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2 April 2004

Status of the LHCb Experiment

Report to April 2004 RRB
By the LHCb Collaboration

I) Introduction

Two Technical Design Reports (TDR's) for the trigger and the reoptimized detector, respectively, were approved by the Research Board in February. The experiment is in the construction phase and some reorganization was made in order to adapt to this phase. The decision to use the Hybrid Photon Detector (HPD) as the RICH photon detector reduced the total cost of the experiment to become 71.65 MCHF, i.e. 1.09 MCHF less than that at the time of the last RRB in October 2003. However, there still exists a considerable uncertainty in the cost of the HPD production. The funding request to the BMBF by the German groups has been approved in March 2004.

II) Detector Subsystems

II-1) Beam Pipe

After metrological and vacuum tests, the 25 mrad Be prototype was qualified to be used as the final beam pipe. The VELO exit window vacuum seal has been successfully tested at bake-out temperature. Tendering procedures for all beryllium sections have been completed and a Production Readiness Review (PRR) took place in February. Contracts will be placed following the March Finance Committee. Activation studies have started.

Changes: none.

Concerns: none.

Plans: Place contracts for all the beryllium sections of the beam pipe in this spring and start the production of the remaining sections. Refine the design of supports and fixed points.

II-2) Magnet

The lower and two vertical parts of the yoke have been assembled. The lower coil is installed in its final position and the upper coil has been mounted on top of the lower one.

Changes: Slight delay in the assembly, however with little consequence.

Concerns: none.

Plans: Finish the magnet assembly in the second quarter of 2004 and move the magnet to its final position. Start the commissioning and the magnetic field measurement in summer 2004.

II-3) Vertex Locator

The PRR of the VELO vacuum vessel was completed in February 2004 and the vessel can now be ordered. There are concerns with respect to contamination of the NEG coating due to fluorine originating from viton seals. This is being studied both at NIKHEF and CERN. The Beetle 1.3 chip has been characterized and found satisfactory for the VELO. An internal review on the analogue link and front-end hybrid was held in February 2004. The analogue link was tested successfully with a Beetle 1.3, a line driver, a 60m cable and a digitizer board (RB3). This test will be repeated this summer including a hybrid populated with Beetle chips and bonded to a prototype sensor. The

sensor order is being finalized.

Changes: none.

Concerns: Delivery time for the sensors and hybrids. NEG contamination.

Plans: Submit Beetle for an engineering run in May. Test a prototype silicon sensor close to the final design with the Beetle1.3 and final hybrid in test-beam in May. Test the final *r* and ϕ sensors in test-beam together with the final electronics and mechanics in August.

II-4) Silicon Tracker

The design of the Trigger Tracker (TT) station has been simplified, and less read-out sensors are now required for the same coverage. The design parameters of the silicon sensors have been finalized and the mechanical design of the detector ladders and the station frames is progressing well. The preparation of the production sites for the TT silicon ladders is underway. The mechanical design of the Inner Tracker (IT) detector boxes is being finalized, and the design of station frames is being developed in close contact with the Outer Tracker group. The design parameters of the IT silicon sensors have been finalized and the purchase order is being processed. The preparation of the production sites for the IT silicon ladders is underway.

Changes: Responsibilities for the mechanical design of IT and TT have been redefined: the mechanical design of IT (ladders and station mechanics) by Lausanne and TT by Zurich.

Concerns: Delay in the submission of the Beetle 1.3 chips.

Plans: Finalize mechanical design of TT station. Start the ladder pre-production for TT and IT in autumn 2004.

II-5) Outer Tracker

Over 10% of all detector panels have been assembled at INP Krakow and shipped to the production sites. Final assembly tools are operational at all three detector production sites (Heidelberg, NIKHEF and Warsaw). Two full-size “long” modules (5m) have been produced and tested at NIKHEF, and one at Heidelberg. One "short" module (2.5m) has been produced and tested at Warsaw. The PRRs will start with the NIKHEF production site in April, and Heidelberg and Warsaw will follow. Two fully equipped Front-End Electronics boxes have been produced, assembled, and successfully tested using a system designed by Tsinghua. ASDBLR02 chips have been delivered and tests are in progress.

Changes: none.

Concerns: Delay in starting the series production in all detector production sites. Manpower for the installation at CERN.

Plans: Achieve a steady production status of the detector in all three sites by summer. Continue aging studies. Test the integration of mechanics and electronics by constructing and assembling a quarter of an OT Station in autumn 2004.

II-6) RICH

The HPD was chosen as the RICH photon detector in October 2003. Preparations for all stages of the HPD production are in place and the tendering/ordering procedure is in progress. For RICH2, the construction of the large lightweight windows was completed. The manufacture of the main structure is close to completion in the UK and will be delivered to CERN in April. All mechanical components for the optics have been delivered to CERN as well as the first 10 spherical mirrors. The PRR for the magnetic shielding house of the HPDs took place and tendering is now in progress. The detailed

engineering design for the RICH1 detector, which was affected by the reoptimization, is advancing. The specifications for a full-scale prototype beryllium mirror for RICH1 are currently being finalized.

Changes: HPD chosen as the RICH photon detector.

Concerns: Tight schedule for completion of RICH-1 mechanics.

Plans: Begin assembly of RICH2 structure at CERN in April. Place order for HPDs by this summer. Conduct RICH1 engineering design review by the middle of 2004. Start reflective coating of the mirrors at CERN around June.

II-7) Calorimeter

All the required 3300 ECAL modules produced at ITEP have been delivered to CERN. An additional 50 spare modules have also been produced. Out of the required 52 HCAL modules, 30 have been produced at IHEP and 28 have been delivered to CERN. The optics assembly and quality control of the HCAL modules is progressing at CERN. A total of 17 modules have undergone full quality control and are ready for installation. A total of 2175 photomultiplier tubes for the ECAL and HCAL out of 7800 have been delivered and about 60% have been tested on the three dedicated test benches. The rejection rate of 5% is well below the acceptable level of 10%. The design of the Cockroft-Walton High Voltage system for the ECAL and HCAL phototubes has been frozen and the bases have been ordered. For the Preshower and SPD detectors the mass production of detector modules has started at INR after completion of the PRR in November 2003. For 1990 scintillator tiles (out of a total of 12000) the WLS fibres have been glued into the tiles. Out of the required 444 detector modules, 114 have been assembled and have successfully undergone quality control tests. The specifications for the Multi Anode Photomultiplier Tubes (MAPMT) for the Preshower and SPD detectors have been frozen. The installation and integration for the complete Calorimeter System has been successfully reviewed during an EDR in November 2003. The design of the support chariots and electronics platforms for the ECAL and HCAL is well advanced.

Changes: none.

Concerns: none.

Plans: Order support chariots in May 2004. Order MAPMTs for Preshower and SPD by mid 2004. Finish HCAL modules production by end 2004. Be ready for ECAL and HCAL installation by end 2004.

II-8) Muon

For the MWPC construction, orders for wire, panels, cathodes and other components are out and production of panels is ongoing with excellent quality. The PRR for the CERN, LNF and PNPI production sites took place. The start-up of Ferrara and Firenze production sites is delayed and their PRR should take place in April-May. The production rates from CERN and LNF are approaching the planned values. Triple-GEMs have been selected for the innermost region of the M1 and an Addendum for the TDR is in preparation. New milestones and schedule for the electronics have been introduced with the Engineering Run for all the ASIC chips this summer. The latest CARIOCA version (10) was reviewed and selected for the front-end. The last version of SYNC (received last September) showed some timing problems, which will be corrected in the Engineering Run. The final DIALOG was submitted in a November MPW and is still to be tested. Delay in the delivery of the QPLL chip from CERN delayed completion of the ODE Board test. The chariots for the muon filter have been ordered and will be delivered in April. The filter design has been finalized. The design

of the support structures is progressing according to schedule and detailed engineering work will start soon, using an outside company.

Changes: None.

Concerns: MWPC production rates of the centres. Delay in the start of MWPC production at the Ferrara and Firenze centres. Tight schedule for chip engineering and production runs.

Plans: Reach nominal production rates at CERN, LNF and PNPI production centres in spring. Start production at Ferrara and Firenze centres by summer. Submit the ASIC chip designs for Engineering Run in summer. Complete the full chain-test of electronics by June. Construct the Muon Filter by the end of 2004.

II-9) Trigger

A prototype of the key element of the L0-muon trigger (the Processing Board), very close to the final version, has been tested successfully. Effects of "single event upset" were studied on the selected ribbon optical emitter. The results obtained match well the requirements of the trigger interface in the muon front-end electronics. The jitter and bit error rate for the ribbon optical link were measured and found to be acceptable. The comparator performance of the Beetle 1.3 is not satisfactory for the Pile-Up detector and has to be modified. However, since only 64 chips are necessary, enough chips can be obtained in a Multi Project Wafer run with an improved version. The software of the L1 and HLT triggers has been reviewed and a common implementation of the tracking part has been released for the coming data challenge.

Changes: none.

Concerns: none.

Plans: Continue prototype work for all L0 sub-systems. Establish HLT strategy to get required reduction rate.

II-10) Computing

Online: The Timing and Fast Control (TFC) prototypes were tested and their functionality was found to be very satisfactory; production has started with the TFC switch modules. Contacts have been established with major switch manufacturers to receive their equipments on loan for testing them for viability as the central readout network components. A test-bed has been setup at CERN for this purpose. Also different (high end) servers are being evaluated as subfarm controllers. For studying the implementation of the CPU farm, a rack has been filled with PCs of 1-U height to study the cooling issue. The Credit-Card PCs have been ordered and the associated gluecard is working well. For slow control, the integration of the SPECS system into PVSS starts in April. The first prototype of the Tell1 board (the common front-end electronics board) is being tested.

Offline Software: The new simulation application Gauss based on Geant 4 has been validated for production, by comparisons with Geant 3 as well as with test beam results. The Software framework Gaudi has integrated POOL as the persistency layer. The digitization process (Boole) has been split off from the reconstruction program (Brunel). The RICH digitization in C++ has been integrated and commissioned. This essentially completes the full transition of the LHCb offline software to C++.

Offline Computing: Detailed preparations are under way for the spring data challenge. The LHCb production system (Dirac) has been re-engineered completely, in order to make it compliant with the recommendations of the LCG ARDA report. LHCb have selected the AliEn file catalog as the main catalog for the coming data challenge and its integration with the production system is being commissioned. A cost-sharing model for

the offline computing has been agreed within the collaboration. This will provide input to the ongoing computing MoU dialogue.

Changes: none.

Concerns: Lack of manpower for the core software. Lack of manpower in online computing (slow control).

Plans: Start data challenge in May 2004 with close to 200 million events simulated and reconstructed, where 50% of data is to be produced with LCG2.

III) Experimental Area

The services dedicated to the dipole magnet have been installed up to the proximity (roughly 10 m) of the final position of the magnet. The DC cables from the power station located at surface (SR8 building) and the water-cooling pipes from the UW85 zone are ready to be connected to the magnet from April 2004 as scheduled. The last major cryogenic component (QURCA cold box) for the LHC Machine has been installed on February 2004 at the end of the UX85 area. The dismantling of the first bridge (in front of the RB84 area) is now scheduled for the end of May 2004 in order to move the dipole magnet to its final position when the assembly will be finished. The dismantling of the second part of the bridge (RB86 side) is scheduled for September 2004. However, this operation is correlated to the end of the transportation of the cryogenic-line segments (QRL) dedicated to the 8-1 sector. Delays in that region would imply delays on the assembly of the calorimeters in the UX85 area.

IV) Organization

Laboratoire de Physique Nucléaire et des Hautes Energies, Universités Paris VI et Paris VII, joined the LHCb collaboration. Since all the subsystem TDR's were approved, the subsystems have been organized as projects. In order to coordinate projects closely related two coordination panels have been introduced. The list of names for the project leaders and coordination panel chairpersons are given below.

Project	Leader	Deputies
Exp. Area	D. Lacarrere	-
Magnet	W. Flegel	-
VELO	J. van den Brand	M. Ferro-Luzzi
RICH	D. Websdale	O. Ullaland
OT	A. Pellegrino	-
ST	U. Straumann	O. Steinkamp
Calorimeter	A. Schopper	J. Lefrancois
Muon	G. Carboni	P. Campana and B. Schmidt
L0 Trigger	R. Le Gac	-
Online	B. Jost	-
Offline Computing	N. Brook	-
Core Software	P. Charpentier	-
Reconstruction	T. Ruf	M. Merk and O. Callot
Physics	O. Schneider	-

Coordination Panel	Chair
Trigger	H. Dijkstra
Physics, Software and Computing	O. Schneider

V) Milestone Plot

Figure: Cumulative plot of the LHCb Milestones.