LHC BLM SYSTEM:
SUMMARY OF CHANGES AND RE-COMMISSIONING AFTER YETS

Machine Protection Panel 23/03/2018

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Overview

- Status of checks to be performed during:
  - Hardware Commissioning
  - Machine Checkout
  - Beam Tests
- Resolved issues
- Long standing issues (reminder)
- Future developments (preview)
- Summary

STATUS OF CHECKS PERFORMED

Hardware and Machine Checkout

- All Hardware Commissioning and Machine Checkout checks need to be completed successfully.
- Those include:
  - 8 Hardware checks
  - 3 Machine Checkout checks
- Majority of checks completed
  - See attached xls file for some details (more info will be added) and
  - MPS document LHC-OP-MPS-0009 v.3.4 for explanations on reasons and conditions
    - New version in circulation with minor changes

Pending tasks

- Exchange of one processing card
  - surface SR6.R crate
  - ➢ seems FPGA or backplane connection issue
- LSA Settings database
  - renaming of DUMP monitors
  - new monitor at TCLVW.A5L1.B2
  - ➢ changes need to propagate through MTF, Layout, LSA to electronics.
- 31L2 and 16L2 installations need grounding
  - Human safety

Beam Tests

	Rep.	Action
1	S	**Validate Interlock Request functionality of the BLM crates.**
	FW-CS	Decrease thresholds to very low value (trim application).
	FW-TC	Inject low intensity pilots in regular intervals in Beam 1 and/or Beam 2.
		At each interval close sequentially collimator jaws around the ring in order to force different BLM crates to trigger interlock requests.
		Aim to have the majority of crates at least once.
		Time estimate: 2h
2	S	**Validate Interlock Request functionality of the BLETC modules.**
	FW-TC	Decrease thresholds to very low value (trim application).
	FW-CS	Inject a low intensity pilot in Beam 1 and/or Beam 2.
	FW-CF	Create a local bump until an interlock request is sent by the system.
		Aim to have up to the 1.3 s Running Sum measurement over its Threshold value.
		Time estimate: 1h
3	S	**Measure the interlock request system latency.**
	FW-TC	Decrease thresholds to very low value (trim application).
	FW-CS	Close one TCP collimator jaw in Point 3 and a second in Point 7 in order to block completely the passage of beam.
	FW-CF	Inject a low intensity pilot in Beam 1 and Beam 2.
		Calculate the system latency to initiate an interlock request by making the difference between the timestamps recorded by the BIS and the Injection Kicker. (for added accuracy the propagation delays can be removed for the beam to reach from the injection region to the detector the requested the interlock)
		Time estimate: 2h
4	S	**Test interface of direct BLMs with the beam dumping system (same test as 7.3.4 of [1]).**
		Reduce the voltage setting of the abort threshold.
		Dump the injected beam on the collimator TCDQ and TCSG (with local bump). The threshold must have been lowered sufficiently, to provoke a beam dump request.
		Record the beam dump.
		This test must be repeated for each beam and for both TCDQ and TCSG.
		From the amount of lost beam and the BLM reading, deduce the nominal threshold setting.
		Are there variations with respect to the impact conditions?
		Measure delay between the time where the loss signal exceeds the threshold and the time of the beam dump (time stamps in logging DB).
		Time estimate: 2h (without the two accesses: could be scheduled during injection tests)
5	S, O	**Verify Injection Interlock Inhibit functionality**
		Tests with pilot beam during commissioning of injection protection system. Create losses above dump threshold and modify blindout time Record interlock input from blindable/non-blindable crates If losses above dump threshold cannot be reached, lower the monitor factor of blindable crates BLMs
		Tests with trains (288 b or what is being used for scrubbing) Tighten TCDIs from 5 sig to 4.5 sig (likely settings for Hilumi) Tighten monitor factor
		Time estimate: 1h (first time might be more)

Injection Interlock Inhibit

- Tests with pilot beam
  - During commissioning of injection protection system
  - Create losses above dump threshold
  - Modify blindout time
  - Record interlock input from blindable/non-blindable crates
  - If losses above dump threshold cannot be reached, lower the monitor factor of blindable crates BLMs
- Tests with trains
  - 288 b or what is being used for scrubbing
  - Tighten TCDIs from 5 sig to 4.5 sig (likely settings for Hilumi)
  - Tighten monitor factor

Criteria for successful test:

- Functionality: detectors in blindable crates DO NOT interlock within given blindout time and losses above threshold
- Redundancy: detectors in non-blindable crates DO interlock in case losses go above threshold on those, while blindable ones do not interlock
- Inhibit time: get feeling for which blindout time is needed – not critical, can be adjusted later

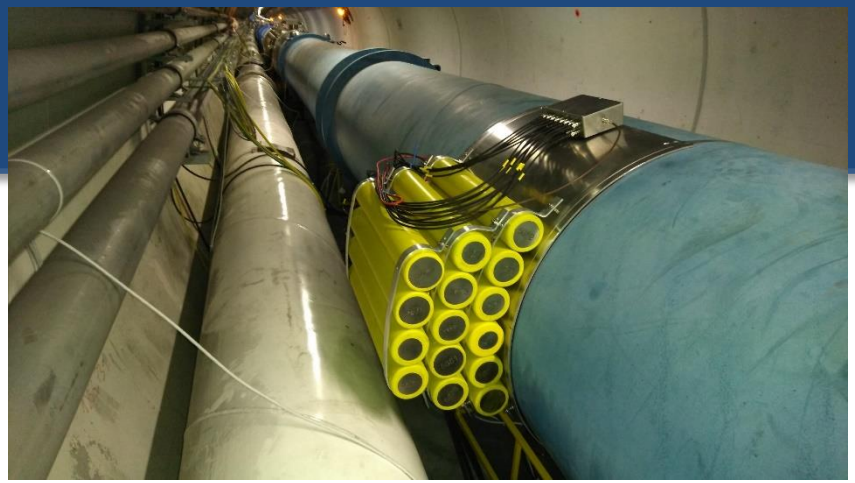
Issues resolved to date

RESOLVED ISSUES & NEW INSTALLATIONS

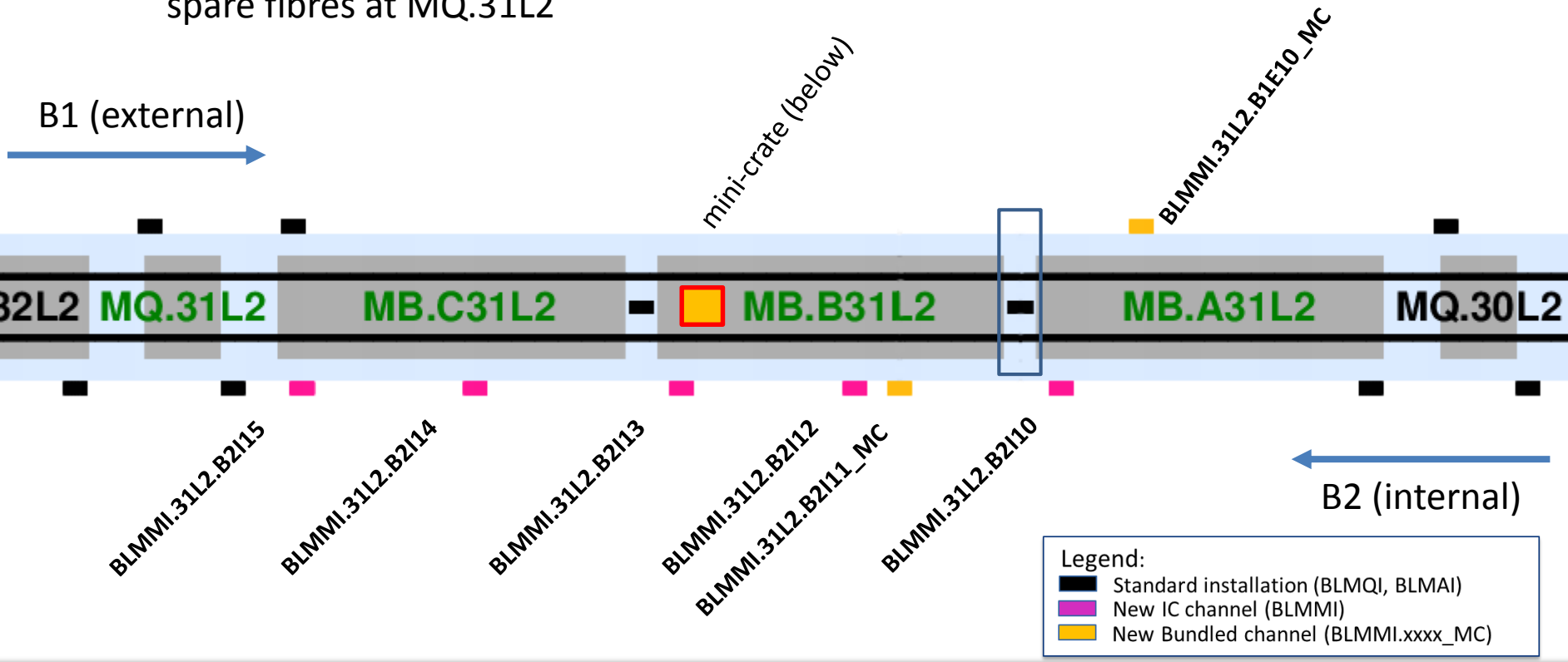
Corrective Actions during YETS

- Multiple cards have been exchanged
  - 8 acquisition and 7 processing cards
  - Mostly communication issues
- Several connectors and cables replaced
- Acquisition card reset through WorldFIP become operational for the ARCs
  - Reduced significantly the number of interventions
  - ExpertGUI under development by BI-SW
- BST got an update and fixes regarding timestamps
- LTIMs upgraded to FESA3
- All concentrators moved to new server
- Many applications re-delivered to get latest libraries

BLMs at 31L2

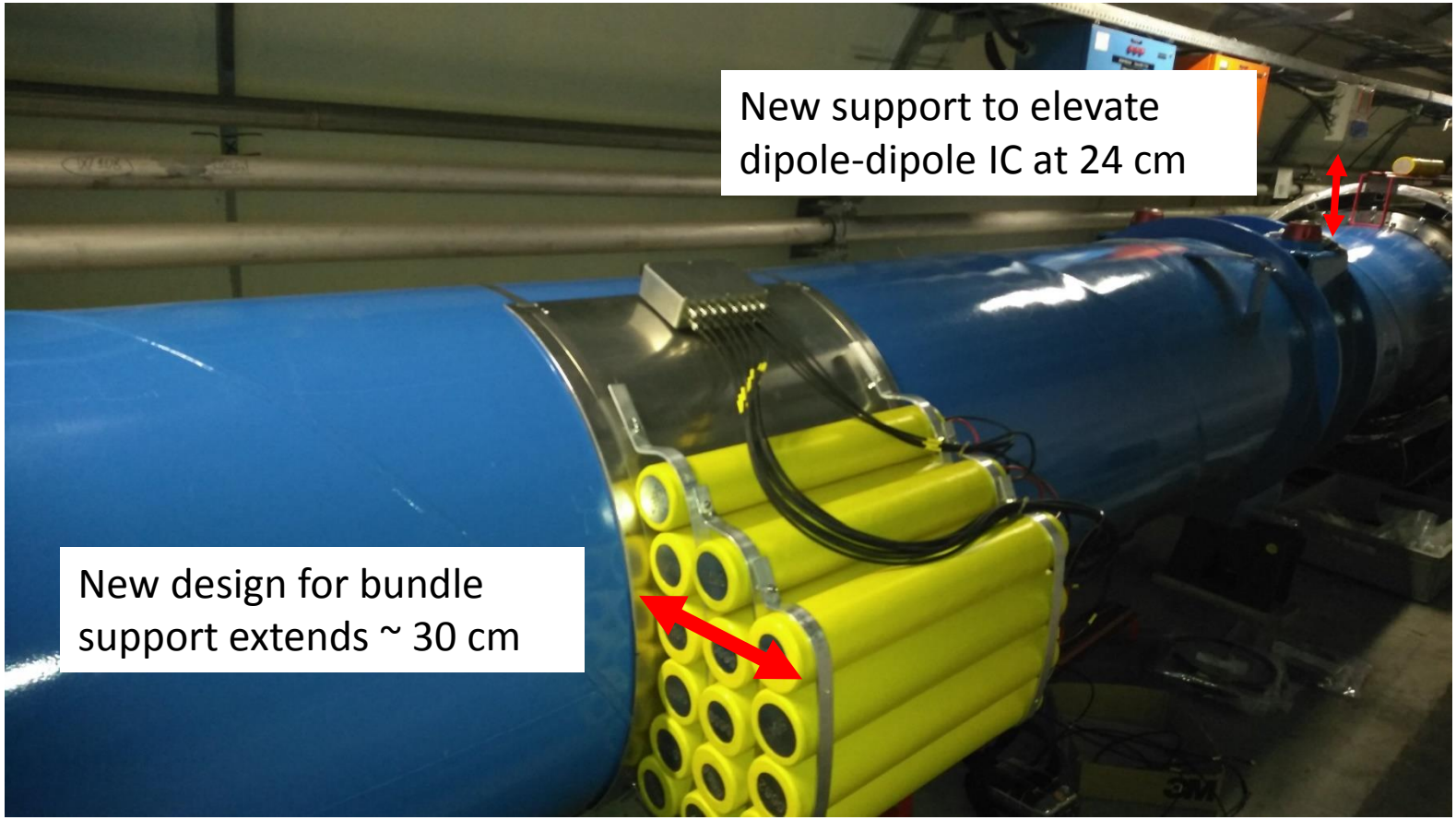


- Installed:
  - 2 x Bundles of 15 ICs around the solenoid
  - 5 x ICs across the dipoles
  - Modified support of IC above dipoles
  - Mini-crate for acquisition connected to spare fibres at MQ.31L2



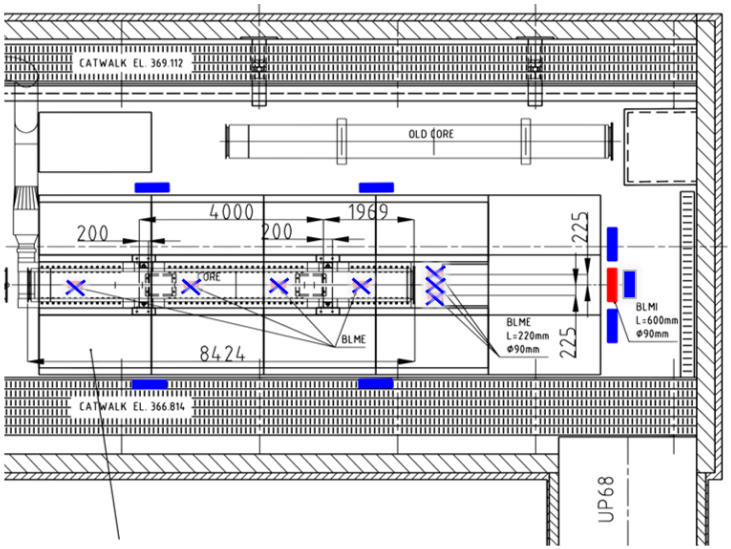
BLMs at 31L2

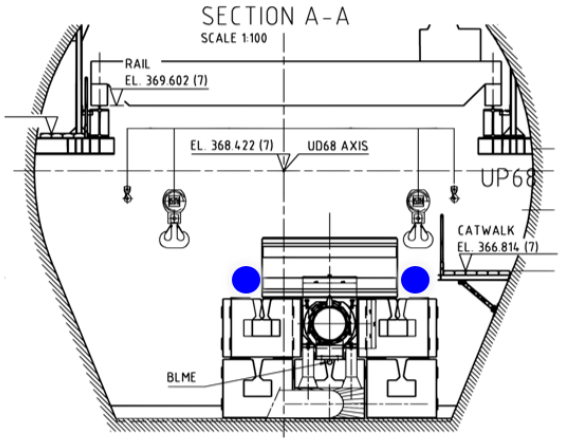
- Bundle at internal position – Beam 2



BLMs at the DUMPs

- Solution consists of
  - Adding six ICs and one LIC per DUMP
  - using rad-tol cables (kapton insulation)
  - Portable supports





BLMs at the DUMPs

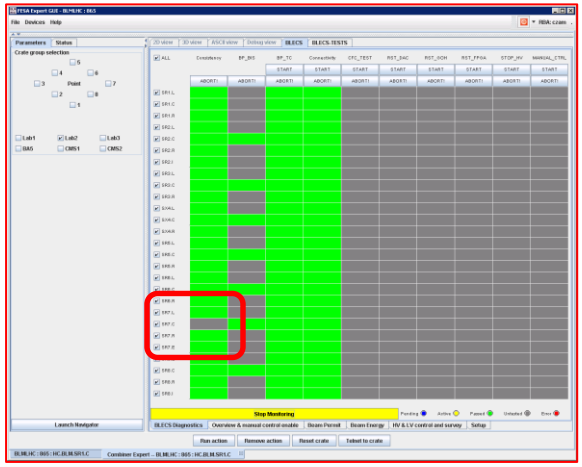
OUTSTANDING ISSUES

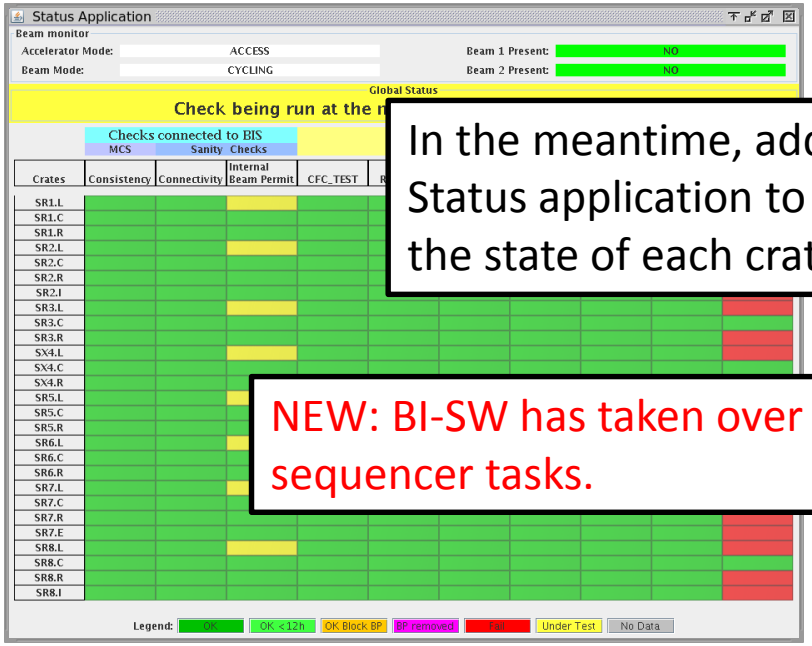
Sanity Checks

BIBML-937: Sanity Checks' result in the Sequencer does not always gets registered in the BLECS

- Several calls from the CCC that checks cannot complete
- MCS Check had passed (thus the Sequencer showed as green, but the BLECS did not get the result as TRUE to release the permit). During the retries, MCS was being skipped.

Not yet sure what is the cause.





In the meantime, added a Status application to show the state of each crate

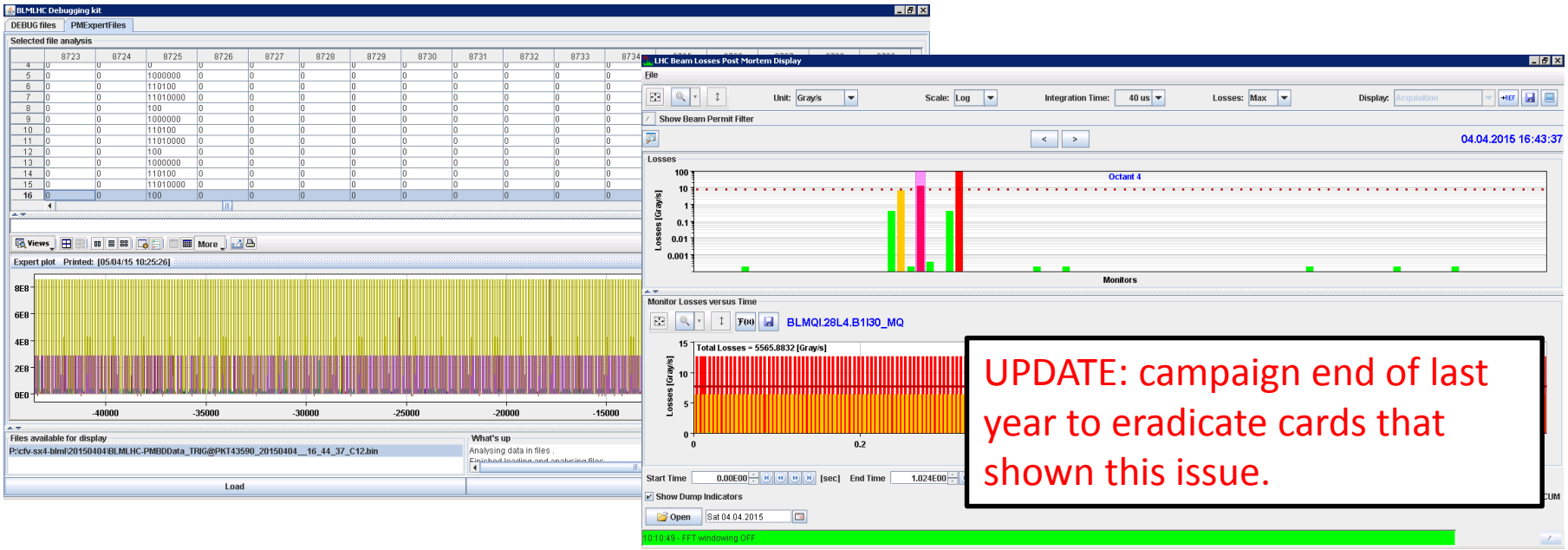
NEW: BI-SW has taken over the sequencer tasks.

Post-Mortem Data 1/2

BIBML-881: In few cases the GPM Buffer is not working correctly

- The issue is on the SRAM recording of the data.
- The spikes seen are the markers between channels.

Cards has been exchanged (Note: had 5 similar cases in Run 1)

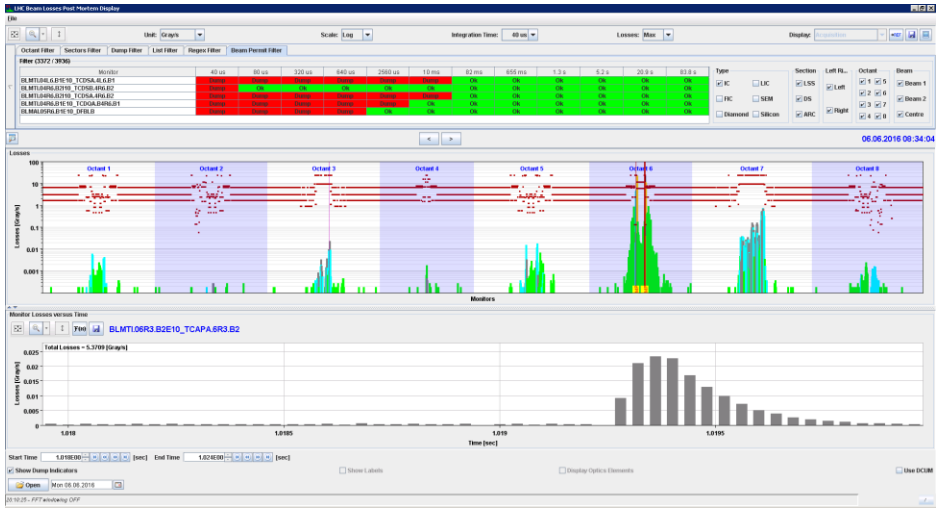


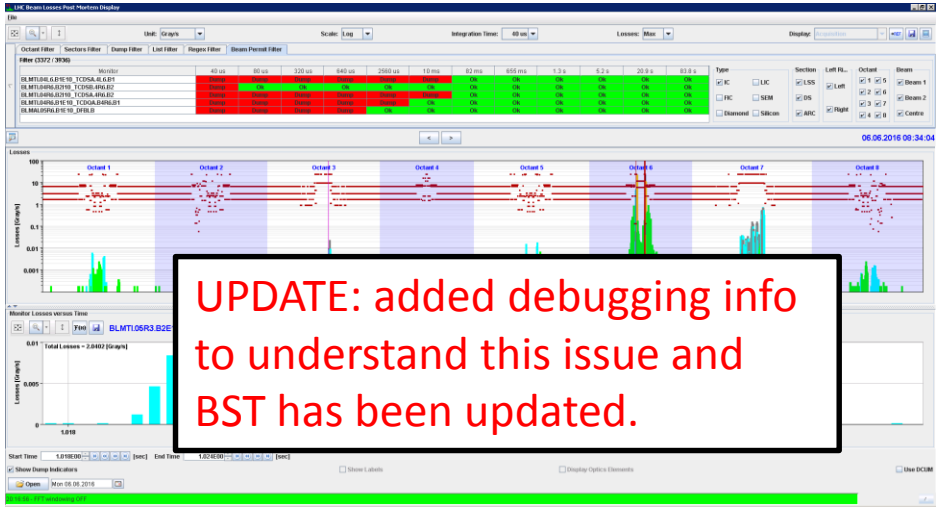
Post-Mortem Data 2/2

BIBML-1249:PM data sometimes not in sync between crates

- In few of the PM data recorded it is visible 1 ms misalignment
- A common factor on those observed events is that the BeamDumped1 & 2 events had a ms difference

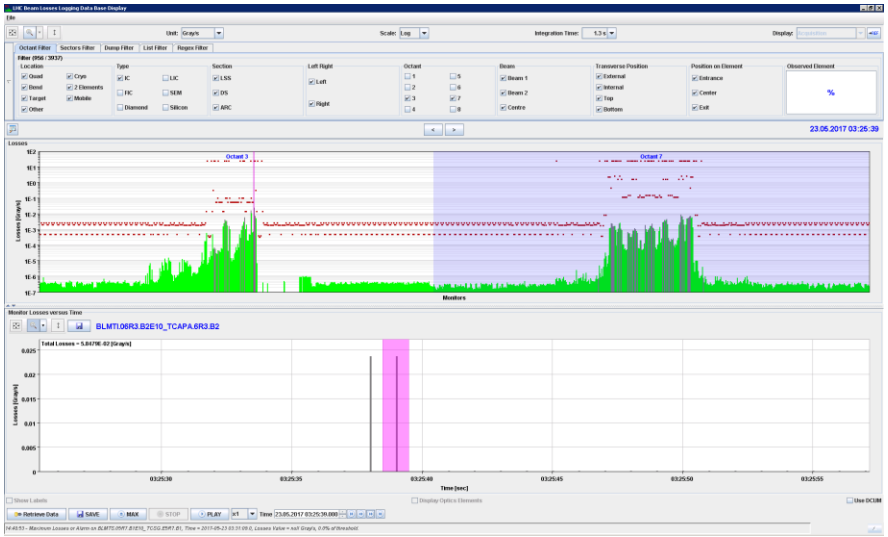
- One possible explanation is that the PM data for the misaligned crates have been readout from a different buffer than the rest

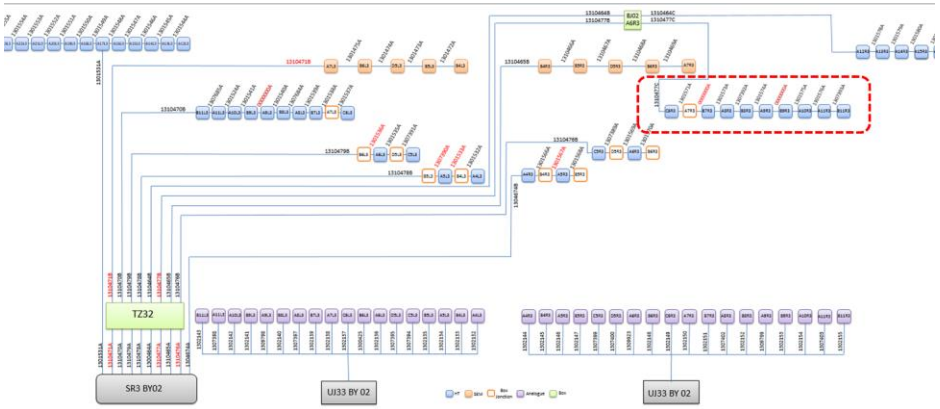




Signal Drop at IP3

- During the Loss Maps Validation several BLM signals drop to zero at DS of R3
- The issue has been reported twice in Run 2:
  - BIBML-990 on 2015/05/05 & BIBML-1344 on 2017/05/23
- Specificities of the location
  - HV cable is ~ 3km (all other locations < 200m)
  - Very long signal cables (~ 800m)





UPDATE: Objective and additional manpower set for 2018 to investigate and propose solutions

WORK IN PROGRESS & FUTURE PLANS

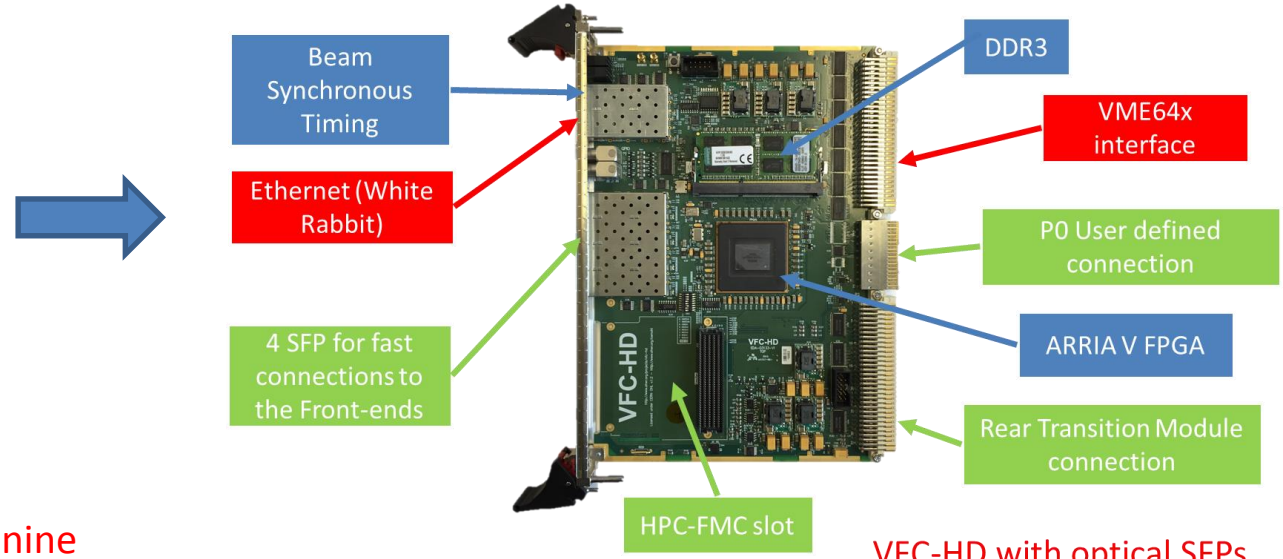
NXCALS

- BE-CO has been working to bring all LHC BLM data to the next Logging DB
  - New schema has been agreed to optimise performance
  - All metadata have been created
  - Concentrator has been modified to push data to both DBs
  - Old data is being prepared to be copied
- To become fully operational after LS2

New Processing Module

- 1150 boards under production for BI
  - ~ 700 for BLM systems
  - Common board across accelerators

DAB64x + mezzanine



VFC-HD with optical SFPs

New VME core

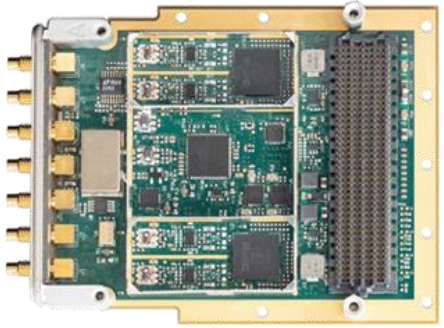
- With the addition of the new processing module and the optical links in SFP only bottleneck is the VME communication.
- New faster VME core has been developed
  - Operational at Injectors BLM using MBLT access mode

Transfer Type	Tr. Data [Bytes]	Data Rate [MB/s]	CO Group VME Core Data Rate [MB/s]
MBLT READ	2048	33.85	23.79
BLT READ	256	15.79	11.33
SCT READ	4	20.83	14.81
MBLT WRITE	2048	33.61	30.93
BLT WRITE	256	15.91	12.86
SCT WRITE	4	23.81	16.13

Current LHC BLM system at ~ 2MB/s and only SCT R/W

New Diamond Acquisition System

- FMC-HPC module with
  - 2x1000 MSPS 14-bit ADCs,
  - 2x1000 MSPS DACs,
  - DC coupled A/D & DACs



- Diamond installations at SPS and LHC
  - From 2018 all have the new acquisition system
  - Parallel installation to the operational system
  - Four new diamonds with all electronics deployed
- Aim to start after LS2 with the new system only
  - Already in very good state with most functionality available
  - This year, additional features, data taking and optimisation

Summary

Commissioning:

- Hardware and Machine checkout checks ongoing
  - DBs and minor hardware issue to complete
- Tests with beam to be planned
  - For most of them good experience to achieve
  - Test for the ‘blindable’ channels was not achieved last year

System Issues:

- No known machine protection critical issues
- Some work still needed to bring the system into operational mode