

5 April 2002

MEMORANDUM

To: Members of the RRB via R. Cashmore / DG-DI, Chair

From: M&O Scrutiny Group¹

Subject: M&O Scrutiny Group Report (April 2002 RRB)

1. Introduction

The M&O Scrutiny Group was formed at the end of August 2001 to review and scrutinize the M&O cost estimates of the four LHC Collaborations. In its first report prepared for the October 2001 RRB meetings (RRB report D-2001-8), the M&O Scrutiny Group presented a detailed description of its work and the results obtained. Due to the very short time available only a limited but well visible number of category “A” items were carefully scrutinized using the guidelines listed below:

- 1) flag items (or time periods for items) that are more correctly linked to Construction, Commissioning & Integration than to Maintenance & Operation;
- 2) flag items for which cost estimates are intrinsically unreliable or likely to vary with time;
- 3) flag items for which a change of strategy might produce economies e.g. gas recycling versus consumption;
- 4) identify activities akin to shutdown activities but occurring before full machine operation;
- 5) identify the cost drivers;

The Scrutiny Group added two additional guidelines:

- 6) standardize the data presentation formats in order to facilitate comparisons between Collaborations;
- 7) ensure that the spending profile corresponds to that expected for M&O;

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After the October 2001 RRB meetings, the Scrutiny Group continued to meet regularly in order to complete the scrutiny of the remaining “A”, “B” and “C”² costs. As proposed during the October meetings, it developed a more adequate, sub-system oriented template for the review of “B” costs.

1. Scrutiny of “A” costs

Several meetings between Resource Coordinators and Scrutiny Group members took place at CERN in order to review thoroughly the M&O “A” costs of the four experiments. In particular, all items related to “Commissioning and Integration” were carefully separated out. Each entry in the M&O “A” tables was carefully checked to ensure that the items listed refer to equipment already at the stage where they can legitimately incur M&O costs. This applies to: a) detector related costs, b) test beams and calibration facilities, c) laboratory operations and d) general services. The Scrutiny Group has tried to standardize the data presentation format to facilitate comparison between Collaborations. However, the group understood that the Collaborations have different attitudes to various items, i.e. ALICE treats counting rooms, test beams and workshop as Common Fund items, which explains their higher M&O “A” costs. For ATLAS and CMS these costs are considered to be mainly of type “B”. The time-dependence of the spending profile now has the correct form for M&O and reflects increasing activity around maintainable detector items as one approaches machine commissioning and data taking.

As already mentioned in the previous report, manpower and service contracts are the main cost drivers. Therefore, the Scrutiny Group strongly recommends careful monitoring of the manpower estimates of the Collaborations on a year-by-year basis. The errors in scrutiny are dominated by the estimate of the manpower needed to maintain and operate the LHC detectors.

Concerning the ‘on-line computing’ M&O costs, a special meeting was held with the aim of achieving a uniform approach to these costs. In particular, a common strategy is needed towards charging for raw data storage and a common set of guidelines should be laid out for equipment replacement cycles. More work is required and the conclusions and resulting costs will be communicated to the RRB in a separate note. There should be little effect on cost estimates for the years 2002 and 2003.

Summarizing, the Scrutiny Group concluded that the “A” cost estimates as presented are reasonable. However, while the M&O estimates for 2002 and 2003 are fairly independent of the machine schedule, the M&O cost estimates for 2004-2007 are highly dependant on the LHC completion schedule. Therefore, the recommendation to the RRB is to endorse the costs for 2002 and 2003 and review the 2004-2007 costs at the time when the LHC schedule is final.

² The categorization of costs into A, B and C was neither defined nor discussed by the Scrutiny Group

2. Review of “B” costs

In contrast to (common fund) “A” costs, which were since ~1990 monitored and endorsed by Finance Review Committees, (sub-system specific) “B” costs have always been internally handled by the collaborations. Identification, funding and management of category “B” M&O costs were traditionally, and in particular during LEP times, left to the Collaborations and institutes involved in particular sub-systems. Considering that LHC sub-systems have reached the size of LEP Collaborations, there is justification for the request of CMS, ALICE and, in particular, ATLAS to have their “B” costs reviewed. LHCb having the size of a LEP experiment prefers to handle their “B” costs in the traditional way. In addition, LHCb is not yet sufficiently advanced to give estimates for visible “B” costs.

For the purpose of reviewing Category “B” costs, the maintenance and operation of each sub-detector has been divided broadly into the following categories: (a) mechanics, (b) service systems (gas, cryo, cooling), (c) FE electronics, (d) commercial electronics, controls, (e) areas (clean-rooms, maintenance facilities, test beams, storage, workshops), (f) communications, (g) store items and (h) manpower.

Sub-system oriented templates were developed taking into account the above-mentioned subdivision. In parallel, simple guidelines for cost estimates based on experience from previous experiments at CERN, were introduced (cf. Table below).

Experiment:	
Subsystem:	Guide for M&O B costs
Mechanics	Maintenance of moving parts, ~2% of capital investment
Gas-system	Maintenance + consumption, if not in "A"
Cryo-system	Maintenance + consumption, if not in "A"
Cooling system	Maintenance + consumption, if not in "A"
FE electronics	Spares exceeding what was included in CORE, to be indicated in the year of payment
Standard electronics, PS (LV, HV)	~ 5% of value
Standard electronics, Crates	~ 5% of value
Standard electronics, RO Modules	~ 5% of value
Controls, (DCS, DSS)	~ 5% of value
Sub-Detector Spares	Spares exceeding CORE costs, to be indicated in the year of payment
Areas	Maintenance of clean rooms, active and passive storage (including rentals), workshops
Communications	Piquet tools (ACB, GSM, etc...)
Stores Items	Materials (screws, washers, tools, etc...)
Hired Manpower @ CERN (CHF)	(Industrial Support)
Technical Manpower @CERN (FTE)	(Technicians from Collaboration Institutes)

The M&O Scrutiny Group insisted that, right from the beginning of the cost review exercise, upgrades, construction and C&I costs were removed.

FE electronics spares often have to be ordered in advance with the main procurement. In the case of ATLAS, provision to buy spares is made by borrowing from the future. In order to avoid “falsifying” the M&O spending profile, early spares have been listed in a separate line (cf. Appendix 2).

The entry ‘manpower’ was subdivided into ‘hired’ and ‘technical’ manpower. Technicians sent by collaborating institutions can be credited once agreement on a common conversion factor is reached.

The group reviewed the M&O “B” cost estimates subsystem by subsystem strictly applying the guidelines listed in Table 1. In addition the group checked that the M&O costs in the years of full operation did not exceed 5% of the CORE costs of the subsystem.

The Scrutiny Group concluded that the cost estimates are reasonable and are considered to be adequate as a planning base for the Collaborations for the years 2002 and 2003. Beyond these years, they will depend on the final LHC machine schedule.

3. Scrutiny of “C” costs

The Scrutiny Group discussed the Category “C” costs at length. The group carefully assessed these costs and concluded that the list of items is incomplete. It is the opinion of the Group that CERN support for the LHC experiments is substantially more than appears in the present tables. The Scrutiny Group therefore recommends the RRB to ask CERN Management for a complete list with cost estimates.

4. Summary

The Scrutiny Group concludes that the M&O cost estimates given by the Collaborations for the years 2002 and 2003 are sound and independent of the LHC machine schedule. The cost estimates for the years 2004-2007 and beyond depend strongly on the final machine schedule. Independently of the cost category, one of the main cost drivers for maintenance and operation is the entry labelled manpower and service contracts.

Dietrich Schinzel

Appendix 1- Category A and C Cost Estimates

Appendix 2- Category B Cost Estimates

M&O A Cost Estimates in kCHF

	2002 ALICE	2002 ATLAS	2002 CMS	2002 LHCb	2003 ALICE	2003 ATLAS	2003 CMS	2003 LHCb	2004 ALICE	2004 ATLAS	2004 CMS	2004 LHCb
Detector related costs	5	19	199	0	150	242	597	5	270	457	774	165
Magnet	0	0	0	0	0	0	0	0	0	0	0	0
Magnet controls	0	0	0	0	0	0	0	0	0	0	0	0
Magnet power supply	0	4	0	0	0	12	0	0	0	12	0	0
Gas systems	0	0	0	0	30	0	30	0	45	50	40	0
Gas consumption	0	0	0	0	10	0	30	0	20	0	40	0
Cooling systems	0	0	50	0	0	70	100	0	0	70	200	100
Cooling fluids(> -50°C)	0	0	0	0	10	5	20	0	20	10	30	0
External cryogenics	0	0	60	0	0	0	210	0	0	0	170	0
Cryogenic fluids(<-50°C)	0	0	0	0	0	0	0	0	0	0	0	0
Moving/hydraulic systems	0	0	50	0	40	100	50	0	40	100	50	0
Detector safety systems	0	0	0	0	0	0	15	0	20	0	20	0
Shutdown activities	0	0	0	0	0	0	0	0	0	0	0	0
General Technical support	0	0	0	0	0	0	0	0	0	0	0	0
UPS maintenance	0	0	0	0	0	0	0	0	0	0	0	0
Electronics pool rentals	0	0	0	0	10	0	0	5	10	30	30	15
Beam pipe & vacuum	0	0	0	0	0	0	0	0	0	0	0	0
Counting & control rooms	0	0	0	0	0	0	50	0	20	0	50	0
Secretariat	41	40	45	45	114	110	115	120	150	155	205	125
Secretarial assistance	0	0	0	0	70	45	70	70	100	90	140	70
Economat	0	0	0	0	0	0	0	0	0	0	0	0
Printing and publication	15	10	15	15	15	15	15	15	15	15	15	20
Communications	0	0	5	0	0	10	5	7	0	15	10	9
GSM phones /on-call service	0	0	0	0	0	0	0	0	0	0	0	0
Automatic call back	0	0	5	0	0	10	5	7	0	10	10	9
On-line comp. (no rec. media)	0	75	80	0	10	75	260	0	20	530	1 150	150
System management	0	0	0	0	10	0	70	0	20	120	180	110
Data storage (temp.on disk)	0	0	0	0	0	0	0	0	0	0	0	0
Detector controls	0	0	0	0	0	0	0	0	0	0	0	0
Computers/processors/LANs	0	20	0	0	0	20	40	0	0	20	90	0
Software licenses	0	0	0	0	0	0	0	0	0	300	720	0
Common desktop infrastructure	0	55	80	0	0	55	150	0	0	90	160	30
	0	0	0	0	0	0	0	0	0	0	0	0

M&O A Cost Estimates in kCHF		2002 ALICE	2002 ATLAS	2002 CMS	2002 LHCb	2003 ALICE	2003 ATLAS	2003 CMS	2003 LHCb	2004 ALICE	2004 ATLAS	2004 CMS	2004 LHCb
Test beams calibration		295	720	150	110	217	710	250	120	167	785	170	120
General operation	O	0	240	60	5	0	240	60	5	0	240	60	5
	C	112	0	20	10	80	0	120	10	30	0	20	10
Common electronics	O	0	0	0	0	0	0	0	0	0	0	0	0
	C	46	85	20	25	0	95	20	25	0	95	40	25
Electronics pool rentals	O	0	0	0	0	0	0	0	0	0	0	0	0
	C	70	60	30	0	70	60	30	0	70	60	30	0
Gas systems	O	40	0	0	45	40	0	0	45	40	0	0	45
	C	7	0	10	5	7	0	10	5	7	0	10	5
Gas consumption	O	0	0	0	0	0	0	0	0	0	0	0	0
	C	20	0	10	20	20	0	10	30	20	0	10	30
External cryogenics	O	0	260	0	0	0	260	0	0	0	340	0	0
	C	0	75	0	0	0	55	0	0	0	50	0	0
Laboratory operations		0	20	20	65	260	80	20	55	260	130	20	45
Assembly areas clean rooms	O	0	0	0	0	40	0	0	0	40	0	0	0
	C	0	0	0	50	0	50	0	40	0	100	0	30
Workshops	O	0	0	0	5	120	0	0	5	120	0	0	5
	C	0	0	20	10	50	10	20	10	50	10	20	10
Laboratory instruments	O	0	0	0	0	50	0	0	0	50	0	0	0
	C	0	20	0	0	0	20	0	0	0	20	0	0
General services		104	288	502	151	268	1,186	759	353	574	1,863	972	508
Cooling & ventilation	O	25	36	34	28	50	73	67	39	76	109	101	59
	C	25	36	34	28	50	73	67	39	76	109	101	59
Power	O	0	0	0	0	0	0	0	0	0	0	0	0
	C	24	80	95	50	132	560	280	170	383	1,030	350	100
Power distribution system	O	0	0	0	0	0	0	0	0	0	0	0	0
	C	0	0	10	0	0	20	10	0	0	25	20	0
Heavy transport	O	0	0	0	0	0	60	0	0	0	60	0	0
	C	0	0	0	0	0	0	0	0	0	0	0	0
Cranes	O	0	0	0	0	0	60	0	0	0	60	0	190
	C	0	5	30	0	0	30	30	0	0	60	50	0
Cars	O	0	0	0	0	0	0	0	0	0	0	0	0
	C	10	0	30	15	15	30	30	15	20	30	40	30
Survey	O	0	60	0	0	0	110	0	40	0	210	0	40
	C	0	0	0	0	0	0	0	0	0	0	0	0
Storage space	O	0	0	0	0	0	0	0	0	0	0	0	0
	C	0	0	50	0	0	0	50	0	0	0	75	0
Common desktop infrastructure	O	0	0	0	0	0	0	0	0	0	0	0	0
	C	0	20	30	0	0	20	35	0	0	20	45	0
Academic subsistence	O	0	0	130	20	0	100	130	40	0	100	130	20
	C	0	0	0	0	0	0	0	0	0	0	0	0
Outreach	O	0	0	0	0	0	0	0	0	0	0	0	0
	C	20	50	60	10	20	50	60	10	20	50	60	10
TOTALS		446	1,162	1,001	371	1,019	2,413	2,006	660	1,441	3,935	3,301	1,122
Operation sub-items		65	605	334	103	480	1,075	782	244	616	1,616	1,011	544
Consumables sub-items		380	556	668	268	539	1,338	1,224	416	826	2,319	2,290	578

Appendix 1 – Category A Cost Estimates (2002 - 2004)

M&O A Cost Estimates in kCHF

	2005 ALICE	2005 ATLAS	2005 CMS	2005 LHCb	2006 ALICE	2006 ATLAS	2006 CMS	2006 LHCb	2007 ALICE	2007 ATLAS	2007 CMS	2007 LHCb
Detector related costs	589	2 107	1 414	691	1 650	4 413	2 849	1 044	1 803	4 413	2 794	1 044
Magnet	O 0	40	80	12	0	40	100	20	0	40	100	20
C 0	50	20	10	0	0	50	25	15	0	50	25	15
Magnet controls	O 46	210	0	0	61	180	0	0	61	180	0	0
C 11	59	0	0	0	15	45	0	0	15	45	0	0
Magnet power supply	O 8	8	20	4	8	8	20	4	8	8	20	4
C 10	75	0	5	10	75	30	5	10	75	30	5	
Gas systems	O 60	50	90	120	180	50	160	120	180	50	160	120
C 30	50	40	20	50	100	50	20	50	100	50	20	
Gas consumption	O 0	0	0	0	0	0	0	0	0	0	0	0
C 110	150	200	300	312	200	300	300	455	200	300	300	
Cooling systems	O 60	120	150	20	180	120	190	20	180	120	190	20
C 30	45	30	10	50	45	40	10	50	45	30	10	
Cooling fluids(> -50°C)	O 0	5	0	5	0	5	0	5	0	5	0	5
C 0	25	15	10	0	75	20	10	0	75	20	10	
External cryogenics	O 0	700	250	0	0	1 040	300	0	0	1 040	300	0
C 0	320	30	0	0	430	30	0	0	430	30	0	
Cryogenic fluids(< -50°C)	O 0	0	0	0	0	0	0	0	0	0	0	0
C 0	0	24	0	0	0	24	0	0	0	24	0	
Moving/hydraulic systems	O 40	100	50	5	80	50	50	5	80	50	50	5
C 10	20	25	10	10	40	25	10	10	40	25	10	
Detector safety systems	O 40	0	25	10	40	0	25	10	40	0	25	10
C 0	30	20	10	0	60	40	10	0	60	40	10	
Shutdown activities	O 0	0	0	0	160	400	530	150	160	400	470	150
C 0	0	0	0	0	35	50	20	0	35	50	20	0
General Technical support	O 0	0	180	0	120	300	350	0	120	300	350	0
C 0	0	25	0	0	660	80	0	0	660	60	0	
ITPS maintenance	O 0	0	0	0	0	0	0	0	0	0	0	0
C 20	50	40	25	20	50	50	25	20	50	80	25	
Electronics pool rentals	O 0	0	0	0	0	0	0	0	0	0	0	0
C 38	0	0	100	48	0	0	100	58	0	0	100	
Beam pipe & vacuum	O 0	0	0	0	80	120	120	80	80	120	120	80
C 0	0	0	0	0	80	120	120	80	80	120	120	80
Counting & control rooms	O 40	0	50	10	60	0	100	30	60	0	100	30
C 35	0	50	5	50	100	50	15	50	100	50	15	
Secretariat	199	215	205	165	202	270	300	180	206	290	300	195
Secretarial assistance	O 140	140	140	105	140	140	185	105	140	140	185	105
C 0	0	0	0	0	0	0	0	0	0	0	0	0
Economat	O 0	0	0	0	0	0	0	0	0	0	0	0
C 20	15	15	20	20	20	20	15	20	20	15	20	
Printing and publication	O 0	0	0	0	0	0	0	0	0	0	0	0
C 39	60	50	40	42	110	100	55	46	130	100	70	
Communications	10	15	40	9	10	15	40	9	10	15	40	9
GSM phones /on-call service	O 0	0	0	0	0	0	0	0	0	0	0	0
C 10	10	20	9	10	10	20	9	10	10	20	9	
Automatic call-back	O 0	0	0	0	0	0	0	0	0	0	0	0
C 0	5	20	0	0	5	20	0	0	5	20	0	
On-line comm. (no rec. media)	238	1 690	1 560	570	471	2 925	1 990	740	1 167	3 945	7 640	780
System management	O 180	480	660	400	320	600	870	400	450	600	1 100	400
C 0	0	0	0	0	0	0	0	0	0	0	0	0
Data storage (temporary on)	O 0	0	0	0	0	0	0	0	0	0	0	0
C 0	0	50	10	0	0	100	40	23	0	500	40	
Detector controls	O 0	0	0	0	0	0	0	0	0	0	0	0
C 25	30	150	50	50	30	150	50	102	30	150	50	
Computers/processors/I ANs	O 0	0	0	0	0	0	0	0	0	0	0	0
C 0	1 000	560	50	10	2 040	680	190	443	3 060	5 650	230	
Software licenses	O 0	0	0	0	0	0	0	0	0	0	0	0
C 33	150	140	30	91	225	190	30	149	225	240	30	
Common desktop infrastructure	O 0	0	0	0	0	0	0	0	0	0	0	0
C 0	30	0	30	0	30	0	30	0	30	0	30	

M&O A Cost Estimates in kCHF

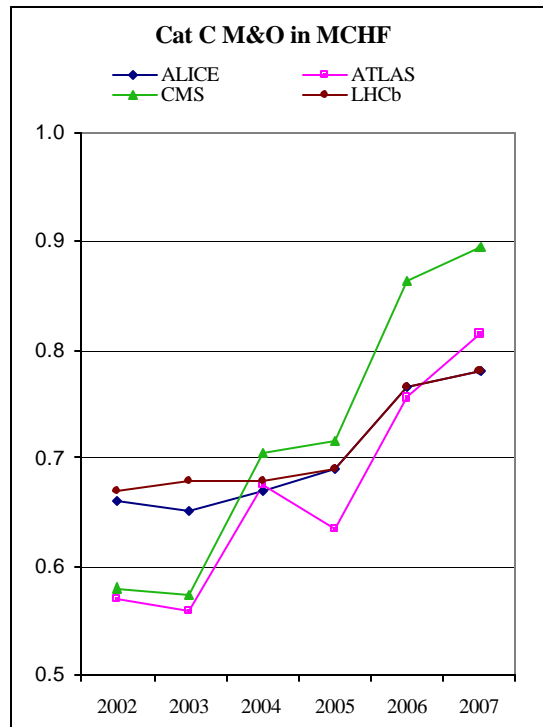
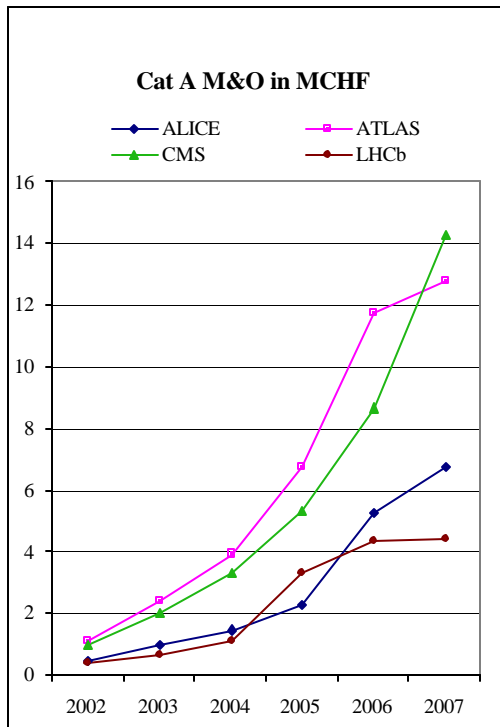
	2005 ALICE	2005 ATLAS	2005 CMS	2005 LHCb	2006 ALICE	2006 ATLAS	2006 CMS	2006 LHCb	2007 ALICE	2007 ATLAS	2007 CMS	2007 LHCb
Test beams calibration	167	140	170	100	167	65	110	70	167	65	90	70
General operation	O 0	0	60	5	0	0	40	5	0	0	20	5
	C 30	0	20	10	30	0	20	10	30	0	20	10
Common electronics	0	0	0	0	0	0	0	0	0	0	0	0
	C 0	95	40	15	0	20	10	15	0	20	10	15
Electronics pool rentals	O 0	0	0	0	0	0	0	0	0	0	0	0
	C 70	45	30	0	70	45	20	0	70	45	20	0
Gas systems	O 40	0	0	45	40	0	0	25	40	0	0	25
	C 7	0	10	5	7	0	10	5	7	0	10	5
Gas consumption	O 0	0	0	0	0	0	0	0	0	0	0	0
	C 20	0	10	20	20	0	10	10	20	0	10	10
External cryogenics	O 0	0	0	0	0	0	0	0	0	0	0	0
	C 0	0	0	0	0	0	0	0	0	0	0	0
Laboratory operations	260	115	200	45	260	75	250	35	260	75	250	25
Assembly areas clean rooms	O 40	0	0	0	40	0	0	0	40	0	0	0
	C 0	50	20	30	0	0	20	20	0	0	20	10
Workshops	O 120	0	150	5	120	0	200	5	120	0	200	5
	C 50	10	30	10	50	20	30	10	50	20	30	10
Laboratory instruments	O 50	0	0	0	50	0	0	0	50	0	0	0
	C 0	55	0	0	0	55	0	0	0	55	0	0
General services	827	2.461	1.759	1.746	2.531	3.959	3.136	2.276	3.148	4.024	3.131	2.256
Cooling & ventilation	O 101	146	134	78	126	182	168	98	126	182	168	98
	C 101	146	134	78	126	182	168	98	126	182	168	98
Power	O 0	0	0	0	0	0	0	0	0	0	0	0
	C 485	1.470	1.000	1.000	1.644	2.820	2.000	1.600	2.226	3.010	2.000	1.600
Power distribution system	O 0	0	0	0	0	0	0	0	0	0	0	0
	C 0	25	30	10	160	35	30	10	160	35	30	10
Heavy transport	O 0	60	0	100	120	60	250	20	120	60	250	20
	C 0	0	20	0	0	0	60	0	0	0	60	0
Cranes	O 0	60	0	190	160	120	0	160	160	120	0	160
	C 0	60	50	0	0	60	70	0	0	60	70	0
Cars	O 0	0	0	0	0	0	0	0	0	0	0	0
	C 20	30	40	30	20	30	30	30	20	30	30	30
Survey	O 0	210	0	40	30	110	50	40	40	60	50	20
	C 0	0	0	0	0	0	10	0	0	0	5	0
Storage space	O 0	0	0	0	0	0	0	0	0	0	0	0
	C 0	0	100	0	0	0	50	0	0	0	50	0
Common desktop infrastructure	O 0	0	0	0	0	0	0	0	0	0	0	0
	C 0	30	60	0	25	30	60	0	50	30	60	0
Academic subsistence	O 100	100	130	200	100	130	130	200	100	130	130	200
	C 0	0	0	0	0	0	0	0	0	0	0	0
Outreach	O 0	50	0	0	0	100	0	0	0	50	0	0
	C 20	75	60	20	20	100	60	20	20	75	60	20
TOTALS	2.291	6.743	5.348	3.326	5.291	11.722	8.675	4.354	6.761	12.827	14.245	4.379
Operation sub-items	1.065	2.479	2.169	1.354	2.215	3.755	3.838	1.502	2.355	3.655	3.988	1.482
Consumables sub-items	1.226	4.265	3.178	1.972	3.076	7.967	4.837	2.852	4.405	9.172	10.257	2.897

Appendix 1 - Category A Cost Estimates (2005 - 2007)

M&O Category C
Cost Estimates in
kCHF

		2002				2003				2004				2005				2006				2007			
		ALICE	ATLAS	CMS	LHCb	ALICE	ATLAS	CMS	LHCb	ALICE	ATLAS	CMS	LHCb	ALICE	ATLAS	CMS	LHCb	ALICE	ATLAS	CMS	LHCb	ALICE	ATLAS	CMS	LHCb
General services		660	570	580	670	650	560	575	680	670	675	705	680	690	635	715	690	765	755	865	765	780	815	895	780
Cooling & ventilation	C O	11	16	14	12	22	31	29	17	32	47	43	25	43	62	58	33	54	78	72	42	54	78	72	42
Safety & radioprotection	C O			5				5	10			10	10			10	10	60	120	60	60	60	120	60	60
INB compliance	C O	160	160	160	160	160	160	160	160	160	160	160	160	120	120	120	120	80	80	80	80	80	80	80	80
Radioactive waste	C O																								
Access system	C O	30		10	30	30		10	30	30		30	30	30		30	30	30		30	30	30		30	30
Elevators	C O	20		15	20	20		15	20	20		30	20	20		30	20	20		30	20	20		30	20
Gerant de site	C O	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250
Flood control	C O	10		10	10	10		10	10	10		10	10	10		10	10	10		10	10	10		10	10
Insurance (CERN)	C O																								
Cleaning	C O	100	50	50	100	100	50	50	100	100	100	100	100	150	100	150	150	200	200	200	200	200	200	200	200
Office space	C O	10	10	10	10	10	10	10	10	10	15	15	10	10	15	15	10	10	15	15	10	10	15	15	10
TOTALS		660	570	580	670	650	560	575	680	670	675	705	680	690	635	715	690	765	755	865	765	780	815	895	780
Operation sub-items		491	436	474	492	502	451	489	507	512	472	548	515	493	447	523	483	514	423	607	502	514	423	607	502
Consumables sub-items		191	166	134	202	192	171	144	207	222	297	243	215	283	312	308	273	359	488	402	347	374	548	432	362

Appendix 1 - Category C Cost Estimates (2002-2007)



ALICE	2002	2003	2004	2005	2006	2007	TOTAL [kCHF]
Pixel	0	0	0	36	72	72	180
Drift	0	0	129.6	182	182	182	675.6
Strip	0	0	0	71.5	143	143	357.5
TPC	0	0	0	50	100	100	250
TRD	0	0	0	40	80	80	200
TOF	0	0	0	30	65	130	225
HPMID	0	0	0	77	154	154	385
PHOS	0	0	0	11.8	23.5	47	82.3
Mu Track	0	0	0	26.5	53	53	132.5
Mu Trigg	0	0	0	30	60	60	150
PMD	0	0	0	0	1.5	1.5	3
ZDC	0	0	0	0	11	22	33
DAQ	0	0	0	55	110	110	275
TOTAL	0	0	129.6	609.8	1055	1154.5	2948.9

ATLAS	2002	2003	2004	2005	2006	2007	2008	2009	2010	TOTAL [kCHF]
ID	360	360	315	705	1605	2910	3060	2650	3550	15515
TileCal	105	105	105	95	475	525	520	515	515	2960
Muons	240	190	160	295	1295	1325	815	815	815	5950
LAr	125	65	40	290	375	1025	1025	1025	1025	4995
TOTAL	830	720	620	1385	3750	5785	5420	5005	5905	29420
Spares										
ID	1100	1134	1533	733	0	0	0	0	0	4500
TileCal	0	100	0	0	0	0	100	0	0	200
Muons	600	600	270	0	0	0	0	0	0	1470
LAr	1200	200	0	0	0	0	0	0	0	1400
TOTAL	2900	2034	1803	733	0	0	100	0	0	7570
Manpower [CHF]										
ID	30	30	50	360	1000	550	550	550	550	3670
TileCal	0	0	0	0	150	150	150	150	150	750
Muons	40	60	90	180	330	330	330	330	330	2020
LAr	15	5	5	200	200	150	150	150	150	1025
TOTAL	85	95	145	740	1680	1180	1180	1180	1180	7465
Manpower [FTE]										
ID	1	1	2	2	4	4	4	4	4	26
TileCal	1	1	1	1	5	5	5	5	5	29
Muons	2	2	2	15	10	13	8	8	8	68
LAr	0	1	5	8	8	7	7	7	7	50
TOTAL	4	5	10	26	27	29	24	24	24	173

The spending profile extends to 2010 to show pay-back of spares

Appendix 2 - Category B Cost Estimates (ALICE AND ATLAS)

CMS	2002	2003	2004	2005	2006	2007	TOTAL [kCHF]
MUON	339	341	274	333	1145	1055	3487
Tracker	250	285	1445	1480	725	1755	5940
Trigger	120	120	310	620	620	620	2410
ECAL	15	136	591	762	1781	1621	4906
HCAL	0	0	294	698	858	948	2798
EMU	193	657	697	866	1059	1184	4656
TOTAL	917	1539	3611	4759	6188	7183	24197
Manpower [CHF]							
MUON	17	17	135	130	175	86	560
Tracker	0	0	0	0	100	200	300
Trigger	0	0	0	0	0	0	0
ECAL	0	72	159	298	479	511	1519
HCAL	0	0	0	0	0	0	0
EMU	0	0	0	0	0	0	0
TOTAL	17	89	294	428	754	797	2379
Manpower [FTE]							
							TOTAL [FTE]
MUON	2	9	10	10	10	9	50
Tracker	0	0	0	0	4	6	10
Trigger	2	2	4	4	8	8	28
ECAL	1.5	3.6	7.5	11.7	11.7	11.7	47.7
HCAL	1	9	11	13	16	16	66
EMU	0.5	12.5	19.5	23	20	20	95.5
TOTAL	7	36.1	52	61.7	69.7	70.7	297.2

LHCb	2002	2003	2004	2005	2006	2007	TOTAL [CHF]
DAQ	15	20	0	0	0	0	35
RICH	10	20	0	0	0	0	30
Outer Tra	15	20	0	0	0	0	35
Inner Tra	15	20	0	0	0	0	35
VELO	15	20	0	0	0	0	35
Calorim	20	20	0	0	0	0	40
Muon	30	30	0	0	0	0	60
TOTAL	120	150	0	0	0	0	270

Appendix 2 - Category B Cost Estimates (CMS AND LHCb)

COMPARISON "B" COST ESTIMATES										
TOTAL "B" MATERIAL										
EXP	2002	2003	2004	2005	2006	2007	2008	2009	2010	TOTAL [kCHF]
ALICE	0.0	0.0	129.6	609.8	1055.0	1154.5				2948.9
ATLAS	830.0	720.0	620.0	1385.0	3750.0	5785.0	5420.0	5005.0	5905.0	29420.0
CMS	917.0	1539.0	3611.0	4759.0	6188.0	7183.0				24197.0
LHCb	120.0	150.0	0.0	0.0	0.0	0.0				270.0
TOTAL	1867.0	2409.0	4360.6	6753.8	10993.0	14122.5	5420.0	5005.0	5905.0	56835.9
TOTAL "B" MANPOWER [kCHF]										
ALICE	0.0	0.0	0.0	10.0	10.0	10.0				30.0
ATLAS	85.0	95.0	145.0	740.0	1680.0	1180.0	1180.0	1180.0	1180.0	7465.0
CMS	17.0	89.0	294.0	428.0	754.0	797.0				2379.0
LHCb	0.0	0.0								0.0
TOTAL	102.0	184.0	439.0	1178.0	2444.0	1987.0				6334.0
TOTAL "B" MANPOWER [FTE]										TOTAL[FTE]
ALICE										
ATLAS	4.0	5.0	10.0	26.0	27.0	29.0	24.0	24.0	24.0	173.0
CMS	7.0	36.1	52.0	61.7	69.7	70.7				297.2
LHCb										
TOTAL	11	41.1	62	87.7	96.7	99.7				470.2
Agreed conversion factor: 1 FTE = 91.25 kCHF										

Appendix 2 - Category B Cost Estimates (Comparisons)