Status of CMS
Progress Summary Report for October 2005 RRB21

In the current CMS Master Schedule, v34.2, the initial detector will be installed and closed for beam on 30 June 2007 and will be ready for first collisions in late summer of 2007. Installation of the pixel tracker, (ready in summer 2007), and the ECAL endcaps is now foreseen during the 2007/2008 winter shutdown, in time for the first physics run in spring 2008. The staged items include the fourth endcap muon station ME4/2, RPC chambers at low angles ($|\eta|>1.6$), 60% DAQ online farm and third forward pixel disks.

Civil Engineering

Status
Civil Engineering (CE) works at Point 5 (located at Cessy, France) are finished. Installation of the counting room and service infrastructure in cavern USC55 is advancing well. Racks are in position, the electrical distribution is nearly finished and the cooling system is in progress. The counting room is expected to be ready for sub-detector readout crate installation by the end of 2005. The infrastructure of the PM54 shaft has also been installed. The underground cavern UXC55 (for the experiment proper) was handed-over to CERN in February 2005 and the installation of infrastructure is progressing well. The mechanical jacks for the HF calorimeters have been recessed into the floor, the metallic structures for racks and walkways have been installed, the crane is operational, and the ventilation ducts are being positioned. Water leaks in the experiment cavern shaft PX56 have been successfully repaired. The experiment cavern will thus be ready to receive detector elements in the late spring of 2006. The last surface building, SDX5, has also been delivered, the crane and lift are operational and installation of pipes and services in the PM54 shaft is progressing. The surface control room, SCX, was handed over to CERN in the second quarter of 2005, and installation of the infrastructure is progressing. Piping for cooling the computer farm has been completed and the false floor has been installed.

The 2000-ton shielding plug, which will also be used as a lifting platform for the transfer of the experiment underground, is now regularly used. The contract for the heavy operation is underway and the large gantry will be installed over the surface building before the end of the year.

Changes
Civil engineering is complete. Installation of infrastructure is in progress in all buildings.

Plans for 2005/2006
Continue installation of infrastructure in all buildings and caverns. The UXC cavern is expected be ready in time for lowering of CMS.

Concerns
None.

Installation and Infrastructure

Status
Gas and cooling pipes for CSCs and for DTs/RPCs have been installed on the six yoke disks and on the five barrel wheels. Contracts for the cooling plants (water and fluorocarbon) are in progress and installation of the active elements will start soon in the

underground service cavern. Definition of the rack system and electrical distribution has been completed after some modifications to the LV distribution system. The 400Hz generators have been replaced by a UPS system to be installed on the surface. This has allowed the finalization of the cabling plan.

After a slow start, the cabling of the two YE±1 disks has been completed, allowing calibration of HE±1 on the surface in phase with coil activities. Cabling of the wheel YB+2 has started in September and two wheels should be fully cabled before the end of the year in phase with the magnet test schedule. The HF cable chains are ready to be ordered and the tender for the main yoke disk and yoke wheel chains will be carried out in time for these chains to be installed and pre-cabled in the underground area.

The HF support tables and forward cylindrical shielding, manufactured in Iran, have been fully assembled around the two HF calorimeters at CERN. The manufacture of the second rotating shielding has been completed and tested at Protvino, then delivered to CERN. Installation of these structures in the underground area will start as soon as the metallic floor plates are completed.

Changes
The electrical distribution system for racks has been finalized after changes to the LV distribution system. The 400 Hz distribution system has been replaced by a UPS system to be positioned on the surface.

Plans for 2005/2006
Complete installation of shielding and cable chains. Complete pre-cabling from USC racks to cable chain patch panels.

Concerns
Bulk cabling on YB+2 and YB+1 on the surface before the magnet test on the surface.

Magnet

Status
The magnet yoke has been assembled at Point 5 for some time. All five coil-modules have been delivered to CERN and assembled and connected in the vertical position before being covered by the external thermal screen. The coil has been swiveled to the horizontal position on 25 August and inserted into the outer vacuum tank on 17 September. After having reached the nominal cooling power the cold box has been disconnected from the test cryostat to allow insertion of the coil. Cabling of the magnet to the temporary control room on the surface is completed in preparation for the magnet test.

Changes
Final assembly of the solenoid is now in full swing.

Plans and milestones for 2006
The coil schedule foresees the pumping of the cryostat at the end of 2005 and the start of cool-down at the beginning of 2006.

Concerns
The critical path goes through coil test on the surface, and thus through the final assembly and commissioning steps.

Tracker

Status
Three main phases can be identified in the construction of the Tracker: module production, assembly of modules into TOB-rods, TIB-shells, and TEC-petals and the integration of TOB rods, complete TIB and complete TEC structures into the Tracker Support Tube.

The contract for the thick sensors was concentrated at HPK. Around 15500 thick HPK sensors, out of 17400 are now in hand. The last delivery is expected in October. The hybrids delivery rate is following the plan and the quality of delivered hybrids is good. All the hybrids (including spares) for TIB, 92% of the TOB and 70% of the TEC are now in hand. Both sensor and hybrid production are now off the critical path. Module production is now progressing well. By mid-September 81% of TIB, 48% of TOB and 43% of TEC modules had been produced. Again the quality is good.

The assembly of modules on TOB-rods, TEC-petals and TIB-shells is now proceeding. Layer 3+ and 4+ of TIB-shells are complete. This corresponds to 44% of one half of TIB. The assembly of modules in TID+ has also started. The overall quality is excellent. About 40 pre-production TOB-rods have been produced (out of ~ 700), and the mass production will start in mid-October after fixing an interconnect electronics problem. About 40 (of 288) TEC-petals have been produced, and a set of 18 petals have been read out into the DAQ system and commissioned. Again the quality is found to be excellent.

Progress in integrating the mechanical structures is also very good. Thermal screens have been inserted into the Tracker Support tube and commissioned. Trial insertions of both TOB and TIB mechanical structures into the support-tube have been successfully carried out over the summer. The bare TEC- mechanical structure will be trial-inserted into the support tube in early October.

The construction of the Tracker Integration Facility (TIF) has started in Building 186 and beneficial occupancy is foreseen for the end of October 2005. Services will then be installed and the integration of the tracker will be started. The aim is to test the whole Tracker (~ 25% at a time) in Building 186. This would guarantee a working and thoroughly debugged tracker, including system aspects, to be delivered to Point 5.

The procurement of the power supplies has started in the second quarter of 2005. The order for the Front End Driver (FED) has been placed and first deliveries are expected in October 2005.

Pixels: The final version of the deep-sub-micron (DSM) readout chip (ROC) has been tested and the order is about to be placed. The Token Bit Manager chip has been ordered. A first set of barrel and endcap sensors have been ordered. The order has been placed for the pre-production of the modules for barrel and endcap. An Engineering Design Review took place in June. The barrel (endcap) module mass-production has been authorized and is expected to start in the last (first) quarter of 2005 (2006).

Changes
The sensor and hybrid production are off the critical path. The assembly of rods, petals and shells is now proceeding. The construction of the TIF has been launched.

Plans and milestones for 2005/2006
The global tracker integration partitions into three parts:

Up to Oct 05	Prepare Integration Facility
Oct 05 to Jun 06	Integration of the Tracker

Jun 06 to Oct 06	Commissioning Tracker in Bat 186
Nov 2006	Delivery of the Tracker to SX5

Concerns
The schedule for the completion of the tracker is very tight.

Electromagnetic Calorimeter

Status

By the end of September, about 42000 out of 62000 of the barrel crystals had been delivered and are being used to construct modules (comprising 400 or 500 crystals) in CERN and Rome. Eighty-eight modules, out of 144, have been assembled. Twenty-two bare supermodules (SM, each comprising 1700 crystals) have been assembled.

The current BCTP contracts have been completed at the end of August 2005. New contracts with two vendors (JSC Russelectronics, subcontracting to BCTP, and Shanghai Institute of Ceramics) for the remaining 21000 barrel crystals and for 7500 endcap crystals have been placed at the end of June 2005. The last 7000 endcap crystals will be contributed by the Russian Federation.

The production runs of all ECAL ASICs in Deep Submicron (DSM) technology have been completed. The delivery of the various electronics boards for the Barrel calorimeter is well advanced: 75% of the ~13000 very front-end and all the ~2600 front-end boards have been produced and are being tested and calibrated. The production of all the 140000 APDs has been complete for some time and 12000 of the 15000 VPTs have been produced.

The serial integration of electronics into bare SMs started in the spring and three SMs were equipped. It was shown that the integration could proceed at the required rate and yield SMs with essentially zero faults and excellent analogue performance. Unfortunately, some non-conformity was detected on the welds of the electronics cooling circuitry, forcing suspension of the serial integration, which should now restart in October.

The construction of the Endcap mechanics is progressing according to schedule. Electronics tests, using the endcap version of the very front-end electronics attached to a supercrystal comprising 25 channels, have shown that the expected performance has been attained.

Preshower: The wafer production of the Preshower ASICs has been completed. Twenty percent of these ASICS have already been packaged and tested. The tendering procedure for the hybrids has been conducted by Greece; pre-series hybrids have been received and the final order is being prepared. The first pre-series motherboards manufactured in Taipei have also been received.

Changes
Contracts for the remaining crystals have been signed with two vendors and the corresponding delivery has started.

Plans and Milestones for 2005/2006
Restart and continue integration of electronics into the SMs, integrate all EB+ modules by May 2006.

Concerns
Crystal production is on the critical path. The schedule for the completion of the ECAL is very tight.

Hadron Calorimeter

Status
Modules of all geographic parts of HCAL [HB (barrel), HE (endcap), HO (outer) and HF (forward)] absorber and optics are completed. Both HF detectors have been assembled in B186, ready for calibration.

HCAL was tested extensively in beam in 2004 using final electronics. Data were also taken with low energy pions and electrons from 3 to 9 GeV. The results will be used to tune the GEANT4-based simulation. All HCAL devices now have established a calibration relating radioactive source measurements to beam tests with pions and muons. These calibration data will allow HCAL to establish an initial calibration prior to first collisions.

The front-end electronics has been produced and tested for linearity and other quality factors. The "burned-in" electronics have been delivered to CERN for installation. As of late September 2005, a team of physicists, engineers and technicians from CERN, US and RDMS is in the process of installing and commissioning of electronics on HE endcaps and HB half-barrels. All services (power, water, gas) have been installed. Comprehensive calibration of HCAL has begun using Co-60 sources.

Changes
None.

Plans and milestones for 2005/2006
Complete source calibration of HCAL before the magnet test. Prepare HF for lowering into UX5 in the second quarter of 2006.

Concerns
None.

Muon Detector

Status
Endcap Cathode Strip Chambers: All of the chambers (a total of 496 including 6% spares) have been assembled and tested in sites in China (IHEP-Beijing), Russia (JINR-Dubna, PNPI-St Petersburg) and US (FNAL, UC and UF). All of the chambers are at CERN and after final tests about 300 (64%) have been installed on the magnet yoke disks; approximately 60% of the chambers have been fully commissioned after installation. Recently all 72 ME1/1 chambers manufactured in Dubna, Russia, have been installed and tested. Installation of ME1/2 chambers is now starting.

Barrel Drift Tubes: The four assembly sites have already assembled 220 chambers (88% of the expected number) and more than 190 are already at CERN. The three sites at CIEMAT, Aachen and Legnaro are continuing to produce chambers of type MB1, MB2 and MB3 at the required rate of 18 chambers/year/site. The assembly in these three sites is expected to finish by the end of 2005. The fourth assembly site, Torino, has already assembled 21 MB4 chambers (52% of the total needed) and is continuing at the expected rate of 3 chambers/month. The MB4 assembly is expected to finish in April 2006. The 'dressing' of chambers in the CERN-ISR is proceeding well. Manufacture of new-design high voltage distribution boards is completed. Replacement of the old boards in the chambers will be completed by the end of October. Installation of chambers in the yoke is progressing well. The surface installation in yoke wheels YB+2 and YB+1 (84 chambers) is completed apart from 2 chambers in each wheel that must be installed during the cabling operation. The installation in YB0 has been postponed until the welding on the cryostat is

completed. The commissioning of YB+2 is finished and the cabling operation has just started.

Assembly and test of minicrates in Bologna, CIEMAT and Legnaro is also progressing very well, more than 100 have been assembled, tested and delivered to CERN. Although the production of minicrates is still a critical item, it is not now expected to affect the installation.

Barrel RPCs (RB): The gap and chamber production is proceeding well. Over 400 chambers (~80%) have been assembled, ~280 are at CERN and 156 have been installed. Chamber production is expected to be completed by March 2006.

The barrel muon community is striving to use the delay in the magnet test for the preparation of additional chambers for installation in YB0. Depending of the access window to YB0 they plan to install from 50% to 80% of the entire wheel before the magnet yoke is closed for testing.

Endcap RPCs (RE): Mass production of gaps is proceeding according to schedule at the factory installed in Korea. Gaps for chambers in RE1 and RE2 stations have been delivered to CERN and Pakistan respectively. Priority has been given to RE1 chambers and 145 out 160 chambers have been produced. The installation of RE1 chambers should be completed by the end of this year. Forty-five out of 144 RE2 chambers have been assembled, although completion in time for surface installation is critical.

Alignment: The hardware for the magnet test is in production. There is good progress in defining and procuring cables. All MABs (carbon fibre position reference structures) are at CERN. Installation and cabling of components has started in YE+. Calibration of MABs is progressing well at the ISR.

Changes

Plans and milestones for 2005/2006
Barrel Drift Tubes and RPC's: Finish RPC assembly and DT chamber assembly in Aachen, Madrid and INFN_Padova. Install 130 DT+RPC packages in YB yokes before the magnet test. Sector commissioning in YB+2.
Endcap CSCs: finish installation and commissioning of all CSC chambers before disks are lowered into UX.
Endcap RPCs: Continue production and proceed with installation of RE1 chambers.
Alignment: Prepare for the magnet test.

Concerns
CSCs: None.
DTs: Assembly, installation and commissioning in multiple sites at CERN.
RPCs: RE2 integration and installation, procurement of cables, LV and HV systems.

Trigger and Data Acquisition

Status
Trigger: The trigger system is mostly in production and testing. Some trigger production has already finished. There is much work underway on software and firmware. Integration tests of detector primitive generators, trigger system and DAQ are underway. Components of the trigger system are being thoroughly exercised and integrated with other trigger and detector electronics systems in the Electronics Integration Centre (Building 904 on the Prevessin site) in preparation for installation in USC55. Some components of the final system will be used in data taking during the magnet test at SX5 in early 2006.

DAQ: The production of the Data to Surface (D2S) custom components (570 Front-End Readout Links (FRL), 720 Slink-64 boards (CMC), 50 FRL trigger controllers, 50 Fast Monitor Module (FMM) and 50 Compact PCI crates) have been completed and the electrical and functional tests have been passed. The final system tests (full crate load and transmission error measurements) will start in October in Building 904. The D2S FED builder system (1024 Myrinet 2XP link boards, 10 Myrinet Crates and switches) has been delivered and part of the modules have been installed in the pre-series system at Point 5. The market surveys and the tenders submission for the procurement of the rest of the D2S equipment (100 FRL-FMM-DCS PCs, USC and SCX water cooled PC racks, 200m Optical cables for USC-SCX data readout) are on the way. All D2S components (except PC and fibers) will be available in December 2005 ready for the installation and the start of the readout commissioning in USC. Meanwhile the software development is continuing with the last releases of XDAQ 3.2, a new monitoring system, the Event Builder and the Run control systems. A 16x16 readout builder with 16 FRL-FED columns is permanently running in Point 5 and used to test the integration of the central DAQ with the detector systems participating in the Magnet Test.

Changes
One more DAQ slice has been staged. Three out 8 slices will now be deployed at startup.

Concerns
The time available for installation and commissioning in the underground area is short.

CPT

Computing and Core Software, Physics Reconstruction and Selection, Tridas

Status
The CPT project underwent a restructuring which was initiated in January 2005 and was completed by June 2005. In brief, the old CCS (Computing and Core Software) and PRS (Physics Reconstruction and Selection) projects were merged and instead a single unified project, still called "CPT", was put in place. The scope of the new project is the union of the original two projects. Internally, CPT is further divided into four areas: Computing, Software, Detector-PRS and Analysis-PRS. The leaders of these four areas, the members of the "project office" and the project manager constitute the Management Board (CPT-MB) of the project. The CPT-MB is the ultimate steering body of the project.

Within the computing area, the emphasis was placed on the preparation of the Computing TDR, which was submitted in June 2005. The computing area was also reorganized, as described in the Computing TDR. A major addition with respect to the past is the "Integration Task" which is charged with providing coherence across new developments and the currently deployed systems.

The computing sub-project also provides production and analysis services to enable the work of the physics groups for the Physics TDR. In addition to the continued use of the Grid for Monte-Carlo production, a large fraction of the analyses are being performed using resources on EGEE/LCG and OSG. Thousands of analysis jobs are being submitted by physics users across the Grids every day, using a software stack of Grid middleware and CMS experiment-specific services. At this moment, user analysis is still concentrated at most of the Tier-1 centres that host large CMS datasets. The Computing sub-project is participating very actively in the ongoing LCG Service Challenge 3 as part of its Computing Integration activities. Through these efforts some 10 Tier-2 centres will become available to host CMS data sets and to run analysis on the time scale of months.

On the software side, the new organization has resulted in the merging of the "core" and "physics" software within the same sub-project – the "software" sub-project. Beyond this, another change of the past year has been the decision to launch a new software framework. The decision was based on (a) the need to introduce interactive analysis functionality directly into the CMS software framework (b) the need to implement improvements that were identified through the experience gained over the past four years of deployment. This new effort was launched in January 2005, and has since made significant progress. A first release of the new framework was made in September 2005. The highest priority has been to enable the readout of the CMS detectors for the upcoming magnet test/cosmic challenge in early 2006. The second highest priority is the local reconstruction within detector elements – and this is where the current effort is concentrated.

In parallel, and in association with the development of the new framework, a new task on detector calibration and alignment has been launched within the software sub-project. There is currently intense development in this area and very good progress has been made in the basic software infrastructure including database services. The goal is to meet all the requirements of operating with the real detector configuration of the upcoming cosmic challenge.

As part of the consolidation of the software activities, the High-Level Trigger activity has been enlarged to include the Data Quality Monitoring task and the combination is now part of the software sub-project. The focus in this area has been on the integration of the farm with the DAQ system. A prototype sub-farm has been put in place and is currently under tests. A first version of the control and monitor system has been released. The software framework for the filter nodes is now essentially complete, and attention is turning to the operation of the Filter sub-farm at Point 5 in anticipation of the magnet test/cosmic challenge.

Meanwhile, the existing simulation and reconstruction codes have continued to be developed and are now nearly complete and are being used extensively in the work for the Physics Technical Design Report. The plan is to re-use the overwhelming majority of this "higher-level" code in the framework. The porting of large segments of software has commenced and is now well in progress.

On the PRS side, the priority has been on the completion of the detector reconstruction and performance studies. Another major activity has been the initiation of calibration and alignment procedures that will be utilized at the LHC startup. The DST that was created in the context of DC04 is now used extensively in numerous analyses. A total of almost 100 million events have been reconstructed and are fully utilized for all the studies of the Physics TDR (Volume I). The Physics TDR will document the full procedures and code that will be used to commission and operate the CMS detector. Broadly speaking, the basic aim of the Physics TDR is to document the way in which CMS will carry out its physics program.

A second volume of the Physics TDR is planned for completion in late Spring 2006. This work will document the actual startup of the experiment in 2007, along with the very early physics reach with 0.1 fb^{-1} and $1fb^{-1}$. The last part of Volume II will document the physics reach with ~10 and 30 fb^{-1}.

Changes

A re-organisation of CPT has been carried to streamline the structures in preparation for acquisition, monitoring, distribution and analysis of data from the first physics run.

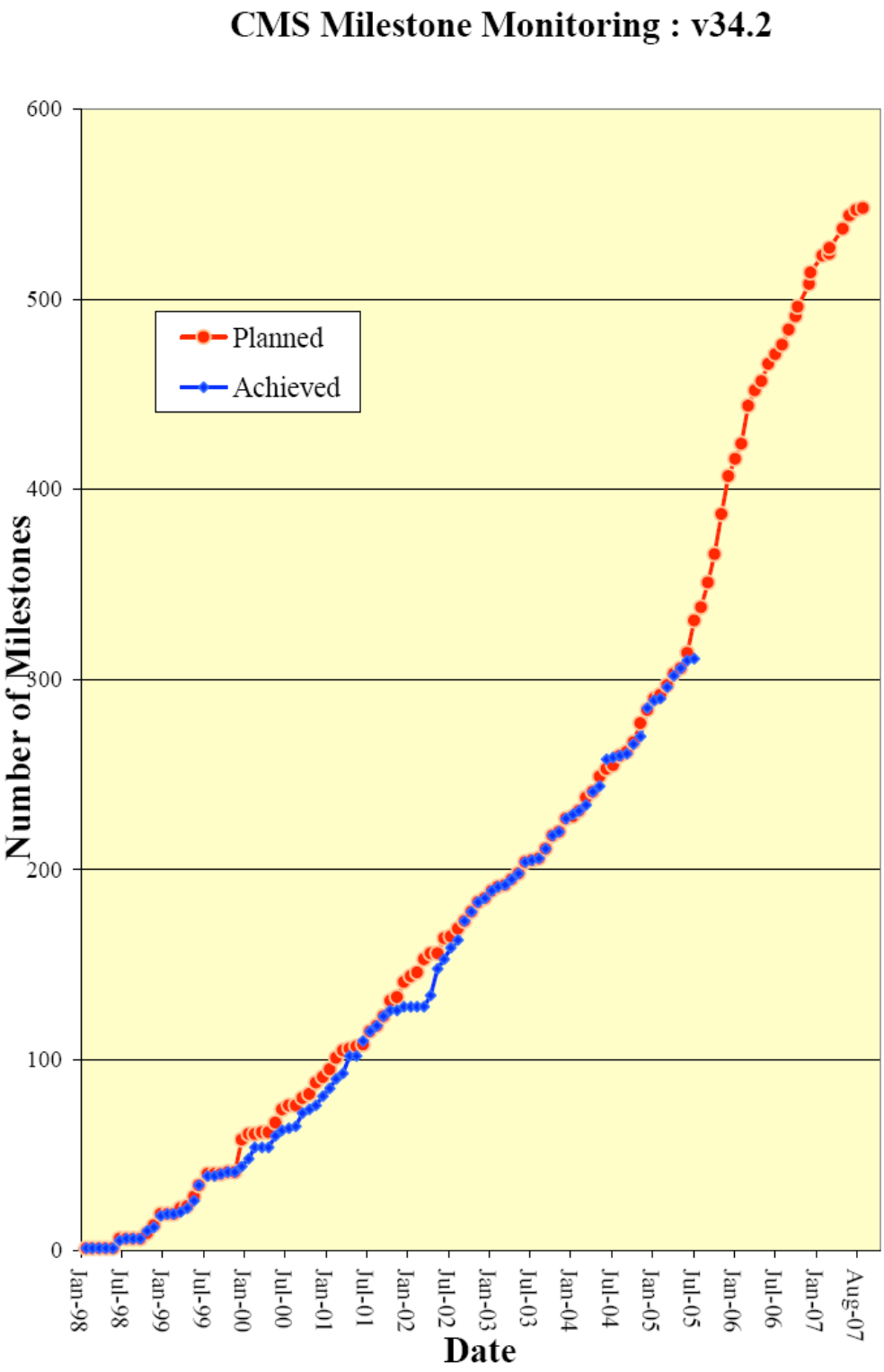
Plans and milestones for 2006
A Physics TDR will be written for the end of 2005/beginning of 2006. A combined Computing Software and Analysis Challenge (CSA2006) is currently scheduled to start in mid 2006. This will be an integrated test of the full end-to-end chain of the complete system, from (simulated) raw data to analysis at Tier-1 and Tier-2 centers.

Concerns
Schedule for the Computing and Physics TDRs as well as CSA2006 is tight.

Overall Milestone Completion

In Figure 1, the intended and achieved integrated numbers of milestones completed are compared, month-by-month, with the re-baselined CMS schedule labeled v34.2. The assembly planning allows an initial detector to be closed on 30 June 2007. A six-week delay is currently forecast, with overall contingency at the level of 2 months. Ways of recovering the six-week delay, after the lowering operation, are being investigated.

Fig. 1


CMS Milestone Monitoring : v34.2
Planned
Achieved
Number of Milestones
0
100
200
300
400
500
600
Jan-98
Jul-98
Jan-99
Jul-99
Jan-00
Jul-00
Jan-01
Jul-01
Jan-02
Jul-02
Jan-03
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Jan-04
Jul-04
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Jul-05
Jan-06
Jul-06
Jan-07
Aug-07
Date

CMS Financial Plan

Unforeseen cost increases principally in the cost of crystals (~22 MCHF) and in the silicon tracker (~5 MCHF) have led to a substantial cost increase of the CMS detector. A financial plan was presented to the April Resources Review Board (RRB20), requesting extra resources at the level of ~ 32 MCHF. The proposed sharing was also presented and is detailed in Table 1. Encouraging comments were made by representatives of several Funding Agencies. The next step foreseen was to send letters to the Funding Agencies requesting commitments, with payment profiles, by the October 2005 RRB. The letters have been sent, the responses are still coming and the situation will be presented at the RRB meeting in October.

After having submitted the Financial Plan it was realized that the chances of delivery of a quality assured and debugged Tracker to Point 5 in November 2006 would be considerably improved if a large integration facility, capable of testing 25% of the tracker at a time (and hence the entire tracker in four operations), could be set up rapidly. The resources required were not in the Financial Plan submitted to the April RRB. In consultation with the RRB Chair the CMS Collaboration decided to stage one out of the four non-staged DAQ slices to liberate the necessary funds.

Table 1: Overall Request and Proposed Sharing (kCHF)

	(1) MoU Tot. Ctr.	(2) CTC	(3) CTC Update/ Pending	(4) MoU + CTC	(5) Guidelines Cost Increase	(10) Tot. Ctr.
Austria	3,900	600		4,500	275	4,775
Belgium-FNRS	2,500	435		2,935	150	3,085
Belgium-FWO	2,500	40	395	2,935	150	3,085
Bulgaria	600			600	27	627
CERN	85,200	13,500		98,700	4,800	103,500
China	4,315	500		4,815	300	5,115
Croatia	280	49		329	20	349
Cyprus	600	106		706	43	749
Estonia	90	16		106	6	112
Finland	5,000	870		5,870	300	6,170
France-CEA	5,600	1,687		7,287	445	7,732
France-IN2P3	19,700	2,000		21,700	2,000	23,700
Germany	17,000	2,709		19,709	1,100	20,809
Greece	5,000			5,000	305	5,305
Hungary	1,000	58		1,058	65	1,123
India	4,400	100	200	4,700	500	5,200
Iran	510	700		1,210	74	1,284
Italy	55,000	8,927		63,927	5,000	68,927
Korea	1,315	500		1,815	189	2,004
Pakistan	2,445		230	2,675	149	2,824
Poland	3,000			3,000	183	3,183
Portugal	2,000	300		2,300	140	2,440
RDMS-Russia	12,047	2,211		14,258	7,800	22,058
RDMS-DMS	6,815			6,815	0	6,815
Serbia		400	50	450	24	474
Spain	6,000	1,350		7,350	450	7,800
Switzerland-ETHZ	75,500			75,500	0	75,500
Switzerland-PSI	8,500			8,500	500	9,000
Switzerland-Universities	2,500			2,500	200	2,700
Taipei	2,330	410		2,740	167	2,907
Turkey	1,000	58		1,058	65	1,123
United Kingdom	9,100	918		10,018	2,300	12,318
USA-DOE USA-NSF	104,320	12,800		117,120	4,750	121,870
Sum	450,067	51,244	875	502,186	32,478	534,664

Conclusions

CMS assembly planning v34.2 allows an initial detector to be closed on 30 June 2007.

The initial detector will be without the previously staged items and the ECAL endcaps. The ECAL endcaps will be installed during the winter shutdown of 2007/2008 and be ready for the first physics run in 2008. The schedules for the completion of the Tracker and ECAL are tight.

Encouraging responses from many Funding Agencies have been received for covering the deficit caused by increased costs primarily in the ECAL and the Tracker sub-systems. It is still hoped that the full deficit could be covered by 2010.