

Status of ALICE: Report to the April 2007 RRB

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 close to 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° to 135° 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 a single-arm electromagnetic calorimeter (PHOS). The forward muon arm (2° - 9°) 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) will be installed on top of the L3 magnet. A proposal by a group of US, Italian, and French institutes to construct an electromagnetic jet calorimeter (EMCAL) is under consideration by the respective funding agencies.

The detailed design of ALICE has been laid down in 14 detector Technical Design Reports. The Technical Proposal for the EMCAL has been approved end 2006.

Construction of infrastructure items, supports, the muon magnet and most detectors is completed; detector and services installation has started in mid 2006 and is progressing on schedule.

Silicon Pixel Detectors

Status: The two half-barrels have been fully assembled on the surface in the CERN DSF area. Extensive test and pre-commissioning have been carried out using concurrent operation of trigger, calibration, DAQ, DCS and ECS. Test runs with cosmics have been done on an individual sector and on sectors on a half-barrel. The two half-barrel are undergoing the final mechanical checks and are being prepared for the installation in the experimental area at the end of April. The prototype processor module for the pixel trigger (FastOR) is working well.

Changes: No major changes.

Concerns: No major concerns.

Plans: Installation in the experimental area.

Silicon Drift Detectors

Status: During the second half of 2006 the production of all components for the ALICE Silicon Drift Detectors has been completed. All detectors and front end electronics chips have been assembled into modules and each individual module has been mapped with a laser. The modules were mounted in linear structures called ladders, and each individual ladder was tested in detail. Finally, the ladders which passed all test steps were mounted on the final mechanical structure to form the two SDD layers. At the end of January 2007 the assembled SDD layers were transported to CERN. After further tests they were integrated together with the SSD layers. Mid March the SSD and SDD layers were installed on the assembly rails and moved into their parking position inside the ALICE TPC.

Changes: No major changes

Concerns: No major concerns

Plans: Connection to the final cables in May and commissioning with cosmics in the summer of 2007.

Silicon Strip Detectors

Status: The last ladder was mounted on the SSD support structure, cabled and tested by mid November. After a month of full testing of all ladders including the hydraulic circuits, the SSD was shipped to CERN where it arrived mid December. There it was rotated into its final horizontal position and again fully tested. Late February, the SDD was inserted into the SSD and common test were done. The installation of the ITS barrel (SSD+SDD) took place on 15 March. A combined commissioning test, including a fully equipped spare ladder, Trigger, DAQ, DCS, and ECS, has successfully been performed in March in the laboratory.

Changes: No major changes.

Concerns: Late delivery of power supplies.

Plans: Connect and test SSD before summer.

Time Projection Chamber (TPC)

Status: Pre-commissioning of the TPC in SXL2 was completed by Dec 06. The last phase included re-testing all sectors for about 40h each with the final cabling. No failures of electronics occurred in this phase. After a very thorough study of the front end noise situation, elevated levels of noise that had been seen at the outer readout chamber boundaries were completely removed with a modification of the grounding scheme.

The TPC was prepared for the transport from SXL2 to UX25 in Dec, the transport was performed in the first week after the Christmas closure of CERN, bringing the TPC in its transport frame to a position in front of the L3 magnet. From there it was moved to the final position at the interaction point and aligned. The TPC was then moved back by end of Feb by 4.6 m to the so-called parking position to allow installation of the ITS, beam pipe and forward detectors.

At present the services are being prepared and the cooling system is pre-commissioned, in order to be ready to connect the TPC and start commissioning in situ, starting Jun 07 on the C-side. On the A-side, the services will become available only in August after installation of more TRD and TOF modules; A-side commissioning will start then.

Changes: No major changes.

Concerns: No major concerns.

Plans: Commissioning June to Sept 07 (TPC standalone), global commissioning from Oct.

Multigap Resistive Plate Chambers (MRPC) for TOF

Status: The production of the MRPC strips has been completed for the 18 SuperModules (SM). A test at PS of a sample of strips chosen from 2 years of mass production has confirmed the excellent performances of the detector (99.6% efficiency, 48 ps global time resolution). The delivery of mechanical components of the modules has reached 78% of the total and the module's assembly with MRPC strips 50%. After the module tests in the Cosmic Ray Facility at CERN, the first two SM were assembled and installed in the Spaceframe in October 2006. Due to a mechanical interference (small clearance) with the Backframe, a new design of the SM mechanics had to be implemented, leading to some delay in the SM production. The mass production and delivery of the Front-end cards (FEA and FEAC) is almost completed (80% and 95% respectively). The delivery of the readout electronic boards is ongoing: 64% of the TRM (TDC Readout Module), 45% of the LTM (Local Trigger Module), 100% of the CPDM (Clock and Pulser Distribution Module) cards have been delivered and tested. One third of the custom crates with the LV DC-DC converters has been delivered and tested. The first two DRM (Data Readout Module) boards equipped with the final, radiation-hard Actel FPGA have been delivered and fully qualified in a combined test with the ALICE DAQ team. The integration with the DAQ, TRIGGER, DCS and ECS systems is very well in progress; the final complete test with a SM is scheduled in April.

Changes: No major changes

Concerns: Tight schedule for the SuperModule assembly.

Plans: Complete mass production of mechanical and electronic components. Continue module and SM assembly and install at least five new SM's in July.

High Momentum Particle Identification Detector (HMPID)

Status: After the installation of the detector inside the ALICE magnet in September 2006, the assembly, installation and connection of the services (gas, cooling and C₆F₁₄ circulation systems, low and high voltage, DCS, DAQ) started in October. All cables and pipes have been installed, tested and connected inside the magnet. The connection of the cables in the Control Rooms will be completed before Easter and the authorization to power on the detector will be granted by the end of March, subject to a final safety inspection. This will allow to start the commissioning of the DCS and DAQ system as well as to check the performance of the front-end electronics.

The assembly of the pumping station (located in the cavern) for the circulation of liquid C₆F₁₄ in the radiator trays is completed and commissioning will start beginning of April. The assembly of the purification station (located in CR5) will start middle of April, after a final design review, and will be delivered by July.

Changes: No major changes.

Concerns: No major concerns.

Plans: Completion of the services installation and of the C₆F₁₄ circulation system. Final commissioning of the detector and of the software tools by end of September.

Transition Radiation Detector (TRD)

Status: More than half of the readout chambers of the now fully funded TRD have been finished at the five production sites (Bucharest, Frankfurt, Heidelberg, GSI, and JINR) including production of the new Layer 0 chambers. The first super module has been completely assembled and installed in the ALICE space frame and is currently being connected to the services. Prior to installation it was shown that the noise level anticipated in the TDR is reached ($\sigma=1.07$ ADC counts corresponding to 1070 electrons). Power consumption matches simulations in the TDR for different trigger conditions. The trigger rate dependent power consumption is matched by the capacity of the cooling system. The entire readout chain involving the first modules of the Global Tracking Unit (GTU) as well as components of the ALICE DAQ has been successfully exercised. The Detector Control System (DCS) is operational for all components of the TRD (HV, LV, MCM configuration, gas, cooling). A first version of the DCS involving Finite State Machines will be installed at CERN and tested under realistic conditions in April.

Production of the electronics (MCMs and readout boards) is now done with good yield by industry. For most efficient mass production of TRD super modules the work has been redistributed between the participating institutions. Mounting of the pad planes is now done in Darmstadt, equipping chambers with electronics and testing of the equipped chambers takes place in Frankfurt, and super module assembly and testing with cosmic rays is done in Münster.

Changes: redistribution of work for efficient mass production of super modules

Concerns: tight schedule for the super module production

Plans: production of 2 additional super modules for installation in July

Photon Spectrometer (PHOS)

Status: The first PHOS module has been assembled, pre-commissioned and calibrated with electron beams at the CERN PS. Some improvement of the module is now underway. Crystals for two further modules (2&3) have been produced; these will be ready for installation end 2007. Funds for the

production of the mechanics have been allocated in Russia, and for the APD's and preamplifiers in Japan. A revision of the mechanics design has been done and production of modules 2&3 is underway. Two final modules (4&5) are partially funded. Production of the FEE cards is funded by China, and production of APD's and preamplifiers is funded by Japan. Funds for production in 2007 – 2010 of the crystals and mechanics for these last modules are requested in Russia. The full PHOS with five modules can be completed by the end 2010 provided that additional Russian funds are available.

Plans: Installation of the first module in June. Assembly, test and commissioning of modules 2&3 by the end 2007.

Changes: No changes.

Concerns: No technical concerns. The production of crystals in Russia has stopped due to lack of funding. Funding from Russia for production of the crystals and mechanics for modules ##4&5 is under review.

Muon Tracking Chambers

Status: All the MANAS FEE chips and 75% of the MANU cards are delivered. They have been used to equip 7 half-chambers of stations 4 and 5, 8 quadrants of station 1 and will be used on 6 out of 8 quadrants of station 2.

The installation of stations 4 and 5 rails is done. The installation of supports and cooling of station 1, 2, and 3 is finished. Six half-chambers of stations 4 and 5 are installed in the cavern and two more are ready for installation. The installation of services between supplies and detectors is done for stations 1 and 2 and will finish end of April for stations 3, 4 and 5. The cabling on the detectors has started.

All the FRT, CRT, chassis and backplanes of the DAQ CROCUS are produced. Calibration cards are produced and calibration tests have been done on quadrants and are in progress on slats. CROCUS software needs still developments and tests on larger scale. A global DAQ test in the laboratory, involving DAQ, CROCUS, Trigger Dispatcher, LV and HV DCS, ECS, has been successfully performed in March.

Concerns: No major concern.

Plans: Installation of stations 4 and 5 will finish mid-April. The commissioning will start on station 1 end of March and on station 4 in April.

Muon Trigger Detectors

Status: The mechanical support of the trigger detectors (RPCs) has been installed and aligned on the superstructure. The complete set of RPCs is presently installed in its working position. The whole FE electronics (~2500 boards) is mounted on the RPC readout planes and tested in the ALICE cavern. Installation of the service columns and of the translation system has been completed. The signal cables (1500 cables in total) are built and installation was started. At present, about 37% of the signal cables, corresponding to 3 out of 8 half planes, are installed.

The Local (242 units in total) and Regional (16 units) trigger electronics are in place in the cavern. The Global trigger board (1 unit) is ready for installation.

Commissioning of the whole electronics (including cables, FE, trigger electronics, JTAG links for the configuration of the Local boards) is performed using a pulse generator and following the progress of cabling. Presently two half planes are fully validated. The readout makes use of the DARC prototype card. The final DARC boards (2 units) are being produced. Test of the interface with the ALICE central Trigger, DAQ and ECS is scheduled in spring.

Changes: No major changes.

Concerns: No major concern

Plans: Installation of signal cables and test of the whole trigger electronics; Detector commissioning.

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

Status: The ZDC support platforms are produced and commissioned, integration with the detector is under way.

The ACORDE electronics is being installed and the communication with trigger and DAQ has been successfully tested. Electronics production for T0 is ongoing. V0C production is complete and the detector will be installed in April. PMD and V0A production are proceeding.

The Forward Multiplicity detector (FMD) assembly is 80% complete and two of the three rings (FMD2, FMD3) have been moved to CERN. The detectors have been tested and commissioned with full DAQ, Trigger and with partial DCS system at CERN. All channels exhibit a signal to noise between 25 and 45. The system operates routinely at rates up to 1 kHz (read out and accepted by DAQ). The FMD3 detector will be installed in the ALICE pit mid April, to be followed by FMD2 a few weeks later. The remaining ring (FMD1) will be brought to CERN before the summer and installed after the summer.

Changes: No major changes.

Concerns: No major concerns.

Plans: V0C electronics ready end March. T0-C will be installed in April and T0-A in September 2007. ZDC installation in May.

Trigger

Status: At present, four complete Central Trigger Processor (CTP) systems are in operation, two in Birmingham and two at CERN. The two Birmingham systems are being used for training and system development respectively. The CTP has been comprehensively tested and found to work according to specification. One of the CERN systems is connected to test modules in the DAQ lab via 60m cables and fibres, allowing detailed tests of the trigger, DAQ and ECS systems working together. The configuration and control software is ready, and development of monitoring and offline software is continuing. Commissioning of the trigger interfaces of the detectors, using a Local Trigger Unit (LTU) is in progress. The tests include a mandatory joint trigger/DAQ/ECS test on the surface prior to installation at Point 2. In addition, the trigger interfaces and state of readiness of the sub-detectors was reviewed at a workshop in February. The fifth CTP system and the local trigger crates are being installed at Point 2, and the first detector test (with ACORDE) at Point 2 is expected during April. Following completion of the ACORDE commissioning, the trigger system will be able to distribute both cosmic and pulser triggers.

Changes: No major changes

Concerns: No major concerns.

Plans: Completion of installation of CTP at point 2 and start of detector commissioning *in situ*.

Data Acquisition (DAQ)

Status: The production of all the DDL has been performed and a large fraction has been delivered to the various teams to equip their detector. The production of the D-RORC is done. DDL and RORC prototype cards are used by most detectors for the test and commissioning. All the other hardware elements of the DAQ are purchased from industry and the first stage of equipment has been delivered and installed in the DAQ counting room. This equipment and the ALICE DAQ software framework (DATE V5) have been exercised intensively during the ALICE Data Challenge VII reproducing conditions very close to the ones of a heavy ion run: a sustained throughput of 1 GByte/s during 4 days and a total of 1.4 PBytes archived in 18 days. The combined commissioning of the detector with the DAQ (DDL and DATE) and the other online systems (Trigger, HLT, DCS, ECS) is being performed in a systematic manner before the installation of the detectors in the experimental area. The installation of the optical fibres from the detectors to the DAQ is in progress. The ALICE Control Room has been installed and is being equipped.

Changes: No major changes.

Concerns: No major concerns.

Plans: Continue integration of DAQ/ECS with detector subsystems.

High Level Trigger (HLT)

Status: The infrastructure for the first year running is setup at Point-2. This includes the installation and commissioning of all computers, the installation of the H-RORC cards as well as the DDL interface devices DIU. The remote administration devices CHARM are fully installed. All network cables and patch panels were installed for the final HLT size. All interfaces to the various systems, such as ECS, DCS, off-line are installed on fully redundant machines. The networking is in place.

The HLT was used successfully during the TPC commissioning and is now prepared for the various TPC calibration tasks, where the HLT is going to be used. The full TPC analysis chain has already been exercised at Point-2 with simulated data. The on-line software for the TRD, DiMuon and PHOS detectors are currently being commissioned. PHOS is using the HLT for the first level data compression. Appropriate compression algorithms for the TPC and TRD are currently being evaluated.

Changes: No major changes.

Concerns: No major concerns.

Plans: Calibration of the TPC as large scale use case and reliability tests of the detector analysis code.

Offline

Status: The development of the AliRoot software has entered the last phase leading to the version to be used for the processing of the data from the first LHC run. Work is still going on to reduce memory and CPU consumption, to make the code more robust and to reduce the size of data (raw and ESD). The common AOD data structured has been prototyped. The analysis framework has been released and adopted by users. The access to calibration data in the OCDB is fully operational and is being optimized further. The implementation of the detector geometry as installed is in progress including cables and services. The validation of the Fluka transport is progressing. The integration of the GEANT 4 package into AliRoot is completed and validation is starting. The detector visualisation, fully integrated in ROOT, is available for almost all detectors. Alignment and calibration is implemented in the reconstruction algorithms for most detectors but the integration of the survey data remains to be done. The framework to calculate the calibration parameters online (DAQ, DCS, HLT) and to feed them into the Offline Condition Data Base is fully operational. The implementation of the detector specific algorithms within this framework has started and several have been tested.

The development of a new version of the AliEn file catalogue with faster access and improved scalability is being finalized and will be released in April. The interface to the Nordic ARC GRID is still under development. The development of the interface to the US OSG GRID is pending the approval of the ALICE-USA computing plan. The ALICE storage architecture based on xrootd is fully operational. Interfaces to the LCG storage solutions are in advanced tests and validation stage (dCache) or close to be released for testing (CASTOR2 and DPM).

The currently running 2007 Physics Data Challenge is a continuation of the PDC 06. Its main goals are to produce events required by the Physics Working Groups and to test and validate the new releases of the Grid and application software. In the past 11 months, 1200 jobs on average were running over the entire period. During this challenge new sites will be added to the ALICE Grid, the new components of the LCG Grid and of the application software will be validated with special emphasis on standard LCG storage solutions. All sites which have pledged resources to ALICE take part to the challenge. However, there remains a substantial amount of resources still to be set-up in Poland, NDGF, KISTI, China, and US.

The last major exercise of PDC 06 was the scheduled data replication exercise, using the FTS service. During this exercise, the nominal transfer rate of 300 MB/s between the CERN Tier0 and the ALICE Tier1s has been reached.

A “full dress rehearsal” is scheduled to start before summer. It will combine all steps needed to produce the ESDs from RAW and requires the synchronous running of DAQ, DCS, HLT and Offline. Elements of the various frameworks have already been tested in 2006, but only a few of them together, and none under stress.

The parallel analysis framework based on PROOF and to be deployed on the CAF is operational and tested by several concurrent users. The framework is continuously developed to make it more robust (data access), to be able to cope with an increasing number of users (priority scheduler, support for GRID certificate). Several physics analysis use cases have been developed and implemented in the analysis framework that allows running interactively or in batch mode on the GRID. Analysis tasks are continuously running on the GRID.

Monthly tutorial sessions on AliRoot and user analysis on the Grid are organized for the ALICE collaborators.

Changes: none

Concerns: The situation of the computing resources made available to ALICE remains a concern. In 2006 only 50% of the pledged resources was made available to us. More pledged resources become slowly available (NDGF, Poland, US). Additional resources are promised but have not yet materialized.

The stabilisation of 3-4 staff on long term positions at CERN in the Core Offline remains a priority.

Plans: Commissioning of the offline framework together with the detector commissioning, full dress rehearsal, user driven analysis challenge, discuss with the sites the availability of more resources.

Installation & Assembly activities

Status: The installation of two TOF modules, one TRD module, the HMPID detector and one third of the ACORDE detector has been completed. The installation of the TPC and ITS detectors has started. The Muon Trigger chambers are installed and half of all Tracking chambers have been installed. All large support and infrastructure installations have been completed. Intense work on installation of cables is in progress.

All racks and counting room installations have been prepared and individual powering of racks has started. The initial design and integration activities have been completed and preparation of *as built* documentation has started.

Changes: The installation schedule has been up-dated and aligned with the progress of the detector installation program.

Concerns: Access and the protection of the installed detector units.

Plans: Continuation of installation of detector units and services.

MILESTONES

The planning shown as ‘baseline’ in the plot below was established in early 2005, aiming at closing the detector in April 2007. The achieved milestones show a delay with respect to this plan but are well in line with the revised LHC schedule as announced in June 2006. The ITS system, which has been on the critical path in the past, is now being installed. Installation of some parts of our modular detectors (PHOS, TOF, TRD) will continue beyond that date.

