GEM IN-92-14

Cost Estimate Review: Overview, Methodology, Estimate Summary

Gary Sanders
SSC Laboratory

June 23, 1992

Abstract:

Presentations by Gary Sanders at the GEM Cost Estimate Meeting held at the SSC Laboratory on June 23, 1992.

GEM COST ESTIMATE REVIEW

JUNE 23, 1992

OVERVIEW, METHODOLOGY, ESTIMATE SUMMARY

Gary Sanders

SSCL GUIDELINES

Following 1990 Snowmass PAC review, and again following December 1990 review, SSCL issued design to cost guidelines to proponents of major SSC detectors.

My paraphrase:

1. SSC project includes $550 million FY90$ for possible two major detectors. Smaller detectors to be funded from $75 million FY90$ reserved for this purpose.

2. SSCL commits $225 million FY90$ to each of two possible major detectors. Remainder of $550 million FY90$ ($100 million) held in reserve for major detectors to be allocated based upon scientific and technical merit. Practical effect of this is that $275 million FY90$ used as planning number.

3. SSCL guidance is to design to cost using a target no more than $500 million FY90$.

4. Gap between SSC project funds and estimated cost of a major detector is to be provided by contributions from non-Federal sources.

Cost estimates prepared according to normal US DOE requirements and methods. Final funding plan to reflect responsibility matrix and actual offsets against US estimate. Recent letter from Schwitters provides renewed guidance on funding plan.

Table 1 L* Cost Review Evaluation Summary

(Costs in 1990 Millions of Dollars)

	L* Cost Book (Resistive Coil/BaF2)		L* Cost Panel Estimate Revision		Variance
Detector Costs					
EDIA					
- identified Engineering/Design	32				
- assumed *1	20				
Subtotal EDIA	52	(11%) *2	114	(25%)	62
Labor	109				
Material	346				
Subtotal (Material and Labor)	455		457	*3	2
Direct Costs	507		571		64
Contingency	96	(19%)	143	(25%)	47
Subtotal	603		714		111
R&D	25	(5.5%) *2	50	(11%)	25
Total Detector FY90 $M	**628**		**764**		**136**
Escalation (Midpoint Apr 96) Excluding R&D	1.20		1.20		
Total Then Year $M	**749**		**907**		**158**

Major Concerns:

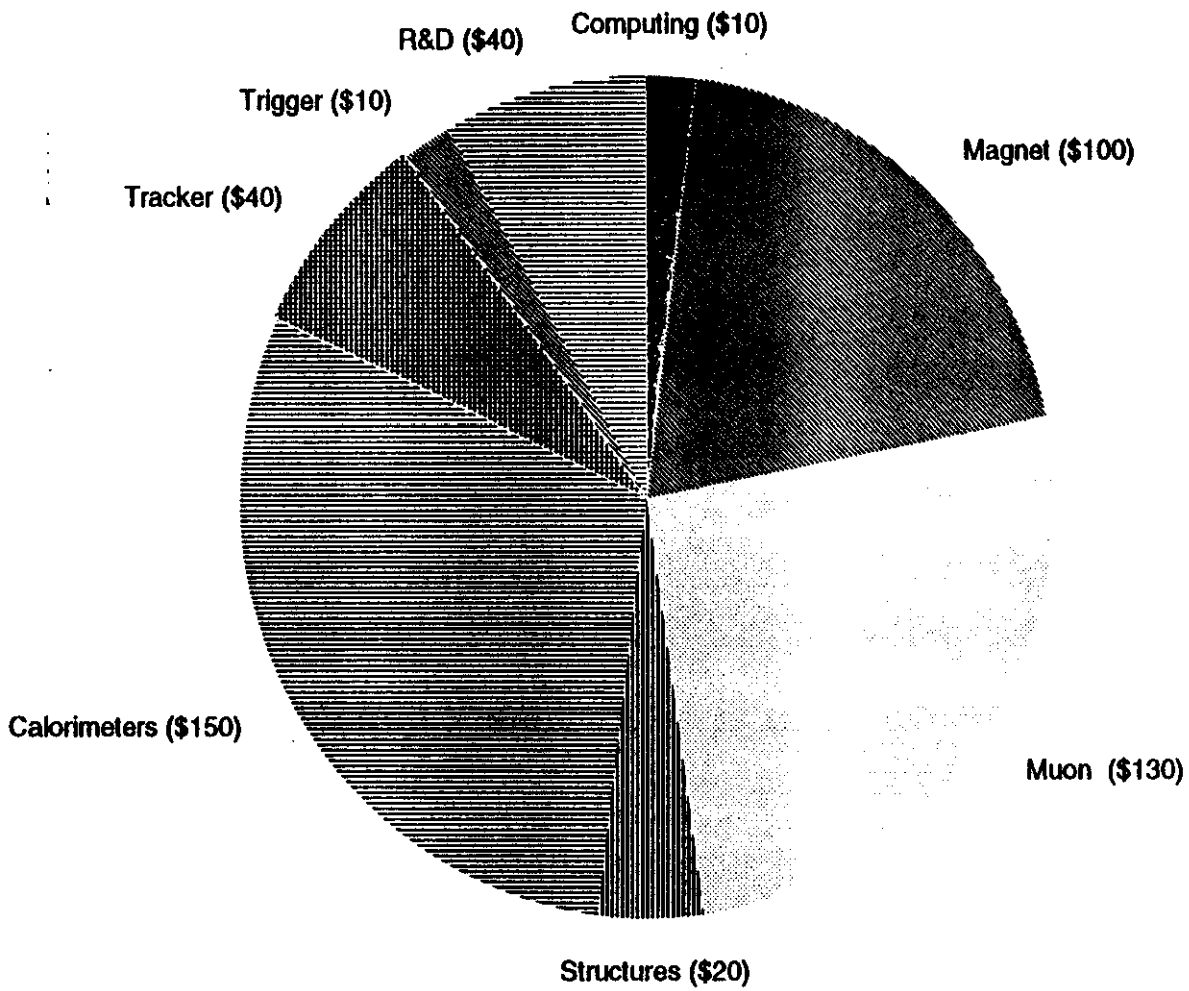
- EDIA Variance +$62M
- Contingency Variance +$47M
- R&D Variance +$25M

*1 includes project engineering, consulting, and engineering design associated w/ proc/fab & assy/instl
*2 % of subtotal (material & labor)
*3 Increased S.C. Insert Coil Cost

1830.1048

L* Theriot cost	STAGE 1	STAGE 2	STAGE 3
	double coil 5% muons 16 wires F/B muons out	single coil minimum iron pole	Liquid argon or fiber integrated calorimeter
			$472 million or
$758 million	$555 million	$498 million	$439 million

GEM COST TARGETS (29 JULY 1991)
($ MILLIONS)



1992 GEM WORKPLAN

WORKPLAN DESIGNED FOR NOVEMBER, 1992 TDR SUBMITTAL

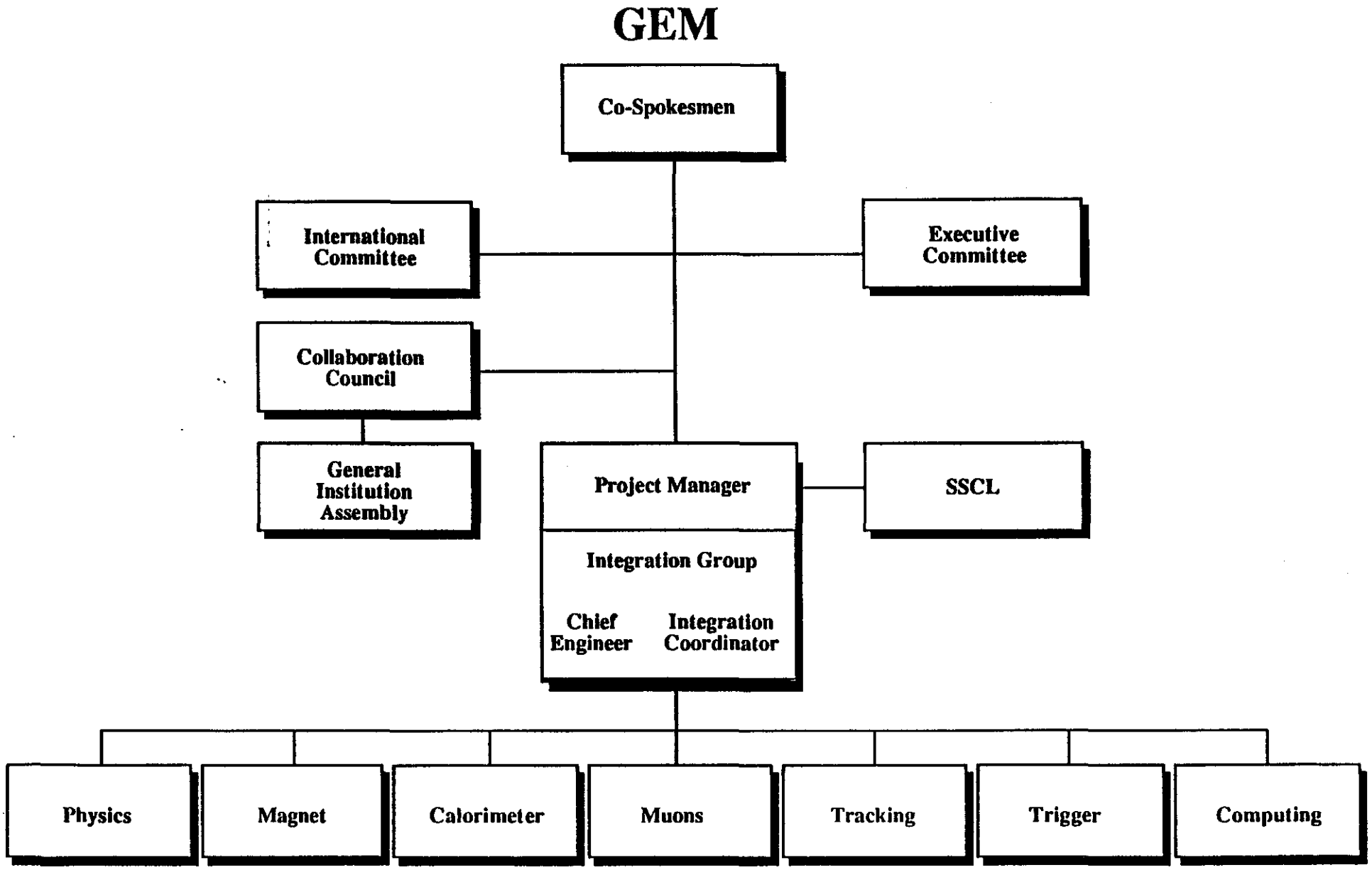
1. BASELINE 1 established March. Engineering design, simulations, cost studies focused on this baseline.

2. BASELINE 2 revision scheduled June, 1992. In progress now.

3. BASELINE 3 choices scheduled in August, 1992. This will be final TDR configuration. Calorimeter selection is principal choice to be made.

Cost estimate presented at this review is based upon published BASELINE 1 with a few minor adjustments approved at June Executive Committee meeting. BASELINE 2 study is not mature enough to present revised costs.

GEM Project Department



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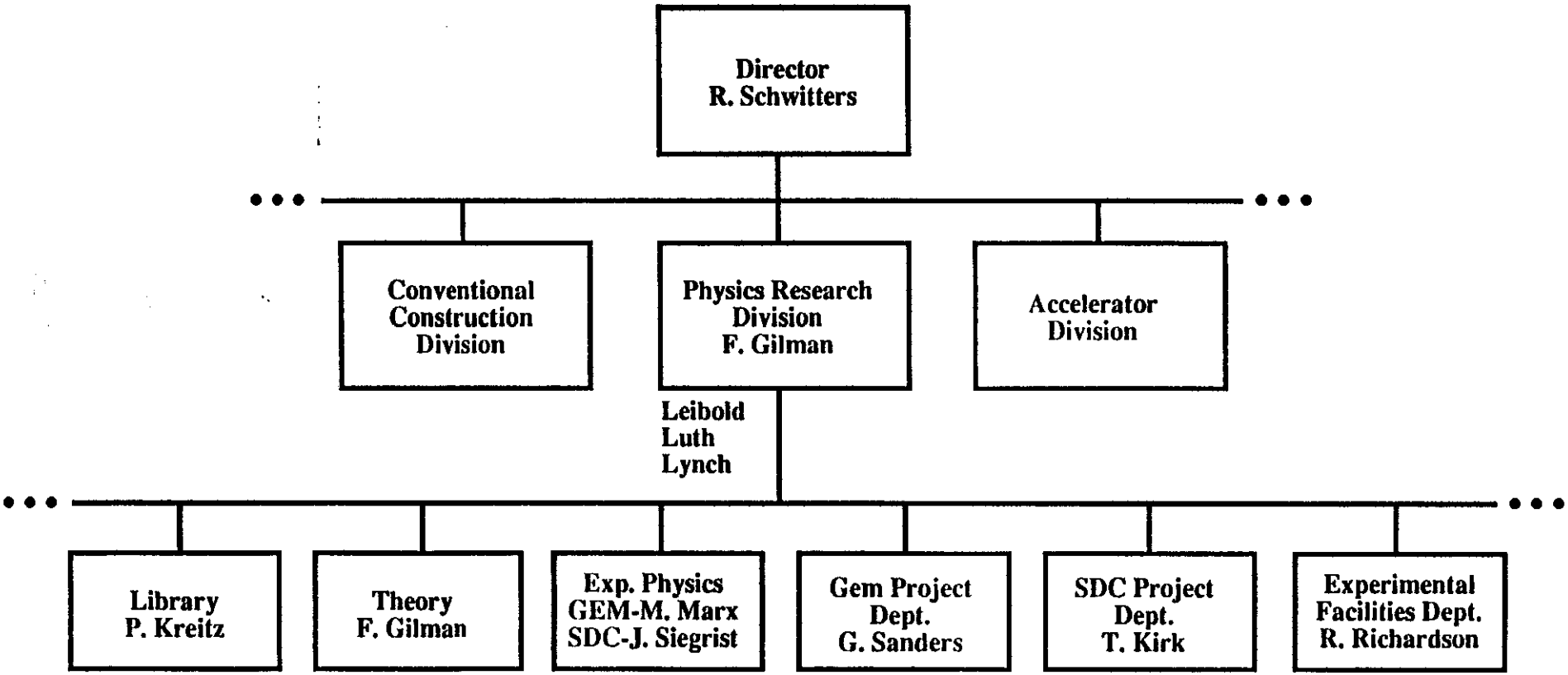
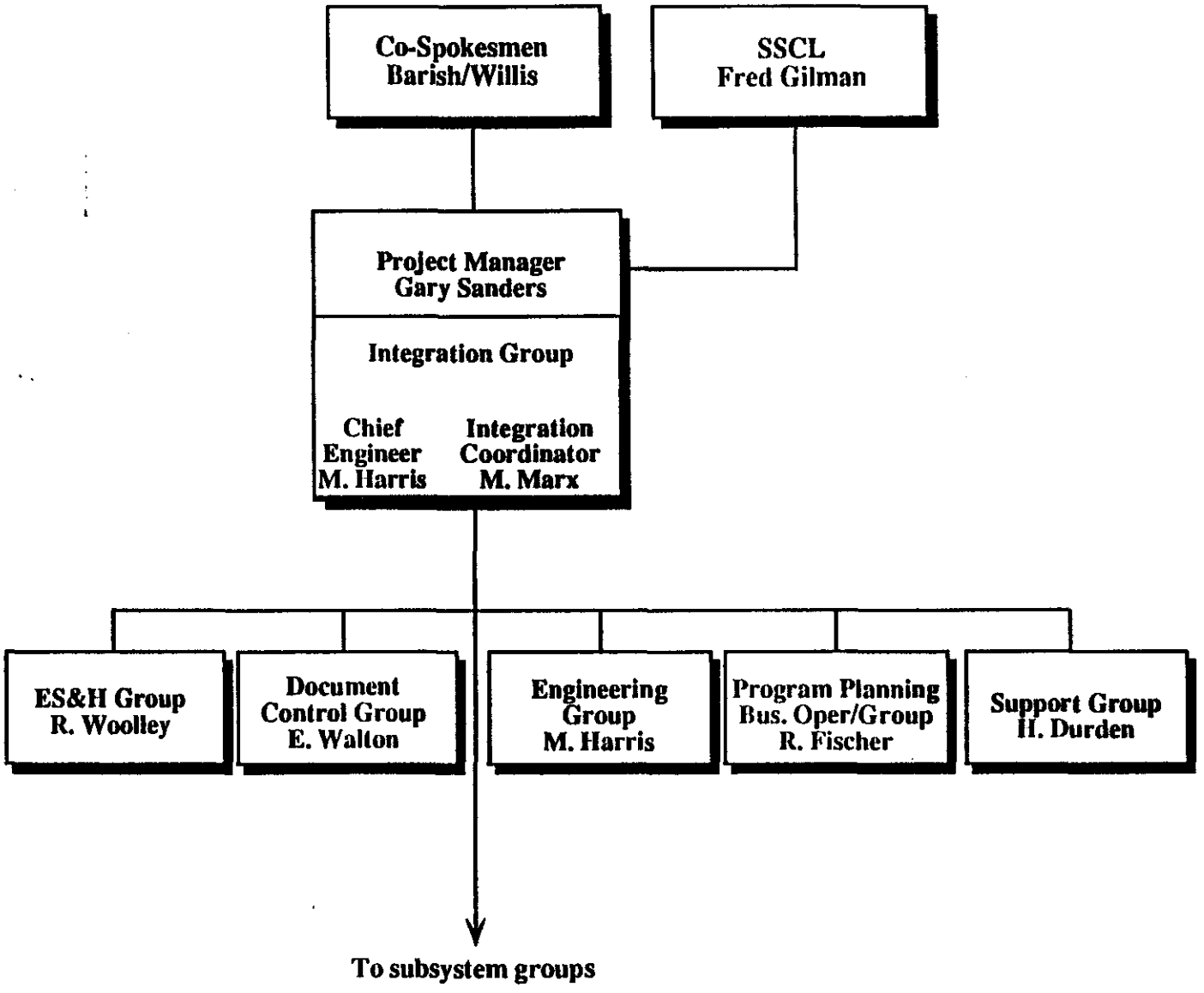
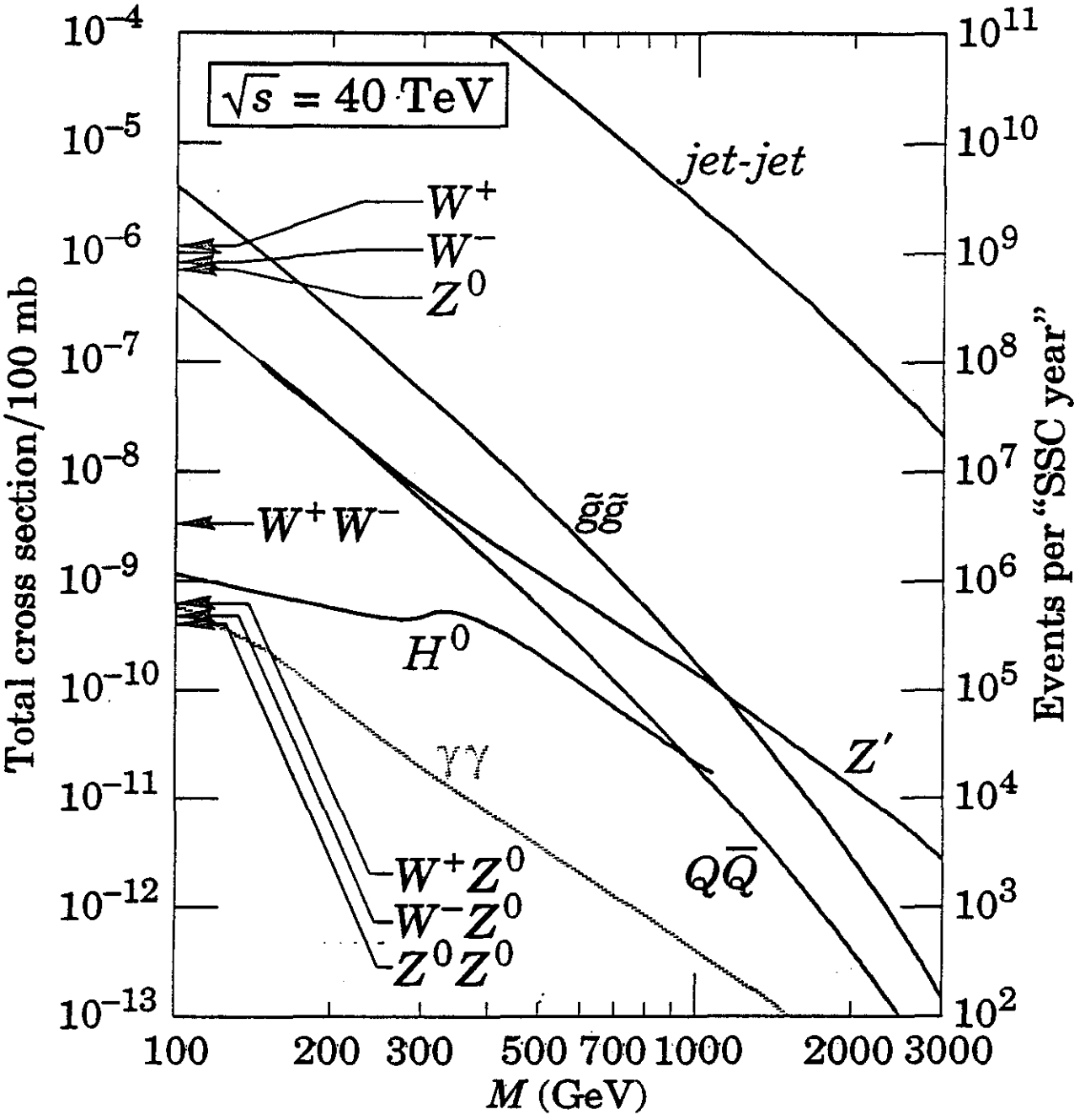
GEM Project Department in SSCL



GEM Project Management




$\sqrt{s}$ = 40 TeV
jet-jet
W^+
W^-
Z^0
W^+W^-
$\tilde{g}\tilde{g}$
H^0
$\gamma\gamma$
Z'
$Q\bar{Q}$
W^+Z^0
W^-Z^0
Z^0Z^0
Total cross section/100 mb
Events per "SSC year"
M (GeV)
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^{-9}
10^{-10}
10^{-11}
10^{-12}
10^{-13}
10^{11}
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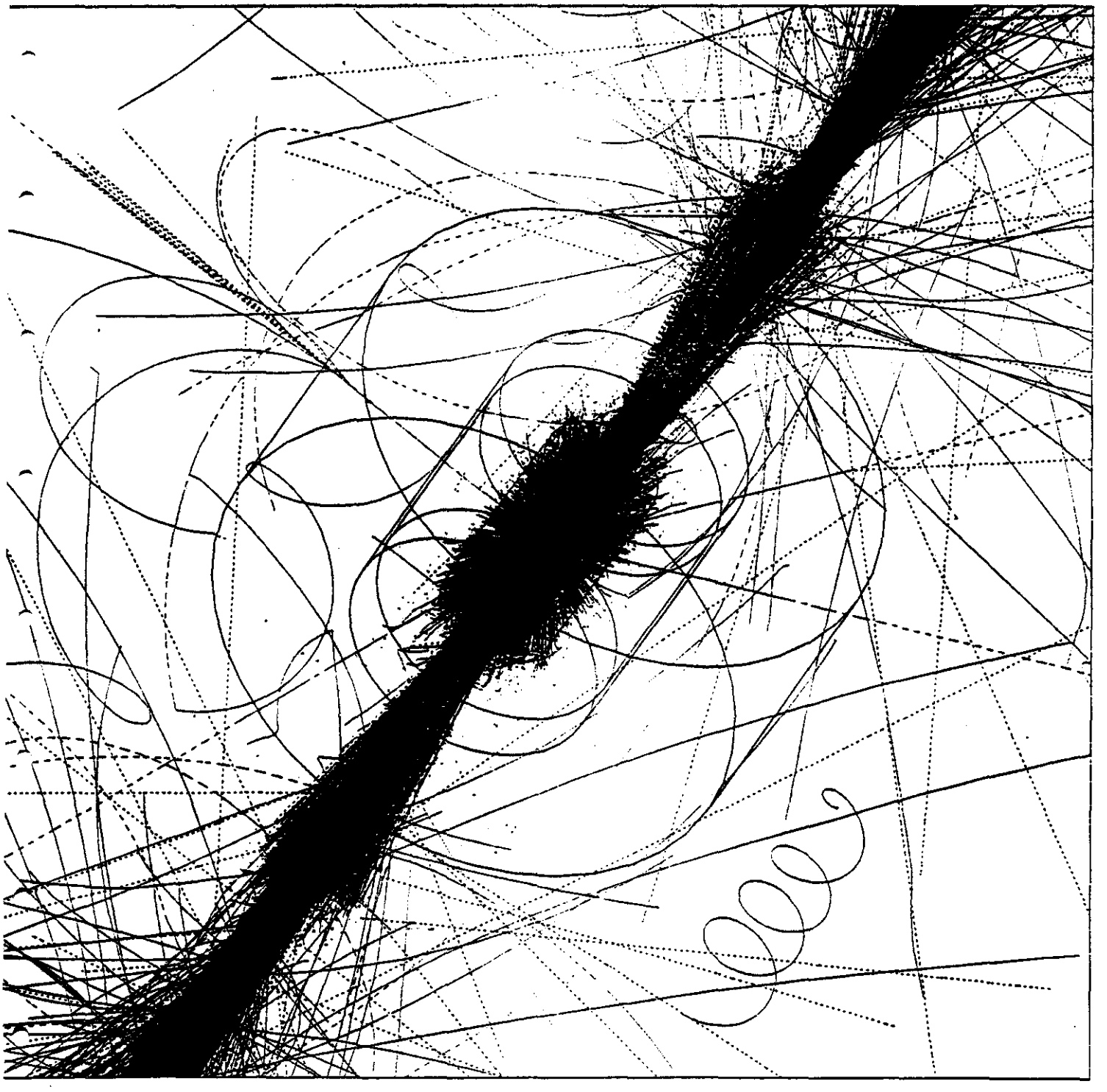
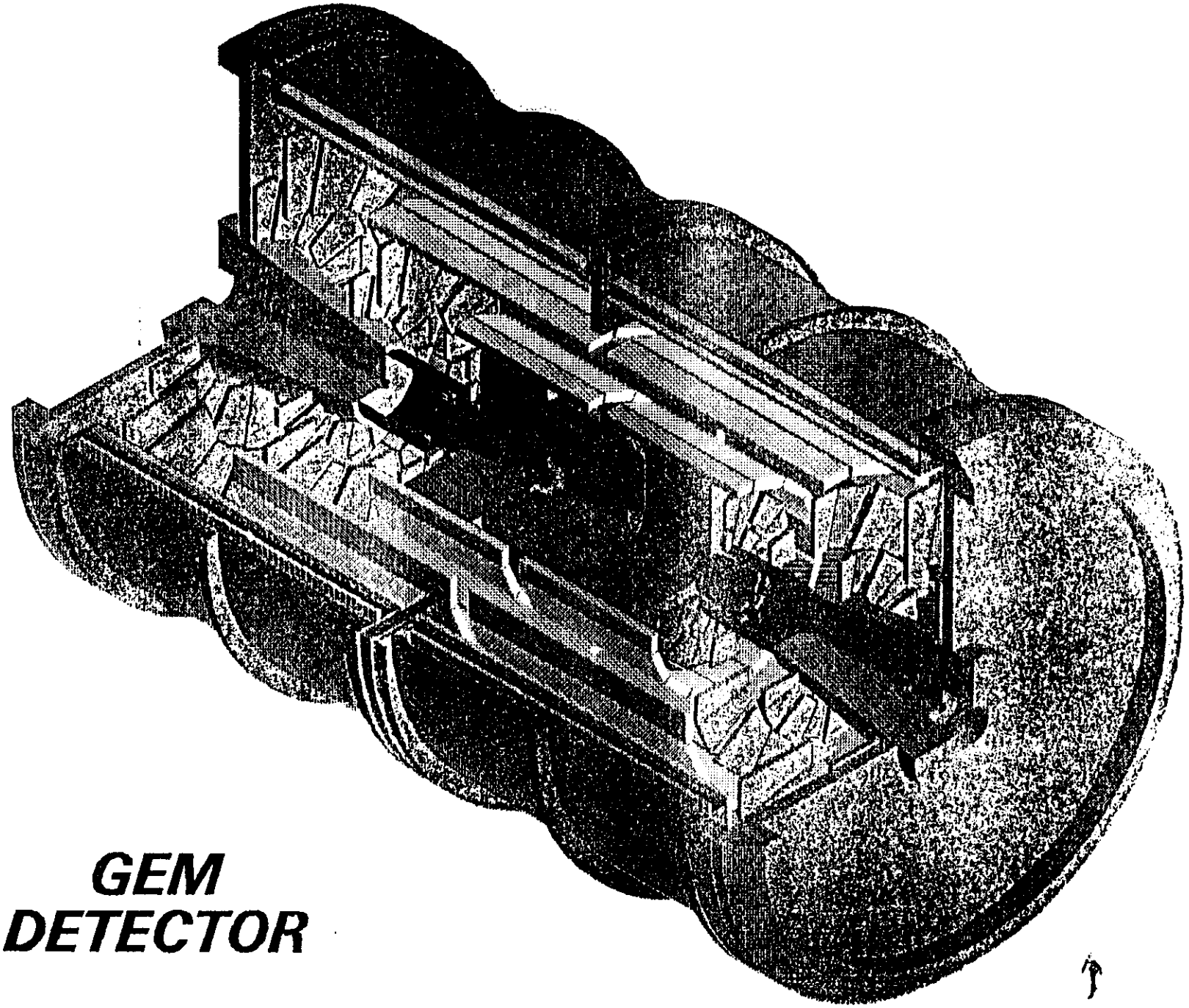
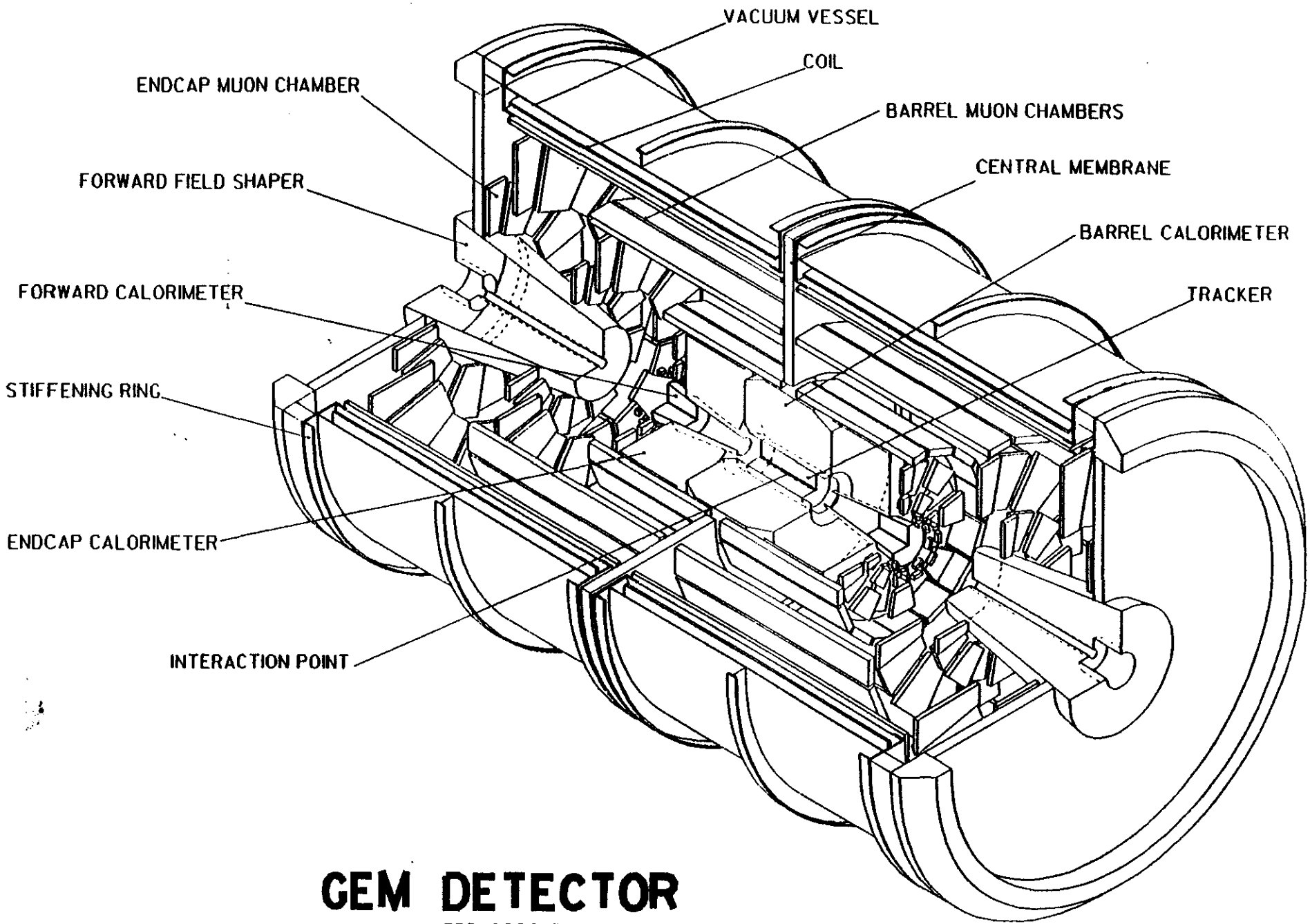




GEM DETECTOR

EMPHASIS IN GEM

- Very precise measurement of muon momenta using only the outer muon spectrometer in an open magnetic volume
- Very precise measurement of electron and photon energies using a precision electromagnetic calorimeter with no coil in front of the calorimeter
- Hermetic calorimetry and good jet resolution
- Central tracker emphasis on ensuring clean measurement of physics signals without requiring full pattern recognition
- High luminosity



GEM DETECTOR

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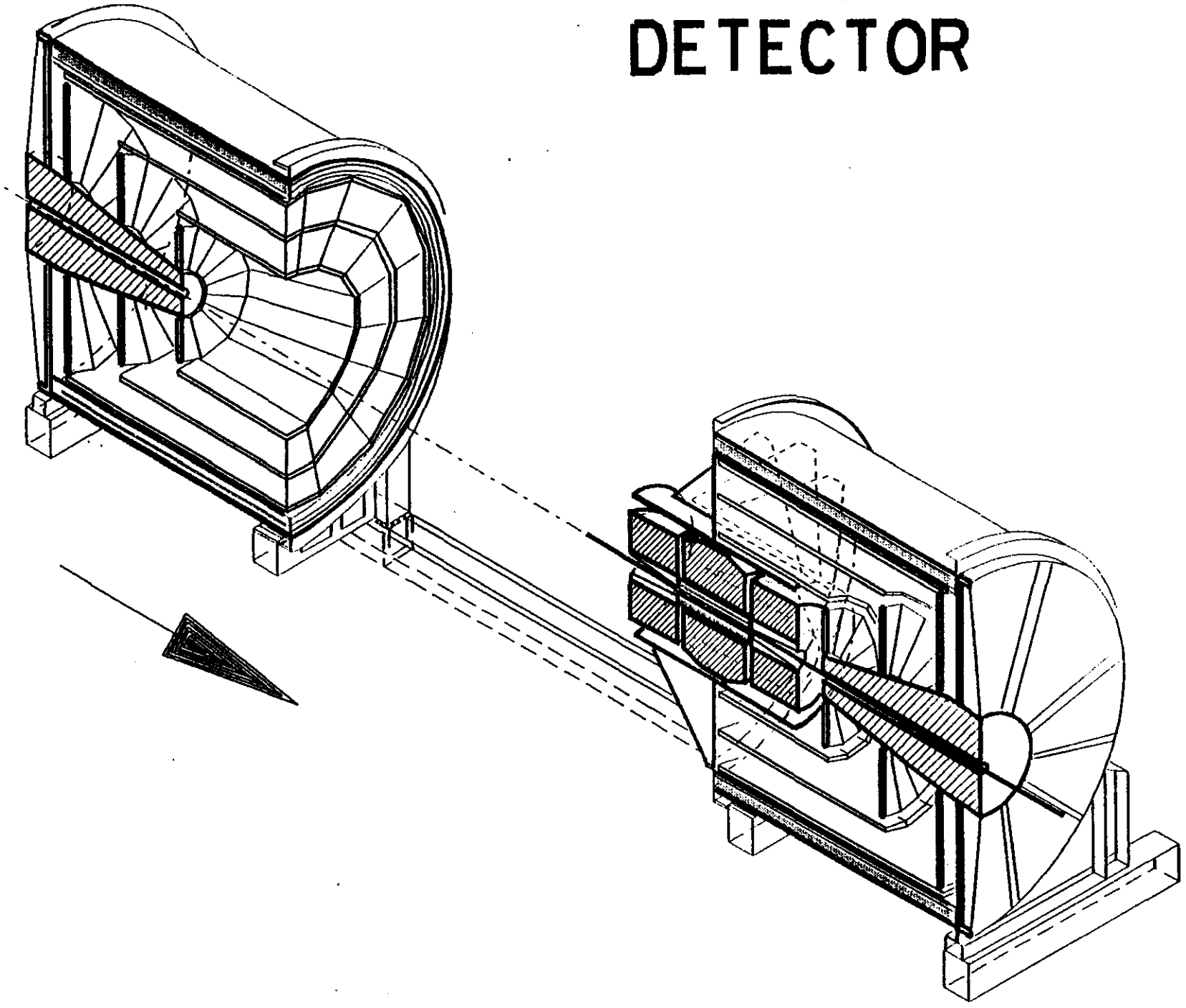
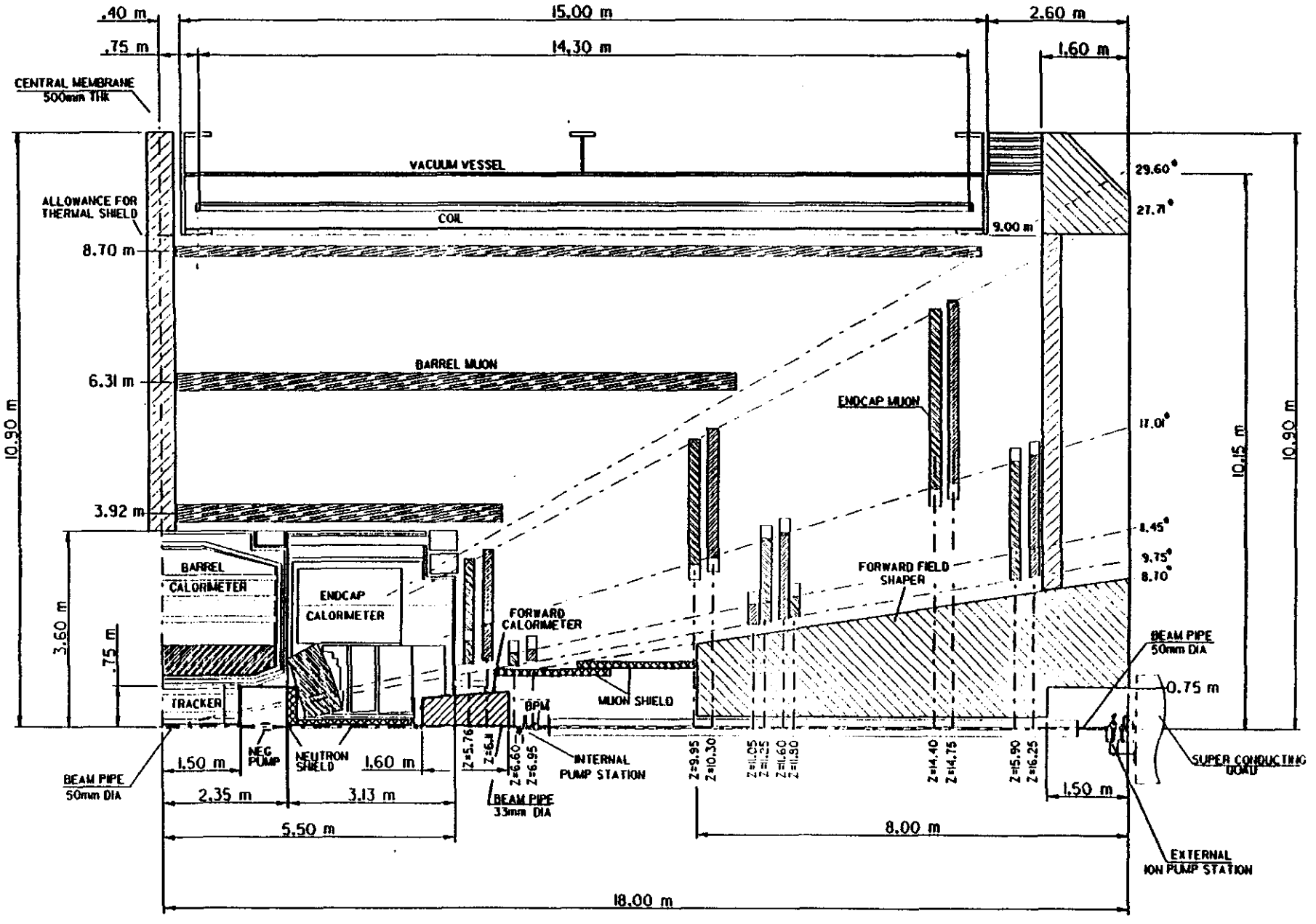
GEM DETECTOR



GEM DETECTOR ELEVATION



(GEMDET9204152C)

COST ESTIMATING METHODOLOGY

1. GEM COST ESTIMATING PLAN, rev. E provides guidance on methodology across all subsystems.

2. WBS established. Three main categories Construction, R&D, and Conceptual/Preliminary Design. Latter two categories include all costs from beginning of GEM in mid-1991. WBS at lower levels is by subsystem.

3. WBS is used to organize estimate spreadsheet. It includes Engineering, Design, Inspection, Administration, Procurements/Fabrication, Assembly, Installation and Contingency. Materials and Labor are separated. WBS includes Project Management, and within each subsystem, Subsystem Management. These include PM, QA, systems engineering, ES&H, administration.

4. Estimate worksheet includes attached data sheets for risk analysis/contingency and also, "basis of estimate" information by item. All work is driven to be "bottom-up".

5. All items and terms are defined in the Plan.

6. All labor rates are standardized (SSCL, national average industrial,...) or composite national lab rates. These rates are tabulated in the Plan. Very few labor operations are based upon actual rates at intended suppliers. Thus, cost reductions afforded by using low cost suppliers have not been included in this estimate. That work will be included prior to TDR. No credit for foreign labor taken yet.

BASIS OF ESTIMATE

Spreadsheet contains code which designates "estimate type".

1. Bottom-up (BU)
2. Specific analogy (SA)
3. Parametric study (PS)
4. Review and update (RU)
5. Trend analysis (TA)
6. Expert opinion (EO)

Most reliable estimates are based upon bottom-up design accompanied by vendor estimates in writing, when feasible. All estimates are progressing towards the highest possible fraction of costs based upon this category. Magnet estimate has a very high fraction based upon vendor estimates.

All estimate lines in spreadsheet should be supported by estimators worksheets documenting all design assumptions, basis of estimates, risk analysis, etc. Magnet, muon and central tracker have highly developed workbooks available at this review. Calorimeters use different backup format, providing equivalent information.

Fabrication and assembly operations analyzed by formalized manufacturing analysis in many subsystems. Calorimeters and muon subsystem are principal examples.

RISK/CONTINGENCY ANALYSIS

On a line-by-line basis, each item in the WBS is assigned a technical, cost and schedule risk factor on a standardized numerical scale (1-15 for technical and cost, 2-8 for schedule).

These weights are multiplied by a risk percentage ranging from 1% to 4% based upon design, manufacturing, material cost or labor rate uncertainties.

Contingency is the linear combination of these factors and percentages.

"Good judgment" is required of all estimators, especially for unusual items.

SCHEDULE AND ESCALATION

Estimate worksheet includes start and completion dates for all items. Escalation can then be handled in a natural way.

ESTIMATE PRESENTED HERE IS NOT IN ACTUAL YEAR DOLLARS. OUR ESTIMATE IS DEVELOPED IN FY92 DOLLARS AND COMPARED TO OUR $500 MILLION "DESIGN-TO-COST" TARGET IN SSC PROJECT BASE YEAR FY90 DOLLARS. WE ALSO SUMMARIZE IN FY91 DOLLARS.

GEM has a top-level schedule now submitted to the SSC Integrated Project Schedule. We are now tiering our milestones according to the SSCL Project Specification Tree. Bottom up task scheduling and duration estimates are part of the design effort. This is checked against our top level milestone schedule. There are some negative slack paths (central tracker installation) and these issues are under study within the design and will be resolved prior to the TDR.

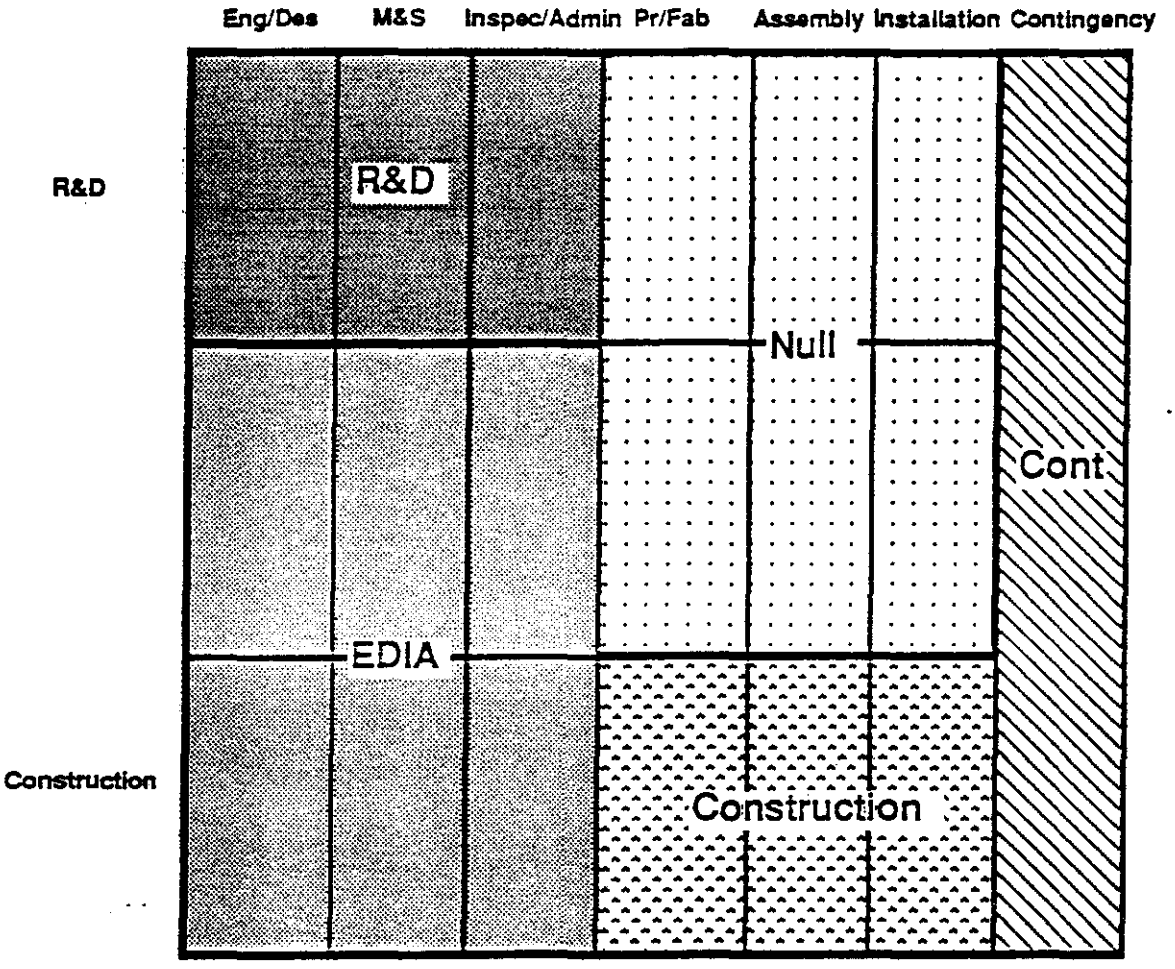
LABOR RATES

Labor rate tables in the Cost Estimating Plan:

National Laboratory average rates
National average rates
SSC employees
Job/shop in Dallas area
Contractor (Davis-Bacon) installation

Very few activities are estimated for this review using lower cost labor such as foreign, university, or student rates. No labor rate optimization has been performed to reduce costs. This is a "hidden contingency" built into estimate which should be extracted as estimate matures. No optimization of manufacturing algorithm has been performed either. This also must be brought to a mature optimization in the next year.

While rates are standardized, labor/skill mixes for teams are assigned by subsystem designers. If labor mixes are downgraded to lower rates, this is compensated in many subsystems by task duration extensions through the manufacturing algorithm.



$$\text{R\&D \%} = \frac{\text{R\&D}}{\text{Construction}}$$

$$\text{EDIA \%} = \frac{\text{EDIA}}{\text{Construction}}$$

$$\text{Contingency \%} = \frac{\text{Contingency}}{\text{Construction} + \text{EDIA}}$$

Table 5. Cost matrix components

ESCALATION FACTORS

Top level GEM Cost Estimate Summaries are expressed in FY90, FY91, and FY92 dollars for this review. FY90 is SSC project base year.

Procedures followed by GEM follow DOE order guidance. Estimate worked bottom up in current year dollars. Comparison with project base year is made using official DOE escalation factors.

Estimate presented here is not a fully escalated estimate. It is an FY92 estimate de-escalated to SSC project base year.

Our detailed study of national laboratory labor rates shows escalation far in excess of official DOE escalators. This high escalation (10% - 25%) is due to ES&H review and remedial plan overhead charges applied in FY92 following Tiger Team reviews. Since we have worked in FY92 dollars and applied DOE escalators to return to base year, <u>our labor estimate for EDIA is higher than that predicted by DOE escalation factors.</u> This will be adjusted out in future as labor is assigned to lowest cost laboratories, and moved to industrial, university and foreign institutions. This will result in a marked lowering of EDIA labor costs in our estimate.

DOE ESCALATION FACTORS:

FY90 to FY92	6.32%
FY91 to FY92	3.66%

GEM COST ESTIMATE SUMMARY

June 23, 1992
(with Liquid Argon, LSDT Option)
(Costs in millions of FY90 dollars)

Procurements/Fabrication	197	
Installation/Assembly	58	
Subtotal (Procurements and Labor)	255	
EDIA	113	(44%)*
Direct Costs	368	
Contingency	97	(26%)
Subtotal	465	
R&D	25	(10%)*
TOTAL DETECTOR FY90 $M	490	

* % of subtotal (Procurements and Labor)

GEM COST ESTIMATE SUMMARY

June 23, 1992
(with Liquid Argon, LSDT Option)
(Costs in millions of FY91 dollars)

Procurements/Fabrication	202	
Installation/Assembly	60	
Subtotal (Procurements and Labor)	262	
EDIA	117	(44%)*
Direct Costs	379	
Contingency	100	(26%)
Subtotal	479	
R&D	26	(10%)*
TOTAL DETECTOR FY91 $M	505	

* % of subtotal (Procurements and Labor)

GEM COST ESTIMATE SUMMARY

June 23, 1992
(with Liquid Argon, LSDT Option)
(Costs in millions of FY92 dollars)

Procurements/Fabrication	210	
Installation/Assembly	62	
Subtotal (Procurements and Labor)	273	
EDIA	121	(44%)*
Direct Costs	394	
Contingency	104	(26%)
Subtotal	498	
R&D	27	(10%)*
TOTAL DETECTOR FY92 $M	524	

* % of subtotal (Procurements and Labor)

GEM DETECTOR SECOND LEVEL SUMMARY

WBS	Item	Eng/design k$	M&S k$	Inspection Admin k$	Proc/Fab Material k$	Assembly k$	Installation k$	Subtotal Labor k$	Subtotal Material k$	Subtotal Lab & Mat'l k$	Conting. k$	Total k$
	TOTAL SUMMARY OF OPTIONS											
522.5a	GEMa (w/LAR,LSDT)	69426	41103	36990	210291	47186	15429	155302	265124	420425	103920	524344
522.5b	GEMb (w/ScFib,BaF,LSDT)	73834	35261	34988	235144	38020	14620	147921	283943	431865	98930	530794
522.5c	GEMc (wLAR,PDT)	69708	41548	37064	214499	47886	15429	156397	269737	426133	105598	531730
522.5d	GEMd (w/ScFib,BaF,PDT)	73834	35263	35021	239352	38720	14620	148695	288113	436808	100434	537242
	SUBSYSTEMS SUMMARY											
522.5.1	CENTRAL TRACKER	7700	1896	2720	8386	2466	441	12530	11078	23608	7668	31276
522.5.2.1	LIQ ARGON CAL	12694	8725	3968	38605	16588	806	34056	47330	81385	22463	103847
522.5.2.2	LIQ ARG FCAL	3043	317	178	6509	1142	41	4404	6826	11230	4077	15307
522.5.2.3	SCINT LIQ FCAL	3092	736	275	6031	1524	197	5087	6767	11853	3590	15443
522.5.2.4	SCINT LIQ HADRON	9485	1967	1091	25444	3896	463	14936	27411	42346	12193	54539
522.5.2.5	BAF EM CAL	10330	1111	925	51219	3144	292	14691	52330	67022	10788	77810
522.5.3.1	MUON (PDT)	10116	3035	10508	21211	21862	6226	39617	33341	72958	20590	93549
522.5.3.2	MUON (LSDT)	10116	3033	10474	17003	21163	6226	38844	29171	68015	19086	87101
522.5.4	MAGNET	11774	6907	8576	71602	4082	2544	24833	80652	105485	21611	127096
522.5.5	ELECTRONICS OPT'S A&C	15667	17003	1419	50099	219	3581	19231	68757	87988	21092	109080
522.5.5	ELECTRONICS OPT'S B&D	12906	16389	1271	37371	219	2666	15597	55224	70821	16071	86892
522.5.6	COMP&CONTROLS	3742	1334	893	8959	0	1409	6044	10294	16337	3267	19604
522.5.7	INTERFACE	836	0	0	9129	1526	381	2743	9129	11872	3205	15077
522.5.8	PM	3854	1888	8763	0	0	0	12617	1888	14505	1450	15955

GEM DETECTOR SECOND LEVEL SUMMARY

WBS	Item	Eng/design k$	M&S k$	Inspection Admin k$	Proc/Fab Material k$	Assembly k$	Installation k$	Subtotal Labor k$	Subtotal Material k$	Subtotal Lab & Mat'l k$	Conting. k$	Total k$
	CONSTRUCTION SUMMARY OF OPTIONS											
522.50a	GEMa (w/LAR,LSDT)	48339	24346	35407	210291	47186	15429	132631	248366	380998	94012	475009
522.50b	GEMb (w/ScFib,BaF,LSDT)	49664	22849	33493	235144	38020	14620	122258	271531	393789	88522	482310
522.50c	GEMc (wLAR,PDT)	48339	24348	35441	214499	47886	15429	133405	252536	385941	95517	481457
522.50d	GEMd (w/ScFib,BaF,PDT)	49664	22851	33527	239352	38720	14620	123031	275701	398732	90026	488758
	CONSTRUCTION SUBSYSTEMS											
522.50.1	CENTRAL TRACKER	3869	801	2173	8386	2466	441	8152	9983	18136	5368	23503
522.50.2.1	LIQ ARGON CAL	10490	1879	3968	38605	16588	806	31851	40483	72335	20085	92418
522.50.2.2	LIQ ARG FCAL	2002	100	178	6509	1142	41	3363	6609	9972	3795	13767
522.50.2.3	SCINT LIQ FCAL	1947	97	275	6031	1524	197	3942	6128	10070	3067	13137
522.50.2.4	SCINT LIQ HADRON	7156	358	1091	25444	3896	463	12607	25802	38409	11009	49418
522.50.2.5	BAF EM CAL	6856	341	925	51219	3144	292	11217	51560	62777	9054	71831
522.50.3.1	MUON (PDT)	6933	1981	10508	21211	21862	6226	36434	32287	68721	19743	88464
522.50.3.2	MUON (LSDT)	6933	1979	10474	17003	21163	6226	35661	28117	63778	18238	82016
522.50.4	MAGNET	5813	1775	8576	71602	4082	2544	18872	75520	94392	19302	113695
522.50.5	ELECTRONICS OPT'S A&C	13215	15817	1069	50099	219	3581	16429	67571	84000	20136	104136
522.50.5	ELECTRONICS OPT'S B&D	11074	15503	1010	37371	219	2666	13504	54338	67842	15395	83237
522.50.6	COMP&CONTROLS	1409	147	393	8959	0	1409	3211	9106	12317	2463	14780
522.50.7	INTERFACE	836	0	0	9129	1526	381	2743	9129	11872	3205	15077
522.50.8	RM	3772	1848	8576	0	0	0	12348	1848	14196	1420	15616

GEM DETECTOR SECOND LEVEL SUMMARY

WBS	Item	Eng/design k$	M&S k$	Inspection Admin k$	Proc/Fab Material k$	Assembly k$	Installation k$	Subtotal Labor k$	Subtotal Material k$	Subtotal Lab & Mat'l k$	Conting. k$	Total k$
	R&D SUMMARY OF OPTIONS											
522.51a	GEMa (w/LAR,LSDT)	11805	13966	1147	0	0	0	12951	13966	26916	7372	34289
522.51b	GEMb (w/ScFib,BaF,LSDT)	15034	9760	1072	0	0	0	16106	9760	25866	7907	33773
522.51c	GEMc (wLAR,PDT)	11805	13966	1147	0	0	0	12951	13966	26916	7372	34289
522.51d	GEMd (w/ScFib,BaF,PDT)	15034	9760	1072	0	0	0	16106	9760	25866	7907	33773
	R&D SUBSYSTEMS											
522.5.1.1	CENTRAL TRACKER	3278	937	468	0	0	0	3746	937	4683	1968	6651
522.5.1.2.1	LIQ ARGON CAL	1154	6804	0	0	0	0	1154	6804	7957	2209	10166
522.5.1.2.2	LIQ ARG FCAL	738	202	0	0	0	0	738	202	939	282	1221
522.5.1.2.3	SCINT LIQ FCAL	853	624	0	0	0	0	853	624	1477	524	2001
522.5.1.2.4	SCINT LIQ HADRON	1895	1585	0	0	0	0	1895	1585	3480	1183	4663
522.5.1.2.5	BAF EM CAL	2898	741	0	0	0	0	2898	741	3639	1528	5167
522.5.1.3.1	MUON (PDT)	1791	754	0	0	0	0	1791	754	2545	509	3054
522.5.1.3.2	MUON (LSDT)	1791	754	0	0	0	0	1791	754	2545	509	3054
522.5.1.4	MAGNET	760	3595	0	0	0	0	760	3595	4355	998	5354
522.5.1.5	ELECTRONICS OPTS A&C	2075	593	296	0	0	0	2371	593	2964	711	3675
522.5.1.5	ELECTRONICS OPTS B&D	1550	443	221	0	0	0	1771	443	2214	502	2716
522.5.1.6	COMP&CONTROLS	2009	1082	383	0	0	0	2392	1082	3473	695	4168
522.5.1.7	INTERFACE	0	0	0	0	0	0	0	0	0	0	0
522.5.1.8	FM	0	0	0	0	0	0	0	0	0	0	0

GEM DETECTOR SECOND LEVEL SUMMARY

WBS	Item	Eng/design k$	M&S k$	Inspection Admin k$	Proc/Fab Material k$	Assembly k$	Installation k$	Subtotal Labor k$	Subtotal Material k$	Subtotal Lab & Mat'l k$	Conting. k$	Total k$
	CONCPT & PREDESIGN SUMMARY OF OPTIONS											
522.52a	GEMa (w/LAR,LSDT)	9283	2792	436	0	0	0	9719	2792	12511	2535	15046
522.51b	GEMb (w/ScFib,BaF,LSDT)	9135	2652	422	0	0	0	9558	2652	12210	2501	14711
522.52c	GEMc (wLAR,PDT)	9565	3235	476	0	0	0	10041	3235	13276	2709	15985
522.52d	GEMd (w/ScFib,BaF,PDT)	9135	2652	422	0	0	0	9558	2652	12210	2501	14711
	CONCPT & PREDESIGN SUBSYSTEMS											
522.5.2.1	CENTRAL TRACKER	553	158	79	0	0	0	632	158	790	332	1122
522.5.2.2.1	LIQ ARGON CAL	1051	42	0	0	0	0	1051	42	1093	169	1262
522.5.2.2.2	LIQ ARG FCAL	303	15	0	0	0	0	303	15	319	0	319
522.5.2.2.3	SCINT LIQ FCAL	292	15	0	0	0	0	292	15	306	0	306
522.5.2.2.4	SCINT LIQ HADRON	434	24	0	0	0	0	434	24	458	0	458
522.5.2.2.5	BAF EM CAL	576	29	0	0	0	0	576	29	605	206	811
522.5.2.3.1	MUON (PDT)	1392	300	0	0	0	0	1392	300	1692	338	2030
522.5.2.3.2	MUON (LSDT)	1392	300	0	0	0	0	1392	300	1692	338	2030
522.5.2.4	MAGNET	5201	1537	0	0	0	0	5201	1537	6738	1310	8048
522.5.2.5	ELECTRONICS OPT'S A&C	377	593	54	0	0	0	431	593	1024	245	1269
522.5.2.5	ELECTRONICS OPT'S B&D	282	443	40	0	0	0	322	443	765	174	939
522.5.2.6	COMP&CONTROLS	324	106	117	0	0	0	441	106	547	109	657
522.5.2.7	INTERFACE	0	0	0	0	0	0	0	0	0	0	0
522.5.2.8	PM	82	40	186	0	0	0	268	40	309	31	339

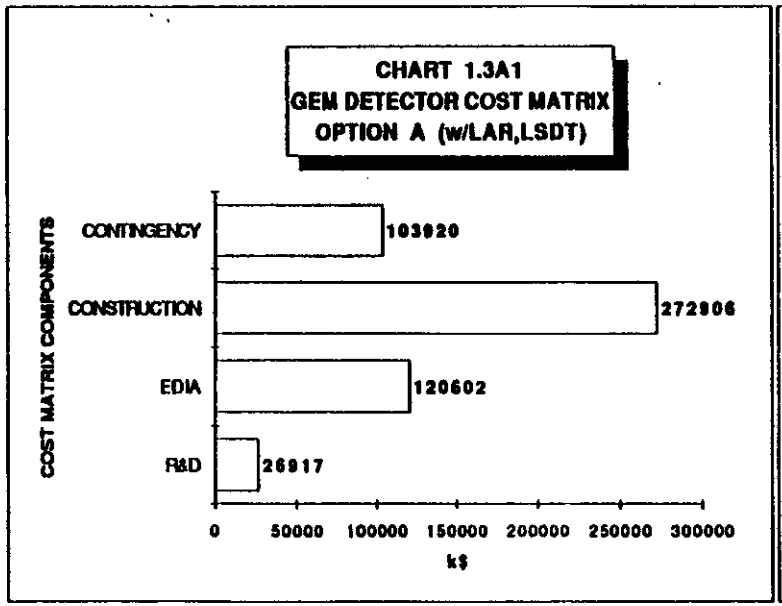
COST MATRIX COMPNENTS OPTION A

GEM DETECTOR w/LAR & LSDT

	69426 Eng/Des	41103 M&S	36990 Inspec/Admin	210291 Pr/Fab	62615 Inst/Assy	103920 Conting	524344 Total
R&D	[illegible]	[illegible]	[illegible]	0	0	7372	34289
Concep/Pre Design	9263	2792	436	0	0	2535	15046
Construction	48339	24346	35407	210291	62615	94012	475009

R&D %= 9.86% EDIA %= 44.19% Contingency %= 26.41%

R&D %= R&D / Construction EDIA %= EDIA / Construction Contingency %= Contingency / Construction + EDIA



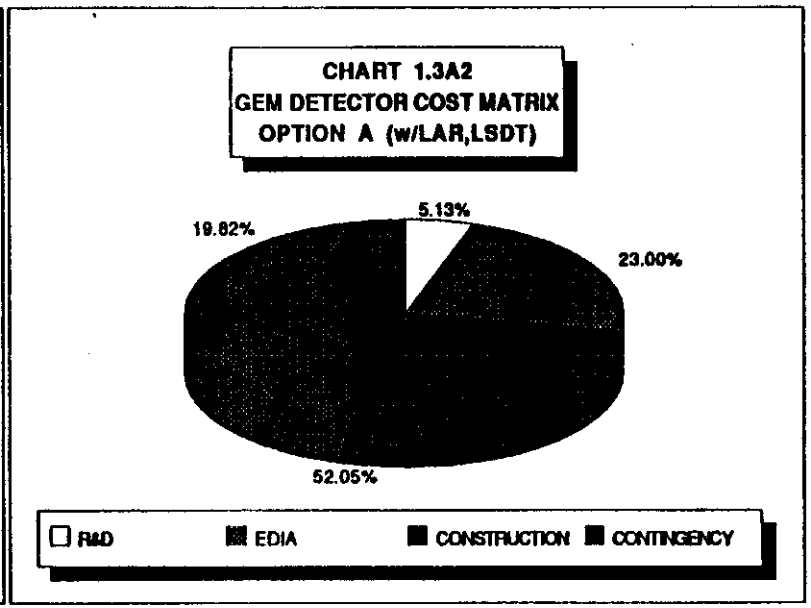


CHART 1.4
GEM DETECTOR SUBSYTEMS LABOR DISTRIBUTION

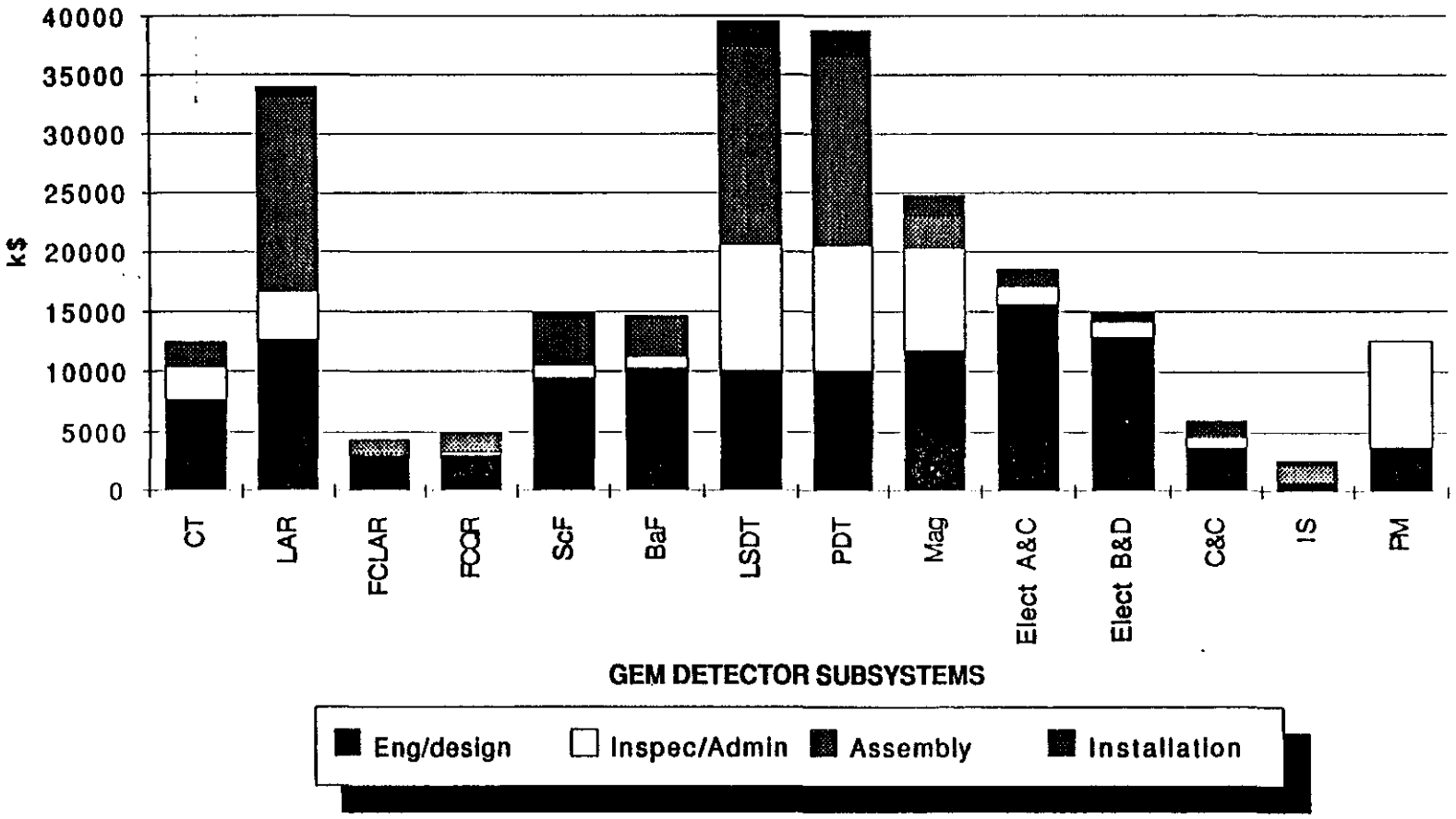


CHART 1.5
GEM DETECTOR SUBSYTEMS MATERIAL DISTRIBUTION

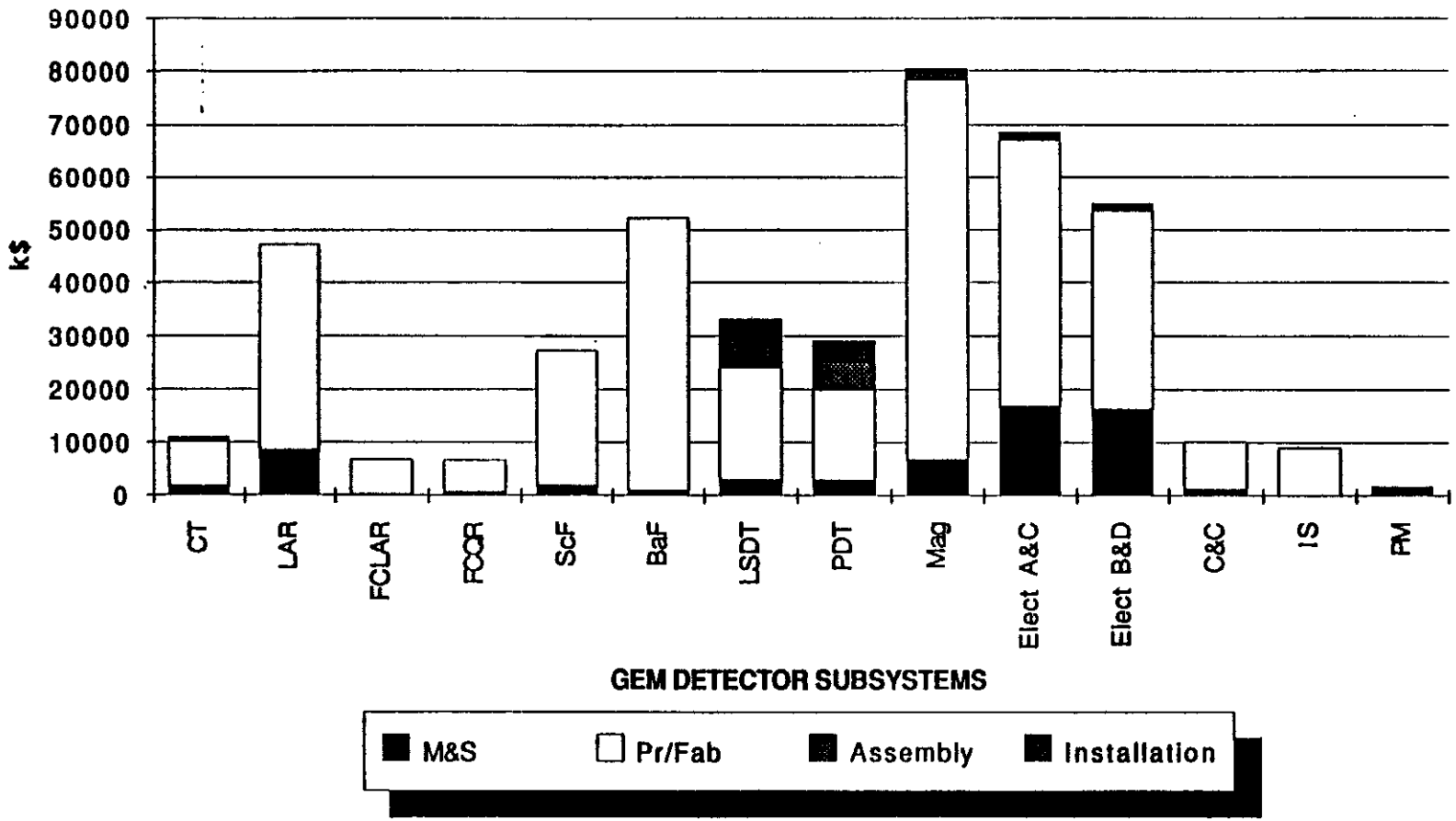
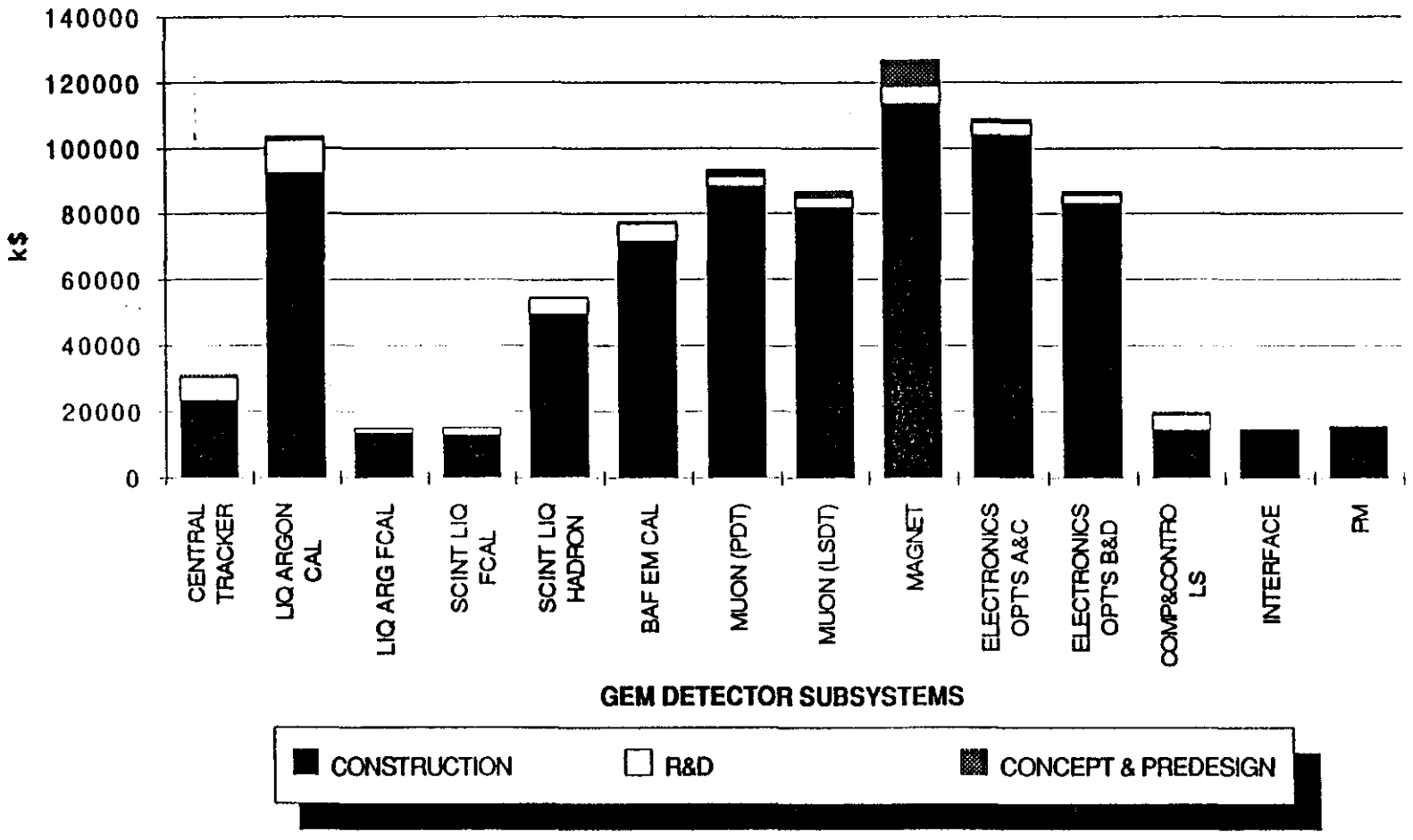


CHART 2
TOTAL COST DISTRIBUTION BY SUBSYSTEM



EDIA, R&D and Contingency Analysis

	Total Cost - K$ (w/contingency)	Total Cost - K$ (w/o contingency)	Construction Cost - K$ (Pr/Fab/Inst/Assy)	EDIA - K$ (no R&D)	EDIA% (% of const.)	R&D - K$	R&D % (% of const.)	Contingency - K$	Contingency % %(Total-R&D)
GEMa (w/LAR,LSDT)	524344	420425	272906	120602	44%	26917	10%	103920	26%
GEMb (w/ScFib,BaF,LSDT)	530794	431865	287784	118216	41%	25866	9%	98930	24%
GEMc (wLAR,PDT)	530791	425368	277814	120638	43%	26917	10%	105424	26%
GEMd (w/ScFib,BaF,PDT)	537242	436808	292691	118252	40%	25866	9%	100434	24%
CENTRAL TRACKER	31276	23608	11293	7633	67.6%	4683	41.5%	7668	41%
LIQ ARGON CAL	103847	81385	55999	17429	31.1%	7958	14.2%	22463	31%
LIQ ARG FCAL	15307	11230	7691	2599	33.8%	939	12.2%	4077	40%
SCINT LIQ FCAL	15443	11853	7751	2625	33.9%	1477	19.1%	3590	35%
SCINT FIB HADRON	54539	42346	29804	9063	30.4%	3480	11.7%	12193	31%
BAF EM CAL	77810	67022	54655	8727	16.0%	3639	6.7%	10788	17%
MUON (PDT)	93549	72958	49299	21114	42.8%	2545	5.2%	20590	29%
MUON (LSDT)	87101	68015	44391	21078	47.5%	2545	5.7%	19086	29%
MAGNET	127096	105485	78229	22901	29.3%	4355	5.6%	21611	21%
ELECTRONICS OPT'S A&C	109080	87988	53899	31125	57.7%	2964	5.5%	21092	25%
ELECTRONICS OPT'S B&D	86892	70821	40257	28352	70.4%	2214	5.5%	16071	23%
COMP&CONTROLS	19604	16337	10368	2496	24.1%	3473	33.5%	3267	25%
INTERFACE	15077	11872	11036	836	7.6%	0	0.0%	3205	27%
PM	15955	14505	0	14505	Infinity	0	0.0%	1450	10%

CHART 6
EDIA COST DISTRIBUTION BY SUBSYSTEM

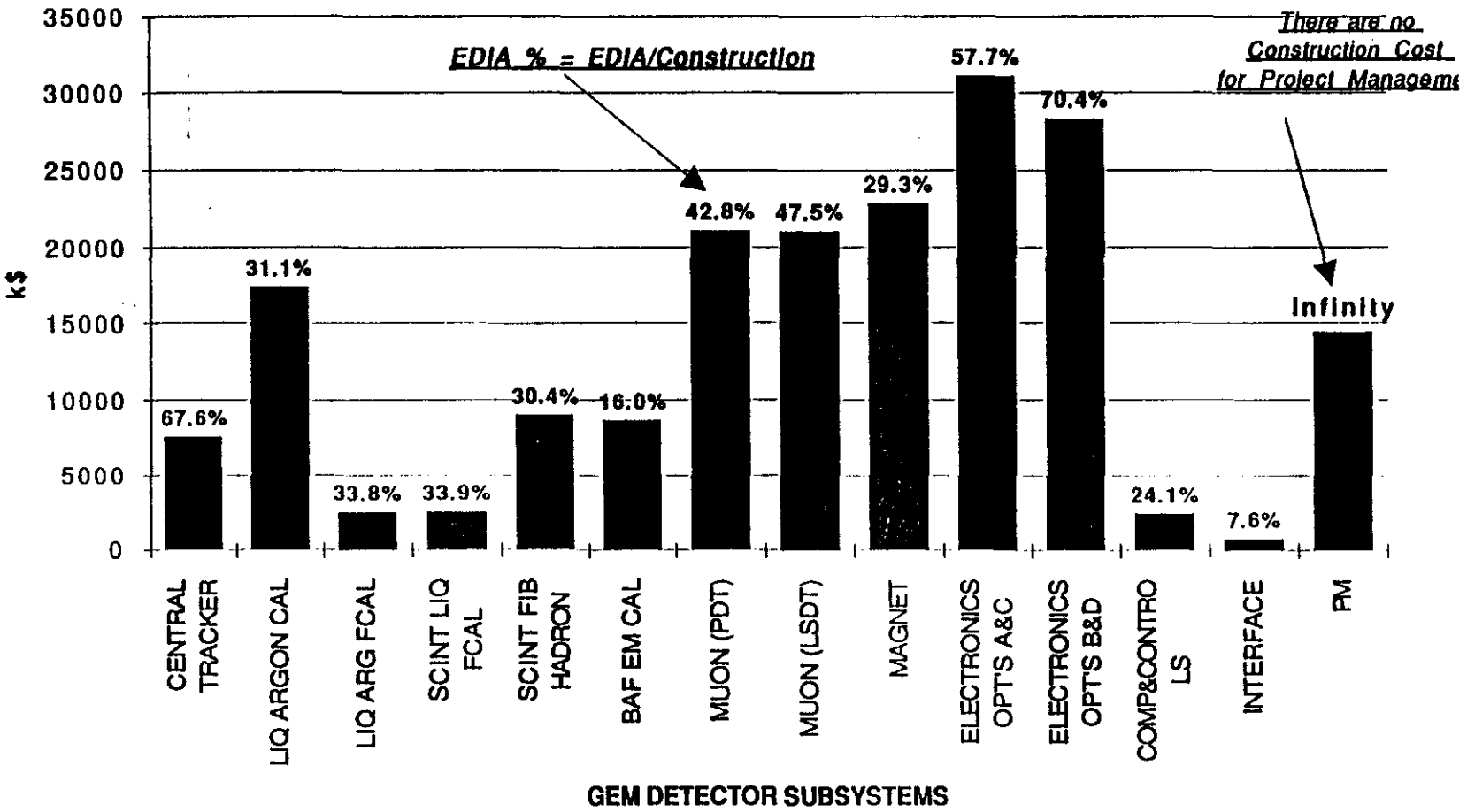


CHART 7
R&D COST DISTRIBUTION BY SUBSYSTEM

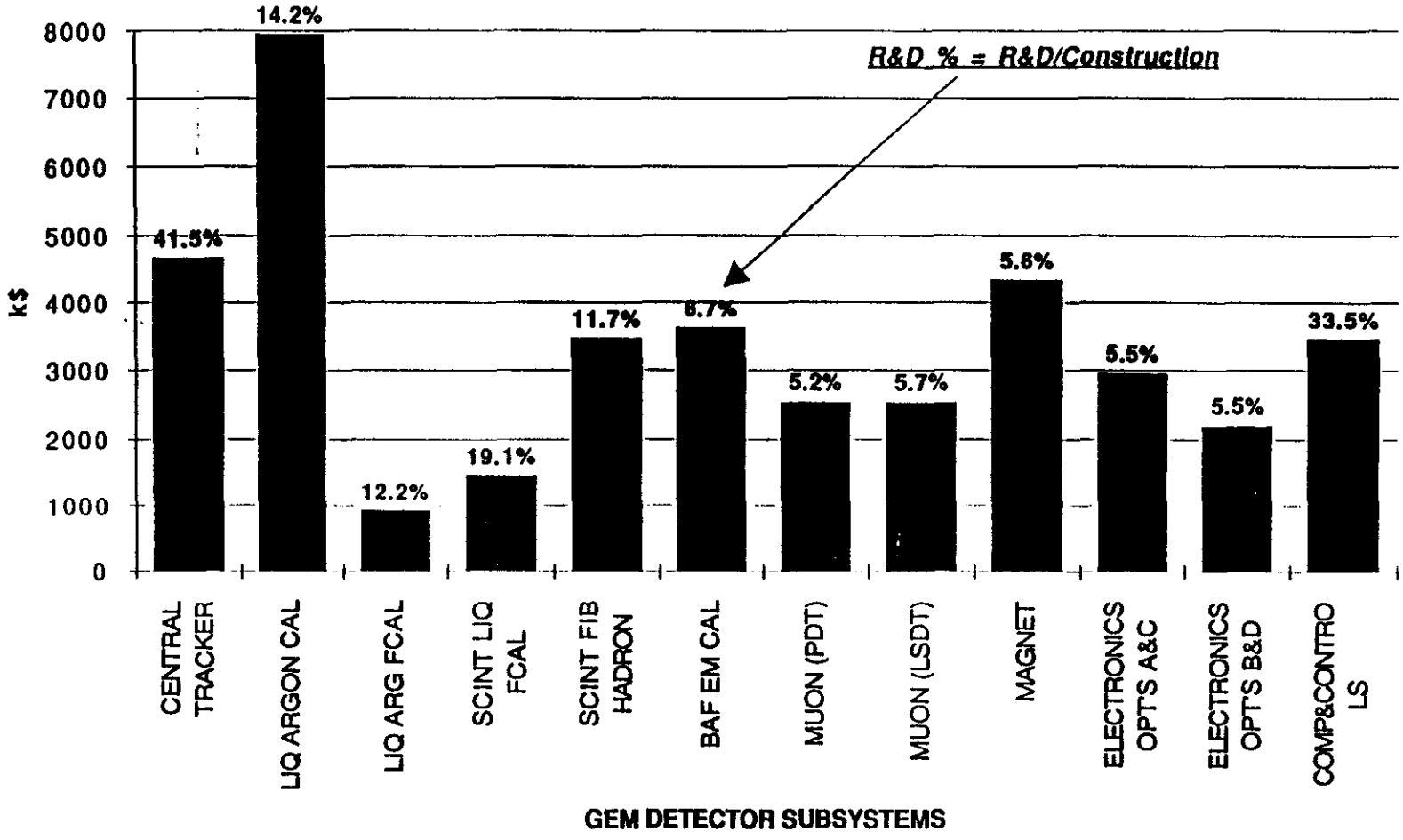
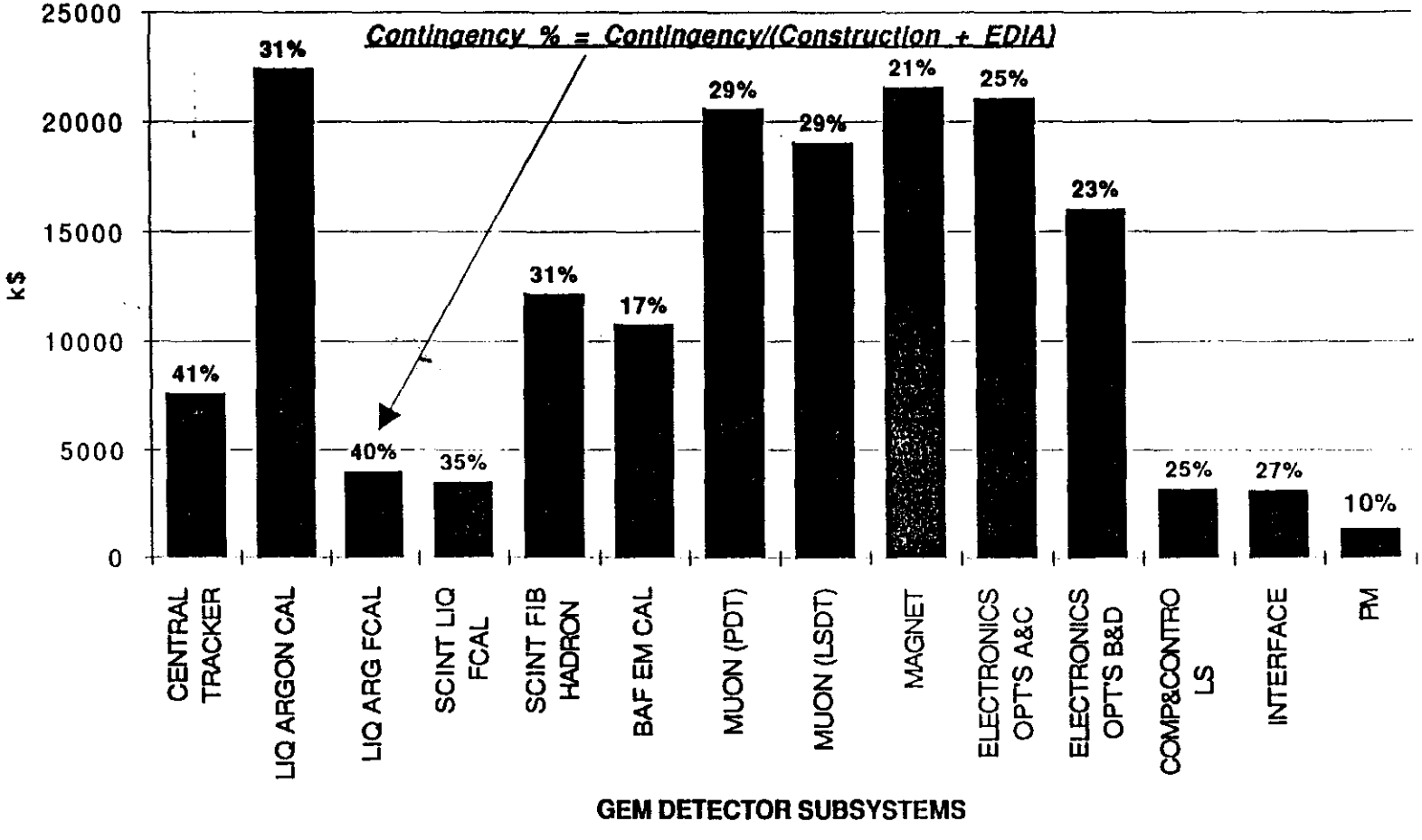


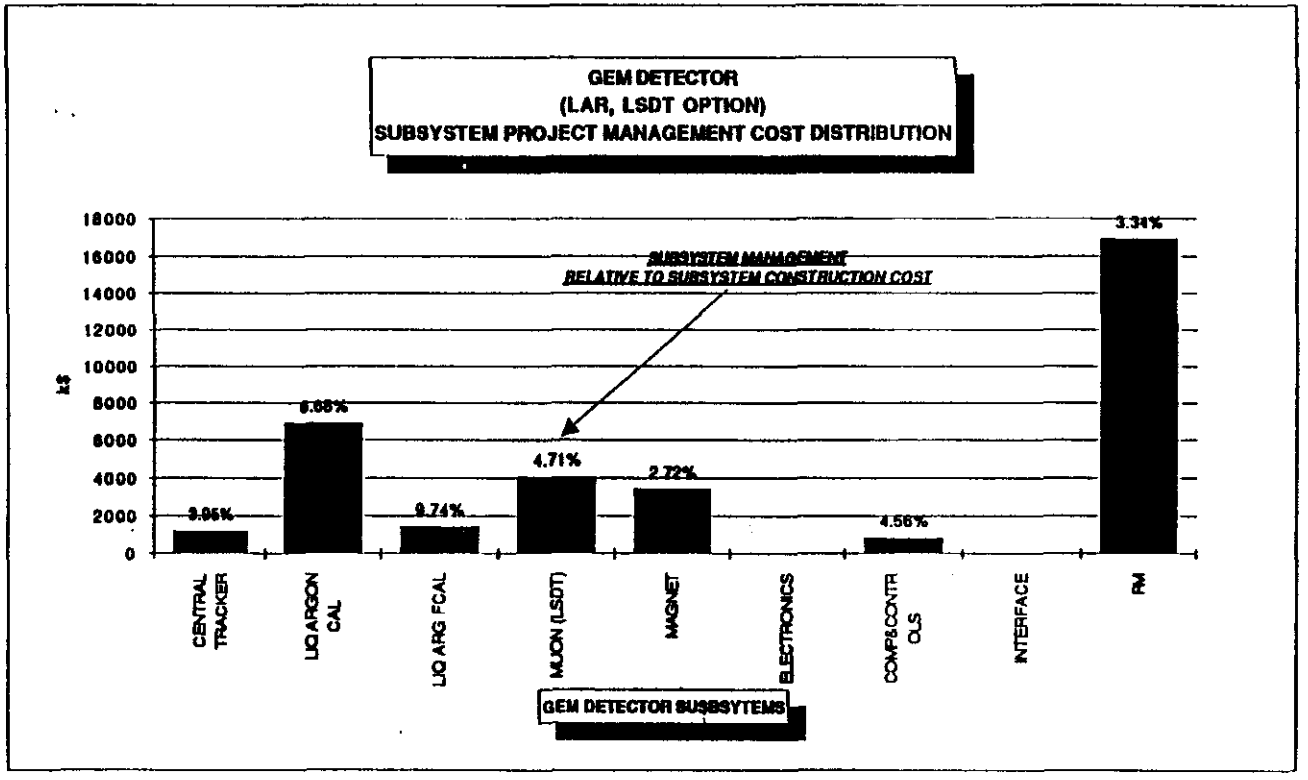
CHART 8
CONTINGENCY COST DISTRIBUTION BY SUBSYSTEM



SUBSYSTEM PROJECT MANAGEMENT
(LIQUID ARGON & LSDT OPTION)

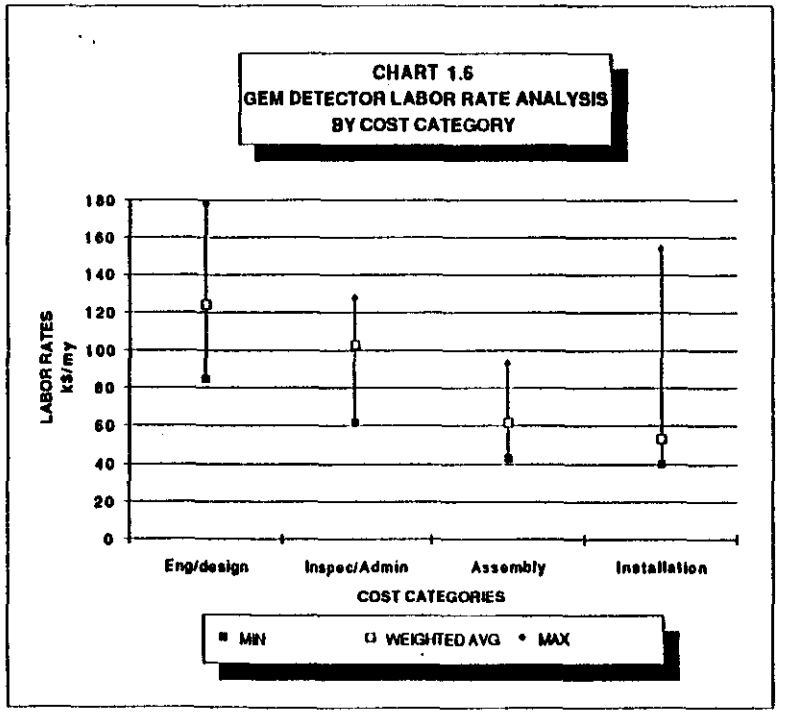
SUBSYSTEM	Subtotal Lab&Mat'l k$	Contingency k$	Total k$	OPTION A CONST. k$	% OF CONST
CENTRAL TRACKER	1050	184	1234	31276	3.95%
LIQ ARGON CAL	6082	851	6933	103847	6.68%
LIQ ARG FCAL	1183	307	1490	15307	9.74%
MUON (LSDT)	3731	373	4104	87101	4.71%
MAGNET	3007	451	3458	127096	2.72%
ELECTRONICS	0	0	0	109080	0.00%
COMP&CONTROLS	745	149	893	19604	4.56%
INTERFACE	0	0	0	15077	0.00%
PM	15431	1543	16974	15955	3.34%
TOTAL PROJECT MANAGEMENT	31228	3858	35086	475009	7.39%

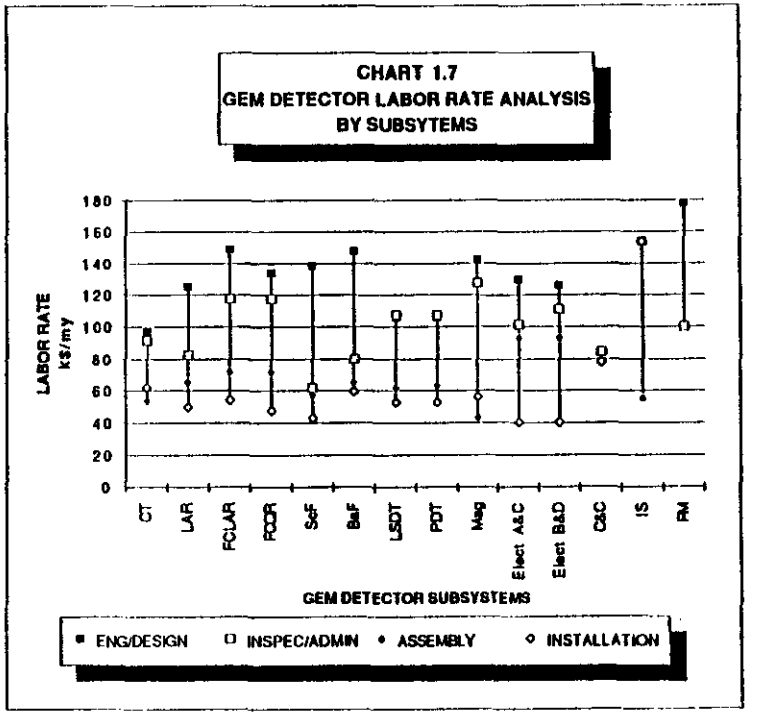
CONSTRUCTION W/O PM 439923 7.98%



GEM DETECTOR LABOR RATE ANALYSIS

	COST CATEGORIES							
	Eng/design		Inspec/Admin		Assembly		Installation	
	Labor	Rate	Labor	Rate	Labor	Rate	Labor	Rate
SUBSYSTEMS	my	k$/my	my	k$/my	my	k$/my	my	k$/my
CT	79	97	30	92	33	54	5	62
LAR	101	125	48	83	253	66	16	50
FCLAR	20	149	2	118	16	72	1	54
FCCR	23	134	2	118	21	72	4	48
ScF	69	138	18	62	68	57	11	43
BaF	70	148	12	80	48	65	5	60
LSDT	95	106	98	108	272	62	41	53
PDT	95	106	97	107	253	64	41	53
Mag	83	143	67	128	64	43	31	56
Elect A&C	121	130	14	102	2	93	32	40
Elect B&D	102	126	11	111	2	93	14	40
C&C	44	85	11	85			18	78
IS	5	154			28	55	2	154
PM	22	178	87	100				
MIN		85		62		43		40
WEIGHTED AVG		124		103		62		53
MAX		178		128		93		154





GEM INTERNAL COST REVIEW

Reviews are scheduled periodically. In some cases, review panels are appointed, with some non-GEM members. Action items and findings are written up and provided to the design and estimating team and to the GEM Executive Committee.

Some recent GEM internal reviews:

2/25/92	Central tracker review
3/19/92	Electronics cost review
4/4/92	Magnet cost review
4/21/92	Liquid argon calorimeter cost review
4/22/92	Other calorimeters cost review
4/23/92	Electronics cost review
5/6/92	Muon system cost review
5/7/92	Central tracker cost review

These are called by GEM Project Manager. Other reviews take place within the subsystem groups.

INDEPENDENT COST ANALYSIS

Earlier this year, SSCL declined to call an external (to GEM) cost review. We planned to present a preliminary cost estimate to the July PAC session and a final estimate at TDR submission.

As a management tool, we decided that we needed an independent review of GEM cost estimating as an ongoing process. This was accentuated by the lack of scheduled external reviews.

GEM has hired U.S. Cost/SAIC to perform an independent analysis of all GEM estimating methodology, all GEM subsystem estimates, and to search for uniformity in approach, and to independently review our labor, manufacturing, assembly, installation, EDIA, contingency estimates.

We got authorization to proceed with this contract at the beginning of May and began the work with the scintillating fiber calorimeter (the most conventional detector assembly problem in GEM), the magnet, our methodology, and cost/schedule controls system. The magnet report is due this week.

We will receive several reports prior to the July PAC meeting and all will be received prior to technology choices.

We have been informed that this company is being placed under contract to provide similar services for SDC.

GEM MILESTONES

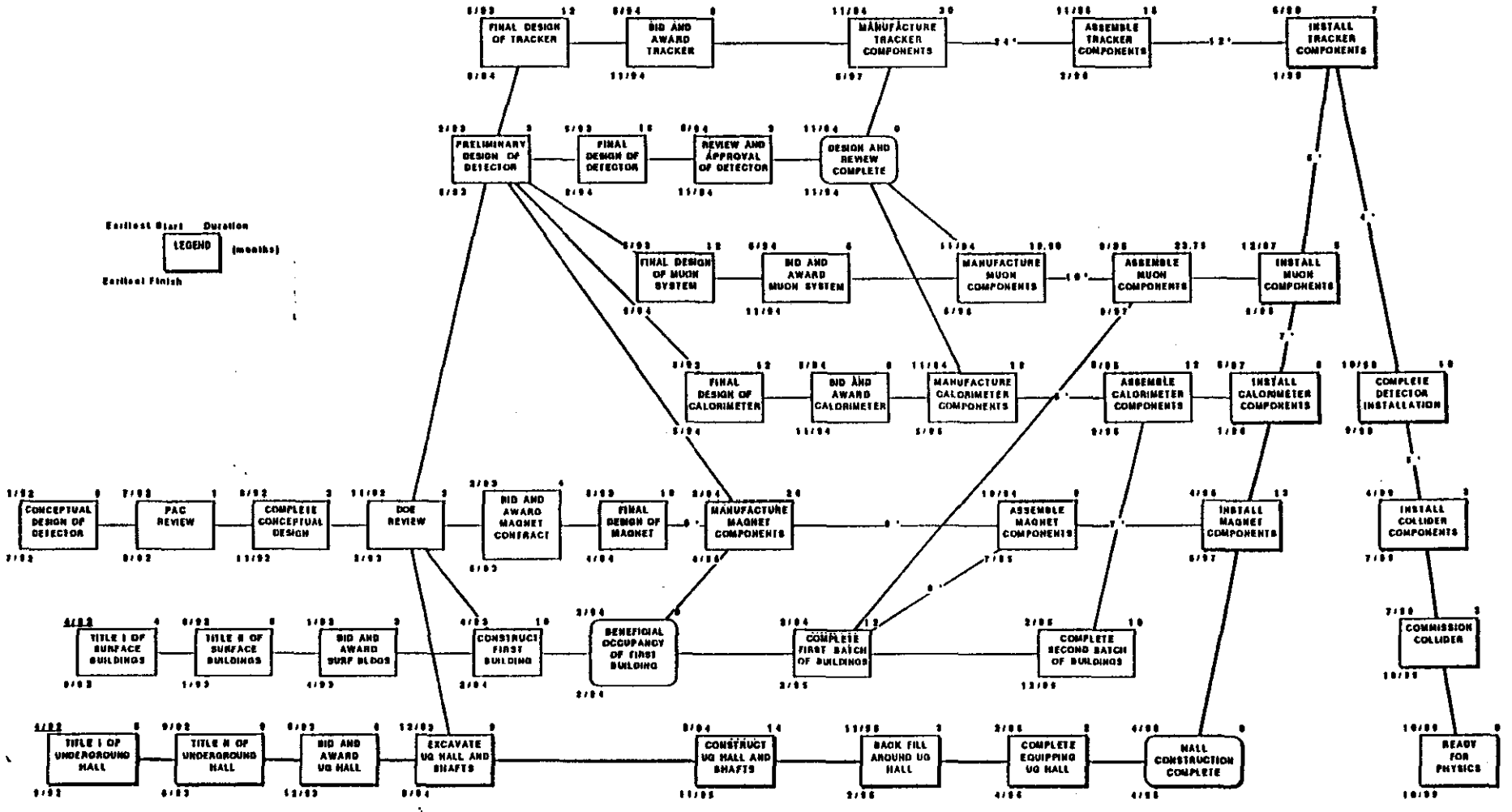
I

NTP GEM Conceptual Design	January, 1992
Detector Cost Book Review	June, 1992
Magnet Conceptual Design Report Submittal	June, 1992
PAC Detector and Magnet Specific Review	July, 1992
GEM Baseline II Complete	September, 1992
Magnet Design Report Submittal to DOE	August, 1992
DOE Magnet Review	September, 1992
Technical Proposal Submittal	November, 1992
DOE Technical Proposal Review	March, 1993
Detector Ready for Physics	October, 1999

II

Start Title 1 Design of UG Hall	April, 1992
Start Design of Magnet Coil Building	April, 1992
Complete Title 1 of the Magnet Coil Building	July, 1992
Calorimeter Option Decision	August, 1992
Start Title 1 of Other Surface Facilities	September, 1992
Start Title 2 Design and Details of UG Hall	October, 1992
Joint Occupancy of the Underground Hall	January, 1996
Start Magnet Rail Installation	January 1996
Start Magnet Installation	April, 1996
Beneficial Occupancy of Underground Hall	August, 1996
Start Calorimeter Installation	May, 1997
Start Muon Installation	December, 1997
Start Tracker Installation	June, 1998
Detector Installation Complete	April, 1999

MH 6/17/92



GEM DETECTOR GENERAL SCHEDULE

JNG 6/17/92

WORK IN PROGRESS
AREAS OF POTENTIAL ESTIMATE GROWTH

1. Audit of all conventional equipment in Interface Systems and in all subsystems to properly identify missing and duplicated items.

2. Management of foreign activities.

3. Costs traded off for schedule to be included, if necessary, when mature schedule is completed. This work has to be coordinated with conventional facilities design now in Title I.

WORK IN PROGRESS
AREAS OF POTENTIAL ESTIMATE DECREASE

1. Assembly estimates now based upon manufacturing engineering approach for major subsystems. No manufacturing optimization has been performed. This optimization expected to decrease estimate by at least **$6 million FY92$** (10% of approx. $60 million in current estimate).

2. Optimization of Engineering and Design labor rates by selecting lower cost suppliers without downgrading skill mix can be expected to save at least **$7.5 million FY92$** (10% of approx. $75 million in current estimate).

3. Eliminate stainless steel from magnet FFS, central support and undercarriage, and substitute low carbon steel. Magnetic field impact under study. Novosibirsk requests this change. Estimate cost would be reduced by **$5.6 million FY92$.**

4. Eliminate mobility from magnet design. Estimate reduction **$1.5 million FY92$.**

5. Reduce total calorimeter thickness from 12 interaction lengths to 11. Impact upon muon system under study. Estimate reduction at $5 million FY92$.

These items could represent a **$25 million FY92$** reduction if all were achieved. These are reductions to the US cost estimate.

TRANSITION TO FUNDING PLAN

This estimate will be maintained as design for TDR matures. Estimate growth will be balanced by cost discipline to maintain a design cost below our target.

Final GEM cost volume in TDR planned to include this estimate with actual costs from institutions committed by collaboration to produce agreed upon items, to the maximum extent possible at the TDR submission date. This plan will make use of foreign cost offsets, TNRLC, and high-energy physics base program efforts. The use of foreign, university and student labor will further lower the labor costs beyond the optimization described above.

A funding plan for foreign and non-SSCL project participation is being developed within GEM.