THE LHC PROJECT*

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This write-up represents a very compact version of a status report of the LHC project, a little more than a year before first beams will be injected. This status report is based on very recent extensive presentations to CERN Council and its Committees, by the LHC Project Leader (L. Evans) and the present author. Additional input was provided on behalf of ATLAS (P. Jenni), CMS (T.S. Virdee), LHCb (T. Nakada), ALICE (J. Schukraft), TOTEM (E. Radermacher) and LCG (L. Robertson).

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LHC machine

Production, delivery and cold-testing of magnets is proceeding according to plan, as is the installation in the tunnel. Delivery of the last magnet is expected for October 2006 and magnet installation in the tunnel should be complete by March 2007. The magnet interconnection rate is now ramping up to the desired rate, after having followed the usual learning curve. The nominal rate is 24 per week with a possibility to increase to 32 by employing an additional team. In any case, this rate should reach the value necessary to catch up and keep up with magnet installation. Closure of the LHC machine is planned for end of August 2007.

Many other activities are ongoing in order to have an accelerator ready for beam in the fall of 2007. We very briefly list the most important items here; the present status of the related activities is consistent with the target dates mentioned above.

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- Cryogenics infrastructure and refrigerators (both at 4.5K and 1.8K, on the surface and downstairs); cryogenic distribution;
- Distribution feed boxes (DFB's) providing the electrical current to the magnets — this in fact is a 'critical path' item that requires an additional effort in order to keep the schedule;
- Injection septum magnets; kicker magnets;
- RF infrastructure.

Machine commissioning

The installation activities in an LHC octant are concluded by hardware tests of the magnets (power; protection systems) at 1.9K and full field. It has recently been realized that a more optimal approach to bring the LHC into operation would be the following. If the injected beams (450 GeV) would be brought into collision at injection energy, invaluable operational experience would be gained, both for the machine and the detectors, before having to deal with the additional complications of bringing the beams up to full energy. The main additional complication has to do with what is known as 'the snap back effect': a variation of the sextupole components in the magnetic field during ramp up. It is important to master this effect, i.e. avoid loosing the beam during ramp-up. Furthermore, operating the machine at injection energy initially has the advantage that the hardware does not have to be commissioned at full energy (power) before starting operations. A schedule is being worked out that foresees first collisions (at 900 GeV) by November 2007, leaving sufficient time to gain invaluable experience for both machine and experiments until the winter shutdown. First explorations of the snap-back effect, expected to occur around 1 TeV may also take place during this period. The winter shutdown is expected to last up to the beginning of April 2008 and will be used by machine and experiments for repairs, interventions and remaining installation work. In particular it will be used for the hardware commissioning up to full energy of those machine octants for which this commissioning was not completed before the 2007 run (Four out of the eight octants, according to the planning). The aim is to have a physics run in 2008 that will allow the collection of several fb-1 at 14 TeV.

The experiments

The installation schedules of the experiments are consistent with the machine schedule outlined above. In particular the 'closing date' of August 31 2007, drives these schedules.

ATLAS

Pixel detector: still on schedule for installation before 'day 1', but encountering problems due to cooling pipe leaks and faulty low-mass cables (barrel). SCT (Silicon tracker, barrel and end-caps): full system pre-assembled. TRT (Transition Radiation Tracker): fully pre-assembled, services integration in progress.

Calorimeters (Lar and scintillator tiles): all three cylinders installed in underground cavern, commissioning has started.

Magnet system: barrel toroid installed, being pumped down; full excitation tests summer 2006. End-cap toroids in the final integration phase (on the surface), installation in cavern end of 2006. Solenoid has been tested in situ at reduced current. Full current after closure of calorimeter end-caps.

Muon chambers: all chambers (Monitored Drift Tubes, Thin Gap Chambers, Resistive Plate Chambers) ready; installation of barrel chambers in progress; end-cap sectors being pre-assembled on the surface.

CMS

CMS is being assembled on the surface for magnet test and 'slice test' with cosmic rays. Solenoid is cold; Hadronic Barrel and Endcaps installed; muon chamber installation in progress (Drift Tubes, Cathode Strip Chambers and Resistive Plate Chambers). Tracker integration proceeding according to plan in the Tracker Integration Facility. PbWO4 crystal production proceeding according to plan; timely delivery of the end-cap crystals remains a concern. Installation of (part of) the electromagnetic end-caps is to be foreseen for the beginning of 2008. Important milestone for summer 2006: magnet test, slice test (cosmics) and subsequent field mapping. Important next milestone: start of the lowering operation, i.e. start of installation of CMS in the underground cavern, in October 2006.

LHCb

Magnet commissioned and measured; Vertex Locator vacuum tank installed, silicon sensor module production started; Outer Tracker (straw tubes) module production completed (investigating unexpected gain loss, not fully understood yet); Silicon tracker (inner tracker and trigger tracker) ladder and support structure production in progress; Ring Imaging Cerenkovs: RICH2 mechanics and RICH1 shielding box installed; calorimeters (electromagnetic, 'shaslik' and hadronic, tiles) installed, preshower detector ready for installation; muon chamber production in progress.

ALICE

Completed detectors: Time Projection Chamber; High Momentum Particle ID (RICH); Photon Spectrometer module (PbWO4) and Zero Degree Calorimeter. TPC under commissioning on the surface, detecting cosmic rays (a major milestone). Detectors nearing completion: muon chambers, time-of-flight system (multi-gap RPC's), transition radiation detector and inner tracking system (ITS). ITS features pixel detectors, silicon drift detectors and silicon strip detectors. It is on the critical path, a serious concern. Installation : large support structures, muon absorbers and magnets (central solenoid and muon spectrometer dipole are installed and have been measured); installation of muon chambers just started.

TOTEM

Order of 8 Roman Pots imminent after test of first Roman Pot recently delivered and partly assembled. 40 edgeless silicon detectors delivered; 10 (out of 40) GEM chambers produced (for T2 telescope); pre-production of 4 CSC chambers (for T1 telescope) started.

LCG (LHC Computing GRID)

Good progress on EGEE (Europe) and OSG (USA) interoperability. There is a steady increase in GRID usage. Service Challenge 4 has just started (using gLite 3.0 middleware). This is the last test before start of operation of 'the service' in October 2006. The MoU that forms the basis for the Worldwide LHC Computing GRID is collecting signatures.

Conclusions

The LHC Project continues to make steady progress on all fronts: machine, detectors and computing. This progress is consistent with start of operations (at 900 GeV) in the fourth quarter of 2007.