Beam Current Change Monitor

Status and plans for the LHC start-up

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on behalf of

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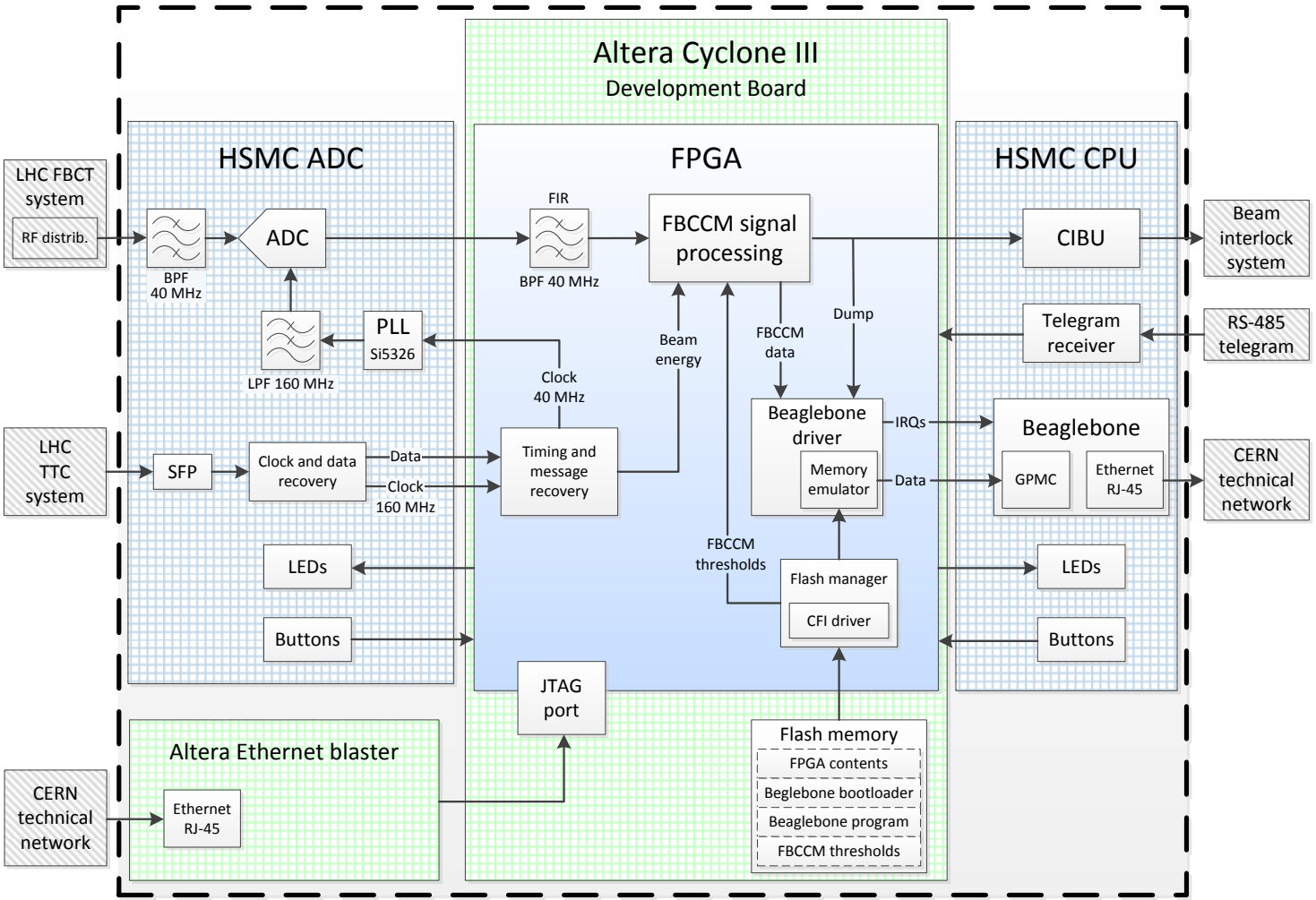
BCCM block schematic

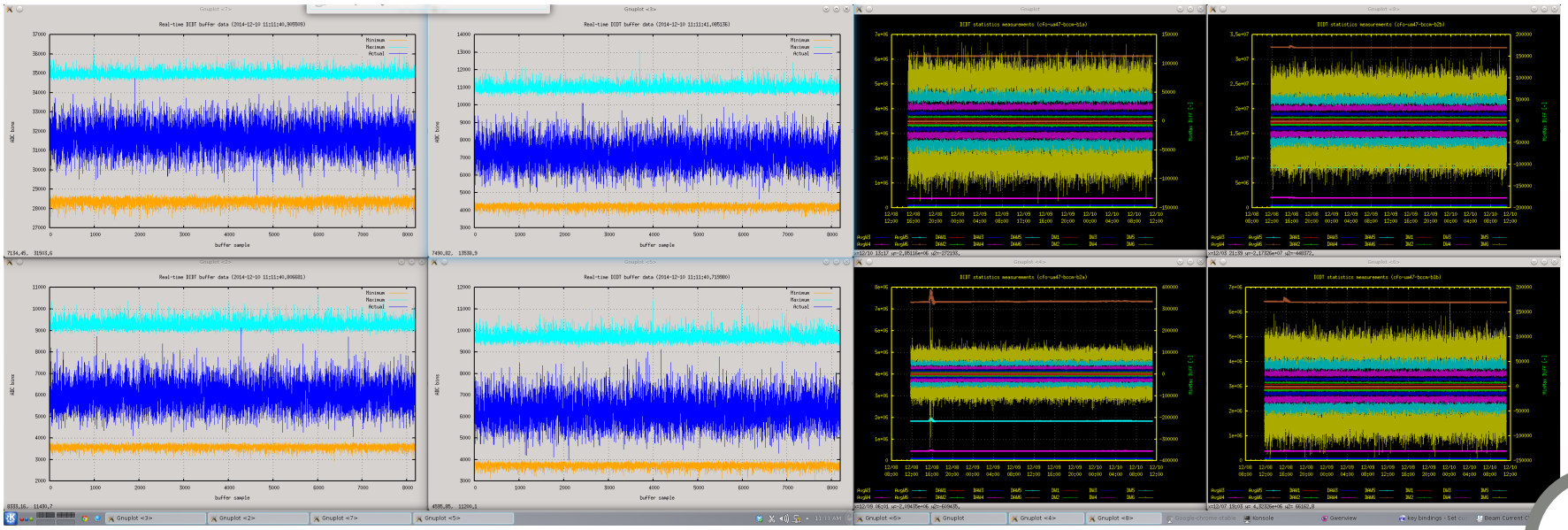


BCCM 'hardware'

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:

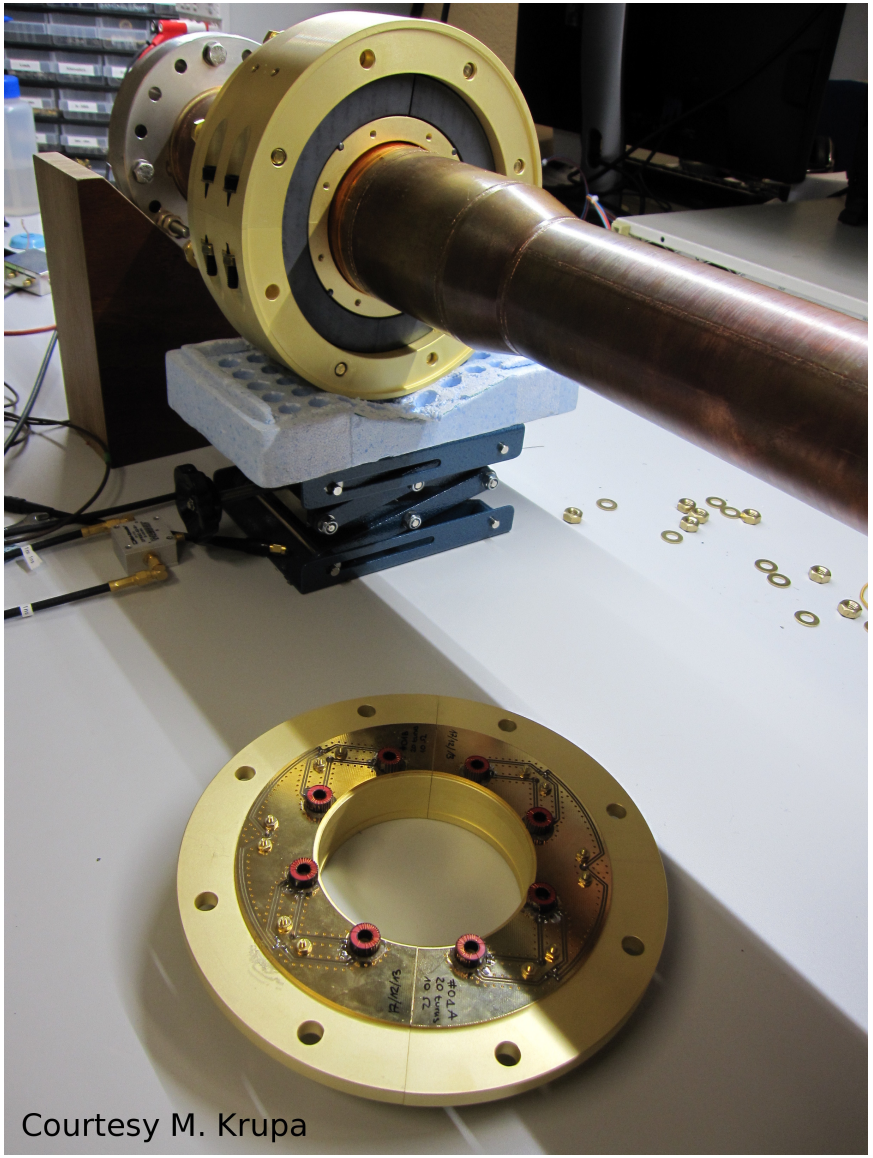


Devices connected

The BCCM units are connected to different devices:

- operational BCCMs are connected to the FBCTs
  - $\rightarrow$ known beam position dependency
- development BCCMs:
  - Beam 1 BCCM uses a new Integrating Current Transformer (BCTI)
  - Beam 2 BCCM uses a new Wall Current Transformer (BCTW)

One old BCCM is still connected to the Beam 1 of the operational system.


Courtesy M. Krupa

Current Status

BCCM transmitted data format changed since the start of LS1:

- BCCM now sends more information in the statistics packets (each 10 seconds)
- All events time-stamps in 64-bit resolution (hence precise dump request time-stamp)
- Matrix of all setup thresholds is sent to the connected client on each connection

  → at certain point this will go to the sequencer check

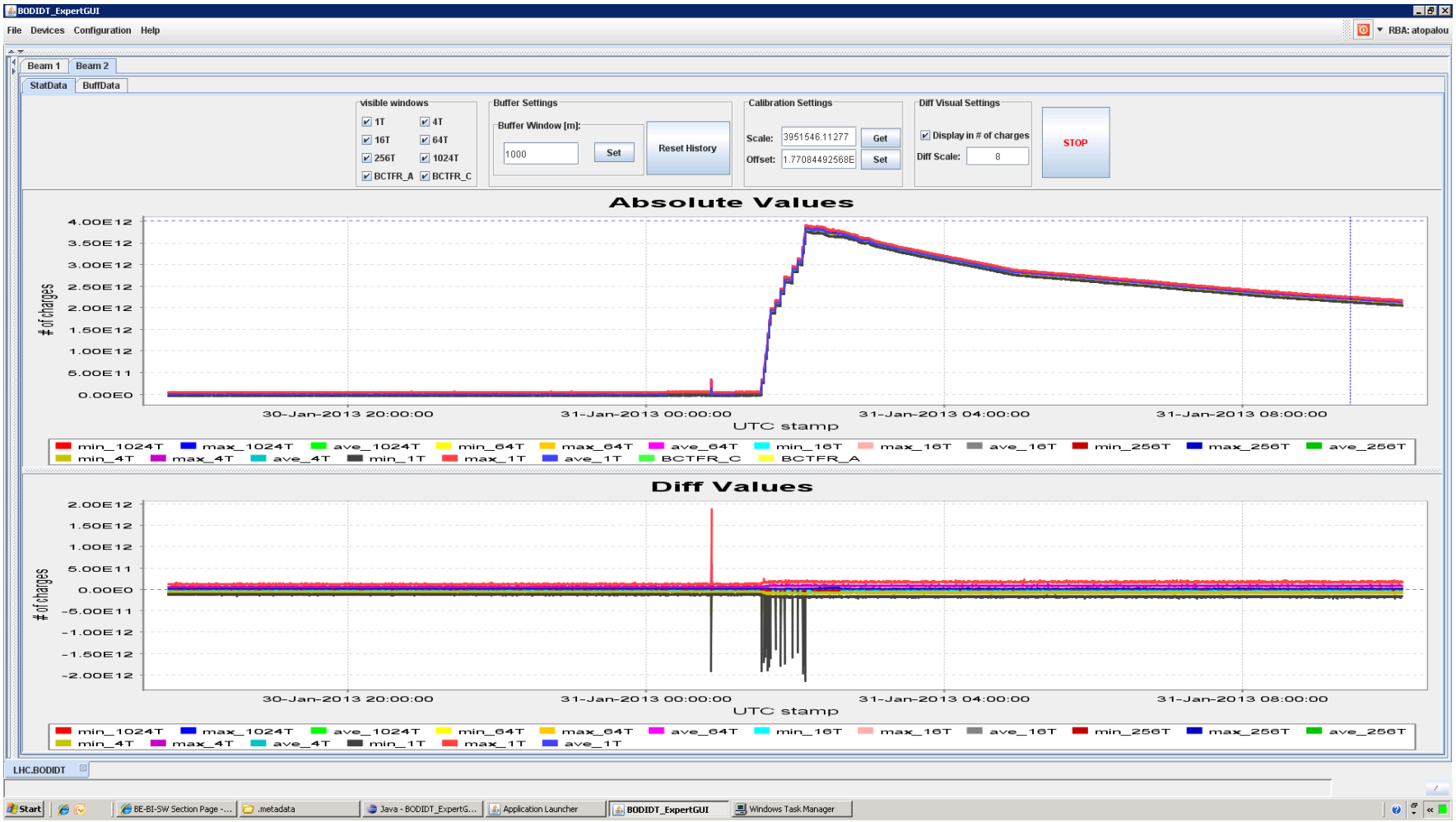
- Dynamic messages are sent to all clients upon change of the connection state (connect/disconnect)

  this information is re-sent when another client connects to keep track of connected clients

- more variables will come to the TIMBER (BST watchdog, beam momentum as seen by BCCM, firmware revisions, currently used thresholds, ADC dynamic range)

The FESA class is currently being updated.

ExpertGUI



The ExpertGUI done, update needed to take into account the additional data sent by BCCM.

BCCM statistics packet

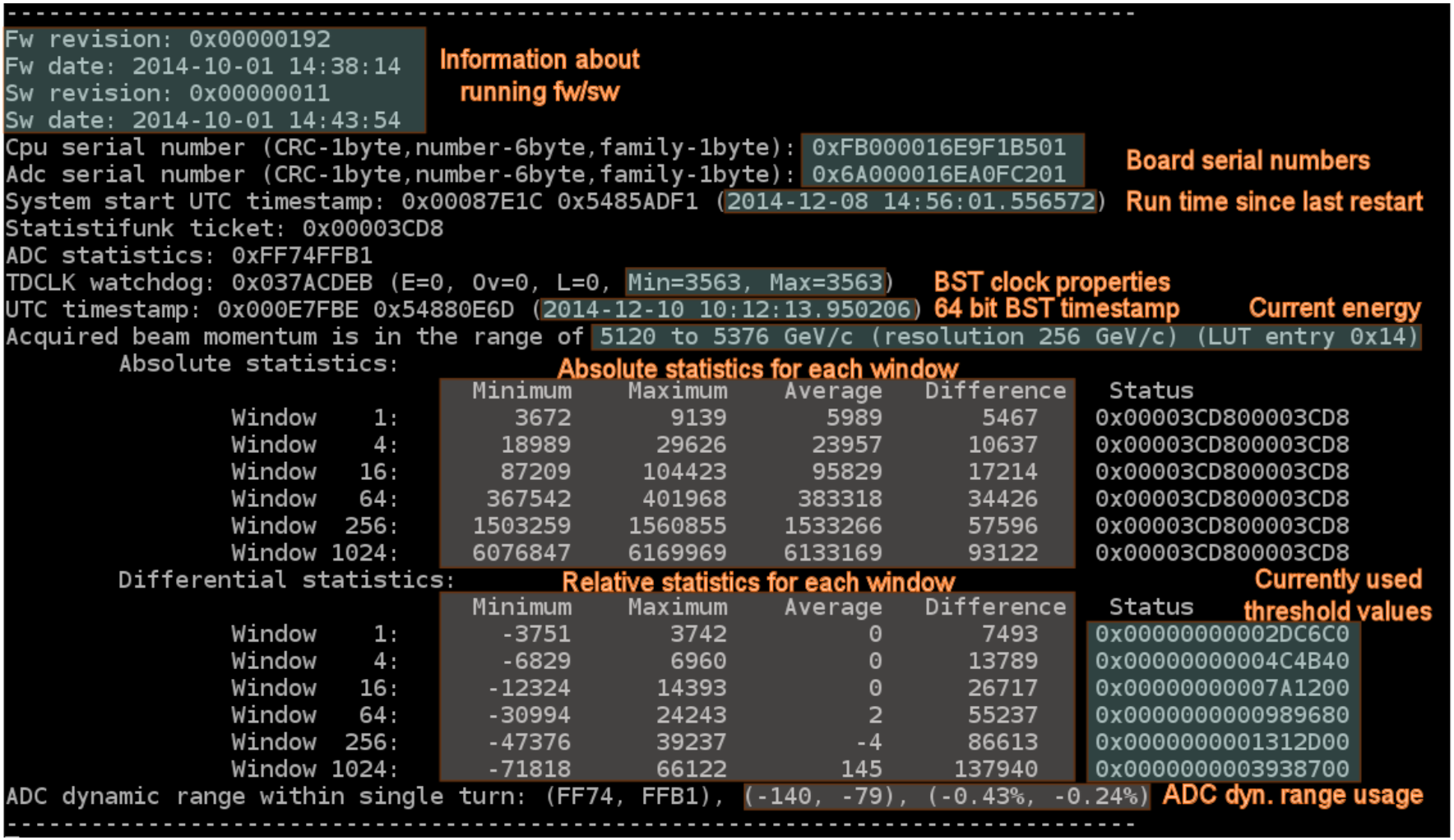
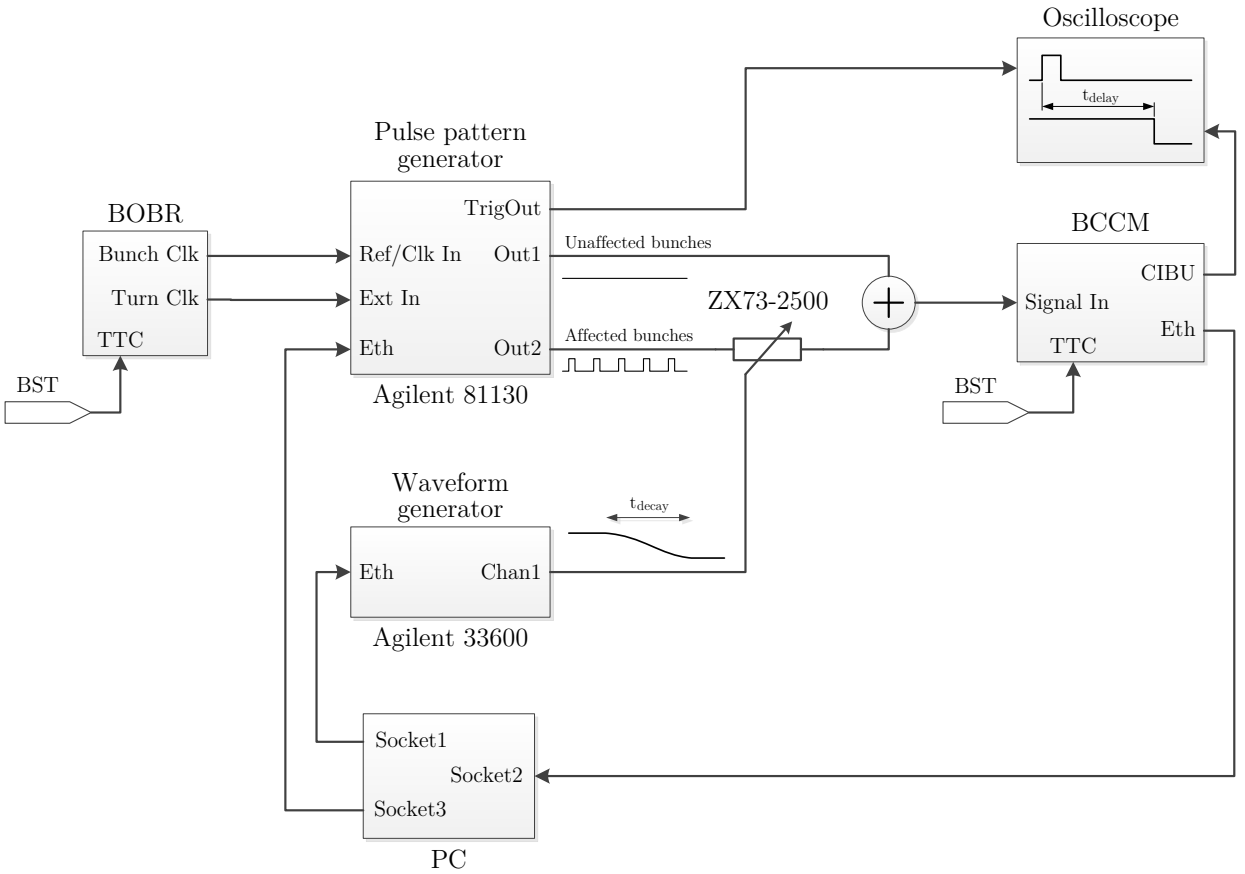


Figure: New (green) information added to the statistics packet.

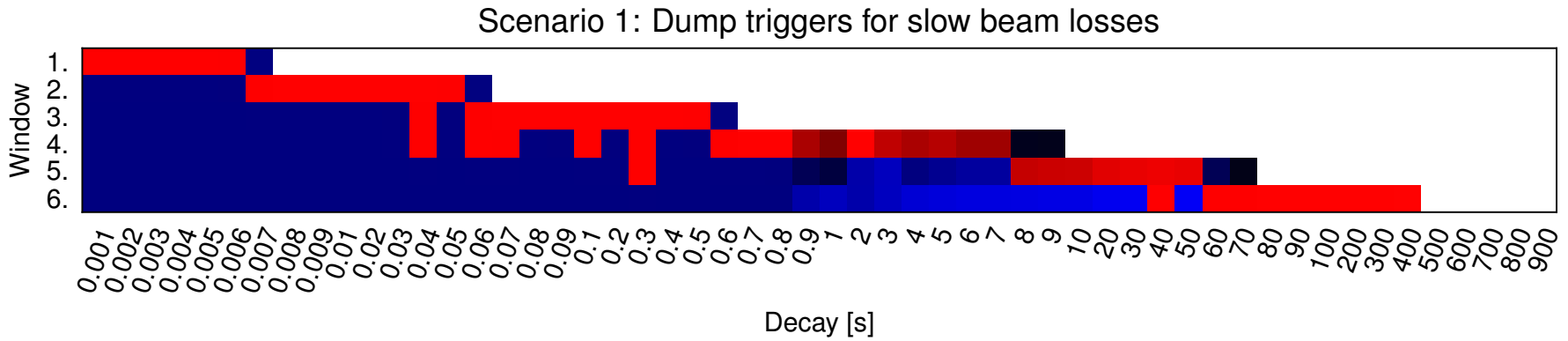
Laboratory Tests

Automatic test-bench to measure the BCCM behaviour:



+ lots of python scripts

Results, e.g. triggers map

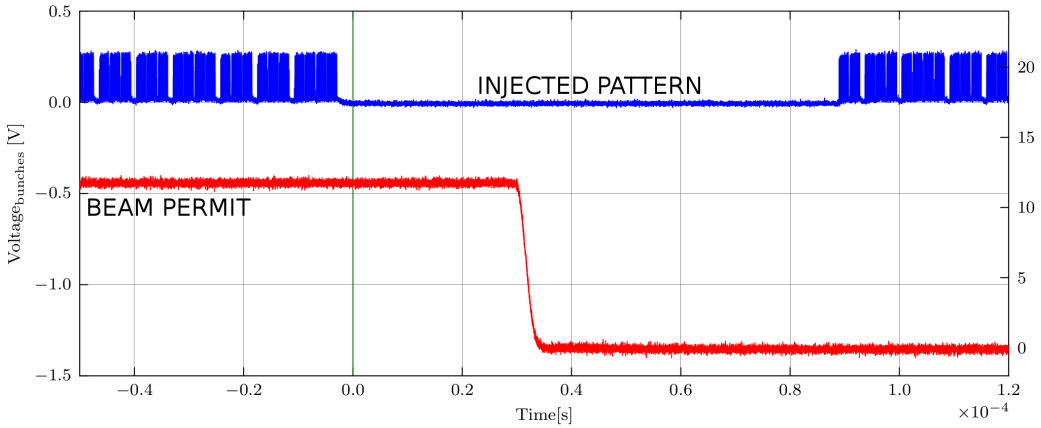


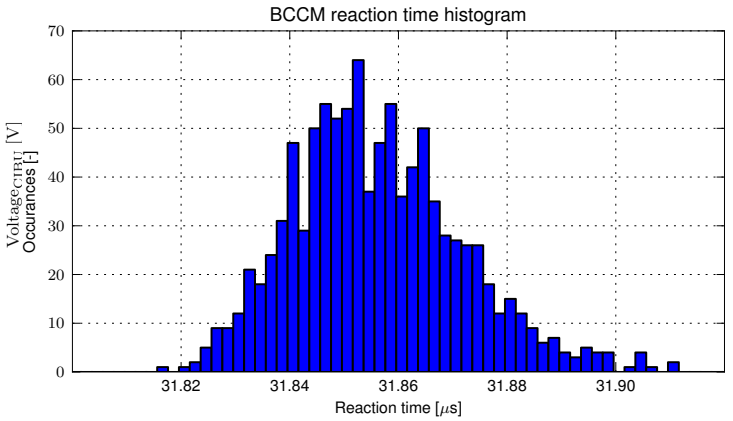
The colour intensity is proportional to percentage of occurrences

First trigger
Other triggers

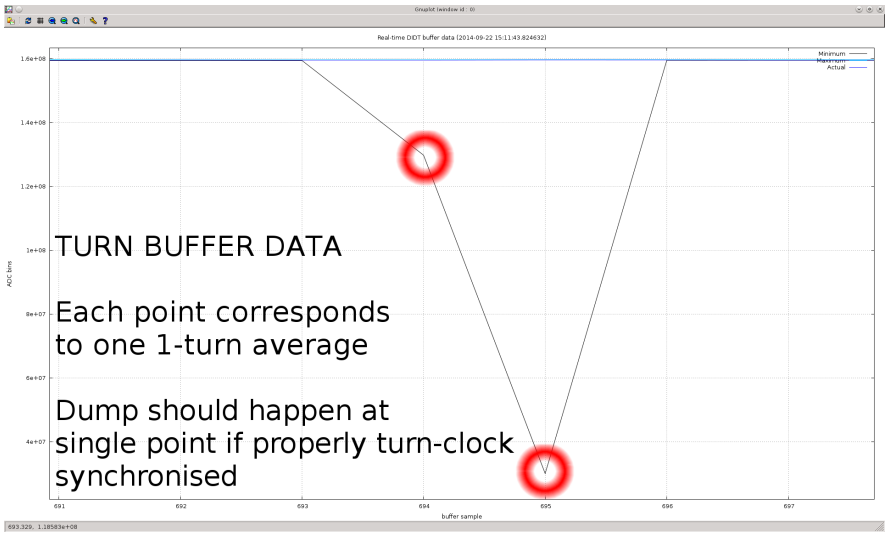
- All windows trigger the beam dump

Results, e.g. Reaction Time Histogram





- Reaction time histogram divided in 80 ns interval
- Typical reaction time 31.85μs 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

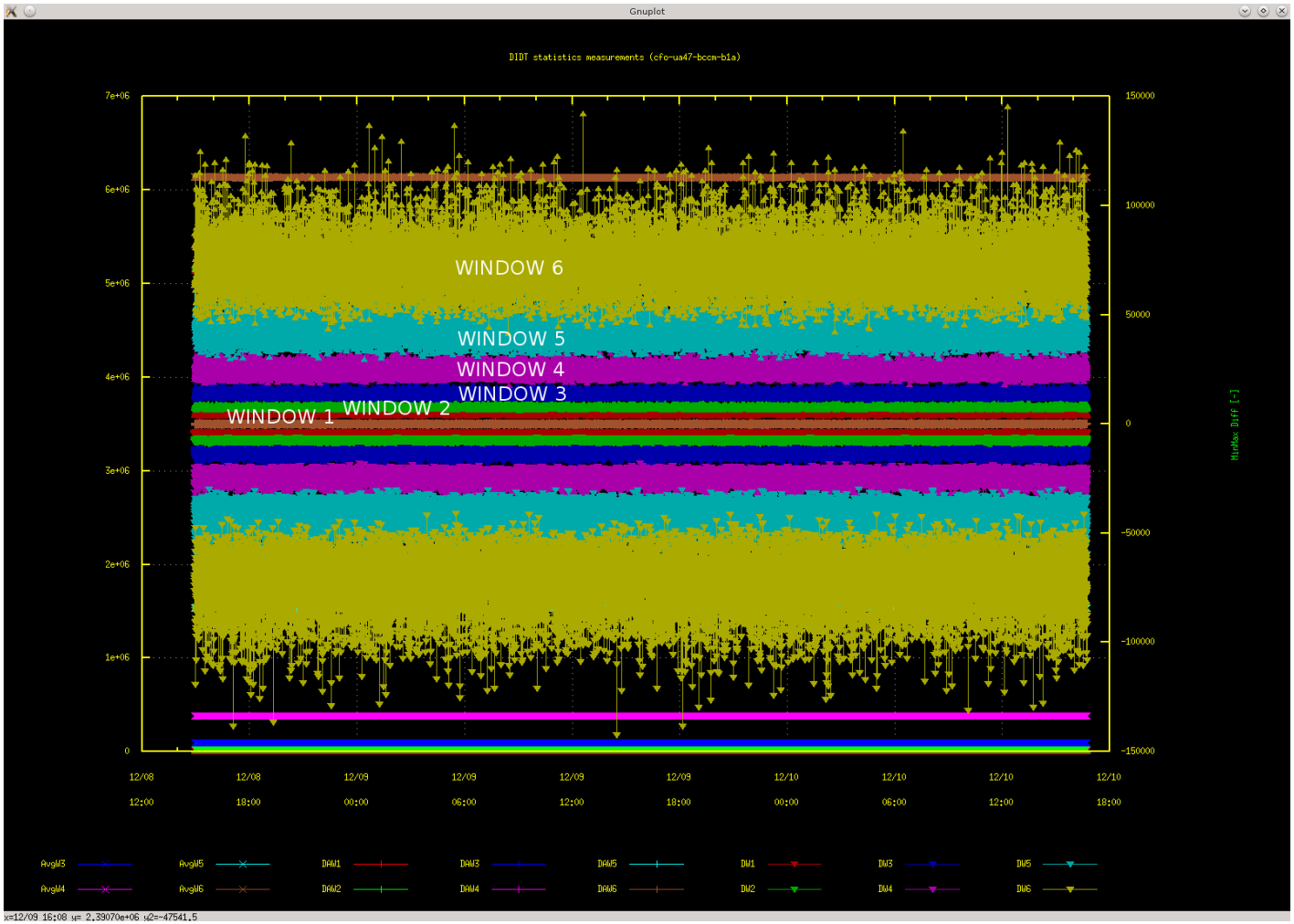
So totally 192 levels to be set-up. BCCMs installed in the UA47 are set-up with common 'optimistic' threshold:

Window	N^o turns [-]	Threshold [ADC bins]	% FS [%]
Window 1	1	3e6	0.75
Window 2	4	5e6	0.32
Window 3	16	8e6	0.12
Window 4	64	1e7	0.04
Window 5	256	2e7	0.02
Window 6	1024	6e7	0.015

(NB: Window 1: 4×10^8 max ADC bins, Window 6: 0.015% $\approx$ 8×10^{10} charges @ 2×10^{11} ch/b)

LHC measured noise floor

The 3-days measurement of the noise floor of the operational beam 1 BCCM installed in the UA47:



Commissioning phase

The threshold values are for the moment guessed but new values will be setup during the commissioning.

We will start with the thresholds set intentionally too high not to cause too many false dumps.

To be noted, that 50 ns bunch spacing scenarios cannot be easily matched to 25 ns bunch spacing scenarios:

- FBCTs and ICT have a limited bandwidth. The acquired bunch signal leaks into another bunch slot
- FBCTs are position dependent and 25 ns bunch spacing will worsen the dependency considerably

Following scenarios *are proposed* to test the equipment:

→ ... next page

Incomplete list of commissioning tests wishes

- bunch amplitude check: injection of pilot and ultimate bunch and check if for all BCCMs the ADCs are not saturating
- the pilot bunch injection and dump - estimate the minimal diff such that dumping pilot successfully generates BCCM dump
- pilot bunch @ 450 GeV and 7 TeV generate $\approx$ 5-10 different loss rates, each for 5 minutes to validate behaviour of different averaging sections.
- for the ultimate bunch: repeat step loss rate measurement using the same loss rates
- inject, ramp, dump of an ultimate bunch having different bunch lengths (what is available?)
- inject ultimate bunch, measure position dependency by sweeping horiz. and vert. position of the beam at the FBCTs position
- injection of the SPS batch, 5-6 different loss rates of the SPS batch @ 450 GeV, the same loss rates as in (3), dump
- during 5 different beam energies generate a 'controlled' loss
- if possible, generate the same controlled loss with the SPS batch

cont'd

- study of the influence of the machine operation with the SPS batch (e.g. squeeze and cogging)
- during the tests observation of various machine operations (e.g. LBDS check)

... at the later stage:

- in the sequencer before every injection:
  - check currently set-up thresholds against the database values
  - inject a specific pattern to the FBCTs and validate correct response of the system

    $\rightarrow$ this will probably not be possible with BCTWs and will have to be injected into the BCCM input by a combiner
- when beam dumped:
  - verify that BCCM correctly generated dump

Conclusion

1. the devices are installed and constantly monitored
2. still few quirks in the firmware need to be repaired
3. SW is being updated
4. BCTW will be installed when ready
5. formal specification of the BCCM commissioning has to be written

Items (2) to (3) issues do not require an LHC access. Item (4) requires an access to RA (few hours).

Operational BCCMs are ready for the start-up, development BCCMs will be ready in 3-4 weeks.

Thank you for your attention!

Questions?