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 83 institutions in 29 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 a single-arm electromagnetic calorimeter (PHOS). 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 trigger detectors (ZDC, PMD, FMD, T0, V0) are located at small angles.

So far 11 TDR’s have been approved (HMPID, ZDC, PHOS, ITS, muon arm, PMD, TPC, TOF, muon arm addendum, TRD, TOF addendum); the last one for the TOF addendum in autumn 2002. Construction of most detectors and large infrastructure items as well as preparation of the experimental area are well under way.

An overview of the financial situation concerning ‘Cost-to-Completion’ (6.9 MSF including detector and Commissioning & Integration costs) has been presented to the RRB in October 2002. Additional funds totaling 5.8 MSF have been pledged by the ALICE funding agencies. A contingency plan to deal with the remaining shortfall of up to 1.1 MSF has been endorse by the LHCC.

Silicon Pixel Detectors

**Status:** Detector ladders of 300µm thick chips bump bonded to 200µm sensor tiles have been produced and tested. An advanced prototype of the aluminium/kapton pixel bus has been developed. A front-end MCM equipped with analogue and digital PILOTs, together with a GOL ASIC laser driver, has been developed. A module for the characterization and testing of the front-end electronics chain has been designed and is functional. The assembly procedure has been defined and the carbon fibre support sector geometry has been finalised. Bump-bonding has been held up for a number of months because of equipment failure at the supplier; the problem is currently being solved.

**Changes:** No major changes

**Concerns:** Tight deadlines for the completion of pre-production validation.

**Plans:** Half-stave prototype assembly and cooling test.

Silicon Drift Detectors

**Status:** The first qualifying batch of 6 SDD detectors has been delivered to INFN-Trieste with the new final design. Of those detectors 3 are produced on the old material, 3 on the new material produced for ALICE by Topsil. The Topsil material has doping fluctuation within specs when measured on the ingot. A detailed characterization of those detectors is in progress. The full-scale front-end chips (PASCAL-64 and AMBRA-4) have been re-submitted following improved design rules, after the yield problems observed in 2002 (also encountered by other designs in the same technology). Their tests give good results for both yield and the functionality. This additional iteration delayed the engineering run for the front-end to Q2/03; but the SDD (and the ITS) will still be ready for installation at CERN in March 2006. The tests of the second version of the rad-tol readout-ASIC (CARLOS), submitted in Q4/02, were successful. The carbon fiber space-frames for the SDD and the SSD have been completely produced (with 50% spares), qualified and delivered to CERN. Prototypes of the 5-layer Al-upilex hybrid for the 32-channel version of the FEE have been used with dummy chips to begin the tests of the TAB bonding procedures. New HV Al-kapton micro-cables are being produced to match the final detector mask and to improve the reliability of the...
ladder assembly. Studies on the SDD air circulation system are ongoing on a dedicated full-scale mock-up to accurately measure the temperature gradients along the SDD drift paths; their completion is foreseen by June/03. The full-scale ITS-integration mock-up now includes the muon-absorber, the V0 and T0 detectors and the installation tools for the muon-absorber side. The installation tools for the opposite side will be designed by mid 2003 and prototyped by October.

**Changes:** No major changes.

**Concerns:** SDD FEE production on the critical part; SDD cooling system to be validated.


**Silicon Strip Detectors**

**Status:** The pre-series of the double-sided silicon detectors were delivered by the three companies according to schedule and were found of nominal quality after testing. The HAL25 front-end chip was submitted in August 2002, with some modifications in order to investigate the low (60%) yield experienced in previous runs. The results exhibit a yield close to 100% for both the current as well as the previous design, implying the fabrication process as the most likely cause of the fluctuating yield. This fabrication will be repeated to check reproducibility. A full feature detection module has been assembled and tested with good results. More modules are in preparation at the present time. The engineering run for HAL25 is ordered for early April.

**Changes:** No major changes

**Concerns:** Timely startup of module mass production.

**Plans:** Production of a small series of detection module prototypes before September 2003.

**Time Projection Chamber (TPC)**

**Status:** Construction of the TPC is progressing very well. The assembly of the field cage at SXL2 is well advanced and will be completed in 2003, with final testing until April 2004. The series production of inner readout chambers (IROC) in Bratislava (second half of chambers) is under way, about 70% of the total is assembled by now; this production should finish in 2003. The outer readout chambers (OROC) series production started late in 2002 and has now reached the foreseen pace of one chamber per week which will allow to complete the production in 2003. The two service support wheels, carriers of the FEE cards, have been modeled in one sector with all services; final construction is foreseen to be completed this year. The front-end electronics (FEE) of the TPC has completed prototyping of all components. The full production of the 16-channel digital chips (ADC and digital processing) has been delivered end 2002. The PASA final layout was completed and will now be ported to the final design. System tests with the full readout chain on one IROC are ongoing with cosmos and later in the year with test-beam. Full production of all components will start beginning mid 2003 after all tests of the full chain are passed. The laser system for the TPC has successfully passed a PRR; most components are at hand or will be produced in 2003. The TPC gas system is nearly finished and will be commissioned this year.

**Changes:** No major changes

**Concerns:** No major concerns

**Plans:** Completion and commissioning of the Field Cage by Apr 04. Completion of Readout chamber production in 2003. Start production of all FEE components.

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

**Status:** A second “mass” preproduction of MRPC strips has been tested at the PS in October 2002 in order to check again the reproducibility and performance for strips built by different teams. The effects of changing some details of the construction procedure have also been studied. The results in
terms of efficiency, time resolution and uniformity are excellent. Two strips have been irradiated at the GIF with a total charge of 0.0097 Coulomb/cm² (equivalent to about 750 days of Pb-Pb run at LHC with a rate of 50 Hz/cm²); when measured at the PS after an equivalent running time of 200 days they did not show ageing effects. Moreover, the chemical analysis of the outgoing gas did not show any presence of fluorine which could damage the glass; the current drawn by the two chambers is stable and normal along the full period of irradiation. The HPTDC (High Performance TDC) v.1.3 chips have been tested with respect to the Integral Non Linearity and the RC delay-line calibration (both improved relative to the v1.2 chips). A multi-board prototype of the DRM (Data Readout Module) has been built. The second prototype of the front-end analogue ASIC has been tested in the laboratory and with the cosmic-ray station in Bologna; preliminary results show that its performances is fully compatible with the one of the commercial-component FEE used so far.

**Changes:** No major changes

**Concerns:** No major concerns

**Plans:** A prototype of the TOF intermediate module will be tested at the PS. Prototypes of the R/O TRM and DRM cards and of the HV and LV (DC-DC converters) systems will also be tested. Final decision on the FEE before the end of 2003.

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

**Status:** The complete FEE/RO chain has been fully qualified during the Oct. 2002 test beam equipping PROTO-3 with a total of 3840 channels. The interface to the DDL and the TTCRx system has been produced and is at presently under test. The gas system passed the PRR and is now under construction. Module #1 has been tested for gas tightness and HV. Preliminary gain uniformity has been performed using radioactive sources. The optical fiber system for a more precise evaluation of the gain uniformity has been commissioned using PROTO-3 and the final test of module #1 will be performed in April. Assembly of module #2 has started. The entire set of 63 fused silica plates, employed as radiator vessel, passed the quality control. Three radiator vessels (out of 21) have already been assembled. The test and qualification of 500 (out of 4000) readout DILOGIC-III ASIC chips has been accomplished showing a yield > 96%, the test is in progress at a rate of 200 chips/week. The production of the cathode planes has started and a first batch of 10 (out of 42) will be delivered by May. The commissioning of the VUV scanner has started and the results will be crosschecked with test beam data for final validation in May. The Finite State Machine (FSM) paradigm has been applied to the DCS and a first test of the integration between DCS, ECS and DAQ has been carried out successfully. The production design of the C6F14 circulation systems has been finalized and will be completed for the PRR in June. The glove box for mounting the CsI coated photo-cathode in an inert atmosphere is under construction and will be delivered in May.

**Changes:** No major changes.

**Concerns:** No major concerns.

**Plans:** Continue the assembly of the detector modules; qualify module #1 with test beam; finish the production of the FEE and R/O board by the end of the year.

**Transition Radiation Detector (TRD)**

**Status:** The TRD is advancing towards the production phase. Several Engineering Design Reviews were held and the PRR for the preamplifier/shaper ASIC took place. Successful beam tests were carried out with the first full-size prototype detector (1.2m x 1.6m). Together with smaller test chambers it was verified that the individual electron/pion identification capability in a stack of detectors is preserved as expected. Two further full-size prototypes are currently being assembled to establish the final chamber design along with the assembly procedure, the necessary tooling, and quality control measures. Production of parts of the radiator has started. A section of a super module with dummy chambers has been built in order to finalize routing of all services. During beam tests the final gas system for the TRD was shown to work reliably. Currently, work is under way to establish the most suitable procedure for regeneration of the Xe used in the detector.
The preamplifier/shaper circuit is now ready for production. The first version of the digital chip containing a test version of a newly developed low power 10MHz 10bit ADC, digital filters, tracklet pre-processors, data buffers, configuration devices, and processors was tested. A second final design version of this ASIC is currently being prepared for submission.

**Changes:** Slight change in the geometry of the chambers in order to reduce the total number of different chamber types from 16 to 12.

**Concerns:** No major concerns

**Plans:** PRR and start of production for the read out chambers, engineering run for the PASA, MPW submission of digital chip, test of full electronics chain, PRR for the gas system.

**Photon Spectrometer (PHOS)**

**Status:** Production of PbWO4 crystals continues in the North Crystal Co plant, Apatity, Russia. A production rate of ~300 crystals per month is achieved. Some 2500 full-size (2.2x2.2x18 cm³) shaped crystals were accepted in 2002 after tests using the optical and light yield test benches of the Kurchatov Institute. In total some 3000 crystals are accepted in 2001-2002, and a first batch of 500 crystals has been delivered to CERN and 2000 more are expected soon. Beam tests of a matrix of 8x8 crystals were performed with electron and pion beams in the energy range of 0.6 – 180 GeV. The crystals were equipped with APD’s coupled to new low-noise preamplifiers as photo-detectors. Good performance was demonstrated. The PHOS Front-End Electronics (FEE) project has been re-organized, and R&D for the new FEE started.

**Changes:** A decision on FEE functionality (functions: energy and timing measurement, trigger signal, an APD bias regulation) and options (baseline: the ALICE/TPC ALTRO R/O chain) was taken. Participation of Japanese labs is still under consideration.

**Concerns:** No major technical concerns. Participation of China under review.

**Plans:** Continuation of the crystal production with the aim to produce in 2003 some 3000 new crystals (subject to available funding); R&D for the FEE, the decision to be taken in Sept. 2003; completion of the detailed engineering design study of the PHOS mechanics and cooling.

**Muon Dipole Magnet**

**Status:** The horizontal factory assembly of the yoke has been finished in December 2002. The inspection and survey gave globally satisfactory results. The yoke components are now being prepared for shipping to CERN. A dummy coil pancake has been successfully terminated in October 2002. All coil manufacturing tooling has been produced and tested and coil production has started in January 2003. Manufacturing contracts for the coil supports are attributed; delivery is scheduled for July 2003. The 1st unit of the 22 inter-pancake bus-bars is being tested. A temporary foundation has been installed at the pre-assembly site for the magnet in UX25/RB24. Hydraulic and electric power lines are being installed. The power converter and transformer for the magnet have been delivered and installed at point 2.

**Changes:** No major changes.

**Concerns:** No major concerns.

**Plans:** The transport of the yoke components to CERN shall take place in April 03. The pre-assembly in the UX25 cavern will be terminated after delivery of the coils end of August 2003. Pre-commissioning work including power tests and magnetic field checks are planned from October until end 2003.

**Muon absorber**

The design optimization of the absorber has been completed and the tendering for the main components has started. The design work is now concentrating on the assembly and installation procedures.
Changes: Assembly at CERN
Concerns: No major concerns
Plans: The construction and delivery of the main absorber components to CERN by the end of 2003.

Muon Tracking Chambers

Status: The first “final” quadrant of the Station 1 has been tested at the PS in July 2002. The data have shown gain variation across the detector of up to a factor of three. Further investigations in the lab (source tests, mechanical survey) have lead to the preliminary conclusion that the chamber does not possess sufficient mechanical stability. Design improvements are being studied. A prototype for Station 2, which is of similar but more rigid design, is currently under construction and should be ready for beam tests in September.

For the stations 3, 4 and 5, the PCBs of the standard slats have been validated and all the components (carbon sandwiches, spacers, PCBs, bus-bars) are being fabricated or will be ordered in the two next months. The mass production will start at the beginning of September 2003 with the fabrication of one qualification slat at each of the four production sites. A rounded slat (located around the beam pipe) will be in-beam tested in July. The tendering of the support frames is completed.

A first batch of 2000 preamplifiers MANAS has been delivered and 250 chips have been mounted on MANU boards which are currently under tests. A last iteration of the MARC chip will be launched by May and a first batch should be available by October. The read-out (CROCUS crate) is made of three types of elements: a crate with a back panel, a concentrator board and frontal boards. The two first elements have been fabricated and successfully tested. A prototype of the LV power supply has been delivered and is under test. Extensive simulations on the FEE air cooling system have been performed, in particular for the station 1 which is the most critical, and the design is being finalized.

Changes: The thickness of the station 1 will increase to improve stiffness.
Concerns: Station 1 redesign necessary, MANAS and cooling of the FEE to be validated.
Plans: A new “final” quadrant of the station 1 should be ready by November. The in-beam tests of the first quadrant of the Station 2 will be performed in September. Start of slat mass production foreseen in September, PRR of the electronics by summer.

Muon Trigger Detectors

Status: The dimuon trigger is based on single gap Resistive Plate Chambers (RPCs) made with low resistivity (a few 10^{9} \, \Omega \cdot cm) bakelite plates and operated in streamer mode. Long-term irradiation of small and full scale prototypes (some with a thin double-layer of linseed oil which reduces ageing and operated with/without fine-tuned gas humidity) are performed at the GIF (Gamma Irradiation Facility) since 2001. Several detectors tested in these conditions proved to be still efficient after having integrated a charge equivalent to a few ALICE-years of data taking. However, the operation of the detector strongly depends upon the background from beam-gas interactions in p-p, which is being revised.

The final front-end chips (especially designed for the streamer mode) and boards have been successfully operated in various test beams since 2001. The PRR for the front-end electronics has been passed in Nov 02. The test bench for the mass production is ready. The Local trigger electronics (234 VME 9U boards) is now ready for the PRR. The dedicated crate controllers, called Regional boards (16 units), as well as the DAQ interface, are in progress.

A reduced size prototype of the muon trigger setup, including detector, front-end and trigger electronics, has been operated at the GIF in June 2002 and has shown an excellent detection efficiency and background rejection capability.

Changes: No major changes.
Concerns: Beam-gas background and running scenario in pp.

Plans: Tests at the GIF of a full scale RPC, fully equipped.

Forward and Trigger Detectors

Status: The first Zero Degree Calorimeter for neutrons has been tested in June 2002 at the SPS with hadron and electron beams. The results of the test confirm that the calorimeter works according to the expectations. The W-alloy slabs for the second neutron calorimeter have been grooved and the quartz fibres have been cut and polished.

The PMD preproduction prototype is under fabrication and will be tested in July; the PRR is scheduled for October. Infrastructure for detector fabrication at various centers within India has been set up. The document describing the new location and design is almost final and will be submitted by end of May 2003. The results suggest that the PMD will perform better in the new location.

Mechanical prototypes for FMD (Si pads), V0 (scintillator + PMT) and T0 (Quartz + PMT’s) have been constructed and functional prototypes for all these detectors are under test.

Changes: No major changes

Concerns: No major concerns.

Plans: The second ZDC neutron calorimeter will be mounted and tested in July 2003 with hadron beams and in October 2003 with HI beams. The forward detector TDR is planned for end 2003.

Trigger

Status: Following a successful Preliminary Design Review for the Local Trigger Unit (LTU) in October 2002, detailed design of the LTU is now underway. The Final Design Review will take place in May, and the units will be delivered by December 2003. During 2002, following a workshop in Birmingham to discuss the software framework for the trigger project, and a follow-up meeting in Køge, work has started on the control system for the trigger (using SMI) and the configuration software for the LTU.

Changes: No major changes.

Concerns: Resources and schedule remain tight.

Plans: Production of the LTU modules including software and documentation by end 2003. The Preliminary Design Review for the Central Trigger Processor (CTP) is to take place in July, and the Technical Design Report for the trigger (to be produced jointly with the High Level Trigger (HLT) and Data Acquisition (DAQ) groups) is to be completed by end 2003.

Data Acquisition (DAQ)

Status: The TPC and the ITS drift detector have successfully integrated their readout controller with the first version of the Detector Data Link (DDL) and its PCI interface. The second generation of DDL, based on new opto-electronics components at 2.5 Gbit/s, has been designed and tested successfully. It will deliver more than double the performance at constant cost. Irradiation tests of the DDL components have started. The PCI interface for the DDL has been used on a regular basis: it reaches the maximum performance of the PCI bus (120 MByte/s). The DDL has been interfaced to the HLT-ROCR.

DATE version 4, released last year, has been fully documented. It includes several new key features addressing the issues of larger DAQ configurations. Stability and scalability of this major software DAQ component has been demonstrated as part of the Data Challenge IV (ADC IV) during running periods of several weeks and on a DAQ fabric made of 80 nodes, 20 disk servers and 10 network switches. The package for the online monitoring of the DAQ performances (AFFAIR) has proven to be able to monitor tens of parameters on 100 nodes, to generate the hundreds of corresponding plots and to display them on the web. All the performances milestones of the ADC IV have been
exceeded: 1.8 Gbyte/s of throughput in the event building network, 350 Mbyte/s of aggregate data recording to disk and 280 Mbytes/s over the whole DAQ chain including magnetic tapes. Systematic testing of different disk storage configurations has been pursued together with the mass storage software (CASTOR) and a solution has been identified for the final ALICE DAQ system.

The development of the Experiment Control System (ECS) has started in collaboration with the Trigger and Detector Control projects. The first ECS developments address the needs of HMPID and TPC.

A major new release of the Trigger/DAQ simulation program has been developed in collaboration with the Trigger project. It includes more realistic models of the detectors readout and of the trigger system behaviour. The simulation of the Trigger and DAQ systems has indicated critical areas for sharing of the DAQ resources between the data streams of different triggers. A solution based on dynamic downscaling of frequent triggers that use most of the bandwidth has been identified.

**Changes:** Introduction of a scheme to reduce the dead time for rare triggers.

**Concerns:** No major concerns

**Plans:** Finalize irradiation tests of the DDL; development of a second generation of PCI interface for the DDL allowing HLT processing; ALICE Data Challenge V; DAQ TDR by end of 2003.

**High Level Trigger (HLT)**

**Status:** A batch of 20 HLT PCI-RORC boards operating 64-bit, 66 MHz PCI were produced and successfully tested. The FPGA cluster finder algorithm was improved and now includes cluster deconvolution. Work continued on the FPGA Hough transform and on combined TRD-TPC-ITS tracking. Efficiencies and performance of various TPC tracking methods (cluster finder and track follower, Hough transform) were studied in detail. The performance of the HLT publish-subscriber communication framework was optimized. A complete, fault tolerant HLT processing chain operates with realistic data and a full analysis chain. First prototypes of a DDL to FPGA co-processor interface and an HLT to DATE interface have been successfully tested. The Conceptual Design Report has been released and reviewed.

**Changes:** No major changes

**Concerns:** No major concerns

**Plans:** Technical Design Report end 2003.

**Offline**

**Status:** The ALICE offline framework, AliRoot, has seen continued development and is being used for the Physics Performance Report. Thanks to the AliEn GRID system, more than 22,000 jobs have been run so far in more than 30 facilities around the world. The Virtual Monte-Carlo interface is now in production. The GEANT4 and GEANT3 implementations are working, and the FLUKA one is now undergoing detailed testing. A geometrical modeller for detector simulation, reconstruction and display has been developed and is now part of ROOT. Validation of GEANT4 physics has continued and the new flexible I/O system has been completed.

Reconstruction programs, in particular all of the tracking software, have undergone substantial changes resulting in significant improvements in both efficiency and accuracy. A functional prototype of the Parallel ROOT Facility (PROOF) will be tested in realistic analysis. This system will allow data processing and analysis to be done in parallel, transparent for the user, on distributed PC clusters making use of the Grid services.

AliEn has been further developed and it now has a prototype analysis harness that will be soon used in production. An interface to the DataGRID software has been developed and demonstrated. ALICE has continued to test the prototype software delivered by the DataGRID project.

**Changes:** No major changes

**Concerns:** Stability of the small CERN based CORE team.
**Plans:** Preparation for the ALICE Data Challenge 5 in fall 2003 and for the Physics Data Challenge in the first half of 2004. Introduction of the new I/O framework. FLUKA detector simulation via the Virtual Monte Carlo, the new geometry modeller, and the AliEn and PROOF based distributed analysis framework.

**L3 magnet, Installation & Integration**

**Status:** The installation of the Alice detector is proceeding according to the planning. Market survey and tendering for major support structures are in progress. The door-frames of the L3 magnet are being modified in order to facilitate the installation of services. The construction of the new control room for the Alice experiment has been successfully completed. The experimental area has been cleaned and painted. A temporary foundation for the assembly of the dipole magnet has been constructed.

**Changes:** No major changes.

**Concerns:** No major concerns.

**Plans:** Preparations to receive the iron for the Muon magnet; construction of the space frame.

**MILESTONES**