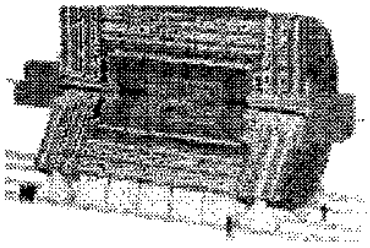


US CMS
the
Compact
Muon
Solenoid

Dan Green
Detector
Contingency
January 16, 1997

The Status of the US CMS Design

Dan Green

US CMS Spokesperson

The Status of the US CMS Design

- **We first examine the quality of the cost estimate (WBS). The level of contingency clearly depends on the maturity of the design of the experiment.**

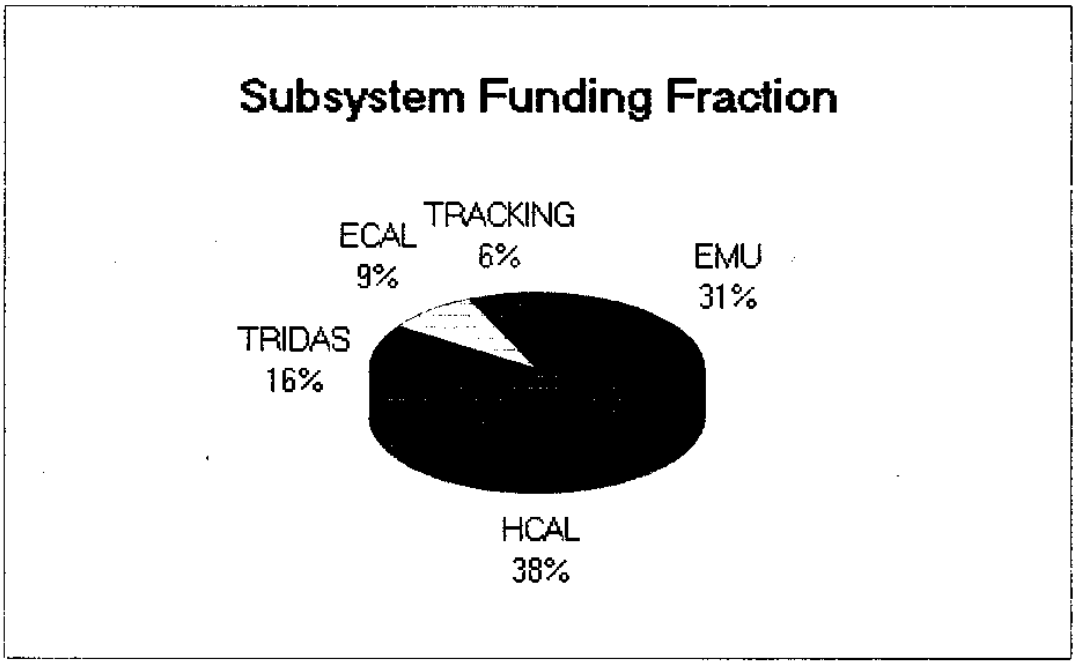
- **We concentrate on the HCAL and EMU subsystems as they constitute the bulk of the cost of US CMS. These subsystems have mature WBS which go to level 7.**

- **Within a subsystem we concentrate on M&S and EDIA. For US CMS we have chosen to take responsibility for design, tooling and procurement rather than assembly. This strategy aids in minimizing contingency risk.**

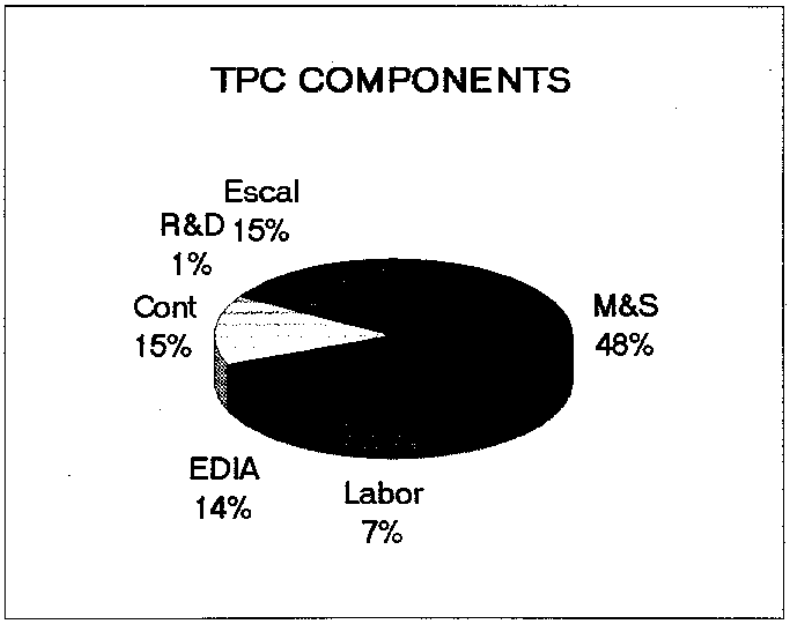
- **Another element of risk has to do with schedule. We are fully integrated into CMS planning. In preparation for the June review of US CMS we have first defined L1 (US CMS) milestones. Then L2 milestones (US CMS subsystems) have been formulated. We are now at the point of integrating costs (WBS) and schedules (L2).**

- **At the present time our overall contingency is estimated to be 27% of the base cost. Within our adopted methodology, this level is entirely appropriate.**

US CMS is 69% HCAL+EMU



- **M&S is the majority of US CMS WBS base cost estimate. The next largest is EDIA. Labor is the smallest component. Base cost = M&S+Labor+EDIA. TEC is Base+Contingency.**



(L7 HCAL WBS)

CMS HCAL Cost Estimate version 8f

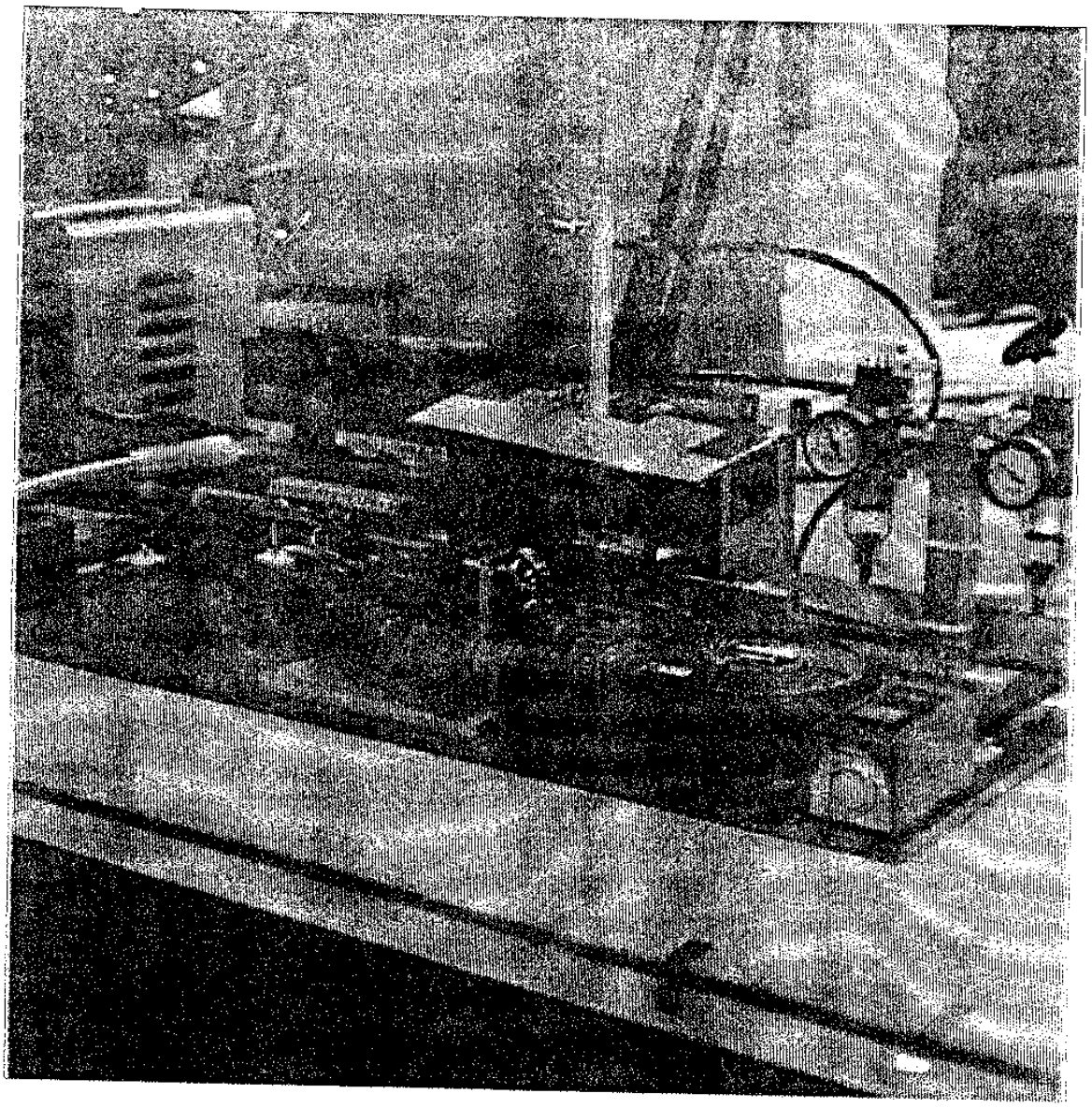
[USE COF FOR OPTICS]

26 Nov 96

WBS Number	Description	CMS Const. Respons.	US Mfg M&S (K$)	US Mfg Labor (K$)	US EDIA (K$)	US Base Cost (K$)	US Cont (K$)	Total US Cost (K$)	CMS Cost Estimate US Cost (K$)	CMS Cost Estimate US Cost (KCHF)
	Source tube funnel		*1*			1	0	*1*	*1*	*1*
	Source tube install			*49*		49	12	*61*		
	Pan capture fixture		*0*			0	0	*1*	*0*	*1*
	Installation disposables		*10*			10	2	*12*	*10*	*13*
2.1.1.2.2	***Optical Cables***		***24***		***150***	***174***	***42***	***215***	***24***	***31***
	Optical cables EDIA				*150*	150	36	*186*		
	Optical connectors (dbl end cables)		*24*			24	6	*29*	*24*	*31*
	Acrylic multi-fiber cable (17 fibers @.5/m)									
	Assembly (cement and polish)									
	Test									
2.1.1.2.3	***Pig Tails***		***203***	***335***	***200***	***738***	***177***	***915***	***203***	***264***
	Pig tails design				*200*	200	48	*248*		
	*WLS fiber(17*1.2m)*1.3*		*63*			63	15	*78*	*63*	*82*
	*Clear fiber (17*2.4m)*1.3*		*116*			116	28	*144*	*116*	*151*
	WLS fibers, cut & polish (20/hr +20%			*83*		83	20	*103*		
	WLS fibers, silver & coat (400/day)			*4*		4	1	*4*		
	Clear fiber, cut & polish (20/hr + 20%			*50*		50	12	*62*		
	Splice (20/hr + 20%)			*50*		50	12	*62*		
	Spliced fibers test (10/hr, +20% ove			*50*		50	12	*62*		
	Insert fibers			*49*		49	12	*61*		
	Connector		*24*			24	6	*29*	*24*	*31*
	Fill & cement connector			*25*		25	6	*30*		
	Cut & polish connector			*25*		25	6	*30*		
2.1.1.2.4	***Installation***		***10***	***75***	***150***	***235***	***56***	***291***	***10***	***13***
	Installation EDIA				*150*	150	36	*186*		
	Install pans			*6*		6	1	*7*		
	Connect & route cables			*15*		15	4	*18*		
	Fiber hold-downs		*0*			0	0	*0*	*0*	*0*
	Connect & route source tubes (permt)			*20*		20	5	*25*		
	Install & connect flasher			*4*		4	1	*5*		

"LAB 5" OPTICS FACTORY

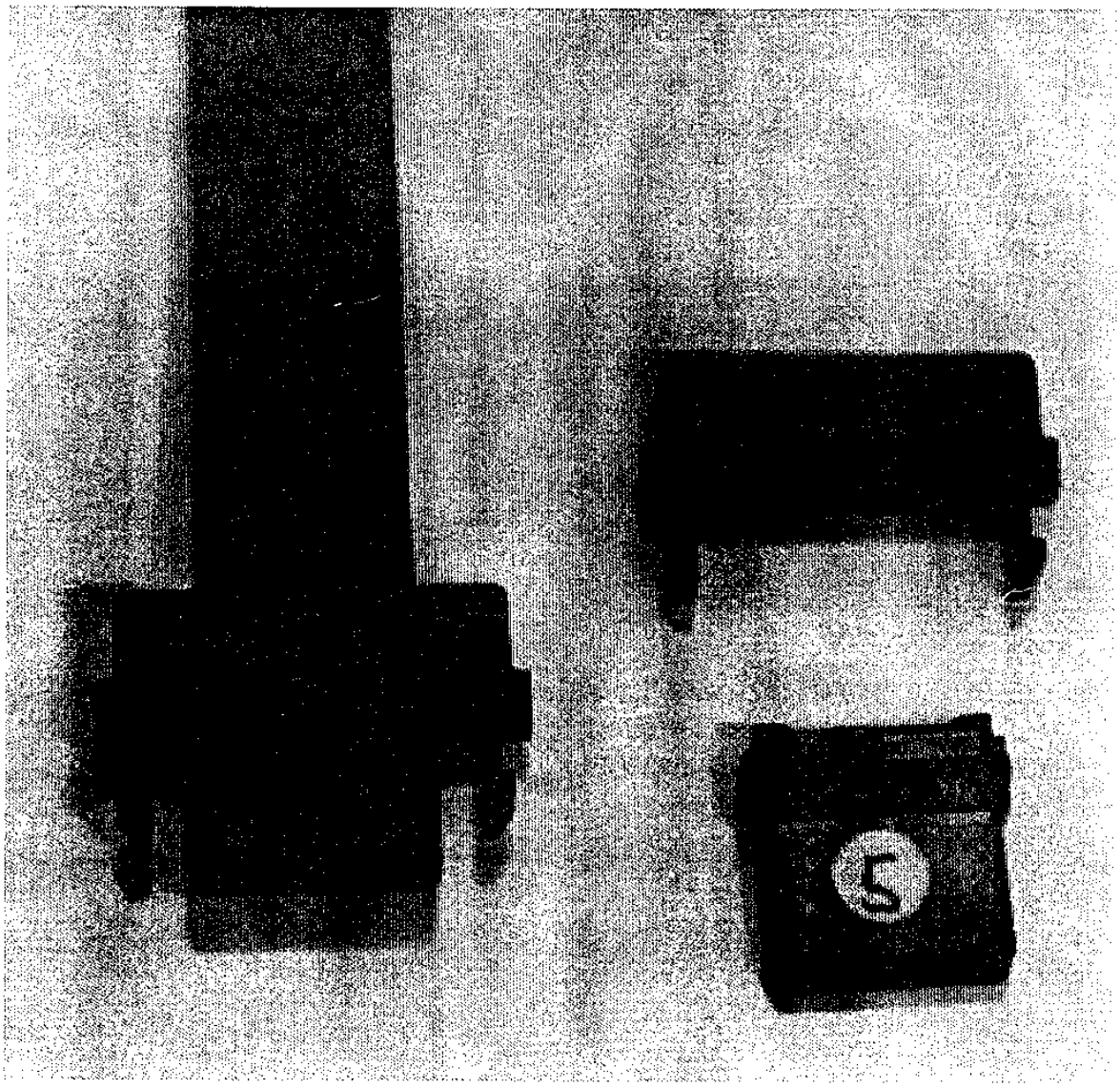
EXISTS — E.G. SPLICER



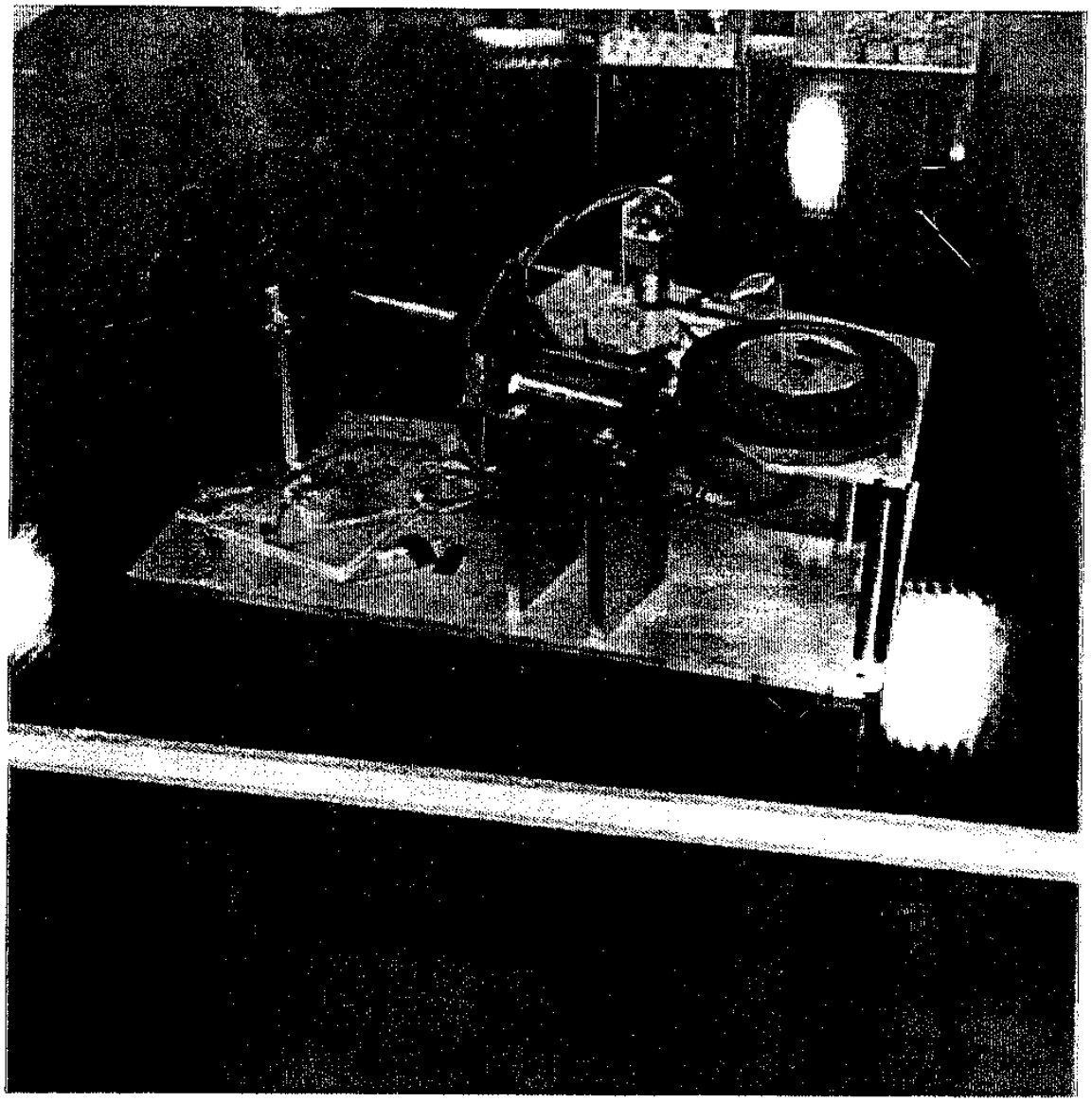
OPTICAL CABLES DEVELOPED

IN COF → DØ

→ CMS



"SOURCE TUBE" FACTORY QC
AND CALIBRATION EXISTS



RFQ FOR ABSORBER PPP

Fermi National Accelerator Laboratory
P.O. Box 500
Batavia, IL 60510

REQUEST FOR BUDGETARY QUOTE

TELEPHONE: 630/840-352
FAX: 630/840-245

«company»
«street»
«city», «state» «zip»

«attention»

Date: 01/13/97
Quotation #: 000-NES
Quotations Close: 02/11/97
(See Late bid Criteria)
Page 1 of 4 Pages

ITEM	QTY.	DESCRIPTION	PRICE	DEL. DATE
		BUDGETARY QUOTE		
		This is a Request for a Budgetary Quote for the following. Please refer to the attached document title "Request for Prices" for details:		
		Furnish all labor, materials, services, equipment and facilities necessary to fabricate and deliver.		
1	17	Absorber Plates; dwg., #3.		
2	16	Absorber Plates; dwg., #4.		
3	1	Inner Stainless Steel Plate; dwg., #5.		
4	1	Outer Stainless Steel Plate; dwg., #6.		
5	1	Machining the Final Assembled Wedge; dwg., #7 & #8.		
		Material - If you are capable of performing all machining required; please include in your quote the machining cost for all the materials listed. If you are a supplier or a manufacturer of materials please quote supplying material only using the list of materials below (you may add material that will meet our		

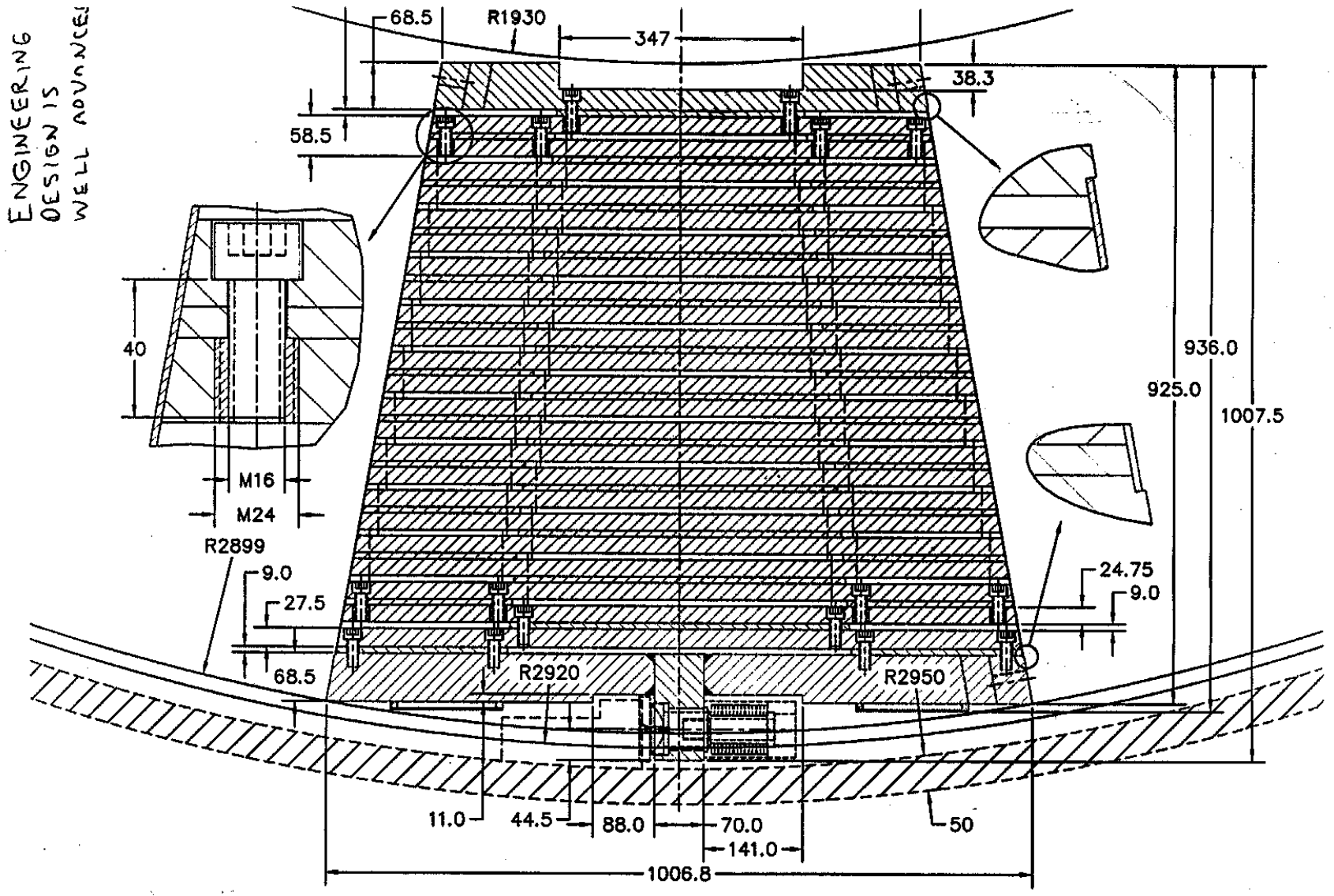
Exceptions to specifications and extra charges for containers, tooling, etc. must be clearly indicated.

COMPANY NAME_____
ADDRESS_____
TERMS_____FOB_____
SUBMITTED BY:_____
DATE SUBMITTED:_____

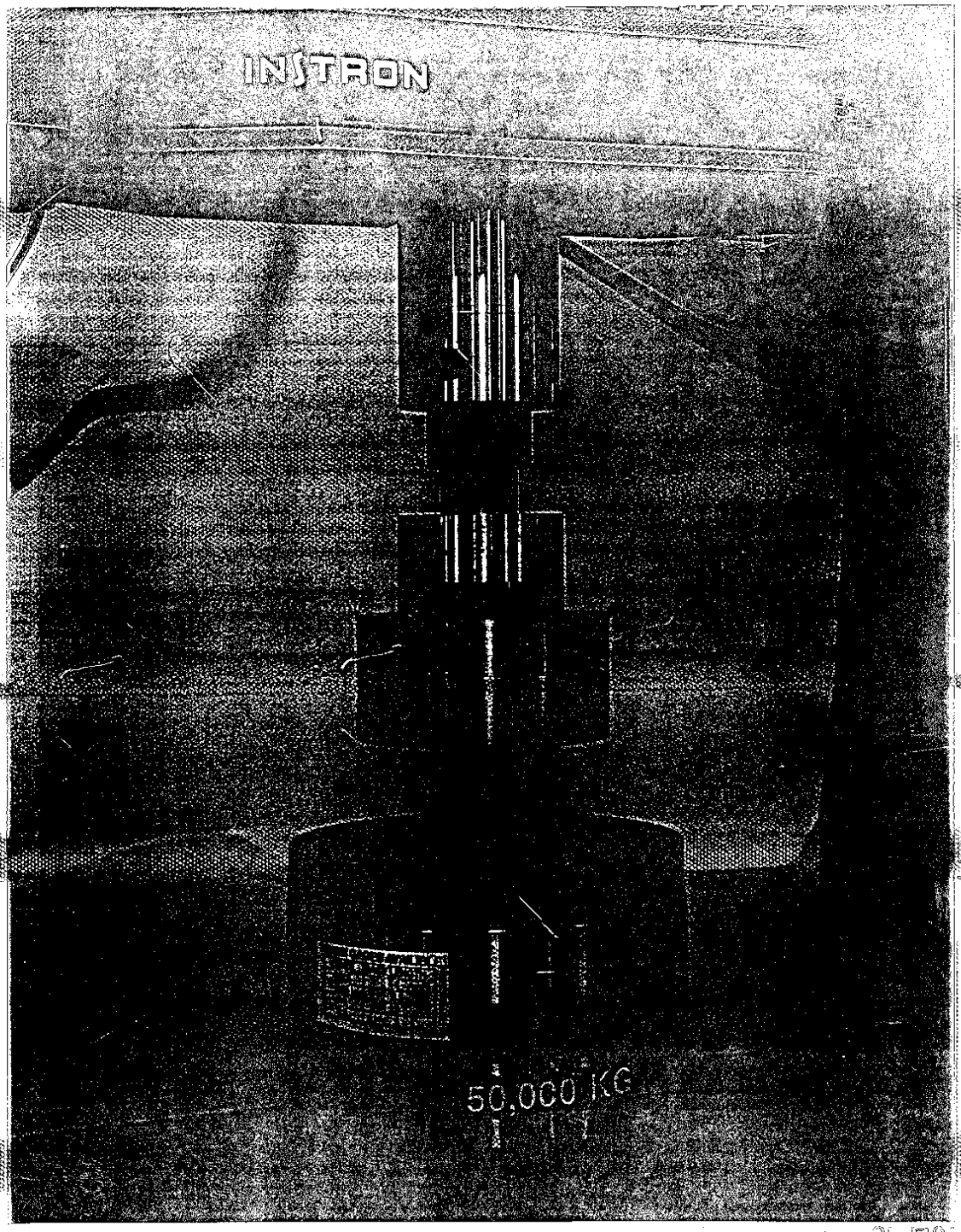
MATERIALS, SUPPLIES OR SERVICES RESULTING FROM THIS QUOTE ARE FOR WORK DONE UNDER PRIME CONTRACT NO. DE AC02 76CH03000 WITH THE UNITED STATES DEPARTMENT OF ENERGY. ANY ITEMS COVERED BY G.S.A. CONTRACTS SHOULD BE SO INDICATED.

Nelson E. Sample, Fabrication Specialist

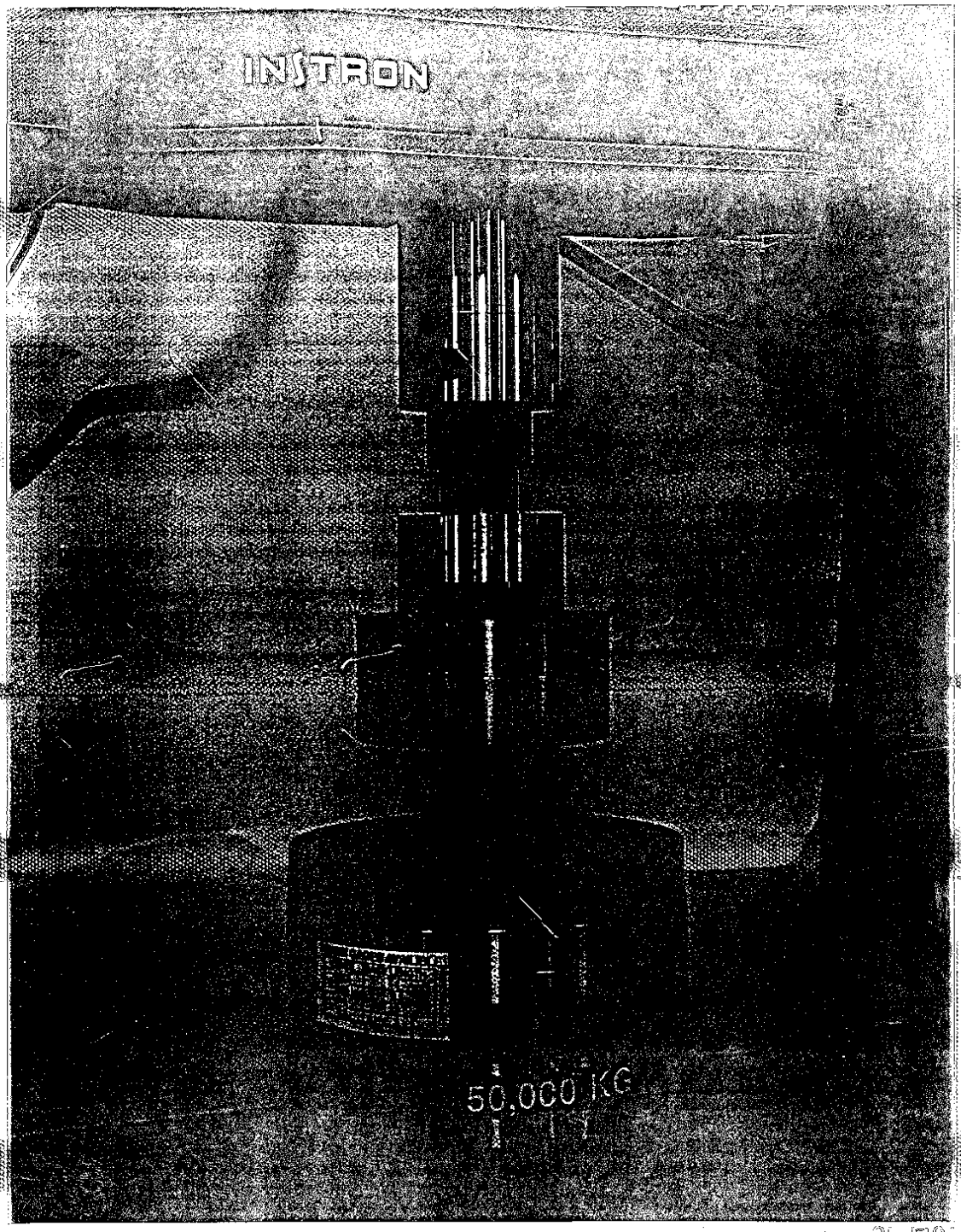
ENGINEERING
DESIGN IS
WELL ADVANCED



MATERIALS TESTS ARE COMPLETE

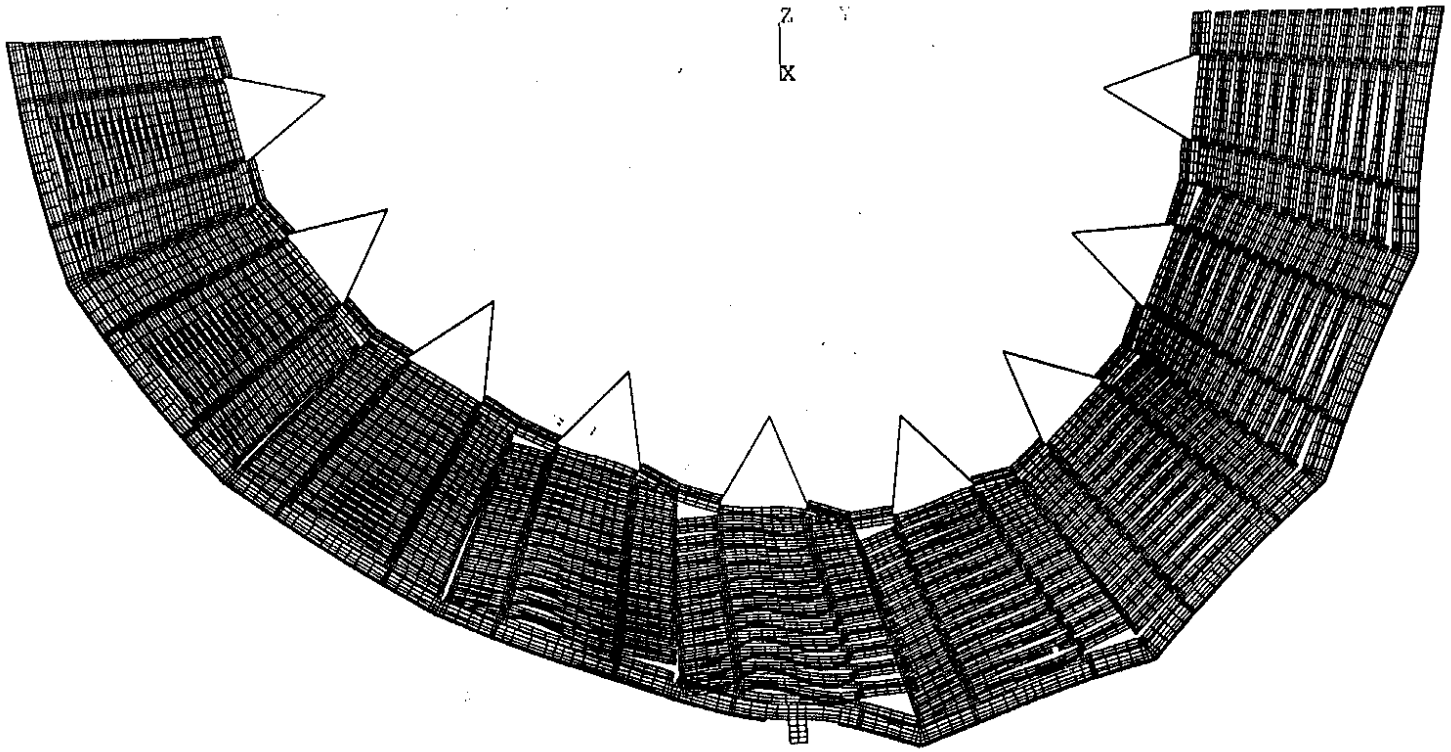


MATERIALS TESTS ARE COMPLETE



1

COMPLETE FEA IS IN HAND



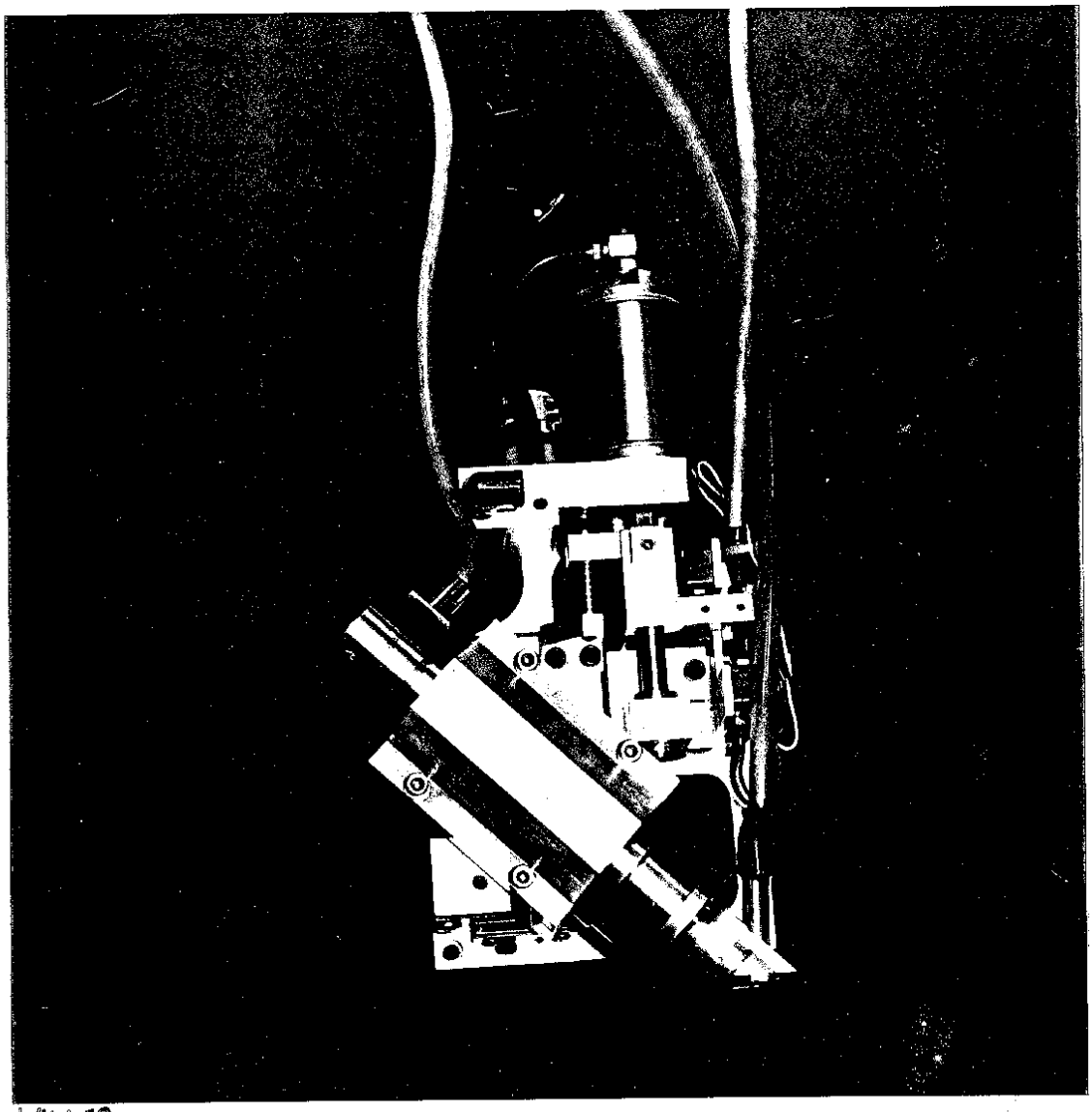
HCAL, deformed shape.

(11/14/96)

EMU WBS EXISTS DOWN TO L7

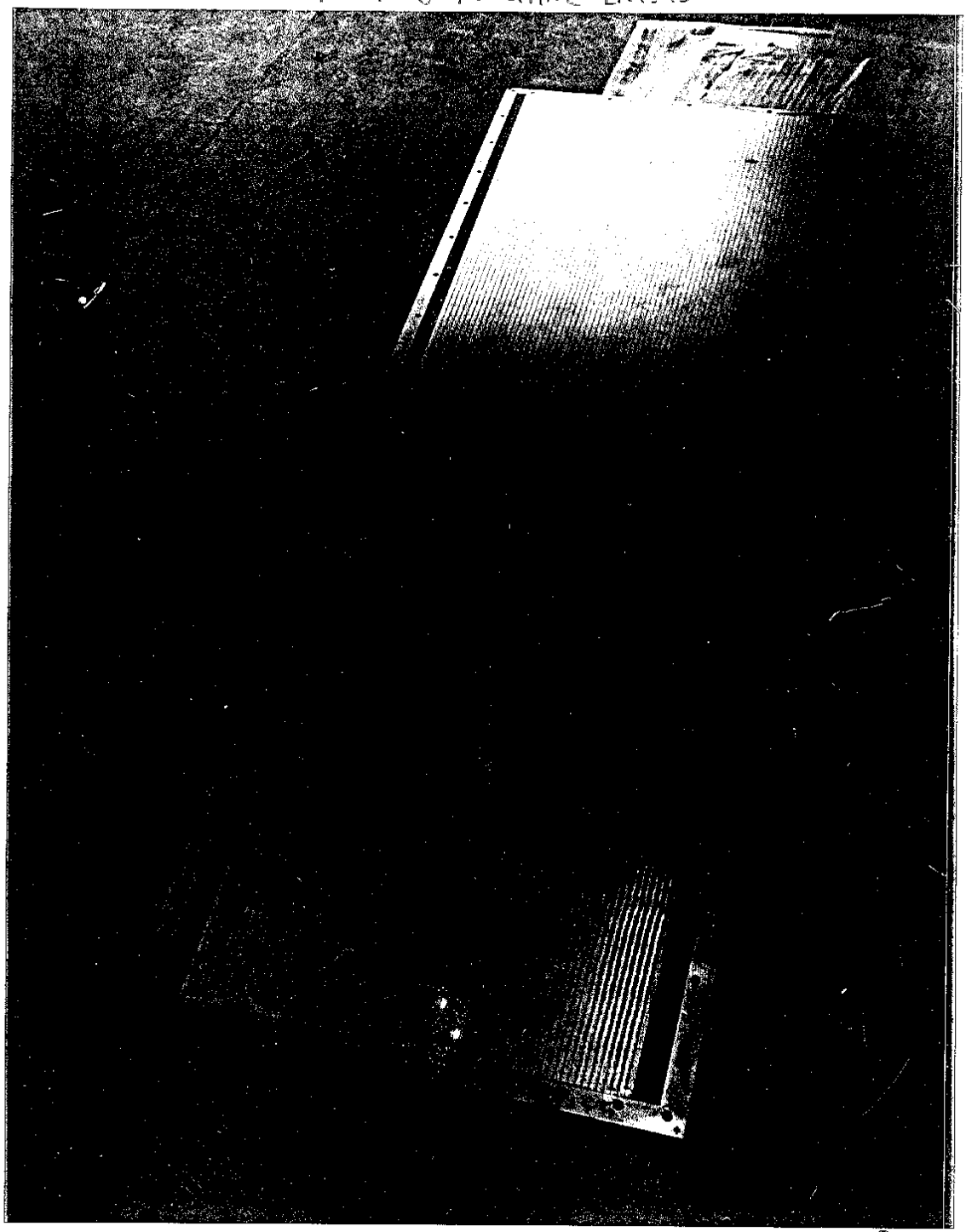
WBS Number	WBS or Activity Description	Unit	Qty	Unit Cost ($) (m&s only)	M & S (K$)	Mfg Labor (K$)	EDIA (K$)	EDIA (%)	Base Cost (K$)	Cont (K$)	Cont (%)	Descope	Total Cost (K$)	CERN CMS Estimate US Cost (K$)	US Cost (KCHF)	US Manpower
1	Endcap Muon System															
1.1	Muon Measurement System				19,593	6,411	3,572	12%	29,696	7,399	25%		36,297	19593	25,471	191
1.1.1	CSC Chambers				8956	4794	1155	8%	14905	3129	21%		18034	8956	11643	101
1.1.1.1	R&D, tests, preproduction				743	357	310	22%	1410	79	6%		1489	743	966	10
1.1.1.1.1	Large chamber prototyping				168	108	55	17%	331				331	168	218	
1.1.1.1.1.1	Cosmic ray setup				88	9		0%	97				97	88	114	
1.1.1.1.1.2	P1 tests				5	60		0%	65				65	5	7	
1.1.1.1.1.3	P2 design and construction				75	39	55	33%	169				169	75	98	
1.1.1.1.2	Factory R & D				233	61	255	46%	549				549	233	303	
1.1.1.1.2.1	Site proposals						60	100%	60				60	0	0	
1.1.1.1.2.2	Tool prototyping				233	61	195	40%	489				489	233	303	
1.1.1.1.3	Performance studies				42	13		0%	55				55	42	55	
1.1.1.1.4	Tests				200	50		0%	250				250	200	260	
1.1.1.1.5	Preproduction				100	125		0%	225	79	35%		304	100	130	
1.1.1.2	MF1/2		74	7,412	549	106	75	10%	730	119	16%		849	549	713	3
1.1.1.2.1	Design and documentation						75	100%	75	12	16%		87	0	0	
1.1.1.2.2	Materials				512	0	0	0%	512	61	12%		573	512	666	
1.1.1.2.2.1	Panels				188			0%	188	26	14%		214	188	244	
1.1.1.2.2.2	Anode wire				30			0%	30	2	7%		33	30	40	
1.1.1.2.2.3	Gap frames				40			0%	40	4	10%		44	40	51	
1.1.1.2.2.4	Anode wire fixation bars				62			0%	62	9	14%		70	62	80	
1.1.1.2.2.5	Guard strips				8			0%	8	1	11%		9	8	11	
1.1.1.2.2.6	Standard electrical components				51			0%	51	3	5%		54	51	67	
1.1.1.2.2.7	Non-standard electrical components				11			0%	11	2	16%		12	11	14	
1.1.1.2.2.8	Mechanical components				26			0%	26	2	8%		29	26	34	
1.1.1.2.2.9	External frame				74			0%	74	12	16%		86	74	96	
1.1.1.2.2.10	Misc. (epoxy,RTV,solder,tape)				22			0%	22	1	5%		23	22	29	
1.1.1.2.3	Manufacturing				0	106		0%	106	34	32%		141	0	0	
1.1.1.2.3.1	Fabricating cathode panels					106		0%	106	34	32%		141	0	0	
1.1.1.2.3.2	Chamber assembly in China							0%	0				0	0	0	
1.1.1.2.4	Shipping between sites				36.3			0%	36	11.6	32%		48	36	47	
1.1.1.3	MF1/3		74	8,082	598	103	75	10%	776	123	16%		899	598	778	3
1.1.1.3.1	Design and documentation						75	100%	75	12	16%		87	0	0	
1.1.1.3.2	Materials				562			0%	562	67	12%		629	562	730	
1.1.1.3.2.1	Panels				188			0%	188	26	14%		214	188	244	
1.1.1.3.2.2	Anode wire				41			0%	41	3	7%		44	41	53	
1.1.1.3.2.3	Gap frames				40			0%	40	4	10%		44	40	51	
1.1.1.3.2.4	Anode wire fixation bars				92			0%	92	13	14%		105	92	120	
1.1.1.3.2.5	Guard strips				11			0%	11	1	11%		12	11	15	
1.1.1.3.2.6	Standard electrical components				50			0%	50	3	5%		53	50	65	
1.1.1.3.2.7	Non-standard electrical components				11			0%	11	2	16%		12	11	14	
1.1.1.3.2.8	Mechanical components				31			0%	31	2	8%		33	31	40	
1.1.1.3.2.9	External frame				74			0%	74	12	16%		86	74	96	
1.1.1.3.2.10	Misc. (epoxy,RTV,solder,tape)				25			0%	25	1.3	5%		26	25	33	

STRIP ROUTING (45°) HAS
BEEN REFINED

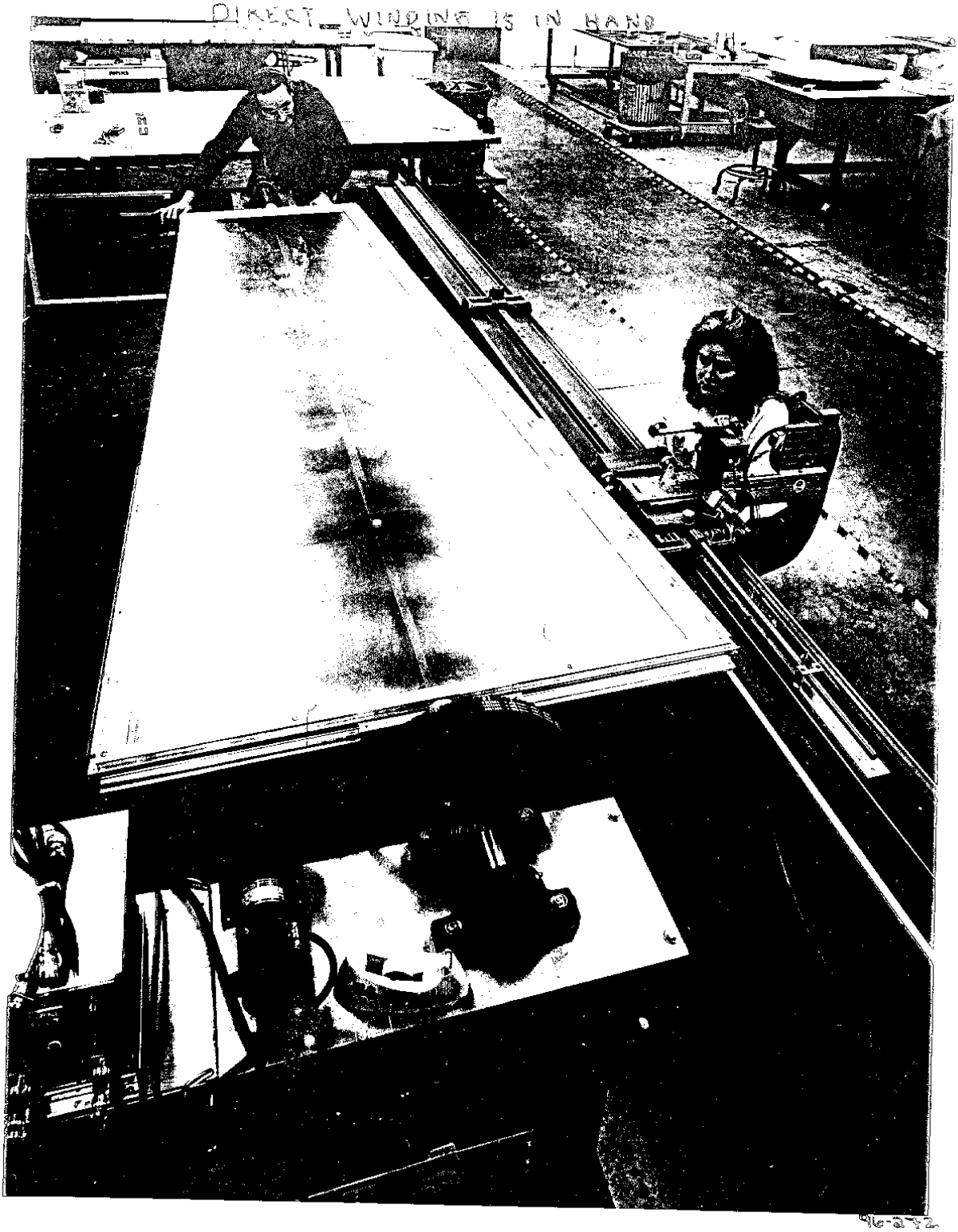


J-PIJ-EP

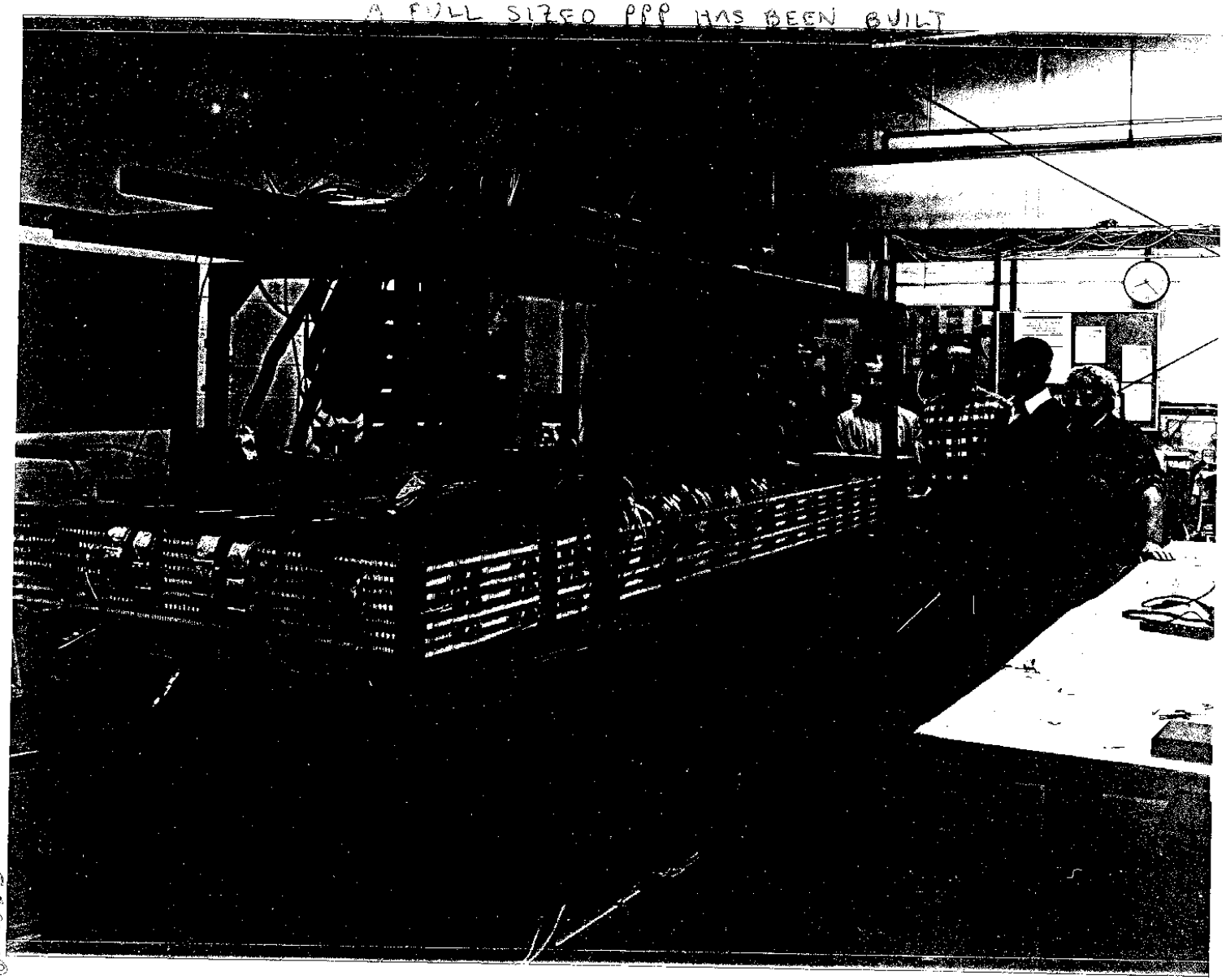
ROUTING MACHINE EXISTS



96-76

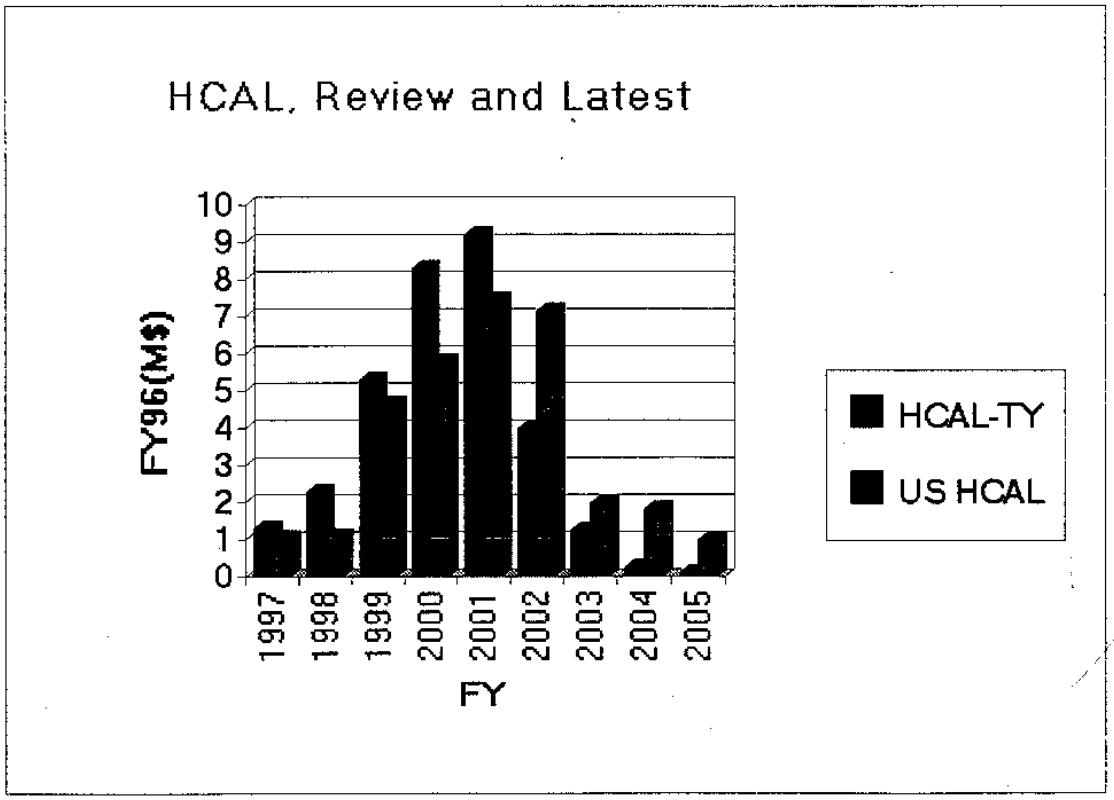

DIRECT WINDING IS IN HAND
96-272

A FULL SIZED PPP HAS BEEN BUILT



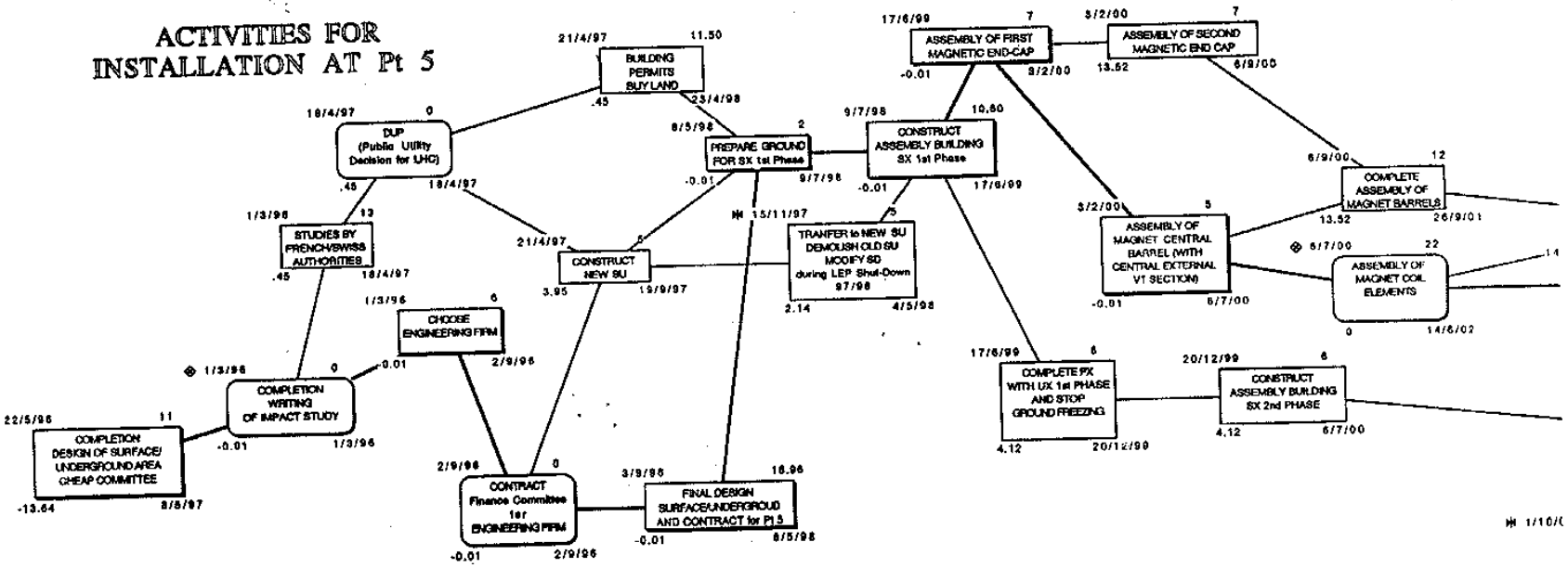
Cost Profile for US CMS HCAL

- **Use CMS planning to extract US CMS L1 milestones**
- **Use L1 milestones to derive L2 milestones for US CMS subsystems**
- **Define Resource Sheet using WBS items for subsystem**
- **Attach Resource Sheet to L2 milestones (schedule) to get resource loaded cost/schedule. First cut done for HCAL.**



INTEGRATE US CMS TO CENTRAL CMS PLANNING

ACTIVITIES FOR INSTALLATION AT Pt 5



GENERAL PLANNING for CMS
VERSION-22 of 22/05/96

SUBJECT TO APPROVAL BY THE CMS COLLABORATION.

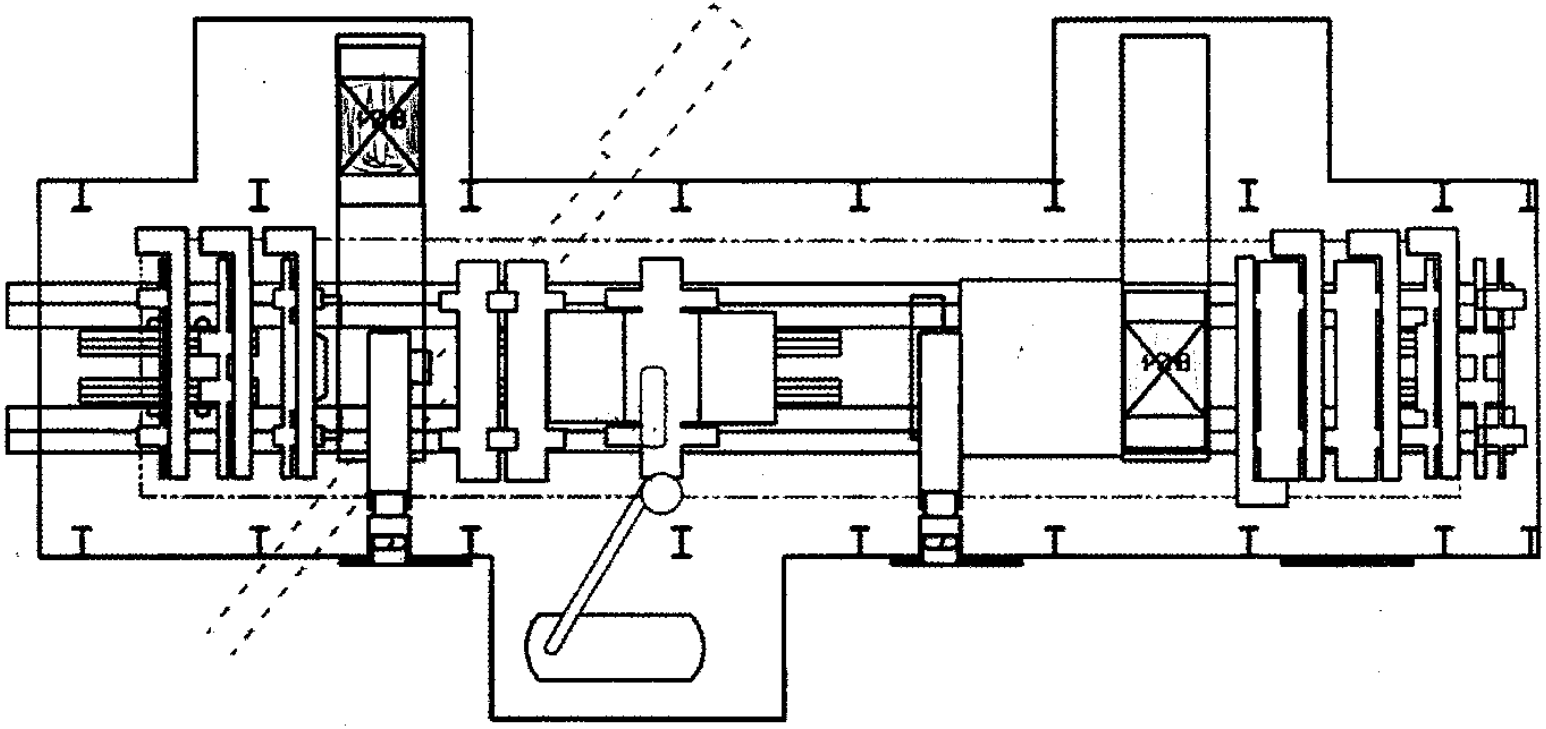
LATEST START DURATION IN MONTHS

SLACK IN MONTHS LATEST FINISH

Redactor: A. Hervé Tel: 6557 Beep: 19x5028
GSM: + 41.89.201.02 x 5
Alain_Herve@macmail.cern.ch

SCHEDULE AH SPACE FOR CMS

DISMANTLE WINDING MACHINE
ASSEMBLY 1/2HB-
PLACE YB 0 FOR CONNECTING CRYO LINES
ASSEMBLY MUON CHAMBERS ON YB-1,-2 & YE-1



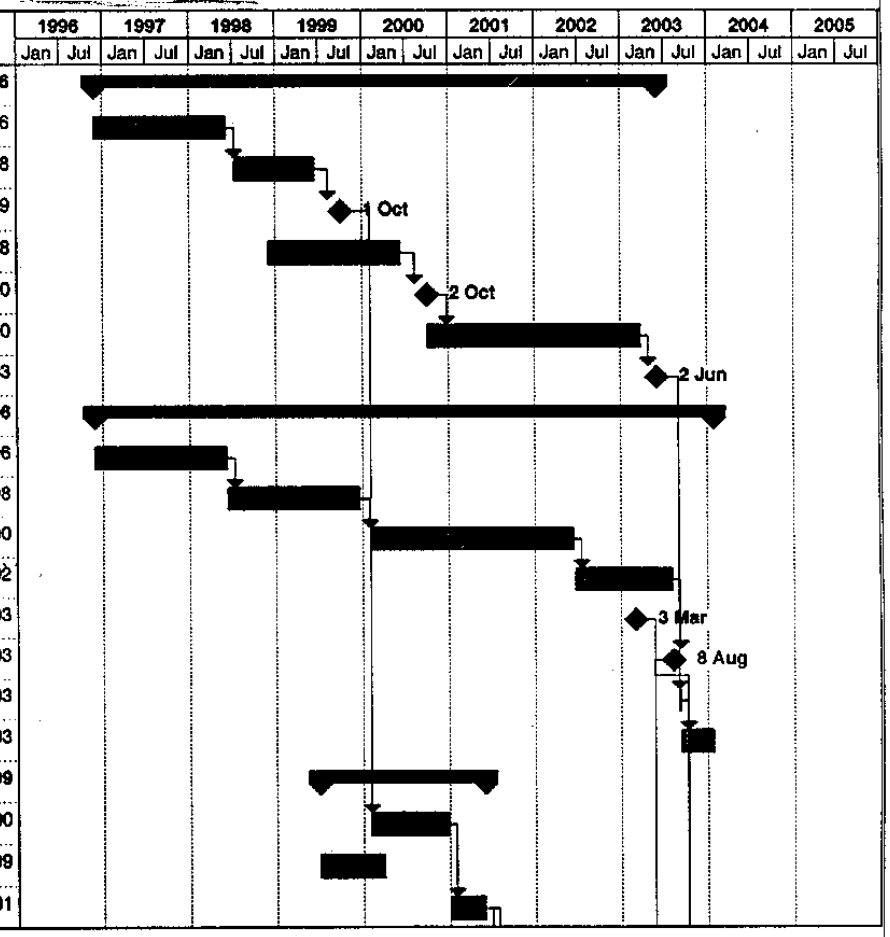
VEILLET L 03-02-96

Phase 27 :Du 09/01/03 au 26/02/03

PH27

US CMS Level 1 Milestones

ID	Task Name	Duration	Start
1	**Experimental Halls**	**1698d**	**27 Nov '96**
2	D=Design,AH=Assembly Hall	400d	27 Nov '96
3	F=Fabricate AH	246d	9 Jul '98
4	BO=Beneficial Occup AH	0d	1 Oct '99
5	D CH=Collision Hall	400d	1 Dec '98
6	LEP stop, Begin F of CH	0d	2 Oct '00
7	F CH	650d	2 Oct '00
8	BO CH	0d	2 Jun '03
9	**Magnet**	**1869d**	**27 Nov '96**
10	R&D magnet	400d	27 Nov '96
11	F magnet	400d	10 Jun '98
12	Assemble coil, tank in AH	617d	3 Feb '00
13	Cool magnet and close	300d	17 Jun '02
14	HB in Vac Tank-test	0d	3 Mar '03
15	Mag power test in AH	0d	8 Aug '03
16	I=Install magnet in CH	6d	1 Sep '03
17	C=Commission magnet in CH	100d	9 Sep '03
18	**Yoke-Barrel(B), Endcap(E)**	**502d**	**1 Jul '99**
19	Assemble YB yoke	237d	3 Feb '00
20	Assemble YE- yoke	197d	1 Jul '99
21	Assemble YE+ yoke	110d	1 Jan '01

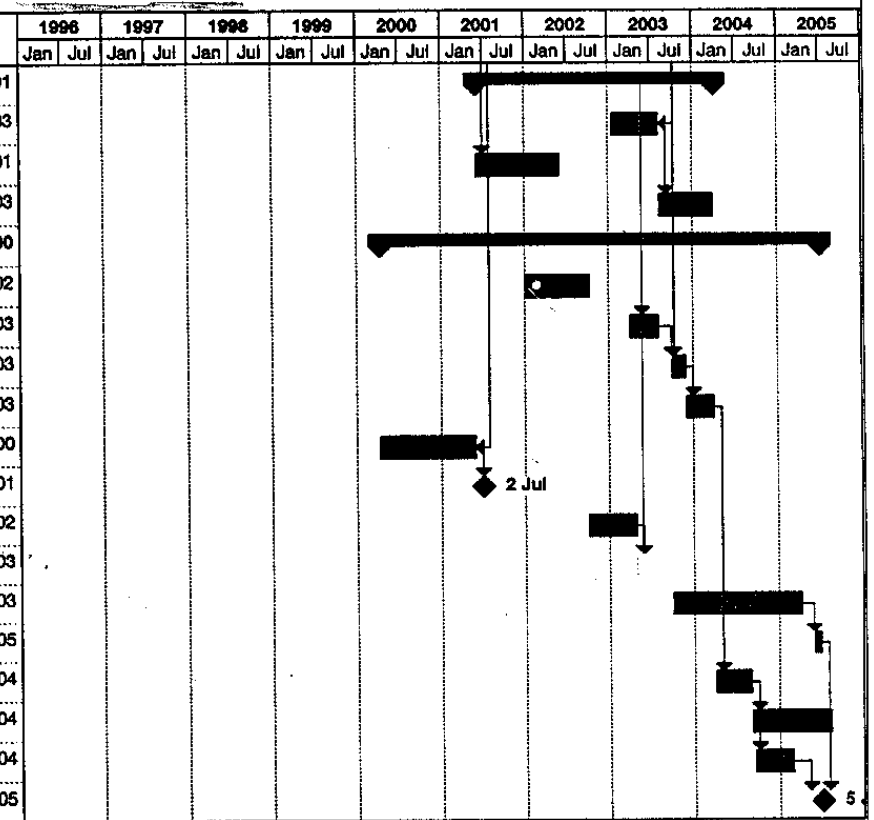


Project: US CMS L1 Milestones
Date: 16 Dec '96

Task
Progress
Milestone
Summary
Rolled Up Task
Rolled Up Milestone
Rolled Up Progress

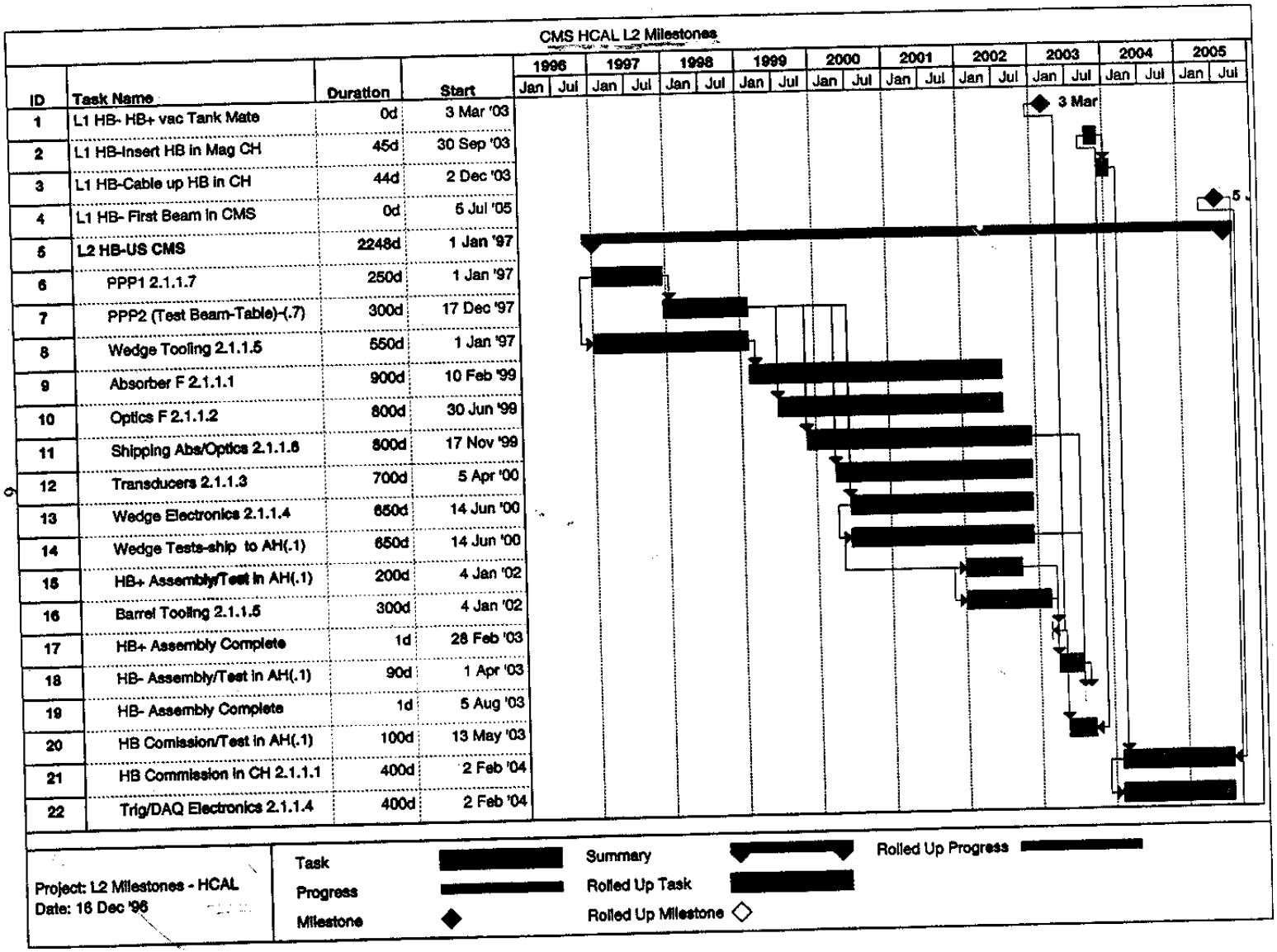
US CMS Level 1 Milestones

ID	Task Name	Duration	Start
22	Muon	738d	4 Jun '01
23	Assemble CSC YE- in AH	150d	13 Jan '03
24	Assemble CSC YE+ in AH	261d	4 Jun '01
25	I ME in CH	168d	11 Aug '03
26	HCAL	1367d	10 Apr '00
27	Assemble HB+ in AH	200d	4 Jan '02
28	Assemble HB- in AH	90d	1 Apr '03
29	Insert HB into Magnet in CH	44d	1 Oct '03
30	Commission HB	87d	2 Dec '03
31	Assemble HE+	300d	10 Apr '00
32	HE+YE+ connect	0d	2 Jul '01
33	Assemble HE-	150d	1 Oct '02
34	HE-YE- connect	1d	29 Apr '03
35	Assemble HF in AH	400d	1 Oct '03
36	Install HF and shielding	23d	3 Jun '05
37	ECAL - install EB	111d	1 Apr '04
38	ECAL - install EE	250d	3 Sep '04
39	Tracker - install	120d	17 Sep '04
40	First CMS Data	0d	5 Jul '05



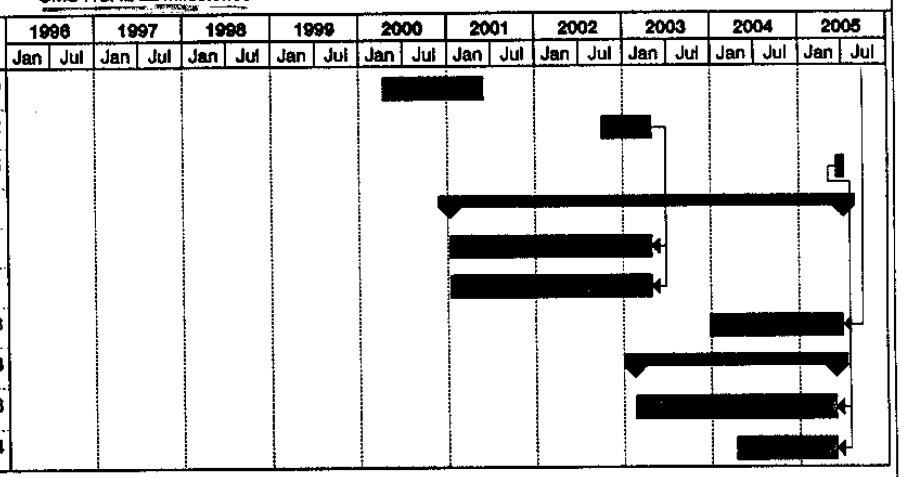
Project: US CMS L1 Milestones
Date: 16 Dec '96

Task
Progress
Milestone
Summary
Rolled Up Task
Rolled Up Milestone
Rolled Up Progress


CMS HCAL L2 Milestones
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
Jan Jul Jan Jul Jan Jul Jan Jul Jan Jul Jan Jul Jan Jul Jan Jul Jan Jul Jan Jul
3 Mar
5
ID
Task Name
Duration
Start
1 L1 HB- HB+ vac Tank Mate 0d 3 Mar '03
2 L1 HB-Insert HB in Mag CH 45d 30 Sep '03
3 L1 HB-Cable up HB in CH 44d 2 Dec '03
4 L1 HB- First Beam in CMS 0d 5 Jul '05
5 L2 HB-US CMS 2248d 1 Jan '97
6 PPP1 2.1.1.7 250d 1 Jan '97
7 PPP2 (Test Beam-Table)-(.7) 300d 17 Dec '97
8 Wedge Tooling 2.1.1.5 550d 1 Jan '97
9 Absorber F 2.1.1.1 900d 10 Feb '99
10 Optics F 2.1.1.2 800d 30 Jun '99
11 Shipping Abs/Optics 2.1.1.6 800d 17 Nov '99
12 Transducers 2.1.1.3 700d 5 Apr '00
13 Wedge Electronics 2.1.1.4 650d 14 Jun '00
14 Wedge Tests-ship to AH(.1) 650d 14 Jun '00
15 HB+ Assembly/Test in AH(.1) 200d 4 Jan '02
16 Barrel Tooling 2.1.1.5 300d 4 Jan '02
17 HB+ Assembly Complete 1d 28 Feb '03
18 HB- Assembly/Test in AH(.1) 90d 1 Apr '03
19 HB- Assembly Complete 1d 5 Aug '03
20 HB Comission/Test in AH(.1) 100d 13 May '03
21 HB Commission in CH 2.1.1.1 400d 2 Feb '04
22 Trig/DAQ Electronics 2.1.1.4 400d 2 Feb '04
Project: L2 Milestones - HCAL
Date: 16 Dec '96
Task
Progress
Milestone
Summary
Rolled Up Task
Rolled Up Milestone
Rolled Up Progress

CMS HCAL L2 Milestones

ID	Task Name	Duration	Start
23	L1 Assemble HE+	300d	10 Apr '00
24	L1 Assemble HE-	150d	1 Oct '02
25	L1 HF in CH	23d	3 Jun '05
26	**L2 HE US CMS**	**1170d**	**9 Jan '01**
27	HE Transducer 2.2.1.3	600d	9 Jan '01
28	HE Front Ends 2.2.1.4	600d	9 Jan '01
29	HE Trig/DAQ Elect 2.2.1.4	400d	23 Dec '03
30	**L2 HF US CMS**	**600d**	**14 Feb '03**
31	Assemble HF+, HF- in AH	600d	14 Feb '03
32	Electronics HF	300d	9 Apr '04



Project: L2 Milestones - HCAL
Date: 16 Dec '96

Task
Progress
Milestone
Summary
Rolled Up Task
Rolled Up Milestone
Rolled Up Progress

FIRST CUT AT COST/SCHEDULE

L2 Milestones - HCAL

ID	Resource Name	Initials	Group	Max. Units	Std. Rate	Ovt. Rate	Cost/Use	Accrue At
1	.1.1 wedges		mech	100	$0.00/h	$0.00/h	$13,233.00	Prorated
2	.1.2 assembly-B		mech	100	$0.00/h	$0.00/h	$2,065.00	Prorated
3	.2.1 pizza		optics	100	$0.00/h	$0.00/h	$2,954.00	Prorated
4	.2.2 cable		optics	100	$0.00/h	$0.00/h	$441.00	Prorated
5	.2.3 install(wedge)		optics	100	$0.00/h	$0.00/h	$247.00	Prorated
6	.3.1 HPD		transducer	100	$0.00/h	$0.00/h	$1,109.00	Prorated
7	.3.2 cables		transducer	100	$0.00/h	$0.00/h	$209.00	Prorated
8	.3.3 calib		transducer	100	$0.00/h	$0.00/h	$943.00	Prorated
9	.3.4 temp		transducer	100	$0.00/h	$0.00/h	$155.00	Prorated
10	.3.5 decoder		transducer	100	$0.00/h	$0.00/h	$1,056.00	Prorated
11	.4.1 QIE front end		electronics	100	$0.00/h	$0.00/h	$1,000.00	Prorated
12	.4.2 Tridas elec		electronics	100	$0.00/h	$0.00/h	$1,075.00	Prorated
13	.5.1 scint tool		tooling	100	$0.00/h	$0.00/h	$931.00	Prorated
14	.5.2 wls tool		tooling	100	$0.00/h	$0.00/h	$1,017.00	Prorated
15	.5.3 HPD test		tooling	100	$0.00/h	$0.00/h	$95.00	Prorated
16	.5.4 wedge test		tooling	100	$0.00/h	$0.00/h	$206.00	Prorated
17	.5.5 wedge tool		tooling	100	$0.00/h	$0.00/h	$79.00	Prorated
18	.5.6 barrel tool		tooling	100	$0.00/h	$0.00/h	$1,269.00	Prorated
19	.6 shipping		ship	100	$0.00/h	$0.00/h	$504.00	Prorated
20	.7 install(Wedge-Barr)2		install	100	$0.00/h	$0.00/h	$325.00	Prorated
21	.8 PPP(2)		PPP	100	$0.00/h	$0.00/h	$1,365.00	Prorated

- WBS : RESOURCE SHEET
- FIXED COST

FIRST CUT AT COST/SCHEDULE

L2 Milestones - HCAL

ID	Resource Name	Cost	1997		1998		1999		2000		2001		2002		2003		2004		2005	
			Jan	Jul	Jan	Jul	Jan	Jul	Jan	Jul	Jan	Jul	Jan	Jul	Jan	Jul	Jan	Jul	Jan	Jul
1	.1.1 wedges	$13,233.00					808h	1056h	1040h	1040h	1040h	1048h	1032h	136h						
2	.1.2 assembly-B	$2,065.00									984h	1048h	368h							
3	.2.1 pizza	$2,954.00					8h	1056h	1040h	1040h	1040h	1048h	1032h	136h						
4	.2.2 cable	$441.00					8h	1056h	1040h	1040h	1040h	1048h	1032h	136h						
5	.2.3 install(wedge)	$247.00							104h	1040h	1040h	1048h	1032h	936h						
6	.3.1 HPD	$1,109.00							504h	1040h	1040h	1048h	1032h	936h						
7	.3.2 cables	$209.00							504h	1040h	1040h	1048h	1032h	936h						
8	.3.3 calib	$943.00							504h	1040h	1040h	1048h	1032h	936h						
9	.3.4 temp	$155.00							504h	1040h	1040h	1048h	1032h	936h						
10	.3.5 decoder	$1,056.00							504h	1040h	1040h	1048h	1032h	936h						
11	.4.1 QIE front end	$1,000.00							104h	1040h	1040h	1048h	1032h	936h						
12	.4.2 Tridas elec	$1,075.00														56h	1040h	1056h	1032h	16h
13	.5.1 scint tool	$931.00					8h	1056h	1040h	1040h	1040h	1048h	1032h	136h						
14	.5.2 wls tool	$1,017.00					8h	1056h	1040h	1040h	1040h	1048h	1032h	136h						
15	.5.3 HPD test	$95.00							504h	1040h	1040h	1048h	1032h	936h						
16	.5.4 wedge test	$206.00							104h	1040h	1040h	1048h	1032h	936h						
17	.5.5 wedge tool	$79.00	1032h	1056h	1032h	1056h	224h													
18	.5.6 barrel tool	$1,269.00									984h	1048h	368h							
19	.6 shipping	$504.00					808h	1056h	1040h	1040h	1040h	1048h	1032h	136h						
20	.7 install(Wedge-Barr)2	$650.00							104h	1040h	2024h	2096h	1400h	936h						
21	.8 PPP(2)	$2,730.00	1032h	1056h	1032h	1056h	224h													

- RESOURCE USAGE

FIRST CUT AT COST SCHEDULE

Yearly Cash Flow as of 05/12/96
L2 Milestones - HCAL
Dan Green - Fermilab

	1997	1998	1999	2000	2001	2002	2003	2004	2005
L1 HB- HB1-vac Tank Mate									
L1 HB-Insert HB in Mag CH									
L1 HB-Cable up HB in CH									
L1 HB- First Beam in CMS									
L2 HCAL									
PPP1 2.1.1.7	$1,365.00								
.8 PPP(2)	$1,365.00								
PPP2 (Test Beam-Table)-(.7)			$1,365.00						
.8 PPP(2)			$1,365.00						
Wedge Tooling 2.1.1.5			$79.00						
.5.5 wedge tool			$79.00						
Absorber F 2.1.1.1						$13,737.00			
.1.1 wedges						$13,233.00			
.6 shipping						$504.00			
Optics F 2.1.1.2						$5,343.00			
.2.1 pizza						$2,954.00			
.2.2 cable						$441.00			
.5.1 scint tool						$931.00			
.5.2 wls tool						$1,017.00			
Shipping Abs/Optics 2.1.1.6									
Transducers 2.1.1.3						$3,567.00			
.3.1 HPD						$1,109.00			
.3.2 cables						$209.00			
.3.3 calib						$943.00			
.3.4 temp						$155.00			
.3.5 decoder						$1,056.00			
.5.3 HPD test						$95.00			
Wedge Electronics 2.1.1.4						$1,000.00			
.4.1 QIE front end						$1,000.00			
Wedge Tests-ship to AH(.1)						$778.00			
.2.3 install(wedge)						$247.00			
.5.4 wedge test						$206.00			
.7 install(Wedge-Barr)2						$325.00			
HB1 Assembly/Test in AH(.1)						$325.00			
.7 install(Wedge-Barr)2						$325.00			
Barrel Tooling 2.1.1.5						$3,334.00			
.1.2 assembly-B						$2,065.00			
.5.6 barrel tool						$1,269.00			
HB1 Assembly Complete									
HB2 Assembly/Test in AH(.1)									
HB2 Assembly Complete									

US CMS Contingency Analysis

- **The US CMS Collaboration adopted the "SSC" methodology for its contingency analysis.**
- **The Fermilab Main Injector, at the conceptual design phase, assigned a 20% contingency. At present, the level of contingency assignment is only 10%. There is an existence proof.**
- **The US CMS contingency is globally at the 27% level. The ECAL and EMU subsystems are under a rigorous "bottoms up" review of their contingencies. Note that ~70% of the US CMS TEC resides in HCAL+EMU+TRIDAS.**

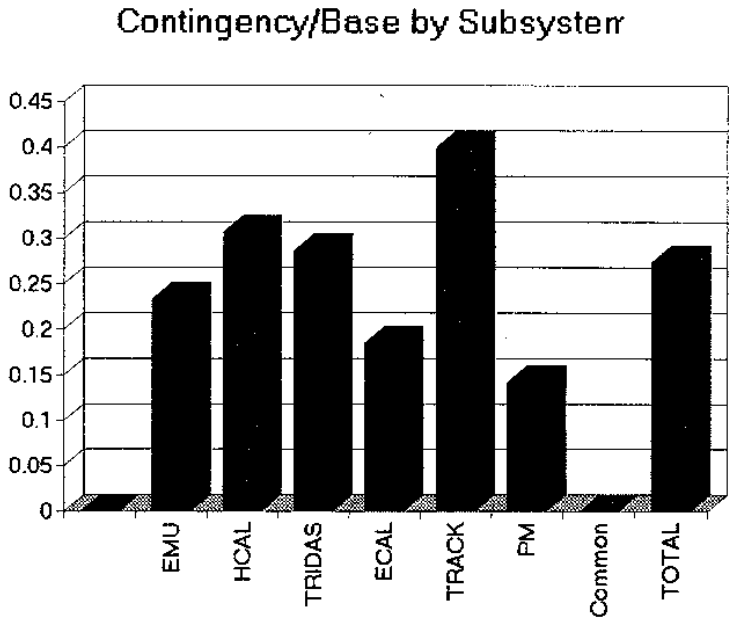


Table 15-2
The cost of the SDC detector in equivalent U.S. FY92 MS.

	MATL & LAB	EDIA	% EDIA	SUB TOTAL	CONT	% CONT	TOTAL
1 TRACKING SYSTEMS	55.5	14.1	20%	69.6	19.2	28%	88.8
1.1 SILICON TRACKING SYSTEM	27.8	4.7	15%	32.5	8.7	27%	41.2
1.2 BARREL TRACKER	20.9	5.0	19%	25.8	5.7	22%	31.5
1.3 INTERMEDIATE TRACKER	6.8	4.4	39%	11.3	4.8	43%	16.1
2 CALORIMETRY	95.5	30.3	24%	125.8	36.6	29%	162.4
2.1 BARREL CALORIMETER	55.2	15.5	22%	70.7	19.9	28%	90.6
2.2 ENDCAP CALORIMETER	32.6	13.0	29%	45.7	13.5	30%	59.2
2.3 FORWARD CALORIMETER	7.6	1.8	19%	9.4	3.2	34%	12.5
3 MUON SYSTEM	75.0	19.9	21%	94.9	20.9	22%	115.8
3.1 MAGNET SYSTEMS	41.3	9.0	18%	50.3	9.3	19%	59.6
3.2 MUON MEASUREMENT SYSTEM	33.7	10.9	24%	44.6	11.6	26%	56.2
4 SUPERCONDUCTING MAGNET	29.2	3.1	10%	32.3	10.1	31%	42.4
4.1 SUPERCONDUCTING SOLENOID	23.8	1.8	7%	25.6	8.3	33%	33.9
4.2 CRYOGENIC SYSTEM	5.4	1.3	19%	6.7	1.8	27%	8.5
5 ELECTRONICS SYSTEMS	47.1	30.2	39%	77.3	19.8	26%	97.0
5.1 FRONT-END ELECTRONICS	26.5	9.1	26%	35.7	8.2	23%	43.9
5.2 DATA ACQUISITION SYSTEM	10.4	6.1	37%	16.4	4.0	24%	20.4
5.3 TRIGGER SYSTEMS	9.3	12.5	57%	21.9	7.0	32%	28.8
5.4 ANCILLARY CONTROLS	0.8	2.5	75%	3.3	0.6	18%	3.9
6 ON-LINE COMPUTING	3.9	3.6	48%	7.5	1.8	24%	9.3
7 CONVENTIONAL SYSTEMS	7.0	4.4	39%	11.5	2.7	24%	14.2
8 INSTALLATION AND TEST	21.0	8.7	29%	29.7	6.5	22%	36.2
8.1 TEST BEAM PROGRAM	4.2	3.1	42%	7.3	1.6	22%	8.9
8.2 SUBSYSTEM INSTALL. AND TEST	16.8	5.6	25%	22.4	4.9	22%	27.3
9 PROJECT MANAGEMENT	1.9	14.0	88%	15.9	2.5	16%	18.4
TOTALS	336	128	28%	464	120	26%	584

SDC WAS > 4 YEARS AGO

WE ARE REALIZING THE FRUITS OF THE SSC DESIGNS. THEY ARE NOW MUCH MORE ADVANCED. (3 CERN TEST BEAM CYCLES)

∴ OUR US CMS CONTINGENCY LEVEL IS ≥ SDC ⇒ A CONSERVATIVE ESTIMATE

A WORKED EXAMPLE

US CMS Hadron Calorimeter Contingency Analysis

J. Hanlon, 2-Jan-97

		Tech. Risk	Cost Risk	Sched. Risk	Tech. Wt.	Cost Wt.	Sched. Wt.	Cont. (%)	Base Cost	Total Cost
2	**Hadron Calorimeter**							**31**	**33,262**	**43,514**
2.1	**Barrel Hadron Calorimeter (HB)**							31	25,377	33,340
2.1.1	Barrel							31	22,889	30,063
2.1.1.1	Mechanical Structure	4	4	8	4	2	1	32	9,501	12,541
2.1.1.2	Optical System	3	4	4	4	2	1	24	3,082	3,822
2.1.1.3	Phototransducers	6	4	4	4	2	1	36	2,671	3,632
2.1.1.4	Electronics	6	4	4	4	2	1	36	1,400	1,904
2.1.1.5	Tooling	3	4	8	4	2	1	28	3,748	4,797
2.1.1.6	Shipping	1	4	4	2	1	1	10	388	427
2.1.1.7	Prototypes (2 wedges)	6	6	4	4	2	1	40	2,100	2,940
2.1.2	Outer Barrel							32	2,488	3,277
2.1.2.1	Mechanical Structure	4	4	8	4	2	1	32		
2.1.2.2	Optical System	3	4	4	4	2	1	24	891	1,104
2.1.2.3	Phototransducers	6	4	4	4	2	1	36	1,020	1,388
2.1.2.4	Electronics	6	4	4	4	2	1	36	577	785
2.2	**Endcap Hadron Calorimeter (HE)**							34	4,465	5,984
2.2.1	Barrel							35	2,887	3,890
2.2.1.1	Mechanical Structure	4	4	8	4	2	1	32	751	991
2.2.1.2	Optical System	3	4	4	4	2	1	24	57	71
2.2.1.3	Phototransducers	6	4	4	4	2	1	36	1,194	1,624
2.2.1.4	Electronics	6	4	4	4	2	1	36	885	1,204
2.2.1.5	Tooling	3	4	8	4	2	1	28		
2.2.1.6	Shipping	1	4	4	2	1	1	10		
2.2.1.7	Prototypes (2 wedges)	6	6	4	4	2	1	40		
2.2.2	Outer Barrel							33	1,577	2,094
2.2.2.1	Mechanical Structure	4	4	8	4	2	1	32	170	224
2.2.2.2	Optical System	3	4	4	4	2	1	24	372	461
2.2.2.3	Phototransducers	6	4	4	4	2	1	36	647	879
2.2.2.4	Electronics	6	4	4	4	2	1	36	388	528
2.3	**Forward Calorimeter (HF)**							23	3,420	4,191

Summary and Conclusions

- US CMS has used the "best available" contingency methodology.
- One should not overly rely on inappropriate precedents in comparing US CMS to other detector projects. In fact, given the protracted period of SSC R&D, US CMS is a rather mature project.
- We would very much like to have "early warning" from our funding agencies on issues which might arise at our full scale review in June.
- However, a balance between extremes is called for - which requires taste and judgment. We want neither a preemptive and unmotivated increase in contingency requiring a descope in activities, nor do we want the DoE and NSF to be forced to heavily "backstop" the US CMS Project.
- We are eager to work with DoE and NSF to adopt a more appropriate methodology (if it exists) or to modify our existing procedures. Our goal is to move expeditiously to the status of approved project in FY98.