

## **Overview**

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  $45^\circ$  to  $135^\circ$  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 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 ( $2^\circ$ - $9^\circ$ ) 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 calibration trigger on cosmic rays (ACORDE) is installed on top of the L3 magnet.

## **Experiment status**

An extended commissioning program during the year 2008 prepared the ALICE experiment for first LHC beam in September 2008. ALICE is grouped into 18 subdetectors. At the time of first LHC beam, 14 subdetectors were fully installed, 3 subdetectors were partially installed (TRD/PHOS/PMD) and one subdetector (EMCAL) had just started with construction.

The Technical Design report for the EMCAL has been approved by the LHCC and the detector is expected to be complete by 2012. TRD construction, which was fully approved and funded only in 2006, is ongoing. Construction of the two remaining PHOS modules is currently on hold; funding has been requested in Russia. The PMD was only partially installed due to spark protection issues.

From May and until mid October ALICE, all 17 installed detector systems have been operated continuously (24/7) for about 6 months, taking cosmic and calibration triggers for global system commissioning, alignment and calibration. As far as could be verified with cosmics, the performance of all subsystems is very close to (or better than) specification.

ALICE entered into shut-down mode in October 2008 for a number of modifications, improvements and maintenance operations which will be carried out during the repair period of the LHC. The major activities include a re-cabling of the ITS and TPC services on the miniframe to improve the access to the TPC electronics, improvements to the ITS cooling system, noise reduction on the muon system and installation of addition TRD, PHOS, and EMCAL modules. This extensive program is currently ongoing according to the planning.

## **Silicon Pixel Detectors.**

**Status:** The SPD is installed and operational in ALICE including the prompt (FastOR) trigger processor. The detector and trigger commissioning was completed by mid 2008 and the detector was ready to record the first collisions in LHC. The SPD and its prompt trigger are fully integrated in the ALICE central systems, i.e. ECS, DAQ, DCS and CTP. The overall performance is well in agreement with the design objectives. Extended data taking with cosmics has allowed a preliminary alignment of the detector. The cooling performance has been studied in detail; the cause of the local lower cooling efficiency, which prevented the full operation of a few modules, has been found and corrective action has been taken. During the shutdown the cooling system has been modified in order to optimize the operating parameters accordingly.

**Changes:** No major changes.

**Concerns:** No major concerns.

**Plans:** Re-commissioning of the services and the detector after the reinstallation of the mini-frame.

## **Silicon Drift Detectors**

**Status** The extended data taking with cosmic rays in 2008 has allowed a detailed test of most aspects of the detector and to tune and commission the procedures for calibration and alignment. This analysis of these cosmic data has provided an excellent opportunity to tune and streamline the calibration and analysis procedures. In parallel, following the experience gained during the data taking, new software has been implemented in the readout boards (CARLOS-RX), which provides a new coding of the data with considerable reduction of the data volume. The design of a

completely new CARLOS-RX board, using a more powerful state-of-the-art FPGA is progressing well. The new board should allow more flexible operation of the detector and much better handling of errors. Following a decision taken by ALICE after the 2008 run, the routing of services on the so-called miniframe has been redesigned, in order to provide easier access to the TPC chambers and electronics for maintenance. This major activity has involved all services carried by the miniframe, and has required the redesign of some of the patch panels and a detailed optimization of the routing. The new services will be in place for the closing of the experiment prior to the 2009 data taking.

**Changes:** Improved control cards (CARLOS-RX) currently under design, new routing of services on the miniframe and patch panels, new software in the existing CARLOS-RX.

**Concerns:** No major concerns

**Plans:** Re-installation of the services and re-commissioning and the detector. Installation of the new Carlos-RX, which is not specifically tied to the shutdown since these boards are located in the counting room.

### Silicon Strip Detectors

**Status:** The SSD was stably operated from July until October and tens of thousands of cosmic hits were collected and processed. Both gain calibration and alignment were achieved to the level of a few percent and better than 0.1 mm, respectively. For geometrical reasons, the ladders with almost vertical modules did not collect enough statistics for this calibration or alignment. Some half-ladders with SINTEF modules developed bias problems and were switched off for normal data taking. During the winter stop the behavior of these ladders is being studied both in Alice and with spare parts in the laboratories. Some low-voltage power supplies appeared to be out-of-specifications. All supplies of the same type will be sent back for modification.

**Changes:** No major changes.

**Concerns:** Some half-ladders with SINTEF modules show increasing bias current.

**Plans:** Change of patch-panels position in the miniframe. Re-commissioning of A-side after miniframe reinstallation. Study behavior of SINTEF ladders.

### Time Projection Chamber (TPC)

**Status:** After the commissioning phase which lasted until October 2008, a large program was started to improve accessibility to the electronics, replace some faulty HV capacitors and electronics, and further improve infra-structure and services. This work is progressing very well and will be completed by May 2009. Meanwhile, analysis of data from the commissioning runs with Kr, cosmic radiation, and laser tracks is continuing. At present the gains of the nearly 560000 read-out pads are equalized to better than 1% and work is in progress to improve the calibration near the edges of read-out chambers. A complete survey was done of distortions in the TPC by precision analysis of tracks from the 2 calibration lasers. The results of these studies are presently incorporated into the calibration.

**Changes:** No major changes.

**Concerns:** No major concerns.

**Plans:** We plan to start running with the TPC in May to further improve the calibration and prepare for running with LHC beams later this year.

### Multigap Resistive Plate Chambers (MRPC) for TOF

**Status:** All 18 TOF SuperModules are fully installed and the gas tests have been completed. The last eight LV DC-DC converters with an assembly flaw have been repaired. The integration with the DAQ, TRIGGER, DCS and ECS systems has continued during the global commissioning and cosmic runs in autumn (September-October 2008). The TOF detector has taken data both in the global DAQ partition with many other subdetectors and in two special partitions with a few subdetectors, giving a cosmic trigger with the CTTM (Cosmic and Topology Trigger Module) to the TRD and to the HMPID. The analysis of these data, while not allowing a single-channel calibration of the full detector (more than 150000 channels) because of the poor statistics, has nevertheless allowed a test and rough calibration of the relevant TOF parameters and the corresponding correction algorithms. Moreover, the matching algorithms of the extrapolated TPC tracks with the TOF hits could be tested and refined.

**Changes:** No major changes

**Concerns:** No major concerns.

**Plans:** Commissioning with cosmics till the start of data taking with p-p.

### **High Momentum Particle Identification Detector (HMPID)**

**Status:** The analysis of the events taken during the LHC injection test showed a gain higher than expected from measurements with test beam. After thorough investigations, in collaboration with CAEN, an error was discovered in the calibration of the HV supply boards, leading to an applied voltage about 60V higher than nominal. All boards have been sent to CAEN for re-calibration and are due back to CERN by the end of March. The upgrade of the DCS started beginning of March and is expected to be completed before the end of the month. The firmware of the readout boards has been updated in order to improve the stability at high trigger rate and to implement a new data header for debugging purposes. Both the online and offline software has been updated accordingly. The integration of the online monitor of the  $C_6F_{14}$  transparency will start after the DCS upgrade together with the repair of a leak in the detector liquid system, already located, inside the L3 magnet.

**Changes:** No major changes

**Concerns:** No major concerns.

**Plans:** During the shutdown the system to monitor online the transparency of the liquid  $C_6F_{14}$ , already commissioned in the laboratory, will be integrated in the circulation system at P2.

### **Transition Radiation Detector (TRD)**

**Status:** The readout chamber production of 540 chambers plus spares has recently been completed. The first two installed supermodules have been removed and disassembled to repair the microleaks also in those 60 chambers. The repair has been completed. The first of these modules was reassembled and is ready at CERN for installation. Reassembly of the 2<sup>nd</sup> is ongoing. In the mean time 2 more supermodules were completed, installed and integrated into the ALICE setup.

The problems in the read-out board production have been diagnosed by the manufacturer and a plan with slight modifications in the multi-chip module production has been agreed on. A first batch of 1000 is just being produced. If successful, production will resume with a rate of 5000 per 2 weeks and with 2 weeks offset 275 read-out boards every 2 weeks.

The control of the TRD is readied for operation by the ECS and non-expert shift operators.

The data taken in the cosmic run with 4 supermodules were used for calibration. Currently tracking is optimized for the purpose of internal alignment of the TRD chambers and then alignment relative to the TPC.

**Changes:** Modifications in the manufacturing of the multi-chip modules.

**Concerns:** Yield in readout board production and possibility of repair.

**Plans:** Production of new super modules at a rate of one every 6 weeks; possible installation of 2 more before start of the data taking this year and completion of the rest for installation after the long run 2009/2010.

### **Photon Spectrometer (PHOS)**

**Status:** End September, 2008, production of the improved and airtight casings for 3 PHOS modules started. End February, the production was completed for the first casing, and the PHOS module #3 without crystals and electronics was successfully tested for air tightness. Beginning March, re-assembly of the crystals and electronics started. It is planned that one PHOS module is re-assembled, tested and ready for installation by middle April. The production of the remaining two new casings is underway. It is expected that the other two PHOS modules are re-assembled, tested and ready for installation by middle June. Two final modules (4&5) are partially funded (FEE cards by China, APD's and preamplifiers by Japan). No funds from Russia are available in 2009 for crystals and mechanics, and the situation with the Russian funds for the next years is uncertain.

**Changes:** No major changes.

**Concerns:** No major concerns.

**Plans:** One PHOD module ready for installation mid April, the remaining two ready for installation in mid June.

### **Electromagnetic Calorimeter (EMCal)**

**Status:** Fabrication of all subsystems continues at maximum capacity. The first two super modules have been completed and both have gone through complete laboratory cosmic ray testing and calibration. The first of these super modules has been delivered to point-2 from Wayne State University (USA) and the second from LSPC-Grenoble (France). The installation of these first two super modules is planned for mid March. A third super module is presently undergoing final assembly at Wayne State and should be delivered to point-2 in June.

**Changes:** First two super modules completed and delivered

**Concerns:** No major concerns

**Plans:** Continue mass production of detector and electronics. Finalize integration with ALICE trigger and DAQ and participate in first LHC run.

### **Muon Tracking Chambers**

**Status:** All the stations are installed. The commissioning continues, done for station 1 and station 2 and still ongoing for stations 3/4/5, mostly due to electronics connection problems, slowing down the progress and requiring careful handling of the electronics. However, stations 4 and 5 are basically ready and their final tuning is scheduled in April. Station 3, which is more difficult to access will be ready by end of May. With one exception, all chambers are read out by the global Alice DAQ. The noise on slats of stations 3/4/5 has been identified and essentially completely removed by modifying the low voltage power supplies and reducing the noise coming from some ventilation units. The alignment monitoring system (GMS) for the muon spectrometer is close to completion and its commissioning is progressing in parallel with chamber commissioning.

**Changes:** No major changes. Noise has been understood and removed

**Concerns:** Delay due to read-out commissioning.

**Plans:** Continue the commissioning to be fully ready by mid-June. A muon cosmic run with stable configuration is planned in March-April.

### **Muon Trigger Detectors**

**Status:** The complete muon trigger detector is fully installed since early 2008. Detector alignment, with an accuracy of  $\pm 2$  mm, is completed. The Detector Control System as well as the readout system are fully operational. The Muon Trigger can now be operated either in streamer or avalanche mode thanks to a number of recent upgrades. A number of minor improvements and maintenance operations have been carried out during the current shutdown. The Muon Trigger, operated in streamer mode, was commissioned with cosmic rays in December 2007, February and June 2008. During the test period of June 2008, the Muon Trigger was successfully delivering trigger signals for cosmic events. The Muon Trigger participated to the LHC injection tests carried out in summer 2008 and a large background, from the interactions of the injected protons with beam screens, was detected.

**Changes:** No major changes.

**Concerns:** No major concerns.

**Plans:** Further commissioning (March-April and summer 2009) of the whole Muon Trigger system with long cosmic runs, in streamer mode and avalanche mode

### **Forward and Trigger Detectors (ZDC, PMD, FMD, T0, V0, ACORDE)**

**Status:** The ZDC detector is fully installed, integrated and commissioned. Standalone laser runs were performed to check the stability of the monitoring system.

The installation of electronics protection circuits is ongoing for the PMD. The series resistors have been implemented in each channel of the front-end electronics and tested for stability. In order to overcome the problem of EMI interference, the cables are being shielded properly. 80% of the detector modules have already been tested and certified for use. The complete detector will be installed and commissioned for data taking before the start of the next LHC run.

The FMD detector was operated during LHC injection tests, showing excellent energy response. The system including slow control and readout was fully commissioned, including better zero suppression and fast busy signal logic. The rate capabilities of the detector have been improved to 4kHz; further increase is being studied. Due to the work on the ALICE miniframe the FMD1 detector has been removed and will be reinstalled in June 2008. Work is ongoing to develop analysis methods for first physics analysis using the FMD.

The ACORDE, V0 and T0 detectors have been commissioned as trigger detectors and to monitor background rates during the first LHC injections in August/September.

**Changes:** No major changes.

**Concerns:** No major concerns.

**Plans:** Complete PMD installation, re-installation of A-side detectors (T0/V0/ZEM) which were removed during miniframe modification.

### Trigger

**Status:** The Central Trigger Processor has been fully operational for more than one year, and has been used successfully with both cosmic rays and circulating beam. Following the LHC shutdown as from the end of September 2008, a programme of improvements has been started for 2009 operation. These focus on software and firmware upgrades, for example in data logging of the trigger operation and new monitoring tools, allowing much more detailed information on running conditions to be retrieved in future. There is better integration with the data interface provided by the LHC accelerator on running conditions. The use of the new data logging facilities in offline applications is being developed.

**Changes:** No major changes

**Concerns:** No major concerns.

**Plans:** Continue refinement of software. Preparation of configuration files for different modes of operation with beams.

### Data Acquisition (DAQ)

**Status:** The DAQ is in use during the shutdown for the commissioning of individual detectors. The global schedule foresees 4 weeks of online commissioning in July and 6 weeks of cosmic run in August/September. New versions of the DAQ and ECS software packages are being developed to answer to new requirements (software access to the electronic Logbook, new DCS Finite-State machines, etc) or to address issues identified during the run of 2008 (stability of long global runs). The DAQ performance will be increased from its current value of 40% to its nominal value by completing the hardware deployment. This addition of new hardware will mainly concern the event building, the data storage, and the data quality monitoring. The administrative part of this purchase is in progress in order to complete the installation by the end of July.

**Changes:** No major changes.

**Concerns:** No major concerns.

**Plans:** Complete installation to 100% DAQ capacity.

### Detector Control (DCS)

**Status:** DCS is continuously up and running throughout the shutdown in order to assure the safety of the installations and to assist the detectors in their commissioning activities. Several parts of the system are being extended and upgraded both in terms of hardware and software. This concerns in particular the control and monitoring of the electricity distribution, the rack cooling system and the DCS network infrastructure.

New versions of the DCS software systems, tools and components are being developed to overcome limitations and weaknesses experienced during the runs in 2008 and this will be installed during spring 2009 in all the 150 servers of the distributed control system. Each detector system will in this way be individually upgraded and subsequently re-integrated into the global DCS system. Common operation and commissioning of all detectors is foreseen during 4 weeks in July followed by a cosmic run in August and September.

**Changes:** No major changes.

**Concerns:** No major concerns.

**Plans:** Revise, upgrade and re-commission DCS.

### High Level Trigger (HLT)

**Status:** The HLT infrastructure for the first year running was installed at Point-2 by mid 2008 and fully operational; including on-line reconstruction, event visualization, calibration and data

compression during cosmic running and injection tests. While not operated in on-line mode, the HLT executes off-line grid jobs on the HLT cluster.

During the shutdown period, ITS and EMCAL reconstruction is being implemented and tested as well as improvements in the TPC calibration. For the TPC on-line reconstruction, the tracking algorithm based on the cellular automaton method has been successfully tested with simulated pp and PbPb data. The HLT Trigger Infrastructure is being implemented and the first HLT Trigger algorithms are in the process of inclusion into the HLT. These first trigger are a high-pt Jet Trigger, D0 Trigger, DiMuon Trigger and high-pt barrel tracks Trigger.

**Changes:** No major changes.

**Concerns:** No major concerns.

**Plans:** PC cluster upgrade for 2<sup>nd</sup> year running, finalizing of triggering infrastructure.

### Offline

**Status:** Software: AliRoot went through strict test in preparation of pp events processing and in particular for fine-tuning of the reconstruction algorithms and parameters. The analysis framework is in production status for Grid end-users analysis, for Grid organized analysis (analysis train) and for prompt parallel analysis on PROOF clusters at CERN (CAF) and GSI. A new Analysis Facility is being deployed at CCIN2P3.

Full Dress Rehearsal: The tests of the various elements (online calibration and reconstruction, export of data, offline reconstruction at T0 and T1s) of the computing model were tested separately for limited time periods to save computing resources. The number of regular GRID users for analysis is presently about 150 users.

Physics Data Challenge: Several large scale MC productions focused on the production of data required for first physics in 0.9 and 10 TeV pp collisions.

Grid Services: A xrootd-enabled SE is available in most T2s.

**Changes:** No major changes.

**Concerns:** Insufficient computing resources remain a concern.

**Plans:** Prepare the AliRoot release for data taking; organize a full dress rehearsal together with the other LHC experiments, MC production and large scale distributed analysis.

### Installation & Assembly activities

**Status:** The shutdown activities were started in October 2008. The main shutdown goals are: Modification of miniframe services, installation of at least two EMCAL supermodules, modification of one PHOS module and installation of two additional ones, repair of two TRD modules and installation of at least two additional ones, installation of the full PMD detector.

The miniframe, carrying the services of A-side TPC and ITS, is restricting the access to the TPC which turned out to be a sever restriction for servicing the TPC. The miniframe was therefore brought to the surface where the services are rerouted and all access issues are being improved. The activity is ongoing and reinstallation is planned for May 2009.

Two EMCAL supermodules have arrived at CERN and are being installed in March 2009. If the access conditions during LHC powering tests permit, 1-2 additional supermodules could be installed before LHC start-up.

The PHOS module installed for the 2008 period experienced problems with air condensation at low temperatures and was therefore operated at ambient temperature during the 2008 commissioning. The module was removed from the cavern and is currently being modified. Two more modules are in preparation for installation.

Two installed TRD modules with excessive leak rate were removed in October 2008 and are being repaired. Two new modules were installed early 2009 and the two repaired ones will be installed before June, which will bring the system to 6/18 modules. Additional modules could be installed depending on access conditions during LHC powering tests.

The PMD solved the spark protection problems and the detector is currently being assembled on the surface at P2.

**Changes:** No major changes.

**Concerns:** Manpower to complete shutdown program in time.

**Plans:** Complete currently planned installations and modifications in June; additional EMCAL and TRD modules in July if possible during LHC power tests.

### **Global commissioning and operation**

**Status:** ALICE entered into shut-down mode in October 2008 to allow sufficient time for modification of the ITS and TPC services on the miniframe and re-commissioning of services and detectors. Stand-alone detector and systems tests are however continuing on a lower level.

**Changes:** No major changes

**Concerns:** Need to reduce the manpower needed to operate the detector. Readiness for data taking after long shutdown with major hardware intervention in cabling of central detectors and software upgrades.

**Plans:** Detector re-commissioning will start for individual systems in March/April and continue until early July. This will be followed by system integration tests in July and continuous (24/7) global commissioning and cosmic data taking in August until the restart of the LHC with beams in September.