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Status of the LHCb Experiment

Report to October 2002 RRB
By the LHCb Collaboration

I) Introduction

Re-optimization of the detector to reduce its material budget is advancing and a baseline detector, so-called LHCb-light, has been defined. The spectrometer magnet, RICH-2 and Calorimeter system are unaffected from this change and their construction is advancing. Equally unaffected are the three tracking stations after the dipole magnet (ST-1 to ST-3), consisting of the straw Outer Trackers and silicon Inner Tracker. Their designs are identical to those for the T9 station described in the approved Outer Tracker TDR. For the Muon system, if there is any change, it will be limited to the first station in front of the Calorimeter system. The change to the Vertex Locator (VELO) will be minimal. For the Level-1 trigger, an all silicon tracking station (TT) is introduced behind RICH-1 and its design has to be finalised. A major change is required for the RICH-1 in order to protect the photon detectors from the increased fringe magnetic field of the dipole due to the removal of the shielding plate. This change has been introduced to enhance the Level-1 trigger performance. The overall cost of the detector remains unchanged. A preliminary study of the baseline detector indicates that the expected physics performance is similar to that described in the Technical Proposal. However, the TDR of the re-optimized detector originally planned for the end of 2002 has been postponed to September 2003, in order to understand fully the physics potential of the LHCb-light detector. This delay is necessary to finalise our reconstruction software and to generate sufficient number of events for background studies, as well as to complete the RICH-1 and TT designs. In order to maintain consistency, submission of the Trigger TDR originally planned for the beginning of 2003 is also delayed to September 2003. Although the construction of the detector systems that are affected by the re-optimisation process will start after the approval of the TDR, it does not introduce any delay in the overall project.

Changes: Submission of LHCb-light and Trigger TDR's delayed till September 2003.

Concerns: No major concern

II) Detector Subsystems

II-1) Beam Pipe

The beam pipe design has been further refined by the optimization of the location of flanges and bellows in order to minimize the background in the detectors in their proximity. A Beryllium prototype for the first 25-mrad section is being ordered. Changes in the design of the exit window of the VELO vacuum tank following the RICH-1 modifications are being finalized. Aluminium blocks have been delivered to CERN to machine prototype exit windows for vacuum and destructive tests in the coming weeks.

Changes: no major change

Concerns: none

II-2) Magnet

All the conductor material has been delivered by Holton Machinery (UK) to SigmaPhi (F) for coil production and 24 pancakes out of 30 are wound. Four out of 10 triplets have been potted and the fifth is in preparation. For the yoke, a total of 600 tons of iron is at Jebens (D) and waiting to be cut. The delivery of the plates for the lower yoke part shall start in December.

Changes: none

Concerns: none

II-3) Vertex Locator

Full-size prototypes for the thin aluminium RF box and the rectangular bellows are being produced. A new version of the Beetle chip with bug fixes and an improved front-end amplifier is available and both SCTA-VELO and Beetle 1.2 are being tested in the laboratory. Full-size hybrids equipped with either 16 SCTA-VELO chips or 16 Beetle1.1 chips bonded to VELO prototype sensors were tested with beam. Based on the results from these tests, the choice of the chip will be made by the beginning of 2003.

Changes: no major change

Concerns: none

II-4) Inner Tracker

The strip pitch for the Inner Tracker silicon sensors has been decided based on the prototype tests with beam done in May/June using Beetle chips. A mechanical design of the detector has been completed after investigations on the cooling concept and on the choice of materials for the ladder supports and detector box mechanics. A prototype optical readout link with 100 m optical cables has been assembled and is operational in the laboratory. The Inner Tracker Technical Design Report for the ST stations will be ready for submission to the LHCC beginning of November as planned. In parallel, a conceptual design for an all-silicon TT station is being developed. Prototype sensors for the TT station have been received and a cosmic test setup is being prepared.

Changes: TT station became all silicon

Concerns: none

II-5) Outer Tracker

All the work done concerns only the stations behind the dipole magnet not affected by the re-optimization. Responsibilities for the module production have been defined. The detector elements have been defined and first prototypes of full size panels (5 m long) have been made. A contract for the full production has been placed to Krakow and tool preparation is under way. Development of the wire locators and end-pieces in collaboration with Philips Electronics N.V. (NL) is in progress. A new foil material for the production of the straws has been successfully tested. Another batch will be ordered to assess the production reliability from Lamina. The mechanical layout of the FE electronics boards is in progress and the first prototypes of OTIS chips have been received and tested successfully so far.

Changes: none

Concerns: none

II-6) RICH

The RICH2 detector Engineering Design Review was completed in May 2002 and approved by the collaboration. Detailed designs of the superstructure are under way. Con-

struction of the entry and exit gas enclosure windows will commence at the end of 2002. Tendering for the optical components has begun and the first batch of 10 spherical mirrors will be delivered for evaluation early in 2003. A milestone to produce some prototype HPD's in June was missed due to a serious problem with the quality of the bump-bonding. In view of the delay of the LHC, a panel that included external members recommended to delay the milestone to the end of 2002. Recent progress shows encouraging results in the bump-bonding. In order to keep a commercially available multi-anode PMT as a viable backup, development of a front-end chip based on Beetle has started. The 40MHz pixel readout chips from an engineering run for the final chip have been comprehensively tested and shown to fully satisfy the RICH specifications. The RICH-1 detector is currently undergoing a redesign, as a part of the LHCb-light detector optimization. Several candidate technologies for the lightweight mirrors have been prototyped and commercially produced carbon-fibre composite mirrors show promising results.

Changes: RICH-1 being redesigned to reduce material budget and to cope with B field

Concerns: Delay in HPD R&D

II-7) Calorimeter

The series production of ECAL is ongoing at ITEP Moscow. A total of 1200 ECAL modules (out of 3300) have been delivered to CERN. The HCAL series production has started in May 2002 at IHEP Protvino and the first two modules (out of 52) have been delivered to CERN. The preparation of the Preshower/SPD detector series production is ongoing at INR. The ECAL/HCAL electronic chips have been produced and are being encapsulated at present. The Preshower/SPD electronic chip design is being modified for higher gain to decrease the average PMT current in order to extend the lifetime of the Multi Anode PM tubes in the central region.

Changes: no major change

Concerns: none

II-8) Muon

The construction of final MWPC prototypes for all the four regions in station M3 is advancing and beam tests will start in October as planned. Ageing tests of the RPC detectors showed a substantial reduction of the rate capability with respect to the past year (now at most 250 Hz/cm^2). For this reason the LHCb collaboration decided to abandon this technology in favour of an all-MWPC solution. A revised production plan will be presented to the LHCC in a forthcoming document. R&D work for the inner region detectors is progressing. The design of the tooling is well advanced and work has started to equip the production centres. Concerning the electronics, the design of the DIALOG chip is now complete, while some more work is needed for the CARIOCA chip. A design of the SYNC chip will be submitted at the end of the year. The test of the complete readout chain, planned for the end of 2002, should take place as expected.

Changes: RPC abandoned and the all-MWPC solution adapted

Concerns: Required manpower for the MWPC construction due to this change

II-9) Trigger

For Level-0, the muon trigger group has produced a detailed specification of the processing board. The prototype vertex finder board and hybrid have been laid out for the Pile-up Veto and their production is underway. The whole Level-0 trigger electronics was reviewed by a panel including two external referees and no major concern was expressed. For Level-1, a decision was made to build the TT station with silicon only, af-

ter a detailed trigger simulation study. The Level-1 trigger architecture was reviewed by a panel including two external referees and its report is being formulated. In order to synchronise with the LHCb-light TDR, submission of the Trigger TDR is delayed to September 2003.

Changes: TDR submission date delayed to September 2003

Concerns: none

II-10) Computing

Software: While the event generation and detector material simulation are still based on FORTRAN, the hit digitization and event reconstruction processes have been completely transferred to the Object Oriented GAUDI framework and the output is written as OO DST. Physics analysis is also done in the OO framework. A total of 3.3 million events were produced during this summer over a period of 7 weeks using 9 different production centres for the trigger and physics performance studies. This has been also useful to gain experience for several components of the LHCb Computing model.
Online system: Prototypes of various hardware components for the DAQ and Experimental Control System such as the Timing and Fast Control switch, Readout Supervisor and 'glueboard' have been produced and are being tested. The second version of the software framework for the controls system was released and is used in the LHCb test beam and also in the online lab for tests of the TFC system prototypes. A copper version of the S-Link to GbEthernet interface module is due to be delivered by the end of October. A prototype of an optical version has been tested and works according to specifications.

Changes: none

Concerns: none

III) Experimental Area

The concrete structure of the head wall of UX85 was reinforced and unnecessary concrete structure in RB84 area was removed. The metallic structures in the PZ area (stairs, barriers) are being installed and the reinstallation of the general service in the UX85 cavern will be completed by spring 2003. The support structure for the LHCb dipole will be installed in the beginning of 2003.

IV) Organization

As from 1st of July 2002, Werner Witzeling became Technical Coordinator of the LHCb experiment. Other appointments made are
Thomas Ruf (CERN): VELO Project Leader
Antonio Pellegrino (NIKHEF): Outer Tracker Project Leader
David Websdale (ICL): RICH Project Leader
Olav Ullaland (CERN) RICH Deputy Project Leader
Andreas Schopper (CERN): Calorimeter Project Leader
Jacques Lefrancois (LAL): Calorimeter Deputy Project Leader

V) Milestones

All the milestones agreed with the LHCC at the time of the TDR approval have been revised in view of the new LHC schedule, i.e. the first beam in April 2007. The plan was made so that the installation of the LHCb detector is completed by summer 2006 for sufficient commissioning time. The collaboration considers this to be essential in order to exploit the physics potential of the LHC and the LHCb detector from the beginning.

LHCb-light Baseline Detector