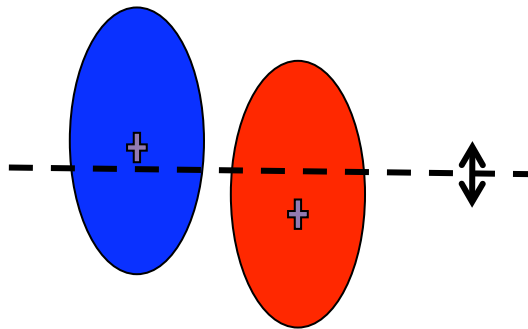


Leveling test: machine experience preliminary results

T. Pieloni for the beam-beam team
G. Arduini, X. Buffat, W. Herr, F. Roncarolo
OP crews on shift

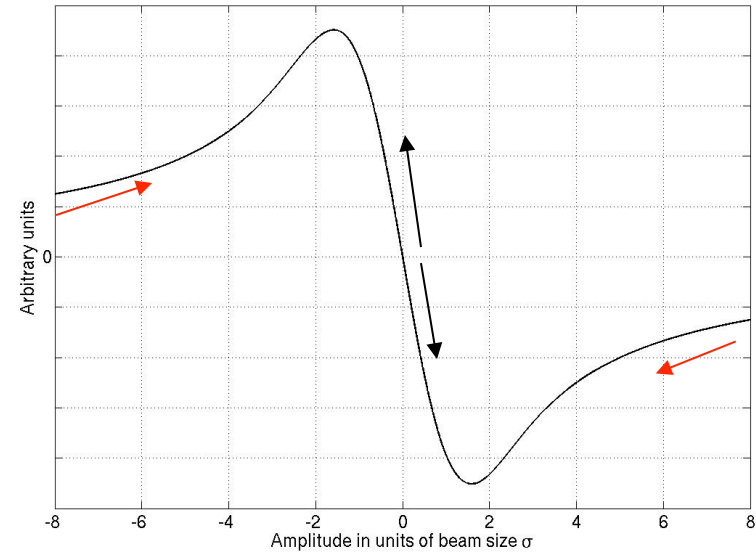
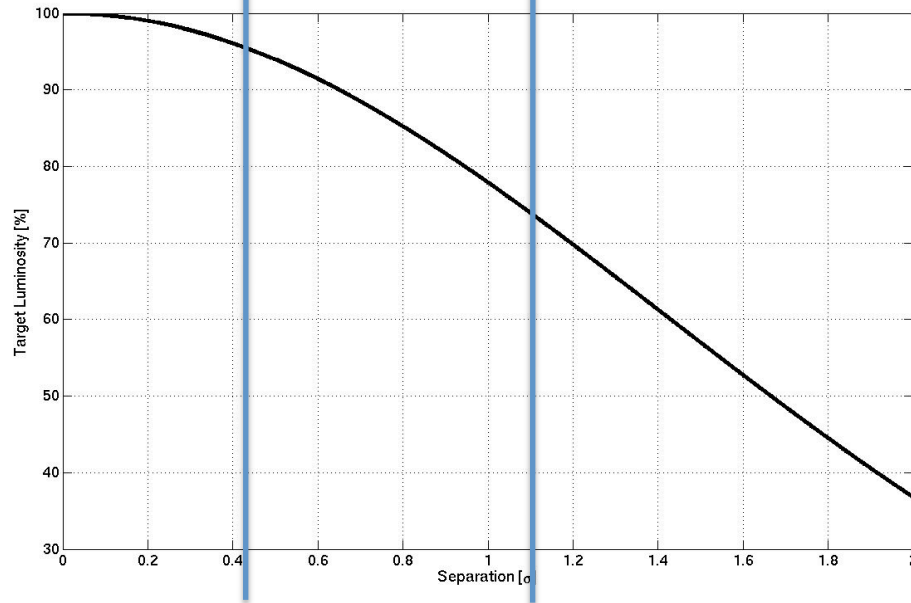
Luminosity leveling with trasverse offset

IP1 & IP5 request reduced lumi to 70-80%



95%

75%

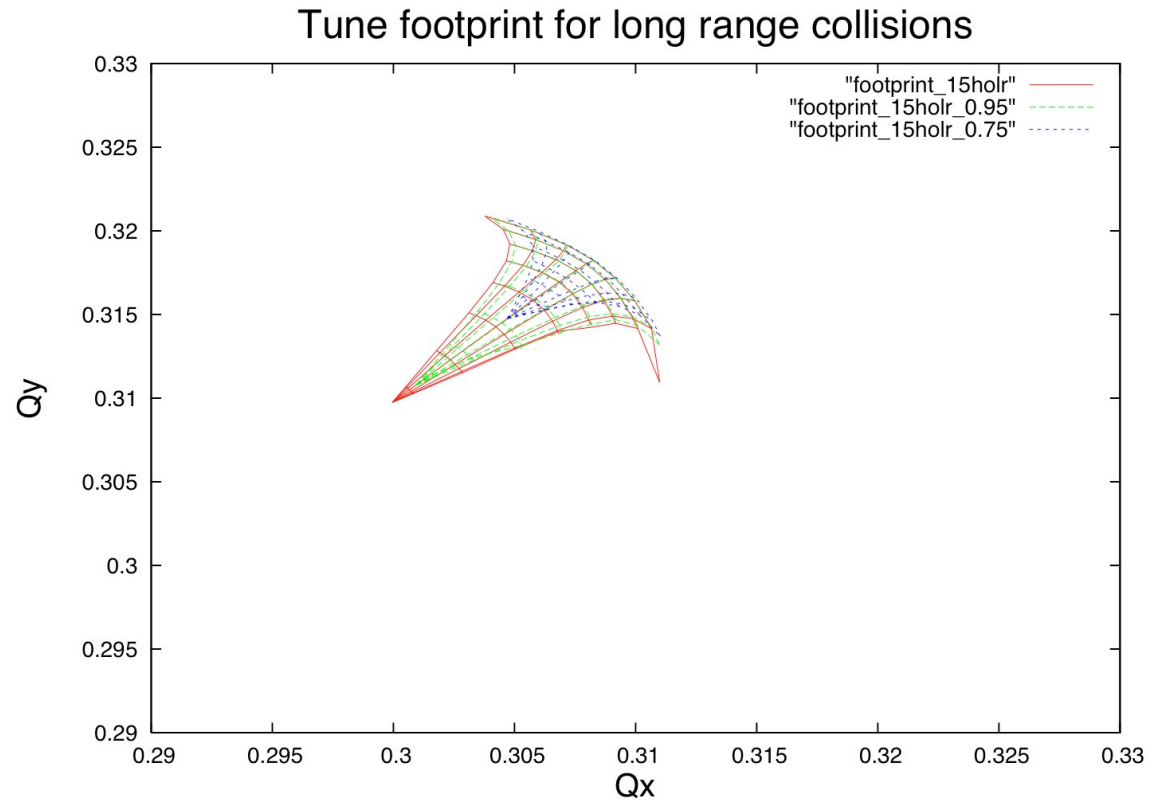
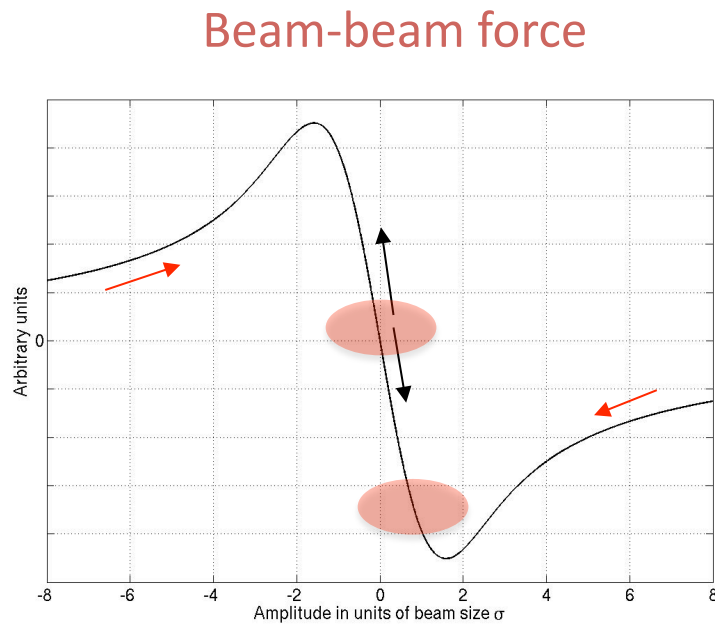


Beam-beam Effects

- Different dynamics of particles
- Orbit effects
- Slow emittance growth with offsets
- Passive compensation

Why 95% and 75%

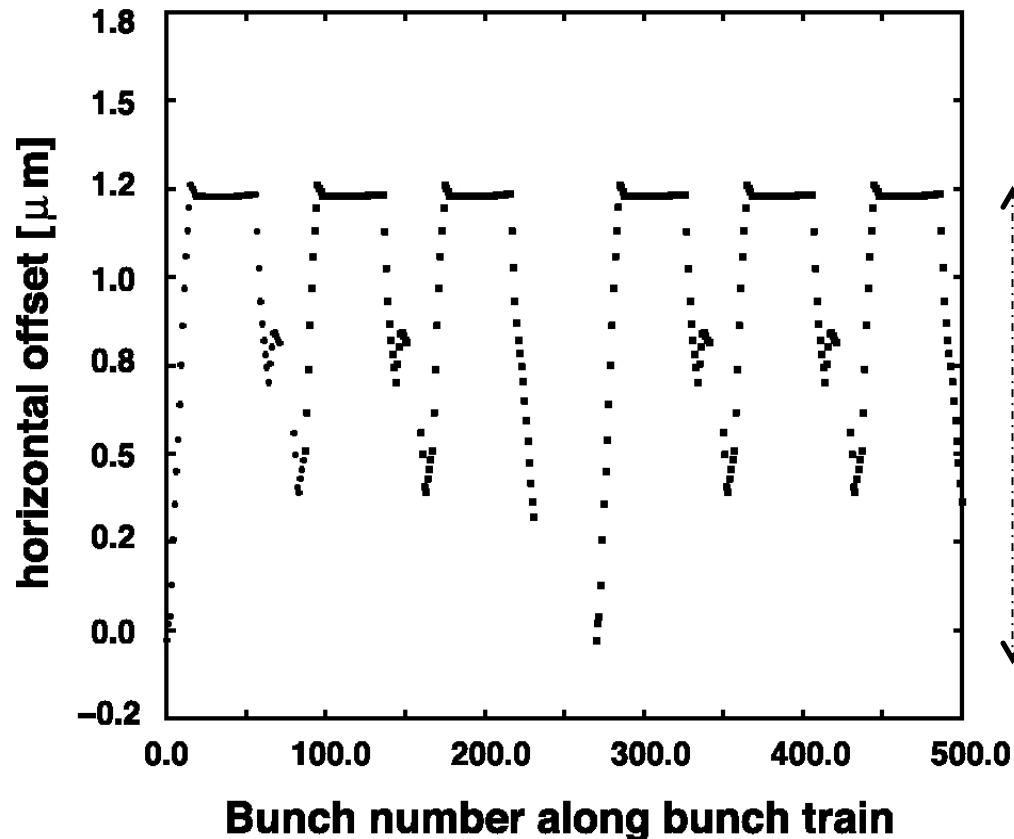
Different beam-beam dynamics at 0.4σ and 1.2σ



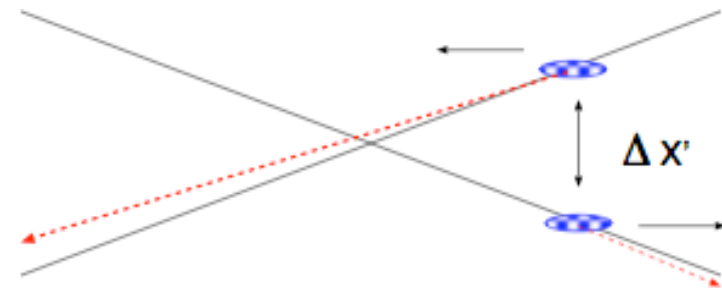
Depending on the offset the force seen by the other beam is different
Depending on the offset bunches have different tunes

Why 95% and 75%

Orbit effects different due to pacman effects and the many long-range add up giving a non negligible effect



$d = 0 - 0.4$ units of beam size



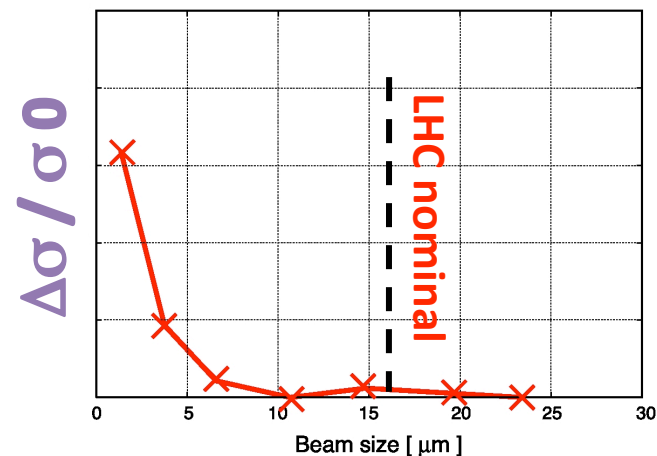
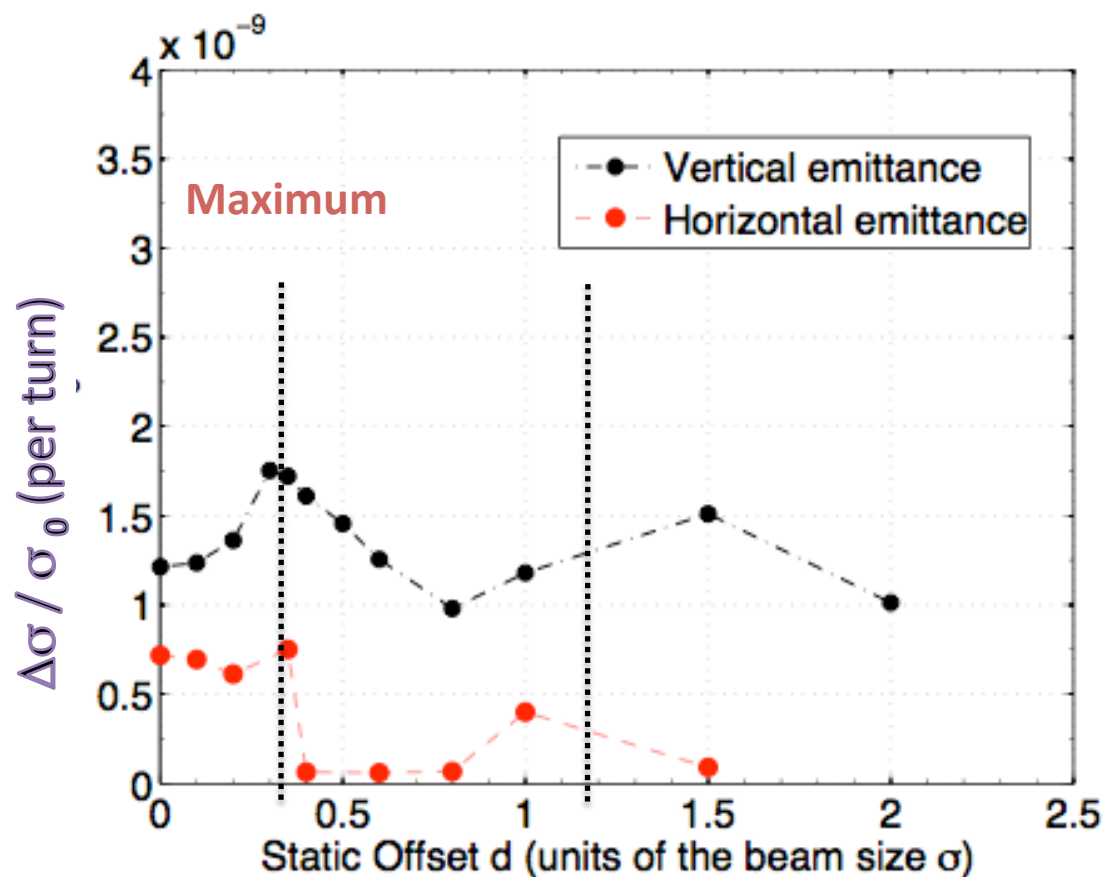
Small Offsets from long-range interactions

$$\Delta x' = \frac{const}{d} \left[1 - \frac{x}{d} + O\left(\frac{x^2}{d^2}\right) + \dots \right]$$

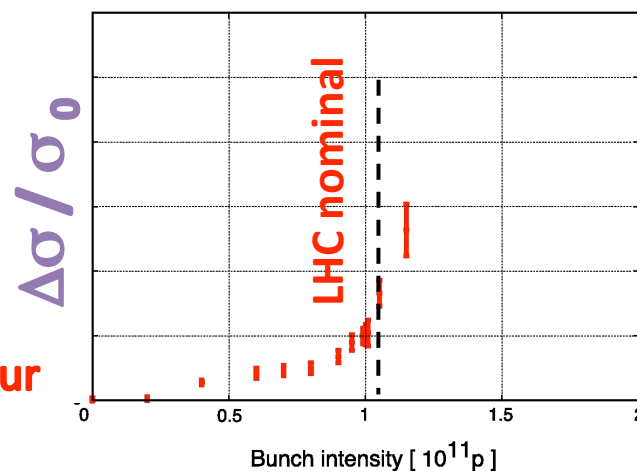
0.4 σ offset is what the experiments will have from LR for nominal LHC

Why 95% and 75%:

Offsets in collision give Slow Emittance growth



And strong tune dependency stay away from 3rd order resonance

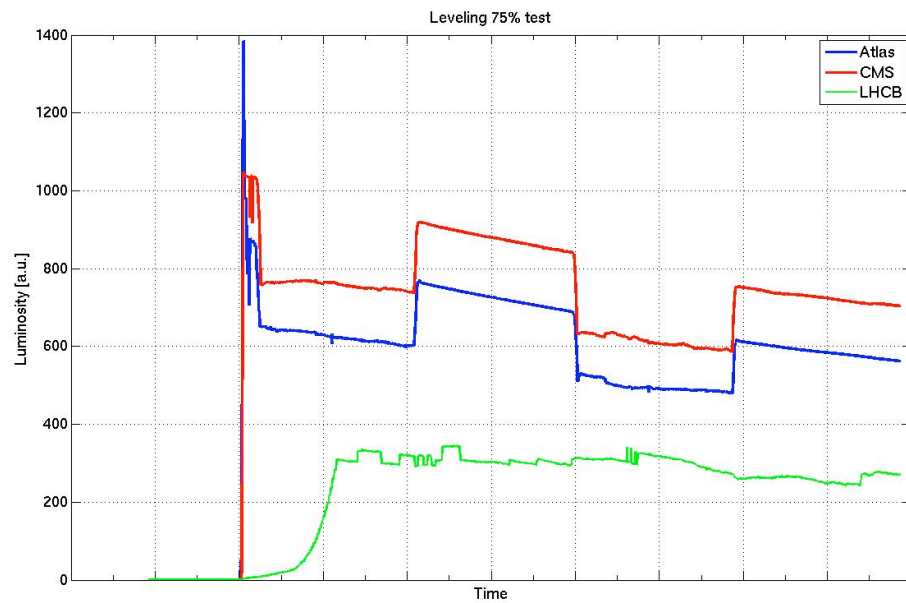


Numerical models show a slow emittance growth (8% hour for nominal LHC)

Reduce orbit effects (passive compensation)

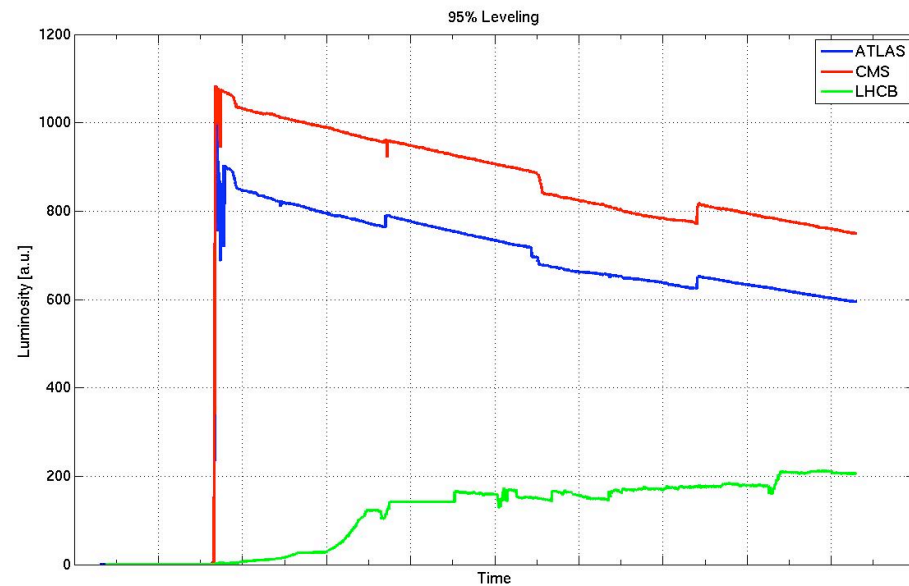
Interplay with parameters to not enter threshold values and working point optimization

Fill 2488 and 2489

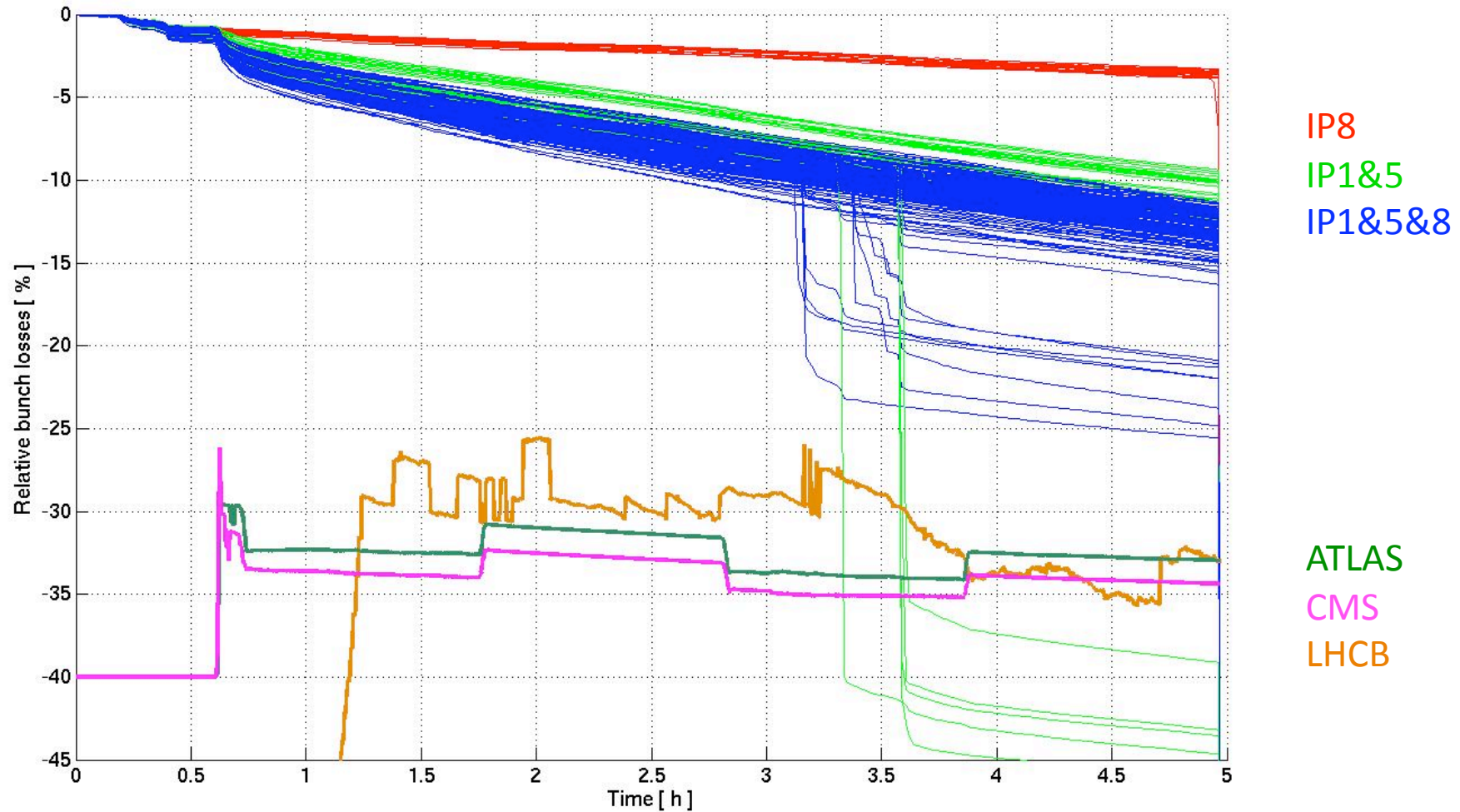


Fill 2488 8th April 00:26-05:10
ADT B1H ½ GAIN

Fill 2489 8th April 06:51-11:36
ADT B1H back full GAIN @9:00



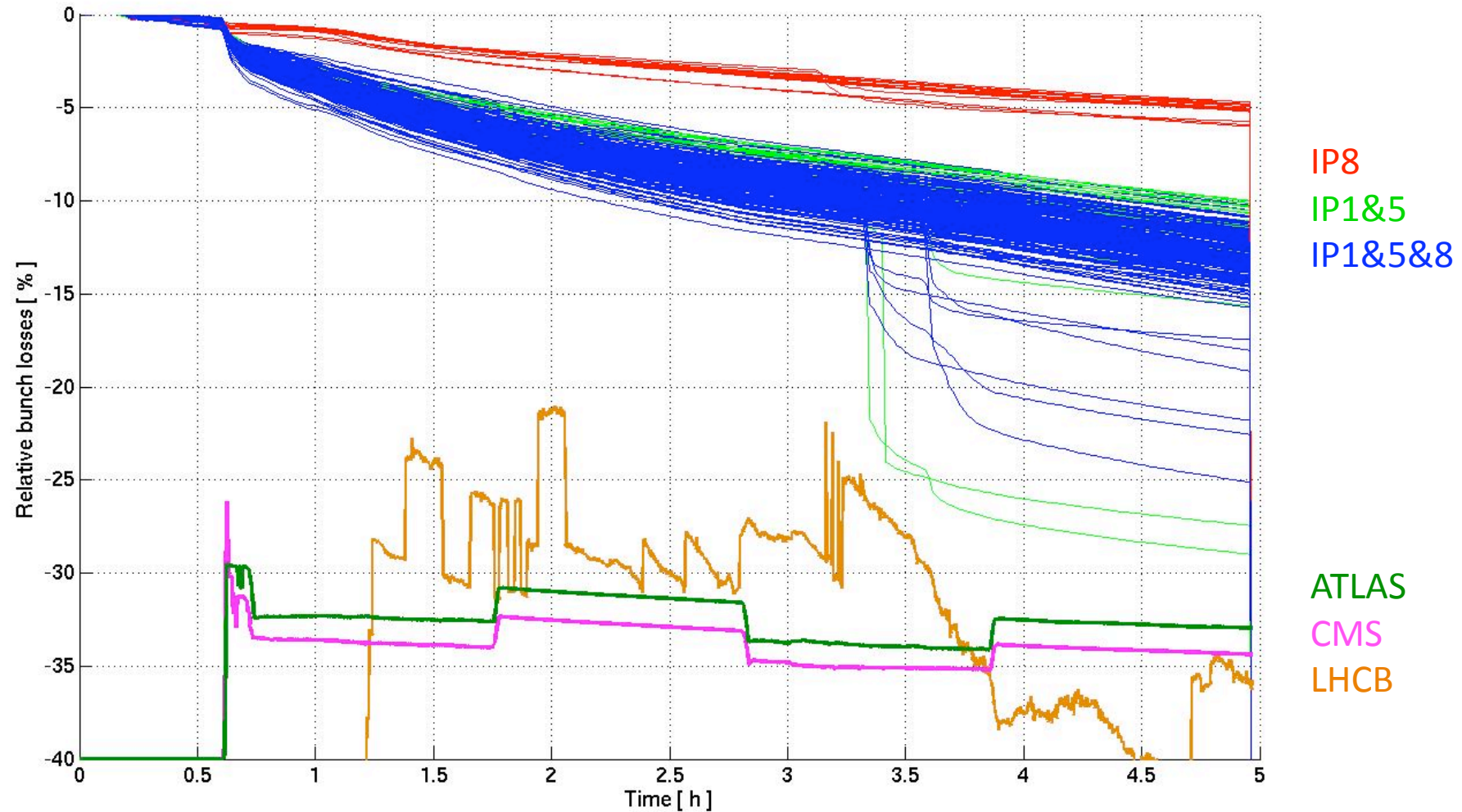
Bunch by Bunch losses Fill 2488 B2



LHCb leveling drives unstable few bunches of Beam 2

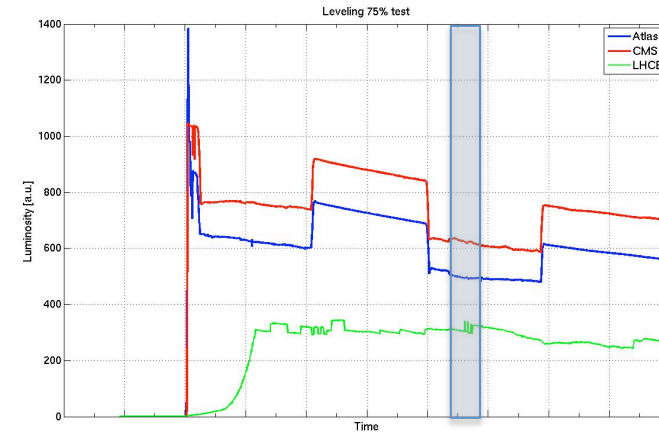
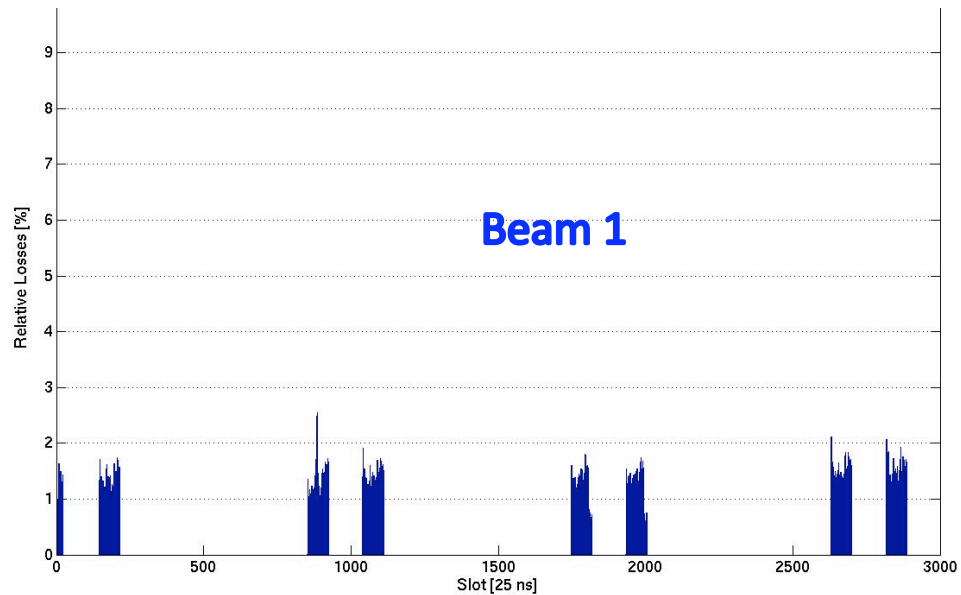
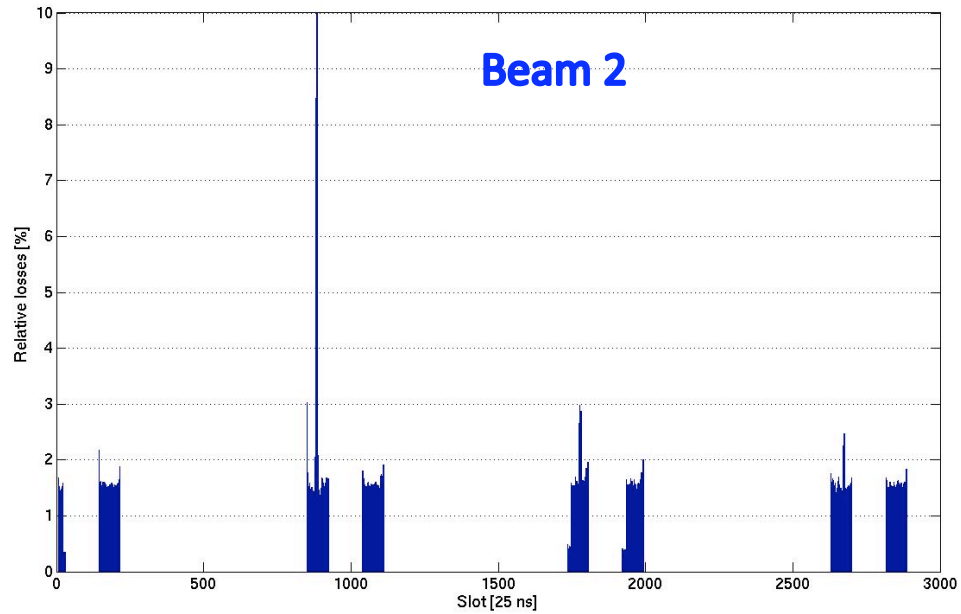
Nothing to do with offset in IP1 & IP5

Bunch by Bunch losses Fill 2488 B1



Instability propagates to Beam 1 via coupling in IP1 and IP5

Few bunches of B1 & B2 unstable

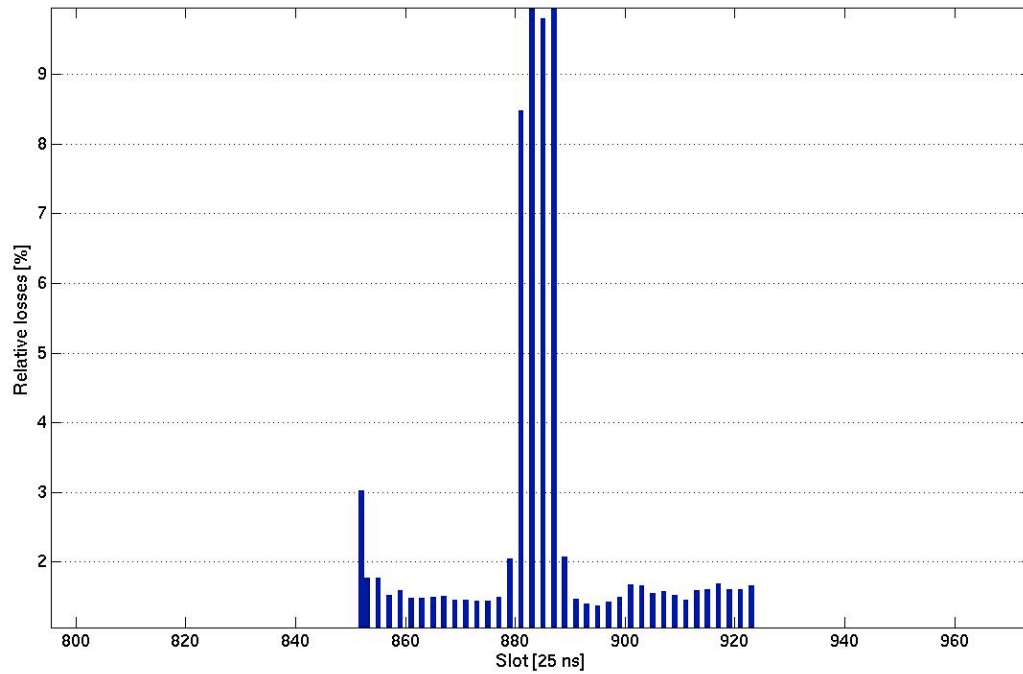
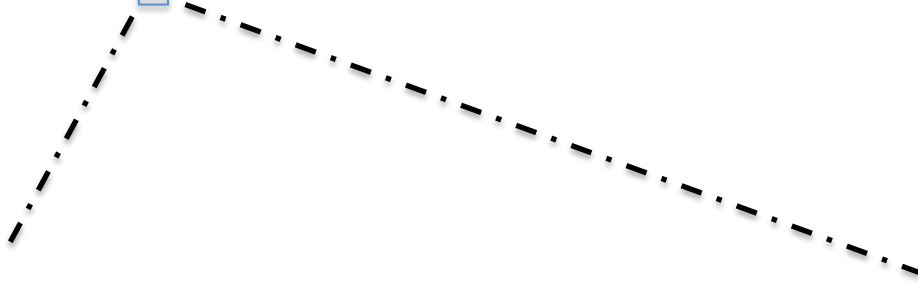
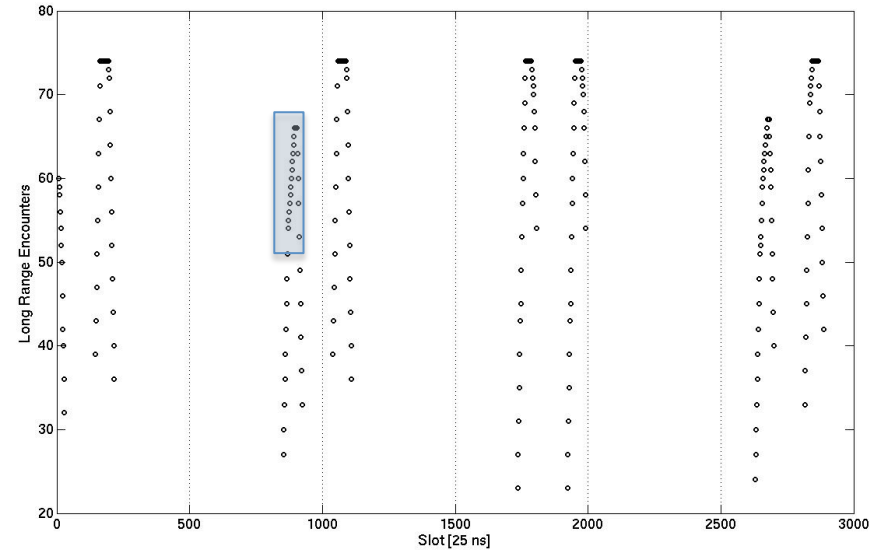
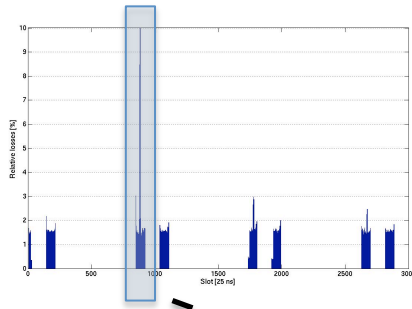


During leveling at IP8 few bunches start loosing:

- B1: 2 bunches just colliding in IP8
- B2: few bunches colliding in IP1-5-8

Instability starts with few bunches of B1 & B2 and then propagates to the other colliding partners at the different IPs

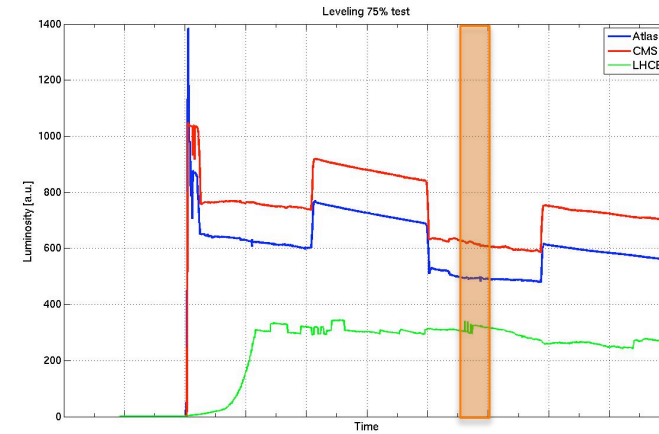
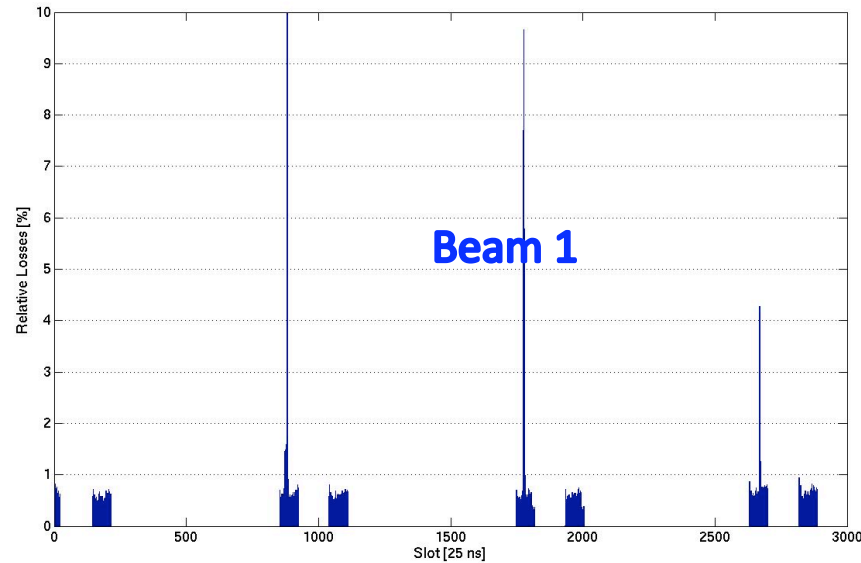
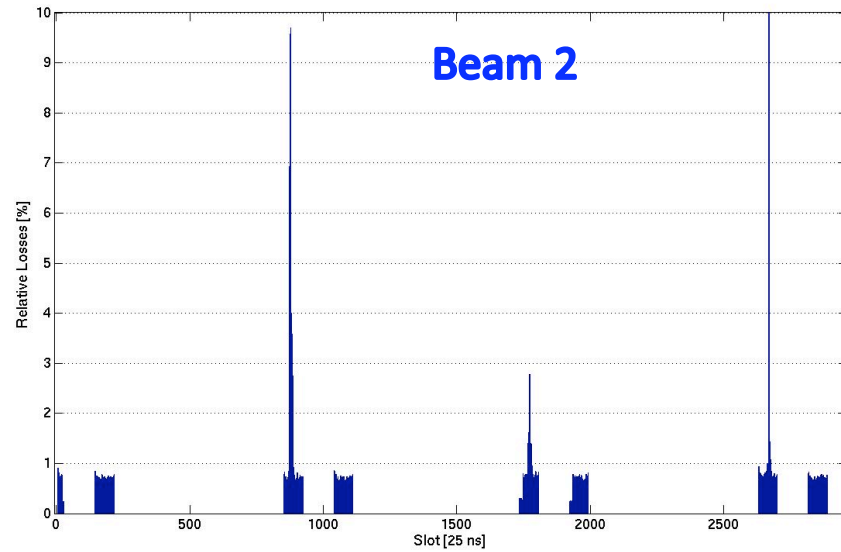
Special bunches?



**These 4 bunches of Beam 2
Has full complement of LR collisions in IP8**

**Any coherent excitation on 1 beam couples
to the other beam**

Instability propagates to colliding pairs

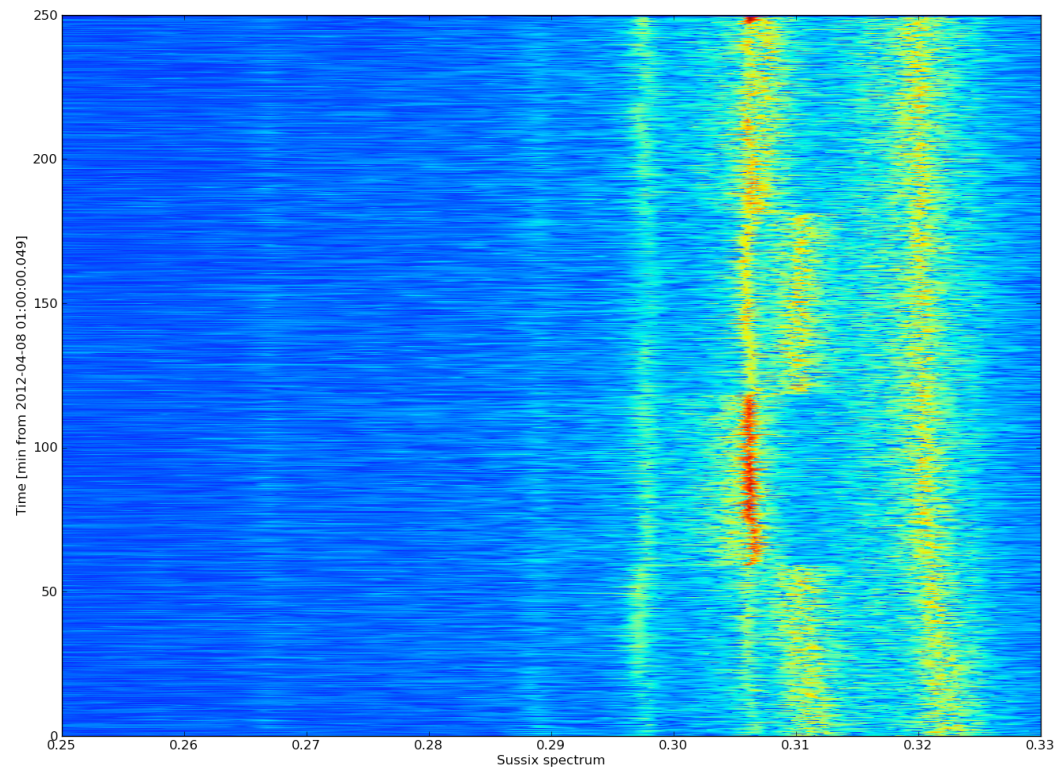


Beam-beam couples the effect to many more bunches

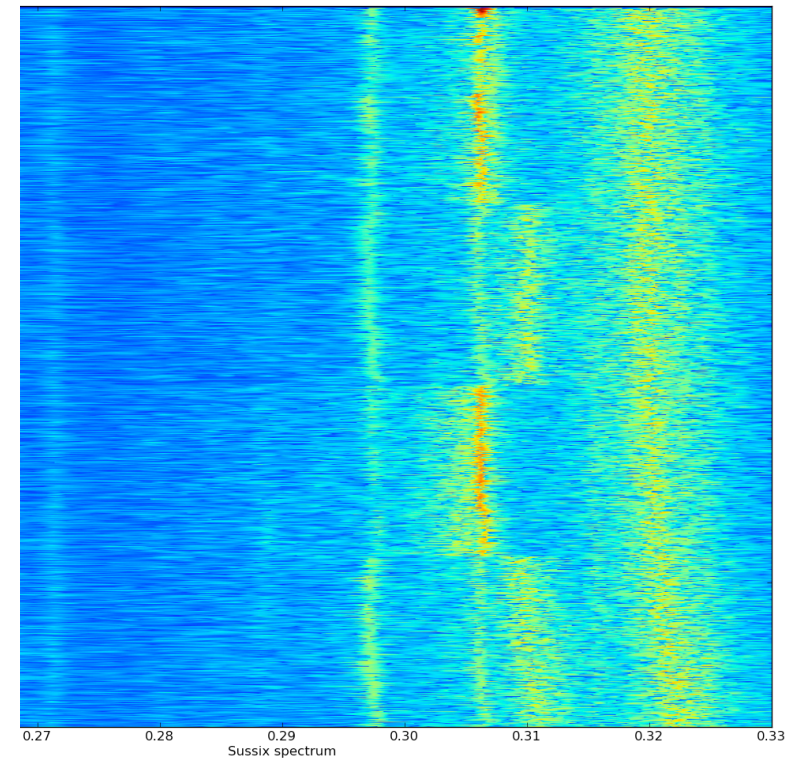
Still investigating the source of transverse excitation

Tunes Fill 2488 B1

B1 V



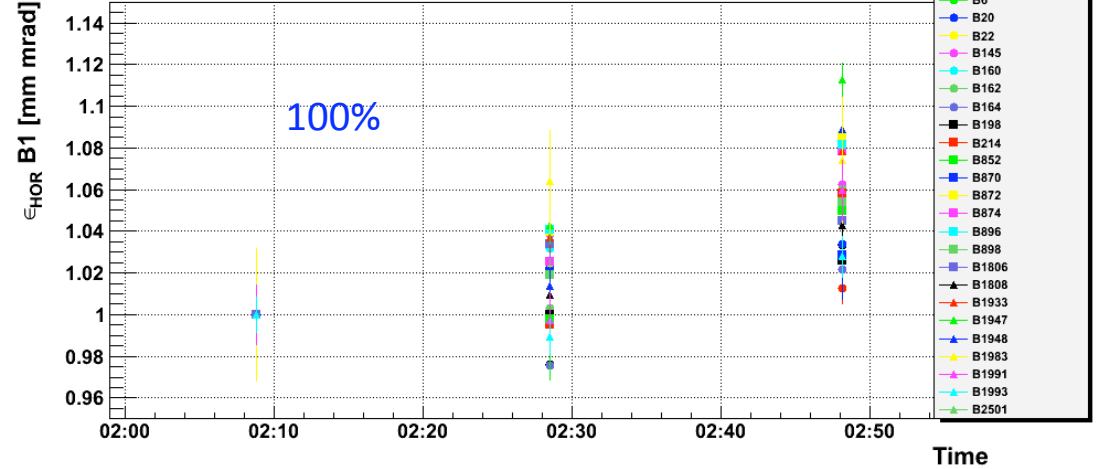
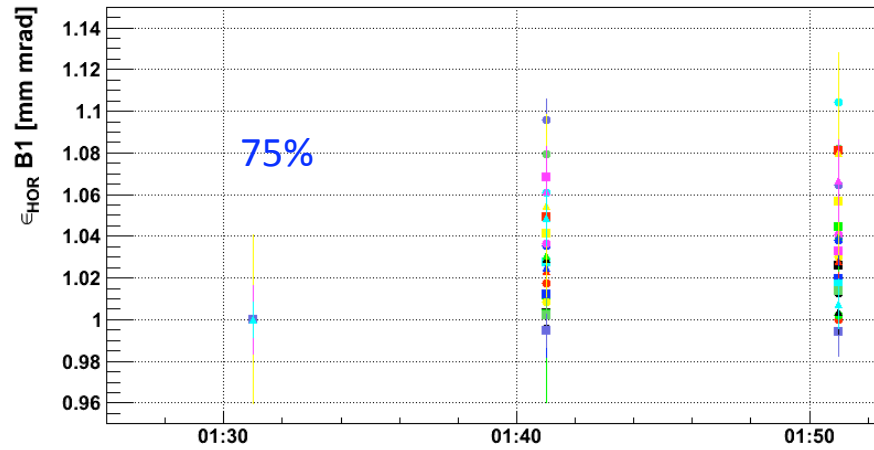
B2 V



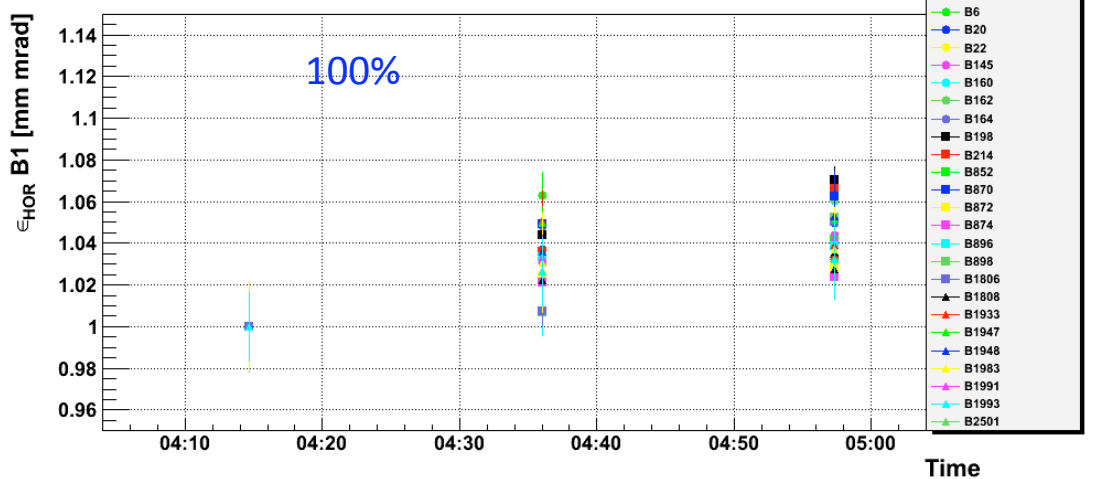
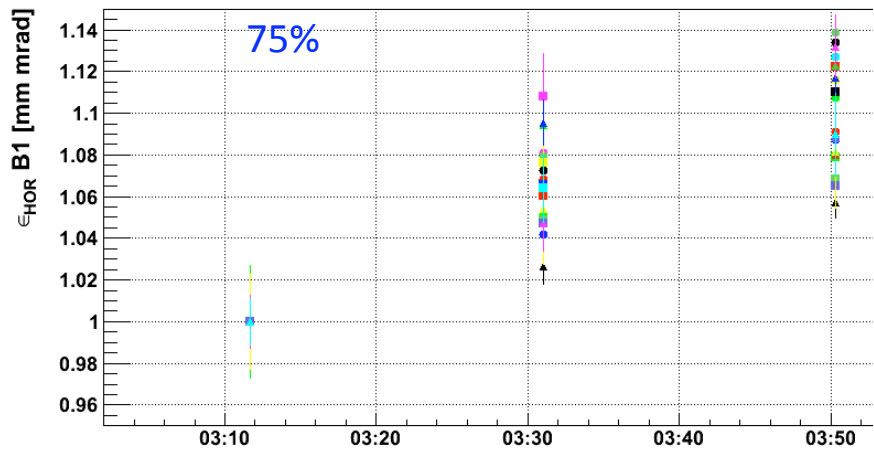
**Clear evidence of beam-beam tune shifts during the leveling test
but still analysis needed**

Bunch by bunch Emittances B1 Hor

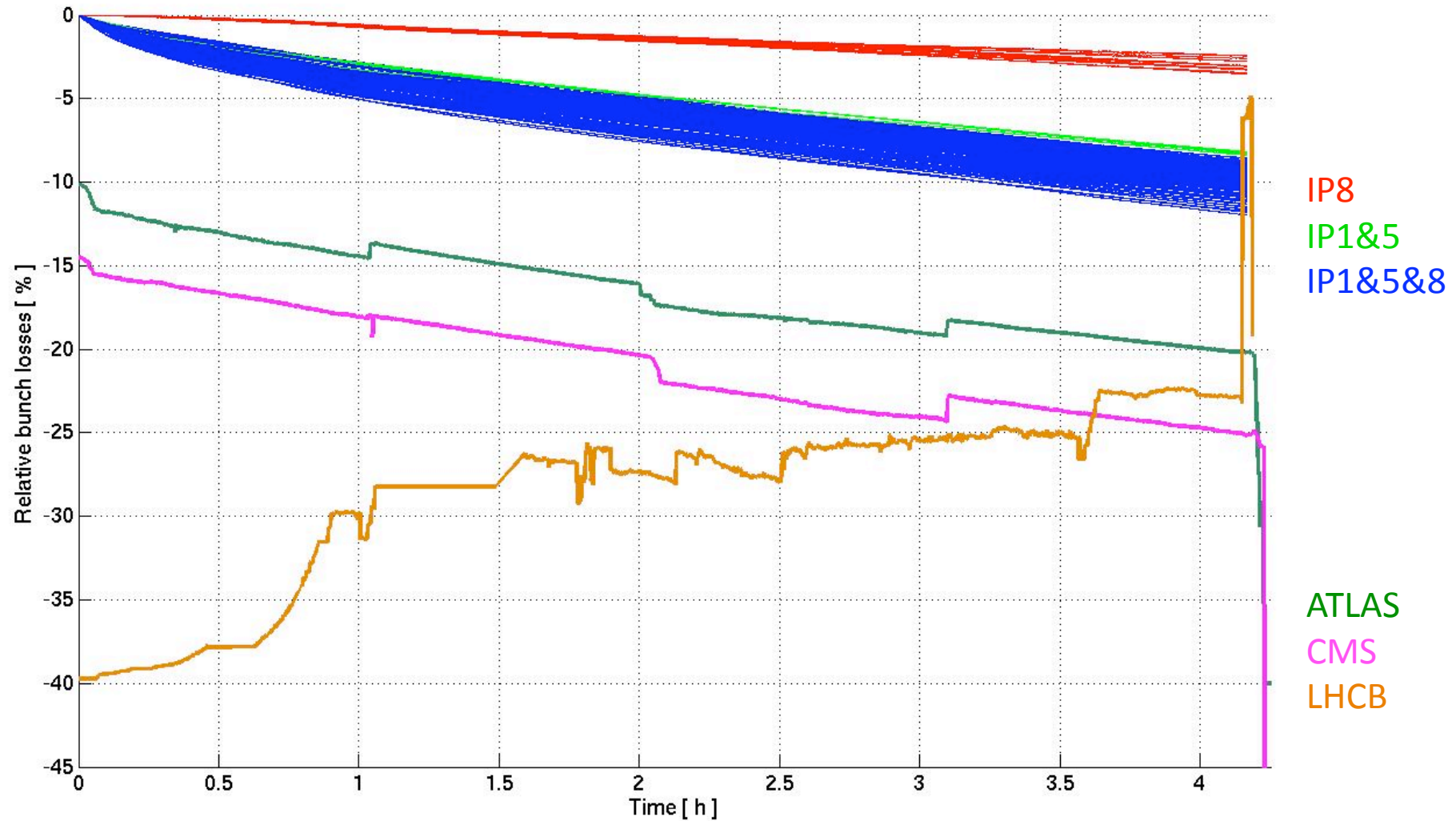
Fill 2488



No significant effects due to offset at IPs
Detailed analysis still on-going to relate to bunch collision schedule

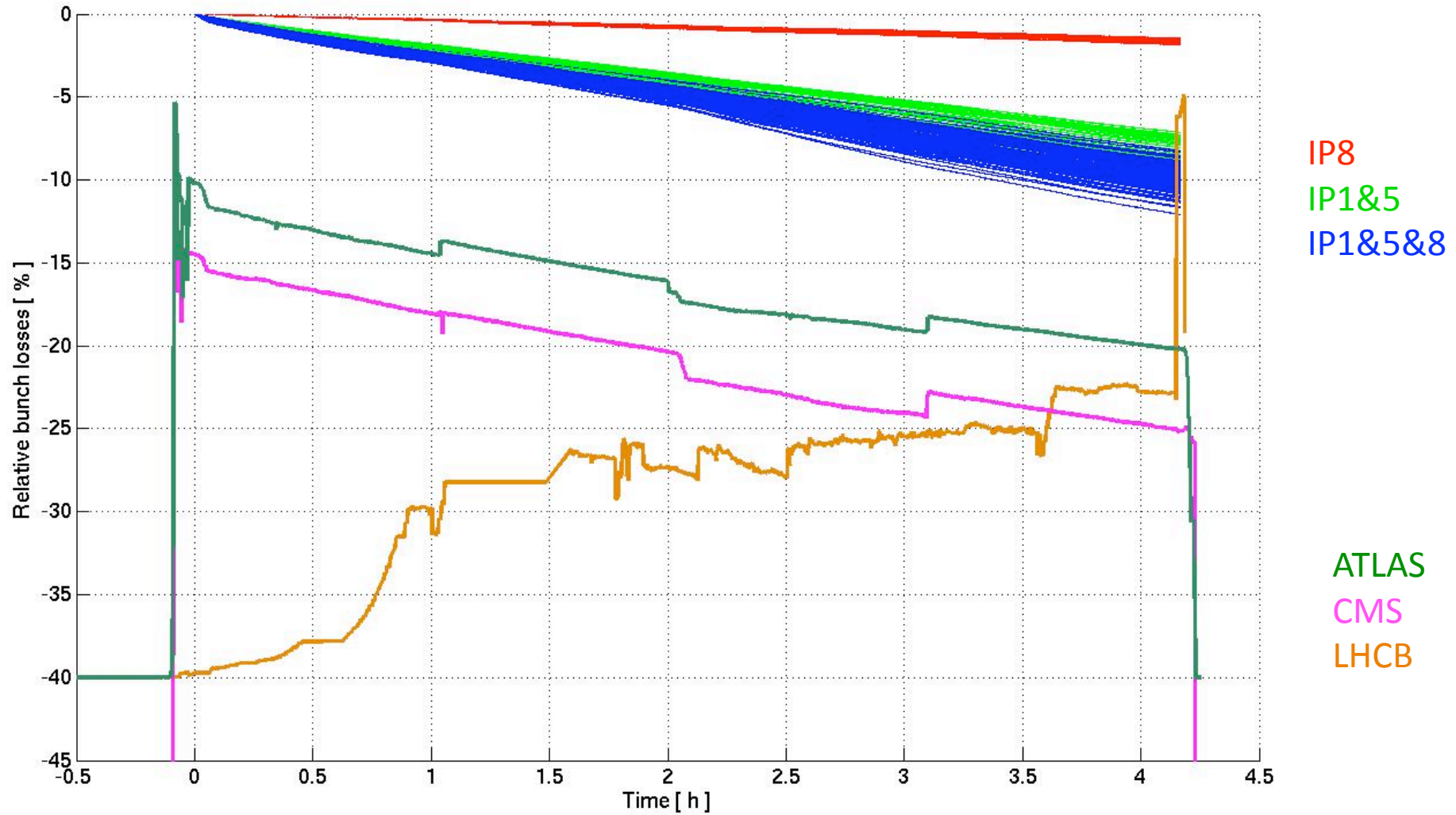


Bunch by Bunch losses Fill 2489 B1



Beam 1 during 95% luminosity test is stable and no visible differences in lifetimes

Bunch by Bunch losses Fill 2489 B2

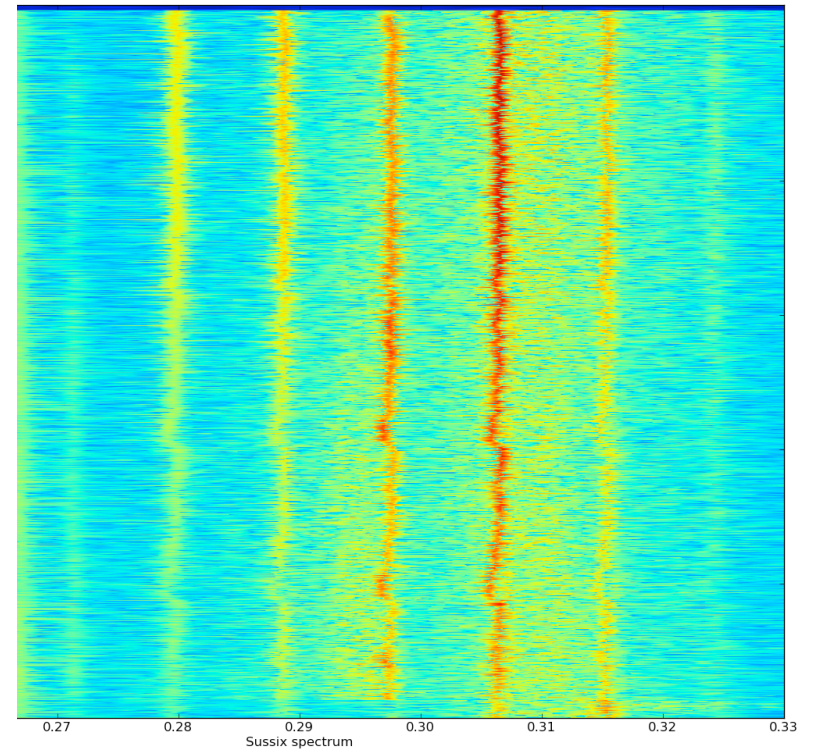
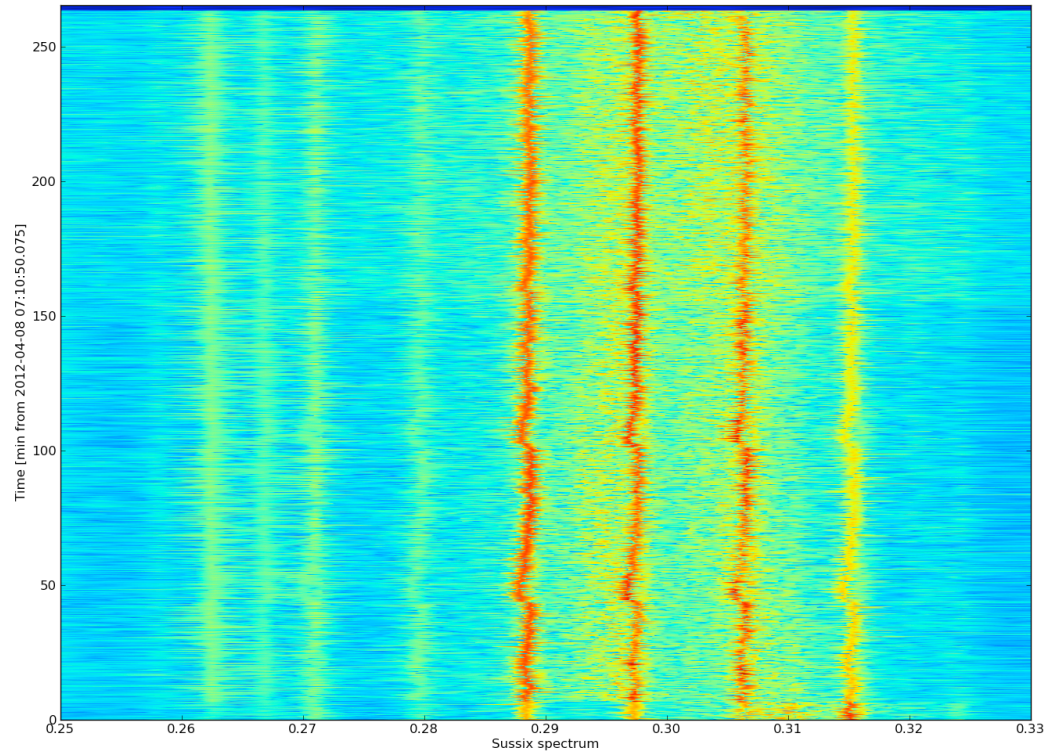


Beam 2 during 95% luminosity test stable and no visible differences in lifetimes

Tunes Fill 2489

B1 H

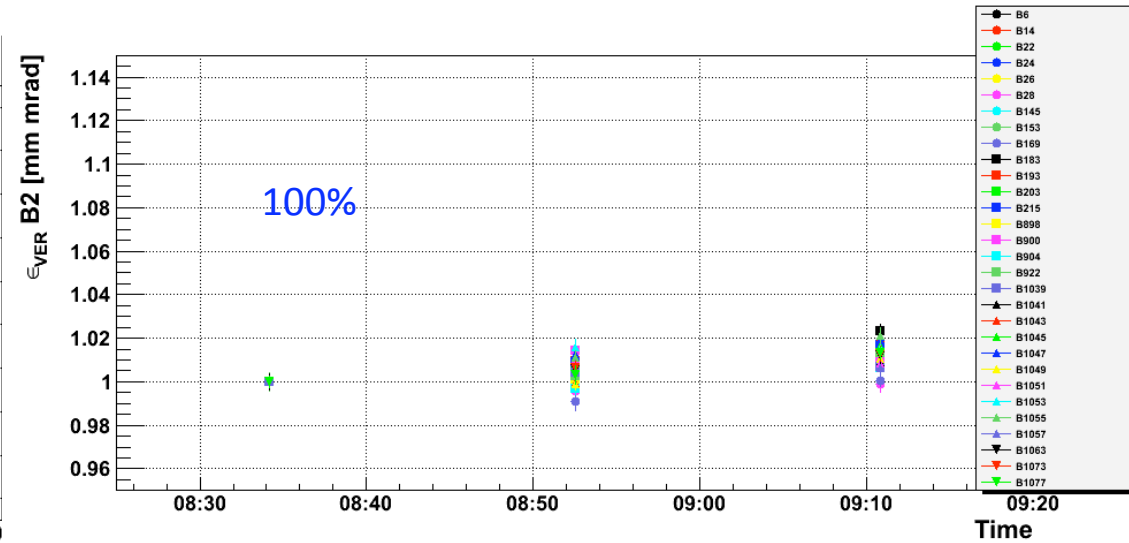
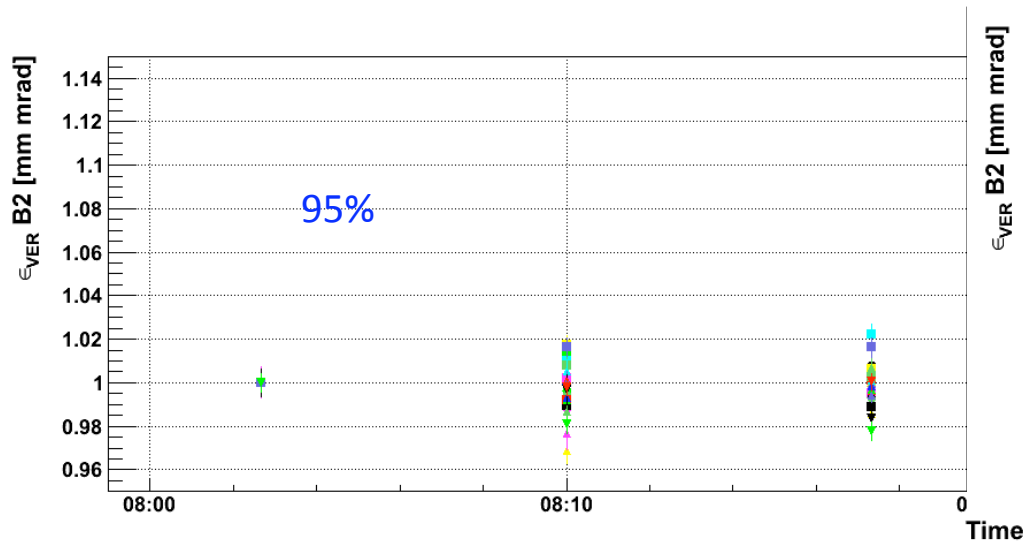
B2 H



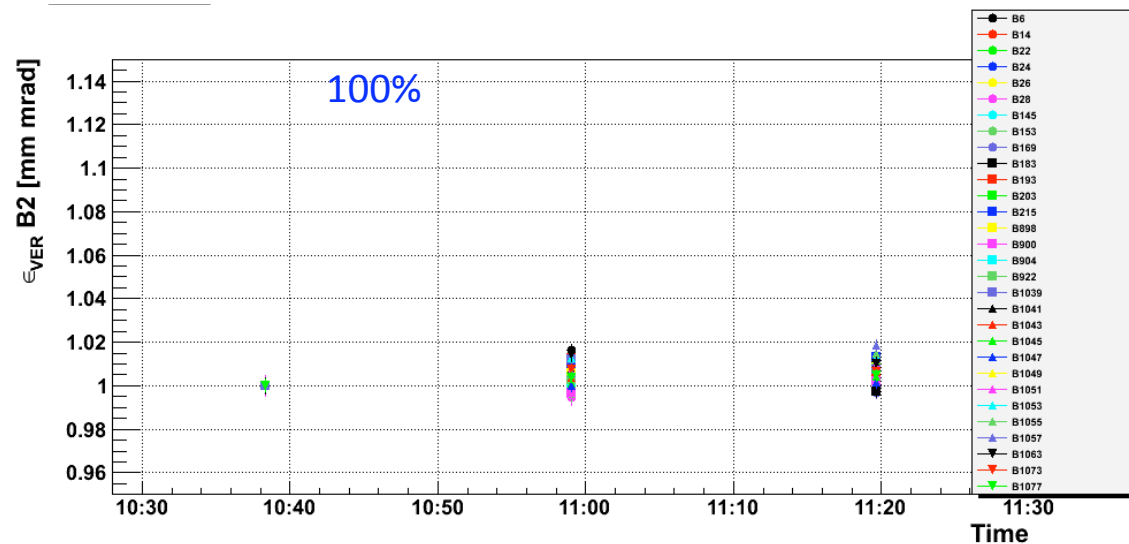
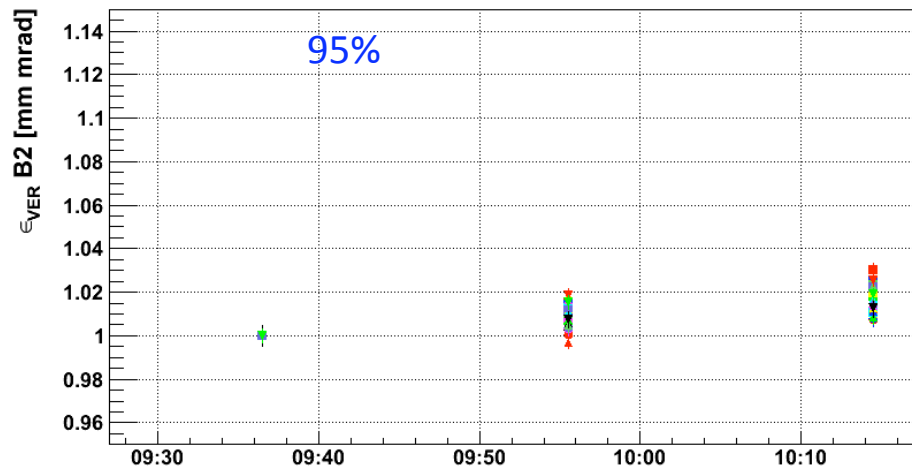
95% leveling almost zero effect on tunes but still data to be analyzed

Bunch by bunch Emittances B2 VER

Fill 2489



No significant effect related to leveling
Detailed analysis still on-going to relate to bunch collision schedule



Summary

- Successful test with static offsets with 75% and 95% luminosity
- No visible problems from beam-beam for the test configuration (emittances, lifetimes)
- **Any movement of one beam (leveling) is transferred to the colliding bunches**
- Detailed analysis on-going and some observations still to be understood

Some cures?

- ADT ? B1H at half gain during Fill 2488.
- Alternative leveling with β^* and constant crossing angles for a transparent head-on beam-beam collision (MD request with High Priority for 2011 and 2012)