Status of CMS

Progress Summary Report for October 2001 RRB

The master assembly sequence currently being followed (v31) is based on completion of CMS (except for the pixel system and now the two ECAL endcaps) in time for first collisions in April 2006. The installation will be completed during a 3-month shut-down in 2006 prior to a long physics run starting in August 2006. A new set of milestones (v31) has been given to the LHCC and is enclosed.

Civil Engineering and Assembly

Status
The surface SGX (gas) and SUX (cooling and ventilation) buildings have been handed over to CMS. The concreting for the pillar wall, separating the underground experimental hall (UXC55) and the underground service cavern (USC55), was recently finished. The pillar was completed about 3 months later than foreseen, mainly due to poor geological conditions. The v31 construction schedule up to the magnet test is not affected.

Changes
None

Plans and milestones for 2001/2002
The excavation of the underground caverns has started and will continue through 2002. We are exploring ways of mitigating the effects of further civil engineering delays. These involve moving more of the underground operations onto the surface that will require additional resources.

Concerns
The critical path goes through timely delivery of the equipped underground cavern UXC55 and USC55.

Magnet

Status

All the five barrel yoke rings and the three disks of the 1st endcap yoke have been assembled at Point 5. The coil-swiveling platform has been manufactured and trial assembled in Korea. One good length (2'650m) of the conductor (sc strands, pure Al insert and Al alloy reinforcement) has been produced at Techmeta. Eight (out of twenty) lengths of the insert (Rutherford cable co-extruded with pure aluminium) have been produced at Cortaillod (Switzerland). The Rutherford cable is being produced at Brugg Kabelwerk (Switzerland). The winding machine has been tested at Ansaldo (Italy). The end of the test of the magnet in the surface building is scheduled for July 2004. The magnet project is on schedule. However two out of 11 Rutherford cables were lost due to a failure in the cabling machine.

Changes

For the first time since the start of the project the cost of the magnet has been increased (see CMS RRB-D 2001-112).

Plans and milestones for 2001/2002
The assembly of all the endcap yoke disks will be completed at Point 5 by April 2002.
The first coil module should be finished in Q1-02.

Concerns
Further accidental loss of cables.

Tracker

Status
Two vendors for silicon sensors have been selected and orders are being placed. Both vendors have provided sensors for a milestone consisting of 200 modules with equipped front-end hybrids. Some delay has been incurred in finalizing these hybrids and in getting them produced industrially. Commercial actions for opto-electronics are well advanced and the orders will be placed within the next 3 months. A test of 3 modules with hybrids of the final design has yielded excellent results. Much progress has been made in setting-up module production and testing centres. Good progress has been made on pixel electronics and sensors.

Changes
None.

Plans and milestones for 2001/02
Major orders will be placed (mechanics, optical links) by the end of 2001. Industrially produced hybrids are expected in Mar-02. Launch of mass assembly of modules is foreseen for Q2-02.

Concerns
Timely launch of Si-module production and ramp-up time for production.
Shortfall in funding.

Electromagnetic Calorimeter

Status
Nine thousand barrel crystals have now been produced at BCTP, Russia. All the barrel crystals are now under contract with BCTP. However the infrastructure costs to ensure timely production have turned out to be higher than previously estimated. Offers are in hand for the endcap crystals. The problem of a small fraction of APDs dying after irradiation has been resolved and about 15,000 of the 130,000 APDs have been delivered. The pre-production of 500 VPTs has been successful. The CERN and Rome regional centers are ready for the mass assembly of modules and supermodules.

The final version of the front-end chip (FPPA) displays a factor 4 higher noise than anticipated. The problem has been identified and the chip will be resubmitted soon. In addition to the previously signaled delays the additional delay caused by this

problem has forced reconsideration of the construction sequence and schedule. The cost of the optical link has turned out to be higher than anticipated. Steps are being taken to contain the increase by employing a smaller number of faster optical links.

Pre-shower: An EDR and a PPR (sensors) were passed for the pre-shower project. The performance of the DMILL front-end chips is good. However a backup in 0.25 μm technology is being considered because of concerns of yield of good DMILL chips.

Changes
Construction of most of the endcap Dees will be postponed until after the barrel supermodules are complete. It is unlikely that all the barrel or endcap modules can be pre-calibrated in test beam.
The loss of critical electronics manpower has forced a reorganisation of the electronics team, with new manpower to be injected.
The ECAL cost has been re-evaluated and shows a significant increase due to additional infrastructure for crystal production, the electronics chain and some mechanical components.

Plans and Milestones for 2001/02
EB EDR at end-01 to authorize supermodule mechanics assembly
EE EDR in mid-2002.
Assemble a few SMs without the front-end electronics during 2002.
Beam test of module M0′ (~ 400 crystals).
Seek to reduce the cost of the electronics chain by employing faster optical links.

Concerns
Delays in procurement of the electronics and the cost of the electronics chain.
Assurance of funding: several orders are pending.
Crystals are priced in dollars/cm^3. The currently prevailing US$/Swiss Franc ratio, which is higher than foreseen in Cost Book 9, increases the overall project cost in Swiss Francs.

Hadron Calorimeter

Status
All the barrel (HB) absorber has been delivered to CERN. All the HB optics (scintillator and fibres) for the barrel will be completed by the end of 2001. The HB-1 half-barrel is being assembled at Point 5. The HE-1 (Hadronic Endcap on –x side) absorber has been delivered at CERN, and the optics manufacture is well advanced. An EDR was passed for the absorber of the HF (forward calorimeter). Mass manufacture of the HF wedges has commenced. The PRR for HF quartz fibres and photomultipliers was passed and the orders will be placed soon. One third of the HO scintillator tiles have been machined and the pigtail manufacture has started.

The optical cross-talk problem in HPDs is close to being resolved and the order will be placed soon. QIE chips from the first submission have been received recently and work relatively well. The QIE is now off the critical path

Changes

The longitudinal sampling of the HCAL has been reduced. The physics impact is small. The cost saving covers the missing funds in HF.

Plans and major milestones for 2001/2002
Both the half-barrels of the HB will have been assembled by Q4-02. Schedule permitting, several modules of the 2nd half-barrel will be calibrated in test beam in 2002.
HE-1 (HE+1) absorber and optics will have been delivered by the end of 2001 (2002) respectively.
Final submission of the QIE chip.

Concerns
None

Muon Detector

Status
Endcap CSCs: 46 out of 148 CSC chambers have been manufactured at Fermilab (US). The sites at IHEP, Beijing and PNPI, St Petersburg have assembled and tested 2 pre-production chambers and the production will start in Nov. 2001. For the ME1/1 chambers, 470 out of 525 panels have been milled and the assembly of chambers will start soon. The production of anode and cathode front-end electronics boards has started.

Barrel Drift Tubes: The sites at CIEMAT, Aachen and Legnaro have assembled 12, 9 and 6 superlayers respectively. One MB2 chamber, built in CIEMAT, is at CERN. I-beam electrode manufacture at nominal speed has been demonstrated in IHEP, Protvino. The procurement of electronics sitting inside the gas volume is on schedule.

RPCs: One pre-production barrel RPC and one forward RPC have been delivered to CERN.

Alignment: Good results have been obtained for LINK and endcap.

Changes
The Torino site was approved by the INFN for manufacture of DTs. The plates electrode production has been transferred from Torino, Italy to Dubna, Russia.
The internal surfaces of the barrel RPCs will be coated with linseed oil.

Plans and milestones for 2001/2002
Barrel Drift Tubes: Reach nominal speed of electrode production and DT assembly in Q1-2002.
RPCs: Start production of barrel RPCs in Q1-2002. Decide by Jun-2002 whether or not to coat forward RPC bakelite with oil.
Alignment: MAB prototype should be ready for Dec-2001.

Concerns
CSCs: Funds for electronics and skew-clear cables for ME1/1.
DTs: rate of chamber production, parts flow and TRACO chip.
RPCs: Startup of chamber production. Funding of services.

Trigger and Data Acquisition

Status
Trigger: Final full-function prototypes of many elements are being constructed and tested. An enhanced PACT chip for the RPC trigger will be produced in 0.25-micron CMOS. Many new physics performance studies have further validated the design of the trigger system.
DAQ: Results from prototypes and demonstrators (32x32 event builder using Myrinet 2000 or GigaEthernet switches) have confirmed the feasibility of the proposed DAQ design. The design has been made more modular allowing easier upgrading as technology evolves.

Changes
There are no significant changes.

Plans and milestones for 2001/2002
Trigger: Move into the phase of prototypes integration– conduct systems tests between trigger sub-system prototypes and with detector front-end electronics prototypes.
DAQ: Extend the technology demonstrators to include functionality of the trigger, builder and filter units. Continue development of on-line software and run control.
Submit DAQ TDR by end-2002.

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

CPT

Computing and Core Software, Physics Reconstruction and Selection, Tridas

Status
Large-scale event generation for the Physics Reconstruction and Selection Groups is being completed. Eleven prototype regional centers worldwide are participating in this exercise. The substantial complexity and shortage of expert manpower led to delays w.r.t. the milestone set. To date we have used Objectivity as the Event-store technology. Reconstruction software is well advanced and in use.
PRS: The High Level Trigger (HLT) code has been improved and new elements have been added. Triggering at a luminosity of $2x10^{33}$ $cm^{-2}s^{-1}$ has been studied. The effect of staging some sub-detector elements has been studied.

Changes
While Objectivity is technically sound, commercial concerns have prompted two additional lines of investigation, namely Oracle based and Root based with a more conventional file and data management layer.
The proposal to submit an iMoU for Core-Software has been shelved. Currently we are actively recruiting individuals/groups through bi-lateral discussions between Core-Software Project and CMS Institutes.

Plans and milestones for 2001/2

In 2002 focus on only one backup technology for event store.
Start tuning GEANT4 simulation software.
DAQ TDR: Provide support software and event-generation for HLT studies. Study HLT for high luminosity operation. Establish DAQ parameters for the TDR.
Deliver baseline software for Physics TDR.

Concerns
Lack of professional software engineers remains a critical problem.

Overall Milestone Completion

In Fig 1, the intended and achieved integrated numbers of milestones completed are compared month by month. The milestone monitoring was re-baselined (consistent with v31 planning) in July 2001, when, according to the previous baseline (consistent with v26 planning) 92% of intended Level 1 and Level 2 milestones were completed. By definition, the intended and achieved numbers became identical at the point where the new baseline was adopted to monitor the progress of CMS construction.

Conclusion

CMS is following an assembly sequence, v31, that allows a complete detector (except for ME4/2 and 3rd forward pixel layer) to be ready for the first physics run in August 2006. As indicated previously the delays in civil engineering are being recovered by carrying out on the surface some operations previously planned for underground. This will require more resources.

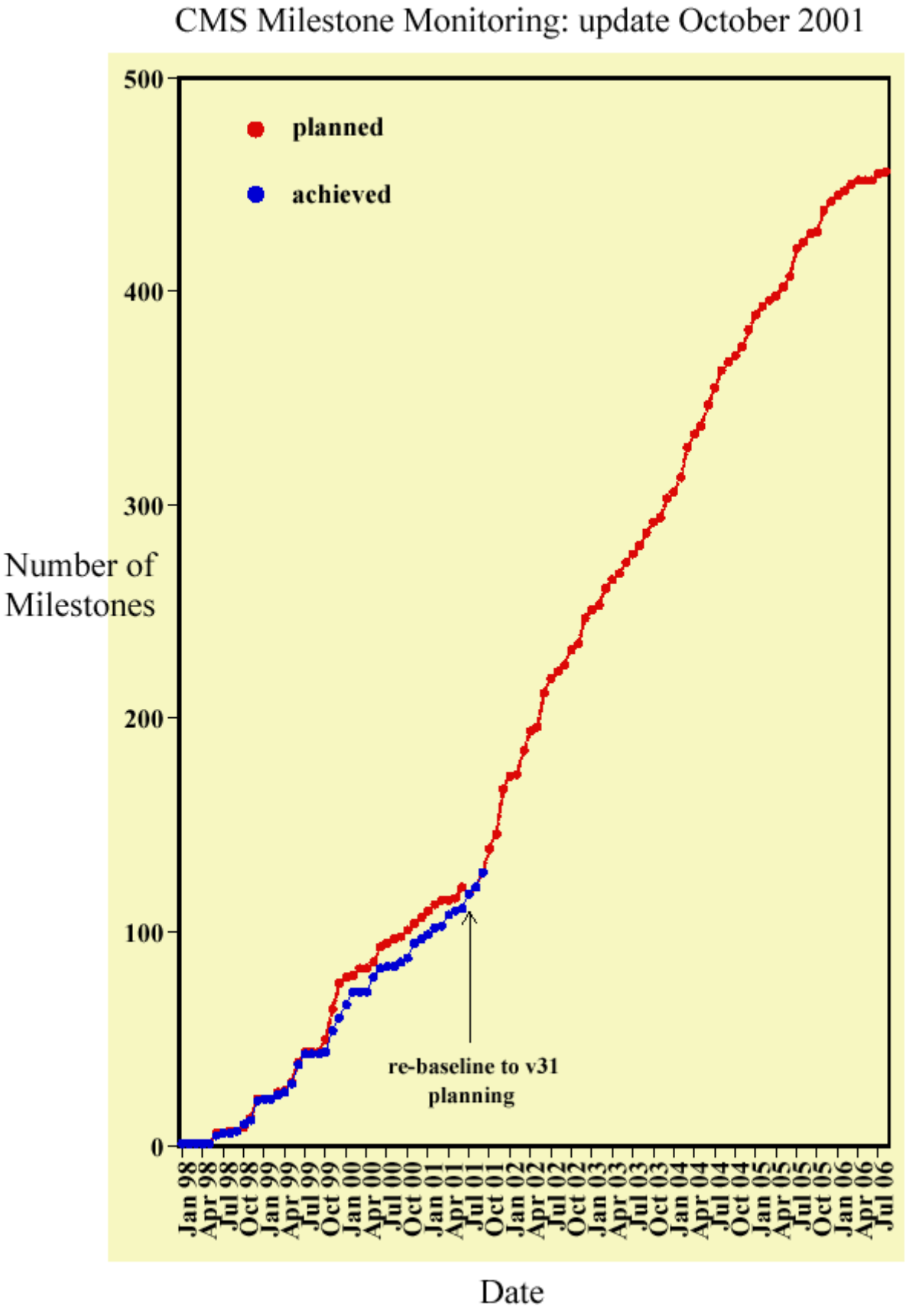
CMS Milestone Monitoring: update October 2001
planned
achieved
500
400
300
200
100
0
Number of Milestones
re-baseline to v31 planning
Jan 98
Apr 98
Jul 98
Oct 98
Jan 99
Apr 99
Jul 99
Oct 99
Jan 00
Apr 00
Jul 00
Oct 00
Jan 01
Apr 01
Jul 01
Oct 01
Jan 02
Apr 02
Jul 02
Oct 02
Jan 03
Apr 03
Jul 03
Oct 03
Jan 04
Apr 04
Jul 04
Oct 04
Jan 05
Apr 05
Jul 05
Oct 05
Jan 06
Apr 06
Jul 06
Date

Figure 1.