



Post Mortem System

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TE-MPE-PE and TE-MPE-MS teams

Special thanks to J-C. Garnier, Z. Charifoulline,
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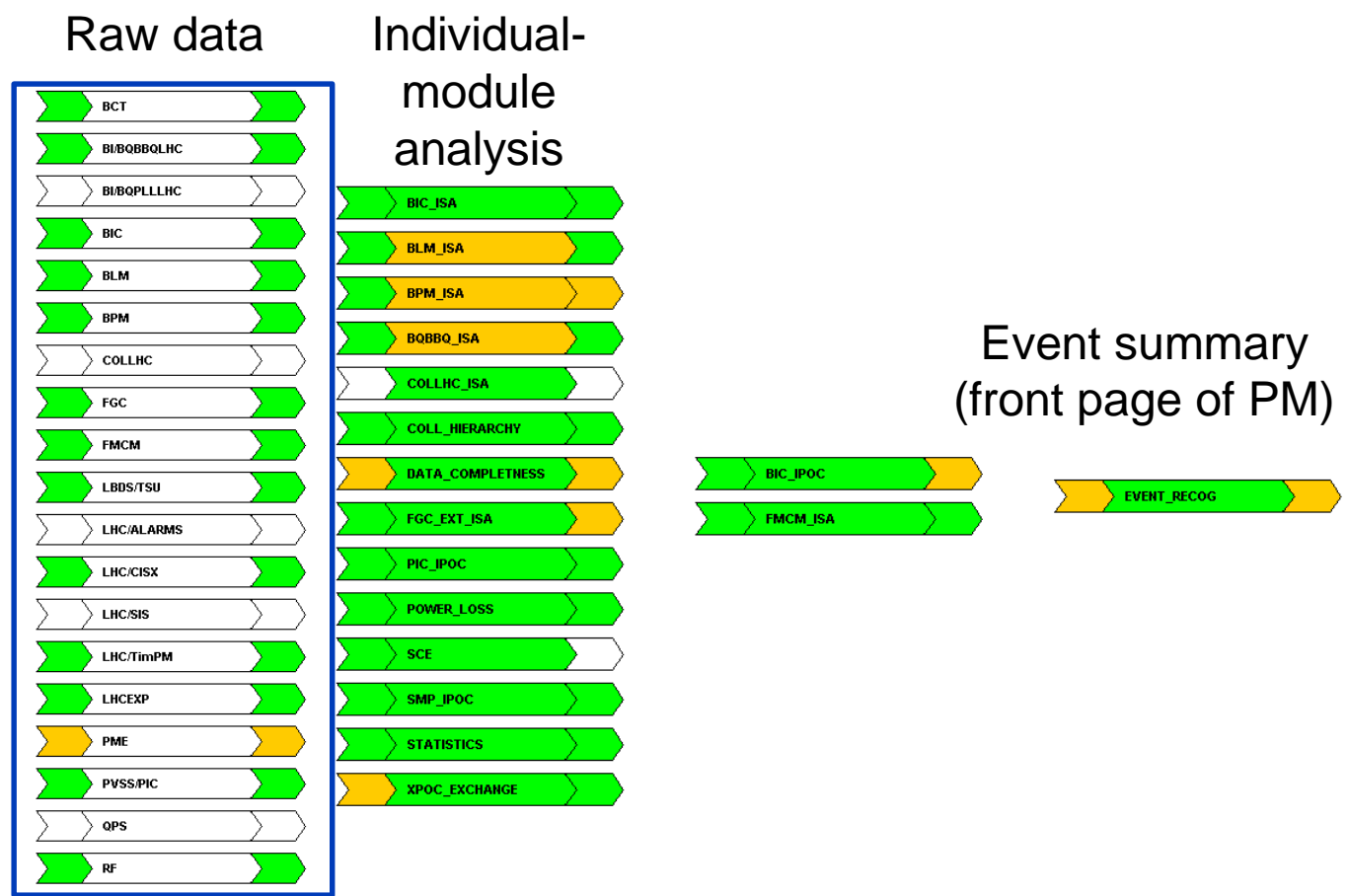
Motivation

- PM system is needed to understand the reason and consequences of a beam dump
- PM stores information about
 - sequence of events
 - status of the MPS before/during/after dump
- Correct behavior of the MPS and other systems



Which systems are sending data to PM?

- BLM
- BCT
- BIC
- BPM
- FMCM
- LBDS
- BBQ
- RF
- Collimators
- Experiments
- PIC
- SIS
- etc..





Front page of PM

GLOBAL : GPM1 : 14.04.2015 09:22:21 (1428996141474520075) - PLAYBACK by vchevter on 11.06.2015 at 09:20:37

Final analysis is finished

Session confirmation | Modules graph | Results

BIC IPOC | BLM LOSSES | BLMdiamond | BLMLHC | BPM ORBIT | QBQQ ISA | COLL HIERARCHY | COLLHC ISA | EVENT SEQ | Event overview | FGC DATA RED | FMCM ISA | PIC IPOC | PM EVENT | POWER LOSS | RF | SMP | SMP IPOC

Dump context

Event timestamp: 2015.04.14 09:22:21 CEST

Fill number: 3620

Filling pattern: alternating b1 buck1 + b2 buck 2001

Acc / Beam mode: BEAM SETUP / FLAT TOP

Energy: 6499680 MeV

Intensity B1: 1 e¹⁰ charges

Intensity B2: 0 e¹⁰ charges

SMP flags: PRESENT, SAFE / PRESENT, SAFE

BSTAR 1/2/5/B: 11.0 / 10.0 / 11.0 / 10.01 m

Event sequence

Event category: PROTECTION_DUMP

Event classification: MULTIPLE_SYSTEM_DUMP

Event sequence: First USR_FERMIT change: Ch 4-BLM_UNM: B T -> F on CIB.UA83.L8.B1

Triggered BIC inputs: Ch 4-BLM_UNM(L8.B1), Ch 4-BLM_UNM(L8.B2), Ch 6-CIBDS Beam 2(R6.B2), Ch 6-CIBDS Beam 1(L6.B1), Ch 2-LBDS-b2 (TSU)(R6.B2), Ch 2-LBDS-b1 (TSU)(L6.B1), Ch 12-PIC_MSK(L1.B2), Ch 12-PIC_MSK(L1.B1), Ch 5-PIC_UNM(L1.B2), Ch 5-PIC_UNM(L1.B1), Ch 5-PIC_UNM(R1.B1), Ch 12-PIC_MSK(R1.B1), Ch 5-PIC_UNM(R1.B2), Ch 12-PIC_MSK(R1.B2), Ch 5-PIC_UNM(R8.B1), Ch 12-PIC_MSK(R8.B1), Ch 12-PIC_MSK(R8.B2), Ch 5-PIC_UNM(R8.B2), Ch 12-PIC_MSK(L8.B1), Ch 12-PIC_MSK(L8.B2), Ch 5-PIC_UNM(L8.B1), Ch 5-PIC_UNM(L8.B2), Ch 3-LBDS-b2 (PLC)(R6.B2), Ch 3-LBDS-b1 (PLC)(L6.B1), SW Permit(S3.B2), SW Permit(S3.B1)

SCEvents: RPMBB.RR13.RQT12.L1B2; RPMBB.UA87.RSD2.AB1B1; RPLB.UA87.RCO.AB1B1; RPMBB.RR13.RQT12.L1B1; RPMBB.UA87.RSD2.AB1B2; RPLB.UA87.RCO.AB1B2; RPMBB.RR13.ROD.AB1B2; RPMBB.RR13.RSS.AB1B2; ...and 52 more...

Machine protection features

Event description: BIC_IPOC analysis finished with warnings. Possible magnet quenches.

Highest beam losses: BLMBI.15RB.BOT20_MBA-MBB

Magnet quenches: MB.B15R8; RSF2.AB1B2; RSD1.AB1B2; RQT13.L1B2; RQT12.L1B2; RQTL11.R8B1; RCO.AB1B2; RCD.AB1B1; RQS.R8B2; RQTD.AB1B1

nQPS triggers: No nQPS events found

BIC IPOC: FMCM ISA: PIC IPOC:

XPOC B1: XPOC B2:

Safe for injection?: PM Overall:

Comments

User:

Advised actions:

Input your comment and confirmation parameters for session confirmation:

Beam Losses: Loss type:

Orbit Changes: Classification:

Confirm Discard Release SIS

- Most of the modules existed before LS1
- Due to changes of the names (collimators, BPMs etc), and FESA classes the modules were not fully operational after LS1
 - Problem solved during commissioning
- Some data structures changed



Automatic PM analysis – BLM, BPM ORBIT and EVENT_SEQ modules

Event with

GLOBAL : GPM1 : 14.04.2015 09:22:21 (142899)

Session confirmation Modules graph Reso

BCT BIC_IPOC BLM LOSSES BLMDiamond BL

Event timestamp: 2015.04.14 09:22
 Fill number: 3620
 Filling pattern: alternating b1 bud
 Acc / Beam mode: BEAM SETUP / FLA
 Energy: 6499680 MeV
 Intensity B1: 1 e^10 charges
 Intensity B2: 0 e^10 charges
 SMP flags: PRESENT, SAFE / I
 BSTAR 1/2/5/8: 11.0 / 10.0 / 11.0

Event description: BIC_IPOC analy
 Highest beam losses: BLMB1.15R8.B0
 Magnet quenches: MB.B15R8; RSF B1; RQS.R8B2;
 nQPS triggers: No nQPS events

BIC IPOC:
 XPOC B1:
 Safe for injection?:

BCT data m
BPM ORBIT
Dumped on

bic_eventseq >> Version: 1.0.1 Responsible: Ivan Romera Ramirez

HEADER		SUMMARY	
System	BIC	pmAnalysisModuleVersion	1.0.1
Class	EVENT_SEQ	Analysis result description	First USR_PERMIT change: Ch 4-BLM_UNM: B T-> F on CIB.UA83.L8.B1
Source	ISA	Triggered BIC inputs	Ch 4-BLM_UNM(L8.B1), Ch 4-BLM_UNM(L8.B2), Ch 6-CIBDS Beam 2(R6.B2), Ch 6-CIBDS Beam 1(L6.B1)...
Event stamp	09:22:21.474 14/04/15	Beam 1 propagation delay to LBDS	46000 ns
Version	1.0.1	Beam 2 propagation delay to LBDS	44000 ns
Encoding	BIC/EVENT_SEQ	OVERALL	40 BICs triggered valid PM data
Qualifier			
Analysis flags	[NORMAL]		

EVENT OVERVIEW				SOURCE OVERVIEW		
Index	Loc.Permit/AB	Time	Delta(uSec)	Description	BIC name	
57		09:22:21+474433	0	USER_PERMIT: Ch 4-BLM_UNM: B T-> F	CIB.UA83.L8.B1	
58		09:22:21+474433	0	USER_PERMIT: Ch 4-BLM_UNM: A T-> F	CIB.UA83.L8.B1	
59		09:22:21+474433	0	USER_PERMIT: Ch 4-BLM_UNM: B T-> F	CIB.UA83.L8.B2	
60		09:22:21+474433	0	USER_PERMIT: Ch 4-BLM_UNM: A T-> F	CIB.UA83.L8.B2	
222		09:22:21+474479	46	USER_PERMIT: Ch 6-CIBDS Beam 2: A T-> F	CIB.UA67.R6.B2	
242		09:22:21+474481	48	USER_PERMIT: Ch 6-CIBDS Beam 1: A T-> F	CIB.UA63.L6.B1	
313		09:22:21+474527	94	USER_PERMIT: Ch 2-LBDS-b2 (TSU): B T-> F	CIB.UA67.R6.B2	
314		09:22:21+474527	94	USER_PERMIT: Ch 2-LBDS-b2 (TSU): A T-> F	CIB.UA67.R6.B2	
333		09:22:21+474550	117	USER_PERMIT: Ch 2-LBDS-b1 (TSU): A T-> F	CIB.UA63.L6.B1	
334		09:22:21+474550	117	USER_PERMIT: Ch 2-LBDS-b1 (TSU): B T-> F	CIB.UA63.L6.B1	
360		09:22:21+474555	122	USER_PERMIT: Ch 6-CIBDS Beam 1: B T-> F	CIB.UA63.L6.B1	
357		09:22:21+474611	178	USER_PERMIT: Ch 6-CIBDS Beam 2: B T-> F	CIB.UA67.R6.B2	
345		09:22:21+492976	18543	USER_PERMIT: Ch 12-PIC_MSK: B T-> F	CIB.US15.L1.B2	
346		09:22:21+492976	18543	USER_PERMIT: Ch 12-PIC_MSK: A T-> F	CIB.US15.L1.B2	
347		09:22:21+492977	18544	USER_PERMIT: Ch 12-PIC_MSK: B T-> F	CIB.US15.L1.B1	
348		09:22:21+492977	18544	USER_PERMIT: Ch 12-PIC_MSK: A T-> F	CIB.US15.L1.B1	
349		09:22:21+492977	18544	USER_PERMIT: Ch 5-PIC_UNM: A T-> F	CIB.US15.L1.B2	
350		09:22:21+492978	18545	USER_PERMIT: Ch 5-PIC_UNM: B T-> F	CIB.US15.L1.B1	
351		09:22:21+492978	18545	USER_PERMIT: Ch 5-PIC_UNM: A T-> F	CIB.US15.L1.B1	
352		09:22:21+492978	18545	USER_PERMIT: Ch 5-PIC_UNM: B T-> F	CIB.US15.L1.B2	
357		09:22:21+493043	18610	USER_PERMIT: Ch 5-PIC_UNM: B T-> F	CIB.US15.R1.B1	
358		09:22:21+493044	18611	USER_PERMIT: Ch 12-PIC_MSK: B T-> F	CIB.SR2.INJ1.B1	
359		09:22:21+493044	18611	USER_PERMIT: Ch 12-PIC_MSK: A T-> F	CIB.US15.R1.B1	
360		09:22:21+493044	18611	USER_PERMIT: Ch 5-PIC_UNM: B T-> F	CIB.US15.R1.B2	
361		09:22:21+493045	18612	USER_PERMIT: Ch 12-PIC_MSK: B T-> F	CIB.US15.R1.B2	
362		09:22:21+493045	18612	USER_PERMIT: Ch 12-PIC_MSK: A T-> F	CIB.US15.R1.B2	
366		09:22:21+493047	18614	USER_PERMIT: Ch 5-PIC_UNM: A T-> F	CIB.SR3.S3.B1	
367		09:22:21+493048	18615	USER_PERMIT: Ch 5-PIC_UNM: A T-> F	CIB.US15.R1.B2	
369		09:22:21+494103	19670	USER_PERMIT: Ch 5-PIC_UNM: A T-> F	CIB.UA87.R8.B1	

Index	Source Name	Data Valid
1	CIB.UA87.R8.B2	true
2	CIB.UA87.R8.B1	true
3	CIB.UA23.L2.B1	true
4	CIB.UA23.L2.B2	true
5	CIB.TZ76.U7.B2	true
6	CIB.UA67.R6.B1	true
7	CIB.TZ76.U7.B1	true
8	CIB.UA67.R6.B2	true
9	CIB.USC55.R5...	true
10	CIB.USC55.L5...	true
11	CIB.UJ33.U3.B1	true
12	CIB.USC55.L5...	true
13	CIB.UJ33.U3.B2	true
14	CIB.SR8.INJ2.1	true
15	CIBDS.UA63.L6	true
16	CIB.UA63.L6.B1	true
17	CIB.UA43.L4.B2	true
18	CIB.UA43.L4.B1	true
19	CIB.UA63.L6.B2	true
20	CIB.US15.L1.B1	true
21	CIB.US15.L1.B2	true
22	CIB.SR2.INJ1.2	true
23	CIB.SR7.S7.B1	true
24	CIB.SR2.INJ1.1	true
25	CIB.SR7.S7.B2	true
26	CIB.SR8.INJ2.1	true
27	CIB.SR3.S3.B1	true
28	CIBDS.UA67.R6	true
29	CIB.SR3.S3.B2	true
30	CIB.UA27.R2.B2	true
31	CIB.UA27.R2.B1	true
32	CIB.UA83.L8.B2	true
33	CIB.UA83.L8.B1	true
34	CIB.CCR.LHC...	true
35	CIB.UA47.R4.B1	true
36	CIB.CCR.LHC...	true
37	CIB.UA47.R4.B2	true

FILTER

Beam_Permit_Loop Beam_Permit Local_Permit User_Permit User_Permit_Glitch Software Mask Masked_Permit

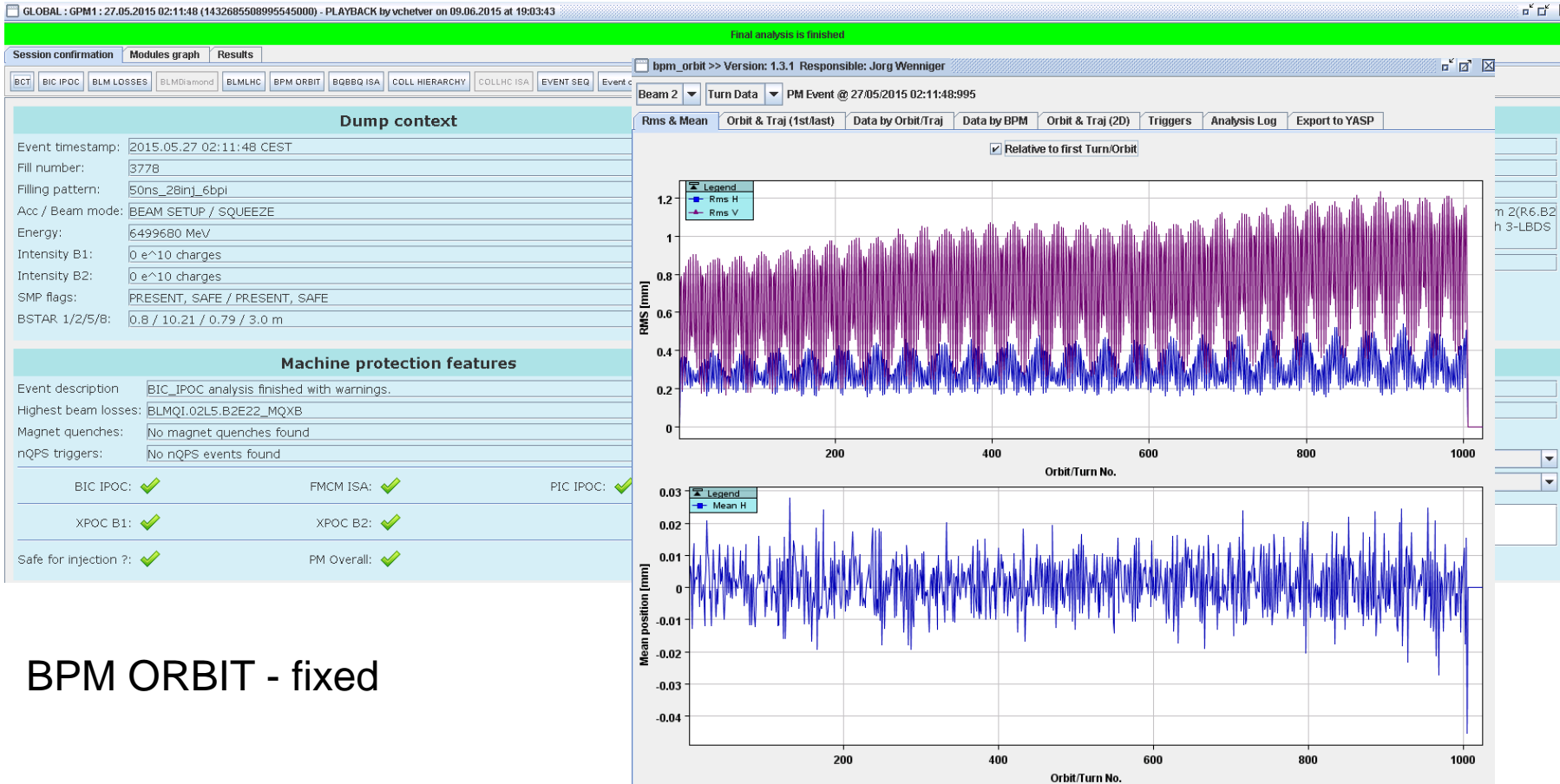
Disabled_Permit Channel_Enable Test Power Self_Test Time Safe_Beam_Flag Marker Injection_BICs

Channel A Channel B Beam 1 Beam 2 Generator CIBDS



Automatic PM analysis – BPM ORBIT module

Event with Beam dump triggered by losses at IP5 due to AC dipole excitation



BPM ORBIT - fixed

Post Mortem Analysis Results

Machine protection features		
Event description	BIC_IPOC analysis finished with warnings.	
Highest beam losses:		
Magnet quenches:	No magnet quenches found	
nQPS triggers:	No nQPS events found	
BIC IPOC:	FMCM ISA:	PIC IPOC:
XPOC B1:	XPOC B2:	
Safe for injection ?:	PM Overall:	

- System experts defined the specifications or implemented the modules BIC IPOC, FMCM ISA, PIC IPOC and XPOC B1/B2
- “Safe for injection ?” is a logical AND of BIC IPOC, FMCM ISA and PIC IPOC overall results
- PM Overall is false if nQPS or magnet quenches are present, or BIC, PIC and FMCM analysis results contains “INTERESTING_EQP”
- All details : <https://wikis.cern.ch/x/ZQNgAQ>

Changes during LS1

- BLM: data available for 1024 ms (vs 82 ms before LS1)
- Data acquisition
 - new library to support CMW-RDA3. Only internal changes and backward compatible API so far. Bigger upgrades to come end of the year.
- Storage:
 - no updates except following technology changes, e.g. from 32b to 64b architecture, and some bug fixes in the storage and its API.
- Analysis modules:
 - new Quench Heater Discharge Analysis module by Zinur, the rest of the modules were mostly kept the same, with some internal technology changes and/or optimization. Adaptation of energy extraction analysis modules by Arek for the 600A and 13kA circuits.

Automated Analysis of POWERING events

- Similar to Global (beam) Post Mortem, a PM_POWERING analysis server is continuously analysing events in the LHC magnet system
 - Automated event and source identification (global events)
 - 600A Energy Extraction + 13kA Energy extraction
 - 600A Quench Detection (trip identification,...)
 - Quench Heater Discharge Analysis
 - (MP3) logbook entries, automatic e-mails and PM Database (APEX)

LHC MPP [Saturday 23-May-2015 DAY]

Filters: EVT SOURCES LOCATION Clear

Event Timestamp: 23/05/15 02:01:28.547
 Circuit name: RQ10.L6
 Circuit type: IT
 Event category: FAST_POWER_ABORT
 Circuit current: 6647.4970703125

Advised Action: Fast Power Abort of main circuit, contact MSE standby service (and eventually as

LHC MPP LOCATION > Sector 2-3
 IT_RZ Called by OCC around 7:30. See OP Logbook for details
 Checked heaters discharge. Necessary to search manually for the reference curve (time stamp in)
 For DIS2, no QPS file. Reading analysis manual, this could be normal as it was during the ramp
 Found discharges during 2015 recommissioning and in 2012. Strange curves but seemed OK.
 Looking in Timers, DIS2 heaters have not discharged so far see OP for supporting.
 The origin is a quench in the HTS part of the current lead. This is likely caused by the loss of
 operator to complete the test. Protection by QPS was ensured

Post Mortem Database - Data Browser

User: ZERLAUTH Help

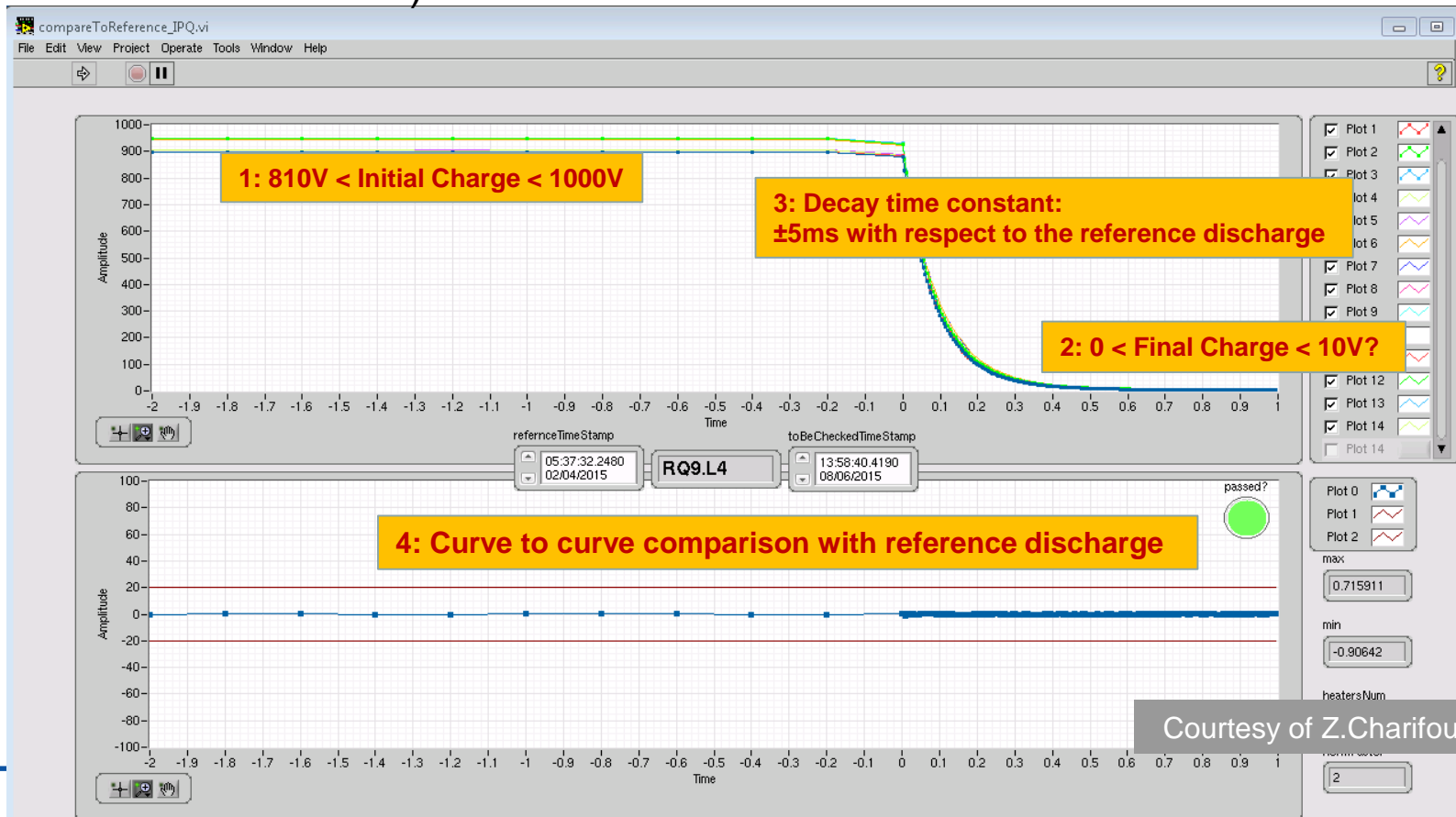
Global PM events Powering PM events Global statistics Fill Statistics MPS Statistics SEU Failure Count Events Data Analysis Data Raw Data

E.g. Heater firings after thunderstorms

Event	Timestamp	Circuit Name	Event Type	Event Source	Event Category	Circuit Current	Overall Result	Circuit Lock	Mps Exp Comment	Quench Type Name	Quench Description
08-JUN-2015	13.58.40.420000	RQ10.L6	SUBSECTOR_ABORT	YES	FAST_POWER_ABORT	-	NOT OK	YES	-	-	-
08-JUN-2015	13.58.40.417000	RQ10.L6	SUBSECTOR_ABORT	YES	FAST_POWER_ABORT	248.39915466308594	NOT OK	NO	-	QPS trip	Heater firing due to thunder-storm
08-JUN-2015	23.35.04.453000	RQ10.L6	NO_GLOBAL_EVENT	YES	IDLE	-	NOT OK	NO	-	-	-
08-JUN-2015	23.35.04.451000	RQ10.L6	NO_GLOBAL_EVENT	YES	IDLE	-	NOT OK	NO	-	QPS trip	Heater firing due to thunder-storm
06-JUN-2015	23.16.06.080000	RQ10.L6	SUBSECTOR_ABORT	NO	FAST_POWER_ABORT	100.00392150878906	OK	NO	-	-	-
05-JUN-2015	22.05.30.568000	RQ10.L6	SUBSECTOR_ABORT	NO	FAST_POWER_ABORT	248.43763732910156	OK	NO	-	-	-
05-JUN-2015	07.38.17.320000	RQ10.L6	SUBSECTOR_ABORT	NO	FAST_POWER_ABORT	100.00218963623047	OK	NO	-	-	-
27-MAY-2015	14.23.51.820000	RQ10.L6	NO_GLOBAL_EVENT	YES	POWERING_FAILURE	968.2384033203125	NOT OK	YES	-	-	-
02-MAY-2015	05.18.17.511482	RQ10.L6	SUBSECTOR_ABORT	NO	FAST_POWER_ABORT	3595.74368234375	OK	NO	-	-	-
24-APR-2015	16.57.21.697312	RQ10.L6	SUBSECTOR_ABORT	NO	FAST_POWER_ABORT	248.4078826904297	OK	NO	-	-	-

IPD, IPQ and IT circuits: quench heater analysis automation

- Quench heater discharge analysis (MB, MQ, IPQ, IPD, IT) will be fully automated after TS1
- Must increase efforts to systematically screen more powering equipment during operation (refactoring/generalisation and inclusion of HWC modules)



Courtesy of Z.Charifouline



Conclusions

- What is missing/nice to have?
 - dBLMs (Why? the only system for bunch-by-bunch loss detection – injection losses, dump losses, losses during scrubbing etc)
 - BPMS-IR6
 - Some data structures changed => time vector of the BCT_DC
 - Collimator time stamps (currently ~4 sec delay)
 - Review ***Event Classification***: SINGLE_SYSTEM_DUMP vs MULTIPLE_SYSTEM_DUMP
 - Review protection dump classification in case of operator button use.
- Are we ready?
 - Essential systems are fully back in operation
 - Some modules still need to be revised