



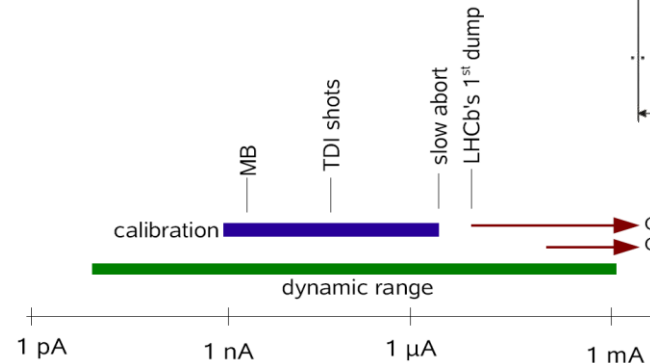
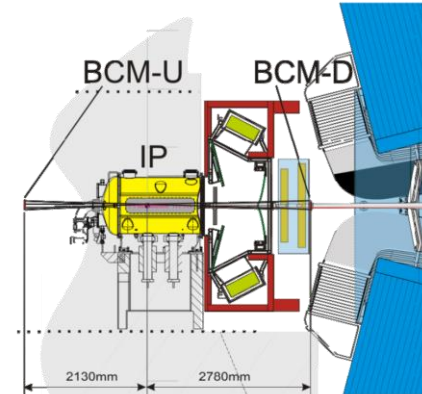
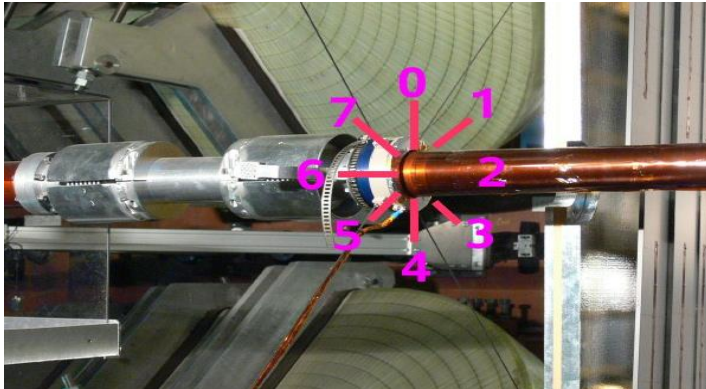
LHCb report on UFO induced dumps 2016

*F. Alessio, CERN
BLMTWG, 28-02-2017*

LHCb main dump system BCM

Beam Condition Monitor (BCM) – Main LHCb Life Guard

- 2 stations (Upstream/Downstream) of 8 diamonds (CVD) each 5/4cm from beam axis
 - $z = -2.131$ m (U) and $z = +2.765$ m (D)
- 40us integration.
 - Computed Running Sums: **RS1 over 40 us and RS32 over 1280 us**



- System has no dependence on control/software
 - Immediately operational on power-up
 - Reset after dump normally by software but may be done with hardware
- Beam permit (Injection Permit) is false for O(2-3 min) after PM



LHCb BCM dump logic and thresholds

– Dump logic:

- 3 adjacent diamonds with RS1 above threshold for two frames (RS2)
 - Exclude triplet (6,7,0) as known to be noisy
 - Ignore RS2 when in injection
- sum of all RS32 diamonds above threshold
 - Exclude lowest and two highest RS32

– Thresholds:

- RS1
 - BCM-D: 500 (2600 nA, 2130)
 - » $(500 \times 5.2 \text{ nA}) / (34 \text{ MIP} \times (36 \text{ pA/MIP}))$, 72k MIP*
 - BCM-U: 500 (10100 nA, 8274)
 - » $(500 \times 20.2 \text{ nA}) / (34 \text{ MIP} \times (36 \text{ pA/MIP}))$, 72k MIP*
- RS32
 - BCM-D: 100 (83200 nA, 68157)
 - » $(100 \times 5.2 \text{ nA} \times 32 \times 5) / (34 \text{ MIP} \times (36 \text{ pA/MIP}))$, 2.3M MIP*
 - BCM-U: 100 (323200 nA, 264765)
 - » $(100 \times 20.2 \text{ nA} \times 32 \times 5) / (34 \text{ MIP} \times (36 \text{ pA/MIP}))$, 2.3M MIP*

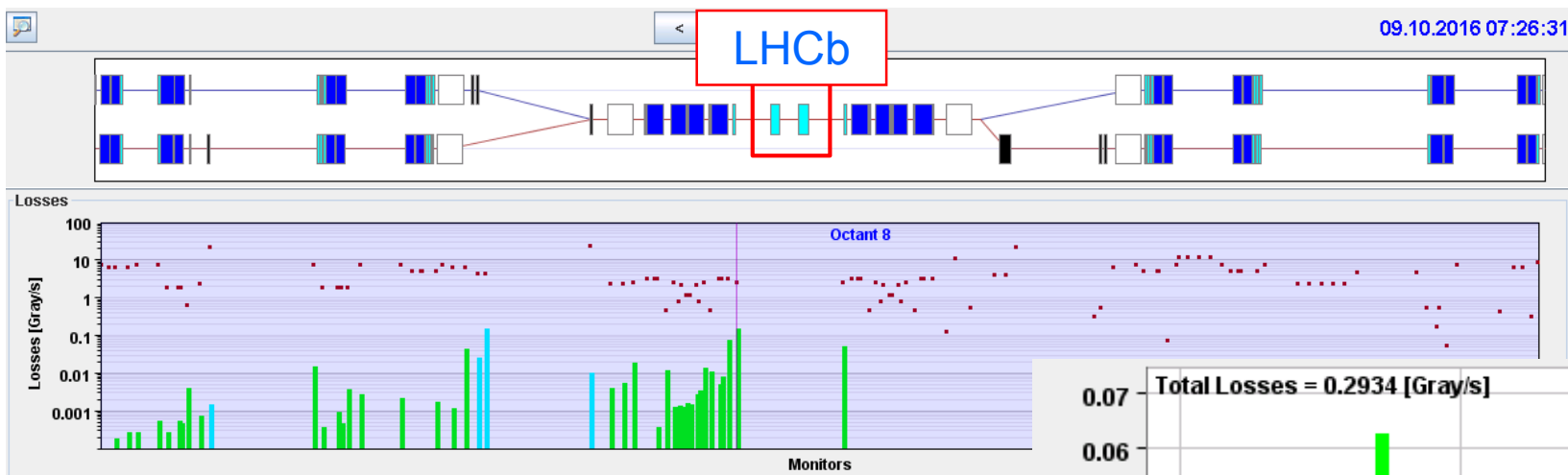
*inferred, documentation missing



LHCb dumps in 2016

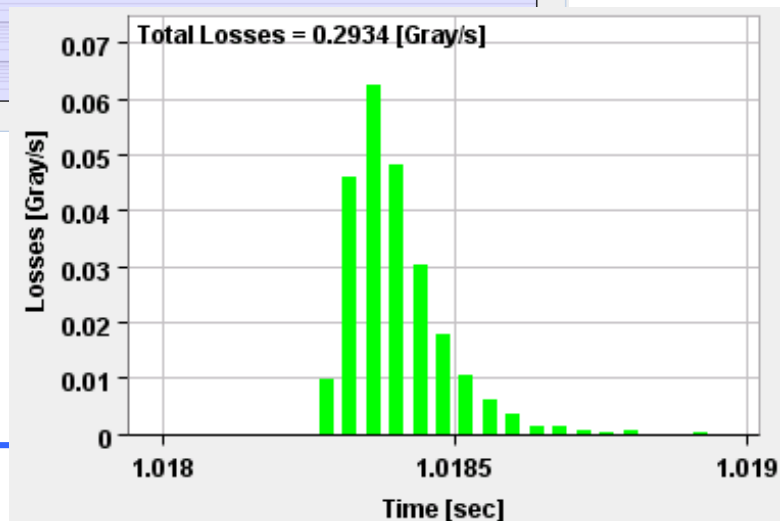
LHCb dumped 2 times over the year (in physics operation):

- 09 October at Flat Top → UFO around IP8, Q1.R8 (Beam2)
- 16 October in Stable Beams → UFO around IP8, Q1.R8 (Beam2)



BLM pictures
provided by Anton
Lechner

At Flat Top, in an
intensity ramp-up
between 600 and 2200
bunches.





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Post Mortem selector

Double click to inspect plots

BCM-U

dia	RS1	RS2	2*RS2	RS32
0	37759.5	37277.2	74554.3	2803.3
1	41649.9	41095.9	82191.7	3115.7
2	50924.2	49860.3	99720.5	3765.2
3	44632.5	43744.2	87488.4	3309.3
4	37085.1	36377.8	72755.6	2738.4
5	43931.1	43829.4	87658.7	3311.0
6	44585.5	43489.5	86979.1	3321.7
7	42433.6	42137.4	84274.9	3169.3
avg	42031.2	41548.8	83097.7	3141.7

BCM-D

dia	RS1	RS2	2*RS2	RS32
0	24499.9	15967.8	31935.5	1274.0
1	24904.8	16097.1	32194.1	1302.1
2	24252.7	15689.9	31379.7	1262.6
3	24284.1	15779.6	31559.2	1260.1
4	23932.3	15516.7	31033.3	1246.8
5	24424.9	15883.0	31766.0	1274.0
6	22773.8	14728.7	29457.4	1181.0
7	21011.2	13559.6	27119.1	1093.2
avg	23933.6	15519.6	31039.1	1244.9

Close

RS2 = (RS1_a + RS1_b) / 2

RS32

All sensors above threshold in RS2

BCM-U RS2 **x 4.1 above** threshold
→ 41548 nA (avg) vs 10100nA (thresh)

BCM-D RS2 **x 6.0 above** threshold
→ 15520 (avg) vs 2130 (thresh)

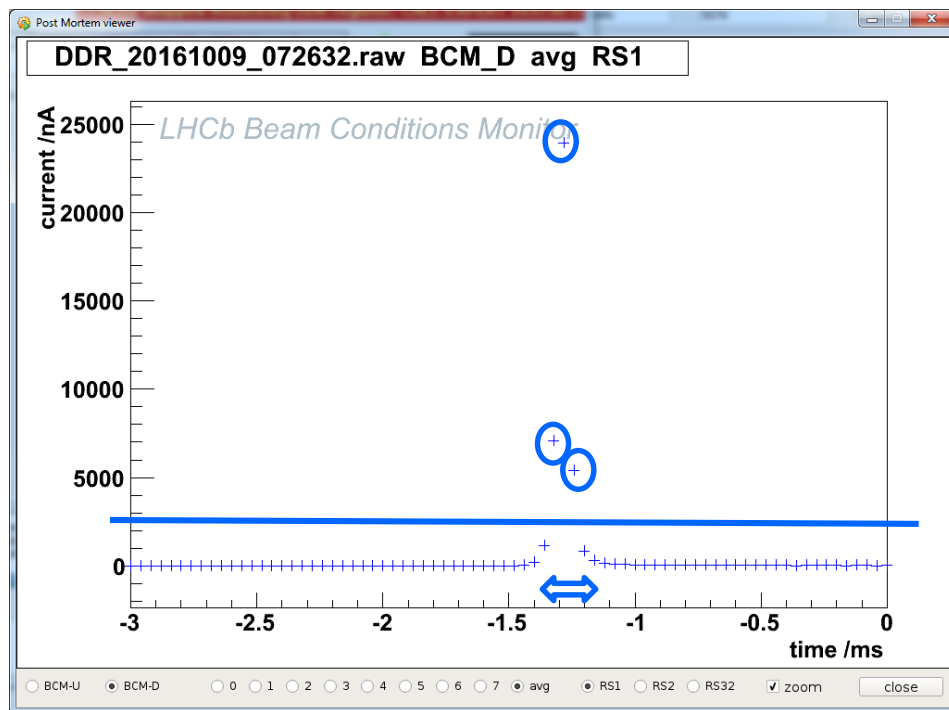
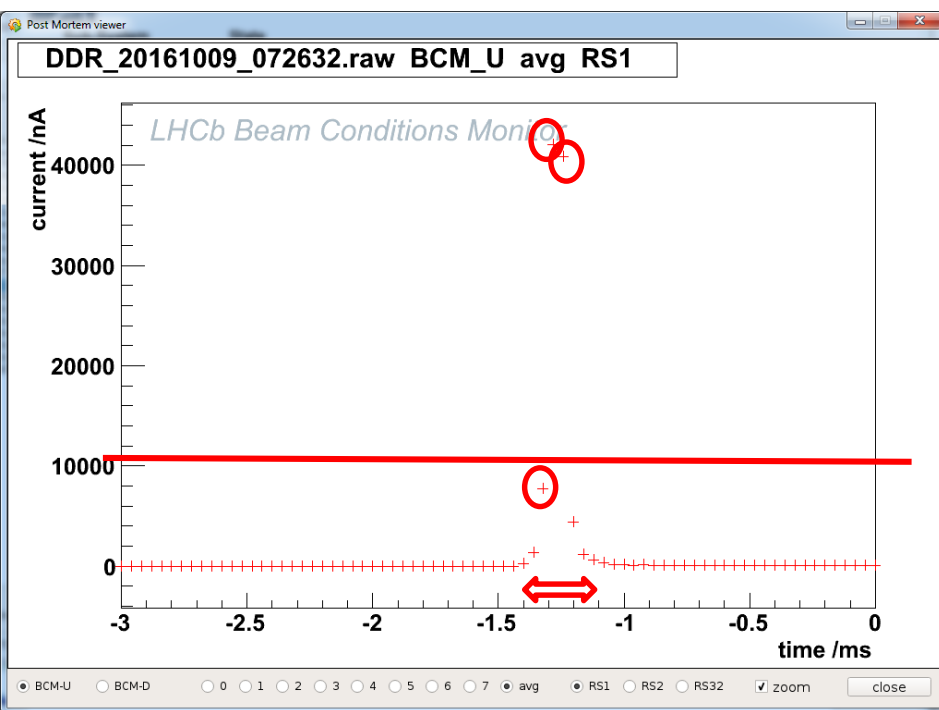
RS32 far from thresholds



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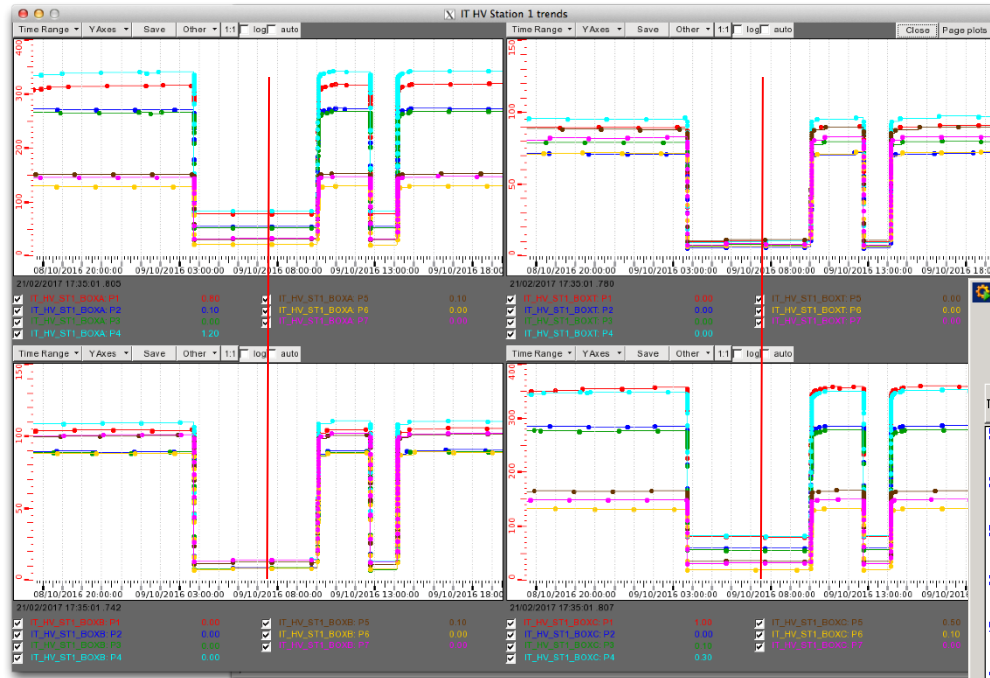
Width is ~ 320 us $\rightarrow 8 \times 40$ us



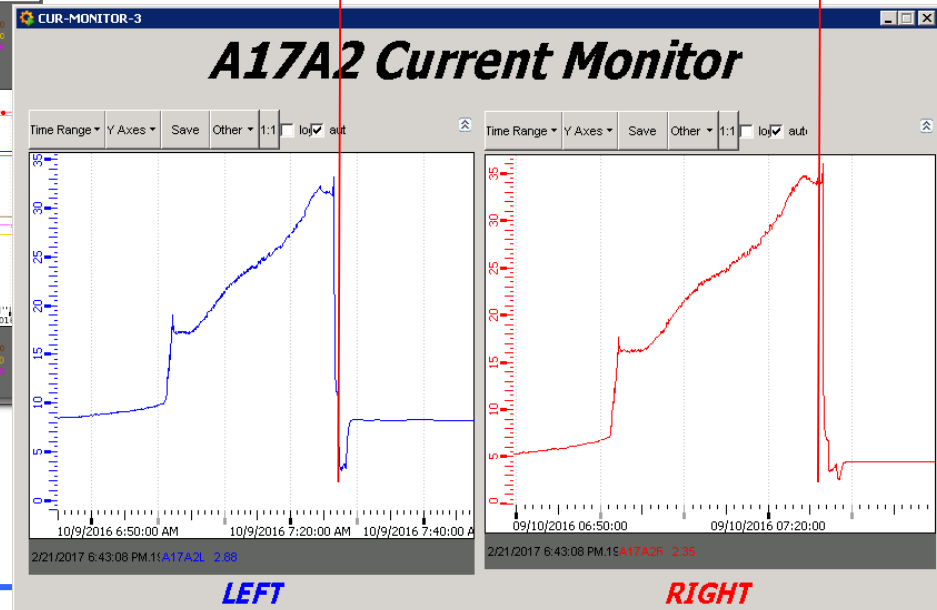
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NO signs of trips or dramatic increase in currents in Silicon detectors and inner GEMs (MUON)

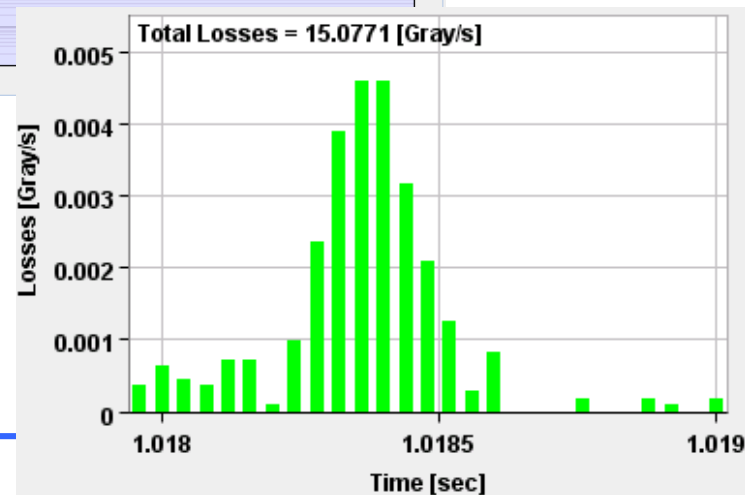
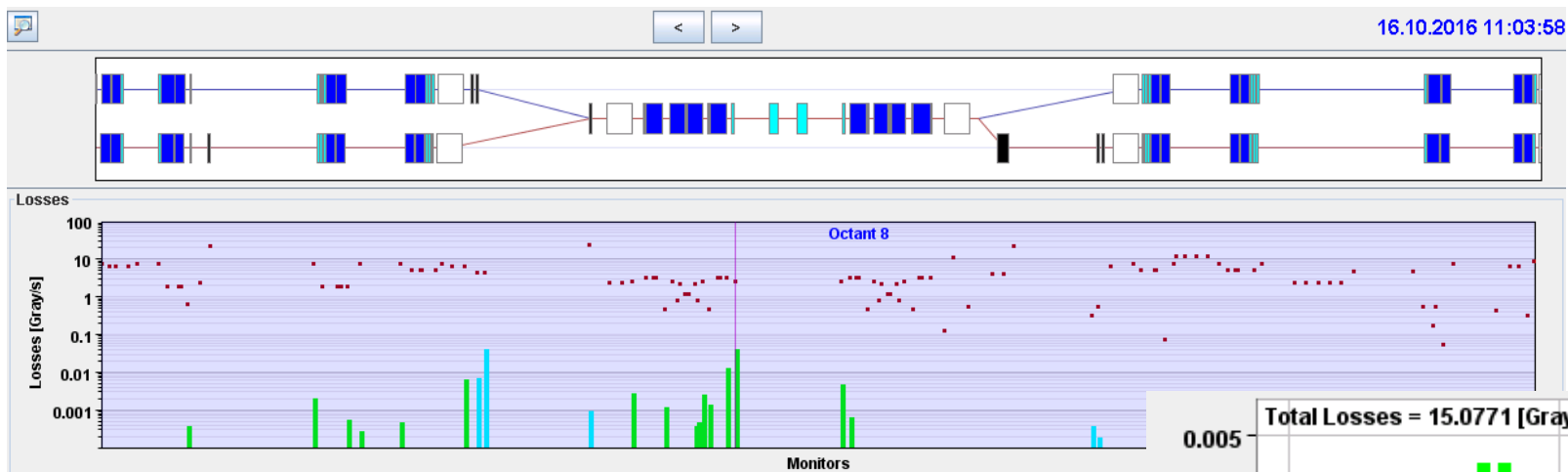




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- **16 October in Stable Beams → UFO around IP8, Q1.R8 (Beam2)**



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In Stable Beams, B2 had
one train less due to MKI
heating



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BCM-U

Maximum currents BCM-U /nA	dia	RS1	RS2	2*RS2	RS32
	0	4855.9	4413.3	8826.5	480.1
	1	5931.6	5355.5	10711.0	600.6
	2	7652.6	7092.4	14184.8	782.1
	3	6727.7	6061.8	12123.6	679.1
	4	4966.9	4512.8	9025.5	506.9
	5	7374.4	6516.3	13032.6	727.4
	6	7477.9	6897.4	13794.9	777.3
	7	6151.0	5540.7	11081.4	618.8
avg		6230.3	5597.4	11194.8	623.8

BCM-D

Maximum currents BCM-D /nA	dia	RS1	RS2	2*RS2	RS32
	0	2080.2	2033.6	4067.2	217.7
	1	2313.8	2081.8	4163.6	228.8
	2	2090.4	2055.6	4111.1	218.1
	3	2356.0	2280.0	4560.0	246.2
	4	2570.5	2342.5	4685.0	256.4
	5	2698.5	2584.1	5168.2	280.3
	6	2580.5	2390.4	4780.7	258.5
	7	2209.7	2152.0	4304.0	228.5
avg		2308.1	2182.4	4364.7	235.6

Close

$$RS2 = (RS1_a + RS1_b) / 2$$

RS32

None in BCM-U above threshold
→ 4413 nA (min) – 7092 nA (max)
vs 10100 nA (thresh)

3 sensors in BCM-D close to threshold, but not above
→ 2584 nA (max) vs 2600 nA (thresh)
→ Tracked to be due to software conversion, to be fixed

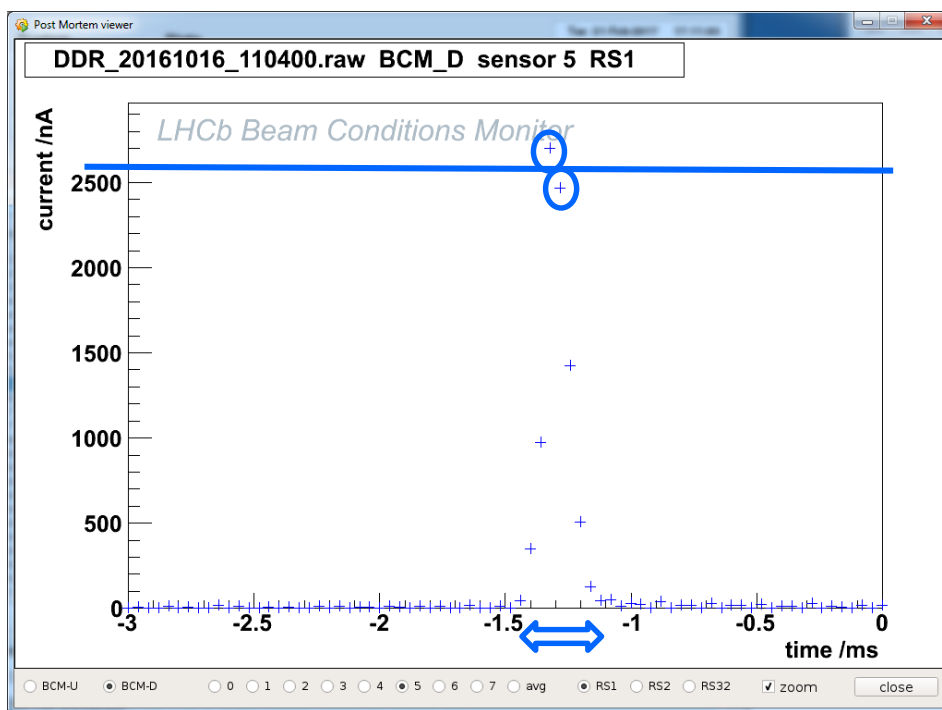
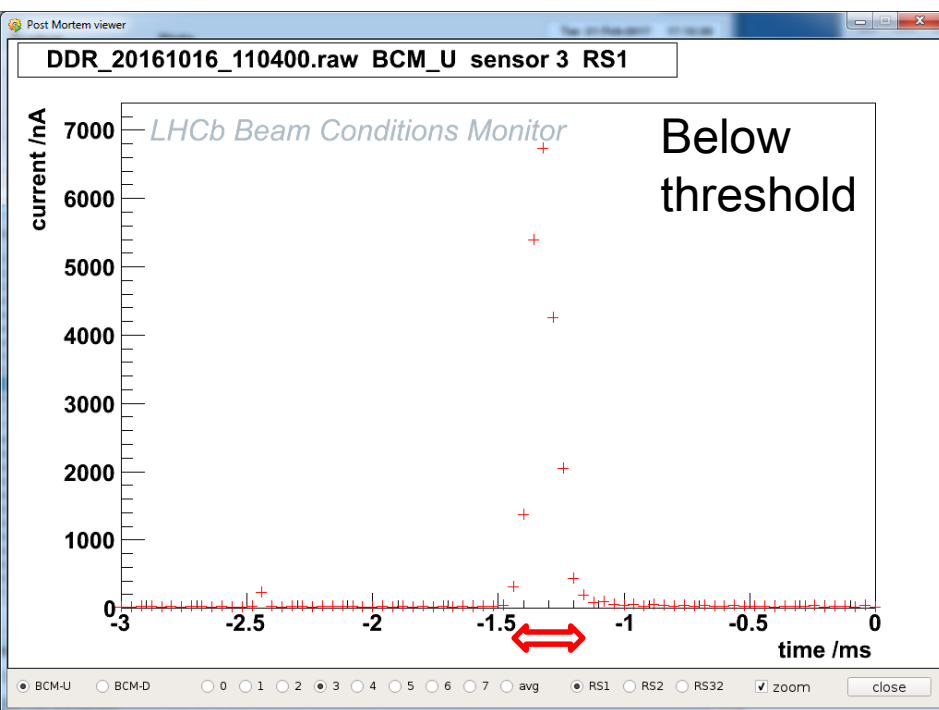
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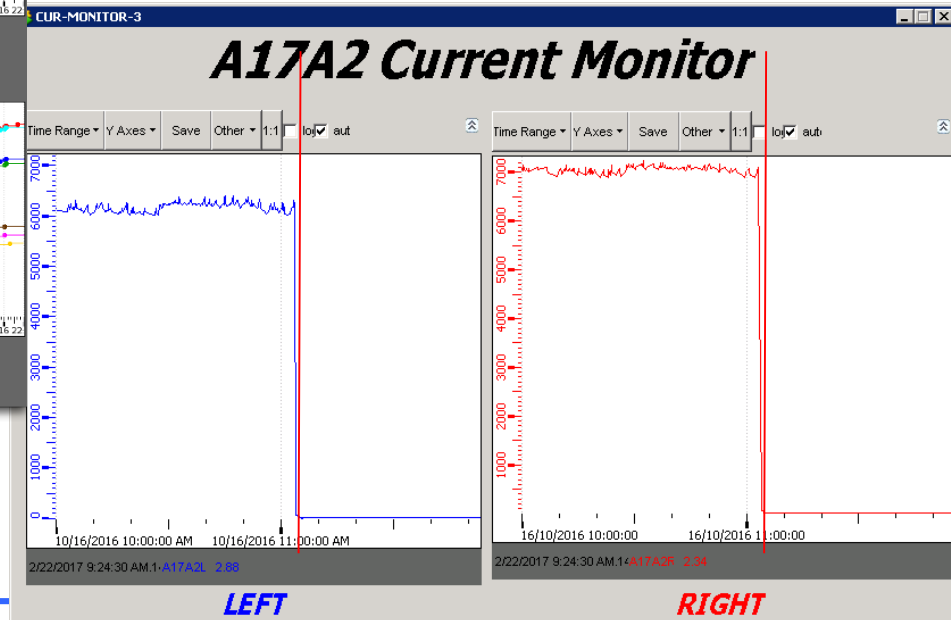
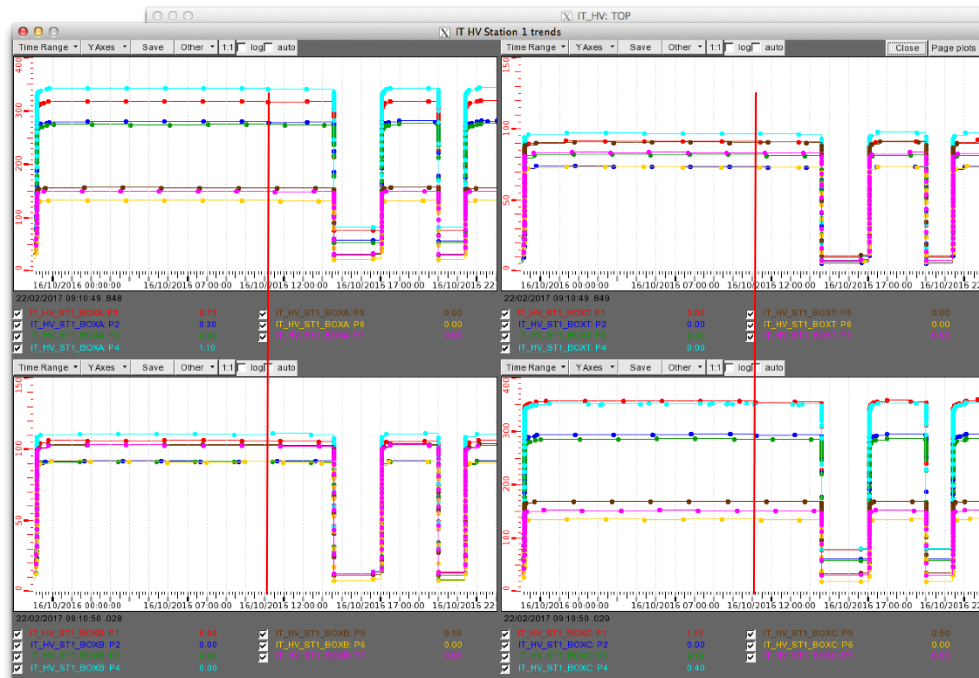


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LEFT

RIGHT



LHCb BCM threshold changes

- **Thresholds are encoded in the BCM readout board firmware**
 - Firmware needs to be recompiled
 - Developers not around anymore, need time to dig everything out
 - Some documentation is missing or details not well explained (will review this)

- **Two options:**
 - Leave it as is (😊), knowing that we'll dump once or twice over the year
 - Bite the bullet and change thresholds
 1. adapting them to the worst case scenario
 2. or higher? If so, by how much?

 - We may also investigate the possibility of masking the dump during special injection tests
 - But in that case, will request rigorous usage of accelerator/beam modes