

LHC Beam Dumping System

Reliability Run Summary

MPP 21.04.2017

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Thanks to all of my TE/ABT colleagues for their inputs

OUTLINE

- Summary of Winter Shutdown 7 TeV Tests
- Main LBDS activities during EYETS
- Main objectives of LBDS Reliability Run
- Preparation for LBDS Reliability Run
- Reliability Run Overview
- TSU & CIBDS retrigger pulses validation
- Summary of problems encountered
- Operation with MKBH reduced voltage

Winter Shutdown 7 TeV Tests

Initial conditions:

- MKD.LB1 cleaned following sparking tests in previous TS
- MKB generators untouched, but decoupling of retrigger lines on MKB generators done:
 - Isolation of MKBH retrigger boxes w.r.t. generator top cover (not ground actually)
 - Installation of nanocrystalline tores on retrigger lines between MKBHs.

Outcome (B1: 78h 7 TeV, 240h 6.750-6.875 TeV; B2: 350h at 7 TeV):

- 4x self trigger of MKD.LB1 (1x 6.9 TeV, 3x 7 TeV)
- 1x self trigger of MKBH.AB1 (6.875 TeV)
- 2x self trigger of MKBH.DB1 (during ramping up 6.473 TeV and 6.822 TeV)
- No problem on MKD B2 !
- 1x self trigger of MKBH.DB2 (7 TeV)

Conclusions:

- MKBH coupling removed after rejection of common mode signal on re-trigger lines
- Confirmation of MKBH generator weaknesses identified during 2016 run
- Good feeling for potential performance of LBDS for operation at 7 TeV
- Weakest generators identified and removed from operation beginning 2017

Main LBDS activities during EYETS

- Renovation of HV generators, following cleaning and sparking test campaign during this EYETS:
 - Full generators exchanged (1x MKD, 1x MKBH), only GTO stack exchanged (5x MKD, 9x MKBs)
 - Peltier module replacement (1x MKD)
 - Insertion of a separation between GTO stack and PTU crates on all MKBH generators
- MKB self-trigger coupling problem study and solving:
 - Problem reproduced in lab.
 - Decoupling of the retrigger boxes from top part of generator on all MKB generators
 - Addition of nanocrystalline toroids on all retrigger-lines, to reduce common mode coupling.
- Upgrade of TSU cards:
 - Following card failure in 2016: Power supply weaknesses identified and corrected
 - New asynchronous dump scenarios identified: (138th MPP 2016 – E.Carlier)
 - In case of bad contact on the cable between TSU and RTD, a pulse is sent on the retrigger lines (Hardware upgrad)
 - In case of glitches on the BRF signal, synchronous triggers are issued asynchronously (Firmware upgrad).
- Upgrade of CIBDS cards:
 - New hardware, new firmware, added test mode capability (135th MPP 2016 – S.Gabourin)
- Increased CIBDS Re-Trigger Delay up to 320us.
- Preventive exchange of all LBDS PLC power supplies (154) / LBDS PLC ASi-Bus renovation
- Some software updates (PLC / IPOC)

All these changes need revalidation under operational conditions before operation with beam.

Main objectives of LBDS Reliability Run

- Validate the good state of LBDS HV generators:
 - We need a lot of dumps to validate the stability of kicker waveforms over time
 - We need cycles up to 7 TeV with long flat-tops to validate the HV sustainability, with some margin for operation.
- Validate the upgraded TSU & CIBDS cards:
 - We need a lot of arm / dump to validate the correct behaviour of TSU and CIBDS cards during arm/dump actions
 - We need long time with BIS armed to validate the stability of BIS loops.
 - We need a lot of dumps to check the presence and correct position of TSU & CIBDS pulses on the retrigger lines.
- Validate the upgraded PLC code and hardware:
 - We need a lot of arm / dump to validate the correct behaviour of PLCs.
 - We need many ramps to check the tracking of beam energy.

Not a lot of time available:

⇒ We can satisfied all these requests during a reliability run with Local BIS Loops

Preparation for LBDS Reliability Run...

- Local BIS loops: New BIS hardware and software deployed in Point6

The screenshot displays the 'bis-gui-pro-lhc' interface. The main window shows the 'Local Loop' status for various components. A secondary window titled 'CIBM.UA63.LLL6.B1 frame' provides a detailed view of the 'SAFE BEAM FL...' status, including a table of input and disabled states.

Local Loop Status:

Component	Status
CIBM.UA63.LLL6.B1	Green
CIBG.UA63.LLL6.B1	Green
CIBDS.UA63.LLL6.B1	Green
CIBM.UA67.LLR6.B1	Green
CIBG.UA67.LLR6.B2	Green
CIBDS.UA67.LLR6.B2	Red
CIBM.UA67.LLR6.B2	Red

CIBM.UA63.LLL6.B1 frame Detailed View:

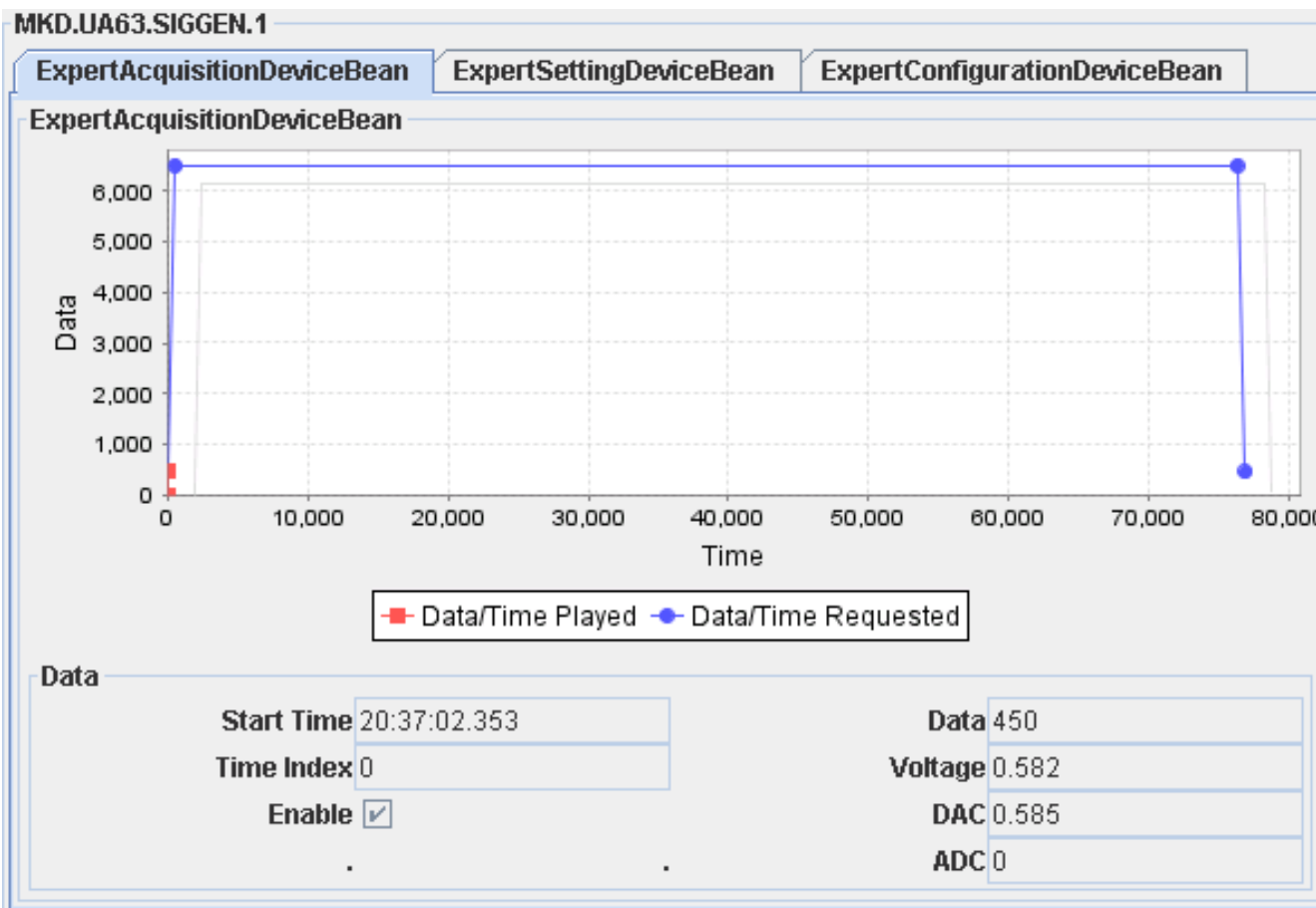
Index	Input	DISABLED
	Software Permit	TRUE
1	not used	FALSE
2	LBDS-b1 Local Loop (TSU)	TRUE
3	LBDS-b1 Local Loop (PLC)	FALSE
4	not used	FALSE
5	not used	FALSE
6	CIBDS B1 Local Loop	FALSE
7	not used	FALSE

DISABLED buttons: YES, NO, YES, YES, NO, YES

20:30:19 - Set timeout policies succeed.

Preparation for LBDS Reliability Run...

- BETS-Simulator used to generate the main bends current cycles for BETS



- BETS-Simulator connected to BEM cards.
- - MSD / Q4 BEI cards removed from BETS

Preparation for LBDS Reliability Run...

- New XPOC server for the validation of every dump action

The screenshot displays the XPOC Viewer - PRO interface. At the top, it shows session information for 'RBA: nmagnin'. Two beam status panels are visible: 'SIS LATCH - BEAM1 - 20.04.2017 - 21:06:54.182'000'000' with a green 'BEAM1 IS PERMITTED' indicator, and 'SIS LATCH - BEAM2 - 20.04.2017 - 21:06:54.295'000'000' with a red 'BEAM2 IS BLOCKED' indicator. Below this, a green bar indicates 'BEAM 1 - PROTON (SHUTDOWN) E: 450.00 GeV I: 0.00E0 p+ #b: 0 20.04.2017 - 21:06:24.138'841'375'. A left sidebar lists modules with status icons: XPOC (green check), CONTEXT (red X), MKD (green check), MKB (green check), TSU (green check), MKDGEN (green check), SCSS (green check), and BETS (green check). The main area shows 'Module results' for 'Module: MKB' with 'Analysis: OK' and 'Check: OK'. A sub-section for 'Source: MKBH.UA67.XPOC.AB1' also shows 'Analysis: OK' and 'Check: OK'. A table of 'CHECKS' is displayed with columns for Property, Value, Min Value, Ref Value, Max Value, Diff., Units, and Check. Below the table is a 'Waveform & Points' plot showing 'Current [kA]' vs 'Time wrt Dump [us]' with a sinusoidal wave and several data points.

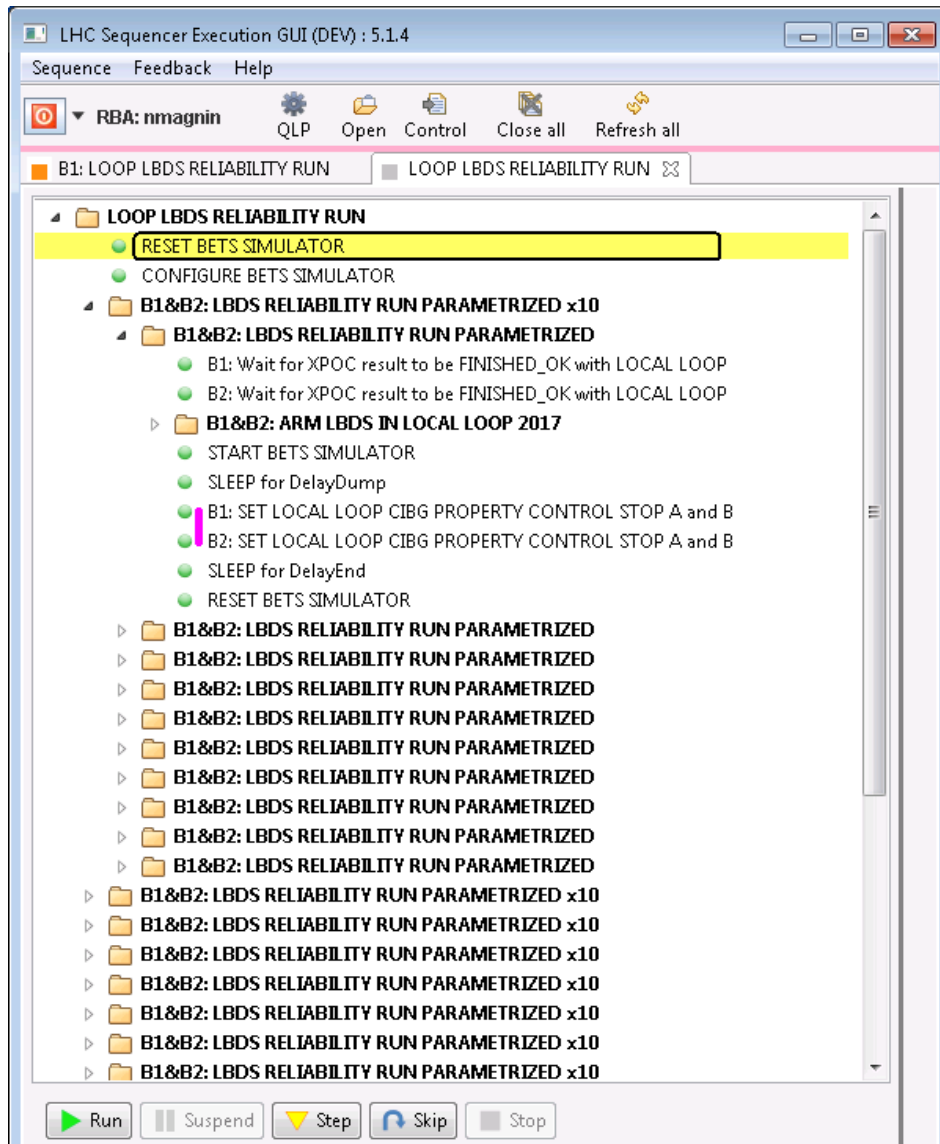
Property	Value	Min Value	Ref Value	Max Value	Diff.	Units	Check
ref17_SpcTime	1.056E1	1.008E1	1.058E1	1.108E1	-1.391E-2	us	OK
max1Current	1.536E0	1.505E0	1.535E0	1.566E0	5.535E-4	kA	OK
zero1Time	5.335E1	5.285E1	5.335E1	5.385E1	1.881E-3	us	OK
halfPeriod	3.865E1	3.815E1	3.865E1	3.915E1	-3.051E-3	us	OK
max2Ratio	8.046E1	7.844E1	8.044E1	8.244E1	1.456E-2	%	OK
min1Ratio	-9.354E1	-9.556E1	-9.356E1	-9.156E1	1.366E-2	%	OK
endRatio	5.358E1	5.019E1	5.419E1	5.819E1	-6.080E-1	%	OK
period	7.637E1	7.585E1	7.635E1	7.685E1	1.107E-2	us	OK

New XPOC-HWC configuration:

- Only ABT modules
- No BE/BI data
- “Beam Dumped” timing event not sent = XPOC-HWC server starts sessions on LBDS trigger

Preparation for LBDS Reliability Run...

- New Sequencer tasks needed to arm / start cycle / dump with local BIS



Sequence “LOOP LBDS RELIABILITY RUN”:

- 160x Dump / Arm at 450GeV every 60s
= 2h 40min
- 1x Arm / 21h flat-top at 7 TeV / Dump
= 21h 20min

24h cycle played in loop...

Preparation for LBDS Reliability Run

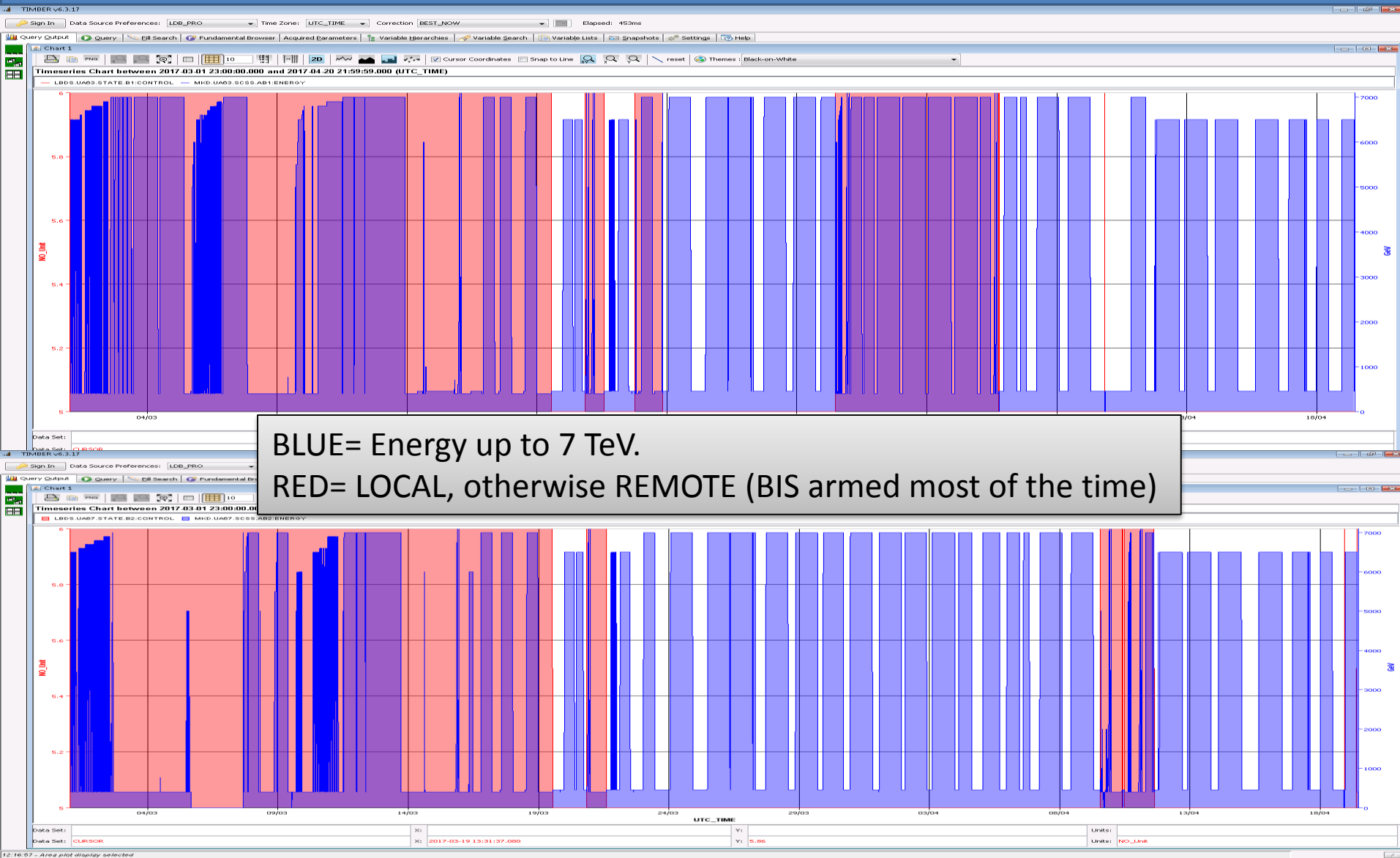
- **LBDS Reliability Run with Local BIS loops do not come for free!**
 - Many people involved from various groups
 - Complicated configuration of all these BIS, Sequencer, XPOC, etc applications
 - A lot of time requested for the follow up of this 24h/7d reliability run.
 - Very good support from other groups, even during evenings and week-ends !

Many thanks to our friends from BE/CO, BE/OP, TE/MPE... and TE/ABT for their help and collaboration !

LBDS Reliability Run Overview – Log

- 03.03.2017: Start Reliability run in LOCAL at 7TeV
- 10.03.2017: TSU back in LHC – Trigger and AGK delays adjusted – In Local BIS Loops
- 20.03.2017: LBDS switched to REMOTE first arming tests with Local IS loops
- 21.03.2017: Two E-Scan for reference, regeneration of all LBDS settings after EYETS
 - 23.03.2017: Compensation DCPS for MKD.GB1 failed, DCPS exchanged twice.
- 24.03.2017: Switch to REMOTE, start Reliability Run with Local IS loops
 - 28.03.2017: Two self triggers of MKBH.DB1 at 7 TeV, stack exchanged
 - 31.03.2017: Sparking activity on MKBH.DB1 after stack exchanged, generator exchanged
- 31.03.2017: B1: E-Scan and new settings after MKBH.DB1 replacement, LOCAL reliability run at 7TeV until 04.06.2017 for B1
- 31.03.2017: New CIBDS in LHC - In Local BIS Loops.
- 01.04.2017: Update of sequencer and BIS software to integrate the CIBDS
 - 05.04.2017: Dump from the BIS, no logging configured for the local BIS loops, not understood.
- 06.04.2017: B1 E-Scan for reference.
- 06.04.2017: B1 Switch back to REMOTE- Reliability Run at 7TeV
 - 07.04.2017: Self trigger of LBDS.B2, source not clear, could come from MKD.FB2
 - 10.04.2017: Switch ratio error on MKD.DB2 after dump at 7TeV
 - 11.04.2017: Replacement of stack on MKD.DB2, GTO in CC.
- 11.04.2017: UPS tests for LBDS, no problem found
- 12.04.2017: Stop of Reliability Run at 7TeV, continue at 6.5TeV
 - Many problems with PLC and BETS tracking, identified as PLC communication problems
- 21.04.2017: Continue Reliability Run over the week-end ?

LBDS Reliability Run Overview – Logging



LBDS Reliability Run Overview - Statistics

Statistics from 1st March 2017:

Time spent at 7 TeV (h)	433	393
Time spent at 6.5 TeV (h)	119	119
Number of triggers	4572	4044
Number of triggers at 7 TeV	121	118

Note: Number of triggers counts LOCAL + REMOTE (BIS Armed)

Main Problems found during Reliability Run

HV generators:

- 2x self trigger of MKBH.DB1, 2 stacks replaced , then generator exchanged
- Switch ratio error on MKD.DB2 after dump at 7 TeV, stack replaced
- Erratic on MKD B2, source not clearly understood, could come from MKD.FB2
 - no sparking visible on MKDGEN IPOC before erratic
 - Noise on retrigger line that triggered PTM, source is MKD sparking ?..

Electronic & Controls:

- Compensation DCPS for MKD.GB1 failed, DCPS exchanged twice.

TSU & CIBDS:

- One event of trigger from the BIS not understood (No logging configured for BIS).

PLC software

- Many problems of communication, between PLCs, yielding to tracking errors. Difficult to identify, still under investigation...

XPOC errors:

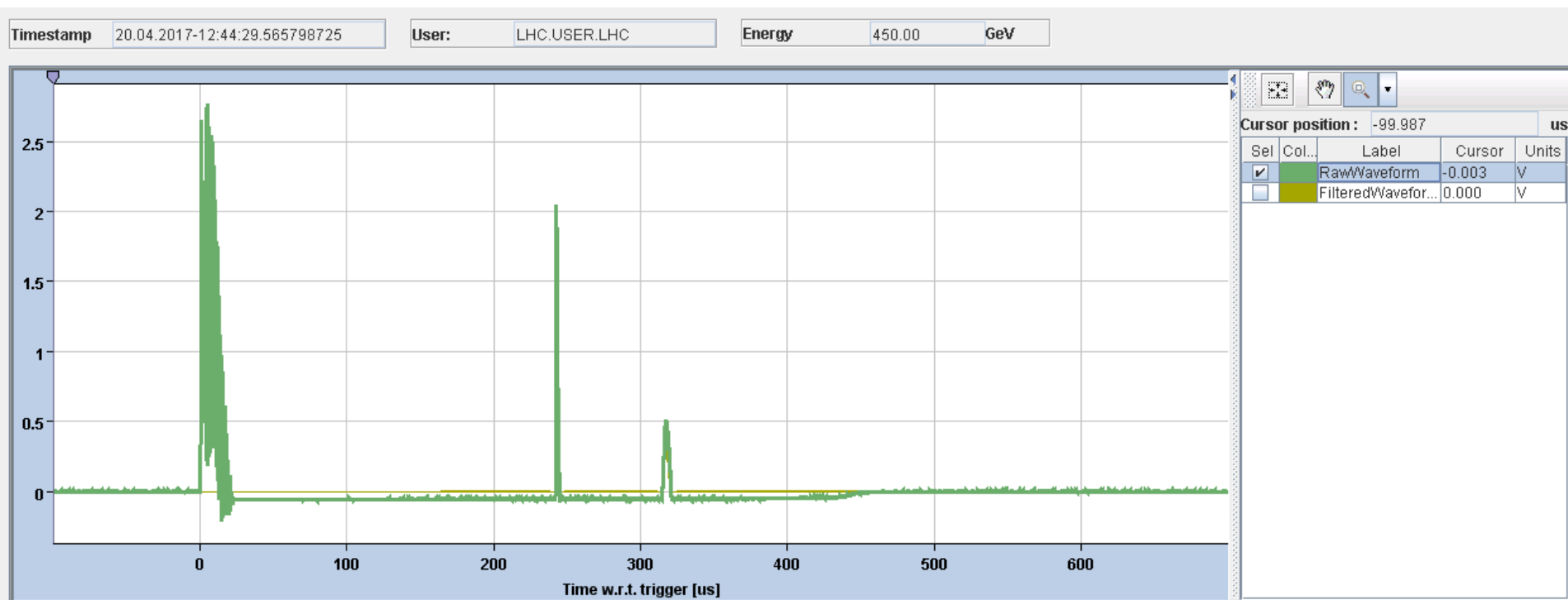
- TSU data missing = Old CTRV driver bug ?
- Missing some analysis sessions

Sequencer problems:

- Error waiting for XPOC result...

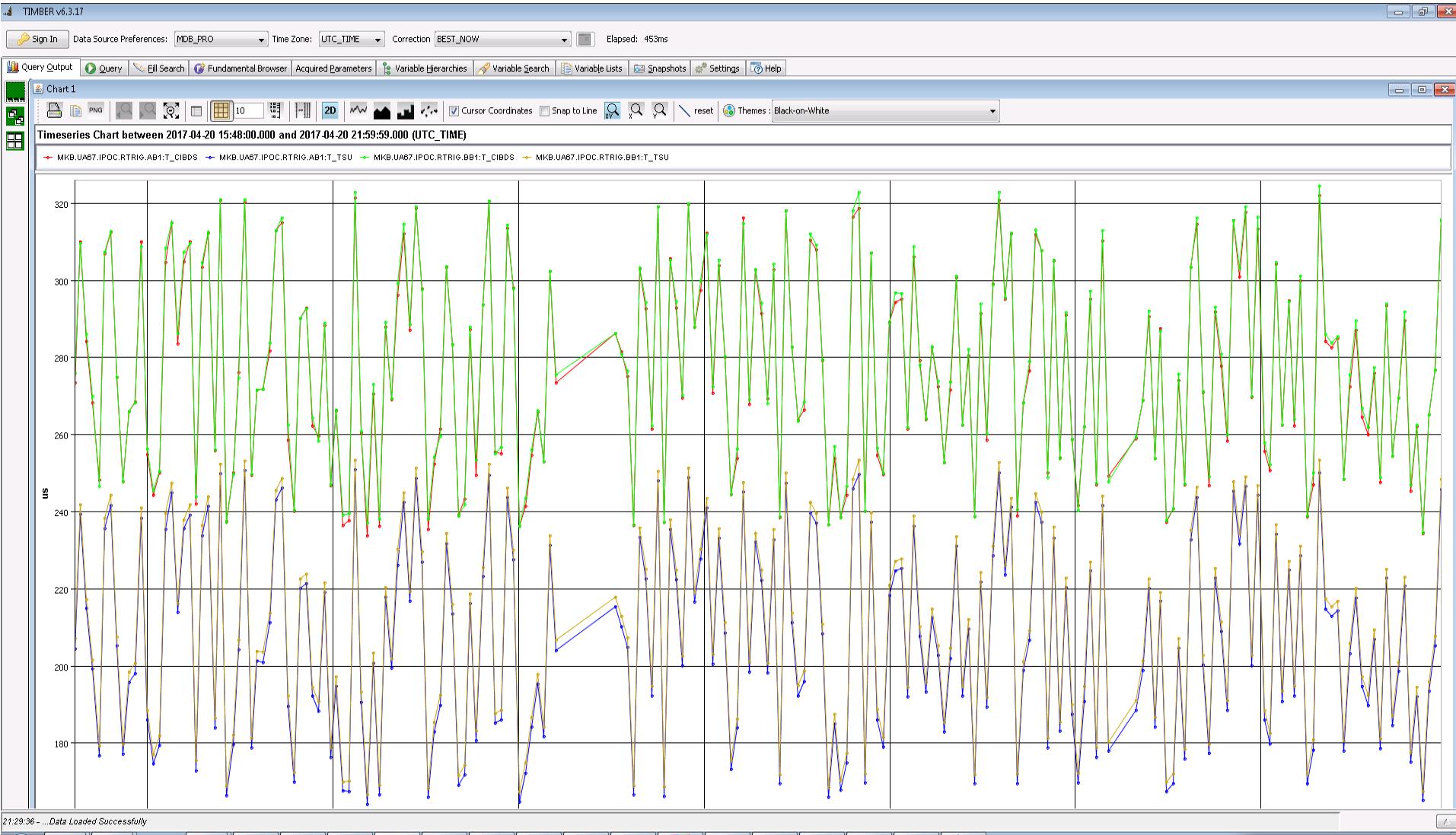
TSU & CIBDS retrigger pulses validation

- IPOC analysis of retrigger line pulses is implemented.
 - Signal on both ends of each retrigger line is analysed (4 waveforms per beam).
 - Position and Amplitude of TSU and CIBDS pulses stored in PM and Logging DB
- Deployed late in the Reliability Run, so all recorded waveforms are analysed off-line to check the presence of both TSU and CIBDS pulses.
- XPOC module implementation is still ongoing, should be released soon...



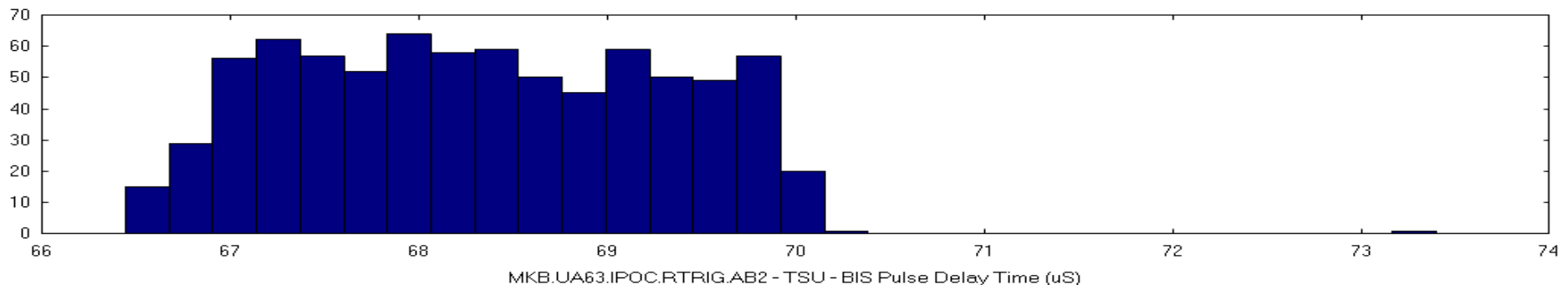
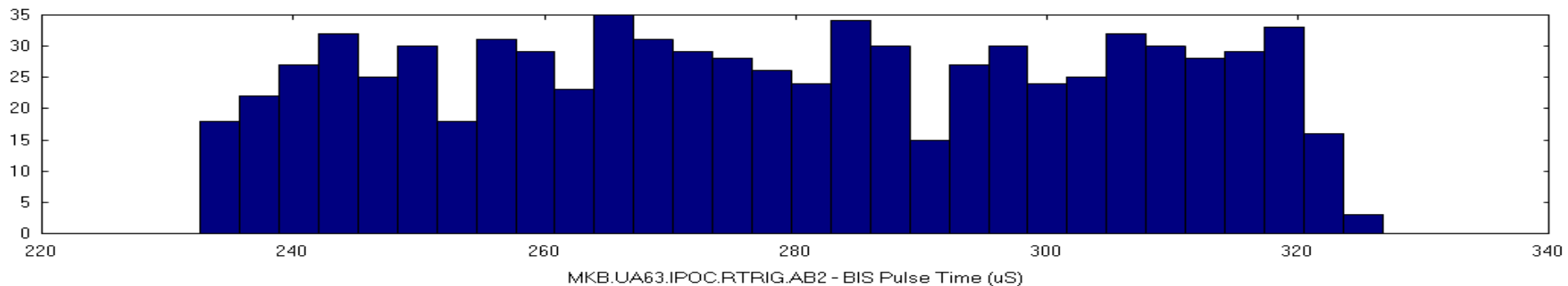
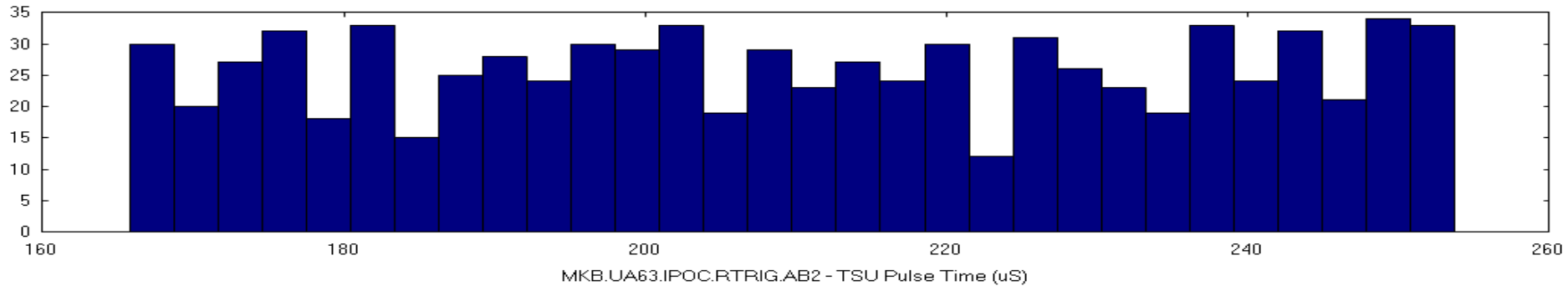
TSU & CIBDS retrigger pulses validation

New IPOC ReTrigger lines analysis implemented, data pushed to Logging DB.
Time difference between TSU & CIBDS pulses seem constant, as expected...



TSU & CIBDS retrigger pulses validation

Statistics on IPOC ReTrigger lines analysis results confirm that the time difference between TSU & CIBDS pulses is constant, as expected for BIS dump requests...



Operation with MKBH reduced voltage

Regarding running at lower horizontal dilution (90% ?):

Looking at performances during Reliability Run, we decided:

- To start with 100% dilution
- To apply normal procedure in case of self trigger
- Change to reduced horizontal dilution could be done during a TS, if needed
- Max 2 days required to compute the new settings and reconfigure the LBDS

Summary

Reliability Run indeed very useful for...

- Validation of HV generators, weakest ones removed from operation
- Validation of upgrades in Trigger Synchronisation and Distribution System (TSDS)
- Validation of upgrades in Controls software and hardware

Improvement of Re-Trigger line performances and diagnosis

- Removed MKBH coupling through re-trigger lines
- New IPOC to analyse re-trigger line pulses, all waveforms analysed off-line are OK

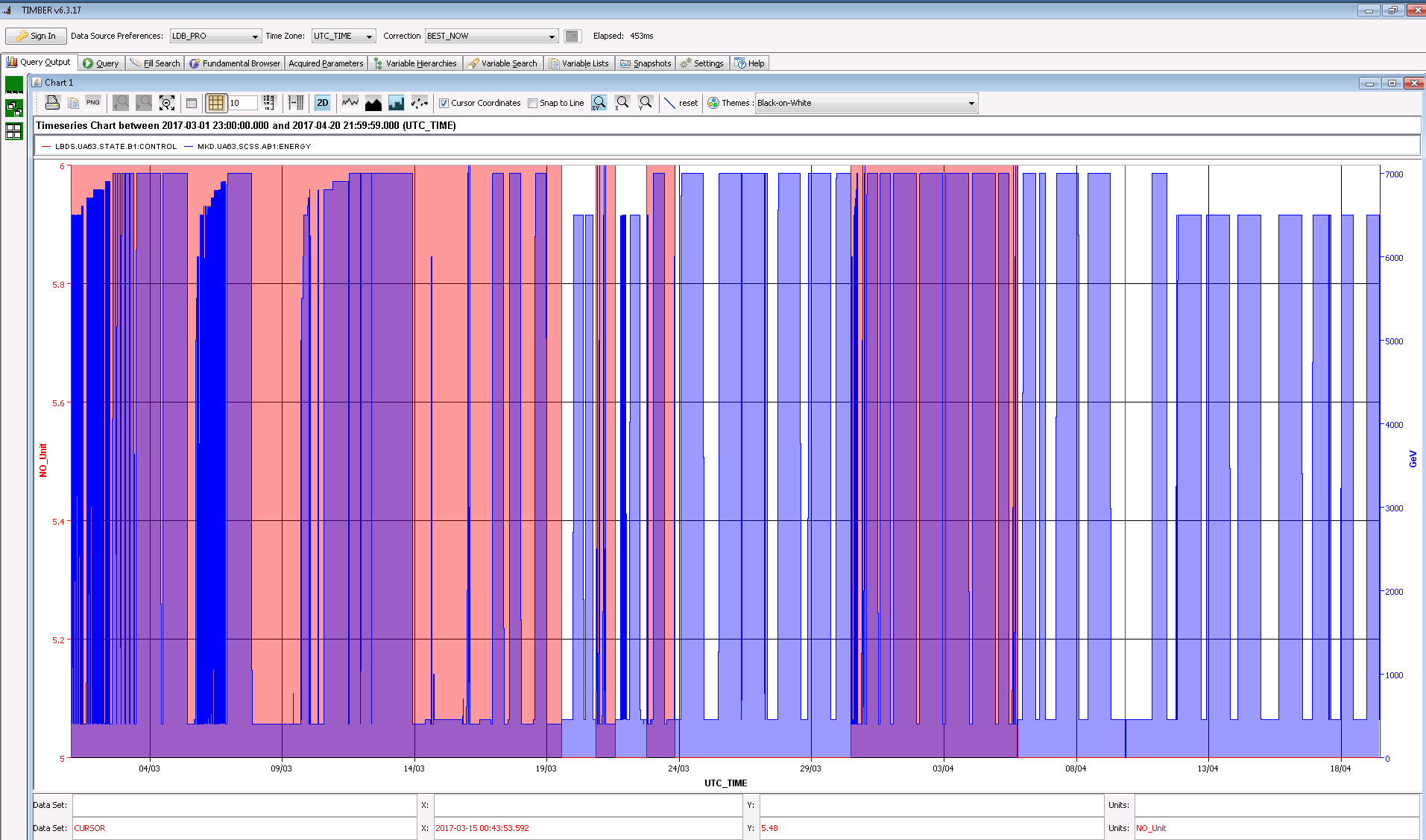
Good overall performance of LBDS during Reliability Run

Starting with 100% dilution, will discuss reduction if needed

We should plan a Reliability Run with Local BIS loops after every YETS !

Spares slides / Removed...

LBDS Reliability Run Overview – B1



LBDS Reliability Run Overview – B2

