BCCM bunch intensity limitation and proposed solution

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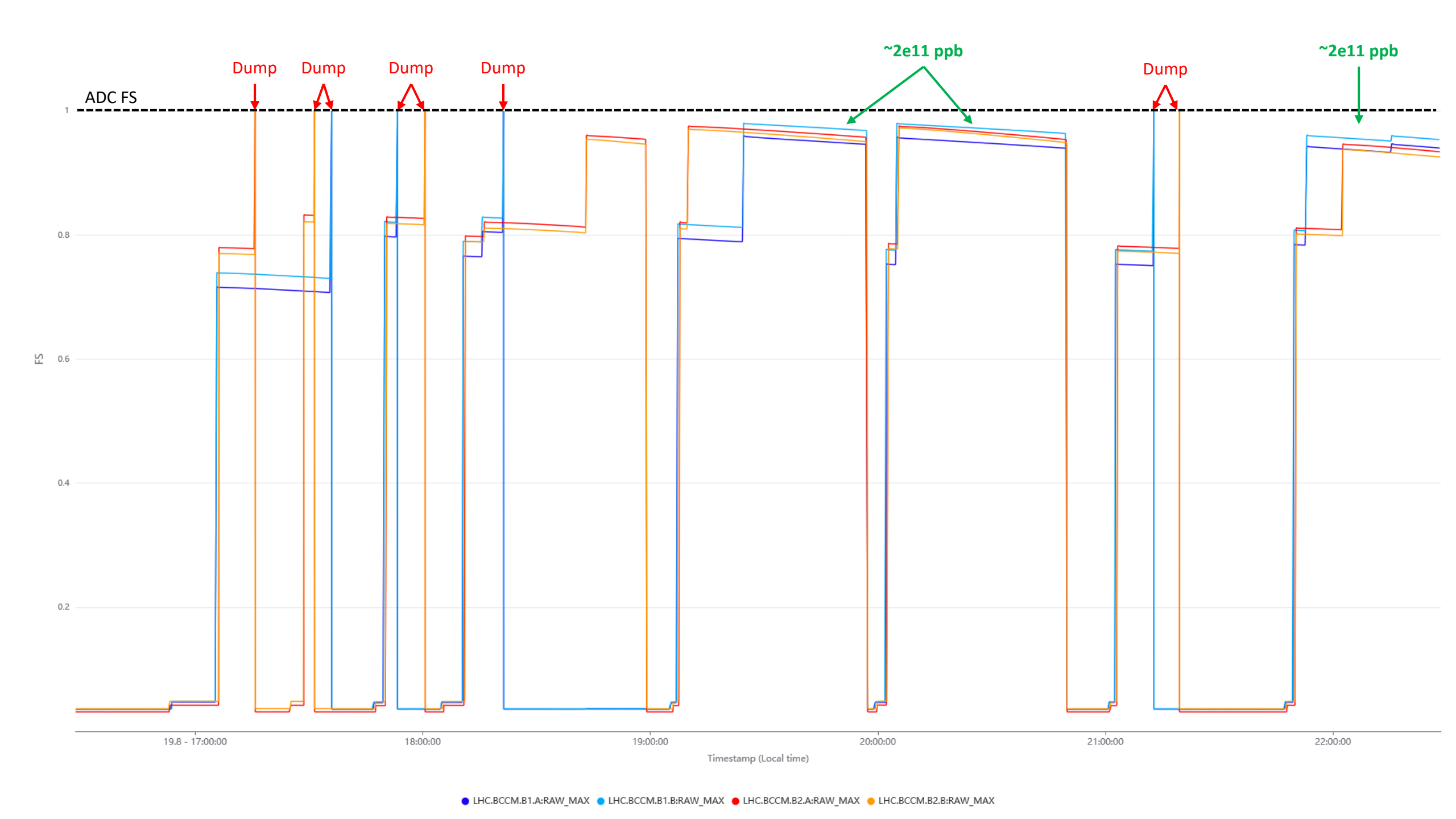
Issue

- Issue seen during recent MDs when trying to inject high intensity (> 2e11 ppb) trains
- BCCM interlock dumps the beam at injection
- Some time spent checking the RF as de-bunching suspected
- After that, not obvious to OP why…
- **Note: currently no analysis of BCCM PM data – to be implemented!**


Dump
Dump
Dump
Dump
~2e11 ppb
Dump
~2e11 ppb
ADC FS
1
0.8
0.6
0.4
0.2
FS
19.8 - 17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
Timestamp (Local time)
LHC.BCCM.B1.A:RAW_MAX
LHC.BCCM.B1.B:RAW_MAX
LHC.BCCM.B2.A:RAW_MAX
LHC.BCCM.B2.B:RAW_MAX

Explanation

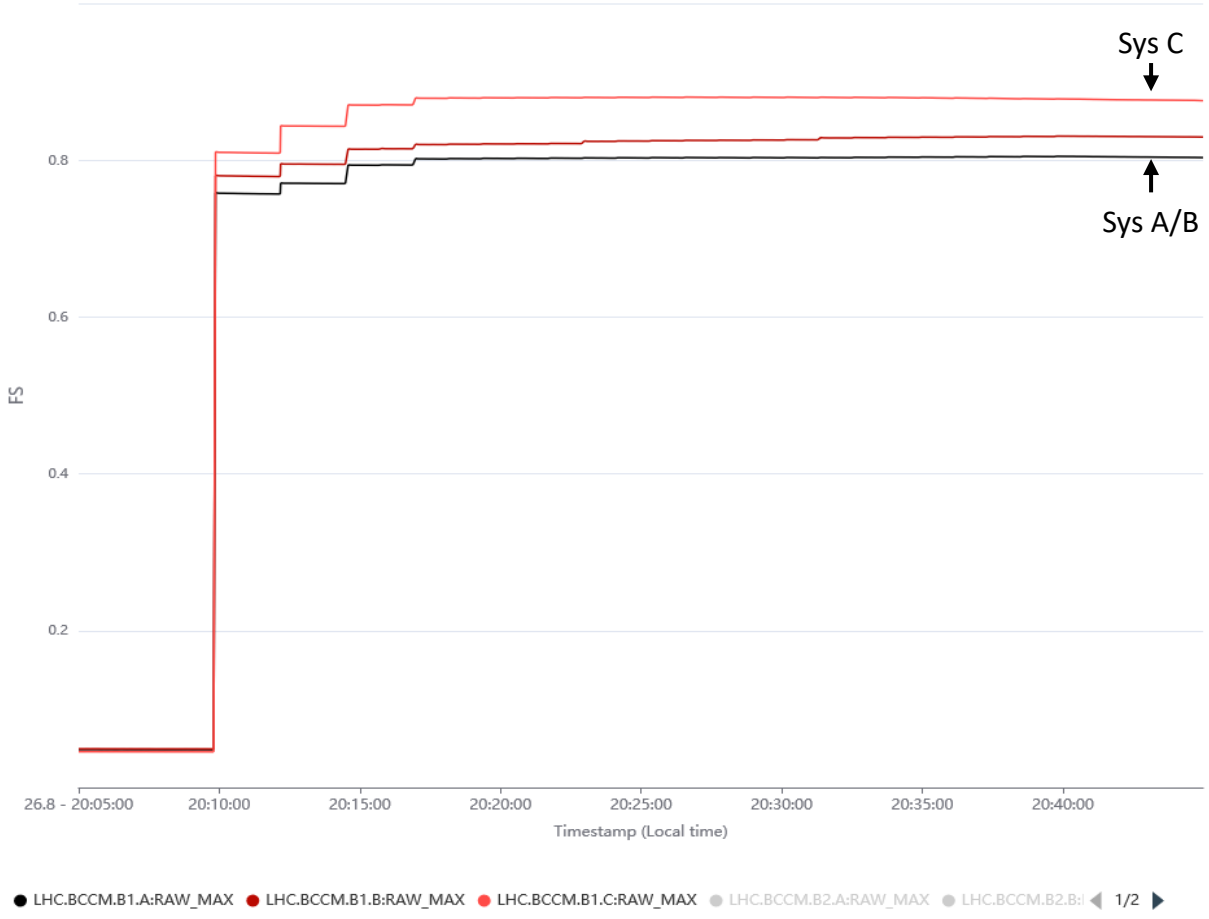
- BCCM interlocks when the signal level reaches the ADC full scale
  - As we cannot guarantee the protection in this case
- Full scale level is a trade off with noise
  - Higher maximum bunch intensity brings higher noise
- For the initial BCCM system we were **very** concerned about the noise
  - It was not obvious that we could meet the specs
- The run 2 beam spec was understood to be max 1.8e11 ppb in trains
  - The full-scale was set based on this with some margin
  - Limit is around ~2.2e11 ppb (absolute maximum) so practically 2.0-2.1e11 ppb
- Note that, due to the dynamics of the detector used, the limit is higher with larger bunch spacing (and much higher with single bunches)

Solution

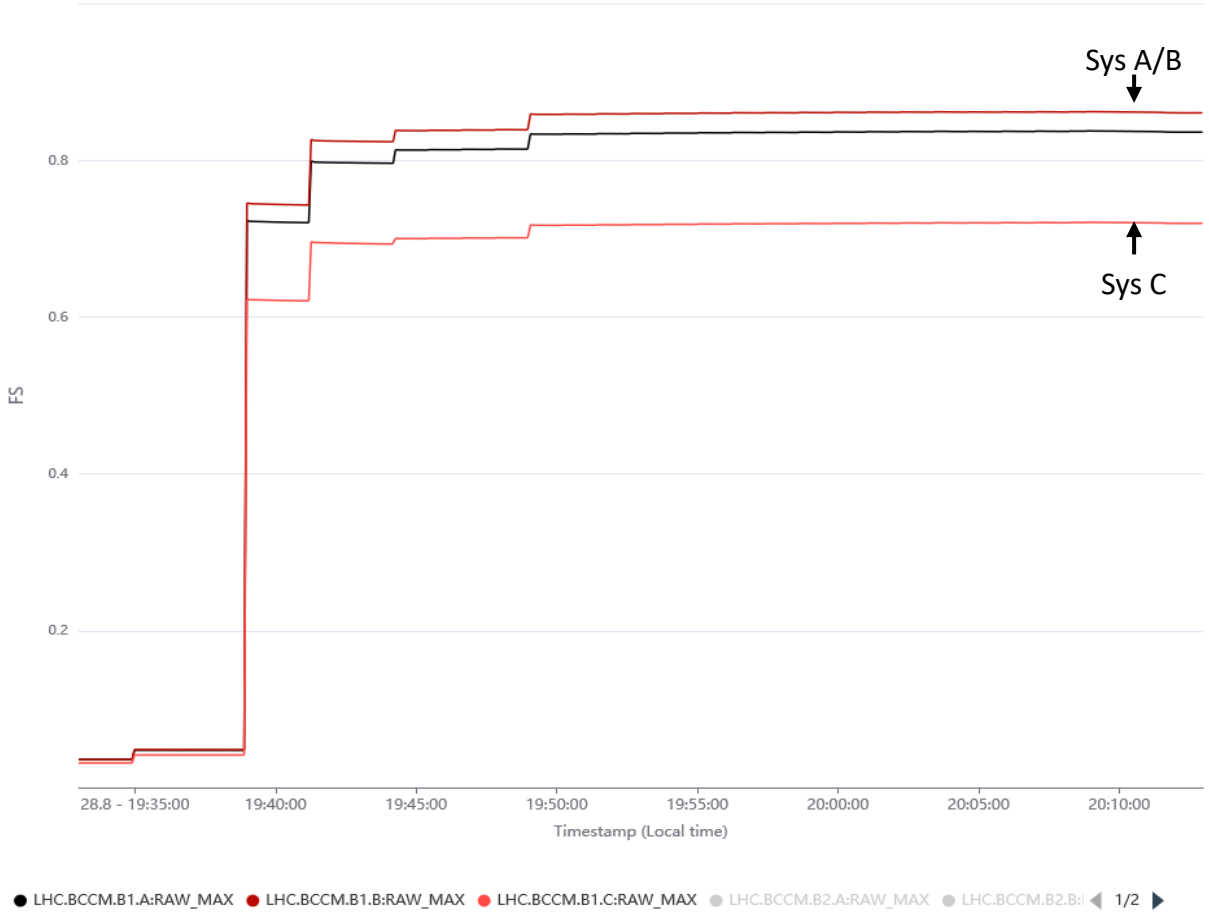
- In practice, we have some margin with the noise levels
- So, we can increase full-scale range by installing 2dB attenuators
  - Increases absolute maximum by ~25% from 2.20e11 to 2.75e11
- 2dB attenuators ordered and installed on System C (development system, not interlocked) during access on 26/08
- Scaling factors (LSA setting) multiplied by 1.26 to compensate

Comparison B1 raw max

Without 2dB:

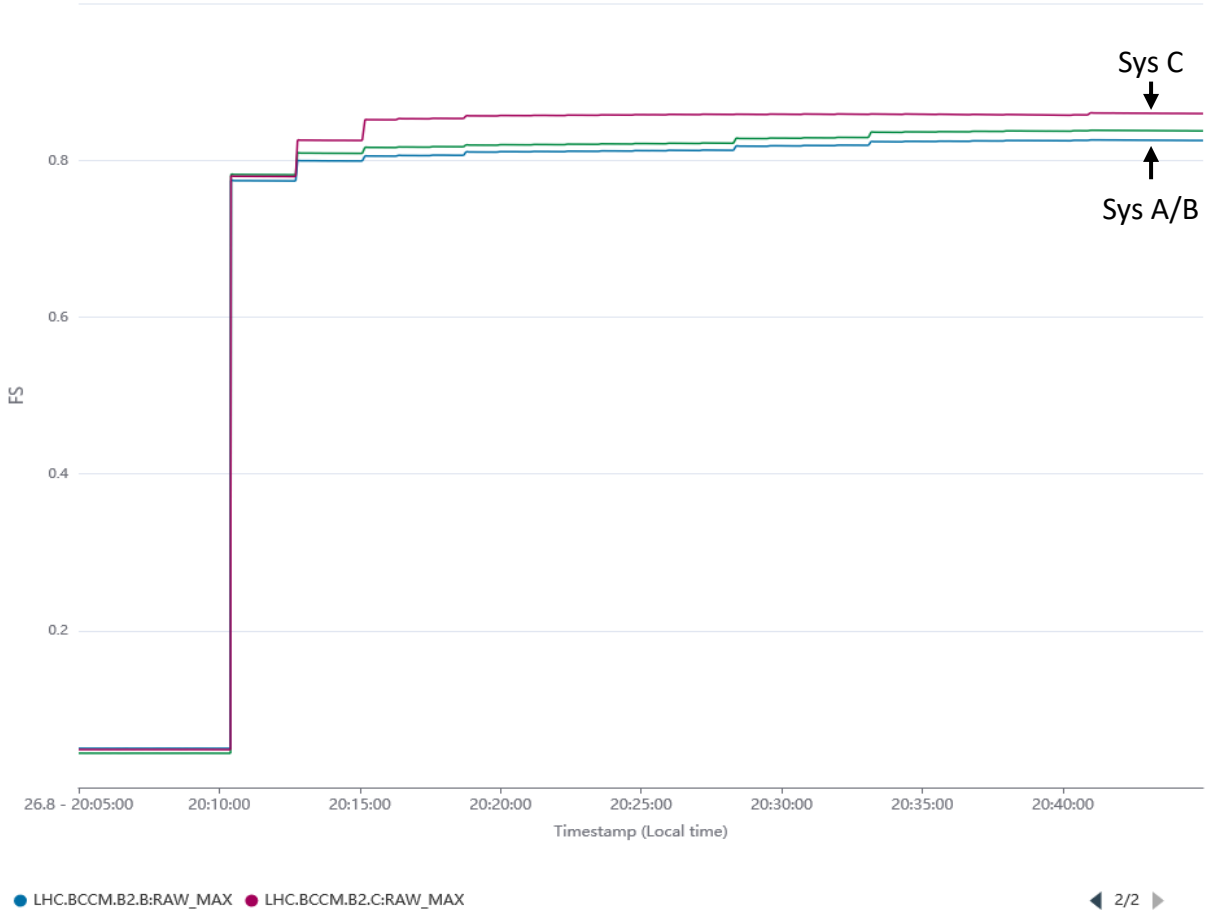


With 2dB:

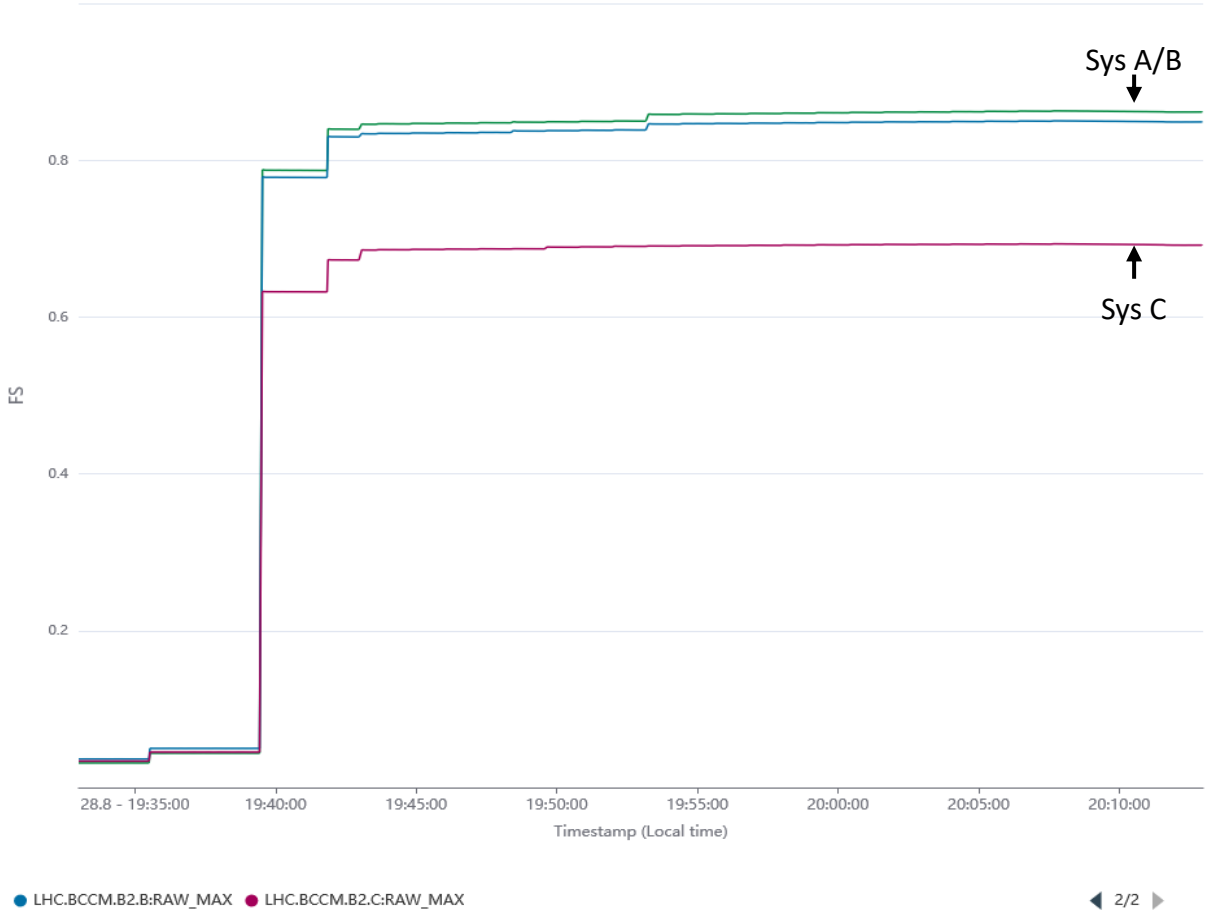


Comparison B2 raw max

Without 2dB:

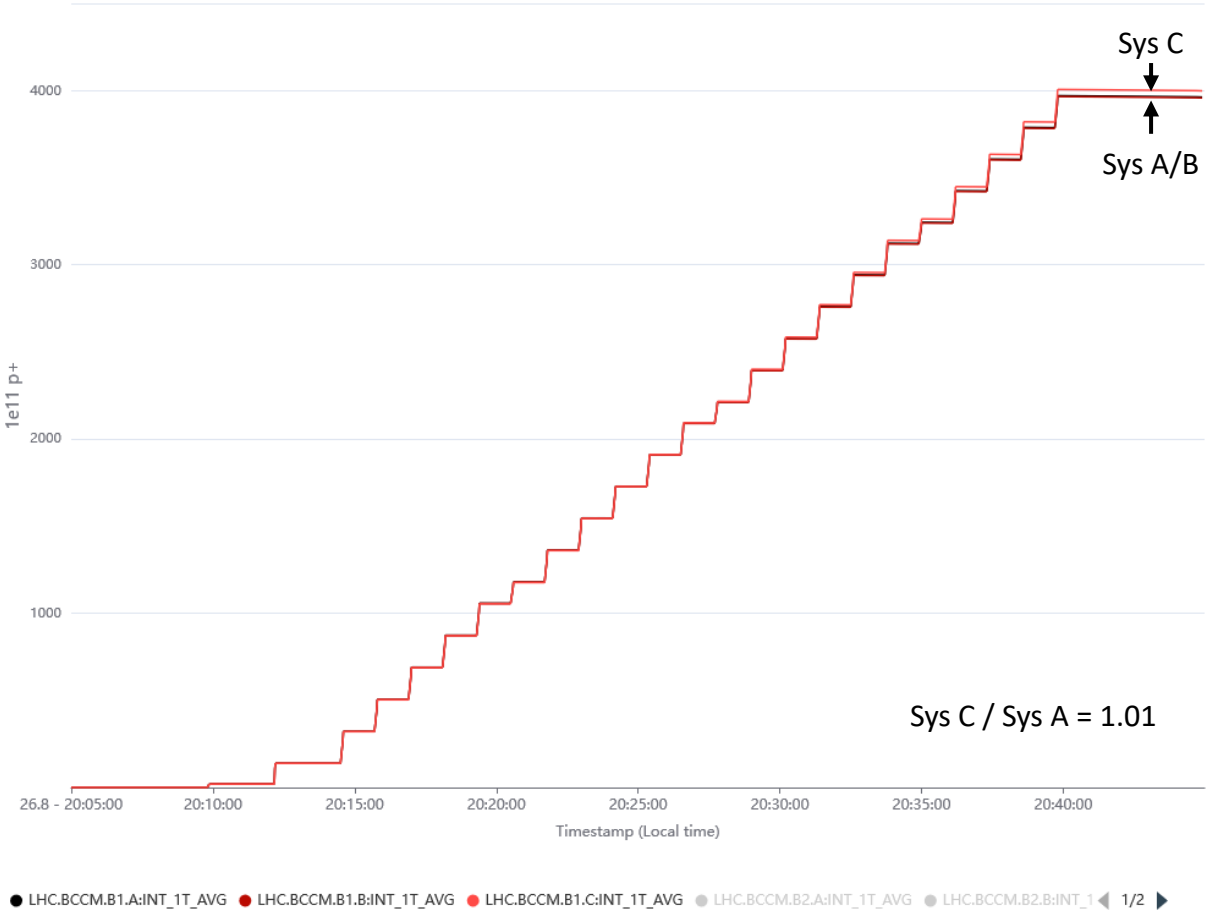


With 2dB:

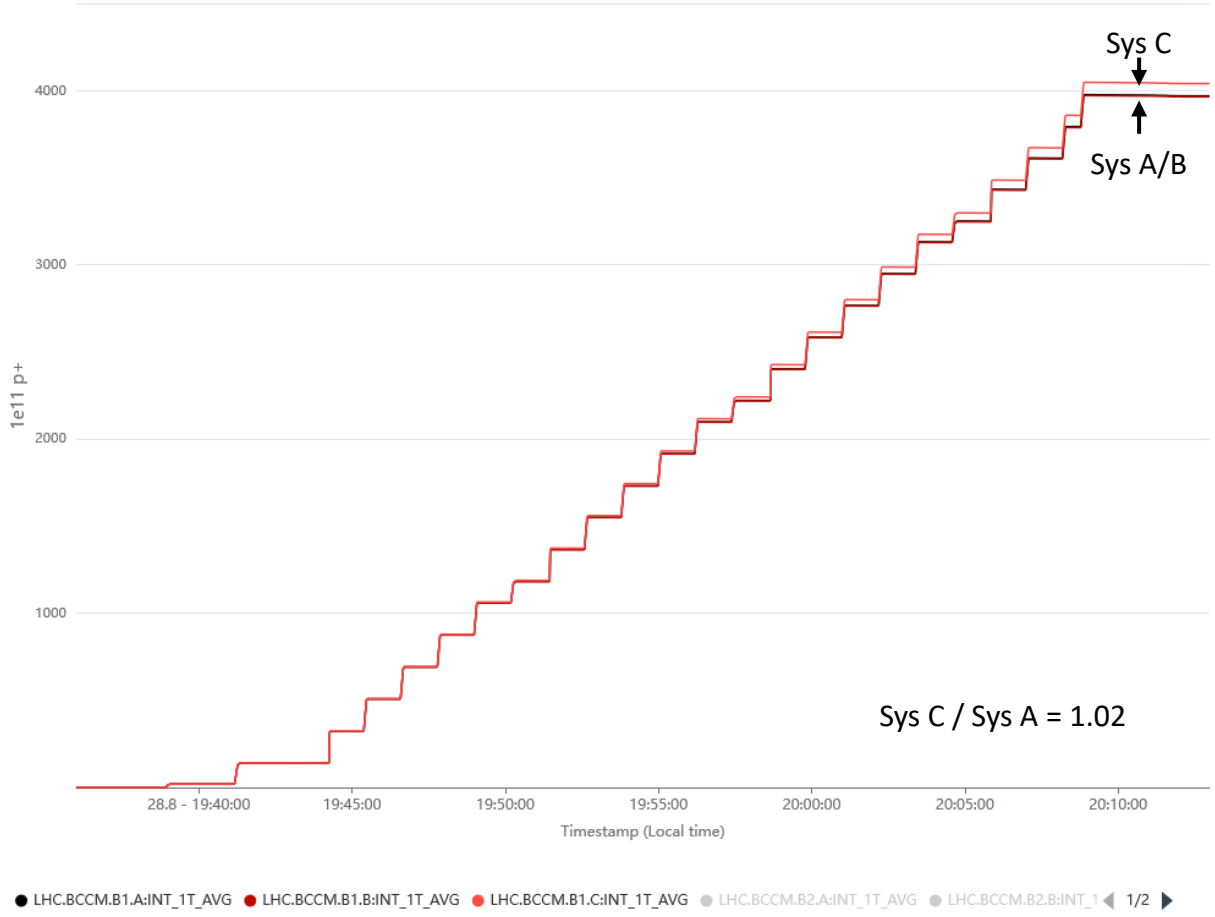


Comparison B1 intensity

Without 2dB:

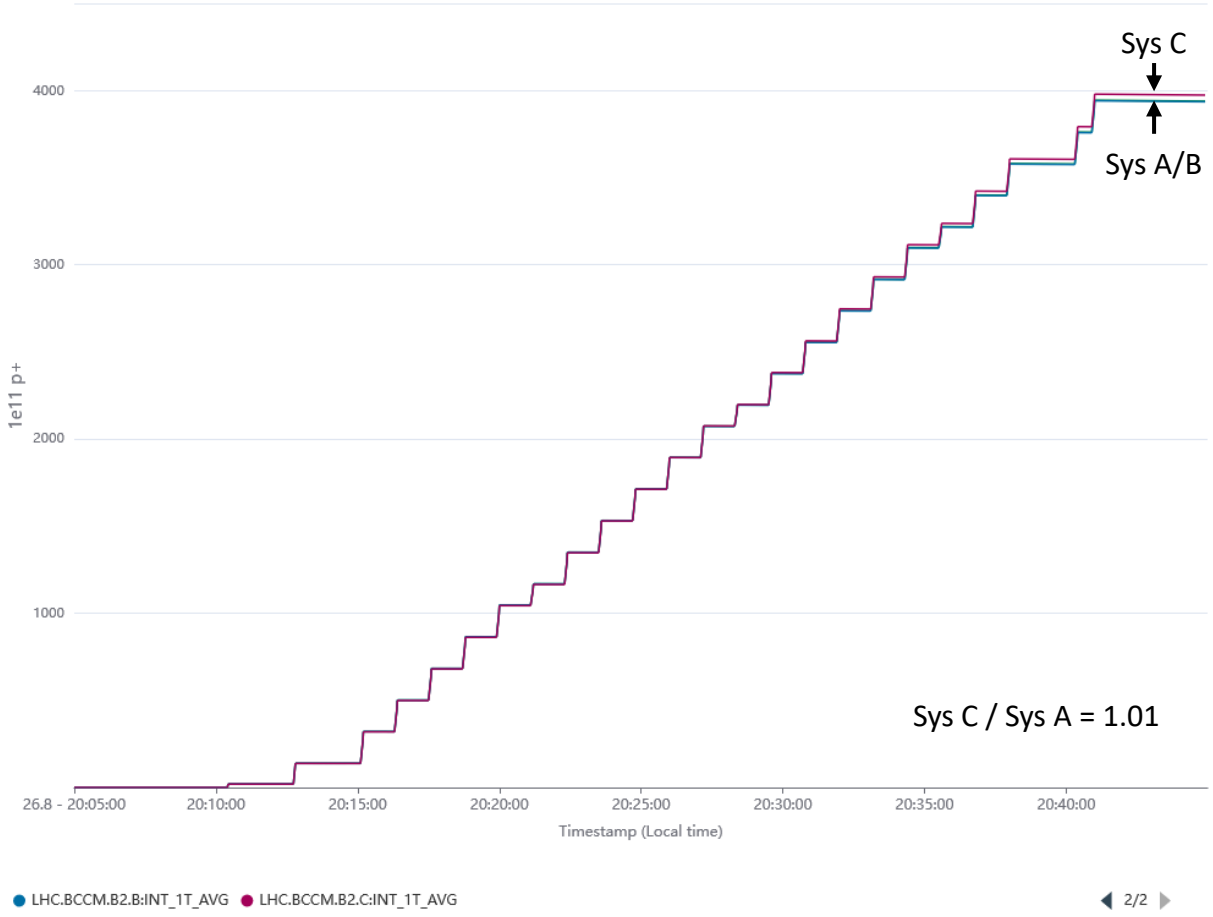


With 2dB:

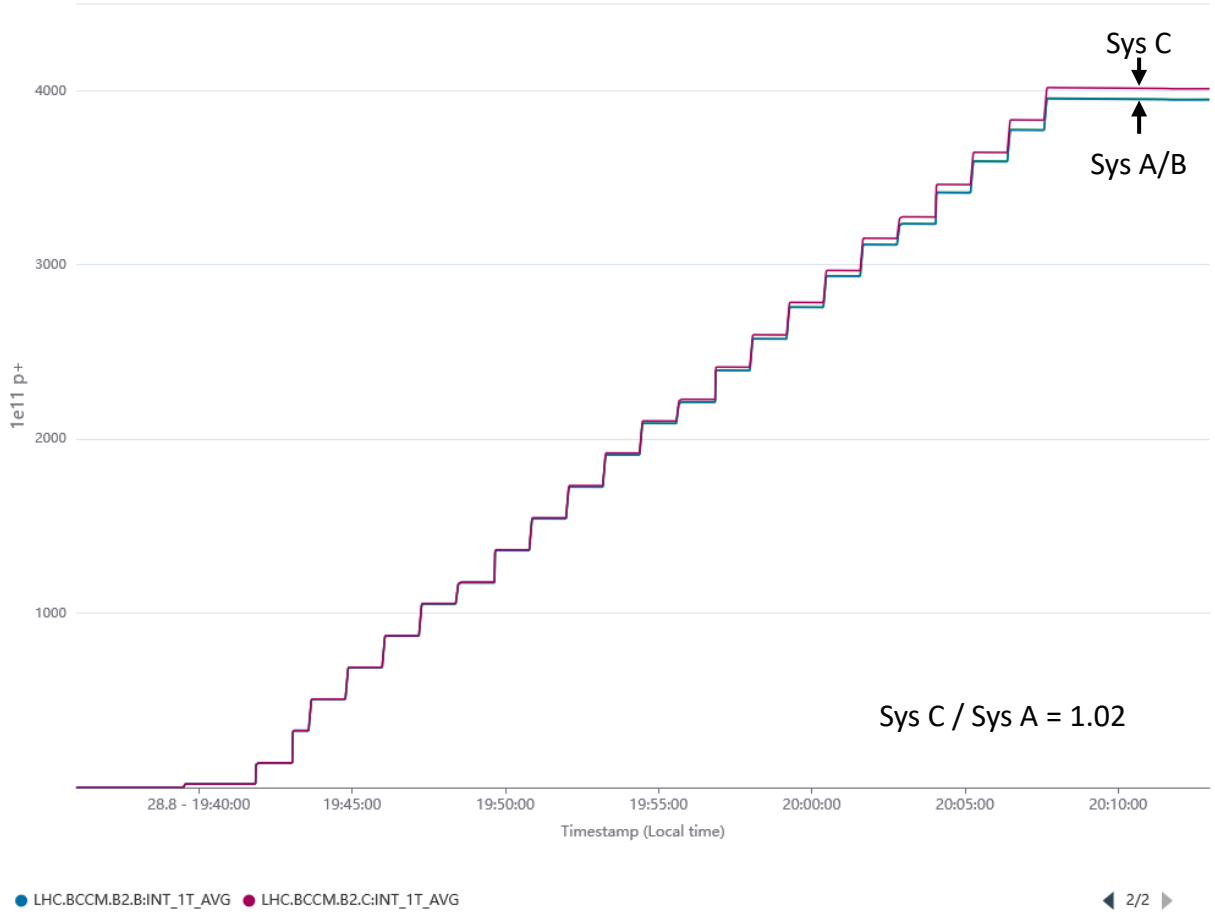


Comparison B2 intensity

Without 2dB:

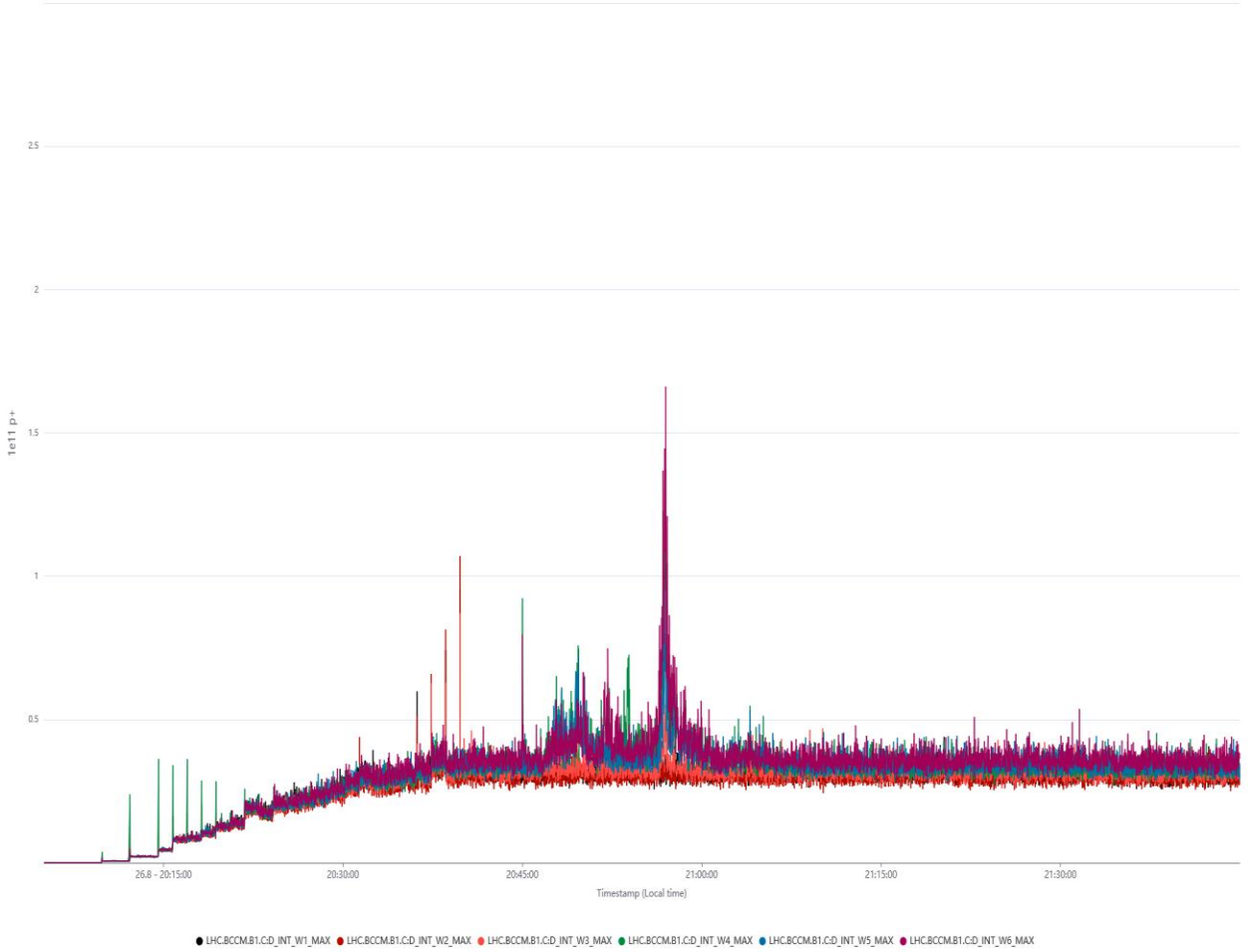


With 2dB:

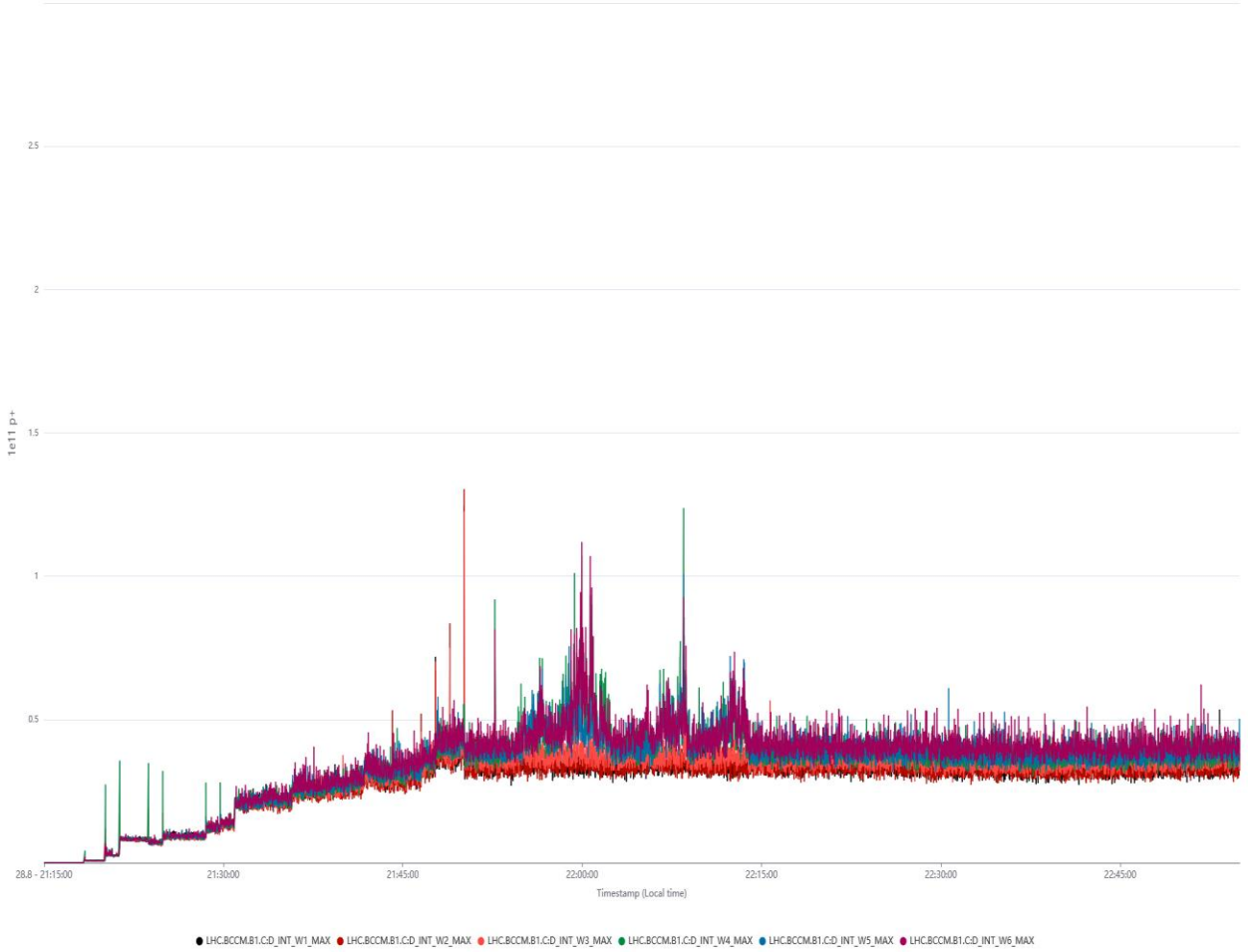


Comparison B1 dI/dt

Without 2dB:

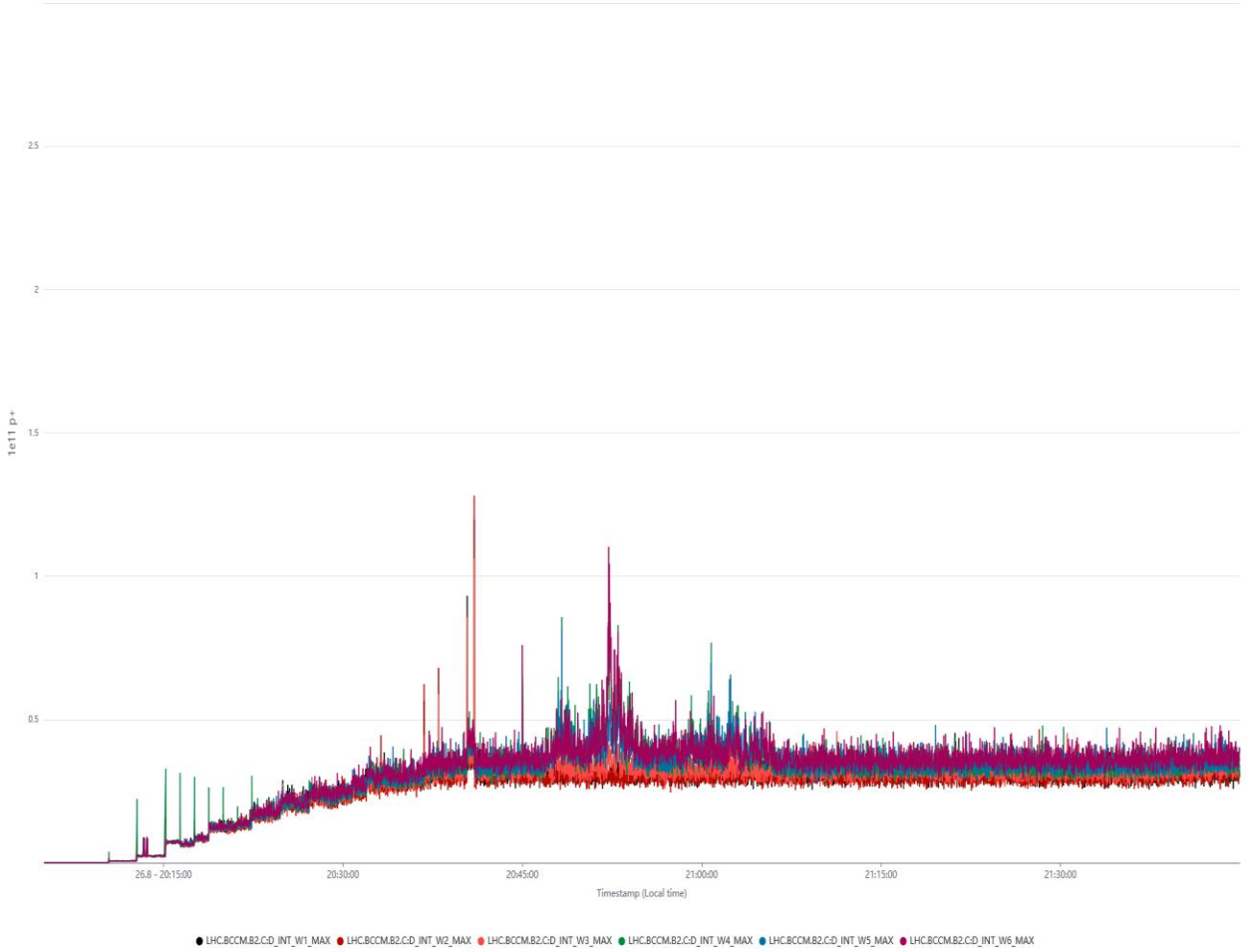


With 2dB:

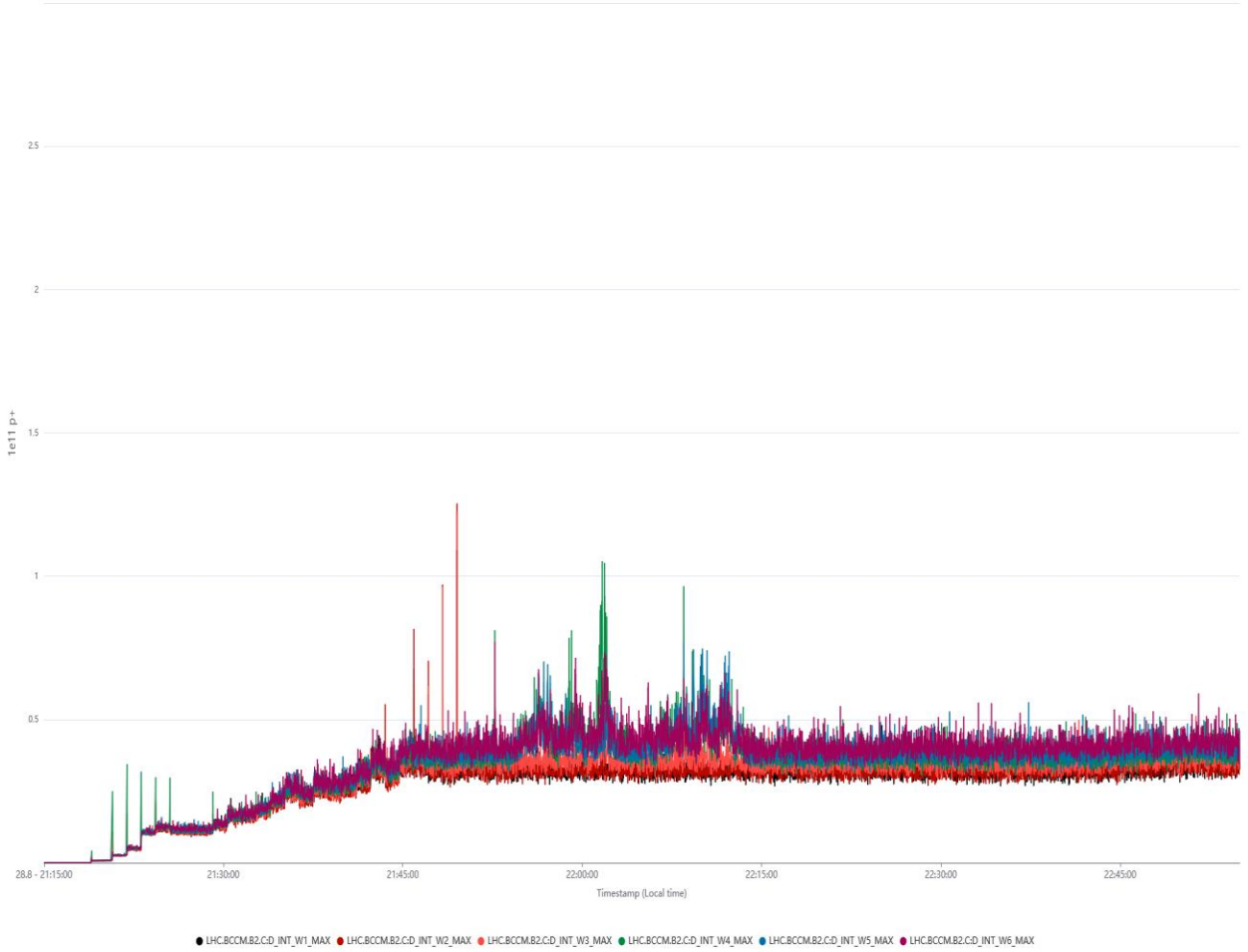


Comparison B2 dI/dt

Without 2dB:



With 2dB:



Proposal

- Install the 2dB attenuators on System A/B before next MD block
- Two options:
  - Single access: changing both systems with single recommissioning
  - Two accesses: only changing 1oo2 with recommissioning for each
- Adjust LSA scaling factors by 2dB
  - Should result in +1% scaling factor compared to now
  - Note: the scaling factors are intentionally set 3-4% above the FBCT to ensure we never underestimate the intensity
- Dates: preferably after 16th September
  - As both myself and Marek will be absent until then
- Further recommissioning steps to do?
  - Or we validate during a normal physics fill at the dump?