LHCC
June 03, 2014
CERN

Introduction to the Trigger & Online Upgrade TDR

R. Le Gac

CPPM, CNRS/IN2P3

The LOI (March 2011)

- Instantaneous luminosity of 1×10^{33} $cm^{-2}s^{-1}$
- Expect to gain a factor 2 on the trigger efficiency for hadronic final states by removing the hardware level (L0).
- Keep the L0 as a safety belt, to regulate the rate at the input of the EFF farm, and, rename it LLT.
- HLT parameters:
  - Input rate 5-10 MHz,
  - Algorithms very similar to those of Run 1.
  - Processing time of ~20 ms
  - Output rate 20 kHz

EFF size	5×2011	10×2011
LLT-rate (MHz)	5.1	10.5
HLT1-rate (kHz)	270	570
HLT2-rate (kHz)	16	26
Total signal efficiency		
$B_s \to \phi\phi$	0.29	0.50
$B^0 \to K^*\mu\mu$	0.75	0.85
$B_s \to \phi\gamma$	0.43	0.53

The Framework TDR (May 2012)

- Baseline luminosity at 1×10^{33} $cm^{-2}s^{-1}$.
  But, detectors which need replacement will be designed such that they can sustain a luminosity of 2×10^{33} $cm^{-2}s^{-1}$.
- Total integrated luminosity of 50 fb^{-1} in less than 10 years.
- Common readout board for DAQ, TFC, ECS and LLT.
- Event builder similar to the one used in Run 1
  but with a larger bandwidth.
- The EFF farm input rate is 10 MHz.

Trigger designs

- End 2012, the luminosity of $2\times10^{33}cm^{-2}s^{-1}$ became the baseline.

- Three designs were studied in order to establish the feasibility of the trigger running in the upgrade condition:
  - Pure software HLT
  - HLT assisted with a co-processor, TPU, finding upstream tracks
  - Low Level Trigger

  An additional difficulty in designing the upgrade trigger was that several options were proposed for the tracking system, each with different characteristics.

Tracking system

- Jun. 2013 + Jan. 2014, the collaboration selects the detectors technologies for the tracking: VELO pixel, SciFi and UT.
  - The VELO+SciFi allow very fast tracking algorithm
  - The VELO+UT association reduced the processing time of the tracking sequence by a factor 3 [LHCb_TDR-015].

Bidirectional event builder

- February 2014, the bidirectional event builder with the readout electronics located at the surface is selected as the baseline.
  - This choice is endorsed by the review committee.
  - Event building at 30 MHz day one.
  - Open the road for the LLT implementation in software.

Full software trigger

- The trigger studies show that all presented designs are technically feasible at the upgrade conditions with good efficiency. They also show that the trigger can be implemented in different ways.

- March 2014, the full software trigger is selected as the baseline.
  - Choice endorsed by the review committee.
  - Process 30 MHz inelastic collisions day one.
  - Very flexible

- The Trigger & Online TDR is based on the documents prepared for the Online and Trigger reviews as well as on the comments and suggestions collected during that process.

Outline of the TDR

1. Introduction
2. Requirements
3. Online (28 p.)
   - 3.1 System design
   - 3.2 Long distance cabling
   - 3.3 Readout board
   - 3.4 Timing and fast control
   - 3.5 Event building
   - 3.6 Event filter farm
   - 3.7 ECS
   - 3.8 Infrastructure
   - 3.9 Project Organization
4. Full Software Trigger (33 p.)
   - 4.1 Event anatomy
   - 4.2 Trigger sequence
   - 4.3 Global event cuts
   - 4.4 LLT algorithms
   - 4.5 Tracking reconstruction + PID
   - 4.6 Trigger selections + efficiencies
   - 4.7 Robustness
   - 4.8 Project Organization