Status of ALICE : Report for April 2002 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 900 members from more than 75 institutions in some 28 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 fourteen stations of tracking and triggering chambers. Several smaller trigger detectors (ZDC, PMD, FMD, T0) are located at small angles.

So far 10 TDR's have been approved (HMPID, ZDC, PHOS, ITS, muon arm, PMD, TPC, TOF, muon arm addendum, TRD). An addendum to the TOF will be submitted by early 2002. Construction of most detectors has started, L3 dismantling is finished and the preparation of the experimental area is under way.

An overview of the financial situation in ALICE and an estimate of 'cost-to-completion' including Commissioning & Integration costs will be submitted in a separate document to the April RRB.

Silicon Pixel Detectors

Status: Single flip-chip assemblies, from two suppliers of different bump-bonding processes, have been tested in a 150GeV/c pion beam. Efficiency and cluster size have been measured and found in agreement with expected values. Ladders (5 chips on a common sensor substrate) have also been produced and tested. A system of 10 chips on the pixel bus, equivalent to a half-stave, has been assembled and successfully operated. A substantial quantity of pixel chip wafers and sensor wafers has been procured. Bump-bonding with wafer thinning is under way. The PILOT chip has been tested and found to work to specs. The capability for a low-multiplicity trigger has been evaluated and is being implemented.

Changes: No major changes

Concerns: Some slippage in the time schedule, to be absorbed in production.

Plans: Completion of the bump-bonding optimization. Ladder module assembly including gluing and wire-bonding to the pixel bus.

Silicon Drift Detectors

Status: The production test facilities for the SDD have been set up and the software for half of the planned measurement is ready. The detector masks have been finalized after minor corrections, mainly to improve the assembly yield. The production of a high homogeneity silicon ingot (from TOPSIL), had to be shifted to Q2/2002 because of funding constraints. However, NTD wafers are already available to start the SDD production within Q2/2002. Prototypes of the final front-end chips (PASCAL-64, with 64 channels, and AMBRA-4, with four buffer levels) have been produced and their test will start in April. Low power LVDS drivers and receiver will be submitted with the April MPW and included in PASCAL-64 and AMBRA-4 for their engineering run, planned for November 2002. The tests of the integration of the first readout-ASIC prototype (CARLOS) with the ALICE DAQ standard components (DDL) is still ongoing due to problems encountered; their completion is foreseen by June. A first rad-tol version of CARLOS, containing the interface circuitry, was produced and successfully tested; the submission of its final rad-tol version is planned for November 2002. The end-ladder cooling system has been finalized with a convenient safety margin. Temperature measurements of the full-scale cooling mock-up have started and a dedicated ladder

mock-up was built for the air cooling measurements. The full-scale ITS-integration mock-up now includes the beam pipe-handling and a prototype of the supports for the forward multiplicity detectors.

Changes: No major changes

Concerns: NTD silicon availability for SDD production, SDD cooling system.

Plans: PASCAL and AMBRA engineering in November 2002. Submission of final prototype of the rad-tol version of CARLOS by November 2002. Detector production should start by Q2/2002. Tests results on final SDD cooling system by June 2002.

Silicon Strip Detectors

Status: Evaluation of the HAL25 front-end chip in deep submicron is continuing. While some of the chips work as specified, the overall yield is low and not understood. After an additional multi-project run it was found that the yield problem is related to processing steps at IBM. The observed effects are under discussion with IBM. The hybrid definition is completed and the production will be started as soon as the design of the front-end chip is validated. Four offers for the detector procurement were received and three companies were selected for production. The first pre-series detectors are expected in May 2002. Construction of the carbon fiber support ladders is essentially completed.

Changes: No major changes

Concerns: Production of the HAL25 front-end chip.

Plans: Improve yield of front-end chips, setting up of assembly lines

Time Projection Chamber (TPC)

Status: Construction of all parts of the TPC field cage is progressing at the expected pace. The first of the four composite TPC cylinders has arrived fully assembled at CERN in March 2002, the others will be constructed at CERN by the manufacturer, in cooperation with CERN staff, to be completed before summer. The aluminum end plates are in the final phase of production. The clean area for the construction and assembly of the field cage in SXL2 is finished such that work on the field cage cylinders can start, as foreseen, in May. The production of 50% of the small readout chambers has been finished at GSI. A first module is under assembly at Bratislava, where the second half of the chambers will be produced during this year. The prototype of the large outer readout chamber has been completed and is under tests at GSI. The TPC gas system is fully designed and production has started. The laser system design has progressed. After feed-back from the technical board a document with all technical layouts and specifications will be produced. The preamplifier chip has come back from the foundry and first tests were successful. The integration of the commercial ADC into the ALTRO digital chip has been completed and the prototype has been successfully tested, reaching or surpassing the design specifications.

Changes: No major changes

Concerns: No major concerns

Plans: The field cage prototype will be used for a beam test with one of the readout chambers and about 5000 channels of final electronics in April 03. Start of outer readout chamber production in April 02. Assembly of a full readout chain in April 02.

Multigap Resistive Plate Chambers (MRPC) for TOF

Status: The improved double-stack structure of the MRPC has been extensively tested during the autumn 2001 test beam period. Eighteen double-stack MRPC strips (2 x 5 gaps, 250 microns each) were built and assembled inside two full size module prototypes. The results of this first large preproduction (equivalent to 1% of the full TOF detector) confirm the excellent performances of the prototypes both in terms of intrinsic detection efficiency (99-100%) and of time resolution (50-60 ps).

The uniformity of response over the readout pads of a single strip and over the different strips show that the procedures for building a large number of detector elements are under control. The mechanical properties of the module were also studied by comparing the two different prototypes of the gas volume box and the central support plate. The rate capability of the double-stack MRPC was measured at the GIF and was found to be in excess (about one order of magnitude) of the maximum expected flux of charged particles in the ALICE experiment (50 Hz/cm^2). A test board with two HPTDC (High Performance TDC) prototype chips has been built in Bologna and the complex functionality of these chips have been tested, obtaining results in complete agreement with those from the EP-MIC group at CERN. A test board with the second version of the HPTDC has also been designed and is under test with the MRPC cosmic-ray station in Bologna.

Changes: No major changes

Concerns: No major concerns

Plans: Submit the TDR Addendum in April 2002.

High Momentum Particle Identification Detector (HMPID)

Status: The module production is in progress; mechanical assembly of module 1 has been successfully completed. Three batches of nine fused silica plates each have been shipped to CERN. Transmission measurement of the fused silica plates and construction of the radiator vessels are proceeding in parallel. The procurement of the full production of the read/out DILOGIC-II ASIC (4000 chips) has been accomplished. Four new photo-cathodes with electrolytic Ni-Au substrate have been coated with CsI and successfully tested at PS, confirming the improvement in Quantum Efficiency (QE) observed at the end of 2000. A first version of Detector Control System (DCS) based on PLCs and off-the-shelf HV/LV units has been developed in the JCOP-Framework running in PVSSII environment. The design of the ancillary fluid (liquid, gas and cooling) systems is in progress.

Changes: The HMPID location was moved in azimuth from 12 o'clock to the 2 o' clock.

Concerns: No major concerns

Plans: Carry out the assembly of modules # 2-3. Complete the construction of the 21 radiators and the design of gas, cooling and C_6F_{14} circulation systems.

Transition Radiation Detector (TRD)

Status: The TRD was approved in February 2002. With the funds available, slightly less than 60% of the acceptance will be equipped. Several prototypes were used to study the pion rejection and tracking performance both with and without magnetic field. The space point resolution (better than 300 microns) and pion rejection are conforming to specifications. The sandwich structure of the radiator, now made out of carbon fiber laminated ROHACELL and polypropylene fibers has been finalized. Tests of the re-circulating gas system for the Xe/CO2 mixture were successful. The readout electronics of the TRD has made major advances. The preamplifier/shaper ASIC has undergone two further iterations and the design is now close to final. The digital chip (0.18 micron UMC) contains for each of the 18 channels a newly developed ADC (10 bit 10 MHz) along with a tail cancellation network, the tracklet processor, buffer memory, and configuration chain. The design passed its conceptual design review in January 2002. The tools for manufacturing the multi-chip modules containing both chips have been extensively exercised.

Changes: No major changes

Concerns: No major concerns

Plans: The first full-scale prototype of the readout chamber and the radiator are being assembled in Heidelberg. At least three of these chambers will be used for an in-beam test at the CERN PS in the Fall of this year. The dies from the first submission of the digital chip and the latest preamplifier/shaper will be mounted on multi-chip modules in July in time for the test at CERN. A first prototype cooling system and detector control system will be designed and tested. The collaboration is actively seeking additional funds for the timely completion of the full detector.

Photon Spectrometer (PHOS)

Status: Pre-production of PbWO4 crystals continues in the North Crystal Co plant, Apatity, Russia. Currently 24 furnaces for the crystal growth and 6 furnaces for annealing are in operation. The crystal growth and annealing technologies are being optimized. The crystal cutting machinery is being adapted for shaping the PbWO4 crystals. Some 600 full-size (2.2x2.2x18 cm^3) shaped crystals were accepted after tests using the optical and light yield test benches of the Kurchatov Institute. A decision was taken to use Avalanche Photo Diodes (APD's, as in CMS) as photo-detectors in order to increase the accessible energy range. Beam tests of a matrix of 3x3 new crystals with APD photo-readout were performed with electron beams in the energy range of 0.6 - 50 GeV. Preliminary test results show that the crystals are to specifications and the APD's are of high performance in a broad energy range.

Changes: A decision was taken to use APD's as photodetectors. A proposal has been submitted to DOE on participation of several US institutes in ALICE, and, in particular, in the ALICE/PHOS project. Participation of Japanese collaborators is under consideration.

Concerns: No major technical concerns, the funding situation however needs to be reviewed in particular in the light of significant increases in the crystal price.

Plans: Optimization of the crystal mass production technology (growth, annealing and cutting) at the Apatity plant. Production of some 15000 crystals in 2002. R&D for a modified low-noise preamplifier for the APD photo readout.

Muon Dipole Magnet

Status: Machining of the yoke modules is progressing on schedule. The production assembly of the yoke base has started at the end of March 2002. The producer is presently elaborating the technique of assembly in operational condition. The first length of production grade conductor has been delivered to the coil manufacturer in satisfactory condition. The winding of the dummy pancake has been successfully terminated and the technology of coil shaping and impregnation fully defined.

Changes: Design and manufacturing of the coil supports is being rescheduled for tender in Industry.

Concerns: No major concerns.

Plans: Horizontal production assembly of the yoke by winter 2002. The dummy sub-coil shall be finished in June 2002. The final production of the six sub-coils can start in the second half of the year, after some further testing of the technology.

Muon Tracking Chambers

Status: The second version of the new-preamplifier/shaper, MANAS, has been tested. Despite some (trivial) problems which occurred during processing at the foundry, the functionality of the chip was found to be satisfactory. A new run has been done and should be ready by end of March. Several chamber prototypes for the stations 3,4 and 5 are under tests and the PRR was passed end 2001. A full size slat (2.4m) has been built. In-beam tests at the PS with this prototype in October have given satisfactory results and have validated the slat structure and the read-out electronics. The first quadrant of station 1, which is currently in construction, should be completed by May and in-bean tested in July.

Changes: No major changes

Concerns: No major concerns

Plans: The PRR for Station 1 & 2 should happened by June 2002. The production of stations 3, 4 and 5 will begin by the end of 2002.

Muon Trigger Detectors

Status: Long-term irradiation tests of small prototypes at the Gamma Irradiation Facility at CERN have shown that a thin double-layer of linseed oil on the electrodes improves the aging properties of the RPCs. A prototype with these characteristics is still functional after an irradiation equivalent to 70 ALICE-years in Pb-Pb, while the ability of operating the detector in p-p strongly depends on the machine background and running scenario. The tests will be continued this year. A full-scale RPC prototype has been tested at the GIF end 2001. The overall behavior of the prototype was satisfactory at low rates, but some inhomogeneity in the rate capability was found which is currently under investigations. The final dual threshold front-end chip and board have been successfully operated. The test bench for the mass production has been prepared. The PRR for the detector and front-end is scheduled for the end of 2002 and the production should start in 2003.

The second generation of the local trigger electronic boards (VME 9U board) has been built and is presently under evaluation. A full scale mock-up of a part of the trigger setup (~3×3 m^2) has been built for investigating some mechanical and cabling aspects. The cables between the FEE and the trigger electronics (23 km of 16 pairs cables) have been ordered.

Changes: No major changes

Concerns: Background conditions during pp running, which have recently been revised upward by the machine by over an order of magnitude.

Plans: Aging tests of small prototypes will continue this year to further increase the detector lifetime. A second full-scale prototype will be tested in spring and summer 2002. A "mini-trigger" experiment, a small scale reproduction of the full dimuon trigger, is scheduled at the GIF in June 2002.

Forward Detectors

Status: The prototype of the zero degree e.m. calorimeter, equipped with different photomultipliers, has been tested in October 2001. The results are in agreement with the simulations. The machining of the tungsten alloy plates for the construction of the first neutron calorimeter is in progress. The quartz fibres have been ordered.

The Si- FMD (Forward Multiplicity Detector) baseline has been fixed. The system will now provide full pseudorapidity coverage from -5.1 to +3.4 together with the ITS inner pixel layer, for charged particle multiplicity and fluctuation studies. The overall design is based on 5 Si ring counters segmented into 25600 strips. Basic specifications of the Si-sensors and of the FE electronics have been defined. The project is ready for going to industrial bids towards manufacturing of realistic prototypes. Integration and installation studies for the forward detectors are in progress. Further optimization of the vacuum chamber design may provide important reduction of the background of secondary particles for all the forward detectors.

The baseline T0 system has been defined with comprehensive physics simulations and integration studies. Beam tests indicate that an intrinsic time resolution better than 55 ps can be achieved. The radiators will be manufactured of quartz coupled to fine mesh photomultiplier tubes. A realistic prototype will be manufactured in 2002. Design for electronics is advancing.

Several prototypes of the Photon Multiplicity Detector (PMD) have been fabricated and tested in the beam with satisfactory results. Optimization of the detector geometry and further beam tests are planned in 2002.

Changes: A new lay-out for the forward detectors (FMD, T0, V0, PMD) has been defined. Responsibility for T0 detector transferred to Finland.

Concerns: The position and granularity of the PMD is currently being revisited.

Plans: The first final ZDC neutron calorimeter will be assembled in June 2002. Laser and beam tests of prototypes for the T0 (FEE and pre-production PMT's), electronics design and integration with DAQ and Trigger.

Trigger

Status: A new description of the ALICE Central Trigger Processor has been prepared, and the User Requirement Document approved at the ALICE Technical Board in January 2002. The new trigger foresees considerable increases in inputs and in the number of allowed concurrent trigger classes. This is achieved by allowing CTP dead time and by restricting the number of independent groups of detectors (detector "clusters") which can be read out at any one time. In order to strengthen the trigger group, now facing a significant increase in requirements, new collaborators are being sought to enlarge the group.

Changes: New Central Trigger functionalities.

Concerns: Resources (both manpower and funding) are very tight. The redesign has resulted in a delay of about 1 year in the Trigger project.

Plans: Freeze details on detector interface and proceed to the technical specification of the CTP electronics.

DAQ

Status: The prototype of the optical Detector Data Link (DDL) has been tested extensively with fast data sources. A PCI 32 bits adapter card for the DDL has been developed and has achieved data transfer at the maximum PCI speed bus (120 MByte/s). The first data transfer from the TPC electronics over the DDL have been achieved and integration is starting now with the ITS Drift detector. The version 4 of the ALICE DAQ framework 'DATE' is currently under development. It realises the integration with the DDL and its PCI adapter card and includes several new key features addressing the issues of larger DAQ configurations: a configuration database, a run-control based on state machines and a load balancing for the event building. The Data Challenge IV has started in March and the scalability tests have already been successfully performed on more than 70 nodes. The new package for online monitoring of the DAQ performances (AFFAIR) has been integrated in the Data Challenge. Systematic testing of different storage options and of the CASTOR system is in progress. The first version of the new Trigger/DAQ simulation program has been used to study the DAQ behaviour under different running scenarios and it has indicated critical areas for sharing of the DAQ resources between the data streams of different triggers.

Changes: New definition of responsibilities and interfaces between the DAQ and newly formed HLT project.

Concerns: Long-term development and support of the CASTOR mass storage system, availability and funding of the common LHC computing test bed.

Plans: The final form factor of the DDL has been decided and the design of the second generation of DDL has started. Irradiation tests of the DDL will carry on to verify the radiation tolerance of the source interface. The DAQ is participating to the development of a second generation of PCI interface for the DDL allowing HLT processing. The ALICE Data Challenge IV performance tests are scheduled for the middle of this year. It should demonstrate sustained data rates of 200MBytes/s to tape. A new version of the simulation program is in development now to execute a more realistic simulation of the detectors and the trigger system behaviour.

High Level Trigger (HLT)

Status: Work continues on data compression, fast cluster finder and track reconstruction algorithms. A track finding method working on raw data (Hough transformation) yields high efficiencies even for the inner sectors with very high occupancy. Several physics case studies (dielectron/dimuon background event rejection, jet selection, momentum filter for D-detection, pile-up filter for pp) have resulted in first estimates of HLT rejection/compression factors. The interfaces of the HLT system are defined. The performance of the publish-subscriber process communication environment has been measured on the Heidelberg test cluster. This data challenge achieved a rate of 270 Hz running pp pile-up removal application (currently limited by TCP/IP over fast ethernet). An FPGA-coprocessor for the PCI-RORC has been designed and the layout is now being finished. An FPGA-implementation of a fast cluster finder has been developed and its functionality verified on a test bench.

Changes: No major changes

Concerns: No major concerns

Plans: Continue with alternative tracking methods for the HLT and debugging of the PCI-RORC prototype with FPGA coprocessor functionality. Extension of HLT simulation studies to more detectors (e.g. ITS, TRD). Final version of the Conceptual Design Report.

Offline

Status: The ALICE offline framework, AliRoot, has seen active development over the last year with many updates in the infrastructure and many additions to the detector specific code. A first version of the complete framework, from simulation to reconstruction and analysis, has been finalized. The offline group participated actively in the Alice Data Challenge to test the basic ROOT I/O system for its suitability for the storage of raw data at very high rates. A distributed file and resource management and monitoring system called AliEn has been developed, offering a large fraction of the functionality to perform distributed computing tasks. This system will be interfaced to existing and emerging GRID MiddleWare. ALICE has participated in the DataGRID project, which has recently been through a successful EU review. Collaboration with US GRID projects has started, mainly via the Ohio Supercomputing Centre, now member of the ALICE collaboration. Work is ongoing to provide a Parallel ROOT Facility (PROOF) that will allow data processing and analysis to be done in parallel, transparent for the user, on distributed PC clusters making heavy use of the Grid services.

A first test of the complete framework, from simulation to reconstruction and analysis has been completed during 5-week test in which 9 sites participated in production of 5800 events (corresponding to 5TB of data and requiring 10^5 CPU hours). This production was carried out entirely using AliEn. Another large AliEn based production has taken place for the design of the propose Electromagnetic Calorimeter involving mainly US sites and Lyon.

Special attention has been devoted to prepare a high level planning taking into account the new accelerator schedule, as well as a very detailed medium term planning covering the major activities of the project.

Changes: No major changes

Concerns: CERN support for some of the main software packages used in ALICE (ROOT, FLUKA).

Plans: The ALICE Data Challenge 4 scheduled for the spring 2002, the Alice Physics Performance Report distributed data simulation, reconstruction and analysis.

L3 Magnet, Installation & Integration

Status: The L3 door plugs have been fabricated in Russia; delivery has started and will be completed in April 2002. A call for tender has been issued for repairing the inner cooling circuits of the L3 magnet. The clean room for TPC assembly is ready, civil engineering in the underground area is essentially finished.

Changes: No major changes.

Concerns: No major concerns.

Plans: Installation of the counting room. Installation of L3 door plugs to start in April.

MILESTONES

After essentially finishing the design phase of the experiment, ALICE has updated and integrated the overall planning and milestones at the end of 2000, taking into account also the new LHC machine schedule. Milestones for the TRD will be included once agreed upon with the LHCC.