Summary of Expenditure for CMS Maintenance & Operations for the Year 2012

INTRODUCTION

This document summarizes the expenditure that the CMS Collaboration has made in 2012 in order to maintain and operate the detectors and Collaboration-wide facilities (M&O Cat. A) as well as expenses made directly by the Sub-detector communities to maintain their respective Sub-detectors (M&O Cat. B).

It presents the income received and reports on the payments classified following the Scrutiny Group's guidelines.

This is the eleventh report that the CMS Collaboration presents on M&O Expenditures and the tenth year we report the M&O Cat. B. The budget request for M&O in 2012 was made in October 2011 (cf. CERN-RRB-2011-079).

Commitments are not detailed in this report owing to the very nature of M&O: long-term commitments should be rare and they will be commented upon in the text in the event they occur.

1. INCOME

The M&O 2012 approved budget totalled 13'235 kCHF plus 1'800 kCHF for Energy consumption.

The actual total invoiced amount was 14'050 kCHF.

We note that for 2011 and 2012 the amount of 884 kCHF is still outstanding to date.

2. PAYMENTS

2.1 M&O-A

An overview of expenditure versus budget is shown in the Annex 1.

- **Expenses**

As indicated in the 2011 Expenditure Report (cf. CERN-RRB-2012-032), the budget over the years 2010 and 2011 has been fully balanced with expenditures over the corresponding period. CMS has subsequently made every effort to maintain its 2012 expenditures within the overall M&O-A budget envelope. This has been successfully achieved with only a slight over-spend of the 2012 allocation below the 1% level.

In the area A.1.05, Gas Consumption, there was an overspend of some 73 kCHF, which is due to the fact that the total gas consumption was estimated at 50 kCHF per month based on 90% CF4 recuperation (and thus monthly costs for CF4 of about 5 kCHF per month) Unfortunately, the available technology can only achieve around 80% recovery rate.

There was an under-spending of 44 kCHF in the area A.1.07, Cooling fluids (above –50°C), where CMS did not replenish usual spare stocks of C6F14, since operational reliability requirements in 2013 are not stringent and consequently savings could be made.

There was some under-spending in the area A.1.08, External Cryogenics, amounting to about 26 kCHF since part of usual maintenance cycle was skipped due to major revisions planned for 2013-14.

In the area A.1.09, Cryogenic fluids (below –50°C) there was an overspend of 36 kCHF due to several magnet technical incidents during the year, including a fast discharge, leading to an accumulation of Helium losses in evaporation.

In the area of A.1.10, Moving/hydraulic systems there was an overspend of 16 kCHF due to preparation of systems for Long Shutdown 1 (LS1).

In the area of A.1.12, Shutdown activities there was an overspend of 18 kCHF which was mainly due to hired manpower and support for Collaboration manpower engaged in pre-cabling activities for LS1 and in equipping the Operations Support Centre (OSC) in SX5.

This was also the case for the area A.1.17 Counting & control rooms where and overspend of some 11 kCHF was due to pre-cabling work for the full revision of the power distribution in LS1.

In the area of A.2.01, Secretarial assistance an overspend of 70 kCHF was necessary, mainly due to cover the cost of replacing a staff member on maternity leave.

The actual amount of expenditures for the area A.4, Online Computing, was 1'785 kCHF for a total budget of 2'818 kCHF. However, the total allocation is considered as expenditures and, in agreement with the Scrutiny Group, the unspent funds are transferred to the special DAQ account approved at the October 2011 RRB. They will be used at the most appropriate time when On-line hardware would be purchased, most likely towards the end of 2013.

Many of the increased expenditures were related to the Operations Support Centre (OSC). More specifically, in the area A.6.01 Assembly areas, clean rooms where an overspend of 31 kCHF is mainly related to the need for installing additional facilities to allow work on the Pixel Tracker at cold temperatures. Furthermore, in the area of A.7.04, Heavy transport an overspend of 21 kCHF is mainly due to the need for three man-months of additional driver/rigger time for activities related to the completion of the OSC.

In the area of A.7.11, Reviewing & Engineering an overspend of some 28 kCHF was mainly generated by reviews of LS1 projects and manpower to get started on integration work for LS1 (pipework design engineer).

A global view of the M&O-A spending in 2012 shows that overspending on some budget lines has been mostly compensated by savings in made in other areas. This has resulted in an overall overspending of the M&O-A budget (without Electrical Power) by some 85 kCHF, which represents only 0.6% of the budget.

With regard to expenditures on electrical power consumption it should be noted that the payments reported in Annex 1 are significantly lower than the allocated budget. This is due to the fact that power costs are not invoiced to Funding Agencies, which belong to CERN Member States and hence not reported as expenditures. Discussions are underway with the RRB Scrutiny Group concerning the allocation for Power with the objective of proposing a reduction for the 2014 budget request made to the October 2013 RRB.

- **Outstanding commitments**

The total amount of open commitments at the end of the year totalled some 978 kCHF, of which some 45% are related to industrial support contracts for 2012. The remainder are for consumables and goods to be delivered this year, of which 202 kCHF is for DAQ equipment and 92 kCHF for safety-related items.

2.2 M&O-B by sub-detector

- **Tracker**

Contributions from Funding Agencies covered 99.0% of the TK budget request. Due to bureaucratic delays it has not been possible to obtain during 2012 the contributions from Iran and Spain, which are among the new contributors since the sharing scheme was changed to one based on PhD count. On the other hand, in addition to the 2012 due, France has paid a small debt left from the previous year, which had been due to exchange rate fluctuations.

Overall, thus, there was no real funding problem in 2012. The arrangements with individual Funding Agencies and Institutes worked as expected in almost all cases.

In the Cooling and Dry Gas Systems there appears to be a large overspending. This was expected and planned. Indeed in reusing previously accumulated savings to reduce the budget request for 2013, one year ago the Tracker had anticipated the need to spend already in 2012 up to 300 kCHF more than budgeted to procure ahead of time parts for consolidation work to be started on the system at the onset of LS1. In a few categories (Mechanics, Power systems, Read-out electronics and Store Items) the expenses have been lower than budgeted, again for the same reason as last year: jobs that are needed but can only be performed during a long shutdown, and which were indeed planned for 2012 when the budget was requested, have been forcibly deferred to not earlier than 2013 - onset of LS1).

As a result of the apparent overspending in Cooling and Dry Gas and, for smaller amounts, in other areas on one hand, and the underspending in Mechanics, Power systems, Read-out electronics and Store Items on the other hand, in total the expenses amounted to 1’539 kCHF, just 3% short of the full request (1’590 kCHF).

- **ECAL**

The total 2012 M&O-B requests for the Material Resources for the Electromagnetic Calorimeter of CMS amounted to 1'123 kCHF. Contributions to these expenses were made either by placing orders directly or by cash contributions to the ECAL M&O-B account.
The full requested amounts were obtained from all participating Funding Agencies.

The main expense continues to be in the category of Hired Manpower at CERN (B.1.14), principally for engineers to work on the data acquisition system. No extraordinary problems occurred in the ECAL in 2012. The funds allocated for spares were sufficient to cover repairs and replacement items where necessary. A new solid-state laser (for monitoring the transparency changes of the crystals under irradiation) was purchased in 2012 through an additional contribution from US-CMS, amounting to around 250 kCHF.

ECAL covered the costs of all ancillary equipment, amounting to around 60k CHF. This laser has proven to be more stable and reliable than the previous lasers.

No major upgrades or repairs are needed to the ECAL hardware during LS1. A full consolidation of the DAQ software will be performed for all components of the ECAL (barrel, endcaps and preshower). Some of the tasks will need to be performed by professional software engineers, requiring a modest increase in expenditure in B.1.14 compared to 2012. A second solid-state laser will also be purchased in order to ensure full redundancy for future operation. A majority of the costs for this second laser will be covered by ECAL.

A redistribution of funds will enable ECAL to obtain an overall expenditure in 2013 that is 100 kCHF lower than in 2012. As concerns the ECAL projection up to 2017, the preliminarily estimate shows the same total amount as for 2013, with some further evolution of the distribution of funds.

- **HCAL**

HCAL has in the past operated largely on a "you built it, you maintain it" model, with groups joining HCAL after construction completion assuming their proportionate share of maintenance and operations costs. As such there is no explicit HCAL M&O-B fund, but rather the in-kind contributions of the collaborating institutions/Funding Agencies. Recently, however, HCAL has found it useful to have a few common expenditures, e.g. safety equipment needed for LS1 work. Cash contributions from Funding Agencies have increased slightly, but the largest contribution from collaborating institutes still continues to be with manpower for the maintenance and operation of the detector either at CERN or at the home Institute.

HCAL experienced stable operations throughout 2012. The increasing luminosity posed challenges, but the detector performed well, with over 99% good channels. All participating Funding Agencies contributed to these activities.

One low level issue that occurred in operation was several QPLL/crystal failures that caused an entire readout box (72 channels) to run unsynchronized to the LHC clock. This problem will be addressed in LS1 and requires re-fabrication of 2 (out of 4) boards in the Clock Control Module (CCM). In addition to that project, the source driver refurbishment was started in order to calibrate the HCAL sub-detectors before or after the LS1 intervention. HCAL expenditures in 2012 were slightly higher than the proposed budget due to these projects.

The largest expenditure in 2012 was Hired Manpower at CERN. The overall HCAL expenditures increased in 2012 in preparation for the LS1 activities. In addition to detector operations, manpower at CERN increased to accommodate testing activities needed to prepare equipment (CCMs, HO Silicon PMTs (SiPMs), and HF PMTs) for LS1 installation. The largest material expenditures were from the refurbishment of the CCM, from the HF multi-anode photomultiplier (PMT) baseboards and socket fabrication, and from infrastructure improvements needed to establish test stands/areas at CERN. In addition, spare supplies increased in 2012 in preparation for LS1.

The current estimate is that this higher budget will be maintained through LS1 (2014), but will drop to lower levels during normal data taking operations (2015-2017). This M&O-B funding does not include the purchase of the HF cables for the new PMTs or the micro-TCA back-end electronics that will be installed in LS1.

• Muon Systems

CSC System

During the 2012 running the CSC system performed very well with a typical efficiency about 97.5%. The CSC spending on M&O-B was in line with the budget. Most of the M&O-B expenditure is for hired manpower at CERN and this is expected to continue. During the significant increase in luminosity over the year we observed no major problems. The funding agencies provided the necessary resources as requested. There were no unforeseen expenditures.

A few instances of low voltage dropping below the required minimum were observed. By reseating the power board on the peripheral crates (CRB) the problem disappeared, and it did not cause any lost data during the run. However, the problem has been traced to a galvanic effect due to the use of tin-plated connectors on the peripheral crate backplane and gold-plated connectors on the CRB. This problem is being investigated and will need to be corrected before the next running in 2015.

During the long shutdown of 2013 and 2014 the M&O-B operations personnel will be busy commissioning the new ME4/2 chambers and the refurbished ME1/1 chambers. As a result, no change in the amount of hired manpower is expected during LSI. The M&O-B funding will not cover the new chambers or the new electronics for ME1/1.

The expectation is that the current M&O-B budget will be maintained through 2017. The data runs of 2011 and 2012 provided a stable situation and the anticipation is that future runs will be similar.

DT System

During 2012, the largest fraction of the budget was spent, as foreseen, on electronics for the planned refurbishment of the stock of spare Trigger boards (TRB) and spare A3050 PS modules. Although the total expenses in the year 2012 were 30% larger than the annual budget, this is in line with the DT Group strategy according to which the known and planned expenses are distributed over several years in order to cope with next years' activities while keeping the overall budgetary envelope constant.

The same strategy is applied for the DT budget plan for 2014-2017. With the completion of the TRB operation, it is foreseen, in the following three years of stable data taking conditions, a reduction of the overall M&O-B budget.

Expenses on hired manpower, in order to keep key positions of experts and coordinators available at CERN for maintenance and operation of the apparatus and of the alignment system, are at a constant level. The amount of repairs of the HV-LV system was according to expectations.

The M&O-B sharing between the Funding Agencies took into account the overall responsibilities. All contributions from 2012 budget were received or their payment is imminent. The contribution of the previous year (2011) has been fully delivered.

RPC System

In the 2011 it was decided to postpone the procurements of some spare electronic components in the view of the LS1. For this reason in 2012 we spent about 50% more than the estimated, using a large fraction of the 2010-2011 residual budget.

In 2012 a consistent fraction of the budget was spent on hired manpower, in order to keep few positions of experts at CERN for the operation of the system and to keep a very high

data taking efficiency as requested by CMS. A fraction of the Hired Manpower budget was also used to invite some students of small institutions at CERN.

Taking into account the 2011-2012 experience and the manpower needed during LS1 the RPC System will require a higher allocation of hired manpower starting from 2013, as it was already agreed in 2012.

After the LS1 shutdown there will be three years of data taking from the 2015 to the 2017 and for this reason the estimated budget for the 2015-2017 M&O-B will be reduced by about 30%.

• Trigger

In the course of 2012 the amount spent was about 25.5 kCHF above the Trigger allocation for 2012. The deficit was covered by the prior year's balance.

A large fraction of the funds were spent on hired manpower at CERN. The manpower was necessary to provide software support for Trigger operations during the critical period of data taking in 2012. The effort was crucial in enabling smooth operation of the Trigger systems, upgrades of the software before the run began and timely resolution of occasional errors reported during operations. Some of the funds were used for routine repairs as anticipated. Communications (cell phones) funds were also critical to maintain the contact between the experts and the operations at Point 5.

Additional expenses were incurred at the institutions to support the CMS operations as planned.

About 10 kCHF were spent unexpectedly on the manufacture of prototypes of optical transmitter (oSLB) and receiver modules (oRM). These modules are needed for refurbishing the calorimeter Trigger system during the shutdown years 2013-2014, and therefore, the urgency to manufacture them before the Upgrade plans are settled.

All Funding Agencies and Institutes contributed as planned and arrangements for M&O-B worked out as expected. No changes in cost-sharing scheme are foreseen for future years.

ANNEXES

Annex 1 : M&O Cat. A Expenditures vs. Budget in 2012

ANNEX 1

M & O Cat. A Expenditure vs. Budget in 2012

Year	2012
System	A. M&O-A

				kCHF	
Type		Subsystem	Item	Budget	Payments
Expense	M&O-A w/o Power	A.1. Detector related costs	A.1.01 Magnet	30	30
			A.1.02 Magnet controls	142	145
			A.1.03 Magnet power supply	41	40
			A.1.04 Gas systems	260	264
			A.1.05 Gas consumption	600	663
			A.1.06 Cooling systems	226	225
			A.1.07 Cooling fluids(above –50°C)	220	44
			A.1.08 External cryogenics	375	351
			A.1.09 Cryogenic fluids (below –50°C)	40	76
			A.1.10 Moving/hydraulic systems	175	191
			A.1.11 Detector safety systems	200	203
			A.1.12 Shutdown activities	278	296
			A.1.13 General Technical support	544	552
			A.1.14 UPS maintenance	80	82
			A.1.15 Power supply maintenance	85	86
			A.1.16 Beam pipe & vacuum	150	144
			A.1.17 Counting & control rooms	152	163
			A.1.18 Safety	360	359
		A.1. Detector related costs Total		3,956	3,914
		A.2. Secretariat	A.2.01 Secretarial assistance	232	302
			A.2.02 Economat	15	10
			A.2.04 Printing and publication	50	49
		A.2. Secretariat Total		297	361
		A.3. Communications	A.3.01 GSM phones; on-call service	20	20
			A.3.02 Collaborative tools	350	348
		A.3. Communications Total		370	368
		A.4. On-line computing	A.4.01 System management	980	987
			A.4.02 Data storage, (temporary on disk)	0	0
			A.4.03 Detector controls	0	0
			A.4.04 Computers/processors/LANs	2,818	2,818
		A.4. On-line computing Total		3,798	3,805
		A.5. Test beams, calibration facilities	A.5.01 General operation	41	45
			A.5.02 Common electronics	15	15
			A.5.03 Electronics pool rentals	20	20
			A.5.04 Gas systems	10	10
			A.5.05 Gas consumption	10	10
		A.5. Test beams, calibration facilities Total		96	100
		A.6. Laboratory operations	A.6.01 Assembly areas, clean rooms	600	631
			A.6.02 Workshops	293	293
		A.6. Laboratory operations Total		919	925
		A.7. General services	A.7.01 Cooling & ventilation	595	597
			A.7.03 Power distribution system	60	59
			A.7.04 Heavy transport	297	318
			A.7.05 Cranes	35	36
			A.7.06 Cars	30	30
			A.7.08 Survey	157	157
			A.7.09 Storage space	50	40
			A.7.10 Common desktop infrastructure	40	42
			A.7.11 Reviewing & Engineering	350	378
			A.7.12 Outreach	222	221
		A.7. General services Total		1,835	1,880
		A.9. Core Computing Infrastructure & Services	A.9.01 Central computing environment	562	551
			A.9.02 Software process service	317	339
			A.9.03 User support	208	201
			A.9.04 Central production operations	806	812
			A.9.05 Hardware	70	63
		A.9. Core Computing Infrastructure & Services Total		1,964	1,967
	M&O-A w/o Power Total			13,235	13,320
	Power			1,800	372
Expense Total				15,035	13,692