CERN-RRB-2007-112

Report of the LHC M&O Scrutiny Group for the October 2007 RRB

Membership of the RRB M&O Scrutiny Group for 2007:
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1. **Introduction**

The RRB Scrutiny Group (SG) met on 10 and 11 May 2007 for initial discussions of the submissions from the four experiments, ALICE, ATLAS, CMS and LHCb. At that meeting the Group met with each of the four Resource Coordinators (RC), to review the figures for past spend and the proposed future budgets. Over subsequent months, subgroups of the SG had further meetings with the RCs and others, to continue reviewing and refining the figures. The SG met again on 24 and 25 September, when further discussions were conducted with the four RCs to finalise the figures for projected future M&O costs, for submission to the RRB.

The work of the SG has been greatly helped by the quality of the documentation provided by the RCs and by their co-operation, patience and competence in addressing the many issues raised by the Group.

The Group had discussions with Jos Engelen at both its May and September meetings.

Over the winter 2006/07, one member of the SG (Vera Luth) worked with the four resource coordinators to develop a common set of spreadsheets to act as summaries of total past income and total spend for Category A M&O, together with the future projections. These spreadsheets are now complete and up-to-date for the four experiments, and cover the period from 2002-2010.

The Scrutiny Group recognizes that the task of projecting M&O costs for 2008 and beyond, into the operational phase of the experiments, necessarily involves significant uncertainties. Currently we are in a period where many M&O costs are rising steeply as the experiments move to a new regime of operation and exploitation. The SG has paid particular attention to the build up of costs for core computing, and notes that all of the experiments are evolving their strategies in the light of changing expectations about machine switch-on and expected luminosities.

The SG believes that the current projected M&O costs for 2008 and beyond are reasonable. They are however subject to significant uncertainty, and would be affected by changes in the machine schedule.

Table 1 gives a summary of the requests for Category A M&O for 2008.

Experiment	Total (excl power)	Total (incl power)
ALICE	4591	7183
ATLAS	11994	14194
CMS	10159	11959
LHCb	2345	2645

Table 1. Year 2008 Category A estimates (in kCHF).

2. **Composition of the Scrutiny Group**

This year the SG had an unfilled vacancy, previously occupied by a delegate from a small member state. In addition, the French delegate (Marc Winter) was unable to participate, and one of the CERN members (Edo Sbrissa) resigned over the summer due to pressure of other work (and was replaced by Martyn Davenport). Effectively therefore the group functioned three people short of its full complement for this year's process. Nevertheless, the Group believes that the scrutiny process was rigorous and robust.

3. **Service Agreements**

A significant fraction of the experiments' M&O budgets are allocated to Service Agreements with several CERN departments. These cover items such as beam pipe and vacuum systems, cryogenics, magnet controls, power converters, cooling and ventilation, power distribution systems, safety monitoring and access controls, surveying, gas distribution, cranes and transport. A subgroup of the SG reviewed the Service Agreements with the RCs, and the table below summarizes the current situation. These costs are expected to be substantial during the exploitation phase, and the figures will evolve in the light of operational experience. Currently the experiments believe that these agreements represent good value. The SG expects to continue to monitor and scrutinize these figures in the future. In addition to the agreements whose costs and included in the summary table, there are several that have still to be approved.

Expt \ *Year*	*2007*	*2008*	*2009*	*2010*
ALICE	705	720	720	720
ATLAS	4369	4208	3893	3873
CMS	1834	1779	1779	1779
LHCb	434	448	466	371

Table 1. Current status of M&O Service Agreements: Figures are in kCHF and show total amounts in M&O A that are covered by Service Agreements.

4. **ALICE**

ALICE submitted the closing report for the 2006 M&O Budget on 3 April 2007. The actual costs (spent plus committed) amounted to 2,531 kCHF for Category A, including power costs. These actual costs are to be compared with budgeted costs of 2,733 kCHF.

ALICE provided the Scrutiny Group with a level-2 breakdown for 2006 accounting, which information has been very useful to understand the 2007 current expenditure and 2008 previsions.

For CY 2008, the Category A projected budget rises to 4591 kCHF without power (and 7183 kCHF including power), an increase of 40% over the total CY 2007 budget of 5108 kCHF. The largest increase is due to power costs, with other significant increases being due to detector related costs. All costs at level-1 reach their maximum (or plateau) values in 2008, with the exception of online computing, since the maximum rate of PC replacement will not be reached till after 2009.

The SG examined in detail the overall ALICE M&O costs. Particular attention was given to items under Detector Related Costs, Test Beams & Calibration Facilities and Online Computing. The SG also scrutinized the list of the Service Agreements and the annual cost profile for the technical services.

The Scrutiny Group acknowledges the temporary need for additional M&O A resources (140 kCHF) until the end of 2008 to cover hiring of external staff for the ALICE magnet control. The SG expects that from 2009 this task will be covered again by the CERN ALICE group.

ALICE has revised the budget previsions for Test Beam and Calibration Facilities for years 2008-2010. The SG notes that the 2008 Shutdown Activities (currently foreseen to cost 160 kCHF for operations plus 150 kCHF for consumables) will probably be put off (partially or totally) until 2009. It should be noted that ALICE include in this item only the real shutdown activities, while other experiments include also shutdown preparation and related activities.

ALICE has implemented in its budget previsions its new scheme for online computer replacement, lowering the expected costs in 2008-2010.

Overall, the RRB SG considers the M&O procedures and associated costs presented by ALICE to be reasonable, and no other significant issues were identified.

5. **ATLAS**

ATLAS submitted the closing report for the 2006 M&O Budget to the RRB on April 24, 2007. The actual costs amounted to 9,309 kCHF for Category A (including power costs of 370 kCHF paid by non-CERN member states) and 3,522 kCHF for Category B. Also included are 333 kCHF of prior year commitments for Category A, comprising largely delayed payments for technical services provided by CERN. The total costs are to be compared with budgeted costs of 8,765 KCHF and 4,372 KCHF for Categories A and B, respectively.

As in past years, Category A expenses in CY2006 were driven by the various technical services invoiced by CERN, such as access and crane operations, gases and coolants, cooling and ventilation plants (4,000 kCHF), and for the operation of the cryogenics plant (2,200 kCHF) and the magnets. The cost for the hired manpower to support all these activities was 1,500 kCHF. This was the first year for which technical manpower to support the core offline computing was included in Category A, at a cost of 1400 kCHF, as budgeted.

Integrated over the years 2002 to 2006, the total Category A budget of 20,177 kCHF is well balanced compared to the total costs recorded for this period of 20,147 kCHF. This is also closely balanced with the total contributions by the funding agencies over this period, although some of these contributions were made very late in the calendar year, and CERN management allowed temporary overdrafts on M&O A accounts until the missing contributions were transferred.

The Category B costs were driven by system tests and electronics repairs in the ATLAS cavern for all ATLAS systems, primarily the support for technical manpower (1,500 kCHF) and supplies for gas and cooling systems.

Integrated over the years 2002 to end of 2006, the total Cat. B budget is 8,937 kCHF, compared to the total cost recorded for this period of 7,875 kCHF.

ATLAS projects a Category A M&O budget of 12,767 kCHF (including 858 kCHF for power charges to non-member states) in CY2008, which is an increase of 18% relative to CY2007. Before mid-2008, the entire ATLAS detector is expected to be fully operational. The M&O budget increases are driven by higher consumption of gases, coolant, and spare parts, and the increase in TDAQ and technical computing staff.

The dominant cost drivers remain the technical services at about 4,000 kCHF, the magnet and LAr system at 2,800 kCHF, and the operation and maintenance of the TDAQ at 2,500 kCHF. ATLAS has recently completed the service contracts with CERN and reviewed and updated their budget projections for the years 2008 to 2010. The major change is the transfer of the costs for detector gases and cooling fluids from Category B to Category A, resulting in an increase of 880 kCHF/year (this figure is slightly lower than the one finally discussed and agreed by the SG, having been reduced after checking). Based on experience in the past two years, ATLAS has decided to increase the staff that supports core computing functions, from 16 to 20 FTE, resulting in an additional cost to Category A of 350 kCHF.

The current budget projection takes into account the changes in the maintenance of the online computing facilities (CPUs, disk space, and networking). ATLAS has developed a plan for the procurement of the TDAQ system that targets completion of the system at the end of 2009 (reaching 80% in CY2008). Any further delay of the LHC plans for luminosity buildup would probably lead to further delay of the initial installation (supported by project funds) and subsequently a deferral of the rise in the annual maintenance costs. Based on the current plan for the TDAQ build-up, the annual replacement costs will peak in 2011 and 2012, and beyond that may fluctuate greatly.

ATLAS projects a Category B M&O budget of 6,866 kCHF in CY2008, which is comparable to the CY2007 budget. The support for technical manpower at CERN is expected to decrease from 60 FTEs in 2007 to 20 FTEs in 2008, provided that the LHC start up schedule remains as currently planned. Category B includes core computing tasks such as various management tasks, computer operations and data bases. The support for core computing has grown rapidly since 2006, and is expected to remain at roughly 100 FTEs, all supplied in-kind by the ATLAS Collaboration.

For Category B, apart for TDAQ and computing, the main cost drivers are the detector subsystem operation and related electronics maintenance and replacements. The amortization of the critical spares for the calorimeter and inner detector is included.

6. **CMS**

CMS submitted the closing report for the 2006 M&O Budget to the RRB on April 23, 2007. The actual costs amounted to 6,890 kCHF for Category A (including power costs of 700 kCHF paid by non-CERN member states). Also included are 216 kCHF of prior year commitments

for Category A, reserved either for delayed payments for technical services provided by CERN or for delayed deliveries. The total Category A costs are to be compared with budgeted costs of 6,952 kCHF. There were savings due to slower build-up of the staff for core and on-line computing, and consumption of chamber gases was higher than expected, primarily due to the lack of a recycling system for the RPCs.

As in past years, in CY2006 Category A expenses were driven by the various technical services invoiced by CERN, such as access and crane operations and spare parts, gases, cooling and ventilation plants, and magnet operation. This was the first year for which technical manpower to support the core offline computing was included in Category A, at a cost of 1,000 kCHF, as budgeted.

Integrated over the years 2002 to 2006, the total Category A budget is 15,832 kCHF compared to the total costs recorded for this period of 14,888 kCHF, leaving a surplus of close to 1,000 kCHF. At the end of CY2006, the total contributions by the funding agencies over this period were low by about 500 kCHF, compared to the total invoiced contributions.

The Category B support is provided directly by the collaboration. The material budget was set at 6,058 kCHF, and the total technical staff at 41 FTE, and an additional 70 FTEs to support core computing.

CMS projects a Category A M&O budget of 10,159 kCHF (not including power costs) in CY 2008, which is an increase of 25% relative to the adjusted CY2007 budget. By 2009, the entire CMS detector is expected to be installed and operational. The M&O budget increases are dominated by an increase in technical computing staff and the TDAQ build-up, and to a lesser extent by higher consumption of gases, coolant and spare parts.

The dominant cost drivers remain the technical services, at about 1,800 kCHF, the magnet, and the operation and maintenance and replacement of components of the TDAQ systems at 2,800 kCHF. CMS has recently completed service contracts with CERN and reviewed and updated their budget projections for the years 2008 to 2010. Based on experience in the past two years, CMS decided to increase the staff that supports core computing functions to 15 FTEs, resulting in a total projected cost of 1,411 kCHF.

The current budget projection takes into account the changes in the maintenance of the online computing facilities (CPUs, disk space, and networking). CMS has developed a plan for the procurement of the TDAQ system that targets completion of the system at the end of 2010 (reaching 65% in CY2008 and 90% in CY2009).

CMS projects a Category B M&O budget of 6,315 KCHF in CY 2008, which is comparable to the CY2007 budget. The support for technical manpower at CERN is expected to change slightly from 51 FTEs in 2007 to 54 FTEs in 2008, provided that the LHC start up schedule remains as currently planned. Category B includes core computing tasks such as various management tasks, computer operations and data bases. The support for core computing has grown rapidly since 2006, and is expected to reach a plateau of 96 FTEs in 2008, all supplied in-kind by the CMS Collaboration.

For Category B, apart for TDAQ and computing, the main cost drivers are the detector subsystem operation and related electronics maintenance and replacements.

7. **LHCb**

LHCb submitted the closing report for the 2006 M&O Budget to the RRB on April 4, 2007. The actual costs amounted to 1,463 kCHF for Category A (excluding power costs), well in line with the budgeted costs of 1,478 kCHF. The main cost drivers for LHCb are general services, online computing and detector-related costs.

For CY2008, the proposed LHCb Category A M&O budget amounts to 2,345 kCHF (not including power costs), an increase of 5% relative to the CY2007 budget. The total is projected to remain stable over the next few years.

The SG discussed with LHCb in detail most lines in their M&O Category A request, and was satisfied that proposed costs were justified. Currently LHCb charge a large number of electronics pool rental items to Category A. The Scrutiny Group has received a detailed list of these items and has requested that, where appropriate, costs should be moved to Category B.

8. **TOTEM**

A preliminary budget for TOTEM was tabled at the Scrutiny Group's meeting on 25th September, only a short time before the scheduled end of the meeting. The Group had time only for a cursory look at the document, and concluded that insufficient material was available to allow it to make an informed attempt at scrutiny of the proposed budget at that time. It is proposed that the SG will reconvene in November to scrutinize the TOTEM figures, by which time the experiment would have had time to prepare additional documentation to assist the Group in understanding the M&O requirements.

9. **Other issues**

The SG remains concerned about the apparent lack of progress in provision of a sufficient number of state-of-the-art meeting rooms for phone and video-conferencing. The current situation is unclear, and the experiments are adopting a number of ad-hoc solutions. This issue may become critical once data start to flow from the experiments.

The success of the experiments in the exploitation phase will rely on the knowledge and skills of a large pool of technical manpower, much of it provided by CERN or charged to M&O A. The SG would be concerned if there were significant reductions in expert manpower before stable operations.

10. **Composition of the Scrutiny Group in 2008**

For 2008, significant changes are required to the composition of the Scrutiny Group. The scientific secretary, Chris Jones, will be moving on by the end of 2007. The US delegate, Vera Luth, has (more than) completed her term and is to be replaced. The French delegate, Marc Winter, has also completed his term and a replacement needs to be found. And the Group needs an additional new member, preferably from a small state.

11. **Summary**

Table 1 gives a summary of the requested M&O Category A budgets for ALICE, ATLAS, CMS and LHCb. The SG has carefully scrutinized the budgets of these four experiments, examining in detail many of the line items. The Scrutiny Group took note of Category B estimates where available, but looked in more detail than in the past at the Category B budget for ATLAS. The SG expects to give a similar level of attention, before the end of 2007, to the proposed M&O A budget of TOTEM.

The RRB Scrutiny Group recommends that the 2008 estimates for the M&O budgets for ALICE, ATLAS, CMS and LHCb be approved by the RRB.

Acknowledgements

We would like to thank Vera Luth, Edo Sbrissa, and Marc Winter whose contributions to the work of the Group have been most valuable. VL in particular agreed to stay on the group well beyond the normal period of tenure, and did sterling work throughout her time as a member of the Group. We also thank Chris Jones for his excellent work as Secretary.