



MD3246 16L2 UFO dynamics investigations
MD3207 UFO dynamics studies during physics
operation with blown-up bunches

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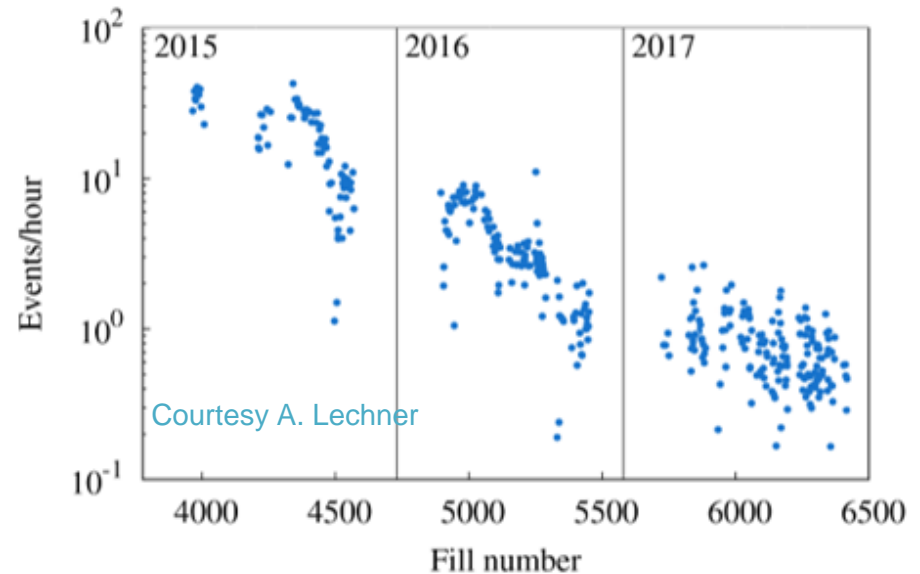
Many Thanks to D. Valuch, the OP shift team and ecloud/heat load team
for supporting these studies



LSWG – 4 December 2018

Motivation

- UFOs have had a significant impact on LHC availability on run 1 and beginning of run 2
- Conditioning and optimization of BLM thresholds has largely mitigated this issue
- Nevertheless, the source, release mechanism, UFO dynamics and conditioning mechanism are not sufficiently understood
- UFO rate post LS2 is expected to increase significantly (to 2015 levels?)
- Difficult to predict impact on 7 TeV operation (lower quench margins etc)



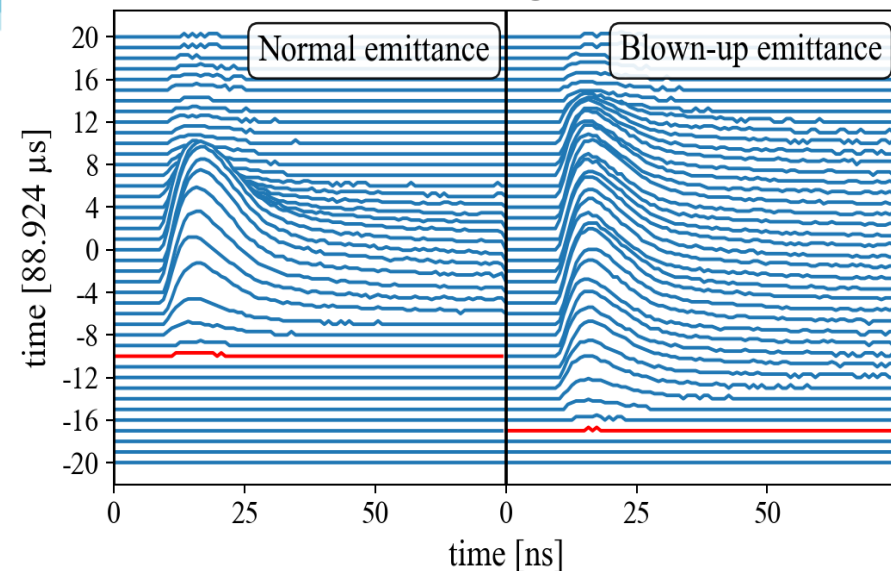
Goal of the MDs:

- Improve knowledge of UFO dynamics and validate simulation models by
 - Confirming the plane of movement
 - Comparing the energy deposition and # of nuclear interactions with simulations -> identify UFO material/size
- Blown-up bunches allow studying dynamics

Method and Experiments

- Observe bunch-by-bunch losses with diamond detectors
 - two per beam downstream of primary collimators in IR7, one per beam at 16L2
- Position of macro particle in relation to beam can be derived from the loss signals

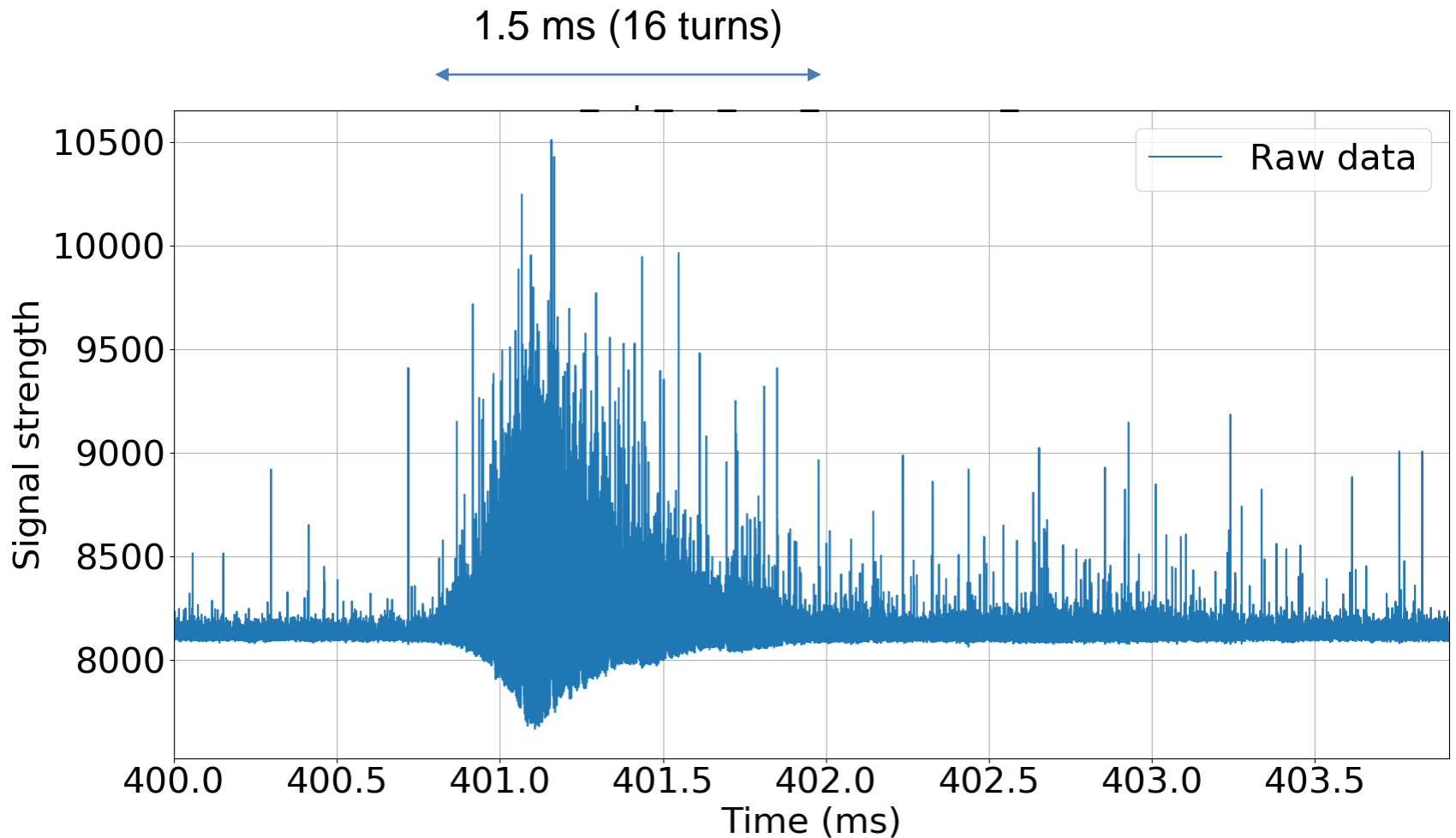
- UFO dynamics study (MD3207):
 - Blow up 2b per beam (ver/hor) in non-colliding 12b train
 - Procedure applied to all normal proton physics fills from 29th September until MD4
- 16L2 dynamics study (MD3246, parasitic on MD2484):
 - Blow up 36 bunches (3 x 12b trains)
 - 6b per train vertically, 6b per train horizontally
 - EOF: blow up hundreds of bunches, switch off 16L2 solenoid to trigger 16L2 type UFOs → dumped fill during blow-up of first 576 bunches



Recorded UFO Events

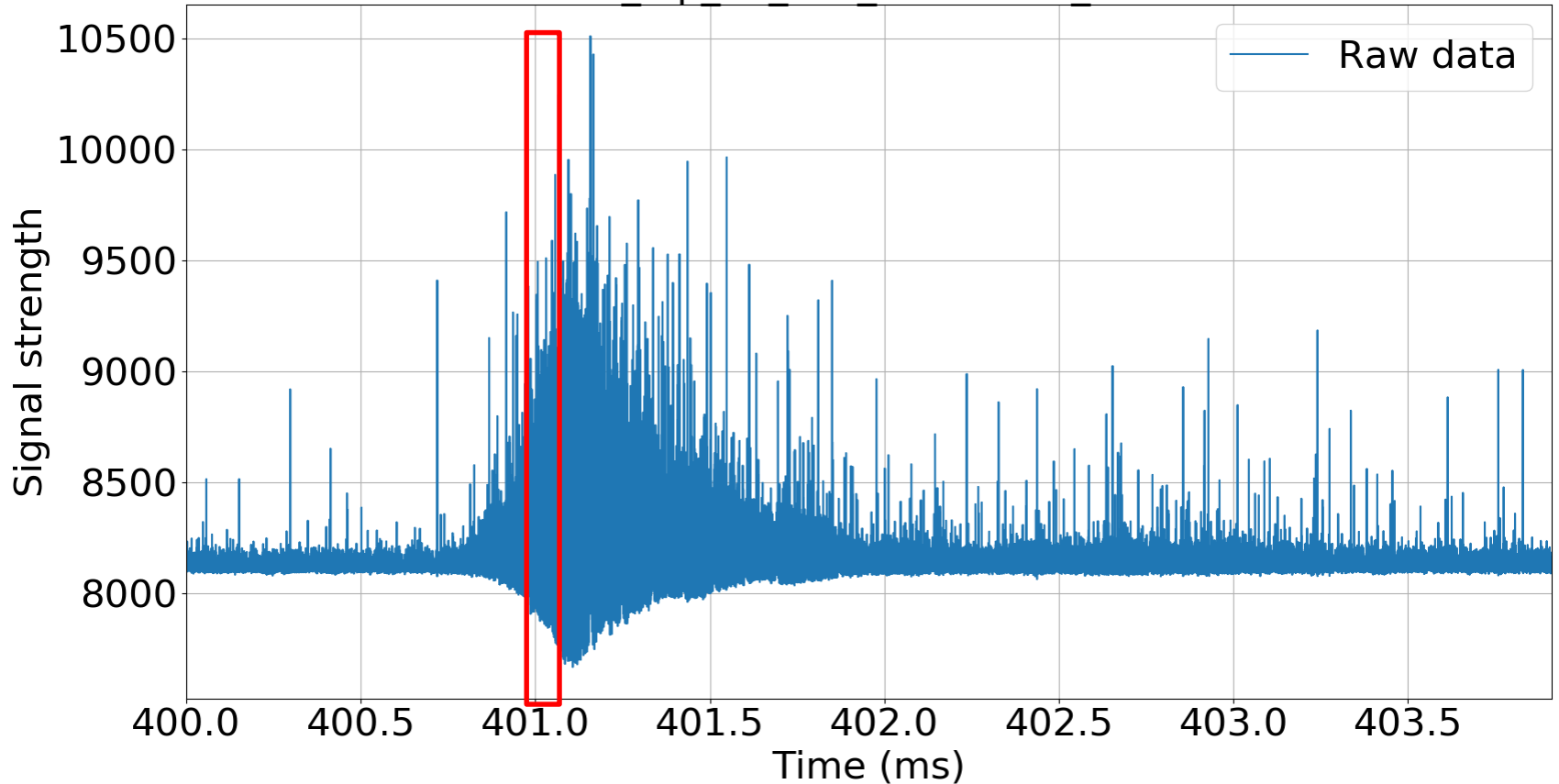
- 11 events recorded with dBLMs during physics fills with blown up bunches
 - 3 at 6.5 TeV
 - 8 during ramp (1.1 – 4.5 TeV)
- UFO Buster detected 33 UFOs
 - 6 coincident events
- Difference to UFO buster detections due to:
 - Different algorithm (spatial versus temporal pattern)
 - dBLMs trigger on peak detection and integration
 - UFO Buster triggers only on integration
 - UFO Buster is blind to events at TCP and the experiments
 - dBLM depends on phase advance UFO source -> TCP
- One 16L2 event recorded during heat load MD

Raw waveform – full event



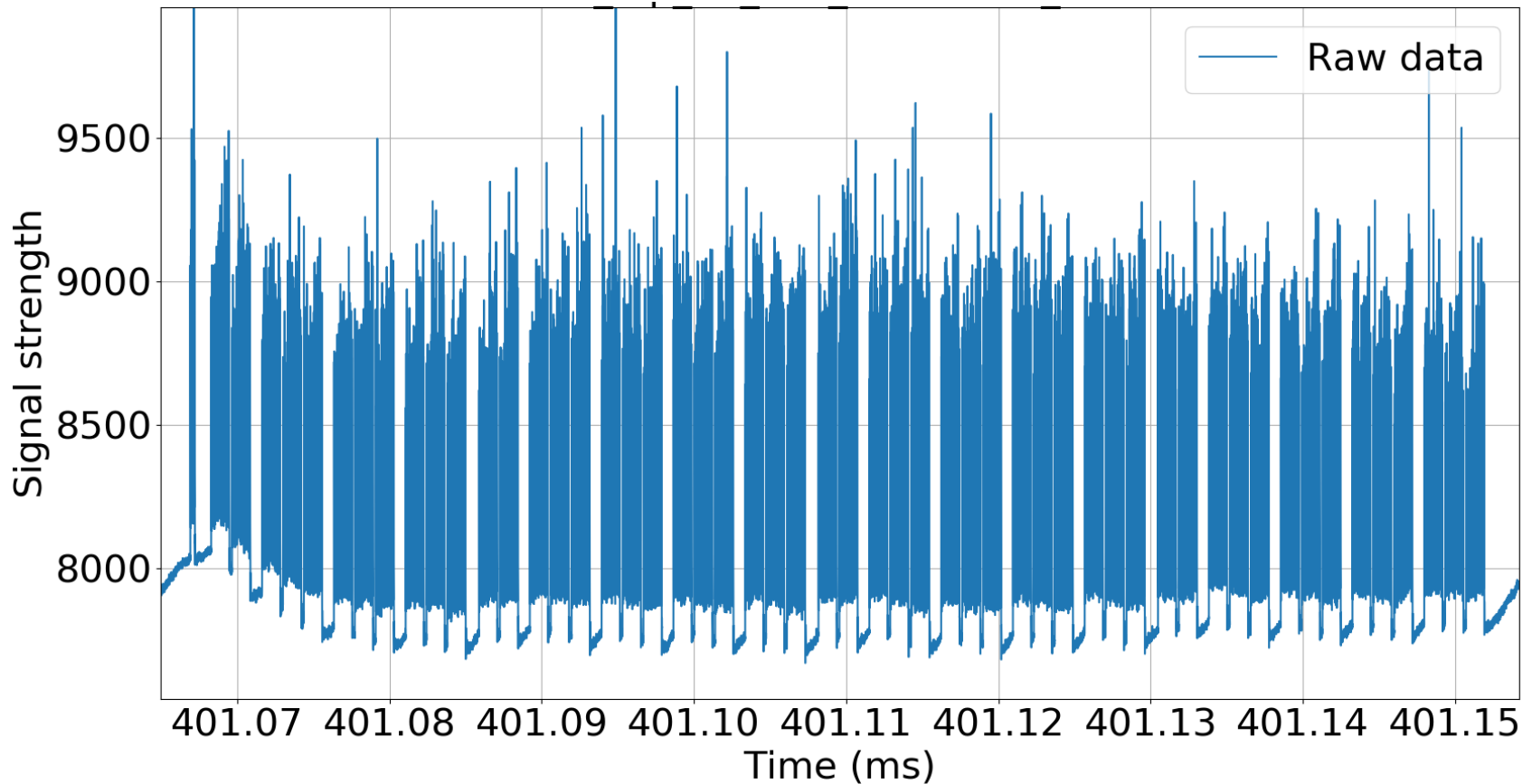
Event 30/09 22:47:52 (6.5 TeV)

Raw waveform – full event



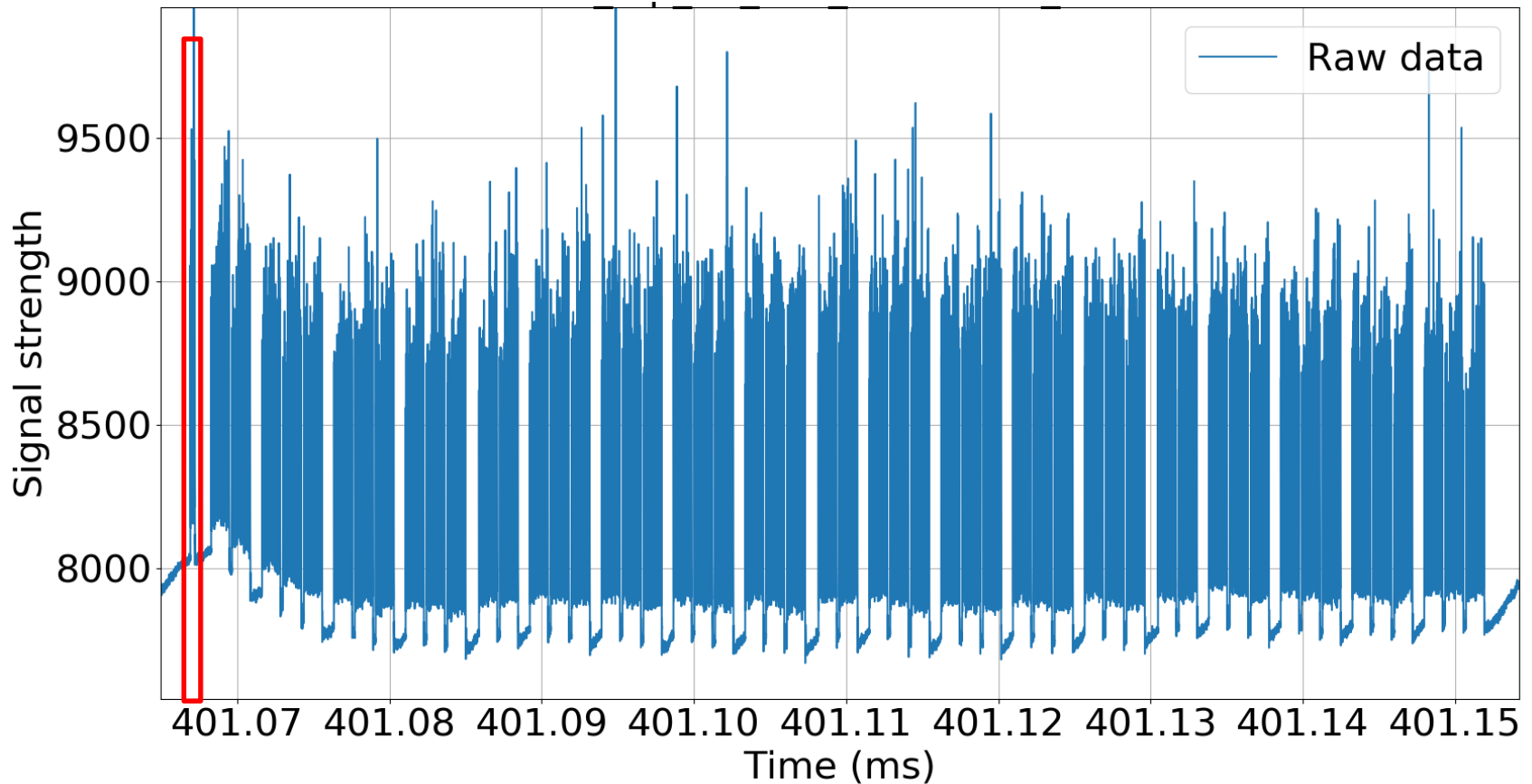
Event 30/09 22:47:52 (6.5 TeV)

Raw waveform – zoom in one turn



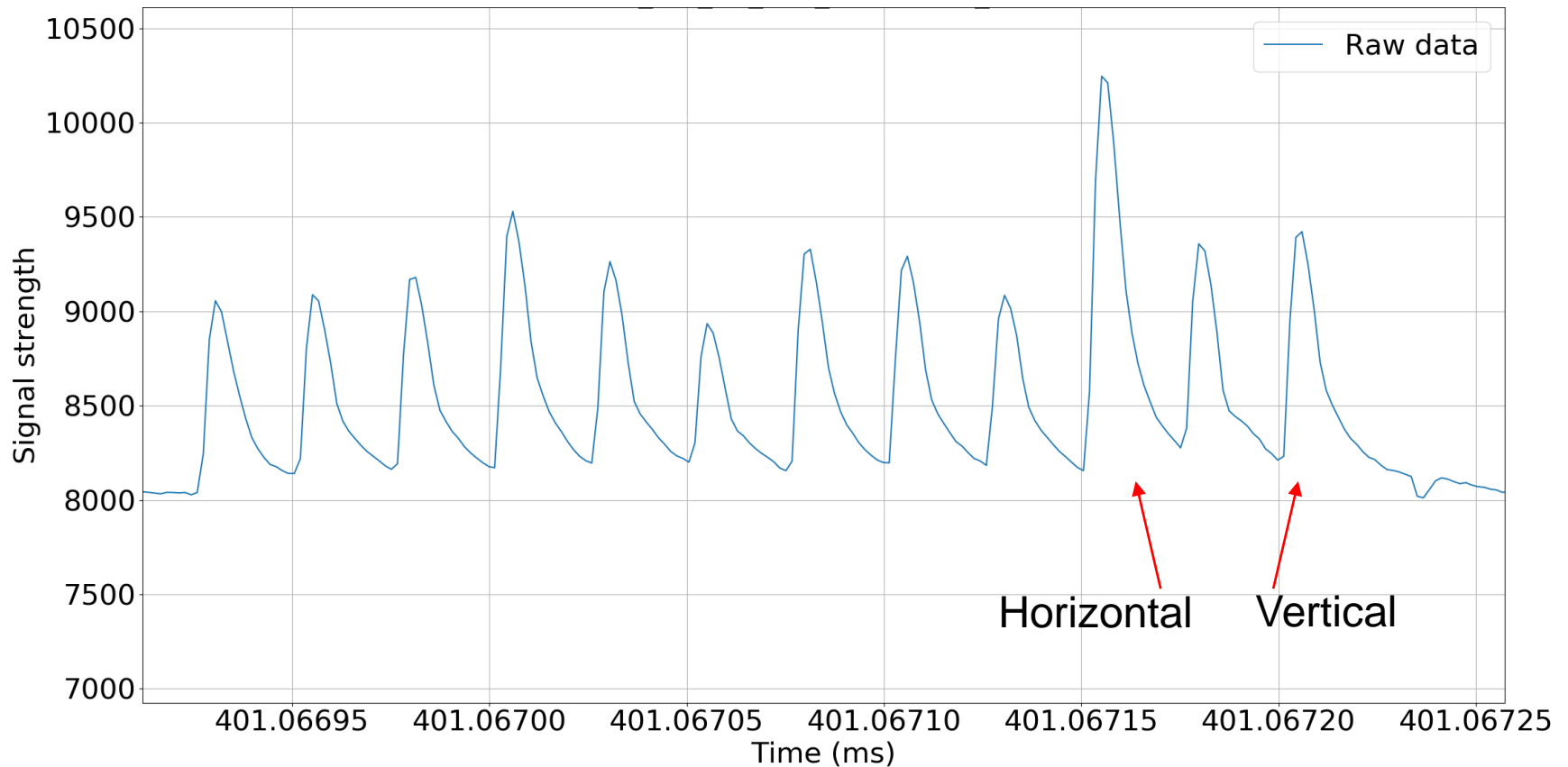
Event 30/09 22:47:52 (6.5 TeV)

Raw waveform – zoom in one turn



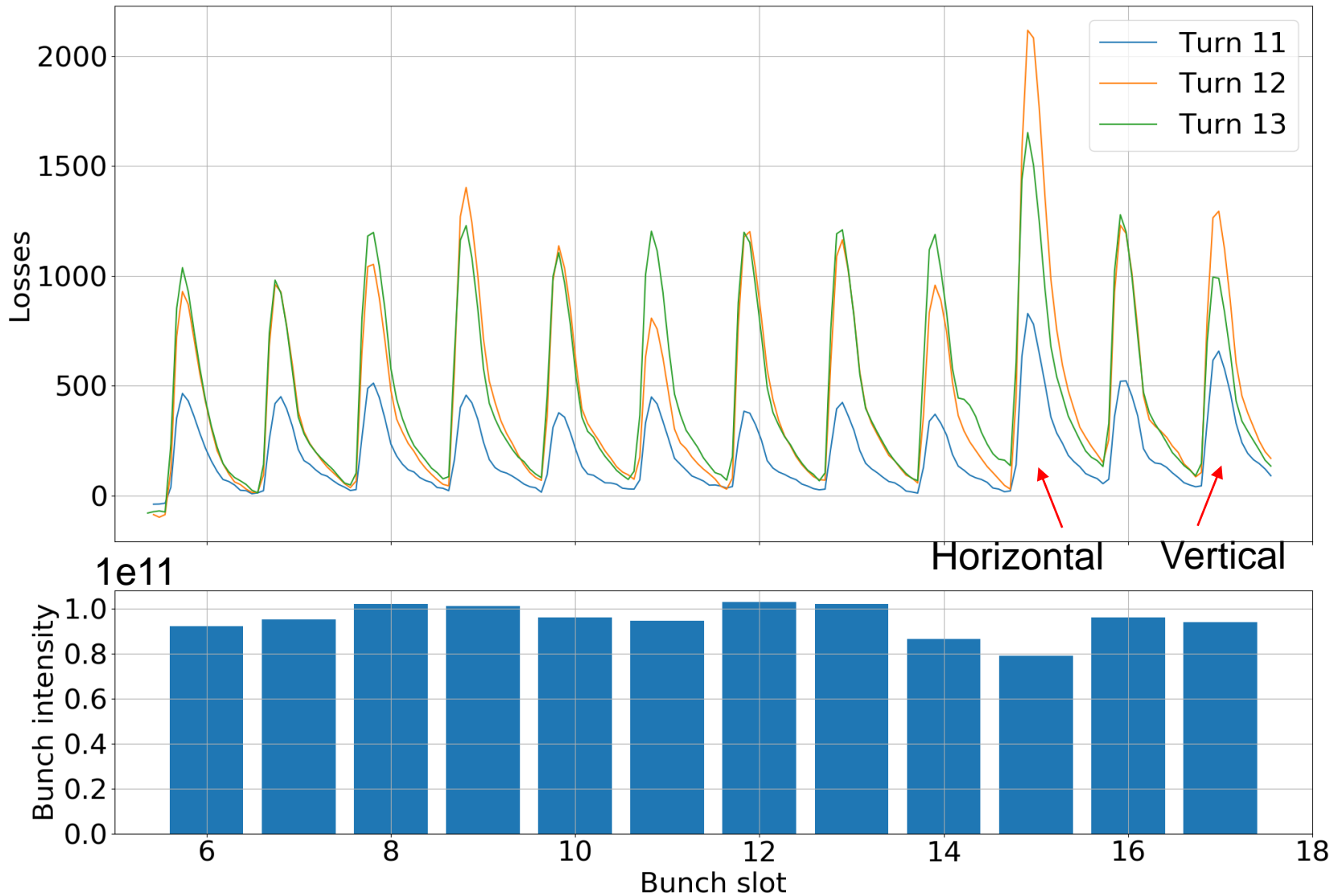
Event 30/09 22:47:52 (6.5 TeV)

Raw waveform – zoom in 12 b train



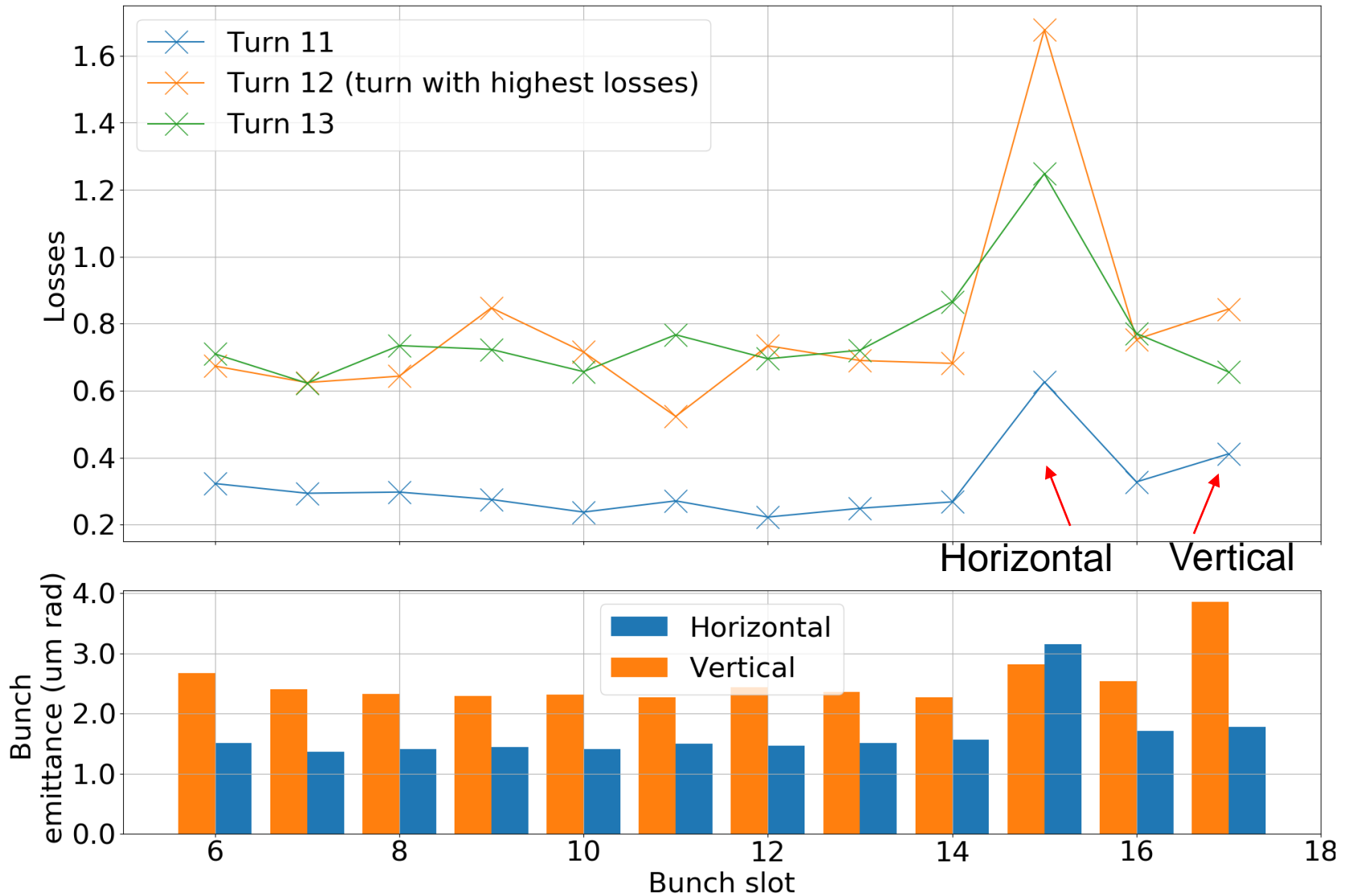
Event 30/09 22:47:52 (6.5 TeV)

Time evolution of losses in 12 b train

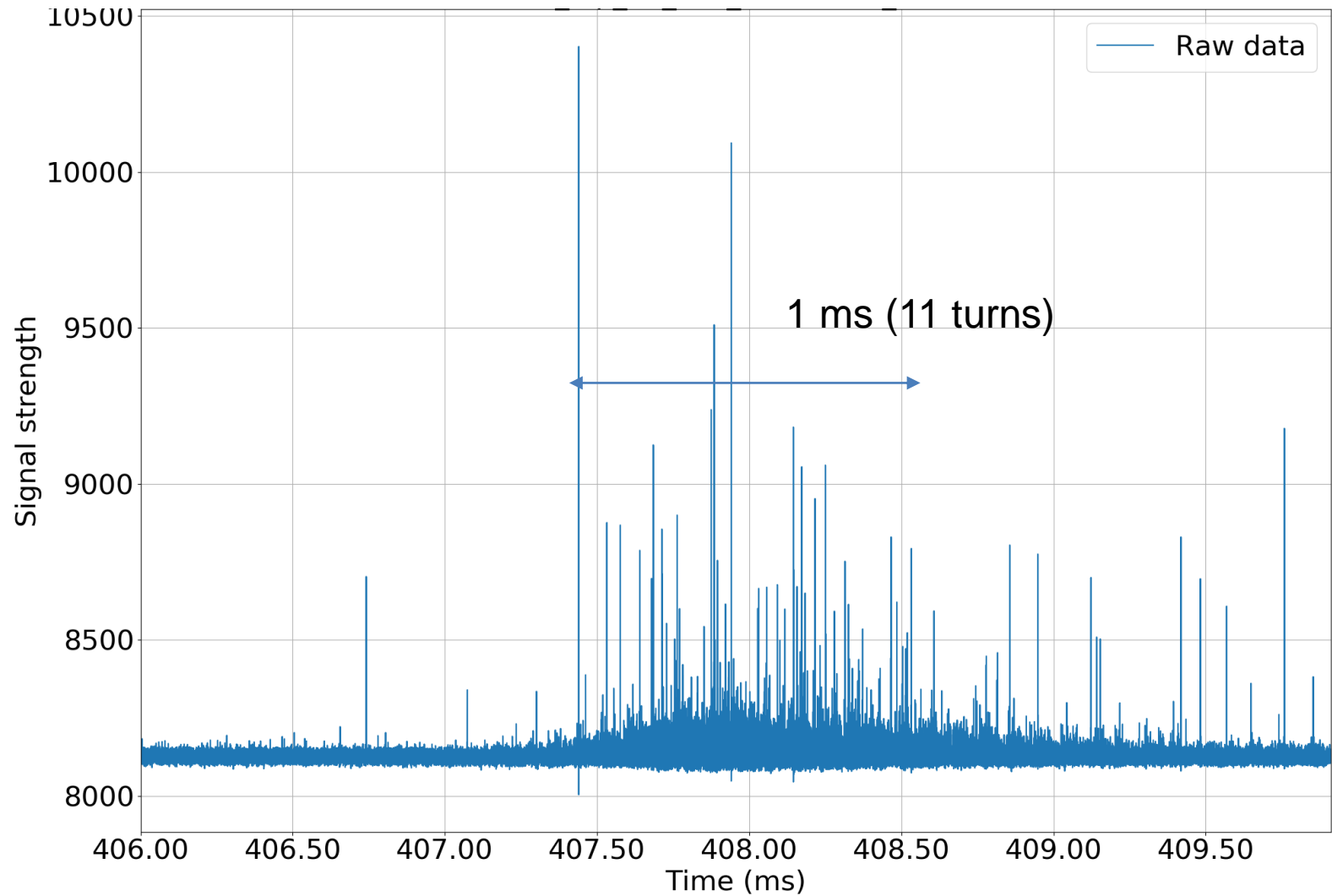


Bunch-by-bunch losses normalised to intensity

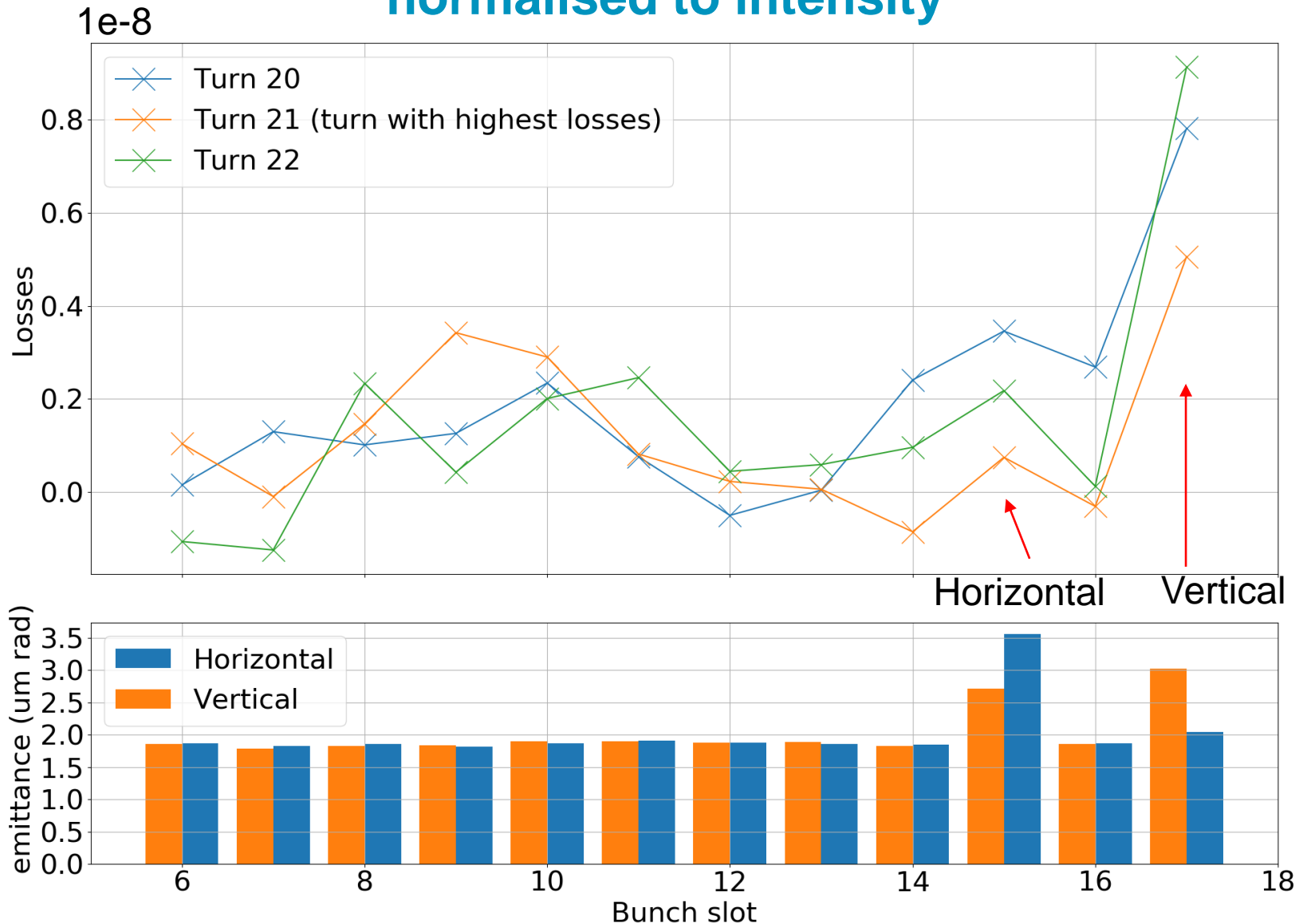
1e-7



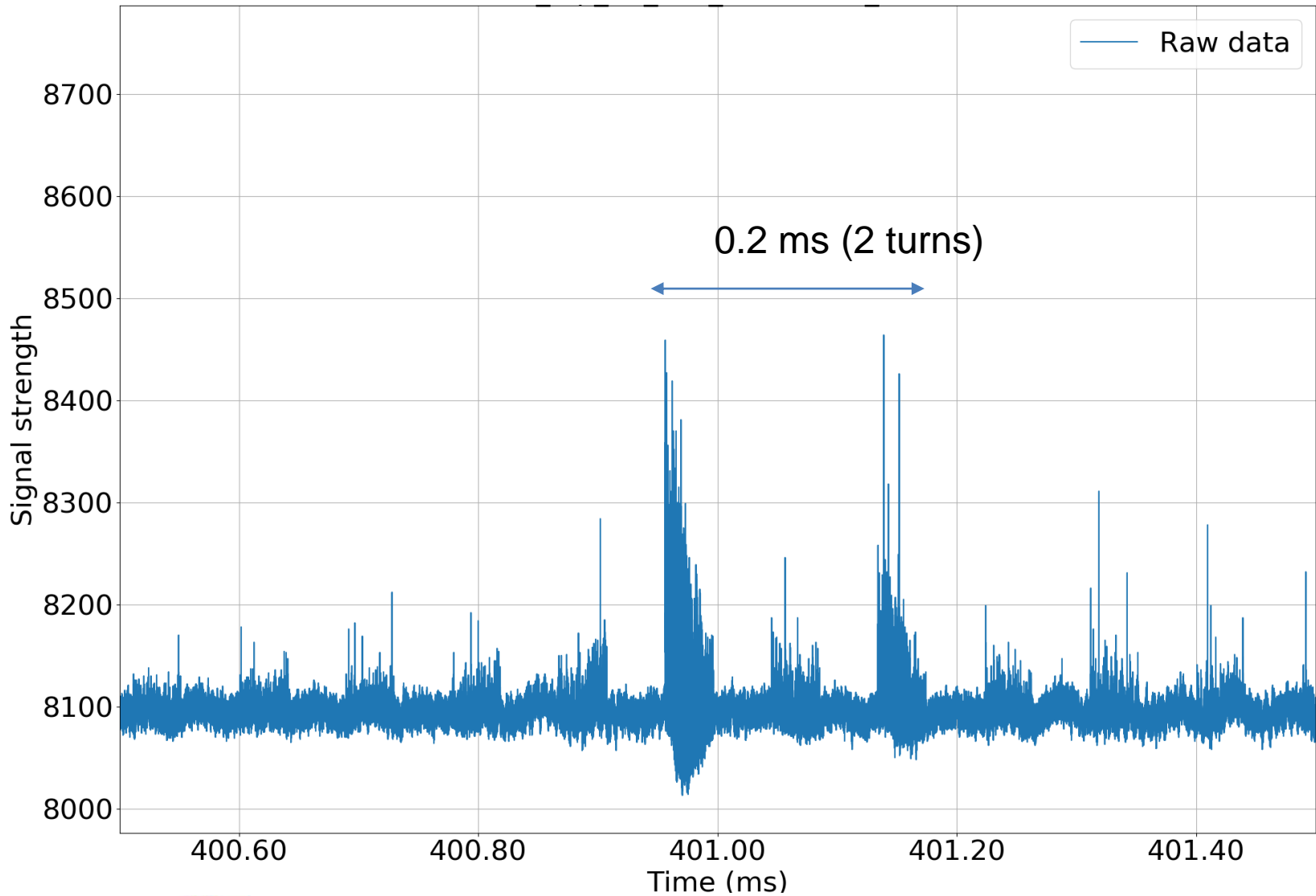
Event 17/10 23:53:50 (1.6 TeV) Raw waveform – full event



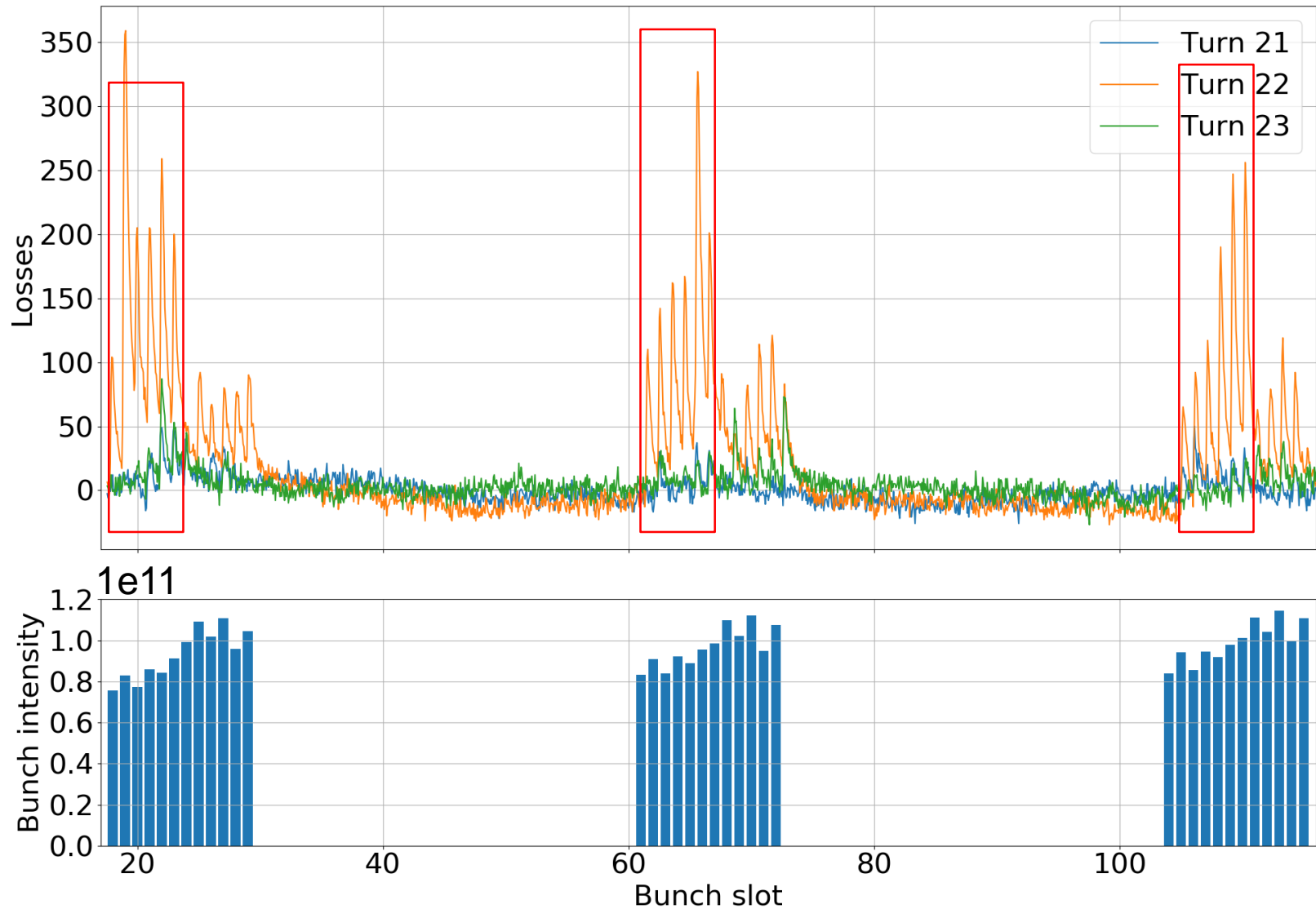
Event 17/10 23:53:50: Bunch-by-bunch losses normalised to intensity



16L2 event (TCP, 6.5 TeV): raw waveform – full event



16L2 event: bunch-by-bunch losses (3 x 12b trains)



Preliminary Conclusions

- Successfully used blown-up bunches in all normal proton physics fills without issues and triggered dBLMs on UFOs
- Observed UFO losses in horizontally and vertically blown-up bunches → indicates that movement is in both planes, to be confirmed by further simulation studies
- Blown-up bunches in combination with dBLMs and the new read-out electronics (VFC) are good tools to study UFO events
 - Sensitivity of method is closely correlated to number of blown-up bunches & emittance → careful statistical analysis together with simulations (on-going)
 - Biasing on UFO detection during ramp to be understood
- Detailed analysis ongoing
- Optimized system should be available for restart after LS2 to confirm conclusions → higher expected UFO rates