

Observations during stable beams

(follow up: sudden beam losses, very preliminary ...)
to trigger discussions and possible strategies

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Conditions

■ Conditions:

- Squeeze to 3.5m with separation bumps on
- Crossing angles in all IPs
- Basic filling scheme: 3 bunches per beam,
 $\approx 10^{11}$ /bunch
slots: 1 - 895 - 1786 / 1 - 892 - 1786
buckets: 1(3) - 8941(2) - 17851(3) / 1(3) -
8911(2) - 17851(3)
- 6, 7, 12, 13, ... bunches are derived from this
- usually a tune split applied

Side-effects of these conditions

■ Unequal collision scheme:

- Bunches 1, 1786: 3 head on collisions
 - Bunches 895/892: 2 head on, 1 long range collisions
 - Long range separation not very large, depends on emittance, β -beating
- ➔ Rather different tune spread and shift

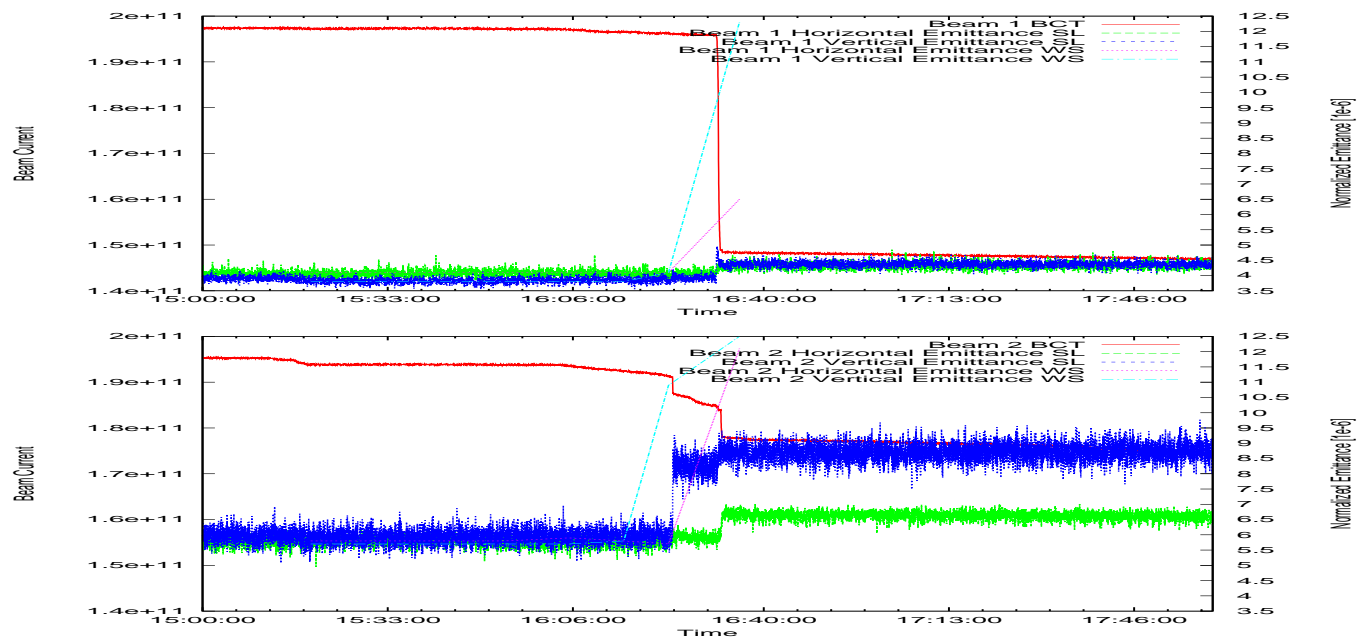


A few observations

- Sudden beam losses observed during a fill (very fast and not reproducible, makes analysis difficult)
- Adding a witness bunch (7x7) indicates that loss is beam-beam related.
- Here some of the observations
- Discuss and test some of the possible causes



Very first occasion: Sunday, 20.6.

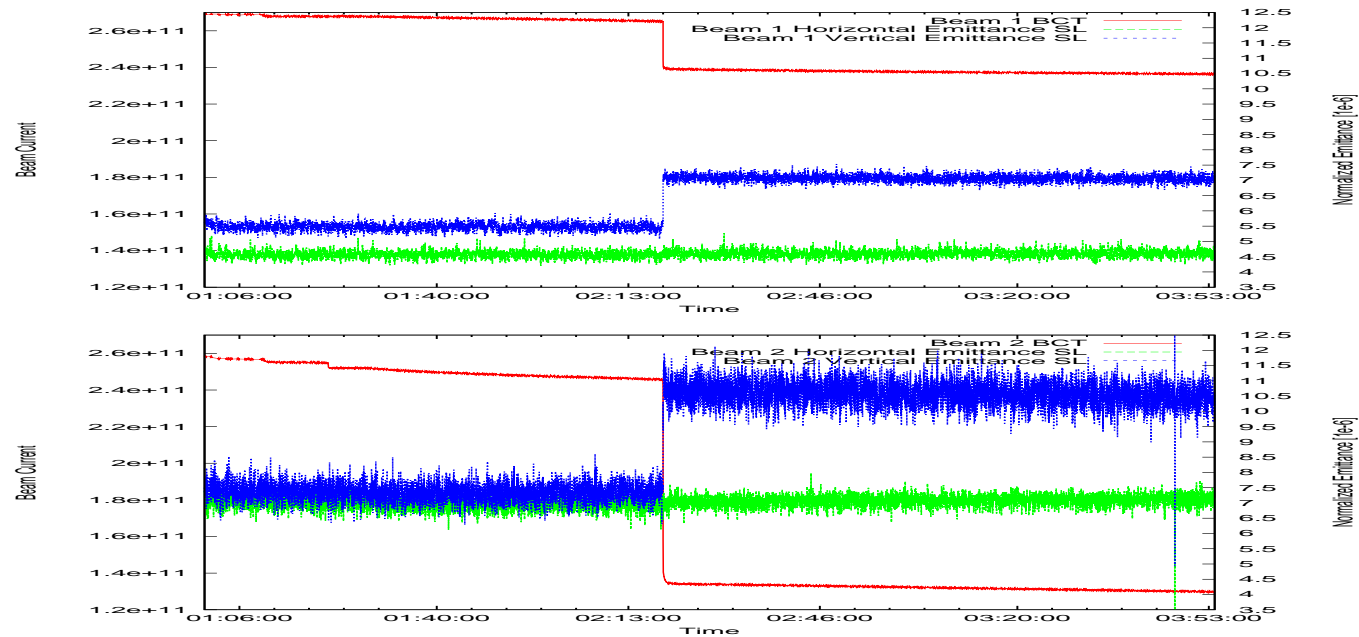


■ Small loss on beam 2 with emittance increase, followed by strong loss on beam 1

➔ Note: emittance increase seen by wire scanners too large



Friday, 25.6.

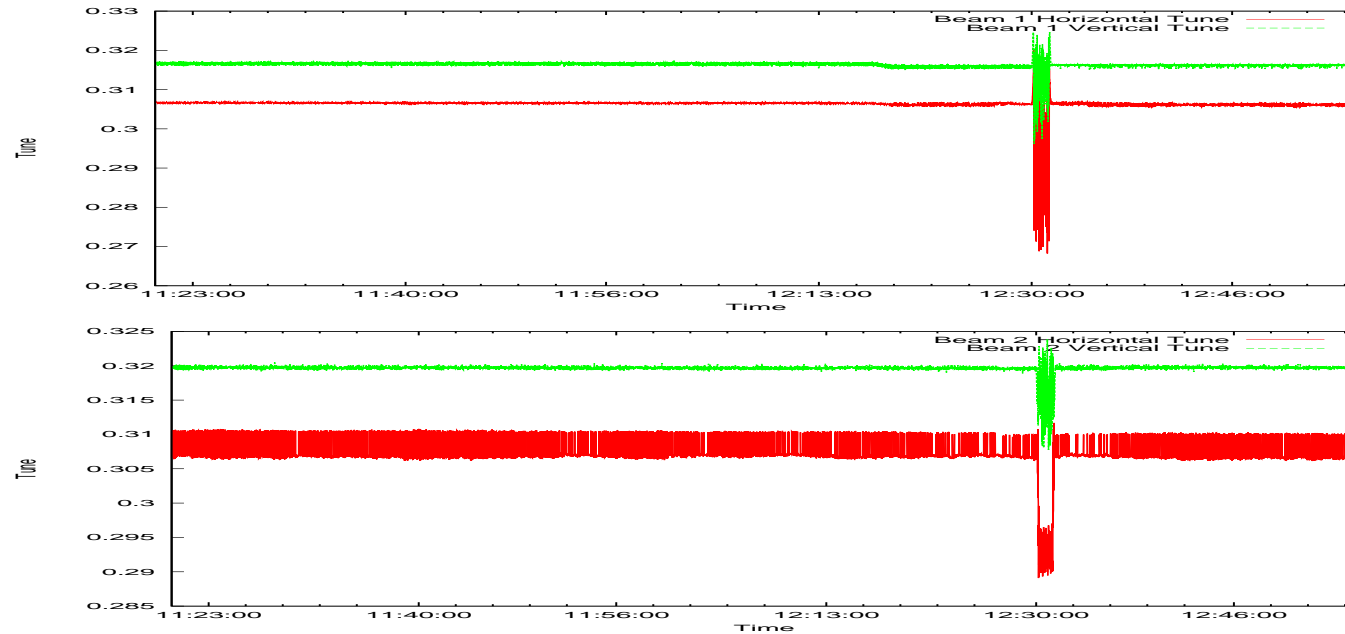


Simultaneous loss in both beams together with emittance increase (vertical)

➔ Note: happened about 1 min after a lumi scan



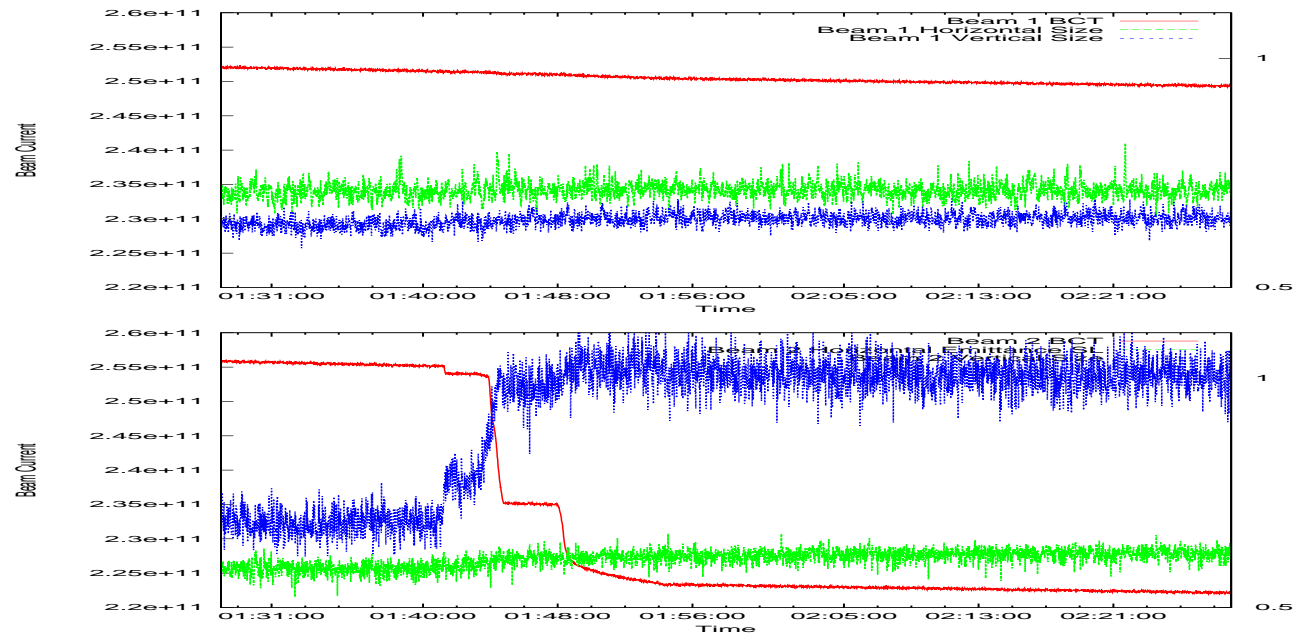
Saturday, 26.6.



- No intensity loss, but strong tune change during collapse ? Locked on some mode ?
- If real, tune difference very large for coherent beam-beam modes (unless ..)



Sunday, 27.6.



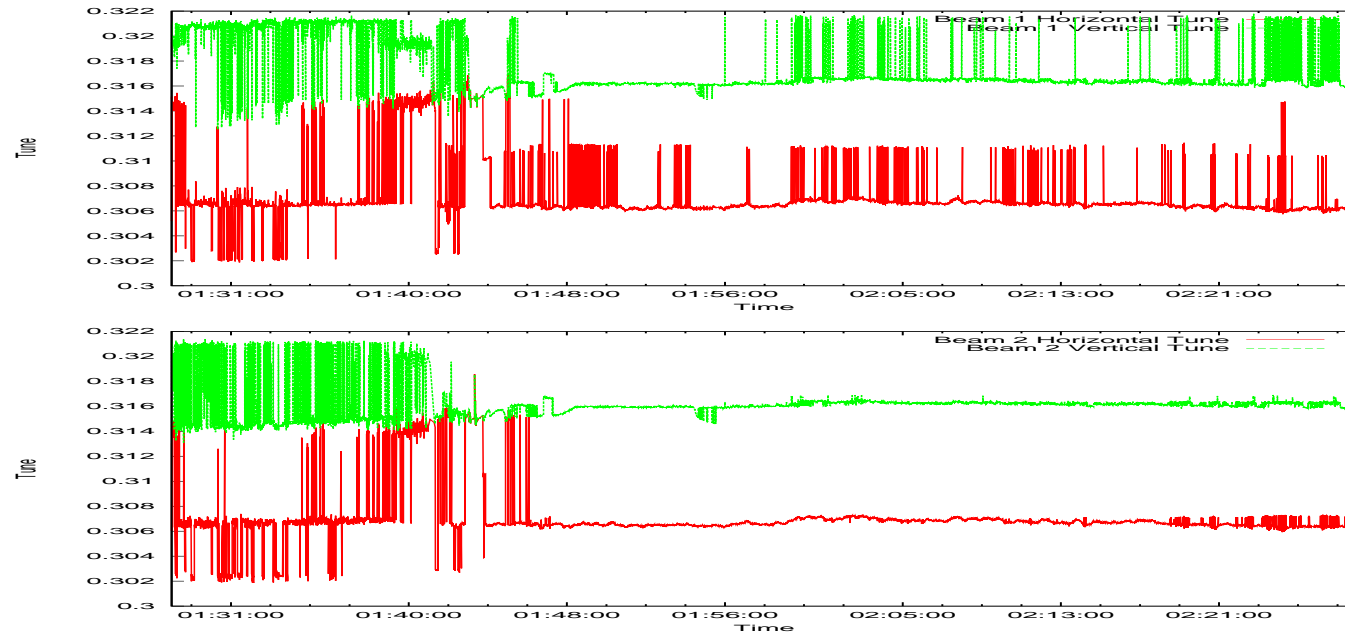
■ Modest loss and emittance increase on beam 2

Something is happening on the beam before the second loss

■ What happened to the tunes ?



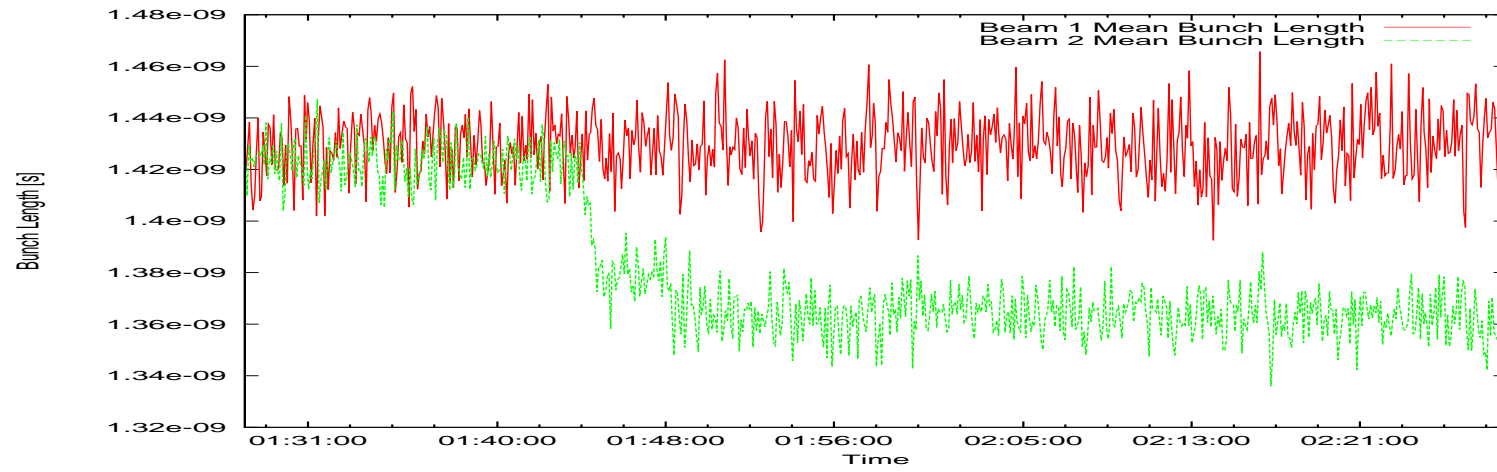
Sunday, 27.6.



- Strong fluctuation of peak signal on beam 2 before the loss, quiet after .., additional modes, tune split, different bunches ?
- Any other observation ?



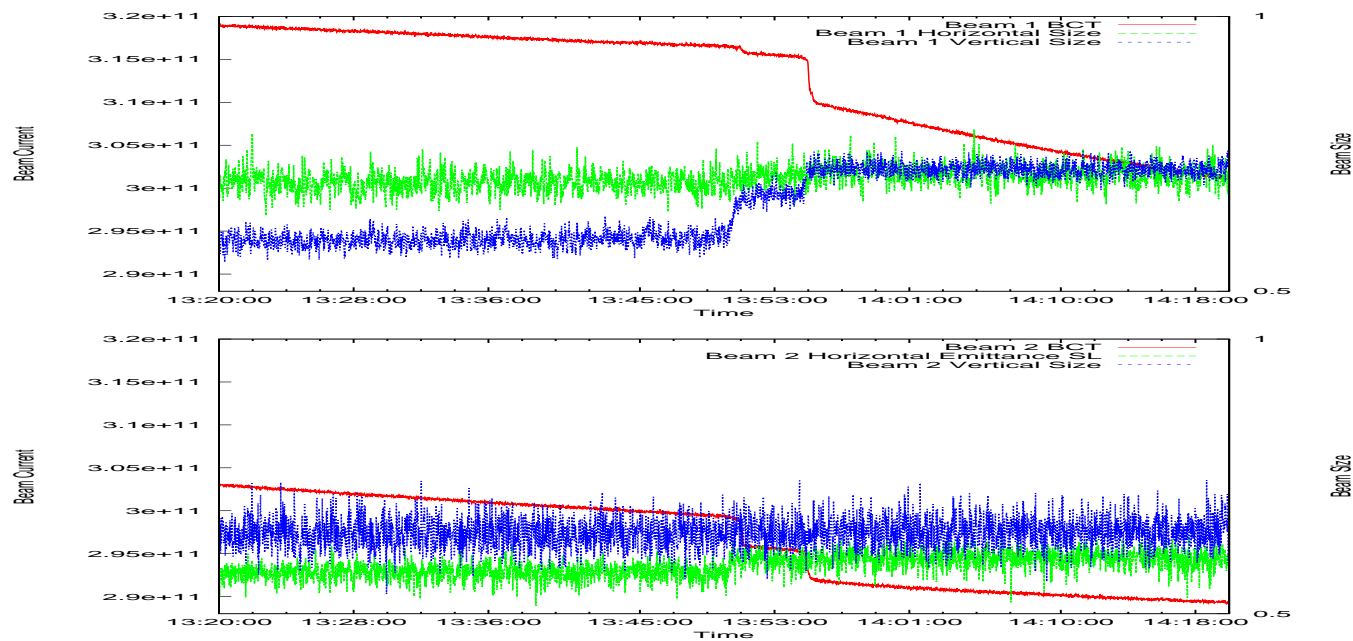
Sunday, 27.6.



 Bunch length of beam 2 slightly smaller, observed again later



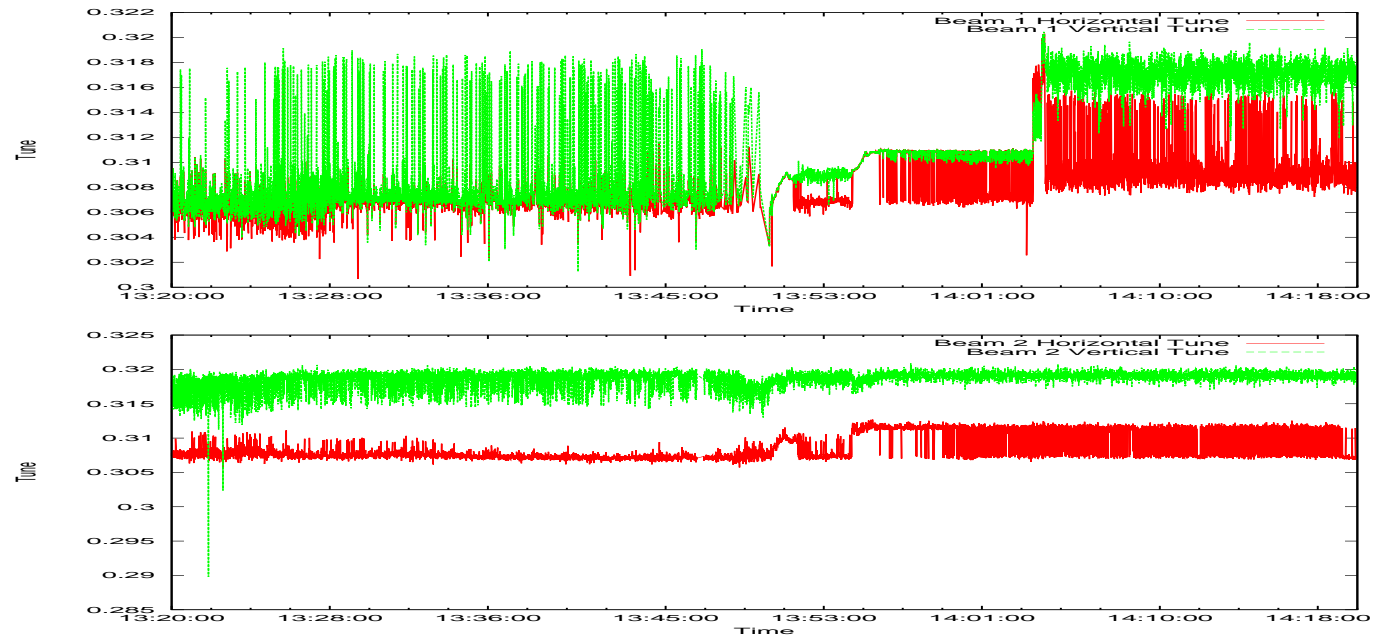
Tuesday, 29.6.



Similar observation, happened again a few minutes after a lumi scan



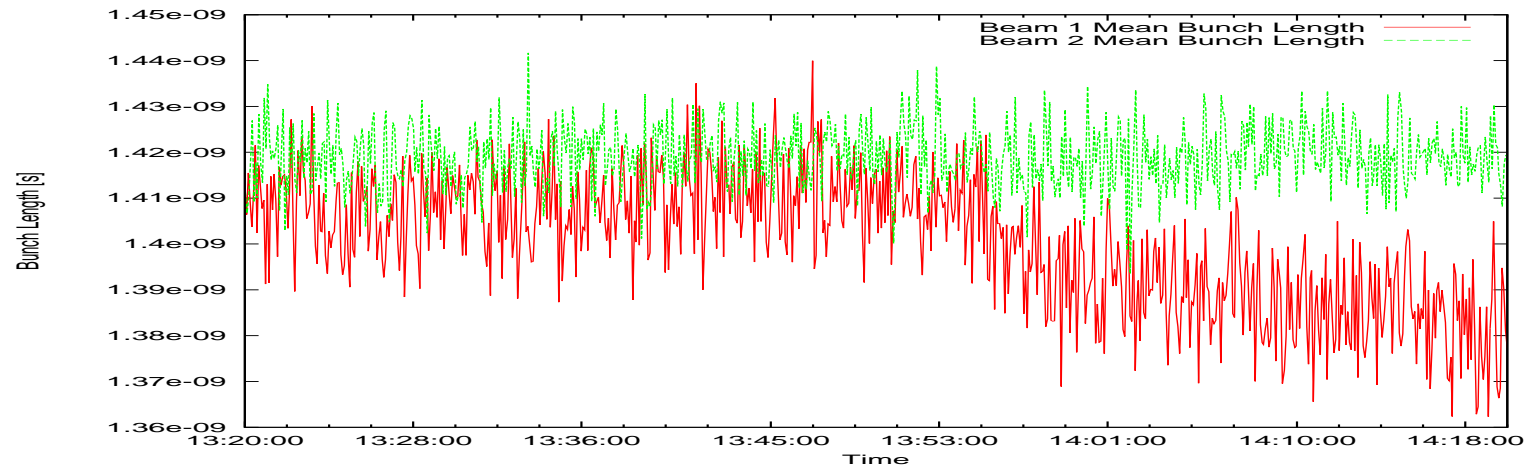
Tuesday, 29.6.



 Tunes: not very clear signature



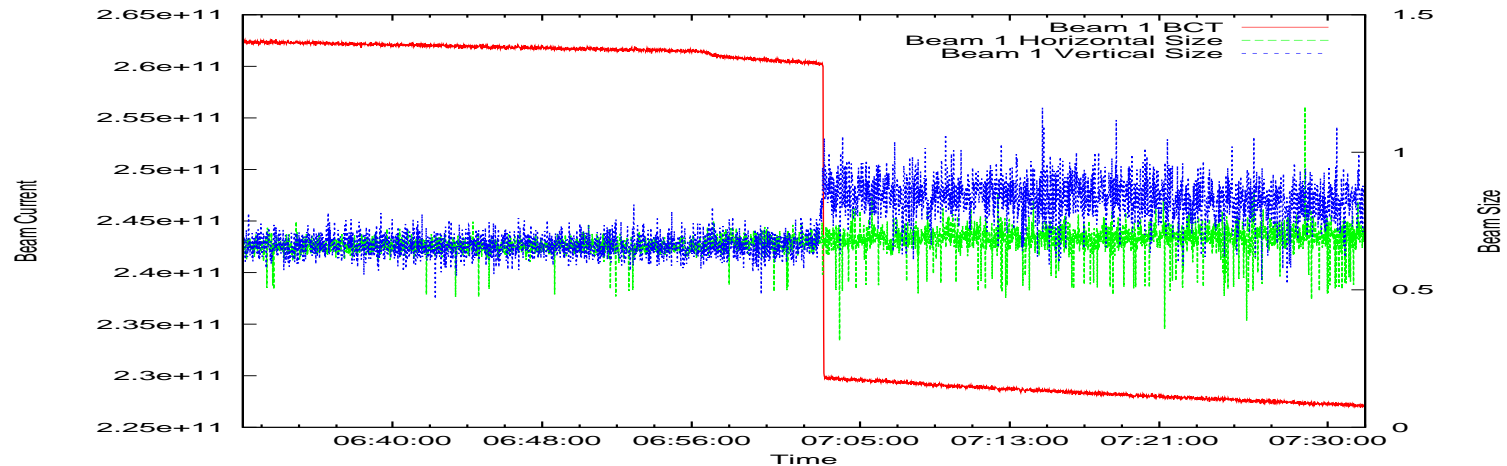
Tuesday, 29.6.



 Small change of bunch length on one beam



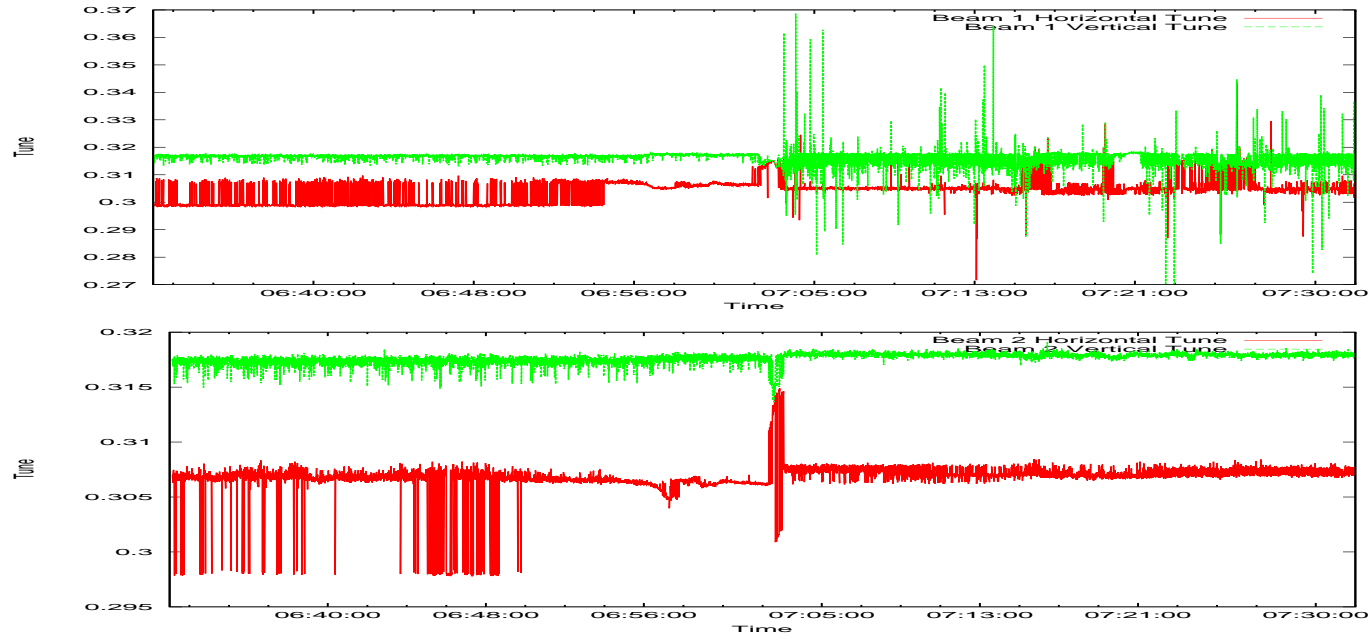
Thursday, 1.7.



- Beam 1 only, well known signature
- Observation: large luminosity drop in ATLAS and CMS (much less in ALICE, LHCb) about 5 min before loss, (reconstructed beam size increase in both planes)



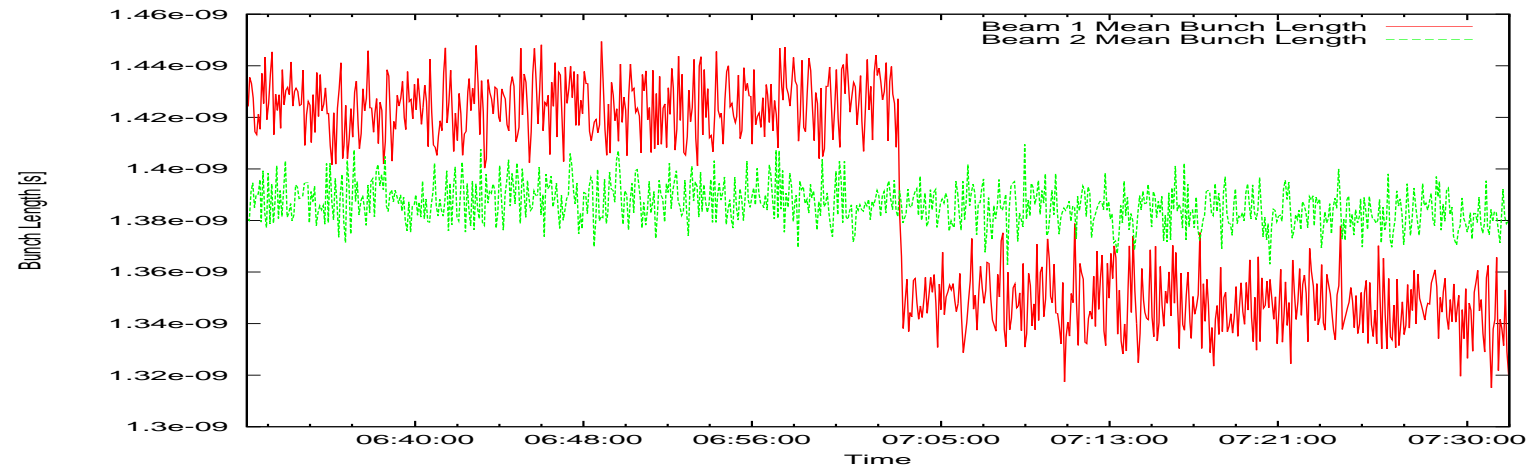
1.7.



 Tunes: very clear signal during time of the loss



1.7.



 Small change of bunch length on one beam



What could be the reason ?

- Is it related to beam-beam ?
 - ➔ Yes, but how ... (cause versus symptom)
 - Unequal collision pattern and emittances ?
 - ➔ Test with collision scheme equal number of collisions for all bunches (10x10, but should have nominal intensities)
 - Contribution of the (single) long range encounter ?
 - ➔ Test with equal number of collisions and **no** long range
 - Reduction of dynamic aperture due to beam-beam ?
 - ➔ No ! Should cause bad life time and be **worse** after emittance increase
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What could be the reason ?

- Unequal beam sizes (remember SPS) ?
 - ➔ Very unlikely, should lead to bad lifetime, but not to a sudden loss
 - ➔ β -beating: as above, except for long range interaction
 - ➔ What if emittances are smaller than we think: strong coherent dipole kicks when beams are moving, check !
 - Coherent beam-beam, self exciting ?
 - ➔ Very unlikely with unequal bunches, but cannot exclude, should never happen with tune split
 - ➔ (Note bene: 3rd order can drive coherent beam-beam, for a while)
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What could be the reason ?

- (Small) excitation from outside source (hump ? not always present) ?
- ➔ Any excitation of one beam can (will) cause troubles when beams are in collision (are all gadgets off ?)
- ➔ Remember: we have basically nominal intensity, i.e. head-on beam-beam
- Any RF noise (e.g. phase) ?
- ➔ Possible, needs to be studied



What could be the reason ?

- Loss of Landau damping ?
 - ➔ Always possible, but requires collective motion (open a big hole) and change of damping
 - ➔ Behaviour seems to be far too "reproducible" for that
- Effect of crossing angle ?
 - ➔ Possible, if something moves the beam longitudinally (RF noise)
 - ➔ Test without crossing angle (filling scheme) and maybe with RF



Summary I

- Behaviour not yet understood
- Some candidates, need to be tested, ideally under simplified conditions
- Beam-beam yes, but unlikely to be the cause, rather the executioner ..



Summary II

- Recommend to test some of the possible culprits (first attempts with 10 bunches)
- Transient dipole kick difficult to avoid, should try with FB, possibly at end of fill first
- Must try to understand, retreat to "working" scenario not a long term solution
- For equal number of collisions per bunch and per IP, we pay a big price
- Follow up continues ..

