



# LHC intensity cruise checklist

Yuancun NIE  
TE-MPE-PE

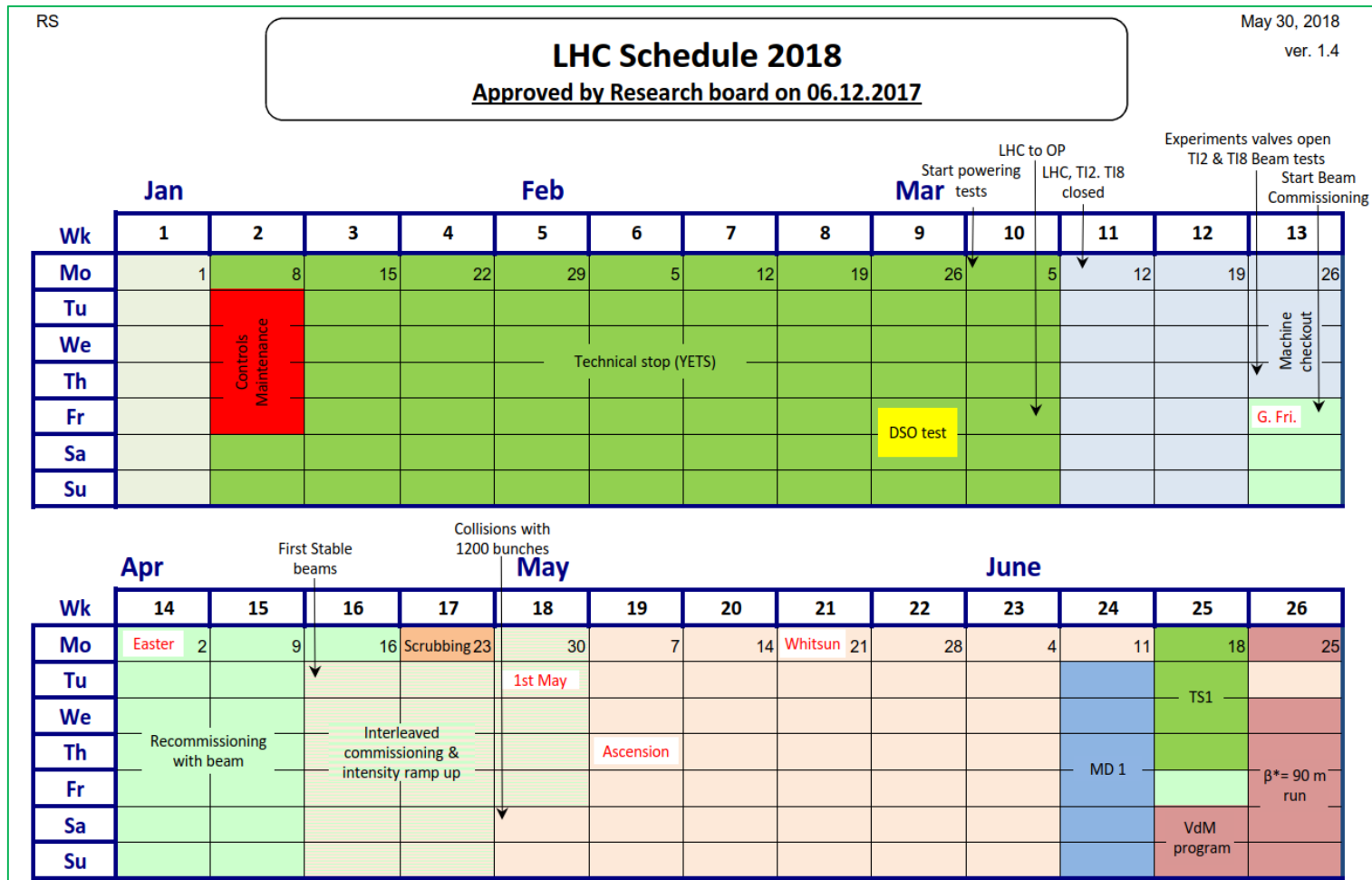
Acknowledgments:

D. Wollmann, M. Zerlauth, J. Uythoven, R. Schmidt, etc

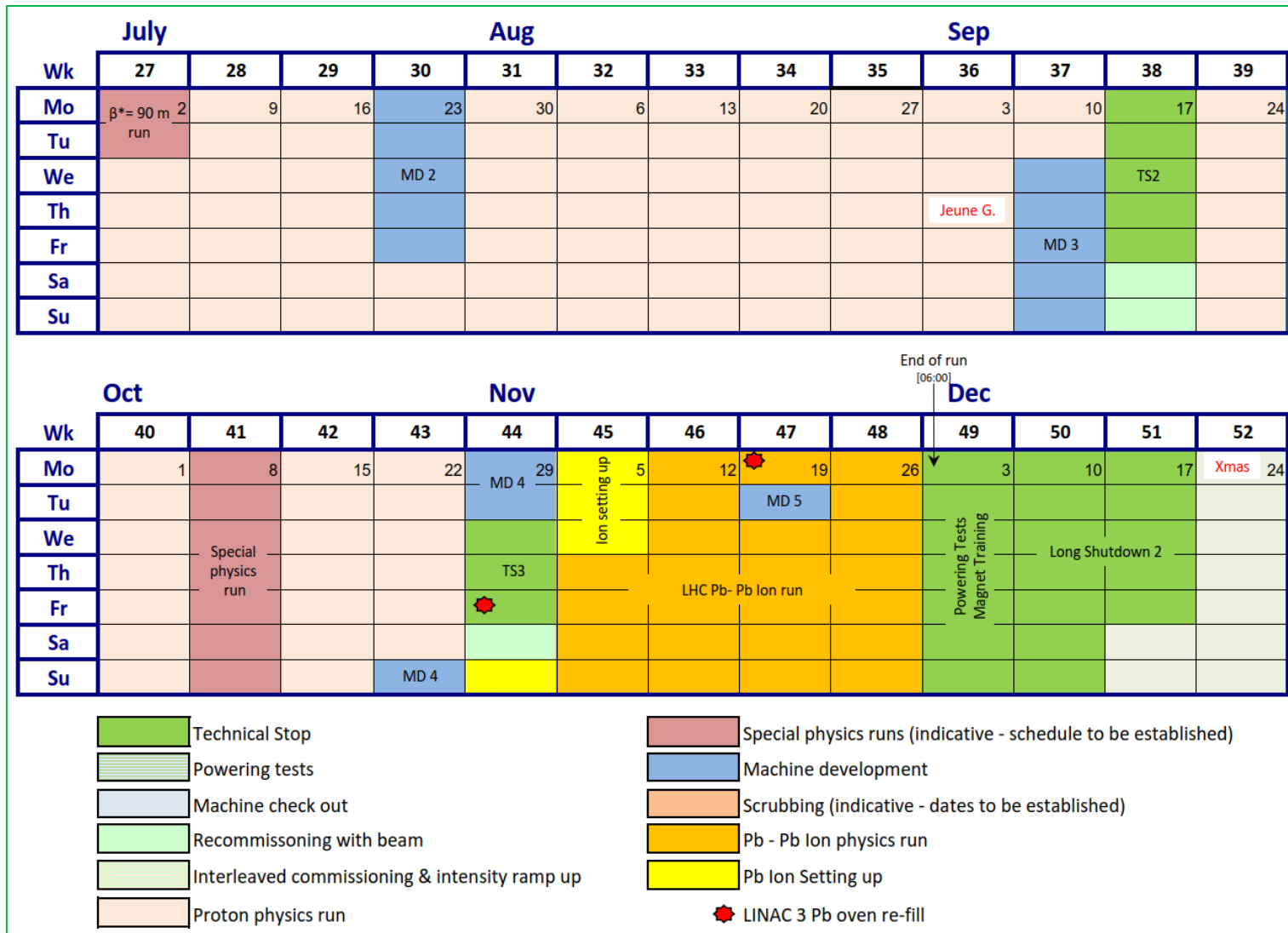
# Outline

- I. What is LHC intensity cruise checklist
- II. How to prepare a checklist
- III. Examples of beam dump
- IV. Conclusion

# I. What is LHC intensity cruise checklist



# I. What is LHC intensity cruise checklist



# I. What is LHC intensity cruise checklist

- Regular checklists during the LHC intensity cruise, in order to
  - Analyse and document the correct functionality and performance of the machine protection systems and other critical systems (magnet powering MP3, beam and powering interlocks, RF, BI, Collimation, Operation/orbit and feedbacks, Beam dump, Injection, Heating of equipment).
- Note that for the same purpose, intensity ramp-up checklists are needed during the restart after long technical stop (YETS)
- An example of checklist can be seen here:  
[LHCintensityCruiseJune2018](#)

# I. What is LHC intensity cruise checklist

- 8 intensity increase checklists during ramp up, from 17<sup>th</sup> April to 4<sup>th</sup> May 2018
- 2 intensity cruise checklists before TS1 (18<sup>th</sup>-21<sup>st</sup> June 2018)
- One checklist is under preparation for June-August 2018

LHC intensity increase check list for going from 3/12b to 75b - 25 ns o...	@ 1	Released	2018-04-19	Daniel WOLLMANN
LHC intensity increase check list for going from 75b to 300b - 25 ns o...	@ 1	Released	2018-04-21	Daniel WOLLMANN
LHC intensity increase check list for going from 300 to 600 bunches	@ 1	Released	2018-04-25	Markus ZERLAUTH
LHC intensity increase check list for going from 600b to 950b - 25 ns ...	@ 1	Released	2018-04-26	Daniel WOLLMANN
LHC intensity increase check list for going from 950b to 1200b - 25 ns	@ 1	Released	2018-04-28	Markus ZERLAUTH
LHC intensity increase check list for going from 1200b to 1800b - 25 ns	@ 1	Released	2018-04-30	Markus ZERLAUTH
LHC intensity increase check list for going from 1800b to 2100b - 25 ns	@ 1	Released	2018-05-02	Markus ZERLAUTH
LHC intensity increase check list for going from 2100b to 2556b - 25 ns	@ 1	Released	2018-05-04	Markus ZERLAUTH
LHC intensity cruise checklist May 2018	@ 1	Draft For Discussion	2018-06-05	YUANCUN NIE
LHC intensity cruise checklist June 2018	@ 1	Draft For Discussion	2018-07-16	YUANCUN NIE

## II. How to prepare a checklist: workflow

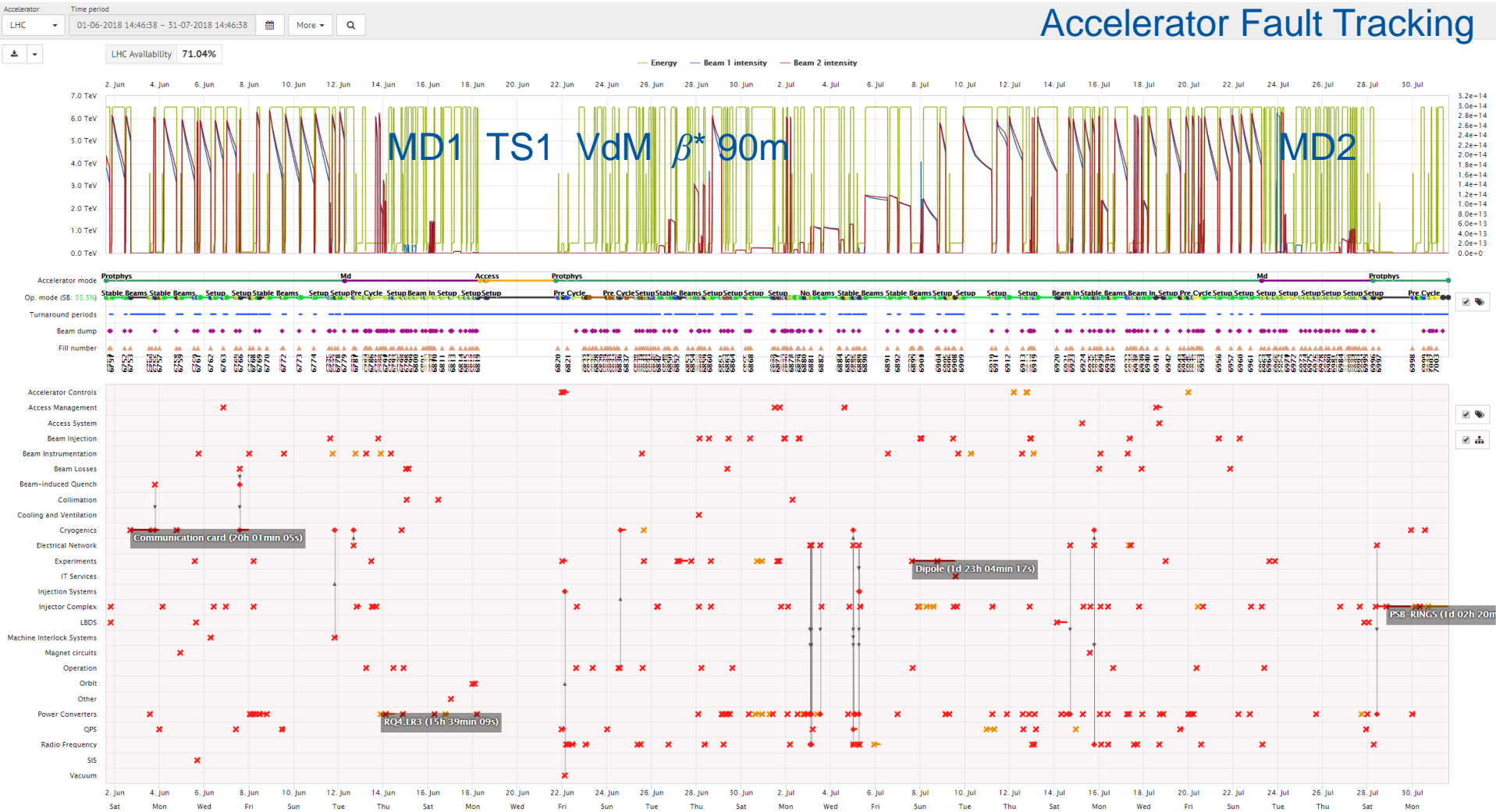
1. Period, Fills, Dump statistics → **MPP (global check)**
2. MP3, Interlocks, RF, BI, Collimation, Operation/orbit and feedbacks, Beam dump, Injection, Heating of equipment → **respective experts (comments, new failures/behaviours)**
3. Follow up and finally document/share with CERN colleagues via **EDMS:**

LHC Operation/Restricted Machine Protection Panel (rMPP)/Intensity Checklists



# II. How to prepare a checklist: tools

## Accelerator Fault Tracking



VdM: Van-der-Meer scan for luminosity scale calibration

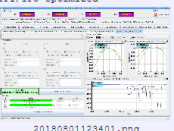
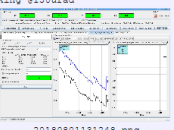




# II. How to prepare a checklist: tools

<http://elogbook.cern.ch>

LHC OP [Wednesday 01-Aug-2018 Morning]

Filters: EVT SOURCES | LOCATIONS | CIRCUITS | ACCESS | INFO | OPERATION | PIQUETS | EXPERTS | BEAM

#	Time	PROTON PHYSICS	Comment
1	07:01	1	Ron & Matte
2	07:10	1	Cryo asked to postpone the dump. They have presently some issues to regulate the BS cooling with 600 b, due to the "missing" compressor in P8
3	08:45	1	We postpone the dump to around midday
4	09:55	1	PX24 put in maintenance mode.
5	12:33	1	IP1/IP8 optimized  20180801123401.png
6	13:11	1	Continuous Xing angle levelling stopped. We'll do the last 2 urad manually to anticipate the beta* levelling
7	13:12	1	LHC SEQ: IP1/IP8 TCTs THRESHOLDS TIGHTENED FOR BETA STAR LEVELLING
8	13:12	1	Xing @130ured  20180801131248.png
9	13:22	1	beta* = 25 cm  20180801132304.png 20180801132310.png
10	13:23	1	Optimization 

19	14:15	1	Global Post Mortem Event Event Timestamp: 01/08/18 14:15:02.586 Fill Number: 7005 Accelerator / beam mode: PROTON PHYSICS / STABLE BEAMS Energy: 6499200 [MeV] Intensity B1/B2: 4635 / 4627 [e <sup>10</sup> charges] Event Category / Classification: PROGRAMMED_DUMP / MULTIPLE_SYSTEM_DUMP First BIC input Triggered: First USR PERMIT change: Ch 1-Programable Dump bl: B T -> F on CIB.CCR.LHC.B1
20	14:15	1	Global Post Mortem Event Confirmation Dump Classification: Programmed Dump Operator / Comment: gtrad / Programmed End of the ~600b fill (trains of 12 b)

# II. How to prepare a checklist: tools

<http://lhc-postmortem.web.cern.ch/lhc-postmortem/>



Post Mortem Database - Data Browser

User: YNIE Help

Logout

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

Go Actions

Event Timestamps in the last 1 months

## Post-Mortem Event Database

Event Timestamp	Fill Number	Beam Energy [MeV]	Intensity_B1 [1e10]	Intensity_B2 [1e10]	Stable Beams [hours]	Fill Luminosity [nb <sup>-2</sup> .s]	Mps_Dump_Cause	Mps_First_Detection	Mps_Experit_Comment	Injection_Scheme
01-JUL-2018 20:51:31.698927	6871	6499200	8	9	0	0	Beam Loss	BLM	Off-momentum loss map at Flat Top, nominal cycle, RF trim -500Hz. MPS dump cause: Beam Loss?	2nominals_10pilots_lossmaps_coll_allIPs
01-JUL-2018 22:16:01.989000	6872	449880	135	1834	0	0	-	-	-	25ns_2460b_2448_2052_2154_144bpl_19injv2
01-JUL-2018 23:08:06.689000	6873	450000	136	136	0	0	-	-	-	25ns_2460b_2448_2052_2154_144bpl_19injv2
01-JUL-2018 23:47:23.883000	6873	449880	2097	2104	0	0	-	-	-	25ns_2460b_2448_2052_2154_144bpl_19injv2
02-JUL-2018 01:43:40.746000	6874	6499200	27180	27052	.285	24.027538	PC	PIC	Dump of fill with 2460b in stable beam by PC trip of RQTL9.R7B1. Clean dump.	25ns_2460b_2448_2052_2154_144bpl_19injv2
02-JUL-2018 05:23:01.961000	6875	450000	26732	27435	0	0	-	-	-	25ns_2460b_2448_2052_2154_144bpl_19injv2
02-JUL-2018 07:33:04.463000	6877	450000	0	0	0	0	-	-	-	100ns_86b_84_0_0_18bpl_7inj
02-JUL-2018 12:36:22.746000	6877	6499200	734	727	2.5	19.069658	EOF	OK	Operator dump of first ramp-up fill with 90m and 100ns bunch spacing. Clean dump.	100ns_86b_84_0_0_18bpl_7inj
02-JUL-2018 14:27:49.889000	6878	449880	17	9	0	0	-	-	-	100ns_302b_300_0_0_72bpl_7inj
02-JUL-2018 14:40:45.089000	6879	450000	9	9	0	0	-	-	-	100ns_302b_300_0_0_72bpl_7inj
02-JUL-2018 14:52:18.689000	6879	450000	9	9	0	0	-	-	-	100ns_302b_300_0_0_72bpl_7inj
02-JUL-2018 19:30:54.595889	6879	6499200	2161	2124	2.72	44.261982	EOF	OK	Second ramp-up fill for 90m with 100ns bunch spacing. Clean dump	100ns_302b_300_0_0_72bpl_7inj
03-JUL-2018 02:40:13.533000	6880	450000	5496	5491	0	0	-	-	-	100ns_734b_732_0_0_72bpl_13inj
03-JUL-2018 03:59:38.999000	6881	450000	0	0	0	0	-	-	-	100ns_734b_732_0_0_72bpl_13inj
03-JUL-2018 13:29:50.504690	6881	6499200	5191	4882	6.34	218.93726	EL Net	FMCM	Fill dumped by electrical glitch affecting FMCM on exchanged RD1 LR5. Clean dump.	100ns_734b_732_0_0_72bpl_13inj
04-JUL-2018 08:54:14.999000	6882	6499200	4873	4904	15	511.0395	EOF	OK	Programmed dump at the end of fill with 734b in 90m run. Clean dump.	100ns_734b_732_0_0_72bpl_13inj
04-JUL-2018 14:34:58.376989	6884	6499200	2724	2705	2.24	72.547325	EOF	OK	Programmed dump of 90m 50ns fill with 302b in stable beam. Clean dump.	50ns_302b_300_70_63_72bpl_7inj
05-JUL-2018 00:20:22.199000	6885	6499200	5943	5762	2.12	136.27235	EL Net	FMCM	Dump of 90m 50ns fill with 734b just before the programmed dump due to electrical glitch. Clean dump.	50ns_734b_732_284_398_144bpl_11inj
05-JUL-2018 06:31:14.919000	6887	450000	1188	97	0	0	-	-	-	50ns_1452b_1450_21_1128_144bpl_11inj
06-JUL-2018 13:01:18.415364	6890	6499200	10893	11165	22.9	1705.5411	EOF	OK	Programmed dump of fill with 1452b. Clean dump.	50ns_1452b_1450_21_1128_144bpl_11inj
06-JUL-2018 23:50:19.087980	6891	6499080	11264	11169	7.45	924.52167	PC	WIC	Dump due to spurious trip of RMSD LR6B2. Clean dump.	50ns_1452b_1450_21_1128_144bpl_11inj
07-JUL-2018 14:02:20.346000	6892	6499200	9568	9553	11.3	1036.8818	EOF	OK	Programmed dump of 50ns fill with 1452b. Clean dump.	50ns_1452b_1450_21_1128_144bpl_11inj
07-JUL-2018 15:52:13.787000	6893	450000	0	0	0	0	-	-	-	2nominals_10pilots_RomanPot_Alignment
07-JUL-2018 16:28:07.889000	6894	450000	0	0	0	0	-	-	-	2nominals_10pilots_RomanPot_Alignment
08-JUL-2018 00:15:52.289000	6896	450000	130	1628	0	0	-	-	-	25ns_2460b_2448_2052_2154_144bpl_19injv2
08-JUL-2018 01:00:14.674000	6898	450000	18996	9423	0	0	-	-	-	25ns_2460b_2448_2052_2154_144bpl_19injv2
08-JUL-2018 01:59:24.689000	6900	450000	11272	1798	0	0	-	-	-	25ns_2460b_2448_2052_2154_144bpl_19injv2
08-JUL-2018 18:20:13.404364	6901	6499080	6663	6822	14.3	233221.16	EOF	OK	Programmed dump of 25ns fill with 2460b to refill for physics. Clean dump.	25ns_2460b_2448_2052_2154_144bpl_19injv2



# II. How to prepare a checklist: tools

Operational Configuration: LHCOP

Wednesday, 1 August 2018 16:28

## Post-Mortem Event Playback via CCM

Fast analysis is confirmed

Session confirmation Modules graph Results

BCT BIC IPOC BLM LOSSES BLMdiamond BLM LHC BPM ORBIT BOBBO ISA COLL HIERARCHY COLL LHC ISA EVENT SEQ Event overview FGC DATA RED FMCM ISA PIC IPOC PM EVENT POWER LOSS RF SIS SMP SMP IPOC

### Dump context

Event timestamp: 2018.07.02 01:43:40 CEST  
 Fill number: 6874  
 Filling pattern:  
 Acc / Beam mode: PROTON PHYSICS / STABLE BEAMS  
 Energy: 6499200 MeV  
 Intensity B1: 27180 e<sup>10</sup> charges  
 Intensity B2: 27052 e<sup>10</sup> charges  
 SMP flags: PRESENT, STABLE, MOVEABLE / PRESENT, STABLE, MOVEABLE  
 BSTAR: 1/2/5/B: 0.3 / 10.0 / 0.3 / 3.0 m

### Machine protection

Event description: BIC\_IPOC analysis finished with warnings. Possible magnet quenches.  
 Highest beam losses: BLMTI.04L6.B1E10\_TCDSA.4L6.B1 BLMTI.04R6.B2I10\_TCDSA.4R6.B2  
 Magnet quenches: RQTL9.R7B2; RQTL9.R7B1; RQTL10.R7B1; RQTL10.R7B2  
 nQPS triggers: No nQPS events found

BIC IPOC:  FMCM ISA:   
 XPOC B1:  XPOC B2:   
 Safe for injection?:  PM Overall:

### Event sequence

Event category: PROTECTION\_DUMP  
 Event classification: MULTIPLE\_SYSTEM\_DUMP  
 Event sequence: First USR\_PERMIT change: Ch 13-PIC\_MSK Right: B T -> F on CIB.TZ76.U7.B1  
 Triggered BIC inputs: Ch 13-PIC\_MSK Right(U7.B1), Ch 13-PIC\_MSK Right(U7.B2), Ch 12-PIC\_MSK Left(U7.B1), Ch 12-PIC\_MSK Left(U7.B2), Ch 6-CIBDS Beam 2(R.6.B2), Ch 6-CIBDS Beam 2(L.6.B1), Ch 7-LPDC b2 (Trapez)(L.6.B1), Ch 7-LPDC b1 (Trapez)(L.6.B1), Ch 11-PLM\_MSK(L.6.B1), Ch 11-PLM\_MSK(R.6.B2)

### Machine protection

ipm\_orbit >> Version: 3.0.0 Responsible: Jorg Wenniger  
 Turn Data PM Event @ 02:07/2018 01:43:40:746

Rms & Mean Orbit & Traj (1st last) Data by Orbit/Traj Data by BPM Orbit & Traj (2D) Relative to first Turn/Orbit

RMS (mm) vs Orbit/Turn No. (0 to 500). Legend: Rms H (blue), Rms V (purple). Values are low, around 0.005 mm.

Mean position (mm) vs Orbit/Turn No. (0 to 500). Legend: Mean H (blue), Mean V (purple). Shows oscillations between -0.005 and 0.005 mm.

### bin\_blnhlc >> Version: 1.0.19 Responsible: Fabio Follin

Unit: Grays Scale: Log Integration Time: 40 us Losses: Max Display: Equation

Octant Filter Sectors Filter Dump Filter List Filter Regex Filter Beam Permit Filter

Filter (3601 / 3953)

Monitor	40 us	80 us	320 us	640 us	2560 us	10 ms	82 ms	855 ms	1.3 s	5.2 s	20.9 s	83.8 s	Type	Section	Left RL	Octant	Beam	
BLMTI.04L6.B1E10_TCDSA.4L6.B1	Dump	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	<input checked="" type="checkbox"/> IC	<input checked="" type="checkbox"/> LSS	<input checked="" type="checkbox"/> Left	<input checked="" type="checkbox"/> 1	<input checked="" type="checkbox"/> 5	<input checked="" type="checkbox"/> Beam 1
BLMTI.04R6.B2I10_TCDSA.4R6.B2	Dump	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	<input checked="" type="checkbox"/> PIC	<input checked="" type="checkbox"/> SEM	<input checked="" type="checkbox"/> DS	<input checked="" type="checkbox"/> 3	<input checked="" type="checkbox"/> 6	<input checked="" type="checkbox"/> Beam 2
													<input type="checkbox"/> Diamond	<input type="checkbox"/> Silicon	<input checked="" type="checkbox"/> ARC	<input checked="" type="checkbox"/> 4	<input checked="" type="checkbox"/> 8	<input checked="" type="checkbox"/> Centre

02.07.2018 01:43:41

### Losses

Losses (Grays) vs Time [sec]. Shows octants 1-8 and monitors. Y-axis is logarithmic from 0.001 to 100.

### Monitor Losses versus Time

Total Losses = 30.1402 [Grays]

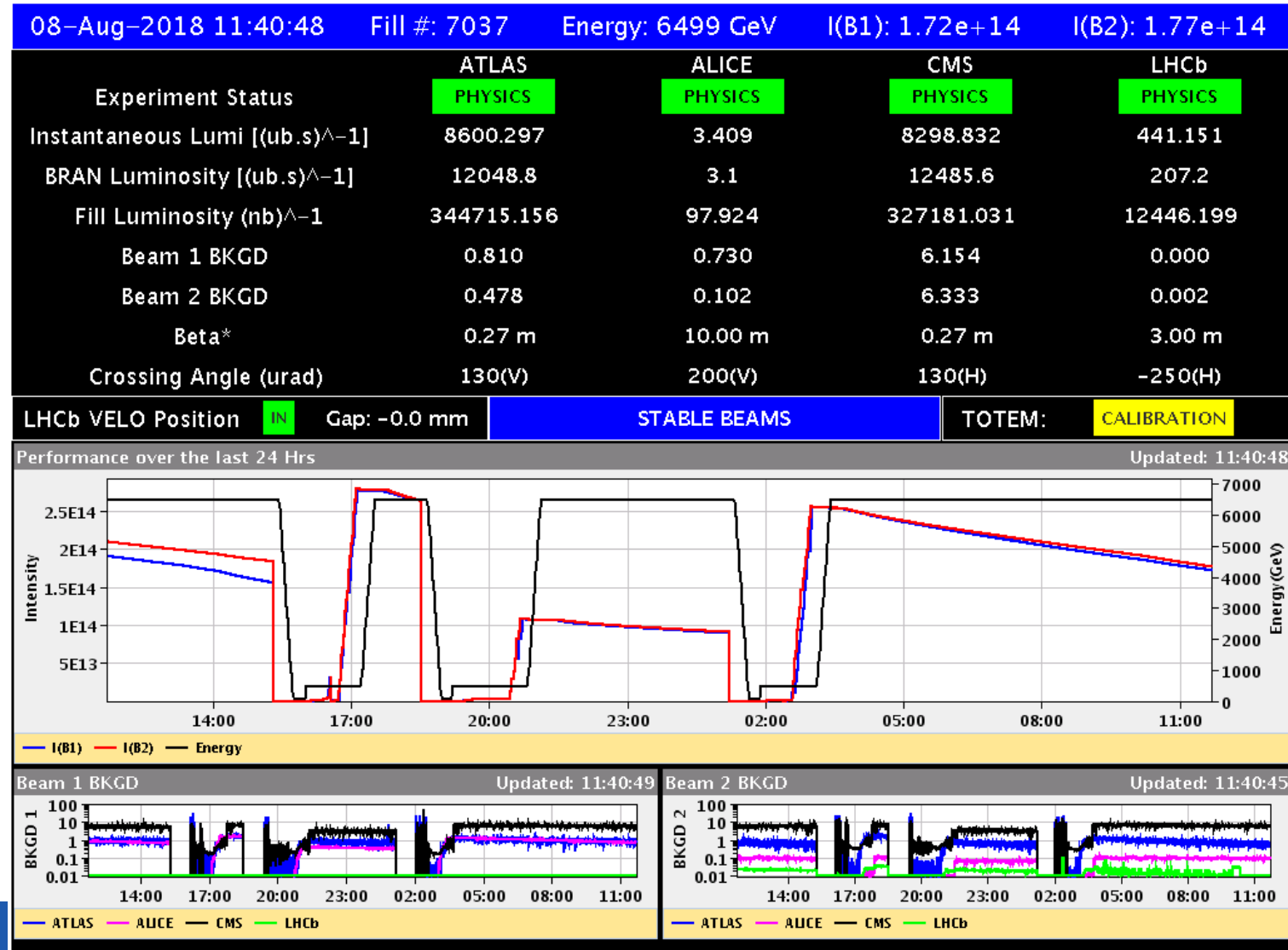
Losses (Grays) vs Time [sec]. Shows losses for monitor BLMTI.04R6.B2I10\_TCDSA.4R6.B2. Y-axis is linear from 0 to 0.35.

Start Time: 1.018E00 [sec] End Time: 1.024E00 [sec]  
 Show Dump Indicators  Show Labels  Display Optics Elements  Use DCUM



## II. How to prepare a checklist: tools

<https://op-webtools.web.cern.ch/vistar/vistars.php?usr=LHC3>



## II. How to prepare a checklist: tools

### LHC morning meetings -Beam operation - WEEK 31 - 30.07-05.08 2018

30 Jul 2018, 07:00 → 5 Aug 2018, 17:00 Europe/Zurich

874/1-011 (CERN)

Jorg Wenninger (CERN), Rende Steerenberg (CERN)

#### MONDAY, 30 JULY

08:30 → 08:50 **Beam operation**

2018.07.30-mornin... 2018.07.30-mornin... MD#2 2018 first res... MD#2 2018 first res...

#### TUESDAY, 31 JULY

08:30 → 08:50 **Beam operation**

2018.08.01-mornin... 2018.08.01-mornin... LHC\_MKBVflashove... LHC\_MKBVflashove...

#### WEDNESDAY, 1 AUGUST

08:30 → 08:50 **Beam operation**

2018.08.01-mornin... 2018.08.01-mornin...

#### FRIDAY, 3 AUGUST

08:30 → 08:50 **Beam operation** 20m

#### August 2018

- 27 Aug - 02 Sep LHC morning meetings -Beam operation - WEEK 35 - 27.08-02.09 2018
- 20 Aug - 26 Aug LHC morning meetings -Beam operation - WEEK 34 - 20.08-26.08 2018
- 13 Aug - 19 Aug LHC morning meetings -Beam operation - WEEK 33 - 13.08-19.08 2018
- 06 Aug - 12 Aug LHC morning meetings -Beam operation - WEEK 32 - 06.08-13.08 2018

#### July 2018

- 30 Jul - 05 Aug LHC morning meetings -Beam operation - WEEK 31 - 30.07-05.08 2018
- 23 Jul - 29 Jul LHC morning meetings -MD2 - WEEK 30 - 23.07-29.07 2018
- 16 Jul - 22 Jul LHC morning meetings -Beam operation - WEEK 29 - 16.07-22.07 2018
- 09 Jul - 15 Jul LHC morning meetings -Beam operation - WEEK 28 - 09.07-15.07 2018
- 02 Jul - 08 Jul LHC morning meetings -Beam operation - WEEK 27 - 02.07-08.07 2018

#### June 2018

- 25 Jun - 01 Jul LHC morning meetings -Beam operation - WEEK 26 - 25.06-01.07 2018
- 18 Jun - 24 Jun LHC morning meetings -TS1 & recovery - WEEK 25 - 18.06-24.06 2018
- 11 Jun - 17 Jun LHC morning meetings - Beam operation / MD1 - WEEK 24 - 11.06-17.06 2018
- 04 Jun - 10 Jun LHC morning meetings - Beam operation - WEEK 23 - 04.06-10.06 2018

#### May 2018

- 28 May - 03 Jun LHC morning meetings - Beam operation - WEEK 22 - 28.05-03.06 2018
- 21 May - 27 May LHC morning meetings - Beam operation - WEEK 21 - 21.05-27.05 2018
- 14 May - 20 May LHC morning meetings - Beam operation - WEEK 20 - 14.05-20.05 2018
- 07 May - 13 May LHC morning meetings - Beam operation - WEEK 19 - 07.05-13.05 2018

#### April 2018

- 30 Apr - 06 May LHC morning meetings - Beam operation - WEEK 18 - 30.04-06.05 2018
- 23 Apr - 29 Apr LHC morning meetings - Beam operation - WEEK 17 - 23.04-29.04 2018

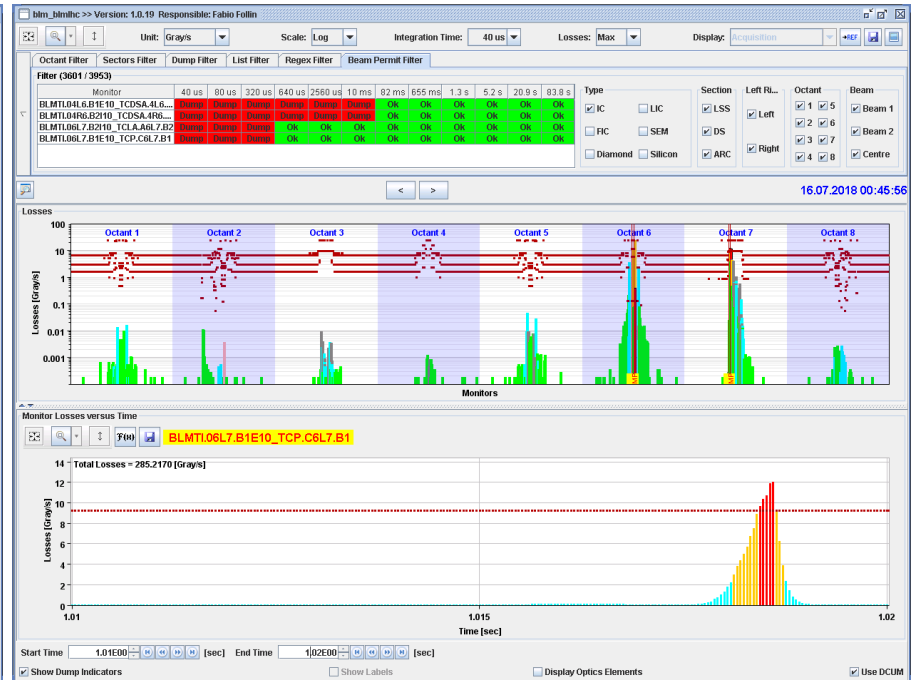
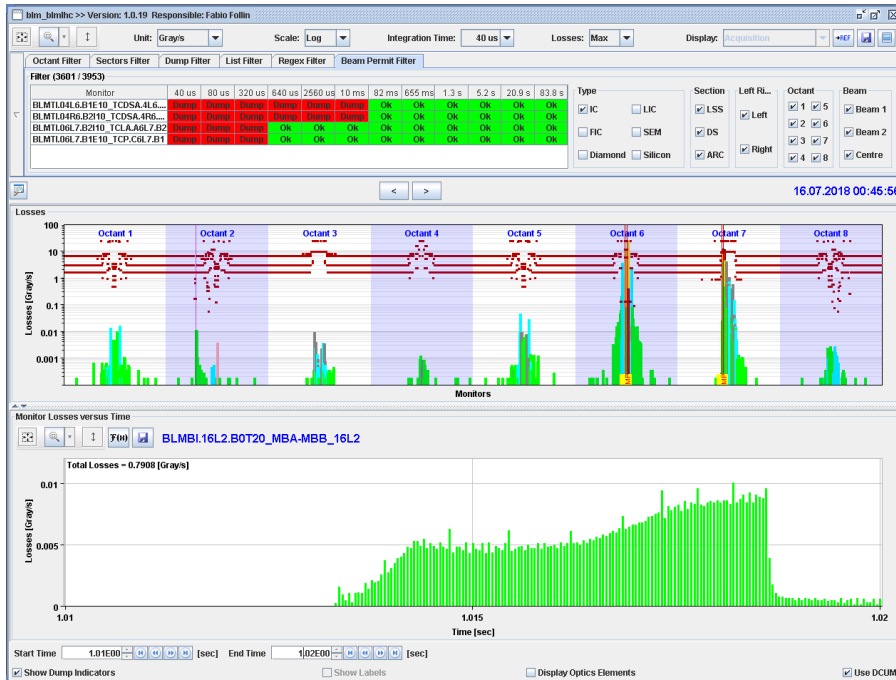
### III. Examples of beam dump: UFOs at top energy

Event Timestamp	Fill Number	Mps Expert Comment	Mps First Detection	Mps Dump Cause
06-MAY-2018 09.46.28.715000	6647	UFO in triplet R1, triggered dump by ATLAS_DET. Clean dump.	EXP	UFO
15-MAY-2018 02.57.41.764903	6683	16L2 event with 2556b at 6.5 TeV, B1, very fast (~3ms), dumped in IP7. Clean dump.	BLM	UFO
31-MAY-2018 16.51.55.236000	6746	16L2 B1 (2556b) @ 6.5TeV during squeeze, ~10ms, dumped in IP7. Clean dump.	BLM	UFO
07-JUN-2018 14.35.51.879000	6765	Large-UFO induced quench of A22R3, subsequent quench of B22R3 and C22R3 due to magnetic coupling, and subsequent quench of 5 other magnets (3 dipoles, 2 quads) at lower current due to heat propagation. Total of 8 magnet quenches (1 beam induced). About 12h cryo recovery. (during RAMP @ 6.4 TeV)	BLM	UFO
16-JUL-2018 00.45.56.199827	6927	16L2 B1 (2556b) @ 6.5 TeV, ~5 ms, dumped in IP7. Clean dump.	BLM	UFO
17-JUL-2018 22.07.21.108775	6938	Dumped by 16L2 losses when squeezing down, due to a small UFO in 16L2, ~20 ms, B1. Clean dump.	BLM	UFO
21-JUL-2018 21.17.09.546000	6956	Dumped by small UFO in IR8 and LHCb. Fast losses at the experiment (LHCb_DET) triggered the interlock, not the ring BLMs. Clean dump.	EXP	UFO
07-AUG-2018 18.31.17.111935	7035	16L2 B1 (2556b) @ 6.5TeV, ~5ms, dumped in IP7. Clean dump.	BLM	UFO

- Mostly UFO type II (16L2), also UFO type I
- In the 16L2 events, beam usually dumped by losses at IP7, and occasionally by losses at 16L2 (Fill #6938)
- UFOs can result in beam dump, and occasionally magnet quenches

# III. Examples of beam dump: UFOs at top energy

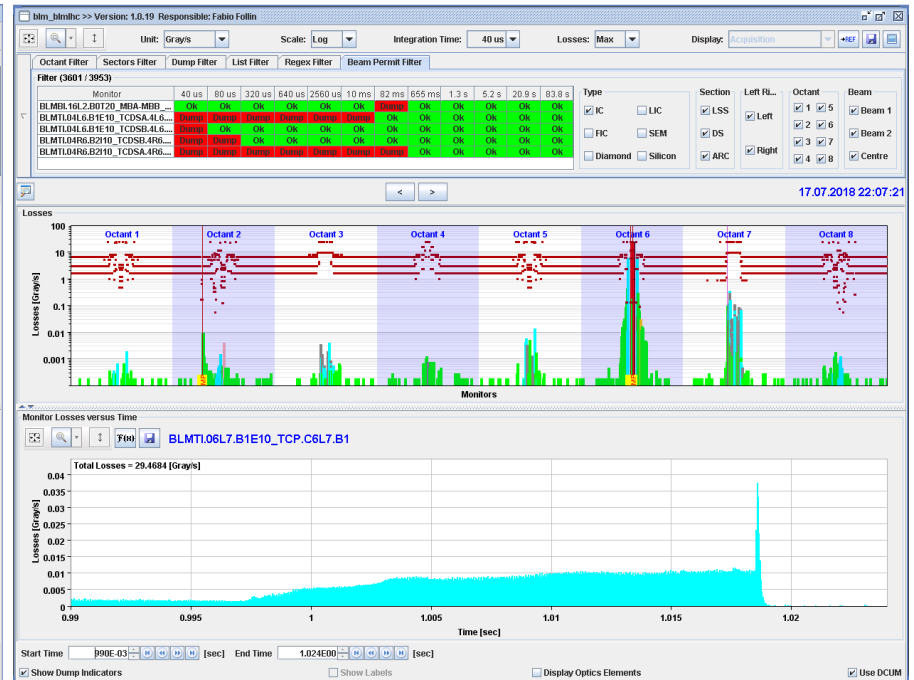
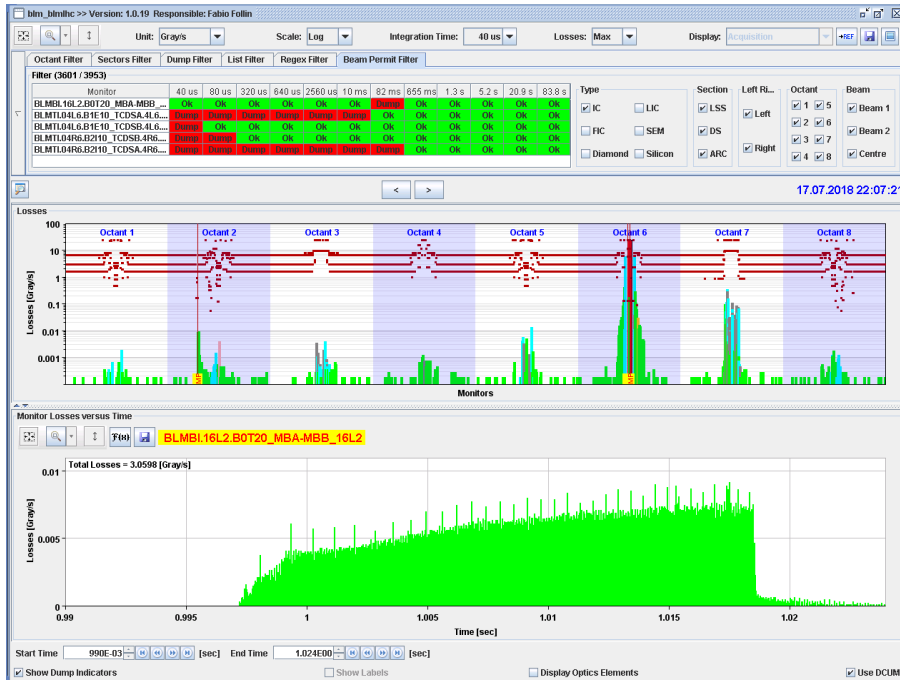
Event Timestamp	Fill Number	Mps Expert Comment	Mps First Detection	Mps Dump Cause
16-JUL-2018 00.45.56.199827	6927	16L2 B1 (2556b) @ 6.5 TeV, ~5 ms, dumped in IP7. Clean dump.	BLM	UFO





# III. Examples of beam dump: UFOs at top energy

Event Timestamp	Fill Number	Mps Expert Comment	Mps First Detection	Mps Dump Cause
17-JUL-2018 22.07.21.108775	6938	Dumped by 16L2 losses when squeezing down, due to a small UFO in 16L2, ~20 ms, B1. Clean dump.	BLM	UFO



# III. Examples of beam dump: EL Net at top energy

Event Timestamp	Fill Number	Mps Expert Comment	Mps First Detection	Mps Dump Cause
15-JUL-2018 19.01.07.941718	6925	Dumped by FMCM of RQ4.LR3 due to glitch on the 400 kV network, which tripped many circuits in all sectors: IT.R1 quenched and also Q10.L2 and Q8.R8; RF line M2B2 tripped as well. Clean dump.	FMCM	EL Net

**Session Details:**  
 Event timestamp: 2018.07.15 19:01:07  
 Fill number: 6925  
 Acc / Beam mode: PROTON PHYSICS / 6.499200 MeV  
 Intensity B1: 24539 e<sup>+</sup>10 charges  
 Intensity B2: 24979 e<sup>+</sup>10 charges  
 SMP flags: PRESENT, STABLE, N  
 BSTAR 1/2/5/6: 0.3 / 10.0 / 0.3 / 3.0

**System Selection:**  
 FMCMs: C/F SR2 RD34, C/F SR3 RQ4, C/F SR3 RQ5, C/F SR7 RD34, C/F SR7 RQ4, C/F SR7 RQ5, C/F UA27 REB., C/F UA27 REB., C/F UA87 RMEDB1, C/F UA87 RMEDB2, C/F US192 RD1, C/F US055 RD1

**Amplitude vs Time Plot:**  
 Shows amplitude (0 to 16) over time (19:01:07.880 to 19:01:07.960). A red line indicates the dump threshold, which rises sharply at approximately 19:01:07.941. A vertical dashed line marks the 'Self Trigger' event.

**V(t) vs Time Plot:**  
 Shows V(t) (250 to 520) over time (19:00:40.000 to 19:01:30.000). A sharp peak is visible at approximately 19:01:07.941, labeled 'FMCM Trigger'. A horizontal dashed line indicates the 'I-Meas @ Trigger' level.

**Field Values:**

Field	Value
I-DiForm Excess	15.2558
I-DiForm	SELF_TRIGGEO
I-Sim	SELF_TRIGGEO
U-Mag	ONLINE
Warning Thres.	OK
Dump Threshold	OK
Triggering Cha.	1A 1B 2A 2B

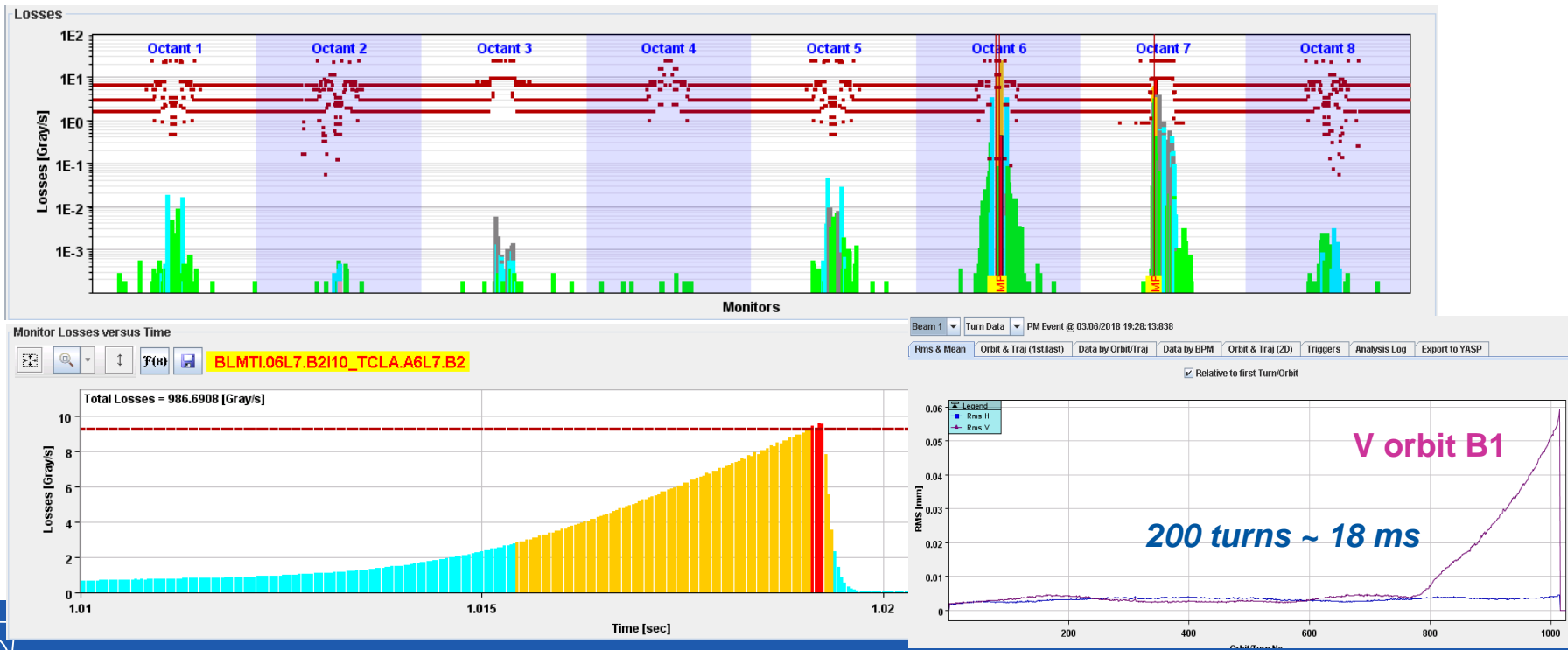
**Field Values (V(t) plot):**

Field	Value
V-Peak	521.3168
I@Trigger	518.6517
d@T	1.8734E-4
V@Trigger	272.7984
WIC @Trigger	-
WIC @T	-
WIC V@Trigger	-



# III. Examples of beam dump: magnet quenches

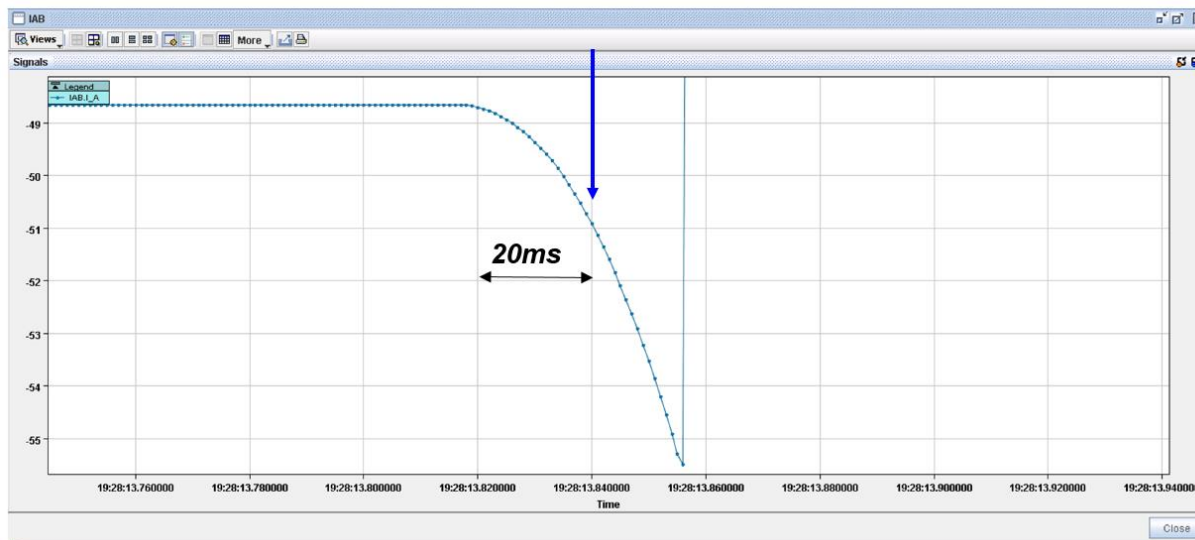
Event Timestamp	Fill Number	Mps Expert Comment	Mps First Detection	Mps Dump Cause
01-JUN-2018 01.11.40.289000	6748	Injection losses triggered quench heater firing on dipole B8L2 (2 QH first, followed 200ms later by the second two after detection of quench by QPS).	BLM	Transv. beam instability
03-JUN-2018 19.28.13.838000	6755	The vertical orbit of B1 drifted by 60 um rms leading to a dump by BLMs @6.5 TeV. Quench of ITR1, but first trigger sent by BLM in point 7. No local losses at ITR1. The quench heaters were fired on triplet R1 with a PIC interlock arriving ~17 ms after the dump. 20 ms before the dump a current decay could be observed on RTQX1.R1, which is likely responsible for the trigger of the QPS.	BLM	Cryo



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*Dump by BLMs*



**MP3:** symmetric quench in Q1 due to the collision debris in ATLAS leading to loss of cryo condition.

[LHC morning meeting, 4<sup>th</sup> June 2018]

## IV. Conclusion

- LHC intensity ramp-up and cruise checklists are important to make sure the correct functionality and performance of the critical systems relating to machine protection.
- It is a daily work to prepare/organize regular checklists during the LHC intensity cruise. Main efforts are put at top energy (6.5 TeV), but also at injection/ramp when important thing happens (magnet quenches, UFOs, etc).
- This is an efficient way to cooperate with many system experts, to run the complex machine safely, to detect new failure scenarios/behaviours, and to explore new mitigation methods of failures for the existing and future machines.



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