

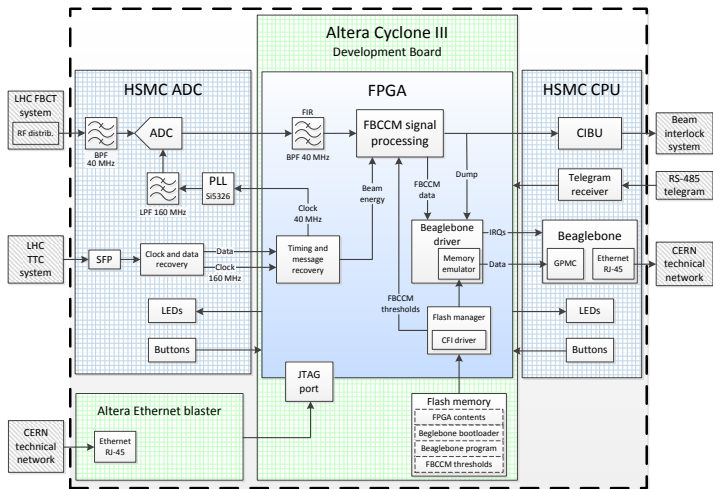
Beam Current Change Monitor

Status and plans for the LHC start-up

D. Belohrad, J. Kral, L. Jensen, A. Topaloudis, S. Gabourin

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BCCM block schematic

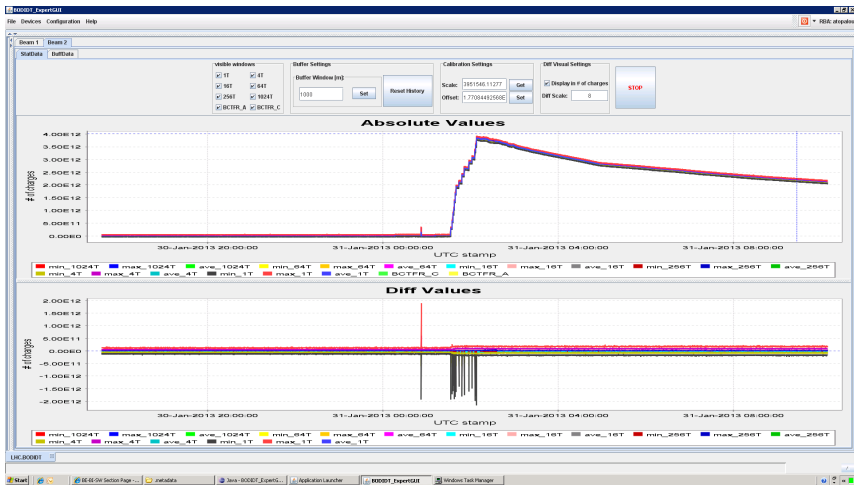


BCCM 'hardware'



Current Status

- BCCM transmitted data changed: after each connection the device transmits:
 - matrix of all thresholds
 - list of connected clients
 - this information is re-sent when another client connects to keep track of connected clients
- FESA and Expert GUI are currently being updated:
 - BCCM now sends more information in the statistics packets (each 10 seconds)
 - BCCM sends as well all events time-stamps in 64-bit resolution (hence precise dump request time-stamp)
 - FESA and RT application need to parse new data packets: works ongoing
 - more variables will come to the TIMBER (BST watchdog, beam momentum as seen by BCCM, firmware revisions, currently used thresholds, ADC dynamic range)



All the software done, update needed to take into account the additional data sent by BCCM.

BCCM statistics packet

```

-----
FW revision: 0x00000192
FW date: 2014-10-01 14:38:14
SW revision: 0x00000011
SW date: 2014-10-01 14:43:54
CPU serial number (CRC-1byte,number-6byte,family-1byte): 0xFB000016E9F1B501
ADC serial number (CRC-1byte,number-6byte,family-1byte): 0x6A000016EA0FC201
System start UTC timestamp: 0x00087E1C 0x5485ADF1 (2014-12-08 14:56:01.556572)
Statistifunk ticket: 0x00003CD8
ADC statistics: 0xFF74FFB1
TDCLK watchdog: 0x037ACDEB (E=0, Ov=0, L=0, Min=3563, Max=3563)
UTC timestamp: 0x000E7FBE 0x54880E6D (2014-12-10 10:12:13.950206)
Acquired beam momentum is in the range of 5120 to 5376 GeV/c (resolution 256 GeV/c) (LUT entry 0x14)
-----
Information about running fw/sw
Board serial numbers
Run time since last restart
BST clock properties
64 bit BST timestamp
Current energy
-----
Absolute statistics for each window
-----
Absolute statistics:
Window 1:      Minimum 3672   Maximum 9139   Average 5989   Difference 5467   Status 0x00003CD800003CD8
Window 4:      Minimum 18989  Maximum 29626 Average 23957  Difference 10637  Status 0x00003CD800003CD8
Window 16:     Minimum 87209 Maximum 104423 Average 95829  Difference 17214  Status 0x00003CD800003CD8
Window 64:     Minimum 367542 Maximum 401968 Average 383318  Difference 34426  Status 0x00003CD800003CD8
Window 256:    Minimum 1503259 Maximum 1560855 Average 1533266  Difference 57596  Status 0x00003CD800003CD8
Window 1024:   Minimum 6076847 Maximum 6169969 Average 6133169  Difference 93122  Status 0x00003CD800003CD8
Differential statistics:
Window 1:      Minimum -3751   Maximum 3742   Average 0   Difference 7493   Status 0x00000000002DC6C0
Window 4:      Minimum -6829  Maximum 6960   Average 0   Difference 13789  Status 0x00000000004C4B40
Window 16:     Minimum -12324 Maximum 14393  Average 0   Difference 26717  Status 0x00000000007A1200
Window 64:     Minimum -30994 Maximum 24243  Average 2   Difference 55237  Status 0x0000000000989680
Window 256:    Minimum -47376 Maximum 39237  Average -4  Difference 86613  Status 0x0000000001312D00
Window 1024:   Minimum -71818 Maximum 66122  Average 145  Difference 137940  Status 0x0000000003938700
-----
ADC dynamic range within single turn: (FF74, FFB1), (-140, -79), (-0.43%, -0.24%)
-----
Currently used threshold values
ADC dyn. range usage
-----

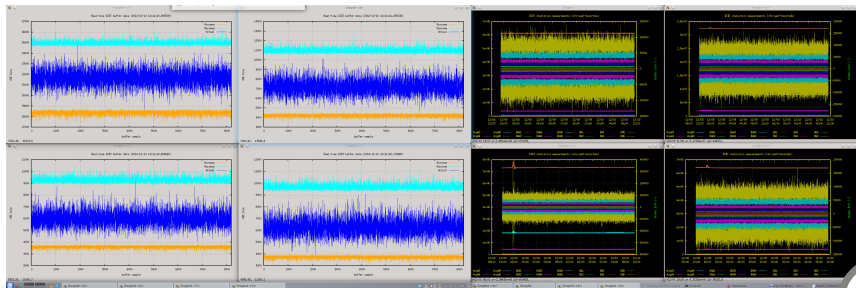
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Figure: New (green) information added to the statistics packet.

BCCM tunnel installations

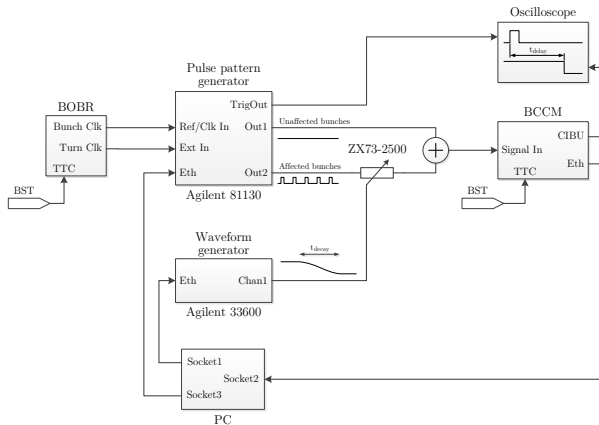
Four BCCMs installed in UA-47:

- ✓ Dedicated optical fibres for the BST installed
- ✓ the BST timing on the BCCM dedicated fibers commissioned
- ✓ the BCCM remote programming verified
- 👁 the BCCM noise floor measurements in progress
- ✓ the CIBU links for *all* BCCMs installed in UA47 commissioned
- 👁 the CIBU links set to DISABLED
- 👁 the 4 UA47 BCCMs are permanently monitored by MOU tool:

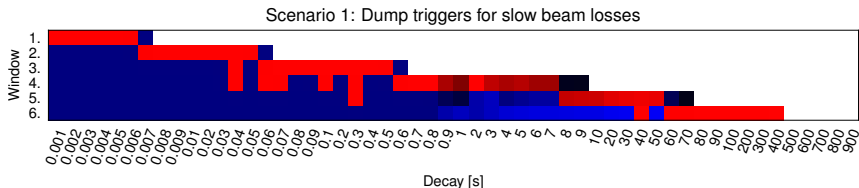


Laboratory Tests

- ✓ Scenario 1: Constant slow losses
- ✗ Scenario 2: Fast losses on a few selected bunches
- ✓ Scenario 3: Injection
- 👁 Scenario 4: Beam dump



Scenario 1 – Slow losses



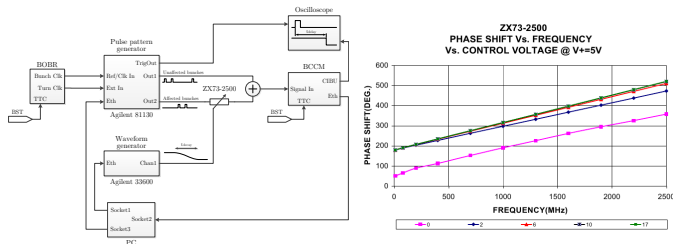
The colour intensity is proportional to percentage of occurrences

- Red: First trigger
- Blue: Other triggers

- All windows trigger the beam dump

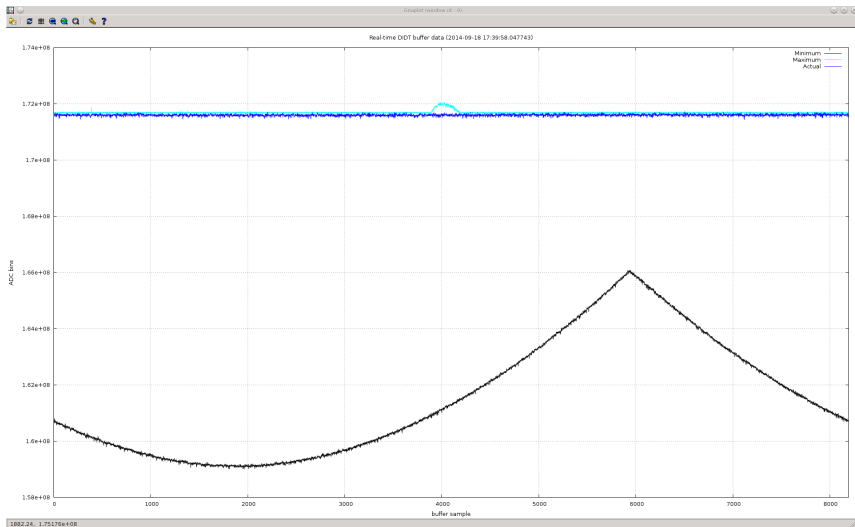
Scenario 2 – Fast Losses on Selected Bunches: Troubles

- Phase shift of variable attenuator is dependent on control voltage



- when a selected bunch 'loses the amplitude' by modulating the variable attenuator (VA), the VA phase shift 'distorts' the bunch train and an amplitude transition occurs
- No known way how to test Scenario 2

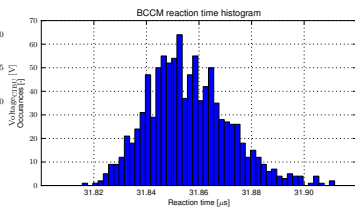
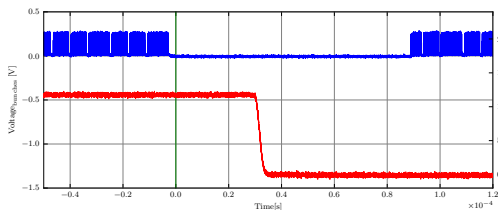
Scenario 2 – Typical result



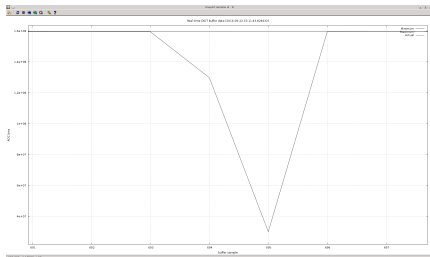
Scenario 3 – Bunch Injection: Results

- VA was not used and a separate pulse generator generated the 'injected' bunches into an already 'circulating' beam. The trigger response was observed.
- Thresholds were set-up such, that with 'no-signal' the BCCM unit did not trigger the beam dump ($\text{THR}_{\text{window}} = 2 \times \text{DIFF}_{\text{window,max}}$)
- 1, 12, 144, 288 bunches randomly injected into randomly filled ring
 - 44 sub-tests in total
- No injection caused the beam dump

Scenario 4 – Beam Dump: Reaction Time Histogram



- Reaction time histogram divided in 80 ns interval
- Typical reaction time $31.85\mu\text{s}$ with $\sigma \approx 20$ ns
- System is turn-synchronised, dump in '1 turn' interval, but fails to sync correctly (FW bug):



Energy thresholds

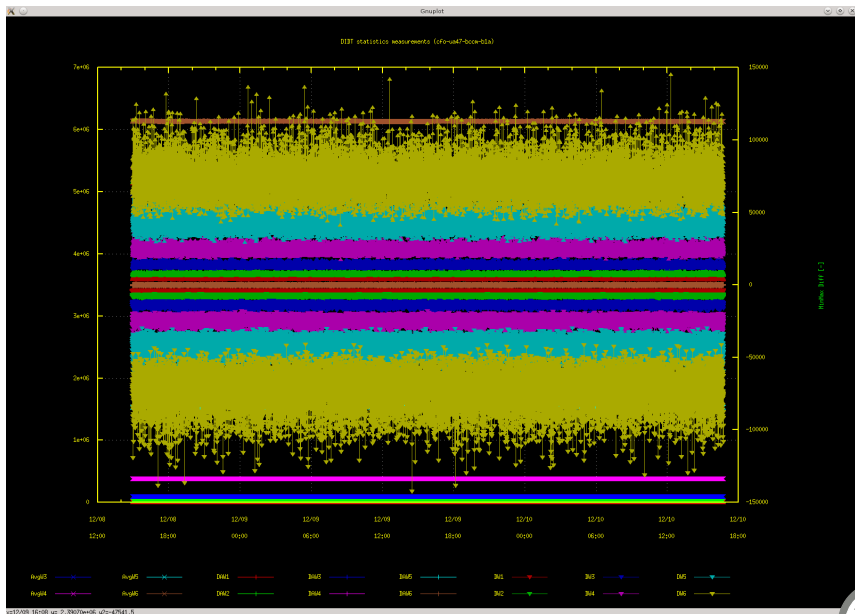
The main concern for the start-up is **how to set-up the threshold tables**. Currently:

- 6 averaging windows & 32 energy levels

So totally 192 levels to be set-up. Currently the BCCMs installed in the UA47 are set-up with common 'optimistic' threshold for each energy not to cause false dumps:

Window	N ^o turns	Threshold [ADC bins]
Window 1	1	3e6
Window 2	4	5e6
Window 3	16	8e6
Window 4	64	1e7
Window 5	256	2e7
Window 6	1024	6e7

Statistics vs threshold values



Statistics vs threshold values

These values are **guessed** for the moment.

When machine operation takes place, they will have to be risen.

Proposed strategy:

- at the LHC start-up set-up all the thresholds intentionally very high
- for the pilot and ultimate in 'single bunch' and 'full machine' mode, and on the injection energy observe the measured differential values
- setup thresholds not to cause dump on the injection energy
- at the physics energy observe(= analyse) the diff values and update the threshold tables at physics energy only
- (...big unknown...) linear approximation between the energy levels?

Work to be done

- repair bug with turn synchronisation of the Window1
- update SW to accept the new data structures, update Expert GUI
- add more variables to observe by TIMBER
- verify the hardware link between the BCCMs CIBUs and BIC

When

- operational *beam intensity measurements* (systemA) is a high priority task, expected to have all done late January
- SW upgrades of the BCCM is already started
- CIBU link test scheduled Feb/March 2015 before the machine is started
- stability tests are ongoing
- turn-clock synchronisation issue solved after the systemA works take the place

Thank you for your attention!

Questions?