2.2.5.3	Channel Control ASIC				15	0.0	1			15	19
2.2.5.3.1	Production	each	15	894	13					13	17
2.2.5.3.1a	spares	each	15	89	1					1	2
2.2.5.3.2	QA/QC and Monitoring	each		983		1 min tech					
2.2.5.3.2.1	technician	tc days	218	3		0.0	1			1	
2.2.5.4	Data Link				276					276	359
2.2.5.4.1	Acquisition	each	330	760	251					251	326
2.2.5.4.1a	spares	each	330	76	25					25	33
2.2.5.5	Voltage Regulator				5					5	7
2.2.5.5.1	Acquisition	each	2.00	2,400	5					5	6
2.2.5.5.1a	spares	each	2.00	240	0					0	1
2.2.5.6	3 Channel PCBs				33	0.0	2			35	43
2.2.5.6.1	Production	each	5.00	760	4					4	5
2.2.5.6.1a	spares	each	5.00	76	0					0	0
2.2.5.6.2	Assembly	each	35	836	29					29	38
2.2.5.6.3	QA/QC and Monitoring	each		836		3 min tech					
2.2.5.6.3.1	technician	tc days	218	8		0.0	2			2	
2.2.5.7	Backplane				39	0.0	0			39	50
2.2.5.7.1	Production	each	100	60	6					6	8
2.2.5.7.1a	spares	each	100	2	0					0	0
2.2.5.7.2	Assembly	each	525	62	33					33	42

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2.2.5.7.3	QA/QC and Monitoring	each		62		3 min tech					
2.2.5.7.3.1	technician	tc days	218	1		0.0	0			0	
2.2.6	Calibration Systems				50	0.4	20			70	65
2.2.6.1	Calibration System M&S				50					50	65
2.2.6.2	Calibration System Mfg. Labor					0.4	20			20	
2.2.7	Trigger/DAQ Electronics				143	0.2	15			158	186
2.2.7.1	Multi-Chip Modules				63	0.1	9			71	82
2.2.7.1.7	HO-B Production	each	100	570	57	0.5 mo eng				57	74
2.2.7.1.7a	spares	each	100	57	6					6	7
2.2.7.1.7.1	engineering	en days	423	10		0.0	4			4	
2.2.7.1.8	QA/QC			627		10 min tech per MCM					
2.2.7.1.8.1	technician	tc days	218	21		0.1	5			5	
2.2.7.2	VME Modules				50	0.1	4			54	65
2.2.7.2.9	HO-B Production	each	1,200	38	46	0.5 week tech				46	59
2.2.7.2.9a	spares	each	1,200	4	5					5	6
2.2.7.2.9.1	technician	tc days	218	3		0.0	1			1	
2.2.7.2.10	QA/QC			42		2 hour tech per module					
2.2.7.2.10.1	technician	tc days	218	17		0.1	4			4	
2.2.7.3	9U VME Crates				11	0.0	0			11	14
2.2.7.3.1	HO-B Production	each	5,000	2	10					10	13
2.2.7.3.1a	spares	each	5,000	0	1					1	1
2.2.7.3.2	QA/QC			2		4 hour tech per crate					
2.2.7.3.2.1	technician	tc days	218	2		0.0	0			0	
2.2.7.4	FED/DDU				18	0.0	1			19	23
2.2.7.4.1	HO-B Production	each	4,000	4	16					16	21
2.2.7.4.1a	spares	each	4,000	0	2					2	2
2.2.7.4.2	QA/QC			4		1 day tech per FED/DDU					
2.2.7.4.2.1	technician	tc days	218	4		0.0	1			1	
2.2.7.5	Data Link				1	0.0	0			2	2
2.2.7.5.1	HO-B Production	each	330	4	1					1	2

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2.2.7.5.1a	spares	each	330	0	0					0	0
2.2.7.5.2	QA/QC			4		1 hour tech per link					
2.2.7.5.2.1	technician	tc days	218	1		0.0	0			0	
2.2.8	Voltage Supply Systems				124	0.2	12			136	161
2.2.8.1	HO-B High Voltage				59	0.1	7			66	77
2.2.8.1.1	Module	each	785	60	47					47	61
2.2.8.1.1a	spares	each	785	6	5					5	6
2.2.8.1.2	6U VME Crate	each	2,000	3	7					7	9
2.2.8.1.2a	spares	each	2,000	0	1					1	1
2.2.8.1.3	QA/QC					6 tech week					
2.2.8.1.3.1	technician	tc days	218	30		0.1	7			7	
2.2.8.2	HO-B High Voltage Cable/Connector				32					32	41
2.2.8.2.1	Cable	100 ft	100	240	24					24	31
2.2.8.2.1a	spares	100 ft	100	48	5					5	6
2.2.8.2.2	Connector	each	20	120	2					2	3
2.2.8.2.2a	spares	each	20	24	0					0	1
2.2.8.3	HO-B Low Voltage				33	0.1	5			38	43
2.2.8.3.1	Supply Acquisition	each	3,300	5	17					17	21
2.2.8.3.1a	spares	each	3,300	1	3					3	4
2.2.8.3.2	Cable Acquisition	60 ft	106	120	13					13	17
2.2.8.3.2a	spares	60 ft	106	6	1					1	1
2.2.8.3.3	QA/QC on Installed Cable	unit		120		1 hour tech					
2.2.8.3.3.1	technician	tc days	218	24		0.1	5			5	
2.2.9	Detector Control System				107	0.6	35			142	139
2.2.9.2	Arcnet				42	0.1	3			45	55
2.2.9.2.1	Outer Barrel Spokes	each	200	60	12					12	16
2.2.9.2.2	HO-B CAN Interface	each	500	60	30	2 week tech				30	39
2.2.9.2.2.1	technician	tc days	218	10		0.0	2			2	
2.2.9.2.3	QA/QC					1 week tech					
2.2.9.2.3.1	technician	tc days	218	5		0.0	1			1	

WBS Number	Description	Unit	Unit Cost ($)	Quantity	Mfg M&S (K$)	Mfg Labor (Yrs)	Mfg Labor (K$)	EDIA Labor (Yrs)	EDIA Labor (K$)	Base Cost (K$)	CMS Cost (KCHF)
2.2.9.3	EPICS IOC				28	0.1	4			32	36
2.2.9.3.1	Front Ends	each	7,000	2	14					14	18
2.2.9.3.2	QA/QC	each				1 week tech each					
2.2.9.3.2.1	technician	tc days	218	10		0.0	2			2	
2.2.9.3.3	TriDAS	each	7,000	2	14					14	18
2.2.9.3.4	QA/QC	each				1 week tech each					
2.2.9.3.4.1	technician	tc days	218	10		0.0	2			2	
2.2.9.4	EPICS IOC Bridge				3	0.0	1			4	4
2.2.9.4.1	HO-B High Voltage	each	1,000	3	3					3	4
2.2.9.4.2	QA/QC					1 week tech					
2.2.9.4.2.1	technician	tc days	218	5		0.0	1			1	
2.2.9.5	TTC				30	0.5	26			56	39
2.2.9.5.1	HO-B	each	500	60	30	2 day tech each				30	39
2.2.9.5.1.1	technician	tc days	218	120		0.5	26			26	
2.2.9.6	Software License				4					4	5
2.2.9.6.1	HO-B	each	1,000	4	4					4	5
2.2.10	Pre-production Prototypes				123	0.6	23	0.3	32	178	160
2.2.10.1	Pre-production Prototype - EDIA							0.3	32	32	
2.2.10.2	Pre-production Prototype - M&S				123					123	160
2.2.10.3	Pre-production Prototype - Labor					0.6	23			23	

WBS Number	Description	Unit	Unit Cost ($)	Quantity	Mfg M&S (K$)	Mfg Labor (Yrs)	Mfg Labor (K$)	EDIA Labor (Yrs)	EDIA Labor (K$)	Base Cost (K$)	CMS Cost (KCHF)
2.3	Endcap Hadron Calorimeter (HE)				8,475	15.1	1,543	2.3	611	10,629	11,017
2.3.1	Mechanics				5,690					5,690	7,397
2.3.1.1	HE Mechanics			2	4,640					4,640	6,032
2.3.1.1.1	cu+mach+assembly+tooling+transport	tonne	8,000	290	4,640					4,640	6,032
2.3.1.2	HE-EMU Interface			2	1,050					1,050	1,365
2.3.1.2.1	steel	endcap	380,000	1	760					760	988
2.3.1.2.2	fabrication/assembly/installation (labor)	endcap	130,000	1	260					260	338
2.3.1.2.3	miscellaneous	endcap	15,000	1	30					30	39
2.3.2	Optics				617	5.5	1,002		370	1,989	803
2.3.2.1	Optical system EDIA								370	370	
2.3.2.1.1	optics design (2 FTE for 1 yr)	en days	846	250					211	211	
2.3.2.1.2	production management (1 FTE)	en days	423	375					159	159	
2.3.2.2	Tile trays				305		456			761	396
2.3.2.2.1	4 mm SCSN81(m**2)	sqm	200	1,274	255					255	331
2.3.2.2.2	9 mm SCSN81(m**2)	sqm	449								
2.3.2.2.3	2 mm plastic(m**2)	sqm	4.40	1,085	5					5	6
2.3.2.2.4	1 mm plastic(m**2)	sqm	2.20	1,085	2					2	3
2.3.2.2.5	Kapton tape(m)	m	0.17	7,013	1					1	2
2.3.2.2.6	Black tape (m)	m	0.17	8,726	1					1	2
2.3.2.2.7	Tyvek (m**2)	sqm	1.19	3,250	4					4	5
2.3.2.2.8	tedlar (m**2)	sqm	0.61	3,800	2					2	3
2.3.2.2.9	rivets	each	0.20	43,000	8					8	11
2.3.2.2.10	Glue										
2.3.2.2.11	source tubes(m)	m	1.00	5,817	6					6	8
2.3.2.2.12	Couplers (source tubes)	each	5.00	1,224	6					6	8
2.3.2.2.13	optical connectors	each	2.00	1,350	3					3	4
2.3.2.2.14	Quartz connectors	each	5.00	162	1					1	1
2.3.2.2.15	positioning spring	each	7.00								
2.3.2.2.16	1.34mm ball bit	each	50	200	10					10	13

WBS Number	Description	Unit	Unit Cost ($)	Quantity	Mfg M&S (K$)	Mfg Labor (Yrs)	Mfg Labor (K$)	EDIA Labor (Yrs)	EDIA Labor (K$)	Base Cost (K$)	CMS Cost (KCHF)
2.3.2.2.17	CNC milling machine (exists)			1							
2.3.2.2.18	CNC code	ds days	370	125			46			46	
2.3.2.2.19	CNC operator (2 techs for 1.5 yrs)	ts days	437	375			164			164	
2.3.2.2.20	tile tray assembly (3 techs for 1.5 yrs	ts days	655	375			246			246	
2.3.2.2.21	miscellaneous										
2.3.2.3	Pigtails				180	2.5	137			316	233
2.3.2.3.1	Y-ll fiber (km)	km	1,333	30	40					40	51
2.3.2.3.2	clear fibers (km)	km	1,261	24	30					30	39
2.3.2.3.3	optical connectors	each	2.00	1,350	3					3	4
2.3.2.3.4	quartz fiber (km)	km	1,410	9	13					13	16
2.3.2.3.5	fiber scanner	each	30,000	1	30					30	39
2.3.2.3.6	fiber splicer	each	10,000	3	30					30	39
2.3.2.3.7	fiber polishers	each	10,000	3	30					30	39
2.3.2.3.8	connector polisher	each	5,000	1	5					5	7
2.3.2.3.9	assembly (4 techs for 1.25 yrs)	ts days	874	156		2.5	137			137	
2.3.2.4	Final assembly and testing						246			246	
2.3.2.4.1	megatile scanner (FY'97)										
2.3.2.4.2	insert fibers	ts days	218	375			82			82	
2.3.2.4.3	test magatiles	ts days	218	375			82			82	
2.3.2.4.4	final packaging	ts days	218	375			82			82	
2.3.2.5	Optical Cables				54	1.0	55			109	71
2.3.2.5.1	optical cable (m)	m	35	1,400	49					49	64
2.3.2.5.2	optical connectors	each	2.00	2,700	5					5	7
2.3.2.5.3	assembly (1 tech for 1 yrs)	ts days	218	250		1.0	55			55	
2.3.2.6	Shipping				19					19	25
2.3.2.6.1	shipping crates	each	500	27	14					14	18
2.3.2.6.2	shipping to CERN	each	200	27	5					5	7
2.3.2.7	Installation into absorber				60	2.0	109			169	78
2.3.2.7.1	receiving/insp./inst.	ts day	437	250		2.0	109			109	
2.3.2.7.2	QA station - bldg. 168 (see HB)										

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2.3.2.7.3	Installation fixtures - assembly bldg				20					20	26
2.3.2.7.4	Workstations	each	10,000	2	20					20	26
2.3.2.7.5	Portable source system	each	20,000	1	20					20	26
2.3.3	Readout Boxes	box	15,785	24	198	2.1	148	0.2	33	379	257
2.3.3.1	Design Engineering	eu hours	75	240				0.1	18	18	
2.3.3.2	Box outer enclosure				37	0.5	33			70	49
2.3.3.2.1	ext wall material (copper 1/4 inch)		913	4	3					3	4
2.3.3.2.2	water fittings		1.20	96	0					0	0
2.3.3.2.3	gas fittings		0.60	48	0					0	0
2.3.3.2.4	mounting bolts+brackets		5.00	192	1					1	1
2.3.3.2.5	aluminum cooling plates		2.10	13,545	28					28	37
2.3.3.2.6	copper plates		193	6	1					1	1
2.3.3.2.7	patch panel		72	48	3					3	4
2.3.3.2.8	technical support	tu hours	30	262		0.1	8			8	
2.3.3.2.9	machining + assembly	mu hours	35	720		0.4	25			25	
2.3.3.3	box internal structure				50	0.3	10			60	65
2.3.3.3.1	interior walls		913	4	4					4	5
2.3.3.3.2	sorting plate		72	48	3					3	4
2.3.3.3.3	tube support plate		72	48	3					3	4
2.3.3.3.4	calibration support plate		72	48	3					3	4
2.3.3.3.5	HPD Alignment and Fixturing		250	144	36					36	47
2.3.3.3.6	technical support	tu hours	30	262		0.1	8			8	
2.3.3.3.7	assembly	su hours	10	262		0.1	3			3	
2.3.3.4	box optical				88	1.0	63			151	115
2.3.3.4.1	fiber 940mm multiclad ps		0.90	13,289	12					12	16
2.3.3.4.2	fiber 300 mm multiclad ps		0.65	8,942	6					6	8
2.3.3.4.3	fiber 200 mm quartz		25	240	6					6	8
2.3.3.4.4	Y11 Blocks		74	48	4					4	5
2.3.3.4.5	Delrin Cookies		24	144	3					3	4
2.3.3.4.6	sleeves		1.00	3,888	4					4	5

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2.3.3.4.7	Connectors for ps fiber		5.00	2,880	14					14	19
2.3.3.4.8	Connectors/splitters for laser calibration		30	264	8					8	10
2.3.3.4.9	LEDs		21	96	2					2	3
2.3.3.4.10	Photodiodes and associated circuitry		133	72	10					10	12
2.3.3.4.11	Fiber Bundle assembly jigs		1,050	12	13					13	16
2.3.3.4.12	flycutting		50	144	7					7	9
2.3.3.4.13	technical support+assembly	hours	30	2,095		1.0	63			63	
2.3.3.5	Assembly and QC				22	0.3	16	0.1	15	53	29
2.3.3.5.1	Q/C fixturing		1,175	6	7					7	9
2.3.3.5.2	Q/C test equipment		15,000	1	15					15	20
2.3.3.5.3	Q/C Engineering	eu hours	75	200				0.1	15	15	
2.3.3.5.4	Q/C Technical	tu hours	30	524		0.3	16			16	
2.3.3.6	Installation					0.1	26			26	
2.3.3.6.1	install decoder boxes	ts days	218	24		0.0	5			5	
2.3.3.6.2	install cooling pipes	ts days	218	24		0.0	5			5	
2.3.3.6.3	install HV/LV cables	ts days	218	24		0.0	5			5	
2.3.3.6.4	install signal cables	ts days	218	48		0.0	10			10	
2.3.4	Photodetectors	sector		24	396	0.6	35			431	515
2.3.4.1	HPD19	each	2,500	4	240					240	312
2.3.4.1a	spares/aging tests	each	2,500	0.4	24					24	31
2.3.4.2	HPD73	each	2,500	2	120					120	156
2.3.4.2a	spares/aging tests	each	2,500	0.2	12					12	16
2.3.4.3	Test photodetectors	tc days	218	158		0.6	35			35	
2.3.5	Front-end Electronics				607	0.2	10			616	788
2.3.5.1	QIE ASIC				95	0.1	3			98	124
2.3.5.1.1	Production	each	20	4,320	86					86	112
2.3.5.1.1a	spares	each	20	432	9					9	11
2.3.5.1.2	QA/QC and Monitoring	each		4,752		1 min tech					
2.3.5.1.2.1	technician	tc days	218	16		0.1	3			3	
2.3.5.2	ADC				26	0.1	3			29	34

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2.3.5.2.1	Acquisition	each	7.00	3,410	24					24	31
2.3.5.2.1a	spares	each	7.00	341	2					2	3
2.3.5.2.2	QA/QC and Monitoring	each		3,751		1 min tech					
2.3.5.2.2.1	technician	tc days	218	13		0.1	3			3	
2.3.5.3	Channel Control ASIC				21	0.0	1			22	27
2.3.5.3.1	Production	each	15	1,272	19					19	25
2.3.5.3.1a	spares	each	15	127	2					2	2
2.3.5.3.2	QA/QC and Monitoring	each		1,399		1 min tech					
2.3.5.3.2.1	technician	tc days	218	5		0.0	1			1	
2.3.5.4	Data Link				392					392	510
2.3.5.4.1	Acquisition	each	330	1,080	356					356	463
2.3.5.4.1a	spares	each	330	108	36					36	46
2.3.5.5	Voltage Regulator				8					8	10
2.3.5.5.1	Acquisition	each	2.00	3,410	7					7	9
2.3.5.5.1a	spares	each	2.00	341	1					1	1
2.3.5.6	3 Channel PCBs				48	0.0	3			50	62
2.3.5.6.1	Production	each	5.00	1,080	5					5	7
2.3.5.6.1a	spares	each	5.00	108	1					1	1
2.3.5.6.2	Assembly	each	35	1,188	42					42	54
2.3.5.6.3	QA/QC and Monitoring	each		1,188		3 min tech					
2.3.5.6.3.1	technician	tc days	218	12		0.0	3			3	
2.3.5.7	Backplane				17	0.0	0			17	22
2.3.5.7.1	Production	each	100	25	3					3	3
2.3.5.7.1a	spares	each	100	3	0					0	0
2.3.5.7.2	Assembly	each	525	28	14					14	19
2.3.5.7.3	QA/QC and Monitoring	each		28		3 min tech					
2.3.5.7.3.1	technician	tc days	218	0		0.0	0			0	
2.3.6	Calibration Systems				162	3.0	180			342	210
2.3.6.1	Laser routing system				22	1.0	60			82	28
2.3.6.1.6	Quartz fiber to splitters	m	10	200	2					2	3

WBS Number	Description	Unit	Unit Cost ($)	Quantity	Mfg M&S (K$)	Mfg Labor (Yrs)	Mfg Labor (K$)	EDIA Labor (Yrs)	EDIA Labor (K$)	Base Cost (K$)	CMS Cost (KCHF)
2.3.6.1.7	12-fold splitters	each	2,000	4	8					8	10
2.3.6.1.8	Quartz fiber to decoder boxes	m	10	480	5					5	6
2.3.6.1.9	Connectors (2/fiber)	each	5	96	0					0	1
2.3.6.1.11	Quartz fiber to tiles	m	10	432	4					4	6
2.3.6.1.12	Connectors (2/fiber)	each	5	288	1					1	2
2.3.6.1.13	PIN diode mounting mechanics		150	4	1					1	1
2.3.6.1.14	PIN diode read-out electronics		50	4	0					0	0
2.3.6.1.15	Assembly (1 tech-year)	tu days	240	250		1.0	60			60	
2.3.6.2	Source routing system				140	2.0	120			260	182
2.3.6.2.1	Souce driver motors	each	10,000	7	70					70	91
2.3.6.2.2	Sources	each	5,000	7	35					35	46
2.3.6.2.3	Controllers	each	5,000	7	35					35	46
2.3.6.2.4	Assembly labor	tu days	240	500		2.0	120			120	
2.3.7	Trigger/DAQ Electronics				205	0.3	19			224	267
2.3.7.1	Multi-Chip Modules				89	0.2	11			100	116
2.3.7.1.7	HE Production	each	100	810	81	0.5 mo eng				81	105
2.3.7.1.7a	spares	each	100	81	8	0.5 mo eng				8	11
2.3.7.1.7.1	engineering	en days	423	10		0.0	4			4	
2.3.7.1.8	QA/QC			891		10 min tech per MCM					
2.3.7.1.8.1	technician	tc days	218	30		0.1	6			6	
2.3.7.2	VME Modules				71	0.1	6			77	93
2.3.7.2.9	HE Production	each	1,200	54	65	0.5 week tech				65	84
2.3.7.2.9a	spares	each	1,200	5	6	0.5 week tech				6	8
2.3.7.2.9.1	technician	tc days	218	3		0.0	1			1	
2.3.7.2.10	QA/QC			59		2 hour tech per module					
2.3.7.2.10.1	technician	tc days	218	24		0.1	5			5	
2.3.7.3	9U VME Crates				17	0.0	1			17	21
2.3.7.3.1	HE Production	each	5,000	3	15					15	20
2.3.7.3.1a	spares	each	5,000	0	2					2	2
2.3.7.3.2	QA/QC			3		4 hour tech per crate					

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2.3.7.3.2.1	technician	tc days	218	3		0.0	1			1	
2.3.7.4	FED/DDU				26	0.0	1			28	34
2.3.7.4.1	HE Production	each	4,000	6	24					24	31
2.3.7.4.1a	spares	each	4,000	1	2					2	3
2.3.7.4.2	QA/QC			7		1 day tech per FED/DDU					
2.3.7.4.2.1	technician	tc days	218	7		0.0	1			1	
2.3.7.5	Data Link				2	0.0	0			2	3
2.3.7.5.1	HE Production	each	330	6	2					2	3
2.3.7.5.1a	spares	each	330	1	0					0	0
2.3.7.5.2	QA/QC			7		1 hour tech per link					
2.3.7.5.2.1	technician	tc days	218	1		0.0	0			0	
2.3.8	Voltage Supply Systems				85	0.2	11			96	111
2.3.8.1	Endcap High Voltage				24	0.0	2			26	31
2.3.8.1.1	Module	each	785	24	19					19	24
2.3.8.1.1a	spares	each	785	2	2					2	2
2.3.8.1.2	6U VME Crate	each	2,000	1	3					3	3
2.3.8.1.2a	spares	each	2,000	0	0					0	0
2.3.8.1.3	QA/QC					2 week tech					
2.3.8.1.3.1	technician	tc days	218	10		0.0	2			2	
2.3.8.2	Endcap Voltage Cable/Connector				35					35	45
2.3.8.2.1	Cable	100 ft	230	120	28					28	36
2.3.8.2.1a	spares	100 ft	230	24	6					6	7
2.3.8.2.2	Connector	each	25	48	1					1	2
2.3.8.2.2a	spares	each	25	10	0					0	0
2.3.8.3	Endcap Low Voltage				27	0.2	8			35	35
2.3.8.3.1	Supply Acquisition	each	3,300	5	17					17	21
2.3.8.3.1a	spares	each	3,300	1	2					2	2
2.3.8.3.2	Cable Acquisition	100 ft	177	48	8					8	11
2.3.8.3.2a	spares	100 ft	177	2	0					0	1
2.3.8.3.3	QA/QC on installed cable	unit		48		4 hour tech					

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2.3.8.3.3.1	technician	tc days	218	38		0.2	8			8	
2.3.9	Detector Control System				112	0.5	29	0.1	8	149	145
2.3.9.1	Toolkit				23	0.1	8	0.1	8	40	30
2.3.9.1.1	End Cap	each	10,000	1	10	4 week software			4 week en	10	13
2.3.9.1.1.1	engineering	en days	423	20				0.1	8	8	
2.3.9.1.1.2	software	cp days	423	20		0.1	8			8	
2.3.9.1.1.3	hardware		13,000	1	13					13	17
2.3.9.2	Arcnet				35	0.1	3			38	45
2.3.9.2.1	End Cap Spokes	each	200	24	5					5	6
2.3.9.2.2	End Cap Hub	each	7,000	2	14					14	18
2.3.9.2.3	End Cap Interconnect	each	2,000	2	4					4	5
2.3.9.2.4	End Cap CAN Interface	each	500	24	12	1 week tech				12	16
2.3.9.2.4.1	technician	tc days	218	5		0.0	1			1	
2.3.9.2.5	QA/QC					2 week tech					
2.3.9.2.5.1	technician	tc days	218	10		0.0	2			2	
2.3.9.3	EPICS IOC				35	0.1	5			40	46
2.3.9.3.1	Front Ends	each	7,000	2	14					14	18
2.3.9.3.2	QA/QC	each				1 week tech each					
2.3.9.3.2.1	technician	tc days	218	10		0.0	2			2	
2.3.9.3.3	TriDAS	each	7,000	3	21					21	27
2.3.9.3.4	QA/QC	each				1 week tech each					
2.3.9.3.4.1	technician	tc days	218	15		0.1	3			3	
2.3.9.4	EPICS IOC Bridge				2	0.0	1			3	3
2.3.9.4.1	End Cap High Voltage	each	1,000	2	2					2	3
2.3.9.4.2	QA/QC					1 week tech					
2.3.9.4.2.1	technician	tc days	218	5		0.0	1			1	
2.3.9.5	TTC				12	0.2	10			22	16
2.3.9.5.1	End Cap	each	500	24	12	2 day tech each				12	16
2.3.9.5.1.1	technician	tc days	218	48		0.2	10			10	
2.3.9.6	Software License				5					5	7

WBS Number	Description	Unit	Unit Cost ($)	Quantity	Mfg M&S (K$)	Mfg Labor (Yrs)	Mfg Labor (K$)	EDIA Labor (Yrs)	EDIA Labor (K$)	Base Cost (K$)	CMS Cost (KCHF)
2.3.9.6.1	End Cap	each	1,000	5	5					5	7
2.3.10	Pre-production Prototypes				403	2.8	110	2.0	200	713	524
2.2.10.1	Pre-production Prototype - EDIA							2.0	200	200	
2.2.10.2	Pre-production Prototype - M&S				403					403	524
2.2.10.3	Pre-production Prototype - Labor					2.8	110			110	
2.4	Outer Endcap Calorimeter (HO-E)				553	3.0	170	1.5	207	930	719
2.4.1	Mechanics				50			1.0	150	200	65
2.4.1.1	EDIA	eu days	600	250				1.0	150	150	
2.4.1.2	M&S				50					50	65
2.4.2	Optics				137	2.3	130	0.5	57	324	178
2.4.2.1	Optical system EDIA							0.5	57	57	
2.4.2.1.1	optics design (2 FTE for 1 month)	en days	846	40				0.3	34	34	
2.4.2.1.2	production management (1 FTE)	en days	423	55				0.2	23	23	
2.4.2.2	Tile trays				108	1.2	69			177	140
2.4.2.2.1	10 mm BC408(m**2)	sqm	900	114	103					103	133
2.4.2.2.3	2 mm plastic(m**2)	sqm	4.40	84	0					0	0
2.4.2.2.4	1 mm plastic(m**2)	sqm	2.20	84	0					0	0
2.4.2.2.5	Kapton tape(m)	m	0.17	541	0					0	0
2.4.2.2.6	Black tape (m)	m	0.17	673	0					0	0
2.4.2.2.7	Tyvek (m**2)	sqm	1.19	251	0					0	0
2.4.2.2.8	tedlar (m**2)	sqm	0.61	293	0					0	0
2.4.2.2.9	rivets	each	0.20	3,316	1					1	1
2.4.2.2.10	Glue				0					0	0
2.4.2.2.11	source tubes(m)	m	1.00	449	0					0	1
2.4.2.2.12	Couplers (source tubes)	each	5.00	94	0					0	1
2.4.2.2.13	optical connectors	each	2.00	104	0					0	0
2.4.2.2.14	Quartz connectors	each	5.00	12	0					0	0
2.4.2.2.15	positioning spring	each									
2.4.2.2.16	1.34mm ball bit	each	50	15	1					1	1

WBS Number	Description	Unit	Unit Cost ($)	Quantity	Mfg M&S (K$)	Mfg Labor (Yrs)	Mfg Labor (K$)	EDIA Labor (Yrs)	EDIA Labor (K$)	Base Cost (K$)	CMS Cost (KCHF)
2.4.2.2.17	thermwood machine (exists)			1							
2.4.2.2.18	thermwood code	ds days	370	25		0.1	9			9	
2.4.2.2.19	thermwood operator (2 techs for 55 c	ts days	437	55		0.4	24			24	
2.4.2.2.20	tile tray assembly (3 techs for 55 day	ts days	655	55		0.7	36			36	
2.4.2.2.21	miscellaneous				1					1	1
2.4.2.3	Pigtails				11	0.3	16			27	14
2.4.2.3.1	Y-ll fiber (km)	km	1,333	2	3					3	4
2.4.2.3.2	clear fibers (km)	km	1,261	3	3					3	4
2.4.2.3.3	optical connectors	each	2.00	104	0					0	0
2.4.2.3.4	quartz fiber (km)	km	1,410	3	4					4	5
2.4.2.3.5	fiber scanner	each		1							
2.4.2.3.6	fiber splicer	each		3							
2.4.2.3.7	fiber polishers	each		3							
2.4.2.3.8	connector polisher	each		1							
2.4.2.3.9	assembly (4 techs for .15 yrs)	ts days	874	19		0.3	16			16	
2.4.2.4	Final assembly and testing					0.7	36			36	
2.4.2.4.1	megatile scanner (FY'97)										
2.4.2.4.2	insert fibers	ts days	218	55		0.2	12			12	
2.4.2.4.3	test magatiles	ts days	218	55		0.2	12			12	
2.4.2.4.4	final packaging	ts days	218	55		0.2	12			12	
2.4.2.5	Optical Cables				17	0.2	9			26	22
2.4.2.5.1	optical cable (m)	m	35	475	17					17	22
2.4.2.5.2	optical connectors	each	2.00	208	0					0	1
2.4.2.5.3	assembly (1 tech for .15 yrs)	ts days	218	40		0.2	9			9	
2.4.2.6	Shipping				1					1	2
2.4.2.6.1	shipping crates	each	500	2	1					1	1
2.4.2.6.2	shipping to CERN	each	200	2	0					0	1
2.4.3	Readout Boxes	box		24							
2.4.3.1	Design Engineering	eu hours	75	20				0.0	2	2	
2.4.3.2	Box outer enclosure				19	0.0	3			22	25

WBS Number	Description	Unit	Unit Cost ($)	Quantity	Mfg M&S (K$)	Mfg Labor (Yrs)	Mfg Labor (K$)	EDIA Labor (Yrs)	EDIA Labor (K$)	Base Cost (K$)	CMS Cost (KCHF)
2.4.3.2.1	ext wall material (copper 1/4 inch)		913	2	2					2	2
2.4.3.2.2	water fittings		1.20	96	0					0	0
2.4.3.2.3	gas fittings		0.60	48	0					0	0
2.4.3.2.4	mounting bolts+brackets		5.00	192	1					1	1
2.4.3.2.5	aluminum cooling plates		2.10	6,773	14					14	18
2.4.3.2.6	copper plates		193	3	1					1	1
2.4.3.2.7	patch panel		72	24	2					2	2
2.4.3.2.8	technical support	tu hours	30	22		0.0	1			1	
2.4.3.2.9	machining + assembly	mu hours	35	60		0.0	2			2	
2.4.3.3	box internal structure				13	0.0	1			14	17
2.4.3.3.1	interior walls		913	2	2					2	2
2.4.3.3.2	sorting plate		72	24	2					2	2
2.4.3.3.3	tube support plate		72	24	2					2	2
2.4.3.3.4	calibration support plate		72	24	2					2	2
2.4.3.3.5	HPD Alignment and Fixturing		250	24	6					6	8
2.4.3.3.6	technical support	tu hours	30	22		0.0	1			1	
2.4.3.3.7	assembly	su hours	10	22		0.0	0			0	
2.4.3.4	box optical				38	0.1	5			43	49
2.4.3.4.1	fiber 940mm multiclad ps		0.90	4,637	4					4	5
2.4.3.4.2	fiber 300 mm multiclad ps		0.65	2,318	2					2	2
2.4.3.4.3	fiber 200 mm quartz		25	240	6					6	8
2.4.3.4.4	Y11 Blocks		74	24	2					2	2
2.4.3.4.5	Delrin Cookies		24	24	1					1	1
2.4.3.4.6	sleeves		1.00	1,008	1					1	1
2.4.3.4.7	Connectors for ps fiber		5.00	576	3					3	4
2.4.3.4.8	Connectors/splitters for laser calibration		30	240	7					7	9
2.4.3.4.9	LEDs		21	48	1					1	1
2.4.3.4.10	Photodiodes and associated circuitry		133	72	10					10	12
2.4.3.4.11	Fiber Bundle assembly jigs		1,050	1	1					1	1
2.4.3.4.12	flycutting		50	24	1					1	2

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2.4.3.4.13	technical support+assembly	tu hours	30	175		0.1	5			5	
2.4.3.5	Assembly and QC				2	0.0	1	0.0	1	5	3
2.4.3.5.1	Q/C fixturing		1,175	1	1					1	2
2.4.3.5.2	Q/C test equipment		1,250	1	1					1	2
2.4.3.5.3	Q/C Engineering	eu hours	75	17				0.0	1	1	
2.4.3.5.4	Q/C Technical	tu hours	30	44		0.0	1			1	
2.4.3.6	Installation					0.1	26			26	
2.4.3.6.1	install decoder boxes	ts days	218	24		0.0	5			5	
2.4.3.6.2	install cooling pipes	ts days	218	24		0.0	5			5	
2.4.3.6.3	install HV/LV cables	ts days	218	24		0.0	5			5	
2.4.3.6.4	install signal cables	ts days	218	48		0.0	10			10	
2.4.4	Photodetectors										
2.4.4.1	HPD61 (included in HE)	each	2,500								
2.4.4.2	Test photodetectors	tc days	218								
2.4.5	Front-end Electronics				187	0.1	3			191	244
2.4.5.1	QIE ASIC				30	0.0	1			31	38
2.4.5.1.1	Production	each	20	1,344	27					27	35
2.4.5.1.1a	spares	each	20	134	3					3	3
2.4.5.1.2	QA/QC and Monitoring	each		1,478		1 min tech					
2.4.5.1.2.1	technician	tc days	218	5		0.0	1			1	
2.4.5.2	ADC				8	0.0	1			9	11
2.4.5.2.1	Acquisition	each	7.00	1,060	7					7	10
2.4.5.2.1a	spares	each	7.00	106	1					1	1
2.4.5.2.2	QA/QC and Monitoring	each		1,166		1 min tech					
2.4.5.2.2.1	technician	tc days	218	4		0.0	1			1	
2.4.5.3	Channel Control ASIC				7	0.0	0			7	8
2.4.5.3.1	Production	each	15	396	6					6	8
2.4.5.3.1a	spares	each	15	40	1					1	1
2.4.5.3.2	QA/QC and Monitoring	each		436		1 min tech					
2.4.5.3.2.1	technician	tc days	218	1		0.0	0			0	

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2.4.5.4	Data Link				122					122	159
2.4.5.4.1	Acquisition	each	330	336	111					111	144
2.4.5.4.1a	spares	each	330	34	11					11	14
2.4.5.5	Voltage Regulator				2					2	3
2.4.5.5.1	Acquisition	each	2.00	1,060	2					2	3
2.4.5.5.1a	spares	each	2.00	106	0					0	0
2.4.5.6	3 Channel PCBs				15	0.0	1			16	19
2.4.5.6.1	Production	each	5.00	336	2					2	2
2.4.5.6.1a	spares	each	5.00	34	0					0	0
2.4.5.6.2	Assembly	each	35	370	13					13	17
2.4.5.6.3	QA/QC and Monitoring	each		370		3 min tech					
2.4.5.6.3.1	technician	tc days	218	4		0.0	1			1	
2.4.5.7	Backplane				4	0.0	0			4	5
2.4.5.7.1	Production	each	25	25	1					1	1
2.4.5.7.1a	spares	each	25	3	0					0	0
2.4.5.7.2	Assembly	each	125	28	3					3	4
2.4.5.7.3	QA/QC and Monitoring	each		28		3 min tech					
2.4.5.7.3.1	technician	tc days	218	0		0.0	0			0	
2.4.6	Calibration Systems				20	0.2	10			30	26
2.4.6.1	Calibration System M&S				20					20	26
2.4.6.2	Calibration System Mfg. Labor					0.2	10			10	
2.4.7	Trigger/DAQ Electronics				68	0.1	7			75	89
2.4.7.1	Multi-Chip Modules				30	0.1	4			34	39
2.4.7.1.7	HO-E Production	each	100	270	27	0.2 mo en				27	35
2.4.7.1.7a	spares	each	100	27	3					3	4
2.4.7.1.7.1	engineering	en days	423	4		0.0	2			2	
2.4.7.1.8	QA/QC			297		10 min tech per MCM					
2.4.7.1.8.1	technician	tc days	218	10		0.0	2			2	
2.4.7.2	VME Modules				24	0.0	2			26	31
2.4.7.2.9	HO-E Production	each	1,200	18	22	0.5 week tech				22	28

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2.4.7.2.9a	spares	each	1,200	2	2					2	3
2.4.7.2.9.1	technician	tc days	218	3		0.0	1			1	
2.4.7.2.10	QA/QC			20		2 hour tech per module					
2.4.7.2.10.1	technician	tc days	218	8		0.0	2			2	
2.4.7.3	9U VME Crates				6	0.0	0			6	7
2.4.7.3.1	HO-E Production	each	5,000	1	5					5	7
2.4.7.3.1a	spares	each	5,000	0	1					1	1
2.4.7.3.2	QA/QC					4 hour tech per crate					
2.4.7.3.2.1	technician	tc days	218	1		0.0	0			0	
2.4.7.4	FED/DDU				9	0.0	0			9	11
2.4.7.4.1	HO-E Production	each	4,000	2	8					8	10
2.4.7.4.1a	spares	each	4,000	0	1					1	1
2.4.7.4.2	QA/QC			2		1 day tech per FED/DDU					
2.4.7.4.2.1	technician	tc days	218	2		0.0	0			0	
2.4.7.5	Data Link				1	0.0	0			1	1
2.4.7.5.1	HO-E Production	each	330	2	1					1	1
2.4.7.5.1a	spares	each	330	0	0					0	0
2.4.7.5.2	QA/QC			2		1 hour tech per link					
2.4.7.5.2.1	technician	tc days	218	0		0.0	0			0	
2.4.8	Voltage Supply Systems				36	0.0	2			38	47
2.4.8.1	HO-E High Voltage				24	0.0	2			26	31
2.4.8.1.1	Module	each	785	24	19					19	24
2.4.8.1.1a	spares	each	785	2	2					2	2
2.4.8.1.2	6U VME Crate	each	2,000	1	3					3	3
2.4.8.1.2a	spares	each	2,000	0	0					0	0
2.4.8.1.3	QA/QC					2 week tech					
2.4.8.1.3.1	technician	tc days	218	10		0.0	2			2	
2.4.8.2	HO-E High Voltage Cable/Connector				13					13	16
2.4.8.2.1	Cable	100 ft	100	96	10					10	12
2.4.8.2.1a	spares	100 ft	100	19	2					2	2

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2.4.8.2.2	Connector	each	20	48	1					1	1
2.4.8.2.2a	spares	each	20	10	0					0	0
2.4.8.3	Endcap Low Voltage (none - LV from HE)										
2.4.8.3.1	Supply Acquisition	each	3,300								
2.4.8.3.1a	spares	each	3,300								
2.4.8.3.2	Cable Acquisition	100 ft	177								
2.4.8.3.2a	spares	100 ft	177								
2.4.8.3.3	QA/QC on Installed Cable	unit				4 hour tech					
2.4.8.3.3.1	technician	tc days	218								
2.4.9	Detector Control System				54	0.3	17			71	70
2.4.9.2	Arcnet				17	0.0	2			19	22
2.4.9.2.1	Outer End CAp Spokes	each	200	24	5					5	6
2.4.9.2.2	HO-E CAN Interface	each	500	24	12	1 week tech				12	16
2.4.9.2.2.1	technician	tc days	218	5		0.0	1			1	
2.4.9.2.3	QA/QC					1 week tech					
2.4.9.2.3.1	technician	tc days	218	5		0.0	1			1	
2.4.9.3	EPICS IOC				21	0.1	3			24	27
2.4.9.3.1	Front Ends	each	7,000	2	14					14	18
2.4.9.3.2	QA/QC	each				1 week tech each					
2.4.9.3.2.1	technician	tc days	218	10		0.0	2			2	
2.4.9.3.3	TriDAS	each	7,000	1	7					7	9
2.4.9.3.4	QA/QC	each				1 week tech each					
2.4.9.3.4.1	technician	tc days	218	5		0.0	1			1	
2.4.9.4	EPICS IOC Bridge				1	0.0	1			2	1
2.4.9.4.1	HO-E High Voltage	each	1,000	1	1					1	1
2.4.9.4.2	QA/QC					1 week tech					
2.4.9.4.2.1	technician	tc days	218	5		0.0	1			1	
2.4.9.5	TTC				12	0.2	10			22	16
2.4.9.5.1	EOC	each	500	24	12	2 day tech each				12	16
2.4.9.5.1.1	technician	tc days	218	48		0.2	10			10	

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2.4.9.6	Software License				3					3	4
2.4.9.6.1	HO-E	each	1,000	3	3					3	4
2.4.10	Pre-production Prototypes										

WBS Number	Description	Unit	Unit Cost ($)	Quantity	Mfg M&S (K$)	Mfg Labor (Yrs)	Mfg Labor (K$)	EDIA Labor (Yrs)	EDIA Labor (K$)	Base Cost (K$)	CMS Cost (KCHF)
2.5	Forward Calorimeter (HF)				5,194	18.6	1,037	7.7	737	6,968	6,394
2.5.1	Mechanics				1,076	6.7	368	3.0	284	1,728	1,399
2.5.1.1	Design							3.0	284	284	
2.5.1.1.1	Engineering	en days	423	500				2.0	211	211	
2.5.1.1.2	Drafting	df days	289	250				1.0	72	72	
2.5.1.2	Module Fabrication				921					921	1,197
2.5.1.2.1	Cu Plates (3.0 mm thick)	plate	42	8,700	369					369	480
2.5.1.2.2	Cu Plates (2.0 mm thick)	plate	45	8,700	388					388	504
2.5.1.2.3	Ship Cu plates to RU	each	7,500	8	60					60	78
2.5.1.2.4	Groove/cut Tooling	each	20,000	2	40					40	52
2.5.1.2.5	Groove Inspection Tooling	each	5,000	2	10					10	13
2.5.1.2.6	Module Production (Diffus) Tooling	each	20,000	2	40					40	52
2.5.1.2.7	Module Inspection Tooling	each	5,000	2	10					10	13
2.5.1.2.8	Other Testing and Tooling	each	2,000	2	4					4	5
2.5.1.3	Quad Assembly and Machining				125	6.0	328			453	163
2.5.1.3.1	Face Plates	each	500	8	4					4	5
2.5.1.3.2	Side Plates	each	300	24	7					7	9
2.5.1.3.3	Brackets	each	50	32	2					2	2
2.5.1.3.4	Bolts	each	20	64	1					1	2
2.5.1.3.5	Rollers	each	100	32	3					3	4
2.5.1.3.6	Module Production Labor	ts days	218	500		2.0	109			109	
2.5.1.3.7	Quadrant Assembly Labor	ts days	218	500		2.0	109			109	
2.5.1.3.8	Component Machining Labor	ts days	218	500		2.0	109			109	
2.5.1.3.9	Aux components	each	5,000	8	40					40	52
2.5.1.3.10	Ship Assembled Quads to HU/TR	each	7,500	8	60					60	78
2.5.1.3.11	Shipping Crates	each	1,000	8	8					8	10
2.5.1.4	HF Assembly with Quads				20	0.2	13			33	26
2.5.1.4.1	Assembly 1/2 HF	ts days	218	30		0.1	7			7	
2.5.1.4.2	Assembly HF+ and HF -	ts days	218	30		0.1	7			7	

WBS Number	Description	Unit	Unit Cost ($)	Quantity	Mfg M&S (K$)	Mfg Labor (Yrs)	Mfg Labor (K$)	EDIA Labor (Yrs)	EDIA Labor (K$)	Base Cost (K$)	CMS Cost (KCHF)
2.5.1.4.3	Assembly Fixtures	each	10,000	2	20					20	26
2.5.1.5	Installation in Hall				10	0.5	27			37	13
2.5.1.5.1	Assembly	ts days	218	125		0.5	27			27	
2.5.1.5.2	Lifting Fixtures	each	5,000	1	5					5	7
2.5.1.5.3	Aux Components	each	5,000	1	5					5	7
2.5.2	Optics				1,536	3.7	203	1.4	144	1,883	1,997
2.5.2.1	Optical Materials				1,218					1,218	1,584
2.5.2.1.1	QQ Fibers	km	1,410	391	551					551	717
2.5.2.1.2	QP Fibers	km	210	3,138							
2.5.2.1.2.1	QP Fibers - US				165					165	214
2.5.2.1.2.2	QP Fibers - other				494					494	643
2.5.2.1.3	Plastic Fibers	km	120								
2.5.2.1.4	Glue	kg	100	25	3					3	3
2.5.2.1.5	Tape	km	200	3	1					1	1
2.5.2.1.6	Plastic Tubing	km	100	0	0					0	0
2.5.2.1.7	miscellaneous		5,000	1	5					5	7
2.5.2.2	Optical system EDIA							1.4	144	144	
2.5.2.2.1	Optical System Design	en days	423	250				1.0	106	106	
2.5.2.2.2	Production Management	en days	423	90				0.4	38	38	
2.5.2.3	Tooling				76					76	99
2.5.2.3.1	Fiber Insertion Tooling	each	20,000	1	20					20	26
2.5.2.3.2	Fiber Bundle Tooling	each	4,000	2	8					8	10
2.5.2.3.3	Bundle/cut Tooling	each	8,000	2	16					16	21
2.5.2.3.4	Glue/polish Tooling	each	8,000	2	16					16	21
2.5.2.3.5	Inspection Tooling	each	4,000	2	8					8	10
2.5.2.3.6	Other Tooling and Testing	each	8,000	1	8					8	10
2.5.2.4	Optical Mechanics				162					162	210
2.5.2.4.1	Bundle Mechanics (+5%)	tower	15	2,230	33					33	43
2.5.2.4.2	Ferrules	tower	2.50	2,230	6					6	7
2.5.2.4.3	Bundle Couplers	tower	5.00	2,230	11					11	14

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2.5.2.4.4	Light Mixers	tower	40	2,230	89					89	116
2.5.2.4.5	PMT Couplers	tower	10	2,230	22					22	29
2.5.2.5	Final Assembly and Testing					3.7	203			203	
2.5.2.5.1	Insert Fibers	ts days	218	250		1.0	55			55	
2.5.2.5.2	Fill and Glue Ferrules	ts days	218	250		1.0	55			55	
2.5.2.5.3	Cut and Polish Bundles	ts days	218	250		1.0	55			55	
2.5.2.5.4	Inspection	ts days	218	100		0.4	22			22	
2.5.2.5.5	Final Packaging	ts days	218	80		0.3	17			17	
2.5.2.6	Shipping				80					80	104
2.5.2.6.1	Shipping Crates	each	2,500	8	20					20	26
2.5.2.6.2	Shipping to CERN	each	7,500	8	60					60	78
2.5.3	Readout Boxes				79	2.7	154	0.7	78	310	102
2.5.3.1	Design							0.7	78	78	
2.5.3.1.1	Engineering	en days	423	125				0.5	53	53	
2.5.3.1.2	Production Management	en days	423	60				0.2	25	25	
2.5.3.2	Box Outer Enclosure				50	0.5	26			76	65
2.5.3.2.1	Box structure	each	150	139	21					21	27
2.5.3.2.2	N2 gas fittings	each	15	278	4					4	5
2.5.3.2.3	Mounting Bolts+Brackets	each	10	1,112	11					11	14
2.5.3.2.4	Patch Panel	each	100	139	14					14	18
2.5.3.2.5	Technical Support	ts days	218	60		0.2	13			13	
2.5.3.2.6	Machining and Assembly	ts days	218	60		0.2	13			13	
2.5.3.3	Box Internal Structure				13	1.0	55			67	16
2.5.3.3.1	Cross Bars	each	2.50	556	1					1	2
2.5.3.3.2	Brackets and Support	each	2.50	556	1					1	2
2.5.3.3.3	Calibration Components Support	each	10	278	3					3	4
2.5.3.3.4	Misc Components		50	139	7					7	9
2.5.3.3.5	Technical support	ts days	218	125		0.5	27			27	
2.5.3.3.6	Assembly	ts days	218	125		0.5	27			27	
2.5.3.4	Assembly and QC					0.9	53			53	

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2.5.3.4.1	QC Fixturing	ts days	218	30		0.1	7			7	
2.5.3.4.2	QC Test equipment	ts days	218	30		0.1	7			7	
2.5.3.4.3	QC Engineering	en days	423	30		0.1	13			13	
2.5.3.4.4	QC Technical	ts days	218	125		0.5	27			27	
2.5.3.5	Shipping of PMT Boxes				16					16	21
2.5.3.5.1	Shipping Crates	each	500	8	4					4	5
2.5.3.5.2	Shipment		1,500	8	12					12	16
2.5.3.6	Installation					0.4	20			20	
2.5.3.6.1	Install PMT Boxes	ts days	218	30		0.1	7			7	
2.5.3.6.2	Install Gas Lines	ts days	218	20		0.1	4			4	
2.5.3.6.3	Install HV/LV Cables	ts days	218	20		0.1	4			4	
2.5.3.6.4	Install Signal Cables	ts days	218	20		0.1	4			4	
2.5.4	Photodetectors				636	1.0	55			690	826
2.5.4.1	PMTs	tower	275	2,230	613					613	797
2.5.4.2	PMT Sockets	tower	10	2,230	22					22	29
2.5.4.3	PMT Testing	ts days	218	250		1.0	55			55	
2.5.5	Front-end Electronics				573	0.8	44	1.1	88	704	745
2.5.5.1	QIE ASIC				62	0.0	2			65	81
2.5.5.1.1	Production	each	20	2,832	57					57	74
2.5.5.1.1a	spares	each	20	283	6					6	7
2.5.5.1.1.1	QA/QC	each		3,115		1 min tech					
2.5.5.1.1.1.1	technician	tc days	218	10		0.0	2			2	
2.5.5.2	ADC				17	0.0	2			19	22
2.5.5.2.1	Acquisition	each	7.00	2,236	16					16	20
2.5.5.2.1a	spares	each	7.00	224	2					2	2
2.5.5.2.2	QA/QC	each		2,460		1 min tech					
2.5.5.2.3	technician	tc days	218	8		0.0	2			2	
2.5.5.3	Channel Control ASIC				14	0.0	1			14	18
2.5.5.3.1	Production	each	15	833	12					12	16
2.5.5.3.1a	spares	each	15	83	1					1	2

WBS Number	Description	Unit	Unit Cost ($)	Quantity	Mfg M&S (K$)	Mfg Labor (Yrs)	Mfg Labor (K$)	EDIA Labor (Yrs)	EDIA Labor (K$)	Base Cost (K$)	CMS Cost (KCHF)
2.5.5.3.2	QA/QC	each		916		1 min tech					
2.5.5.3.3	technician	tc days	218	3		0.0	1			1	
2.5.5.4	Data Link				257					257	334
2.5.5.4.1	Acquisition	each	330	708	234					234	304
2.5.5.4.1a	spares	each	330	71	23					23	30
2.5.5.5	CAN Interface PCB				43	0.0	2	0.2	17	62	55
2.5.5.5.1	Specifications								2 week en		
2.5.5.5.2	engineering	en days	423	10				0.0	4	4	
2.5.5.5.3	technical support	ts days	218	5				0.0	1	1	
2.5.5.5.4	Prototype	each	750	3	2					2	3
2.5.5.5.5	Test Adapter	each	3,000	1	3	2 week tech			2 week en	3	4
2.5.5.5.6	engineering	en days	423	10				0.0	4	4	
2.5.5.5.7	technical support	ts days	218	5				0.0	1	1	
2.5.5.5.8	technician	tc days	218	10		0.0	2			2	
2.5.5.5.9	Evaluation								2 week en		
2.5.5.5.10	engineering	en days	423	10				0.0	4	4	
2.5.5.5.11	technical support	ts days	218	10				0.0	2	2	
2.5.5.5.12	Acquisition	each	500	68	34					34	44
2.5.5.5.12a	spares	each	500	7	3					3	4
2.5.5.5.13	QA/QC	each		75		3 min tech					
2.5.5.5.14	technician	tc days	218	1		0.0	0			0	
2.5.5.6	3 Channel Mezz. Card				37	0.2	9	0.3	28	74	48
2.5.5.6.1	Technical Design Report								1 week en		
2.5.5.6.2	engineering	en days	423	5				0.0	2	2	
2.5.5.6.3	Prototype	each	50	25	1				2 week en	1	2
2.5.5.6.4	engineering	en days	423	10				0.0	4	4	
2.5.5.6.5	technical support	ts days	218	5				0.0	1	1	
2.5.5.6.6	Assembly		10	25	0	2 week tech				0	0
2.5.5.6.7	technician	tc days	218	10		0.0	2			2	
2.5.5.6.8	Test Adapter	each	3,000	1	3	2 week tech			2 week en	3	4

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2.5.5.6.9	engineering	en days	423	10				0.0	4	4	
2.5.5.6.10	technical support	ts days	218	5				0.0	1	1	
2.5.5.6.11	technician	tc days	218	10		0.0	2			2	
2.5.5.6.12	Evaluation								0.5 mo en		
2.5.5.6.13	engineering	en days	423	10				0.0	4	4	
2.5.5.6.14	technical support	ts days	218	20				0.1	4	4	
2.5.5.6.15	Design Modification								1 week en		
2.5.5.6.16	engineering	en days	423	5				0.0	2	2	
2.5.5.6.17	technical support	ts days	218	5				0.0	1	1	
2.5.5.6.18	Pre-Production Prototype	each	50	25	1	2 week tech				1	2
2.5.5.6.19	technician	tc days	218	10		0.0	2			2	
2.5.5.6.20	Evaluation								1 week en		
2.5.5.6.21	engineering	en days	423	5				0.0	2	2	
2.5.5.6.22	technical support	ts days	218	5				0.0	1	1	
2.5.5.6.23	Production	each	5.00	708	4					4	5
2.5.5.6.23a	spares	each	5.00	71	0					0	0
2.5.5.6.24	Assembly	each	35	779	27	1 week tech				27	35
2.5.5.6.25	technician	tc days	218	5		0.0	1			1	
2.5.5.6.26	QA/QC	each		779		3 min tech			software		
2.5.5.6.27	technician	tc days	218	8		0.0	2			2	
2.5.5.6.28	software	cp days	423								
2.5.5.7	PCB				80	0.3	14	0.3	27	121	104
2.5.5.7.1	Requirements Report								1 week en		
2.5.5.7.2	engineering	en days	423	5				0.0	2	2	
2.5.5.7.3	Technical Design Report								1 week en		
2.5.5.7.4	engineering	en days	423	5				0.0	2	2	
2.5.5.7.5	Prototype	each	2,000	2	4	2 week tech			2 week en	4	5
2.5.5.7.6	engineering	en days	423	10				0.0	4	4	
2.5.5.7.7	technical support	ts days	218	20				0.1	4	4	
2.5.5.7.8	technician	tc days	218	10		0.0	2			2	

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2.5.5.7.9	Test Stand	each	12,000	1	12	2 week tech			software	12	16
2.5.5.7.10	technician	tc days	218	10		0.0	2			2	
2.5.5.7.11	software	cp days	423								
2.5.5.7.12	Evaluation								2 week en		
2.5.5.7.13	engineering	en days	423	10				0.0	4	4	
2.5.5.7.14	technical support	ts days	218	15				0.1	3	3	
2.5.5.7.15	Design Modifications								1 week en		
2.5.5.7.16	engineering	en days	423	5				0.0	2	2	
2.5.5.7.17	technical support	ts days	218	5				0.0	1	1	
2.5.5.7.18	Pre-Production Prorotype	each	2,000	2	4	2 week tech				4	5
2.5.5.7.19	technician	tc days	218	10		0.0	2			2	
2.5.5.7.20	Evaluation								1 week en		
2.5.5.7.21	engineering	en days	423	5				0.0	2	2	
2.5.5.7.22	technical support	ts days	218	5				0.0	1	1	
2.5.5.7.23	Production	each	800	68	54	1 week tech				54	71
2.5.5.7.23a	spares	each	800	7	5	1 week tech				5	7
2.5.5.7.24	technician	tc days	218	5		0.0	1			1	
2.5.5.7.25	QA/QC	each		75		2 hour tech					
2.5.5.7.26	technician	tc days	218	30		0.1	7			7	
2.5.5.8	Powered 9U VME Crate				64	0.2	13	0.2	16	93	83
2.5.5.8.1	Custom Specification								2 week en		
2.5.5.8.2	engineering	en days	423	10				0.0	4	4	
2.5.5.8.3	technical support	ts days	218	15				0.1	3	3	
2.5.5.8.4	Prototype	each	12,000	1	12	2 week eng				12	16
2.5.5.8.5	technician	tc days	218	10		0.0	2			2	
2.5.5.8.6	Evaluation				3	1 week tech			2 week en	3	3
2.5.5.8.7	engineering	en days	423	10				0.0	4	4	
2.5.5.8.8	technical support	ts days	218	20				0.1	4	4	
2.5.5.8.9	technician	tc days	218	5		0.0	1			1	
2.5.5.8.10	Radiation Validation	each			5	1 week eng, 1 mo tech				5	7

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2.5.5.8.11	engineering	en days	423	5		0.0	2			2	
2.5.5.8.12	technician	tc days	218	20		0.1	4			4	
2.5.5.8.13	Acquisition	each	10,000	4	40	1 week tech				40	52
2.5.5.8.13a	spares	each	10,000	0	4					4	5
2.5.5.8.14	technician	tc days	218	5		0.0	1			1	
2.5.5.8.15	QA/QC					2 week tech					
2.5.5.8.16	technician	tc days	218	10		0.0	2			2	
2.5.6	Calibration Systems				269	1.7	102			371	350
2.5.6.1	Laser routing system				70	1.0	60			130	91
2.5.6.1.1	Laser (HF rad dam monitor)				10					10	13
2.5.6.1.2	Quartz fiber to splitters	m	10	600	6					6	8
2.5.6.1.3	L1 4-fold splitters	each	1,000	4	4					4	5
2.5.6.1.4	Quartz fiber to splitters	m	10	32	0					0	0
2.5.6.1.5	Connectors (2/fiber)	each	5	32	0					0	0
2.5.6.1.6	L2 8-fold splitters	each	1,000	16	16					16	21
2.5.6.1.7	Quartz fiber to PMT boxes	m	10	256	3					3	3
2.5.6.1.8	Connectors (2/fiber)	each	5	256	1					1	2
2.5.6.1.9	L3 (16-fold) air-core splitters	each	50	64	3					3	4
2.5.6.1.10	PMT monitor fibers	m	1.41	2,124	3					3	4
2.5.6.1.11	Rad Dam fibers	m	1.41	12,744	18					18	23
2.5.6.1.12	Optical Feedthroughs	each	10	128	1					1	2
2.5.6.1.13	PIN diode mounting mechanics		150	20	3					3	4
2.5.6.1.14	PIN diode read-out electronics		50	20	1					1	1
2.5.6.1.15	Assembly	tu days	240	250		1.0	60			60	
2.5.6.2	Source routing system				130	0.3	19			149	169
2.5.6.2.1	Souce drivers	each	10,000	4	40					40	52
2.5.6.2.2	Sources	each	5,000	4	20					20	26
2.5.6.2.2.1	Controllers	each	5,000	4	20					20	26
2.5.6.2.3	x-y table	each	10,000	4	40					40	52
2.5.6.2.4	Pigs	each	5,000	2	10					10	13

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2.5.6.2.5	Assembly labor	tu days	240	80		0.3	19			19	
2.5.6.3	LED System				25	0.3	15			40	32
2.5.6.3.1	LEDs	each	5.00	64	0					0	0
2.5.6.3.2	LED Driver Module	module	2,000	8	16					16	21
2.5.6.3.3	Cabling (Driver to LEDs)	each	100	8	1					1	1
2.5.6.3.4	LED Couplings (Mech+Elect)	each	25	64	2					2	2
2.5.6.3.5	PIN PD+Elec	each	50	64	3					3	4
2.5.6.3.6	Cabling (PIN to ADC)	each	100	8	1					1	1
2.5.6.3.7	Assembly labor	tu days	240	64		0.3	15			15	
2.5.6.3.8	Prototype (LED)	each	2,000	1	2					2	3
2.5.6.4	Radiation Monitors				45	0.1	7			52	59
2.5.6.4.1	Radiation Monitors	each	2,500	16	40					40	52
2.5.6.4.2	Installation	tu days	240	30		0.1	7			7	
2.5.6.4.3	Prototype (Radiation Monitors)	each	2,500	2	5					5	7
2.5.7	Trigger/DAQ Electronics				167	0.3	20			187	217
2.5.7.1	Multi-Chip Modules				59	0.2	13			72	77
2.5.7.1.7	HF Production	each	100	540	54	1 mo eng				54	70
2.5.7.1.7a	spares	each	100	54	5	1 mo eng				5	7
2.5.7.1.7.1	engineering	en days	423	20		0.1	8			8	
2.5.7.1.8	QA/QC			594		10 min tech per MCM					
2.5.7.1.8.1	technician	tc days	218	20		0.1	4			4	
2.5.7.2	VME Modules				48	0.1	5			52	62
2.5.7.2.9	HF Production	each	1,200	36	43	1 week tech				43	56
2.5.7.2.9a	spares	each	1,200	4	4					4	6
2.5.7.2.9.1	technician	tc days	218	5		0.0	1			1	
2.5.7.2.10	QA/QC			40		2 hour tech per module					
2.5.7.2.10.1	technician	tc days	218	16		0.1	3			3	
2.5.7.3	9U VME Crates				22	0.0	1			23	29
2.5.7.3.1	HF Production	each	5,000	4	20					20	26
2.5.7.3.1a	spares	each	5,000	0	2					2	3

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2.5.7.3.2	QA/QC			4		4 hour tech per crate					
2.5.7.3.2.1	technician	tc days	218	4		0.0	1			1	
2.5.7.4	FED/DDU				35	0.0	2			37	46
2.5.7.4.1	HF Production	each	4,000	8	32					32	42
2.5.7.4.1a	spares	each	4,000	1	3					3	4
2.5.7.4.2	QA/QC			9		1 day tech per FED/DDU					
2.5.7.4.2.1	technician	tc days	218	9		0.0	2			2	
2.5.7.5	Data Link				3	0.0	0			3	4
2.5.7.5.1	HF Production	each	330	8	3					3	3
2.5.7.5.1a	spares	each	330	1	0					0	0
2.5.7.5.2	QA/QC			9		1 hour tech per link					
2.5.7.5.2.1	technician	tc days	218	2		0.0	0			0	
2.5.8	Voltage Supply Systems				349	0.5	26	0.5	43	418	454
2.5.8.1	Forward High Voltage				297	0.3	15	0.4	34	346	386
2.5.8.1.1	Requirements Report								3 week en		
2.5.8.1.1.1	engineering	en days	423	15				0.1	6	6	
2.5.8.1.2	Technical Design Report								3 week en		
2.5.8.1.2.1	engineering	en days	423	15				0.1	6	6	
2.5.8.1.2.2	technical support	ts days	218	10				0.0	2	2	
2.5.8.1.3	Prototype Channel	each	200	5	1	3 week tech				1	1
2.5.8.1.3.1	technician	tc days	218	15		0.1	3			3	
2.5.8.1.4	Channel Test Adapter	each	3,000	1	3	2 week tech			2 week en	3	4
2.5.8.1.4.1	engineering	en days	423	10				0.0	4	4	
2.5.8.1.4.2	technician	tc days	218	10		0.0	2			2	
2.5.8.1.5	Evaluation								1 week en		
2.5.8.1.5.1	engineering	en days	423	5				0.0	2	2	
2.5.8.1.5.2	technical support	ts days	218	10				0.0	2	2	
2.5.8.1.6	Prototype Module	each	4,000	1	4	4 week tech			2 week en	4	5
2.5.8.1.6.1	engineering	en days	423	10				0.0	4	4	
2.5.8.1.6.2	technical support	ts days	218	10				0.0	2	2	

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2.5.8.1.6.3	technician	tc days	218	20		0.1	4			4	
2.5.8.1.7	Evaluation								1 week en		
2.5.8.1.7.1	engineering	en days	423	5				0.0	2	2	
2.5.8.1.7.2	technical support	ts days	218	10				0.0	2	2	
2.5.8.1.8	Module Production	each	3,570	68	243	2 week tech				243	316
2.5.8.1.8a	spares	each	3,570	7	24	2 week tech				24	32
2.5.8.1.8.1	technician	tc days	218	10		0.0	2			2	
2.5.8.1.9	9U VME Crates	each	5,000	4	20					20	26
2.5.8.1.9a	spares	each	5,000	0	2					2	3
2.5.8.1.10	QA/QC					3 week tech			software		
2.5.8.1.10.1	technician	tc days	218	15		0.1	3			3	
2.5.8.1.10.2	software	cp days	423								
2.5.8.2	Forward HV Voltage Cable/Connector				40					40	53
2.5.8.2.1	Cable	100 ft	100	256	26					26	33
2.5.8.2.1a	spares	100 ft	100	26	3					3	3
2.5.8.2.2	Connector	each	5.00	2,230	11					11	14
2.5.8.2.2a	spares	each	5.00	223	1					1	1
2.5.8.3	Forward Low Voltage Rad. Tolerance				12	0.2	11	0.1	8	31	15
2.5.8.3.1	Requirements Report								2 week en		
2.5.8.3.1.1	engineering	en days	423	10				0.0	4	4	
2.5.8.3.2	Technical Specifications								2 week en		
2.5.8.3.2.1	engineering	en days	423	10				0.0	4	4	
2.5.8.3.3	Prototype Acquisition	each	3,000	3	9					9	12
2.5.8.3.4	Radiation Tolerance Validation				3	1 week eng, 8 week tech				3	3
2.5.8.3.4.1	engineering	en days	423	5		0.0	2			2	
2.5.8.3.4.2	technician	tc days	218	40		0.2	9			9	
2.5.8.3.5	Supply Acquisition (none - from crates	each	2,000								
2.5.8.3.5a	spares	each	2,000								
2.5.8.3.6	QA/QC	unit				4 hour tech					
2.5.8.3.6.1	technician	tc days	218								

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2.5.9	Detector Control System				93	0.3	20	0.1	8	121	121
2.5.9.1	Toolkit				23	0.1	8	0.1	8	40	30
2.5.9.1.1	Forward	each	10,000	1	10	4 week software			4 week en	10	13
2.5.9.1.1.1	engineering	en days	423	20				0.1	8	8	
2.5.9.1.1.2	software	cp days	423	20		0.1	8			8	
2.5.9.1.1.3	hardware		13,000	1	13					13	17
2.5.9.3	EPICS IOC				56	0.2	9			65	73
2.5.9.3.1	Front Ends	each	7,000	4	28					28	36
2.5.9.3.2	QA/QC	each		4		1 week tech each					
2.5.9.3.2.1	technician	tc days	218	20		0.1	4			4	
2.5.9.3.3	TriDAS	each	7,000	4	28					28	36
2.5.9.3.4	QA/QC	each				1 week tech each					
2.5.9.3.4.1	technician	tc days	218	20		0.1	4			4	
2.5.9.4	EPICS IOC Bridge				4	0.0	1			5	5
2.5.9.4.1	Forward High Voltage	each	1,000	4	4					4	5
2.5.9.4.2	QA/QC					1 week tech					
2.5.9.4.2.1	technician	tc days	218	5		0.0	1			1	
2.5.9.5	TTC				2	0.0	2			4	3
2.5.9.5.1	Forward	each	500	4	2	2 day tech each				2	3
2.5.9.5.1.1	technician	tc days	218	8		0.0	2			2	
2.5.9.6	Software License				8					8	10
2.5.9.6.1	Forward	each	1,000	8	8					8	10
2.5.10	Pre-production Prototypes				140	0.2	13	0.1	13	166	182
2.5.10.1	Technical Tests				5					5	6
2.5.10.1.1	Cu Plates	each	45	15	1					1	1
2.5.10.1.2	Shipment of Cu Plates to RU		2,000	1	2					2	3
2.5.10.1.3	Diffusion Welding Tests		2,000	1	2					2	3
2.5.10.2	Preproduction Prototype I				136	0.2	13	0.1	13	161	176
2.5.10.2.1	Cu Plates (2.0 mm thick)	plates	45	100	4					4	6
2.5.10.2.2	Cu Plates (3.0 mm thick)	plates	42	100	4					4	6

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2.5.10.2.3	Shipment of Cu Plates	each	3,000	2	6					6	8
2.5.10.2.4	Diffusion Welding		5,000	1	5					5	7
2.5.10.2.5	Machining		5,000	1	5					5	7
2.5.10.2.6	Support Structure	each	5,000	1	5					5	7
2.5.10.2.7	Shipment to HU	each	2,000	1	2					2	3
2.5.10.2.8	QQ Fibers	km	2,820	11	30					30	40
2.5.10.2.9	QP Fibers	km	1,250	32	41					41	53
2.5.10.2.10	Fiber Insertion/Motion Mechanism	each	2,000	1	2					2	3
2.5.10.2.11	Optics Engineering	en days	423	30				0.1	13	13	
2.5.10.2.12	PMT Testing	ts days	218	30		0.1	7			7	
2.5.10.2.13	PMT Box Materials	each	1,000	2	2					2	3
2.5.10.2.14	PMT Box Assembly	ts days	218	30		0.1	7			7	
2.5.10.2.15	PMTs	each	325	32	10					10	14
2.5.10.2.16	Magnetic Shielding	each	20	32	1					1	1
2.5.10.2.17	Patch Panel (Box)	each	1,000	2	2					2	3
2.5.10.2.18	Light mixing optics/couplings	each	250	32	8					8	10
2.5.10.2.19	Light Source Calibration Hardware	each	1,000	1	1					1	1
2.5.10.2.20	Rad Source Calibration Hardware	each	1,000	1	1					1	1
2.5.10.2.21	Misc hardware	each	2,000	1	2					2	3
2.5.10.2.22	Shipping Crates	each	1,000	2	2					2	3
2.5.10.2.23	Shipment	each	2,000	1	2					2	3
2.5.11	Luminosity Monitor				275	0.7	33	0.8	80	388	
2.5.11.1	Rate Monitor Electronics				40					40	52
2.5.11.1.1	Digitizing electronics		20,000	1	20					20	26
2.5.11.1.2	Slow controls		20,000	1	20					20	26
2.5.11.2	Beam Condition Monitor (6)										
2.5.11.2.1	Materials (scintillator/quartz)		3,000	6							
2.5.11.2.2	Support structure		1,000	6							
2.5.11.2.3	Photodetectors (PMTs)		1,600	6							
2.5.11.2.4	Assembly		1,500	6							

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2.5.11.2.5	Digitizing and Scaling Electronics		2,500	6							
2.5.11.2.6	Prototype		12,000	1							
2.5.11.2.7	Spare		9,600	1							
2.5.11.3	Roman Pot Detectors (4)				188	0.7	33	0.8	80	301	244
2.5.11.3.1	Materials (scintillating fiber, silicon)		1,500	4	6					6	8
2.5.11.3.2	Housing, vacuum interface, movement		12,500	4	50	0.2	12	0.3	25	87	65
2.5.11.3.2.1	EDIA							0.3	25	25	
2.5.11.3.2.2	Manufacturing Labor					0.2	12			12	
2.5.11.3.2.3	Bellows		1,000	2	8					8	10
2.5.11.3.2.4	Flanges		1,000	2	8					8	10
2.5.11.3.2.5	Pipe		1,000	1	4					4	5
2.5.11.3.2.6	Window		250	2	2					2	3
2.5.11.3.2.7	Pressure compensation		2,000	1	8					8	10
2.5.11.3.2.8	Rough control		1,000	1	4					4	5
2.5.11.3.2.9	Fine control		4,000	1	16					16	21
2.5.11.3.3	Photodetectors		8,000	4	32					32	42
2.5.11.3.4	Assembly M&S		1,000	4	4					4	5
2.5.11.3.4	Assembly Labor					0.4	21			21	
2.5.11.3.5	Digitizing electronics EDIA							0.3	25	25	
2.5.11.3.5	Digitizing electronics M&S		3,000	4	12					12	16
2.5.11.3.6	Slow control, interlock electronics		18,000	2	36					36	47
2.5.11.3.7	Prototype EDIA							0.3	30	30	
2.5.11.3.7	Prototype M&S		25,000	1	25					25	33
2.5.11.3.8	Spare		23,000	1	23					23	30
2.5.11.4	Power Supplies				8					8	10
2.5.11.4.1	High voltage		2,000	4	8					8	10
2.5.11.5	Cables				20					20	26
2.5.11.5.1	High voltage cables		1.00	10,000	10					10	13
2.5.11.5.2	Low voltage cables		1.00	10,000	10					10	13
2.5.11.6	Testing Facilities				19					19	25

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2.5.11.6.1	Cosmic ray set-up		9,000	1	9					9	12
2.5.11.6.2	DAQ system		10,000	1	10					10	13