Status of ALICE: Report to the October 2010 RRB CERN-RRB-2010-072

Introduction and Organization

ALICE is a general-purpose heavy-ion detector designed to study the physics of strongly interacting matter and the quark-gluon plasma in nucleus-nucleus collisions at the LHC. It currently includes over 1000 members from around 100 institutions in some 30 countries.

ALICE consists of a central part, which measures hadrons, electrons and photons, and a forward spectrometer to measure muons. The central part, which covers polar angles from 45^0 to 135^0 over the full azimuth, is embedded in the large L3 solenoidal magnet. It consists of an inner tracking system (ITS) of high-resolution silicon tracking detectors, a cylindrical Time Projection Chamber (TPC), three particle identification arrays of Time-of-Flight (TOF), Cerenkov (HMPID) and Transition Radiation (TRD) counters and two single-arm electromagnetic calorimeters (high resolution PHOS and large acceptance EMCAL). The forward muon arm (2^0-9^0) consists of a complex arrangement of absorbers, a large dipole magnet, and 14 stations of tracking and triggering chambers. Several smaller specialized detectors (ZDC, PMD, FMD, T0, V0) are located at small angles. A scintillator array to trigger on cosmic rays (ACORDE) is installed on top of the L3 magnet.

An extension of the EMCAL, proposed early this year, was approved in July. In 2010, the following institutes joined the Collaboration: University of Texas at Austin (USA); Chicago State University (USA), COMSATS Institute of Information Technology (Islamabad, Pakistan, Associate member). Discussions to join the Collaboration are ongoing with Bose Institute (Kolkata, India), Gauhati University (Assam, India), Korea Institute of Science and Technology Information (KISTI, Republic of Korea, Associate member), PINSTECH High Energy Physics Group, Physics Division, Directorate of Science (Pakistan, Associate member). The Collaboration elected P. Giubellino (INFN Torino, Italy) as Spokesperson and P. Braun-Munzinger (GSI, Germany) as chair of the Collaboration Board, to a 3 year term starting Jan. 2011.

Detector status:

Tracking Detectors (ITS, TPC):

With the exception of the SPD cooling, all 3 systems of the ITS - silicon pixels (SPD), drift (SDD) and strip (SSD) detectors- are operating stable and reliably during data taking. The insufficient cooling flow of the SPD, most likely due to clogged filters very close to the detector, allows operation of between 80% and 90% of the detector staves. A test set-up in the lab has been completed to study in detail the cooling flow and it is foreseen to move the TPC into parking position during the long shutdown of 2012 to get access to the SPD filters. The ventilation system of the SSD was improved and is now providing stable humidity. Studies are ongoing to further reduce the common mode signal generated by the low-voltage power supplies in view of implementing a solution during the 2012 shutdown. Alignment with data has reached the design accuracy for the SPD and SSD detectors and made significant progress for the SDD, the latter being more complex because alignment is coupled to the (time dependent) drift velocity calibration.

The TPC is running close to design specifications. Calibration of small field non-linearities, caused e.g. by mechanical tolerances in construction and assembly of the TPC, is nearly complete with remaining track distortions at the level of at most 400 μm. Occasional trips of some of the inner read-out chambers have been observed, in particular with high beam intensity and/or occasional splashes of beam related background. Measures to address this issue have been implemented, including increasing the gas humidity (to 200 ppm) and modifying the connections of the chambers to the HV supply.

Particle Identification Detectors (TOF, HMPID, TRD):

With improved calibration and alignment, the TOF resolution has reached 90 ps, which includes time slewing corrections at the level of individual frontend cards. Also in the HMPID occasional voltage trips have occurred with increased beam intensity, often during periods of beam steering. In July a leak has been detected in one of the HMPID radiator trays; the radiator has been by-passed during one of the LHC technical stops and no further degradation in the performance of the affected module has been observed. Production of TRD modules is ongoing; 3 further supermodules are ready and will be installed end 2010, the remaining 8 supermodules will be installed during the long 2012 shutdown.

Calorimeters (PHOS, EMCAL, ZDC):

Activity for the PHOS and EMCAL electromagnetic calorimeters concentrates on calibration of the installed modules (3/5 for PHOS and 4/10 for EMCAL) with data and commissioning of the respective triggers. Because of the very compressed construction schedule, these detectors could not be calibrated with test

beams prior to installation. The calibration precision improves in line with the collected statistics using the π^0 peak position. EMCAL production is continuing at maximum capacity, with two more supermodules ready and a 3rd being prepared for shipping to the test calibration site. All 6 remaining supermodules will be ready for installation in the coming winter shutdown, whereas production for the recently approved extension of the EMCAL (called DCAL) will continue into 2011.

The performance of the forward Zero Degree Calorimeter (ZDC) with heavy ion beams will ne negatively affected by the presence of the machine collimator, which intercepts a fraction of the produced neutral forward particles. Discussions with the LHC experts are ongoing to overcome the issue.

Muon spectrometer:

Alignment of the muon chambers with zero field data is progressing and has significantly improved the resolution; this work is ongoing. Noise performance is overall very satisfactory but a small fraction of the electronic channels suffers from slow baseline shifts which require frequent calibration runs; corrective actions are being investigated for implementation during the next shutdown. The Muon Trigger chambers, working in avalanche mode, have shown a stable behavior, with low currents, low counting rates and high efficiency.

Other Detectors (PMD, FMD, T0, V0, ACORDE):

All detector systems are fully included in regular data taking and operate stably. The T0 start-time counter has reached a time resolution of 50 ps after amplitude slewing and time walk correction for each readout channel. The V0 gain and timing has been equalized for all channels. The PMD stability has been improved by adjusting the chamber gains to their nominal values. The material in front of the FMD has been mapped in more detail to allow the measurement of charged particle density at forward rapidity.

Online Systems (DAQ, CTP, HLT, DCS):

The online Data Quality Monitoring software has been extensively tested and commissioned since the beginning of the pp run. The new software package ACT (ALICE Configuration Tool) is now used routinely to efficiently and reliably configure the experiment, including triggers and read-out modes. The Data Acquisition is being tested in view of the Heavy Ion run with HI-like data generated by the detectors electronics. These tests cover the whole online dataflow from the detectors electronics up to the mass-storage in the computing center.

The High Level Trigger (HLT) has been participating in the 2010 pp data taking period to commission and test both hardware and software components, including various physics trigger algorithms. At the current luminosity, it is mainly in use for data quality monitoring and online calibration tasks. The HLT capacity is currently being upgraded for the heavy ion run later this year.

The Detector Control System (DCS) is evolving with operational experiences as new requirements arise and new features have to be added to the system. As this system is crucial for the operation of the experiment, and in particular in view of decreasing the manpower required on site during data taking, user friendly interfaces, troubleshooting tools and an extensive user training have been put in place.

Offline and Computing:

Software: The main issue of excessive memory consumption by the reconstruction task is progressively coming under control. Data size and CPU power for pp reconstruction are according to the values foreseen in the Computing Model. CPU power for Monte-Carlo processing is still larger than the values assumed in the Computing Model. No substantial reduction is foreseen in the near future

Operation: All Data collected by ALICE (700 M of minimum bias triggers and 70 M of rare triggers plus various millions of cosmic and calibration events) have been reconstructed in a first pass quasi on line at the CERN T0. Pass 2 has been processed with improved algorithms and condition parameters in external T1 sites on the raw data replicated outside of CERN. The reconstructed events are replicated four times in Tier1s and Tier2s for analysis. Several analysis trains are run regularly over the entire set of reconstructed data. End users analyses are actively pursued on the GRID and on the PROOF-enabled analysis facilities. Since mid this year, all CPU power available to ALICE in T0, T1s and T2s is used for raw data reconstruction, Monte Carlo production and analysis tasks. About 50% of the installed disk storage is used so far. The computing resources required in 2013 will be calculated using the real parameters rather than those from the Computing Model.

Installation & shutdown activity:

Activities in this area include planning and organizing short consolidation and maintenance work during the regular short technical stops (~ once per month) as well as preparing for the longer winter shutdown period. The construction of one major structure for easier removal of the TPC to the parking position is currently under way and should be concluded by early 2011. TRD installation tooling and infrastructure tooling to temporarily hold the Miniframe is also being constructed and should be concluded by early 2011. Integration work for the DCAL support structure which will replace the PHOS cradle and rails and which will support DCAL, PHOS, CPV and possibly other upgrade detector in the future, is ongoing. For 2010/2011 LHC winter break of around 9 weeks, a major activity is planned to open the experiment and install the remaining 6 EMCAL modules and up to three TRD modules.

Frequent problems which occurred earlier this year with the primary electrical power and UPS system ('Uninterruptible Power Supply') are largely understood and cured. The UPS equipment, dating back to LEP, will soon run out of warranty and needs to be replaced and upgraded. The ITS ventilation system was tuned and improved such that its performance was acceptable during this summer; a replacement with a adequate machine is however foreseen in the near future. The SPD cooling problem is unchanged and located with high probability inside the TPC, and area which will be accessible earliest in 2012.

Operation & Data taking:

Data taking with proton beams at 7 TeV started end of March and steadily continued throughout the year. Up to end of August some 700 M of minimum bias triggers and 70 M of rare triggers plus several millions of cosmic and calibration events have been accumulated. As the machine luminosity increased, measures have been taken to reduce pile-up events by successfully colliding the beams in IR2 slightly displaced with respect to each other. Under these conditions a high multiplicity trigger has been put in place with a 50% duty cycle. In addition, a sufficient sample of 900 GeV pp data has been ensured.

In parallel, substantial progress has been made in increasing the robustness of the detectors and online-systems. The introduction of so-called Technical runs, exercised during machine development periods, and the extensive use of the ALICE Configuration Tool, have contributed to this progress. Interfacing with the LHC machine was improved significantly. With increasing stability of both the detectors and the online systems, and improving automatization and diagnostics, the operations crew could be reduced to 6 persons per shift (from some 30 early in 2010), supported by large number of on-call experts.

Physics & Analysis:

Starting November 2009, the analysis concentrated on proton-proton collisions data collected at three energies (0.9, 2.36, and 7 TeV). The collaboration focus is on signals which are needed as comparison data for the upcoming heavy ion period; however many of these results are also relevant in the context of pp collisions. The collaboration has published to date six articles in different scientific journals and a comparable number are in various stages of preparation. Since about mid-summer, an increasing fraction of the physics activity has been devoted towards preparing software and analysis for the heavy ion run, which is expected to start in November.