Beam instrumentation and background monitoring

ALICE-LHC Interface: Upgrading for Run 3, 28/06/2019

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Beam instrumentation devices

• Beam Condition Monitor (BCM) → Beam loss/(large)background online monitoring

• Beam Phase and Intensity Monitor (BPIM, readout board of BPTX) → beam clock phase monitoring
The Beam Condition Monitor system

- The BCM system consists of two stations of 8 diamond sensors on the A-side and 7 diamond sensors on the C-side.
- The BCM readout electronics (CFC card + LHCb TELL1) integrates the signal over three Running Sums: RS1 40 µs, RS2 80 µs and RS32 1.28 ms.
- Initiates Beam Dump via BIS if signal is above threshold, delay for complete beam extraction is ~ 250 -290 µs.
- Rises Injection Inhibit flag to prevent further injection (and removes it during handshake).

Beam dump logic:
- RS1 or RS2 coincidences:
  - dump the beam if at least 3 adjacent diamond sensors show a current > thr_{RS1} or thr_{RS2}, respectively.
- RS32-Sum:
  - Sorting out the two highest and the lowest of 8 sensors, dump the beam if RS32-Sum > thr_{RS32}.

A dynamic threshold system is implemented in order to set high/low value depending on detector status (SAFE/READY) and beam modes:

<table>
<thead>
<tr>
<th>RUN2</th>
<th>Detectors READY, STABLE BEAM: Low thresholds</th>
<th>Detectors SAFE, not.STABLE BEAM: High threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>RS1</td>
<td>500 nA</td>
<td>2700 nA</td>
</tr>
<tr>
<td>RS2</td>
<td>250 nA</td>
<td>1350 nA</td>
</tr>
<tr>
<td>RS32-Sum</td>
<td>35 nA (1E32 Hz/cm²)</td>
<td>300 nA (8.5E32 Hz/cm²)</td>
</tr>
</tbody>
</table>
BCM response during RUN-3 equivalent test on 07/09/2018
BCM response during other high-lumi fills

RUN3-eq. test 2018 - Fill 6772

Response below 15-20% of dump threshold
BCM system plans for RUN3

• In principle no changes foreseen on dump threshold. However x-check of max tolerated currents in gaseous detectors
• During LS2 test all sensors to verify noise and gain + check commercial devices in case replacement is necessary
BPTX system for LHC clock monitoring

Clock signal transmitted over ~ 14.9 Km of optical fibres at a depth of 1 m from P4 to Prevesin and then to P2

-> clock drift due to temperature variations inducing optical fibers refractive index change (dn/dT 1.3x10^-5 /°C)

• Estimated max. diurnal drift: 200 ps
• Estimated max. seasonal drift: 8ns
Phase shift correction in CTP during RUN1 and RUN2

TTCmi VME crate

RF RX RF RX CORDE RF2TTC Fan-out Fan-out Fan-out

2 2

MAIN_BC MAIN_ORB BC1 ORBIT1 ORBIT2

Fan-out

BC1 ORBIT1, ORB2

ORB1, ORB2

2

BC1, BC2 after fine adjustment

CORDE range: -5120: +5110 ps (10 ps steps)

RF2TTC range: 25 ns, 0.5 ns steps

NB: full range exploitation requires calibration

CBM

LTU 1

LTU 19

Oscilloscope

BPTXA BPTXC

BPIM

• Automatically set to 0 by CTP on SQUEEZE;
• Manual reset by shift leader if > 200 ps
BPTX: summary of clock phase shift in RUN1 and RUN2

Wrong phase correction on restart after winter stop
BPTX: summary of clock phase shift in RUN1 and RUN2
BPIM plans for RUN3

• No changes in HW or SW, under study with LHCb possible alternative to CCPC not supported anymore (however enough spares available)

• Establish procedures for alignment of new CTP and FIT?
Background (beam-gas) monitoring

• During RUN1 and RUN2 based on V0 and AD, respectively
• BKGD publications to LHC during RUN2
  • **BKGD1** is a measure of the beam-gas for beam1 measured by the AD detector. Units are % normalized to 100kHz.
  • **BKGD2** is a measure of the beam-gas for beam2 measured by the AD detector. Units are % normalized to 100kHz.
  • **BKGD3** is given by the 80 μs Running Sum (RS) from the ALICE BCM normalized to the dump threshold. Units are %.
Background (beam-gas) monitoring in RUN3

• In RUN3 entirely new system FIT (including upgraded T0, V0A and AD)

• In principle similar capability_measurements available (to be worked out...)
• New BKGD1 and BKGD2 publications to be discussed (and BKGD4, 5, ...)
• Verify RADMONS usage and integration
Back-up slides
BPTX/BPIM

Four electrostatic beam pick-ups located at about 146 m from the I.P. on each incoming beam, readout via BPIM (Beam Phase and Intensity Monitor) board.
Seasonal drift

- If T increases, n increases then signal propagation speed decreases and clock front edge is delayed and moves towards bptx bunch signal.
ALICE Diffractive detector

Beam-Gas rate from timing (events in time with the crossing of one beam on both side of the experiment).

\[ t_{BG} < t_{BB} \quad \text{and} \quad t_{BG} = t_{BB} \]
The V0 detector

Time spectra allow bkgd rejection
(same principle used for new AD detector)
V0 timing properties

Beam1

**V0A** + **V0C** ≈ 11.3 ns

**V0A** - **V0C** ≈ 3 ns

Beam2

**V0A** + **V0C** ≈ 8.3 ns

**V0A** - **V0C** ≈ 14.3 ns

Beam background from beam1

Beam background from beam2

Satellites

Bkgd1 (BGA)

V0A + V0C ≈ 8.3 ns

V0A - V0C ≈ 14.3 ns

Bkgd2 (BGC)

V0A + V0C ≈ -8.3 ns

V0A - V0C ≈ -14.3 ns

Collisions