Status of ALICE: Report to the October 2005 RRB CERN-RRB-2005-087

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 almost 1000 members from over 80 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 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 (2^0-9^0) 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 calibration trigger on cosmic rays (ACORDE) will be installed on top of the L3 magnet.

The detailed design of ALICE has been laid down in 14 detector Technical Design Reports. The Computing TDR has been submitted in June 2005.

Construction of infrastructure items, supports and the muon magnet is largely completed and detector construction and assembly are well under way.

Silicon Pixel Detectors

Status: The production of detector ladders and low mass readout boards (MCMs) is under way. Automated test benches with well established procedures are operational in several locations. The assembly of half-staves has been optimized leading to a substantial capacity increase in order to speed up production. The first sector (12 half-staves) has been fully assembled and is being moved to the CERN DSF clean room where a dedicated test and integration area has been set up. Several readout modules (Routers) are under test. A prototype DCS system, including the interface with the front-end DAQ, has been developed.

Changes: No major changes.

Concerns: Several components, including the aluminium-polyimide laminate bus, are at the cutting edge of special technologies and production yields are an issue. Extremely tight schedule.

Plans: Assembly of half-staves and sectors, system integration.

Silicon Drift Detectors

Status: Detector deliveries from CANBERRA are progressing regularly at an increased rate of 24-26 detectors/month. The yield is of about 50% and efforts are being made to further improve this figure. In particular, the quality of the wafer surface before starting the process is being qualified for every single wafer and new tools have been developed in order to eliminate any risk of accidental contact. Yield increase and process optimization (towards 36 wafers/month) should allow to meet the schedule agreed with the producer to deliver the needed 260 SDDs by April 06 and 40 spares by June 06. The detector characterization equipment is operational at INFN-Trieste and OSU.

The wafer-testing of front-end chips (PASCAL and AMBRA) proceeds at INFN-Roma at a rate of about 3 wafers/months followed by thinning and dicing at WSI; 52% of the chips needed were delivered by August to the assembly pipeline, thinned and diced. The 600 readout/compression chips CARLOS-v.5 are being tested at INFN-Bologna (yield of 85% on the first 150 chips, total need is 300 including spares).

Sub-hybrids and chip-cables are being delivered regularly from Kharkov. The chip-cable and FE-hybrid production rate measured in Torino in July-August correspond to 10 good SDD modules per week, which is consistent with the completion of the needed 260 modules by April 2006.

The ITS-integration mechanics was successfully tested at SLX2 with the TPC and with the mock-up of the forward detectors. The assembly of the carbon fiber ITS support-mechanics proceeds according to schedule. In particular, the precision assembly of the positioning elements of all the SDD ladders has been completed.

Changes: No major changes.

Concerns: Delivery rate of good SDD sensors from CANBERRA. Tight schedule.

Plans: Completion of the barrel planned by April/06. Commissioning of the barrel planned for March-May/06.

Silicon Strip Detectors

Status: Mass production of sub-hybrids and chip cables in the Ukraine is ongoing, 'just in time', and the contract for ladder cables has been signed. Sensor delivery has been disturbed by quality problems with one producer (SINTEF); contracts have been renegotiated and the missing sensors (15%) will be produced by CANBERRA. Module production problems have been solved and a total of 42% of the modules have been produced in Helsinki, at the MIPOT company and in Strasbourg at a rate close to required speed. Ladder frames are in routine production. Assembling of the first ladder has been postponed to September 2005, but will be done now concurrently at two sites (Amsterdam and Nantes). Mass production of the EndCap end-ladder modules is running smoothly. All cables are selected and the majority is ordered.

Changes: Supply contracts for sensor changed

Concerns: very tight schedule, late startup of ladder assembly.

Plans: First ladder assembly in September.

Time Projection Chamber (TPC)

Status: After completion of the TPC-ITS integration test in Apr 06, preparations for the mounting of the readout chambers started in May. The first version of the mounting tool had been designed in Heidelberg and tested already at GSI Darmstadt with a TPC end plate mock-up. An existing hydraulic platform was modified to carry the chamber mounting tool and the whole arrangement was exercised and optimized extensively. Installation of all 36 chambers on one side of the TPC proceeded very smoothly and within schedule. The second half of the ROCs will be installed before mid October. This will be followed by aligning the chambers parallel to the HV-electrode with a precision of < 300 μm, sealing and leak testing.

FE card testing at IKF Frankfurt is ongoing, more than half the production has been tested and the complete batch will be available for FEE mounting towards the end of 05. The redesigned rad-hard RCU production and testing are well advanced, about 50% are done and should be finished in Oct05. The installation of the front-end electronics is planned for Dec 05 to Feb 06, followed by 6 months pre-commissioning of the TPC above ground.

Changes: No major changes

Concerns: No major concerns.

Plans: Installation of FE electronics starts end 2005; Mar06 – Aug 06 commissioning in SXL2.

Multigap Resistive Plate Chambers (MRPC) for TOF

Status: The production of the MRPC strips is well in progress, enough strips for four SuperModules have been built by the end of August. The delivery of mechanical components of the modules and their assembly have started; the tests with a cosmic-ray station at CERN have also started. The irradiation or magnetic field tests of electronic components has been completed for the Front-end cards (FEA and FEAC), the Local Trigger Module (LTM) and the Clock and Pulser Distribution

Module (CPDM). The prototype of the custom crate with the TRM (TDC Readout Module) cards and the LV DC-DC converters has been tested with respect to : i) the functionality of the TRM, ii) the efficiency of the DC-DC inside a magnetic field of 0.53 T, iii) the LV controls with a 60 m long cable and the real location of the LV PS inside the UX25 cavern (with both magnets on), iv) the cooling system. The performances are as expected, but the cooling system has to be partially improved. The robot testing of all packaged NINO ASICs has been finished and the yield is excellent (92%). The tender for FE cards production is finished and the production prototypes have been tested; mass delivery of the cards is expected to start before the end of September. The production prototypes of the DRM (Data Readout Module), LTM and CPDM cards are expected in November. The delivery of the HPTDC chips from the last 22 wafers has been delayed by a technical problem at the packaging company; it is expected to happen in September and the test of the chips should be finished in October.

Changes: No major changes.

Concerns: No major concerns.

Plans: Continue mass production and test of all mechanical and electronic components. Test of the DRM, LTM and CPDM production prototypes. Start SuperModule assembly.

High Momentum Particle Identification Detector (HMPID)

Status: The assembly and quality test of the seven modules has been successfully completed. The production of the photocathode planes is proceeding and will be completed by beginning of 2006. The construction of the cosmic ray facility, needed to commission the remaining two HMPID modules in view of the lack of test beams at CERN in 2005, is about to finish. The installation of the ancillary systems on the aluminium support structure (cradle) is well advanced. The jig required to install the seven modules onto the cradle has been fabricated and delivered in CERN. The cooling system and a prototype of the cooling panel have been tested using final type of insulating hoses. The 350 row controller cards have been delivered to CERN and related quality control tests are underway. The LV power supply system has been selected after a market survey and laboratory tests and is being ordered. Cables and connector types have been selected.

Changes: No major changes.

Concerns: No major concerns.

Plans: Complete the construction of the liquid system. Perform the insertion test of the cradle onto the space-frame by beginning of 2006 followed by the installation of the seven modules onto the cradle.. Pre-commissioning of the system at the surface hall. Installation of the detector inside the L3 magnet by mid 2006.

Transition Radiation Detector (TRD)

Status: The TRD is now well into its production phase. Production has also started for the new layer 0 chambers (reducing the overall dimensions of the TRD super modules while preserving the six layer design). Series production of readout chambers is ongoing in Heidelberg, Bucharest, JINR, and GSI. Frankfurt is to start production after finishing pad plane soldering and testing in fall. A distribution procedure of centrally produced or acquired materials has been established. By now 25% of the chambers have been completed.

After modification of the dimensions of the super module envelope the originally foreseen rail system for installation has been replaced by a system of gliders attached to the space frame. Installation tests with a dummy super module have been successful.

The full production of the preamplifier/shaper chip (PASA) has been thinned and has undergone testing, showing a yield in excess of 99%. No unexpected process variations have been observed. Production and test procedures for the MCMs have been established. Test equipment for the wafer testing of the digital chap (TRAP) has been completed. Optimization of the readout board has been

finished. The noise level after integration is close to the theoretical limit. The master/slave system of the HV system has been prototyped and is ready for testing.

Data from the stack test of 6 chambers of October 2004 has been analyzed and electron pion separation fulfills the design specifications with a pion rejection better than 100 at 90% electron efficiency. The angular resolution has been measured to be better than 0.5°.

Changes: No major changes.

Concerns: Reliable production of the readout board with good yield has not yet been established. Tight schedule for the first super module production.

Plans: Integration of front-end electronics on chambers, assembly of first super module by mid 2006.

Photon Spectrometer (PHOS)

Status: Production of $PbWO_4$ (PWO) crystals continues in the North Crystal Co plant, Apatity, Russia, at a rate of ~350 crystals per month (governed by available funding). Produced crystals are certified at the test facility of the Kurchatov Institute. In total more than 10500 crystals have been accepted.

The PHOS cradle has arrived and is being assembled at CERN and the module mechanics has been completed in Russia. Production of the module LED monitoring system is completed at IHEP, Protvino, Russia. The pre-series FEE boards have been successfully tested in the lab and mass production for the first module has started in China (Wuhan). The design of the trigger card is finished and prototypes will be produced by October.

Changes: No major changes.

Concerns: No major technical concerns. Funding from China and Japan is still under review.

Plans: Continuation of the crystal production with the aim to produce in 2005 some 2500 new crystals (subject to available funding); assembly of the cradle, production of FEE cards for the first module, assembly of the first PHOS module.

Muon Dipole Magnet

Status: The final commissioning of the muon magnet was successfully terminated on 14 July 2005. During two weeks the magnet was ramped up to full power at both polarities and operated continuously over a period of more than 24 hours. The commissioning tests confirmed the compliance to all design parameters and the long-term stability of magnet operation. The magnetic field has been measured during August/September.

Changes: No major changes.

Concerns: No major concerns.

Plans: The magnet can be considered as fully operational.

Muon Tracking Chambers

Status: The construction of the detectors is progressing normally: the slats for stations 3, 4 and 5 will be completed by end 2005, the quadrants for stations 1 and 2 for early 2006. The mechanical supports have been ordered for station 2 and are ready for stations 1. The production of the carbon sandwich frames (stations 3, 4 and 5) was completed in spring 2005. Cooling and services (LV, HV, R/O, gas…) integrations are in progress.

Concerning DAQ, the production of the front card (FRT) of CROCUS will start before end 2005. Irradiation tests will be performed on CROCUS components in September 2005.

Production of the MANAS FEE electronics was interrupted because of production problems in the factory; however delivery has resumed and the quality seems again under control; final test are close to completion. The company building the MANU cards has been chosen in May 2005. A pre-

production of these cards starts in September. The production will follow depending on the progress on the FEE chips.

Changes: The assembly of the chambers has been postponed to the beginning of 2006.

Concerns: The electronics is on the critical path. The CROCUS software development requires additional manpower.

Plans: We will start to prepare and equip the assembly hall (SXL2) at the end of 2005 in order to start the assembly with the final electronics of one half-plane of the station 4 in the beginning of 2006, the other planes following during 2006. The assembly and installation in the cavern will be performed in parallel. The assembly with final electronics of stations 1 and 2 will be done at Orsay in the first half of 2006; the second half will see the installation of the quadrants in the cavern.

Muon Trigger Detectors

Status: The dimuon trigger is based on single gap Resistive Plate Chambers (RPCs). The construction of the gas gaps and readout strip planes has been completed in 2004. Stiffener and strip planes drilling is under way (75% done) as well as connector mounting and final assembly of the chambers (60% done). A station, where all the RPCs will be tested with cosmic rays, has been built and, at present, about 50% of the chambers have been tested. The integration aspects are almost finalized.

The whole FE electronic board production (~2500 boards) has been delivered, tested and is ready for installation. The production of the signal cables (1500 cables in total) is completed. A pre-production batch of 20 Local trigger boards (260 units in total) has been delivered and tested with positive results. The whole production has been delivered and is at present under test (about 50% done) together with the final crates. The construction of the readout card (DARC) prototype is completed and tests are in progress. The test bench for the full trigger electronics validation is under construction.

Changes: No major changes.

Concerns: Assembly/validation of the full trigger electronics.

Plans: Completion of RPC assembly and test with cosmics. Completion of tests of the trigger electronics

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

Status: The second ZDC for spectator protons is ready for assembly in November at CERN and the production of the support platform for the detectors is under way.

The unit module fabrication of the PMD is on schedule and work on the FEE is in progress.

FMD prototype (inner-ring type) Si detectors from Hamamatsu have been bonded to Hybrid preamplifier cards equipped with VA-ALICE chips and tested in a 680 MeV electron beam. Tests show an excellent performance in beam (Signal to Noise ratio 60:1) exceeding specification. A custom digitizer board, based on ALTRO, has been developed and tested with TPC RCU boards.

Construction of the trigger detectors T0 and V0 has started. Radiation tests of V0 and T0 front-end electronics have been performed in August 2005. All components worked well up to 100 krad/cm^2, which is about twice the maximum dose expected over 10 years.

Changes: Minor changes to the PMD supermodule design.

Concerns: No major concerns.

Plans: Continue construction of PMD/V0/T0/FMD detectors. Beam test of PMD in May 2006. Final radiation tests of FMD electronics.

Trigger

Status: Construction of the CTP boards has been in progress for most of the year, and is now almost completed. The last boards should be delivered by the end of October. Systematic tests of each board have been carried out. Software development has continued in parallel. Full system tests will start soon. The trigger system is scheduled to be sent to CERN in the first quarter of 2006.

Changes: No major changes.

Concerns: No major concerns.

Plans: Completion of the construction of the CTP boards. Development of the first full version of the CTP software. Full system tests at the end of the year.

Data Acquisition (DAQ)

Status: The final test of the radiation-tolerant DDL prototype is being performed. The new PCI interface for the DDL (D-RORC) including the DAQ-HLT interface and the DDL readout and download software are routinely exploited for DAQ development. DDL and RORC cards have been delivered to all detectors. The integration of the detector readout chain with the DAQ (DDL and DATE V4) has been realized for the SPD, SSD, SDD, TPC, TRD, TOF, HMPID, Muon Tracking, PHOS, and EMCal. DATE V5 has been released and is being used by 4 detector groups. A DAQ reference system made of data sources, DDLs and D-RORCs, PCs, storage, network and infrastructure has been assembled to verify the performance and the installation aspects. This reference system is controlled by the Experiment Control System (ECS) and has permitted to successfully demonstrate the ECS concept of partition. The Computing Data Challenge VI has been completed with the new version of the mass storage software (CASTOR), DATE V5, and the ALICE performance monitoring software (AFFAIR). A sustained aggregate throughput of 1500 MByte/s has been achieved for the event building and 450 MByte/s for the data storage to tape. The development of the data-quality monitoring framework (MOOD) has been pursued in view of the detector installation. The DAQ layout and the cables database have been prepared for the installation at Point 2. The installation of the first stage of the DAQ system will start in 2005 and will be used during detectors test and commissioning.

Changes: No major changes.

Concerns: No major concerns.

Plans: DDL and D-RORC production, Computing Data Challenge VII, DATE V5, DAQ at Point 2.

High Level Trigger (HLT)

Status: A major effort has been carried out to merge the online and offline HLT analysis code. This will ease development and maintenance and allow evaluation of HLT data processing components without changes of the source code. A new interface for HLT components has been defined inside AliRoot and schemes for the handling of components from multiple detectors have been introduced. A new C-interface to the online Publisher-Subscriber Framework makes it possible to use exactly the same binary program code in both frameworks. All TPC HLT components have been converted to the new scheme. Significant progress has been made in the development of TPC online monitoring tools.

The H-RORC based on Xilinxs' Virtex-4 FPGA has been designed and a few prototypes produced. The card is currently being tested and no errors have been found so far. The device supports remote reconfiguration with a safe fall-back design. The PCI core is installed and detected by the computer. The computer remote administration and control device CHARM (former CIA) is ready for production. There was a successful 25 units preproduction run. Installation of Ethernet infrastructure cabling in the counting rooms CR2 and CR3 is scheduled for October.

Changes: New interface for HLT processing components

Concerns: No major concerns.

Plans: Production of the new H-RORC. Preparation for TPC comissioning, TPC online monitoring

Offline

Status: Phase 3 (distributed data analysis) of the Physics Data Challenge 2004 has been cancelled because of the unavailability of middleware with the required functionalities. The architecture of the infrastructure for distributed computing has been redesigned and is based on the baseline services provided by the EGEE/LCG gLite middleware, AliEn2 providing required functionalities not present in the gLite distribution and the high level interfaces between the ALICE framework and the gLite services. The software has been released and deployed on several sites. The Physics Data Challenge 2005 is now starting.

The FLUKA transport code has been fully validated and will progressively replace GEANT3. The new geometrical modeller from the ROOT project is in production. The reconstruction programs, including global tracking and global particle identification, are mature. The calibration and alignment framework has been implemented. All detectors have interfaced the calibration algorithm to the framework. The alignment part will require additional work to adapt the geometry description to this task. The framework for distributed analysis based on the Parallel ROOT Facility (PROOF) is operational but not yet release to the general users. The tag metadata content has been defined and implemented in the AliRoot framework. The Computing TDR has been submitted to the LHCC.

Changes: No major changes.

Concerns: The computing resources pledged so far by Funding Agencies for ALICE are well below the needs documented for and validated by the Computing Resources Review.

Plans: Execution of Physics Data Challenge 5 using the gLite baseline services and the ALICE specific services and interfaces. Finalisation of the alignment and calibration framework. Finalisation of the metadata.

Installation & Assembly activities

Status: The installation activities in the Alice experimental area is continuing according to the planning. The Muon filter and the Dipole magnet were successfully installed in their final positions and the field mapping measurements of the combined Solenoid and Dipole magnets are finished. The stray fields have been measured in the different rack areas and the obtained values are consistent with expectations from the simulation.

The work on the pre-commissioning activities is advancing in a satisfactory manner. A full load test of the main support structure (Space Frame) was performed. The deformations are fully in line with the calculations. A complete installation test of the TPC – ITS detectors into the space Frame allowed a detailed validation of the installation procedure. A number of problems were detected and corrected. The Muon Absorber has been fully assembled and tested together with the conical vacuum chamber. The Muon chamber superstructure has been fully assembled and tested using the final support rails for the detector stations. The refurbishing of the counting rooms continues.

Changes: No major changes.

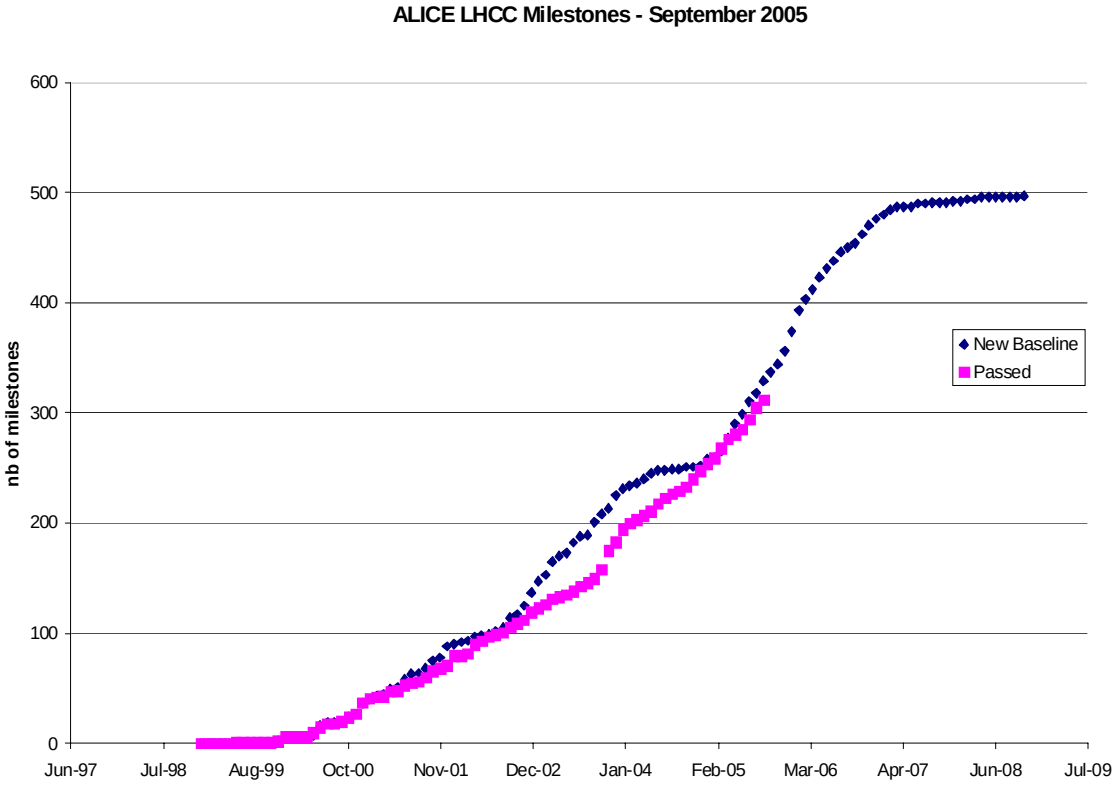
Concerns: No major concerns.

Plans: Completion of the magnetic field measurements, installation of racks and services in the underground cavern.

MILESTONES

In early 2005 ALICE has re-arranged the planning (dating back to mid 2002) to take into account the actual status of detector production. A number of corrective actions have been implemented and the schedule has been adjusted in order to have a working detector in place for the initial operation of the

LHC with first collisions expected in summer 2007. Installation of some parts of our modular detectors (PHOS, TRD) will continue beyond that date. Some items on the critical path remain very tight and without contingency. Actions are being undertaken to speed up production in particular of the ITS detectors.


ALICE LHCC Milestones - September 2005
nb of milestones
600
500
400
300
200
100
0
Jun-97
Jul-98
Aug-99
Oct-00
Nov-01
Dec-02
Jan-04
Feb-05
Mar-06
Apr-07
Jun-08
Jul-09
New Baseline
Passed