High Luminosity LHC

Measurements during operation and MDs

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The HiLumi LHC Design Study is included in the High Luminosity LHC project and is partly funded by the European Commission within the Framework Programme 7 Capacities Specific Programme, Grant Agreement 284404.

Outline

1. Analysis of RunI data:
   a. earthquakes
   b. eigen-frequencies IT (squeeze)
2. Possible measurements:
   a. eigen-frequencies IT (squeeze)
   b. MD on high and low frequency excitation

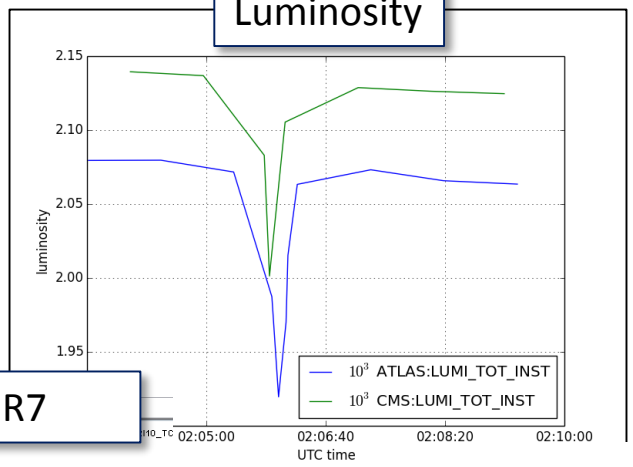
Analysis of RunI data

Analysis of effect earthquake events in 2011/2012:

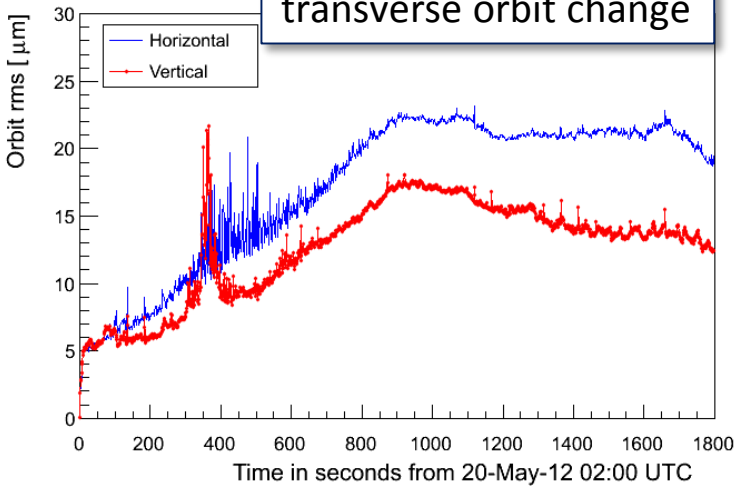
- detected by HLS system or nearby geological stations (see. J. Wenninger, “Earthquake effects on the LHC”, LMC,15.02.2015) in view of Geothermie 2020
- two events analyzed in more detail (Italy, 20.05.2012 and Costa Rica, 05.09.2012)
- visible effect on beam losses (BLMs), beam intensity and luminosity

earthquake in Italy:

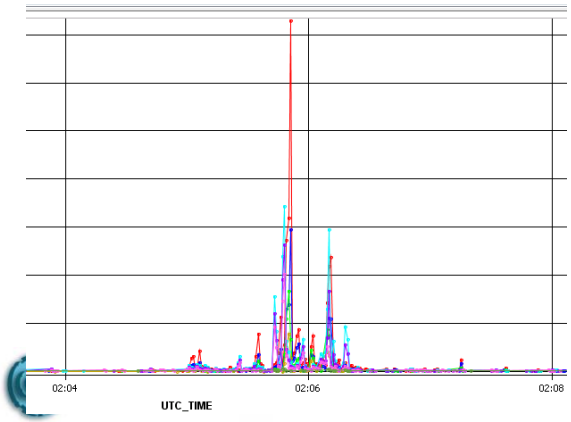
Luminosity



transverse orbit change

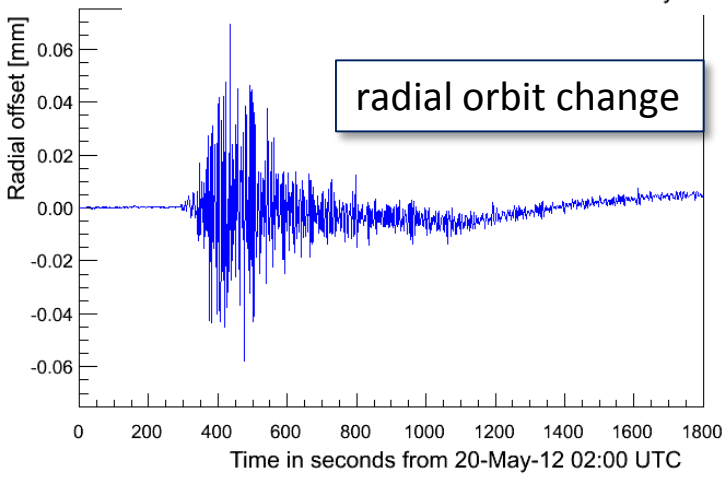


Losses at TCPs in IR7



Courtesy
J. Wenninger

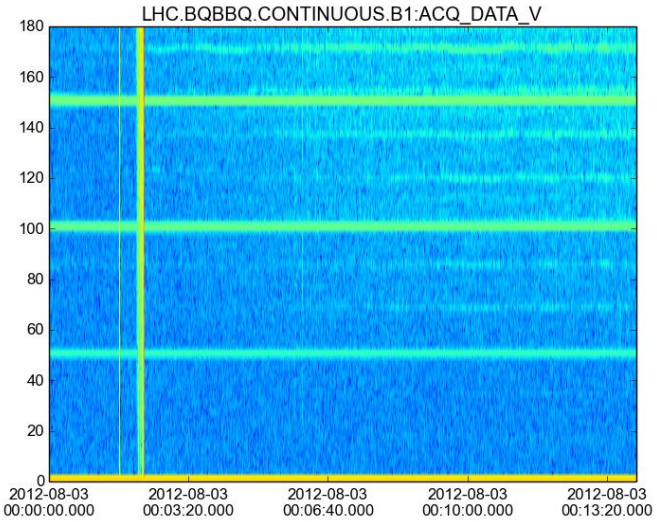
radial orbit change



Analysis of RunI data + proposed measurements

Analysis of squeezes during 2011/2012/2013 in order to determine IT eigen-frequencies:

- Idea: beta-function increases during squeeze mainly in IT -> sensitivity to excitation due to IT movement/powering increases with beta* -> low frequency lines could appear in spectrum during squeeze, like e.g.:



- advantage: if successful, the eigen-frequencies of the string of IT magnets is known and not only e.g. Q1
- measurement devices: ADT (no data available), BBQ (thanks to Riccardo data is partly available)

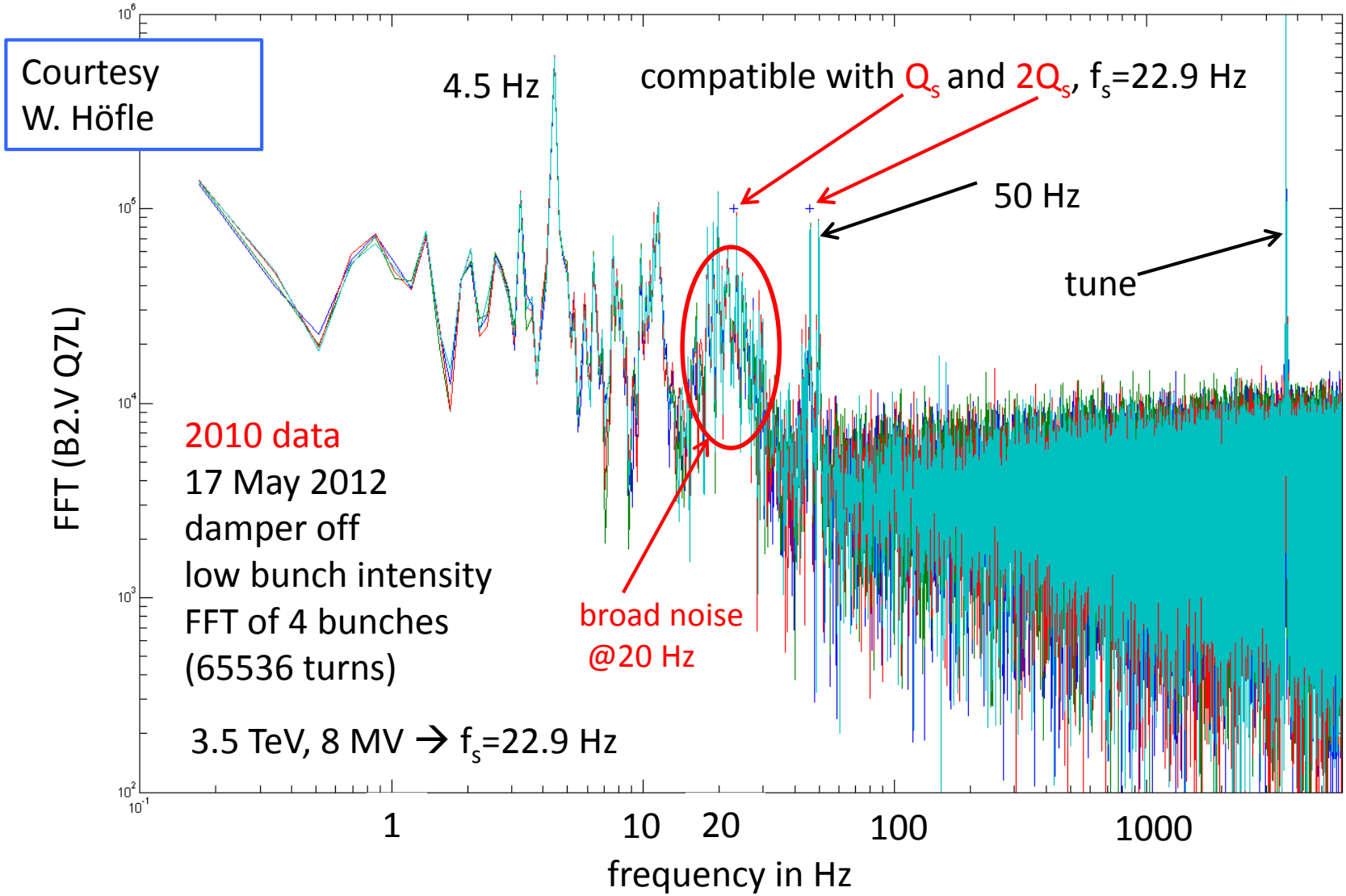
-> analysis of BBQ data not very conclusive and other data not available

-> new measurements during optics corrections of squeeze (maybe this week) with ADT and BBQ:

- more conclusive results if low frequency lines are visible with the ADT and BBQ
- low intensity beam (less instabilities) during commissioning
- repeat measurements for following squeezes in order to verify measurements

2010 data

Clean spectrum between 50 Hz and tune



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possible MD requests

in general two regimes are distinguished:

1. “high frequency”, f > 3 kHz : overlap with betatron sidebands at $(\nu_{x/y}-n)\cdot f_{rev,LHC}$
2. “low frequency” , 0<f< 3 kHz : $\nu_{x/y} \cdot f_{0,LHC} = 3485$ Hz, less harmful

1. high frequency: MD proposed by X. Buffat, J. Barranco, T. Pieloni to study in general the effect of noise on the emittance
2. low frequency excitation: MD proposed by R. Bruce, M. Fitterer, W. Höfle, Y. Papaphilippou, D. Valuch, J. Wenninger

create low frequency dipole noise with ADT or AC dipole:

- real frequency spectrum: more challenging to implement
- single or multiple sinusoidal excitation(s): easier and already available with ADT

study effect on:

- tail population: collimator scans, wire scanners, diamond monitors (2ns acquisition time)
- emittance growth: BSRT, wire scanner and luminosity monitors

=> ideally flat top, squeezed, colliding and full intensity to obtain max. tune spread and non-linearities from beam-beam

=> measure tail population with and without low frequency excitation

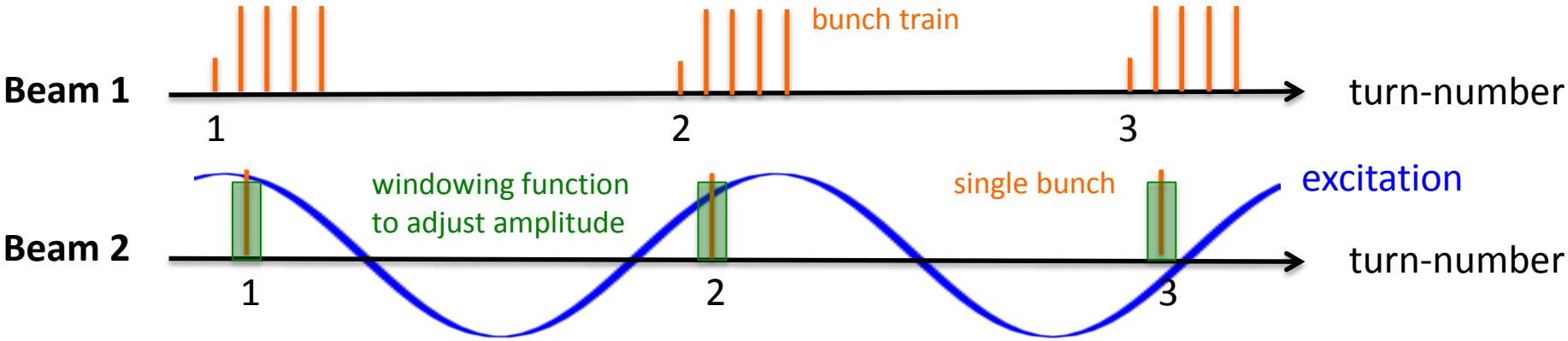
beam/tail distribution and diffusion rates for the two cases:

- without excitation (construction off)
- with excitation (construction on)

-> caculate particles lost at TCPs for different scenarios (see previous talk)

possible MD requests

2. low frequency excitation:
   - beam configuration:



   - measurement procedure:
     1. no excitation:
        measurement of the emittance (BSRT, wire scanner) and halo (collimator scans, wire scanner)
     2. introduce low-frequency excitation by changing the ADT firmware or using the AC dipole:
        possibly different excitations on different bunches and one bunch without excitation for reference. The excitation might have to be applied for several minutes up to hours as the expected emittance growth is possibly slow.
     3. effect of excitation:
        measurement of the emittance (BSRT, wire scanner) and halo (collimator scans, wire scanner)

Thank you for your attention!