Coherent Effects at injection

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10/08/17

Introduction

- We have observed strong noise lines in both the BBQ and the ADTObsBox data for the data acquired in fill 5885 & 6054. (To be expanded to check all fills).
- Shown are detailed plots for fill 6054, with summary of quick checks for fill 5885 shown below.
- If noise lines are present in the beam spectrum, then the ADT will act on it which could lead to slow emittance growth.

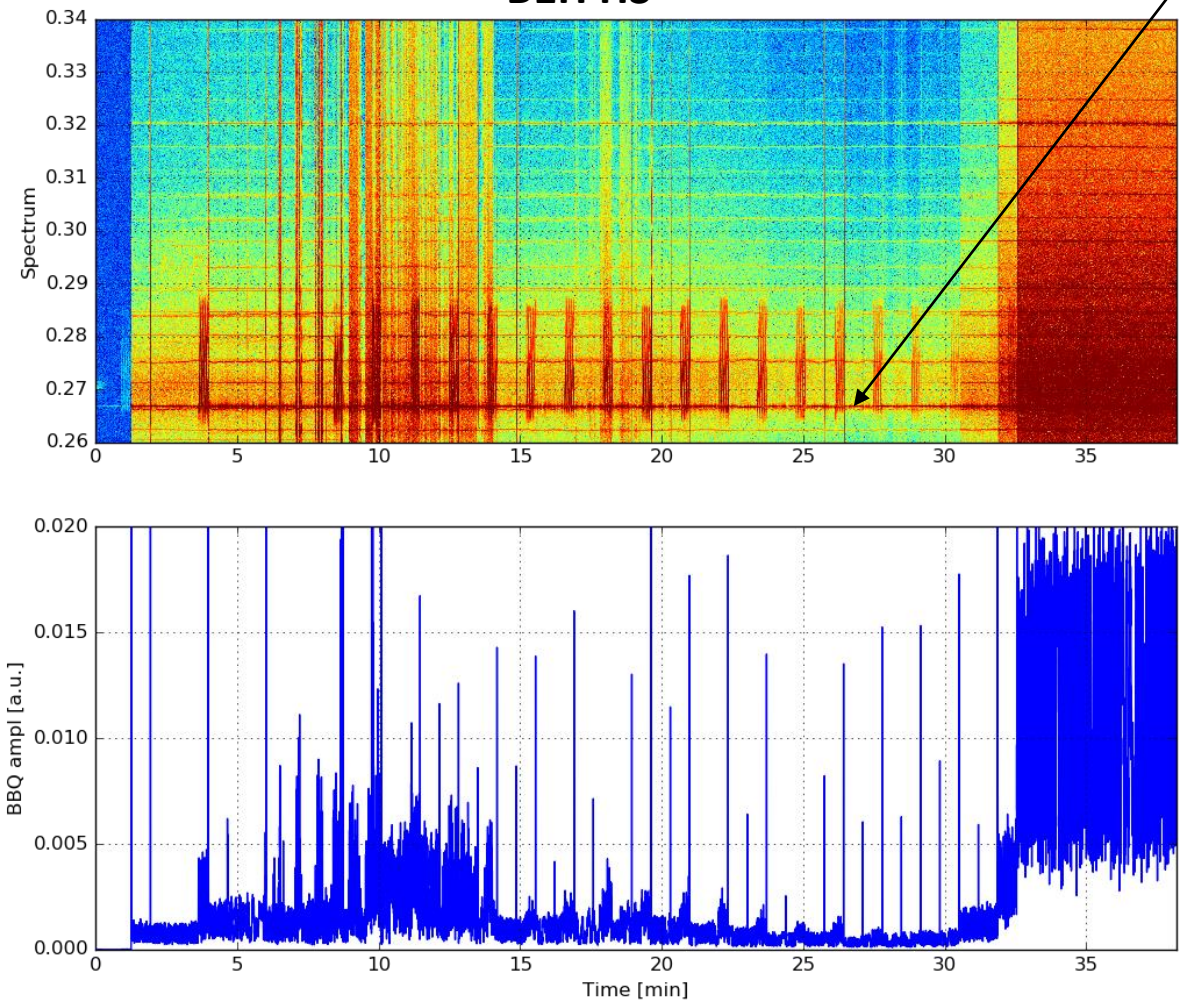
- For fill 6054:
  - strong noise lines seen in B1H (0.267) and B2H (0.271) both in ADTObsBox and BBQ
  - strong noise lines seen in B2V (0.2971) in ADTObsBox that is not seen in the BBQ. Smaller peak seen in B2V (0.2837) that is found in both BBQ and ADTObsBox.
  - Consistent line seen in B1V (0.2837) but not the strongest list from the BBQ. No other lines seen in ADTObsBox.

- For fill 5885:
  - Horizontal noise lines behave as before but this time B1H and B2H are both at 0.267 and seen in both beams.
  - The strong noise line seen in V is now at 0.2983 in both B1V and B2V which is not one of the suspected 50Hz noise lines and is shifted compared to fill 6054. Not seen in BBQ.

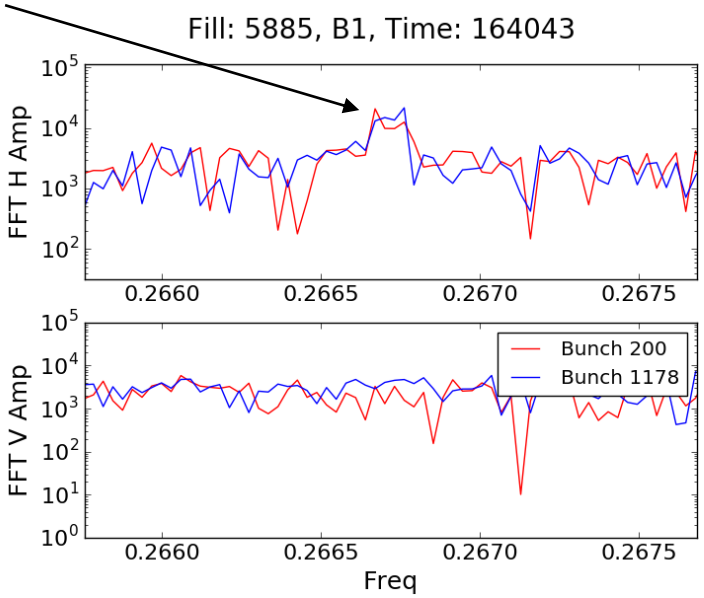
BBQ for fill 6054

Frequency of ~0.267

B1H HS

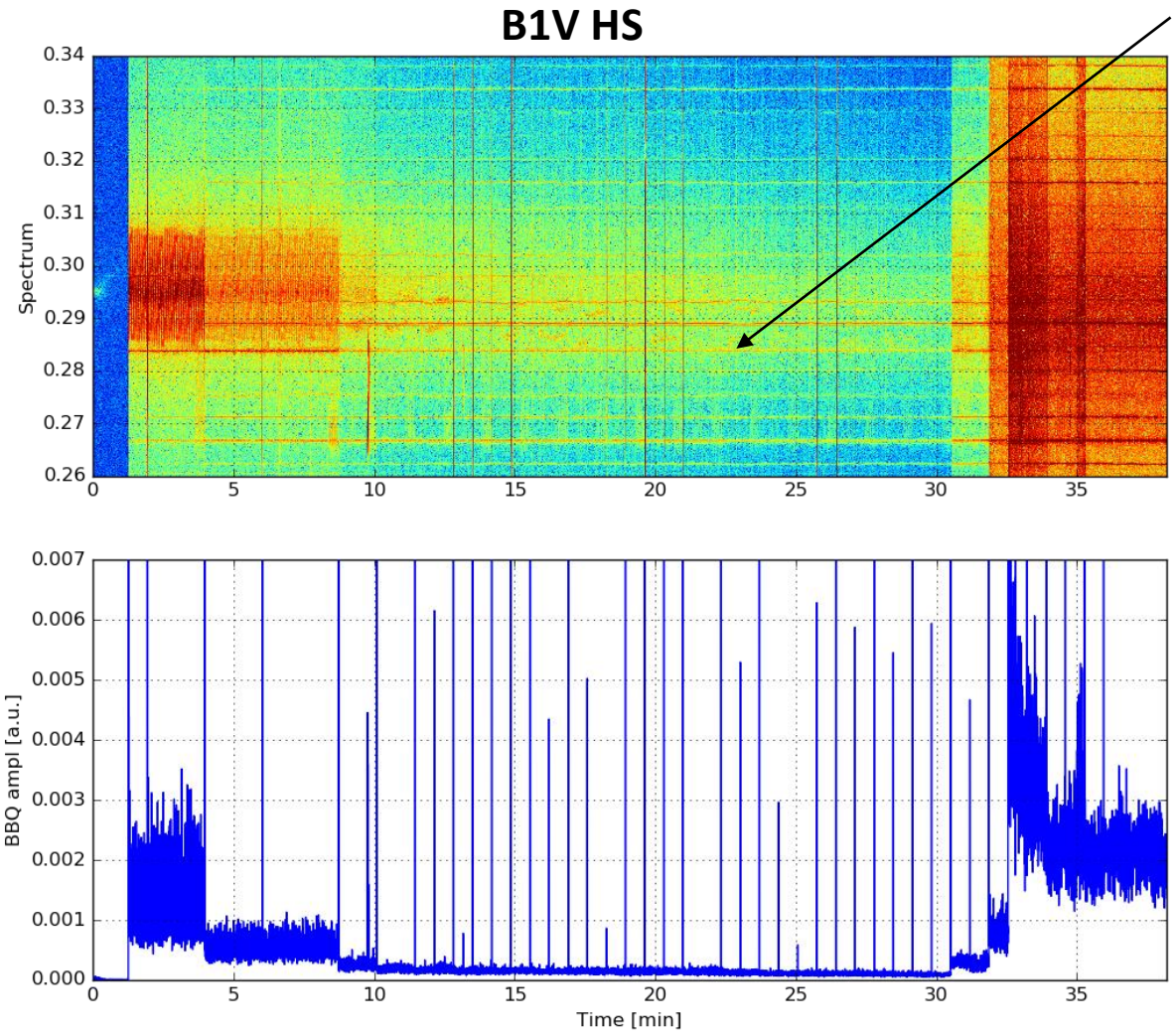


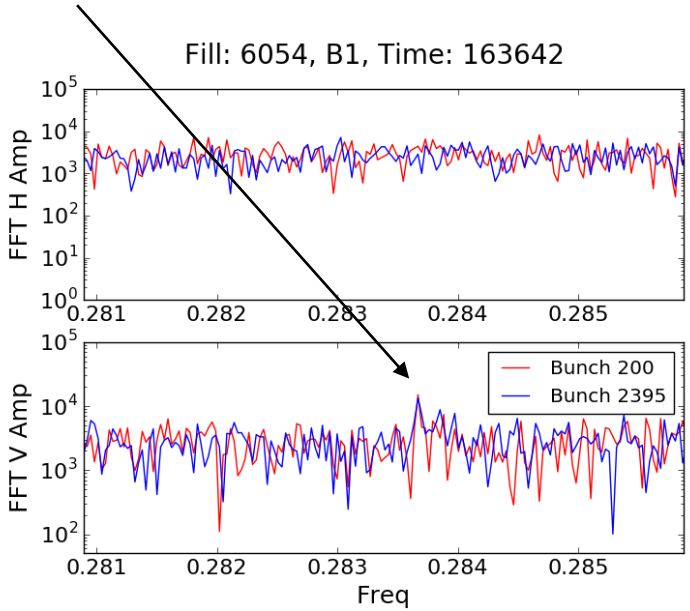
ADTObsBox Inj32k



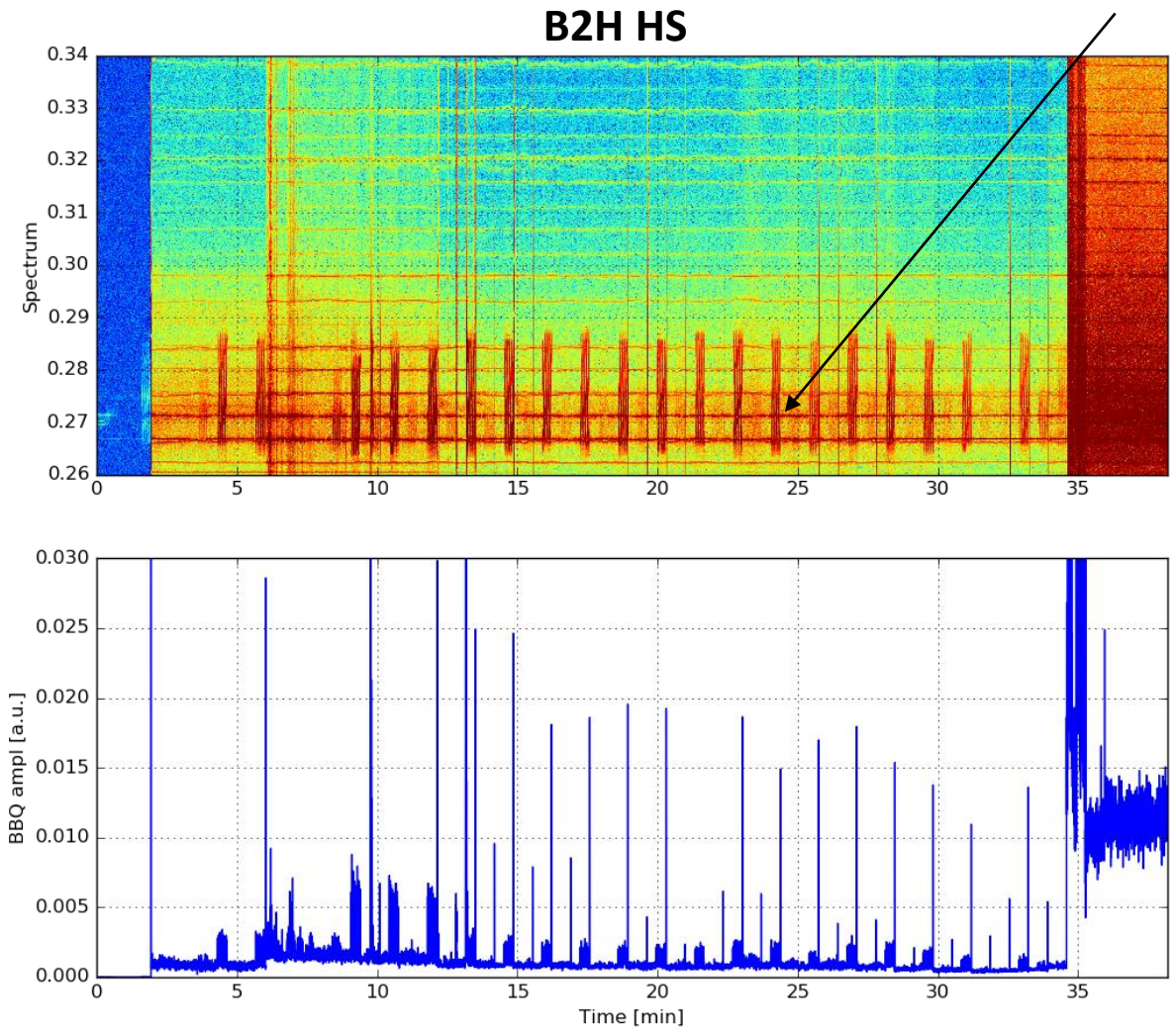
- An ADTObsBox acquisition was taken with the 32k turn buffer to see how many bunches contained this noise line.
- For one example, out of a total of 1980 circulating bunches (including the newly injected), 1529 bunches had their peak amplitude coming from a frequency within 1e-3 of this noise line.
- When accounting for the 2*96b that were affected from the injection oscillation, this 1529/1788 i.e. most bunches.

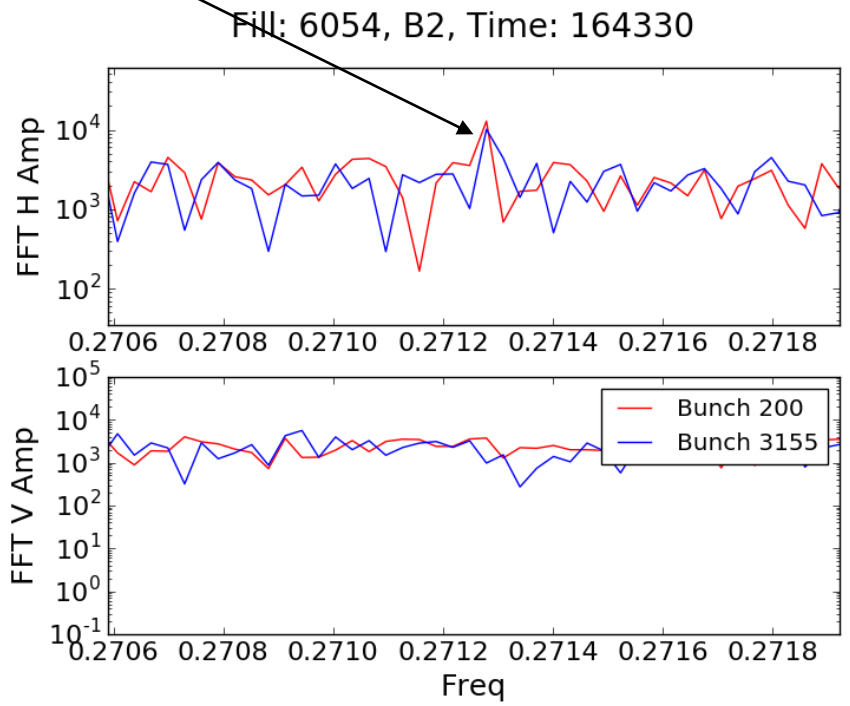
Frequency of ~0.2837





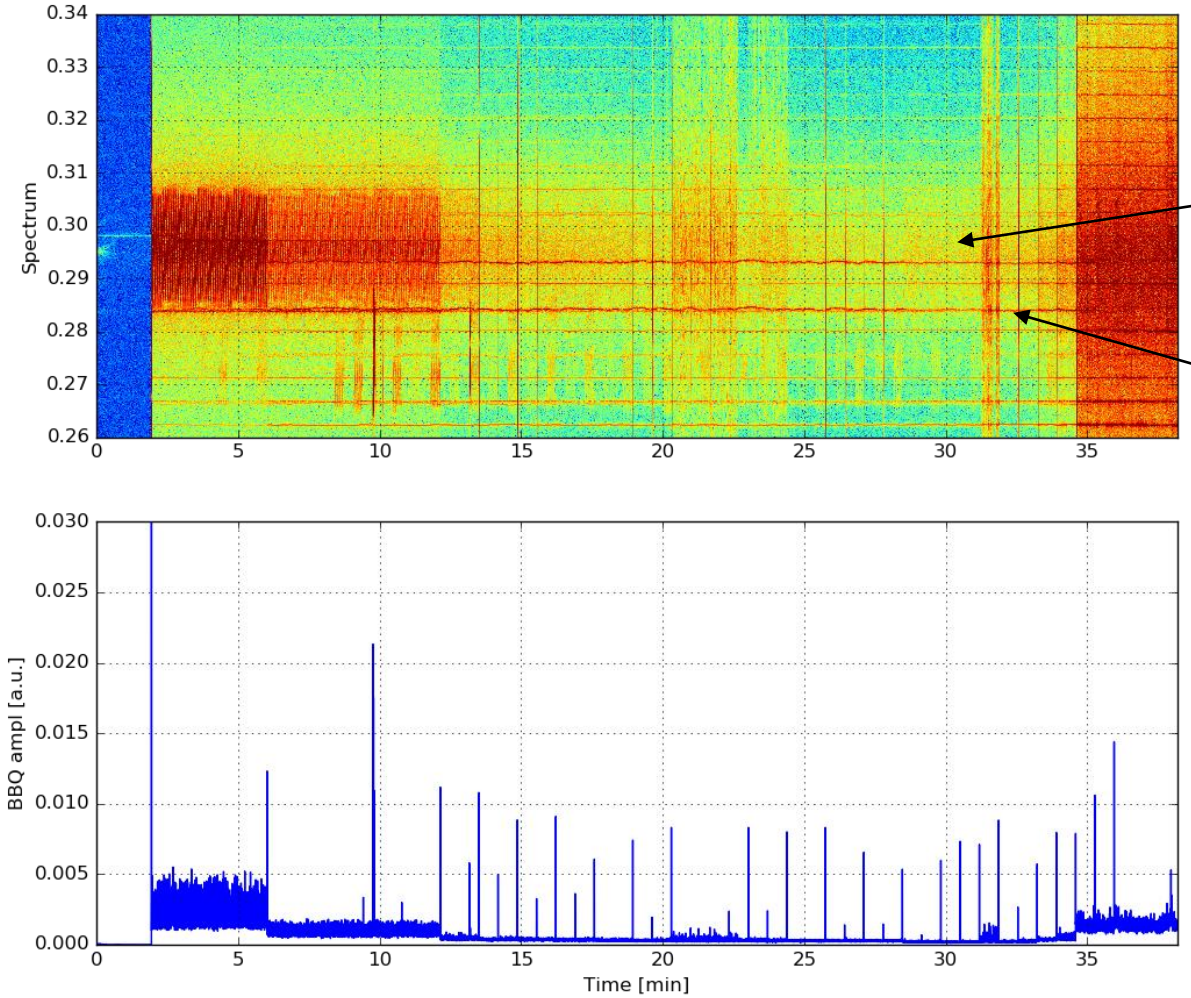
Frequency of ~0.271





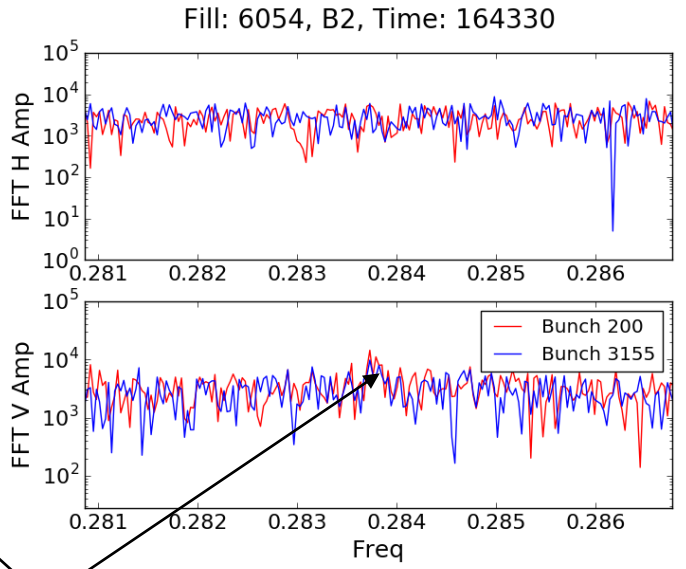
- Several noise lines are strong in the BBQ, but only the peak at 0.2712 is seen in the ADTObsBox.

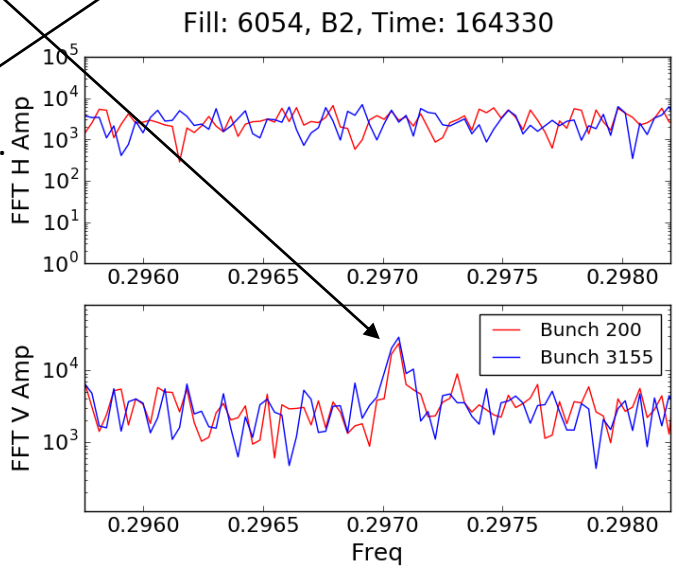
B2V HS



Frequency of 0.2971. Very large but not seen in BBQ

Frequency of 0.2837. Small but seen in ADTObsBox



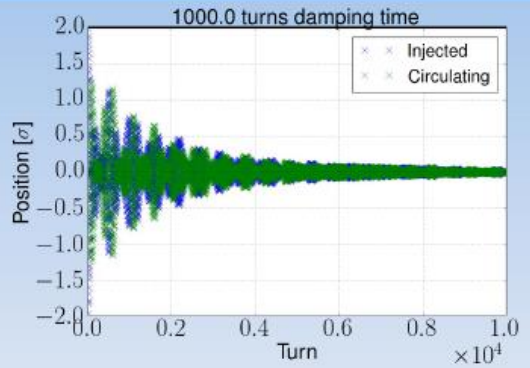


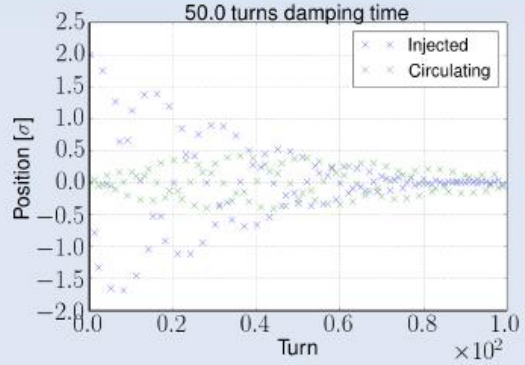
ALL bunches in B2V had its strongest peak at 0.2971.±1e-3. This peak not seen in BBQ.

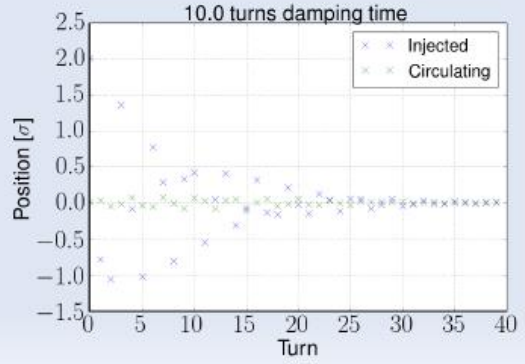
Proposal

- There are clear noise lines seen in the ADTObsBox that are also seen in the BBQ.
- The ADT will try kick at this frequency which could cause emittance blowup.
- Moving the tunes around may help, increasing H by 5e-3 (from 0.27 to 0.275) could make a difference.
- This would reduce the tune separation but with Laslett shift correction and good coupling correction there are unlikely to be coupling related issues (as seen in the past).
- More analysis is needed to make a recommendation for V.

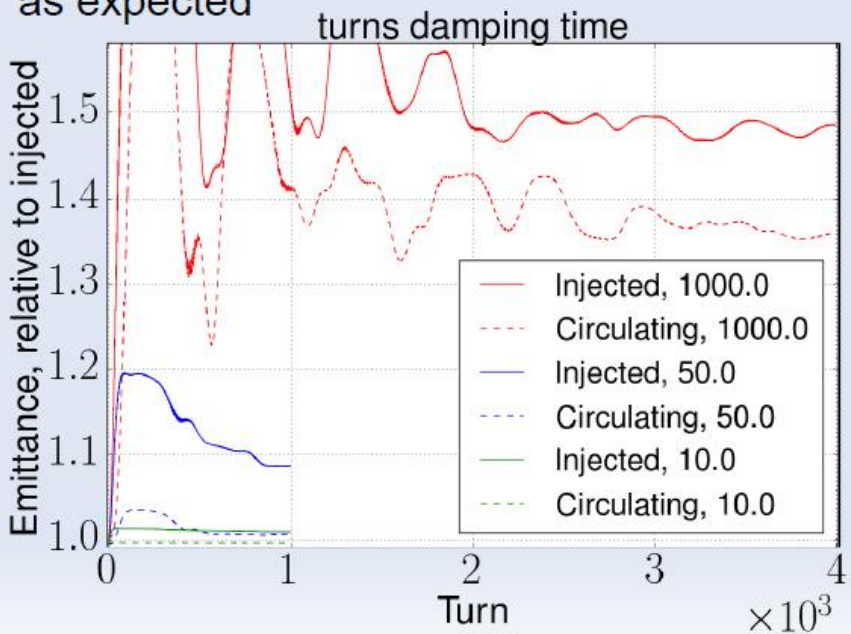
Transmission of oscillations







- COMBI model, including all long-range interactions in one IP at a normalised separation of 15 σ (slightly pessimistic), Q'=15, Ioct = 34 A and the ADT with different gains
- The transmission of the oscillations to the other beam is :
  - Total for low gain (~1000 turns)
  - Partial for intermediate gain (~50 turns)
  - Negligible for operational gain (~10 turns)
- The emittance growth due to decoherence follows the same trend, as expected



- For operational gain, the emittance growth is ~1% for the injected beam and <0.1% for the circulating (Assuming a 2 σ injection offset)

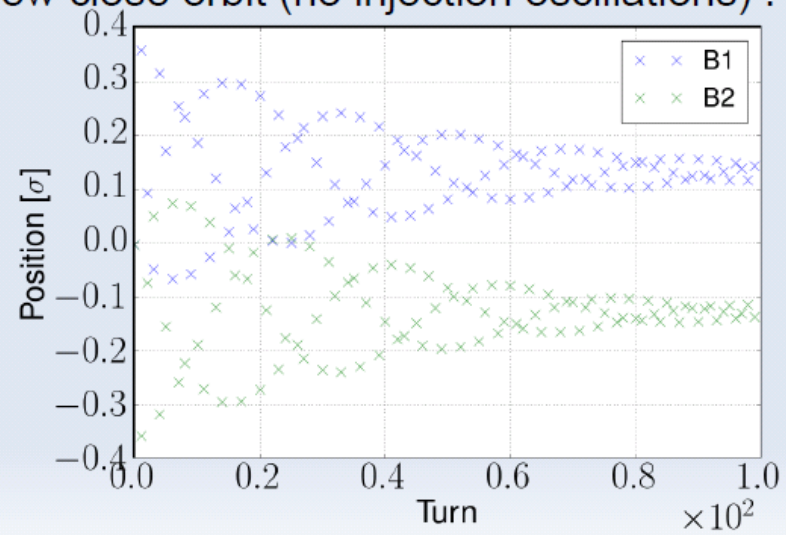
Orbit effect at injection

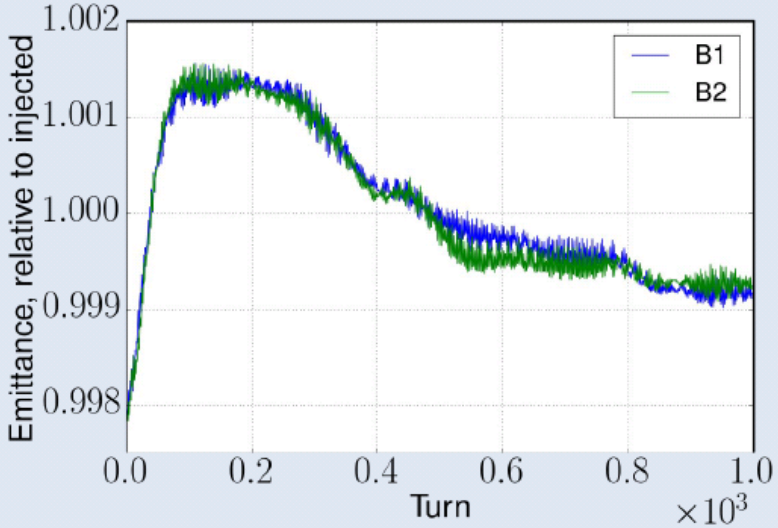
- The normalised separation between the beams at injection is about 18 σ both for the parasitic encounters and the one at the IP (i.e. the *separated head-on* interaction)
- The maximum orbit effect at injection is about 0.2 σ in each plane due to IPs 1 and 5 (nominal bunches)

  → The rematching of the orbit of the other beam results in a 0.4 σ oscillation, damped by the ADT

  - The orbit effect is inversely proportional to the normalised separation at the interactions (Need a very large crossing angle to fully suppress the effect)
  - It is present even in absence of injection oscillation (i.e. injection perfectly on close orbit)

Oscillations due to rematching around the new close orbit (no injection oscillations) :





Negligible impact on the emittance, even with intermediated gain (50 turns)

Effect of MKI