Headtail measurements from SPS 2018 data & perspectives regarding HL-LHC resolutions

Aaron Farricker

University of Liverpool & Cockroft Institute
Introduction

• Study is in the framework of CC noise induced emittance growth reduction (cf. P. Baudrenghien https://indico.cern.ch/event/1013753/)

• The theoretical prediction for emittance growth in the HL—LHC due to RF noise is estimated to be 5.3% which is more than the 2% budget allowed

• One method to reduce this is feedback and to do this the excess tilt needs to be measured

• Here I quickly revisit some of the CC measurements in the SPS looking at the limitations of the HT monitor
The Head Tail Monitor

- The Headtail monitor is a stripline monitor used to look at intra bunch motion
- It is wideband with a bandwidth of approximately 2 GHz
- The difference signal shows an image of transverse displacement of slices of the bunch
- The main questions here are can the HTtype monitor see the motion due to the CC noise & can we do a frequency domain analysis of this

Figure 2: A mode $|m| = 4$ instability, captured by the headtail monitor, before and after the baseline removal.

T. Levens et al.
Revisiting the SPS CC MDs

- In the first CC MD in the SPS on 23/05/2018 crabbing was successfully shown
- The HT monitor was used to reconstruct the transverse phase space
- In the third Plot the offset of the head and tail of the bunch in the vertical and in opposite directions is clear
- Zooming in on a few turns throughout the cycle we can see offset of around 250-300 um

- With offsets this large an FFT can be taken and there is a sign it correlates with the tilt. Checks of this are still ongoing
In 2018 MDs looking at the impact of noise were carried out. It was clearly shown that by injecting noise the emittance of the beam increased significantly over time. So what I have done is revisited some of the HT data that is available from these MDs. If we are able to see the excess tilt in this case there is at least some mileage in investigating further.

L.Carver et al. https://indico.cern.ch/event/800428/
CC noise induced emittance growth MD

• The data at first glance is nowhere near as clear as when the beam is just crabbed
• It also looks a lot more noisy
• However zooming in on the bunch image we can see the excess tilt
• In terms of the previous plot this MD was the middle of the three regimes

• This suggests that the HT monitor may be able to see the impact of the noise
• To look further we need to know the expected bunch tilts at the proposed location of the CC monitors
CC noise induced emittance growth MD

• Looking at the delta/sigma the trace is noisy
• The clearest indicator of the tilt from here appears to be the slope of the signal
• We can access this through the phase of the voltage
• Looking at the possibility of seeing this in the frequency domain is ongoing
Summary

• The headtail monitor in the SPS is able to see the impact of noise on the beam
• The signal strength is relatively small but clearly visible
• More detailed studies with the location and size of the tilts expected in the LHC are needed to see if it is possible to use the signals for feedback in the HL—LHC