Status of ALICE : Report for October 2001 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 77 institutions in 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, CASTOR, T0) are located at small angles.

So far 9 TDR's have been approved (HMPID, ZDC, PHOS, ITS, muon arm, PMD, TPC, TOF, muon arm addendum); the last remaining TDR for the TRD has been submitted in October 2001. An addendum to the TOF will be submitted by the end of this year. Construction of most detectors has started, L3 dismantling is essentially finished and the preparation of the experimental area is under way.

An overview of the financial situation in ALICE including a preliminary estimate of 'cost-to-completion' and Commissioning & Integration costs will be presented to the October RRB.

Silicon Pixel Detectors

Status: Wafer probing of the engineering run of the ALICE1 pixel chip (0.25µm CMOS) has been completed and has shown a good yield. The first phase of bump-bonding trials with the two chosen suppliers has been successful. A number of assemblies (single chips bump-bonded to silicon sensors) have been produced and submitted to lab and beam tests. On-line results confirm that performance is good, a detailed analysis of beam data is under way. Wafer thinning trials have been started. Irradiation of chips with x-rays and protons has confirmed outstanding radiation hardness characteristics. The PILOT chip (front-end control) has been submitted to the foundry and the prototype is under test.

Changes: No major changes

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

Plans: Completion of the bump-bonding optimization, using ladders. Thinning of wafers after bump deposition. Development of the ladder module assembly.

Silicon Drift Detectors

Status: The SDD pre-production sample has been tested confirming functionality and yield (70%). The tender for the final production was launched at the beginning of the year, a supplier (Canberra) has been selected and production should start by spring 2002. The production test facilities are being set up. To address the shortage in the supply of neutron transmutation doped (NTD) silicon, we are working on a collaboration between a Danish producer (TOPSIL) and INFN Trieste. First dedicated ingots using a technology optimized for high doping homogeneity should be produced within 2001.

Prototypes of the front-end chips (PASCAL-32 and AMBRA-2) were successfully tested in the beam, the Design Review for the final chips was passed in September. Preliminary tests of the prototype of the readout chip (the data compressor CARLOS) are satisfactory; the integration tests with the ALICE DAQ standard components will be performed in the beginning of October. Prototypes of the

300 μm thick HV Al-kapton microcable were successfully tested at twice the operating voltage. Prototyping and testing proceeds on a number of other items (hybrid circuit, LV power supply, tools for the ITS installation on a full-scale mock-up). The full-scale mock-up of SDD cooling system for the ladders was built but the hydraulic tests have not been completed. The mock-up of the end-ladder cooling system was successfully tested but requires a few improvements to gain a convenient safety margins.

Changes: No major changes

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

Plans: Submission of final prototypes of PASCAL and AMBRA chips by November 2001. Submission of first prototype of the final version of CARLOS chip by November 2001. The production of the ladder mechanical structure is planned to start by the end 2001. Detector production should start by spring 2002. Tests results on final SDD cooling system by June 2002.

Silicon Strip Detectors

Status: The front-end chip has been re-designed and submitted in February in order to improve the radiation tolerance and latch-up sensitivity. A number of chips from the February 2002 run are working as specified. A number of chips have problems which are now under investigation in order to define either the expected yield with the present design or some yield improvements with a modified design. An extra wafer will probably be necessary. The hybrid production is somewhat delayed with respect to the original milestone. The specification of the hybrid was completed in July 2001, after the design of the new radiation tolerant chip was completed. As soon as the current layout of the front-end chip can be confirmed, after thorough analysis of the prototype chip, the first hybrid prototypes will be produced. Four offers for the detector procurement were received. Final negotiations are in progress. The contract will be signed in October; actual production of the pre-series of the detectors will shift to approximately March 2002.

Changes: No major changes

Concerns: Production date of the HAL25 front-end chip.

Plans: Evaluation of the HAL25 front-end chip prototype.

Time Projection Chamber (TPC)

Status: Following a series of new tenders, the construction of the TPC field cage has started. Contracts for the manufacture of the composite structures and the precision aluminum end plates have been placed recently with several firms, limiting the overall delay to approximately 6 months. It is expected to catch up on the baseline schedule during the assembly phase of the TPC. The preparation of the field cage assembly space in SXL 2 is also underway and will finish on schedule.

The production of the small inner readout chambers (IROC) is running at the foreseen pace. The prototype of the larger outer readout chambers (OROC) is under construction. The pad plane, segmented into 4 pieces for the outer chambers, has already been delivered, the Al body is in production; the prototype is expected to be functional end Nov01. The TPC gas system is fully designed and will have a PRR in Dec01. The laser system design has progressed such that an engineering design review is now planned for Dec01. The ADC evaluation has finally led to a scheme where a commercial ADC is integrated with the ALTRO digital chip into ONE 16-channel chip. The design of the integrated chip is finished and a first production scheduled with delivery in Jan02. The preamplifier chip has been modified to accommodate the chosen ADC (differential input). Delivery of the next production is scheduled for Jan02.

Changes: No major changes

Concerns: No major concerns

Plans: The field cage prototype has finished all radiation tests and will be prepared for a final joint beam test with a small TPC readout sector and real TPC electronics due in summer 2002. End of

IROC production at GSI (50%) Jan02, start of production in Bratislava still this year, start of OROC production Feb02. Assembly of a full FEE chain including DDL transfer to the DAQ starting Feb02.

Multigap Resistive Plate Chambers (MRPC) for TOF

Status: An improved structure of the MRPC (Multigap Resistive Plate Chamber) has been implemented. It consists of a double-stack of resistive plates and readout PCBs that allows to put anode and cathodes closer thus sharpening boundaries between pads, to get larger signals by summing the output of the two stacks, to increase the number of gas gaps and to work at lower HV. Four different prototypes of full size were built and tested on beam. The results obtained with a double-stack MRPC of 5 x 2 gaps show that this new device has excellent performance : a) a very large streamer- free HV plateau, b) full efficiency at the center of the pads and a global efficiency of 96%, c) the intrinsic time resolution is below 50 ps, d) the double-hit probability and the rate capability are substantially improved. A 16-ch FEE card equipped with very fast commercial amplifiers and comparators has been used for these tests on beam; the good performances measured on the test bench have been confirmed when attached to the MRPC strip for test beam measurements.

Changes: The INFN tender for the analogue ASIC design has been cancelled.

Concerns: No concern

Plans: Test a central module prototype of the TOF detector and a prototype card for the HPTDC readout. Submit the TDR Addendum end 2001.

High Momentum Particle Identification Detector (HMPID)

Status: The project has progressed on schedule and entered the production phase. Contracts for a number of items have been placed or are already being delivered (fused silica plates, pad cathode frames, module mechanics , Gassiplex chips) . The DILOGIC-II chip, which performs the data reduction, has been produced and successfully tested. A large sample (~300 chips) is already available and the procurement of about 3000 chips has started. In view of the mass production of the photocathode PCBs, an improved version of pad planes has undergone intensive testing that will be completed by fall 2001. New photo-cathodes have been coated with CsI and tested confirming the improvement in Quantum Efficiency (QE) observed at the end of 2000. Ageing test of photo-cathodes evaporated 6 and 7 years ago have shown a remarkable stable QE. The assembly of the first HMPID module with the full equipment has started while, in parallel, DCS and FEE electronics are going to be tested on Proto-3 by the end of October 2001.

The large area ALICE prototype, representing 2/3 of the final ALICE module, installed in 1999 into the STAR detector at RHIC has smoothly started the operation with Au beams at the maximum achievable energy of 200 GeV in the nucleon-nucleon CM .

Changes: No major changes

Concerns: No major concerns

Plans: Complete the assembly of module # 1. Start construction of the 21 radiators and of the 50 pad planes. Finalize the design of the cradle and installation platform. Complete the design of gas, cooling and C_6F_{14} circulation systems.

Transition Radiation Detector (TRD)

Status: The TRD Technical Design Report has been submitted in Oct. '01. Measurements using secondary beams at GSI have shown that the detector will be able to meet the requirement for a pion detection efficiency of less than 1% at 90% detection efficiency for electrons for momenta larger than 1 GeV/c. Several prototypes have been built in order to study the required mechanical stability with the requirement of minimal radiation thickness. First tests of a recirculating gas system for the anticipated Xe/CO2 mixture were successful. The readout electronics of the TRD has made major advances. Two ASICs (preamplifier/shaper and digital processor) have been designed and tested. After complete evaluation of the preamplifier a revised version has been submitted and produced

and is currently undergoing extensive tests. Furthermore, a first attempt has been made to put the whole electronics chain onto a multi-chip module. In cooperation with the ALICE TPC electronics group a very low power 10bit ADC (10 MHz) has been identified for digitization of the pulses. A first design of the detector is fully implemented in ALIROOT and a tracking package has been developed. Simulations studies have shown that as a function of multiplicity space point resolution, momentum resolution, efficiency, and tracking trigger performance are satisfactory even at dN/dy=8300.

Changes: No major changes

Concerns: No major concerns

Plans: Currently, the efforts focus on finalizing the design and constructing a full-scale prototype both for the readout chamber and the radiator. A dedicated test system for in-depth studies of the gas properties of the anticipated Xe/CO2 mixture is being set up. Using the complete electronics chain (TTC, pre-amp shaper, digital chip) detailed tests of the combination of low-noise analog and high-speed digital electronics in close vicinity will be further tested focusing on specific issues related to the implementation of all ASICs on a single board as a ball grid array (BGA). A prototype for a new type of ADC with extremely low power consumption in 0.18 micron UMC technology is under development.

Photon Spectrometer (PHOS)

Status: Pre-production of PbWO4 crystals continues in the North Crystal Co plant, Apatity, Russia. For the moment, 18 furnaces for the crystal growth 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 100 full-size (2.2x2.2x18 cm^3) shaped crystals were delivered and are under tests using the optical and light yield test benches of the Kurchatov Institute. Preliminary test results demonstrate that the crystals meet the PHOS specifications. Beam tests of a matrix of 5x5 new crystals as well as matrices of crystals produced by the Bogoroditzk plant (1999 delivery) were performed with electron beams in the energy range of 0.6 - 30 GeV. 64 crystals were equipped with APD's as photo detectors. Preliminary test results show that the crystals from both producers are of the same quality and to specifications and the APD's are of high performance in a broad energy range.

Changes: Evaluation of APD's as an alternative to PIN photo detectors started in 2000. Participation of several US labs is under consideration.

Concerns: No concerns

Plans: Optimization of the crystal mass production technology (growth, annealing and cutting) at the Apatity plant. Production of some 2000 crystals in 2002. Decision on the photo detector to be taken by the end of 2001.

Muon Dipole Magnet

Status: The purchase contracts for the supply of the Aluminum conductor and the manufacturing of the two excitation coils have been attributed to industry. Material tests of the conductor show satisfactory results. The production line for the coil winding has been set up. The design of the flux return yoke has been finished by JINR and the machining of the yoke modules is under way in Russian industry. The supplier for the power converters for ALICE and LHCb has been selected.

Changes: The delivery of the conductor to the coil manufacturer site had to be rescheduled to fit the production plan for the coils. This is without consequences to the delivery date for the coils.

Concerns: No major concerns.

Plans: The production of a dummy pancake will start in November 2001. The production of coils and yoke will continue according to schedule during 2002.

Muon Tracking Chambers

Status: The second version of the new-preamplifier/shaper, MANAS, has been launched. The track and hold problems in the first version should be solved. The size has not yet been changed and the chip should be tested soon (November). Several chamber prototypes were tested on beam in June and a full size slat (2.4m) was built. The test will be finished in October. The new tests should be done with the second iteration of the MARC (the MCM readout chip).

Changes: A new cooling scheme has been designed for all the chambers in order to keep temperature at acceptable level for the electronics.

Concerns: Beam tests in June were not totally conclusive (not enough time) so October tests are important.

Plans: The PRR for Stations 3,4 and 5 should be done on December 2001 while the one for Station 1 & 2 should happened in spring 2002. The production of Stations 3, 4 and 5 will begin immediately after the PRR. A pre-production of the MANAS should be done in spring 2002 (about 500 chips) in order to test the first chambers with the definitive electronics

Muon Trigger Detectors

Status: The present activity is focused on studies of RPC aging in streamer mode. Long-term irradiation tests of small prototypes have been carried on at the GIF (Gamma Irradiation Facility) at CERN in the first half of 2001. They indicate that a thin double-layer of linseed oil on the electrodes improves the aging properties of the chambers. A fine tuning of the percentages of the elementary gases in the mixture is also under investigation. The tests of the FE chip (ADULT discrimination technique) are carried on in parallel. The final version of the FE chip was received recently. The test bench for the FE mass production is now almost ready. The second generation of the trigger electronic boards, local and regional, has been designed and built.

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.

Changes: none

Concerns: RPC aging (further tests in progress at the GIF)

Plans: A full-scale RPC prototype, equipped with a few channels of the final FE, will be tested at the GIF during the end of the year. Besides the aging aspects, the response uniformity of the detector will be checked. Concerning the trigger electronics, the tests of the final boards will start soon.

Forward Detectors

Status: The magnetic parameters of LHC optics (v 6.2) have been released. The results of the simulation show that the percentage of spectator protons accepted in the ZDC proton calorimeters is comparable with that reported in the TDR. A tungsten alloy has been chosen as replacement material in the ZDC neutron calorimeter and its procurement has been started.

A second, improved prototype for the CASTOR calorimeter consisting of 4 reading units (~ 25 % of one octant) is under construction and will be tested in October 2001. A first FMD prototype (employing Si pads) and its associated analogue-digital electronics has been constructed and is being tested. The layout (position, granularity, technology) of the FMD and T0 arrays has been fixed.

Changes: PMD re-optimization to avoid excessive background is ongoing.

Concerns: The position and granularity of the PMD is currently being revisited. The influence of the compensator magnet on CASTOR acceptance is under investigation.

Plans: The procurement of the ZDC quartz fibers is starting; tests on different photo detectors for ZDC are planned in October 2001.

Trigger, DAQ and High Level Trigger (HLT) projects

Status: The ALICE trigger system has been re-evaluated. Important changes to the ALICE Central Trigger Processor are being implemented, following suggestions made during the LHCC comprehensive review in Jan01. The number of trigger inputs and in particular the number of trigger classes has been increased substantially, requiring a more complex design. A revised User Requirement Document is in preparation. The new description allows for independent treatment of a larger number of rare triggers.

The integration of the prototype of the Detector Data Link (DDL) has started with the readout controllers of the TPC and the ITS drift detectors. A PCI interface for the DDL has been developed and is reaching the maximum performance of the PCI bus (120 MByte/s). The ALICE DAQ framework 'DATE' is being used in the ALICE test beams and by several experiments (NA57, NA60, COMPASS, HARP). The evolution of the DAQ VME platform towards commodity standard has been started. A major release of DATE is currently under development. It will include 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 development of a new package for the online monitoring of the DAQ performances has been initiated. The CASTOR mass storage system has demonstrated during the ALICE Data Challenge III a sustained bandwidth of 85 MByte/s during a week and a total amount of data stored of more than 110 TBytes. A systematic testing of CASTOR has started in view of the Data Challenge IV.

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. The interfaces of the HLT system are being defined. The performance of the publish-subscriber interface has been improved. A test cluster with 50 nodes has been acquired to be used for on-going system integration tests. A FPGA-coprocessor for the PCI-RORC has been designed. FPGA-implementations of a fast cluster finder and the Hough transformation for track finding are being developed. A draft of the HLT conceptual design report has been written.

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

Concerns: The changes in the central trigger has lead to a better performing, but also more complex system. Probably the trigger project has to be strengthened, also in order to recuperate the time lost in the redesign. Long-term development and support of the CASTOR mass storage system, availability and funding of the common LHC computing test bed.

Plans: Irradiation tests of the DDL will be made to verify the radiation tolerance of the source interface. The DAQ will participate to the development of a second generation of PCI interface for the DDL allowing HLT processing. The ALICE Data Challenge IV is scheduled for the middle of next year. It should demonstrate sustained data rates of 200MBytes/s to tape and test a number of new components. Continue with alternative tracking methods for the HLT. Develop a PCI-RORC prototype with FPGA coprocessor functionality. Extend HLT simulation studies to more detectors (e.g. ITS).

Offline

Status: Evolution of the offline framework of ALICE, based on ROOT, has continued with the development of reconstruction from raw data for all the detectors. Global reconstruction and track matching exists for the barrel detectors and is being optimised. Off-line subprojects have been initiated in the areas of planning, world computing, HLT algorithms, GRID computing and detector databases with effort provided by collaborating institutes. A first large-scale production of pp simulated events has been performed and the data have been reconstructed and analysed. A larger production of HI events for the Physics Performance Report is starting. Major tests of distributed job submission and transparent file access have been performed in the framework of the DataGRID project, involving several sites in different continents. Detailed tests of the physics of the GEANT4 MonteCarlo have been performed and the GEANT4 MonteCarlo integration in the AliRoot framework is close to completion.

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

Status: Status: Final drawings and production methods of the new door structures are in a final stage of preparations. The final text of the agreement between CERN and ITEP has been prepared and the industrial partner in Russia has been chosen.

Changes: No major changes.

Concerns: No concerns.

Plans: The door structures are foreseen to be delivered in January 2002 in full agreement with the overall installation planning for ALICE.

Installation & Integration

Status: The dismantling of the L3 experiment, including the large central support tube has been successfully terminated. Constructions to provide a clean room structure are in progress.

Changes: No major changes.

Concerns: No concerns.

Plans: Preparations are being made for a number of smaller civil engineering changes to the ALICE experimental cavern.

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.