CERN-RRB-2008-082
31st October 2008

ATLAS Progress Report for the November 2008 RRB

1. Introduction and Collaboration Composition

The installation of the initial configuration of the ATLAS detector has been completed in time to meet the start-up schedule of the LHC. As a highlight, the first beam-related events were successfully recorded and reconstructed on 10th September 2008 during the official LHC start-up day.

Parallel to the final installation activities, the past months since the last RRB meeting were fully devoted to commissioning the detector, the trigger and data collection, the monitoring of the data quality, calibrations and alignments, and exercising the whole analysis chain with world-wide distributed computing, fully employing the worldwide LHC Computing Grid Project (wLCG) as a backbone. The experiment has been kept operational continuously since end of August, typically recording cosmic ray data during nights and weekends, and performing dedicated commissioning work during week-day periods.

The ATLAS detector 'as built' and its basic performance have been documented in a comprehensive publication in the Open Access journal JINST. It can be briefly recalled that the detector concept 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 3-level Trigger and Data Acquisition system collects the data for the collaboration-wide computing and physics analysis activities.

The initial staged detector configuration, now operational, corresponds to the financial framework which was defined in the Completion Plan as presented and approved at the October 2002 RRB (CERN-RRB-2002-114rev1) and updated at the October 2006 RRB (CERN-RRB-2006-069).

The ATLAS Collaboration consists today of 169 Institutions from 37 countries with roughly 2800 scientific authors (including 800 PhD students). Since the last RRB the Collaboration Board has unanimously approved three Expressions of Interest to join ATLAS, namely from the Julius-Maximilians-University of Würzburg, Germany, from the Palacký University in Olomouc, Czech Republic, and from the University of Texas at Dallas, U.S.A. The RRB is invited to endorse these new collaborating Institutions.

2. Commissioning of the Magnet System

The ATLAS superconducting magnet system comprises the Central Solenoid (CS), the Barrel Toroid (BT), two End-Cap Toroids (ECT), and their common services.

Status: Like before for the CS and the BT, the ECT have first been commissioned in stand-alone operation. Whereas this went very smoothly for ECT-C, a Helium leak developed in an electrical isolation pipe for ECT-A. After warming up, the repair was made *in-situ* and the stand-alone tests were completed in July. The commissioning of

the full toroid system was then pursued. Both during stand-alone tests, and also in the higher-load configuration of the full system, several training quenches, always in different coils, were observed in ECT-A. The full magnet system, the toroids and the solenoid, have now been operated for many weeks for the cosmic ray commissioning data taking. In order to avoid further training quenches the toroid current setting has been reduced very slightly for the time being, from 20.5 to 20.4 kA.
Changes: None.
Concerns: None.
Plans: Operation when needed for data collection, standard maintenance during the shut-down period.

3. Commissioning of the 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).

Status: Shortly after the last RRB in April, the commissioning of the SCT and Pixels was seriously delayed because of a problem in the evaporative cooling system plant, whereas the TRT commissioning progressed steadily. On May 1st three out of the six compressors for the evaporative cooling system failed, and locally polluted - in the service cavern USA15 - the plant. The fault occurred in the torque-limiting magnetic couplers between motor and compressor shafts, leading to damage of parts, and heating of plastics which polluted the coolant (C3F8). The compressors were repaired and all newly equipped with sensors for protecting against similar faults, and new coolant liquid was purchased. In a crash effort the repair ended late in July, just in time for the safe and successful bake-out of the beam pipe in early August, for which the Pixel system needed to be cooled for protection. Commissioning of the SCT and Pixel sub-systems is in full swing since September, with the cooling system operating steadily on 199 of the 204 cooling loops (three of the missing ones could be run with small leaks to be investigated during the shutdown). A new concern comes from the failure rate of the off-detector opto-transmitter plug-ins, used for both Pixel and SCT. A replacement production has recently been started. The dead channel counts were typically less than 2% at LHC start-up for all sub-systems.
Changes: Repair and improvements in the evaporative cooling plant.
Concerns: The evaporative cooling system is delicate to operate, and further improvements and refurbishing actions are needed at the next shutdown and on the medium term. Failing of off-detector opto-transmitter electronics needs full replacement.
Plans: Complete ID commissioning as far as possible with cosmic ray data. Recover during the shutdown, in the cases where possible, part of the small fraction of missing modules and cooling loops.

4. Commissioning of the Calorimeters

Status: All three calorimeter cylinders, with the outside rings of Tile Calorimeters around the LAr cryostats, have been operated for more than a year. The on-detector electronics refurbishing campaigns for the LAr (front-end boards, FEBs, and low voltage power supplies) and for the Tile Calorimeter (electronics drawers) were completed in May according to schedule. A wealth of cosmic ray data has been collected since then for the tuning of the calorimeters. The overall dead channel count is very low, less than 1%. The most significant region to be repaired during the shutdown is 1 out of 8 LAr hadronic end-cap sectors with a failing low voltage (LV)

power supply. A few not yet fully understood LAr FEB failures were recently observed, which will be given priority for investigations during the forthcoming shutdown activities. As there are also remaining doubts about the medium- and long-term reliability of the retro-fitted LAr LV supplies, development R&D contracts were placed with two vendors.
Changes: Refurbishing of on-detector electronics completed.
Concerns: LAr FEB failures that are not yet fully understood, medium- and long-term reliability of the LAr LV power supplies.
Plans: Repair during the shutdown of the faulty on-detector electronics including LV power supplies both in the LAr and Tile Calorimeters, and continue mainly off-line commissioning with cosmic ray data.

5. Commissioning of the Muon Detectors

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).

Status: With the remaining end-wall chambers installed end of May and early June, the complete muon chamber instrumentation for the initial detector configuration was available for the LHC start-up. The commissioning with cosmic rays was ongoing for both the barrel and end-cap regions since spring, gradually increasing the number of sectors involved, reaching the full system now. As reported before, the commissioning progress remained seriously affected by the late delivery of power supplies (from a single vendor delivering also to the other LHC experiments). More than 99% of the alignment lines are working, and the fraction of problematic chambers is typically below 1%, which will be further improved during the shutdown period. An unexpected read-out limitation with the Read-Out Drivers (RODs) of the CSCs precluded them to be included in the overall detector commission runs, but the fault is being corrected now.
Changes: None.
Concerns: None.
Plans: Complete commissioning work, in particular on the RPCs and CSCs. Repair as far as possible problematic chambers (HV, gas) during the shutdown. Take advantage of the extended shutdown to replace the read-out fibres of the ‘Big-Wheel’ end-cap MDT chambers with rad-hard fibres.

6. Forward Detectors

The forward detectors for the first phase of ATLAS consist of a Luminosity Cerenkov Integrating Detector (LUCID) placed around the beam pipe inside the forward shielding at 17 m from the Interaction Point (IP), of a Zero Degree Calorimeter (ZDC) placed in the absorber structure TAN where the beams join separate beam pipes at 140 m away from the IP, and of an Absolute Luminosity for ATLAS (ALFA) detector in Roman Pots at 240 m from the IP.

Status: A reduced version of the LUCID detector was installed and operational for the LHC start-up. Parts of the ZDC are installed, but not yet functional, and a first full-size prototype of the ALFA detector has undergone a test beam campaign.
Concerns: None.
Plans: Develop all detectors for full operation in the coming two years.

7. Commissioning of the Trigger and DAQ System

Status: The components of the Level-1 Trigger (with the sub-systems calorimeter, muon and central trigger processor (CTP)), the High Level Trigger (HLT), the Data Acquisition (DAQ) and the Detector Control System (DCS) have been operational at Point-1 for quite some time, in the underground control room as well as in the surface HLT/DAQ computer room (in reduced configuration for the latter as available for the initial staged detector). The full chain is working well and has been tuned both in real data taking conditions of the combined cosmic ray runs and in special technical runs pushing the performance beyond its design limits, also demonstrating the future scalability of the system. At this stage about 35% of the final HLT cpu capacity is installed and operational.
Changes: None.
Concerns: None for the initial system. However, the initial performance 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 full Trigger, DAQ and DCS system.

8. Global Commissioning of the Detector and First LHC Beam Events

Status: The full ATLAS detector has been operated for a few months collecting cosmic ray data. The experiment was kept operational continuously since end of August, typically recording cosmic ray data during nights and weekends, complemented with dedicated sub-system commissioning work during week-day periods. As a highlight, the first beam-related events were successfully recorded and reconstructed on 10th September 2008 during the official LHC start-up day. These first LHC beam-splash events, as well as the few beam-halo background events from the first stored single LHC beam runs, have been used very efficiently for initial timing adjustments. Figure 1 displays such a beam-halo event. Since the LHC incident, which occurred on 19th September, the full detector was essentially continuously operated in cosmic ray data collection mode. Several hundred million cosmic ray triggers have been collected until 20th October with the full detector, with about 100'000 muons passing also through the smallest-volume detector, the Pixels. These events are very valuable for improving monitoring and data quality procedures as well as for initial global alignments and calibrations. Cosmics data collection with partial configurations, according to the shutdown detector opening work, will continue until mid-December 2008.

A major aspect of the commissioning running was also to get first positive experience with the shift and operation tasks organizations. The period was fundamental to train an increasing fraction of ATLAS members to become familiar with running the experiment. As already mentioned at previous RRBs, a first estimate of the effort needed to operate the ATLAS experiment was made. The estimate of the so-called 'Operation Tasks' (OTs) amounts to about 600 FTE per year, covering from operation at Point-1 to the computing and data preparation tasks, which can be partially executed remotely (a rough estimate indicates about 40%). Per ATLAS member the projected share of operation task duties is very similar to that of large contemporary experiments running elsewhere. The shared obligations of operation tasks among the Institutions will be proportional to their number of ATLAS members. The OT planning is implemented through a new, dedicated Web tool which is still evolving, according to the first experience that is being accumulated.

Changes: None.
Concerns: Operation (in the broad sense as specified above) will require significant resources for which Funding Agencies need to plan ahead.
Plans: Continue collecting cosmic ray data for commission until mid-December 2008, and restart full operation in April 2009.

9. Commissioning of the Computing and Software chain

The Collaboration-wide distributed computing infrastructure is fully embedded into the framework of the wLCG of which ATLAS is a very active partner. However, it must be noted that in addition to this Grid infrastructure there is a very sizable experiment-specific effort required to efficiently interface the ATLAS software suite and analysis framework to the wLCG infrastructure.

Status: During the past years ATLAS and wLCG successfully performed large data transfer exercises, from the Tier-0 to all Tier-1s and Tier-2s. Shortly after the last RRB meeting the most significant such exercises were the Common Computing Readiness Challenge (CCRC) phase-2 run at the end of May together with the other LHC experiments, and the second phase of the ATLAS internal Full Dress Rehearsal with large simulated data samples which 'stress-tested' the full data flow, various calibration and data quality steps, and distributed analysis using the whole Tier-1, Tier-2 and Tier-3 structures. The whole computing and software chain has been operational since the continuous cosmic ray data taking, and demonstrated its efficiency during the first LHC beam induced data taken on the LHC start-up 10/11 September 2008. The core computing infrastructure and services tasks, defined as M&O category A, play a crucial role for the smooth operation. It enables ATLAS to more optimally exploit the large investments of computing resources made worldwide by the wLCG collaboration partners.
Changes: None.
Concerns: None, but the Collaboration is somewhat concerned about the slower than planned build-up of computing resources at some sites in order to meet the anticipated 2009 requirements. A few deliverables from wLCG are still on the critical path as will be discussed in the Computing RRB.
Plans: Consolidate and commission further the software and computing for the Collaboration-wide, distributed approach, in full coherence with the wLCG infrastructure backbone.

10. Shutdown Planning

As already detailed in the previous sections, ATLAS has adopted a plan of its activities at Point-1 matched with the anticipated LHC down time due to the incident of 19th September 2008. The planning of activities is shown in Figure 2. Global cosmic ray data collections have stopped on 20th October, and will continue until mid-December 2008 with only those parts of the detector not yet affected by detector opening work. The critical path is getting access to LAr FEBs in order to investigate the failures mentioned in Section 4. The other critical work concerns the refurbishing of the muon Big Wheel MDT read-out fibres mentioned in Section 5. The ATLAS detector will then be closed again and in commissioning mode by end of April 2009.

11. Updates on the Completion Planning

No major updates on the completion planning are to be reported with respect to the situation presented and discussed in the April 2008 RRB. The following section

recalls the framework, and updates the situation, in which the detector construction and installation have proceeded.

The framework of ATLAS completion was laid down at the RRB meeting in October 2002, when the 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 were not fully covered as deliverables, including 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. In 2002 the CtC envelope was set at 68.2 MCHF, at that time imposing on ATLAS a scheme to stage and defer components and activities from its initial detector configuration, in order to fit into available resources.

In October 2006 the RRB has accepted a new assessment of the CtC, which resulted in an additional cost increase of 4.4 MCHF (from the magnet system, Big Wheel support structures, LAr cryogenics, and installation efforts, see CERN-RRB-2006-069). The Collaboration stressed that these additional costs could be accommodated within the 2002 Completion Plan *provided* all funding partners contribute their full calculated share to the CtC, thanks to the fact that CERN contributed a larger than calculate share, and *provided* that all Funding Agencies fulfill their baseline Common Fund obligations (Construction MoU).

The ATLAS Collaboration is very grateful to all Funding Agencies that have committed, initially and during all these years, funding towards the full CtC. The current situation is given in Table 1, where an encouraging progress can be seen towards pledges covering the full calculated 2002 CtC, therefore making it not necessary to request additional CtC funding. A total of 71.2 MCHF have been pledged to cover the total needed CtC funds of 72.6 MCHF (68.2 MCHF + 4.4 MCHF), and a number of Funding Agencies have kindly indicated that they may help temporarily with the resulting cash flow issue.

However, it has to be noted that the Collaboration also still faced a deficit of 6 MCHF at the end of 2008, mainly due to late payments of baseline Common Fund contributions, as discussed in the corresponding budget document CERN-RRB-2008-120.

The Collaboration most strongly urges all Funding Agencies that have not yet committed to their full calculated share of CtC funding, or have not yet financed their baseline Common Fund contributions, 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.

Cost to Completion Funding Planning (all in kCHF)
(revised 22nd October 2008)

Funding Agency	Cost to Completion 2002 (CtC) calculated share			Member Fee 2004-6 (incl. in CC)	New funding (category 1) incl. Member F	New funding requests (category 2)	CtC 2006 proposed sharing
	Total	CC	C&I		Total	Total	Total
Argentina					**75**		
Armenia	**66**	48	18	38	**45**		
Australia	**357**	242	115	75	**357**		
Austria	**67**	52	15	38	**80**		
Azerbaijan	**43**	38	5	38	**38**		
Belarus	**85**	75	10	75	**75**		
Brazil	**64**	47	17	38	**41**		
Canada	**2090**	1528	562	263	**2090**		
Chile					**38**		
China NSFC+MSTC	**141**	99	42	38	**141**		
Colombia					**38**		
Czech Republic	**316**	196	120	113	**316**		
Denmark	**422**	290	132	38	**118**	304	
France IN2P3	**5890**	4176	1714	225	**5890**		
France CEA	**1940**	1379	561	38	**1940**		
Georgia	**42**	37	5	38	**42**		
Germany BMBF	**4531**	3250	1281	338	**4531**		
Germany DESY					**38**		
Germany MPI	**1093**	761	332	38	**1093**		
Greece	**261**	173	88	113	**261**		
Israel	**739**	497	242	113	**739**		
Italy	**6638**	4650	1988	450	**6288**		
Japan	**4362**	3029	1333	563	**4362**		
Morocco	**57**	47	10	38	**42**		
Netherlands	**1934**	1368	566	75	**1934**		
Norway	**581**	391	190	75	**581**		
Poland	**136**	94	42	75	**136**		
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**		
Taipei	**445**	318	127	38	**445**		
Turkey	**85**	75	10	75	**75**		
United Kingdom	**4387**	3063	1324	450	**4387**		
US DOE + NSF (1)	**12245**	8438	3807	1238	**12245**		
CERN	**8452**	5770	2682	38	**9300**		4400
Total	**68176**	47272	20904	5563	**66839**	411	**4400**

(1) The remaining 4.5 MCHF to C&I is provided on a best effort basis

New funding requests as prospects (category 2) are without firm commitment from the Funding Agencies

Table 1

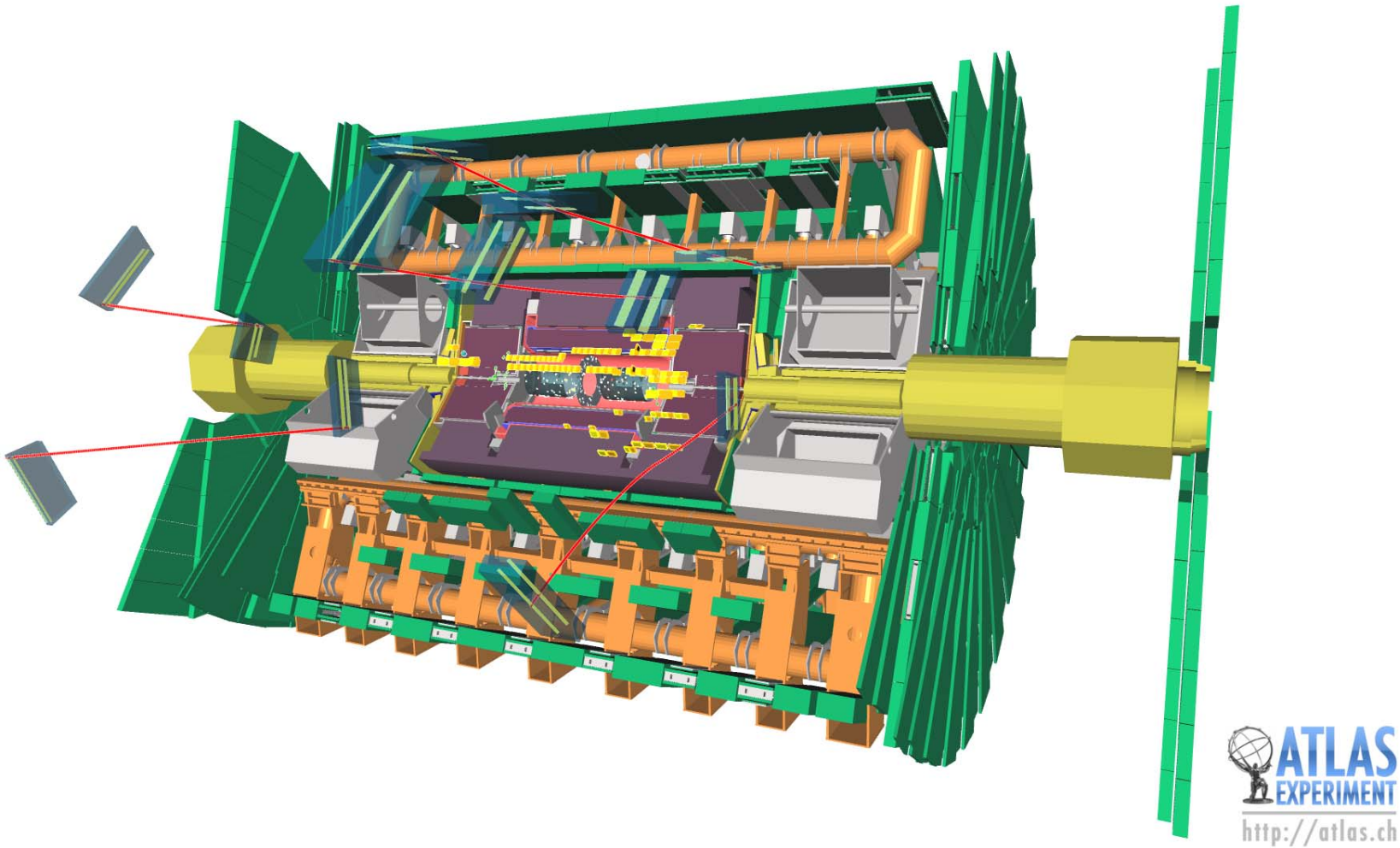

Figure 1 LHC beam-halo event recorded in ATLAS

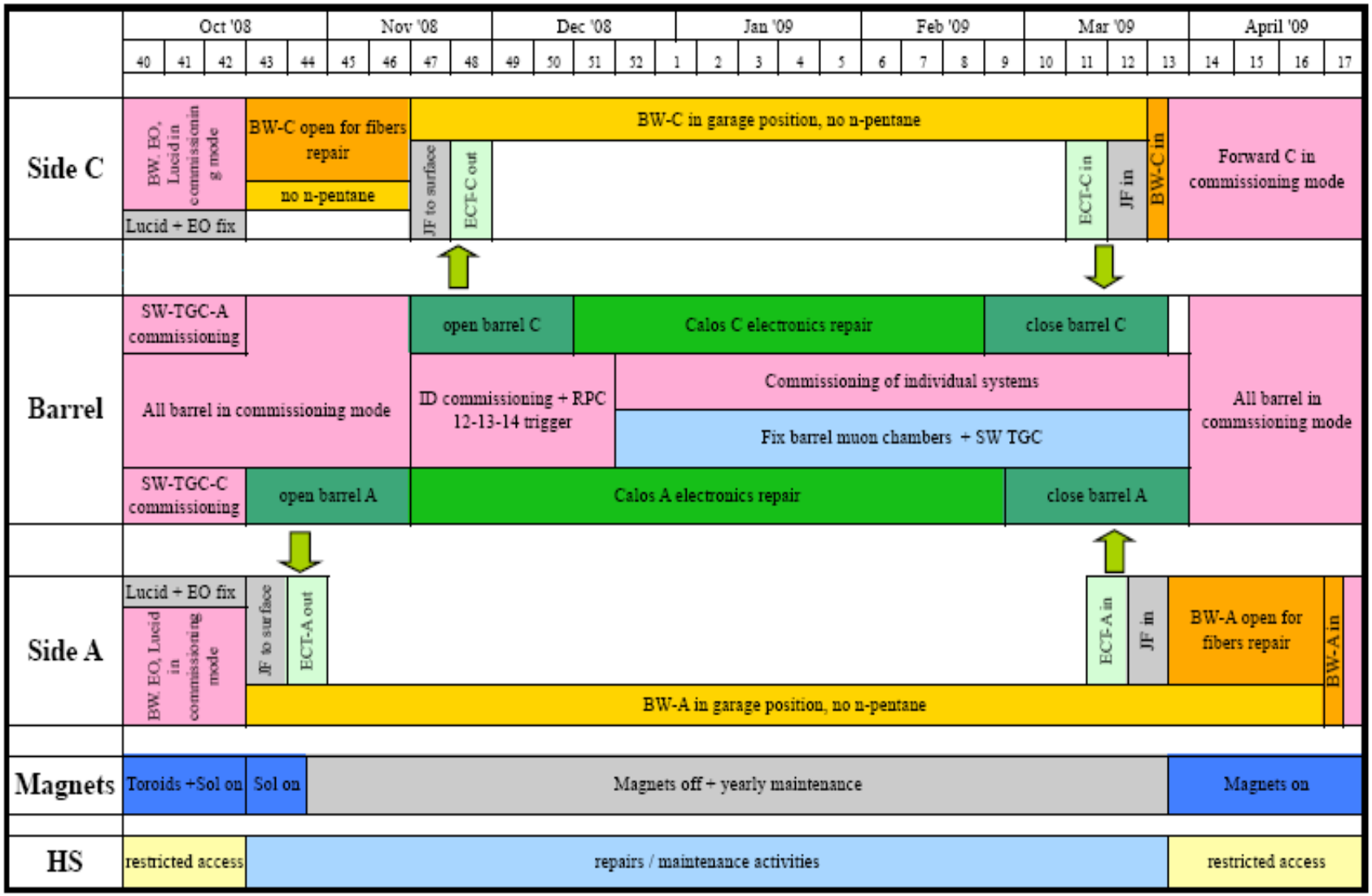

Figure 2 ATLAS shutdown planning winter 2008/2009 (Schedule Version 10.1)