Status of CMS

Progress Summary Report for November 2008 RRB27

The dedicated and strenuous efforts of many over the summer allowed a powerful CMS detector to be prepared for LHC startup. After almost 20 years of design and construction, CMS started taking data with LHC beams. The solenoid and the inner tracking system were to be off until stable beams were established. We have shown that CMS can take good quality data and that we can react fast to changing beam conditions. All indications are that sub-detectors, online, offline, computing and analysis systems performed well.

The operational CMS Detector used for cosmics runs before and after first beams includes: barrel and endcap pixels; silicon strip Tracker, barrel and endcap crystals electromagnetic calorimeter (ECAL), hadronic calorimeter (barrel, endcap and forward HCAL), Muons (DTs, CSCs and RPCs), Level-1 Trigger, and 50 kHz DAQ.

Since the incident of 19 September the solenoid was taken to operating field and a cosmics run with field begun. The cosmics run will continue until mid-November, when the experiment will be turned off for obligatory annual maintenance of the cooling system, followed by the installation of the preshower in early 2009. During the shutdown, we will also work to consolidate various aspects of our software, computing, and detector operations, in order to have as high efficiency as possible when beams return.

The main highlights during the last six months are recalled:

i) The beampipe through CMS was installed, confirmed to be leak-tight, and baked-out in June. It was then returned to atmospheric pressure (with ultra pure neon), pumped out again for the turn-on of the LHC in early September, and is again filled with neon.

ii) CMS solenoid: The coil was tested to 3 T in final configuration before beam, and run at full field of 3.8 T since. CASTOR, the calorimeter close to the beam pipe, was temporarily removed as a precaution as some movement was observed.

iii) The CMS Tracking System is complete and has been commissioned with CMS. After overcoming some problems with the cooling system, reported in April, the Silicon Strip Tracker was commissioned with CMS early in July. The Pixel Systems (Barrel and Forward) were installed in late July and commissioned with CMS in August. There remains an issue concerning a high rate of fluid leaking from the cooling system. Mitigating actions are being pursued to be implemented during the shutdown.

iv) ECAL: Both endcaps were installed and commissioned, and are operational. Meanwhile the barrel continues to perform well. The Preshower construction is in full swing, with installation of both ends foreseen during the current shutdown.

v) *In situ* Commissioning: a 24/7 run was made in mid-August (CRUZET4) with the whole experiment switched on. On 7 September CMS was timed-in and recorded

the third LHC shot to hit the collimator 150 m upstream of CMS. On 10 September and subsequent days, CMS recorded more shots on collimators, beam halo muons and beam-gas collisions from circulating and captured beams.

vi) Trigger and DAQ: The complete Level-1 and High-Level-Trigger configurations for first LHC beams were operational; Phase 1 of the data acquisition system was also completed and used for first beams.

vii) Software & Computing: Software releases for simulation, data taking, and reconstruction were deployed and used with cosmics and with first LHC beams. Simulation of large data sets proceeded with both fast and full simulation. Computing exercises, separately and concurrently with other LHC experiments, were successful and led to further improvements in the computing infrastructure.

viii) Preparation for physics analysis continued with the focus on start-up integrated luminosities of 1, 10 and 100 pb^{-1}, and associated issues of calibration and alignment. At time of first beam, these preparations had consolidated the analyses for up to 10 pb^{-1}.

Installation and Infrastructure

Status

The final installation tasks foreseen at the April RRB, namely the installation of the beam pipe, pixels, ECAL Dees, and beam monitoring instrumentation, were completed. The closure of the detector and subsequent raising of the forward HCAL structures were then completed on 3 September, with final pump-down of the beam pipe completed on 8 September. Behind these successes (which included all four Dees whereas only two Dees were foreseen in April), was a summer of intense activity by many teams (from the experiment and three CERN departments) working together on tasks that were challenging.

During first-beam operation, the beam and radiation monitors, along with the calorimeters and muon detectors, detected the beam as expected. The injection inhibit and the beam abort were made active.

Plans for 2008 and early 2009

Immediately after the incident of 19 September, planning began for revised scenarios for the winter shutdown. The beam-pipe was filled again with neon at atmospheric pressure. Until mid-November, data-taking with cosmics and the magnet on is of great value for understanding the detector and is being pursued. Maintenance of the cooling system will then begin, followed by a program of carefully selected repairs interleaved with installation of the Preshower detector. CMS will then be closed up and returned to a state of cosmics data-taking without and with the magnet on, well before the re-start of the LHC.

Concerns

With the shutdown beginning earlier than foreseen, maintenance activities and installation of the Preshower may need to be moved forward. Therefore there is reduced time for planning and acquiring some material and personnel possibly requiring extra resources.

Magnet

Status
The cool-down of the CMS solenoid to the nominal temperature of 4.5K was achieved at the beginning of August. A series of tests culminated in the magnet reaching 3 T before first-beam, with the solenoid performing as expected. Higher than expected fringe fields in the cavern resulted in slowing the schedule for increasing the field 3.8 T. After a series of careful measurements and mitigation of some effects of the fringe field, the CMS solenoid reached its nominal operating field of 3.8 T a few days after access to the CMS cavern became possible following the 19 September incident. Since then the magnet has been cycled and used for magnet-on data-taking of cosmics.

Plans for 2008 and early 2009
The fast dump will be re-tested after the end of cosmics data-taking. During the shutdown, general maintenance will be performed.

Commissioning

Status
Since the spring, the full CMS commissioning has made steady progress with the reliability of the data-taking now consolidated. It is now possible to keep runs going overnight without interruption at logging rates of 300-400 events per second. Recently we have systematically pushed the system to run with a mixture of real cosmics triggers and artificially generated random triggers. Eight-hour shift runs are now sustainable with Level-1 trigger rates in excess of 45 KHz (logging at ~400 events/s) with negligible deadtime. Most subdetectors can hold in excess of 80 Hz without introducing deadtime, while the ones which start back-pressuring are being studied in order to optimise their performance.

The demonstration of readiness to take data came when LHC started circulating beams around 10 September. During the 40 hours of beams and the continuous reliable data-taking, we demonstrated that:

- we could adapt our trigger and data-taking conditions to rapidly varying external conditions without losing efficiency, and
- we could verify the inter-detector synchronisation established by the many months of running with cosmic ray triggers (both at the data pipelines and at the trigger primitive generation), and that we could further refine this synchronisation using the 'splashes' of large numbers of particles per cm^2 impinging all over the surface of CMS when the beam was being stopped just ahead of us on the last set of collimators.

Since late August we have been running with the whole of CMS, interleaving global data-taking exercises with local calibration runs. Since mid-October we have been running continuously with all of CMS and the nominal magnetic field, aiming to collect in excess of 300 million cosmics triggers with field on.

During the CSA08 global data challenge in late spring and continuing in early summer, the Detector Performance Groups (DPGs) associated to each subsystem have been demonstrating and validating their calibration and alignment workflows. The workflows are being used routinely now to process the real data coming from the cosmics trigger of the global runs.

A subset of the DPGs, the prompt analysis task force, working off the remote centres (principally the CMS Analysis Centre at CERN, but importantly also the ROC at FNAL)

has contributed quasi-real time feedback on the quality of the data and to a large extent validated the data reconstruction and data flow.

The data coming from the experimental cavern is typically processed within about one hour and dispatched to the various Tiers and to the CAF, which has been heavily used by the DPGs to exercise workflows and perform first analysis of the data.

Plans until LHC restart
The data collected during the recent cosmic ray campaigns with and without field is providing data for the DPGs and the physics teams to produce new sets of calibration and alignment constants.

On the detector side, the plan is to consolidate operations in order to improve reliability and efficiency. We are working actively to reduce the overall number of people needed to operate the detector (currently five central shifters plus varying numbers of shifters for each subdetector).

From February onwards we plan to continue the consolidation process with the aim to be in stable and continuous running mode one month before the re-start of LHC.

Tracker

Status
The CMS Tracking System is complete and has been commissioned with CMS. After overcoming some problems with the cooling system, reported in April, the Strip Tracker was commissioned with CMS early in July. The Pixel Systems (BPix and FPix) were installed in late July and commissioned with CMS in August.

The failure of part of the CMS Tracker cooling system in November 2007 was reported at the April meeting of the RRB. In May there was a second similar failure of a heat exchanger in the cooling system, resulting in the decision to change all heat exchangers in the system. The complete system was updated and refurbished and the Silicon Strip Tracker was commissioned with CMS after the cooling was restored. There remains an issue concerning a high rate of fluid leaking from the cooling system. This does not interfere with the current cosmics running but needs to be mitigated for longer runs in the future. Mitigating actions are being pursued, to be implemented during the shutdown.

Cosmic ray data collected with CMS were analysed quickly, with the encouraging result that the performance of the Strip Tracker fully meets the specifications defined in the CMS Technical Design Report.

In July, both the Barrel and Forward Pixel Systems were installed in CMS and connected to the pre-installed and tested services. The detailed calibration of the pixel detectors started immediately, and within three weeks the complete pixel system was collecting cosmics data with the Strip Tracker and CMS.

Concern
The fluid leak rate in the cooling system is still high and needs to be mitigated.

Plans for 2008 and the shutdown

Continue to collect cosmics data with CMS at 3.8 T and to understand the detailed calibration, alignment and systematic effects of the complete Tracking System.

Work on the cooling system.

Electromagnetic Calorimeter

Status
Barrel: The ECAL Barrel is fully integrated into the general CMS DAQ system and contributes to all the CMS global runs. The Trigger and the Selective Readout Processor (which implements an optimum zero suppression) have also been commissioned.

The crystals for the 37th (spare) supermodule have been received, tested, and assembled in submodules. The supermodule assembly is planned for early 2009.

Endcaps: The assembly of the Dees was completed in mid-July and all four Dee's were installed and commissioned in CMS by mid-August. The Endcaps calorimeter was therefore operational for the first beam shots recorded on 10 September.

The trigger modules (EETCC) are under production and will be installed in CMS by the end of 2008.

Preshower: The production of all the needed (4300) silicon modules was completed by the end of July. A few hundred spare modules are being assembled during the autumn.

The production of the readout motherboards and all of the internal services are also complete. The off-detector readout electronics modules have been produced and their test is 60% complete.

The large-scale assembly, which is taking place at the former Tracker Integration Facility, is making fast progress. Four out of the eight absorber planes have been assembled at ambient temperature. Three of them are fully cabled up to the external patch panel, including the delicate optical fibres. Two have been successfully commissioned at cold temperature (-15 °C). The assembly should be completed by the end of this year and the installation in CMS is foreseen during the shutdown.

Plans and Milestones for 2008 and Early 2009
Compete and commission the Endcaps Trigger by end 2008.

Complete the assembly of both Preshowers by December 2008 and install them in CMS by early 2009.

Hadron Calorimeter

Status
All of the HCAL has been installed underground for more than a year. HCAL has participated in all global runs during 2008 and verified its calibration using cosmic rays. It has also participated in many of the Global Calorimeter Trigger and Global Trigger commissioning studies. HCAL timing was verified during the splash events of the LHC start-up of 9 and 10 September. With the exception of a few channels, HCAL is fully operational. It is expected that the few defective channels will be repaired during the present winter shutdown.

HPD noise has been studied extensively. The sources are ion feedback initiated by any electron hitting the silicon pixels as well as electric flashover noise in the walls of the HPD. This latter source is enhanced in intermediate magnetic fields but not at the CMS operating point of 3.8 T. Further studies of HCAL performance at 3.8 are underway.

We have confirmed that the HF PMTs can operate normally in the fringe field when the CMS magnet is at the full value of 3.8 Tesla. The fringe field is well below the value for which the PMT shielding is effective (up to 400 gauss).

The integration of the ZDC into CMS continues. As noted above, CASTOR was removed as a precaution after some movement was observed, and will be re-installed on a re-engineered table for 2009 running.

Muon Detector

Status

Endcap Cathode Strip Chambers (CSC): All services (gas, cooling, LV, HV) have been connected and are operational. All 468 chambers were commissioned by summer 2008 and we typically have approximately 97% of the chambers in the readout. Accessibility to a few of the chambers that developed faulty circuit boards was too short for repairs during the work towards completion of the LHC start-up. These will be repaired during the current shutdown. With the CMS detector fully closed, the operational features (start-up, detector control, data quality monitoring, etc.) of the CSC system are being improved. During the brief running with beams the CSC system was able to provide very good data. Measured chamber efficiency for halo muons was roughly 99% per plane (six planes per chamber). For the next few months, until the beam running in 2009, we will continue to refine the software and firmware for triggering and data acquisition.

Barrel Drift Tubes (DT): The four mobile wheels were completed and closed over the vacuum tank in April and May 2008. Since then the Barrel DT was continuously operated to give trigger to the inner detectors. Over 150 million events were collected and carefully analysed to understand the detector behaviour.

The main focus was the improvement of the performance of the detector control system. This increased the stability and reliability of the detector.

The Trigger performance is excellent and was extensively tested and integrated in the general CMS Trigger. The coarse synchronisation of the chambers of the same wheel and between the different wheels was successfully completed. A careful inventory was made of the few noisy and faulty channels.

Taking advantage of the continuous and long operation, a first attempt is going on to study the electronics and the few chamber failures in order to understand their time development and to make a plan for intervention during the winter shutdown. Minor interventions on some chambers are planned.

The six months of operation showed that the detector is remarkably stable.

Resistive Plate Chambers (barrel RB and endcap RE): Commissioning of RB and the positive endcap RE was completed after some chambers with significant gas leakage were found and replaced. Full commissioning of RE on the minus endcap was delayed by late-arriving power supplies and will be completed during the shutdown. A major milestone was reached when the closed loop gas system became operational with a fresh mixture percentage initially about 20% and now lowered to 10%. Chamber currents are stable and the gas quality is monitored before and after purification, with additional gas chromatograph analysis performed daily. However some RE chambers show an increase in the current drawn the source of which is being investigated.

Participation in global runs was another important achievement. During CRUZET-1 several million good events were collected and their analysis demonstrated good performance. All of the monitoring tools (DCS, DQM, Prompt Analysis) worked reasonably well. By the time of CRUZET-4, many improvements were made, including implementation of RPC trigger synchronisation, which was further refined with first LHC beams.

Alignment: The LINK System that connects the Tracker to the Barrel and Endcap Muon detectors was successfully installed in the positive side of CMS. It performs well within the requested stability and precision. Some parts of it could not be installed in the negative part due to unexpected problems in the Muon disk-closing. It will be completed during the winter shutdown.

All of the 36 MABs are installed in the Barrel, but three of them are not fully operational and were slightly displaced during the closing operation. However the system is redundant enough to cope with this problem.

Some interventions will be needed during the shutdown. The reconstruction software is in good shape for the Link and slightly late for the Barrel part. A task force was set up to speed up and finalise this part by the end of the year.

Plans for 2008 and the shutdown
Complete commissioning of the negative endcap RE. Address the cause of an increased current drawn in some RE chambers.

Perform selected interventions on some CSC, RPC, and DT chambers.

Trigger and Data Acquisition

Status
Level-1 Trigger: The installation, cabling and testing of the trigger systems in the underground service cavern USC55 is concluded, with the exception of ECAL endcap trigger hardware (TCC48) which should be finished by the end of 2008. Detailed extensive inter-system integration testing is also completed. Various system tests validated the trigger timing control, trigger software, and rate throttling. The Level-1 trigger system, integrated with the subdetectors and the run control, has been operating successfully in the Global Runs since May 2007. Stable operation was achieved during the runs with first LHC beams. Currently, all muon triggers and the calorimeter trigger are providing stable cosmics triggers to the experiment at correct rates using the final infrastructure. The commissioning of the trigger systems was performed with all detector components except the negative RPC endcap, which will be completed during the winter shutdown as the power supplies are installed.

Trigger Coordination: The Trigger Studies Group has produced a series of Level-1 and Higher Level Trigger (HLT) menus especially suited for the LHC start-up through 10^{32} $cm^{-2}s^{-1}$. These include a suite of minimum bias triggers that provide data samples for the initial trigger and physics studies. There is also a suite of calibration and alignment triggers that can output small fragments of the detector information at higher rates especially designed for start-up detector and physics commissioning.

The initial start-up L1 and HLT menus were successfully tested in the beam commissioning tests. L1 and HLT online and offline trigger data monitoring was also deployed and operated.

DAQ: The development, purchase, and installation of all the components needed to build the phase-1 40-kHz DAQ system have been completed during the last months. The equipment consists of the full detector readout with 2 Terabit/s data to surface optical links; eight DAQ slices with 40 kHz event building capacity (January 2008); 720 8-core PC forming the High Level Trigger Filter Farm (July 2008); and a 16-node storage manager system allowing a writing rate up to 2 GByte/s and a total capacity of 300 TB (September 2008).

The online software new releases and the commissioning of the overall system are proceeding concurrently with the Global Runs operations and the services needed to maintain and manage the online computing and networking complex (about 2000 PCs, multiple servers, 200 users, technical and data networks, data storage and file systems, Control Room etc.).

Offline Software

Status

Following new production software releases in the CMSSW_2_0_x cycle during April, two activities, CRUZET-1 (Cosmics RUn at ZEro Tesla) and Computing, Software and Analysis 2008 challenge (CSA08), have had very successful outcomes. During CRUZET-1 more than 30M cosmic events were logged amounting to ~3.5 TB of raw data and ~10 TB of reconstructed data. Reconstruction was conducted at the Tier-0 computing centre with a latency of less than one hour and for the first time, data quality monitoring was operational in the offline workflow. In parallel, the CSA08 exercise was aimed at testing the full scope of data handling and analysis activities needed for LHC data-taking in 2008. A major achievement of this challenge was to exercise the full set of alignment and calibration workflows in 'real-time,' in very much the same way that is needed for real data-taking.

Development has continued in the CMSSW_2_1_x cycle. Production releases were made in August for use in the on-going commissioning exercises with cosmics (CRUZET-3) and in preparation of the large-scale Monte Carlo production that started in September. Some of the latest important changes include the new magnetic field map (3.8 T), the use of new improved Geant4 physics models (Bertini cascade model), the development of a common physics analysis toolkit (PAT) and convergence towards the final geometry and material budget. In addition, campaigns continued in order to further optimise performance at all levels e.g., to improve memory footprint and CPU performance and to review event content and reduce its size. Another important achievement has been the commissioning of Fast Simulation for use in studies requiring very large-scale productions of simulated events (~500M events/production).

The last six months have also seen a rapid evolution in the data and workflow management tools, which provide processing, data transfer and analysis services for managing production work in both simulation and data-taking environments. Production of large Monte Carlo samples has continued at scale, with further improvements in the automation of the production system, and worldwide data transfers (using PhEDEx) have performed well. The almost continuous series of Global Runs has been extremely useful for exposing the software to unforeseen use-cases and a number of bugs have been identified and fixed in rapid succession.

The project has also prepared a plan for putting into place the infrastructure required to run essential services for data-taking. A first working offline DQM infrastructure, including shifts, was exercised during Global Run data-taking periods; procedures and tools continue to be refined for providing fast feedback on data quality and for certification of good runs when beam returns. The Offline Run Manager will follow day-to-day issues as regards to data-taking needs and on-call support will be provided by experts in order to ensure the availability of critical services on a 24x7 basis.

Plans and milestones

We plan to make a new software release in early 2009 to integrate ongoing improvements in CMSSW software, and to upgrade to more recent versions of compilers (gcc 4.3, python 2.5) and external libraries, such as ROOT and GEANT4. This new release is to be used for data-taking with cosmics in preparation for the re-start of the LHC.

Computing

Status
In May 2008, the CSA08 was combined with the LHC Combined Computing Readiness Challenge (CCRC'08). CSA08 tested the full scope of data processing and analysis activities required during the first three months of LHC data-taking. For CSA08, two large sets of Monte Carlo samples were generated; each corresponding to one week of data taking with two different machine scenarios (43 colliding bunches with 1 pb-1 of luminosity and 156 colliding bunches with 10 pb-1). For CCRC'08 CMS focused on augmenting the load of the CSA'08 exercises to test the computing system. The areas exercised were the T0 workflows (including Cessy to CERN transfers), the T1 workflows (including test of the load from skimming jobs on T1 centres), the distributed data transfers (all T0→T1, T1→T1, T1→T2, T2→T1 routes, with measurement of throughput and latencies), and the analysis load on T2 sites. All LHC experiments had a full schedule for tests, such that many activities were run in parallel at the centres. A full analysis of the results was performed at the WLCG workshop on 12 and 13 June.

The main focus during the summer was to handle data coming from the detector and to perform Monte Carlo production. The lessons learned during the CCRC and CSA08 challenges in May were addressed by dedicated campaigns lead by the Integration team. Improvements were achieved in the stability and reliability of the CMS Tier-1 and Tier-2 centres by regular and systematic follow-up of faults. In preparation for data-taking, the roles of a Computing Run Coordinator and regular computing shifts to monitor the services and infrastructure as well as the interfacing to the data operations tasks were defined. User support worked on documentation and organised several training sessions.

A group studying the Evolution of the Computing Model (ECoM) delivered the report on "Use Cases for Start-up of pp Data-Taking". For start-up of data taking an adjustment of the computing model is recommended; an analysis model initially based on widespread access of the RECO event format, and the storage of the full primary datasets at the CAF, are the most salient points. The roles of the CAF as well as the express and calibration streams have been clarified - also in view of the asymptotic mode of operation. In a situation where short luminosity runs are interleaved with long periods without collisions, a special high trigger rate configuration is attractive in order to obtain larger data samples. Several tests along the data path downstream of the HLT have been performed to define a safe working point for this scenario.

Plans for 2008 and the shutdown
Further production of Monte Carlo event samples for physics and trigger studies, including extremely large fast simulation samples.

Further improvement of monitoring and fault detection in the distributed computing infrastructure.

Analysis of CRAFT Data and Monte Carlo events, mainly at Tier-2 centres.
Dedicated functional tests as preparation for 2009 data processing and analysis.

Physics

Status
Readiness for initial data-taking has been the highest priority of the CMS Physics programme in 2008. The Physics Object and Physics Analysis groups prepared detailed work plans focused on preparations for early LHC operation. Workshops dedicated to start-up physics were held and continuous improvements were achieved in reconstruction and identification of all of the main physics objects. The development of

data-driven techniques has played a major role in the preparation of early physics analyses.

A series of meetings entitled, "En route to discoveries," took place in 2008. The first of the series covered the measurements of the Standard Model signals as necessary prerequisites to any claim of signals beyond the Standard Model. The second meeting concentrated on the commissioning of the Physics Objects, while in a third meeting the theme was the strategy for key new physics signatures.

In parallel, a considerable effort took place to integrate the activities of the Detector Performance groups, the Physics Objects groups, and the Physics Analysis groups around specific signatures. These efforts culminated in "Vertical Integration" Workshops on early measurements of track multiplicity, on physics commissioning of muons, electrons, photons and taus, and on the understanding of jets and missing transverse energy with early data. A final Workshop on Particle Flow reconstruction took place in October 2008.

During the CSA08 exercise, Physics groups participated with four physics analyses (dimuon resonances, dielectron resonances, dijet cross section, measurement of track multiplicity) run in quasi-real time at the CAF with data sent out directly by the Tier-0. Calibrations and corrections were computed with data driven techniques and applied to the analysis workflow.

Considerable effort was also put in 2008 on the development of the Physics Analysis Toolkit (PAT). The goal of the PAT is to bridge the gap between the Analysis Object Data (AOD) format and the physics results. This 'common analysis language,' which will diminish the technical boundaries between physics groups, is materialising: numerous analyses are being ported into this new framework and first experience is positive. Training on the PAT has also started, with six tutorials completed so far.

The physics groups are also the main users of the massive simulation of events produced during the year. In particular, a first test production of 500 M events, with fast simulation, took place in the spring and was used to validate and get acquainted with this new tool. A large recently-completed full-simulation production (200 M), based on the reconstruction software used for the first LHC beams, is the basis of the physics analyses that are currently taking place.

Plans and milestones for 2008

The physics groups are planning the production of a very large sample of events with the fast simulation, based on the latest reconstruction software and on the experience matured with the first LHC beam data and cosmic data. These samples, together with the full simulation sample mentioned above, will be the basis of realistic studies, aimed to prepare the 2009 LHC data-taking.

Conclusions

CMS was ready for first beams in September and was running well during the few days of intermittent beam while reacting quickly to changing beam conditions. Before and since, CMS has recorded hundreds of millions of cosmics, which continue to be analysed in studies of detector performance. The shutdown period will be used for a broad range of activities aimed towards making next year's run as efficient as possible, both for data-taking and for rapid analysis of the data.

CMS Financial Plan
Provisional Balance for the End of Construction

The foreseen deficit for CMS Construction was presented at the RRB23 meeting in October 2006. A request to cover this deficit in 3 steps was also presented; see Table 1 (cf. CERN-RRB-2006-105). With respect to that Financial Plan, we have now reviewed the current status of expenditure, the pending and foreseen payments for the original construction MoU (cf. RRB CMS-D 98/31) and the Cost to Completion (cf. CERN-RRB-2002-010 and CERN-RRB-2005-105).

In this report we have concentrated solely on activities funded via and up to Step 1.

Step 1 Activities

Crystals

The expenditure was in line with the forecasted deficit of 14 MCHF and no additional deficit is foreseen.

Common Fund

The forecasted deficit of the Common Fund amounted to 2.035 MCHF. This is to be compared with the current but provisional anticipated deficit of 2.725 MCHF. The extra 690 kCHF are mostly due to the extended rental contract of the Heavy Lifting crane (560 kCHF).

C&I

The forecasted deficit of Commissioning and Integration amounted to 1.495 MCHF. This is to be compared with the current anticipated deficit of 5.541 MCHF. The additional 4.046 MCHF are mostly due to the extra 11 months of commissioning and integration (3.466 MCHF) before first startup.

In total the three areas above show a deficit of 22.266 MCHF, to be compared with the requested Step 1 funds of 17.53 MCHF. This leaves an additional deficit of 4.736 MCHF to be funded.

As announced in previous RRB meetings, funds from Step 2 and Step 3 will be used to cover shortfalls in Step 1 activities.

Step 2 Activities

No expenses have been carried out.

We propose to cover the additional Step 1 deficit of 4.736 MCHF by funds requested in Step 2 (8.4 MCHF). This would leave 3.664 MCHF for the DAQ slices. It is likely that we shall be able to attain the full DAQ/Filter Farm capability by using these remaining

Step 2 funds and replacement slices funded via the M&O Cat. A funds during the next few years.

Status of Requests for Additional Funding

CMS is very grateful to the many Funding Agencies that have already made commitments to above-mentioned steps. The current situation is outlined in Tables 2 and 3.

The deficits mentioned above, and the strategy that we are proposing to follow requires all of the Funding Agencies to fulfill their obligations, at least for Steps 1 and 2. If this is not done then the deficit will be larger.

In order to balance the income with the expenditure for the low luminosity detector CMS urgently requests all the Funding Agencies that have not yet made commitments with respect to the October 2006 Global Financial Plan to do so, at least for the Steps 1 and 2 and to the restoration of the Phase 1 of the RE system.

Summary

CMS has reviewed the costs of the startup detector and has made a provisional estimation of the accounts. The deficit is somewhat larger than previously anticipated but can be accommodated within the costs of the low luminosity detector with **the crucial assumption that all Funding Agencies pledge funds requested in October 2006 as far as the Steps 1 and 2 are concerned**. With this proviso CMS is not requesting any additional funds with respect to the original request of October 2006.

Table 1: Completing the Design Luminosity CMS detector in three steps (kCHF).

From October 2006 RRB (CERN-RRB-2006-105)

	PhDs	MoU Funding 2002	CTC1 RRB15 Oct02	CTC2 RRB20 Apr05	Constr. Funding 2006	Low Lumi Constr.	DAQ 4 slices PhD	Low Lumi + DAQ	Upscope Rest PhD	Total Design Lumi	
Austria	11	3,900	600	275	4,775	211	45	256	171	427	
Belgium	27	5,000	870	300	6,170	272	111	384	420	803	
Brazil	9				0	0	37	37	140	177	
Bulgaria	5	600	0	0	600	26	21	47	78	125	
CERN	72	85,200	13,500	4,800	103,500	4,569	297	4,865	1,119	5,984	
China	13	4,315	500	300	5,115					*in kind RPC*	
Croatia	7	280	49	20	349	15	29	44	109	153	
Cyprus	3	600	106	43	706	31	12	44	47	90	
Estonia	2	90	16	6	112	5	8	13	31	44	
Finland	12	5,000	870	300	6,170	272	49	322	187	508	
France CEA	14	5,600	1,687	445	7,732	341	58	399	218	617	
France IN2P3	38	19,700	2,000	2,000	23,700		*2,000*	*2,000*	*0*	*2,000*	*Pledged*
Germany BMBF	41	17,000	2,709	1,100	20,809	919	169	1,087	637	1,725	
Germany DESY	5				0	0	*2,000*	*2,000*	*0*	*2,000*	*New Collab.*
Greece	17	5,000		0	5,000	221	70	291	264	555	
Hungary	6	1,000	58	0	1,058	47	25	71	93	165	
India	26	4,400	300	500	5,200					*in kind RPC*	
Iran	3	510	700	0	1,210					*in kind RPC*	
Ireland	1				0	0	4	4	16	20	
Italy	181	55,000	8,927	4,000	67,927	2,998	746	3,744	2,813	6,557	
Korea	14	1,315	500	147	1,962					*in kind RPC*	
Mexico	5				0	0	21	21	78	98	
New Zealand	3				0	0	12	12	47	59	
Pakistan	3	2,445	230	149	2,824					*in kind RPC*	
Poland	12	3,000		0	3,000	132	49	182	187	368	
Portugal	5	2,000	300	140	2,440	108	21	128	78	206	
RDMS	72	18,862	2,211	1,657	22,730	1,003	297	1,300	1,119	2,419	
Serbia	3		450	0	450	20	12	32	47	79	
Spain	34	6,000	1,350	450	7,800	344	140	484	528	1,013	
Switzerland	30	86,500		200	86,700	0	124	124	466	590	
Taipei	11	2,330	410	0	2,740	121	45	166	171	337	
Turkey	18	1,000	58	0	1,058	47	74	121	280	401	
UK	49	9,100	918	3,000	13,018	575	202	777	762	1,538	
USA	418	104,320	12,800	1,868	118,988	5,252	1,722	6,974	6,497	13,471	
Sum	**1170**	**450,067**	**52,119**	**21,700**	**523,843**	**17,530**	**8,400**	**25,930**	**16,600**	**42,530**	
Requested			**63,000**	**32,000**							

Table 2: Status of Pledged or Paid Additional Funding (kCHF)

	Step 1	Step 2	Step 3	Comment
Austria	**211**	**45**	**171**	
Belgium-FNRS	136	56	**311**	
Belgium-FWO	136	56	**109**	
Brazil	n.a.	**37**		
Bulgaria				Awaiting response
CERN	4,569	297	1,119	
China	Endcap RPC	Endcap RPC	Endcap RPC	
Croatia	15	**29**	**109**	
Cyprus	**31**	**12**	**47**	
Estonia	5	8	31	
Finland	272	49		Funding in 2010 and 2011
France-CEA	341	58	218	
France-IN2P3	n.a.	2,000	n.a.	
Germany BMBF	919	169	637	
Germany DESY	n.a.	2,000	n.a.	
Greece				News in Nov RRB
Hungary				Discussing
India	Endcap RPC	Endcap RPC	Endcap RPC	Request Submitted, News in Nov RRB
Iran	Endcap RPC	Endcap RPC	Endcap RPC	Discussing
Ireland	n.a.	4	16	
Italy	2,500			Step 1 likely to be partially covered
Korea	Endcap RPC	Endcap RPC	Endcap RPC	
Mexico	n.a.			Awaiting Response
New Zealand	n.a.	12		Discussing Step 3
Pakistan	Endcap RPC	Endcap RPC	Endcap RPC	
Poland	132	49		
Portugal	108	21		
RDMS-DMS				Discussing
RDMS-Russia				Discussing
Serbia	20	**12**		
Spain	344	140		
Switzerland	n.a.	124	466	
Taipei	121	45		
Turkey	47	74		
U.K.	575	202	762	
USA-DoE/NSF	5,252	1,722		
Sum	**15,734**	**7,221**	**3,996**	
Requested	**17,530**	**8,400**	**16,600**	
% covered	**90%**	**86%**	**24%**	

Bold: Input since April 2008 RRB

Table 3: The state of funding of the restoration of the forward RPC system.

FUNDING **Countries**	**Contributions** **kCHF**	**Comments**
Belgium	420	Likely to use its Step 3 funds for RPC system
China	**500**	
India	800	Request made. News in Nov.
Iran		Discussing. Request made in Oct. 2006 RRB was for 800 kCHF
Korea	405	
Pakistan	1250	