LHC MD2722: Investigation of Landau damping by means of BTF measurements

Op crew on shift and injectors

LSWG 18/01/2018
• 1st Fill: several scans (excitation length, excitation amplitude, exc. delay) on both beams and planes
• 2nd Fill: BTF measurements on B2 (1 bunch ~ 9E10 p/bunch) reached end of squeeze (instability observed without transverse feedback)
• 3rd Fill: BTF measurements on both beams (single bunch per beam) at injection
1st Fill: BTF set-up and scans

**GOAL**: find an optimal setup of the BTF system to better reconstruct Stability Diagram and improve signal to noise ratio
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- For each set-up we acquired several measurements in the same configurations
- The average and the RMS of the different BTF acquisitions are computed
Set-up scans: excitation amplitude

- Excitation amplitude scan with fixed bandwidth (5) and no excitation delay
- Increasing the excitation amplitude helps to improve signal however if too high it can induce emittance blow-up
• No emittance blow-up observed while increasing the bandwidth (acquisition length per frequency step)

• The noise increases both in the amplitude and phase response while increasing the acquisition length (opposite w.r.t expectations!)
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Set-up scans: acquisition length scan
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Increasing the delay between excitations helps to improve signal the trend is the same
Reconstructed Stability Diagram

- Improvement in the reconstruction of the SD averaging the amplitude and phase signal (B1 H, bandwidth 10 no exc. delay)
- Tune spread from the fitting function ~ a factor 2 w.r.t. the expectations (10 A, injection)
Instability at injection

- Instability observed in B1 H during BTF excitation (ampl: 0.01)
- Instability is probably due to the drift of the chromaticity that was below -6/6 units on B1 and -4/5 on B2
2nd Fill: Instability at Flat top

Could not recover good quality signal on B1V BTF. Tried to correct coupling automatically and manually. Tried increasing the vertical tune, without success:

- We injected a train of 48 nominal bunches in B1
- BTF measurements performed on B2 (single bunch of 0.9E10 p/bunch, emittance: 1.8μm)

Instability B2 H after BTF excitation (despite low amplitude ~0.005 a.u.). We increased the octupole current to maximum despite this beam 2 got unstable without damper (close to stability limit?)
Second part of the MD: end of squeeze

Due to instability at flat top we decided to reach end of the betatron squeeze to profit of long range tune spread to increase stability → Despite the increase of octupole current to ~510 A and (for a Q’ of 10 units and 5 units) the instability was still present without ADT.

Beam was unstable at the end of the betatron squeeze without transverse damper even with smaller crossing angle (larger tune spread from bb long range interactions)
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Second peak appears in the horizontal plane
3rd Fill: octupole scan at injection
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B2 Horizontal

Evaluated measured tune spread by fitting function w.r.t. to expectations:

Factor 2 in the measured tune spread w.r.t. expectations for a current of 3.5 A, factor 1.2 for a current of 20 A
Summary

First part at injection energy:

- Several scans performed to set-up the BTF measurements: increasing the acquisition length (bandwidth) the noise increases: → to be further investigated (look at the ADT data if there is any oscillation intra-bunch)
- Five measurements were acquired for each scan to average the BTF signal: → improvement in the SD reconstruction
- Beam instabilities were observed: the first one in B1 H (mode 0) and the second one on B2 H and V (mode 1) probably due to negative chromaticity (-6 units) resulted from the decay at injection energy.

Second part at flat top energy:

- We injected a train of 48 bunches in B1 and one single bunch in B2. At flat top after the excitation of B2 with an amplitude of 0.005 an instability was observed. Despite the increase of octupole current to ~510 A and (chromaticity sets to 5 units and 10 units) the instability was still present without transverse damper → close to stability limit?
- Reduction of the crossing angle to increase the tune spread coming from the long range interactions (2 steps: 290 and 280 μrad) to cure instability → without transverse damper B2 got unstable despite the maximum octupole strength and high chromaticity

Third part at injection recover earlier settings:

- Octupole scan at injection: factor 2 in the measured tune spread w.r.t. expectations for a current of 3.5 A, factor 1.2 for a current of 20 A
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Propositions for Next MDs

- Investigate the intensity dependency (impact of the impedance on BTF when close to stability thresholds) MD in asymmetric configuration: trains in one beam and single bunches in the other beam with different intensities (GATED BTF system needed, to be prepared with ADT team)
- AC dipoles + BTF measurements with and without colliding beams