	LHC	SPS	PS	PSB	LINAC 4
Time resolution [us]	40 us	40 to 1000 us is OK. For smaller values watch out for data volumes !	2 us	2 us	2 µs ("standard" BLMs) 100 ns for some (ACEM), to resolve chopper structure Number and location t.b.c. Read-out scope
Largest loss [Gy/s]	23	Total per cycle ~ 5 Gy (TT20 splitters, with factor 2 safety margin) Rate can be > 0.2 G/0.02 ms ~ 10'000 Gy/s. Maybe that number makes no sense…	Instantaneous loss of 4E13 protons at 26 GeV/c.	Instantaneous loss of 4E13 protons at 2.12 GeV/c.	1 linac4 pulse (longest), i.e. 4E13 protons. It should be pointed out that for Linac4 operation the high sensitivity region (losses <~1%) is the most interesting region. Therefore the sensitivity has to be adjustable depending on the BLM location. Confirm location of worst loss, and need simulation of accident scenarios. 1% change looks OK
Integration widows	12	Could consider: • 0.04 or 0.02 ms • 1-4 ms • 10-20 ms • Cycle ~ 100 s	2 integration windows: • 1 ms • entire cycle	2 integration windows: • 2 µs • entire cycle	Between 2 µs, and the maximum value
Max window [s]	80	~80 -100	6s (5 x 1.2s basic period)	1.2s (1 x 1.2s basic period)	1.2s (includes LP SPL)
Post mortem	yes	Not absolutely needed? We mostly want the data per cycle.	Not required, but would be nice to have.	Not required, but would be nice to have.	Not required, but would be nice to have.
Capture data					Integration window and number of values t.b.c.

Post mortem buffer length	42000	With 1 ms resolution, we need 80'000 to 100'000 points to cover a cycle. Reusing 42'000 would allow us to cover 100 s with a granularity of ~2 ms.	Should be based on operational window (1ms) and max window length (6s) 6000	Should be based on operational window (1ms) and max window length (1.2s) 1200	2048 as LHC
Logging frequency [Hz]	1	Once per cycle.	Once per cycle. Max: 1/900ms	Once per cycle. Max: 1/900ms	2.0
Synchronisation	no	Essential, to start of cycle.	Yes, at start of cycle, followed by the revolution frequency.	Yes, at start of cycle, followed by the revolution frequency.	Yes, to start cycle
Beam permit (thresholds)	yes	yes	??	??	Need to keep the possibility
Beam permit response [ms]	0.04	0.02 (extractions).	??	??	Certain equipment may not withstand loss of one full pulse; if pulse-by-pulse stop sufficient, then response time can be 500ms (2Hz). If beam stop during pulse required, then 5µs is necessary. To be defined how many and which ones need to be fast. T.b.c if needed
Thresholds energy dependent	yes	no	no	no	no

Comments for SPS

1. Synchronization and data structure generalities:
    a. For the SPS it is essential that the data is synchronized to the start of each cycle to correlate with other equipment.
    b. The integrated loss over one cycle must be available, for example with one long window (100 s?). This is the most commonly used data stream and also the one that is logged every cycle. It is also compact.
    c. For detailed studies and diagnostics, the full cycle data with a granularity of 1 to 10 ms is ideal. That corresponds to a buffer depth of 10'000 to 100'000 points. Maybe 10 ms (10'000 points) is a reasonable value.
    d. For MD or super-detailed studies a granularity of 0.04 ms as for the LHC could be interesting. This however poses the problem of how to acquire. A full 100 s cycle would yield 2'500'000 points. So this may have to be split…

2. Windows and thresholds:
    a. Following from the previous, one could consider acquisition windows of :
        a. 0.04 or 0.02 ms (1 turn)
        b. 1-5 ms → for full cycle coverage
        c. 10-20 ms → for full cycle coverage.
        d. Full cycle ~ 100 s
    b. Thresholds:
        I think we would need 2 thresholds:
        1. One threshold for the 'cycle window' to dump the beam when the integrated loss is above threshold. This is what we have now. Note that the system must dump as soon as the value in the window exceeds the threshold, not just at the end of the cycle…. Seems trivial – but just to be sure!
        2. A second threshold for the 10-20 ms window to dump the beam on fast losses.

        Adding more thresholds probably makes the system complicated without much gain.

Comments for PS Complex

1. Time resolution:
    a. The smallest time resolution is required to be 500 ns for the PSB and 2 us for the PS in order to be able to observe losses turn-by-turn, which is particularly interesting at injection, transition and ejection to observe fast losses during these processes. In fact we would like to have 1 measurement every revolution period. The revolution period in the PSB varies between ~1.5 us at injection and ~580 ns at extraction. The revolution period in the PS varies between ~2.3 us at injection and ~2.1 us at extraction.
    Due to the large amount of data we can accept to have this data available over a limited period of variable length with a minimum of 1ms and a maximum of 100 ms, which will generate in the worst case 2E5 values per BLM for the PSB and 5E4 values per BLM for the PS. It should be possible to shift this time window along the cycle in steps of 1 ms.
    b. In the mode to observe a complete cycle we would like to maintain this resolution, but providing a value integrated over 1 ms is sufficient.

    Question:

    What time resolution can be obtained from the detector and will the ionisation add up later to the fast electron signal (Pile-up)?
    In other words: Can we, for the short time resolutions, only use the electrons signal and not be perturbed by the ionisation signal?
2. Usable measurements and integration windows:
    a. High time resolution measurement (not a window):
    The system shall provide one measurement per revolution period for specific observations over a time-wise movable (steps of 1ms) time window with a length of minimum 1ms and maximum 100ms.
    b. Operational window:
    Every 1 ms an integrated value, issued from the measurement per turn, should be available during the complete cycle.
    c. Cycle window;
    At the end of a complete cycle each BLM should provide the total integrated losses over the complete cycle as a single value. At this moment the maximum cycle length that has been used in the PSB is 1.2s and in the PS 6s.
3. Thresholds:
    The system should provide two thresholds (A and B) that can be enabled or disabled and of which the threshold value can be programmed per BLM. Both parameters should be multiplexed. The status of each BLM w.r.t. its threshold, of the whole machine or a predefined part of the machine (transfer lines), shall be put in a logical OR relationship and the outcome shall provide a signal to the control system for each threshold A and B.
    a. Instantaneous threshold

If the BLM exceeds threshold A an exceed signal is provided to the control system. Typically in this case we use the MTG to cut the beam as quickly as possible, but other means like internal dump in the PS can be envisaged.

b. Average threshold
The BLM can exceed a pre-determined (programmable, multiplexed) number of times the threshold B, counting up or down for each cycle that is executed. If the threshold B is exceeded more than the pre-determined number of pulses an exceed signal is provided to the control system. Typically in this case we use the MTG to cut the beam as soon as possible.

Comments for Linac4