CERN-RRB-2006-069
15th September 2006

Updated ATLAS Progress Report for the October 2006 RRB

1. Introduction and Collaboration Composition

The distributed series production of detector components is completed. The technical efforts are now fully concentrated on the remaining surface integration work, the massive underground installation activity, and the rapidly growing detector commissioning. In parallel, the distributed computing and physics analysis tools are being set up, employing fully the Worldwide LHC Computing Grid Project (WLCG) as a backbone. The Collaboration is evolving its internal working structures to reflect the transition from construction to commissioning, and towards data taking.

It can be briefly recalled that the ATLAS detector uses a superconducting magnet system with a central solenoid around the inner detector and large air-core toroid magnets for the muon spectrometer. Between the two are the liquid Argon (LAr) and tile calorimeters. A hierarchical trigger and data acquisition system collects the data for the collaboration-wide computing and physics analysis activities.

The financial framework for the construction was defined in the Completion Plan for the staged initial configuration of the detector. This plan takes into account the Cost to Completion (CtC) for the parts which are not covered as deliverables, including the Commissioning & Integration (C&I) pre-operation costs as well as the available resources, as presented and approved at the October 2002 RRB (CERN-RRB-2002-114rev1), and is updated regularly. As the RRB was informed at its April 2006 meeting, ATLAS has undertaken over the past months to reassess the projected final costs for the common items. Additional cost increases of 4.4 MCHF are anticipated, and actions to deal with them are discussed in the last section of this report.

The ATLAS Collaboration consists today of 161 Institutions from 35 countries with roughly 1680 scientific authors (including about 360 PhD students). Two teams from Germany (DESY and Humboldt University Berlin) and two from the U.S.A. (New York University and SLAC) have been admitted as new ATLAS Institutions at the last Collaboration Board meeting on 14th July 2006, and the RRB is invited to endorse their membership. New Expressions of Interest to join ATLAS have been submitted, after detailed initial discussions about possible contributions, by the Fachhochschule Wiener Neustadt (Austria), University of Regina (Canada), and Nagoya University (Japan). The Collaboration Board will consider these applications at its next meeting on 6th October 2006 following the standard procedures defined in the Construction MoU. The Collaboration took also note of the withdrawal of Naruto University of Education, Tokushima (Japan), which has completed its initially expected contribution to ATLAS.

2. Magnet System

The ATLAS superconducting magnet system comprises the central solenoid, the barrel toroid (BT), two end-cap toroids (ECT), and their common services.

2.1 Central Solenoid

Status: The solenoid has been successfully commissioned at full current and its safety systems tested in-situ during August 2006, followed by a field mapping measurement.
Changes: Commissioned.
Concerns: None.
Plans: Ready for operation.

2.2 Barrel Toroid

Status: The BT cool-down in-situ is complete. Initial electrical tests have been made at very low current. Full excitation tests will start at the end of September, after a final cleaning campaign of the cavern from magnetic material, and when these tests will be compatible with the overall planning of other installation activities.
Changes: None.
Concerns: None.
Plans: First in-situ excitation tests starting at the end of September 2006.

2.3 End-Cap Toroids

Status: The assembly of the cold masses for both ECTs has progressed well, but after insertion of the first one into the vacuum vessel technical problems arose for accurately aligning it with respect to the outside force transfer points. A corrective mechanical design change is now being implemented. However this causes major delays for their installation readiness of about 6 months and puts them on the critical path for the overall installation schedule. The consequences of the delays, and actions to recover, are currently assessed, including the option to skip the mechanical surface cold test (at Nitrogen temperature). The first ECT, side A, is scheduled to be ready for the Pit only at the end of February 2007. The second ECT will follow about 2 months later.
Changes: Redesign of the cold mass support alignment mechanics inside the vacuum vessels, and ensuing modifications.
Concerns: Major delay accumulated due to cold mass support redesign.
Plans: Continuation of the assembly and integration, possibly followed by the ECT-A surface cold test (Nitrogen temperature, under discussion) in January 2007 and the transport to the Pit end of February 2007, with ECT-C following after 2 months.

3. Inner Detector

The Inner Detector (ID) combines three concentric sub-system layers, from inside out the Pixel detectors, the Silicon detectors (SCT) and the Transition Radiation Straw Tracker (TRT). The distributed module production is finished, integration work is proceeding in the clean room facility SR1 at the Pit 1 surface area, and first components have already been installed underground into the detector.

3.1 Pixel Detector

Status: The technical problem with corrosion leaks in some of the barrel cooling tubes has been overcome by implementing the repair and replacement strategy mentioned at the last RRB. A further issue had to be faced with broken low-mass cables for the barrel services. With very strict quality checks, and a new production of

part of these delicate cables, the integration of the barrel cylinders has been resumed after an interruption of about three months. The integration of the outermost cylinder has just been completed. Both end-caps, each containing three fully integrated disks, have been delivered to CERN and passed all acceptance tests. All the barrel recovery actions proceed so far encouragingly well along a very tight schedule which foresees readiness for installation in April 2007.
Changes: Extra effort to recover delays due to technical problems in the barrel.
Concerns: Schedule risk for the system to be installed and commissioned for LHC start-up.
Plans: Complete barrel and end-cap integrations, and make system tests with cosmic rays in SR1 prior to installation.

3.2 Silicon Detector

Status: After the insertion of the barrel SCT into the TRT already reported in April, a successful cosmic ray test took place with both detectors combined in SR1. End of August both of them have been installed underground into the barrel LAr cryostat. The end-cap integration is also well advanced, and both sides are now being prepared for insertions into the TRT end-caps, the first one being scheduled for end of September 2006. The production of the off-detector read-out electronics and of the power supplies is essentially completed.
Changes: None.
Concerns: None.
Plans: In-situ commissioning of the barrel part. Final integration and tests for the two end-caps, followed by their installation in-situ in January and February 2007.

3.3 Transition Radiation Tracker (TRT)

Status: The barrel TRT has been integrated, tested, and installed with the barrel SCT as mentioned above. The integration work for the two end-caps has progressed well, and they are expected to be ready for the forthcoming integration with the end-cap SCT during the coming months.
Changes: None.
Concerns: None.
Plans: Complete the end-cap integration and tests at SR1, together with the SCT, followed by installation as mentioned above.

3.4 Infrastructure and Common ID Items

Status: The underground services installation has been completed as far as needed for the detector installation, and proceeds for the rest. A sizeable fraction of the evaporative cooling, the liquid cooling and the gas distribution plants have been commissioned. The installation of electronics and the planning for overall commissioning are well underway.
Changes: None.
Concerns: Complexity in the services installation.
Plans: Continue and complete electronics and services installation in the cavern.

4. LAr Calorimeter

All three LAr calorimeter cryostats are installed in the cavern and the main activities concentrate on completing electronics installation and system commissioning in the cavern. Major points of attention remain the low- and high-voltage power supplies which impact the commissioning progress.

4.1 LAr Barrel Calorimeter

Status: The LAr barrel calorimeter, in its final position, is cold since May 2006, and is now gradually being brought into operation. Cosmic ray signals in the combined LAr and Tile calorimeters have been recorded very recently in the first modules.
Changes: None.
Concerns: None.
Plans: Continue in-situ commissioning.

4.2 LAr End-Cap Calorimeters

Status: The mechanical installation of both end-caps is completed, and the work proceeds now with completing the services connections and the on-detector electronics installation. The cool-down of the first end-cap, side A, is scheduled for the end of the year.
Changes: None.
Concerns: None.
Plans: Completion of the services and electronics installations, followed by cool-down and system commissioning, starting with side A.

4.3 LAr Electronics

Status: Both the low- and high-voltage power supply situations continue to call for special attention. In both cases intense iterations with the two different suppliers are ongoing and have improved the performance, albeit not yet fully satisfactorily, and with slow delivery rates. In order to keep open a back-up option, alternative suppliers are being investigated for the future. All other electronics components are on schedule and commissioning is progressing well.
Changes: None.
Concerns: Both low- and high-voltage power supply fabrications are on the critical path, with technical improvements still to be fully demonstrated.
Plans: Continue installation and commissioning of the full electronics chain. Follow with highest priority the technical power supply issues, and their fabrication.

5. Tile Calorimeter

Status: All three Tile Calorimeter cylinders are installed, and in-situ commissioning is in full swing. A major activity just starting is to record combined cosmic ray data together with the LAr EM calorimeter. The commissioning of the on-detector electronics has been slowed down because of failures in the low-voltage power supplies and occasional HV trips. The implementation of corrective actions for both issues shows good improvements. However the low-voltage power supply system requires implementation of a redesign which is very time-critical for the LHC start-up, and commissioning therefore has to proceed with a temporary modification to the control electronics in question.
Changes: Improved design for the low-voltage power supply system.
Concerns: Schedule and cost for the implementation of an improved low-voltage power supply system.
Plans: Proceed with the commissioning work, paying special attention to the power supply issues. Combined cosmic ray tests with the LAr EM calorimeter.

6. Muon Spectrometer

The Muon Spectrometer is instrumented with precision chambers for the momentum measurement (Monitored Drift Tube chambers, MDTs, and for a small high-radiation forward area Cathode Strip Chambers, CSCs) and with fast chambers for triggering (Resistive Plate Chambers, RPCs, in the barrel, and Thin Gap Chambers, TGCs, in the end-caps). The series construction of all the chamber sub-systems has been completed. The barrel station installation is well advanced and commissioning ongoing. The end-cap sector pre-assembly and their installation in the cavern are in full swing.

6.1 Barrel Chambers

Status: Over the past months the installation of the barrel stations (MDT plus RPC in the middle and outer layers) has progressed constantly, within the access constraints given by the overall installation activities in the cavern. About two thirds of the stations are in place, completion is scheduled for the end of October 2006. Along with the chambers the services and the alignment system are put into place. The system commissioning has started, and first cosmic ray tracks have been recorded, for example, jointly in muon stations and Tile Calorimeter modules.
Changes: None.
Concerns: Tight and constrained installation schedule, requiring frequent reconfiguration of access platforms.
Plans: Complete station installation and continue with commissioning.

6.2 End-Cap Chambers

Status: The main activity now concentrates on the assembly and integration of fully tested sectors for the end-cap wheels, including their alignment system, and their installation. The so-called ‘Big Wheels’ in the middle station consist of a total of 2 MDT wheels and 6 TGC wheels, preassembled in 32 MDT sectors and 72 TGC sectors. At this stage 24 MDT and 26 TGC sectors are completed. The first TGC Big-Wheel will be completed in the underground cavern by mid-September 2006. The completion of the Big Wheels is on the critical path, and their installation will be affected by the ECT delays reported in section 2.3. As corrective action it has been decided to duplicate installation tools for enabling parallel work on both sides of the cavern. The integration of the ‘Small Wheel’ chambers for the inner end-cap station is planned to start at the end of 2006 and is expected to meet the schedule. The special stations in the barrel to end-cap transition region are on schedule as well.
Changes: Duplication of Big Wheel installation tools to enable parallel work.
Concerns: Schedule for on-time completion of the end-cap wheels, affected by ECT delay.
Plans: Continue sector preparation and commissioning, and underground Big Wheel installation.

7. Trigger and DAQ System

The Level-1 Trigger, the High Level Trigger (HLT), the Data Acquisition (DAQ) and the Detector Control System (DCS) have all been field-proven in the combined test beam running and large-scale system tests over the past years. Components of the final system are now being installed at Point-1, both in the underground control room as well as in the surface HLT/DAQ computer room, and they are gradually being used in the commissioning of the ATLAS detector as it gets installed.

7.1 Level-1 Trigger

Status: The level-1 trigger system (with the sub-systems calorimeter, muon and central trigger processor (CTP)) is fully in production and installation for both hardware and software. The muon trigger sub-system proceeds on a very tight schedule for the on-chamber components as reported previously. The calorimeter trigger installation is following the availability of the corresponding detector signals in the underground counting room. Major parts of the CTP sub-system have been already installed, and all components are available.
Changes: None.
Concerns: Tight schedule for on-detector muon-trigger electronics.
Plans: Proceed with the construction and for all components, continue in-situ installation and commissioning.

7.2 High Level Trigger, DAQ and Detector Control System

Status: The HLT, DAQ and DCS activities proceed according to plans. Major emphasis is put on all aspects of the HLT and DAQ software developments. The HLT and DAQ pre-series system hardware at Point-1 was used successfully in a 10% data flow test already last year. The system installations are now growing according to the needs for detector commissioning work. An important element for the initial commissioning is the local DAQ capability available to the detector system communities. The operational infrastructure at Point-1 is fully active (central file server and a number of local service machines operational with standard DAQ software, system administration, and networking). Furthermore, large parts of the final Read Out Systems have been installed and commissioned, for example for the barrel LAr and Tile Calorimeters. The DCS is operational, at least to a large extent, in the underground installations at Point-1.
Changes: None.
Concerns: The performance of the initial system remains limited by the availability of funds, implying deferrals of processors as foreseen by the Completion Plan, in case not all the Cost to Completion funding becomes available.
Plans: Continued optimization of the HLT/DAQ/DCS system and its software, and build up gradually the full system at Point-1. Operate at the same time the online software infrastructure as well as DAQ and DCS tools for detector commissioning.

8. ATLAS Detector Installation Schedule

Status: The installation status and the forthcoming milestones for the detector components have been addressed in the previous sections. It must be noted that in all cases the installation of the services and cables, with their cable trays, patch panels and movable chains, is one of the most manpower-intense activities in the underground cavern, which requires considerable attention and supervision work from Technical Coordination. This massive activity will remain on the critical path until the end of 2006. The planning of the activities in the cavern is displayed in Figure 1, taking into account the new date for the closure of the beam pipe, end of August 2007, from the revised LHC machine schedule. The installation of the initial detector is scheduled to be completed with the forward shielding at that moment, whereas the installation of the end-wall muon chambers may continue until October 2007. The LHCC milestone progress for the remaining construction is shown in an integrated

way in Figure 2, by the fraction passed as compared to the baseline planning from the last revision agreed with the LHCC in 2004.
Changes: Installation schedule aligned with the revised LHC machine schedule as presented at the June CERN Council meetings, re-sequencing of installation to accommodate delays of the ECTs.
Concerns: Inherent risks by the overall complexity of the installation process, including the cabling and services, critical delays for the availability of the ECTs, and availability of enough time for the Pixel detector installation.
Plans: Completion of the barrel region (except end-cap ID and Pixels) by end of 2006, as well as most of the muon 'Big Wheels' completed for one side and started on the other one. Services and cable installations continue throughout 2006.

9. Computing, Software and Physics Preparation

Status: The Collaboration-wide distributed computing infrastructure part is fully embedded into the framework of the WLCG of which ATLAS is a very active partner. It must be stressed that in addition there is of course a large, experiment-specific effort needed and ongoing to interface the ATLAS software suite efficiently to this framework. During the first quarter of this year ATLAS and WLCG performed successfully a large data transfer exercise from the Tier-0 to all Tier-1s, known as Service Challenge 3 (SC3), and the next phase, SC4, is underway to demonstrate operation at full rates over a sustained period. The WLCG is used constantly for running large simulation productions which are used to develop and exercise more and more realistic approaches to the data collection and analysis including detailed trigger, calibration and alignment aspects, known within ATLAS as Computing System Commissioning (CSC). The core computing infrastructure and services tasks, defined as M&O category A, play a crucial role for the smooth operation.

Further large efforts continue to include the simulation and analysis of the data from the 2004 combined test beam deploying real components of the software and computing framework, and developments of fast simulation frameworks. Many specific tools and procedures, encompassing online and offline aspects, for the whole ATLAS software are being developed and implemented within Collaboration-wide task forces. Particular emphasis is being put on usability of the whole analysis suite. Another important goal is to collect, distribute and analyze real cosmic ray data from Point-1, which will be used to demonstrate all these steps.

The preparations for the physics are at this stage very much driven by a detailed planning for the very early phase of the LHC operation. The main goal is to debug the detector, computing and software, and to gain as efficiently as possible an excellent understanding of the detector performance to ensure the quality of the data. These preparations are organized within a framework guiding the future operation of the experiment, as documented internally in ATLAS in the Operation Model.
Changes: None.
Concerns: None.
Plans: Consolidate and commission the software and computing for a Collaboration-wide, distributed approach, in full coherence with the WLCG infrastructure backbone, and running of SC4 in the second half of 2006. Further improve the usability of the software, and implement all minimally required functionalities for data taking in the CSC exercise.

10. Updates and New Assessment on the Completion Planning

At the RRB meeting in October 2002, a Completion Plan for the initial ATLAS detector was approved. This plan (CERN-RRB-2002-114rev1) took into account the Cost to Completion (CtC) for the parts that are not covered as deliverables, and included the Commissioning and Integration (C&I) pre-operation costs until 2006. It fitted into the framework of the available resources agreed to at that RRB meeting by the Funding Agencies (called category 1 funding in Annex 2 of the above document). The document also included an indication of further funding prospects, without commitments yet, from the Funding Agencies (called category 2). The detailed implementation of the plan was understood to evolve within the specified overall framework when further financial commitments would become available. The CtC envelope was set at 68.2 MCHF, imposing on ATLAS at that time a scheme to stage and defer components and activities from its initial detector configuration, in order to redirect a total of 21.7 MCHF to cover the difference.

The detector construction has since continued within this framework. Constructive interactions have been pursued with funding partners ever since to improve the situation. The ATLAS Collaboration is very grateful to all Funding Agencies that committed, initially and during all these years, funding towards the full CtC.

As the RRB was informed at its April 2006 meeting, ATLAS has undertaken over the past months to reassess the projected final costs for the common items. Additional cost increases of 4.4 MCHF are anticipated, in excess of the 68.2 MCHF estimated in 2002. The 4.4 MCHF are composed of 1.76 MCHF for the magnet system (largely due to adjustments in the engineering contracts), of 1.39 MCHF for the Big-Wheel support structures (due to their complexity and to necessary improvements of the mechanics design), of 0.25 MCHF for the LAr Cryostat and Cryogenics project (changes in the end-cap cooling procedures), and of 1.00 MCHF in Technical Coordination manpower (particularly over-time work expenses for speeding up installation). Parts of these cost overruns are due to schedule slippage. This is particularly the case for the installation manpower, but also the other items are affected by the delays.

The ATLAS Collaboration Board has conducted through a review group a scrutiny of these additional costs, and accepted them. The review concurred with the ATLAS management’s view that these estimates are a firm evaluation for the completion of the initial detector, albeit with the exception of a manpower cost risks in case of further delays of the project beyond the revised LHC and ATLAS installation schedules.

The Collaboration stresses that these additional costs can be accommodated within the 2002 Completion Plan provided all funding partners contribute their full calculated share to the CtC, given the fact that CERN contributed a larger than calculate share (see Table 1), and provided that all Funding Agencies fulfill their baseline Common Fund obligations (Construction MoU). The Collaboration therefore urges most strongly all Funding Agencies that have not yet committed to their full calculated share of CtC funding to continue their utmost efforts to secure the missing resources. Only a strong and solid solidarity across all funding partners will allow the Collaboration to complete its powerful detector to fully exploit the great LHC physics opportunities as early as possible.

Should this appeal for fulfilling the baseline obligations and the contributions to the full calculated share of the CtC funding (2002 Completion Plan) not be successful, an alternative solution would have to be envisaged to cover the funding gap. As such a fall-back, the Collaboration has decided to eventually request the RRB to agree to an extension of the Institutional Member Fee (12.5 kCHF per Institution and year, Art. 6.3 of the Construction MoU) for 3 years (2007-2009). If necessary, such a decision would have to be taken in the April 2007 RRB meeting.

The updated CtC funding planning is given in Table 1, which at this stage shows a category 1 funding of 62.7 MCHF and a category 2 funding prospect of 2.2 MCHF. It has to be noted that the Collaboration also currently faces a deficit of about 10 MCHF due to late payments of baseline Common Fund contributions, as discussed in the corresponding budget document CERN-RRB-2006-071.

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Cost to Completion Funding Planning (all in kCHF)
(revised 15th September 2006)

Funding Agency	Cost to Completion proposed sharing Total	Constr. Comp.	C&I	Member fee 2004-6 (included in Constr. Comp.)	New funding (category 1) including member fee Total	New funding requests as prospects (category 2) without commitment from FA Total
Argentina						
Armenia	**66**	48	18	38	**45**	
Australia	**357**	242	115	75	**140**	238
Austria	**67**	52	15	38	**67**	
Azerbaijan	**43**	38	5	38	**38**	
Belarus	**85**	75	10	75	**75**	
Brazil	**64**	47	17	38	**41**	
Canada	**2090**	1528	562	263	**2090**	0
China NSFC+MSTC	**141**	99	42	38	**141**	
Czech Republic	**316**	196	120	113	**316**	
Denmark	**422**	290	132	38	**58**	375
France IN2P3	**5890**	4176	1714	225	**5890**	0
France CEA *)	**1940**	1379	561	38	**1334**	
Georgia	**42**	37	5	38	**38**	
Germany BMBF	**4531**	3250	1281	338	**4531**	0
Germany DESY						
Germany MPI	**1093**	761	332	38	**1093**	
Greece	**261**	173	88	113	**113**	148
Israel	**739**	497	242	113	**739**	
Italy	**6638**	4650	1988	450	**6288**	
Japan	**4362**	3029	1333	563	**4362**	
Morocco	**57**	47	10	38	**41**	
Netherlands	**1934**	1368	566	75	**1934**	
Norway	**581**	391	190	75	**581**	
Poland	**136**	94	42	75	**123**	13
Portugal	**446**	265	181	38	**339**	107
Romania	**140**	85	55	38	**140**	
Russia	**2991**	1995	996	263	**1759**	
JINR	**1066**	660	406	38	**521**	
Serbia					**300**	
Slovak Republic	**72**	53	19	38	**82**	
Slovenia	**223**	152	71	38	**223**	
Spain	**1706**	1109	597	113	**1706**	
Sweden	**1691**	1121	570	150	**1691**	
Switzerland	**2372**	1701	671	75	**2372**	0
Taipei	**445**	318	127	38	**445**	
Turkey	**85**	75	10	75	**75**	
United Kingdom	**4387**	3063	1324	450	**3133**	1254
US DOE + NSF	**12245**	8438	3807	1238	**6200**	
CERN	**8452**	5770	2682	38	**13700**	
Total	**68176**	47272	20904	5563	**62764**	2135

*) The commitment shown does not include a 1 MCHF additional engineering contribution provided on the initial BT contract (see MoU Annex 8.A)

Table 1

ATLAS Installation Activities in the Cavern

15-09-2006

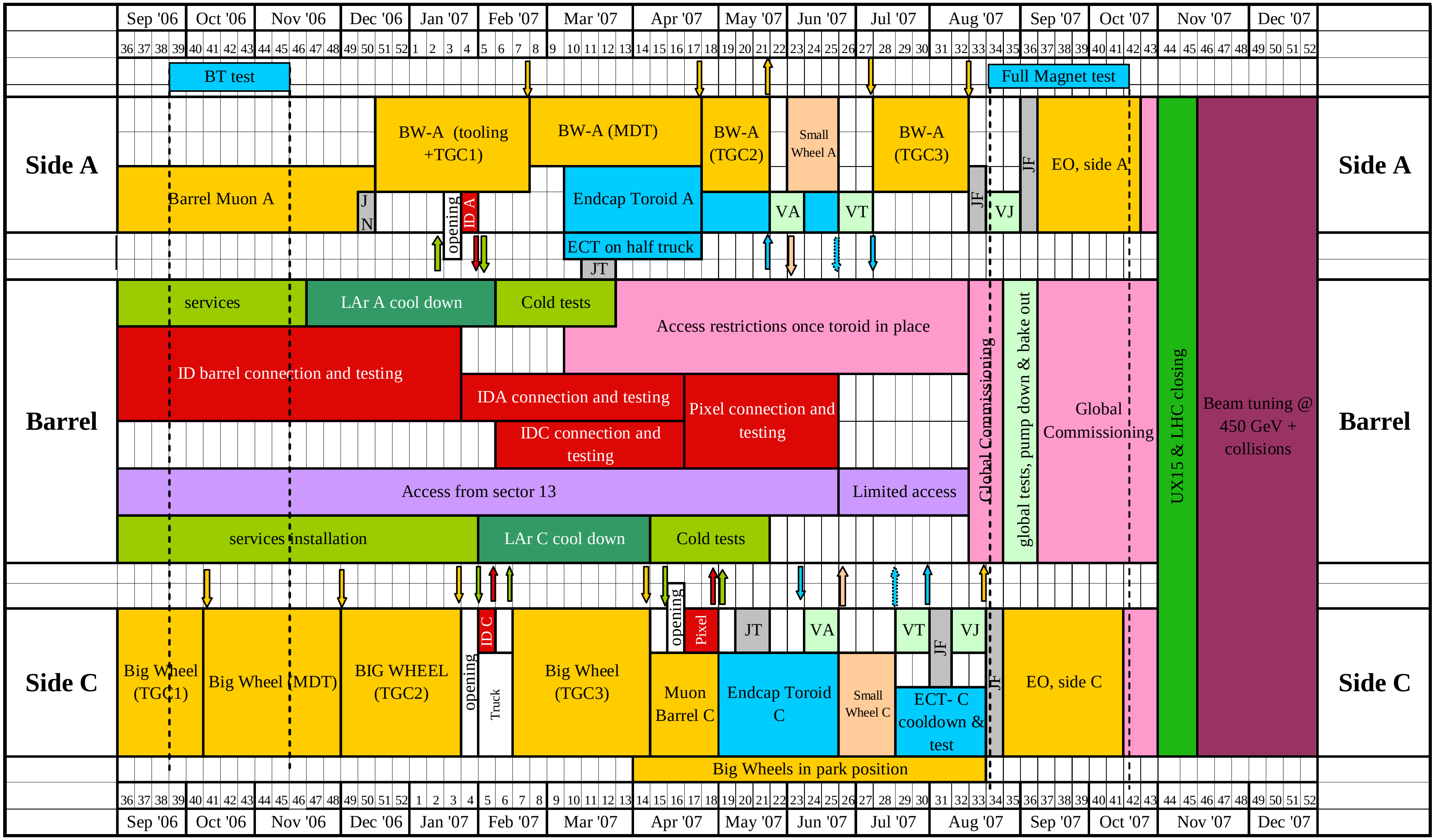

Figure 1

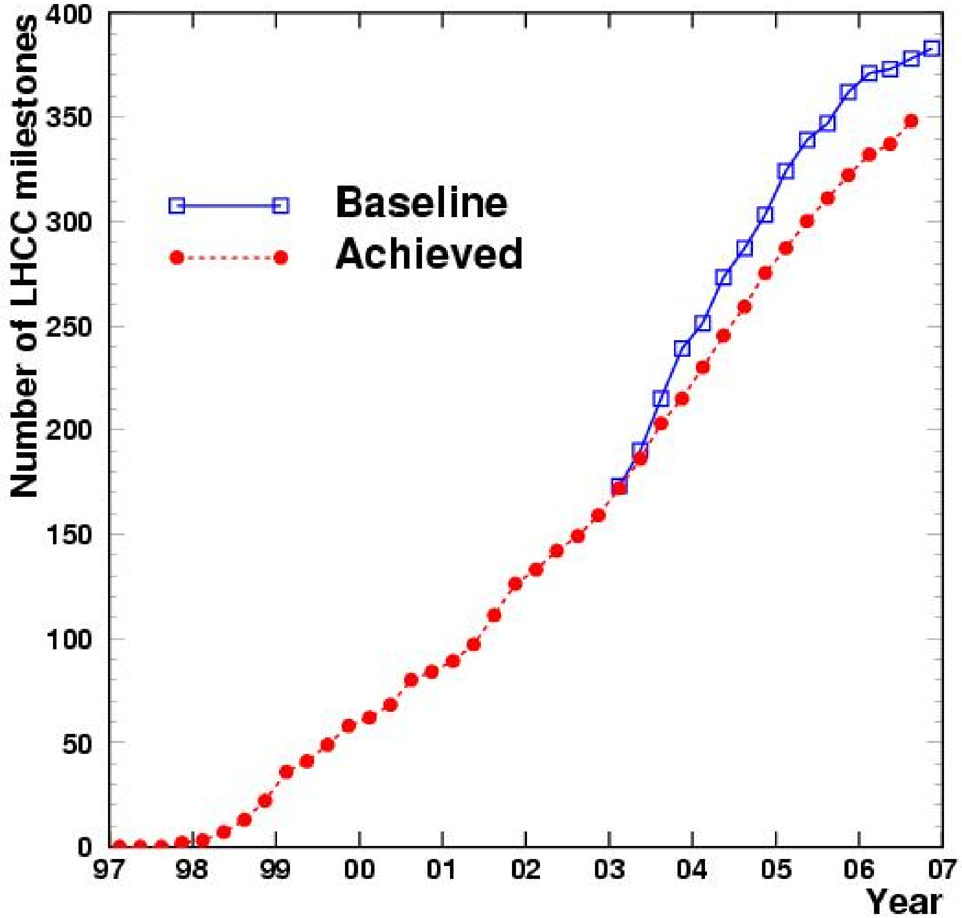

Figure 2: Integrated LHCC Milestone Plot