



Report on UFO-induced dumps by ATLAS BCM/BLM

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for the BCM/BLM/RadMon group

49th BLM Thresholds WG Meeting

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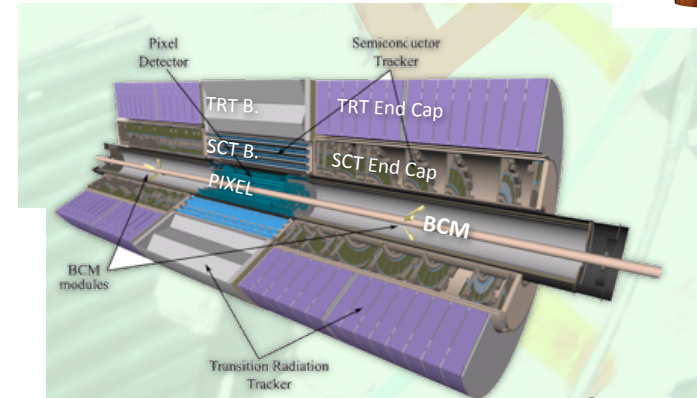
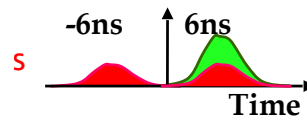


BCM/BLM

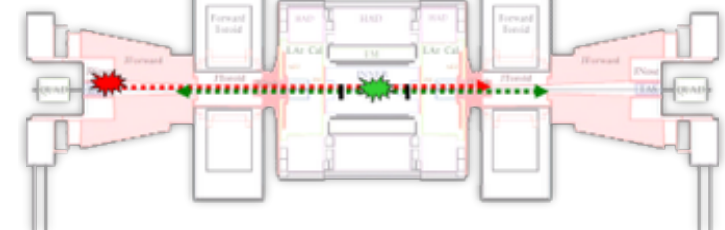


• Beam Condition Monitor:

- 2x1 cm² pCVD diamond, 4 modules per side
- Interaction at $\Delta t = 0, 25, .. ns$
- background at at $\Delta t = 2z/c = 12.5 ns$
- High thr. (LG) vs. low thr. (HG, single MIP sensitivity) signal splitting currently ~1:150

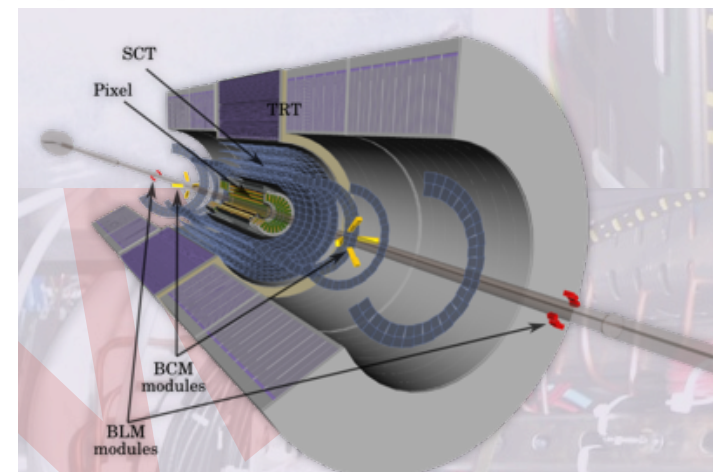


$z = \pm 1.84 m$ $r = 5.5 cm$ $angle = 45^\circ$



• Beam Loss Monitor:

- 6 diamond sensors on the ID end plate
- $z = \pm 3.46 m$
- 2 LHCCFC crate (one per side) , 1 BLMTC
- HW and FW modification (ATLAS specific)
- > Current integration down to ~40 us (RS0 running sum 0)





Summary of Thresholds



- SCT (most conservative) damage threshold: **25 kMIP/cm²** within 25 ns
 - based on most unlikely event of all particles coming along Silicon strips
 - see: <https://indico.cern.ch/event/527184/contributions/2157821/attachments/1270537/1882536/BCMBLM-MachineBLMThresholdsMeeting.pdf>
- BCM threshold: **250 MIP/cm²** within 25 ns per low gain channel
 - > sensitive to single bunch losses
- BLM threshold: **55 kMIP/cm²** within 40 μ s per channel
- Very different thresholds for single-bunch/multi-bunch LHC operation



ATLAS BCM/BLM BA conditions



- **Beam Condition Monitor:**

- Single HT (LG) channel threshold set to $\sim 250 \text{ MIP/cm}^2$ in 25 ns at HV = 1000V
- **Basic 3+3** abort condition: 3 or 4 “out-of-time” signals on A (or C) side coincident with 3 or 4 “in-time” signals on the opposite side
- BCM **Beam Abort algorithm**: basic 3+3 abort condition met twice in 1 orbit + 1 BC
- > after upgrade of BCM FW, BCM re-activated in CIBU in Dec 2012

- **Beam Loss Monitor:**

- 1 MIP in BLM diamond sensor ($\sim 1\text{fC}$ charge) in $40 \mu\text{s}$ causes current of $\sim 25 \text{ pA}$.
- BLM thresholds set to $\sim 750 \text{ nA}$ (350 bits) in $40 \mu\text{s}$ integration channels -> 55 kMIP/cm^2
- Loss of **Injection Permit**: 2/6 BLM channels to exceed threshold within $40 \mu\text{s}$ on A side or C side
- Loss of **Beam permit**: requiring lost of IP on both (A and C) sides simultaneously



Threshold Settings

- **BLM :**
 - Raised from 230 to 350 bits in 2011 via tuning of the read out card
- **BCM:**
 - Change of the nominal condition (HV, thresholds) has impact on luminosity
 - Resistor exchange to rise High threshold. vs. Low threshold. signal splitting:
 - > now at ~1:150 close to the saturation of the amplifier (at 1V, 0.5 kMIP/cm²)
 - Change the Beam Abort Algorithm at the cost of detecting single bunch losses with possible damages to ID ATLAS systems

Little 'room' for further attenuation of the BCM 'fast abort' threshold

BCM Beam Dump of 05.10.2015



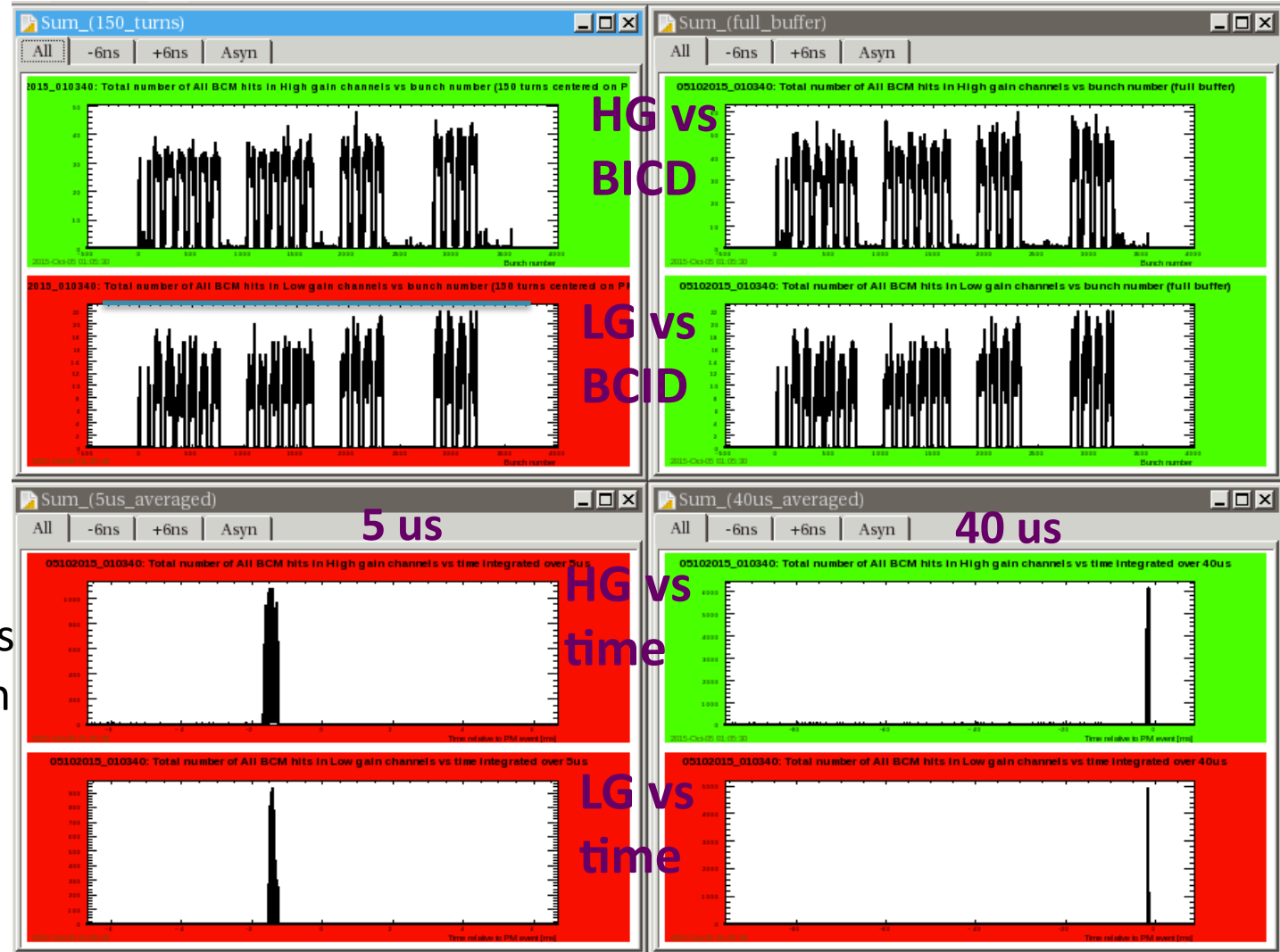
BCM PM histograms



- BCM removed the BP at 01h03m41s
- LHC on flat-top with 1452 bunches
- LG PM histograms vs time show a fast increase in hits
- LG PM vs BCID show a relative uniform losses slightly more in the high BCID number bunches
- 6 instances of the basic 3+3 abort condition

Last 150 turns

Last ~1100 turns

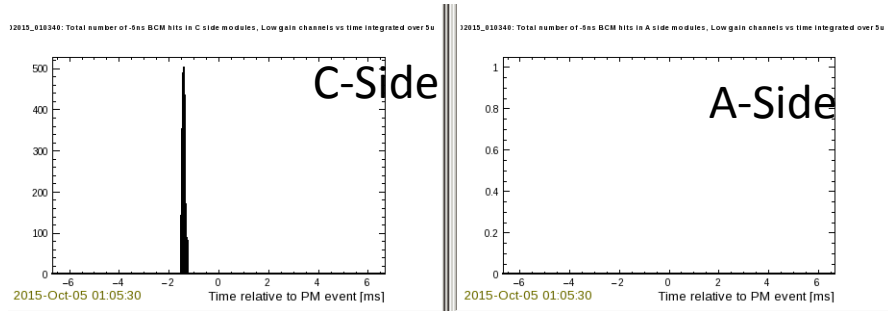




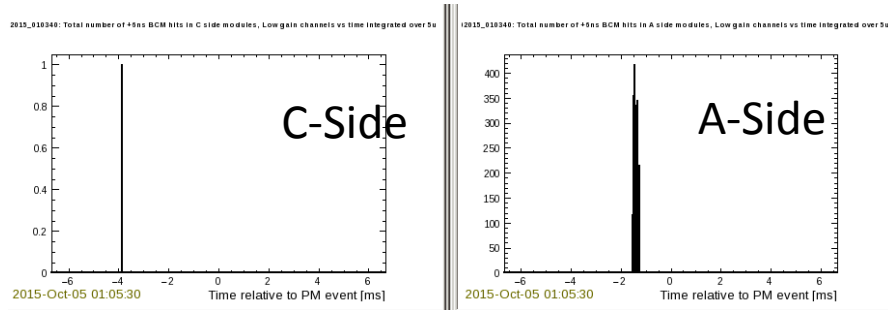
BCM Beam Abort Time Structure



EARLY LG HITS vs time: -6 ns

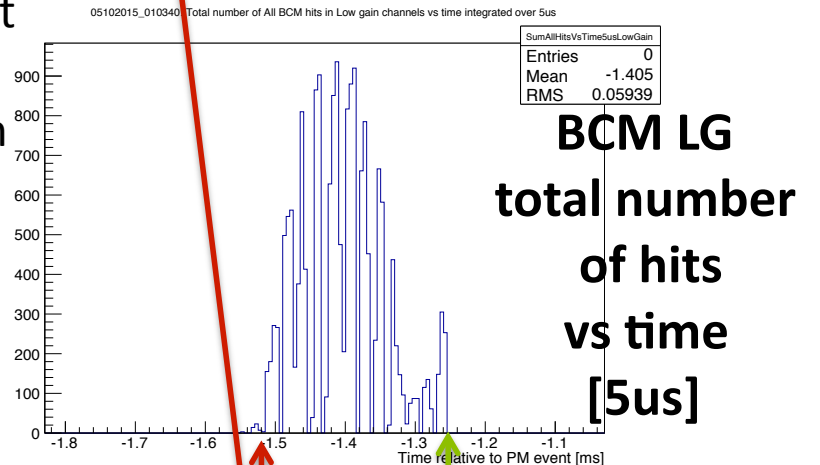
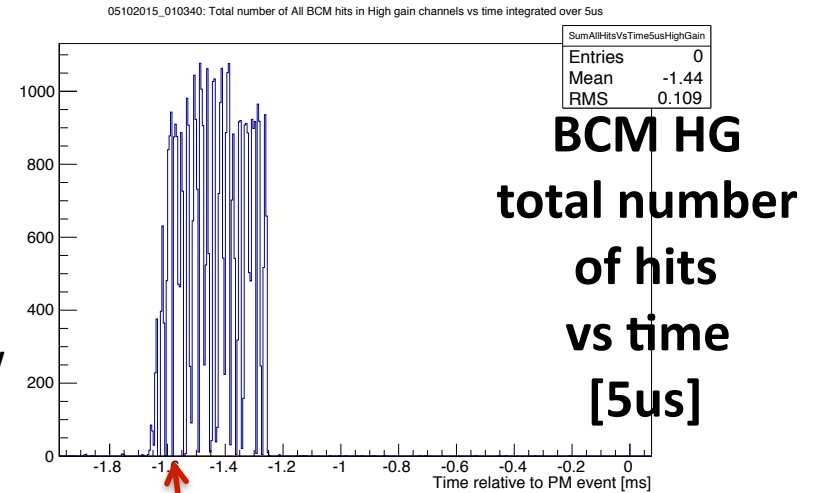


IN-TIME LG HITS vs time: +6ns



Losses in beam 2 direction: C-> A side

High\Low gain channels saturate at ~1.6k in 5μs bin



BA request

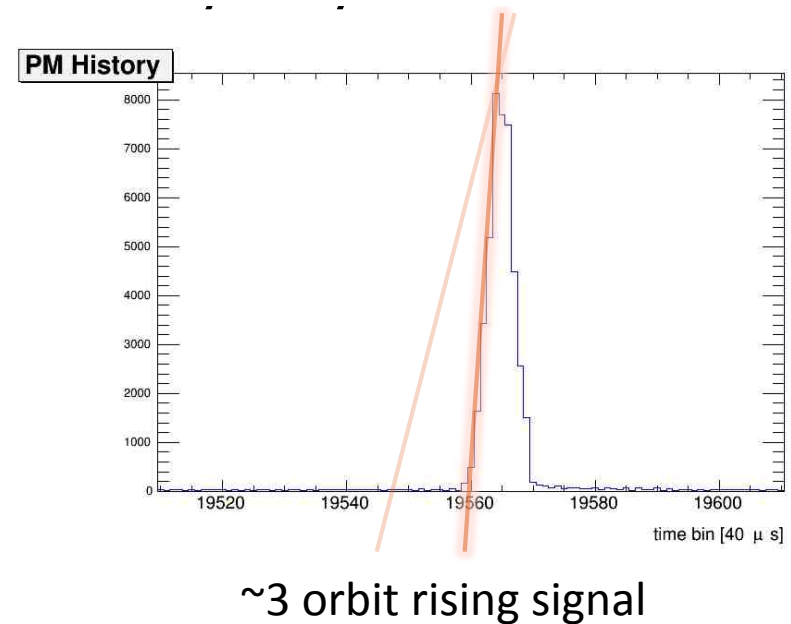
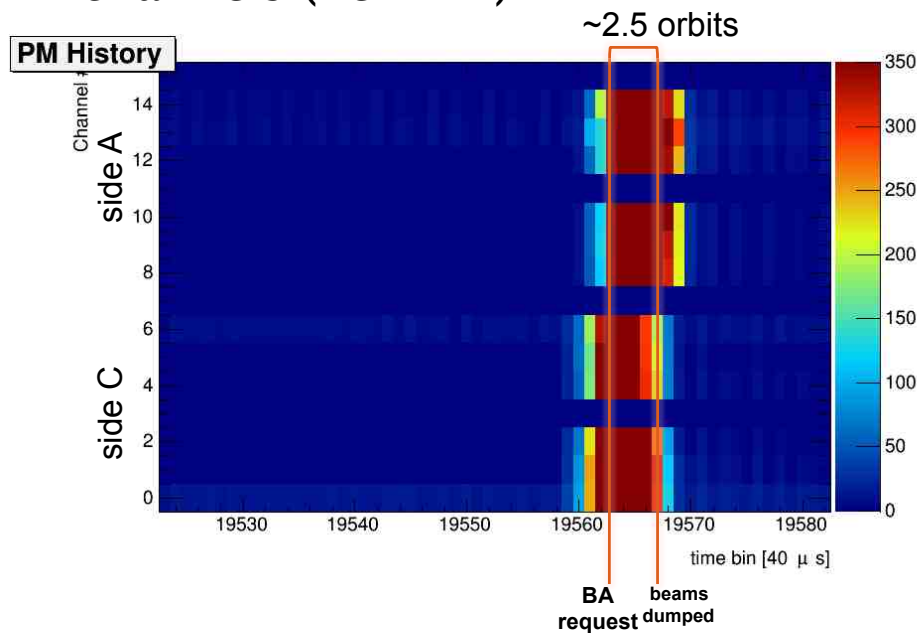
~3 orbits (~0.28 ms) Beams Dumped



BLM Beam abort



- Beam Abort Condition met also for the BLM:
 - > More than 350 bits on both side in 2 channels simultaneously
- Losses in RSO (running sum 0) ~ 2.5 times above the threshold



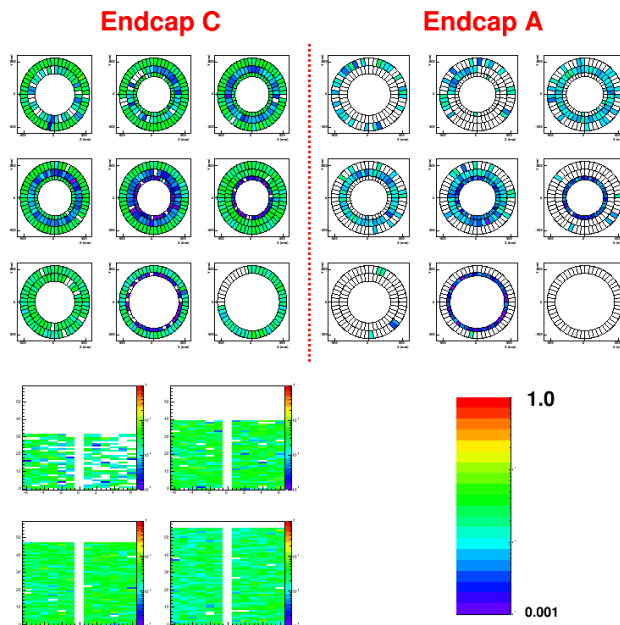


ATLAS SCT feed back

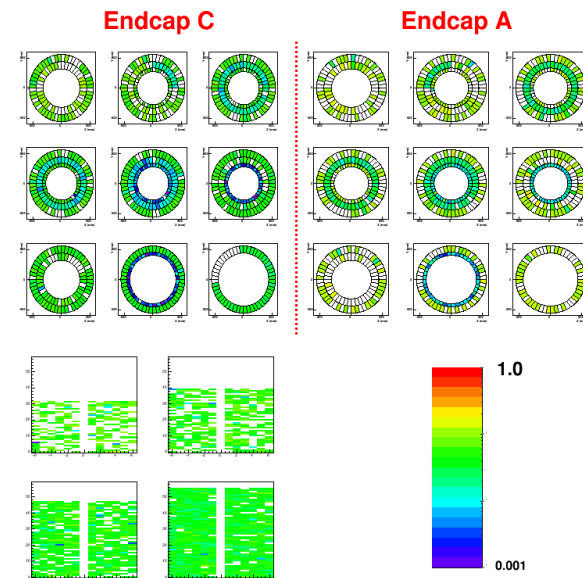


- HV was turned off
- Few events with pretty high occupancy at 01:03:40 am
- $\sim > 10\%$ occupancy in the largest event, which is definitely high...

ATLAS Internal Run 280981



ATLAS Internal Run 280981

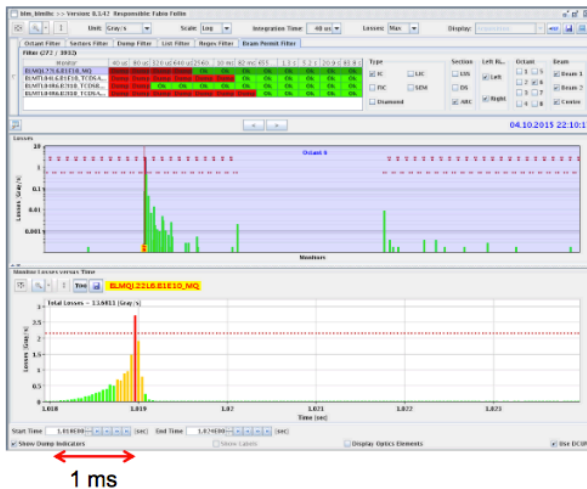




LHC feed back



Dumped due to UFO 22L6



LHC DUMPS AT ~2.1 Gray/s

Fill #4456 small UFO ATLAS



- Possibility to raise thresholds?

BCM DUMPED AT ~0.06 Gray/s
TOTAL LOSSES: ~0.4 Gray/s

BCM Beam Dump of 30.09.2016



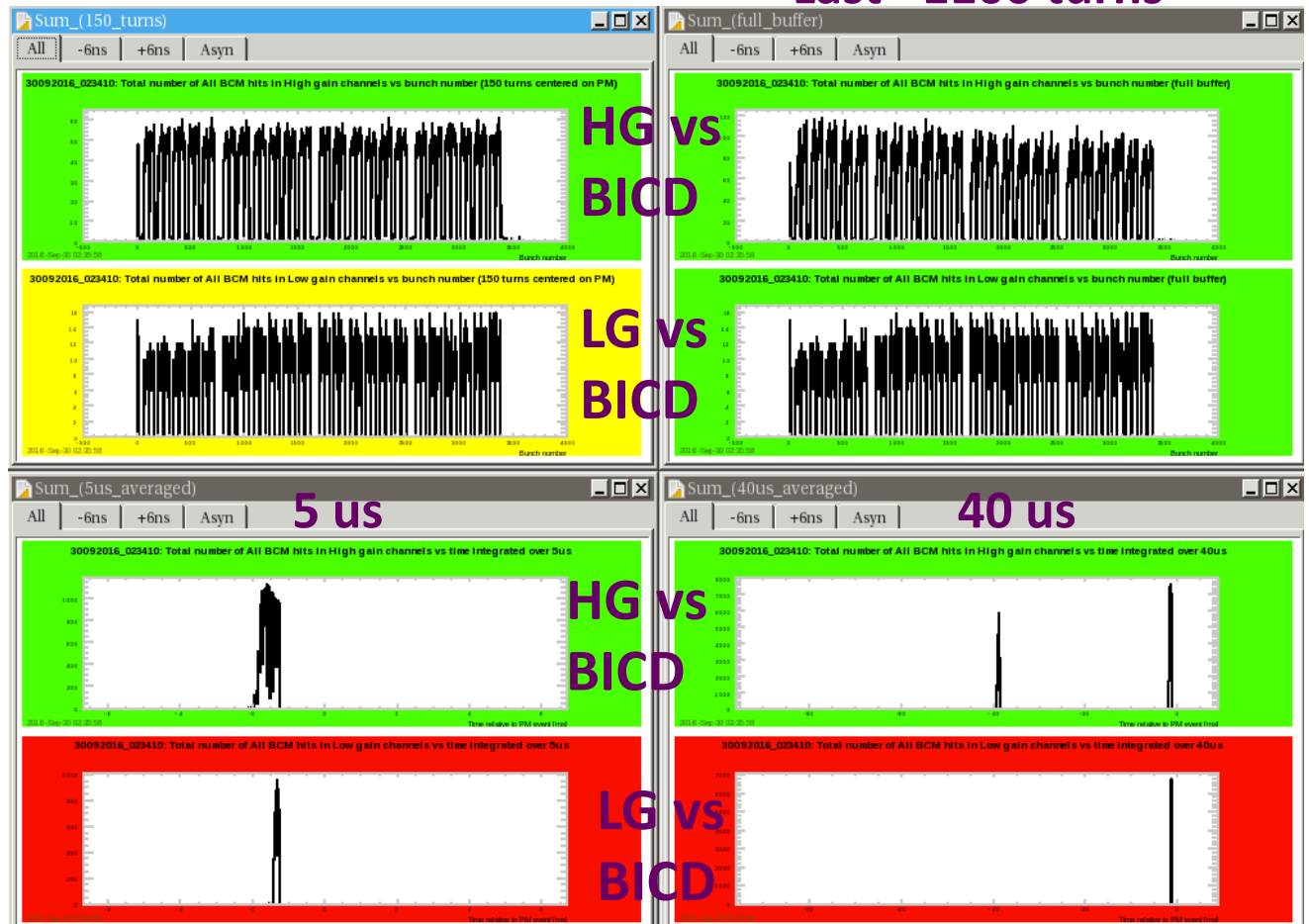
BCM PM Histograms



- During ramp up with 2200 bunches at 02h34m10s
- Basic 3+3 beam abort condition met ~ 150 times
- ~ 20 times above the RED threshold for unclean dump
- LHC BLMs detected no abnormal activities

Last 150 turns

Last ~ 1100 turns

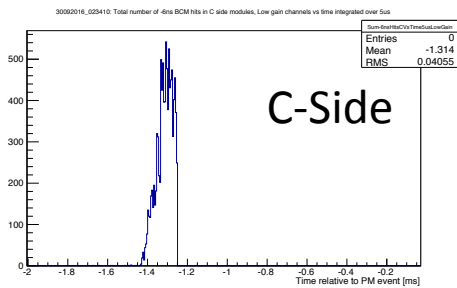




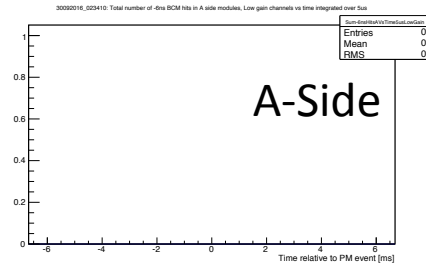
BCM Beam Abort Time Structure



EARLY LG HITS vs time: -6 ns



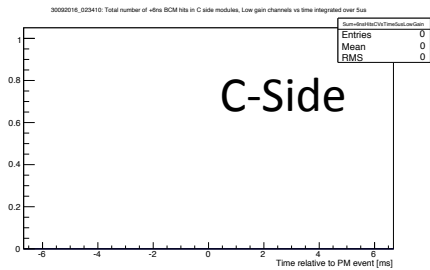
C-Side



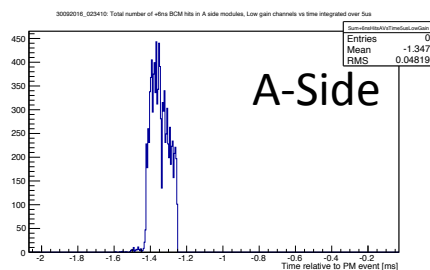
A-Side

High/Low gain channels saturate at $\sim 1.6k$ in $5\mu s$ bin

IN-TIME LG HITS vs time: +6ns

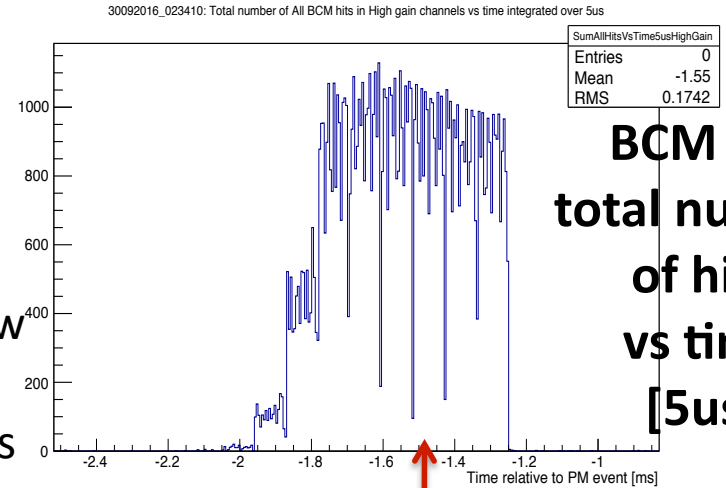


C-Side

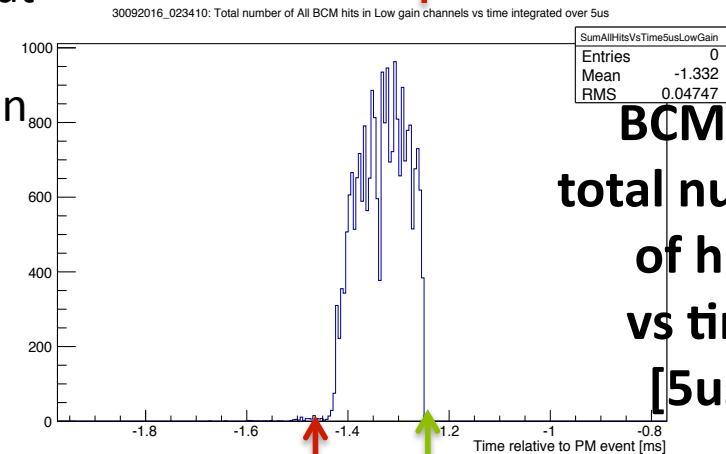


A-Side

Losses in beam 2 direction: C-> A side



BCM HG total number of hits vs time [5us]

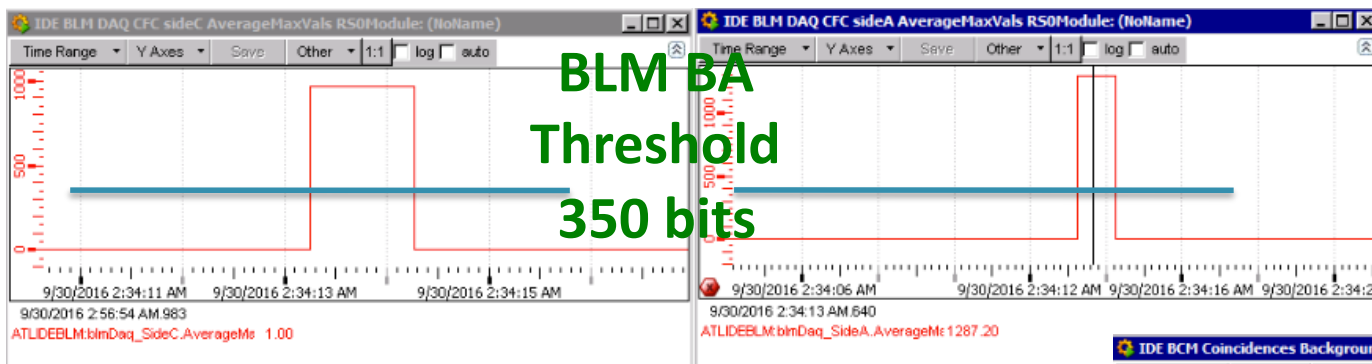


BCM LG total number of hits vs time [5us]

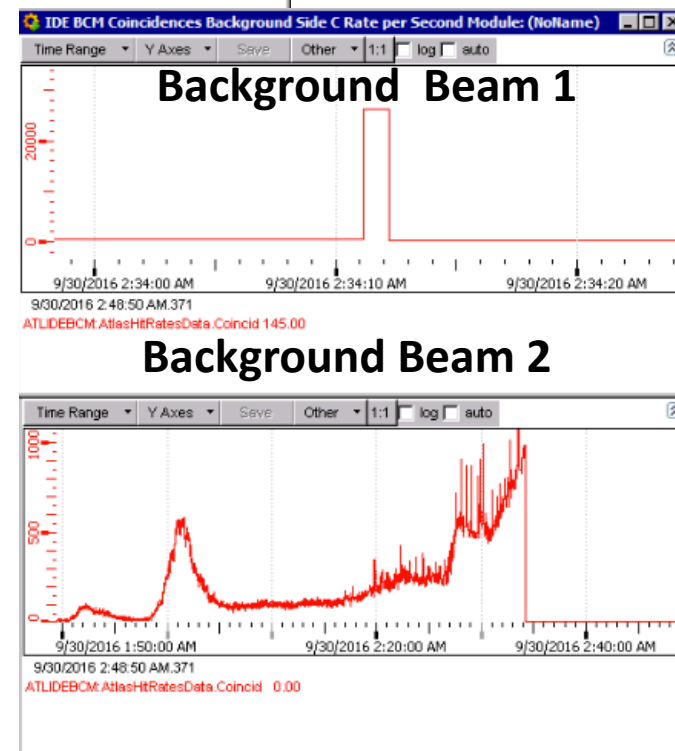
BA request ~ 3 orbits (~ 0.26 ms) Beams Dumped



BLM Beam Abort



- BLM also met the abort condition (\sim factor \sim 3)
- Several spikes in the BCM background rates
- Non collision background also showed abnormal activities





Conclusions



- BCM back in BIS since December 2012 after upgrade of the BCM FW
- BLM activated in April 2010
- ATLAS BCM and BLM are **complementary** safety systems
- Thresholds set for protection of **ATLAS Inner Detector**
- In these two beam abort occasions **both system** met their respective **beam abort condition** (one at level of SCT damages)
- No indication of any operational problem observed and **no false beam dump** so far
- Not straightforward to predict how losses seen in the ATLAS BCM/BLM propagated to the closest LHC BLMs