

Report of the LHC M&O Scrutiny Group for the October 2011 RRB

1. Membership of the RRB M&O Scrutiny Group for 2011:

The members of the Scrutiny Group in 2011 are the same as in 2010 except for Enrico Iacopini who replaced Giovanni Batignani. The members are:

Gabriele Cosmo (CERN), Martyn Davenport (CERN), Paul Dauncey (Imperial College London), Cristinel Diaconu (Marseille), George Ginther (FNAL, Rochester), Enrico Iacopini (INFN Firenze), Bernd Löhner (DESY, Chair), Gerhard Mallot (CERN), Sascha Schmeling (CERN; Secretary), Emmanuel Tsesmelis (CERN), Michał Turała (INP Cracow).

2. Scrutiny process

The first meeting of the RRB M&O Scrutiny Group in 2011 took place on 16-18 May. At this meeting, the Resource Coordinators of the five experiments, ALICE, ATLAS, CMS, LHCb and TOTEM, met with the Scrutiny Group to review the amounts spent in 2010 and to present proposals for the budgets in 2012 and projections for following years. During the summer months, the Scrutiny Group members conducted 12 meetings with Resource Coordinators and other representatives of the experiments plus additional telephone conferences and email exchanges to scrutinize in detail the budget requests of the experiments for the year 2012 and thereafter. The last meeting took place on 17 August. After that date the scrutinizers of each experiment summarized the scrutiny process in internal reports. The Scrutiny Group held their autumn meeting with the five experiments on 29 and 30 August 2011. The Resource Coordinators and other representatives of the experiments provided additional clarifications of their budget requests for 2012 and beyond, and the final numbers were agreed upon between the experiments and the Scrutiny Group. This year, for the first time the M&O B budget requests from all LHC experiments were scrutinized in some detail. This has been done for ATLAS M&O B already in the previous years on the request of ATLAS, but not for the other experiments. The scrutiny process for M&O B is described separately later in this document. The efficiency of the scrutiny process was made possible due to the well appreciated co-operation of the Resource Coordinators and other representatives of the experiments and by the quality of the information provided.

3. General remarks

At the beginning of 2011, a new long-term schedule for LHC operations was adopted. This schedule includes routine running until the end of 2012 followed by the first long shutdown 1 in 2013-2014. In the previous schedule, 2012 was planned to be a shutdown year. After long shutdown 1 the LHC is expected to run at energies up to the design value of 14 TeV. After the second long shutdown 2 in 2017-2018 the LHC is expected to operate at full design energy and design luminosity. In the third long shutdown 3 in 2021-2022 the LHC will be upgraded to higher luminosities aiming at $>250 \text{ fb}^{-1}$ per year. This update to the running schedule, in particular the shift of the shutdown from 2012 to 2013, results in modifications to the experiments' M&O spending profiles which had not been completely implemented in the preliminary budget requests presented at the RRB meeting in April 2011. For this and other

reasons to be explained below, the final budget requests for 2012 and the projections for the years up to 2015 which are presented in this document differ from the numbers presented in April.

The LHC performed extremely well in 2011 having delivered nearly 2 fb^{-1} by the end of July. Also the experiments operated with very good efficiency and collected substantial amounts of high quality data which have been analysed within a short time. These impressive achievements have been highlighted by the many high quality contributions to this year's summer conferences. The results were achieved at a bunch spacing of 50 ns instead of the design value of 25 ns, which stresses the DAQ- and trigger-systems of the experiments. The large amount of collected data and the need for timely analyses have impacts on the hardware and manpower for computing.

The budget projections presented by the collaborations are based upon the assumption that the LHC will be moving to the nominal 25 ns bunch spacing. If this transition is deferred, there are likely substantial implications for the performance of the detectors, or the required budgets (or both).

This year's scrutiny process included, in addition to the usual activities, some common topics of discussion which are highlighted below.

- At recent RRB meetings, the funding agencies encouraged the Resource Coordinators of the LHC experiments to provide requests which minimized year to year variations. The Resource Coordinators attempted to honour this request for the 2012 budgets and projections beyond by distributing the requests for long term consolidation projects with variable spending profile over several years. A special project of the latter kind is the reoccurring replacement online-hardware replacement. Implementing this request is challenging. Budgets which do not reflect the anticipated costs in a given year reduce transparency, increase the chances of confusion and complicate the scrutiny process.
- The hardware components of the experiment's TDAQ systems have to be replaced routinely at certain intervals. This replacement strategy was outlined in an agreement reached in 2004 which specified replacement cycles for various components. The biggest cost driver is the replacement of the PCs for the online farm which, according to the 2004 agreement, was proposed to occur typically after four years. Details of the implementation varied between the experiments, and in some cases the agreement was interpreted as replacement after at least three full years of service. Since the build-up of the TDAQ systems are nearing completion, the regular replacement of TDAQ components is becoming a major part of the M&O A costs. Already in 2010, the Scrutiny Group questioned the validity of the replacement model and requested that the 2004 agreement be revisited. In discussion with and among the experiments' TDAQ experts a new understanding has been reached. The TDAQ-component replacement costs for 2012 and beyond have been evaluated assuming four full years of operation before PCs of the online farm are replaced. The experiments will explore the possibility of extending this period of usage to five full years. This depends, however, on negotiations with vendors because the experiments currently assert that the PCs must be kept under maintenance contract during the entire service period. It has yet to be determined whether vendors are willing to offer such contracts and whether the costs will be competitive. These issues require time and the answers were not available in time for the 2012 budget calculations. The experiments will work on this question with the vendors and are willing to change to a five years running cycle for the 2013 budgets if conditions permit. After reaching a final conclusion on the longest manageable replacement cycle, a new agreement on the TDAQ-hardware replacement procedure will need to be formalized next year.

- An essential part of the revised understanding on online hardware replacement strategy is that the experiments will procure new equipment when it is needed, e.g. to be installed during shutdown times. In order to accommodate the funding agency requests to maintain the budget requests as nearly constant as a function of time requires the carryover of costs and/or accumulation of funds over several years. For this purpose the collaborations will define special accounts to which the yearly funds will be transferred and from which only expenses for TDAQ-hardware replacements may be withdrawn. CERN will allow these special purpose accounts to go positive and negative. A positive balance on this account will not be considered in the evaluation of a possible refund if the overall cash balance per year is more than 10% of the year's income. At the RRB meetings the Resource Coordinators of the collaborations will report separately on these accounts and Finance will present the money flow together with the activation codes of the orders.
In the future, it may become necessary to adopt additional special accounts with similar controls to address other longer term consolidation projects.
- The CERN IT-Department and the LHC experiments are presently evaluating an alternative for the EVO system as a video communication tool. This is a commercial product called VIDYO. A change to this system was foreseen in 2011 and therefore the collaborations allocated in their 2011 budgets only half of the 2010 amount for EVO costs. Tests of VIDYO by the experiments and necessary improvements of the product took longer than anticipated. The chairman of the RRBs advised the collaborations to request for 2012 again the full amount estimated for use of EVO. Since it still unclear when a transition to VIDYO will take place, the projections for the following years also currently include the full estimated EVO costs. These requests will be modified appropriately after the transition.

4. Remarks on the M&O B scrutiny process

Through 2010, a detailed scrutiny process for M&O B was performed only for the ATLAS experiment because ATLAS M&O B costs are shared by the funding agencies almost in the same way as for M&O A costs. Invoices for M&O B costs are sent to the funding agencies and the contributions are transferred to CERN accounts which are under the control of the ATLAS Resource Coordinator. For the other LHC experiments the procedures differ from collaboration to collaboration. In general the Project Managers of detector subsystems evaluate the resources necessary for their subsystems and the institutes responsible for the subsystems negotiate directly with their funding agencies for the necessary support. The granted funds may stay in the hands of the institutes or may be transferred to a CERN account which may be controlled by the project manager. Some collaborations don't use CERN accounts at all for M&O B funds.

For the 2012 budgets requests the Scrutiny Group has been asked to perform a scrutiny process for the M&O B requests of each of the LHC experiments. For each experiment the subsystem Project Managers and Resource Managers reported on the M&O B activities planned for their subsystems and provide estimated costs. For all experiments a major part of almost all M&O B costs is due to manpower efforts. It is often difficult to translate these efforts into Swiss Francs. Therefore the scrutiny process for M&O B can not be conducted to the same standard as the M&O A scrutiny. Nevertheless, thanks to the efforts and the good cooperation of the subsystem project managers with the Scrutiny Group, tables for M&O B budgets have been compiled which are provided in the following chapters. However, the

numbers must be treated with appropriate care and comparisons are difficult between the different experiments and even between subsystems of the same experiment.

Prior to the scrutiny process conducted by the RRB's Scrutiny Group essentially all M&O B budget requests underwent an internal collaboration scrutiny. Written reports of these internal scrutiny processes have been made available to the Scrutiny Group. In addition, many institutes had to undergo national scrutiny process for their fund requests in their home countries. Considering the effort involved in the M&O B scrutiny process and the resulting information content, the Scrutiny Group questions the usefulness of the detailed RRB Scrutiny Group scrutiny of M&O B requests and does not recommend continuing this process with the exception of the ATLAS M&O B budget requests. We recommend maintaining our mandate to "make critical comments on the arrangements for Category B costs".

4. Budget requests for 2012

Table 1 provides a summary of the M&O requests for the year 2012.

Experiment	Total w/o power costs	Total with NMS power costs	Total with Full power costs
ALICE M&O A	4934	5693	7320
ALICE M&O B	1832		
ATLAS M&O A	15047	15978	17867
ATLAS M&O B	5150		
CMS M&O A	13235	14048	15035
CMS M&O B	6639		
LHCb M&O A	2575	2702	3545
LHCb M&O B	1148		
TOTEM M&O A	440	440	440
TOTEM M&O B	247		

Table 1: Request for 2012 M&O (in kCHF).

5. ALICE

Closing report for 2010

The closing report for the ALICE 2010 M&O-A Budget was submitted to the RRB meeting on 13 April 2011. The Scrutiny Group received a detailed level-2 breakdown of the closing report for their meeting on 17 May 2010. The expenditures without power costs for M&O-A amounted to 4,474 kCHF including commitments of 513 kCHF from previous years. In addition 501 kCHF was committed to be paid in future year. The NMS part of the power costs was 678 kCHF resulting in total costs with NMS power of 5,152 kCHF. The budget was

4,978 kCHF plus a NMS power share of 641 kCHF minus a refund of 575 kCHF in 2008. After further subtracting a budget reduction of 29 kCHF the total budget including NMS power contributions for 2010 was 5,015 kCHF. The actual income from funding agencies for 2010 was 5729 kCHF, which included 490 kCHF of late payments from previous years and a contribution of 303 kCHF due in 2011 but paid early. The budget balance without power was 504 kCHF and the one including NMS power was -80 kCHF. The cash balance for 2010 of ALICE M&OA increased by 577 kCHF. This results in an integrated cash surplus of 3,115 kCHF at the end of 2010.

The scrutinizers looked through all items in the level-2 breakdown, all expenditures were found to be well justified. The Scrutiny Group expressed concern about the large amount of integrated cash surplus. Part of this surplus will be used to reduce budget requests in 2012 and future years.

The Scrutiny Group recommends approval of the ALICE 2010 M&O A closing report.

Situation in 2011

The spending in 2011 so far is close to expectation. However, a modification of the beampipe in the ZDC area during the 2011-2012 technical stop has become necessary because a collimator casts a shadow on the calorimeter when it is closed to the nominal position. Up to now the collimator could be opened far enough to avoid disturbing the performance of the calorimeter. At increased luminosity in the future this operating mode will no longer be possible. CERN will contribute to the cost of the modification and 250 kCHF will be paid from the ALICE M&O A cash surplus.

Budget request for M&O Category A in 2012

Table 2 shows the 2011 M&O A budget for ALICE, the proposed budget for 2012 and the projections until 2015.

ALICE M&O A Budget Requests	2011	2012	2013	2014	2015
<i>Detector related costs</i>	1,416	1,253	1,907	1,332	1,269
<i>Secretariat</i>	238	208	208	208	208
<i>Communications Total</i>	30	40	40	40	40
<i>Core computing</i>	537	537	537	537	537
<i>On-line computing</i>	1,269	2,012	1,052	1,872	1,990
<i>Test beams, calibration facilities</i>	95	85	30	85	85
<i>Laboratory operations</i>	270	250	280	245	235
<i>General services</i>	636	550	880	615	570
TOTALS without power	4,491	4,934	4,934	4,934	4,934
<i>Power</i>	2,801	2,386	150	1,963	2,386
GRAND TOTALS	7,292	7,320	5,084	6,897	7,320

Table 2: ALICE M&O A budget request for 2012 and projections until 2015 (in kCHF).

The ALICE M&O A request for 2012 including full power costs amounts to 7,320 kCHF. This is 405 kCHF less than estimated at the RRB meeting in April 2011. The estimated sum of the budgets for 2012 to 2014 are now about 2 MCHF lower than presented at the April RRB meeting. The biggest part of the reduction originates from lower costs for on-line computing and detector related costs. Several longer term consolidation projects have been

taken out of the budgets for 2012-2014. The costs are 240 kCHF in 2012 and amount to 785 kCHF over the three years. These costs will be paid from the accumulated cash surplus. At the end of 2011 it is planned to transfer about 1 MCHF from the cash surplus to special account for online-hardware replacement. ALICE has to share one surveyor with CMS. ALICE reports that this is an unsatisfactory situation in view of the long shutdown. Therefore it is planned to pay for two surveyors from 2012 onwards.

The Scrutiny Group discussed in detail all level-2 items of the M&O A requests with the ALICE representatives.

The scrutinizers examined the shutdown costs in some detail. A major contribution to the extra cost is the effort needed for shutdown operations from crane drivers, surveyors and technical support; these will cost 1211 kCHF in 2013 compared with roughly 600 kCHF in running years. A breakdown of this effort by year and task was shown to the scrutinizers and they satisfied themselves that the effort proposed was reasonable and necessary.

The planned costs for 2012 are considered justified and appropriate as are the estimates for future years.

The Scrutiny Group recommends approval of the ALICE request for the 2012 M&O A budget.

Budget request for M&O Category B in 2012

In ALICE, the M&O B budgets are not managed centrally. Therefore it was not possible to perform a M&O B budget scrutiny process at the same level of detail as for the M&O A budget. Thanks to the great effort invested by the project managers and the ALICE Resource Coordinator, the Scrutiny Group received sufficient information to understand the budget requests. The request for 2012 and projections through 2015 are shown in table 3.

ref	budget description	Data			
		2012	2013	2014	2015
A01	Mechanics	29	44	27	28
A02	Gas Systems	82	62	62	62
A03	Cooling Systems	110	98	108	108
A04	FEE spares	101	93	93	94
A05.1	Standard Electronics LV/HV PS	421	315	330	330
A05.2	Standard Electronics Crates	64	63	63	63
A05.3	Standard Electronics R/O modules	173	183	178	178
A06	Controls (DCS & DSS)	33	34	29	29
A07	Sub-Detector spares	82	47	42	28
A08	Areas	57	42	42	42
A09	Communications	93	93	93	93
A10	Store Items	84	98	81	81
A11.1	Technical Manpower @ CERN Industrial Support	23	14	14	14
A11.3	Technical Manpower @ CERN from Collaborating Institutes	462	453	425	423
Grand Total in kCHF		1,811	1,635	1,583	1,569

ref	budget description	2012	2013	2014	2015
A11.2	Technical Manpower @ CERN: in-kind contribution from Collaborating Institutes in man-month	180	206	160	160
Grand Total in man-month		180	206	160	160

Table 3: ALICE M&O B budget request for 2012 and projections until 2015 (in kCHF).

The required M&O B effort needed to run the experiment is now better defined. This has meant that some projects have reduced costs; in particular the Inner Tracking System (ITS) previously had separate run coordinators for the three systems (ITS-SPD, ITS-SDD, ITS-SSD) but these have been consolidated with joint coordination for all three. In contrast, the TPC and TRD detectors each report a need for a full-time run coordinator. These together require 102 kCHF per year. The ITS-SDD needs new HV power supplies which will cost 150 kCHF in 2012 and 75 kCHF in 2013. Also the cooling system needs consolidation in 2012/3, costing 88 kCHF. The TRD must replace a cooling tank for 10 kCHF. These projects have all been internally scrutinized within ALICE and again by the Scrutiny Group and these items are required for efficient operation of the ALICE experiment. However, for more general tasks, many of the subsystem's needs can not be reliably projected into 2013 or beyond with any accuracy as the leadership cannot foresee what equipment will fail and hence require replacement. In many cases, the subsystem budget for 2012 is simply reproduced in future years as this is the current best estimate. While this procedure is reasonable at this stage, the uncertainty on these M&O B projections must be understood to be significantly higher than for M&O A.

The Scrutiny Group recommends approval of the ALICE M&O B budget for 2012.

6. ATLAS

M&O A closing report for 2010

ATLAS submitted their closing report for the 2010 M&O A budget to the RRB on 12 April 2011. The total costs excluding power were 14,142 kCHF including 335 kCHF in obligations deferred to 2011. The NMS power costs amounted to 950 kCHF. These figures should be compared to the budget of 13,841 kCHF without power and a NMS power budget of 949 kCHF. The budget balance for 2010 is -302 kCHF and the integrated budget balance is 206 kCHF through the end of 2010. The integrated cash balance at the end of 2010 is -845 kCHF including the 335 kCHF in deferred commitments. Outstanding invoiced contributions are 1,051 kCHF. An overspend of about 1.1 MCHF for magnet consolidation in 2010 has been almost compensated by an underspend of 920 kCHF for detector related costs, mainly in consumables for external cryogenics. The budget and the payments are reasonably well balanced for 2010.

The Scrutiny Group recommends approval of the ATLAS M&O A book closing for 2010.

M&O B closing report for 2010

The ATLAS M&O B closing report for 2010 was submitted to the RRB meeting on 12 April 2010. The sum of M&O B expenditures in 2010 for all subsystems was 5,700 kCHF including costs for manpower at CERN. The subsystem costs were: ID 3,285 kCHF including 657 kCHF for the IBL; LAr 1331 kCHF; TileCal 663 kCHF; MUON 421 kCHF. This should be compared to the 2010 M&O B budget of 5,501 kCHF. The expenditures for M&O B are reasonably well balanced against the budget. The integrated unobligated M&O B budget balance through the end of 2010 (once deferred commitments are taken into account) is 651 kCHF.

The Scrutiny Group recommends approval of the ATLAS 2010 M&O B closing report.

Situation in 2011

There are no indications yet that the M&O A costs and the M&O B costs will significantly deviate from the 2011 budgets.

Budgets for M&O 2012 and future years

In order to comply with the requests of the RRBs outlined in chapter 3, the ATLAS collaboration presented projections for budgets through 2018, and then provided smoothed budgets.

As a consequence, ATLAS changed their philosophy from alerting the Scrutiny Group of possible increases which might come up two years later but not implementing these potential increases in the budget requests until they become more certain to a scheme where most anticipated costs are now incorporated into the projected budgets (with some notable exceptions highlighted below). ATLAS reports that they will reduce then actual budget requests if such items are later found to be unnecessary. ATLAS does not intend to interpret a Scrutiny Group endorsement of the budget for the following year as an endorsement of budgets for the future years for which details are still under development.

Budget request for M&O Category A in 2012 and forecasts to 2018

Table 4 shows the proposed budget for ATLAS in 2012 and the projections until 2018.

ATLAS M&O A Budget requests	ATLAS							
	2011	2012	2013	2014	2015	2016	2017	2018
<i>Detector related costs</i>	6,378	6,493	6,568	6,463	5,293	5,663	6,193	6,233
<i>Secretariat</i>	305	305	305	305	305	305	305	305
<i>Communications Total</i>	220	410	507	447	407	407	407	447
<i>Core computing</i>	2,128	2,128	2,128	2,128	2,128	2,128	2,128	2,128
<i>On-line computing</i>	3,995	1,897	3,314	3,242	5,527	4,946	4,353	3,706
<i>Test beams, calibration facilities</i>	1,182	2,435	910	500	500	500	500	940
<i>Laboratory operations</i>	125	105	105	135	105	105	105	135
<i>General services</i>	1,291	1,274	1,763	1,693	1,334	1,334	1,364	2,013
TOTALS without power	15,624	15,047	15,600	14,913	15,599	15,387	15,354	15,907
Power	2,820	2,820	2,200	2,820	2,820	2,820	2,820	2,200
GRAND TOTALS	18,444	17,867	17,800	17,733	18,419	18,207	18,174	18,107

Table 4: ATLAS M&O A budget for 2011, proposal for 2012 and projections through 2018 (in kCHF).

There are some major changes of the proposed budgets w.r.t. the ones presented at the RRB meetings in October 2010 and in April 2011. The changes in the schedule of operation of the LHC extended the current running period to the end of 2012 and shifted shutdown dates and future running periods. This not only shifted special shutdown costs between years but also required changes in the schedule of some consolidation and repair projects. The collaboration decided to advance the installation of the IBL to the 2013-2014 shutdown. By 2018, major parts of the infrastructure and detector components will have been operating for 10 years. Major repair work and maintenance is expected to be necessary by that time. This has now

been incorporated in the planning up to 2018. Costs for these anticipated major repairs are spread over several years prior to 2018. The second major change of the predicted budgets originates from the revisions of the TDAQ online hardware replacement plan, which is now calculated on the basis of a full 4 years usage before replacement. The reduction in the budgeted costs due to implementation of the 4 full year replacement cycle offset the increased smoothed costs for consolidation and repair. The long term consolidation project for magnet and cryogenics had foreseen expenditures of 1,155 kCHF in 2012. Now the spending profile is delayed. ATLAS nevertheless proposes to maintain the budget profile introduced last year. The M&O A budget plan for the IBL was established in 2009 and the collaboration proposes no adjustment to this plan. A contract has been signed for the beryllium beampipe for 1.1 MCHF which is 30% higher than the original estimate. However, this should put no increased burden on the M&O A budget. The Scrutiny Group had requested the submission of a TDR for the IBL and its review by the LHCC. The TDR has been submitted this year and the Scrutiny Group is expecting positive statement from the LHCC after their meeting on 21-22 September 2011. ATLAS indicated that ~800 PCI mezzanine cards for the Readout System (ROS) will need to be redesigned and replaced as part of the next ROS replacement. This cost has not yet been included in the budget requests. For reference, the current version of the ROS was estimated to cost 2 MCHF.

The ATLAS collaboration uses the special TDAQ hardware replacement account for smoothing of the overall budget from 2012 to 2018. Table 5 shows the actual replacement plan for TDAQ computer nodes, the smoothed request for funds and the projected balance in the special account at the end of each year.

Year	2011	2012	2013	2014	2015	2016	2017	2018
Node replacements	614	606	139	1066	1234	778	151	151
Special account request	2,235	137	1,554	1,482	3,767	3,146	2,503	1,856
Special account balance	0	-1,983	-919	-3,167	-3,720	-3,299	-1,326	0

Table 5: ATLAS online-hardware replacement plan, showing the numbers of nodes to be replaced per year, the smoothed TDAQ budget request and the estimated balance in the special account (in kCHF).

Although this plan is based on a 4 full year replacement cycle, the replacement of 1235 nodes which would have been due in 2018 has been delayed to the following year because 2018 is a year of the second long shutdown. Together with the regular exchanges due in 2019 this would result in a very high deficit in the special account in 2019. During the years 2012 to 2017 the balance of the special account is consistently negative. ATLAS also reported that the network switch replacement is handled through a CERN IT/CS contract and the plan is to replace the chassis switches during the 2013 shutdown. The estimated cost of 750 kCHF for this switch replacement is not included in the current ATLAS budget projections.

The Scrutiny Group does not consider the current version of the ATLAS online-hardware replacement plan to be sustainable over the long term due to the large potential deficit anticipated after 2018, and recommends that the underlying assumptions be revisited in 2012. This will occur naturally as part of the experiment's exploration of the possibility of a 5 year replacement cycle.

The Scrutiny Group recommends approval of the ATLAS M&O A budget proposal for the year 2012 but anticipates that the online-hardware replacement plan for future years will be further refined next year.

Budget request for M&O Category B in 2012 and forecasts to 2018

The ATLAS Collaboration conducts its own internal scrutiny of the M&O B budgets for each of the subsystems and provides reports to the Scrutiny Group. The M&O B budget request for 2012 is 5150 kCHF. This is about 1 MCHF less than the value presented at the RRB meeting in April 2011. Tables 6a and 6b show the proposed amounts for the M&O B budgets of the detector subsystems.

ATLAS & O B	2011	2012	2013	2014	2015	2016	2017	2018
Inner Detector	3,585	2,435	2,465	2,676	2,245	2,245	2,245	2,345
Liquid Argon	1,186	1,196	1,196	1,196	996	996	996	996
Tile Calorimeter	724	617	647	647	604	604	604	604
Muons	640	640	650	570	570	800	830	830
Forward Detectors		262	259	195	183	164	167	163
Total	6,135	5,150	5,217	5,284	4,598	4,809	4,842	4,938

Table 6a: ATLAS M&O B subsystems budget request for 2012 and projections for 2013 through 2018 (in kCHF).

ATLAS M&O B requests								
ID&TileCal&LAR&Muons	2011	2012	2013	2014	2015	2016	2017	2018
Mechanics	48	58	63	78	73	140	140	140
Gas-system	29	69	29	29	29	29	29	29
Cryo-system	5	5	5	5	55	55	55	55
Cooling system	33	33	33	33	33	33	33	33
FE electronics	1530	500	487	862	131	131	131	131
Standard electronics, PS (LV, HV)	957	868	720	697	865	730	730	730
Standard electronics, Crates	377	411	411	386	401	539	539	539
Standard electronics, RO Modules	450	348	447	327	310	315	315	315
Controls, (DCS, DSS)	190	200	142	133	127	162	162	167
Sub-Detector Spares	71	63	83	50	50	81	81	75
Areas	245	308	308	308	308	338	341	338
Communications	29	32	32	32	32	32	32	32
Store Items	184	201	215	215	197	207	207	207
Hired Manpower @ CERN (CHF)	1,697	1,764	1,952	1,839	1,697	1,727	1,757	1,857
Hired Inst. MP @ 90 kCHF/FTE	290	290	290	290	290	290	290	290
Technical Manpower @CERN (FTE)	320	315	325	325	315	315	325	325
Core computing (infra & services in FT)	157	157	157	157	0	0	0	157
TOTALS (excl. FTEs)	6135	5150	5217	5284	4598	4809	4842	4938

Table 6b: ATLAS M&O B subsystems budget for 2012 and projections for 2013 through 2018 (in kCHF).

The ATLAS Collaboration provided the Scrutiny Group with a detailed breakdown of the needs for manpower. Major changes in the 2012 budget requests compared to the 2011 budget are for the Inner Detector (ID) and in the addition of the Forward detector subsystems to Category B. The ID contains part of the IBL costs. The IBL is funded through M&O A, M&O B, and project contributions. The total IBL cost is 9,741 kCHF and stays unchanged. The

previous planning foresaw an M&O B contribution of 4,400 kCHF and a project contribution of 1,276 kCHF. Some funding agencies preferred to pay their pledged share as project contributions rather than as M&O B shares. Therefore the M&O B part of the IBL has been reduced by 1,919 kCHF. The maintenance of the Forward Detectors (ALFA, LUCID, ZDC) was previously funded via the M&O A budget with 87 kCHF plus a technician. Since 2011 a new Institute Board has been formed for the Forward Detectors and the detector maintenance has been moved to M&O B by requesting 262 kCHF in 2012 including manpower costs. From tables 6a and 6b it appears that the costs are projected to go down from 2012 on. Taking into account the shift of IBL contributions from M&O B to project there is in fact an average increase of about 3% neglecting the Forward Detector budget and of 7% including the Forward Detector budget. This effective increase is partly generated by advance preparations for the second long shutdown in 2018 for which some of the necessary funds are planned to be accumulated in advance. The model of spending 5% per year of the core investment for electronics replacement is maintained in these M&O B budget projections.

The Scrutiny Group reviewed in detail the proposed ATLAS M&O B budget. The requests are considered reasonable. The Scrutiny Group recommends approval of the ATLAS M&O B proposal for 2012.

7. CMS

Closing reports for 2010

CMS submitted their closing report for 2010 M&O A budget to the RRB on 11 April 2011. The payments were 12,809 kCHF for Category A including NMS power costs of 518 kCHF. In addition there are commitments of 931 kCHF to be paid in 2011 leading to total costs of 13,740 kCHF. This should be compared to the 2010 M&O A budget of 12,742 kCHF. The budget balance for 2010 is -998 kCHF, including the open commitments, and the integrated budget balance is -685 kCHF. The substantial budget deficit in 2010 was foreseen in 2010 and the Scrutiny Group accepted it. The reason was the necessary repair of faulty bushings during the Technical Stop 2009/10. The costs of this repair amounted to over 1 MCHF which had to be paid in 2010. The Scrutiny Group was informed about these unexpected expenses in a timely manner and it was agreed to shift the costs to the 2011 budget provided that efforts will be made to save as much as possible in 2011 to accommodate the 2010 overspend.

The Scrutiny Group recommends approval of the CMS 2010 M&O A closing report.

Status in 2011

The Resource Coordinator of CMS reported that the collaboration most likely will manage to make sufficient savings w.r.t. the original 2011 budget to accommodate the 2010 budget deficit and anticipate closing out 2011 without a major overspend, assuming there are no major interventions during the technical stop at the end of this year.

Budget request for M&O Category A in 2012 and projections until 2015

Table 7 shows the proposed M&O A budget for CMS in 2012 and the projections until 2015.

CMS M&O A Budget requests	CMS				
	2011	2012	2013	2014	2015
<i>Detector related costs</i>	4,310	3,956	4,650	4,492	3,837
<i>Secretariat</i>	297	297	297	297	297
<i>Communications Total</i>	282	370	370	370	370
<i>Core computing</i>	1,964	1,964	1,964	1,964	1,964
<i>On-line computing</i>	2,843	3,798	3,298	3,898	4,198
<i>Test beams, calibration facilities</i>	96	96	96	96	96
<i>Laboratory operations</i>	893	919	1,035	556	484
<i>General services</i>	1,870	1,835	2,247	2,093	1,835
TOTALS without power	12,555	13,235	13,957	13,766	13,081
Power	1,800	1,800	1,650	1,750	1,800
GRAND TOTALS	14,355	15,035	15,607	15,516	14,881

Table 7: CMS M&O A budget proposal for 2012 and projections until 2015.

The CMS M&O A budget request for 2012 without power is 1.7 MCHF lower than presented at the RRB meeting in April 2011. There is a slight increase in detector related cost and communications but over 2 MCHF reduction for online computing. The latter is due to the change of the LHC schedule and the new online-hardware replacement model with the implementation of the special account. The schedule led to a deferral of replacements to 2013/14. The contributions to the special account have been used to smooth the total budget from 2012 to 2015. The proposed funding and the plan for online-hardware replacement would result in the special account staying positive or balanced over this period.

The experience from 2010/11 showed survey tasks are on the critical path during shutdown times. In full opening scenarios, two survey teams are at work simultaneously. During running times important routine tasks have to be performed by dedicated surveyors including the maintenance of the survey database. Presently one staff surveyor is provided from CERN who is, however shared between ALICE and CMS. The CMS representatives consider this arrangement unsatisfactory. Agreement has been reached with CERN that in the future a staff engineer will be 100% available to CMS plus an engineering fellow during shutdowns and technical stops. The experiment is expected to provide an engineer or an applied physicist dedicated to survey tasks and skilled visiting technical support during shutdown times. These manpower costs are included in the budgets. In an attempt to save as much as possible from the 2011 budget manpower has been reduced. It turns out that CMS does not believe this reduction can be sustained. Therefore CMS requests a workshop machinist/welder until the end of the first long shutdown. Thereafter, this request should be reviewed. For the same reason and a partial loss of available manpower, a new position of technician is requested for the CMS moving- and hydraulics-systems.

In 2010 three projects were started: the Engineering Integration Centre (ENIC), the Electronics Integration Centre (ELIC), and the Operation Support Centre (OSC). The allocated funds for ENIC have been used as intended, in particular for the support of a CAD

librarian and integration engineer. The ELIC project is complete and the allocated funds have been spent. The engineer from CMS for commissioning will be available in 2011/12 instead of 2010 as originally foreseen. The completion of the OSC has been delayed in response to the change in schedule for the first long shutdown. For the operation of the ENIC, the ELIC, and the OSC beyond 2013 support is needed, in particular for continuing the DAQ system administration. The costs are estimated to be 250 kCHF per year from 2013 onwards. They are not included in the present budget projections.

The CMS inner tracking detector is an all-silicon detector. To minimize the impact of radiation damage, the detectors must be run at low temperatures. The detectors must also be kept cold also during shutdown times. In order to run at low temperatures the detector is purged with dry nitrogen to avoid condensation. Presently the detector is operated at a few degrees Celsius because the tracker purge seals are leaky and the humidity level inside the tracker volume does not allow lower operating temperatures. By 2014, the tracker must be run at about -15°C because of increased radiation levels. The repair of the tracker seals is a major task and CMS is currently evaluating whether the CMS detector should be opened during the technical stop 2011/12 to inspect the seals and eventually prepare for actions during the 2013/14 shutdown. There is no decision at present, but if the CMS detector is opened, costs of about 1 MCHF will be incurred and these costs are not in the budget.

The Scrutiny Group discussed in detail the proposed CMS budget for 2012 and beyond. The requests for 2012 are considered justified and appropriate as are the projections for future years. The Scrutiny Group recommends approval of the CMS M&O A budget for the 2012.

Budget request for M&O Category B in 2012 and forecasts to 2015

The CMS M&O B budget plans are established by the subsystem Project Managers and the subsystem Resource Managers. Collaboration internal Scrutiny Groups are set up to review the subsystem budget proposals and to send a written report to the CMS Resource Manager. These reports for the 2012 budget proposals and projections have been made available to the RRB Scrutiny Group. All subsystem Project Managers and Resource Managers presented their budget proposals in a meeting with the Scrutiny Group members associated to CMS. The CMS M&O B budget request for 2012 is shown in table 8a. The projections until 2015 are presented in table 8b.

Year	2012									
		CMS M&O B								
Amount (kCHF/FTE)		Detector								
Description	Ref.	Details	Tracker	ECAL	HCAL	Muon	Trigger	Core Computing	Grand Total	
Material Resources (kCHF)	B.1.01	Mechanics	40	25	21	10			96	
	B.1.02	Gas-system	60	15	0	20			95	
	B.1.03	Cryo-system			0	0			0	
	B.1.04	Cooling system	250	90	0	0			340	
	B.1.05	FE electronics		0	638	55			693	
	B.1.06	Standard electronics, PS (LV, HV)	110	83	32	115			340	
	B.1.07	Standard electronics, Crates		20	61	70			151	
	B.1.08	Standard electronics, RO Modules	100	115	25	92	300		632	
	B.1.09	Controls, (DCS, DSS)	140	85	27	37			289	
	B.1.10	Sub-Detector Spares	0	0	58	32			90	
	B.1.11	Areas	90	80	7	89			266	
	B.1.12	Communications	30	10	49	43			132	
	B.1.13	Store Items	50	50	4	41			145	
	B.1.14	Hired Manpower @CERN	720	550	608	1,291	200		3,369	
	B.2.01	Technical Manpower @CERN	0	0	0	0	0		0	
		Material Resources (kCHF) Total	1,590	1,123	1,531	1,895	500	8	6,639	
		Human Resources (FTE) Total	0	0	0	0	0	8	8	

Table 8a: CMS M&O B subsystems budget request for 2012 (in kCHF).

CMS M&O B							
Amount (kCHF/FTE)			Year				
Description	Detector	Subsystem	2011	2012	2013	2014	2015
Material Resources	Tracker	Pixel	190	285	285	280	265
		SST	1,545	1,305	1,305	1,290	1,235
	Tracker Total		1,735	1,590	1,590	1,570	1,500
	ECAL		1,140	1,123	1,273	1,123	1,123
	HCAL		902	1,531	919	919	919
	Muon	Barrel Alignment	93	53	53	53	53
		Drift Tubes	484	488	481	483	483
		EMU	1,066	1,063	1,063	1,063	1,063
		LinkAlignment	39	16	16	16	16
		RPC	269	275	363	363	254
	Muon Total		1,951	1,895	1,976	1,978	1,869
	Trigger		690	500	500	500	500
Material Resources Total			6,418	6,639	6,258	6,090	5,911
	Trigger		8	0	0	0	0
	Core Computing		8	8	8	8	8
Human Resources Total			16	8	8	8	8

Table 8b: CMS M&O B subsystems budget projections (in kCHF).

The CMS M&O B budget is slightly higher in 2012 than in the previous year. This is mainly due to a one time transducer replacement for HCAL. In the following years the budget is projected to decrease. A laser replacement for ECAL in 2012 is under discussion. Possible costs of about 200 kCHF are foreseen in the 2012 and 2013 M&O B budgets. The maintenance of the Trigger- and DAQ-system is included in the M&O A budget except for the Level-1 Trigger. The contract for CAEN and Wiener power supplies is now managed centrally through CERN. Therefore 85 kCHF have been moved to the M&O A budget. The Tracker had accumulated integrated savings of 500 kCHF at the end of 2010. From this surplus 200 kCHF will be spent in 2012 but the rest is planned to be retained for quick interventions on the cooling system which continues to be a vulnerable system of the Tracker. Also the Level-1 Trigger maintains continuously a reserve of 200 kCHF for quick interventions if required. The manpower effort included in the CMS M&O B budget is at a high level for most of the subsystems, with about 50% on average and reaching up to about 70% for MUONS. The Scrutiny Group received a detailed list of tasks to be performed by the provided manpower.

The Scrutiny Group recommends approval of the CMS M&O B budget for 2012.

8. LHCb

Closing reports for 2010

LHCb submitted their closing report for 2010 M&O A budget to the RRB on 13 April 2011. The actual costs amounted to 2,316 kCHF for Category A including 79 kCHF for NMS power. This lies below the budgeted costs of 2,591 kCHF. The major contribution to the budget balance of 275 kCHF originated from items Detector Related (104 kCHF) and Online Computing (96 kCHF). The surplus for Online Computing is an accumulation of funds towards the peak in the planned hardware replacement in 2016. It should be noted that LHCb follows a different online hardware replacement model than the other LHC experiments. They calculate the replacement rate based on a lifetime which is a Gaussian distribution with a

mean value of 6 years and a width of 2 years, together with a decrease in unit price of 12 % per year. The integrated total balance (budgeted-actual) for the years 2002-2010 amounts to 864 kCHF. This is high compared to a typical yearly M&O A budget but dominated by the positive Online Computing balance. The integrated cash balance is 483 kCHF excluding outstanding contributions of 380 kCHF.

The Scrutiny Group recommends approval of the LHCb M&O A closing report for 2010.

Situation in 2011

There are no indications yet that the M&O A costs will significantly deviate from the 2011 budget.

Budget request for M&O Category A in 2012

Table 9 shows the proposed M&O A budget for LHCb in 2012 and the projections until 2015.

LHCb M&O A Budgets requests	LHCb				
	2011	2012	2013	2014	2015
<i>Detector related costs</i>	920	880	920	920	880
<i>Secretariat</i>	185	185	185	185	185
<i>Communications Total</i>	30	50	50	50	50
<i>Core computing</i>	150	150	150	150	150
<i>On-line computing</i>	810	900	900	900	900
<i>Test beams, calibration facilities</i>	30	30	40	40	30
<i>Laboratory operations</i>	60	50	50	50	50
<i>General services</i>	360	330	330	330	330
<i>TOTALS without power</i>	2,545	2,575	2,625	2,625	2,575
Power	970	970	970	300	600
<i>GRAND TOTALS</i>	3,515	3,545	3,595	2,925	3,175

Table 9: LHCb M&O A budget proposal for 2012 and projections until 2015.

The proposed M&O A budgets without power for 2012 up to 2015 are very similar and at the same level as the 2011 budget. The NMS part of the power cost in 2012 is 127 kCHF. The actual power costs will be lower in the shutdown years 2013 and 2014 which, following LHCb policy, is reflected in the lower power requests in years 2014 and 2015.

The LHCb on-line farm was completed by the end of 2010 using core funds and consolidated further using non-core funds. The online computing budget had already been increased for 2011 and from 2012 to 2015 the budget is constant but at a slightly higher level than foreseen last year due to additional costs associated with running the experiment at maximised luminosity. The contributions to system management and to the replacement of hardware are almost equal and are responsible for more than 80% of the online computing costs. The detector related costs vary slightly being higher for the shutdown years 2013 and 2014. The LHCb online-hardware replacement model has not been updated since the start of data taking. It should be updated in time for the 2013 request on the basis of the experience gained by then.

LHCb has not so far included in the budgets up to 2015 any consolidation-type contingencies for renovation of aging equipment and infrastructure which is will reach ~10 years of age in the following years. If any such costs are anticipated beyond 2015, it is possible that contributions will have to be added into the 2013 budget request or in the projection for future years beyond 2013.

The Scrutiny Group discussed in detail the requested M&O A budget for 2012 and the projections for 2013-2015 with the Resource Coordinator and the Technical Coordinator of LHCb. Satisfactory answers were received to all raised questions. The Scrutiny Group considers the requests in the 2012 budget to be justified.

The Scrutiny Group recommends approval of the requested LHCb M&O A budget for 2012.

Budget request for M&O Category B in 2012 and forecasts to 2015

The Scrutiny Group discussed the status of M&O B whose costs are at the level about 50% of M&O A. LHCb is working to produce a more formalised and well-defined structure and agreements (technical and financial sharing) between the institutes participating in each project together with clear long term obligations. At present not all sub-detectors have provided the agreement. Since the institutions are also not obliged to use common accounts, it is not possible to make a full detailed picture of the M&O B budget and expenditures and manpower centrally at this time.

Table 10 shows the LHCb M&O B budget for 2010. It amounts to 1148 kCHF and variations in future years are expected to be of the order of ~10%.

CALO (CERN, ES, FR, RO, RU)	315
Level_0 (FR, IT)	60
Muons (CERN, IT, RU)	151
On Line (CERN)	80
Outer Tracker (GE, NL, PL, PRC)	120
RICH (CERN, IT, UK) *incl HPD-spare	207*
Silicon Trackers (CH, ES, GE, UKR)	80
VELO (CERN, CH, EI, NL, RU, UK, USA)	135

Table 10: A typical LHCb M&O B budget (in kCHF).

Table 10 does not contain the VELO spare contributions. The VELO replacement program is funded by an annual payment of 100 kCHF over the years 2009 to 2013 and is considered as a planned replacement of radiation damaged components and is not an upgrade. The request for funds for the VELO replacement is made in parallel to the request for M&O A, but the VELO funds are transferred to a common funds account (similarly for the HPD spares program for the RICH).

The Scrutiny Group members discussed the M&O B request with the LHCb Resource Coordinator who explained to them that the presented model for detector component maintenance worked to the satisfaction of the collaboration and they plan to maintain it at the present level.

The Scrutiny Group recommends approval of the LHCb M&O B budget for 2012.

9. TOTEM

Closing reports for 2010

TOTEM submitted their closing report for the 2010 M&O A budget to the RRB on 12 April 2010.

The actual costs amounted to 420 kCHF. No power costs arise for TOTEM. The power consumed by TOTEM is paid by CMS. The M&O A budget for 2010 is 448 kCHF. Taking into account the carry-over from previous years and existing commitments, the integrated cash balance is presently 8 kCHF.

The Scrutiny Group recommends approval of the TOTEM 2010 M&O A closing report.

Situation in 2011

There are no indications yet that the M&O A costs will significantly deviate from the 2011 budget.

Budget request for M&O Category A in 2012

Table 11 shows the proposed M&O A budget for TOTEM in 2012 and the projections until 2014.

TOTEM M&O A Budget request	TOTEM			
	2011	2012	2013	2014
<i>Detector related costs</i>	142	142	138	138
<i>Secretariat</i>	44	44	42	42
<i>Communications Total</i>	3	3	3	3
<i>Core computing</i>	92	92	92	92
<i>On-line computing</i>	96	96	72	72
<i>Test beams, calibration facilities</i>	20	20	26	26
<i>Laboratory operations</i>	13	13	15	15
<i>General services</i>	30	30	21	21
TOTALS without power	440	440	409	409
Power	0	0	0	0
GRAND TOTALS	440	440	409	409

Table 11: TOTEM M&O A budget proposal for 2012 and projections through 2014 (in kCHF).

The TOTEM M&O A budget is planned to decrease slightly after 2012. The biggest reductions are in online computing and in particular in system management and data storage. The costs for general services went down after finishing the T1-telescopes. Both T1

telescopes have been installed in CMS during the technical stop 2010/11. This installation needed a combined effort of TOTEM and CMS personal and resources. CERN will support this installation by 200 kCHF for CMS and 90 kCHF for TOTEM. If the CMS detector will have to be opened for maintenance during shutdown, the T1- and T2-detectors might have to be removed. CMS will ask for the necessary support for such actions in their M&OA budget.

The Scrutiny Group recommends approval of the TOTEM M&O A budget for 2012.

Budget request for M&O Category B in 2012

Table 12 shows the TOTEM M&O B request for 2012 and the previous two years. The M&O B budget is projected to be constant at the same level also for the coming years.

TOTEM M&O B request	TOTEM		
	2010	2011	2012
Detector related costs	195	195	195
On-line computing	50	50	50
General services	2	2	2
GRAND TOTAL	247	247	247

Table 12: TOTEM M&O B budget proposal for 2012 and comparison to previous years.

The Scrutiny Group recommends approval of the TOTEM M&O B budget for 2012.

10. Service Level Agreements

A meeting on Service Level Agreements (SLA) took place on 5 May between all the LHC experiments, the EN Department and Scrutiny Group members to review the status of the SLAs.

- **Power Distribution & Cooling/Ventilation**
The current agreement covers the period 2005-2010. EN Department has completed relevant input data on which new cost estimates have been based and which will be validated by the experiments. The experiments Technical Coordinators and Resource Coordinators will be requested to sign-off on the resulting new agreement.
- **Detector Cooling**
Separate SLAs exists for detector cooling. This document needs to be extended in validity as the current version expired at the end of 2010. The costs for dry air and the inertion systems are not yet included. ALICE and CMS request the preparation of a corresponding document.

- Gas Systems
A common agreement exists for all LHC experiments. An extension in validity is needed as this agreement expired at the end of 2010.
- Video Conference Tools
The planned transition to VIDYO as a replacement for EVO is advancing but not yet finished. It is expected that VIDYO will be funded exclusively by CERN

All other Service Level Agreements are still valid. Nothing else has to be done now.

11. Composition of the Scrutiny Group in 2011

At the end of 2010, all members of the Scrutiny Group except E. Iacopini have served for at least three years. They might not be members of the Scrutiny in 2012. The Chairman of the Scrutiny Group thanks all his colleagues in the Scrutiny Group for their invaluable contributions to the work of the group.

12. Summary

Table 1 gives a summary of the requested M&O Category A budgets for ALICE, ATLAS, CMS, LHCb and TOTEM. The Scrutiny Group has carefully scrutinized the budget requests of these five experiments, examining in detail many of the line items. For the first time the Scrutiny Group also performed a scrutiny process for M&O B for each of the experiments. Reasons are given in chapter 4 why the Scrutiny Group recommends against a general continuation of this procedure for the future. It should be noted that the Scrutiny Group anticipates that ATLAS will revisit their online-hardware replacement plan as an important component of next year's scrutiny process.

The RRB Scrutiny Group recommends approval by the RRBs of the 2012 requests for M&O budgets for ALICE, ATLAS, CMS, LHCb and TOTEM.