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GEM TN-92-107

Muon Engineering Status Meeting - M.I.T.

May 27, 1992

Abstract:

Agenda, attendees, and transparencies of the GEM Muon Engineering Status Meeting held at M.I.T. on May 27, 1992. Agenda items: Comments; Report on SSCL Align MTG., 5/22; Update of Cost Matrix; Review of 5/20 Action Items; Review Draft Memo for A/I #4 (Magnet Info); Comments on Other Eng. Efforts; Action Items; and Set Agenda for Next Week.

DRAPER LABORATORY

HWB-92-003

TO: Distribution

FROM: H. Baker

DATE: May 29, 1992

SUBJECT: Material from 27 May 1992 GEM/Muon Engineering Status Meeting at M.I.T.

The attached material was presented at the subject meeting. Action item information will be distributed under a separate letter.

Howard Baker
GEM/Muon
Project Assistant Manager

DISTRIBUTION:

Draper	M.I.T.	SSCL
H. Baker	J. Kelsey	M. Harris
M. DePiero	F. Taylor	M. Marx
M. Furey		G. Sanders
J. Govignon		E. Walton
R. Gustavson		
A. Kondoleon		
F. Nimblett	B.U.	
J. Paradiso		
E. Womble	S. Whitaker	

KG/rc

Attachment

The Charles Stark Draper Laboratory, Inc.
555 Technology Square, Cambridge, Massachusetts 02139-3563
Telephone: 617 258-1000

Attendees List

Attendees List

GEM/Muon Engineering Status Meeting

5/27/92

Name	Organization
F. Taylor	M. I. T.
S. Whitaker	B. U.
H. Baker	Draper
F. Nimblett	Draper
R. Gustavson	Draper
M. DePiero	Draper
M. Furey	Draper
A. Kondolean	Draper
E. Womble	Draper
J. Kelsey	M. I. T.

Action Items

Action Items, Muon Eng Status Meeting-update 5/27

Action Item* (5/20 mtg)	Action Item	Assignee	Due Date	Notes
"5-20-1"	We need interface drawings specifying stay-clear regions between magnet and support structure and calorimeter. Drawings are also needed to specify the chamber mounting concept. What support structure is needed for the barrel (graphite frame as envisioned fot the RPC.)	F. Nimblett	~~TBD~~ 6/3	Nimblett to generate a list of required info. Letter to be sent on 5/28 to Harris/Sanders. Reqest info available 6/3.
"5-20-2"	It was suggested that the barrel chamber configuration be changed to 4:8:4 for costing. The resolution performance will also have to be evaluated for this configuration.	A. Kondoleon	5/27	Complete
"5-20-3"	The details of the chamber coverage needs to be worked out in the region between sectors. For the PDT's, how many tube layers will there be in that reqion, and what is the dead space? For the LSDT's, what is the dead space in that region? We need blow-up drawings of this corner, indicating the attachment of the chambers and the dead space.	F. Nimblett	5/27	In process-Kelsey to provide drawings
"5-20-4"	We need to get the deflection specification of the cryostat. How much out of round, stability of the length of the magnet.....Suggest that the requested information be written in a memo and sent to Mike Harris, Livermore, Mike Marx	F. Nimblett	~~5/28~~ 6/3	Draft to be presented 5/27. To be sent on 5/28. Info needed 3-Jun
"5-20-5"	Are there any structural members in the present space frame design which bare no load?	M. Furey	5/27	None. Complete
"5-20-6"	Reaction to Jacques Pier-Amory's proposal for installation of chambers. Practical?, Cost effective?	A. Kondoleon		On-going

These items connected

Action Item#	Action Item	Assignee	Due Date	Notes
"5-20-7"	What savings will result from construction of the FFS using non-tapered iron plates? What is the results of the resolution, L-angles, nonuniform magnetic field?	J. Sullivan	TBD	on-going
"5-20-8"	We need to review the need for removing chambers? Should this be a design goal? What is the associated cost to build in this feature?	A. Kondoleon	~~TBD~~ 6/5	For CSC-mandatory. Depends upon technology. Discussions at muon mtg on 6/5
"5-20-9"	For alignment, there is a need to specify the dynamic range needed for the straightness monitors. Photopots may not work in the B-field. Need another technology.	J. Paradiso	5/27	Discussions on-going w/SDC 2mm dynamic raange of the quad cell-baseline.
"5-20-10"	A decision has to be made soon about what alignment apparatus we should have for the TTR this summer. The May 22 meeting should focus on this issue.	J Paradiso	5/27	Per FET, this action will only be a transfer of information.
"5-20-11"	The technology proponents are requested to supply updated cost information by May 22. May 27 is the deadline by which info has to be sent to SSCL.	R. Gustavson	5/27	Completed
"5-20-12"	A need has been indicated for a master organizational chart for the Muon sub system.	H. Baker	~~5/27~~ 6/5	1st Draft-delayed to following week.

Action Items, Muon Eng Status Meeting - update 5/27

Action Item* (5-27 mtg)	Action Item	Assignee	Due Date	Notes
"5-27-1"	Provide draft input to TRD	J. Paradiso	5/29	
"5-27-2"	Provide baseline drawing of alignment concept. Determine quantization.	J. Paradiso	PAC mtg	

Agenda
27 May 1992

AGENDA

GEM MUON ENGINEERING STATUS MEETING

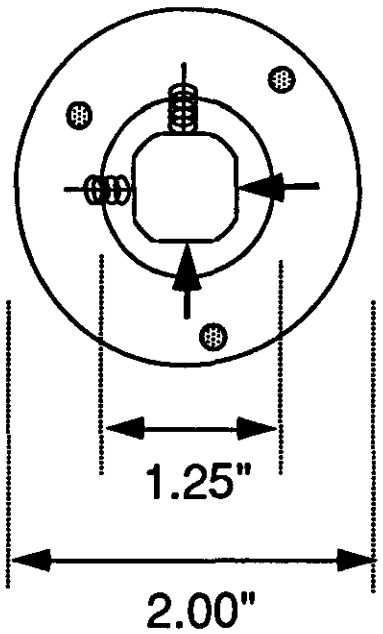
AT DRAPER

3PM- -27 MAY 1992

• COMMENTS	FRANK TAYLOR	5 MIN
• COMMENTS	HOWARD BAKER	5 MIN
• REPORT ON SSCL ALIGN MTG, 5/22	JOE PARADISO	15 MIN
• UPDATE OF COST MATRIX	DICK GUSTAVSON	10 MIN
• REVIEW OF 5/20 ACTION ITEMS	ALL	30 MIN
• REVIEW DRAFT MEMO FOR A/I#4 (MAGNET INFO)	FRANK NIMBLETT	10 MIN
• COMMENTS ON OTHER ENG. EFFORTS	ALL	
• ACTION ITEMS	ALL	
• SET AGENDA FOR NEXT WEEK	ALL	
• ADJOURN		NO LATER THAN 5PM

Joe Paradiso/Draper

Re-Design of Alignment Fixtures for TTR



- Use same size fixture for lens, detector, source
- Adjust on 2 orthogonal (flattened) axis against spring plungers, use setscrews with denser thread
- Lens fixture must be reduced to 1.25" outer diameter

→ Minimal changes from original design!

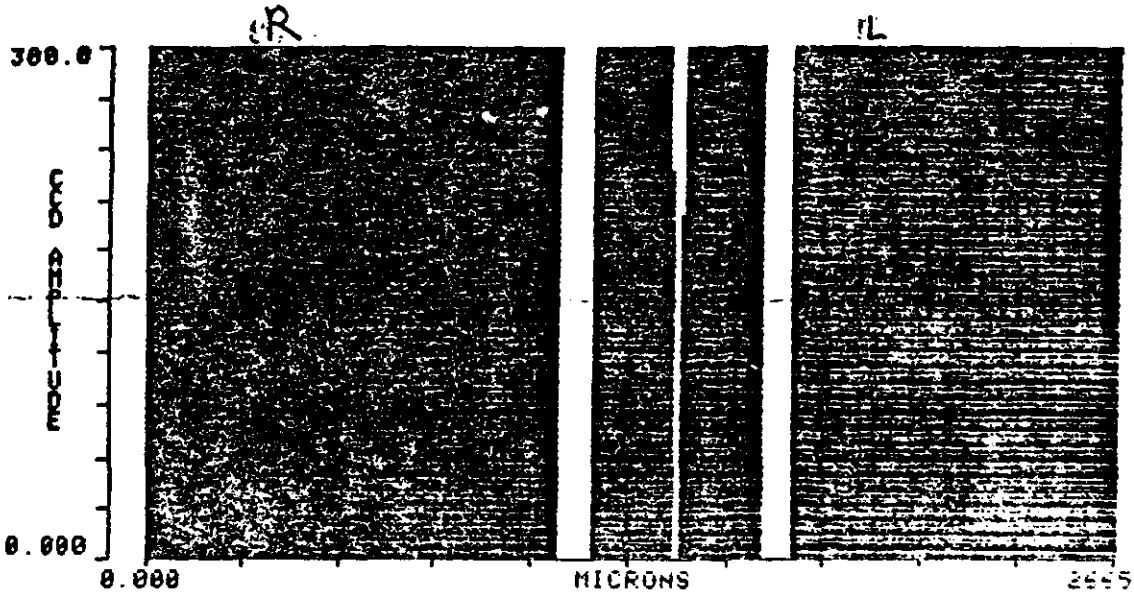
→ Can use in-house calibration jig

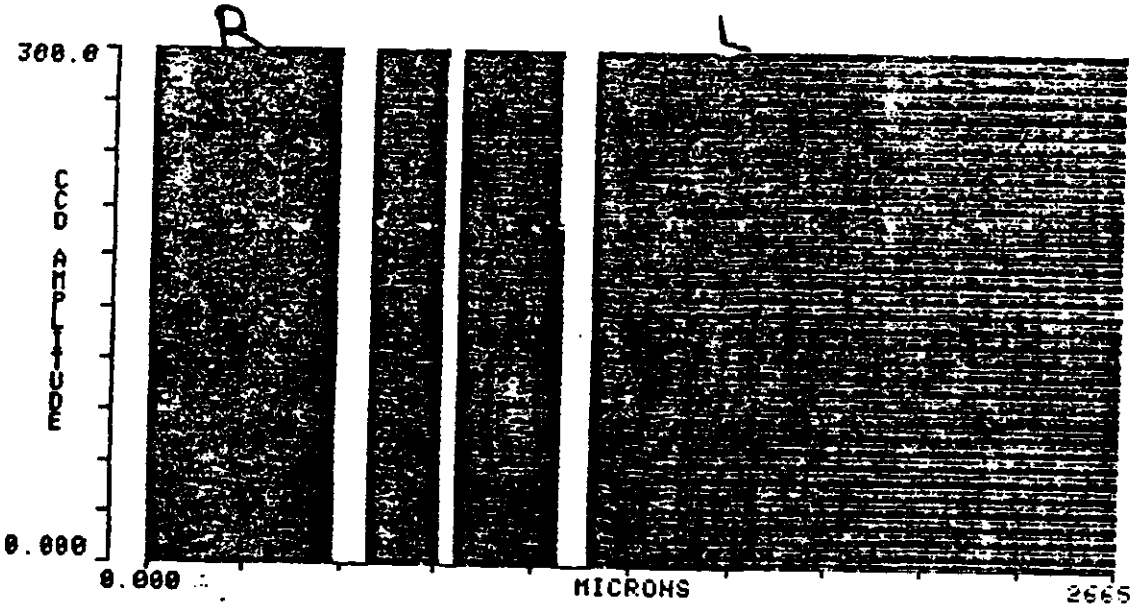
- Lens: Barrel = Melles Griot 01LMP049 (f=1 m, d=2.5 cm, t=3.3 mm)
  Endcap = Melles Griot 01LDX049 (f=2.86 cm, d=1.27 cm, t=3.4 mm)

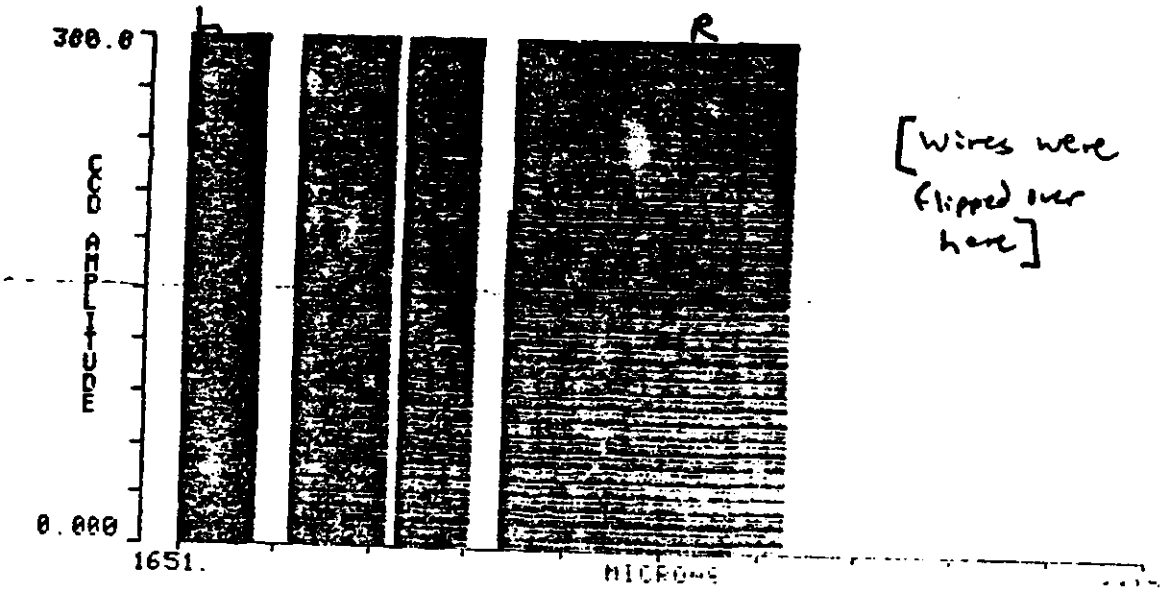
- Endcap lens is narrower; must sandwich between a pair of rings.

Discussions @ Alignment meeting 5/22

- Lee Griffith on wires (SWAT)
  - Measures position of wire shadow in 2 coordinates (using encapsulated proximity sensors); micron accuracy over ≈ 2 mm dynamic range.
  - Experience using 65 meter Cu/Be 8 mil wire over 65 meters w. 4 Kg tension, producing 3 cm of sag (a known quantity).
  - Wire contained inside tube, dynamics not a problem?
  - Extend measurement range, remove ambiguity.
  - Calibration, setup can be more involved...
- Lee Griffith on Poisson spot
  - Illuminate ball bearing with uniform laser, active control for lateral beam stability, measure Poission spot position to micron accuracy over hundreds-thousands of meters.
  - Cute technique, but not relevant to GEM detector.
- Many discussions....
  - Alignment Requirements (this week; SSC & JAP)
  - Alternate multipoint sensors (i.e. UV laser, laser beacon, X-rays)
  - Dynamic range of sensors (assume 2 mm, CCD or straightness?)
  - Will baseline combination of SWAT and 3-point straightness monitors for July PAC



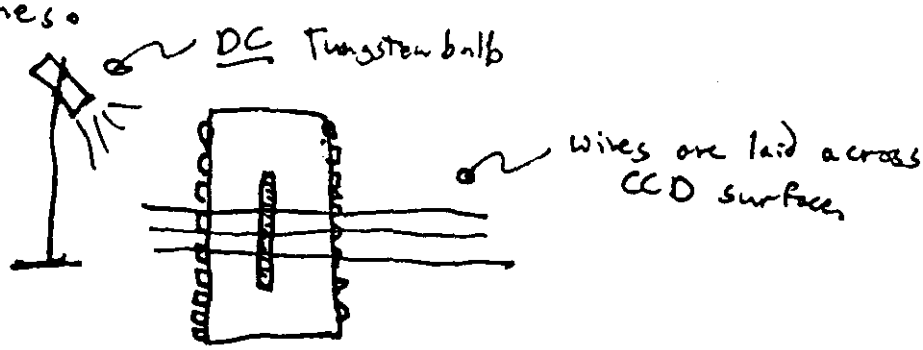




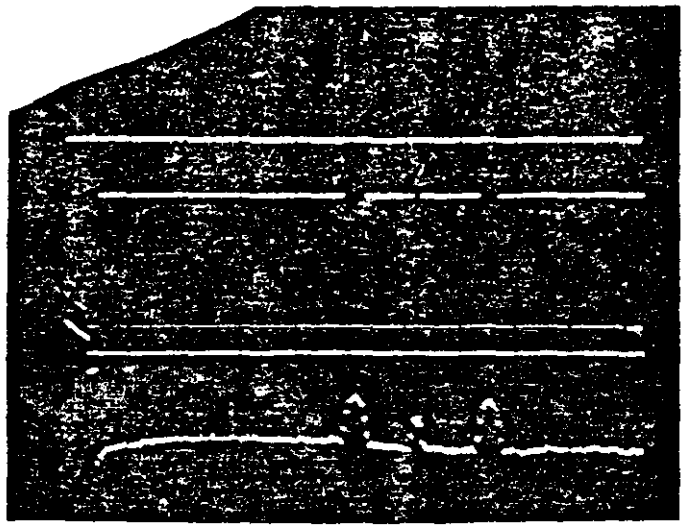
[wires were flipped over here]

The chamber has been opened, + grid + wire plane removed. THE RIGHT pickup wire (measured from front of chamber) is closer to the anode!

The CCD readout system has been interfaced to the LeCroy 3500 CAMAC. The 2-pseudo-bit digitizer developed @ MIT is still used. Setup to measure wire planes:



Resulting CCD waveform is:



= Digitized pseudo bit

= CCD output

A "2x" output of the wire plane (spanning 1/2 the CCD) is shown @ Right. The intensity on the CCD (vert.) is plotted against cell position (horiz.). 100 CCD samples here taken.

Dick Gustavson/Draper

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GEM Muon Subsystem Cost Matrix - Rev. 11

We are required to "firm-up" all of the information in the cost books. My plan is to use summer help to make the paper-work modifications and to put all back-up information into the same font.

What SSCL needs for each WBS element is:

1. Assure that the scope is correctly stated.

2. Determine adequacy of engineering/design, M&S, and inspection/administration. Verify period of performance.

3. Review component procurement/fabrication requirements.
   a. create a process plan for each component (so that CSDL may use its manufacturing system design programs to establish the appropriate parameters), or
   b. provide a quote for the necessary (SSC) quantity.
   c. verify period of performance.

4. Review assembly/installation requirements.
   a. create an assembly process plan (so that CSDL may use its manufacturing system design programs to establish the appropriate parameters), or
   b. provide a quote for the necessary (SSC) quantity.
   c. verify period of performance.

5. Examine the currently specified contingency factors. The final values are to be extracted from Table 1.

6. Determine a "cost basis descriptor" from

BU	Bottom-up
SA	Specific analogy
PS	Parametric study
RU	Review and update
TA	Trend analysis
EO	Expert opinion

7. Review comments, revise as necessary.

8. Conform to "Engineering calculations, drawings, similarities to other systems, and other pertinent data will be collected and organized into individual subsystem cost books. In addition, basic subsystem configuration will be defined along with a list of critical assumptions made during the estimating process"

A lot of this work has been done, more than once probably. In light of the potential funding limitations, we must continue to do the best estimating job possible.

R.E. Gustavson 27 May 1992

Table 1 - Risk Factors

Risk Factor	Technical	Cost	Schedule
1	Existing design & off the shelf hardware	Off the shelf or catalog item	not used
2	Minor modifications to existing design	Vendor quote from established drawings	No schedule impact on any other item
3	Extensive changes to an existing design	Vendor quote with some design sketches	not used
4	New design within established product line	In-house estimate for item within current product line	Delays completion of non-critical path subsystem item
6	New design different from established product line. Existing technology	In-house estimate for item with minimal company experience but related to existing capabilities	not used
8	New design. Requires some R&D development but does not advance the state-of-the-art	In-house estimate for item with minimal company experience and minimal in-house capability	Delays completion of critical path subsystem item
10	New design. Deve'opment of new tech ›logy which adavances the state-of-the-art	Top down estimate rom analogous programs	not used
15	New designs way beyond the current state-of-the-art	Engineering judgement	

Risk Percentage T:ble

	Condition	Risk Percentage
Technical	Design or mfg. concerns only	2%
	Design and mfg. concerns	4%
Cost	Material cost or labor rate concern	1%
	Material cost and labor rate concern	2%
Schedule		1%

MUON SYSTEM
COST ESTIMATION WORKSHEET

WBS Element Title: Sector Support Stucture; Off-Site; Machining/Inspection LSDT

WBS Element No: 3.2.1.2.5.1.2 **Date:** 21 May 92 **Rev:**1 **Estimator:**Kondoleon

Scope: This element covers the labor and labor costs for the machining and inspection of structure components. Also, oversight for purchasing stock and matertial for machining.

Engineering/Design **PY:** **Comp. Rate($K/PY):** **PoP:**
N/A

M&S: Engineering/Design and Inspection/Administration **($K): 46**

Misc. office supplies for Administration:	$13K
Travel: 1 person, 4 trips to machine shop, inspection shop @$2K/trip	$8K
PC/Mac/workstation charges:	$14K
Software supplies	$11K

Inspection/Administration **PY:** 3.77 **Comp. Rate($K/PY):** 73 **PoP:** 1/94-3/96

Assumes Engineering (nat'l. avg.) oversight of purchasing activity: 1/3-time for 24 months = .67 PY
Assumes Engineering (SSCL) oversight of machining and inspection activity: 1/3-time for 2.25 yrs = .75 PY
Assumes forman(nat'l.avg) required 2.35 PY

Procurement/Fabrication Material **($K)** 1095

Material:

Side supports	$109K
Cross supports	$59K
End plugs (side)	$26K
End plugs (cross)	$6.9K
Joints	$19K
Mounts	$19K
Capital equipment cost	$711K
Tooling cost	$145K

Installation/Assembly **PY:** 11.5 **Comp. Rate($K/PY):** 74 **PoP:** 1/94-3/9
Requires 11.5 machinists at full-time

Material: Installation/Assembly **($K)** 62

Misc. office supplies for Installation/Assembly	$28K
Misc software supplies	$35K

Contingency **Total:** 38

Technical:	0	Basis:	none
Cost:	30	Basis:	engineering judgement, material and labor rate concern
Schedule:	8	Basis:	delays completion of critical path item

Comments
Material cost based on quotes from Ryerson 12-5&6 91
Engineering estiimate used to size the number and lengths of the structural elements needed.
Machine cost based on interface with E. McCormack (Draper shop group leader 5-6-92)

MUON SUBSYSTEM COST MATRIX - Rev. 10

The complete cost matrix now has two additional columns:

1. Contingency percentage

2. Last modified (date)

The WBS is believed to conform to Rev. E of the GEM Cost Estimating Plan.

The two options (PDT and LSDT) are combined into one matrix. All common WBS categories are denoted _3.1 (which includes PDT items) except those which are exlusively LSDT (denoted _3.2).

The cost summary chart is available is two forms:

1. Short form - Table 1 of the Cost Estimating Plan.

2. Expanded form - includes determination of EDIA and Construction costs as well the tabular data useful for creating graphs such as those included.

A new cost summary matrix exhibiting the breakdown of labor and materials. Page 1 shows the results using 1991 labor rates while page 2 reveals the (first approximation) cost changes due to 1992 labor rates. The latter were found by stating that all off-site labor costs increase by 11% while all on-site labor costs decrease by 12% (both percentages are nominal based upon the updated rates). Note that there is virtually no change in total costs.

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R.E. Gustavson 26 May 1992

G E M

Muon Subsystem Cost Matrix

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MUON SUBSYSTEM COST MATRIX Rev 10 5/26/92

		Engineering/Design			M&S	Inspection/Admin			Proc/Fab		
		Labor	Rate	Total		Labor	Rate	Total	Material	Labor	Rate
WBS no.	Item	my	k$/my	k$	k$	my	k$/my	k$	k$	my	k$/my
(-3.1)	PDT Muon Detector cost	102.4	125	12745	5841	92.6	115	10601	45622	267.1	60
(-3.2)	LSDT Muon Detector cost	102.4	125	12745	5839	92.4	115	10586	37441	304.8	62
					Sub-group 03.1 is used for all construction breakdown categories ex						
03.1 - PDT	Muon Subsys. Construction PDT	78.73	121	9562	4787	92.57	115	10601	45622	267.13	60
03.2 - LSDT	Muon Subsys. ConstructionLSDT	78.73	121	9562	4785	92.37	115	10586	37441	305	62
03.1.1-PDT	Central Region	45.06	117	5257	2226	41.09	102	4187	29871	140.11	82
03.2.1-LSDT	Central Region	45.06	117	5257	2224	40.89	102	4173	21690	177.75	81
03.1.1.1	Central Region Installation	9.00	99	891	75	3.51	71	250	2870		
03.1.1.1.1	On-Site	0.00		0	8	1.38		108	2570		
03.1.1.1.1.1	Test				0	0.00		0	70		
03.1.1.1.1.2	Mechanical Assembly				3	0.50	78	39	2075		
03.1.1.1.1.3	Electrical/Electronics Assy				2	0.38	78	30	325		
03.1.1.1.1.4	Fac Prep				3	0.50	78	39	100		
03.1.1.1.2	Off-Site	9.00		8[illegible]	67	2.13		143	300		
03.1.1.1.2.1	Install. Tool Fnl Dsgn, Mach, Assy	9.00	99	891	67	2.13	67	143	300		
03.1.1.2	Central Region Sector Assy-PDT	15.82	104	1653	391	30.33	95	2893	17636	126.11	81
03.2.1.2	Central Region Sector AssyLSDT	15.82	104	1653	389	30.13	96	2878	10518	163.75	80
03.1.1.2.1	On-Site	0.00		0	9	1.44		112	800	12.83	53
03.1.1.2.1.1	Sector Storage			0	0	0.00		0	50		
03.1.1.2.1.2	Test			0	3	0.56	78	44	125	1.25	59
03.1.1.2.1.3	Assembly			0	4	0.63	78	49	575	10.83	52
03.1.1.2.1.4	Fac Prep			0	2	0.25	78	20	50	0.75	59
03.1.1.2.2	Off-Site	3.00		297	23	0.88		62	85	2.13	

MUON SUBSYSTEM COST MATRIX Rev 10 5/26/92

		Engineering/Design			M&S	Inspection/Admin			Proc/Fab		
		Labor	Rate	Total		Labor	Rate	Total	Material	Labor	Rate
WBS no.	Item	my	k$/my	k$	k$	my	k$/my	k$	k$	my	k$/my
03.1.1.2.2.1	Assy Fixt Final Dsgn, Mach, Assy	3.00	99	297	23	0.88	71	62	85	2.13	69
03.1.1.2.3	Pressurized Drift Tubes	3.25	102	332	86	9.49	97	919	10011	52.38	89
03.1.1.2.3.1	Off-Site	3.25		332	86	9.49		919	10011	52.38	
03.1.1.2.3.1.1	Shipping				2	0.23	133	31	50	0.46	107
03.1.1.2.3.1.2	Test				3	0.50	133	67	28	5.66	110
03.1.1.2.3.1.3	Assembly				14	2.25	133	299	50	18.35	98
03.1.1.2.3.1.4	Facility Prep				5	0.75	133	100	0	3.75	97
03.1.1.2.3.1.5	Machining, Inspection				42	5.63	72	405	9883	24.16	75
03.1.1.2.3.1.6	Final Design, Drwg/Spec Mods	3.25	102	332	20	0.13	133	17			
0.3.2.1.2.3	Limited Streamer Drift Tubes	3.25	102	332	86	9.49	97	919	2686	91.07	83
03.2.1.2.3.1	Off-Site	3.25		332	86	9.49		919	2686	91.07	
03.2.1.2.3.1.1	Shipping				2	0.23	133	31	50	0.46	107
03.2.1.2.3.1.2	Test				3	0.50	133	67	28	5.66	110
03.2.1.2.3.1.3	Assembly				14	2.25	133	299	405	20.00	98
03.2.1.2.3.1.4	Facility Prep				5	0.75	133	100	0	3.75	97
03.2.1.2.3.1.5	Machining, Inspection				42	5.63	72	405	2203	61.20	75
03.2.1.2.3.1.6	Final Design, Drwg/Spec Mods	3.25	102	332	20	0.13	133	17			
03.1.1.2.4	Resistive Plate Counters	3.25	102	332	89	10.05	95	959	4908	43.47	85
03.1.1.2.4.1	Off-Site	3.25		332	89	10.05		959	4908	43.47	
03.1.1.2.4.1.1	Shipping				2	0.23	133	31	50	0.46	107
03.1.1.2.4.1.2	Test				3	0.50	133	67	50	5.50	109
03.1.1.2.4.1.3	Assembly				14	2.25	133	299	300	4.16	113
03.1.1.2.4.1.4	Facility Prep				5	0.75	133	100	0	3.75	97
03.1.1.2.4.1.5	Machining, Inspection				45	6.19	72	446	4508	29.60	75
03.1.1.2.4.1.6	Final Design, Drwg/Spec Mods	3.25	102	332	20	0.13	133	17			
03.1.1.2.5	Sector Support Structures PDT	5.00	108	540	72	5.22	83	434	1148	13.05	73
03.1.1.2.5.1	Off-Site	5.00		540	72	5.22		434	1148	13.05	
03.1.1.2.5.1.1	Shipping				2	0.50	78	39	20	0.50	50
03.1.1.2.5.1.2	Machining, Inspection				48	3.97	73	290	1128	12.55	74
03.1.1.2.5.1.3	Final Design, Drwg/Spec Mods	5.00	108	540	22	0.75	140	105	0	0	0
03.2.1.2.5	Sector Support StructuresLSDT	5.00	108	540	70	5.02	84	419	1115	12.00	73
03.2.1.2.5.1	Off-Site	5.00		540	70	5.02		419	1115	12.00	
03.2.1.2.5.1.1	Shipping				2	0.50	78	39	20	0.50	50
03.2.1.2.5.1.2	Machining, Inspection				46	3.77	73	275	1095	11.50	74

		Engineering/Design			M&S	Inspection/Admin			Proc/Fab		
		Labor	Rate	Total		Labor	Rate	Total	Material	Labor	Rate
WBS no.	Item	my	k$/my	k$	k$	my	k$/my	k$	k$	my	k$/my
03.2.1.2.5.1.3	Final Design, Drwg/Spec Mods	5.00	108	540	22	0.75	140	105	0	0	0
03.1.1.2.6	Alignment & Calibrtn Sys PDT	1.32	116	153	112	3.25	125	407	684	2.25	95
03.1.1.2.6.1	Local Chamber Alignment	0.66		77	52	1.63		203	534	1.00	
03.1.1.2.6.1.1	Off-Site	0.66		77	52	1.63		203	534	1.00	
03.1.1.2.6.1.1.1	Shipping				25	1.00	125	125		0.00	0
03.1.1.2.6.1.1.2	Test				5	0.13	125	16		0.25	95
03.1.1.2.6.1.1.3	Assembly				5	0.13	125	16		0.25	95
03.1.1.2.6.1.1.4	Facility Prep				5	0.13	125	16	25	0.25	95
03.1.1.2.6.1.1.5	Machining, Inspection				2	0.25	126	32	509	0.25	95
03.1.1.2.6.1.1.6	Final Design, Drwg/Spec Mods	0.66	116	77	10						
03.2.1.2.6	Alignment & Calibrtn Sys LSDT	1	116	153	112	3	125	407	924	2	95
03.2.1.2.6.1	Local Chamber Alignment	0.66		77	52	1.63		203	774	1.00	
03.2.1.2.6.1.1	Off-Site	0.66		77	52	1.63		203	774	1.00	
03.2.1.2.6.1.1.1	Shipping				25	1.00	125	125		0.00	0
03.2.1.2.6.1.1.2	Test				5	0.13	125	16		0.25	95
03.2.1.2.6.1.1.3	Assembly				5	0.13	125	16		0.25	95
03.2.1.2.6.1.1.4	Facility Prep				5	0.13	125	16	25	0.25	95
03.2.1.2.6.1.1.5	Machining, Inspection				2	0.25	126	32	749	0.25	95
03.2.1.2.6.1.1.6	Final Design, Drwg/Spec Mods	0.66	116	77	10						
03.1.1.2.6.2	Global Sector/Region Monitor	0.66	116	77	60	1.63	125	203	150	1.25	95
03.1.1.2.6.2.1	Off-Site	0.66		77	60	1.63		203	150	1.25	
03.1.1.2.6.2.1.1	Shipping				25	1.00	125	125		0.00	0
03.1.1.2.6.2.1.2	Test				5	0.13	125	16		0.25	95
03.1.1.2.6.2.1.3	Assembly				5	0.13	125	16		0.25	95
03.1.1.2.6.2.1.4	Facility Prep				5	0.13	125	16	25	0.25	95
03.1.1.2.6.2.1.5	Machining, Inspection				10	0.25	125	31	125	0.50	95
03.1.1.2.6.2.1.6	Final Design, Drwg/Spec Mods	0.66	116	77	10						
03.1.1.3	Elctrncs/Elctr. Hrdwre - PDT	12.24	146	1785	1620	4.75	154	732	8565	2.00	95
03.2.1.3	Elctrncs/Elctr. Hrdwre - LSDT	12.24	146	1785	1620	4.75	154	732	7502	2.00	95
03.1.1.3.1	Pressurized Drift Tubes	6.46	150	970	1085	1.75	154	270	6611	0.00	0
03.1.1.3.1.1	Off-Site	6.46		970	1085	1.75		270	6611	0	
03.1.1.3.1.1.1	Sense Electronics / Triggers	5.80	154	893	650	0.75	154	116	6053		
03.1.1.3.1.1.2	Calibration Electronics Des, Fab, S	0.66	116	77	15	0.50	154	77	250		

		Engineering/Design			M&S	Inspection/Admin			Proc/Fab		
		Labor	Rate	Total		Labor	Rate	Total	Material	Labor	Rate
WBS no.	Item	my	k$/my	k$	k$	my	k$/my	k$	k$	my	k$/my
03.1.1.3.1.1.3	High / Low Voltage Systems	0.00	154	0	420	0.50	154	77	308		
03.2.1.3.1	Limited Streamer Drift Tubes	6.46	150	970	1085	1.75	154	270	5548	0.00	0
03.2.1.3.1.1	Off-Site	6.46		970	1085	1.75		270	5548	0	
03.2.1.3.1.1.1	Sense Electronics / Triggers	5.80	154	893	650	0.75	154	116	5053		
03.2.1.3.1.1.2	Calibration Electronics Des, Fab, S	0.66	116	77	15	0.50	154	77	250		
03.2.1.3.1.1.3	High / Low Voltage Systems	0.00	154	0	420	0.50	154	77	245		
03.1.1.3.2	Resistive Plate Counters	4.46	148	662	460	2.00	154	308	1754		
03.1.1.3.2.1	Off-Site	4.46		662	460	2.00		308	1754		
03.1.1.3.2.1.1	Beam Crossing / Triggers	3.80	154	585	420	1.00	154	154	1403		
03.1.1.3.2.1.2	Calibration Electronics Des, Fab, S	0.66	116	77	25	0.50	154	77	250		
03.1.1.3.2.1.3	High / Low Voltage Systems	0.00	154	0	15	0.50	154	77	101		
03.1.1.3.3	Align and Cal System Elec	1.32	116	153	75	1.00	154	154	200	2.00	95
03.1.1.3.3.1	Local Chamber Alignment	0.66		77	35	0.50		77	100	1.00	
03.1.1.3.3.1.1	Off-Site Assembly, Test				25	0.50	154	77	100	1.00	95
03.1.1.3.3.1.2	Final Design, Drwg/Spec Mods	0.66	116	77	10						
03.1.1.3.3.2	Global Sector/Region Monitor	0.66	116	77	40	0.50	154	77	100	1.00	95
03.1.1.3.3.2.1	Off-Site Assembly, Test				25	0.50	154	77	100	1.00	95
03.1.1.3.3.2.2	Final Design, Drwg/Spec Mods	0.66	116	77	15						
03.1.1.4	Gas Systems - PDT	4.00	116	464	70	1.25	125	156	400	6.00	95
03.2.1.4	Gas Systems - LSDT	4.00	116	464	70	1.25	125	156	400	6.00	95
03.1.1.4.1	Pressurized Drift Tubes	2.00	116	232	35	0.63	125	78	200	3.00	95
03.1.1.4.1.1	Off-Site	2.00		232	35	0.63		78	200	3.00	
03.1.1.4.1.1.1	Shipping				5	0.13	125	16		0.25	95
03.1.1.4.1.1.2	Subassembly, Test				5	0.13	125	16		1.00	95
03.1.1.4.1.1.3	Machining, Inspection				5	0.13	125	16		1.00	95
03.1.1.4.1.1.4	Procurement				5	0.13	125	16	200	0.75	95
03.1.1.4.1.1.5	Final Design, Drwg/Spec Mods	2.00	116	232	15	0.13	125	16			
03.2.1.4.1	Limited Streamer Drift Tubes	2.00	116	232	35	0.63	125	78	200	3.00	95
03.2.1.4.1.1	Off-Site	2.00		232	35	0.63		78	200	3.00	
03.2.1.4.1.1.1	Shipping				5	0.13	125	16		0.25	95
03.2.1.4.1.1.2	Subassembly, Test				5	0.13	125	16		1.00	95

MUON SUBSYSTEM COST MATRIX Rev 10 5/20/92

		Engineering/Design			M&S	Inspection/Admin			Proc/Fab		
		Labor	Rate	Total		Labor	Rate	Total	Material	Labor	Rate
WBS no.	Item	my	k$/my	k$	k$	my	k$/my	k$	k$	my	k$/my
03.2.1.4.1.1.3	Machining, Inspection				5	0.13	125	16		1.00	95
03.2.1.4.1.1.4	Procurement				5	0.13	125	16	200	0.75	95
03.2.1.4.1.1.5	Final Design, Drwg/Spec Mods	2.00	116	232	15	0.13	125	16			
03.1.1.4.2	Resistive Plate Counters	2.00	116	232	35	0.63	125	78	200	3.00	95
03.1.1.4.2.1	Off-Site	2.00		232	35	0.63		78	200	3.00	95
03.1.1.4.2.1.1	Shipping				5	0.13	125	16		0.25	95
03.1.1.4.2.1.2	Subassembly, Test				5	0.13	125	16		1.00	95
03.1.1.4.2.1.3	Machining, Inspection				5	0.13	125	16		1.00	95
03.1.1.4.2.1.4	Procurement				5	0.13	125	16	200	0.75	95
03.1.1.4.2.1.5	Final Design, Drwg/Spec Mods	2.00	116	232	15	0.13	125	16			
03.1.1.5	Cooling Systems - PDT	4.00	116	464	70	1.25	125	156	400	6.00	95
03.2.1.5	Cooling Systems - LSDT	4.00	116	464	70	1.25	125	156	400	6.00	95
03.1.1.5.1	Pressurized Drift Tubes	2.00	116	232	35	0.63	125	78	200	3.00	95
03.1.1.5.1.1	Off-Site	2.00		232	35	0.63		78	200	3.00	
03.1.1.5.1.1.1	Shipping				5	0.13	125	16		0.25	95
03.1.1.5.1.1.2	Subassembly, Test				5	0.13	125	16		1.00	95
03.1.1.5.1.1.3	Machining, Inspection				5	0.13	125	16		1.00	95
03.1.1.5.1.1.4	Procurement				5	0.13	125	16	200	0.75	95
03.1.1.5.1.1.5	Final Design, Drwg/Spec Mods	2.00	116	232	15	0.13	125	16			
03.2.1.5.1	Limited Streamer Drift Tubes	2.00	116	232	35	0.63	125	78	200	3.00	95
03.2.1.5.1.1	Off-Site	2.00		232	35	0.63		78	200	3.00	
03.2.1.5.1.1.1	Shipping				5	0.13	125	16		0.25	95
03.2.1.5.1.1.2	Subassembly, Test				5	0.13	125	16		1.00	95
03.2.1.5.1.1.3	Machining, Inspection				5	0.13	125	16		1.00	95
03.2.1.5.1.1.4	Procurement				5	0.13	125	16	200	0.75	95
03.2.1.5.1.1.5	Final Design, Drwg/Spec Mods	2.00	116	232	15	0.13	125	16			
03.1.1.5.2	Resistive Plate Counters	2.00	116	232	35	0.63	125	78	200	3.00	95
03.1.1.5.2.1	Off-Site	2.00		232	35	0.63	154	78	200	3.00	95
03.1.1.5.2.1.1	Shipping				5	0.13	125	16		0.25	95
03.1.1.5.2.1.2	Subassembly, Test				5	0.13	125	16		1.00	95
03.1.1.5.2.1.3	Machining, Inspection				5	0.13	125	16		1.00	95
03.1.1.5.2.1.4	Procurement				5	0.13	125	16	200	0.75	95
03.1.1.5.2.1.5	Final Design, Drwg/Spec Mods	2.00	116	232	15	0.13	125	16			

		Engineering/Design			M&S	Inspection/Admin			Proc/Fab		
		Labor	Rate	Total		Labor	Rate	Total	Material	Labor	Rate
WBS no.	Item	my	k$/my	k$	k$	my	k$/my	k$	k$	my	k$/my
03.1.2	End Cap Region	33.67	128	4306	2000	28.89	106	3058	16043	125.12	36
03.1.2.1	End Cap Region Installation	3.00	99	297	36	2.87	72	206	1811		
03.1.2.1.1	On-Site	0.00		0	8	1.24		97	1661		
03.1.2.1.1.1	Test				2	0.33	78	26	37		
03.1.2.1.1.2	Mechanical Assembly				2	0.33	78	26	1537		
03.1.2.1.1.3	Electrical/Electronics Assembly				2	0.33	78	26	37		
03.1.2.1.1.4	Fac Prep				2	0.25	78	20	50		
03.1.2.1.2	Off-Site	3.00		297	28	1.63		109	150		
03.1.2.1.2.1	Install. Tool Final Dsgn, Mach, Assy	3.00	99	297	28	1.63	67	109	150		
03.1.2.2	End Cap Region Sector Assy	12.57	105	1322	361	21.39	105	2255	5359	115.87	31
03.1.2.2.1	On-Site	0.00		0	9	1.94		189	750	10.33	24
03.1.2.2.1.1	Sector Storage					0.50	154	77	0		
03.1.2.2.1.2	Test				3	0.56	78	44	125	1.25	59
03.1.2.2.1.3	Assembly				4	0.63	78	49	575	8.33	52
03.1.2.2.1.4	Facility Prep				2	0.25	78	20	50	0.75	59
03.1.2.2.2	Off-Site	3.00		297	23	0.88		62	85	2.13	69
03.1.2.2.2.1	Assy Fixt Fnl Dsgn, Mach, Assy	3.00	99	297	23	0.88	71	62	85	2.13	69
03.1.2.2.3	Cathode Strip Chambers	3.25	102	332	86	9.49	95	901	3395	96.21	27
03.1.2.2.3.1	Off-Site	3.25		332	86	9.49		901	3395	96.21	
03.1.2.2.3.1.1	Shipping				2	0.23	133	31	50	0.46	107
03.1.2.2.3.1.2	Test				3	0.50	133	67	28	52.00	110
03.1.2.2.3.1.3	Assembly				14	2.25	133	299	38	20.00	95
03.1.2.2.3.1.4	Facility Prep				5	0.75	133	100	0	3.75	97
03.1.2.2.3.1.5	Machining, Inspection				42	5.63	72	405	3279	20.00	75
03.1.2.2.3.1.6	Final Design, Drwg/Spec Mods	3.25	102	332	20	0.13	133				
03.1.2.2.4	Sector Support Structures	5.00	108	540	147	5.83	119	696	829	4.70	84
03.1.2.2.4.1	Off-Site	5.00		540	147	5.83		696	829	4.70	
03.1.2.2.4.1.1	Shipping				25	1.00	125	125	0	0.00	0

		Engineering/Design			M&S	Inspection/Admin			Proc/Fab		
		Labor	Rate	Total		Labor	Rate	Total	Material	Labor	Rate
WBS no.	Item	my	k$/my	k$	k$	my	k$/my	k$	k$	my	k$/my
03.1.2.2.4.1.2	Test				15	1.00	125	125			
03.1.2.2.4.1.3	Assembly				15	1.00	125	125	0		
03.1.2.2.4.1.4	Facility Prep				10	0.50	125	63			
03.1.2.2.4.1.5	Machining, Inspection				36	2.77	77	213	537	6.60	74
03.1.2.2.4.1.6	Final Design, Drwg/Spec Mods	5.00	108	540	22	0.75	140	105			
03.1.2.2.5	Alignment & Calibration Sys	1.32	116	153	96	3.25	125	406	300	2.50	95
03.1.2.2.5.1	Local Chamber Alignment	0.66		77	48	1.63		203	150	1.25	
03.1.2.2.5.1.1	Off-Site	0.66		77	48	1.63		203	150	1.25	
03.1.2.2.5.1.1.1	Shipping				25	1.00	125	125		0.00	0
03.1.2.2.5.1.1.2	Test				2	0.13	125	16		0.25	95
03.1.2.2.5.1.1.3	Assembly				2	0.13	125	16		0.25	95
03.1.2.2.5.1.1.4	Facility Prep				2	0.13	125	16	25	0.25	95
03.1.2.2.5.1.1.5	Machining, Inspection				2	0.25	125	31	125	0.50	95
03.1.2.2.5.1.1.6	Final Design, Drwg/Spec Mods	0.66	116	77	15						
03.1.2.2.5.2	Global Sector/Region Monitor	0.66	116	77	48	1.63	125	203	150	1.25	0
03.1.2.2.5.2.1	Off-Site	0.66		77	48	1.63		203	150	1.25	
03.1.2.2.5.2.1.1	Shipping				25	1.00	125	125		0.00	0
03.1.2.2.5.2.1.2	Test				2	0.13	125	16		0.25	95
03.1.2.2.5.2.1.3	Assembly				2	0.13	125	16		0.25	95
03.1.2.2.5.2.1.4	Facility Prep				2	0.13	125	16	25	0.25	95
03.1.2.2.5.2.1.5	Machining, Inspection				2	0.25	125	31	125	0.50	95
03.1.2.2.5.2.1.6	Final Design, Drwg/Spec Mods	0.66	116	77	15						
03.1.2.3	Electronics/Electronics Hardwar	16.78	151	2534	1552	0.75	145	109	8123	1.25	91
03.1.2.3.1	Cathode Strip Chambers	15.46	154	2381	1535	0.00	0	0	7491	0.00	
03.1.2.3.1.1	Off-Site	15.46		2381	1535	0.00	0	0	7491	0.00	
03.1.2.3.1.1.1	Sense Electronics Design, Fab, Ship	7.00	154	1078	700				5082		
03.1.2.3.1.1.2	Triggering Electronics Des, Fab, Sh	5.50	154	847	440				1637		
03.1.2.3.1.1.3	Beam Crossing Electronics Des, Fab	2.30	154	354	390				347		
03.1.2.3.1.1.4	Calibration Electronics Des, Fab, S	0.66	154	102	5				100		
03.1.2.3.1.1.5	High-Voltage Systems Des, Fab, Sh	0.00	154	0	0				325		
03.1.2.3.2	Align and Cal System Elec	1.32	116	153	17	0.75	145	109	632	1.25	91
03.1.2.3.2.1	Local Chamber Alignment	0.66		77	6	0.25		32	532	0.25	
03.1.2.3.2.1.1	Off-Site Assembly/Test				2	0.25	126	32	532	0.25	75
03.1.2.3.2.1.2	Final Design, Drwg/Spec Mods	0.66	116	77	4						

		Engineering/Design			M&S	Inspection/Admin			Proc/Fab		
		Labor	Rate	Total		Labor	Rate	Total	Material	Labor	Rate
WBS no.	Item	my	k$/my	k$	k$	my	k$/my	k$	k$	my	k$/my
03.1.2.3.2.2	Global Sector/Region Monitor	0.66	116	77	11	0.50	154	77	100	1.00	95
03.1.2.3.2.2.1	Off-Site Assembly/Test				7	0.50	154	77	100	1.00	95
03.12.2.3.2.2.2	Final Design, Drwg/Spec Mods	0.66	116	77	4						
03.1.2.4	Gas System	0.66	116	77	25	2.00	126	252	400	4.50	95
03.1.2.4.1	Cathode Strip Chambers	0.66	116	77	25	2.00	126	252	400	4.50	95
03.1.2.4.1.1	Off-Site	0.66		77	25	2.00		252	400	4.50	
03.1.2.4.1.1.1	Shipping				7	1.50	126	189	200	1.75	95
03.1.2.4.1.1.2	Subassembly, Test				4	0.13	125	16		1.00	95
03.1.2.4.1.1.3	Machining, Inspection				5	0.13	125	16		1.00	95
03.1.2.4.1.1.4	Procurement				5	0.13	125	16	200	0.75	95
03.1.2.4.1.1.5	Final Design, Drwg/Spec Mods	0.66	116	77	4	0.13	125	16			
03.1.2.5	Cooling System	0.66	116	77	26	1.88	126	237	350	3.50	95
03.1.2.5.1	Cathode Strip Chambers	0.66	116	77	26	1.88	126	237	350	3.50	95
03.1.2.5.1.1	Off-Site	0.66		77	26	1.88		237	350	3.50	
03.1.2.5.1.1.1	Shipping				7	0.13	125	16	0	0.00	95
03.1.2.5.1.1.2	Subassembly, Test				5	0.13	125	16		1.00	95
03.1.2.5.1.1.3	Machining, Inspection				5	1.50	126	189	150	1.75	95
03.1.2.5.1.1.4	Procurement				5	0.13	125	16	200	0.75	95
03.1.2.5.1.1.5	Final Design, Drwg/Spec Mods	0.66	116	77	4	0.00	125	0			
03.1.3	Subsystem Project Mgmt.				585	21.40	154	3296			
03.1.3.1	Administration/Oversight				300	9.50	154	1463			
03.1.3.2	Resource Management				45	1.19	154	183			
03.1.3.3	ES&H Assurance				90	2.38	154	367			
03.1.3.4	Quality Assurance Program				90	3.57	154	550			
03.1.3.5	Systems Integration				30	2.38	154	367			
03.1.3.6	Subsystem Cost/Schedule Monitor				30	2.38	154	367			
13	Muon Subsystem R&D	11.63	154	1791	754						
13.1	CSC Subgroup	2.64	154	407	220						

MUON SUBSYSTEM COST MATRIX Rev 10 5/20/92

		Engineering/Design			M&S	Inspection/Admin			Proc/Fab		
		Labor	Rate	Total		Labor	Rate	Total	Material	Labor	Rate
WBS no.	Item	my	k$/my	k$	k$	my	k$/my	k$	k$	my	k$/my
13.2	LSDT Subgroup	3.13	154	482	144						
13.3	PDT Subgroup	1.94	154	299	203						
13.4	RPC Subgroup	1.48	154	228	148						
13.5	TTR Subgroup	2.00	154	308	6						
13.6	SCARF Subgroup	0.44	154	68	33						
23	ENG Sbgrp Concept Des, TP Prep	12.00	116	1392	300						

Assembly				Installation					Totals						
Subtotal	Material	Total	Labor	Rate	Subtotal	Material	Total	Labor	Material	Subtotal	Contingency		Total		Last
k$	k$	k$	my	k$/my	k$	k$	k$	k$	k$	k$	Rate	Amount, k$	k$		modified
16107	1651	17758	42.1	58	2461	278	2739	41914	53392	95306	34%	32811	128117		26-May-92
18969	1545	20514	42.1	58	2461	278	2739	44761	45103	89864	34%	30732	120596		26-May-92
cept those which are specifically LSDT (03.2).															
16107	1651	17758	42	58	2461	278	2739	38731	52338	91069	35%	31964	123032		26-May-92
18969	1545	20514	42	58	2461	278	2739	41578	44049	85627	35%	29884	115511		26-May-92
11552	1045	12597	24.40	61	1488	201	1689	22484	33343	55827	36%	20325	76152		26-May-92
14414	939	15353	24.40	61	1488	201	1689	25332	25054	50386	36%	18245	68631		26-May-92
			24.40	61	1488	201	1689	2630	3146	5776	28%	1625	7401		3-May-92
			14.66		845	114	959	953	2692	3645	22%	815	4460		
			3.00	78	234	79	313	234	149	383	17%	65	448		2-May-92
			3.16	56	177	18	195	216	2096	2312	23%	532	2844		2-May-92
			2.00	58	116	9	125	146	336	482	23%	111	592		2-May-92
			6.50	49	319	8	327	358	111	469	23%	108	576		6-Jan-92
			9.74		643	87	730	1677	454	2131	38%	810	2940		
			9.74	66	643	87	730	1677	454	2131	38%	810	2940		6-Jan-92
10222	865	11087						14768	18892	33660	36%	12173	45834		3-May-92
13084	759	13843						17615	11666	29281	36%	10519	39801		3-May-92
681	76	757						793	885	1678	23%	378	2057		
0	50	50						0	100	100	15%	15	115		13-Jan-92
74	6	80						117	134	251	23%	58	309		2-May-92
563	19	582						612	598	1210	23%	278	1489		2-May-92
44	1	45						64	53	117	23%	27	144		10-Jan-92
25	3	28						384	111	495	42%	208	704		

Assembly				Installation					Totals					
Subtotal	Material	Total	Labor	Rate	Subtotal	Material	Total	Labor	Material	Subtotal	Contingency		Total	Last
k$	k$	k$	my	k$/my	k$	k$	k$	k$	k$	k$	Rate	Amount, k$	k$	modified
25	3	28						384	111	495	42%	208	704	10-Jan-92
4646	430	5076						5896	10527	16423	37%	6126	22549	
4646	430	5076						5896	10527	16423	37%	6126	22549	
49	201	250						80	253	333	38%	126	459	23-Jan-92
623	7	630						689	38	727	38%	276	1003	23-Jan-92
1798	24	1822						2098	88	2186	38%	831	3016	22-Apr-92
364	125	489						464	130	594	23%	137	730	22-Jan-92
1812	73	1885						2217	9998	12215	38%	4642	16857	7-May-92
								349	20	369	31%	114	483	22-Jan-92
7586	330	7916						8836	3102	11938	37%	4422	16359	
7586	330	7916						8836	3102	11938	37%	4422	16359	
49	101	150						80	153	233	38%	88	321	23-Jan-92
623	7	630						689	38	727	38%	276	1003	23-Jan-92
1960	24	1984						2259	443	2702	38%	1027	3729	22-Jan-92
364	125	489						464	130	594	23%	137	730	22-Jan-92
4590	73	4663						4995	2318	7313	38%	2779	10092	30-Apr-92
								349	20	369	31%	114	483	22-Jan-92
3703	137	3840						4993	5134	10127	37%	3751	13879	
3703	137	3840						4993	5134	10127	37%	3751	13879	
49	101	150						80	153	233	38%	88	321	24-Jan-92
600	7	607						666	60	726	38%	276	1002	24-Jan-92
470	6	476						769	320	1089	38%	414	1503	21-Apr-92
364	5	369						464	10	474	23%	109	582	24-Jan-92
2220	18	2238						2666	4571	7237	38%	2750	9987	21-Apr-92
								349	20	369	31%	114	483	23-Jan-92
954	169	1123						1928	1389	3317	37%	1217	4534	
954	169	1123						1928	1389	3317	37%	1217	4534	
25	101	126						64	123	187	15%	28	215	12-Jan-92
929	68	997						1219	1244	2463	38%	936	3398	26-May-92
0	0							645	22	667	38%	253	920	2-May-92
876	163	1039						1835	1348	3183	37%	1167	4350	
876	163	1039						1835	1348	3183	37%	1167	4350	
25	101	126						64	123	187	15%	28	215	12-Jan-92
851	62	913						1126	1203	2329	38%	885	3214	26-May-92

Assembly				Installation				Totals						
Subtotal	Material	Total	Labor	Rate	Subtotal	Material	Total	Labor	Material	Subtotal	Contingency		Total	Last
k$	k$	k$	my	k$/my	k$	k$	k$	k$	k$	k$	Rate	Amount, k$	k$	modified
0	0							645	22	667	38%	253	920	2-May-92
214	50	264						773	846	1619	30%	493	2112	
95	25	120						375	611	986	32%	320	1306	
95	25	120						375	611	986	32%	320	1306	
0	25	25						125	50	175	15%	26	201	31-Jan-92
24		24						39	5	44	23%	10	55	31-Jan-92
24		24						39	5	44	23%	10	55	31-Jan-92
24		24						39	30	69	23%	16	85	31-Jan-92
24		24						55	511	566	42%	238	804	3-May-92
		0						77	10	87	23%	20	106	31-Jan-92
214	50	264						773	1086	1859	1	593	2453	
95	25	120						375	851	1226	34%	421	1647	
95	25	120						375	851	1226	34%	421	1647	
0	25	25						125	50	175	15%	26	201	31-Jan-92
24		24						39	5	44	23%	10	55	31-Jan-92
24		24						39	5	44	23%	10	55	31-Jan-92
24		24						39	30	69	23%	16	85	31-Jan-92
24		24						55	751	806	42%	339	1145	3-May-92
		0						77	10	87	23%	20	106	31-Jan-92
119	25	144						398	235	633	27%	172	806	
119	25	144						398	235	633	27%	172	806	
0	25	25						125	50	175	15%	26	201	31-Jan-92
24		24						39	5	44	23%	10	55	31-Jan-92
24		24						39	5	44	23%	10	55	31-Jan-92
24		24						39	30	69	23%	16	85	31-Jan-92
48		48						79	135	214	42%	90	304	31-Jan-92
		0						77	10	87	23%	20	106	31-Jan-92
190	0	190						2706	10185	12891	40%	5126	18017	21-Apr-92
190	0	190						2706	9122	11828	40%	4701	16529	21-Apr-92
0	0	0						1239	7696	8935	40%	3574	12509	
0	0	0						1239	7696	8935	40%	3574	12509	
								1009	6703	7712	40%	3085	10796	21-Apr-92
								154	265	419	40%	167	586	21-Apr-92

MUON SUBSYSTEM COST MATRIX Rev 10 5/20/92

Assembly			Installation					Totals						
Subtotal	Material	Total	Labor	Rate	Subtotal	Material	Total	Labor	Material	Subtotal	Contingency		Total	Last
k$	k$	k$	my	k$/my	k$	k$	k$	k$	k$	k$	Rate	Amount, k$	k$	modified
								77	728	805	40%	322	1127	21-Apr-92
0	0	0						1239	6633	7872	40%	3149	11021	
0	0	0						1239	6633	7872	40%	3149	11021	
								1009	5703	6712	40%	2685	9396	21-Apr-92
								154	265	419	40%	167	586	21-Apr-92
								77	665	742	40%	297	1039	21-Apr-92
								970	2214	3184	40%	1274	4457	
								970	2214	3184	40%	1274	4457	
								739	1823	2562	40%	1025	3587	21-Apr-92
								154	275	429	40%	171	600	21-Apr-92
								77	116	193	40%	77	270	21-Apr-92
190	0	190						497	275	772	36%	279	1051	
95	0	95						249	135	384	36%	139	522	31-Jan-92
95	0	95						172	125	297	40%	119	416	31-Jan-92
								77	10	87	23%	20	106	31-Jan-92
95	0	95						249	140	389	36%	140	528	
95	0	95						172	125	297	40%	119	416	31-Jan-92
								77	15	92	23%	21	113	31-Jan-92
570	90	660						1190	560	1750	40%	700	2450	
570	90	660						1190	560	1750	40%	700	2450	
285	45	330						595	280	875	40%	350	1225	
285	45	330						595	280	875	40%	350	1225	
24	5	29						39	10	49	40%	20	69	31-Jan-92
95	15	110						111	20	131	40%	52	183	31-Jan-92
95	15	110						111	20	131	40%	52	183	31-Jan-92
71	10	81						87	215	302	40%	121	423	31-Jan-92
								248	15	263	40%	105	368	31-Jan-92
285	45	330						595	280	875	40%	350	1225	
285	45	330						595	280	875	40%	350	1225	
24	5	29						39	10	49	40%	20	69	31-Jan-92
95	15	110						111	20	131	40%	52	183	31-Jan-92

Assembly				Installation					Totals						
Subtotal	Material	Total	Labor	Rate	Subtotal	Material	Total	Labor	Material	Subtotal	Contingency		Total		Last
k$	k$	k$	my	k$/my	k$	k$	k$	k$	k$	k$	Rate	Amount, k$	k$		modified
95	15	110						111	20	131	40%	52	183		31-Jan-92
71	10	81						87	215	302	40%	121	423		31-Jan-92
								248	15	263	40%	105	368		31-Jan-92
285	45	330						595	280	875	40%	350	1225		
285	45	330						595	280	875	40%	350	1225		
24	5	29						39	10	49	40%	20	69		31-Jan-92
95	15	110						111	20	131	40%	52	183		31-Jan-92
95	15	110						111	20	131	40%	52	183		31-Jan-92
71	10	81						87	215	302	40%	121	423		31-Jan-92
								248	15	263	40%	105	368		31-Jan-92
570	90	660						1190	560	1750	40%	700	2450		
570	90	660						1190	560	1750	40%	700	2450		
285	45	330						595	280	875	40%	350	1225		
285	45	330						595	280	875	40%	350	1225		
24	5	29						39	10	49	40%	20	69		31-Jan-92
95	15	110						111	20	131	40%	52	183		31-Jan-92
95	15	110						111	20	131	40%	52	183		31-Jan-92
71	10	81						87	215	302	40%	121	423		31-Jan-92
								248	15	263	40%	105	368		31-Jan-92
285	45	330						595	280	875	40%	350	1225		
285	45	330						595	280	875	40%	350	1225		
24	5	29						39	10	49	40%	20	69		31-Jan-92
95	15	110						111	20	131	40%	52	183		31-Jan-92
95	15	110						111	20	131	40%	52	183		31-Jan-92
71	10	81						87	215	302	40%	121	423		31-Jan-92
								248	15	263	40%	105	368		31-Jan-92
285	45	330						595	280	875	40%	350	1225		
285	45	330						595	280	875	40%	350	1225		
24	5	29						39	10	49	40%	20	69		31-Jan-92
95	15	110						111	20	131	40%	52	183		31-Jan-92
95	15	110						111	20	131	40%	52	183		31-Jan-92
71	10	81						87	215	302	40%	121	423		31-Jan-92
								248	15	263	40%	105	368		31-Jan-92

Assembly				Installation					Totals					
Subtotal	Material	Total	Labor	Rate	Subtotal	Material	Total	Labor	Material	Subtotal	Contingency		Total	Last
k$	k$	k$	my	k$/my	k$	k$	k$	k$	k$	k$	Rate	Amount, k$	k$	modified
4461	602	5063	18	55	972	77	1049	12797	18722	31519	36%	11311	42830	3-May-92
			17.74	55	972	77	1049	1475	1924	3399	28%	962	4361	
			12.83	52	663	21	684	760	1690	2450	23%	563	3013	
			6.00	51	306	7	313	332	46	378	23%	87	465	27-Jan-92
			1.58	56	88	7	95	114	1546	1660	23%	382	2042	2-May-92
			3.00	52	156	4	160	182	43	225	23%	52	276	27-Jan-92
			2.25	50	113	3	116	132	55	187	23%	43	230	27-Jan-92
			4.91	63	309	56	365	716	234	950	42%	399	1348	
			4.91	63	309	56	365	716	234	950	42%	399	1348	27-Jan-92
3587	522	4109						7164	6242	13406	33%	4491	17897	
245	76	321						434	835	1269	22%	282	1551	
0	50	50						77	50	127	15%	19	146	13-Jan-92
75	6	81						119	134	253	23%	58	311	2-May-92
150	19	169						199	598	797	23%	183	980	2-May-92
20	1	21						40	53	93	23%	21	114	10-Jan-92
147	3	150						506	111	617	42%	259	877	
147	3	150						506	111	617	42%	259	877	10-Jan-92
2563	306	2869						3796	3787	7583	35%	2679	10262	
2563	306	2869						3796	3787	7583	35%	2679	10262	
49	101	150						80	153	233	15%	35	268	2-May-92
24	7	31						91	38	129	23%	30	158	23-Jan-92
1220		1220						1519	52	1571	23%	361	1933	2-May-92
50	125	175						150	130	280	23%	64	344	22-Jan-92
1220	73	1293						1625	3394	5019	42%	2108	7127	2-May-92
								332	20	352	23%	81	432	22-Jan-92
395	107	502						1631	1083	2714	35%	937	3651	
395	107	502						1631	1083	2714	35%	937	3651	
0	75	75						125	100	225	15%	34	259	31-Jan-92

Assembly				Installation					Totals						
Subtotal	Material	Total	Labor	Rate	Subtotal	Material	Total	Labor	Material	Subtotal	Contingency		Total		Last
k$	k$	k$	my	k$/my	k$	k$	k$	k$	k$	k$	Rate	Amount, k$	k$		modified
								125	15	140	23%	32	172		31-Jan-92
								125	15	140	23%	32	172		31-Jan-92
								63	10	73	38%	28	100		31-Jan-92
488	36	524						702	609	1311	38%	498	1809		26-May-92
								645	22	667	38%	253	920		2-May-92
238	30	268						797	426	1223	27%	333	1556		
119	15	134						398	213	611	27%	167	778		
119	15	134						398	213	611	27%	167	778		
0	15	15						125	40	165	15%	25	190		31-Jan-92
24		24						39	2	41	23%	10	51		31-Jan-92
24		24						39	2	41	23%	10	51		31-Jan-92
24		24						39	27	66	23%	15	82		31-Jan-92
48		48						79	127	206	42%	86	292		3-May-92
		0						77	15	92	23%	21	113		31-Jan-92
119	15	134						398	213	611	27%	167	778		
119	15	134						398	213	611	27%	167	778		
0	15	15						125	40	165	15%	25	190		31-Jan-92
24		24						39	2	41	23%	10	51		31-Jan-92
24		24						39	2	41	23%	10	51		31-Jan-92
24		24						39	27	66	23%	15	82		31-Jan-92
48		48						79	127	206	42%	86	292		31-Jan-92
		0						77	15	92	23%	21	113		2-Dec-91
114	0	114						2756	9675	12431	40%	4945	17376		21-Apr-92
0	0	0						2381	9026	11407	40%	4563	15970		
0	0	0						2381	9026	11407	40%	4563	15970		
								1078	5782	6860	40%	2744	9604		21-Apr-92
								847	2077	2924	40%	1170	4094		21-Apr-92
								354	737	1091	40%	436	1528		21-Apr-92
								102	105	207	40%	83	289		21-Apr-92
								0	325	325	40%	130	455		21-Apr-92
114	0	114						375	649	1024	37%	382	1407		
19	0	19						127	538	665	38%	252	917		
19		19						50	534	584	40%	234	818		31-Jan-92
								77	4	81	23%	19	99		31-Jan-92

MUON SUBSYSTEM COST MATRIX Rev 10 5/20/92

Assembly				Installation					Totals					
Subtotal	Material	Total	Labor	Rate	Subtotal	Material	Total	Labor	Material	Subtotal	Contingency		Total	Last
k$	k$	k$	my	k$/my	k$	k$	k$	k$	k$	k$	Rate	Amount, k$	k$	modified
95		95						249	111	360	36%	130	490	
95	0	95						172	107	279	40%	112	391	31-Jan-92
								77	4	81	23%	19	99	31-Jan-92
428	40	468						756	465	1221	40%	488	1709	
428	40	468						756	465	1221	40%	488	1709	
428	40	468						756	465	1221	40%	488	1709	
166	0	166						355	207	562	40%	225	787	2-Dec-91
95	15	110						111	19	130	40%	52	181	2-Dec-91
95	15	110						111	20	131	40%	52	183	2-Dec-91
71	10	81						87	215	302	40%	121	423	2-Dec-91
								92	4	96	40%	38	135	2-Dec-91
333	40	373						646	416	1062	40%	425	1486	
333	40	373						646	416	1062	40%	425	1486	
333	40	373						646	416	1062	40%	425	1486	
0	0	0						16	7	23	40%	9	33	2-Dec-91
95	15	110						111	20	131	40%	52	183	2-Dec-91
166	15	181						355	170	525	40%	210	735	2-Dec-91
71	10	81						87	215	302	40%	121	423	2-Dec-91
								77	4	81	40%	32	113	2-Dec-91
								3296	585	3881	10%	388	4269	
								1463	300	1763	10%	176	1939	27-Nov-91
								183	45	228	10%	23	251	27-Nov-91
								367	90	457	10%	46	502	27-Nov-91
								550	90	640	10%	64	704	27-Nov-91
								367	30	397	10%	40	436	27-Nov-91
								367	30	397	10%	40	436	27-Nov-91
								1791	754	2545	20%	509	3054	
								407	220	627	20%	125	752	31-Jan-92

Assembly				Installation					Totals					
Subtotal	Material	Total	Labor	Rate	Subtotal	Material	Total	Labor	Material	Subtotal	Contingency		Total	Last
k$	k$	k$	my	k$/my	k$	k$	k$	k$	k$	k$	Rate	Amount, k$	k$	modified
								482	144	626	20%	125	751	31-Jan-92
								299	203	502	20%	100	602	31-Jan-92
								228	148	376	20%	75	451	31-Jan-92
								308	6	314	20%	63	377	31-Jan-92
								68	33	101	20%	20	121	31-Jan-92
								1392	300	1692	20%	338	2030	31-Jan-92

G E M

Muon Subsystem Cost Summary

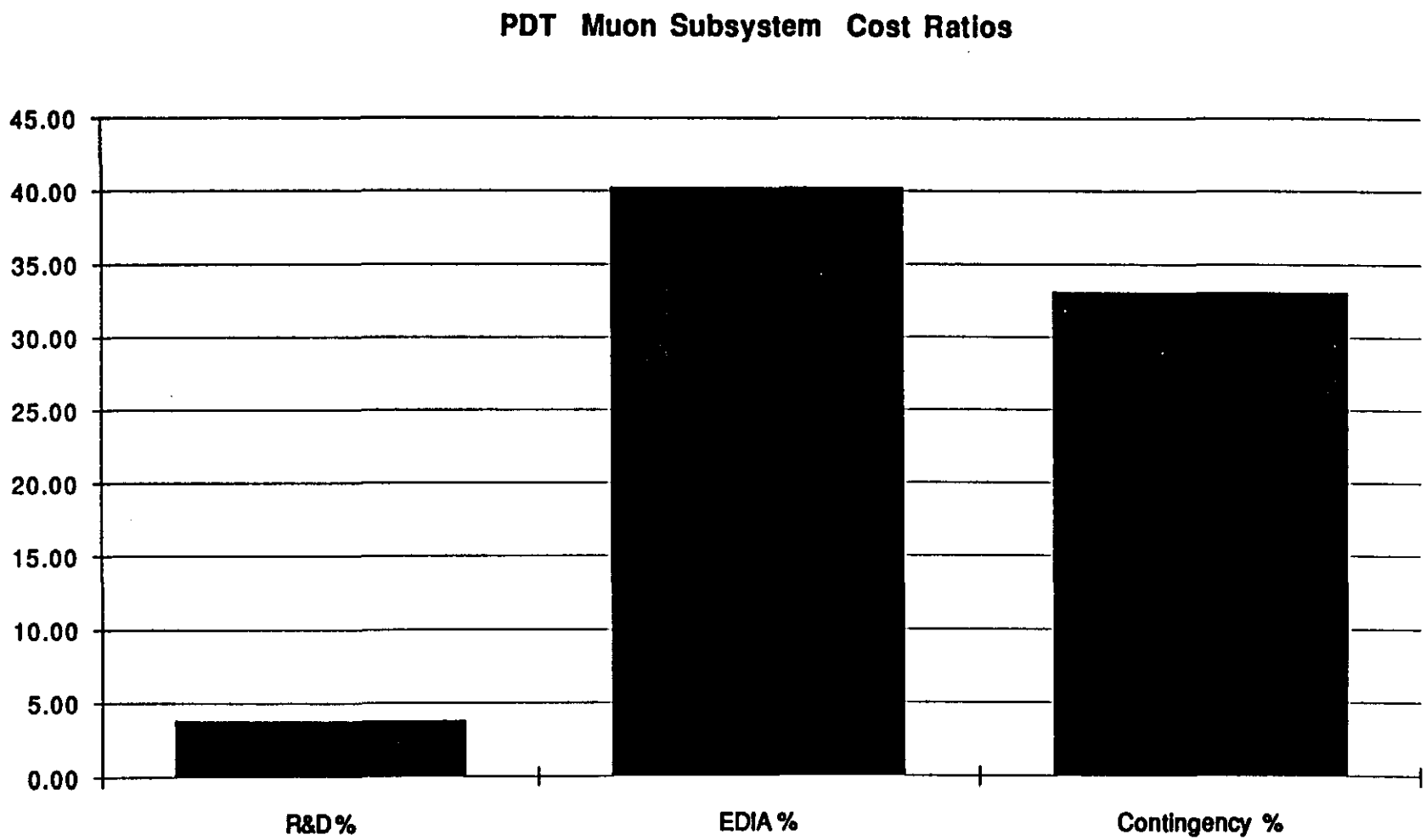
DRAPER LABORATORY

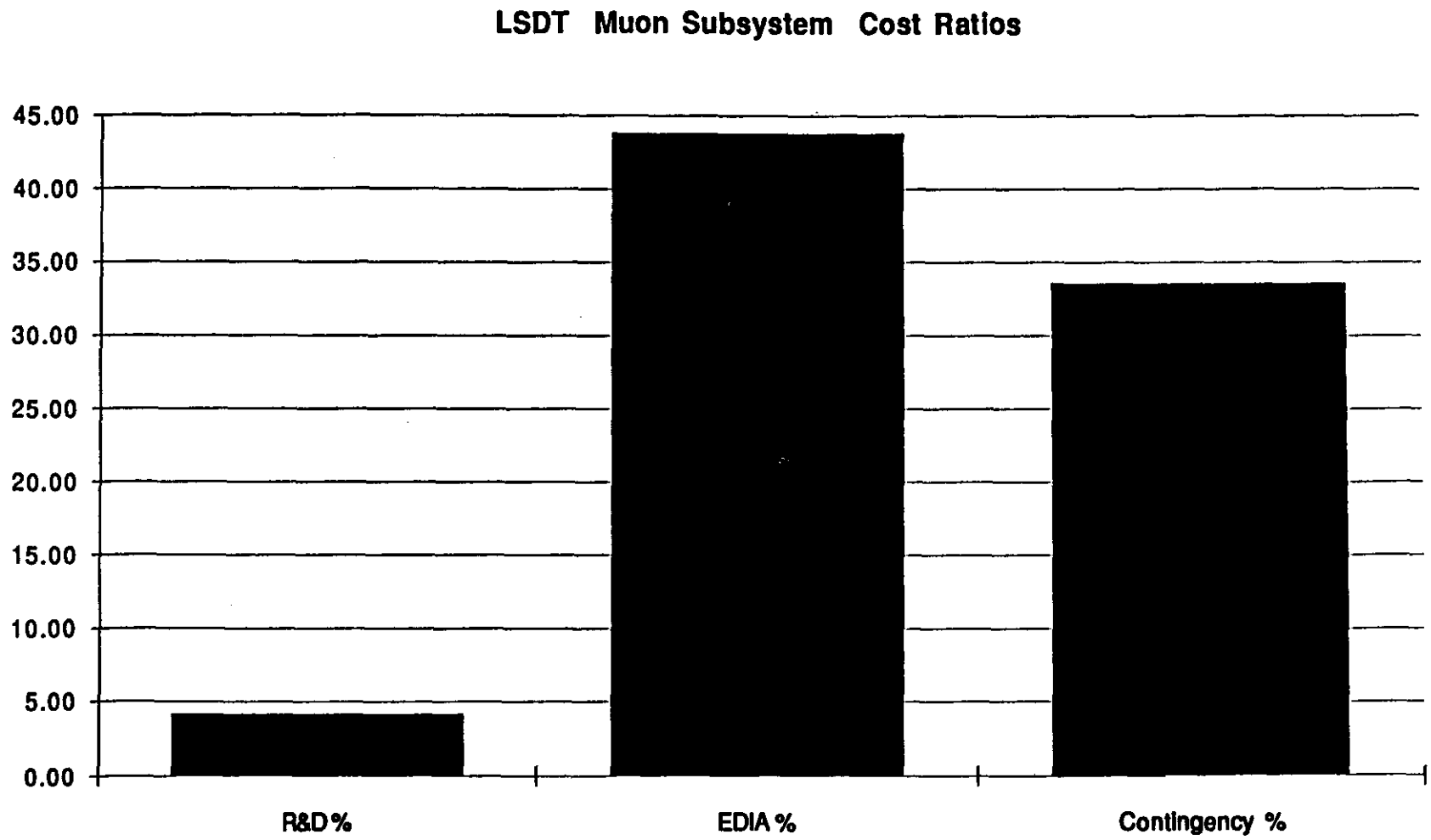
Muon Subsystem Cost Summary - Rev. 10 5/26/92

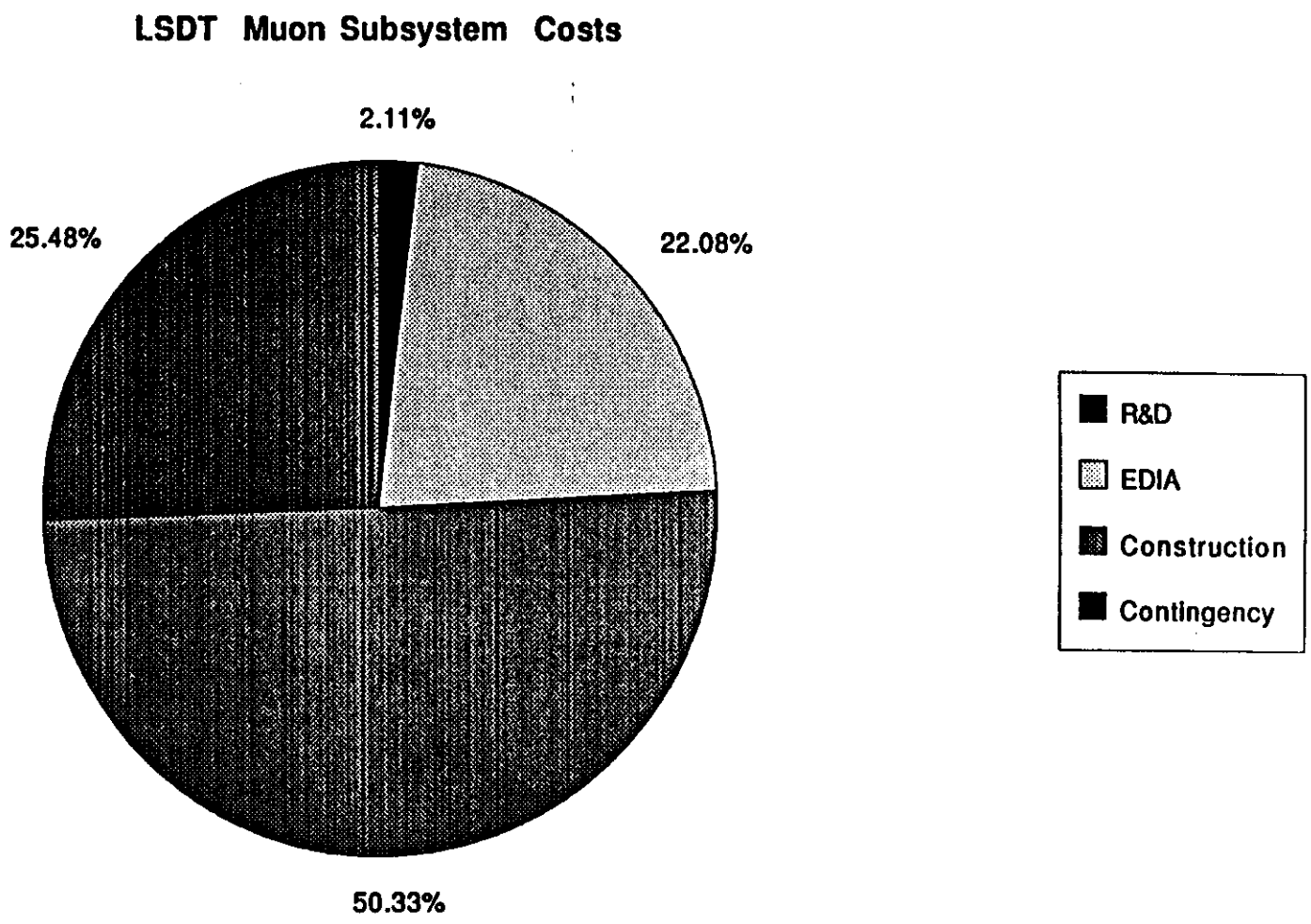
WBS No.	Item	Engrg/Design	M&S	Insp/Admin	Materials	Assembly	Installation	Sub-total	Contingency	Total
(-3.1)	Totals - PDT	12.747	5.84	10.602	45.622	17.759	2.738	95.308	32.81	128.118
(-3.2)	Totals - LSDT	12.747	5.838	10.587	37.441	20.515	2.738	89.866	30.731	120.597
03.1.1	Central Region - PDT	5.257	2.226	4.187	29.871	12.597	1.689	55.827	20.324	76.151
03.1.1.1	Installation	0.891	0.075	0.25	2.87	0	1.689	5.775	1.625	7.4
03.1.1.2	Sector Assembly	1.653	0.391	2.893	17.636	11.087	0	33.66	12.173	45.833
03.1.1.3	Electronics	1.785	1.62	0.732	8.565	0.19	0	12.892	5.126	18.018
03.1.1.4	Gas Systems	0.464	0.07	0.156	0.4	0.66	0	1.75	0.7	2.45
03.1.1.5	Cooling Systems	0.464	0.07	0.156	0.4	0.66	0	1.75	0.7	2.45
03.2.1	Central Region - LSDT	5.257	2.224	4.172	21.69	15.353	1.689	50.385	18.245	68.63
03.2.1.1	Installation	0.891	0.075	0.25	2.87	0	1.689	5.775	1.625	7.4
03.2.1.2	Sector Assembly	1.653	0.389	2.878	10.518	13.843	0	29.281	10.519	39.8
03.2.1.3	Electronics	1.785	1.62	0.732	7.502	0.19	0	11.829	4.701	16.53
03.2.1.4	Gas Systems	0.464	0.07	0.156	0.4	0.66	0	1.75	0.7	2.45
03.2.1.5	Cooling Systems	0.464	0.07	0.156	0.4	0.66	0	1.75	0.7	2.45
03.1.2	End Cap Region	4.307	1.975	3.119	15.751	5.162	1.049	31.363	11.251	42.614
03.1.2.1	Installation	0.297	0.036	0.206	1.811	0	1.049	3.399	0.962	4.361
03.1.2.2	Sector Assembly	1.322	0.337	2.315	5.067	4.207	0	13.248	4.431	17.679
03.1.2.3	Electronics	2.534	1.552	0.109	8.123	0.114	0	12.432	4.945	17.377
03.1.2.4	Gas Systems	0.077	0.025	0.252	0.4	0.468	0	1.222	0.488	1.71
03.1.2.5	Cooling Systems	0.077	0.025	0.237	0.35	0.373	0	1.062	0.425	1.487
03.1.3	Project Mgmt.	0	0.585	3.296	0	0	0	3.881	0.388	4.269
13	R&D	1.791	0.754	0	0	0	0	2.545	0.509	3.054
23	Concept Design	1.392	0.3	0	0	0	0	1.692	0.338	2.03

Muon Subsystem Cost Summary - Rev. 10 5/26/92

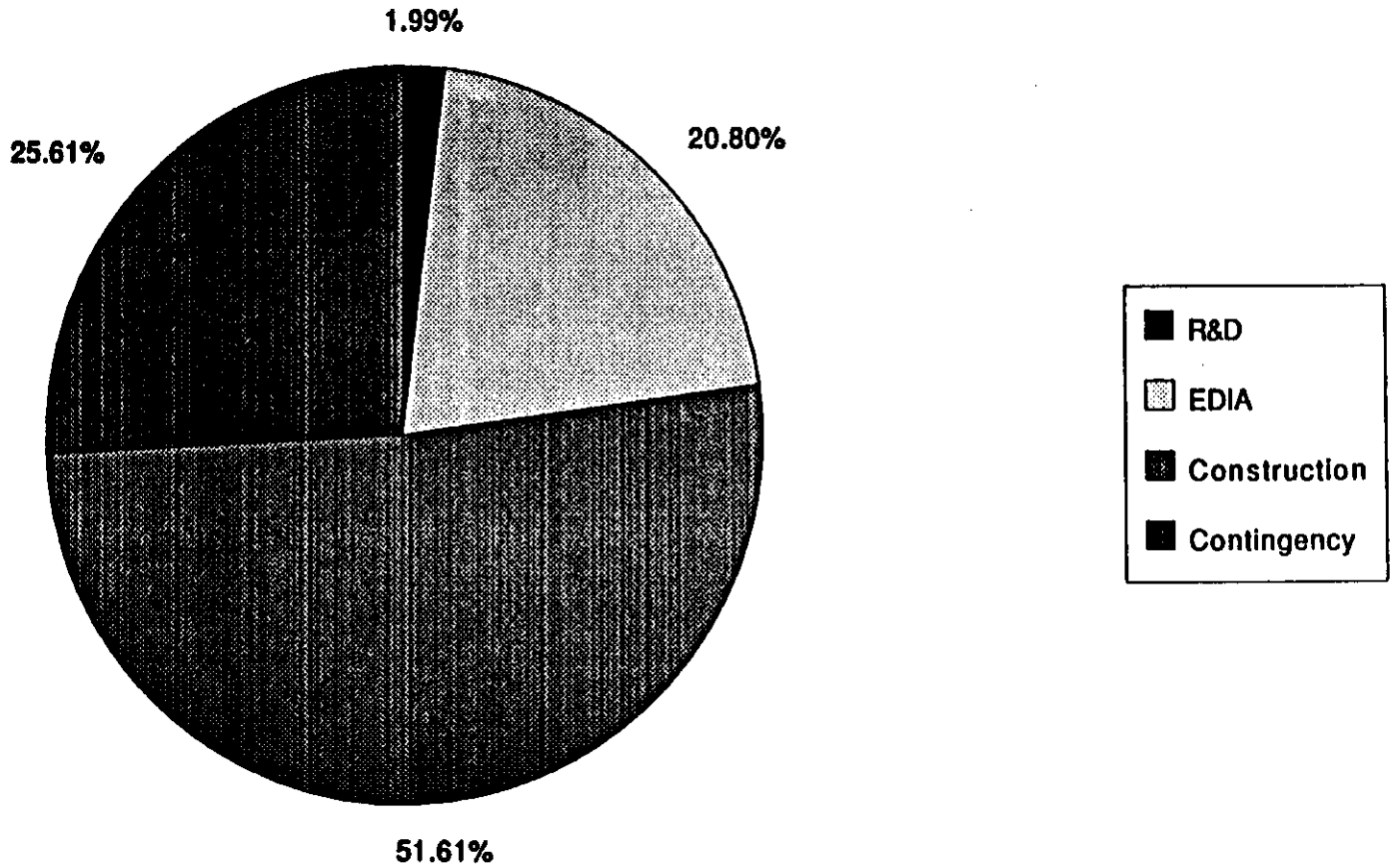
	A	B	C	D	E	F	G	H	I	J	K	M	N
1	WBS No.	Item	Engrg/Design	M&S	Insp/Admin	Materials	Assembly	Installation	Sub-total	Contingency	Total	EDIA	Construction
2													
3	(-3.1)	Totals - PDT	12.747	5.84	10.602	45.622	17.759	2.738	95.308	32.81	128.118	29.189	66.119
4													
5	(-3.2)	Totals - LSDT	12.747	5.838	10.587	37.441	20.515	2.738	89.866	30.731	120.597	29.172	60.694
6													
7	03.1.1	Central Region - PDT	5.257	2.226	4.187	29.871	12.597	1.689	55.827	20.324	76.151	11.67	44.157
8	03.1.1.1	Installation	0.891	0.075	0.25	2.87	0	1.689	5.775	1.625	7.4	1.216	4.559
9	03.1.1.2	Sector Assembly	1.653	0.391	2.893	17.636	11.087	0	33.66	12.173	45.833	4.937	28.723
10	03.1.1.3	Electronics	1.785	1.62	0.732	[illegible]	0.19	[illegible]	12.892	5.126	18.018	4.137	8.755
11	03.1.1.4	Gas Systems	0.464	0.07	[illegible]	[illegible]	0.66	[illegible]	1.75	0.7	2.45	0.69	1.06
12	03.1.1.5	Cooling Systems	0.464	[illegible]	[illegible]	0.4	0.66	[illegible]	1.75	0.7	2.45	0.69	1.06
13													
14	03.2.1	Central Region - LSDT	5.257	2.224	4.172	21.69	15.353	1.689	50.385	18.245	68.63	11.653	38.732
15	03.2.1.1	Installation	0.891	0.075	0.25	2.87	0	1.689	5.775	1.625	7.4	1.216	4.559
16	03.2.1.2	Sector Assembly	1.653	0.389	2.878	10.518	13.843	0	29.281	10.519	39.8	4.92	24.361
17	03.2.1.3	Electronics	[illegible]	1.62	0.732	7.502	0.19	0	11.829	4.701	16.53	4.1[illegible]	7.692
18	03.2.1.4	Gas Systems	0	0.07	0.156	0.4	0.66	0	1.75	0.7	2.45	0.69	1.06
19	03.2.1.5	Cooling Systems	0.464	0.07	0.156	0.4	0.66	0	1.75	0.7	2.45	0.69	1.06
20													
21	03.1.2	End Cap Region	4.307	1.975	3.119	15.751	5.162	1.049	31.363	11.251	42.614	9.401	21.962
22	03.1.2.1	Installation	0.297	0.036	0.206	1.811	0	1.049	3.399	0.962	4.361	0.539	2.86
23	03.1.2.2	Sector Assembly	1.322	0.337	2.315	5.067	4.207	0	13.248	4.431	17.679	3.974	9.274
24	03.1.2.3	Electronics	2.534	1.552	0.109	8.123	0.114	0	12.432	4.945	17.377	4.195	8.237
25	03.1.2.4	Gas Systems	0.077	0.025	0.252	[illegible]	0.468	0	1.222	0.488	1.71	0.354	0.868
26	03.1.2.5	Cooling Systems	0.077	0.025	0.237	[illegible]	0.373	0	1.062	0.425	1.487	0.339	0.723
27													
28	03.1.3	Project Mgmt.	0	0.585	3.296	0	0	0	3.881	0.388	4.269	3.881	0
29													
30	13	R&D	1.791	0.754	0	0	0	0	2.545	0.509	3.054	2.545	0
31													
32	23	Concept Design	1.392	0.3	0	0	0	0	1.692	0.338	2.03	1.692	0
33													
34	(-3.1)	Totals - PDT	12.747	5.84	10.602	45.622	17.759	2.738	95.308	32.81	128.118	29.189	66.119
35													
36	(-3.2)	Totals - LSDT	12.747	5.838	10.587	37.441	20.515	2.738	89.866	30.731	120.597	29.172	60.694
37													
38													
39					PDT					LSDT			
40													
41				Central Region	End Cap Region	Totals			Central Region	End Cap Region	Totals		
42			EDIA	11.67	9.401	29.189		EDIA	11.653	9.401	29.172		
43			Construction	44.157	21.962	66.119		Construction	38.732	21.962	60.694		
44			Contingency	20.324	11.251	32.81		Contingency	18.245	11.251	30.731		
45													
46													
47		R&D	2.545		R&D %	3.85		R&D	2.545		R&D %	4.19	
48		EDIA	26.644		EDIA %	40.30		EDIA	26.627		EDIA %	43.87	
49		Construction	66.119		Contingency %	33.17		Construction	60.694		Contingency %	33.61	
50		Contingency	32.81					Contingency	30.731				
51													

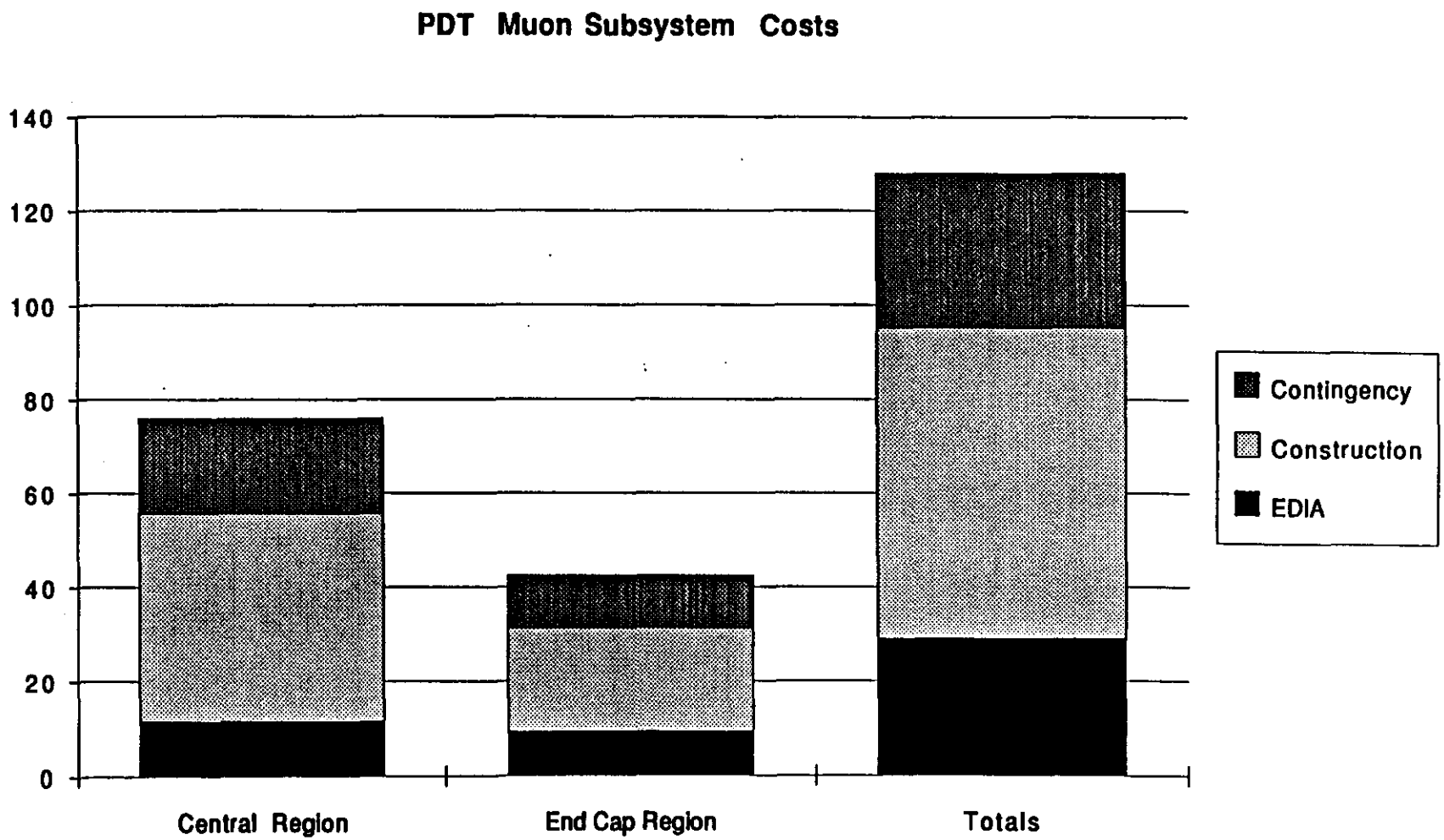

PDT Muon Subsystem Cost Ratios
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
R&D %
EDIA %
Contingency %

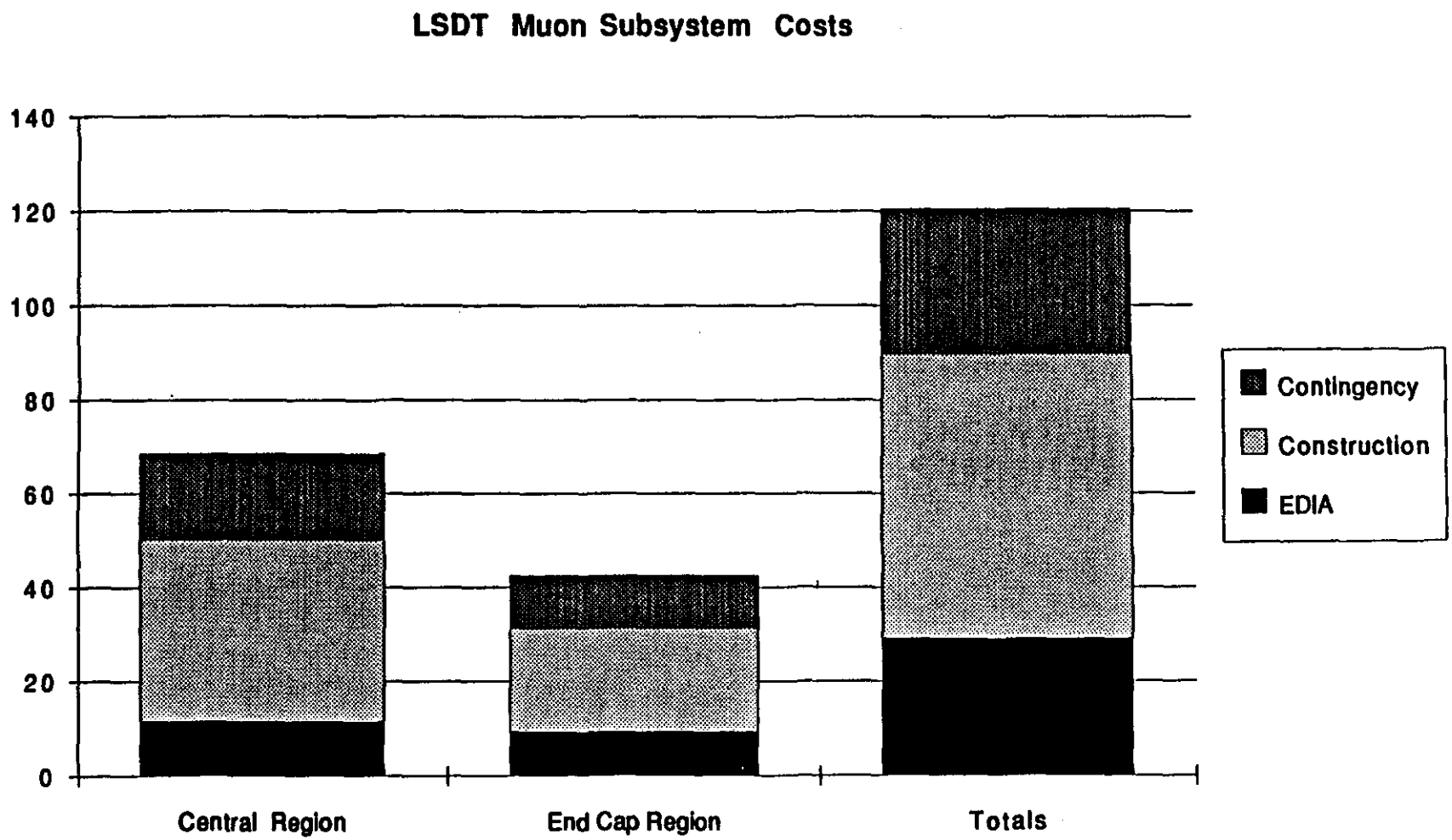

LSDT Muon Subsystem Cost Ratios
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
R&D %
EDIA %
Contingency %


LSDT Muon Subsystem Costs
2.11%
22.08%
25.48%
50.33%
R&D
EDIA
Construction
Contingency

PDT Muon Subsystem Costs




PDT Muon Subsystem Costs
140
120
100
80
60
40
20
0
Central Region
End Cap Region
Totals
Contingency
Construction
EDIA


LSDT Muon Subsystem Costs
140
120
100
80
60
40
20
0
Central Region
End Cap Region
Totals
Contingency
Construction
EDIA

G E M

Muon Subsystem Cost Summary

('92 vs. '91 rates)

DRAPER LABORATORY

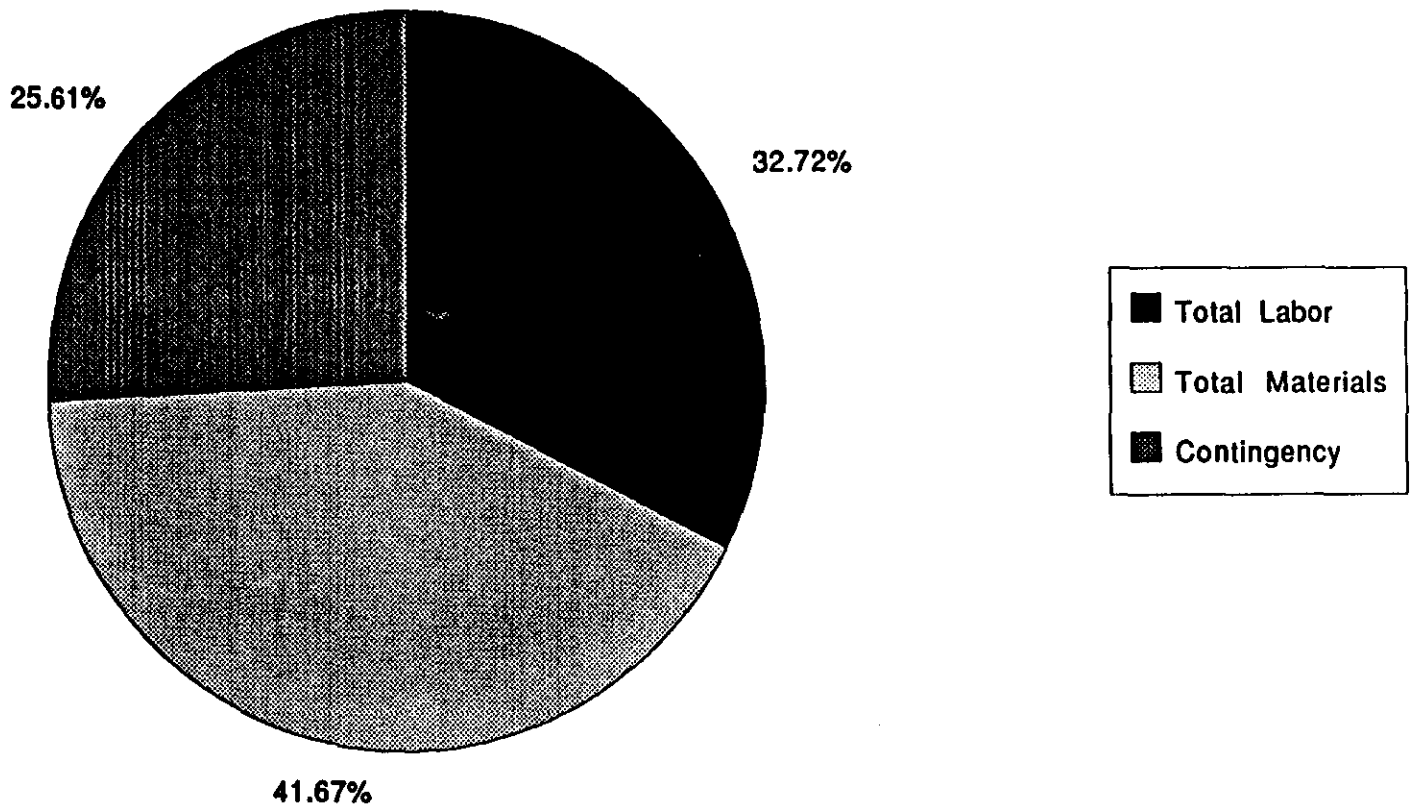
Muon Subsystem Cost Summary (91/92) 5/26/92

WBS no.	Item	Engrg./Design	M&S	Insp./Admin.	Materials	Assy. Labor	Assy. Mat'l.	Install. Labor	Install. Mat'l.	Total Labor	Total Material	Subtotal	Contingency	Total
(-3.1)	Totals - PDT	12747	5841	19692	45622	16198	1651	2460	278	41917	53392	95309	32810	128119
(-3.2)	Totals - LSDT	12747	5839	19587	37441	18978	1545	2460	278	44764	45103	89867	30731	120598
03.1.1	Central Region - PDT	5257	2226	4187	29871	11552	1045	1488	201	22484	33343	55827	20324	76151
03.1.1.1	Installation	891	75	250	2870	0	0	1488	201	2629	3146	5775	1625	7400
03.1.1.2	Sector Assembly	1653	391	2893	17636	10222	865	0	0	14768	18892	33660	12173	45833
03.1.1.3	Electronics	1785	1620	732	8585	190	0	0	0	2707	10185	12892	5126	18018
03.1.1.4	Gas Systems	464	70	156	400	570	90	0	0	1190	560	1750	700	2450
03.1.1.5	Cooling Systems	464	70	156	400	570	90	0	0	1190	560	1750	700	2450
03.2.1	Central Region - LSDT	5257	2224	4172	21690	14414	939	1488	201	25331	25054	50385	18245	68630
03.2.1.1	Installation	891	75	250	2870	0	0	1488	201	2629	3146	5775	1625	7400
03.2.1.2	Sector Assembly	1653	389	2878	10518	13084	759	0	0	17615	11666	29281	10519	39800
03.2.1.3	Electronics	1785	1620	732	7502	190	0	0	0	2707	9122	11829	4701	16530
03.2.1.4	Gas Systems	464	70	156	400	570	90	0	0	1190	560	1750	700	2450
03.2.1.5	Cooling Systems	464	70	156	400	570	90	0	0	1190	560	1750	700	2450
03.1.2	End Cap Region	4307	1978	3119	15751	4556	806	972	77	12954	18410	31364	11251	42615
03.1.2.1	Installation	297	36	206	1811	0	0	972	77	1475	1924	3399	962	4361
03.1.2.2	Sector Assembly	1322	337	2315	5067	3681	526	0	0	7318	5930	13248	4431	17679
03.1.2.3	Electronics	2534	1552	109	6123	114	0	0	0	2757	8675	12432	4945	17377
03.1.2.4	Gas Systems	77	25	252	400	428	40	0	0	757	465	1222	488	1710
03.1.2.5	Cooling Systems	77	26	237	350	333	40	0	0	647	416	1063	425	1488
03.1.3	Project Mgmt.	0	585	3296	0	0	0	0	0	3296	585	3881	388	4289
13	R&D	1791	754	0	0	0	0	0	0	1791	754	2545	509	3054
23	Concept Design	1392	300	0	0	0	0	0	0	1392	300	1692	338	2030

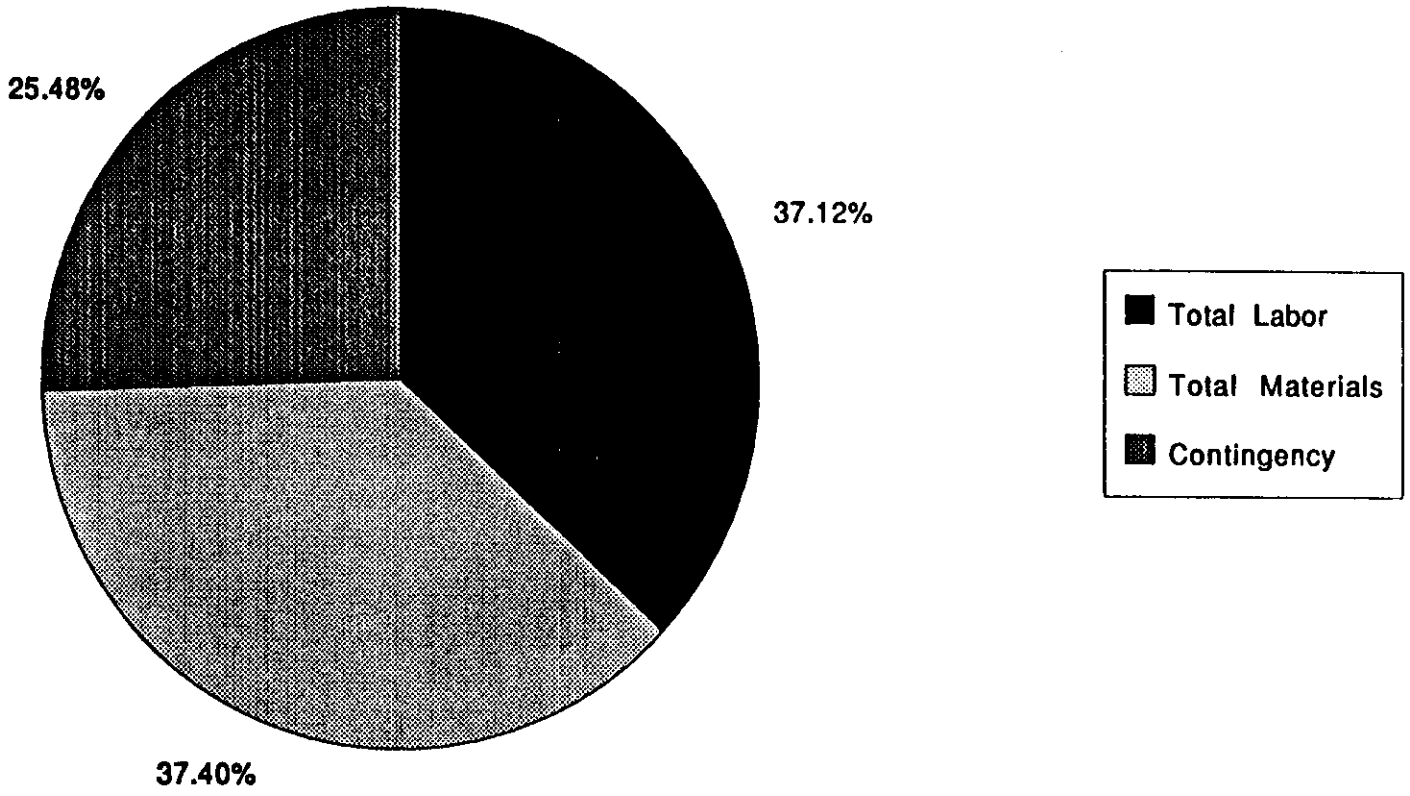
WBS no.	Revised Labor	Rev. Subtotal	Rev. Contingcy	Revised Total	% change	Depr. Mat'l.
(-3.1)	42257	95649	32829	128478	6.26%	7770
(-3.2)	44759	89862	38881	128744	6.12%	7662
03.1.1	21958	55301	20509	75810	-0.45%	3472
03.1.1.1	2576	5722	1640	7362	-0.51%	276
03.1.1.2	14041	32933	12442	45375	-1.00%	1256
03.1.1.3	2961	13146	5027	18173	0.86%	1620
03.1.1.4	1190	1750	700	2450	0.00%	160
03.1.1.5	1190	1750	700	2450	0.00%	160
03.2.1	24460	49514	18561	68075	-0.81%	3384
03.2.1.1	2576	5722	1640	7362	-0.51%	276
03.2.1.2	16543	28209	10919	39128	-1.69%	1148
03.2.1.3	2961	12083	4602	16685	0.94%	1620
03.2.1.4	1190	1750	700	2450	0.00%	160
03.2.1.5	1190	1750	700	2450	0.00%	160
03.1.2	13108	31518	11183	42701	0.20%	2659
03.1.2.1	1414	3338	980	4317	-1.00%	113
03.1.2.2	7276	13206	4445	17651	-0.16%	863
03.1.2.3	3034	12709	4837	17546	0.97%	1552
03.1.2.4	742	1207	494	1701	-0.53%	65
03.1.2.5	642	1058	427	1485	-0.22%	66
03.1.3	3659	4244	355	4598	7.72%	585
13	1988	2742	472	3214	5.25%	754
23	1845	1845	310	2155	6.16%	300

56

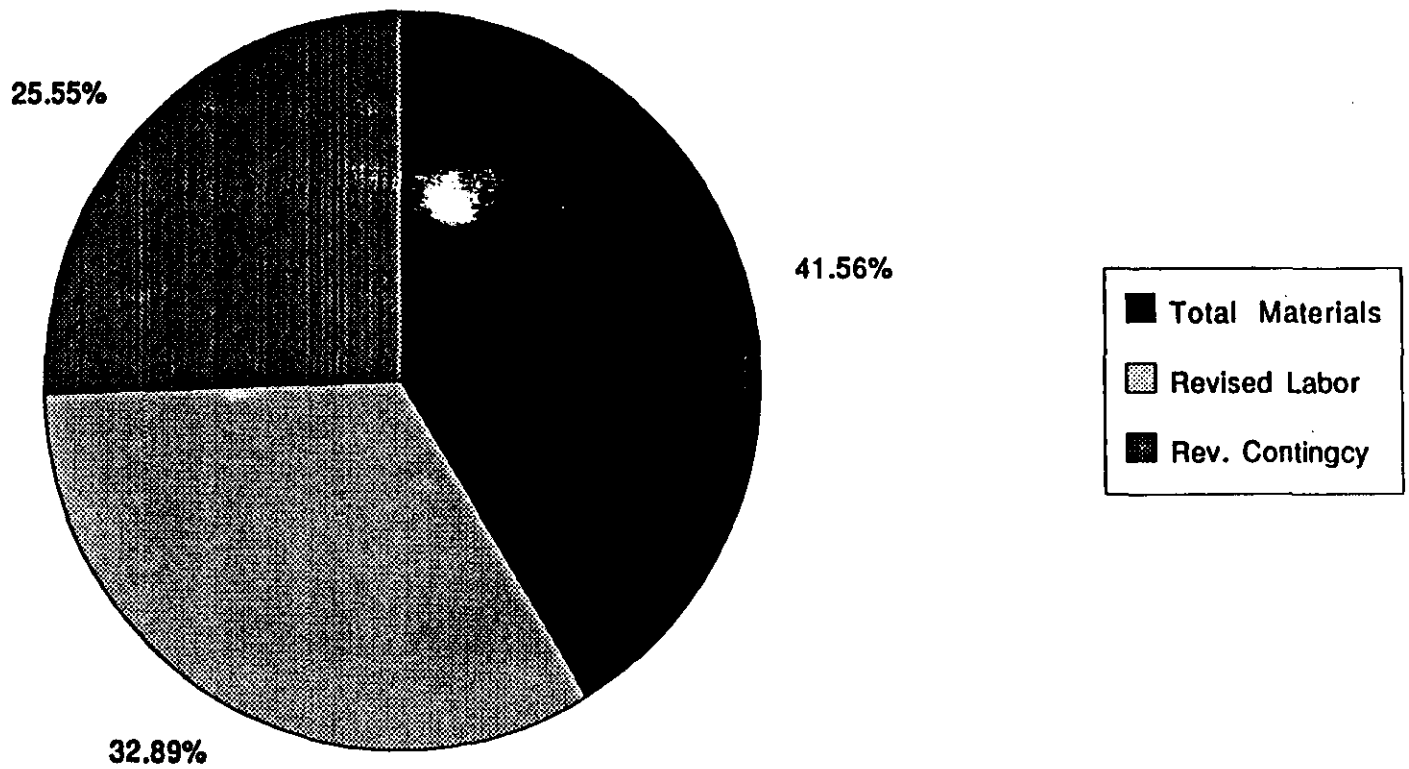
PDT Muon Subsystem Cost ('91 rates)



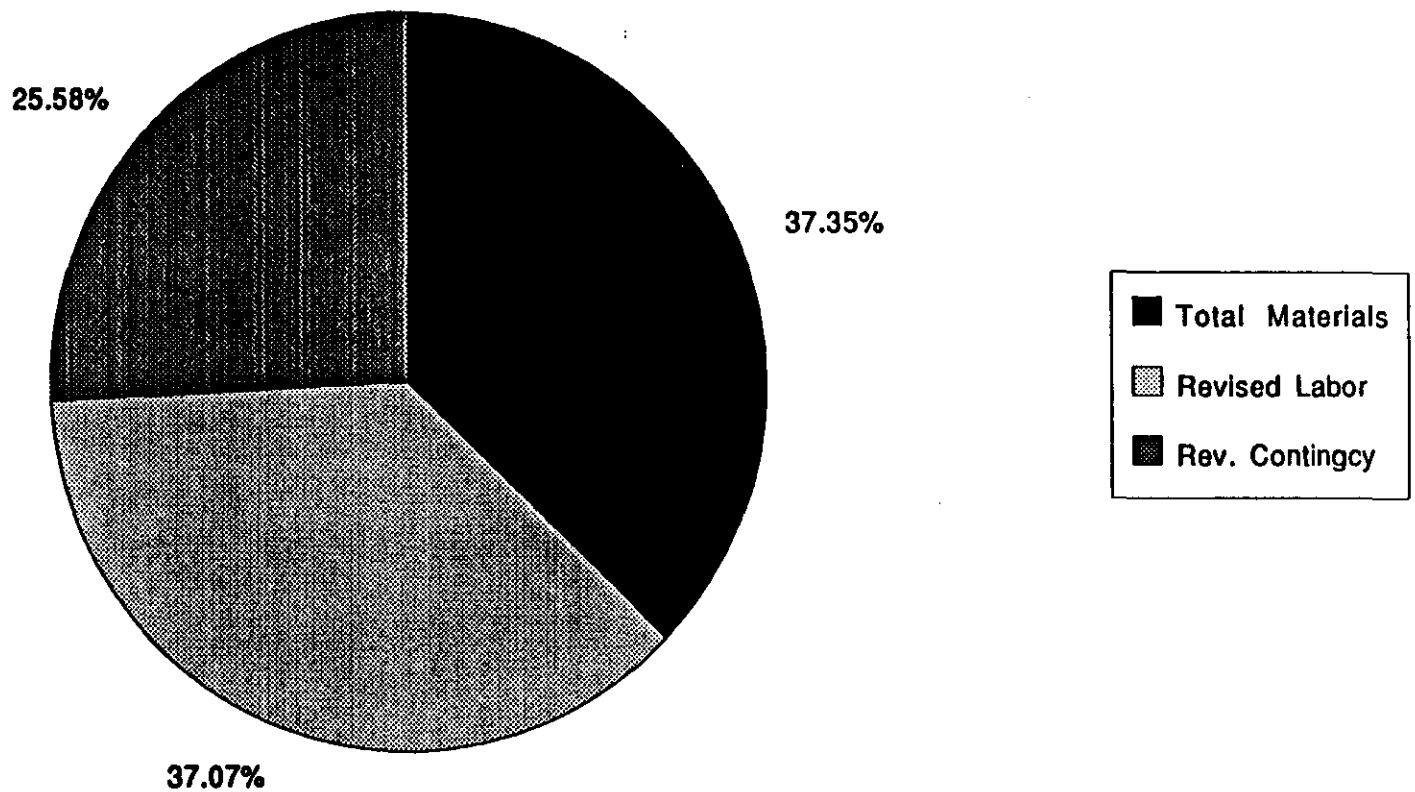
LSDT Muon Subsystem Costs ('91 rates)



PDT Muon Subsystem Costs (estimate using '92 rates)



LSDT Muon Subsystem Costs (estimate using '92 rates)



Tony Kondolean/Draper

CHARLES STARK DRAPER LABORATORY

CAMBRIDGE, MASS.

PREPARED BY: A.K

DATE: 5-27-92

SHEET 1 OF 1

PDT GAS SYSTEM

WBS#	TITLE	E/D LABOR PY	E/D LABOR K$	INSP/ADM LABOR $	INSP ADM LABOR K$	INSTALL ASSY LABOR PY	INSTALL ASSY LABOR K$	EQIA ~~MAT~~ M&S K$	PROC & material K$	INSTALL & ASS support K$	CONTIN TOTAL %
3.1.1.4.1.1	OFF-SITE SYSTEM DESIG & DRAWINGS	2.30	300	.58	104	0	0	59	0	0	26
3.1.1.4.1.2.1	ON-SITE SYST. DESIGN	4.03	233	1.15	84	0	0	76	0	0	26
3.1.1.4.1.2.2	ON-SITE TEST PROC.	.46	26	.23	17	0	0	10	0	0	39
3.1.1.4.1.2.3	ON-SITE SAFETY PROC	.58	34	.23	17	0	0	12	0	0	39
3.1.1.4.1.2.4	ON-SITE MAINT. PROC	.58	34	.23	17	0	0	12	0	0	39
3.1.1.4.1.2.5	ON-SITE INST & TEST	0	0	1.04	84	5.00	270	11	0	54	39
3.1.1.4.1.2.6	SURFACE GAS SYSTEM	0	0	.52	5	0	0	5	445	0	34
3.1.1.4.1.2.7	HULL GAS SYSTEM	0	0	.86	58	0	0	9	655	0	34
TOTALS		7.95	627	4.84	416	5.00	270	194	1,100	54	—
TOTAL PY	TOTAL $										
17.79	2661										
5.63	875	WBS									

Just for PDI

WBS

7502F079

The Charles Stark Draper Laboratory, Inc.
555 Technology Square, Cambridge, Massachusetts 02139

PREPARED BY: A.K

DATE: 5-27-92

SHEET _____

OF _____

88-4 vs 4-8-4

	PDT		PDT		LSDT		LSDT
	8-8-4		4-8-4		8-8-4		4-8-4
Level 1 channel	600		292		420		204
Level 2 "	1464		1464		1392		1392
Level 3 "	1368		1368		976		976
Total channel/mod	3432		3124		2788		2572
Total " System	109,832		99,968		89,216		82,304
ELECTRONICS	12,509		11,356		11021		10167
Δ K$			1.153				854
ASSY & TEST	4019		3648		4732		4365
Δ K$			370				367
MACH & INSP	16857		15303		10092		9310
Δ K$			1254				782
SAVINGS (K$)			2,777				2003

DL 7308104 (WAS IL 29)